Free Energy From Air Circuit

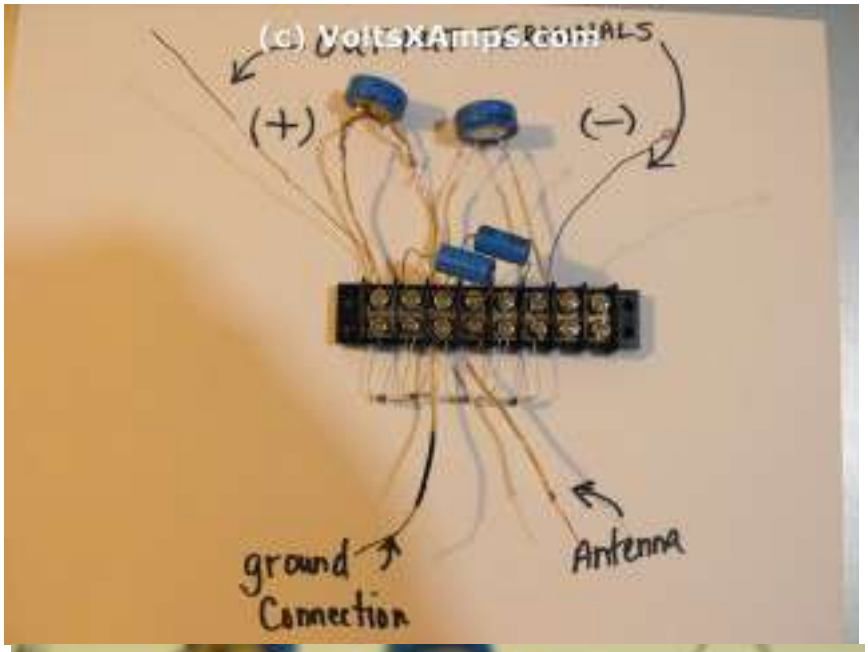

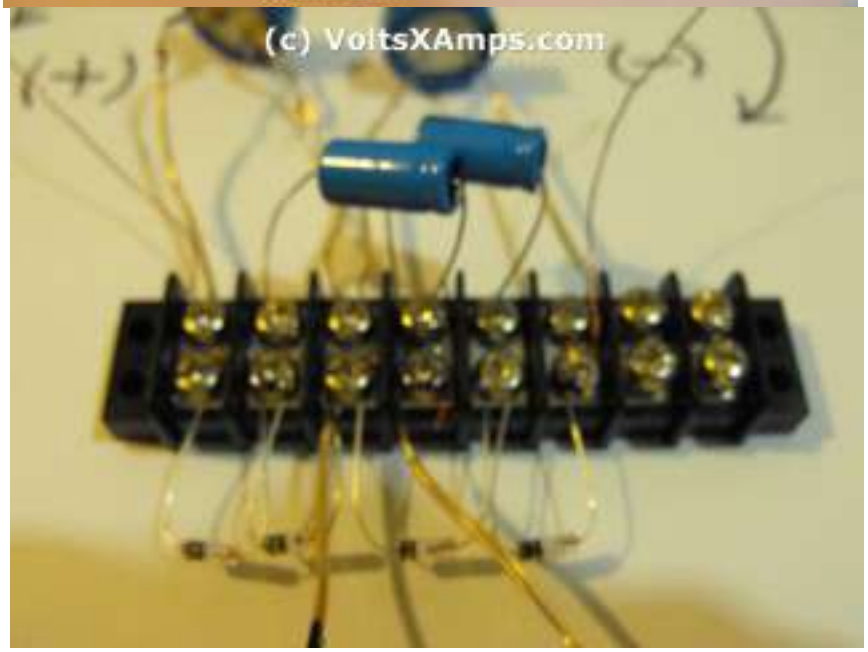

Last year I found a United States Patent that showed how to collect ambient energy right from the air. I finally decided to build this curcuit just to see what it could do.

[protected]

The above images are from the circuit I built. Most of the text and info comes direct from the US4628299filed by Joseph Tate.
US4628299

The Amazing Ambient Power Module

Parts List for the APM-2

Four 1N34 germanium diodes (Radio shack #276-1123) ~ Figure 1, X1, X2, X3, & X4
Two 0.2 mfd 50 V ceramic capacitors ~ Figure 1, C1 & C2
Two 100 mfd 50V electrolytic capacitors (Radio Shack #272-1016) ~ Figure 1, C3 & C4
Copper wire for antenna & ground connections

Introduction

The Ambient Power Module (APM) is a simple electronic circuit which, when connected to antenna and earth ground, will deliver low voltage up to several milliwatts. The amount of voltage and power will be determined by local radio noise levels and antenna dimensions

Generally a long wire antenna about 100' long and elevated in a horizontal position about 30' above ground works best. A longer antenna may be required in some locations. Any type copper wire, insulated or not, may be used for the antenna. More details about the antenna and ground will be discussed further on.

The actual circuit consists of two oppositely polarized voltage doublers (Figure 1). The DC output of each doubler is connected in series with the other to maximize voltage without using transformers. Single voltage doublers were often found in older TV sets for converting 120 VAC to 240 VDC. In the TV circuit the operating frequency is 60 Hz.

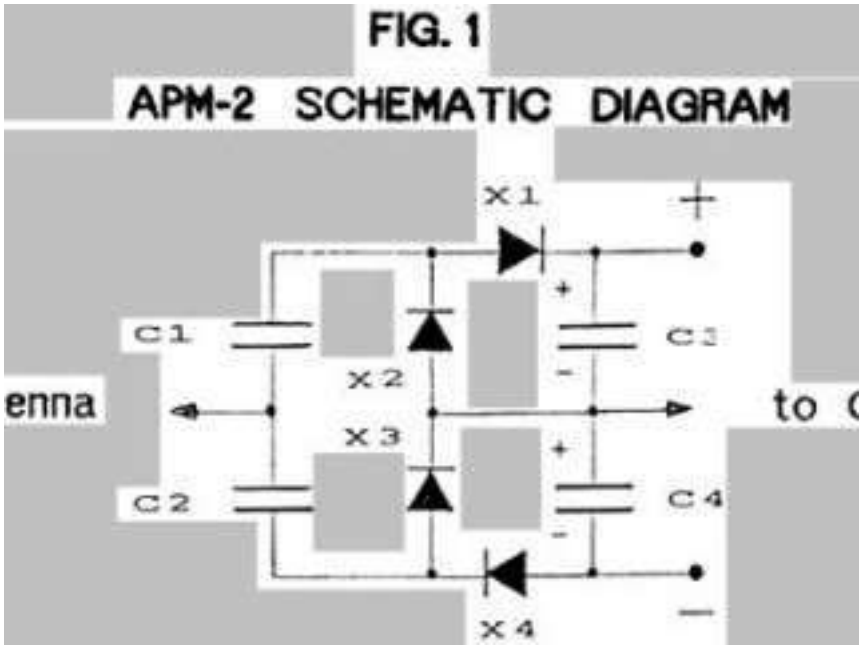

The APM operates at radio frequencies, receiving most of its power from below 1 MHz. The basic circuit may be combined with a variety of voltage regulation schemes, some of which are shown in Figure 2. Using the APM-2 to charge small NiCad batteries provides effective voltage regulation as well as convenient electrical storage. This is accomplished by connecting the APM-2 as shown in Figure 2B.

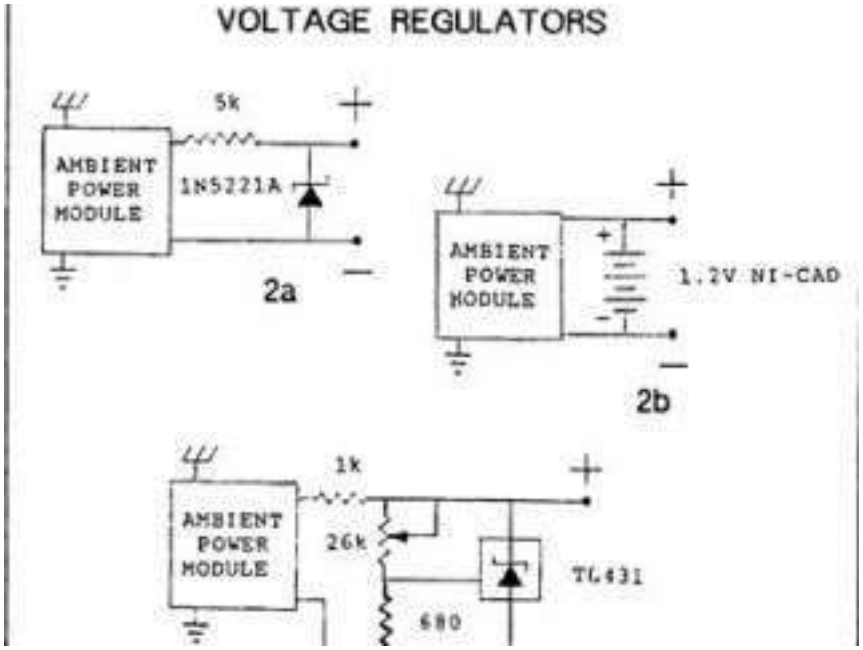

Charging lead acid batteries is not practical because their internal leakage is too high for the APM to keep up with. Similarly, this system will not provide enough power for incandescent lights except in areas of very high radio noise.

It can be used to power small electronic devices with CMOS circuitry, like clocks and calculators. Smoke alarms and low voltage LEDs also can be powered by the APM.

Figure 3 is a characteristic APM power curve measured using various loads from 0-19 kOhm. This unit was operating from a 100' horizontal wire about 25' high in Sausalito CA. As can be seen from the plot, power drops rapidly as the load resistance decrease from 2 kOhm. This means that low voltage, high impedance devices, like digital clocks, calculators and smoke alarms are the most likely applications for this power source. Some applications are shown in Figures 4 through 7.

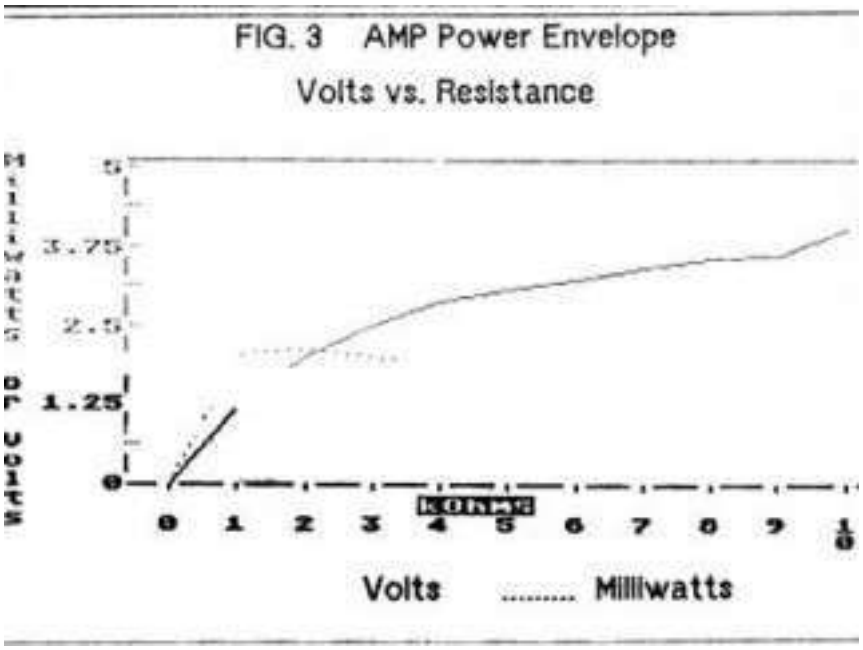

Figure 4 ~ A digital clock is shown powered by the APM-2. The 1.5 volt clock draws 28 microamps. Its position on the power envelope curve would be off the scale to the right and almost on the bottom line, dissipating only 42 microwatts.

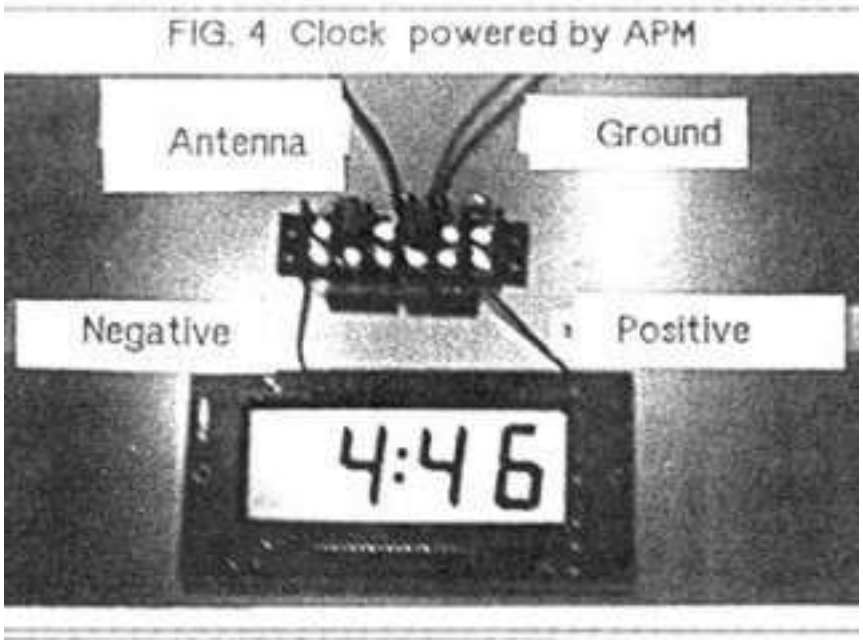

FIG. 5 APM charging a battery

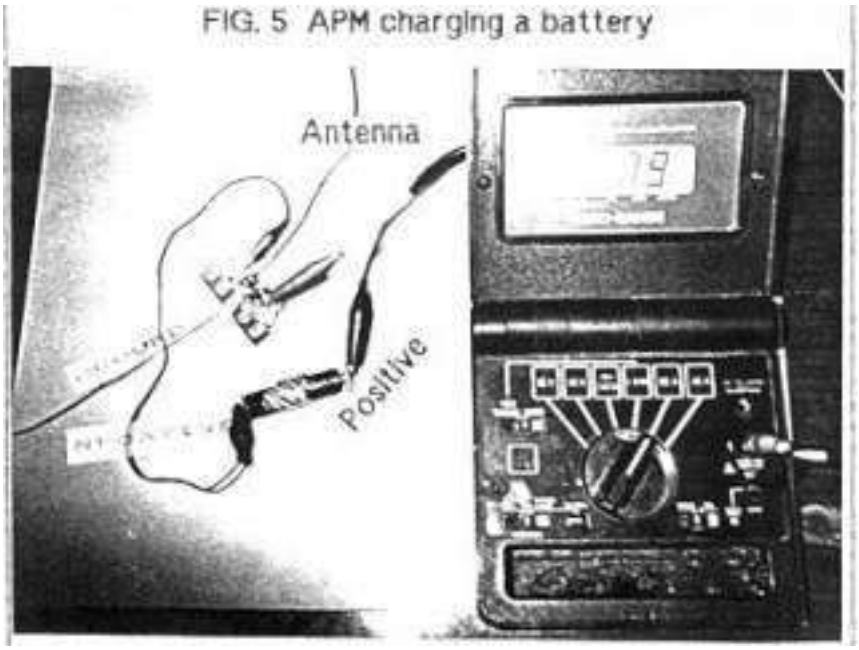

Figure 6 shows a clock which has the APM-2 built into it so it is only necessary to connect the antenna and ground wires directly to the clock. The antenna for this clock, which is a low frequency marine type, is shown in Figure 7.These antenna are expensive, not generally available, and usually don't work any better than the long wire mentioned above. But it may be necessary to use them in urban areas where space is limited and radio noise is high.

FIG. 6

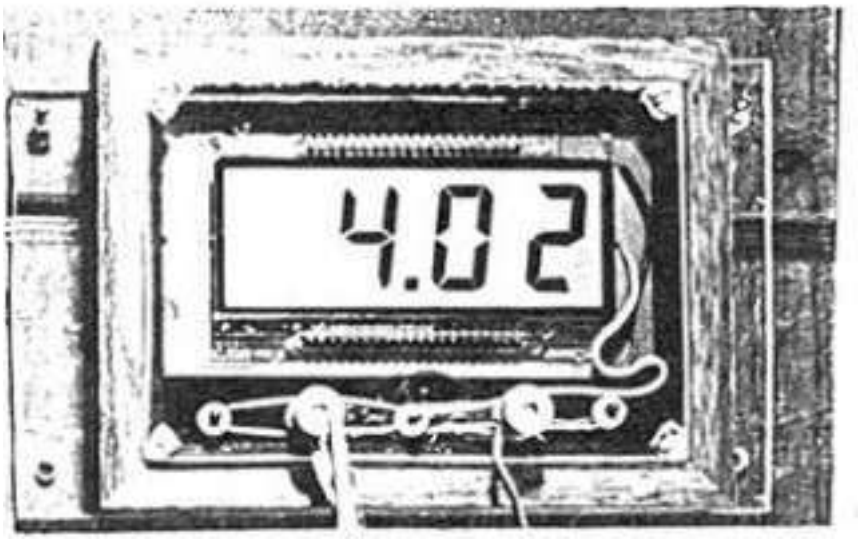

Building the Module

The builder has a choice of wiring techniques which may be used to construct the module. It may be hand wired onto a terminal strip, laid out on a bread board, experiment board, or printed circuit. Figure 8 shows some of the different ways of constructing the APM-2.

Figure 8A is constructed on a screw strip terminal; Figure 8B is constructed on a perforated breadboard; Figure 8C is built on a standard experiment board; Figures 8D, 8E, and 8F are all printed circuits; Figure 8F is made up on a solder strip terminal.

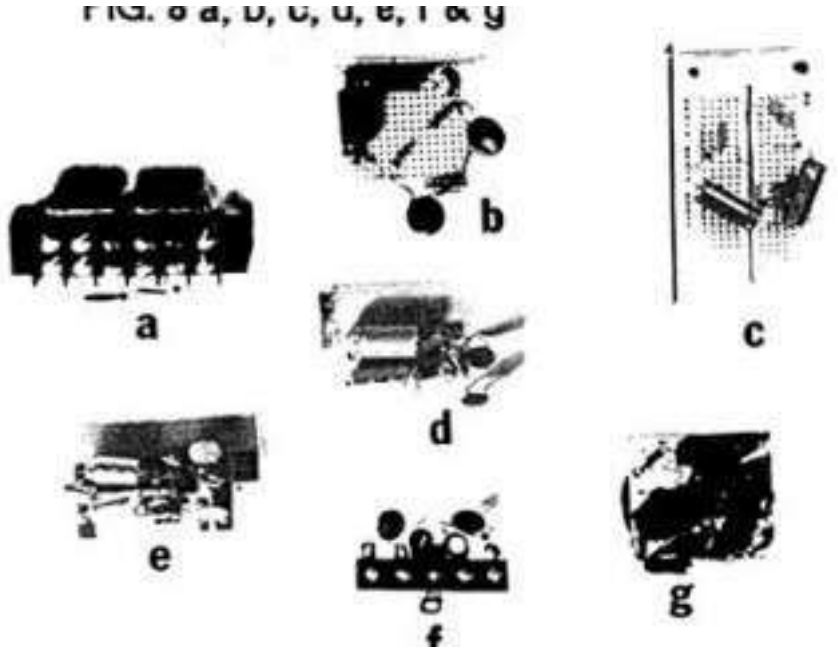

If you wish to make only one or two units, hand wiring will be most practical, either on a terminal strip or breadboard. Assembly on the terminal strip (Figure 8A) can be done easily and without soldering. It is important to get the polarity correct on the electrolytic capacitor. The arrow printed on the side of the capacitor points to negative.

Figure 9 is a closer view of the terminal strip with an illustration of the components and how they are connected.

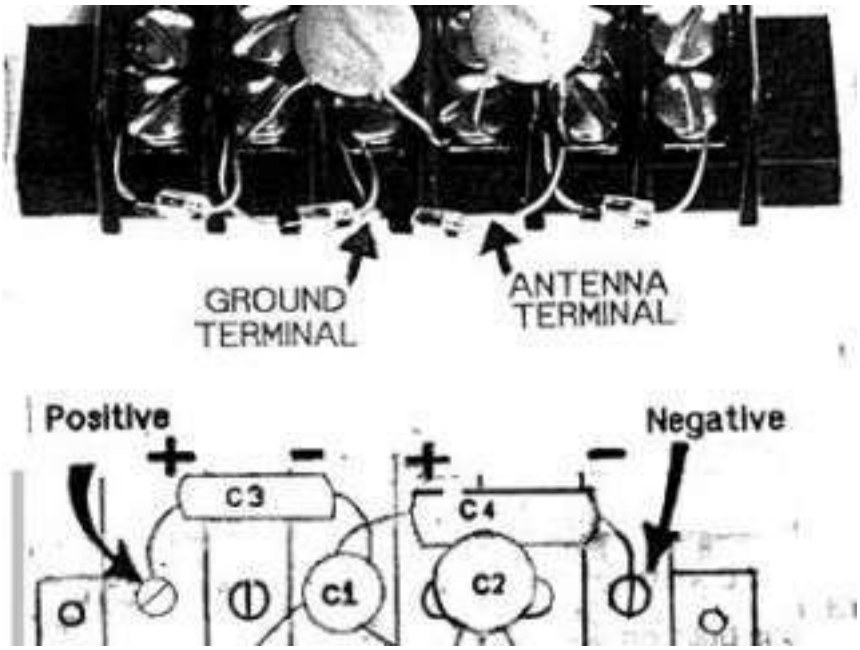

The breadboard unit is shown in Figure 10 with all components on one side and all connections on the other. All you need is a 2" x 2" piece of perforated breadboard (Radio Shack #276-1395) and the components on the parts list. Push component wires through the holes and twist them together on the other side. Just follow the pattern in the photo, making sure to observe the correct polarity on the electrolytic capacitors and the diodes. The ceramic capacitors may be inserted in either direction.

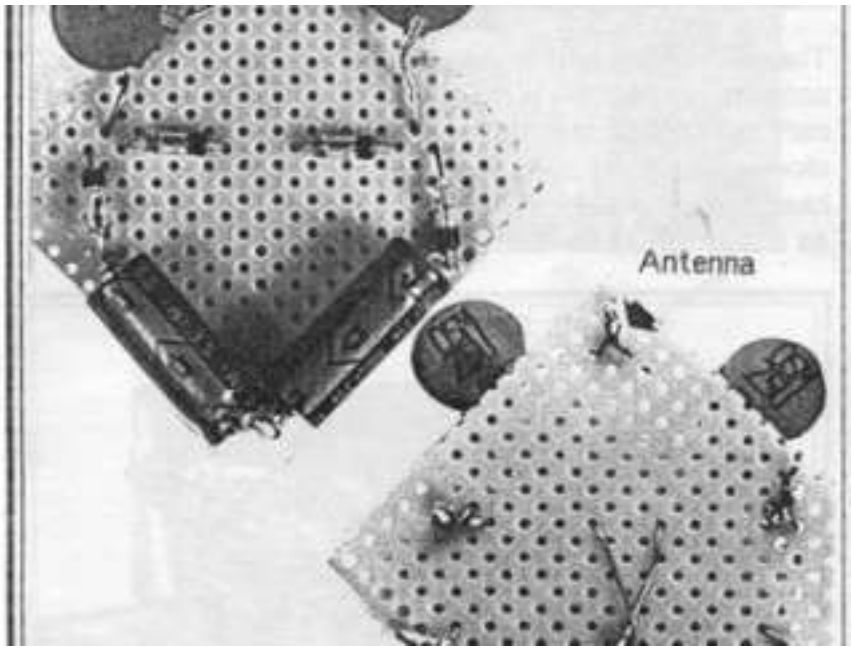

The experiment board unit is assembled by simply pushing the component leads into the board as shown in Figure 11. This unit is powering a small red LED indicated by the arrow.

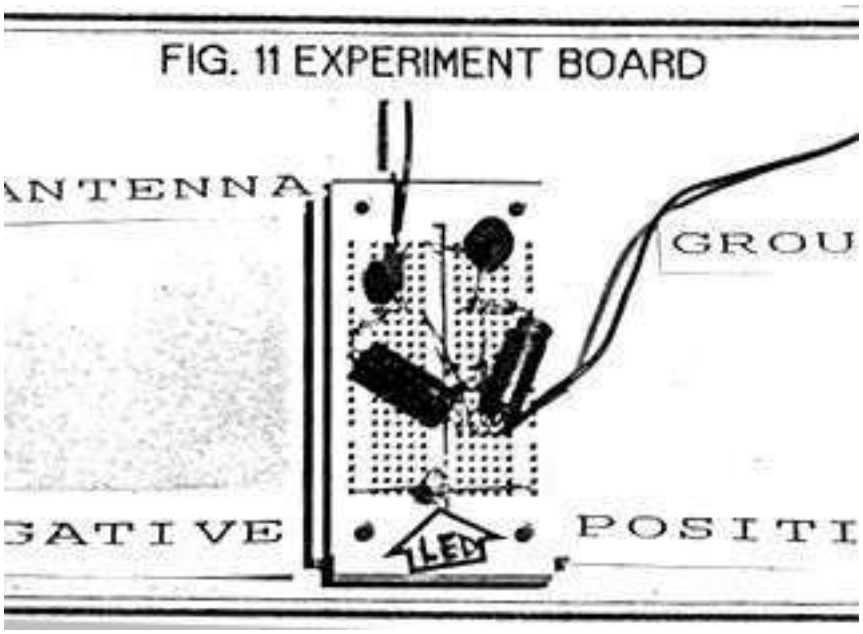

The solder strip unit is made up on a five terminal strip. The antenna connection is made to the twisted ends of the ceramic capacitors. When soldering the leads of the 1N34 diodes, care must be taken to avoid overheating. Clip a heat sink onto the lead between the diode and the terminal as shown in Figure 12.

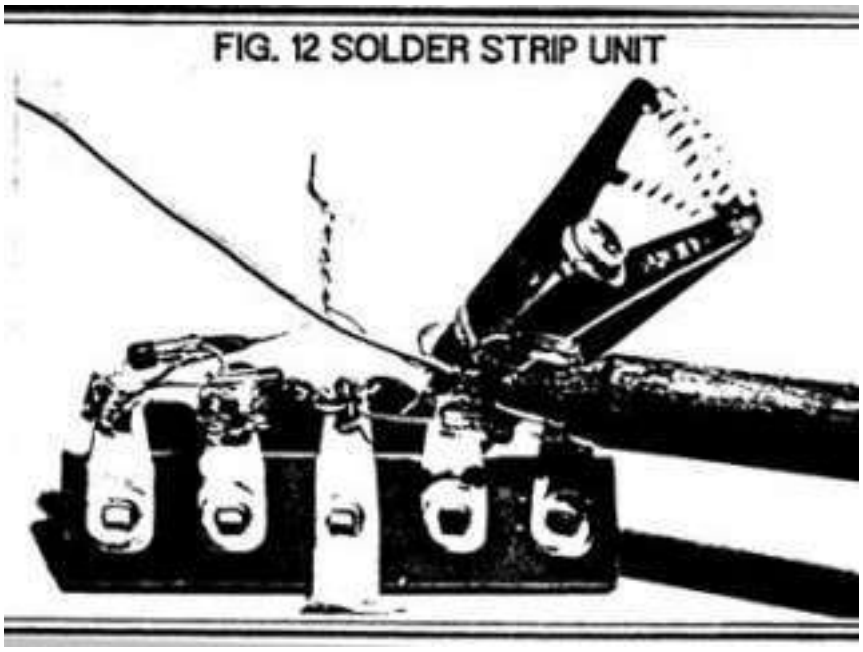

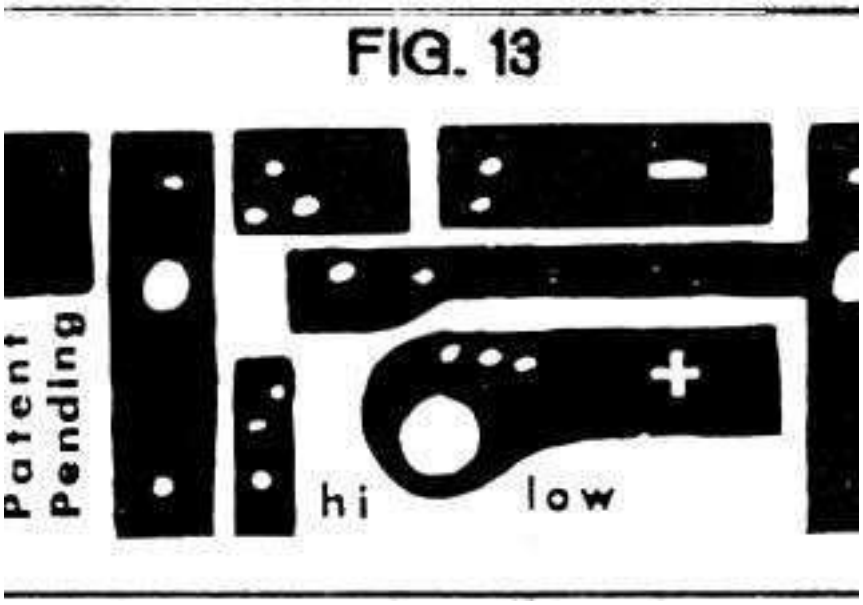

Figure 14 shows the front and back view of the completed printed circuit.

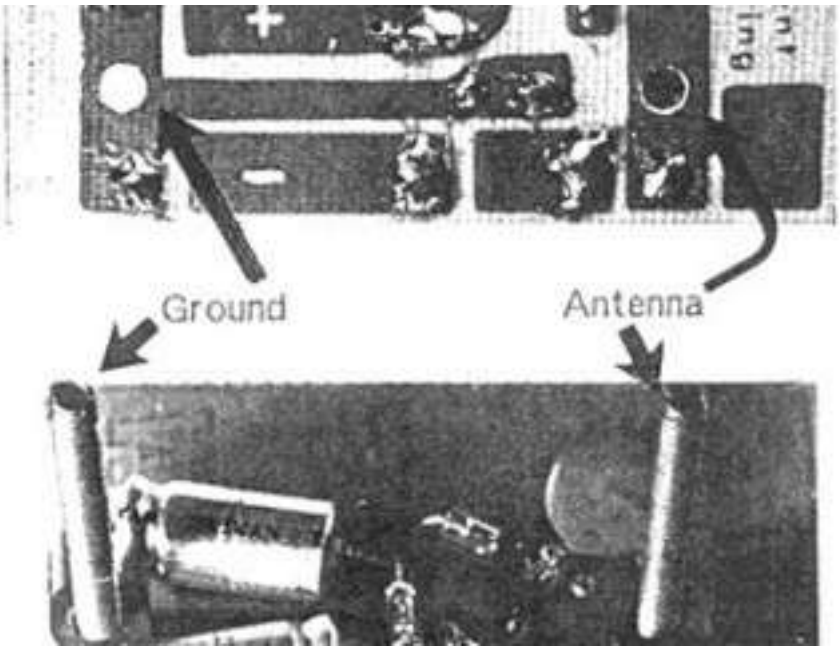

A small switch may be installed on the board to activate the zener regulator (Figure 15). This board was designed for use in clocks.

FIG. 15

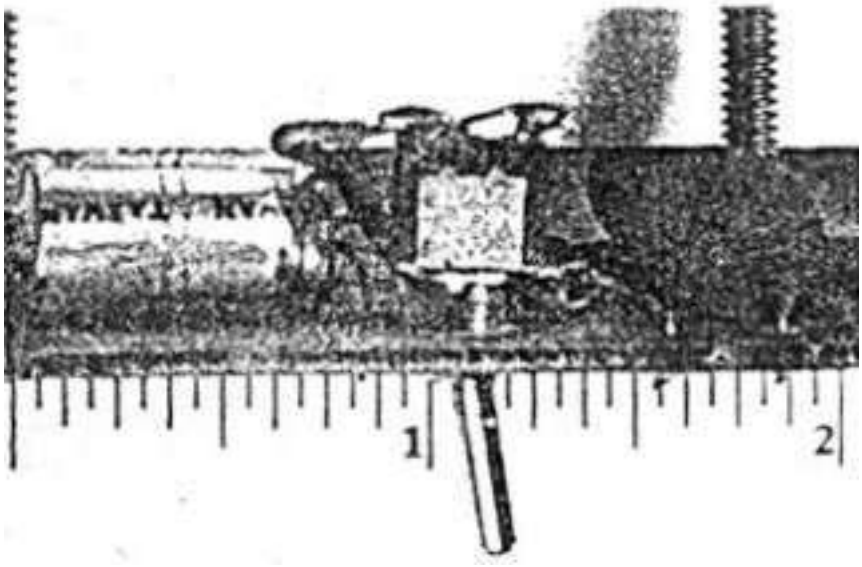

Antenna Requirements

The antenna needs to be of sufficient size to supply the APM with enough RF current to cause conduction in the germanium diodes and charge the ground coupling capacitors. It has been found that a long horizontal wire works best. It will work better when raised higher. Usually 20-30 feet is required. Lower elevations will work, but a longer wire may be necessary.

In most location, possible supporting structures already exist. The wire may be stretched between the top of a building and some nearby tree or telephone pole. If live wires are present on the building or pole, care should be taken to keep your antenna and body well clear of these hazards.

To mount the wire, standard commercial insulators may be sued as well as homemade devices. Plastic pipe makes an excellent antenna insulator. Synthetic rope also works very well, and has the advantage of being secured simply by tying a knot. It is convenient to mount a pulley at some elevated point so the antenna wire may be pulled up to it using the rope which doubles as an insulator (Figure 16).

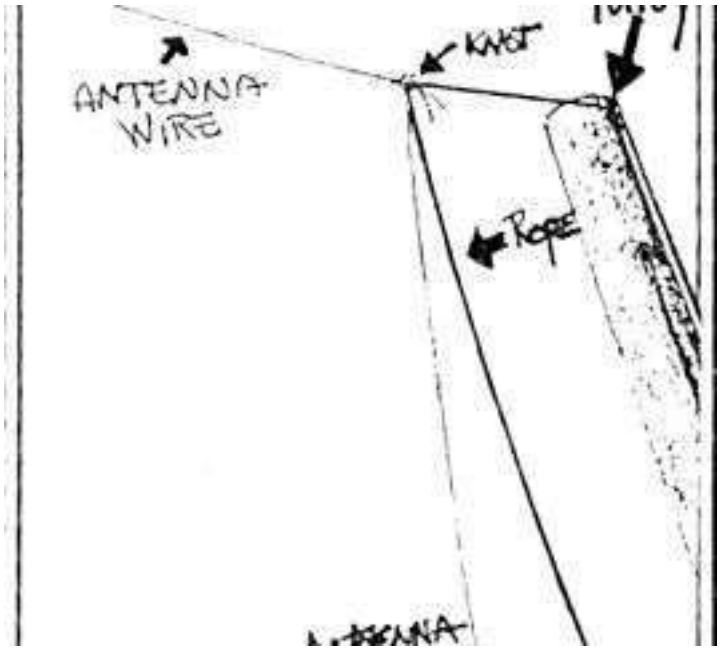

Figure 17 is an illustration of a horizontal wire antenna using a building and tree for supports.

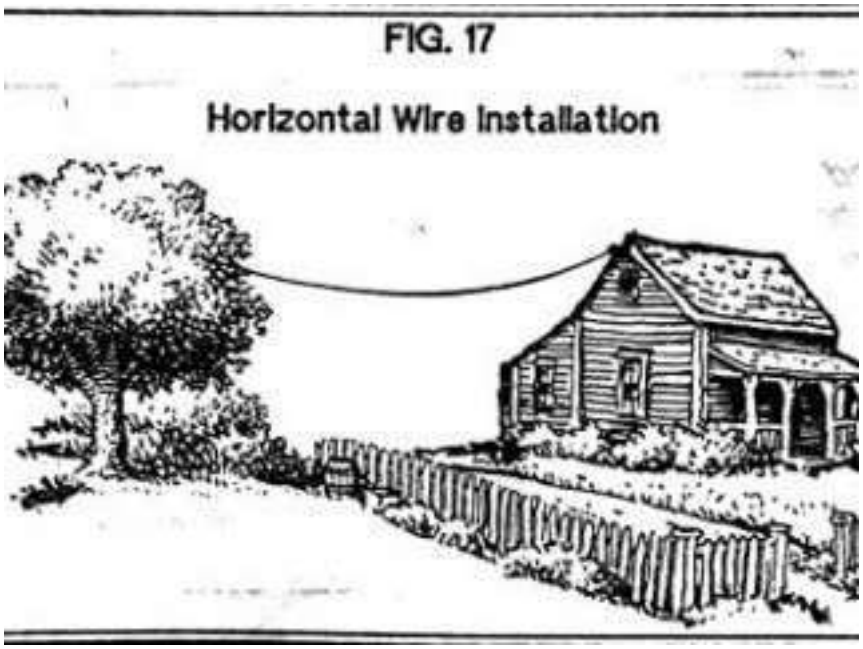

Grounding

Usually a good ground can be established by connecting a wire to the water or gas pipes of a building. Solder or screw the

wire to the APM-2 ground terminal. In buildings with plastic pipes or joints, some other hookup must be used. A metal rod or pipe may be driven into the ground in a shady location where the earth usually is damper. Special copper coated steel rods are made for grounds which have the advantage of good bonding to copper wire. A ground of this type usually is found within the electrical system of most buildings.

Conduit is a convenient ground provided that the conduit is properly grounded. This may be checked with an ohmmeter by testing continuity between the conduit and system ground (ground rod). Just as with the antenna, keep the ground wire away form the hot wires. The APM's ground wire may pass through conduit with other wires but should only be installed by qualified personnel.

Grounding in extremely dry ground can be enhanced by burying some salts around the rod. The slats will increase the conductivity of the ground and also help retain water. More information on this subject may be found in an antenna handbook.

Good luck getting your Ambient Power Module working. It is our hope that experimenters will find new applications and improve the power capabilities of the APM.

CopyRight Joseph Tate

Inventors: Tate, Joseph B. (Sausalito, CA)
Brown, David E. (Mill Valley, CA)

Application Number: 06/695632

Publication Date: 12/09/1986

Filing Date: 01/28/1985 NOTE: The images maybe hard to see as they were originally scanned and uploaded in black and white. If it helps you to replicate this device you may want to check the images of the one I built at the very top (in color) Here are some more photos of my completed unit for your review.

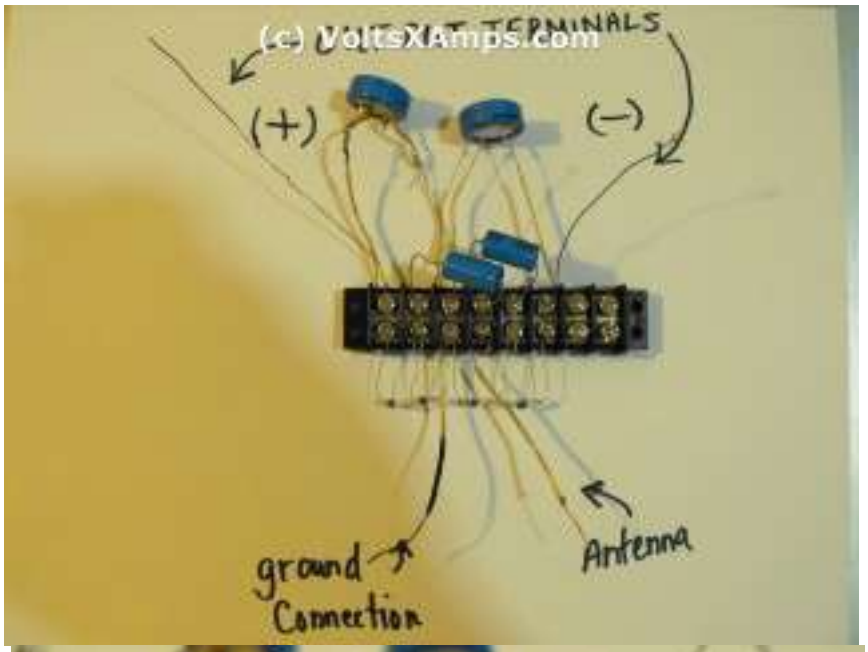
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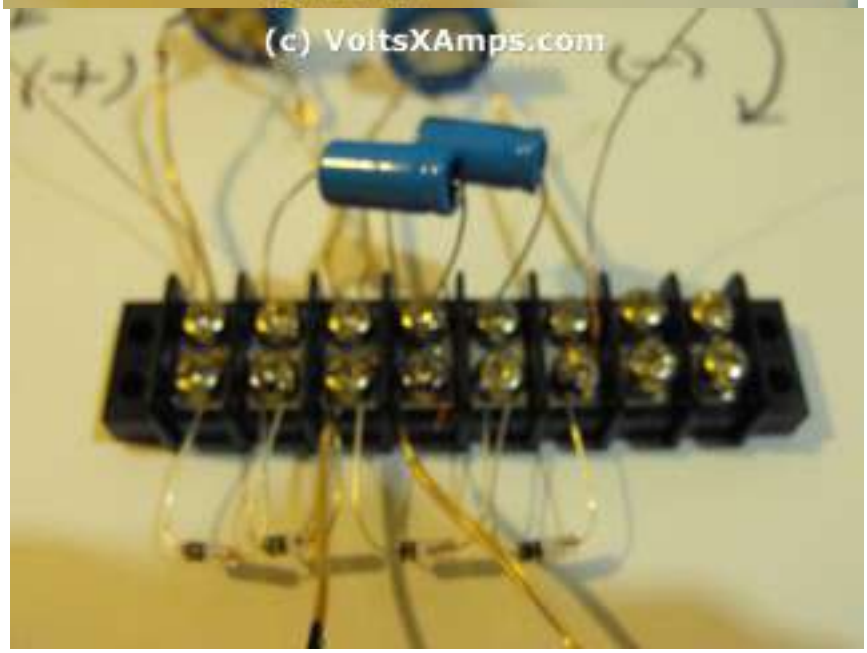
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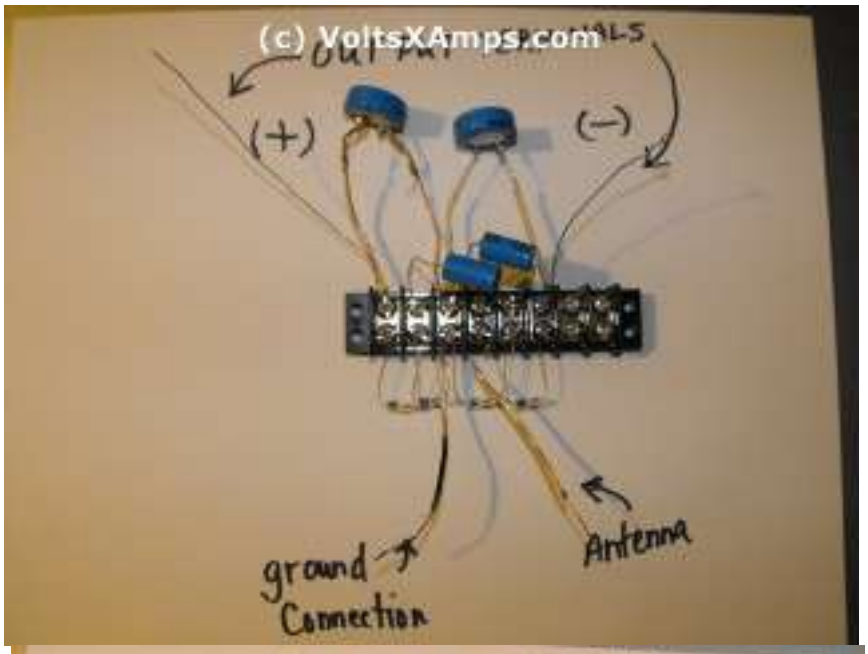
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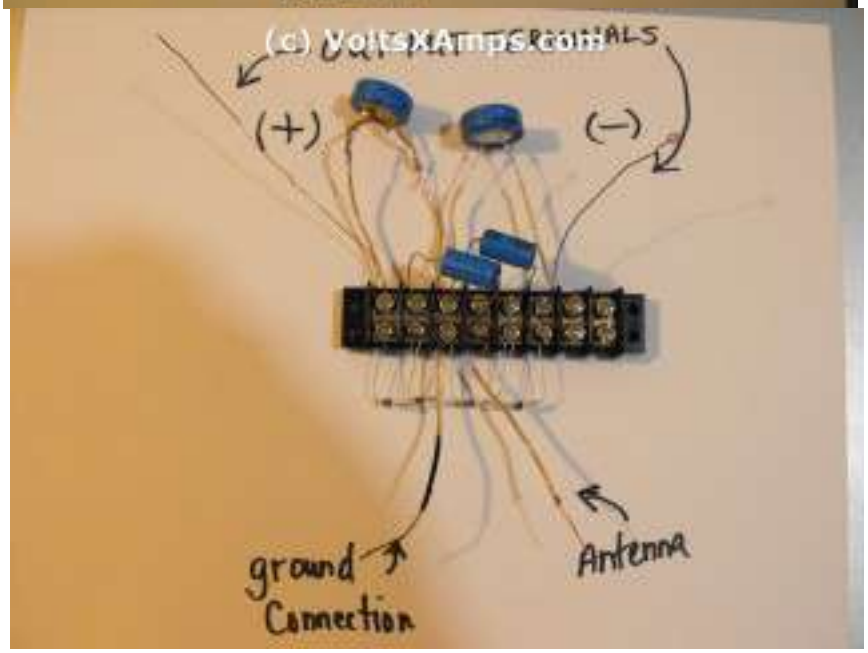
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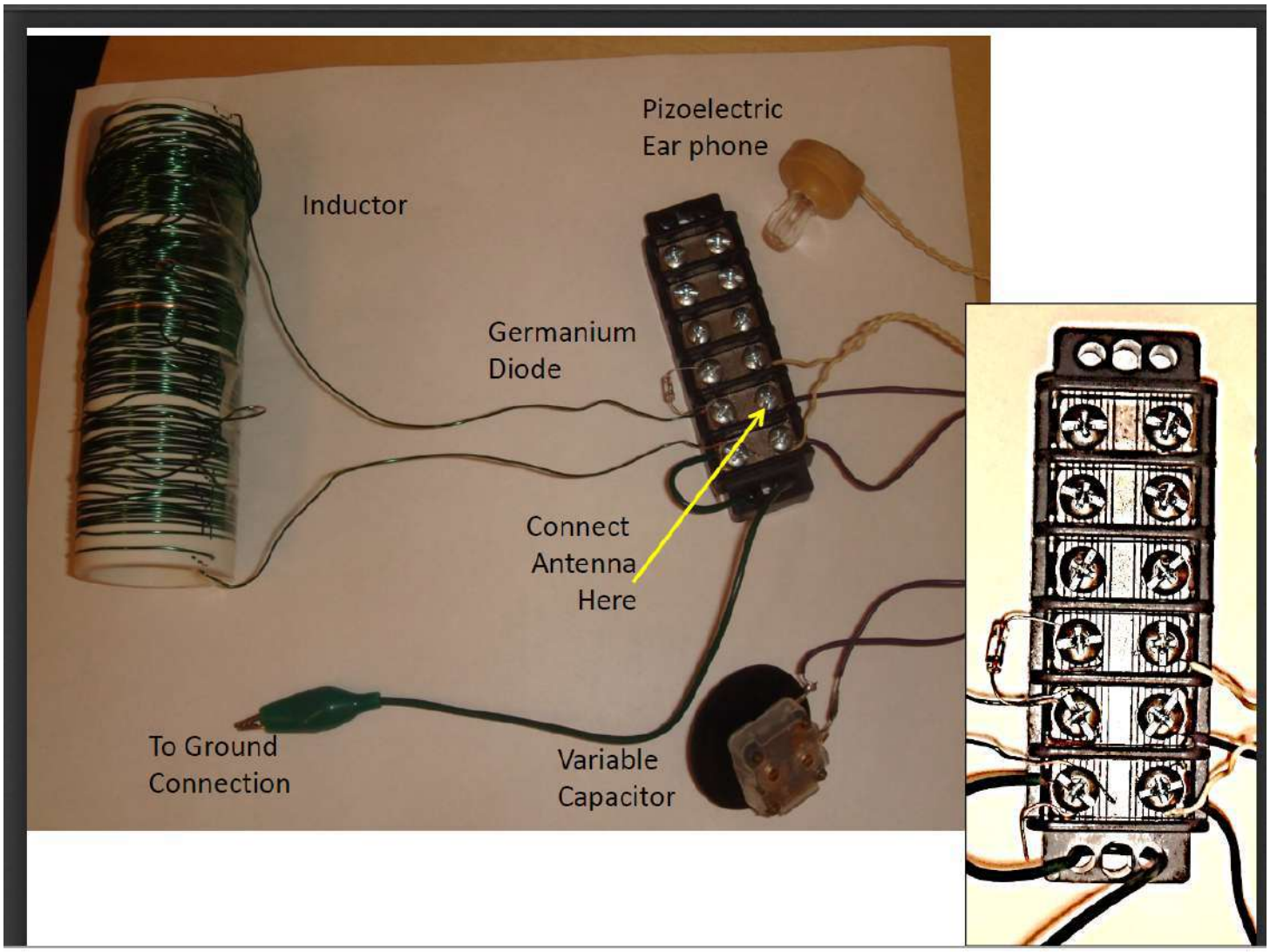
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FM Crystal Radios?

copyright © 2006 by Larry J Solomon

I have heard, even from a physicist, that it is impossible to build FM crystal radios. On the other hand some experimenters claim that they have built them. This argument intrigued me to try and build an FM crystal radio, which I have done successfully. To my surprise, the result is an astounding performer, pulling in four local stations in Tucson. When connected as a receiver to a good sound system the sound fidelity is as good or better than more expensive AM radios. In fact, it sounds "high-fidelity".

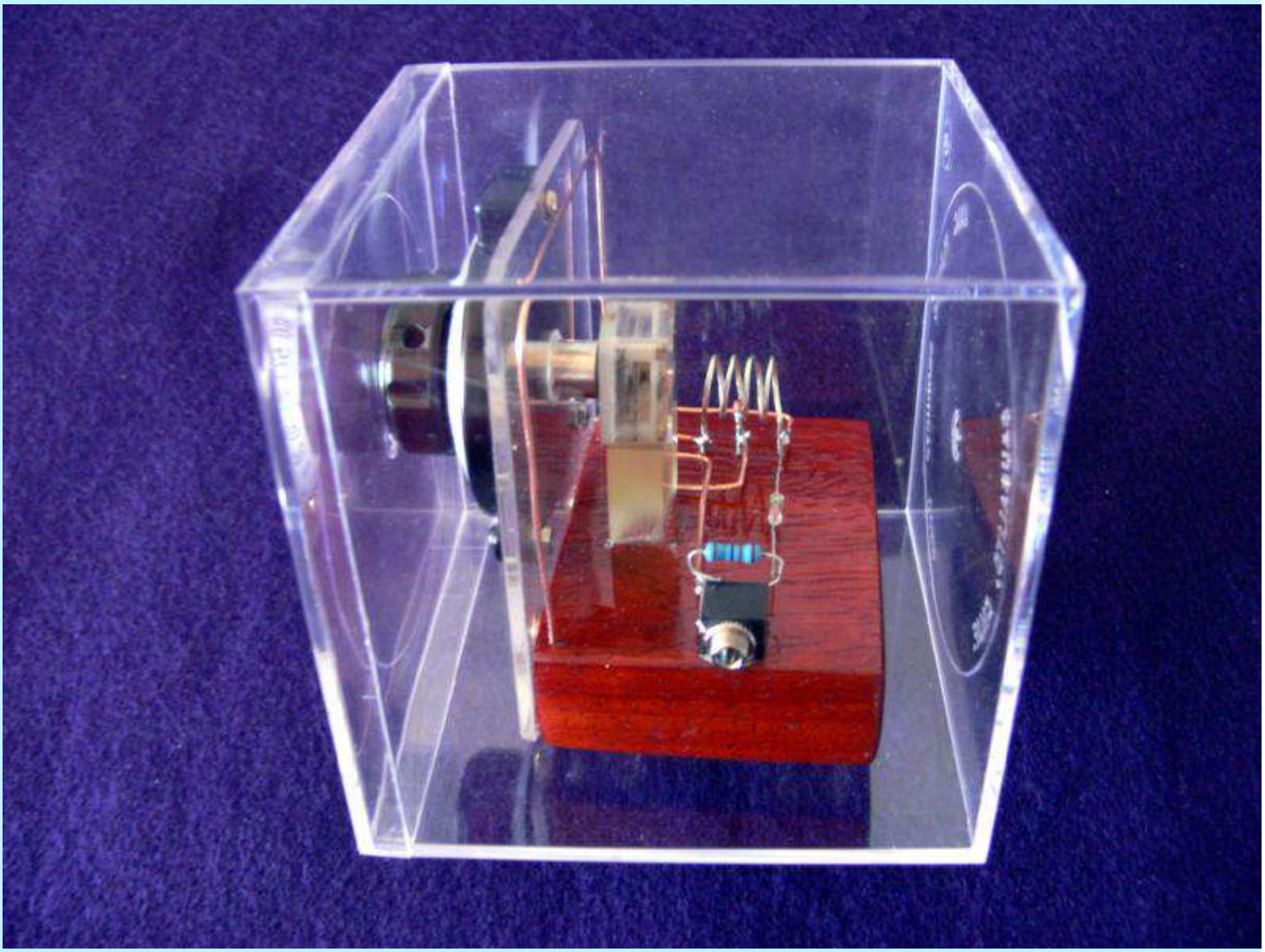

This picture shows the Solomon FM Crystal Set in an acrylic display case. I made the set specifically to fit inside this case (the case came first).

My definition of a crystal radio is one that is not powered, except by the radio transmission itself and employs a crystal detector. So, it should work without any batteries or AC power. An FM crystal receiver must be able to detect and receive FM signals well enough to be heard in earphones without any such extra power.

This FM receiver is an amazing performer. It has crystal clear reception (pun intended), good sensitivity, but only fair selectivity. This set was a discovery for me. I started out by designing and building the normal AM sets. Then one day while testing the "Mystery" set (see my other web links), to my surprise, in addition to the expected panoply of AM stations, I heard a very faint signal that I could not tune out. At first, it seemed too weak to identify. When I tuned out all the AM stations, I was astonished to hear the announcement "KiiM FM, 99.5"! This is a

country music FM station here in Tucson. It was all over the dial, untunable, but the much louder AM signals masked it when they were tuned in.

I set myself the task of trying to improve the FM reception. I tried some simple circuit modifications that did not seem to improve anything. Then I connected a dipole antenna instead of the AM antenna I normally use. Suddenly, the FM signal was much clearer, although still weak. By using the audio output and sound system amplifier, I was even more amazed that four different FM stations came in loud (or rather medium) and clear. I found that changing the telescoping antenna length and position I could tune the stations in and out. They were KRQ, KLPX, KiiM, and KHYT all local FM stations with transmitters nearby. Their reception was also affected by the length and position of the audio output cable.

After doing some research, I discovered that there was a physical theory that claimed that FM reception was possible and even probable using the same circuit as an AM receiver. The theory is called "slope detection". So, I set out to find circuit improvements. A web search yielded little, mostly theory. But there was enough information that I thought I could make some modifications to the AM circuits to make them more tunable to FM signals and less tunable to AM. Since FM operates at higher frequencies, all I had to do, I thought, was make the coil and caps smaller. After much "tinkering" I arrived at the current circuit.

The circuit looks identical to a classic AM crystal circuit but is even simpler to build. The components were reduced in dimension to resonate at higher frequencies. This was done by experimenting with smaller and smaller coils and capacitors. The antenna is also much reduced in size (from that of AM) to resonate at higher frequencies (the antenna is crucial). The air variable capacitor I used has two trimmers in it which should be adjusted for best reception.I have found that a commonly available vernier dial and knob will fit the capacitor nicely. See end of article for a picture of the variable. C3 is a ceramic capacitor of 18 pf, but may be anywhere from 10 to 50pf. A detected FM signal is converted to AM due to an effect called slope detection that modulates amplitude.

This FM Crystal Set works best near the transmitter (I have not tested it beyond about 10 miles). Secondly, the sound level is quiet, especially without an amplifier. A quiet room is needed for listening with earphones. One must be willing to move the set around to find a location for the best reception of signals. However, in addition to listening with high impedance earphones (crystal or otherwise), the set can be connected directly to an audio amplifier's low level magnetic input which can then play amplified through a sound system at any volume -- sounds GREAT. In fact, I recommend starting tests with the FM crystal set by connecting it to the low-level phono inputs of a receiver or preamplifier. (Nowadays, many receivers don't even have a phono input!) That way you can crank up the volume, which makes it more likely to find the FM stations. If no signals are detected, I also recommend connecting an external "rabbit ear" antenna or hanging a short wire (12 inches or so) in various positions next to the internal antenna. The variable length of rabbitt ears can help to tune in stations.

No additional wiring or antenna is necessary (the antenna is optimized in length for FM.)

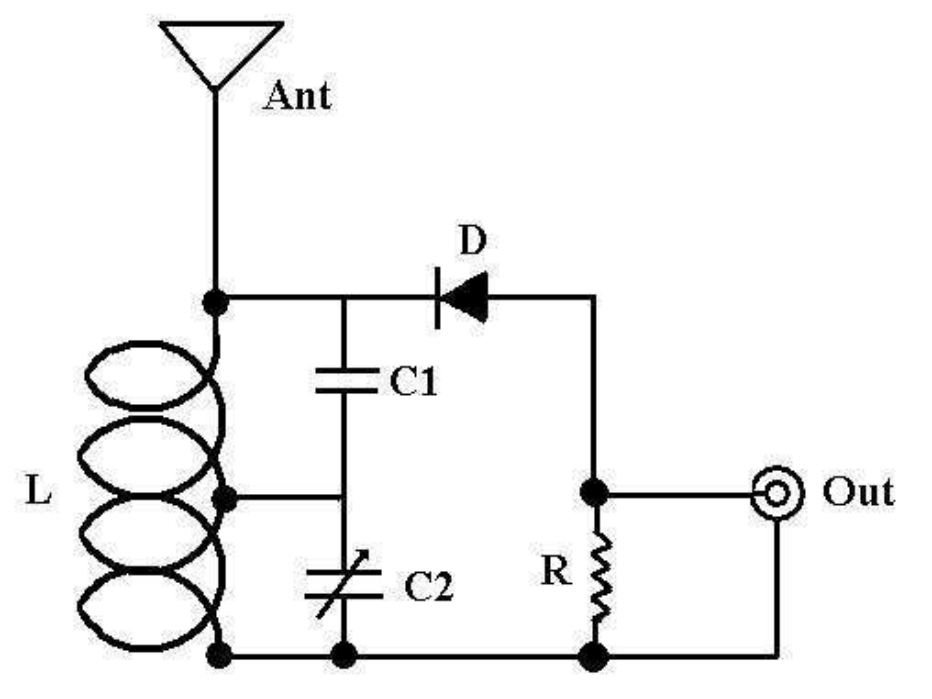

L - 4 turns #18 copper or silver wire, 12mm inside diameter, tapped at 2.5 turns
Ant - 7 inches of #18 bare copper wire
C1 - 18 pf ceramic capacitor
C2 - 50 pf air variable capacitor
D - 1N34 diode or rock crystal
R - 150K resistor

The diode is tapped directly to the antenna. The vernier dial fits directly on the tuning capacitor. The antenna parallels the perimeter of the acrylic face plate. "Military style" #18 AWG wiring is used without any insulation. It is important to keep the components physically close together. The component specifications are the same as in circuit #2. The coil is silver rather than copper, but copper does just as well. I think that the contrast of the silver and copper is beautiful. The coil was wrapped around a Sharpie Permanent Marker, then slipped off and expanded slightly. The wooden base is made from lacquered, polyurethane padouk.

I consider this set a work of art as well as science and think it is the most elegant crystal receiver I have created. I love the contrast of the silver coil, the copper antenna, the clear acrylic faceplate, the black vernier dial, the white and transparent variable capacitor, and the subtle colorings on the resistor, the diode, and the lucite base. Yet the circuit is so ridiculously simple that some will not believe it is possible without building it themselves. No shielding is necessary, and there is no problem with hand capacitance. However, the output cable position may affect reception sensitivity.

Photos of wired circuit

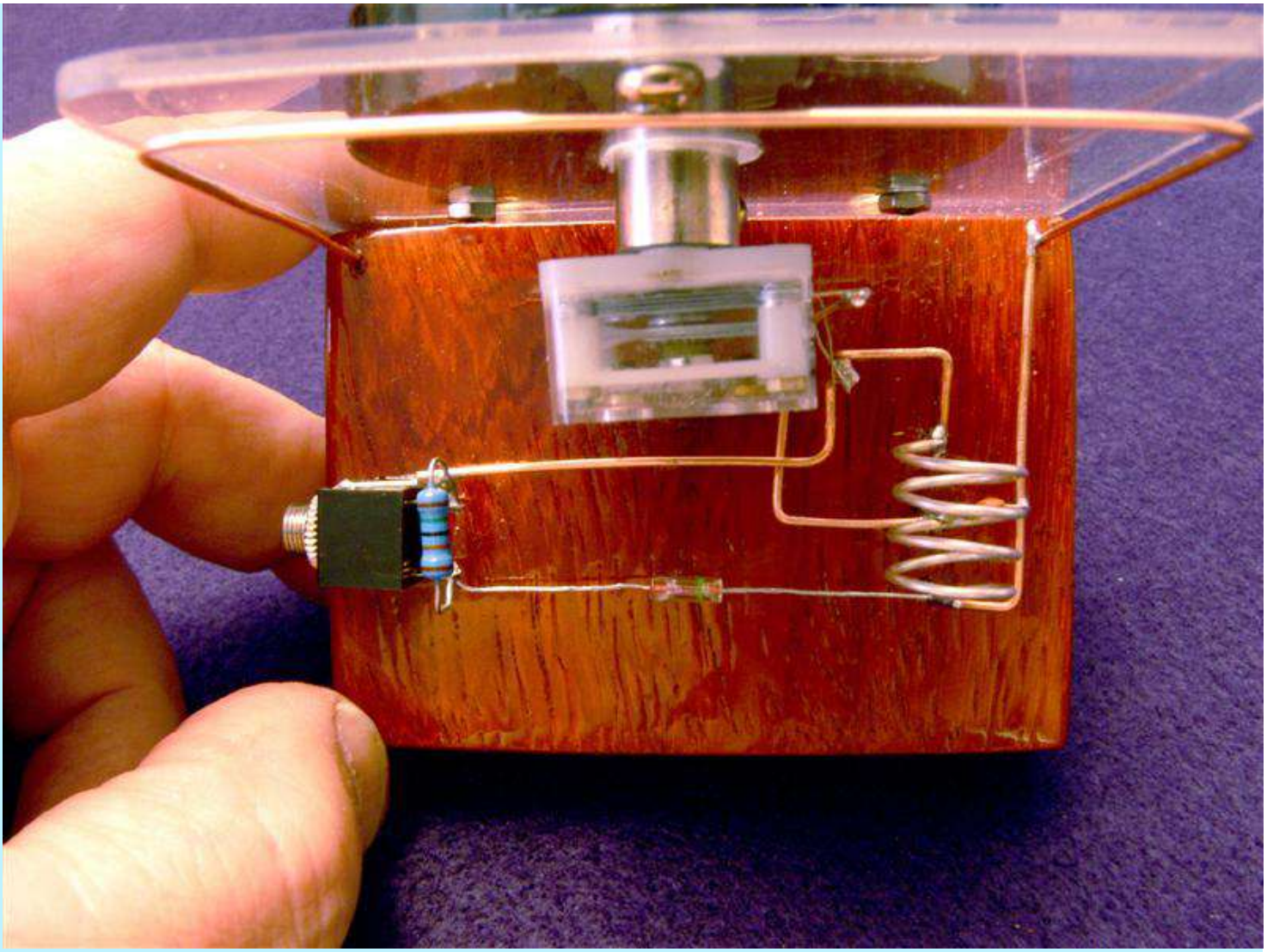

A hand is included in this photograph to show scale. Note the military style wiring, diode, and antenna. I wanted the wiring to create a modern design similar to a Mondrian painting. Not only is this set beautiful, it works! No power and no long antenna! It looks like a work of fiction.

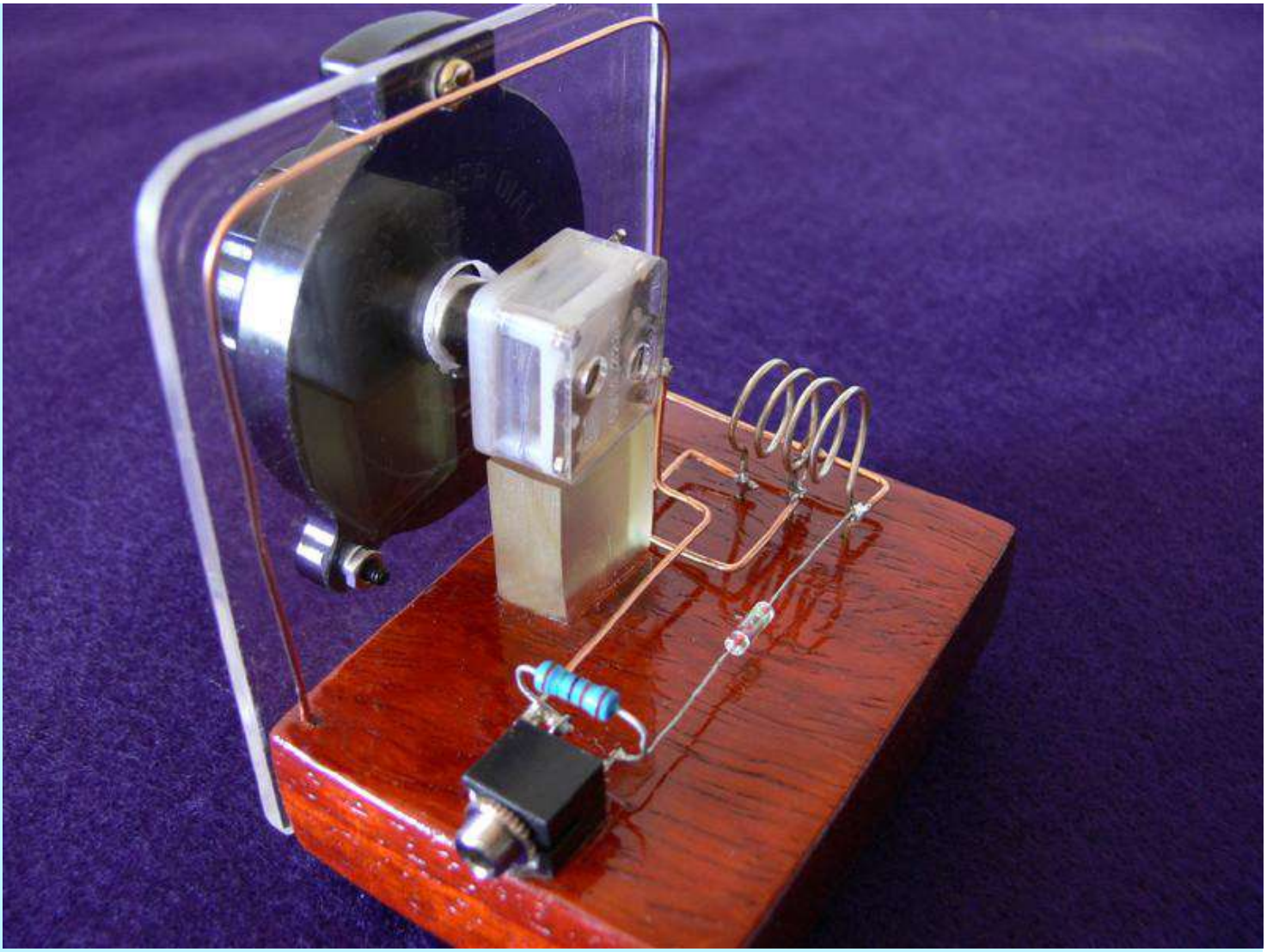

Is this thing imaginary -- science fiction? Well, imagination did play a part, but it is definitely not science fiction. This shot shows the elegance of the FM set best, I think. There is only one resistor and one fixed capacitor.

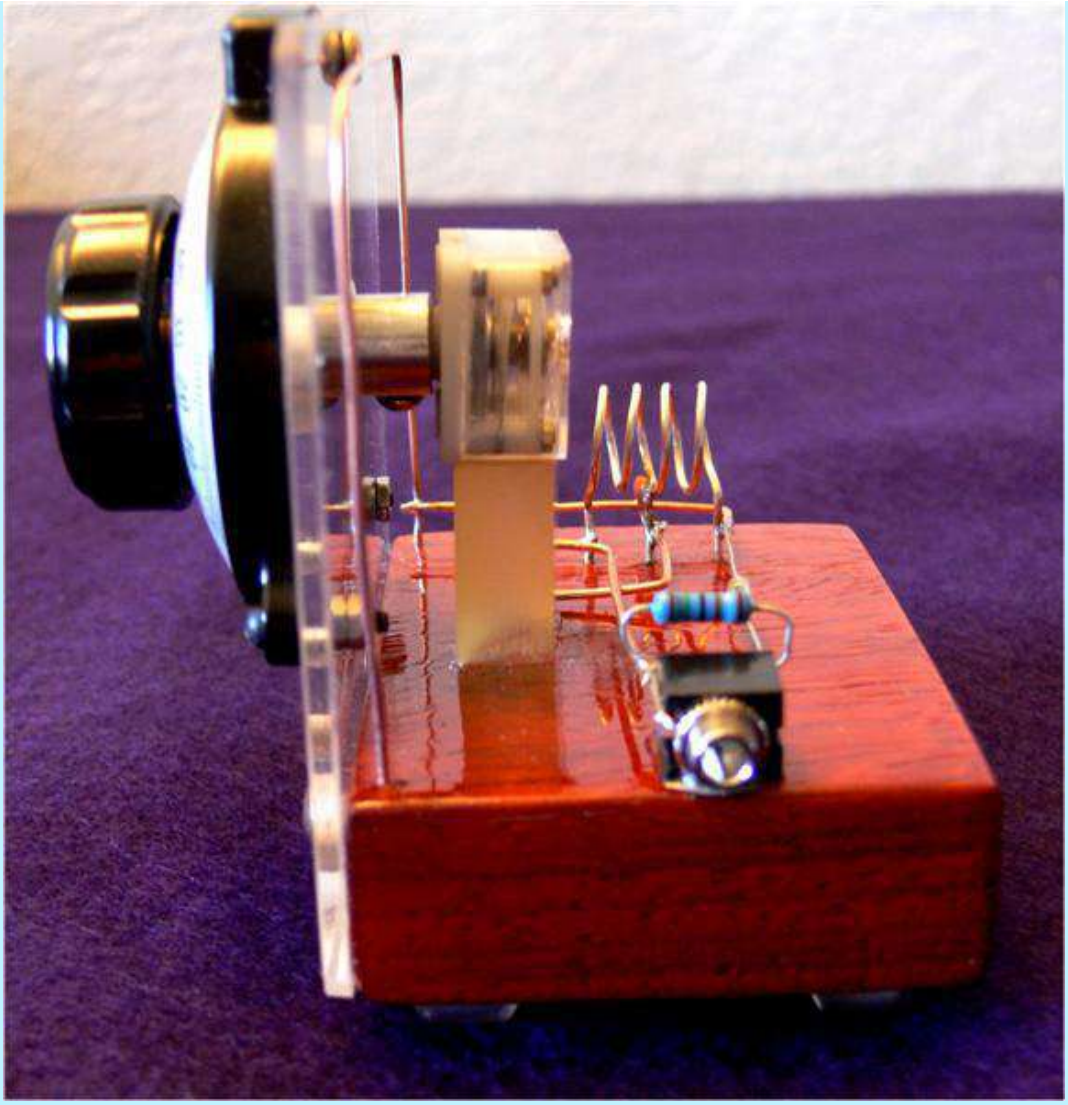

The inside of the tuning capacitor and the phono jack/output can be seen here. Can you spot the fixed ceramic capacitor? Note the polished edge of the face plate and the reflection in the wooden base.

A quarter-inch piece of lucite was fitted under the tuning capacitor to anchor it. Note the two tiny trimmers on the back of the tuning capacitor. Brass screws were used to enhance appearance.

The vernier dial is large to accomodate ease of tuning, and the vernier makes it easy to separate stations. Two golden (brass) wood screws fix the face plate to the base. Holes for the face plate were made with special plastic drills, but ordinary drills may be used if drilled very SLOWLY. The knob is removable.

FM Crystal Circuit #2

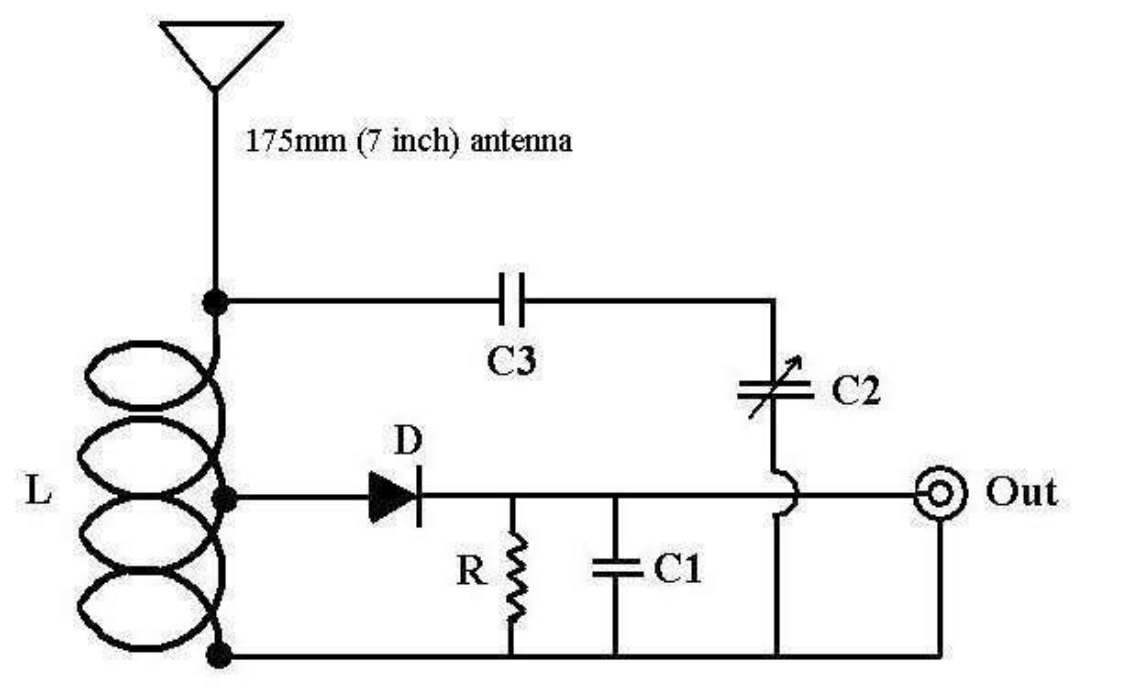

L - 5 turns AWG#18 bare copper or silver wire, 12mm inside diameter, tapped at 2.5 turns
D - 1N34 or rock crystal diode
C1 - 82 pf capacitor
C2 - 80 pf air variable capacitor
C3 - 18 pf capacitor
R - 150K resistor

The following photographs show the circuit wired with the handmade Saturn Dial. and knob. It is perhaps not as visually striking as set No. 1, but it works just as well. In fact, this set was the original version. Notice that all the wiring and coil are copper.

The Saturn dial and knob were fashioned from a "doll's head" from Michael's Arts and Crafts, a piece of lucite cut with two circle cutters, and a brass paper fastener. The knob is fixed to the tuning capacitor with a small machine screw that fits in the hole below the brass fastener. The most difficult part of this was fashioning "Saturn's rings". This must be done very carefully and slowly. The inside edge should be cut slightly undersized and then sanded with a drum sander to fit snugly. The outside edges can be sanded with fine sandpaper and polished with a plastic polisher.

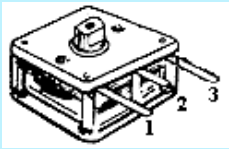

The air variable capacitor may be obtained from Electronix Express at http://www.elexp.com/. Part number 14VCRF10-280P. The 80 pf side is recommended for the second circuit, contacts 2-3. Contacts 1 and 3 were used for the first circuit (50pf).

- OSC: 5-59 pf
- ANT: 5-142 pf
- OSC and ANT Trimmer 10pf range

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FREE ENERGY FROM THIN AIR!

Technology (/technology/) > Science | by DrewPaulDesigns (/member/DrewPaulDesigns/) Follow

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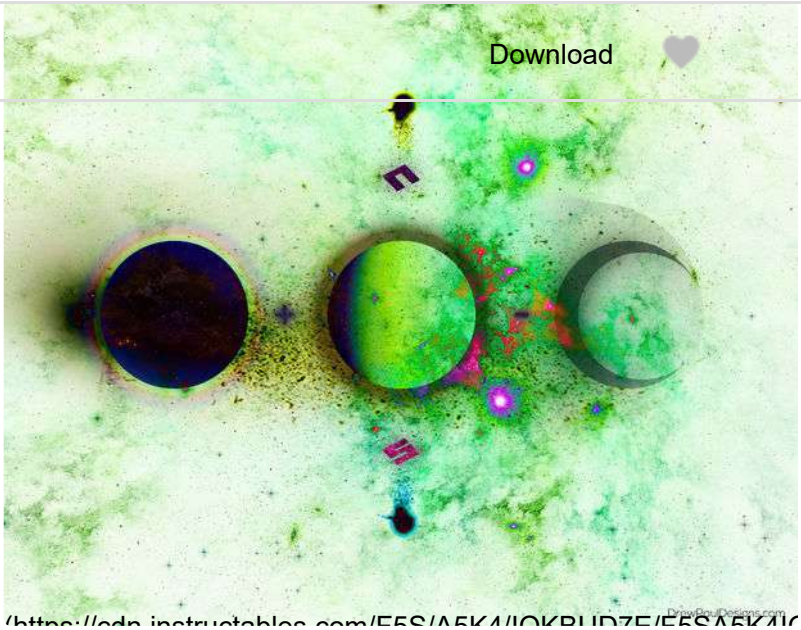

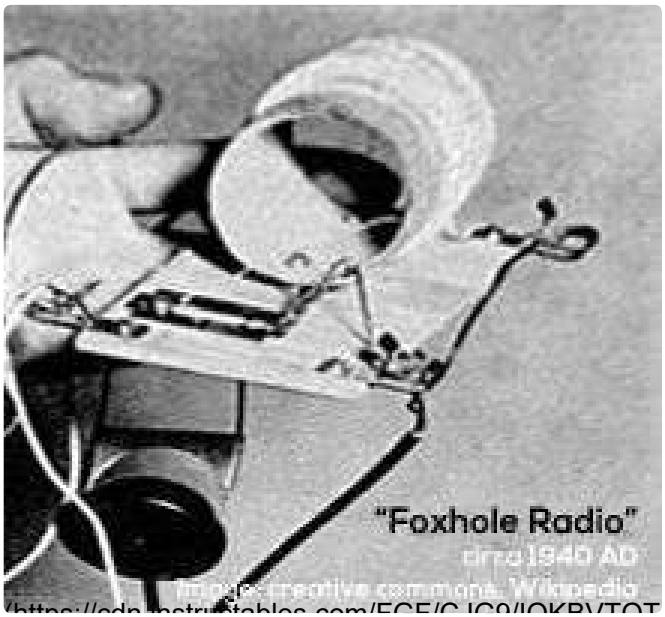

"Free energy from the air?, Yea, right!" Sardonic skepticism was my first reaction to this unusual concept, as well.

Though, its not so far out there, in fact. Light can be converted to DC current with solar panels, electricity can be converted to magnetism as I did in my last article (https://www.instructables.com/id/DIY-Electro-Magnetic-Levitation/), in a microphone sound waves are converted to an electrical signal (by vibrating a magnet near a coil (http://hyperphysics.phy-astr.gsu.edu/hbase/audio/mic.html)), solar rays can even be focused and converted to heat in awesome devices like this! (http://www.gosunstove.com/) When we think about it, energy is all around us and can be harvested in an enumerable many of ways.

Download

Today, we are going to take a rather novel approach. We are going to build a device specifically designed to sense and capture a particular band of energy which is all around us.

The earth is magnetic and anyone who has ever used a compass knows this. Magnetic bodies in motion produce electricity, we can see this in any alternator, like the one in your car. So, therefore the earth is electric as well as magnetic, by definition.

Can we detect this energy? Yes, we sure can! Ever turn on a radio in the middle of nowhere and heard static? That is your radio picking up naturally occurring energy in the RF spectrum!

Can we use this energy to do work? Absolutely! This has been known for a long time. Crystal radios (https://en.wikipedia.org/wiki/Crystal_radio) have been around since before the 1930's and can run with no input energy other than the radio signal. Even when completely isolated, but from the atmosphere, a crystal radio will produce a voltage in the earpiece resulting in a sound (albeit and undesirable one).

Well, this is where it gets interesting...

Can we replicate this effect? Yea, and with modern components like the high quality crystals found in germanium diodes, we can even increase efficiency. By applying this concept as a Crystal Energy Receiver we can take advantage of a wide range of energetic frequencies rather than tuning in to just one.

Can we scale it up? Definitely. Things like micro germanium diodes, high efficiency antennas and compact contemporary capacitors make the components that are required to build a crystal receiver fit in the palm of your hand. While there may or may not be a more efficient way, this renewable energy solution is simple to employ

and can be scaled up, or down, indefinitely.

Download

It sounds like we can build a Crystal Energy Receiver. Let's give it a shot...

Add Tip Ask Question

Step 1: What You'll Need

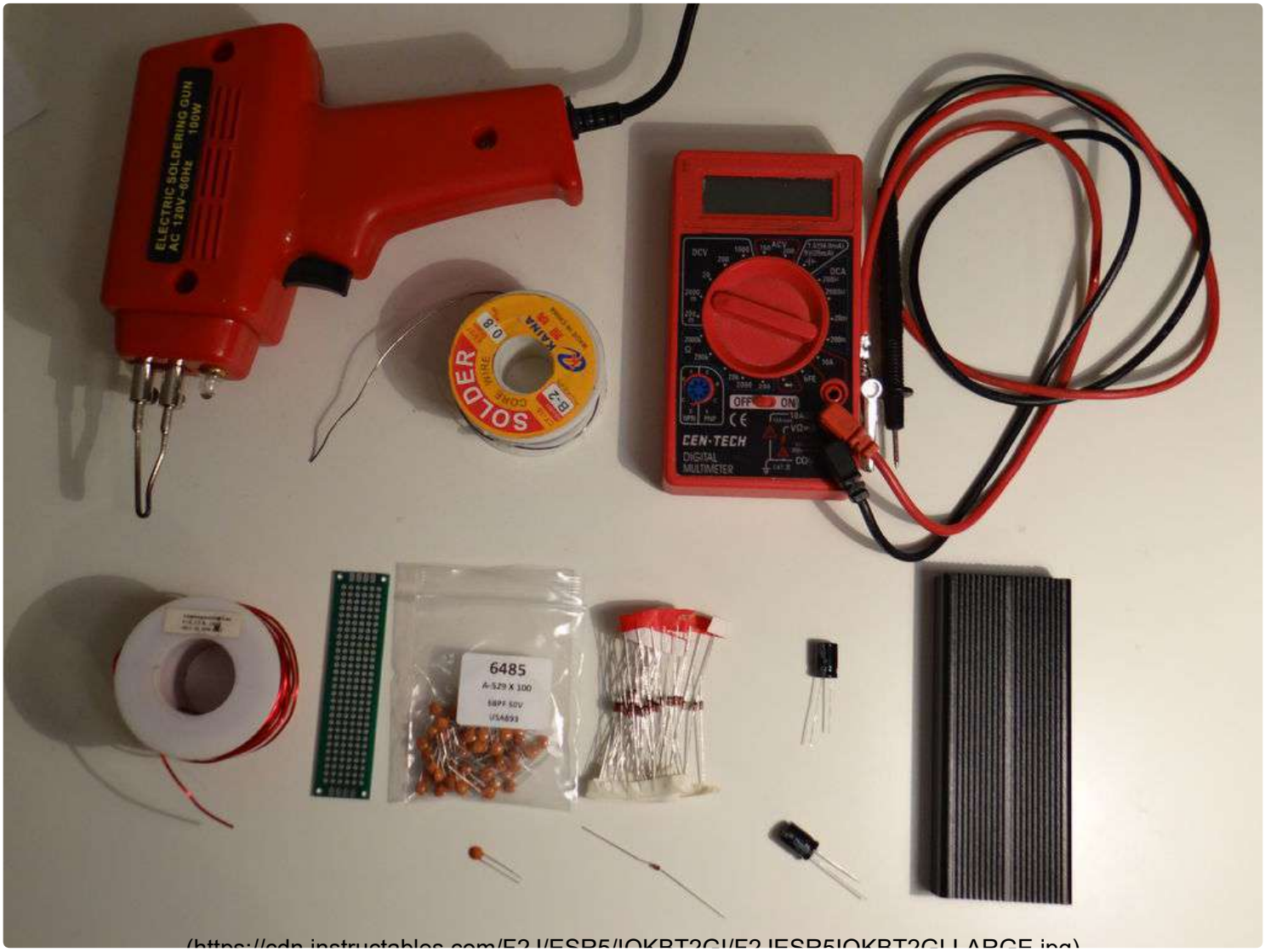

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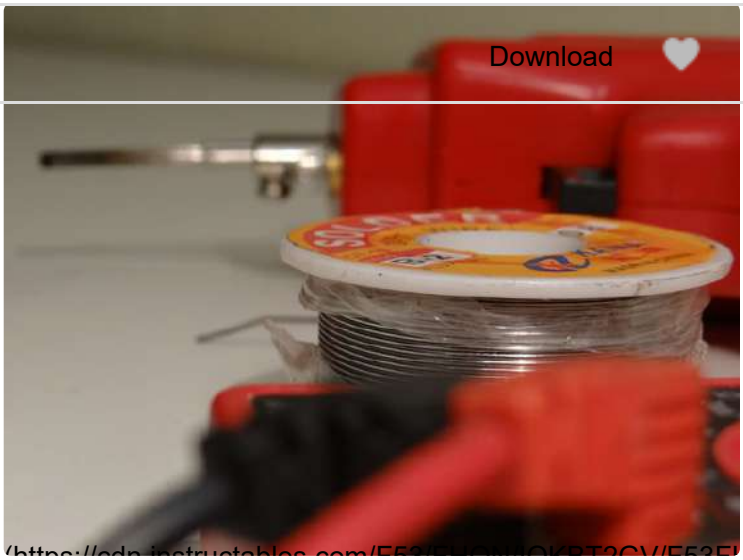

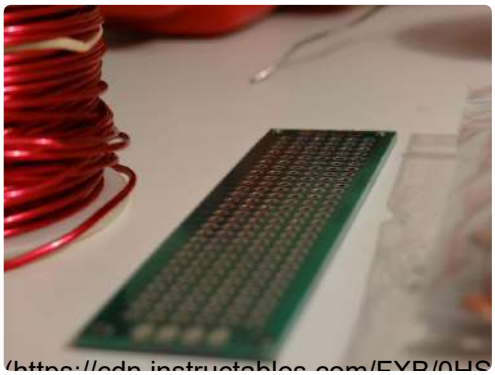

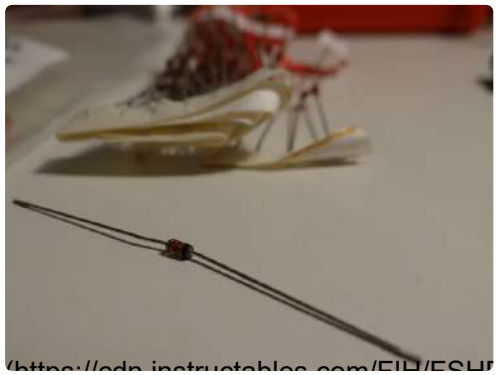

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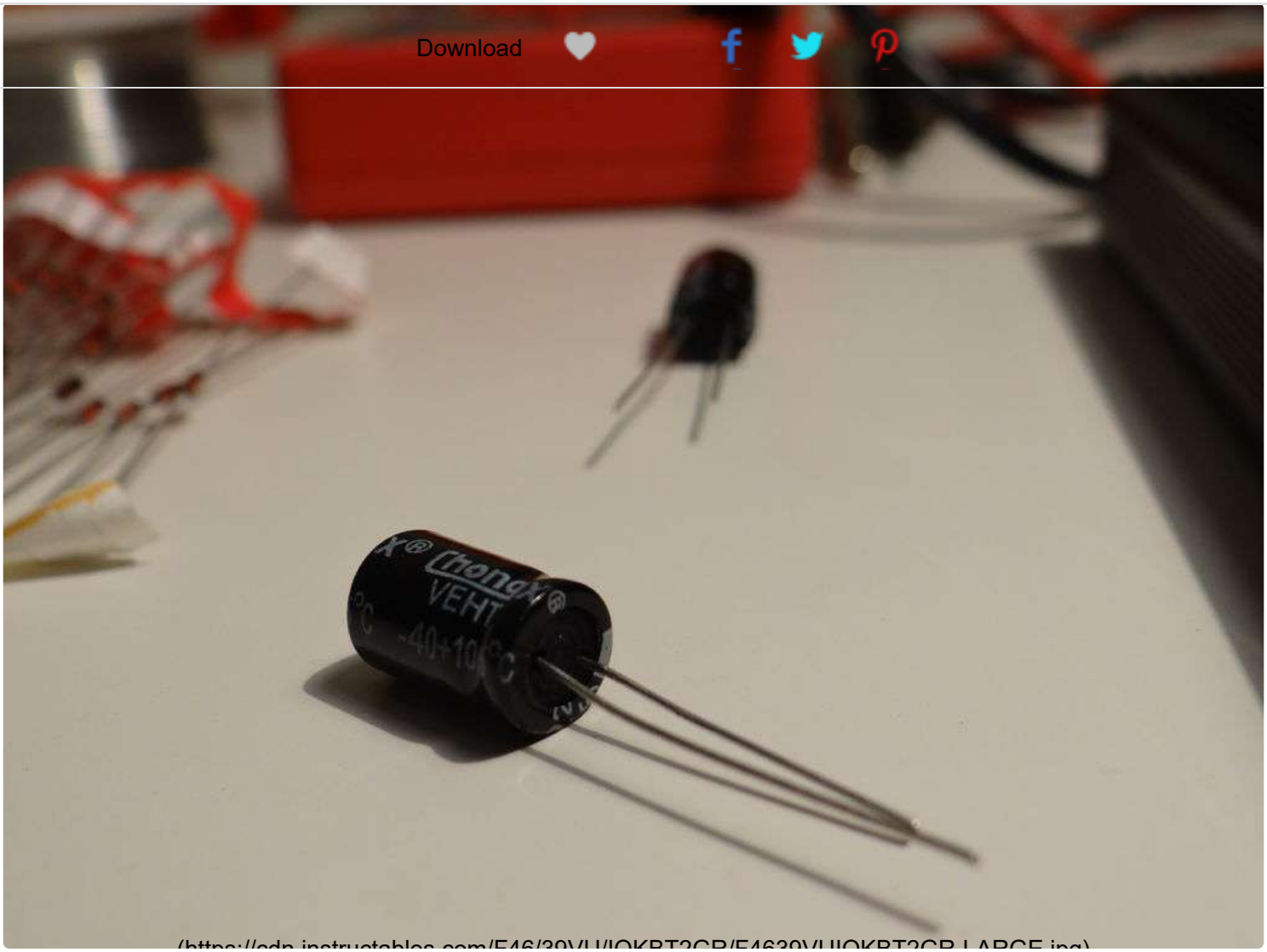

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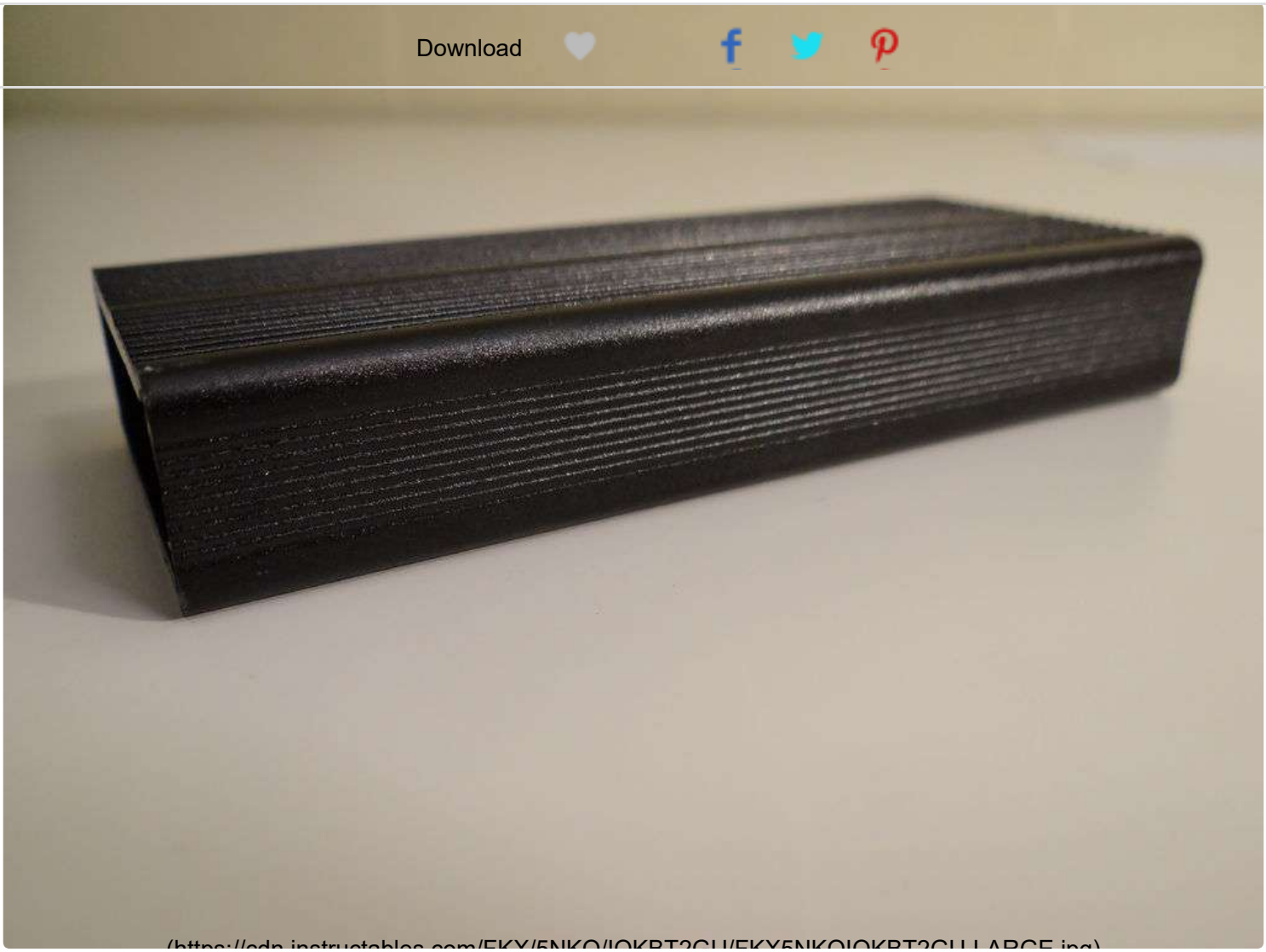

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One of the reasons this particular renewable energy harvesting method is so viable is the relatively few and easy to obtain materials required.

The simplest crystal receiver design needs no power and can be built with only three parts: a coil, a crystal and a resistor. We're going to optimize that design in order to produce a cleaner and more reliable output signal by first polarizing the input amplitude, then rectifying and filtering the signal. Then we'll add an antenna, case and connections.

Get the circuit diagram here (http://www.drewpauldesigns.com/crystal-energy-receiver-kit.html)
Get the kit here (http://www.drewpauldesigns.com/crystal-energy-receiver-kit.html)

Download

The parts for the circuit include:

(1) Circuit Board (http://www.drewpauldesigns.com/crystal-energy-receiver-kit.html)

(1) 10-18 gauge Copper Wire

(2-12+) Ceramic Capacitors (matched)

(2-6+) Electrolytic Capacitors (matched)

*note various types of capacitors can be used

(4) Germanium Crystal Diodes (1A+)

Total Unit Cost: +/- $0.40 (USD, scaled for volume of 1,000+ units)

In addition, you'll probably want to get:

(1) Project box (optional)

(1) Antenna (a loop antenna or elevated antenna is recommended and can be made with copper wire)

The tools you'll need are:

Soldering Iron/ Solder (optional)

Multimeter

Oscilloscope (http://www.seeedstudio.com/depot/DSO-Nano-v3-p-1358.html?cPath=63_65) (optional)

That's it. Yup, that's all. Once we've got it all, let's begin.

Add Tip Ask Question

Step 2: Build the Circuit

Download

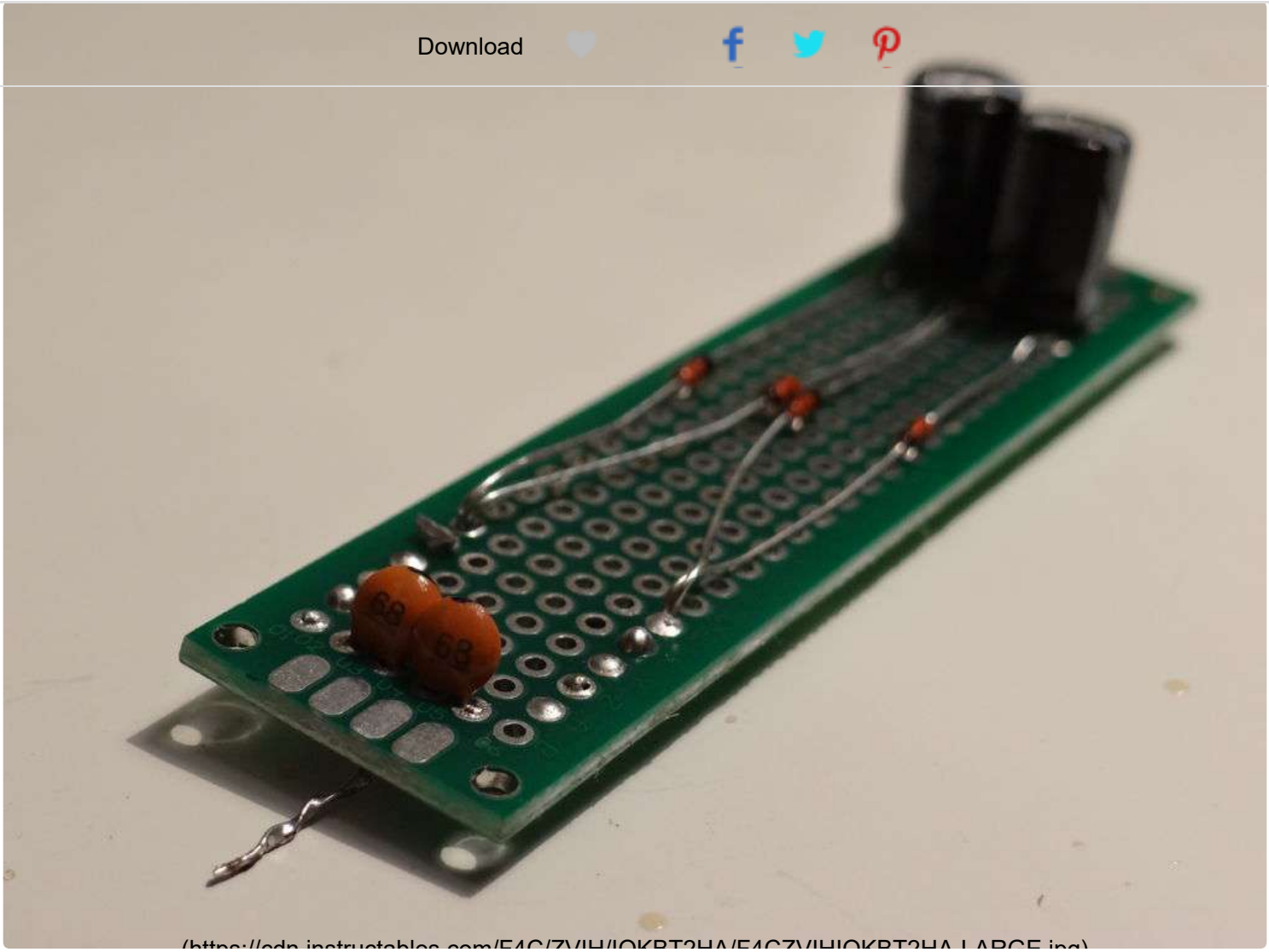

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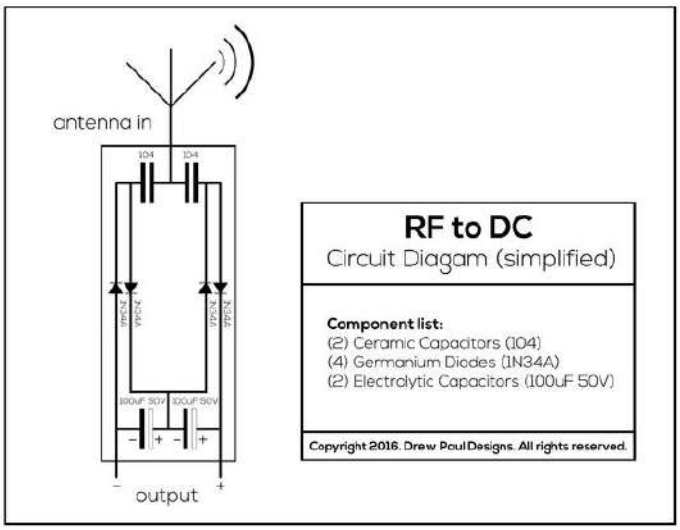

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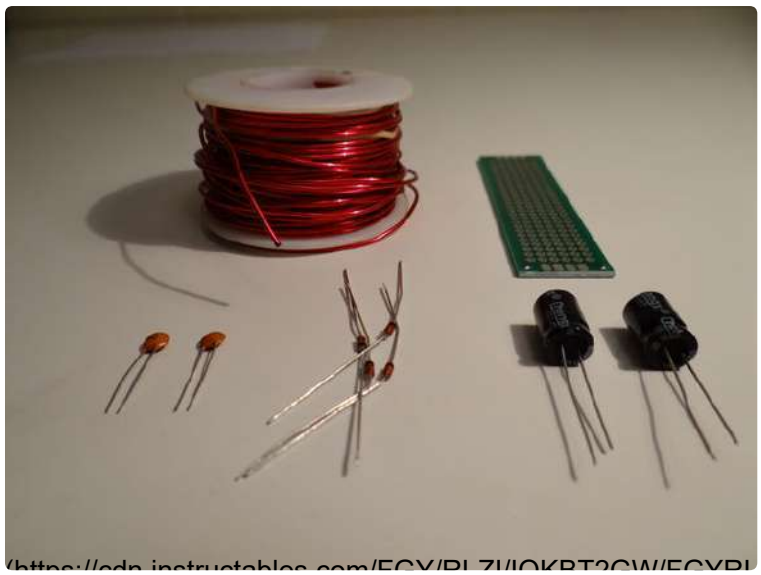

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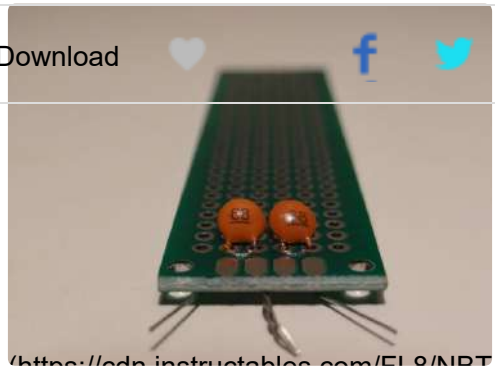

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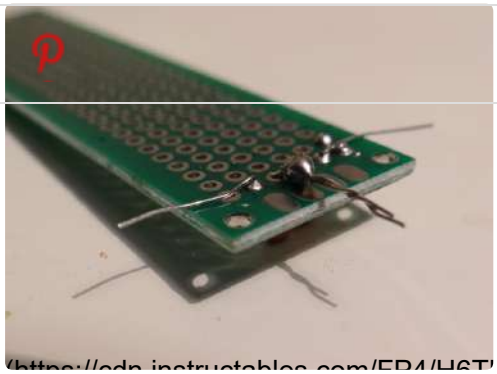

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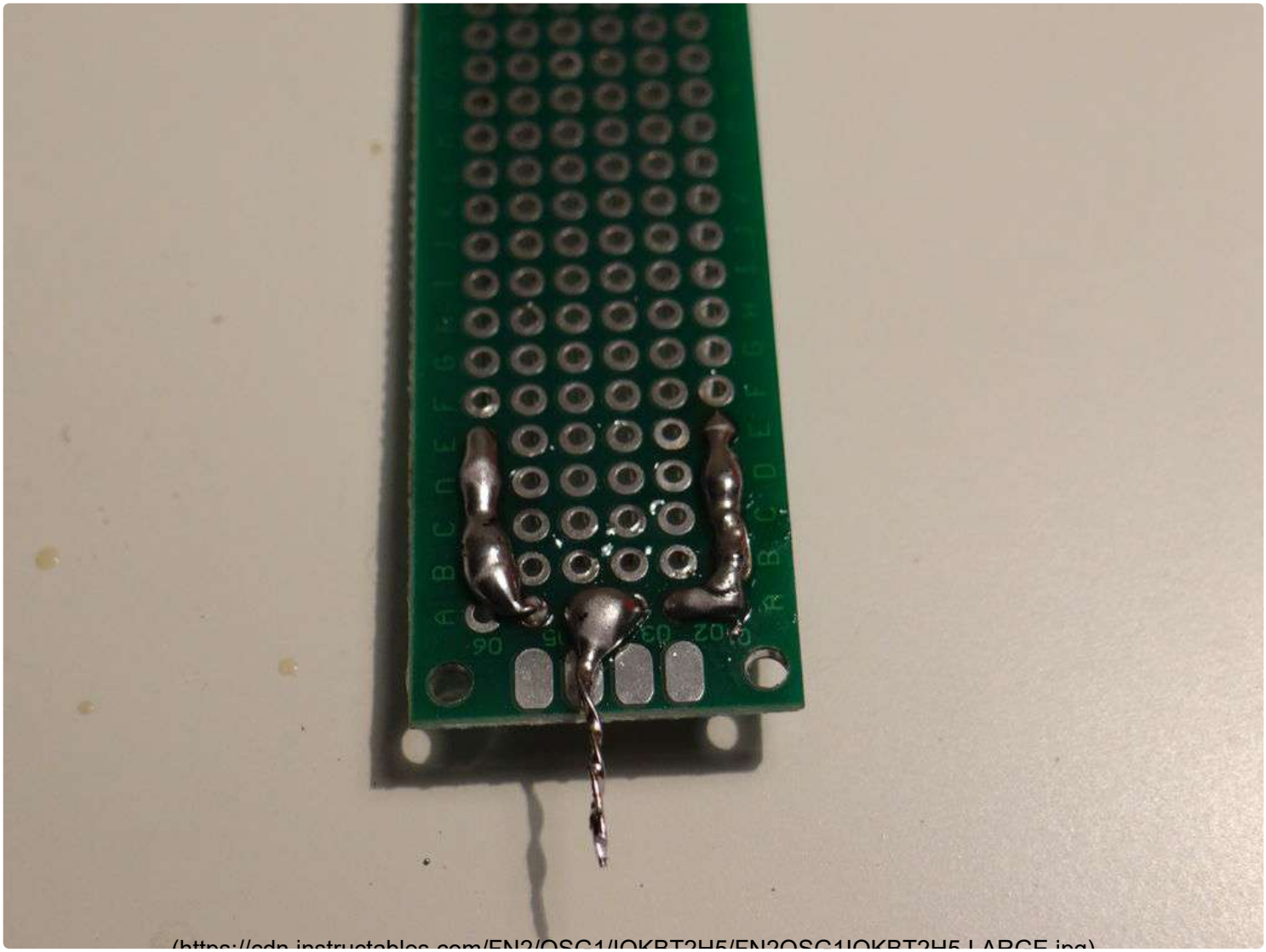

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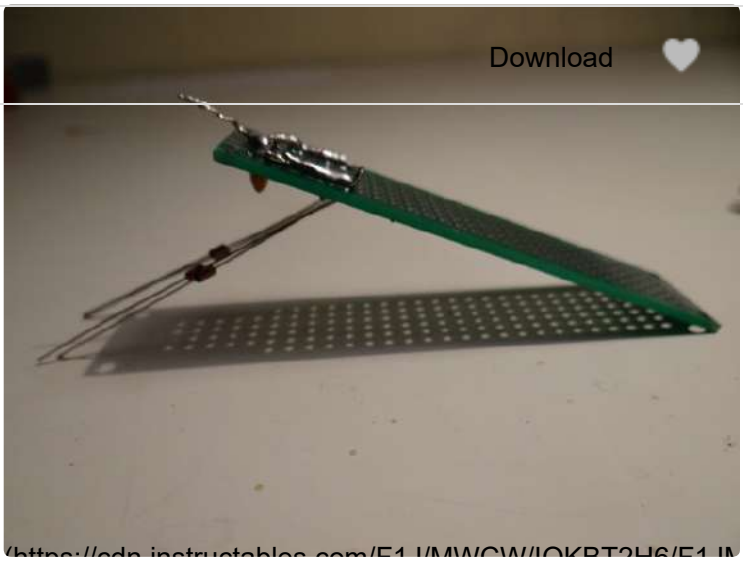

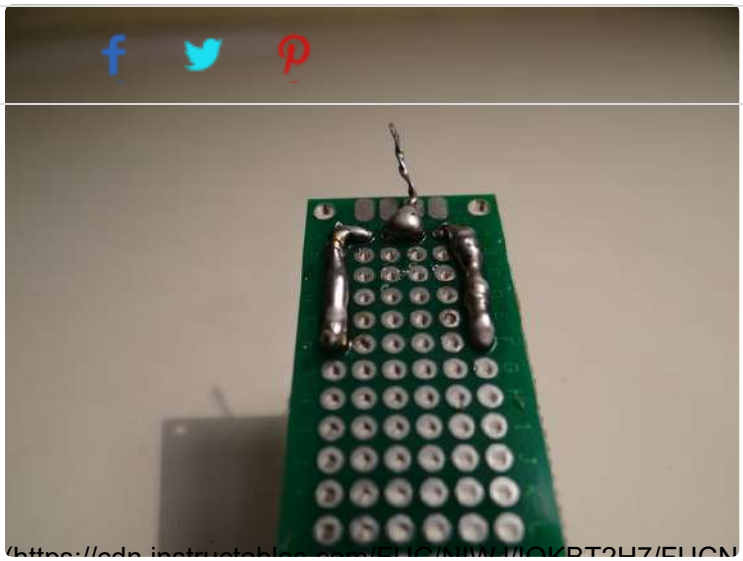

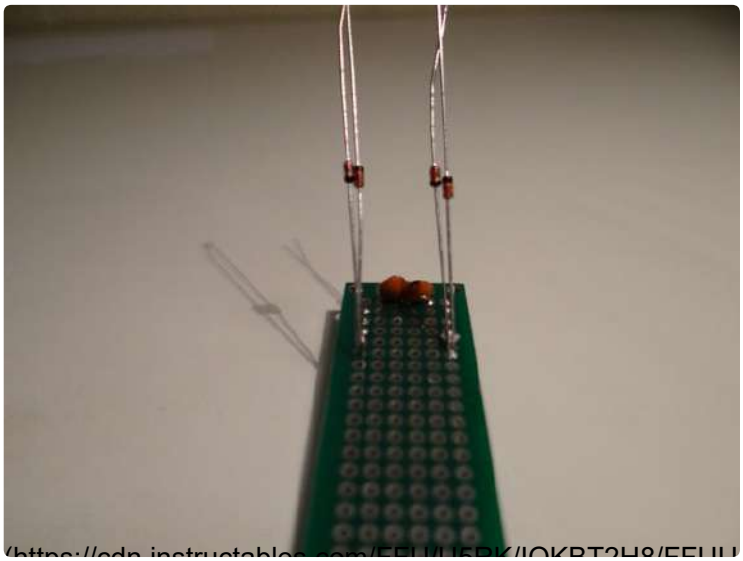

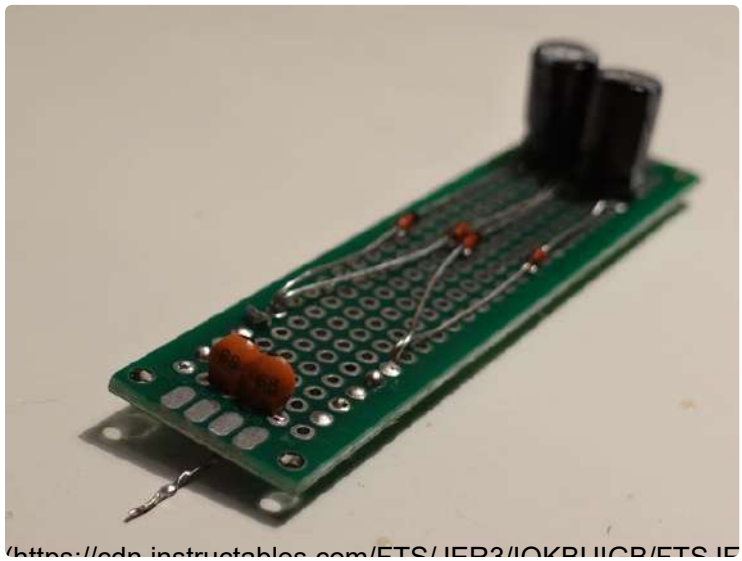

We're going to build the simplest version of this circuit variation in order to understand how each component interacts and as a proof of concept.

There are three simple systems at work in the circuit that are composed of capacitors, which store energy, and diodes that direct it.

Energy in the band of radio waves, among others, will vibrate a wire antenna on an atomic level, sending a discernible signal to its lead. This signal will then meet the junction between two ceramic capacitors wired in series. This junction will force positive charge from the wave to travel in one direction and negative charge in the other direction which, when collected again, makes the signal uniform and polar. Connecting the two capacitors in series creates leads on each end; the now positively charged side of one and the now negatively charged side of the other

creates a two cell battery. Download

This next stage of the circuit takes a signal with a net value of zero, adds the absolute values of the positive and negative amplitudes with respect to the origin and produces a positive integer. This concept can be thought of as taking:

(+1) + (-1) + (+1) + (-1) = 0

and converting it to:

| [(+1) + (+1)] | = 2
+
| [(-1) + (-1)] | = 2
= 4

Isn't math fun?

To each of these leads from our two capacitors in series, we will connect two crystal diodes, one facing each direction, to form what is called a bridge rectifier. A bridge rectifier is a configuration which will convert an alternating current to a direct one by cleverly rerouting the signal.

By connecting the bridge rectifier as shown in the circuit diagram, this direct current from the diodes then charges the electrolytic capacitors. This stage normalizes the amplitude, making the current constant and usable.

Components can easily be twisted together for testing and then soldered to a circuit board to secure.

Add Tip Ask Question

Step 3: Test and Optimize Your Circuit

Download

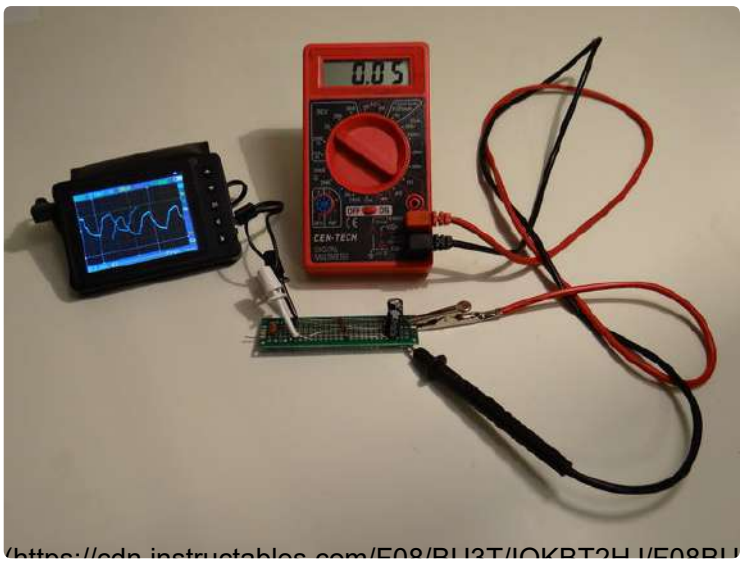

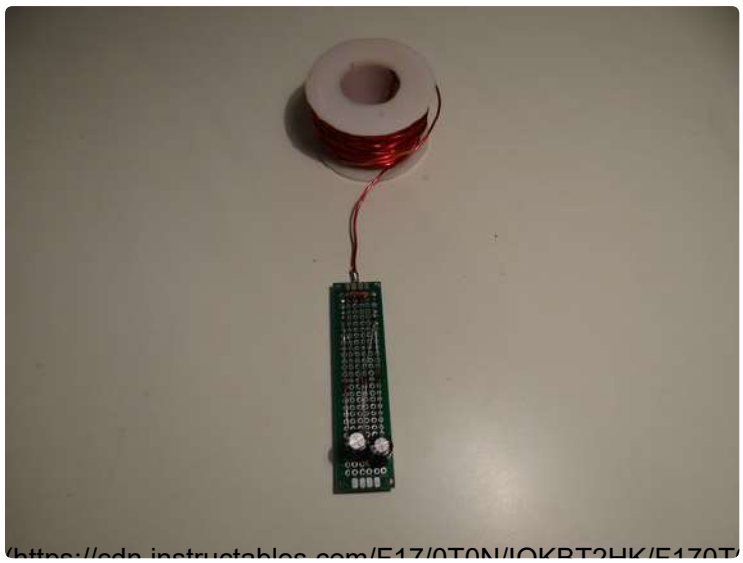

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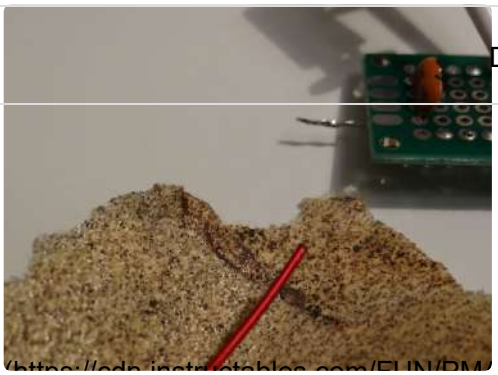

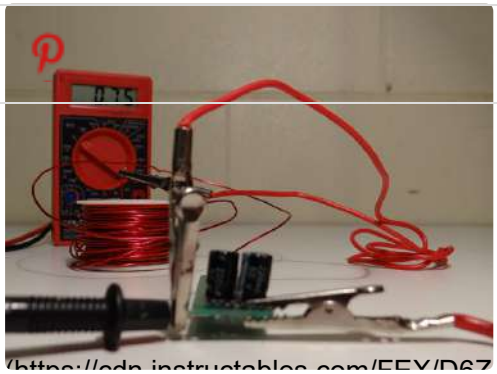

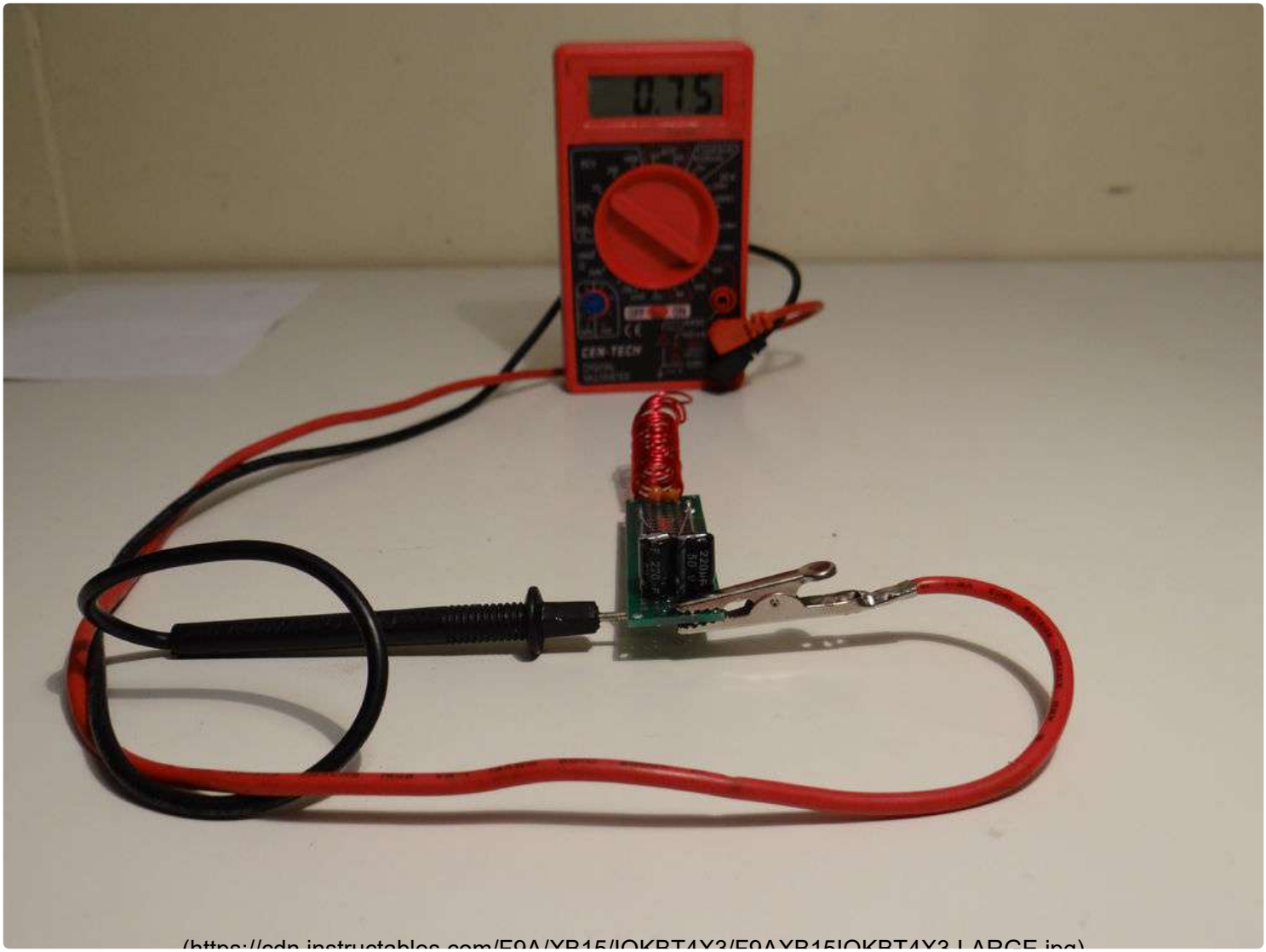

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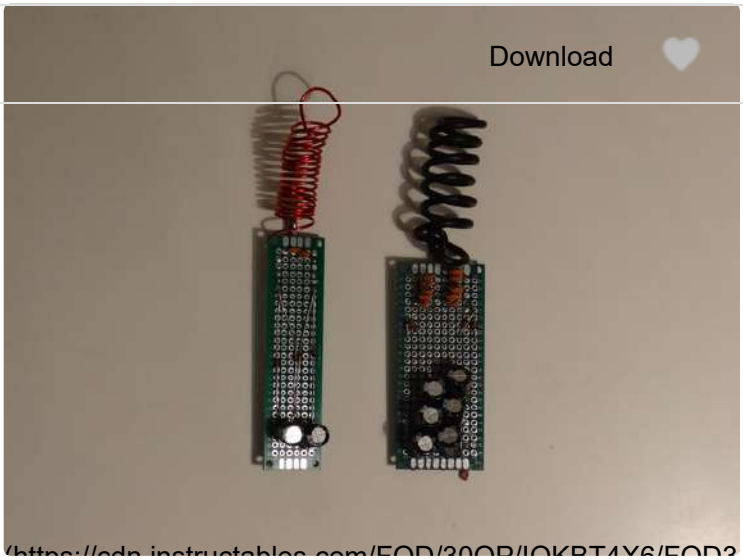

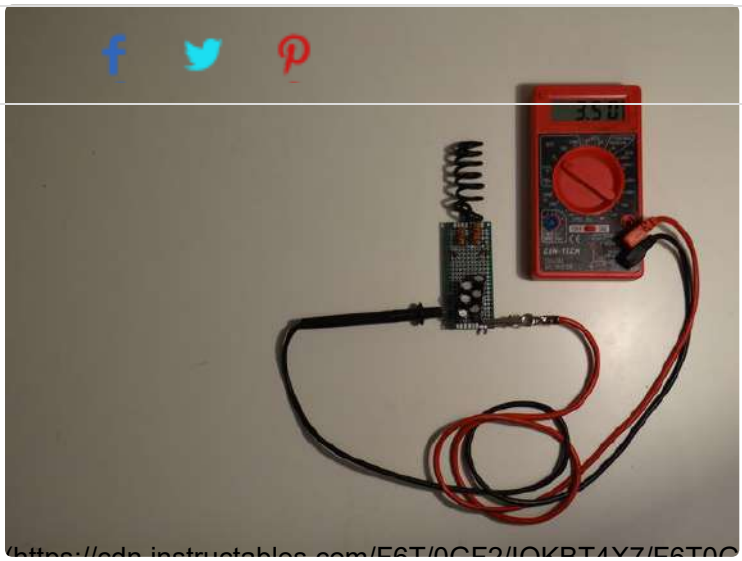

To test and analyze our circuit, we'll be using a digital voltmeter and oscilloscope.

By connecting a voltmeter to the output, we'll immediately begin to see a small voltage climbing in the 10-100mV range. If not, we'll want to check our connections and make sure the circuit is not isolated from the environment by taking it outside to a clear area.

Then, by connecting an oscilloscope to the outside leads of our two ceramic capacitor bank, we will see the the polarized signal being captured from the air around us. We can then connect after the diodes to see our varying direct current and then to after the electrolytic capacitors to see a normalized, usable direct current at our output.

We can then optimize the input resistance in two ways. Firstly, we can add additional ceramic capacitors in parallel to our original two and make sure our soldered connections are consistent and thick in this area.

We can optimize the circuit's capacity by adding electrolytic capacitors in parallel to our original two which will allow this circuit to charge slightly when not in use. For this purpose, a charging circuit can also be added here in order to incorporate an optional battery bank.

Download

We can optimize the antenna by attaching loops and coils of copper wire in various positions, store-bought antennas or by stringing some wire up to the highest point you can reach.

We don't have to stop there, either. We can now connect multiple circuits in series to increase voltage or in parallel to increase current. This can be done indefinitely.

Add Tip

Ask Question

Step 4: Add a Case and Antenna

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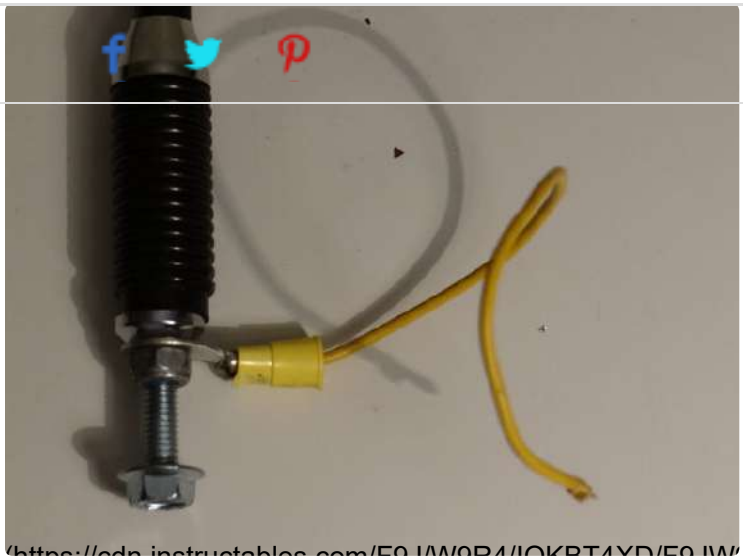

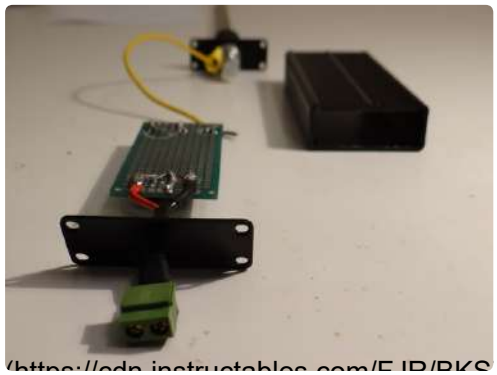

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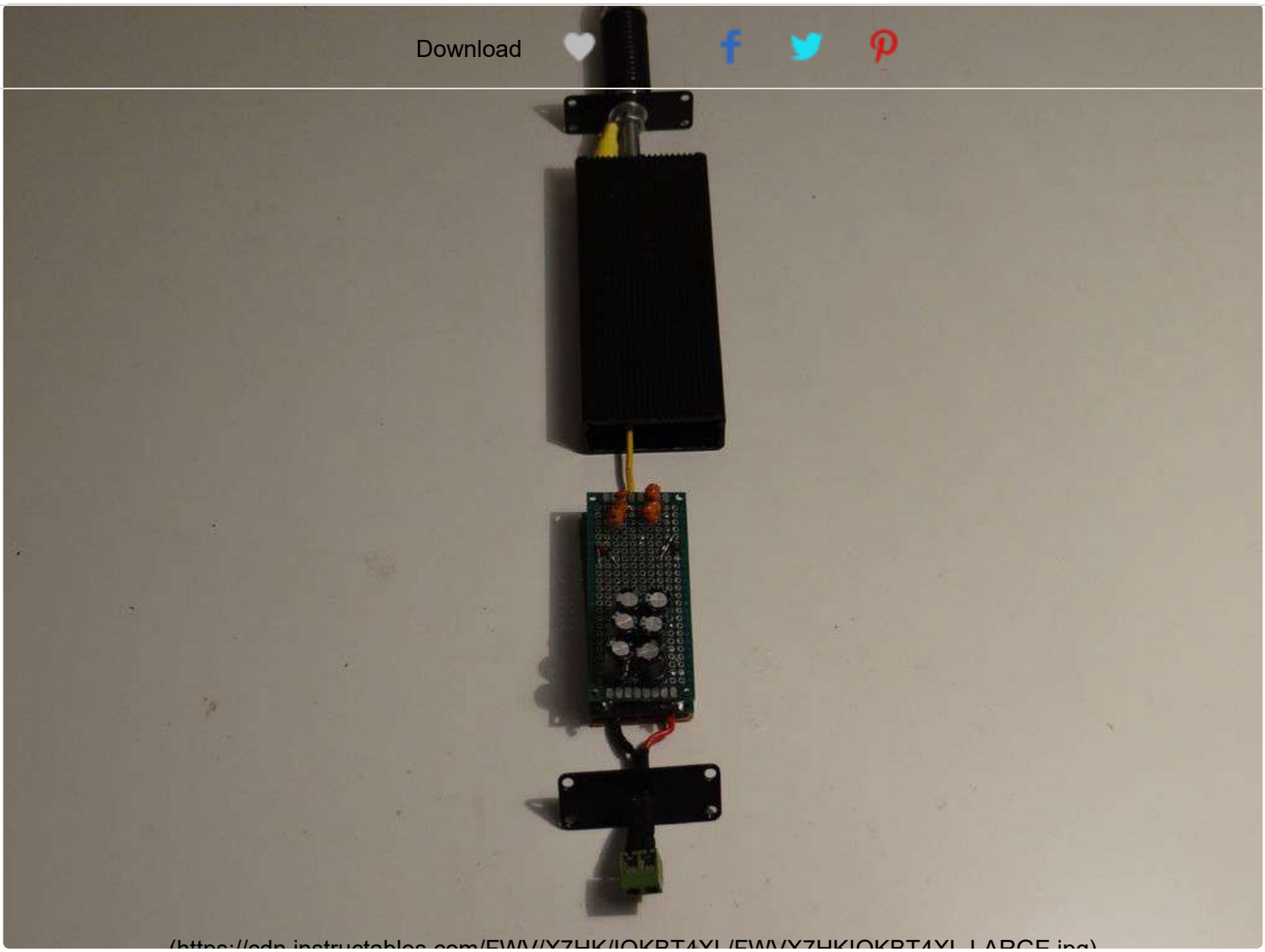

After choosing an antenna in the last step we'll now want to permanently wire it. Whether you choose a compact antenna for portability or a tall fixed antenna for power and range, we will wire it in the same manner according to the diagram in the previous step. Note that the input on the configuration here is grounded to the metallic case, and thus the users hand, and incorporation of longer antennas will require proportionally more substantial grounding.

Download

We will then attach a terminal to the output to allow us to connect this circuit to an electrical device or charging circuit and battery bank.

Next, we will add a case, making sure to isolate exposed leads with non-conductive material especially if mounting in a conductive case. A piece of cardboard secured with glue is sufficient for the circuit's bottom and shrink wrap or electrical tape can be used in the case of any additional exposed leads. Drill two holes in your enclosure, one for the antenna or antenna lead and another for your output terminals. You can then insert your components, fasten the enclosure and your device is ready to use!

Add Tip

Ask Question

Step 5: Your Crystal Energy Receiver Is Complete!

Download

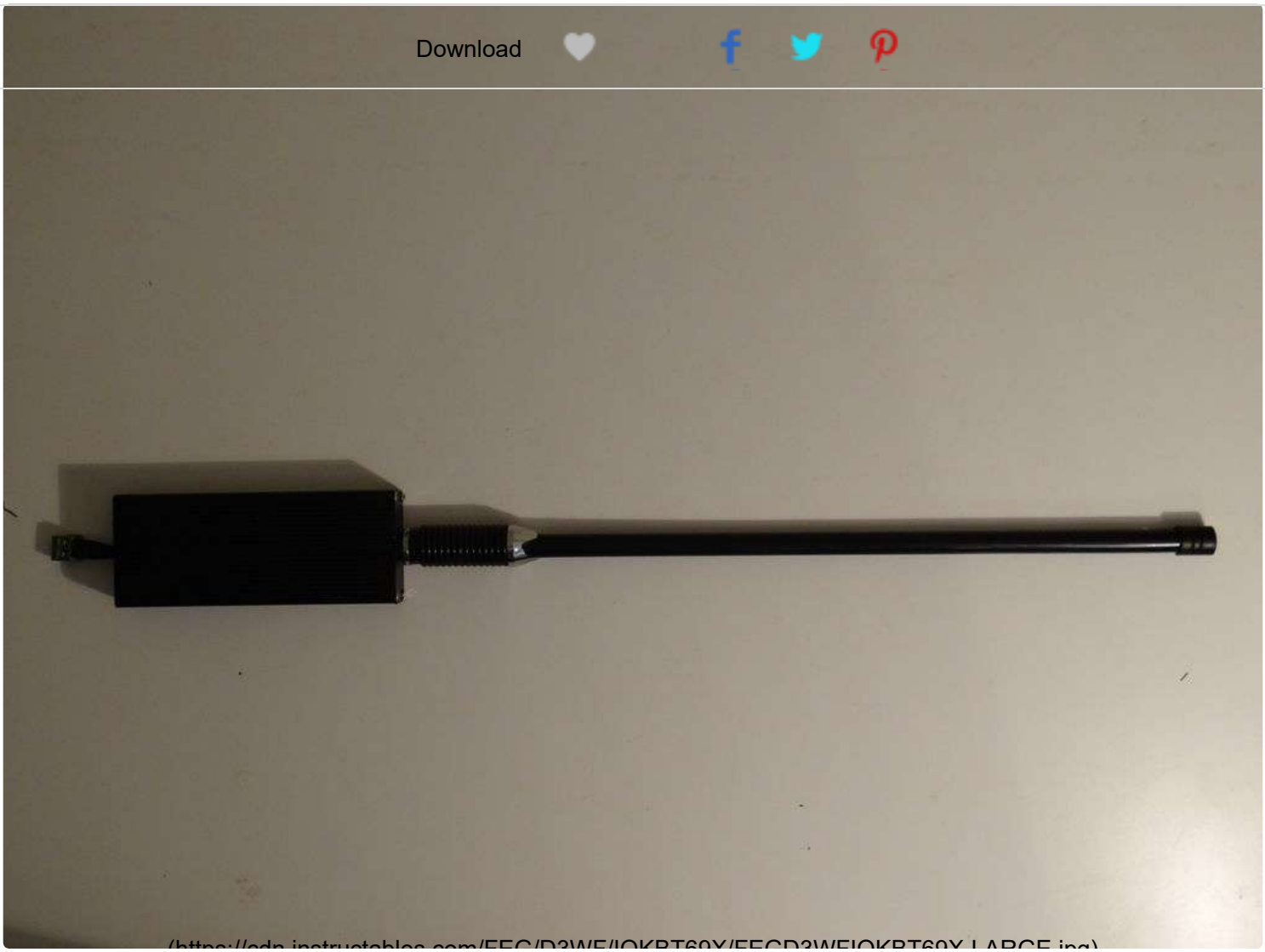

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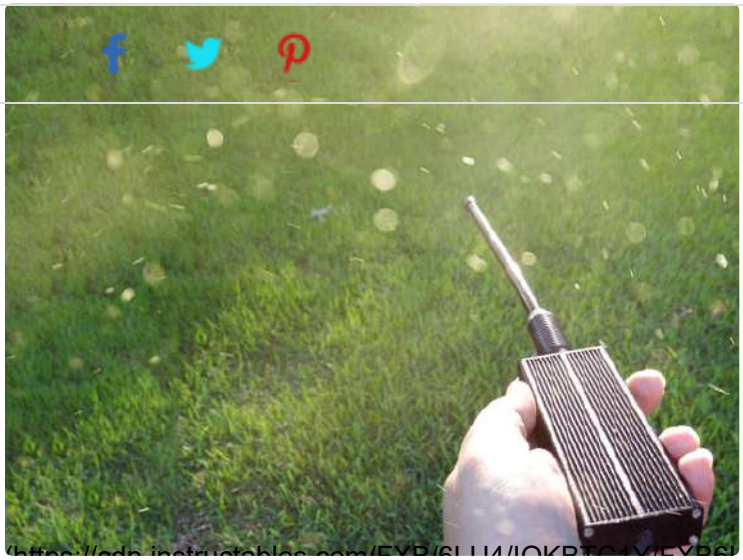

Your Crystal Energy Receiver is now complete and ready to use!

I built a portable version, for proof of concept and demonstration purposes. However, you can go as big as you want- to passively charge batteries or run equipment remotely; or go as small as you want- to power sensors, RFID devices, small electronics and more.

I used this harvested energy to easily power a low-consumption quartz clock, a digital chronograph with integrated circuits and LCD and was even able to momentarily rotate a small dc motor.

Because of its simplicity this device is a durable, efficient and reasonably effective method of harvesting radiant energy in a simple, replicable and sustainable way. I humbly hope that the contributions made here, and by those reading, can be one day used by people worldwide to conveniently capture free energy.

Thanks for checking out my project and I look forward to seeing everyone's variations, suggestions and improvements!

Add Tip

Ask Question

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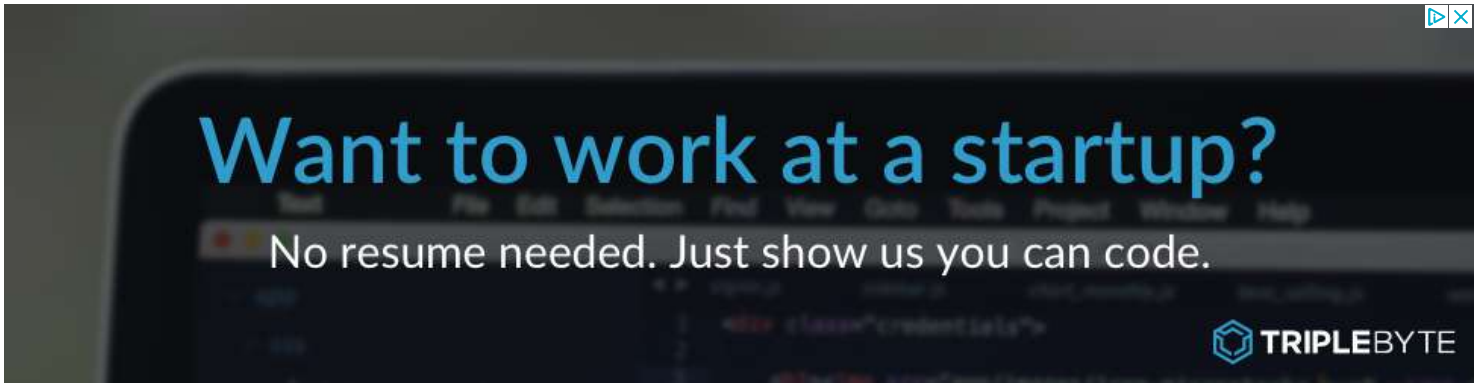

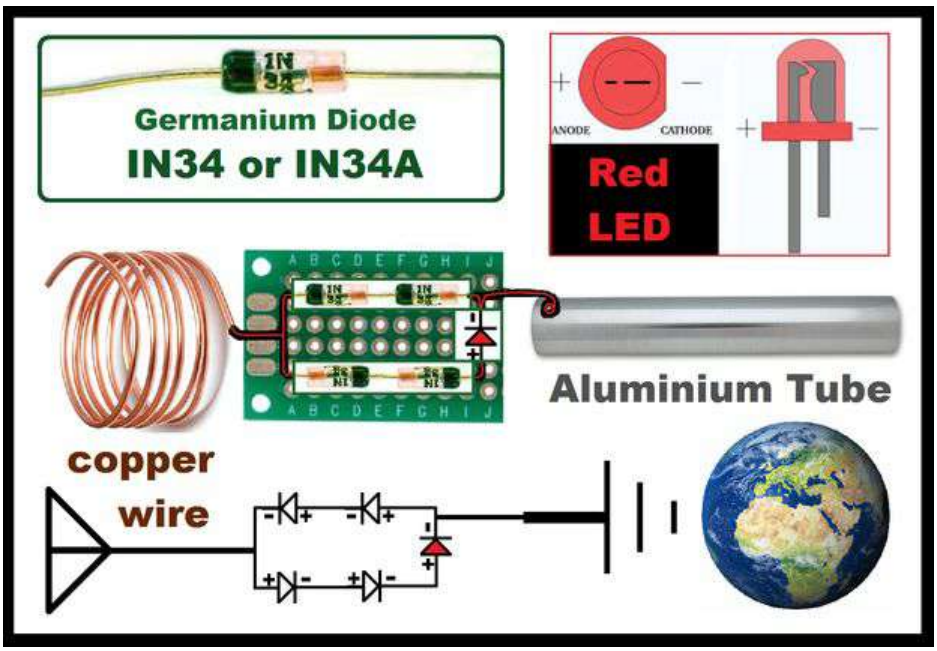

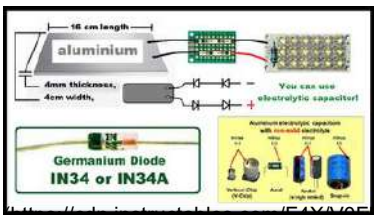

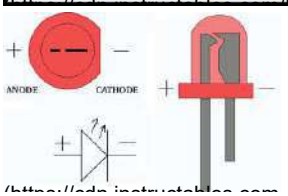

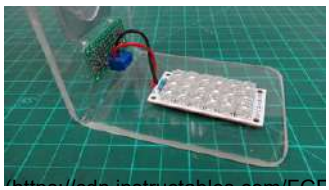

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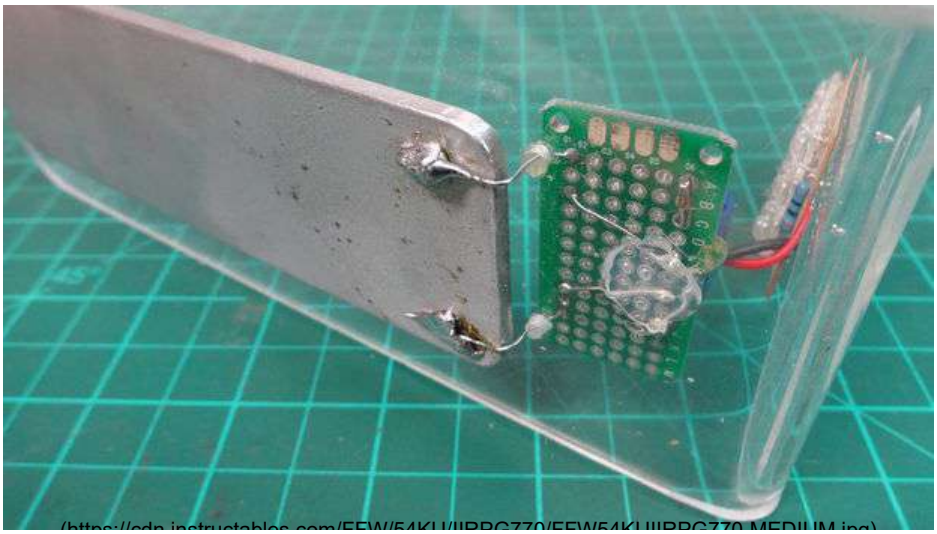

How to Make a Electrostatic RF Detector or Ghost Detector, Hunting Solution. Much cheaper and easier than you may think For Under $5 ! A simple description is that IN34 or IN34A RF Germanium Diodes for Crystal Radio can take "Ambient" or "Radio Waves" to turns them into DC energy. I would like to show the Tesla Coil Transmitter, where I made an homemade "RF Detector" this is the simplest detector! without any batteries or hardships circuit, only with IN34 diodes and Ether to Earth!.. Stay Tuned and Enjoy! Please click the "like" button, subscribe my channel, and share this with your friends... To support my "work" every little bit helps! Watch the "ADS" THANKS

- See the original video https://www.youtube.com/watch?v=cSxqeGVC9t0

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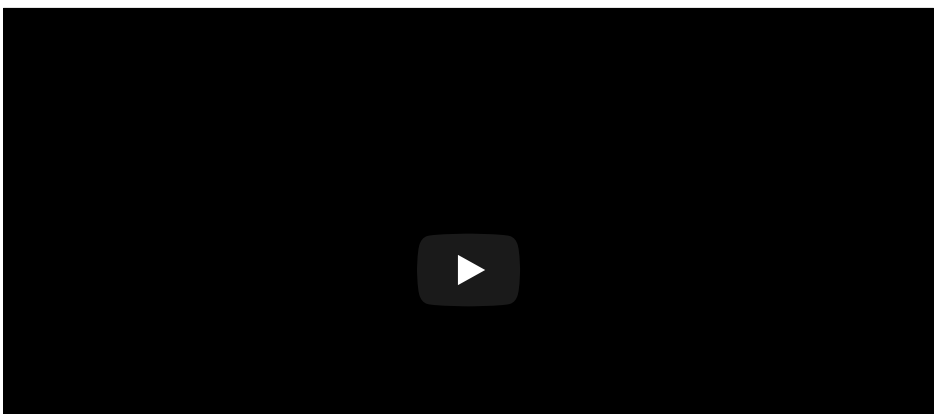

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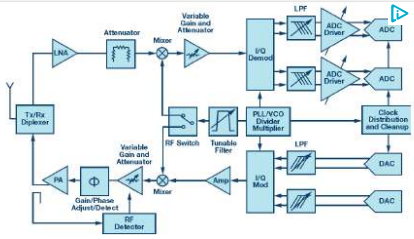

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Build a Homebrew Radio Telescope

Explore the basics of radio astronomy with this easy to construct telescope.

Mark Spencer, WA8SME

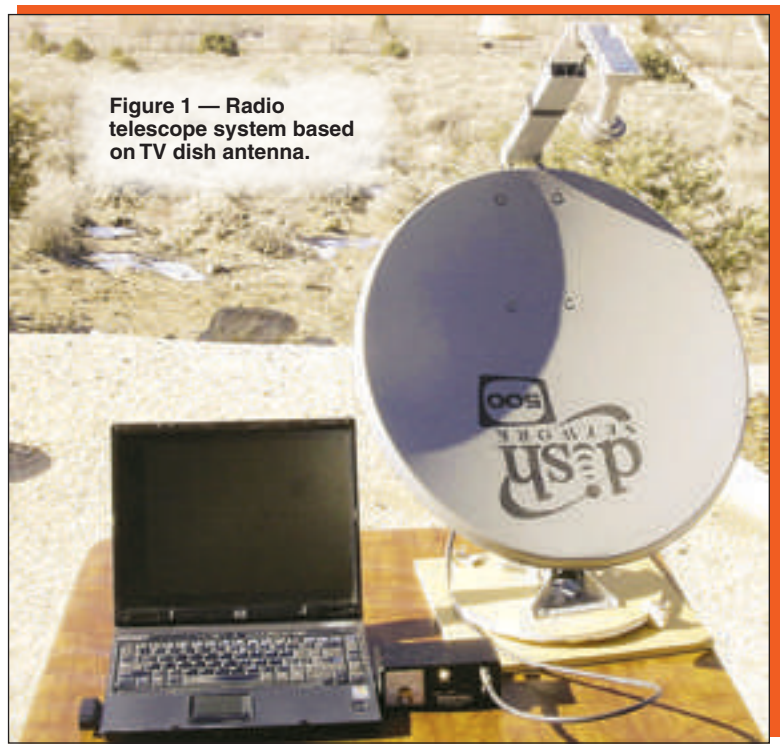

Figure 1 — Radio telescope system based on TV dish antenna.

There are many ham radio related activities that provide a rich opportunity to explore and learn more about the science of radio. One of those opportunities is radio astronomy.

All matter emits radio frequency (RF) energy dependent on the temperature and makeup of the matter, including the matter in space. The foundation of radio astronomy is to study the heavens by collecting and analyzing the RF energy that is emitted by bodies in space, very much as optical astronomers use light energy collected by telescopes. It sounds complicated. While professionals use very sophisticated and expensive equipment, you can, with some simple equipment and a little investment, build a radio telescope that will allow you to learn and explore the fundamentals of radio astronomy.

A Homemade Radio Telescope

In this article, I will build on an existing design of a radio telescope made from one of those ubiquitous TV dish antennas that you see around your neighborhood. The radio telescope (RT) project described here can easily be reproduced. Although this is not a fully capable RT, it can provide a wonderful learning opportunity for you, or perhaps students in your local school.

Figure 1 shows the radio telescope set up. The major components include a modified TV dish antenna mounted on a wooden support structure to allow pointing the antenna, a commercial satellite signal strength detector that displays the signal strength of signals collected by the dish on a meter and an interface that converts the signal strength into a amplitude modulated tone. The tone is fed into a computer sound card and finally a computer and software graphically displays the signal strength as a function of time.

The TV dish modifications are structural, and any available TV dish system can be used. The signal strength detector costs between $40 and $65 and is widely available from Web retailers. The interface circuit, which will be described shortly, is easily duplicated and costs approximately $20. Finally, the display software is free.

Figure 2 — Dual LNB mount. Note two coax connectors.

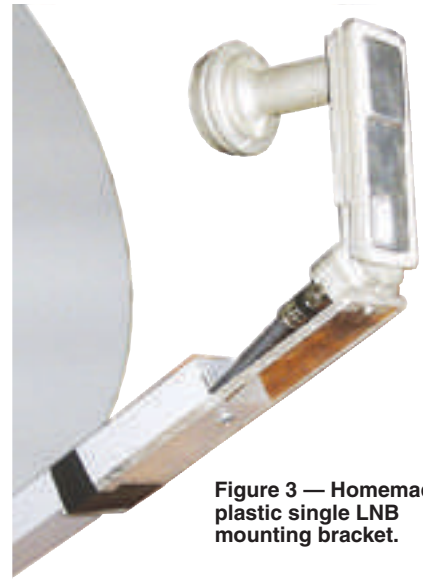

Figure 3 — Homemade plastic single LNB mounting bracket.

What it Can Do

The following is just a sample of what you can do with this simple RT:

- Use the sun to study and determine the beamwidth of the dish and verify the mathematic formula that is used to predict dish antenna performance.
- Measure the radiation intensity of the Sun and perhaps detect changes in solar activity.
- Measure the relative changes in the surface temperature of the moon.
- Learn about and explore a common radio astronomy collection technique called the *drift scan*.

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Figure 4 — Dual coax connector configured LNB. Terminate one connector with a dummy load.

Figure 5 — CM satellite signal strength meter.

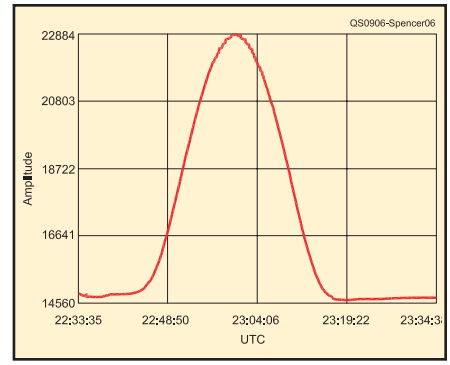

Figure 6 — *SkyPipe* screen showing antenna response.

- Explore the fundamental principle of energy emission as a function of temperature by detecting the relative differences between the temperatures of emitting bodies.
- Detect satellites parked along the Clarke Belt in geosynchronous orbit and illustrate how crowded space has become.
- Detect the Earth's rotation around the Sun and the Earth's spin on its axis by comparing daily drift scans of the horizon.

Antenna Subsystem

The basic RT system is based on the "Itty-Bitty" design that is described in two Web pages.[1,2] The TV dish is an offset 18 inch dish that has down converter(s) mounted at the focal point of the dish. The down converter is called a low noise block (LNB). The LNB is a preamplifier/down converter that converts the satellite signals from around 12 GHz down to around 2.4 GHz. Most modern dishes have two or more LNBs to access more than one TV satellite at a time without changing the pointing of the dish (Figure 2). The LNBs are mounted to share the focal point of the dish. Since only one LNB is required for the RT, I made a minor adjustment to the published Itty-Bitty design to position the single LNB at the dish focal point. Mounting the single LNB at the focal point really helps in pointing the antenna.

I used the existing LNB housing and mounting bracket as a template to determine the distance between the edge of the mounting arm to the mounting hole of the LNB. I then used a piece of plastic to fabricate a new mounting bracket for the LNB as shown

[1]Notes appear on page 45.

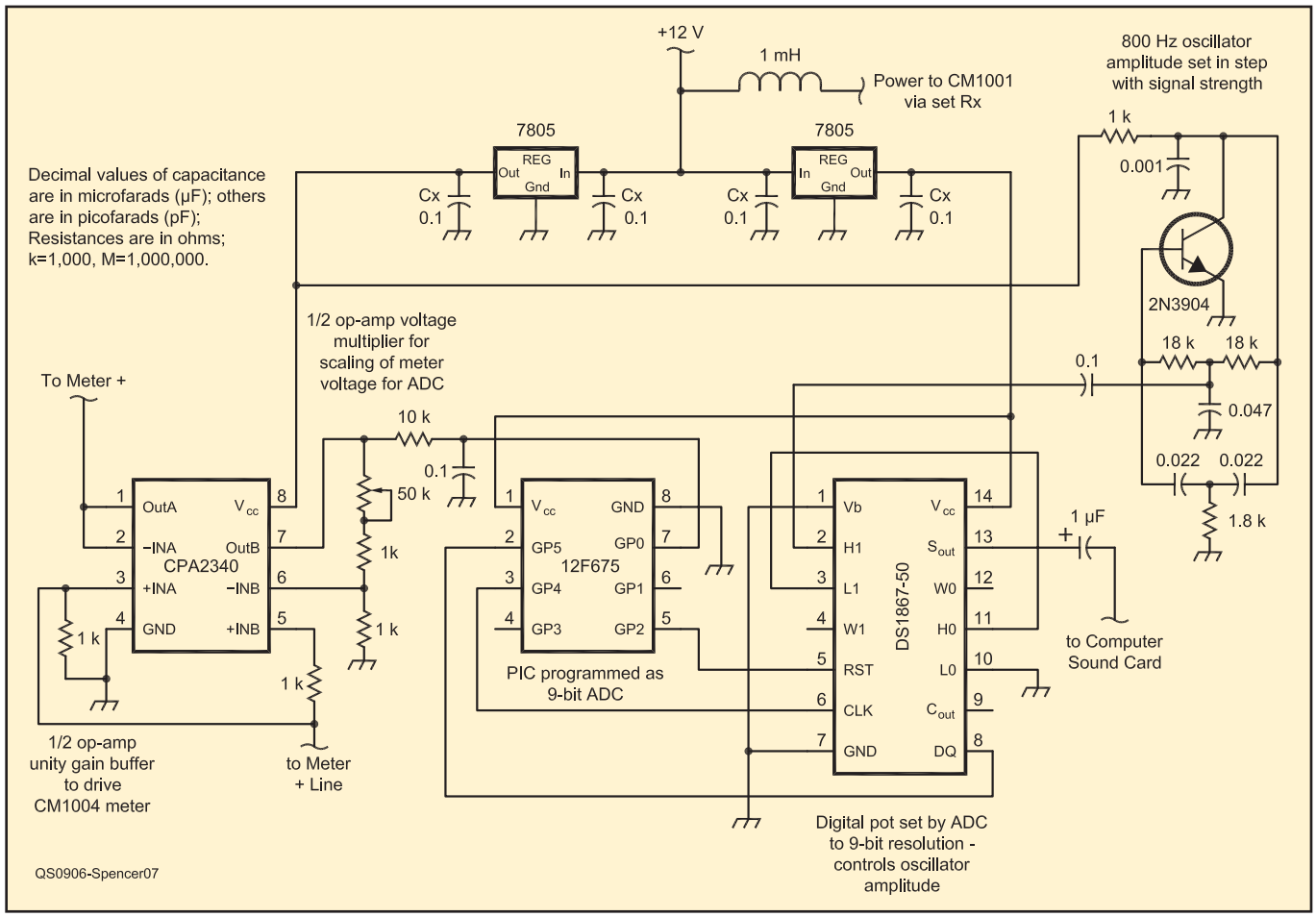

Figure 7 — RT Interface circuit diagram.

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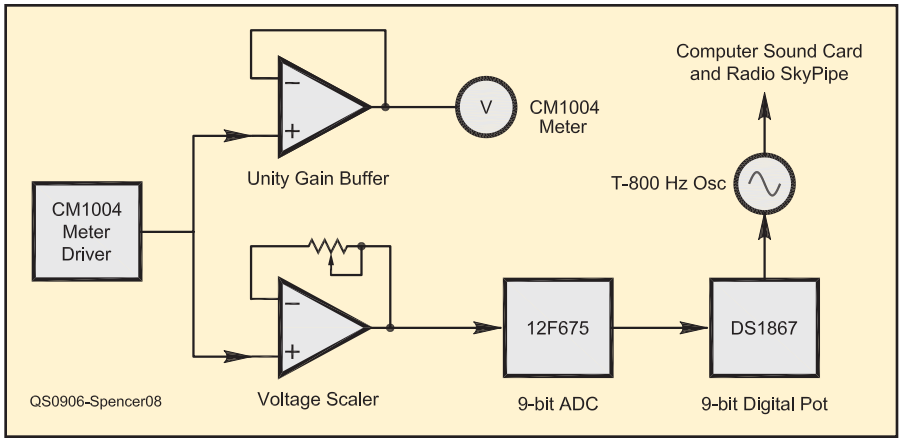

Figure 8 — RT Interface block diagram.

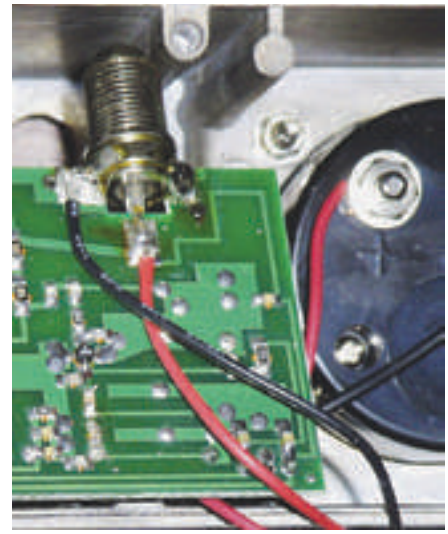

Figure 9 — Power and ground connection to CM board.

in Figure 3. The dimensions are not super critical, but careful placement certainly will improve the RT performance.

Some LNBs have two coax connectors. Only one will be used in the RT (Figure 4). It is a good idea to terminate the extra coax connector with a 75 Ω dummy load plug to balance the load on the LNB. The dummy loads for F type TV coax connectors are readily available from electronic parts retailers.

Note that the dish is mounted upside down. Though this orientation is not ideal for receiving satellite signals, this arrangement helps with pointing the dish in its radio telescope role.

Satellite Detector

The detector used in this project is the Channel Master (CM) satellite signal level meter model 1004IFD (Figure 5).[3] The CM is connected to the LNB. Power is supplied to the LNB through the coax connection from the CM. The CM detects the signal coming from the LNB and gives a meter indication of the signal strength and also varies the frequency of an audio tone to help technicians point the dish at the desired satellite. As you move the dish through the beam coming from the satellite, the meter indication will increase and then decrease coincident with the pitch of the audio tone.

The Itty-Bitty plans detail how to connect power to the CM and in turn connect power to the LNB (this power connection is handled by the interface in this project). Though somewhat effective, the CM meter and variable frequency tone indications provide limited utility in detecting changes in signal strengths required for radio astronomy.

Display

To really study the signals received by the RT, you will need to see them displayed graphically on a strip chart. There is an excellent software package called *Radio-SkyPipe* that is posted on radio astronomy Web sites.[4] The free version of this software is a good place to start. *SkyPipe* uses the computer sound card to measure the incoming signal strength and graphically displays the signal strength as a function of time. Figure 6 is illustrative of a signals detected by the RT. *SkyPipe* is very easy to use but some study of the HELP files will make it easier for you to fully tap into the capabilities of this software.

SkyPipe requires audio signals to be fed into the sound card MICROPHONE jack. The output of the CM detector is either an analog meter reading or a frequency modulated (constant amplitude) tone that is not really compatible with *SkyPipe*. An interface is required.

Interface

What is required to make the CM output work with *SkyPipe* and a sound card is to convert the signal level into an amplitude varying audio tone. The interface designed to do this is shown in Figure 7 and as a block diagram in Figure 8. Refer to the block diagram during the description of the interface function.

The unity-gain op-amp is used as a buffer between the CM meter driver circuit and the analog meter. The other op-amp is used as a voltage multiplier to scale the CM meter driver output voltage to match the 5 V reference voltage of the following analog to digital converter (ADC). The variable resistor in this voltage multiplier circuit is used to calibrate the CM to *SkyPipe*. The voltage from the multiplier is fed to a programmable interface controller (PIC) that is programmed as a 9-bit ADC to covert the analog voltage that is a function of received signal strength to a 9-bit digital word that is used to control a digitally controlled variable resistor. The interface includes a simple Twin-T audio oscillator circuit that provides a tone of approximately 800 Hz that is fed to the computer sound card. The amplitude of this audio oscillator is varied by the digital pot that is being controlled by the PIC. The result is the audio amplitude being varied in step with the signal strength detected by the CM.

The circuit provides power to the CM and the LNB. A 12 V source in the CM is tapped through an RF choke and this is connected to the LNB coax connector inside the CM (Figure 9). The 12 V is also regulated to 5 V to provide power to the interface. Though probably not required, there are two 5 V sources, one for the digital components of the interface, and the other for the analog components with one common ground point. This arrangement is used to isolate potential digital and analog noise sources within the circuit.

The interface is built on a circuit board and mounted right inside the CM box

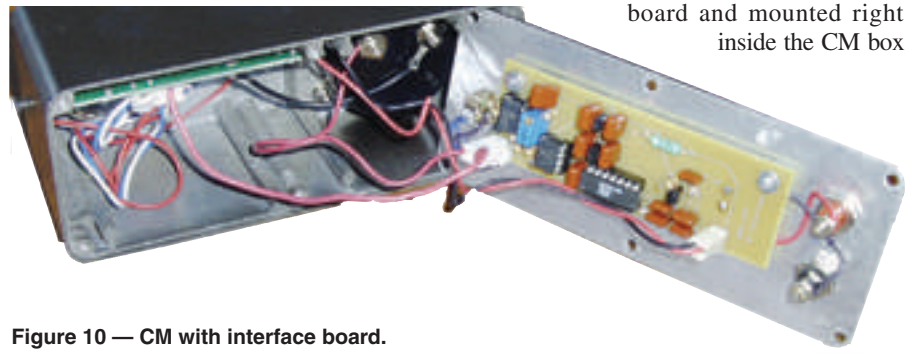

Figure 10 — CM with interface board.

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Figure 11 — Aiming the RT at the Sun, note LNB shadow location.

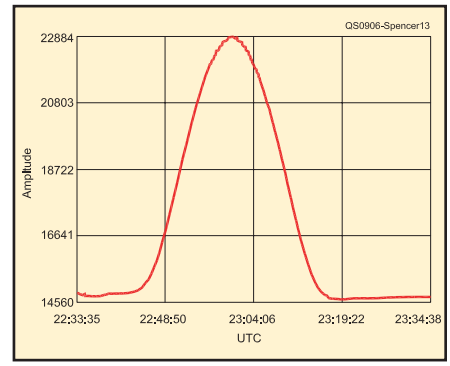

Figure 13 — Drift scan of the Sun indicating antenna's azimuth pattern.

(Figure 10). Though I made an etched circuit board for the circuit, the hand wired prototype worked equally well for those who would rather roll their own. The PIC firmware is available on the *QST* Web site.[6]

RT in Action

The first thing you need to do is learn how to point the RT antenna. The best place to start is to connect the CM to the antenna and point the antenna at the Sun. *Caution*: Do not look into the Sun as you do this, or at any time. Adjust the pointing angle and elevation until you get peak signal strength as indicated on the CM meter or hear the highest pitch audio tone. With the antenna pointed directly at the Sun, take note of the position of the shadow of the LNB on the surface of the dish (left in Figure 11). If you look from behind the dish, along the LNB

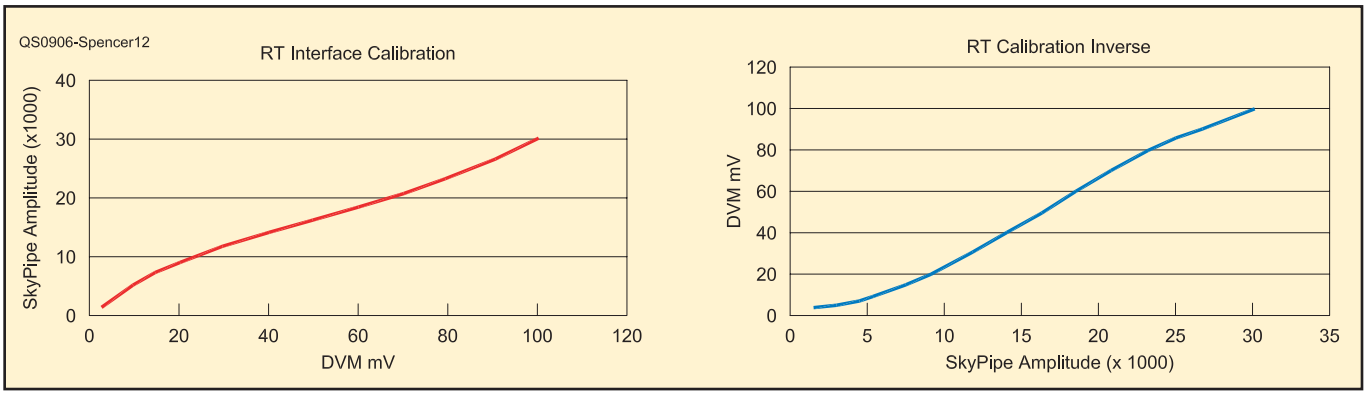

Figure 12 — Example calibration curves.

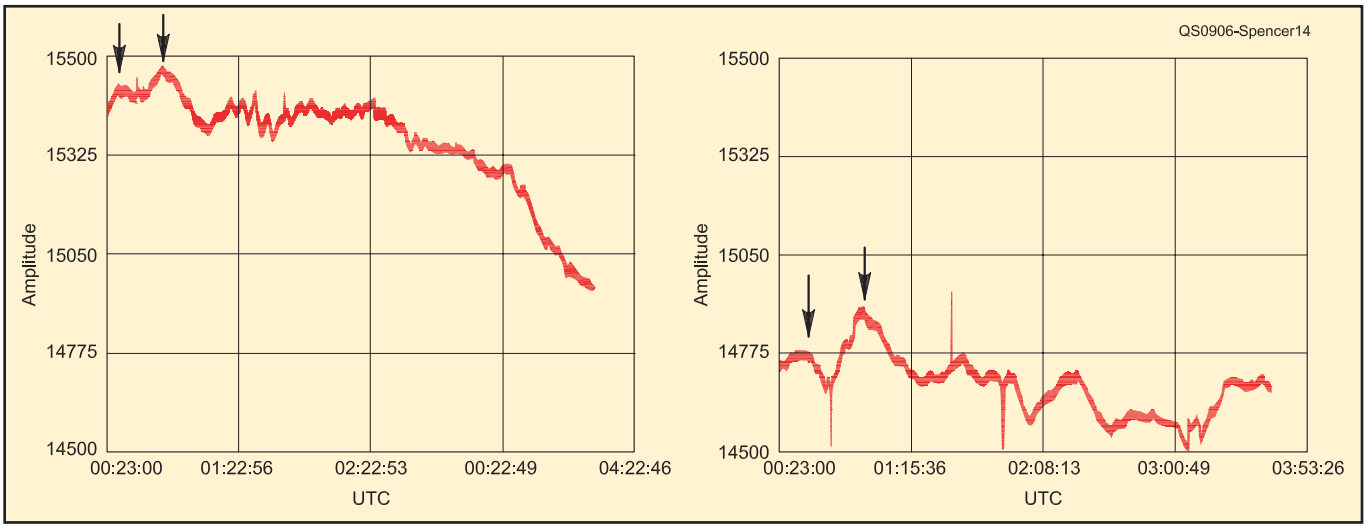

Figure 14 — Sequential drift scans. Note the time offsets between the peaks.

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supporting arm (between the arm and the rim of the dish), you will see the Sun being blocked by the LNB.

Once you have the RT set up, it needs to be calibrated to match the output of the CM to *SkyPipe*. I have developed an *Excel* spreadsheet template to help with the calibration and a few of the other activities that you can accomplish with the RT (also available from the *QST* Web site). Turn the RT to a signal source, the Sun, or the side of a building would work. Turn the gain control of the CM to set the meter to maximum. Run *SkyPipe* and adjust the variable resistor on the interface board until you get a reading on the *SkyPipe* graph vertical (y) axis of approximately 32,000. With the maximum value set, adjust the CM gain control through the voltage range (0 to 100 mV) in 10 mV steps and record the corresponding y axis value on *SkyPipe*. This data is entered into the *Excel* spreadsheet to compute the calibration curve between voltage and y axis value. Both voltage and y axis values are used in analyzing recorded signal strength data (Figure 12).

A good first activity is to do a drift scan of the Sun. A drift scan means that you set the antenna azimuth (AZ) and elevation (EL) to some fixed pointing angle and allow the Earth to serve as the rotator to drag the antenna across the sky. To do a drift scan of the Sun, first set the elevation and azimuth to point directly at the Sun (maximum signal) and then move the azimuth toward the west

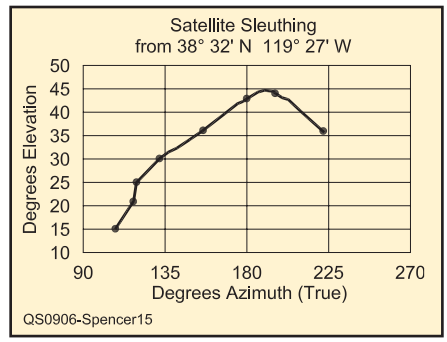

Figure 15 — Clarke Belt plot — tracking down satellites.

(leave the elevation set) until you are off the peak signal. Now start *SkyPipe*. In about 15 minutes, the Sun will pass through the antenna pattern beam width and the result will be as illustrated in Figure 13. You can also use this collection technique to explore the antenna performance parameters.

A good second activity is to do two drift scans of the night sky on two consecutive nights (beginning the scans at the same time each night) using the same fixed antenna azimuth (AZ) and elevation (EL). Figure 14 shows two such drift scans. Although at first glance they may not seem similar, there are some interesting features that are pointed to by arrows. If you compare the time that these two peaks occurred, the time difference is about 4.5 minutes. This shift is the result of the distance the Earth had traveled during the 24 hours between collections. This illustrates that the Earth's rotation as well as its travel in orbit needs to be considered when comparing drift scans. Enough to make your head spin (pun intended)?

A final good starting activity is to point the antenna toward the Clarke Belt and find all the satellites in geosynchronous orbit transmitting on 12 GHz. If you record signal strength peaks and AZ and EL for each peak, you will develop a graph of the Clarke belt as illustrated in Figure 15.

I have only scratched the surface, and the sky is the limit of this little project. The RT project can certainly broaden your horizons and expand your understanding of our universe. If you would like more detail than can be presented here, please contact the author.

Notes

[1]**www.setileague.org/articles/lbt.pdf**.
[2]**www.aoc.nrao.edu/epo/teachers/ittybitty/procedure.html**.
[3]**www.pctinternational.com/channelmaster/0612/satellite.html**.
[4]**radiosky.com/skypipeishere.html**.
[5]**en.wikipedia.org/wiki/Geostationary**.
[6]**www.arrl.org/files/qst-binaries/**.

Mark Spencer, WA8SME, is ARRL Education and Technology Program Coordinator. He is an ARRL member and holds an Amateur Extra class license. You can reach Mark at 774 Eastside Rd, Coleville, CA 96107 or at **wa8sme@arrl.org**.

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Simple demonstration to explore the radio waves generated by a mobile phone.

Dr Jonathan Hare, Sussex University, Department of Physics, Falmer, Brighton. BN1 9QH
Note: this article has been published: Simple demonstration to explore the radio waves generated by a mobile phone J P Hare, 2010, Journal of Physics Education, Institute of Physics, 45, p. 481 45 481

Also see the brief full article at: mobile phone detector

IMPORTANT NOTE: this device works very well on the old style mobile phones (as shown in the photo above). However, it does not always work well with modern smart phones. This may be because modern phones use higher frequencies, less power and use the power in a slightly different way (e.g. spread spectrum). Some smart phones do work and success may be due to the signal strength of the local mobile phone mast nearby. If you are in a low signal area the phone will create more power to ensure reliable communications. If you are in a very strong signal area (very near the local network) your phone will drop its output power and consiquently there will be less power to pick-up and to convert to a voltage to light the LED.

Described is a simple low cost home-made device that converts the radio wave energy from a mobile phone signal into electricity to light an LED. No battery or complex circuitry is required. The device can form the basis of a range of interesting experiments on the physics and technology of our mobile phones.

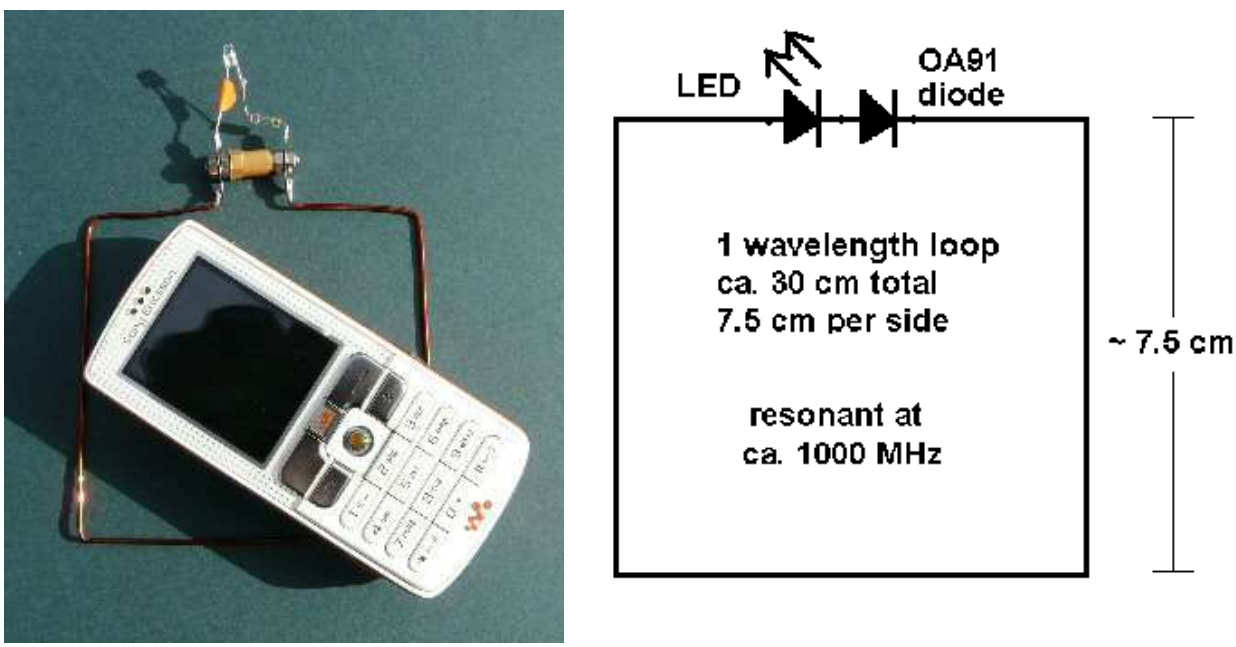

Fig. 1: left: mobile phone radio wave detector and right: the simple schematic

Introduction

Electromagnetic radiation (EMR) is at the heart of modern mobile phone data communications networks. The way a mobile phone and local base stations (the antenna covered masts you see dotted all around the place) communicate between each other is by using EMR in the radio wave part of the spectrum [1,2,3]. On switch-on your mobile sends digital information pulses by rapidly switching on and off the radio waves rather like a fast Morse code signal. Your text or voice is also converted into a series of digital pulses and sent across the network to be decoded (reassembled) by another mobile phone you dialled.

EM radiation and radio waves

Mobiles make use of various bands of radio frequencies to communicate between the mobile to base and the base to mobile: in Europe these include 900 and 1800 MHz (850 and 1900 MHz in the USA and Canada) [2, 3].

The relationship between wavelength, speed of light and the frequency follows the well known formula:

Wavelength λ (m) = speed / frequency = c (ms^{-1}) / ν (Hz)
λ (m) = 300,000,000 / ν (Hz) or approximately:
λ (m) = 300 / ν (MHz) ..... Equation 1.

So for a mid-range of about 1000 MHz (1 GHz) we get a typical mobile phone wavelength of about:
λ = 300/ 1000 = 0.3 m = 30 cm.

Simple radio wave detector

The loop consists of about a wavelength of wire, ca. 30 cm so each side is about 30/4 = 7.5 cm. The dimensions are not critical. The two ends are connected directly to a simple series circuit consisting of a high brightness LED and a germanium diode. They need to be connected correctly. All these components are cheap and readily available from electronic stores [4]. The loop can be made from a piece of copper wire roughly bent into a square (although a circular loop or rectangle will also work). If the wire is insulated remember to scrap off the insulation and solder-tin the ends. Simply solder the germanium diode and LED into circuit as shown in the diagram.
On a new LED the long lead is the positive (anode) while the short lead is the negative (cathode). The germanium diode has a line (band) around the end which is the cathode. When correctly wired the LED and the germanium diodes are connected so they both allow current to pass in the same direction, i.e. in the circuit diagram the arrows point in the same direction. In practice this means the LED and germanium diode are joined at the cathode of one and the anode of the other.
In my prototypes I used an insulator between the loop ends (light coloured cylinder in the photo) to make the whole thing more sturdy but this was purely for mechanical reasons and is not needed for the circuit to function properly. Note: a much more sensitive version using a x10 and x100 DC amplifier is described on my web site [6].

How it works and how to use it

When a radio wave passes across a metal object the EM fields cause the charged electrons in the metal to oscillate and this causes small AC currents at the same frequency to be induced into the metal. If a mobile is brought near to the loop and a call or text is made [5] the radio waves emitted from the phone pass across the loop. This induces a voltage into the antenna (the loop) and if it is close enough will be large enough to light the LED. As the loop is about one wavelength in size it is resonant and so there is a good transfer of power (low reactance) between the radio wave and LED.

The mobile phone automatically tests the network and adjusts its transmission power to maximise the battery life and minimise network interference. As a result the brightness of the LED will depend on the data being sent (the average signal), the local signal strength and how close the loop is to the phone. Why the second diode? - It's curious why the germanium diode is needed at all. The LED is a Light Emitting Diode after all and one would not think that another diode would help. However my initial experiments failed because I had not included it. The LED will have a relatively high capacitance which at these frequencies will tend to de-tune the loop and short out the LED. The germanium diode however is made up of a tiny wire which only makes a point-of-contact onto a piece of semiconducting germanium so it's 'self' capacitance is very low keeping the loop resonant.

The germanium diode will rectify the AC signal from the loop forming a series of DC pulses that will be nicely smoothed by the LED's capacitance. Without the diode however the raw AC signal from the loop will tend to be averaged to zero by the LED's capacitance.

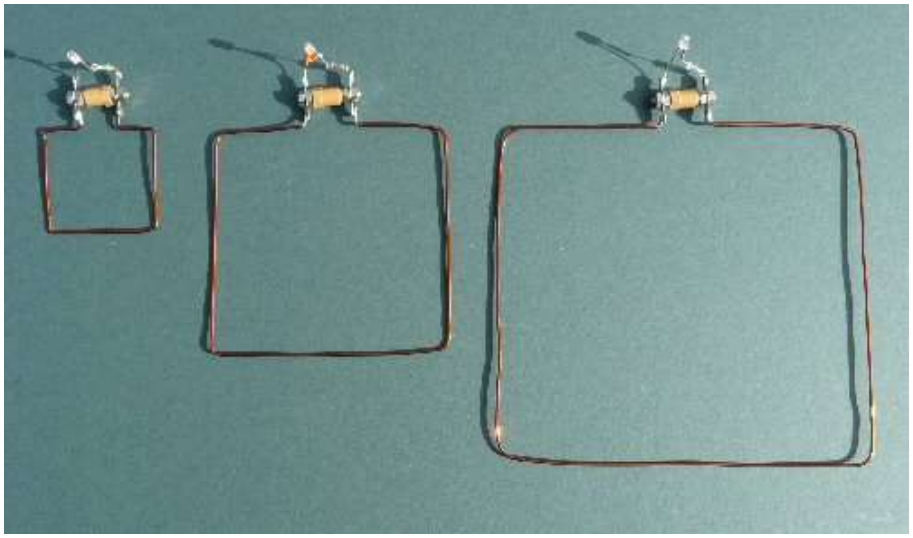

Fig. 2: Three loops in a row of varying size. The one described here and shown in Fig. 1 is shown in the middle. Smaller ones may well work better for higher frequencies such as the 3G networks (see below).

Other size loops
Fig. 2 shows a set of three loop devices with edge lengths of roughly 3.7, 7.5 and 15 cm. You can find out for yourself that the best match to the mobile signal is with the full wave loop of ca. 7.5cm per side. The other loops do work to varying degrees however (smaller ones may work better for the 3G network). The larger loop works well for the '70 cm' amateur radio bands.

Polarisation
The electric and magnetic fields making up the EM wave are orthogonal (they are at right angles to each other as they pass through space) to each other but depending how they are generated by the transmitting antenna can arrange themselves in any orientation with respect to the ground. If the electric field is parallel with the ground we say the wave is 'horizontally polarised' while if its normal to the ground we say its 'vertically polarised'. The loop antenna will respond best to one type of polarisation (depending on its orientation) so it's worth experimenting with the orientation of the mobile (or the loop) to get the strongest signal - brightest LED.

Mobile antenna
Inside your mobile phone is a transmitter / receiver and antenna. Many mobiles have this antenna at the top of the phone but some of the PDA type phones have it at the bottom. As a result you can locate the position of the antenna by moving it around the center of the loop till you get maximum LED brightness.

Networks
There are various different networks that a mobile may use both in the UK and abroad. It may be that you need to adjust the network phone settings on your mobile i.e. change from "automatic select" to set for "GSM" so as it get the strongest signal to light the LED. Note: the 3G network might not be powerful enough to light the LED. As the GMS network is currently the main network over the UK the device should work anywhere where you can get a signal as long as you check the correct selection on your mobile menus [5, 7]. The 3G network operates on a higher frequency (smaller wavelength) so you might find a smaller loop will work better than the main one described here. See 'other experiments' section below.

Test signals
In order to pick up the radio wave energy from the phone it obviously needs to be transmitting a signal. There are a few ways to do this:

1) On switch 'on' (or change of network) you can see that the mobile initially transmits for a few seconds to the network to tell it it's there (especially if you have moved since turning it off). You don't actually need to dial a number to detect these signals.
2) Even if don't text or call, throughout the day the mobile will send out data to 'keep up' with the network, especially if you are moving around (going through train tunnels etc. see below).

3) When you make a phone call you will transmit. Initially there is quite a lot of data being sent but in a few seconds data / power only gets transmitted when you speak. So to light the LED continuously you need to talk or provide some background sound continuously. Your service provider voicemail might be a good free phone number to try for these experiments [5].

4) Texting is the easiest way to show the radio wave power being transmitted. Long texts will light the LED for longer than short texts.

5) Finally set up the mobile on the loop and use another phone to text or phone the mobile. Even though you are not directly using the phone you will see that even on 'receive' the mobile phone transmits data to and fro. Ring off before you get charged.

Note: If you can use a free phone number it will save you money [5].

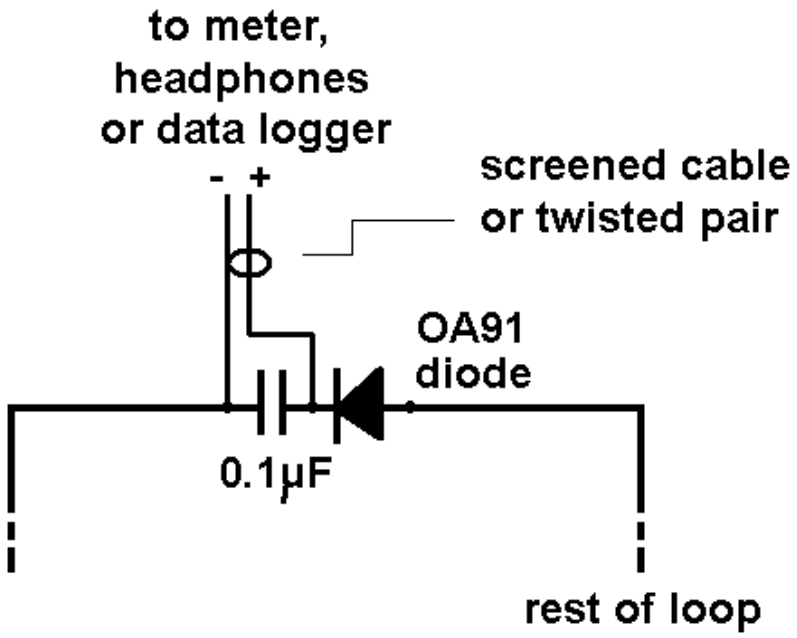

Fig. 3: Adding a capacitor and coax (or twin) lead so that headphones, a meter or a data logger can be connected (Note: diode is reverse wired compared to Fig. 1).

Other experiments:
Hearing data - if headphones are wired across the LED they will convert the voltages into sound and you can 'hear' the clicks of the digital data being transmitted. These are the same clicks that so easily get picked up by sensitive electronics such as a stereo amp or recording equipment when making a video for example. Hence - 'no phones on' when filming.

Logging data - if a meter, or better still a stand-alone data logger, is attached across the LED then one can monitor the EMR from the phone. For example even if you are not making a call your mobile will send signals too (and receive signals from) the network while travelling around. Fig. 3 shows a simple modification using a de-coupling capacitor so that a coax cable (or twisted pair) can be used to go to headphones, meter or data logger. Note the diode has been reversed so that the logger has the correct + and – connections for a unipolar input logger. The capacitor should help average the signal and stop radio frequencies going down to the logger. If one is available a few turns of the wire can be wound within a ferrite ring near to the logger so that maximum immunity to the mobile phone signal can be obtained for the logger electronics.

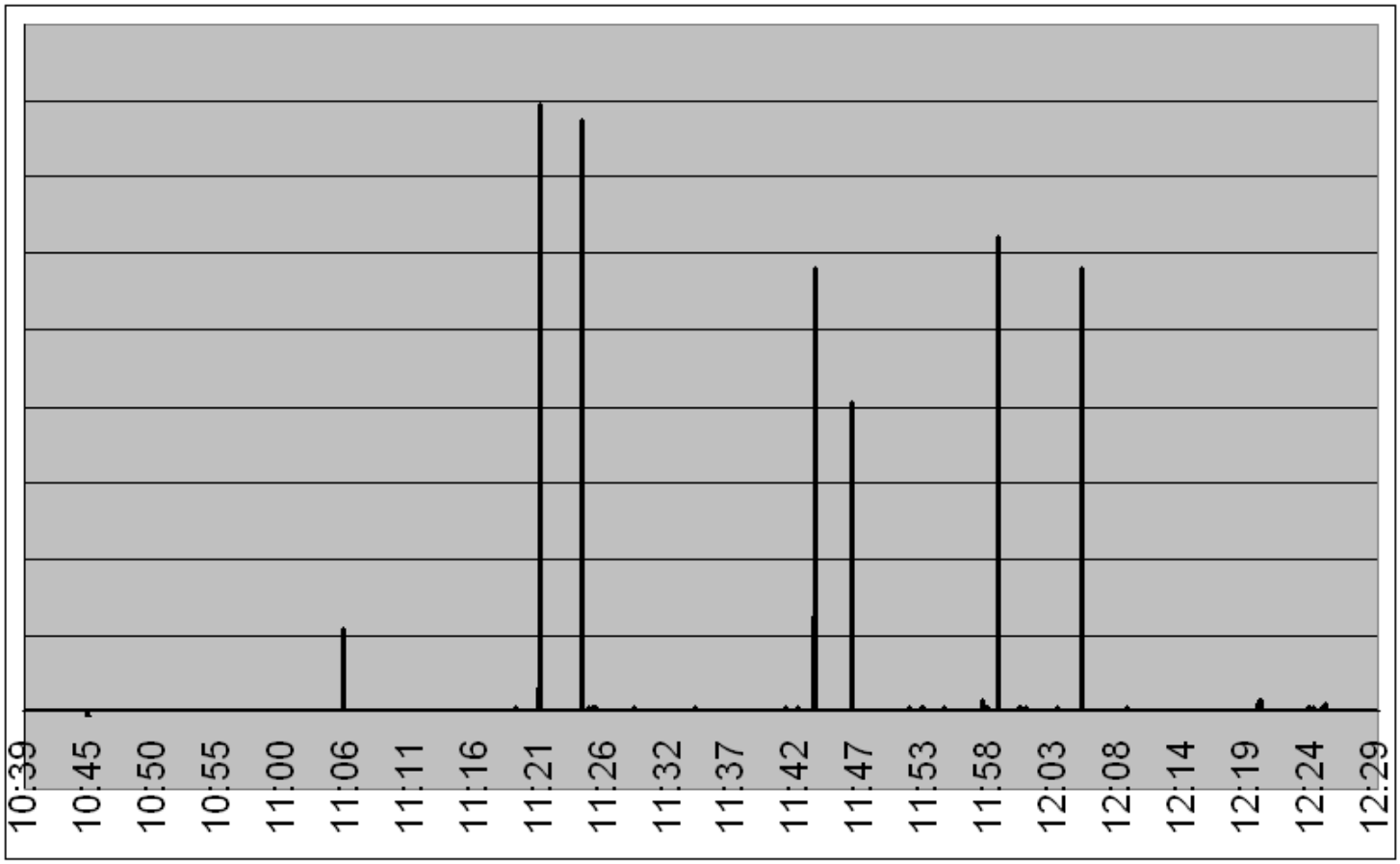

Fig. 4: Typical mobile phone data signals sent out onto the network while travelling around. These were recorded by a data logger from a mobile using the loop (no calls or text were made) while travelling on the train from Brighton to London Victoria (and then around London and return). Many of these peaks were the phone sending out 'I am here' data after coming out of one of the many long tunnels under the South Downs during the journey.

Out and about - Once you can log data you can discover all sorts of interesting things your mobile phone is doing without you realising it. Fig. 4 shows the plot over a few hours of travelling between Brighton and London (and within London) on the train. The detector was simply placed near to a phone that was not making or receiving a phone call or text, but was turned on.

The graph shows that the mobile sends out signals to tell the network where it is as it travels along and in particular goes in and out of long train tunnels. The peak heights vary because of the different powers the mobile transmits at depending on the signal strength of the local network and also because of the way the data logger 'snatches' a reading from the circuit every few seconds. As your phone sends out data onto the network to ensure the very best communications as you move around, so your mobile and the network obviously knows where you are and where you have been. Thieves and criminals beware the police can track you!

The inverse square law - If the transmitting mobile phone is moved away from the loop one would expect the signal to drop off. Unfortunately because both diodes need a certain threshold before they conduct the detector is not sensitive to small signals and not very linear. Therefore it's not very easy to use the device to measure the inverse square law (drop in signal v distance away) but of course you can see the signal go down. You could perhaps use the device to plot isobars - i.e. plot the equal intensity signals around the phone / nearby objects.

Changing the resonant frequency of the loop - you might be able to make some simple sliding mechanism (e.g. a small trombone-like mechanism) out of metal tube for example to tune the loop device for different frequencies. Then you can use it to find the average wavelength and so determine the center frequency by adjusting the size for maximum brightness of the LED. The wavelength can be determined by measuring the total distance around the loop. If we assume the antenna is one wavelength in total length then the frequency can be established by rearranging Equation 1, i.e. ν (MHz) = 30,000 / L (cm), where L is the length around the loop (cm).

Note: You will need to allow the transmitted digital signal to 'settle down' i.e. make measurements only after a few seconds after dialling / pick up so that only the sound data is being transmitted rather than the initial connection data. A constant sound will also need to be made so that the mobile phone continuously transmits data. It's worth playing music near to the phone or constantly whistling to keep sound coming into the phones microphone.

Mobile phone detector - teachers who want to know if the students / pupils really have turned-off their mobile phones (rather than just put on 'silent') can wire the loop device into the class room white-board speakers. Any mobile that is on in the class will send out signals which (if you are close enough) you will hear the data going to and fro - you will have your very own 'who's got their mobiles on' device which might be useful for exams etc.

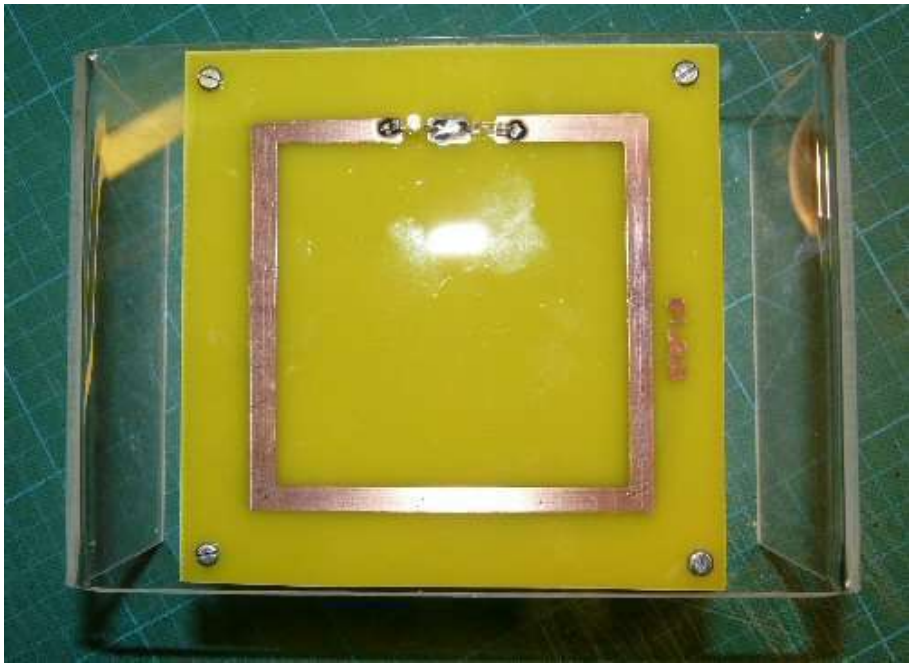

Fig. 5: The SEPNet 'deluxe' printed circuit board version (pcb) on a perspex stand where the loop is composed of a pcb copper track and the diode and LED soldered onto the board (top) [8,9].

Summary

All in all then, for such a simple easy to make device I hope you agree that there is a lot of scope for interesting science / technology investigations with your mobile phone. The device would make a good science week project (for radio amateur clubs etc.) A 'deluxe' pcb version (Fig. 5) on a perspex display case (Fig. 5) is currently going around the southern UK as part of the SEPnet outreach work, see the 'Radiation Exhibition' [8] and also as part of my on-going lecture series [9].

Post publication additions

(What follows was not included in the published article as this calculation was worked out later). A full wave loop is resonant and so looks purely resistive to the radio waves. Such a loop will have a resistance of about 100 ohms (Note: this is the AC resistance and not the DC resistance which will be very low). Now power P = V x I (V = voltage and I = current) and resistance = R = V/ I therefore $P = V^2 / R$ or rearranging $V = \sqrt{(P \times R)}$ which means that the voltage created by a power level of say 50mW (say for argument that roughly half the mobile phone power) arriving at the antenna will be about $V = \sqrt{(100 \times .05)}$ which is aprox. V = 2V, enough to light an LED.

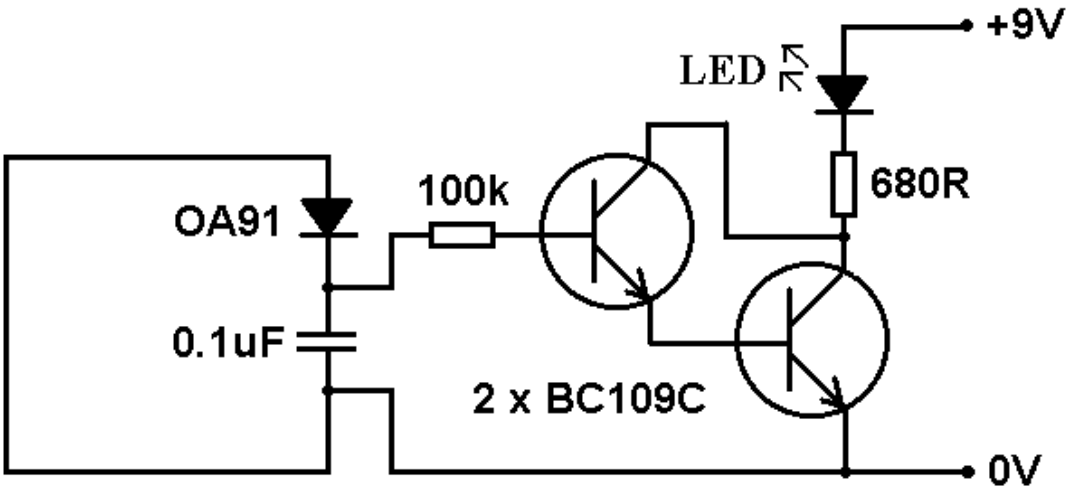

This circuit uses a two transistor darlington driver to amplify the signal from the loop and diode making the detector much more sensitive. The LED will be much brighter using this circuit. Note: the circuit needs a battery to power it (e.g. a PP3 9V)

References

[1] These ultra high frequencies (UHF, > 1000 MHz) are also often called microwaves.
[2] wiki pages
[3] Elektor Electronics magazine, June 2005
[4] order codes for the germanium diode and LED are:
e.g. Germanium diode: Maplin Electronics: QH71N, Rapid Electronics: 47-3114
e.g. LED: Maplin Electronics: UF72P , Rapid Electronics: 55-0085
[5] to save money use your voice mail service (often you simply dial 121).
[6] for details of an amplified detector see: wavemeter
[7] select 'network setting' from the mobile phone 'settings' menu and then go to 'network mode' and select 'GSM 900/1800' rather than 'automatic'.
[8] SEPnet mobile phone device on display throughout southern UK. [9] for details of my talks see: talks and workshops

THE CREATIVE SCIENCE CENTRE

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Simple demonstration to show mobile phones emit radio waves

Dr Jonathan Hare, Sussex University, Department of Physics, Falmer, Brighton. BN1 9QH
Note: this article is in press: Elektor Magazine, July-August 2010, p. 56-57

For other experiments with this device please see my full article at: mobile phone detector

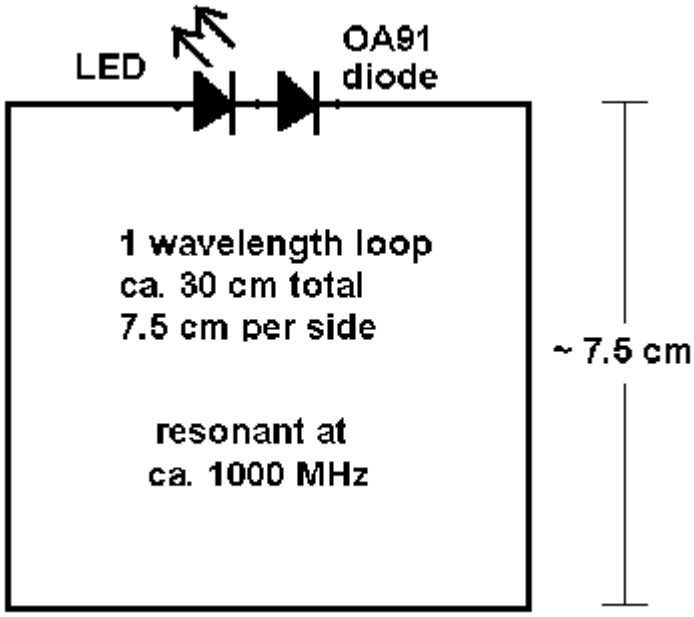

left: mobile phone radio wave detector and right: the simple schematic. Below: detail of the LED and germanium diode.

IMPORTANT NOTE: this device works very well on the old style mobile phones (as shown in the photo above). However, it does not always work well with modern smart phones. This may be because modern phones use higher frequencies, less power and use the power in a slightly different way (e.g. spread

spectrum). Some smart phones do work and success may be due to the signal strength of the local mobile phone mast nearby. If you are in a low signal area the phone will create more power to ensure reliable communications. If you are in a very strong signal area (very near the local network) your phone will drop its output power and consiquently there will be less power to pick-up and to convert to a voltage to light the LED.

This is a very simple and cheap device that demonstrates mobile phones ('cell phones' or 'handies') generate radio waves. We have a 30 cm (7.5 cm per side) full-wavelength loop antenna (a 'Quad' to radio amateurs) connected to a germanium diode and a hyper-bright LED. The loop can be made of copper wire, thin sheet metal or a track on a pcb. The diodes need to be wired correctly. I think the germanium diode is needed as the LED probably has too great a self-capacitance to perform at the very high AC frequencies generated by the phone (ca. 900 or 1800 Hz) but will work well with the DC pulses from the germanium diode (which has a very small capacitance).

To show the mobile generates radio waves put the mobile near to the loop and dial a number (use a free phone number, e.g. your voice mail) or text. The radio waves will induce a voltage into the loop, large enough to light the LED. The LED will flash indicating the digital data being sent by the mobile phone transmitter. You may need to set your phone to 'GSM 900/1800' rather than the '3G' network in the settings menu.

parts:
germanium diode: Maplin Electronics: QH71N or Rapid Electronics: 47-3114
LED: Maplin Electronics: UF72P or Rapid Electronics: 55-0085

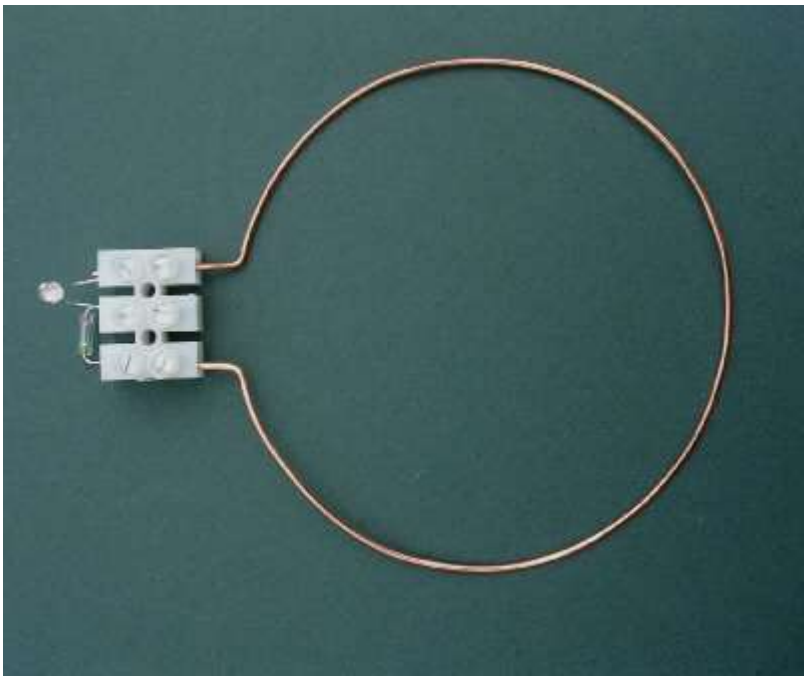

A very simple connector block version and a circular 1 wavelength loop

THE CREATIVE SCIENCE CENTRE

Dr Jonathan Hare, Brighton, East Sussex. BN1 9QJ.

BACK TO G1EXG RADIO PAGE

EPAD MOSFET - 'near zero' and 'zero' threshold devices (e.g. the ALD110900)

I will add more details to this page later on but for the moment it gives links to important and inspiring sites.

ARTICLES
1) High Sensitivity Crystal sets, Technical Topics, Pat Hawker, Rad Com, p. 77-78, May 2007.
2) A novel kind of 'crystal set' radio, Giles Read, Rad Com, p. 60-61, June 2007.
3) also see Pat Hawker, Technical Topics, Rad. Com. January 200, page 53-57.
4) High Sensitivity Crystal Set by By Bob Culter (N7FKI)
5) Next-generation Zero-Threshold Voltage EPAD™ design enables circuits with greater operating range in low voltage supply environments

LINKS ABOUT THE CHIPS / DEVICES
1) Advanced Linear Devices web site
2) EPAD MOSFET (ALD web site)
3) ALD110800 and ALD110900 page (ALD web site)
4) ALD110802 and ALD110802 page (ALD web site)

ORDERING THE CHIPS / DEVICES
1) mouser.com (USA)

'CRYSTAL SET' RADIO'S - DIFFERENT DETECTORS

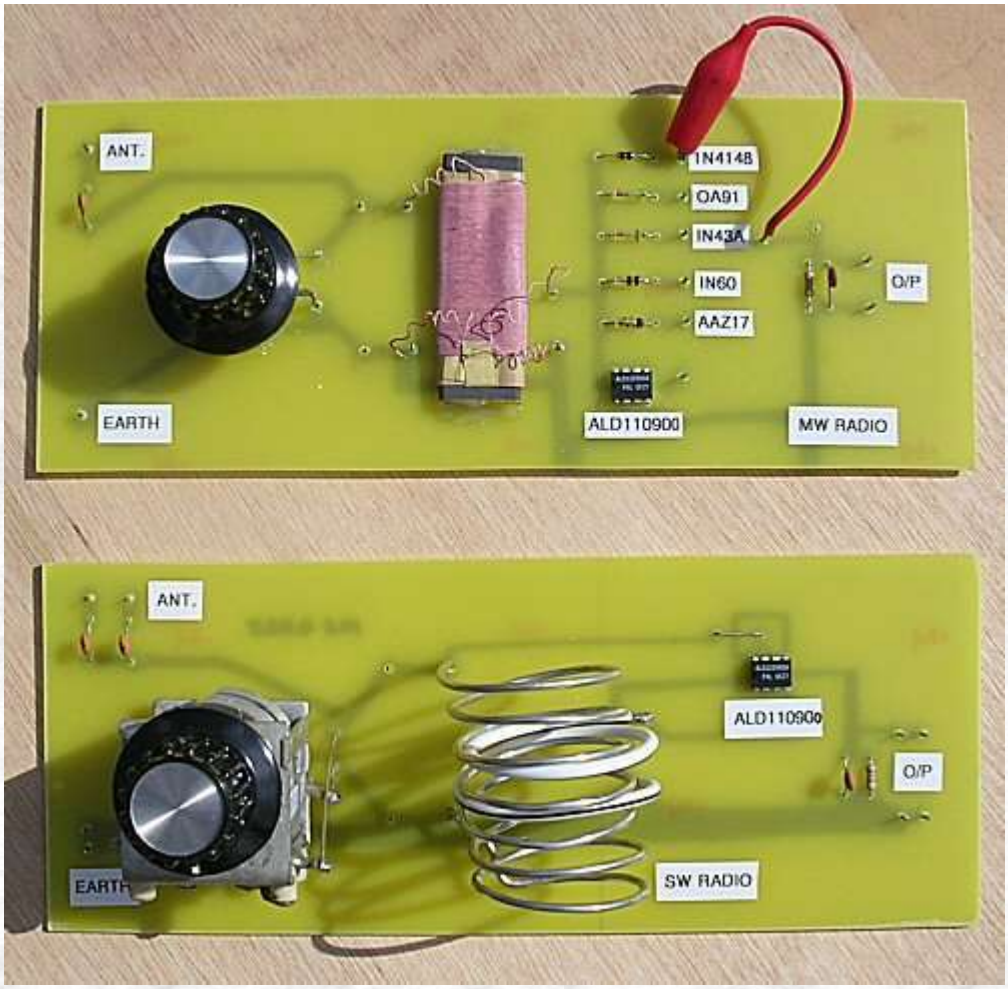

Top: the medium wave (MW) test radio with a selection of 'detectors' (selected by the croc clip lead)
Bottom: the short wave (SW) version with a ALD110900 detector
(on each circuit board the connections are: antenna - top left, Earth - bottom left, audio output (heaphones / amp) - far right.)

RADIO AND RADIO WAVES

The simplest 'radio' can be a piece of wire attached to the input of an amplifier. Why does this pick up radio signals? Well in principle it should not be able to pick up anything but in reality poor solder joints in the amplifier circuitry, as well as point contact effects between the ends of the anenna wire going into the input socket of the amp as well as other effects mean that you do often hear radio signals.

Radio waves are electromagnetic waves as they pass through a metal they induce small voltages into it. Any piece of metal e.g. metal fram specs, tape measures, metal window frames, a piece of wire etc. will act as an antenna and have tiny voltages induced into them. These voltages will be due to natural radio waves (from Space as well as the Sun and Earth), radio stations, satellites, mobile phones, garage door remote controls, microwave ovens .... the list goes on and on.

In the case of long, medium and short wave radio stations the amplitude of the radio wave signal is modified by the music, voice or program - we call it Amplitude modulation AM. Here the strength of the radio waves varies as the tones, loudness and pitch of the program vary. As a result the voltages induced in the metal object antennas distant from the radio wave stations also vary in accord this program information or modulation.

To actually hear the programs on the radio waves you cant actually take this tiny signal and listen to it directly (say with headphones or an amplifier). This is because the signal is a very high frequency signal out of the range of human hearing. To get the audible information - the program - 'off' the radio signal you need a device known

as a 'detector'. This is usually a diode but lots of other things can act as inefficent detectors for example a mineral called galena, coke (burnt coal) ... as well as rusty screws and bad solder joints which is how the ampilfier mentioned above apparently picks up radio signals.

In the early days of radio crystals of galina were used as diodes and so these radios became known as 'crystal set radios'. They did not have any amplifiers and did not require any battery to work. They got all their power from that induced into the (of very long) antenna by the radio signal(s). The radio detector is an extremely important part of the radio and its proper function determines how well the radio works.

The radio signal is an AC signal. A speaker or headphones can not resonate at such high frequencies as radio waves and if you try to wire in the RF to the headphones the diaphram just averages the power. As half the time the RF is positive and half the time negative, in an AC signal, the average is zero and so you dont hear anything. The diode or detector is a device called a diode which only conducts electricity in one direction. So it only allows the positive, or negative half (one half but but not both) of the AC signal to go through (depending on which way it is wired). After the diode the average is now no longer zero its actually a changing signal dependant on the modulation of the radio wave - which is the information we want to hear. As this is at audio frequencies, and as the diaphram can move at audio frequencies, you hear the information on the detected RF signal - the music, voice or what ever.

Why should some detectors (diodes) be 'better' than others? The answer is not that some are better at 'magnifying' the signals but rather that each diode requires a certain threshold voltage in order to start conducting (one way). Signals below this level will not get passed through and a signal only slightly larger will therefore only pass through weekly (the diode unfortunatly absorbing the majority of the signal). As a result for large signals you wont expect to see much difference between different detectors but for weak signals there can be a great deal of difference. In an ideal world the diode would start to (forward) conduct at just above zero volts and this ideal detector (which does not conduct at all in reverse) would produce the greatest signal possible for the particular strength signal applied to it.

Recently I was playing around with OA91 germanium diodes for a mobile phone detector. I made a simple 10cm per side square loop and wired it directly to an LED. I was hoping that if I brought the mobile near to the loop and texted, or made a phone call, the RF should be picked up by the loop (which is almost resonant) and the LED should light - it didnt work! But putting an OA91 in series I did get it to work. So why did I need the OA91 diode when the LED is itself a diode?

It can't be due to the threshold voltage in this case as I am still using the LED and I did get it to work with the same signal! So I guess it because the capacitance of the LED is very high compared to the point-contact germanium diode. If we extend this thinking to the crystal set radio I guess the germanium diodes have very little capacitance and so dont allow any of the 'wrong' half of the AC signal through and so act as a more perfect detector. An LED would have a high capacitance and so let some of the wrong half of the AC signal through which on averaging by headphones would be nearer zero (see above) - hence less sound.

A low threshold (turn-on) voltage and a low self capacitance are crucial things in a good detector. Point contact germanium diodes having a very small area (a point of contact) have low capacitance and the germanium semiconductor-metal junction of the contact has a low turn on voltage. EPAD Mosfets also have low capacitance, high input resistance (low loading of the signal) and low turn on voltage.

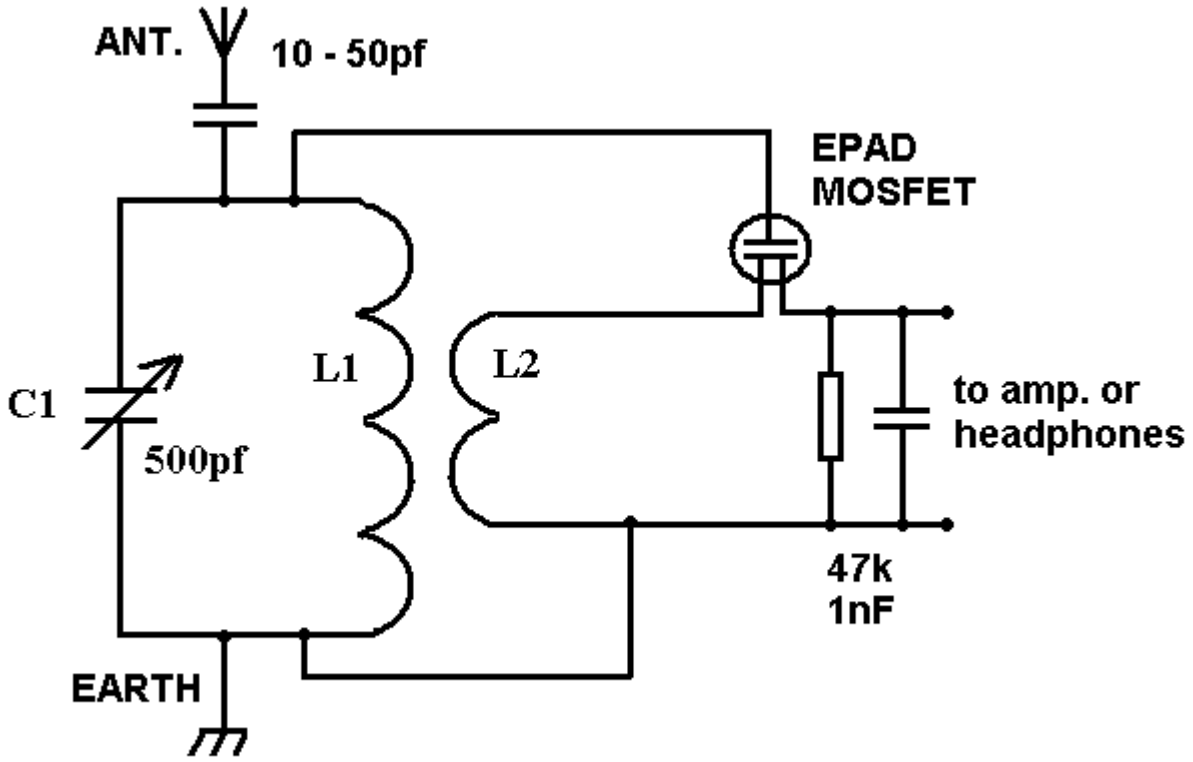

MEDIUM WAVE TEST CIRCUIT (top in photo)
As a simple test circuit to compare detectors I made up a simple 'crystal set' radio from a ferrite rod coil from an old radio, tuning capacitor an array of diodes (crystals) and a simple RF filter composed of a 47k resistor and 1nF capacitor. The coil and capacitor formed the resonant circuit which was fed via a 10 - 50pf capacitor by the antenna (long wire). This capacitor helps to reduce the effect of the antennas own capacitance and inductance from modifying the resonant frequency of the tuned circuit. Ideally this should be as small a capacitance as you can get away with but too small a value will reduce the radios sensitivity ....

An earth was connected to the ground connection of the circuit. Instead of taking the antenna end of the resonant circuit to a diode detector (as many simple crystal sets do) I used a ca. 10 turn coupling coil around the coil. This was done to limit the loading on the resonant circuit by the detector. It should help keep the tuning sharp and also help to keep the overall (band) spread of tuning as large as possible.

Because of the reduction in turns (ca. 100 turns : 10 turns, i.e. 10:1) the coupling coil reduces the signal that is available to drive the detector. For example if I use a standard silicon diode (e.g. a 1N4148) which requires about 0.6V to conduct then we might need ca. 10 x 0.6 = 6V of RF to be developed in the resonant circuit! A high Q resonant circuit might do this with a long antenna coupled to it but without such a generious antenna such a set-up wont be very sensitive.

RESULTS
I tried an array of 'crystal set' type diodes to campare them. Typical rough results are shown in the table below. This was with an Earth and about 3-4m of antenna wire randomly strung near to ground level (so its a pretty bad set up really - a good test).

The EPAD MOSFET data sheets described how the gate and drain of one of the MOSFETS can be joined together to form the anode of a diode the source then forms the cathode. I tried this arangement with the ALD110900 in order to make up a 'crystal set' diode from this MOSFET but it didnt perform well.

Then I tried the alternative arrangement as described in the references above. In these articles they dont use the MOSFETS as diodes but connect the gate directly to the resonant circuit. As the input resistance is extremely high (c.a. 1E12 ohms) and the input capacitance is very low (c.a 3pf) it does not load the tuned circuit by any appreciable amount. The source and drain are then wired between the coupling coil and filter just as the usual diode detector is in a crystal set radio. In this configuration the MOSFET is working more as a gate voltage controlled resistor rather than a diode i.e 'off' for half an RF cycle and 'on' for the rest - this lets the envelope through and you hear the music or sound. One article describes the arrangement as a synronious detector. As there are two MOSFETS in one package the two are wired in parallel i.e. gate to gate, drain to drain (there is a common source) etc.

DETECTOR TYPE	AF voltage produced after filtering
1N4148 silicon	no signal
OA91 germanium	1mV
1N43A germanium	1mV
1N60 germanium	1mV
AAZ17 germanium	1.5mV
ALD110900 EPAD MOSFET wired as diode	<1mV
ALD110900 EPAD MOSFET wired as sync. detc.	10mV

Typical results of the AF voltages produced by the detector (for use by headphones or amplifier) for an Earth connection, small (ca. 3-4m antenna wire near ground level) and the prototype 'crystal set' radio.

For the simple set-up described above there was not enough signal to get the silicon diode to work at all (although a much longer wire did provide a very small signal). A simple listening test and measurement of the AF prodiced by each diode showed that their was very little difference between the various germanium diodes. The MOSFET simply wired as a diode (gate wired directly the drain) was a poor detector - better than a silicon but not nearly so good as any of the germanium diodes. Finally the EPAD MOSFET wired as a syncronious detector worked really very well apparently producing ca. 10 times the signal (in other words it has much less loss than a germanium diode) for this particular set up and station than the germanium diodes.

As the syncronious arrangement was so succesful it got me thinking about this circuit. As the gate goes straight in on the main resonant circuit where the voltages, in a good Q circuit, might well be relatively high I thought I would try a standard FET (2N3819) and MOSFET (VN10KM) instead - and they worked! (they are a lot cheaper than an EPAD MOSFET chip and easier to get). Some FETS have a larger input capacitance so it helped to put a 10pf capacitor in series to the gate (a 10M ohm from gate to earth might reduce 50Hz pick up).

They were not as good as the EPAD MOSFET (although I only tried a single device) but the arrangment was still better than a simple 'crystal set' diode. For weak signals the EPAD MOSFET should perform better as it is able to keep going while the FET and the standard MOSFET will start to trail off as the resonant circuit voltage drops below the relatively higher gate voltage required for these devices. However it was interesting to see that it seems to be possible to get a more efficent set-up for a 'crystal' radio using a standard FET or MOSFET than with the standard germanium diode detector.

By the way I recently re-tried the 1N4148 diode but wired a 1.5V AA battery with a 100k resistor across it to forward bias it - and it worked ! It seemed to work better than a OA91!

SHORT WAVE 'CRYSTAL SET RADIO (bottom in photo)
The bottom circuit shown in the photo above is my own short wave version of the 'crystal set' radio but based on the references above. It's the same circuit as the MW radio but has a reduction drive tuning capacitor and different coil. I used about 7 turns (ca. 4cm diameter) for the resonant circuit and a couple of turns of insulated wire (white) for the coupling coil. I guess the radio tunes from about 3-8 MHz - I havent tried a sig gen on it yet.

I made this in the summer months (not the best time for listening on this part of the spectrum). Using an Earth and few meters of wire for antenna I heard 2 or 3 stations from around the world during the day while at night there were at least 7 including the voice of Russia world service, Radio Thailand as well as German and French speaking stations.

BACK TO G1EXG RADIO PAGE

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10

Design Issues in Radio Frequency Energy Harvesting System

Chomora Mikeka and Hiroyuki Arai
Yokohama National University
Japan

1. Introduction

Emerging self powered systems challenge and dictate the direction of research in energy harvesting (EH). State of the art in energy harvesting is being applied in various fields using different single energy sources or a combination of two or more sources. In certain applications like smart packaging, radio frequency (RF) is the preferred method to power the electronics while for smart building applications, the main type of energy source used is solar, with vibration & thermal being used increasingly. The main differences in these power sources is the power density; for example RF (0.01 ~ 0.1 μW/cm^2), Vibration (4 ~ 100 μW/cm^2), Photovoltaic (10 μW/cm^2 ~ 10mW/cm^2) and Thermal (20 μW/cm^2 ~ 10mW/cm^2). Obviously RF energy though principally abundant, is the most limited source on account of the incident power density metric, except when near the base stations. Therefore, in general, RF harvesting circuits must be designed to operate at the most optimal efficiencies.

This Chapter focuses on RF energy harvesting (EH) and discusses the techniques to optimize the conversion efficiency of the RF energy harvesting circuit under stringent conditions like arbitrary polarization, ultra low power (micro or nanopower) incidences and varying incident power densities. Harvested power management and application scenarios are also presented in this Chapter. Most of the design examples described are taken from the authors' recent publications.

The Chapter is organised as follows. Section 2.1 is the introduction on RF energy sources. Section 2.2 presents the antenna design for RF EH in the cellular band as well as DTV band. The key issue in RF energy harvesting is the RF-to-DC conversion efficiency and is discussed in Section 2.3, whereas Section 2.4 and 2.5 present the design of DTV and cellular energy harvesting rectifiers, respectively. The management of micropower levels of harvested energy is explained in Section 2.6. Performance analysis of the complete RF EH system is presented in Section 3.0. Finally, conclusions are drawn in Section 4.0.

1.1 RF energy sources

These include FM radio, Analogue TV (ATV), Digital TV (DTV), Cellular and Wi-Fi. We will present a survey of the measured E-field intensity (V/m) for some of these RF sources as shown in Table 1, [1]-[2]. Additionally, measured RF spectrums for DTV and Cellular signals are presented as shown in Fig. 1 to show on the potential for energy-harvesting in

these frequency bands. In general, many published papers on RF-to-DC conversion, have presented circuits capable of converting input or incident power as low as -20dBm. This means that, if an RF survey or scan finds signals in space, with power spectrum levels around -20dBm, then, it is potentially viable to harvest such signal power. In Fig. 1 (left side), the spectrum level is well above -20dBm and hence, a higher potential for energy harvesting. In Fig. 1 (right side), while the spectrum level is below -20dBm, what we observe is that the level increases with decrease in the distance toward the base station (BTS). Using free space propagation equation with this data, it was calculated that at a distance 1.4 m from the BTS, the spectrum level could measure 0dBm. An example calculation and plot for the estimated received power level, assuming 0dBi transmitter (BTS) and receiver antenna gains and free space propagation loss (FSPL) for FM and DTV is presented in Section 2.1.1. For the example estimation in Section 2.1.1, we select FM and DTV because they measured with a higher level than cellular and Wi-Fi for example.

Source	**V/m**	**dBm**	**Reference**	
FM radio	0.15~3		Asami et al.	
Analogue TV	0.3~2			
Digital TV	0.2~2.4	-40~0.0	Asami et al.	Arai et al.
Cellular		-65~0.0	Mikeka and Arai	
Wi-Fi		≅ -30		

Table 1. RF energy sources, measured data.

In Table 1, FM radio has the highest E-field intensity implying the highest potential for energy harvesting. However, due to the requirements for a large antenna size and the challenges for simulations and measurements at the FM frequency i.e. 100 MHz or less (See Section 2.2.3, example FM antenna at 80 MHz), this Chapter will focus on DTV (470~770 MHz band) and Cellular (2100 MHz band) energy harvesting.

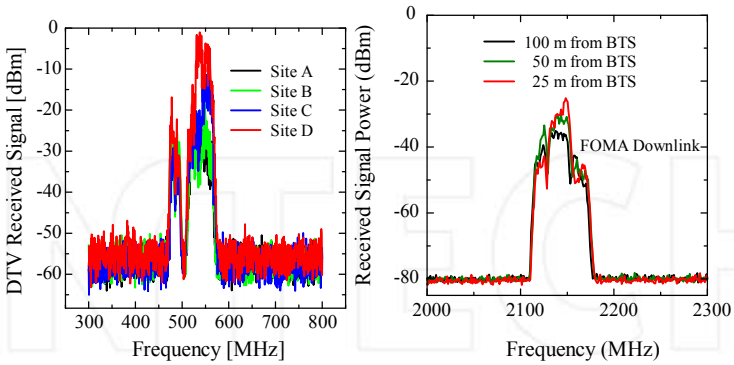

Fig. 1. DTV signal spectrum measured in Tokyo City (left side graph) and Cellular signal spectrum measured in Yokohama City (right side graph).

The received DTV signal power is high and also wide band, presenting high potential for increased energy harvesting unlike in cellular signals. We demonstrated in [2] that the total RF-to-DC converted power is roughly the integral over the DTV band (1), and is significantly larger than in the case of narrow band cellular energy harvesting.

$$P_{DC(DTV)} = \alpha \int_{470}^{770} \delta P_{DC}(f)\,df\ , \tag{1}$$

where α is the attenuation factor on the rectifying antenna's RF-to-DC conversion efficiency due to multiple incident signal excitation. δP_{DC} is the small converted DC power from each of the single DTV signals in the 470 MHz to 770 MHz band.

In detail, we derive (1) from fundamentals as follows.

The incident power density on the rectifying antenna (rectenna), $S(\theta,\phi,f,t)$, is a function of incident angles, and can vary over the DTV spectrum and in time. The effective area of the antenna, $A_{eff}(\theta,\phi,f)$, will be different at different frequencies, for different incident polarizations and incidence angles. The average RF power over a range of frequencies at any instant in time is given by:

$$P_{RF}(t) = \frac{1}{f_{high} - f_{low}} \int_{f_{low}}^{f_{high}} \int_{0}^{4\pi} S(\theta,\phi,f,t) A_{eff(\theta,\phi,f)}\, d\Omega df \tag{2}$$

The DC power for a single frequency (f_i) input RF power, is given by

$$P_{DC}(f_i) = P_{RF}(f_i,t).\eta\left(P_{RF}(f_i,t),\rho,Z_{DC}\right), \tag{3}$$

where η is the conversion efficiency, and depends on the impedance match $\rho(P_{RF},f)$ between the antenna and the rectifier circuit, as well as the DC load impedance. The reflection coefficient in turn is a nonlinear function of power and frequency.

The estimated conversion efficiency is calculated by P_{RF}/P_{DC} . This process should be done at each frequency in the range of interest. However, DC powers obtained in that way cannot be simply added in order to find multi-frequency efficiency, since the process is nonlinear. Thus, if simultaneous multi-frequency or broadband operation like in DTV band is required, the above characterization needs to be performed with the actual incident power levels and spectral power density. In this Chapter, we shall demonstrate DTV spectrum power harvest, given a rectenna than has been characterised in house at each single frequency in the DTV band.

1.1.1 An example calculation and plot for the estimated received power level

In this example we consider Tokyo's DTV and FM base stations (BS) as the RF sources. Both DTV and FM BS transmitter power (P_t) equals 10 kW (70dBm). The antenna gains are assumed 0dBi in both cases but also at the points of reception for easiness of calculation but with implications as follows. Assuming 0dBi antenna at each reception point, demands that we specify the frequency of the transmitted signal. For this reason we specify DTV signal frequency to be equal to 550 MHz while the FM signal frequency equals 80 MHz (Tokyo FM).

The received power, P_r is calculated using the simplest form of Friis transmission equation given by

$$P_r = P_t + G_t + G_r + FSPL\,, \tag{4}$$

where P_t = 70dBm, $G_t = G_r$ = 0dBi. G_r is the receiving antenna gain while FSPL is the free-space path loss given by

$$FSPL(dB) = 20\log(d) + 20\log(f) + 32.45\,, \tag{5}$$

where $\boldsymbol{d}$ is in (km) and $\boldsymbol{f}$ is in (MHz). The plot for the received power as a function of distance from the DTV and FM base stations is shown in Fig. 2.

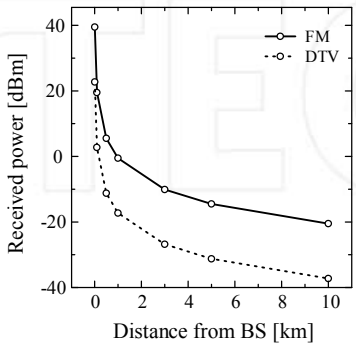

Fig. 2. DTV and FM received signal power level against distance.

With respect to Fig. 2, FM registers higher received power level than DTV at every reception point due to its lower transmit frequency and hence lower free-space path loss. For example at 1 km distance, FM received power level is -0.51dBm while for DTV, the received power is -17.26dBm. The important thing however, is that the received power level is frequency independent. It means that P_t is the transmitter power and the received power level at the position of distance $\boldsymbol{d}$ is $\frac{P_t}{4\pi d^2}$. However, if we assume 0dBi antenna at each reception point as in the above example, the power level is different because the antenna size of 0dBi is frequency dependent. As a result, high transmit power level is favorable for RF energy harvesting. Also near the base station is favorable.

1.2 Antenna design for the proposed RF energy harvesting (EH) system

It is well known that RF EH system requires the use of antenna as an efficient RF signal power receiving circuit, connected to an efficient rectifier for RF-to-DC power conversion. Depending on whether we want to harvest from cellular or DTV signals, the antenna design requirements are different. We will discuss the specific designs in the following sub sections.

1.2.1 Cellular energy harvesting antenna design

We propose a circular microstrip patch antenna (CMPA) for easy integration with the proposed rectifier (Section 2.5.1). However, the use of circular microstrip patch antennas (CMPA) is often challenged by the need for impedance matching, circular polarization (CP) and higher order harmonic suppression.

To address the above concerns, we create notches on the circular microstrip patch antenna. In our approach, we use only two, thin, fully parameterized triangular notches to achieve higher order harmonic suppression, impedance matching and circular polarization, all at once. This is the novelty in our proposed antenna. Our proposed CMPA is shown in Fig. 3. We study the behaviour of CMPA surface current vectors when notches (triangles ABC) are created on the structure at $\alpha = 45^0$ and $\alpha = 225^0$.

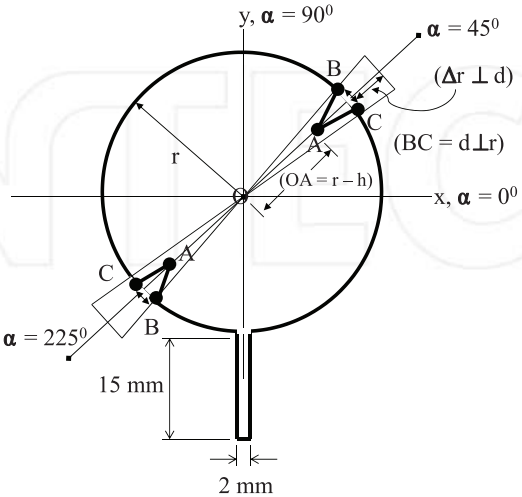

Fig. 3. Cellular energy harvesting antenna structure.

Notch parameters ***d*** and ***h*** in Fig. 3 were investigated by calculation using CST microwave Studio.

Without notches, the CMPA's input is not matched at f_c= 2.15 GHz as shown in Fig. 4 (left side). However, with notches, matching is achieved. The parameter combination ***d*** = 7 and ***h*** = 6 offers a matched and widest band input response and hence we adopt it for cellular energy harvesting applications.

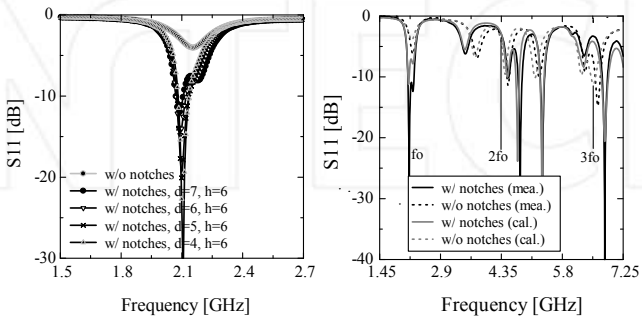

Fig. 4. *Left side:* ***d*** and ***h*** parameter investigation. *Right side:* Comparison between (cal.) and (mea.) S_{11} at f_0 = 2.175 GHz, $2f_0$ = 4.35 GHz and $3f_0$ = 6.53 GHz. The adopted notch parameters are ***d***=7 mm while ***h***= 6 mm.

The comparison between calculated and measured S_{11} is shown in Fig. 4 (right side). The 2nd and 3rd harmonics are suppressed as required by design. The comparison between calculated and measured radiation patterns is shown in Fig. 5, where $E_\vartheta \cong E_\varphi$ due to the 45^0 tilted surface current vector. Ordinarily, without notches, the surface current vector is parallel to the microstrip feeder axis. In conclusion, our proposed CMPA is sufficiently able to suppress higher order harmonics while simultaneously radiating a circularly polarized (CP) wave. The CP is required to efficiently receive the arbitrary polarization of the incident cellular signals at the rectenna.

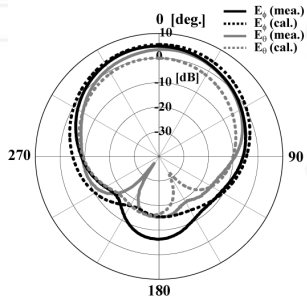

Fig. 5. Cellular energy harvesting antenna pattern at f_c= 2.15 GHz.

1.2.2 DTV energy harvesting antenna design

Unlike in the cellular energy harvesting antenna, the DTV energy harvesting antenna must be wideband (covering 470 MHz to 770 MHz), horizontally polarized and omni-directional.

The proposed antenna is typically a square patch (57 mm x 76 mm) with a partial ground plane (9 mm x 100 mm). The patch is indirectly fed by a strip line (9 mm x 3 mm). The proposed antenna geometry is shown in Fig. 6. The partial ground plane is used to achieve omni-directivity and a certain level of wide bandwidth. To tune the impedance of this antenna as well as to adjust the bandwidth within the target band, a "throttle" with stepped or graded structures is used between the microstrip feed line and the square patch, as shown in Fig. 6 (left side).

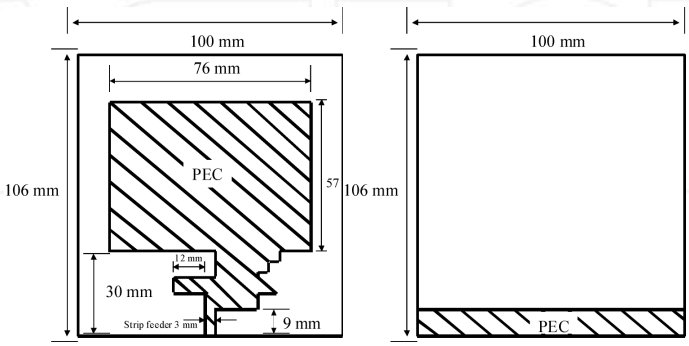

Fig. 6. Proposed DTV antenna geometry. *Left side:* Front view. *Right side:* Back view. The antenna is printed on FR4 substrate; t = 1.6 mm, ε_r = 4.4.

The input response for the proposed antenna is shown in Fig. 7 (left side). The omni directivity is confirmed by measurement at 500 MHz, 503 MHz, and 570 MHz as shown in Fig. 7 (right side). The radiation patterns shown in Fig. 7 are for the xz plane, which happens to be the vertical polarization for the antenna. DTV signals are horizontally polarized and therefore, when using this antenna, the orientation must be in such a way as to efficiently receive the DTV signal. Simply a 90 degree rotation of the antenna along the z axis achieves this requirement.

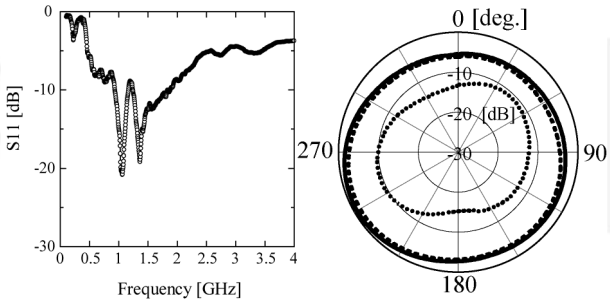

Fig. 7. Proposed DTV antenna performance. *Left side:* The antenna's measured input performance. *Right side:* The omni directivity in the vertical plane is confirmed at 500 MHz, 503 MHz, and 570 MHz. The outermost, black solid and dotted line patterns represent 503 MHz and 500 MHz directivity, respectively. The innermost dotted line pattern is the directivity at 570 MHz.

1.2.3 Example design for an 80 MHz FM half-wave dipole antenna

A half-wave dipole is the simplest practical antenna designed for picking up electromagnetic radiation signals, see Fig. 8 (courtesy of Highfields Amateur Radio Club). Calculating the optimal antenna length to pick up a certain frequency signal is fairly straightforward because antenna physics demand that the total length of wire used in the antenna be equal to one wavelength of the type of electromagnetic radiation it will be picking up. This means that the total length of the antenna should be equal to half the desired wavelength. By converting the 80 MHz frequency into a wavelength, you can thus obtain your antenna length as 1.875m by using the magic equation, $\lambda = \frac{c}{f}$. However, the actual length is typically about 95% of a half wavelength in free space, hence a half-wave dipole for this frequency should be 1.788m long, which would make each leg of the dipole 0.894m in length.

1.3 RF-to-DC conversion efficiency improvement techniques

A Schottky diode circuit connected to an antenna is used for RF-to-DC power conversion. To convert more of the antenna surface incident RF power to DC power, high RF-to-DC conversion efficiency is required of the rectifying circuit. Many authors have shown that the efficiency depends on several factors like Schottky diode type, harmonics suppression capability, load resistance selection, and the capability to handle arbitrary polarized incident waves. What is missing in most of these published works is the efficiency optimization for

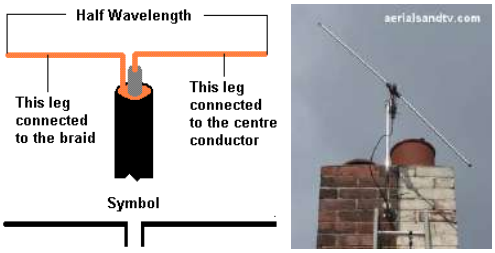

Fig. 8. Half-wave dipole. *Left side:* Antenna structure. *Right side:* Typical deployment.

ultra low power incident waves and the explanation of the physical phenomena behind most of the recommended efficiency optimization approaches.

This Chapter will show for example that a Schottky diode that delivers the highest efficiency at 0dBm incidence may not necessarily deliver the highest efficiency at lower power incidence e.g. –20dBm. We will therefore classify which diodes perform better at given power incidences; of course, this will also be compared to the diode manufacturers' application notes. Simulations in Agilent's ADS using SPICE and equivalent circuit models will compare the performance of few selected Schottky diodes namely; HSMS-2820, HSMS-2850, HSMS-2860, HSC-276A, and SMS7630. Moreover, the effect of the Schottky diode's junction capacitance (C_j) and junction bias resistance (R_j) on the conversion efficiency will be shown from which, special techniques for Schottky diode harmonic suppression and rectifying circuit loading for maximum efficiency point tracking will be presented.

1.3.1 The schottky diode

The classical *pn* junction diode commonly used at low frequencies has a relatively large junction capacitance that makes it unsuitable for high frequency application [3]. The Schottky barrier diode, however, relies on a semiconductor-metal junction that results in a much lower junction capacitance. This makes Schottky diodes suitable for higher frequency conversion applications like rectification (RF-to-DC conversion) [3]. We will demonstrate the effects of junction capacitance and resistance in the following sub section.

1.3.2 The effect of Schottky diode's C_j and R_j on the conversion efficiency

We have studied Schottky diode's C_j and R_j and published our results in [4]. In this work, we designed a rectifying antenna tuned for use at 2 GHz. The circuit proposed in [4] is a voltage doubler by configuration, but we replaced the amplitude detection diode (series diode) with its equivalent circuit adapted from [5]. The results of this investigation show that variation of C_j shifts the tuned frequency position and also introduces a mismatch in the resonant frequency, see Fig. 9 (left side graph). Therefore for this circuit at 2 GHz, we recommend using a Schottky diode having C_j = 0.2pF. In general, a smaller value of C_j is desirable at higher frequencies. Similarly, for R_j investigation, a smaller value is desirable for better matching at 2 GHz for example. If the R_j is increased towards 10kΩ, there is a mismatch in the resonant frequency but no shift in the frequency, see Fig. 9 (right side graph). Another approach to the study of Schottky diodes for higher frequency and efficiency rectenna design is presented in [6].

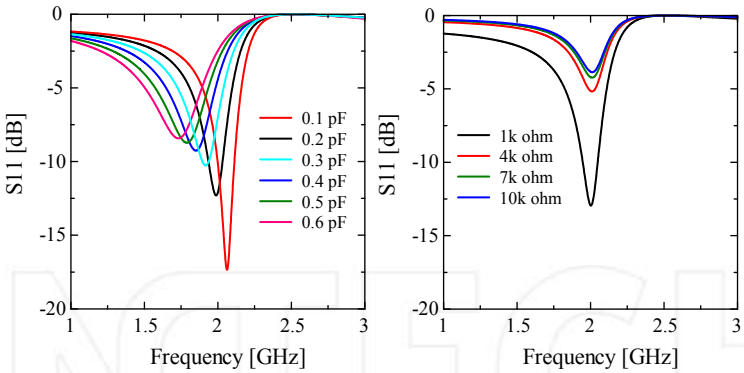

Fig. 9. Schottky diode's C_j effect (Left) and R_j effect (Right) on 2 GHz rectenna's input response.

1.4 Rectifying circuit for DTV energy harvesting

In the design of a DTV energy harvesting circuit, several basic design considerations must be paid attention to. First is the antenna; it must be wideband (covering 470 MHz to 770 MHz), horizontally polarized and omni-directional. Secondly is the rectifier; it must also be wideband, and optimized for RF-to-DC conversion for incident signal power at least -40dBm. Until recently, very few authors have published on DTV energy harvesting circuit. For the few publications, the antenna could not meet all those three requirements and a discussion on the performance of the harvesting circuit for ultra low power incidences has been neglected. In this Chapter we will present such a rectenna with conversion efficiencies above 0.4% at -40dBm, above 18.2% at -20dBm and over 50% at -5dBm signal power incidence. We will closely compare simulated and measured performance of the rectenna and discuss any observed disparities.

Agilent's ADS will be used to simulate the nonlinear behaviour of the rectifying circuit based on harmonic balance tuning methods. To simulate the multiple incident waves, a multi-tone excitation in the DTV band will be invoked. The wideband input characteristic will be achieved by the input matching inductors and capacitors.

The generic version of our proposed DTV energy harvesting circuit is shown below in Fig. 10. The implementation, however, is in two phases or scenarios as follows. First, we investigate the class called "ultra low power" DTV band rectenna. Secondly, we introduce the "medium power" DTV band rectenna.

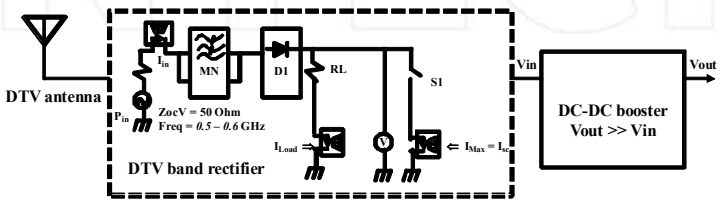

Fig. 10. Generic version of our proposed DTV energy harvesting circuit.

1.4.1 Ultra low power DTV rectenna

We define an ultra low power rectenna as one impinged by RF power incidence in the range between – 40dBm and -15dBm. Below in Fig. 11 is the circuit we designed; optimized for -20dBm input. The matching network is complex so as to achieve a wide band input characteristic. The fabricated circuit was well matched for the frequency range between 470 MHz and 600 MHz. More details about the circuit design can be found in [7].

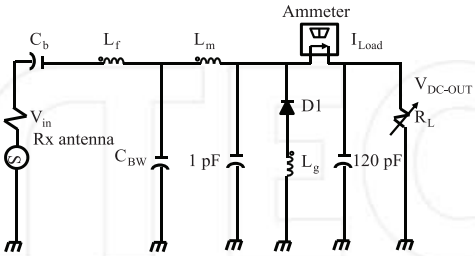

Fig. 11. Ultra low power DTV band rectenna circuit. SMS7630 Schottky diode by SKYWORKS offered the best performance.

The RF-to-DC conversion efficiency for this circuit is shown in Fig. 12 where at input power equal to -40dBm, efficiency is at least 0.4% and rectified voltage equals 1mV; at -20dBm, we have at least 18.2% by measurement and a rectified voltage of 61.7mV. The level of rectified voltage is too low and disqualifies this circuit for purposes of charging capacitors or batteries to accumulate such micropower over time. Instead, boosting the low voltage to usable levels is the option available and we shall discuss this at a later stage, (in Section 2.6).

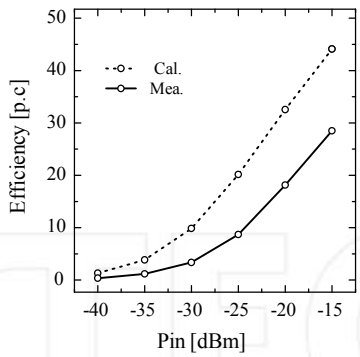

Fig. 12. Ultra low power DTV band rectenna efficiency.

1.4.2 Medium power DTV rectenna

We define a medium power rectenna as one impinged by RF power incidence in the range between – 5dBm and 0dBm. Below in Fig. 13 is the circuit we designed, optimized for -5dBm input. The matching network is simpler than as shown in section 2.4.1 since we require a narrow band around 550 MHz, with received peak power spectrum levels at least -5dBm. The circuit in Fig. 13 is a modification of Greinacher's doubler rectifier. In the circuit, C_b equals 1 pF and is used to block DC current against flowing towards the source. The shunt

capacitance, C_{BW} equals 3300 pF and is used to set the input bandwidth. The grounding inductance, L_g equals 56nH (optimal) and is used to improve the RF-to-DC conversion efficiency by cancelling the Schottky diodes (D_b and D_D) capacitive influence; thereby minimizing the harmonic levels (harmonic suppression). We used HSMS2850 diodes in these circuits for their better performance at this level of incident power.

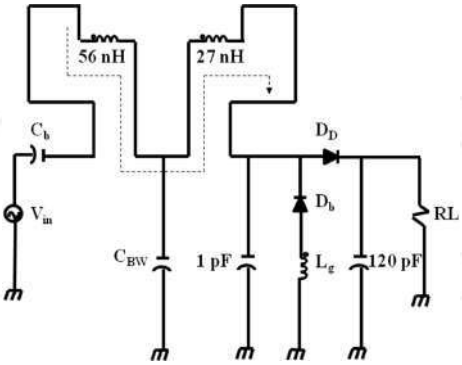

Fig. 13. Medium power DTV rectenna circuit. HSMS 2850 or 2820 from Hewlett-Packard offered the best performance.

The RF-to-DC conversion efficiency for this circuit is shown in Fig. 14 where at input power equal to -5dBm, we achieve at least 50% conversion efficiency by measurement, equivalent to 1.2 V DC rectified at 8.2kΩ optimal load. If we change the load to 47kΩ, over 2 V DC is rectified. This rectenna circuit is ideal for powering small sensors that run on 1.5 V or 2.2 V and draw around 6μA nominal current. If we need to power sensors demanding more power, say at least 2.2 V and 0.3mA to 1.47mA current consumption, we have to accumulate the power in a capacitor over time.

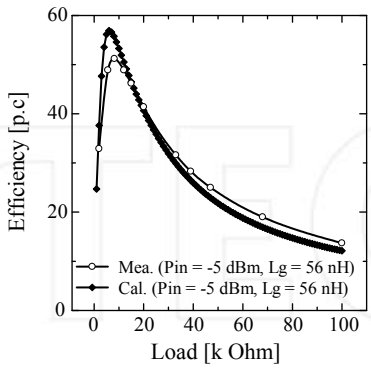

Fig. 14. Medium power DTV band rectenna efficiency.

1.4.3 DTV energy harvesting scenario and application demo

Using the medium power DTV band rectenna, connected to a gold capacitor as an accumulator, energy harvesting was initiated as shown in Fig. 15. Details about the gold

capacitor, which include its charge function, backup time and leakage losses are presented in [8]. For the scenario shown in Fig. 15, the accumulated voltage by measurement i.e. capacitor charge function follows the path;

$$V_{acc} = 0.5388\ln(t) + 1.4681 \tag{6}$$

where V_{acc} is the accumulated voltage in volts and t the time in hours. It takes 4.5 hours to accumulate 2.25 V, given a rectified charging voltage and current of 2.4 V and 51μA, respectively, supplied by the DTV band rectenna instantaneously.

With this rectenna, it was possible to power up many different kinds of sensors. Sensors with ultra low power consumption were powered directly, without need to accumulate the power in a capacitor, as shown in Fig. 16.

Fig. 15. DTV energy harvesting in a park at some line of sight from the base station.

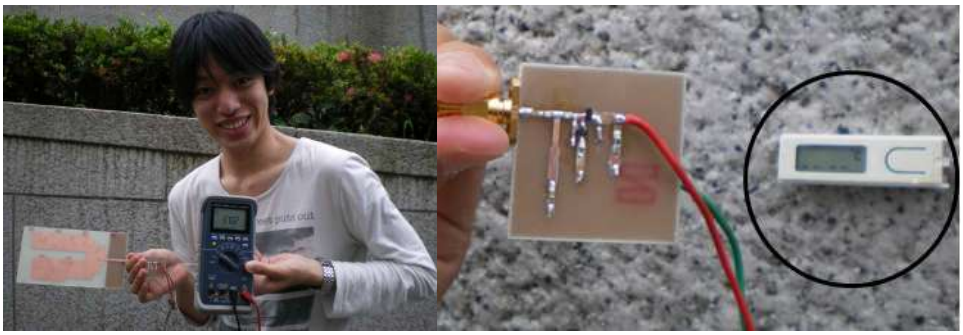

Fig. 16. Directly powering a thermometer mounted on a car park wall (right picture). The maximum instant voltage rectification on record equals 3.7 V (left picture).

1.5 Rectifying circuit for cellular energy harvesting

Unlike in the DTV energy harvesting circuit, for cellular energy harvesting, the antenna must be narrowband (50 MHz bandwidth is acceptable), and circularly polarized even

though cellular signals are vertically polarized. The circular polarization is desired to maximize the RF-to-DC conversion efficiency of the arbitrary polarization incident signals in the multipath environment. Similarly, the rectifier must be narrowband, and optimized for RF-to-DC conversion over a wide range of incident signal power.

Thinking about the potential applications for cellular energy harvesting is useful. Other authors have reported on powering a scientific calculator or a temperature sensor from GSM energy harvesting. In this Chapter we will present a special application for energy harvesting in the vicinity of the W-CDMA cellular base station and analyze the system performance by calculation from experimental data. A cellular energy harvesting circuit optimized for over 50% RF-to-DC conversion efficiency given approximately 0dBm incidence will be presented.

1.5.1 Cellular band rectenna

Below in Fig. 17 is the circuit we designed, optimized for 0dBm input. Simple input matching network is ideal since we require a narrow band response around 2.1 GHz. The optimum value for L_g equals 5.6nH, where L_g is used to improve the RF-to-DC conversion efficiency as earlier discussed. HSMS2850 diode was used.

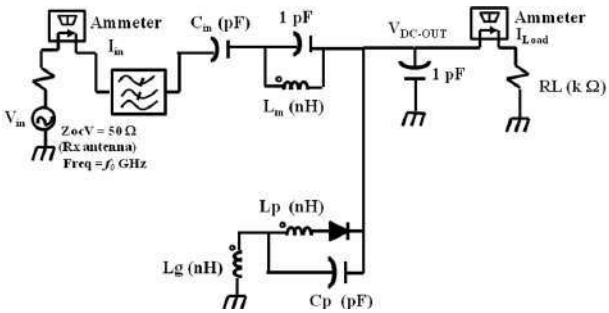

Fig. 17. Shunt rectifier configuration for the cellular band. The matching elements L_m = 3.2nH, while C_{in} =2.5pF. The load resistance is fixed at R_L = 2.1kΩ.

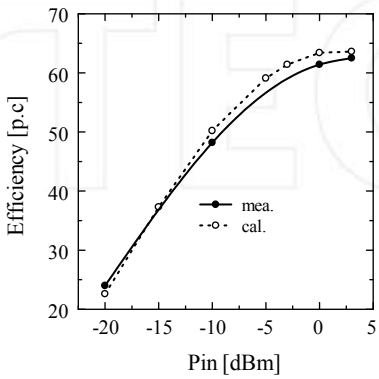

Fig. 18. Conversion efficiency as a function of input power (P_{in}) in the cellular band.

The RF-to-DC conversion efficiency for this circuit is shown in Fig. 18 where at input power equal to 0dBm, we achieve at least 60% conversion efficiency by measurement, given a 2.1kΩ optimal load. This rectenna circuit is ideal for powering small sensors that run on 1.5 V or 2.2 V and 6μA nominal current consumption. If we need to power sensors demanding more power, say at least 2.2 V and 0.3mA to 1.47mA, we have to accumulate the power in a capacitor over time as discussed in section 2.4.3 above.

1.5.2 Cellular energy harvesting application example

Environmental power generation in the neighbourhood of a cellular base station to power a temperature sensor is proposed as shown in Fig. 19 below. Electric field strength measurements in the base station neighbourhood have demonstrated the potential for environmental power generation, and the proposed temperature sensor system is designed based on these values. The rectenna described in Section 2.5.1 is used as the RF-to-DC rectifying circuit with the notched circular microstrip patch antenna (CMPA) proposed in Section 2.2.1. RF-to-DC conversion efficiency equal to 53.8% is obtained by measurement. The temperature sensor made for trial purposes clarifies the capability for temperature data wireless transmission for 20 seconds per every four hours in the base station neighbourhood.

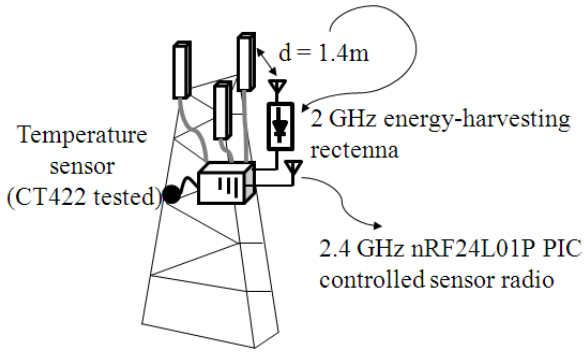

Fig. 19. Application example in the vicinity of the cellular base station.

1.6 Micropower energy harvesting management

A rectifying antenna circuit for -40dBm incident power harvesting generates 1mV at 2kΩ load, given 0.4% efficiency as presented in Section 2.4.1. At -20dBm incidence and at least 18.2% efficiency, 61.7mV is generated given a 2kΩ load [7]. The generated DC power in both of these two cases is in the μW range, hence the micropower definition. To manage such micropower, power accumulation or energy storage is required. Storage devices may either be a gold capacitor, super capacitor, thin film battery or the next generation flexible paper batteries. These storage devices have specific or standard maximum voltage and trickle charging current minimum requirements. Typically, gold capacitors have voltage ratings like 2.7 V, 5.5 V for 100 μA, 10mA or 100mA maximum discharge current. On the other hand, standard ratings for batteries are 1.8 V, 2 V, 3.3 V and 4.1 V. Therefore, to directly charge any of these storage devices from 1mV, or 61.7mV DC is impractical.

Published works have demonstrated the need for a DC-to-DC boost converter placed between the rectifying antenna circuit (rectenna) and the storage device. Recent efforts have demonstrated that a 40mV rectenna output DC voltage could be boosted to 4.1 V to trickle charge some battery. A Coilcraft transformer with turns ratio ($N_s : N_p$) equal to 100 was used in the boost converter circuit. An IC chip leading manufacturer (Linear Technology Corp., LT Journal, 2010) has released a linear DC-to-DC boost regulator IC chip capable of boosting an input DC voltage as low as 20 mV and supplying a number of possible outputs, specifically suited for energy harvesting applications. While this IC is a great milestone, readers and researchers need to understand the techniques to achieve such ICs and also the limitations that apply. In the following sub section, we will describe the methods toward designing a DC-DC boost converter, suitable for micropower RF energy harvesting.

In the design, we will attempt to clarify the parameters that affect the DC-DC conversion efficiency. For this design, Envelope simulation in Agilents's ADS is used. This simulation technique is the most efficient for the integrated rectenna and DC-DC boost converter circuits.

1.6.1 DC-DC boost converter design theory and operation

The DC-DC boost converter design theory and actual implementation are presented in this section. The inequality $V_{in} \ll V_{out}$ defines the boost operation. In this Chapter, our boost converter concept is illustrated in Fig. 20. A small voltage, V_{in} is presented at the input of the boost converter inductive pump which as a result, generates some output voltage, V_{out}. The output voltage is feedback to provide power for the oscillator. The oscillator generates a square wave, F_{OSC} that is used for gate signalling at the N-MOSFET switch.

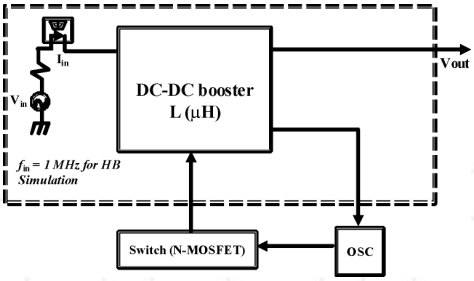

Fig. 20. Boost converter concept.

The drain signal of the N-MOSFET is used as the switch node voltage, V_{sn} at the anode of the diode inside the boost converter circuit block. From the concept presented in Fig. 20, the actual implemented circuit is shown in Fig. 21. The circuit was designed in Agilent's ADS and fabricated for investigation by measurement.

The circuit in Fig. 21 is proposed for investigation. Since a DC-DC boost converter is supposed to connect to the rectenna's output, it therefore, becomes the load to the rectenna circuit. This condition demands that the input impedance of the boost converter circuit emulates the known optimum load of the rectenna circuit. This has the benefit of ensuring

maximum power transfer and hence higher overall conversion efficiency from the rectenna input (RF power) to the boost converter output (DC power). In this investigation, as shown in [7], the optimum load for the rectenna is around 2kΩ. In general, emulation resistance R_{em} is given by

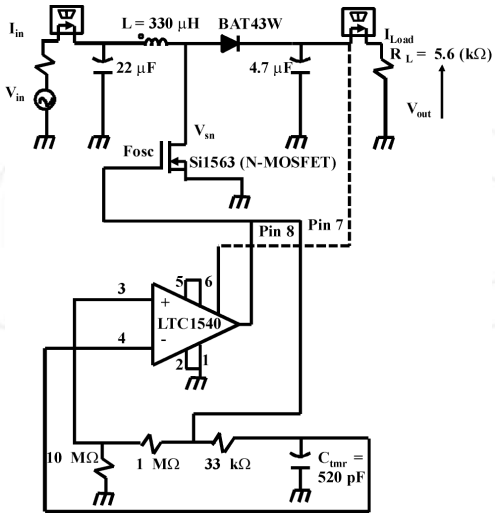

Fig. 21. The proposed boost converter circuit diagram. Designed in Agilent's ADS and fabricated for investigation by measurement.

$$R_{em} = \frac{2LT}{t_1^2 k}\left(\frac{M-1}{M}\right) \tag{7}$$

where $\boldsymbol{L}$ is the inductance equal to 330µH as shown in Fig. 20, $M = \frac{V_{out}}{V_{in}}$, $\boldsymbol{T}$ is the period of F_{OSC}, $\boldsymbol{t_1}$ is the switch"ON" time for the N-MOSFET, and $\boldsymbol{k}$ is a constant that according to [3] is a low frequency pulse duty cycle if the boost converter is run in a pulsed mode and typically, $\boldsymbol{k}$ may assume values like 0.06 or 0.0483. With reference to (7), we select L as the key parameter for higher conversion efficiency while V_{in} = 0.4 V DC is selected as the lowest start up voltage to achieve oscillations and boost operation. Computing the DC-DC boost conversion efficiency against different values of L, we have results as shown in Fig. 22.

From the results above, L = 100µH is the optimum boost inductance that ensures at least 16.5% DC-DC conversion efficiency, given R_L = 5.6kΩ.

Now having selected the optimum boost inductance given some load resistance, the emulation resistance shown in Fig. 23 is evaluated from the ratio of voltage versus current at the boost converter circuit's input.

The results show a constant resistance value against varying inductance. In general, we can say that this boost converter circuit has a constant low input impedance around 82.5Ω. This impedance is too small to match with the optimum rectenna load at 2kΩ. This directly affects the overall RF-to-DC conversion efficiency.

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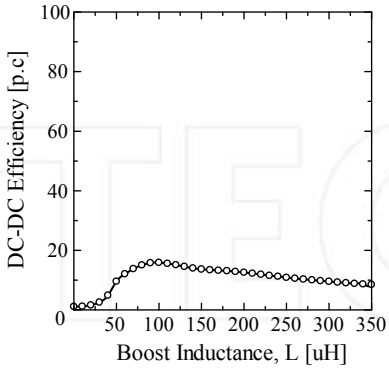

Fig. 22. Boost inductance variation with DC-DC conversion efficiency for a 5.6 kΩ load.

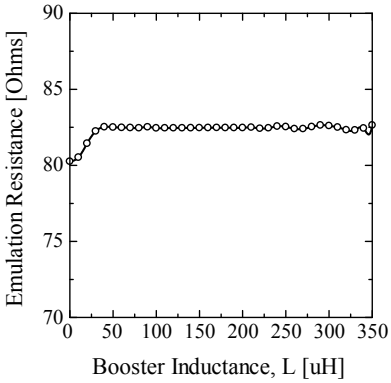

Fig. 23. Boost converter's input impedance: the emulation resistance.

Another factor, which affects the overall conversion efficiency is the power lost in the oscillator circuit. Unlike the circuit proposed in [9], which uses two oscillators; a low frequency (LF) and high frequency (HF) oscillator; in Fig. 21, we have attempted to use a single oscillator based on the LTC1540 comparator, externally biased as an astable multivibrator.

The power loss in this oscillator is the difference in the DC power measured at Pin 7 (supply) to the power measured at pin 8 (output). We term this loss, L_{osc}; converted to heat or sinks through the 10MΩ load. A comparison of the oscillator power loss to the power available at the boost converter output is shown in Fig. 24.

Looking at Fig. 24; we notice that the power loss depends on whether the oscillator output is high or low. The low loss corresponds to the quiescent period where the power lost is

almost negligible. However, during the active state, the lost power (power consumed by the oscillator) nearly approaches the DC power available at the boost converter output. This results in low operational efficiency.

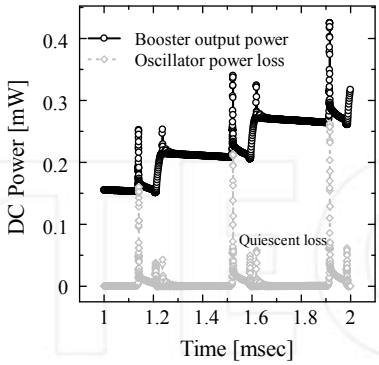

Fig. 24. The power loss in the oscillator.

To confirm whether or not the circuit of Fig. 21 works well, we did some measurements and compared them with the calculated results. Unlike in calculation (simulation), during measurement, L = 330μH was used due to availability. All the other component values remain the same both in calculation and measurement. In Fig. 25 (left side graph) and (right side graph), we see in general that the input voltage is boosted and also that the patterns of F_{osc} and V_{sn} are comparable both by simulation and measurement. To control the duty cycle of the oscillator output (F_{osc}), and the level of ripples in the boost converter output voltage (V_{out}), we change the value of the timing capacitance, C_{tmr} in the circuit of Fig. 21. Simulations in Fig. 25 (left side graph) show that C_{tmr} = 520pF realizes a better performance i.e. nearly constant V_{out} level (very low ripple).

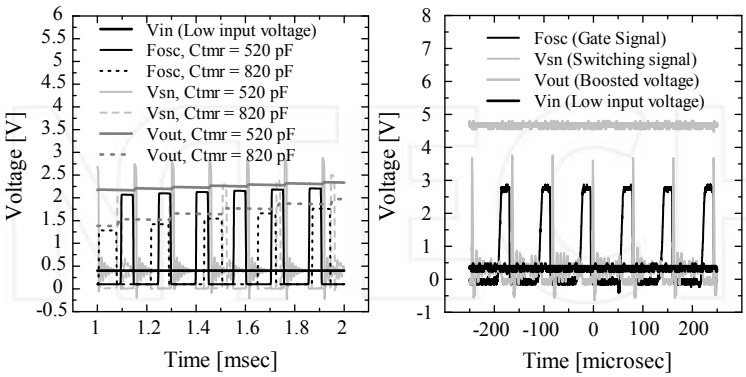

Fig. 25. Voltage characteristics of the developed boost converter circuit. The left side graph represents simulation while the right side graph is for measurements.

Generally, we observe that with this kind of boost converter circuit topology, it is difficult to start up for voltages as low as 61.7mV DC generated by the rectenna at -20dBm power

incidence and at least 18.2% rectenna RF-to-DC conversion efficiency. Self starting is the issue for this topology at very low voltages.

At least 11.3% DC-DC conversion efficiency was recorded by measurement and is comparable to the calculation in Fig. 22. During measurement it was clearly revealed that the boost converter efficiency does depend on the value of **L** and the duty cycle derived from $\mathbf{t_1}$. To efficiently simulate the complete circuit, from the RF input to the DC output, envelope transient simulation (ENV) in Agilent's ADS was used. The (ENV) tool is much more computationally efficient than transient simulation (Tran). This simulation is appropriate for the boost converter circuit's resistor emulation task. Moreover, the boost converter's DC-DC conversion efficiency, and the overall RF-to-DC conversion efficiency can be calculated at once with a single envelope transient simulation.

In summary, though not capable to operate for voltages as low as 61.7mV DC, the proposed boost converter has by simulation and measurement demonstrated the capability to boost voltages as low as 400mV DC, sufficient for battery or capacitor recharging, assuming that the battery or the capacitor has some initial charge or energy enough to provide start-up to the boost converter circuit.

The limitations of our proposed boost converter circuit include; low efficiency, lack of self starting at ultra low input voltages, and unregulated output. To address these limitations, circuit optimization is required. Moreover, alternative approaches which employ a flyback transformer to replace the boost converter inductance must be investigated. A regulator circuit with Low Drop Out (LDO) is necessary to fix the boost converter output voltage commensurate with standard values like 2.2 V DC for example. For further reading, see [7]

2. Performance analysis of the complete RF energy harvesting sensor system

To demonstrate how one may analyze the performance of an RF energy harvesting system including its application, we extend the discussion of Section 2.5.2 to this Section. We propose a transmitter assembled as in Fig. 26 for temperature sensor wireless data transmission.

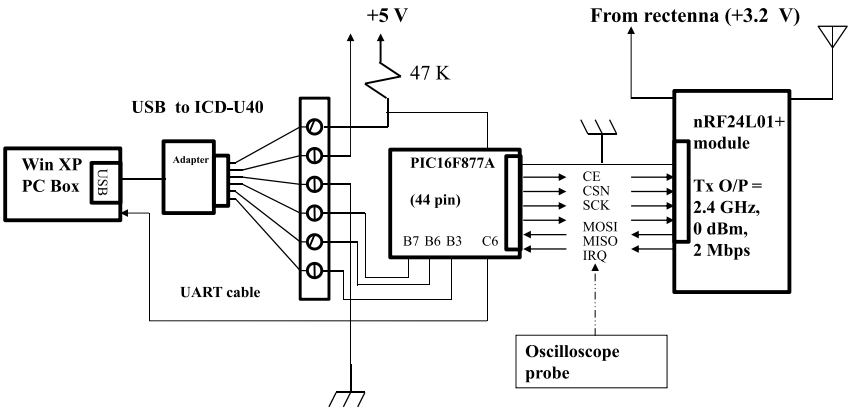

Fig. 26. The assembly and test platform for the proposed battery-free sensor transmitter.

The transmitter consists of one-chip microcomputer (MCU) PIC16F877A and wireless module nRF24L01P for the control, and MCU can be connected with an outside personal computer using ICD-U40 or RS232 cable. The wireless module operates in transmission and reception mode, and controls power supply on-off, transmitting power level, the receiving mode status, and transmission data rate via Serial Peripheral Interface (SPI). Figure 27 shows the operation flow when transmitting.

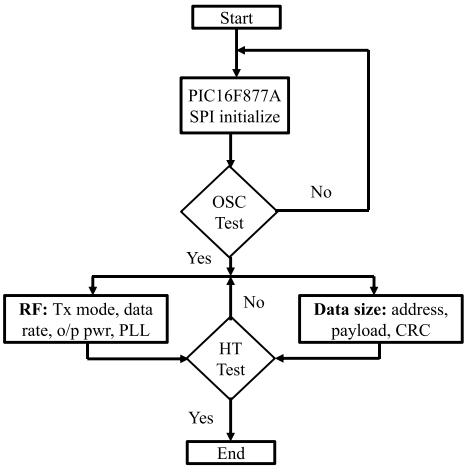

Fig. 27. Operation flow during transmission.

The experimental system composition is shown in Fig. 28 to transmit acquired data by the temperature sensor with WLAN at 2.4 GHz (ISM band). An ISM band sleeve antenna is used for the transmission. Using the cellular band rectenna shown and discussed in Section 2.5.1, at least 3.14 V is stored in the electric double layer capacitor over a period of four hours. To harvest a maximum usable power for the overall system, we charge the capacitor up to 5V. The operation voltage for the wireless module presented in Fig. 26 above is between 1.9V and 3.6V.

The signal was transmitted from the wireless module while a sleeve antenna, same like the one for transmission was used with the spectrum analyzer and the reception experiment was performed. Received signal level equal to -43.4dBm was obtained at a distance 3.5m between transmitter and reception point. The capacitor's stored voltage was used to supply the wireless module in the above-mentioned experiment. Successful transmission was possible for 5.5 minutes after which, the capacitor terminal voltage decreased from 3.16V to 1.47V, and the transmission ended. The sending and receiving distance of data can be estimated to be about 10m when the sensitivity of the receiver is assumed to be -60dBm, given 0dBm maximum transmit power.

Hereafter, the overall system examination is done by environmental power generation using the transmitted electric waves from the cellular phone base station, proposed based on the above-mentioned results. First of all, the power consumption shown in Fig. 29 is based on the fact that 120mW (5V, 24mA) is saved in the electric double layer capacitor by environmental power generation, achieved by calculation as discussed earlier.

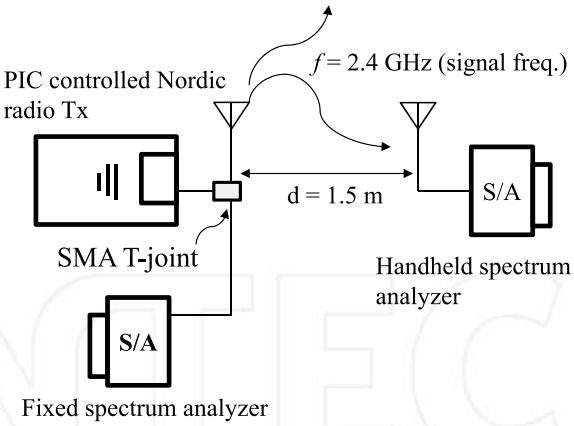

Fig. 28. Indoor measurement setup for received traffic from the sensor radio transmitter.

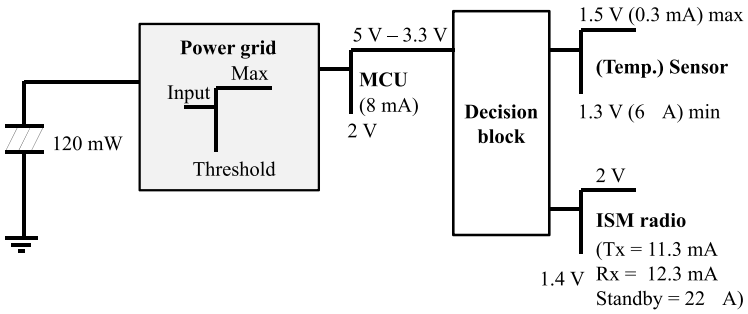

Fig. 29. Power management scheme for the cellular energy-harvesting sensor node.

The sensor data packet is transmitted wirelessly in ShockBurst mode for energy efficient communication. The data packet format includes a pre-amble (1 byte), address (3 bytes), and the payload i.e. temperature data (1 byte). The flag bit is disregarded for easiness, and cyclic redundancy check (CRC) is not used.

The operation of the proposed system is provisionally calculated. When the rectenna is set up in the place where power incidence of 0dBm is obtained in the base station neighbourhood (as depicted in Section 2.5.2), an initially discharged capacitor accumulates up to 3.3V by a rectenna with 53.8% conversion efficiency (presented in Section 2.5.1). At this point, it takes 1.5 minutes to start and to initialize a wireless module, and the voltage of the capacitor decreases to 2V. This trial calculation method depends on the capacitor's back up time discussed in [8]. After this, when the wireless module is assumed to be in sleep mode, the capacitor is charged by a 0.28mA charging current for four hours whereby the capacitor's stored voltage increases up to 5V. The power consumption in the sleep mode or standby is 33μW (1.5V, 22μA).

When the wireless module starts, after data transmission and the confirmation signal is sent, the voltage of the capacitor decreases by 0.6V, and consumes the electric power of 7.4mW.

The voltage of the capacitor decreases to 2V when 3.2mW is consumed to the acquisition of the sensor data, and the operation time of MCU is assumed to be one minute to the data storage in the wireless module etc. As for the capacitor voltage, when the wireless module continuously transmits data for 20 seconds, it decreases from 2V to 1.4V and even the following operation saves the electric power. Therefore, a temperature sensing system capable of transmitting wireless data in every four hours becomes feasible by environmental power generation from the cellular phone base station if we consider intermittent operation by sleep mode.

3. Conclusion

This Chapter has given an overview of the present energy harvesting sources, but the focus has stayed on RF energy sources and future directions for research. Design issues in RF energy harvesting have been discussed, which include low conversion efficiency and sometimes low rectified power. Solutions have been suggested by calculation and validated by measurement where possible, while highlighting the limitations of the proposed solutions. Potential applications for both DTV and cellular RF energy harvesting have been proposed and demonstrated with simple examples. A discussion is also presented on the typical performance analysis for the proposed RF energy harvesting system with sensor application.

4. Acknowledgment

The authors would like to thank Prof. Apostolos Georgiadis of Centre Tecnològic de Telecomunicacions de Catalunya (CTTC, Spain) for the collaboration on the design and development of the DC-DC boost converter circuit. Further thanks go to all those readers who will find this Chapter useful in one way or the other.

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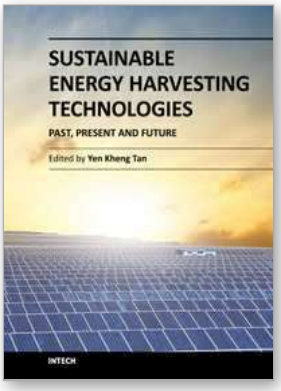

Sustainable Energy Harvesting Technologies - Past, Present and Future

Edited by Dr. Yen Kheng Tan

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In the early 21st century, research and development of sustainable energy harvesting (EH) technologies have started. Since then, many EH technologies have evolved, advanced and even been successfully developed into hardware prototypes for sustaining the operational lifetime of low?power electronic devices like mobile gadgets, smart wireless sensor networks, etc. Energy harvesting is a technology that harvests freely available renewable energy from the ambient environment to recharge or put used energy back into the energy storage devices without the hassle of disrupting or even discontinuing the normal operation of the specific application. With the prior knowledge and experience developed over a decade ago, progress of sustainable EH technologies research is still intact and ongoing. EH technologies are starting to mature and strong synergies are formulating with dedicate application areas. To move forward, now would be a good time to setup a review and brainstorm session to evaluate the past, investigate and think through the present and understand and plan for the future sustainable energy harvesting technologies.

How to reference

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Multi-Service Highly Sensitive Rectifier for Enhanced RF Energy Scavenging

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Due to the growing implications of energy costs and carbon footprints, the need to adopt inexpensive, green energy harvesting strategies are of paramount importance for the long-term conservation of the environment and the global economy. To address this, the feasibility of harvesting low power density ambient RF energy simultaneously from multiple sources is examined. A high efficiency multi-resonant rectifier is proposed, which operates at two frequency bands (478–496 and 852–869 MHz) and exhibits favorable impedance matching over a broad input power range (−40 to −10 dBm). Simulation and experimental results of input reflection coefficient and rectified output power are in excellent agreement, demonstrating the usefulness of this innovative low-power rectification technique. Measurement results indicate an effective efficiency of 54.3%, and an output DC voltage of 772.8 mV is achieved for a multi-tone input power of −10 dBm. Furthermore, the measured output DC power from harvesting RF energy from multiple services concurrently exhibits a 3.14 and 7.24 fold increase over single frequency rectification at 490 and 860 MHz respectively. Therefore, the proposed multi-service highly sensitive rectifier is a promising technique for providing a sustainable energy source for low power applications in urban environments.

AMBIENT energy harvesting is attracting widespread interest as it has the potential to provide a sustainable energy source for future growth and protection of the environment. Considerable research effort has been directed toward low-profile, low-power, energy efficient and self-sustainable devices aiming to harvest energy from inexhaustible sources such as solar energy, thermal, biomass, mechanical sources (e.g. wind, kinetic, vibration, and ocean waves) wastewater, and microwave energy. A thorough set of reviews is given in the literature[1–4]. Among these green energy sources, there has been a growing interest for radio frequency (RF) energy scavenging, as the availability of ambient RF energy has increased due to advancements in broadcasting and wireless communication systems. Furthermore, the development of wireless power transmission (WPT) technologies[5] that allow micro sensors[6], mobile electronic devices[7], wireless implantable neural interfaces[8] and far-field passive RFID (Radio-Frequency Identification) systems[9–11] to operate without batteries has triggered impetus for RF energy harvesting.

Efficient RF energy harvesting is a very challenging issue, as it deals with the very low RF power levels available in the environment. Furthermore, the scavengeable power level can vary unpredictably, depending on several factors such as the distance from the power source, the transmission media, the telecommunication traffic density and the antenna orientation. The majority of available literature on RF rectification has been dedicated to narrowband rectennas, which essentially operate at a single frequency and hence provide low DC output power[12,13]. Various topologies, such as voltage doublers or multipliers have been employed in order to increase the RF to DC conversion efficiency and the output DC voltage for specific applications[14–16]. However, from an ambient RF scavenging perspective, harvesting energy from various available frequencies could maximize power collection and hence increase the output DC power. Ultra-wideband and broadband rectenna arrays have been proposed as a potential solution[17,18]. However in some cases, simulation and experimental results were not provided to demonstrate the findings[17]. A broadband rectenna consisting of a dual-circularly polarized spiral rectenna array operating over a frequency range of 2–18 GHz was demonstrated[18]. The rectified DC power was characterized as a function of DC load, RF frequency and polarization for power densities between 10^{-5} and 10^{-1} mW/cm^2. However, the proposed rectenna was matched at a single input RF power level for a specified load resistance for the characterization. Also, due to the low Q value of the rectifier circuit, the conversion efficiency was a fraction of 1% at −15.5 dBm. From a design point of view, while it is relatively easy to achieve a broadband antenna, it is very challenging to realize a broadband rectenna due to the non-linearity of the rectifier impedance with input power across the frequency band[19].

To address this, a promising approach is to use a dual-band or multi-band configuration. This can maximize the power conversion efficiency (PCE) at the specific frequencies where the maximum ambient signal level is

available. Various dual-band RF energy harvesting systems has been demonstrated[20–24], however a large signal analysis of the rectifier was commonly not provided over a broad input power range. A dual-band RF energy harvesting using frequency limited dual-band impedance matching has been proposed[20] and the PCE was shown over a high power range of 0 to 160 mW, however it was only matched at a single input power level (10 dBm). A CMOS dual-narrowband energy harvester circuit was modeled at environmental power levels[21]. Again, the rectifier efficiency was demonstrated with only single input power levels of −19 and −19.3 dBm at 2 GHz and 900 MHz respectively, and a large signal analysis was not presented. A compact dual-band rectenna operating at 915 MHz and 2.45 GHz has been demonstrated[22] and the PCE was shown for input power levels of −15, −9 and −3 dBm. However, the reflection coefficient was evaluated at a single incident power level. Furthermore, the efficiency results with dual-tone excitation simultaneously and single-tone excitation (at 915 MHz) are very similar, hence the impact of applying a dual-band technique does not demonstrate a clear advantage over a single band. A dual-frequency rectenna for WPT has been proposed[23] which achieved a conversion efficiency of 84.4% and 82.7% at 2.45 and 5.8 GHz with a high input power level of 89.84 and 49.09 mW respectively. These power levels far exceed ambient levels in the environment[19]. A conformal hybrid solar and electromagnetic (EM) energy harvesting rectenna has been presented[24] and the PCE was provided with −30 to 5 dBm input power, achieving an efficiency up to 40% at 1.85 GHz for higher input power levels (above −5 dBm). However the reflection coefficient was not provided at low input power range.

A multi-resonant rectenna that uses a multi-layer antenna and rectifier has been evaluated for a −16 dBm to +8 dBm RF received power level, but the rectifier circuit layout and large signal analysis were not provided to clarify the findings[25]. Furthermore, a rectenna for triple-band biotelemetry communications has been proposed using a triple-band antenna and single frequency rectifier[26]. However, this rectenna is not suitable for RF energy scavenging due to the low efficiency at lower input power levels. Another triple band rectenna presented an RF-DC efficiency over the input power range of −14 to +20 dBm[27], however the reflection coefficient results were only evaluated at a single input power level. This rectenna was shown to harvest 7.06 μW of DC power from three sources simultaneously at a high input power level of +10 dBm. A multi-band harvesting system has also been proposed where four individual harvesters are designed to cover four frequency bands[28]. However, a large signal analysis was not provided over a broad input power range. Furthermore, the proposed harvesting system has a minimum sensitivity of −25 dBm, whilst in a real environment more sensitive systems are required as the available RF power levels are very low[19].

Tunable impedance matching networks have been demonstrated in order to collect RF signals from various sources and convert them to DC power[29]. However from an application point of view, this is still single frequency rectification and it is not widely applicable to environmental RF energy scavenging where the available power is very low.

In order to increase the amount of RF energy scavenged by a rectenna, it is crucial to identify and harvest multiple ambient frequency sources over their realistic available energy range. Our previous research has demonstrated the feasibility of RF energy harvesting through RF field investigations and maximum available power analysis in metropolitan areas of Melbourne, Australia[19]. The maximum available power for different frequency bands based on antenna aperture and number of antennas in a given collection area was analyzed. Measured results and analysis indicated that cellular systems and broadcast sources are well suited to harvesting, with scavengeable RF power ranging from −40 to −10 dBm. This identifies two important considerations in the design of efficient rectenna for RF energy harvesting: the scavengeable ambient RF power sources available, and the significant variance of this power.

The RF to DC rectifier solutions proposed in recent literature have focused on maximizing the system efficiency at a given, and often quite high, input power level. This neglects the issues related to input power variation which can lead to unexpected variations in the matching network due to diode non-linearity. Also, the scavangeable levels of ambient RF power have been shown to be orders of magnitude lower. Therefore, based on our previous research outcomes and recommendations[19], an efficient power harvesting solution could encompass a multi-band matching circuit at the specific frequencies where maximum signal power is available, enabling greater power harvesting due to the combination of RF signals. This also results in a higher power being fed to a single rectifier, utilizing the diode function more efficiently.

This paper presents an RF energy harvesting method that can scavenge a wide range of ambient power levels which are orders of magnitude lower than previous reported techniques in the literature. An efficient dual resonant rectifier circuit is proposed, matched to a 50 Ω input port at 490 and 860 MHz over a broad low input RF power range from −40 to −10 dBm. The proposed dual resonant matching network operates efficiently at two identified harvesting frequency bands over a wide input power range, maximizing DC power by scavenging two sources simultaneously.

The remainder of this paper is organized as follows. First, the key results for the reflection coefficient and output DC power are presented. Subsequently, the Discussion section summarizes the results and demonstrates their potential implications, the limitations of this study, open questions and future research. Finally, the Method section describes the proposed rectifier design.

Results

A dual resonant rectifier was fabricated on a 1.58 mm FR-4 substrate with a dielectric constant $\varepsilon_r \approx 4.5$ and a loss tangent $\delta \approx 0.025$. These substrate parameters were measured using the Nicolson-Ross method[30] so accurate values could be used in the rectifier design. A photograph of the fabricated dual resonant rectifier is shown in Fig. 1 which depicts input RF port, dual-band matching network lumped components, Schottky diodes and the output terminal. The performance of the rectifier was verified by measuring the input reflection properties, and the output power was calculated from the measured output DC voltage for the input powers from −40 to −10 dBm.

Reflection Coefficient. The $|S_{11}|$ of the rectifier was evaluated using a vector network analyzer (VNA). The VNA was re-calibrated for each input power level. Figure 2 compares the simulated and measured $|S_{11}|$ versus frequency for the dual resonant rectifier circuit at four different input power levels from −40 to −10 dBm. The measured results show very good agreement to the simulations. Slightly higher reflection was observed for the resonant frequencies at the lower part of the input power range (due to the diode characteristics). However, the proposed rectifier circuit is well-matched ($|S_{11}| < -10$ dB) at the desired frequency bands of

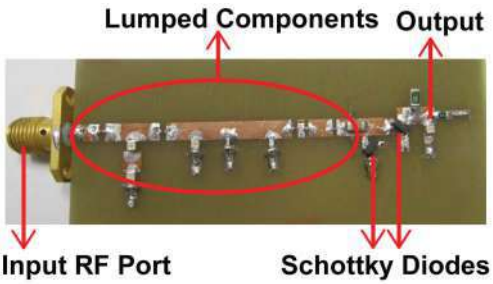

Figure 1 | Fabricated rectifier prototype.

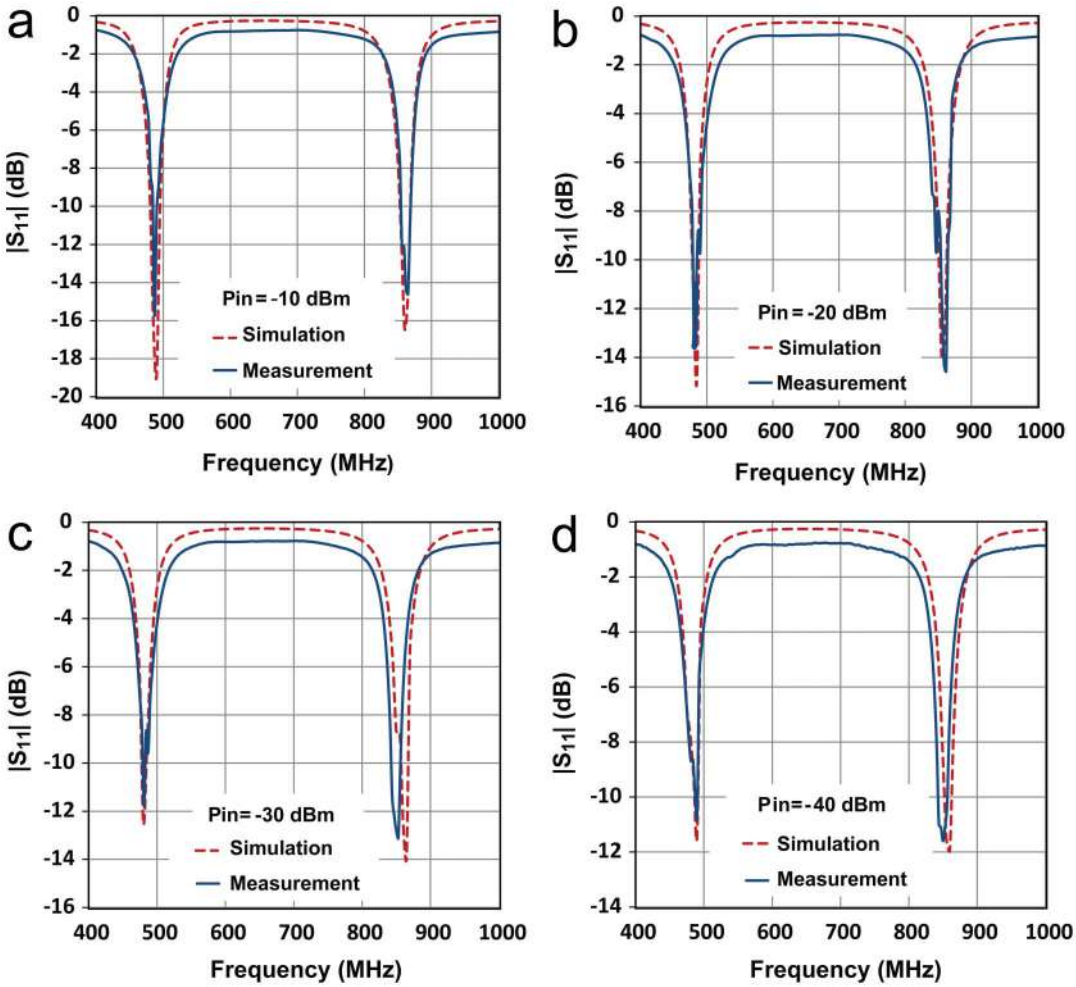

Figure 2 | Simulated and measured $|S_{11}|$ as a function of frequency and input RF power for the proposed dual resonant rectifier circuit. (a) −10 dBm. (b) −20 dBm. (c) −30 dBm. (d) −40 dBm.

478–496 MHz and 852–869 MHz over the broad range of input powers from −40 to −10 dBm. The small difference between simulation and measurement is due to the parasitic extraction accuracy.

Output DC Power. In the frequency domain, the Harmonic Balance method of analysis provides a comprehensive treatment of a multispectral problem[18]. The method intrinsically takes into account the DC component and a specified number of harmonics, while allowing the ability to specify the source impedance and harmonic terminations. A Harmonic Balance simulation was used to numerically evaluate the output DC voltage of the dual resonant rectifier for both a single and two tone input. The output DC voltage across the load resistor was also measured and used to calculate output DC power. Measurements were performed using a Wiltron 68247B synthesized signal generator as a RF power source for the rectifier circuit. Recording of the output DC voltage across the load resistance was achieved with a Fluke 79III digital voltage meter. The RF source power was initially set at −10 dBm, and decreased in 2 dB steps. In the dual-band measurement case, two RF signal generators were fed to the rectifier circuit simultaneously via a power combiner.

The simulation and measurement results for single and dual input tones are summarized in Fig. 3(a) and (b). A measured DC voltage of 772.8 mV is achieved with two simultaneous input tones at an input power of −10 dBm. For single tone measurements, DC voltages of 436 mV and 286 mV at 490 MHz and 860 MHz respectively are produced. The comparison between the 490 and 860 MHz single rectifiers highlights the impact of the input frequency on the PCE. A higher amount of DC voltage can be generated at the lower frequency. This difference comes from decreasing diode performance at the higher frequency due to the higher junction capacitance of the diode[31].

Importantly, a slightly higher DC voltage can be generated with the dual resonant rectifier as compared to the sum of output voltage from the two single bands, particularly at the lower input power levels as can be seen in Fig. 3(b) which shows the lower power section of Fig. 3(a) in more detail. By maximizing power collection from various sources of different frequencies and delivering the combined power to the rectification circuit, the diode conversion efficiency is enhanced which results in a higher level of rectified voltage. Figure 4 compares the simulated and measured output DC power for the dual resonant rectifier circuit with both single and dual input tones. A measured DC power of 17.3 μW and 7.5 μW can be generated at 490 MHz and 860 MHz respectively with a single tone input of −10 dBm (100 μW). This represents true efficiencies of 17.3% and 7.5% for the individual single band rectification (see Fig. 5). However, the measured DC output power with two concurrent input tones of −10 dBm is 54.3 μW which corresponds to an effective efficiency of 54.3% for the dual-band rectifier (see Fig. 6). This represents a 3.14 and 7.24 times increase in output DC power over the single tone excitation at 490 MHz or 860 MHz respectively. This trend is evident down to low input power levels (around 40 μW). Furthermore, there is a significant increase in the PCE of the dual resonant rectifier for lower input power levels (<40 μW).

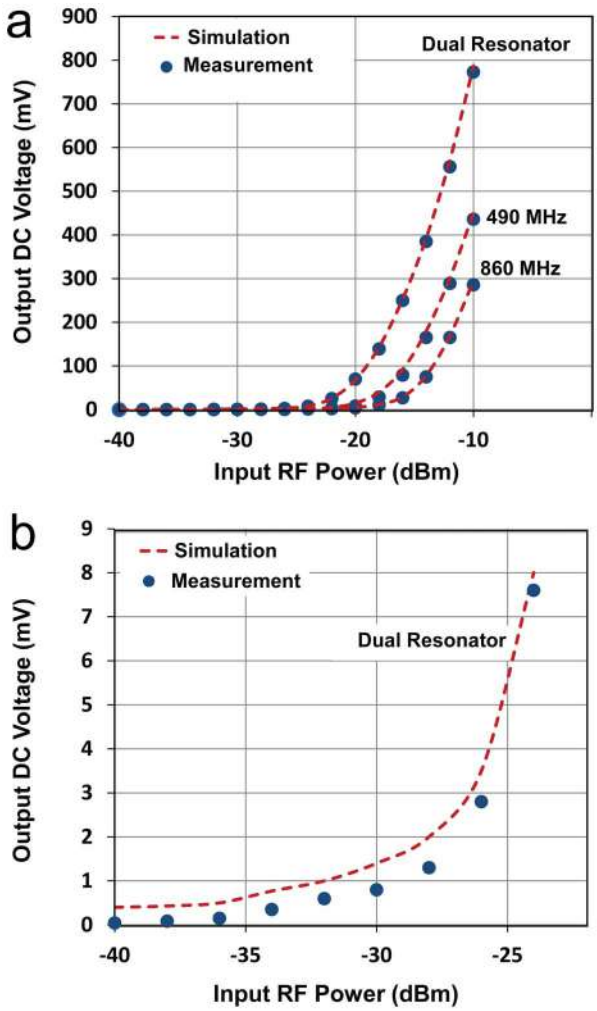

Figure 3 | Output DC voltage as a function of input RF power for single input tone at both 490 MHz and 860 MHz and for dual input tones (a) with −40 to −10 dBm input RF power (b) with −40 to −25 dBm input RF power. (This power range is associated with the signal source).

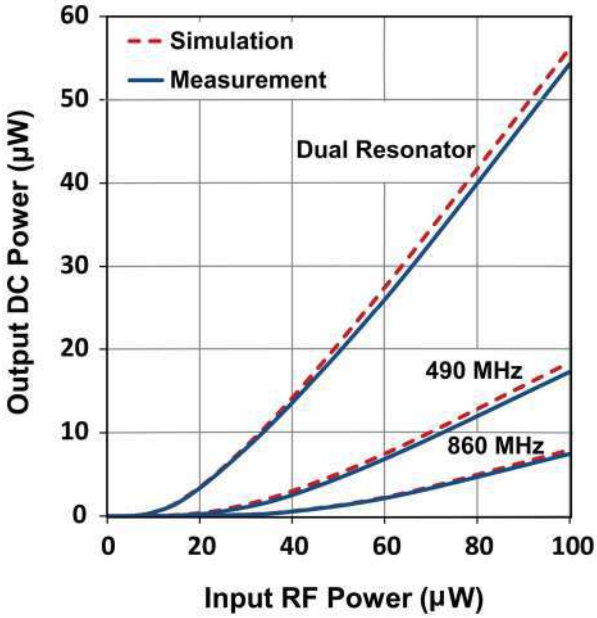

Figure 4 | Output DC power as a function of input RF power for single and dual input tones.

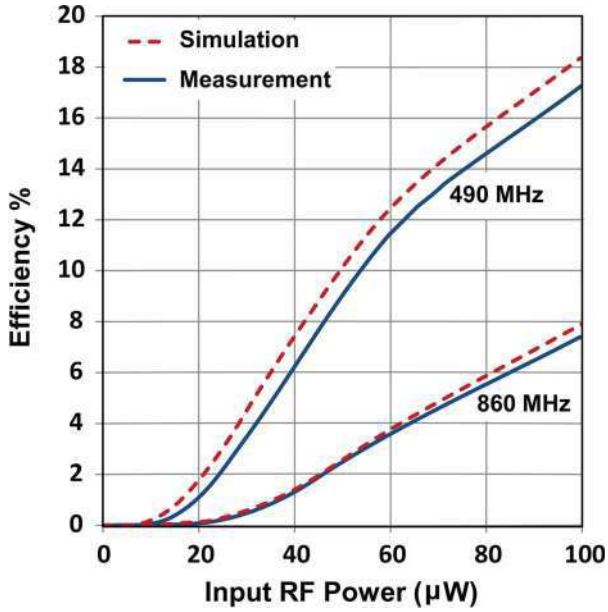

Figure 5 | RF to DC conversion efficiency as a function of input RF power for single band rectification.

Here, the effective efficiency is defined as the ratio of output DC power to the available input RF power rather than the power delivered to the diodes (equation (1)). The available power level is associated with the signal source. For the single resonator, the available input power is −10 dBm and the delivered power is also −10 dBm (assuming no loss). However, by creating a dual resonant matching network the power delivered to the diodes is −7 dBm (combined total input power from two signal generators) but the available power is still −10 dBm.

$$\eta = \frac{p_o}{p_i} = \frac{\left(\frac{V_o^2}{R_L}\right)}{p_i} \tag{1}$$

Therefore, combining input RF signals into a single rectification stage results in high sensitivity rectifier, which is widely applicable to

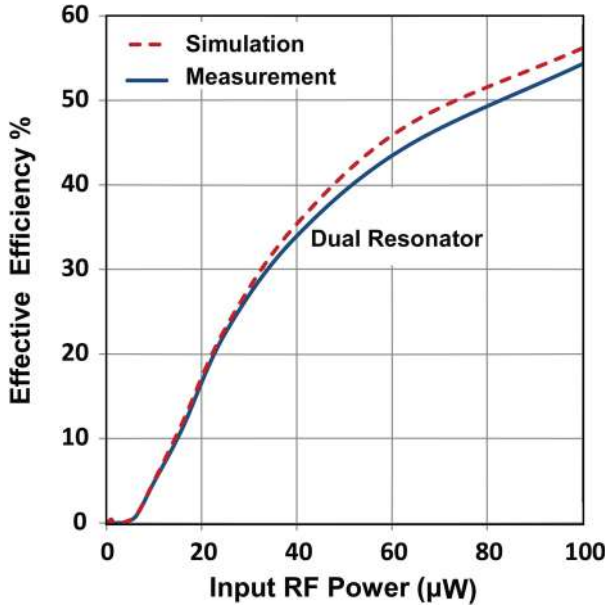

Figure 6 | Effective RF to DC conversion efficiency as a function of input RF power for dual resonant rectification.

Table 1 | Rectifier performance comparison

Ref.	Technology	Measured Efficiency (%)	RF power variation (in PCE evaluation)	Rectification Technique
13	Schottky diode	82@50 mW	N/A	Single resonator
16	Schottky diode	44@−10 dBm	N/A	Single resonator
18	Schottky diode	20@0.07 mW/cm^2 0.1@5×10^{-5} mW/cm^2	10^{-5} to10^{-1} mW/cm^2	Broad band
20	Schottky diode	77.13@22 dBm (158.49 mW)	0 to 160 mW	Dual resonator
21	CMOS	9.1@−19.3 dBm (900 MHz) 8.9@−19 dBm (2 GHz)	N/A	Dual resonator
22	Schottky diode	37 (915 MHz)@−9 dBm 30 (2.45 MHz)@−9 dBm	−40 to 0 dBm	Dual resonator
23	Schottky diode	84.4@89.84 mW (2.45 GHz) 82.7@49.09 mW (5.8 GHz)	0 to 100 mW	Dual resonator
27	Schottky diode	80@10 dBm (940 MHz) 47@8 dBm (1.95 GHz) 43@16 dBm (2.44 GHz)	−14 to 20 dBm	Triple resonator
29	Schottky diode	50@−5 dBm	−25 to 0 dBm	Dual resonator with tunable input response
This work	Schottky diode	54.3@−10 dBm 11.25@−18 dBm (490 and 860 MHz)	−40 to −10 dBm	Dual resonator

Table 2 | Environmental measurement results

Suburb	Available frequencies (MHz)	Respective available RF power (dBm) [μW]	Measured DC power (μW)
Bayswater	486, 488, 489, 490, 491, 867, 868, 869, 870, 871, 872, 873, 874	−19[12.5], −20[10], −17[19.95], −15[31.62], −22[6.3], −37[0.199], −37[0.199], −30[1], −24[3.98], −20[10], −30[1], −37[0.199], −40[0.1]	39.38
Bentleigh	491, 492, 494, 495, 865, 866, 867, 868, 869, 870, 871	−12[63.09], −46[0.02], −42[0.063], −57[0.001], −27[1.99], −27[1.99], −30[1], −37[0.199], −40[0.1], −40[0.1], −41[0.07]	30.9
RMIT University (Melbourne CBD)	487, 488, 489, 490, 491, 851, 861, 862, 866, 867, 868, 869	−30[1], −22[6.3], −29[1.25], −22[6.3], −20[10], −23[5.01], −21[7.94], −21[7.94], −30[1], −35[0.31], −40[0.1], −40[0.1]	14.5

real environmental RF energy scavenging. This multi-band technique can provide higher DC power than combining two separate single frequency rectifier circuits operating at the same frequencies. This is due to the fact that harvesting RF energy from various available sources simultaneously increases the delivered power to the rectifier, which improves the diode conversion efficiency and consequently enhances the output DC power. Table 1 summarizes this work as compared to previous published work.

In order to provide a realistic scenario for the proposed dual-band rectifier, measurement results were taken in three suburbs of Melbourne, Australia, congruent with our previous research outcomes[19]. Table 2 summarizes these environmental measurement results. It should be noted that the lower band (478–496 MHz) has a 3.67% fractional bandwidth and the higher band (852–869 MHz) has around 2% fractional bandwidth. Hence, various RF frequencies from different sources can be harvested within these two bands. The environmental measurement results demonstrate the feasibility of harvesting ambient EM energy from multiple sources simultaneously.

Discussion

The feasibility of harvesting ambient EM energy from multiple sources simultaneously is investigated in this paper. The proposed dual resonant rectifier operates at two frequency bands (478–496 and 852–869 MHz), which are used for broadcasting and cellular systems respectively. The dual resonant rectifier exhibits favorable impedance matching over a broad input power range (−40 to −10 dBm) at these two bands. The achieved sensitivity and dynamic range demonstrate the usefulness of this innovative low input power rectification technique. Simulation and experimental results of input reflection coefficient and rectified output power are in excellent agreement. The measurement results demonstrate that a two tone input to the proposed dual-band RF energy harvesting system can generate 3.14 and 7.24 times more power than a single tone at 490 or 860 MHz respectively, resulting in a measured effective efficiency of 54.3% for a dual-tone input power of −10 dBm. It is evident that this dual resonant rectification technique increases the RF to DC effective conversion efficiency, and hence the recoverable DC power for low power applications. Furthermore from a design and economic perspective, utilizing a large number of components (e.g. antennas, diodes) to realize individual rectifier circuits for each frequency band creates additional expense. In order to provide more realistic measurement results, the proposed dual-band rectifier was tested in three suburbs of Melbourne, Australia. Therefore, this dual-band technique offers a simple and cost-effective solution which is of paramount importance for environmental power harvesting systems. This innovative technique has the potential to generate a viable perpetual energy source for low power applications in urban environments.

Limitation of the study, open questions and future work

Utilizing diodes which are more suitable to low power applications ($P_i < -20$ dBm) could increase the voltage sensitivity, resulting in a higher RF-DC conversion efficiency[32]. Applying a power optimized waveform excitation to the rectifier circuit in these frequency bands, a higher amount of DC power can be generated when compared with a single and dual tone excitations with the same input power[33,34]. However this technique is not applicable to energy harvesting where the input waveform is arbitrary.

Utilizing our proposed dual resonant rectification technique to combine resonant circuits for any other arbitrary frequency bands could lead to PCE improvement, provided that suitable diodes for the desired frequency bands are selected. Note that by increasing the operating frequency the rectification performance degrades due to

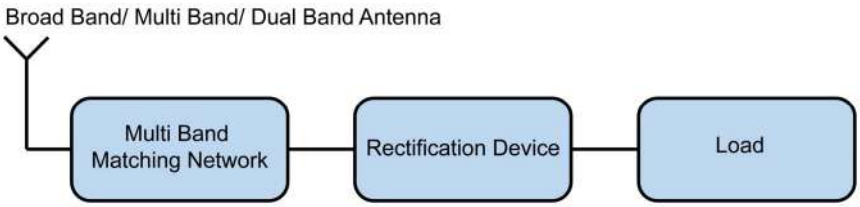

Figure 7 | General block diagram of the RF energy harvesting system.

the higher junction capacitance of the diode. Hence, lower output voltage is expected at higher frequency bands.

It is the object of our future work to design a multi-band rectenna array for enhanced RF energy harvesting. Furthermore, increasing the bandwidth, sensitivity and efficiency will also be investigated.

Methods

The major goal in designing an efficient RF harvesting system is to produce high DC output power. Toward this goal, a high sensitivity rectifier is crucial for optimum RF scavenging. A significant factor governing the sensitivity of a rectifier is the threshold voltage of the diode used for rectification. The diode must be able to "switch on" for very low ambient energy levels.

To address this sensitivity issue, a system that scavenges power from multiple frequency bands and combines them to activate a rectification circuit is proposed. The general block diagram of the proposed system is depicted in Fig. 7. Various environmental RF energy sources of different frequencies are collected by an appropriately designed antenna, and delivered to the rectification circuit via a multi-band matching network. The rectification circuit converts the combination of RF signals into DC power for low-power applications. The embodiment in this paper realizes a dual resonant matching circuit as a transition between a 50 Ω nominal antenna output and the non-linear rectification device at 490 and 860 MHz. Based on the Australian Radiofrequency Spectrum Plan[35], these bands are allocated to broadcasting services and cellular systems.

Device Selection. Due to the very low ambient power available in a real environment[19], a very low threshold voltage rectification device is required in order to increase sensitivity. For this reason, Schottky diodes (GaAs or Si) are commonly employed for RF energy harvesting. In this work, a microwave Schottky detector HSMS2820 ($C_{j0} = 0.7$ pF, $R_s = 6$ Ω, $I_s = 2.2e^{-8}$ A) is chosen due to its excellent high frequency performance, low series resistance (R_s) and junction capacitance (C_j), and low threshold voltage with high-saturation current[31]. This low threshold voltage (0.15–0.3 V) supports rectification at low input power levels.

Proposed Rectifier Design. In order to design an efficient RF harvesting system, the non-linearity of the rectifier impedance with frequency and input power should be matched to the 50 Ω output of the antenna at the desired frequency bands. Therefore, the diode input impedance as a function of frequency and different power levels were calculated and analyzed[36]. In order to match the input impedance of the rectifier to the 50 Ω output of the antenna, the total load impedance for different input power and frequencies should be determined. A circuit consisting of a pair of Schottky Barrier Diodes (SBD) terminated with a load resistor ($R_{Load} = 11$ kΩ) and an output bypass capacitor ($C2 = 6.8$ pF) was simulated using Agilent ADS software. Figure 8 shows the proposed geometry of the voltage-doubler topology[31,37]. The voltage doubler rectifier structure is employed for the design of the RF-DC power conversion system as this topology is well suited to low power rectification. The resistor and capacitor at the output will filter high frequencies. The high load resistor (11 kΩ) was chosen to observe a reasonable output voltage at very low currents. Using Large Signal S-Parameters analysis in Agilent ADS software, the load impedance and bypass capacitor were determined and optimized.

The voltage doubler rectifier in Fig. 8 consists of a peak rectifier formed by *D2* and bypass capacitor *C2* (6.8 pF) and a voltage clamp formed by *D1* and *C1* (total capacitance of the transmission lines and diode's parasitic capacitance (C_p)). In the negative phase of the input, current flows through *D1* while *D2* is cutoff. The voltage across *D1* stays constant around its threshold voltage and the voltage at node 1 is charged to $-V_{th1}$ (where $-V_{th1}$ is the threshold voltage of the *D1*). At the negative peak, the voltage across *C1* is $V_{amp} - V_{th1}$ (where V_{amp} is the amplitude of the input signal). In the positive phase of the input, current flows through *D2* while *D1* is cutoff. The voltage across *C1* remains the same as the previous phase because it has no way to discharge. At the positive peak, the voltage across *D1* is $2V_{amp} - V_{th1}$. Since *D2* is conducting current to charge *C2*, the voltage at the output is $V_{out} = 2V_{amp} - V_{th1} - V_{th2}$.

The DC equivalent circuit of the SBD is a voltage source in series with the junction resistor R_j which is obtained by differentiating the diode voltage–current characteristic and is given by equation (2)[31,38]:

$$R_j = \frac{nKT}{q(I_s + I_b)} \tag{2}$$

Where n is the diode ideality factor, K is the Boltzmann's constant, T is the temperature in degrees Kelvin, q is the electronic charge, I_s is the diode saturation current and I_b is the external bias current. At low power levels, the saturation current is very small ($I_s = 2.2\ e^{-8}$ A) and for a zero-biased diode, $I_b = 0$. Therefore, the resulting value of junction resistance at room temperature is approximately 1.7 MΩ. Since, the saturation current is highly temperature dependent, R_j will be even higher at lower temperatures which tends to decrease the output voltage. As the input power increases, some circulating rectified current will cause a drop in the value of R_j and this phenomenon will increase the value of the DC output voltage. Furthermore, it is worth to highlight that the rectified current produced by the first diode (*D1*) in Fig. 8 constitutes the external bias current of the second diode (*D2*) which will help to reduce the R_j and hence the detection sensitivity is improved. Therefore, depending on the amount of available bias current, R_j is varying (equation (2)), hence the matching network is changing which impacts the amount of delivered power to the diode and results in different values of PCE.

A Schottky barrier diode can be modeled by the linear equivalent circuit shown in Fig. 9, where L_p and C_p are the diode's parasitic inductance and capacitance respectively due to packaging ($L_p = 2$ nH and $C_p = 0.08$ pF) which are generally unwanted[39]. This linear model is used for determining the diode impedance at a given input power.

The diode impedance analyzed using a Harmonic Balance simulator and a non-linear model of the diodes over the frequency range of 400 to 900 MHz at various input power levels (Fig. 10). Due to the large junction resistor at low input RF power levels, the rectification device is turned off in absence of an appropriate matching network. Large Signal S-parameter analysis was conducted and higher input power (associated with the signal source) is applied directly to the Schottky diodes configuration of Fig. 8 which does not include a matching network in order to turn on the diodes (reduce the value of R_j) and extract approximate input impedance value as our starting point in design of a matching network. As it can be seen in Fig. 10, with increasing the source power, the diode impedance is varying and it is beginning to switch on. Hence, the input impedance needs to be determined when the diode is

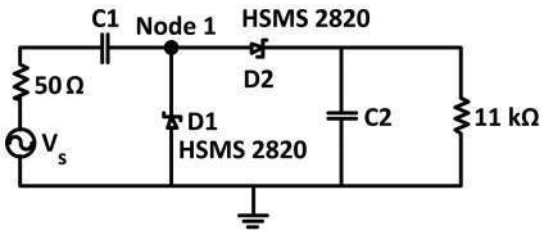

Figure 8 | Schematic of a voltage-double rectifier without matching network.

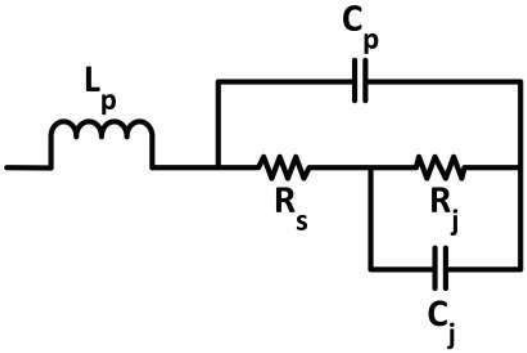

Figure 9 | HSMS 2820 Schottky diode equivalent circuit.

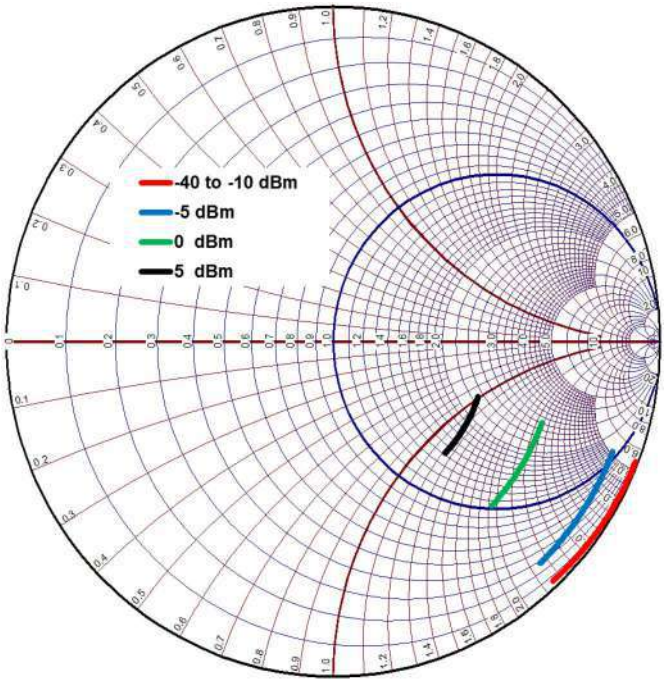

Figure 10 | Diode input impedance calculated with Large Signal S-parameter analysis over the frequency range of 400 to 900 MHz with various unmatched input power levels.

turned on to realize the matching network for a rectifier circuit. Obviously, in the presence of an appropriate matching network the rectification device can be turned on at lower power levels, whilst in the absence of a matching network a higher input power should be applied to switch on the diode. (Note that, with an unmatched rectifier the total applied input power from the signal source cannot be delivered to the diode due to the high reflection in the circuit).

The aim is to match the input impedance of the device to 50 Ω at 478–496 MHz and 852–869 MHz bands over a broad range of input RF powers. The procedure commences by matching the diode input impedance at high unmatched source power and shifting the diode input impedance at various power levels to within the voltage standing wave ratio (VSWR) <2 circle on the Smith chart. This procedure assumes that diode input impedance does not drastically change in this low power range. The simulation results of Fig. 10 prove that this is the case.

In order to provide maximum power transfer from the antenna to the rectifier circuit, a dual resonant rectifier network is designed as a transition between a 50 Ω nominal antenna output and the non-linear rectification device over the power range of −40 to −10 dBm (see Fig. 11). Hence, a coupled-resonator structure with both series and shunt resonators is designed to achieve a dual-band network[40]. The linear equivalent circuit model of the SBD chip[39] has been taken into consideration to design the dual band match at the desired frequency bands. In Fig. 11, $C_{equivalent}$ represents the total capacitance of the diodes and bypass capacitor and $L_{equivalent}$ is the overall parasitic inductance of the diodes. The series *L-C* resonator ($L4 + L_{equivalent}$ and $C_{equivalent}$) and the parallel L-C resonator (*C3* and *L3*) define the dual resonant circuit. The series resonator corresponds closely to the higher band specification of 852–869 MHz, whilst the parallel resonator approximates the lower 478–496 MHz band. A minimum number of components were used in order to reduce the ohmic and parasitic losses.

The resonant frequency of each sub-circuit was determined in isolation using the following equation:

$$f = \frac{1}{2\pi\sqrt{LC}} \tag{3}$$

The 852–869 MHz band resonator circuit components were calculated. Here, $C = C_{equivalent} \cong 1.3$ pF consists of the combination of the bypass capacitor (6.8 pF) and

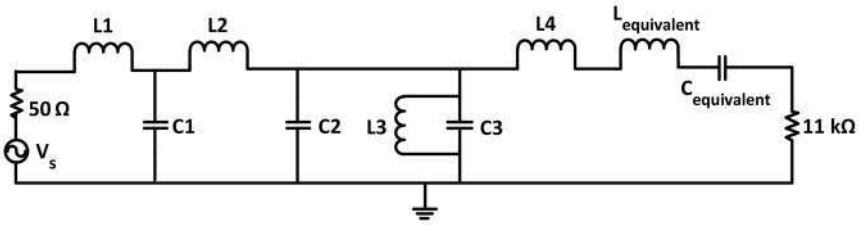

Figure 11 | Schematic of a dual resonant rectifier (optimized parameters of the chip components are: *L1* = 3.9 nH, *C1* = 0.2 pF, *L2* = 12 nH, *C2* = 1.8 pF, *L3′* = 3.9 nH, *C3′* = 7.5 pF, *L4′* = 11.6 nH, $L_{equivalent} \cong 1$ nH, $C_{equivalent} \cong 1.3$ pF).

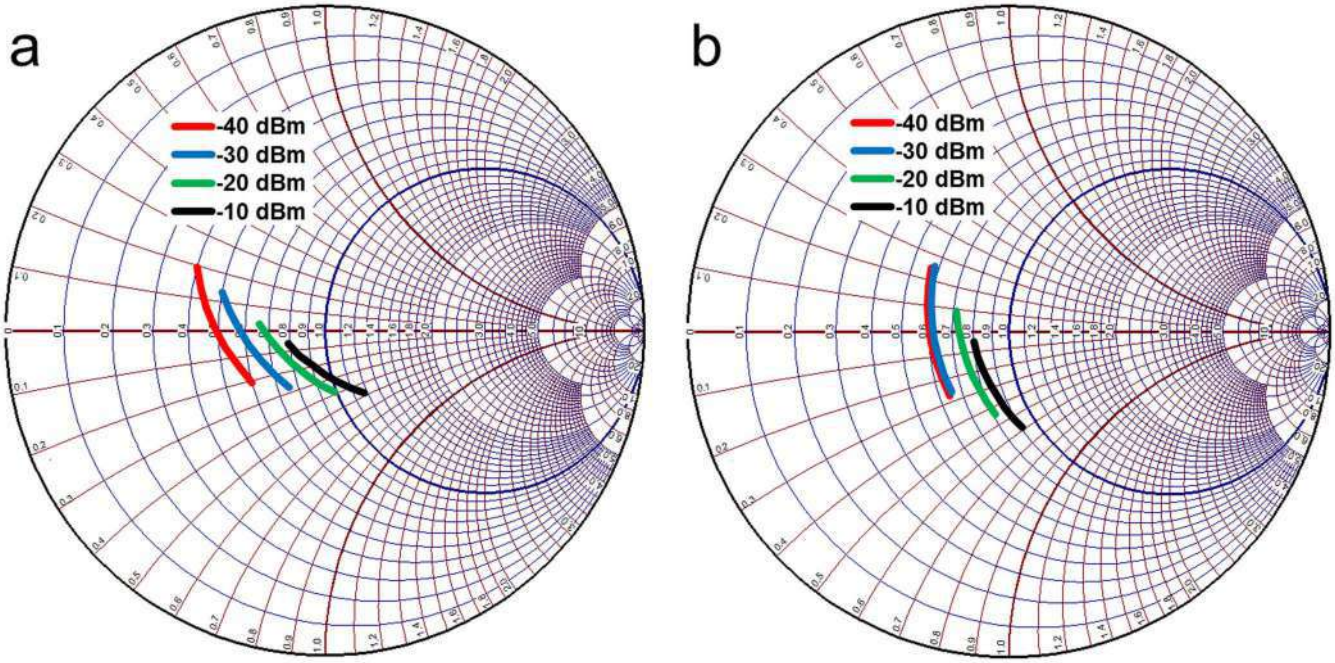

Figure 12 | Dual resonant impedance matching with −40 to −10 dBm input RF power. (a) 478–496 MHz. (b) 852–869 MHz.

the overall junction ($C_{j0} = 0.7$ pF) and parasitic capacitance ($C_p = 0.08$ pF) of *D1* and *D2*. Thus, *L* is calculated to be 26.5 nH in order to achieve an appropriate resonant frequency. Note that, *L* consists of L_4 and the overall parasitic inductance ($L_{equivalent} \cong 1$ nH) of *D1* and *D2*. The 478–496 MHz band resonator circuit components were calculated as $C3 \cong 15$ pF and $L3 \cong 7.2$ nH. Hence, the initial component values are determined for the two resonant circuits.

Initially these resonators were combined to achieve a dual-band structure. Then standard *LC* matching technique[40] is utilized to determine *C1*, *C2*, *L1*, and *L2* to achieve minimum reflection at the resonant frequencies. The substitution of realistic chip component values with their associated parasitics, and addition of 50 Ω microstrip lines and T-junctions introduce delay and shift the imaginary part of the input impedance. The via-holes also contribute to extra inductance in the circuit. Hence minor circuit adjustments are made in order to fine tune the resonant frequencies to the desired values. The final optimized values of the standard chip components are: $L3' = 3.9$ nH, $C3' = 7.5$ pF and $L4' = 11.6$ nH. Large Signal S-parameter analysis is also performed to demonstrate the matching network performance as the input power is varied. Simulation results for the input impedance of the circuit depicted in Fig. 11 are illustrated in Fig. 12. The proposed dual-resonant matching circuit achieves a VSWR <2 at 478–496 MHz and 852–869 MHz for input power ranging from -40 to -10 dBm. It should be noted that the matching circuit was designed based on the input impedance of two diodes and the output resistor and capacitor (Fig. 10). Therefore, selecting a different value for the load resistor requires a new matching circuit to be designed.

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Author contributions

N.S. designed and simulated the rectifier, carried out the measurements, interpreted results and wrote the paper. K.G. directed the research, contributed to perform the simulation and measurement and validation of design and results. W.S.T.R. supervized the research, analyzed the data and contributed to the general concept, validation of design and results. J.R.S. analyzed the data and contributed to the general concept, validation of design and results. All authors reviewed the manuscript.

Additional information

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Article

Optimization of Passive Low Power Wireless Electromagnetic Energy Harvesters

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Abstract: This work presents the optimization of antenna captured low power radio frequency (RF) to direct current (DC) power converters using Schottky diodes for powering remote wireless sensors. Linearized models using scattering parameters show that an antenna and a matched diode rectifier can be described as a form of coupled resonator with different individual resonator properties. The analytical models show that the maximum voltage gain of the coupled resonators is mainly related to the antenna, diode and load (*remote sensor*) resistances at matched conditions or resonance. The analytical models were verified with experimental results. Different passive wireless RF power harvesters offering high selectivity, broadband response and high voltage sensitivity are presented. Measured results show that with an optimal resistance of antenna and diode, it is possible to achieve high RF to DC voltage sensitivity of 0.5 V and efficiency of 20% at −30 dBm antenna input power. Additionally, a wireless harvester (*rectenna*) is built and tested for receiving range performance.

Keywords: RF energy harvesting; wireless power transmission; coupled resonators; Schottky diode; RF to DC power converter; impedance matching; PI-matching; L-matching; rectenna

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1. Introduction

For autonomous powering of sensor nodes in remote or inaccessible areas, wireless power transfer provides the only viable option to power them from an energy source. Due to the low power density of ambient RF at far-field from transmitters, there is a need to optimize each aspect of a wireless RF energy harvester for possible realistic applications. Today remote autonomous sensors are mostly powered by batteries, which have limited lifespan. Renewable powering has the potential to power autonomous sensors perpetually. Due to the expansion of telecommunications technology ambient electromagnetic (EM) power is among the most common sources of ambient energy. There are power transmitters/receivers scattered in practically any society, ranging from television transmission stations to cell phone transmitters and even wireless routers in our homes/offices or mobile phones. These transmitters in our environment and others which are on special dedicated frequencies produce ambient RF power (on the order of microwatts) which can be used as a source for powering remote microwatt budget sensors through wireless energy harvesting. This work presents different matching techniques based on different application requirements using Schottky diode-based RF to DC power converting circuits for wireless remote EM energy harvesting around 434 MHz and 13.6 MHz. Generalized analytical models and limitations of the matched RF to DC power converters are discussed. A wireless RF energy harvester consisting of an antenna and a matched diode rectifier is then realized and its performance tested. Passive wireless energy harvesting also finds applications in near field communications (NFC) [1], RFID tags [2–5], implantable electronics [6,7], and environmental monitoring [8], among others.

1.1. State of the Art

Hertz was the first to demonstrate the propagation of EM waves in free space and to demonstrate other properties of EM waves such as reflection using parabolic reflectors [9]. Wireless power transmission was then investigated and demonstrated for possible wireless remote powering by Tesla. Electromagnetic power beaming for far field wireless power transfer using collimated EM waves was proposed in the 1950s [9]. Recent advances in ultralow power sensors means ambient omni-directional EM power can be used as a source for powering remote sensors without the need to collimate the EM power through the wireless space. Mickle [10] and McSpadden [11] have presented earlier work on wireless energy harvesting systems using Schottky diodes and rectennas where the usability of ambient RF power into DC power was shown. Sample [12] presented a wireless harvester which can harvest EM power from TV and radio base stations transmitting 960 kW of effective radiated power; 60 μW was harvested at a range of about 4 km. Umeda [13] and Le [14] have presented more integrated wireless energy harvesters based on CMOS RF to DC rectifying circuits. CMOS-based rectifying power converters provide full compatibility with standard CMOS technologies and have advantages in batch processes for mass production. The drawback of CMOS-based diode connected transistors is the need to bias the gate of the transistors for the rectifying circuits to effectively function. This gate bias is provided externally, which makes the system not passive. Without the injection of external charges or a biasing of the transistor gate, the circuit has low efficiency, especially when the amplitude of the input voltage is low [15]. Shameli [2] presented a passive CMOS RF to DC power converter with a

voltage sensitivity of 1 V at −14.1 dBm input, but the circuit efficiency was only 5 %. Zbitou [16] presented an RF to DC converter based on Schottky diodes and achieved 68 % efficiency at 20 dBm RF input power. Ungan [17,18] presented antennas and high quality factor RF to DC power converters at 24 MHz and 300 MHz for RF wireless energy harvesting at -30 dBm input power. The power converter used high quality factor resonators for impedance matching the EM source and the diodes and achieved high open circuit voltage sensitivity of 1 V/μW. Boquete [19] presented a risk assessment system for calculating insurance premiums by monitoring mobile phone usage while driving. This was done by harvesting EM power from detected mobile phone usage during driving for risk assessment. Heikkinen [20] presented rectennas on different substrates at 2.4 GHz using transmisson lines to match the antennas output resistance (*at resonance*) to the rectifying diodes. Akkermans [21] presented a rectenna design by complex conjugating impedance provided by a microstrip structure to a diode so that resonance may be achieved for a working frequency. This design approach may need sophisticated tools to realize and the dominant resonance frequency of the rectenna can be unpredictable in practice. Hagerty [22] presented rectenna arrays for broadband ambient EM harvesting and characterized the harvesters from 2 GHz to 18 GHz; rectennas combine impedance matching the RF rectifying circuit and the antenna into one compact device, but an array of rectennas may increase the overall size of an EM harvester. Herb [23] and Vullers [24] have provided a comprehensive state of the art for micro energy harvesting and have explored the various techniques used for harvesting ambient renewable energy.

2. RF to DC Power Converter

2.1. Diode Rectifier

A junction diode equivalent circuit and simple Schottky diode rectifier are shown in Figure 1. R_{DS} is the diode resultant series resistance, C_{DS} is the diode resultant series capacitance, R_{DP} is the diode resultant parallel resistance, C_{DP} is the diode resultant parallel capacitance, Vs is the sinusoidal source voltage and Vc is the voltage across the capacitor.

Figure 1. (**a**) Diode series equivalent model, (**b**) Diode parallel equivalent model, (**c**) Simple diode detector.

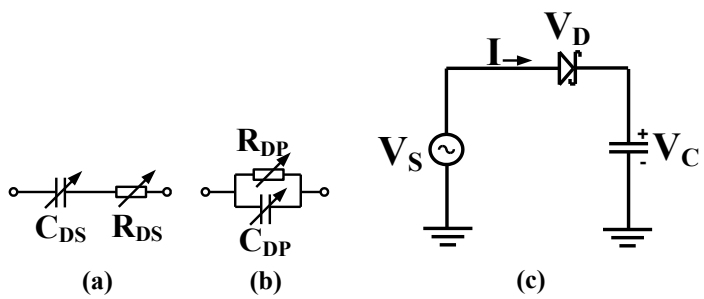

The diode capacitive impedance is mainly due to the junction capacitances provided by the metal, its passivation and the semiconductor forming the diode. AC power incident on a forward biased diode input is converted to DC power at the output. The current-voltage behavior of a single metal/semiconductor diode is described by the Richardson equation [25] as in Equation (1):

$$I = I_S\left(e^{\left(qV_D/nKT\right)} - 1\right) \tag{1}$$

where I is the current through the diode, I_S is the saturation current, q is the charge of an electron, V_D is the voltage across the diode, T is the temperature in degrees Kelvin and K is Boltzmann constant. The voltage equation around the loop can be derived from Figure 1(c) and is given in Equation (2):

$$V_D = V_S - V_C \tag{2}$$

Since the same current flows through the diode and the capacitor, one can find the average current through the circuit by integrating Equation (1) over a time period. By substituting Equation (2) into Equation (1), V_C can be expressed in terms of V_S by averaging the diode current to zero. This is given in Equation (3) [26]:

$$V_C = \frac{KT}{q}\ln\left[\vartheta_0\left(\frac{qV_S}{KT}\right)\right], \tag{3}$$

where ϑ_0 is the series expansion of the sinusoidal source voltage. Equation (3) can further be simplified for very small amplitude V_S as Equation (4):

$$V_C \approx \frac{qV_S^2}{4KT} \tag{4}$$

Equation (4) shows that for a small voltage source, the circuit output voltage is proportional to the square of the input sinusoidal voltage; hence it's so-called square law operation. Extensions of this model for voltage multipliers and other input signals are presented in [27] and [28]. Equation (4) further confirms that for low input voltage (power ≤ 10 dBm), an impedance matching network between the source and the diode is necessary to improve the detected output voltage and efficiency.

2.2. Impedance Matching

The maximum power transfer theorem states that the highest power is transferred to the load when the source resistance is the same as the load resistance. For systems with both resistive and reactive impedances from source and load, the source and the load impedance should be adjusted in a way that they are the complex conjugate of each other through impedance matching. For the purposes of this work, a 50 Ω resistive source is chosen as reference for load impedance matching. The antenna which captures the ambient RF signals is tuned to provide this source resistance at resonance for the rectifying circuit in a complete EM wireless remote harvester. The load is the resistance of the Schottky diodes and the actual connected resistance (*remote sensor*). The specific type of matching network which can be used for complex conjugation depends on the nature of load or source impedance, the desired RF to DC converter functionality and other factors like circuit size, cost, *etc.* The response of a matched RF to DC power converter depends on the matching network used as well as the source or load component quality factors and impedances.

2.3. Diode Impedance

Schottky diodes HSMS-285C and HSMS-286C from Avago [29,30] are used to build the RF to DC power converters. The HSMS-285× or 286× series diodes can be operated as zero biased with relatively low forward junction potential. This allows for the realization of completely passive RF to DC power converters for wireless energy harvesting. The HSMS-285C or 286C is a pair of series connected Schottky diodes in a SOT-323 package. The impedance of the HSMS-285C and HSMS-286C diodes was first measured so it can be matched to the resistance (50 Ω) of the antenna source. This is done by connecting the input of the diodes to a network analyzer and measuring the scattering parameters. These scattering parameters are then converted to the corresponding impedances. The input impedance of a diode depends mainly on the resistive and capacitive impedance provided by the junction of the diode and its connected load. For a couple of diodes arranged in a package such as the HSMS-285C or 286C, the input impedance is the vector sum of the impedances provided by each diode in the package arrangement, the extra impedance associated with the packaging and the connected load. The diode measuring board is as shown in Figure 2. The diodes were measured at room temperature for an input power of -30 dBm at a diode connected load of 1 MΩ with a 100 pF filter capacitor. For the sake of this work, the input impedance of the diodes will always be referred to at these connected load conditions.

Figure 2. (**left**) Reference circuit layout for measuring diodes input impedance, (**right**) measuring printed circuit board (PCB) for diodes input impedance on 1 mm FR4 substrate.

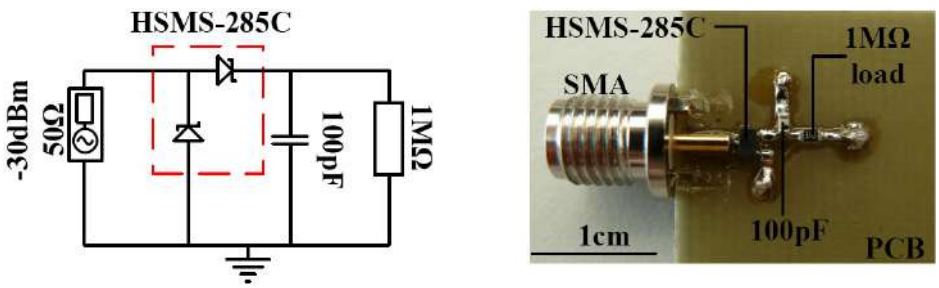

Figure 3. Measured input impedance (Δ resistive, □ capacitive) of HSMS-285C (**left**) and HSMS-286C (**right**) diodes at −30 dBm input with 1 MΩ load and 100 pF filter.

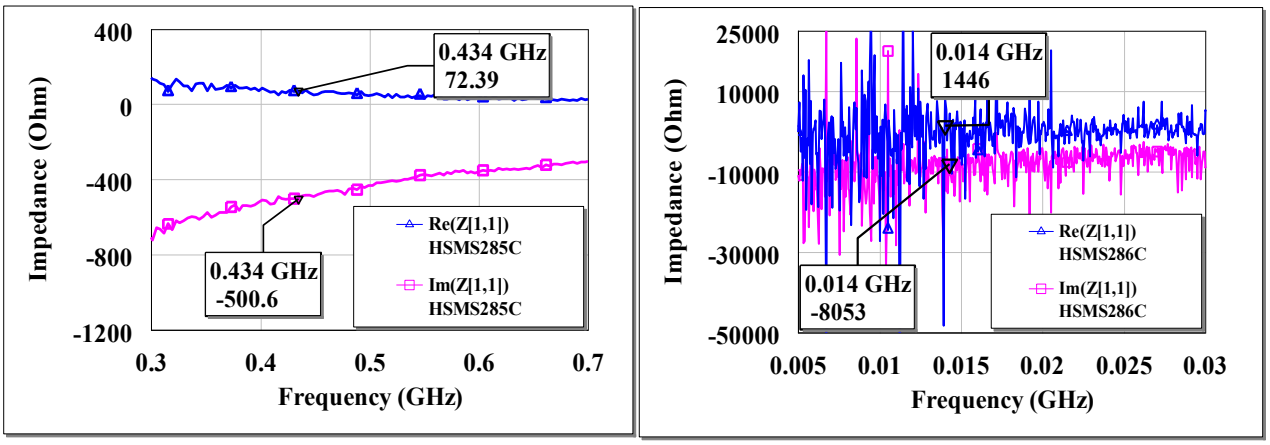

The board is fabricated such that components are soldered directly one into another to prevent additional impedances introduced by copper route. The PCB backside had the ground layer. An example of measured input impedance for HSMS-285C and HSMS-286C is shown in Figure 3.

The diodes quality factor is given by $X_{DS}R_{DS}^{-1}$, where X_{DS} is the resultant series capacitive impedance of the diodes. At an input power of −30 dBm, the measured input impedance of the HSMS-285C diodes is 72–j501 Ω at 434 MHz and 587–j1239 Ω at 13.6 MHz. For HSMS-286C diodes, it is 10–j503 Ω at 434 MHz and ~1.5–j8.1 kΩ at 13.6 MHz for −30 dBm input. The measured impedance of the HSMS-286C diodes at low frequencies (< 60 MHz) shows pronounced fluctuations. The low-frequency excess flicker noise and the shot noise observed in the HSMS-286C have been studied by several authors [31–33]. The pronounced presence of trap states in the depletion region of the semiconductor, mobility fluctuations in carriers, edge effects among other reasons is reported to cause deviations from the ideal Schottky diode behavior and hence generation-recombination noise for some diodes such as the HSMS-286C [34]. When a diode rectifier is matched at a reference operating condition, the matching network may function less effectively at other input power levels, connected load and other operating frequencies. This is due to possible changes in the diode input impedance. Throughout this work the imperfections of the matching circuit at other operating conditions away from the matched reference conditions are accepted without changes to the matching network.

2.4. Voltage Doubler

The Delon voltage doubler and Greinacher doubler are both used to realize the RF to DC power converters presented in this work. The Delon voltage doubler and Greinacher doubler are shown in Figure 4. The diodes output voltage (V_{out}) is doubled what is detected by a simple detector circuit shown in Figure 1. Both doublers produce the same output performance, the only difference is that the Delon doubler has an instantaneous input ground which is not shared with the output.

Figure 4. Circuit diagram of voltage doubler, (**a**) Delon doubler and (**b**) Greinacher doubler.

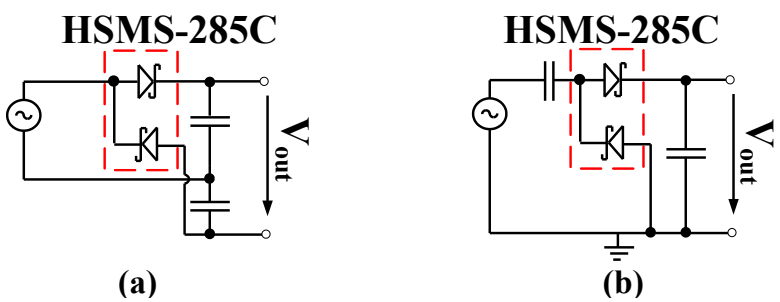

2.5. Matching Techniques for Antenna Source and RF to DC Power Converter

2.5.1. L-match RF to DC Power Converter

An L-match network converts a source series impedance to its equivalent load parallel impedance or *vice-versa* and tunes out by subtracting or adding any surplus reactance from the load or source with the counter impedance. Series impedance is converted to its parallel equivalent impedance using Equations (5–7):

$$Q_S = \frac{X_S}{R_S} \tag{5}$$

$$Q_P = \frac{R_P}{X_P} \tag{6}$$

where Xs is the total series reactive impedance, Rs is the total series resistance, R_P is the total parallel resistance, Xp is the total parallel reactive impedance, Q_S and Qp are the series and parallel quality factors respectively:

$$R_S + jX_S = \frac{R_P \times jX_P}{R_P + jX_P} \tag{7}$$

Equation (7) is the equation of a series sum of impedances and a parallel sum of impedances. It is interesting to note that Q_S and Q_P from an L-matched network may be different from the individual component quality factors as a result of the inherent resistive and reactive impedances in that component. By virtue of Equation (7), Q_S and Q_P must be equal in an L-matched network. Using Equations (5,6) and (7), the ratio of the parallel resistance (*or reactance*) to the series resistance (*or reactance*) can be derived in terms of the quality factors Q_P or Q_S [35]. Since at match conditions, only the resistive impedances dissipate power, the loaded quality factor Q, of the L-matched network can be expressed as in Equation (8):

$$R_P = (Q^2 + 1)R_S \tag{8}$$

Using Equations (5,6) and (8), series impedance can be converted to its parallel equivalent for a fixed frequency and power level. As an example; a series impedance 72–j501 Ω (HSMS-285C at 434 MHz for −30 dBm input power) is easily converted to $-j510(3519)/(-j510 + 3519)$ Ω as its parallel equivalent with a component quality factor of 6.96. The source resistance is taken as part of the parallel matching network in an L-match circuit if the source series equivalent resistance is greater than the load series equivalent resistance. On the other hand, the load resistance is taken as part of the parallel matching network if the load series equivalent resistance is greater than the source series equivalent resistance. For the purpose of this work, inductors were only used for series impedance matching and capacitors as shunts. This prevents power seeping through any shunt inductor used for impedance matching due the short circuit provided by a shunt inductor to ground and resulting in less output efficiency. Resistors were not used for impedance matching.

2.5.2. L-match RF to DC Converter Generalized Analytical Model

The classical matching technique using Equations (5,6) and (8) is first used to L-match the 50 Ω resistance of the antenna to the resistance of the HSMS-286C diodes (and load) at 434 MHz for −30 dBm input and then the generalized model is discussed. The antenna source resistance was L-matched to the resistance of the diodes (and load). The 50 Ω resistance of the antenna is taken as the parallel matching component and the diodes 10 Ω resistance is the series matching component. The loaded Q is found as 2 between the 50 Ω antenna source resistance and the 10 Ω diode series resistance using Equation (8). From this loaded Q, a shunt capacitive impedance of 25 Ω (14.6 pF at 434 MHz) using Equation (6) and a series inductive impedance of 20 Ω (7.3 nH at 434 MHz) using Equation (5)

will match the 50 Ω source to the 10 Ω HSMS-286C diodes (and load) series resistance at −30 dBm input. Since the HSMS-286C diodes inherently provides 503 Ω series capacitive impedance at −30 dBm, a resultant series inductive impedance of 523 Ω (192 nH at 434 MHz) is needed to tune the 50 Ω resistive source to the complete HSMS-286C diodes impedance at 434 MHz for −30 dBm input. The L-matched HSMS-286C diodes rectifier is as shown in Figure 5(a).

Figure 5. (**a**) L-match RF to DC harvester using the HSMS-286C diodes at 434 MHz for −30 dBm input. (**b**) Small signal impedance model of a generalized L-matched RF to DC power converter as capacitive coupled series RLC resonator with different resonator elements.

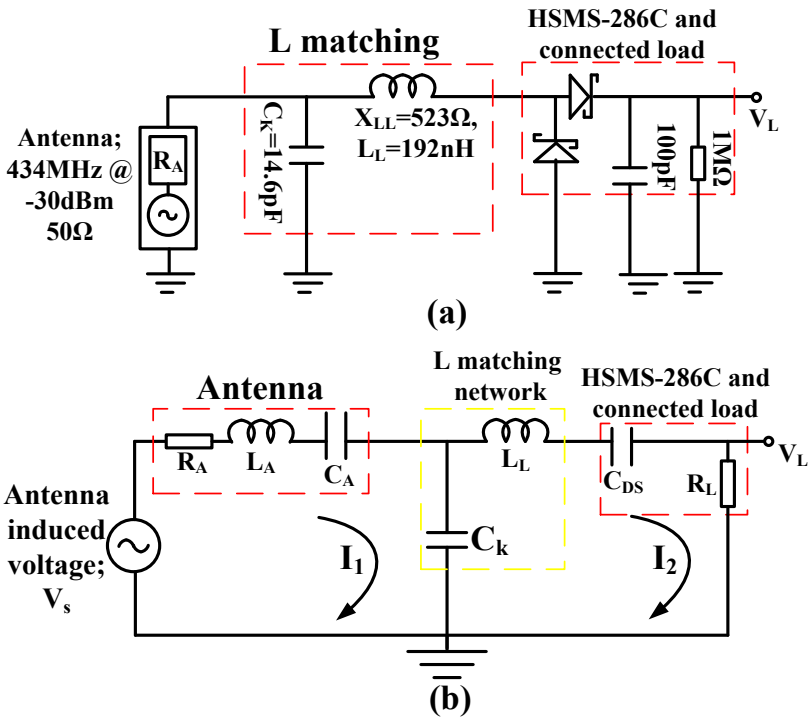

C_K is the tuning capacitance, L_L is the tuning inductance, X_{LL} is the tuning inductive impedance, C_{DS} is the diodes series capacitance, X_{DS} is the diodes series capacitive impedance, V_S is the antenna captured ambient EM voltage, R_A is the resistance of antenna, L_A is the inductance of antenna, C_A is the capacitance of antenna, R_L is the resultant series resistance from the diodes and the connected load resistance, V_L is the resistive load voltage. From Figure 5(a) the power dissipated in the resistance of the diodes (and connected load); P_L is given by Equation (9), where R_L is the series resistance of the diodes and load:

$$P_L = \frac{V_L^2}{R_L} \tag{9}$$

The source power; P_S is given by Equation (10), where V_S* is the root mean squared (RMS) antenna captured source voltage. Half of the source power is transferred to the resistance of the diodes (and connected load) at match conditions as described by the maximum power transfer theorem:

$$P_S = \frac{V_S^2}{R_A} \quad \text{or } P_S = \frac{V_{S*}^2}{2R_A} \tag{10}$$

Equating P_L and half RMS P_S gives a condition of maximum voltage gain for the matched RF to DC power converter shown in Figure 5(a):

$$\frac{V_L}{V_{S*}} = \frac{1}{2}\sqrt{\frac{R_L}{R_A}} \tag{11}$$

From Equation (8), substituting the series and parallel resistance ratio into Equation (11) the voltage gain can be expressed in terms of the loaded quality factor as in Equations (12) and (13), where Q is the loaded quality factor of the RF to DC power converter:

$$\frac{V_L}{V_{S*}} = \frac{1}{2}\sqrt{\frac{1}{1+Q^2}} \tag{12}$$

Equation (12) is the voltage gain in-terms of the loaded Q if the resistance of the diodes (and connected load) is part of the series matching network and the resistance of the antenna source is part of the parallel matching network as in Figure 5(a). If the resistance of the diodes is part of the parallel matching network, then Equation (13) may be written as the voltage gain in-terms of the loaded Q in an L-matched circuit:

$$\frac{V_L}{V_{S*}} = \frac{1}{2}\sqrt{1+Q^2} \tag{13}$$

Equations (12) and (13) shows that the maximum voltage gain is directly related to the relative differences between the diodes (and connected load) resistance and source resistance at matched conditions or the circuit loaded quality factor. It is interesting to note that the circuit shown in Figure 5(a) has a loaded Q of 2, but an HSMS-286C unloaded quality factor of 50 (at 434 MHz for −30 dBm).

Figure 5(a) is generally modeled as capacitive coupling of two series RLC resonators with a voltage source. This linearized model can be made at any defined frequency and power level. The model however neglects the metal/semiconductor physics of the diode's junction potentials which results in a Schottky barrier. The first series RLC resonator is modeled as impedance from the antenna with or without some passive matching components. The voltage source V_S, is the antenna captured electromagnetic voltage. The second series RLC resonator is the impedance from the diodes (at a defined condition), connected resistance and some passive matching components. Ck is modeled as the coupling element between the two series RLC resonators. Figure 5(b) gives a more general look at the special scenario shown in Figure 5(a). The voltage equations in the two loops are given by Equations (14,15) according to Kirchhoff's voltage loop laws, where ω is the angular frequency and I_1, I_2 are the currents in the first loop and second loop, respectively:

$$V_S = I_1\left[R_A + j\omega L_A - \frac{j}{\omega C_A} - \frac{j}{\omega C_K}\right] + \frac{jI_2}{\omega C_K} \tag{14}$$

$$0 = \frac{jI_1}{\omega C_K} + I_2\left[R_L + j\omega L_L - \frac{j}{\omega C_{DS}} - \frac{j}{\omega C_K}\right] \tag{15}$$

Using Cramers rule, I_2 can be expressed as:

$$I_2 = \frac{\dfrac{-jV_S}{\omega C_K}}{\left[R_A + j\omega L_A - \dfrac{j}{\omega C_A} - \dfrac{j}{\omega C_K}\right]\left[R_L + j\omega L_L - \dfrac{j}{\omega C_{DS}} - \dfrac{j}{\omega C_K}\right] + \dfrac{1}{\omega^2 C_K^2}}. \tag{16}$$

The voltage across R_L is V_L; given by I_2R_L:

$$V_L = \frac{\dfrac{-jV_S}{\omega C_K} R_L}{\left[R_A + j\omega L_A - \dfrac{j}{\omega C_A} - \dfrac{j}{\omega C_K}\right]\left[R_L + j\omega L_L - \dfrac{j}{\omega C_{DS}} - \dfrac{j}{\omega C_K}\right] + \dfrac{1}{\omega^2 C_K^2}} \tag{17}$$

The voltage gain of the coupled resonator can be expressed as in Equation (18):

$$\frac{V_L}{V_S} = \frac{\dfrac{-jR_L}{\omega C_K}}{\left[R_A + j\omega L_A - \dfrac{j}{\omega C_A} - \dfrac{j}{\omega C_K}\right]\left[R_L + j\omega L_L - \dfrac{j}{\omega C_{DS}} - \dfrac{j}{\omega C_K}\right] + \dfrac{1}{\omega^2 C_K^2}} \tag{18}$$

At resonance, there is no resultant reactance in the RLC resonators or the capacitive and inductive impedances become equal; hence Equation (19) can be written:

$$\omega L_A - \frac{1}{\omega}\left\{\frac{1}{C_A} + \frac{1}{C_K}\right\} = 0 \text{ and } \omega L_L - \frac{1}{\omega}\left\{\frac{1}{C_{DS}} + \frac{1}{C_K}\right\} = 0 \tag{19}$$

Equations in Equation (19) can be used to find the resonant frequencies of the series coupled resonator. The voltage gain of the coupled resonator at resonance can then be expressed as in Equation (20):

$$\frac{V_L}{V_S} = V_{gain} = \frac{\dfrac{-jR_L}{\omega C_K}}{R_A R_L + \dfrac{1}{\omega^2 C_K^2}} \tag{20}$$

where V_{gain} is the voltage gain. V_{gain} at resonance is a function of the resistance of the source and load and the coupling element. The maximum of Equation (20) is obtained when:

$$\frac{dV_{gain}}{dC_K} = 0. \tag{21}$$

This gives the results as in Equation (22):

$$\frac{dV_{gain}}{dC_K} = \frac{j2R_L}{\omega^3 C_K^4} - j\left\{R_A R_L + \frac{1}{\omega^2 C_K^2}\right\}\frac{R_L}{\omega C_K^2} = 0 \text{ or } R_A R_L^2 = \frac{R_L}{\omega^2 C_K^2} \tag{22}$$

Equation (22) can be simplified to find $C_{K(max)}$:

$$C_{K(\max)} = \pm\frac{1}{\omega}\sqrt{\frac{1}{R_A R_L}} \tag{23}$$

where C_{Kmax} is the value of the coupling element where maximum power transfer from the first resonator to the second resonator occurs. Using Equations (19) and (23) the unknown optimal matching impedances can be found from the known impedances just like the classical L-matched procedure using Equations (5,6) and (8). By substituting $C_{K(max)}$ into Equation (20) and taking the magnitude of V_{gain}, gives the maximum voltage gain of the coupled series resonator at resonance:

$$\left|\frac{V_L}{V_S}\right| = \frac{1}{2}\sqrt{\frac{R_L}{R_A}} \text{ or simply } \frac{V_L}{V_{S*}} = \frac{1}{2}\sqrt{\frac{R_L}{R_A}} \tag{24}$$

For wireless harvesters consisting of an antenna and a diode rectifying circuit, the diode resistive impedance at any condition is dependent on the diode realized parameters, signal frequency, connected load and the input power level. The source impedance is determined by the impedance of the antenna. For maximum efficiency, the ratio of the source resistance to the load resistance must tend to zero at matched conditions. The efficiency η of the circuit is given by Equation (25):

$$\eta = \frac{P_L}{P_S}; \eta \to 1 \ when \ \frac{R_A}{R_L} \to 0 \tag{25}$$

2.5.3. L-Match RF to DC Converter Experimental Results and Discussion

The presented circuit was L-matched between the 50 Ω resistance of the antenna source and the resistance of the HSMS-285C diodes (and load) at 434 MHz for −30 dBm input as shown in Figure 6. Since the series equivalent resistance of the HSMS-285C diodes and load (72 Ω) is greater than the 50 Ω series resistive antenna source, the diode is taken as parallel matching network with a parallel equivalent impedance of $-j510(3519)/(-j510 + 3519)$ Ω. The analysis follows the same procedure as in Section 2.5.2 after this step. Figure 6(b) shows the resultant L-matched RF to DC power converter. C_{DP}* is the resultant shunt matching capacitance.

Figure 6. (**a**) L-matched impedance circuit for matching the HSMS-285C diodes at 434 MHz for −30 dBm input. (**b**) Resultant network, (**c**) PCB layout of the L-matched Delon doubler with adjusted values on FR4 substrate (**d**) Fabricated PCB of the L-network matched Delon voltage doubler.

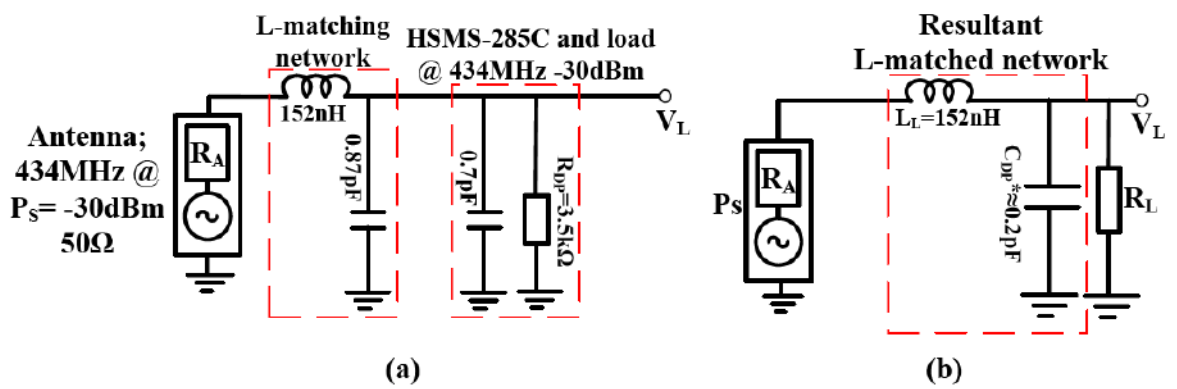

Figure 6. *Cont.*

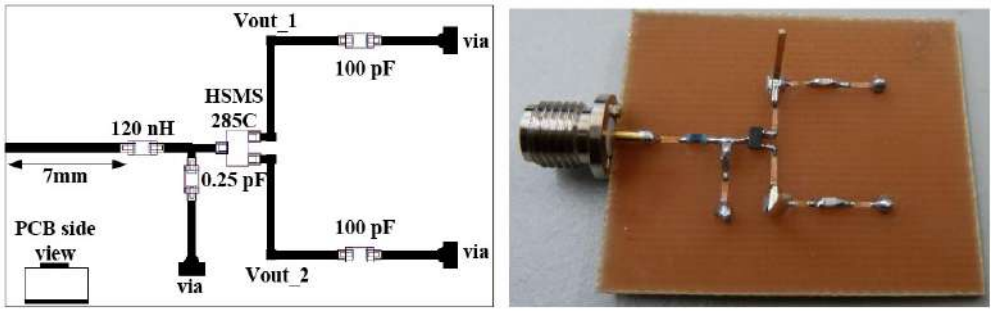

(c) (d)

Figure 6(a,b) assume perfect characteristic impedance between the various components in the matched circuit. When a copper route is introduced between components and on a material substrate, it must be accounted for in the total impedance as seen by the source or load. This PCB impedance compensation is carried out in Advance Design Systems (ADS) from Agilent [36]. ADS has extensive models for microstrip substrates to account for its impedances. The optimized layout using ADS microstrip models and its compensated values in the passive tuning components for a Delon doubler is shown in Figure 6(c).

The circuit reflection coefficient (S_{11}) and input impedance at open circuit are shown in Figure 7. There is high return loss and resonance around 434 MHz. The circuit input impedance at open circuit conditions is ~38 Ω at resonance for −40 dBm and ~17 Ω at −10 dBm input.

The measured L-matched circuit efficiency and voltage sensitivity is shown in Figure 8. The maximum measured L-matched efficiency at −30 dBm is 22% at ~20 kΩ load and an open circuit voltage of 124 mV. At −10 dBm, the maximum efficiency and open circuit voltage is 47% and 2 V respectively. At the optimal load of ~20 kΩ, the detected voltage is 58 mV and 1 V at −30 dBm and −10 dBm respectively.

Figure 7. Measured open circuit S_{11} of the L-matched Delon circuit at different input power levels from a 50 Ω source (**left**), measured open circuit input impedance at −10 dBm and −40 dBm of the L-matched circuit (**right**).

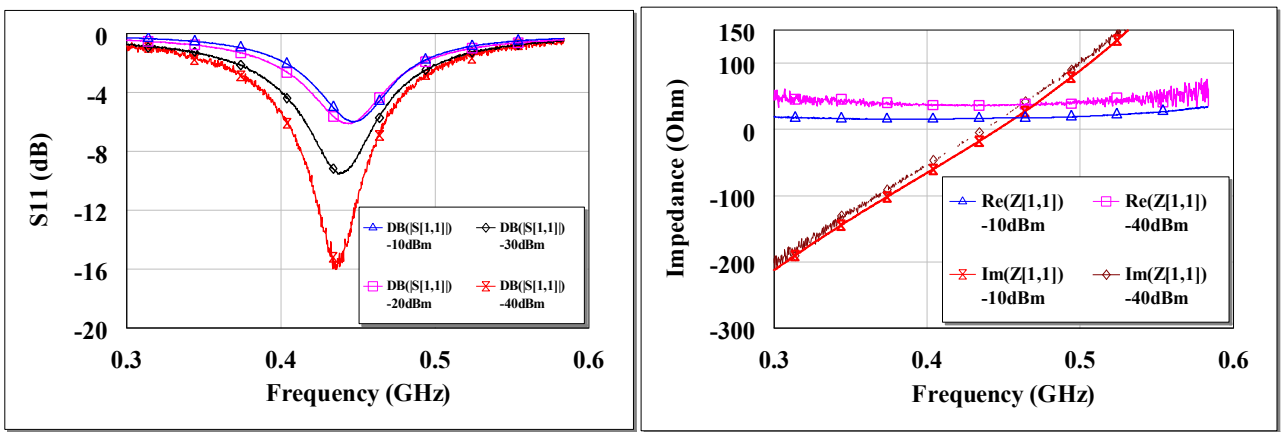

The open circuit voltage gain is 25 at −30 dBm and 40 at −10 dBm. The maximum measured efficiency at −35 dBm is 27%. This is higher than that of −30 dBm due to the better matched circuit

impedance at −35 dBm (35 Ω) than at −30 dBm (27 Ω) input. The L-matched RF to DC power converter has a loaded Q, sensitivity and efficiency determined mainly by the diodes resistance, diodes junction potential, connected resistance and antenna source resistance at matched conditions.

Figure 8. Measured L-matched circuit efficiency *versus* resistive load at various input power levels at 434 MHz (**left**), measured open circuit voltage and at 17 kΩ load *versus* input power at 434 MHz (**right**).

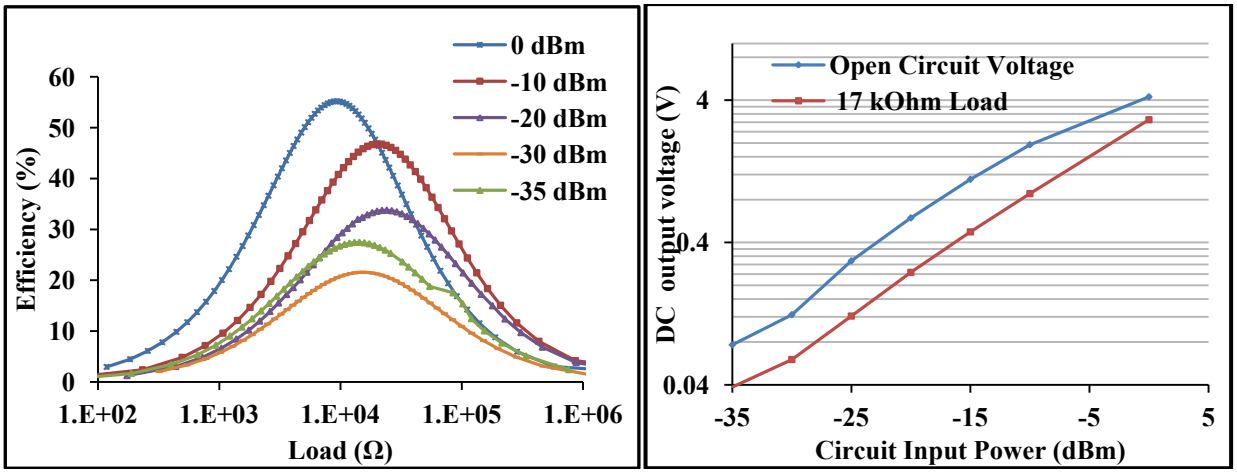

2.5.4. PI-match RF to DC Power Converter

A highly selective or small frequency bandwidth RF power converter is realized with a PI-network in-between the source impedance from the antenna and the diode rectifier. A PI-network is a 'back to back' L-network that are both configured to match the load and source impedance to an invisible resistance located at the junction between the two L-networks [37]. The quality factor of the L-network with the parallel resistance is given by Equation (26):

$$Q_P^* = \sqrt{\frac{R_P}{R^*} - 1}, \tag{26}$$

where R_P is the parallel resistance, R^* is a virtual resistance and Q_P^* is the quality factor of the L-network with the parallel resistance. The quality factor of the L-network with the series resistance is given by Equation (27):

$$Q_S^* = \sqrt{\frac{R_S}{R^*} - 1}, \tag{27}$$

where Q_S^* is the quality factor of the L-network with the series resistance. The unloaded quality factor; Q_S^* or Q_P^* is set higher than what is normally achieved with a single L-network [37] to realize the small frequency bandwidth circuit. The resistance of the load is assigned the parallel network in a PI-matched circuit if its series equivalent resistance is higher than the source series equivalent resistance; the opposite is true if the source is higher than the load. Equation (26) and Equation (27) are synonymous to Equation (8), except the lowest resistive impedance in Equation (8) is substituted with the virtual resistance which is dependent on the newly desired circuit selectivity. From Equations (26) and (27) the loaded quality factor of the PI-matched circuit can be written as Equation (34) in terms of Q_S^* and Q_P^*:

$$Q^2 = \left[\left(\frac{Q_P^{*2} + 1}{Q_S^{*2} + 1}\right) - 1\right], \tag{28}$$

where Q is the loaded quality factor of the PI-network. Q_S* or Q_P* are the unloaded quality factors of the PI-matched network. The larger value among the unloaded quality factors result in small frequency bandwidth response which is desired when matching a source and load impedance with a PI-network. Some authors approximate the highest value of Q_S* or Q_P* or their algebraic sum as the loaded quality factor of the PI-network as in [35] and [37], but Equation (28) gives the exact loaded Q of the PI-matched circuit in terms Q_S* and Q_P*. This allows for the correct estimation of the maximum voltage gain from the loaded quality factor.

2.5.5. Selectivity RF to DC Converter Generalized Analytical Model

An example of a PI-matched RF to DC converter using the HSMS-285C diodes operating at 434 MHz for −30 dBm input is presented first and then the generalized model is discussed. The circuit is matched for Q_P* of 60 between the antenna and the resistance of the diodes as shown in Figure 9.

Figure 9. Impedance diagram of PI-matched RF power converter; (**a**) Impedance diagram of 50 Ω source and the HSMS-285C diodes at 434 MHz, (**b**) Resultant PI matched network between the antenna source and load resistance.

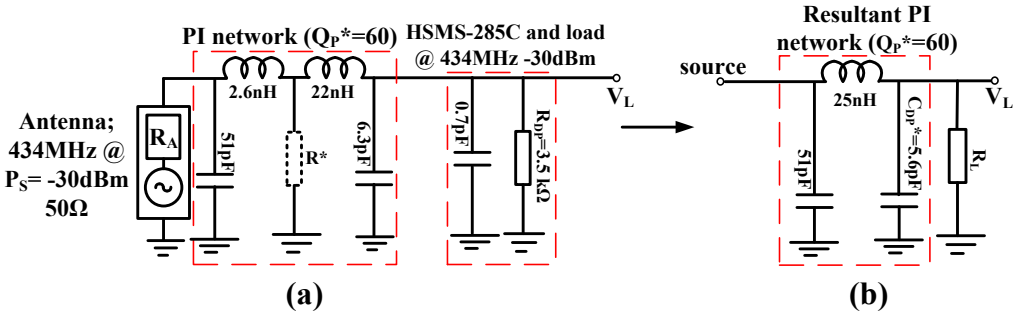

Figure 9(b) can also be modeled as an inductive coupling of two parallel RC circuits. A more general look at such a circuit is shown in Figure 10, as an inductive coupling of two parallel RLC resonators with a current source.

Figure 10. Inductive coupled parallel RLC small signal model of a generalized PI-matched antenna and diode rectifier.

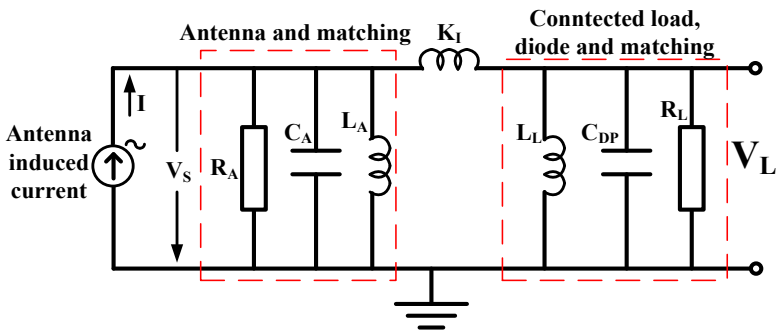

The first parallel RLC resonator is modeled as impedance from the antenna and some passive matching components. The second parallel RLC resonator is modeled as impedance from the linearized diodes, its connected load and some passive matching components. I is the antenna induced current, V_S this time is the voltage across the parallel R_A and K_1 is the coupling element between the two parallel resonators. Using Kirchoff's current laws, the node equations can be expressed as Equations (29) and (30):

$$I = V_S\left[\frac{1}{R_A} + j\omega C_A - \frac{j}{\omega L_A} - \frac{j}{\omega K_1}\right] + \frac{jV_L}{\omega K_1} \tag{29}$$

$$0 = \frac{jV_S}{\omega K_1} + V_L\left[\frac{1}{R_L} + j\omega C_{DP} - \frac{j}{\omega L_L} - \frac{j}{\omega K_1}\right] \tag{30}$$

Load voltage (V_L) and the source voltage (V_S) at resonance are given by the equations in Equation (31). The resonance frequencies are given by Equation (32):

$$V_L = \frac{\frac{-jI}{\omega K_1}}{\left[\frac{1}{R_A R_L} + \frac{1}{\omega^2 K_1^2}\right]} \quad \text{and} \quad V_S = \frac{\frac{I}{R_L}}{\left[\frac{1}{R_A R_L} + \frac{1}{\omega^2 K_1^2}\right]} \tag{31}$$

$$\omega C_A - \frac{1}{\omega}\left\{\frac{1}{L_A} + \frac{1}{K_1}\right\} = 0 \text{ and } \omega C_{DP} - \frac{1}{\omega}\left\{\frac{1}{L_L} + \frac{1}{K_1}\right\} = 0 \tag{32}$$

From V_L and Vs in Equation (31), the voltage gain at resonance can be expressed as:

$$\frac{V_L}{V_S} = \frac{R_L}{j\omega K_1} \tag{33}$$

The maximum of Equation (33) is obtained when:

$$j\omega K_1 \to 0 \;\; or \;\; R_L \to \infty \tag{34}$$

Since $j\omega K_1$ is restricted by the conditions in Equation (32) to attain resonance, one cannot manipulate $j\omega K_1$ alone without changing the resonance conditions. What can drive the voltage gain is if R_L is very large at resonance conditions. If the input impedance (V_S/I) of the coupled resonator is maximum at resonance, conditions in Equation (35) hold:

$$\left(\frac{Vs}{I}\right) \to maximum \;\; when \;\; \frac{R_L}{\omega^2 K_1^2} \to 0 \tag{35}$$

Equation (36) may be assumed when $\frac{R_L}{\omega^2 K_1^2} \to 0$:

$$\frac{V_S}{I} = R_A \tag{36}$$

Under these conditions and an optimal coupling coefficient K_{1max}, the maximum voltage gain of the parallel coupled resonator can be written as in Equation (37), where K_{1max} is given by Equation (38):

$$\left|\frac{V_L}{V_S}\right| = \left|V_{gain}\right| = \left|\frac{1}{2}\sqrt{\frac{R_L}{R_A}}\right| \tag{37}$$

$$K_{1(\max)} = \mp \frac{1}{\omega}\sqrt{R_A R_L} \tag{38}$$

The analysis of Section 2.5.2 and parallel coupled RLC resonators show that any antenna and matched rectifying diode can be described as an equivalent circuit of a coupled resonator at a defined operating point. This general model can be applied to optimize other harvesters with complex output impedance such as piezo-harvesters or vibration harvesters for maximum transfer of power or voltage to its connected load. The model can also be applied to near field magnetically coupled antennas/coils for optimization.

2.5.6. Broadband RF to DC power converter

A broadband network is preferred when an RF to DC power converter is to be operated for a wide range of frequencies. A broadband converter is realized by connecting successive L-networks together in a multi-network between the antenna source and the rectifying diodes. The result is broadband or multiband RF power converter around certain frequencies. This can be deduced from the general model of a coupled resonators that by choosing certain passive components between a source and the load, it is possible to have more frequencies (ω) fulfilling Equation (32) and hence a result of multiple resonant frequencies or broader bandwidth at match conditions. For a two stage L-connected match, the quality factor of the L-network with the parallel resistance is given by Equation (39):

$$Q_P^* = \sqrt{\frac{R_P}{R^*} - 1} \tag{39}$$

The quality factor of the L-network with the series resistance is given by Equation (40):

$$Q_S^* = \sqrt{\frac{R_*}{R_S} - 1} \tag{40}$$

From Equations (39) and (40) the loaded quality factor of the two stage L-connected broadband network may be written as Equation (41) in terms of the unloaded quality factors; Q_S* and Q_P*:

$$Q^2 = \{(Q_P^{*2} + 1)(Q_S^{*2} + 1)\} - 1 \tag{41}$$

R* in this case may be chosen if it is larger than R_S and lower than the R_P. The highest possible bandwidth between a resistive source and resistive load is found for a virtual resistance (R*) given in Equation (42) [37]:

$$R^* = \sqrt{R_S R_P} \tag{42}$$

For complex loads such as rectifying diodes or transistors, the largest achievable bandwidth prescribed by Equation (42) is limited by the load or source component quality factor, since Equation (42) does not take into account reactive impedance associated with the source or load.

2.5.7. Broadband-Match RF to DC Converter Results and Discussion

The antenna source resistance was broadband matched to the HSMS-285C diodes (and load) resistance at −30 dBm input around 434 MHz. For a desired Q_P* and Q_S* of 2.7 there is ~0.4 pF inherent diode capacitance which is un-tuned using a two stage L-matching network [Figure 11(b)]. This is because the HSMS-285C diodes provides an inherent component quality factor of 6.96 at 434 MHz for −30 dBm input, hence a broadband circuit with Q_P* lower than this inherent component quality factor of the diodes (and load) is difficult to achieve without trade-offs. However, connected L-networks with Q_P* as high as the diode component quality factor may perform worse than a single L-matched network with similar loaded quality factor. This is due to redundant components of the connected L-networks which have inherent losses.

Figure 11. Impedance diagram of broadband RF power converter; (**a**) Broadband match around 434 MHz with loaded Q of 2.7, (**b**) Resultant impedance matching network with un-turned capacitance of 0.4 pF.

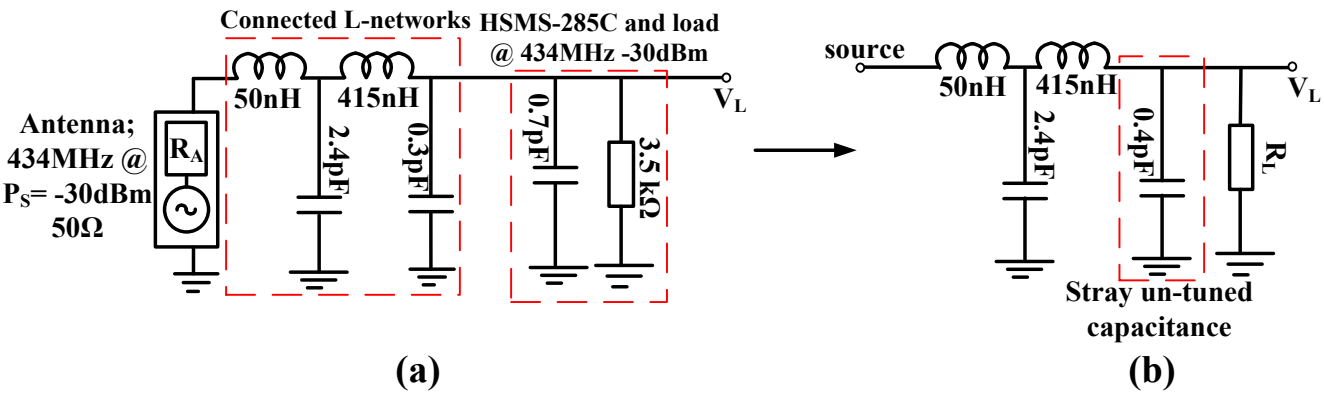

Figure 12. Measured open circuit S_{11} of the broadband circuit around 434 MHz at different input power levels from a 50 Ω source (**left**), measured open circuit input impedance at −10 dBm and −40 dBm of the broadband circuit (**right**).

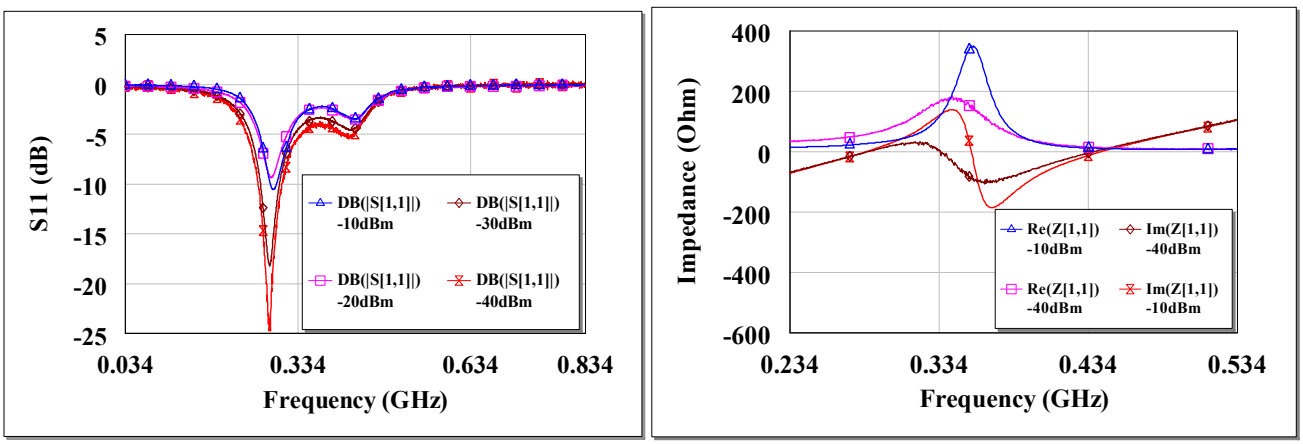

Therefore the broadband circuit is matched for Q_P* of 2.7, notwithstanding the un-tuned shunt capacitance as can be seen in Figure 11(b). Figure 12 shows the circuit S_{11} at various input power levels and input impedance at open circuit conditions. From Figure 12 (left) there is ~−5 dB return loss

from 200 MHz to 500 MHz providing an operating band of ~300 MHz. The impedance of the circuit shows resonances at ~290 MHz and ~450 MHz as shown in Figure 12(right). A third resonance occurs around 356 MHz at −10 dBm as the frequency of highest harvester input resistance (~350 Ω) and where the reactive impedances approach their extremes. Figure 12 show that a wireless EM harvester can exhibit different resonance scenarios depending on the dominant instantaneous conditions. The efficiency and voltage sensitivity of the broadband matched wireless EM harvester are shown in Figure 13. The average open circuit voltage is 47 mV and 1.1 V at −30 dBm and −10 dBm, respectively, when operating from 200 MHz to 500 MHz.

Figure 13. Measured open circuit voltage *versus* frequency sweep from 200 MHz to 500 MHz for −10 dBm and −30 dBm (**left**), measured efficiency at 17 kΩ load *versus* frequency sweep for −10 dBm and −30 dBm (**right**).

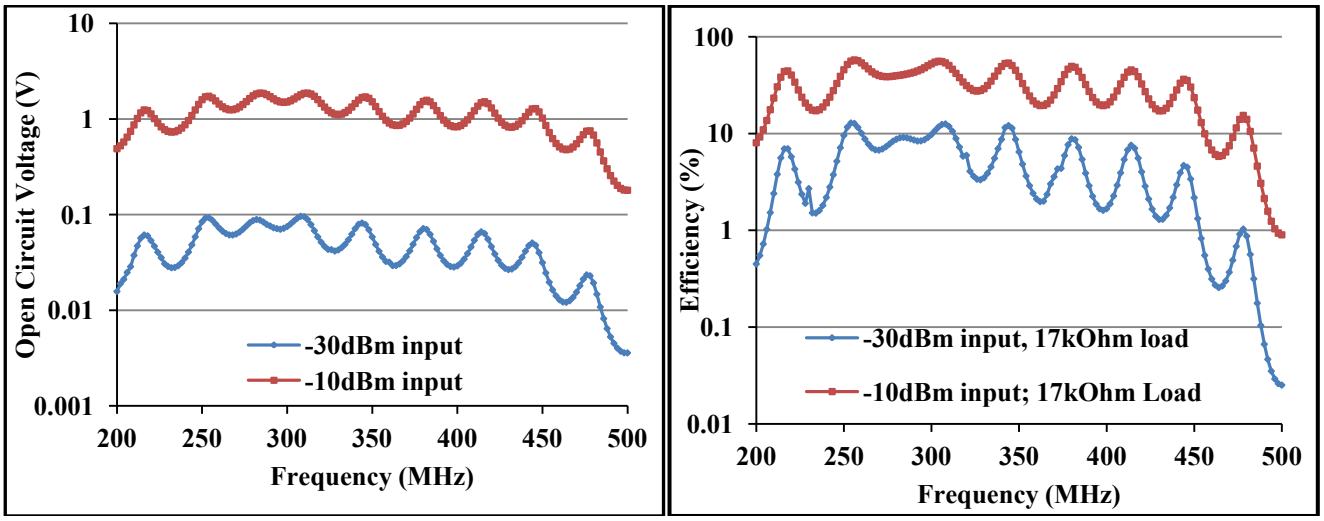

The broadband circuit achieves average efficiency of 5% at 17 kΩ load for −30 dBm and 30% at 17 kΩ load for −10 dBm input power from 200 MHz to 500 MHz. Figure 13 further confirm a direct link between frequency response and the unloaded quality factors. For Q_S* and Q_P* of ~2.7, the circuit response is broadband around 434 MHz.

2.6. High Voltage Sensitive RF to DC Converter

The current state of the art low power remote sensors would require a DC voltage supply of about 1 V and DC current of about 30 μA for operation. Therefore, the issue is not only how efficient a wireless EM harvester is in converting RF to DC power, but also what the output DC voltage and current of the EM harvester are at the RF input power level [38]. Equations (11,24) and (33) show that the maximum voltage sensitivity of a coupled resonator system or an RF to DC power converter is mostly related to the load and the source resistances at resonance. Therefore high voltage sensitive wireless EM harvester can be achieved with a diode voltage doubler with a very high input resistance relative to the antenna source without the need to cascade the diodes as in voltage multipliers. If the diodes been used for the RF to DC power conversion cannot provide high resistive impedance at the working frequency relative to the antenna source, then a DC-DC converter can be applied after the EM harvester as presented in [39] or the diodes may be cascaded by way of multipliers as presented in our

earlier work [40] and by several other authors [3,5,14]. In case of multipliers, the input voltage ought to be high enough to overcome the junction potential of the several diodes in the multiplier network. If frequency is not a constraint, then a frequency sweep *versus* impedance for the diodes can be made and the frequency where the diodes exhibits high resistive impedance can be used to realize high voltage sensitive wireless RF harvester. For Schottky diodes, high resistive impedance occurs mostly at lower frequencies (see Figure 3). The measured voltage gain of a high resistive diode pair (voltage doubler) is presented in the next results.

2.6.1. High Voltage Sensitive RF to DC Converter Results and Discussion

The presented result was L-matched using 50 Ω resistance of the antenna source and the resistance of the HSMS-286C diodes (and load). The HSMS-286C diodes do provide high resistive impedance at low frequencies; notwithstanding the flicker noise which causes its resistive (and reactive) impedance to fluctuate. The HSMS-286C has low forward junction potential (~350 mV at 1 mA) per diode and series impedance of ~1.5–j8.1 kΩ or parallel impedance of ~−*j*8.3(46.3)/(−*j*8.3 + 46.3) kΩ at 13.6 MHz for −30 dBm input. Even though the HSMS-286C diodes unloaded component quality factor at 13.6 MHz is similar to that of the HSMS-285C diodes at 434 MHz, the elevated resistive impedance at 13.6 MHz fulfills the condition for high voltage sensitivity relative to a 50 Ω antenna source at resonance conditions.

Figure 14. (**a**) L-matched impedance diagram for matching the HSMS-286C diodes at 13.6 MHz at -30 dBm input. (**b**) Resultant network, (**c**) PCB layout of the L-matched Greinacher doubler with adjusted values due to impedances provided by copper route on FR4 substrate with thickness of 1 mm. (**d**) Fabricated PCB of the L-matched RF to DC power converter.

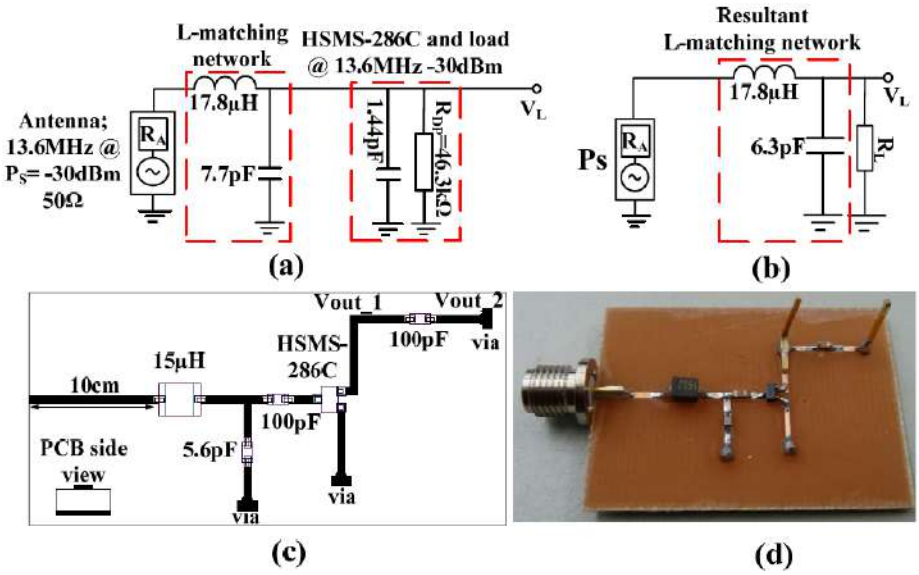

The high voltage sensitive EM harvester operating at 13.6 MHz is as shown in Figure 14. On the realized PCB is a Greinacher doubler. An inductance of 15 μH and a shunt capacitance of 5.6 pF were the adjusted values after the microstrip contributions.

The measured S_{11} and input impedance at open circuit are shown in Figure 15. There is high return loss and resonance around 13.6 MHz. The circuit input impedance at open circuit conditions is 58 Ω at resonance for both −40 dBm and −10 dBm.

Figure 15. Measured open circuit S_{11} of the L-matched HSMS-286C diodes at 13.6 MHz for different input power levels from a 50 Ω source (**left**), measured open circuit input impedance at −10 dBm and −40 dBm of the L-matched HSMS-286C diode at 13.6 MHz (**right**).

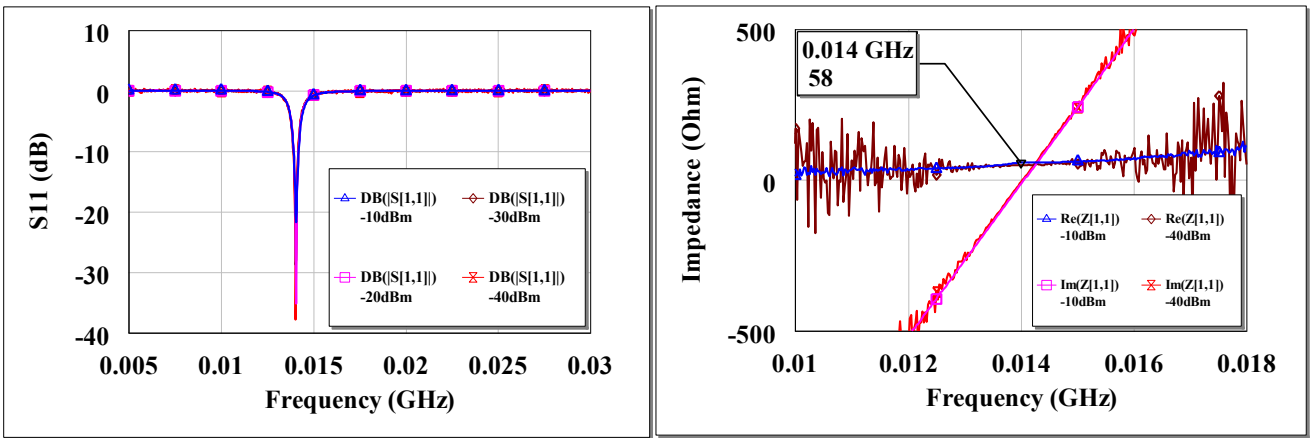

The efficiency and voltage sensitivity of the high voltage sensitive wireless EM harvester are shown in Figure 16.

Figure 16. Measured circuit efficiency *versus* load at various input power levels at 13.6 MHz (**left**), measured open circuit voltage and at 200 kΩ load *versus* input power at 13.6 MHz (**right**).

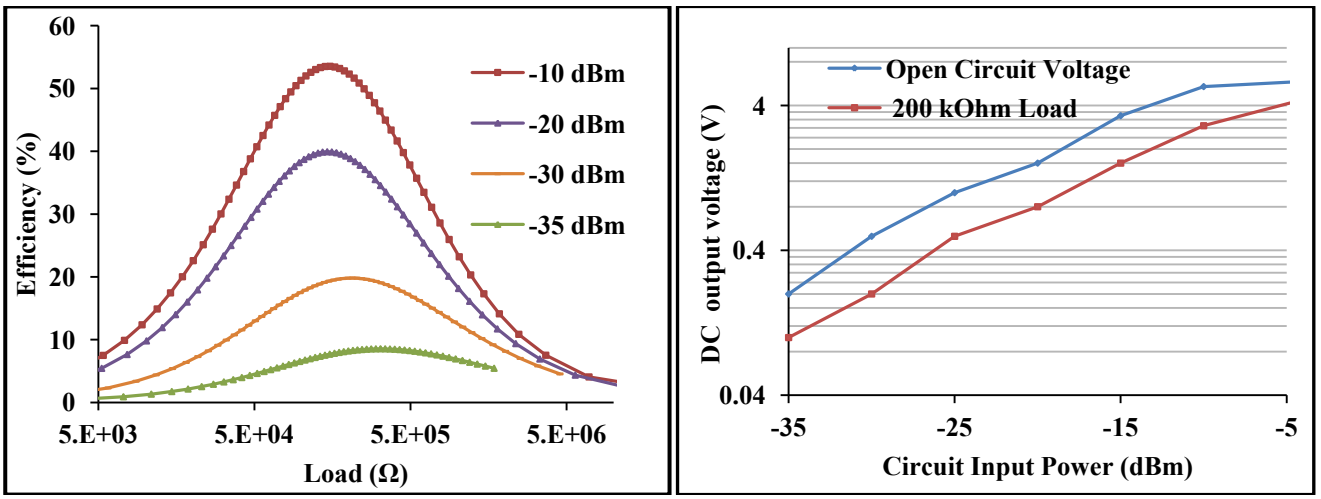

The maximum measured efficiency at −30 dBm is 20% for ~200 kΩ load and an open circuit voltage of 0.5 V. At −10 dBm, the maximum efficiency and open circuit voltage are 54% and 5.4 V respectively. At the optimal load of ~200 kΩ, the detected voltage is 0.2 V and 2.9 V at −30 dBm and −10 dBm respectively. The open circuit voltage gain is 100 at −30 dBm and 108 at −10 dBm.

Even though the RF to DC converter presented in Section 2.5.3 is the same as the L-match circuit realized with the HMSM-286C diodes at 13.6 MHz, the voltage gain is increased by a factor of 4 due to the large difference between the diodes (and load) resistance and source resistance so that at matched conditions high voltage gain occurs. The loaded Q of the L-matched circuit is 30 which results in small frequency bandwidth just like a PI-matched diode rectifier presented in our earlier work [40]. From this result and the results from our earlier presented PI-matched EM harvester, it can be inferred that all high loaded Q RF to DC circuits have high selectivity but not all highly selective RF to DC circuits have high loaded Q. The voltage sensitivity of the matched HSMS-286C diode at 13.6 MHz can be improved if its resistive impedance is not lowered by the flicker noise.

3. Wireless EM Power Harvester

A wireless EM harvester, consisting of a rectifying antenna (*rectenna*) was designed to find a compromise between size and performance of its antenna. The rectenna is shown in Figure 17.

Figure 17. Rectenna realized on a Duroid 5880, 1.57 mm substrate. (**a**) Backside of the rectenna, (**b**) cross-section of antenna output coplanar stripline dimensions (**c**) frontside of the rectenna.

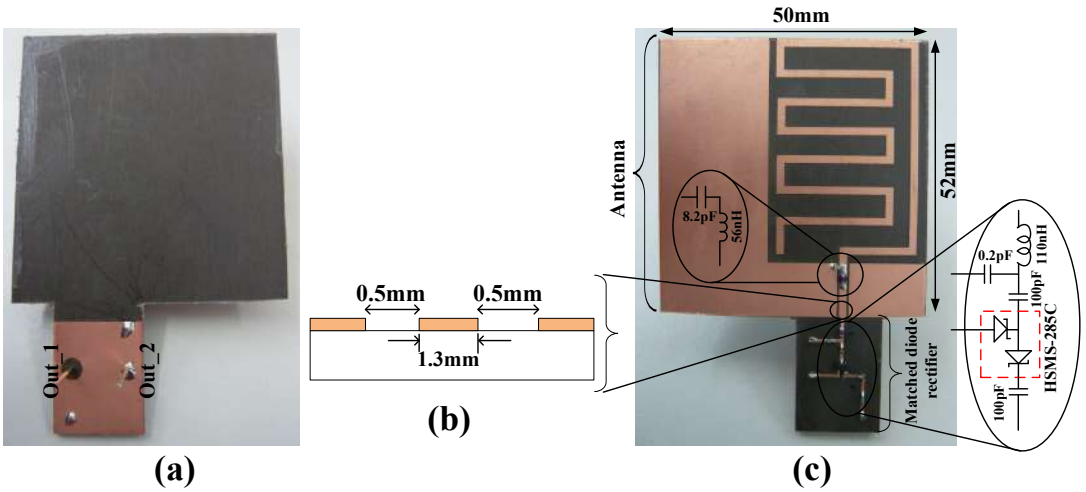

The antenna (planar) part of the rectenna is based on our earlier work [41]. In contrast to the earlier presented antenna, this rectenna is realized on a Duroid [42] substrate of thickness 1.57 mm. Duroid 5880 has lower loss tangent of 0.0004 at 1 MHz compared to 0.025 at 1 MHz for FR4. This means there is less loss in the transmission of signals on a Duroid PCB at this frequency range. The antenna part is fabricated to resonate around 434 MHz; hence its dimensions of 5 × 5.2 cm make it electrically small. The antenna is tuned with a chip inductor and a capacitor to achieve the resonance frequency around 434 MHz [Figure 17(c)]. This is done at a cost of reduced antenna radiation efficiency. An antenna is one of the few components the size of which is related to the operating frequency. Thus, if the size of an antenna is fixed, resonance frequency reduction of the antenna can only be achieved with penalty factors [10]. The antenna's output impedance is tuned with the dimensions of the coplanar stripline as shown in Figure 17(b).

HFSS [43] was used to simulate the presented antenna and to find the correct capacitive and inductive components for frequency tuning before the optimized design was fabricated. The simulated antenna resonances occur at 438 MHz and 445 MHz. At these frequencies, the radiation efficiency is 20% and a peak gain of −6 dBi. The rectifying part of the rectenna consists of L-matched HSMS-285C diodes (Figure 17(c)). The L-matched HSMS-285C part of the rectenna can be engineered to be as small as possible if required. The separate parts of the rectenna were characterized by terminating their ends and measuring the individual reflection coefficients just like the power converters presented in Section 2. Figure 18 shows the measured antenna and matched rectifier individual S_{11} and impedance. Figure 18 (left) also show the HFSS simulated S_{11} results. From Figure 18 (right), the measured antenna resonance where the input impedance is at maximum is ~434 MHz. At ~434 MHz, the antenna input resistance is 376 Ω and the reactive impedances approach their extreme (*so called anti-resonance*). The other resonance occurs when the input resistance is 'finite' and the reactive impedance is zero; at ~441 MHz. The input resistance is 57 Ω at ~441 MHz. The rectifier circuit is matched for the antenna's resistance at ~441 MHz.

Figure 18. Antenna HFSS simulated, antenna measured, and measured L-matched diode rectifier S_{11} on a Duroid 5880 PCB for −30 dBm input (**left**), Measured open circuit input impedance of antenna and rectifier at −30 dBm input (**right**).

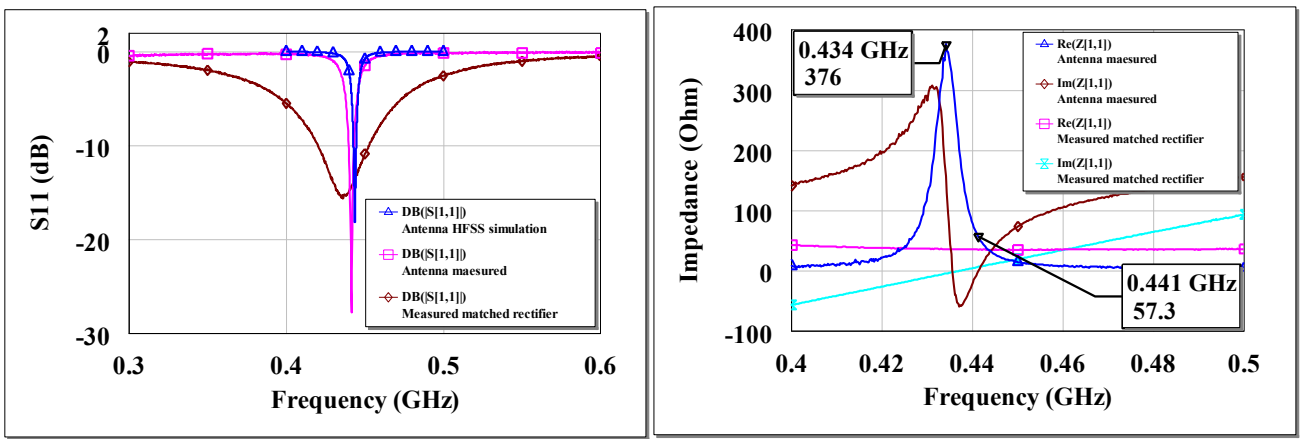

3.1. EM Range Results and Discussion

At far field between wireless EM transmitting and receiving antenna, the coupling mechanism between the transmitting and receiving antenna is neither capacitive nor inductive as is the case for the RF to DC converters. The coupling is radiative which can be described by the Friis equation of transmission on the assumption that the transmitting and receiving antenna are in free space [44]. A modified Friis equation for a transmitting and receiving antenna at far-field (R >> λ and R >> transmitting antenna largest dimension) to each other at a specified direction is given by Equation (43) [45]. Equation (43) assumes real world open space conditions:

$$\frac{P_r}{P_t} = F_{envt} G_t G_r \left(\frac{\lambda}{4\pi R} \right)^2, \tag{43}$$

where *Pr* is the power at the receiving antenna port, *Pt* is the power supplied at the transmitting antenna port, F_{envt} is a factor accounting for environmental effects as such ground reflections among others, *Gt and Gr* are the transmitting and receiving antenna gain (*at specified direction*) respectively. *R* is the distance between the transmitting and receiving antenna and λ is the wavelength of the transmitting EM wave. The rectenna receiving range measurements were carried out in an open space (*hall*) with the antennas 2 m above ground level. The transmitting and receiving antennas were arranged in the direction of their peak gain. The rectenna range performance is shown in Figure 19. According to Equation (43), the efficiency of RF power transferred between a sending and receiving antenna depends on controllable factors like the gain of the antennas in the arranged direction and the radiation efficiency of the antennas. Since the receiving/transmitting antenna's incorporated in remote harvesters for sensor powering are normally small in relation to their operating frequencies, they tend to be less efficient.

Figure 19. Rectenna receiving range performance by sending 17 dBm (50 mW) at a gain of −6 dBi at 437 MHz. Output DC voltage *versus* receiving distance for different loads (**left**), loads output power *versus* receiving distance (**right**).

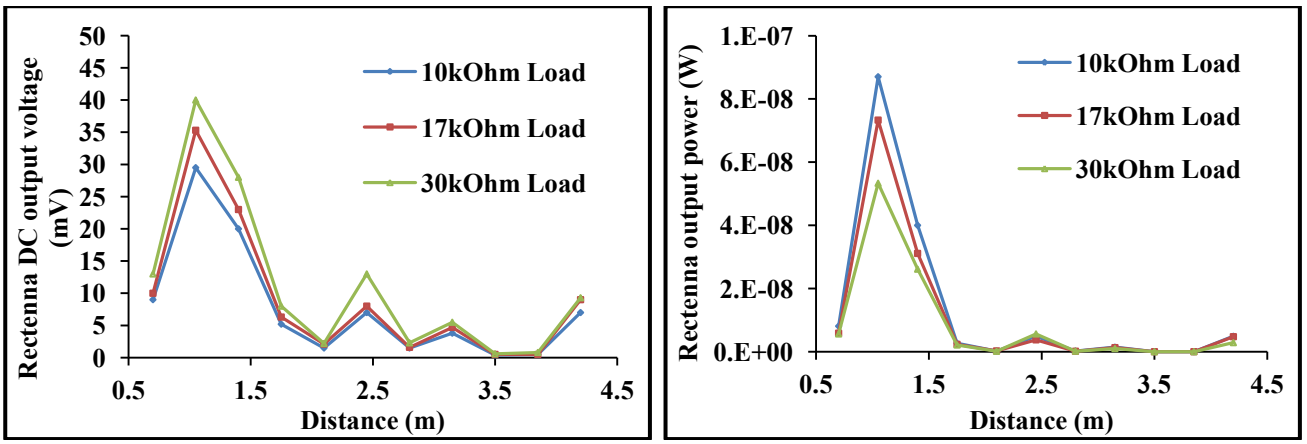

The efficiency of the rectenna's antenna is ~20% at resonance. A 'perfectly' matched RF to DC power converter operating in its square law region has efficiencies in the region of 20% as depicted in Section 2. The transmitting antenna was the same as the antenna incorporated in the rectenna. By transmitting the EM power with a small antenna (5 cm × 5.2 cm) at 437 MHz with efficiency of ~20% and at a gain of −6 dBi, the power delivered by the rectenna is generally low at far-field from the transmitter as can be seen in Figure 19. A mediocre transmitting antenna was used to transmit the EM waves due to limitations in the European Union about transmitting EM power at certain frequencies; so the goal in the rectenna range experiment is to show the lowest limit functionality of such a harvester. At 4.2 m from the electrically small transmitting antenna transmitting at 17 dBm, the rectenna harvested DC voltage and power are 9 mV and 5 nW respectively for 10 kΩ load. It can be seen from Figure 19 that the harvested voltage/power generally degrades as an inverse square of distance from transmitter as described by Friis equation. The measured received power however alternate along this R^{-2} fit as shown in Figure 19. This anomaly is accounted for by F_{envt} [Equation (43)] as influence of ground reflections and polarization in real world open field measurements [45]. For any particular distance *R*, the signals reflected from ground can be constructive with the direct signal to the rectenna,

in which case the measured power may be higher than that predicted by the original Friss equation as in [44]. The ground effect can also be destructive, in which case the measured power will be lower than what is predicted by the original Friis equation.

4. Conclusions

Optimization of Schottky diode-based RF to DC power converters using different matching techniques for wireless EM energy harvesting applications is presented. Using scattering parameters for small signal modeling, it is shown that wireless EM harvesters can be generally described as coupled resonators with efficiencies and maximum voltage sensitivity depending mostly on the source and load resistances under matched conditions. The analytical models allow systematic control in the design of passive wireless EM harvesters. Based on these analyses, a rectenna is built and tested for lower limit functionality from harvesting ambient EM waves. The analysis presented in this work may also be applied to optimize derivatives of wireless EM harvesters like RFID tags, NFC, wireless chargers *etc.*, for efficient powering of their sensors or integrated circuits. Generally, most energy harvesters and their matched loads can be described as coupled resonators and thus may be optimized with the methods presented in this work.

Acknowledgments

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Appendix A: Measuring Setup for RF Rectifier Efficiency and Voltage Sensitivity

The measuring setup is as shown in Figure A1.

Figure A1. RF to DC Power converter characterization setup.

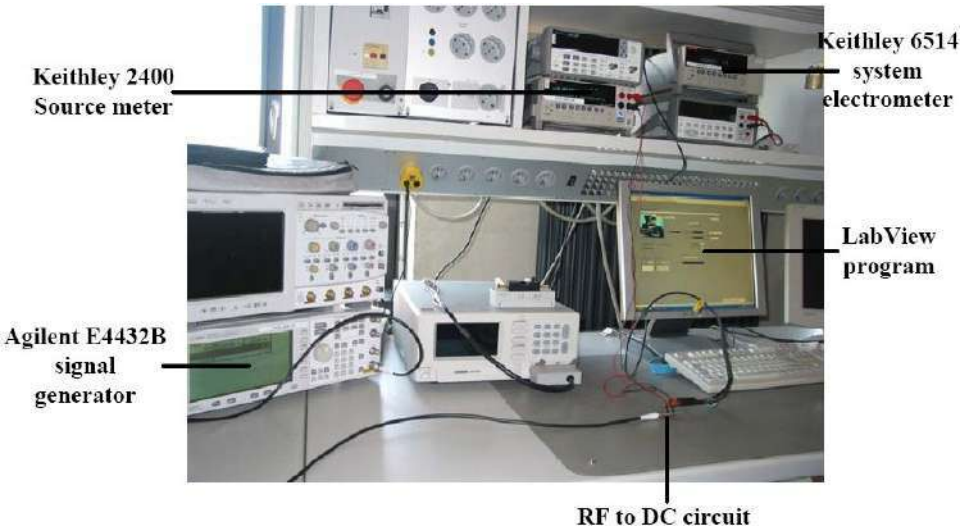

The RF to DC circuit efficiency and voltage sensitivity measurements were made with a Keithley 2400 source meter and Keithley 6514 system electrometer with an Agilent E4432B signal generator providing 50 Ω RF signal into the circuit board.

The closed circuit current drawn by the RF to DC power converter (*without load*) from the generator is first determined by the Keithley 2400 source meter; then starting from this current, the value of the current is decreased at set intervals to creates virtual load resistances to the circuit for up to a lowest current of 0.1 μA. The 6514 system electrometer is used to measure the output voltage. The number of data point is set through LabView [46] as well as the measurements. Additionally open circuit voltage or at specific loads and frequency sweep can be made through the LabView program. At −40 dBm input power and below, the detected voltages and currents were difficult to measure accurately with the measuring setup; hence measurements were made up to a minimum of -35 dBm input power. The circuit layout for the efficiency and voltage sensitivity measurements is schematically shown in Figure A2.

Figure A2. RF to DC power converter characterization circuit.

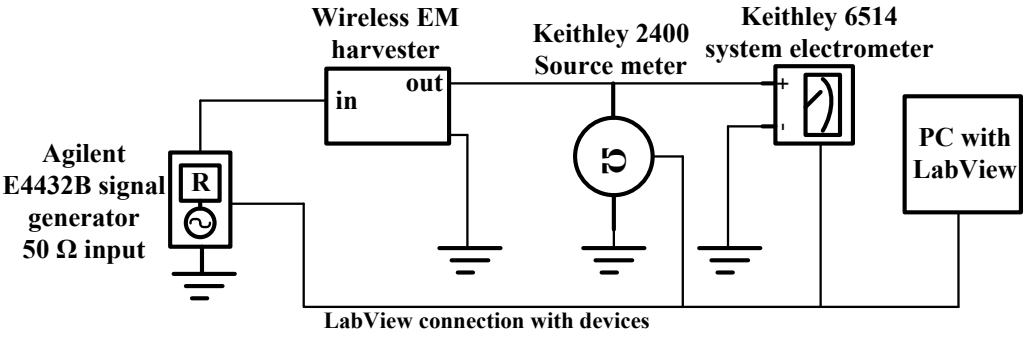

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STANDARD ANTENNA TERMS AND RELATED FORMULAS

The "IEEE Standard Definitions of Terms for Antennas" (IEEE STD-145) represents a consistent and comprehensive vocabulary suited for the effective communication and understanding of antenna theory. General use of these definitions of terms would eliminate much of the wide-spread inconsistency concerning antenna characteristics, particularly with regard to the basic parameters of gain, beamwidth, polarization and efficiency. For convenience, IEEE antenna terms of general interest are listed here. Wherever these terms appear in this catalog, the definitions given below apply. Other commonly used terms, not covered by the IEEE standard, are shown with an "*."

ANTENNA APERTURE. A surface, near or on an antenna, on which it is convenient to make assumptions regarding the field values for the purpose of computing fields at external points. **Note:** The aperture is often taken as that portion of a plane surface near the antenna, perpendicular to the direction of maximum radiation, through which the major part of the radiation passes.

ANTENNA EFFICIENCY OF APERTURE - TYPE ANTENNA. For an antenna with a specified planar aperture, the ratio of the maximum effective area of the antenna to the aperture area.

*** ANTENNA FACTOR.** That quantity by which the voltage developed across the output of an antenna is related to the incident field strength in which the antenna is immersed. **Note:** Applicable to low frequency antennas and usually refers to a 50 ohm output.

$$\mathrm{AFE}\ (\mathrm{dB\ m^{-1}}) = \mathrm{E}\ (\mathrm{dB\ V/m})\ -\ \mathrm{V}\ (\mathrm{dB\ V})$$

AFE = Electric Field Antenna Factor
E = Electric Field Strength at antenna
V = Voltage at terminals of antenna

$$\mathrm{AFH}\ (\mathrm{dB\ AV^{-1}m^{-1}}) = \mathrm{H}\ (\mathrm{dB\ A/m}) - \mathrm{V}(\mathrm{db\ V})$$

AFH = Magnetic Field Antenna Factor
H = Magnetic Field Strength at antenna
V = Voltage at terminals of antenna

$$\mathrm{AFE}\ (\mathrm{dB\ m^{-1}})\ =\ \mathrm{AFH}\ (\mathrm{dB\ AV^{-1}m^{-1}}) + 51.53$$

for a plane wave in free space.

$$\mathrm{AFB}\ (\mathrm{dB}\frac{\mathrm{pT}}{\mu\mathrm{V}})\ =\ \mathrm{B}\ (\mathrm{dBpT})\ -\ \mathrm{V_o}\ (\mathrm{dB}\mu\mathrm{V})$$

AFB = Magnetic flux Antenna Factor
B = Magnetic flux at the antenna
pT: picoTesla units
V = Voltage at the terminals of the antenna

$$\mathrm{AFB}\ (\mathrm{dB}\frac{\mathrm{pT}}{\mu\mathrm{V}}) = \mathrm{AFH}\ (\mathrm{dB}\frac{\mathrm{A}}{\mathrm{Vm}})\ +2$$

APERTURE ILLUMINATION. The field over the aperture as described by amplitude, phase, and polarization distributions.

APERTURE ILLUMINATION EFFICIENCY. For a planar antenna aperture, the ratio of its directivity to the directivity obtained when the aperture illumination is uniform.

BEAM. The major lobe of the radiation pattern.

CIRCULAR POLARIZATION. It may be either right hand circular polarization (RHCP) or left hand circular polarization (LHCP). The sense of polarization is determined by observation of the direction of rotation of the electric field vector from a point behind the source, RHCP and LHCP correspond to clockwise and counter-clockwise respectively. **Note:** RHCP transmit requires a like polarization to receive.

CO-POLARIZED. The polarization which the antenna is intended to radiate or receive. Also "like polarization".

*** CROSS POLARIZATION DISCRIMINATION (XPD).** Cross polarization discrimination is the measure of the antenna's ability to differentiate between the vertical and the horizontal polarization of an antenna. This difference, shown in relative signal level, is indicated on directional pattern envelopes (DPE's).

STANDARD ANTENNA TERMS AND RELATED FORMULAS

*** DIRECTIONAL PATTERN ENVELOPES (DPE'S).** In accordance with standard practice, radiation characteristics in any given plane of polarization are measured and plotted using 360-degree polar coordinate systems. The resultant Directional Pattern Envelope is the smoothed composite of all these measurements. The purpose of these DPE's is to emphasize the worst composite condition.

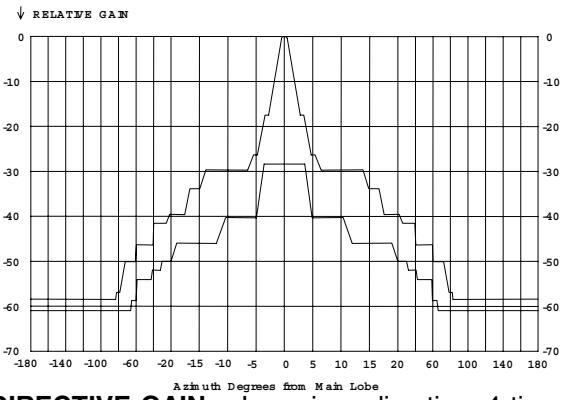

DIRECTIVE GAIN. In a given direction, 4 times the ratio of the radiation intensity in that direction to the total power radiated by the antenna.

DIRECTIVITY. The value of the directive gain in the direction of its maximum value.

EFFECTIVE AREA OF AN ANTENNA. In a given direction, the ratio of power available at the terminals of a receiving antenna to the power per unit area of a plane wave incident on the antenna from that direction, polarized coincident with the polarization that the antenna would radiate.

FAR FIELD REGION. That region of the field of an antenna where the angular field distribution is essentially independent of the distance from a specified point in the antenna region.

*** FRONT-TO-BACK RATIO**. The ratio of the maximum directivity of an antenna to its directivity in a specified rearward direction.

*** Gain, dBi**. The gain expressed in decibels relative to an isotropic radiator that is linearly polarized.

$$G(dBi) = 10\log(G) \qquad G = 10^{\frac{G(dBi)}{10}}$$

*** GAIN, dBic**. The gain expressed in decibels relative to an isotropic radiator that is circularly polarized.

HALF-POWER BEAMWIDTH. In plane containing the direction of the maximum of a beam, the angle between the directions in which the radiation intensity is one half the maximum value of the beam.

HALF-WAVE DIPOLE. A half wavelength antenna, center fed so as to have equal current distribution in both halves. Mounted vertically, it has a doughnut shaped pattern, circular in the horizontal plane. It is an antenna that can be constructed. It has some inherent losses. When used as a gain reference, the half-wave dipole has a power gain of about 1.7 dBi.

*** ISOLATION.** Refers to the ability of one port of a dual polarized feed to discriminate against a signal fed into the other port.

ISOTROPIC RADIATOR. A hypothetical antenna having equal radiation intensity in all directions. Note: An isotropic radiator represents a convenient reference for expressing the directive properties of actual antennas.

NEAR-FIELD REGION. The spherical region of space between the antenna and the far field region.

NULL. The region of a radiation pattern, either computed or measured, where the amplitude goes through a minimum value. Note: (1) It represents the angular position where the phase or the far field pattern crosses the zero axis if the pattern is plotted as a phasor instead of a scalar value. Note: (2) The region outside the main beam of a directive antenna pattern consists of a series of minor lobes separated by nulls.

PARALLEL POLARIZATION. The condition where the electric vector is parallel to the local conducting surface. Note: Over the earth, this is usually referred to as being horizontal polarization.

PHASE CENTER. The location of a point associated with an antenna such that, if it is taken as the center of a sphere whose radius extends into the far-field, the phase of a given component over the surface of that radiation sphere is essentially constant, at least over the portion of the sphere where the radiation is significant.

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STANDARD ANTENNA TERMS AND RELATED FORMULAS

POLARIZATION. The polarization of an antenna is defined as the polarization of the electromagnetic wave as described by the shape and orientation of an ellipse, which is the locus of the extremity of the field vector, and the sense in which the ellipse is traversed with time. The elliptical locus is called the polarization ellipse and the wave is said to elliptically polarized. Circular polarization and linear polarization are degenerate cases of elliptical polarization.

POWER DENSITY AT A POINT

$$S_{av} = \frac{GP_t}{4\pi r^2}$$

S_{av} = Time average power density in W/m^2
P_t = Power transmitted in watts
G = Antenna gain relative to an isotrope
r = Distance from antenna to point in meters

POWER DENSITY TO VOLTS/METER IN FREE SPACE

$$E^2 \ (V / m) = 377 \ S_{av} \ (W / m^2)$$

$$S_{av} \ (W / m^2) = E^2 \ (V / m) / 377$$

$$1 \ V / m = 2.65 \ mW / m^2$$

POWER GAIN. In a given direction, 4 times the ratio of the radiation intensity in that direction to the net power accepted by the antenna from the connected transmitter. **Note:** (1) When the direction is not stated, the power gain is usually taken to be the power gain in the direction of its maximum value. (2) Power gain does not include reflection losses arising from mismatch of impedance.

POWER GAIN IN PHYSICAL MEDIA. In a given direction and at a given point in the far field the ratio of the power flux per unit area from an antenna to the power flux per unit area from an isotropic radiator at a specified location with the same power input as the subject antenna.

Note: The isotropic radiator must be within the smallest sphere containing the antenna. Suggested locations are antenna terminals and points of symmetry, if such exist.

POWER GAIN REFERRED TO A SPECIFIED POLARIZATION. The power gain of an antenna, reduced by the ratio of that portion of the radiation intensity corresponding to the specified polarization to the radiation intensity.

POWER TRANSMISSION FORMULAS

$$P_r = P_t \frac{G_t G_r \lambda^2}{(4\pi r)^2}$$

$$P_r \ (dB \ W) = P_t \ (dB \ W) + G_t \ (dBi) + G_r \ (dBi) - 20 \log r - 20 \log f + 27.56$$

$$P_r \ (dB \ W) = P_t \ (dB \ W) - AFE_t \ (dB \ m^{-1}) - AFE \ (dB \ m^{-1}) - 20 \log r + 20 \log f - 32$$

P_r = Power received
P_t = Power transmitted
G_r = Gain of receiving antenna
G_t = Gain of transmitting antenna
f = Frequency in MHz, λ = Wavelength
r = distance between antennas in meters
AFE_r = AFE of receiving antenna
AFE_t = AFE of transmitting antenna

RADIATOR. Any antenna or radiation element that is a discrete physical and functional entity.

RADIATION, ELECTROMAGNETIC. The emission of energy in the form of electromagnetic waves.

RADIATION INTENSITY. In a given direction, the power radiated from an antenna per unit solid angle.

RADIATION LOBE. A portion of the radiation pattern bounded by regions of relatively weak radiation intensity

RADIATION PATTERN (ANTENNA PATTERN). A graphical representation of radiation properties of the antenna as a function of space coordinates. **Note:** (1) In the usual case the radiation pattern is

determined in the far-field region and is represented as a function of directional coordinates. (2) Radiation properties include power flux density, field strength, phase, and polarization.

*** RADIATION RESISTANCE OF AN ELECTRICALLY SMALL LOOP ANTENNA.** The resistive component of an antenna's input impedance that results from the coupling of the antenna to its environment. This resistance dissipates the power that is actually radiated from the antenna.

$$R_r = 20\,(2\pi/\lambda)^4\, n^2 A^2 \text{ ohms}$$

n = number of turns
A = area of the loop

REALIZED GAIN. The power gain of an antenna in its environment, reduced by the losses due to the mismatch of the antenna input impedance to a specified impedance.

*** REALIZED RADIATOR EFFICIENCY.** The efficiency of an antenna in its environment reduced by all losses suffered by it, including: ohmic losses, mismatch losses, feedline transmission losses, and radome losses.

RELATIVE POWER GAIN. The ratio of the power gain in a given direction to the power gain of a reference antenna in its reference direction. **Note:** Common reference antennas are half-wave dipoles, electric dipoles, magnetic dipoles, monopoles, and calibrated horn antennas.

RETURN LOSS. The reflection coefficient of a mismatch expressed in decibels. **Note:** Modern swept VSWR techniques actually sense the reflected component which is normalized to the forward component to yield return loss. A 2:1 VSWR is equivalent to 9.5 dB return loss.

VSWR. The voltage standing wave ratio of a component such as an antenna. It is referred to the characteristic impedance of the transmission line being used. **Note:** The most common characteristic impedance is 50 ohms, but 75 and 300 ohms are frequently used in coaxial or twin lines for VHF, UHF applications.

NOTES:

THE HANDYMAN'S GUIDE TO OSCILLOSCOPES (Part 2 of 2)

by Paul Harden, NA5N

Making some advanced measurements with your Oscilloscope

Print as .pdf file
4 pages
8½ x 11 or A4

In Part 1, oscilloscope operation was covered for making basic voltage, time and frequency measurements. In this part, we'll continue with some more advanced uses of a scope, and in particular, how to use a scope for testing and troubleshooting ham radio QRP transceivers in the homebrewer's workshop.

Receiver Filter Bandwidth.

This procedure uses a scope (a DVM can be used with less accuracy) for determining the overall filter bandwidth (or selectivity) of a receiver. It is basically measured by plotting output voltage vs. audio frequency to construct a picture of the filter response.

Connect scope to the receiver audio output (speaker or phone jack); measurement will be based on peak-to-peak voltages (Vpp) on a scope, or rms voltage (Vrms) on a DVM.

Using a signal generator, set the frequency for the band of interest on your radio. For example, on a general coverage shortwave receiver, you might set it for 10 MHz (top end of the 31M band), or perhaps to 7.040 MHz on a 40M ham radio receiver/transceiver. Tune the receiver to the signal generator signal. If you don't have a signal generator, you can also tune to a steady carrier or station to produce a hetrodyne audio "pitch." Tune in the signal to the pitch that causes the maximum peak-to-peak display. Adjust the scope and volume control to produce a 2Vpp display (4 divisions). This is the peak response of the overall filtering stages as shown in **Fig. 13**.

Now determine the audio frequency at this peak response by measuring the time period between cycles and covert to frequency. In the example to the right, the period of one cycle is 1.7mS, which is an audio tone of 750Hz (1/.0017sec). A frequency counter on the output can also be used.

Next, tune the receiver such that the sidetone pitch goes UP in frequency and the peak-to-peak signal will decrease in magnitude. Tune to the point where the signal is exactly 1Vpp on the scope. See **Fig. 12**.

This is the –6dB point of the high end of the filter (20log 1v/2v =–6dB). Determine the frequency of the audio pitch as before. In the example, this is 1100 Hz. Record the data.

From these two data points, the –6dB bandwidth can be estimated. The bandwidth from the filter peak (750 Hz) to the –6dB point (1100 Hz) is 350 Hz. The bandwidth (BW) between the two –6dB points is usually twice this value, or 700 Hz. A filter with a –6dB BW of 700Hz is a mediocre filter for CW reception, and way too narrow for SSB or AM.

Of course you can determine the exact –6dB BW by tuning the receiver back to the 2Vpp peak response, and continue tuning DOWNward in frequency until the audio is again exactly 1Vpp. Determine this frequency and record. In this example, it should occur around 400 Hz if the filter shape is symmetrical.

Plot these three data points on a sheet of graph paper as shown in **Fig. 15** to construct the filter shape. Return to the upper –6dB point (1100Hz in the example) and continue tuning upwards in audio pitch, recording the frequency at 0.5v (–12 dB), 0.25v (–18 dB), 125mV (–24 dB), etc. Everytime you "halve the voltage," it is a 6 dB change. The more points you collect, the more accurate your filter response plot will be.

Fig. 13 – Displaying Filter Peak Response

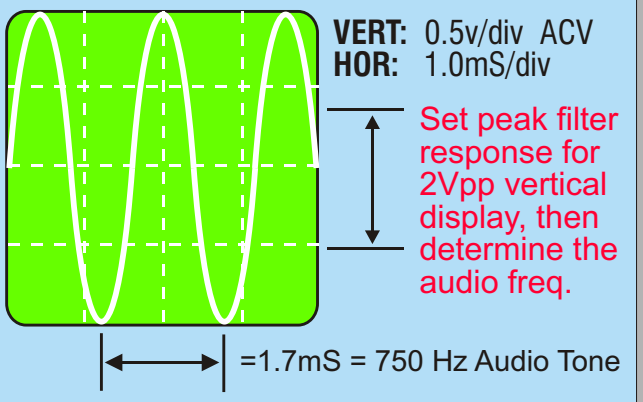

Fig. 14 – Displaying –6dB Frequency

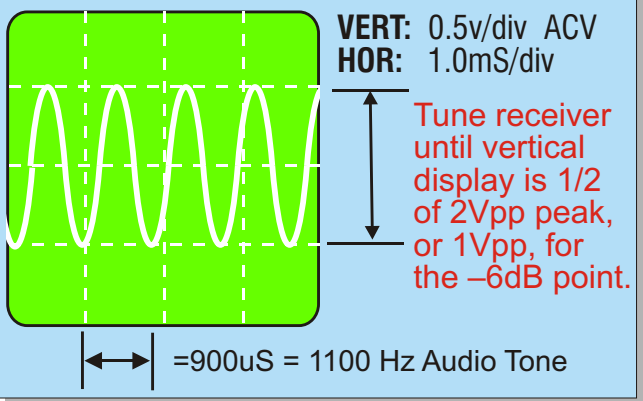

Of interest to proper rig alignment is to repeat the above using the output of the product detector. To maximize the effectiveness of the filtering, the receive offset frequency set by the BFO should be adjusted to the same frequency as the peak frequency response of the audio. In this example, with the peak audio response occuring at 750Hz, if your BFO is set for a sidetone frequency of 700 Hz, you are loosing 2–3 dB, since this is in your filter skirt. This is shown on the response plot in **Fig. 15** by the dashed lines. By adjusting your BFO for a sidetone frequency of 750 Hz, you will pick up 3-4dB of overall gain in your receiver, plus increase the selectivity a bit as well. Why? Because nearby stations, such as one at 800–900Hz tone, could actually be louder than the 700Hz tone signal you are trying to copy, since the gain of the receiver is greater at those tones than at 700Hz, as shown in the plot.

Fig. 15 – Plotting Audio Response

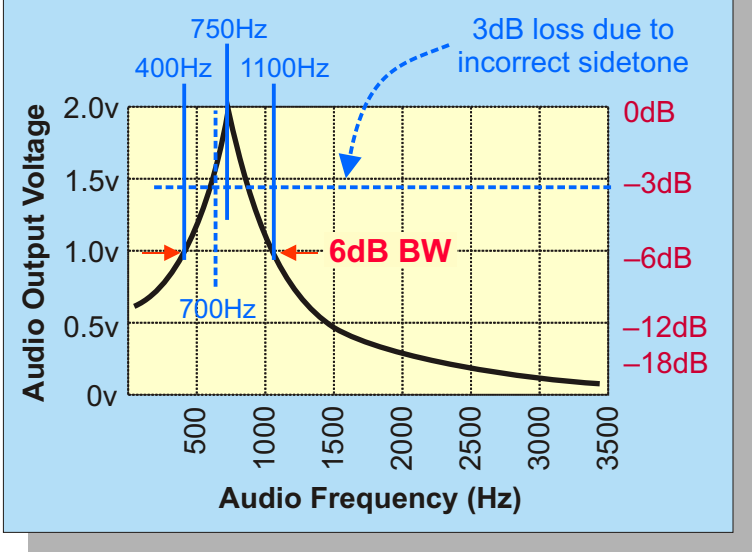

Opposite Sideband Rejection

A superhet receiver is supposed to pass just one sideband and reject the other. Poor opposite sideband rejection could indicate the crystals in your IF filter are not well matched or other problems. It is measured almost identical to plotting the filter response just described. First, you tune the receiver to the test signal to find the peak response frequency, or 750Hz in this example. Set the scope display for 2Vpp. Now tune downward in audio pitch, passing zero-beat, and continue tuning and you should hear the test signal, much weaker, now rising again in tone. This is the *opposite sideband*. Measure the peak-to-peak voltage, if you can. For example, say it is 80mVpp, as shown in **Fig. 16**. Calculate the opposite sideband rejection by:

$$\text{rejection} = 20\log\frac{80\text{mV}}{2.0\text{v}} = \frac{80\text{mV}}{2000\text{mV}} = -28\text{dB}$$

If you can't hear the opposite sideband, then obviously you have excellent filter rejection. If you can just barely hear it, you may have to increase the sensitivity of your scope (set vertical gain to 20 or 50 mV/div). In this example, –28dB rejection of the opposite sideband is quite good. A –30dB rejection means the opposite sideband is only 1/1000th of the desired sideband, a very suitable attenuation of the opposite sideband.

Fig. 16
Calculating Opposite Sideband Rejection

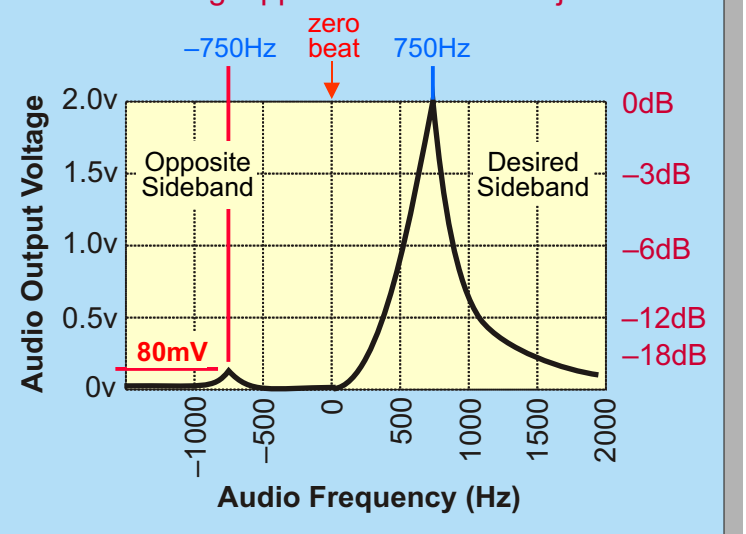

These tests are important to perform on your rig for documenting it's current performance, and repeated periodically to detect unfavorable changes or for troubleshooting when a problem is evident. For homebrewing, these tests can allow you to evaluate different circuits or when experimenting with different components or part values.

Oscillator Phase Noise

When homebrewing a basic oscillator circuit, such as a VFO, looking at the oscillator output on a scope can reveal several problems. One is to check for excessive phase noise. Phase noise is small variations of the oscillator frequency that causes power in the close-in sidebands, usually measured on laboratory equipment within 100KHz, or even within 10 KHz.

To check for oscillator phase noise, connect the oscilloscope to the oscillator output, loading the output of the oscillator as little possible. Most scopes have sufficiently high input impedances where this shouldn't be a problem, but some cheaper scopes can load an oscillator circuit. If you suspect your scope is loading the oscillator, couple the scope to the circuit with a small value capacitor, less than 20pF.

Display 2–3 cycles of the oscillator output as shown on the scope display shown in **Fig. 17**. Properly focus the scope and carefully observe if the waveform appears in focus at the peaks, but slightly out-of-focus at the zero-crossing points, that is, on the rising and falling edges of the sine wave.

Fig. 17 – Checking Oscillator Phase Noise

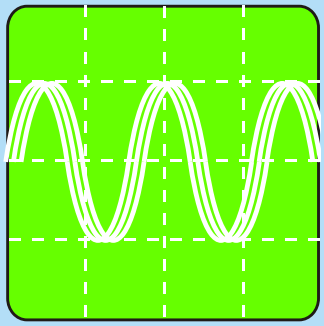

If it appears out-of-focus, this is excessive phase noise jittering the signal and "smearing" the waveform along the time (horizontal) axis. Extreme phase noise may show 2-3 sine waves very close to each other, as shown in the exagerated waveform to the right — assuming you have your scope properly triggered.

Phase noise is random, instantaneous changes in the oscillator frequency that smears the display. If you can see this on a scope, the phase noise is excessive! If you can't see it, it doesn't mean the oscillator has no phase noise (all oscillators have some phase noise), it just means it is not excessive enough to see on a scope. A scope is not a good instrument for checking phase noise, but for homebrew circuits, it is a check to ensure you do not have a serious oscillator problem.

Excessive oscillator phase noise in receivers can cause IMD products and noise in the audio range at the output of the mixer(s), including the product detector. In a transmitter, excessive oscillator phase noise will put power in the close-in sidebands of your carrier, not only wasted power for lower transmitter efficiency, but may produce strange sounds (buzzing or chirping) to the receiving station. A few causes of phase noise are excessive current in the oscillator transistor, low-Q coil(s), high dissipation in the tuning caps or poor power supply filtering at the oscillator frequency.

AM (Amplitude) Noise

Another oscillator problem may be AM noise, or amplitude modulated noise. It is an opposite effect on a scope when displaying the oscillator output — the sine wave appears out-of-focus or thicker at the peaks, and in-focus elsewhere as shown in **Fig. 18**.

If you detect AM noise, slow down the scope's sweep rate to the audio frequencies or slower to see if you can notice a lower frequency component. A common cause of AM oscillator noise is 60 Hz from the power mains leaking into the circuits. This is particularly true if using a power supply off of 120v 60 Hz, or sometimes it can be due to the AC lighting above your head! If the AM noise seems to be at the same frequency as the audio output tone, it means audio is getting into the Vcc bus, likely due to poor bypass filtering at the audio amplifier stages (particular if using an LM386 or similar).

Fig. 18 – Checking for AM Oscillator Noise

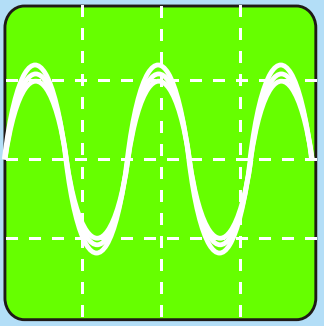

If you can't find a low frequency component, the AM noise may be random, which may indicate poor voltage regulation, a noisy voltage regulator, or perhaps a circuit in VHF oscillation. If the AM noise seems to occur on key-down only on a transmitter, the transmit current may be loading the power supply, the voltage regulator is under-rated, or just simply loading the oscillator. In the case of loading the power supply or regulator(s), perhaps a separate voltage regulator or zener circuit should be used, dedicated for the oscillator(s). In the case of transmit loading, adding a buffer amplifier or emitter follower to isolate the load from the oscillator may help.

Much of this can be diagnosed also with the scope, by looking at the AC ripple on the DC power lines. You should have less than 50mV of any AC component on the 8-12v DC wiring, whether 60Hz, audio or RF. If >50mV, then additional low or high frequency filtering on the DC power is needed.

Monitoring Transmitter RF Output

RF Power (in watts) is E^2/R, where E is in rms and R=50 . The voltage displayed on the scope (peak-to-peak) must be converted to rms by Erms=.707(Epp/2). To measure properly, the transmitter should be on a 50 dummy load using the normal hi-Z scope input. If your scope has a selectable "50 "input, it can be the transmitter dummy load directly, providing it can tolerate the 50Vpp input. (Always know what the maximum p-p input voltage your oscope will tolerate. It is often stated on your scope at the vertical channel inputs. 50Vpp to 100Vpp are typical).

Measuring Transmitter RF Output Power

Figure 19 shows how you can use an oscilloscope to fairly accurately measure output power from a low power transmitter (generally 10W or less with a 1X probe and 20-30W with a 10X probe). Connect transmitter output to a 50 dummy load. Connect the scope lead to the transmitter output (after the low pass filters) or directly to the dummy load. Do not connect the scope leads to the collector or drain of the final PA transistor. The displayed voltage in this case will be erroneous.

In the example, the output transmit voltage across the dummy load measures 24Vpp. Convert this voltage to Vrms, then use the equation (Vrms squared divided by the load resistance) to calculate the power in watts. In the example, 24Vpp, the output power is 1.4 watts. A 5W QRP transmitter should produce about 45Vpp.

The accuracy of your power measurements depend upon the condition of your oscilloscope:

1) Ensure your scope's vertical sensitivity (volts/division) is properly calibrated (see Part I)
2) Ensure your vertical sensitivity is properly calibrated with the 1X or 10X probe you are using.
3) Ensure that the transmitter frequency is well within the bandwidth of your scope. A 100 MHz scope should give reliable readings on all HF bands. A 50 MHz scope should be reliable on all HF bands except slight errors at 28MHz.

Fig. 19 –Oscilloscope as a Power Meter

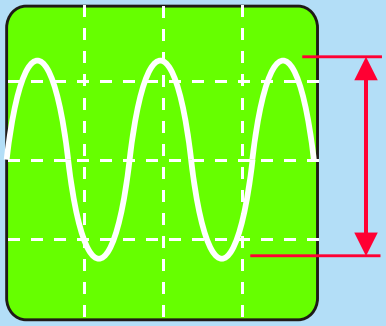

1. Measure output voltage. 24Vpp
2. Convert Vpp to Vrms
   Vrms=.707(Vpp/2) 8.5Vrms
3. Calculate power in watts

$$\frac{Vrms^2}{R} = \frac{8.5v^2}{50} = 1.4W$$

Checking Transmitter Purity

Phase Noise of the transmitter is measured identically to the phase noise checks on page 2–3. With the scope properly triggered and focused, you are looking for an out-of-focus "fuzziness" around zero crossing. If it appears phase noise exists, the fault is generally at the beginning of the transmit chain. That is, seldom does the PA transistor add phase noise; it's merely amplifying what it is given. Phase noise on the transmitter output is more likely due to the transmit oscillator, or the transmit mixer if used.

Harmonic Power can also be detected on a scope while looking at the transmitter RF output power. In **Fig. 20**, notice the "dips" or the two "peaks" on the top and bottom of each sine wave. This is caused by excessive 2nd harmonic output power. The rule-of-thumb is – if you can see any 2nd harmonic power (a dip or flattening at the peaks), then you are right at or exceeding the –30dBc FCC harmonic specification. A clean sine wave implies FCC compliance, providing the 2nd harmonic is within your scope's bandwidth. Obviously, a spectrum analyzer should be used for accurate harmonic evaluation, but a scope can be used to indicate if you have a problem. If you build your own transmitter, it is your responsibility to ensure it is compliant. An approximate method of estimating 2nd harmonic attenuation is shown.

–30dBc means the 2nd harmonic power is 1/1000th of the fundamental power. For a 5W transmitter, this means the 2nd harmonic power should be 5mW or less, or about 1Vpp. In displaying a 5W signal on a scope (45Vpp), it would be difficult to resolve much less than a 1Vpp dip or ripple.

Fig. 20 –Checking 2nd Harmonic Power

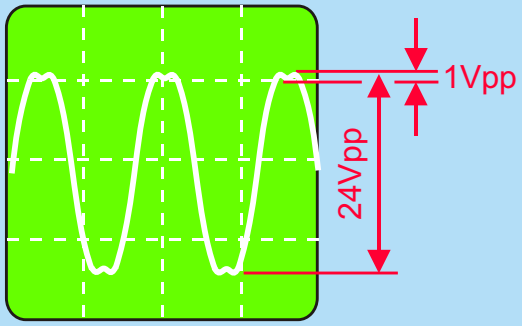

1. Measure output voltage. 24Vpp
2. Measure ripple voltage. 1Vpp
3. Calculate dBc of 2nd harmonic ripple

$$20\log\frac{V2}{V1} = 20\log\frac{1v}{24v} = -27.6\ dBc$$

or, not quite FCC compliant!

Conclusion. This concludes the NA5N "Handiman's Guide to Oscilloscopes." Hopefully, it has helped you to understand your oscilloscope to make simple measurements, and with some practice, perform the more advanced measurements discussed. An oscilloscope is a very powerful tool that is invaluable on the homebrewer's workbench. If there is a particular measurement you feel I omitted, please let me know and I will add it when time permits.

73, Paul Harden, NA5N (na5n@zianet.com or pharden@nrao.edu)

THE HANDYMAN'S GUIDE TO OSCILLOSCOPES (Part 1 of 2)

by Paul Harden, NA5N

Print as .pdf file
5 pages
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Getting Acquainted with your Scope and making some measurements

Updated May 2004 *with actual oscope waveforms*

When in the course of human events, it becomes necessary to look at neat signals floating around your radio, you go to a hamfest and buy that $50 o-scope. Now what? This two part article will attempt to explain basically how an oscilloscope works, operator functions, basic measurements, and some advanced applications. An o-scope is a powerful tool in any shack – even a real "cheapie" with limited bandwidth.

HOW AN OSCILLOSCOPE WORKS

A block diagram of a typical o-scope is shown in **Fig. 1**. The test probe usually plugs into the scope via a BNC connector, then passes through a switch to determine whether the input signal will be dc or ac coupled (to remove any dc component). Often this switch will have a "ground" position for setting the zero-volts reference. Next is the input attenuators. The vertical input amplifier is quite sensitive, designed for 20-50mV of input. For larger input voltages, the signal is applied to attenuators comprised of simple voltage dividers. This is the first area of concern for cheap o-scopes, as the input attenuators may not be very linear or accurate. For example, if you appy a 10Vpp signal on the 10v/division setting, the signal should be 1 division high. Switching to 1v/div., the signal should be 10 divisions (usually full-scale) high. If it is not exactly 10 divisions, the attenuator for that setting needs adjusting. Some scopes have internal adjustments for fine-tuning each attenuator setting.

Following the attenuators, the signal is applied to the first vertical amplifier, which converts the input to a differential signal. This differential signal is amplified up to high voltages for the oscilloscope deflecting plates – moving the beam up and down (in the vertical axis).

The sweep generator is usually a constant current source charging a capacitor to make a sawtooth waveform that eventually deflects the beam in the horizontal axis. The frequency of the sawtooth determines how fast the beam travels from the left to the right side of the tube, and is controlled by the sweep control, usually calibrated in seconds, milli-seconds or micro-seconds per division. This is the second area of concern for an oscilloscope – how linear the sawtooth waveform is generated. For example, a sawtooth with a nonlinear ramp will cause the signal displayed in the central portion of the tube to be expanded or compressed compared to the signal at the ends.

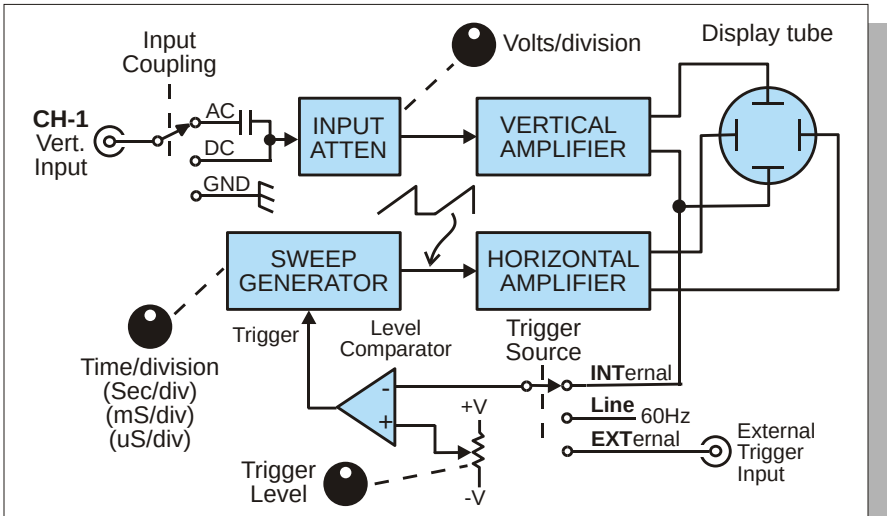

FIG. 1 - Basic block diagram of an Oscilloscpe

The sawtooth ramp is amplified to high voltages, applied to the oscope tube, to deflect the beam from left to right. An important task of an oscope is when the horizontal deflection begins. Normally a switch labeled "Trigger Source" determines what initiates the sawtooth ramp. In the "Internal" position, a sample of the input signal (in the vertical amplifiers) is sampled, with a variable resistor setting the level. When the input signal exceeds the "Trigger Level," a pulse is generated to start the sawtooth ramp and hence the horizontal sweep. The purpose of triggering is to keep the input waveform synchronized to the sweep so it appears stationary on each sweep. The trigger source usually has a "Line" position, which simply triggers the sweep off of 60Hz from the power supply. This synchronizes the sweep to the AC power frequency and is useful for checking television signals, which are synchronized to the power mains. Also, an "External" position may be present, which connects an external input signal (via a BNC connector) to trigger the sweep generator.

Other features your oscope may have are two vertical channels for dual trace operation, various modes to display both waveforms (alternate, chopped, A+B added, etc.), delayed sweep features, dual sweep time bases, built in calibrators, etc.

CALIBRATING YOUR OSCILLOSCOPE

The first thing you should do upon acquiring an o-scope is to check its calibration.

The vertical amplfiers can be checked with a known voltage source or 9v transistor radio battery. Measure the output voltage of the battery with an accurate voltmeter. Let's say it just happens to be +9v exactly. Set the input coupling to ground (0v) and move the trace to the bottom division. Switch the input coupling to DC and set the attenuators to 1v/div. The deflection should be 9

divisions. Switching to 10v/div., deflection should be 0.9 divisions. Internal to the oscope (or perhaps accessible from the outside) are adjustments for the vertical amplifier gain. Adjust this for 9 divisions of deflection in the 1v/div. range. Procedure can be repeated with a 1.5v flashlight battery (assuming you know the exact voltage from a DVM).

The horizontal amplifiers should be checked/calibrated using a signal generator. For example, a 1MHz signal has a period of 1uS. Setting the sweep rate to 1.0uS/div., a 1MHz signal should take exactly 1 division per cycle. Set the horizontal width control properly to ensure the beam starts at the first division and ends at the last division. If the sweep rate appears incorrect, an internal adjustment (Sweep gain or similar) can be set for proper display of the test signal.

The main operator controls are:

- **Intensity** - controls the brightness of the beam. **NOTE: Too bright a beam can damage to the CRT tube!**
- **Focus** - adjusts the beam for the thinnest and sharpest display.
- **VERT & HOR Position** - controls the vertical and horizontal position of the display respectively
- **VERT V/div** - controls the vertical sensitivity of the display, i.e., how many volts (or mV) per division.
- **HOR Sweep Speed** - sets the horizontal sensitivity, i.e., how many mS or uS per division.
- **VERT & HOR vernier** - allows the vertical and horizontal sensitivity settings to be varied in small steps.

Other adjustments you may find on your scope are:

Astigmatism - With the scope intensity and focus properly set, this adjustment compensates for the curvature of the CRT tube by making it in-focus across the sweep. If your trace is out-of-focus in certain areas, but in-focus elsewhere, the astigmatism needs to be adjusted. See ***Fig. 2***.

Trace Rotation - is a small coil around the CRT that skews the trace to ensure it is perfectly horizontal. On scopes without this adjustment, the trace is leveled by physically rotating the CRT to align the trace to the graticle grid. See ***Fig. 2***.

DC BAL (DC Balance) - is a dc offset in the vertical amplifiers that causes a shift in the trace baseline when changing vertical scales. It is most obvious when measuring ac voltages. For example, you are displaying a 10Vpp sine wave, centered on the center graticle, at 2v/div. Changing to 5v/div, the sine wave shifts off the center graticle ... that is, it assumes a dc bias error. The DC BAL is adjusted until the shift no longer occurs when changing vertical scales.

HV ADJ. - is the high voltage that controls the intensity of the trace. Turn up the **Intensity** control to its brightest position, then adjust the HV ADJ for a trace slightly brighter than normal intensity. The **Intensity** control now has the proper range. The HV ADJ might have to be re-adjusted to acquire proper focus.

NOTE: Very bright trace displays can cause permanent damage to the CRT, particularly on a well-used scope.

Fig. 2 – Effects of Astigmatism & Trace Rotation

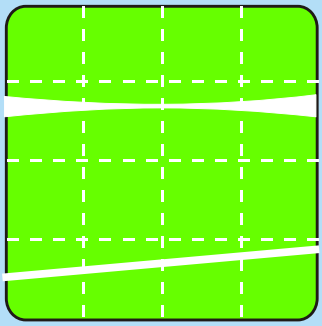

LET'S MAKE SOME MEASUREMENTS

It is assumed you have your scope relatively calibrated and familiar with the front panel controls. The sample o-scope displays are based on eight vertical and ten horizontal divisions on the CRT screen, typical to most oscilloscopes. Most waveforms are actual displays of the signal cited, photographed from my trusty Tektronix 475 oscilloscope.

First ... a word on TRIGGERING.

Most oscilloscopes have a knob or two for "Triggering." This tells the oscilloscope when to start the sweep. When the **Triggering Slope** is placed in the **(+)** position, the scope will begin its trace when the *input* signal goes positive. Likewise, when **(–)** triggering is selected, the trace will begin when the input signal goes negative, as shown in **Fig. 3**. Often there will be the option to chose the **Triggering Source**, such as "CH.1" or "LINE." Line means the scope is triggered off the 60Hz line voltage, and is useful when synchronizing on television signals or looking at 60Hz power supply noise. CH.1 or CH.2 means the scope will trigger off the signal on channel 1 or 2 respectively. **Trigger Level** is at what voltage of the input signal triggering begins. For example, if set high, triggering may not begin until the input signal reaches several volts. When set around zero, it will trigger the moment the signal goes positive (if set for (+) triggering). This setting can be troublesome if noise exists on the signal. Adjust for stable triggering.

Fig. 3 – Triggering

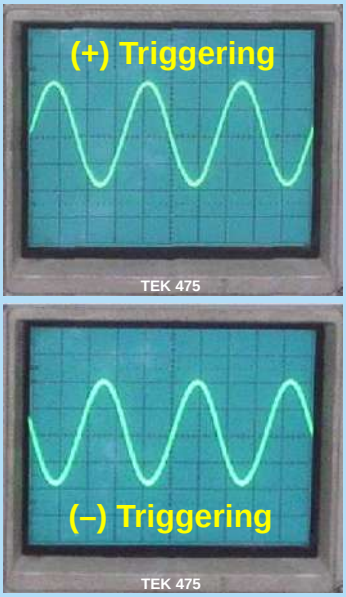

DC Voltages.

Say you want to check the transmit-receiver (T-R) switch in your QRP rig, or other digital signal. See ***Fig. 4.*** The key line is the input to the HCT240 inverter to form the 0v TX– on key- down and the 0v RX– on key- up. This switches the rig between transmit and receive (T-R Switch). It is a logic function, that is, a voltage to represent ON or OFF.

Place the scope lead on pin 13 at 10v/div. and you should see the waveform like the top trace in ***Fig. 4*** ... about +6v on key-up and 0v on key down. Move the scope lead to pin 7 and you should see 0v on key-up and about +8v on key-down (bottom trace). If the output does not go "HI" (+8v) on key-down, or does not go to a solid "LO" (<1v) on key-up, the inverter is not working properly. (It's busticated). Many shortwave receivers use similar schemes for switching filters or attenuators.

While this test could be done with a DVM, the integration time is slow, requiring long key-downs to get the voltages. A scope will also show you how clean the switching is, or if there is an ac voltage (or RF noise) riding on the T-R voltage.

Scopes are thus good dc voltmeters, with about a 5% reading accuracy.

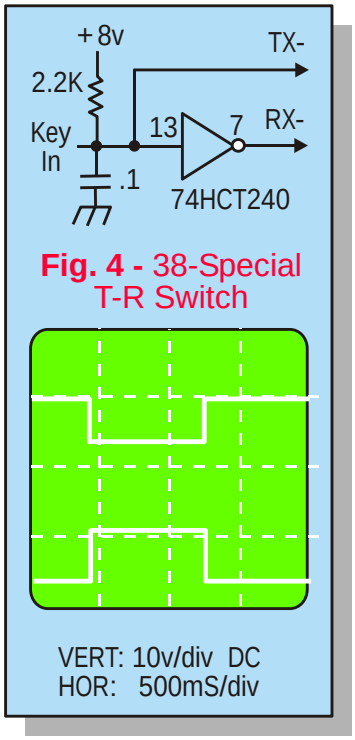

Fig. 4 - 38-Special T-R Switch

AC Voltages.

Here is where an oscilloscope pays for itself by making AC voltage (and frequency) measurements. You must remember, AC voltages are displayed on a scope as ***peak-to-peak voltages***, while a voltmeter measures in ***rms***. RMS voltages are about 1/3 the p-p voltage read on a scope, or specifically:

$$Vrms = \tfrac{1}{2}(.707 \times Vpp) = 0.354 \times Vpp$$

For example, let's measure the output voltage and frequency from the sidetone oscillator in your QRP rig. Place the scope lead on the audio amplifier output. On key-down, you get the waveform shown in ***Fig. 5***. The transmit sidetone audio is 1.9Vpp.

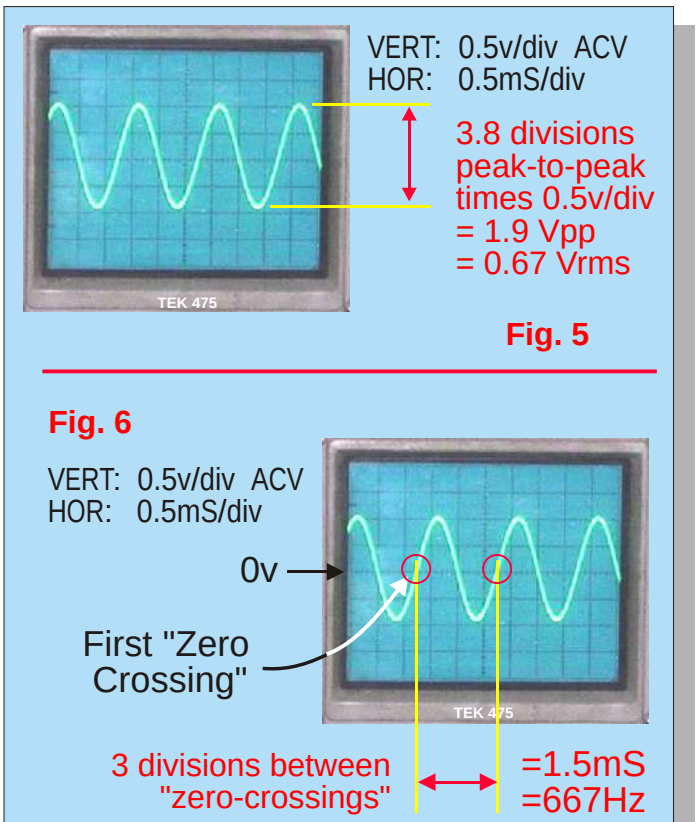

AC Frequency Measurement.

With this waveform, we might as well see what frequency our sidetone or transmit-offset frequency is. Most operators prefer the sidetone to be about 700–750Hz. Trigger the scope for a stable waveform and set the time-base (sweep) to display 2 or 3 cycles, as shown in ***Fig. 6***. Center the waveform between two horizontal divisions so zero volts on the waveform is on a graticle line, then move the horizontal position so the first "zero– crossing" is also on a division line.

Measure the time it takes to make one complete sine wave from one zero-crossing to the next. In this example, it is 1.5 divisions, at 1mS per division, or 1.5mS. Frequency is simply the reciprocal of time, such that the sidetone frequency is:

$$f = \frac{1}{t} = \frac{1}{1.5mS} = 667\ Hz$$

For some, this may be about right. For others, this may be a little low to your liking. To raise it to 700Hz, calculate the time period of 700Hz (1/700 = 1.4mS). At 1.0mS/div, you can adjust your sidetone or transmit offset until zero-crossings for a single sinewave is 1.4 divisions. This will be about 700 Hz. (Sidetone may not be adjustable on some rigs).

All frequency measurements are made in this fashion, by measuring the distance between zero-crossings (or from one peak to the next) and converting the time period to frequency. This should emphasize the importance of ensuring your sweep speed is calibrated; as any error in the time base will cause a corresponding error in the accuracy of your time or frequency measurements.

Quality of the waveform is another feature of a scope that is unsurpassed since you are "seeing" the waveform in real time. Two examples of waveform quality are shown in ***Fig. 7***.

The top trace shows the sidetone frequency with distortion, perhaps due to improper time-constant on the coupling capacitors or improperly biased audio amplifiers. The bottom trace would be a raspy sounding side tone, due to the amplifier being over-driven and in compression (clipping). The o-scope is an invaluable tool for detecting and diagnosing such impurities in the signal quality.

FIG. 8 – Full Scale Signal Display

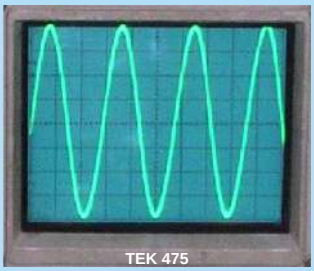

Actual display Tektronix 475

MORE NIFTY MEASUREMENTS

Amplifier Gain.

The gain of an amplifier can be measured in terms of voltage or decibels (dB). For voltage gain, it is simply Vout/Vin of the amplifier. For example, if the input is 1Vpp and the output is 4Vpp, then the amplifier has a voltage gain of 4.

Gain in dB is often more useful and is how the gains of amplifiers are usually expressed. With dB's, every-time you double the AC voltage, you add 6dB of gain. It is the **ratio** of output to the input, and this **ratio** is easy to measure on a scope.

It is often easier to start with the output. Set the vertical amplifier gain to display the amplifier **output** as a full-scale signal as shown in ***Fig. 8***. Now move the scope probe to the amplifier **input** without disturbing the scope gain. You will of course have a much smaller signal, and the ratio of the input to the output will be the gain in dB. In our example of using eight divisions for full-scale, then four divisions would be 6db, 2 divisions 12dB, etc. as shown in **Fig. 9.** You may want to add your own dB scale along your scope display to remind you of this relationship. Note: this is ***voltage gain*** (Av=20log x Vout/Vin). In this example, with 4Vpp output and 1Vpp input (Av=4), then the gain is dB=20log(4) = 20(0.602) = 12dB, or as shown directly on the CRT tube. Since this is a relative measurement, the absolute Vin or Vout voltage does not need to be determined.

Fig. 9 – Volt. vs. dB relationship

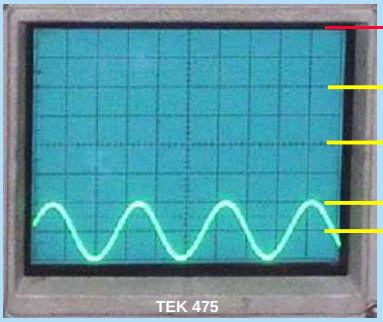

Zero Crossings

Fig. 10 Measuring Phase Shifts

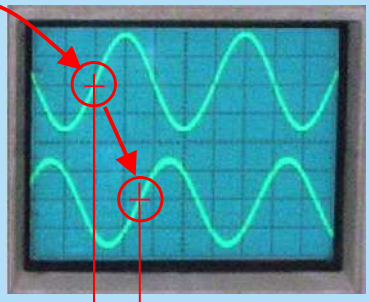

1.6 divisions x90 =145°

Insertion Loss.

In some circuits, such as filters or attenuators, the ***loss*** in the circuit needs to be measured, and like circuit gain – expressed in dB. The loss through a circuit is called the ***insertion loss.*** It is determined in the same way as amplifier gain just presented, except start with the input (the highest AC voltage) as the full-scale or reference display, then measure the output AC voltage (the lowest level). **The ratio is the insertion loss in dB.**

For example, with a signal generator connected to your receiver, you want to measure the insertion loss through the IF crystal filter. At the filter input, you can just barely squeek out 2 divisions of input signal on your scope at its most sensitive setting. The output from the crystal filter is 1.5 divisions. The insertion loss would be 20log(1.5/2.0 div.) = –2.5 dB. If the output were only 1.0 division (50% reduction), the insertion loss would be 6dB.

Fig. 11 –Phase Shift by imposition

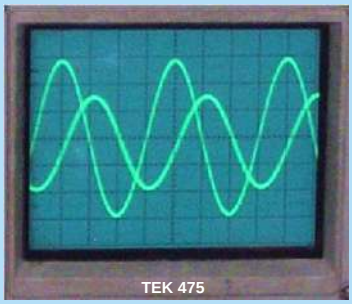

Measuring Phase Shifts.

Phase relationships between two signals at the same frequency can be measured with 2-5° accuracy with a scope, although more suited for a dual-trace scope. The reference signal is applied to CH. 1 and the signal to be measured to CH. 2. For proper phase measurements, ensure your dual trace display is in the **chopped** mode, not **alternate** mode for proper phased referenced triggering.

There are many methods to do this. One is to stretch out the signal so it takes 4 horizontal divisions, such that each division is 90° of phase, as shown in **Fig. 10**. By measuring from a common point on one signal (zero-crossing or from peak-to-peak) to the next, the phase can be measured. For example, say you are making a phased-array antenna in which one feedline must cause a 90° delay. You calculate the electrical length for a ¼λ [L=(246/f) x Velocity Factor] and cut the coax to that length. You are now working on blind faith that you have exactly 90°. With a scope, you can measure it fairly accurately by injecting a signal into one end with a signal generator (at the frequency of interest) and a 50Ω load on the other. Connect the scope CH.1 to the coax (signal) input and CH.2 to the load end and measure the phase. In the **Fig. 10** example, the CH.2 signal is delayed by 1.6 divisions, at 90° /div is 145°. ***Your delay line is too long!*** Cut off an inch or two at a time until the CH.2 signal is 90° from CH.1 for precise tuning of the delay

line. (While departing from o-scopes for a moment, the sharp null of a phased array is astounding when exactly 90° delay is achieved. More than 10-15° in error causes a very “mushy” null with little difference over a single vertical antenna. Most errors in achieving exactly 90° by the "measure-and-cut" method are due to uncertainties in the stated velocity factor of the coax).

Another method is to superimpose the two signals on top of eachother. Make one signal larger than the other so you know which one is what, as shown in **Fig. 11**. In this example, the smaller signal lags the larger signal by about 100°, estimated by where they cross. For more accurate determination, use the time base to measure the time period of one cycle (T1), then the time period one signal lags (or leads) the other (T2). The phase shift is then $\theta=(T2/T1)x360^o$.

Phase measurements can be made on a single trace scope as well. First, connect the reference signal, uisng a BNC "T," to both the *external trigger* and the normal *vertical input*. Adjust the trigger level so the zero-crossing occurs at the beginning of the trace (left-hand graticle). Remove the reference from the vertical input, but not the e*xternal trigger,* and apply the signal to be tested to the vertical input – without altering the time base or trigger level. The distance of zero-crossing of the test signal is from the left-hand graticle can now be measured to determine the phase, though with slightly less accuracy than using a dual-trace scope.

An interesting experiment is to measure the phase shift of the audio signal at different frequencies as it travels through the stages in a CW, SSB or AM active filter. What is the phase shift of the wanted vs unwanted frequencies?

Measuring Rise and Fall Times.

In digital circuits, it is sometimes important to know the rise and fall times of a signal through a gate. In amateur radio transceivers, this same interest could be applied to how fast the T-R switch switches. On key-down, if the transmitter turns on slightly before the receiver is turned off, it can produce an annoying "thump" in the receiver. Rise and fall times are measured by triggering on the edge of the signal of interest, then increase to a faster sweep speed to measure the time it takes the signal to reach 90% of its final level. The signal to be measured is shown in **Fig. 12** on the top trace, and the expanded version on the bottom. For proper rise times, the signal being measured should be well within the bandwidth of your scope and using a low capacity probe.

For example, in **Fig. 12** (bottom trace), the rise time is about 1/4th of a division. If the sweep speed is 100nS/division, the rise time would then be about 25nS.

Fig. 12 –
Rise and Fall Times

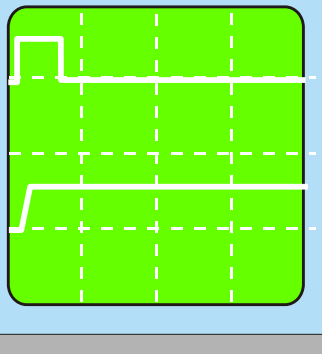

USING LIMITED BANDWIDTH SCOPES

Today's scopes have 200–500MHz bandwidths. Likely your scope is much less than that. A limited bandwidth scope is still very useful to the amateur or homebrewer. Say the bandwidth of your scope is 5MHz. This does not mean you can't see 7MHz signals. It just means the peak-to-peak value has lost meaning, and will likely be very weak, since it is beyond the bandwidth of the scope. (Like other bandwidth measurements in electronics, the “bandwidth” of a scope is usually based on the “3dB bandwidth.” That is, at the maximum bandwidth, you are already at the –3dB point, or a 25% reduction in the peak-to-peak voltage display). You can still resolve individual cycles higher than the cited bandwidth to a certain degree and make gain and phase measurements, since they are based on ***ratios.***

Most of the examples in this article explore many regions of a communications receiver or ham transceiver without the benefit of any great bandwidth. Experiment with your scope to learn its limitations. ***Use a good scope probe and make measurements with a good ground to get the most out of the bandwidth you have.***

For the homebrewer building circuits in the HF bands, a 50 MHz scope **with good calibration** will yield fairly accurate measurements up to 30 MHz with little concern for accuracy. The old 465 or 475 series of Tektronix scopes, with 100/200 MHz bandwidths, make an excellent oscilloscope for the amateur or experimenter. They can often be found at hamfests today for $100–150, and tend to maintain a fairly good calibration almost regardless of how much use they have seen.

In Part 2 **-** we'll probe (bad pun) into some advanced measurement techniques, even with a simple scope ... such as measuring sideband rejection, filter responses, VCO phase noise, etc. (and what it all means).

72, Paul NA5N

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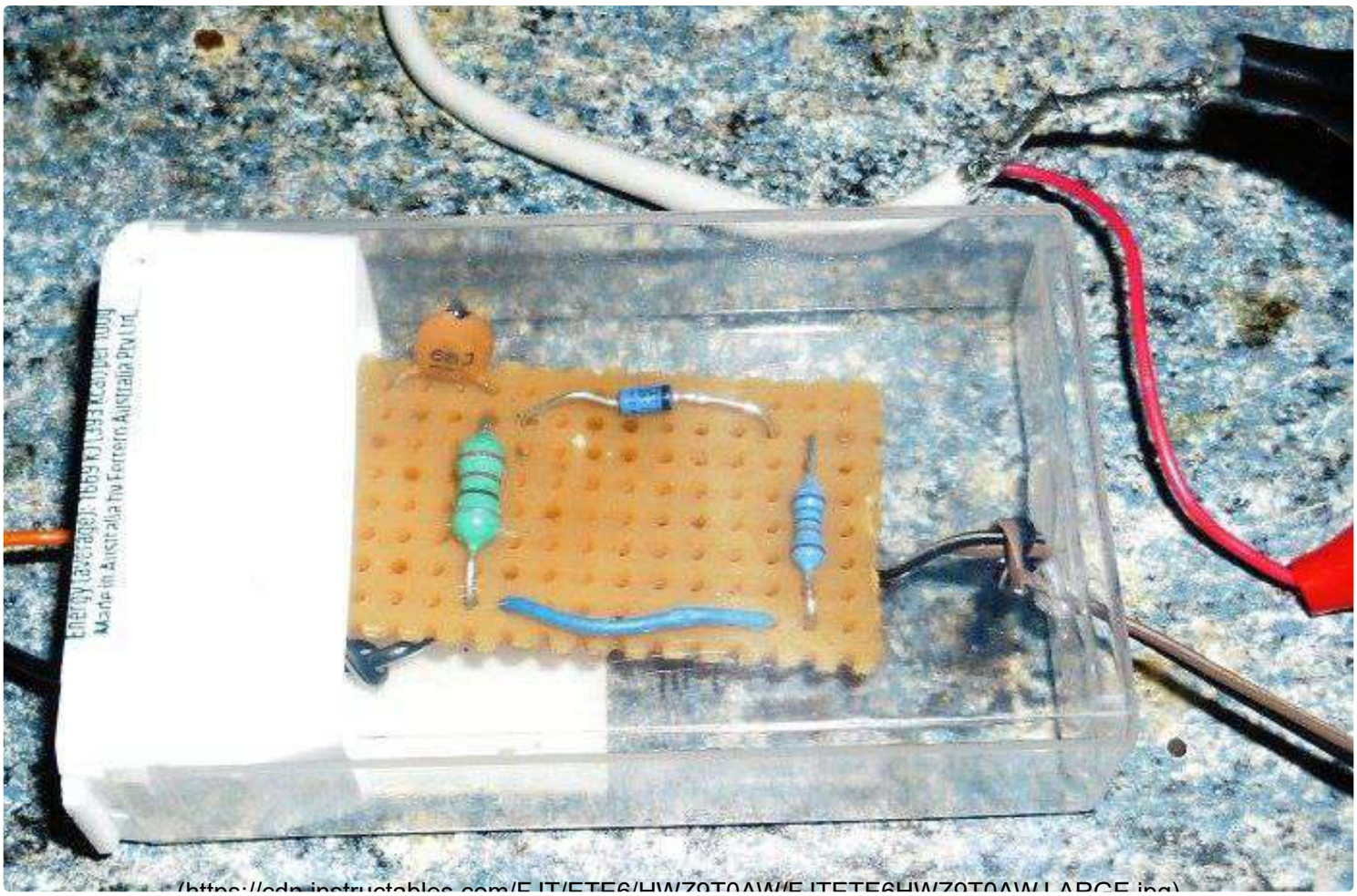

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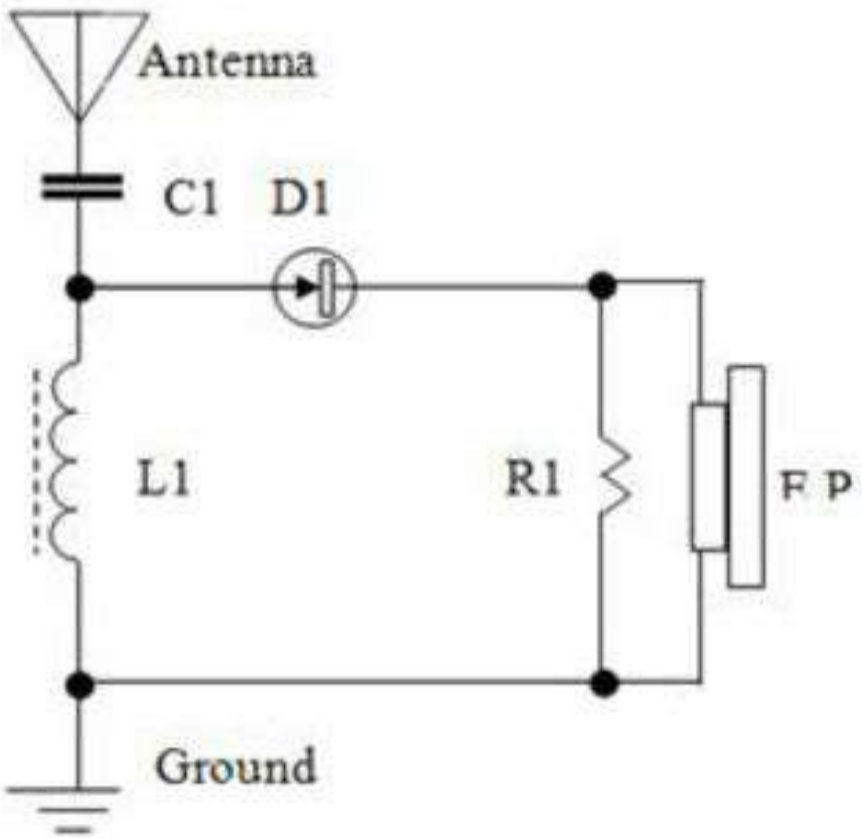

Hi there! This Instructable is all about building a basic crystal radio set that is so simple to build and understand, that a child could do it - with help from mum or dad - or even at school, as a class project. Parts can be bought "off the shelf" at Jaycar Electronics and other suppliers, or purchased online via Ebay and Paypal.

I built my first ever crystal set when I was 9 years old, but that was a different world. We're going to build a 21st century style radio with all modern components which are relatively easy to obtain at your local electronics store or on the Internet.

The radio is contained inside a Tic Tac box, and is called "The Nic Nac Tic Tac Radio". It is built on a square of matrix board, with the component leads poked through the holes in the board, and joined underneath. It is a very simple crystal set, designed to initially receive only one station, but you can expand the tuning range with the addition of only one extra component.

The Tic Tac radio can be constructed by simply twisting the component leads together, underneath the matrix board and attaching antenna/ground wires as well as the earphone wires to the board, using that same technique. You don't have to

solder any wires, but there is another way to join them all together - more on that later.

The Tic Tac Radio is a very easy set to put together - you don't need to wind bulky coils or use heavy tools and screw strange looking parts onto a large breadboard. See step 1 for the parts list you will need.

Add Tip | Ask Question

Step 1: Parts and Tools You Will Need

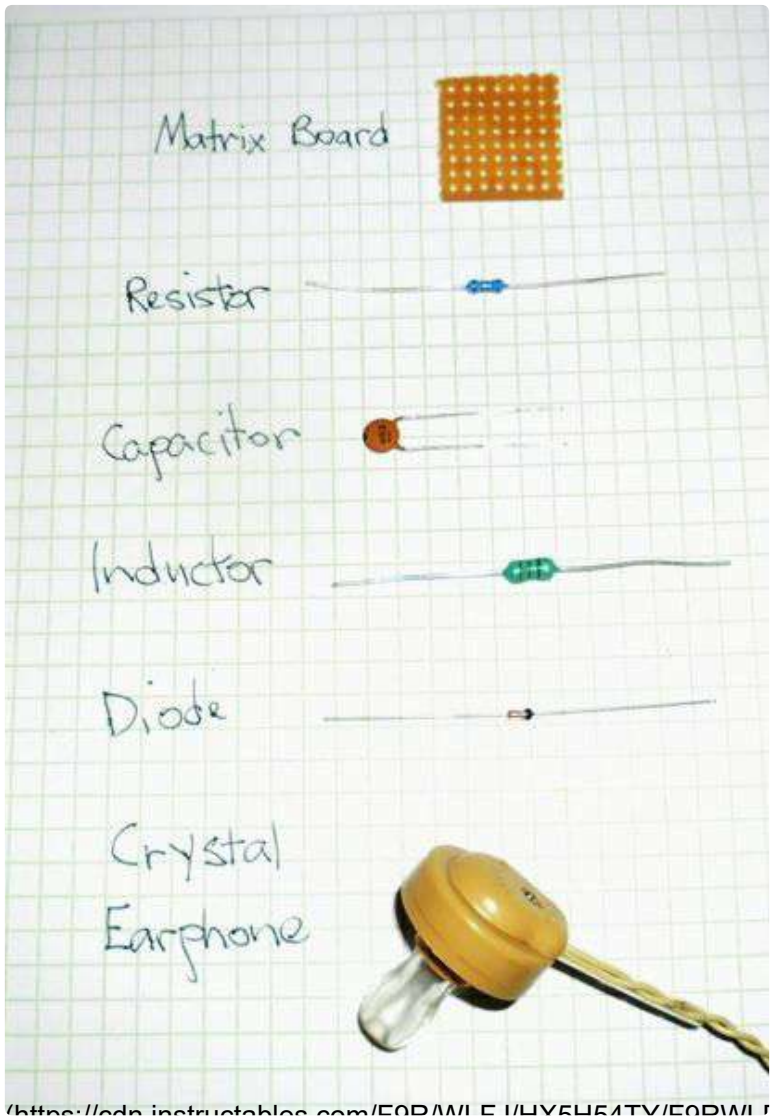

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You will need to acquire the following components from a local electronics shop or an online electronics business.

I am adding the catalogue numbers for Jaycar Electronics, so if you live in Australia or North America, you may be able to visit a Jaycar store and buy the parts over the counter, if not then you may be able to do an online mail order via Paypal:

Parts List

Resistor - 47k - yellow-purple-black-red and brown - RR 0612 (pkt of 8)

Capacitor - 68pF - ceramic x 2 - RC 5322 (pkt of 2) and a 100 or 120 pF value as well for experiments.

Inductor - 220 uH - red-red-brown silver - LF 1538 (resistive type)

Polyvaricon tuning capacitor - 220 pF - RV 5728 - with knob and mounting screws

Diode - BAT46 - ZR 1141 (You can also use a 1N34A Germanium Diode too if you have one at home)

Ceramic Earphone - AS 3305 *

A 25 meter roll of yellow hook up wire for the Antenna wire and a 3 meter length of wire for the Ground wire.

Please note that some Jaycar parts come in multiples of 2 or more per packet. And please note the following:

PLEASE NOTE: THIS PROJECT/KIT CONTAINS SMALL PARTS THAT MAY FORM A CHOKING HAZARD FOR SMALL CHILDREN OR PETS. NOT SUITABLE FOR CHILDREN UNDER FIVE (5) YEARS OLD.

*A normal crystal radio earphone is OK, but if you can't get one of these, or if the one you bought goes dead (as they sometimes do,) you can use a substitute, such as the Murata PKM44EW passive transducer (see picture above) which is available from an old Telstra TF200 touchphone, (the one on the left in the diagram above,) or an equivalent, such as the ARIO transducer, from an old Telstra T1000 pushbutton phone.

The ARIO unit is soldered to the phone's pc board so you'll need to be able to unsolder the three mounting pins underneath the board, or find someone in the neighbourhood who is able.

Take the back off the TF200 (if you've obtained one of these phones,) and you'll see a black disc shaped object 2" round by 1/2' thick - with a red and black wire. Unplug the wires from the circuit board, and unscrew any retaining screws and remove the transducer. Cut the mini plug off, carefully strip the insulation from the ends of the wires and extend them by about 18" with 2 thin lengths of hookup wire. These pietzo devices make good earphones for crystal sets and can be housed in an old pair of ear muffs.

Miscellaneous Materials:

A Tic Tac box (smaller size)

A piece of matrix board at least 7 holes long by 8 holes across. Cut the board to fit neatly inside the Tic Tac box.

A short length of 2 differently coloured wires 60 mm in length and 2 crocodile clips with red and black plastic covers

A length of antenna wire at least 25 metres long and a 3 metre length of a different colour for the Ground wire.

A metal rod or cold water pipe for the ground stake. Be careful which pipes you connect your Ground wire to.

You will need a small sharp object for punching holes in the Tic Tac box.

A small pair of wire cutters for cutting and stripping wires.

Add Tip Ask Question

Step 2: How a Crystal Radio Works

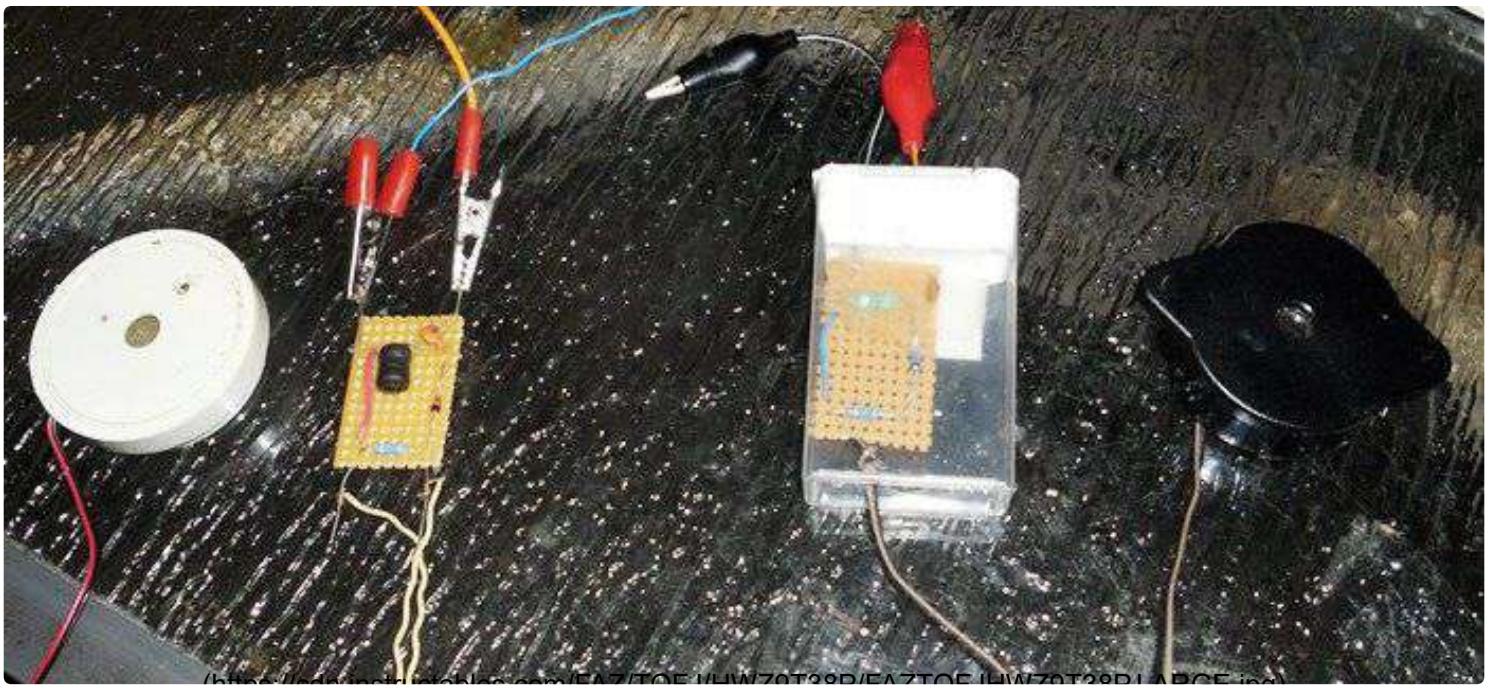

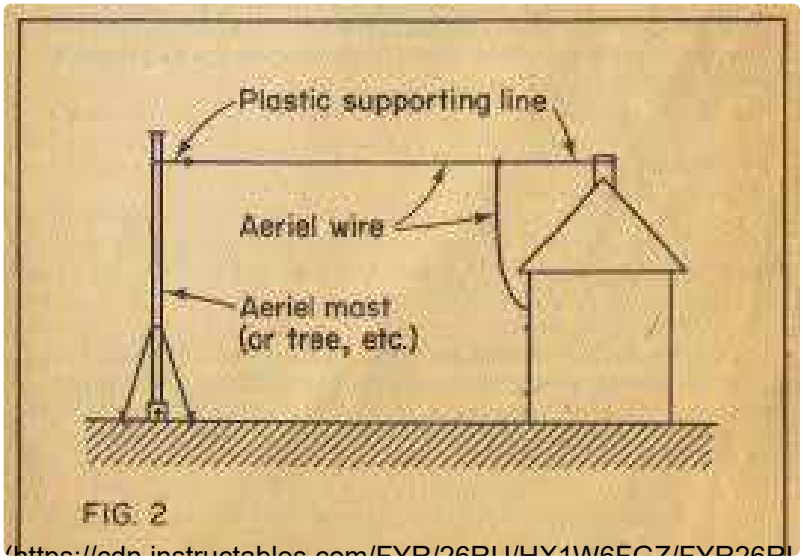

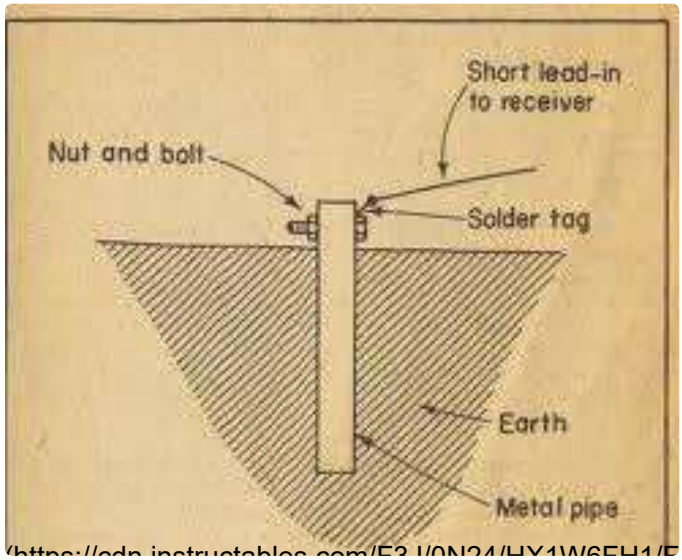

Radio signals consists of two parts - the 'carrier wave' which is the AM radio station's frequency of operation, and the 'program signal' which is mixed with the carrier wave for transmission.

Radio waves travel out from the AM transmitter tower through the atmosphere. We want to capture one specific frequency so we can listen to it, so we need the antenna/ground wire system to capture that signal. We also need a 'tuned circuit' that will filter out the desired AM signal, and discard the rest, so that all the other unwanted radio signals pass out through the ground wire to earth.

Two components in our circuit will perform that task for us. The capacitor C1, together with L1 inductor, form a basic 'series tuned' circuit. Their respective values will determine just which local AM radio station we will capture.

We also need a diode to 'detect' the voice and music, so we can hear them in our earphone, which transduces electrical signals into sound waves that we can hear.

In the photo above you can see a completed Tic Tac crystal radio. It is already inside the box. The other set is connected to the antenna/ground wire circuit, undergoing a 'soak test'. It is necessary to do this to ensure that the radio will work once inside the box!

The first diagram shows a typical antenna wire installation. Coming out of a window, the wire is anchored to the building and then over some distance (10 metres +) to a nearby tree or other building.

You must take great care not to erect antenna wires near to power or telephone cables, near your home!

The ground wire comes out the same window and is anchored to a metal pipe/water pipe or metal ground stake, embedded in soft, moist soil.

You must not connect ground wires to electrical mains wiring installations, including wall power outlets!

Another electrical hazard to consider is lightning strikes! Although it is very rare for anyone to be seriously injured or die from a lightning strike it is not impossible. So, if you hear a thunderstorm coming your way (you may hear the lightning 'crashes' in your earphone first,) then disconnect your antenna wire immediately, connect it to the ground wire and put it well up out of the way. Stay well clear of this temporary antenna/ground connection until the storm has completely passed away from your general area - miles away!

Add Tip Ask Question

Step 3: How to Build the Tic Tac Crystal Radio Set

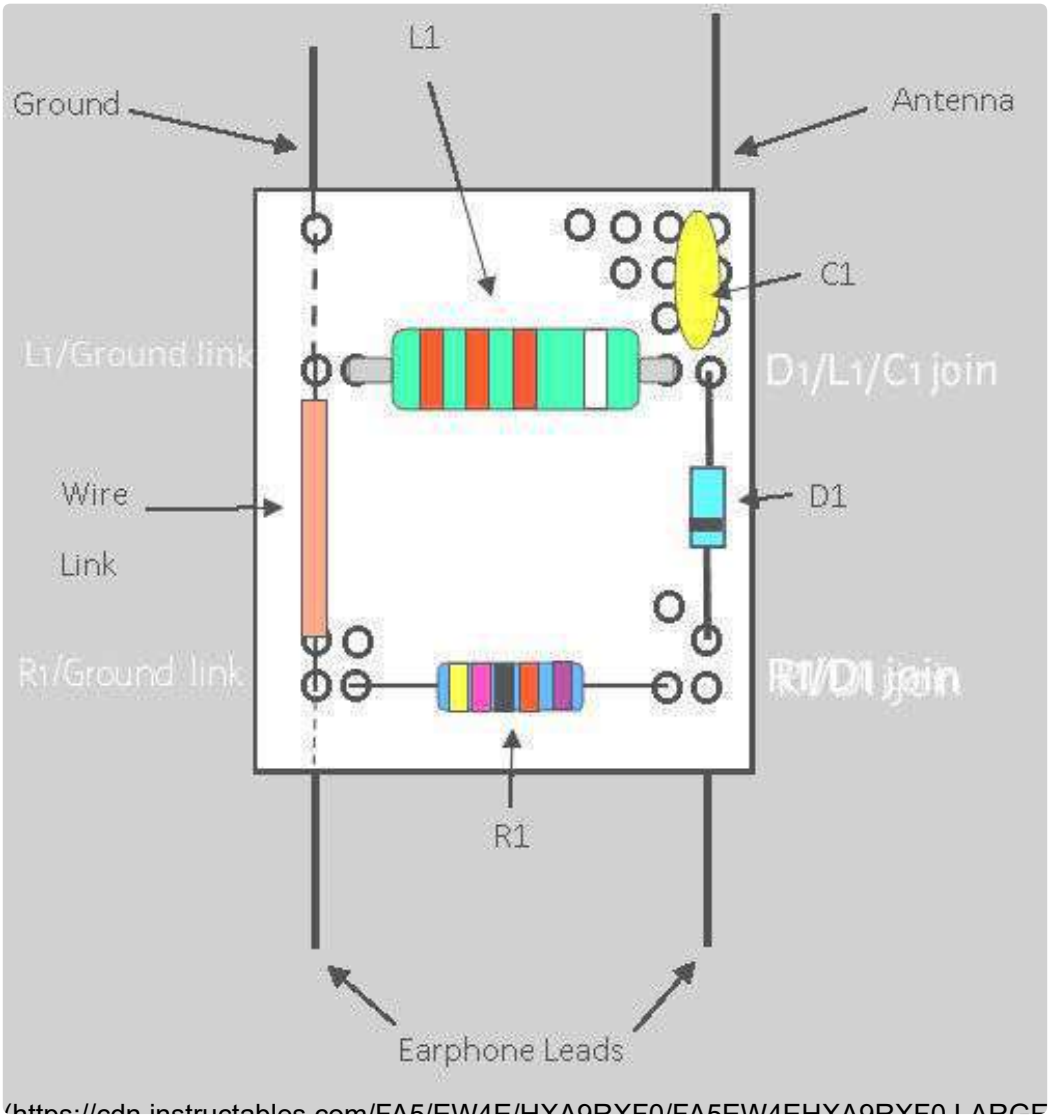

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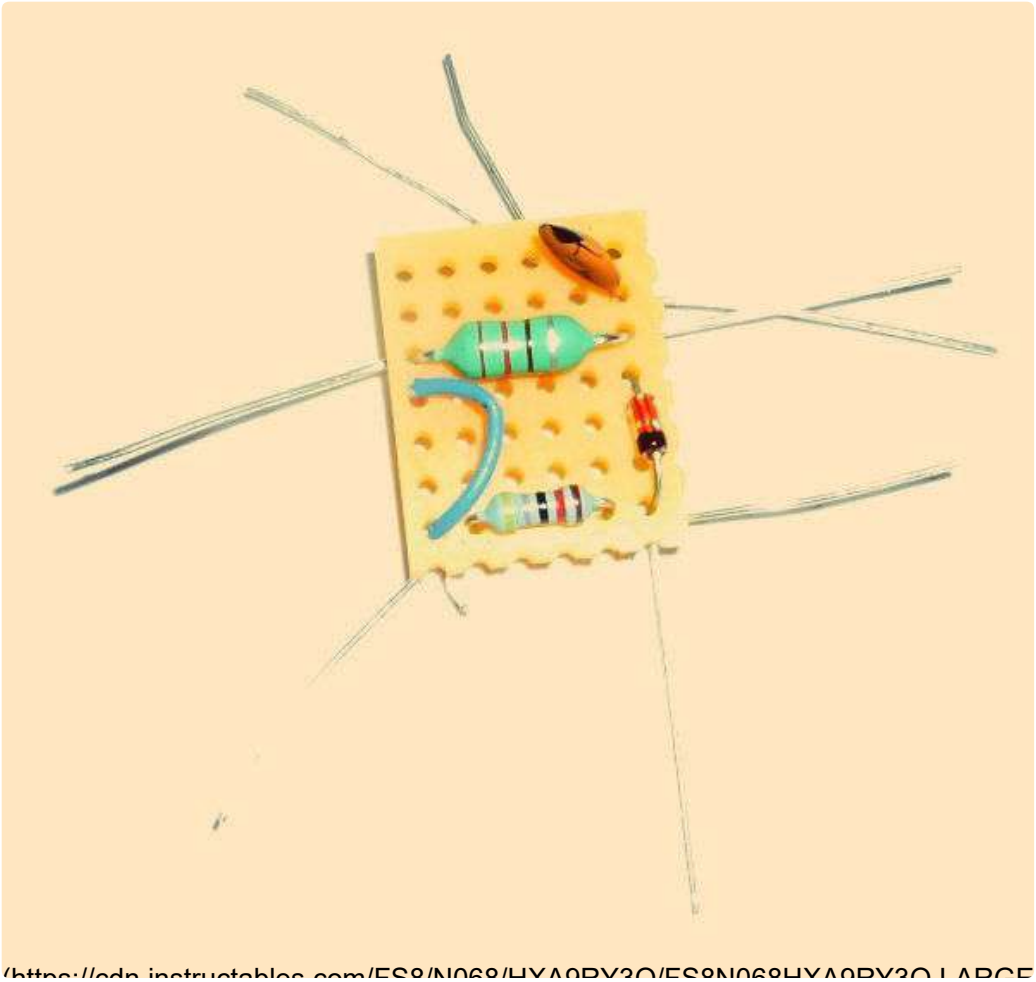

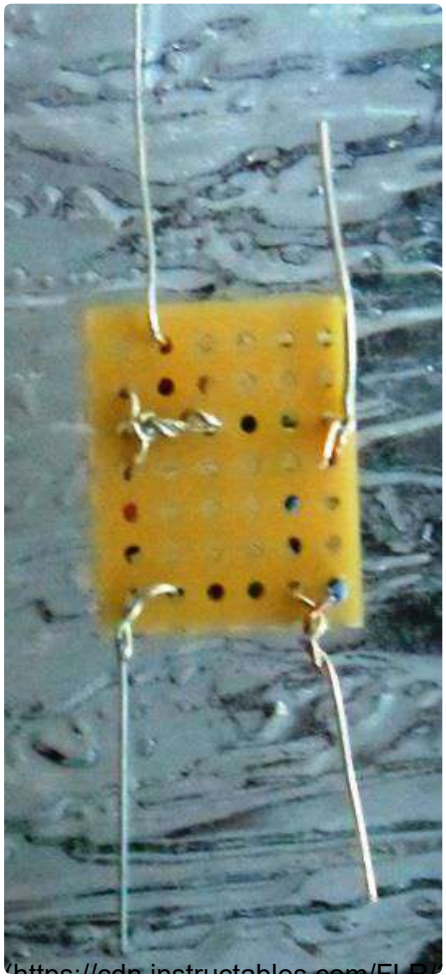

1. Take the components and lay them out on a clean surface.

2. Take the square of matrix board (this is also called 'perf board' because of all the holes or perforations in the material) and beginning with the 220uH (uH = micro-Henry) and place it as shown in the diagram.

3. Then take the diode, capacitor and resistor and place them in the places shown for them, making sure that the coloured band at one end of the diode joins with the resistor wire, as shown

4. Then take each junction where wires come together through their respective holes and gently twist them together, until they form a neat, tight bundle. Take your side cutters and cut off any excess length, taking care not to cut any one wire too short, so that it comes undone from the join.

.5. Take the link wire, strip 2 centimetres of insulation from each end of the wire and install that wire between the free ends of the inductor and resistor, and the matrix board construction is complete.

6. Then take the ceramic earphone, cut the plug off the end, and strip the 2 wire ends about 1.5 centimetres in length. Wrap each earphone wire around each end of the resistor component, underneath the matrix board.

7. Finally, strip the insulation off both ends of the 60mm long differently coloured wires, and attach them to the matrix board - one goes to the inductor/link wire junction and this will be the Ground connection wire. Attach the other one to the free end of capacitor C1 and this will be the antenna wire connection. Both connections are made underneath the matrix board. The Nic Nac Tic Tac Crystal Radio is now ready for testing.

Add Tip Ask Question

Step 4: Final Checks and Installation of Wires

24g NET
FRESHNESS IN 2 CALORIES
tic tac
Strawberry Fields

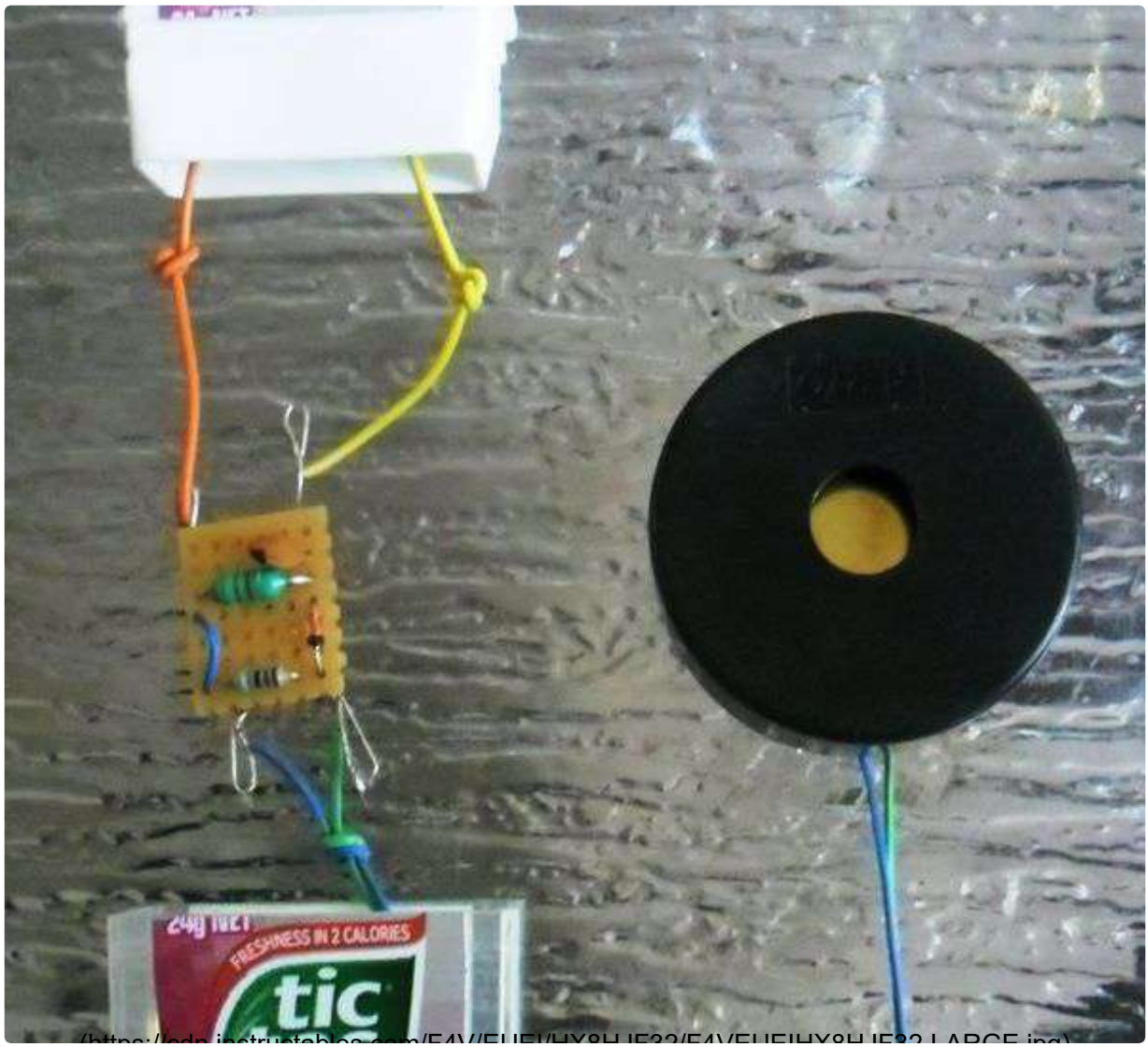

When you've finished constructing the matrix board circuit and have clipped all the excess component leads off, puncture three (3) holes in the Tic Tac box - 2 small holes on the top lid of the box, about an inch (24mm) apart, so that your antenna and ground wire leads can come through the box lid, and be connected to the matrix board at those 2 points.

Feed the wires through the holes and then tie small knots in each one, near the underside of the box lid, so that they won't pull back out if strained, and disconnect themselves from the matrix board.

Then make one larger hole in the centre of the bottom of the box (clear part) so that your earphone wires can be fed through to the connecting points on that part of the matrix board. Tie a larger knot in the earphone lead so as to prevent it from pulling

out of the box if it is strained. Strip the insulation off the earphone leads, and wrap them around the matrix board leads at those 2 points. You are now ready to test out the Nic Nac Tic Tac Crystal Radio.

Add Tip Ask Question

Step 5: Testing Out the Tic Tac Radio

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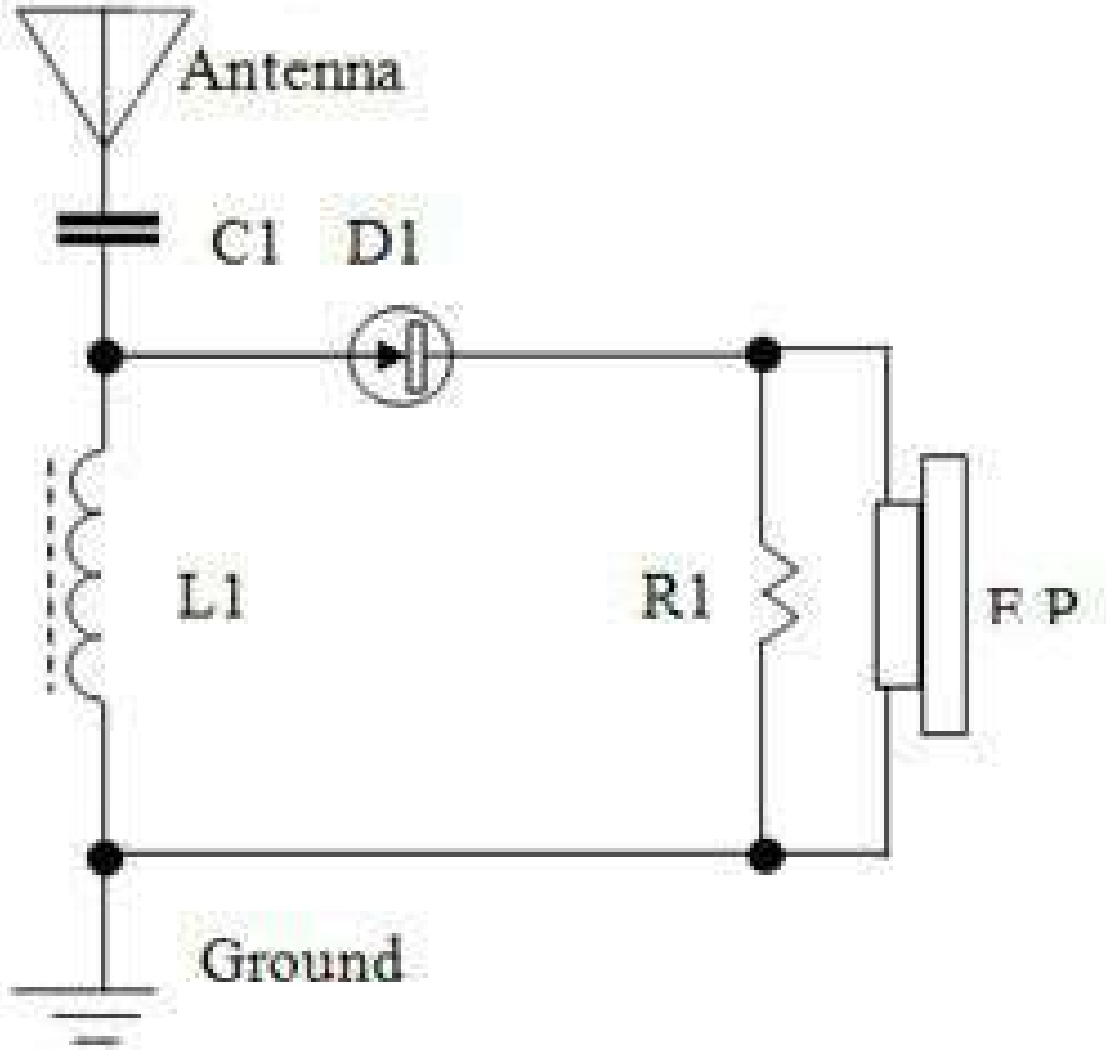

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Take your finished Tic Tac Radio (with the lid part gently pushed back inside the top of the box) and connect your Antenna and Ground wires to the lead outs from the box lid. Place the earphone in/over your ear,and listen carefully for a local AM radio station. This crystal radio is a simple one, and you may have to make one or two adjustments to the components, before you succeed in receiving one or more local AM radio stations, in your area.

If you can't hear anything in the earphone, don't panic. It might just be a simple wiring mistake, which is easily fixed. Go back over all of the steps, making sure that you have the right value components from the electronics store. Make sure that each component is in the right place on the matrix board, (don't confuse the L1 inductor with the R1 resistor - they look a lot like each other!) and that no component wires have come undone from the twisted joins you have just made. I'll

be writing up a troubleshooting step soon, so if you run into any problems, post your questions in the 'comments' section down at the bottom of the page, and I'll try and answer them as soon as possible.

Make sure that your antenna and ground wires aren't snagged on anything metal or anything dangerous!

If you have ANY doubts about the electrical safety of your antenna or ground wires, then consult a licensed electrical trades person, who will be able to advise you on electrical safety principles and procedures!

Always remember that electrical safety is your responsibility! If you don't think it is safe to proceed, then don't!

You will need at least 10 to 15 metres of antenna wire, strung between 2 insulating points (not connected to anything metallic, or that gets wet,) at least 2 to 3 metres in height - anything less than this minimum arrangement may mean that you cannot receive any signals at all.

Some places are regarded as 'radio dead spots', so you may need to try an open space, such as a park or a remote corner of a beach. If you do erect antenna and ground wires in public places, hang some streamers or balloons off of them, to alert people to their presence, otherwise people going past may become entangled with them - and get cranky with you!!!

As a final word for now, you'll be happy to know that the completed "Nic Nac Tic Tac Radio" shown in the picture above, picked up local AM radio station 1116 khz 4BC here in Brisbane, with a very clear signal and quite good volume. It works! So be safe kids, have some fun and look forward to more... mk484

Add Tip

Ask Question

Step 6: Nic Nac Extras

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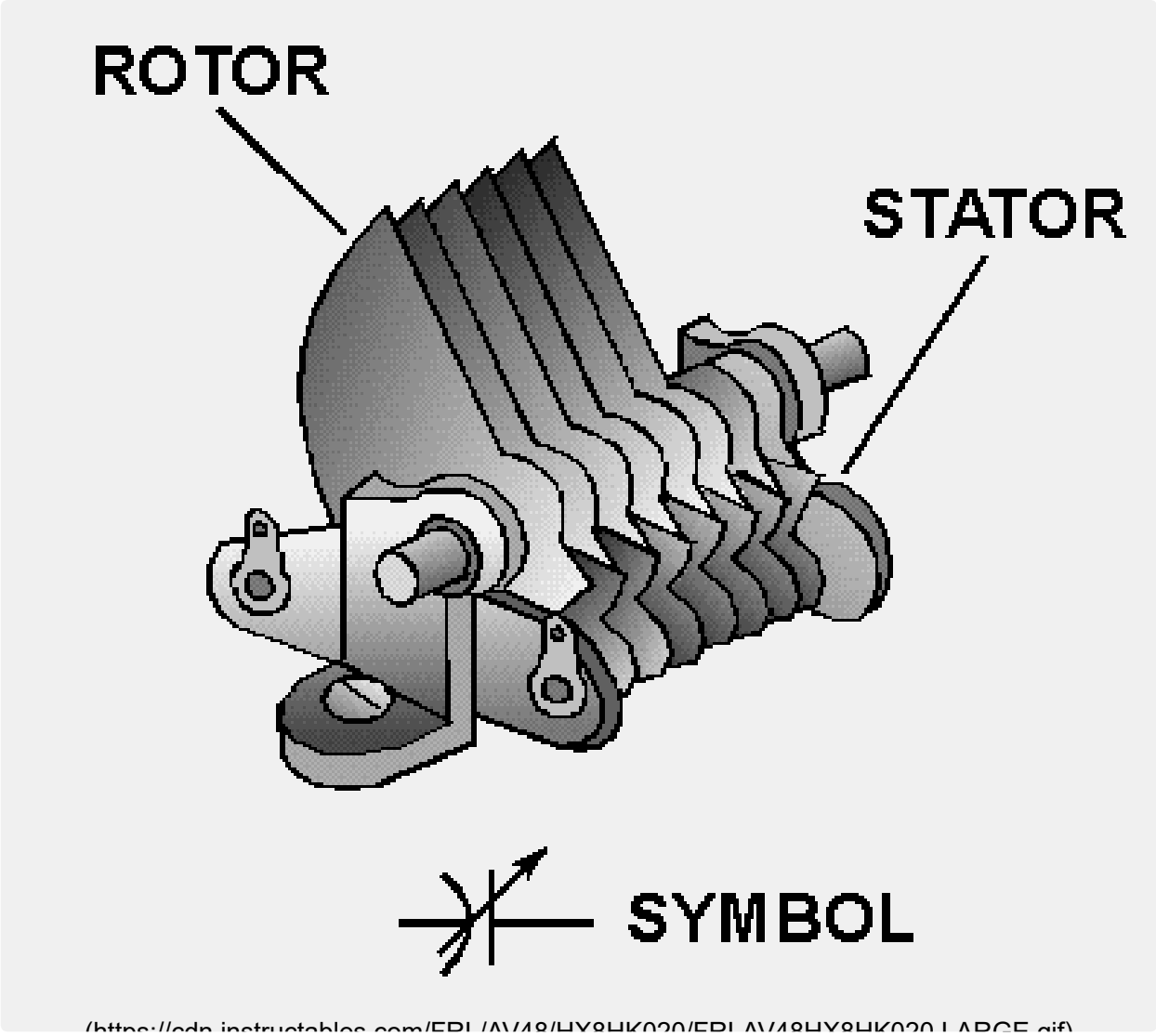

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If you've built your Tic Tac crystal set and found that you can't receive a local AM radio station yet - don't panic - help is in on the way. You have just built the simplest version of the Tic Tac crystal radio and you may need to add one more component part for it to work properly. This is called a 'polyvaricon' - a miniature tuning capacitor, which can vary the frequency that your radio will receive at. You can see a picture of one up above - the small white box with the black knob next to it. It has 3 connecting tags - the one in the middle ('G') goes to the moving plates and the shaft, while the 2 outer tags ('O' and 'A') go to 2 sets of fixed plates. the smaller set of plates has a value of 60pF - pF is short for 'picoFarad' - a unit of measurement for capacitance. The larger set of plates is valued at 160 pF so that the combined value of the polyvaricon is 220 pF - or 220 picoFarads.

The other picture shows you what happens inside a basic tuning capacitor. there are 2 sets of metal plates - one set is fixed and the other set moves on a rotating shaft, connected to the tuning knob of your radio set. Both sets of plates are mounted on an insulating frame so that they won't 'short out' by touch each other.

The fixed capacitor C1, was chosen to tune somewhere close to the middle of the AM radio band. This band of frequencies starts at 531 kilohertz (Khz) and goes as far as 1701 Khz here in Australia. So we need a combination of coil and capacitor which will tune across all of those frequencies. Our simple Tic Tac radio is known as a 'series tuned' set. If you look at the circuit diagram, you can see electronic symbols for all components in the radio set.If you start at the top with the antenna symbol, you can see the capacitor C1 underneath that, the inductor L1 underneath C1 and then finally, the ground symbol - all wired in series with each other.

The diode D1 detector, the resistor and the earphone plus the link wire, can be considered as one block - the "detector unit". The Antenna wire, ground wire, inductor/coil and capacitor/polyvaricon, can be also be considered as another block - the "tuned circuit". So joining both blocks together, we have the tuned circuit that tunes in only one frequency, passing all other unwanted signals out through the ground wire to earth. This one 'tuned frequency' passes through the diode detector, which strips away the 'carrier wave' and leaves only the 'program signal' (voice,

music etc,) behind, which is then fed via the resistor into the earphone. The earphone changes electrical impulses from the diode detector, into sound waves that we can hear. You need the R1 resistor to provide a pathway for the signals going through the diode, out to the ground wire connection. Without this resistor, the signals would sound very distorted and you couldn't hear the program signal very clearly.

Add Tip Ask Question

Step 7: Adding the Polyvaricon Tuning Capacitor

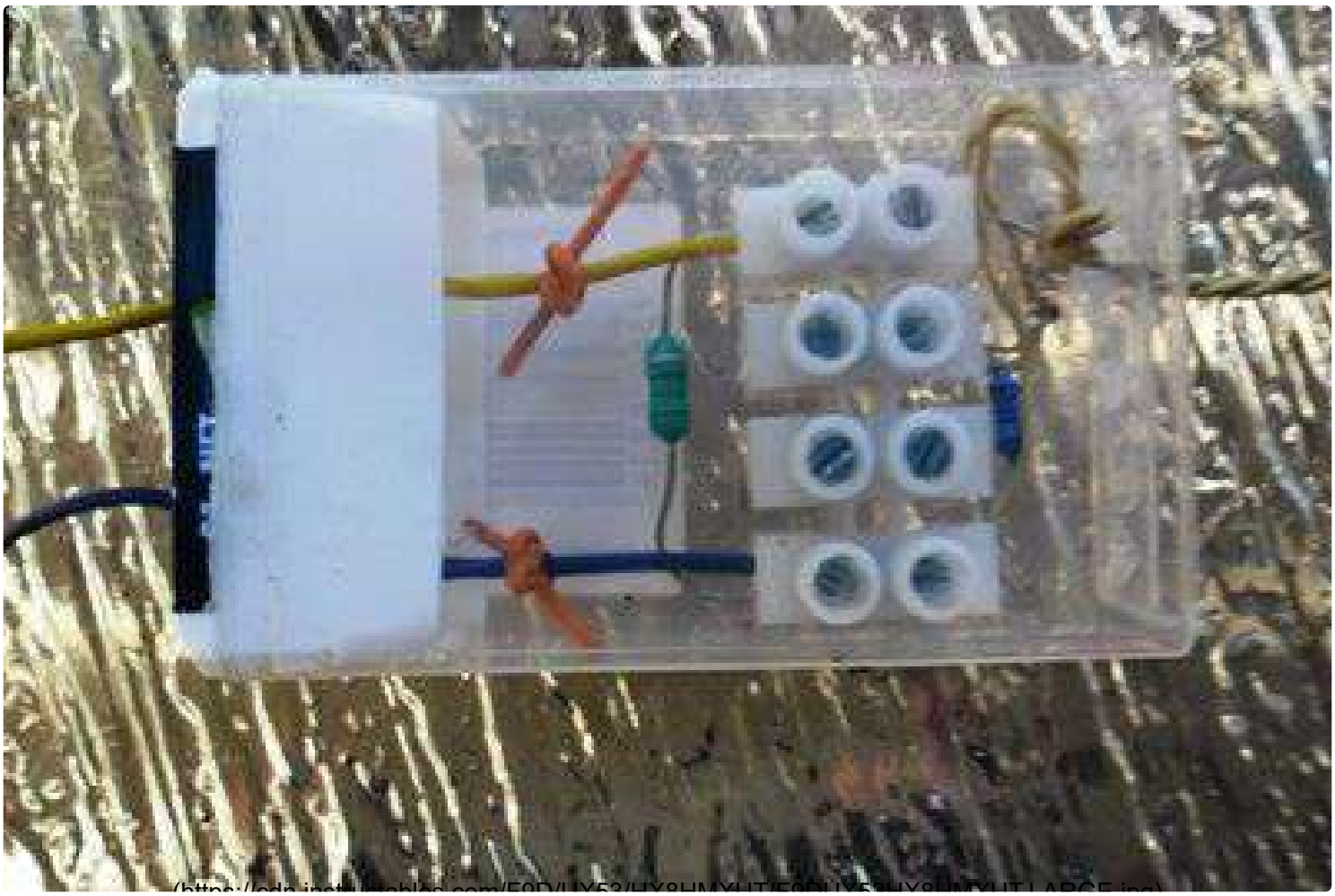

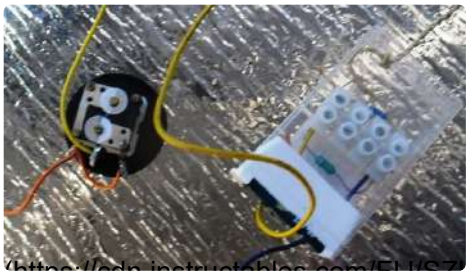

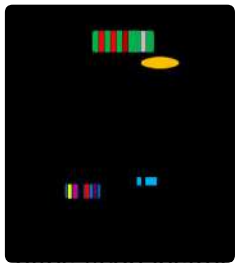

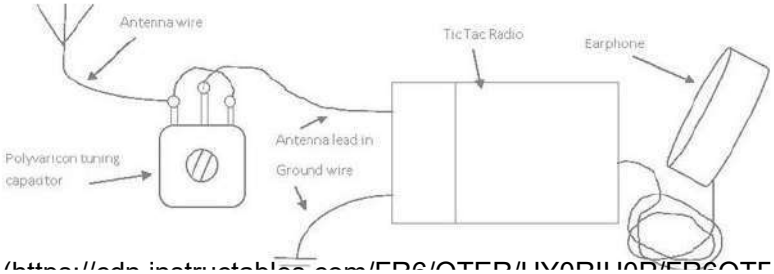

If you want to expand the tuning range of your Tic Tac Radio, than all you have to do is a simple modification (change) to the circuit of your radio set. You can see from the 2 pictures above, that there's an alternative way of building the crystal radio - you can use the matrix board method or you can use a 4 way screw terminal strip.

To use the screw terminal version, cut yourself a 4 way strip of terminals as shown in the diagram and pictures. Undo the screws right out as far as they will go without falling out of the strip. Connect the component leads and wires from the antenna/ground system as well as the earphone wires. Cut off any excess from component leads that you don't need. Wrap thin wires from the antenna/ground system and the earphones, around the thicker component leads before screwing the screws in tight.

Regardless of which method you have used, all we will now wire up the tuning capacitor between the actual Antenna wire and the junction (join) where the diode D1, the fixed capacitor C1 and one end of the inductor meet. Remove the capacitor from the matrix board, and connect the Antenna lead out wire straight to the join of the diode and inductor. Then take the polyvaricon and another piece of wire. Strip both ends of that wire and join the two outer tags (tagged 'O' and 'A' - the centre on is tagged 'G') and then connect you actual Antenna wire to one of the outer tags. Connect the antenna lead out wire, coming out of the box, to the 'G' (middle) tag of the tuning capacitor,so that the antenna wiring now looks like the picture up above.

If you're having problems following the pictures, then refer to the diagrams, which clearly shows all of the connections Make sure your ground wire is connected to the set, and then, listening with your earphone in/over your ear, slowly turn the

tuning cap's flat knob, until you hear one or more stations. Congratulations - you now have a "tuneable" Tic Tac crystal set! Happy listening! And don't forget to post in your results, questions, problems etc... mk484 :)

Add Tip Ask Question

Step 8: Tic Tac One Transistor Amplifier - Use Your Earbuds and Hear Great Sound...

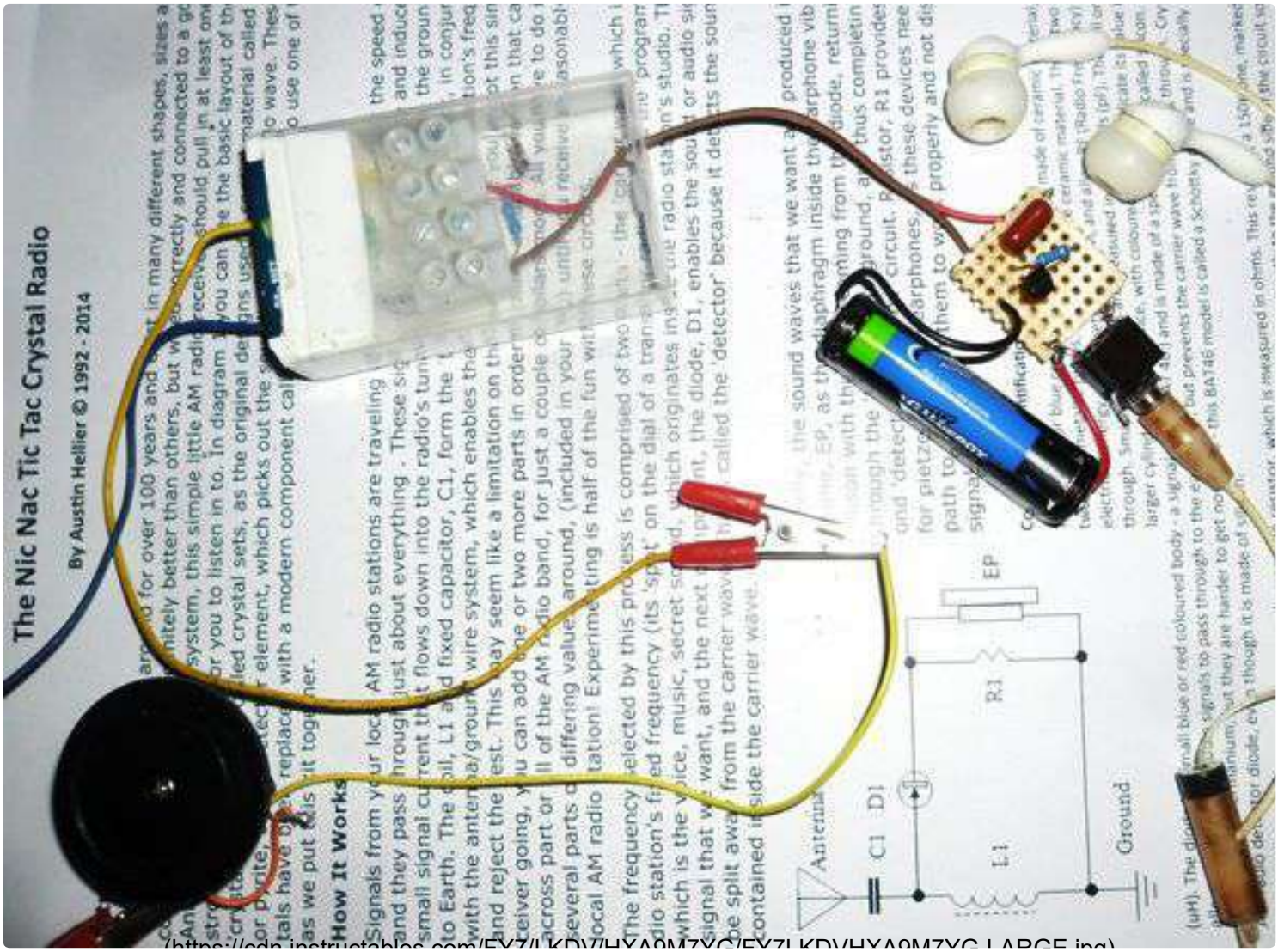

Hi there folks - this isn't really an extra 'Step' as such - it's a sneak preview at a picture of my upcoming Instructable for a one transistor amplifier, which will connect to the Tic Tac Radio - and give you some really good volume - in your Iphone

earbuds!

Yes, it's entirely possible nowadays, with modern circuit design, to fit a one transistor amp in such a small space (yes kiddies - it WILL fit inside the smaller Tic Tac box...) and at the same time, get that great sound that comes from those "inside your ear" type earbuds.

This circuit took me about a half hour to complete, uses only 3 electronic components, costing about $1.00, a stereo earphone jack and a 1.5 volt AAA battery and plastic holder costing about another $3 to $4, so you can build the amplifier for about $5 all up - don't forget to shop around and - mums and dads - cheap batteries will be OK for this project, and the battery can simply be replaced without soldering or undoing half a dozen screws....

I can hear my Tic Tac Radio with great volume and clarity - and so will you, so "stay tuned" (ha ha ha) to this series of Instructables, and you will hear great sound too...

mk484

Add Tip

Ask Question

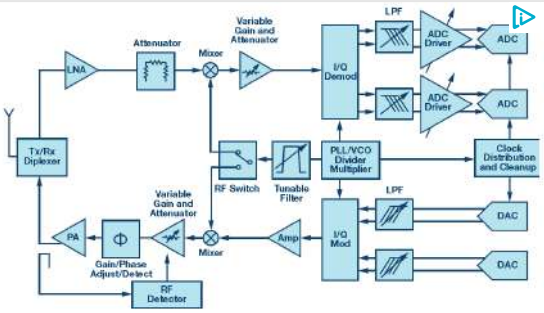

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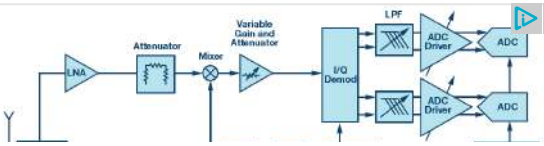

go to: Talking Electronics Website

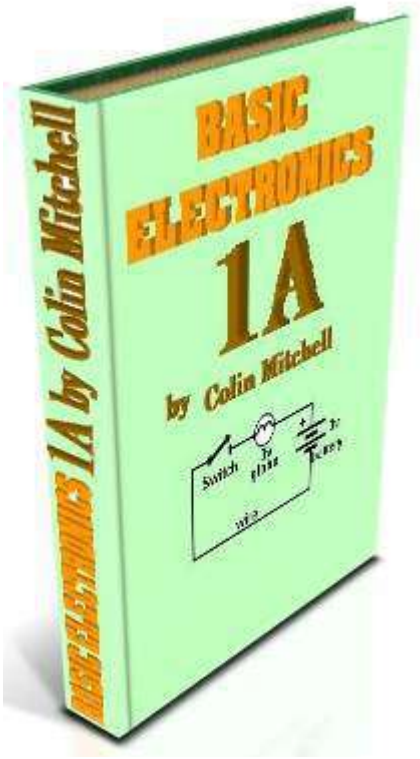

For any enquiries email Colin Mitchell

THE MULTIMETER

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The Diode - how the diode works
Circuit Symbols - EVERY Circuit Symbol
Soldering - videos
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Diode - measuring	Voltage - measuring

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TWO MULTIMETERS

There are basically two different types of MULTIMETER. ANALOGUE and DIGITAL

Analogue Multimeters have a NEEDLE or POINTER that moves across a scale.

Digital Multimeters have a numeric display of 3 or more digits. A Digital Multimeter with 3½ digits means the first digit shows only "1."

You really need both types to cover the number of tests needed for designing and repair-work. We will discuss how they work, how to use them and some of the differences between them.

The black (negative lead) ALWAYS stays in the

black hole and the red lead changes to the other red hole to measure 10 amps

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BUYING A MULTIMETER

There are many different types on the market.
The cost is determined by the number of ranges and also the extra features such as diode tester, buzzer (continuity), transistor tester, high DC current and others.
Since most multimeters are reliable and accurate, buy one with the greatest number of ranges at the lowest cost. The cheapest multimeters are on **eBay**.
This article explains the difference between an analogue meter and a digital meter.

Multimeters are sometimes called a "meter", a "VOM" (Volts-Ohms-Milliamps or Volt Ohm Meter) or "multi-tester" or even "a tester" - they are all the same.

One term used to describe a **DIGITAL MULTIMETER** is **3½ digits**.
This is the number of digits on the display. The first digit is usually made from two pixels and can only produce "1." This is called a half-digit. The other digits are full digits. The cheapest digital multimeters have 3½ digits. This will produce a reading of 1999 and the decimal point can produce values from 1.999 to 19.99 to 199.9 to 1999.
Another term is **DISPLAY COUNTS**. This is connected with the accuracy of the display, but since digital meters are accurate to 1% or less and we are using resistors with an accuracy of 5%, even a $10.00 digital meter will be perfect.

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USING A MULTIMETER

Analogue and **digital** multimeters have either a rotary selector switch or push buttons to select the appropriate function and range. Some Digital Multimeters (DMMs) are auto ranging; they automatically select the correct range of voltage, resistance, or current when doing a test. However you need to select the function.

Before making any measurement you need to know what you are checking. If you are measuring voltage, select the AC range (10v, 50v, 250v, or 1000v) or DC range (0.5v, 2.5v, 10v, 50v, 250v, or 1000v). If you are measuring resistance, select the Ohms range (x1, x10, x100, x1k, x10k). If you are measuring current, select the appropriate current range DCmA 0.5mA, 50mA, 500mA, 10A. Every multimeter is different however the photo below shows a low cost Analogue multimeter with the basic ranges.

An ANALOGUE MULTIMETER

The most important point to remember is this:
You must select a voltage or current range that is bigger or HIGHER than the maximum expected value, so the needle does not swing across the scale and hit the "end stop."
If you are using a DMM (Digital Multi Meter), the meter will indicate if the voltage or current is higher than the selected scale, by showing "OL" - this means "Overload."
If you are measuring resistance such as 1M on the x10 range the "OL" means "Open Loop" and you will need to change the range. Some meters show "1' on the display when the measurement is higher than the display will indicate and some flash a set of digits to show over-voltage or over-current. A "-1" indicates the leads should be reversed for a "positive reading."
If it is an AUTO RANGING meter, it will automatically produce a reading, otherwise the selector switch must be changed to another range.

A typical DIGITAL Multimeter

The Common (negative) lead ALWAYS fits into the "COM" socket. The red lead fits into the red socket for Voltage and Resistance. Place the red lead (red banana plug) into "A" (for HIGH CURRENT "Amps") or mA,uA for LOW CURRENT.

The black "test lead" plugs into the socket marked "-" "Common", or "Com," and the red "test lead" plugs into the meter socket marked "+" or "V-W-mA." The third banana socket measures HIGH CURRENT and the positive (red lead) plugs into this. You DO NOT move the negative "-" lead at any time.
The following two photos show the test leads fitted to a digital meter. The probes and plugs have "guards" surrounding the probe tips and also the plugs so you can measure high voltages without getting near the voltage-source.

Analogue meters have an "Ohms Adjustment" to allow for the change in voltage of the battery inside the meter (as it gets old).

"Ohms Adjust" is also called "ZERO SET"

The sensitivity of this meter is 20,000ohms/volt on the DC ranges and 5k/v on the AC ranges

Before taking a resistance reading (each time, for any of the Ohms scales) you need to "ZERO SET" the scale, by touching the two probes together and adjust the pot until the needle reads "0" (swings FULL SCALE). If the pointer does not reach full scale, the batteries need replacing. Digital multimeters do not need "zero adjustment."

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ANALOGUE Vs DIGITAL

You cannot say one meter is better than the other because BOTH have advantages and disadvantages.
An analogue multimeter is the "old style" and it puts a load on a circuit and this may change the reading to give an incorrect readout, but it has the advantage of the needle moving across the scale fairly quickly so you can sometimes see if the voltage is fluctuating.
It also gives a more-accurate result in some high frequency circuits as it does not pick up stray fields and produce a false reading.
Digital meters put almost no load on a circuit and produce accurate readings from both low-impedance and high-impedance circuits.
Digital meters can display very low resistances.
You must remember to turn a Digital meter OFF to prevent the battery going flat.

If you are testing a circuit containing a high-frequency oscillator, use BOTH an ANALOGUE and DIGITAL meter to check the reading. Sometimes the leads of a Digital multimeter will pick up signals and create a false reading.
Sometimes you will get a voltage reading with a Digital multimeter due to a high resistance leak and a zero reading with an Analogue meter. This is why you need **BOTH** meters.

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MEASURING VOLTAGE

Most of the readings taken with a multimeter will be VOLTAGE readings.
Before taking a reading, you should select the highest range and if the needle does not move up scale (to the right), you can select another range.
Always switch to the highest range before probing a circuit and keep your fingers away from the component being tested.
If the meter is Digital, select the highest range or use the auto-ranging feature, by selecting "V." The meter will automatically produce a result, even if the voltage is

AC or DC.
If the meter is not auto-ranging, you will have to select V⎓ if the voltage is from a DC source or V~ if the voltage is from an AC source. DC means Direct Current (but this does not mean you select the CURRENT range - you are taking a voltage reading that is not rising and falling. That's why we say it is **DC** and do not say the words "direct current"). The voltage is coming from a battery or supply where it is steady and not "rising and falling."
You can measure the voltage at different points in a circuit by connecting the black probe to chassis. This is the 0v reference and is commonly called "Chassis" or "Earth" or "Ground" or "0v."
The red lead is called the "measuring lead" or "measuring probe" and it can measure voltages at any point in a circuit. Sometimes there are "test points" on a circuit and these are wires or loops designed to hold the tip of the red probe (or a red probe fitted with a mini clip).
You can also measure voltages ACROSS A COMPONENT. In other words, the reading is taken in PARALLEL with the component. It may be the voltage across a transistor, resistor, capacitor, diode or coil. In most cases this voltage will be less than the supply voltage.
If you are measuring the voltage in a circuit that has a HIGH IMPEDANCE, the reading will be inaccurate, up to 90% !!!, if you use a cheap analogue meter.

Here's a simple case.

The circuit below consists of two 1M resistors in series. The voltage at the mid point will be 5v when nothing is connected to the mid point. But if we use a cheap analogue multimeter set to 10v, the resistance of the meter will be about 100k, if the meter has a sensitivity of 10k/v and the reading will be incorrect.
Here how it works:
Every meter has a sensitivity. The sensitivity of the meter is the sensitivity of the movement and is the amount of current required to deflect the needle FULL SCALE. This current is very small, normally 1/10th of a milliamp and corresponds to a sensitivity of 10k/volt (or 1/30th mA, for a sensitivity of 30k/v).
If an analogue meter is set to 10v, the internal resistance of the meter will be 100k for a 10k/v movement.
If this multimeter is used to test the following circuit, the reading will be inaccurate.
The reading should be 5v as show in diagram **A**.
But the analogue multimeter has an internal resistance of 100k and it creates a circuit shown in **C**.
The top 1M and 100k from the meter create a combined PARALLEL resistance of 90k. This forms a series circuit with the lower 1M and the meter will read less than 1v
If we measure the voltage across the lower 1M, the 100k meter will form a value of resistance with the lower 1M and it will read less than 1v
If the multimeter is 30k/v, the readings will be 2v. See how easy it is to get a totally inaccurate reading.

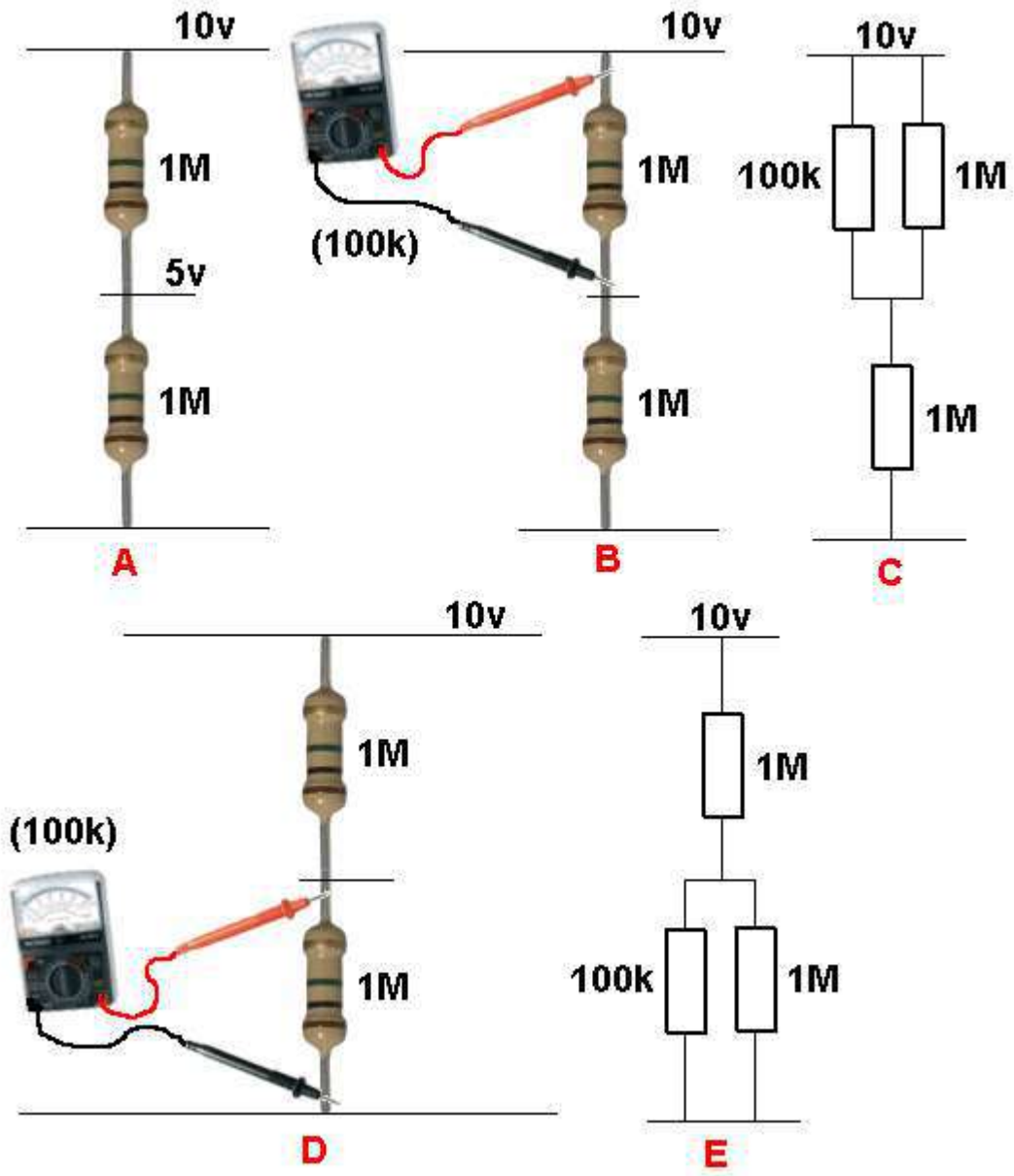

If the reading is taken with a Digital Meter, it will be more accurate as a DMM does not take any current from the circuit (to activate the meter). In other words it has a very HIGH input impedance. Most Digital Multimeters have a fixed input resistance (impedance) of 10M - no matter what scale is selected. That's the reason for choosing a DMM for high impedance circuits. It also gives a reading that is accurate to about 1%.

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MEASURING VOLTAGES in a CIRCUIT

You can take many voltage-measurements in a circuit. You can measure "across" a component, or between any point in a circuit and either the positive rail or earth rail (0v rail). In the following circuit, the 5 most important voltage-measurements are shown. Voltage "A" is across the electret microphone. It should be between 20mV and 500mV. Voltage "B" should be about 0.6v. Voltage "C" should be about half-rail voltage. This allows the transistor to amplify both the positive and negative parts of the waveform. Voltage "D" should be about 1-3v. Voltage "E" should be the battery

voltage of 12v.

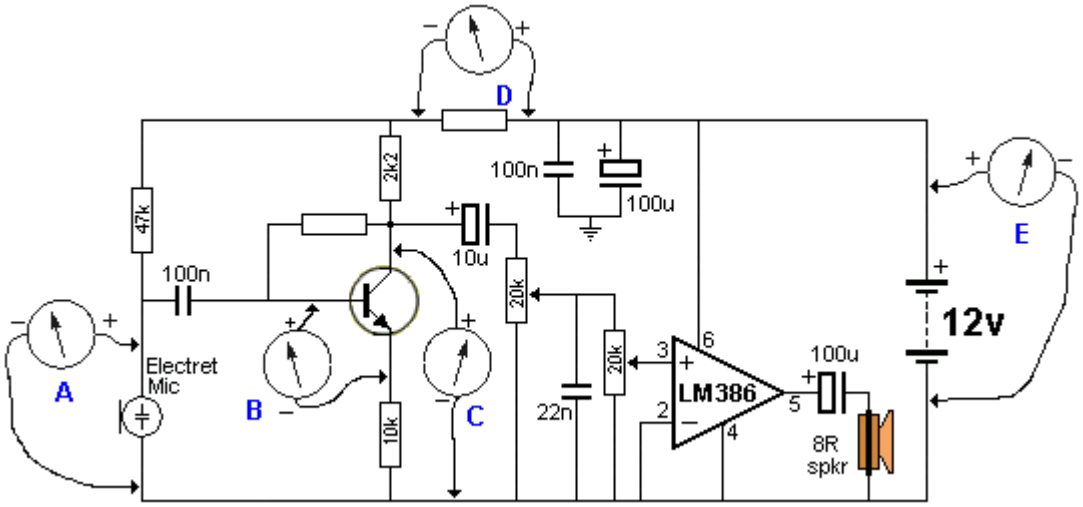

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MEASURING CURRENT

You will rarely need to take current measurements, however most multimeters have DC current ranges such as 0.5mA, 50mA, 500mA and 10Amp (via the extra banana socket) and some meters have AC current ranges. Measuring the current of a circuit will tell you a lot of things. If you know the normal current, a high or low current can let you know if the circuit is overloaded or not fully operational.

Current is always measured when the circuit is working (i.e: with power applied).
It is measured IN SERIES with the circuit or component under test.
The easiest way to measure current is to remove the fuse and take a reading across the fuse-holder. Or remove one lead of the battery or turn the project off, and measure across the switch.
If this is not possible, you will need to remove one end of a component and measure with the two probes in the "opening."
Resistors are the easiest things to desolder, but you may have to cut a track in some circuits. You have to get an "opening" so that a current reading can be taken.
The following diagrams show how to connect the probes to take a CURRENT reading.
Do not measure the current ACROSS a component as this will create a "short-circuit."
The component is designed to drop a certain voltage and when you place the probes across this component, you are effectively adding a "link" or "jumper" and the voltage at the left-side of the component will appear on the right-side. This voltage may be too high for the circuit being supplied and the result will be damage.

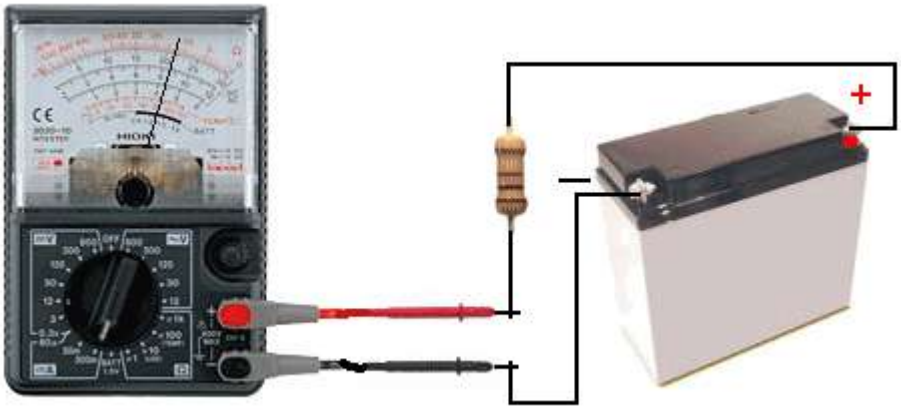

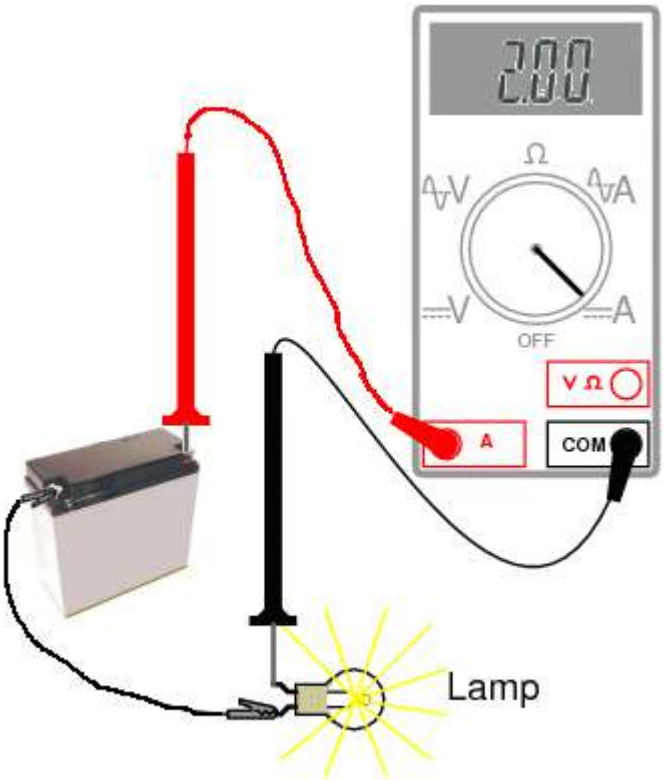

Measuring the current of a globe

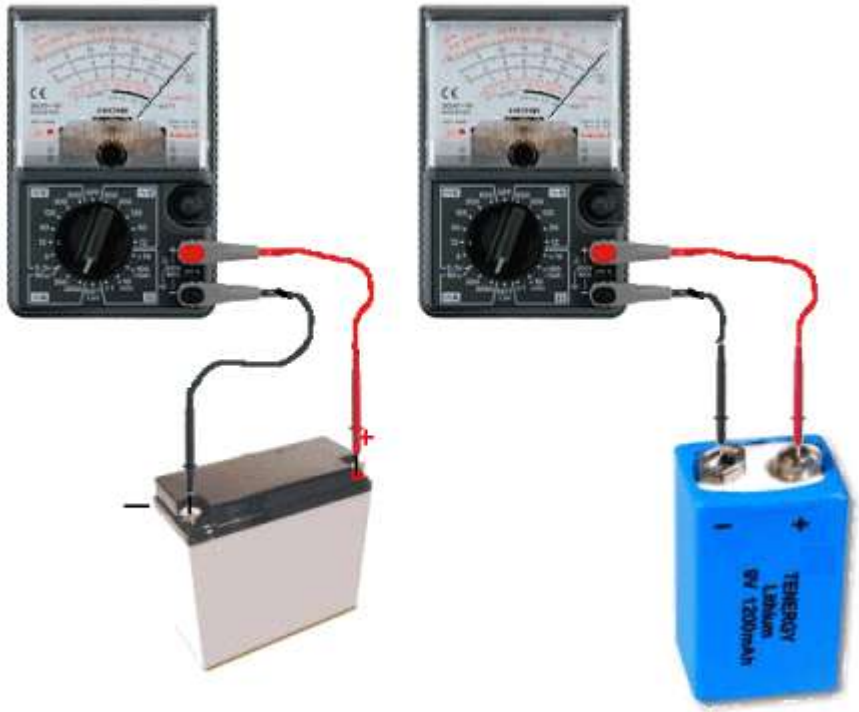

Do NOT measure the CURRENT of a battery
(by placing the meter directly across the terminals)
A battery will deliver a very HIGH current
and damage the meter

Do not measure the "current a battery will deliver" by placing the probes across the terminals. It will deliver a very high current and damage the meter instantly. There are special battery testing instruments for this purpose.

When measuring across an "opening" or "cut," place the red probe on the wire that supplies the voltage (and current) and the black probe on the other wire. This will produce a "POSITIVE" reading.
A positive reading is an UPSCALE READING and the pointer will move across the scale - to the right. A "NEGATIVE READING" will make the pointer hit the "STOP" at the left of the scale and you will not get a reading. If you are using a Digital Meter, a negative sign "-" will appear on the screen to indicate the probes are around the wrong way. No damage will be caused. It just indicates the probes are connected incorrectly.
If you want an accurate CURRENT MEASUREMENT, use a digital meter.

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MEASURING RESISTANCE

Turn a circuit off before measuring resistance.
If any voltage is present, the value of resistance will be incorrect.
In most cases you cannot measure a component while it is in-circuit. This is because the meter is actually measuring a voltage across a component and calling it a "resistance." The voltage comes from the battery inside the meter. If any other voltage is present, the meter will produce a false reading.
If you are measuring the resistance of a component while still "in circuit," (with the power off) the reading will be lower than the true reading.

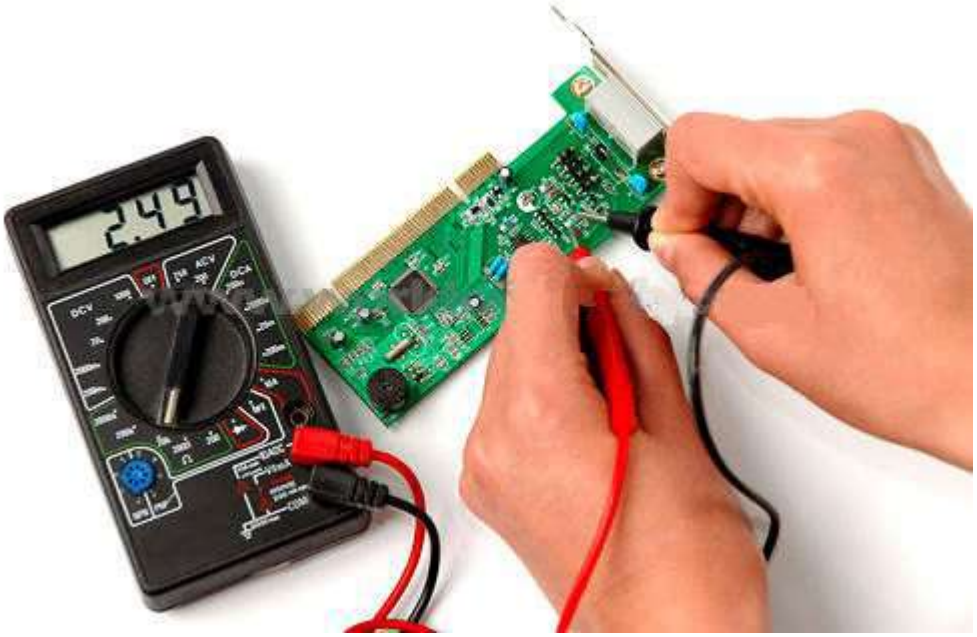

Measuring resistance

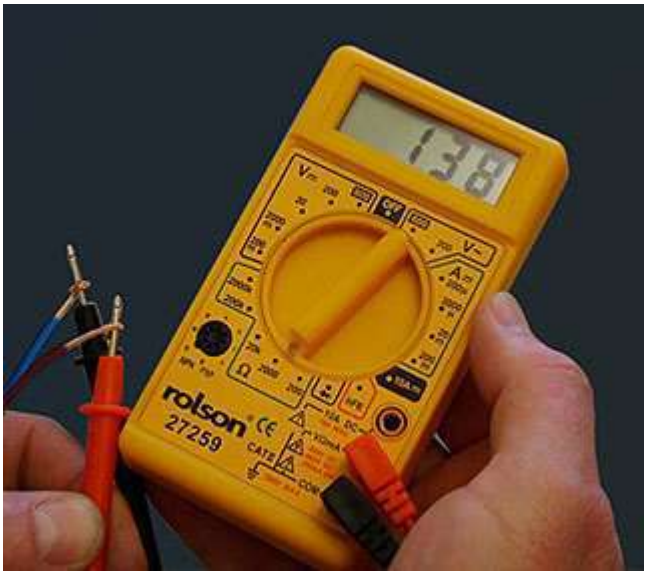

Measuring resistance of a heater
(via the leads)

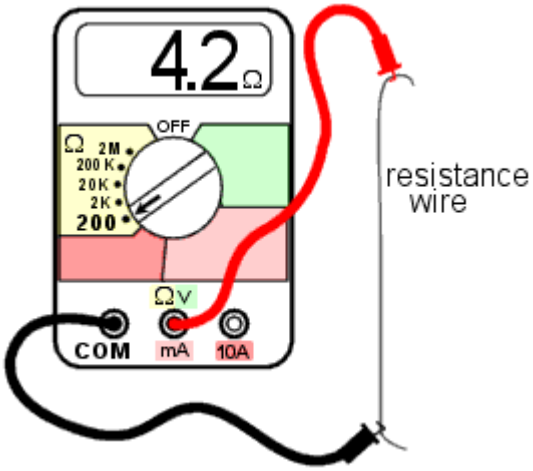

Measuring the resistance of a piece of resistance-wire

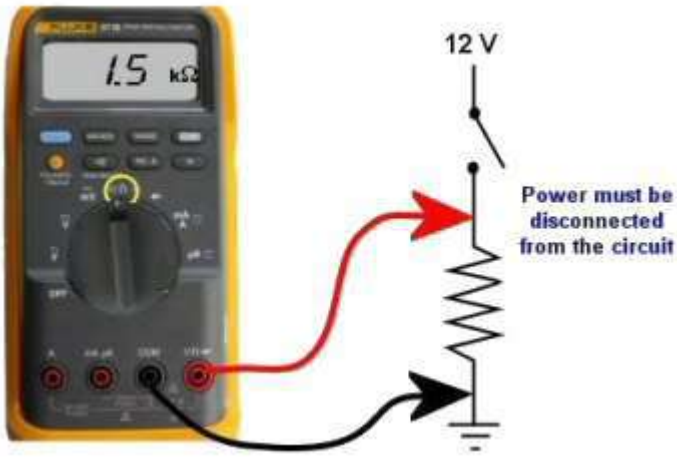

Measuring the resistance of a resistor

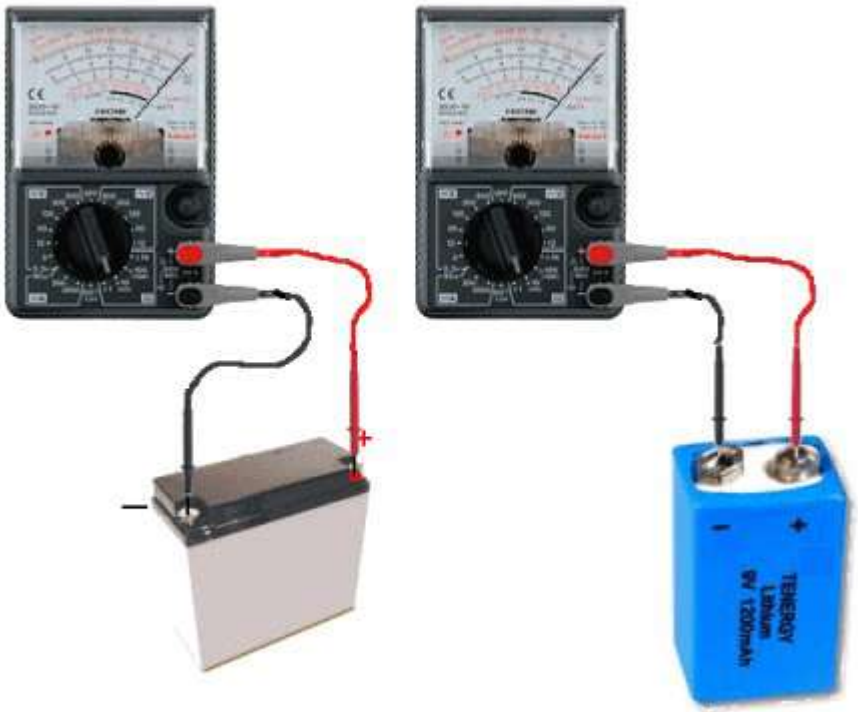

Do not measure the "Resistance of a Battery"

1. Do not measure the "resistance of a battery." The resistance of a battery (called the Internal impedance) is not measured as shown in the diagrams above. It is measured by creating a current-flow and measuring the voltage across the battery. Placing a multimeter set to **resistance** (across a battery) will destroy the meter.
2. Do not try to measure the resistance of any voltage or any "supply."

Resistance is measured in OHMs.
The resistance of a 1cm x 1cm bar, one metre long is 1 ohm.
If the bar is thinner, the resistance is higher. If the bar is longer, the resistance is higher.
If the material of the bar is changed, the resistance is higher.
When carbon is mixed with other elements, its resistance increases and this knowledge is used to make RESISTORS.
Resistors have RESISTANCE and the main purpose of a resistor is to reduce the CURRENT FLOW.
It's a bit like standing on a hose. The flow reduces.
When current flow is reduced, the output voltage is also reduced and that why the water does not spray up so high. Resistors are simple devices but they produce many different effects in a circuit.
A resistor of nearly pure carbon may be 1 ohm, but when non-conducting "impurities" are added, the same-size resistor may be 100 ohms, 1,000 ohms or 1 million ohms.
Circuits use values of less than 1 ohm to more than 22 million ohms.

Resistors are identified on a circuit with numbers and letters to show the exact value of resistance - such as 1k 2k2 4M7

The letter Ω (omega - a Greek symbol) is used to identify (or express) (or represent) the word "Ohm."
But this symbol is not available on some word-processors, so the letter "R" is used. The letter "E" is also sometimes used and both mean "Ohms."
A one-ohm resistor is written "1R" or "1E." It can also be written "1R0" or "1E0."
A resistor of one-tenth of an ohm is written "0R1" or "0E1." The letter takes the place of the decimal point.
10 ohms = 10R
100 ohms = 100R

1,000 ohms = 1k (k= kilo = one thousand)
10,000 ohms = 10k
100,000 ohms = 100k
1,000,000 ohms = 1M (M = MEG = one million)

The size of a resistor has nothing to do with its resistance. The size determines the wattage of the resistor - how much heat it can dissipate without getting too hot.
Every resistor is identified by colour bands on the body, but when the resistor is a surface-mount device, numbers are used and sometimes letters.
You MUST learn the colour code for resistors and the following table shows all the colours for the most common resistors from 1/10th of an ohm to 22 Meg ohms for resistors with 5% and 10% tolerance.

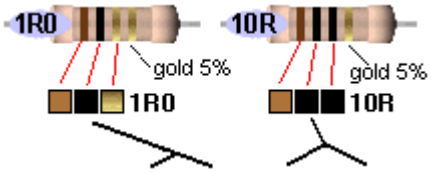

If 3rd band is gold, Divide by 10
If 3rd band is silver, Divide by 100
(to get 0.22ohms etc)

ROW	SILVER	GOLD	BLACK	BROWN	RED	ORANGE	YELLOW	GREEN
1-	R10	1R0	10R	100R	1K0	10K	100K	1M0
2-	R11	1R1	11R	110R	1K1	11K	110K	1M1
3-	R12	1R2	12R	120R	1K2	12K	120K	1M2
4-	R13	1R3	13R	130R	1K3	13K	130K	1M3
5-	R15	1R5	15R	150R	1K5	15K	150K	1M5
6-	R16	1R6	16R	160R	1K6	16K	160K	1M6
7-	R18	1R8	18R	180R	1K8	18K	180K	1M8
8-	R20	2R0	20R	200R	2K0	20K	200K	2M0
9-	R22	2R2	22R	220R	2K2	22K	220K	2M2
10-	R24	2R4	24R	240R	2K4	24K	240K	2M4
11-	R27	2R7	27R	270R	2K7	27K	270K	2M7
12-	R30	3R0	30R	300R	3K0	30K	300K	3M0
13-	R33	3R3	33R	330R	3K3	33K	330K	3M3
14-	R36	3R6	36R	360R	3K6	36K	360K	3M6
15-	R39	3R9	39R	390R	3K9	39K	390K	3M9
16-	R43	4R3	43R	430R	4K3	43K	430K	4M3
17-	R47	4R7	47R	470R	4K7	47K	470K	4M7
18-	R51	5R1	51R	510R	5K1	51K	510K	5M1
19-	R56	5R6	56R	560R	5K6	56K	560K	5M6
20-	R62	6R2	62R	620R	6K2	62K	620K	6M2
21-	R68	6R8	68R	680R	6K8	68K	680K	6M8
22-	R75	7R5	75R	750R	7K5	75K	750K	7M5
23-	R82	8R2	82R	820R	8K2	82K	820K	8M2
24-	R91	9R1	91R	910R	9K1	91K	910K	9M1
								10M (BLUE)

COLOR CODES FOR THE WHOLE E12/E24 RANGE OF RESISTORS
The twelve odd rows - 1, 3, 5... - represent values available in the E12 range only, plus 10M

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MAKE YOUR OWN RESISTOR

Make your own variable resistor that changes resistance according to the pressure.
Use a piece of conductive foam used to package Integrated Circuits. You can ask at an electronics shop.
Use two coins or pieces of printed circuit board or aluminium foil for the top and bottom conductors.
You can solder wires to the PC board or fold the aluminium foil over a few times to hold the wires.
The resistance of the foam will reduce as you press on the "cell."
The actual resistance-values will depend on the size of the foam, the thickness and

pressure.
This cell is a very simple cell called a **LOAD CELL**.

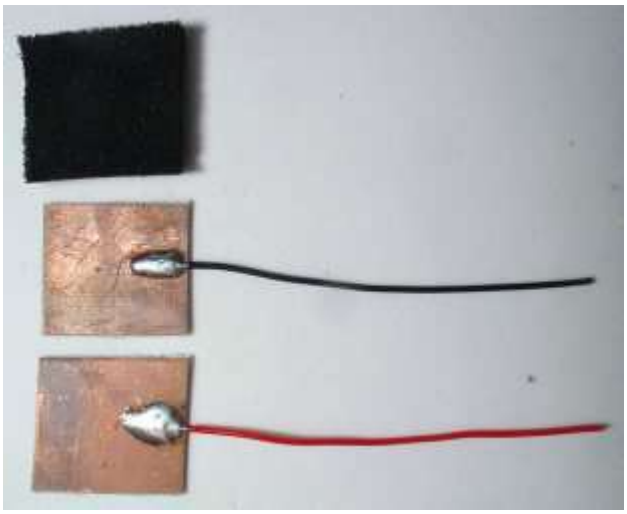
The top and bottom "plates"

The foam is placed between the plates.

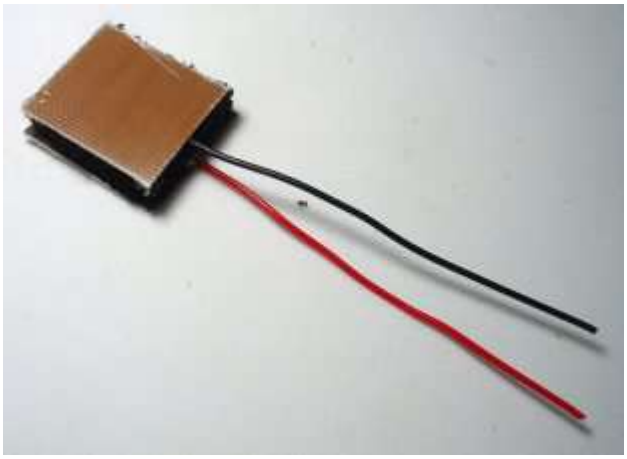
The complete LOAD CELL

The resistance of the unloaded LOAD CELL

The fully loaded resistance can be as low as 9,330 ohms

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MEASURING CONTINUITY

CONTINUITY is the same as **ZERO OHMS** or the resistance of a short length of wire. It can also mean the resistance through a switch or globe or a low-value resistor.
It basically means a "PATH" and sometimes refers to a whole circuit when the switch is closed. In other words CONTINUITY means we have a "circuit." We have "current flowing" and generally refers to a low-resistance circuit.
Both ANALOGUE and DIGITAL multimeters can measure CONTINUITY and you have to work out the approximate value of resistance for the circuit you are testing, - BEFORE TAKING A READING.
If the reading is above 300 ohms or contains a diode, you cannot use a DIGITAL MULTIMETER as the buzzer on the continuity setting will not respond.

The project being tested must not have the power applied as the resistance ranges on a multimeter are actually measuring a voltage across the leads and any voltage on the circuit or contained in any electrolytics, will upset the reading.

To take a reading with an **ANALOGUE** multimeter, select the x1 setting and the pointer will move across the scale to the actual value of resistance.
It it move full scale, you have ZERO OHMS resistance and this can mean a short-circuit or continuity via a wire.
If a diode is in the circuit you must also reverse the leads to get a reading.
The resistance of a globe will be very low when it is not illuminated, so don't think a fault is present.
Measuring CONTINUITY is the same as measuring LOW RESISTANCE.

To take a reading with a **DIGITAL** multimeter, select the buzzer setting. It will respond if the resistance is less than 300 ohms. It will not respond if a diode is in the circuit.

Meter set to BUZZER - CONTINUITY

You can also use the x1 resistance setting to get an accurate value of resistance. Touch the probes together to get the initial reading and subtract this value from the final reading.
When probing a circuit containing electrolytics, you may get a beep from the buzzer. This indicates the resistance is low because the multimeter is charging the electrolytic and it will beep until the electrolytic is charged to about 0.7v.
The same applies when probing across the power rails of a circuit. The circuit may contain electrolytics that will charge when probing and the buzzer will beep.
The Digital multimeter is actually detecting a voltage less than 0.7v across the probes and is created by a voltage-divider network inside the meter.
The voltage divider put 2v across the probes and when this drops to less than 0.5v, the buzzer is activated. That why it odes not buzz when testing a diode as the diode drops the voltage to 0.6v.

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MEASURING A DIODE

A diode can be measured to see if it is "open" or "damaged" or "working" by placing the probes across the component.
If the diode is "open" (it will not work), the needle will NOT swing across the scale when touching the component with the probes in one direction or when the probes are reversed.
If the diode is "damaged" (does not work), the needle will swing fully across the scale when touching the component with the probes in one direction or when the probes are reversed.
If the diode is FUNCTIONAL, (works) the needle will swing about mid-way when touching the leads of the diode in one direction and it will not move when the probes are reversed.

WHY?

The positive of the battery inside an analogue multimeter comes out the black probe and that is why you will get a reading when the probers are "around the wrong way." The needle will swing a different amount for each resistance setting on the dial as the needle represents 0.6v drop and NOT an actual resistance.

There are two things you must remember.
1. When the diode is measured in one direction, the needle will will **not move at**

all. The technical term for this is the diode is **reverse biased**. It will not allow any current to flow. Thus the needle will not move.
When the diode is connected around the other way, the needle will swing to the right (move up scale) to about 80% of the scale. This position represents the voltage drop across the junction of the diode and is NOT a resistance value. If you change the resistance range, the needle will move to a slightly different position due to the resistances inside the meter. The technical term for this is the diode is **forward biased**. This indicates the diode is not faulty.
The needle will swing to a slightly different position for a "normal diode" compared to a Schottky diode. This is due to the different junction voltage drops.
However we are only testing the diode at very low voltage and it may break-down when fitted to a circuit due to a higher voltage being present or due to a high current flowing.

2. The leads of an **Analogue Multimeter** have the positive of the battery connected to the black probe and the readings of a "good diode" are shown in the following two diagrams:

The diode is REVERSE BIASED in the diagram above and diodes not conduct.

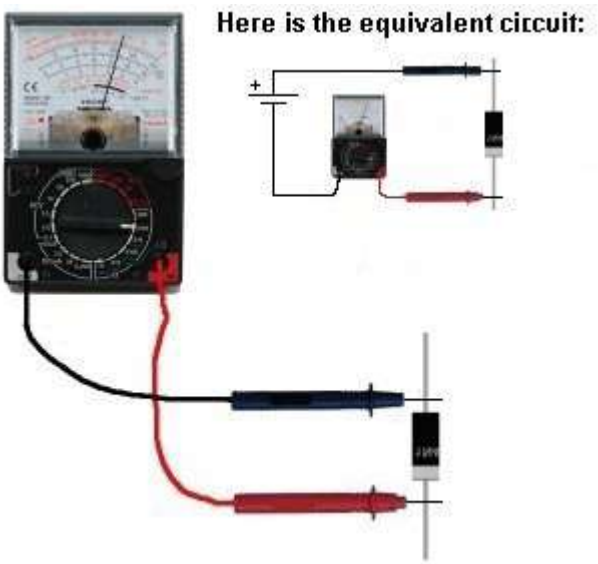

The diode is FORWARD BIASED in the diagram above and it conducts

TESTING A DIODE ON A DIGITAL METER

A Digital multimeter will measure the voltage-drop across the diode when the probes are connected in one direction (approx 0.640 on the scale) and a high reading (1) in the other direction. You need to select the "DIODE" setting on the dial as the other settings will produce a meaningless reading.

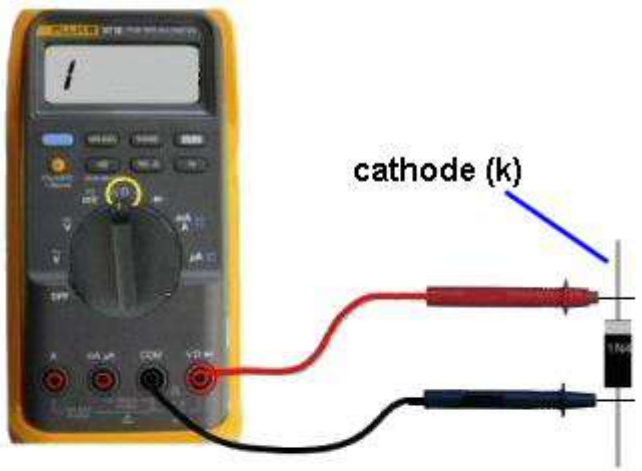

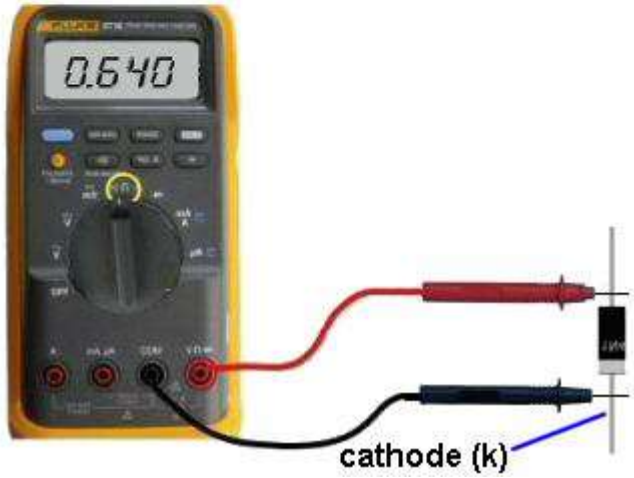

Some DIGITAL MULTIMETERS will show mV drop across the diode when the setting on the meter is "diode" or the "x1" or "x10" resistance range.

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TESTING A LED

Some multimeters will test LEDs.
It depends on the voltage of the battery inside the case of the multimeter.
Many analogue multimeters have a single 1.5v cell and these cannot test LEDs.
Analogue Multimeters with 3v (for the resistance ranges) can test some LEDs.
White LEDs need about 3.6v and they may not illuminate on 3v.

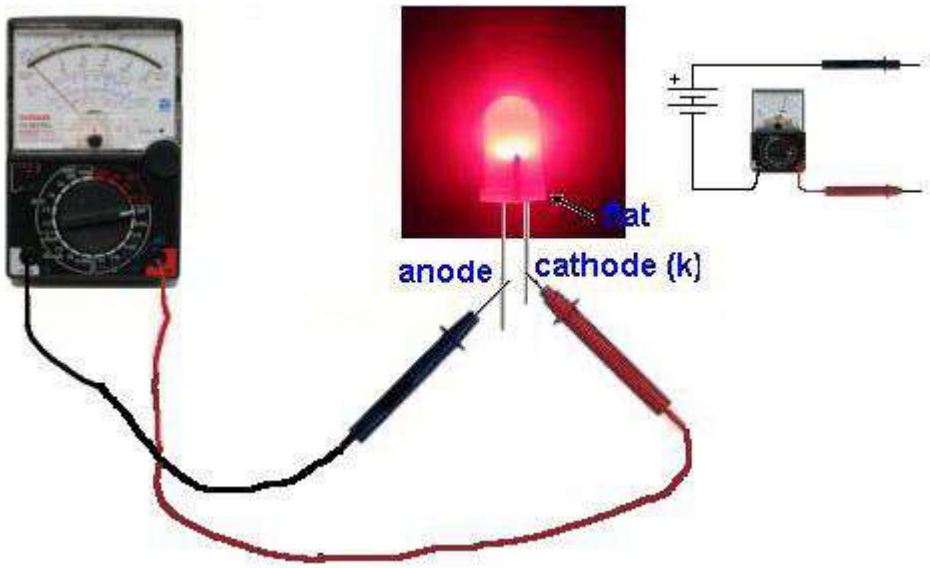

The negative lead of an ANALOGUE meter is POSITIVE!
The multimeter must have 3v (2 cells)

Digital multimeters have a 9v battery and they will illuminate all colour LEDs when the leads are placed as shown in the diagram:

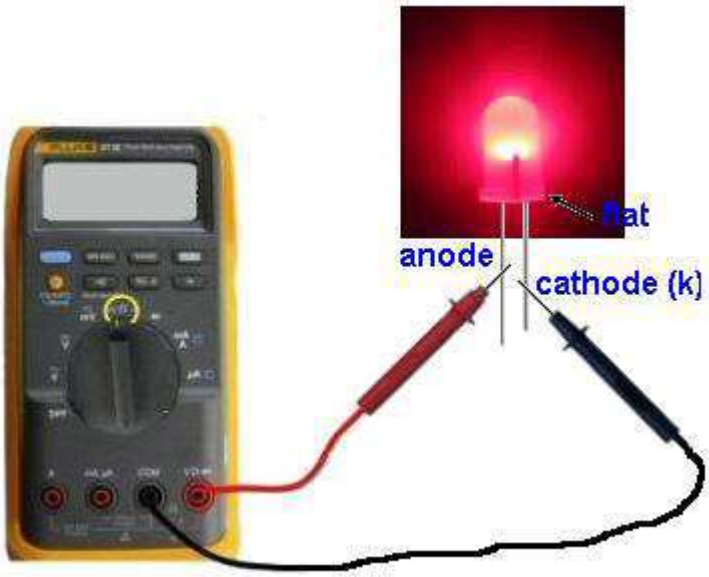

A Digital meter will illuminate all LEDs and the black probe touches the cathode.

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TESTING A TRANSISTOR WITH A DIGITAL METER

Testing a transistor with a **Digital Meter** must be done on the "DIODE" setting as a digital meter does not deliver a current through the probes on some of the resistance settings and will not produce an accurate reading.
The "DIODE" setting must be used for diodes and transistors. It should also be called a "TRANSISTOR" setting.

TESTING A TRANSISTOR WITH AN ANALOGUE METER

The first thing you may want to do is test an unknown transistor for COLLECTOR, BASE AND EMITTER. You also want to perform a test to find out if it is NPN or PNP. That's what this test will provide.
You need a cheap multimeter called an ANALOGUE METER - a multimeter with a

scale and pointer (needle).
It will measure resistance values (normally used to test resistors) - (you can also test other components) and Voltage and Current. We use the resistance settings. It may have ranges such as "x10" "x100" "x1k" "x10"
Look at the resistance scale on the meter. It will be the top scale.
The scale starts at zero on the right and the high values are on the left. This is opposite to all the other scales.
When the two probes are touched together, the needle swings FULL SCALE and reads "ZERO." Adjust the pot on the side of the meter to make the pointer read exactly zero.

How to read: "x10" "x100" "x1k" "x10"
Up-scale from the zero mark is "1"
When the needle swings to this position on the "x10" setting, the value is 10 ohms.
When the needle swings to "1" on the "x100" setting, the value is 100 ohms.
When the needle swings to "1" on the "x1k" setting, the value is 1,000 ohms = 1k.
When the needle swings to "1" on the "x10k" setting, the value is 10,000 ohms = 10k.
Use this to work out all the other values on the scale.
Resistance values get very close-together (and very inaccurate) at the high end of the scale. [This is just a point to note and does not affect testing a transistor.]

Step 1 - FINDING THE BASE and determining NPN or PNP
Get an unknown transistor and test it with a multimeter set to "x10"
Try the 6 combinations and when you have the black probe on a pin and the red probe touches the other pins and the meter swings nearly full scale, you have an NPN transistor. The black probe is BASE
If the red probe touches a pin and the black probe produces a swing on the other two pins, you have a PNP transistor. The red probe is BASE
If the needle swings FULL SCALE or if it swings for more than 2 readings, the transistor is **FAULTY**.

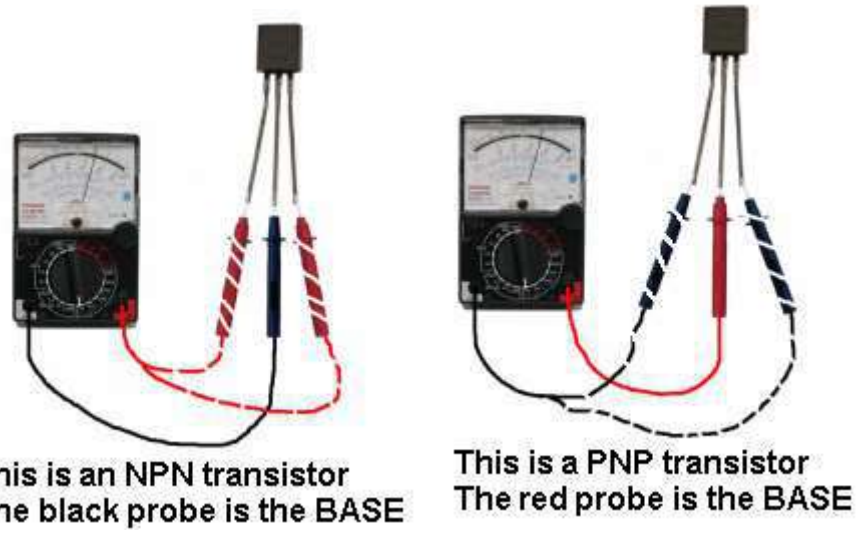

Step 2 - FINDING THE COLLECTOR and EMITTER
Set the meter to "x10k."
For an NPN transistor, place the leads on the transistor and when you press hard on the two leads shown in the diagram below, the needle will swing almost full scale.

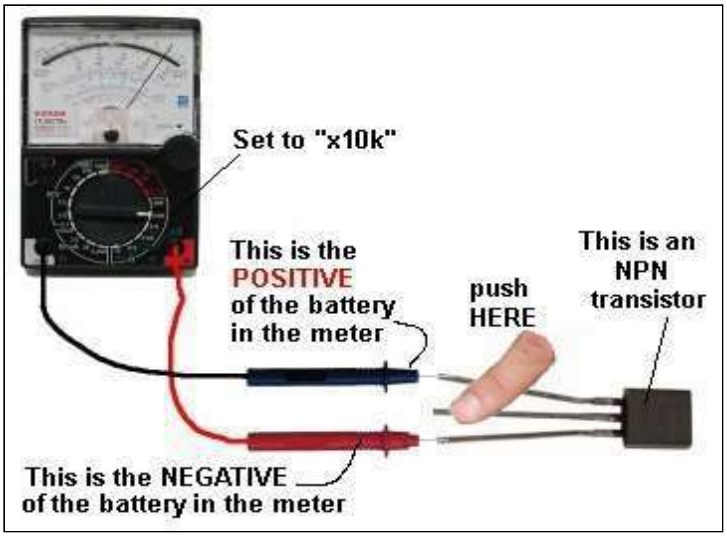

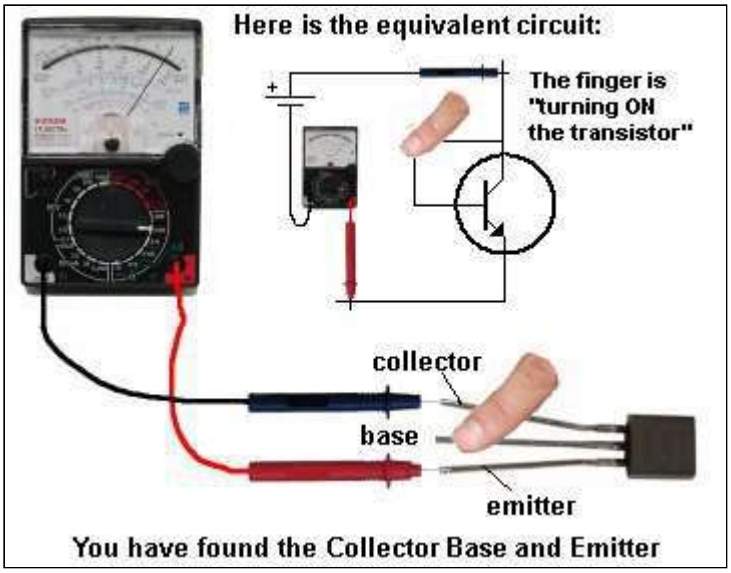

For a PNP transistor, set the meter to "x10k" place the leads on the transistor and when you press hard on the two leads shown in the diagram below, the needle will swing almost full scale.

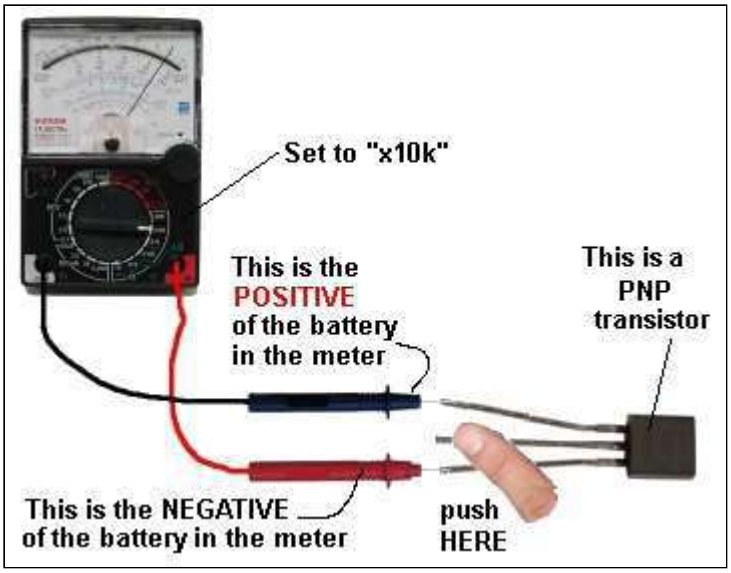

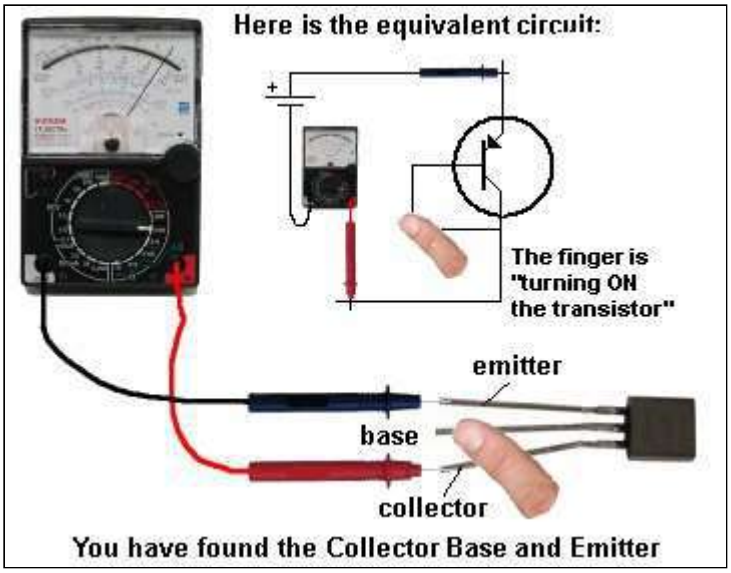

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For more details on testing components with a multimeter, see:
Testing Electronic Components.

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MULTIMETER TEST

1. What is the reading on the multimeter:

Answer

to Index

2. What is the reading on the multimeter:

Answer

to Index

3. What is the reading on the multimeter:

Answer

to Index

4. What is the voltage between the following points:

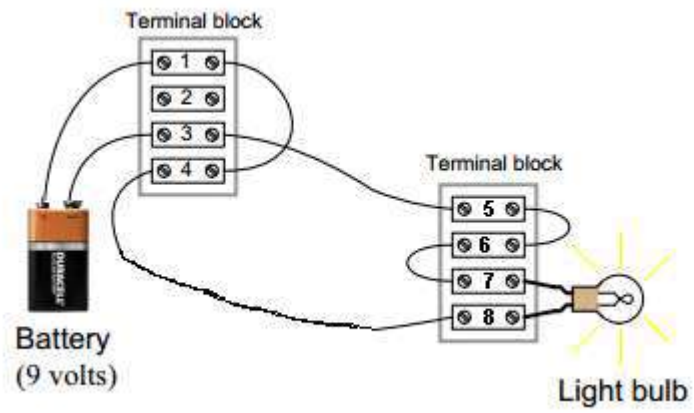

Between 1 & 3	Between 5 & 7	Between 3 & 8	Between 1 & 7
Answer	**Answer**	**Answer**	**Answer**

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5. What is the voltage on each multimeter:

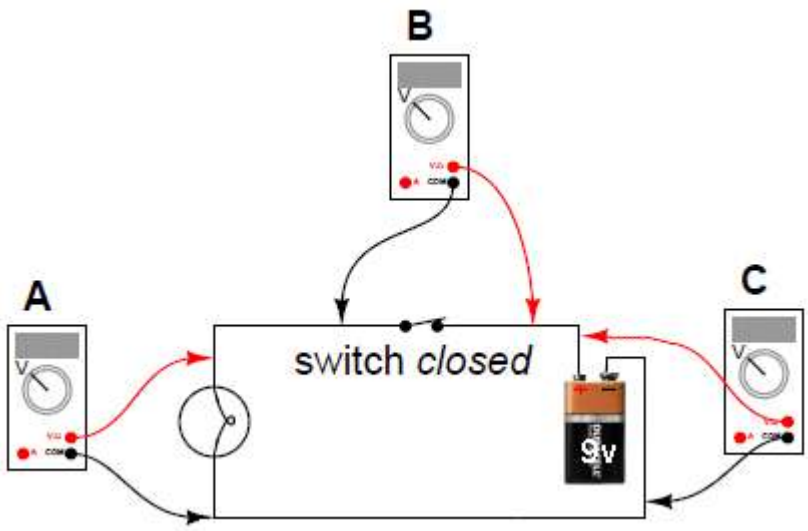

Meter A	Meter B	Meter C
Answer	**Answer**	**Answer**

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6. What is the voltage on each multimeter:

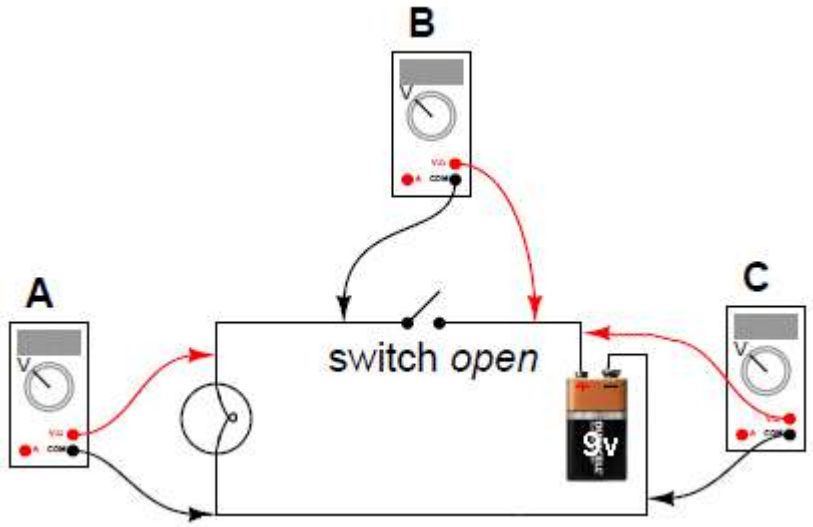

Meter A

Answer

Meter B

Answer

Meter C

Answer

to Index

7. What is the reading on the multimeter:

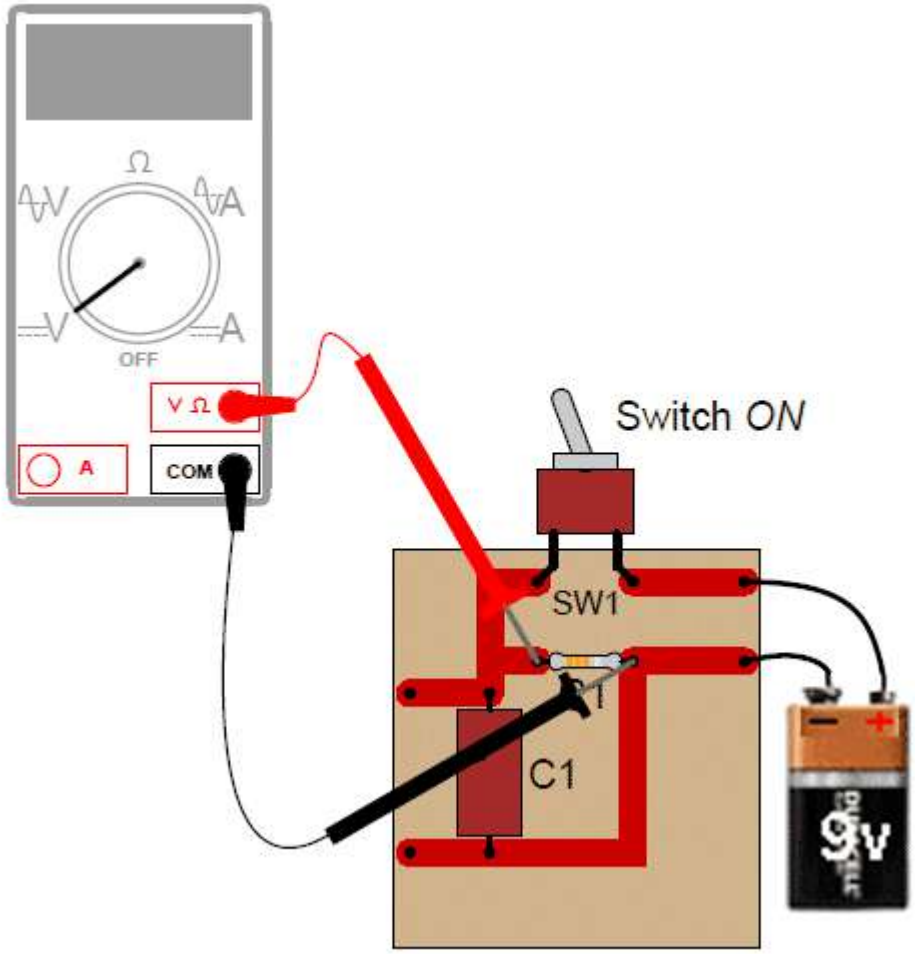

Answer

to Index

8. The multimeter has three resistance ranges: **x1 ohms** **x100 ohms** **x10k ohms**. How far across the scale will the needle move on each range for a 4k7 resistor:

x1 **x100** **x10k**

Answer **Answer** **Answer**

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9. The resistance ranges on an ANALOGUE multimeter use the battery inside the case to move the pointer. If the multimeter is left on "**ohms range**" with the probes apart, will the battery go flat?

Answer

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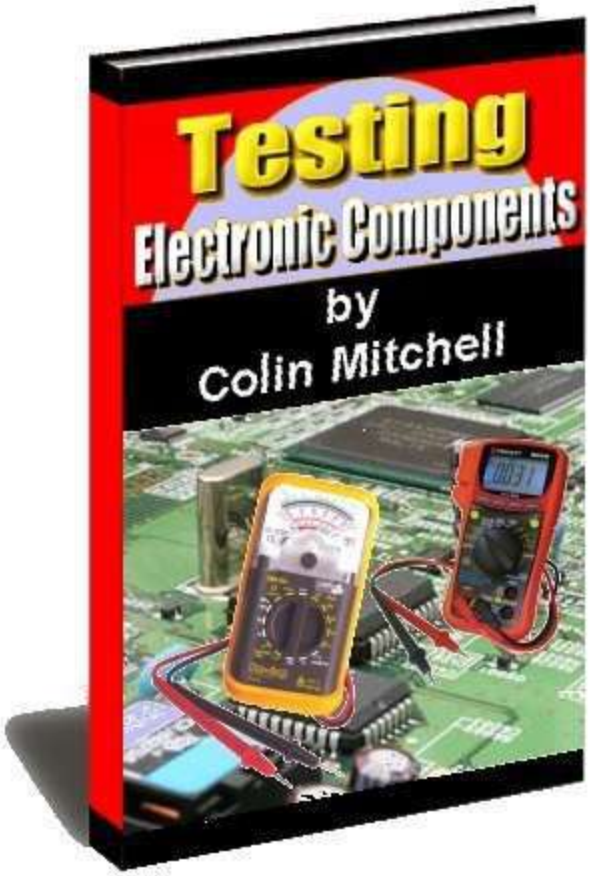

This eBook shows you how to TEST COMPONENTS.
To do this you need "TEST GEAR." The best item of Test Gear is a MULTIMETER. It can test almost 90% of all components. And that's what we will do in this eBook:

CONTENTS

Analogue Multimeter	Multimeters
Audio Stages	Non-polar Capacitor (electrolytic)
Batteries - testing	Open Circuit
Burnt Resistor	"Open" Resistor - damaged
Buying A Multimeter	Opto-couplers
Capacitors	Parallel - resistors
Capacitors - decoupling caps	Parallel and Series Capacitors
Capacitors in Parallel	Piezo Diaphragms
Capacitor Substitution Box	Piezo Buzzers
Cells - batteries	Potentiometers
Circuit Symbols	Pots - testing
Co-Ax Cables	Power Diodes
Colour Code (Resistor)	Power Supply -see Basic Electronics 1A
Coils	Reed Switch
Continuity	Relays
Creating any value of R	Remote Controls

Current - measuring
Current Sensing Resistors
Current Transformer
Damper Diodes
Darlington Transistors
Digital Chips
Digital Multimeter
Digital Transistors
Diodes replacing a diode
Discharge a Capacitor
Earth Leakage Detectors
Electrolytics
FETs
Fingers - to feel temperature
Focus pots
Fuses and 100mA fuses
Germanium Diodes
Heatsinks
Impedance - of a stage
IC's - also called Digital Chips
IC's - Analogue Chips
"In-Circuit" testing
Inductors
Inductors - measuring
Integrated Circuits
Isolation Transformer
Latching Reed Switch
LEDs
Logic Probe MkIIB
Logic Probe - Simple
Logic Probe - using CD4001
Logic Probe - using CD4011
Making your own components
Measuring Resistance
Measuring Voltage
Mica Washers and Insulators
Motor - testing
MOSFETs
Resistor Colour Code
Resistor Networks
Resistors - series
Resistor Substitution Box
Ripple Factor
Schottky Diodes
SCRs
Short Circuit
Signal Injector
Silicon diodes
Soldering
Spark Gaps
Speaker
Substitution Box
Super Probe MkII
Surface Mount - Packs
Surface-Mount Resistors
Surface-Mount Resistor Markings
Switches
Symbols
Test Equipment
Testing A Circuit
Testing A Resistor
Testing Components "In-Circuit"
Transformers - current transformer
Transformer Ratings 28v-0-28v
Transistor Outlines
Transistors
Transistors Digital
Triacs
Unknown resistors - testing
Using A Multimeter
Voltage Divider
Voltage Regulators
Voltages on a circuit
Wire Wound Resistor
Yokes
Zener Diodes
4-Band Resistors
5-Band Resistors
10-Turn Pots

Use your "brain, knowledge and your fingers."

Before we start, fixing anything is a combination of skill, luck and good diagnosis.
Sometimes you can fix something by letting it run until it finally fails.
Some things start to work as soon as you touch them.
Some things can never be fixed.
But some things can be fixed by feeling the temperature rise and deciding if it is getting too hot.
Sometimes you can smell something getting too hot.
Sometimes you can see SMOKE.
All these things make you a very clever technician and about 50% of faults will be fixed by looking for dry joints, burnt parts, overheating and carefully inspecting an item before you disturb it.

By simply touching different items you can quite often feel a hot item and home-in on the fault - at a saving of hours of work.
Servicing is not "A bull at a gate" approach.
You may be able to service something by turning it on and leaving it for hours - and start thinking.
It may take you a day to come up with the answer.
Believe me. That's how it worked for me - while fixing over 35,000 TV's.

TEST EQUIPMENT

Everyone thinks TEST EQUIPMENT will "solve the problem."
This is a big big MISTAKE.
Test equipment can help solve a problem and it can "lead to frustration," "give an incorrect answer," "mess you up," and make things worse.
You have to be very careful with test equipment and especially EXPENSIVE equipment because it is very sensitive and can detect pulses and glitches and voltages that are not affecting the operation of the circuit.
You will learn a lot of tricks when reading through this article, but let me say two things.
There are lots of faults and components that you cannot test with "test equipment" because they are either intermittent or the equipment does not load the device to the same extent as the circuit.
And secondly you need both an ANALOGUE multimeter and a DIGITAL meter to cover all the situations.
And if you are working on a car, you only need a $5.00 analogue meter because it will be dropped or fall into a crack, and you will only lose $5.00
You will learn that a digital meter will pick up spikes and signals on a line and show an incorrect reading.
That's why you need to back-up your readings with an analogue meter.
When you charge a battery it gets a "floating voltage" and this will be higher than the actual voltage, when the battery is fitted to a project. An analogue meter will draw a slight current and remove the "floating voltage."
Component testers can also give you a false reading, either because the component is out of range of the tester or intermittent and you need to be aware of this.
Oscilloscopes can also display waveforms that are parts of glitches or noise from other chips and these do not affect the operation of the part of the circuit you are investigating.
Sometimes you cannot pickup a pulse because it is not regular and the trigger on the oscilloscope does not show it on the screen. You may think it is missing.
It all depends on the "speed of the oscilloscope" - it's maximum frequency of operation.
Lastly- Power Supplies. You cannot test globes and motors on a power supply because the starting current can be 5 times more than the operating current. The power supply may not be able to deliver this high current and thus you will think the motor or globe is faulty.

MULTIMETERS

There are two types:

DIGITAL and ANALOGUE

A **Digital Multimeter** has a set of digits on the display and an Analogue Multimeter has a scale with a pointer (or needle).
You really need both types to cover the number of tests needed for designing and repair-work. We will discuss how they work, how to use them and some of the differences between them.

DIGITAL AND ANALOGUE MULTIMETERS

BUYING A MULTIMETER

There are many different types on the market.
The cost is determined by the number of ranges and also the extra features such as diode tester, buzzer (continuity), transistor tester, high DC current and others.
Since most multimeters are reliable and accurate, buy one with the greatest number of ranges at the lowest cost.
This article explains the difference between a cheap analogue meter, an expensive analogue meter and a digital meter. You will then be able to work out which two meters you should buy.

Multimeters are sometimes called a "meter", a "VOM" (Volts-Ohms-Milliamps or Volt Ohm Meter) or "multi-tester" or even "a tester" - they are all the same.

USING A MULTIMETER

Analogue and digital multimeters have either a rotary selector switch or push buttons to select the appropriate function and range. Some Digital Multimeters (DMMs) are auto ranging; they automatically select the correct range of voltage, resistance, or current when doing a test. However you need to select the function.

Before making any measurement you need to know what you are checking. If you are measuring voltage, select the AC range (10v, 50v, 250v, or 1000v) or DC range (0.5v, 2.5v, 10v, 50v, 250v, or 1000v). If you are measuring resistance, select the Ohms range (x1, x10, x100, x1k, x10k). If you are measuring current, select the appropriate current range DCmA 0.5mA, 50mA, 500mA. Every multimeter is different however the photo below shows a low cost meter with the basic ranges.

The most important point to remember is this:
You must select a voltage or current range that is bigger or HIGHER than the maximum expected value, so the needle does not swing across the scale and hit the "end stop."
If you are using a DMM (Digital Multi Meter), the meter will indicate if the voltage or current is higher than the selected scale, by showing "OL" - this means "Overload." If you are measuring resistance such as 1M on the x10 range the "OL" means "Open Loop" and you will need to change the range. Some meters show "1' on the display when the measurement is higher than the display will indicate and some flash a set of digits to show over-voltage or over-current. A "-1" indicates the leads should be reversed for a "positive reading."
If it is an AUTO RANGING meter, it will automatically produce a reading, otherwise the selector switch must be changed to another range.

The Common (negative) lead ALWAYS fits into the "COM" socket. The red lead fits into the red socket for Voltage and Resistance. Place the red lead (red banana plug) into "A" (for HIGH CURRENT "Amps") or mA,uA for LOW CURRENT.

The black "test lead" plugs into the socket marked "-" "Common", or "Com," and the red "test lead" plugs into meter socket marked "+" or "V-W-mA." The third banana socket measures HIGH CURRENT and the positive (red lead) plugs into this. You DO NOT move the negative "-" lead at any time.
The following two photos show the test leads fitted to a digital meter. The probes and plugs have "guards" surrounding the probe tips and also the plugs so you can measure high voltages without getting near the voltage-source.

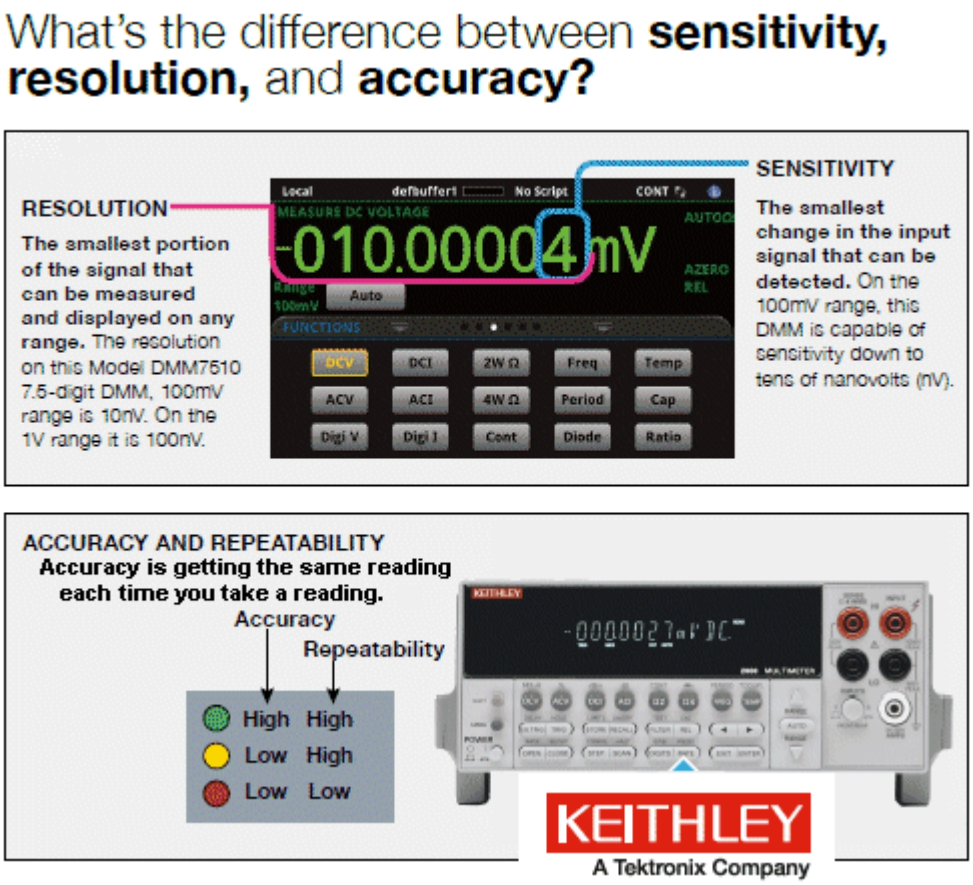

The question above applies to both (every) type of multimeter and the type of meter you use depends on the accuracy you need. Sometimes you are looking for 1mV change on a 20v rail. Only a DMM will (or a CRO) will produce a result.

Analogue meters have an "Ohms Adjustment" to allow for the change in voltage of the battery inside the meter (as it gets old).

"Ohms Adjust" is also called "ZERO SET"

The sensitivity of this meter is 20,000ohms/volt on the DC ranges and 5k/v on the AC ranges

Before taking a resistance reading (each time on any of the Ohms scales) you need to "ZERO SET" the scale, by touching the two probes together and adjust the pot until the needle reads "0" (swings FULL SCALE). If the pointer does not reach full

scale, the batteries need replacing. Digital multimeters do not need "zero adjustment."

FIXING A MULTIMETER

A multimeter can get "broken" "damaged" and go "faulty."
I don't know why, but eventually they stop working.
It can be something simple like a flat battery, corroded battery contacts, broken switch or something complex, like the circuitry failing.
Multimeters are so cheap, you can buy a new one for less than $10.00
These meters can have a 10 amp range, transistor tester and measure up to 2 meg ohms.
That's why I suggest buying a $10.00 meter. They are just as good as a $60.00 meter and the cheapest meters last the longest.
Dropping an analogue meter can cause the hair spring to loop over one of the supports and the needle will not zero correctly. You will need to open the cover on the movement and lift the spring off the support with a needle.
A faulty meter can be used in a battery-charger circuit to measure the current or voltage if that scale is still reading-correctly.
Otherwise keep the leads and throw the meter out. It is too dangerous keeping a meter that shows an incorrect reading.

MEASURING FREQUENCY

Before we cover the normal uses for a multimeter, it is interesting to note that some **Digital Multimeters (DMM)** have features such as Capacitance, Frequency and measuring the gain of a transistor as well as a number of other features using probes such as a temperature probe. The VICHY VC99 meter above is an example and costs about $40.00.

Basic function	Range
DCV	600mV/6V/60V/600V/1000V
ACV	6V/60/600/1000V
DCA	600uA/6000uA/60mA/600mA/6A/20A
ACA	600uA/6000uA/60mA/600mA/6A/20A
Capacitance	40nF/400nF/4uF/40uF/400uF/20uF
Resistance	600Ω/6kΩ/60kΩ/600kΩ/6MΩ/60MΩ
Frequency	100Hz/1kHz/10kHz/100kHz/1MHz/60MHz

Temperature	-40°C~1000°C
	0°F~1832°F

MEASURING VOLTAGE

Most of the readings you will take with a multimeter will be VOLTAGE readings. Before taking a reading, you should select the highest range and if the needle does not move up scale (to the right), you can select another range.
Always switch to the highest range before probing a circuit and keep your fingers away from the component being tested.
If the meter is Digital, select the highest range or use the auto-ranging feature, by selecting "V." The meter will automatically produce a result, even if the voltage is AC or DC.
If the meter is not auto-ranging, you will have to select V⎓ if the voltage is from a DC source or V~ if the voltage is from an AC source. DC means Direct Current and the voltage is coming from a battery or supply where the voltage is steady and not changing and AC means Alternating Current where the voltage is coming from a voltage that is rising and falling.
You can measure the voltage at different points in a circuit by connecting the black probe to chassis. This is the 0v reference and is commonly called "Chassis" or "Earth" or "Ground" or "0v."
The red lead is called the "measuring lead" or "measuring probe" and it can measure voltages at any point in a circuit. Sometimes there are "test points" on a circuit and these are wires or loops designed to hold the tip of the red probe (or a red probe fitted with a mini clip or mini alligator clip).
You can also measure voltages ACROSS A COMPONENT. In other words, the reading is taken in PARALLEL with the component. It may be the voltage across a transistor, resistor, capacitor, diode or coil. In most cases this voltage will be less than the supply voltage.
If you are measuring the voltage in a circuit that has a HIGH IMPEDANCE, the reading will be inaccurate, up to 90% !!!, if you use a cheap analogue meter.

Here's a simple case.

The circuit below consists of two 1M resistors in series. The voltage at the mid point will be 5v when nothing is connected to the mid point. But if we use a cheap analogue multimeter set to 10v, the resistance of the meter will be about 100k, if the meter has a sensitivity of 10k/v and the reading will be incorrect.
Here how it works:
Every meter has a sensitivity. The sensitivity of the meter is the sensitivity of the movement and is the amount of current required to deflect the needle FULL SCALE. This current is very small, normally 1/10th of a milliamp and corresponds to a sensitivity of 10k/volt (or 1/30th mA, for a sensitivity of 30k/v).
If an analogue meter is set to 10v, the internal resistance of the meter will be 100k for a 10k/v movement.
If this multimeter is used to test the following circuit, the reading will be inaccurate.
The reading should be 5v as show in diagram **A**.
But the analogue multimeter has an internal resistance of 100k and it creates a circuit shown in **C**.
The top 1M and 100k from the meter create a combined PARALLEL resistance of 90k. This forms a series circuit with the lower 1M and the meter will read less than 1v
If we measure the voltage across the lower 1M, the 100k meter will form a value of resistance with the lower 1M and it will read less than 1v
If the multimeter is 30k/v, the readings will be 2v. See how easy it is to get a totally inaccurate reading.

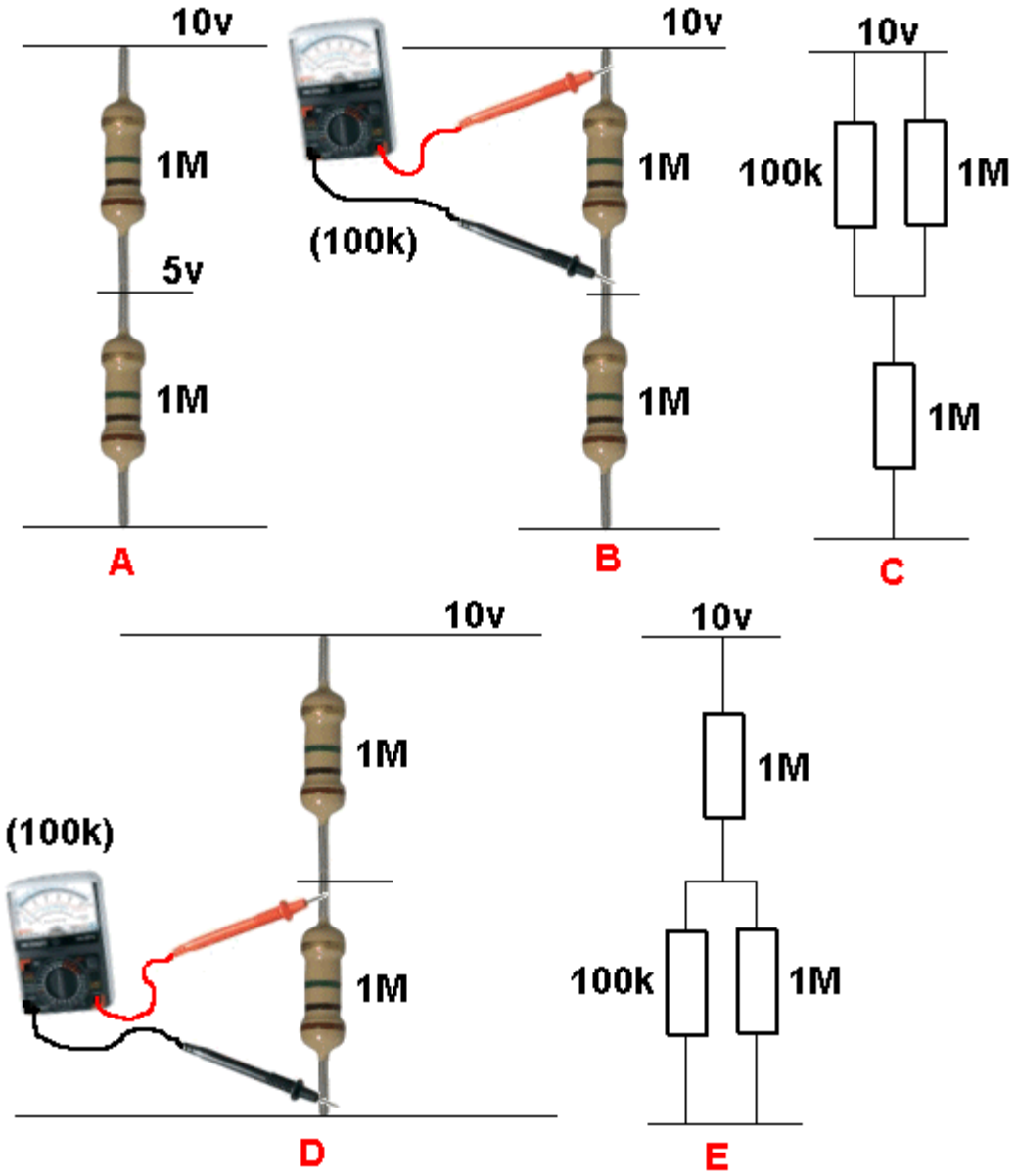

This introduces two new terms:
HIGH IMPEDANCE CIRCUIT and "RESISTORS in SERIES and PARALLEL."

If the reading is taken with a Digital Meter, it will be more accurate as a DMM does not take any current from the circuit (to activate the meter). In other words it has a very HIGH input impedance. Most Digital Multimeters have a fixed input resistance (impedance) of 10M - no matter what scale is selected. That's the reason for choosing a DMM for high impedance circuits. It also gives a reading that is accurate to about 1%.

MEASURING VOLTAGES IN A CIRCUIT

You can take many voltage-measurements in a circuit. You can measure "across" a component, or between any point in a circuit and either the positive rail or earth rail (0v rail). In the following circuit, the 5 most important voltage-measurements are shown. Voltage "A" is across the electret microphone. It should be between 20mV and 500mV. Voltage "B" should be about 0.6v. Voltage "C" should be about half-rail voltage. This allows the transistor to amplify both the positive and negative parts of the waveform. Voltage "D" should be about 1-3v. Voltage "E" should be the battery voltage of 12v.

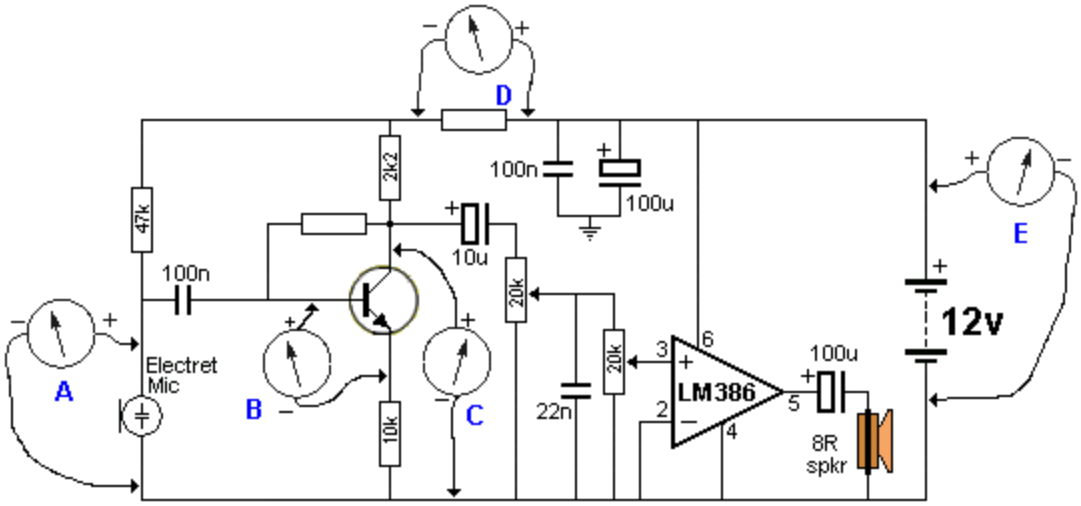

MEASURING VOLTAGES IN A CIRCUIT

MEASURING CURRENT

You will rarely need to take current measurements, however most multimeters have DC current ranges such as 0.5mA, 50mA, 500mA and 10Amp (via the extra banana socket) and some meters have AC current ranges. Measuring the current of a circuit will tell you a lot of things. If you know the normal current, a high or low current can let you know if the circuit is overloaded or not fully operational.

Current is always measured when the circuit is working (i.e: with power applied).
It is measured IN SERIES with the circuit or component under test.
The easiest way to measure current is to remove the fuse and take a reading across the fuse-holder. Or remove one lead of the battery or turn the project off, and measure across the switch.
If this is not possible, you will need to remove one end of a component and measure with the two probes in the "opening."
Resistors are the easiest things to desolder, but you may have to cut a track in some circuits. You have to get an "opening" so that a current reading can be taken.
The following diagrams show how to connect the probes to take a CURRENT reading.
Do not measure the current ACROSS a component as this will create a "short-circuit."
The component is designed to drop a certain voltage and when you place the probes across this component, you are effectively adding a "link" or "jumper" and the voltage at the left-side of the component will appear on the right-side. This voltage may be too high for the circuit being supplied and the result will be damage.

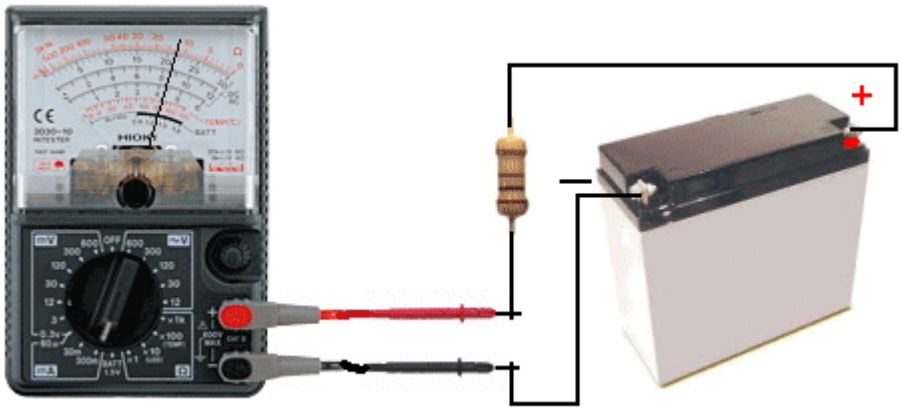

Measuring current through a resistor

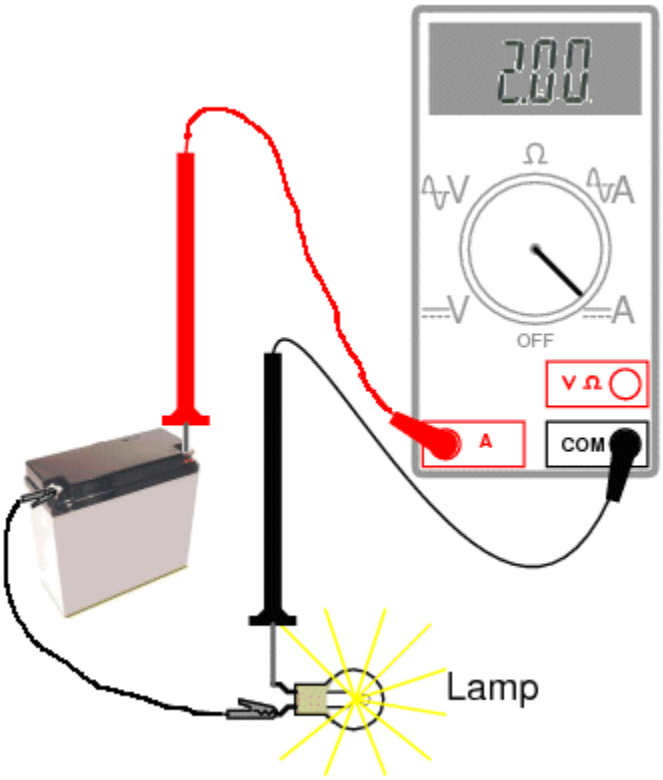

Measuring the current of a globe

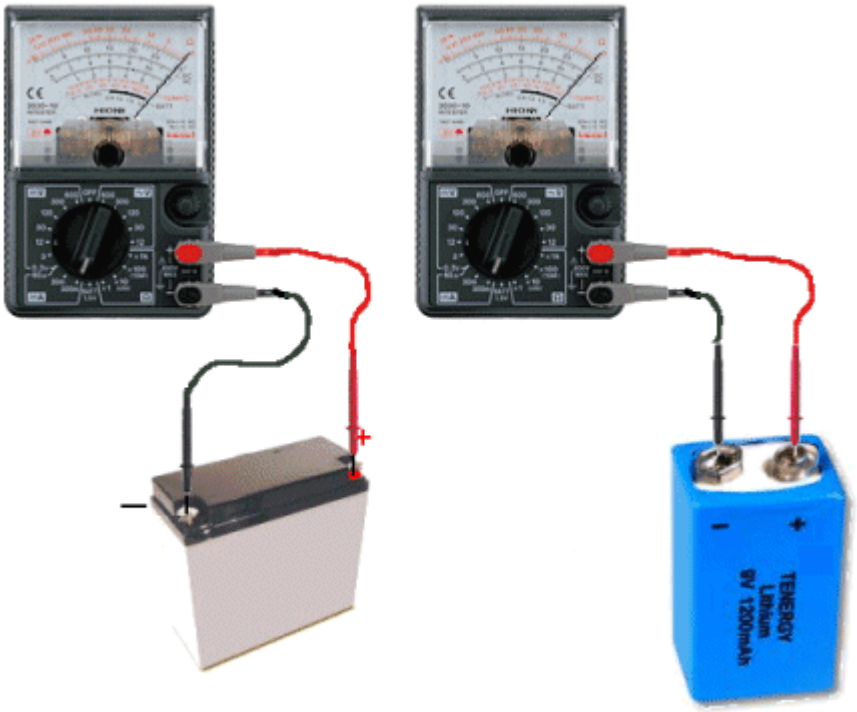

Do NOT measure the CURRENT of a battery

(by placing the meter directly across the terminals)

A battery will deliver a very HIGH current and damage the meter

Do not measure the "current a battery will deliver" by placing the probes across the terminals. It will deliver a very high current and damage the meter instantly. There are special battery testing instruments for this purpose.
When measuring across an "opening" or "cut," place the red probe on the wire that supplies the voltage (and current) and the black probe on the other wire. This will produce a "POSITIVE" reading.

A positive reading is an UPSCALE READING and the pointer will move across the scale - to the right. A "NEGATIVE READING" will make the pointer hit the "STOP" at the left of the scale and you will not get a reading. If you are using a Digital Meter, a negative sign "-" will appear on the screen to indicate the probes are around the wrong way. No damage will be caused. It just indicates the probes are connected incorrectly.
If you want an accurate CURRENT MEASUREMENT, use a digital meter.

MEASURING RESISTANCE

Turn a circuit off before measuring resistance.
If any voltage is present, the value of resistance will be incorrect.
In most cases you cannot measure a component while it is in-circuit. This is because the meter is actually measuring a voltage across a component and calling it a "resistance." The voltage comes from the battery inside the meter. If any other voltage is present, the meter will produce a false reading.
If you are measuring the resistance of a component while still "in circuit," (with the power off) the reading will be lower than the true reading.

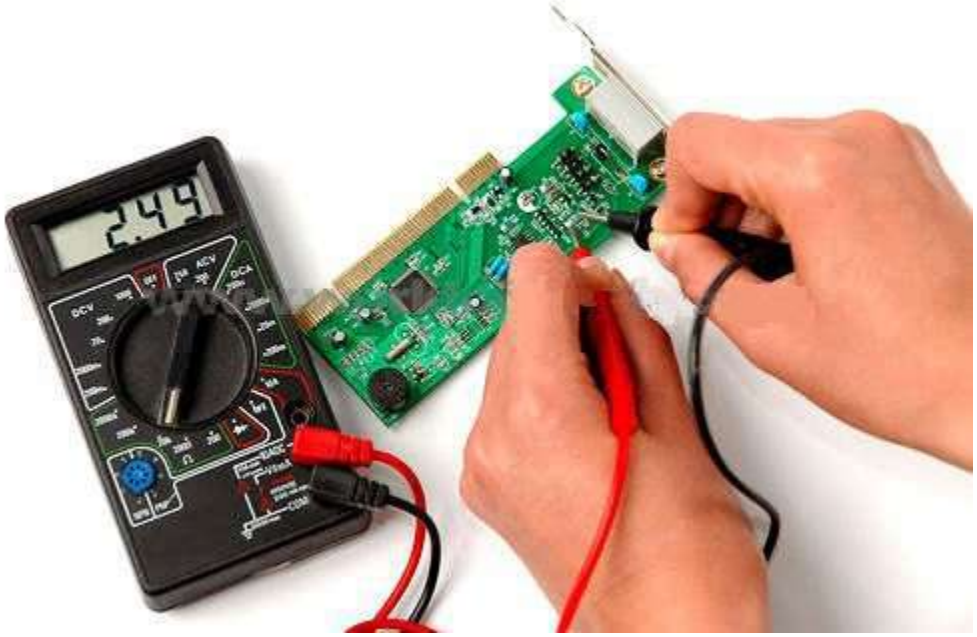

Measuring resistance

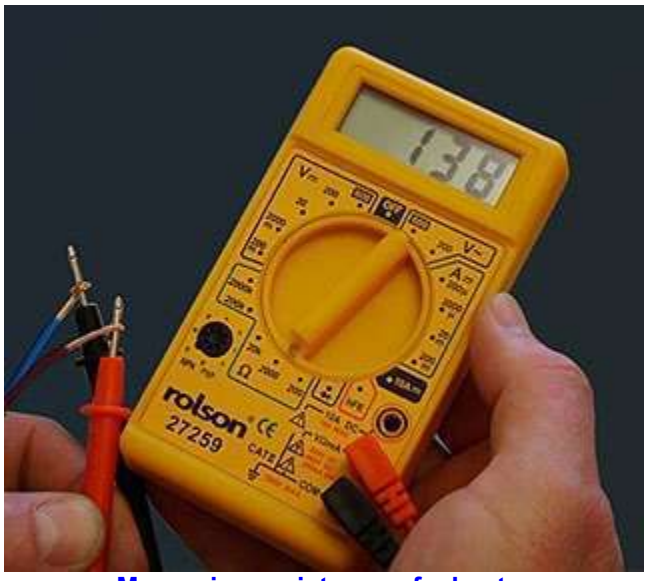

Measuring resistance of a heater (via the leads)

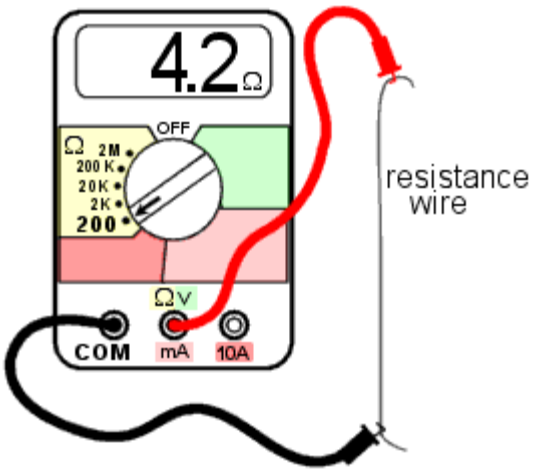

Measuring the resistance of a piece of resistance-wire

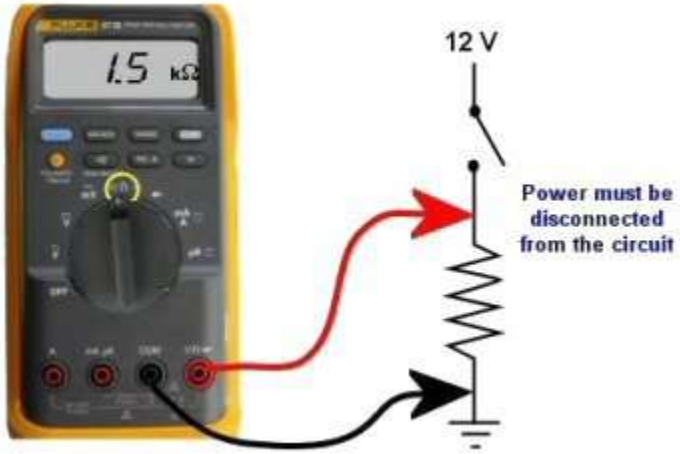

Measuring the resistance of a resistor

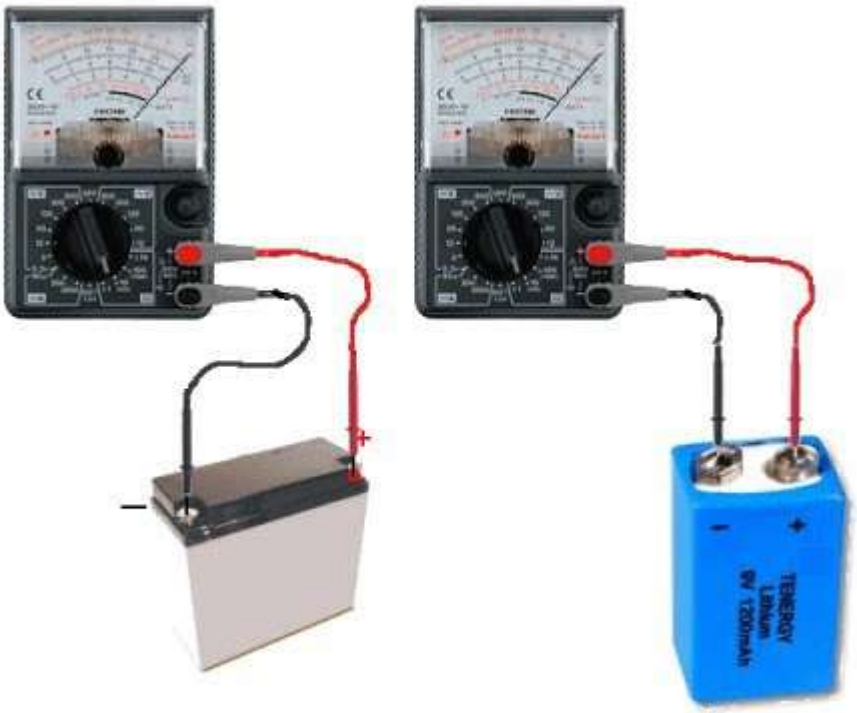

Do not measure the "Resistance of a Battery"

1. Do not measure the "resistance of a battery." The resistance of a battery (called the Internal impedance) is not measured as shown in the diagrams above. It is measured by creating a current-flow and measuring the voltage across the battery.

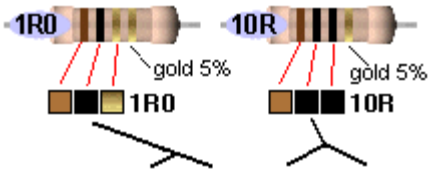

Placing a multimeter set to **resistance** (across a battery) will destroy the meter.
2. Do not try to measure the resistance of any voltage or any "supply."

Resistance is measured in OHMs.
The resistance of a 1cm x 1cm bar, one metre long is 1 ohm.
If the bar is thinner, the resistance is higher. If the bar is longer, the resistance is higher.
If the material of the bar is changed, the resistance is higher.
When carbon is mixed with other elements, its resistance increases and this knowledge is used to make RESISTORS.
Resistors have RESISTANCE and the main purpose of a resistor is to reduce the CURRENT FLOW.
It's a bit like standing on a hose. The flow reduces.
When current flow is reduced, the output voltage is also reduced and that why the water does not spray up so high. Resistors are simple devices but they produce many different effects in a circuit.
A resistor of nearly pure carbon may be 1 ohm, but when non-conducting "impurities" are added, the same-size resistor may be 100 ohms, 1,000 ohms or 1 million ohms.
Circuits use values of less than 1 ohm to more than 22 million ohms.

Resistors are identified on a circuit with numbers and letters to show the exact value of resistance - such as 1k 2k2 4M7
The letter Ω (omega - a Greek symbol) is used to identify the word "Ohm."
but this symbol is not available on some word-processors, so the letter "R" is used.
The letter "E" is also sometimes used and both mean "Ohms."
A one-ohm resistor is written "1R" or "1E." It can also be written "1R0" or "1E0."
A resistor of one-tenth of an ohm is written "0R1" or "0E1." The letter takes the place of the decimal point.
10 ohms = 10R
100 ohms = 100R
1,000 ohms = 1k (k= kilo = one thousand)
10,000 ohms = 10k
100,000 ohms = 100k
1,000,000 ohms = 1M (M = MEG = one million)

The size of a resistor has nothing to do with its resistance. The size determines the wattage of the resistor - how much heat it can dissipate without getting too hot.
Every resistor is identified by colour bands on the body, but when the resistor is a surface-mount device, numbers are used and sometimes letters.
You MUST learn the colour code for resistors and the following table shows all the colours for the most common resistors from 1/10th of an ohm to 22 Meg ohms for resistors with 5% and 10% tolerance.

If 3rd band is gold, Divide by 10
If 3rd band is silver, Divide by 100
(to get 0.22ohms etc)

ROW	SILVER	GOLD	BLACK	BROWN	RED	ORANGE	YELLOW	GREEN
1-	R10	1R0	10R	100R	1K0	10K	100K	1M0
2-	R11	1R1	11R	110R	1K1	11K	110K	1M1
3-	R12	1R2	12R	120R	1K2	12K	120K	1M2
4-	R13	1R3	13R	130R	1K3	13K	130K	1M3
5-	R15	1R5	15R	150R	1K5	15K	150K	1M5
6-	R16	1R6	16R	160R	1K6	16K	160K	1M6
7-	R18	1R8	18R	180R	1K8	18K	180K	1M8
8-	R20	2R0	20R	200R	2K0	20K	200K	2M0
9-	R22	2R2	22R	220R	2K2	22K	220K	2M2
10-	R24	2R4	24R	240R	2K4	24K	240K	2M4
11-	R27	2R7	27R	270R	2K7	27K	270K	2M7
12-	R30	3R0	30R	300R	3K0	30K	300K	3M0
13-	R33	3R3	33R	330R	3K3	33K	330K	3M3
14-	R36	3R6	36R	360R	3K6	36K	360K	3M6
15-	R39	3R9	39R	390R	3K9	39K	390K	3M9
16-	R43	4R3	43R	430R	4K3	43K	430K	4M3
17-	R47	4R7	47R	470R	4K7	47K	470K	4M7
18-	R51	5R1	51R	510R	5K1	51K	510K	5M1
19-	R56	5R6	56R	560R	5K6	56K	560K	5M6
20-	R62	6R2	62R	620R	6K2	62K	620K	6M2
21-	R68	6R8	68R	680R	6K8	68K	680K	6M8
22-	R75	7R5	75R	750R	7K5	75K	750K	7M5
23-	R82	8R2	82R	820R	8K2	82K	820K	8M2
24-	R91	9R1	91R	910R	9K1	91K	910K	9M1
								10M (BLUE)

COLOR CODES FOR THE WHOLE E12/E24 RANGE OF RESISTORS

The twelve odd rows - 1, 3, 5... - represent values available in the E12 range only, plus 10M

Reading 4-band resistors

The most "common" type of resistor has 4 bands and is called the 10% resistor. It now has a tolerance of 5% but is still called the "10% type" as the colours increase by 20% so that a resistor can be 10% higher or 10% lower than a particular value and all the resistors produced in a batch can be used.

The first 3 bands produce the resistance and the fourth band is the "tolerance" band.

Gold = 5%

(Silver =10% but no modern resistors are 10%!! - they are 5% 2% or 1%)

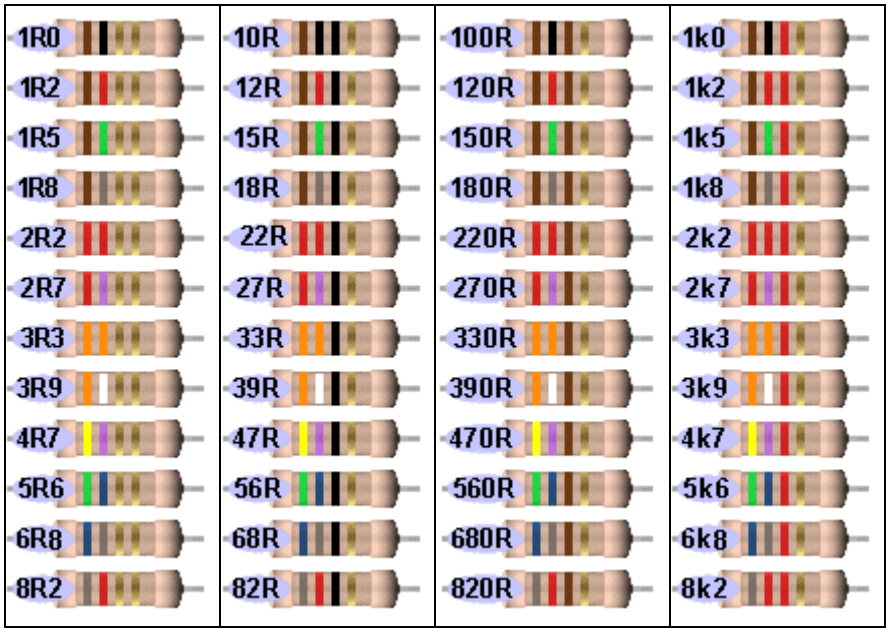

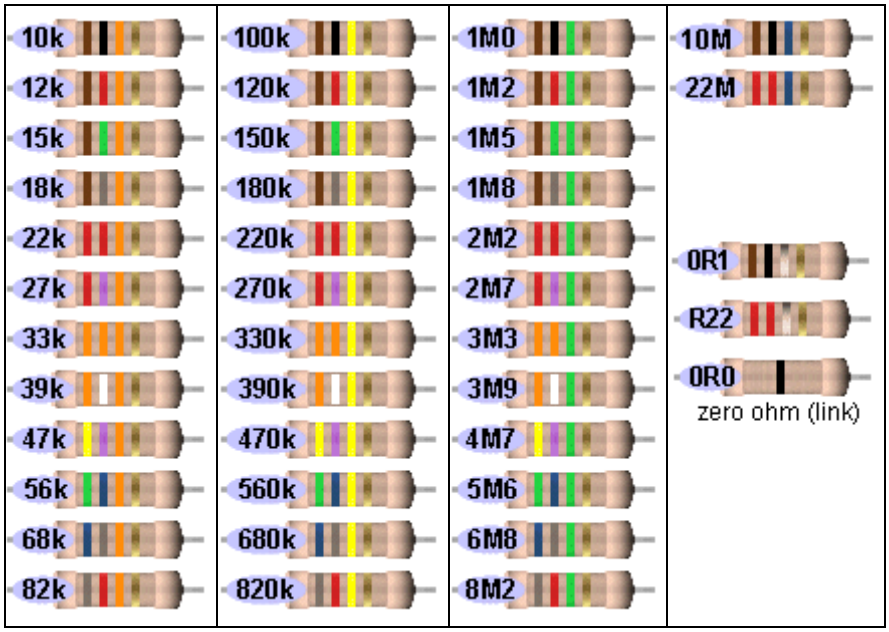

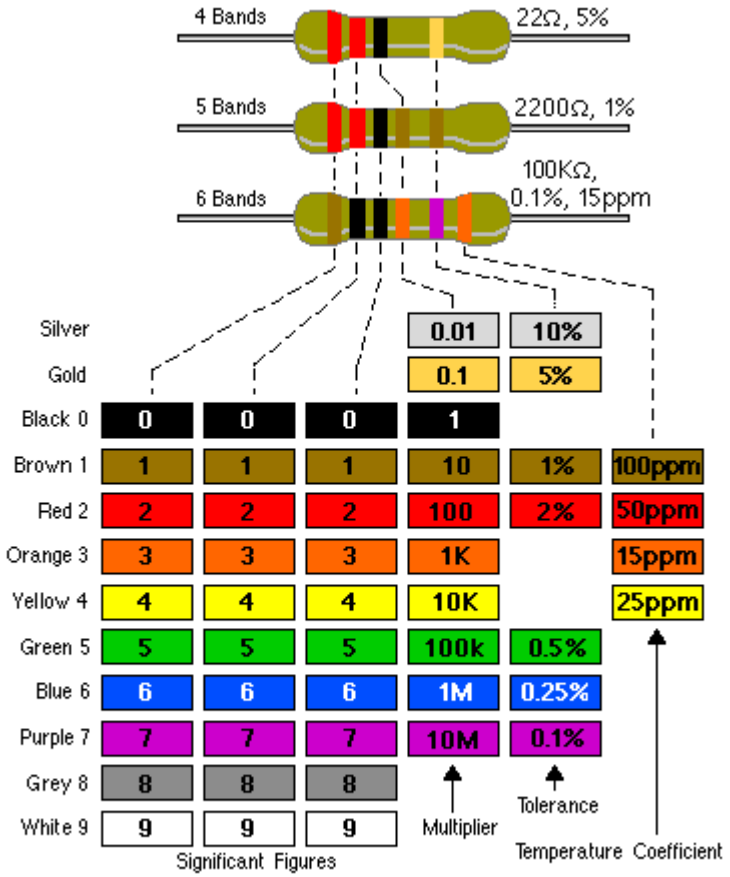

Resistor Color Code System

Here is another well-designed resistor colour code chart:

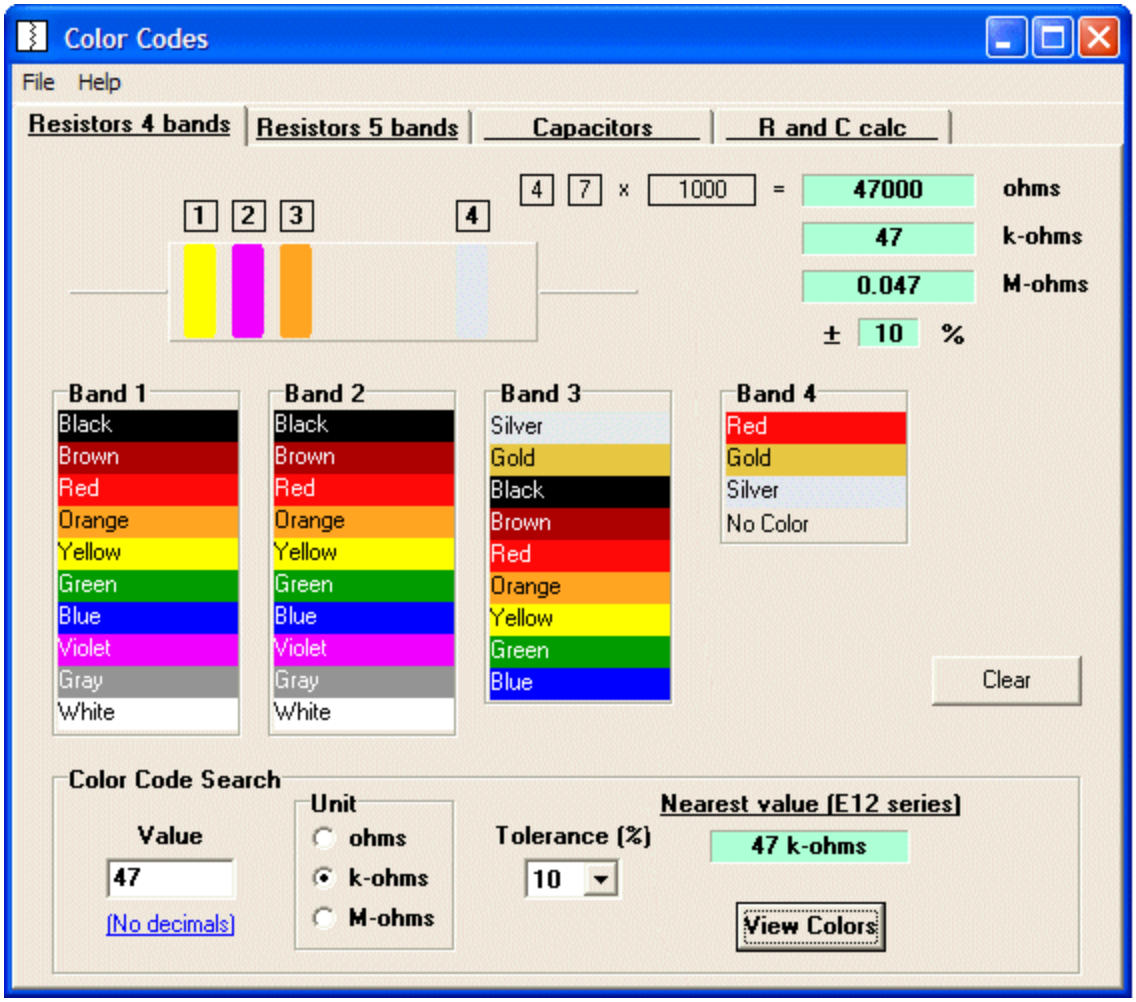

Download the program and save it on your desk-top for future reference:
ColourCode.exe (520KB)
ColourCode.zip (230KB)
ColourCode.rar (180KB)

RESISTORS LESS THAN 10 OHMS

When the **third** band is gold, it indicates the value of the "colors" must be divided by 10.
Gold = "divide by 10" to get values 1R0 to 8R2
When the **third** band is silver, it indicates the value of the "colors" must be divided by 100. (Remember: more letters in the word "silver" thus the divisor is "a larger division.")
Silver = "divide by 100" to get values R1 to R82
e.g: 0R1 = 0.1 ohm 0R22 = point 22 ohms
See 4th Column above for examples.

The letters "R, k and M" take the place of a decimal point.
e.g: 1**R**0 = 1 ohm 2**R**2 = 2 point 2 ohms 22**R** = 22 ohms
2**k**2 = 2,200 ohms 100**k** = 100,000 ohms
2**M**2 = 2,200,000 ohms

HOW TO REMEMBER THE COLOUR CODE:

Each colour has a "number" (or divisor) corresponding to it.
Most of the colours are in the same order as in the spectrum. You can see the spectrum in a rainbow. It is: ROY G BIV and the colours for resistors are in the same sequence.

black
brown - colour of increasing temperature

red
orange
yellow
green
blue
(indigo - that part of the spectrum between blue and violet)
violet
gray
white

colour	value	No of zero's
silver	-2	divide by 100
gold	-1	divide by 10
black	0	No zeros
brown	1	0
red	2	00
orange	3	,000 or k
yellow	4	0,000
green	5	00,000
blue	6	M
violet	7	
gray	8	
white	9	

Band Color	Digit	Multiplier	Tolerance
Black	0	1	---
Brown	1	10	±1%
Red	2	100	±2%
Orange	3	1,000	±3%
Yellow	4	10,000	±4%
Green	5	100,000	---
Blue	6	1,000,000	---
Violet	7	10,000,000	---
Gray	8	100,000,000	---
White	9	---	---
Gold	---	0.1	±5%
Silver	---	0.01	±10%
None	---	---	±20%

Here are some common ways to remember the colour code:

Bad Beer Rots Our Young Guts, But Vodka Goes Well
Bright Boys Rave Over Young Girls But Violet Gets Wed
Bad Boys Rave Over Young Girls But Violet Gets Wed with Gold and Silver.

Reading 5-band resistors:

5-band resistors are easy to read if you remember two simple points. The first three bands provide the digits in the answer and the 4th band supplies the number of zero's.

Reading "STANDARD VALUES" (on 5-band resistors)

5-band resistors are also made in "Standard Values" but will have different colours to 4-band "common" resistors - and will be confusing if you are just starting out. For instance, a 47k 5% resistor with 4-bands will be: yellow-purple-orange-gold. For a 47k 1% resistor the colours will be yellow-purple-black-red-brown. The brown colour-band represents 1%.
The first two colour-bands for a STANDARD VALUE or "common value" in 1% or 5% will be the SAME. These two bands provide the digits in the answer.
It's the 3rd band for a 5% resistor that is expanded into two bands in a 1% resistor. But it's easy to follow.
For a standard value, the 3rd band in a 1% resistor is BLACK. This represents a ZERO in the answer. (For 5-band resistors BLACK represents a ZERO when in the third band. This is different to 4-band resistors where black represents the word OHMS! If the third band is BROWN, the answer will be 1).
So the 4th band has to represent one-less ZERO and is one colour UP THE COLOUR CHART! In other words the 3rd and 4th bands (combined) on a 1% resistor produces the same number of zero's as the 3rd band on a 5% resistor!

Resistors come in a range of values and the two most common are the E12 and E24 series. The E12 series comes in twelve values for each decade. The E24 series comes in twenty-four values per decade.

E12 series - 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82

E24 series - 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91

Here is the complete list of 1% 1/4watt resistors from:
CIRCUIT SPECIALISTS. The following list covers 10 ohms (10R) to 1M.
To buy 1% resistors from Circuit Specialists, click: HERE.

10R	121R	806R	3k83	7k15	14k7	39k2	121k
12R1	150R	825R	3k92	7k5	15k	40k2	147k
15R	182R	909R	4k02	7k87	15k8	44k2	150k
18R2	200R	1k0	4k22	71k5	16k9	46k4	182k
22R1	221R	1k21	4k64	8k06	17k4	47k	200k
27R4	240R	1k5	4k75	8k25	17k8	47k5	212k
30R1	249R	1k82	4k7	8k45	18k2	49k9	221k
33R2	274R	2k	4k87	8k66	20k	51k1	226k
36R5	301R	2k21	4k99	8k87	22k1	53k6	249k
39R2	332R	2k2	5k11	9k09	22k6	56k2	274k
47R5	348R	2k43	5k23	9k31	23k7	61k9	301k
49R9	392R	2k49	5k36	9k53	24k9	68k1	332k
51R1	402R	2k67	5k49	9k76	27k4	69k8	357k
56R2	475R	2k74	5k62	10k	29k4	75k0	392k
68R1	499R	3k01	5k76	11k	30k1	82k5	475k
75R	565R	3k32	5k9	12k	33k2	90k	487k
82R5	604R	3k48	6k04	12k1	34k8	90k9	499k
90R9	681R	3k57	6k19	12k4	36k5	95k3	562k
100R	750R	3k74	6k81	13k	38k3	100k	604k
							1M

Here is the list of 1% resistors from suppliers (such as Farnell):

1R0	13R	68R	360R	1k8	9k1	47k	240k
1R2	15R	75R	390R	2k0	10k	51k	270k
1R5	16R	82R	430R	2k2	11k	56k	300k
2R2	18R	91R	470R	2k4	12k	62k	330k
2R7	20R	100R	510R	2k7	13k	68k	360k
3R3	22R	110R	560R	3k	15k	75k	390k
3R9	24R	120R	620R	3k3	16k	82k	430k
4R7	27R	130R	680R	3k6	18k	91k	470k
5R6	30R	150R	750R	3k9	20k	100k	510k
6R2	33R	160R	820R	4k3	22k	110k	560k
6R8	36R	180R	910R	4k7	24k	120k	620k
7R5	39R	200R	1k	5k1	27k	130k	680k
8R2	43R	220R	1k1	5k6	30k	150k	750k
9R1	47R	240R	1k2	6k2	33k	160k	820k
10R	51R	270R	1k3	6k8	36k	180k	910k
11R	56R	300R	1k5	7k5	39k	200k	1M
12R	62R	330R	1k6	8k2	43k	220k	

Surface Mount Resistors

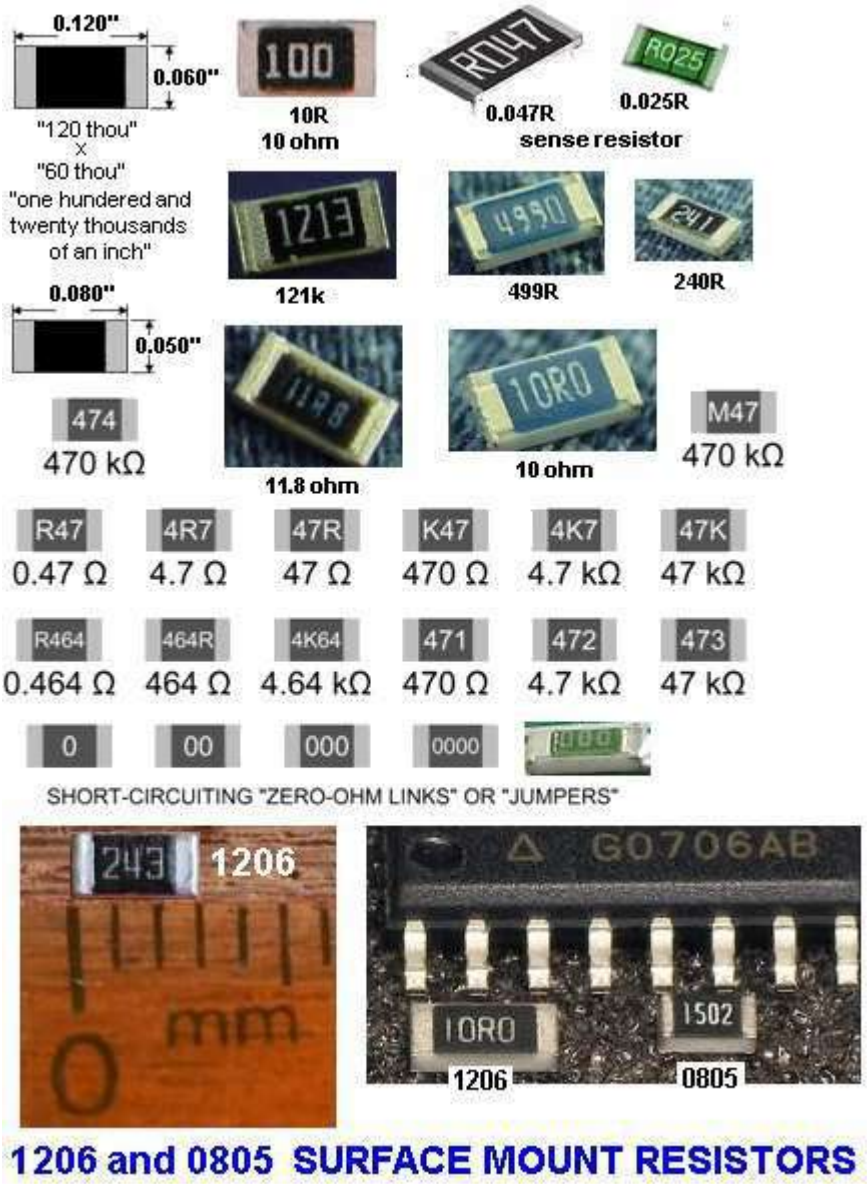

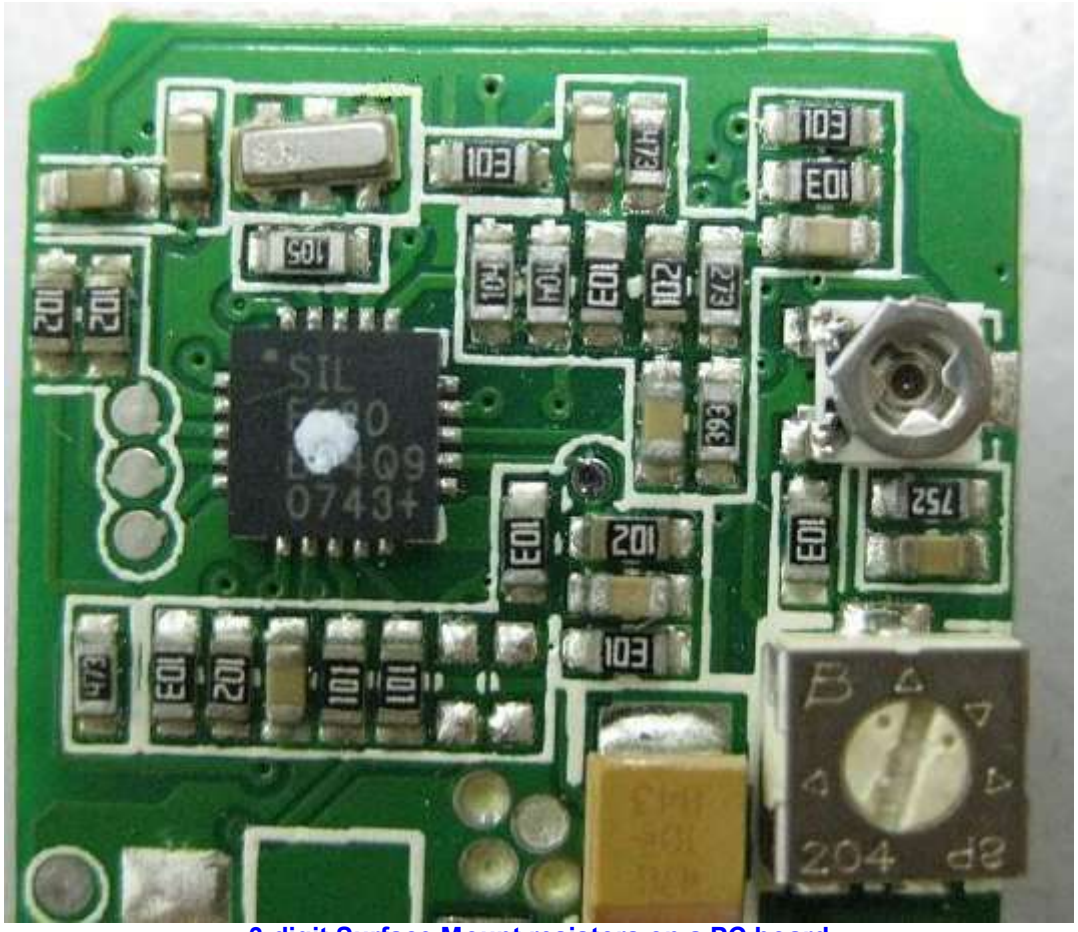

3-digit Surface Mount resistors on a PC board

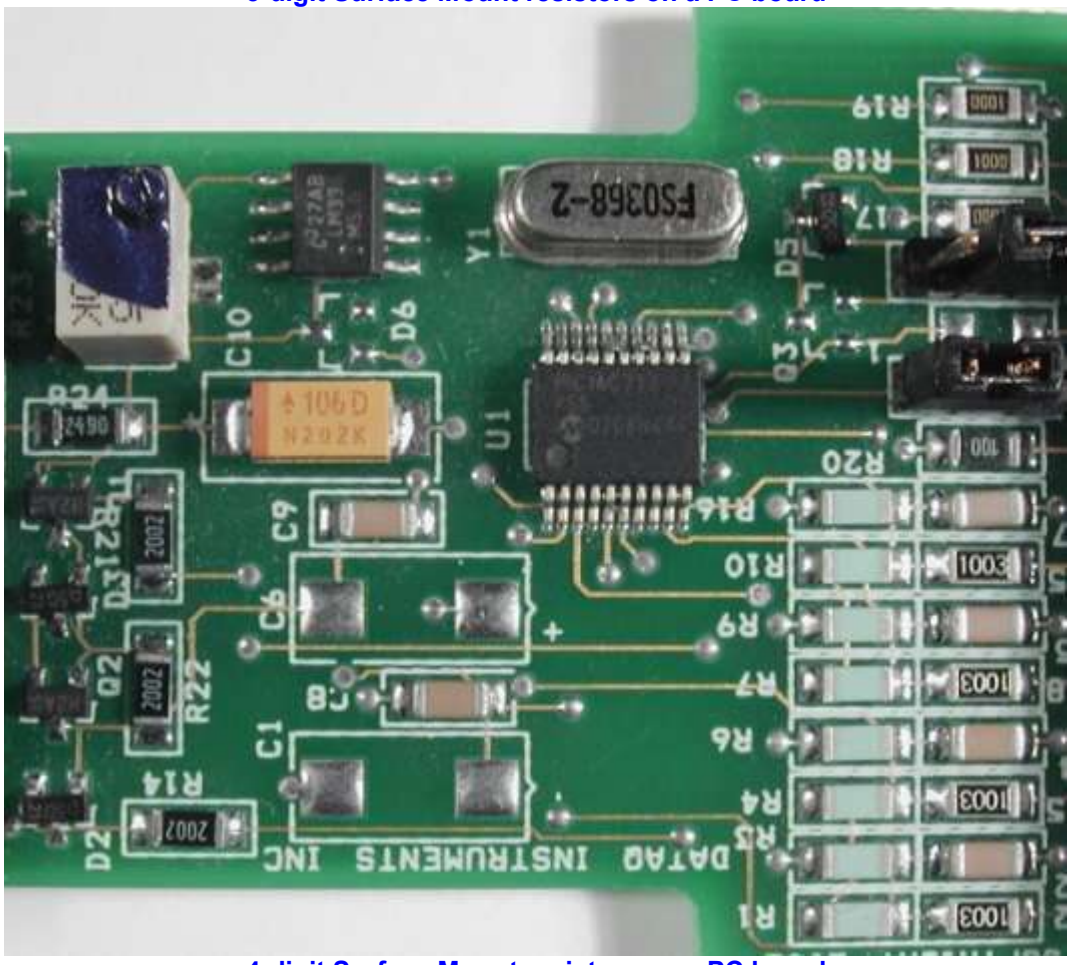

4-digit Surface Mount resistors on a PC board

The photo above shows surface mount resistors on a circuit board. The components

that are not marked are capacitors (capacitors are NEVER marked).
All the SM resistors in the above photos conform to a 3-digit or 4-digit code. But there are a number of codes, and the 4-digit code caters for high tolerance resistors, so it's getting very complicated.
Here is a basic 3-digit SM resistor:

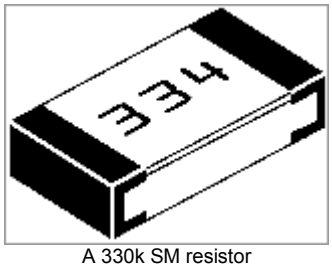

A 330k SM resistor

The first two digits represent the two digits in the answer. The third digit represents the number of zero's you must place after the two digits. The answer will be OHMS. For example: 334 is written 33 0 000. This is written 330,000 ohms. The comma can be replaced by the letter "k". The final answer is: 330k.
222 = 22 00 = 2,200 = 2k2
473 = 47 000 = 47,000 = 47k
474 = 47 0000 = 470,000 = 470k
105 = 10 00000 = 1,000,000 = 1M = one million ohms
There is one trick you have to remember. Resistances less than 100 ohms are written: 100, 220, 470. These are 10 and NO zero's = 10 ohms = 10R
or 22 and no zero's = 22R or 47 and no zero's = 47R. Sometimes the resistor is marked: 10, 22 and 47 to prevent a mistake.

Remember:
R = ohms
k = kilo ohms = 1,000 ohms
M = Meg = 1,000,000 ohms
The 3 letters (R, k and M) are put in place of the decimal point. This way you cannot make a mistake when reading a value of resistance.

Surface Mount **CURRENT SENSING** Resistors

Many new types of CURRENT SENSING surface-mount resistors are appearing on the market and these are creating lots of new problems.
Fortunately all resistors are marked with the value of resistance and these resistors are identified in MILLIOHMS. A miili ohm is one thousandth or an ohm and is written 0.001 when writing a normal mathematical number.
When written on a surface mount resistor, the letter R indicates the decimal point and it also signifies the word "OHM" or "OHMS" and one milli-ohm is written R001
Five miiliohms is R005 and one hundred milliohms is R100
Some surface mount resistors have the letter "M" after the value to indicate the resistor has a rating of 1 watt. e.g: R100M These surface-mount resistors are specially-made to withstand a high temperature and a surface-mount resistor of the same size is normally 250mW or less.
These current-sensing resistors can get extremely hot and the PC board can become burnt or damaged.
When designing a PC board, make the lands very large to dissipate the heat.
Normally a current sensing resistor is below one ohm (1R0) and it is easy to identify them as R100 etc.
You cannot measure the value of a current sensing resistor as the leads of a multimeter have a higher resistance than the resistor and few multimeters can read values below one ohm.
If the value is not visible, you will have to refer to the circuit.
Before replacing it, work out why it failed.
Generally it gets too hot. Use a larger size and add tiny heatsinks on each end.
Here are some surface=mount current-sense resistors:

THE COMPLETE RANGE OF SM RESISTOR MARKINGS

Click to see the complete range of SM resistor markings for 3-digit code:

Click to see the complete range of SM resistor markings for 4-digit code:

0000 is a value on a surface-mount resistor. It is a zero-ohm **LINK**!
Resistances less than 10 ohms have 'R' to indicate the position of the decimal point.
Here are some examples:

Three Digit Examples	Four Digit Examples
330 is 33 ohms *- not 330 ohms*	**1000 is 100 ohms** *- not 1000 ohms*
221 is 220 ohms	**4992 is 49 900 ohms, or 49k9**
683 is 68 000 ohms, or 68k	**1623 is 162 000 ohms, or 162k**
105 is 1 000 000 ohms, or 1M	**0R56 or R56 is 0.56 ohms**
8R2 is 8.2 ohms	

A new coding system has appeared on **1% types**. This is known as the EIA-96 marking method. It consists of a three-character code. The first two digits signify the 3 significant digits of the resistor value, using the lookup table below. The third character - a letter - signifies the multiplier.

code	value	code	value	code	value	code	value	code	value	code	value
01	100	17	147	33	215	49	316	65	464	81	681
02	102	18	150	34	221	50	324	66	475	82	698
03	105	19	154	35	226	51	332	67	487	83	715
04	107	20	158	36	232	52	340	68	499	84	732
05	110	21	162	37	237	53	348	69	511	85	750
06	113	22	165	38	243	54	357	70	523	86	768
07	115	23	169	39	249	55	365	71	536	87	787
08	118	24	174	40	255	56	374	72	549	88	806
09	121	25	178	41	261	57	383	73	562	89	825
10	124	26	182	42	267	58	392	74	576	90	845
11	127	27	187	43	274	59	402	75	590	91	866
12	130	28	191	44	280	60	412	76	604	92	887
13	133	29	196	45	287	61	422	77	619	93	909
14	137	30	200	46	294	62	432	78	634	94	931
15	140	31	205	47	301	63	442	79	649	95	953
16	143	32	210	48	309	64	453	80	665	96	976

The **multiplier** letters are as follows:

letter	mult	letter	mult
F	100000	B	10
E	10000	A	1
D	1000	X or S	0.1
C	100	Y or R	0.01

22A is a 165 ohm resistor, **68C** is a 49900 ohm (49k9) and **43E** a 2740000 (2M74). This marking scheme applies to 1% resistors only.

A similar arrangement can be used for **2% and 5%** tolerance types. The multiplier letters are identical to 1% ones, but occur **before** the number code and the following **code** is used:

2%				5%			
code	value	code	value	code	value	code	value
01	100	13	330	25	100	37	330
02	110	14	360	26	110	38	360
03	120	15	390	27	120	39	390
04	130	16	430	28	130	40	430
05	150	17	470	29	150	41	470
06	160	18	510	30	160	42	510
07	180	19	560	31	180	43	560

08	200	**20**	620	**32**	200	**44**	620
09	220	**21**	680	**33**	220	**45**	680
10	240	**22**	750	**34**	240	**46**	750
11	270	**23**	820	**35**	270	**47**	820
12	300	**24**	910	**36**	300	**48**	910

With this arrangement, **C31** is 5%, 18000 ohm (18k), and **D18** is 510000 ohms (510k) 2% tolerance.
Always check with an ohm-meter (a multimeter) to make sure.

Chip resistors come in the following styles and ratings:
Style: 0402, 0603, 0805, 1206, 1210, 2010, 2512, 3616, 4022
Power Rating: 0402(1/16W), 0603(1/10W), 0805(1/8W), 1206(1/4W), 1210(1/3W), 2010(3/4W), 2512(1W), 3616(2W), 4022(3W)
Tolerance: 0.1%, 0.5%, 1%, 5%
Temperature Coefficient: 25ppm 50ppm 100ppm

EIA marking code for surface mount (SMD) resistors

01S = 1R	01R = 10R	01A = 100R	01B = 1k	01C = 10k	01D = 100k	01E = 1M	01F = 10M
02S = 1R02	02R = 10R2	02A = 102R	02B = 1k02	02C = 10k2	02D = 102k	02E = 1M02	
03S = 1R05	03R = 10R5	03A = 105R	03B = 1k05	03C = 10k5	03D = 105k	03E = 1M05	18F = 15M
04S = 1R07	04R = 10R7	04A = 107R	04B = 1k07	04C = 10k7	04D = 107k	04E = 1M07	
05S = 1R1	05R = 11R	05A = 110R	05B = 1k1	05C = 11k	05D = 110k	05E = 1M1	30F = 20M
06S = 1R13	06R = 11R3	06A = 113R	06B = 1k13	06C = 11k3	06D = 113k	06E = 1M13	
07S = 1R15	07R = 11R5	07A = 115R	07B = 1k15	07C = 11k5	07D = 115k	07E = 1M15	
08S = 1R18	08R = 11R8	08A = 118R	08B = 1k18	08C = 11k8	08D = 118k	08E = 1M18	
09S = 1R21	09R = 12R1	09A = 121R	09B = 1k21	09C = 12k1	09D = 121k	09E = 1M21	
10S = 1R24	10R = 12R4	10A = 124R	10B = 1k24	10C = 12k4	10D = 124k	10E = 1M24	
11S = 1R27	11R = 12R7	11A = 127R	11B = 1k27	11C = 12k7	11D = 127k	11E = 1M27	
12S = 1R3	12R = 13R	12A = 130R	12B = 1k3	12C = 13k	12D = 130k	12E = 1M3	
13S = 1R33	13R = 13R3	13A = 133R	13B = 1k33	13C = 13k3	13D = 133k	13E = 1M33	
14S = 1R37	14R = 13R7	14A = 137R	14B = 1k37	14C = 13k7	14D = 137k	14E = 1M37	
15S = 1R4	15R = 14R	15A = 140R	15B = 1k4	15C = 14k	15D = 140k	15E = 1M4	
16S = 1R43	16R = 14R3	16A = 143R	16B = 1k43	16C = 14k3	16D = 143k	16E = 1M43	
17S = 1R47	17R = 14R7	17A = 147R	17B = 1k47	17C = 14k7	17D = 147k	17E = 1M47	
18S = 1R5	18R = 15R	18A = 150R	18B = 1k5	18C = 15k	18D = 15k	18E = 1M5	
19S = 1R54	19R = 15R4	19A = 154R	19B = 1k54	19C = 15k4	19D = 154k	19E = 1M54	
20S = 1R58	20R = 15R8	20A = 158R	20B = 1k58	20C = 15k8	20D = 158k	20E = 1M58	
21S = 1R62	21R = 16R2	21A = 162R	21B = 1k62	21C = 16k2	21D = 162k	21E = 1M62	
22S = 1R65	22R = 16R5	22A = 165R	22B = 1k65	22C = 16k5	22D = 165k	22E = 1M65	
23S = 1R69	23R = 16R9	23A = 169R	23B = 1k69	23C = 16k9	23D = 169k	23E = 1M69	
24S = 1R74	24R = 17R4	24A = 174R	24B = 1k74	24C = 17k4	24D = 174k	24E = 1M74	
25S = 1R78	25R = 17R8	25A = 178R	25B = 1k78	25C = 17k8	25D = 178k	25E = 1M78	
26S = 1R82	26R = 18R2	26A = 182R	26B = 1k82	26C = 18k2	26D = 182k	26E = 1M82	
27S = 1R87	27R = 18R7	27A = 187R	27B = 1k87	27C = 18k7	27D = 187k	27E = 1M87	
28S = 1R91	28R = 19R1	28A = 191R	28B = 1k91	28C = 19k1	28D = 191k	28E = 1M91	
29S = 1R96	29R = 19R6	29A = 196R	29B = 1k96	29C = 19k6	29D = 196k	29E = 1M96	
30S = 2R0	30R = 20R0	30A = 200R	30B = 2k0	30C = 20k0	30D = 200k	30E = 2M0	
31S = 2R05	31R = 20R5	31A = 205R	31B = 2k05	31C = 20k5	31D = 205k	31E = 2M05	
32S = 2R10	32R = 21R0	32A = 210R	32B = 2k10	32C = 21k0	32D = 210k	32E = 2M10	
33S = 2R15	33R = 21R5	33A = 215R	33B = 2k15	33C = 21k5	33D = 215k	33E = 2M15	
34S = 2R21	34R = 22R1	34A = 221R	34B = 2k21	34C = 22k1	34D = 221k	34E = 2M21	
35S = 2R26	35R = 22R6	35A = 226R	35B = 2k26	35C = 22k6	35D = 226k	35E = 2M26	
36S = 2R32	36R = 23R2	36A = 232R	36B = 2k32	36C = 23k2	36D = 232k	36E = 2M32	
37S = 2R37	37R = 23R7	37A = 237R	37B = 2k37	37C = 23k7	37D = 237k	37E = 2M37	
38S = 2R43	38R = 24R3	38A = 243R	38B = 2k43	38C = 24k3	38D = 243k	38E = 2M43	
39S = 2R49	39R = 24R9	39A = 249R	39B = 2k49	39C = 24k9	39D = 249k	39E = 2M49	
40S = 2R55	40R = 25R5	40A = 255R	40B = 2k55	40C = 25k5	40D = 255k	40E = 2M55	
41S = 2R61	41R = 26R1	41A = 261R	41B = 2k61	41C = 26k1	41D = 261k	41E = 2M61	
42S = 2R67	42R = 26R7	42A = 267R	42B = 2k67	42C = 26k7	42D = 267k	42E = 2M67	
43S = 2R74	43R = 27R4	43A = 274R	43B = 2k74	43C = 27k4	43D = 274k	43E = 2M74	
44S = 2R80	44R = 28R0	44A = 280R	44B = 2k80	44C = 28k0	44D = 280k	44E = 2M80	
45S = 2R87	45R = 28R7	45A = 287R	45B = 2k87	45C = 28k7	45D = 287k	45E = 2M87	
46S = 2R94	46R = 29R4	46A = 294R	46B = 2k94	46C = 29k4	46D = 294k	46E = 2M94	
47S = 3R01	47R = 30R1	47A = 301R	47B = 3k01	47C = 30k1	47D = 301k	47E = 3M01	
48S = 3R09	48R = 30R9	48A = 309R	48B = 3k09	48C = 30k9	48D = 309k	48E = 3M09	
49S = 3R16	49R = 31R6	49A = 316R	49B = 3k16	49C = 31k6	49D = 316k	49E = 3M16	
50S = 3R24	50R = 32R4	50A = 324R	50B = 3k24	50C = 32k4	50D = 324k	50E = 3M24	
51S = 3R32	51R = 33R2	51A = 332R	51B = 3k32	51C = 33k2	51D = 332k	51E = 3M32	
52S = 3R4	52R = 34R0	52A = 340R	52B = 3k4	52C = 34k0	52D = 340k	52E = 3M4	
53S = 3R48	53R = 34R8	53A = 348R	53B = 3k48	53C = 34k8	53D = 348k	53E = 3M48	

54S = 3R57	54R = 35R7	54A = 357R	54B = 3k57	54C = 35k7	54D = 357k	54E = 3M57
55S = 3R65	55R = 36R5	55A = 365R	55B = 3k65	55C = 36k5	55D = 365k	55E = 3M65
56S = 3R74	56R = 37R4	56A = 374R	56B = 3k74	56C = 37k4	56D = 374k	56E = 3M74
57S = 3R83	57R = 38R3	57A = 383R	57B = 3k83	57C = 38k3	57D = 383k	57E = 3M83
58S = 3R92	58R = 39R2	58A = 392R	58B = 3k92	58C = 39k2	58D = 392k	58E = 3M92
59S = 4R02	59R = 40R2	59A = 402R	59B = 4k02	59C = 40k2	59D = 402k	59E = 4M02
60S = 4R12	60R = 41R2	60A = 412R	60B = 4k12	60C = 41k2	60D = 412k	60E = 4M12
61S = 4R22	61R = 42R2	61A = 422R	61B = 4k22	61C = 42k2	61D = 422k	61E = 4M22
62S = 4R32	62R = 43R2	62A = 432R	62B = 4k32	62C = 43k2	62D = 432k	62E = 4M32
63S = 4R42	63R = 44R2	63A = 442R	63B = 4k42	63C = 44k2	63D = 442k	63E = 4M42
64S = 4R53	64R = 45R3	64A = 453R	64B = 4k53	64C = 45k3	64D = 453k	64E = 4M53
65S = 4R64	65R = 46R4	65A = 464R	65B = 4k64	65C = 46k4	65D = 464k	65E = 4M64
66S = 4R75	66R = 47R5	66A = 475R	66B = 4k75	66C = 47k5	66D = 475k	66E = 4M75
67S = 4R87	67R = 48R7	67A = 487R	67B = 4k87	67C = 48k7	67D = 487k	67E = 4M87
68S = 4R99	68R = 49R9	68A = 499R	68B = 4k99	68C = 49k9	68D = 499k	68E = 4M99
69S = 5R11	69R = 51R1	69A = 511R	69B = 5k11	69C = 51k1	69D = 511k	69E = 5M11
70S = 5R23	70R = 52R3	70A = 523R	70B = 5k23	70C = 52k3	70D = 523k	70E = 5M23
71S = 5R36	71R = 53R6	71A = 536R	71B = 5k36	71C = 53k6	71D = 536k	71E = 5M36
72S = 5R49	72R = 54R9	72A = 549R	72B = 5k49	72C = 54k9	72D = 549k	72E = 5M49
73S = 5R62	73R = 56R2	73A = 562R	73B = 5k62	73C = 56k2	73D = 562k	73E = 5M62
74S = 5R76	74R = 57R6	74A = 576R	74B = 5k76	74C = 57k6	74D = 576k	74E = 5M76
75S = 5R9	75R = 59R0	75A = 590R	75B = 5k9	75C = 59k0	75D = 590k	75E = 5M9
76S = 6R04	76R = 60R4	76A = 604R	76B = 6k04	76C = 60k4	76D = 604k	76E = 6M04
77S = 6R19	77R = 61R9	77A = 619R	77B = 6k19	77C = 61k9	77D = 619k	77E = 6M19
78S = 6R34	78R = 63R4	78A = 634R	78B = 6k34	78C = 63k4	78D = 634k	78E = 6M34
79S = 6R49	79R = 64R9	79A = 649R	79B = 6k49	79C = 64k9	79D = 649k	79E = 6M49
80S = 6R65	80R = 66R5	80A = 665R	80B = 6k65	80C = 66k5	80D = 665k	80E = 6M65
81S = 6R81	81R = 68R1	81A = 681R	81B = 6k81	81C = 68k1	81D = 681k	81E = 6M81
82S = 6R98	82R = 69R8	82A = 698R	82B = 6k98	82C = 69k8	82D = 698k	82E = 6M98
83S = 7R15	83R = 71R5	83A = 715R	83B = 7k15	83C = 71k5	83D = 715k	83E = 7M15
84S = 7R32	84R = 73R2	84A = 732R	84B = 7k32	84C = 73k2	84D = 732k	84E = 7M32
85S = 7R5	85R = 75R0	85A = 750R	85B = 7k5	85C = 75k0	85D = 750k	85E = 7M5
86S = 7R68	86R = 76R8	86A = 768R	86B = 7k68	86C = 76k8	86D = 768k	86E = 7M68
87S = 7R87	87R = 78R7	87A = 787R	87B = 7k87	87C = 78k7	87D = 787k	87E = 7M87
88S = 8R06	88R = 80R6	88A = 806R	88B = 8k06	88C = 80k6	88D = 806k	88E = 8M06
89S = 8R25	89R = 82R5	89A = 825R	89B = 8k25	89C = 82k5	89D = 825k	89E = 8M25
90S = 8R45	90R = 84R5	90A = 845R	90B = 8k45	90C = 84k5	90D = 845k	90E = 8M45
91S = 8R66	91R = 86R6	91A = 866R	91B = 8k66	91C = 86k6	91D = 866k	91E = 8M66
92S = 8R87	92R = 88R7	92A = 887R	92B = 8k87	92C = 88k7	92D = 887k	92E = 8M87
93S = 9R09	93R = 90R9	93A = 909R	93B = 9k09	93C = 90k9	93D = 909k	93E = 9M09
94S = 9R31	94R = 93R1	94A = 931R	94B = 9k31	94C = 93k1	94D = 931k	94E = 9M31
95S = 9R53	95R = 95R3	95A = 953R	95B = 9k53	95C = 95k3	95D = 953k	95E = 9M53
96S = 9R76	96R = 97R6	96A = 976R	96B = 9k76	96C = 97k6	96D = 976k	96E = 9M76

If you want an accurate RESISTANCE measurement, remove the resistor from the circuit and use a Digital meter.

SURFACE MOUNT COMPONENTS - PACKS

Talking Electronics has packs of components for the repairman. The following packs are available:

SURFACE MOUNT RESISTOR PACK consists of 1 off each standard value
10 ohms to 1M & 2M2 (60 resistors)
$14.20 including pack and post

SURFACE MOUNT CAPACITOR PACK consists of:
2 - 10p 5 - 47p 5 - 100p 5 - 470p 5 - 1n 5 - 10n 5 - 22n 5 - 100n
5 - 1u 16v electrolytic 5 - 10u 16v electrolytic
(40 components)
$23.80 including pack and post

SURFACE MOUNT DIODE PACK consists of:
5 - 1N 4148 (marked as "A6")
$10.00 including pack and post

SURFACE MOUNT TRANSISTOR PACK consists of:
5 - BC 848 (marked as "1K") NPN
5 - BC858 PNP
$10.00 including pack and post

email **Colin Mitchell** for details on how to pay by credit card or PayPal.

CREATING ANY VALUE OF RESISTANCE

Any value of resistance can be created by connecting two resistors in PARALLEL or SERIES.
You can also create a higher wattage resistor by connecting them in SERIES OR PARALLEL.
We are only going to cover two EQUAL VALUE resistors in SERIES or in PARALLEL.
If you want to create a "Special Value," simply connect two resistors and read the value with a Digital Meter. Keep changing the values until you get the required value.
We are not going into series or Parallel formulae. You can easily find a value with a multimeter.

TWO EQUAL-VALUE RESISTORS IN SERIES

Two equal-value resistors IN SERIES creates a value of DOUBLE. You simply ADD the values.
This can be done with any to two values as shown. Three equal-value resistors in series is three times the value.

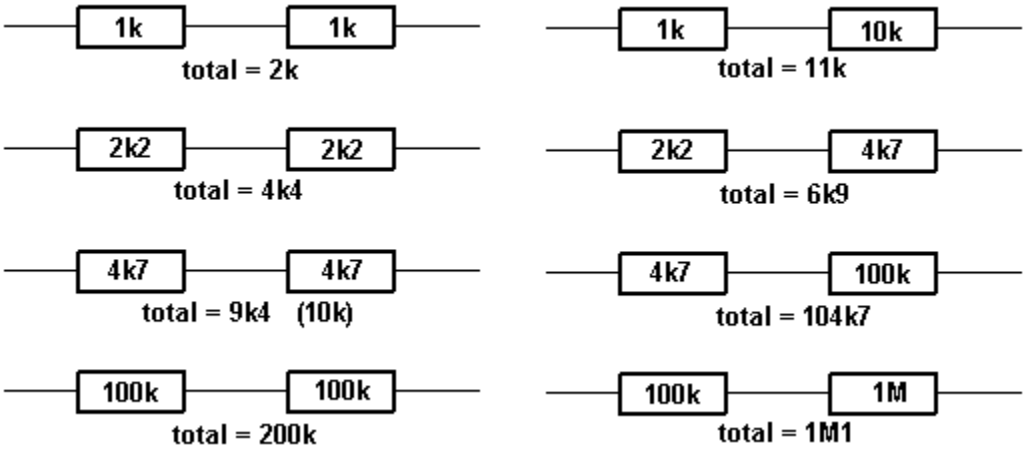

TWO EQUAL-VALUE RESISTORS IN PARALLEL

Two equal-value resistors IN PARALLEL creates a value of HALF. Three equal-value resistors in parallel is equal to one-third the value.

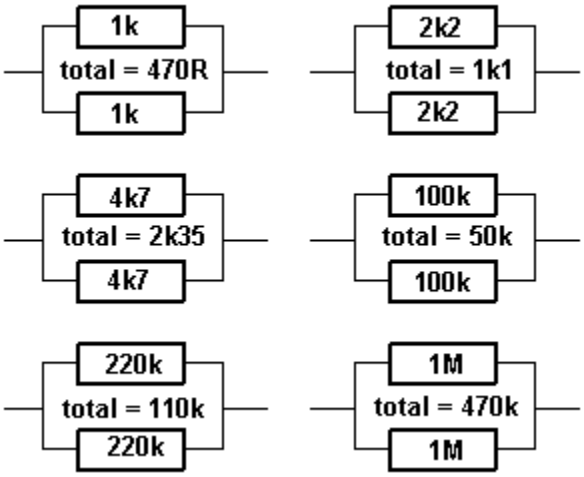

If you want a particular value and it is not available, here is a chart.
Use 2 resistors in series or parallel as shown:

Required Value	R1	Series/ Parallel	R2	Actual value:

10	4R7	S	4R7	9R4
12	10	S	2R2	12R2
15	22	P	47	14R9
18	22	P	100	18R
22	10	S	12	22
27	22	S	4R7	26R7
33	22	S	10	32R
39	220	P	47	38R7
47	22	S	27	49
56	47	S	10	57
68	33	S	33	66
82	27	S	56	83

There are other ways to combine 2 resistors in parallel or series to get a particular value. The examples above are just one way. 4R7 = 4.7 ohms

TESTING A RESISTOR

To check the value of a resistor, it should be removed from the circuit. The surrounding components can affect the reading and make it lower.
Resistors **VERY RARELY** change value, but if it is overheated or damaged, the resistance can increase. You can take the reading of a resistor "in-circuit" in one direction then the other, as the surrounding components may have diodes and this will alter the reading.
You can also test a resistor by feeling its temperature-rise. It is getting too hot if you cannot hold your finger on it (some "metal film" resistors are designed to tolerate quite high temperatures).

TESTING AN "AC" RESISTOR

There is no such thing as an "AC" resistor. Resistors are just "resistors" and they can be in AC circuits or DC circuits. Resistors can be given names such as "Safety Resistor" "Ballast Resistor" "LOAD Resistor" "Feed Resistor" "Dropper Resistor" or "Supply Resistor." These are just normal resistors with a normal resistance - except a "Safety Resistor."
A safety resistor is made of a flame-proof material such as metal-oxide-film and not carbon-composition. It is designed to "burn out" when too much current flows BUT NOT CATCH FIRE. It is a low-value resistor and has a voltage-drop across it but this is not intentional. The voltage-drop is to create a "heating-effect" to burn out the resistor. In all the other types of resistor, the voltage-drop is intentional.
A Ballast resistor is a normal resistor and can be called a Power resistor, Dropper resistor, Supply resistor or Feed resistor. It is designed to reduce the voltage from one source and deliver a lower voltage. It is a form of: "in-line" resistor.
A Load Resistor is generally connected across the output of a circuit and turns the energy it receives, into heat.

RESISTOR NETWORKS

To reduce the number of resistors in a circuit, some engineers use a set of identical resistors in a package called a Single-In-Line (SIL) resistor network. It is made with many resistors of the same value, all in one package. One end of each resistor is connected all the other resistors and this is the common pin, identified as pin 1 and has a dot on the package.
These packages are very reliable but to make sure all the resistors are as stated, you need to locate pin 1. All values will be identical when referenced to this pin.

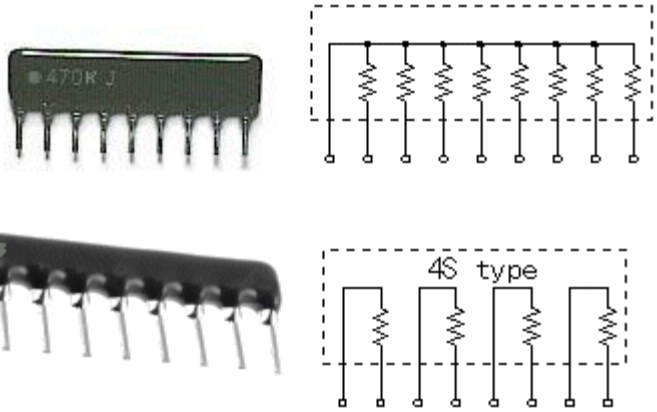

RESISTOR NETWORKS

Some resistor networks have a "4S" printed on the component. The 4S indicates the package contains 4 independent resistors that are not wired together inside. The housing has eight leads as shown in the second image.
Independent resistors have an even number of pins and measuring between each pair will produce identical values. Resistance between any pair will indicate leakage and may be a fault.

WIRE WOUND RESISTOR

A wire wound resistor is also called a POWER RESISTOR. This type of resistor can have a resistance as low as 0.1 ohms (one-tenth of an ohm) or as high as about 10k.
The image shows a 0.68 ohm resistor as the letter "R" represents the DECIMAL POINT and R68 is the same a .68 and this is 0.68 ohms. The wattage is 9 watts.
This resistor will allow xxx amps to flow. To work out the current, use the formula:
Power = Current x Current x resistance
9 = Current x Current x .68
Divide both sides by 0.68
13.2 = Current x Current
Find the square root of 13.2
Current = 3.6 amps

When 3.6 amps flow through the resistor, the voltage appearing across it will be:
V = current x resistance
= 3.6 x 0.68
= 2.5v and the wattage (heat) loss will be 9 watts.

The purpose of a resistor like this is to stop or reduce "ripple." Ripple is the noise or hum in an amplifier when the sound is turned up.
There are many reasons why you need to reduce the level of hum and this resistor will remove ripple as large as 2.5v when 3.6 amps is flowing, provided you have filter electrolytics on both side of the resistor to assist in removing the ripple.

If the letter "R" is in a different position, the value of resistance would be:

68R = 68Ω
6R8 = 6.8Ω
R68 = 0.68Ω

If you replace the R68 resistor a 6R8 resistor by mistake, the voltage across it will rise to 25v and if 3.6 amps flows, the wattage will be: 90 watts!!!
The resistor will glow red and burn out.

TESTING A POSISTOR

A Posistor is a resistor that connects in series with the degaussing coil around the picture tube or **Monitor.** When cold, it has a very low resistance and a large current flows when the monitor or TV is switched on. This current heats up the Posistor and the resistance increases. This causes the current to decrease and any magnetism in the shadow mask is removed. The posistor can one or two elements and it is kept warm so the resistance remains high. Many Posistors have a second element inside the case that connects directly to the supply to keep the Positive Temperature Coefficient resistor high so that the current through the degaussing coil falls to almost zero. This constant heat eventually destroys the package.
The heavy current that flows when a set is turned ON also causes the posistor to crack and break and this results in poor purity on the screen - as the shadow mask gradually becomes magnetic..
Posistors have different resistance values from different manufacturers and must be replaced with an identical type.
They can be checked for very low resistance when cold but any loose pieces inside the case will indicate a damaged component.

A "BURNT" RESISTOR - normally and technically called a "burnt-out" resistor.

The resistance of a "burnt" resistor can sometimes be determined by scraping away the outer coating - if the resistor has a spiral of resistance-material. You may be able to find a spot where the spiral has been damaged.

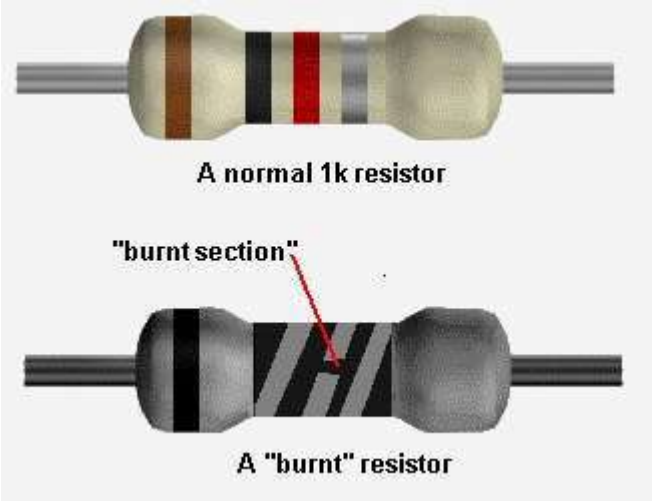

**Note the spirals of conductive carbon.
The number of spirals has nothing to with the resistance.
It is the amount of carbon particles in the "track" that
determines the resistance. It is also the thickness and width
of the track that determines the resistance.
And then it is the overall size of the resistor that determines the wattage.
And then the size of the leads, the closeness to the PCB and
the size of the lands that eventually determines how hot the resistor
will get.**

Clean the "spot" (burnt section of the spiral) very carefully and make sure you can get a good contact with the spiral and the tip of your probe. Measure from one lead of the resistor to the end of the damaged spiral. Then measure from the other lead to the other end of the spiral.
Add the two values and you have an approximate value for the resistor. You can add a small amount for the damaged section.
This process works very well for damaged wire-wound resistors. They can be pulled apart and each section of the resistance-wire (nichrome wire) measured and added to get the full resistance.

There is another way to determine the value of a damaged resistor.
Get a set of resistors of the same wattage as the damaged component and start with a high value. It's handy to know if the resistor is in the range: 10ohm to 100ohms or 1k to 10k etc, but this is not essential.
Start with a very high value and turn the circuit ON. You can perform voltage tests and if you know the expected output voltage, decrease the resistance until this voltage is obtained.
If you do not know the expected voltage, keep reducing the value of resistance until the circuit works as designed.
This is the best advice in a situation where you do not know the value of a resistor.

There is a third way to determine the value and this requires measuring the voltage drop across the resistor and the current-flow. By multiplying the two you will get a wattage and this must be less than the wattage of the resistor being replaced.

TESTING POTENTIOMETERS (variable resistors)

To check the value of a variable resistor, it should be removed from circuit or at least 2 legs should be removed. A Rheostat is a variable resistor using only one end and the middle connected to a circuit.
The resistance between the two outside pins is the value marked on the component and the centre leg will change from nearly zero to the full resistance as the shaft is rotated.
"Pots" generally suffer from "crackle" when turned and this can be fixed by spraying up the shaft and into the pot via the shaft with a tube fixed to a can of "spray-lubricant" (contact cleaner).
"Pre-set pots" and "trim pots" are miniature versions of a potentiometer and they are all tested the same. The photo shows a pot, two mini pots and 3 mini trim pots.

10-Turn POTs

A 10-turn pot is one of the worst items to be designed. I remove them immediately from any design.
You don't know the position of the wiper. You don't know which way you are turning the wiper and you can't remember which way you turned the post "the last time."
The screwdriver always falls out of the slot.
If you need fine adjustment, place fixed resistors on each side of the pot and use a normal mini trim pot with much less resistance.

FOCUS POTS

Focus pots quite often get a spot of dirt where the wiper touches the track. Cleaning with spray fixes the bad focus but if the pot is leaking to chassis from inside the pot (due to the high voltage on the terminals) simply remove it from the chassis and leave it floating (this will restore the high voltage to the picture tube) or you can use one from an old chassis.

MAKING YOUR OWN RESISTOR, CAPACITOR, INDUCTOR or DIODE

Quite often you will not have the exact value of resistance or capacitance for a repair.
We have already covered placing resistors and capacitors in parallel and series:

Resistors in Parallel and/or Series
Capacitors in Parallel and/or Series

Here are some extras:

RESISTORS
Two 1k 0.5watt resistors in parallel produces a 470R 1watt resistor.
Two 1k 0.5watt resistors in series produces a 2k 1watt resistor.

CAPACITORS
Two 100n 100v capacitors in series produces a 50n capacitor @200v

INDUCTORS: Two inductors in series - **ADD THE VALUES**

DIODES: Two 1Amp 400v diodes in series produces a 1Amp 800v diode
Two 1Amp 400v diodes in parallel produces a 2Amp 400v diode

ZENER DIODES: Zener diodes can be connected in series to get a higher voltage.
Two 12v zener diodes in series produces a 24v zener.

CONTINUITY

Some multimeters have a "buzzer" that detects when the probes are touching each other or the resistance between the probes is very LOW. This is called a CONTINUITY TESTER.
You can use the resistance scale "x1" or "x10" to detect low values of resistance.
Set the pointer to "0" (right end of the scale) by touching the probes together and adjusting the "zero ohms" control.
When taking a reading, you will have to decide if a low value of resistance is a short-circuit or an "operating value."
For instance, the cold resistance of a 12v car globe is very low (about 2 ohms) and it increases (about 6 times) to 12 ohms when hot.
The "resistance of a circuit" may be very low as the electrolytics in the circuit are uncharged. This may not indicate a true "short-circuit."
The measurement across a diode is not a resistance-value but a "voltage-drop" and that is why the needle swings nearly full-scale.
Leads and wires and cords have a small resistance and depending on the length of the lead, this small resistance may be affecting a circuit.
Remember this:
When a circuit takes 1 amp, and the resistance of the leads is 1 ohm, the voltage drop across the leads will be 1v.
That's why a 12v battery supplying a circuit with these leads will have 11v at the circuit.
Note:
Turn off the equipment before making any continuity tests. The presence of even a small voltage (from an electrolytic) can give a false reading.
You can determine the resistance of a lead very accurately by taking the example above and applying it to your circuit.
If the battery is 12.6v and the voltage across the circuit is 10v, when the current is 2.6 amps, the resistance of the "leads" is 12.6 - 10 = 2.6 R=V/I = 2.6/2.6 = 1ohm. By making the lead shorter or using thicker wire, the resistance will be less and the voltage on the project will increase.
When taking readings in a circuit that has a number of diodes built-into IC's (Integrated Circuits) and transistors, some Continuity Testers will beep and give a false reading.
The following circuit has the advantage of providing a beep when a short-circuit is detected but does not detect the small voltage drop across a diode. This is ideal when testing logic circuits as it is quick and you can listen for the beep while

concentrating on the probe. Using a multimeter is much slower.

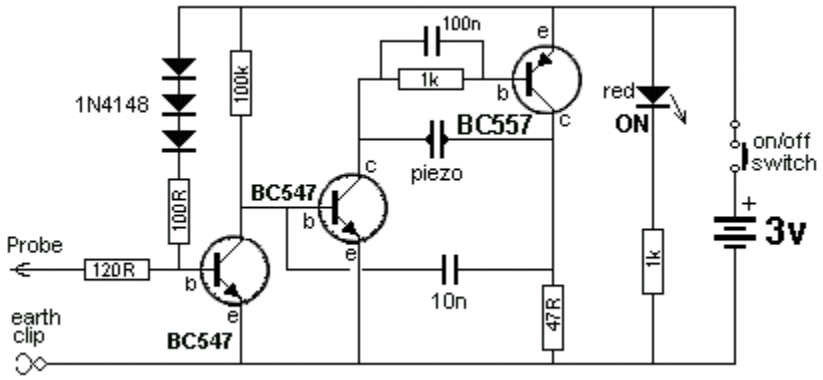

CONTINUITY TESTER

You can build the circuit on Matrix Board and add it to your Test Equipment.
You will need lots of "Test Equipment" and they can be built from circuits in this eBook.

TESTING FUSES, LEADS AND WIRES

All these components come under the heading TESTING for CONTINUITY. Turn off all power to the equipment before testing for shorts and continuity. Use the low resistance "Ohms Scale" or CONTINUITY range on your multimeter. All fuses, leads and wires should have a low, very low or zero resistance. This proves they are working.

A BLOWN FUSE

The appearance of a fuse after it has "blown" can tell you a lot about the fault in the circuit.
If the inside of the glass tube (of the fuse) is totally blackened, the fuse has been damaged very quickly. This indicates a very high current has passed through the fuse.
Depending on the rating of the fuse, (current rating) you will be able to look for components that can pass a high current when damaged - such as high power transistors, FETs, coils, electrolytics. Before re-connecting the supply, you should test the "SUPPLY RAILS" for resistance. This is done by measuring them on a low OHMs range in one direction then reverse the leads to see if the resistance is low in the other direction.
A reading can be very low at the start because electrolytics need time to charge-up and if the reading gradually increases, the power rail does not have a short. An overload can occur when the supply voltage rises to nearly full voltage, so you sometimes have to fit a fuse and see how long it takes to "blow."
If the fuse is just slightly damaged, you will need to read the next part of this eBook, to see how and why this happens:

FAST AND SLOW BLOW FUSES

There are many different sizes, shapes and ratings of a fuse. They are all current ratings as a fuse does not have a voltage rating. Some fuses are designed for cars as they fit into the special fuse holders. A fuse can be designed for 50mA, 100mA, 250mA, 315mA, 500mA, 1Amp, 1.5amp, 2amp, 3amp, 3.15amp 5amp, 10amp, 15amp, 20amp, 25amp, 30amp, 35amp, 50amp and higher.
Some fuses are fast-blow and some are slow-blow.
A "normal" fuse consists of a length of thin wire. Or it may be a loop of wire that is thin near the middle of the fuse. This is the section that will "burn-out."
A "normal" fuse is a fast-blow fuse. For instance, a 1amp fuse will remain intact when up to 1.25 amp flows. When a circuit is turned on, it may take 2-3 amps for a very short period of time and a normal 1 amp fuse will get very hot and the wire will stretch but not "burn-out." You can see the wire move when the supply turns on.
If the current increases to 2amps, the fuse will still remain intact. It needs about 3 amp to heat up the wire to red-hot and burn out.

If the current increases to 5 amp, the wire VOLATILISES (burns-out) and deposits carbon-black on the inside of the glass tube.
A slow-blow fuse uses a slightly thicker piece of wire and the fuse is made of two pieces of wire joined in the middle with a dob of low-temperature solder. Sometimes one of the pieces of wire is a spring and when the current rises to 2.5 amp, the heat generated in the wire melts the solder and the two pieces of wire "spring apart."
A slow-blow fuse will allow a higher current-surge to pass through the fuse and the wire will not heat up and sag.
Thus the fuse is not gradually being damaged and it will remain in a perfect state for a long period of time.
A fuse does not protect electronic equipment from failing. It acts AFTER the equipment has failed.
It will then protect a power supply from delivering a high current to a circuit that has failed.
If a slow-blow fuse has melted the solder, it could be due to a slight overload, slight weakening of the fuse over a period of time or the current-rating may be too low.
You can try another fuse to see what happens.
You can replace a fast-acting fuse (normal fuse) with a slow blow if the fast-acting fuse has been replaced a few times due to deterioration when the equipment is turned on.
But you cannot replace a slow-blow fuse with a fast acting fuse as it will be damaged slightly each time the equipment is turned on and eventually fail.

100mA FUSES

Fuses below about 100mA are very hard to make and very unreliable.
Many circuits take a high current when turned to charge the electrolytics and a 100mA (or 50mA or 63mA fuse) will bow and stretch and change shape, every time the equipment is turned ON.
Eventually it will break, due to it heating-up and stretching.
To produce a reliable fuse below 100mA, some manufacturers have placed a resistor inside the fuse and connected it to a spring. One end of the resistor is soldered to a wire with low-temperature metal and when the resistor gets hot, the metal softens and the spring pulls the resistor away from the wire.
Quite often you can heat up the metal and connect the wire and the fuse is perfect.
This type of fuse is called a DELAY fuse and the current rating is shown on the end-cap.
The value of the resistor determines the current rating.
There is a small voltage across this type of fuse and it means the circuit sees a slightly lower voltage than the supply voltage.
The third photo shows the pot of solder or low-temp metal and a wire connected to a spring. The heat generated in the wire is passed to the solder and it softens. The spring pulls the two components apart. You can smash the glass and set up the fuse in the two fuse-holders and repair the fuse while you wait for a new fuse to arrive.

TESTING COILS, INDUCTORS and YOKES

Coils, inductors, chokes and yokes are just coils (turns) of wire. The wire may be wrapped around a core made of iron or ferrite.
It is labeled "L" on a circuit board.
You can test this component for continuity between the ends of the winding and also make sure there is no continuity between the winding and the core.
The winding can be less than one ohm, or greater than 100 ohms. A coil of wire is also called an INDUCTOR and it might look like a very simple component, but it can operate in a very complex way.
The way it works is a discussion for another eBook. It is important to understand the turns are insulated but a slight fracture in the insulation can cause two turns to touch each other and this is called a "SHORTED TURN" or you can say the inductor has "SHORTED TURNS."
When this happens, the inductor allows the circuit to draw MORE CURRENT. This causes the fuse to "blow."
The quickest way to check an inductor is to replace it, but if you want to measure the inductance, you can use an INDUCTANCE METER. You can then compare the inductance with a known good component.
An inductor with a shorted turn will have a very low or zero inductance, however you may not be able to detect the fault when it is not working in a circuit as the fault may be created by a high voltage generated between two of the turns.
Faulty yokes (both horizontal and vertical windings) can cause the picture to reduce in size and/or bend or produce a single horizontal line.
A TV or monitor screen is the best piece of Test Equipment as it has identified the fault. It is pointless trying to test the windings further as you will not be able to test them under full operating conditions. The fault may not show up when a low voltage (test voltage) is applied.

MEASURING AND TESTING INDUCTORS

Inductors are measured with an INDUCTANCE METER but the value of some inductors is very small and some Inductance Meters do not give an accurate reading. The solution is to measure a larger inductor and note the reading. Now put the two inductors in SERIES and the values ADD UP - just like resistors in SERIES. This way you can measure very small inductors. VERY CLEVER!

Question from a reader: *Can I add an inductor to stop a fuse blowing?*

Basically, an inductor NEVER prevents a fuse blowing because an inductor prevents spikes on one lead (we will call the INPUT lead), appearing on its other lead.
This is the detection and prevention of current that exists for a very short period of time.
A fuse detects an excess of current that occurs over a very long period of time and they are entirely two different "detectors."
One cannot assist the other in any way.

An inductor is basically a coil of wire. It may be thick or thin wire. The value of the inductor is a combination of the number of turns and the material on which the wire is wound.
The value of an inductor does not change over say a period of 20 years but it can go faulty by the enamel cracking and two turns touching. This can also be due to the difference in voltage between the two turns creating a spark between the turns and creating a "short."
When you test it, the high voltage is not present and it will test ok.
You may not think a few turns of wire will have any effect on improving a circuit, but spikes are very high frequency and the inductor will have a very big effect on reducing them.
An inductor (say 100uH) can be produced in many different sizes and the thickness of the wire will be important as it determines the current that can flow through the inductor.
The term "inductor" also includes those with two or more windings and these components are called TRANSFORMERS. These devices can get "shorts" and "leaks" between the windings and sparks can be seen between the windings. These sparks do not occur when you are testing them on test-equipment so the only way to

guarantee success is to replace it with an identical replacement.

TESTING SWITCHES and RELAYS

Switches and relays have contacts that open and close mechanically and you can test them for CONTINUITY. However these components can become intermittent due to dirt or pitting of the surface of the contacts due to arcing as the switch is opened.
It is best to test these items when the operating voltage and current is present as they quite often fail due to the arcing. A switch can work 49 times then fail on each 50th operation. The same with a relay. It can fail one time in 50 due to CONTACT WEAR.
If the contacts do not touch each other with a large amount of force and with a large amount of the metal touching, the current flowing through the contacts will create HEAT and this will damage the metal and sometimes reduce the pressure holding the contact together.
This causes more arcing and eventually the switch heats up and starts to burn.
Switches are the biggest causes of fire in electrical equipment and households.

A relay also has a set of contacts that can cause problems.
There are many different types of relays and basically they can be put into two groups.
1. An electromagnetic relay is a switch operated by magnetic force. This force is generated by current through a coil. The relay opens and closes a set of contacts. The contacts allow a current to flow and this current can damage the contacts.
Connect 5v or 12v to the coil (or 24v) and listen for the "click" of the points closing.
Measure the resistance across the points to see if they are closing.
You really need to put a load on the points to see if they are clean and can carry a current.
The coil will work in either direction.
If not, the relay is possibly a CMOS relay or Solid State relay.

2. An electronic relay (Solid State Relay) does not have a winding. It works on the principle of an opto-coupler and uses a LED and Light Activated SCR or Opto-TRIAC to produce a low resistance on the output. The two pins that energise the relay (the two input pins) must be connected to 5v (or 12v) around the correct way as the voltage is driving a LED (with series resistor). The LED illuminates and activates a light-sensitive device.

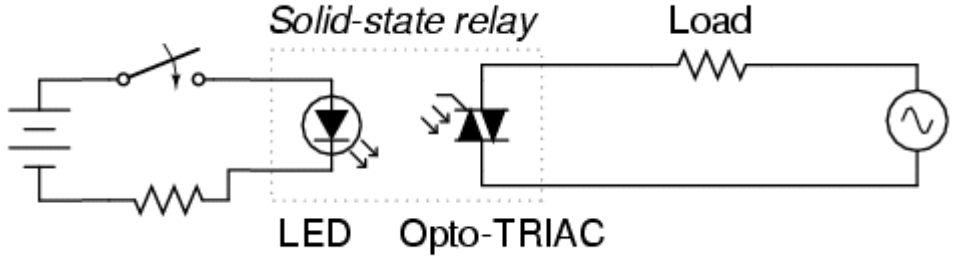

TESTING REED SWITCHES

A reed switch is generally contained in a long glass tube:

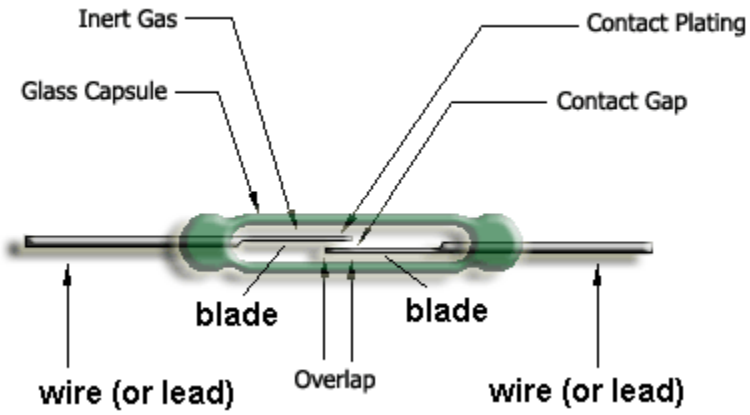

A wire or lead comes out each end for soldering to the reed switch to the project.
The two "blades" inside the switch are made from a material that can be magnetised but does not retain its magnetism. This effect is called "temporally magnetised" (not permanently magnetised) and really only "passes" magnetism from one end to the other when in the presence of a magnet. One of the blades is made of a soft material and it will bend very easily. The other one is much stiffer.

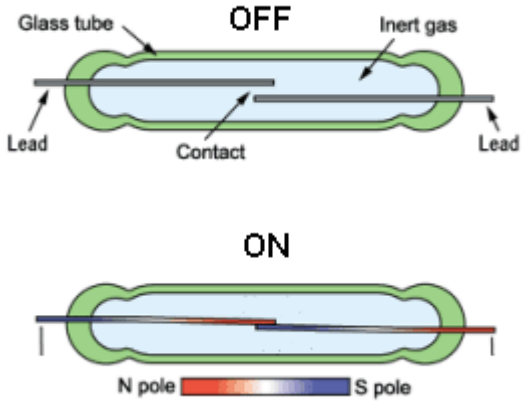

When a magnet is placed under the two blades (or on top), the magnetism from the magnet is passed to the two blades (INDUCTION or MUTUAL INDUCTION - commonly called INDUCED) and it produces a very weak magnet (in the blade) that is identical to the powerful magnet as far as the position of the north and south poles are concerned). Initially it produces a N-S and N-S set of poles and this makes the two blades click together because the top blade will be South at the contact and the bottom blade will be North.
When the two blades click together the magnetism runs through the two blades and keeps them together. The two blades attract and the switch is closed. When the magnet is removed, the magnetism in the two blades ceases and the two blades move apart.
Since there is a very small amount of movement in the top blade, this switch has a limited number of operations. Eventually it will fail. It is a mechanical device and is not suited for detecting a spinning shaft as 100,000 revolutions will very quickly weaken the switch.
If the switch does not make contact or remains closed, the moveable blade can be cracked or broken. This can be very hard to see. So replace the switch.

LATCHING REED SWITCH

A "normal" reed switch can be converted into a **LATCHING REED SWITCH** by carefully placing a magnet below the switch and moving it away so the two blades open. Now move it slightly closer but do not allow the blades to close.
This is called putting a "SET" on the switch and the two blades will have a small magnetic effect "induced" in them but not enough to close the contacts:

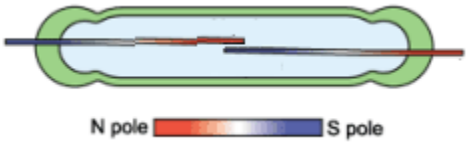

Now bring a strong magnet up to the reed switch on the other side of the glass tube with the north pole above the north of the lower magnet. This effect will increase the INDUCED MAGNETISM in the blades and close the contacts:

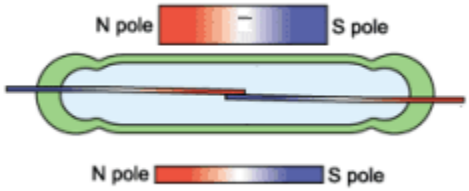

Remove the top magnet and the lower magnet will induce enough magnetism into the blades to keep them closed:

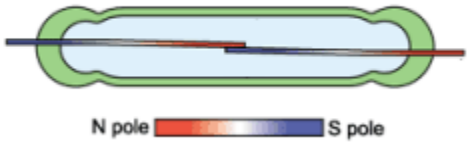

Now bring the upper magnet near the reed switch with the south pole above the north pole of the lower magnet. (In other words: AROUND THE OTHER WAY) This will have the effect of reducing the induced magnetism in the blades and a point will be reached when the two contacts will separate:

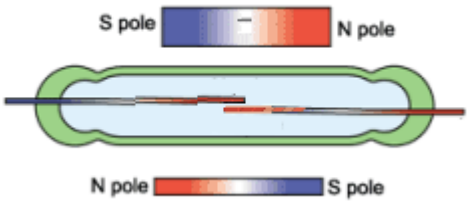

Remove the top magnet and the switch will remain separated because the lower magnet will not have sufficient influence on the blades to close the contact:

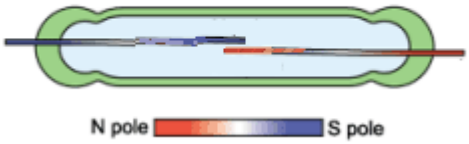

CAPACITORS

Capacitors are one of the most difficult things to test. That's because they don't give a reading on a multimeter and their value can range from 1p to 100,000u.
A faulty capacitor may be "open" when measured with a multimeter, and a good capacitor will also be "open."

You need a piece of test equipment called a CAPACITANCE METER to measure the value of a capacitor.

HOW A CAPACITOR WORKS

There are two ways to describe how a capacitor works. Both are correct and you have to combine them to get a full picture.
A capacitor has INFINITE resistance between one lead and the other.
This means no current flows **through** a capacitor. But it works in another way.
Suppose you have a strong magnet on one side of a door and a piece of metal on the other. By sliding the magnet up and down the door, the metal rises and falls.
The metal can be connected to a pump and you can pump water by sliding the magnet up and down.
A capacitor works in exactly the same way.
If you raise a voltage on one lead of a capacitor, the other lead will rise to the same voltage. This needs more explaining - we are keeping the discussion simple.
It works just like the magnetic field of the magnet through a door.
The next concept is this:
Capacitors are equivalent to a tiny rechargeable battery.
They store energy when the supply-voltage is present and release it when the supply drops.
These two concepts can be used in many ways and that's why capacitors perform tasks such as filtering, time-delays, passing a signal from one stage to another and create many different effects in a circuit.

CAPACITOR VALUES

The basic unit of capacitance is the FARAD. (C) This is the value used in all equations, but it is a very large value. A one FARAD capacitor would be the size of a car if made with plates and paper. Most electronic circuits use capacitors with smaller values such as 1p to 1,000u. 1p is about equal to two parallel wires 2cm long. 1p is one picofarad.

The easiest way to understand capacitor values is to start with a value of 1u. This is one microfarad and is one-millionth of a Farad. A 1 microfarad capacitor is about 1cm long and the diagram shows a 1u electrolytic.

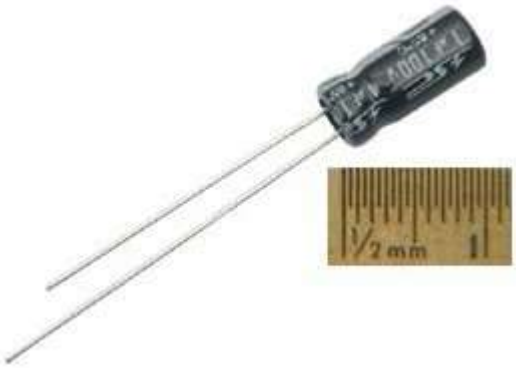

Smaller capacitors are ceramic and they look like the following. This is a 100n (0.1u)ceramic:

To read the value on a capacitor you need to know a few facts.

The basic value of capacitance is the FARAD.
1 microfarad is one millionth of 1 farad.
1 microfarad is divided into smaller parts called nanofarad.
1,000 nanofarad = 1 microfarad
Nanofarad is divided into small parts called picofarad
1,000 picofarad = 1 nanofarad.

Recapping:
1p = 1 picofarad. 1,000p = 1n (1 nanofarad)
1,000n = 1u (1 microfarad)
1,000u = 1millifarad
1,000,000u = 1 FARAD.

Examples:
All ceramic capacitors are marked in "p" (puff")
A ceramic with 22 is 22p = 22 picofarad
A ceramic with 47 is 47p = 47 picofarad
A ceramic with 470 is 470p = 470 picofarad
A ceramic with 471 is 470p = 470 picofarad
A ceramic with 102 is 1,000p = 1n
A ceramic with 223 is 22,000p = 22n
A ceramic with 104 is 100,000p = 100n = 0.1u

TYPES OF CAPACITOR
For testing purposes, there are two types of capacitor.
Capacitors from 1p to 100n are non-polar and can be inserted into a circuit around either way.
Capacitors from 1u to 100,000u are electrolytics and are polarised. They must be fitted so the positive lead goes to the supply voltage and the negative lead goes to ground (or earth).
There are many different sizes, shapes and types of capacitor. They are all the same. They consist of two plates with an insulating material between. The two plates can be stacked in layers or rolled together.
The important factor is the insulating material. It must be very thin to keep things small. This gives the capacitor its VOLTAGE RATING.
If a capacitor sees a voltage higher than its rating, the voltage will "jump through" the insulating material or around it.
If this happens, a carbon deposit is left behind and the capacitor becomes "leaky" or very low resistance, as carbon is conductive.

CERAMIC CAPACITORS

Nearly all small capacitors are **ceramic capacitors** as this material is cheap and the capacitor can be made in very thin layers to produced a high capacitance for the size of the component. This is especially true for surface-mount capacitors.
All capacitors are marked with a value and the basic unit is: "p" for "puff" However NO surface mount capacitors are marked and they are very difficult to test.

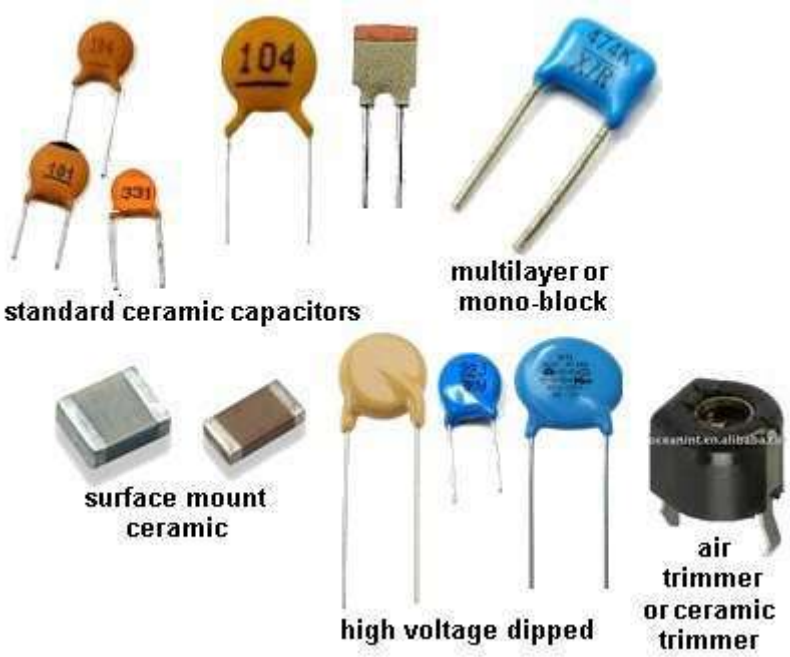

VALUE:	VALUE WRITTEN ON THE COMPONENT:
0.1p	0p1
0.22p	0p22
0.47p	0p47
1.0p	1p0
2.2p	2p2
4.7p	4p7
5.6p	5p6
8.2p	8p2
10p	10 or 10p
22p	22 or 22p
47p	47 or 47p
56p	56 or 56p
100p	100 on 101
220p	220 or 221
470p	470 or 471
560p	560 or 561
820p	820 or 821
1,000p (1n)	102
2200p (2n2)	222
4700p (4n7)	472
8200p (8n2)	822
10n	103
22n	223
47n	473
100n	104
220n	224
470n	474
1u	105

POLYESTER, POLYCARBONATE, POLYSTYRENE, MYLAR, METALLISED POLYESTER, ("POLY"), MICA and other types of CAPACITOR

There are many types of capacitor and they are chosen for their reliability, stability, temperate-range and cost.

For testing and repair work, they are all the same. Simply replace with exactly the same type and value.

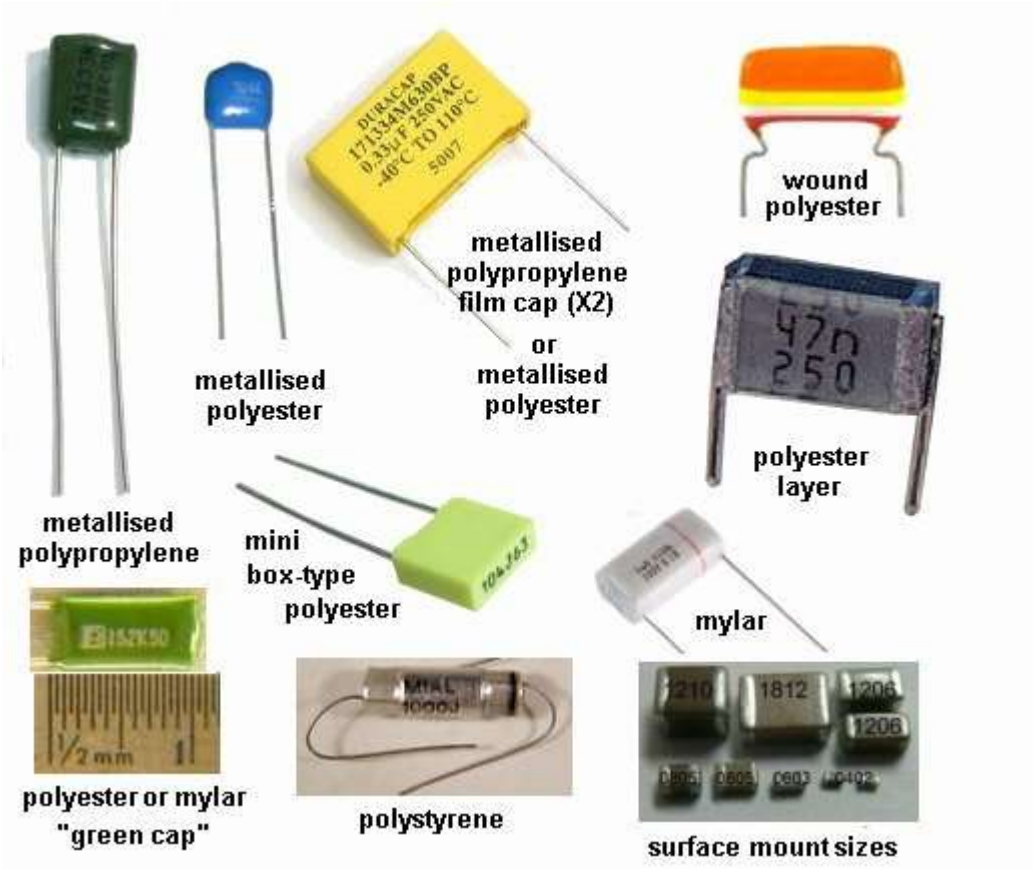

Capacitor Colour Code Table

Colour	Digit A	Digit B	Multiplier D	Tolerance (T) > 10pf	Tolerance (T) < 10pf	Temperature Coefficient (TC)
Black	0	0	x1	± 20%	± 2.0pF	
Brown	1	1	x10	± 1%	± 0.1pF	$-33x10^{-6}$
Red	2	2	x100	± 2%	± 0.25pF	$-75x10^{-6}$
Orange	3	3	x1,000	± 3%		$-150x10^{-6}$
Yellow	4	4	x10,000	± 4%		$-220x10^{-6}$
Green	5	5	x100,000	± 5%	± 0.5pF	$-330x10^{-6}$
Blue	6	6	x1,000,000			$-470x10^{-6}$
Violet	7	7				$-750x10^{-6}$
Grey	8	8	x0.01	+80%,-20%		
White	9	9	x0.1	± 10%	± 1.0pF	
Gold			x0.1	± 5%		

Silver			x0.01	± 10%		

Pico Farads (pF)	Nano Farads (nF)	Micro Farads (µF)
1	0.001	0.000001
10	0.01	0.00001
100	0.1	0.0001
1,000	1	0.001
10,000	10	0.01
100,000	100	0.1
1,000,000	1,000	1
10,000,000	10,000	10
100,000,000	100,000	100

Type ⊕ = polarized	Pic	Cap Range
Ceramic		pF - µF
Mica (silver mica)		pF - nF
Plastic Film (polyethylene polystyrene)		few µFs
Tantalum ⊕		µFs
OSCON ⊕		µFs
Aluminum Electrolytic ⊕		high µFs

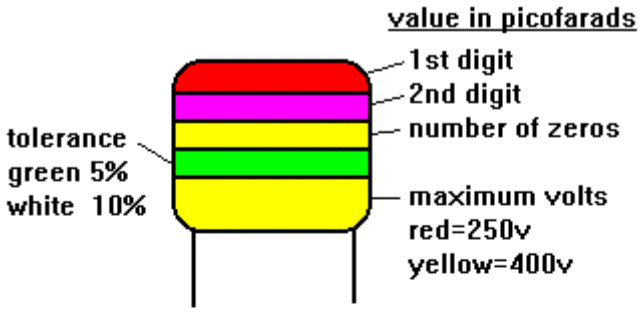

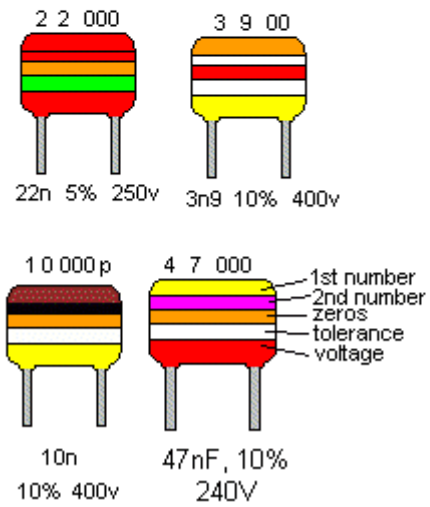

Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

ELECTROLYTIC and TANTALUM CAPACITORS

Electrolytics and Tantalums are the same for testing purposes but their performance is slightly different in some circuits. A tantalum is smaller for the same rating as an electrolytic and has a better ability at delivering a current. They are available up to about 1,000u, at about 50v but their cost is much higher than an electrolytic.

Electrolytics are available in 1u, 2u2 3u3 4u7 10u, 22u, 47u, 100u, 220u, 330u, 470u, 1,000u, 2,200u, 3,300u, 4,700u, 10,000u and higher.
The "voltage" or "working voltage" can be: 3.3v, 10v, 16v, 25v, 63v, 100v, 200v and higher.
There is also another important factor that is rarely covered in text books. It is RIPPLE FACTOR.
This is the amount of current that can enter and leave an electrolytic. This current heats up the electrolytic and that is why some electrolytics are much larger than others, even though the capacitance and voltage-ratings are the same.
If you replace an electrolytic with a "miniature" version, it will heat up and have a very short life. This is especially important in power supplies where current (energy) is constantly entering and exiting the electrolytic as its main purpose is to provide a smooth output from a set of diodes that delivers "pulsing DC." (see "Power Diodes")

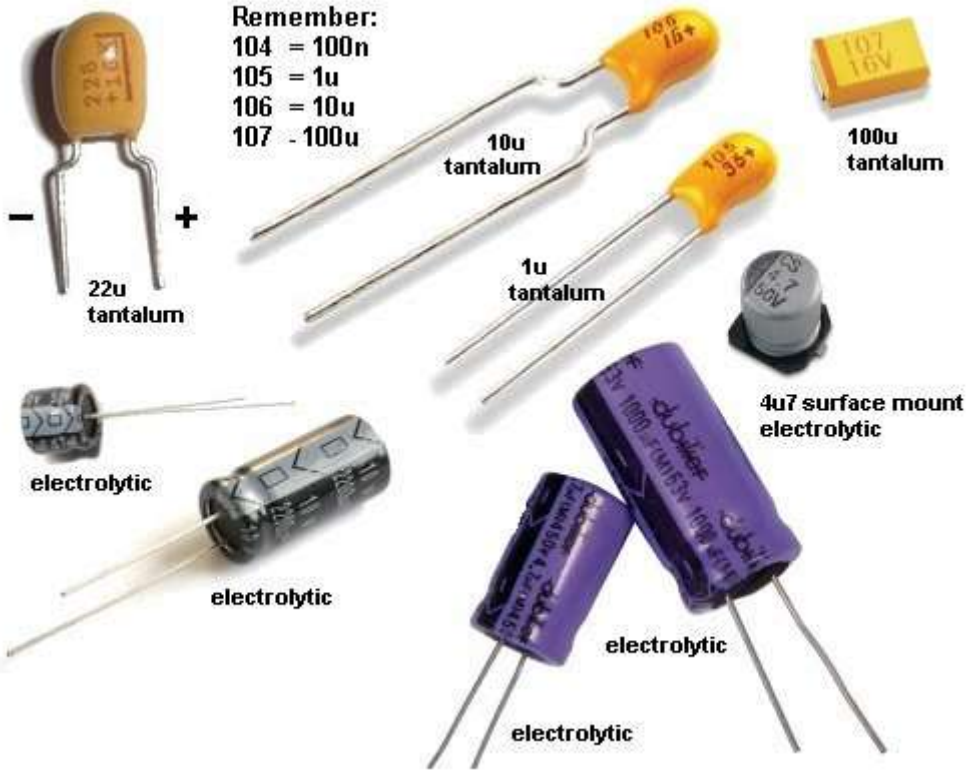

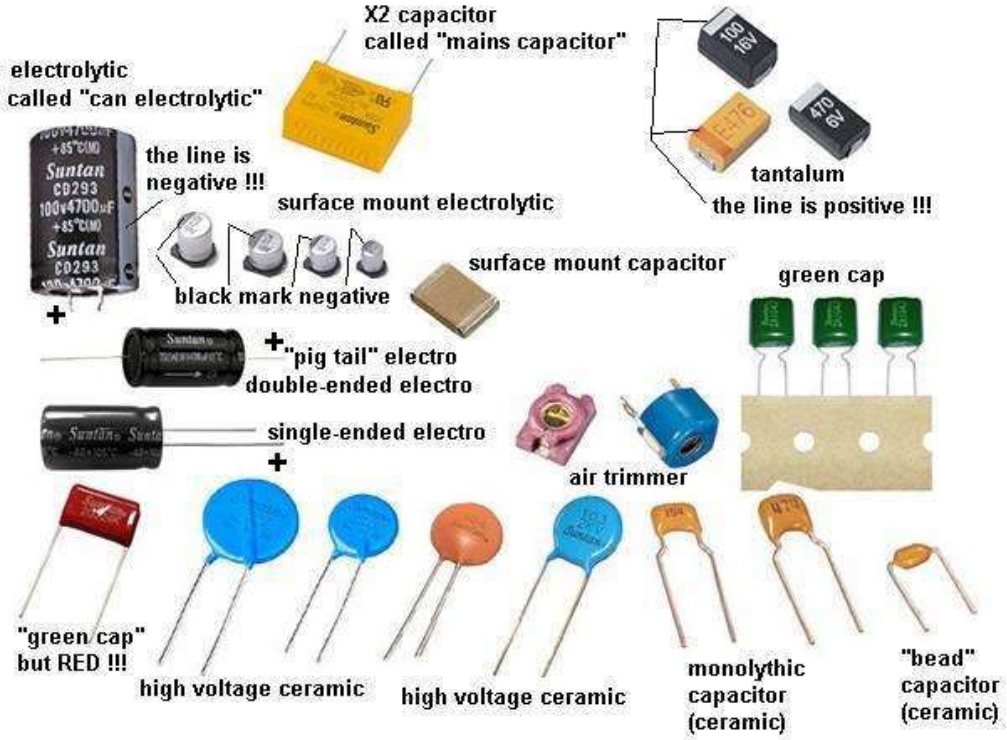

tantalum capacitors can
"go up in smoke"

"bead" tantalum

PARALLEL and SERIES CAPACITORS

Capacitors can be connected in PARALLEL and/or SERIES for a number of reasons.
1. If you do not have the exact value, two or more connected in parallel or series can produce the value you need.
2. Capacitors connected in series will produce one with a higher voltage rating.
3. Capacitors connected in parallel will produce a larger-value capacitance.

Here are examples of two equal capacitors connected in series or parallel and the results they produce:

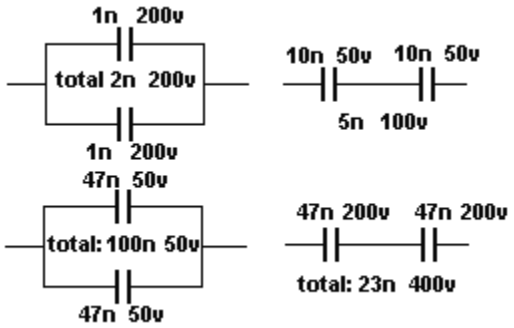

NON-POLAR CAPACITORS (ELECTROLYTICS)

Electrolytics are also available in non-polar values. It sometimes has the letters "NP" on the component. Sometimes the leads are not identified.
This is an electrolytic that does not have a positive and negative lead but two leads and either lead can be connected to the positive or negative of the circuit.
These electrolytics are usually connected to the output of an amplifier (such as in a filter near the speaker) where the signal is rising and falling.
A non-polar electrolytic can be created from two ordinary electrolytics by connecting the negative leads together and the two positive leads become the new leads.
For example: two 100u 63v electrolytics will produce a 47u 63v non-polar electrolytic.
In the circuit below, the non-polar capacitor is replaced with two electrolytics.

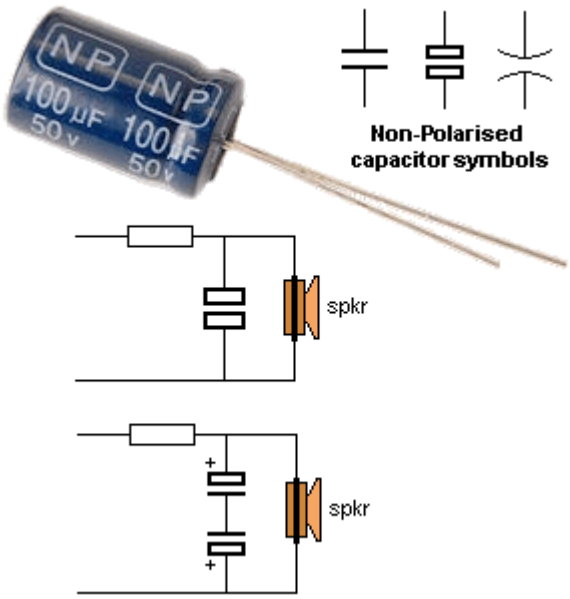

MAKING A NON-POLAR ELECTROLYTIC

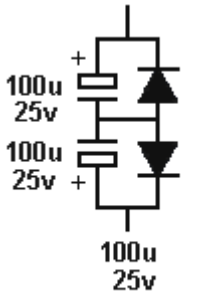

non-polar

A normal electrolytic must be connected the correct way in a circuit because it has a thin insulating layer covering the plates that has a high resistance.
If you connect the electrolytic around the wrong way, this layer "breaks-down" and the resistance of the electrolytic becomes very small and a high current flows. This heats up the electrolytic and the current increases. Very soon the capacitor produces gasses and explodes.
One big mistake in many text books shows how to make a non-polar electrolytic by connecting two "back-to-back."
They claim 2 x 100u connected back-to-back is equal to 47u.
This appears to be case when testing on a meter but the meter simply charges them for a short period of time to get a reading.
If you allow them to charge fully you will find the reverse electrolytic has a very small voltage across it.
Secondly, when you are charging them, you are putting a high current through the reverse electrolytic and damaging the layer.
To prevent this, you need to add two diodes as shown in the diagram.
In addition, 2 x 100u "back-to-back" is very near 100u.

Here is a question from a reader:
I have an amplifier with 2 x2,200u electrolytics on the output of a bridge. Can I replace them with a single 10,000u?

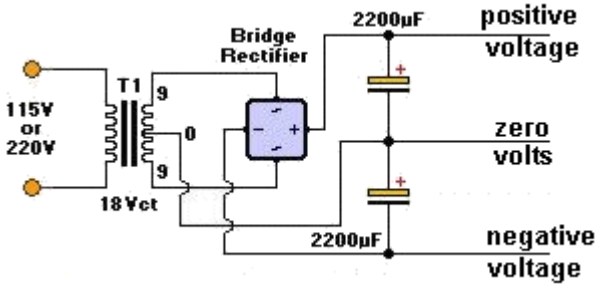

You need to look at the circuit of your amplifier. The two 2,200u electrolytics are possibly connected as shown in the circuit above and you will notice they are joined to produce a positive rail and a negative rail with zero (called earth) in the centre.
This forms two different circuits with the top electrolytic filtering the positive rail and the bottom electro filtering the negative rail. They must be connected to the zero volts rail.
A single 10,000u cannot be connected to the 0v rail and cannot be substituted for the two electro's.
You can easily determine of the two electro's are connected as shown above.
Test the positive terminal of each electro by placing the negative of the meter on the chassis.
If the positive of one electro have zero volts, it will be the lower electro in the diagram above. The negative terminal of the electro will have a minus voltage on it.

VOLTAGE RATING OF CAPACITOR
Capacitors have a voltage rating, stated as WV for working voltage, or WVDC. This specifies the maximum voltage that can be applied across the capacitor without puncturing the dielectric. Voltage ratings for "poly," mica and ceramic capacitors are typically 50v to 500 VDC. Ceramic capacitors with ratings of 1kv to 5kv are also available. Electrolytic capacitors are commonly available in 6v, 10v 16v, 25v, 50v, 100v, 150v, and 450v ratings.

THE SIZE OF A CAPACITOR - RIPPLE FACTOR
The size of a capacitor depends on a number of factors, namely the value of the capacitor (in microfarads etc) and the voltage rating. But there is also another factor that is most important. It is the RIPPLE FACTOR. **Ripple Factor** is the amount of voltage-fluctuation the capacitor (electrolytic) can withstand without getting too hot. When current flows in and out of an electrolytic, it gets hot and this will eventually dry-out the capacitor as some of the liquid inside the capacitor escapes through the seal. It's a very slow process but over a period of years, the capacitor looses its capacitance.
If you have two identical 1,000u 35v electrolytics and one is smaller, it will get hotter when operating in a circuit and that's why it is necessary to choose the largest electrolytic.

CAUTION
If a capacitor has a voltage rating of 63v, do not put it in a 100v circuit as the insulation (called the dielectric) will be punctured and the capacitor will "short-circuit." It's ok to replace a 0.22uF 50WV capacitor with 0.22uF 250WVDC.

SAFETY
A capacitor can store a charge for a period of time after the equipment is turned off. High voltage electrolytic caps can pose a safety hazard. These capacitors are in power supplies and some have a resistor across them, called a bleed resistor, to discharge the cap after power is switched off.
If a bleed resistor is not present the cap can retain a charge after the equipment is unplugged.

How to discharge a capacitor
Do not use a screwdriver to short between the terminals as this will damage the capacitor internally and the screwdriver.
Use a 1k 1 watt or 3watt or 5watt resistor on jumper leads (or held with pliers) and keep them connected for up to 15 seconds to fully discharge the electro.
Test it with a voltmeter to make sure all the energy has been removed.

Before testing any capacitors, especially electrolytics, you should look to see if any are damaged, overheated or leaking. Swelling at the top of an electrolytic indicates heating (and pressure inside the case) and will result in drying out of the electrolyte. Any hot or warm electrolytic indicates leakage and ceramic capacitors with portions missing indicates something has gone wrong (such as it being "blown apart").

Here is a 120u 330v electrolytic from a flash circuit in an old-fashioned film camera. If the flash does not "fire," the electrolytic will be charged to about 350 volts !!
Use a 1k resistor (held with pliers) to slowly discharge it. It may take 15 seconds to fully discharge.

TESTING A CAPACITOR
There are two things you can test with a multimeter:
1. A short-circuit within the capacitor
2. Capacitor values above 1u.

You can test capacitors in-circuit for short-circuits. Use the x1 ohms range.
To test a capacitor for leakage, you need to remove it or at least one lead must be removed. Use the x10k range on an analogue or digital multimeter.
For values above 1u you can determine if the capacitor is charging by using an analogue meter. The needle will initially move across the scale to indicate the cap is charging, then go to "no deflection." Any permanent deflection of the needle will indicate leakage.
You can reverse the probes to see if the needle moves in the opposite direction. This indicates it has been charged. Values below 1u will not respond to charging and the needle will not deflect.
This does not work with a digital meter as the resistance range does not output any current and the electrolytic does not charge.

Rather than spending money on a capacitance meter, it is cheaper to replace any suspect capacitor or electrolytic.
Capacitors can produce very unusual faults and no piece of test equipment is going to detect the problem.
In most cases, it is a simple matter to solder another capacitor across the suspect component and view or listen to the result.
This saves all the worry of removing the component and testing it with equipment that cannot possibly give you an accurate reading when the full voltage and current is not present.
It is complete madness to even think of testing critical components such as capacitors, with TEST EQUIPMENT. You are fooling yourself. If the Test Equipment says the component is ok, you will look somewhere else and waste a lot of time.

FINDING THE VALUE OF A CAPACITOR

If you want to find the value of a surface-mount capacitor or one where the markings have been removed, you will need a CAPACITANCE METER. Here is a simple circuit that can be added to your meter to read capacitor values from 10p to 10u.
The full article can be found HERE.

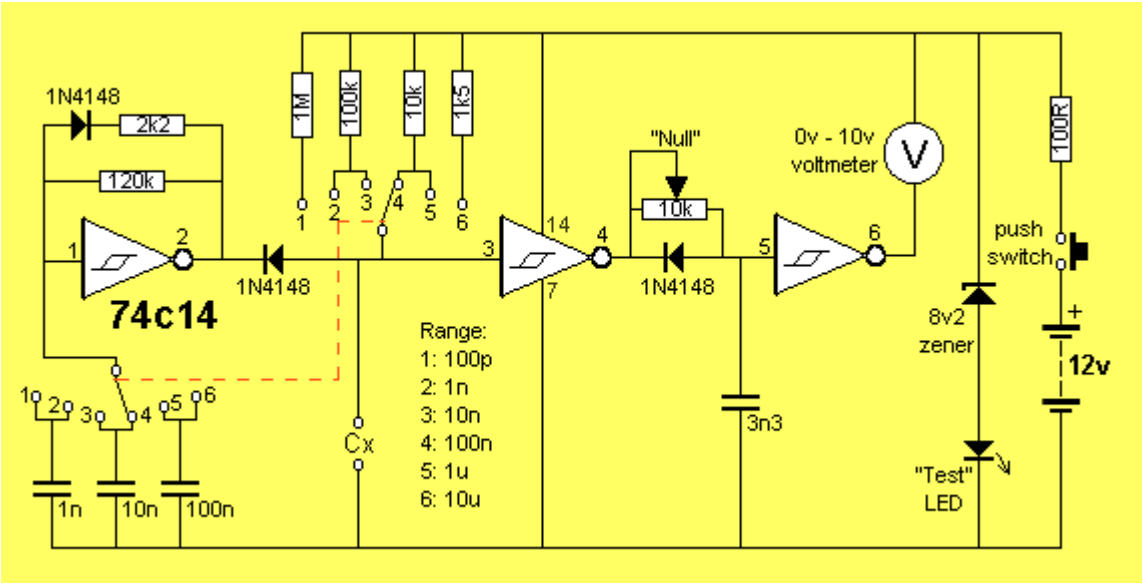

ADD-ON CAPACITANCE METER

CAPACITOR SUBSTITUTION BOX

You can get a kit or a ready-made piece of test gear called **CAPACITOR SUBSTITUTION BOX** and also **RESISTOR SUBSTITUTION BOX**.
I bought one of each 30 years ago and I have only used them ONCE.
They appear to be very handy but when you are testing a circuit, you want the component next to the other parts.
It is just as easy to pick the component you need from your junk box and connect it to the circuit via jumper leads.

REPLACING A CAPACITOR

Always replace a capacitor with the exact same type.
A capacitor may be slightly important in a circuit or it might be extremely critical.
A manufacturer may have taken years to select the right type of capacitor due to previous failures.
A capacitor just doesn't have a "value of capacitance."
It may also has an effect called "tightening of the rails."
In other words, a capacitor has the ability to react quickly and either absorb or deliver energy to prevent spikes or fluctuations on the rail.
This is due to the way it is constructed. Some capacitors are simply plates of metal film while others are wound in a coil. Some capacitors are large while others are small.
They all react differently when the voltage fluctuates.
Not only this, but some capacitors are very stable and all these features go into the decision for the type of capacitor to use.
You can completely destroy the operation of a circuit by selecting the wrong type of capacitor.
No capacitor is perfect and when it gets charged or discharged, it appears to have a small value of resistance in series with the value of capacitance. This is known as "ESR" and stands for EQUIVALENT SERIES RESISTANCE. This effectively makes the capacitor slightly slower to charge and discharge.
We cannot go into the theory on selecting a capacitor as it would be larger than this eBook so the only solution is to replace a capacitor with an identical type.
However if you get more than one repair with identical faults, you should ask other technicians if the original capacitor comes from a faulty batch.
The author has fixed TV's and fax machines where the capacitors have been inferior and alternate types have solved the problem.
Some capacitor are suitable for high frequencies, others for low frequencies.

DECOUPLING CAPACITORS

A Decoupling Capacitor can severe one, two or three functions. You need to think of a decoupling capacitor as a miniature battery with the ability to deliver a brief pulse of energy when ever the line-voltage drops and also absorb a brief pulse of energy when ever the line voltage rises (or spikes).
Decoupling capacitor can range from 100n to 1,000u.
100n capacitors are designed to absorb spikes and also have the effect of tightening-

up the rails for high frequencies. They have no effect on low frequencies such as audio frequencies.
These capacitors are generally ceramic and have very low internal impedance and thus they can operate at high frequencies.
Capacitors above about 10u are used for decoupling and these are nearly always electrolytics.
Decoupling means "tightening-up the power rails." The electrolytic acts just like a miniature rechargeable battery, supplying a small number of components in a circuit with a smooth and stable voltage.
The electrolytic is usually fed from a dropper resistor and this resistor charges the electrolytic and adds to the ability of the electrolytic to create a "separate power supply."
These two components help remove spikes as an electrolytic cannot remove spikes if connected directly to the supply rails - it's internal impedance is high and the spikes are not absorbed.
Decoupling capacitors are very difficult to test.
They rarely fail but if a project is suffering from unknown glitches and spikes, it is best to simply add more 100n decoupling caps on the underside of the board and replace all electrolytics.
Some small electrolytics will dry out due to faulty manufacture and simply replacing every one on a board will solve the problem.
Some of the functions of a decoupling capacitor are:
Removing ripple - hum or buzz in the background of an amplifier
Removing glitches or spikes.
Separating one stage from another to reduce or remove MOTORBOATING - a low frequency sound due to the output putting a pulse on the power rails that is picked up by the pre-amplifier section and amplified.

TESTING DIODES

Diodes can have 4 different faults.
1. Open circuit in both directions.
2. Low resistance in both directions.
3. Leaky.
4. Breakdown under load.

TESTING A DIODE ON AN ANALOGUE METER

Testing a diode with an **Analogue Multimeter** can be done on any of the resistance ranges. [The high resistance range is best - it sometimes has a high voltage battery for this range but this does not affect our testing]
There are two things you must remember.
1. When the diode is measured in one direction, the needle will **not move at all**. The technical term for this is the diode is **reverse biased**. It will not allow any current to flow. Thus the needle will not move.
When the diode is connected around the other way, the needle will swing to the right (move up scale) to about 80% of the scale. This position represents the voltage drop across the junction of the diode and is NOT a resistance value. If you change the resistance range, the needle will move to a slightly different position due to the resistances inside the meter. The technical term for this is the diode is **forward biased**. This indicates the diode is not faulty.
The needle will swing to a slightly different position for a "normal diode" compared to a Schottky diode. This is due to the different junction voltage drops.
However we are only testing the diode at very low voltage and it may break-down when fitted to a circuit due to a higher voltage being present or due to a high current flowing.

2. The leads of an **Analogue Multimeter** have the positive of the battery connected to the black probe and the readings of a "good diode" are shown in the following two diagrams:

The diode is REVERSE BIASED in the diagram above and diodes not conduct.

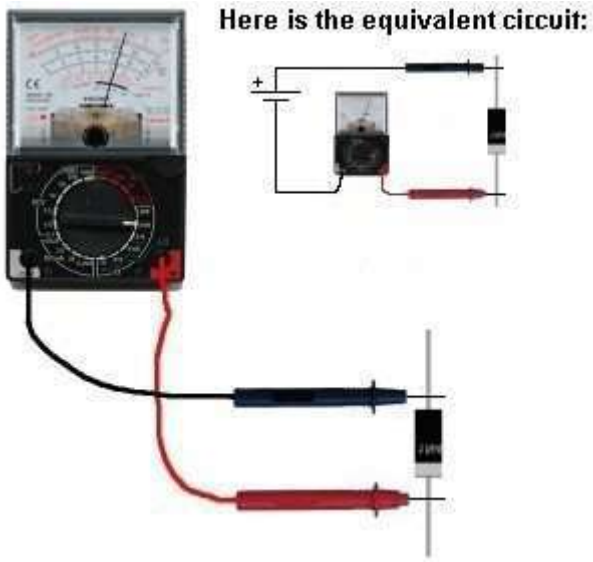

The diode is FORWARD BIASED in the diagram above and it conducts

TESTING A DIODE ON A DIGITAL METER

Testing a diode with a Digital Meter must be done on the "DIODE" setting as a digital meter does not deliver a current through the probes on some of the resistance settings and will not produce an accurate reading.

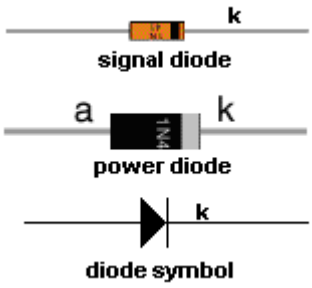

The best thing to do with a "suspect" diode is to replace it. This is because a diode has a number of characteristics that cannot be tested with simple equipment. Some diodes have a fast recovery for use in high frequency circuits. They conduct very quickly and turn off very quickly so the waveform is processed accurately and

efficiently.
If the diode is replaced with an ordinary diode, it will heat up as does not have the high-speed characteristic.
Other diodes have a low drop across them and if an ordinary is used, it will heat up.
Most diodes fail by going: SHORT-CIRCUIT. This can be detected by a low resistance (x1 or x10 Ohms range) in both directions.
A diode can also go OPEN CIRCUIT. To locate this fault, place an identical diode across the diode being tested.
A leaky diode can be detected by a low reading in one direction and a slight reading the other direction.
However this type of fault can only be detected when the circuit is working. The output of the circuit will be low and sometimes the diode heats up (more than normal).
A diode can go open under full load conditions and perform intermittently.
Diodes come in pairs in surface-mount packages and 4 diodes can be found in a bridge.
They are also available in pairs that look like a 3-leaded transistor.
The line on the end of the body of a diode indicates the cathode and you cannot say "this is the positive lead." The correct way to describe the leads is to say the "cathode lead." The other lead is the anode. The cathode is defined as the electrode (or lead) through which an electric current flows out of a device.
The following diagrams show different types of diodes:

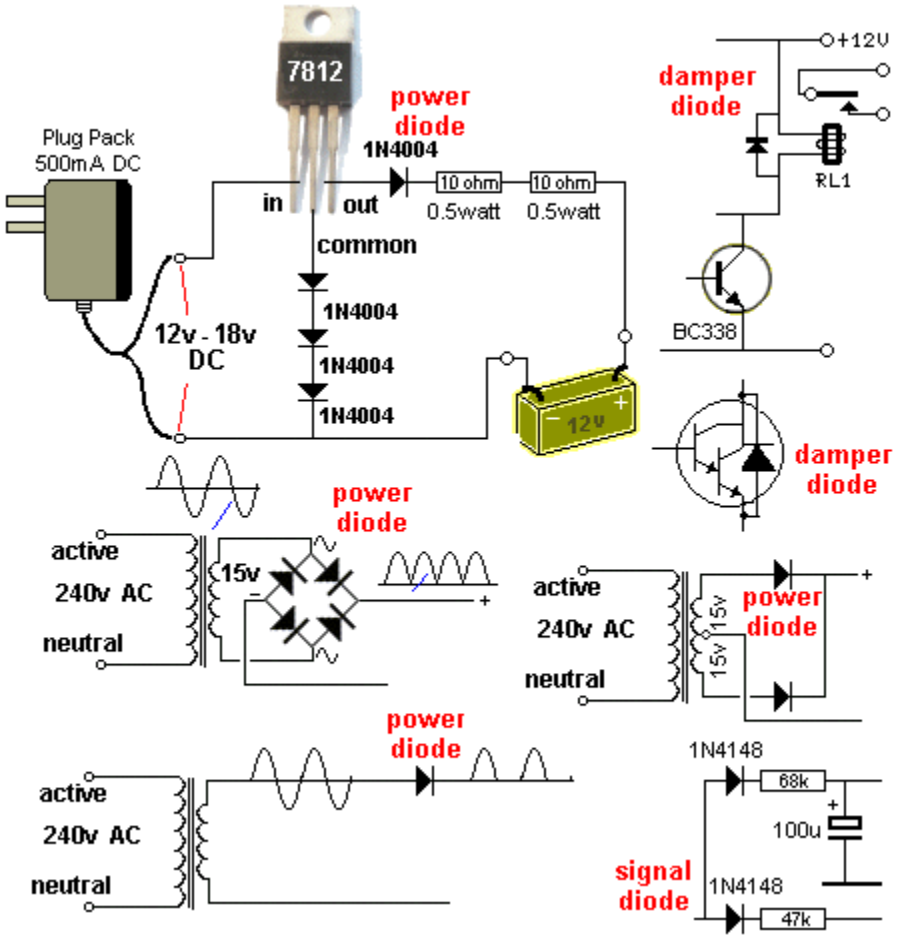

POWER DIODES

To understand how a power diode works, we need to describe a few things. This has NEVER been described before, so read carefully.
The 240v AC (called the "mains") consists of two wires, one is called the ACTIVE and the other is NEUTRAL. Suppose you touch both wires. You will get a shock. The neutral is connected to an earth wire (or rod driven into the ground or connected to a water pipe) at the point where the electricity enters the premises and you do not get a shock from the NEUTRAL.

But the voltage on the active is rising to +345v then goes to -345v at the rate of 50 times per second (for a complete cycle).
345v is the peak voltage of 240v. You never get a 240v shock. (It is a 345v shock.)
In other words, if you touch the two wires at a particular instant, you would get a POSITIVE 345v shock and at another instant you would get a negative 345v shock.
This is shown in the diagram below.
We now transfer this concept to the output of a transformer. The diagram shows an AC waveform on the output of the secondary.
This voltage is rising 15v higher than the bottom lead then it is 15v LOWER than the bottom lead. The bottom lead is called "zero volts." You have to say one lead or wire is not "rising and falling" as you need a "reference" or starting-point" or "zero point" for voltage measurements.
The diode only conducts when the voltage is "above zero" (actually when it is 0.7v above zero) and does not conduct (at all) when the voltage goes below zero.
This is shown on the output of the Power Diode. Only the positive peaks or the positive parts of the waveform appear on the output and this is called "pulsing DC."
This is called "half-wave" and is not used in a power supply. We have used it to describe how the diode works. The electrolytics charge during the peaks and deliver energy when the diode is not delivering current. This is how the output becomes a steady DC voltage.
Power supplies use FULL WAVE rectification and the other half of the AC waveform is delivered to the output (and fills in the "gaps") and appears as shown in "A."

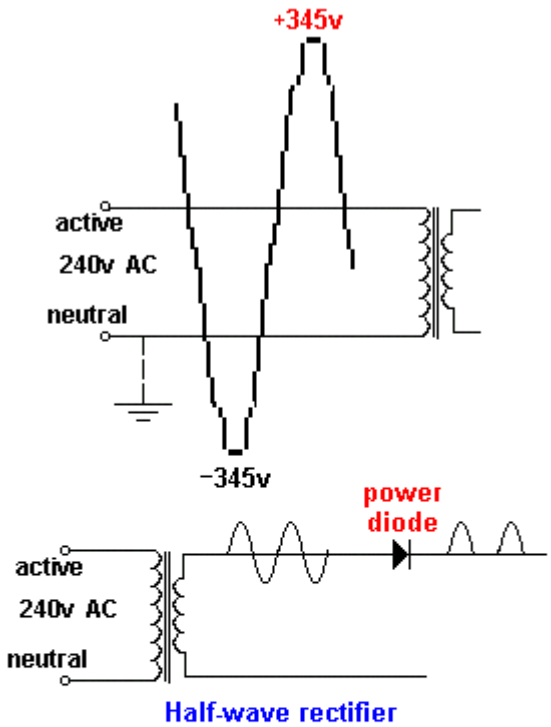

ONE FAULTY DIODE

One diode in a bridge can go open (any of the 4 diodes will produce the same effect) and produce an output voltage that can be slightly lower than the original voltage.

The actual "voltage-drop" will depend on the current taken by the circuit and the ability of the transformer to produce the required voltage and current during half-wave operation. The voltage during each half cycle (when none of the diodes is delivering any energy to the circuit) is maintained by the electrolytic and its size (relative to the current taken by the circuit) will determine the size of the ripple that will result when the diode fails. The ripple will be 100 to 1,000 times greater after the failure of a diode, depending on the value of the filter capacitor.
To locate the faulty diode, simply get a diode and place it across each of the diodes in the bridge (in turn) when the circuit is working.
For a bridge rectifier, the ripple-frequency will be twice the mains frequency and its ripple will be very small if the electrolytic is the correct value. When a diode fails, the ripple-frequency will be equal to mains-frequency and the amplitude will increase considerably. You may even hear background hum from audio equipment.
If you cannot find a faulty diode, the filter capacitor will be at fault. Turn off the equipment and connect an electrolytic across the filter capacitor via jumper leads. Turn the power ON and see if the hum has reduced.

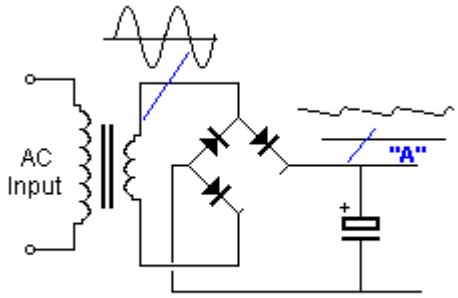

One diode "burnt-out"

DAMPER DIODES

A damper diode is a diode that detects a high voltage and SQUELCHES IT (reduces it - removes it). The signal that it squelches is a voltage that is in the opposite direction to the "supply voltage" and is produced by the collapsing of a magnetic field. Whenever a magnetic filed collapses, it produces a voltage in the winding that is opposite to the supply voltage and can be much higher. This is the principle of a flyback circuit or EHT circuit. The high voltage comes from the transformer.
The diode is placed so that the signal passes through it and less than 0.5v appears across it.
A damper diode can be placed across the coil of a relay, incorporated into a transistor or FET or placed across a winding of a flyback transformer to protect the driving transistor or FET.
It can also be called a "Reverse-Voltage Protection Diode," "Spike Suppression Diode," or "Voltage Clamp Diode."
The main characteristic of a Damper Diode is HIGH SPEED so it can detect the spike and absorb the energy.
It does not have to be a high-voltage diode as the high voltage in the circuit is being absorbed by the diode.

SILICON, GERMANIUM AND SCHOTTKY DIODES

When testing a diode with an analogue meter, you will get a low reading in one direction and a high (or NO READING) in the other direction. When reading in the LOW direction, the needle will swing nearly full scale and the reading is not a resistance-value but a reflection of the characteristic voltage drop across the junction of the diode. As we mentioned before, a resistance reading is really a voltage reading and the meter is measuring the voltage of the battery minus the voltage-drop across the diode.
Since Silicon, Germanium and Schottky Diodes have slightly different characteristic voltage drops across the junction, you will get a slightly different reading on the scale. This does not represent one diode being better than the other or capable of handling a higher current or any other feature.
The quickest, easiest and cheapest way to find, fix and solve a problem caused by a

faulty diode is to replace it.
There is no piece of test equipment capable of testing a diode fully, and the circuit you are working on is actually the best piece of test equipment as it is identifying the fault UNDER LOAD.

Only very simple tests can be done with a multimeter and it is best to check a diode with an ANALOGUE MULTIMETER as it outputs a higher current though the diode and produces a more-reliable result.
A Digital meter can produce false readings as it does not apply enough current to activate the junction.
Fortunately almost every digital multimeter has a **diode test mode.** Using this, a silicon diode should read a voltage drop between 0.5v to 0.8v in the forward direction and open in the reverse direction. For a germanium diode, the reading will be lower, around 0.2v - 0.4v in the forward direction. A bad diode will read zero volts in both directions.

REPLACING A DIODE

It is alway best to replace a diode with the same type but quite often this is not possible. Many diodes have unusual markings or colours or "in-house" letters.
This is only a general guide because many diodes have special features, especially when used in high-frequency circuits.
However if you are desperate to get a piece of equipment working, here are the steps:
Determine if the diode is a signal diode, power diode, or zener diode.
For a signal diode, try 1N4148.
For a power diode (1 amp) try 1N4004. (for up to 400v)
For a power diode (3 amp) try 1N5404. (for up to 400v)
For a high-speed diode, try UF4004 (for up to 400v)

If you put an ordinary diode in a high-speed application, it will get very hot very quickly.
To replace an unknown zener diode, start with a low voltage such as 6v2 and see if the circuit works.
The size of a diode and the thickness of the leads will give an idea of the current-capability of the diode.
Keep the leads short as the PC board acts as a heat-sink.
You can also add fins to the leads to keep the diode cool.

LIGHT EMITTING DIODES (LEDs)

Light Emitting Diodes (LEDs) are diodes that produce light when current flows from anode to cathode. The LED does not emit light when it is revered-biased. It is used as a low current indicator in many types of consumer and industrial equipment, such as monitors, TV's, printers, hi-fi systems, machinery and control panels.
The light produced by a LED can be visible, such as red, green, yellow or white. It can also be invisible and these LEDs are called Infrared LEDs. They are used in remote controls and to see if they are working, you need to point a digital camera at the LED and view the picture on the camera screen.
An LED needs about 2v - 3.6v across its leads to make it emit light, but this voltage must be exact for the type and colour of the LED. The simplest way to deliver the exact voltage is to have a supply that is higher than needed and include a voltage-dropping resistor. The value of the resistor must be selected so the current is between 2mA and 25mA.
The cathode of the LED is identified by a flat on the side of the LED. The life expectancy of a LED is about 100,000 hours. LEDs rarely fail but they are very sensitive to heat and they must be soldered and de-soldered quickly. They are one of the most heat-sensitive components.
Light emitting diodes cannot be tested with most multimeters because the characteristic voltage across them is higher than the voltage of the battery in the meter.
However a simple tester can be made by joining 3 cells together with a 220R resistor

and 2 alligator clips:

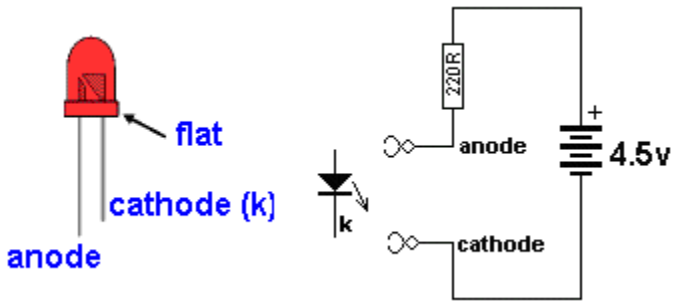

LED TESTER

Connect the clips to a LED and it will illuminate in only one direction.
The colour of the LED will determine the voltage across it. You can measure this voltage if you want to match two or more LEDs for identical operation.
Red LEDs are generally 1.7v to 1.9v. - depending on the quality such as "high-bright"
Green LEDs are 1.9v to 2.3v.
Orange LEDs are about 2.3v and
White LEDs and IR LEDs are about 3.3v to 3.6v.
The illumination produced by a LED is determined by the quality of the crystal. It is the crystal that produces the colour and you need to replace a LED with the same quality to achieve the same illumination.
Never connect a LED across a battery (such as 6v or 9v), as it will be instantly damaged. You must have a resistor in series with the LED to limit the current.

ZENER DIODES

All diodes are Zener diodes. For instance a 1N4148 is a 120v zener diode as this is its reverse breakdown voltage.
And a zener diode can be used as an ordinary diode in a circuit with a voltage that is below the zener value.
For instance, 20v zener diodes can be used in a 12v power supply as the voltage never reaches 20v, and the zener characteristic is never reached.
Most diodes have a reverse breakdown voltage above 100v, while most zeners are below 70v. A 24v zener can be created by using two 12v zeners in series and a normal diode has a characteristic voltage of 0.7v. This can be used to increase the voltage of a zener diode by 0.7v. See the diagram above. It uses 3 ordinary diodes to increase the output voltage of a 3-terminal regulator by 2.1v.
To tests a zener diode you need a power supply about 10v higher than the zener of the diode. Connect the zener across the supply with a 1k to 4k7 resistor and measure the voltage across the diode. If it measures less than 1v, reverse the zener. If the reading is high or low in both directions, the zener is damaged.

Here is a zener diode tester. The circuit will test up to 56v zeners.

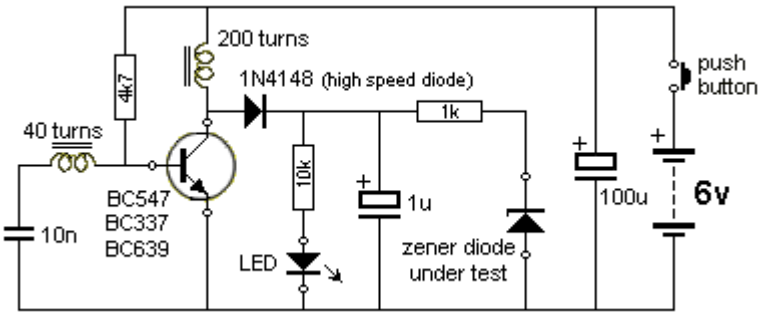

ZENER DIODE TESTER

TRANSFORMERLESS POWER SUPPLY
Here's a circuit that uses zener diodes in a power supply to show how they work. This clever design uses 4 diodes in a bridge to produce a fixed voltage power supply capable of supplying 35mA.
If we put 2 zener diodes in a bridge with two ordinary power diodes, the bridge will break-down at the voltage of the zener. This is what we have done. If we use 18v zeners, the output will be 17v4.

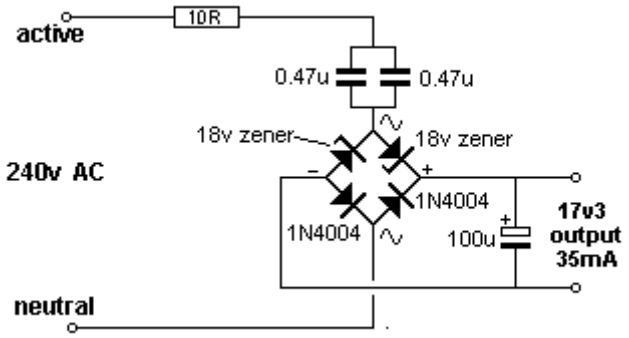

SUPPLY USING ZENER DIODES

When the incoming voltage is positive at the top, the left zener provides 18v limit (and the other zener produces a drop of 0.6v). This allows the right zener to pass current just like a normal diode. The output is 17v4. The same with the other half-cycle.
You cannot use this type of bridge in a normal power supply as the zener diode will "short" when the input voltage reaches the zener value. The concept only works in the circuit above.

VOLTAGE REGULATORS
A Voltage Regulator takes a high input voltage and delivers a fixed output voltage. Providing the input voltage is 4v above the output voltage, the regulator will deliver a fixed output voltage with almost no ripple.
Voltage regulators are also called "3-TERMINAL REGULATORS" or "REGULATOR IC's" - although this name is not generally used.
In most cases, a voltage regulator gets quite hot and for this reason it has a high failure-rate.
If a regulator is not getting hot (or warm) it has either failed or the circuit is not operating.
A regulator can only decrease the voltage. It cannot increase the current. This means the current being supplied to a circuit must also be available from the circuit supplying the regulator.
All regulators have different pin-outs, so you need to find the input pin and output pin and make sure the voltage-difference is at least 4v. Some regulators will work with a difference as low as 1v, so you need to read the specifications for the type you are servicing.
Some regulators are called "negative voltage regulators" and the input voltage will be negative and the output will be negative.
You need to test a voltage regulator with the power "ON".
Make sure you do not allow the probes to short any of the pins together as this will destroy the regulator or the circuit being supplied.
With the power turned off or the regulator removed from the circuit, you can test it with a multimeter set to resistance to see if it is ok. If any resistance readings are very low or zero ohms, the regulator is damaged.

TRANSFORMERS
All transformers and coils are tested the same way. This includes chokes, coils,

inductors, yokes, power transformers, EHT transformers (flyback transformers), switch mode transformers, isolation transformers, IF transformers, baluns, and any device that has turns of wire around a former. All these devices can go faulty.
The coating on the wire is called insulation or "enamel" and this can crack or become overheated or damaged due to vibration or movement. When two turns touch each other, a very interesting thing happens. **The winding becomes two separate windings.**

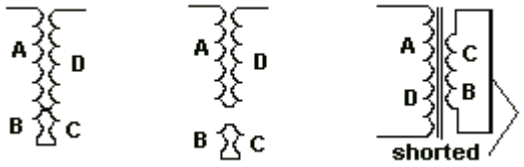

We will take the case of a single winding such as a coil. This is shown in the first diagram above and the winding is wound across a former (a former is a bobbin or plastic molding or something to hold the winding) and back again, making two layers. The bottom and top layers touch at the point shown in the diagram and the current that originally passed though A, B, C, D now passes though A & D.

Winding B C becomes a separate winding as shown in the second diagram.
In other words the coil becomes a TRANSFORMER with a SHORT CIRCUIT on the secondary winding as shown in the third diagram.
When the output wires of a transformer are shorted together, it delivers a very high current because you have created a SHORT-CIRCUIT. This short-circuit causes the transformer to get very hot.
That's exactly what happens when any coil or transformer gets a "shorted turn."
The shorted turns can be a single turn or many turns.
It is not possible to measure a fault like this with a multimeter as you don't know the exact resistance of a working coil or winding and the resistance of a faulty winding may be only 0.001 ohms less.
However when a transformer or coil is measured with an inductance meter, an oscillating voltage (or spike) is delivered into the core as magnetic flux, then the magnetic flux collapses and passes the energy into the winding to produce a waveform. The inductance meter reads this and produces a value of inductance in Henry (or milliHenry or microHenry.)
This is done with the transformer removed from the circuit and this can be a very difficult thing to do, as most transformers have a number of connections.
If the coil or transformer has a shorted turn, the energy from the magnetic flux will pass into the turns that are shorted and produce a current. Almost no voltage will be detected from winding.
The reading from the inductance meter will be low or very low and you have to work out if it is correct.
However there is one major problem with measuring a faulty transformer or coil.
It may only become faulty when power is applied.
The voltage between the turns may be sparking or jumping a gap and creating a problem. A tester is not going to find this fault.
Secondly, an inductance meter may produce a reading but you do not know if the reading is correct. An improved tester is a RING TESTER.
The circuit for a ring tester can be found here:

http://www.flippers.com/pdfs/k7205.pdf

It sends a pulse to the coil and counts the number of returning pulses or "rings." A faulty coil (or winding) may return one pulse but nearly all the energy will be passed to the shorted turns and you will be able to see this on the scale. You will only get one or two return pulses, whereas a good winding will return more pulses.

One way to detect a faulty power transformer is to connect it to the supply and feel the temperature-rise (when nothing is connected to the secondary).
It should NOT get hot.
Detecting shorted turns is not easy to diagnose as you really need another identical

component to compare the results.
Most transformers get very hot when a shorted turn has developed. It may deliver a voltage but the heat generated and a smell from the transformer will indicate a fault.

ISOLATION TRANSFORMER

An isolation transformer is a piece of **Test Equipment** that provides "Mains Voltage" but the voltage is "floating." You will still get a shock if you touch the two output leads, but it has a special use when testing unknown equipment.
Many electrical appliances are fully insulated and only have two leads connected to the mains.
When you take these appliances apart, you do not know which end of say a heating element is connected to the "live" (active) side of the mains and which end connects to the neutral.
I am not suggesting you carry out the following tests, but they are described to show how an isolation transformer works.
If you touch a soldering iron on the "live" (active) end of the heating element it will create a short-circuit.
However when the appliance is connected to the mains via an **isolation transformer**, you can touch an earthed soldering iron on either end of the heater as both leads from the isolation transformer are "floating."
Note: As soon as you earth one lead of the output an isolation transformer, the other lead becomes "active."
You can make your own **Isolation Transformer** by connecting two identical transformers "back-to-back."
The following diagram shows how this is done:

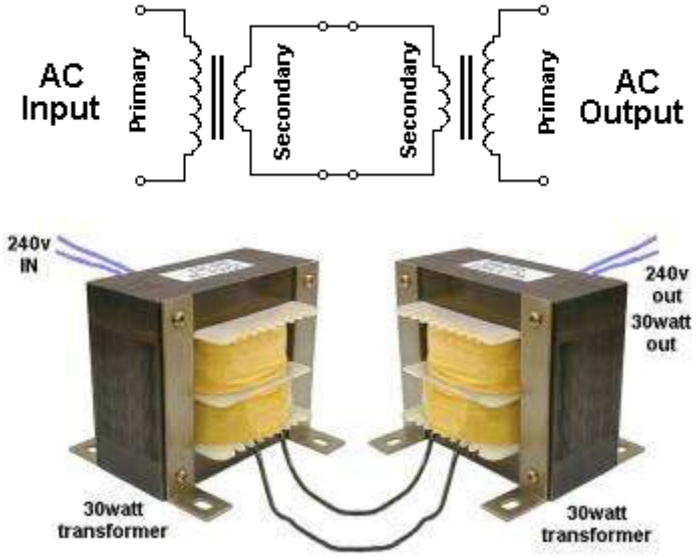

You can use any transformers providing the primary and secondary voltages are the same. The current capability of the secondary winding does not matter. However if you want a supply that has almost the same voltage as your "Mains," you need two transformers with the same voltages.
This handy isolation transformer will provide you with "Mains Voltage" but with a limited current.
In other words it will have a limited capability to supply "wattage." If you are using two 15VA transformers, you will only be able to test an appliance rated at 15 watts.
This has some advantages and some disadvantages.
If you are working on a project, and a short-circuit occurs, the damage will be limited to 15 watts.
If you are using two transformers with different VA ratings, the lower rating will be the capability of the combination.
If the secondaries are not equal, you will get a higher or lower "Mains Voltage."
If you get two transformers from TVs or Monitors, with a rating on the compliance plate of 45 watts, or 90 watts, you can assume the transformers are capable of delivering this wattage and making an isolation transformer will enable you to test

similar items with the safety of being isolated from the mains.
Colin Mitchell designs a lot of "LED lighting lamps" that are connected directly to the mains. He always works with an isolating transformer, just to be safe. Working on exposed "mains" devices is extremely nerve-wracking and you have to be very careful.
The isolation transformer will prevent a BIG EXPLOSION.

DETERMINING THE SPECS OF A TRANSFORMER
Suppose you have a "mains transformer" with unknown output voltages and unknown current capability.
You must be sure it is a mains transformer designed for operation on 50Hz or 60Hz.
Switch-Mode transformers operate at frequencies 40kHz and higher and are not covered in this discussion.
To be on the safe-side, connect the unknown transformer to the output of your isolating transformer.
Since the transformer will take almost no current when not loaded, the output voltages it produces will be fairly accurate. Measure the input AC voltage and output AC voltage.
If the transformer has loaded your isolating transformer it will be faulty.
Mains transformers are approx 15VA for 500gm, 30VA for 1kgm 50VA for 2kgm and and 100VA for 2.5kgm.
VA stands for Volts-Amps and is similar to saying watts. Watts is used for DC circuits, while VA refers to AC circuits.
Once you have the weight of the transformer and the output voltage, you can work out the current capability of the secondary.
For transformers up to 30vA, the output voltage on no-load is 30% higher than the final "loaded voltage."
This is due to the poor regulation of these small devices.
If the transformer is 15VA and the output voltage is 15v AC, the current will be 1 amp AC.
You can check the "quality" of the transformer, (the regulation) by fully loading the output and measuring the final voltage. If the transformer has a number of secondaries, the VA rating must be divided between all the windings.

240v to 110v ISOLATION TRANSFORMER

Here's how to create a 110v isolating transformer:
Find a 240v:12v transformer.
Now find a transformer that has two secondary windings, such as 240v:12v+12v.

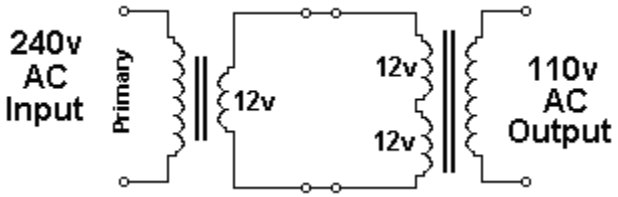

Connect the two transformers as shown in the circuit above. If the output is zero, connect ONE of the 12v windings of the second transformer around the other way.

110v to 240v ISOLATION TRANSFORMER

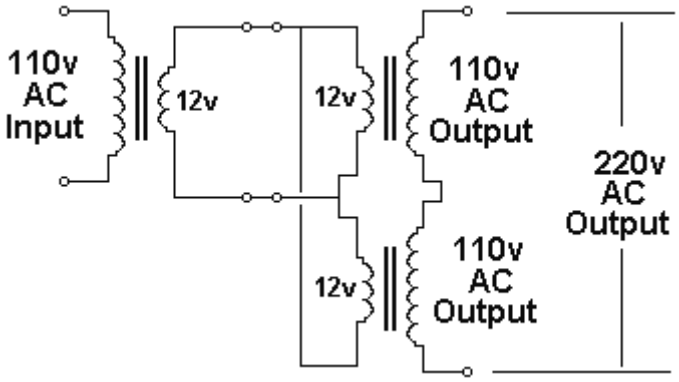

A 110v to 240v isolation transformer can be created by connecting 3 identical transformers as shown in the diagram above. If the output is zero, connect one of the outputs around the other way.

TRANSFORMER RATINGS

Question from a reader:

I have a 28v - 0 - 28v transformer @3amps. Does this mean each side is 1.5 amps?

The transformer is called CENTRE TAPPED and is shown in figures B and C.
It is designed to be connected to two diodes so each winding takes it in turn to deliver the current as shown in diagram C and the output will be 28v AC at 3 amps.
The 28v and 3 amp are both AC values.
If you connect across both outside wires, the output will be 56v at 1.5 amp.
This is because the transformer has a VA rating of 28 x 3 = 84VA. This is very similar to the term "watts."
When the 28v AC is rectified and smoothed, it becomes 28 x 1.4 = 39v (minus 0.6v across the diode) and since the transformer has a rating of 84 VA, the current must be reduced to 84/39 = 2.1 amps to maintain the VA rating.
Some transformers are specified as say: 12v - 0 - 12v, but the wiring diagram is shown as "A." This transformer should be specified as 12v + 12v as the secondaries are separate.
12v - 0 - 12v means the two secondary windings are NOT separate.
It does not make any difference to the output voltage and current, if the windings are separate or joined. The only difference is 12v +12v can be turned into two separate 12v outputs.
If you do not know the output current for a particular transformer, go to the website of electronic parts suppliers and compare the weight of your transformer with others. This will give you a VA rating and you can work out the current, once you know the output voltage.
Note: the output current finishes up ONLY 60% of the rating on the transformer tag because the rating is an **AC RATING**.
With 2 separate secondaries, you can parallel the outputs to get double the current, but don't forget 12v + 12v @ 3amp means 12v in parallel with 12v will provide 2amp DC and the DC voltage will be about 17v.

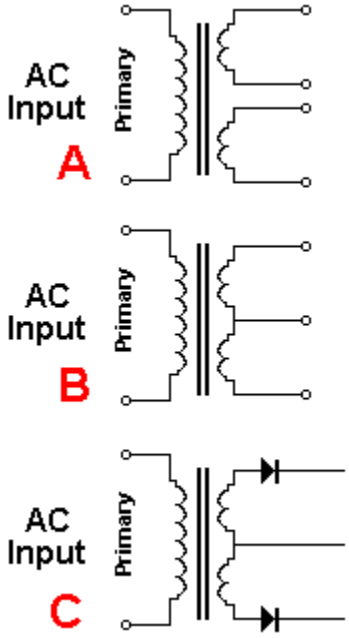

CURRENT TRANSFORMER

A Current Transformer is really an ordinary transformer.
All transformers produce a CURRENT output and a VOLTAGE output.
If you put an ammeter across the secondary, the current will increase through the meter when the primary voltage is increased.
This is because the output voltage will increase and this voltage will allow a higher current to flow.

WHY DETECT CURRENT? Why not voltage?

Because the voltage of say the "240v AC" is always 240v but the current can increase from say 1 amp to nearly 15 amps, depending what appliance is connected. So it is pointless measuring voltage.
A Current Transformer is a step-up transformer. When we say step-up and step-down, we are referring to the voltage - comparing the primary voltage to the secondary voltage. (Most transformers on the "mains" are step-down transformers and are used as power supplies to laptops, phone chargers etc.) Even a welding transformer is a step-down device and produces about 20v to 70v, while the current can be as high as 100 amps. This current is higher than the mains will deliver and is needed to melt the metal at the point of contact of the probe and the item being welded.
A Current Transformer is a step-up transformer. The primary consists of a single turn (or maybe 2 - 5 turns) and the secondary has 100 turns (or more).
This means the voltage seen by the primary will be increased 100 times and appear as anything from a few hundred millivolts to a few volts, depending on the quality of the coupling. (the magnetic coupling between the wire through the centre of the core, the quality of the core to transfer this magnetic flux to the secondary turns.)
This voltage is then passed to a low value resistor, where the voltage is reduced to a level that suits the detection circuit and the resulting millivolts is interpreted as current in the wire being tested.

Recapping:

The reading on the secondary has no relation to the current in the primary. We need to add a LOAD RESISTOR and create a table before we can use the transformer.
There is no such thing as a CURRENT TRANSFORMER. It is really an INSTRUMENT TRANSFORMER and the scale has been marked in units of CURRENT after measurements have been made. (INSTRUMENT TRANSFORMER means it is a device that helps us to produce a connection between current flowing through a wire and a reading on a meter or display).
If we connect a load to the secondary, (say an ammeter), it will produce a reading that increases when the current through the single primary turn is increased. That's because the ammeter is a LOAD. But the reading is meaningless until be calibrate the scale.

Now, lets look at the primary.
A wire (or cable) through the centre of the core is counted as one turn. If the turn is wrapped around the core, the coupling will be improved, but if we always use a straight wire, it does not matter where it is positioned inside the centre of the core.
It does not matter if the magnetic interaction of the flux from the wire is good or bad, we just have to keep to the same way of using the transformer.
The calibration can be done with any poor coupling and the result will be accurate for all future readings.
If a low-value resistor is placed across the secondary, the voltage across this resistor will increase and also the current through it will increase. But we are not going to measure the current through the resistor. We are going to measure the voltage across the resistor and by taking lots of reading we will finish up with a scale or table and this is called CALIBRATION. The results will be equated to the current flowing through the primary wire (primary turn).
A clamp meter uses a current transformer and the jaws must be closed completely and cleanly for the flux to flow around the core and produce a reading in the secondary.
Dirt in the jaws will reduce the reading considerably.
You cannot measure the current in a "power cord" because it contains both the active and neutral wires.
Even though the current is a maximum in both conductors at the same time, the current is flowing in two different directions and the magnetic flux produced by one conductor is clockwise and the other is anticlockwise and they are cancelled by each other.

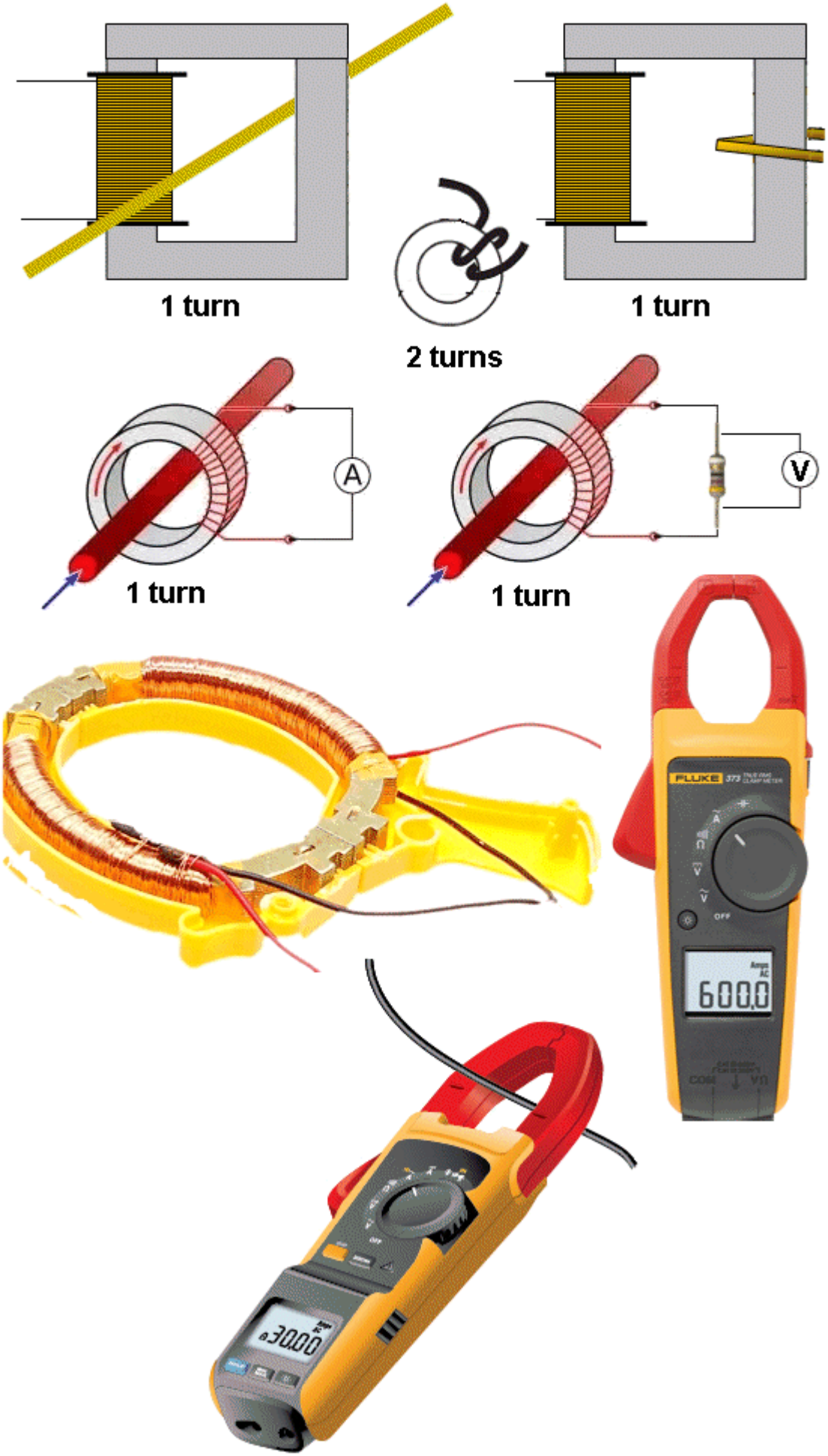

Identifying ONE TURN.
The quality (the coupling) of a single STRAIGHT wire

through the centre of a core is very poor
but if all readings are taken with this amount
of coupling, the readings will be accurate, as the
calibrations have been done with this arrangement.

OPTO ISOLATORS and OPTO COUPLERS

Opto Isolators and Opto Couplers are the same thing. A common opto-coupler is 4N35. It is used to allow two circuits to exchange signals yet remain electrically isolated. The signal is applied to the LED, which shines on a silicon NPN photo-transistor in the IC.
The light is proportional to the signal, so the signal is transferred to the photo transistor to turn it on a proportional amount. Opto-couplers can have Light Activated SCR's, photodiodes, TRIAC's and other semiconductor devices as an output. The 4N35 opto-coupler schematic is shown below:

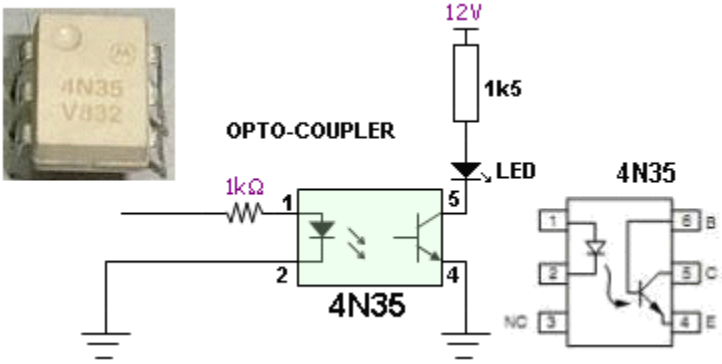

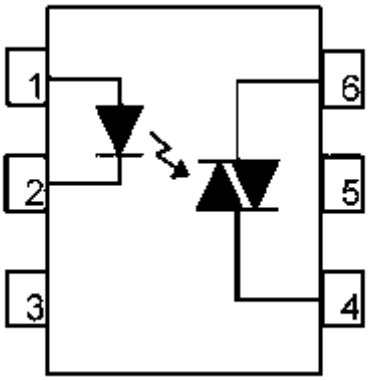

An opto-Coupler using a TRIAC
Note: the pinout is different to 4N35

TESTING AN OPTO COUPLER

Most multimeters cannot test the LED on the input of an opto-coupler because the ohms range does not have a voltage high enough to activate the LED with at least 2mA.
You need to set-up the test-circuit shown above with a 1k resistor on the input and 1k5 on the output. When the 1k is connected to 12v, the output LED will illuminate. The opto-coupler should be removed from circuit to perform this test.

TRANSISTORS

Transistors are solid-state devices and although they operate completely differently to a diode, they appear as two back-to-back diodes when tested.
There are basically 2 types of transistor NPN and PNP.
A transistor is sometimes referred to as BJT (Bi-polar Junction Transistor) to distinguish it from other types of transistor such as Field Effect transistor, Programmable Unijunction Transistor and others.

In the following diagram, two diodes are connected together and although the construction of a transistor is more complex, we see the transistor as two diodes when testing it.

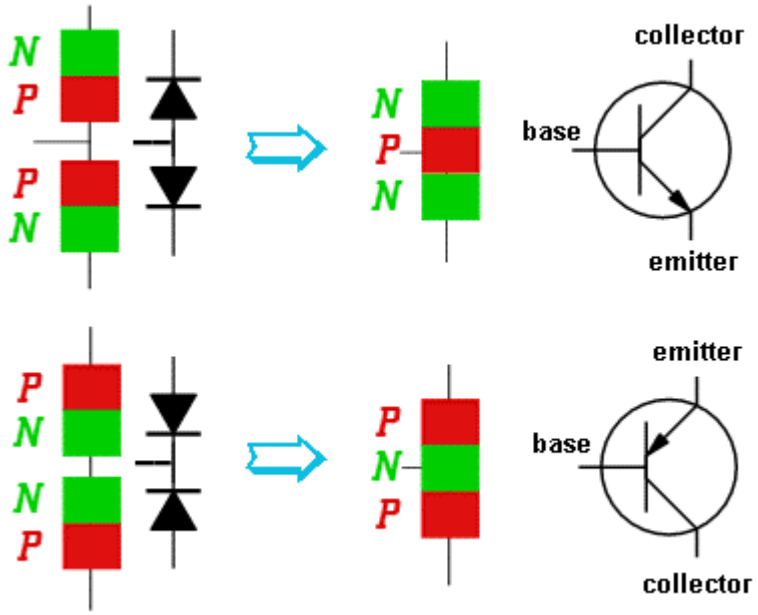

A TRANSISTOR APPEARS AS TWO DIODES WHEN TESTING IT

All transistors have three leads. Base (b), Collector (c), and Emitter (e).
For an NPN transistor, the arrow on the emitter points away from the base.
It is fortunate that the arrow on both symbols points in the direction of the flow of current (Conventional Current) and this makes it easy to describe testing methods using our simplified set of instructions. The symbols have been drawn exactly as they appear on a circuit diagram.

All transistors **are the same** but we talk about digital and analogue transistors. There is no difference between the two.
The difference is the circuit. And the only other slight difference between transistors is the fact that some have inbuilt diodes and resistors to simplify the rest of the circuit.
All transistors work the same way. The only difference is the amount of amplification they provide, the current and voltage they can withstand and the speed at which they work. For simple testing purposes, they are all the same.

NPN transistors are the most common and for an NPN transistor, the following applies.
(the opposite applies for PNP)
To test a transistor, there is **one thing** you have to know:
When the base voltage is higher than the emitter, current flows though the collector-emitter leads.
As the voltage is increased on the base, nothing happens until the voltage reaches 0.55v. At this point a very small current flows through the collector-emitter leads. As the voltage is increased, the current-flow increases. At about 0.75v, the current-flow is a MAXIMUM. (can be as high as 0.9v). That's how it works. A transistor also needs **current** to flow into the base to perform this amplifying function and this is the one feature that separates an ordinary transistor from a FET.

If the voltage on the base is 0v, then instantly goes to 0.75v, the transistor initially passes NO current, then FULL current. The transistor is said to be working in its two states: OFF then ON (sometimes called: "cut-off" and "saturation"). These are called digital states and the transistor is said to be a **DIGITAL TRANSISTOR** or a **SWITCHING TRANSISTOR** , working in **DIGITAL MODE.**

If the base is delivered 0.5v, then slowly rises to 0.75v and slowly to 0.65v, then

0.7v, then 0.56v etc, the transistor is said to be working in ANALOGUE MODE and the transistor is an **ANALOGUE TRANSISTOR**.
Since a transistor is capable of amplifying a signal, it is said to be an active device. Components such as resistors, capacitors, inductors and diodes are not able to amplify and are therefore known as passive components.

In the following tests, use your finger to provide the **TURN ON** voltage for the base (this is 0.55v to 0.7v) and as you press harder, more current flows into the base and thus more current flows through the collector-emitter terminals. As more current flows, the needle of the multimeter moves UP-SCALE.

TESTING A TRANSISTOR ON A DIGITAL METER

Testing a transistor with a **Digital Meter** must be done on the "DIODE" setting as a digital meter does not deliver a current through the probes on some of the resistance settings and will not produce an accurate reading.
The "DIODE" setting must be used for diodes and transistors. It should also be called a "TRANSISTOR" setting.

TESTING AN unknown TRANSISTOR

The first thing you may want to do is test an unknown transistor for COLLECTOR, BASE AND EMITTER. You also want to perform a test to find out if it is NPN or PNP. That's what this test will provide.
You need a cheap multimeter called an ANALOGUE METER - a multimeter with a scale and pointer (needle).
It will measure resistance values (normally used to test resistors) - (you can also test other components) and Voltage and Current. We use the resistance settings. It may have ranges such as "x10" "x100" "x1k" "x10"
Look at the resistance scale on the meter. It will be the top scale.
The scale starts at zero on the right and the high values are on the left. This is opposite to all the other scales.
When the two probes are touched together, the needle swings FULL SCALE and reads "ZERO." Adjust the pot on the side of the meter to make the pointer read exactly zero.

How to read: "x10" "x100" "x1k" "x10"

Up-scale from the zero mark is "1"
When the needle swings to this position on the "x10" setting, the value is 10 ohms.
When the needle swings to "1" on the "x100" setting, the value is 100 ohms.
When the needle swings to "1" on the "x1k" setting, the value is 1,000 ohms = 1k.
When the needle swings to "1" on the "x10k" setting, the value is 10,000 ohms = 10k.
Use this to work out all the other values on the scale.
Resistance values get very close-together (and very inaccurate) at the high end of the scale. [This is just a point to note and does not affect testing a transistor.]

Step 1 - FINDING THE BASE and determining NPN or PNP

Get an unknown transistor and test it with a multimeter set to "x10"
Try the 6 combinations and when you have the black probe on a pin and the red probe touches the other pins and the meter swings nearly full scale, you have an NPN transistor. The black probe is BASE
If the red probe touches a pin and the black probe produces a swing on the other two pins, you have a PNP transistor. The red probe is BASE
If the needle swings FULL SCALE or if it swings for more than 2 readings, the transistor is **FAULTY**.

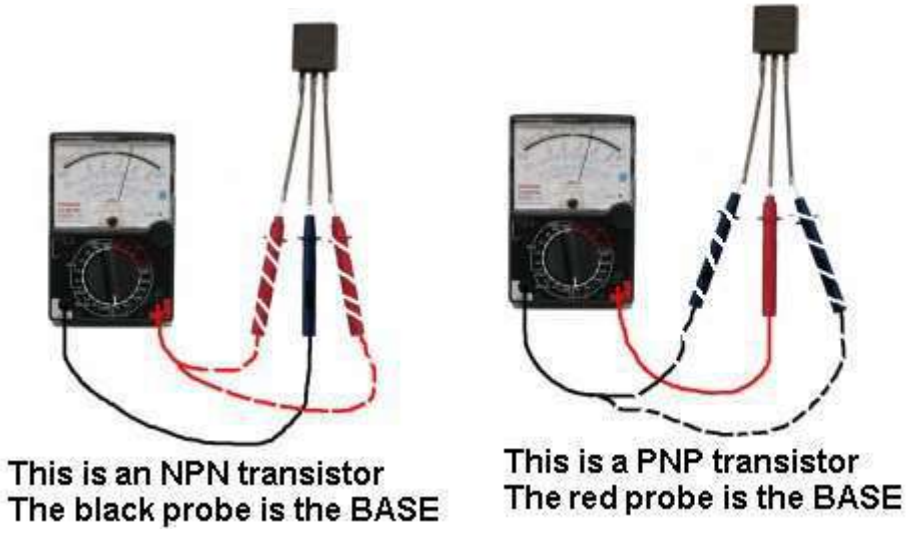

Step 2 - FINDING THE COLLECTOR and EMITTER
Set the meter to "x10k."
For an NPN transistor, place the leads on the transistor and when you press hard on the two leads shown in the diagram below, the needle will swing almost full scale.

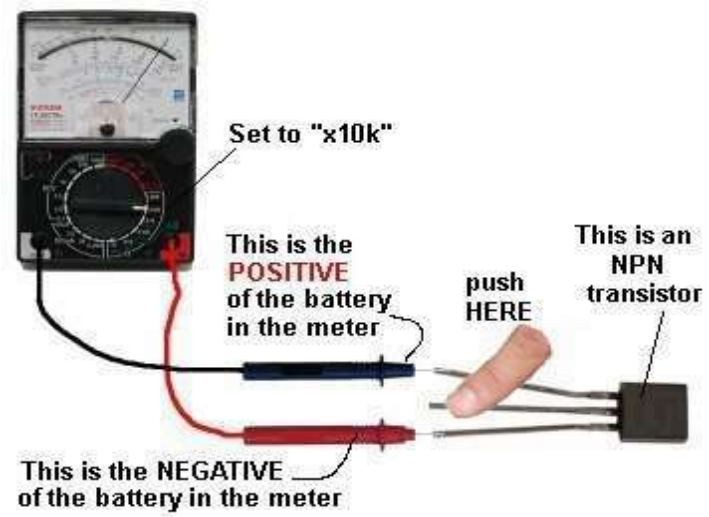

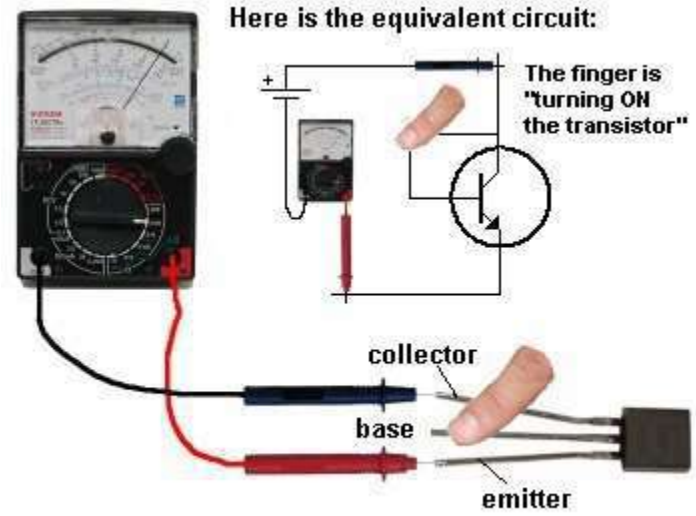

You have found the Collector Base and Emitter

For a PNP transistor, set the meter to "x10k" place the leads on the transistor and when you press hard on the two leads shown in the diagram below, the needle will swing almost full scale.

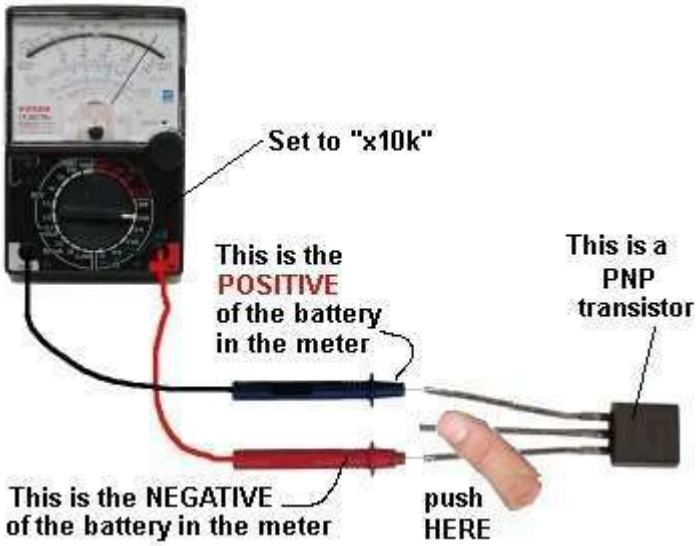

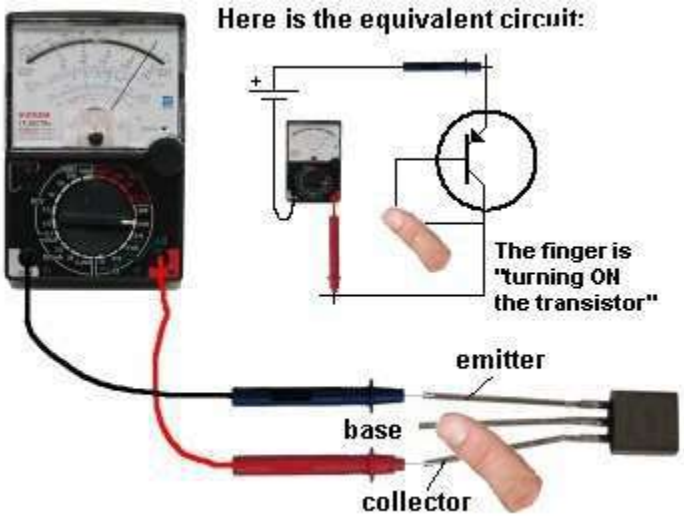

You have found the Collector Base and Emitter

SIMPLEST TRANSISTOR TESTER

The simplest transistor tester uses a 9v battery, 1k resistor and a LED (any colour). Keep trying a transistor in all different combinations until you get one of the circuits below. When you push on the two leads, the LED will get brighter.
The transistor will be NPN or PNP and the leads will be identified:

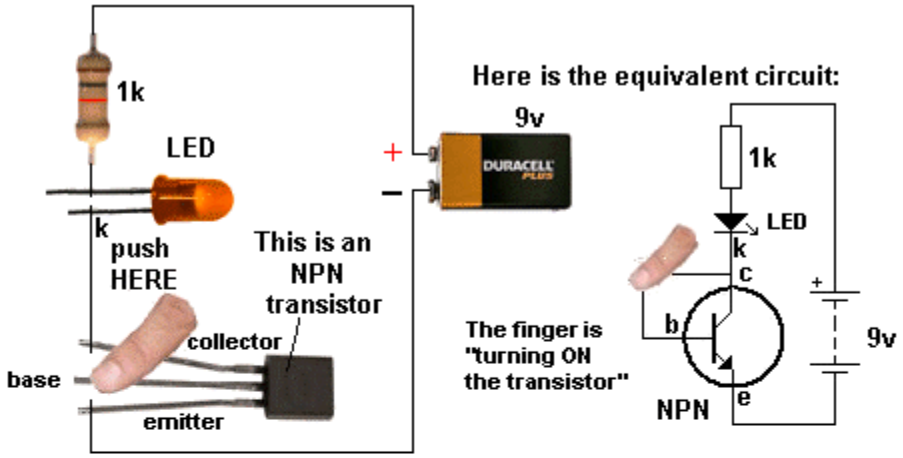

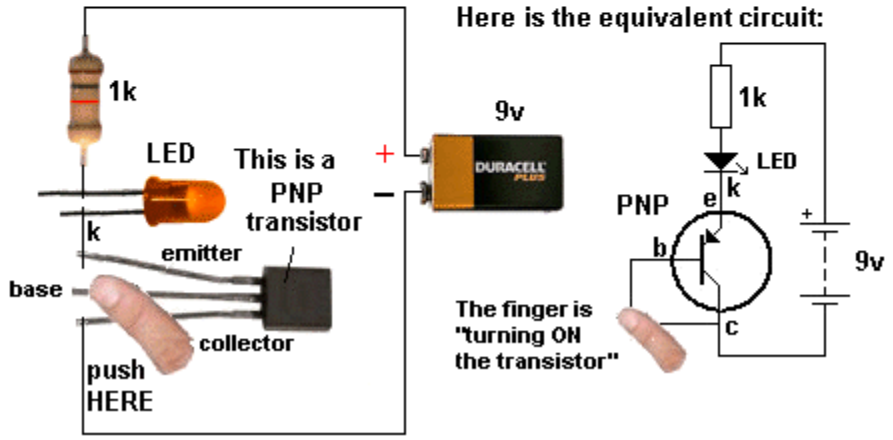

The leads of some transistors will need to be bent so the pins are in the same positions as shown in the diagrams. This helps you see how the transistor is being turned on. This works with NPN, PNP transistors and Darlington transistors.

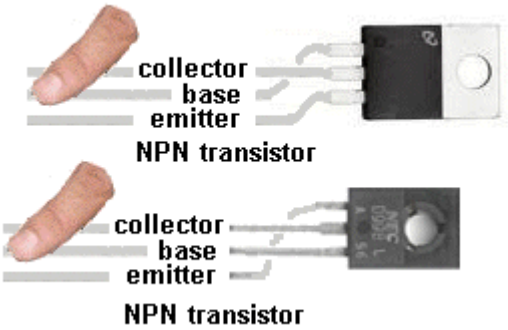

HEATSINKING

Heat generated by current flowing between the collector and emitter leads of a transistor causes its temperature to rise. This heat must be conducted away from the transistor otherwise the rise may be high enough to damage the P-N junctions inside the device. Power transistors produce a lot of heat, and are therefore usually mounted on a piece of aluminium with fins, called a **HEATSINK**.
This draws heat away, allowing it to handle more current. Low-power signal transistors do not normally require heat sinking. Some transistors have a metal body or fin to connect to a larger heatsink. If the transistor is connected to a heatsink with a mica sheet (mica washer), it can be damaged or cracked and create a short-circuit. (See Testing Mica Washers). Or a small piece of metal may be puncturing the mica. Sometimes white compound called **Heatsink Compound** is used to conduct heat through the mica. This is very important as mica is a very poor conductor of heat and the compound is needed to provide maximum thermal conduction.

TRANSISTOR FAILURE

Transistor can fail in a number of ways. They have forward and reverse voltage ratings and once these are exceeded, the transistor will ZENER or conduct and may fail. In some cases a high voltage will "puncture" the transistor and it will fail instantly. In fact it will fail much faster via a voltage-spike than a current overload.

It may fail with a "short" between any leads, with a collector-emitter short being the most common. However failures will also create shorts between all three leads.
A shorted transistor will allow a large current to flow, and cause other components to heat up.
Transistors can also develop an open circuit between base and collector, base and emitter or collector and emitter.
The first step in identifying a faulty transistor is to check for signs of overheating. It may appear to be burnt, melted or exploded. When the equipment is switched off, you can touch the transistor to see if it feels unusually hot. The amount of heat you feel should be proportional to the size of the transistor's heat sink. If the transistor has no heat sink, yet is very hot, you can suspect a problem.
DO NOT TOUCH A TRANSISTOR IF IT IS PART OF A CIRCUIT THAT CARRIES 240VAC.
Always switch off the equipment before touching any components.

TRANSISTOR REPLACEMENT

If you can't get an exact replacement, refer to a transistor substitution guide to identify a near equivalent.

The important parameters are:
- Voltage
- Current
- Wattage
- Maximum frequency of operation

The replacement part should have parameters equal to or higher than the original.

Points to remember:
- Polarity of the transistor i.e. PNP or NPN.
- At least the same voltage, current and wattage rating.
- Low frequency or high frequency type.
- Check the pinout of the replacement part
- Use a desoldering pump to remove the transistor to prevent damage to the printed circuit board.
- Fit the heat sink.
- Check the mica washer and use heat-sink compound
- Tighten the nut/bolt - not too tight or too loose.
- Horizontal output transistors with an integrated diode should be replaced with the same type.

DIGITAL TRANSISTORS

There is no such thing as a DIGITAL TRANSISTOR or an AUDIO TRANSISTOR.
All transistors are just "TRANSISTORS" and the surrounding components as well as the type of signal, make the transistor operate in DIGITAL MODE or ANALOGUE MODE.
But we have some transistors that have inbuilt resistors to make them suitable for connecting to a digital circuit without the need for a base resistor.
Here is the datasheet for an NPN transistor BCR135w and PNP datasheet for BCR185w.
These transistors are called "Digital Transistors" because the "base lead" can be connected directly to the output of a digital stage. This "lead" or "pin" is not really the base of the transistor but a 4k7 (or 10k) resistor connected to the base allows the transistor to be connected to the rest of a digital circuit.
You cannot actually get to the base. The resistor(s) are built into the chip and the transistor is converted into a "Digital Transistor" because it will accept 5v on the "b"

lead.
The 47k is not really needed but it makes sure the transistor is fully turned OFF if the signal on the "b" lead is removed (in other words - if the input signal is converted to a high-impedance signal - see tri-state output from microcontrollers for a full explanation).
This transistor is designed to be placed in a circuit where the input changes from low to high and high to low and does not stop mid-way. This is called a DIGITAL SIGNAL and that is one reason why the transistor is called a digital transistor. (However you could stop half-way but the transistor may heat up and get too hot).
Any transistor placed in a digital circuit can be called a "digital transistor" but it is better to say it is operating in DIGITAL MODE.

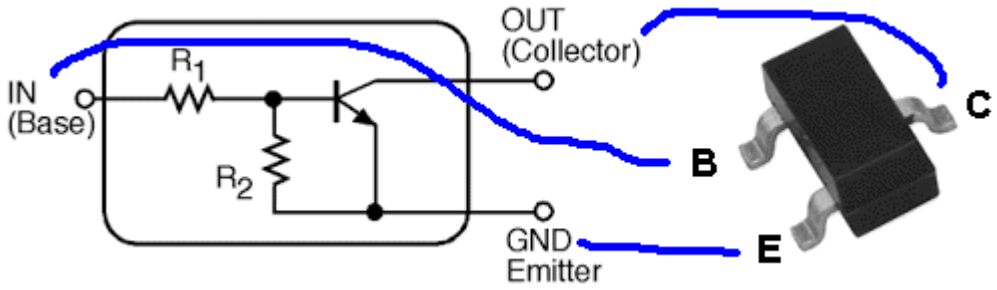

The digital transistor has two resistors included inside the case
R1 is about 10k and R2 is approx 47k

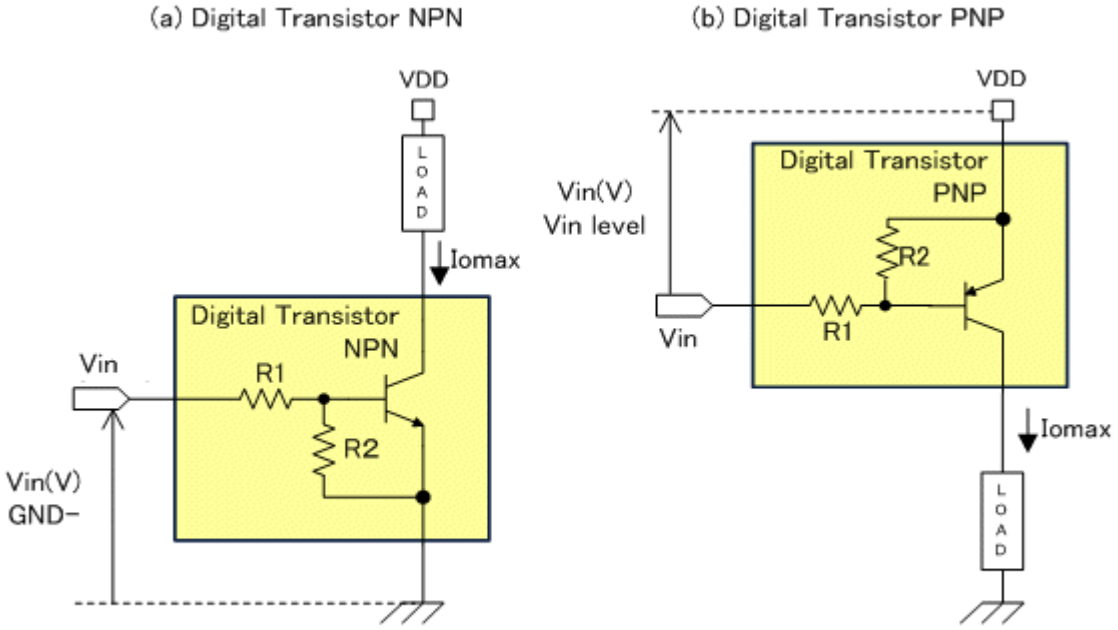

Equivalent circuit of the digital transistor

These transistors can be made to work in analogue circuits because they are ordinary transistors with a 10k base resistor, but you will have to know what you are doing.

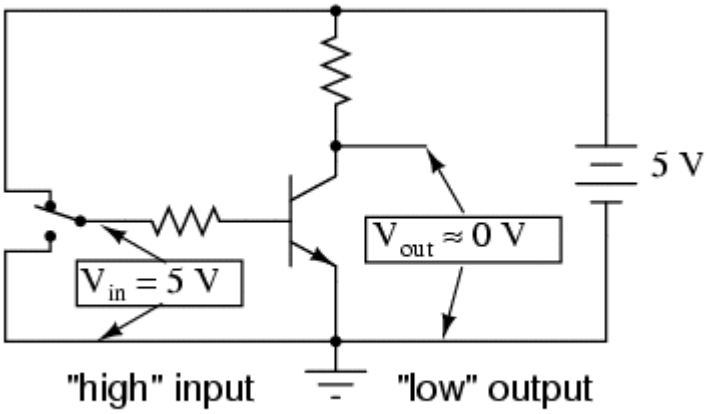

Transistor in saturation

The circuit above shows the digital transistor is designed to allow a voltage of 5v to be supplied to the "base" pin and the transistor will Fully Conduct.
This type of transistor saves putting a base resistor on the PC board.
It can be tested just like a normal transistor but the resistance between base and emitter will be about 5k to 50k in both directions. If the collector-emitter is low in both directions the transistor is damaged.
Here's how to look at how the transistor works:
The 10k resistor on the base will allow 0.5mA to flow into the base. But the 47k will reduce this to 0.4mA. If the transistor has a gain of 100, the collector-emitter current can be 40mA.
To determine the current capability of the transistor, connect 100R load and turn the transistor ON. This will allow about 100mA for the collector-emitter current. Measure the collector-emitter voltage. If it is more than 0.5v, the transistor is OVER-LOADED.

DARLINGTON TRANSISTORS

A DARLINGTON TRANSISTOR is two transistors in a single package with three leads. They are internally connected in cascade so the gain of the pair is very high. This allows a very small input signal to produce a large signal at the output. They have three leads (Base, Collector and Emitter and can be PNP or NPN) and are equivalent to the leads of a standard individual transistor, but with a very high gain. The second advantage of a Darlington Transistor is its high input impedance. It puts very little load on the previous circuit.
Some Darlington transistors have a built-in diode and/or built-in resistor and this will produce a low reading in both directions between the base and emitter leads.

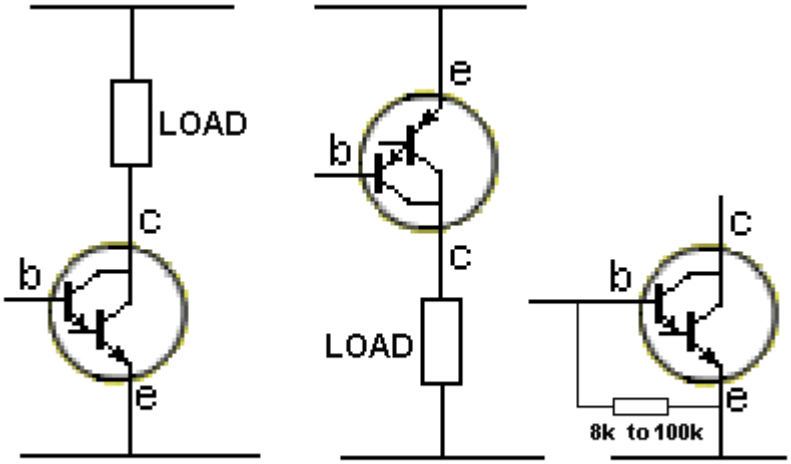

NPN Darlington PNP Darlington

Darlington transistors are tested the same as an ordinary transistor and a multimeter will produce about the same deflection, even though you will be measuring across two junctions, (and a base-emitter resistor is present).

HORIZONTAL OUTPUT TRANSISTORS, SWITCH-MODE TRANSISTORS, FLYBACK TRANSISTORS, POWER TRANSISTORS, VERTICAL TRANSISTORS . . . .

These are all names given to a transistor when it is used in a particular circuit. ALL these transistors are the same for testing purposes.
We are not testing for gain, maximum voltage, speed of operation or any special feature. We are just testing to see if the transistor is completely faulty and SHORTED.
A transistor can have lots of other faults and the circuit **using the transistor** is the best piece of TEST EQUIPMENT as it is detecting the fault.

TESTING MOSFETs and FETs

MOSFETs and **JFETs** are all part of the **FET** family.
MOSFET stands for **Metal Oxide Semiconductor Field Effect Transistor.**
FETs operate exactly the same as a "normal" transistor except they have different names for the input and output leads and the voltage between the gate and the source has to between 2v to 5v for the device to turn on fully. A FET requires almost NO CURRENT into the Gate for it to turn on and when it does, the voltage between drain and source is very low (only a few mV). This allows them to pass very high currents without getting hot. There is a point where they start to turn on and the input voltage must rise higher than this so the FET turns on FULLY and does not get hot.
Field Effect Transistors are difficult to test with a multimeter, but "fortunately" when a power **MOSFET** blows, it is completely damaged. All the leads will show a short circuit. 99% of bad **MOSFETs** will have GS, GD and DS shorted.
The following symbols show some of the different types of MOSFETs:

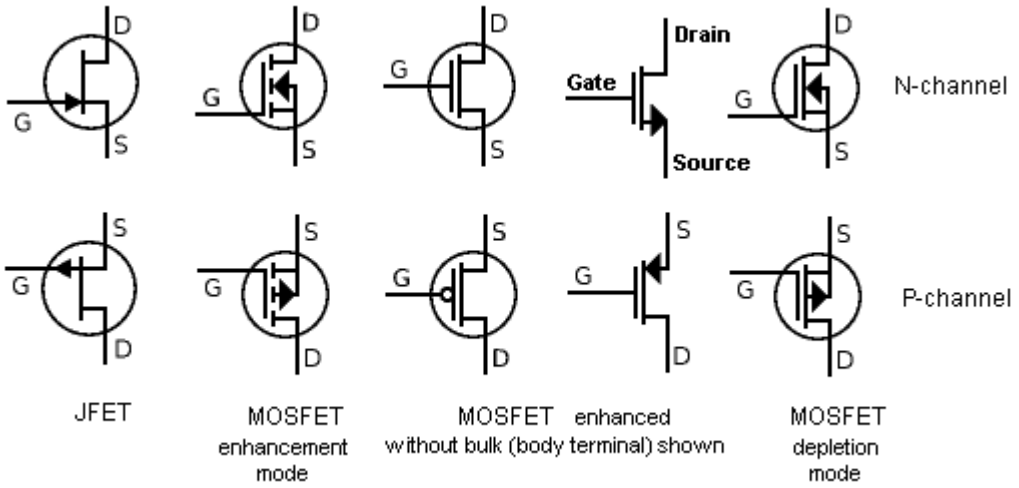

Most **MOSFET** transistors cannot be tested with a multimeter. This due to the fact that the Gate needs 2v - 5v to turn on the device and this voltage is not present on the probes of either meter set to any of the ohms ranges.
You need to build the following Test Circuit:

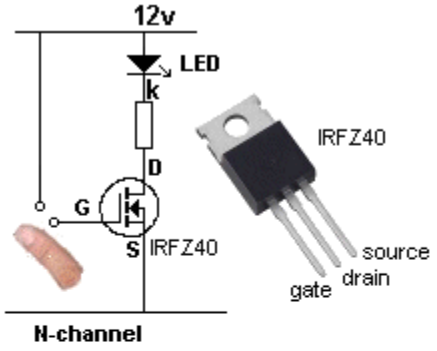

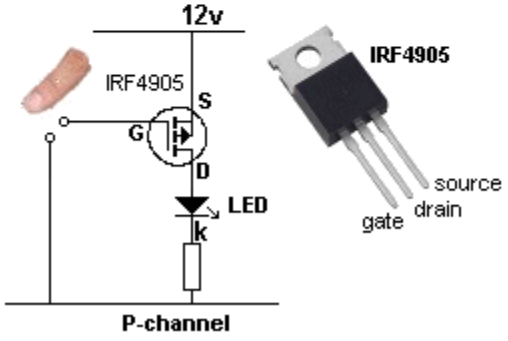

Touching the Gate will increase the voltage on the Gate and the MOSFET will turn ON and illuminate the LED. Removing your finger will turn the LED off.
Large devices such as the TO-220 types shown above do not like static electricity on the gate and you have to be careful not to "spike" the gate with any static. Generally this type of device is not "super sensitive" and you can use your finger or a large value resistor.
When replacing one of these devices, there are 2 things to match-up.
Voltage and Current.
In most cases, the "turn-ON" resistance (the resistance between Source and Drain) will be the same (something like 22 milli ohms) and the speed of operation will be ok.
Check the voltage needed to turn the gate ON and make sure you can supply the required voltage.

SILICON CONTROLLED RECTIFIERs (SCR)

The **Silicon Controlled Rectifier** (SCR) is a semiconductor device that is a member of a family of control devices known as **Thyristors**. It is a 3-leaded device and when a small current enters the Gate, the **thyristor** turns on. AND STAYS ON. It only conducts current between Anode and Cathode in one direction and it is mainly only used in DC circuits. When it is used with AC, it will only conduct for a maximum of half the cycle.

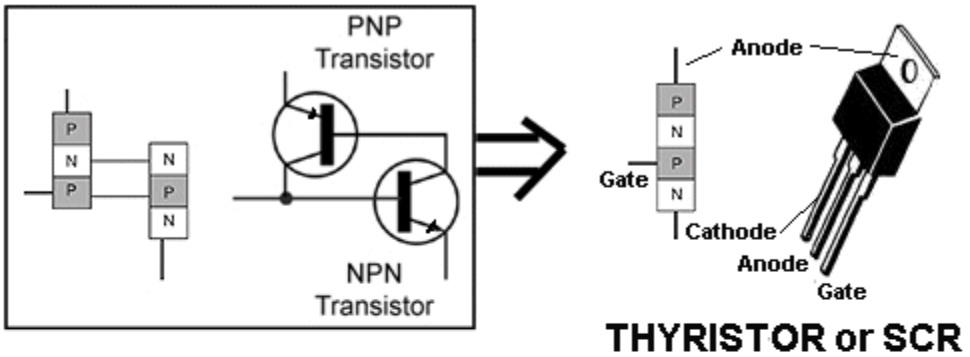

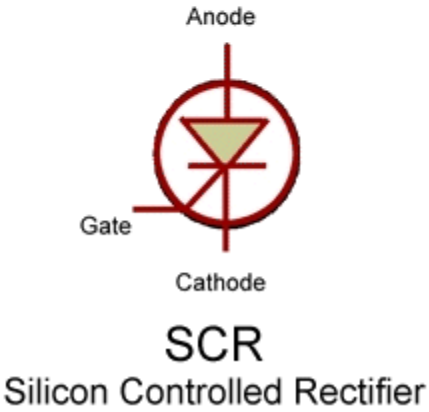

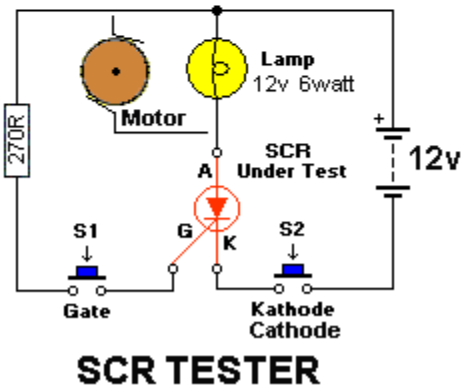

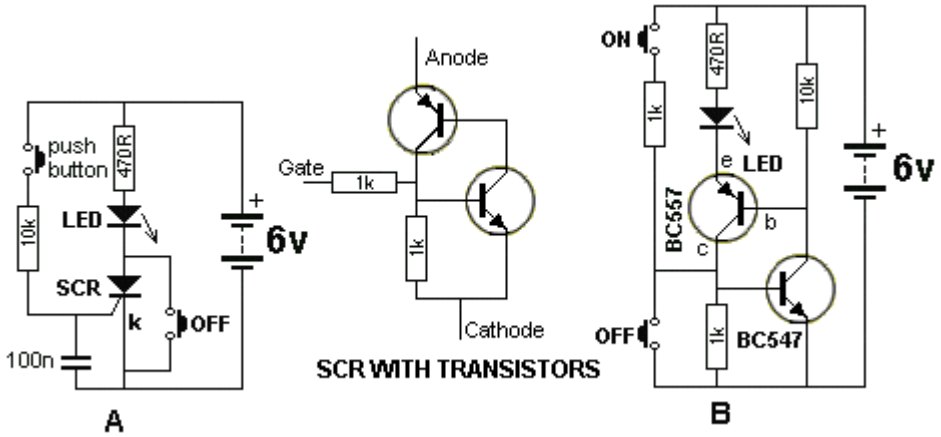

To understand how an SCR "latches" when the gate is provided with a small current, we can replace it with two transistors as shown in diagram B above. When the ON button is pressed, the BC547 transistor turns on. This turns ON the BC557 and it takes over from the action of the switch.
To turn the circuit off, the OFF button removes the voltage from the base of the BC547.

Testing an SCR

An **SCR** can be tested with some multimeters but a minimum current Anode-to-Cathode is needed to keep the device turned on. Some multimeters do not provide this amount of current and the **SCR Tester** circuit above is the best way to test these devices.
Shorted SCRs can usually be detected with an ohmmeter check (SCRs usually fail shorted rather than open).
Measure the anode-to-cathode resistance in both the forward and reverse direction; a good SCR should measure near infinity in both directions.
Small and medium-size SCRs can also be gated ON with an ohmmeter (on a digital meter use the Diode Check Function). Forward bias the SCR with the ohmmeter by connecting the black (-) lead to the anode and the red (+) lead to the cathode

(because the + of the battery is connected to the negative lead, in most analogue multimeters). Momentarily touch the gate lead to the anode while the probes are still touching both leads; this will provide a small positive turn-on voltage to the gate and the cathode-to-anode resistance reading will drop to a low value. Even after removing the gate voltage, the SCR will stay conducting. Disconnecting the meter leads from the anode or cathode will cause the SCR to revert to its non-conducting state.
When making the above test, the meter impedance acts as the SCR load. On larger SCRs, it may not latch ON because the test current is not above the SCR holding current.

Using the SCR Tester
Connect an SCR and press Switch2. The lamp should not illuminate. If it illuminates, the SCR is around the wrong way or it is faulty.
Keep Switch 2 PRESSED. Press Sw1 very briefly. The lamp or motor will turn ON and remain ON. Release Sw 2 and press it again. The Lamp or motor will be OFF.

TRIACs

A triac is a bidirectional, three-terminal dual, back-to-back thyristor (SCR) switch. This device will conduct current in both directions when a small current is constantly applied to the Gate.
If the gate is given a small, brief, current during any instant of a cycle, it will remain triggered during the completion of the cycle until the current though the Main Terminals drops to zero.
This means it will conduct both the positive and negative half-cycles of an AC waveform. If it is tuned on (with a brief pulse) half-way up the positive waveform, it will remain on until the wave rises and finally reaches zero. If it is then turned on (with a brief pulse) part-way on the negative wave, the result will be pulses of energy and the end result will be about 50% of the full-energy delivered at a rate of 100 times per second for a 50HZ supply.
TRIACs are particularly suited for AC power control applications such as motor speed control, light dimmers, temperature control and many others.

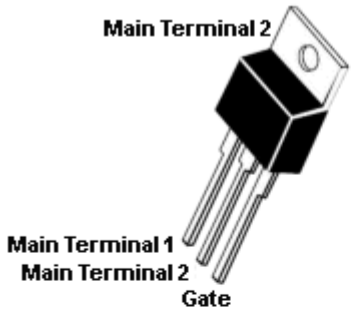

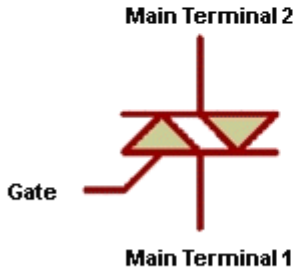

TRIAC (2 SCR's)
TRIode for Alternating Current

Using the TRIAC Tester

Connect a TRIAC and press Switch2. The lamp should not illuminate. If it illuminates, the TRIAC is faulty.
Keep Switch 2 PRESSED. Press Sw1 very briefly. The lamp or motor will turn ON and remain ON. If the lamp does not turn on, reverse the TRIAC as the current into the gate must produce a slight voltage between **Gate** and **Main Terminal 1**.
Release Sw 2 and press it again. The Lamp or motor will be OFF.

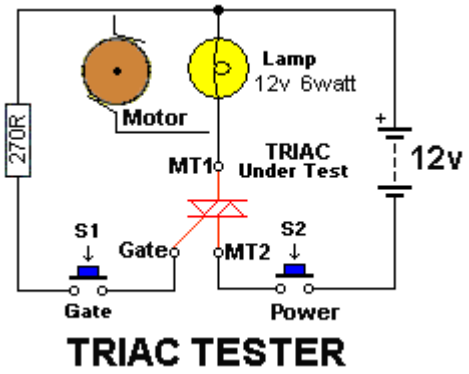

MICA WASHERS AND INSULATORS

Plastic insulating sheets (washers) between a transistor and heatsink are most often made from mica but some are plastic and these get damaged over a period of time, turn dark and become cracked.
The plastic eventually becomes carbonized and conducts current and can affect the operation of the appliance. You can see the difference between a mica sheet (washer) and plastic by looking where it extends from under the transistor. Replace all plastic insulators as they eventually fail.

SPARK GAPS

Some TV's and monitors with a CRT (picture tube), have spark gaps either on the socket at the end of the tube or on the chassis.
These can consist of two wires inside a plastic holder or a glass tube or special resistive device.
The purpose of a spark gap is to take any flash-over (from inside the tube), to earth. This prevents damage to the rest of the circuit.
However if the tube constantly flashes over, a carbon track builds up between the wires and effectively reduces the screen voltage. This can cause brightness and/or focus problems. Removing the spark-gap will restore the voltage.
These are not available as a spare component and it's best to get one from a discarded chassis.

CO-AX CABLES

Co-Ax cables can produce very high losses and it seems impossible that a few metres of cable will reduce the signal. The author has had a 3 metre cable reduce the signal to "snow" so be aware that this can occur. Faults can also come from a splitter and/or balun as well as dirty plugs and sockets. This can result in very loud bangs in the sound on digital reception.

TESTING EARTH LEAKAGE DETECTORS or Residual Current Devices or Ground Fault Circuit Interrupters or GFCI

An Earth Leakage Detector or Sensor is a circuit designed to continuously monitor the imbalance in the current in a pair of load carrying conductors.
These two conductors are normally the Active and Neutral. Should the imbalance current reach 30mA the sensor will "trip" and remove the voltage (and current) from

the line being monitored.
Some detectors will trip at 15mA.
You cannot alter the sensitivity of the device however there are a number of faults in these devices that can be fixed.
In some devices the contact pressure for the 10Amp or 15 Amp contacts is very weak and they arc and produce an open circuit. The result is this: When you press the rest button, power is not restored to the output.
Clean the contacts with a small file and bend the metal strips to the contacts so they make a very strong contact.
The other fault is the trip mechanism.
The magnetism from the coil does not allow the pin to move and "trip" the contacts. It may be due to a small metal filing or the pin not moving freely enough.
All good Earth Leakage Detectors have a TEST BUTTON. This connects a resistor between the active line and earth so that 15mA or 30mA flows.
The detector should trip immediately. Make sure the trigger mechanism trips when the test button is pressed.
None of the electronics in the detector can be replaced however you can test the mechanical operation and the pressure on the contacts when the unit is removed from the power. Do not work on the device when it is connected to the mains.

TESTING CELLS AND BATTERIES

There is an enormous number of batteries and cells on the market and a number of "battery testers." Instead of buying a battery tester that may give you a false reading, here is a method of testing cells that is guaranteed to work.
There are two types of cell: a **rechargeable** cell and a non rechargeable cell.

The easiest way to test a **rechargeable** cell is to put a group of them in an appliance and use them until the appliance "runs down" or fails to work. If you consider the cells did not last very long, remove them and check the voltage of each cell. The cell or cells with the lowest voltage will be faulty. You can replace them with new cells or good cells you have in reserve.
There is no other simple way to test a rechargeable cell.
You cannot test the "current of a cell" by using an ammeter. A rechargeable cell can deliver 10 amps or more, even when nearly discharged and you cannot determine a good cell for a faulty cell.

Dry cells are classified as "non-rechargeable" cells.
DRY CELLS and MANGANESE CELLS are the same thing. These produce 1.5v per cell (manganese means the Manganese Dioxide depolariser inside the cell. All "dry cells" use manganese dioxide).
ALKALINE CELLS produce between 2 - 10 times more energy than a "dry cell" and produce 1.5v per cell.
Alkaline cells can fail for no reason at any stage in their life and are not recommended for emergency situations.
The output voltage of some Alkaline cells can fall to 0.7v or 0.9v for not apparent reason.
There are lots of other cells including "button cells," hearing-aid cells, air cells, and they produce from 1.2v to 3v per cell.

Note:
Lithium cells are also called "button cells" and they produce 3v per cell.
Lithium cells are non-rechargeable (they are generally called "button cells") but some Lithium cells can be recharged. These are Lithium-ion cells and generally have a voltage of 3.6v. Some Lithium-ion cells look exactly like 3v Lithium cells, so you have to read the data on the cell before charging.

You cannot test the voltage of a cell and come to any conclusion as to the age of the cell or how much energy remains. The voltage of a cell is characteristic to the chemicals used and the actual voltage does not tell you its condition.
Some "dry cells" deliver 1.5v up to the end of their life whereas others drop to about 1.1v very quickly.

Once you know the name of the cell that drops to 1.1v, avoid them as the operation of the equipment "drops off" very quickly.

However if you have a number of different cells and need to know which ones to keep, here's the solution:

1. Check the voltage and use those with a voltage above 1.1v
2. Next, select 500mA or 10A range on a meter and place the probes on a cell. For a AAA or AA cell, the current should be over 500mA and the needle will swing full scale very quickly.
Keep the testing short as you are short-circuiting the cell but it is the only way to determine the internal impedance of the cell and this has a lot to do with its stage-of-charge.
This will give you a cell with a good terminal voltage and a good current capability.

This also applies to button cells, but the maximum current they will deliver will be less.
If you want to get the last of the energy out of a group of cells they can be used in the following circuits:

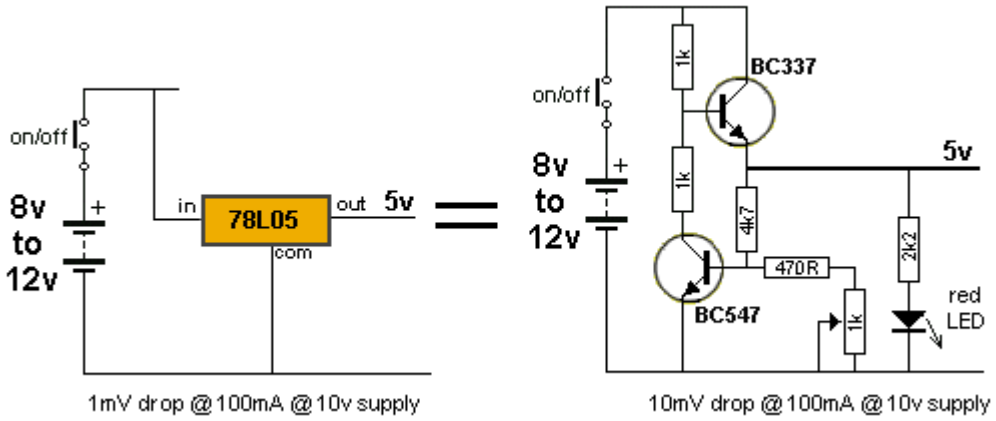

TESTING PIEZO DIAPHRAGMS and PIEZO BUZZERS

There are two types of piezo devices that produce a sound.
They are called **PIEZO DIAPHRAGMS** and **PIEZO BUZZERS**.
A **piezo diaphragm** consists of two metal plates with a ceramic material between.
The ceramic expands and contracts when an alternating voltage is placed on the two plates and this causes the main plate to "dish" and "bow."
This creates a high-pitched sound. There are no other components inside the case and it requires an AC voltage of the appropriate frequency to produce a sound.
A **piezo buzzer** has a transistor and coil enclosed and when supplied with a DC voltage, the buzzer produces a sound.
Both devices can look exactly the same and the only way to tell them apart is by connecting a 9v battery. One device may have "+' and "-" on the case to indicate it is a piezo buzzer, but supplying 9v will make the buzzer produce a sound while the piezo diaphragm will only produce a "click."

A piezo diaphragm will produce a click
when connected to 9v DC.
A piezo buzzer will produce a tone when
connected to a DC voltage.

How a PIEZO BUZZER WORKS

A Piezo Buzzer contains a transistor, coil, and piezo diaphragm and produces sound when a voltage is applied. The buzzer in the circuit above is a PIEZO BUZZER.

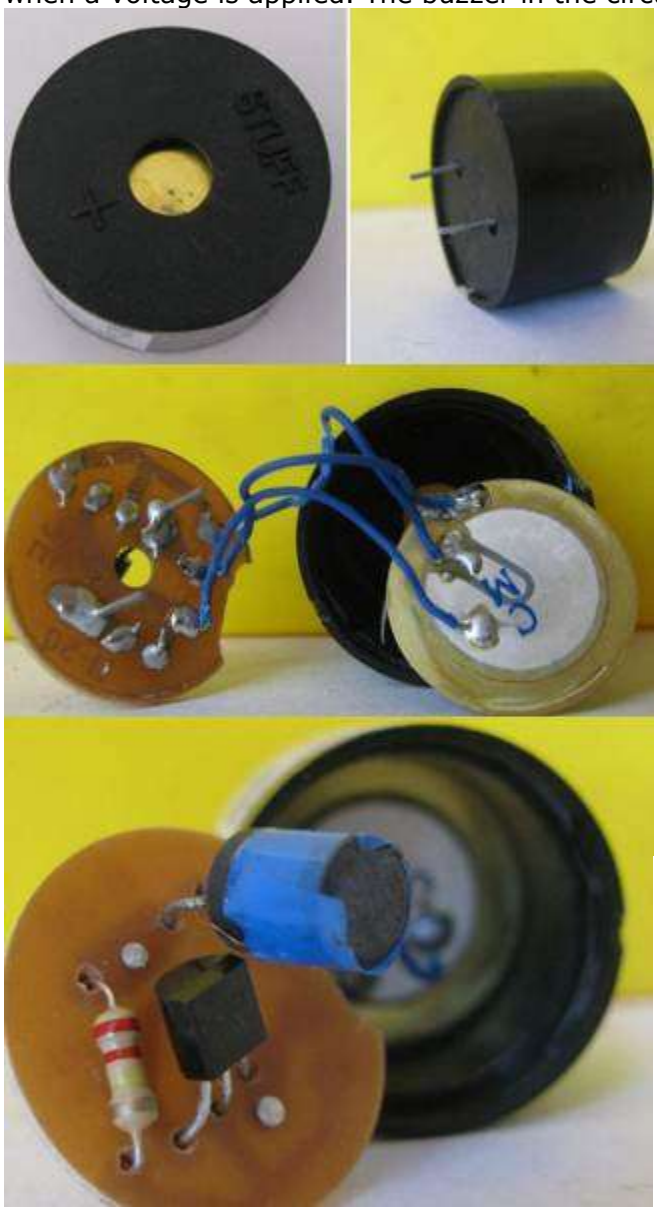

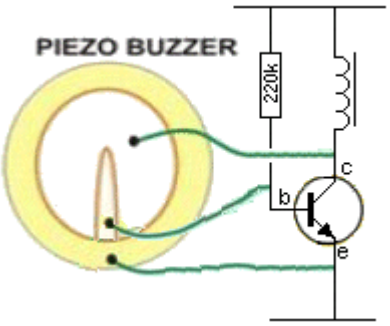

The circuit starts by the base receiving a small current from the 220k resistor. This produces a small magnetic flux in the inductor and after a very short period of time the current does not increase. This causes the magnetic flux to collapse and produce a voltage in the opposite direction that is higher than the applied voltage.
3 wires are soldered to pieces of metal on the top and bottom sides of a ceramic substrate that expands sideways when it sees a voltage. The voltage on the top surface is passed to the small electrode and this positive voltage is passed to the base to turn the transistor ON again. This time it is turned ON more and eventually the transistor is fully turned ON and the current through the inductor is not an INCREASING CURRENT by a STATIONARY CURRENT and once again the magnetic flux collapses and produces a very high voltage in the opposite direction. This voltage is passed to the piezo diaphragm and causes the electrode to "Dish" and produce the characteristic sound. At the same time a small amount is "picked-off" and sent to the transistor to create the next cycle.

TESTING A SPEAKER

A speaker (also called a **loud speaker**) has coil of wire wrapped around a magnet but it does not

touch the magnet as it is wound on a thin cardboard former so that the coil will be pulled closer to the magnet when a current flows in the coil.
When the current flows in the other direction, the coil moves away from the magnet.
The coil is called voice coil and it is connected to a sheet of thin card called a CONE and as the cone vibrates, the speaker reproduces music or noise.
Use a multimeter on a low ohms scale to read the value of resistance of the coil.
It can be as low as 2 ohms or as high as 100 ohms.
Most speakers have an 8R voice coil and the actual resistance may be slightly lower than this.
Some speakers have a resistance of 16R, 32R or 50R and even 75 ohms.
You would think putting a 16R speaker in place of 8R would reduce the sound output, but this is not always the case.
You can even use 50R or 75R and get the same performance.
This may sound amazing, but here is the reason.
The cone is deflected a certain amount due to the current flowing and the number of turns.
These two values are multiplied together to produce a value called AMP-TURNS.
If we have an 8R speaker with 80 turns and 100mA, the result is 0.1 x 80 = 8.
If we use a 16R speaker, the average current flow will be 50mA and the number of turns will be about 160. The multiplication of 0.05 x 160 = 8.
The author then tried a 50R speaker and the sound output was equal to 8R and the same with 75R speaker.
This might not apply in all situations, but the 75R speaker was slightly larger and the ticking sound form the **Metal Detector** kit was louder than using an 8R mini speaker.

To see if the cone of a speaker is undamaged, push it slightly and it will move towards the magnet. If it does not move, it is bent or damaged. If the cone is scratchy when pushed, it is rubbing against the magnet.
A cone should be able to be pushed and pulled from its rest-state. If not, it will produce a distorted sound.

TESTING A CIRCUIT

Whenever you test a circuit, the TEST EQUIPMENT puts "a load" or "a change" on it.
It does not matter if the test equipment is a multimeter, Logic Probe, CRO, Tone Injector or simply a LED and resistor.
There are two things you need to know.
1. The IMPEDANCE of the circuit at the location you are testing, and
2. The amount of load you are adding to the circuit via the test equipment.

There is also one other hidden factor. The test equipment may be injecting "hum" due to its leads or the effect of your body at absorbing hum from the surroundings or the test equipment may be connected to the mains.
These will affect the reading on the test equipment and also any output of the circuit.
Sometimes the test equipment will prevent the circuit from working and sometimes it will just change the operating conditions slightly. You have to be aware of this.
The last section of this eBook covers High and Low Impedance and understanding impedance is something you need to know.
The point to note here is the fact that the equipment (and the reading) can be upset by hum and resistance/capacitance effects of test equipment. This is particularly critical in high impedance and high frequency circuits.

TESTING INTEGRATED CIRCUITS (IC's)

Integrated Circuits can be tested with a LOGIC PROBE. A Logic Probe will tell you if a line is HIGH, LOW or PULSING.
Most logic circuits operate on 5v and a Logic Probe is connected to the 5v supply so the readings are accurate for the voltages being tested.
A Logic Probe can also be connected to a 12v CMOS circuit.
You can make your own Logic Probe and learn how to use it from the following link:

http://www.talkingelectronics.com/projects/LogicProbeMkIIB/LogicProbeMk-IIB.html

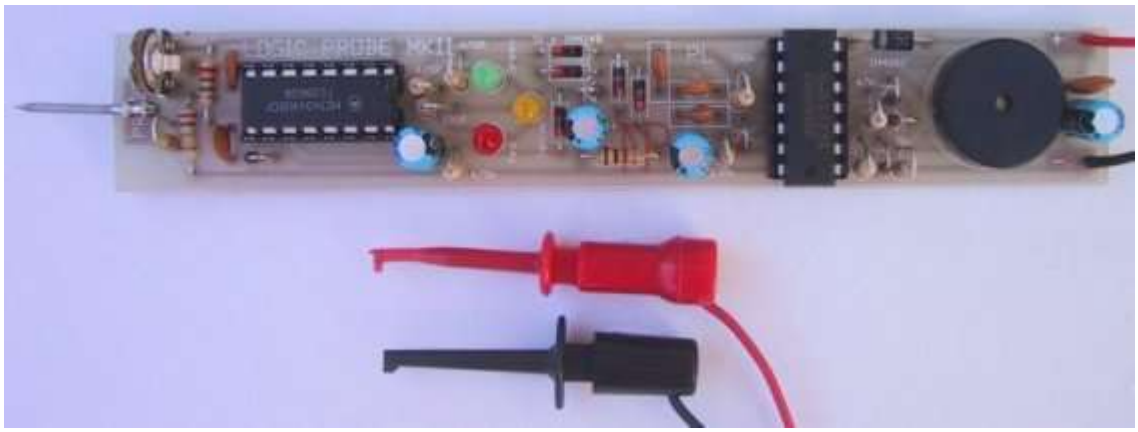

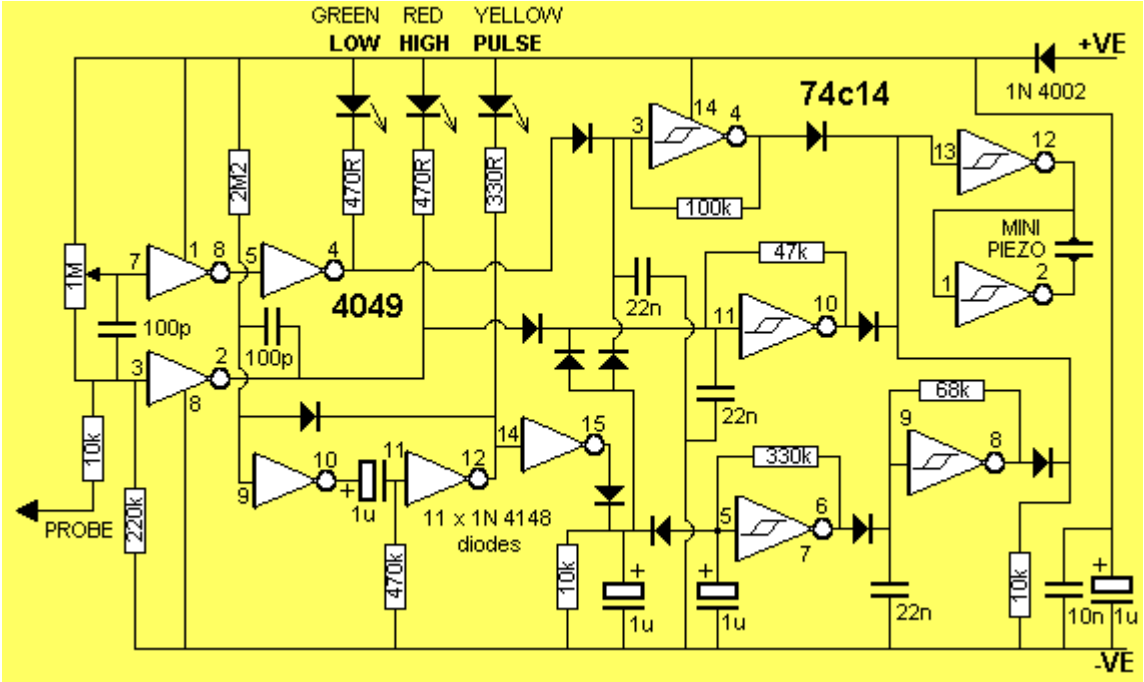

LOGIC PROBE with PULSE

This is a very simple transistor circuit to provide HIGH-LOW-PULSE indication for digital circuits. It can be built for less than $5.00 on a piece of matrix board or on a small strip of copper clad board if you are using surface mount components. The probe will detect a HIGH at 3v and thus the project can be used for 3v, 5v and CMOS circuits.

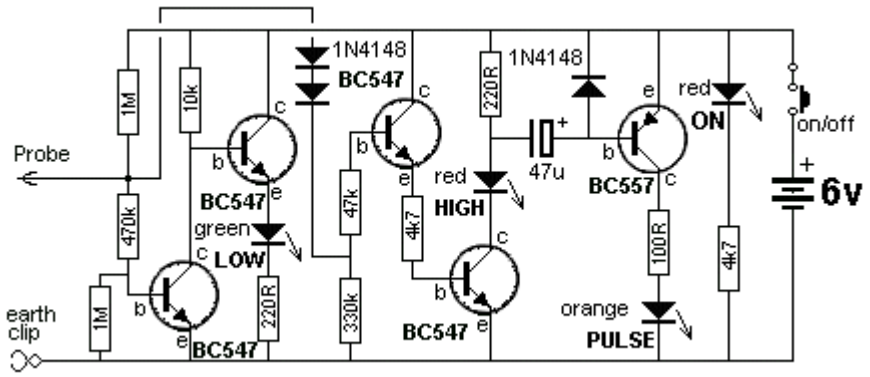

LOGIC PROBE using CD4001 and CD4011

Here is a simple Logic Probe using a single chip. The circuits have been designed for the **CD4001** CMOS quad NOR gate and **CD4011** CMOS NAND gate. The output has an active buzzer that produces a beep when the pulse LED illuminates (the buzzer is not a piezo-diaphragm but an active buzzer containing components).

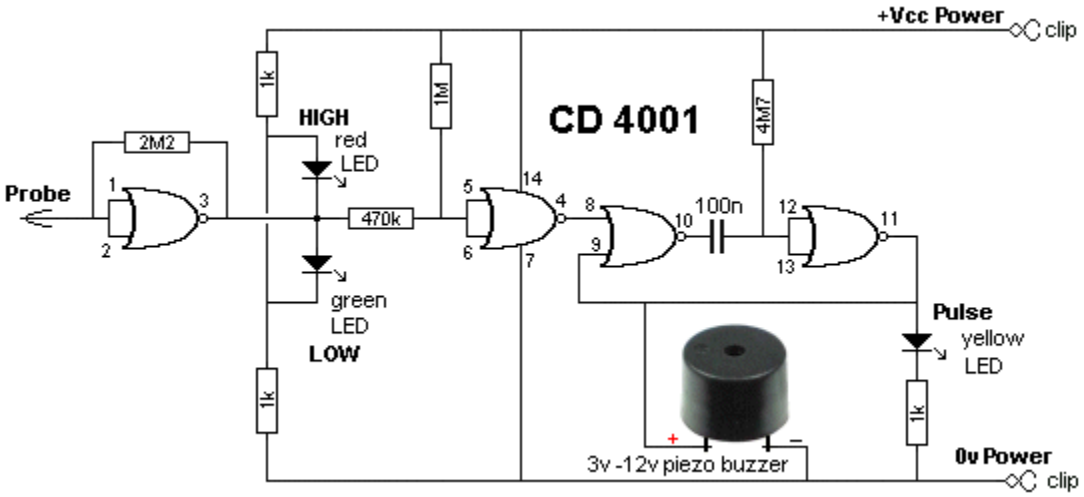

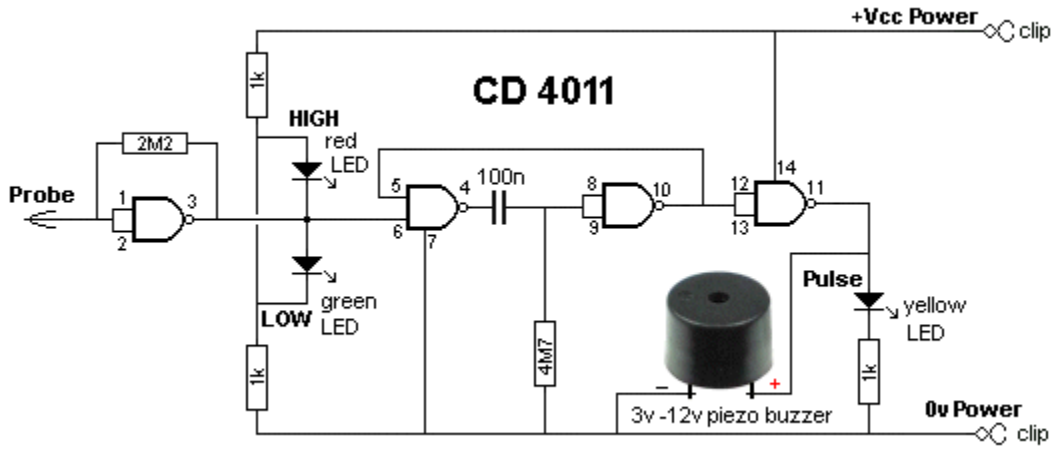

SUPER PROBE MkII has 20 different features including a Logic Probe, capacitance tester, Inductance tester, and more.

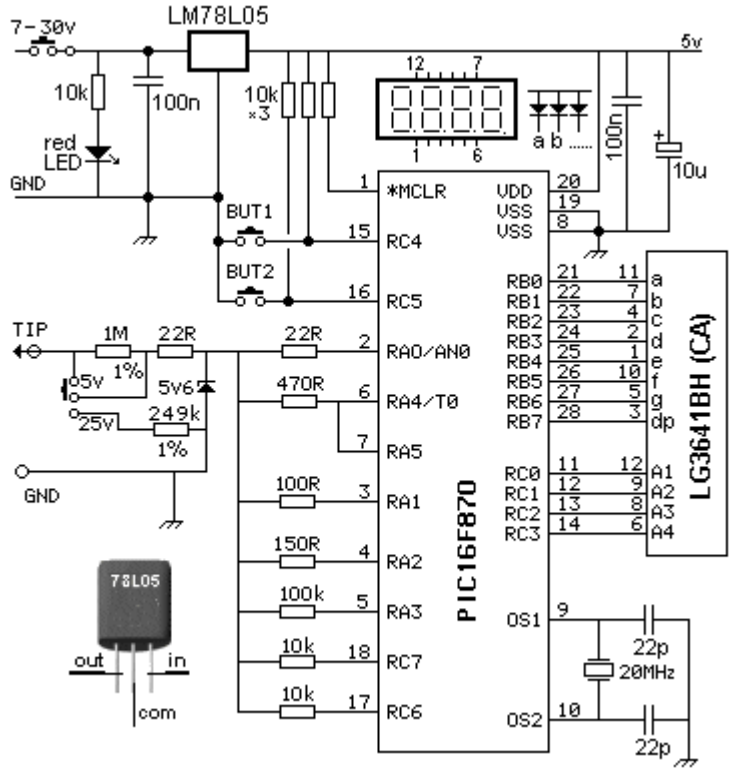

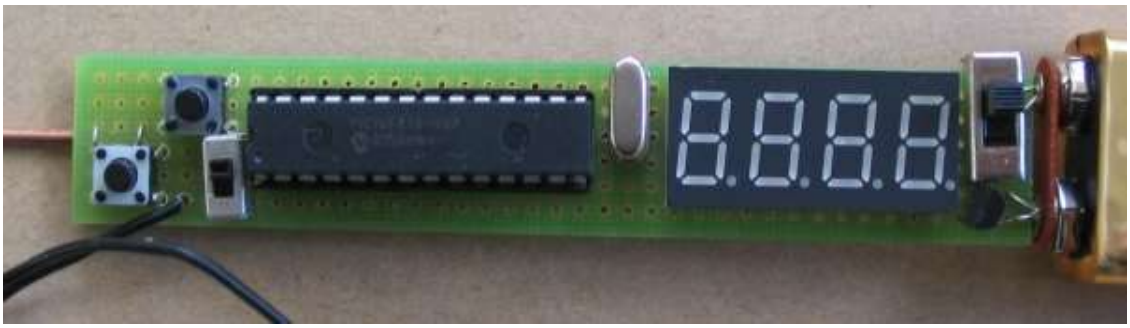

SUPER PROBE MkII

To test an IC, you need a circuit diagram with waveforms. These diagrams will show the signals and are very handy if a CRO (cathode ray Oscilloscope) is used to diagnose the problem. The CRO will reproduce the waveform and prove the circuit is functioning correctly.
A Logic Probe will just show activity and if an output is not producing a "pulse" or "activity," you should check the power to the IC and test the input line.
It is beyond the scope of this eBook to explain how to diagnose waveforms, however it is important to know if signals are entering and exiting an IC and a Logic Probe is designed for this.

SIGNAL INJECTOR
This circuit is rich in harmonics and is ideal for testing amplifier circuits. To find a fault in an amplifier, connect the earth clip to the 0v rail and move through each stage, starting at the speaker. An increase in volume should be heard at each preceding stage. This Injector will also go through the IF stages of radios and FM sound sections in TV's.

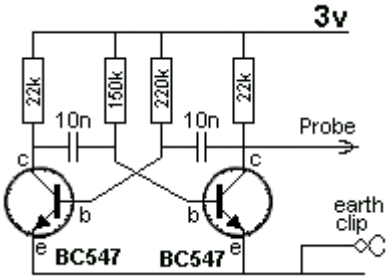

TESTING AUDIO AMPLIFIERS and AUDIO IC's

The **Super Probe MII** described above has a "noise" function and a tone function that allows you to inject a signal into an audio stage, amplifier (made from discrete components) or an audio chip, and detect the output on a speaker.
Audio stages are very difficult to work-with if you don't have a TONE GENERATOR or SIGNAL INJECTOR.
The signals are very small and not detected by a multimeter.
You can start anywhere in an amplifier and when a tone is heard, you can keep probing until the signal is not present or louder. From this you can work out which way the signal is travelling.
A Signal Injector is very handy for finding shorts and broken wires in switches, plugs, sockets and especially leads to headphones.
You can determine the gain of a stage (amplification) by probing before and after a chip or transistor and listen for the relative increase in volume from the speaker.
You can also use your finger to produce "hum" or "buzz" if a **Signal Injector** is not available.
Nearly all audio problems are plugs, sockets and cracks in the PC board, but finding them takes a lot of time and skill.

TESTING IC's - also called "CHIPS"

An Integrated Circuit is also called a "chip." It might have 8 pins or as many as 40.
Some chips are ANALOGUE. This means the input signal is rising and falling slowly and the output produces a larger version of the input.
Other chips are classified as DIGITAL and the input starts at 0v and rises to rail voltage very quickly. The output does exactly the same - it rises and falls very quickly.
You might think the chip performs no function, because the input and output voltage has the same value, but you will find the chip may have more than one output and the others only go high after a number of clock-pulses on the input, or the chip may be outputting when a combination of inputs is recognised or the output may go HIGH after a number of clock pulses.

ANALOGUE CHIPS **(also see above)**
Analogue chips are AUDIO chips or AMPLIFIER chips.
To test these chips you will need three pieces of test equipment:
1. A multimeter - this can be digital or analogue.
2. A Signal Injector
3. A Mini Bench Amplifier.

The Mini Bench Amplifier is available as a kit.

MINI BENCH AMPLIFIER

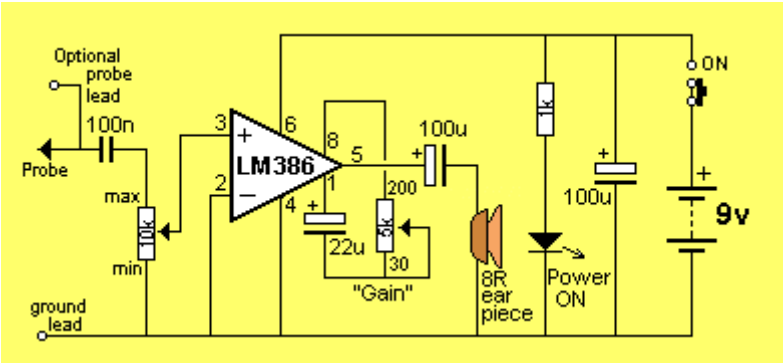

MINI BENCH AMPLIFIER CIRCUIT

Start by locating the power pin with a multimeter.
If the chip is receiving a voltage, you can use the Mini Bench Amplifier to detect an output.
Connect the Ground Lead of the Mini Bench Amplifier to 0v and touch the Probe tip on each of the pins.
You will hear faint audio on the Input pin and very loud audio on the Output pin.
If no input is detected, you can use a Signal Injector to produce a tone.

Connect the clip of the Signal Injector to 0v and the probe to the input pin of the amplifier chip. At the same time, connect the Mini Bench Amplifier to the output pin and you will hear a very loud tone.
These pieces of test equipment can also be used to diagnose an amplifier circuit constructed with individual components.
Amplifier circuits using discrete components are very hard to trouble-shoot and these pieces of test equipment make it very easy.

DIGITAL CHIPS

It is always best to have data on the chip you are testing, but if this is not available, you will need three pieces of equipment:
1. A multimeter - this can be digital or analogue.
2. A Logic Probe,
3. A logic Pulser.
Firstly test the chip to see if power is being delivered. This might be anything from 3v3 to 15v.
Place the negative lead of the multimeter on the earth rail of the project - this might be the chassis, or the track around the edge of the board or some point that is obviously 0v.
Try all the pins of the chip and if you get a reading, the chip will have "supply."
Identify pin 1 of the chip by looking for the "cut-out" at the end of the chip and you may find a small dimple below the cut-out (or notch). This is pin 1 and the "power pin" can be directly above or any of the other pins.
Next you need to now if a signal is entering the chip.
For this you will need a LOGIC PROBE.
A Logic Probe is connected to the same voltage as the chip, so it will detect a HIGH and illuminate a red LED.
Connect the Logic Probe and touch the tip of the probe on each pin.
You will not know if a signal is an input or output, however if you get two or more active pins, you can assume one is input and the other is output. If none of the pins are active, you can assume the signal is not reaching this IC.
If only one pin is active, you can assume the chip is called a CLOCK (or Clock Generator). This type of chip produces pulses. If more than two pins are active, you can assume the chip is performing its function and unless you can monitor all the pins at the same time, you don't know what is happening.
This is about all you can do without any data on the chip.

If you have data on the chip, you can identify the input(s) and output(s).
A Logic Probe on each of these pins will identify activity.
A Logic Probe has 3 LEDs. Red LED indicates a HIGH, Green indicates a LOW and Orange indicates a PULSE (activity).
Some Logic Probes include a piezo and you can hear what is happening, so you don't take your eyes off the probe-tip.
It is important not to let the probe tip slip between the pins and create a short-circuit.

LOGIC PULSER

If you have a board or a single chip and want to create activity (clock pulses), you can use a Logic Pulser. This piece of test equipment will produce a stream of pulses that can be injected into the clock-line (clock input) of a chip.
You can then use a Logic Probe at the same time on the outputs to observe the operation of the chip.

You can also use the Mini Bench Amplifier to detect "noise" or activity on the inputs and outputs of digital chips.
This only applies if the frequency is in the audio range such as scanning a keyboard or switches or a display.

This is how to approach servicing/testing in a general way. There are thousands of digital chips and if you want to test a specific chip for its exact performance, you will need to set-up a "test-bed."

REMOTE CONTROLS

There are two types of remote control - Infrared and RF. Infrared is used for short-range, line-of-sight for TV's DVD's etc.
A few faults can be fixed, but anything complex needs a new remote control.
Check the batteries and battery-contacts. See if the IR LED is illuminating by focusing it into a digital camera and looking on the screen for illumination.
The only other things are a sticky button, a worn-out button or a crack in the PC board. Water damage is generally too much work to repair.
RF remote controls for cars, garage doors etc need a second working unit to check the power output.
Here is a simple circuit that can be connected to an analog multimeter to detect the signal strength at a very close range:

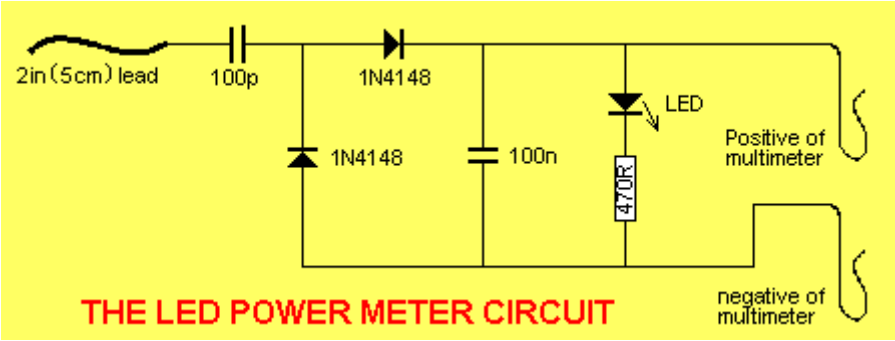

To hear the tone from a transmitter, the **Mini Bug Detector** circuit can be used:

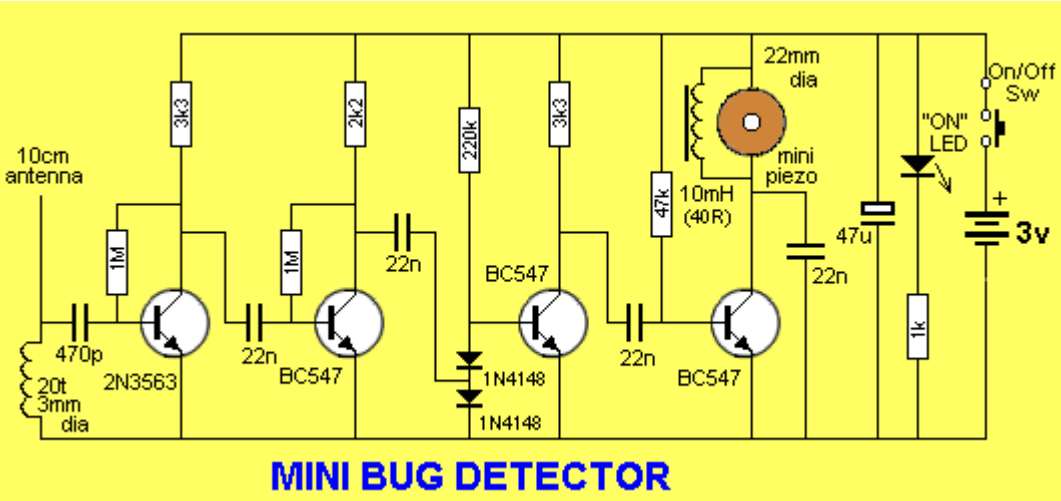

Any further investigation requires a circuit diagram so you can work out what is actually being sent from the transmitter.
Most of the time it is a faulty switch, battery or contacts. Make sure the setting is correct on the "dip switches" and use a working unit to compare all your testing.

TESTING VOLTAGES ON (in) A CIRCUIT

There are basically two different types of circuit.
1. **ANALOGUE CIRCUIT**
An analogue circuit can also be called an AUDIO CIRCUIT and the voltages at different points in a circuit can be measured with a multimeter but the changes (the waveforms) will be quite small or changing at a rapid rate and cannot be detected by a multimeter.
You need a CRO to "see" the signals or a **Signal Injector** to inject a waveform into the circuit and hear the result on the circuit's speaker.

2. **DIGITAL CIRCUIT**
A digital circuit can also be called a "Computer Circuit" or "Logic Circuit" and some of

the voltages can be measured with a multimeter (such as supply voltages) but the "signal lines" will be be changing from HIGH to LOW to HIGH very quickly and these signals are detected with a **Logic Probe**.

Here are some circuits with details of how to test the voltages.
Most circuits do not show voltages at various different points and we will explain what to expect on each "stage."

A "STAGE"

A stage is a set of components with an input and output. A "stage" can also be called a "Building Block."
Sometimes it has a capacitor on the input and one on the output.
This means the stage is completely isolated as far as DC is concerned.
The stage has a supply (a DC supply) and it is producing its own voltages on various points on the "stage." It can only process (amplify) "AC." (signals).
Sometimes the stage can be given a name, such as small-signal amplifier, push-pull amplifier or output.
If the stage has a link or resistor connected to a previous stage, the previous stage will have a "DC effect" on the stage. In other words it will be biasing or controlling the voltages on the stage. The stage may be called a "timer" or "delay" or "DC amplifier."

It is important to break every circuit into sections. This makes testing easy. If you have a capacitor at the input and output, you know all the problems lie within the two capacitors.
In a digital circuit (no capacitors) you need to work on each IC (integrated Circuit) and test the input for activity and all the outputs.

Once you have determined if the circuit is Analogue or Digital, or a combination of both, you have to look at the rail voltage and work out the size or amplitude of the voltage or waveform.
This is done before making a test, so your predictions are confirmed.
You will need a **multimeter** (either Digital or Analogue) a **Logic Probe** and a **Signal Injector** (**Tone Generator**). An analogue meter has the advantage that it will detect slight fluctuations of voltage at a test-point and its readings are faster than a digital meter. A digital meter will produce an accurate voltage-reading - so you should have both available.

HIGH IMPEDANCE AND LOW IMPEDANCE

Every point in a circuit has a characteristic called "IMPEDANCE." This has never been discussed before in any text book. That's why it will be new to you.
In other words, every point will be "sensitive to outside noise."
An audio amplifier is a good example. If you put your finger on the active input, it will produce hum or buzz in the speaker. This is because it is a HIGH IMPEDANCE line or high impedance section of the circuit.
The same applies to every part in a circuit and when you place Test Equipment on a line for testing purposes, the equipment will "upset" the line. It may be very slight but it can also alter the voltage on the point CONSIDERABLY.
We have already mentioned (above) how a cheap multimeter can produce a false reading when measuring across a 1M resistor. That's why you need high impedance test Equipment so you do not "load" the point you are testing and create an inaccurate reading.
The word **Impedance** really means resistance, but when you have surrounding components such as diodes, capacitors, transistors, coils, Integrated Circuits, supply-voltages and resistors, the combined effect is very difficult to work out as a "resistance" and that's why we call it "Impedance."
The term "**High and Low Impedance**" is a relative term and does not have any absolute values but we can mention a few points to help you decide.
In general, the base of a transistor, FET input of an IC are classified as HIGH IMPEDANCE.
The output of these devices are LOW IMPEDANCE.

Power rails are LOW IMPEDANCE.
An oscillator circuit and timing circuit are HIGH IMPEDANCE.
A LOAD is low impedance.
And it gets tricky: An input can be designed to accept a low-impedance device (called a transducer or pick-up) and when the device is connected, the circuit becomes LOW impedance, but the input circuitry is actually high impedance.
The impedance of a diode or LED is HIGH before the device sees a voltage higher than the junction voltage and then it becomes LOW Impedance.
Impedance is one of the most complex topics however it all comes down to testing a circuit without loading it.
That's why test equipment should have an input impedance higher than 1M.

The first circuit we will investigate is the **Mini Bug Detector**, shown above and below. Points on the circuit have been labelled A, B, C etc:

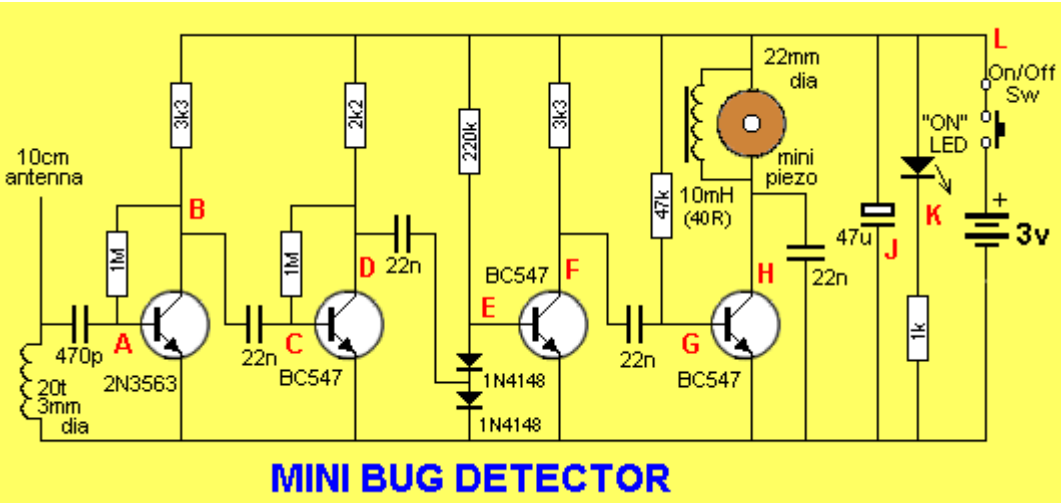

Point A - The first transistor is "self-biased" and will have 0.6v on the base. The antenna is connected to a 20 turn coil and you might think the coil will "short" the signals to earth.
But the coil and 470p capacitor form a circuit that oscillates at a high frequency when the antenna wire picks up stray signals. The coil and capacitor actually amplify the signals (see Talking Electronics website: Spy Circuits to see how a TANK CIRCUIT works) and these signals enter the base of the first transistor.
This is classified as a HIGH Impedance section because the signals are small and delicate and any loading via test equipment will kill them. The first transistor amplifies the signals about 70 times and they appear at **Point B**.

The signal passes though a 22n to **Point C** and the transistor amplifies the signal about 70 times to **point D**. **Point C** is classified as high impedance as any voltage measurement at this point will upset the biasing of the stage as a few millivolts change in base-voltage will alter the voltage on the collector considerably. **Point D** is classified as low impedance as any voltage-testing will not alter the voltage appreciably.
The output of the second stage passes through a capacitor to the join of two diodes. These two diodes are not turned on because the voltage at **Point E** can never rise above 0.7v as this is the voltage produced by the base-emitter of the third transistor.
The purpose of the two diodes is to remove background noise. Background noise is low amplitude waveforms and even though the transistor is turned on via the 220k, low amplitude signals will not be received. The third transistor works like this: It cannot be turned ON any more because any waveform from the 22n will be "clipped" by the bottom diode and it will never rise above 0.6v.
So, the only signal to affect the transistor is a negative signal - to turn it OFF.
Firstly we have to understand the voltage on the 22n. When the second transistor is sitting at mid-rail voltage, the 22n gets charged via the 2k2 and lower diode. When

the transistor gets tuned ON, the collector voltage falls and the left side of the 22n drops. The right side of the 22n also drops and when it drops 0.6v, the top diode starts to conduct and when the voltage on the 22n drops more than 0.6v the third transistor starts to turn OFF. This effect is amplified by the transistor at least 100 times and appears at **Point F.** All the voltages around the two diodes are classified as HIGH Impedance as any piece of test equipment will upset the voltage and change the output.
There are some losses in amplitude of the signal as it passes through the 22n coupling capacitors but the end result is a very high strength signal at **point G.** The 4th transistor drives a 10mH choke and the mini piezo is effectively a 20n capacitor that detects the "ringing" of the inductor to produce a very loud output.
The 22n capacitor on the collector eliminates some of the background noise. The choke and piezo form an oscillatory circuit that can produce voltages above 15v, even though the supply is 3v.
The 47n capacitor at **Point J** is to keep the supply rails "tight" (to create a LOW Impedance) to allow weak cells to operate the circuit.
The "Power-ON" LED tells you to turn the device off when not being used and **Point L** is the power supply - a low impedance line due to the 47u electrolytic.

Testing the Mini Bug Detector
To test the Mini Bug Detector, you will need a Signal Injector.
Place the Injector on **Point G** and you will hear a tone. Then go to **E**, **C** and **A**. The tone will increase in volume. If it does not increase, you have pin-pointed the faulty stage.

The next circuit is a combination of digital and analogue signals. It is a **Logic Probe**:

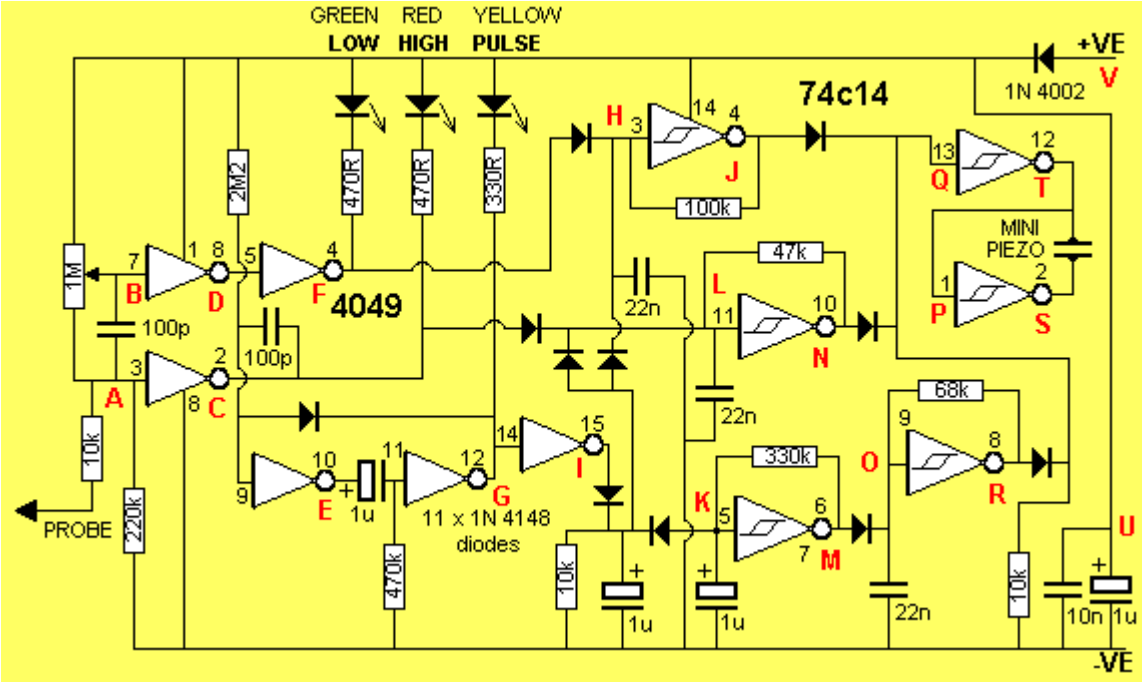

The voltage on a circuit (to be tested) is detected by the probe at **Point A** of the circuit above and the "tip" is classified as "reasonably high impedance" as it has a 220k resistor between the tip and 0v rail. The 1M reduces the impedance by about 20% but the inputs of the two inverters have no effect on the "tip" impedance as they are extremely high input-impedance devices.
The 1M trim pot is designed to put put a voltage on **point B** that is slightly higher than mid-rail so the green LED is turned off.
Point A will see a voltage below mid-rail and **point C** will be HIGH. **Point C** and **F** are low-impedance outputs.
When the tip of the probe is connected to a LOW voltage, Point B sees a LOW and Point F goes LOW to illuminate the green LED. At the same time it removes the "jamming voltage" produced by the diode between pin 4 of the 4049 and pin 3 of the

74C14 and the oscillator between **points H and J** produces a low-tone via the 100k resistor and 22n to indicate a LOW.
When the probe tip sees a HIGH, a lot more things happen.
Point C goes LOW and turns on the red LED. At the same time the 100p is in an uncharged state and the right lead goes LOW. This takes the left lead LOW as the left lead connects to a HIGH Impedance line and pin 9 goes LOW. This makes **point E** HIGH
and since the 1u is in an uncharged state, pin 11 goes HIGH. This makes **point G** LOW and the diode between pins 9 and 12 keeps pin 9 LOW and takes over from the pulse from the 100p. The yellow LED is illuminated. The 1u starts to charge via the 470k and when it is approx half-charged, pin 11 sees a HIGH and **point G** goes low. This creates the length of pulse for the yellow LED.
At the same time, **Point L** goes LOW because the "jamming diode" from pin 2 of the 4049 goes low and allows the inverter between point L and N to produce a tone for the piezo.
In addition, **Point I** goes HIGH and quickly charges a 1u electrolytic. This removes the effect of the jamming diode on pin 5 of the 74C14 and a low frequency oscillator made up of 68k and 1u between pins 5&6 turns on and off an oscillator between **points O** and **R** to get a beep. The mini piezo is driven n bridge mode via the two gates between **points QT** and **PS**.
Point U is a 1u electrolytic to reduce the impedance of the power rail and **Point V** is a protection diode to prevent damage if the probe is connected to the supply around the wrong way.

Testing the Logic Probe
You can test the Logic Probe with the simple Logic Probe with Pulse project described above. It will let you know if each point in the circuit is HIGH or LOW. You will also find out the difficulty in testing the points that are HIGH Impedance, as the Probe will upset the voltage levels and the reading may be inaccurate.

More circuits will be added here in the future.

THE VOLTAGE DIVIDER - this topic could fill a book.

You need to read lots of other sections in this eBook, including the section on measuring across a resistor with a multimeter, and high impedance circuits, to fully understand the complexities of a VOLTAGE DIVIDER CIRCUIT.
It is one of the most important BUILDING BLOCKS to understand. Even though it may consists of two components, you have to understand what is happening between these two components. You have to realise there is a voltage at their join that will be rising and falling due to one of the components changing RESISTANCE. Sometimes you can work out the voltage at the join by using Ohm's LAW but quite often it will be impossible as it is changing (rising and falling) during the operation of the circuit.
At the beginning of this discussion we will only dealing with DC circuits and the voltage across a particular component will be due to its RESISTANCE. We are not going into any formulas, as it is very easy to measure the voltages with a multimeter set to VOLTS and you will have an accurate result.
The simplest two components in series are resistors. They always have the same resistance during the operation of a circuit and the voltage across each will not change.
In a further discussion we will cover "resistors" that change value according to the temperature. These are called THERMISTORS. And we have "resistors" that change value according to the light they receive. These are called LIGHT DEPENDENT RESISTORS (LDR's) or PHOTO RESISTORS.
A transistor that is partly or fully turned ON can be considered to be similar to a resistor.
In these 3 cases we need to measure the voltage at the join with a voltmeter as it will be a lot of work to measure the resistance and work out a value.
You can also keep a voltmeter on the joint and watch the voltage change.
Finally we have some components that produce a fixed voltage across them (or nearly fixed) and the remaining voltage is dropped across a resistor. These

components MUST have a resistor connected in series to limit the current and allow the component to pass the specified in the datasheet.
These devices include LEDs, diodes and zener diodes. A LED will have a fairly fixed voltage across it from 1.7v to 3.6v depending on the colour. A diode will have a voltage of 0.7v across it when it is connected to a voltage via a resistor. And a zener diode will have a fixed voltage across it when it is connected with the cathode to the positive rail via a resistor. The voltage across it will be as marked on the zener.
The concept of a VOLTAGE DIVIDER is very simple, but it takes a lot of understanding because both VOLTAGE and CURRENT are involved in the UNDERSTANDING-PROCESS.
Each component has a resistance and this can be measured with a multimeter. When two components are connected in series, a current will flow and a voltage will develop across each item.
More voltage will develop across the item with the higher resistance and the addition of each voltage will always equal the supply voltage.
That's the simple answer.
There is a little more involved . . . It is the word CURRENT. Here is an explanation:
Suppose we have a 1k and 2k resistor on a 12v supply. The voltage at the join will be 4v.
In other words, there will be 4v across the 1k and 8v across the 2k.
If we have a 10k and 20k resistors in series, the voltage will also be 4v at the join.
If we have a 100k and 200k resistors, the voltage will also be 4v at the join.
The voltage will be the same in all cases, but the current will be different. The current in the second case will be one-tenth and only one hundredth in the third case.
If you want to go further, place a one ohm and two ohm in series and get 4v. But the resistors will get very hot and burn out very quickly.

SOLDERING

Here are three 30-minute videos on soldering.
1. **TOOLS**
2. **Soldering components**
3. Soldering **SURFACE MOUNT** components

TESTING A MOTOR

Strictly speaking, a motor is not an electronic component, but since a website gave a useless description on testing motors, I have decided to supply the correct information.
The only REAL way to test a motor is to have two identical motors and check the torque by connecting them to a low voltage and trying to stop the shaft with your fingers. This will give you two results. Firstly it will let you know the torque of the motor.
This is the twisting effect of the shaft. There is no way to determine the torque by knowing the voltage or current.
The unknown factor is the strength of the field magnets (permanent magnets) and this determines the torque.
Secondly, feeling the shaft will let you know if the torque is even for a complete revolution.
By having two identical motors, you can see if one has a lower torque.
Almost nothing can go wrong with a motor except for the brushes. If the brushes wear out, additional resistance will be produced at the interface between the brush and commutator and this can be detected by allowing the shaft to rotate slowly and feeling the resistance as it revolves. A 3-pole motor will have three places where the strength is greatest and each should have the same feeling. A 5-pole motor will have five places of strength.
If the strength is weak or not uniform, the motor is faulty.
You cannot test a motor with a multimeter as the resistance of the armature winding is very low and if the motor is allowed to spin, the back voltage produced by the spinning, increases the reading on the meter and is false.

Micro motors have a coreless armature. This means the 3 windings for the armature are wound on a machine then bent slightly into shape and glued. A circular magnet with 3 poles is in the centre and the armature rotates around this.
This type of motor is reasonably efficient because the armature is the greatest distance from the point of rotation, and the motor reaches full RPM very quickly because the armature has very little inertia.
I have not heard of the armature-winding flying apart but if you hear any scraping noise, it may be the winding.
3-pole, 5-pole and micro motors can be found in printers, eject mechanisms of CD players, toys, RC helicopters, cars etc and rarely fail.
Motors do not work on "voltage." They actually work on CURRENT and as you increase the voltage, more current will flow and produce a stronger magnetic field (by the winding on each pole). This magnetic field will be attracted by the permanent magnet surrounding the armature and repelled by the surrounding permanent magnet, depending on where the face of the pole is, during each revolution.
If the permanent magnet is not very strong, the repulsion part of the interaction will be very weak and thus the torque will be small.
Because motors work on "current" you must have a high current available when you increase the voltage as the motor will require short bursts of high current during each revolution.
It is the combination of voltage and current (called watts) that gives the motor "strength" (torque) as well as the "strength" of the permanent magnets (called the field magnets) and the number of turns of wire on each pole (and the gauge of wire).
Basically, if a motor is hard to spin, and has 3 "hard spots" on each revolution, it will be powerful.
A 2-pole motor does not self-start and will spin in either direction. But a 3-pole motor will self-start and you can determine the direction of rotation.
A 5-pole motor has a lower RPM. It is slightly smoother in output but is not more powerful than a 3-pole version.
A motor with "permanent magnets" is called a DC motor as it will not work on AC. If the magnets are replaced with a coil, it will work on AC and it will be called a "shunt wound" motor of the field coil is connected across the same terminals as the brushes or a "series wound" motor if the field coil is in series with the armature.

TESTING COMPONENTS "IN-CIRCUIT"

You can test components while they are IN CIRCUIT, but the surrounding components will have an effect on the results.
You can get all sorts of "In-Circuit" testers. They are expensive and offer little more accuracy than a multimeter.
In-Circuit testing with a multimeter can give you the same results as a tester.
All you have to do is turn the project ON and use a multimeter (set to voltage) to determine the voltage at various points. It is best to have a circuit of the equipment so you can what to expect at each point.
Only major departures from the expected can be located in this way.
Obviously the first thing to look for is burnt-out components. Then feel components such as transistors for overheating.
The look for electrolytics that may be dry. Sometimes these have changed colour or are slightly swollen.
If they are near hot components, they will be dry.
For the cost of a few dollars I change ALL THE ELECTROLYTICS in some pieces of equipment, as a dry electrolytic is very difficult to detect.
Testing a transistor "in-circuit" is firstly done with the supply ON. That's because it is quicker.
Measure the voltage between ground and collector.
In most cases you should get a voltage of about half-rail. If it is zero, or close to rail voltage, you may have a problem.
Turn off the supply and use the multimeter on low-ohms to measure all six resistances between the leads.
A low resistance in both directions on two leads will indicate a fault.
Resistors almost NEVER go "HIGH." For instance, a 22k will never go to 50k.
However a low-value resistor will "burn-out" and you will read the value of the surrounding components.

Don't forget, some low-value resistors are designed to burn-out (called fusible resistors) and anytime you find a damaged low-value resistor, you will need to look for the associated semiconductor.
You can replace the resistor quickly and turn the circuit ON to see it burn out again.
Alternatively you can trace though the circuit and find the shorted semiconductor.
It's always nice to "see the fault" then "fix the fault."
Sometimes a transistor will only break-down when a voltage is present, or it may be influenced by other components.
When the piece of equipment is turned OFF, you can test for resistance values. The main thing you are looking for is "dry joints" and continuity. Dry joints occur around the termination of transformers and any components that get hot. Rather than wasting time checking for dry joints, it is better to simply go over the connections with a hot iron and fresh solder.
You may need to check the continuity of a track (trace) and it may go from one side of the PC board to the other.
Use a multimeter set to low-ohms and make sure the needle reads "zero-ohms."
It is very dangerous to do any testing on a project using a multimeter set to "amps" or "milliamps."
You cannot test "current flowing through a component" by placing the probes across a component. You will simply over-load the rest of the circuit and create a problem.
To find out if current is flowing though a circuit or a low-value resistor, turn the project ON and measure the voltage either across the component or the voltage on one end then the other.
A voltage-drop indicates current is flowing.
That's about it for testing "in-circuit." Use the rest of this eBook to help you with diagnosis.
Don't think an IN-CIRCUIT COMPONENT TESTER is going to find a fault any faster than a multimeter. They all use a multimeter principle.

SHORT CIRCUIT

Nearly every component can fail and produce an effect called a SHORT CIRCUIT.
This basically means the component takes more current than normal and it may fail completely or simply take more current and the operation of the circuit may be reduced only a small amount.
The resistance of the component may reduce a very small amount but this may have a very large effect on the operation of the circuit.
For instance, two turns in the horizontal or vertical winding of a yoke on the picture tube or monitor may arc and weld together and reduce the size of the picture on the screen, but measuring the winding will not detect the difference in resistance.
The same with the windings on a motor and a short between two winding in a transformer.
If the "short" is between two near-by turns, the change in resistance will be very small. If the "short" is between to different layers, the resistance will be reduced and it may be detected.
When a "short" occurs, the winding turns into a transformer. To be exact, an AUTO-TRANSFORMER.
In the following diagram you can see a normal winding in fig A:

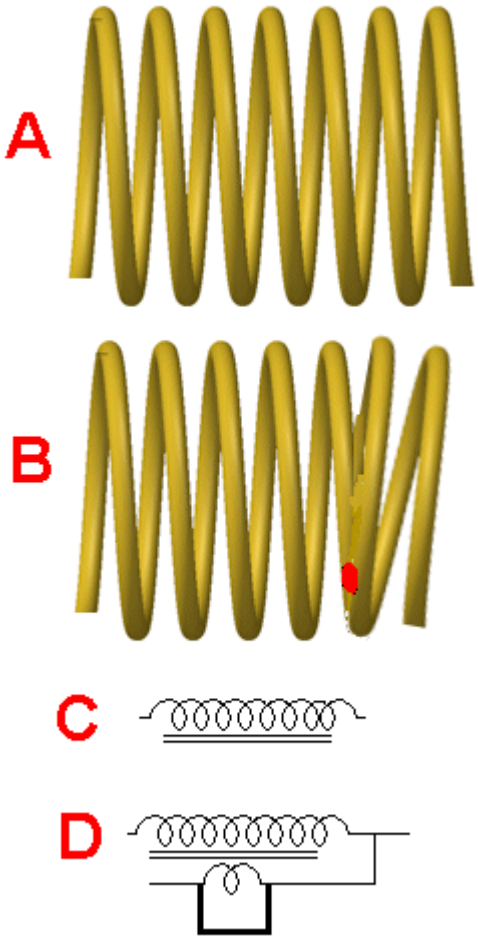

Fig B shows two turns touching each other and if the wire is enamelled, the coating has been damaged so the copper wire from the two turns is touching. This is called a SHORTED TURN.
In fig C you can see two turns touching.
In fig D the shorted-turn has been moved to the other side of the symbol to show the effect it has on the operation of the winding.
The shorted-turn is exactly like the secondary of a transformer with a "jumper" across the output.
This will produce a very high current in the secondary.
A very high current flows through the shorted turn and this changes the operation of the rest of the winding.

1. In most cases a SHORT CIRCUIT can be detected by feeling the additional heat generated by the component.
2. Next, turn off the supply and measure the resistance of the component. If it is lower than expected, the component will be faulty.
3. Next, measure the voltage across the component. If it is lower than normal, the component will be faulty.
4. Next, measure the current taken by the component. If it is higher than normal, the component will be faulty.
5. If the component is an inductor, such as a motor, coil or transformer, you can use an inductance meter. Compare a good winding with a faulty winding. Sometimes the fault will disappear because an arc develops across the fault when the component is operating.

INTERNAL AND EXTERNAL SHORTS

An **internal short** refers to two windings shorting together and the winding has a very high resistance between the winding and the frame on which it is wound. An external short refers to a winding shorting to the frame of the component - such as one of the armature windings shorting to the metal core, around which the wire is

wound.
This may not be important unless another winding shorts to the metal frame and creates "**inter winding**" problems (**inner winding** problems is within the same winding).

The opposite to a short circuit is an OPEN CIRCUIT.

This is generally a broken lead or contact or a wire that has "burnt-out" or been "eaten-away" by acid attack or galvanic action by water and voltage (current).
1. No current will flow when an OPEN CIRCUIT exists.
2. The voltage on each end of the OPEN CIRCUIT will not be the same.
3. Measure the current across the OPEN CIRCUIT and determine if excess current is flowing.
4. Join the two ends of the OPEN CIRCUIT and see if the circuit operates normally.

> HEATSINKS

This is not an electronic component but it can certainly affect the operation of a circuit.
If you cannot hold your fingers on a heatsink, it is getting too hot. This is because the actual location where the heat is being generated is much hotter than the part you are touching.
Transistors and IC's can withstand a high temperature but if they go above this temp, they BLOW UP.
They also have a shorter life when operating at a high temperature.
The secret to a good heatsink is called an INFINITE HEATSINK.
This is the metal frame of a case.
There are lots of charts and data on choosing a heatsink but they don't take into account two factors:
Sometimes a circuit takes a very high current for a short time and this creates a high temperature gradient. This will cause the transistor to get very hot and fail.
The solution is to have two or more transistors in parallel to separate the "heat spots."
The second problem with designing a heatsink is the unknown location of the heatsink and the air-flow. Products placed on a shelf or in a cupboard will get very little air-flow.
Remember: some transistors are mounted on thermal insulators. This means the transistor will have a voltage on it but the heatsink will be zero voltage.
The temperature of the transistor will be MUCH HIGHER than the heatsink under the transistor and the transfer of the heat from the transistor to the heatsink will be very slow. This can be the cause of the transistor failing. Sometimes the transistor will fail because insulation is high temp plastic and it gets brittle. The plastic can carbonise and leak and sometimes a voltage can flash through the insulator. Some amazing things have happened under these transistors and you may need to pull it apart and replace all the insulation.
Finally, feel the heatsink after 15 minutes and feel right up to the transistor. If you cannot touch the transistor, increase the thickness of the heatsink or use two transistors to dissipate the heat.
To design a heatsink, you have to have some idea of the size of a heatsink for the application.
Charts and data can send you in the wrong direction.
Start with a heatsink twice the recommended size and feel the temp after 15 minutes. Put the project in a cupboard and see how the temperature rises.
If possible, connect the heatsink to the metal case to get added dissipation and if you include fan-cooling, remember the fan will eventually gather dust and reduce its efficiency.
It is very difficult to explain how heat passes through a mica washer or plastic washer, but if the transistor has a copper base, the heat transfer has a value of 400. For aluminium it is 200. If it is steel, the transfer has a value of 50. For a mica sheet it is 1 and for plastic it is 0.1
Even though the sheet is very thin, the transfer is a lot less than metal-to-metal transfer.

Most references state the temperature difference is about one degree C for each watt of heat generated by the transistor.
Don't believe anything you read.
Feel the temperature yourself and if you cannot hold your finger on the transistor, fix the problem.

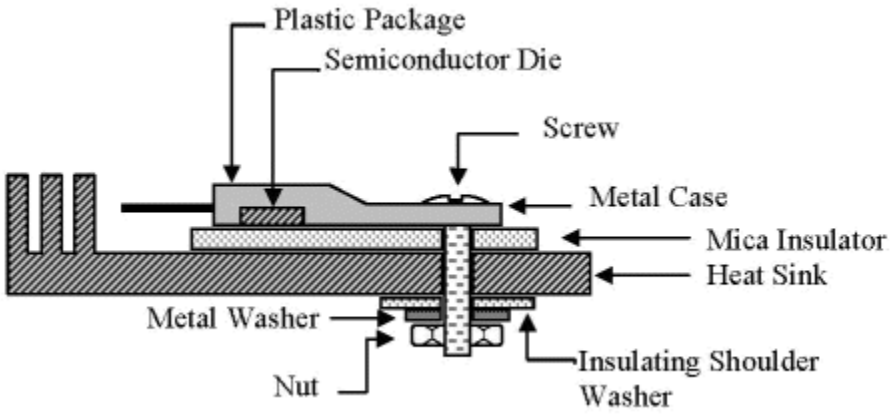

In the end, use a heatsink 50% larger than recommended.

THE END

This is not the full story to learning about servicing. It is just the beginning.
We have only covered the simplest tests and shown how 90% of faults can be found by checking voltages, waveforms and looking for obvious things such as burnt out components, cracks in PC boards.
The author has fixed over 35,000 TV's, radios, stereos, VCRs and all those things that were on the market 30 years ago.
Things have not changed. It's just that some repairs cost nearly as much as buying a new product and half the customers opt for dumping a faulty item and buying the latest "flat screen" version. That's why you have to get things through the workshop as fast and as cheaply as possible, to make a living.

If you want any more devices added to this list, email **Colin Mitchell**.

To help with understanding how a transistor circuit works, we have produced an eBook: **The Transistor Amplifier.** It covers a whole range of circuits using a transistor.

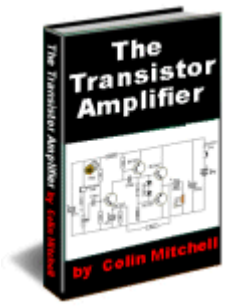

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See the enormous amount of information on Talking Electronics website

CIRCUIT SYMBOLS by TALKING ELECTRONICS

AC current: voltage:	ALTERNISTOR TRIAC A TRIAC and 33 - 43v DIAC Main Terminal1 Gate Main Terminal 2	Ammeter (amp meter)
AND Gate	AND Gate	Antenna balanced
Antenna Loop, Shielded	Antenna Loop, Unshielded	Antenna unbalanced
Attenuator, fixed (see Resistor)	Attenuator, variable (see Resistor)	Battery
Bilateral Switch (DIAC)	Bridge Rectifier (Diode Bridge)	BUFFER (Amplifier Gate)
BUFFER (Amplifier Gate)	Buzzer	Capacitor feedthrough
Capacitor non-polarised	Capacitor polarised (see electrolytic)	Capacitor Variable
Cavity Resonator	Cell	Circuit Breaker
Coaxial Cable	CRO – Cathode Ray Oscilloscope	Crystal Microphone (Piezoelectric)
Connectors Plug (male) Jack (female) connected Plug (male) (female)	Crystal Piezoelectric Darlington Transistor collector base emitter DIAC (Bilateral Switch)	DC current: voltage: Delay Line Diode
Diode - Gunn	Diode - Light Emitting (LED)	Diode Photo Sensitive
Diode Photovoltaic	Diode Bridge (Bridge Rectifier)	Diode - Pin
Diode - Varactor	Diode - Zener	Earth Ground
Earpiece (earphone, crystal earpiece)	Electroluminescence el	Electret Microphone (Condenser mic)
Electrolytic (Polarised Capacitor) alternate symbols: (positive on top)	Electrolytic - Tanatalum positive end black band or chamfer 106 10u tantalum	Exclusive-OR Gate (XOR Gate) Exclusive-OR Gate (XOR Gate)
Field Effect Transistor (FET) n-channel also: N-Channel J FET Gate Drain Source	Field Effect Transistor (FET) p-channel also: P-Channel J FET Gate Drain Source	Flashing LED (Light Emitting Diode) (Indicates chip inside LED)

Ferrite Bead	Fuse	Galvanometer
Globe	Ground Chassis	Ground Earth
Heater (immersion heater) (cooker etc)	IC Integrated Circuit power ground	Inductor Air Core
Headphone		Inductor Iron Core or ferrite core
Inductor Tapped	Inductor Variable	Integrated Circuit
Inverter (NOT Gate)	INVERTER (NOT Gate)	
Jack Co-axial	Jack Phone (Phone Jack)	Jack Phone (Switched)
Jack Phone (3 conductor)	Key Telegraph (Morse Key)	Lamp Incandescent
Lamp - Neon	LASCR (Light Activated Silicon Controlled Rectifier)	LDR (Light Dependent Resistor)
LASER diode laser diode photo diode	Light Emitting Diode (LED)	Light Emitting Diode (LED - flashing) (Indicates chip inside LED)
Mercury Switch	Micro-amp meter (micro-ammeter)	Microphone (see Electret Mic)
Microphone (Crystal - piezoelectric)	Milliamp meter (milli-ammeter)	Motor
NAND Gate	NAND Gate	Nitinol wire "Muscle wire"
Negative Voltage Connection	NOR Gate	NOR Gate
NOT Gate Inverter	NOT Gate Inverter	Ohm meter
Operational Amplifier (Op Amp)	Optocoupler (Transistor output)	Opto Coupler (Opto-isolator) a c k e Photo-transistor output
Optocoupler (Darlington output)	Opto Coupler (Opto-isolator) a c k e TRIAC output	OR Gate
OR Gate	Oscilloscope see CRO	Outlet (Power Outlet)
Piezo Diaphragm	Photo Cell (photo sensitive resistor)	Photo Diode
Photo Darlington Transistor	Photo FET (Field Effect Transistor) Gate Drain Source	Photo Transistor

Photovoltaic Cell
(Solar Cell)

Piezo Tweeter
(Piezo Speaker)

Positive Voltage
Connection

Potentiometer
(variable resistor)

Programmable
Unijunction
Transistor PUT
gate
anode
cathode

Rectifier
Silicon Controlled
(SCR)
Anode
Gate
Cathode

Rectifier
Semiconductor
k

Reed Switch
N

Relay - spst

Relay - spdt

Relay - dpst

Relay - dpdt

Resistor
Fixed

Resistor
Non Inductive

Resistor
preset

Resistor
variable

Resonator
3-pin

RFC
Radio Frequency Choke

Rheostat
(Variable Resistor)

Saturable Reactor

Schmitt Trigger
(Inverter Gate)

Schottky Diode
(also Shottky)
Low forward voltage 0.3v
Fast switching
also called Schottky Barrier Diode
k
k

Shielding

Signal Generator

Shockley Diode
k
4-layer PNPN device
Remains off until forward current
reaches the forward break-over voltage.

Silicon Bilateral Switch (SBS)
T_2 Terminal
Gate
T_1 Terminal
e.g: BS08D
T_2 G T_1

Silicon Unilateral Switch (SUS)
Anode
Gate
Cathode(k)
A G k

Silicon Controlled
Rectifier (SCR)
Anode
Gate
Cathode

Solar Cell

Surface Mount
SOT-23
c
b
e
c
b
e
b
e
k
k
k
A
no connection
& LED

Switch - spst

Switch - spdt

Switch - dpst

Switch - dpdt

Switch - mercury
tilt switch

Spark Gap

Switch - process activated
normally open: normally closed:
Flow
Level
Pressure
Temperature

Speaker
8R

Switch - push
(Push Button)

Switch - push off
(used in alarms etc)

Switch - Rotary

Test Point

Thermal Probe
NTC: as temp rises,
resistance decreases
t° = ?
NTC

Thyristors: Main Terminal1
Bilateral
Switch
Anode
Gate
Cathode
MT2
Anode
Gate
Cathode
DIAC **SCR** **TRIAC** **TRIAC**

Thermocouple

Tilt switch
mercury

Touch Sensor

Transformer
Air Core

Transformer
Iron Core

Transformer
(Tapped Primary/Sec)

Transistor Bipolar - NPN collector base emitter	Transistor Bipolar - PNP emitter base collector	Transistor n-channel Field Effect Gate Drain Source
Transistor p-channel Field Effect Gate Drain Source	Transistor Metal Oxide Single Gate	Transistor Metal Oxide Dual Gate
Transistor Photosensitive	Transistor Schottky - NPN collector base emitter	Transistor Unijunction - UJT Emitter Base 1 Base 2 Unijunction Transistor (UJT) N-type
TRIAC Main Terminal1 Anode Gate MT2 Cathode	Transistor Unijunction - UJT Emitter Base 1 Base 2 Unijunction Transistor (UJT) P-type	Tunnel Diode Unijunction Transistor - UJT Emitter Base 2 Base 1
Varactor varactor diode	Voltage Regulator (7805 etc) in out 7805 out common in 7805	Voltmeter
Wattmeter	Wires	Wires Connected
Wires Not Connected	XOR Gate (exclusive OR)	XOR Gate (exclusive OR)
Zener Diode k k	Learn **BASIC ELECTRONICS** Go to: http://www.talkingelectronics.com	

More chapters of this eBook on: Talking Electronics.com

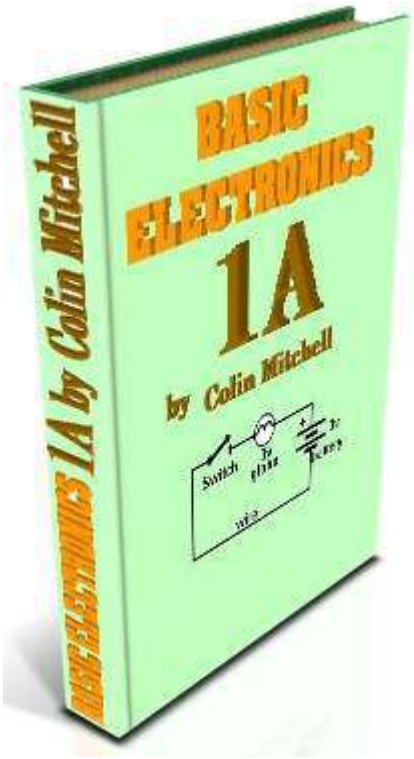

For any enquiries email Colin Mitchell

BASIC ELECTRONICS

(this is the Basic Electronics section i.e. Page 1)

(Chapters 1 and 3 are available as .pdf)

Quick Quiz - to see how much you know
Encyclopedia of Components - this is excellent !!!

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- PNP or NPN Transistor TEST
Page 2a: The 555 IC
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The 555 - 2
The 555 - 3
The 555 TEST
Page 3: The Power Supply download as .pdf (900kB)
3a: - Constant Current
3b: - Voltage Regulator
3c: - Capacitor-fed Power Supply
Page 4: Digital Electronics

4a: - Gates Touch Switch Gating
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Remember: the animations do not work in .pdf

the site is being constantly updated

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KIT OF PARTS

Talking Electronics supplies a kit of parts that can be used to build the majority of the circuits in this eBook.
The kit costs $15.00 plus postage.

Kit for Transistor Circuits - $15.00

BUY NOW

A kit of components to make many of the circuits described in this eBook is available for $15.00 plus $7.00 post.
Or email Colin Mitchell: talking@tpg.com.au

The kit contains the following components:
(plus **extra** 30 resistors and 10 capacitors for experimenting), plus:

3 - 47R
5 - 220R
5 - 470R
5 - 1k
5 - 4k7
5 - 10k
2 - 33k
4- 100k
4 - 1M
1 - 10k mini pot
1 - 100k mini pot
2 - 10n
2 - 100n
5 - 10u electrolytics
5- 100u electrolytics

5 - 1N4148 signal diodes
6 - BC547 transistors - NPN - 100mA
2 - BC557 transistors - PNP - 100mA
1 - BC338 transistor - NPN - 800mA
3 - BD679 Darlington transistors - NPN - 4amp
5 - red LEDs
5 - green LEDs
5 - orange LEDs
2 - super-bright WHITE LEDs - 20,000mcd
1 - 3mm flashing LED
1 - mini 8R speaker
1 - mini piezo
1 - LDR (Light Dependent Resistor)
1 - electret microphone
1m - 0.25mm wire
1m - 0.5mm wire
1 - 10mH inductor
1 - push button
5 - tactile push buttons
1 - Experimenter Board (will take 8, 14 and 16 pin chips)
5 - mini Matrix Boards: 7 x 11 hole,
11 x 15 hole, 6 x 40 hole, surface-mount 6 x 40 hole board and others.

Photo of kit of components.
Each batch is slightly different:

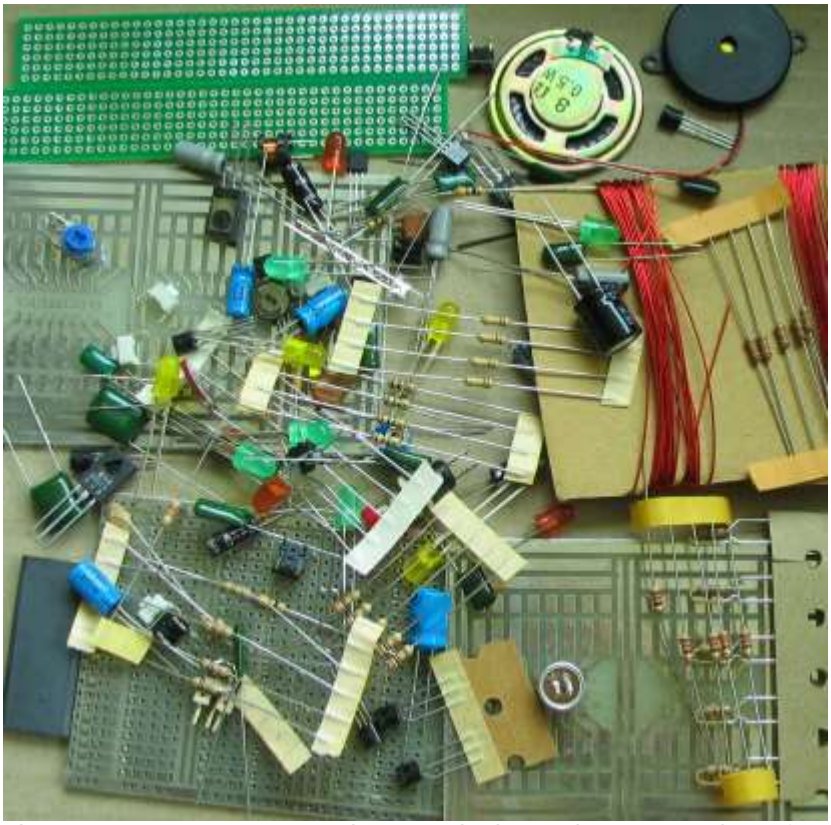

There are more components than you think. . . plus an extra bag of approx 30 components. The 8 little components are switches and the LDR and flashing LED is hiding.
In many cases, a resistor or capacitor not in the kit, can be created by putting two resistors or capacitors in series or parallel or the next higher or lower value can be used.

BEFORE WE START

Too many text books start with the physics of the atom and have equations and mathematics to show how smart the author is.
Don't worry, we wont have any physics or equations.
The reason . . .
This is not a physics course. It is a practical electronics course to teach the basics as quickly as possible. There are no equations because most transistor circuits cannot be worked out mathematically as the gain of a transistor changes according to the current-flow and these gain-values are never provided. So the mathematics is worthless.
To get an answer, all you have to do its build the circuit and measure the values with a multimeter.
Also lots of discussions in text books will never be used in your next 40 years of electronics, so this course doesn't have any unnecessary material and is much-more concentrated than anything you have read before.
Every frame contains important points - especially the animations - as they show you how a circuit works in slow-motion - something that has NEVER been done before.

ELECTRONICS BLOCKS

Here is an idea from Instructables to produce blocks with screws, containing a single component and they can be connected with jumper leads (alligator clips).

Use a slotted head for the negative screw and a philips head for the positive screw.

Learn electronics from the beginning . . .

START HERE:

All electrical and electronic components need wire to connect them to the circuit.
In a diagram called a CIRCUIT DIAGRAM, the wires are drawn as lines.
When the wires (or lines) cross, they may be joined or just passing.
It is **VERY IMPORTANT** to show the difference between lines that are **JOINED** and lines that are **NOT JOINED**.
When the lines are joined, it is best to place a dot

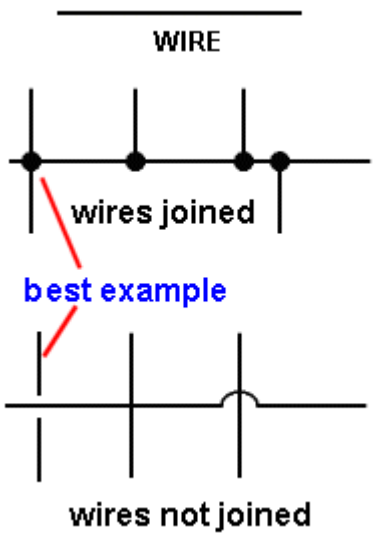

Fig 1 The wire in a circuit diagram

on the connection to PROVE the lines are joined. When the lines are just crossing, a gap should be made so it is obvious that one wire goes under the other and does not touch.
Lines should be "across the page" or "up and down." Very few lines should be at 45°.
You can make a line thicker to indicate a power rail or a wire that will be thick in reality.

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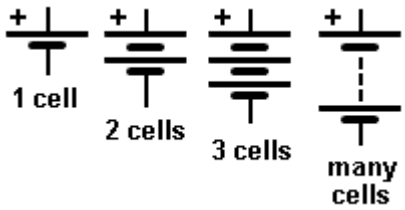

Fig 2 A single Cell and many Cells

Next we need a **battery**. A battery consists of two or more cells. The positive terminal of a battery is the long line in the diagram and you must add the voltage (of the cell or battery) to the symbol as a single cells can be 1.2v, 1.5v, 2.2v or up to 3.6v.
The symbol does not let you know the voltage.
The positive is always at the top and is the longest line on the battery symbol.

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Fig 3: A Globe

Next we need a globe. A globe has two connections (a fine wire inside a glass bulb glows when the globe is connected to a battery).

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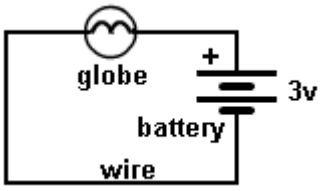

Fig 4: A Circuit

With a globe, battery and wire we have produced a **CIRCUIT**.
A **CIRCUIT** is a complete path and we say the "electricity" the **CURRENT** emerges from the positive of the battery, moves through the globe and returns to the battery via the wire.
If the globe is a "3v GLOBE" it will glow when connected to a 3v battery.
The globe can be connected either way around.
The circuit we have shown is called a **SCHEMATIC** and consists of symbols: a globe symbol and a battery symbol.
The line connecting the two components is called WIRE.

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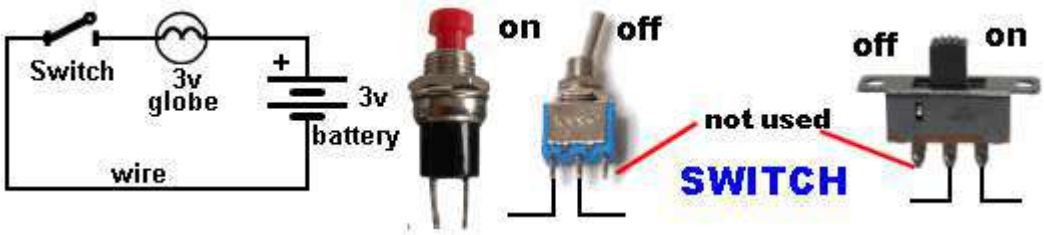

Fig 5:Adding a SWITCH

To turn the globe ON and OFF we need a SWITCH.
The switch may be a push button, a toggle switch (a "click" action) or a slide switch. You could

twist the wires together and untwist them. The result is the same. We say the circuit is "broken" or "open" via the switch and the lamp does not glow. Closing the switch turns ON the globe.

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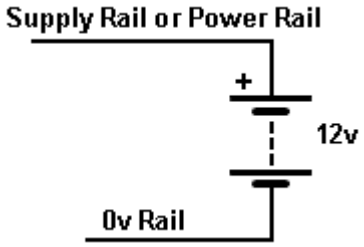

Fig 6: Naming the RAILS

The top rail of the **CIRCUIT DIAGRAM** is called the **SUPPLY RAIL** or **POWER RAIL**.
The lower rail is called the **0v Rail** or **EARTH RAIL**.
Do not connect the Supply rail (+12v) to the 0v rail as this will cause a high current to flow and is called a **SHORT CIRCUIT**:

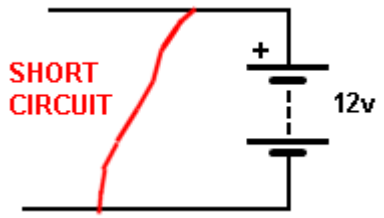

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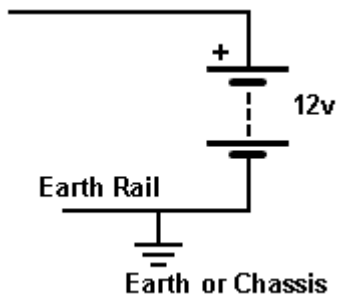

Fig 7: The **EARTH RAIL**

The lower rail is also called the **Chassis**.
This comes from the "old days" when electronics constructors build radios on a metal chassis (metal box) and it was connected via wire to a pipe in the ground to help the radio pick up distant radio stations.
The term also comes from car and truck wiring where one side of each globe is connected to the frame or chassis so that only one wire is needed to each globe and the return "path" is via the chassis.

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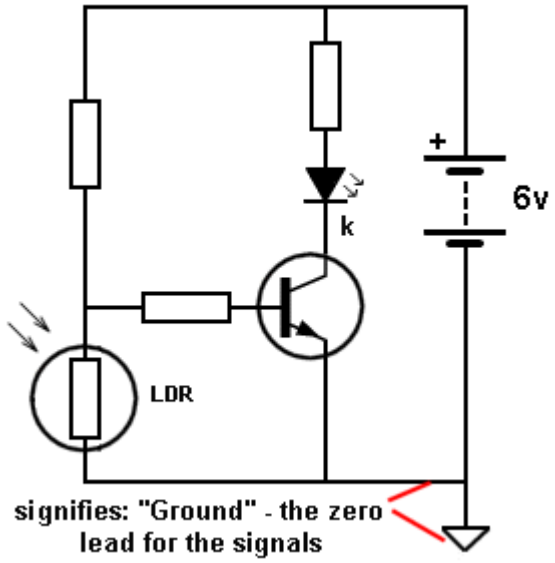

Fig 7a: Ground

Some circuits identify the "**Ground Lead**" or "**Ground Wire**" of a project to show where all the **signals** have been "referenced to." In other words, all the signals rise and fall above and below this "Ground wire" or "Ground Lead." This lead may not be at **earth potential** as the project may be in a plastic box but it identifies where the earth lead of a Cathode Ray Oscilloscope or the negative lead of a multimeter is connected.
On some printed circuit boards, the negative terminal of the battery (the 0v wire or terminal) is connected to a very large area of copper and this is called the EARTH PLANE or GROUND PLANE. It is designed to prevent signals travelling along the tracks (called traces) being radiated and also prevents outside interference upsetting the project. It also "tightens-up" the earth rail.

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The circuit shows a 12v globe connected to a 12v battery and the circuit appears to be "broken" (not continuous).
But the **current returns** via the earth connection.

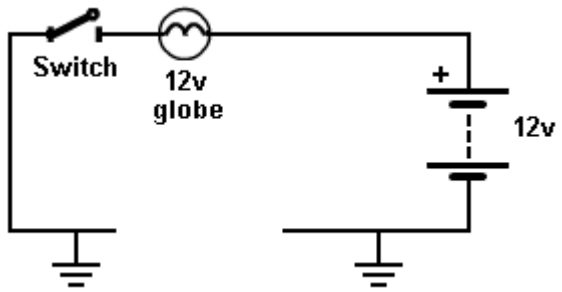

Fig 8: EARTH Return

We talk about the **CURRENT RETURNING**. We don't say: the voltage returning.
The voltage of the globe must be the same as the battery voltage, otherwise it will not glow fully or it will **burn out** if it is say a 6v globe.

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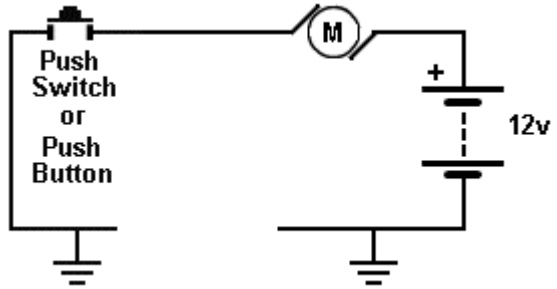

Fig 9: Connecting a Motor

The circuit shows a 12v **Motor**.
It is turned ON when the push-switch is pressed.

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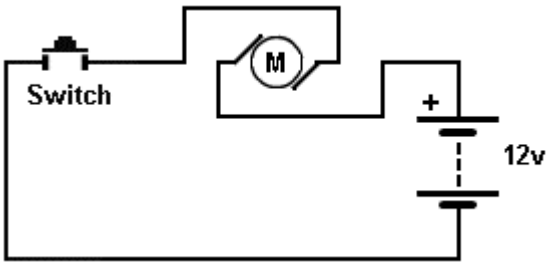

Fig 10: Reversing a Motor

If the wires are connected to the motor "around the other way," the motor will reverse direction.

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VOLTAGE AND CURRENT

What is voltage and what is current?
Here is a very simple description.
A battery produces a voltage called DC. (This is a very confusing name because the letter actually refer to Direct Current, so we just say **DC Voltage**).
A battery also produces current called DC - Direct Current. We say **DC current**.

VOLTAGE

Voltage is a value produced by an electrical component called a battery or cell.
A single cell produces one and a half volts. (1.5v) and although this is not a high voltage, when cells are connected together we get higher voltages.
If 6 cells are connected in series we get 9v.
Here is a 9v battery:

CURRENT

You cannot feel current with your tongue so we have to carry out another experiment:

Touch the two terminals with your tongue. You get a tingle. This is a 9v tingle. Now you have "felt" electricity. This is a 9v tingle.

Place a 22 ohm or 47 ohm resistor across the terminals of the battery and hold your fingers on the resistor. It will get hot. This is the result of current flowing through the resistor and heating it up. The current will be about half an amp and the voltage is 9v, so the wattage will be about 2 to 4 watts. Feel the heat produced.

Milli - milli means 1/1,000th (one thousandth) - such as one milliamp or one millivolt.
In other words one thousand milliamps is equal to 1 amp.
One volts is not a very large value as a battery produces 9v and a cell produces 1.5v to 3.6v (depending on the type of cell.
But 1 amp is a large quality when talking about electronic circuits involving LEDs, motors and transistors.
The globe used in the experiments above requires about 300mA. (1,000mA = 1 amp)
The 3v motor used in the experiments requires about 250mA
The LEDs used in the experiments require about 20mA.
Transistors can pass about 100mA to 800mA via the collector-emitter.
In most cases current-flow in the circuits we will be discussing will be less than 1 amp and will be shown as 25mA, 100mA, 350mA etc.

WATTAGE and CAPACITY

A 9v battery has 6 very small cells and they will not last very long.
A "AAA" cell is larger and a "D" cell is much larger.

A large cell is said to have a **LARGE CAPACITY.** This means it will deliver a larger current for a longer period of time.
The **WATTAGE** of a cell is the multiplication of the voltage x current. The answer is milliwatts or watts.
The **CAPACITY** of a cell is the wattage x hours. The answer is milliwatt-hours or watt-hours. This is also called watt-hours.
You can determine the capacity of a cell (such as a rechargeable cell) by connecting it to a clock-mechanism that has a 4R7 connected across the terminals. The resistor will take a considerable current and deplete the cell in a few hours. The clock will let you know exactly how long the cell delivered the current. You can then compare other cells.

The simplest electrical circuit consists of a battery and resistor. The current flowing through the circuit will depend on the voltage of the battery and the resistance of the resistor R.

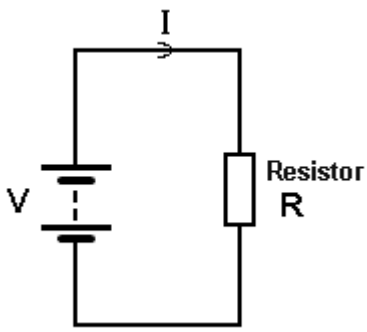

The formula connecting these three quantities is:

$$I = \frac{V}{R}$$

Ohm's Law

$$I = \frac{12}{3}$$

$$I = 4 \text{ amps}$$

This is called **Ohm's Law**. Suppose you have a 12v battery and the resistor is 3 ohms. The current flowing through the resistor will be 4 amps.
Increasing the resistance will decrease the current if the voltage remains fixed.

All the above circuits are called ELECTRICAL CIRCUITS because they contain electrical components (such as a motor, globe, relay, switch).
When the circuit contains an ELECTRONIC component such as a diode, transistor, LED, it is called an ELECTRONIC CIRCUIT or ELECTRONIC SCHEMATIC.

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POWER and ENERGY

Here's an easy way to remember the difference between POWER and ENERGY:
A 9v alkaline battery has enough ENERGY to start a car. But it does not have enough POWER (strength).
Energy is effectively the strength of the battery (and this is the voltage and the current it can deliver) multiplied by the time it can deliver this energy. When the answer is obtained, it consists of three factors ((3 quantities) VOLTS, AMPS and TIME.
This results in an answer called xxxx WATT-HOURS.
For a 9v battery the quantities are: 9 volts, 500mA and the battery will deliver this 9x0.5 = 4.5watts for about 1 hour. This is equal to 4.5 x 60 x 60 = 16,200 watt-seconds.
To start a car requires 250 amps from a 12v battery for 5 seconds.
This is: 12 x 250 x 5 = 15,000 watt-seconds.
This means the energy stored in a 9v battery could start a car if all the energy could be delivered in 5 seconds.
This is not possible however the FACT is this: A 9v battery has enough stored energy to START A CAR.

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BATTERY BOOSTER

One of the simplest things we can do is start a car with a flat battery with the assistance of a BATTERY BOOSTER.
This consists of a 12v rechargeable battery in a handy case with leads to connect to the flat battery in your car.
This simple operation puts two 12v batteries in parallel, but no-one has actually described what happens and why.
That's because the explanation is very complex. We have included it here to show that a simple explanation involves a lot of technical terms and you will understand more after reading the course.

The flat battery in the car is not fully charged but it has some percentage of charge and when it sits for a period of time in a non-fully charged condition, the voltage drops from 12.6v to less than 12v as the battery gradually self-discharges due to the potential at the top of the cell being different to that at the bottom of the cell and the specific gravity of the electrolyte being different at the top and bottom. This causes an internal current to flow within the cell and slowly discharge the cell. But if you try to start the car, the voltage drops to less than 7v because the electrolyte cannot carry the high current and a slight potential is developed across the liquid.

The result is the starter-motor does not crank the car.
The reason is this: When the battery is fully charged, the current taken by the starter motor is about 300 amps. This is about 11v x 300 amps = 3300 watts = 4.4Horsepower.
But when the voltage drops to 7v, the current will drop to 190 amps to deliver 1336 watts = 1.8HP. This is only 40% of normal and that's why the car does not start. The engine needs 4HP to overcome the pressure in the cylinders due to the compression of the air during the "firing stroke."
Let's put it this way. If we have a brand new 7v battery, the car will not start. The starter-motor will only accept 190 amps when the supply is 7v.
So, we have to increase the voltage.
We do this by placing a 12v battery across the flat battery. The voltage of the flat battery will immediately rise to 12.6v. It might take 2 minutes but the flat battery will take a small current (1 to 10amps) from the battery in the "booster" and the output of the combination will be 12.6v. The current-carrying capacity of the electrolyte will improve very quickly and you have effectively given the "flat battery" a very quick charge.
The starter-motor will now accept 300 amps from the combination and **SURPRISINGLY** the cells of the "flat battery" will deliver about 200 amps and the booster battery will deliver about 100 amps. The actual sharing of current will depend on the two batteries but the secret behind the success is the increase in voltage we call **TERMINAL VOLTAGE**. The voltage on the terminals (the alligator clips).
The capacity of the booster battery is not important. It can be from 7AHr to 40AHr. We are just using a very small amount of its capacity to start the car and nearly all batteries will provide 200 Amps for a short period of time.
The voltage of the car battery is very important. The Horsepower taken by the starter-motor is defined by the formula: Pwatts = V^2/R Since the resistance remains constant, a voltage of 7 volts will produce 7x7=49 units and a voltage of 11v will produce 121units. This gives the ratio of 40% to 100% as explained above.

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BATTERY BOOST

Continuing from the previous frame where we showed the effect of placing a weak battery in parallel with a good battery, we can show what happens when a weak cell is placed IN SERIES with a good cell.
This also applies when you have 5 good cells and one weak cell.
Basically, the weak cell will reduce the current. In other words, if the 5 cells are driving a motor and supplying 250mA, the 5 cells and 1 weak cell will deliver 200mA or less, depending if it is weak or very weak. The current flowing through the weak cell will have the effect of giving it a small charge - in other words, you will be charging the weak cell from the good cells when the motor is operating.

BUT . . . .

There is a way to use weak cells. If you have say 6 weak cells driving a motor and the RPM is reducing, you can add 2 more weak cells to increase the RPM.
The effect is this: The voltage from the 8 cells will be higher than from 6 cells and this will allow a higher current to flow. Sometimes the cells will provide this higher current and thus more of the energy will be delivered and you will get the last of the energy from the cells.

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INTERNAL RESISTANCE

All batteries and also all individual cells have a "secret, hidden" value of resistance inside each cell due to the resistance of the chemicals. This resistance is very small when the cell is new but it increases as the cell gets older.
It is very easy to measure this value. Simply put an ammeter directly across the cell and measure the current. Use Ohm's law to work out the resistance. But this not always a wise thing to do as some cells will deliver 10 amps and some will deliver 100 amps and damage the meter.
The diagram opposite shows a large internal resistance for the weak cell and a small internal resistance for the good cell.
If a cell did not have any INTERNAL RESISTANCE it would deliver thousands of amps. It's the Internal Resistance that limits the current.

In most cases we neglect (do not consider) the value of internal resistance when making tests and when using a battery in a project.
But when a battery gets old, it cannot deliver a high current and the internal resistance gets so high that the output voltage drops from say 9v to 7v, even when the battery is not connected to a circuit.
This is the result of the INTERNAL RESISTANCE of the chemicals increasing to a point where they become noticeable and what we call "poisoning" of the chemicals due to the cell "aging" and new chemicals being produced in the cell that have a high resistance. Some of the terms we use are: "drying out and sulphating. Some cells produce spikes or needles that completely short-circuit the cell and make it totally useless.

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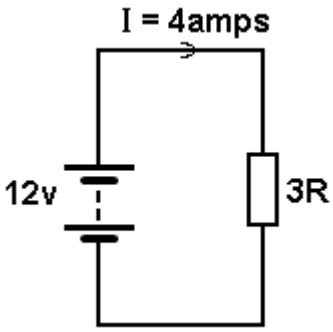

This resistor is dissipating 48 watts.
As a comparison, a soldering iron is dissipating about 10 to 20 watts.

RESISTOR WATTAGE

Resistor Wattage means two things.
1. The physical size of a resistor tells you number of watts it is capable of dissipating. This is called RESISTOR WATTAGE. It is really RESISTOR-SIZE or RESISTOR-CAPABILITY.
2. The multiplication of the voltage across a resistor and the current flowing though it will produce a value called WATTAGE. This is also called RESISTOR-WATTAGE or RESISTOR-LOSS or RESISTOR-DISSIPATION or HEAT-LOSS.
In the circuit shown, the wattage being lost in the resistor is: 12 x 4 = 48 watts.
Most of the resistors we will be using in our projects are 0.25watts. This means they will dissipate 250milliwatts, however the actual wattage being dissipated may be only 70 milliwatts and the resistor will not get hot.
0.25watts is the maximum wattage it can dissipate without overheating.
If it is dissipating 400milliwatts, it will be VERY HOT.
The wattage it is dissipating (the heat it is getting rid of) will depend on the supply voltage and the value of the surrounding components.

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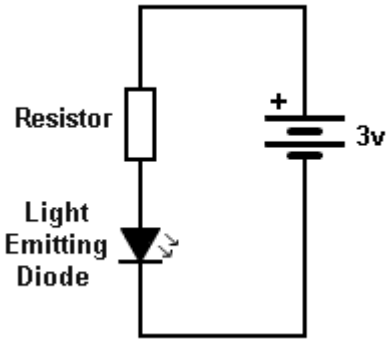

Fig 11. The LED

This simple **ELECTRONIC CIRCUIT** contains a **LIGHT EMITTING DIODE (LED), RESISTOR** and battery.

The circuit is classified as electronic because the LED is not an electrical item (such as a globe) but more-complex, as it produces light when current flows through a crystal and the crystal produces the colour.

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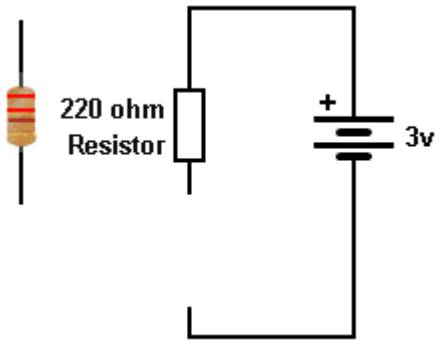

Fig 12. **The Resistor**

A **RESISTOR** must be included in the circuit to prevent the LED being damaged.
The resistor in this circuit must be 220 ohms.
This is shown by the colours on the resistor. The colours for 220 ohms: **red - red - brown**. The 4th band is gold - indicating a tolerance of 5%.
A resistor has **RESISTANCE**.
It reduces the current from the battery to a required amount to prevent the LED glowing too bright.
A resistor is just like putting your foot on a hose. The water trickles out the end. The resistor "resists" the high current-flow that the battery is able to deliver.

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Fig 12a. The **Resistor Colours**

There are hundreds of different resistors because the resistance-values need to cover the range one ohm to 10 million ohms.
There are also small, medium and large resistors. The resistors on the left are just a few in the range. (See the full range below). They show colour bands for 1 ohm to 8.2 ohms and 1 million ohms to 8.2 million ohms. All the other values are shown below.
An electronics engineer does not have the room to store 10 million different resistors so they make each resistor 5% or 10% higher than the previous. This reduces the number to about 100 to 200.

TOLERANCE

The first 3 bands indicate the value of the resistor and the 4th band indicates either 5% or 10% tolerance.
All modern resistors are 5% or 2% or 1%. The "old" 10% resistors are no longer made.
Gold = 5%
Silver = 10%

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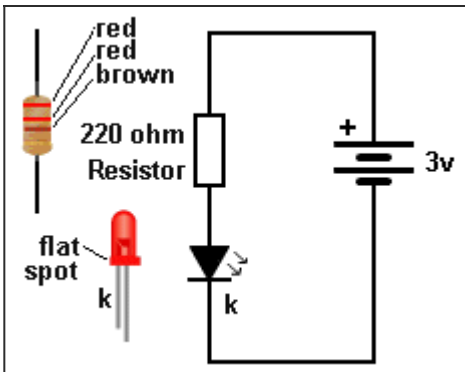

Fig 13. The **Resistor and LED**

The **LIGHT EMITTING DIODE** is called an electronic component (mainly because it is more complex than a globe and it produces light by a more-complex means than heating a wire).
A **LED** must be connected around the correct way. It will not illuminate if connected around the wrong way.
All **LEDs** have one lead longer than the other. The SHORT lead is called the **CATHODE** (k).
All LEDs have a flat on one side and this is the **CATHODE** lead.
The arrows on the diagram indicate light is "given off" (emitted - produced).

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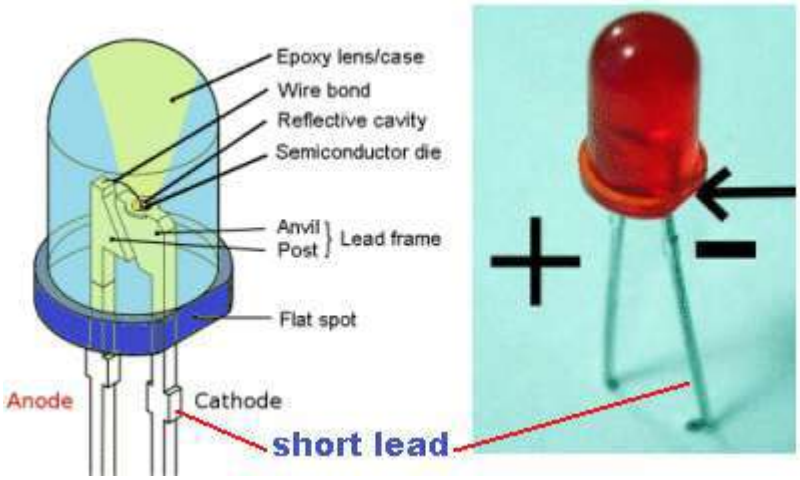

Fig 14. The **LED - showing the flat spot**
A close-up of a red LED. The cathode lead is the short lead and next to a flat side on the LED.
DO NOT show "+" or "-" on a diagram. Only show the letter "k" to indicate cathode.
The symbols "+" and "-" are used when a component produces a voltage or is connected directly to "+" and
"-" A LED is connected via a resistor.

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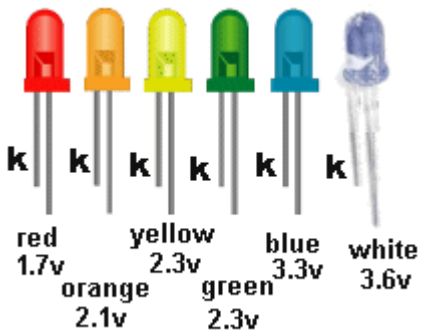

Fig 15. LED VOLTAGES

When a LED is connected to a circuit, (and the correct-value resistor is included), a voltage will be develop across the LED called the **CHARACTERISTIC VOLTAGE DROP**.
This voltage is due to the colour of the LED and the crystal inside the LED that produces the colour.
The diagram on the left shows the approximate voltage developed for each LED.
The voltage **does not change** for small, medium, surface-mount, or large LEDs.

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When a LED is connected to 3v battery, the following **CHARACTERISTIC VOLTAGE DROPs** will develop across each LED.
You will notice we **have not changed** the value of the resistor. It is 220R.
The LED creates the voltage and if the value of resistance is decreased, the LED will illuminate BRIGHTER.
If the LED illuminates too bright it will be DAMAGED.

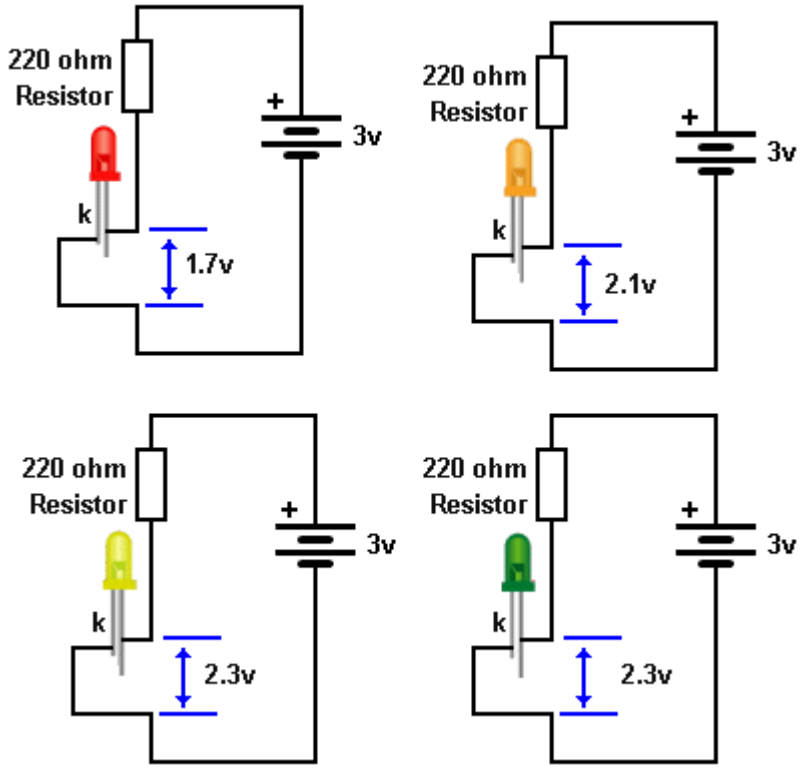

Fig 16. LED VOLTAGES

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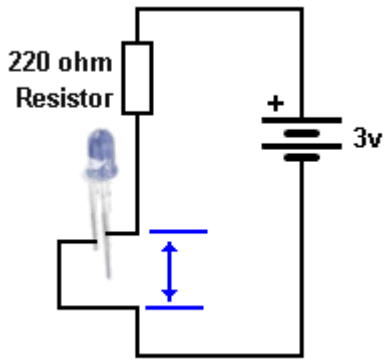

Fig 17. WHITE LED VOLTAGE

If we connect a WHITE LED to 3v supply, it will not illuminate because it needs a supply higher than 3.6v.

The resistor in series with the LED is called a **CURRENT LIMITING RESISTOR**.

In this circuit **no current flows** because the supply is not high enough.

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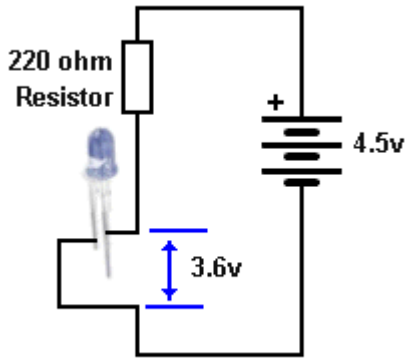

Fig 18. WHITE LED VOLTAGE

When the supply is increased to 4.5v, the 220R resistor will allow a current to flow through the white LED and it will develop a CHARACTERISTIC VOLTAGE DROP of 3.6v across it.

The supply (the voltage of the battery) must be higher than the CHARACTERISTIC VOLTAGE DROP of the LED so the resistor will allow the correct amount of current to flow.
The ideal current for a LED is 20mA, however some LEDs will work when 1mA flows, so you have to know what you are doing.

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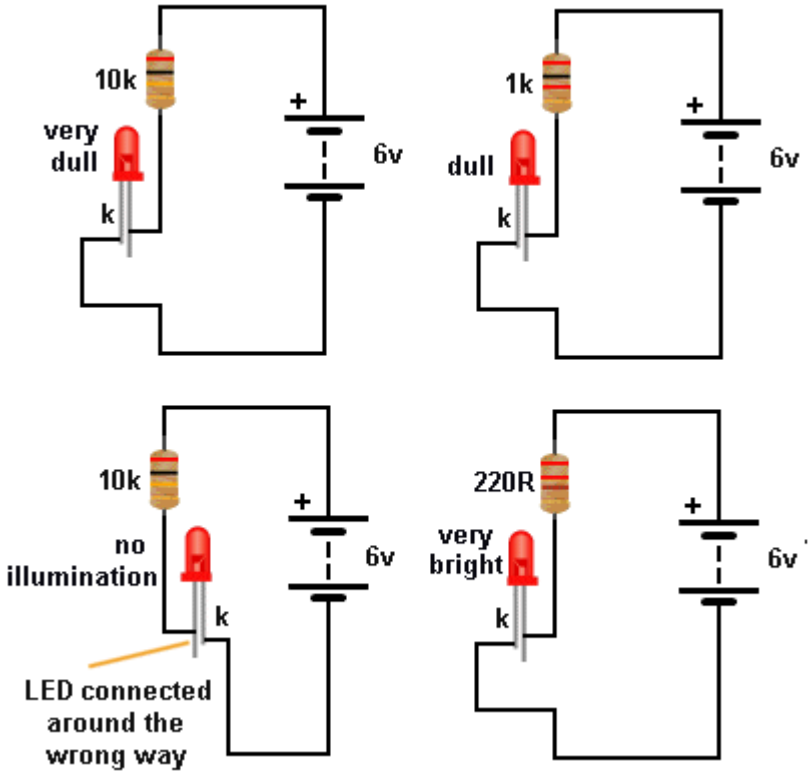

Fig 19. Testing A LED

Now connect either the 1k, 470R or 220R and determine the brightness you need.
As the brightness increases, the current will be higher.
You can use 3v supply for all LEDs except blue and white.

HOW TO TEST A LED

Some clear LEDs produce red or orange and some LEDs do not have the cathode lead clearly identified.
Here's how to find the colour, cathode lead and the current.
You need a 6v battery, 10k resistor, 1k resistor, 470R resistor and 220R resistor.
Connect the 6v battery and 10k resistor to the LED and it will only illuminate when the cathode is connected to the negative of the battery. This is the short lead.

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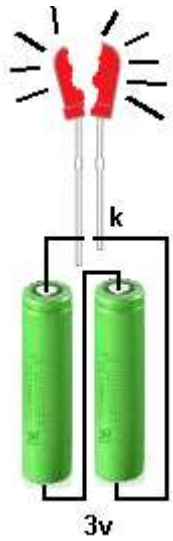

Fig 20. Damage a LED

Do not connect a 3v battery directly across a LED.
It will be DAMAGED. You MUST include a resistor.

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A LED IS CURRENT DRIVEN

You may have seen this statement and tried to work out what it means.
Basically it means an increase in current will make the LED brighter.
But a LED needs 2 things:
It needs a voltage that is EXACTLY the voltage required to produce illumination. And this voltage depends on the colour of the LED.
As soon as you supply the exact voltage, the crystal will begin to glow and as you increase the current, the illumination will increase.
But doing this is VERY VERY difficult.
It is very easy to supply an exact voltage such as 1.7v or 3.4v, but delivering a current such as 10mA or 20mA at the same time is very difficult. You cannot get a 1.7v battery and deliver 10mA to a LED.
As we have shown above, you need a simple components such as a resistor between the battery and LED to achieve the desired result.
A LED is CURRENT DRIVEN but firstly you need to provide a VOLTAGE that is exactly the connect value for the colour of the LED and then the current can be increased.

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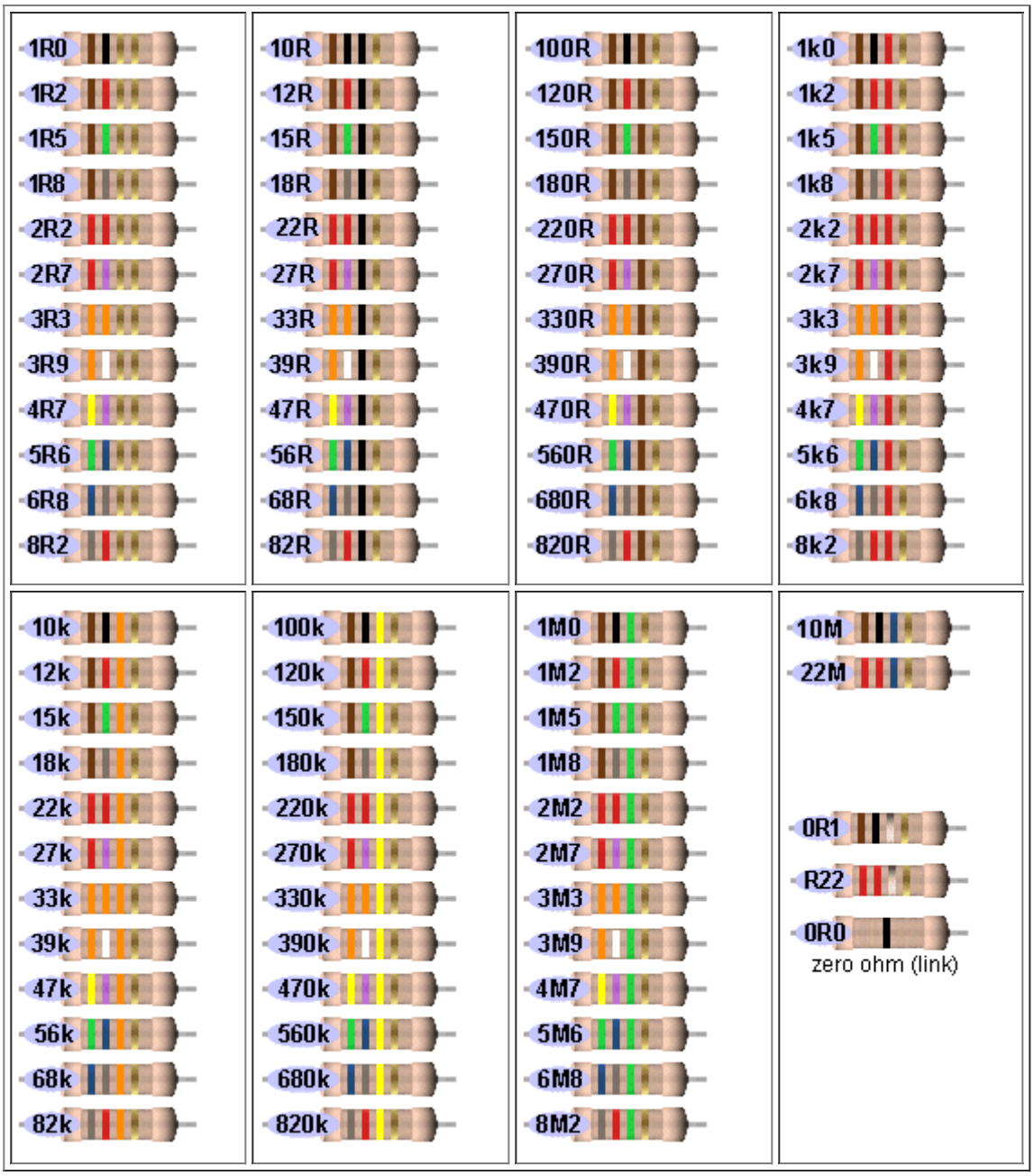

Fig 21. All the resistor values

Here are all the colours and values for the resistors you will using in this course. Just match-up the

colours on your resistor with the resistors above and you will find the value.

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Resistor values are always OHM values. One ohm is a small value. It might be the resistance of a length of wire 3 metres long.
When a switch is open the resistance is infinite - millions and millions of ohms.
The resistance of your body from one hand to the other will be about 70,000 ohms.
The resistance between two wires dipped in water will be about 1,000 to 100,000 ohms (depending on the dissolved-salts in the water - pure water has a very high resistance)
The resistance of the filament of a 3v globe will be about 30 ohms.
The resistance of the winding of a 3v motor will be about 3 ohms.
Resistors are made with values from less than one ohm to more than 10 million ohms by adding carbon to the mixture inside the resistor (and cutting a track around the outside of the resistor) then connecting a lead to each end. Adding more carbon reduces the value of resistance.
Carbon has a low resistance.
Resistance-values are measured with the RESISTANCE settings on a MULTIMETER.
This is called the "Ohms Range." Sometimes with the symbol: Ω
A Multimeter will have 2, 3 4 or more scales to cover the range one ohm to 10 million ohms.
Low value resistors (from 1 ohm to 999 ohms) are written as 1R, 220R, 470R, 999R. with the letter "R" indicating Resistance (ohms). You can also use the symbol "omega" **(Ω)**
For values above 1,000 ohms to 99,999 ohms, they are written as: 1k, 2k2, 4k7, 10k, 100k, 220k, 470k, with the letter "k" indicating "kilo" (thousand).
1M = 1,000,000 - one million ohms 1M2, 2M2, 4M7, 10M.
The letters "R, k and M" are placed so they take the place of the decimal point. This prevents any mistake, as a decimal point can be missing in a poor photocopy.

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MULTIMETERS

There are two types of **MULTIMETER**. The top two are called **DIGITAL MULTIMETERS** (DMM) and show numbers on a display.
The lower two meters are called **ANALOGUE MULTIMETERS** and have a pointer and scale.
All meters come with a set of red and black leads.

The **red lead** is always connected to the positive of the battery or the positive on a project and the **black lead** is connected to the negative or earth or chassis.
When making a resistance measurement, the leads can be around either way.
Resistance measurements are always made with the power removed from a circuit. Any voltage on a circuit will upset the resistance reading.

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Fig 22. Resistance Measurement with Analogue Multimeter

The resistance of a resistor is measured by placing the leads of the multimeter on the ends of a resistor and turning the dial on the analogue multimeter to the resistance scale to make the pointer move to about the centre of the scale.
The resistance scale is marked with a high value on the left and 0 ohm on the right. This is opposite to all the other scales.
You must get the pointer to move to the middle of the scale as it is not accurate at left-end.
Analogue multimeters are only suitable for reading values from 1 ohm to 100,000 ohms. The scale is too hard to read above 100k.
To find the value of a resistor, you can compare the colours with the table above.

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Fig 23. Resistance Measurement with a DMM

A digital multimeter produces a more-accurate reading of resistance.
It is accurate from 1 ohm to 10M ohms.
Select the scale that provides a reading.

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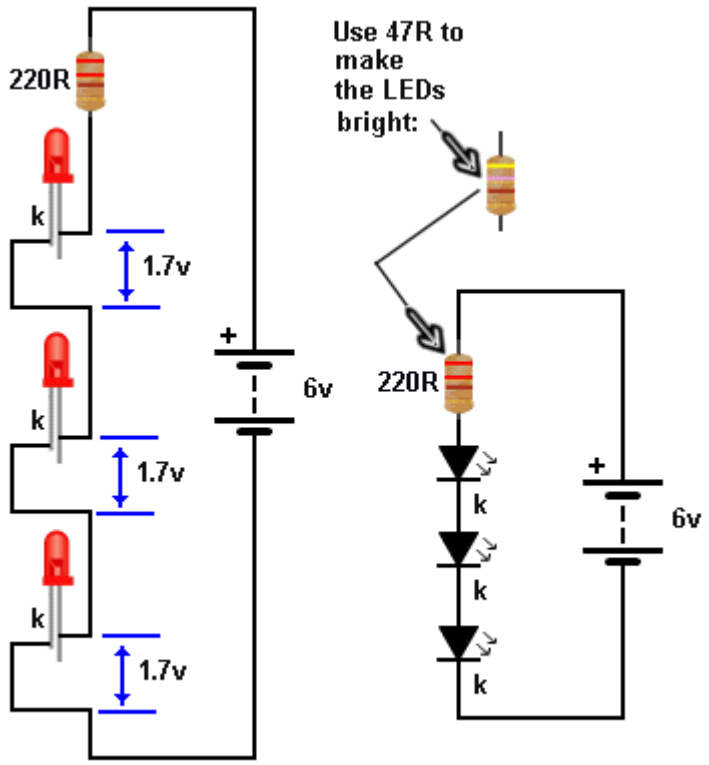

Fig 24. Connecting **LEDs in series**
LEDs can be placed in series provided the total **CHARACTERISTIC VOLTAGE DROP** across the LEDs is LESS than the supply voltage.
In this case the voltage across the LEDs is 1.7v + 1.7v + 1.7v = 5.1v
The supply is 6v and this allows 0.9v for the CURRENT LIMITING RESISTOR.
The LEDs will not be very bright with 220R.
Change the resistor to 47R
If you connect 4 LEDs in series, the total **CHARACTERISTIC VOLTAGE DROP** will be 6.8v and no LEDs will illuminate because the total is higher than the 6v supply.

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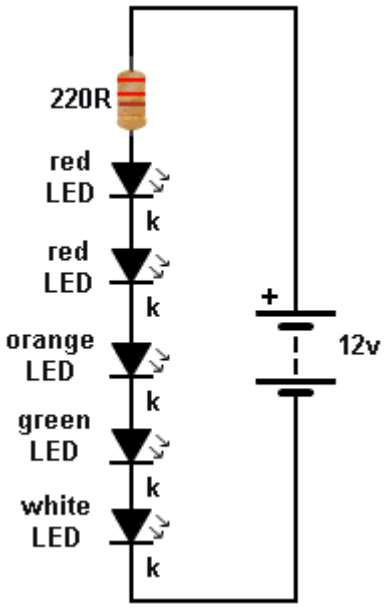

Fig 25. Connecting LEDs in series

Different-colour LEDs can be connected in series. Add up the total Characteristic Voltage for the 5 LEDs and see if it is less than 12v.

The 220R resistor will have to be reduced to 47R to make the LEDs bright.

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LEDs can be connected in parallel if they are the

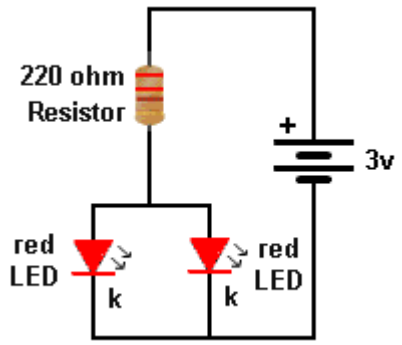

Fig 26. Connecting LEDs in parallel

same colour.
In the diagram a red LED drops a CHARACTERISTIC VOLTAGE of 1.7v and if they are from the same manufacturer or the same batch, they will work ok.
Although we say the characteristic voltage for a red LED is 1.7v, this can change slightly from different manufacturers and one LED may glow brightly while the other is dull.
You have to build the circuit and see the result.

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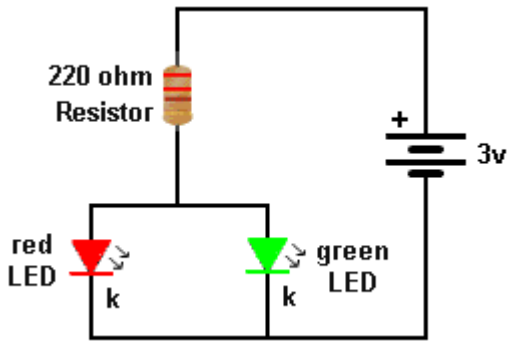

Fig 27. Connecting LEDs in parallel

Different colour LEDs cannot be connected in parallel. The voltage across a red LED is 1.7v. This becomes the "Supply Voltage" for the green LED and it is too low. The green LED needs a supply of 2.1v to 2.3v.
Only the red LED will illuminate.

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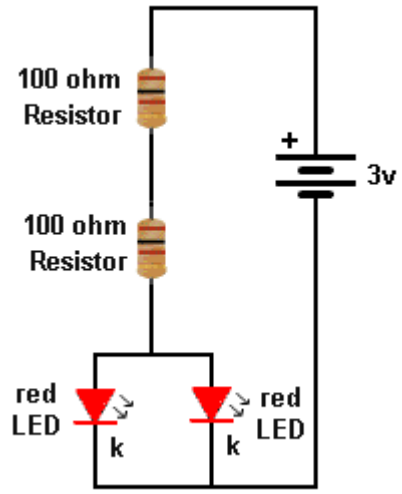

Fig 28. Connecting Resistors in Series

Suppose you don't have a 220 ohm resistor.
You can make a 220 ohm resistor with two resistors in series. The total resistance will be 200 ohms, but resistors are not accurate and the result will be very close to 220R.
Electronic circuits are not very critical. You will not be able to see the difference in brightness between 200 ohms and 220 ohms.

When resistors are connected in series, the total resistance is found by adding the resistance of each resistor.

$$R_{total} = R_1 + R_2 + R_3 + \cdots$$

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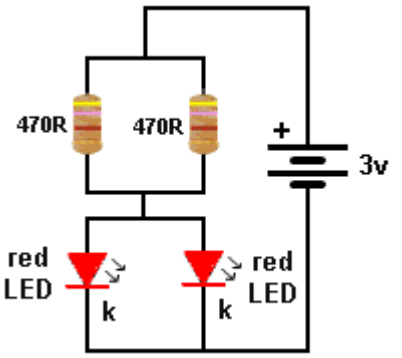

You can create a 220 ohm resistor by connecting two resistors in Parallel.
When two equal-value resistors are connected in Parallel, the total resistance across the combination is HALF.
470R in parallel with 470R produces 235R.
This is very close to 220R.
We are not going into the formula as it is very complex.
Three equal-value resistors in parallel produce a total of **one-third.**
Simply get two resistors and connect them in

Fig 29. Connecting Resistors in Parallel

parallel and measure them with a multimeter.

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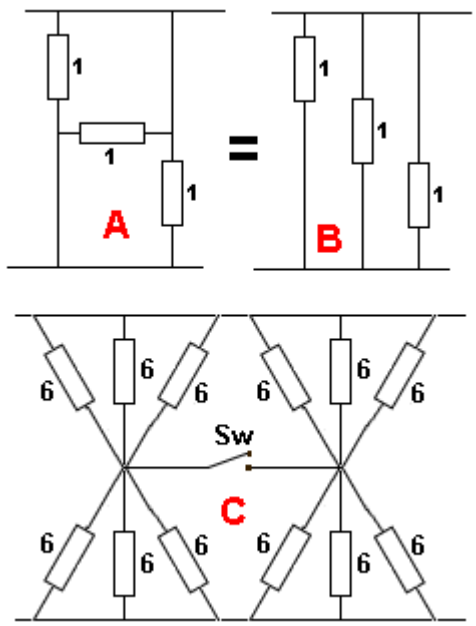

Fig 29a. Two tricky resistor questions

Figure **A** shows three resistors. It looks hard to solve so the middle resistor is turned so it connects directly to the top and bottom rail. Now you can see the circuit is three resistors in parallel. The result is one-third of an ohm.

Figure **C** shows twelve 6 ohm resistors. Replace each group with a 2 ohm resistor, because three 6 ohm resistors in parallel is equal to 2 ohms.

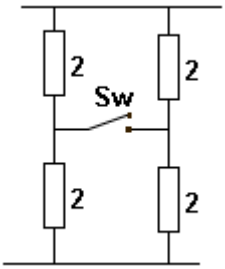

The two left resistors create 4 ohms and the two right resistors create 4 ohms. The result of two 4 ohm resistors in parallel is 2 ohms.
The resistance of the circuit does not change if the switch is open or closed.

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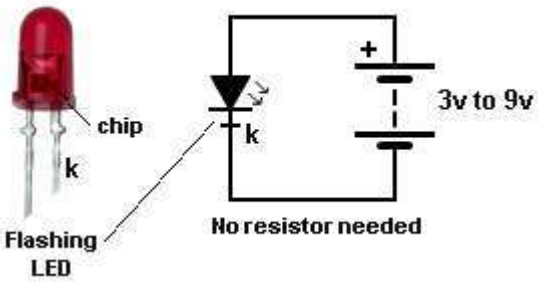

Fig 30. Flashing LED

There are some special LEDs that can be connected to 3v to 9v and they flash or produce a range of colours.
These LEDs have a chip and resistor inside the body of the LED to produce the effect and allow the LED to operate on a voltage without the need for a current limiting resistor.

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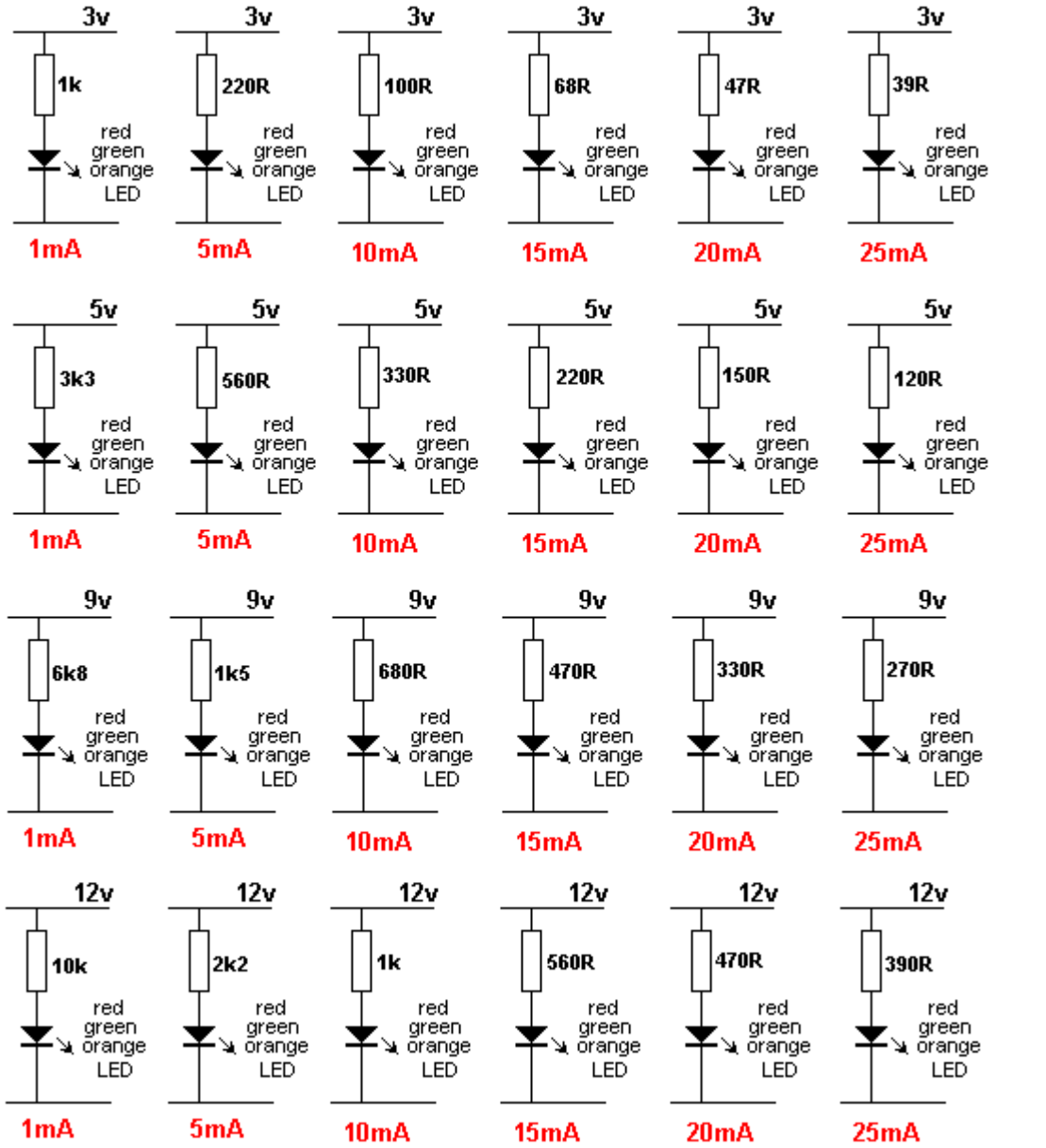

Fig 31. These diagrams show the resistor needed to produce 1mA to 25mA current through a single LED on 3v, 5v, 9v and 12v supply.

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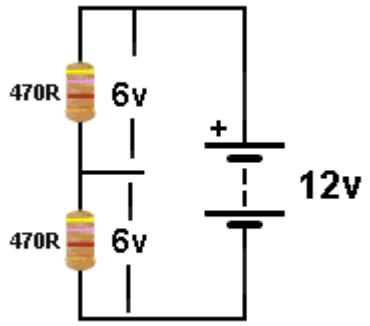

Fig 31a. Voltage Divider Circuit.

THE VOLTAGE DIVIDER

In the circuits above, the resistor and LED are forming a VOLTAGE DIVIDER.
A red LED is dropping 1.7v across it and the resistor is dropping the remaining voltage.
Whenever two (or more) components are placed across a battery, they form a **VOLTAGE DIVIDER**.
Sometimes we want a 6v supply and only have 12v.
We can produce the 6v supply by putting two equal-value resistors across the 12v as shown in the circuit opposite.
We are not going into the mathematics because the selection of the correct value is very complex and the circuit is very wasteful.

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THE CURRENT DIVIDER

The **CURRENT DIVIDER CIRCUIT** is actually a

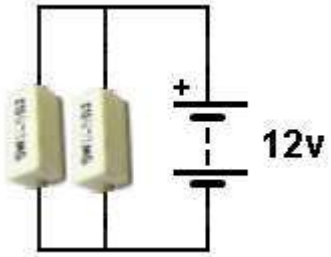

Fig 31b. Current Divider Circuit.

LOAD SHARING CIRCUIT.
Suppose you are testing a Power Supply and need a 10 watt LOAD. But you only have 5 watt resistors.
Placing two 5watt resistors in parallel across the output of the power supply will allow half the current to flow though each resistor. This is called **CURRENT SHARING** or **LOAD SHARING** and the current is divided (or passed) through each resistor according to the value of resistance.

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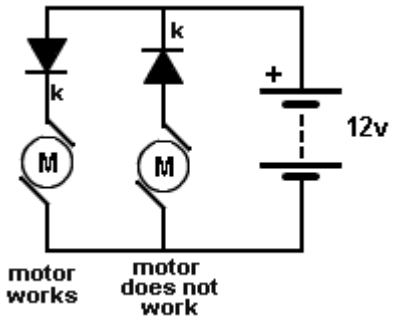

Fig 32. The DIODE

THE DIODE
The next simple electronic component is the **DIODE.**
It only works when connected correctly.
A DIODE allows current to flow through it when it is connected as shown in the diagram.
A Diode is similar to a one-way water valve.
When the diode is "facing down," the motor spins.
When it is "facing up" the motor does not spin.

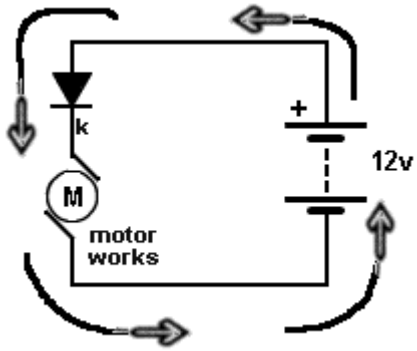

The diagram shows the "current path" around the circuit. The current is measured in AMPS and we discuss current as CONVENTIONAL CURRENT. This is the way current was thought to flow when electricity was born and they said it flows out the POSITIVE TERMINAL of the battery, around the circuit and into the NEGATIVE TERMINAL.
The arrow on the diode shows the current will flow through the diode and allow the motor to spin.
The diode is said to be **FORWARD BIASED**.

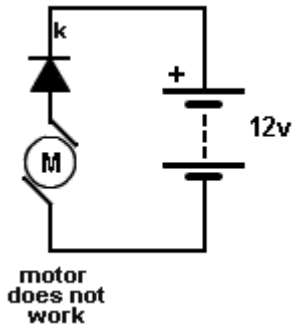

There is no flow of current because the diode prevents any current-flow when connected as shown.
The motor DOES NOT WORK.
The diode is said to be **REVERSE BIASED**.

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There are hundreds of different types of diodes.
Power diodes, signal diodes, low voltage diodes, high voltage diodes, high-speed diodes and many other types.
They all do one thing.
They pass current in one direction and if turned around, they **do not pass** any current.

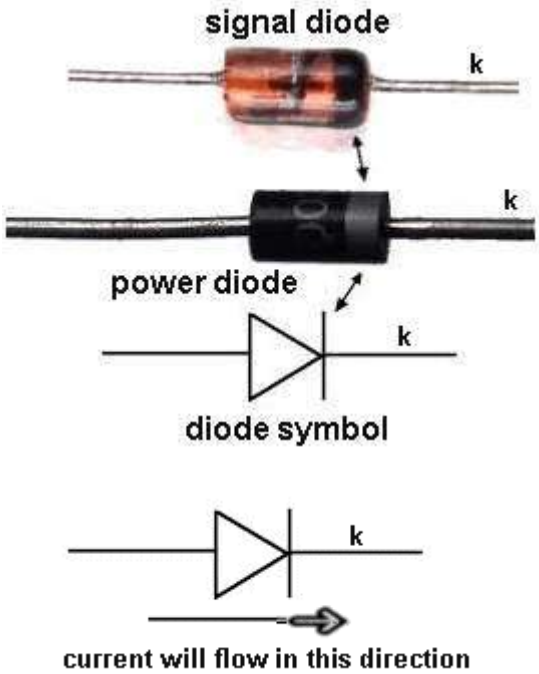

Fig 33. **A Signal diode and a Power diode**

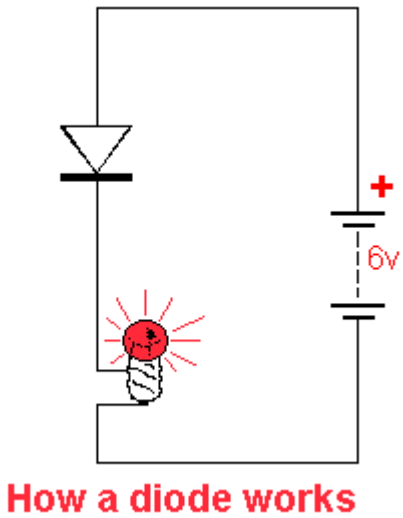

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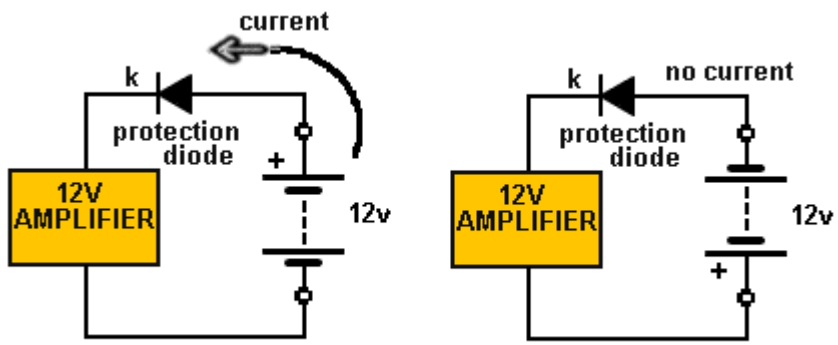

Fig 34. A Protection diode

Diodes perform many function in electrical and electronic circuits. Here is an application as a **PROTECTION DIODE.**
It protects the amplifier. If the 12v battery is connected around the wrong way, no current will flow.

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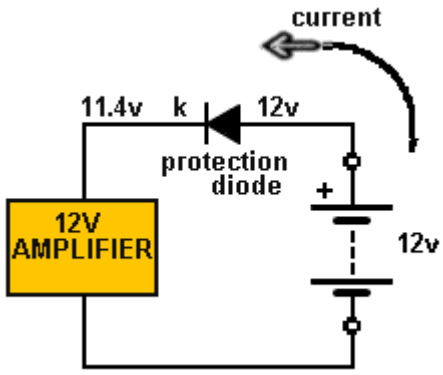

Fig 35. Diode "Voltage Drop"

When a diode is placed in a circuit (and current is flowing), a small voltage develops across the diode. This voltage is called the **FORWARD VOLTAGE DROP.**
This voltage is approximately 0.6v.
This is due to a junction inside the diode where two different materials are joined.
Normally, this voltage is not important because it is only small, but sometimes you need to take it into account.
For the circuit above, the amplifier only gets 11.4v

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Voltage is measured with a

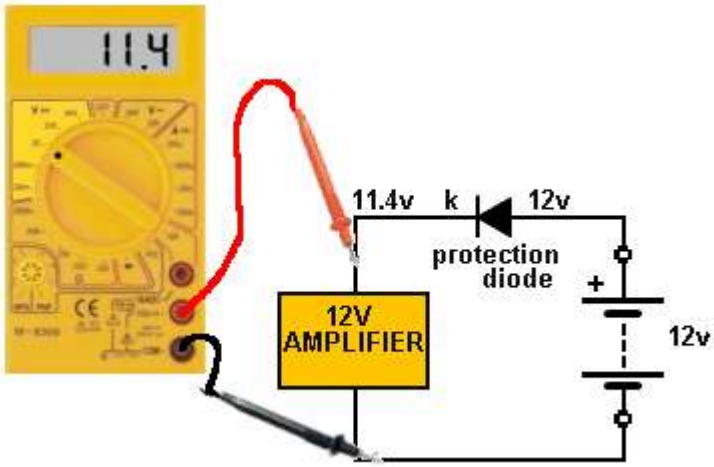

Fig 36. Measuring Voltage with a Digital Multimeter

VOLTMETER.
Multimeters have 2 or 3 voltage ranges so you can measure low voltage (0v to 20v), medium voltages (0v to 200v and high voltages (0v to 500v).
A voltmeter is placed across the component being tested, as shown in the diagram.
The Digital Multimeter is detecting 11.4v across the amplifier.

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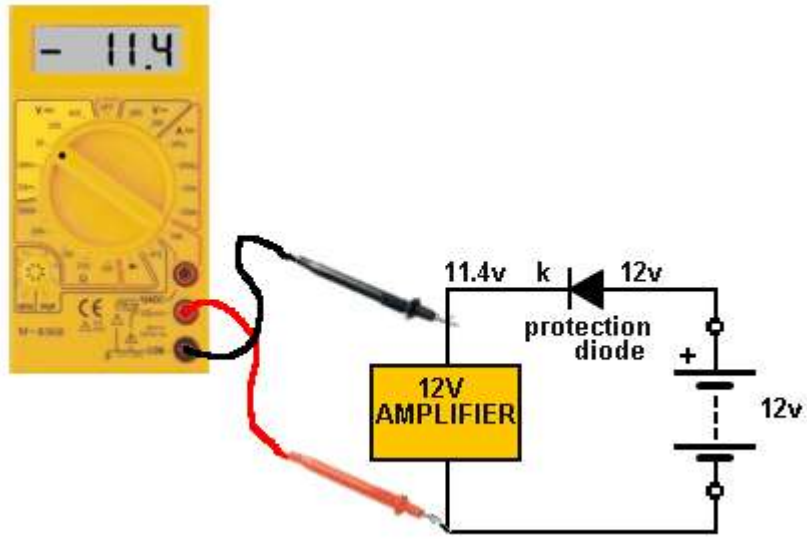

Fig 37. Measuring Voltage with a Digital Multimeter

If you place the probes of a digital multimeter around the wrong way on a component, the display will show a "-" The meter will not be damaged.

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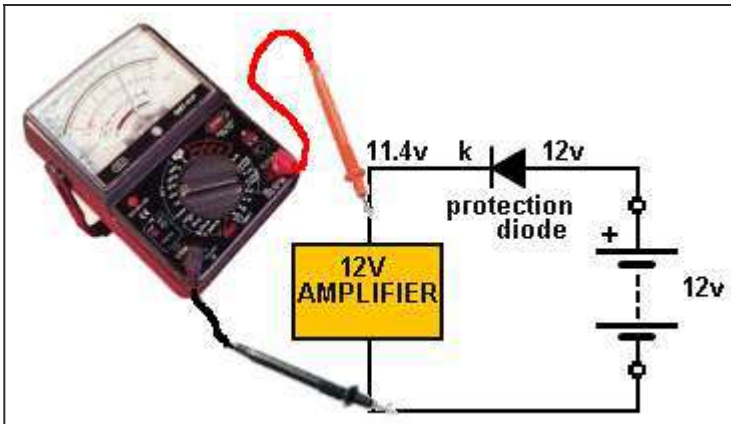

Fig 38. Measuring Voltage with an Analogue Multimeter

An analogue Multimeter must be connected around the correct way to make the pointer move "up scale."
Select the range that will allow the pointer to show somewhere in the middle of the scale.

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Current is measured by

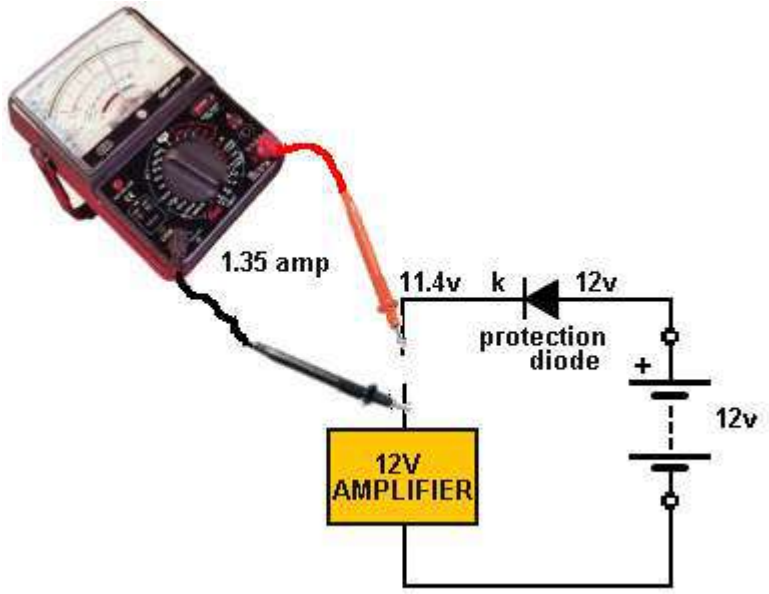

Fig 39. Measuring Current with an Analogue Multimeter

"breaking into the circuit" and inserting the leads so the positive probe is closest to the positive of the battery.
If you connect the leads around the other way, the needle will not move but it will hit the "end stop" and you may have to "bump" the meter to get the pointer to move from its jammed position.

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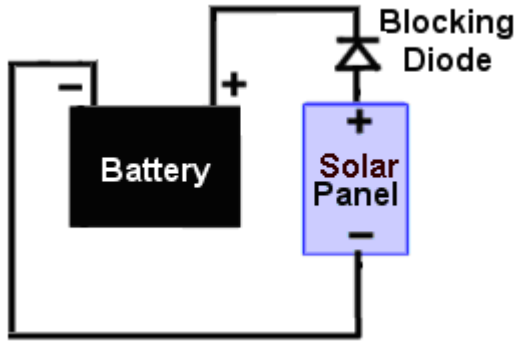

Fig 39a. The Solar Panel and the Blocking Diode

A DIODE is also used with a solar panel to prevent the battery discharging into the solar panel when the sun is not shining.
When the solar panel is not receiving any light it becomes a resistor with a large value and a small current can flow through it from the battery. The diode prevents this current-flow. The diode is called a **BLOCKING DIODE**.

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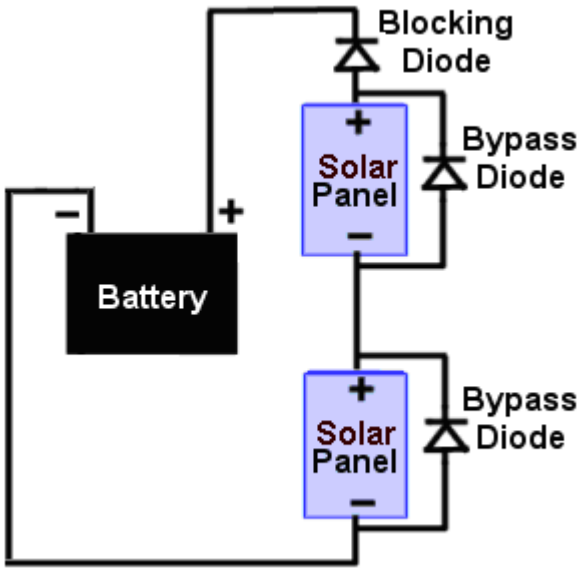

Fig 39b. The Solar Panel with diodes

Diodes are given different names, according to their function. They all perform the same job by passing current in one direction and prevent current-flow in the opposite direction.
When the top solar panel is shaded by a cloud, it generates less current and this will reduce the current into the battery.
By placing a diode across the panel, the diode will pass the current produced by the lower panel to the battery.
These diodes are called **BYPASS DIODES.**

called BLOCKING DIODES and BYPASS DIODES.

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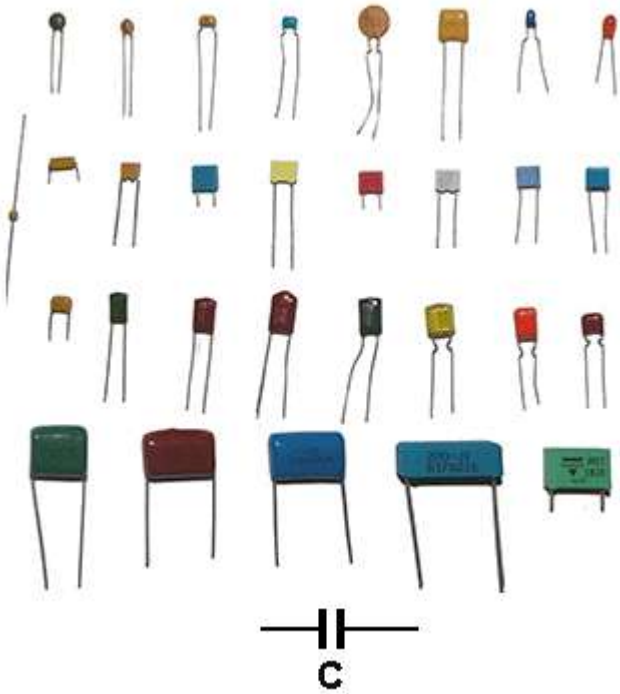

Fig 40. Capacitors and symbol

The next component we cover is the **CAPACITOR**.
There are thousands of different types of capacitor.
Each value of capacitor can have a low voltage rating, medium voltage or high voltage.
Capacitors can be very small in size and shape or very stable with temperature-rise or simply very cheap to make.
A capacitor consists of two thin sheets of metal such as aluminium with a thin sheet of plastic between.
The sheets may be rolled up in a cylinder or laid on top of each other.
The fact is this: the top sheet of metal does not touch the bottom sheet. This is shown in the symbol.
The resistance between the two terminals is INFINITE.
The 6th capacitor in the top row is called a **MONOBLOCK**.

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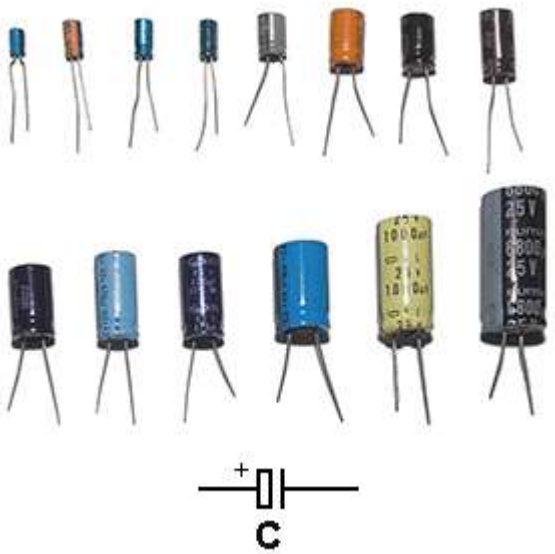

Fig 41. Electrolytic Capacitor

A capacitor gets bigger as its value increases.
It also gets bigger when the voltage-rating increases.
The basic unit of capacitance is the FARAD. A one-farad capacitor would be the size of a house. To make the capacitor smaller the sheets are etched to increase the surface-area and different insulating materials are used between the sheets.
The result is a capacitor called an **ELECTROLYTIC**. It is a bit like a rechargeable battery. It stores a lot of energy in a small space.
The negative lead is shorter and has a black stripe on the side of the electrolytic.

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One FARAD is too big to handle. We use smaller values.
The middle of the range is one microfarad. This is written as 1u. (sometimes you see uF)
This is one-millionth of a FARAD.
The smallest value of capacitance is one picofarad. This is one millionth of a microfarad.
It is written as 1p.
Capacitors are broadly separated into two groups. 1p to 1u and 1u to 100,000u
Capacitors 1p to 1u are ceramic, polyester, air, styroseal, monoblock and other names.
Capacitors 1u to 100,000u are electrolytic or tantalum. A tantalum is the same as an electrolytic - for testing purposes - it is a more-compact electrolytic.

1 microfarad is one millionth of 1 farad.
1 microfarad is divided into smaller parts called nanofarad.
1,000 nanofarad = 1 microfarad
Nanofarad is divided into small parts called picofarad
1,000 picofarad = 1 nanofarad.

Recapping:
1p = 1 picofarad. 1,000p = 1n (1 nanofarad) 1,000,000p = 1u
1,000n = 1u (1 microfarad)
1,000u = 1millifarad
1,000,000u = 1 FARAD.

Examples:
All ceramic capacitors are marked in "p" (puff")
A ceramic with 22 is 22p = 22 picofarad
A ceramic with 47 is 47p = 47 picofarad
A ceramic with 470 is 470p = 470 picofarad
A ceramic with 471 is 470p = 470 picofarad
A ceramic with 101 is 100p (it can also be 100)
A ceramic with 102 is 1,000p = 1n
A ceramic with 223 is 22,000p = 22n
A ceramic with 104 is 100,000p = 100n = 0.1u A common 100n is called a **MONOBLOCK**.
A ceramic with 105 is 1u

TYPES OF CAPACITOR
For testing purposes, there are two types of capacitor.
Capacitors from 1p to 100n are non-polar and can be inserted into a circuit around either way.
Capacitors from 1u to 100,000u are electrolytics (or tantalum) and are polarised. They must be fitted so the positive lead goes to the supply voltage and the negative lead goes to ground (or earth).

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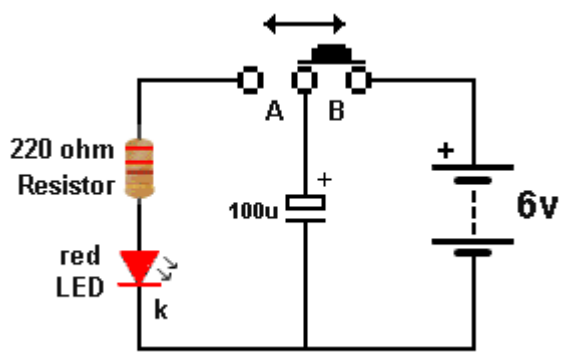

Fig 42. Charging a Capacitor

Here is an experiment to show how much (little) energy is stored in a 100u electrolytic.
When the slide-switch is in position "B", the 100u is charged by the 6v battery.
When the slide switch is moved to position "A" the electrolytic supplies energy to illuminate the red LED via the 220R resistor. It will illuminate for a short period of time.
By moving the switch back and forth, you can keep the LED illuminated.

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Capacitors can be connected in **Series or Parallel** to obtain a value of capacitance you may not have available.
They are also connected in series to increase the effective **VOLTAGE RATING**.
However when two equal-value capacitors are connected in series, the final value is HALF, and thus you need two with double the final-value to get a value with an increased voltage-rating.
When two equal-value capacitors are connected in series, the result is HALF.
(This is the opposite to connecting resistors)

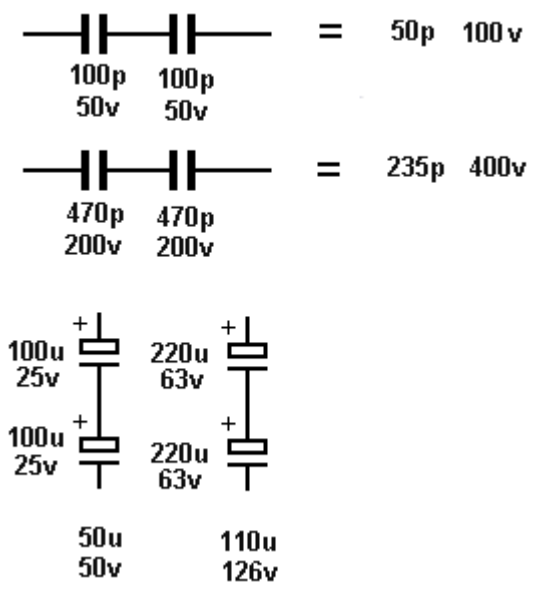

Fig 43. Capacitors in Series

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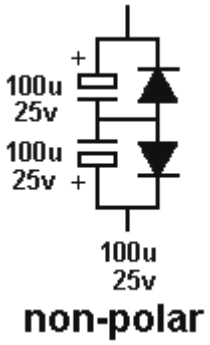

Fig 43a. Non-polar Capacitor

Non-polar Capacitor (electrolytic)

A normal electrolytic must be connected the correct way in a circuit because it has a thin insulating layer covering the plates that has a high resistance.

If you connect the electrolytic around the wrong way, this layer "breaks-down" and the resistance of the electrolytic becomes very small and a high current flows. This heats up the electrolytic and the current increases. Very soon the capacitor produces gasses and explodes.
One big mistake in many text books shows how to make a non-polar electrolytic by connecting two "back-to-back."
They claim 2 x 100u connected back-to-back is equal to 47u.
This appears to be case when testing on a meter but the meter simply charges them for a short period of time to get a reading.
If you allow them to charge fully you will find the reverse electrolytic has a very small voltage across it.
Secondly, when you are charging them, you are putting a high current through the reverse electrolytic and damaging the layer.
To prevent this, you need to add two diodes as shown in the diagram.
In addition, 2 x 100u "back-to-back" is very near 100u.

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Capacitors can be connected in **Parallel** to obtain a value of capacitance you may not have available.
(This does not change the **VOLTAGE RATING**.)
When two equal-value capacitors are connected in parallel, the result is DOUBLE.
(This is the opposite to connecting resistors).
If one electrolytic is 25v

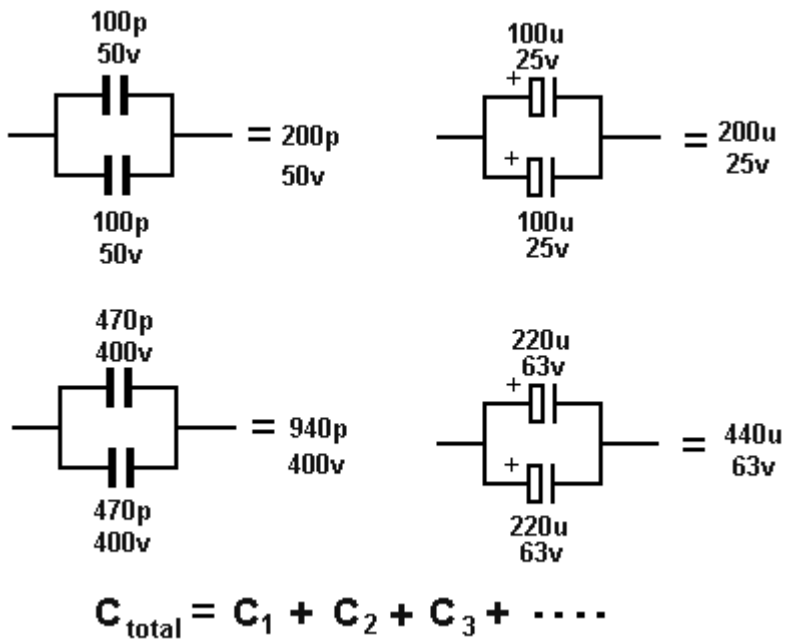

Fig 44. Capacitors in Parallel

and the other 63v, the answer is the LOWER VOLTAGE = 25v.

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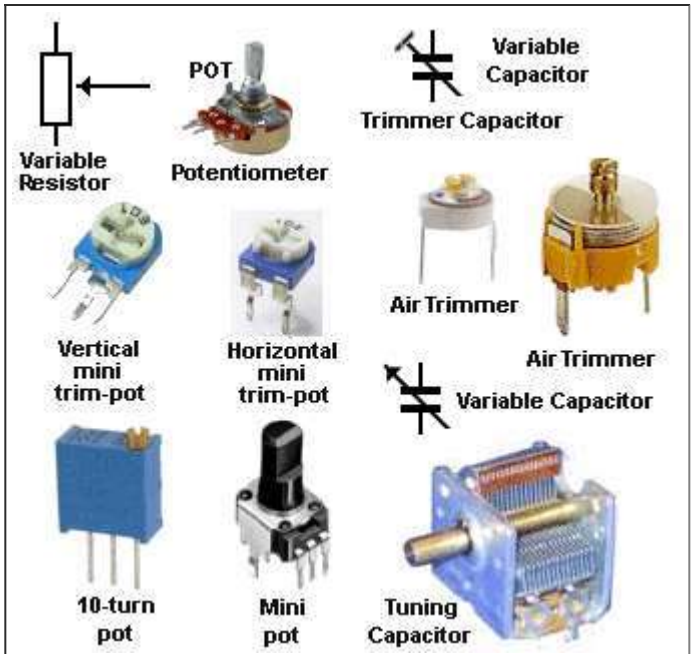

Fig 45. Variable Capacitors and Resistors

The value of a capacitor or resistor may need to be increased or decreased in a circuit to tune in radio stations or increase and decrease the volume of a speaker.
The symbol for these components have an arrow to show they can be adjusted.
The resistance of a potentiometer can be from 1 ohm to 5M
They come in many different shapes and sizes to suit the PC board or front-panel layout.
The "T" represents a trimmer capacitor and this can be from 1p to about 120p.
A variable capacitor will be from about 10p to 415p.

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Simple CIRCUITS
We have covered enough symbols and components to create a number of simple circuits.
These circuits will show how to connect a motor, a LED, (how to make it bright or dull) and how to connect 4 cells to make a battery.

Note: The flashing LED

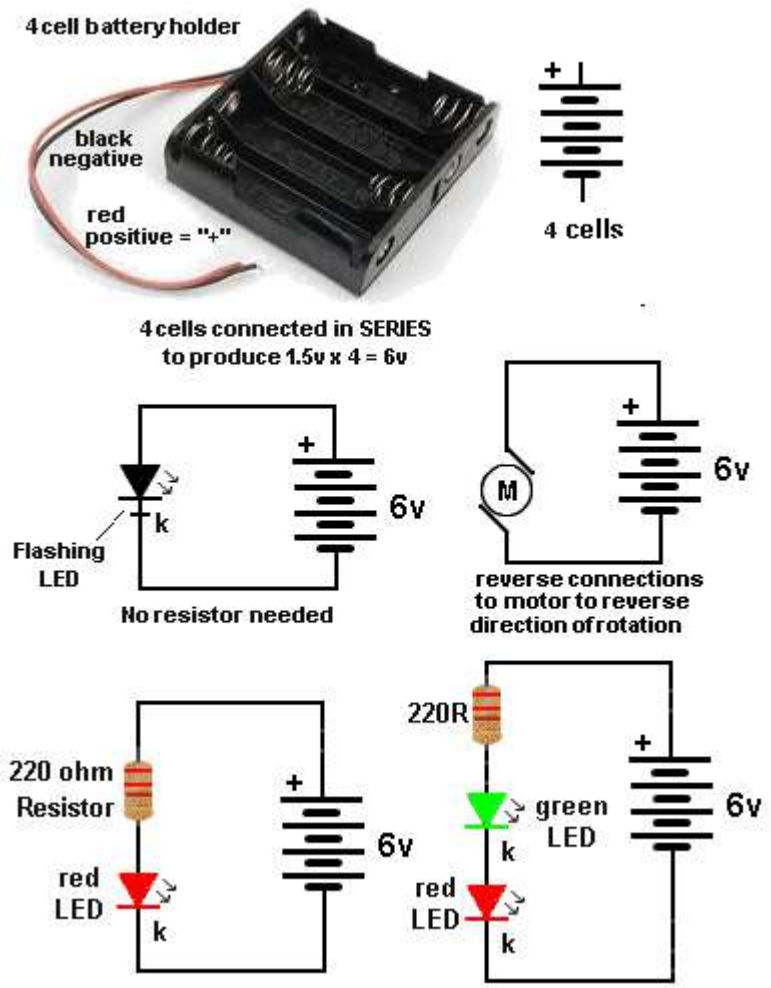

Fig 46. Simple Circuits

does not need a resistor because a resistor and chip are inside the LED, to make it flash and control the current.

Connect all the components around the correct way and then connect them around the wrong way to see what happens.
Connect the flashing LED in series with a red LED and see what happens.

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QUESTIONS

1. Explain why the Flashing LED circuit has no external resistor.
2. How many 1.5v cells are needed to produce a 6v battery
3. Explain what happens when you reverse the leads to a motor.
4. Identify the positive terminal:

5. Can 3 green LEDs be connected in series to a 6v supply?
6. A variable resistor is also called: _____
7. The combined resistance of two 1k resistors in series is: _____
8. The combined resistance of two 1k resistors in parallel is: _____
9. Name the short lead on a LED
10. Name the type of multimeter with a pointer and scale: _____
11. The total capacitance of two 100u electrolytics in series is: _____
12. The total capacitance of two 100u electrolytics in series is: _____
13. Write these values in words:

22R _____
4k7 _____
1n _____
100u _____

14. How many 1.5v cells in a 9v battery?

15. The red probe is: _____ (positive/negative)
16. Conventional current flows from: _____ (positive to negative / negative to positive)
17. Make a 470u electrolytic with two electrolytics:
18. What is the voltage drop across a diode?
19. Name the component that only allows current to flow in one direction: _____
20. Name this symbol:

21. When resistors are connected in series, the resistance of the combination: _____ (increases / decreases)
22. When two capacitors are connected in parallel, the voltage-rating of the combination: _____ (increases / equal to the capacitor with the lowest voltage-rating)
23. Draw two 2k2 resistors in parallel.
24. Which is larger: 470R or 22k
25. What is the value of this combination:

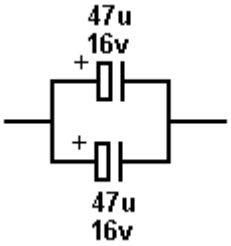

26. What is the name of the resistor in series with a LED: _____
27. What is the voltage across the amplifier: _____

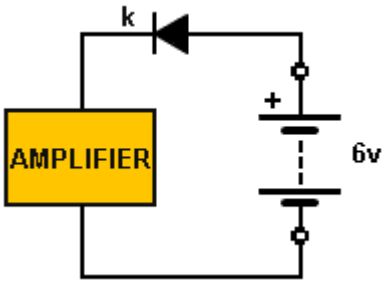

28. Identify the fault with these circuits:

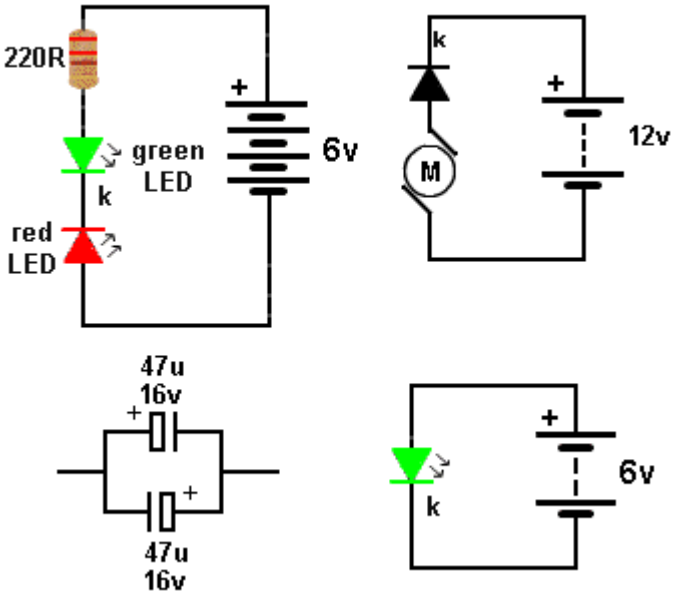

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Passive Components
All the components shown

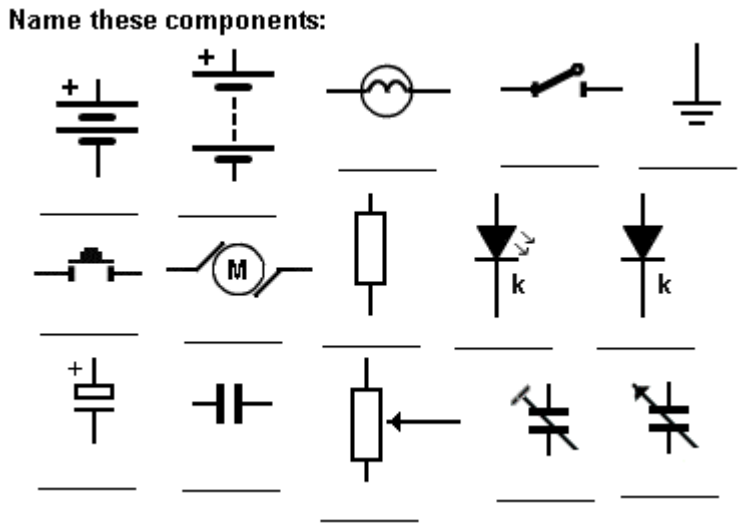

Fig 47. Passive Components

on the left are called PASSIVE COMPONENTS. This means they do not amplify.
Write the name beside each symbol.

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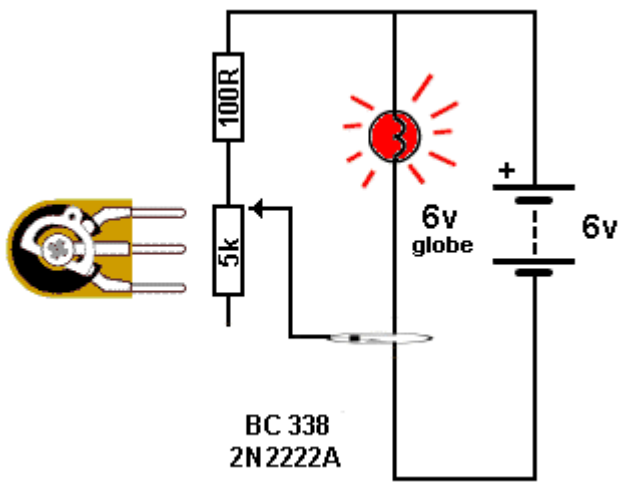

Fig 47a. The Potentiometer in action

The Potentiometer is a variable resistor.
It consists of a curved carbon track with a wiper that touches the track and can be turned via a screwdriver or knob.
The wiper is the middle wire on the circuit symbol and it moves up and down as shown in the animation.
When the three leads are connected the symbol is called a potentiometer.
When two leads are connected it is a variable resistor.
When the resistance increases, less current flows through the pot.

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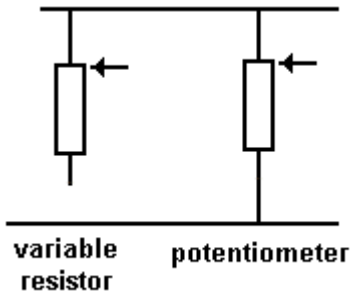

Fig 47b. The Variable Resistor and Potentiometer

There is a difference in operation between a **Variable Resistor** and a **Potentiometer**.
Both will increase or decrease the sound level as a volume control or the speed of a motor or the brightness of a globe, but a Potentiometer will guarantee zero volume or zero brightness when the pot is turned fully anticlockwise (as shown in the animation).
This is because the output will be zero volts, but the variable resistor may still deliver some "energy" (voltage and current) to the circuit when turned fully anticlockwise.

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Potentiometers come in values from 100 ohms to 5 Meg ohms (500R, 1k, 2k, 5k, 10k, 50k, 100k, 200k, 250k, 500k, 1M are most popular).
They come as linear, or logarithmic where the resistance of the track (per mm) is higher at one end. Because our hearing is not linear, these pots can be used as volume controls to produce a gradual (very nearly linear) increase in volume.
Selecting the correct value of resistance for a circuit is VERY complex. If the value is not correct, the volume will not be loud or it will drop to zero before the pot is turned fully anticlockwise. Or

the motor will drop to zero at mid-turn of the pot or it will not reduce in RPM to the desired amount.
The simple answer is to copy a circuit.
Or you can try the whole range of pots and you will find one value is the best.
A Potentiometer can be used in hundreds of different circuits to produce hundreds of different effects, but the actual "thing" that flows between the input and output is a percentage of the voltage. At the same time the current will also be passed to the output at a reduced value. A pot actually delivers BOTH reduced values at the same time and the receiving circuit will be designed to "look for" the change in voltage or current. If the supply voltage is not rising or falling, the "values" are called DC values.
The voltage can also be in the form of a signal (volume). This is called an AC signal.

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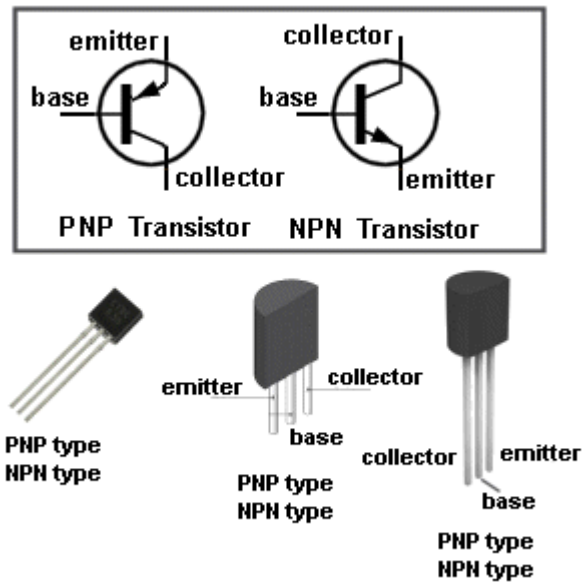

Fig 48. The TRANSISTOR

The TRANSISTOR

A TRANSISTOR is an ACTIVE device. It AMPLIFIES.
There are many types of transistor (over 20,000 different types) from hundreds of manufacturers and they have many different names.
We are going to study the simplest.
It has the technical name **BIPOLAR JUNCTION TRANSISTOR (BJT)** but we are going to call it a **TRANSISTOR**.
There are two types in this group: **PNP** and **NPN**.

The type we will study is also called a **SMALL-SIGNAL TRANSISTOR.**

You cannot tell an **NPN** transistor from **PNP** by looking at it. You must test it in a circuit.
In **Fig 65** you will make a **Transistor Tester** project, but first some basic facts:

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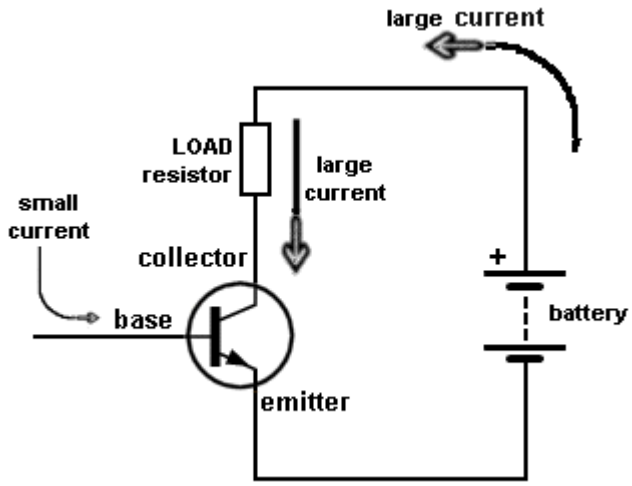

Fig 49. The NPN TRANSISTOR in a Circuit

The first type of transistor we are going to study is the **NPN**.
A transistor has three leads:
BASE, COLLECTOR and **EMITTER**
Basically, a small current enters the base and a large current flows through the collector-emitter leads as shown in the diagram.
The resistor in the collector lead is called the LOAD Resistor.
Sometimes the load is a speaker.

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The transistor is similar to the diagram opposite. A small drop of water entering the base is amplified to

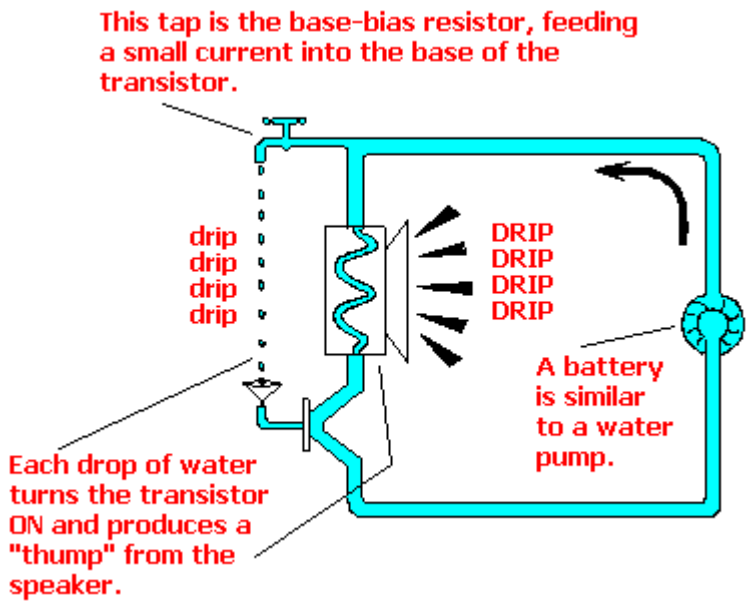

Fig 50. The Water TRANSISTOR

produce a loud DRIP from the speaker.

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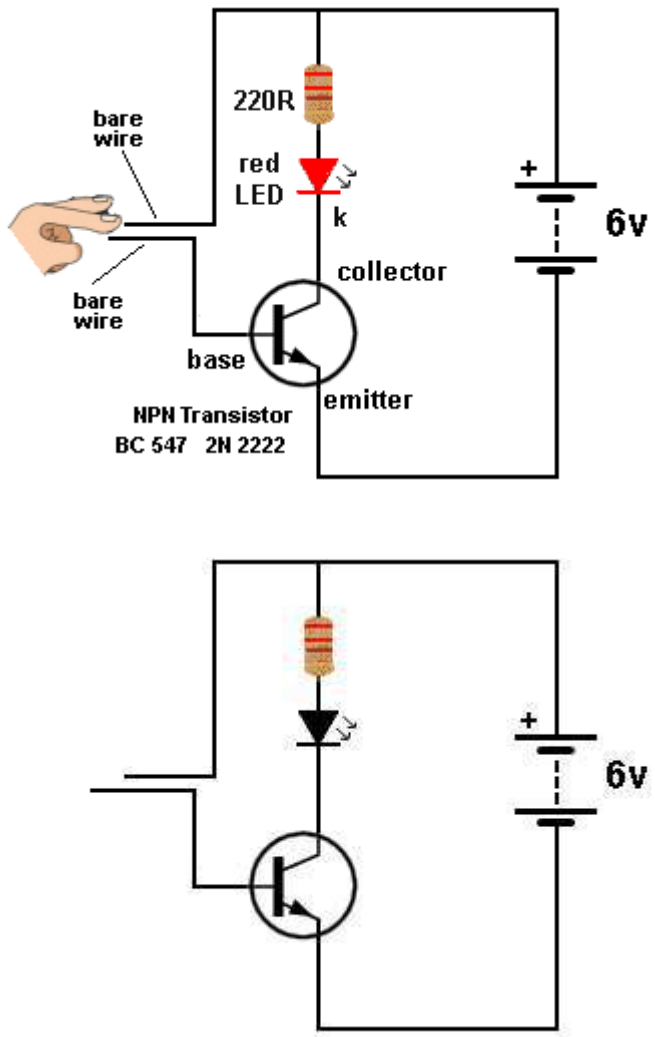

Fig 51. One Transistor Circuit

In this experiment we will construct a ONE TRANSISTOR circuit similar to the WATER TRANSISTOR above and observe the results.
Make sure the two leads DO NOT TOUCH. If they touch, the transistor will be DESTROYED.

The transistor is amplifying the current through your finger via the two leads and it will be very dim.

ANIMATION

The lower diagram shows the transistor turning ON when a finger is pressed against the two wires. The finger produces a resistance that turns the transistor ON and this turns the transistor into a smaller and smaller resistor. That's how more and more current flows through the LED and it gets brighter and brighter.

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By adding another transistor we amplify the

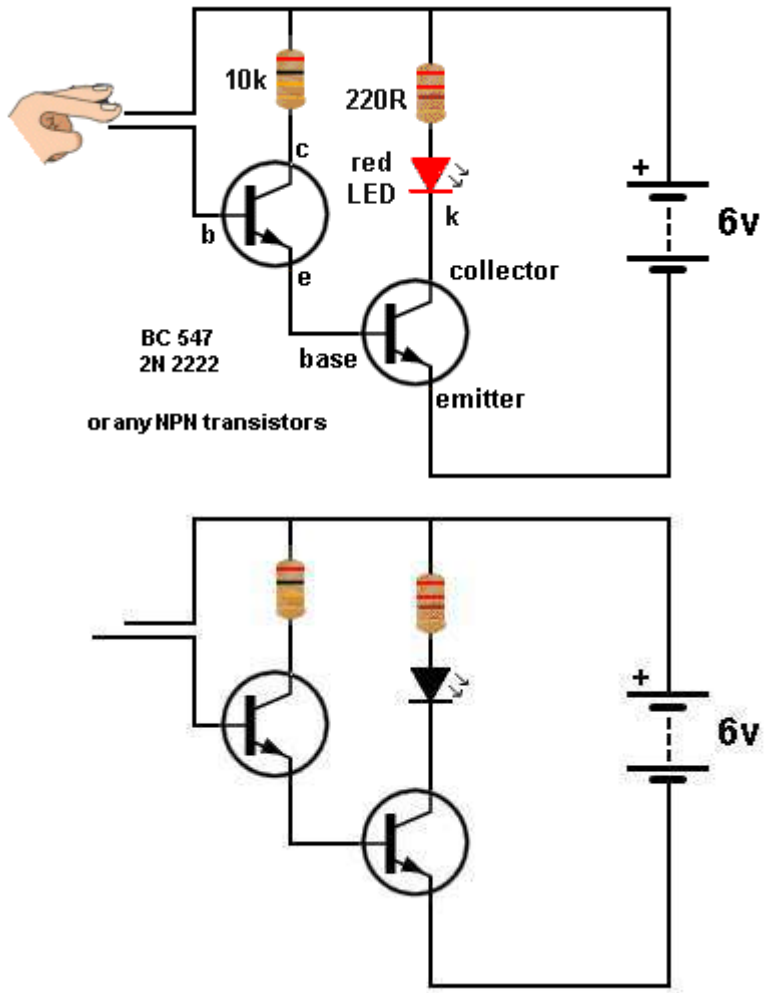

Fig 52. Two Transistor Circuit

current through the finger about 200 times and now the LED will glow bright.

Make sure the bare wires do not touch each other as this will destroy BOTH transistors.

ANIMATION

The lower diagram shows both transistors turning **ON** when a finger is pressed against the two wires.
They both becomes smaller and smaller resistors.
The first transistor allows more current to flow into the base of the second transistor and this is how the second transistor turns on more and more. This allows more current to flow through the LED and it gets brighter and brighter.

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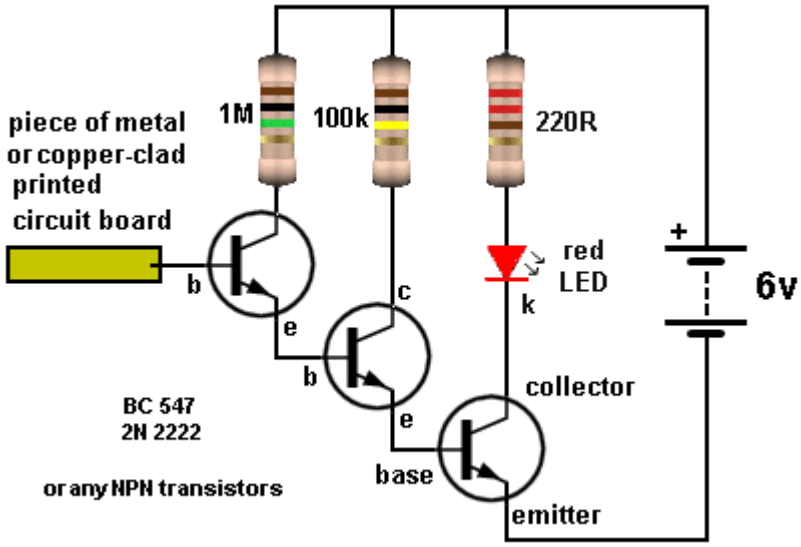

This circuit has enormous gain.
Each transistor has a gain or more than 200 and the final gain will be more than:
200 x 200 x 200 = 8,000,000
8 MILLION!

The circuit is very sensitive to static voltages in the air or electrical waves such as the waveform produced by the electrical wiring in a house.
Move the project around a room and detect all the electrical signals.

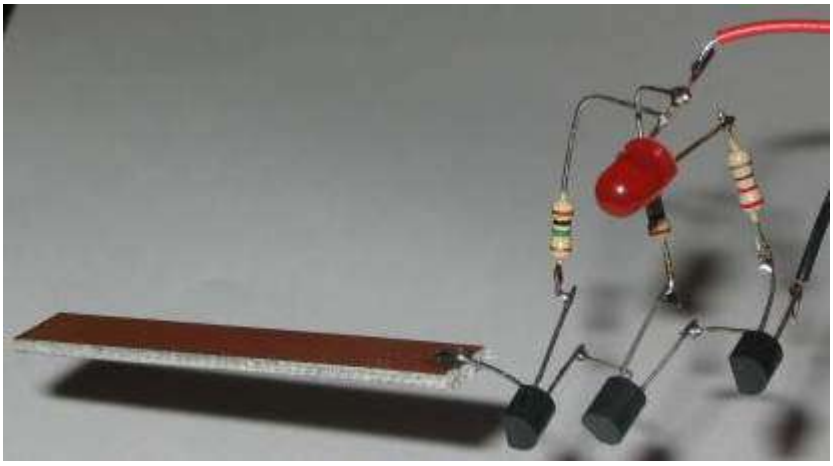

Fig 53. Three Transistors

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You can see the effect of one transistor. It does not do much.
The two transistor circuit allows the resistance of your finger to deliver current into the base of the first transistor and this transistor delivers more current into the base of the second transistor.
The result is more collector-emitter current and the LED illuminates.
The three transistor circuit produce an ENORMOUS effect.
It will pick up STATIC ELECTRICITY and all forms of electro-magnetic energy (radiation) and illuminate the LED.

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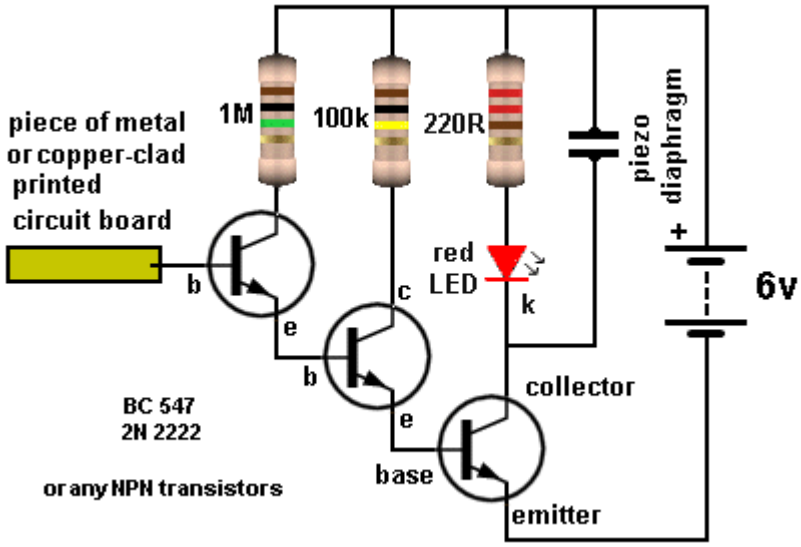

Fig 54. Adding a PIEZO

By adding a piezo diaphragm to the output you will be able to hear the hum of the mains.
This is the frequency of the supply into your house. It will be either 50 cycles per second or 60 cycles per second.
The term: "cycles per second" is given the name HERTZ after **Heinrich Rudolf Hertz**, who was the first to prove the existence of electromagnetic waves.

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The Piezo diaphragm is held around the outer edge inside a plastic case and when a voltage is applied to the two leads, the thin plate curves very slightly.
When the voltage is removed, the plate returns to its flat shape.
If the voltage is reversed, the plate curves in the opposite direction.

The curving is due to a thin layer of ceramic material under the plate and

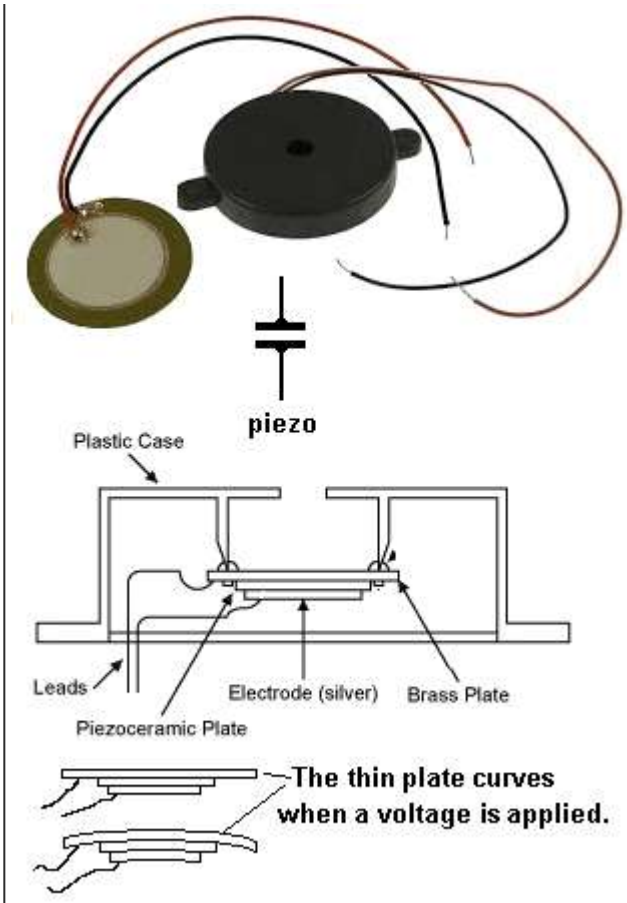

Fig 55. The Piezo

then a film of metal is deposited onto the ceramic so a lead can be soldered.

There is infinite resistance between the two leads as the ceramic material is an INSULATOR.
The capacitance between the two leads is approx 22n.
The Piezo is a passive device. It needs a pulse or frequency for it to produce an output.

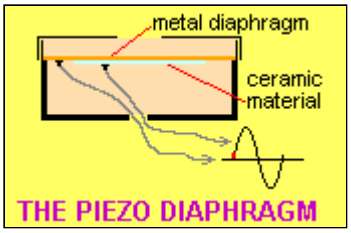

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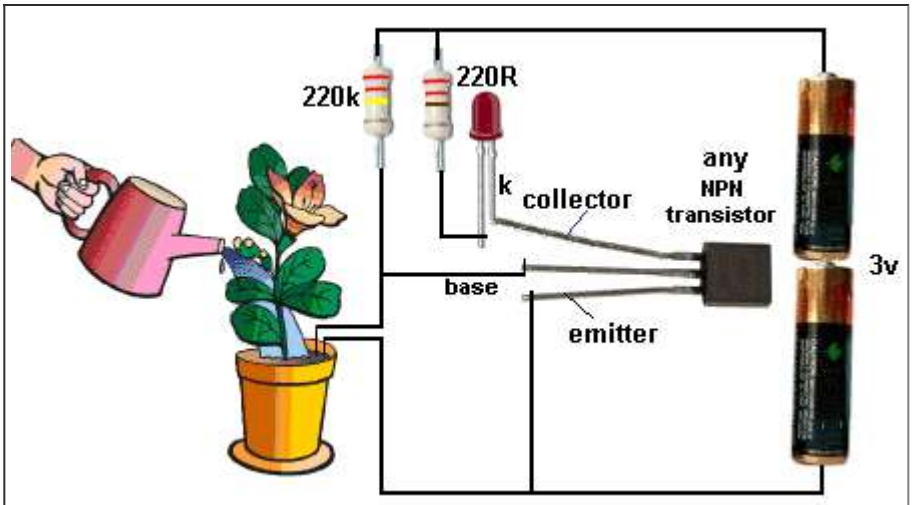

Fig 56. Plant Needs Water

The **ONE TRANSISTOR CIRCUIT** above can be turned into a detector to show when a plant needs water.
Place the two probes into the soil and water the plant. The LED will turn off. As the water evaporates the LED will turn **ON** to let you know the plant needs watering.

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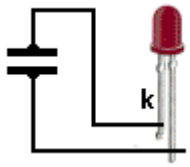

Fig 57. Tap the Piezo

This experiment produces a pulse from the piezo when it is tapped and the LED illuminates briefly.

The LED can be connected either way around.

This proves the diaphragm flexes when a voltage is applied and also in the reverse situation. A voltage is produces when the diaphragm is tapped.

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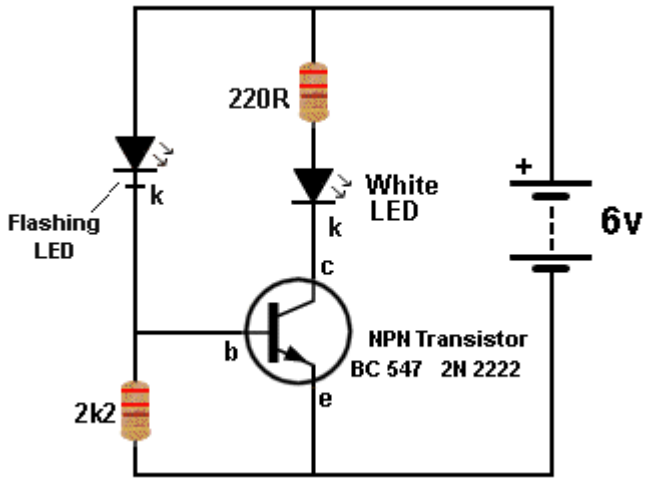

Fig 58. Flashing LED and White LED

A flashing LED is not very bright.
It can be connected to a transistor and the transistor will drive a very bright white LED.
The transistor is an amplifier.
It is amplifying the current flowing through the flashing LED and supplying a higher current for the white LED.

We cannot discuss any further details of the circuit at the moment because the actual operation of the circuit is quite complex.

At the moment we just need to experiment with simple transistor circuits.

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Fig 59. Soldering Iron

We now come to the point of HELPING YOU WITH CONSTRUCTION.
We have already shown you 6 different circuits and there are many ways to build them.
You can:
1. Solder them.
2. Build them on an Experimenter Board
3. Connect the components with clips or twist the leads together.
It does not matter how you build the circuits.
The fact is this: YOU MUST START BUILDING.
The best soldering iron for a beginner is a CONSTANT TEMPERATURE soldering iron.
It has a dial that can be turned to set the desired temperature.
An ordinary soldering iron GETS TOO HOT. It is not suitable for soldering electronic circuits.
This is something that no-one has mentioned before. An ordinary soldering iron will melt the solder TOO QUICKLY and burn the resin inside the solder and make soldering very difficult for a beginner.
Soldering must be done slowly so the resin in the middle of the solder gets hot and cleans the leads of the components so the solder will "stick."
That's why you must apply the solder to the leads you are soldering and allow the resin to "attack" the leads and clean them.
The cheapest TEMPERATURE CONTROLLED soldering Iron is available on eBay for les than $10.00 (post FREE).
You will also need a small roll of solder (0.9mm) and a soldering Iron stand.
Email Colin Mitchell for links to eBay. (talking@tpg.com.au)
A whole book could be written on the ART OF SOLDERING.
Look on the web for articles and videos on SOLDERING.

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SOLDERING

1. Soldering is very easy and very simple. You just need a **Temperature Controlled Soldering Iron**, **Fine solder** and clean components.
2. Remember this: It is **NOT** the solder you need for a joint, but the **FLUX**. And the flux lasts for only 2 seconds. When the flux is **HOT** it attacks and cleans the joint so that the solder will stick.
3. Turn ON the Temperature Controlled Soldering Iron to a low temperature. Put solder on the tip. It will not melt. Turn up the temperature slightly. Try more solder. As soon as the solder starts to melt, this is your starting point. Turn up the temperature slightly MORE and this is the correct temperature for **small, delicate, fine soldering**.
4. Place a component through a hole and bend the lead slightly so the component does not move. Turn the board over and touch the iron on the component and bring the solder **FROM THE OTHER SIDE** so the solder melts and flows towards the iron.
From start-to-finish, count one-two-three and remove the solder. Count four-five and remove the iron. You will have a perfect joint.
If you are soldering thick leads or large pads on a circuit board, you will need to turn the temperature UP slightly.
You must add enough solder to make the joint "bulge" slightly.
Fine solder (1mm or 0.9mm or 0.8mm) makes the best joint because it is easier to use.
Use a wet sponge to clean the tip or a ball of "Steel Wool." Steel wool is the best.
Here is the steel wool, bending the leads and some examples of poor joints due to insufficient solder:

Steel wool cleans the tip beautifully

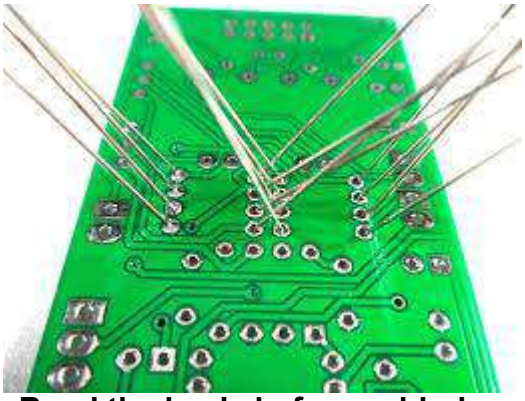

Bend the leads before soldering

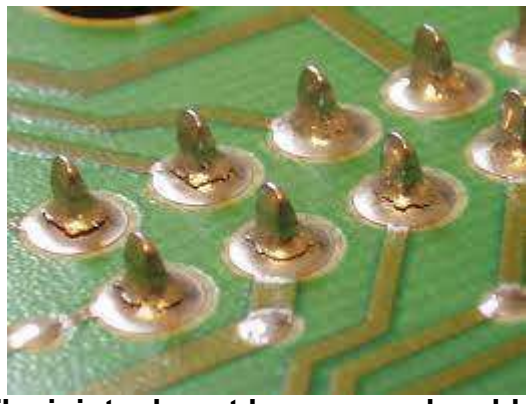

The joints do not have enough solder and that's why they fractured. Called a DRY JOINT.

More "Dry Joints."

This is the cheapest and simplest soldering iron stand.

This stand is very messy as the spring grabs the iron and makes it difficult to remove from the stand. Test the stand before buying. You will se why not to buy this type of soldering stand. Get one with a "wide mouth" and a heavy stand is best as it does not move.

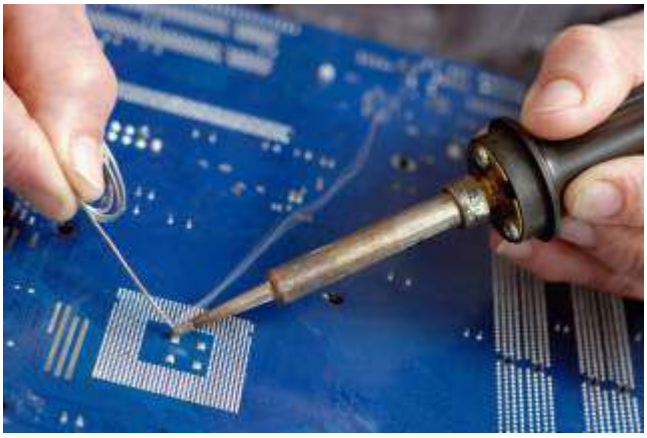

This photo clearly shows how to hold a soldering iron and solder.

This is NOT a temperature-controlled soldering iron and you can see it is too hot as it is burning off the flux too quickly.
Temperature Controlled Soldering Irons are now cheaper than the JUNK soldering iron shown in the photo. See eBay for prices.

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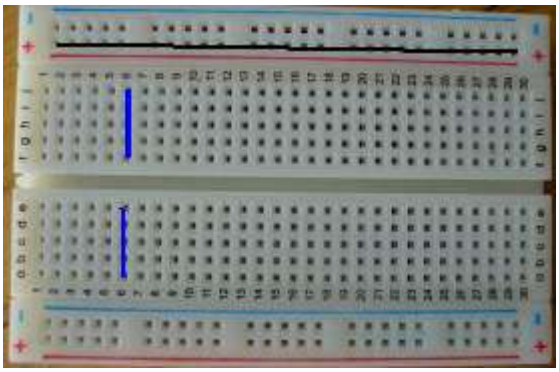

Photo shows a number of components fitted to the breadboard.

BREADBOARD

The term BREADBOARD refers to any piece of wood or plastic containing pins or pegs or clips or holes where you can build a circuit.
The components can be soldered, twisted clipped or fitted into holes.
Breadboard also means the circuit can be easily pulled apart.
Some breadboards do not have two rows for the positive and negative rails.
Connections under the board for the positive rail is shown with a black line in the photo. Connections on the main section of the board are shown with blue lines. Your breadboard MUST look exactly like the photo opposite.
Other breadboards are quite useless.
The breadboard in the photo can be purchased on eBay for less than $5.00 (post FREE).

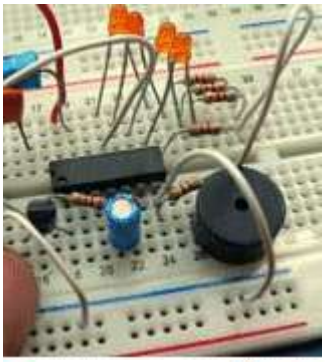

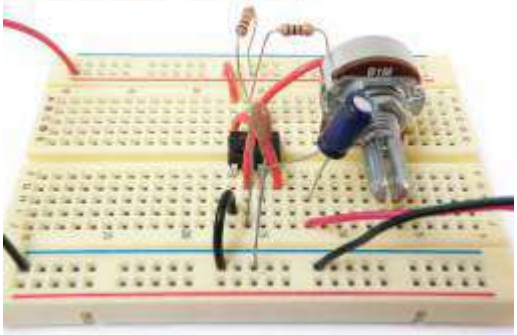

Fig 60. BREADBOARD and Components

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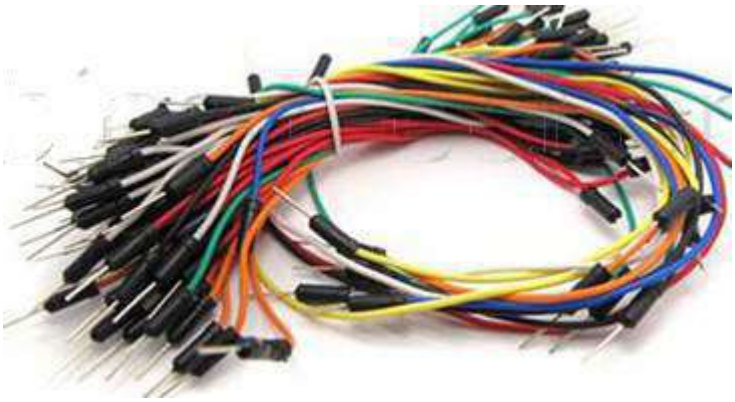

Fig 61. Jumpers

The components on the BREADBOARD are fitted down the holes and metal strips under the board join each column of 5 holes. If you want to join one hole with another, you can use 0.5mm tinned copper wire or JUMPERS. See photo opposite. Jumpers can be purchased on eBay for less than $3.00 posted.

Email Colin Mitchell for links to eBay. (talking@tpg.com.au)

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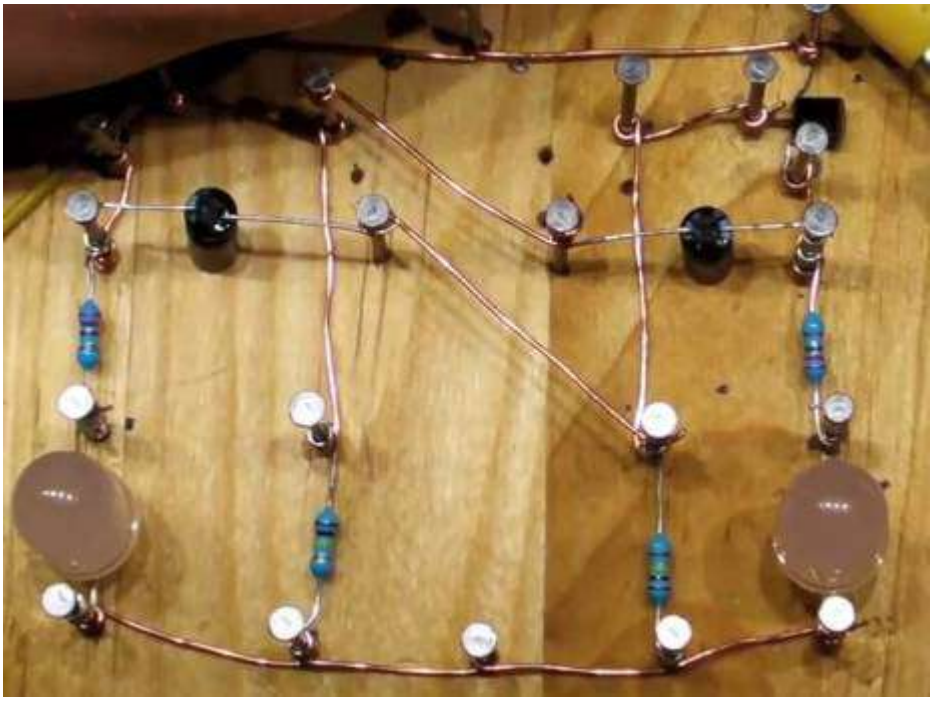

Fig 62. Breadboard with Nails

If you don't have a soldering iron or experimental breadboard, you can make your own board with nails. See the photo above. It is a multivibrator circuit and we will be presenting this circuit in a moment. The components can be twisted around the nails and bare wire used to join some of the nails to complete the circuit.

Another method of connecting the components is called BIRD-NESTING. This involves soldering the components "in the air" as shown in the 27MHz transmitter circuit below:

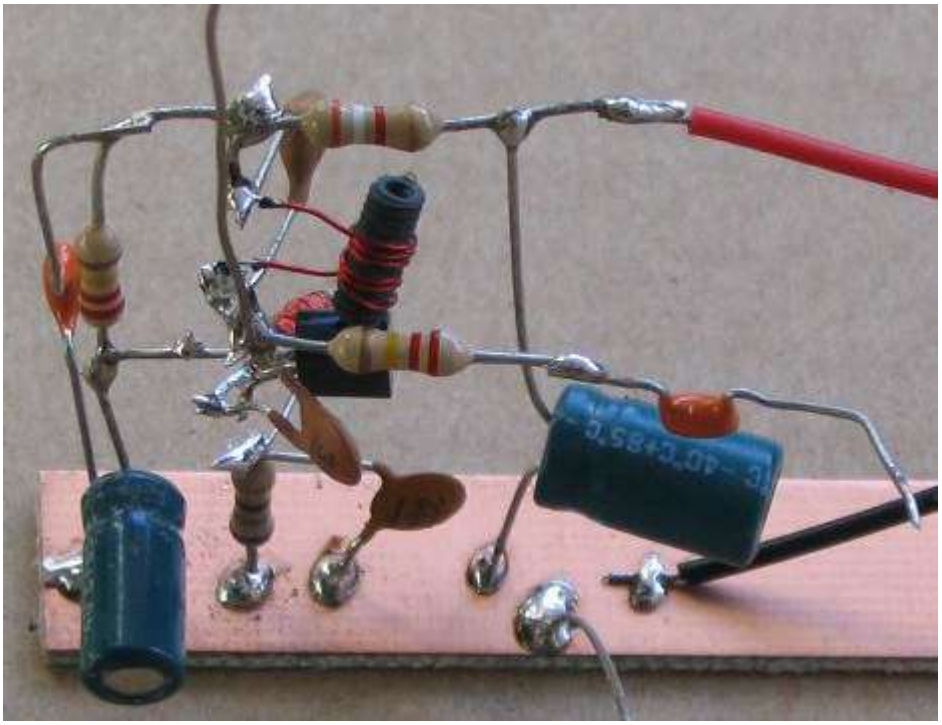

Another way to connect the component(if you don't have a soldering iron), is to wind 6 turns of bare wire around each connection and leaving all the components "in the air." The bare wire can be obtained from hook-up flex. This is plastic coated "wire" containing up to 15 fine strands of wire. Use a single strand for the connections. None of the components will touch each other BY MISTAKE and the circuit will work perfectly. Bird-nesting is a good way to build a quick circuit and test its performance. It might look messy but you can easily change any component.

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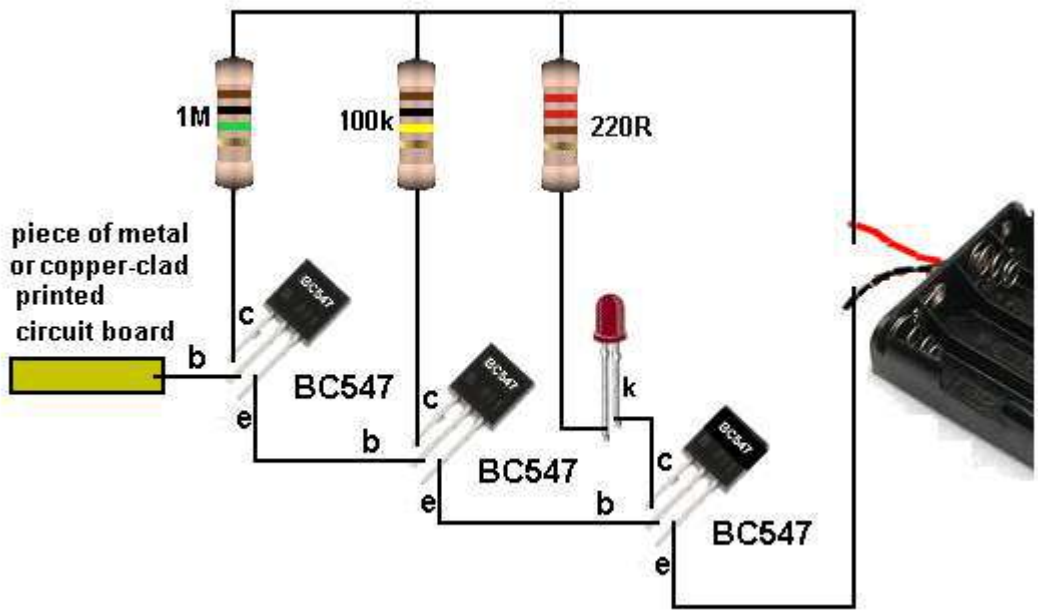

Fig 63. Wiring the 3-Transistor Circuit using BC547 Transistors
The diagram shows how to connect 3 x BC 547 transistors.
The leads of a transistor can be collector-base-emitter OR
emitter-base-collector and that's why we have provided 2 different wiring diagrams.

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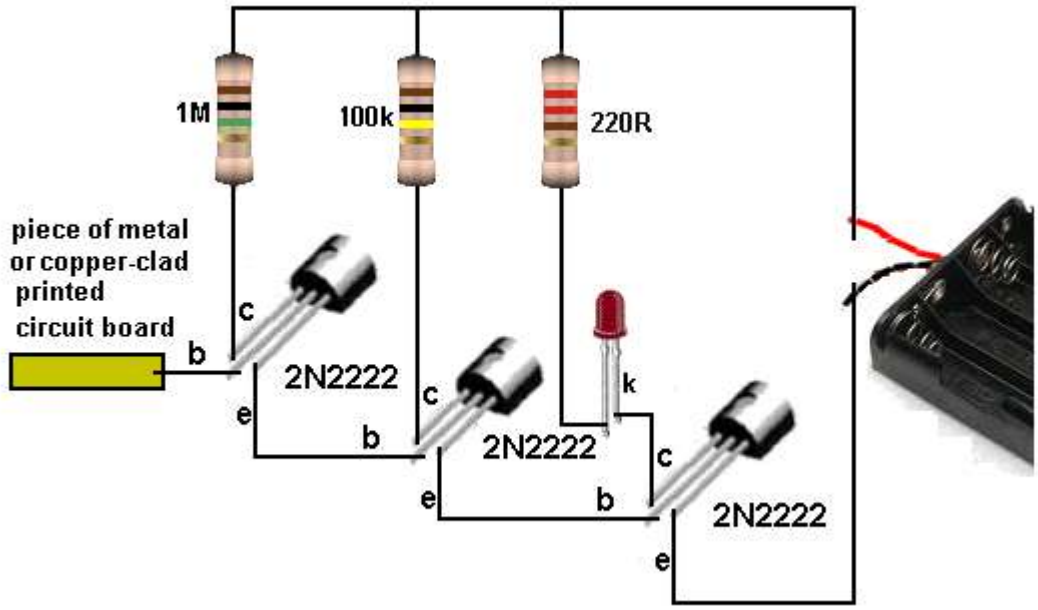

Fig 64. Wiring the 3-Transistor Circuit using 2N2222 Transistors
The diagram shows how to connect 3 x 2N2222 transistors.

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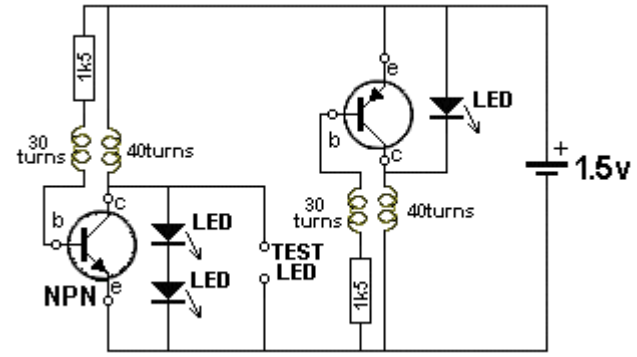

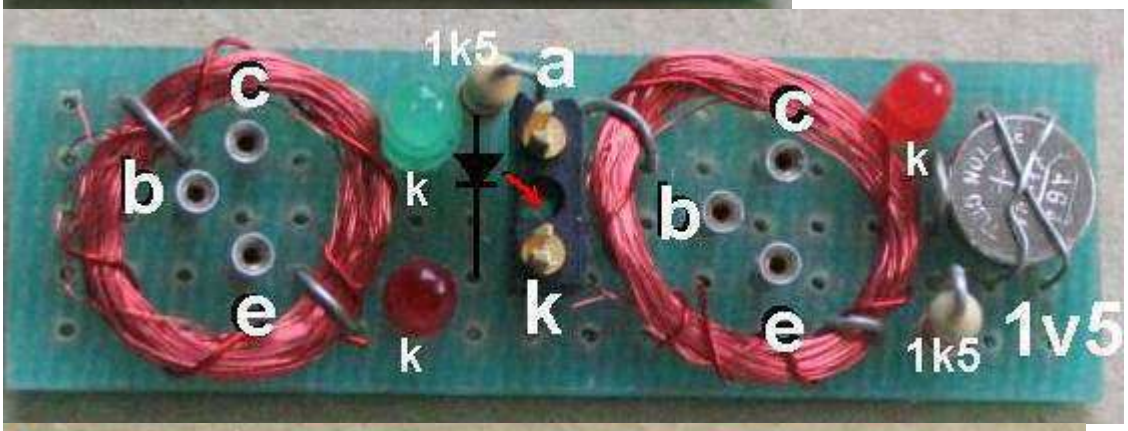

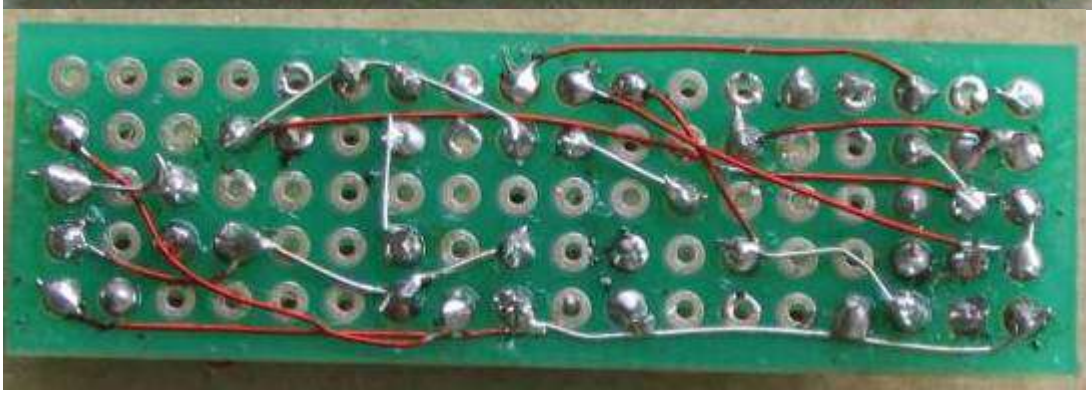

Fig 65. Transistor Tester

This handy transistor and LED tester can be built to test LEDs and both PNP and NPN transistors.
The project consists of two identical circuits, one for NPN and one for PNP.
You can build just the NPN section and then build the PNP section later.

LED VOLTAGE

We have shown a LED needs at least 1.7v supply for it to operate.
This circuit works on 1.5v and thus the action of the transistor and coil (called a Transformer) MUST be increasing the voltage for the LED to illuminate.
This circuit works on two "actions."
1. Transistor ACTION - this is the action of a transistor providing gain to make the circuit oscillate.
2. Transformer ACTION - this is the action of a coil of wire producing a voltage higher than the

supply voltage when it is turned off.

This circuit is very technical and very complex.
We will be explaining it in a very simple way because this is a **Basic Electronics Course**.

THE TRANSFORMER - the two coils of wire on the left and the two coils of wire on the right.
When the voltage (actually the current) is switched off, the 40 turn coil in either of the circuits in this project; the voltage across the coil rises to more than the 1.5v supply and is in the opposite direction to the voltage of the supply.
The circuit looks to be very simple but it uses an air-cored transformer to produce the voltage needed to illuminate the LED indicators and the circuit only works when the transistor is connected correctly. There are two separate circuits, one for NPN transistors and one for PNP transistors. We will cover the NPN section:
The circuit turns ON when the NPN transistor is fitted and the current through the 30 turn coil and 1k5 resistor turns ON the transistor and produces expanding flux in the 40 turn coil. This flux cuts the turns of the 30 turn coil and produces a voltage in the coil that adds to the supply voltage and increases the current into the base. This turns the NPN transistor ON more. This action continues until the transistor is fully turned ON. At this point the current in the 40 turn coil is a maximum but it is not expanding flux and the 30 turn coil ceases to see the extra voltage. Thus the current into the base reduces and this turns the transistor OFF slightly. The flux produced by the 40 turn coil now becomes collapsing (or reducing) flux and it produces a voltage in the opposite direction to greatly reduce the current into the base. In a very short period of time the transistor becomes TURNED OFF and it is effectively removed from the circuit. The flux in the 40 turn coil collapses quickly and it produces a voltage in the 40 turn coil that is higher than the supply voltage and is in the opposite direction. This means the voltage produced by the 40 turns ADDS to the supply voltage and is delivered to the LEDs to illuminate them.
The NPN circuit has two LEDs in series so that a LED of any colour (including white) can be connected to the TEST LED terminals and it will illuminate. You can use any colour LED for any of the LEDs, however it is best to use either green or yellow or white for the single LED.
The two "coils" are wound on a 10mm dia pen with 0.1mm wire (very fine wire). The loops of tinned copper wire holding the coils on the board are connected to separate lands under the board and MUST NOT produce a complete loop as this will create a “Shorted Turn” and the circuit WILL NOT WORK.
If the LEDs do not illuminate, simply reverse the wires to the 30 turn coil.
The circuit does not need an ON/OFF switch because the LEDs require a voltage of over 2v to illuminate (the orange LED) and the supply is only 1.5v. A red LED needs about 1.5v to 1.7v to operate but when it is in series with a green LED, this voltage is over 3.5v.
All the components fit on a small matrix board 5 holes x 18 holes. A kit of parts for the project is available for $4.00 plus $3.00 postage and ordering details can be obtained by emailing Colin Mitchell. (talking@tpg.com.au)
Build the circuit and test your transistors and LEDs.
We will be covering more on the action of a transistor and the action of a transformer in the discussion below, but it is important to build the circuit and see it working.
It is your first piece of **TEST EQUIPMENT**.

Questions

1. Identify the letters "c" "b" and "e"
2. What type of transistor is tested in the first set of hollow pins?
3. Put a PNP transistor into the first set of hollow pins and try all positions. Does the red and green LEDs illuminate?
4. When both the red and green LEDs illuminate, what is the approximate voltage across the pair?
5. When you fit a red LED to the test-socket, what is the approximate voltage across it?
6. When you fit a red LED to the test-socket, why does the red LED and green LED on the PC board turn off?
7. Why doesn't the project need an on/off switch?
8. The two coils for the circuit on the left is called a TRANSFORMER. Do the connections of the windings have to be connected to the circuit around a particular way?

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ROBOT MAN

This multivibrator circuit will flash the Robot Man's eyes as shown

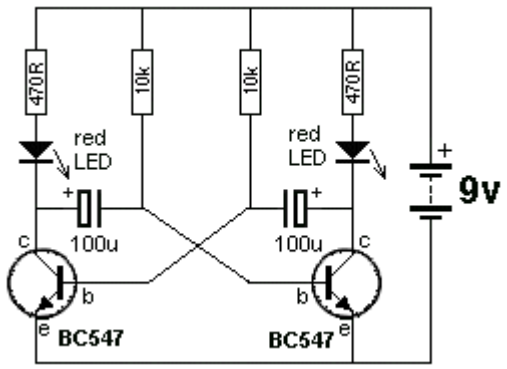

Fig 66. ROBOT MAN
The ASTABLE MULTIVIBRATOR or "free-running" multivibrator.

in the photo. The kit of components is available from Talking Electronics for $8.50 plus postage. Send an email to find out the cost of postage: talking@tpg.com.au
The photo shows the LEDs flashing.
The circuit is called an **ASTABLE MULTIVIBRATOR** and this means it is not stable but keeps switching from one transistor to the other.
It is also called a **FLIP FLOP** circuit.

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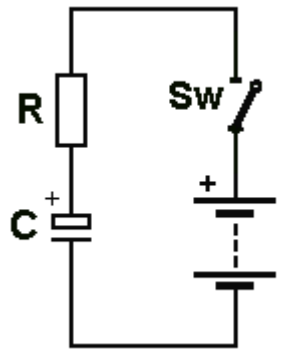

Fig 67. The TIME DELAY

The **TIME DELAY** circuit consists of a Resistor **R** and Capacitor **C** in **SERIES**.
When the switch is closed, the electrolytic (called the CAPACITOR) charges slowly because the resistor only allows a small amount of current to flow.
It's just like charging your mobile phone. The battery takes time to charge because there is a resistor in the circuit to limit the current. If we remove the resistor in the mobile phone, the battery will get too hot when it is being charged but in the **TIME DELAY** circuit, we want the capacitor to charge slowly, because we want a **TIME DELAY.** .

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Fig 68. The charging of a capacitor is the same as building a brick wall.

CHARGING A CAPACITOR

The capacitor in **Fig 67** charges via the resistor **R**.
But the voltage on the capacitor does not rise at a constant rate.
It starts off charging very quickly and as the voltage across it get higher, the voltage increases at a slower and slower rate.
In the photo I am building a brick wall.
I am working at a constant rate.
When I started building the brick wall, I laid 5 rows of bricks (5 courses) in the first hour.
As the wall increased in height, I had to climb the ladder and I could only lay 3 courses an hour and finally the wall was so high I could only lay 1 course per hour.
This is exactly the same as a capacitor charging.
When the capacitor is uncharged, the supply voltage allows a high current to pass through the resistor **R** and the energy quickly fills the capacitor. This results in a rapidly increasing voltage on the capacitor. But as the voltage on the capacitor increases, the difference in voltage between that on the capacitor and the supply is very small and only a small current will pass through the resistor. This means the voltage on the capacitor increases at a slower rate.

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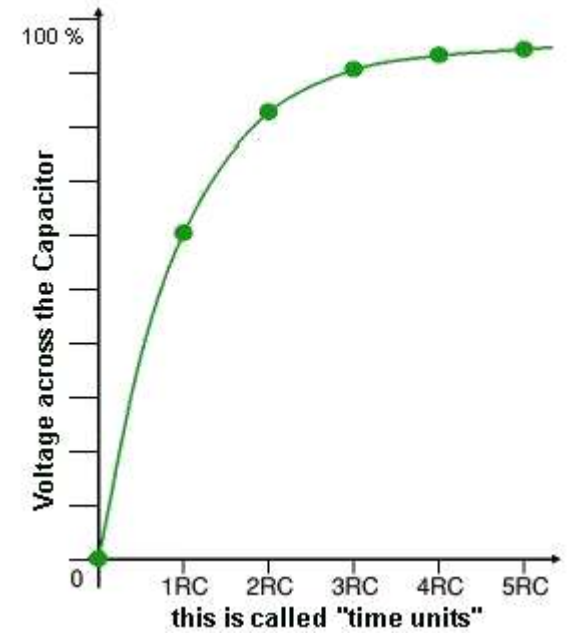

Fig 69. Time Units

It really does not matter how fast or slow or uneven a capacitor charges because most circuits detect a voltage on a capacitor and the time taken to reach this voltage is called the **TIME DELAY**.
But to prevent you thinking the capacitor charges "smoothly" we have to explain what actually happens.
The graph on the left shows the capacitor charging. You can see it charges quickly at the beginning and then charges slowly and then very slowly.
You can see the first part of the graph is fairly "straight" (constant charging) - NOT "straight up and down" but a straight line - and this applies to a voltage of about 63%.
The time taken to reach this voltage is called **ONE TIME UNIT** - also called **ONE TIME CONSTANT**. The graph continues for another 4 "time units" (time-constants) and the final voltage is very nearly 100%. (It never reaches 100%.)

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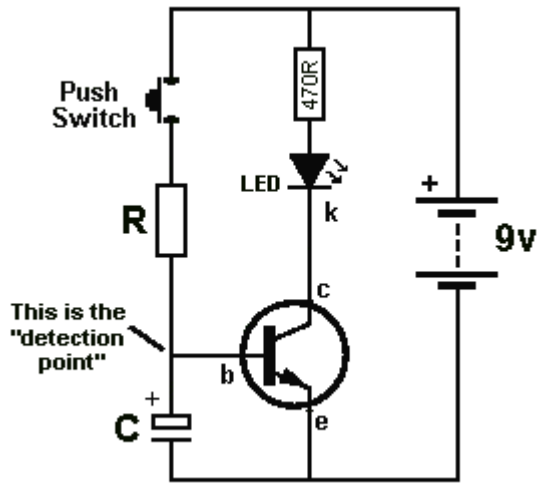

Fig 70. Time Delay Circuit

A **TIME DELAY** circuit needs three things:
1. A Resistor (R)
2. A Capacitor (C)
3. A "Detection Point."

When the switch is pressed, capacitor (**C**) takes time to charge via resistor (**R**) and after a short period of time the voltage at the **DETECTION POINT** is 0.6v and the transistor is TURNED ON. The LED illuminates.

Build the circuit with 100u and 100k and see how long it takes before the LED illuminates.

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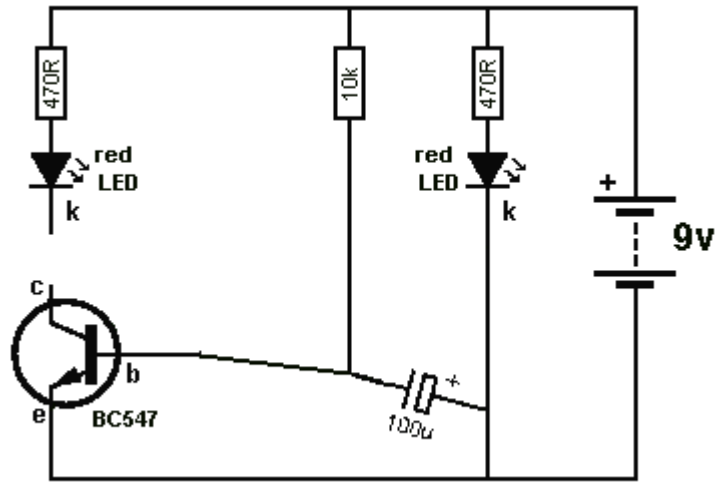

In the **ROBOT MAN** project you can see the "**TIME DELAY**" circuit made up of the 100u, 10k resistor and the base of the transistor.

This is one of the most important **BUILDING BLOCKS** in electronics.
It is the basis of all oscillators and will be discussed below, after we explain a few more details.

Fig 71. The "TIME DELAY" in the ROBOT MAN Project

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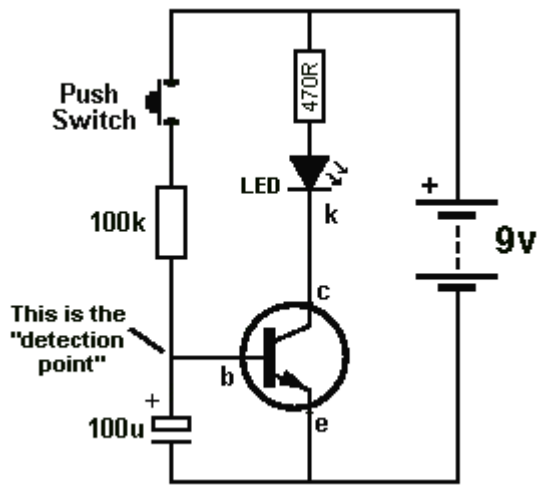

Fig 72. Turning A Transistor ON

We will use the **TIME DELAY** circuit to turn the transistor **ON**.
Make sure the 100u is uncharged by touching both leads (both ends of the capacitor) at the same time with a JUMPER - this is a piece of wire shown in Fig 61.
Push the switch and noting happens. After a short period of time the LED starts to glow and then comes on fully.
This shows two things:
1. The transistor is not turned ON when the base voltage is zero.
2. The base voltage must be 0.6v for the transistor to start to turn ON and when the voltage is 0.65v the transistor is turned **ON FULLY.**

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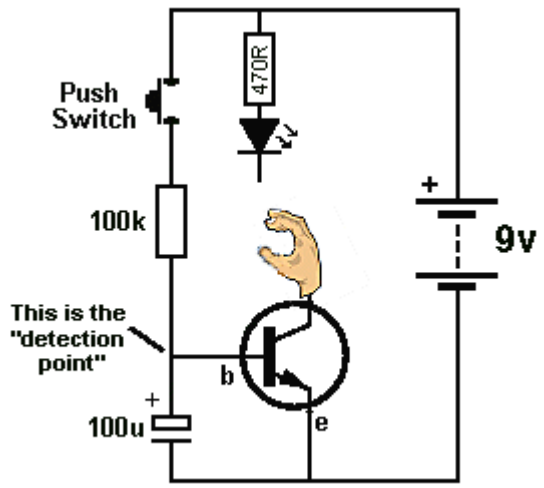

Fig 73. How the LED turns ON

Here is an explanation of how the LED turns ON.
When the circuit is first assembled and the switch is not pressed, the transistor is not turned on and it is just like the diagram opposite. The LED is not connected to the transistor.

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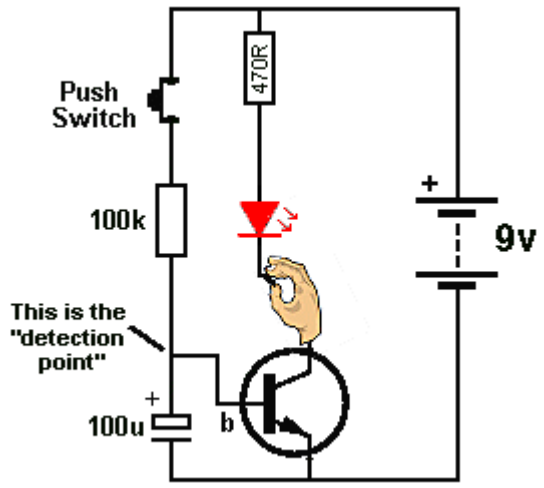

Fig 74. The LED turned ON

When the switch is pushed, the transistor turns **ON** (after a few seconds) and it pulls the lower lead of the LED down towards the 0v rail and this action turns the LED **ON**.

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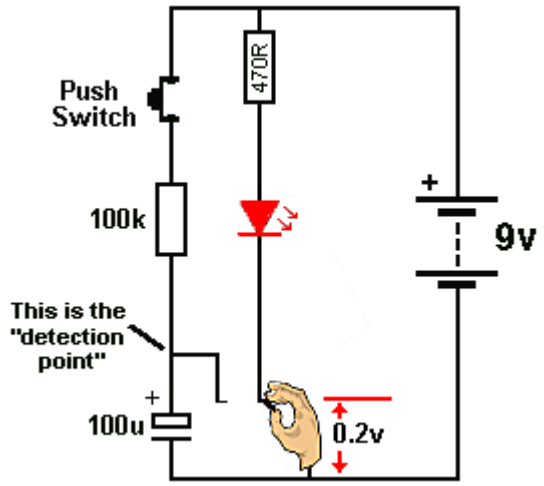

Fig 75. The LED fully turned ON

When the LED is **fully turned ON**, the lower lead of the LED is almost directly connected to the 0v rail.
In other words:
When the transistor is **FULLY TURNED ON**, the lower lead of the LED is almost directly connected to the 0v rail.
The voltage between the lead of the LED and 0v rail is 0.2v. This is the characteristic voltage across the collector-emitter terminals of a transistor when it is TURNED ON.

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In the three diagrams above you can see the LED is changed from an **OFF** condition to an **ON** condition by the action of the transistor.
The transistor is acting **LIKE A SWITCH.**
This action is one of the most important actions in electronics.
It is called: **"The Transistor as a SWITCH"**
It is the basis to ALL Digital Circuits.
It is the basis because of these two facts:
1. When the transistor is **OFF**, the circuit is taking **no current** and no power is being lost or wasted.
2. When the transistor is **ON**, the LED is almost at 0v and no resistor is in the lower lead to waste any power.
Thus we can turn things **ON** and **OFF** without wasting and power.
This is the basis to **DIGITAL ELECTRONICS**.

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DIGITAL ELECTRONICS revolves around circuits that are either **FULLY ON** or **FULLY OFF**. This means they take almost no power and we can combines lots of circuits and still take almost no power.
This means they do not get hot and it also means they will last a long time.
You may not think turning a transistor **ON** and **OFF** will achieve any worthwhile outcome but a circuit can be designed to use two transistors (similar to the **ROBOT MAN** above). The circuit does not Flip-Flop but requires a switch and when the switch is pressed, the circuit changes state. The two transistors are connected together and it takes two presses of the switch to make the output of the second transistor change state ONCE.
The circuit is a divider. It is called a: **divide-by-two** and is the basis of all counting in a computer.
By adding more "**divide-by-two"** circuits we can get "**divide by 4**, **divide by 8**" etc. Two transistors don't do much but when you combine millions of transistors we have a **COMPUTER.**

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Two transistors can do one more thing. They can "**REMEMBER**."
Here is a manual circuit.
Pressing Switch **A** turns the LED **ON** and pressing switch **B** turns the LED **OFF**.
The circuit "remembers" or remains in each state called a stable state.

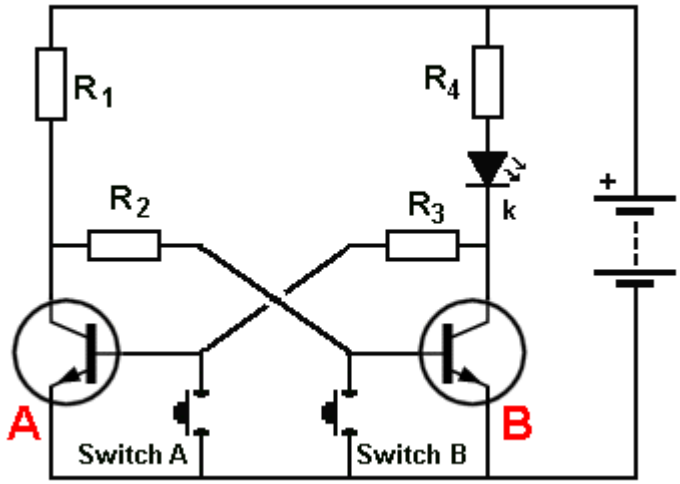

Fig 76. The "MEMORY CELL"

When Switch **A** is pressed, the voltage on the base is removed and transistor **A** turns OFF.
Transistor **B** turns ON via resistors R_1 and R_2 and the LED is turned **ON**.
When the switch is released, the voltage on the collector of transistor **B** is less than 0.6v and the two transistors remain in this state.
Pressing switch **B** turns the LED **OFF.** (transistor **A** turns ON via R_3, R_4 and the LED - very little current flows through the LED and you can hardly see it glowing). The voltage on the collector of transistor **A** is less than 0.6v and the two transistors remain in this state.

The technical name for this circuit is:
BISTABLE MULTIVIBRATOR or **BISTABLE SWITCH** or **BISTABLE LATCH**.

This is the basis to all the memory in a computer.

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In electronics, we talk about the **DIGITAL TRANSISTOR** and **ANALOGUE TRANSISTOR**.
This is just an ordinary transistor (called a Bipolar Junction Transistor) in a **DIGITAL CIRCUIT** or **ANALOGUE CIRCUIT**.
We are now discussing the **DIGITAL CIRCUIT** - The Multivibrator - Astable Multivibrator and Bistable Multivibrator (Memory Circuit).
The **DIGITAL CIRCUIT** has **2 STATES**.
The **ON STATE** and the **OFF STATE**.
It is conducting in the ON STATE and the LED is illuminated.
In the OFF STATE, the LED is not illuminated.
In the ON STATE the transistor is said to be **CONDUCTING** or **BOTTOMED**.
In the OFF STATE the transistor is said to be "**CUT OFF** or "**OFF**."
These two states are reliable and guaranteed. They are not "half on" or "quarter on" or "75% off."
These states are easy to transmit "down a wire." The ON STATE is transmitted as "1" (voltage present) and the OFF STATE is transmitted as "0" (voltage not present).
These are the two **DIGITAL STATES**.

The **ROBOT MAN** is a **DIGITAL CIRCUIT**.
Each LED is ON or OFF.
The waveform on the output of each transistor is called a **DIGITAL SIGNAL**.

The waveform is said to be **DIGITAL** or **SQUARE WAVE**.
The top line of the graph represents the LED OFF.
The bottom line of the graph represents the LED ON. The LED is ON when the collector voltage is LOW because we are pulling the lead of the LED to the 0v rail as shown above.
The circuit changes from one state to the other very quickly and this is called the **RISE TIME**.

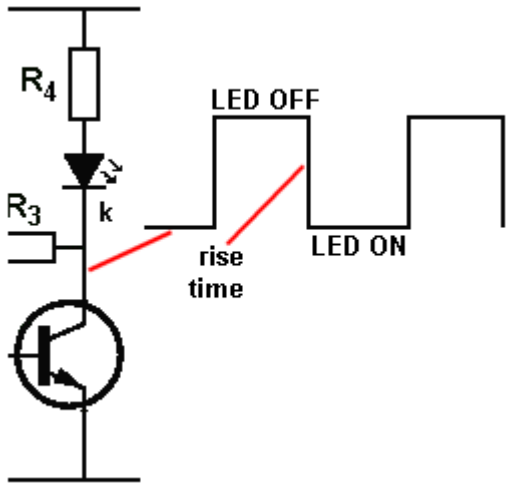

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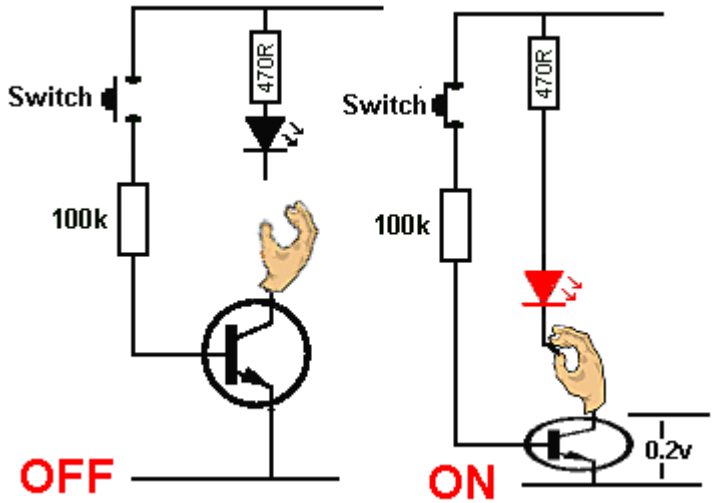

Fig 77. The two Digital States

Going over the two **DIGITAL STATES** for a transistor.

In the first diagram the switch is not pressed and the base does not see a voltage to turn the transistor on. The transistor is "**OFF**" (not conducting) and it is not "grabbing" the LED. The LED is not illuminated.
In the second diagram the base of the transistor sees a voltage via the switch and it is TURNED on. The LED is illuminated.

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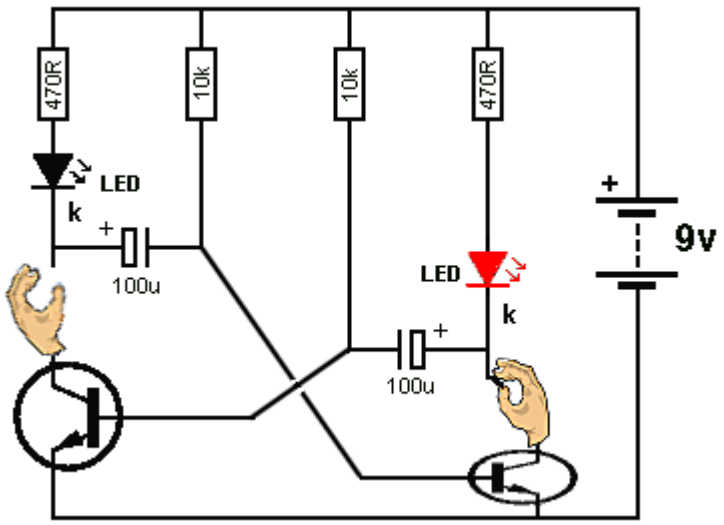

Fig 78. ROBOT MAN Animation
This animation shows how a transistor grabs a LED and pulls it towards the 0v rail to turn it ON.

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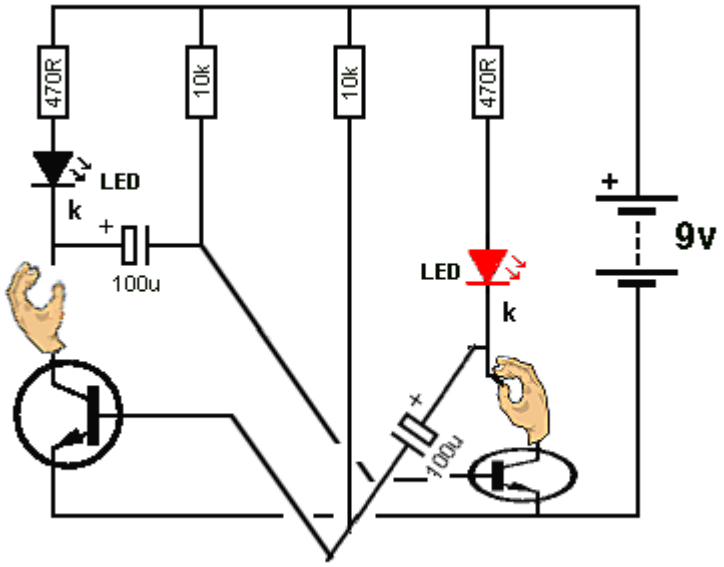

Fig 79. TIME DELAY Animation

The animation in **Fig 78** shows the two transistors turning the LEDs **ON** and **OFF** in a **FLIP FLOP** circuit.
We know the 10k and 100u components form a **TIME DELAY** to create the time for each LED to be illuminated. The timing for one LED plus the other LED creates a **CYCLE** and this is the **FREQUENCY OF OPERATION** for the circuit. It is measured in cycles per second - Hertz - Hz.
We will now go into more detail of how the **TIMING COMPONENTS** create the **TIME DELAY** for each LED.
The circuit is more-complex than you think.
The 100u is already charged from a previous cycle and we show how it gets discharged via the 10k and charged in the opposite direction by the 10k to create a **TIME DELAY**.

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THE CAPACITOR

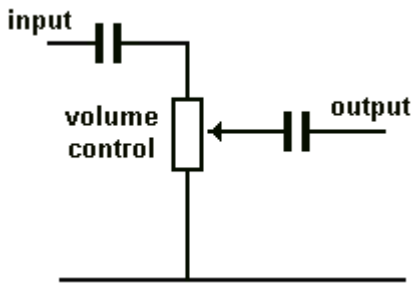

The capacitor can perform many different functions and produce many different effects, depending on its value and the surrounding components.
In this circuit the capacitors on the input and output prevent DC on the volume control creating "scratchy sounds" when the volume is altered.
This is called "DC blocking."
The AC (the signal) passes through the capacitors but the DC voltage on the input is blocked.

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CHARGING A CAPACITOR Part II

It is easy to see how a capacitor charges via a resistor in the **TIMING CIRCUIT** (Delay Circuit) above but many capacitors are not connected to the 0v rail.
They are connected as show in the animation below and their "job" is to pass a waveform.
When they pass the waveform they **CHARGE** and **DISCHARGE**.
The waveform is called an **AC SIGNAL** and the output is smaller than the input.
The circuit is taken from the circuit above, but the same effect applies to all capacitors that "pass a signal."
Here's why:

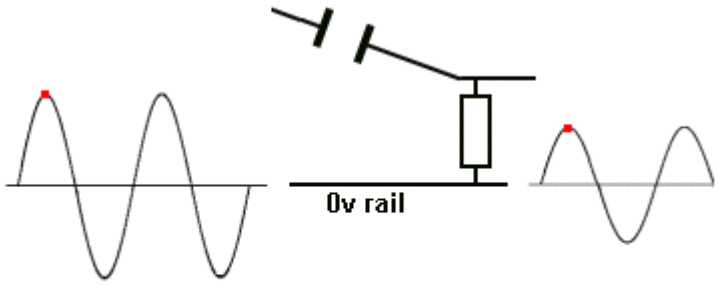

The capacitor charges slightly during the rise of the signal and the right-plate of the capacitor does not rise as high as the left-plate. That's why the output signal is not as large as the input signal.
If the capacitor did not charge, the output would be as large as the input. If you use a capacitor with a large value, it will not charge and thus the output will be as large as the input.
That's why you use a large capacitor !!!!

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CHARGING A CAPACITOR Part III

Here is another CAPACITOR in action.

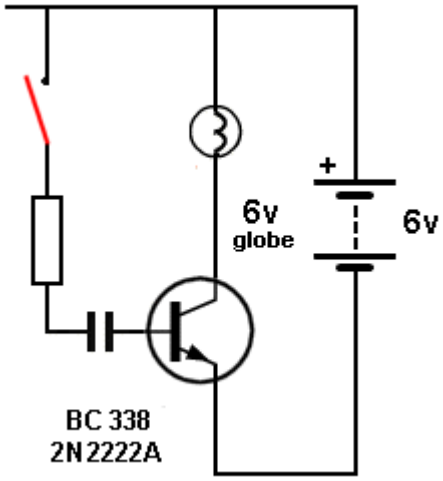

The animation shows a capacitor charging (via a resistor). The initial current is LARGE and this turns the transistor FULLY ON and the globe illuminates. As the capacitor charges, the base current reduces and the transistor starts to turn OFF. Eventually the capacitor is fully charged and the voltage on the base falls to 0v, turning the transistor OFF.

This animation shows three features:
1. The initial charging current is HIGH.
2. It gradually falls to zero.
3.The voltage on the base drops below 0.6v and the transistor turns OFF.

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NEGATIVE VOLTAGE

You will be surprised to learn that many circuits produce a negative voltage or negative spike at some point (when doing circuit-analysis, each location or point or join of components is called a NODE) on the circuit. In other words the voltage will be LESS than the 0v rail of the circuit.
This is due to the presence of a capacitor and the animation shows how a capacitor can produce a negative voltage:

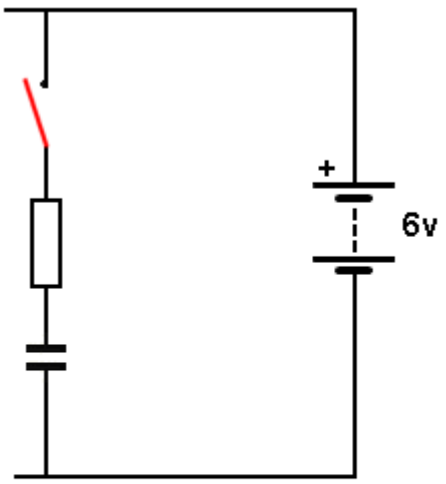

When a charged capacitor is "lowered from one position in a circuit" the positive lead may be lowered by say 3v. This means the other lead will be lowered by 3v. We are assuming the capacitor can be lowered and is not directly connected to the 0v rail.

You can see the electrolytic produces a NEGATIVE VOLTAGE on the base in the following animation, when the two transistors change states:

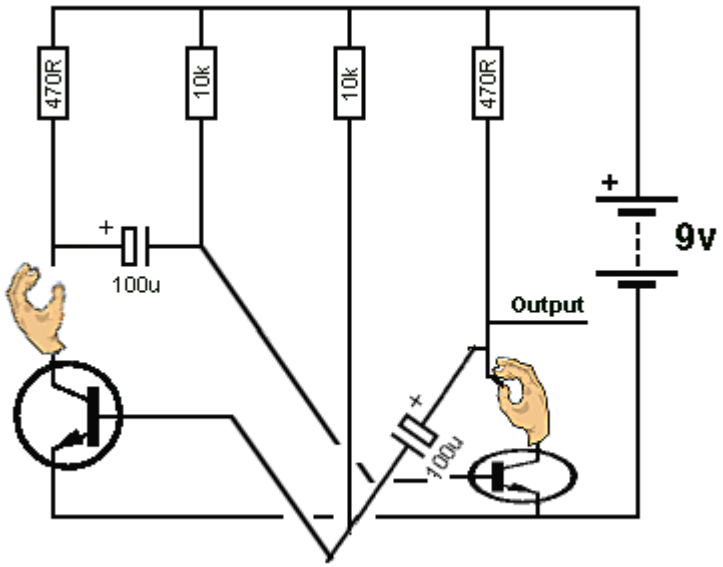

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The Electret Microphone

The most common type of microphone is the ELECTRET MICROPHONE.
It is incorrectly termed the "Capacitor Microphone" or Condenser Microphone." "Capacitor Microphone" descriptions make no mention of a FET as the amplifying device and a polarized diaphragm to detect the audio, so they are something different.
The electret microphone consists of a FET (transistor)

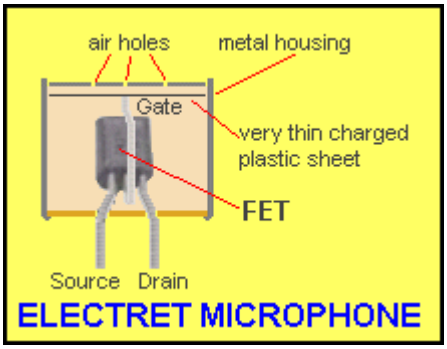

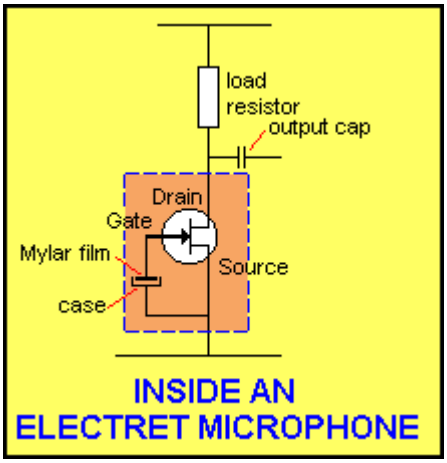

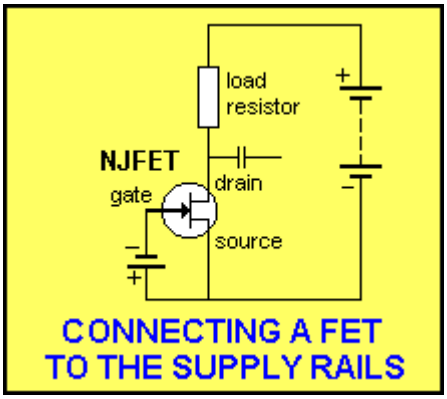

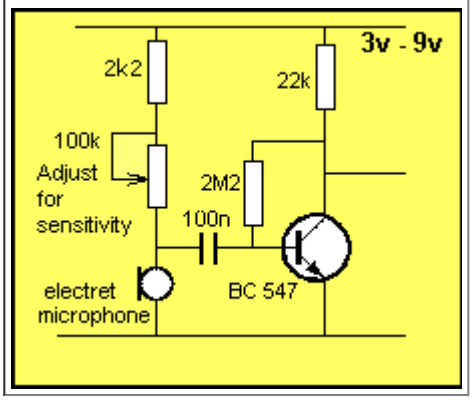

inside an aluminium case with a very thin Mylar film at the front. This is charged and when it moves (due to the audio it receives via a small hole in the front of the case), it vibrates and sends a very small voltage to the GATE lead of the Field Effect Transistor. This transistor amplifies the signal and produces a waveform of about 2mV to 20mV at the output.
The electret microphone requires about 0.5mA and will operate from 1.5v supply with 4k7 LOAD RESISTOR.
For 3v supply, the Load Resistor can be 22k to 47k.
For higher supply voltages the resistor will be 68k or higher.
Electret microphones are extremely sensitive and will detect a pin-drop at 3 metres.

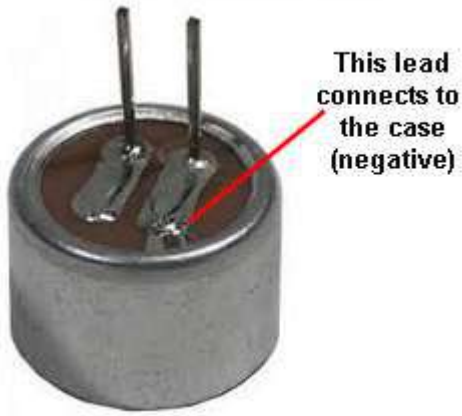

Most electret microphones have two leads. One lead is connected to the case and this lead goes to the 0v rail.
The other lead goes to a LOAD RESISTOR (4k7 to 68k - depending on the voltage of the project).
Reducing the value of the load resistor will increase the sensitivity until the background noise is very noticeable.
They are used in Hearing Aids and are more-sensitive than the human ear.
They are very small, low-cost and very sensitive.

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The Speaker

The most common speaker is about 30mm to 60mm diameter and 8 ohm impedance. This means the voice coil is about 8 ohms resistance.
The two leads can be connected either way to a circuit.
The speaker shown is 32mm diameter and has a realistic wattage of 100mW (NOT 1watt).

These speakers have a Mylar cone and the magnet is a "super magnet" and very small. That's why it is so flat.

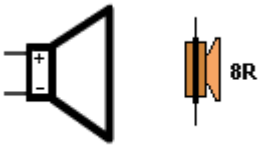

Speaker Symbol

A speaker can be used as a microphone (called a Dynamic Microphone) and a circuit to connect the speaker (mic) to an amplifier can be found on Talking Electronics website. It is not as sensitive as an electret microphone and does not produce the same output amplitude, but it is an emergency microphone.

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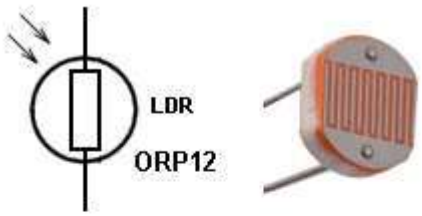

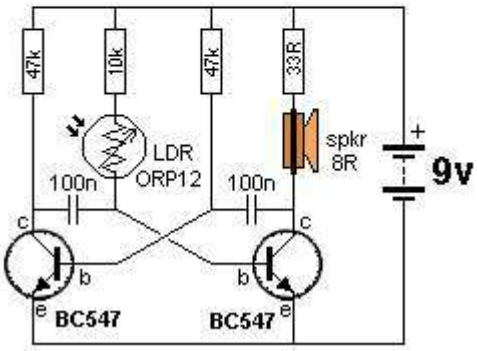

LDR and Light Alarm Circuit

Light Dependent Resistor

(LDR)

Also called **PHOTOCELL** or **PHOTO RESISTOR**
A **Light Dependent Resistor** is a 2-leaded component containing a layer of semiconductor material.
The top contains two interleaving combs of conducting wires with a path of semiconductor material between. When light falls on the component, the resistance of the semiconductor material decreases.
In darkness the LDR will be about 300k. In very bright light the resistance will be about 200 ohms.
But if the light changes only a very small amount, the resistance CHANGE is VERY SMALL. For a large change, see **Photo Transistor**.
The **Light Alarm** circuit will produce a squeal when light falls on the LDR.

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Photo Transistor

The **Photo Transistor** is very sensitive to changes in illumination. It is about 100 times more sensitive than the **LDR**.
The **Photo Transistor** is also available as a **DARLINGTON.**
The Darlington Photo-transistor is 100 x 100 times (10,000) more sensitive than the LDR.

The **Photo Transistor** and **Photo Darlington Transistor** are connected just like a normal transistor but the base lead is not connected. If the value of the LOAD RESISTOR is large, the

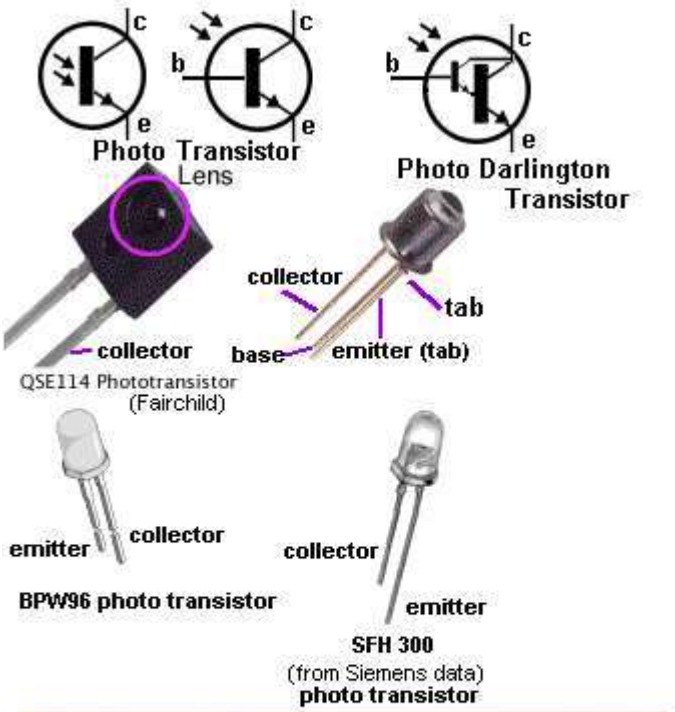

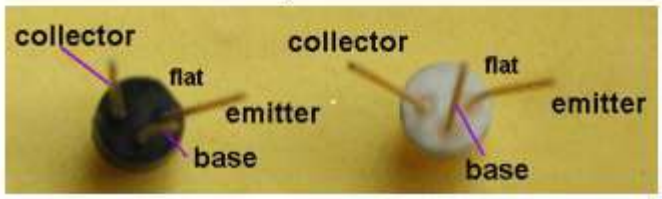

FPT100 Photo Darlington Transistor

The FPT-100 Darlington Photo Transistor is available from Talking Electronics for $1.00 each plus postage.

transistor will not be very sensitive.

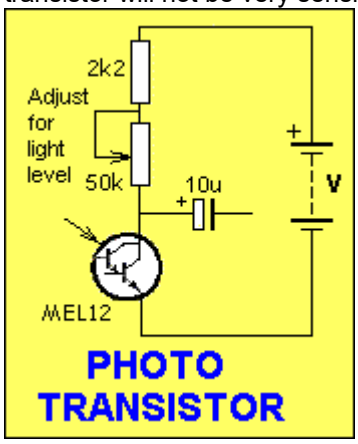

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The Inductor

Also called **"coil,"** or **"Choke."**
An **Inductor** consists of one to many turns of wire wrapped around a former (tube of cardboard). The wire can be jumble-wound or wound in layers. The result is the same. This is called an **air-cored coil** or **air-cored inductor**.
The centre can be filled with a metal such as iron or laminations (thin sheets of metal) or a ferrite material. Different cores operate at higher frequencies.
The core can be circular (doughnut) or rectangular and it is called a **MAGNETIC CIRCUIT** (when it is a closed loop).
Additional turns or increasing the diameter of the turns will increase the inductance.
A coil with a magnetic core can be used to pick up nails and metal items. It is called an **electromagnet**. It can be

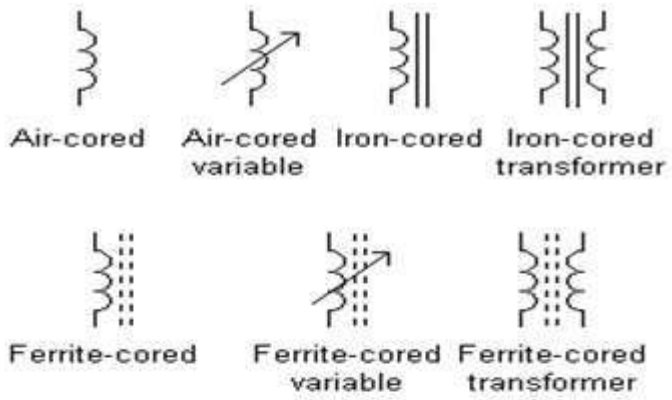

The emerging **magnetic lines of force** from an inductor produce the NORTH POLE - this is just "convention," a simple way to explain things - to get the explanation started.
When two or more coils are wound near each other, the inductor is called a **TRANSFORMER** (but not the armature above).

operated on AC or DC.
When the metal core is loose and gets pulled into the coil it is called a **SOLENOID** or **ACTUATOR** or **LINEAR ACTUATOR**. It can be operated on AC or DC.
The way an inductor works is very complex but we can say it resists any rise or fall in voltage by turning the rise or fall into magnetic flux.
If the applied voltage is suddenly turned off, the inductor produces **a very high voltage** of **opposite polarity** (these are the **two** most important things for you to remember).

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The Antenna

The first time you will need an antenna is when making an FM transmitter.
The antenna is usually a length of wire equal to half the wavelength of the transmitter. The frequency is about 100MHz and the wavelength is 3 metres.
A half-wave antenna is 1.5metres.
The length is important but the height is more important.
The wire should be as high as possible and "up-and-down" if the antenna on the radio is vertical, to get the maximum range.
This is called an **end-fed half-wave antenna** or **half-wave**

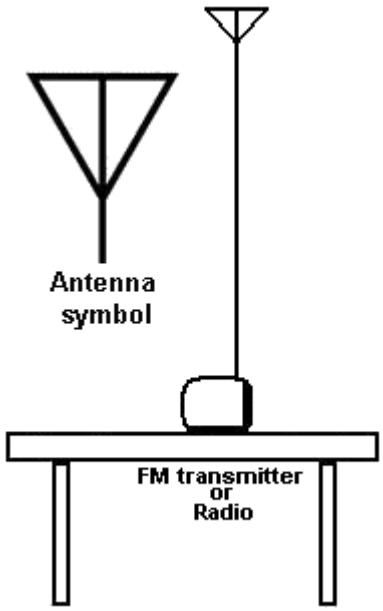

Monopole.
The transmitting circuit should have a good ground-plane such as connection to large batteries so the signal can be pushed and pulled into and out of the antenna.
This signal is then radiated as electromagnetic radiation to the surroundings.

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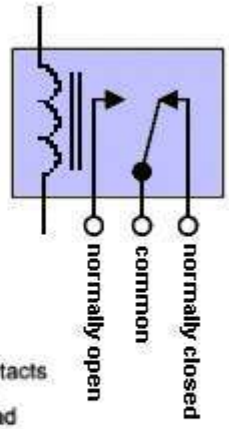

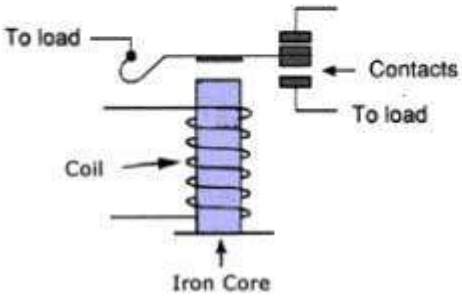

A single contact consists of 2 pins -called SPST (single-pole single-throw).
Or a single pair of contacts can consist of 3 pins - called change-over or SPDT (single-pole double-throw).
A double set of contacts consists of 6 pins, called DPDT (double-pole, double-throw). This is also called a **CHANGE-OVER RELAY** or **REVERSING RELAY** (when connected to a motor).

The RELAY

The word **Relay** comes from the days of Morse Code where a coil of wire (an electromagnet) closed a switch to allow the Morse code to travel further down the telegraph line.
It would "relay" or "pass-on" the information.
A relay allows a "weak circuit" (one with low current) to operate a LOAD that needs a large current. It also separates the two circuits electrically and prevents a voltage such as 240v connecting to a 12v circuit. The coil is separated from the contacts and this gives the two circuits isolation.
A double-pole double-throw relay can be used to reverse a motor as shown here:

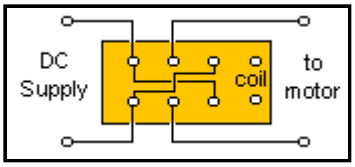

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Driving A Relay

(Powering A Relay)
The first thing you must decide is the voltage of the relay. This will depend on the voltage(s) available. The relay will be driven (activated) by a transistor and the base of the transistor only needs a signal (less than about 1v). This means the project can be operated on a voltage from 3v to 12v and the relay can be connected to a 5v to 12v supply.

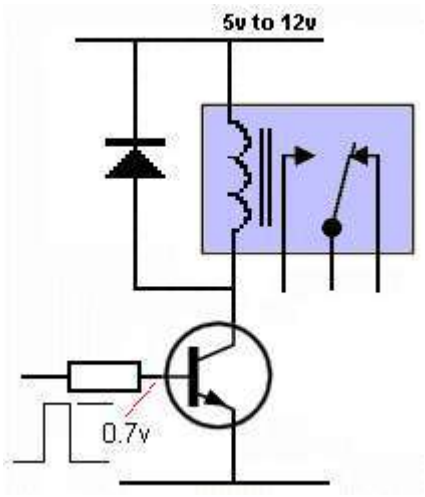

Driving A Relay

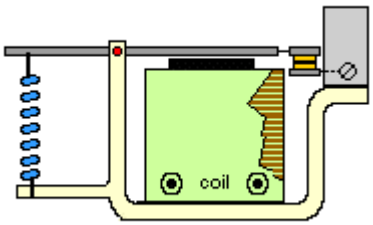

The armature is drawn towards the coil when a current flows through the coil.

Next you need to know the current-rating of the contacts. This will depend on the current taken by the LOAD. The rating of most relays is: 1 amp, 5 amp or 10 amp.
Finally you need to know how many contacts are required.
For a single circuit you will need 2 pins and for two circuits you will need 4 pins (but relays only come with 6 pins).
You can get relays that need a very small current for activation. These are called CMOS relays. But most relays need about 100mA.
To protect the driving-transistor from spikes when the relay is turned off, you will need a diode across the coil.
The top animation shows a "single set of change-over contacts."
The lower animation shows the ARMATURE being drawn to the electromagnet. The electromagnet is the coil with a core of magnetic material that becomes a magnet (an electromagnet) when a current flows through the coil.

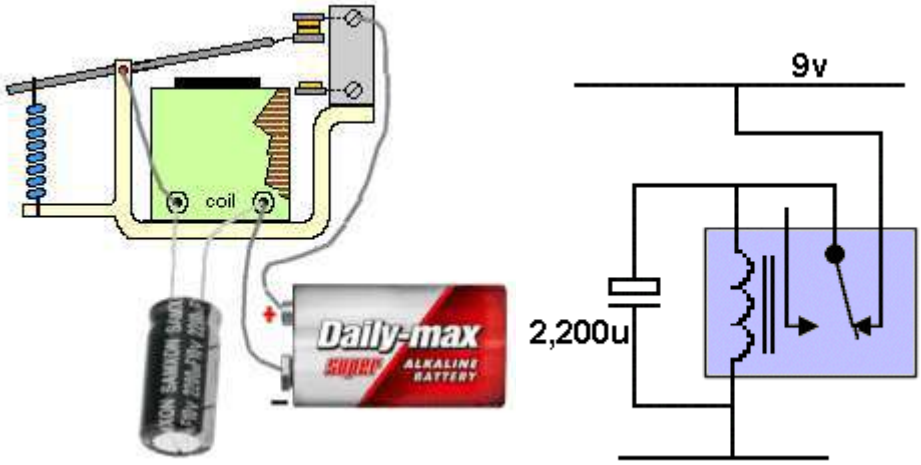

When the circuit is turned ON, the voltage across the 2,200u electrolytic is zero and it gradually charges. When the voltage is about 8v, the coil has enough voltage across it to pull the armature and open the contacts. The electrolytic supplies voltage to the coil for about 1 second and then the electromagnet does not have sufficient magnetism to hold the armature and it returns to close the contacts.

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GATES

Animations of **GATES** and more details of their operation is covered in **DIGITAL ELECTRONICS** chapter.

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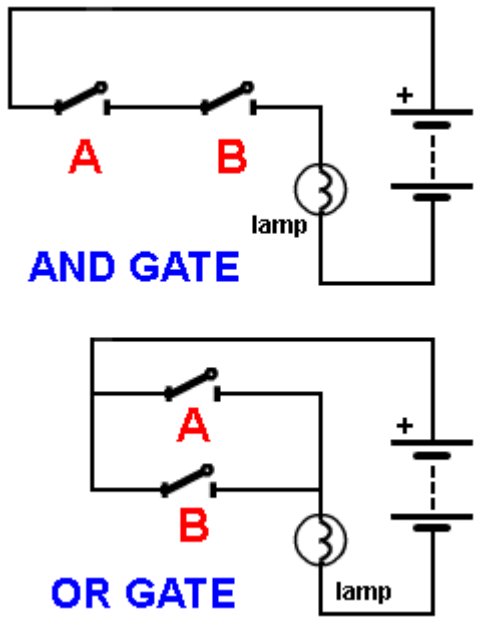

Fig 80. The "AND" GATE and "OR" GATE with switches

The next **BUILDING BLOCK** we will cover is called the **GATE**.
In its simplest form it is an electrical circuit consisting of switches.
Its just two or more switches connected in series or parallel.
We give each circuit a name so we can talk about it and explain its action with a single word.
Later we will cover the electronic version and show how diodes and a transistor are needed to perform a **GATING FUNCTION.**
The type of GATE we are talking about is a **LOGIC GATE**.
The circuit performs an operation called a **LOGICAL OPERATION** on an input or a number of inputs and creates a single output - called a **LOGICAL OUTPUT**.
LOGICAL means "understandable" or "correct" and in this case it means DIGITAL - the signal will rise to full rail voltage or fall to zero voltage. The output will not be half rail or quarter-rail voltage.
The diagram show an **"AND" GATE** and **"OR" GATE** with switches.
For the **AND GATE** close switch A **AND** switch B for the lamp to illuminate.
For the **OR GATE** close switch A **OR** switch B for the lamp to illuminate.

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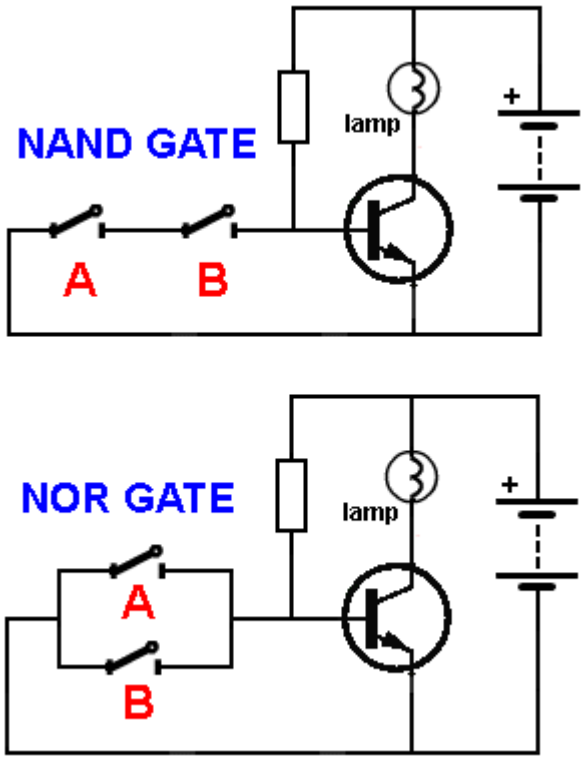

Fig 81. The "NAND" GATE and "NOR" GATE with switches and a transistor

INVERSION

Inversion produces the opposite effect to the results above.
Suppose we want to turn OFF a lamp when one or two switches are pressed.
We need a transistor.
The technical word for Inversion is **NOT**.
It is simplified to the letter "**N**."

For the **NAND GATE** close switch A **PLUS** switch B for the lamp to turn OFF.
For the **NOR GATE** close switch A **OR** switch B for the lamp to turn OFF.

These gates are only **demonstration-gates** to show how one or two switches will turn a lamp OFF.

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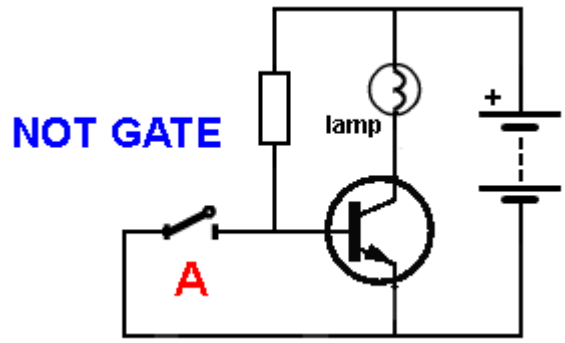

Fig 82. The "NOT" GATE

NOT GATE

A single switch and transistor produces a **NOT GATE.**
This is simply an **INVERSION**.

The resistor turns the transistor **ON** and the lamp illuminates. The switch removes the voltage on the base and the transistor turns **OFF**.
This is only a demonstration circuit to show how a switch can turn a lamp OFF.

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The 5 gates above form the basis to turning a circuit **ON** and **OFF**. We will discuss these gates later in the digital section.

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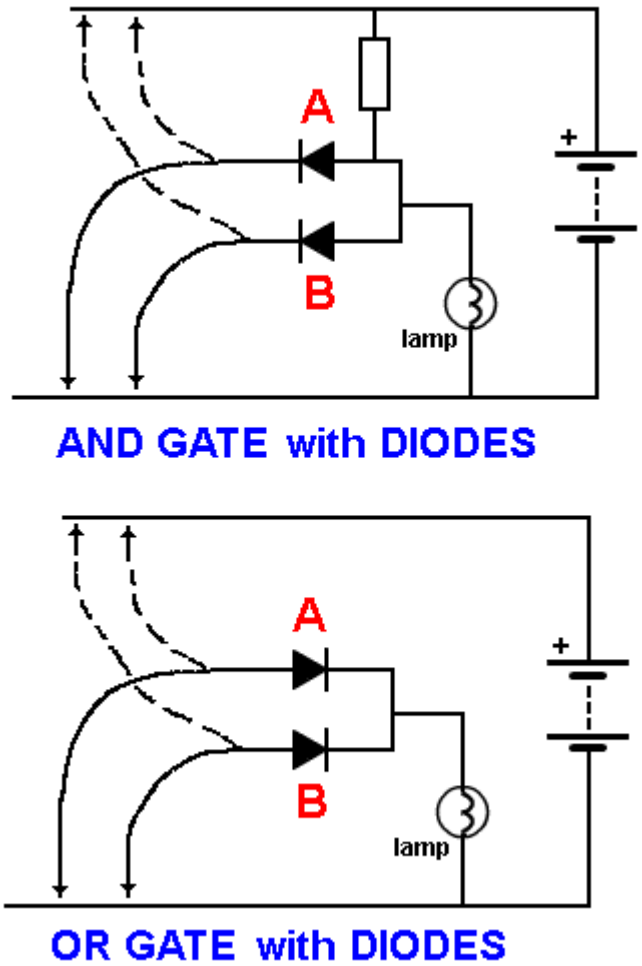

Fig 83. "AND and "OR" gate with diodes

The next building block is the **GATING DIODE**.
We have shown a diode allows current to flow when the diode is correctly placed in a circuit and blocks current when it is reversed.
The 5 gates above are electrical circuits but an electronic circuit works in a slightly different way.
The electronic circuit will be covered later in the DIGITAL section.
For the moment we will explain how a diode can be used to create a **GATE**.
In other words it creates a ONE-WAY PATH to allows signals to pass from one stage to another and prevents signals passing in the opposite direction.
In the AND GATE circuit, both inputs are LOW and current flows through the resistor (it will get HOT). When one input is taken HIGH, current still flows through the other diode and the lamp does not illuminate.
When BOTH inputs are HIGH, current flows through the resistor to illuminate the lamp. No current flows through the diodes.
In the OR GATE, when one input is taken HIGH, current flows through the diode to illuminate the lamp. This can be done with EITHER input.

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A **NAND** and **NOR** gate can be made with diodes and a transistor. This time we the output is either HIGH or LOW. We are gradually producing circuits that

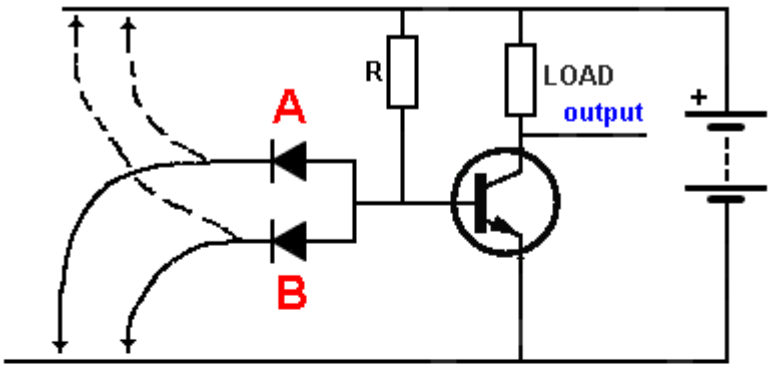

NAND GATE with DIODES and Transistor

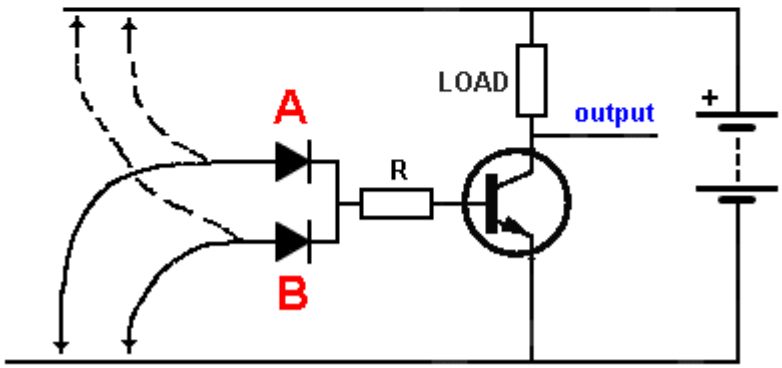

NOR GATE with DIODES and Transistor

Fig 84. "NAND" and "NOR" gate with diodes and a transistor.

are electronic, rather than electrical circuits.
In the **NAND GATE** circuit, taking one of the inputs HIGH will still allow the other input to prevent the transistor turning ON.
When BOTH inputs are HIGH, the transistor turns on via resistor R and the output is LOW.

In the **NOR GATE** circuit, taking one of the inputs HIGH will turn the transistor ON and the output will be LOW.

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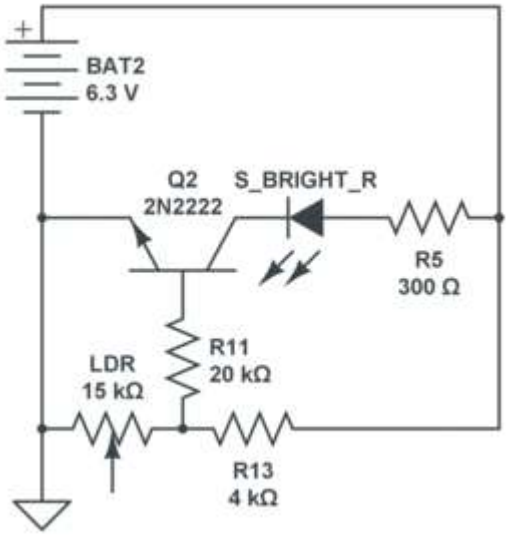

Drawing A Circuit

A circuit must be drawn according to simple rules so it can be instantly recognised.
An electronics engineer can "**see a circuit working**" when it is drawn correctly and can see if it is drawn correctly; if the parts-values are correct and can use the circuit to assist in diagnosing a problem with a faulty circuit.

The top circuit on is very difficult to visualise because it is not drawn in the normal way.
All the components have to be "**turned around in your mind**," to see what the circuit is doing.

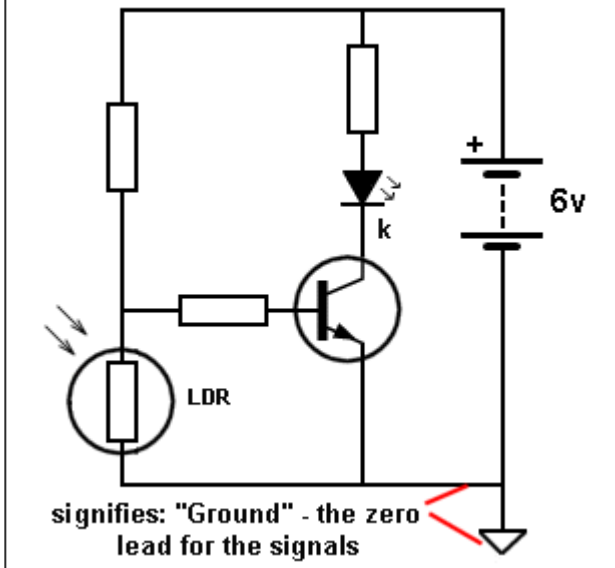

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QUICK QUIZ - to see how much you know

Answer the following 50 questions . . . JavaScript is required!
This test will see how much you have learnt.

Easy To Use, All in One, CRM.
1.5 Million Insightly CRM users worldwide.
insightly TRY FOR FREE
FLUKE CONNECT Capture equipment performance. FLUKE. Learn more
Easy To Use, All in One, CRM.
1.5 Million Insightly CRM users worldwide.
insightly TRY FOR FREE
2 Layers $10 ea
4 Layers $25 ea
Order Now
RUSHPCB
ISO 9001:2008, ITAR, IL LISTED
Locates in Silicon Valley, San Jose, CA

- [ ] An open circuit help

4. What is the approximate characteristic voltage that develops across a red LED?

- [ ] 1.7v
- [ ] 3.4v
- [ ] 0.6v
- [ ] 5v help

5. If two resistors are placed in series, is the final resistance:

- [ ] Higher
- [ ] Lower
- [ ] The same
- [ ] Cannot be determined help

6. Which is not a "common" value of resistance:

- [ ] 2k7
- [ ] 1M8
- [ ] 330R
- [ ] 4k4 help

7. Which value of resistance, placed across a 9v battery will get hot:

- [ ] 22k
- [ ] 22R
- [ ] 220k help

8. If the voltage on the base of a transistor increases, does it:

- [ ] Turn on
- [ ] Turn off
- [ ] Not enough information
- [ ] Remain the same help

9. The resistor identified in brown is called the:

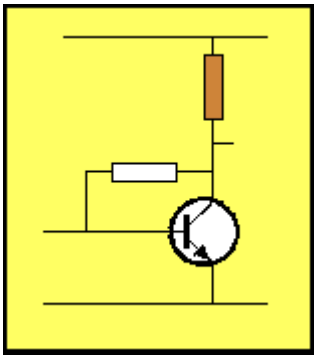

- [ ] Base Bias Resistor
- [ ] Load Resistor
- [ ] Emitter Feedback Resistor
- [ ] Bypass Resistor

help

10. The first three colour bands on a resistor are: yellow - purple - orange

- [ ] 47k
- [ ] 4k7
- [ ] 470k
- [ ] 4R7 help

11. A resistor with colour bands: red-red-red-gold, has the value:

- [ ] 22k 5%
- [ ] 2k2 5%
- [ ] 220R 5%
- [ ] 22R 5% help

12. The lead marked with the arrow is:

- [ ] The Collector
- [ ] The Base
- [ ] The Emitter
- [ ] The case **help**

13. A 10k resistor in parallel with 10k produces:

- [ ] 10k
- [ ] 5k
- [ ] 20k
- [ ] Cannot be determined **help**

14. The symbol is:

- [ ] NPN Transistor
- [ ] PNP Transistor
- [ ] Photo Transistor
- [ ] Field Effect Transistor **help**

15. Two 3v batteries are connected as shown.
The output voltage is:

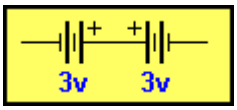

- [ ] 3v
- [ ] 0v
- [ ] 6v **help**

16. 4 resistors in ascending order are:

- [ ] 22R 270k 2k2 1M
- [ ] 4k7 10k 47R 330k
- [ ] 3R3 4R7 22R 5k6
- [ ] 100R 10k 1M 3k3 **help**

17. The closest value for this combination is:

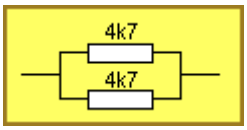

- [ ] 4k7
- [ ] 2k3
- [ ] 9k4 **help**

18. Which LED will illuminate:

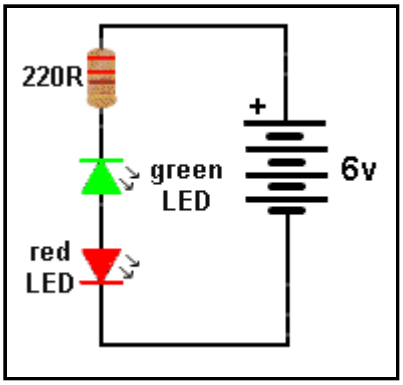

- [ ] Green
- [ ] Both
- [ ] RED
- [ ] None

19. The four symbols are:

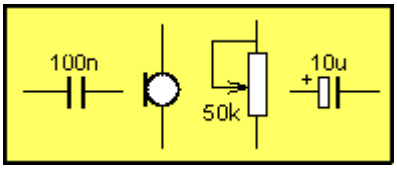

- [ ] Capacitor, Microphone, Potentiometer, Electrolytic
- [ ] Electrolytic, Microphone, Resistor, Capacitor
- [ ] Capacitor, Piezo, Resistor, Electrolytic
- [ ] Electrolytic, Coil, Resistor, Capacitor help

20. The closest value of the combination is:

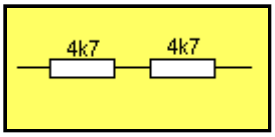

- [ ] 10k
- [ ] 2k3
- [ ] 2k5

21. Which motor will work:

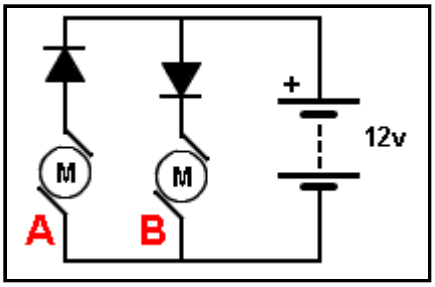

- [ ] A
- [ ] B
- [ ] A and B

22. A resistor and capacitor in series is called a:

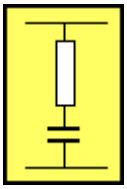

- [ ] Pulse Circuit
- [ ] Timing Circuit/Time Delay Circuit
- [ ] Oscillator Circuit/Frequency Circuit
- [ ] Schmitt Circuit help

23. A red-red-red-gold resistor in series with an orange-orange-orange-gold resistor produces:

- [ ] 5k5
- [ ] 35,200 ohms
- [ ] 55k
- [ ] None of the above help

24. Name the 4 components:

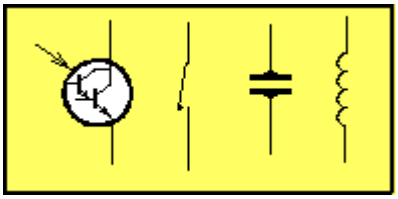

- [ ] Photo transistor, switch, capacitor, coil
- [ ] Transistor, mercury switch, piezo, inductor
- [ ] Photo transistor, reed switch, piezo, coil
- [ ] Photo Darlington transistor, switch, piezo, inductor help

25. To obtain a higher value of resistance, resistors are connected in:

- [ ] Reverse
- [ ] Forward

- [ ] Parallel
- [ ] Series help

26. Which LED will illuminate:

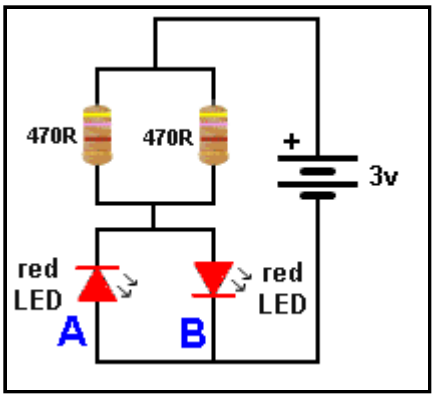

- [ ] A
- [ ] B
- [ ] Both
- [ ] None

27. Name the component that detects light:

- [ ] mini trim pot
- [ ] Light Dependent Resistor
- [ ] piezo
- [ ] speaker help

28. What is 1,000p?

- [ ] 0.01n
- [ ] 0.0001u
- [ ] 0.1n
- [ ] 1n help

29. The current in a circuit is 45mA. This is:

- [ ] 0.045Amp
- [ ] 0.00045A
- [ ] 0.0045A
- [ ] 0.45A help

30. A 100n capacitor can be expressed as:

- [ ] 0.1u u = microfarad
- [ ] 0.01u
- [ ] 0.001u
- [ ] none of the above help

31. 1mA is equal to:

- [ ] 0.001A
- [ ] 0.00001A
- [ ] 0.01A
- [ ] 0.1A help

32. 1,200mV is equal to:

- 12v
- 1.2v
- 0.12v
- 0.0012v help

33. The approximate current for a toy 3v motor is:

- 10mA
- 100mA to 300mA
- 1 amp

34. What is the resistance of this resistor:

- 47k
- 4k7
- 4R7

35. Identify the correctly connected LED:

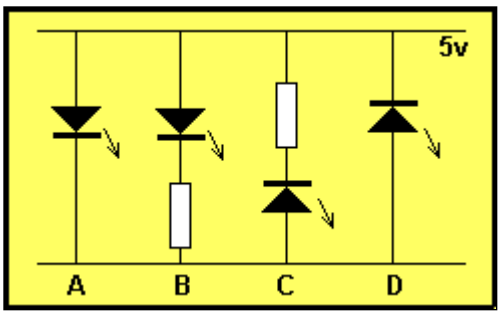

- A
- B
- C
- D help

36. Identify the correct statement:

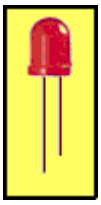

- The cathode lead is longer. It goes to the negative rail
- The cathode lead is shorter. It goes to the negative rail
- The cathode lead is shorter. It goes to the positive rail
- The cathode lead is longer. It goes to the positive rail help

37. The current requirement of a LED is:

- 1.7mA
- 25mA
- Between 3 and 35mA
- 65mA help

38. The multimeter is measuring . . .

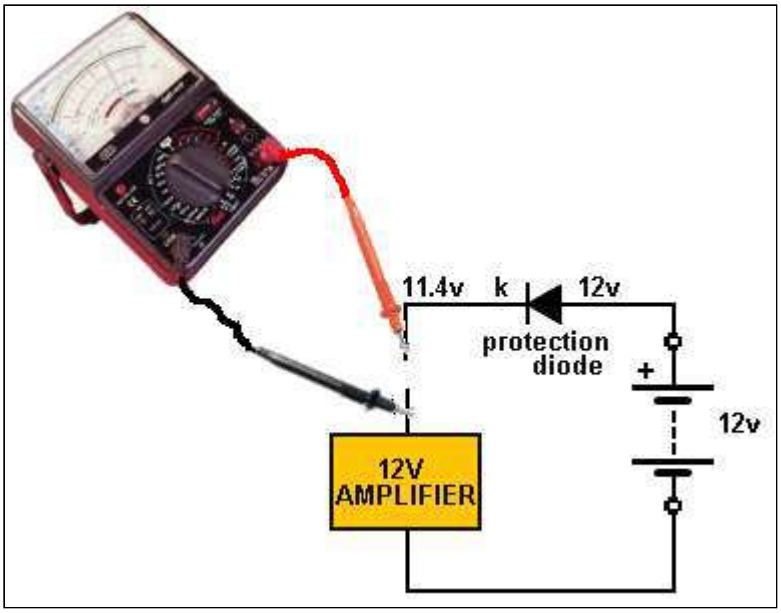

- [ ] Voltage
- [ ] Current
- [ ] Resistance

39. The purpose of the two capacitors:

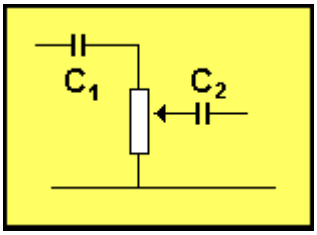

- [ ] To pass AC from the input to the output
- [ ] To allow the signal to oscillate
- [ ] To pass DC from the input to the output
- [ ] To amplify the signal help

40. The direction of conduction for a diode is:

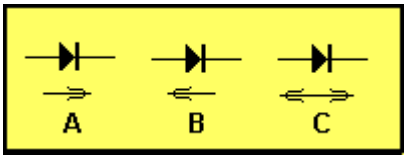

- [ ] A
- [ ] B
- [ ] C help

41. A DC voltage . . .

- [ ] rises and falls
- [ ] is a sinewave
- [ ] remains constant
- [ ] is an audio waveform help

42. Arrange these in ascending order: k, R, M (as applied to resistor values)

- [ ] R, k, M
- [ ] M, R, k
- [ ] k, M, R
- [ ] M, k, R help

43. A battery produces AC current:

- [ ] true
- [ ] false

44. The tolerance bands: gold, silver, represent:

- [ ] 5%, 10%
- [ ] 10%, 5% help

45. 223 on a capacitor represents:

- ☐ 0.022u u = microfarad
- ☐ 22n n = nanofarad
- ☐ 22,000p p = picofarad
- ☐ All of the above **help**

46. Arrange these in ascending order: n, p, u (as applied to capacitor values)

- ☐ p, u, n,
- ☐ n, u, p
- ☐ p, n, u **help**

47. What is the resistance of this resistor:

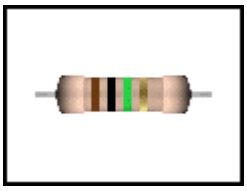

- ☐ 100k
- ☐ 1k
- ☐ 1M
- ☐ 100R

48. The number "104" on a capacitor indicates:

- ☐ 0.1u
- ☐ 100n
- ☐ 1n
- ☐ 10n **help**

49. What is the multimeter detecting:

- ☐ Voltage
- ☐ Current
- ☐ Resistance

50. For the LEDs, what is the characteristic voltage for the red and white LEDs:

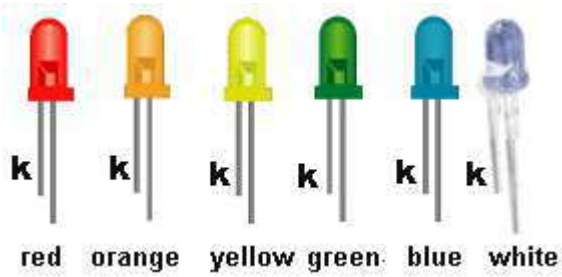

- ☐ 3.6v, 1.7v
- ☐ 2.4v, 3.3v
- ☐ 1.7v, 3.6v

- [ ] Cannot be determined

Final Assessment

THE CRYSTAL-SET RADIO

100 more Crystal Set plans

Everyone wants to make a RADIO.

The simplest radio is a **CRYSTAL SET**. (Sometimes called a **Crystal-Set Radio** or **Xtal Radio Set** or **Crystal Diode Radio**.)

However a **Crystal Set** needs a number of components that are very hard to get: (tuning capacitor with knob) and (crystal earpiece for $1.25).
The "air" TUNING CAPACITOR (20p to 415p) is not easily available and the postage is expensive. The germanium diode is a special component and the aerial coil wound on a ferrite slab is difficult to obtain.

But you don't need these components. They can be substituted.

There are hundreds of websites on the internet describing the **CRYSTAL SET** and if you want to build a "normal" set, you can Google these sites or **100 more Crystal Set plans**. Many of them sell kits too.

But this article is different.

We are going to have all the fun of making a **CRYSTAL SET** but with modern components and easy-to-make components and with an amplifier stage. The output is loud so you don't need a long antenna. And we are going to make our own TUNING CAPACITOR and a very simple aerial coil (called a FRAME AERIAL) as well as replacements for the germanium diode (use a TRF radio IC or a transistor) and in place of hi-impedance headphones (use a piezo diaphragm) and a crystal earpiece equivalent (a piezo diaphragm).
It's even better to have one of each type of component so you can compare the performance, so no matter how many parts your get, nothing will be wasted.

We are also going to explain the fundaments of how the circuit works as even the simplest circuit has a number of very important features that are used in many other circuits.

But first we are going to learn about the components and how they combine to make the circuit work.
When two or more components are connected together they sometimes produce a completely different result to the capabilities of either item.
This is the case with a capacitor and inductor in parallel. An inductor is simply a coil - turns of wire on a cardboard tube - called a former and the centre of the coil is AIR. It is called an air-cored coil or air-cored inductor.
Each component (the coil and capacitor) is called a PASSIVE DEVICE - in other words it does not amplify, but when the are connected together they create a result very near to amplification. And they also produce a result of picking up a huge number of signals and only allowing one signal to appear across the pair. A truly amazing result.

We start by placing a capacitor across the coil.
There is so much activity in the air, from radio, TV, taxi and mobile phone usage that the air is filled with electromagnetic radiation.
This radiation will cut the turns of the inductor (the coil) and produce a microscopic voltage in the turns. This is enough to start the two components passing energy back and forth at a rate

determined by their values. This is the basis of our first discussion.
These two components are called a TUNED CIRCUIT and make up our first building block called THE FRONT END.
.

THE FRONT END

This consists of a coil and capacitor. These two components are in PARALLEL and the signal (called the RADIO SIGNAL or RADIO WAVE) passes through the centre of the coil and produces a voltage in the turns of the coil. The electromagnetic wave has to pass through the centre of the coil.
This voltage is the result of a mass of signals that are interfering with each other and producing a signal called BACKGROUND NOISE.
The voltage can be increased by an external aerial (called an ANTENNA) and it consists of ALL THE LOCAL radio stations (and everything else).
The voltage is a mass of signals and is absolutely useless as it represents all the stations AT THE SAME TIME.
However, across the coil is a capacitor and these signals charge the capacitor with the very small voltage produced by the energy of the signals. When the capacitor is charged, it delivers its voltage to the coil. The coil accepts the energy and converts it to magnetic flux.
After a very short period of time the capacitor becomes discharged and the magnetic flux collapses and produces a voltage in the coil of the opposite polarity to charge the capacitor again in the opposite direction.
These two components keep oscillating back and forth, using the tiny amount of energy from the stations.
There is a natural frequency for the capacitor and coil to pass energy back and forth and one of the stations will provide energy to assist this natural frequency.
When this happens, the amplitude of the signal increases and the signals from all the other stations cancel themselves out and only one signal (waveform) remains.
This signal is called the NATURAL FREQUENCY OF RESONANCE and it corresponds exactly to one of the radio stations.

The end result is a waveform that is the exact same frequency as one of the radio stations and when voice or music is played, the amplitude of the waveform increases and decreases. This will be the signal you hear in the earpiece or speaker.
It is called an AMPLITUDE MODULATED signal and that is where we get **AM RADIO** from.

Understanding the concept of a CAPACITOR and INDUCTOR in parallel is very important. They form a TUNED CIRCUIT that has a natural RESONANT FREQUENCY.
Here is a very similar analogy. You have a heavy metal ball on a long string attached to the gutter on your house - just like a pendulum. You can push the ball very lightly with a finger and after a number of pushes you will be able to get the heavy ball swinging in a very large arc.
The only way to keep it swinging is to push it very lightly at exactly the right time. If you push it at the wrong time it will eventually stop swinging.
The parallel tuned circuit is exactly like the ball. It wants to oscillate at a particular frequency.
All the radio stations are pushing and pulling the circuit at the wrong times and nothing is happening. But one radio station pushes at exactly the right time and the circuit starts to oscillate.
All the other stations are fighting each other just like one person pushing the ball sideways and another pushing the ball from the opposite side. The results cancel each other and you are the only one assisting the swing.
The TUNED CIRCUIT can also be called a FILTER with a very narrow BAND-PASS frequency but our simple explanation describes the operation much more clearly.

There are a few other terms used to describe the components in the font end:

LOOP STICK ANTENNA -This is an alternate name given to the coil of wire wound on a ferrite rod or slab. It also has the name ROD ANTENNA or FERRITE ROD ANTENNA.
The winding can be enamelled wire or flexible wire called LITZ WIRE. This is very fine strands of enamelled wire twisted together and covered in cotton. The purpose of changing a thick wire to lots of very thin wires is to prevent the radio signals creating loops of signals within the wire and these signals will cancel each other and not produce a signal out the end of the wire.
In our experiments, we have not noticed any difference in a coil made with ordinary enamelled wire and Litz wire.

Here is a set of components to make your own Crystal set from **Scott's Electronic Parts**:
You can see the rod antenna, germanium diode, crystal earpiece, capacitor and resistor. The kit costs about $9.00 plus postage and includes knob, clips and screws but no board to mount the parts.

Here is the circuit for a Crystal Set:

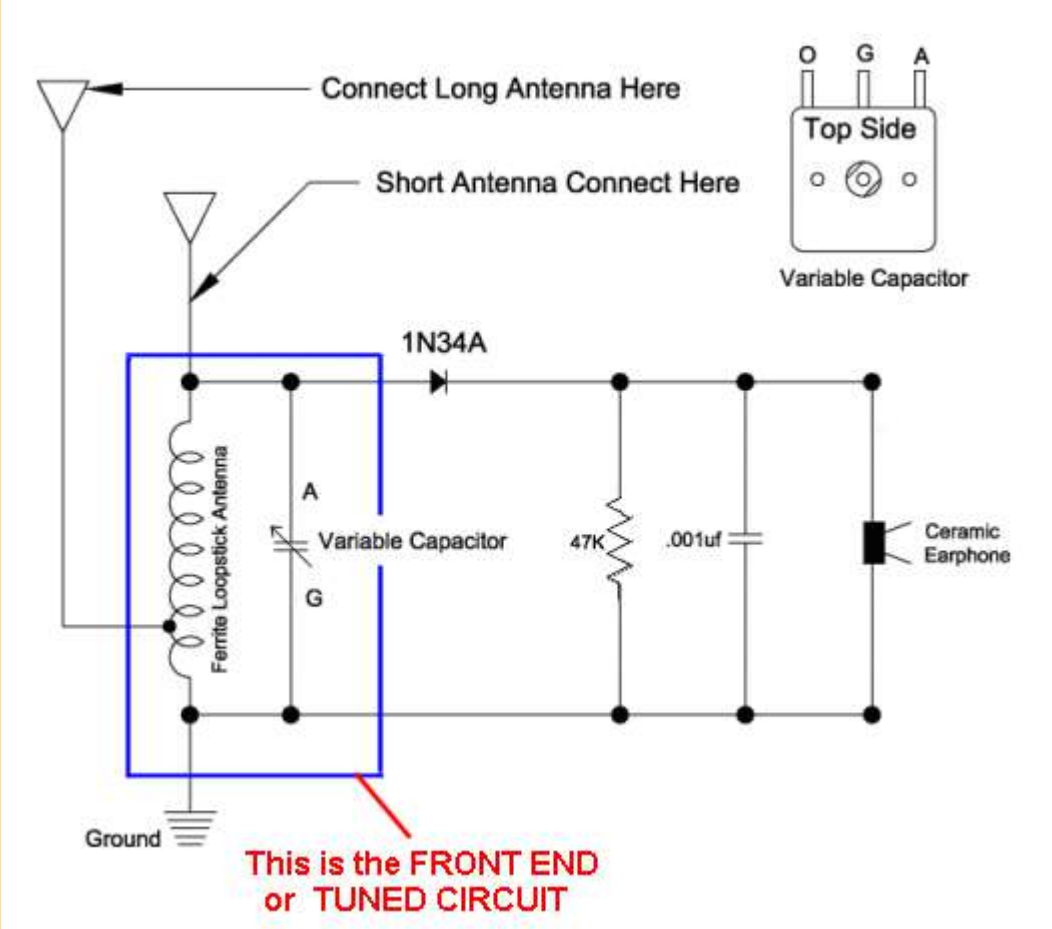

Here are the components mounted on a board called BREADBOARD:

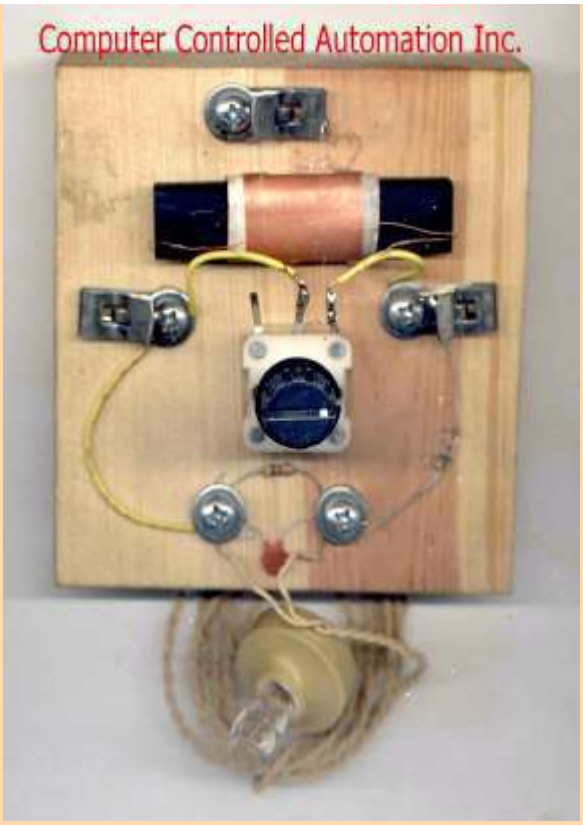

The top clip connects to a long antenna. The left clip connects to ground and the right clip connects to a short antenna.

Let me clear up a point. You do not need a ferrite rod antenna for the coil. You can use an ordinary coil wound on a cardboard tube and it will work just as well if you are using an outside antenna.
Here is the circuit using a home-made coil.

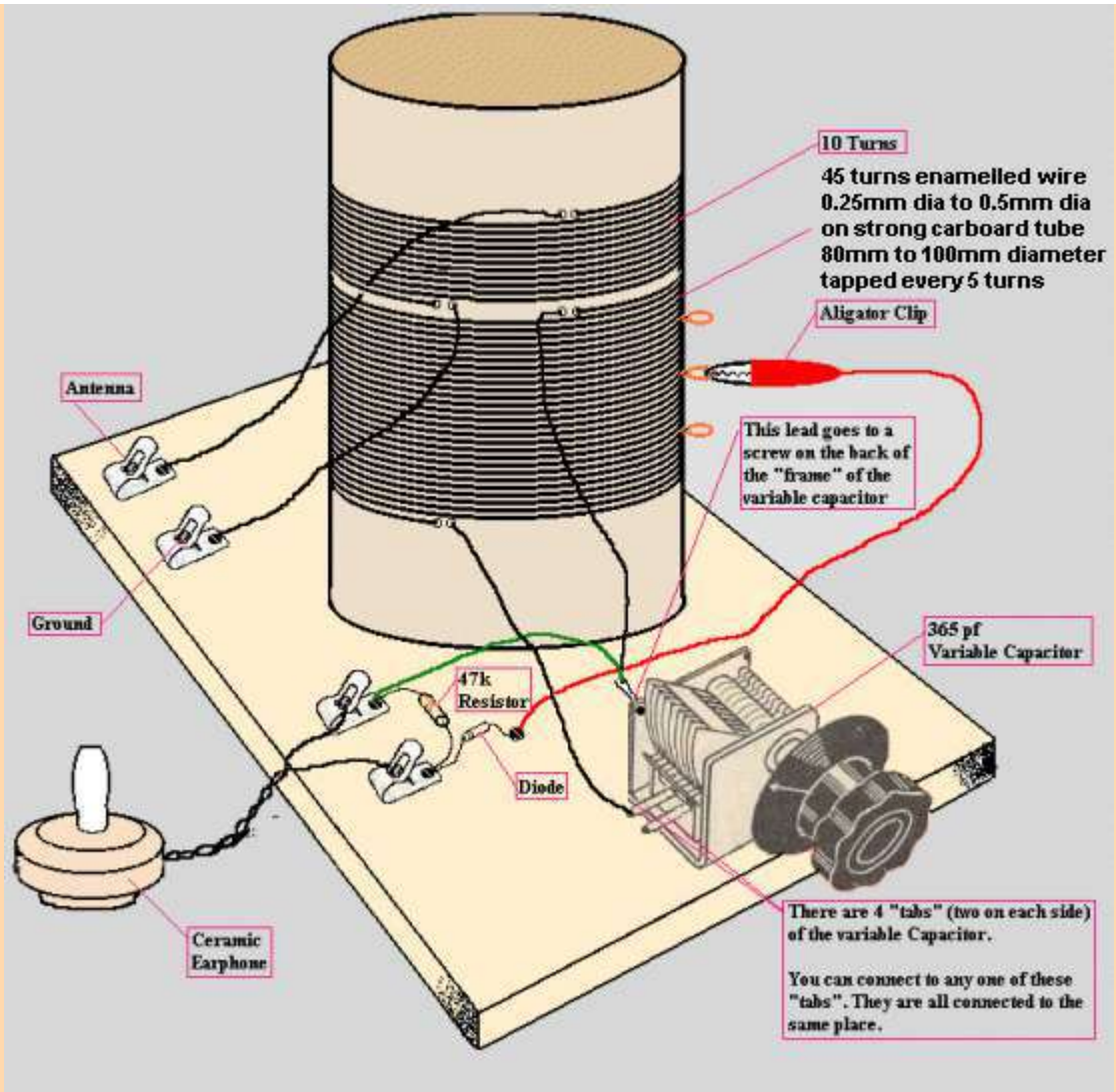

The tappings on the coil allow a wide band of radio stations to be tuned.
Each tapping allows a different portion of the band to be covered.

The next part to understand is this:
The coil and capacitor must not be LOADED. In other words, you cannot connect anything to this combination because the signal it is producing will be "taken away" or "removed" or "considerably reduced" by the item you are connecting to the circuit.
These two components are called a TUNED CIRCUIT and when they are not loaded they pick up all the radio stations, one station at a time, when the natural resonant frequency of the coil and capacitor exactly match the frequency of the radio station. The circuit actually "rejects" all the radio stations except one. Because all the other stations are trying to make the Tuned Circuit oscillate at a different frequency and it does not do this.
The result of the TUNED CIRCUIT oscillating under NO LOAD conditions produces a waveform that is very high and this gives the circuit GOOD SELECTIVITY. The circuit can select one station and reject nearby stations.
It also has good SENSITIVITY as it can pick up weak stations.
If you load the circuit, only the strongest signal will be detected and it will be spread across the full range of the tuning capacitor.
Obviously the theory is more-complex but we are explaining the end-result.
Theory talks about the "Q" value of the coil and this is its ability to produce a very good output when the magnetic flux collapses and the "Q" value increases when the circuit is not loaded. .
Although these voltages are very small (in the order of microvolts or millivolts) the result is very important as the rest of the circuit will be amplifying this waveform a few thousand times.
As we explained above, pushing the weight on a string only needs a push of 1 cm and eventually the weight will swing 1 metre. This is a gain of 100:1 The same thing happens with the tuned circuit. The incoming radio signal is in the order of microvolts, but the coil and capacitor will produce a signal as high as 500 millivolts. This is an improvement or "gain" of more than 1,000 and is referred to as the "Q" of the circuit.
You will also notice the TUNED CIRCUIT is not connected to any supply voltage. It does not have

be connected. It generates its own waveform from the signals in the air.
It should not have any DC current flowing through it via the supply as this would put a load on the circuit and reduce its operation.

However we must "pick-off" the signal so it can be amplified.
This must be done with a very high impedance circuit.

THE CONVERTER (detector) - THE DIODE

The next part of the circuit is the CONVERTER. Commonly called the DETECTOR.
It converts the RADIO FREQUENCY signal to an AUDIO FREQUENCY signal.
This is the job of the DIODE.
The radio frequency signal is a very high frequency signal (say one million cycles per second) and it is sending a tone of one thousand cycles per second through the air-waves.
What is happening is this: The one megahertz signal has a certain amplitude and over a range of the first one-thousand cycles, the amplitude gradually decreases and then increases again. If you look at the tops of this 1,000 cycles you will see a waveform that corresponds to the one kilo-Hertz signal.
The 1MHz signal is picked up by the coil and capacitor in the front end and makes it oscillate.
The radio frequency signal is gradually getting larger over 500 cycles then smaller over the next 500 cycles and this increase and decrease represents the 1,000 cycles per second tone.
This is the waveform (the signal) that passes through the diode. This will be explained further in a moment.
The diode does not pass any signals less than 200mV as the first 200mV is lost in the junction of the diode. This means the signals start to appear on the other end of the diode when they are above 200mV.

This is how the diode works:
Across the crystal earpiece is a capacitor. The capacitor gets charged via the diode.
The diode is present to stop the capacitor getting discharged when the waveform is in the wrong direction. (by this we mean - when the waveform is lower or smaller in amplitude than the voltage on the capacitor).
And the waveform is in the wrong direction about 50% of the time. To charge the capacitor for one-half-cycle requires 500 "little increments" in voltage with each increment adding a microscopic increase in voltage. We don't want this voltage to reduce when the waveform is reversing direction and the diode stops the voltage flowing back to the Tuned Circuit.
During the next half of the cycle when the pulses are getting smaller and smaller, the voltage on the capacitor is "bled off" by the load resistor.
The crystal earpiece detects this voltage. What we mean, is the diode allows the voltage to rise (increase) on the capacitor via lots of little "pulses" and the voltage increases in the form of a sinewave to a maximum amount. This voltage is passed to the crystal earpiece.
Once the voltage rises to a maximum, the little pulses of energy are not quite as strong, and the voltage on the capacitor reduces to form the second portion of the sinewave. This voltage is always being passed to the crystal earpiece and you can hear it as an audio signal.

GERMANIUM OR SILICON DIODE

The preferred type of diode for a Crystal Set is germanium. This is because it drops only about 0.3v.
But a silicon diode can be used, even though it drops about 0.7v, if the radio stations are very loud (close by).
You have to remember, you need a very good aerial (and a water-pipe earth) to get any results with a Crystal Set because you are asking the signal to provide the energy to drive the earpiece.
By simply adding a transistor, you are improving the performance 100 times and the long antenna can be reduced to a FRAME ANTENNA and the earth can be the metal frame of your soldering iron.

THE EARPIECE or EARPHONE
also The Magnetic Earpiece or CRYSTAL EARPIECE

The earphone or earpiece used in a Crystal Set must be a high impedance device because the crystal set does not produce a high current and cannot drive a low-impedance earpiece. That's why a CRYSTAL EARPIECE is ideal.
It has a crystal glued to the back of the earpiece and connected to its top surface is an aluminium diaphragm. When the crystal expands and contracts as a result of a voltage applied via two electrodes, the diaphragm moves and you can hear the signal. It exhibits a very high impedance

because it consists of a crystal and no coil of wire is contained inside the case.
If you do not have a Crystal Earpiece, you can make your own from the shell of an 8 ohm earpiece and a piezo diaphragm. Only the front part of the earpiece is used.

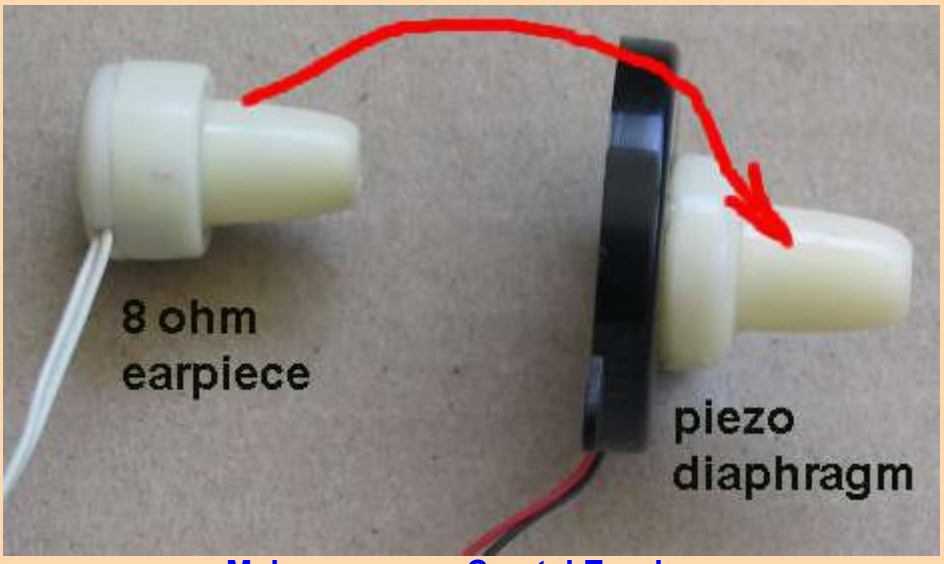

Make your own Crystal Earpiece

Hit the 8 ohm earpiece on the side and the front comes off. Glue the front onto a piezo diaphragm with hot-melt glue. See photo above.
The piezo diaphragm is a ceramic substrate that deflects in the presence of a voltage. It is quite sensitive and you can hear the audio quite clearly.
The waveform emerging from the diode in a Crystal Set is called AUDIO and although it has an amplitude of a few hundred millivolts, it does not have any current associated with it. The crystal earpiece and the piezo diaphragm react to this voltage.

THE 8ohm EARPIECE

The 8 ohm earpiece can be used with our 8ohm Buffer stage shown below.

16ohm 32 ohm and 64 ohm EARPIECE(s)

Earpieces and headsets from mobile phones are 16 ohm or 32 ohm per earpiece and are terminated via a stereo 2.5mm or 3.5mm plug. The earpieces are connected in SERIES to get the best coupling to our radio circuits and you need to find the two pins on a stereo socket to produce series connection. Get a multimeter and switch to "ohms." Try all the pins and you will get a click in the left ear then the right ear. Keep searching until you get a click in both earpieces at the same time. Use these two pins.

Stereo mobile phone headset - unusually 32R or 64R

PROBLEMS

The biggest problem with a Crystal Set is the need for a long antenna.
The first 200mV to 300mV of a signal is lost in the diode and you need a long antenna to pick up a signal so the output of the TUNED CIRCUIT has enough voltage to drive the high-impedance earpiece.
This requires an outside aerial 5 metres long and 3 metres high.
This is not practical for most hobbyists so we will be adding an amplifying stage to the crystal set so a shorter (smaller) aerial can be used.

THE FRAME AERIAL or FRAME ANTENNA or FRAME COIL

The aerial coil shown in the photo above is a ferrite slab with about 80 turns of Litz wire. You can find one of these in an old broken AM radio or from a parts-shop. In the instructions below we show how to make your own Ferrite Rod Antenna
An equally-good substitute is a frame antenna made by winding insulated wire in a rectangle around wooden sticks.

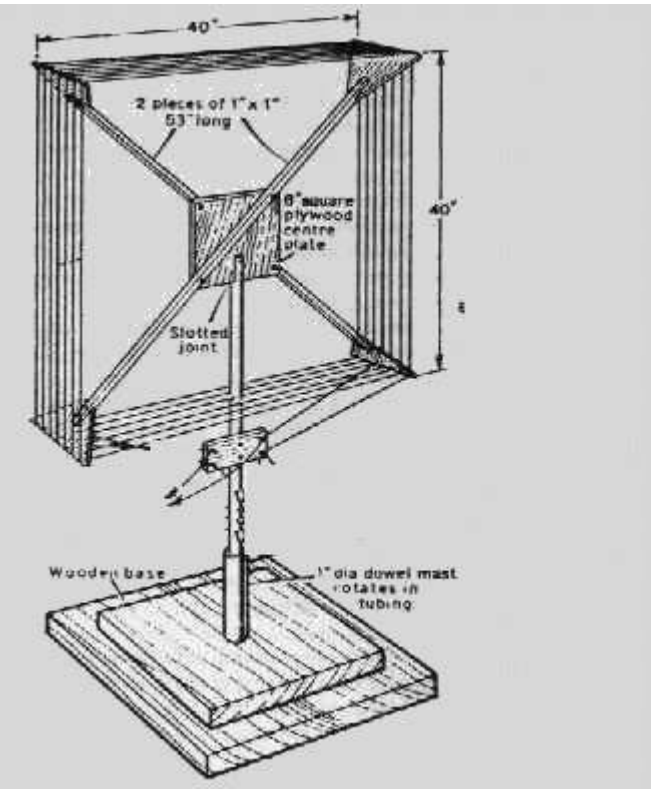

FRAME ANTENNA

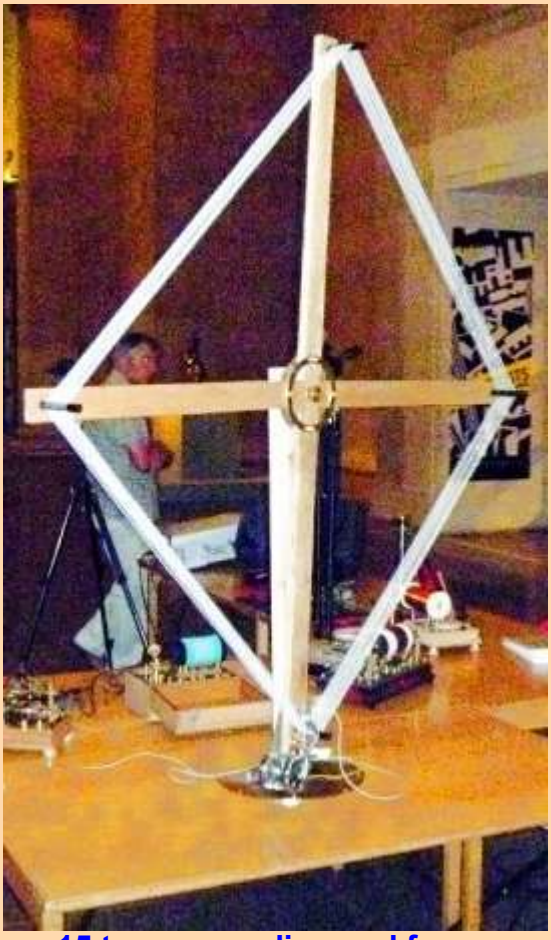

15 turns on a diamond frame

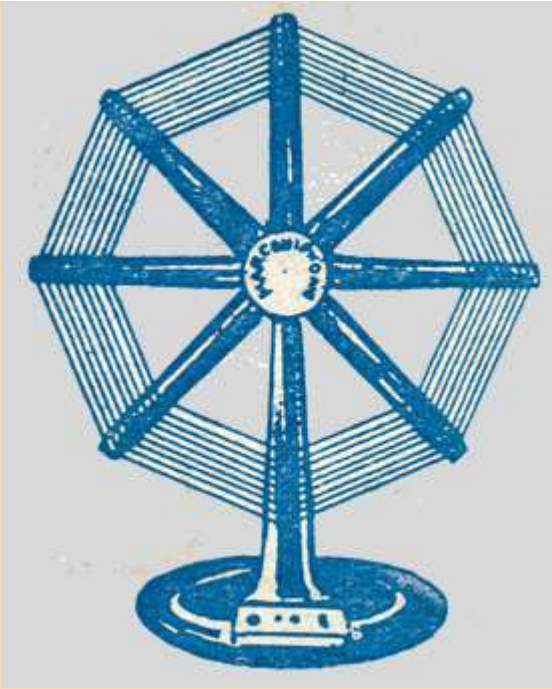

One of the earliest Frame Antennas

The Frame Aerial can be as large as 100cm x 100cm or as small as 10cm x 10cm around a plastic chocolate box.

Here are two FRAME ANTENNAS:

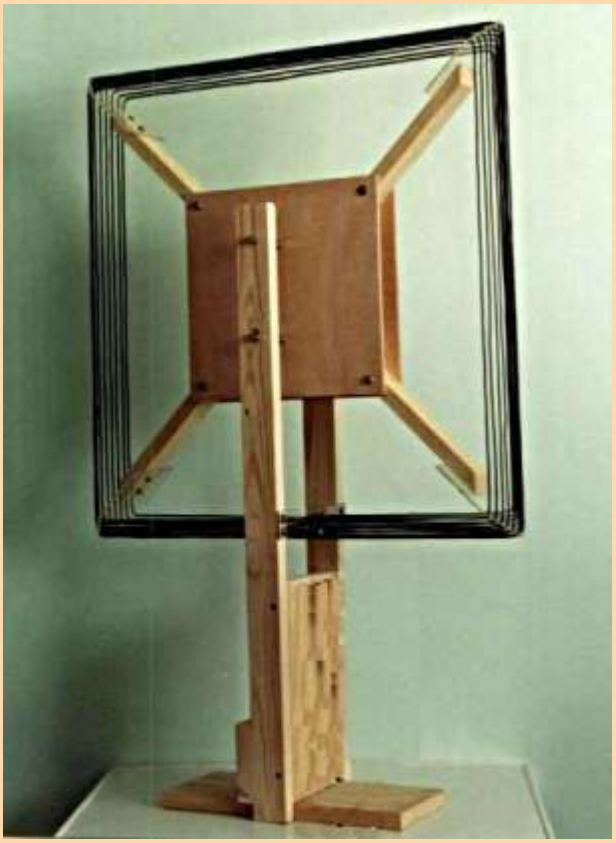

This will work just as good as a ferrite slab antenna. The slab antenna is just 100 times smaller. The slab antenna was invented so a transistor radio could be built in a small case. But if it is not available, you can wind 20 turns around a plastic chocolate box and it will work just as good.

Alternately you can wind 20 turns around a biscuit tin. Put a pencil on the tin and wind the turns over the pencil too. Remove the pencil and it will be easy to remove the turns. Use tape to keep

the turns together.

The FRAME AERIAL does two things. It picks up the radio waves and it becomes the coil (called the INDUCTOR) in the TUNED CIRCUIT. It must be placed away from metal objects, such as a refrigerator.

BASKET WEAVE COIL

There is no point making a complex BASKET WEAVE COIL as it will not work any better than simply jumble winding all the turns at the maximum circumference of the coil, because the energy capturing capability of the coil relies entirely on the amount of flux lines passing through the centre of the coil.
By increasing the centre of the coil, the amount of flux is increased for the same coil size.
In fact, the simplest and cheapest is to wind turns around a box, as explained later in this article, or make a frame antenna as shown above. Technically speaking, a round coil has the best performance but only by a few percent.

A BASKET WEAVE COIL

THE VARIABLE INDUCTANCE TUNING COIL

Whenever the size or shape of the coil is changed, (or the number of turns), the natural frequency of the Tuned Circuit will change and a different radio station will be picked up.
This means tuning across the band can be done by altering the characteristics of the coil while keeping the value of the capacitor fixed.
Changing the inductance can be done in many different ways.
The coil can have taps every 5 turns and an alligator clips selects the correct tap. But very few radio stations will correspond exactly to each tap.
Another way is to have a slider move up and down the turns as shown in the following image:

The slider makes contact where the insulation has been removed. But it may touch two turns at the same time and create a "shorted turn" and reduce the "Q" of the coil.

Another way is to move a ferrite bar (rod) in and out of the coil:

THE SLUG TUNED COIL

To tune across the radio band, the natural frequency of oscillation of the TUNED CIRCUIT must be adjusted (changed). This can be done by changing the value of the capacitor or the value of the inductor.

The value of the inductor can be changed by adding or removing turns or changing the amount of magnetic material in the centre of the coil.
A ferrite bar can be screwed in and out of the coil or slid in and out and this component is called a **SLUG TUNED COIL**.
The following diagram shows a **SLUG TUNED CRYSTAL SET**:

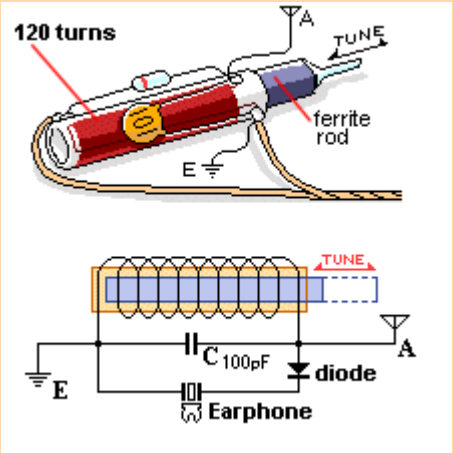

By changing the value of the 100p capacitor, different parts of the band can be picked up.

The photo shows a slug tuned coil using 60 turns of insulated wire on a 10mm tube (or any tube that will fit over a 8-10mm ferrite rod) and a circuit containing an AM radio chip plus a buffer driver transistor:

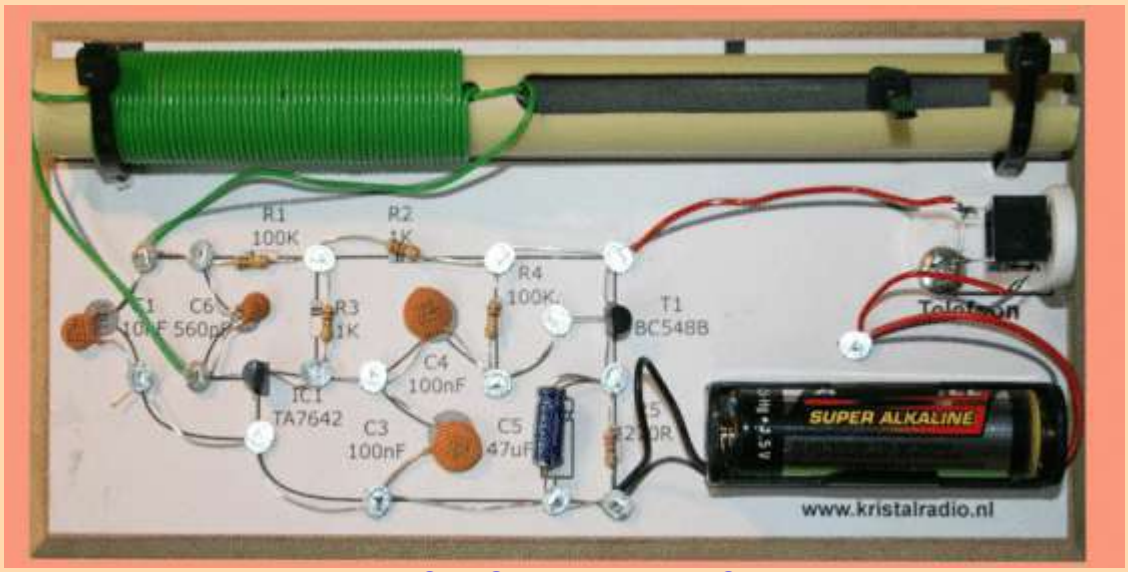

A SLUG-TUNED RADIO

The circuit above is has a broad-band amplifier consisting of 10 transistors (IC1) and they are directly coupled (connected) to each other because it is not possible to "manufacture" a capacitor inside the IC. The IC has 3 terminals (pins, legs) and it looks like an ordinary transistor. Experimenting with this type of IC has shown that it is no better than 2 ordinary transistors connected in a direct-coupling arrangement.

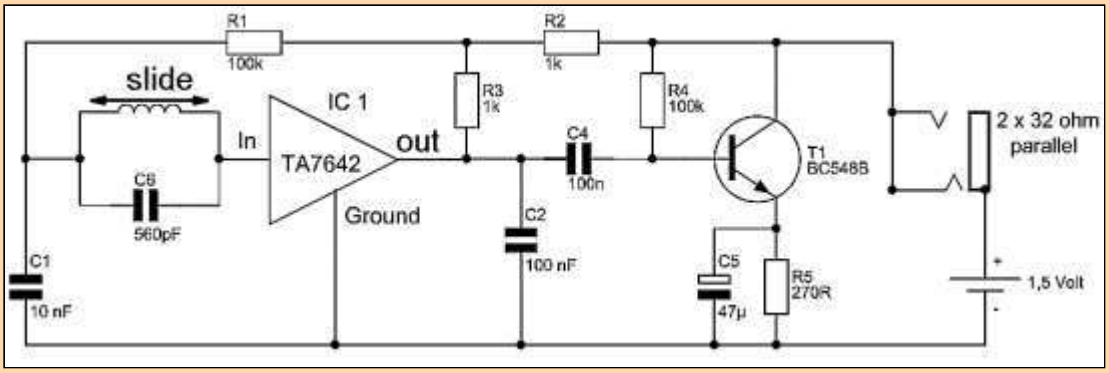

Here is the address of the site for the slug-tuned radio.
http://www.kristalradio.nl/
Unfortunately the site is in Dutch and the kit is not available. However the photos give a clear picture of the how the parts are connected.

The inductance of the coil can also be altered by winding another coil and placing it near the first coil so that the magnetic field interacts with each other and changes the inductance of the circuit. This is called a VARIABLE INDUCTANCE TUNING COIL.
You can have one coil inside the other, two coils near each other or two flat coils side-by-side. Any two coils will interact with each other.

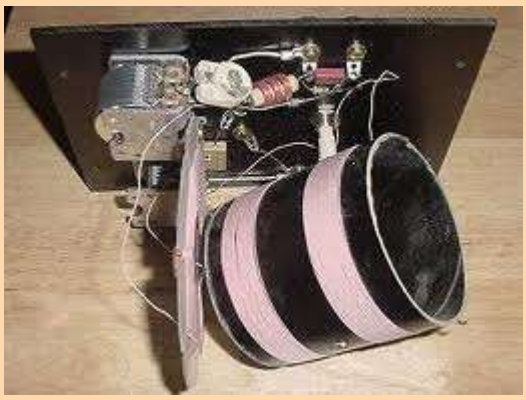

An Inductive TUNING COIL called a VARIOMETER

MAKING YOUR OWN FERRITE ROD ANTENNA

You can make your own FERRITE ROD ANTENNA by winding 60 to 80 turns of 0.25mm enamelled wire onto a 9mm ferrite rod or slab. If you wind it on a paper sleeve, you can move the coil along the rod to get the best performance. When the rod is slid out of the coil, the inductance changes considerably. However the inductance does change very slightly when the coil is moved along the rod.

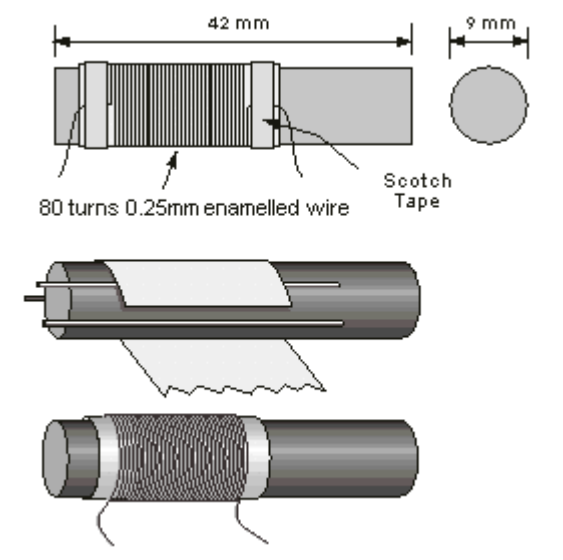

Make your own ferrite antenna

Now we come to the tuning capacitor::

THE TUNING CAPACITOR

The "C" in the "LC" TUNED CIRCUIT can be fixed or variable. When it is variable, it is called a TUNING CAPACITOR. The sheets of aluminium in the air tuning capacitor below are called PLATES and the moving plates are called VANES. The fixed plates make up the STATOR.
The space between the plates is AIR. The photo shows a single capacitor. If two capacitors are connected to the same shaft it is called a GANGED CAPACITOR.
The plates do not come fully out of mesh and that's why the capacitor has a minimum value. The maximum capacitance is when the plates are fully meshed. The odd shape of the plates is designed to produce a fairly constant increase in capacitance as the plates are engaged.

An air tuning capacitor:

Air Tuning Capacitor
(Variable Capacitor)

The capacitor can be made much smaller by using thinner vanes and placing plastic between the vanes. Plastic increases the capacitance about 3 times to 10 times.

Tuning Capacitor as found in a pocket radio

The tuning capacitor can be replaced with a home-made equivalent that will work just the same.
You need:
4 sheets of aluminium foil (cooking foil) 10cm x 10cm.
4 sheets of thin cardboard 15cm x 20cm (cut A4 sheets in half).

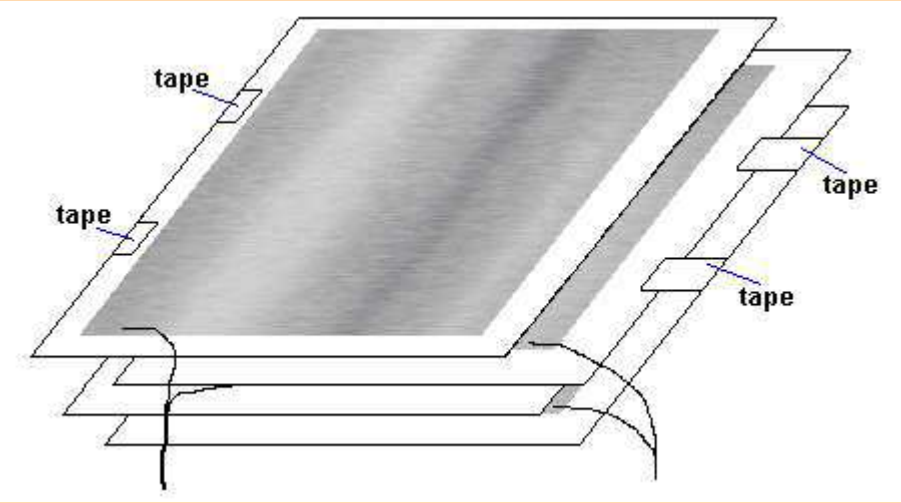

HOME-MADE CAPACITOR

Tape a sheet of aluminium foil to each sheet of cardboard with sticky-tape around all 4 sides. Take one strand of wire from a length of hook-up flex and sticky-tape the end to each sheet of aluminium to make good contact. Place 2 sheets on top of each other and move the top sheet slightly to the left and sticky-tape the edge so they don't move. Do this with the other two sheets but move the top sheet to the right. Now interleave the sets. Connect the wire from the first sheet to the third sheet. Connect the wire from the second sheet to the fourth sheet.
The cardboard (or paper) between the aluminium sheets increases the capacitance three times. The capacitance decreases when the sheets are moved apart and the capacitance increases when the sheets are moved in. The capacitance also INCREASES when the sheets are squashed together such as when a book is placed on them.
You can also make a smaller capacitor by making each sheet smaller and using 6 sheets. You can then add a 100p or 220p in parallel with the home-made capacitor, to select the lower part of the band.

EACH CIRCUIT

Each circuit we describe in the following set of circuits is an improvement or advancement on the previous. We also offer a number of different types of aerial coils, amplifying stages and earphones. Some of the circuits use easy-to-obtain components and home-made equivalents for hard-to-get items. There will be something in this section for everyone to build.

In all radio circuits you will encounter **TWO MAIN PROBLEMS**:

If the FRONT END (the Coil and Capacitor) is loaded too much by the "pick-off" of the amplifying stages, you will only get one station.
If you get squealing or "motor-boating," try a different circuit and layout as the components you are using, plus the voltage of the battery, will need changing.
You cannot always increase the voltage of the supply and get a louder output. Sometimes the increased voltage will stop the circuit working or it may introduce too much gain that the circuit starts to squeal.
The Radio IC (ZN414) DOES NOT WORK on a voltage above 1.5v and some of the transistor circuits completely stop working with a higher voltage. This has to do with the biasing arrangements and if the circuit is designed for a low voltage, you need to keep to the suggested voltage and experiment with a slight increase in voltage and see what happens.
Building a radio is not easy as the enormous amount of amplification of the combined stages creates a feedback loop via the power rail that sets the circuit into oscillation. This effect gets worse with a higher supply voltage and we will explain this further with each of the circuits.

MAKING A CRYSTAL SET

You can buy a **CRYSTAL SET** kit (see the photo of the kit, above) or the individual components (a kit is the cheapest) or use the replacement for the **FERRITE ANTENNA COIL** (16 turns to 20 turns on a 150mm biscuit tin) and/or the **TUNING CAPACITOR** made from aluminium foil and cardboard sheets.
You will need an outside antenna and an earth (such as a water tap or the frame of your soldering iron) to pick up the radio stations.
If you cannot put up an outside antenna, you will need to add one or more amplifying stages and this will allow you to reduce the length of the antenna and increase the volume of the audio.

ADDING AMPLIFYING STAGES TO A CRYSTAL SET

You can add two different types of amplifying stages to a crystal set.
You can connect amplifying stage(s) to the FRONT END and these will be designed to put less load on the front end so the sensitivity and selectivity increases. These stages work at the frequency of the radio signal and they are called RF STAGES (Radio Frequency Stages).
You can build these stages out of individual components or use a chip called a RADIO CHIP or RADIO IC (integrated circuit) for less than $2.00.
The chip contains 5 stages of amplification and these are RF stages (or RF AMPLIFYING STAGES) and the concept is called TRF. (Tuned Radio Frequency).
It is not easy to get this type of amplifier working because the stages produce a very high overall gain and you get a lot of "motor-boating" and squealing if the gain is not controlled. The gain must be reduced when a strong signal is being passed through the circuit because a strong signal will produce a large output and this will be so large that some of the waveform will find its way to the front of the amplifier via the power rail and start to be amplified again. To prevent the output getting too large, the circuit has a negative feedback line - called the AGC line - Automatic Gain Control.
It would be very difficult to reproduce these 5 stages of amplification with discreet components and that's why it is best to use an IC.

The next stage is a DIODE to convert the RF (Radio Frequency) to AF (Audio Frequency). This can be done with the diode-characteristics of a base-emitter junction in a transistor and we will show the alternatives.

Any stages after the diode are AUDIO STAGES or AUDIO AMPLIFIER STAGES.
The main job of the AUDIO AMPLIFIER is to increase the DRIVE CAPABILITY.
In other words, increase the current capability of the circuit for an 8 ohm speaker or 8ohm earpiece (or 16 or 32 ohm).
This is a very difficult thing to do and requires at least 2 stages.
The LOAD you can put on a Crystal Set must be 10,000 ohms or higher. (if you put a lower resistance (impedance) on the output, you will load the FRONT END and reduce its ability to separate the stations.
That's why a crystal earpiece is normally used with a crystal set. It puts almost NO LOAD on the circuit.
If you put a load on the circuit the result will be only one or two stations across the whole dial and only the most powerful station will be received.

If you don't have a crystal earpiece, you will have to use an 8 ohm earpiece. This will require an IMPEDANCE CONVERTING CIRCUIT of 1,250:1
This is a simple way of saying we want the 8 ohm earpiece to appear as 10,000 ohms to the

crystal set.
To produce an overall gain of 1250, we need two stages of amplification.
If a transistor has a gain of 70, it will it will produce an impedance conversion of 70 times. This is a realistic value. Transistors with a gain of 200 will have a gain of about 70 when fitted to a circuit. This means the other transistor needs to have a gain of about 20 and that is easy to achieve.

ADDING AMPLIFYING STAGES TO THE FRONT OF A CRYSTAL SET

Adding stages to the front of a crystal set are called RF STAGES (Radio Frequency Stages) because they amplify the RADIO STATION SIGNAL.
It does not matter if you amplify RF signals or AF signals. The result is the same.
The only difference is this: The frequency of RF signals is much higher (1,000 times higher) and the coupling capacitors can be much smaller.
This allows an RF amplifier to be built into an IC - called a Radio Chip.
One of the most popular Radio IC's is ZN414 or YS414. This chip has been copied by other manufacturers as: MK484, TA7642 and LMF501T.
All the chips are the same but the pinout is different.
These chips work on a 1.5v supply and if the voltage is increased above 1.5v, the gain of the stages increases to a point of total distortion.
To prevent strong signals producing distortion on 1.5v supply, the output is passed back to the input via a 150k resistor. This feedback line is called the AGC (Automatic Gain Control).
The chip contains 5 stages of amplification plus a stage that converts the RF signal to AF (Detector Stage). This means the signal diode in a Crystal Set is not needed.

Here is the circuit of the TA7642 Radio Chip. It performs the same as the ZN414 Radio Chip.

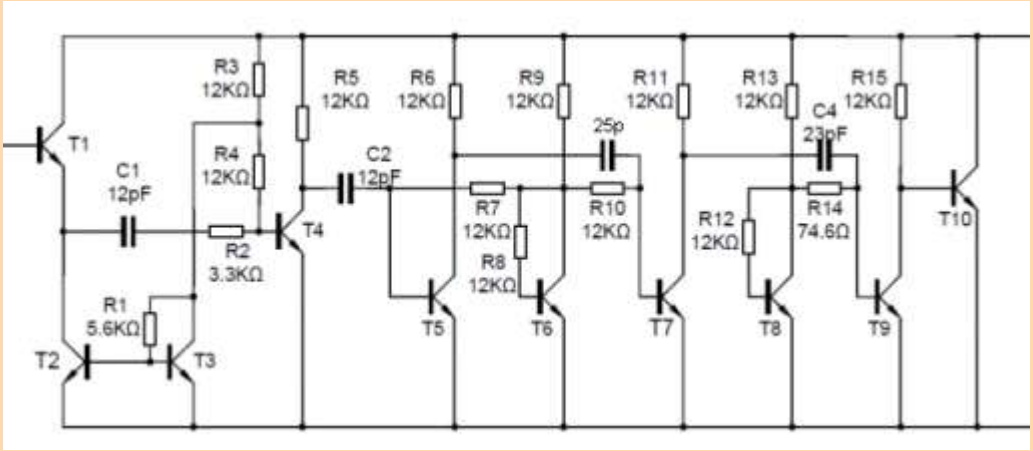

Here is the BLOCK DIAGRAM of the ZN414 Radio Chip:

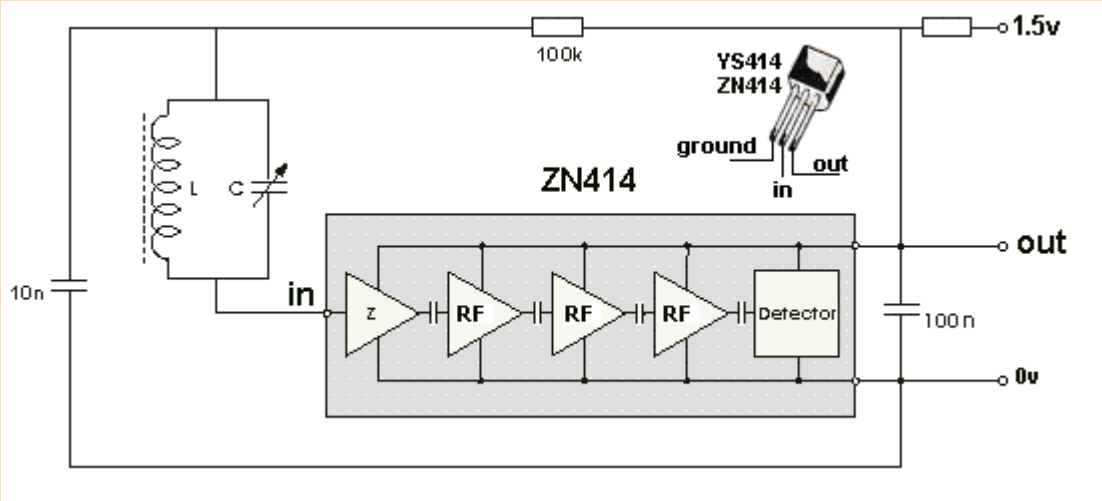

The ZN414 chip can be purchased from Talking Electronics for $1.00 plus postage

USING THE ZN414 RADIO IC

By using the ZN414 radio IC (or any if the equivalents) you can create a POCKET RADIO to drive a headphone or speaker.
But it is not easy to use the chip. The main problem is receiving the strong signals without producing distortion and then being able to pick up the weak stations.
A fixed 100k feedback resistor does not provide adequate control and a TRF radio has limited capabilities.
That's why radio manufacturers make SUPERHETRODYNE receivers. Even though they are more complex, the result is far superior.
However a simple TRF set can be made with the Radio IC and a few stages of audio amplification.

The following circuit uses just the Radio IC and a crystal earpiece or the home-made earpiece described above:
You can use a home-made FRAME ANTENNA or a home-made FERRITE ROD ANTENNA and a home-made VARIABLE CAPACITOR.

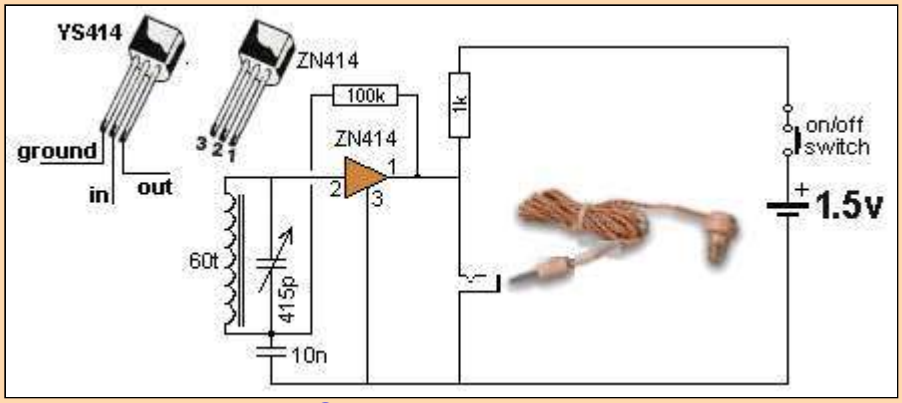

The Simplest ZN414 Radio

Connecting the ground (0v rail) to the frame of your soldering iron or a water tap will increase the output volume. The circuit above shows a Crystal Earpiece. Using a Crystal Earpiece may require adding a 10n across the earpiece to improve the output volume. The substitute Piezo Earpiece is effectively a 20n capacitor and an additional capacitor is not needed.

2 TRANSISTOR RADIO

Here is a simple 2-Transistor radio.
The secret to its performance is the 7 turn "pick-off" from the FRONT END (the TUNED CIRCUIT).
The ratio of 7 turns to 60 turns means a small percentage of the voltage generated in the tuned circuit is passed to the transistor. Thus it puts a small load on the TUNED CIRCUIT.
I don't want to go into any mathematics. The turns ratio is 60:7 = 8 but the effect of the 7 turns "pick-off" has an effect called the IMPEDANCE EFFECT and this is the SQUARE OF THE TURNS RATIO. Thus the IMPEDANCE EFFECT is 8 x 8 = 64. This means the "pick-off" (the LOADING EFFECT) is just a few percent. The front end can produce voltages as high as 500mV because a crystal set can produce a voltage high enough to pass through a diode (350mV) and have sufficient to drive a crystal earpiece.
Even though the front end has a "step-down" ratio, the voltage out the 7 turns will be sufficient to drive the first transistor.
The "transformer" does 2 things: It reduces the loading on the tuned circuit ENORMOUSLY and it produces an output with a higher current than is circuiting in the front end. Even though the transistor is turned ON and biased by the 33k, it is classified as a low-impedance load as far as the front end is concerned and the input signal has to be accompanied by a certain amount of current, otherwise the transistor will not respond to the voltage. The 7-turn "pick-off" is able to provide this current.
Both transistors are biased ON via the 33k base-bias resistors and thus the first transistor responds to the slightest millivolt signal.
This circuit was tested and had the same performance as the **Simplest ZN414 Radio Circuit** above. It can be operated on 1.5v to 6v and the strongest stations tend to overload on 6v. A short antenna is needed.

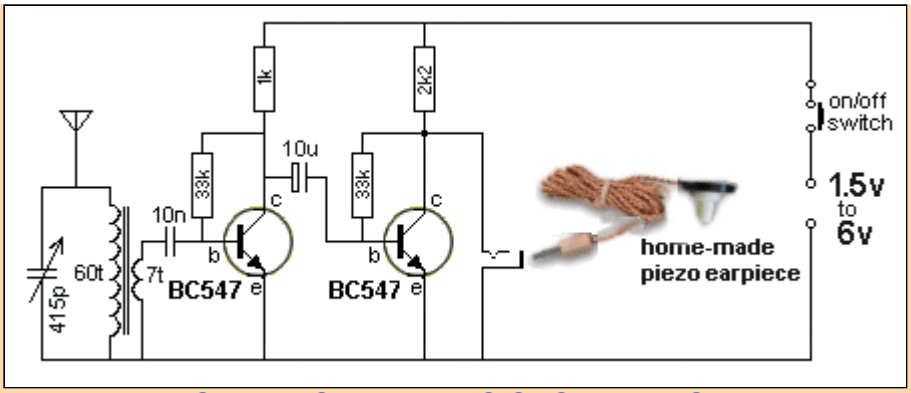

SIMPLEST 2-TRANSISTOR RADIO
using a very-high-impedance earpiece

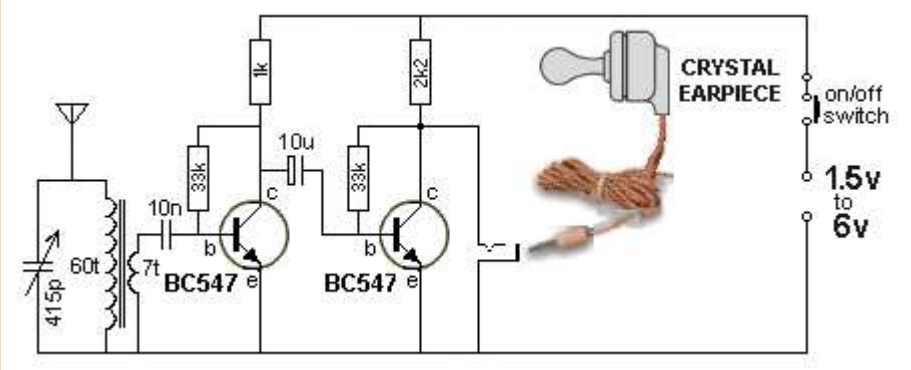

SIMPLEST 2-TRANSISTOR RADIO
using a crystal earpiece

ADDING AN IMPEDANCE MATCHING STAGE

You can add an IMPEDANCE MATCHING STAGE to the output of the circuit above so a low-impedance earpiece can be used.
We call it an IMPEDANCE MATCHING STAGE because this is the correct technical term. It is an AMPLIFYING stage but it amplifies the CURRENT because the second transistor cannot drive an 8 ohm LOAD. 8 ohms is a very low resistance and if it is connected directly to the second transistor, the output will be almost zero.
The reason for this is covered in our discussion: The Transistor Amplifier.
This stage will not increase the volume but simply match the 8 ohm load to the circuit above.
It is very difficult to connect a LOAD to this type of circuit because it will take more current from the battery and cause the supply voltage to fluctuate. These fluctuations will be passed to the first stage and cause variations in the signal. This will be amplified by the first and second transistors in the form of a low-frequency buzzing called **MOTOR-BOATING**.
The only way to reduce or remove this noise is to add an electrolytic across the power rails and reduce the supply voltage. The third transistor simply takes the waveform on the output of the second transistor and delivers it to the earphone with a higher current. It is called an IMPEDANCE MATCHING STAGE as it effectively increases the 8 ohm load by a factor of about 100.

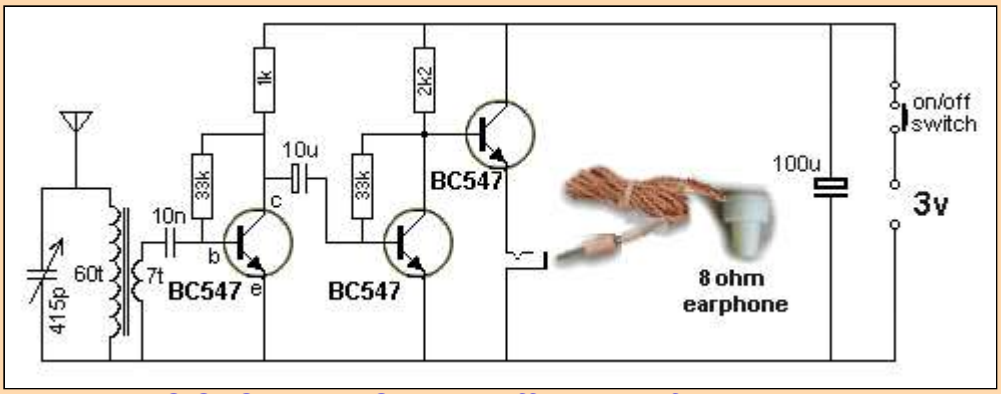

3-TRANSISTOR RADIO with buffer stage for 8 ohm earpiece

The 3rd transistor converts the 8R to about 800R

You can use 16 ohm, 32 ohm or 64 ohm in place of the 8R earpiece and these will give better performance as they will take less current and improve the stability of the circuit.
Low-impedance earphones create "motor-boating" due to the peaks of current and this can be very hard to fix.

A 2-TRANSISTOR RADIO with REGENERATION

The next stage in our discussion to get better performance is a feature called **REGENERATION**. Regeneration sends a small output signal back to a previous stage in the form of POSITIVE FEEDBACK to INCREASE the original signal. The signal on the emitter of the first transistor is the same amplitude as the signal entering the base but the FRAME ANTENNA has a turns ratio of 5:15 and this increases the signal on the receiving section of the antenna by up to 3 times. But we want the returning signal to be just above the amplitude of the receiving signal and so a resistive adjustment (attenuator) is provided on the emitter to deliver just the right amplitude.
This has the effect of increasing the amplitude on the TUNED CIRCUIT and is just like reducing the load on the circuit.
As we have mentioned above, when the tuned circuit is lightly loaded, it will pick up a station at the exact frequency of transmission and if the dial is changed slightly, the station will disappear. This quality is called SELECTIVITY.
At the same time, the Tuned Circuit will pick up weak stations and this is called SENSITIVITY.
The quality of a receiver depends on the loading of the TUNED CIRCUIT.

Here is the original circuit from Elektor Magazine with the prototype made on matrix board and fixed to a base-board with a frame antenna made from two sticks of wood. The photo shows a speaker but the output is so low that you really need headphones.

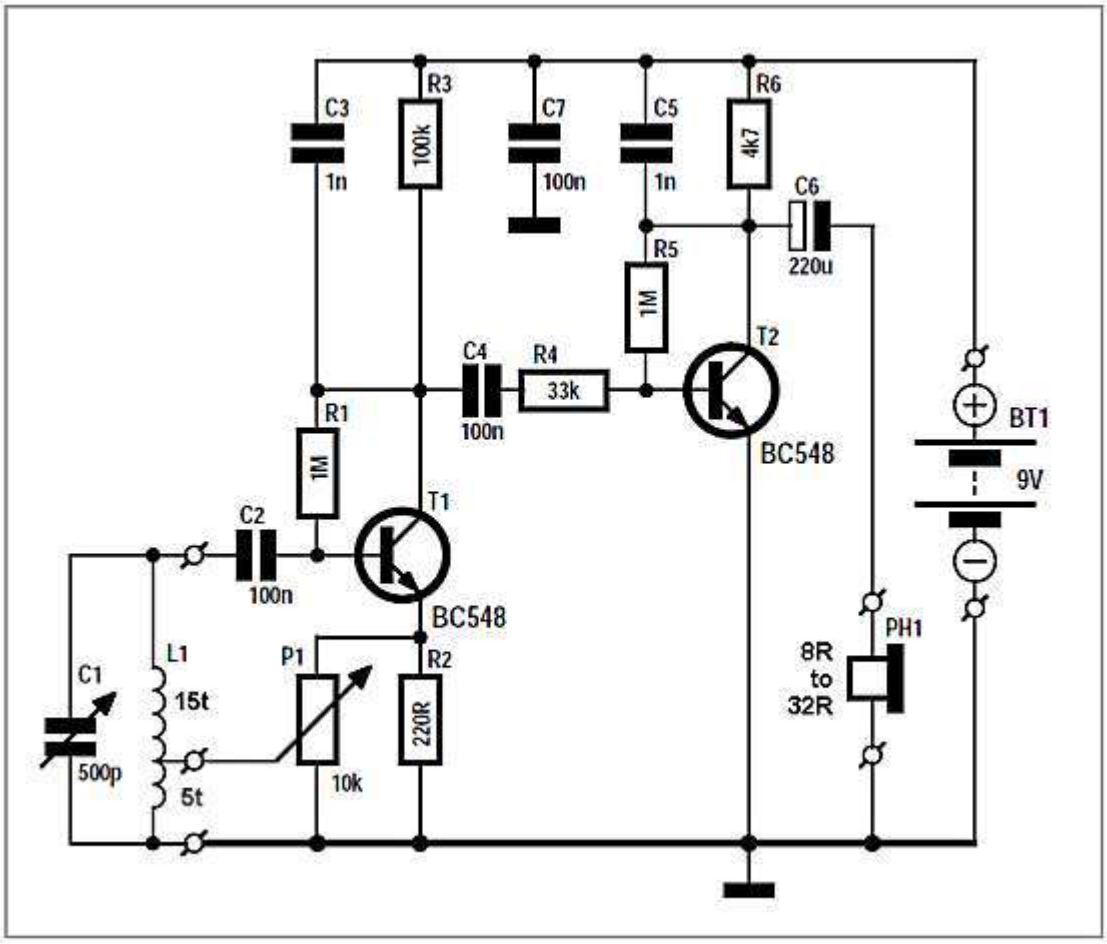

2 TRANSISTOR REGENERATIVE RADIO from Elektor Magazine

The circuit is very complex and the output will be very low as the circuit cannot drive a low-impedance earphone via a 4k7 load resistor. The 4k7 resistor is actually driving the speaker (the transistor is simply discharging the 220u). The 4k7 only allows 32/4700 x 9 = 61mV to appear across the earphone - a very poor result.
The skill of designing a transistor stage is covered in our comprehensive eBook: The Transistor Amplifier and you wont make a mistake like this !!!
The circuit above can be simplified and we can add the REGENERATIVE feature to our **Simplest 2-Transistor Radio** circuit:

Our circuit uses a 15 turn circular FRAME ANTENNA 15cm diameter and a 5 turn REGENERATION coil.

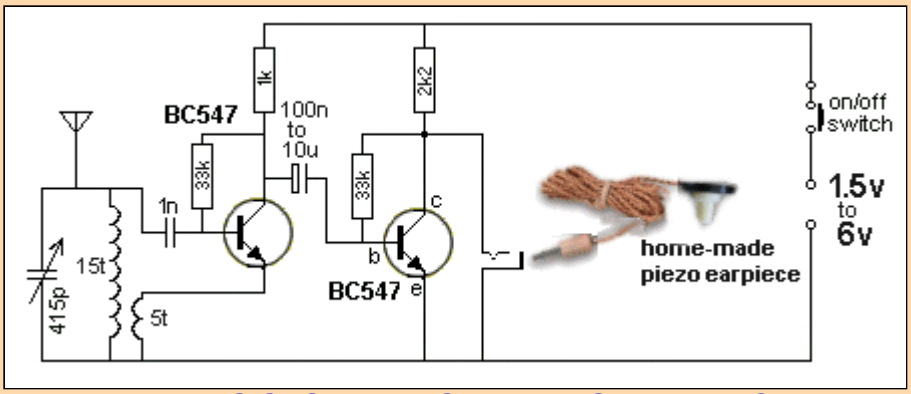

2 TRANSISTOR RADIO with REGENERATION

The regeneration coil is brought near the main coil and as it gets closer you can hear the audio get louder. If this does not happen, turn the coil around.
Early radios used this technique and the operator had to adjust the coil by hand. No-one minded because radio was a fascination and the simplest radio cost more than a weeks wages. To listen

to a broadcast through headphones was an amazement and listeners would sit all night with headphones listening to music.
This is very fiddly and by adding an extra buffer stage, we can use a Frame Antenna with a very clever "pick-off" that does not load the front end. This gives the circuit very good sensitivity and selectivity without regeneration.

3 TRANSISTOR RADIO

Here is our final design for the simplest self-contained 3-Transistor Radio using our home-made Tuning Capacitor and 250mm x 350mm Frame Antenna. It picks up the local stations and drives a low-impedance earphone or set of earphones (from a mobile phone).

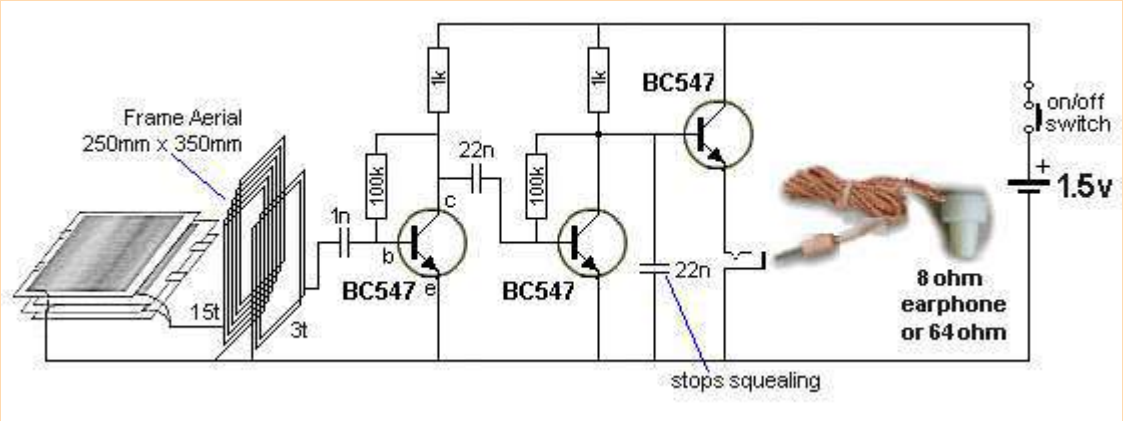

3-TRANSISTOR RADIO

The circuit performs very well and uses readily-available components. The 22n across the output is essential to stop squealing.
The secret to sensitivity and selectivity is the turns-ratio on the Frame Antenna. The 3-turn "pick-off" puts very little load on the front end and this allows the stations to be tuned with our home-made Tuning Capacitor.
The circuit contains all the features we have discussed above and only needs a 1.5v supply.
Build this circuit before you buy any expensive tuning capacitors, IC's or ferrite slab antennas as you will not get any better results.
This is called a TRF circuit and because the stages operate at Radio Frequency or Audio Frequency. Due to the high amount of amplification, the circuit can start to squeal (feedback, motorboat) due to the layout.
You may need to shorten or lengthen the leads or move the parts slightly - it's that critical.
However the result is a portable radio that needs no earth and will pick up the strong stations.
You can try connecting the 0v rail to the metal part of a soldering iron to increase the number of stations.

LOADING

The whole success of picking up a radio station is the RECEIVING CIRCUIT. The receiving circuit is the coil and the signal in the air (from the radio station) must go down the centre of the coil.
It cannot pass over the top or the bottom of the coil. Only the signal that goes down the centre of the coil is received.
As you can see, the centre of the coil is not very big and it is amazing that the signal can pass down the centre. But it does, and that is the only signal that will be amplified.
This signal is passed to the capacitor and we have explained how the signal is gradually increased and increased in amplitude until it is as large as 500mV. The signal from the radio station may be as small as a few millivolts, but as it keeps pushing the "swing" back and forth, the amplitude get larger and larger.
If you put your finger on the "swing" you will prevent it get larger and larger and it only requires the slightest touch of your finger to prevent the swing gaining full amplitude.
In electronic terms, your finger is called LOADING THE CIRCUIT and since we have to pass the signal to further stages of amplification, we need to "tap" or "load" or "pick-off" a signal.
The aim is to load the circuit as least as possible because the actual energy entering the circuit is very small.
In fact, this is all the energy we can remove as that is all the energy entering it.
Because a very small amount of energy is entering the "front-end" we classify it having a very

high impedance. It is very difficult to provide a value of impedance for this circuit because impedance has the term "Z" and the circuit is operating a very high frequency so resistance values are not the same as impedance values.
The actual resistance of the circuit is ONE OHM but the impedance is more like 10,000 ohms to 100,000 ohms.
We can explain its high impedance if we put a 100,000 ohm resistor across the circuit. The waveform will be reduced very slightly. If we put a 10,000 ohm resistor across the circuit, the signal will be reduced a reasonably large amount. If we put 1,000 ohms across the circuit it will stop working.
This means a load of 100,000 ohms will have the least effect.
In a crystal set, the diode creates NO LOAD until a voltage of 350mV is reached. It then passes excess voltage to a crystal earpiece that has a very high impedance. That's why a crystal set will produce a good output. The LOADING is very small.
When a transistor is connected to the TUNED CIRCUIT, it starts to put a load on the circuit after 600mV and this load is VERY HIGH. The "resistance" of the base-emitter junction is about 1k and the signal will find it very difficult to rise above 600mV because the incoming energy is not sufficient to increase the voltage.
Adding a capacitor between the base and the front end allows the transistor to be self-biased and get a turn-on voltage of about 600mV from a base-bias resistor.
The FRONT END is now separated from the transistor and ANY voltage it is producing will be passed to the transistor via the capacitor.
Whereas, with the crystal set, the first 350mV could be produced without any loading, the circuit is now loaded AT ALL TIMES.
This means we have to load the circuit as lightly as possible to be able to pick up individual stations.
The only way we can do this is to use a capacitor of the smallest practical value and this has to be worked out by trying different values. If the value is too small, the transistor will not detect a small signal. If the value is too large, the circuit will stop working.
Values such as 1n, 10n and 100n are suitable.
Values such as 1u, or 10u will be too large.
The CRYSTAL SET loading and a transistor load are completely different.
The transistor loads the front end ALL THE TIME and that's why you need to use a transformer or other ways to reduce the loading. Sometimes a Field Effect Transistor is used as it puts almost no load on the front end.

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Recreating an Alfred P. Morgan crystal set

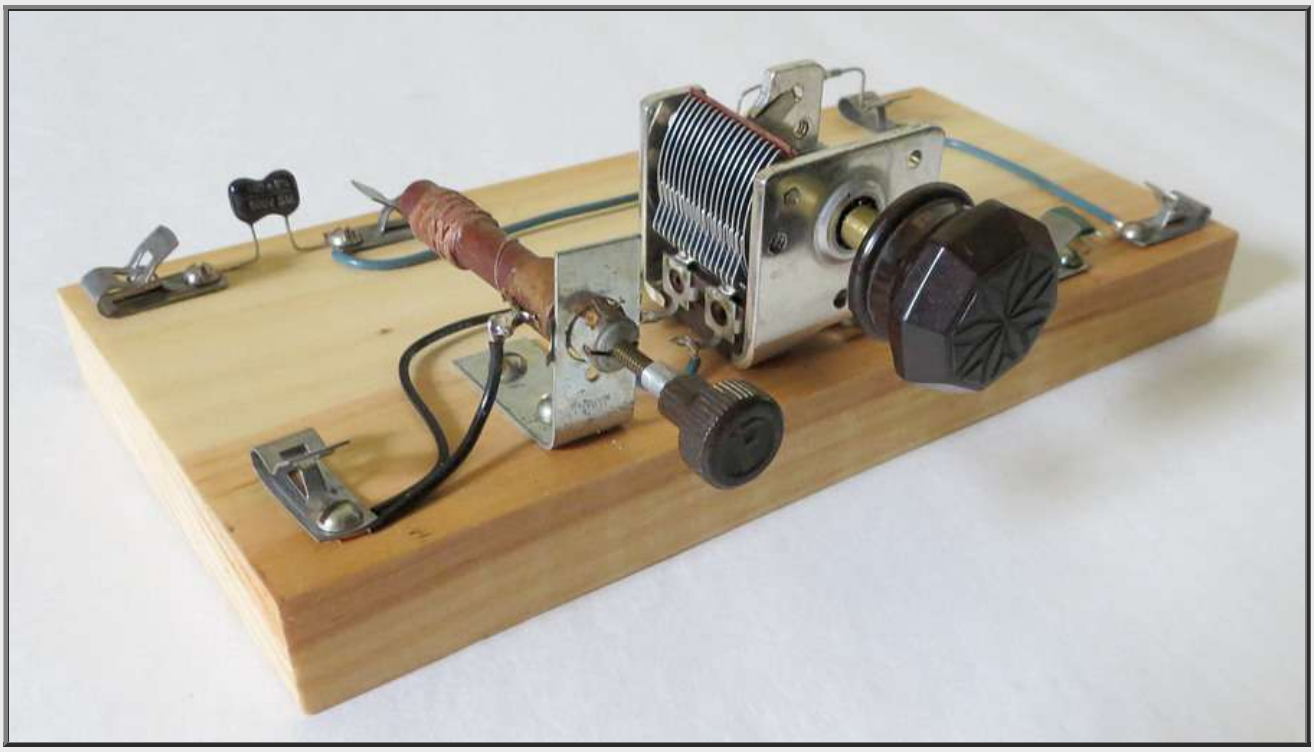

A recreation of my first (working) crystal set, originally built in 1966.

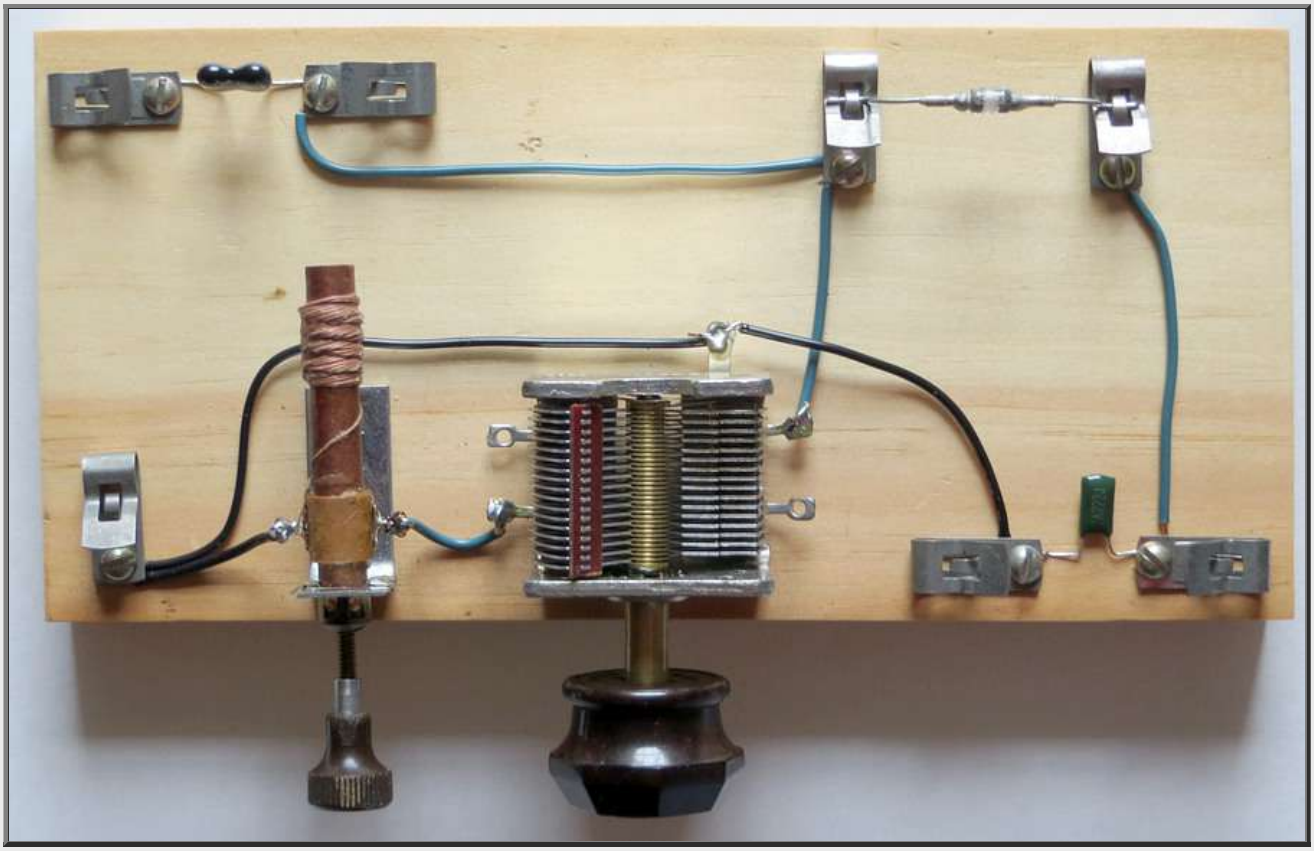

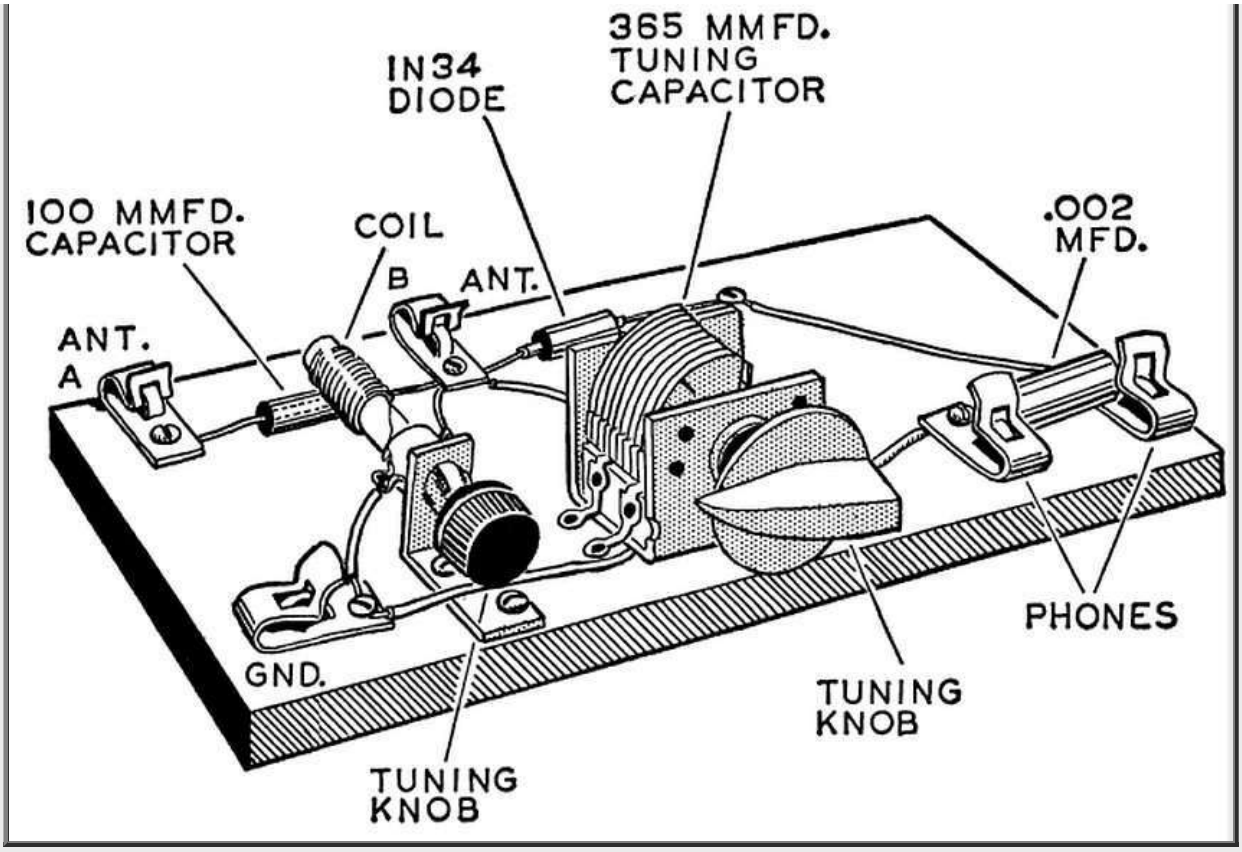

Page from "The Boys' Third Book of Radio and Electronics" by Alfred P. Morgan.

Back Story:

In the Summer of 1966 I was 10 1/2 years old and one of my favorite TV shows was "Get Smart". It was a show about a bumbling secret agent named Maxwell Smart who had all sorts of gadgets at his disposal. My friend Billy Meyers and I decided we wanted to be secret agents, like Max. One of the "secret agent" things we'd do was to pick out a guy with a briefcase walking home from work and declare him a Soviet spy. Then we would "tail" him for a few blocks, making up stories about him.

Billy and I had no way to communicate with each other after we had to come in for the night. He lived half a block away. Kids didn't use the phone back then. There was only one phone in the house and I don't remember using it before I was about 14 years old. Maxwell Smart had a phone in the sole of his shoe. We needed something like that!

Maxwell Smart (Don Adams) Agent 86.

Remco "Monkey Division" Wrist Radios.

One thing I DID have was a set of Monkey Division Wrist Radios. These were powered by a single C battery in the "Master" unit, which also had a button on it that would buzz the other receiver to get the users attention (apparently, the other user was unworthy of a button). A metallic speaker doubled as a microphone. The sound was very tinny, but you could make it out. Unfortunately, they were wired to each other. There was nothing "radio" about them.

I remember taking them outside with my brother Rob, and I could see and hear him talking at the same time his voice was coming over the wrist radio. They were pretty much useless, unless you like running around with a wire connecting you to your brother.

BUT... with some extra wire strung across the driveway, down the backs of the houses and into Billy's bedroom, Billy and I would be able to talk to each other! I immediately presented this great idea to my mom with a request the she fund the cost of the wire, and she immediately refused and told me the electric company would just come out and take the wire down.

Location of my house and Billy's house (actually his grandparent's house) The wire would have to be strung across the driveway. This is part of the West Oak Lane section of Philadelphia.

There was only one thing left to do. Build a radio. I went down the basement and connected a battery to a speaker and used a coat

hanger as an antenna. This was similar to the wrist radio, but the coat hanger antenna replaced the wire. It didn't work! All it did was make clicking sounds in the speaker. I had to wait for my dad to come home from work and ask him why.

When my dad came home I showed him the setup and he said, "You don't have a detector." I asked him what a detector was and he told me to go the library and get a book on radio. The next day I had a copy of "**The Boys' Second Book of Radio and Electronics**" by Alfred P. Morgan. Chapter 2, page 15 was titled "Building Your First Radio Receiver". I wouldn't be able to talk to Billy with it, but that was OK. My mom wouldn't buy me a secret agent coat, we didn't have any gadgets, and our secret agent days were coming to an end.

Now there was another problem. None of the parts needed to build anything in the book could be found around my dad's workbench. There was a store on Ogontz Avenue named REE Electronics, so I headed up there with a list of parts. The store sold stereo equipment and fortunately for me, also repaired stereo equipment. I asked the man in the store if he sold diodes or "capacitaters" and he sent me into the back of the place. There were two guys back there and bins of parts along the wall.

REE Electronics was located at 7709 - 7711 Ogontz Avenue in Philadelphia. The entire block has been razed and rebuilt, and is no longer recognizable. The picture above is the 7900 block of Ogontz Avenue. The store on the left is the only one that retains its original appearance, with the glass store window and the apartment overhead. This is how REE Electronics looked in 1966.

The two guys were pretty cool. I announced that I would like a "three hundred and sixty five micro micro farad variable capacitater". They asked me a couple of questions and told me to come back with the book. They had all the parts I needed except the coil. No problem, I would just build the set with no coil. I came home with Fahnestock clips, a 1N34 Germanium diode, a variable capacitor and a crystal earplug.

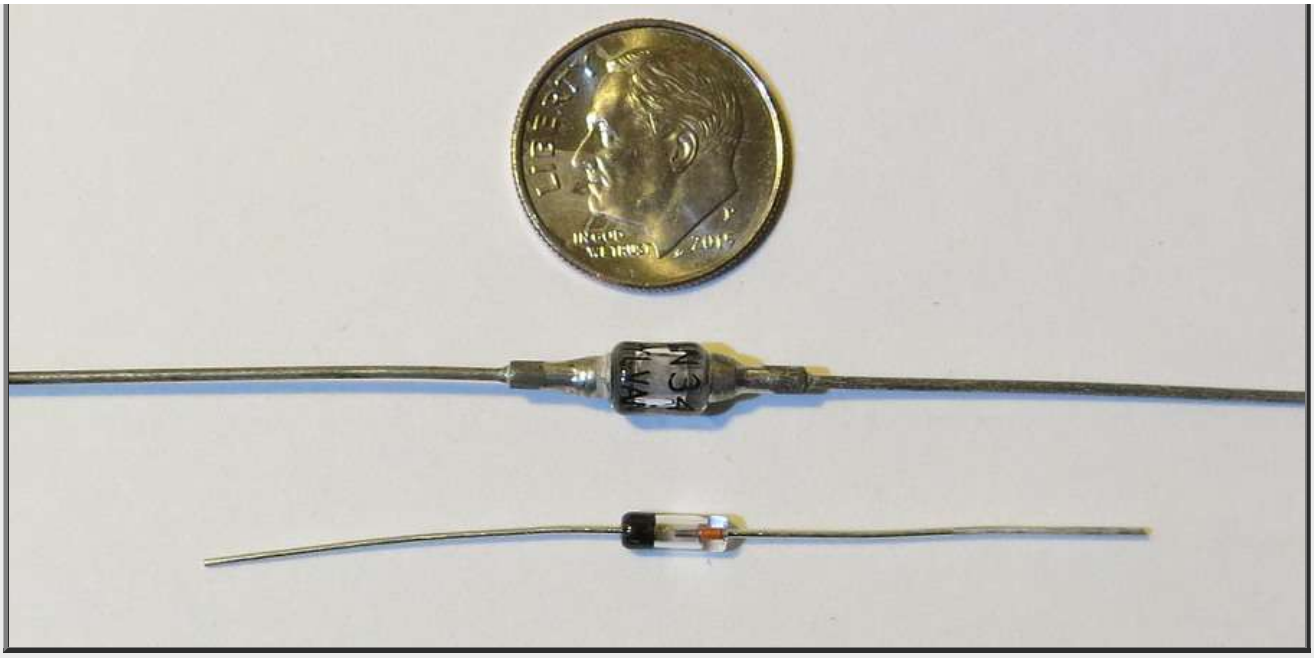

A Sylvania 1N34A Germanium diode (top) from 1949 and its modern counterpart. The new diodes are literally a dime a dozen, less than one cent each. The 1949 Sylvania diode cost me $9.00 in 2015. It is a duplicate of the one I bought at REE Electronics in 1966.

The diode was 65 cents in 1966. I can't use the $9.00 diode because I don't want to bend the leads, so I sort of just look at it.

Of course the radio didn't work without a coil. It did pick up the slightest whisper of KYW AM 1060 mingled with WIBG AM 990. There seemed to be some buzzing associated with it, as what I could hear sounded distorted. I HEARD something, that was the really, really neat part. It made such an impression on me that I remember the date. July 26, 1966.

The "problem" with the Alfred P. Morgan books was that they were not written for anybody as dumb as I was. Morgan didn't write, "If you can't find the coil you can make one." He just said to go buy a coil. Not only that, but there were no photographs in the book, though there were excellent drawings on almost every page. Since I had never seen some of the parts in real life, I didn't know exactly what the coil looked like, and I didn't understand what it did. That's because I didn't read the book! I was stuck on page 15.

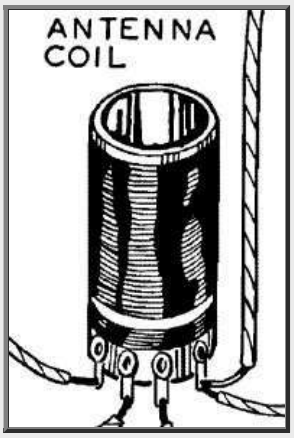

This is the picture of the coil from the book. I didn't know what I was looking at.

I returned the book to the library and came home with "**The Boys' Third Book of Radio and Electronics**." I found a simple radio on page 104 and soon headed back to REE Electronics. This time, they DID have the coil! I can't remember how much time passed after the first non-functioning radio was built. Probably a month or so.

I asked my dad to cut me a wooden base for the radio. I started building the radio and, if I remember correctly, it took me a long time. I didn't have a drill, so any holes in the base were made with the point of a compass. There were three connections that needed soldering. I got some solder from the basement, and the tweezers and alcohol lamp from my chemistry set. The tweezers were heated in the flame of the lamp till the tips began to glow, then I would quickly solder the joint.

One day a friend from school named Leo Pound stopped by on his bicycle. This was a bit unusual because Leo lived miles away. I don't even know how he knew where I lived. He recently told me (via Facebook) that he remembers helping me build the radio. Odd that it was the one and only time he came by. Apparently, we got the radio working that very day.

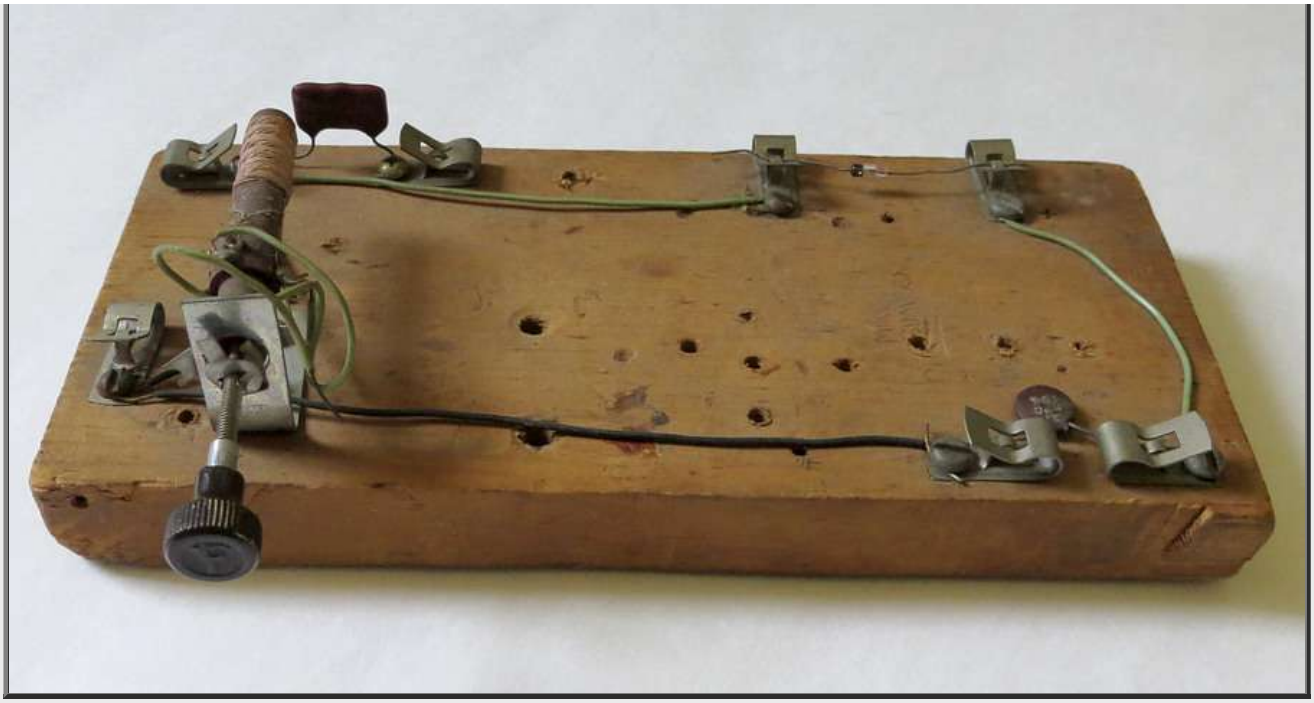

Here is the base of the radio made in 1966.

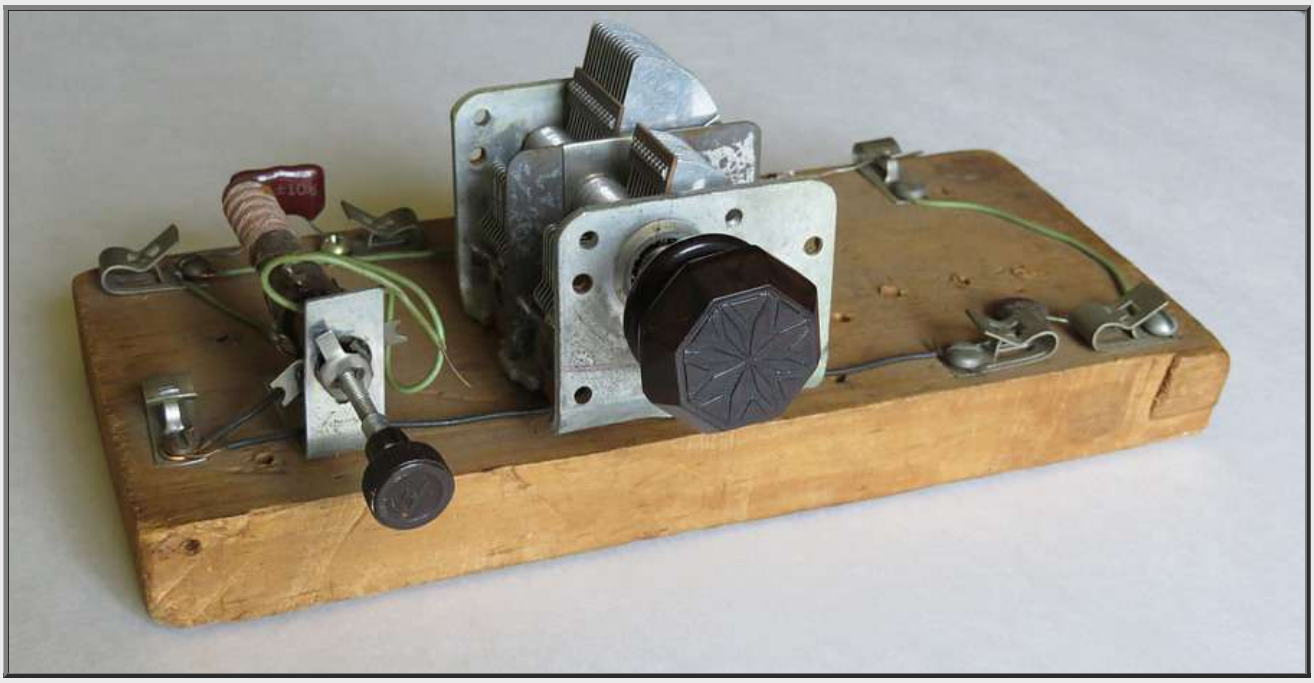

I found all the original parts except for the tuning capacitor. However, it looked like this one. It's just sitting on the base in this photo, but the radio pretty much looked exactly like this. My dad gave me the big tuning knob. The smaller knob came from a lamp in my bedroom. I didn't tell my mom you could no longer turn on the lamp, but eventually I found a lamp in somebody's trash and took the knob off to replace the one on my lamp.

Original coil, diode and main tuning knob from the 1966 radio. The wires on the coil were soldered with a pair of red hot tweezers.

My dad gave me the large knob for the tuning capacitor. He had a second job on the weekends at "John Cusimina's Moving and Storage." I've always wondered if he pulled that knob off of somebody's radio while they were moving. I hope not. He probably did.

Next

CRYSTAL SETS 5
Experimental Crystal Sets

CRYSTAL SETS 5: EXPERIMENTAL CRYSTAL SETS

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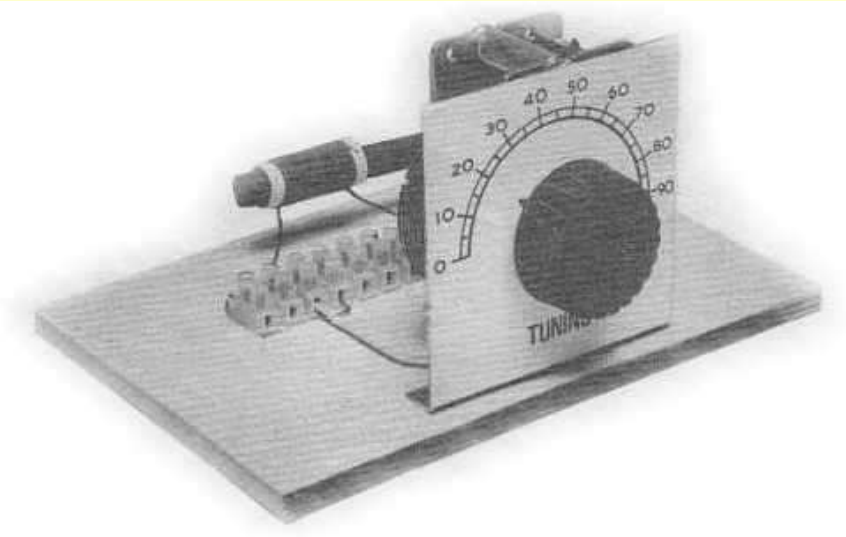

Picture 1 - The Complete Experimental Crystal Set

THE POPULARITY of the crystal radio arises from its simplicity, and the fact that it needs no power supply. The circuit here allows for easy experiments with tuning, aerial and diode coupling, and frequency coverage. Wrong connections can cause no damage to any components.

A Crystal Set is more often than not used for the reception of medium and long wave radio, but short wave reception is also quite feasible. It will normally be possible to receive some of the stronger international radio stations.

This is adapted from an article that appeared in the 1970's in Everyday Electronics, and gave me almost endless hours of fun!

BASIC CIRCUIT

The basic circuit is shown in Picture 2 below. The coil L1 can be air cored, or have a ferrite rod placed in its winding. The variable capacitor C1, in conjunction with aerial-earth capacitance, tunes the circuit to resonate with the wanted radio station frequency. The diode D1 "detects" or demodulates the radio signal so that the programme is heard in the earpiece.

This basic circuit can be modified in various ways to obtain better performance.

EARPHONE

As most constructors will be using a Crystal Earpice to listen to the crystal set it is essential that a 47k Ohm resistor is connected across the earphone terminals (TB1/1 and TB1/2 in the diagram), i.e. in parallel with the earphone, otherwise results will be very quiet.

A High Impedance headset of 20k Ohms (20,000 Ohms) may give even better results, but these are very difficult to obtain , so unless you happen to already own such a headset the Crystal Earphone with 47k resistor will be the only option. An ordinary magnetic earpiece or Walkman headphones will not work with a crystal set.

ASSEMBLY

Construction is of a 'breadboard' type using a wooden board of about 165 x 130 mm. A 12-way block connector, TB1, is used to connected together the components and this is screwed onto the wooden board. The use of a block connector provides an easy method of connecting the components together and then subsequently rearranging them as the experiments progress.

Tuning capacitor C1 is screwed to a bracket made of some scrap metal which is then also screwed firmly down to the baseboard, see Picture 1 above. Thin plywood screwed to the front edge of the baseboard would also provide a suitable method of fixing the tuning capacitor to the base. A knob with pointer is fitted to C1, and a scale is drawn and fitted behind this.

Except for C1, all connections are made by the terminals of the 12-way terminal block as shown in Picture 4. Loosen the screws with a small screwdriver, insert the bared ends of the wires, and tighten the screws. The various locations on the terminal block, TB1, are also shown in the circuit diagram, Picture 2.

AERIAL AND EARTH

Crystal receivers need a long wire aerial preferably strung outside and about 25m long, or as long as is possible to install. If this is outside it should be high and clear of earthed objects as this will improve performance.

An earth is absolutely essential for a crystal set to work properly. The earth lead can be run to an earth rod or spike that is buried to a depth of about 1 meter into damp soil. Or it may be soldered to a bare metal can which is buried in damp soil.

It is feasible, though not recommended, that the earth lead can be connected to the earthing terminal of a hi-fi system or even to the bare metal case of a personal computer that is plugged into an earthed mains outlet, but is switched OFF.

Stranded, insulated wire, or purpose made aerial wire can be used for the aerial and earth leads.

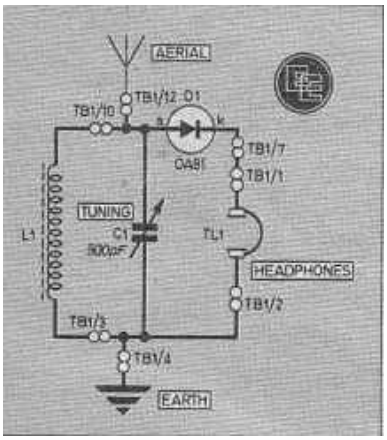

Picture 2 - The Basic Circuit

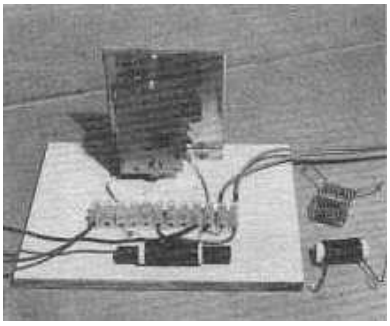

Picture 3 - Photo Of The General Layout

INDUCTORS (The Tuning Coils)

The following four coils are suggested for initial use as L1 :

Coil 1: Make a thin card tube to slide on a 10mm diameter ferrite rod, and on this tube wind about 105 turns of 32 s.w.g. enamelled copper wire, side by side. Secure ends with sticky tape.

Coil 2: Make a similar coil to to coil 1 having about 15 turns of 24 s.w.g. enamelled wire on the card tube. Loops of cotton will help hold the ends in place.

Coil 3: Wind 9 turns of 20 s.w.g. bare tinned copper wire on an object about 20mm in diameter. Remove and stretch to separate the turns, to obtain a coil about 25mm long.

Coil 4: Make a similar coil to coil 3, but with 5 turns.

The Ferrite Rod

It will be necessary to have a ferrite rod of about 60mm to 75mm long available. Coils 1 and 2 will provide reception of medium wave and the longer short wave bands. Coil 3 should cover about 3 - 10MHz shortwave with the ferrite placed in it, or about 6 - 18MHz with the ferrite rod removed. Coil 4 should cover about 6 -13MHz with the rod in, and about 9 - 20MHz without the' rod.

It will be noted that as the ferrite rod is inserted, any particular signal has to be re-tuned by opening Cl. This arises because the ferrite increases the inductance of the winding, so less parallel capacitance is needed for the same resonant frequency.

EFFICIENCY CHECKS

Tune in a m.w. transmission using coil 1 which gives good headphone volume. Place a microammeter or multi-range meter on a sensitive range in series with the headphones. A reading of 50-100uA or more may be obtained, depending on aerial, earth, earphone resistance and resistor value, coil and detector efficiency and strength of signals at your locality.

Placing the ferrite rod in the coil and re-tuning should boost the meter reading to some extent. Surplus or other detector diodes can be tried by substituting them in turn and noting the meter reading. Improvements to the aerial (or earth) will also show up as a rise in meter reading.

If experimenting with a crystal earpiece, which gives no direct current circuit, the meter may be clipped across the phone leads, i.e. D1 cathode to earth.

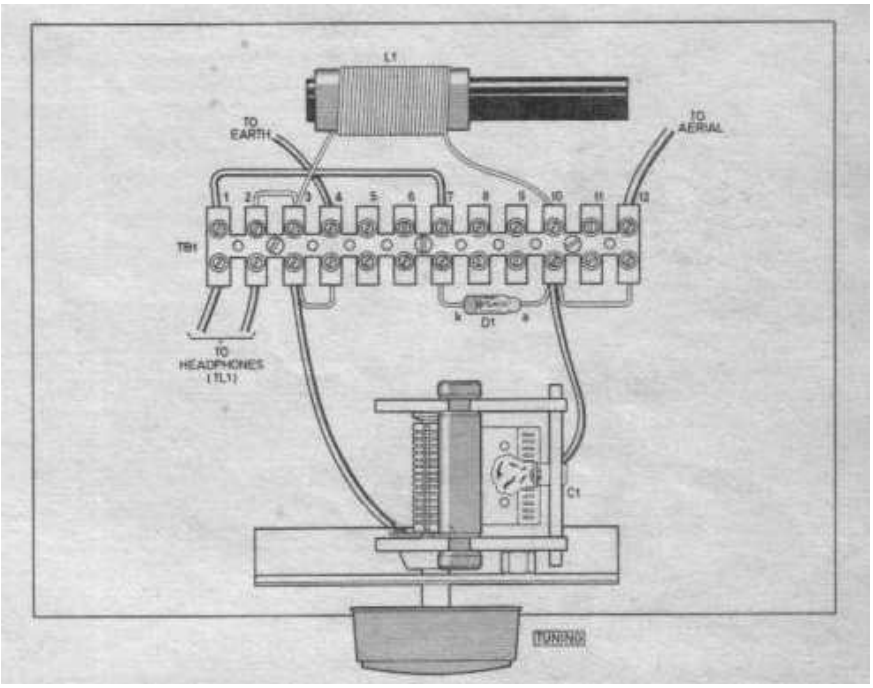

Picture 4 - Baseboard Layout Of The Crystal Set

AERIAL COUPLING

The aerial loads the tuned circuit heavily when connected directly to the top of the tuned circuit, as in Picture 2. This damps the tuning action and it can be found that stations spread out all over the dial, which is unsatisfactory.

The series capacitor, C2 connected in Picture 5(a) reduces the loading and thus improves the sharpness of the tuning. A variable or pre-set capacitor of about 250pF maximum is most suitable. for this role, though it is possible to experiment with a variety of fixed value capacitors in this range also.

Connecting the aerial to a tapping on the coil, as in Picture 5 (b) also sharpens tuning. It may also increase volume. Try about 2 turns from earth for coil 4, or 4 turns from earth for coil 3.

Another method is to have a coupling primary, as in Picture 5 (c). This consists of a second coil, with about one third the turns of the original wound on top of the existing coil.

You can even combine these methods to find what arrangement best suits the aerial in use.

The diode can be disconnected from the end of L1 and taken to a spare position on TB1 for example location TB1/9. You can then run a flying-lead fitted with a crocodile clip from this position, connecting it to various tappings on the coil as required as in Picture 5 (d). This method also reduces loading on the tuned circuit.

Coils with spaced turns of bare wire are readily tapped. For other coils, small loops can be made every ten turns or so, and crocodile clips can be attached to these when selecting tapping points.

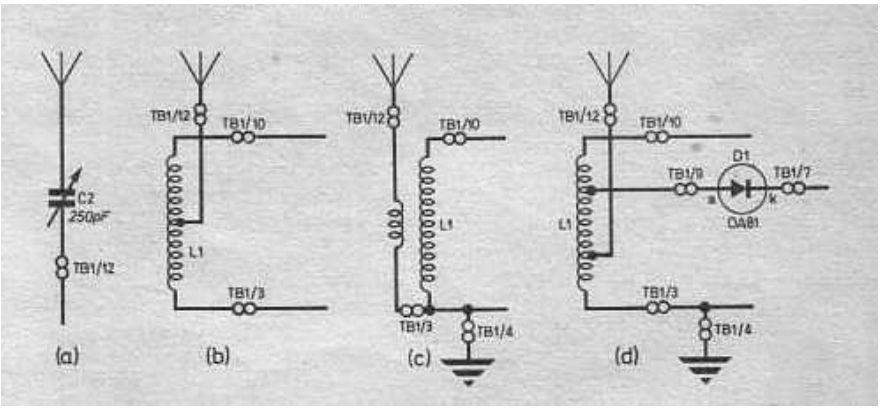

Picture 5 - Alternative Methods Of Aerial Coupling

SHORT WAVES

For shortwave reception, a good efficient outdoor aerial is certainly recommended. Evening listening in the region around 5 - 9MHz in often proves to be the most fruitful.

Since there is no amplification, as with a valve or transistor receiver, certain frequencies will seem to be completely dead at particular times of day. So if the crystal receiver works satisfactorily on medium wave and longwave, but no shortwave signals are heard, check again in the evening, or after dark, when conditions are different.

PARTS REQUIRED

C1	**365pF or 500pF Air Spaced Tuning Capacitor**
D1*	**OA47, IN34, OA81, OA90, OA91, IN94 or similar point contact small signal Germanium Diode** * The OA47 will be of particular interest since it has the lowest forward bias voltage of any of these diodes which will make the crystal set somewhat more sensitive and therefore louder. The US equivalent of the British OA47 is the IN34.
TL1	**High Impedance Headphones (20,000 Ohms) or Crystal Earphone**
TB1	**12-Way Plastic Screw Block Terminal**
Also Required:	**47 k Ohm Resistor for Crystal Earphone: Enamelled Copper Wire: 32 and 24 s.w.g. for L1: 20 s.w.g. tinned wire for L1: Ferrite Rod 10mm diameter x 75 mm long: 25m of wire for aerial: Wire and rod or spike etc for earth: Wood for base e.g. 10mm x165mm x 130mm: Scrap of metal of thin plywood for C1 bracket/front panel: Knob: Crocodile clip(s)**

Adapted from an article in Everyday Electronics magazine, November 1981, By F.G. Rayer.

HERE ARE A COUPLE OF VERY INTERESTING CRYSTAL SET DESIGNS SENT IN BY KRYSATEC - "THE RAT" - FROM THE CZECH REPUBLIC

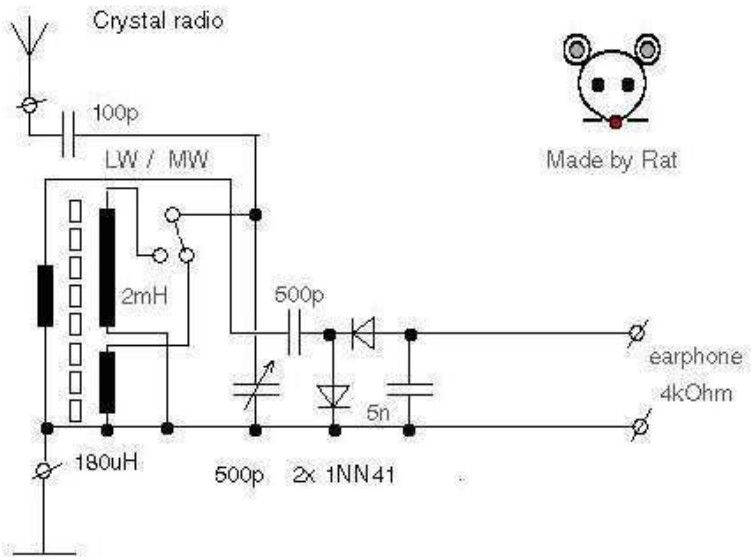

1/ Using old coils from old bulb radio for MW and LW band. Though it would be straightforward to wind the coils - one for Long Wave, one for Medium Wave and a coupling coil. Variable capacitor is 2 x 500pF only one half is used: 500pF. For the crystal earphone a resistor of about 82k ohm in parallel is required. This set also uses two Ge diodes as a multiplier in the quest for for higher audio signal output.

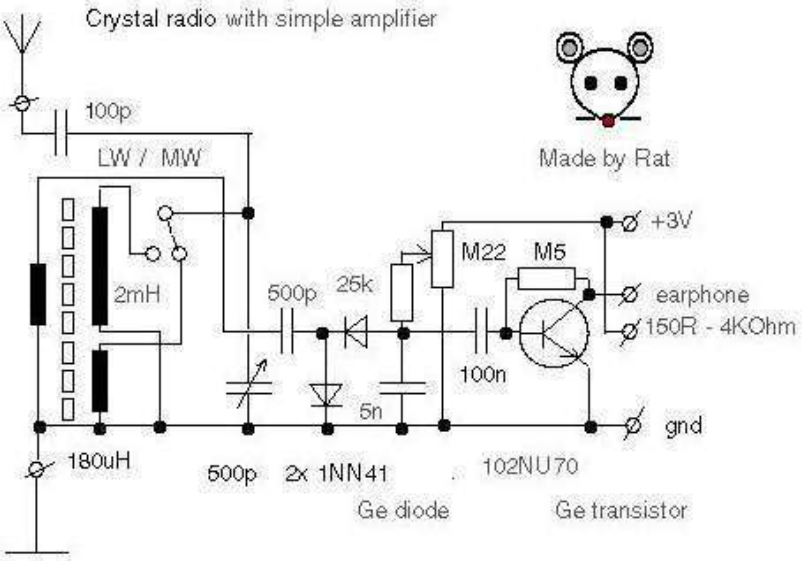

2. If signals are not strong signal in your location, then the above circuit design can be considered. A simple transistor amplifier is used. A variable resistor M22 is used for better sensitivity which can be adjusted for poor signals. This crystal radio is aversion from cca 1960 - 1970 y.

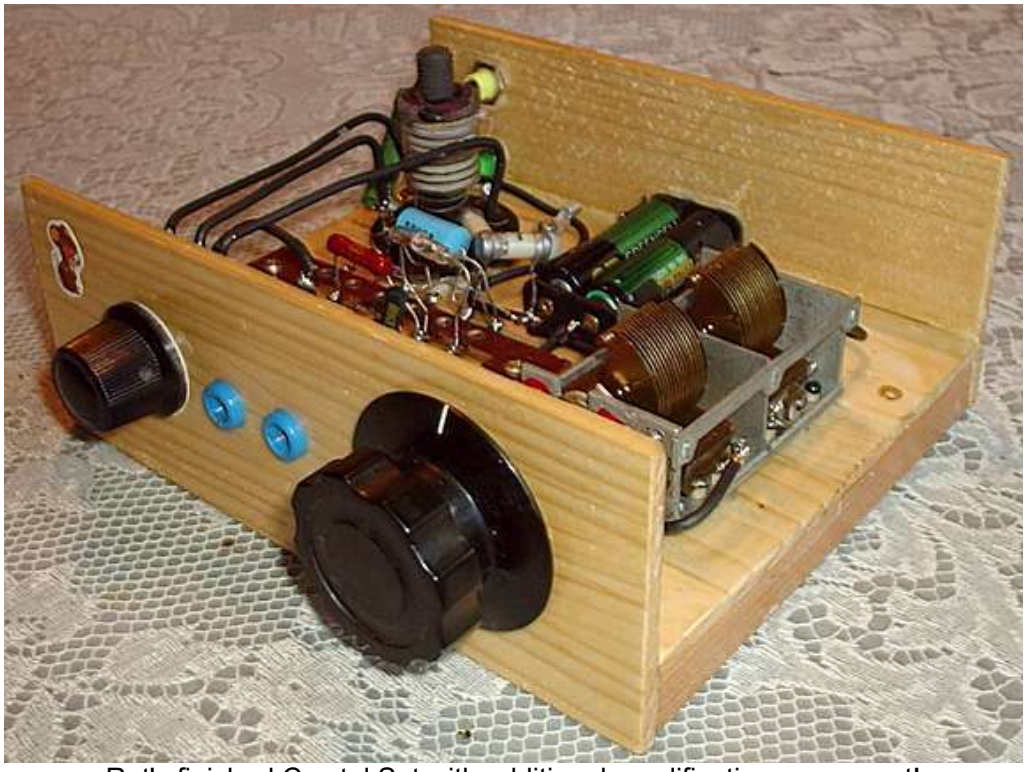

Rat's finished Crystal Set with additional amplification - very neat!

'Minilabs' Crystal Radio

BELOW: Ian Tomlinson kindly sent in a photograph of the box that contained the kit for his John Adams Toys 'Minilabs' Crystal Radio.

It is a very simple circuit consisting of the coil (inductor) with a sliding contact that provides variable tapping points, a diode and crystal earphone. All that is added is the aerial and earth. There is no variable tuning capacitor for simplicity and to keep costs down.

The coil provides the inductance required for tuning into a certain frequency (wavelength). These days a variable "tuning" capacitor is normally wired in parallel across the inductance (coil) in order to vary the resonance of the tuned circuit and therefore enable to easily tune into various transmitters on different frequencies. This crystal is tuned varying the number of turns on the coil (ie varying the inductance) by tapping off at different points using the sliding contact ("ball").

The crystal earpiece, or high Z headphone, is connected between the output of the detector diode (the other end from the coil) and earth. The volume from a crystal earpiece may be considerably improved by connecting a resistor of - somewhere between - 4.7 k and 47k ohms in parallel with the earpiece. A crystal earpiece cannot directly allow current to flow through it and the parallel resistor therefore allows current to better flow through the circuit.

'Minilabs' crystal set by John Adams Toys

A discussion on configurations for Crystal Sets by Felix Scerri VK4FUQ

This discussion, by Felix Scerri VK4FUQ, was posted at this address which no longer appears on the web www.tarc.org.au/techinfo2.htm (error 404) so here it is reproduced:

Crystal Set design is one of my passions closely allied with my obsession for audio and high fidelity.

My main interest in crystal sets, apart from the wonder of a radio receiver that does not require a power source, is the potential excellence of the recovered audio quality from normal AM broadcast stations.

Personally, it is one of my great laments that most people have never heard how good wideband AM can sound. A high performance crystal set or similar TRF approach is, in my opinion,the only way to do it. There are a few people around who have heard the audible results of my efforts,and can only agree.

I have often wondered,given the ultimate simplicity of the crystal set, being essentially a tuned circuit,a diode detector and some form of output device, what it takes to achieve optimum performance. What follows are my thoughts on the matter.

Crystal Set optimisation, is in my opinion, all about reduction of circuit losses. Essentially this means high "Q" tuned circuits and high quality detectors. Efficient output devices also help too. But as we will see, there are some trade-offs required as well. A high "Q" tuned circuit is always benefical, as a high "Q" tuned circuit has lowest RF losses,highest potential selectivity,and highest voltage at resonance, which is very useful for the diode being fed from the tuned circuit. Variable capacitors, even the "modern" miniature variable capacitors (although the older air dielectric units, as used in old valve receivers are more desirable) for various reasons,are generally quite efficient, and a higher "Q" coil will produce the most worthwhile improvements.The best (highest "Q") coils are wound with "Litz" wire, which is a multistranded woven wire with all strands insulated from each other. The performance of Litz wire wound coils is spectacular, unfortunately, although I know Litz wire is still being made, from personal

experience, it is VERY rare in Australia.

Efficient coil design can be quite complex and all my coils are wound on ferrite rods. There seems to be,at least for ordinary single wire windings (close wound), an optimum wire thickness for optimum coil "Q". I have determined .315 mm winding wire to be about optimum for simple (single wire) coils on ferrite rods. Thicker wire is NOT better, believe it or not.

Lacking Litz wire, an interesting winding approach I have developed is to use two slightly thinner wires wound as a bifilar winding connected together at the beginning and end of the coil, yields considerably higher "Q" compared to a simple single wire winding. I have found 0.25 mm winding wire optimum in this application.

Whilst high "Q" coils are beneficial from the RF point of view, there is a possible downside. If one is interested in maximum selectivity and sensitivity, there is no problem, but remember highest "Q" results in a narrowed audio band-width as a simple consequence of band-width. For high fidelity applications this could be a disadvantage under some circumstances, although there are clever ways around this.

Regardless of ultimate coil "Q", selectivity is a major issue with crystal sets generally. Here another trade-off is evident. For the maximum voltage into the diode, connecting the diode to the high impedance end of the coil (i.e. the top) yields the greatest voltage but the selectivity is usually terrible, because of severe "loading" by the diode circuit. For this reason, tapping well own the coil improves selectivity at the expense of signal volume (reduced voltage). Once again there are ways around this. As described in my "Double Tuned Crystal Set Tuner" article in "Amateur Radio" magazine, March 2002, the use of two separately tuned coupled resonant circuits allows top connection into the diode without compromising overall selectivity, thanks to the use of a second tuned circuit which is fed from the external antenna. The whole network forms a double tuned input bandpass filter and in practice this approach works very well. For single coil crystal sets I recommend the use of an un-tuned "antenna" winding adjacent to the "hot" end of the main coil, preferably adjustable (old paper reels from sewing cotton threads are ideal). This allows the degree of coupling to be optimised under actual listening conditions. The double tuned set up is best, yielding superb selectivity, but the un-tuned antenna coil arrangement also works quite well, especially if the diode is tapped well down the main coil.Tapping halfway works well.

The other method of performance improvement involves the use of the most effective detector system possible. Here things get very interesting. In fact the temptation is to use more complex circuitry, but that gets away from the charming simplicity of the crystal set. As an example, my own crystal set tuner has at times mutated into a TRF tuner complete with FET RF preamplifiers, active(powered) detectors and other enhancements. These modifications do work well, but loses the simplicity of a basic crystal set. In actuality, a simple diode detector can work extremely well, subject to some qualification. Diodes like to work with a reasonable level of RF input voltage. Audio distortion can result under conditions of low signal level, due to diode transfer curve non linearity and other factors, such as the widespread use of broadcast station "processing". The actual type of diode makes a difference. The 1N34A germanium diode is very popular for crystal set use, although in my experience just about ANY germanium diode will work, although it is worth trying different specimens. Some are definitely better than others. Even from a pack of twenty 1N34A's from the same source, some were definitely better than others. Measuring the average value of rectified output voltage across the diode load resistor will show which diodes are best. By the way, I regard a diode load resistor as being mandatory. I find a value of about 47K about right, especially if a crystal earpiece is being used or the crystal set is being used as a tuner feeding an audio pre-amplifier and following amplifier. If using high impedance magnetic type headphones, the headphones provide the diode DC load.

Another type of diode that is very interesting, is the hot carrier diode. There seem to be a lot of different hot carrier diodes around these days. There are even hot carrier diodes now being sold as "germanium diode equivalents". I have tried them and they do work acceptably well, but they are not quite as good as genuine germanium diodes such as the 1N34A. Typical UHF mixer hot carrier diodes, such as the 1N5711 will not work well in crystal set service simply because their "turn on voltage"is too high, similar to silicon diodes such as the 1N4148/914 series, which require a lot of RF input to function adequately as RF detectors, however a simple technique can be used to turn hot carrier diodes such as the 1N5711 into superlative detectors.

I guess we are cheating a little, because the technique is to use a little voltage bias supplied via a 1.5v battery, through a simple potentiometer voltage divider arrangement, with capacitor (for DC isolation) fed into the diode from the tuned circuit. With applied adjustable bias, I find the 1N5711 diodes absolutely superlative detectors under ANY signal strength conditions. I find the detection quality also superlative, with a clarity and low noise profile unmatched by any other diode arrangement. In my opinion, hot carrier diodes, running bias,are the best detectors overall.

Regarding other detector arrangements, the diode "voltage doubler" is often recommended, however my own

experiments with the doubler arrangement have been inconclusive and slightly disappointing overall. I have found no real advantage in their use over a simple (one) diode detector, believe it or not.

Yes, they do work, but they're nothing special, at least in my opinion.

Any comments on this general subject of crystal set optimisation would be welcome.

73's Felix Scerri VK4FUQ.
22nd July 2002

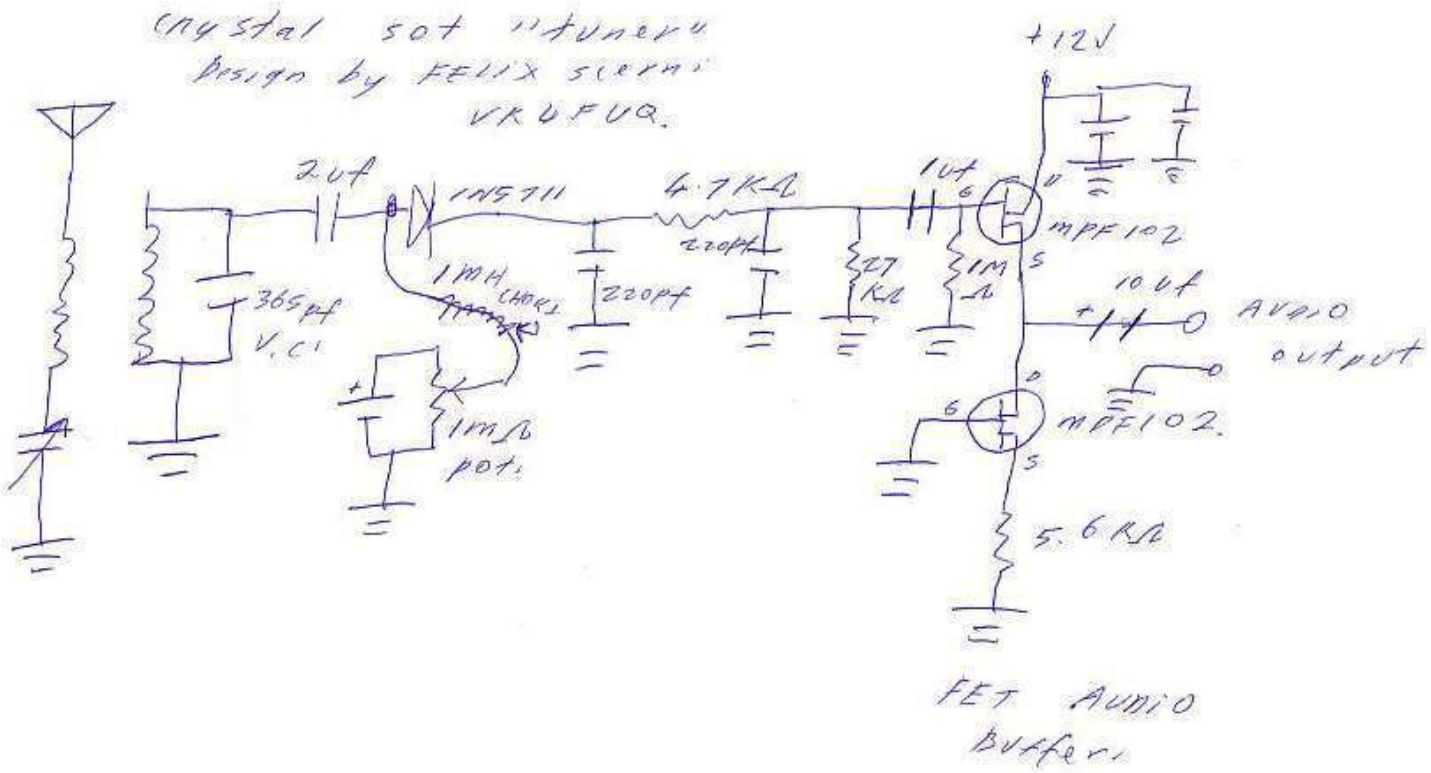

Above: CRYSTAL SET BASED CIRCUIT PROVIDING A HIGH QUALITY PROGRAMME SOURCE

IMPROVED VERSION OF THE ABOVE CONCEPT !! New update from Felix Scerri February 2010:

New 'two FET infinite impedance AM detector'

I've developed a new version of my old favourite FET 'infinite impedance' AM detector that I think sounds very nice. I include a short audio of one of our local AM stations. I picked this station as it is my reference 'torture test AM station' as they run very heavy 'processing' which normally sounds yuck with all my other (diode and non diode) detectors! However it's quite clean with this detector. What do you reckon? I'll do up a circuit if you'd like to feature it in your TRF radio section. A general draft article follows.

'A favourite non diode based AM detector that I've built and used many times over the years is the FET based infinite impedance detector, offering very good general AM detector performance, especially under weak RF signal conditions where diode based detectors do not perform well, especially in terms of audio distortion.

However one of the slightly strange things I've noticed about the simple FET based infinite impedance detector is the variable audio quality noted, even when using the same type of FET. Some I've built have sounded good and others slightly fuzzy when used with an audio preamp and fed into a high quality audio system. I've been giving this a considerable bit of thought of late and I've wondered if the audio distortion might be a result not necessarily of the detection process itself, but the FET stage in its guise as a 'source follower' audio stage which essentially, it is.

I have long been aware that as a simple audio buffer stage, the FET based 'source follower' can exhibit a considerable amount of audio distortion, and a technique I've long used to greatly reduce this audio distortion is to use a second FET in the source lead of the first FET as a 'constant current source' which serves to 'linearise' and

greatly reduce audio distortion in the buffer stage overall. So, to test the theory I built a simple one FET infinite impedance AM detector which worked well, but with just a hint of audio 'fuzziness' on received AM stations. So I added a second FET in the source lead of the first FET wired as a constant current source, taking the output from the source of the first RF detector FET and the source resistor and RF bypass capacitor off the source lead of the second FET 'constant current source'. The result, totally clean audio! The theory seems proved! I call this modified detector the 'Two FET infinite impedance detector'

))) Here's what is sounds like - click to play the audio file (((

Here is the circuit diagram:

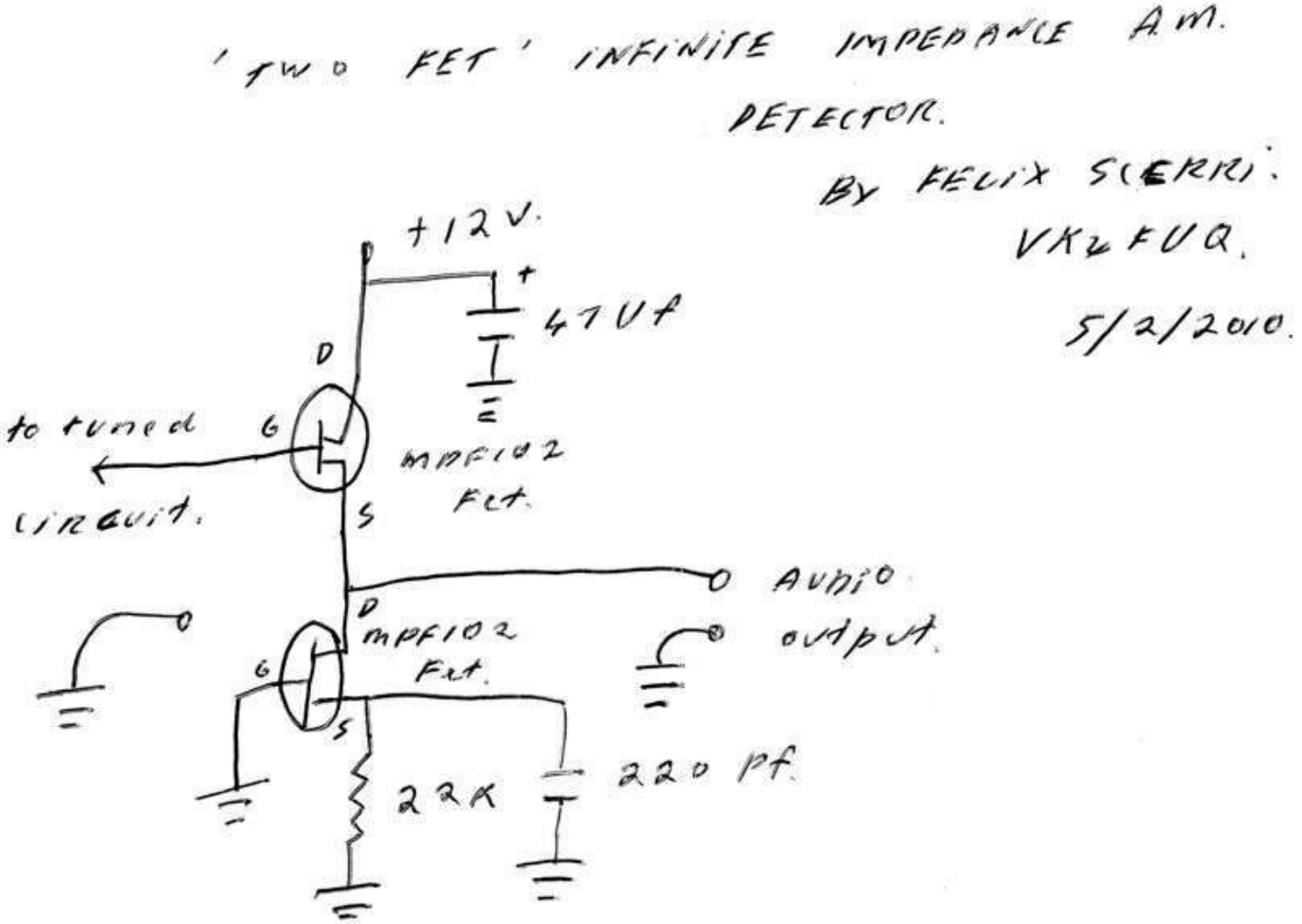

This detector has been a real eye opener for me in terms of its excellent performance, especially considering its circuit simplicity. Indeed in the past I have designed other more complex FET based infinite impedance circuits that do not quite work as well in practical terms as this latest circuit, at least according to my well calibrated ears!

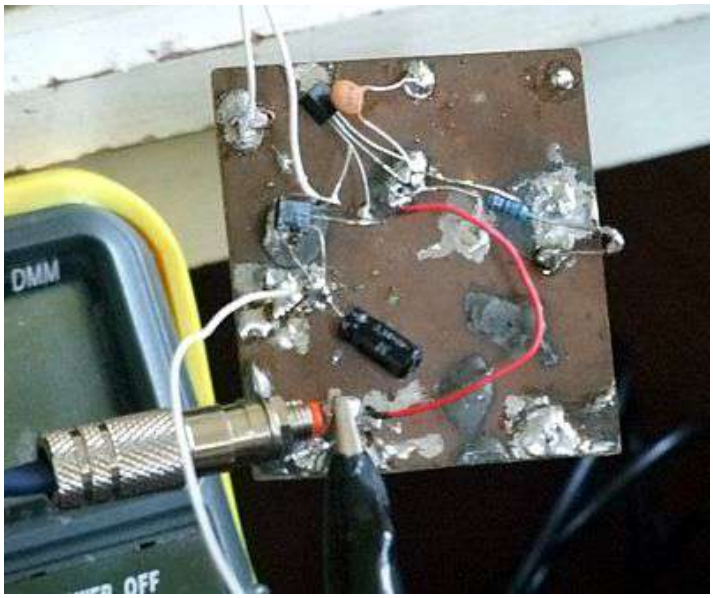

I do not have access to any precise test equipment but my well calibrated ears tell me this 'two FET infinite impedance detector' is a beauty, surpassing practically every other AM detector I've built even at low RF input, and that's rather a impressive claim and the audio quality when used as an AM tuner feeding a high quality audio system is quite remarkable. Possibly the best thing about this detector is its excellent performance under weak signal conditions. Diode based detectors also work beautifully, but the use of an RF stage to ensure detection over a linear portion of the diode's curve is mandatory! This compound infinite impedance detector works

beautifully on the sniff of a useable RF signal.

Just add a high Q tuned circuit and that's it!

Felix Scerri
VK4FUQ

A better FET for the 'basic' Infinite Impedance Detector:

Quite recently by accident, I've realised the MPF102 FET that I've long used in my FET based infinite impedance detectors is possibly not the best FET to use. This was the reason why I developed the 'two FET' infinite impedance detector some time ago which works very well.

However I've found the choice of a more suitable FET works beautifully in the basic FET based infinite impedance detector circuit, which has appeared for many years in many editions of the ARRL Handbook.

I use the 2N5457 and others of the same 'family' may be equally suitable, but I haven't tried them! However with a 2N5457 in place of an MPF102, the basic infinite impedance detector has became my AM detector of choice. It works beautifully even at low signal input with lovely and clean low distortion audio along with a very high input impedance for good tuning selectivity. It's a beauty! The basic generic circuit is attached, courtesy of Rod Elliott's ESP website.

73 Felix VK4FUQ
10 / 02 / 2012.

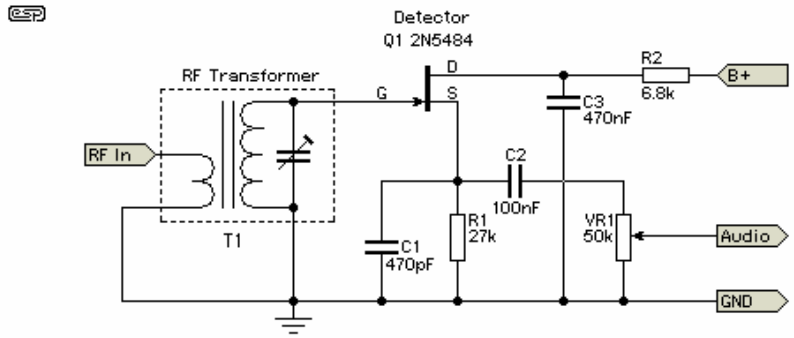

The basic generic circuit is attached, courtesy of Rod Elliott's ESP website
Felix Scerri VK4FUQ

As often happens with me, my renewed interest in FET based 'infinite impedance detectors' of late has led to some interesting new research and I may have considerably improved the 'two FET infinite impedance detector' as a result.

My research suggests that although the use of a CCS (constant current source) reduces audio distortion in an audio stage, the value of the 'source resistor' in the CCS stage is somewhat critical for best results.

By using a potentiometer in lieu of a fixed resistor I have found that a resistance value of around 470 kohms cleaned up all overall audio distortion. I used an MPF102 as the CCS in this circuit. An interesting and worthwhile little circuit refinement.

73 Felix VK4FUQ
21 / 02 / 2012.

A Minimum Component Count High Quality AM Detector

I was generally messing around with various circuit ideas and I came up with this AM detector circuit, a simple diode detector along with a FET stage. It was an attempt to provide good performance along with minimum number of components. Actually I've been pleasantly surprised at the excellent level of general performance and the best of all, it sounds great!

The circuit is quite conventional being a BAT 46 diode detector feeding an MPF102 FET buffer/ common source amplifier stage. I would ordinarily use a FET source buffer stage in this application, but opted to use a simple low gain FET 'common source' amplifier stage instead, with excellent results. I also used a BAT 46 Schottky diode instead of an ordinary germanium signal diode.

This was done for several reasons. Firstly, germanium diodes are now very hard to find but in any case these 'germanium diode equivalent' Schottky diodes are actually a superior diode, having very low noise, almost zero back leakage and an essentially complete absence of carrier storage effects and very good weak signal sensitivity. I call these diodes high fidelity diodes as they sound wonderful as RF detectors.

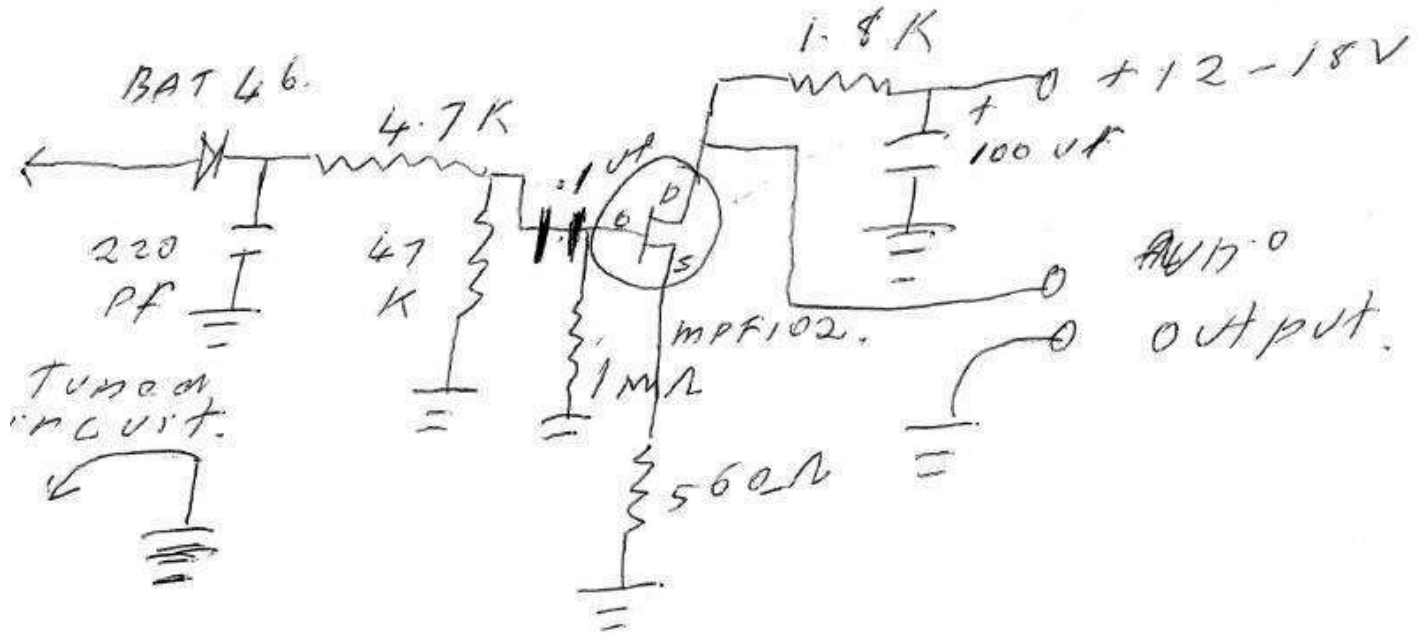

Circuit Diagram of the Minimum Component Count AM Detector by Felix Scerri

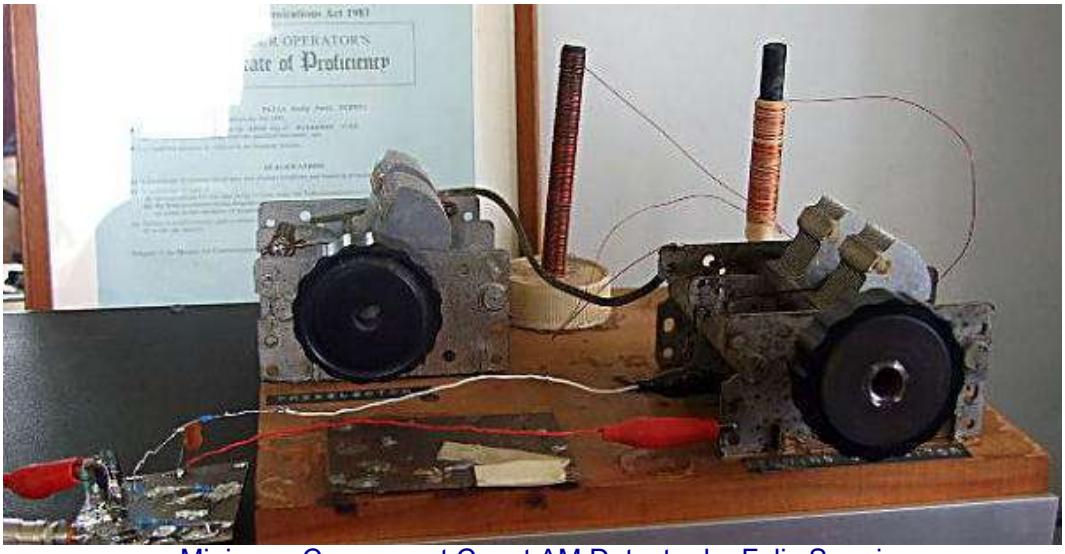

Minimum Component Count AM Detector by Felix Scerri

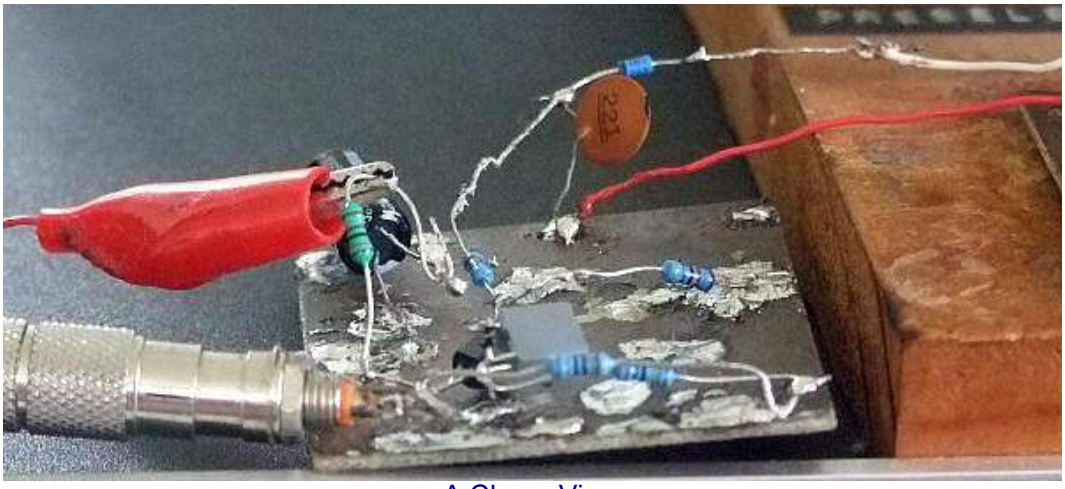

A Closer View

The high impedance of the FET's gate circuit is perfect for optimal buffering of the diode detector, something very important for good low distortion diode detector performance. Apart from providing slight voltage gain, the use of the common source FET amplifier is a new idea, as this prevents the possibility of incidental RF rectification occurring in a FET source follower stage, which can happen. A 1 uf plastic film capacitor may be added in series with the audio 'hot' output lead to block the DC offset out of the FET drain, if required.

Despite no additional RF stage ahead of the diode, audio quality on even relatively weak RF strength stations is actually very good, and of course the audio quality will be even better with increasing RF signal strength, something which will also increase the audio output level. Just on this, for a long time I was somewhat negative regarding diode detectors, as one AM station locally (the strongest one) was always distorted when using a diode detector.

I strongly suspected a transmitter fault, but my complaints were ignored, until one day some time ago when all audio distortion suddenly disappeared! Nothing was ever 'said', but I realised that my suspicions of a long standing transmitter fault were correct, after all!

73 Felix
VK4FUQ
02 March 2012

Voltage Doubler Detector

This is an AM detector circuit that I've long known about and which worked ok, but never seemed to work as well as it should have. However I spent some time late last night trying to optimise the circuit, with some success.

It is a curious circuit being essentially a 'voltage doubler' originally developed for power supply applications, and its use as an AM detector is hard to analyse! It seems that the component values in the circuit are somewhat critical for good performance and if not, the performance is rather 'ordinary'. The circuit that I eventually came up with uses a 150 picofarad 'input capacitor' with a 150 kohm 'load' resistor and loaded into a FET common source voltage amplifier stage (as previously described) through a coupling capacitor with a 1 Mohm input resistance.

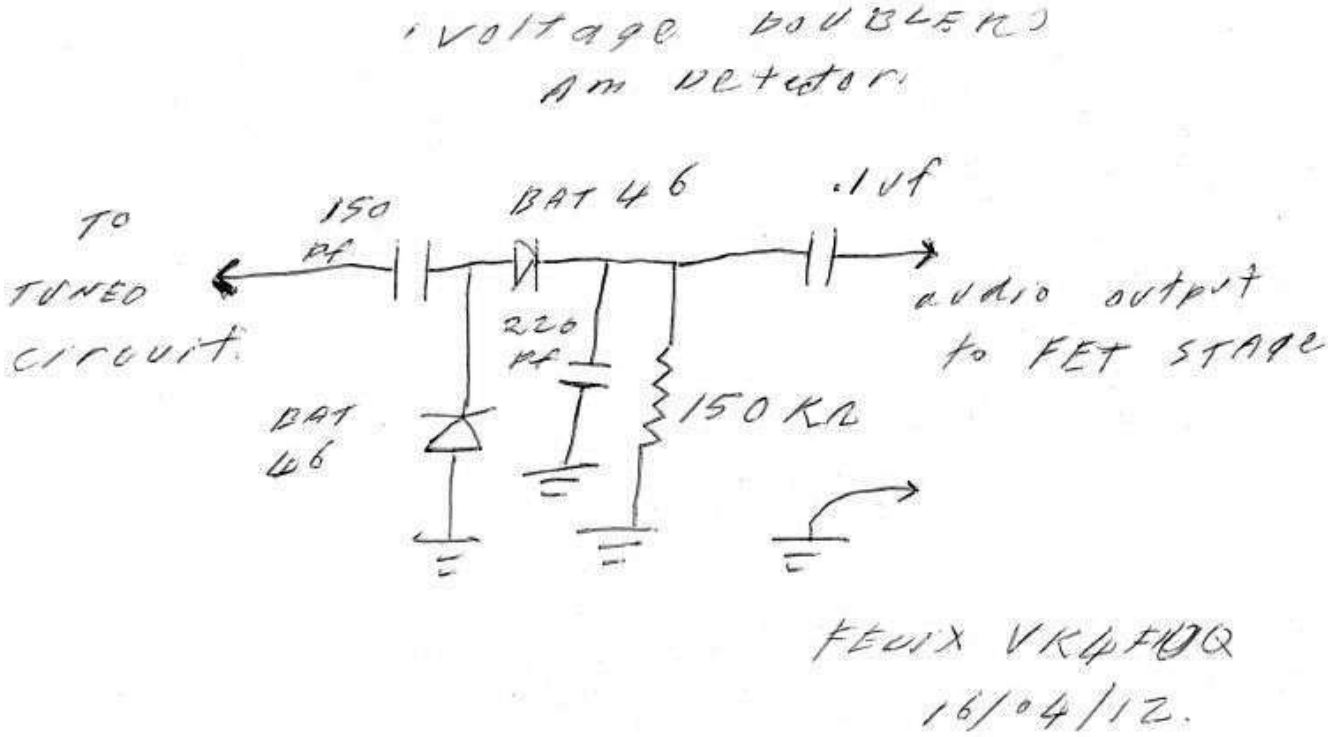

With these circuit values, it all works 'quite well'. Give it a go! It's an interesting AM detector with quite good 'sensitivity' and clean audio quality, and it seems to work well at low signal levels.

73 Felix
vk4fuq.

16th April 2012.

Simple AM detectors: What works best? A practical experimenters viewpoint.

I have written a lot about simple AM detectors for use as tuners for feeding into an audio amplifier, and it has been a long time interest. These days I use either diode based or 'infinite impedance' types of AM detectors. In this location our 'local' AM stations are quite distant and are therefore quite weak in terms of signal strength.

As such I find infinite impedance detectors based on field effect transistors give consistently better results for tuner applications due to their lower apparent overall detector distortion. Diode based detectors are quite 'fussy' as they require both optimal output buffering (AC/DC ratio) and an 'adequate' (beyond the diode knee) level of RF signal injection. http://www.tonnesoftware.com/appnotes/demodulator/diodedemod.html

Diode based detectors will happily 'detect' at very low signal levels, however the (inevitable) audio distortion that results, can be extremely irritating to the ear! Under these conditions I find infinite impedance detectors (even without additional RF preamplification and subject to individual FET characteristics), generally sound 'cleaner' and more pleasant to the ear.

FET's of course require a power source for operation whereas diodes are passive (un-powered) detectors (most of the time), however this is of no real advantage in a tuner application as an 'active' audio amplifier stage will generally be required anyway for audio level boosting, buffering etc.

In the end it will come down to a consideration of prevailing RF signal levels and other related circuit considerations at one's location. If local RF levels are strong, a well designed diode detector will give excellent results. If not, an 'infinite impedance' type of detector is most likely the better option unless one goes towards the option of additional RF preamplification prior to the diode detector.

73 Felix
vk4fuq.

17th April 2012.

ANOTHER DETECTOR by Felix Scerri !

I've tried diode based 'voltage doubler' (or more correctly 'diode integrator') AM detectors before with indifferent results, however the other day, just trying a few ideas I came up with this version that works rather well, with low audio distortion, high audio output and really 'nice' audio quality and the best of all, it seems to work very at very low RF input level.

The two diode 'voltage doubler' detector using two BAT 46 silicon schottky diodes feed directly into a MPF102 source follower stage set at 1 Megohm input resistance. The 'input' capacitor feeding the diodes from a tuned circuit is 68 picofarads.

I have the simple RF filter right on the output of the FET stage. In that respect this circuit is vaguely similar to the old 'Selstead-Smith' valve AM detector of the past. An interesting one! I am very happy with its general performance. Regards, Felix vk4fuq 11/04/2013

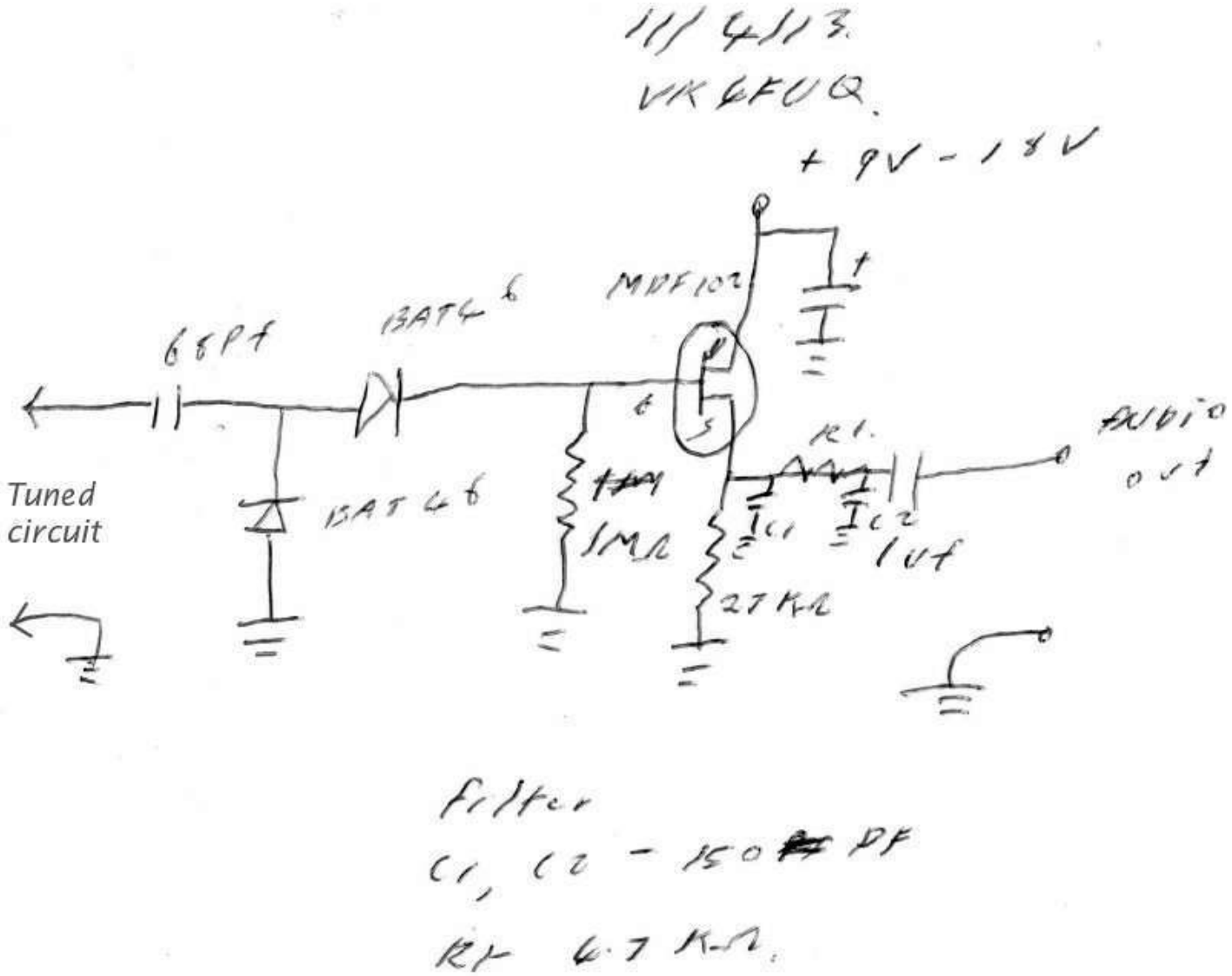

Felix Scerri VK4FUQ

UPDATE - JUNE 2013

G'day all, readers may recall the two FET infinite impedance detector I developed some time ago. That circuit worked well, but some samples of the MPF102 regretfully produced distorted output. However a recent discovery has resulted in an improved version that has truly exemplary performance.

The MPF102 is in all honesty a device essentially designed for VHF applications, but is often used in simple audio applications albeit with occasionally indifferent results, due to general device parameter 'spread'. More or less by empirical trial and error I have found that a simple change in source resistor value to 100 k (from a much lower value), pretty well fixes everything.

In a FET source follower circuit this is interesting as the output impedance is actually a lot lower than 100 k due to the action of the FET's transconductance. It is similar to the action of a bipolar transistor emitter follower circuit. In fact a simple infinite impedance detector with a 100 k source resistor actually works very well and will be good enough for many applications, however the addition of a second FET as a constant current source does markedly reduce overall audio distortion in the stage overall, and produces very clean and low distortion audio quality and also reduces the output impedance considerably (good for tuner applications), so take your pick!

Regards, Felix vk4fuq 02/06/2013.

UPDATE - JANUARY 2014
A simple modification to the basic FET 'infinite impedance' AM detector that dramatically improves performance.

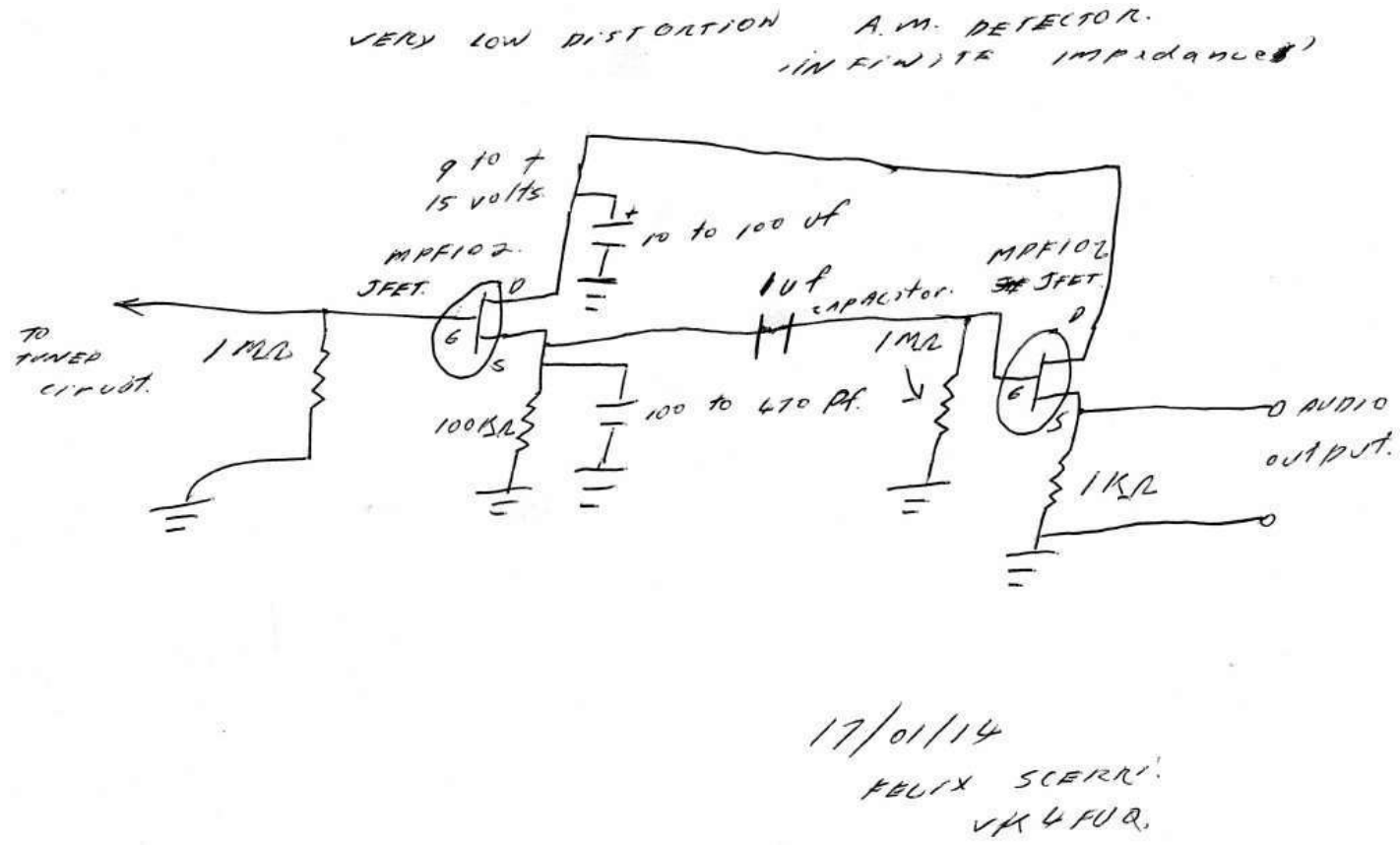

G'day all, over the Christmas break just messing around I worked out (mostly by accident), a simple modification for the simple FET based 'infinite impedance' detector circuit that dramatically improves weak signal performance and also greatly reduces audio distortion.

Essentially by the addition of another FET 'buffer' stage, another source follower, capacitively coupled from the first detector stage. The circuit is actually a simplified version of the circuit that I described in this link, http://sound.westhost.com/articles/am-radio.htm (figure 6) and testing the two head to head, they both sound superb and the simpler version is actually somewhat easier to build. I cannot get over how low distortion and 'nice' the recovered audio sounds. It is a joy to listen to!

Regards, Felix vk4fuq 12/01/2014.

Diodes for ‘weak signal’ crystal set applications.

As I am primarily interested in using crystal sets as AM tuners for feeding into a preamplifier/amplifier and loudspeakers, the actual type of diode can be relatively critical. In a strong signal area, not so much, but in a weak signal area such as where I reside, definitely. A diode with a good ‘square law’ performance (the area below the ‘knee’ in the diode curve), generally results in much cleaner and lower distortion than other good performing diodes, and believe me diode distortion under weak conditions, even with optimised diode ‘buffering’ used is very nasty sounding to the ear!

Testing many, many diodes in actual working crystal sets and listening critically to the audio output, it seems to me that the best diodes to use under weak signal conditions are the so called ‘gold bonded’ germanium diodes. I have sampled many different gold bonded germanium diodes and they all work well in this specific application, although sometimes the rectified output voltage may not be as high as other germanium or silicon schottky diodes, however the audio quality is much cleaner and shows much less apparent distortion!

I have tried OA5, OA47, IN141 and several ‘CG’ gold bonded germanium diodes with consistently excellent results. Other ‘ordinary’ germanium diodes may also work well under weak signal conditions, but they will need to be tested individually to check actual performance in a working circuit. One thing that I have noticed about germanium diodes is that due the ‘point contact’ nature of their construction, even diodes of the same specific type can exhibit rather different levels of performance!

The otherwise very good BAT46 silicon schottky diode works extremely well at good RF input level but not so well at weak RF input, especially when heavy broadcast ‘processing’ (commonplace these days), is used. New ‘gold bonded’ germanium diodes are probably no longer made although I am aware that they can be purchased through vendors over the internet. Apart from that, they may be found in old gear. As stated earlier, ordinary germanium diodes may be quite good but will need to be checked individually. Diodes are complex things!

Felix (vk4fuq). 29/01/2014.

* * * * * * * * * * * * * *

Just when I thought that I’ve tried everything I realised that I’ve not tried a voltage doubler (diode integrator) detector with an RF stage in front. It is an unfortunate fact that all diode detectors ‘need’ a good RF injection level (and buffering) or audio distortion becomes ‘bad’ (an understatement!)

Consider yourself very lucky if you live in a strong signal area! (unfortunately I don’t). Anyway I quickly built a couple of prototypes which worked ok but not as well as hoped. Initially I tried using a source follower buffer (no voltage gain), but converting it to a common source amplifier (with appreciable voltage gain), seemed no better, which was strange.

After staring at my prototype for what seemed like forever with my magnifiers on, I (finally) realised my mistake. A common source stage takes its output off the ‘drain’ terminal of the FET, not the ‘source’ terminal as it does with the FET source follower buffer stage. I shifted one wire, and all worked as expected and it sounds fantastic! All diode detectors (one diode envelope detectors, doubler detectors etc), need good RF input and a simple untuned FET RF gain stage works very well. As to the sound, it sounds great.

73 vk4fuq 10/03/2014.

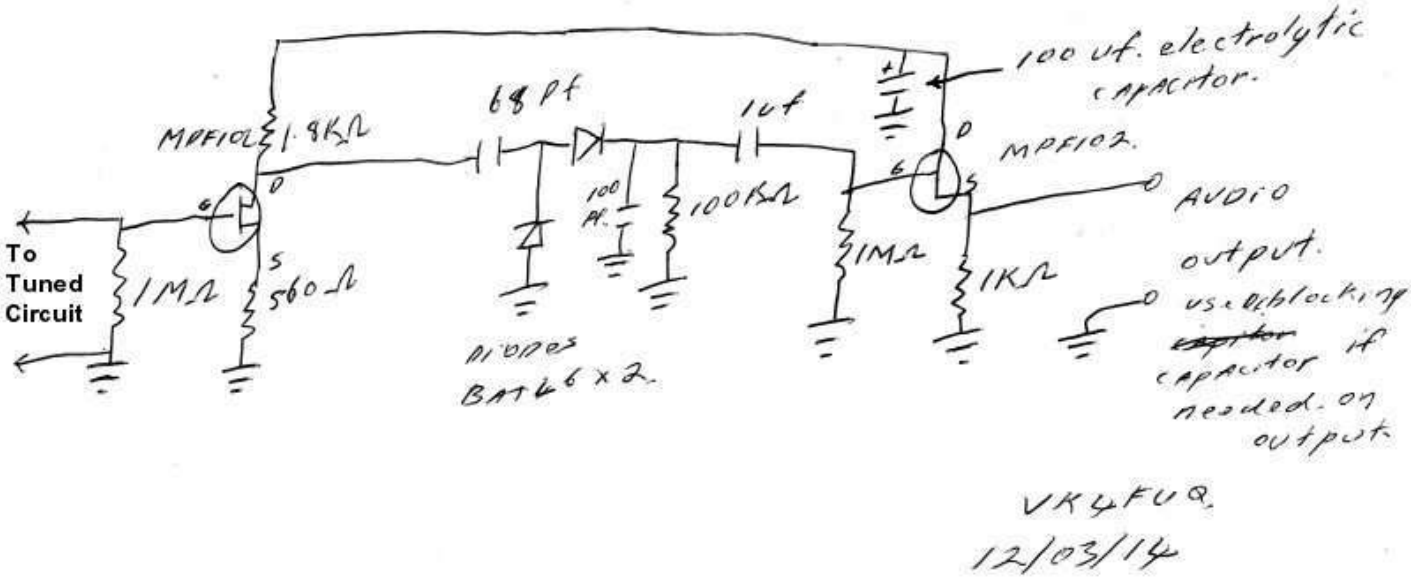

Felix Scerri's FET Crystal Set with Voltage Doubler

A 'nice sounding' AM detector - update October 2015

Looking through these pages the other day I was slightly shocked to realize that I've completely forgotten about some of the circuits that I've contributed in earlier days! They all work pretty well, however in my advancing older age and a little like my tastes in high fidelity generally, I'm starting to show a particular preference for 'nice sounding' bits of audio gear.

I guess that this also means low noise/low distortion too, although with AM broadcasting, at least in this country and probably elsewhere in the world too, the very common use of broadcasting 'processing' tends to make it hard for AM detectors generally, often resulting in a 'hard/compressed' sort of sound although still low in distortion, is not 'nice sounding', if that makes any sense!

Well of all the AM detectors that I've tried and/or developed, only one sounds 'nice' when confronted by heavy broadcast processing and that is an AM detector 'based' on a voltage doubler/diode integrator circuit (similar to the above circuit, actually the 68 pf capacitor should be changed to .1 uf, for slightly greater output).

It has taken me a very long time (years) to 'optimise' this circuit, but as it presently stands this is my favourite 'nice sounding' AM detector, and gets most use for general high quality listening on the AM broadcast band. It sounds really good! It somewhat reminds me of an old OA47 gold bonded diode detector from years ago before such abhorrent 'processing' became commonplace!

Ah yes the OA47….now that is a lovely sounding detector diode!

Regards, Felix vk4fuq. 17 / 10 / 2015.

* * * * * * * * * * * * * *

That's it for crystal sets. I hope you try building one, it's easy and great fun!

See some useful links below....

73's
Mike

Crystal Sets (Part1) | Build Your Own Crystal Set (Part 2)

Spider's Web Crystal Set (Part 3) | Crystal Set By Kenneth Rankin (Part 4) | Crystal Radio Links

Amateur Radio
MØMTJ Visit my amateur radio pages MØMTJ
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No AM radio stations or transmitters in your locality or country?

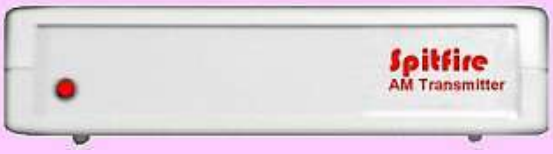

Has your local medium wave broadcast station closed or been moved to VHF/FM or Digital? Don't worry. You can still build and experiment with crystal sets and TRF radios by also buying or even building a simple low power AM transmitter. So, not only can you use your crystal sets but you can also run your own radio station that can be heard in and around your home - playing the music or programmes that you want to hear!

SSTRAN AMT3000 Superb high fidelity medium wave AM transmitter kits from SSTRAN. Versions available for 10kHz spacing in the Americas (AMT3000 or AMT3000-SM) and 9kHz spacing in Europe and other areas (AMT3000-9 and AMT3000-9SM). Superb audio quality and a great and well designed little kit to build: http://www.sstran.com/pages/products.html

http://www.sstran.com/

Other AM transmitters available:

Spitfire & Metzo Complete, high quality ready built medium wave AM Transmitters from Vintage Components: http://www.vcomp.co.uk/index.htm Vintage Components offer a choice of the high quality Spitfire and Metzo transmitters:

SPITFIRE AM Medium Wave Transmitter with 100 milliwatt RF output power:

http://www.vcomp.co.uk/spitfire/spitfire.htm

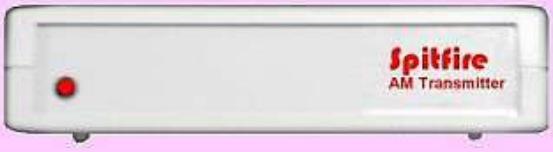

METZO AM Medium Wave Transmitter with built in compressor:

http://www.vcomp.co.uk/metzo/metzo.htm

AM88 LP A basic AM transmitter kit from North County Radio.
http://www.northcountryradio.com/Kitpages/am88.htm

LINKS: Fine links to more Crystal Radio websites here

Component Suppliers: Links to electronic component suppliers here

Visit my Amateur Radio Pages >

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Spider's Web Crystal Set (Part 3) | Crystal Set By Kenneth Rankin (Part 4) | Crystal Radio Links

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Some Practical Designs
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CRYSTAL SET !!

CRYSTAL SETS 2: SOME PRACTICAL DESIGNS

I hope that you attempt building one or two of these crystal set designs and I really do recommend that the components are carefully connected up using soldered joints onto a piece of tag-strip for reliability. However if you are new to constructing such electronic circuits then some simple solder-less techniques could be employed and these are suggested at the bottom of the page. Also see Crystal Sets Part 5 for more ideas on experimenting with crystal sets.

An early and very basic crystal set would have been nothing more than a coil of wire, perhaps 50 -100 turns, wound around a cardboard tube about 3 inches (7cm) in diameter, a detector (or cats whisker) and a pair of special High Impedance headphones (as discussed in part 1).

There would be a very large aerial strung up around the garden and the all important connection to earth.

The coil would have tapping points (connection points) at intervals of around 5 or 10 turns. See the circuit diagram on the right for details of who the set is wired together.

The tapping points on the coil allow the set to be tuned to different frequencies by adjusting the position of tap B. Tap B would be connected to the coil at differently positions by way of a crocodile clip. The fewer turns between the top (aerial end) of the coil and tap B, the shorter the wavelength received (ie the higher the frequency). Tap A would allow the detector to be connected at different positions to vary performance. There is an additional component drawn in the above diagram, the *capacitor* (value 1000pF), this is included in crystal sets that used the *High Impedance* magnetic headphones, and bypassed any remaining radio frequencies (RF) to earth.

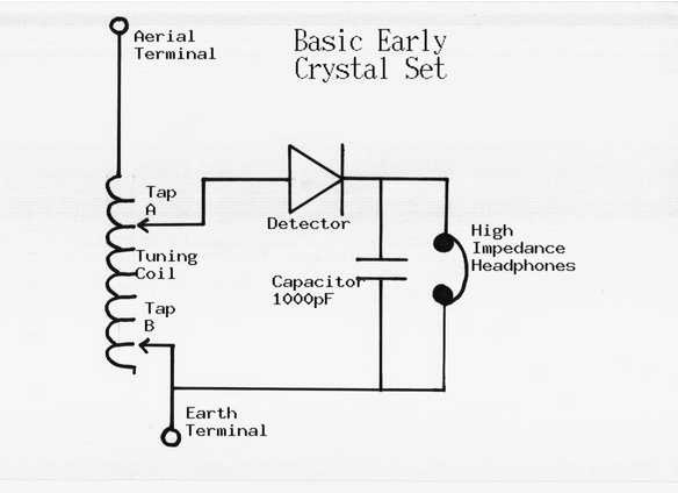

A very basic crystal set circuit.

I have not built the set described above as it is so basic. Such a crystal set above would probably have been adequate in 1920 - 1923 when there would have been only one local transmitter receivable.

When the BBC expanded transmissions and it became possible to hear more than a single station it would have became necessary to include a more convenient means of tuning the set.

This was achieved by including a Variable Tuning Capacitor, of about 500pF (0.0005uF) connected in parallel with the tuning

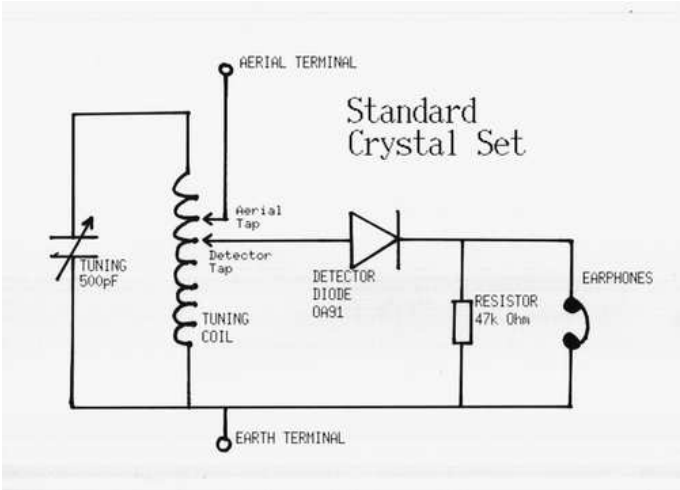

The Standard Crystal Set

coil forming a *tuned circuit*. The tuning capacitor would have a Bakelite knob on the spindle to aid tuning.

Because of the simplicity of crystal sets, it is often difficult to separate stations. When tuned into one station it is often possible to hear another close by station in the background, this is due to lack of *selectivity*. This can be reduced somewhat by adjusting the positions of the Aerial Tap and Detector Tap. Moving them closer to the bottom of the coil, the earthy end, reduces the load on the tuned circuit and this improves selectivity, however it does also reduce *sensitivity* which can make the station quieter. Headphones will often swamp a tuned circuit and reduce its selectivity (Q factor), so moving the tapping point lower down improves this situation. Every circumstance is bound to be different though so the best balance has to be found by experimentation. My crystal set has both the diode and the aerial connected to the same tapping point on the coil, about a quarter of the way down.

The modern 'standard crystal set' shown above uses a Crystal Earphone, since suitable high impedance magnetic headphones (of 2000 to 4000 ohms) are no longer widely available. When using a crystal earpiece the 1000pF capacitor shown in the first diagram can usually be omitted an in its place a 47k ohm resistor is connected, this ensures that the Crystal Earphone will work at its most efficient i.e. the sounds will be as loud as possible. The resistor allows DC current to flow through the circuit efficiently - this would otherwise be blocked when using a crystal earphone. In a modern crystal set the detector used is a *Diode.* Suitable diodes include OA80, OA81, OA90 OA91 and IN94 which are usually available from component stockists.

A Better Diode For Increased Efficiency

The OA47 will be of particular interest since it has the lowest forward bias voltage of any of these diodes which will make the crystal set somewhat more sensitive and therefore louder. The US equivalent of the British OA47 is the IN34.

On the right you will see my real working example of a crystal set

The large plastic knob on the front turns the variable tuning capacitor. This set receives the three UK national stations and also three local radio stations very well at my location.

There is a small 3.5mm jack socket mounted on the front of the plastic case (MB5 from Maplin Electronics) that the crystal earphone plugs into.

The coil can be seen inside the case, it is 70 turns of 30 gauge enamelled copper wire wound around the centre of a toilet roll and tapped every 10 turns, by scraping off the enamel insulation and making a small twist. The croc' clips can be seen clipped on to these twists to connect to the aerial and detector tap points.

A real working crystal set. Radio as if by magic with no battery or mains power.

THE MEDIUM WAVE COIL - MORE DETAILS

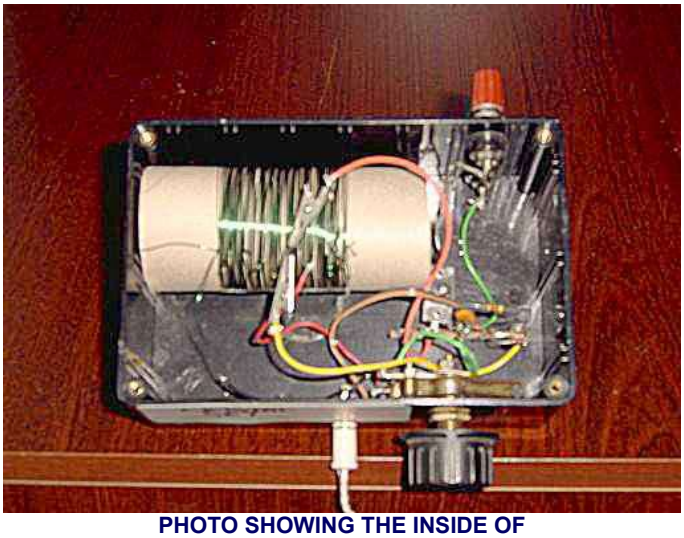

PHOTO SHOWING THE INSIDE OF THE COMPLETED CRYSTAL SET

Medium Wave Coil

The number of turns of wire required on the coil will vary depending on the size of the former (in this case the inside toilet roll) and the thickness of the wire. So to obtain the correct coverage of the medium wave band may need a little experimentation.

I usually find that between 50 to 90 turns is right and I generally use enamelled copper wire that is between 30 s.w.g. and 26 s.w.g (i.e. 0.315mm and 0.45mm diameter), so it's best to start with too many turns and then work down.

The more turns that you use the lower the frequency range will be, i.e. too many and the coverage of the top end of medium wave around 1500 - 1600 kHz will be lost, while too few and the coverage down to 500 kHz will be lost.

It is also important that the coil former is non conducting, i.e. not metallic. It could be wood or cardboard or a short piece of PVC piping and with a diameter of between 1½ and 4 inches (4 to 15 cm) are common sizes. You could try using a ferrite rod too, see below.

This particular set has a coil wound onto a toilet roll tube which consists of 70 turns of 30 s.w.g. (0.315mm dia) enamelled copper wire tapped at every 10 turns. It also has the additional small trimmer capacitor that helps match the aerial to the tuned circuit thereby improving selectivity, see below.

USING A FERRITE ROD AS THE COIL FORMER

The aerial coil could be wound onto a ferrite rod.

A piece of 10mm diameter ferrite rod of between 3 and 6 inches long (80 to 150mm) will be most suitable and will require between 50 and 90 turns of enamelled copper wire to provide coverage of the medium wave band: First make a paper tube that is held together with sticky tape that will easily slide up and down the ferrite rod. Then wind the coil over this with the windings neatly side by side. Make tapping points every 10 or 15 turns so that the aerial and diode tapping points can be adjusted.

Adjustments to the tuning range can be made by removing some wire from the coil so it is best to start off with too many turns and then work down. Fine adjustments can be made to the completed coil by sliding it up and down the ferrite rod.

AN IMPROVEMENT TO THE DESIGN

The crystal set above also has one small, but significant, improvement over the standard crystal set and that is an Aerial Trimmer. A trimmer is a variable capacitor, very similar to the tuning capacitor, except smaller and adjusted with a screwdriver.

The value of the trimmer is usually around 10 - 50pF, but if a small tuning capacitor is available that will probably be just as effective. In the absence of such a variable capacitor, individual fixed ceramic capacitors of e.g. 10pF, 50pF and 100pF can be tried in this position to judge which gives the best results with the particular aerial being used.

The trimmer capacitor adjusts the coupling to the tuned circuit, reducing the load of the aerial on the tuned circuit will improve

the selectivity (Q), and it will be easier to separate stations. Again tapping points are used and I find this to be an excellent arrangement.

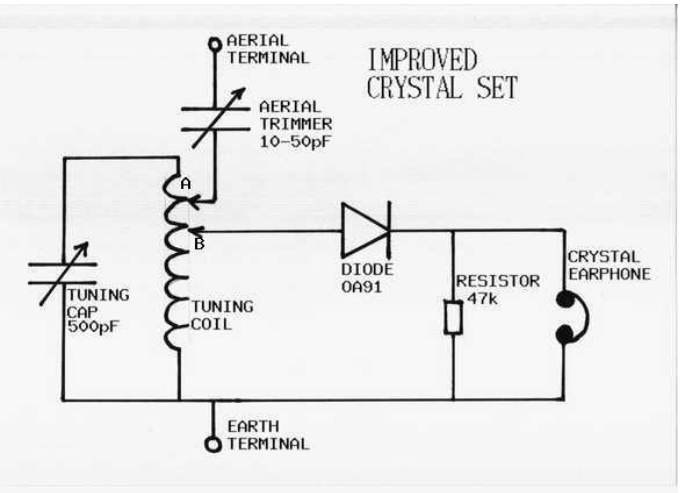

Improved Crystal Set design, with good selectivity

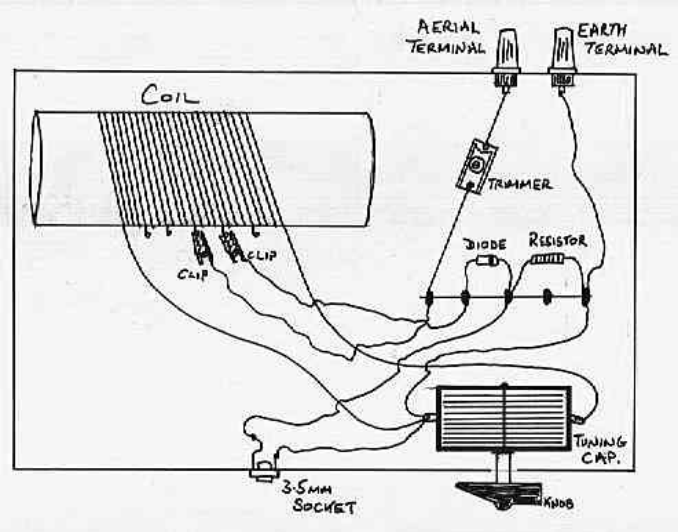

Layout Of The Crystal Set - Although this is soldered together an alternative to tagstrip would be a 5amp mains connector block so that components can be trapped in place with screws. See article below.

The picture on the right shows the general layout of the crystal set above. The coil is of approximately 70 turns is wound on the centre of a toilet roll, and has tapping points at 10 turn intervals.

The trimmer is soldered between the Aerial terminal and the piece of 5-way tag strip, and a wire goes from there to a croc' clip which is clipped onto a tap on the coil. The Diode is also soldered onto the tag strip, one end connected to a piece of wire going to a second croc' clip & connected to a tapping point on the coil, the other end of the diode is connected to the 3.5mm jack socket that the Crystal Earphone plugs into.

The 47k resistor is also connected to the earphone end of the diode and goes to earth, the earth terminal wire is soldered to the tag strip at this point too. The tuning capacitor has two terminals, one connected to each end of the coil, and one of them is also connected to earth as shown. [Where the wires cross over in the diagram, they do not touch and are not connected together].

LONG WAVES

In most areas around Europe and certainly around much of the UK you will be able to hear a Long Wave station. To receive Long Wave on a crystal set will require an aerial coil with a greater number of turns to increase its inductance.

As a good general guide a coil wound on a piece of 10mm diameter ferrite rod will require about 250 turns of enamelled copper wire: First make a paper tube that is held together with sticky tape that will slide up and down the ferrite rod. Then wind the 250 turn coil over this, the windings will have to be made over the top of each other. Make tapping points at, say, 50, 75 and 100 turns to tap the aerial and diode to.

As with the medium wave ferrite rod aerial, adjustments to the tuning range can be made by adding or removing some wire from the coil, and fine adjustments can be made to the completed coil by sliding it up and down the ferrite rod. The longer the ferrite rod the better and anything between 3 and 6 inches long (80 to 150mm) will be very good.

SHORT WAVES

If you like experimenting, then reducing the number of turns on the coil to say 10 to 30 will allow reception of the higher frequencies, the Short Waves. I have found

that winding the coil around a 'ferrite rod' often works even better with short wave reception.

Obtain a ferrite rod about 7 to 15 cm long and about 1cm in diameter. Make a couple of small tubes of card, about 4cm long, that will fit tightly over the rod.

On one tube wind two coils using 0.5mm diameter enamelled copper wire - one coil of about 30 turns and a second one of 2 or 3 turns wound over the top of the first. Secure the windings in place with Sellotape.

On the other card tube wind a similar coil, but use about 15 turns for the first coil and for the second coil wind about 3 to 4 turns over the top, and secure with Sellotape tape.

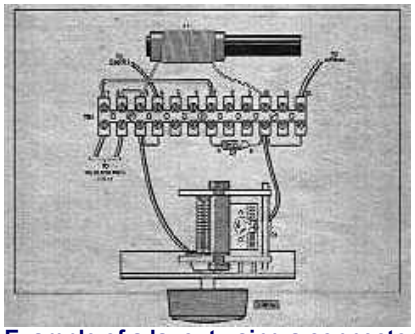

Example of a layout using a connector block to wire up a crystal set

These coils will provide coverage of short wave in two bands using the first coil for the longer wavelengths, typically 60 to 31 metre bands and the second coil for the shorter wavelengths typically 25 to 19 metre band. Wire up the circuit as shown in the circuit diagram below.

USING A TOROID INDUCTOR FOR SHORT WAVES

Even better selectivity performance can be achieved by winding the inductors (coils) on a ferrite toroids (T50-2 yellow, or green will do). The aerial trimmer need not be used if selectivity and sensitivity is found to be adequate. It's all about experimenting, and I find it best to use a trimmer or small coupling capacitor to obtain the best selectivity.

Up to 30 turns of 0.5mm enamelled copper wire can be used for the longer short waves below 10 MHz, while a winding of around 15 turns will provide coverage of the shorter short waves above 10MHz.

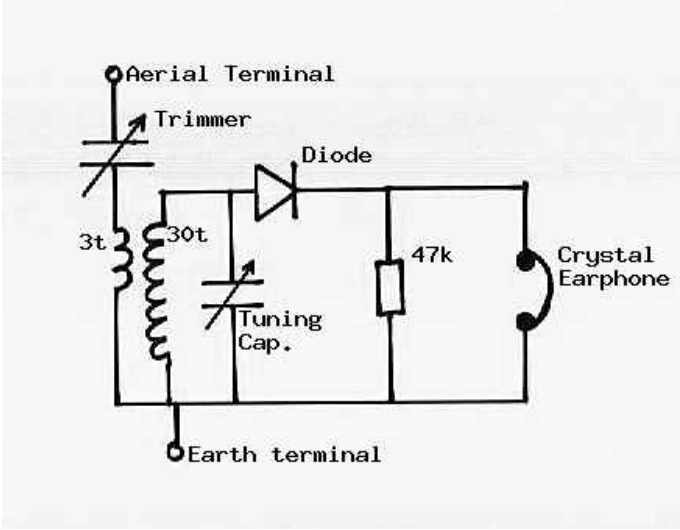

The circuit diagram of the Short Wave Crystal Set

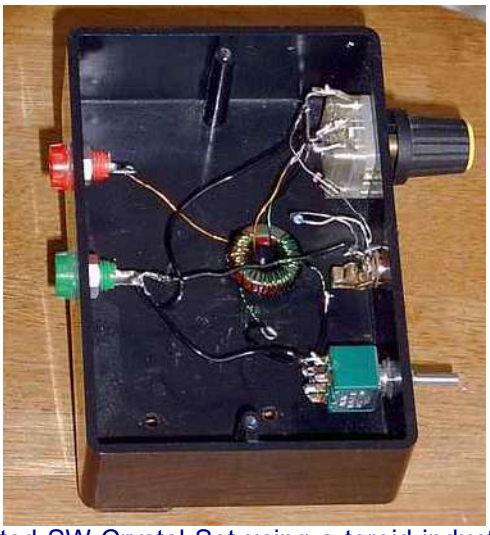

A completed SW Crystal Set using a toroid inductor. Note: the main winding has a tap to allow the switch to short part of the winding and thereby give two ranges.

AUSTRALIAN DESIGN

Moving back to the Medium Waves, here is a circuit for a very interesting Australian design that promises extremely good station separation (selectivity), and having built it I can vouch for that claim, it's really excellent.

I receive three national stations and three local stations at my location with excellent clarity using a modest antenna and standard crystal earphone.

The coil is different to the other crystal sets described above, it is

The front panel of the Australian Crystal Set

much bigger at 3¼ inches (8cm) diameter and 5inches (12cm) long. I made my coil former out of the cardboard from a breakfast cereal box - just like Blue Peter!

The design is often referred to as The Mystery Crystal Set, by Proton.

Two distinct coils are wound on it, the first one consists of about 50 turns of 24 s.w.g (approx) enamelled copper wire. The second coil is 25 turns, very close wound right over the top of the first coil using 30 s.w.g. (approx) wire, try to get this second coil wound in between the windings of the first, for better inductive coupling.

Then carefully wire up the set according to the diagram. Notice that the tuned circuit is not connected to earth and has no *direct* connection to the detector circuit. The detector circuit *is* connected to earth however. The two aerial terminals offer alternative selectivity performance, terminal A gives very good selectivity while B is very wide. I never bother with B.

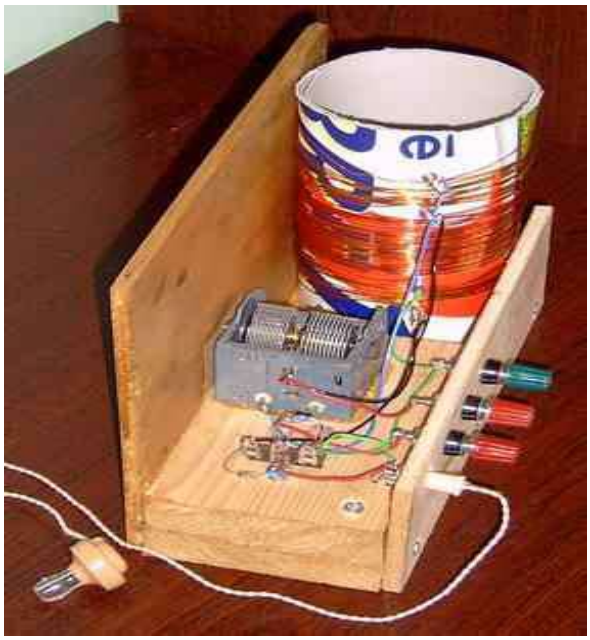

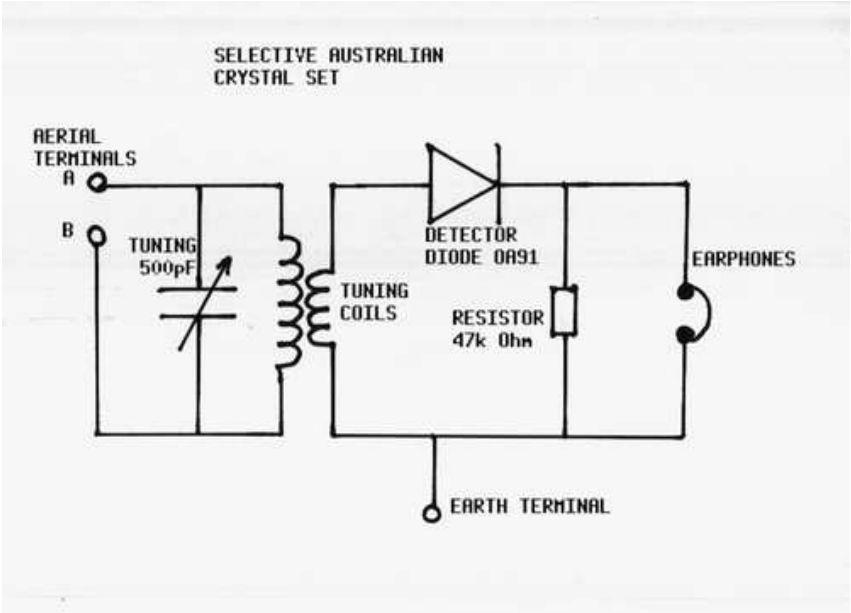

Make the coil carefully and wire up this crystal set according to the circuit diagram opposite and you will be rewarded with a really high performance crystal set of a type that was used in the very early days of broadcasting in 1930's in Australia.

This is probably my favourite crystal set!

THE DENCO PCC1 COIL

The PPC1 coil was a commercially manufactured by Denco Clacton Ltd and was popular among hobbyists not keen on going to the bother of winding their own fiddly little coils. As a child I wanted try one of these coils and sent away for one by mail order. It arrived a few days later in a little cloth bag, like a miniature pump bag, with protective wrapping inside.

The coil windings are entirely enclosed in what I can only describe as a cylindrical ferrite 'shell', the four very thin connecting wires exiting, two either side, from small apertures in the 'shell'. The performance of the circuit shown below I seem to remember was quite pleasing. Unfortunately I cannot find the set or the PPC1 coil at the moment, but here is

a reproduction of the circuit diagram and data:

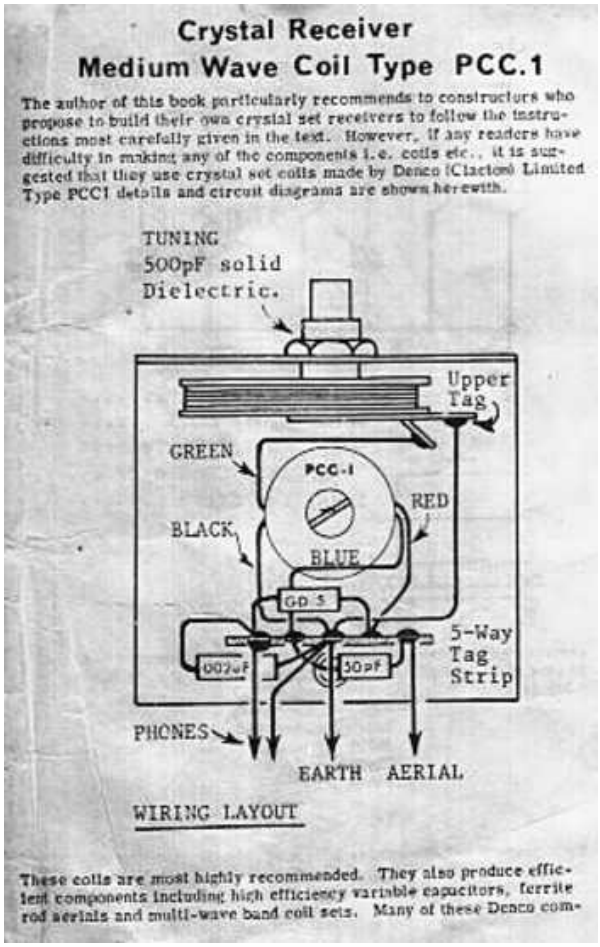

Crystal Receiver
Medium Wave Coil Type PCC.1

The author of this book particularly recommends to constructors who propose to build their own crystal set receivers to follow the instructions most carefully given in the text. However, if any readers have difficulty in making any of the components i.e. coils etc., it is suggested that they use crystal set coils made by Denco (Clacton) Limited Type PCC1 details and circuit diagrams are shown herewith.

WIRING LAYOUT

These coils are most highly recommended. They also produce efficient components including high efficiency variable capacitors, ferrite rod aerials and multi-wave band coil sets. Many of these Denco com-

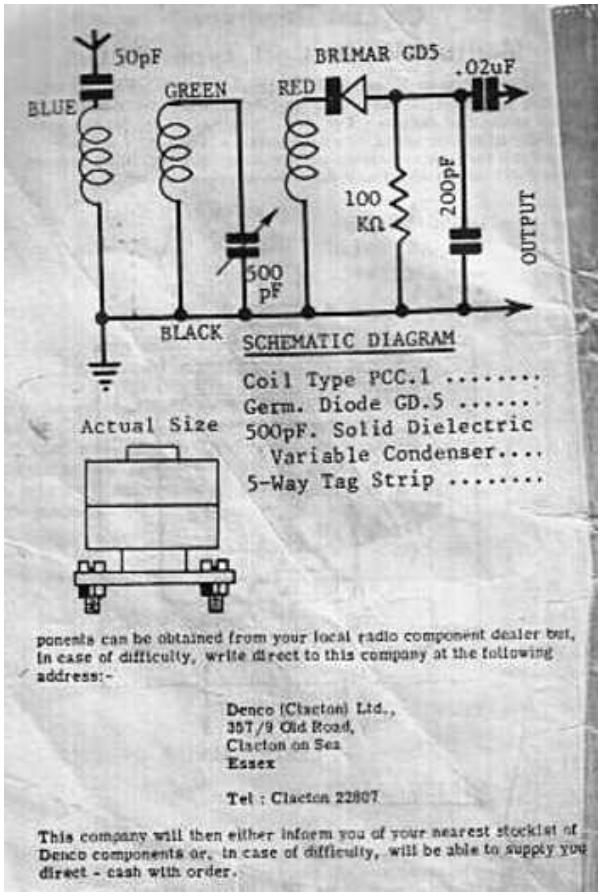

SCHEMATIC DIAGRAM

Coil Type PCC.1 .....
Germ. Diode GD.5 .....
500pF. Solid Dielectric
Variable Condenser....
5-Way Tag Strip .....

Actual Size

ponents can be obtained from your local radio component dealer but, in case of difficulty, write direct to this company at the following address:-

Denco (Clacton) Ltd.,
357/9 Old Road,
Clacton on Sea
Essex

Tel : Clacton 22807

This company will then either inform you of your nearest stockist of Denco components or, in case of difficulty, will be able to supply you direct - cash with order.

THE REPANCO DRR2 COIL

I recently rediscovered an old Repanco DRR2 Longwave / Mediumwave coil that must have been kicking around in my junk box since the 1970's.

The DRR2 coil was made by Repanco in Coventry. It came with a page of suggested circuit diagrams which I thought had been lost to the mists of time, but it recently came to light again, so I have now copied it below.

Once again I included an aerial trimmer which can be adjusted to improve selectivity.

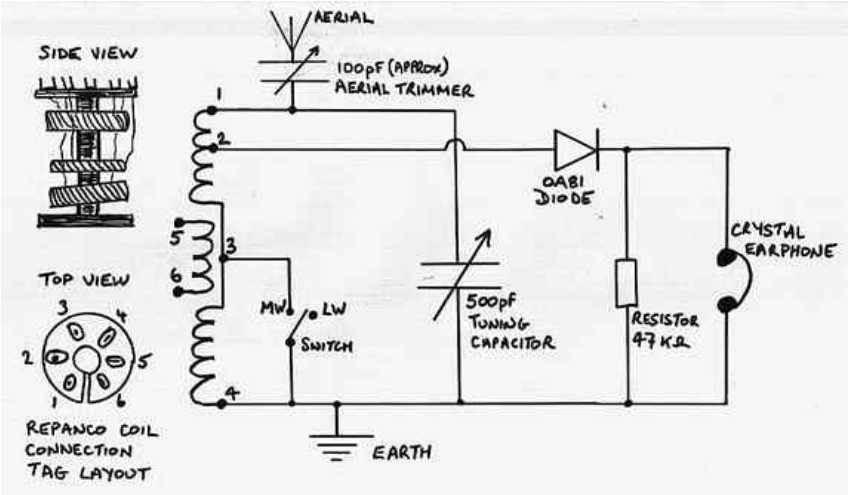

The circuit diagram of the crystal set using the Repanco DRR2 coil

Repanco Ltd was formed by two ex-army signals engineers and from the earliest days of radio supplied crystal set kits and coils to radio construction enthusiasts.

The Repanco DRR2 coil was for medium wave and long wave intended for use in when building simple crystal set and valve radio

A 'lash-up' of the Repanco crystal set

circuits.

It consists of three coils; a Medium Wave coil at the top that includes a tapping point (for the aerial); a coupling coil or tickler in the middle; a lower coil which can be connected in series with to top coil to provide Long Wave reception.

I have built a quick crystal set with the coil and it provides good reception with excellent selectivity, so it must have a very good Q factor.

The Repanco DDR2 coil was provided with a simple Foolscap size information sheet that showed four different radio circuits. Sadly the sheet does not give a huge amount of information and my copy is now rather tatty and faded - it is copied below:

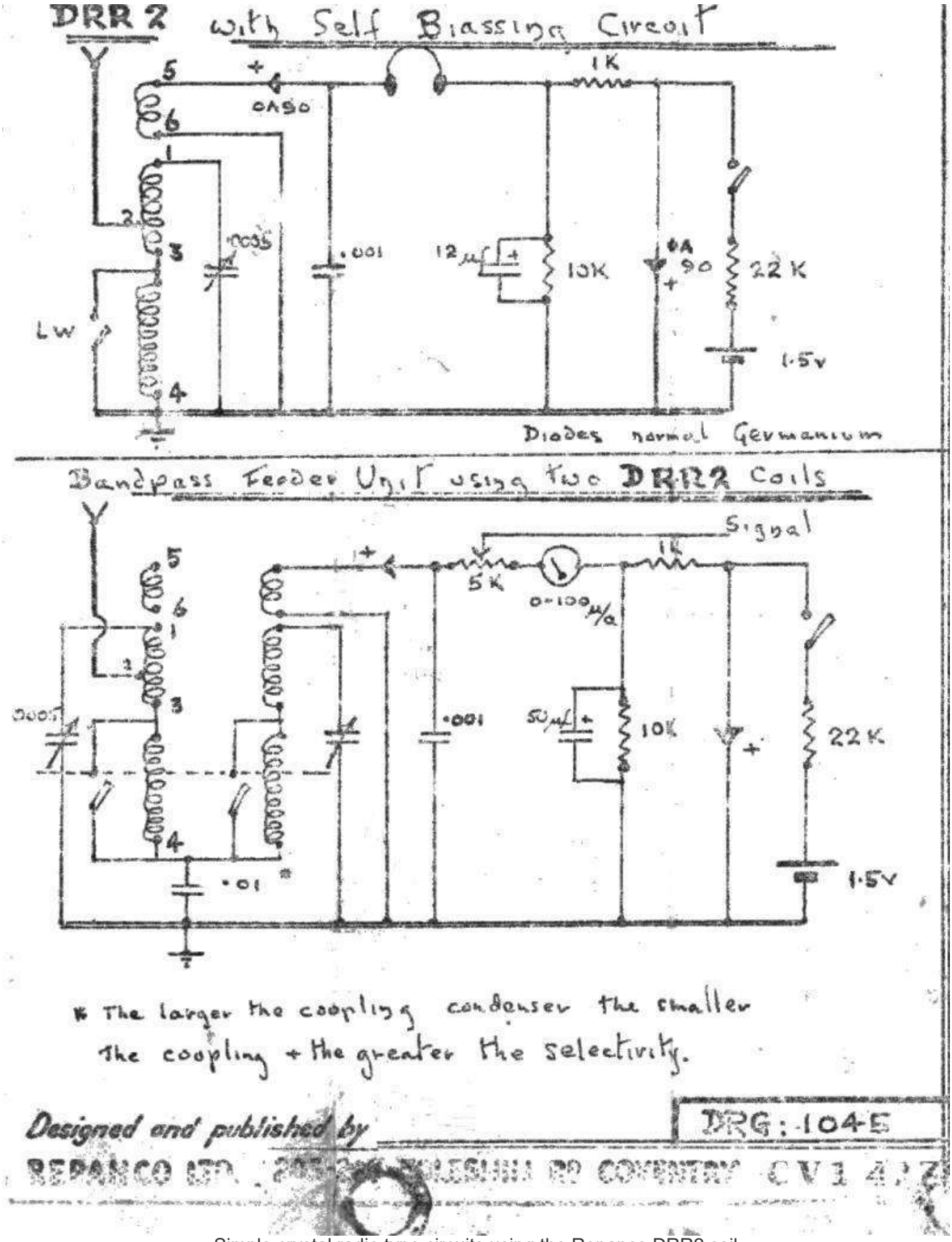

Simple crystal radio type circuits using the Repanco DRR2 coil

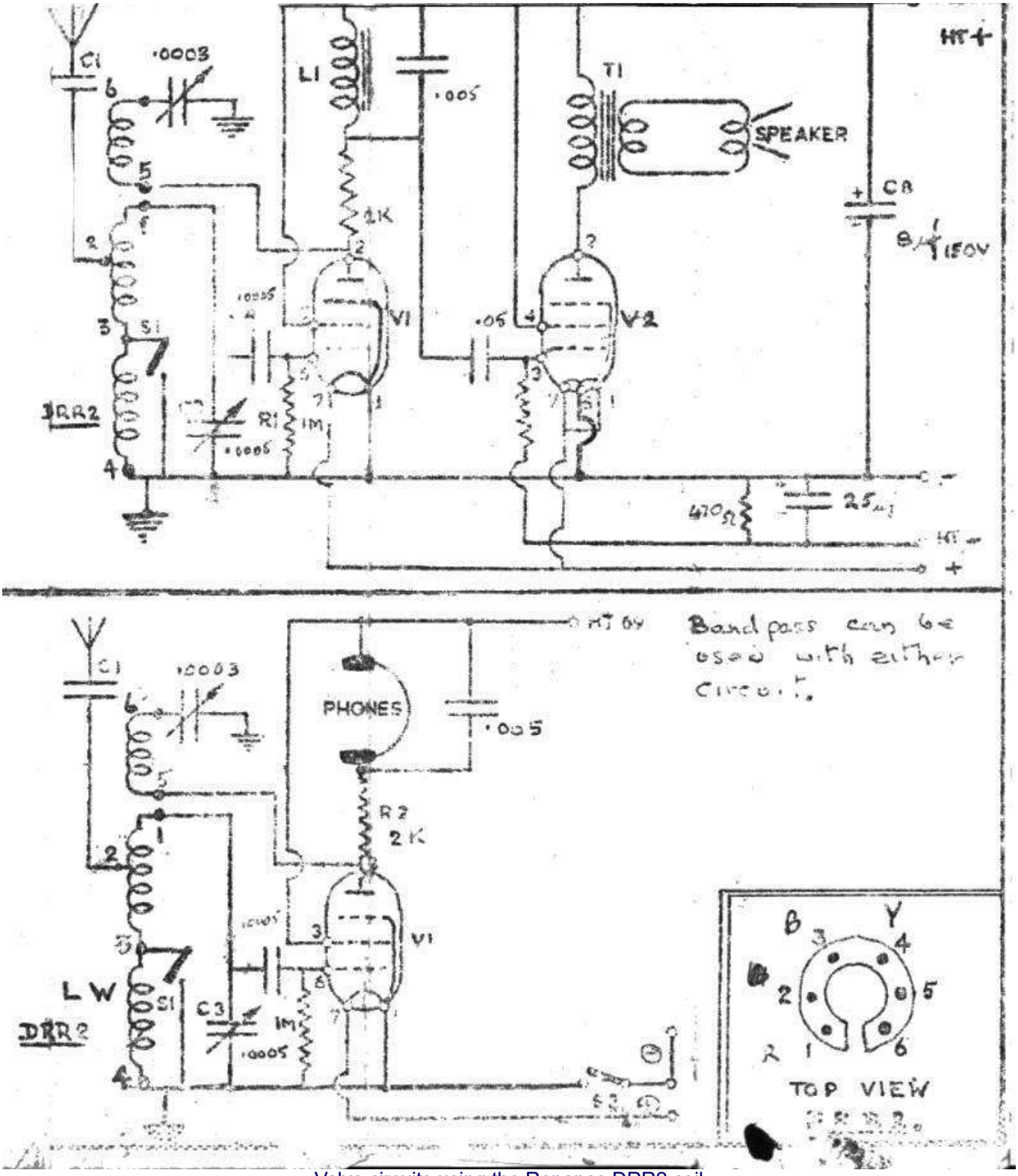

Valve circuits using the Repanco DRR2 coil

Repanco Ltd no longer produces radio coils and crystal set kits for the radio construction enthusiast, as it did in the early days of radio. In 1986 it was renamed Repanco Bartlett Ltd when it merged with Bartlett Electronics. The company moved from the Foleshill Road to Unit 24, Albion Industrial Estate, Endemere Road, Coventry CV6 5NT and now specialises in transformers and wound components and can design and manufacture to commercial customer requirements, their website is: http://www.repancobartlett.co.uk/

CRYSTAL EARPHONES

Here is a good idea and well worth trying, to maximise the use of sound output from your crystal set why not use dual crystal earphones? Having an earphone in each ear helps to block out extraneous noises helping the listener to better concentrate on any weaker stations received.

Using the circuit below, one earphone makes use of one half cycle of the radio wave while the second earphone uses the other half cycle of the wave that would have previously gone to waste when using just one diode. Ensure that the diodes are connected up according to the diagram i.e. one diode is connected the opposite way round to the other.

Also try to make sure that the diodes and crystal earphones are similar to obtain the best results. (You could simply connect two crystal earphones to the same terminals of the single diode, but this would not be as efficient and the sounds would be much quieter.)

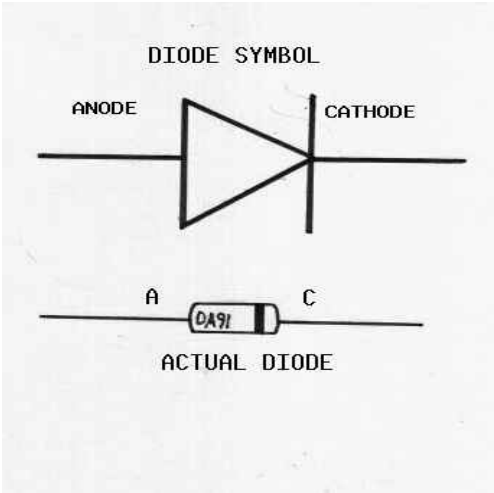

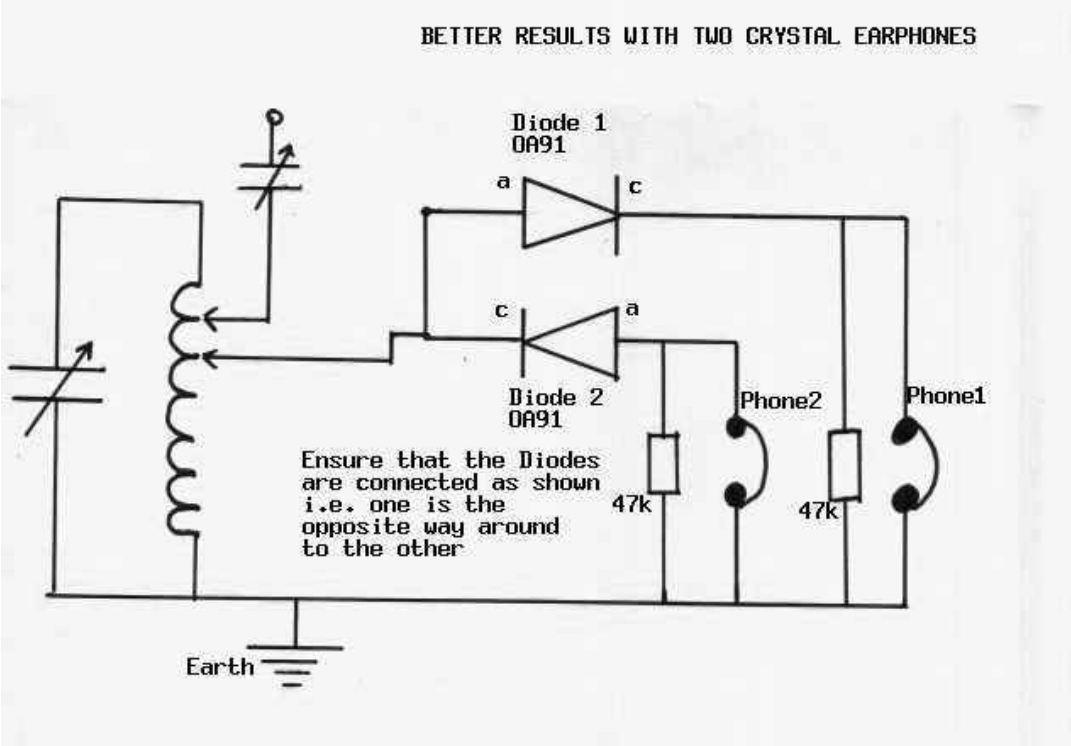

A note about Crystal Earphones: It will be worthwhile buying several different ones from different sources as performance varies between manufacturers quite markedly. I have found the ones marked 'Japan' on the back are the most sensitive and therefore loudest, whereas ones marked 'Receiver' 'Taiwan' are often a little less sensitive and therefore quieter and sometimes more 'tinny' sounding.

As mentioned previously it has been noted that the OA47 diode will be of particular interest since it has the lowest forward bias voltage of any of the common diodes available. This will make the crystal set somewhat more sensitive and therefore louder. The US equivalent of the British OA47 is the IN34.

SPIDERS WEB' COIL

Here is an interesting concept sent in by Chris Dorna of the Vught North Scouts in the Netherlands. It is a crystal set made out of a coil wound in the form of a spiders web:

See more HERE.

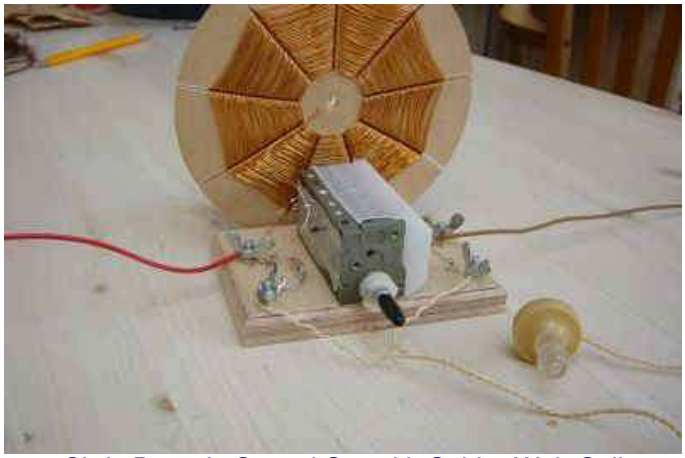

Chris Dorna's Crystal Set with Spider Web Coil

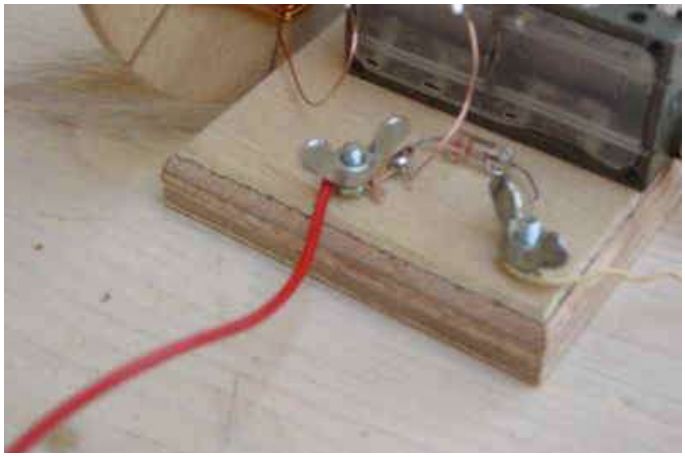

Detail of the germanium diode

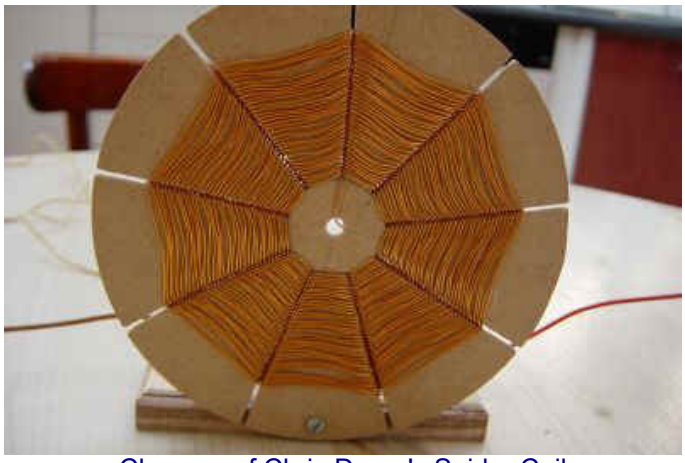

Close up of Chris Dorna's Spider Coil

LOOP THE LOOP!

A crystal set can also be made that does not need a large long wire aerial. If you have ever made a loop aerial for medium wave or long wave DX-ing, then it is a simple matter to add a diode, resistor and a socket to connect a crystal earphone that will allow reception of nearby stations.

See my section on Loop Aerials and ATU's for more constructional details.

A portable loop aerial, that incorporates a crystal set

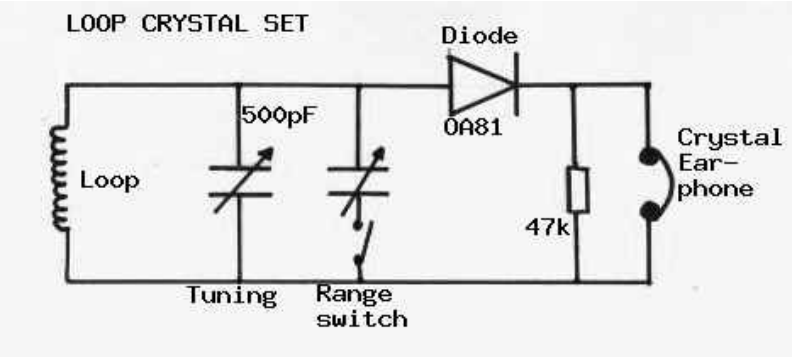

The circuit diagram of the Loop Crystal Set. The loop is 10 turns of 7/0.2mm 'hook-up' wire wound on a 40cm (17") former made of attractive plastic edging strip available from many DIY stores. The loop is very directional in its pick up pattern, which can help eliminate interference from some stations by rotating the loop. The switch and additional capacitor allow tuning of the lower medium wave band from about 650 to 520 kHz. Having a loop with 50 to 60 turns of wire will tune into the Long Wave band.

DIODES - For Crystal Set Use - some notes by Felix Scerri

Germanium diodes for crystal set use.

Although I'm a fan of these new silicon schottky BAT 46 diodes, good germanium diodes still have a lot to offer, especially in terms of 'weak signal' sensitivity. Last night I did an experiment.

I sorted through quite a few of my hundreds of acquired random germanium diodes looking for particularly 'sensitive' ones. I tested this by tuning in a weak AM station and comparing the detected DC output level and also the apparent 'loudness' of the audio signal.

Even amongst germanium diodes of the same type, there was enormous variation all the way from excellent to poor! For very weak signals, germanium diodes 'detect' in the 'square law' region below the diode conduction 'knee', in a rather different part of the curve than with much stronger signals (way beyond the diode knee).

When testing germanium diodes for weak signal sensitivity, the inherent capacitance of the diodes is also a factor, and the 'tuning' may change somewhat and will need to be readjusted with every diode tested!

In the end, out of a large number of germanium diodes tested, I found three or four germanium diodes with excellent weak signal sensitivity and the rest were poor. One other interesting thing, good germanium diodes 'sound' different, rather more 'rounded and smoother' than the schottky's which tend to sound mercilessly clean, almost clinical. I also found almost no variation in weak signal sensitivity with my BAT 46 schottky diodes. Take your pick!

Regards, Felix Scerri VK4FUQ 14/03/2012

SOLDERLESS CONSTRUCTION IDEAS

For a novice the use of a soldering iron may seem a bit daunting at first and while the most reliable results will be obtained with a good soldered joint using a tag strip as shown below, the circuits can still be made without the use of a soldering iron.

5 WAY TAG STRIP

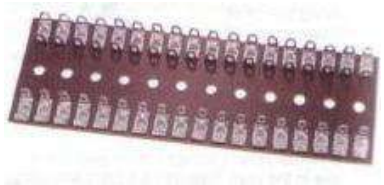

36 WAY TAG STRIP - TWO ROWS

The very simplest circuits could be wired together ,with a little ingenuity, with the component wires being held together in the grip of solderless crocodile clips, whereby the connecting hook-up wire is fixed to the croc' clip by a screw rather than solder.

For more the slightly more complex circuits a plastic Terminal Block (sometimes referred to as a choc' or chocolate block) can be utilised very effectively indeed. These are used in mains wiring and are available in various sizes; 2 Amp, 5 Amp, 15 Amp and 30 Amp. The 5 and 15 Amp Terminal Blocks I have found to be the most suitable. The various component wires can be trapped securely with the screw at each junction point. This method also makes it easy to change the components around when experiment with different circuits. See The EXPERMENTAL CRYSTAL SET for more details in Part 5.

'CHOCOLATE' TERMINAL BLOCK

The Ladybird book called 'Making A Transistor Radio' (also shown on the TRF Radio pages) detailed a very novel approach using brass screws with screw-cups to trap the component wires at each junction point:

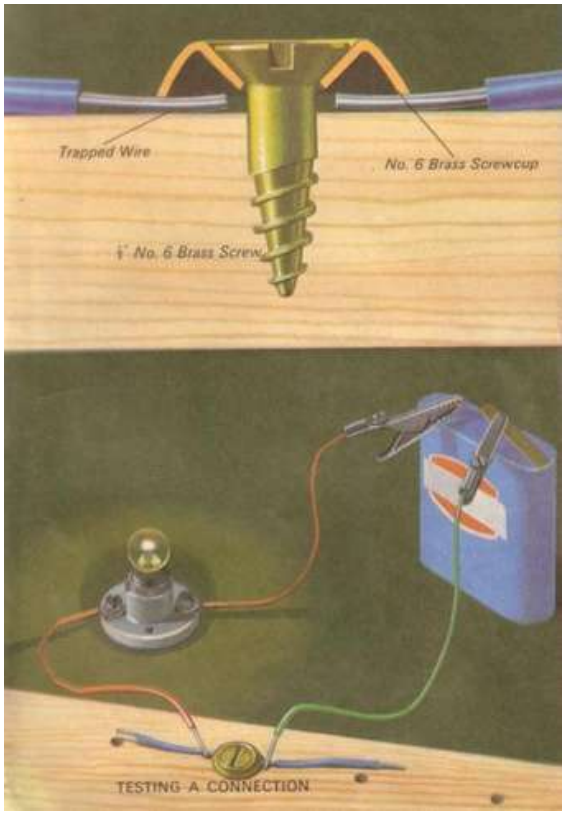

THE BRASS SCREW AND SCREW-CUP METHOD OF CONSTRUCTION

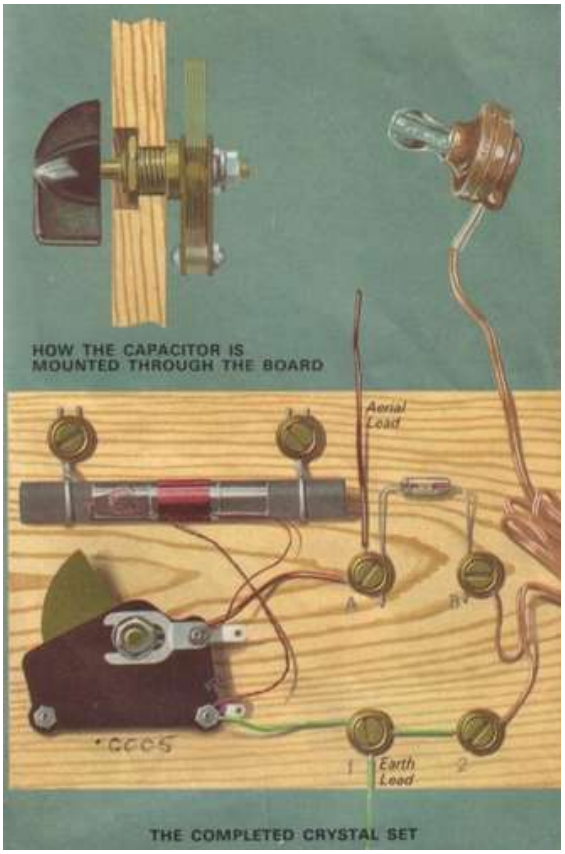

A VERY SIMPLE CRYSTAL SET USING THE BRASS SCREW AND CUP METHOD

Crystal Sets Part Part 3 >

No AM radio stations or transmitters in your locality or country?

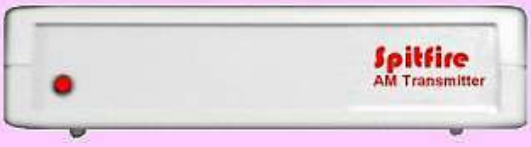

Has your local medium wave broadcast station closed or been moved to VHF/FM or Digital? Don't worry. You can still build and experiment with crystal sets and TRF radios by also buying or even building a simple low power AM transmitter. So, not only can you use your crystal sets but you can also run your own radio station that can be heard in and around your home - playing the music or programmes that you want to hear!

SSTRAN AMT3000: Superb high fidelity medium wave AM transmitter kits from SSTRAN. Versions available for 10kHz spacing in the Americas (AMT3000 or AMT3000-SM) and 9kHz spacing in Europe and other areas (AMT3000-9 and AMT3000-9SM). Superb audio quality and a great and well designed little kit to build:
http://www.sstran.com/pages/products.html

http://www.sstran.com/

Other AM transmitters available:

Spitfire & Metzo: Complete, high quality ready built medium wave AM Transmitters from Vintage Components: http://www.vcomp.co.uk/index.htm Vintage Components offer a choice of the high quality Spitfire and Metzo transmitters:

SPITFIRE AM Medium Wave Transmitter with 100 milliwatt RF output power:

http://www.vcomp.co.uk/spitfire/spitfire.htm

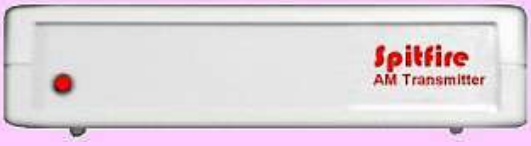

METZO AM Medium Wave Transmitter with built in compressor:

http://www.vcomp.co.uk/metzo/metzo.htm

AM88 LP: A basic AM transmitter kit from North County Radio.
http://www.northcountryradio.com/Kitpages/am88.htm

LINKS:

BOWOOD ELECTRONICS - A friendly, helpful and very speedy source for many of your electronic components at prices that won't frighten your wallet!

THE FOXHOLE and P.O.W RADIOS - Simple crystal set receivers used by soldiers during the war and by prisoners of war (P.O.W.'s).

VINTAGE COMPONENTS - A great resource for crystal sets, components, valve radio kits and medium wave AM transmitters!

6V6 - Electronic Nostalgia and Vintage Components

Crystal Sets Part 3 >

Crystal Sets (Part1) | **Spider's Web Crystal Set (Part 3**

Crystal Set by Kenneth Rankin (Part 4) | **Experimental Crystal Sets (Part 5)** | **Crystal Radio Links**

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Crystal Sets Introduction | Resistor & Capacitor Conversion Tables

www.mds975.co.uk © 2004 - 2014

Mike's Electronic Parts, LLC
Simple Crystal Radio Kit 2

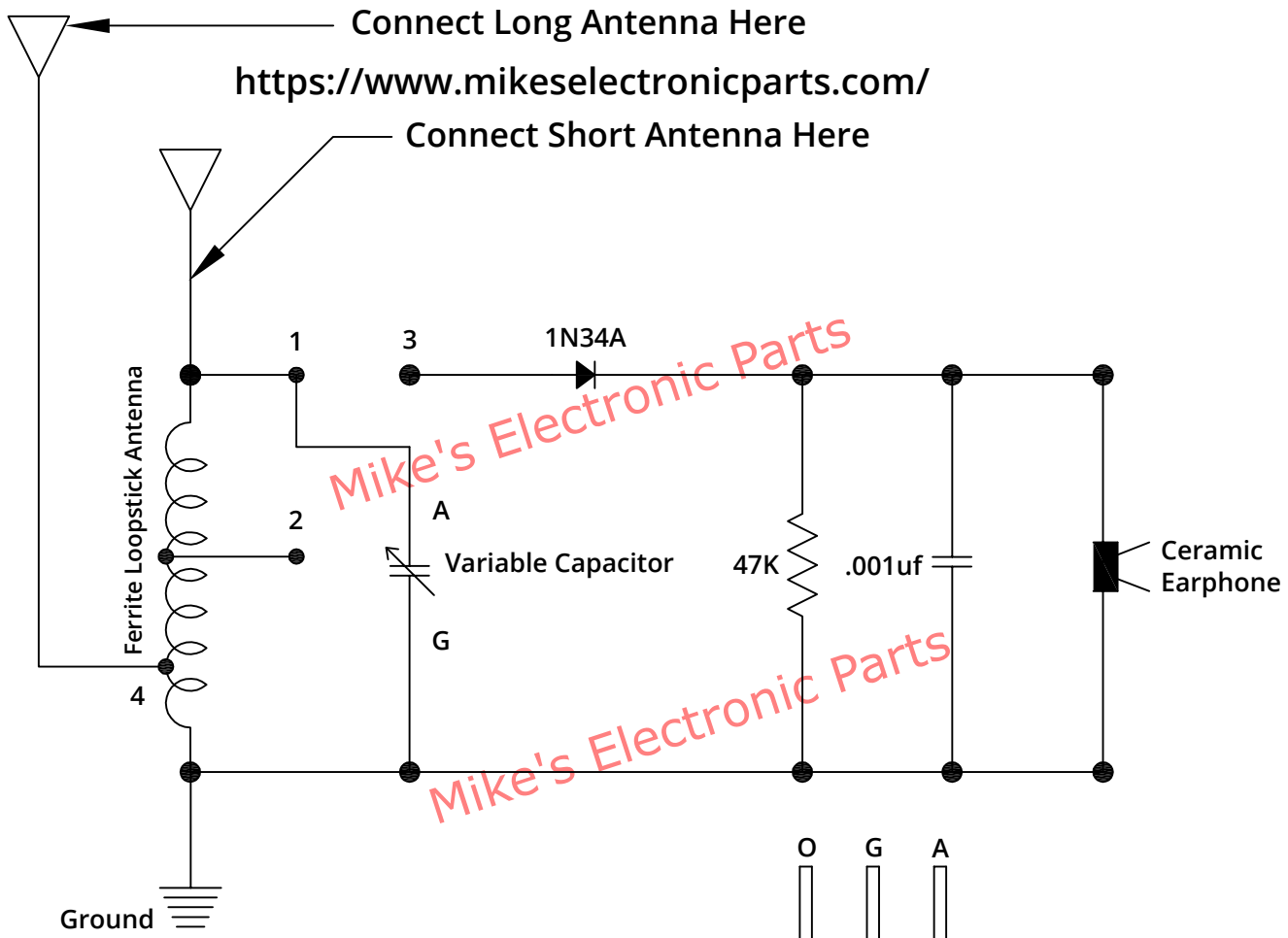

Mike's Electronic Parts
Mike's Electronic Parts

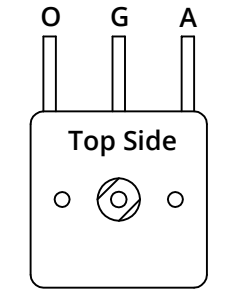

Parts List
1 - Ferrite Loopstick Antenna
1 - Variable Capacitor
1 - Germanium Diode 1N34A
1 - .001uf Capacitor Marked 102
1 - 47K Resistor
1 - 20 Million Ohm Ceramic Earphone
Antenna and Ground wire not include with parts

For short antenna connect a 15ft to 30ft length of wire to "1". For long antenna 40ft to 100ft connect to "4". It is best to use a long wire antenna. If you are not using the taps do not cut the wires. Doing so will cause the coil not to work. Various connections are, Connect 1 to 3 or Connect 2 to 3. Most volume can be had at 1 to 3 less volume but better selectivity connect 2 to 3 and the antenna connected at 1. It is best to solder the coil wire, not doing so may cause a bad connection and the radio will not work.
Drawn By: Scott Lowe
This Kit can be bought at my web site Part Number CRK#2 Kit.

https://www.mikeselectronicparts.com/

THE SMITHSONIAN INSTITUTION

The Smithsonian Institution is home to more than 141 million objects, ranging in size from insects and diamonds to locomotives and spacecraft. It is the world's largest museum complex, comprising 15 museums and galleries and the National Zoo in Washington DC, and two additional museums in New York City. Millions of visitors each year visit the nation's capital to view such treasures as the Hope Diamond, the Star Spangled Banner, and the Wright Flyer. A broad range of exhibits ensures a fun and educational experience for young and old alike.

One of the world's leading scientific research centers, the Institution has facilities in eight states and the Republic of Panama. Research projects in the arts, history and science are carried out by the Smithsonian all over the world. Some of the Smithsonian's research centers include the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, the Smithsonian Marine Station at Link Port, in Florida, and the Smithsonian Tropical Research Institute, in Panama.

For membership information of pre-visit planning material, write or call the Visitor Information and Associates Reception Center, Smithsonian Institution, Washington, D. C., 20560, (202) 357-2700 (voice), (202) 357-1729 (TTY). You may also visit the Smithsonian through our web site, www.si.edu.

HISTORY

James Smithson (1765 –1829), a British scientist, drew up his will in 1826 naming his nephew, Henry James Hungerford, as beneficiary. Smithson stipulated that, should the nephew die without heirs (as he did in 1835), the estate would go to the United States to found "at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge..."

On July 1, 1836, Congress accepted the legacy bequeathed to the nation by James Smithson, and pledged the faith of the United States to the charitable trust. In 1838, following approval of the bequest by the British courts, the United States received Smithson's estate—bags of gold sovereigns—then the equivalent of $515,169. Eight years later, on August 10, 1846, an Act of Congress signed by President James K. Polk, established the Smithsonian Institution in its present form and provided for the administration of the trust, independent of the government itself, by a Board of Regents and Secretary of the Smithsonian.

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National Postal Museum
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Smithsonian American Art Museum

SMITHSONIAN®

CRYSTAL RADIO™

WARNING!
ONLY FOR USE BY CHILDREN OVER 8 YEARS OLD.

READ THE INSTRUCTIONS BEFORE USE, FOLLOW THEM AND KEEP THEM FOR REFERENCE. STORE THE SET OUT OF REACH OF SMALL CHILDREN.

PLEASE KEEP A NOTE OF OUR NAME AND ADDRESS DETAILS FOR FUTURE REFERENCE. IN EUROPE CONTACT:

CE

NSI SIMM GAmbH
D 76162 KARLSRUHE
GERMANY
49-0721-9584-116

PLEASE BE SURE TO READ THE ADVISE FOR SUPERVISING ADULTS AND THE SAFETY RULES CONTAINED IN THIS BOOKLET.

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PRINTED IN USA

ITEM NO. 3261-08

ADVICE FOR SUPERVISING ADULTS:

• READ AND FOLLOW THESE SAFETY INSTRUCTIONS, THE SAFETY RULES AND KEEP THEM FOR REFERENCE.

• SUPERVISING ADULTS SHOULD DISCUSS ANY WARNINGS AND SAFETY INFORMATION WITH THE CHILD BEFORE COMMENCING THE ACTIVITIES.

SAFETY RULES:

• DO READ THE INSTRUCTIONS BEFORE USE, FOLLOW THEM AND KEEP THEM FOR REFERENCE.

• DO KEEP YOUNG CHILDREN AND ANIMALS AWAY FROM THE ACTIVITY AREA.

• DO STORE THE SET OUT OF REACH OF YOUNG CHILDREN.

Facts about early crystal development

Several inventors receive credit for developing a "crystal detector", a device which can pass current better in one direction than the other in an electrical circuit. In Germany, in the 1870's, Karl F. Braun noticed this property in certain mineral substances. Commercial development required a technology that would be suitable. This came with the advent of wireless communication and radio after 1900.

In Japan, Wichi Torikata investigated many minerals, including zincite, pyrolusite, iron pyrites and galena. In the United States, Greenleaf W. Pickard, associated with the Wireless Specialty Apparatus Co. of Boston, conducted extensive experiments as well. He became well known for the PERIKON Detector which employed zincite and chalcopyrite. The early 20th century work was generally done between 1900 and 1912. Included among the scientists is General H.H.C. Dunwoody of the U.S.Army who developed a carborundum detector.

Until radio broadcasting began in 1920 (Station KDKA Pittsburgh) experimenters utilized the crystal detector for radiotelephone communications and for reception of certain Morse Code signals. There was also extensive use by the U.S.Navy and other maritime services.

The modern crystal diode, such as provided with your set, is a spin-off of radar technology developed during World War II. The basic principle, however, remains the same..i.e. to remove the AUDIO (speech, music or Morse-Code) from the radio frequency carrier wave. In one early Pickard crystal design (left) a stiff metal point is adjustable over the crystal surface. In a later version a "Catswhisker" spring impinged on a piece of galena (right) and was varied to give a louder signal.

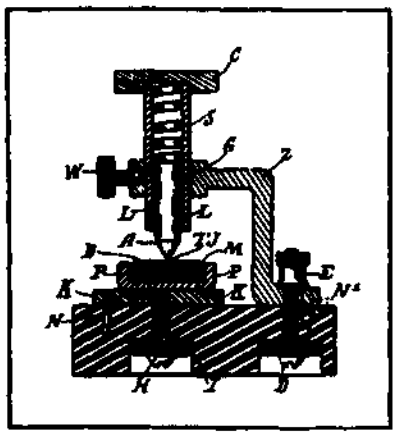

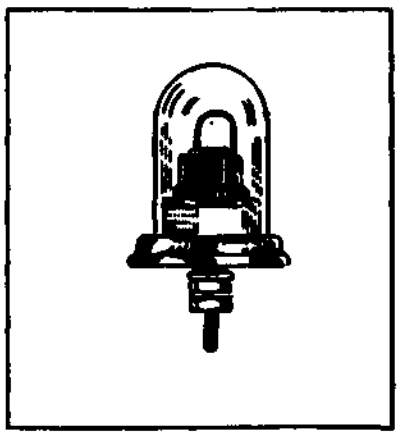

Your Smithsonian Smart Lab Crystal Radio Set contains the following items

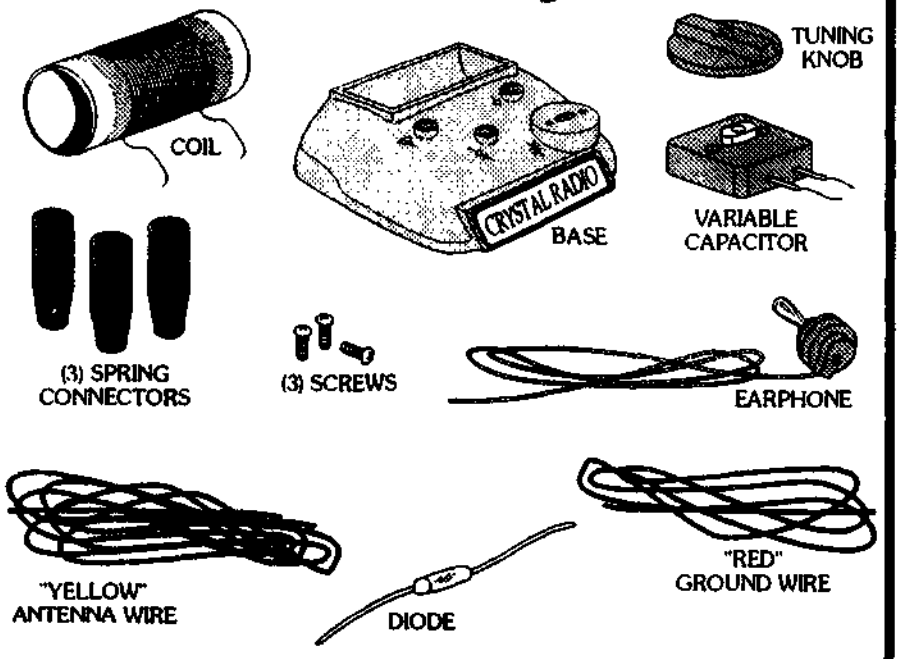

Shown below is a typical wiring diagram of your crystal radio.

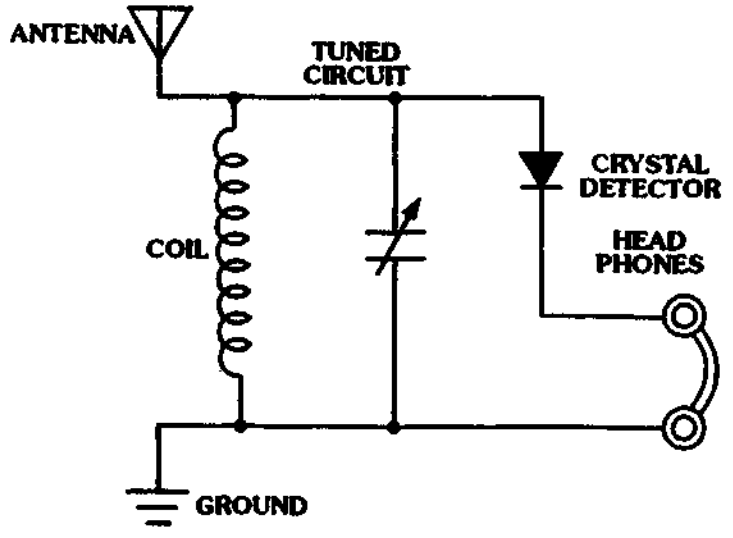

Radio Technology (cont'd)

When these two different energy waves are put together by the mixer stage of the transmitter, the resulting wave, which is the signal that the station broadcasts, looks like this:

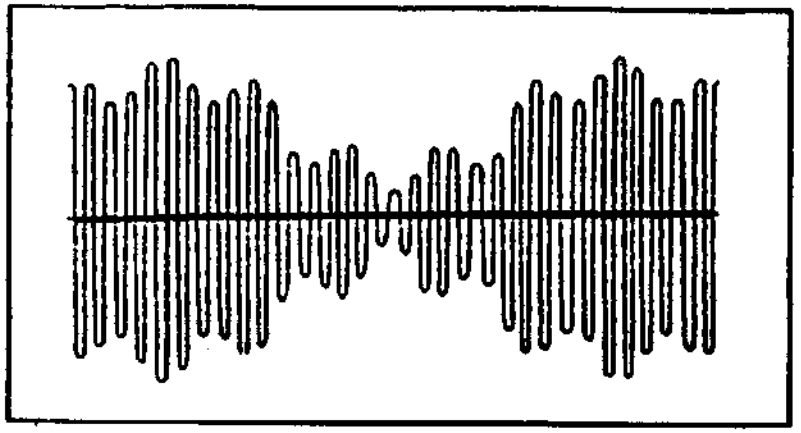

AM Broadcast Wave

The signal is called a MODULATED wave. You will notice that each of the waves is the same length, but the heights vary. Since the height of a wave is called its AMPLITUDE, The type of transmission that WXYZ uses is called AMPLITUDE MODULATION. That's why WXYZ is called an AM station.

The crystal radio that you built works in just the opposite way as the radio station. The modulated signal broadcast by WXYZ is "picked up" by the antenna on your radio.

The antenna is connected to the tuner circuit of the radio, which is made up of a coil of wire and a variable capacitor connected together. As you move the tuning knob, you are able to select, or isolate, the particular

This signal is then DEMODULATED by the diode, separating the voice (audio) wave from the carrier wave.

The voice (audio) wave then moves to the earphone, where it is changed back into sound waves that you can hear.

Learn the basic electronic symbols

Before starting to assemble your Smart Lab Crystal Radio please learn the basic electronic symbols that are shown on the plastic base.

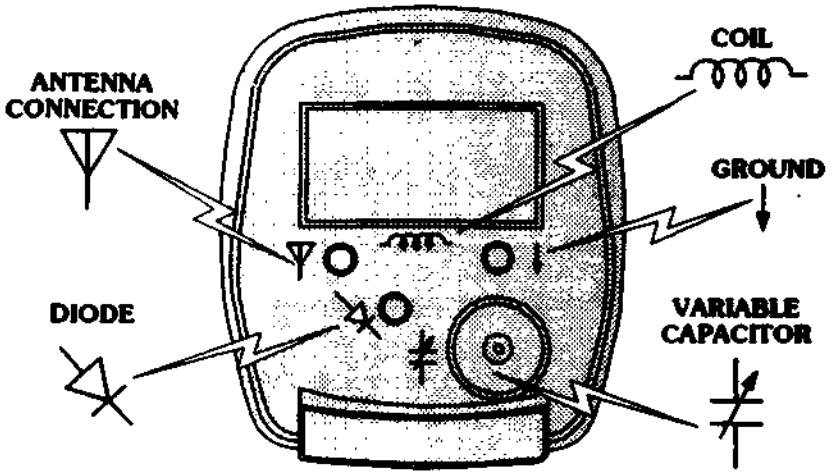

Explanation of components

Variable Capacitor - It is used to tune the radio to a station. The leads that are soldered to the lugs are used to connect it to the circuit.

Diode - A small crystal is sealed inside with leads connected to it. Pay careful attention to the position of the black bands painted on the diode close to one end.

Coil- This is a radio-tuning COIL. It was made by winding enameled copper wire around a paper core 80 times. The leads have been stripped and tinned so it can be connected to the circuit.

Earphone - It contains a small crystal that can make enough electricity to drive a metal diaphragm to produce sound. The leads have been stripped and tinned so it can be connected to the circuit.

Antenna - This is a wire used for radiating or receiving radio waves.

Ground - This is a wire used to make a electric connection with the earth or other type of grounding source to create a common return for an electric circuit.

DEAR CUSTOMER:

If we made an error and left something out of this set, or if something is damaged, we are sorry and wish to correct our error.
Please **DO NOT** return the set to the store where purchased, as the store does not have replacement parts. Instead, write us:

Please include:
1. Date of Purchase
2. Where purchased
3. Price paid
4. Model Number
5. Name of item
6. Brief Description of Problem
7. Include Sales Slip

We will do our best to satisfy you. Send your letter to:

NATURAL SCIENCE INDUSTRIES, LTD.
910 ORLANDO AVENUE
WEST HEMPSTEAD, N.Y. 11552-3942
ATTENTION: QUALITY CONTROL DEPT.

How to assemble your Crystal Radio

Before starting, it's important to assemble the parts correctly. Carefully read the following instructions step by step and have fun . . . half the fun is knowing you made your very own crystal radio.

Step 1

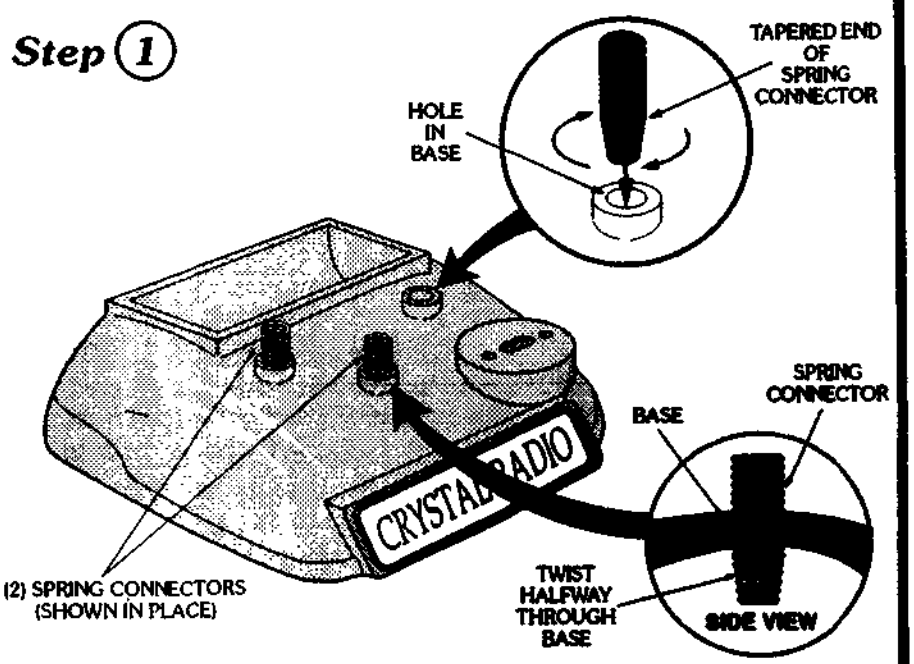

A. Locate the three Spring Connectors.
B. Insert one of the Spring Connectors (tapered end first) into one of the three holes on the Base.
C. Push down on the Spring Connector and twist to the right until the Connector is approximately half way through the base.

NOTE: Check to see if the Spring Connecter is inserted halfway through the Base by turning Base upside down (see insert).
D. Insert the remaining two Spring Connectors into the holes on Base the same way.

Radio Technology

Now that you have your crystal radio assembled and working, it is time to take a brief look at how it works. To do this you are going to take an imaginary trip to a radio station WXYZ, in anytown,USA.

When you arrive at WXYZ, you are met by the station's general manager, Mr. Smith, who is going to show you around.

First, Mr. Smith takes you to a STUDIO, a special room that a program comes from. There is a lot of equipment, including dials and switches, record players, lots and lots of records, and microphones.

Mr. Smith tells you that when you talk into one of the microphones, your words go into the station's electronic equipment. There, it is mixed with the station's carrier wave, and sent out into the air through the station's transmitting antenna - that tall tower you saw on top of the radio station building.

Then Mr. Smith takes a piece of paper and a pencil, and draws diagrams to show you what happens. He begins by saying that all energy travels in waves, and since the sound we make when we talk is a form of energy, it might look something like this:

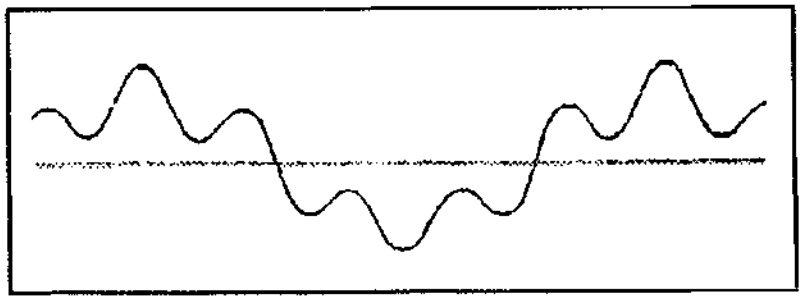

Sound Wave

The station's carrier wave is a radio wave, which is also a form of energy, which looks something like this:

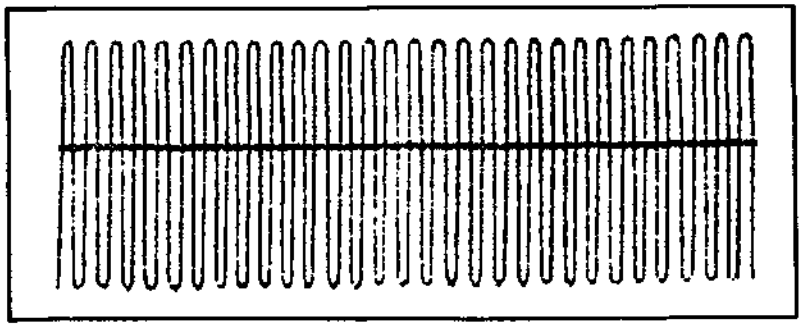

Radio Carrier Wave

How to properly operate your Smart Lab Crystal Radio and troubleshoot

After you have attached all the wires, carefully read the following instructions to make sure your crystal radio operates properly.

A. Place the earphone in your ear and turn the Tuning Knob clockwise and counterclockwise until you pick up the strongest signal.
Note: If you do not pick up a strong signal or do not hear anything, please read some of the troubleshooting solutions explained below.

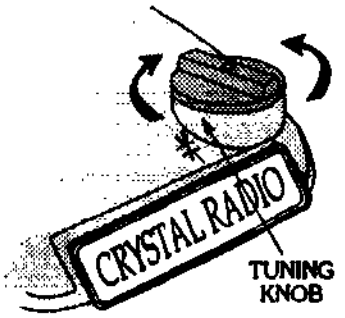

TROUBLESHOOTING HINTS

1. There may be a bad connection caused by improper assembly of your radio. Check all the spring connectors to make sure the wires are attached correctly. If a wire is loose or the bare wire is not making good contact with the spring connector, the radio may not work.

2. If the uninsulated part of the Antenna wire touches anything other than the Antenna Connection on the radio, the radio may work improperly or not at all..

3. If the bare stripped end of the Ground wire is not wrapped tightly around a water pipe (so that it makes good contact), try taping the wire to the shiny part of the pipe using duct tape. If the pipe is dull or rusty, use a piece of sandpaper to gently sand the area where the wire makes contact. Also make sure the wire doesn't touch anything other than the Ground Connection or the radio may not work properly.

4. You may live in an area where radio reception is generally poor. Instead of trying to use your radio during the day, try at night when many radio stations are received better.

5. The Antenna on your radio is a very important component. Make the Antenna as long and high above the ground as possible. If you live in a multi-story dwelling the highest floor should be used when operating the radio. Insulated bell-wire, which is available in hardware stores, makes a very good substitution for your present Antenna.

How to assemble your Crystal Radio (cont'd)

For this step you will need the variable capacitor, (3) screws and turning knob. Be carefull not to misplace the small screws when assembling.

Step 2

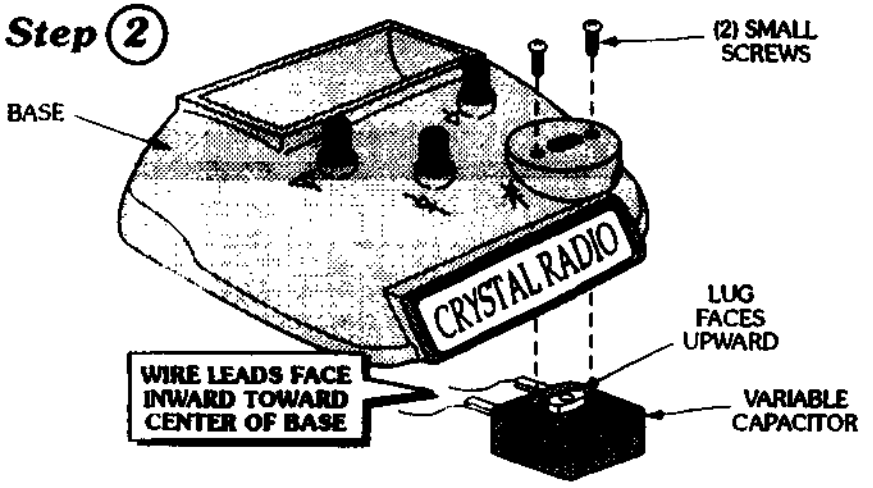

A. First place the Variable Capacitor up into the base so the holes on the capacitor line up with the holes on the base.
Note: When you do this be sure the wire leads face inward toward the base as shown and lug faces upward.

B. Next insert the two small screws into the holes on top of the Base and tighten using a small phillips screwdriver.

Step 3

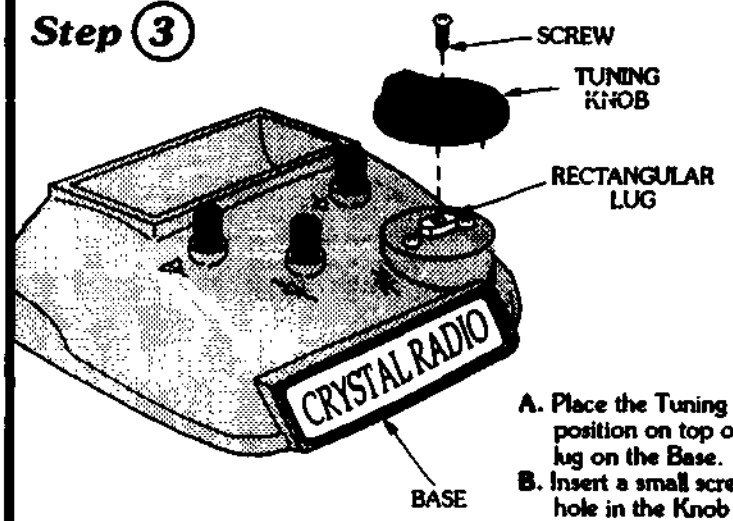

A. Place the Tuning Knob into position on top of the rectangular lug on the Base.
B. Insert a small screw into the hole in the Knob and tighten using a phillips screwdriver.

How to assemble your Crystal Radio (cont'd)

Step 4 **For this step turn the Base upside down.**

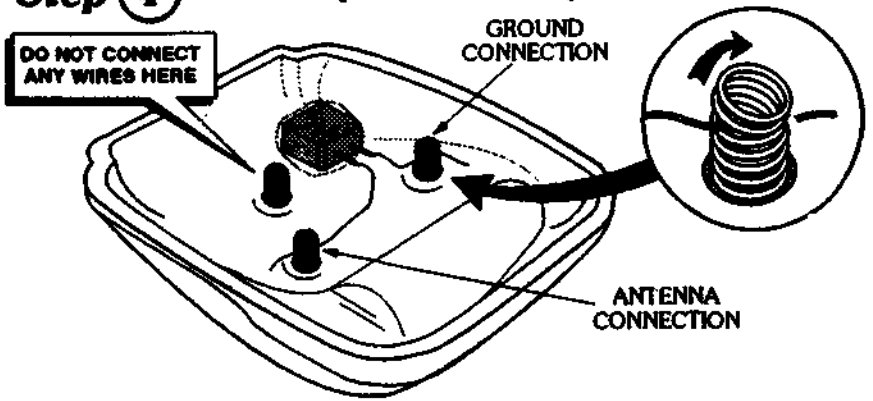

A. Turn the Base upside down.
B. Connect one wire to the Antenna spring connector by bending the spring slightly to one side and inserting the wire through as shown in inset.
C. Connect the other wire to the Ground spring connector in the same manner.
NOTE: Do not connect any of the wires to the Diode spring connector or your crystal set will not work properly.

Step 5

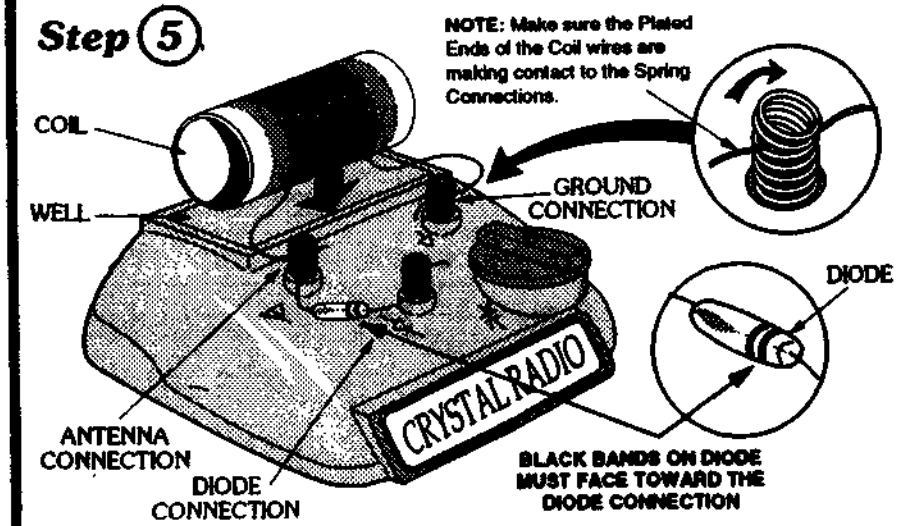

A. Next place the Coil in the well of Base with the wires hanging loosely toward the connectors .
B. Connect one of the plated ends of Coil wires to the Ground Connector by bending the Spring Connector as shown in inset. Connect the other Coil wire to the Antenna Connector.
C. Place the Diode between the Diode and Antenna Connections carefully noting the black bands face toward the Diode Connection.
D. Connect ends of Diode wires to Antenna and Diode spring connectors shown.

How to attach the earphones

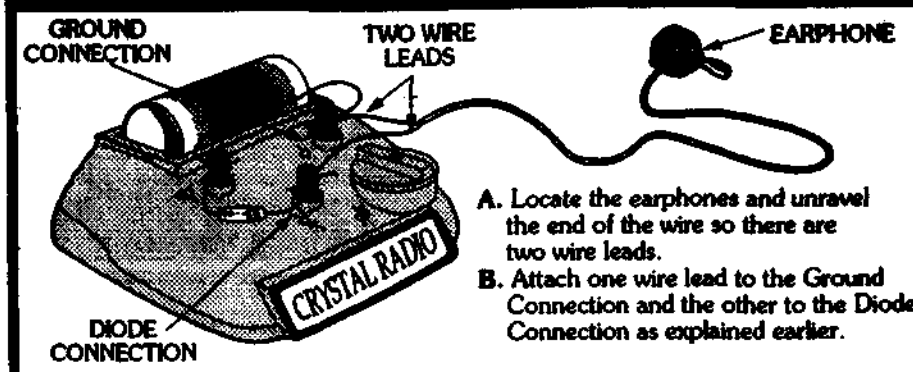

A. Locate the earphones and unravel the end of the wire so there are two wire leads.
B. Attach one wire lead to the Ground Connection and the other to the Diode Connection as explained earlier.

Final assembly and operation

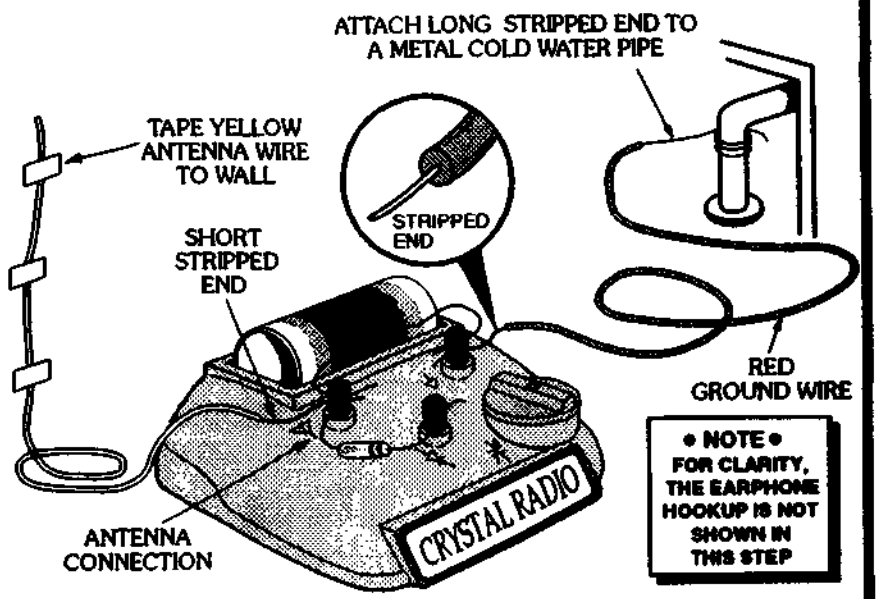

A. Locate the Red Ground and Yellow Antenna wire.
B. Attach the stripped end of Yellow Antenna wire to the Antenna Connection on the Base.
Note: The Antenna should be strung in a straight line away from power lines and large metal objects. We suggest taping it high up on a wall using masking tape as shown.
C. Next attach the short stripped end of the Ground wire to the Ground Connection.
D. Attach the Long stripped end to a metal cold water pipe, metal radiator pipe, etc., near where the radio will be used. Have a adult help you with this since some pipes may be hot.
Note: If there is not enough stripped, bare wire to wrap around a pipe then ask an adult to strip more insulation off the end using a pair of wire strippers.

Germanium vs Silicon Diode Testing: Read this document carefully, so you will not be the victim of cheap knock-off or the wrong type diodes.

The general rule is that ***SILICON*** diodes have a voltage drop across the Anode to Cathode of 0.7 V (7/10 tenths), and the ***GERMANIUM*** diodes have a voltage drop of 0.3 V (3/10 tenths) more or less. Either diode voltage drop (silicon or germanium) will display a reading within approximately 5% of these readings.

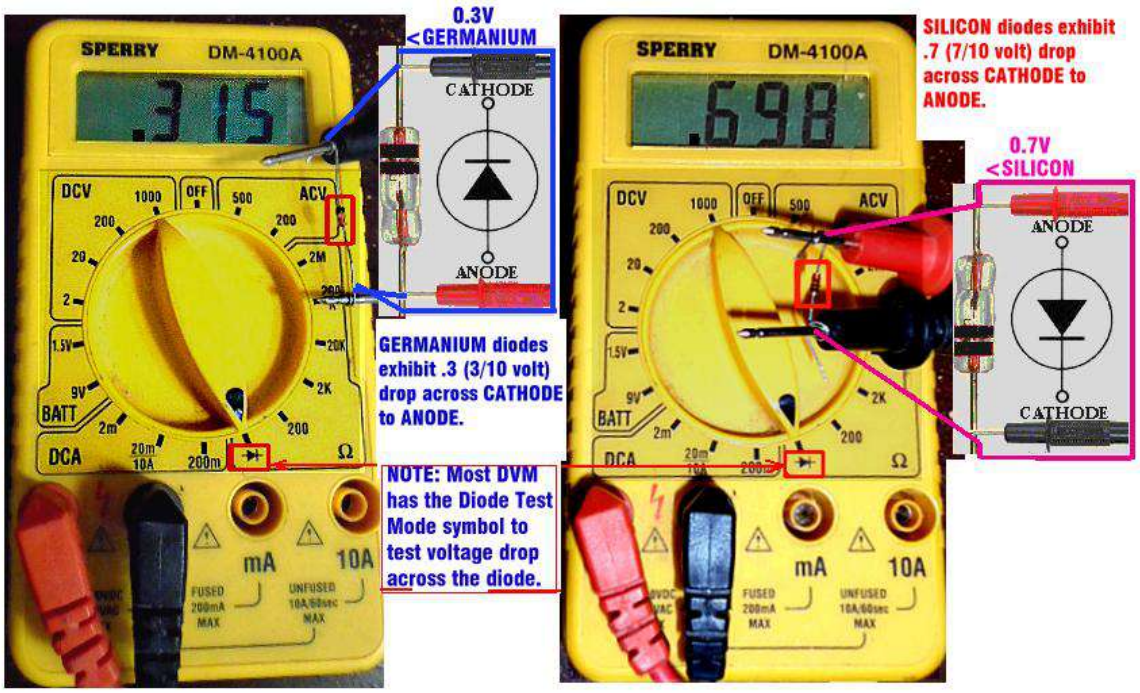

Most digital meters (DVM) have a switch setting that is used to measure voltage drop across these diodes. This setting is usually indicated by a diode symbol to let the user know the DVM is capable of measuring forward bias voltage. This setting will tell you immediately if the diode is a **germanium**, or **silicon** diode. You need to set the selector switch on your meter to the diode test symbol .

Measuring Forward Bias Voltage

To measure the forward bias voltage characteristic you connect the black probe of your meter to the cathode terminal. The cathode terminal is on the end with a band. You then connect the red probe to the anode terminal.

Set your DVM/DMM to the *diode test mode* , it should provide you with the respective voltage drop. If the figure is 0.3 V or less, the diode is a *germanium* type. If the voltage drop is 0.7 V or less the diode is a *silicon* diode.

Sensitivity and Forward Bias Characteristics:

The sensitivity of a diode to radio waves depends upon its *forward bias voltage*. This is the voltage across the diode terminals. When it falls below this threshold value, the diode will stop conducting. Obviously, the lower this threshold value is, the greater the sensitivity of the diode to the weak radio signals.

CONCLUSIONS:

When comparing germanium diodes with silicon diodes of similar forward bias voltage, silicon diodes do not perform as well as the germanium.

Germanium has many properties that silicon diodes do not have. Germanium requires very little forward current. Forward current in a germanium diode is in the *micro*ampere region, while silicon diodes require *amperes*. This makes *germanium* a much better choice for both medium and high frequency radio signals.

Germanium also exhibits a very low, point-contact junction capacitance, while the silicon diode has much higher capacitance. A low junction capacitance allows germanium diodes to operate more effectively at high RF frequencies.

In addition, reverse leakage current for germanium diodes is in the magnitude of 1000, much more than silicon. This makes the non-linear characteristics of the germanium diode much more effective for RF detection and demodulation than silicon.

Therefore, our conclusions are; germanium diodes provide the best performance in crystal radios, RF probes, HF, and VHF signal detection.

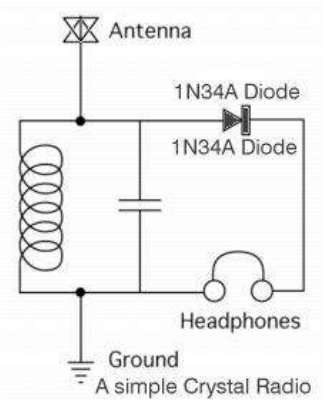

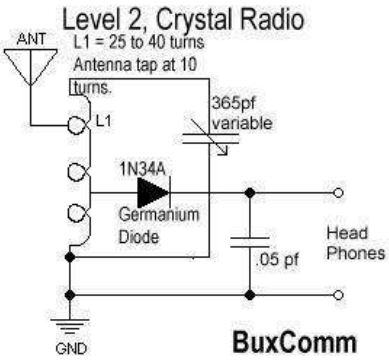

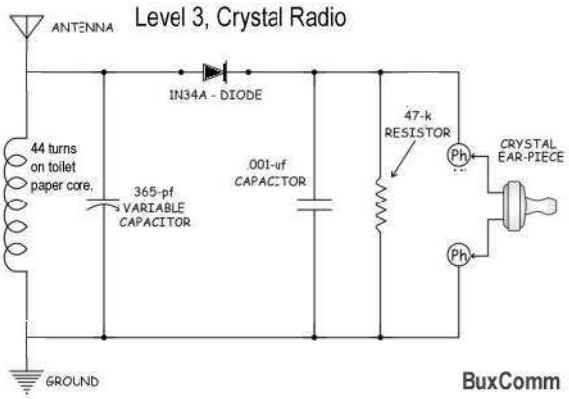

BuxComm High Quality, CRYSTAL RADIO ANTENNA KIT, $14.95 cat# 50CRAK

This Crystal Radio Antenna kit consists of 50 feet of #16 AWG insulated & stranded copper antenna wire, two heavy-duty, Delrin, UV resistant antenna insulators and instruction sheet.

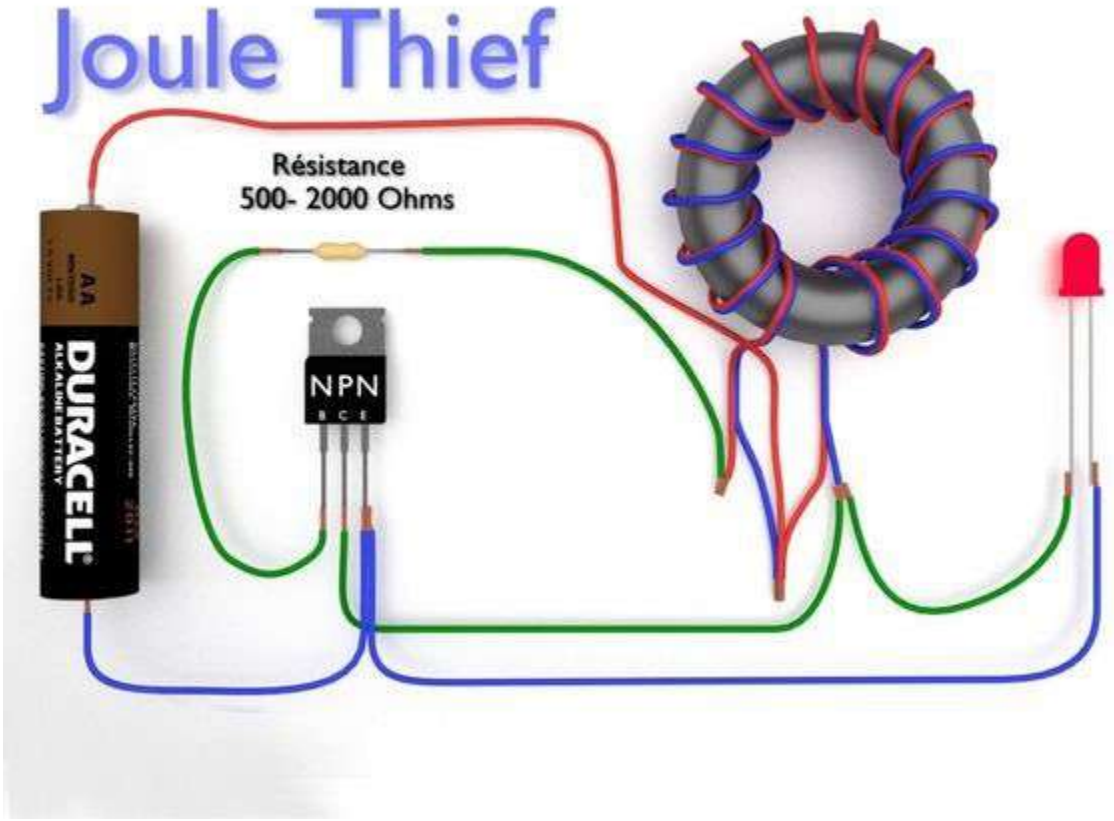
Joule Thief
Résistance
500- 2000 Ohms
NPN
B C E
DURACELL
ALKALINE BATTERY
AA

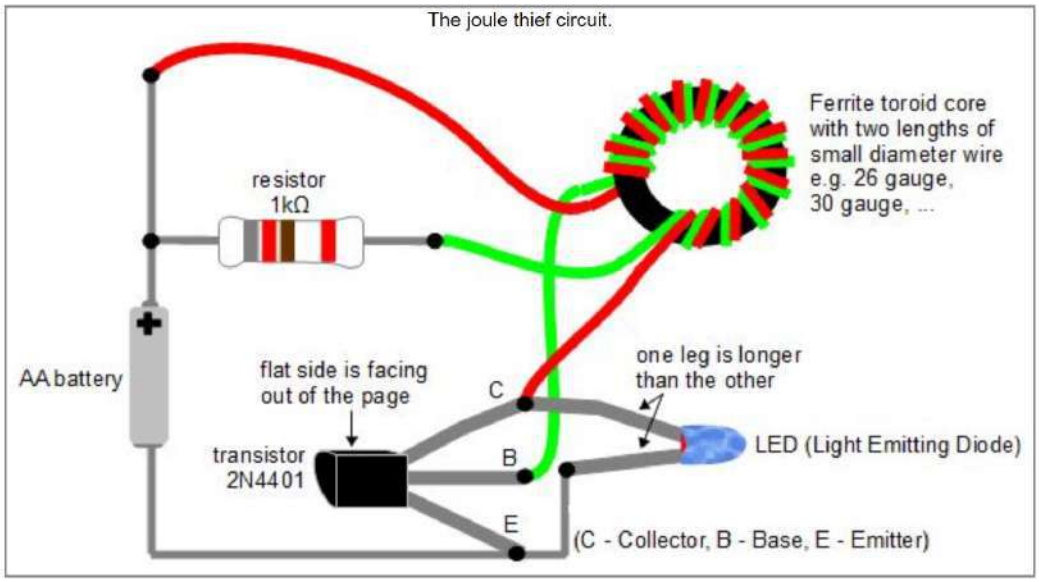

Transistor - The legs of the transistor can be determined by noticing that there's a flat side to the transistor case. See the diagram above. A large number of transistors have been reported to work: 2N4401, NET123AP, BC547B, 2SC2500, BC337, PN2222, to name just a few.

LED - One leg of the LED is longer than the other leg. Use this to determine which one goes where. See the diagram above.

Resistor - The diagram says use a 1 kilo ohm resistor but I've used an 820 ohm one just fine. I've also seen a 2 kilo ohm one in use. Use whatever works for you. You can also use a potentiometer (a variable resistor) so that you can easily adjust it to select the resistance that gives the best light.

Toroid ferrite core - Some people have gotten these by opening up compact fluorescent lightbulbs (CFLs). I took mine out of some device whose original function I don't know. To get it working, my first one had just 13 turns for each wire and I used a 30 gauge wire and a 26 gauge wire. The wire must be insulated. A variety of number of turns will work. This is something you can play with. Look at the diagram carefully to determine where the wires connect to.

Its a Rubbish Challenge
Dog Light
Joule Thief
electronics circuit

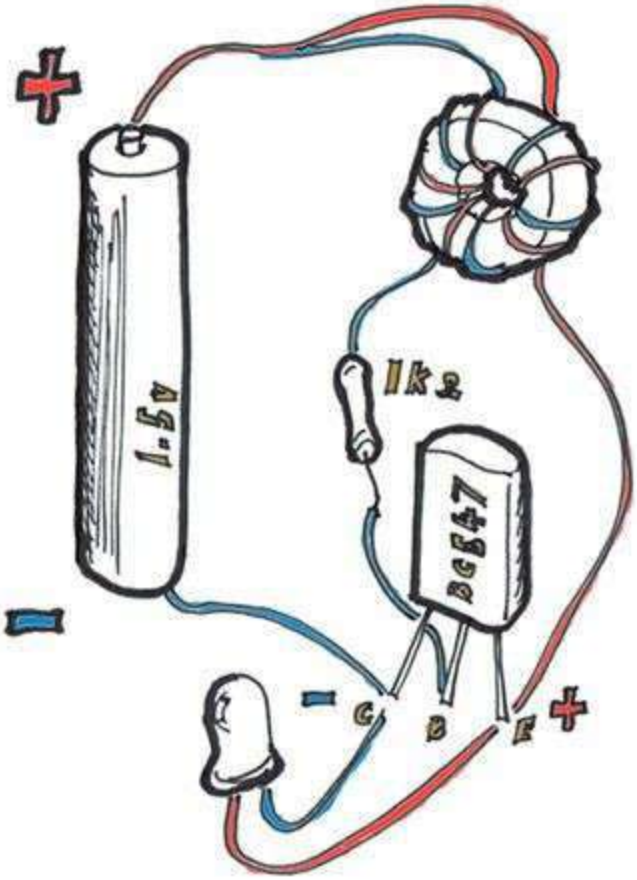

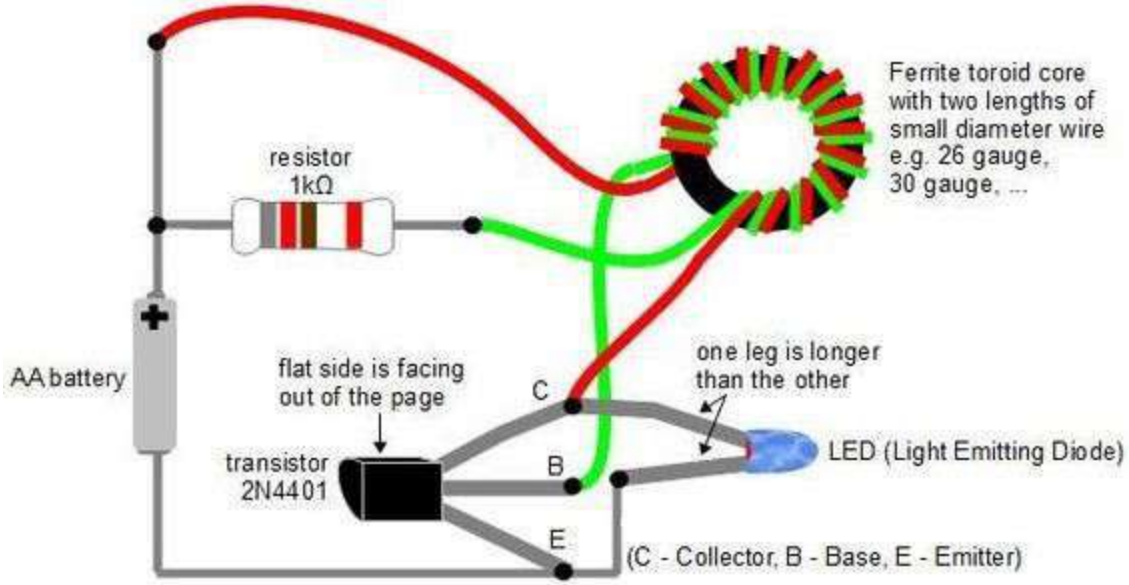
Ferrite toroid core
with two lengths of
small diameter wire
e.g. 26 gauge,
30 gauge, ...
resistor
1kΩ
AA battery
flat side is facing
out of the page
one leg is longer
than the other
C
B
E
transistor
2N4401
LED (Light Emitting Diode)
(C - Collector, B - Base, E - Emitter)

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MAKING A SIMPLE JOULE THIEF (MADE EASY)

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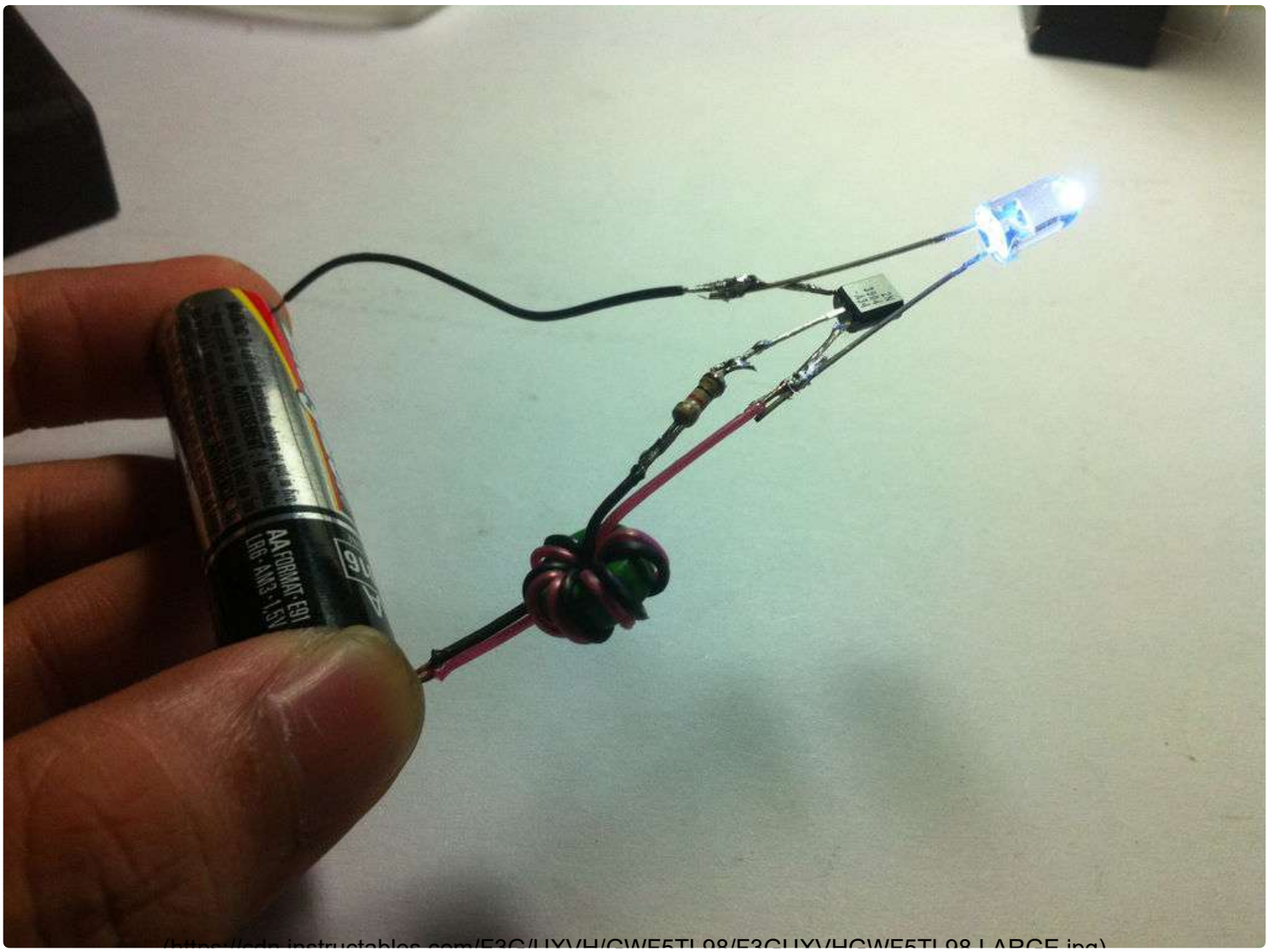

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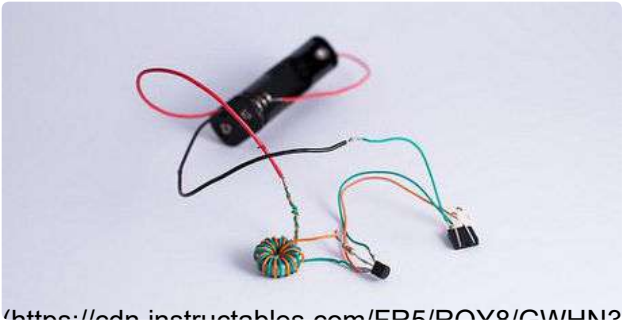

Today I am showing you how to make a very simple joule thief. A joule thief has many applications, the best gadget that I made with was a "Water Powered Lamp", soon I'm going to post on a guide about it but first I need to post this guide. I used an iPhone 4S as my camera :)))

What Is A Joule Thief ?

To simplify everything, a "joule thief" is a circuit that helps drive an LED light even though your power supply is low. What can we do with it? We can use it to squeeze the life out of our old, almost drained, non functioning batteries. This project can also be considered as a green and environmental experiment, we can also use it as a flashlight that can be ran by an old, weak, almost drained battery. I even tried to use my water powered battery from my previous instructable the "Water Powered Calculator (https://www.instructables.com/id/Water-Powered-Calculator/)", the project was featured and displayed in instructable's front page in the "Technologies" category.

My Next Projects That Involves A Joule Thief: (soon to be posted)
- Water Powered Lamp
- Water Powered Flash Light
- Dead Battery Drainer Lamp

Here's A Video From Make Magazine:

Add Tip

Ask Question

Step 1: Parts and Materials

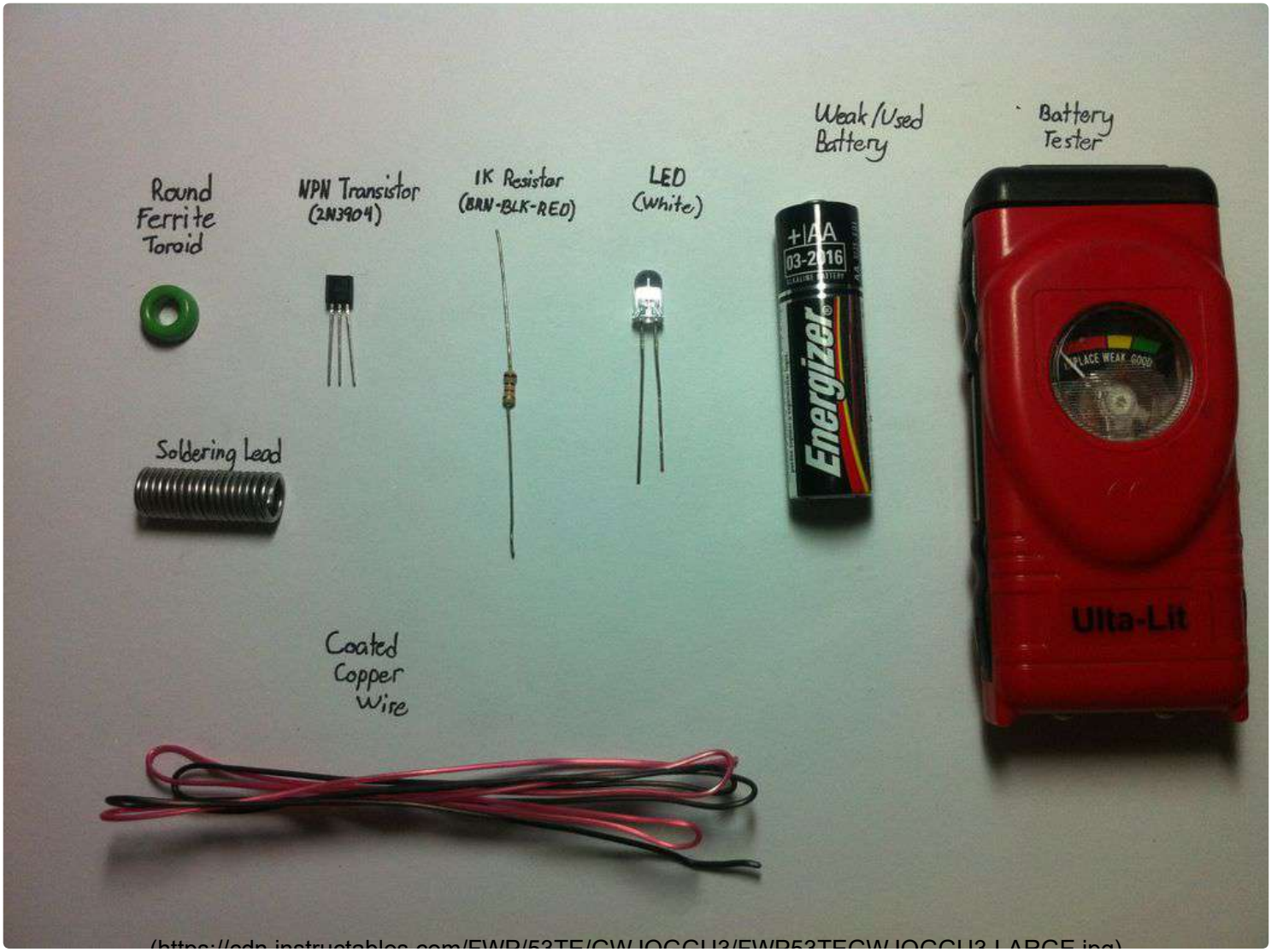

The Parts Needed Are: (click the item to know where to find/ buy)

- Round Ferrite Toroid (can be found in old CFL bulbs)
- Old/ Used Batteries (can be found in garbage cans)
- NPN Transistor (2N3904) (http://www.radioshack.com/product/index.jsp?productId=2062609)
- 1K Resistor (BRN-BLK-RED) (http://www.radioshack.com/product/index.jsp?productId=2062343)
- LED Light (http://www.radioshack.com/product/index.jsp?productId=3096133)
- Battery Tester (http://www.tooldistrict.com/Ulta-Lit-Battery-Tester-5001-p/901233.htm) (optional)
- Soldering Lead (http://www.radioshack.com/product/index.jsp?productId=2062717)

- Copper Wire/ Magnet Wire (http://www.radioshack.com/product/index.jsp?productId=2036277)
- Battery Case/ Holder (http://www.radioshack.com/product/index.jsp?productId=2062247)

I want to share something. Here in the Philippines electronic parts are extremely cheap, they are extremely far cheaper from
radio shack, for example one transistor costs (2 phil. pesos - 6 US cents), a LED cost (9 phil. peso - 29 US cents) and a 1K resistor cost (25 phil. cents - 0.8 US cents). I usually buy thing from Deeco or Alexan. Usually prices here are 15x cheaper from radio shack. Price conversion - $1 US Dollar = P0.31 Philippine Peso (12/24/11).

Add Tip Ask Question

Step 2: Schematic Diagrams

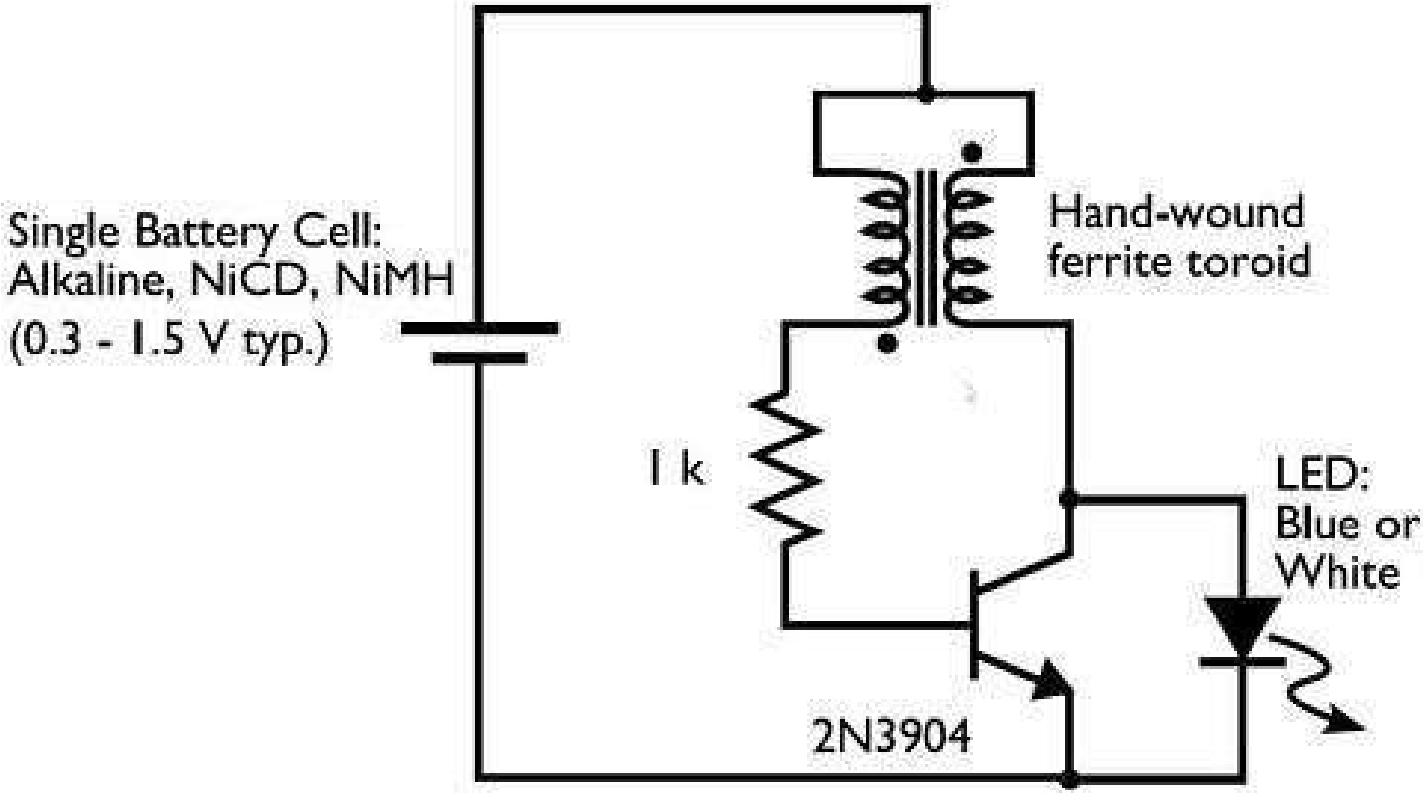

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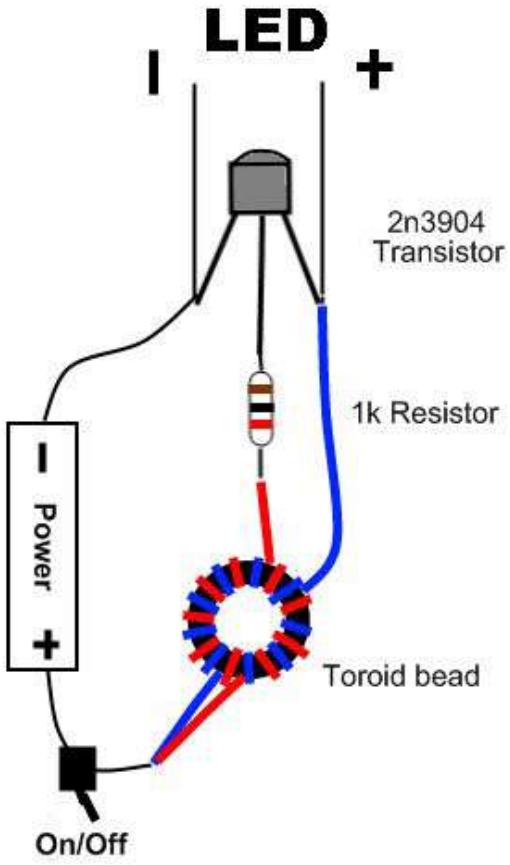

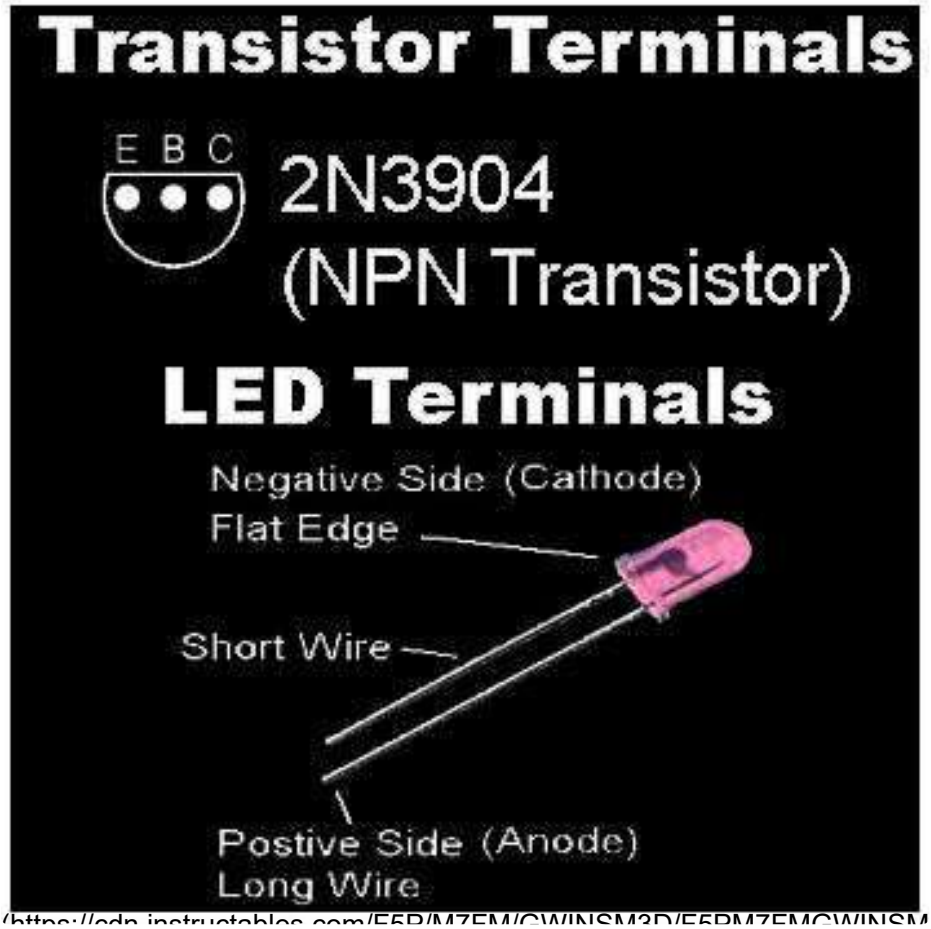

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Here are the schematic diagrams that are involved with the joule thief circuit.

Add Tip

Ask Question

Step 3: Winding Wire at the Toroid

First, connect both ends of the copper wire before wounding, be sure to remove the insulation. Then try to solder the ends so it would not split up. Second, wind the wire until you run out of space in the round ferrite toroid. I have some tips for you, try to use a gauge #22 enamel coated copper wire for better performance, oh! my last tip is that "the more you wind the wire to the ferrite toroid the better".

Add Tip

Ask Question

Step 4: Soldering the Resistor

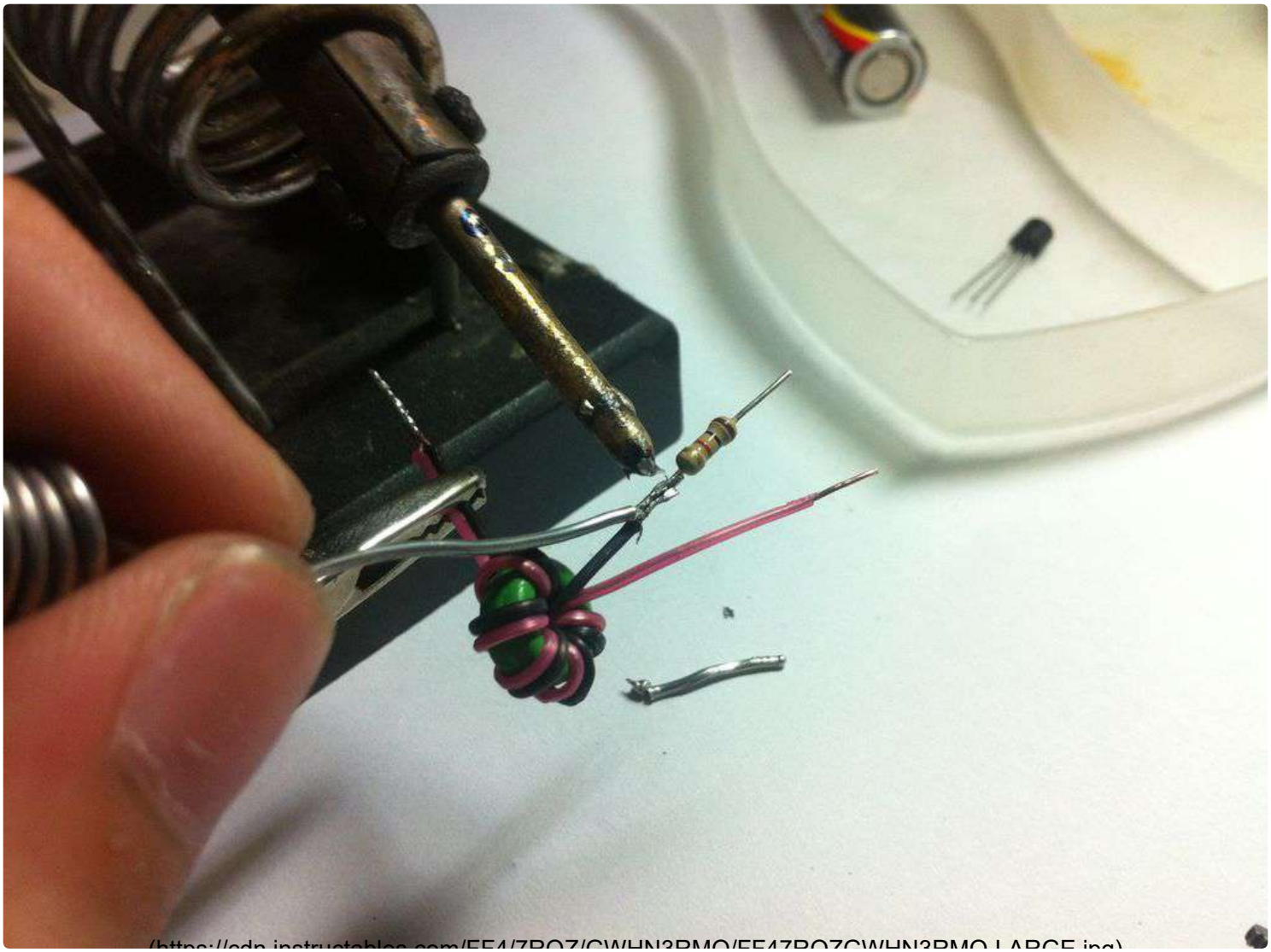

Solder the resistor with one end of the wounded ferrite toroid's wire. Oh! also don't forget to level the other end of the resistor with the other unused wire from the wounded ferrite toroid.

Add Tip

Ask Question

Step 5: Soldering the Transistor

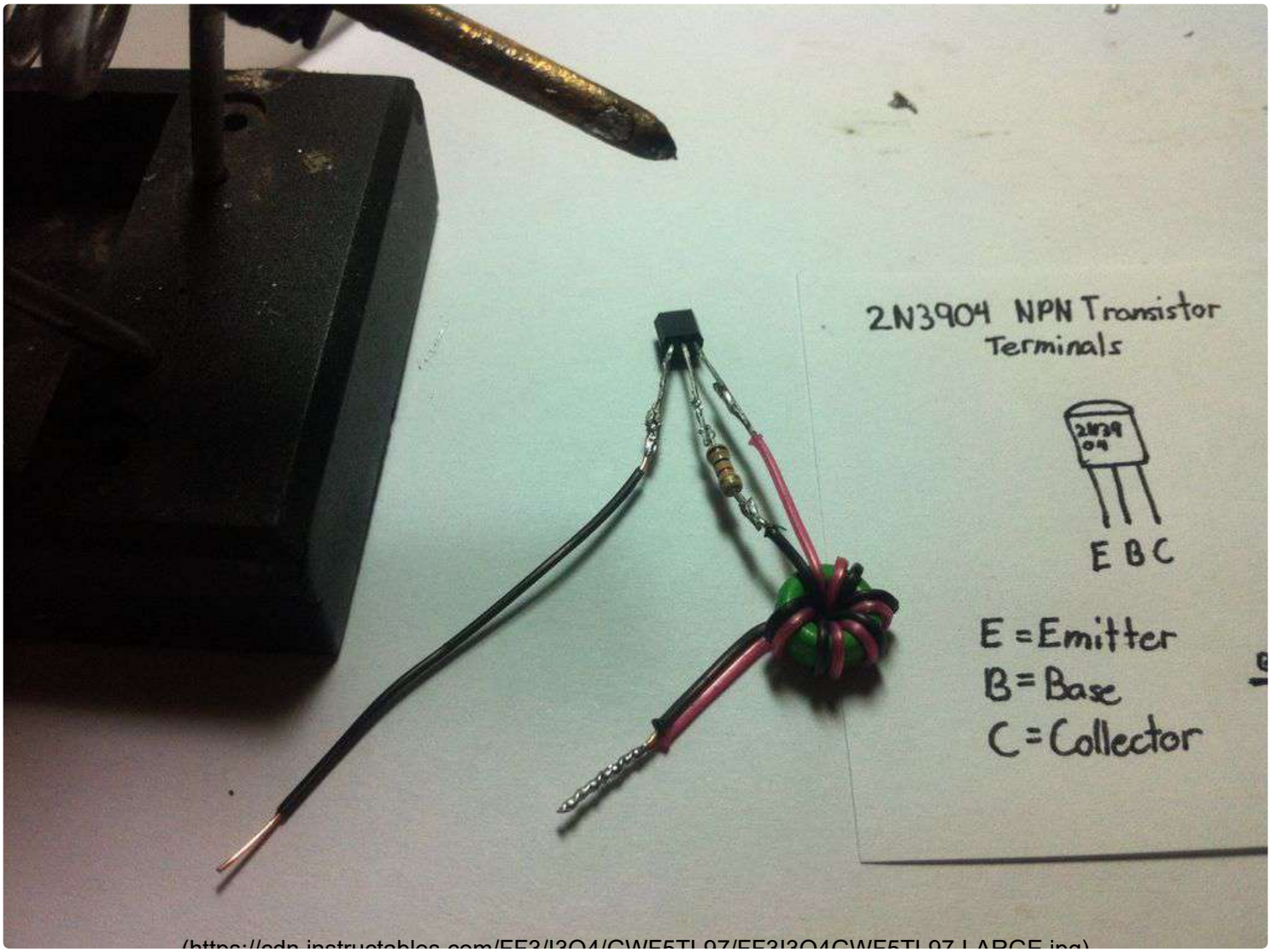

(https://cdn.instructables.com/FF3/I3O4/CWF5TL97/FF3I3O4CWF5TL97.LARGE.jpg)

Solder the proper connections to the transistor. For the emitter - connect another wire, the wire will be connected to the negative part of the battery. For the base - solder the other end of the resistor to the base. For the Collector Solder the unused wire of the ferrite toroid.

Add Tip Ask Question

Step 6: Soldering the LED

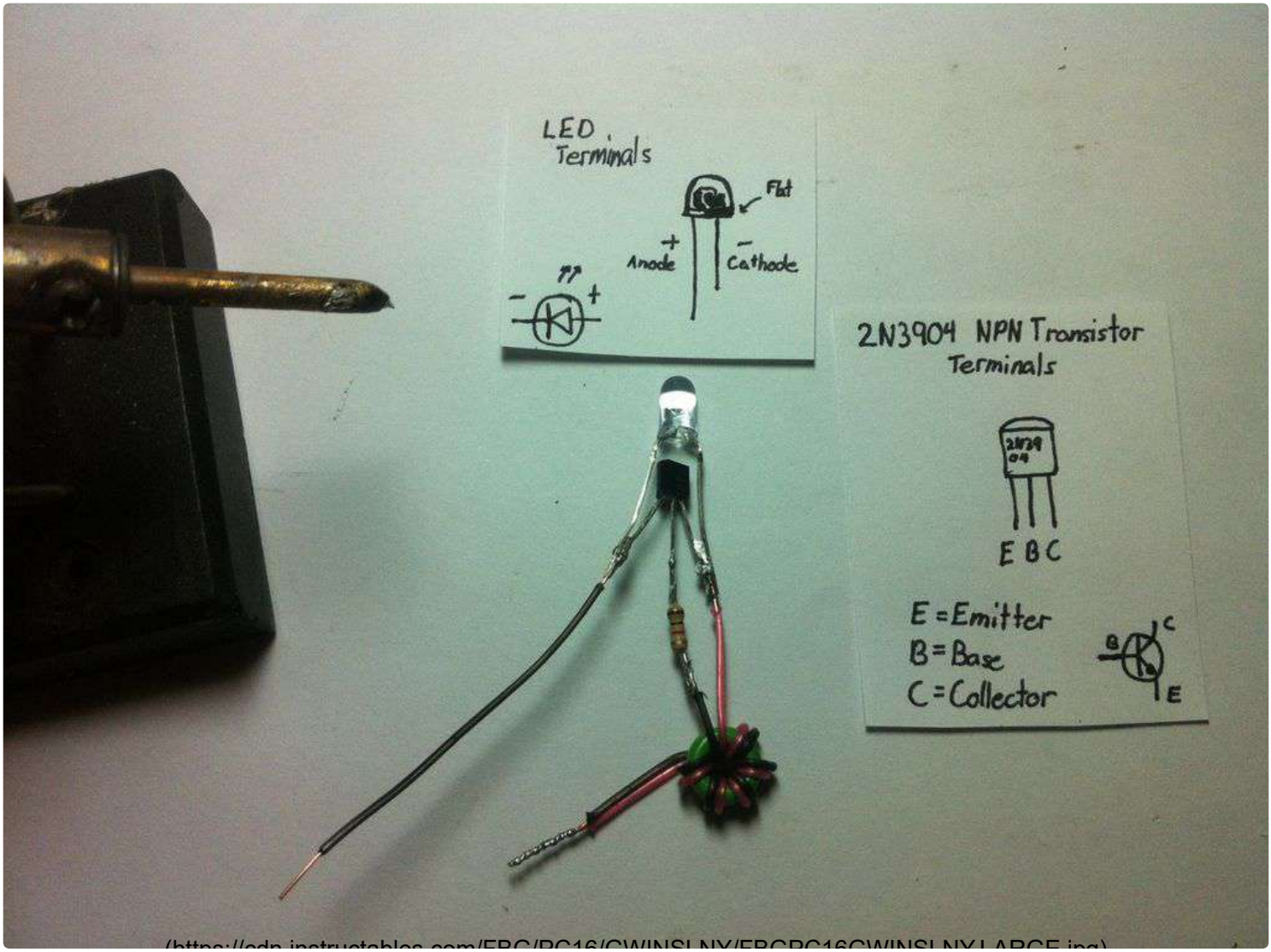

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Solder the shorter wire of the LED to the tansistor's emitter and the longer part of the LED to the transistor's collector. After all that, you can now trim the excess wires.

Add Tip

Ask Question

Step 7: Time to Look for Old Batteries

Use your battery tester to confirm that your battery is close to death. The tester is only an optional tool, it's just used to determine the battery's remaining power.

Add Tip Ask Question

Step 8: Time to Test It - You're Done !!

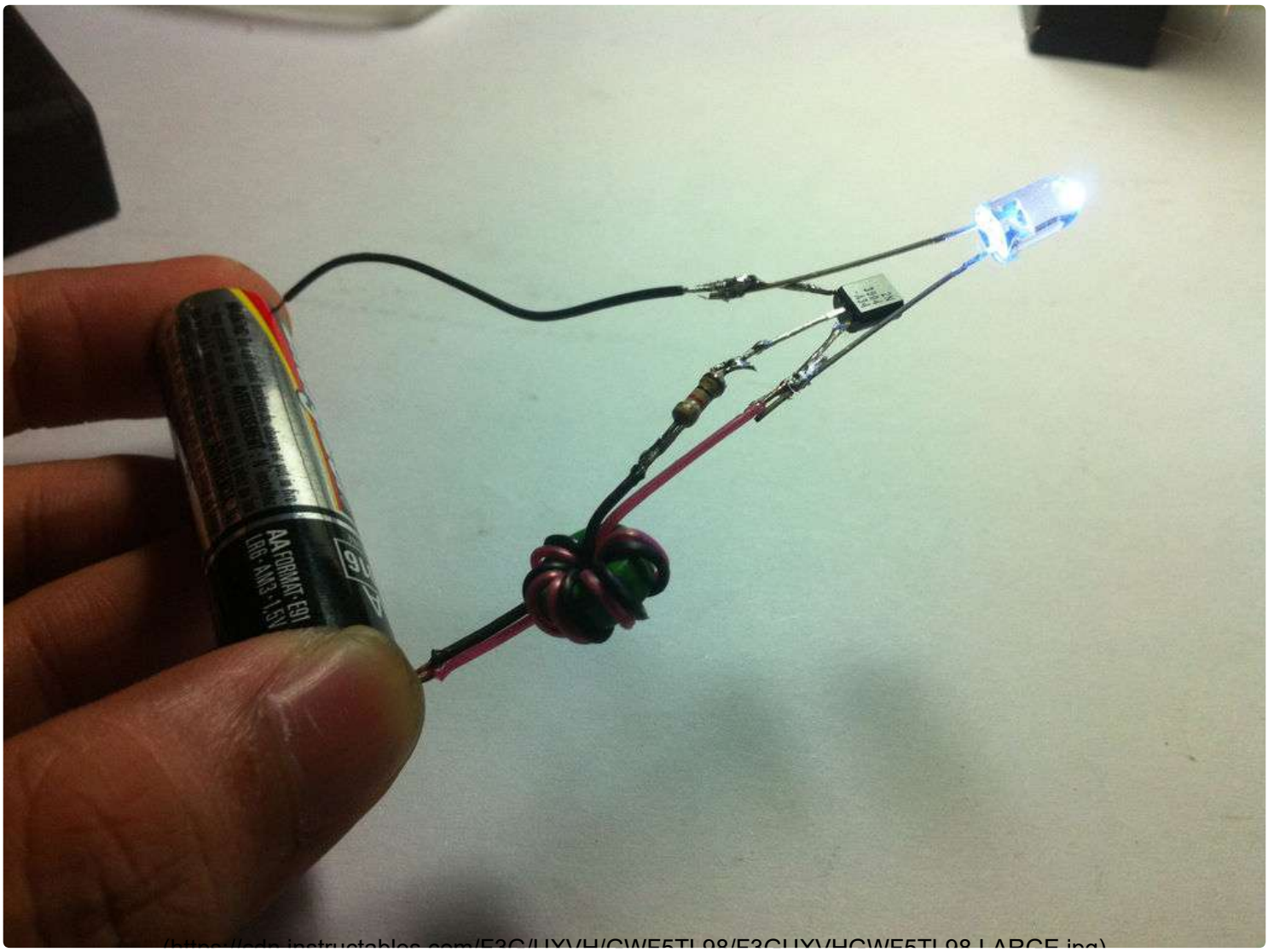

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(https://cdn.instructables.com/FCU/NX0F/CWHN3BZH/FCUNX0FCWHN3BZH.LARGE.jpg)

The wire connected to the transistor's emitter should be connected to the battery's negative side and the remaining wire of the ferrite toroid should be connected to the battery's positive side. Oh! one more thing, I advise everyone to use a battery case or attach a conductive magnet for each wire, so you wouldn't hold it all the time.

Add Tip

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8 People Made This Project!

"Joule Thief" LED Night Light

by **ledartist** on September 2, 2011

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Step 2: Technical Overview 3
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Step 4: Performance 5
Step 5: PCB & Kit 6
Related Instructables 6
Comments 6

Author:ledartist My Blog
I work with LEDs and microcontrollers to create beautiful objects.

Intro: "Joule Thief" LED Night Light

I have many used batteries around. Remote controls, cameras, many electronic gadgets all use batteries, mostly AA size. I always felt guilty for throwing away the used batteries. I know there are rechargeable batteries, but many electronics don't work well with rechargeables.

I also know that those "used" or "spent" batteries usually have some juice left in them. So to come up with a good use of used batteries, I've created a LED night light.

I like having a little night light on when I sleep. LEDs are perfect for this purpose, because they are energy efficient, and good at providing low intensity illumination.

This LED night light operates with just one battery. It utilizes a little circuit called Joule Thief to boost voltage out of an AA battery. I also added a light sensor to turn it on automatically when the surrounding is dark.

The circuit is energy efficient, and requires very low voltage to work. So it effectively sucks every bit of energy out of batteries. This type of circuit is often called "Joule Thief", because it works as though stealing every bit of energy (Joule is a unit for energy) out of battery.

I'm calling this project Night Joule Thief.

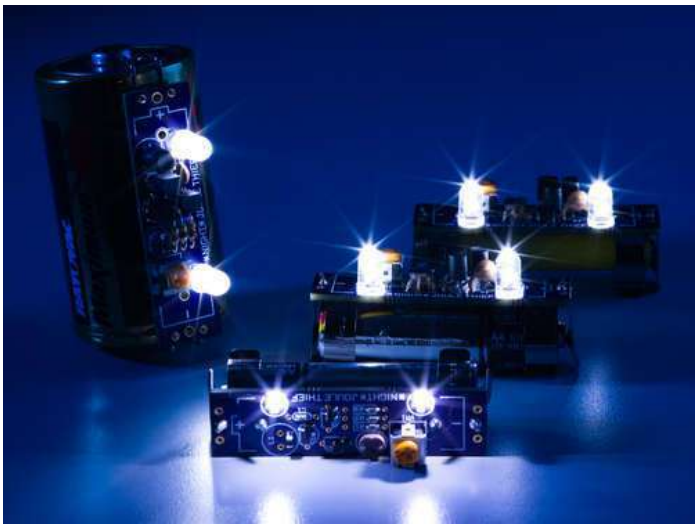

Step 1: Features

Here are the highlights of the Night Joule Thief.

- Compact & streamlined design
- Uses only one AA battery (or any 1.5V battery you can hook up to)
- Easily adaptable to different size batteries - hook up holes to attach home made clips
- Two white LEDs
- Automatic turn on via a light sensor (adjustable sensitivity level)
- Energy efficient - works even with a run-down battery, down to 0.6V
- Choice of through-hole only components or SMD - mix & match on the same PCB

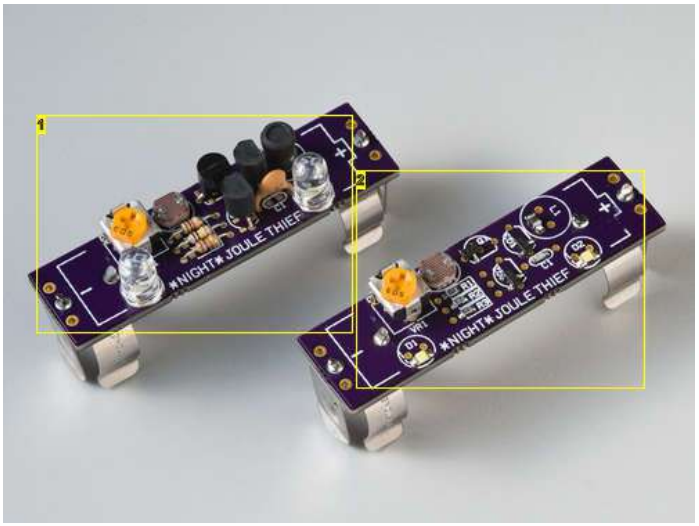

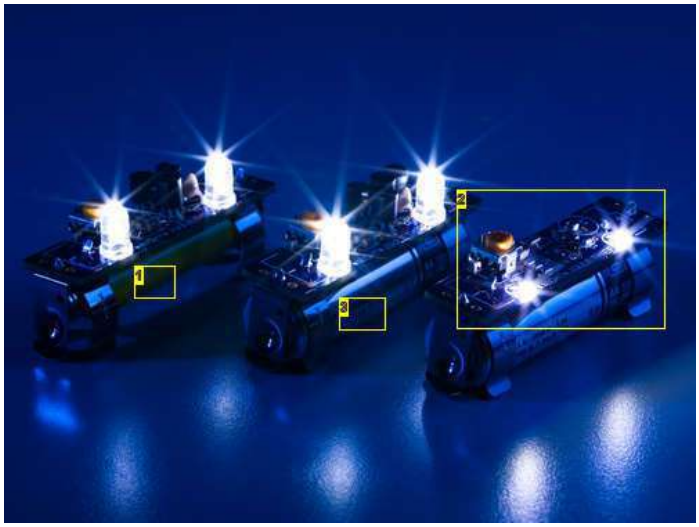

Image Notes
1. Through-hole version.
2. SMD (Surface Mount Device) version. Hard to believe this is the same circuit, but it works exactly the same as one on left. Ok, the LEDs are slightly less bright.

Image Notes
1. AAA battery inserted with a help of small magnets.
2. SMD version - very low profile.
3. Standard AA battery snugly fit in the clips.

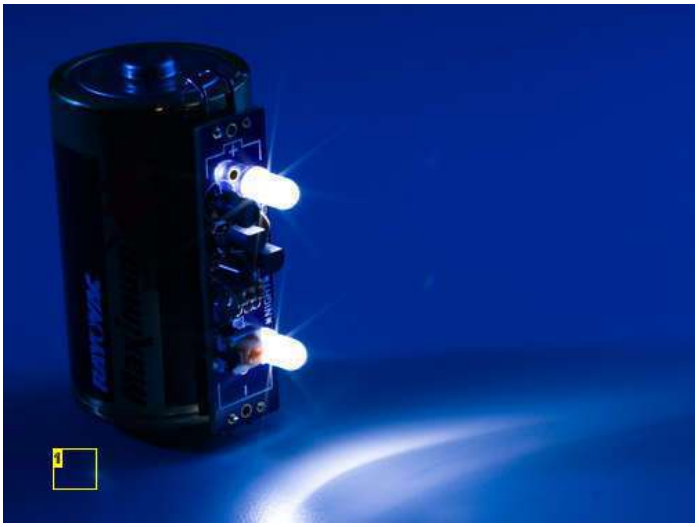

Image Notes
1. Other sizes, such as D cell can be attached by making a pair of little metal clips. Just cut and bend paper clips.

Step 2: Technical Overview

"Joule Thief" circuit is an inductor based voltage booster circuit to light LEDs with low supply voltage. As most of you know LEDs need higher than 2V (3V for white LEDs), so usually at least two batteries are needed to light them. The "Joule Thief" circuit was published in 1999 and has been quite popular. You can see the principle of the circuit here. http://en.wikipedia.org/wiki/Joule_thief

My version is a variation that uses single coil inductor, to make the inductor easily obtainable. I design the circuit using readily available parts only, to make it an ideal DIY project.

Circuit

The L1, Q2, Q3, C1, R2, and LEDs D1 & D2 make the Joule Thief. And the Q1, and the rest of the parts form the light sensor. CdS is the device that actually senses the light and change its resistance accordingly. When the surrounding of CdS is bright, it has low resistance (anywhere around 1k to 3k ohm), and when the surrounding is dark, the resistance goes up to 100k to 3M ohm range. So in this circuit, the base voltage of Q1 is controlled by the ambient light level. When the base voltage of Q1 goes more than 0.6V below the power supply(battery) voltage, current goes through R1, turning the Joule Thief circuit on.

The Joule Thief circuit is boosting the battery voltage up to over 6V to light two LEDs in series. LEDs light up with the battery voltage as low as 0.6V! Amazing!

PCB layout can be downloaded as an editable PDF, so you can etch your own board if you like. Custom 2 layer PCB and kit are available for sale as well. The 2 layer PCBs have extra front pads for SMD where possible, so you can build the same circuit with SMD parts as you wish.

Parts List
1x CdS Photoresistor (rated 3k - 0.3M ohm) (CDS1)
1x 1k ohm (R1)
1x 100k ohm (R2)
1x 10k ohm (R3)
1x 50k ohm trim pot (VR1)
1x 22pF (C1)
1x 470uH (L1) (anywhere between 22 - 470uH would work - might have to reduce the C1 value however)
1x 2N5401 or equivalent (Q1) (or just about any general purpose PNP transistor, such as PN2907, 2N3906, etc...)
2x MPSA06 or equivalent (Q2, Q3) (or just about any general purpose NPN transistor, such as PN2222A, 2N3904, 2N4400, etc...)
2x LED (D1, D2) (Just about any LEDs can be used)
2x Battery Clips

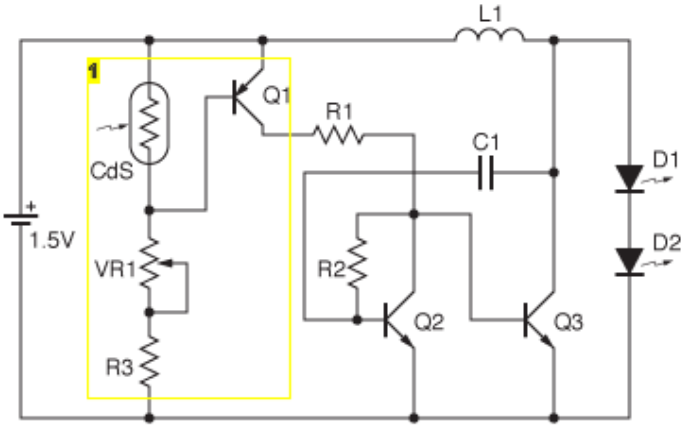

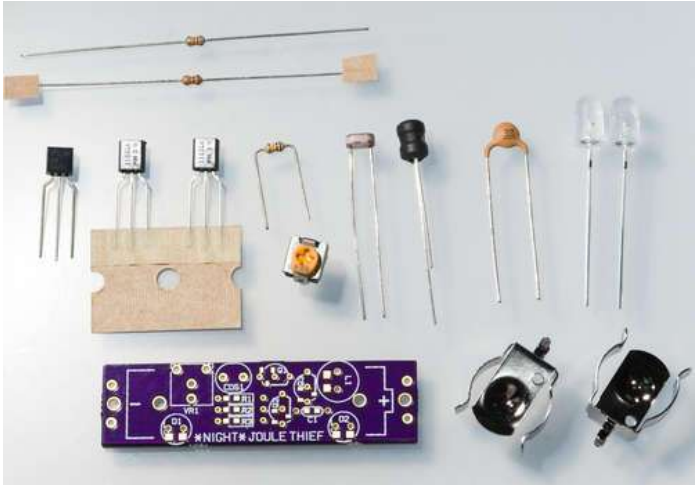

Image Notes
1. Light sensor circuit with sensitivity adjust.

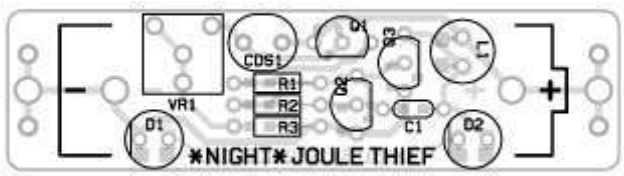

File Downloads

NightJouleThief-PCB.pdf (54 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'NightJouleThief-PCB.pdf']

Step 3: Assembly

The assembly is very straight forward. Insert the parts into the PCB, and solder them. Start with small components, follow the order below.

Parts List (in assembly order)
1x 1k ohm (R1)
1x 100k ohm (R2)
1x 10k ohm (R3)
1x Photoresistor (rated 3k - 0.3M ohm) (CDS1)
1x 50k ohm trim pot (VR1)
1x 22pF (C1)
1x 470uH (L1)
1x 2N5401 or equivalent (Q1)
2x MPSA06 or equivalent (Q2, Q3)
2x LED (D1, D2)
2x Battery Clips

Transistors, and LEDs have polarities, so make sure to insert them in the correct orientation. Battery holders need a bit of force to snap into the holes. They attach from the back side of PCB as you can see in the picture.

Once everything is soldered in place, double check the part placement, orientation and solder joints. Then insert a battery. The polarity is marked on the front side of PCB.
If you don't see the LEDs light up, don't worry. The room is probably too bright. Take a piece of black paper or tape and block the light from hitting CdS light sensor. (and/or darken the room) If the LEDs still don't come on, turn the trimmer (the little orange thing) with a screw driver, counter clockwise. This makes the sensor less sensitive to light, so the LEDs will come on by just placing the sensor under shade, or turning off the room light.

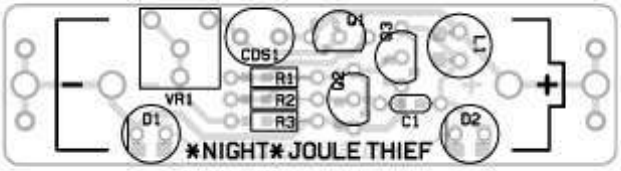

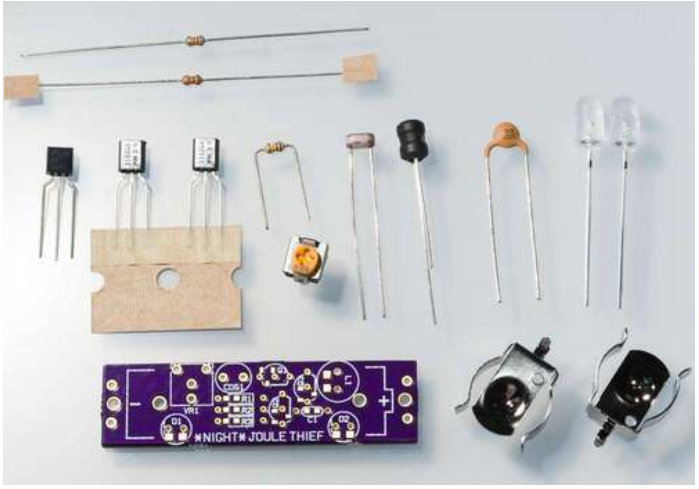

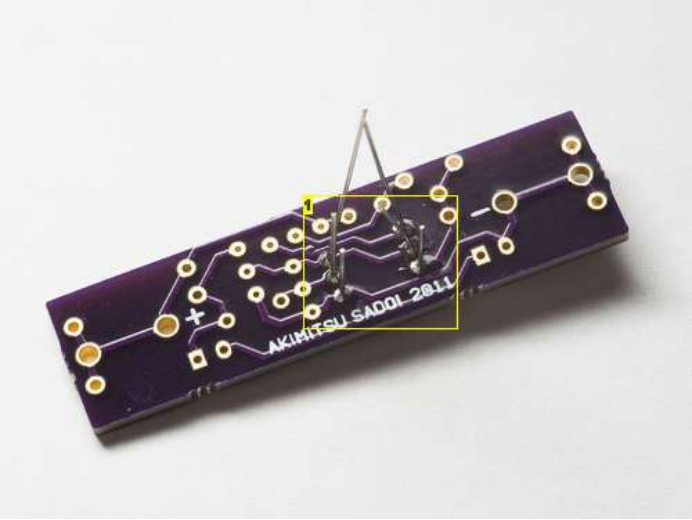

Image Notes
1. Resistors soldered in.

Step 4: Performance

This little night light performs very well. For starters, the brightness is not bad for using just one AA battery. I've been using these as flashlights as well.

The light sensor also works very well. Once adjusted, the light is steadily off during the day, even when you put the sensor under shade. Only when you block the sensor by a black object, the light would turn on. Yet after dusk, the light would come on when you turn off the room light.

A fresh battery lasts for weeks if only used as a night light. And the best use of this light is to "revive" used batteries. Those batteries from remote controls, cameras, etc. usually have quite a bit of juice left in them. Joule Thief sucks the juice out of those batteries till the last drop. It's like getting free energy when you can use something that were going to be thrown out.

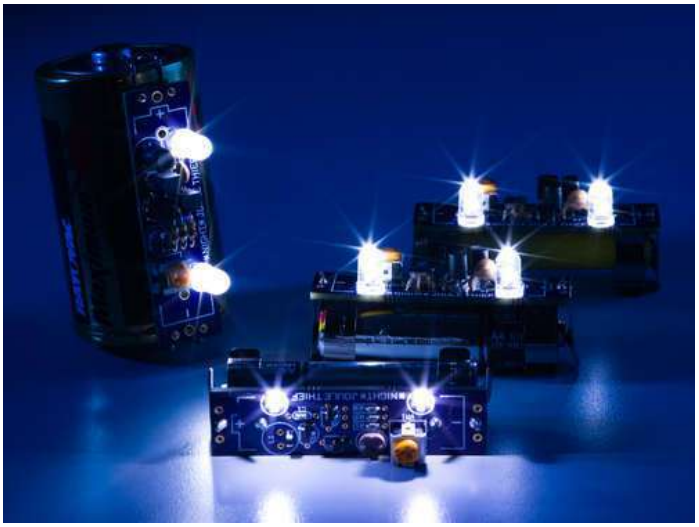

Step 5: PCB & Kit

If you are handy, you can etch your own PCB, and build this night light entirely DIY.

However, to spread the goodness of Joule Thief and to contribute to the greener earth, I am putting together the PCB & kit available.

The details can be found here: http://www.instructables.com/community/Joule-Thief-LED-Night-Light-Kit-PCB/

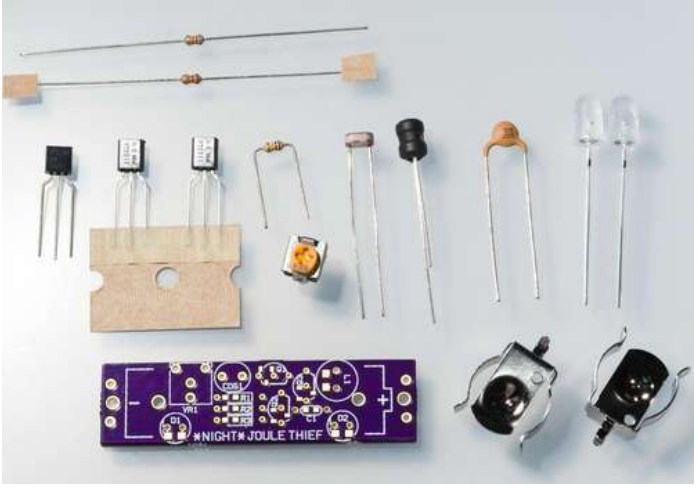

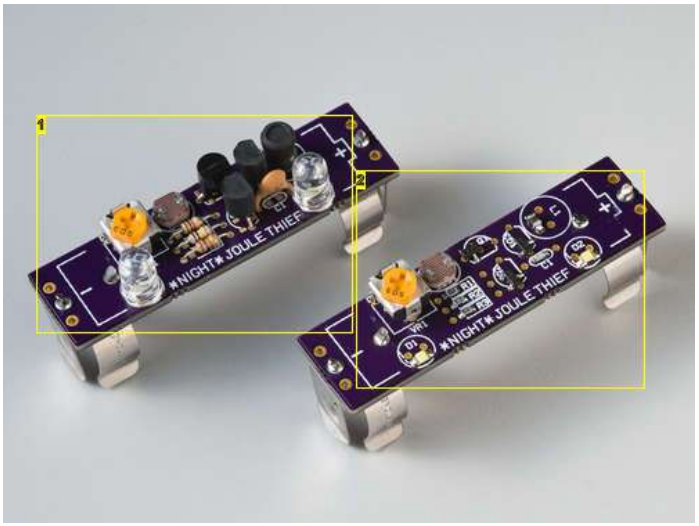

Image Notes
1. Through-hole version.
2. SMD (Surface Mount Device) version. Hard to believe this is the same circuit, but it works exactly the same as one on left. Ok, the LEDs are slightly less bright.

Related Instructables

Joule Thief - use LEDs with only one AA battery! by RazorConcepts

Ferrite, the joule thief (Photos) by botronics

Electronic Night Light by TinkerJim

Ultraviolet Light Pen by junits15

Mini 'Joule Thief' (Photos) by Mudbud

Altoids Joule Thief Flashlight (Photos) by cynical_chemical

Comments

33 comments **Add Comment**

tosacj says: Sep 4, 2011. 10:47 AM **REPLY**
Great idea. Let me know when the kit becomes available.

ledartist says: Sep 4, 2011. 12:38 PM **REPLY**
I will post the information on "Kits" section of the forum and on my blog (theLEDart.com). The kit & PCB are scheduled to be ready in mid September. Thanks, Aki

haxcess says: Sep 5, 2011. 8:16 AM **REPLY**
This is a very neat application of the joule thief. I am wondering if it would be possible to replace the light-sensor circuit with a small battery charging circuit (solar). I suppose that would ruin the beautiful form factor you have here.

apalacios2 says: Sep 5, 2011. 7:07 AM **REPLY**
Excellent circuit. May I remove the CdS circuit and use a button switch instead (thru the resistor connected to the transistor)?
I find great that it uses a coil instead of a toroid transformer. Kudos!

ledartist says: Sep 5, 2011. 7:28 AM **REPLY**

Yes, you can. In fact I made sure that you can fit a 6mm tactile switch in place of trimmer pot. You can omit the CdS, and solder a switch in place of trimmer pot.

You can also remove Q1 and put a switch there as well, but my PCB won't accommodate that.

Yeah I found having to wind my own inductor a hassle, so I designed this circuit to use off-the-shelf inductors.

Aki

---

bhvm says: Sep 4, 2011. 9:17 PM **REPLY**

Excellent build!
How many mA does this circuit give? Can we use a single 150mA power LED in place of 2x 5mm LEDs?

---

ledartist says: Sep 5, 2011. 7:20 AM **REPLY**

The current through the LEDs is about 20mA or less peak (it's pulsed current in about 50kHz)
So you won't get any more light by using a high power LED. By using only one LED, you do get a bit more brightness per LED though. However just a regular LED will give you the same brightness as a high power LED because you are not driving the LED with high current anyway...

It's not that you can't drive high current LED, but this circuit is designed to run with as little power as possible.

Aki

---

abbtech says: Sep 4, 2011. 7:10 PM **REPLY**

Great looking project.

---

ledartist says: Sep 4, 2011. 7:18 PM **REPLY**

Thanks!

---

vruiz3 says: Sep 4, 2011. 1:56 PM **REPLY**

afraid of the night??? :D

---

timotet says: Sep 4, 2011. 1:21 PM **REPLY**

great job!

---

gnafpliotis says: Sep 3, 2011. 3:06 PM **REPLY**

Can't we hack laptop's batteries that way to perform more? Is it only letting through a small amount of amps?

---

ledartist says: Sep 4, 2011. 1:17 PM **REPLY**

Laptops and many other "high-tech" gadget has many of inductor based boost/buck (to reduce voltage) voltage converter circuit in them. Especially LED back light screens use voltage converter to efficiently drive LEDs.
So in a way the battery life is already enhanced. (Some gadgets are better than others, of course...)

Aki

---

jolshefsky says: Sep 4, 2011. 6:19 AM **REPLY**

Yes, but only if you wanted to use your batteries once. Once a lithium rechargeable (like in laptops) is discharged past a certain point, it can no longer be recharged. So there is always some energy left in a laptop battery even when it says it's dead — albeit energy you can't use without ruining the battery.

---

stoobers says: Sep 4, 2011. 7:29 PM **REPLY**

I've heard this theory. Have you done any experiments that might validate this theory?

---

jamwaffles says: Sep 4, 2011. 6:14 AM **REPLY**

This might not be 100% accurate but yes, that's why we can't use the same technique for laptops. Joule thieves ramp the voltage up, but the current goes down due to V = IR, assuming the load is constant which it is if it's the same laptop ;-)

---

jamwaffles says: Sep 4, 2011. 6:15 AM **REPLY**

A very professional looking product. This is a great idea; the amount of power saved using old batteries instead of a herd of plug-in night lights, as well as the amount of batteries re-used is incredible.

Just out of interest, how long do these night lights last on one "averagely discharged" battery?

---

ledartist says: Sep 4, 2011. 1:10 PM **REPLY**

The battery lasts very long, most likely much longer than you might think.
It's hard to define "averagely discharged", but I had one cell that was already at 0.7V (to low to be used with anything), and the although the LEDs were dim, they lighted for over 48 hours.
With my "dead" batteries coming out of a wireless mouse still have over 1V, I have plenty of light.

Aki

YakAttack says: Sep 4, 2011. 8:24 AM **REPLY**

I concur!
@ledartist: Any tests on battery life so far?

nymgeek says: Sep 4, 2011. 7:42 AM **REPLY**

Are those PCBs made by Laen at dorkbot pdx?

ledartist says: Sep 4, 2011. 1:04 PM **REPLY**

Yup. They are very good!

acmefixer says: Sep 4, 2011. 10:06 AM **REPLY**

I should have said in my previous comment that this does not mean there is anything wrong with your circuit. I think I would change Q2 and Q3 to an easier to obtain transistor such as a 2N4401 or PN2222A. Q1 could be a 2N3906 or just about any PNP transistor. If these changes are made, the resistors, especially R2, might need to be reduced. Thanks.

ledartist says: Sep 4, 2011. 1:03 PM **REPLY**

Yes, you can use just about any general purpose transistors. R2 should be fine with most transistors, but 47k ohm might work better with some of them.

Aki

acmefixer says: Sep 4, 2011. 10:00 AM **REPLY**

Unfortunately the link you gave to Joule Thief in Wikipedia is for a poorly written and totally inadequate definition. The authors (apparently several over time) do not have a firm understanding of how a JT works, and furthermore, they have made a mess of it. I have added comments in the discussion and some errors have been deleted, but it is still unworthy of use for a reference.

Also, by definition, the original blocking oscillator circuit later given the Joule Thief name used only a single transistor. Your circuit is not a one transistor blocking oscillator and bears little resemblance to the original JT, so I don't believe it should use the same name.

ledartist says: Sep 4, 2011. 12:59 PM **REPLY**

I know the original circuit only uses one transistor, but the two conductor inductor is harder/expensive to purchase, and winding own inductors is a bit of work. I think using one extra transistor is a good trade off for not having to wind an inductor by hand. It also makes economical sense. (transistors are very cheap, so are single coil inductors.)

I did mention that my version is a _variation_ of original, which I find very often on the net. I also think that showing different ways to achieve the same result can be inspirational.

I also contacted the person who named the circuit "Joule Thief" (Big Clive) and he did not have a problem with me using the name.

Aki

StoryAddict says: Sep 4, 2011. 12:54 PM **REPLY**

"Joule Thief" - I love a clever pun!

MikeDel says: Sep 4, 2011. 10:21 AM **REPLY**

Looks good. I'm interested!

Admiral Aaron Ravensdale says: Sep 4, 2011. 7:30 AM **REPLY**

I like your "green" thinking.
I also use a joule thief in my expedition light.

I am very glad that you will provide the parts as a kit because many kits are able to solder a circuit but etching a little bit too dangerous for them.

Thanks for your endeavour to make this instructables buyable for many people…

kevinhannan says: Sep 4, 2011. 6:35 AM **REPLY**

fantasic project and incredibly well explained.

UOS says: Sep 3, 2011. 2:59 PM **REPLY**

Great instructable! Waiting the kit version to buy one but also I'm gonna make mine from scratch :D

tphillips2 says: Sep 3, 2011. 8:07 AM **REPLY**

You are so inventive! Cool idea and great looking light!

ledartist says: Sep 3, 2011. 8:18 AM **REPLY**

Thanks!

gweeds says: Sep 3, 2011. 4:41 AM **REPLY**

What a great idea! must build one and see how long it gets out of a "used'ish" battery

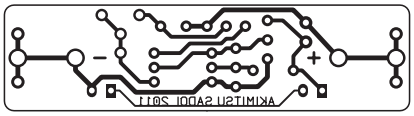
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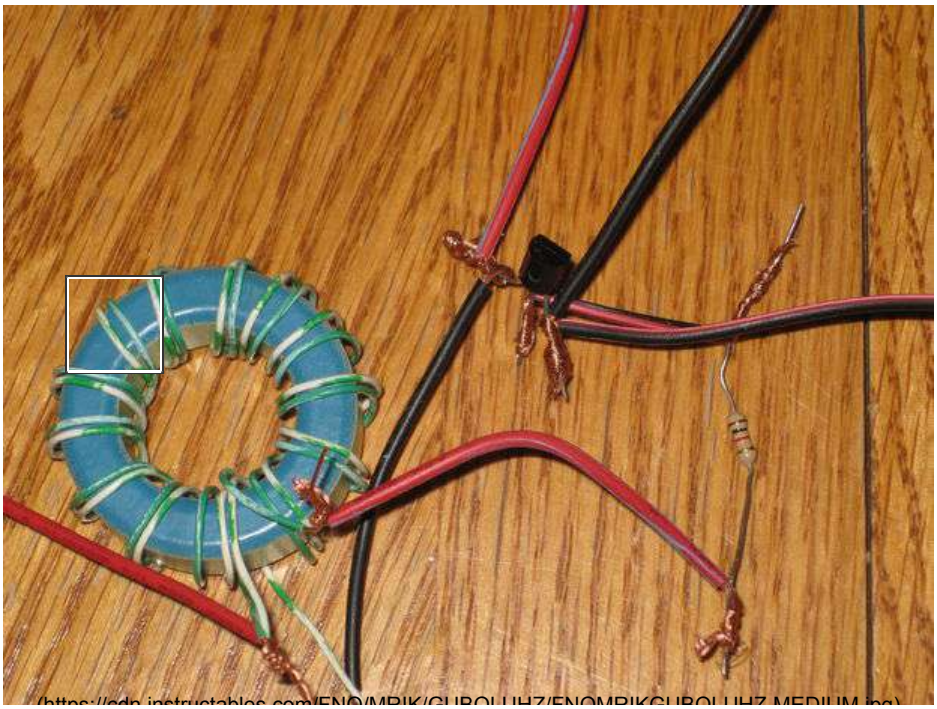

this is my version of the famous joule thief. there's alot of these things out there so i did alot of research and made it as simple as i can without soldering or complicated math. i harvested these parts from an older dell computer that was given to me to scrap. there is only a few parts needed to build this project:

1: toroid bead (ferrite core)
2: 1k ohm resister (brown black red)
3: npn transistor (i used the 2n3904)
4: thin wire

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About This Instructable

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Step 1: Wind the Coil

Joule Thief Without Soldering by

florlayamp (/member/florlayamp/) in electronics (/technology/electronics/)

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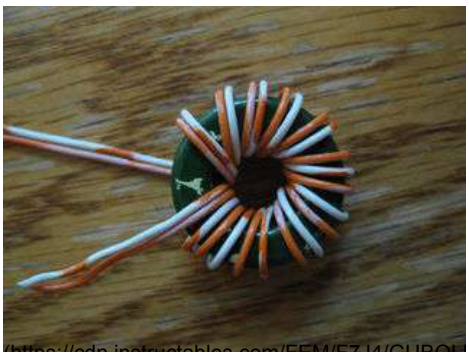

i wound a couple sizes of these things using the same wire. the type of wire i used came from an ethernet cat5 cable. i like it because its a solid core wire that stays in place where i put it. i have 11 turns of wire in the orange one and 13 in the green one. i looked all over the internet to find the reason for the number of turns but couldnt find an exact answer, and 11 winds is all the smaller (orange one) could take, and the green one i just put the 13 turns in it from the same length of wire. the orange coil is half the size (about the size of a dime) of the green one (little bit smaller than a 50cent coin).

Step 2: Connect the Resistor

florlayamp (/member/florlayamp/)
(http://https://www.facebook.com
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Bio: I love building things, and I'm a twin, we both are electrical engineers and inventors. Feel free to ask anything else

More by florlayamp:

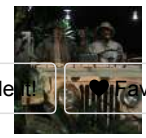

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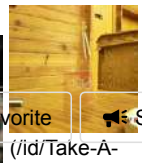

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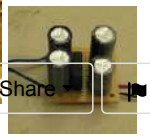

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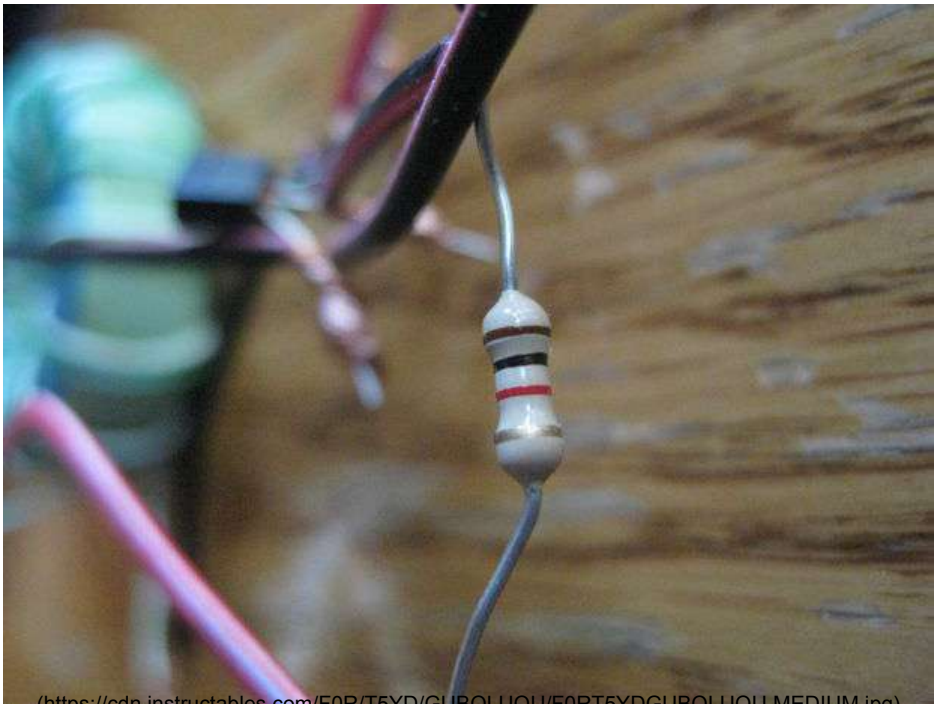

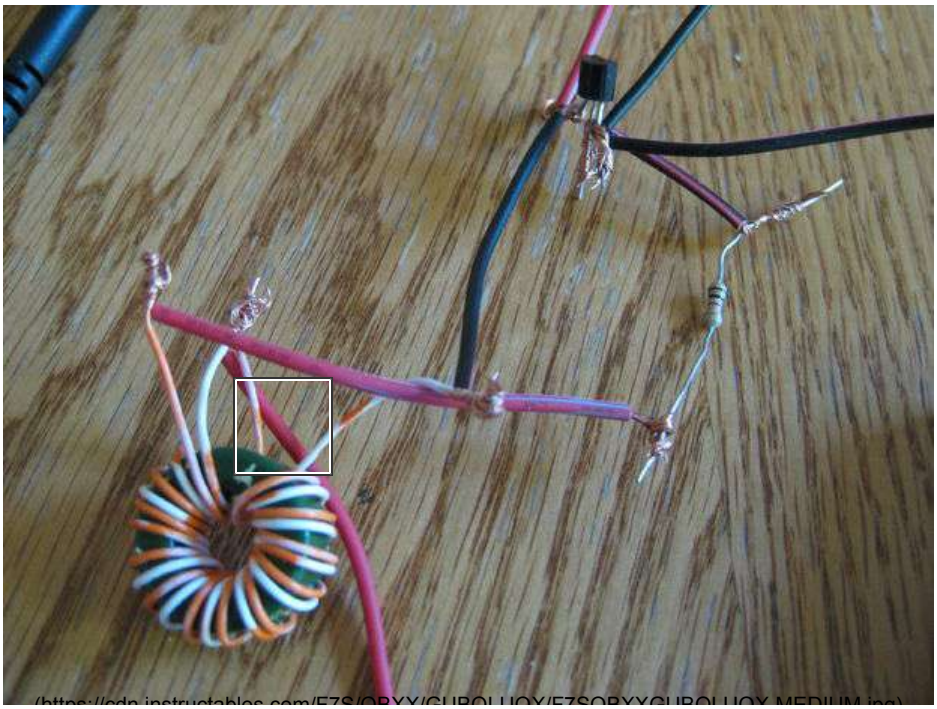

once the coil is wound, cut off the excess wire but make sure to leave enough to work with. strip the ends of all four wires, then take 1 wire of **opposite color from each side** and twist them together. then since i didnt solder any wire, i cut up several small wires to piece the rest of it together. unless you want to solder it you can skip this part. but i took a piece of wire and attached it to one of the single wires on the coil (it doesnt matter which one) and attach the other end of the piece of wire to the 1k ohm resister, then take another piece of wire and attach it to the other single wire which will go to the **collector** leg of the transistor. the final piece of wire for this step attaches to the twisted pair of wires which will become the positive input for the circuit.

Step 3: Connect the Transistor

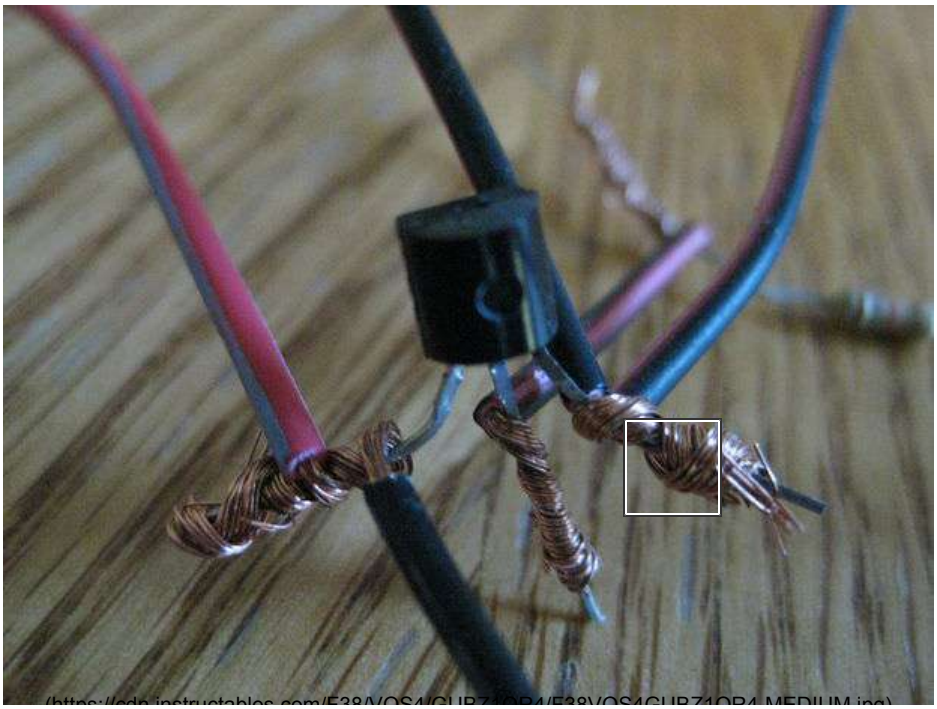

next take a piece of wire and attach it to the other side of the resistor, and then take the other end of the piece of wire and attach it to the **base leg** of the transistor. next, as i mentioned in the previous step, take the open piece of wire from the coil and attach it to the **collector leg** of the transistor, also i attached another piece of wire to this leg for the positive output side . last of all connect two wires to the **emitter leg** which will be the negative side of the circuit. (one wire to negative on battery, then one to the negative output side of an LED light or whatever else you put on it).

Step 4: Hook It Up and Enjoy!

time to hook it up! the positive wire from the double twisted wire on the coil goes to the positive power source, and one of the negative wires on the transistor go to the negative side on the power source. the positive wire on the transistor and the other negative wire on the transistor go to the output power. once its all wired up its ready for use. as you can see in the picture, i hooked up a new AA battery and got about 5 volts! not bad for a 1.5v to 5v boost. and the orange coil circuit i also made produces about 2.5v from a 1.5v source, so this orange one only produces another volt while the green one produces alot more. i dont know why this is really. my only guess is the size of the toroid coil and the 2 winding difference. other than that its all the same parts. below is the results of some playing around with it.

green coil circuit:
1: 1.5v AA produces 5 volts
2: 2 AA 3v produces 20 volts
3: 3v input can power a 12v .25a computer fan.
4: 1.5v lights 3 green LED lights.

orange coil circuit
1: 1.5v AA produces 2.5 volts
2: 2 AA 3v produces 8 volts
3: 3v input also powers same 12v computer fan for 5 seconds...

very inconsistent results between the two but thats what is going on. thanks for looking and hope this helps with your project.

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Comments

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Please be positive and constructive.

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ToXiCATOM (/member/ToXiCATOM/) 2014-02-01 Reply

can i use 2n2222 transistor?

kyooby (/member/kyooby/) ▸ ToXiCATOM (/member/ToXiCATOM/) Reply

2014-03-27

2N3904 = GP NPN Bi-Polar transistor commonly found in toys and small radios. Otherwise you can get them at radio shack, fry's electronics or order them online.

Other compatible ones are:

NPN

2N2222

2N2222A

2N1613

BC107

2N1711

2N2369

2N2484

2N3704

2N3705

2N3706

2N3903

2N3904

Also, if you use a 2N4401 or BC337 transistor, your LED will be brighter because they can handle more amps.

You can get the toroid and transistor from a dead CFL; the transistor is usually labeled 13002

florlayamp (/member/florlayamp/) ▸ ToXiCATOM (/member/ToXiCATOM/) Reply

2014-02-01

I tried that transistor also and I couldnt get it to output anything, I think the internal circuits inside it are backwards for a joule thief.

More Comments

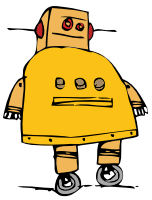

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Make a "Joule Thief" and Create Zombie Batteries for More Power After Death

BY WILLIAM FINUCANE 08/23/2013 5:22 PM MAD POWER!

Just about every household gadget we own runs on 1.5 volt batteries of one size or another. Wouldn't it be great if you could reuse all of those dead AA, AAA, and D batteries after they've passed on? It turns out you can make a simple circuit called a "Joule Thief" to reanimate the undead flesh of your deceased batteries and create a zombie battery.

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2 Start Download Step 1- Install DriverUpdate™. Step 2- Scan. Step 3- Identify Missing Drivers! slimware.com

Materials

- LED
- 1k resistor
- 2n904 transistor
- Thin magnet wire
- Solder
- Soldering iron
- Battery clip
- Ferrite core
- Dead battery

sistor for easy soldering.

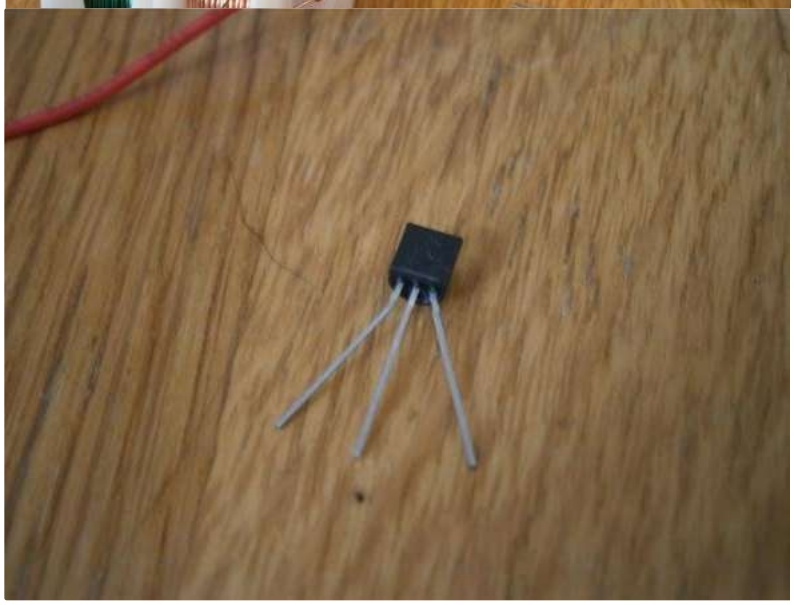

Bend the middle pin back and up behind the black plastic case of the transistor.

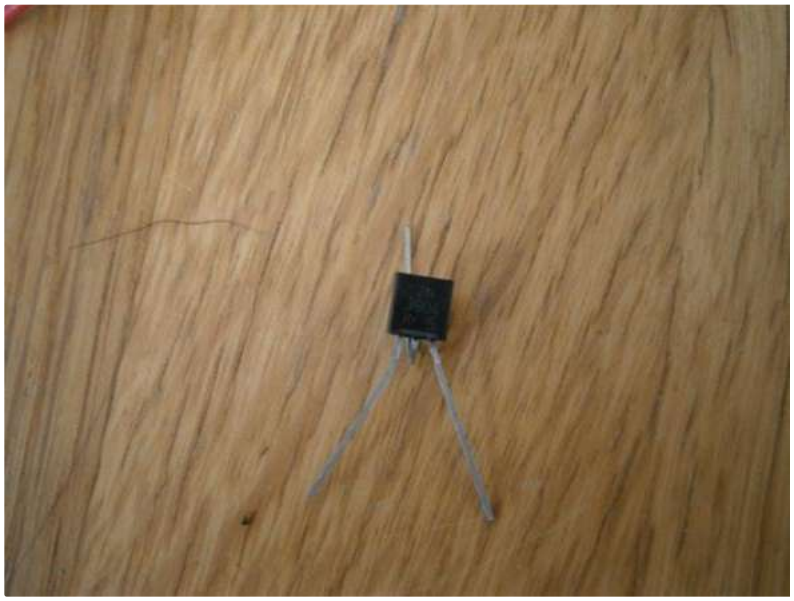

Step 2

Place the LED

The LED is a polarized component. This means it will only work when it is facing the right way in our circuit. The positive lead of the LED is usually longer. Below, the positive lead is on the left, the shorter negative lead is on the right.

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Place the LED on the transistor as shown below, with the positive side facing to the right.

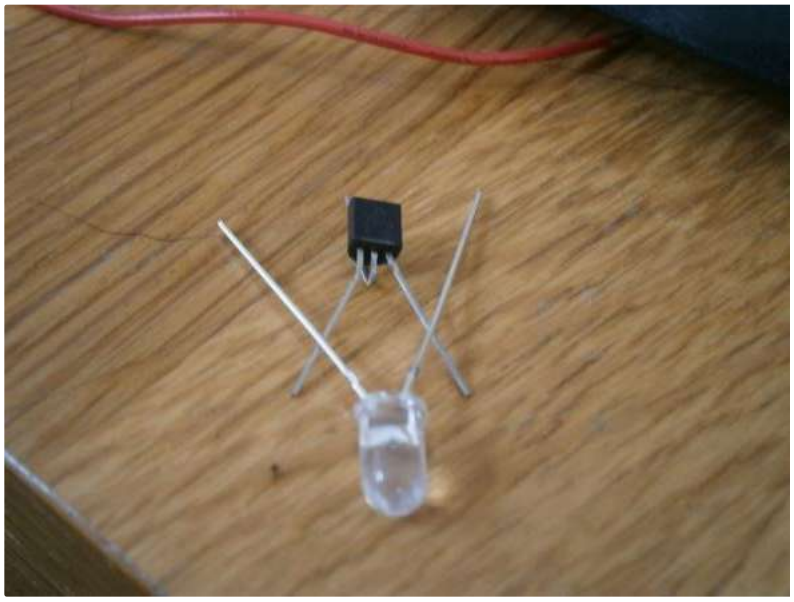

Now, solder the LED to the transistor.

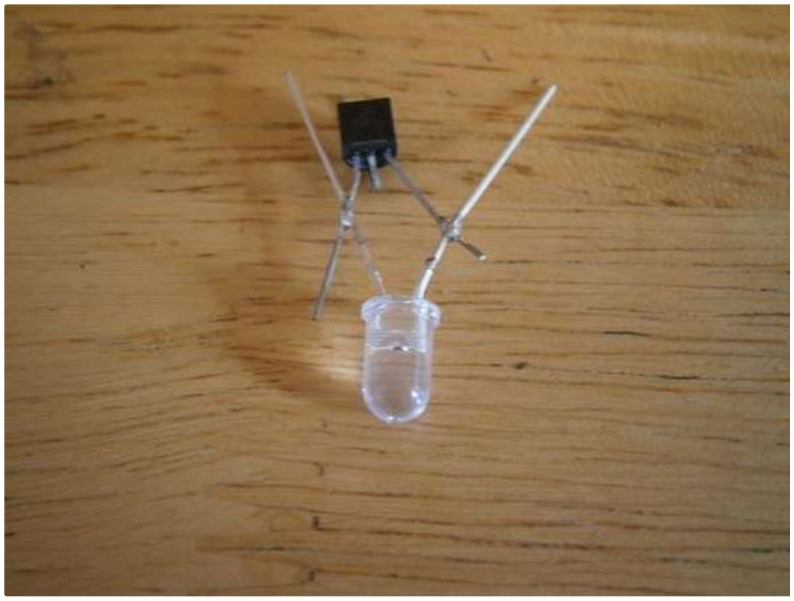

Step 3

Place the Resistor

Place one end of the resistor on the middle pin of the transistor. Make sure the components stay in contact while you solder them.

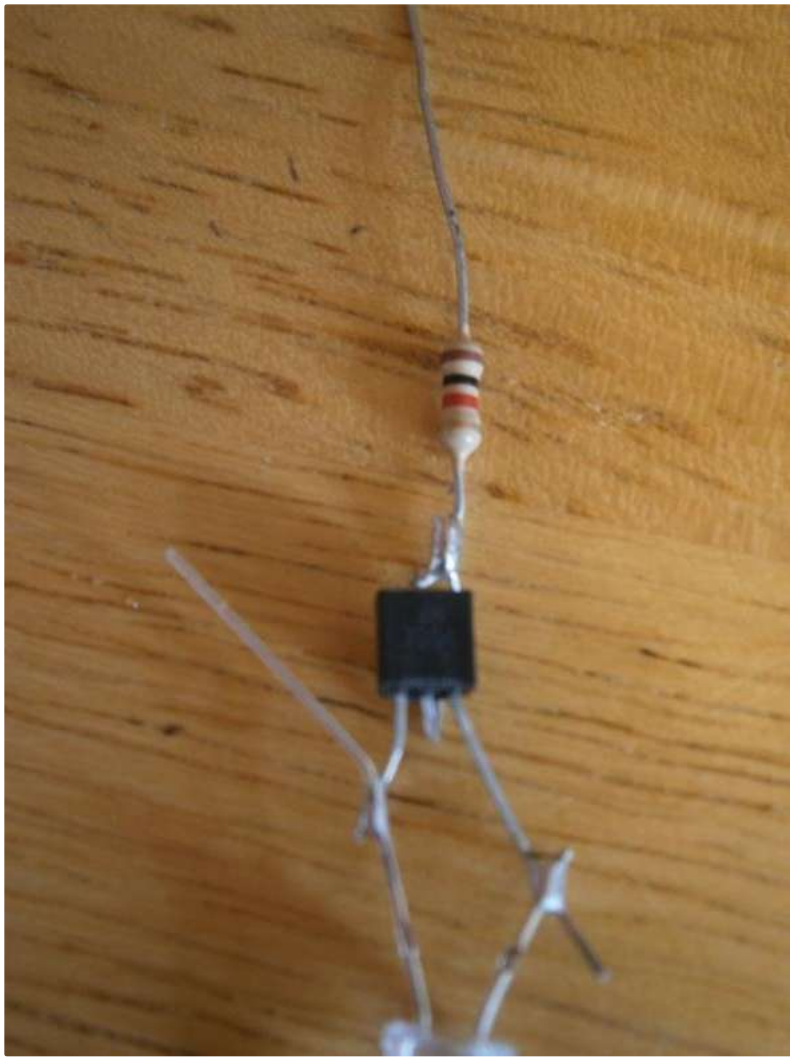

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Step 4

Wrap the Coil

This is where the dark magic happens. Wrap two enamel coated wires around the edge of a ferrite core. More wire will mean a stronger joule thief and a brighter LED. When you have wrapped the core, you should have two pairs of end wires. Connect one pair together as shown below on the right. Splay the other pair apart as shown below on the left.

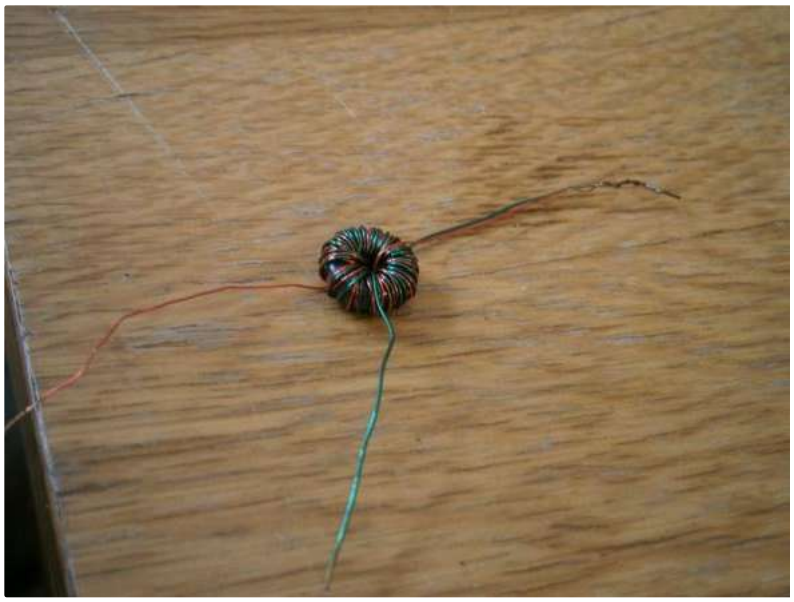

Step 5

Attach Coil

Remember to burn away the enamel on the end of the thin wire with a lighter. With the wires burned and exposed, solder one free coil wire to the 1k resistor. Solder the other free coil wire to the positive side of the LED.

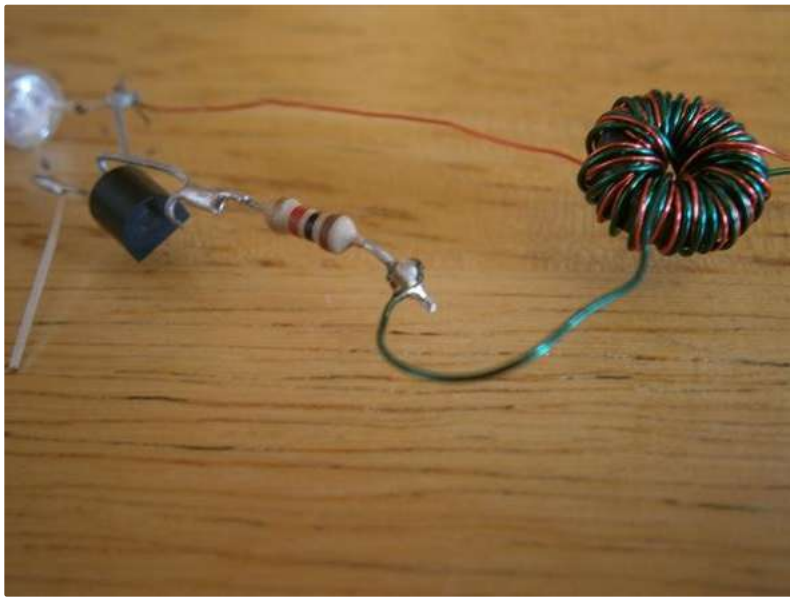

Below, we have to solder a coil wire to the intersection of the transistor and the positive leg of the LED.

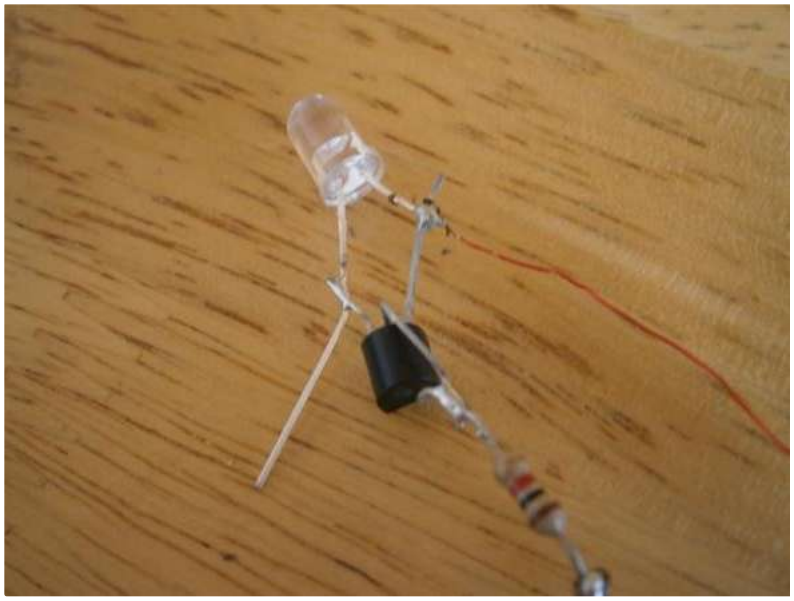

Below, notice that the end of the green enameled wire is exposed because the enamel was burned off.

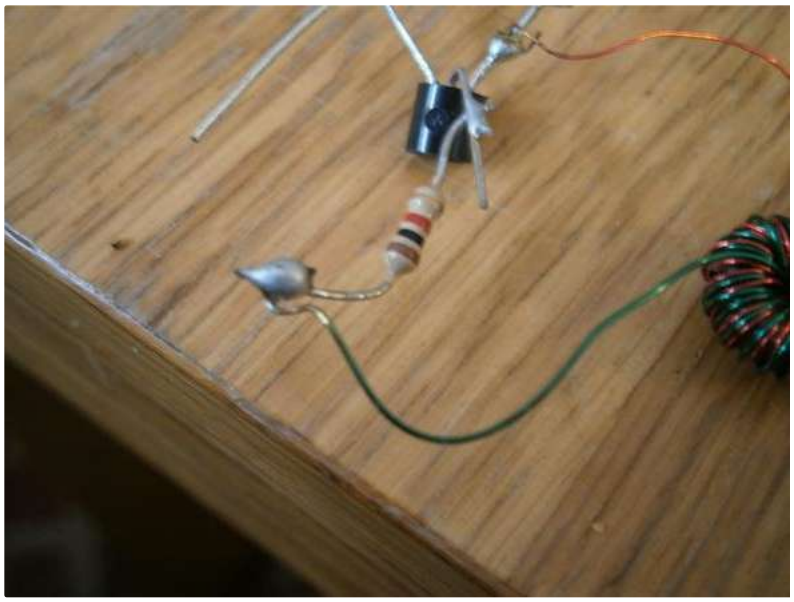

Step 6

Solder Clip

Now that the main joule thief is done, we can attach a battery clip for easy use. The joule thief will work without the battery clip, but only if you hold the wires in place with your fingers.

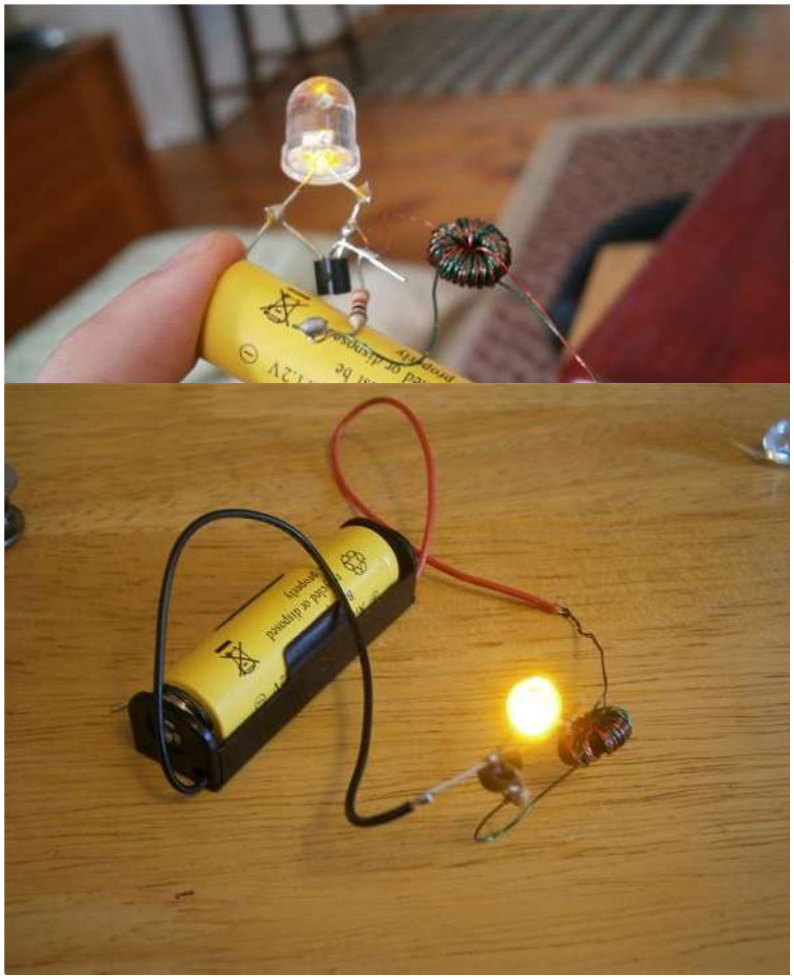

e that both wires in the pair are soldered to the red wire.

For those who need the schematics, this is what we just built:

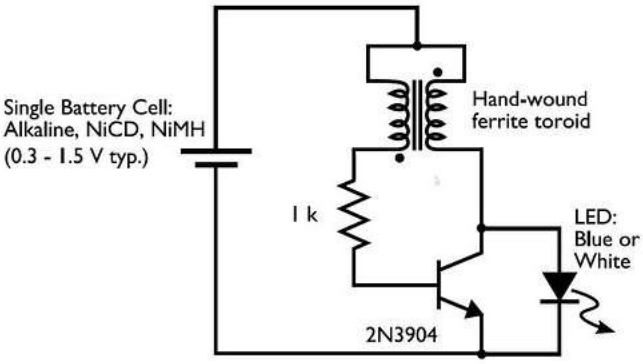

When the current flows through the coil and around the magnet, it produce an electromagnetic field (EMF). When the coil is not powered, the field collapses and produces an EMF kick in the coil that is of a higher voltage than the source was. The last of the electricity gets stored up in the field and released in large bursts to flicker the LED. The magnetic field oscillates so quickly that the blinking LED appears solid to the naked eye.

Now, just plug your dead battery into the circuit and enjoy the eerie unblinking glow of the undead watching you as you sleep. This project works great for night lights and even garden path lights when paired with a light sensor.

What could you light up with all your zombie batteries? Post your ideas and discussion in the forum.

Diagram image from Evil Mad Scientist Laboratories

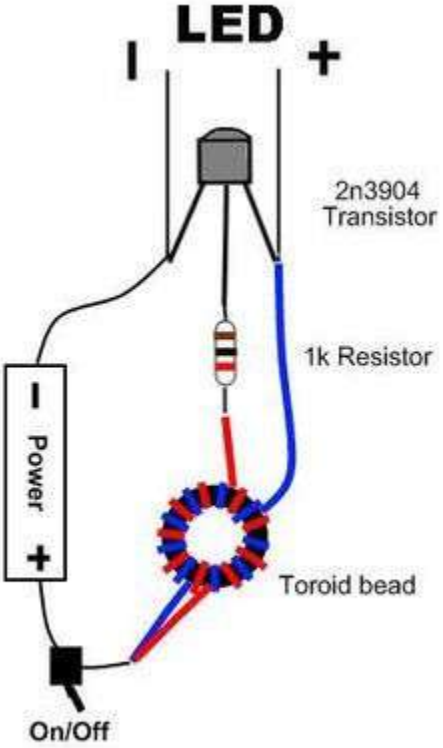
LED
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+
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Transistor
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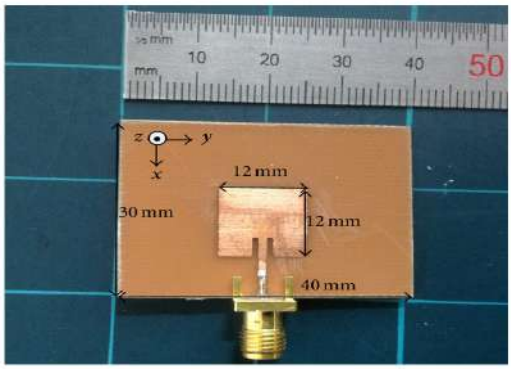

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Also, a lesser degree component design a. Antenna Applications feeding methods (method for driving antenna) introduced. References 1 java@falstad. J yadav r. Pin-pitch Dimensions ii.

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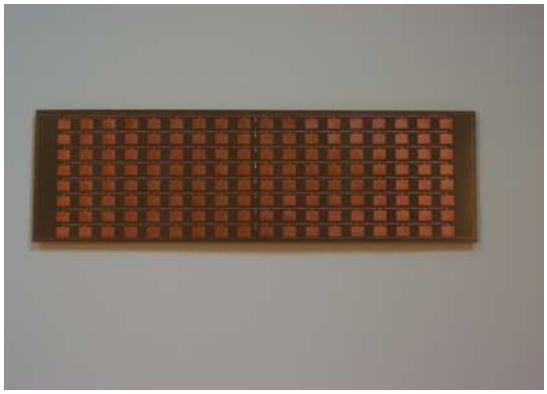

Microstrip patch antennas by kai fong lee

Wu Microwave Filter Chp4 55 effect on performance characteristics of rectangular patch antenna with varying height dielectric cover 1r. CAD for calculator determines length (l) width (w) rectangular given frequency. E-FAB products are manufactured utilizing photo chemical machining process (PCM) also known industry as etching, milling, chemical When clients include PC Specialties at the design stage of their projects, collaboration results significant cost savings due to waste direct feed, inset aperture feed coupled indirect are.

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N5ESE's Classic RF Probe

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NOTE: 'N5FC' is my former call.
This project was constructed while that call was valid, and you may observe references to it.

The RF Probe is one of the handiest accessories you can have around the shack. Using only 3 electronic components, it may rank as one of the simplest and cheapest homebrew projects. The one featured here cost about $10 in parts and supplies, not counting the wire, which I scrounged. When used with a high-impedance DC Voltmeter, it can be used to measure RF voltage (and power), trace RF signals in a new design, and troubleshoot malfunctioning RF circuits. It has its limits, of course, and we'll discuss those here. But once you understand how it's used, and how easy it is to build, you'll wonder why you never built one before.

What's an RF probe, and how does it work?

You might think of an RF probe as a special test lead that converts your regular ol' DC voltmeter to a RF reading voltmeter. Why not just read it using your trusty voltmeter, set on AC? Well, because most voltmeters wont read AC signals having a frequency above 10 or 100 KHz, and RF is way above that. [You can buy special RF-reading voltmeters, but they're very expensive... a homebrew RF probe is dirt-cheap]. Let's examine how an RF Probe works.

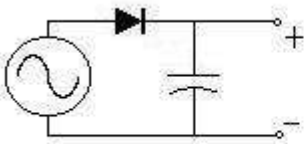

Classic Peak Rectifier

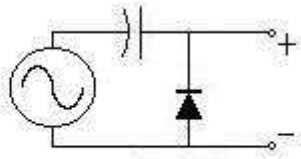

Simplified RF Probe

Above left, we see the schematic of a classic half-wave peak rectifier, commonly seen in power supplies. It's pupose is to take an AC signal at the input (usually from a transformer or the AC line), rectify it, and charge a capacitor. If you don't take a lot of power from the circuit (i.e., if your load doesn't draw a lot of current), the capacitor charges up to the peak voltage of the AC signal, and stays prettty much constant. Notice the simplicity of the circuit: not counting the load, we see it is an AC Source, a diode, and a capacitor in series.

Above right, we see a simplified schematic of the RF Probe. At first glance, it looks quite different from the circuit at the left. But notice: just like the first, it consists of an AC Source, a diode, and a capacitor in series. It's pupose is to take an AC signal at the input (usually from a circuit under test), rectify it, and charge a capacitor.

And just like the first circuit, If you don't take a lot of power from the circuit (i.e., if your load doesn't draw a lot of current), the capacitor charges up to the peak voltage of the AC signal, and stays prettty much constant.

What's the difference between these two circuits, then? One small little thing, really. In the first circuit (the half-wave peak rectifier), any *positive* DC component gets added to the voltage at the output. In the second circuit (the RF Probe), the circuit is insensitive to *positive* DC components. This is good for an RF probe, because we're going to be testing circuits with DC biases applied, and we don't want those biases to affect our readings (we're interested in the AC only, i.e., the RF)

In both these circuits, if we place a DC (not AC) voltmeter at the place where it says "+" and "-" we'll read a DC voltage that is approximately equal to the *peak* of the applied AC voltage. If we knew our applied AC was a sinusoidal signal (or sine wave), then we could divide our reading by 1.414 to obtain the RMS value, which is the way we usually measure AC voltages. Even if it's not a sinusoid, at least we know what the peak voltage is, and that's something we didn't know before we started.

We'll do one more little trick to make the RF Probe more useful, and it will only cost us the addition of a 2-cent resistor. So that we don't have to manually divide our readings by 1.414, we'll use a resistor to create a voltage divider that will do it for us. Here's a classic voltage divider, added to our RF Probe circuit:

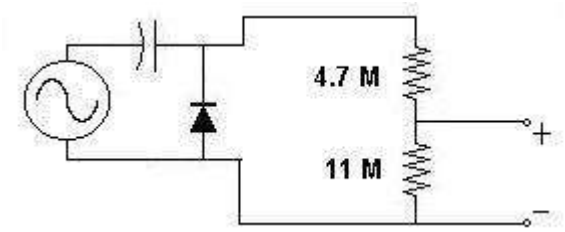

As we know from elemental electronic theory, the voltage across the second resistor (where it says "+" and "-") is equal to the applied voltage multiplied times the ratio of the second resistance divided by the total resistance in series. In our case, for a sinusoidal input, we know the applied DC voltage is equal to the PEAK of the AC voltage. We would like the resistor divider to divide by 1.414, which means that the total resistance in series (including the second resistor) needs to be equal to 1.414 times the second resistance. In our example circuit, shown above, the second resistor is 11 Megohms, and the total series resistance is 11 Megohms PLUS 4.7 megohms, or 15.7 Megohms. Is this ratio 1.414? Pretty close, about 1.427, closer than the typical resistor tolerances.

But wait! I said we would add one resistor, not two! What's up with that? Well, the 11 Megohms is the typical input resistance of a high-impedance voltmeter, like an electronic VTVM or a digital voltmeter. As long as it's 10-11 Megohms, it'll give results close enough for government work (HI). Obviously, it's important to know what your voltmeter's input resistance is, and you can find this out in your voltmeter's specifications, or measure it (I wont get into that). And really, accuracy is often not that important, especially when you're signal-tracing.

Enough! Let's get real... let's build something!

Here's a complete schematic of the classic RF Probe. Simple, eh?

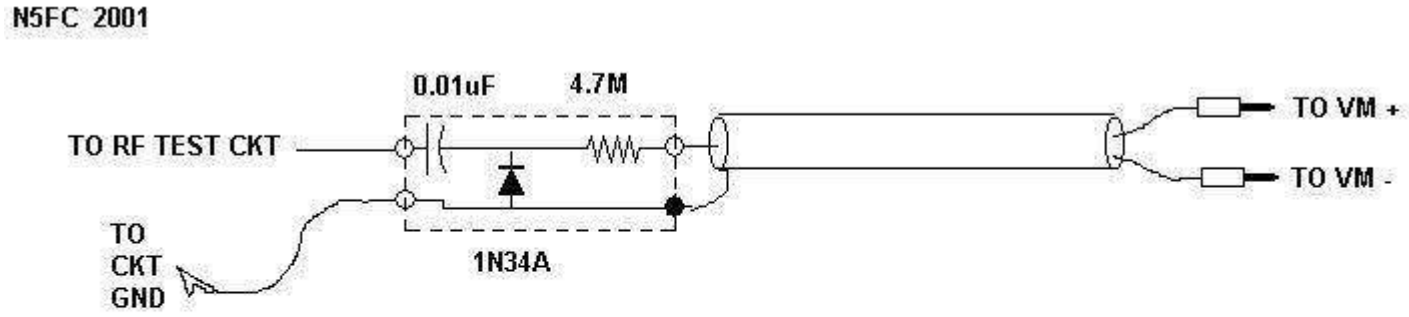

CLASSIC RF PROBE

Reads RMS Equivalent Voltage in test circuit, if Voltmeter is 10 -11 Meg Input Impedance;
Reads 4X RMS Equiv Voltage if VM is 1Meg Input Impedance (Set VM to measure DCV)

We've added a few things from our theoretical discussion that we'll make short note of. Obviously, for "probing" we need a "probe". (Hey! No wonder I get paid the big bucks...). We add a SHORT lead with an alligator clip. The alligator clip goes to our circuit "ground" and the probe goes to our test circuit, where we're probing. Brilliant! We don't want either of these to be long leads, because we're talking RF here, and long leads = antennas, and we don't want to be picking up stray signals or broadcasting them. 10-12 inches for our ground lead is sufficient for circuits to up to 30 MHz.

As shown in the schematic, we'll need to shield the RF Probe circuit, or else our hand and body will pick up stray RF and couple it into the circuit, causing erroneous readings. We'll also shield our leads all the way back to the Voltmeter, as shown, for the same reason. At the far end of the shielded wire, we'll mount banana plugs (or whatever will fit our DC Voltmeter).

In case you're tempted, don't make poor substitutions for the diode. We chose the 1N34A because it had the following key characteristics: Reverse Breakdown Voltage greater than 40 Volts, forward voltage (barrier potential) of less than 0.3 Volts, and good RF qualities. Any diode with these qualities (example, the 1N458A) would work as well, but the 1N34A is readily available (at Radio Shack and others). Silicon and Shottky (hot-carrier) diodes, while good RF devices, have higher barrier voltages, and will not work as well at low RF voltages. The 1N34A is a germanium device, and with a barrier voltage of around 0.25 V, provides about the best performance you can get with this simple circuit.

For best accuracy, size the resistor to match your DC Voltmeter's input impedance:

R = 4.7 Meg for Zin = 11-Meg;
R = 4.3 Meg for Zin = 10-Meg;
R = 430 K for Zin = 1-Meg;

Here's one cheap-and-easy approach to building the RF Probe:

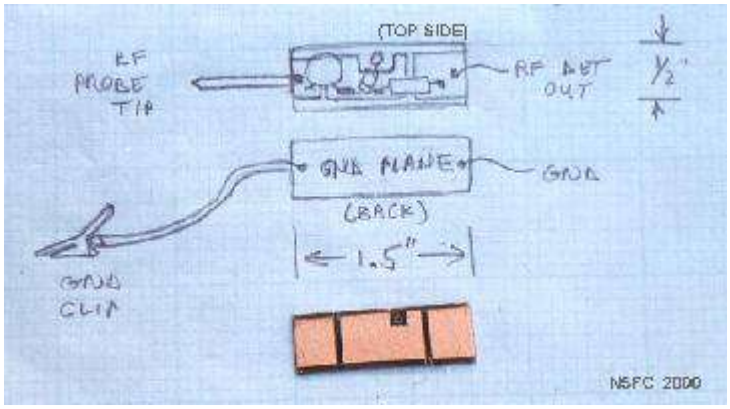

Click on the image above to see a larger

Take a small piece of scrap double-sided printed-circuit board, about 1-1/2 x 1/2 inches, Groove it on one side only, similiar to the image above, to create pads for soldering, but leave the back side as a "ground plane". Mount your diode, capacitor, and resistor as shown, soldering to the pads you made. One side of the diode (the non-banded isde) gets connected to the ground plane (drill a hole through to the other side and solder it). Try to fit all the components neatly inside the edges of the pc board. Solder the braid of the shielded wire (3-4 ft long) to the ground plane, and the center conductor to the pad with the resistor. Also, solder a 10-12 inch hook-up wire to the ground plane. Check that there are no shorts between the center conductor and the ground-plane. Solder the probe tip to the pad with the capacitor (I used a discarded probe tip from a broken test probe).

Here's where we get creative: packaging! One way or another, whatever method we use, it's important to shield the probe circuit, yet without shorting any part of the circuit to our shield (except the ground plane). I was on a kick of using copper pipe, which is very cheap, so I built my shield out of 1/2-inch copper pipe and end caps, commonly available at your local hardware store. I drilled a hole in the end of each end-cap, to pass the shielded cable and the probe tip. I used a shouldered washer to insulate the probe tip from the end cap, but a small rubber grommet would have worked as well. Stuff the assembly inside the copper pipe, and you end up with a completed probe that looks like the following:

Click on the image above to see a larger version

So, how do we use this thing?

Before we use it, a few precautions are in order. Don't use the probe in any circuit where the highest DC supply voltage is greater than the diode's reverse-breakdown voltage. For the 1N34A, this is 50 Volts. Same goes for the capacitor, which should be rated at least 50 Volts. This probably means that the probe cannot be used in most tube circuits. Also, don't try to measure RF power in circuits where the peak voltage will exceed 50 Volts. What will happen if you exceed these voltages by a little? Well, probably nothing; possibly, the diode or capacitor will fail open or short.

The first thing you'll always do in using the RF Probe is to connect the banana-plug end to the +/- jacks of your DC Voltmeter; set the Voltmeter to DC-Volts (not AC).

To use the RF Probe for signal tracing in a malfunctioning RF circuit or a homebrew circuit, connect the aligator clip to a convenient "ground" or "common" point in your circuit. Often this is the chassis. Most of the time, you'll be probing at the base/gate, emitter/source, or collector/drain of a transistor, one either side of a coupling capacitor or transformer, or at the input or output of an IC. Because the circuit's RF must overcome the diode's barrier potential (of 0.25V, for our 1N34A), voltages much less than that won't read at all, and voltages less than about a volt won't read very accurately. Typically, RF and post-mixer-amps in receivers don't have enough RF voltage, unless you inject a very strong signal at the input.

I recently used my RF probe to troubleshoot my dead TenTec Scout, which had suddenly quit transmitting in mid-QSO. I connected the rig to a dummy load, then keyed it while probing. Using the probe, I was able to follow a steadily increasing RF signal through the transmit chain, from the oscillator through the transmit mixer, to the pre-driver, and the driver. The actual voltage measurements weren't important, just that they were increasing from stage to stage where expected. Then, (whoops!) the driver's base circuit had 6 Volts, but the collector circuit only had only 0.1 Volts! The driver transistors had gone south!

You can also use the RF probe to measure RF power with reasonable accuracy, up to about 50 watts in a 50-ohm circuit. By 50-ohm circuit, I mean a 50-ohm antenna system at 1:1 SWR (higher SWRs are not 50 ohms), or a 50-ohm dummy load. Assuming the resistor in your RF probe is sized to match your DC Voltmeter's input impedance (as explained above), you will get quite reasonably accurate measurements using the following formula:

$$PWR = \frac{(V_{(read)} + 0.25)^2}{R_{(load)}}$$

For example, I want to measure the power out of my TenTec 1340 40-Meter QRP transceiver. I place it on a 50-ohm dummy load, and key down. I generally use a BNC-Tee adapter to gain access to the output line, but I could as easily pop the cover off. Using the RF probe (alligator clip to chassis ground), I measure12.2 Volts (DC) (and the same RF RMS Volts). Plugging this into the formula above I have PWR= (12.2 + 0.25) * (12.2 + 0.25) / 50 = 3.1 Watts. The rated power for this rig is 3 Watts, so I've verified everything is hunky-dorey.

We've added the potential barrier to the measured voltage above, but that little trick doesn't work so well when you get down around a volt, and for voltages less than about a volt, the measurement accuracy suffers greatly. Also, the diode's response is severely non-linear below the barrier potential, and will generally read much less than expected in circuits where the RF voltage is less than 1/4 volt. So if you see tiny readings in circuits where it's normal to have voltages less than 1/4 volt RF, don't get too spun-up about the low readings... it may mean everything is normal. My rule of thumb for guessing at this is as follows: For collector/drain circuits in oscillators or transmit-chain amplifiers in key-down, expect RF Voltages about 20-50% of the applied DC (supply) voltage. This depends on the circuitry, of course, but it's a reasonable gesstimate. Base/gate and emitter/source circuits will generally be much less, maybe 5-10%. Circuit impedance will affect this too.

How good is this thing?

Well, we're not talking high performance test equipment here, but we *are* talking very useful. If you account for the barrier voltage, the readings can be quite accurate when measuring most low-impedance circuits (20-200 ohms), provided that the voltage is above 1 or 2 volts. How accurate? +/-10% from 200 KHz to 150 MHz would be a reasonable expectation. Also, the voltage divider is only accurate for sinusoidal signals. If you want "peak" measurements, simply multiply your reading by 1.414. The "peak" measurement should be good regardless of

whether the waveform is sinusoidal. Regarding ultimate accuracy, your results may vary, and you may want to compare it to a laboratory instrument at the frequency of interest if you're really interested in accuracy. If you shield it well, and keep the ground clip lead reasonably short, it should be good in low-impedance circuits up into the VHF region, and down into the upper-audio region. In higher-impedance circuits, the junction capacitance of the diode may cause a low-pass effect at higher frequencies, and you're most likely to see this as a loss of measurement accuracy (i.e., low readings) at frequencies above 30 MHz. This doesn't mean it's not useful; it just means it reads low. Also, the capacitance of the probe may affect some sensitive RF circuits. For example, if you're probing a LC-tuned oscillator circuit, it may stop oscillating or change frequency or become unstable. Actually, most any probe will do this. Also, as we said before, the barrier voltage becomes a bigger part of the measurement error as the circuit voltage drops below a volt or so, and becomes dominant as you approach the barrier voltage. Just keep this in mind as one of it's limits.

Enjoy, good luck, and 73!
monty N5ESE

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N5ESE's Ballpoint RF Probe

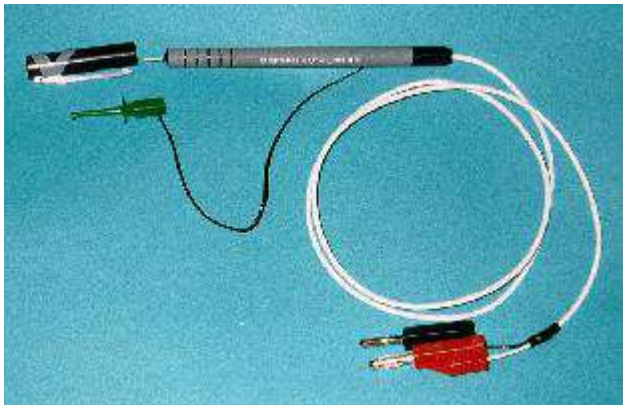

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NOTE: 'N5FC' is my former call.
This project was constructed while that call was valid, and you may observe references to it.

This is one of those afternoon projects that can really be both rewarding to build and useful to have. Electrically, it's identical to the Classic RF Probe described elsewhere (where you can also find the theory discussion for this one). Like the Classic RF Probe, this one is used in conjunction with a high-impedance-input Voltmeter or Digital Voltmeter (DVM). See the schematic below. Cost? About $5, if you can scrounge the ballpoint pen, heat shrink, shielded cable, and copper tape.

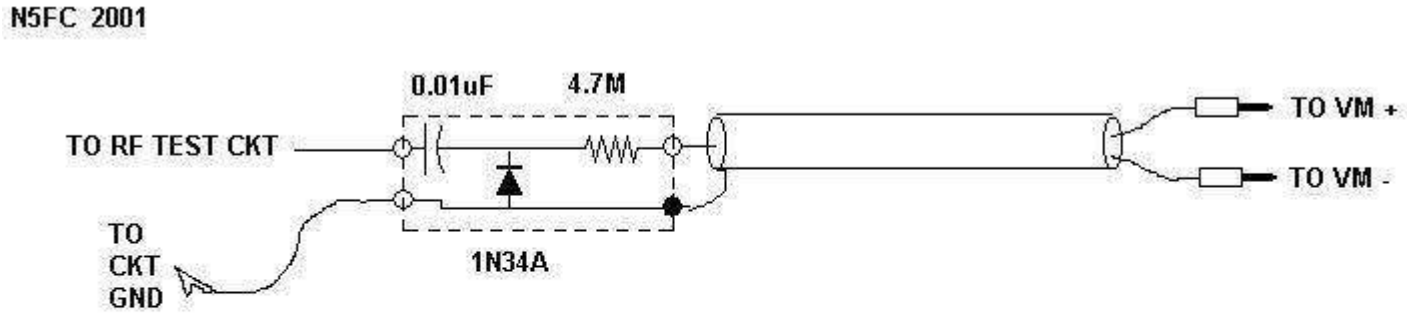

CLASSIC RF PROBE

Reads RMS Equivalent Voltage in test circuit, if Voltmeter is 10-11 Meg Input Impedance;
Reads 4X RMS Equiv Voltage if VM is 1Meg Input Impedance (Set VM to measure DCV)

What makes this probe unique is that it's built inside the shell of a regular ol' ballpoint pen. Besides being conveniently compact, the unit sports a needle-probe suitable for use in probing surface-mount circuits, and good overall shielding. The pen cap protects the needle probe when not in use. When measuring sinusoidal signals, it should provide RMS-corrected readings, using a 10 or 11-Meg input impedance VTVM or DVM. With a 1-Meg DVM, it reads 25% of the sinusoidal RMS voltage. Reasonable accuracy (+/- 10%) can be expected over the HF/VHF range (2-150 MHz), although this hasn't been verified. When used to measure non-sinusoidal signals, the accuracy will be unknown, but it still affords good relative measurements, and most of the time, that's all that's required. It makes an excellent, compact, and portable accessory for troubleshooting or homebrewing QRP equipment with peak voltages less than 50 Volts (i.e., most solid-state equipment)

Construction

The figure below shows the parts required to build the Ballpoint RF Probe. Click on the image to open an larger, annotated image with parts labled, and construction notes. Pick a ballpoint pen with a non-metalized plastic body, and plenty of room inside. The Papermate Flexgrip model I used had an inside diameter a little over 1/4-inch. We'll use an itty-bitty scrap of double-sided printed-circuit-board to mount the electronic components. Trim the PC board to about 2-12" long and 3/16" wide; don't make it too wide, or it won't fit inside the ballpoint pen. Notch or file a little out of the middle of the pc board, so the 1N34A diode will fit easily inside the pen body. then, on one side only, groove in two places, so as to create 3 lands on the "top" side of the board. In addition to the parts shown, you'll need a 2-1/2" piece of heat-shrinkable tubing to cover the electronic assembly (although electrical tape would do instead), and about a foot of 1/4"-wide adhesive-backed copper tape, commonly available in rolls of 200-300 inches at large hobby stores (like Michaels, and Hobby Lobby). Although a chip capacitor is shown in the photo, a very small disc capacitor will do as well.

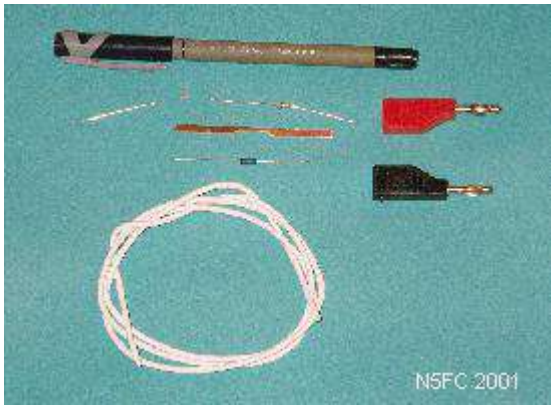

Click on the image above to see a larger, annotated image

In the next image (below), we get a close-up of the electronics assembly. You can see the input capacitor straddling the front-to middle lands, and the 4.7 Meg resistor straddling the middle-to-rear lands. The diode, which snuggles into the notch, connects from the middle land to the ground plane on the rear side of the pc board. The diode's banded end goes to the middle land. Break the sewing needle in half, using two needle nose pliers. **WARNING! Use eye and face protection!!** *ALSO NOTE: Don't try to cut a sewing needle with wire-cutters... you'll ruin the cutters.* Avoid straight pins, which dont have the hardness to perform well as probes. Then, solder the sewing needle to the front land, centering it carefully. You might benefit from burnishing the solder-half of the sewing needle with some fine grit sandpaper, to make it take solder a little better. Center it up nicely, as that will make for a professional-looking probe. Solder the shielded cable to the top/bottom of the pc board, center conductor to the rear land on top, and shield to the ground plane on the bottom. Be careful to aviod straggling shield-wires which could short the electronics. Also,solder a 10-12" pigtail of good, flexible insulated wire onto the ground plane, pigtailed rearward. This will be used as the ground wire in our test circuit. Before you shrink the tubing over the electronic assembly, check for shorts between lands and from lands to ground plane, make sure you have the diode polarity correct, and check that the needle is making solid electrical contact, and is mechanically secure.

Click on the image above to see a larger, annotated image

See the next image, below. After the electronic assembly has been heat-shrunk overall, wrap the copper tape all around the electronic assembly. This will be our shield. Near the rear of the electronic assembly, solder the electonic assembly's ground to the copper tape, near or on the cable shield. Alternative shielding methods can be

tried, for example, you might pull the shield out of a piece of RG-59, and sleeve it over the electronic assembly, soldering it to the ground plane. Whatever you do, be certain that the shield cannot unravel and short against the probe itself or any of the electronics.

Although not shown in the picture, we drill a small hole about 2/3 back on the pen casing, threading the ground pigtail through the hole. This really tests your hand-to-eye coordination. If the pen has a threaded-in rear-cap, drill a hole in it just big enough to accommodate your main shielded cable. Thread the whole cable into the pen casing, and out the other side, and if you had a threaded rear-cap, like I did, thread it on. Pull the electronic assembly gently back into the casing, so that the needle probe sticks out about 1/2 inch. Mix some clear 5-minute epoxy, and let it thicken ever so slightly. Then , while holding the assembly vertically (i.e., probe-tip up), and using a small toothpick or screwdriver, drop epoxy into the probe area, sealing the electronics and probe into place. Allow to dry thoroughly before applying any pressure to the assembly.

When dry, attach your favorite ground-clip to the pigtail, and banana plugs on the end of the shielded cable (red to the center-conductor, black to the shield, to match your Voltmeter)

Click on the image above to see a larger, annotated image

See the next image, below, which shows the completed assembly, annotated. Sometimes, seeing the entire assembly makes everything perfectly clear. Place the pen cap over the needle probe to protect the assembly when not in use.

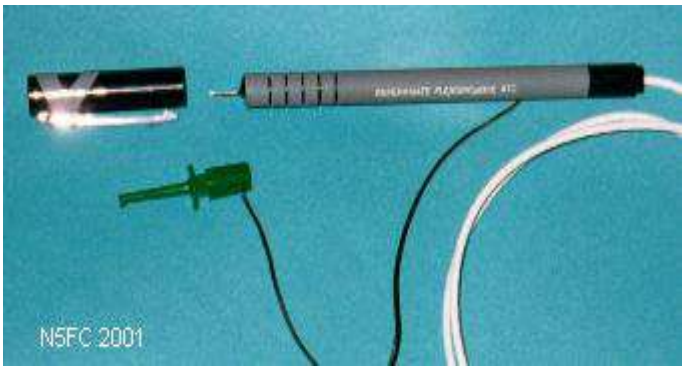

Click on the image above to see a larger, annotated image

And speaking of use, here's our lovely model (OK...XYL) making a measurement in the N0SS Noise Generator. She has the ground clip connected to a convenient place in the circuit's ground, and the probe touches the test point we want to measure. As you can see, we read 0.710 Volts. Since this is broadband noise, the actual voltage reading is not accurate, but it was seen to be much greater than the previous stage, as we expected.

Click on the image above to see a larger, more readable image

Let me know if you build one of these... and send me a picture!

73, monty N5ESE

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Overseer: Monty Northrup ... ... leave e-mail ...

Visit our regular (non-ham, but very popular) homepage

A Coax Switch

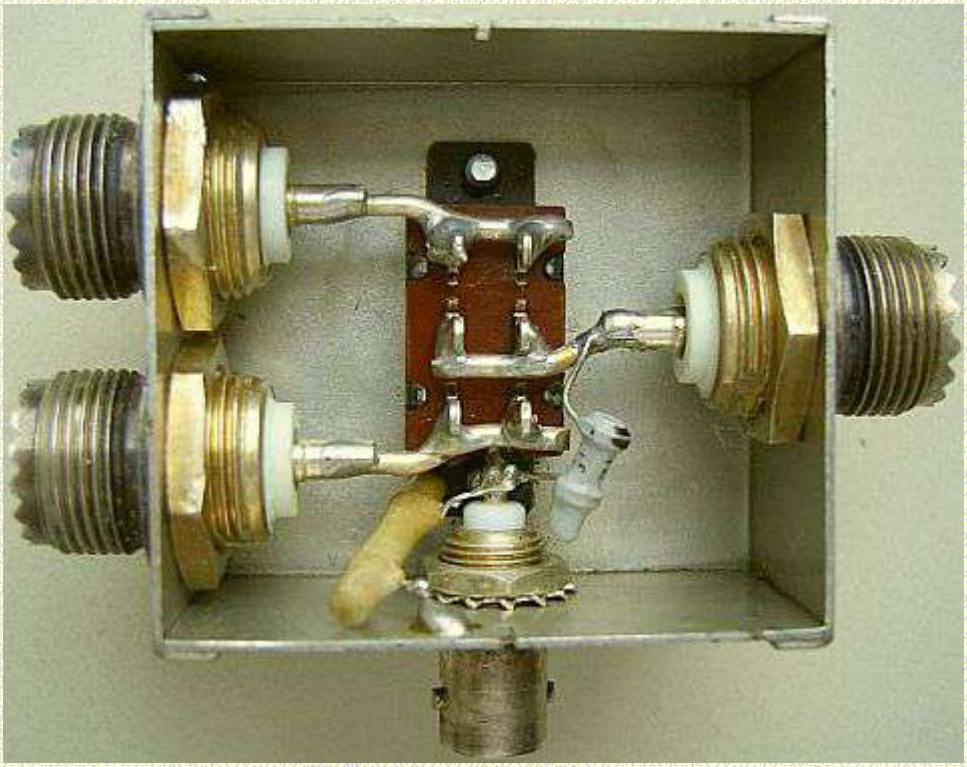

Cheap slide switch in a standard 54 × 50 × 26 mm box.

THE SWITCH

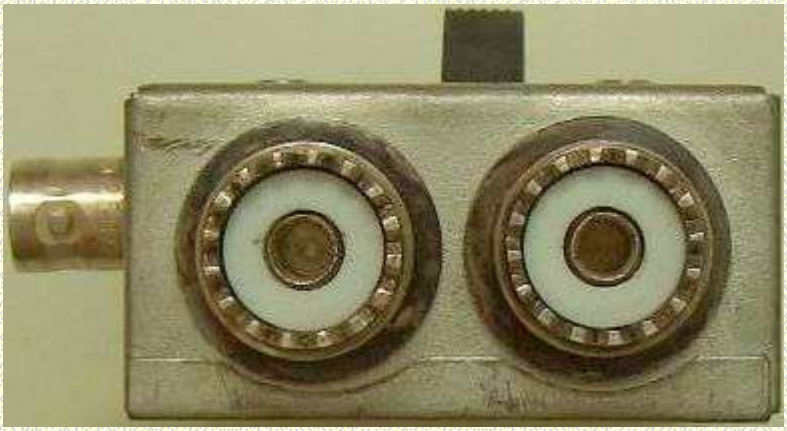

Fig » shows a proven inexpensive home-made antenna selection switch. If you question the use of a cheap slide switch and SO239 coax sockets, read on. Measurements in a physics lab showed there to be practically no reflection on HF and even on 70 cm the SWR was below 1.3 : 1! That is explained as follows:

- The contacts in the slide switch have larger contact surfaces than many a bought coaxial switch.

- The wiring and switch contacts, between the top and bottom of the metal case, act as the centre conductor of a coax of near 50 ?.

It is a standard box measuring 54 × 50 × 26 mm (l × w × h) and the wiring between the switch and the coax sockets is done in 2 mm silver plated wire.

POWER HANDLING CAPABILITY

If the switching is done with power off, the switch can stand 800 W. I have used this switch for more than 15 years and even with 1500 W there have been no problems.

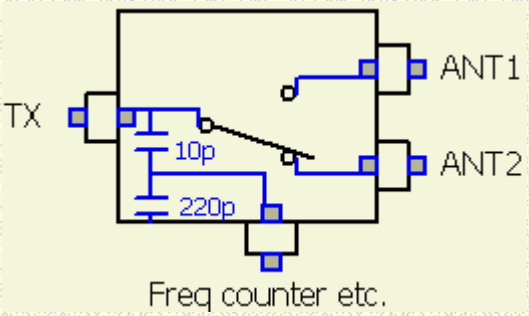

While building this switch, you might as well add a test point, e.g. to connect a 'scope' or frequency counter. The capacitors of 10 and 220 pF make a capacitive voltage divider and the extra loading, 9.6 pF, does not affect performance on HF. In fact, on 10 m it improves the SWR as the extra capacity, in combination with the wiring it makes a filter which favours that frequency.

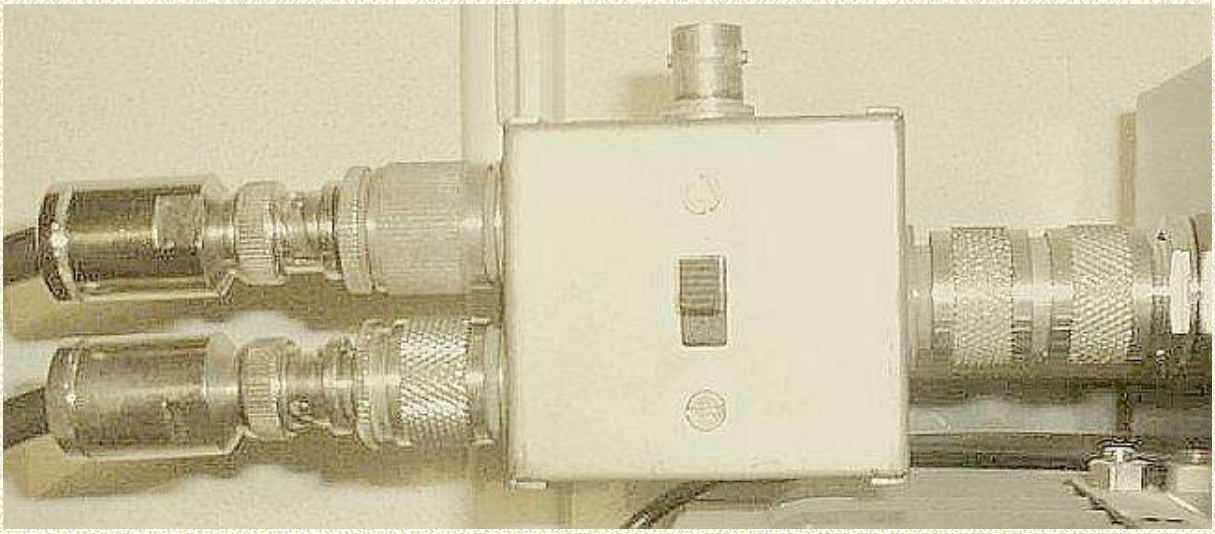

This shows how the switch is used in my station.

«Back
AØFRI

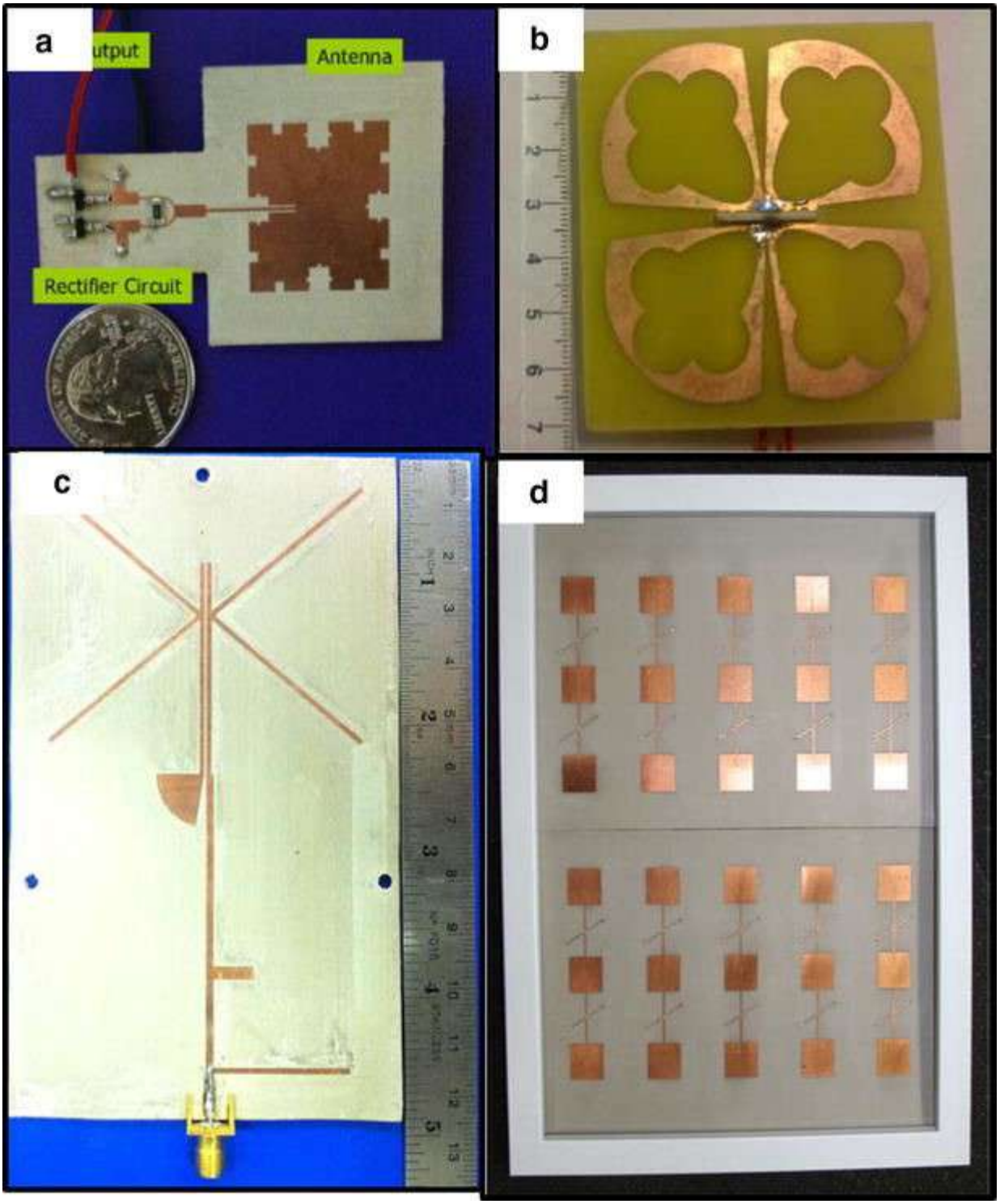
a
utput
Antenna
Rectifier Circuit
b
c
d

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Geometry Aspects and Experimental Results of a Printed Dipole Antenna

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Abstract

Detail experimental measurements of a 2.4 GHz printed dipole antenna for wireless communication systems is presented and discussed. A group of printed dipoles with integrated balun have been designed and constructed on a dielectric substrate. This paper is based on modifications of the known printed dipole architecture. The corresponding printed dipole antennas have differences on their forms that are provided by two essential geometry parameters. The first parameter *l* is related to the bend on microstrip line that feeds the dipole and the second *w* corresponds to the form of the dipole's gap. The impact of these parameters on reflection coefficient and radiation pattern of antenna has been investigated. The corresponding measured results indicate that the return loss and radiation pattern of a printed dipole antenna are independent of the *w* parameter. Instead, variations in the value of the *l* parameter in the dipole's structure affect the form of the corresponding return loss. These observations are very important and provide interesting considerations on affecting design and construction of antenna elements at frequency range of 2.4 GHz.

Keywords: Printed Dipole, Scattering Parameters, Radiation Pattern

1. Introduction

Modern wireless communications offer higher bit rates and efficient quality of services. The majority of the equipment used today introduces requirements for better performance and lower cost. Antennas with quite small sizes, low profiles and versatile features represent interesting solutions that provide modern wireless applications. The printed dipole antenna with integrated balun is widely used as a radiation element on communication systems because of its omni-directional features, narrowband character and simple structure [1–4]. This type of antenna because of its small size can be integrated on the same PCB with other electronics circuits and devices. For the same reason, it can also be used as element on antenna array architecture. The last feature is very interesting and attractive in MIMO modern wireless systems. This printed dipole architecture offers versatile characteristics for design and implementation of antenna arrays on both ends of a MIMO wireless system.

Identify applicable sponsor/s here. *(sponsors)*

In the present paper, we will study and discuss the effect of the variation of the two geometrical parameters (*l*, *w*) of the printed dipole antenna structure. The first corresponds to a discontinuity on microstrip line of printed dipole and the second is related to the discontinuity in the gap. Details of structure concept and design process are presented in Section 2; the experimental results for return loss and radiation pattern for each of the printed dipoles are presented and discussed in Section 3. The paper concludes in Section 4.

2. Design and Structure Aspects

As mentioned above, the proposed analysis is based on geometrical characteristics of a prototype printed dipole antenna with integrated balun. This kind of printed dipole antenna is considered for use in many applications [1–3]. In our study the geometrical parameters of the printed dipole antenna were modified to achieve better performance in the frequency range of 2.4 GHz. This modified design and the corresponding parameters are shown in Figure 1 while the values summarized in Table 1.

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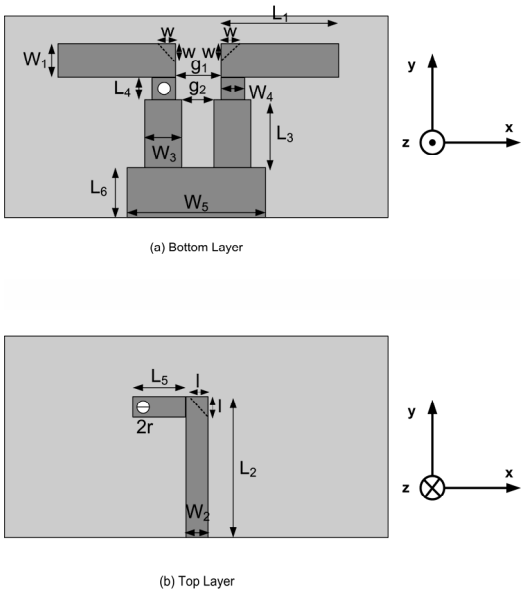

Figure 1. Geometry of printed dipole.

Table 1. Printed dipole dimensions.

Parameter	Values
Dipole strips	L1 = 20.8 mm W1 = 6 mm g1 = 3 mm
Microstrip Balun	L2 = 32 mm L3 = 16 mm L4 = 3 mm L5 = 3 mm W2 = 2 mm W3 = 5 mm W4 = 3 mm g2 = 1 mm
Via radius	r = 0.375 mm
Ground plane	L6 = 12 mm W5 = 17 mm
Side of microstrip bend	l variable (0 mm – 3 mm)
Side of dipole's arms in the gap	w variable (0 mm – 3 mm)

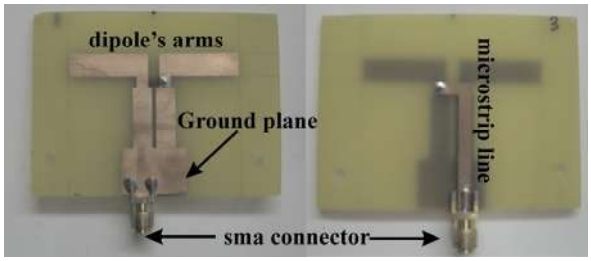

Figure 2. Prototype printed dipole antenna: Top Layer (left) –Bottom Layer (right).

An Fr-4 substrate with thickness of 1.5 mm and permittivity ε_r =4.4 has been used for the fabrication of the dipoles. Figure 2 shows the top and bottom layer for the one of them. It also presents the dipole's arms and gap, the balun, the ground plane and the microstrip line that interface the dipole with the coaxial feed line via sma connector.

From this Figure, we can also see the right angle at the microstrip line and the other two right angles at the dipole's gap. It is known that the presence of right angles in conductors cause discontinuities that leads to degradation in circuit performance [5]. Microwave theory suggests that these angles introduce parasitic reactances which can lead to phase and amplitude errors, input and output mismatch and possibly spurious coupling [5–7]. In order to reduce this effect it is proposed to modify these discontinuities directly, by mitering the conductor. Our investigation and the experimental measurements show the effect of mitering these discontinuities. At first, a prototype printed dipole antenna with unaffected geometrical parameters has been designed and constructed. Secondly, we constructed and measured six different printed dipoles. Three of them had *w = 0 mm* and different *l* values (1 mm, 2 mm, 3 mm) and the other three dipoles had *l = 0 mm* and different values of *w* (1 mm, 2 mm, 3 mm). All these seven dipoles we constructed, the unaffected one and the mitered ones were measured in an anechoic environment. Figures 3 and 4 show a printed dipole for *l = 2 mm* and *w = 0* mm and for *l = 0 mm* and *w = 3 mm*, respectively. The aim of this study is to investigate the return loss coefficient and radiation pattern in each of these seven dipole's forms. The next section discusses the obtained results and presents the significant observations.

3. Results and Discussion

The return loss of the prototype dipole and the six different modified printed dipole antenna we constructed are measured using a Network Analyzer. These results are shown in two Figures. The first (Figure 5) corresponds to *l* parameter's variations keeping the *w* parameter equal to zero. The second (Figure 6) shows the return loss curves where *w* parameter varies but the *l* parameter equals to zero. In both figures we can see the return loss curve that belongs to the prototype printed dipole (*l* and *w equal to 0 mm*).

From these curves, it seems that this dipole antenna design has a resonance point at 2.4 GHz with 500 MHz –

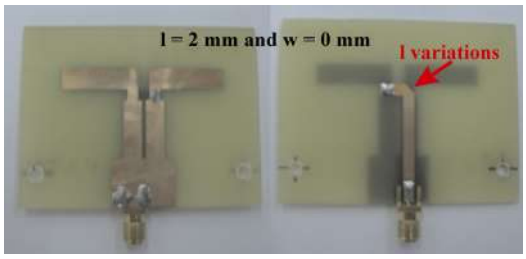

Figure 3. Printed dipole antenna for *l = 2 mm* and *w = 0 mm* Top Layer (left) – Bottom Layer (right).

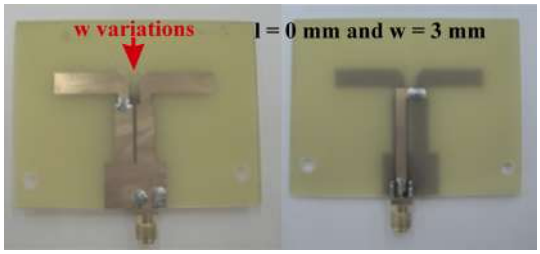

Figure 4. Printed dipole antenna for *l = 0 mm* and *w = 3 mm* Top Layer (left) – Bottom Layer (right).

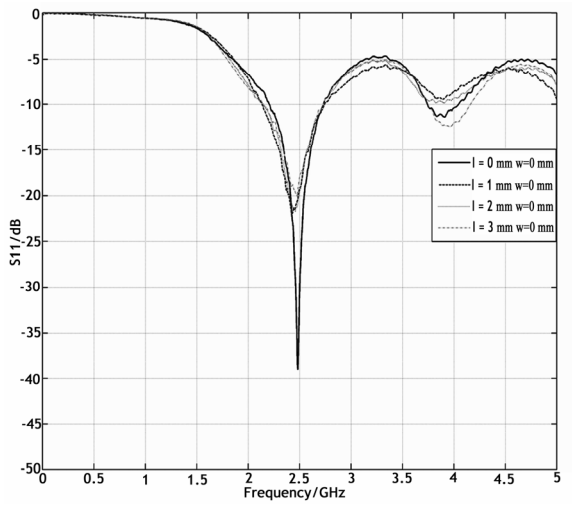

Figure 5. Measured return loss of printed dipole for each value of *l* parameter and *w = 0* mm.

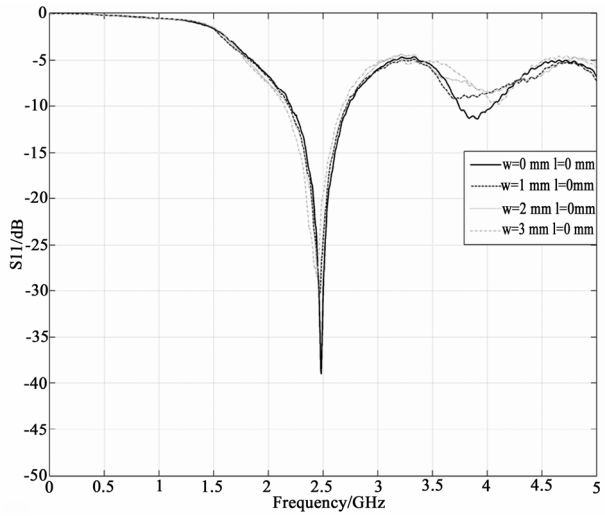

Figure 6. Measured return loss of printed dipole for each value of *w* parameter and *l = 0 mm*.

10 dB bandwidth. The last frequency range has center frequency close to 2.4 GHz which is the frequency value that the return loss is minimized. For these frequencies the corresponding values of return loss are smaller or equal to -10 dB. From Figure 5, it is obvious that as the value of *l* parameter increases, the form of the corresponding return loss curve changes and becomes more flat at the resonance frequency range. On the other hand, the value of *w* parameter does not affect the form of the return loss curve. Each of these seven forms of printed dipole antenna has quite similar return loss curves and introduces narrowband operation at the frequency range of 2.4 GHz. Moreover, for a wireless application that requires design and construction of many identical printed dipoles, it is recommended to choose *l* parameter equals to *2 mm* and *w* parameter equals to *0 mm* for better performance. As it can be seen from Figure 5 the above investigation ensures that the printed dipole antennas will have quite identical return loss curves and performance as elements in an antenna array configuration.

For deeper analysis on this topic, experimental measurements on radiation pattern of these antennas have also been made. Measurements were carried out in a RF anechoic chamber using a calibrated measuring system. In particular, Figure 7 shows the measurements of radiation pattern in E- plane and in H – plane for each dipole

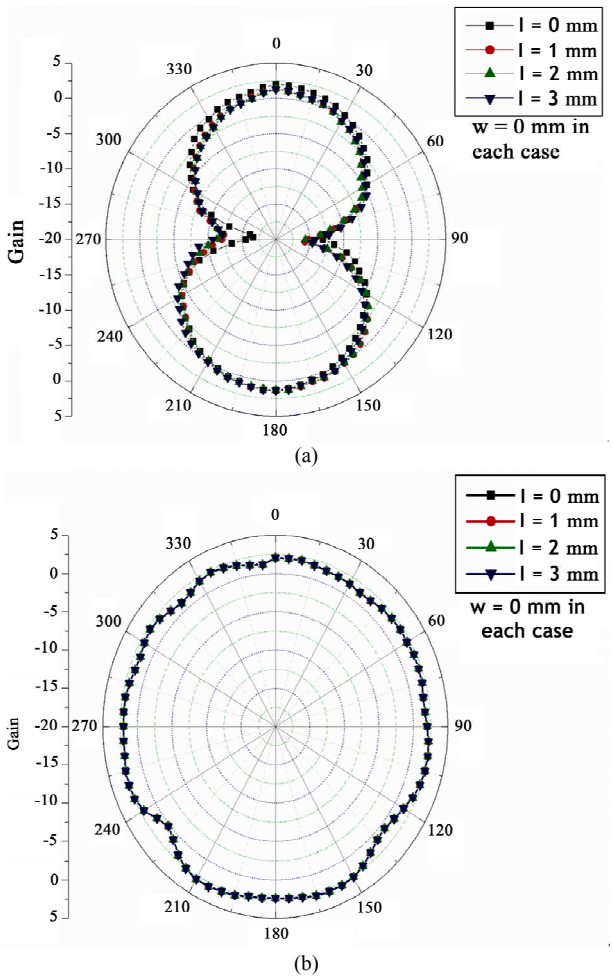

Figure 7. Radiation pattern of dipole for each value of *l* parameter (a) E – plane, (b) H -plane.

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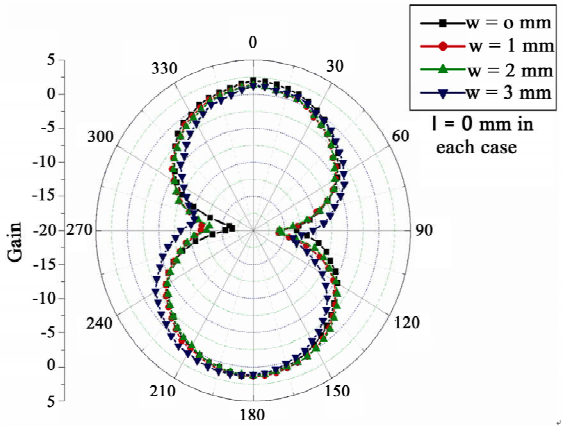

(a)

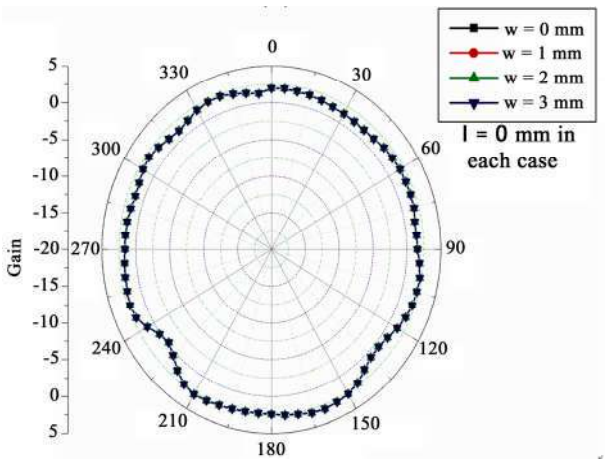

(b)

Figure 8. Radiation pattern of dipole for each value of *w* parameter (a) E – plane, (b) H – plane.

with *w* parameter equals to 0 mm and *l* parameter equals to integer values that ranging from *0 mm* to *3 mm*,. Figure 8 shows the corresponding results for each dipole with *l* parameter equals to *0 mm* and *w* parameter's integer values ranging from *0 mm* to *3 mm*. All these dipole structures introduce radiation characteristics that correspond to a fundamental dipole antenna [6,7]. Each of them has a measured peak gain that equals to quite 2 dBi and introduces omni-directional features. Quite small variations on these curves are on the limits of measurements' accuracy. For this reason, it can be observed that the radiation characteristics of the printed dipole antenna are not affected by the variations on *l* and *w* geometrical parameters. Therefore, the radiation diagrams of them are independent of the *l* and *w* parameters.

4. Conclusions

A number of printed dipole antennas with integrated balun are constructed and studied in terms of return loss and radiation pattern. Each of them has a defined form and geometry. Starting from a dipole antenna we mitered the angles introducing the parameters *l* and *w* that we varied. Experimental measurements on return loss provide the obtained results. These are quite similar and also introduce a resonance point at frequency range of 2.4 GHz with narrow resonance bandwidth. The form of this resonance range is affected only by the *l* parameter. The radiation pattern of these dipoles is also investigated. The corresponding radiation diagrams are independent of these geometrical parameters (*l*, *w*) and are similar to that of the fundamental dipole. These observations on printed dipole architecture are very crucial for wireless communication engineering and antenna design. This is because they introduce the ability of constructing a group of identical dipoles choosing an appropriate value of *l* parameter (*l =2 mm*) with quite identical resonance and radiation characteristics.

5. Acknowledgment

This research project (PENED) is co-financed by E.U.-European Social Fund (80%) and the Greek Ministry of Development-GSRT (20%).

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Optimization of the Voltage Doubler Stages in an RF-DC Convertor Module for Energy Harvesting

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ABSTRACT

This paper presents an optimization of the voltage doubler stages in an energy conversion module for Radio Frequency (RF) energy harvesting system at 900 MHz band. The function of the energy conversion module is to convert the (RF) signals into direct-current (DC) voltage at the given frequency band to power the low power devices/circuits. The design is based on the Villard voltage doubler circuit. A 7 stage Schottky diode voltage doubler circuit is designed, modeled, simulated, fabricated and tested in this work. Multisim was used for the modeling and simulation work. Simulation and measurement were carried out for various input power levels at the specified frequency band. For an equivalent incident signal of –40 dBm, the circuit can produce 3 mV across a 100 kΩ load. The results also show that there is a multiplication factor of 22 at 0 dBm and produces DC output voltage of 5.0 V in measurement. This voltage can be used to power low power sensors in sensor networks ultimately in place of batteries.

Keywords: Energy Conversion; RF; Schottky Diode; Villard; Energy Harvesting

1. Introduction

RF energy harvesting is one type of energy harvesting that can be potentially harvested such as solar, vibration and wind. The RF energy harvesting uses the idea of capturing transmitted RF energy at ambient and either using it directly to power a low power circuit or storing it for later use. The concept needs an efficient antenna along with a circuit capable of converting RF signals to DC voltage. The efficiency of an antenna mainly depends on its impedance and the impedance of the energy converting circuit. If the two impedances aren't matched then it will be unable to receive all the available power from the free space at the desired frequency band. Matching of the impedances means that the impedance of the antenna is the complex conjugate of the impedance of the circuit (voltage doubler circuit).

The concept of energy harvesting system is shown in **Figure 1**, which consists of matching network, RF-DC conversion and load circuits. The authors in [1], used a 2.4 GHz operating frequency with an integrated zero bias detector circuit using BiCMOS technology which produced an output voltage of 1 V into a 1 MΩ load at an input power level of 0 dBm. H. Yan and co-authors revealed that a DC voltage of 0.8 volts can be achieved from a –20 dBm RF input signal at 868.3 MHz through simulation results [2]. In [3], work was carried out on a firm frequency of 900 MHz by matching to a 50 Ω impedance and resonance circuit transformation in front of the Schottky diode which yields an output voltage of over 300 mV at an input power level of 2.5 µ. W. J. Wang, L. Dong and Y. Fu [4] used a Cockcroft-Walton multiplier circuit that produced a voltage level of 1.0 V into a 200 MΩ load for an input power level of less than –30 dBm at a fixed frequency of 2.4 GHz.

The energy conversion module designed in this paper is based on a voltage doubler circuit which can be able to output a DC voltage typically larger than a simple diode rectifier circuit as in [5], in which switched capacitor charge pump circuits are used to design two phase voltage doubler and a multiphase voltage doubler. The module presented in this can function as an AC to DC converter that not only rectifies the input AC signal but also elevates the DC voltage level. The output voltage of the

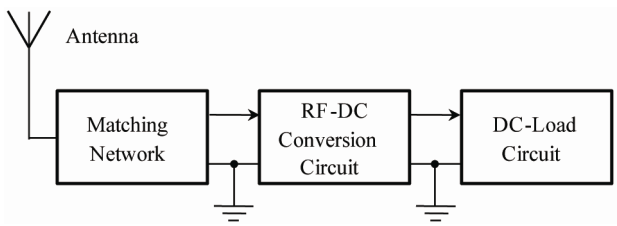

Figure 1. Schematic view of a RF energy harvesting system.

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energy conversion module can be used to energize the low power devices for example sensors for a sensor network in application to agriculture.

Section 2 of this paper discusses on the theoretical background of the voltage doubler circuit. Section 3 presents the simulation study and implementation of the circuit design. Section 4 provides the results and analysis. Section 5 concludes with a discussion on the findings from the simulated and measured results.

2. Voltage Multiplier

There are various voltage multiplier circuit topologies. The design used in this module is derived from the function of peak detector or a half wave peak rectifier. The Villard voltage multiplier circuit was chosen in the circuit design of this paper because it produces two times of the input signal voltage towards ground at a single output and can be cascaded to form a voltage multiplier with an arbitrary output voltage and its design simplicity.

2.1. Diode Modeling

The voltage multiplier circuit in this design uses zero bias Schottky diode HSMS-2850 from Agilent. The attractive feature of these Schottky diodes are low substrate losses and very fast switching but leads to a fabrication overhead. This diode has been modeled for the energy harvesting circuit which comes in a one-diode configuration. The modeling parameters for these diodes are given by Agilent in their data sheets. These parameters are used in Multisim for its own modeling purposes. The modeling is done by transforming the diode into an equivalent circuit using passive components which are described by the SPICE parameters in **Table 1** [6].

The diode used in this design is shown in **Figure 2** and its equivalent model is shown in **Figure 3**. The special features of HSMS-2850 diode is that it provides a low forward voltage, low substrate leakage and uses the non symmetric properties of a diode that allows unidirectional flow of current under ideal condition.

Table 1. SPICE parameters.

Parameters	Units	HSMS 2850
B_V	V	3.8
C_{J0}	pF	0.18
E_G	Ev	0.69
I_{BV}	A	3E–4
I_S	A	3E–6
N	No unite	1.06
R_S	Ω	25
P_B (V_J)	V	0.35
P_T (XTI)	No units	2
M	No units	0.5

Figure 2. Schottky diode.

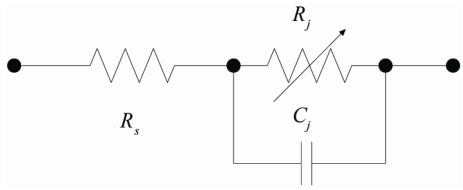

Figure 3. Linear circuit model of the Schottky diode [6].

The diodes are fixed and are not subject of optimization or tuning. This is described using the following derivations. By neglecting the effect of diode substrate, an equivalent linear model that can be used for the diode as shown in **Figure 3**. When C_j is the junction capacitance and R_j is the junction resistance, the admittance Y_z of the linear model is given by

$$Y_Z = Y_{C_j} + Y_{R_j} \tag{1}$$

Equation (1) related to the frequency of operation is given by

$$Y_Z = jwC_j + \frac{1}{R_j} \tag{2}$$

$$= \frac{jwC_jR_j + 1}{R_j} \tag{3}$$

The impedance Z of the linear model is given by

$$Z = \frac{R_j}{1 + jwR_jC_j} \tag{4}$$

The total impedance Z_T is given by

$$Z_T = R_S + \frac{R_j}{1 + jwR_jC_j} \tag{5}$$

where R_S is the series resistance of the circuit and R_j is given by

$$R_j = \frac{8.33 \times 10^{-5} \times N \times T}{I_b + I_S}$$

where:

I_b = bias current in μA;

I_s = saturation current in μA;

T = temperature (K);

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N = ideality factor.

In Equation (5), R_j and C_j are constants and the frequency of operation (w) is the only variable parameter. As the frequency increases, the value of Z is almost negligible compared to the series resistance R_S of the diode. From this it is concluded that the function of the diode is independent of the frequency of operation.

2.2. Single Stage Voltage Multiplier

Figure 4 represents a single stage voltage multiplier circuit. The circuit is also called as a voltage doubler because in theory, the voltage that is arrived on the output is approximately twice that at the input. The circuit consists of two sections; each comprises a diode and a capacitor for rectification. The RF input signal is rectified in the positive half of the input cycle, followed by the negative half of the input cycle. But, the voltage stored on the input capacitor during one half cycle is transferred to the output capacitor during the next half cycle of the input signal. Thus, the voltage on output capacitor is roughly two times the peak voltage of the RF source minus the turn-on voltage of the diode.

The most interesting feature of this circuit is that when these stages are connected in series. This method behaves akin to the principle of stacking batteries in series to get more voltage at the output. The output of the first stage is not exactly pure DC voltage and it is basically an AC signal with a DC offset voltage. This is equivalent to a DC signal superimposed by ripple content. Due to this distinctive feature, succeeding stages in the circuit can get more voltage than the preceding stages. If a second stage is added on top of the first multiplier circuit, the only waveform that the second stage receives is the noise of the first stage. This noise is then doubled and added to the DC voltage of the first stage. Therefore, the more stages that are added, theoretically, more voltage will come from the system regardless of the input. Each independent stage with its dedicated voltage doubler circuit can be seen as a single battery with open circuit output voltage V_0, internal resistance R_0 with load resistance R_L, the output voltage, V_{out} is expressed as in Equation (7).

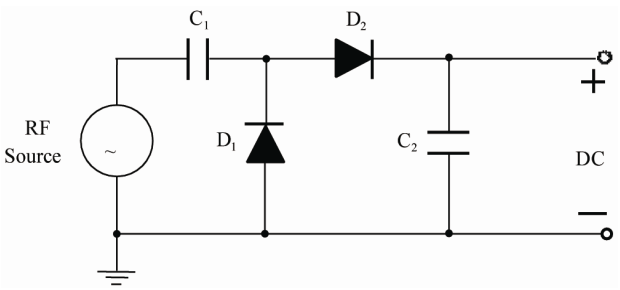

Figure 4. Single stage voltage multiplier circuit [7].

$$V_{out} = \frac{V_0}{R_0 + R_L} R_L \tag{6}$$

When n number of these circuits are put in series and connected to a load of R_L in Equation (6) the output voltage V_{out} obtained is given by this change in RC value will make the time constant longer which in turn retains the multiplication effect of two in this design of seven stage voltage doubler.

$$V_{out} = \frac{nV_0}{nR_0 + R_L} = V_0 \frac{1}{\frac{R_0}{R_L} + \frac{1}{n}} \tag{7}$$

The number of stages in the system has the greatest effect on the DC output voltage, as shown from Equations (6) and (7).

It is inferred that the output voltage V_{out} is determined by the addition of R_0/R_L and $1/n$, if V_0 is fixed. From this analysis it is observed that V_0, R_0 and R_L are all constants. Assume that V_0 = 1 V, R_0/R_L = 0.25, n = 2, 3, 4, 5, 6 and 7, the output voltage V_{out} = 1.33 V, 1.72 V, 2.0 V, 2.22 V, 2.43 V and 2.56 V respectively when substituted analytically in the Equation (7). This analysis can be compared with the results obtained in the circuit design of this module. In simulation at n = 4, V_{out} = 1.42 V, n = 5, V_{out} = 1.67 V; n = 6, V_{out} = 1.92; n = 7, V_{out} = 2.15 V; n = 8, V_{out} = 1.92 V; n = 9, V_{out} = 1.81 V. Also in measurement, for n = 4, V_{out} = 2.1 V; n = 5, V_{out} =2.9 V; n = 6, V_{out} = 3.72 V; and n = 7, V_{out} = 5 V. As n increases, the increase in output voltage will be almost double the input voltage up to some number of stages. But at some point, *i.e.* beyond seven stages, in this circuit the output voltage gained (8 and 9 stages) will be negligible as shown in **Figure 5**.

The capacitors are charged to the peak value of the input RF signal and discharge to the series resistance (R_s) of the diode. Thus the output voltage across the capacitor of the first stage is approximately twice that of the input signal. As the signal swings from one stage to other, there is an additive resistance in the discharge path of the

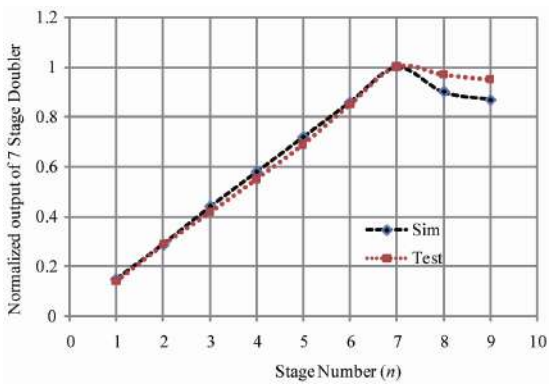

Figure 5. Normalized output voltage multiplier versus number of stages.

diode and increase of capacitance due to the stage capacitors.

2.3. Seven Stage Voltage Multiplier

The seven stage voltage multiplier circuit design implemented in this paper is shown in **Figure 6**. Starting on the left side, there is a RF signal source for the circuit followed by the first stage of the voltage multiplier circuit. Each stage is stacked onto the previous stage as shown in the **Figure 6**. Stacking was done from left to right for simplicity instead of conventional stacking from bottom to top.

The circuit uses eight zero bias Schottky surface-mount Agilent HSMS-285X series, HSMS-2850 diodes. The special features of these diode is that, it provides a low forward voltage, low substrate leakage and uses the non-symmetric properties of a diode that allows unidirectional flow of current under ideal conditions. The diodes are fixed and are not subject of optimization or tuning. This type of multiplier produces a DC voltage which depends on the incident RF voltage. Input to the circuit is a predefined RF source. The voltage conversion can be effective only if the input voltage is higher than the Schottky forward voltage.

The other components associated with the circuit are the stage capacitors. The chosen capacitors for this circuit are of through-hole type, which make it easier to modify for optimization, where in [8] the optimization was accomplished at the input impedance of the CMOS chip for a three stage voltage multiplier. The circuit design in this paper uses a capacitor across the load to store and provide DC leveling of the output voltage and its value only affects the speed of the transient response. Without a capacitor across the load, the output is not a good DC signal, but more of an offset AC signal.

In addition to the above, an equivalent load resistor is connected at the final node. The output voltage across the load decreases during the negative half cycle of the AC input signal. The voltage decreases is inversely proportional to the product of resistance and capacitance across the load. Without the load resistor on the circuit, the voltage would be hold indefinitely on the capacitor and look like a DC signal, assuming ideal components. In the design, the individual components of the stages need not to be rated to withstand the entire output voltage. Each component only needs to be concerned with the relative voltage differences directly across its own terminals and of the components immediately adjacent to it. In this type of circuitry, the circuit does not change the output voltage but increases the possible output current by a factor of two. The number of stages in the system is directly proportional to the amount of voltage obtained and has the greatest effect on the output voltage as explained in the Equation (7) and shown in **Figure 5**.

3. Simulation and Implementation

Multisim software was chosen for modeling and simulation which is a circuit simulation tool by Texas Instruments. The simulation and practical implementation were carried out with fixed RF at 945 MHz ± 100 MHz, which are close to the down link center radio frequency (947.5 MHz) of the GSM-900 transmitter. The voltages obtained at the final node V_{DC} of the multiplier circuit were recorded for various input power levels from –40 dBm - +5 dBm with power level interval (spacing) of 5 dBm.

The simulations were also carried out using same stage capacitance value (3.3 nF) and then with a varied capacitance value for all stages from 4 stages through 9 stages [9]. The capacitance value was varied in such a way that, from one stage to the next, it was halved. For example, if the first stage was 3.3 nF, the second stage was 1.65 nF, third stage was 825 pF, fourth stage was 415 pF and so on. But keeping in view of testing, the capacitance values were chosen to have a close match with the standard available values in the market.

Simulation was carried out through 4 to 9 voltage doubler stages. Based on results obtained a 7 stage doubler is best to implemented for this application.

The design of the printed circuit board (PCB) was carried out using DipTrace software. The material used to

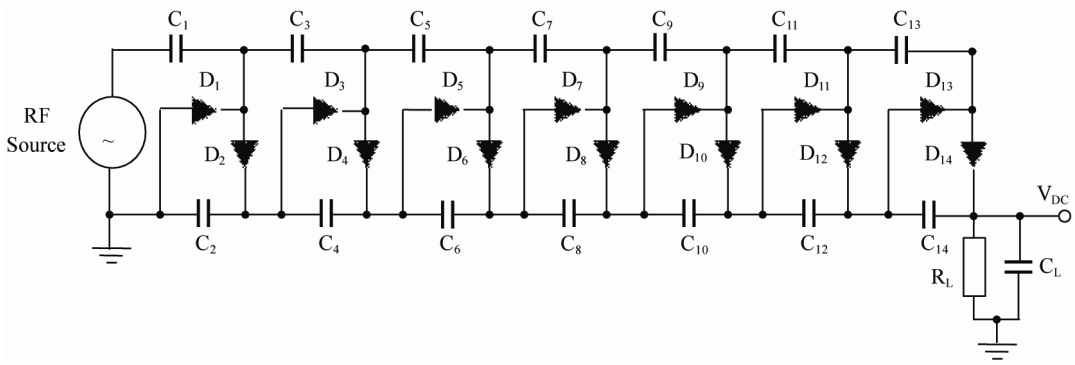

Figure 6. Schematic of 7 stage voltage multiplier.

manufacture the printed circuit board (PCB) is the standard Fiberglass Reinforced Epoxy (FR4), with the thickness of 1.6 mm and dielectric constant of 3.9. The topology is constructed on the PCB with the dimensions of 98 mm × 34 mm (W × H). The Sub Miniature version A (SMA) connectors are used at the input and output of PCB to carry out the measurements. The circuit components consist of active and passive components. The component used in circuit is shown in **Table 2**.

Special handling precautions have been taken to avoid Electro Static Discharge (ESD), while assembling of the surface-mount zero bias Schottky diodes. Also special attention has been given to mount other components and the SMA connectors on to the PCB. The Photograph of Assembled circuit board I shown in **Figure 7**.

4. Results and Analysis

The simulated and measured results at the output voltage of voltage multiplier circuit are shown graphically in **Figure 8**. From the graph analysis, the simulated and the measured results agree considerably with each other. The measured results are shown to be better than the simulation results. The reason behind this may be due to the uncertainty in series resistance value of the diode obtained from SPICE parameters in modeling as explained in Equation (5). This resistance vale of diodes in practical circuit may be lower than in the model, which provides fast discharge path, in turn rise in voltage as passes through the stages and reaches to final output. In this work, the DC output voltages obtained through simulation and measurement at 0 dBm re 2.12 V and 5.0 V respectively. These results are comparatively much better than in ref. [9], where in at 0 dBm, 900 MHz they achieved 0.5 V and 0.8 V through simulation and measurement respectively.

Figures 9 and **10** show the result of a 4 stage voltage doubler circuit with equal and varied capacitance values between the stages as described in Section 3.

From the analysis of these two simulations, it can be observed that the resulting output voltages are equal. The only difference between these two graphs is the rise time of the circuit with varied capacitance value is a little bit slower. But, overall result on the performance of rise time is still under 20 µs to 24 µs and the difference is negligible. From these results, the use of equal stage capacitance of each being 3.3 nF was hence considered for the design of the multiplier.

The results from **Figure 11**, shows that the output voltage reaches to 1.0 V within 20 µS and then uniformly increasing to 1.4 V, 1.67 V, 1.87 V and 2.12 V for 4, 5, 6 and 7 stages respectively compared to 2 mS as shown in [10]. **Figure 12** shows that the conversion ratio of 22 is achieved at 0 dBm input power and drops to 2.5 at –40 dBm. The highest value at 0 dBm is due to the innate characteristics of the zero bias Schottky diodes which conduct fairly well at higher input voltages.

5. Conclusion

From the experimental results, it is found that the pro-

Table 2. Component used in 7 stage voltage multiplier.

Name of component	Label	Value
Stage capacitors	C_1 - C_{14}	3.3 nF
Stage diodes	D_1 - D_{14}	HSMS 2850
Filter capacitor	C_L	100 nF
Load resister	R_L	100 kΩ

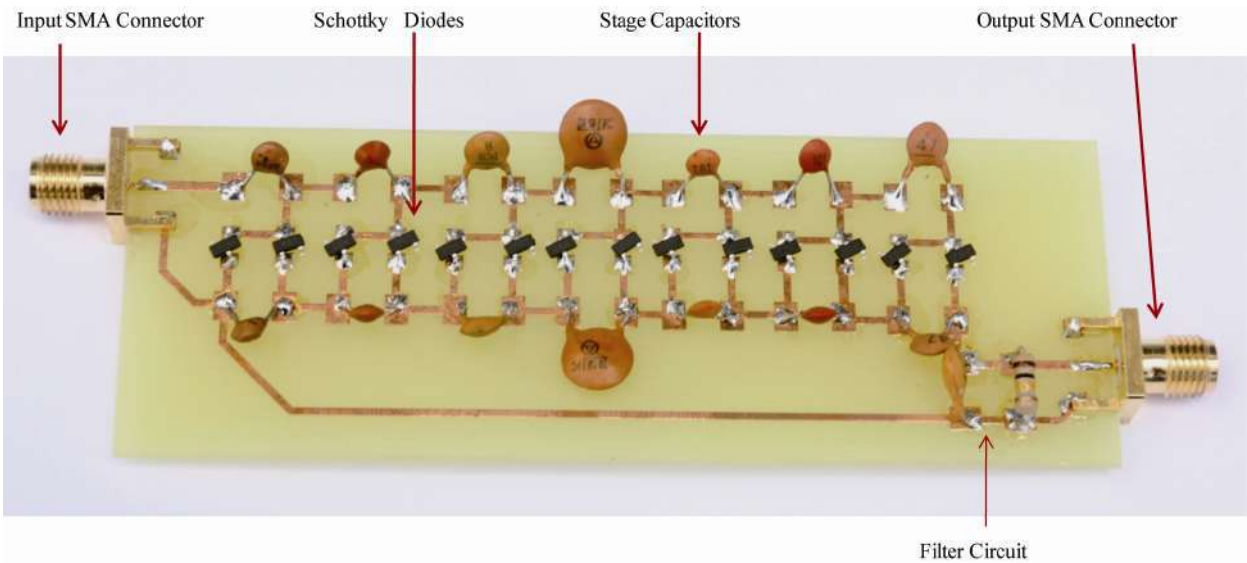

Figure 7. Photograph of assembled circuit board.

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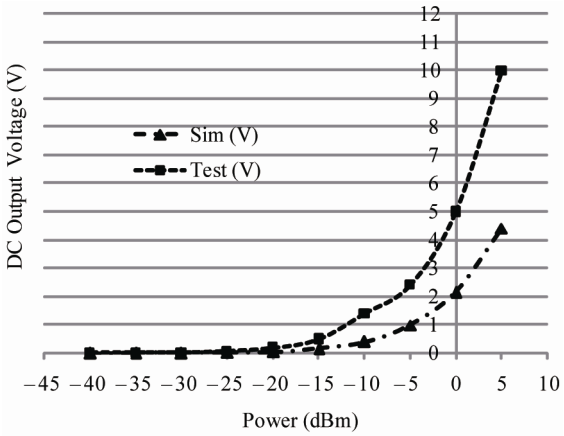

Figure 8. Simulated and test DC output voltage of multiplier as a function of input power.

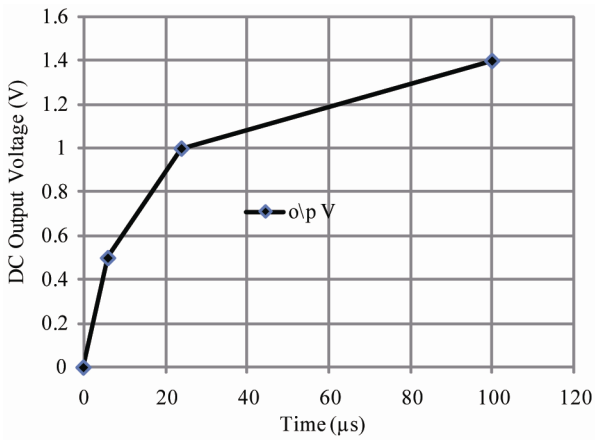

Figure 9. DC output voltage verses rise time of 4 stage voltage doubler circuit with equal stage capacitance [8].

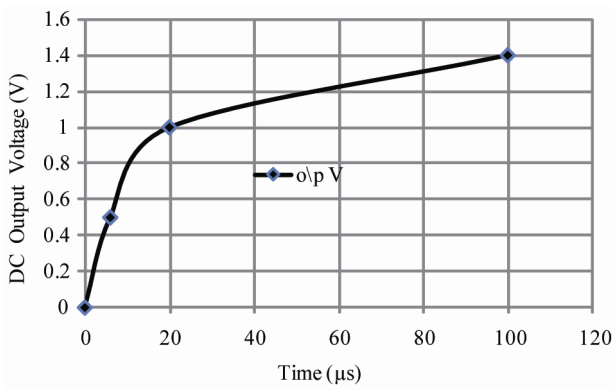

Figure 10. DC output voltage verses rise time of 4 stage voltage doubler with varied stage capacitance [8].

posed voltage multiplier circuit operates at the frequency of 945 MHz with the specified input power levels. The results have shown that there is multiplication of the input voltage. From **Figure 12**, it is shown that at 0 dBm input power, the multiplication factor is 22. This is sig-

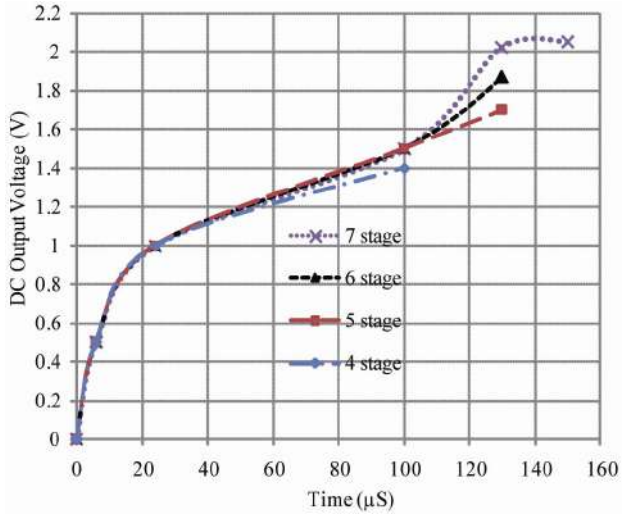

Figure 11. DC output voltage verses rise time of voltage doubler circuit through 4 - 7 stages with equal stage capacitance.

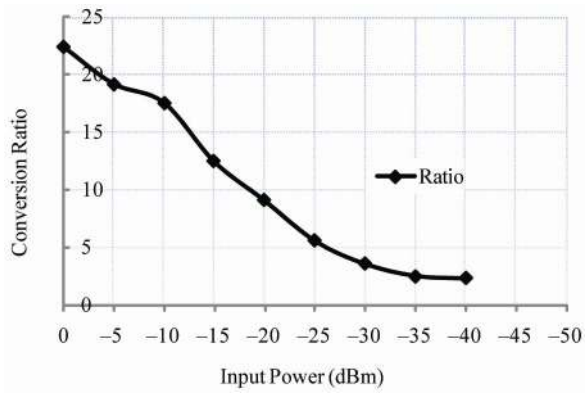

Figure 12. Conversion ratio as a function of input power.

nificant, as the work shows that RF energy in the GSM-900 band can be harvested from the ambient RF source using the Villard circuit topology. The power density levels from a GSM base station is expected from 0.1 mW/m^2 to 1 mW/m^2 for a distance ranging from 25 m - 100 m. These power levels may be elevated by a factor between one and three for the GSM-900 downlink frequency bands depending on the traffic density [10]. The next phase of the research work is to interface the voltage multiplier circuit through a matching network to the antenna at the input side and a low power device to power from the system at the output side to complete the RF energy harvesting system.

6. Acknowledgements

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Double-Sided Microstrip Circular Antenna Array for WLAN/WiMAX Applications

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ABSTRACT

The design, fabrication, and characterization of the microstrip circular antenna arrays were presented. The proposed antennas were designed for single band at 2.45 GHz and dual bands at 3.3 - 3.6 and 5.0 - 6.0 GHz to support WLAN/WiMAX applications. The proposed single and dual band antennas showed omnidirectional radiation pattern with the gain values of 3.5 dBi at 2.45 GHz, 4.0 dBi at 3.45 GHz, and 3.3 dBi at 5.5 GHz. The dual band antenna array was placed on both top and bottom layers to obtain the desired antenna characteristics. The proposed double-sided dual band antenna provides omnidirectional radiation pattern with high gain.

Keywords: Antenna Arrays; Circular Patch; Dual Band; Single Band; Omnidirectional; WLAN/WiMAX Applications; UWB

1. Introduction

Ultra-wideband (UWB: 3.1 to 10.6 GHz) frequency spectrum has been approved by the US Federal Communications Commission (FCC) for unlicensed short range wireless communications since 2002. In this frequency range, wireless local-area network (WLAN) IEEE802.11a and HIPERLAN/2 WLAN operates in 5.0 - 6.0 GHz band. In some European and Asian countries, world interoperability for microwave access (WiMAX) service is provided in the frequency range of 3.3 - 3.6 GHz [1-4]. To support the WLAN/WiMAX application, antenna arrays that provide omnidirectional radiation pattern are required. To respond to this need, recent antenna design efforts were focused on omnidirectional antennas with high gain and no sidelobes [5-8]. Rectangular arrays are common type used for antenna arrays. Studies on dual band antennas employing rectangular arrays were reported [9-12]. Compared to rectangular patch antenna arrays, there are limited numbers of studies performed on circular patch antenna arrays due to difficulties in fabrication [13]. Advantages of circular antenna array include high gain and narrow beam width [13].

In this paper, a new microstrip circular antenna arrays were designed, fabricated, and characterized to provide omnidirectional radiation pattern for WLAN/WiMAX applications. Two antenna arrays were designed—one for single band at 2.45 GHz and the other for dual bands at 3.3 - 3.6 GHz and 5.0 - 6.0 GHz. For single band operation, circular patch array was placed on the top layer of the microtrip and a small rectangular patch was placed on the bottom layer for ground connection. For dual band operation, similar circular patch array was placed on both top and bottom layers of the microstrip with larger rectangular patch placed on the bottom layer. Both single band (single sided) and dual band (double-sided) microstrip antenna arrays provided desirable antenna characteristics for the intended application.

2. Design and Simulation

2.1. Single-Band Antenna at 2.45 GHz

The configuration of the proposed single band antenna at 2.45 GHz is shown in **Figure 1**. It consists of six circular patches which are placed only on the top layer. The small rectangular patch is placed on the bottom layer for ground connection.

The directivity for the circular patch antenna is

$$D_0 = \frac{(k_0 a_e)^2}{120 G_{\text{rad}}} \tag{1}$$

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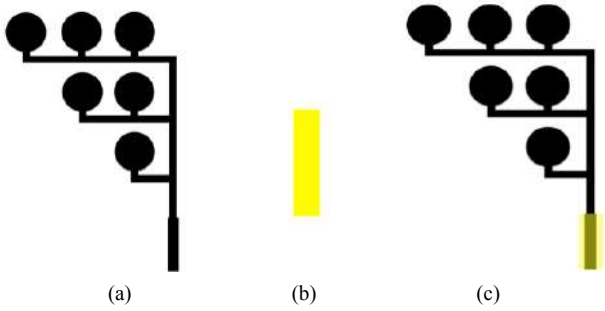

Figure 1. Configuration of the proposed antenna for single band at 2.45 GHz: (a) Top layer; (b) Bottom layer; (c) Top and bottom layers overlaid.

$$k_0 = \frac{2\pi}{\lambda_0} \tag{2}$$

$$a_e = a\left\{1 + \frac{2h}{\pi a \epsilon_r}\left[\ln\left(\frac{\pi a}{2h}\right) + 1.7726\right]\right\}^{1/2} \tag{3}$$

$$G_{\text{rad}} = \frac{(k_0 a_e)^2}{480}\int_0^{\pi/2}\left[J_{02}'^2 + \cos^2\theta J_{02}^2\right]\sin\theta \mathrm{d}\theta \tag{4}$$

$$J_{02}' = J_0(k_0 a_e \sin\theta) - J_2(k_0 a_e \sin\theta) \tag{5}$$

$$J_{02} = J_0(k_0 a_e \sin\theta) + J_2(k_0 a_e \sin\theta) \tag{6}$$

where a_e is the effective radius, a is the actual radius, ϵ_r is the relative permittivity of the microstrip dielectric substrate, h is the height of the microstrip substrate, and J_0 and J_2 are Bessel functions.

The gain of the antenna was calculated using

$$\text{Gain} = \text{Antenna Efficiency} \times \text{Directivity}(D_0) \tag{7}$$

$$\text{Antenna Efficiency} = \frac{\text{Total Efficiency}}{\text{Reflection Efficiency}} \tag{8}$$

The variable corresponding to each dimensions and values for the dimensions of the proposed antenna are shown in **Figure 2** and **Table 1**, respectively. Here, *L*, *W*, and *R* represent the length, the width, and the radius of the circular patch, respectively.

The gain of the proposed antenna shown in **Figure 1** was calculated using (1) - (8) and the dimensions were optimized using ADS [14] which resulted in gain of 3.5 dBi at 2.45 GHz.

2.2. Dual-Band Antenna at 3.3 - 3.6 and 5.0 - 6.0 GHz

The configuration for the doubled-sided microstrip dual band antenna is shown in **Figure 3**. The proposed microstrip antenna has circular arrays both on the top and bottom layers. It consists of three circular patched on each layer.

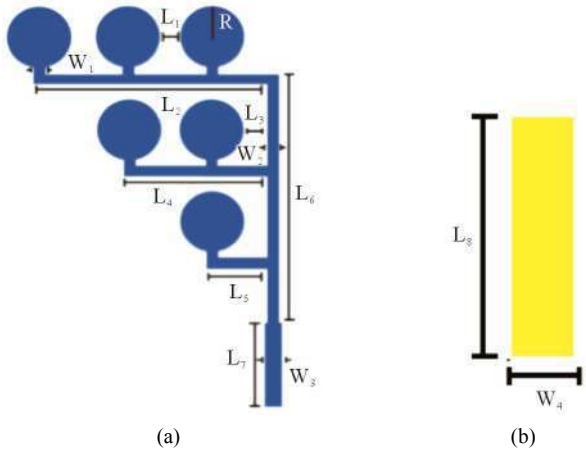

Figure 2. Variables corresponding to each dimension of the proposed single band antenna: (a) Top layer; (b) Bottom layer.

Table 1. Dimensions for the proposed single band antenna at 2.4 GHz.

Variable	Value (mm)
L_1	1.15
L_2	28.9
L_3	1.13
L_4	17.6
L_5	6.60
L_6	35.3
L_7	18.4
L_8	18.4
W_1	1.02
W_2	1.52
W_3	3.30
W_4	6.86
R	5.10

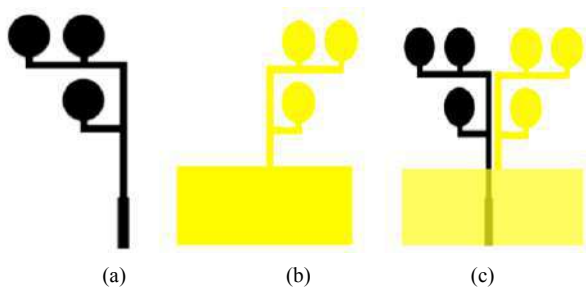

Figure 3. Configuration of the proposed antenna for dual band at 3.3 - 3.6 and 5.0 - 6.0 GHz: (a) Top layer; (b) Bottom layer; (c) Top and bottom layers overlaid.

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The configuration in **Figure 3(a)** is similar to the top layer of the single band antenna as shown in **Figure 1(a)** but with less circular patches. However, the bottom layer in **Figure 3(b)** is different compared to the bottom layer of the single band antenna shown in **Figure 1(b)**. The double-side nature of the antenna provides dual band characteristics. Identical equations were used for the single band antenna were employed in the design process. The variable corresponding to each dimensions and the dimensions for the proposed dual band antenna are shown in **Figure 4** and **Table 2**, respectively.

Simulation was performed using ADS for the configuration shown in **Figure 3(c)**. The simulated gains of the proposed dual band antenna were 4.0 dBi at 3.45 GHz and 3.3 dBi at 5.5 GHz. The double-sided configuration of the antenna provided higher gain compared to the singled-sided antenna.

3. Measurement Results and Discussions

3.1. Single-Band Atnenna at 2.45 GHz

The antennas were fabricated using LPKF Protomat [15] on FR-4 material with height of 1.524 mm. The photos of the fabricated single band antenna are shown in **Figure 5** which has a size of 6.7 × 4.4 (in cm).

Figure 6 shows the comparison between the simulated and the measured S_{11} results.

The measured operating frequency is close to 2.45 GHz with S_{11} value below −15 dB. The 3 dB bandwidth at 2.45 GHz was approximately 18%. The measurement and simulation are in fairly good agreement, and the differences are due to microstrip loss and fabrication errors.

Figure 7 shows the comparison between the simulated and measured radiation pattern in xy-plane at 2.45 GHz which is close to omnidirectional pattern.

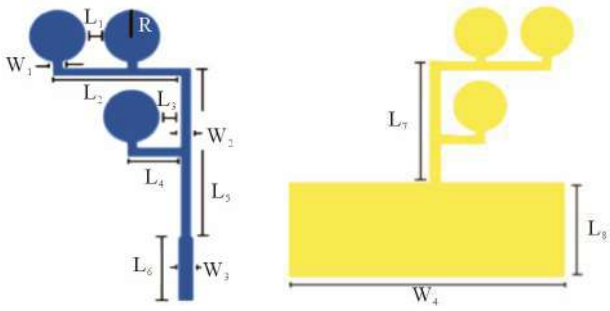

(a) (b)

Figure 4. Variables corresponding to each dimension of the proposed dual-band antenna: (a) Top layer; (b) Bottom layer.

Table 2. Dimensions for the proposed dual band antenna at 3.3 - 3.6 and 5.0 - 6.0 GHz.

Variable	Value (mm)
L_1	1.20
L_2	17.8
L_3	1.08
L_4	6.60
L_5	29.3
L_6	10.0
L_7	21.6
L_8	17.8
W_1	1.02
W_2	1.52
W_3	2.54
W_4	49.1
R	5.21

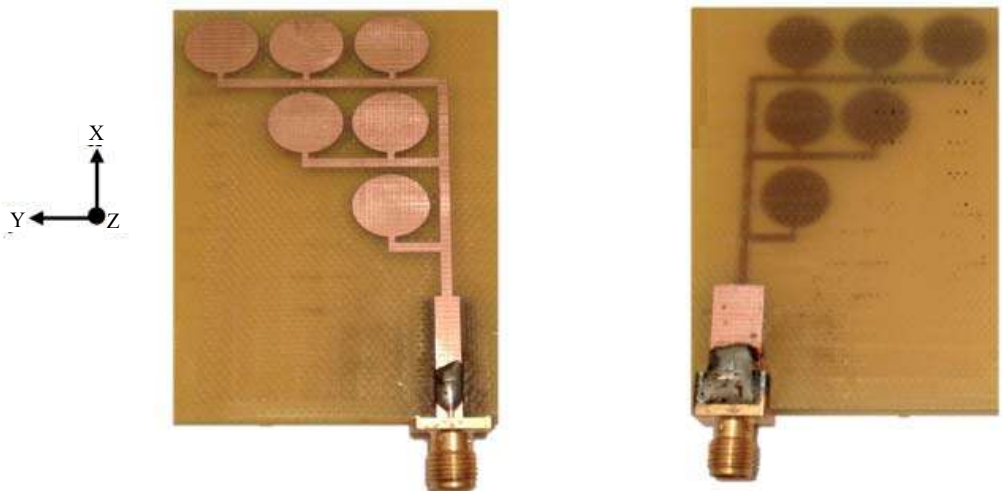

(a) (b)

Figure 5. Photo of the fabricated single-band antenna: (a) Top layer; (b) Bottom layer.

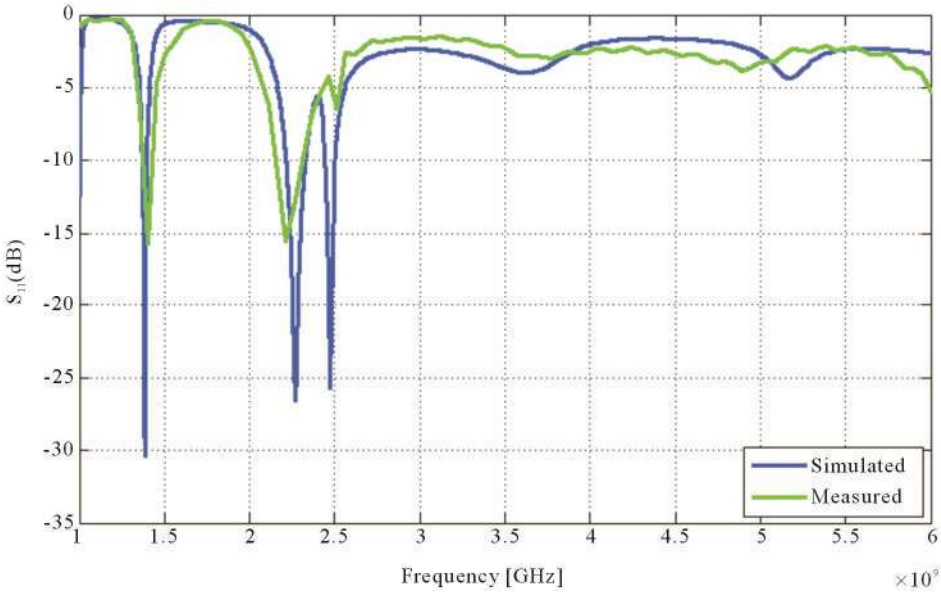

Figure 6. Simulated and measured return loss for the proposed single-band antenna.

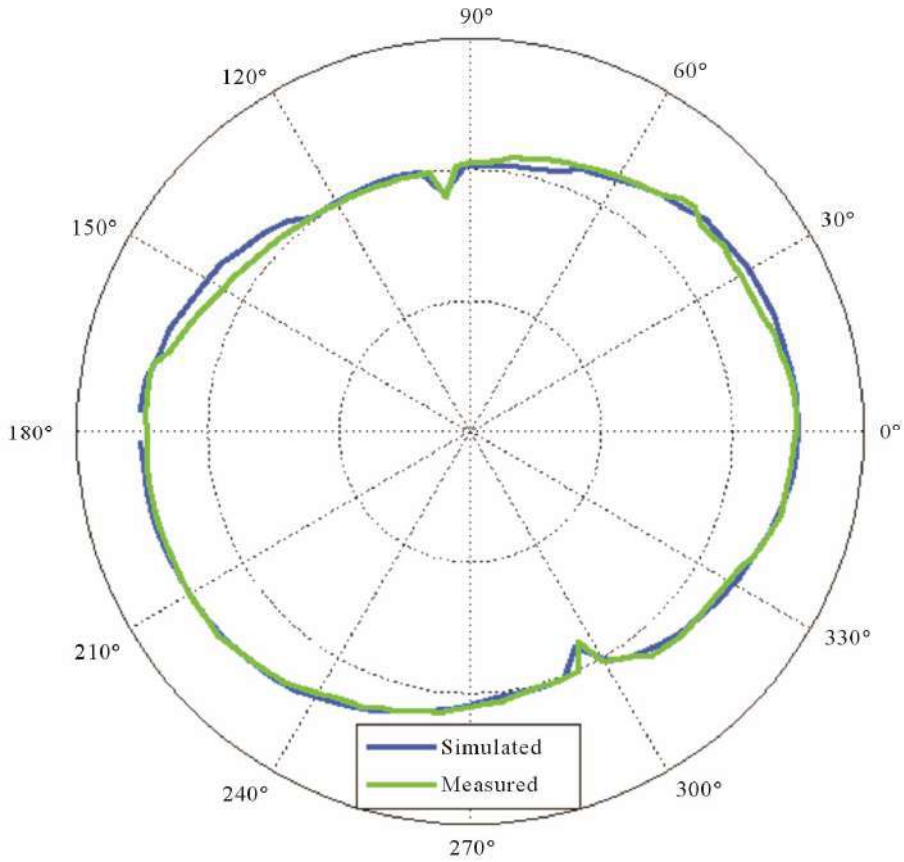

Figure 7. Simulated and measured radiation pattern in xy-plane (coordinate system shown in Figure 5) at 2.45 GHz.

3.2. Dual-Band Antenna at 3.3 - 3.6 and 5.0 - 6.0 GHz

The antennas were fabricated using LPKF Protomat [15] on double-sided FR-4 materials. The photos of the fabricated dual band antenna are shown in **Figure 8** which has a size of 6.6 × 5.2 (in cm).

Figure 9 shows the comparison between the simulated

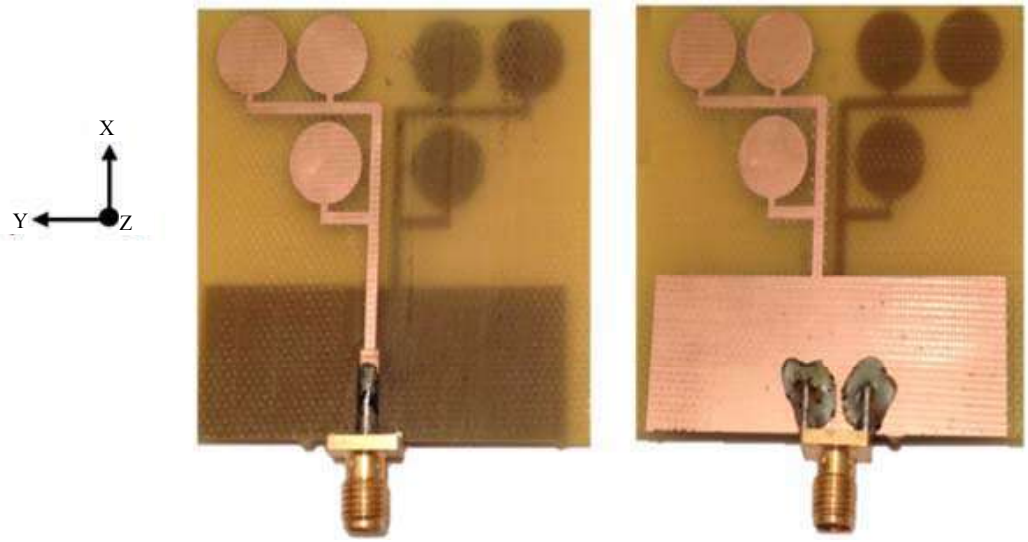

(a) (b)

Figure 8. Photo of the fabricated dual-band antenna: (a) Top layer; (b) Bottom layer.

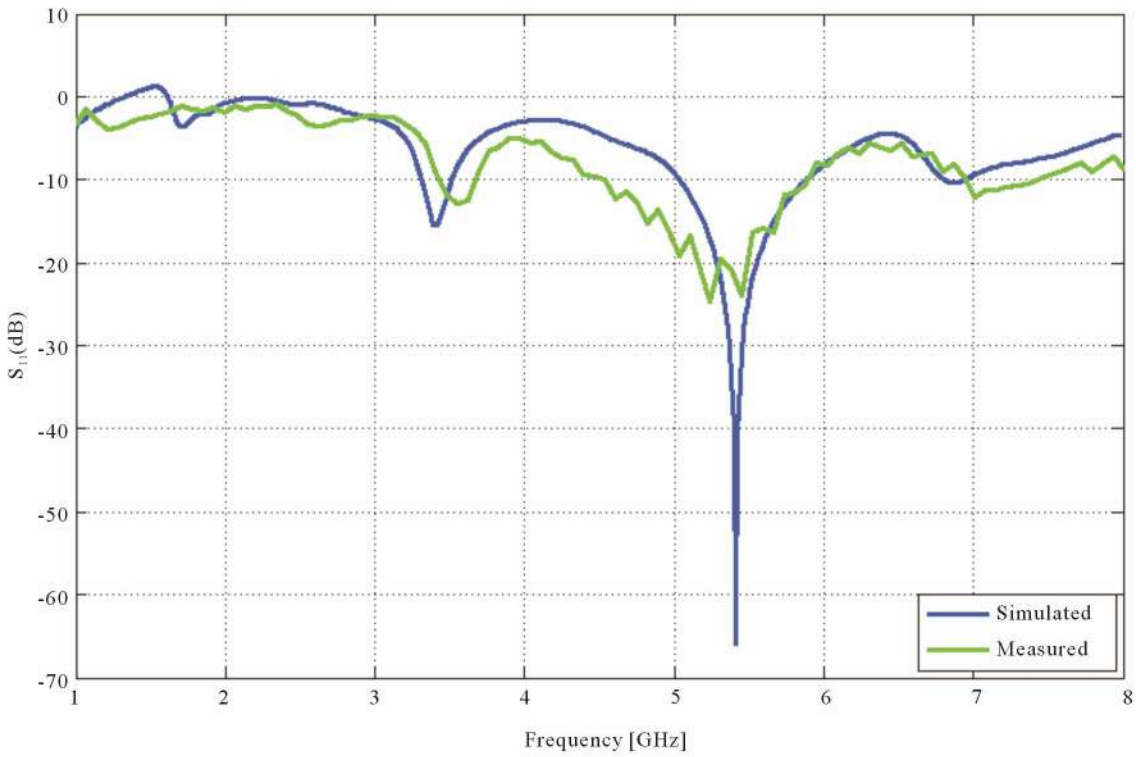

Figure 9. Simulated and measured return loss for the dual band antenna.

and the measured S_{11} results.

The measured S_{11} shows dual band near the designed bands with S_{11} values below −10 dB for both bands. The simulated and measured results give fairly good agreement, and the differences are due to board loss and fabrication errors.

Figure 10 shows the comparison between the simulated and measured radiation pattern in xy-plane at 3.45 and 5.5 GHz which is close to omnidirectional pattern.

4. Conclusion

A microstrip circular antenna arrays were presented for single band at 2.45 GHz and dual bands at 3.3 - 3.6 and

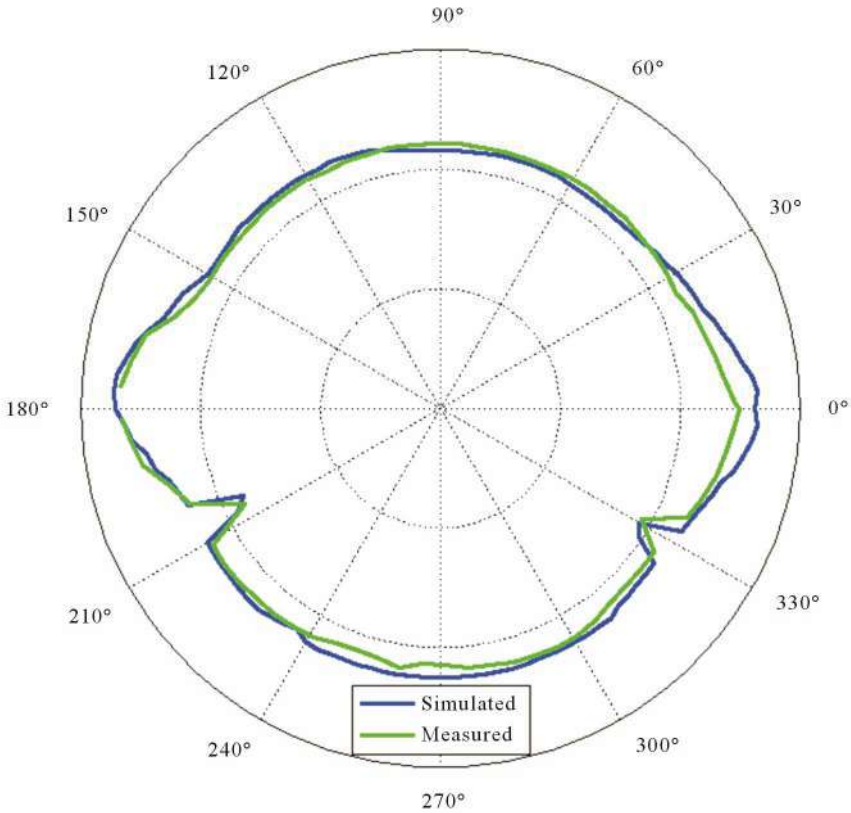

(a)

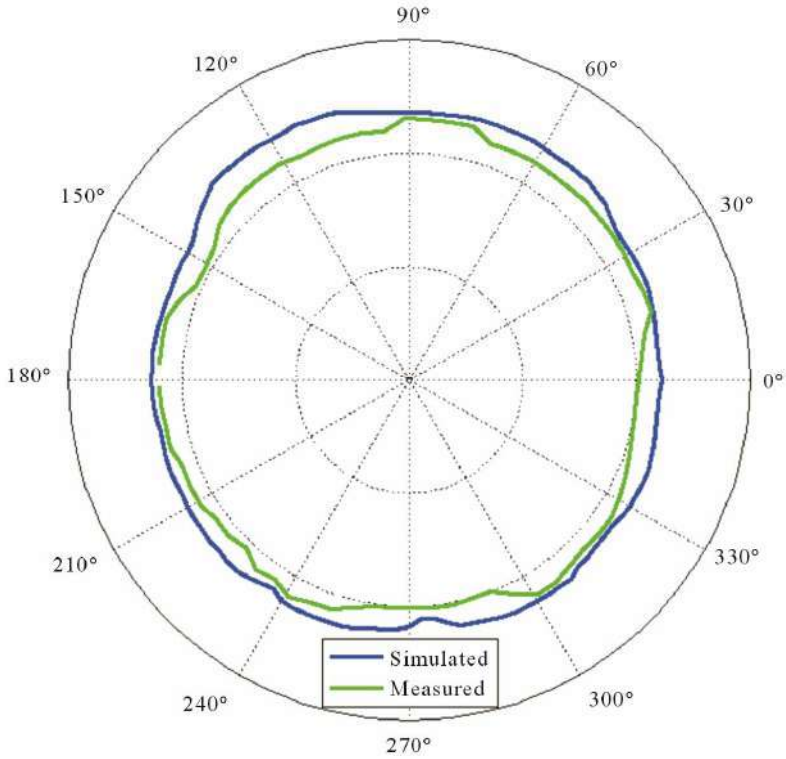

(b)

Figure 10. Simulated and measured radiation pattern in xy-plane (coordinate system shown in Figure 8) at (a) 3.45 GHz and (b) 5.5 GHz.

5.0 - 6.0 GHz for WLAN/WiMAX applications. Both antennas were designed with ADS, fabricated on a FR-4 microstrip material, and characterized. Both single band (single sided) and dual band (double-sided) antenna arrays provided omnidirectional pattern with desired gain.

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Back to Back Combined Single Feed Proximity Coupled Antenna with Dumbbell Shaped DGS

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ABSTRACT

Use of defected ground structure (DGS) to reduce the size of patch antenna is presented in this paper. In order to get a dipole like radiation pattern for some specific application a dumbbell shaped DGS is used in the common ground plane of back to back combined single fed proximity coupled antenna. A size reduction of about 60% is achieved. Parametric analysis has been done to see the resonance behavior of the antenna with DGS.

***Keywords*:** *Defected Ground structure, Microstrip Antennas, Proximity Coupling*

1. Introduction

The continuous shrinking size of electronic equipments demands similar size antenna elements in order to fit properly in wireless devices without compromising the other radiation properties of the antenna. In this respect microstrip patch antennas are quite an obvious choice because of its other benefits like low profile, light weight, low cost and easy fabrication.

But as far as size of these patches concerned, the patch length should be around half-a-wavelength for the structure to act as a good radiator. Different techniques have already been used for the antenna size reduction such as using the substrate with high dielectric constant [1] , edge shorted patches with shorting plates or shorting walls, use of the shorting pin at the suitable position etc [2,3].

As far as our understanding goes much has not been reported regarding the use of DGS for size reduction of microstrip antennas, although its application have been reported for harmonic reduction [4], cross-polarization suppression [5] and mutual coupling reduction [6] in antenna arrays etc. Although the back to back geometries have been reported by the various researchers [7,8] but here a new coupling method *i.e.* proximity coupling with the defected ground structure is used for the consideration of the increased bandwidth.

This paper presents the application of DGS for size reduction of microstrip antennas. A dumbbell shaped DGS is used in the common ground plane of a back to back combined single feed proximity coupled microstrip antenna.

2. Defected Ground Structure

Recently there has been an increasing interest in the use of DGSs for performance enhancement of microstrip antennas and arrays. These are realized by etching off a simple shape defect from the ground plane of the planer circuits.

Although various complicated DGSs were reported in the literature, but the simplest one is the dumbbell shaped DGS. **Figure 1(a)** shows the simple and mostly used dumbbell shaped DGS that is etched in the ground plane below the microstrip line, in which both the areas (L_g*W_g) and the slot gap (g) play a very important role to find the resonance behavior of the DGS.

The head areas (L_g*W_g) is very useful for the variation in the inductance (L) and the slot (g) produces the capacitance (C). The L and C may be calculated from the formulae given below [9].

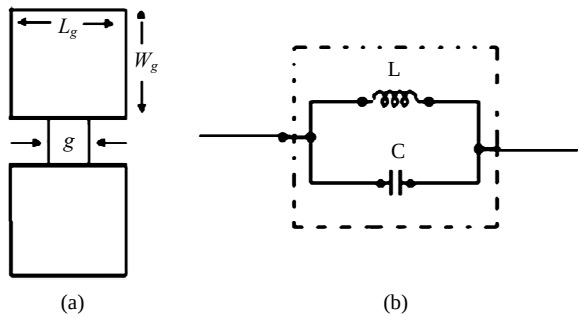

Figure 1. (a) Dumbbell shaped DGS, and (b) DGS Equivalent Circuit.

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$$L = \frac{1}{4\pi^2 f_0^2 C} \quad (1)$$

$$C = \frac{f_c}{2Z_0} \times \frac{1}{2\pi(f_0^2 - f_c^2)} \quad (2)$$

When this DGS is applied to the antenna, the equivalent inductive part due to the DGS increases and produces equivalently the high effective dielectric constant, thereby decreasing the resonant frequency when the DGS is incorporated in the ground plane of a micro strip antenna.

3. Antenna Design with DGS

In this section, the design approach and the performance of the basic antenna and the antenna with DGS is described. At the outset, the single patch antenna was designed and simulated using the CST Microwave studio [10], for the operating frequency at 5.0 GHz. Then another patch of the same size was added in the opposite side of the ground plane and fed in the same way as the first one. The configuration seems as two patch antennas having a common ground plane working at the same frequency. Next the feed lines were combined for the antenna for single feed design. For this purpose the antenna feed lines W_f = 0.934 mm with d_f = 1.5 mm were designed of 100 ohm and for matching to the 50 ohm transmission line (W_p = 3.86 mm) a quarter wave length transformer (W_t = 2 mm) was used to give proper matching (**Figure 2**).

The cross-sectional view of the single fed back to back combined proximity coupled antenna is shown in the **Figure 2(a)**. The layouts of matching networks only are emphasized in this **Figure 2(b)** for convenience. It is observed that the antenna designed in this configuration gives the bandwidth of 137 MHz whereas single antenna gives a bandwidth of 67 MHz. This is due to the fact that as the antenna height increases the quality factor decreases and the bandwidth increases. This becomes a multilayer antenna with more height and higher bandwidth as compared to the single patch antenna.

The simple transmission line model was used for the antenna size calculation. The dielectric constant was taken as 3.38 with the loss tangent 0.0025 and of 1.524 mm thickness. The patch lengths L_p and widths W_p are 15 mm and 19 mm respectively. The feed line has been inserted inside the dielectric at a height equal to the half of the height (h = 3.048 mm) of the antenna on either side. The dumbbell shaped DGS with dimensions L_g = W_g = 8.6 mm and g = 0.76 mm was created in the ground plane of the antenna as shown in the **Figure 2(c)**. A small slot was also created for making the antenna with single feed. The two feed lines were connected with a metal strip which goes through the small slot in the ground plane. The fabricated antenna is shown in **Figure 2(d)**.

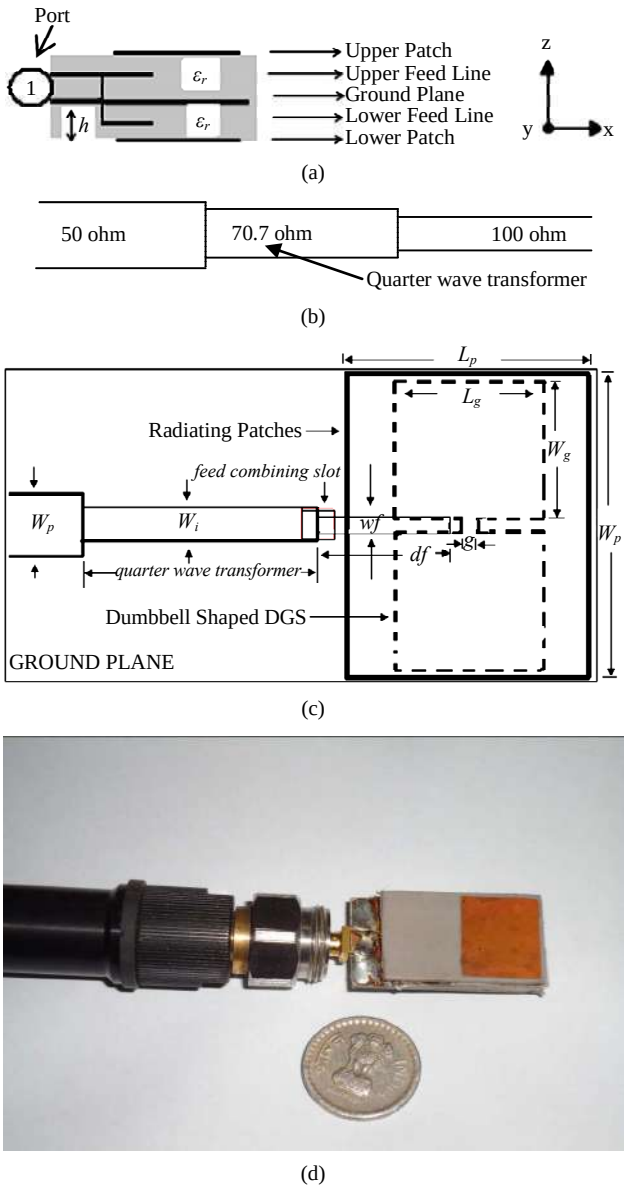

Figure 2. (a) Cross-sectional view of antenna configuration, (b) Feeding Network, (c) Top-View of the antenna, (d) Fabricated Antenna.

4. Results and Discussion

At first the antenna without the DGS in the common ground was simulated and was found to resonate at 5 GHz with 137 MHz Bandwidth.

Then the structure was simulated with the dumbbell shaped DGS. Before reaching to the final size of the DGS, a parametric study was done by varying L_g, W_g and g of

the DGS. As shown in **Figure 3**, with the increase in the value of L_g, the resonant frequency of the antenna is decreasing. Infect, increase in the length of the DGS head gives increasing inductance which in turn decreases the resonant frequency of the antenna.

At this point the increment in the (g) was not possible due to the accuracy in fabrication, so for this reason the other dimension (g) was kept constant for the requirement of the desired frequency (2 GHz). The size of the DGS single square head for the antenna to resonate at 2 GHz (UHF Band) was found to be 8.6 mm × 8.6 mm. The return loss (S11 [dB]) plot of the structure with and without DGS is shown in **Figure 4(a)**. **Figure 4(b)** shows the measured S11 parameter using the HP 8720 B network analyzer. The marker's position near to peak shows the resonance frequency 2.08 GHz with return loss of -13 dB. The result shows good agreement with the simulation results. The measured -10 dB bandwidth is about 60 MHz. The maximum size reduction achieved is about 60%.

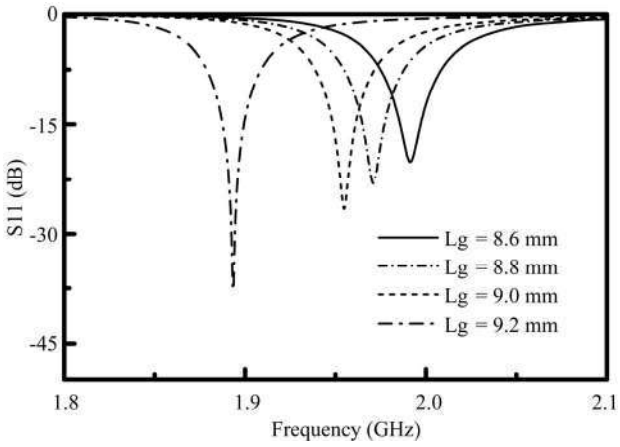

Figure 3. S11 Vs. Frequency response by varying DGS length (Lg).

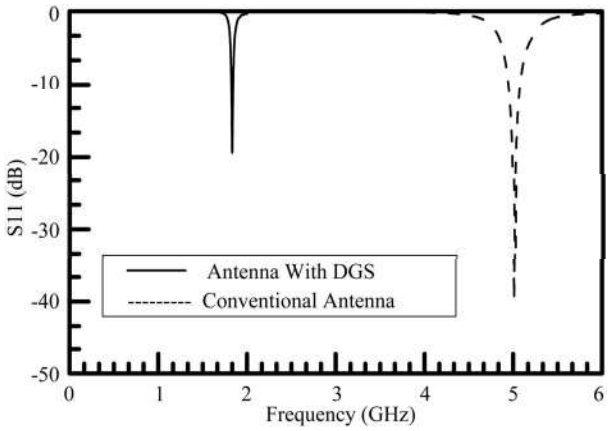

(a)

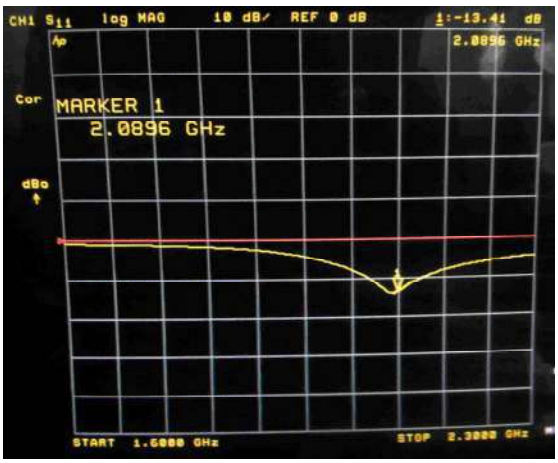

(b)

Figure 4. Antenna Return Loss (a) simulated (b) measured.

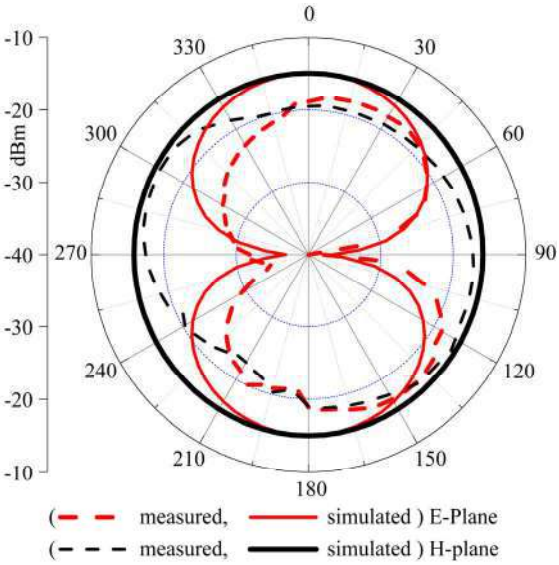

Figure 5. Antenna radiation pattern (measured and simulated) at 2 GHz Frequency.

The measured and simulated power patterns of the antenna are shown in **Figure 5**. It can be observed that the E-plane radiation pattern is similar to the pattern for a dipole antenna. Measurement errors are mainly due to the spurious radiation created by the feeding end and the improper coupling of the elements. However the gain measured experimentally for the proposed antennas with DGS is about -6.9 dB and -7.8 dB (where simulated gain with DGS is 3.8 dB and 5.7 dB is for the antenna without DGS, for both the planes) in both the E and H plane respectively, which is consistent with the size reduction of the antenna.

5. Conclusion

Microstrip patch antenna size reduction with DGS is car-

ried out in this work. A dumbbell shaped DGS in the common ground plane of a back to back microstrip structure was found to give a size reduction of about 60% and shifts the resonance frequency from 5 GHz to 2 GHz, with 60 MHz bandwidth facilitating the antenna, to be used for UHF band applications.

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Vehicular Radio Scanner Using Phased Array Antenna for Dedicated Short Range Communication Service

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ABSTRACT

Now a day's accidents are very common due to increased population of vehicle. In order to ensure safety measures in the vehicle this paper has proposed some methodologies regarding careful driving by automatically scanning and analyzing the blind spot area of an intelligent mobile vehicle. A vehicular antenna with minimum perturbation is proposed to be fitted on the vehicle and collect information of the concern area which would ensure visibility of the operator *i.e.* masked or integrated within the car body. This paper has dealt with the design of Tchebyscheff polynomial based prototype planar microstrip phased array antenna and also redesigned the same when implemented in the body of the car being considered as an electromagnetically large element. Both the design has been experimentally verified with the measurement. The simulated and the measured results in both the cases are found to be in good agreement. More than 11 dB gain was observed at perfectly 30° angles from its broad side direction as desired for blind spot detection with minimum amount of electromagnetic interference inside the car.

Keywords: Intelligent Transportation System; Microstrip Phased Array Antenna; Tchebyscheff Polynomial; Electromagnetic Interference

1. Introduction

Intelligent Transport System (ITS) ensures mobility comfort and safety in transportation system. It also absorbs the hazards due to environmental impact. With the progress of the information processing technology, control systems to minimize accidents for the roadways have also been advanced hence one approach to improve the traffic safety is found and that is automatic collection of data by scanning the blind spot area of the vehicle [1] as shown in **Figure 1**. Many methods were proposed to detect the blind spot area but all of them had certain limitations. Devices like dynamic angling side view mirror [2], side view camera model [3], and shadow or edge features detector [4] were used for detecting blind spot area but their performance was affected during bad weather, fog or mist. Also we know that the mechanical systems, response time is more and the system is prone to wear and tear.

A radio frequency method has been proposed in this paper to scan the blind spot zone efficiently. Four rectangular microstrip antennas (RMSA) are arranged in linear configuration with optimal spacing between the patch elements to construct the phased array radar. A corporate feed network is used to feed the patch element unequally and a progressive phase shifter is designed with 108˚ delay elements to tilt the main beam in the desired direction and then the total unit is simulated and experimented after placing it on the car body which is electromagnetically a large element. The antenna works in the Dedicated Short-Range Communication Service (DSRCS) frequency band [5]. The design of the microstrip phased array antenna is discussed in Section 2 and after that to place the antenna; the design of the entire car is given in Section 3. Results and discussion are portrayed in Section 4 along with conclusion in Section 5.

2. Design of Microstrip Phased Array Antenna

The microstrip phased array antenna is designed for Dedicated Short Range Communication Service at 5.88 GHz with dielectric constant of 2.32 and substrate thickness of 0.785 mm. Firstly the dimension of the rectangular patch is computed as 16.322 mm by 19.8 mm using the method outlined in [6]. With computed inset feed length of 3.8 mm and for the above dimensions of the rectangular patch the return loss is found to be –8.09 dB

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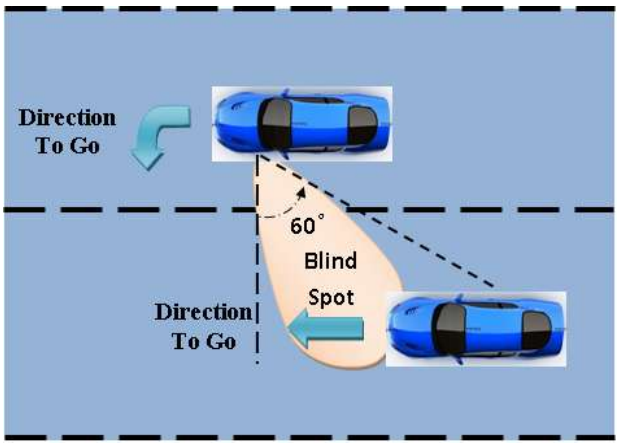

Figure 1. Surrounding regions of a vehicle.

with (30.1 + j26.7) ohm impedance at the feed position. The RMSA is simulated and optimized using Ansoft HFSS™. After optimization the final length is found to be 16.4363 mm with inset feed length of 4.8225 mm keeping the width of the patch unchanged as shown in **Figure 2**.

By considering the above designed patch element, a four element linear array is realized and powered by Tchebyscheff current distribution. The spacing between the elements is kept considering the desired maximum scan angle in order to eliminate the grating lobes within the visible space of the phased array antenna. To optimize the performance of the antenna in respect of its side lobe level (SLL), mutual coupling and gain of the antenna array, the spacing between the elements is studied parametrically [7]. The results of the said study are tabulated in **Table 1**.

After optimization it is found that the optimum spacing between the elements is 0.6 λ_0 while considering, the main lobe to side lobe ratio below 20 dB, optimum mutual coupling and overall gain.

From **Figure 1**, it is observed that the beam of the antenna array is required to be tilted by an angle 30˚ away from the broad side direction. In view of the above a progressive phase shifter of –108˚ is designed with the help of 11.16 mm feed line length. The actual line length is considered as mτ, where m = 0, 1, 2, 3.

To enhance the gain by maintaining the beam width and main lobe to side lobe ratio, the antenna elements are excited by Dolph Chebyshev current distribution. The array consist of four elements, thus third order Tchebyscheff polynomial is calculated. Hence the polynomial is solved and relative current ratio is computed as 1:1.7795:1.7795:1. Both equal and unequal power dividers are designed along with the progressive phase shifter.

For equal power division, a 3 dB equal power divider is designed whose vertical arm is of 50 Ω line and two horizontal quarter-wavelength branch-lines are of 70.71 Ω is used [8]. It is shown in **Figure 3(a)**.

Table 1. Effect on mutual coupling and gain due to variation in spacing (d) between the elements.

d with respect to guided wavelength	d with respect to operating wavelength	Mutual coupling (dB)	Gain (dBi)
0.6 λ_g	0.41 λ_0	>10	7.6
0.7 λ_g	0.48 λ_0	>13	9.9412
0.8 λ_g	0.55 λ_0	>20	10.647
0.9 λ_g	0.6 λ_0	>22	10.919

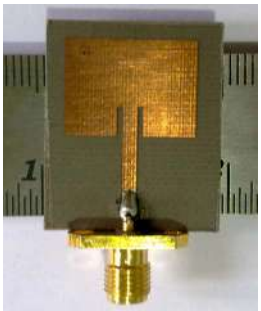

Figure 2. Photograph of the rectangular microstrip antenna element.

To get the unequal current distribution, both the horizontal arm of the microstrip unequal power divider should be of different resistance and it is calculated as 46.368 Ω and 82.49 Ω. The structure is shown in **Figure 3(b)**.

Generally for practical design purpose the gap between the corporate feed networks is taken small but the value of the gap less than 0.11 λ_0 disturbs the frequency response of overall antenna array. The effects of the feed network on the side-lobes are significant in the E-plane pattern. The influence on the H-plane is less important due to the orthogonality of the drive current and the symmetry of all the other currents in this cut [9]. By maintaining the SLL and the surface wave loss, the gaps are taken as 0.11 λ_0 as portrayed in **Figure 4**.

3. Placement of Antenna on the Vehicle

In order to compute the electromagnetic effect of the body of the car on the antenna performance, the entire structure of the car is designed in Ansoft HFSS™. The complete structure of the car consist of hood, roof, trunk, left and right side doors, left and right side quarter panel for front and rear side which are made up of conducting material but the bumpers and wheels are assigned by layered impedance due to their hard rubber and polyester materials as shown in **Figure 5**.

After going through the typical requirement for scanning the blind spot, the antenna is placed just beside the side view mirror. The following problems in the designed are addressed while simulating the effect of the radiation

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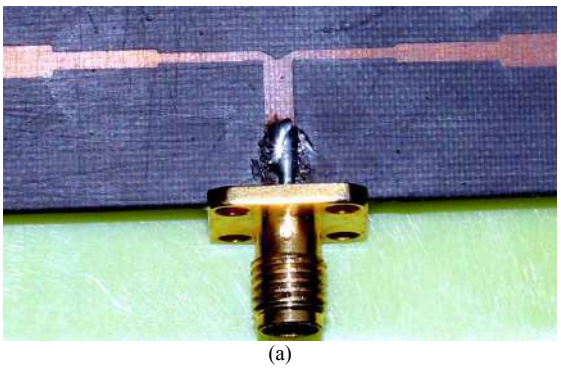

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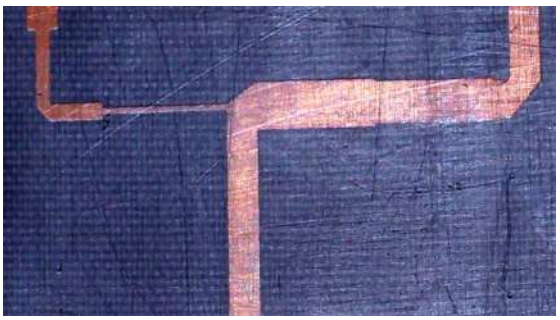

(b)

Figure 3. (a) Photograph of the equal microstrip power divider; (b) Photograph of the unequal microstrip power divider.

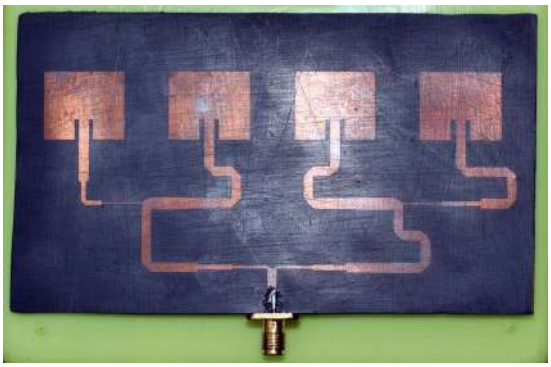

Figure 4. Photograph of the antenna array with corporate feed network.

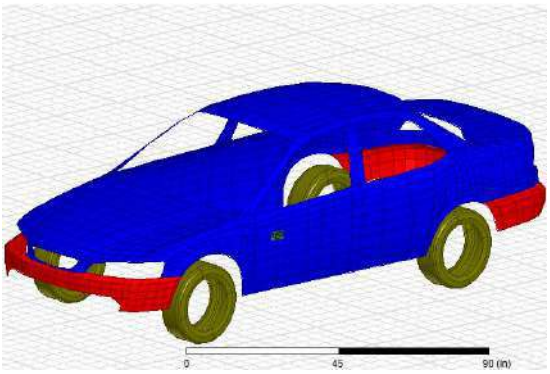

Figure 5. The entire structure of the car along with the antenna array.

characteristics of the antenna after placing it on the vehicle:

1) Spans a large computational domain compared to the wavelength;

2) Requires a fine grid resolution to resolve the detailed antenna structure;

3) Contains largely non-conformal PEC and dielectric structures.

4. Results and Discussion

For obtaining the scattering parameter characteristics, the microstrip antenna has been simulated over the frequency bandwidth ranging from 5.5 GHz to 6.5 GHz and two different circumstances is observed. The first experiments involve the design, simulation and measurement after fabrication of an individual element and then the array with the same without involving the effect of the car. Both of them should used for optimized performance.

The scattering parameter is measured by Agilent Technology Vector Network Analyzer model no. N5320A (10 MHz - 20 GHz) and the radiation pattern is measured by Hittite HMC-T2100 synthesized signal generator (10 MHz - 20 GHz) and Krytar 9000 B power meter (10 MHz - 40 GHz) with 9530 B power sensor (10 MHz - 20 GHz) as shown in **Figure 6**. From **Figure 7**, it is found

(a)

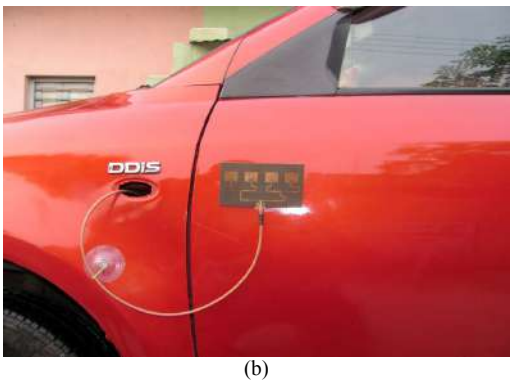

(b)

Figure 6. (a) Experimental set-up to measure the radiation pattern of the antenna array; (b) Experimental set-up to measure the radiation pattern of the antenna array after placing it on the car.

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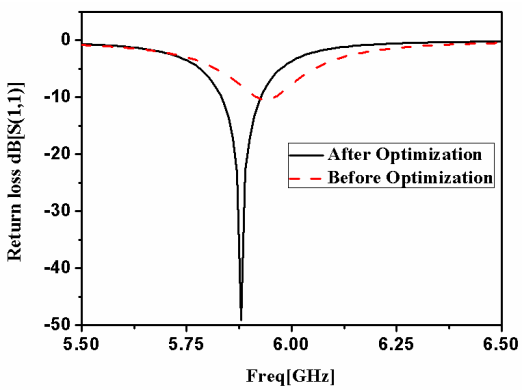

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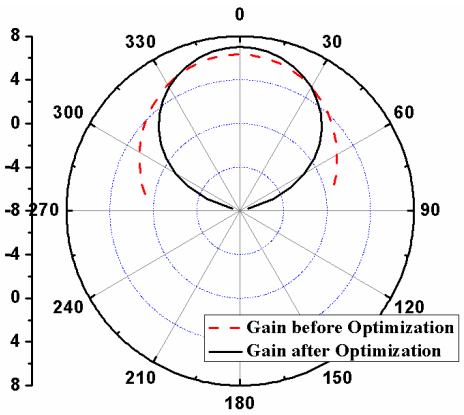

(b)

Figure 7. (a) Return loss a single patch before and after optimization; (b) Gain of a single patch before and after optimization.

that after optimization a perfect match is obtained exactly at 5.88 GHz and gain is also improved from 6.33 dB to 7.01 dB with a very good return loss of –47 dB. The current distribution and the radiation pattern of a single RMSA is portrayed in **Figure 8**.

A parametric study of the return loss of antenna array with different spacing between the elements of the corporate feed network is done and is compared in **Figure 9**. The results of the computational model of the entire antenna array with feed network were compared with the measured data and a good agreement is observed in **Figure 10**.

After getting the satisfactory results, next the same array antenna is experimented again with considering the electromagnetic effect of the car. In order to test the antenna array in association with the vehicle, a numerical model of the car is created using Ansoft HFSS^{TM} and the simulated data is compared with the measured in **Figure 11**. **Figure 12** graphically represents the 3D radiation pattern of the antenna array in presence of the computational model of the vehicle. From **Figure 13**, it is clear that the inside electric field strength is not more than 15 Volt per meter which is very less compare to the standard

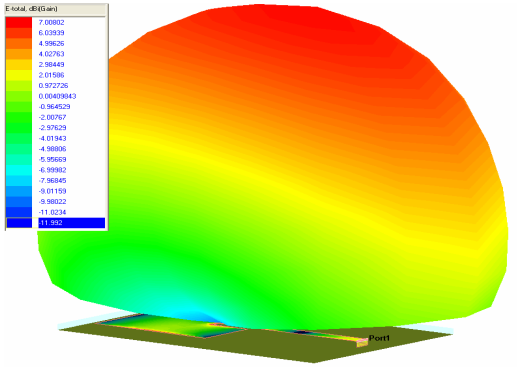

Figure 8. Current distribution and the radiation pattern of the rectangular microstrip antenna.

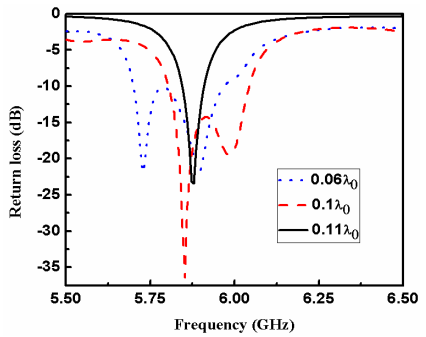

Figure 9. Parametric study of return loss of the antenna array with different spacing between the elements of corporate feed network.

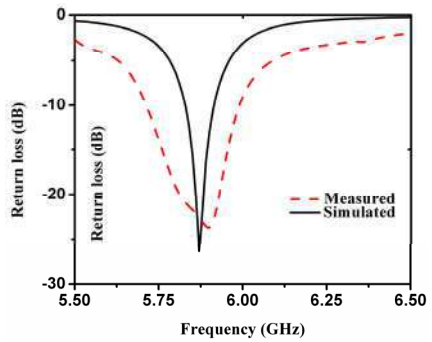

(a)

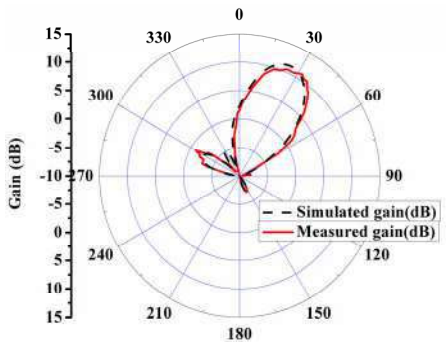

(b)

Figure 10. (a) Return loss of the antenna array; (b) Radiation pattern of the antenna array.

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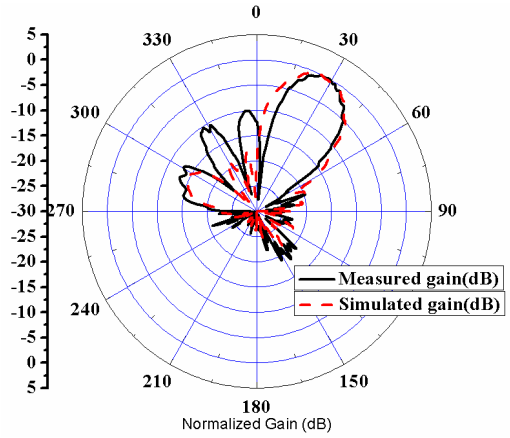

Figure 11. Normalized radiation pattern of the antenna array after placing it on the body of the car.

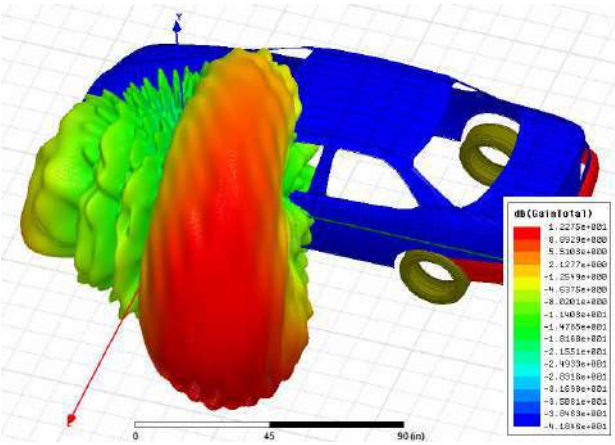

Figure 12. 3D radiation pattern of the antenna array after placing it on a vehicle body.

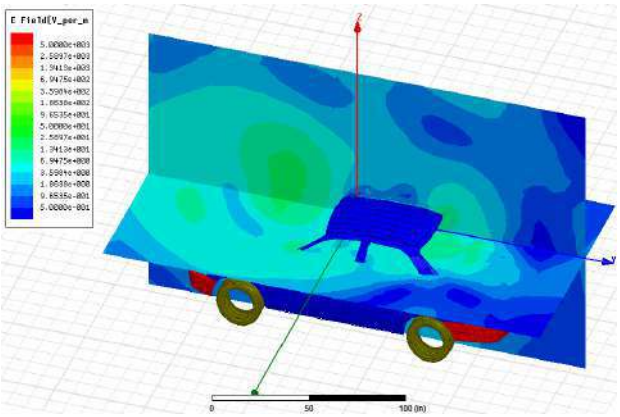

Figure 13. Inside electric field interference of the array after placing it on a vehicle body.

electromagnetic hazards.

5. Conclusion

A Tchebyscheff polynomial based microstrip phased array antenna is designed to detect the blind spot area of the intelligent mobile vehicle. The design is further simulated in Ansoft HFSS™ after placing the antenna on the body of the car and the results are observed. The result of the computational model of the entire antenna array is compared with the measured data before and after placing the said antenna array on the body of the car and found to be in good agreement. An overall 11 dB gain is obtained while measuring in the desired direction with minimum amount of electromagnetic interference inside the car.

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Plus Shape Slotted Fractal Antenna for Wireless Applications

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ABSTRACT

Fractal antennas are characterized by space filling and self-similarity properties which results in considerable size reduction and multiband operation as compared to conventional microstrip antenna. This paper outlines a multiband antenna design based on fractal concepts. Fractal antennas show multiband behavior due to self-similarity in their structure. The plus shaped fractal antenna has been designed on a substrate of dielectric constant $€_r$ = 4.4 and thickness 1.6 mm. The proposed antenna is characterized by a compact size and it is microstrip feed fractal patch of order 1/3. It is observed that the antenna is radiating at multiple resonant frequencies. The resonant frequency is reduced from 2.2 GHz to 900 MHz after I & II iterations respectively. Thus considerable size reduction of 81.77% & overall bandwidth of 12.92% are achieved. The proposed antenna is simulated using the method of moment based commercial software (IE3D) and it is found that simulated results are in good agreement with the experimental results.

Keywords: Fractal Antenna; Multi Frequency; Size Reduction; Wireless Application; Plus Shape Antenna; Slotted Antenna

1. Introduction

In the study of antennas, fractal antenna theory is a relatively new area. The emergence of antennas with fractal geometries has given an answer to two of the main limitations started by Werner (1999) of the classical antennas, which are single band performance and dependence between size and operating frequency. The term "fractal" means broken or irregular fragments. It was originally coined by Mandelbrot (1983) to describe a family of complex shapes that possess an inherent self-similarity or self-affinity in their geometrical structure. Jaggered (1990) defined fractal electrodynamics as an area in which fractal geometry was combined with electromagnetic theory for the purpose of investigating a new class of radiation, propagation and scattering problems. One of the most promising area fractal electrodynamics researches is in its application to antenna theory and design. There are varieties of approaches that have been developed over the years, which can be utilized to archive one or more of these design objectives. The development of fractal geometry came largely from an in depth study of the pattern nature, with the advance of wireless communication system and their increasing importance wide band and low profile antennas are in great demand for both commercial and military applications [1]. A fractal is a rough or fragmented geometric shape that can be split into parts, each of which is a reduced-size copy of the whole and this property is called self-similarity. Fractal [2] geometries are composite designs that repeat themselves or their statistical characteristics and are thus "self-similar" fractal geometry finds a variety of applications in engineering. Fractal geometry is space filling contours of regular or irregular shapes [3-6], and is super imposed of too much iteration and they describe the self-similar property of fractal geometry [7]. Fractals are a class of shapes which have not characteristic size. Each fractal is composed of multiple iterations of a single elementary shape the iteration can continue infinitely, thus forming a shape within a finite boundary but of infinite length or area. Fractal has the following features 1) It has a finite structure at arbitrarily small scales; 2) It is too irregular to be easily described in traditional Euclidean geometric; 3) It is self-similar; 4) Simple and recursive [8]. Modern telecommunication systems require the antenna with wider bandwidth and smaller dimension than conventionally possible. This has initiated antenna research in various directions, are of which is by using fractal shaped antenna elements. In recent years several fractal geometries have been introduced for antenna application with varying degree of success in improving antenna

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characteristics. Some of these geometries have been particularly useful in reducing the size of the antenna, while other designs aim at incorporating multiband characteristics. These are low profile antennas with moderate gain and can be made operative at multiple frequency bands and hence are multifunctional [9]. In our present work we focus on generation of multifrequency which yields increases the bandwidth and size reduction of antenna. A plus shape patch is taken as a base shape and in first iteration four other plus shape patches of the order of 1/3 of base shape are placed touching the base shape. Similarly second iterations are taken by further placing plus shaped patches at even reduced scales. It is found that as the iteration number and iteration factor increases, the resonance frequencies become lower than those of the zero iteration, which represents a conventional plus shape patch.

2. Design Consideration

The base shape of the plus shaped slotted fractal antenna is designed on a dielectric substrate having a relative dielectric constant $€_r$ = 4.4 and thickness 1.6 mm as shown in **Figure 1**. This is the reference antenna or base shape antenna. Further this base shape antenna is modified by inserting horizontal slots on both sides with respect to center of patch as shown in **Figure 2** and it is named as antenna1. The length of the slot Ls is varied on either side of the edge as 5 mm, 10 mm, 15 mm, 20 mm, 21.175 mm, 21.675 mm and the frequency variation has been studied. The optimum length obtained is Ls = 21.675 mm *i.e.*, the distance between slots q = 2 mm is considered for further design.

The first iteration patch is designed with four plus shapes of order (1/3) of base shape are placed touching the base shape as shown in **Figure 3** and it is named as antenna 2 and same procedure is repeated for second iteration. This antenna is as shown in **Figure 4** and it is named as antenna 3. For each iteration plus shapes of the order of $(1/3)^n$ of base shape are taken, where n is the number of iterations. The dimension of first iteration can be calculated as

e = (1/3) a & g = (1/3) c also f = (1/3) b & h = (1/3) d.

i = (1/3) e & k = (1/3) g also j = (1/3) f & L = (1/3) h

So with optimized design the dimensions obtained are a = 45.3 mm, b = 15.1 mm, c = 35.4 mm, d = 11.8 mm. The length of the slot is Ls = 21.675 mm and width of the slot Ws *i.e.* r = 2 mm. The dimension of the ground plan is 55 mm × 85 mm. A 50 ohm SMA connector is used to feed the antenna by using microstrip feed technique. Optimized microstripline with following dimension, m = 0.5 mm, n = 18.55 mm, o = 3.05 mm, p = 18.4 mm. The suitable feed location is obtained through optimization process by using the IE3D software. The fabric

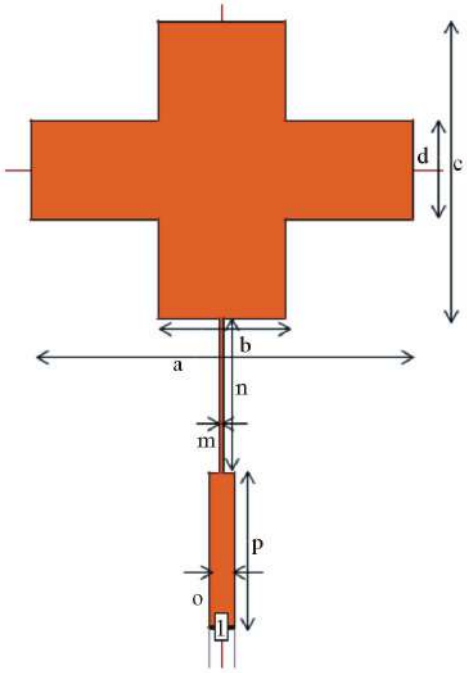

Figure 1. Geometry of base antenna.

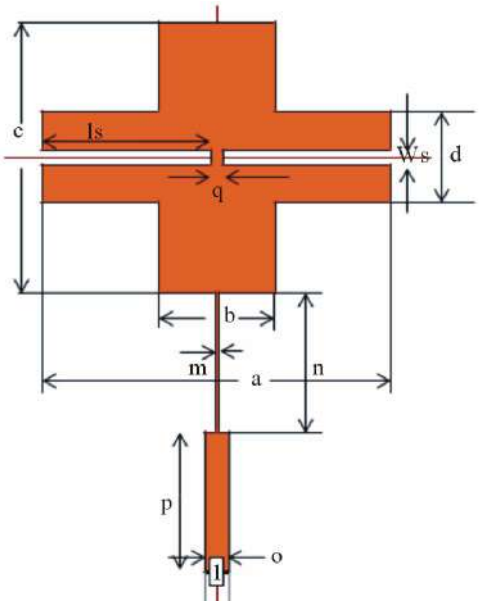

Figure 2. Geometry of antenna 1.

cated photographic view of all proposed antennas is shown from **Figures 5(a)-(e)**.

3. Results and Discussion

The characteristic of the fractal antenna with slot and with iterations has been studied by using IE3D software. Also the results have been verified practically with by using Vector Network Analyzer model Rohde and schewarz, German make ZVK model No.8651.

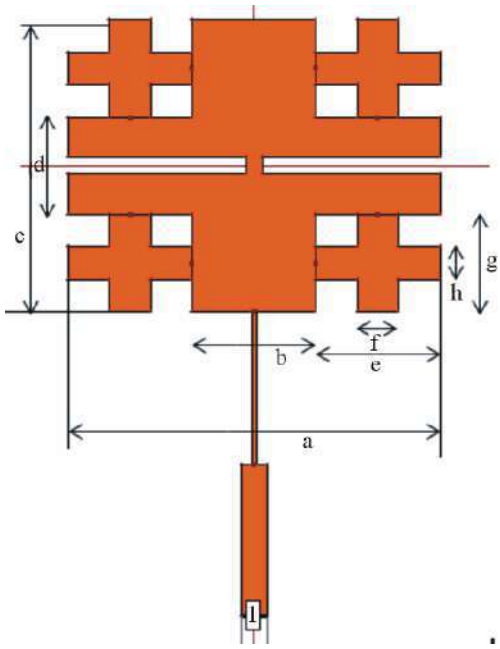

Figure 3. Geometry of base antenna 2.

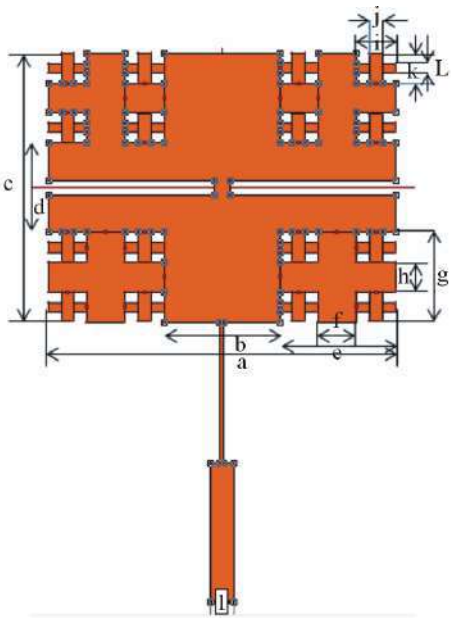

Figure 4. Geometry of antenna 3.

The modified base shape antenna with slots as been optimized by varying slot length Ls. The variation of Ls with resonant frequency of the antenna is shown in **Table 1** and same is presented in graphical form in **Figure 6**. From the tabular results it is found that by increasing slot length Ls on both sides from the edge of the patch, resonant frequency decreases. The lowest possible resonant frequency 1.27 GHz is obtained for Ls = 21.675 mm (*i.e.*, distance between the slots q = 2 mm) & this is taken as optimized length of the slot for further iteration.

The results of all proposed antennas are shown in **Table 2**. The simulated and measured return loss characteristics of proposed antennas are shown from **Figures 7(a)-(d)**.

From the results it is clear that the resonant frequency of the antenna 1 *i.e.*, modified base antenna with slot is fr = 1.27 GHz which is lower compared to the base antenna without slot (fr = 2.199 GHz). So the size reduction obtained is 66.85%. The antenna 2 *i.e.* the modified antenna with slots and first iteration gives multiple bands with lower frequency of 0.99 GHz. The size reduction obtained for antenna 2 is 79.88%. Further antenna 3 *i.e.*, with slot and second iteration gives multiple bands with

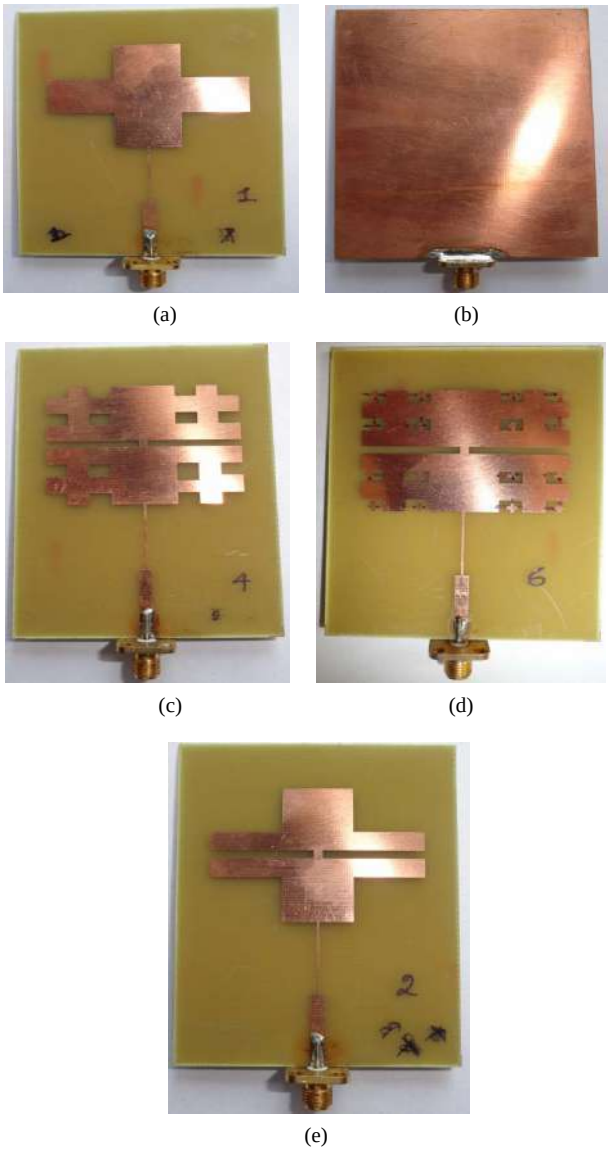

Figure 5. (a) Photograph of top view of base antenna; (b) Photograph of bottom view of base antenna; (c) Photograph of antenna 1; (d) Photograph of antenna 2; (e) Photograph of antenna 3.

Table 1. Variation of slot length v/s resonant frequency.

Slot length (Ls) variation in mm	Resonating frequency (GHz)
0	2.22
5	2.197
10	2.155
15	1.93
20	1.436
12.175	1.34
21.675	1.27

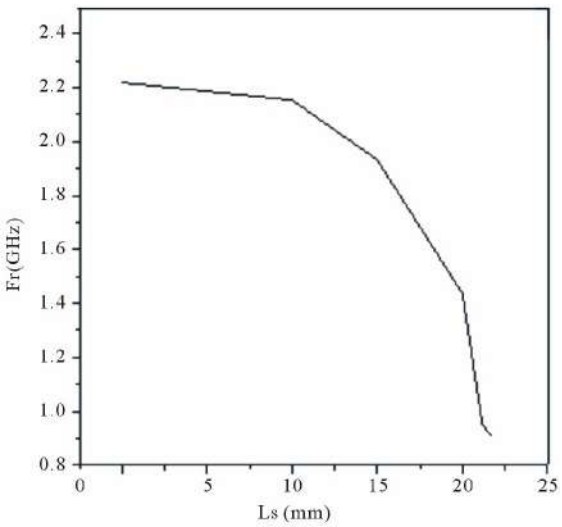

Figure 6. Variation of resonant frequency v/s slot length.

lower resonant frequency of 0.90 GHz. The size reduction obtained for antenna 3 is 81.77% which is more compared to all other proposed antennas.

Further the bandwidths of proposed antennas have been studied through simulation and measurements and the results are shown in **Table 2**. From the results it is clear that the bandwidths of modified antenna with slot, first & second iteration are more compared to base antenna. The measured bandwidth of antenna 1 is 106 MHz (4.895%), antenna 2 is 190 MHz (11.93%) and antenna 3 is 215 MHz (12.92%). The radiation patterns of all proposed antennas are studied and all are giving broadside radiation. Splitting of beam *i.e.* dip is found in **Figure 8(a)** of simulated radiation pattern of base shape at 2.19 GHz. In **Figure 8(b)** splitting of beams merged into broadside pattern at 0.91 GHz at second iterations this results into broadside radiation pattern.

4. Conclusion

This paper presents a new plus shape slotted fractal antenna with first and second iterations. The antenna.3 *i.e.*, slotted fractal antenna with second iteration gives size reduction of 81.77% and band width of 12.92% with broad side radiation pattern. So from the results we conclude that the modified base antenna with slots of second iterations gives a good size reduction and enhanced band width compared to that of modified base antenna with

Table 2. Results of proposed antennas.

Prototype antenna	Resonant frequency fr (GHz)		Return loss (db)		Bandwidth (MHz)		Overall bandwidth (MHz)	
	Sim	Pract	Sim	Pract	Sim	Pract	Sim	Pract
Base antenna	f1 – 2.19	f1 ± 2.19	–19	–24	53	53	79	71
	f2 – 3.42	f2 ± 2.46	–14	–15	26	18		
Antennal with q = 2 mm	f1 ± 1.19	f1 ± 1.27	15.8	–12.8	20	18	133	106
	f2 ± 2.52	f2 ± 2.48	18.4	–20.1	113	44		
		f3 ± 2.56		–18.7		44		
Antennal 2 with q = 2 mm (1st itr)	f1 ± 0.96	f1 ± 0.99	16.7	–14.5	22	80	136	190
	f2 ± 2.9	f2 ± 2.97	–14	–26.9	44	50		
	f3 ± 3.08	f3 ± 3.17	21.5	–21	70	60		
Antennal 3 with q = 2 mm (2nd itr)	f1 ± 0.91	f1 ± 0.990	15.2	–14.2	11	87	81	215
	f2 ± 3.07	f2 ± 2.976	19.4	–17.6	70	50		
		f3 ± 3.168		–18.9		78		

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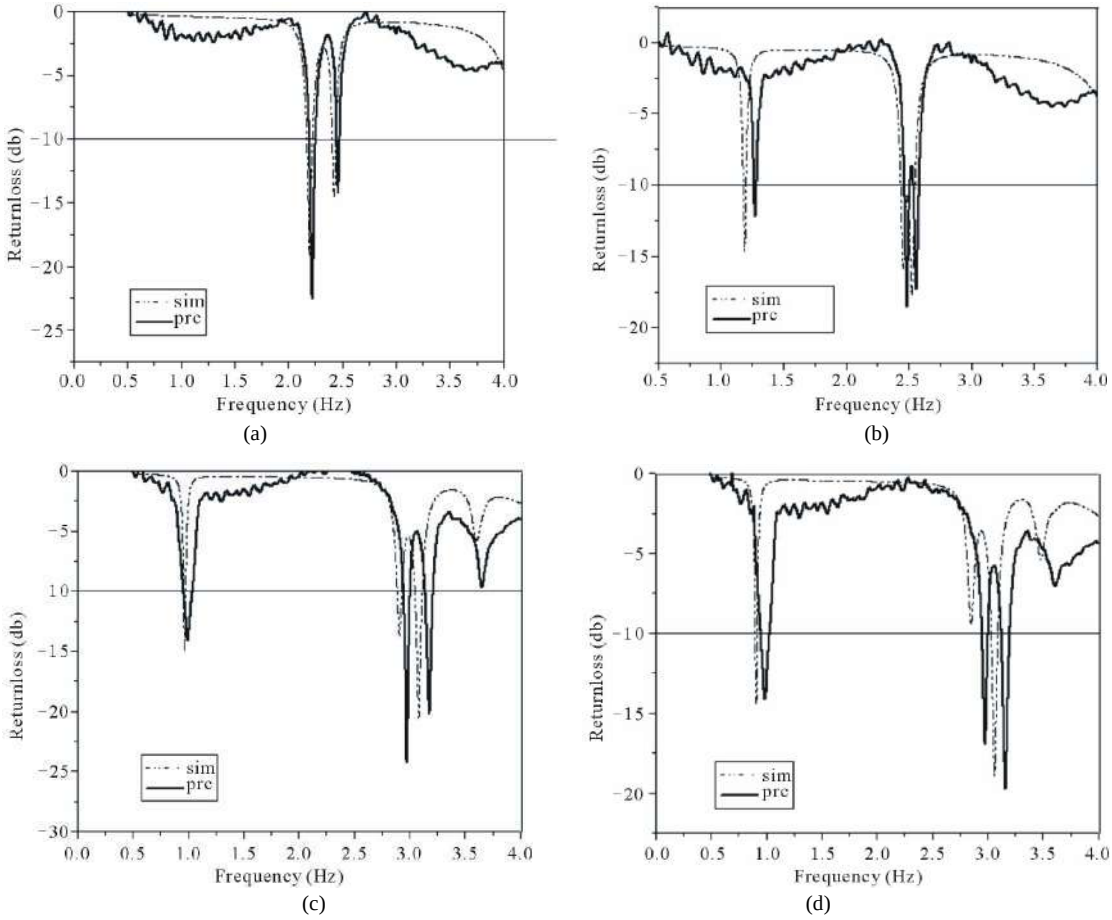

Figure 7. (a) Return loss characteristic of antenna 1 with q = 2 mm; (b) Return loss characteristic of base antenna 2 with q = 2 mm; (c) Return loss characteristic of antenna 2 with q = 2 mm; (d) Return loss characteristic of antenna 3 with q = 2 mm.

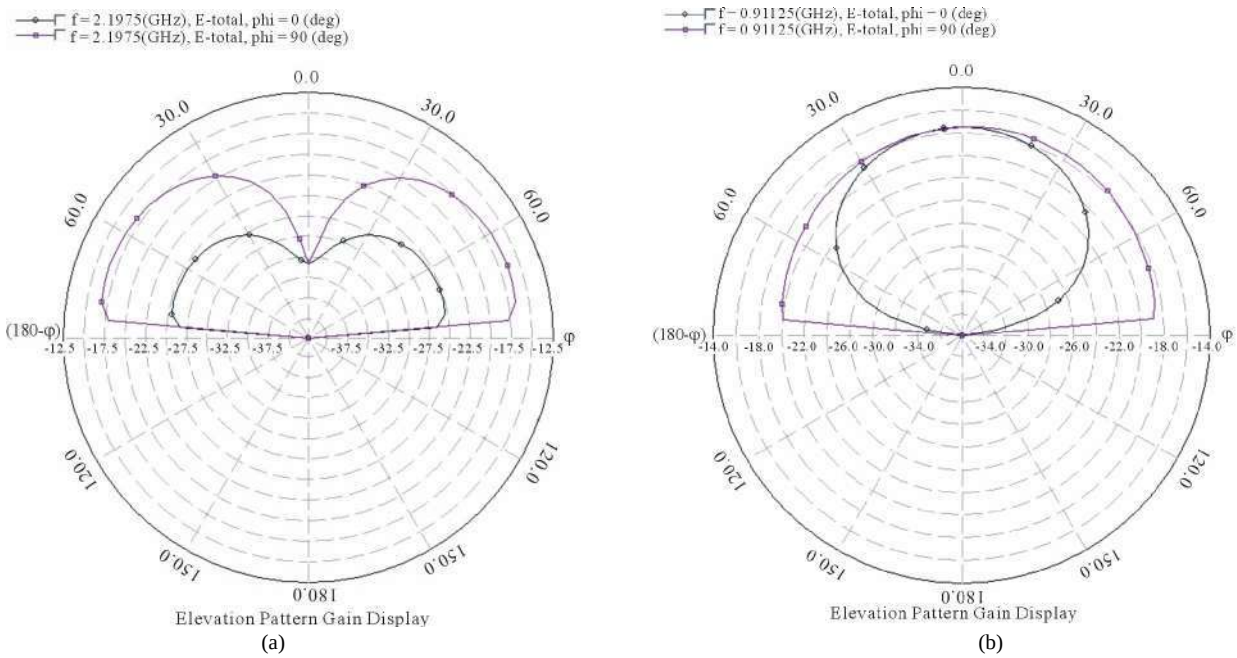

Figure 8. (a) Simulated radiation pattern of base shape at 2.19 GHz; (b) Simulated radiation pattern at 0.91 GHz for second iteration.

slot of first iteration. These antennas may find application in wireless communication systems.

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7

New Antenna Array Architectures for Satellite Communications

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1. Introduction

Ground stations which integrate the control segment of a satellite mission have as a common feature, the use of large reflector antennas for space communication. Apart from many advantages, large dishes pose a number of impairments regarding their mechanical complexity, low flexibility, and high operation and maintenance costs. hus, reflector antennas are expensive and require the installation of a complex mechanical system to track only one satellite at the same time reducing the efficiency of the segment (Torre et al., 2006).
With the increase of new satellite launches, as well as new satellites and constellation of low earth orbit (LEO), medium earth orbit (MEO), and geostationary earth orbit (GEO), the data download capacity will be saturated for some satellite communication systems and applications. Thus, the feasibility of other antenna technologies must be evaluated to improve the performance of traditional earth stations to serve as the gateway for satellite tracking, telemetry and command (TT&C) operation, payload and payload message or data routing (Tomasic et al., 2002). One alternative is the use of antenna arrays with smaller radiating elements combined with signal processing and beamforming (Godara, 1997).
Main advantages of antenna arrays over large reflectors are the higher flexibility, lower production and maintenance cost, modularity and a more efficient use of the spectrum. Moreover, multi-mission stations can be designed to track different satellites simultaneously by dividing the array in sub-arrays with simultaneous beamforming processes. However, some issues must be considered during the design and implementation of a ground station antenna array: first of all, the architecture (geometry, number of antenna elements) and the beamforming process (optimization criteria, algorithm) must be selected according to the specifications of the system: gain requirements, interference cancellation capabilities, reference signal, complexity, etc. During implementation, deviations will appear as compared to the design due to the manufacturing process: sensor location deviation and sensor gain and phase errors (Martínez & Salas, 2010). In an antenna array, the computation of a close approach of the direction of arrival (DoA) and the correct performance of the beamformer depends on the calibration procedure implemented.

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This chapter is organized with the following sections. Section 2, introduces the relationship between applications and antenna design architectures. Section 3, introduces the new antenna array architectures for satellite communication including motivation and explains experimental examples. Section 4, explains adaptive antenna array and receiver architectures for adaptive antennas systems considering the beamforming with synchronization algorithms. Finally, Section 5 explains the A3TB concept.

2. Applications and antenna design architectures

In recent effort, new antenna array architectures have been under analysis and development. In (Tomasic et al., 2002) a highly effective, multi-function, low cost spherical phased array antenna design that provides hemispherical coverage is analyzed. This kind of novel architecture design, as the geodesic dome phased array antenna (GDPAA) presented in (Tomasic et al., 2002) preserves all the advantages of spherical phased array antennas while the fabrication is based on well-developed, easily manufacturable, and affordable planar array technology (Liu et al., 2006; Tomasic, 1998). This antenna architecture consists of a number of planar phased sub-arrays arranged in an icosahedral geodesic dome configuration.

In contrast to the about 10 *m* diameters dome of the GDPAA, there is the geodesic dome array (GEODA) (Sierra et al., 2007) with 5 *m* diameters dome. This antenna, presented in Fig. 1, has two geometrical structure parts. The first one, is based on a cylinder conformed by 30 triangular planar active arrays, and the second is a half dodecahedron geodesic dome conformed by 30 triangular planar active arrays. The GEODA is specified in a first version for satellite tracking at 1.7 GHz, including multi-mission and multi-beam scenarios (Martínez & Salas, 2010). Subsequently, the system of the GEODA has been upgraded also for transmission (Arias et al., 2010).

a b c

Fig. 1. a) The GEODA, b) The active sub-array demonstration, and c) The 45 elements planar active sub-array.

The antenna arrays technology in the user segment for satellite communications will substitute reflectors providing a more compact and easy to install antenna system, which is an interesting solution e.g. for satellite on the move (SOTM) system. There is a great diversity of solutions for fixed and mobile satellite communication systems including a large number of applications. Inmarsat broadband global area network (Inmarsat-BGAN) (Franchi et al., 2000) is the most representative example among mobile satellite systems (MSS), which gives land, maritime and aeronautical high speed voice and data services with global coverage using GEO satellites at L-band.

MSS services are divided into two groups, those that offer a regional coverage usually with GEO satellites, and those which offer a global coverage based on LEO or MEO satellite constellations. Depending on the coverage, there are some examples for MSS with regional coverage as the mobile satellite system (MSAT) in EEUU, Canada and South America, Optus in Australia, N-Star in Japan, Asia cellular satellite (ACeS) in Asia or Thuraya in the Middle East and in the North of Africa. While for MSS of global coverage there are some examples as Iridium, ICO Global Communications, Globalstar, Teledesic, etc. (Evans, 2009; Wu, 1994). Most of the MSSs work at L and S band, new applications on satellite to mobile terminal links work at X, Ku and Ka band, and satellite to base station connections work at L, S and C band. A number of applications is broad and lead terrestrial telecommunications market to offer a wider coverage: high speed voice and data (internet access, SMS, VoIP), digital video broadcasting by satellite 2 (DVB-S2) and digital video broadcasting satellite services to handhelds (DVB-SH), global position system (GPS) and Galileo, security, control and machinery monitoring on ships and aircrafts, teleeducation or telemedicine.

These modern satellite communications systems require new antenna solutions for base stations, aeronautical applications or personal communications services (PCS) on-the-move (Fujimoto & James, 2001). Within these applications, antenna array systems are potentially the best choice due to, as discussed above, its capability to perform electronically steering or beamforming, increase the antenna gain, and conform over curved or multifaceted surfaces the radiating elements. Portable antennas for PCS must be easy to install and mechanically robust, besides compact and lightweight (García et al., 2010) as the antenna array presented in Fig. 4.a. The design of antenna systems to provide high data rates for reliable PCS boarded on ships is not so strict in term of the geometrical requirements because it does not have space limitations (Geissler et al., 2010). However, in the case of land or airborne vehicles, geometrical and mechanical constraints are more severe. Antennas for terrestrial vehicles must be low profile, and for airborne vehicles aerodynamic shapes must be considered (Baggen et al., 2007; Vaccaro et al., 2010). Moreover, for the civil market conformal antenna arrays (Schippers, 2008; Kanno et al., 1996), or multi-surface arrays (Khalifa & Vaughan, 2007) are suitable choices to deal with the system aesthetic partiality.

Technological challenges have been faced during the implementation of satellite communication systems in the last decades. The design of a Test-Bed flexible and modular for testing or debugging beamforming algorithms and receiver architectures is an invaluable contribution in the educational, research and development area on satellite communication systems. The adaptive antenna array Test-Bed (A3TB) concept is based on the use of antenna arrays with beamforming capability to receive signals from LEO satellites (Salas et al., 2008). The scope of the A3TB is to probe the concept of antenna arrays applied to ground stations instead of reflectors for different applications, such as telemetry data downloading. It is also a good chance for Universities and Research Centers aiming to have their own ground station sited in their installations.

The A3TB ground station relies on the use of an antenna array to smartly combine the received signals from the satellite thanks to the implementation based on software defined radio (SDR) technology. The advantages of the SDR implementation is that A3TB architecture can be used to process any received signal from LEO satellites in the band imposed by the radio frequency (RF) circuits. Moreover, most of the processing is performed in software, so that appropriate routines can be used to process any received signal. The A3TB can be used to analyze the feasibility of different receivers and beamformer

algorithms, regarding the capability to switch the receiver architecture in terms of the synchronizer algorithm configuration (Salas et al., 2007).
The current version has been developed to track The National Oceanic and Atmospheric Administration (NOAA) satellites in the very high frequency (VHF) band, in particular, the automated picture transmission (APT) channel (Salas et al., 2008). Previous versions of A3TB dealt with low rate picture transmission (LRPT) signals from the meteorological operational satellite-A (MetOp-A), where a complete receiver with beamforming and synchronization stages has been implemented (Salas et al., 2007; Martínez et al., 2007).

3. Antenna arrays for satellite communications

Satellite applications require compactness, lightweight and low cost antenna systems to be mounted on a terrestrial vehicle, an aircraft or a ship, or as a portable man-pack or a handset, and to be competitive against ground systems. Its major advantage is the possibility of getting a wider or even a global coverage. For such purposes, antenna arrays offer the technology to get a directive system whose steering direction can be electronically and/or mechanically controlled. However, planar arrays usually cannot steer more than 60º-70º from the normal direction of the antenna (Mailloux, 2005). Thus, when a wider angular coverage is required conformal arrays are an appropriate option (Josefsson & Persson, 2006). Arrays can approximate conformal shapes, such as spheres or cylinders, using several planar arrays, simplifying fabrication of active components (Sierra et al., 2007).
Since the low cost and low weight specifications are of importance, micro-strip antennas are mostly used, due to its capacity to be printed over a dielectric substrate with photolithography techniques. Low cost and low permittivity substrates are usually used such as FR4 or PTFE with different quantities of glass or ceramic impurities. For more demanding applications, ceramics, like alumina or high/low temperature co-fired ceramics (HTCC/LTTC) allow the use of smaller components thanks to its high permittivity, and give robustness against mechanical stresses and high temperatures.

3.1 Geodesic antenna array for satellite tracking in ground station

The aim of using a single antenna for tracking many satellites at the same time avoiding mechanical movements as well as its inexpensive cost make these antennas an alternative to be considered (Salas et al., 2008). Multi-beam ability and interference rejection are facilitated thanks to the electronic control system of such antennas that improves the versatility of the ground stations.
The GEODA is a conformal adaptive antenna array designed for MetOp satellite communications with specifications shown in Table 1. This antenna was conceived to receive signals in single circular polarization (Montesinos et al., 2009). Subsequently, in recent efforts the system has been upgraded also for transmission and double circular polarization (Arias et al., 2010). Hence, operating at 1.7 GHz with double circular polarization it can communicate with several LEO satellites at once in Downlink and Uplink. Current structure is the result of a comprehensive study that valued the ability to cover a given spatial range considering conformal shape surface and a given beamwidth (Montesinos et al., 2009). As Fig. 1 shows, GEODA structure consists of a hemispherical dome placed on a cylinder of 1.5 meters height. Both cylinder and dome are conformed by 30 similar triangular planar arrays (panels). Each panel consists of 15 sub-arrays of 3 elements (cells). The radiating element consists of 2 stacked circular patches with their own

RF circuits. The principal patch is fed in quadrature in 2 points separated 90º in order to obtain circular polarization. The upper coupled patch is used in the aim of improving the bandwidth.

Each panel is able to work itself as an antenna since they have a complete receiver that drives the 1.7 GHz signal to an analog to digital converter (ADC). In order to adapt the signal power to the ADC, it is mandatory to implement a complete intermediate frequency (IF) receiver consisting of heterodyne receiver with an automatic gain control block. Hence, each triangular array has active pointing direction control and leads the signal to a digital receiver through an RF conversion and filtering process. To follow the signal from the satellite, the main beam direction has to be able to sweep an angle of 60º. In this way, it is needed a phase shift in the feeding currents of the single radiating element. Previous calculations have demonstrated that 6 steps of 60 degrees are needed to achieve the required sweeping angle. An adaptive digital system allows the adequate signal combination from several triangular antennas. The control system is explained in (Salas et al., 2010).

Parameter	Specification	Parameter	Specification
Frequency range [GHz] **Tx:** **Rx:**	 1.65 to 1.75 1.65 to 1.75	**Isolation between Tx and Rx [dB]**	>20
Polarization	Dual circular for Tx and Rx bands	**VSWR**	1.2:1
G/T [dB/K] **For elevation >30º** **For elevation 5º**	 3 6	**SLL [dB]**	-11
EIRP [dBW]	36	**Size [m]**	1.5x1.5x3
3dB beamwidth [deg.]	5	**Accuracy steering [deg.]**	±1.4
Maximum gain [dBi]	29	**Coverage [deg.]:** **Azimuth** **Elevation**	 360º >5º
Efficiency [%]	50		

Table 1. Main specifications for GEODA antenna.

3.1.1 Cell radiation pattern

Based on the study presented in (Sierra et al., 2007), the single radiating element is a double stacked circular patch that works at 1.7 GHz with 100 MHz bandwidth. In order to obtain circular polarization, the lower patch, which has 90 mm diameter, is fed by 2 coaxial cables in quadrature. Both coaxial cables connect the patch with a hybrid coupler to transmit and

receive signals with both, right and left, circular polarizations. The upper patch is a circular plate with 78.8 mm diameter, and it is coupled to the lower patch increasing the bandwidth by overlapping both resonant frequencies tuning the substrate thickness and the patch diameter size. Fig. 2.a shows the radiating element scheme and main features of the layer structure are specified in (Montesinos et al., 2009).

A cell sub-array of 3 radiating elements shown in Fig. 2.b is considered the basic module to build the planar triangular arrays. The whole cell fulfills radiation requirements since it has a good polar to crosspolar ratio and a very low axial ratio. Likewise, as it is presented in Fig. 2.c, the radiation pattern shows symmetry and low side lobes for full azimuth.

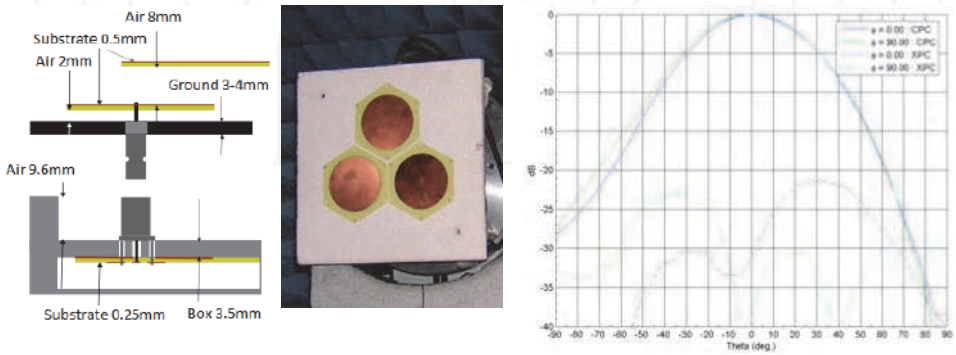

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Fig. 2. a) Assembly of the single radiating element, b) Cell scheme, and c) Cell radiation pattern.

3.1.2 Transmission and Reception (T/R) module and cell distribution

Different T/R module configurations have been considered, providing either single or double polarization (Arias et al., 2010). T/R module allows amplifying and controlling the phase shift between signals, received and transmitted, providing an adaptive beam and steering direction controller in the whole working pointing range. As Fig. 3 shows, the design implemented contains a hybrid coupler, enabling double circular polarization; a double pole double throw (DPDT) switch, selecting polarization associated with transmission and reception way; 2 low noise amplifiers (LNAs), which amplify the signal received or transmitted; a single pole double throw (SPDT) switch, choosing transmission or reception way; and phase shifters, introducing multiples of 22.5º relative shift phases to form the desired beam. These surface mount devices have been chosen in order to reduce space and simplify the design.

Signals transmitted/received by the 3 T/R modules placed in a cell are divided/combined thanks to a divider/combiner circuit composed of 3 hybrid couplers that leads the signal to a general T/R module where signal is amplified. Due to transmission and reception duality, 2 SPDT switches are used to select the amplification way. Furthermore, each T/R module has associated a -25dB directional coupler that is used to test T/R modules in the transmission mode. Additionally, reception mode is tested by measuring signal in the divider/combiner circuit. A single pole 6 throw (SP6T) switch selects the path that is tested.

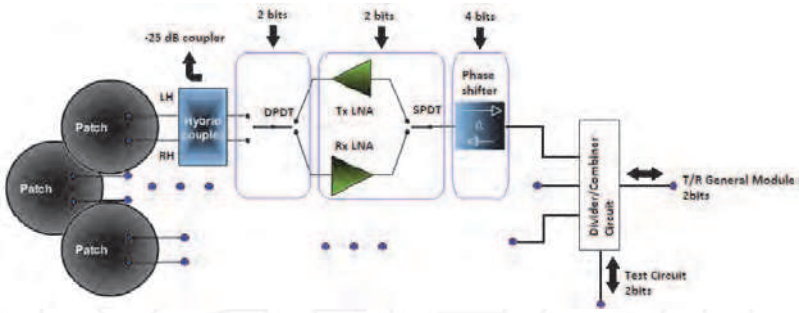

Fig. 3. Cell sub-array and RF circuit.

3.1.3 Control system

The control system has two main parts (Salas et al., 2010), the hardware structure and the control software. The two level hardware structure has the lowest possible number of elements, making the control simpler in contrast to the previous in (Salas et al., 2010). Finally, an inter-integrated circuit (I2C) expander is used to govern T/R modules individually, and one more cover cell needs (LNA of call and test). A multipoint serial standard RS-485 is used to connect the computer with the panels.

3.2 Portable antenna for personal satellite services

New fix and mobile satellite systems (Evans, 2000) require antenna systems which can be portable, low profile and low weight. Planar antennas are perfect candidates to fulfill these specifications. Usually slots (Sierra-Castañer et al., 2005) and printed elements (García et al., 2010) are most used as radiating elements.

3.2.1 Antenna system structure

In this subsection it is introduced a printed antenna for personal satellite communications at X band, in Fig. 4. Table 2 shows main antenna characteristics.

Parameter	Specification	Parameter	Specification
Frequency range[GHz] **Tx:** **Rx:**	 7.9 to 8.4 7.25 to 7.75	**Efficiency [%]**	50
Polarization	Dual circular polarization for Tx and Rx bands	**Isolation between Tx and Rx [dB]**	>17
G/T [dB/K]	7	**VSWR**	1.4:1
EIRP [dBW]	32	**SLL [dB]**	-11
3dB beamwidth [deg.]	5	**Size [m]**	40x40x2.5
Maximum gain [dBi]	25	**Weight [Kg]**	2

Table 2. Portable antenna specifications.

This is a planar, compact, modular, low loss and dual circular polarized antenna, for Tx and Rx bands, simultaneously. It is made up by a square planar array of 16x16 double stacked micro-strip patches, fed by two coaxial probes. A hybrid circuit allows the dual circular polarization (Garg et al., 2001). Elements are divided in 16 sub-arrays excited by a global power distribution network of very low losses, minimizing the losses due to the feeding network and maximizing the antenna efficiency. In order to reduce side lobe levels (SLL), the signal distribution decreases from the centre to the antenna edges, keeping symmetry with respect to the main antenna axes. The antenna works at X band from 7.25 up to 8.4 GHz with a 14.7% relative bandwidth for a 1.4:1 VSWR and a maximum gain of 25 dBi.

3.2.2 Sub-array configuration

The sub-array configuration can be seen in Fig. 4.a. It makes possible to separate the fabrication of these sub-arrays from the global distribution network, simplifying the corporative network and getting a modular structure suitable for a serial fabrication process. Each sub-array is a unique multilayer board, where PTFE-Glass substrate of very low losses has been used as base material. The power distribution network is connected to each sub-array through (SMP-type) coaxial connectors.

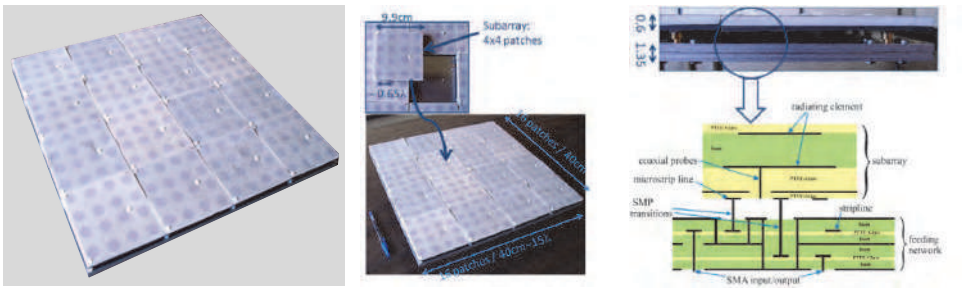

a b c

Fig. 4. a) Dual polarized portable printed antenna for satellite communication at X band, b) Sub-array perspective view, and c) Side view and multilayer scheme.

Fig. 5.a and Fig. 5.b show the sub-array unit cell. In order to obtain better polarization purity, each element is rotated 90º and excited by a 90º phase-shifted signal. Moreover, in Fig. 5.c is showed a miniaturized branch-line coupler (BLC) of three branches working as a wide band hybrid circuit (García et al., 2010; Tang & Chen, 2007).

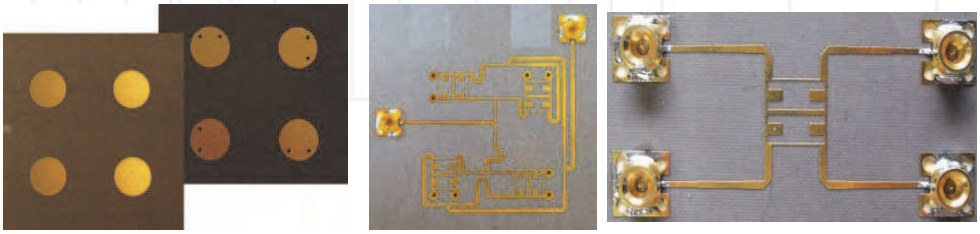

a b c

Fig. 5. Unit cell test board, a) Unit cell test board 2x2 stacked patches, b) Micro-strip feeding network, and c) Miniaturized BLC Prototype.

A conventional configuration takes up an area of 13.3 cm² which is big compared to the radiating element and the sub-array subsystem size. Therefore, a miniaturization of the BLC is needed using the equivalence between a λ/4 transmission line and a line with an open-ended shunt stub. An area reduction about 35% is achieved and the hybrid circuit behaves like a conventional BLC. In Fig. 6.b and Fig. 6.c measurement results for the BLC in Fig. 5.c are shown compared with simulations.
Fig. 7 depicts some sub-array measurements. The copular to crosspolar ratio is better than 25 dB and axial ratio is under 0.9 dB in the whole bandwidth.

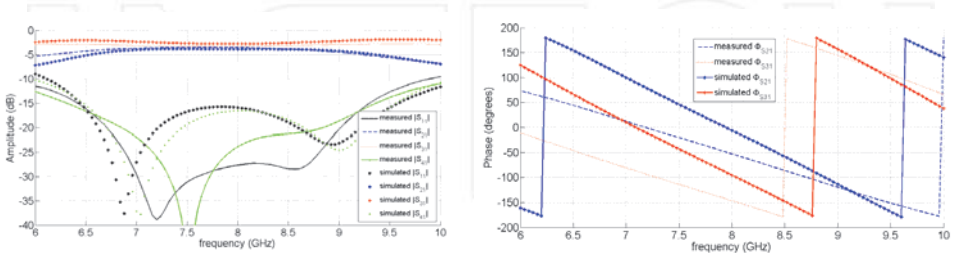

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Fig. 6. Miniaturized BLC, Measured and simulated S-parameters in: a) Amplitude, and b) Phase.

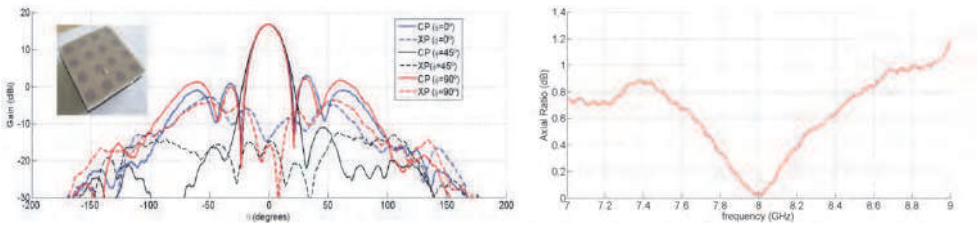

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Fig. 7. 4x4 patch sub-array measurements, a) Radiation pattern at 7.75 GHz, and c) Axial ratio for right-handed circular polarization.

3.2.3 Low losses power distribution network

The global feeding network presented in Fig. 8.a is a protected strip-line, where foam sheets of high thickness are used to get low losses. Such a kind of feeding network allows keeping a trade-off between the simplicity of exciting the radiating elements using printed circuits and the loss reduction when the distribution network is separated in a designed structure to have low losses. Losses in the structure are around 0.6 dB/m which yields to 0.3 dB of losses in the line. Two global inputs/outputs using SMA-type connectors, one for each polarization, excite the strip-line networks.
Vertical transitions have to be treated carefully and must be protected to avoid undesired higher order mode excitation. Thereby, it has been design a short-ended pseudo-waveguide, adding some extra losses about 0.3 dB, for two kinds of vertical transitions, as can be seen in Fig. 8.b and Fig. 8.c.

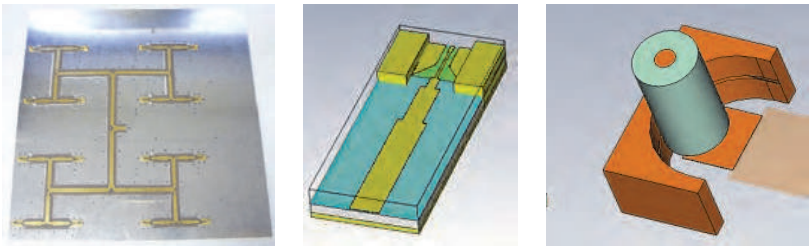

a b c

Fig. 8. a) Protected strip-line global corporative network for one polarization, b) Transitions from strip-line to SMA-type connector, and c) Transitions from strip-line to SMP-type connector.

3.2.4 Antenna performance

Fig. 9 depicts measured radiation pattern at 7.75 GHz, gain and axial ratio for the antenna system. It is shown a maximum gain of 25 dBi in the lower band and about 22 dBi in the upper band, and a SLL around 11 dB. Copolar to crosspolar ratio is better than 30 dB and axial ratio is under 0.7 dB. Total losses are about 4 dB in the working band.

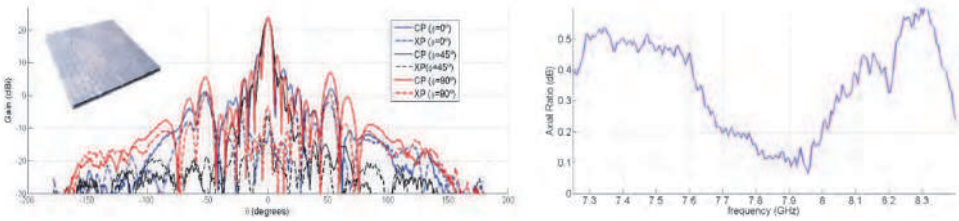

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Fig. 9. Antenna measurements results, a) Radiation pattern at 7.75 GHz, and c) Axial ratio for right-handed circular polarization.

3.3 Electronically steerable antennas for mobile and fixed portable systems

At present, two types of electric steerable antenna systems can be used to access the satellite communication services (Bialkwoski et al., 1996). These are: fixed position portable systems and mobile systems such as those installed on a land vehicle. The fixed portable antenna system is relatively easy to be accomplished by the antenna designer. The design involves standard procedures that concern the operational bandwidth, polarization and moderate gain (García et al., 2010). One drawback of the fixed position portable system is that they require the user to be stationary with respect to the ground. This inconvenience can be overcome with the mobile antenna system. A mobile user complicates the scenario since the ground mobile antenna needs to track the satellite (Alonso et al., 1996). The design of such a system is more challenging as new features associated with the mobility of the system have to be incorporated (Fernández et al., 2009). The requirement leads to a narrow beamwidth, for which satellite tracking is required as the vehicle moves around. Electronically steerable antennas enable the development of reconfigurable antennas for satellite applications.

3.3.1 Steerable antenna for fixed position portable systems

This antenna is a fixed satellite communication system with high gain at X band, consisting of an antenna array that integrates 32 2x2 sub-array modules in the complete antenna, as shown in Fig. 10.a. It is a planar and dual circular polarized antenna for Tx and Rx bands simultaneously. It is made up by a planar array of double stacked circular micro-strip patches, fed by 2 coaxial probes to generate circular polarization. A hybrid circuit allows the dual circular polarization as shown in Fig. 10.b.

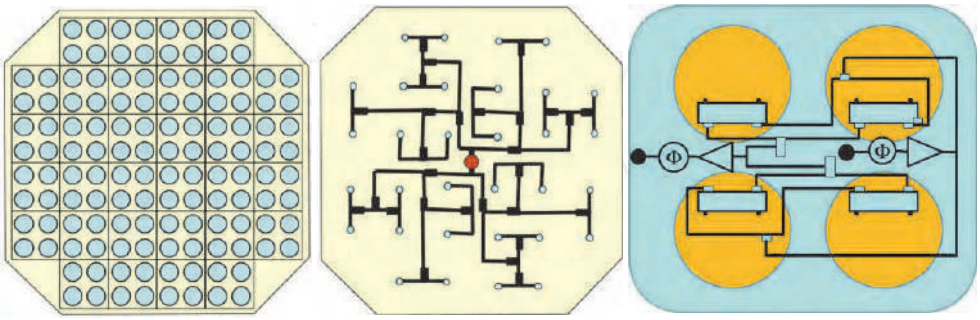

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Fig. 10. Active multi-beam antenna, a) Top view, b) Feeding network of the complete antenna, and c) Beamforming network of the 2x2 sub-array module

The antenna has the same design parameters, structure and configuration as the antenna explained in Section 3.2 but with a different feeding network, as previously shown. In this case, the beamforming network requires changes in the feeding phase in the 2x2 sub-arrays, which can be achieved by phase shifters (ϕ) associated with different sub-arrays (Fig. 10.c). All these sub-arrays are connected to a feeding network, in Fig. 10.b, formed by transmission lines with low losses in strip-line. General specifications of the steerable antenna for fixed position portable systems are provided in Table 3.(a).

3.3.2 Automatic steerable antenna for mobile systems

A broadband circularly polarized antenna for satellite communication in X band is presented in Fig. 11 and specified in Table 3.(b). The arrangement features and compactness are required for highly integrated antenna arrays. It is desired to get a low-gain antenna for mobile satellite communications with low speed of transmission. In this system, the antennas are formed by 5 planar 4x4 arrays of antennas, which form a truncated pyramid with a pointing capability in a wide angular range, so that among the 5 planar arrays the complete antenna can cover any of the relative positions between the mobile system and the satellite in a practical way. The scheme of the active antenna can be seen in Fig. 11.

As it can be observed in Fig. 11.a, the antenna terminal is a multi-beam printed antenna shaped as a trunk pyramid capable of directing a main beam in the direction of the satellite. The antenna steering system consists of a multi-beam feeding structure with switches that lets combine the feed of each 4x4 arrays to form multiple beams. Switching the different 4x4 arrays, it is achieved different multiple beams and the variation of the steering direction.

The complete antenna consists of a Tx and Rx module that works independently in the 2 frequency bands.
The antenna has multiple beams covering the entire space to capture the satellite signal without moving the antenna. The signal detected in each of the beams is connected to a switch, which, by comparison, is chosen the most appropriate 4x4 array. The steering direction of the 4x4 array can vary between a range of directions that covers a cone angle range of 90º. To obtain the required gain and cover the indicated range, it is required around 15 beams, which can be obtained by integrating the beamforming networks with switches in the design as presented in (Fernández et al., 2009).

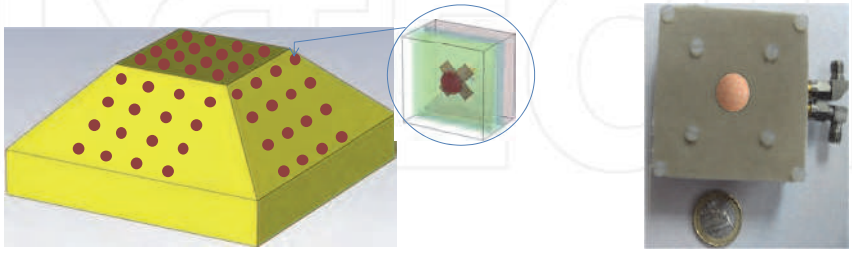

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Fig. 11. Complete antenna structure, a) Radiating element of the 4x4 arrays, and b) Prototype top view.

The radiating element of the 4x4 array is one 2 crossed dipoles with a stacked circular patch as shown in Fig. 11.a and Fig. 11.b. In Fig. 12 the cross-section of the radiating element structure is presented.

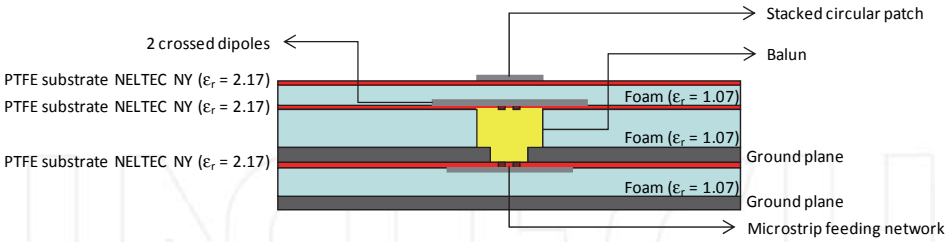

Fig. 12. Cross-section scheme of the radiating element.

The key element of the radiating element feeding structure (Fig. 14.b) is a resonant micro-strip feed ring that has been implemented, as well as a micro-strip 90º branch-line coupler to obtain the desired right hand or left hand circular polarizations (RHCP or LHCP) which ensures adequate port coupling isolation. The S-parameters in amplitude and phase of the micro-strip feeding structure are shown in Fig. 13.a and Fig. 13.b.
Fig. 14.a depicts the S-parameters of the radiating element with the micro-strip feed structure and they fulfill the specification, in Table 3.(b). In Fig. 14.c, the radiation pattern of the radiating element at 7.825 GHz is shown and in Fig. 14.d the radiation pattern of the 4x4

arrays is presented. It is shown a maximum gain of 19.4 dBi at the center frequency band (7.825 GHz). Copolar (CP) to crosspolar (XP) ratio is better than 17 dB and the axial ratio is under -3dB.

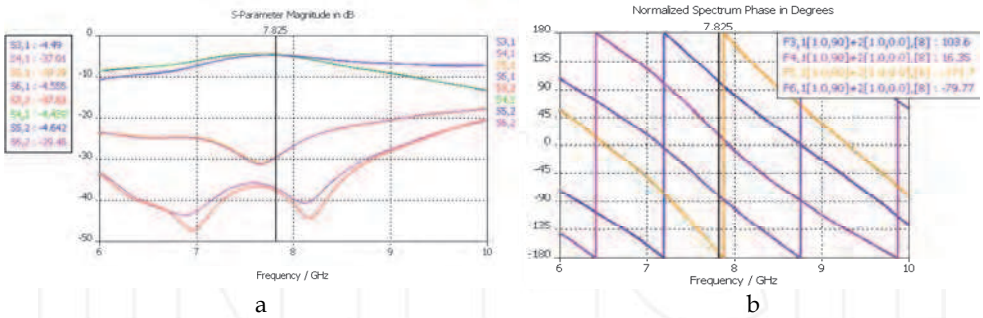

Fig. 13. Micro-strip feeding structure, a) Amplitude of S-parameters, and b) Phase of S-parameters.

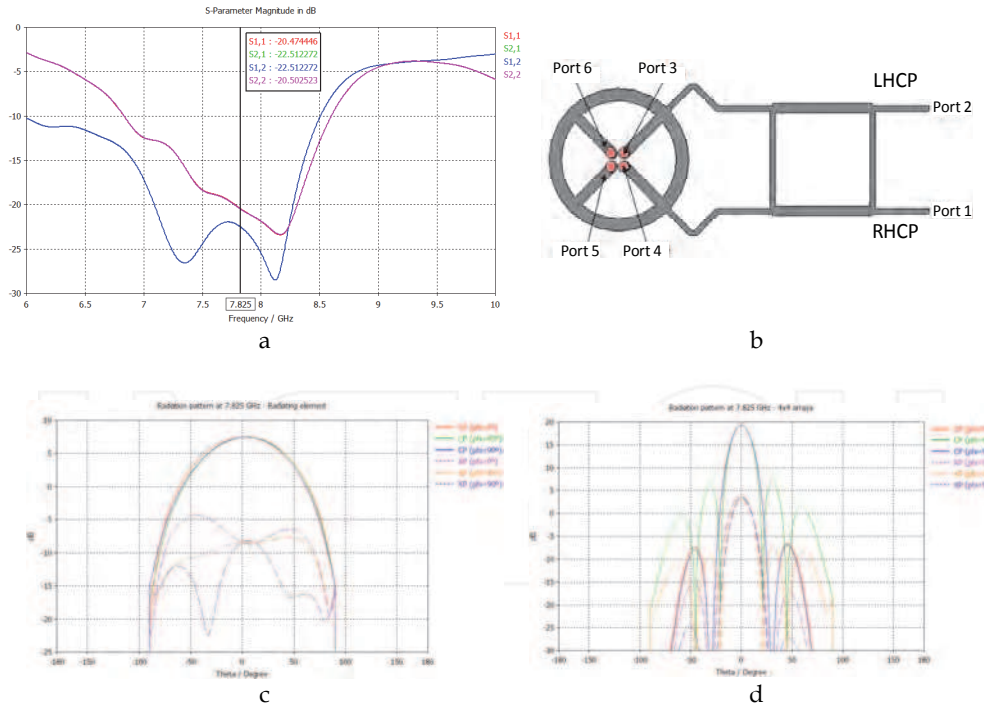

Fig. 14. a) S-parameters, b) Resonant ring + 90º branch-line coupler, c) radiation pattern at 7.825 GHz, and d) 4x4 array radiation pattern.

Parameter	Value (a)	Value (b)	Comments
Freq. range [GHz] **Rx** **Tx**	7.25 - 7.75 7.9 - 8.4	7.25 - 7.75 7.9 - 8.4	Microwave applications.
G/T (in Rx) [dB/K]	7	7	
EIRP (in Tx) [dBW]	32	32	
Beamwidth at -3dB [deg.]	4	20	
Polarization	circular	circular	In both, reception and transmission.
Gain [dBi]	>28	>15	
Axial ratio [dB]	< 1	<3	**(a)** Between ±50º. **(b)** Between ±45º.
VSWR	< 1.4:1 (-15.6 dB)	< 1.5:1 (-13.9 dB)	
Isolation between ports [dB]	< -17	< -15	
Radiation pattern [deg.]	±35	±90	Steering direction tilt.
Dimensions [cm]	40x40x4	20x20x15	

Table 3. (a) General specifications of the steerable antenna for fixed position portable systems , and (b) General features of the automatic steerable antenna for mobile systems.

3.4 Transmit-array-type lens antenna for terrestrial and on board receivers

Technology in satellite communications has revealed an increasing interest in novel smart antenna designs. Phased-array based designs are basic in electronically reconfigurable devices for satellite applications, which are more and more demanding. The strict requirements in terms of architecture, shape and robustness are important constraints for the development of planar lens-type devices. Regarding the usage and location, lens-type devices are useful for either terrestrial or on board receivers, in vehicular technology. Some clear examples are satellite communications for aircrafts preserving the fuselage aerodynamics or for some other kind of vehicles such as trains, etc.

3.4.1 Introduction to lens-type structures

In a general view, in lens-type a particular signal is received (in our case, an electromagnetic wave with specific features in terms of frequency, wave-front, etc.), it is processed (either complex signal processing techniques or only phase correction tasks can be considered in this interface), and finally, the processed signal is retransmitted.

Regarding the lens configuration, a transmit-array lens consists of three well distinguished interfaces: the first one for signal reception, one interface for signal processing, and the last one for processed signal re-radiation, as depicted in Fig. 15.

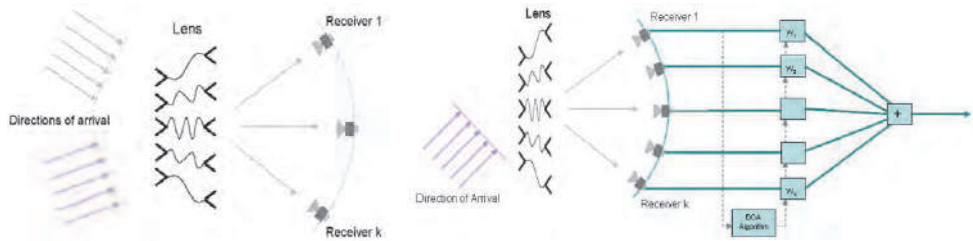

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Fig. 15. a) Multi-user scheme with different receivers and transmitters, and b) Adaptive scheme with DoA determination.

These structures are intimately related to reflect-array ones, where the reception and transmission interfaces are turned to be the same interface, with a reflection-type behavior (Encinar & Zornoza, 2001). Although in an equal output phase configuration a transmit-array device behavior would be similar to the one obtained with a reflect-array, the transmit-array offers the advantage of removing the feed blockage.
In a transmission scheme, depending on the transmitter position regarding the lens, a different steering direction is achieved and a different user is pointed. In the case of reception, the situation is the same: the user position configures the direction of arrival, which determines the receiver position around the lens (Padilla et al., 2010a). In adaptive schemes, applying the proper processing algorithm to the signal received in the different receivers around the lens, it is possible to develop an adaptive steering vector, in terms of the desired direction of arrival.

3.4.2 Transmit-array lens architecture and design

Lens-type structures provide two fundamental advantages. First, phase error correction due to spherical wave front coming from the feeding antenna. Fig. 16.a shows this effect. Second, new radiation patterns configuration. Fig. 16.b depicts this fact.

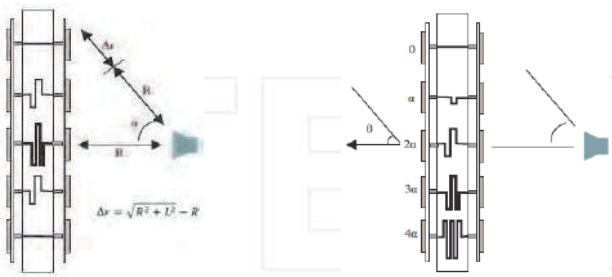

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Fig. 16. a) Phase error correction, and b) Radiation pattern reconfiguration.

3.4.3 Electronically reconfigurable devices for active transmit-array lenses

The addition of reconfigurability on transmit-array devices requires the possibility of controlling the phase response of the transmitted signal at each cell of the lens. Electronic control of phase signal may be added in two different ways: First, electronic tuning of the

radiating element phase response (Padilla et al., 2010a): Modifications in the radiating element circuital behavior lead to changes in phase response (arg[S_{21}]). Fig. 17 shows an electronically reconfigurable microwave patch antenna for this purpose, along with the equivalent circuit and prototype outcomes in terms of phase.

Second, electronic tuning of phase shifters in transmission lines (Padilla et al., 2010c): Modifications in the phase response of the phase shifters lead to corresponding changes in phase response. Some options are applied for these devices, such as hybrid couplers, etc. Fig. 18 shows a microwave phase shifter prototype for this purpose, along with the working scheme and its outcomes in phase.

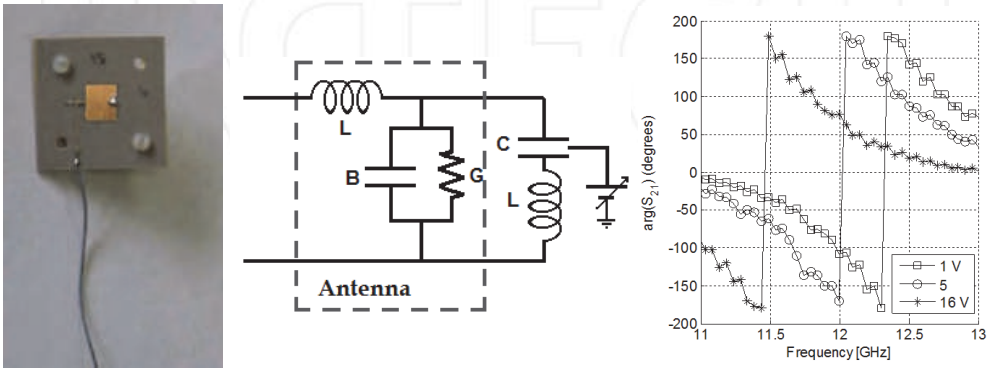

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Fig. 17. Electronically reconfigurable antenna, a) Patch antenna prototypes, b) Equivalent circuit, and c) Phase behavior in frequency.

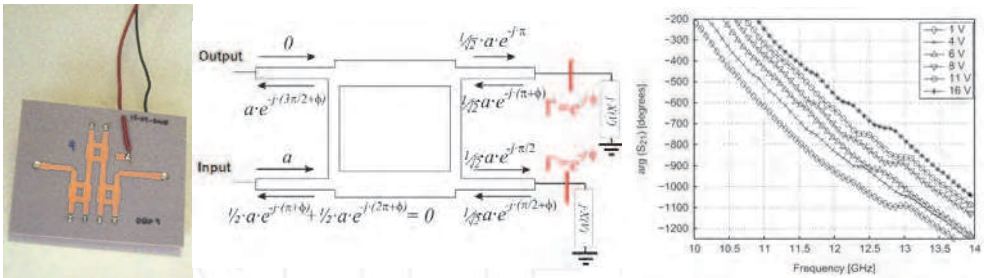

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Fig. 18. Electronically reconfigurable phase shifter, a) Phase shifter prototype, b) Working scheme, and c) Phase behavior in frequency.

3.4.4 Electronically reconfigurable active transmit-array prototype

One electronically reconfigurable prototype is presented in Fig. 19 and detailed in this section. The prototype design implies the use of microwave phase shifters according to the design specified in section 3.4.3. This transmit-array lens prototype operates at 12 GHz. Main specifications are provided in Table 4.

Parameter	Value	Comments
Frequency range [GHz]	12 ± 0.5	Microwave applications.
Polarization	Linear	In both, reception and transmission.
Directivity [dBi]	>21	
Axial ratio [dB]	< 1	Between ±50º elevation.
S_{11} [dB]	< -20	
Radiation pattern [deg.]	±30	Steering direction tilt, for both H and V planes.
Feeding antenna [mm]	120	Corrugated horn linearly polarized
Phase shifters [deg.]	360	Full phase range variation.
Transmit-array elements	36	6x6 array topology.
Separation between elements	$0.7\lambda_0$	Related to the wavelength

Table 4. Main features of the electronically reconfigurable transmit-array prototype.

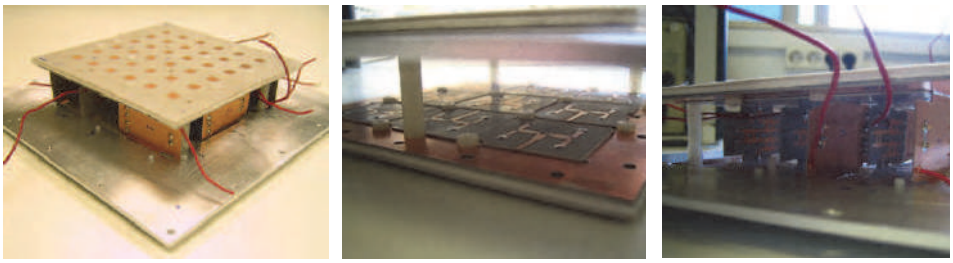

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Fig. 19. Transmit-array core, a) Transmit-array prototype, b) Distribution networks, and c) Phase shifter integration.

The electronically controllable steering capabilities are tested and assured for a range of ± 30ºin each main axis. An example of radiation pattern is provided in Fig. 20, for 9º tilt in one of the main axes.

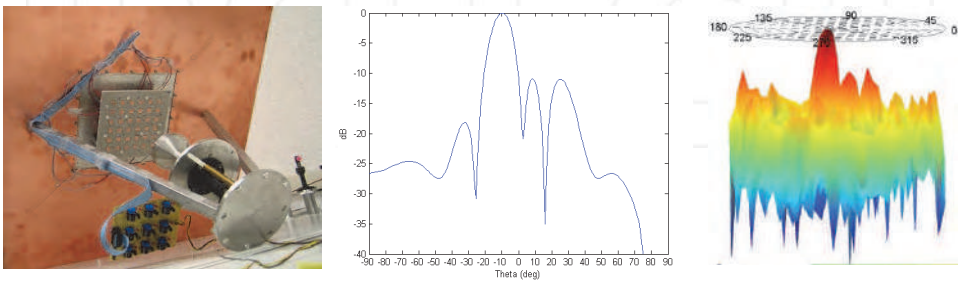

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Fig. 20. a) Complete transmit-array with feeder and control circuits; and transmit-array measurement results for 9º tilt in one axis, b) H plane, and c) 3D plot.

4. Adaptive antenna array

Adaptive antennas can be described as systems usually based on three main parts: the antenna array, the receiver architecture and the beamforming scheme. Thus, adaptive antennas have those advantages owing to those three main parts. The system capabilities increase as complexity and development cost do. Furthermore, since signal processing is the basement of the adaptive antenna concept it is important to analyze the design challenges in terms of hardware architecture and components such as processors and embedded systems.
The antenna array provides the capability of performing the antenna pattern meeting the environment requirement under study. Besides, receiver architectures have some interesting advantages depending on the implemented receiver arraying technique such as signal to noise ratio (SNR) and bit error rate (BER) performance enhancement. Furthermore, symbol synchronization and carrier recovery can be used increasing the receiver complexity but providing higher performances. Finally, beamforming schemes use multiple antennas in order to maximize the strength of the signals being sent and received while eliminating, or at least reducing, interference as discussed in Section 4.3.
Adaptive antenna arrays are often called Smart Antennas because they have some key benefits over traditional antennas, by adjusting traffic patterns, space diversity or using multiple access techniques. The main four key benefits are: First, enhanced coverage through range extension by increasing the gain and steering capability of the ground station antenna; Second, enhanced signal quality through multi-target capability and reduction of interferences; finally, adaptive antennas improve the data download capacity in the ground segment of satellite communication by increasing the coverage range (Martínez et al., 2007).

4.1 Design and architecture based on software defined radio

For design there is the well known waterfall life cyclic model (Royce, 1970) that can be used to manage main aspects of the design of architectures. Thus, some tasks must be fulfilled subsequently as follow in Fig. 21.a.
Fig. 21.b shows the design schemes resulting of the requirement analysis stage corresponding software and hardware system specifications. In the depicted scheme, there are some system components such as the radiating element and RF circuits that are often designed under iterative prototyping model.

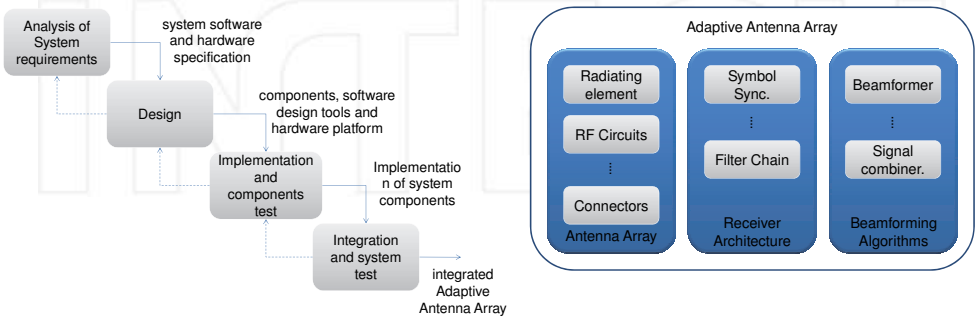

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Fig. 21. a) Water life cyclic model of the adaptive antenna array design, and b) Simplified design scheme of adaptive antenna arrays.

Regarding the hardware implementation, tables presented in (Martínez et al., 2007) show the hardware resource consumption in the field programmable gate array (FPGA) Virtex-4 for the least mean squared (LMS) beamforming algorithm with full spectrum combining (FSC) receiver architecture and SIMPLE beamforming algorithm with symbol combining (SC) receiver architecture. Both scheme designs have an antenna array of 2 elements. The algorithm based on correlation requires less hardware. The main difference can be appreciated in the amount of digital signal processing oriented component (DSP48) resources, typically used for filtering applications (Martínez et al., 2007).

4.2 Receiver architectures based on algorithms type

Several receiver architectures can be implemented, and they are frequently based on the type of the beamforming algorithm used. When training signals are available in the transmitted frame, a time-based reference algorithm can be used. However, this solution is only valid when the earth station is capable of demodulating the received training sequence. Other algorithms used in deep space communications are based on signal correlation and they avoid performing the demodulating process. This kind of algorithms are blind techniques that do not require any additional signal demodulation before applying some beamforming technique and work better in low SNR conditions than time-based algorithms. Several receiver architectures can be implemented exploiting the processing capabilities of the SDR, such as FPGA, application-specific integrated circuits (ASICS), and digital signal processing (DSPs). The design of the receiver architecture fundamentally depends on the selection of beamforming algorithms. An example of beamforming technique is the LMS algorithm whose estimation of coefficients or weights requires a temporal reference and is implemented through SC receiver architecture (Fig. 22.a). In the other hand, the SIMPLE algorithm (Rogstad, 1997) constitutes a beamforming technique that is implemented using FSC receiver architecture (Fig. 22.b) in order to perform the calculation of weights.

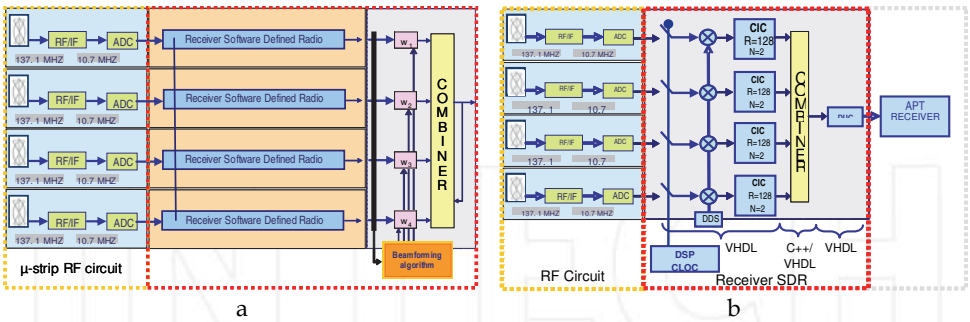

Fig. 22. Comparison of receiver architectures. a) Symbol Combining (SC), and b) Full Spectrum Combining (FSC).

The SC architecture can be divided into two more sub-classes which work on a phase-recovery basis. The complex symbol combining (CSC) recovers the phase information with regard to a reference element using feed-forward and feedback algorithms. One of the advantages of this scheme is that the rate of data sent to the combining module has a rate slightly higher than the symbol rate. For most applications, the symbol rate is relatively low and is a multiple of the data rate. In this kind of schemes, there is an important cost

consideration in real-time applications and the requirements of instrumental phase stability are very severe (Rogstad et al., 2003). Other type of SC architecture is the stream symbol combining (SSC). In this kind of scheme, data are sent to the combining module at a rate equal to the symbol rate. The symbol rate depends on the coding scheme and for most applications is relatively modest. Also, the requirements of instrumental phase stability are no severe, as in the case of CSC scheme. The disadvantage of the SSC is the additional hardware required for each antenna.

Furthermore, there are the baseband combining (BC) and carrier arraying (CA) architectures discussed in (Rogstad et al., 2003). In BC architectures the signal from each antenna is carrier locked and combining in baseband for further demodulation and synchronization. In effect, the carrier signal from the spacecraft is used as a phase reference so that locking to the carrier eliminates the radio-frequency phase differences between antennas imposed by the propagation medium. Besides, in CA architectures, one individual carrier-tracking loop is implemented on each array element. Then, the elements branches are coupled in order to increase the carrier-to-noise ratio (CNR), but losses of radio channel are far compensated (Rogstad et al., 2003).

In general, the selection of the beamforming algorithms is determined by the following aspects: Hardware and computational resources; Speed of convergence and residual error of adaptive algorithms; Calibration requirements and auto-compensation ability; and system signal-transmission characteristics.

4.3 Beamforming techniques for satellite tracking

Some satellites transmit useful information inside its frames for synchronization and tracking purposes. The gathering of satellite data requires the tracking operation along its earth orbit. To accomplish this goal with adaptive array architectures, some beamforming techniques should be implemented. Fig. 23 illustrates a simple example of a narrowband linear adaptive beamformer system.

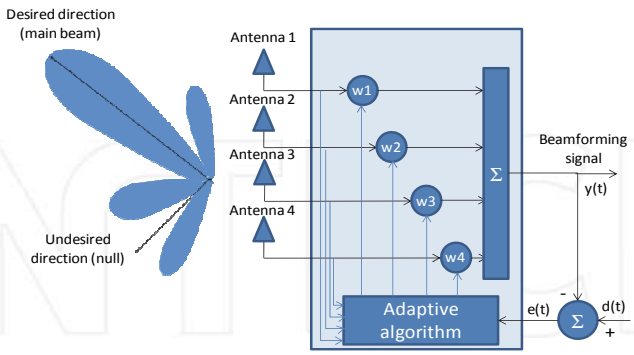

Fig. 23. Adaptive antenna system.

A linear beamformer combines signals according to some weights w_i, to produce a desired radiation pattern. The mathematical expression of a linear beamformer at the array output in vector notation can be expressed as $y = w^H x$, where x is the received signal vector to be combined, w are the weights computed by the beamforming algorithm and ^{H} denotes transposition and conjugate of $(\cdot)$.

In adaptive antennas design, weights are dynamically calculated with a certain algorithm in order to optimize some signal parameter like signal to interference-plus-noise ratio (SINR), SNR, or BER. An extended variety of algorithms exist in the literature for beamforming purpose and the most appropriated selection is done depending on the signal characteristics of the received signal.

4.3.1 Blind techniques

Blind beamformers make use of an inherent property of the received signal, such as the ciclo-stationarity of the constant modulus. In the latter, the algorithm eliminates the fluctuation of the signal amplitude and computes the weights to minimize the effect produced by those variations. The algorithms that make use of these methods are denoted as Constant Modulus Algorithms (CMA) (Biedka, 2001).

CMA algorithms present an important disadvantage: as the phase information is not considered, the constellation of quadrature phase shift keying (QPSK) signals commonly used in satellite communications appears rotated after beamforming, which imposes the need of an additional phase recovery subsystem in the array output.

4.3.2 Temporal-reference algorithms

Algorithms based on a temporal reference require a known reference included in the frame of the signal, such as training sequences, unique word (UW) or pilot bits. Thus, these schemes are normally used for digital signals. The aim of these beamformers is the minimization of the energy of an error signal integrated by interferences and noise. In order to reduce the order of the problem, the weight calculation is usually done iteratively.

The most popular adaptive filters are the LMS and Recursive Least Squares (RLS) algorithms (Haykin, 2002). Briefly, the main differences lie in the method to calculate and the final convergence behavior: while LMS has a linear complexity order with the number of antennas in the array, RLS makes use of matrix operation, so that the complexity order is quadratic, but the convergence is faster.

An interesting alternative to the LMS is the Normalized LMS (NLMS), which normalizes the adaptive step to avoid variation during the convergence process. The counterpart is the more intensive processing requirements to calculate signal power and normalization operation.

4.3.3 Correlation-based algorithm

In contrast to beamformers based on temporal reference, schemes based on signal correlation do not require the demodulation of any signal. These techniques are the most popular to extract the spatial information for beamforming, and we have focused on the use of the SIMPLE algorithm (Rogstad, 1997). This algorithm has been used by the Deep Space Network (DSN) of National Aeronautics and Space Administration (NASA) to combine the signals received from spatial probes in radio telescopes located in different sites around the Earth surface. The main disadvantage of correlation based schemes is the lack of ability to cancel interference signals.

4.4 Performance comparison

Some simulation comparisons between spatial and blind algorithms are presented to show benefits and drawbacks. Four algorithms have been selected with a 4-element uniform linear

array (ULA). The spatial algorithms simulated are post-beamformer interference canceller – orthogonal interference beamformer (PIC-OIB) (Godara, 2004) and minimum power distortionless response (MPDR) (Van Trees, 2002). On the other hand, the blind algorithms are the matrix-free EIGEN and the SUMPLE (Rogstad, 1997). The convergence process is compared as a function of the input SNR as depicted in Fig. 24.
As it can be observed from the above results, spatial algorithms outperform blind ones at low SNR, and vice versa. On the other hand, with medium-low SNR and low or absence of interferences, the behavior of all algorithms is quite similar.

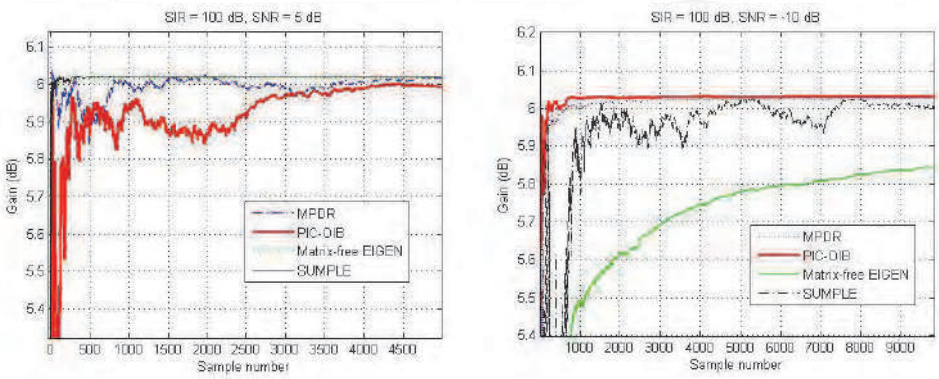

a b

Fig. 24. Convergence behavior of spatial versus blind algorithms in the absence of interferences with several input SNR. a) SNR = 5 dB, and b) SNR = -10 dB.

5. Experimental Test-Bed based on SDR platform

This section presents a test platform known as Adaptive Antenna Array Test-Bed - A3TB, where a comparative study of several beamforming algorithms can be performed and modularity of the architecture is a well proved advantage. The test bed is based on SDR technology and uses a novel architecture that can be used with both blind and spatial-based beamforming algorithms. The A3TB concept can be applied to a number of scenarios as the current version is independent of the signal properties. Simulation results using the A3TB with the APT channel from NOAA satellites show the performance of the concept and the feasibility of the proposed implementation.
The scope of the system development was is to prove the concept of antenna arrays applied to ground stations instead of reflectors for different applications, such as telemetry data downloading or end-user in mobile applications as discussed in the introduction section. In contrast to reflector antennas, antenna arrays offer the possibility of electronic beam-steering avoiding the use of complex mechanical parts and therefore reducing the cost of the antenna. It is also a good chance for Universities and Research Centers aiming to have their own ground station sited in their installations.

5.1 A3TB concept

The A3TB can be defined as *a software-defined radio beamformer applied to a ground station for tracking LEO satellites*. The novelty relies on the use of an antenna array to smartly combine

the received signals from the satellite and its implementation based on SDR technology. The reason to use an antenna array instead of a single antenna is to electronically steer the beam in the direction of the satellite along its orbit without requiring a mechanical system for tracking. In addition to the advantages of the use of SDR technology and antenna array, it is the modularity and flexible architecture implemented in the A3TB. Fig. 25 shows the A3TB architecture where it is evident the feasibility to update or change during operation any of the main blocks. It is possible to change during operation the beamforming algorithm and to include new beamforming modules to the system. Furthermore, changes on the BENADC are possible to implement not during operation, but new receiver architecture at off-line such as those options discussed at follow.

In (Salas et al., 2007), the block diagram represents the software system implementation of the first version of the test-bed prototype and most of it is based on VHDL. Depending on the firmware, three options could be installed into the FPGA Virtex4. The option A is implemented with the signal processing on the PC, so the SIMPLE beamforming is done in the module developed in C++. The option B is implemented completely on VHDL and this option need to export the beamforming weights just to draw the array pattern diagram. Finally, in contrast to the option B, the option C is implemented for the LMS beamforming algorithm.

With the first version of the Test-Bed, the modularity on the selection of firmwares was proved switching between A, B or C receiver architectures, and an important result of the Test-Bed development is the hardware resources occupation presented in (Salas et al., 2007).

The advantage of the SDR implementation is that A3TB architecture can be used to process any received signal from a LEO satellite in the appropriate band imposed by the RF stages. Moreover, most of the processing tasks are performed on software, using appropriate routines to process any receive signal. There are 2 main schemes to implement the beamforming stage: SC and FSC [41]. Both schemes are compared in Section 4.2.

The current version of the A3TB in Fig. 25.a was updated to track NOAA satellites in the VHF band, in particular the APT channel. Previous versions of A3TB dealt with LRPT signals from MetOp-A, where a complete receiver with beamforming and synchronization stages has been implemented(Salas et al., 2007; Martínes et al., 2007).

5.2 Implementation of the A3TB

The A3TB prototype consists of 4 main parts as shown in Fig. 25.a. The first part is the antenna array, which has 4 crossed-dipole antennas as depicted in Fig. 25.b. The second part consists of RF-IF circuits which amplify and down convert to IF incoming signals. Furthermore, an automatic gain control (AGC) was implemented using two steps of variable attenuators in the IF domain.

The third part is the SDR platform which consists of the beamforming algorithms implemented on C++ and the FPGA firmware on VHDL, PC and BENADC blocks show in Fig. 25, respectively. The hardware resources occupation for this Test-Bed implementation is similar to one presented in (Martínes et al., 2007). The last part is the software from weather satellite signal to image decoder (WXtoImg) on the PC using the sound card output/input in order to get the weather satellite image.

Since the implemented architecture is FSC the demodulation is not required and the IF signal is digitized. For the signal processing hardware design the BenADC-v4 has been chosen. This solution includes a FPGA Xilinx Virtex4-SX55 with four 12-bit analog inputs at

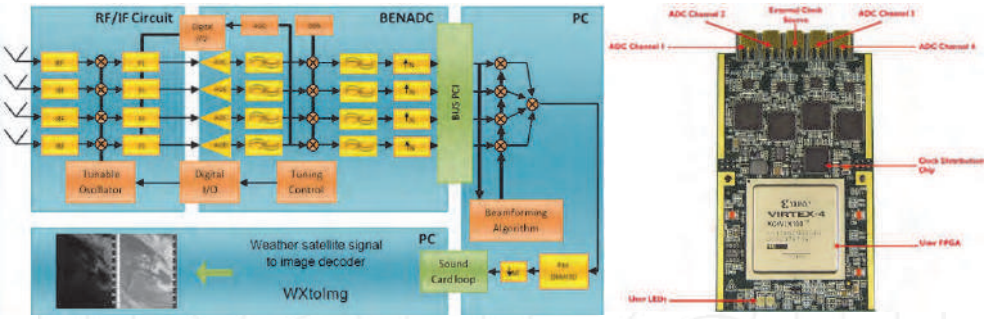

a b

Fig. 25. a) Block diagram of the A3TB, and b) BenADC – Virtex 4-sx55.

250 Msps (Martínes et al., 2007). Digital samples are transferred to the PC where beamforming and subsequent APT demodulation of the array output are performed using C++ routines. This implementation design offers higher flexibility for testing different beamforming schemes. Finally, demodulated APR frames are sent to the WXtoImg software to show meteorological maps.

The A3TB is controlled by the PC for simulations and field trials. The graphical user interface allows presented in (Salas et al., 2008) the user to choose the beamforming algorithm and set all the parameters of the LEO satellite for tracking such as the number of antennas of the array, distance between the elements, direction of arrival and IF frequency. The C++ routine calculates the beamforming weights and plots the synthesized array factor. Subsequently, the reception of meteorological images has real time system requirements. Thus, it is necessary a data transfer from the FPGA to the C++ module to process the samples continuously, and give APT frames to the audio output of the PC. Since, the meteorological satellites often have a low baud rate, in the case of study with NOAA satellites the data transfer is made using two buffers controlled by a thread.

It is important to mention that the A3TB with SDR architecture can evaluate different beamforming algorithms and receiver schemes. The update of A3TB for larger arrays is immediate, as the basis for algorithms is independent of the number of elements in the array. The architecture of a new ground station concept to track LEO satellites based on software defined radio and antenna arraying as Test-Bed is a well proved choice to evaluate future antenna array architectures for satellite communication and benchmark features of the proposed system. As the A3TB VHF version is based on FSC scheme, the concept can be applied to a number of satellite tracing scenarios.

6. Conclusions

The performance analysis of different beamforming algorithms is an important issue in the new generation antenna array development and research. Thus, A3TB helps to analyze beamforming algorithms paving the way for testing and debugging for posteriori use in larger arrays, such as GEODA. Results obtained in real scenarios with A3TB state, for example, that spatial reference algorithms such as MPDR should be used in the absence of interferences, whereas blind algorithms are appropriate for low SNR conditions. Finally, the A3TB can also serve to validate the performance of calibration procedures.

In future work, the A3TB will deal with the system combining of full modularity with the capability of change firmwares based on the first version design of the Test-Bed, plus the flexible architecture of the current design of the Test-Bed based on VHDL, C++ and Antenna Arraying. Furthermore, the addition of more modules to increase the number of antenna array elements is evident in next generations.

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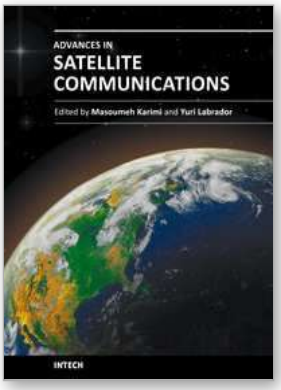

Advances in Satellite Communications

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Satellite communication systems are now a major part of most telecommunications networks as well as our everyday lives through mobile personal communication systems and broadcast television. A sound understanding of such systems is therefore important for a wide range of system designers, engineers and users. This book provides a comprehensive review of some applications that have driven this growth. It analyzes various aspects of Satellite Communications from Antenna design, Real Time applications, Quality of Service (QoS), Atmospheric effects, Hybrid Satellite-Terrestrial Networks, Sensor Networks and High Capacity Satellite Links. It is the desire of the authors that the topics selected for the book can give the reader an overview of the current trends in Satellite Systems, and also an in depth analysis of the technical aspects of each one of them.

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Review Article

Some Recent Developments of Microstrip Antenna

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Although the microstrip antenna has been extensively studied in the past few decades as one of the standard planar antennas, it still has a huge potential for further developments. The paper suggests three areas for further research based on our previous works on microstrip antenna elements and arrays. One is exploring the variety of microstrip antenna topologies to meet the desired requirement such as ultrawide band (UWB), high gain, miniaturization, circular polarization, multipolarized, and so on. Another is to apply microstrip antenna to form composite antenna which is more potent than the individual antenna. The last is growing towards highly integration of antenna/array and feeding network or operating at relatively high frequencies, like sub-millimeter wave or terahertz (THz) wave regime, by using the advanced machining techniques. To support our points of view, some examples of antennas developed in our group are presented and discussed.

1. Introduction

The concept of microstrip antenna was first introduced in the 1950s [1]. However, this idea had to wait nearly 20 years to be realized after the development of the printed circuit board (PCB) technology in the 1970s [2, 3]. Since then, microstrip antennas are considered as the most common types of antennas due to their obvious advantages of light weight, low cost, low profile, planar configuration, easy of conformal, superior portability, suitable for arrays, easy for fabrication, and easy integration with microwave monolithic integrate circuits (MMICs) [4–7]. They have been widely employed for the civilian and military applications such as television, broadcast radio, mobile systems, global positioning system (GPS), radio-frequency identification (RFID), multiple-input multiple-output (MIMO) systems, vehicle collision avoidance system, satellite communications, surveillance systems, direction founding, radar systems, remote sensing, biological imaging, missile guidance, and so on [8].

Despite the many advantages of typical microstrip antennas, they also have three basic disadvantages: narrow bandwidth, low gain, and relatively large size. The narrow bandwidth is one of the main drawbacks of these types of antennas. A straightforward method of improving the bandwidth is increasing the substrate thickness. However, surface wave power increases and radiation power decreases with the increasing substrate thickness [7], which leads to poor radiation efficiency. Thus, various other techniques are presented to provide wide-impedance bandwidths of microstrip antennas, including impedance matching networks using stub [9, 10] and negative capacitor/inductor [11], microstrip slot antennas using the U, L, T, and inverted T slots in the ground plane (sometimes termed defected ground structures (DGSs)) [12, 13], surface wave suppressing using magneto-dielectric substrate [14] and electromagnetic bandgap (EBG) structures [15], and composite-resonator microstrip antennas using metamaterial resonators [16, 17]. Another problem to be solved is the low gain for conventional microstrip antenna element. Cavity backing has been used to eliminate the bidirectional radiation, thereby providing higher gain compared with conventional microstrip antenna [18]. Lens covering is an alternative way to achieve gain enhancement. The lens with canonical profile, like elliptical, hemielliptical, hyper-hemispherical, extended hemispherical, used to focus the radiation beam from the radiator elements. The integrated lens microstrip antenna can be treated as composite antenna combined by microstrip radiator elements and dielectric lens, which is very useful for high frequencies (mm, sub-mm, terahertz (THz), and optical waves) applications

[19]. It is also well known that antenna array is an effective means for improving the gain [20–25].

The last limitation of conventional microstrip antennas is the relatively large size, particularly at lower microwave frequencies, since their operation frequencies are related to the electrical size of antenna. In general, the size of the rectangular microstrip antenna should be of order of a half-guided wavelength. This limitation was mathematically studied by Wheeler [26] and Chu [27]. There have been numerous efforts to minimize the antenna size and obtain the electrically small microstrip antenna with the raised demand towards smaller and smaller wireless devices. Inductive or capacitive loading are effective ways to reduce the size of microstrip antennas [28]. In the former work, we demonstrated that the size of microstrip antenna can be miniaturized using composite metamaterial resonators [16, 17]. Magneto-dielectric substrates have been widely used to miniaturize microstrip antennas due to magnetic substrates and could provide wider bandwidths than dielectric substrates [29–32]. Fractal geometries, which are composed by self-similar structures, have opened an alternative way for antenna miniaturization [33].

From the above discussions, we see that many methods and materials are used to improve the properties of microstrip antennas. However, there should be a relationship among bandwidth, gain, and size of the microstrip antennas. Antenna engineers have recognized that the improvement in one antenna property is frequently accompanied by decline in its other performances. For example, the antenna size is reduced usually at the expense of its bandwidth and gain. Therefore, a more comprehensive consideration must be given on further developments of microstrip antennas.

In this paper, we will suggest three areas for further research based on our previous works on microstrip antenna elements and arrays [16–25, 34–41]. We first note that novel microstrip antenna topologies are proposed to meet the desired requirement of variety of potential wireless applications, such as ultrawide band (UWB), high gain, miniaturization, circular polarization, multipolarized, and so on. Next, we discuss the composite antennas based on microstrip antennas which have more potent than each individual antenna. Finally, with the development of micro-/nano-machining techniques, antennas/arrays with highly integration and with highly operating frequencies are discussed. We present some examples of antennas developed in our group to support our points of view.

2. Variety of Microstrip Antenna Topologies

Microstrip antennas have extensively used in commercial and military applications due to their attractive advantages. However, the traditional microstrip antennas have the impedance bandwidth of only a few percent and radiation pattern with omnidirection, which obviously does not meet the requirements of various wireless applications. To this end, a wide variety of microstrip antenna topologies, including different microstrip antenna element structures and different microstrip array arrangements, have been studied to meet the desired requirement such as ultrawide band (UWB), high gain, miniaturization, circular polarization, multipolarized, and so forth.

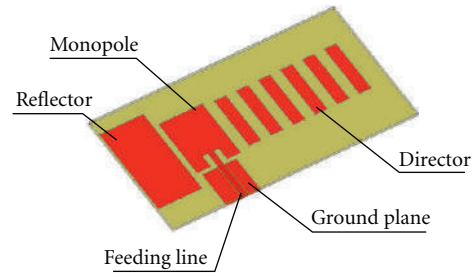

(a) The structure of the quasi-Yagi antenna

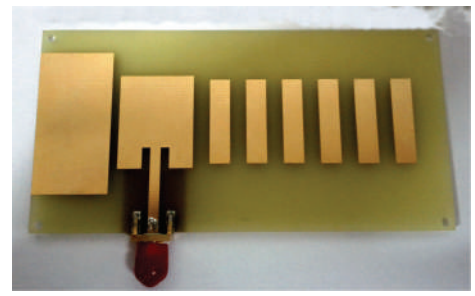

(b) The photograph of the quasi-Yagi antenna

Figure 1: Compact broad-band quasi-Yagi antenna.

As we know, microstrip antennas inherently have narrower bandwidth and lower gain compared to conventional bulky antennas. Some microstrip antennas with special topologies, like quasi-Yagi, planar reflector antenna, are proposed to replace the conventional bulky antennas. Here, we will take a quai-Yagi antenna as an example to show how to design a planar microstrip antenna with Yagi-Uda end-fire radiation pattern. In addition, a microstrip array with special array topology is designed to get dual-polarized property.

2.1. Compact Broad-Band Quasi-Yagi Antenna. A novel S-band compact quasi-Yagi antenna has been designed, fabricated and measured by our group, as shown in Figure 1. This antenna is composed of a printed monopole-driven element, a printed reflector element, and six printed director elements.

To explain the end-fire radiation behavior of the quasi-Yagi antenna, a comparison of radiation patterns, among (1) microstrip monopole only, (2) microstrip monopole and a reflector, (3) microstrip monopole and a director, (4) microstrip monopole and a reflector with one director, and (5) microstrip monopole and a reflector with six director, is shown in Figure 2. We can observe that both the reflector and the director can increase the end-fire radiation, and it could be substantially improved by increasing the number of directors.

The measured VSWR results are shown in Table 1. A bandwidth of 14% for VSWR less than 1.5 is achieved. The gain of the antenna is above 7.5 dBi, as shown in Table 2. In this design, we see that the microstrip antenna with special topology could be conveniently used to replace the bulky Yagi-Uda antenna.

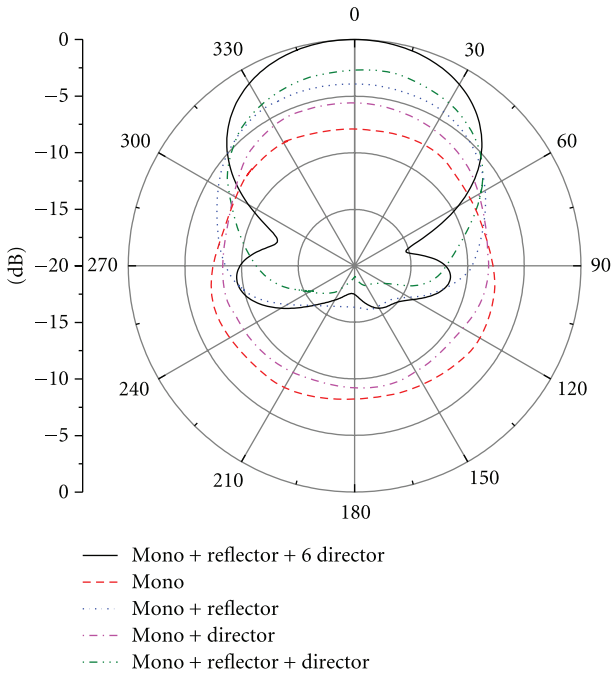

Figure 2: Radiation patterns of microstrip monopole only, microstrip monopole and a reflector, microstrip monopole and a director, microstrip monopole and a reflector with one director, and microstrip monopole and a reflector with six director.

Table 1: The measured VSWR of the quasi-Yagi antenna.

No.	Frequency (GHz)			
	3.25	3.5	3.75	Inband
1	1.36	1.34	1.47	<1.5
2	1.37	1.26	1.49	<1.5
3	1.36	1.25	1.48	<1.5

Table 2: The measured gain of the quasi-Yagi antenna (unit: dBi).

No.	Frequency (GHz)		
	3.25	3.5	3.75
1	7.57	8.73	8.35
2	7.58	8.55	8.37
3	7.56	8.77	8.51

2.2. Dual-Polarized Microstrip Antenna Array. The dual-polarized antenna is highly required for the radar, electronic countermeasure, and aerospace systems. It is known that the microstrip antenna can easily be integrated with microwave circuits and feeding network. Here, a novel Ku-band dual-polarization microstrip antenna array with a mixed feeding network, that is, the slot coupled feeding (V-port) and the co-plane feeding (H-port), is designed by our group, as shown in Figure 3. It is a three layers structure: top microstrip patch layer, middle stripline feeding network layer, and bottom coplane microstrip feeding network layer. Through proper array arrangement, very good isolation can be obtained.

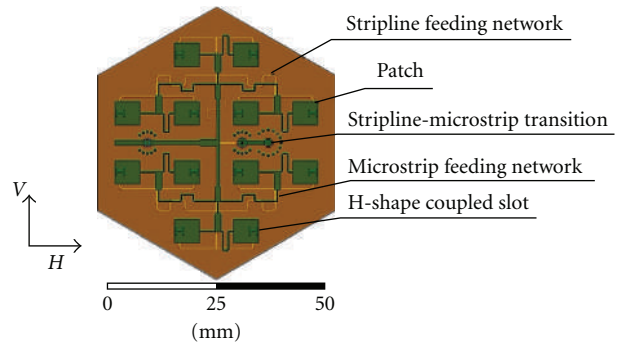

(a) The structure of the dual-polarized microstrip antenna array

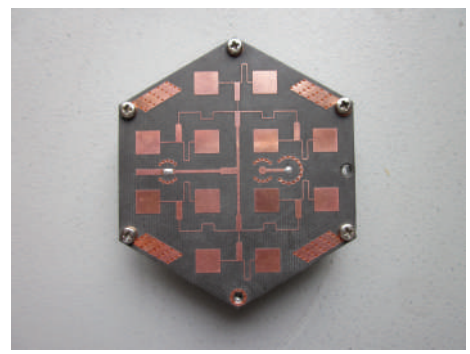

(b) The photograph of the dual-polarized microstrip antenna array

Figure 3: Dual-polarized microstrip antenna array.

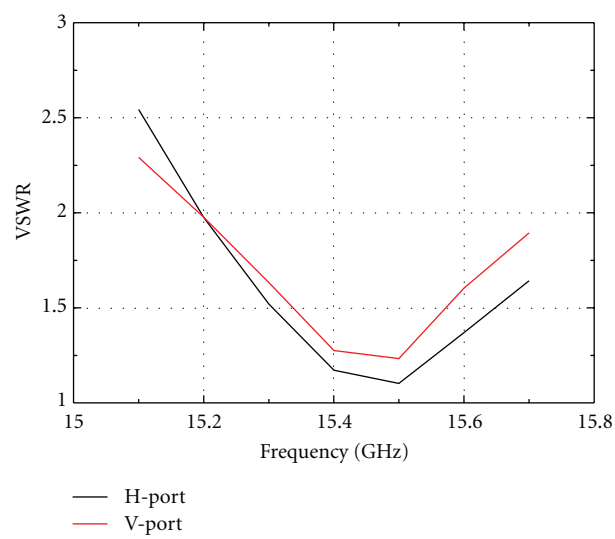

Figure 4: The VSWR of the dual-polarized microstrip antenna array.

The VSWR, radiation patterns, and the isolation between two polarizations of the proposed dual-polarized microstrip antenna array are shown in Figures 4, 5, and 6, respectively. The results indicate that this microstrip antenna array has a good impedance matching, good radiation performance, as well as very high isolation (less than −25 dB), which can be an idea candidate for the dual-polarized wireless systems.

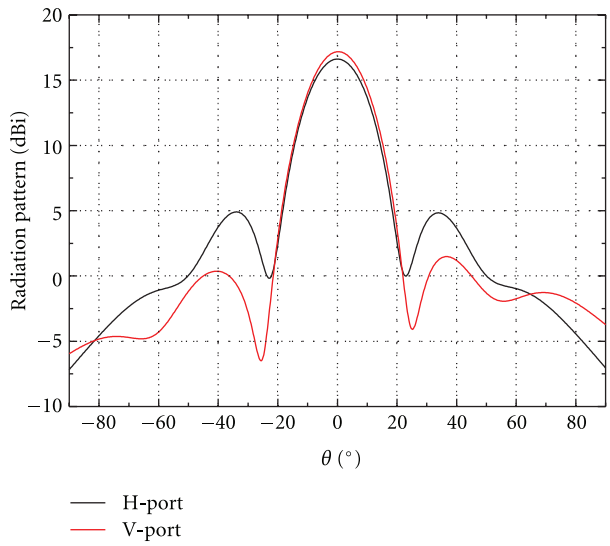

Figure 5: The radiation patterns of the dual-polarized microstrip antenna array at the center frequency.

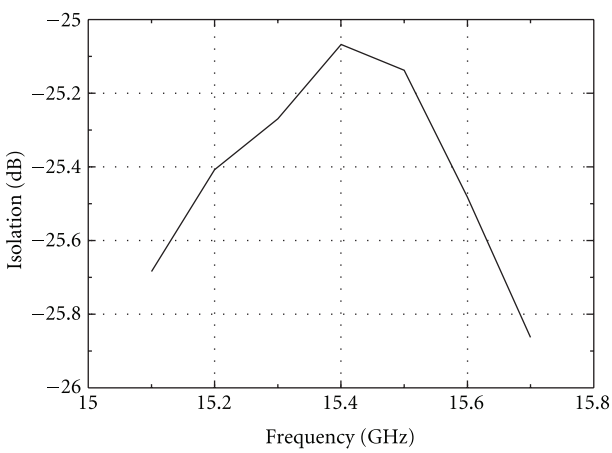

Figure 6: The isolation of the dual-polarized microstrip antenna array.

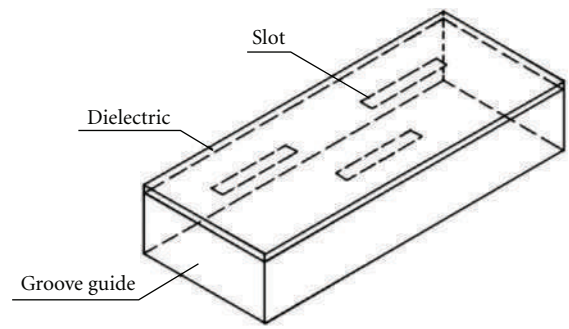

Figure 7: The structure of the DCWS.

3. Microstrip-Antenna-Based Composite Antenna

As many antenna designers have found, it is not easy to design an antenna to meet the user-defined stringent performance requirements demanded by special wireless applications like military radars, surveillances, and missile guidance, if only one type of antenna is considered. This difficulty may require the use of two more different types or structures of antenna elements with different characteristics. Composite antenna formed by two more types or structures of antennas is particularly suitable for these applications due to more advantages offered by different types or structures of antennas. For example, it is a challenging task to use single type of antenna to design a dual-band dual-polarization antenna for satellite digital multimedia broadcast (S-DMB) application [36]. A composite antenna composed with a left-handed circularly polarized (LHCP) microstrip antenna and a linear polarized omnidirectional biconical antenna is proposed by our group to meet this requirement [36]. Another example of composite antenna is comprised of a dielectric lens and microstrip log-period antenna, which has been widely applied to THz systems (this type of antenna will be further discussed in Section 4.2). Here, we will give an example of composite antenna with "structure composite" method.

3.1. Monopulse Circular-Polarized Dielectric Complex Waveguide Slot Antenna Array. Waveguide slot antenna array has been widely used for wireless system, due to its advantages of high radiation efficiency, high power capacity, and high reliability. However, it is hard to overcome the disadvantage of high cost of fabrication.

One composite antenna with waveguide slot antenna array property, termed dielectric complex waveguide slot (DCWS), is composed with slot microstrip line and groove guide, as shown in Figure 7. The slot microstrip line is formed by a metal clad dielectric substrate and slots etched in the metal. This composite antenna not only maintains the advantages of the traditional waveguide slot antenna array but also has the characteristics of high consistence, easy for fabrication, and low cost.

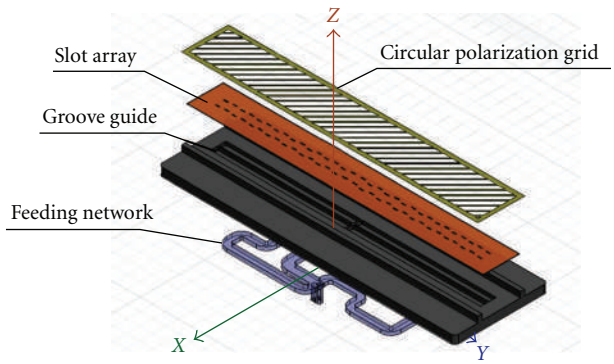

(a) The structure of the monopulse circular-polarized DCWS antenna array (separating view)

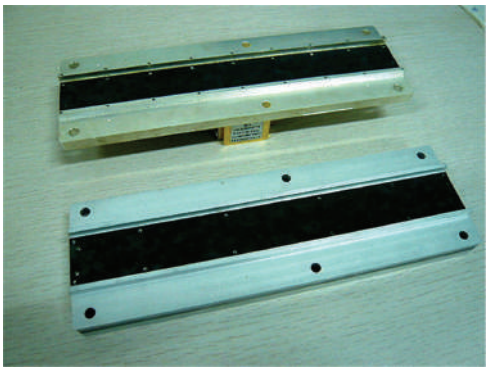

(b) The photograph of the monopulse circular-polarized DCWS antenna array.

Figure 8: Ka-band monopulse circular-polarized dielectric complex waveguide slot (DCWS) antenna array.

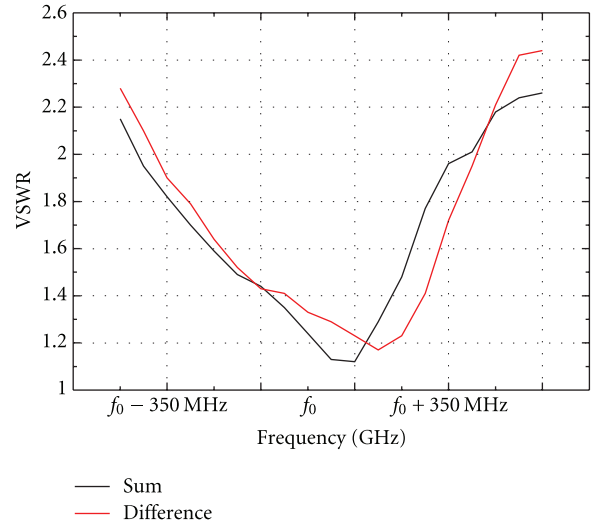

Figure 9: The VSWR of sum and difference port of the monopulse circular-polarized DCWS antenna array.

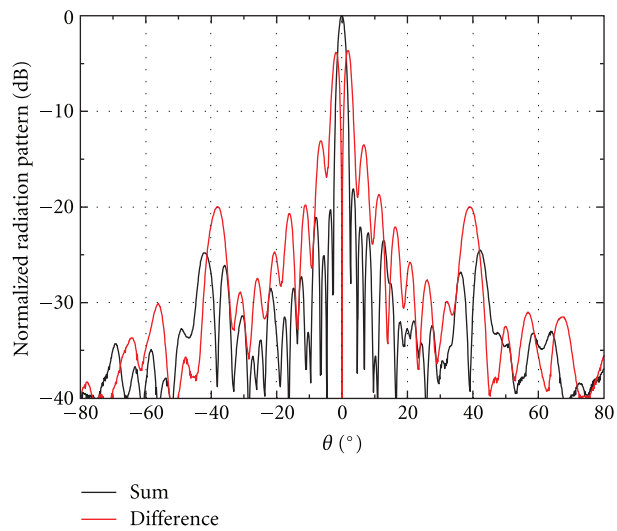

Figure 10: The radiation pattern of the monopulse circular-polarized DCWS antenna array at the center frequency.

A Ka-band monopulse circular-polarized dielectric complex waveguide slot (DCWS) antenna array is designed, fabricated, and measured by our group, as shown in Figure 8. It consists of a circular polarization grid, a slot microstrip array, and a groove guide and feeding network. The slot microstrip array is fabricated on a Rogers 5880 film with dielectric constant of 2.2 and the thickness of 0.254 mm. The measured results of VSWR of sum and different port are shown in Figure 9. Figure 10 shows the measured radiation pattern at the center frequency. Some important array performance parameters such as gain, null depth and axial ratio (AR) are also given in Table 3. As shown in the measured results, very good performance can be obtained with the DCWS antenna array. The radiating efficiency of the DCWS antenna array is 80%, which is almost the same as the traditional waveguide slot antenna array. Moreover, the DCWS antenna array has 40% larger bandwidth than the traditional waveguide slot antenna array.

4. Highly Integration and Highly Operating Frequency Antennas Based on Advanced Machining Techniques

It is known that the microstrip antenna was first fabricated using PCB technology in 1970s, nearly 20 years after its concept was first presented in 1950s [1–3]. Clearly, the development of microstrip antennas is closely related with the machining techniques. Recently, various machining techniques, including multilayer printed circuit board (MPCB), complementary metal oxide semiconductor (CMOS), low-temperature cofired ceramics (LTCC), and micro-electro-mechanical systems (MEMS), are highly developed, opening opportunities for innovative antennas, such as active antennas, reconfigurable antennas, metamaterial-based antennas, THz antennas, and so forth. With the availability of high-precision and high-speed advanced machining techniques, microstrip antennas are growing towards highly integration of antenna/array and feed network and operating at relatively high frequencies. Since they are all based on the advanced

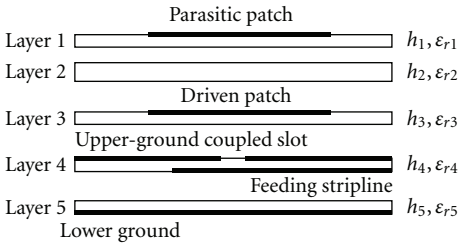

(a) Schematic side view of the structure of the high integrate broadband microstrip antenna array

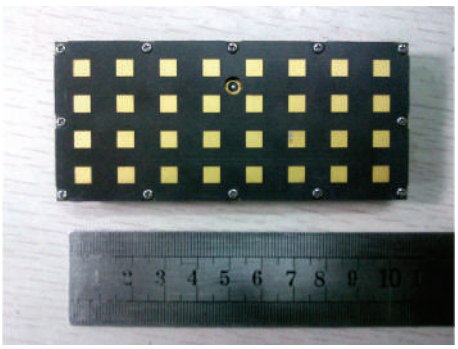

(b) The photograph of the high integrate broadband microstrip antenna array

Figure 11: Ku-band high integrate broadband microstrip antenna array using MPCB technology.

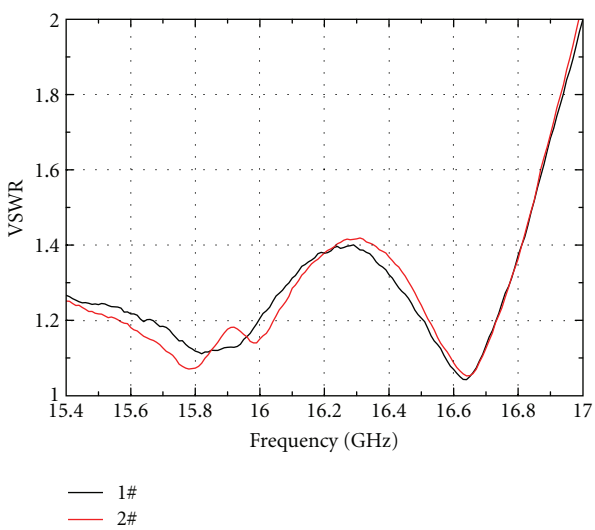

Figure 12: The VSWR of the high integrate broad-band microstrip antenna array using MPCB technology.

machining techniques, we suggest that a third research area of microstrip antennas is constantly introducing novel advanced machining techniques. In the following, two examples will be presented to show how important the advanced machining technique is to fabricate microstrip antennas. One is the highly integrate broad-band microstrip antenna array fabricated using MPCB technology. Another is THz wave planar integrated active microstrip antenna using MEMS technology.

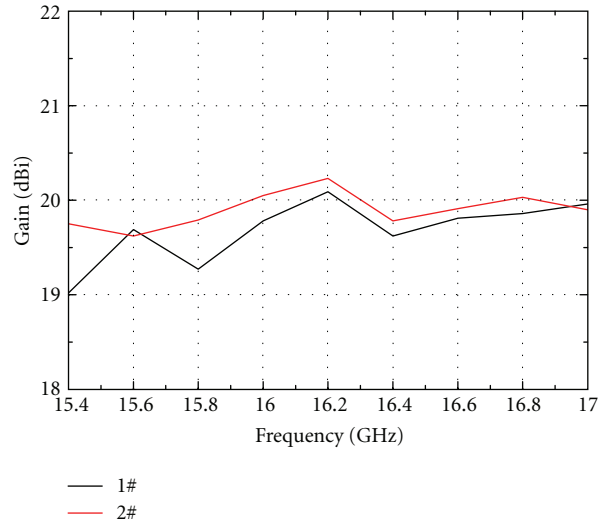

Figure 13: The gain of the high integrate broad-band microstrip antenna array using MPCB technology.

Table 3: The measured data of the monopulse circular-polarized DCWS antenna array.

Fre. (GHz)	Gain (dBi)	Null depth (dB)	AR (dB)
$f_0 - 0.2$	22.8	−37.3	3.8
f_0	21.9	−29.9	2.9
$f_0 + 0.2$	22.1	−26	4.1

4.1. High Integrate Broad-Band Microstrip Antenna Array Using Multilayer Printed Circuit Board (MPCB) Technology. Recently, with the development of the multilayer printed circuit board (MPCB) technology, the microstrip antennas can be designed and fabricated from one-dimensional (1D) to 2D and even 3D structures.

Based on the MPCB technology, a high integrated broad-band Ku-band microstrip antenna array is designed, fabricated, and measured by our group, as shown in Figure 11. This antenna consists of a parasitic patch, a driven patch, a stripline feeding network, a broad-band coaxial line to stripline transition, some buried screw holes, and some via holes. The feeding network is integrated in the bottom of the substrate of the antenna. As all of the structures fabricated at once, the accuracy and the uniformity can be assured. Two antennas of this type are measured. The measured VSWR, gain, and radiation pattern at the center frequency are shown in Figures 12, 13, and 14, respectively. The measured results show that this antenna maintains good radiation and matching performances with relative bandwidth of 13%. They have also shown good uniformity by using MPCB technology.

4.2. THz Wave Planar Integrated Active Microstrip Antenna Using Micro-Electromechanical Systems (MEMSs) Technology. THz waves typically include frequencies between 0.1 THz and 10 THz. THz technology is now becoming a promising technology which has potential applications in many fields, such as short-range communication, biosensor, imaging,

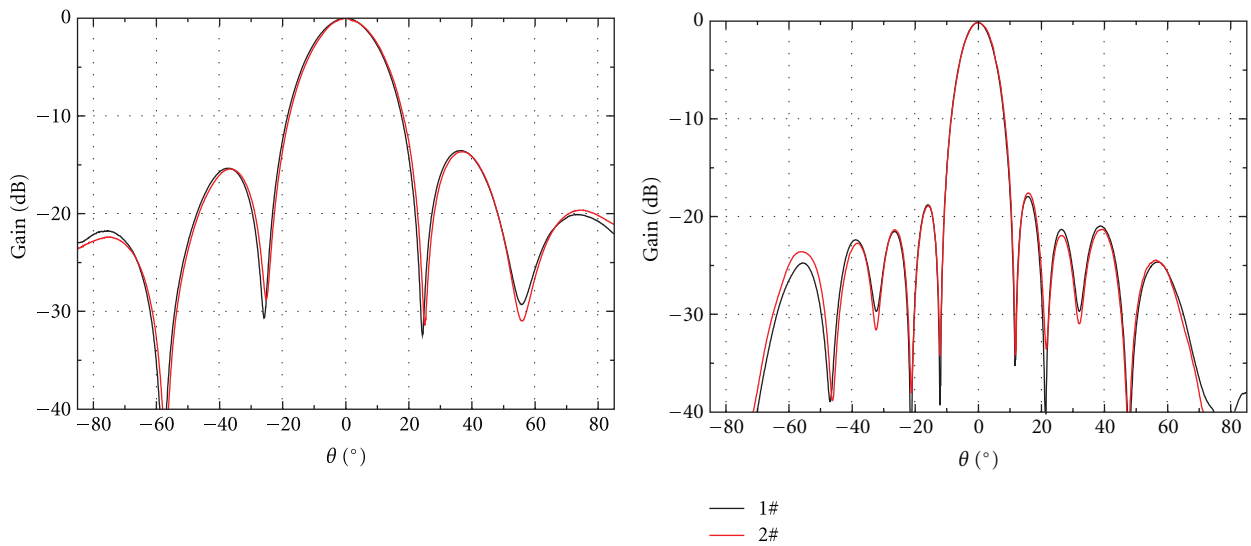

(a) E-plane (b) H-plane

Figure 14: The radiation pattern of the high integrate broad-band microstrip antenna array using MPCB technology at the center frequency.

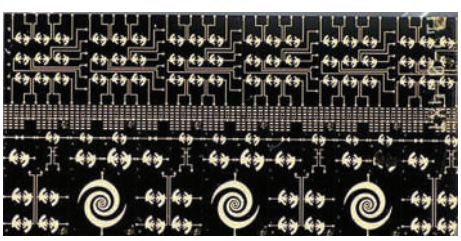

(a) The photograph of the THz monolithic antenna

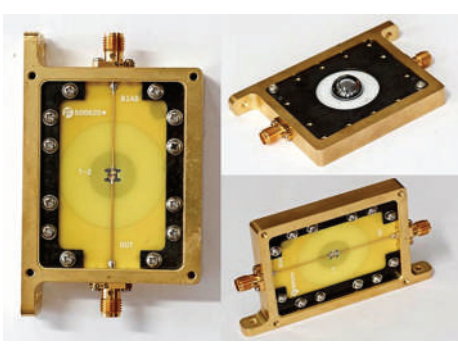

(b) The photograph of the THz monolithic antenna covered by a dielectric lens

Figure 15: THz wave planar integrated active microstrip antenna using micro-electromechanical systems (MEMSs).

national security, space exploration and communication, and so forth [39–46]. To realize THz transceiver system, antenna is an essential component. We often use horn antenna, lens antenna, and dielectric parabolic antenna, for THz systems. However, they are not easy to integrate with monolithic integrate circuits. Although the microstrip antenna has the merits of small volume, light weight, and easy integration with circuit, it is difficult to be processed in such high-frequency regions. MEMS technology opens the way to design of THz antennas, circuits, and systems. THz monolithic antenna fabricated using MEMS technology and covered by a dielectric lens, which can be considered a composite antenna, are designed, fabricated, and measured by our group, as shown in Figure 15.

Diodes have the functions of mixing and/or modulating the carrier-wave signal. It is an effective way to reduce the propagation path for detectors application by integrating the diode and microstrip antenna. The extended hyper-hemispherical dielectric lens is used to increase the gain of the microstrip antenna. An antenna-coupled detector integrated with a dielectric lens is designed and fabricated up to THz range by our group. The planar microstrip log-spiral antenna and log-period antenna have been fabricated using micro-electromechanical systems (MEMSs) technology. The photographs of the antennas are demonstrated in Figure 15. The measured responses of the antenna-coupled detector working at different frequency bands are shown in Figure 16, which can be considered to determine the effective operating frequencies [19, 40]. This detector gave a valid response from 12 GHz to 110 GHz frequencies. The results prove the validity and feasibility of the THz antenna designed using micro-electromechanical systems (MEMSs) technology.

5. Conclusion

The advantages and disadvantages of microstrip antennas are discussed in this paper. In particular, three areas for further development of microstrip antennas are presented based on our previous works on microstrip antenna elements and arrays. Variety of microstrip antenna topologies and microstrip-antenna-based composite antenna are discussed, and

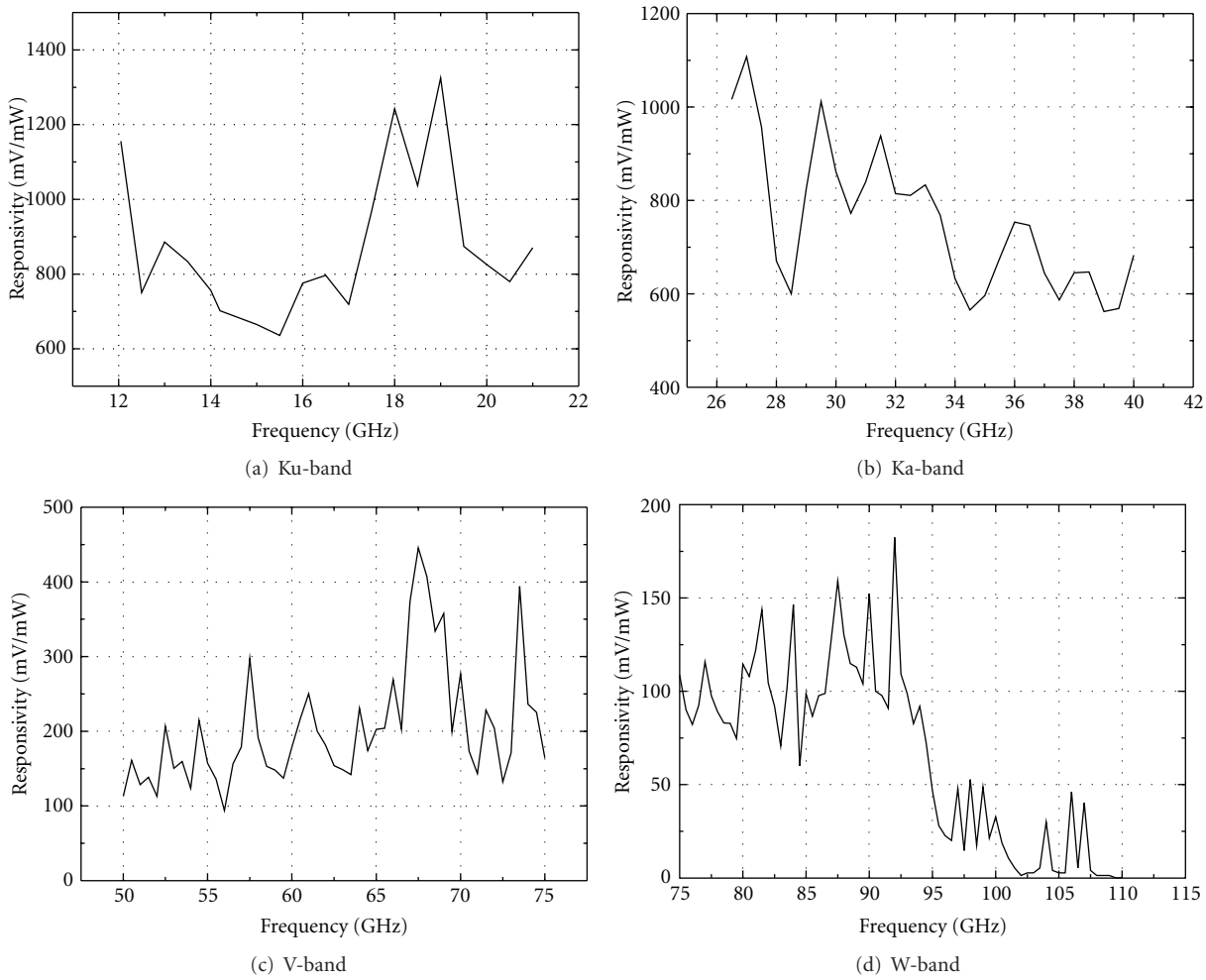

Figure 16: Frequency responses test results of the THz wave planar integrated active microstrip antenna covered by a dielectric lens.

the advanced machining techniques pushing the microstrip antennas towards the highly integration of antenna/array and feeding network and the highly operating frequencies are described. To demonstrate the distinctive features of novel microstrip antennas, various antenna elements and arrays for different applications are presented. This paper has shown that the microstrip antennas are still very promising paradigm for civilian and military wireless applications.

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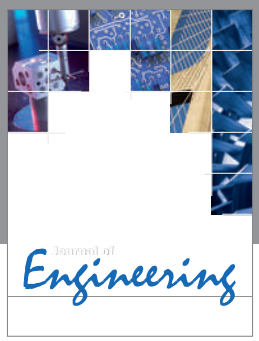

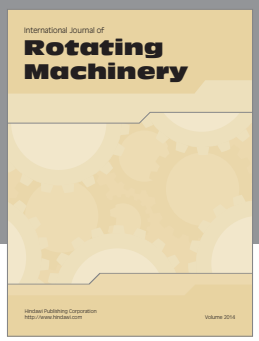

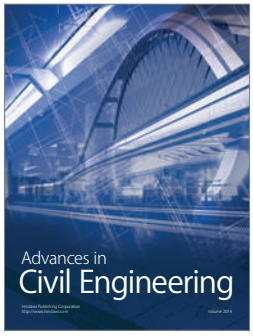

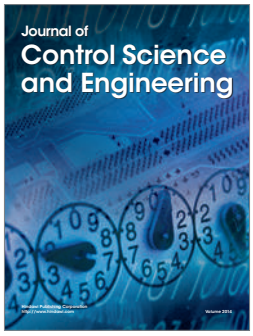

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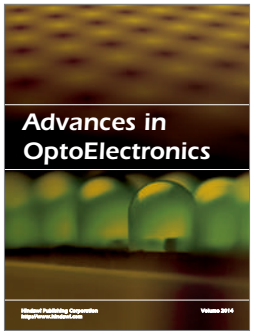

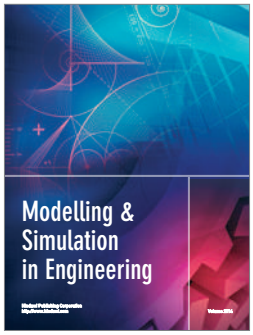

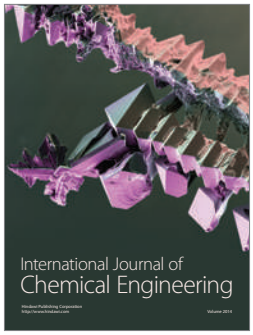

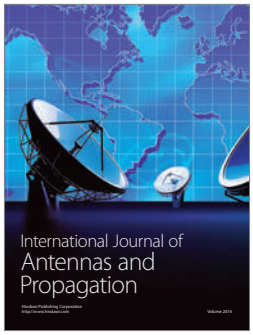

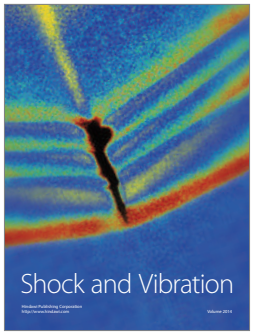

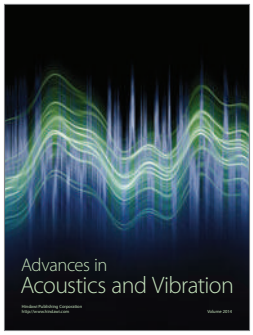

A 2.4 GHz Polarization-diversity Planar Printed Dipole Antenna for WLAN and Wireless Communication Applications

This article presents the design simulation, fabrication and measured performance of a 2.4 GHz polarization-diversity printed dipole antenna for wireless communication applications. Two orthogonal printed dipole antennas, each with a microstrip via-hole balun for vertical and horizontal polarization, are combined and fabricated on a PCB substrate. PIN diodes are used as switches to select the desired antenna polarization. The 3D finite-element-method (FEM) electromagnetic EM simulator, HFSS, is used in the design simulation of this planar antenna structure. Numerical and measured results of the antenna radiation characteristics, including input SWR, radiation pattern coverage and polarization-diversity, are presented and compared.

In wireless communication systems, such as wireless local area networks (WLAN), research and development efforts are aiming at smaller size and better performance. In addition to the use of signal processing techniques to improve communication channel capacity, the radiation characteristics of the portable antenna system is also very important for communication performance.

In urban or indoor environments, the radio wave will propagate through complicated reflection or scattering processes. The polarization of the radio wave may change significantly. In order to effectively receive the communications signal, a polarization-diversity antenna for wireless communications may become an important requirement. A polarization-diversity antenna may have a pair of linearly-polarized antennas, and the radio signal received on both antenna is sampled and compared at

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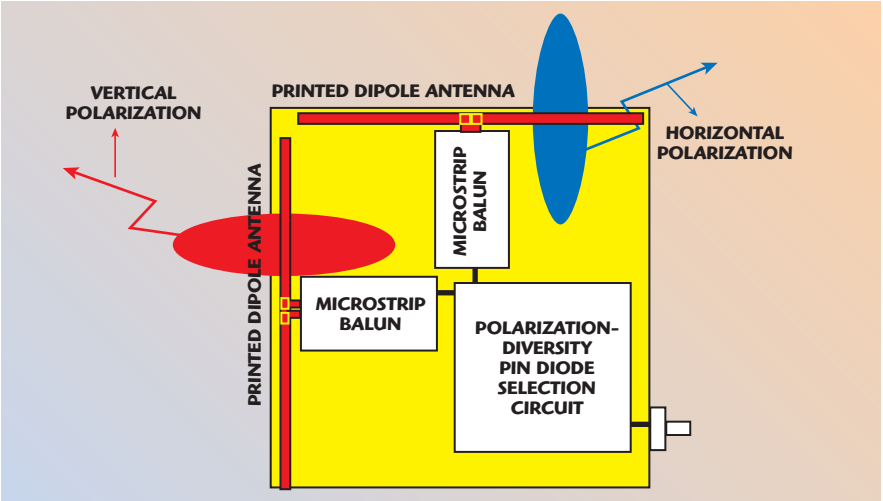

▲ *Fig. 1 A 2.4 GHz polarization-diversity antenna.*

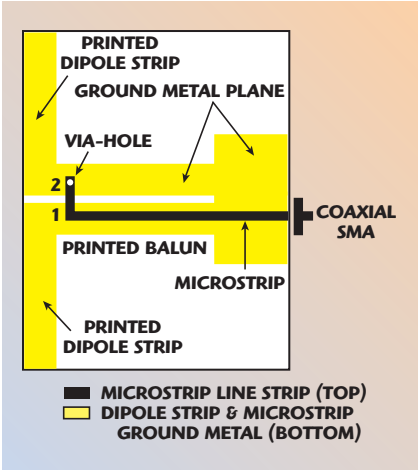

▲ *Fig. 2 Printed dipole antenna with a microstrip balun.*

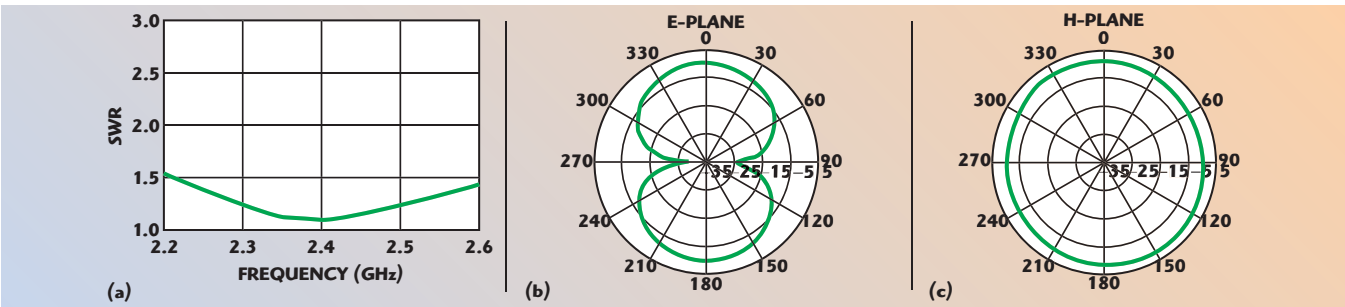

▲ *Fig. 3 Simulated performance of a 2.4 GHz printed dipole antenna placed horizontally; (a) input SWR, (b) E-plane pattern and (c) H-plane pattern.*

certain time intervals. Then the antenna with the best signal quality is selected.

A typical dipole antenna radiates a vertically polarized EM wave and has an omnidirectional antenna pattern. In order to have a preferred planar antenna structure for this 2.4 GHz polarization-diversity antenna, a printed dipole antenna with a microstrip via-hole balun is designed. As shown in ***Figure 1***, two orthogonal printed dipole antennas, for vertical and horizontal polarization, respectively, are combined and fabricated on a PCB substrate. PIN diodes are used to switch and select the desired antenna polarization.

In the antenna design, the high frequency structure simulator (HFSS), based on a 3D FEM, was employed for design simulation of the complete printed dipole structure. A printed dipole antenna and a polarization-diversity planar dipole antenna board (with a polarization-selection PIN diode circuit) have been fabricated on FR-4 PCB substrates. A complete 3D structure FEM simulation and the measured performance of the realized printed dipole-antenna are compared. The measured radiation characteristics of the polarization-diversity planar dipole antenna, including input SWR, radiation pattern coverage and polarization diversity, are presented.

PRINTED DIPOLE ANTENNA WITH MICROSTRIP BALUN

As shown in ***Figure 2***, a printed dipole antenna has a printed microstrip balun which acts as an unbalanced-to-balanced transformer from the feed coaxial line to the two printed dipole strips. The length of the dipole strip and the balun microstrip are both about 1/4 wavelength. The ground plane of the microstrip line and the dipole antenna strips are in the same plane. A via-hole permits the feed point 2 of a printed dipole strip to have the same phase as the feed point 1 of the other printed dipole strip. Due to the 180° phase difference between the top strip and the ground plane of the microstrip line, the feed point 2 of the printed dipole strip will have 180° phase difference with the other feed point 1. Accurate dimensions of the printed dipole strip and the microstrip balun structure are determined by numerical simulation, using HFSS.

The simulation results for a 2.4 GHz printed dipole antenna placed horizontally with a microstrip via-hole balun and fabricated on an FR-4 substrate are shown in ***Figure 3***. The input SWR is less than 1.5 from 2.2 to 2.6 GHz. The simulated E- and H-plane antenna patterns are very close to those of an ideal dipole antenna, where the H-plane pattern is omnidirectional. ***Figure 4*** is a photograph of a realized antenna. The measured input SWR and antenna patterns (measured with the dipole placed vertically) agree well with the simulation results, as shown in ***Figure 5***.

PLANAR POLARIZATION-DIVERSITY PRINTED DIPOLE ANTENNA

Figure 6 shows photographs of a realized 2.4 GHz planar polarization-diversity antenna consisting of two orthogonal printed dipole antennas with a polarization-switched PIN diode circuit. Each printed dipole has

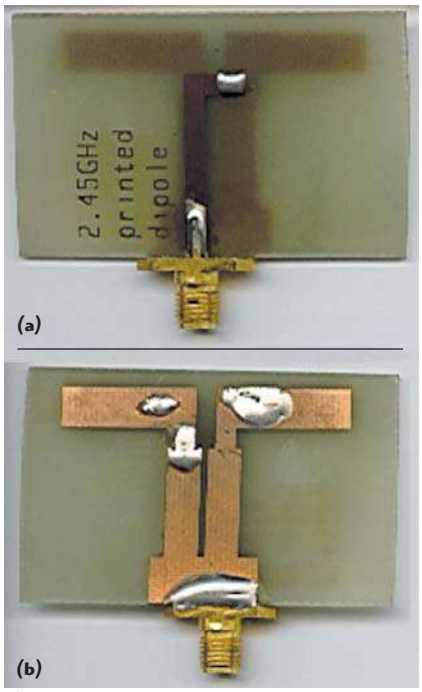

▲ *Fig. 4 A 2.4 GHz printed dipole antenna with a microstrip via-hole balun; (a) top view and (b) bottom view.*

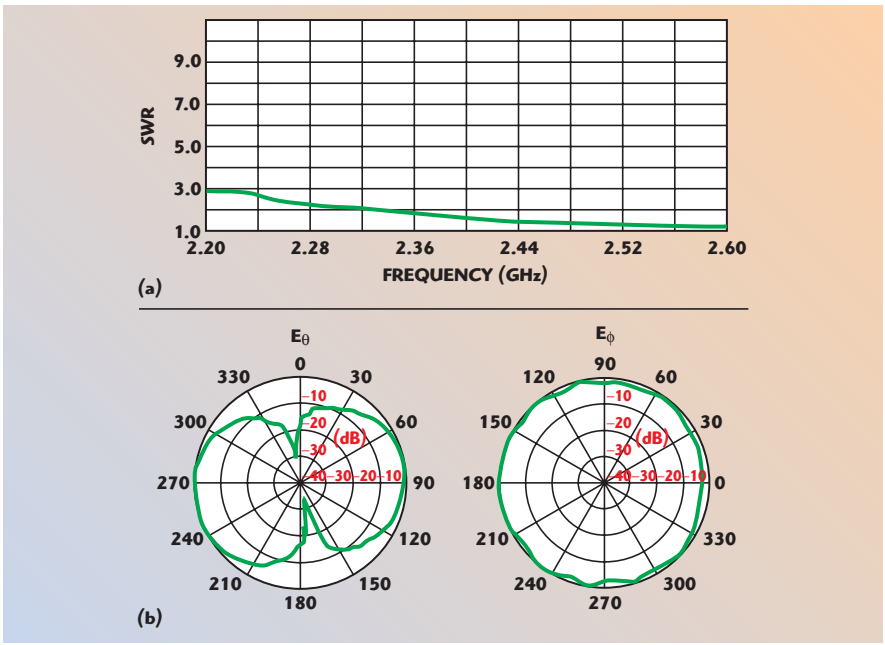

▲ *Fig. 5 Measured input SWR (a) and radiation patterns (b).*

a microstrip via-hole balun. The terminals of the two baluns are connected to a PIN diode selection circuit. Voltages from the transceiver circuit (±5.0V) are fed through a cable to the input of the PIN diode circuit section, to short or open-circuit the PIN diodes. Hence, either the vertical or horizontal printed dipole can be selected and connected to the transceiver.

Since the two dipoles are very close to each other and near the PIN diode circuit section, EM coupling will degrade the performance of each dipole. ***Figure 7*** shows the input SWR simulation results with the vertical dipole antenna selected (+5V to PIN diode switching circuit). The input SWR is less than 2 from 2.25 to 2.60 GHz. The simulated E- and H-plane antenna patterns are all very close to those of an ideal dipole antenna, of which the H-plane pattern is still omnidirectional, as shown in ***Figure 8***. Note that the dominant polarization is the vertical (E_θ) field, which agrees with the selection of the vertical dipole. The antenna pattern has some attenuation in the direction of the PIN diode circuit board. It can also be seen that a certain level of the input RF signal is induced to the horizontal antenna path by EM coupling, which generates some level of cross-

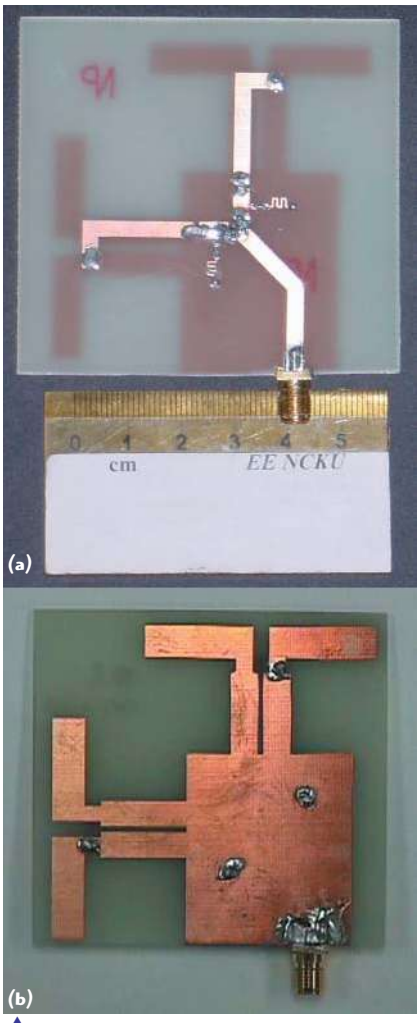

▲ *Fig. 6 A 2.4 GHz planar polarization-diversity antenna with a polarization-switched PIN diode circuit; (a) top view and (b) bottom view.*

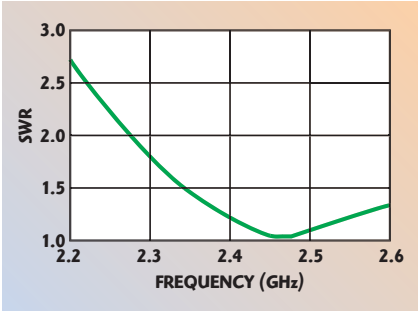

▲ *Fig. 7 Input SWR simulation of a 2.5 GHz polarization-diversity dipole antenna with the vertical dipole selected.*

polarization field. ***Figure 9*** shows the simulation results with the horizontal dipole antenna selected (–5V to PIN diode switching circuit). Results similar to the ones obtained for the vertical dipole antenna can be observed, except that the dominant polarization is the horizontal (E_ϕ) field, which agrees with the selection of the horizontal dipole.

The measured antenna input SWR with vertical or horizontal dipole selection confirms the input SWR of each dipole antenna (through the PIN diode selection circuit) is less than 1.5 from 2.2 to 2.6 GHz, which agrees with the HFSS simulation results. The measured antenna patterns with the selection of the vertical or horizontal dipole shows that for the selection of the vertical dipole, the H-plane pattern is still quite omnidirectional (as an ideal vertical dipole) with some attenuation in the direc-

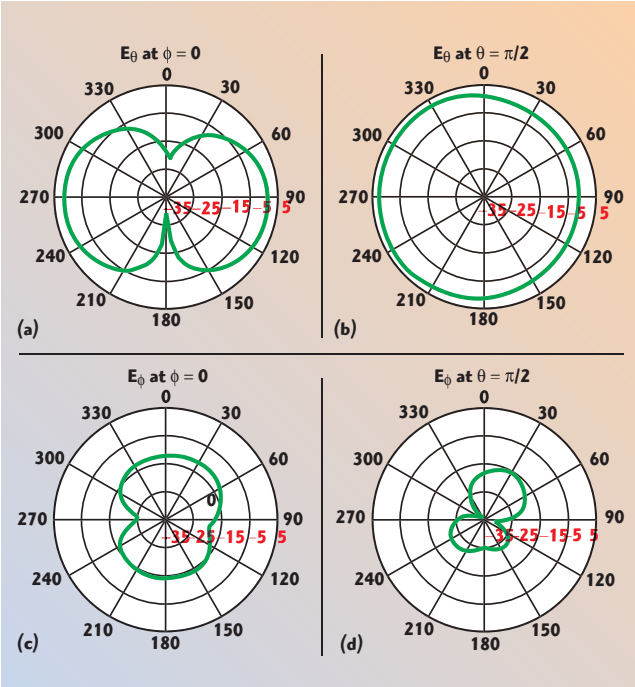

▲ *Fig. 8 Simulation of a 2.5 GHz polarization-diversity dipole antenna with the vertical dipole selected; (a) E_θ-field E-plane pattern, (b) E_θ-field H-plane pattern, (c) E_ϕ-field (cross-polarization) E-plane pattern and (d) E_ϕ-field (cross-polarization) H-plane pattern.*

tion of the PIN diode circuit board. ***Figures 10*** and ***11*** show the mesured SWR and antenna patterns, respectively. A certain level of the induced cross-polarization pattern is observed as predicted by the HFSS simulation due to the proximity of the horizontal dipole strip and the PIN diode circuit board. As for the selection of the horizontal dipole, the E-plane pattern is also close to that of an ideal horizontal dipole. Also, the induced cross-polarization pattern is observed, which is the same situation as the selection of the vertical dipole. The measured data shows a good agreement with the HFSS simulation results and how the antenna polarization-diversity is working.

CONCLUSION

3D FEM design simulation, realization and measurements of a 2.4 GHz printed dipole antenna (with a microstrip via-hole balun) and a planar polarization-diversity printed dipole antenna are presented. The planar polarization-diversity antenna consists of two orthogonal printed dipole antennas for vertical and horizontal polarization and is fabricated on a FR-4 PCB board. A PIN diode switching circuit is used to select the desired antenna polarization. Satisfactory agreement between simulation and measurements is observed. The measured input SWR of the realized printed dipole antenna is less than 1.5 from 2.2 to 2.6 GHz. The measured input SWR of the vertical and horizontal dipole (through the PIN diode switching circuit) of the realized planar polarization-diversity antenna is less than 1.5 from 2.3 to 2.6 GHz. The measured E- and H-plane patterns of the polarization-diversity antenna show that the selected vertical or horizontal dipole have a performance close to a single dipole antenna in a vertical or horizontal position. The designed planar polarization-diversity antenna can be used for wireless communication and WLAN applications.

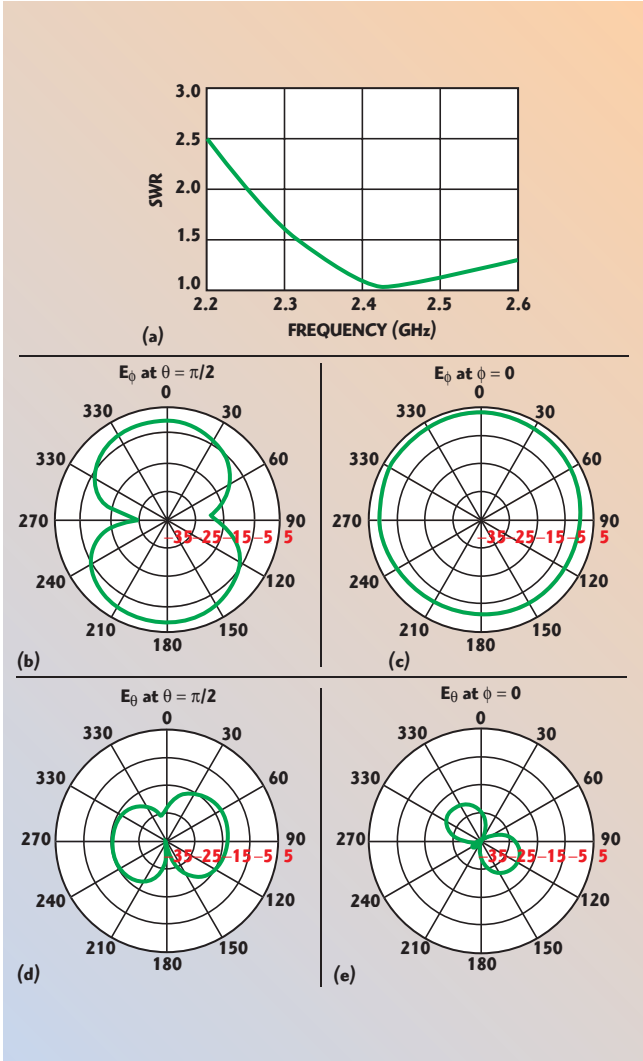

▲ *Fig. 9 Simulation of a 2.4 GHz polarization-diversity printed dipole antenna (with the horizontal dipole selected); (a) input SWR, (b) E_ϕ-field E-plane pattern, (c) E_ϕ-field H-plane pattern, (d) E_θ-field (cross-polarization) E-plane pattern and (e) E_θ-field (cross-polarization) H-plane pattern.*

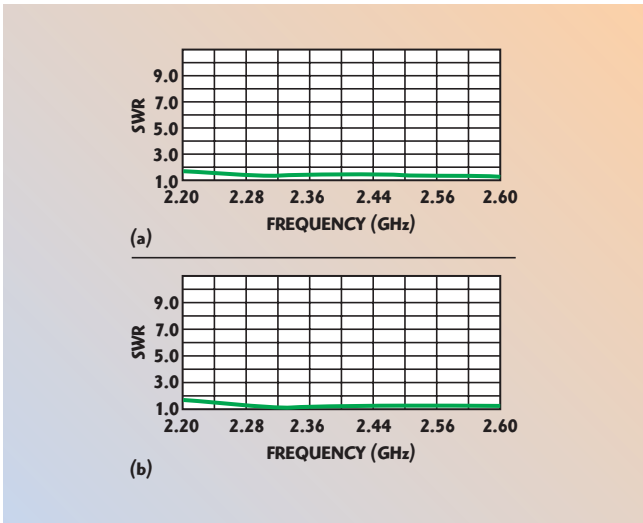

▲ *Fig. 10 Measured input SWR of a 2.4 GHz polarization-diversity printed dipole antenna; (a) vertical dipole selection and (b) horizontal dipole section.*

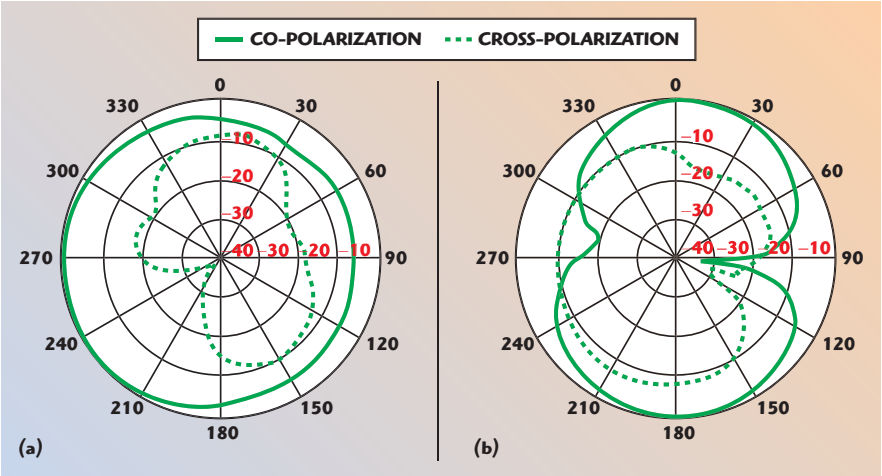

▲ *Fig. 11 Measured co-and cross-polarized patterns of a 2.4 GHz polarization-diversity printed dipole antenna; (a) vertical dipole selected and (b) horizontal dipole selected.*

ACKNOWLEDGMENT

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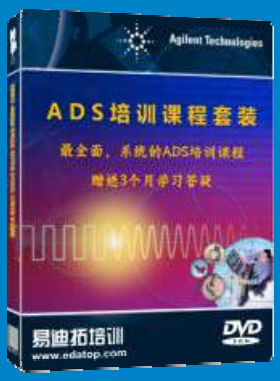

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※ 经验丰富的一线资深工程师讲授，结合实际工程案例，直观、实用、易学

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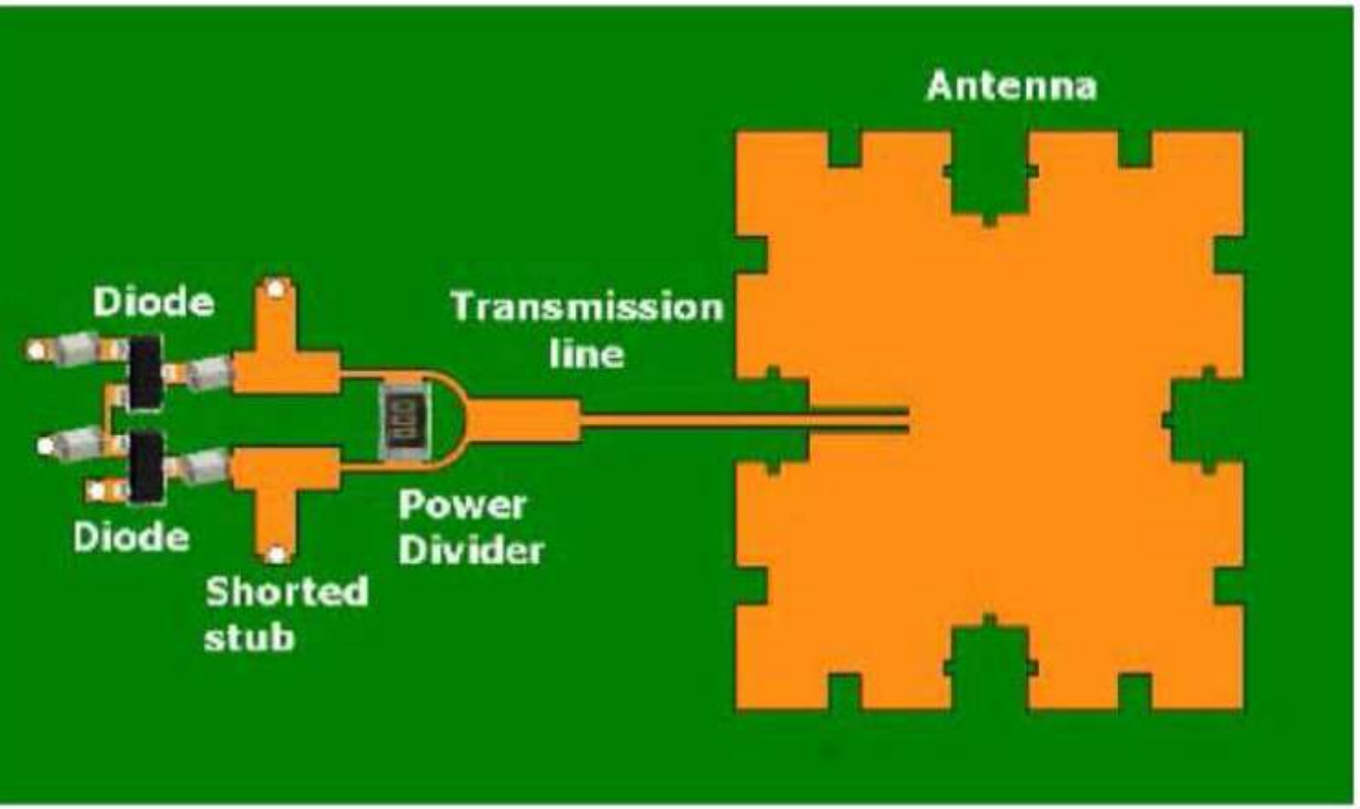
Antenna
Diode
Transmission line
Diode
Power Divider
Shorted stub

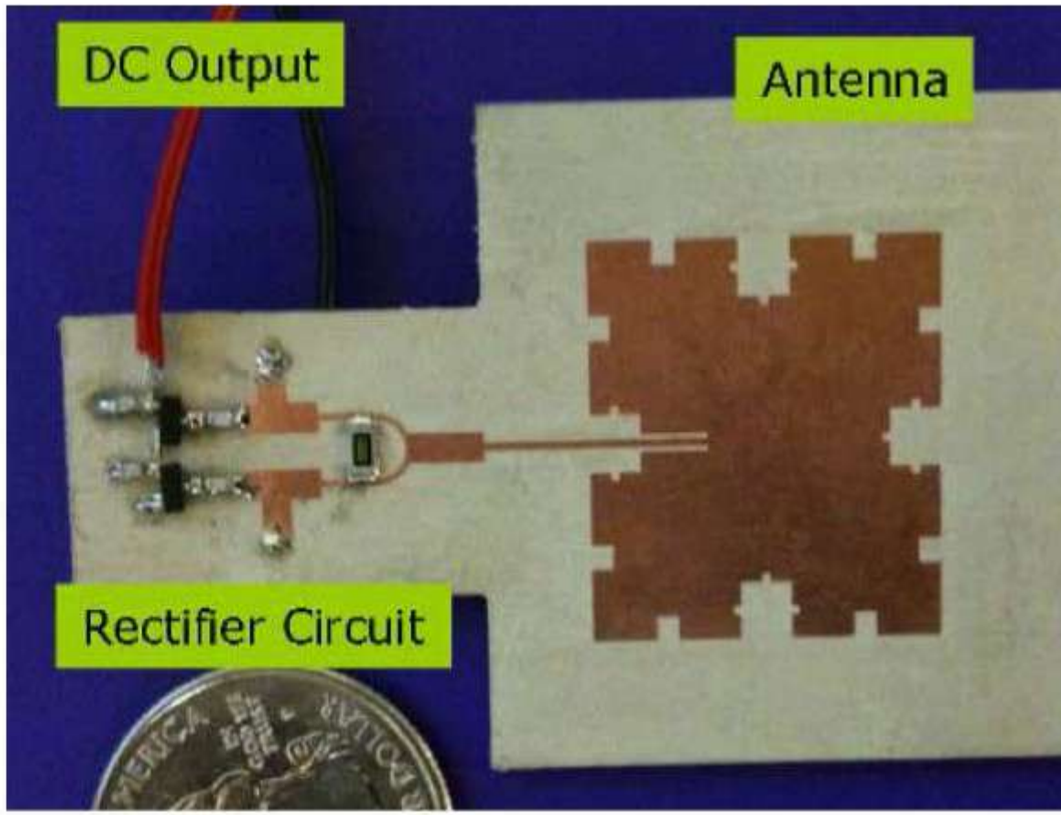
DC Output
Antenna
Rectifier Circuit

Giedrius Rakauskas

Follow

Phased Patch Antenna Array Design

Engineering

1473 17 0

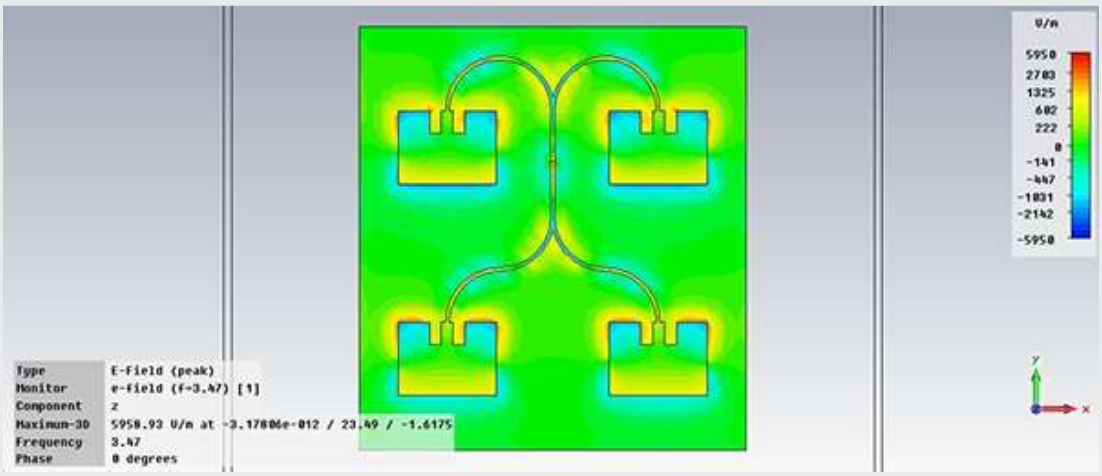

Third Year Project

The aim of this project was to design a directive phased patch antenna array that could be implemented in modern vehicles for distance measurement and autonomous cruise control.

The particular technology allows improved performance as well as reduced costs and size.

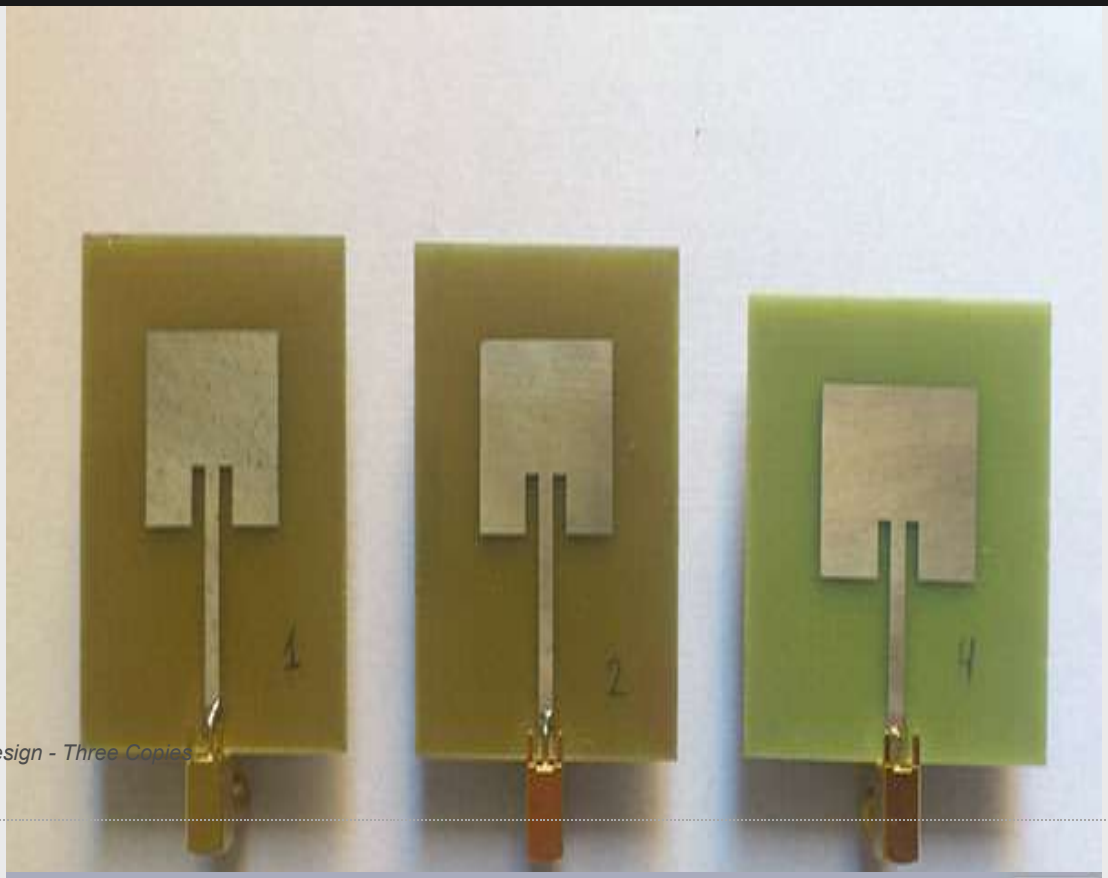

Initial Design - Three Copies

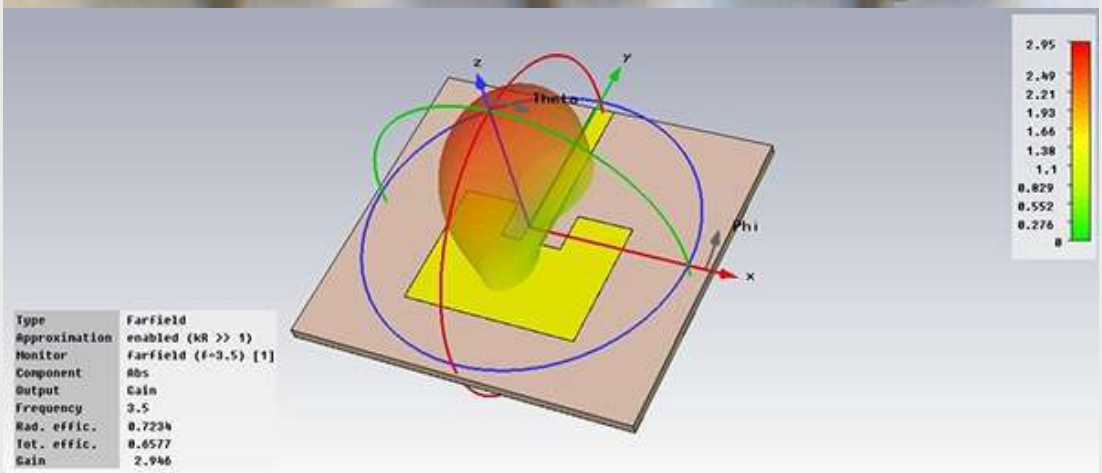

Square Patch Antenna - Farfield Simulation Results

Two-Element Array

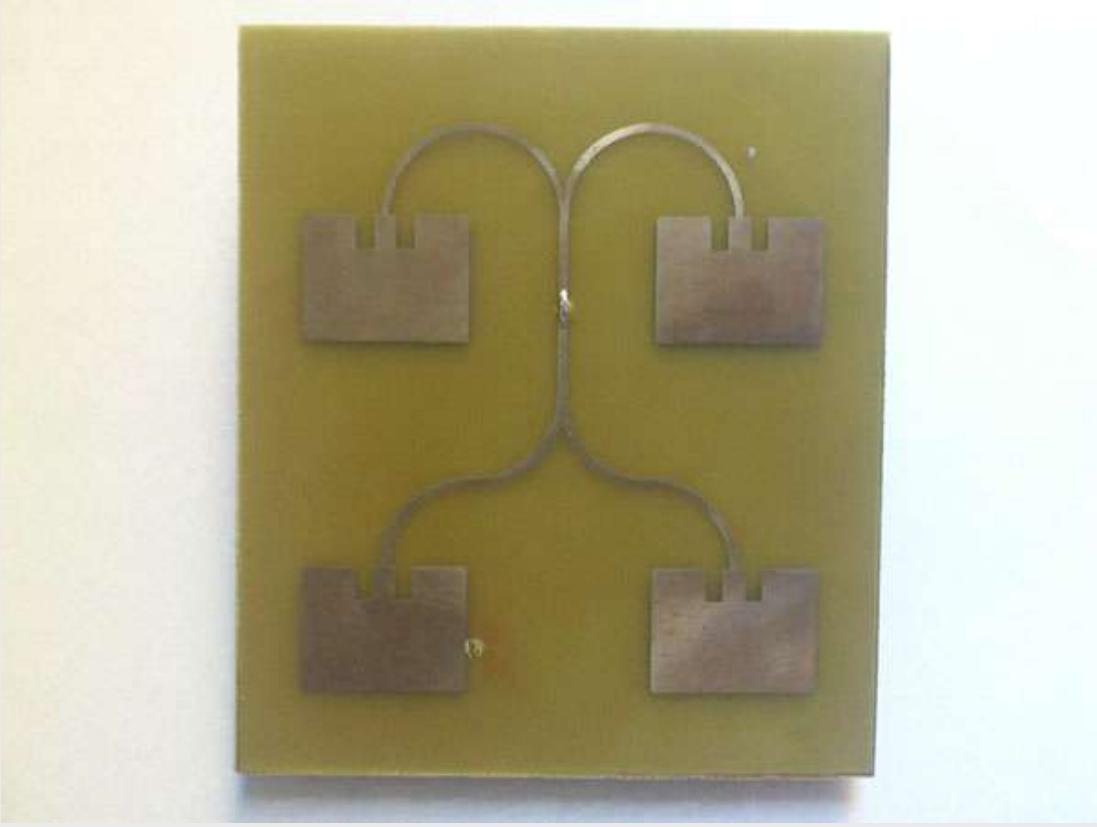

Four-Element Array

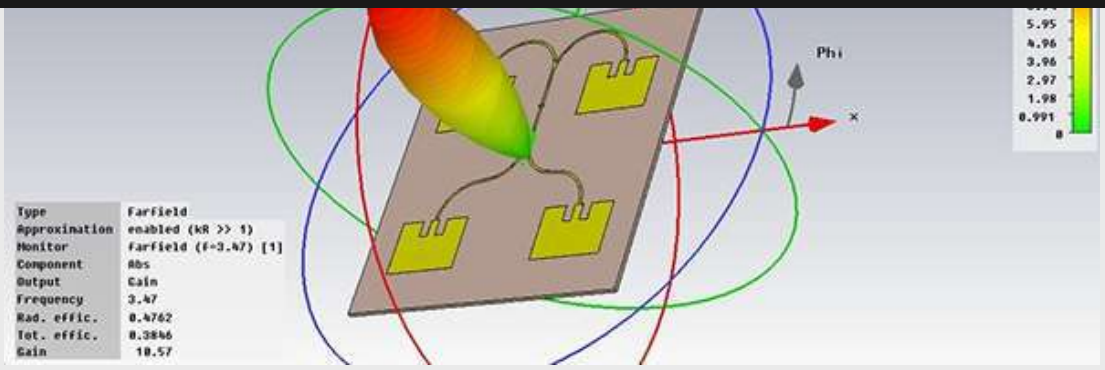

Four-Element Array - CST Microwave Studio Simulation Results

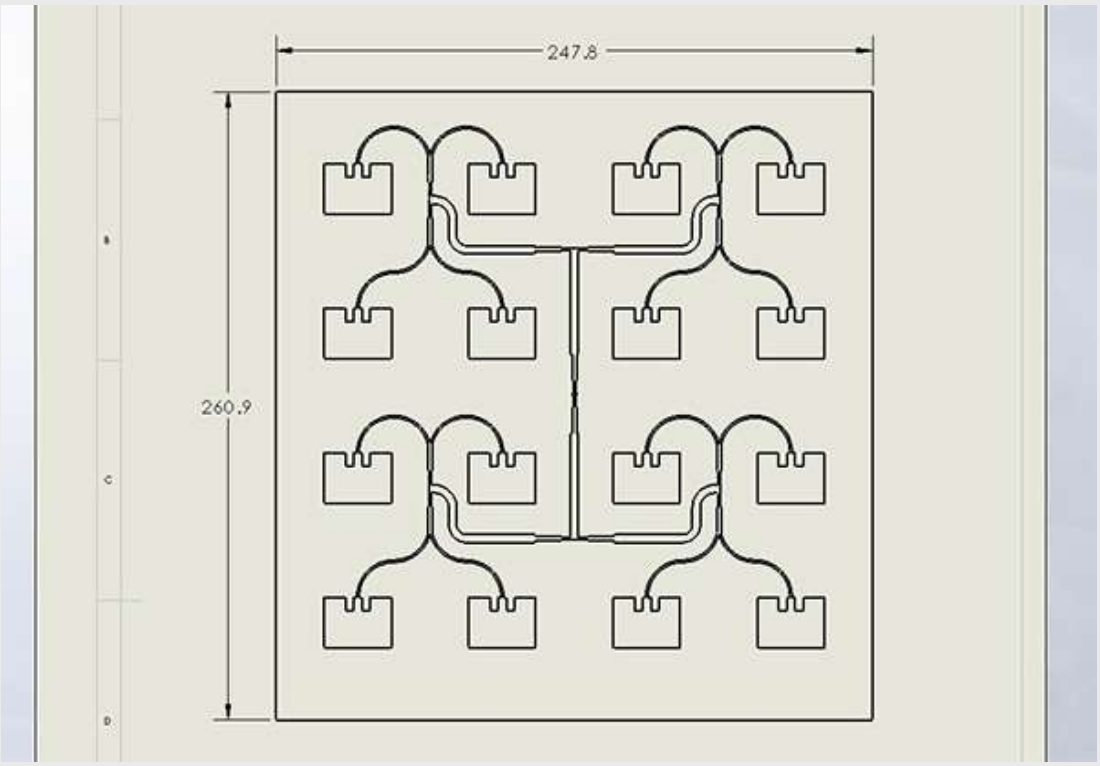

Sixteen-Element Array Design

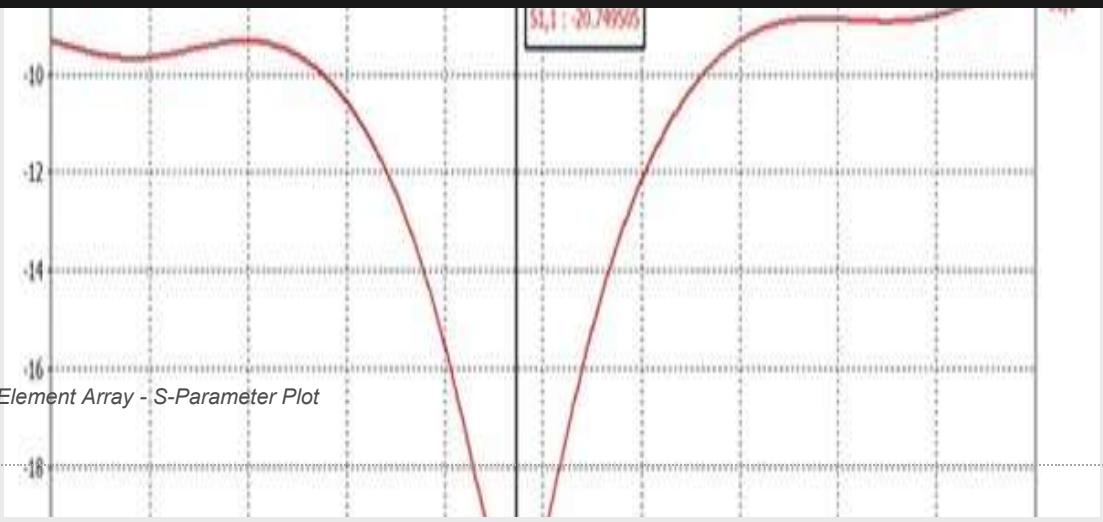

Sixteen-Element Array - S-Parameter Plot

Giedrius Rakauskas
Vilnius, Lithuania

Follow

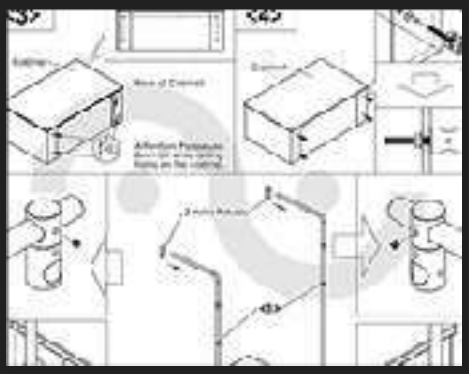

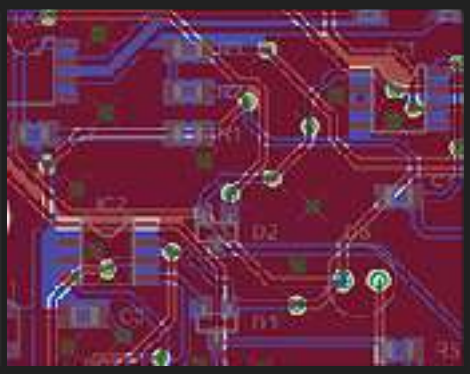

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Basic Info

Third Year BEng Project - Phased Patch Antenna Array

Credits

Giedrius Rakauskas
Vilnius, Lithuania

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Tags

patch antenna | antenna array | square patch antenna | cst mws | cst microwave studio

Tools Used

CST Microwave Studio, FR-4

Report

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Creative Career Tips Apps

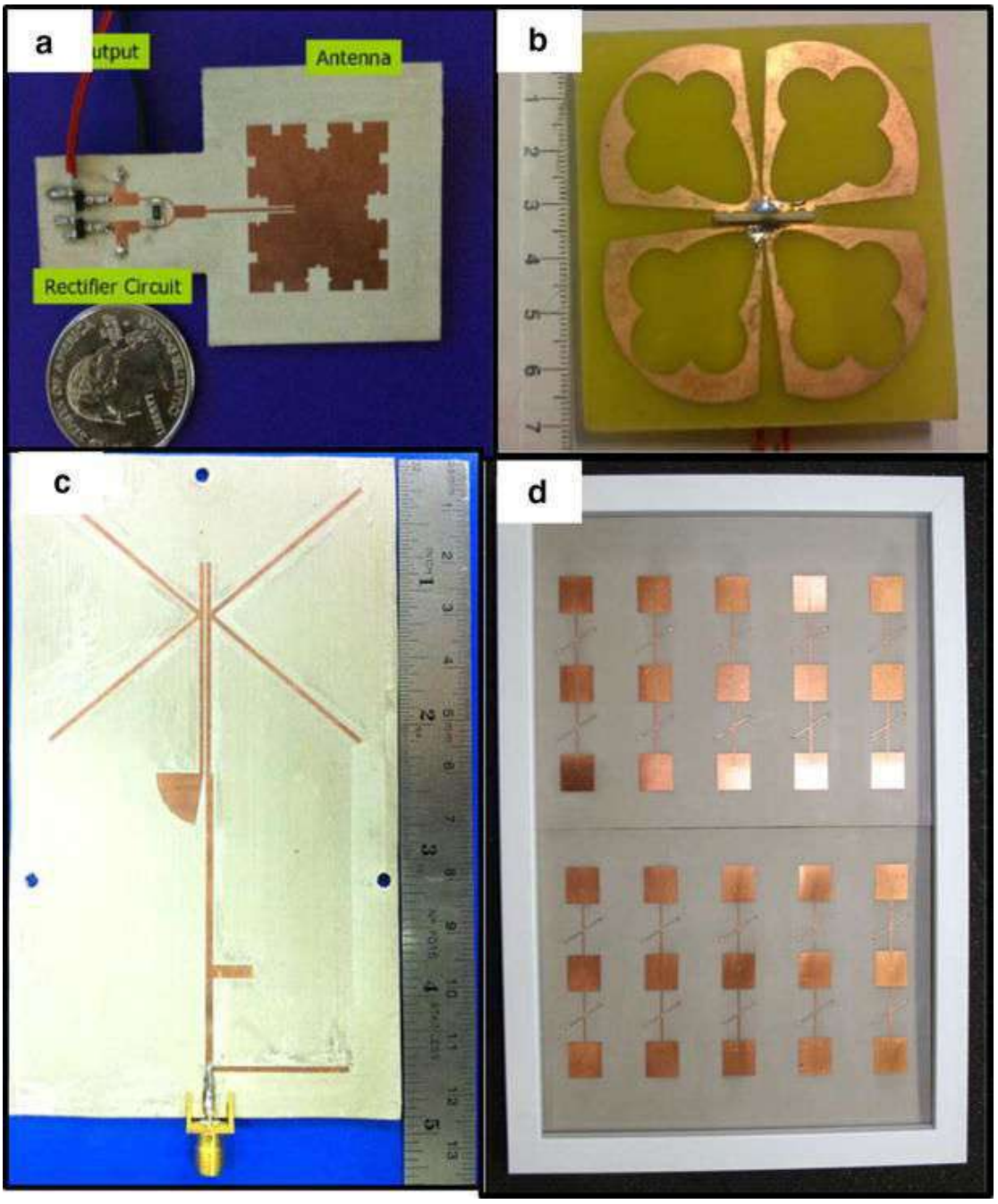

Fig. 4

Types of antennas **a** 2.45 GHz patch antenna with rectifier [38]. ©2010 IEEE. All rights reserved; **b** Planar dual-polarized antenna [24]. ©2015 IEEE. All rights reserved; **c** Microstrip antenna [37]. ©2012 IEEE. All rights reserved; **d** Array of stacked differential patch antenna [33]. ©2015 IEEE. All rights reserved

The plate antennas are popular and have many applications [27, 34, 38]; on-chip antennas are preferred for small and compact applications. Recently, many publications addressed wide-band and multi-band antennas. It has been proven that narrow-band antennas offer high energy conversion efficiencies but can only retrieve a limited amount of energy. On the other hand, wide-band or multi-band frequency antennas can retrieve more RF energy in space. However, the tradeoffs are low overall efficiency and large aperture. In [32], antennas with a resonance frequency of 4.9 and 5.9 GHz were designed with PCEs of 65.2 and 64.8%, respectively. Further work by Lu et al. [26] on polarization antennas supports the assertion that expanding the bandwidth of an antenna leads to increasing the amount of power harvested. In this work, the demonstration of broadband polarization antennas with three separate modes allows the antenna to operate in a wider range of frequencies. One common mechanism in the aforementioned works is the control of the antenna configuration by switching the diodes on and off, thus altering its resonant frequencies. However, since it uses separate modes for different frequencies, this antenna is not able to simultaneously resonate at two frequencies. On the other hand, the antenna presented in [39] is capable of operating at 2.45 and 5.8 GHz, simultaneously, providing 2.6 V output with a PCE of 65% and power density of 10 mW/cm^2.

The main purpose of aligning antennas in arrays is to enhance the antenna gain and obtain high voltage/current. Array antennas are preferred over large aperture antennas because they do not require large breakdown voltage diodes to operate. Antenna arrays can be connected before or after rectification. The first configuration enhances the retrieved power at the main beam while the second configuration expands the ability to retrieve power from various angles away from the main beam [40]. In case the RF waves are combined before rectification, the rectifier requires a large breakdown diode. If RF waves are combined after rectification, combining DC current becomes problematic. Antenna arrays can be connected in series or parallel to obtain high voltage or large current. Nonetheless, expanding the arrays yields better output but this might cause a deduction in conversion efficiency [33].

For demonstrating antenna arrays, Sun et al. [35] invented a T-junction to connect four quasi-Yagi antennas together. The advancement in this work was that the T-junction was flexible in changing from 1 × 4 array to 2 × 2 array topologies. Consequently, the system was able to operate at an ambient power level as low as 455 μW/cm^2 while obtaining 40% PCE.

Impedance matching network

In low-power consumption electrical systems, power leakage during transmission may lead to energy insufficiency. In these circumstances, adding an impedance matching network (IMN) ensures that the maximum power transfers between the RF source and load. For WPH applications, the receiving antenna is considered as the source while the rectifier/voltage multiplier is considered as the load. It is acknowledged that in DC, power transfer is optimum when the resistances of the source and load are indistinguishable. In an RF circuit, the impedance is referred to instead of resistance. An impedance mismatch between the source and load creates reflected power flow in the circuit that lowers the efficiency of the system. As its name indicates, the IMN ensures that the impedance of the source and load are identical by adding reactive components in between.

There are three basics matching configurations i.e. L, T and π matching networks (Fig. 5). The L matching is commonly used since it typically has two components, which simplifies the designing and controlling process. Additionally, the L matching networks do not alter the quality factor (Q) of the circuit.

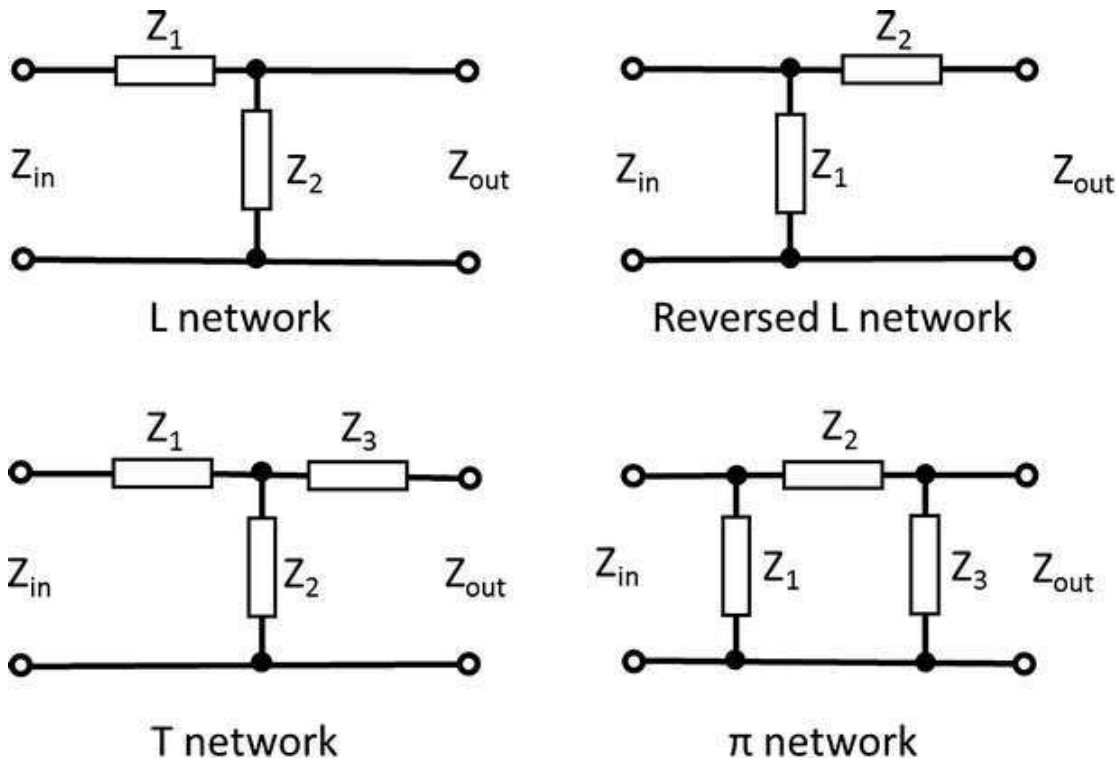

Fig. 5

Configuration of common impedance matching networks

The T and π matching configurations are more complex than the L network. Furthermore, organizing the T and π configurations into multiple stages will retain the final matching results but will change the Q factor. This strategy is useful in improving voltage boost.

There are tradeoffs between the attributes of an IMN, which include frequency, bandwidth, adjustability, and complexity. For instant, in [41], the suboptimal impedance matching and multiport ladder matching methods were introduced to enhance the

matching performance and harvested power of antennas, respectively. However, the tradeoff was that implementation of these configurations required more components than traditional matching networks, thus, escalating the circuit's complexity.

Etor et al. [42] designed an IMN for THz frequencies applications using transmission lines and self-designed metal–insulator-metal diodes instead of lumped components. Moreover, fixed IMN and tunable IMN [43, 44, 45] were introduced as a technique for better matching with wide-band and multi-band antennas.

Rectifier/voltage multiplier

RF energy extracted from free space usually possesses low power density since the electric field power density decreases at the rate of $1/d^2$, where d is the distance from the RF source [46]. Therefore, a power amplifier circuit is required that yields enough DC energy from the electromagnetic waves to drive the loads. This gives rise to two possibilities, if the power consumption of the load is lower than the average power harvesting, the electronic devices at the load may work continuously; otherwise, if the load consumes more energy than the power harvesting circuit can generate, the devices cannot work continuously [47].

Rectifying is the most popular application of diodes, which refers to the conversion of AC current to DC current. In terms of power harvesting application, the RF signal retrieved in the antenna has a sinusoidal waveform. The signal after transformation through IMN would be rectified and boosted to meet the power requirements of the application.

The most fundamental topology of the rectifier is the half-wave rectifier that comprises of a single diode D1 (Fig. 6a). When AC voltage transfers through D1, only the positive cycle remains and the negative cycle is cutoff; thus, it diminishes half of the AC power. Moreover, the output V_{out} is discontinuous since the negative cycle is cutoff. Despite its simplicity, a half-wave rectifier is usually inadequate for common applications. Hence, a full-wave rectifier is more preferable. The circuit design of the full-wave rectifier is shown in Fig. 6b. During the first negative cycle of AC input, diode D1 is conductive and capacitor C1 is charged to the corresponding energy level of V_{peak} of the input. Then, at the next positive cycle, diode D1 is blocked, diode D2 is conductive so that capacitor C2 is also charged. In consequence, the output V_{out} would see two capacitors in series (each one is storing a voltage of V_{peak}). Thus, V_{out} is twice V_{peak}. Therefore, this topology is more stable and efficient than the half-wave rectifier. There is also a bridge rectifier that rectifies both positive and negative cycles of the AC input but retains $V_{out} = V_{peak}$ by alternatively blocking pairs of diodes D1, D4 and D2, D3 (Fig. 6c).

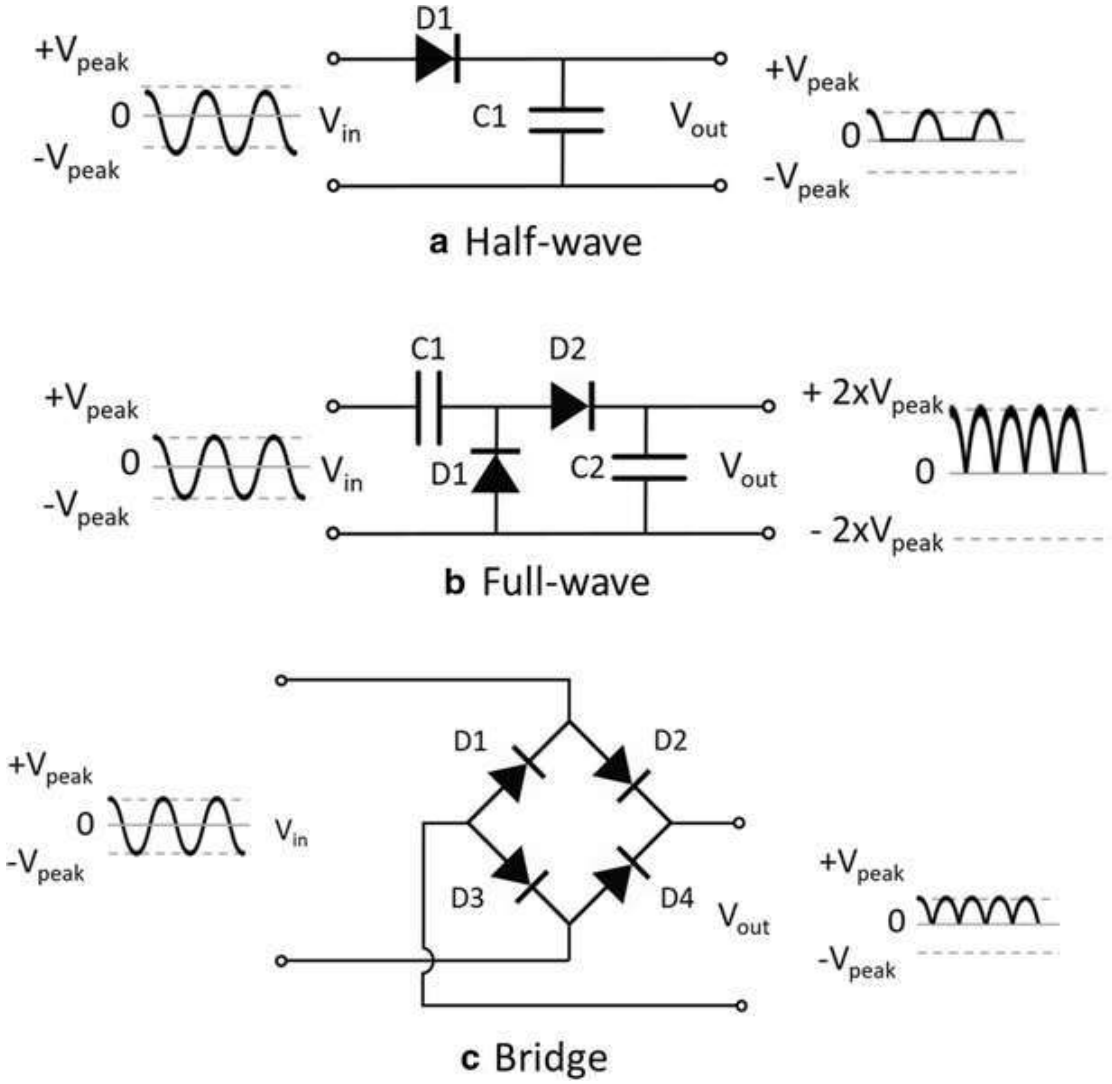

Fig. 6

Some common topologies of a rectifier

Voltage multiplier is a special type of rectifier circuit that converts and boosts AC input to DC output. In some case where the rectified power is inadequate for the application, there is a need for boosting the output DC by stacking single rectifiers into series, forming the voltage multiplier [48]. Several configurations of the voltage multiplier are shown in Fig. 7. The most fundamental configuration is the Cockcroft–Walton voltage multiplier (Fig. 7a). This circuit's operational principle is similar to the full-wave rectifier (Fig. 6b) but has more stages for higher voltage gain. The Dickson multiplier in Fig. 7b is a modification of Cockcroft–Walton's configuration with stage capacitors being shunted to reduce parasitic effects. Thus, the Dickson multiplier is preferable for small voltage applications. However, it is challenging to obtain high PCE due to the high threshold voltage among diodes creating leakage current, thus reducing the overall efficiency. Additionally, for high resistance loads, output voltage drops drastically leading to low current supply to the load. A summary of recent works related to voltage multiplier is shown in Table 3.

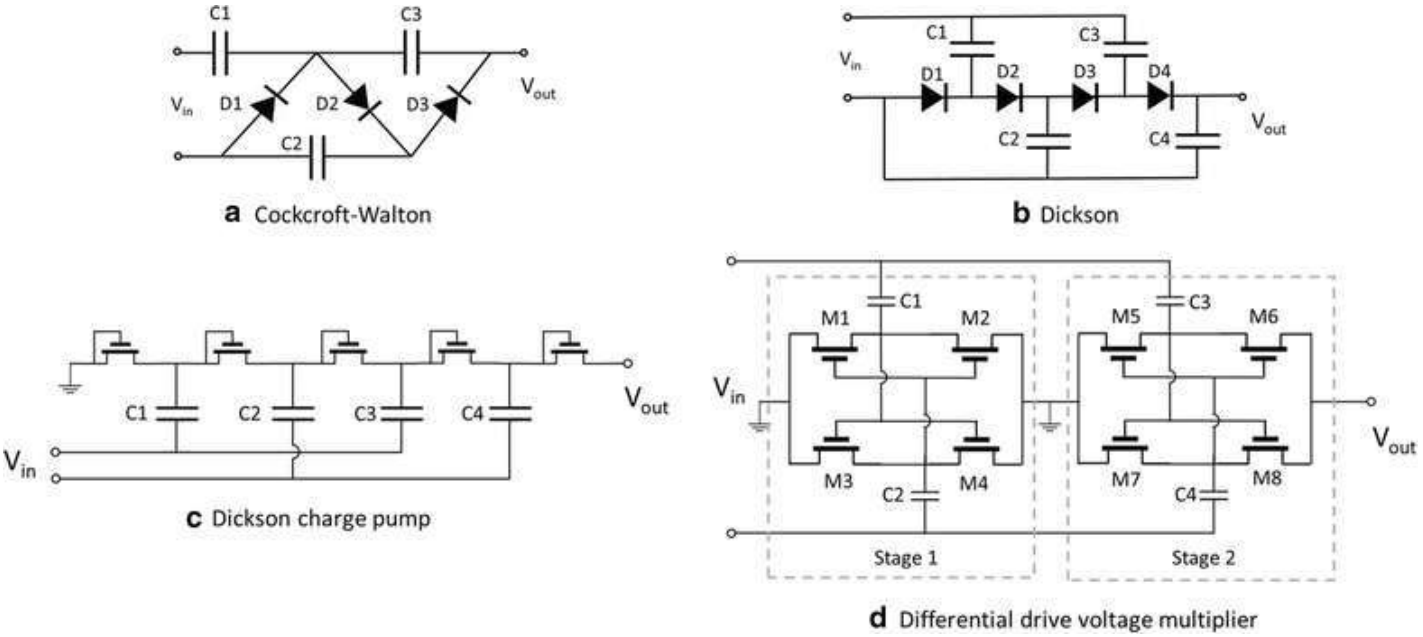

Fig. 7

Common voltage multiplier configurations: **a** Three stages Cockcroft–Walton voltage multiplier, **b** Four stages Dickson voltage multiplier, **c** Four stage Dickson voltage multiplier using CMOS technology, **d** Two stages voltage multiplier comprised of differential drive unit

Table 3

Published work comparison regarding voltage multiplier

Ref.	Rectifier topology	No. of stage	Freq. (MHz)	Tech.	Range (dBm)	Maximum PCE	Size
[51]	Differential	2	433	0.18 µm CMOS	0–20	74% @ 2 dBm	–
[52]	PMOS transistors	7	900	40 nm CMOS	–	44% @ > 390 mV	0.04 mm^2
[53]	Half-wave	4	900	0.18 µm CMOS	–	37.42% @ 390 mV	–
[54]	Comparator-based/active-diode	3	13.56	0.18 µm CMOS	8–15	67.9% @ 12.8 dBm	–
[55]	Dickson	3	13.56	250 nm CMOS	–	72%	0.13 mm^2
[56]	–	–	915	0.13 µm CMOS	−21.6	22.6% @ −16.8 dBm	0.186 mm^2

Prototyping Methods

There's more on this in Scherz, *Practical Electronics for Inventors*.

Solderless Breadboard or **Plugboard**

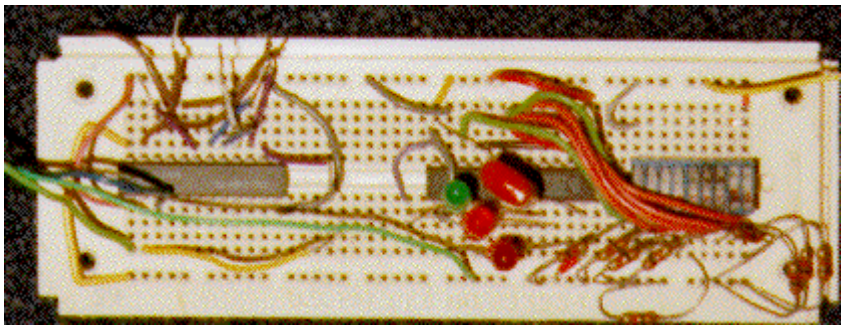

This is what we've been using in lab.

Advantages

- Very fast to build and make changes.
- Works well with DIP ICs

Disadvantages

- Limited reliability—lab testing only, for limited-size circuits.
- High capacitance between adjacent rows (~ 10 pF).
- Only for small-lead-size components (.032" or 0.82 mm max—a 1 A diode lead is just barely too big to meet the spec.)

Springboard

Used in ENGS 22

Advantages

- Fast to build and make changes.
- Accomodates large wire sizes.
- Secure, reliable connections.
- Can handle higher current/power.

Disadvantages

- Can't accommodate small lead spacings such as on ICs.
- Although it is reliable enough for long-term use, it's expensive for that purpose.

Wirewrap

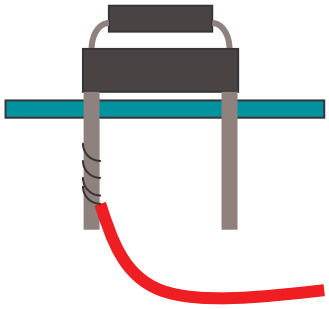

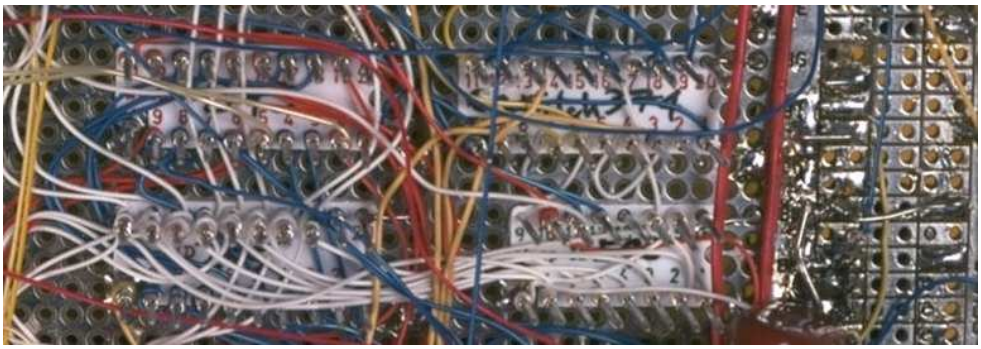

Connections made by fine wire wrapped tightly around square pins of special IC sockets. This is a great way to make a permanent version of a digital circuit almost as quickly as using a solderless breadboard. Used in ENGS 31.

Advantages

- Fast to build and make changes.
- Can make a complex circuit compact.
- Reliable.
- Can be used permanently.
- Inexpensive.

Disadvantages

- Low current—limited to under a few hundred mA.
- High inductance/resistance—on the order of 0.1 ohm, 0.25 μH per foot.
- Only makes reliable connections to square leads (as are on wire-wrap IC sockets). Discrete components (e.g., resistors, capacitors, transistors) need to be soldered to a "header" that goes in an IC socket or to individual wire-wrap pins.

Perfboard and Solder.

Using the same perfboard as used in wire-wrap work, it is possible to simply twist and solder leads, and run wires where needed.

Advantages

- Reliable, if done well.
- Can be used permanently.
- Inexpensive.
- Can handle any size components
- Convenient for working with discrete components.

Disadvantages

- Slow, requires skill to do well.
- Works for ICs, but not very easily.

Variations:

- Perfboard with individual copper pads on each hole so that the solder will better hold things in place. (Photo below)
- Perfboard with a perforated ground plane. Provides the shielding and grounding benefits of a ground plane, and makes ground connections easy, but requires care to avoid shorts. Some have the ground plane etched from around the holes; others require you to cut the copper away from the holes with a special tool. This is also possible with wire-wrap, as in the photo in that section.

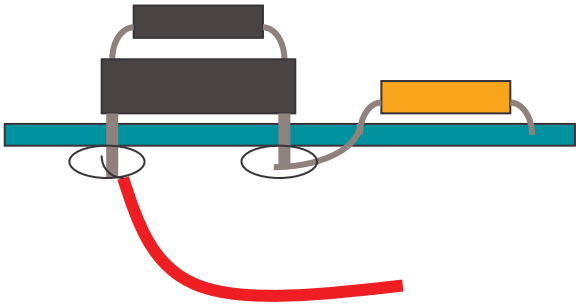

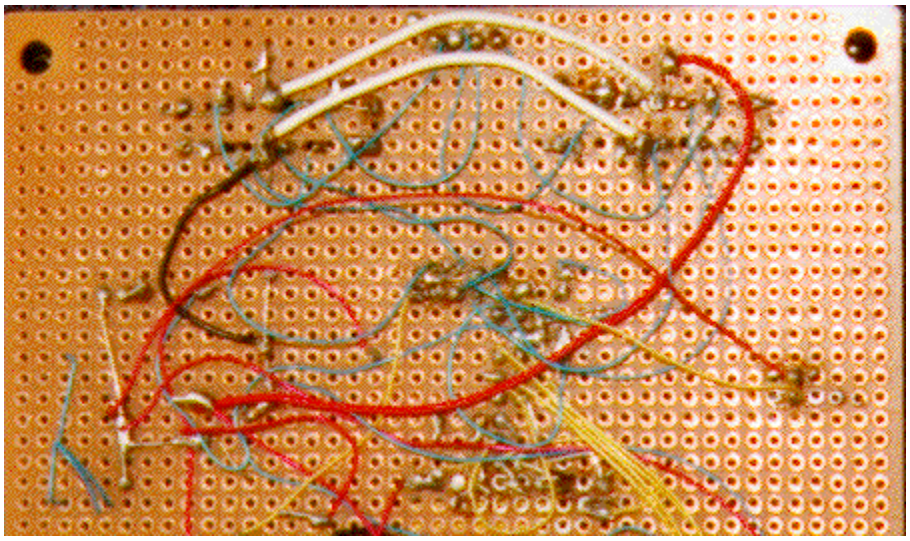

Generic Printed-Circuit Board—multiple hole-per-pad.

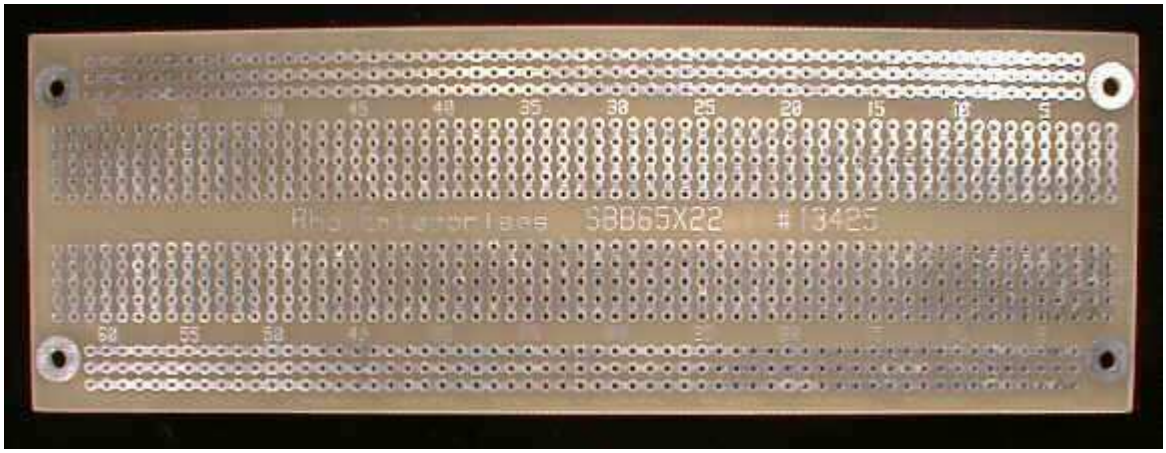

A printed circuit board with a pattern of holes and connections similar to a solderless breadboard.

Advantages

- Easier than using plain perfboard, especially for ICs.
- Reliable.
- Can be used permanently.
- Available with ground planes if needed.

Disadvantages

- Usually not as compact a final circuit as some alternatives, because you are constrained by layout.
- Pads bigger than needed can add capacitance, but not much.
- Can be expensive, especially the “vectorboard” brand.
- Sometimes awkward for odd sized or large components.

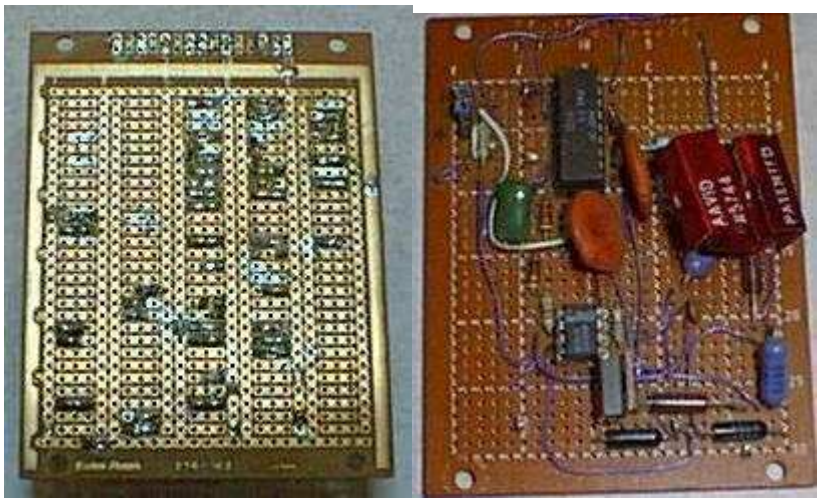

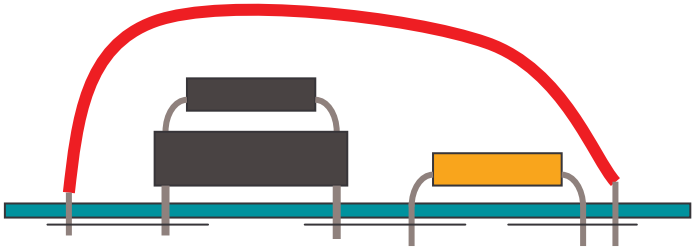

“Dead Bug,” or “Ugly-board”

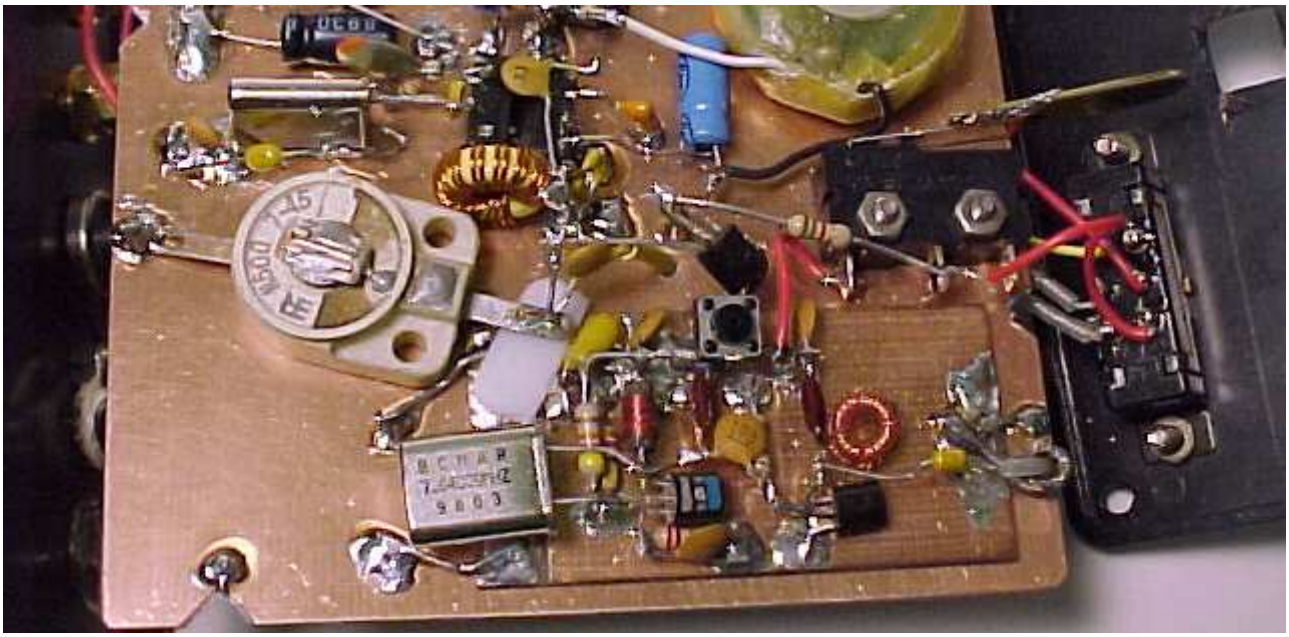

Start with a plain copper-clad board. Glue ICs down with the leads sticking up in the air. Then solder to them

Advantages

- Provides an excellent ground plane. Can be a high performance way to build sensitive and/or high-frequency analog circuits
- Can make a complex circuit compact.
- Reliable.
- Can be used permanently.
- Inexpensive.

Disadvantages

- Requires high soldering skill.
- Takes a long time to build.
- Mechanical support for components is marginal; can add glue (“RTV”) after debugging.
- Only makes reliable connections to square leads (as are on wire-wrap IC sockets). Other components (e.g., resistors, capacitors, transistors) need to be soldered to a “header” that goes in an IC socket or to individual wire-wrap pins.

Variations:

- Manually cut the board with a dremel tool to isolate sections for purposes other than ground plane (use the back for ground plane). See photo below.
- Glue on little rectangles of cut-out board to add power busses, etc.

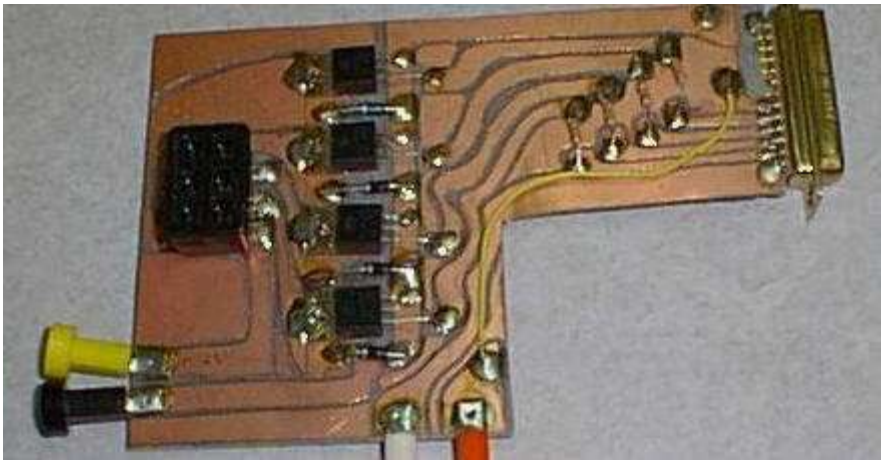

Printed circuit board (PCB)

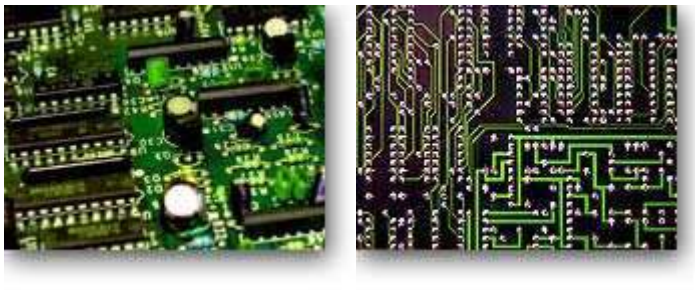

This is what is used virtually universally in production of electronics.

Advantages

- Easy to build in production.
- Repeatable, controllable stray L, C.
- Can handle virtually any component, power level.
- Highly reliable.
- Can make very compact.
- Design can be (somewhat) automated from a schematic you have entered.

Disadvantages

- Laying out the board and getting it fabricated takes time, although you can pay for fabrication in a few days if you can afford it.
- Expensive, on the order of hundreds of dollars for one, but with almost no increase in cost to make many.
- Hard to make changes, but making changes may be easier than building another type of prototype.

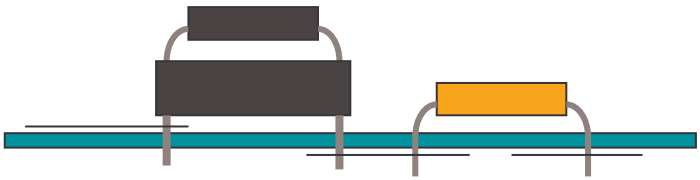

Notes on surface-mount components

Most modern production designs now use surface-mount components instead of “through hole” components. The circuits can be more compact, and the board layout is easier because different things can be done on each side (and in additional layers between sides) without through-holes interfering. But prototyping gets much more difficult!

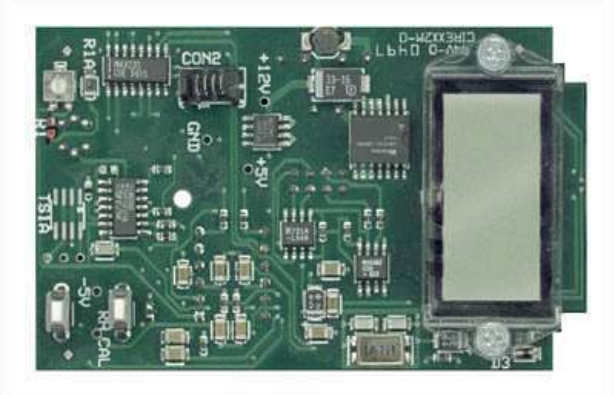

Prototyping options for surface mount

- Simulate, and then lay out a PCB. Don’t ever make a breadboard.
- Order DIP ICs and leaded passives for the prototype, and then switch to surface mount for production.
- Get adaptors that have pads to solder surface-mount ICs to, and then standard-spacing (0.1”) pins in DIP or SIP layout. Digikey carries “surfboards” made by Capital Advanced Technologies, and adaptors made by Aries Electronics. In addition to DIP and SIP adaptors, there are boards with solder pads for connecting larger wires; these work well for prototypes built in “dead bug” style.

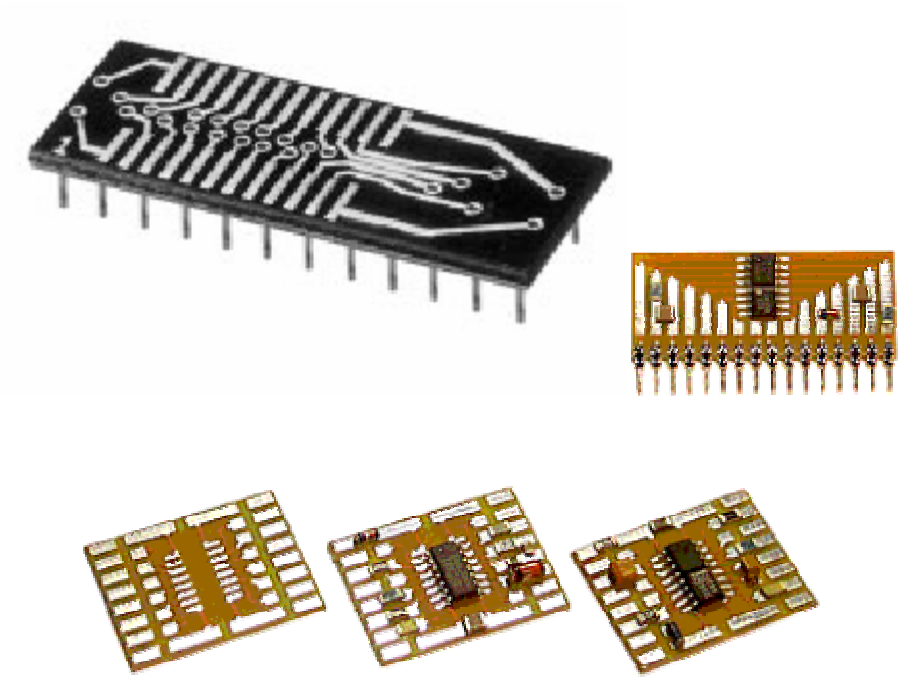

Crystal receiver set 11

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This receiver has a single tuned circuit, the Q factor of the tuned circuit is quite low.
The receiver can be used well for reception of local stations, for reception of distant stations it is less suitable.

I tried to give this receiver a nice "old-fashioned" look, the reception performance was in this design of less importance.
This receiver is for sale, I made a series production of these, and will build more on request.
This receiver is also for sale as do-it-yourself kit.
See the shop for more information.

The front panel of the receiver.
On the left side the socket for the headphone.
In the middle the tuning knob.
On the right the connections for antenna (upper) and ground (lower).

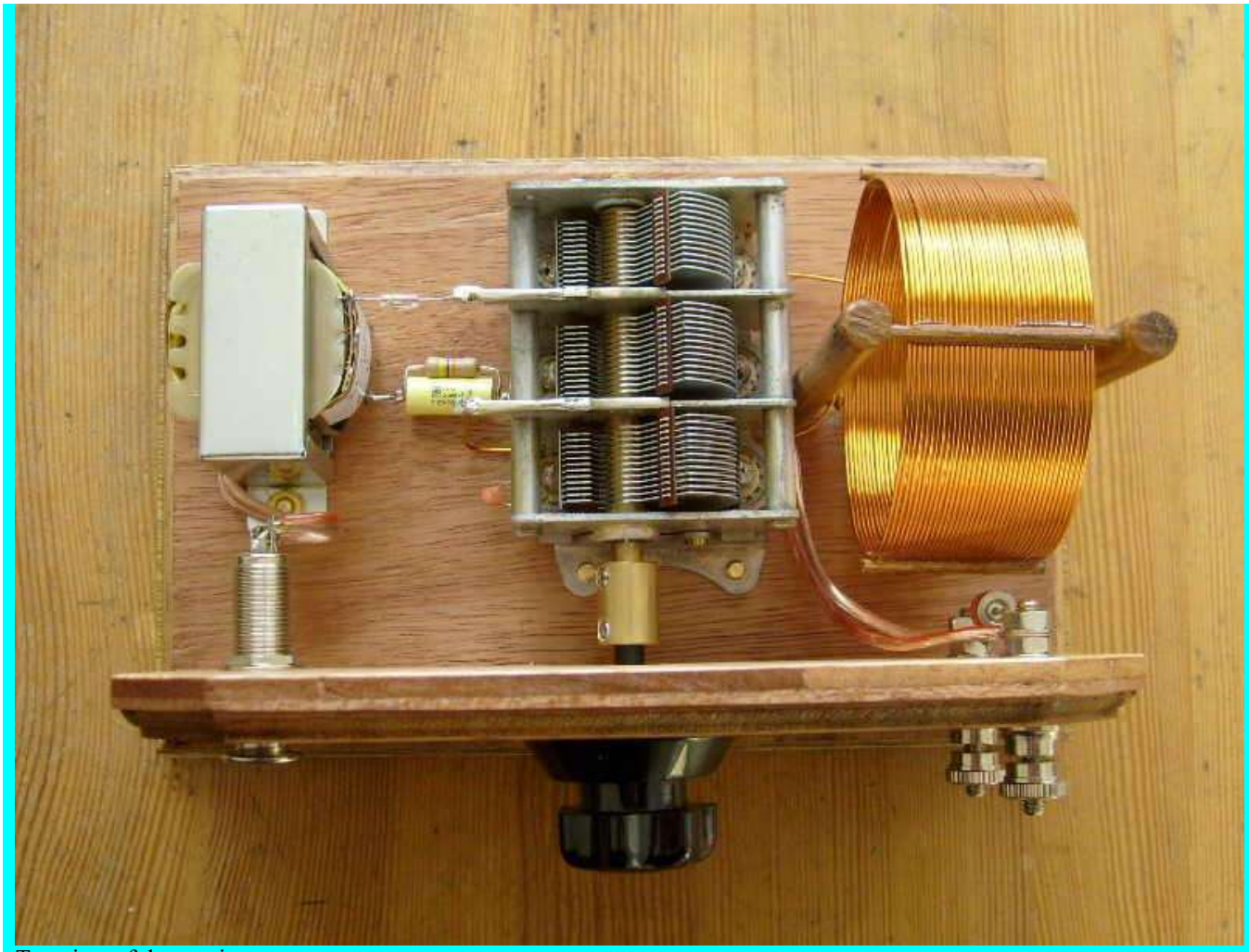

Top view of the receiver.

Circuit diagram of receiver set 11

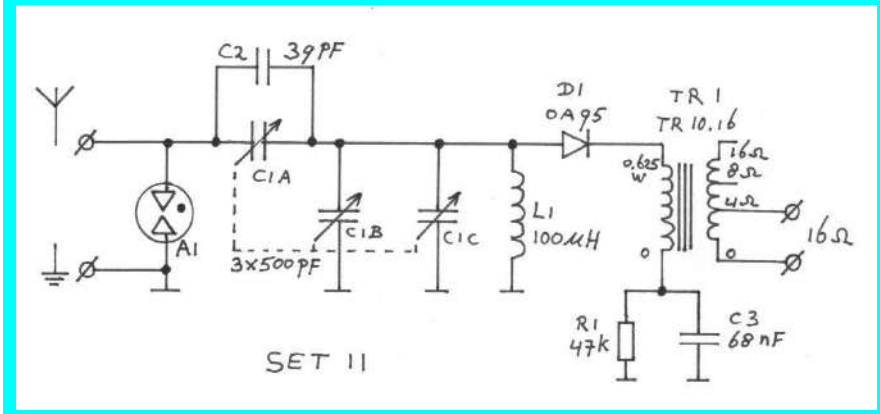

Circuit description.
The resonance circuit is formed by coil L1 and C1b and C1c (together 1000 pF).
Capacitor C1a and C2 provide the matching between antenna and tuned circuit.
The frame (rotor) of the tuning capacitor is carrying the RF signal, by this it is possible to tune simultaneously the tuned circuit (C1b and C1c) and the antenna matching (C1a).
Germanium diode D1 provides the signal detection.
Transformer TR1 is loaded with 16 Ω at its 4 Ω output, through this the input impedance increases from 16 kΩ to about 43 kΩ.
At the output a headphone of 2x 32 Ω can be connected, with the two speakers parallel, the impedance is 16 Ω.

Component A1 is a *gas discharge tube* (also called: *surge arrester*) with type number: N81-A90X.
The gas discharge tube protects the antenna input for too high voltages.

These high voltages can occur if the antenna picks up static charge from the air (especially occurs with long outdoor antennas from non insulated antenna wire).
As the voltage at the antenna is higher then 90 Volt, the gas discharge tube will start to conduct and short the high voltage to ground.
As soon as the charge has flown to ground, the conduction stops automatically.

Frequency range of the receiver.
Frequency range without antenna: 500 - 2500 kHz.
Frequency range with 10 meter antenna connected: 487 - 1860 kHz.
Both with and without antenna connected, the whole medium wave band can be tuned.

Q factor of the LC circuit (Without antenna and without diode connected):
600 kHz: Q= 83
900 kHz: Q= 81
1200 kHz: Q= 75
1500 kHz: Q= 65
The circuit Q is rather low, one reason for this is because the RF signal is in this design on the frame of the tuning capacitor.
Because the frame of the tuning capacitor is directly connected to the wooden bottom plate losses occur here.

You can find a complete building instruction op the following pages:

Step 1 Preparing the components

Step 2 Making the frame of the receiver

Step 3 Making the coil

Step 4 Placing the components

You will find here the part list of this receiver.

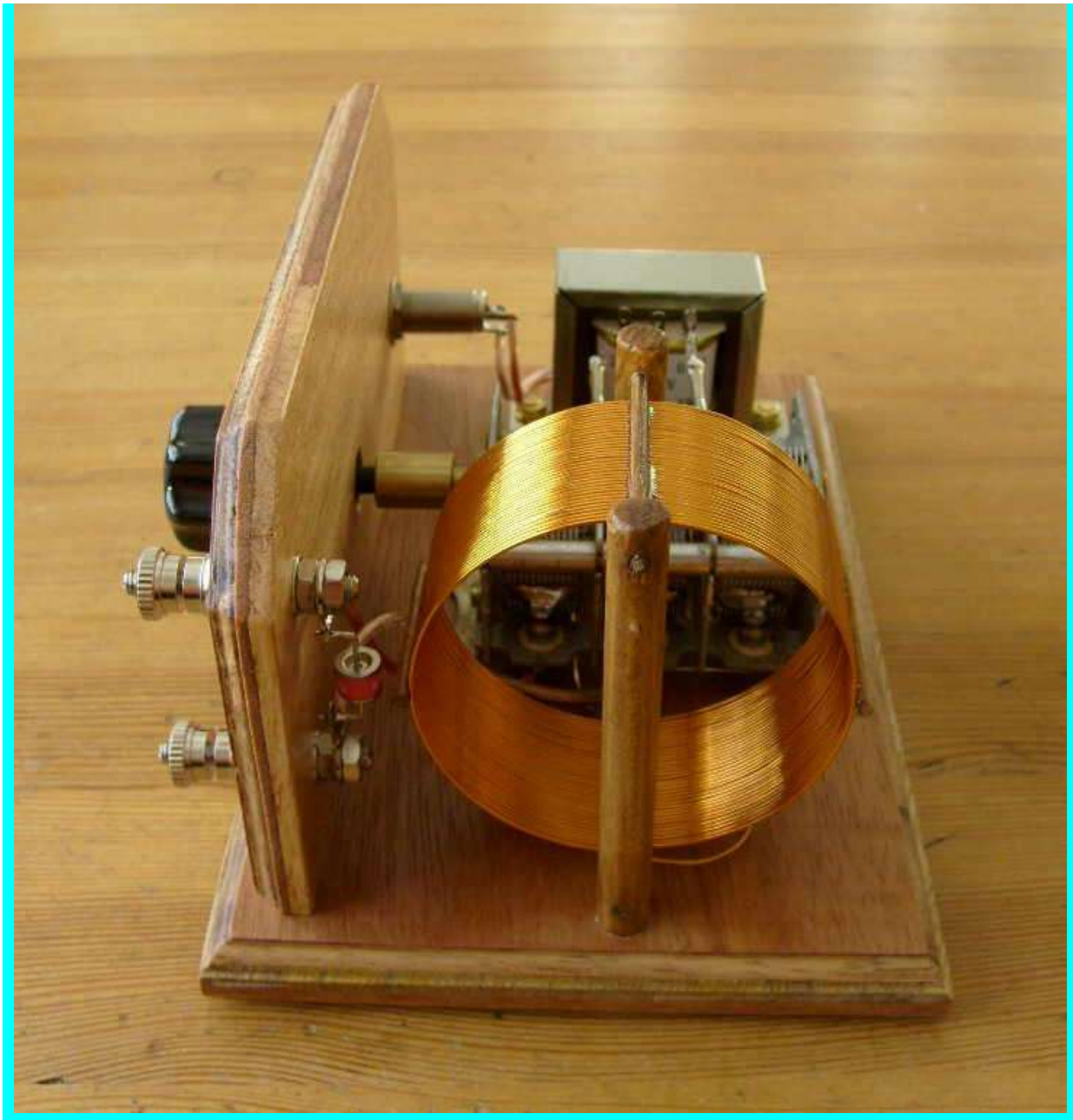

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How to make a batteryless (crystal set) radio

By **Sagar Sapkota** - July 21, 2012

CRYSTAL SET

The simplest radio receiver, known as a Crystal Set, consists of nothing more than a coil, tuning capacitor, diode detector, and a pair of earphones. A typical circuit diagram for a Crystal Set Radio is given below where inductor or coil L1 is tuned by variable capacitor VC1 to the transmitter frequency. Diode D1 demodulates the signal, which is fed straight to the earphones. There is no amplification.

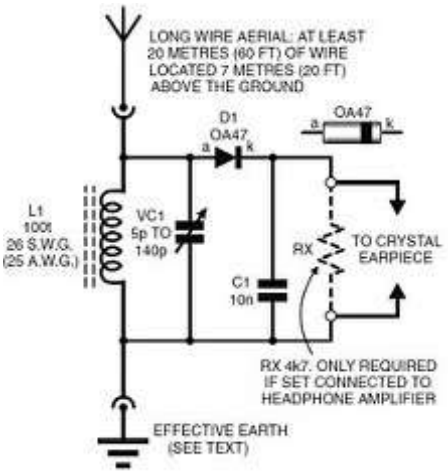

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** You can use 1N34 Germanium diode in place of OA47*

A long (at least 20 metres), high (17 metres or more) aerial and a good earth (a buried biscuit tin or a metre of copper pipe driven into damp ground) are required in order to ensure audible headphone reception. The earphones originally used with these receivers had an impedance of around 4000 ohms and were very sensitive (and heavy and uncomfortable). They are no longer available, but a crystal earpiece, which relies on the piezoelectric effect, will give acceptable results.

Low impedance "Walkman" type earphones are NOT suitable.

Component details:

Resistor- RX-4.7k, 0.25 W- only required if set is connect to audio amplifier

Capacitors- C1- 10nF disc ceramic VC1- 5p to 140p, polythene dielectric variable capacitor.

Semiconductors: D1: OA47 or 1N34- Germanium Diode

Miscellaneous: L1- Ferrite Rod, 100mm(4 inch)x9mm/10mm dia., with coil.

Crystal earpiece and jack socket to suit; plastic control knob; plastic insulated flexible cable for aerial wire, downlead and earth connection, 30 meters minimum; buried biscuit tin or 1 meter of copper pipe for earth system; 50gm reel of 26SWG enamelled copper wire, for tuning coil; card and glue for coil former; multistrand connecting wire; crocodile clips or terminals for aerial and earth lead connection; solder, etc.

READ MY EXPERIENCES- HOW EASILY I MADE A BATTERYLESS RADIO

DRAWBACKS

Quite apart from the absence of amplification, two factors seriously limit the performance of crystal receivers. Germanium diodes become increasingly reluctant to conduct as the applied voltage falls below 0.2V, and this makes the receiver insensitive to weak signals. Silicon diodes have a threshold of around 0.6V, and are, therefore, unsuitable for circuits of this kind.

** Silicon diodes like 1N4001 are not suitable*

The earphone loading imposes heavy damping on the tuned circuit, hence, reduces its ability to separate signals. With such low selectivity insensitivity can be a blessing, and crystal sets are normally only capable of receiving a single, strong transmission on the long and medium wavebands. They will sometimes receive more than one if a shortwave coil is fitted.

The aerial and diode can be connected to tappings on the tuning coil in order to reduce damping, but the improvement in selectivity is usually at the expense of audio output. When valves cost a week's wages and had to be powered by large dry batteries and lead/acid accumulators, the construction of simple receivers of this kind could be justified. With high performance transistors now costing only a few pence or cents, crystal sets are now regarded as 'nostalgic pieces". Some readers may, however, wish to build one out of curiosity, or for the novelty of having a receiver that **does not require a power supply.**

CIRCUIT DETAILS

Ferrite loop aerial L1 and polythene dielectric variable capacitor VC1 form the tuned circuit. Point contact germanium diode D1 (1N34 or OA47) demodulates the signal; capacitor C1 bypasses residual r.f. (radio frequency) to earth and also exhibits a reservoir action, enabling the a.f. (audio frequency) output to approach its peak value. The recovered audio signal is fed directly to a crystal earpiece. Signal voltages

introduced in the ferrite loop aerial by the radiated magnetic field are much too much to produce an output from the detector, and the component is used here simply as a tuning coil. The ferrite core does, however, reduce the number of turns required for the coil winding, thereby reducing its resistance and increasing its audio quality.

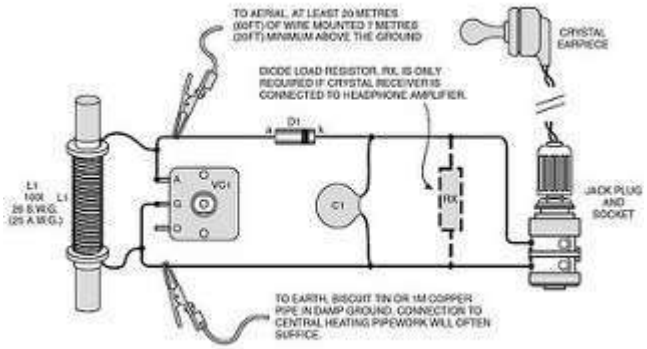

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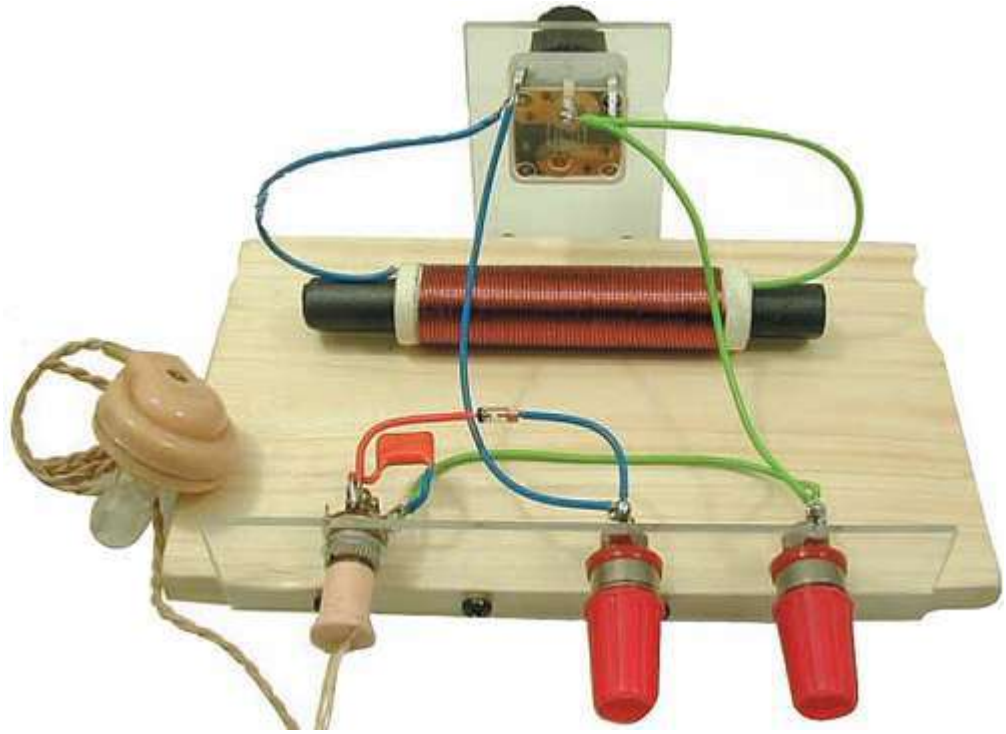

COIL DETAILS

Full construction and winding details for the ferrite tuning/ aerial coil L1 are shown in figure.

The coil is made from 26 SWG(25 AWG) enamelled copper wire, close wound on a cardboard former.

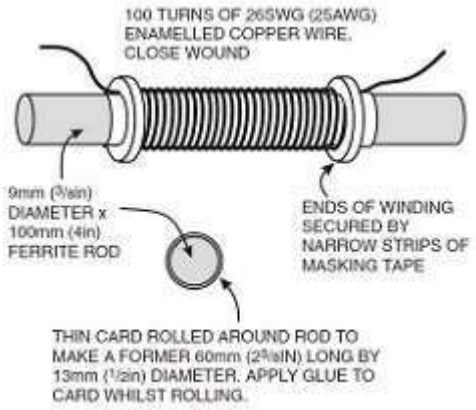

The r.f. bypass capacitor C1 can in practice, be omitted with no noticeable reduction in performance. However, if the set is to be connected to either the headphone amplifier or speaker amplifier decribed next month, the component together with diode, load resistor, RX, must be included.

AMPLIFICATION Audio frequency amplification, after the diode detector will permit the use of low impedance Walkman type earphones or even loud speaker operation. It will do nothing, however, to overcome the diode's insensitivity to weak signals. For this we must have radio frequency amplification of the signals picked up by the aerial before they reach the detector(The standard circuit for a transistor portable receiver has three stages of radio frequency amplification ahead of the diode).

For amplification, you can use a simple audio amplifier using LM386.

READ MY EXPERIENCES ON MAKING A BATTERYLESS RADIO

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Fully printed flexible and disposable wireless cyclic voltammetry tag

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A disposable cyclic voltammetry (CV) tag is printed on a plastic film by integrating wireless power transmitter, polarized triangle wave generator, electrochemical cell and signage through a scalable gravure printing method. By proximity of 13.56 MHz RF reader, the printed CV tag generates 320 mHz of triangular sweep wave from +500 mV to −500 mV which enable to scan a printed electrochemical cell in the CV tag. By simply dropping any specimen solution on the electrochemical cell in the CV tag, the presence of solutes in the solution can be detected and shown on the signage of the CV tag in five sec. 10 mM of N,N,N′,N′-tetramethyl-p-phenylenediamine (TMPD) was used as a standard solute to prove the working concept of fully printed disposable wireless CV tag. Within five seconds, we can wirelessly diagnose the presence of TMPD in the solution using the CV tag in the proximity of the 13.56 MHz RF reader. This fully printed and wirelessly operated flexible CV tag is the first of its kind and marks the path for the utilization of inexpensive and disposable wireless electrochemical sensor systems for initial diagnose hazardous chemicals and biological molecules to improve public hygiene and health.

Cyclic voltammetry (CV) has been used as a powerful tool for the study of electrochemical redox reactions between the electrodes and the solutions of all kind of solutes such as metals[1], organic molecules[2], proteins[3], bacteria[4], viruses[5], and DNA[6]. Because of the high sensitivity of the electron transfer redox reactions, CV could become a very promising ubiquitous electrochemical sensor protocol if the cost and size of the CV system were significantly reduced to commercially viable single-use disposable units for checking traces of hazardous materials such as lead[7], mercury[8], arsenic[9], e-*coli*[10], and pesticides[11] in water or to diagnose the level of glucose[12], cholesterol[13] and specific enzymes[14] in blood. This single-use disposable CV would dramatically reduce the cost of maintaining the public health system[15]. Therefore, inexpensive and disposable CV measurement system that can be operated wirelessly using a smartphone or RF (radio frequency) reader without complicate operation processes is in high demand for the realization of an ubiquitous sensor network system (Figure 1a). They would mainly be used as ubiquitous diagnostic and testing tools for detecting and monitoring the level of target specimens. However, there is no technology that is advanced enough yet to build a wireless, inexpensive and disposable CV system. In this paper, as a form of RF-tag, an extremely inexpensive, disposable and fully printed CV system is demonstrated for the first time by mimicking and combining basic CV concepts and wireless power transmission technologies of RF devices. To realize the fully printed CV tag, a key issue of wirelessly generating triangular waveform (±500 mV) that can scan the electrochemical cell at a low frequency (<1 Hz) to set up a redox reaction needs to be addressed through a minimum number of printed thin film transistors (TFTs). Fully printed 13.56 MHz rectenna and a ring oscillator with large trap charges in the channels of printed TFTs were respectively utilized to wirelessly generate triangular waveform by using only 10 printed TFTs.

Results

Based on two key units of the wireless power transmitter (Figure 1b-①) and the triangular wave generator (Figure 1b-②), the circuit layout of the fully printed wireless CV tag was designed by using a minimum number of printed thin film transistors (TFTs) to alleviate the issue of V_{th} shift and shown in Figure 1b as a platform of disposable CV system. The circuit of CV tag was fabricated using all scalable printing methods, a roll-to-roll gravure, a roll-to-plate gravure, a drop casting, and a screen printer (Figure S1 in Supplementary Information).

To provide a polarized DC voltage from the coupled 13.56 MHz AC signal of the reader, we modified our previously reported R2R gravure printed rectenna[16,17], as shown in the layout in Figure 2a and the resulting

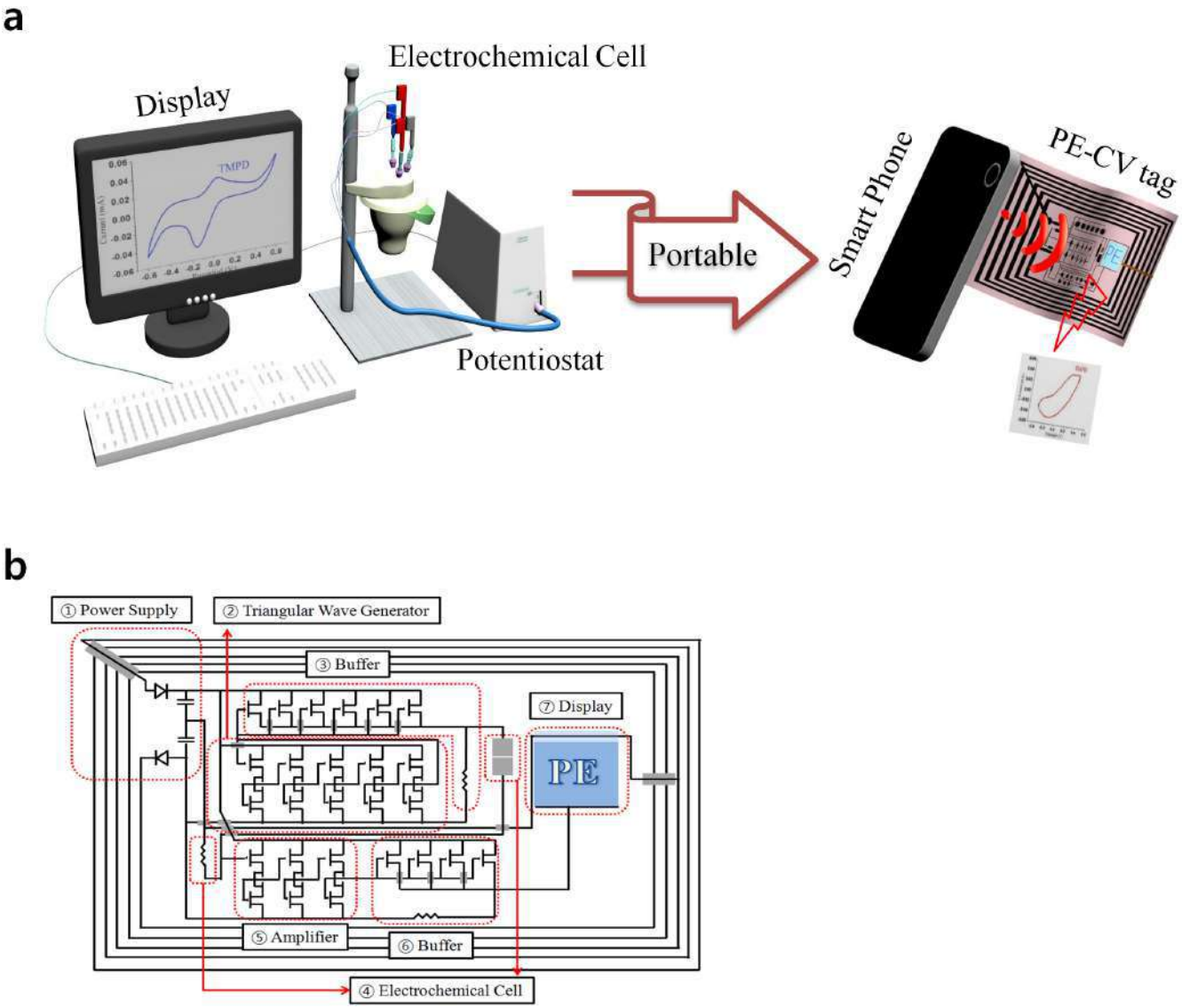

Figure 1 | (a) Informative illustration of typical CV system and disposable printed CV tag. (b) Schematic circuit diagram of the gravure printed wireless cyclic voltammetry (CV) tags. The circuit was designed to couple AC power from a 13.56 MHz reader and then convert the coupled AC to polarized DC ±10 V (① in Figure 1b). Polarized DC will operate the printed ring oscillator to generate a triangular voltage waveform (② in Figure 1b). The generated waveform will pass through the buffer to meet the impedance difference from the electrochemical cell (③ in Figure 1b). The electrochemical cell will run the redox reaction with a single drop of specimen solution (④ in Figure 1b) by the voltage triangular waveform. The output current of the electrochemical redox reaction will be amplified *via* an amplifier circuit (⑤ in Figure b) and the signal will pass through the buffer to meet the impedance difference from the printed signage (⑥ in Figure b). The signage will indicate the concentration level of specimen in the solution (⑦ in Figure b). It will indicate whether the concentration is above or below a pre-determined value.

printed diodes and capacitors are shown in Figure 2b. The printed diodes showed a rectifying ratio of 10^3, and capacitances of two printed capacitors were all about 8 nF/cm^2. The polarized DC voltages (Figure 2c) were measured by placing the printed rectenna on the RF (13.56 MHz) reader with a distance of 2 cm. We adapted a center tap transformer, consisted by divided antenna, 2 diodes and 2 capacitors, to provide the + and − DC voltage for printed triangle wave generator. Using a load of 1 MΩ, voltages of +9.4 V and −10.8 V DC were attained for the optimized printed antenna by monitoring the rectified polarized DC voltages and varying the values of the inductance of the antenna (Figure S2 in Supplementary Information). The polarized DC voltage was also decreased with decreasing load's resistance (Figure 2d).

To generate a cyclic waveform with a low frequency (<1 Hz) from the rectified polarized DC voltage, fully gravure printed *p*-type SWNT-based channel network thin film transistors (*cn*TFTs) were used to construct a five stage ring oscillator with *p*-type inverters. The *cn*TFTs can operate under less than 20 V and their mobility range (0.01 to 10 cm^2/Vs) can be controlled through the loading concentration of SWNT in the ink[18–21]. To print the five stage ring oscillator, we used the same silver and $BaTiO_3$ inks as in the printing of the rectenna for reducing a number of printing steps while SWNT ink was used for printing the channel of the *cn*TFTs. To manufacture the ring oscillator, roll-to-plate (R2P) gravure was used to print 10 *cn*TFTs with a gate width of 300 μm and channel length of 160 μm for both the drive and load *cn*TFTs (Figure S3 in Supplementary Information). The optimized cell depth of gravure plate was 37–40 μm with the cell wall thickness of 50–55 μm for the printing active layers of drive and load TFTs using low viscosity of SWNT based ink (~30 cp) (Figure S4 in Supplementary Information). By repeating the printing of active layers on load TFTs, a higher SWNT network density can be achieved to generate higher current in the

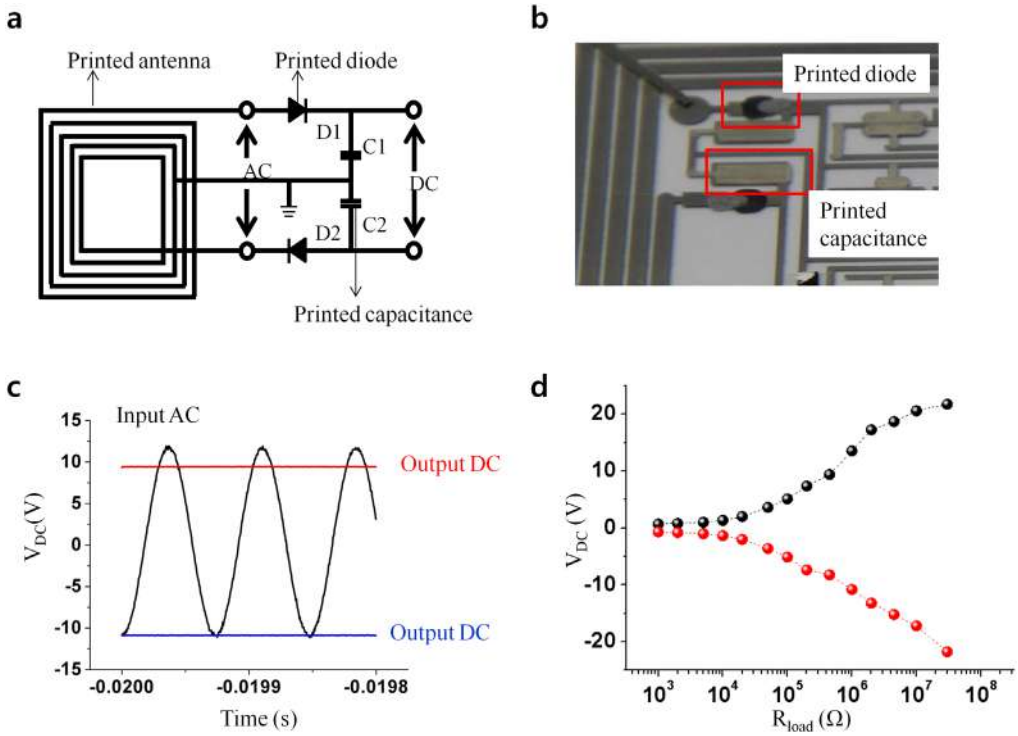

Figure 2 | (a) Circuit layout of the printed rectenna to provide polarized DC power, (b) a real image of printed diodes and capacitors, (c) input-output electrical characteristics of the rectifier at 13.56 MHz AC input and (d) output ± DC voltages under variations in load resistance.

channels while thicknesses of all printed gate, dielectric and drain-source electrodes are kept same (Figure S5 in Supplementary Information).

Their output and transfer characteristics are shown in Figure 3a and 3b respectively. Based on the attained transfer characteristics, the mobility (μ), transconductance (g_m), on-off current ratios from I_{DS}-V_{DS} and threshold voltages (V_{th}) for both five drive *cn*TFTs and five load *cn*TFTs were extracted and shown in Table S1 (Supplementary Information). The shift range of V_{th} from the fully gravure printed 10 *cn*TFTs were about ±0.4 V for the drive *cn*TFTs and ±0.6 V for load *cn*TFTs. Those shift ranges are narrow enough to run the printed ring oscillator for generating the triangular wave. Each inverter delivered a gain of 3 (Figure 3c), and the ring oscillator with five inverters generated a pseudo triangular waveform with a voltage amplitude of 7 V at 320 mHz (Figure 3d). In fact, the pseudo triangular wave can be only generated by the printed *cn*TFTs based ring oscillator because of the parasitic and trapped channel capacitances due to carbon nanotube network structures in *cn*TFTs. Although we only showed the frequency of 320 mHz at here, the frequency can be varied from 0.3 Hz to 2 Hz based on the printed network density of SWNT of printed *cn*TFTs. This is an advantage of our printed *cn*TFTs for scanning electrochemical cell in CV tag over other technologies such as amorphous silicon TFTs where only a sine wave with a designed single frequency can be generated because of no trap capacitance in the channel (Figure S6 in Supplementary Information). The frequency of the triangular waveform can be fine-tuned in the range of 0.3 Hz to 2 Hz as shown in the Figure S7 (Supplementary Information) by simply changing loading concentration of SWNTs.

When the generated triangular waveform is supplied directly into the printed electro-chemical cell (Figure S8 in Supplementary Information), wherein printed silver and carbon electrodes were used with a poly(ethylene oxide) and $LiCF_3SO_3$ gel type electrolyte, the output voltage range is reduced to zero because of improper impedance matching between the electrochemical cell (10 KΩ) and ring oscillator (1 MΩ). Therefore, a buffer unit is needed to match the impedance levels between the ring oscillator and electrochemical cell. The printed buffer unit (Figure 1b-③) with high on currents and low on-off current ratios (Figure 3e) is consists of 6 *cn*TFTs and a resistor (~7 KΩ). In the printed CV tag, three resistors were printed by screen printer using a carbon paste (DC-20, purchased from Dozen Co. Korea) for the buffer units (Figure 1b-③ and ⑥) and the electrochemical cell (Figure 1b-①). Their electrical parameters are listed in Table S1 (Supplementary Information). The 6 *cn*TFTs of buffer unit were printed using R2P gravure with high SWNT concentration in the semiconducting ink. Each *cn*TFTs exhibited on-currents in the range of 400 ~ 500 μA with a very low on-off ratio due to the enhanced metallic percolation in the dense SWNT networks. The buffer units with low on-off ratio were employed to reduce the input voltage to ±500 mV (Figure 3f) which is the appropriate scanning range of the electrochemical cell. The printed electrochemical cell with two electrodes was proven to be well operated under commercial CV (Figure S9 in Supplementary Information). The resulting current after scanning printed electrochemical cell in the CV tag can be converted to voltage by connecting the printed resistor (Figure 1b-④: ~5 × 10^3 ohm) which provides the output voltage for electrochromic indicator and re-plotted into the cyclic voltammogram.

Because these output voltage (±70 mV) and current (~40 μA) were low after scanning the electrochemical cell, they need to be amplified to turn on the electrochromic indicator for showing predetermined concentration (10 mM) level of N,N,N′,N′-tetramethyl-p-phenylenediamine (TMPD, purchased from Aldrich) as a standard reference in this work (Figure 3g). After running the redox reaction of TMPD (Figure 3h) in the printed cell, the output voltage and current needed to be amplified to reach 1.5 V and 500 μA, respectively, to provide sufficient power to display the letters "PE" as an indicator of the presence of TMPD in the specimen. To construct the amplifier, *cn*TFTs based three inverters were printed with a gain of three to five (Figure S10 in Supplementary Information) to amplify the output signal as shown in Figure 3i. The electrical characteristics of the 6 *cn*TFTs in the inverters with extracted mobility, transcon-

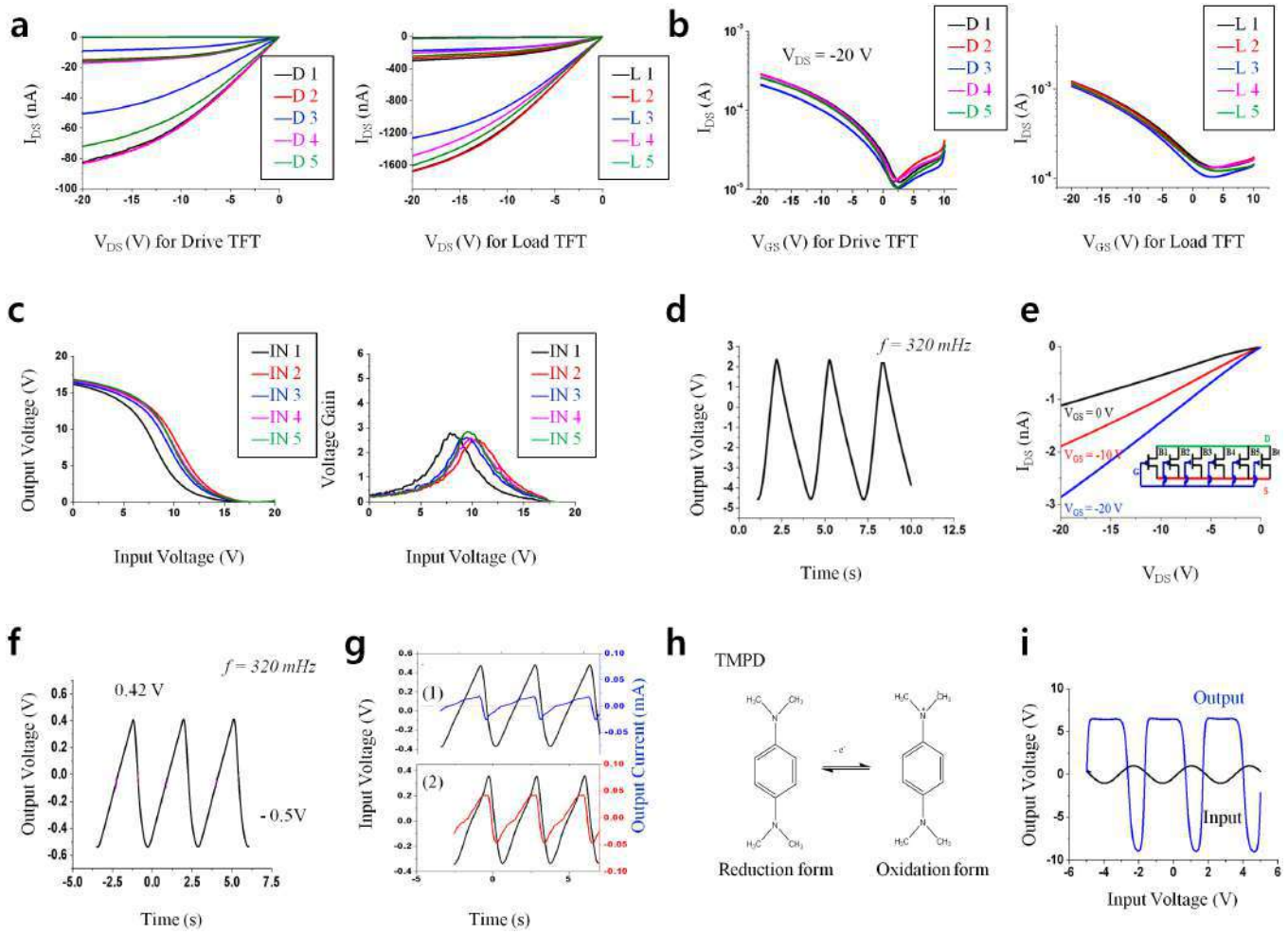

Figure 3 | (a and b) Output and transfer characteristics of the printed *cn*TFTs for 5 drive and 5 load TFTs respectively in the printed ring oscillator. (c) Electrical characteristics of inverters and (d) output characteristic of the ring oscillator. (e) Total output characteristics of the printed buffer unit consisting of 6 *cn*TFTs and a resistor (measured based on contacting gate and drain-source electrodes as shown in the inset circuit). (f) Modified triangular wave following the buffer unit. (g) Generated signals before scanning (black) and after scanning the electrochemical cells without (1, blue) and with TMPD (2, red) in a drop of solution. (h) TMPD structure for oxidation and reduction reaction. (i) The input and amplified output signals after passing through three amplifying inverters.

ductance, on-off current ratios and threshold voltage are shown in Table S2 (Supplementary Information). As the impedance was matched between the ring oscillator and the electrochemical cell using the buffer unit, another buffer unit (Figure 1b-ⓘ) is also needed between the electrochromic signage (20 KΩ) and the amplifier (1 MΩ) for impedance matching. The electrical parameters of the buffer are listed in Table S2 (Supplementary Information).

The amplified output signal was used to run the reduction and oxidation of the patterned conducting polymer in the electrochromic signage, and thus the blinking signage will be used to indicate the presence of chemicals in the specimens. The signage was fully printed and attached on printed CV tag. A clear concept of the printing sequence for the electrochromic signage was given in Figure S11 in Supplementary Information.

Discussion

The fully printed flexible CV tag was completed by assembling the printed circuits including ring oscillator, buffer, electrochemical cell, amplifier, and signage onto the previously R2R gravure printed rectenna. The resultant CV tag is shown in Figure 4a. The working concept of the wireless and flexible CV tag is demonstrated in the following sequences (watch the video file by clicking Figure S12 in Supplementary Information). After dropping 500 μl of TMPD solution (10 mM) on the printed electrochemical cell, the CV tag was placed on the custom made RF (13.56 MHz) reader (Figure S13 in Supplementary Information). The antenna was subsequently coupled to 13.56 MHz AC. The coupled AC was rectified into polarized DC (> ± 10 V) through two diodes and two capacitors which caused the ring oscillator to generate a pseudo triangular waveform with output voltage of 7 V at 320 mHz. This was then passed through the buffer unit to scan the electrochemical cell. The output signal after scanning the electrochemical cell was amplified to turn on the signage according to the concentration level of TMPD in the solution. In this work, whenever the concentration of TMPD was higher than 10 mM, the signage "PE" blinked (Figure 4b) while it did not show anything (Figure 4c) when it was lower than 10 mM. Furthermore, clear cyclic voltammograms for scanning the electrochemical cell with and without 10 mM of TMPD were obtained by re-plotting the output triangular voltage waveform (Figure 4d). The attained half potential ($E_{1/2}$ ~ 0.05 V, oxidation potential is 0.22 V and reduction potential is −0.17 V) of TMPD from the CV tag was nearly identical to the value obtained from a commercial CV instrument, SP-240, Biologic, which uses the same frequency for the triangular voltage waveform and printed electrochemical cell (Figure 4e). However, when the generated triangle wave frequency is higher than 0.6 Hz in the CV tag, the clear redox peaks cannot be

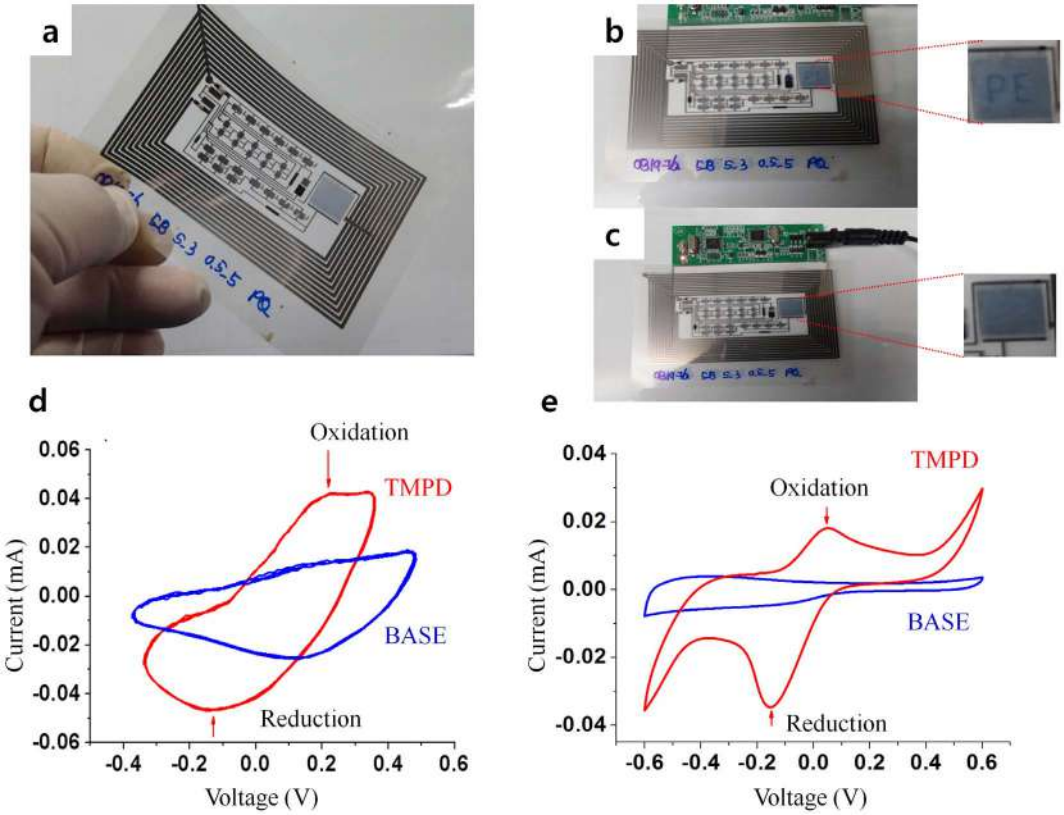

Figure 4 | (a) Optical image of fully printed wireless cyclic voltammetry tag. (b) Operation images of CV tag with and (c) without TMPD in the solution on 13.56 MHz reader. (d) Converted cyclic voltammogram from the printed wireless CV tag *vs* (e) a commercial CV instrument (please refer the interconnected video file for the demonstration of wireless CV tag operation in Figure S12 in Supplementary Information).

observed as shown in Figure S14 (Supplementary Information). Furthermore, as a typical example of testing a specimen in aqueous solution, 10 mM of $K_3(FeCN)_6$ aqueous solution was checked using the CV tag, and results of converted cyclic voltammogram was shown in Figure S15 (Supplementary Information). Those results support that the CV tag can examine specimens not only in organic solution, but also in aqueous one.

Up to present, there has been no commercial success in fully printed TFT-based electronic devices due to some kind of difficulties in integrating a number of printed TFTs through a scalable printing method. As increasing a number of integrated TFTs, the range of threshold voltage shits of TFTs needs to be controlled as narrow as possible to properly operate designed function of printed devices. However, the scalable printing method is not fully understood to integrate a number of TFTs on plastic foils while keeping the constant range of threshold voltage shifts because of difficulty in controlling a constant charge transport through the printed channels. Therefore, the printed TFT-based devices should be constructed by using a minimum number of printed TFTs while a function of printed device needs to be competitive over Si based one. Since the fully printed CV tag required the integration of only 26 *cn*TFTs, the acceptable range of threshold voltage shits of *cn*TFTs is controllable and achievable by using a scalable printing method such as a roll-to-roll gravure. Furthermore, the unique function of printed CV tags cannot be simply reproduced using a Si technology with a comparable cost to the R2R printing process. Therefore, the fully printed CV tag will be the first leading model to show a way of how printed TFT-based electronic devices should go for the successful launching in the IT markets.

In the core of the printed CV tag, fully gravure-printed *cn*TFTs were employed for constructing a circuit consisting of a ring oscillator to generate triangular waveforms, buffer units for an impedance matching, and an amplifier for enhancing output signal to turn on the signage. Those simple units can be combined with a variety of printable sensors and RF devices to create novel devices with an extremely low cost. In other words, the printed rectenna, ring oscillator, buffer and amplifier units in the printed CV tag will be key elements for the construction of variety of printed RF-sensors, this CV tag will be used as a platform for the further construction of a variety of RF based electrochemical sensors.

In conclusion, we have presented a fully printed flexible CV tag with the size of 9.5×5.5 cm^2 that can operate wirelessly using a 13.56 MHz RF reader. However, for the practical purpose, the size of the CV tag can be reduced up to the half (4×2 cm^2) of the current one by optimizing spaces between *cn*TFTs in the circuit of the CV tag and reducing the operation power to less than DC 5 V as the current size of 13.56 MHz antenna is designed to provide maximum coupled AC power using a sufficient length of printed antenna pattern (higher inductance). Furthermore, although we utilized R2P gravure, screen printer and drop casting method for the convenience of fabricating the CV tag in the Lab, the whole fabricating process can be repeated by R2R gravure because the rectenna, ring oscillator, buffers, electrochemical cell, amplifier and signage in the CV tag were all designed to compromise the limit (± 20 μm) of a registration accuracy of a current R2R gravure system. Therefore, this technology could be used as a platform for disposable wireless electrochemical sensors to a variety of specimens in aqueous and organic solutions to monitor or diagnose pathogens and hazardous materials by modifying the electrodes of the electrochemical cells.

Methods

Roll-to-roll (R2R) gravure printed antenna, bottom electrodes, gate electrodes and wires. Two color units of R2R gravure system (Taejin Co. Korea: Figure S1 in the Supplementary Information) was employed to print antenna, bottom electrodes and wires on a roll of poly(ethylene terephthalate) (PET) film (width of 200 mm and

thickness of 100 μm, purchased from SKC, Korea) with silver nanoparticle based conducting ink (PG-007 BB type, Paru Co. Korea) and the web transfer speed of 8 m/min under roll pressure of 0.5 MPa and web tension of 60 N. The silver ink was further formulated to meet the viscosity of 500 cp and surface tension of 47 mN/m using respectively ethylene glycol (Aldrich) and Dipropylene glycol methyl ether (Aldrich). The curing time of printed silver layer was 10 sec by passing through a heating chamber of 150°C, installed in R2R gravure system. The resulting printed silver patterns on PET roll showed the thickness of 450 (±50) nm without any defects and were shown in Figure S16a (Supplementary Information).

Roll-to-plate (R2P) gravure printed ring oscillator, buffer, and amplifier. Full R2P gravure system (Figure S1 in the Supplementary Information) was employed to print single walled carbon nanotube network based thin film transistors (*cn*TFTs), used as a building block to construct all the integrated circuit of printed cyclic voltammetry (CV) tag (Figure 1). 26 *cn*TFTs for the integration of circuit in printed CV tag were printed on the previously R2R gravure printed film (printed antenna, bottom electrodes and wires with thickness of 450 nm; Figure S16b in Supplementary Information) following printing sequences. First, $BaTiO_3$ nanoparticle based dielectric ink (PD-100, Paru Co., Korea) was further formulated to meet viscosity (75 cP) and surface tension (31.8 mN/m) using the ethyl 2-cynoacrylate (Aldrich). As shown in R2P gravure printing scheme (Figure S17 in Supplementary Information), the homogeneous and defect free dielectric layers were first R2P gravure printed with a printing speed of 200 mm/s and roll pressure 7.5 kg_f on previously printed gate electrodes and bottom electrodes (for capacitors) with a thickness of 2.3 (±0.1) μm and width of 940 (±2) μm (Figure S5 in Supplementary Information). The printed dielectric layers were cured for 1 min 20 sec at 150°C. Second, single walled carbon nanotube (SWNT) based semiconducting ink (PR-040, Paru Co., Korea) was diluted by diethylene glycol monobutyl ether (Daejung Co., Korea) to 1 : 1 volume ratio for printing active layers using R2P gravure on the printed dielectric layers with a printing speed of 350 mm/s and a roll pressure of 4 kg_f. The viscosity and surface tension of diluted SWNT ink were respectively 30 cP and 29 mN/m. The resulting SWNT printed films were dried 1 min at 150°C. For using *cn*TFTs in the buffer unit, we used the dilution volume ratio of 5 : 1 between SWNT ink (PR-040, Paru Co., Korea) and diethylene glycol monobutyl ether for printing only on the TFTs in the buffer unit to increase SWNT network density for providing the high current (Figure S5 in Supplementary Information). Finally, drain-source electrodes were R2P gravure printed using silver nanoparticle based ink (PG-007 AA type, Paru Co., Korea) on SWNT printed film with a viscosity of 800 cP and a surface tension of 42 mN/m. The R2P gravure printing was carried out under a printing speed of 200 mm/s and a role pressure of 5 kg_f.

Diode fabrication. Although Shottky diodes were able to print using R2R gravure based on our previous reported process[16,17], the drop casting method was used for the convenience in this work. First, dropping ZnO based hybrid semiconducting ink (PD-070, Paru Co., Korea) on printed silver electrode and then, Al ink (PA-009, Paru Co., Korea) was dropped on the top of ZnO ink. The resulting diodes were further cured for 5 min at 120°C.

Measurements. Formulated and diluted inks were characterized using DCAT21 (Dataphysics Co., Germany) and SV-10 Vibro viscometer (AND Co., Japan) for respectively measure surface tension and viscosity. All measurements in this work were carried out under ambient condition if there are no other comments. Resistance of printed antenna, bottom electrodes, gate electrodes and wires were measured using two probe methods with HP3457A multimeter. Both surface morphology and thickness of printed layers was characterized using surface profiler (NV-2200, Nanosystem, Korea). LCR meter (E4980A, Agilent, USA), semiconductor parameter analyzer (4155C, Agilent, USA) and digital phosphor oscilloscope (DPO 4054, Tektronix, USA) were respectively used to characterize printed *cn*TFT based circuits.

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Author contributions

Y.J., A.J. and G.C. designed the experiments. Y.J., H.P., J.P., Y.C. and M.J. carried out the experiments. J.N., K.J. and K.C. performed device simulations. Y.J. and K.C. performed mobility calculations. Y.J. and M.P. performed electrochemistry and analyzed electrochemical data. Y.J., H.P., M.P., A.J. and G.C. contributed to analyzing the data. M.J., M.P., A.J. and G.C. wrote the paper while all authors provided feedback.

Additional information

Supplementary information accompanies this paper at http://www.nature.com/scientificreports

Competing financial interests: Prof. Cho was a consultant of PARU Co. Korea and received compensation from PARU Co. Both Dr. M. Jung and Mr. K Jung has been employee of PARU Co. Korea. Dr. Y. Jung, Miss H. Park, Ms. J. Park, Dr. J. Noh, Mr. Y. Choi, Prof. Pyo, Mr. K. Chen and Prof. Javey declare no competing financial interests.

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A microwave metamaterial with integrated power harvesting functionality

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A microwave metamaterial with integrated power harvesting functionality

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We present the design and experimental implementation of a power harvesting metamaterial. A maximum of 36.8% of the incident power from a 900 MHz signal is experimentally rectified by an array of metamaterial unit cells. We demonstrate that the maximum harvested power occurs for a resistive load close to 70 Ω in both simulation and experiment. The power harvesting metamaterial is an example of a functional metamaterial that may be suitable for a wide variety of applications that require power delivery to any active components integrated into the metamaterial. © *2013 AIP Publishing LLC*. [http://dx.doi.org/10.1063/1.4824473]

Metamaterials are composed of sub-wavelength particles that exhibit bulk properties that are different from their individual components. Electromagnetic metamaterials are engineered materials that can achieve parameters not possible within naturally occurring materials, such as a negative index of refraction[1] or a zero index of refraction.[2] Exotic properties like these allow for a variety of interesting applications including a superlens device[3] and an invisibility cloak.[4] Integrating active and nonlinear functionality into metamaterials has been demonstrated in the form of dynamic resonant frequency tuning,[5,6] phase conjugation,[7] and wave mixing.[8,9] More specific functional behavior has also been demonstrated in metamaterials, including radio frequency (RF) limiting[10] and harmonic generation.[11]

Metamaterials are also well-suited for other functional behaviors, including electromagnetic power harvesting, the focus of this work. Power harvesting devices convert one type of energy to another, typically converting to a direct current (DC) signal. Many types of energy can be harvested, from acoustic (using a piezoelectric harvester)[12] to electromagnetic (using a rectenna).[13] Power harvesting devices require a method to couple to the energy that will be harvested as well as a device to convert the energy from one form to another. By their very nature, metamaterials are designed to couple to various types of energy, e.g., from acoustic[14] to optical,[15] and thus provide a natural platform for power harvesting. Electromagnetic metamaterials provide flexibility in design due to their electrically small, low-profile nature.[16] Since metamaterials are typically designed as infinite arrays, the resonant frequency and input impedance include coupling effects. Metamaterials can be adapted to various applications, such as flexible sheets to cover surfaces.[17] Moreover, many metamaterials that have been presented in the literature require some form of external signal. This could be a DC bias voltage[18] or a large external pump signal.[7] In general, metamaterials could be modified to harvest such an external signal that is already present for other purposes. With these design advantages, power harvesting metamaterials offer design flexibility for a large number of applications that general antenna-based microwave power harvesting devices may lack.

A recent simulation-based study[19] investigated the conversion efficiency between incident RF power and induced power in a split-ring resonator (SRR). Our work is focused on the experimental measurement of RF to DC efficiency based on the conventional effective area of the SRR. We demonstrate that metamaterials can also include embedded devices to convert the incident RF energy to a DC voltage, providing a platform for power harvesting that utilizes the advantages of metamaterial design.

An SRR is a canonical example of a resonant metamaterial particle and is used as the basis for the unit cells of the metamaterial power harvester designed here. By tuning the SRR parameters, we design an SRR (Fig. 1) to resonate at 900 MHz using an S-parameter simulation within Computer Simulation Technology (CST) Microwave Studio software. Using CST Microwave Studio, we can also simulate the effects of embedding devices within the SRR by retrieving its S-parameters using a lumped port. The retrieved S-parameters are loaded into Agilent Advanced Design System (ADS), allowing us to simulate both fullwave 3D effects and circuit-level nonlinear effects.

An SRR couples strongly to an incident magnetic field and can be loaded with a wide variety of circuit elements. In this work, we embed a rectifying circuit within an SRR to convert the incident RF power to DC power. A number of rectifying circuits could be chosen depending on the particular application for the power harvesting metamaterial. We choose to use a Greinacher[20] circuit because the output voltage is double the input voltage maximum, which allows for

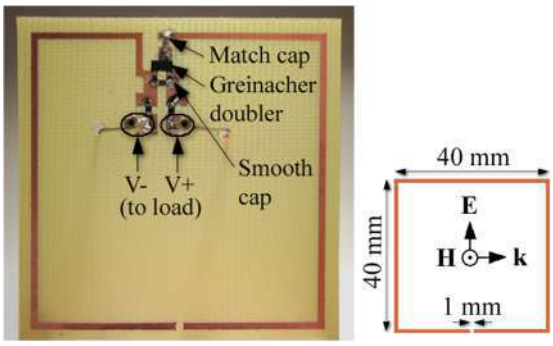

FIG. 1. (Left) Power harvesting SRR. (Right) Plain SRR with dimensions shown, 1 mm traces. Incident wave polarization is also shown.

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easier power transmission and measurement. A Greinacher circuit has a lower effective capacitance in comparison to other rectification circuits (such as a bridge rectifier), allowing faster switching and thus a higher frequency of operation. A Greinacher circuit also has a low threshold voltage, allowing operation at lower incident power levels. A Greinacher voltage doubler can be placed across a gap (Fig. 1) in the top side of the copper trace to rectify the induced current present in the SRR. Schottky diodes are used for the voltage doubler due to their typically low open junction capacitance and fast switching capabilities, which allow for rectification of a high-frequency RF signal, as well as their typically low threshold voltage. A resistive load placed across the output of the voltage doubler is a simple way to determine DC power out using $P = V^2/R$. This DC power is maximized through ADS for matching capacitor and resistor values. The parameters of our selected Schottky diode (HSMS 2862) and the simulated S-parameters of the above SRR in a model of our actual parallel-plate waveguide are input into ADS for the simulation, shown in a schematic in Fig. 2.

The simulated components lead to a maximum efficiency of 61% for an input power of 24.25 dBM, the maximum available experimental power (at an incident power density of approximately 1.6 mW/cm^2). One important figure of merit for a power harvester is its RF-to-DC power conversion efficiency:

$$\eta = \frac{P_{DC}}{P_{RF}}.$$

We determine P_{RF} by measuring the total incident power in our measurement apparatus. For a large metamaterial sample, we assume that the total incident power to the measurement apparatus is incident on the metamaterial. For a single unit cell, it is necessary to use the effective area of the unit cell to determine the incident P_{RF}. The maximum effective area may be calculated by[21]

$$A_{e,max} = \frac{\lambda^2}{4\pi} D_0,$$

where $D_0 = 1.5$ since the SRR is effectively a small loop illuminated by a transverse electromagnetic (TEM) wave. For an SRR resonant at 900 MHz, the effective area is thus $A_{e,max} = 5.3A_{physical}$. The full waveguide area is

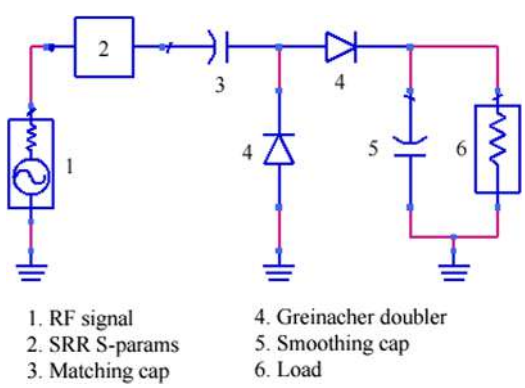

FIG. 2. ADS simulation schematic of SRR power harvester. CST Microwave Studio was used to determine the SRR S-parameters.

FIG. 3. Placement of SRR within open waveguide.

approximately $6.8A_{physical}$ where $A_{physical}$ is the physical area of a single SRR unit cell. As $A_{e,max}$ is 78% of the open wave guide area, 78% of the incident power density is used as input power for simulation of the single cell.

The designed voltage doubler and resistive load are added to an SRR as shown in Fig. 1, resulting in the power harvesting metamaterial unit cell. To observe power harvesting capabilities, the cell is placed in an open, TEM waveguide (Fig. 3) where input power is produced by a signal generator and amplifier, and output power is measured with an oscilloscope via leads placed across the resistive load (Fig. 4). The DC power harvested is determined by $P = V^2/R$ as previously mentioned, and input power is measured with a spectrum analyzer connected to the signal generator and amplifier via the open waveguide. By increasing the incident power from 13 to 24 dBm and measuring the DC output from the SRR, the normalized harvested power, $P_{DC}/P_{RF,incident}$, as a function of incident power $P_{RF,incident}$ and resulting efficiency are determined at each point. The maximum efficiency of the single cell is 14.2%, setting $P_{RF,incident}$ as 78% of the total input power from effective area calculations.

Multiple power harvesting SRR cells are then tested simultaneously to create the power harvesting metamaterial, which is accomplished through a 5×1 array shown in Fig. 5. Through a parallel connection of the leads from each SRR's resistive load, the total power harvested by the metamaterial is found in the same way as the single cell. The maximum efficiency for the 5×1 array is 36.8%, where P_{in} is the entire input power because the array spans the entire length. Measured efficiencies of both the single and the array of power harvesting SRRs are shown in Fig. 6. Also shown in Fig. 6 is the open circuit voltage, V_{OC}, a load-independent measure of the available voltage harvested by the array of SRRs.

The power harvesting metamaterial array is more efficient than the single unit cell. This is partially due to the

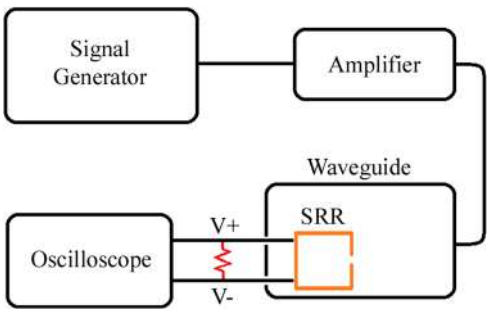

FIG. 4. Experimental test setup schematic.

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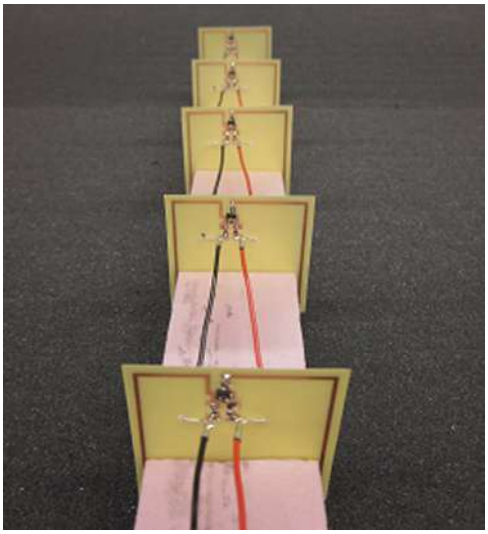

FIG. 5. 5×1 array of power-harvesting SRRs.

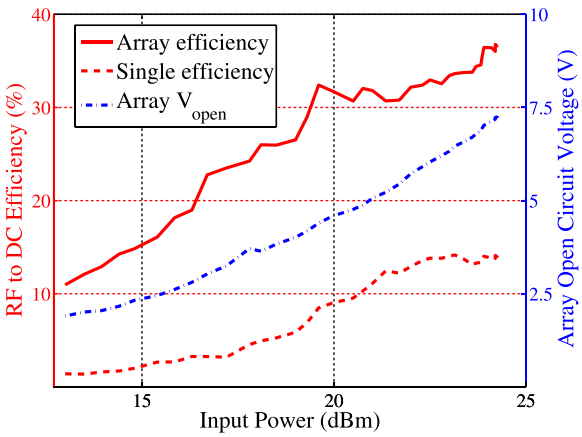

FIG. 6. RF to DC efficiency of power harvesters. The open-circuit voltage of the array is also shown.

larger effective area of the array. While the effective area of the single cell is 78% the entire width of the waveguide, some of this power is not harvested by the single unit cell due to fringing effects on the sides of the waveguide. For this reason, placement of multiple cells that together span the entire waveguide width results in a higher efficiency as the array captures more of the electromagnetic energy that undergoes the fringing effect.

Another important relationship is the efficiency of the power harvesting metamaterial as a function of load resistance. Simulated and experimental efficiencies for the 5×1 array are shown in Fig. 7. Though the experimental efficiencies do not match the values from simulation, the simulation does accurately predict the maximum harvested power as falling approximately within the range of 70–80 Ω, confirmed by the experimental data. The experimental efficiency maximum occurs at 70 Ω, and the simulated maximum occurs at 82 Ω, showing close correspondence.

In summary, we have designed, simulated, and experimentally measured a functional metamaterial power harvester capable of converting up to 36.8% of the incident RF power to DC power. Through a parallel connection of five SRRs, a V_{OC} of 7.3 V is achieved. Simulations match

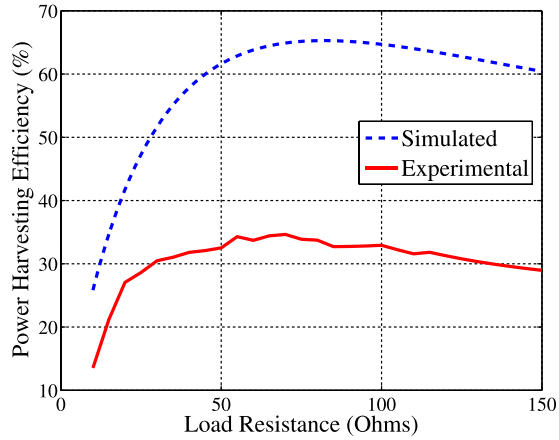

FIG. 7. RF to DC efficiency of SRR array as a function of load resistance, for both simulation and experiment. Note that both show maximum efficiency for around 70–80 Ω.

experimental results showing an optimal resistive load for DC power transfer of 70–80 Ω. The SRR power harvester is an example of functional metamaterial that may be suitable for a wide variety of RF applications that require power delivery to any active integrated components.

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Ambient RF Energy Harvesting in Urban and Semi-Urban Environments

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***Abstract*—RF harvesting circuits have been demonstrated for more than 50 years, but only a few have been able to harvest energy from freely available ambient (i.e., non-dedicated) RF sources. In this paper, our objectives were to realize harvester operation at typical ambient RF power levels found within urban and semi-urban environments. To explore the potential for ambient RF energy harvesting, a city-wide RF spectral survey was undertaken from outside all of the 270 London Underground stations at street level. Using the results from this survey, four harvesters (comprising antenna, impedance-matching network, rectifier, maximum power point tracking interface, and storage element) were designed to cover four frequency bands from the largest RF contributors (DTV, GSM900, GSM1800, and 3G) within the ultrahigh frequency (0.3–3 GHz) part of the frequency spectrum. Prototypes were designed and fabricated for each band. The overall end-to-end efficiency of the prototypes using realistic input RF power sources is measured; with our first GSM900 prototype giving an efficiency of 40%. Approximately half of the London Underground stations were found to be suitable locations for harvesting ambient RF energy using our four prototypes. Furthermore, multiband array architectures were designed and fabricated to provide a broader freedom of operation. Finally, an output dc power density comparison was made between all the ambient RF energy harvesters, as well as alternative energy harvesting technologies, and for the first time, it is shown that ambient RF harvesting can be competitive with the other technologies.**

***Index Terms*—Ambient RF, energy harvesting, maximum power point tracking (MPPT), multiband, rectenna, RF survey, RF-dc.**

I. Introduction

FOR ALMOST 50 years, far-field RF technology has been used to remotely power systems from relatively large unmanned helicopters [1] to very small smart dust sensors [2] and contact lenses that measure eye pressure [3]. With all these systems, a dedicated RF source is used, where the operator may have control over the effective isotropically radiated power (i.e., both transmit power and antenna characteristics), beam pointing and polarization of the RF source, ensuring optimal line-of-sight operation between the source transmitter (TX) and harvesting receiver (RX). It is important to highlight that this work will focus only in radiative power transfer and not inductive or near-field power transfer, as demonstrated in [4]. A more convenient solution, however, is to power these devices from ambient RF energy sources, such as television and mobile phone signals, thus removing the need for a dedicated source. As ambient RF levels are lower than those that can be provided by a dedicated RF source, the efficiency of the harvesting system, and its minimum startup power are of critical importance.

In order to assess the feasibility of deploying ambient RF energy harvesters, the available RF power needs to be measured in different locations. Such measurements, in conjunction with knowledge on harvester performance, can then be used to determine the locations at which RF harvester powered devices can be successfully deployed. Several RF spectral surveys, which measure ambient RF power levels from sources such as television and mobile phone base stations, have been previously reported. Many have been undertaken using personal exposimeters or spectrum analyzers, where the exact location of each measurement is unknown and with RF power levels only being reported under general scenarios (e.g., outdoor, indoor, street, bus, etc.) [5], [6]. While being of academic interest for health-related research [7], the lack of power level and specific time/location information limits their usefulness for exploitation in ambient RF energy harvesting applications.

Most rectennas (normally comprising an antenna, impedance matching network, rectifier, storage element, and load) presented in the open literature have been tested using dedicated sources rather than harvesting from ambient RF energy [8]. In recent years, efficiencies as high as 78% [9] and 90% [10] have been demonstrated with relatively high input RF power levels (i.e., $> +10$ dBm). Moderate efficiencies have also been achieved using dedicated TXs that provided relatively low input RF power levels; e.g., an efficiency of 60% was achieved with -22.6-dBm input power [11]. In one demonstrator [12], designed to operate over a broad range of input RF power levels, (-30 to $+30$ dBm), the efficiency increased from 5% at a low input RF power to a peak of 80% at $+25$ dBm.

Despite advancements in end-to-end (i.e., input RF to output dc) power conversion efficiencies at low input RF power levels (similar to those measured in the spectral surveys), only a few attempts at true ambient RF energy harvesting have been reported. For example, one relatively efficient rectenna, utilizing a modified omnidirectional patch antenna, has an efficiency of 18% with a single-tone input RF power of -20 dBm [13]. This dedicated signal source was meant to emulate the input RF power levels measured from a nearby digital TV (DTV) TX in Tokyo, Japan, but did not take into account the more realistic effect of harvesting from a modulated broadband signal. Another attempt

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at harvesting ambient RF energy from a mobile phone base station at 845 MHz was reported in [14]. This prototype managed to power an LCD thermometer for 4 min, but only after harvesting for 65 h. In that work, when the authors used a dedicated signal source with a single-tone input RF power of -15 dBm, an efficiency of 3% was recorded. A batteryless location sensor has also been demonstrated [15], powered by a rectenna with a printed antenna on a flexible substrate and a solar cell, although no details for the RF-dc efficiency were reported. Finally, successful prototypes capable of harvesting energy using TV antennas were presented, but again no details of their efficiency were given [16], [17].

In order to demonstrate the feasibility for implementing ambient RF energy harvesting, here we first present the results of a citywide RF spectral survey, indicating suitable locations and associated RF bands with sufficient input RF power density levels for harvesting. Based on these results, rectennas were then fabricated and their efficiencies, under ambient RF energy harvesting operation, were calculated using *in-situ* field strength measurements. Furthermore, an investigation of multiband rectenna arrays is also presented, demonstrating the tradeoffs between series (voltage summing) and parallel (current summing) topologies with the aim of reducing the minimum input power required for harvester operation. Finally, a comparison between measured ambient RF energy harvesting and alternative forms of energy harvesting technologies is presented; highlighting, for the first time, the practical feasibility of exploiting existing freely available sources of RF energy.

II. London RF Survey

In order to quantify input RF power density levels present in a typical urban and semi-urban environment, a citywide RF spectral survey within the ultrahigh frequency (0.3–3 GHz) part of the frequency spectrum was conducted within Greater London. A number of citywide RF spectral surveys have previously been conducted, but in general, only a few samples were taken, giving little insight into (semi-)urban environments [14], [18], [19]. Other surveys [20], [21] compare their measurements relative to the distance from the nearest TX. In a (semi-)urban environment, this may not provide enough information about the RF spectrum since there is likely to be local geographical variations in base-station density and propagation characteristics (e.g., multipath effects and diffraction around and attenuation through buildings).

Each station on the London Underground network was used as a survey point to provide a robust dataset for representing Greater London in terms of geographical distribution and population density, having a combination of urban (in the center) and semi-urban (in surrounding areas) characteristics. Measurements were taken at each of the 270 stations (from a randomly chosen exit, at street level and a height of 1.6 m). To provide traceability and for use as a historical reference, time stamps and GPS locations were recorded. In addition, measurements were taken inside a building at Imperial College London (ICL), to represent a typical office block within an urban environment.

A. Methodology

Mobile phone usage varies during the daytime, and hence, ambient RF energy in their bands is expected to be time dependant, with more energy available during the daytime than at night time. Therefore, in order to be able to make fair comparisons between locations, measurements were taken between 10:00 am and 3:00 pm on weekdays over a period of one month (between March 5, and April 4, 2012). Electric field strength was measured between 0.3–2.5 GHz using an Agilent N9912A FieldFox RF analyzer [22] with a calibrated Aaronia BicoLOG 20300 omnidirectional antenna [23]. It is important to note that the spectral measurements were undertaken during the analog-to-digital switchover period in the U.K. and so the measurements for DTV may represent an underestimate of present RF power levels measured now that the switch over is complete [24]. It should also be noted that this survey was conducted prior to the 4G network being switched on within the U.K.

A "panning method," which complies with international regulations for measuring exposure limits, was used [25]–[27]. Here, the calibrated antenna is rotated to three orthogonal axes while the spectrum analyser is set to "max-hold," ensuring that the maximum reading is recorded. For each measurement, more than 1 min was allocated to allow for more than three sweeps across the selected frequency range. Additionally, to maintain a comparable signal-to-noise (S/N) ratio, attenuation was introduced (with a minimum set at 5 dB) to avoid compression when high input RF power levels were detected. For all measurements, the resolution bandwidth (BW) was fixed at 100 kHz, the internal amplifier was turned on and the highest resolution of 1001 points was selected. These settings provide the ability to obtain a snapshot of the power density that can be expected in an urban or semi-urban environment from continuously variable sources.

B. Results

After inputting the manufacturers' frequency-banded antenna factors into the spectrum analyzer, to ensure a fully calibrated system, the electric field strength measurements were taken. The input RF power density (S) is then calculated from the electric field strength measurement. Fig. 1 shows the input RF power density measured outside the Northfields London Underground station, where the spectral bands for DTV, GSM900, GSM1800, 3G, and Wi-Fi can been clearly identified.

A well-designed rectenna should ideally be capable of harvesting energy across an entire band, and thus it is important to calculate the total band power. The banded input RF power density S_{BA} $(\mathrm{nW/cm^2})$ is calculated by summing all the spectral peaks across the band (i.e., in a similar way, the spectrum analyzer calculates channel power). These levels provide a snapshot of source availability at the time and location of the measurement. Moreover, they are used as a harvester design starting point since the power density at each band will define the input impedance of a rectenna.

The exact frequencies for each band are set by the U.K.'s official frequency band allocation [28]; the GSM900, GSM1800 and 3G base transmit (BTx) bands were separated from the associated mobile transmit (MTx) bands. Table I shows average

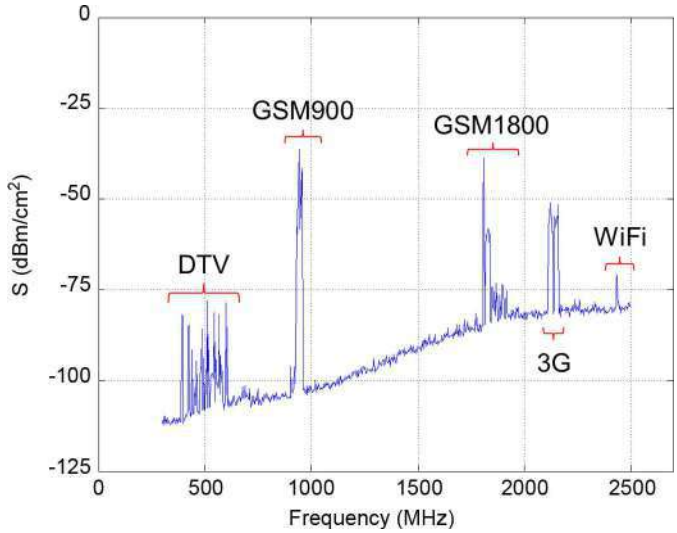

Fig. 1. Input RF power density measurements outside the Northfields London Underground station.

TABLE I
SUMMARY OF LONDON RF SURVEY MEASUREMENTS

Band	Frequencies (MHz)	Average S_{BA} (nW/cm^2)	Maximum S_{BA} (nW/cm^2)
DTV (during switch over)	470-610	0.89	460
GSM900 (MTx)	880-915	0.45	39
GSM900 (BTx)	925-960	36	1,930
GSM1800 (MTx)	1710-1785	0.5	20
GSM1800 (BTx)	1805-1880	84	6,390
3G (MTx)	1920-1980	0.46	66
3G (BTx)	2110-2170	12	240
WiFi	2400-2500	0.18	6

RF power levels across all London Underground stations for the banded input RF power density measurements. It can be seen that all base-station transmit levels are between one and three orders of magnitude greater than the associated MTx levels. For this reason, and the fact that the population of transmitting mobile phones in close proximity of the harvester is highly variable, only base-station TXs will be considered further.

From our London RF survey, DTV, GSM900, GSM1800, 3G, and Wi-Fi were identified as potentially useful ambient RF energy harvesting sources, although DTV appears to be heavily dependent on line-of-sight and sudden changes in atmospheric conditions (e.g., temperature inversion) and Wi-Fi is very dependent on user traffic. It should be noted that the mobile phone base-station TXs employ vertically polarized antennas, placing a constraint on harvester orientation in deployment. With DTV, within the U.K., the main TXs have horizontally polarized antennas, while repeater TXs have vertically polarized antennas.

It is convenient to define the boundary between urban and semi-urban environments by the line that separates zones 3 and 4 on the London Underground map [29]. As one would expect, the central zones 1–3 host the highest density of base stations. As shown in Table II, a banded input RF power density threshold was selected to filter the ten London Underground stations with the highest measurements for each band. With DTV, the highest

TABLE II
INPUT RF POWER DENSITY THRESHOLD: LONDON UNDERGROUND STATIONS WITHIN CENTRAL ZONES 1–3 (URBAN) AND OUTER ZONES 4–9 (SEMI-URBAN)

Band	S_{BA} *Threshold* (nW/cm^2)	Number of Stations	
		Urban	Semi-urban
DTV (during switch over)	40	10	0
GSM900	230	8	2
GSM1800	450	7	3
3G	62	6	4

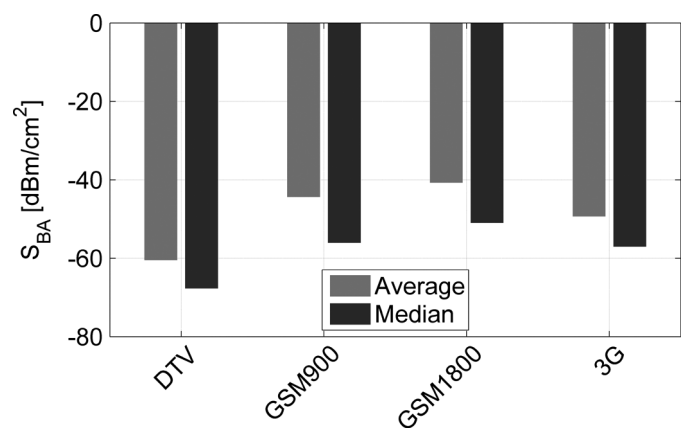

Fig. 2. Banded input RF power density measurements for the four largest ambient sources in Greater London.

recorded measurements were all found within the urban environment. This is because Greater London's main DTV TX (at Crystal Palace) is located on the southeastern boarder of zones 3 and 4 and there are no London Underground stations further south. With mobile phones, more than 50% of the stations were inside the urban environment and those in a semi-urban environment were all located in close proximity to a cluster of base-station TXs.

Using the complete dataset from the London RF survey, Fig. 2 shows the average and median of the banded input RF power density measurements for the four largest ambient RF sources in Greater London. It can be seen that more than half of the locations have below average power levels. This is due to the fact that several stations had maximum levels that were considerably higher than the average because of their close proximity to TV TXs (e.g., Crystal Palace), extremes in base-station density and propagation characteristics.

In addition to the London RF survey, measurements within the Department of Electrical and Electronic Engineering building at ICL were taken on the 11th floor of the south stairwell. These are shown in Table III. As can be seen, DTV and GSM900 have a higher than average power level, due to a near line of sight from the TV TX and a close proximity to the 2G GSM900/1800 base stations.

The dataset from the London RF survey, with all relevant information (e.g., locations, timestamps, and banded input RF power density measurements), can be found at our interactive website: www.londonrfsurvey.org [30]. These measurements were used to design efficient harvesters and compared to ICL

TABLE III
MEASURED BANDED INPUT RF POWER DENSITIES AT ICL

	DTV	GSM900 (BTx)	GSM1800 (BTx)	3G (BTx)
S_{BA} [nW/cm^2]	18	48	50	3

measurements to identify locations in Greater London where the designed harvesters could operate. The design procedures and prototype test measurements will be presented in the following sections.

III. SINGLE-BAND AMBIENT RF ENERGY HARVESTERS

In order to implement efficient ambient RF energy harvesters, designed for the banded input RF power density levels measured at ICL, a set of single-band prototypes were realized and characterized; these will be compared to multiband array architectures in Section V.

A. Antenna Design and Measurements

Since our harvesters are intended to operate within a general (semi-)urban environment, where the exact location of the TX source is unknown, the rectennas' antennas need to be as close to omnidirectional as possible, avoiding the need for beam-pointing during deployment. This is at the obvious expense of limited antenna gain, and therefore, the corresponding levels of P_{RF} that the rectifier can receive. Conversely, if the location of the TX is known, then it may be tempting to use a high gain antenna, but this would require an appropriate level of beam-pointing and polarization matching that can be established and maintained.

Another requirement is that the antennas need to be easily scalable across all frequency bands since one important objective for this work is to compare and contrast different banded harvesters. Finally, the antennas need to be easily fabricated. For all these reasons, a linear polarized folded dipole was selected, although a monopole would also be suitable [31].

To simplify impedance matching between the antenna and rectifier, a modified folded dipole was used to obtain the required 50-Ω reference input impedance. A balun does not need to be employed, as there is no significant degradation in performance for this particular application, even with the use of an unbalanced microstrip rectifying circuit [32]. Furthermore, the antenna was not integrated onto a substrate, to give the additional freedom to embed the harvester on windows or within walls, furnishings, fixtures, or fittings. To this end, two different antennas were fabricated for each band; one made using a 560-μm diameter copper wire and the other with 75-μm-thick 25-mm-wide copper tape. The fabricated antennas are shown in Fig. 3. Since the copper tape was not rigid enough to retain its shape, it was placed on a Perspex substrate, to represent a flat panel.

To design the antennas, full-wave 3-D electromagnetic simulations were performed using CST Microwave Studio. As discussed previously, the antennas were designed to be as omnidirectional as possible, while covering as much of the ambient RF source BW as possible. Fig. 4 shows the typical simulated gain profile for the DTV tape antenna, having a front-to-back ratio of unity. Table IV shows the simulated gain and the 10-dB return-loss fractional BW for the optimized copper wire and tape antennas.

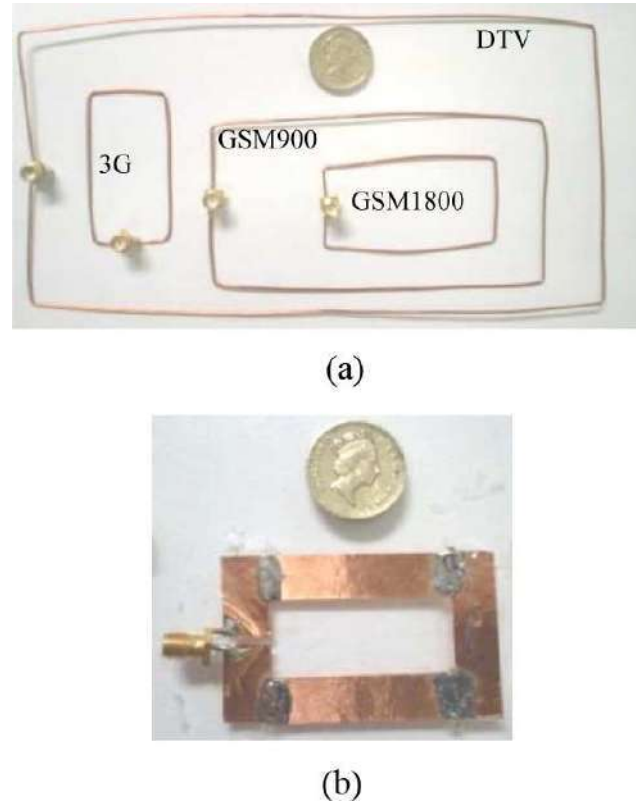

Fig. 3. 50-Ω folded-dipole antennas shown next to a British £1 coin. (a) DTV, GSM900 (BTx), GSM 1800 (BTx) and 3G (BTx) copper wire antennas. (b) 3G (BTx) copper tape antenna on Perspex.

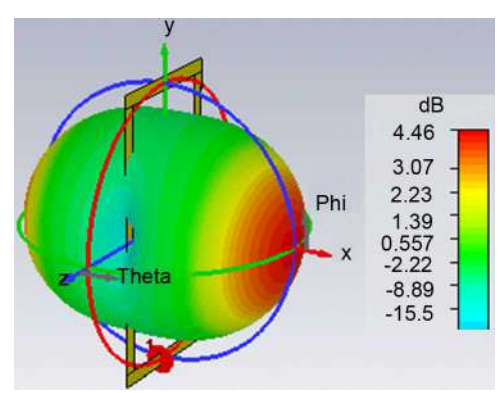

Fig. 4. Simulated beam profile for the DTV tape antenna.

Fig. 5 shows excellent agreement between predicted and measured return-loss results, within a 10-dB return-loss bandwidth, for the eight fabricated single-band antennas. As one would expect with such a simple classical antenna, the out-of-band performances (not shown) were also in good agreement. It was found that better return-loss measurements are achieved with our single-band antennas when compared to other reported single-band omnidirectional [13] and multiband [33] designs. The latter may be important, as it may be tempting to implement a more compact multiband rectenna, but which

TABLE IV
SIMULATED GAIN AND 10-dB RETURN LOSS FRACTIONAL BW FOR FOLDED-DIPOLE SINGLE-BAND ANTENNAS

Band		Wire		Tape	
	BW (%)	Gain (dBi)	BW (%)	Gain (dBi)	BW (%)
DTV	26	4.35	4	4.48	6
GSM900	3.7	4.42	4.3	4.73	4.3
GSM1800	4.1	4.32	5.3	4.73	10.7
3G	2.8	4.39	5.4	4.76	12

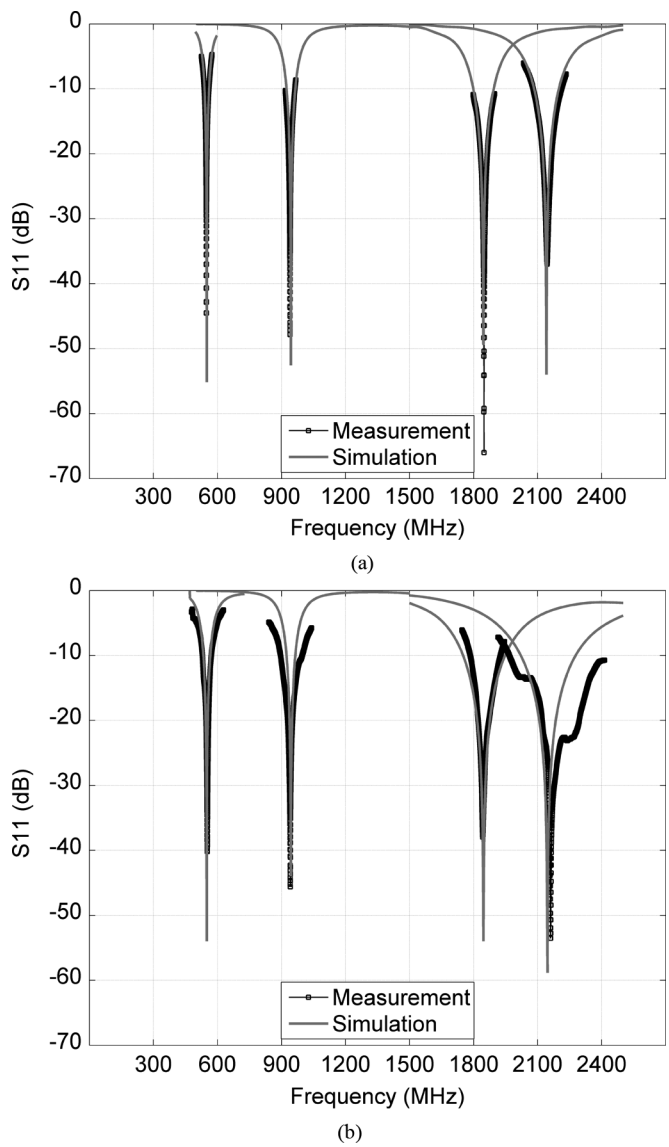

Fig. 5. Input return-loss predictions and measurements for all single-band folded-dipole antennas. (a) Wire. (b) Tape.

may ultimately not give better ambient RF energy harvesting performance.

Obtaining a minimum acceptable return loss over an antenna fractional bandwidth as large as that of the source is key to harvest as much input RF energy as possible. As can be seen in Table IV, where the fractional bandwidth is defined for a 10-dB return loss, our antennas have a fractional bandwidth greater than those of the sources, with the exception of DTV, which

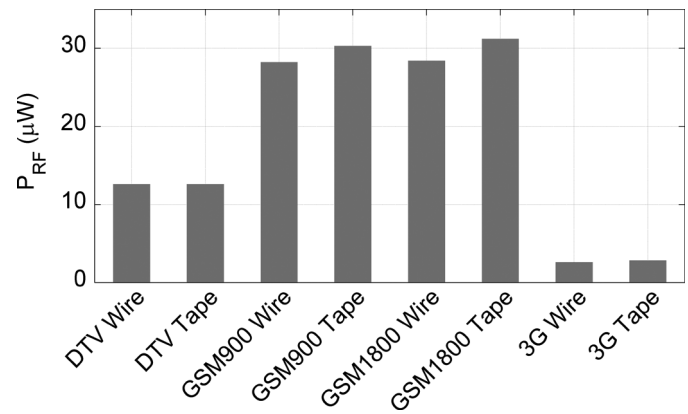

Fig. 6. Predicted input RF power levels for the four largest ambient sources at the ICL testing location.

only covers approximately 35% of the target frequency range. In other work [13], 5-dB return-loss fractional bandwidth is adopted for RF energy harvesting applications.

The fractional bandwidth of the antennas having a minimum return loss of 5 dB is too great to assume a constant antenna gain over the whole band. Therefore, an additional advantage of using 10-dB return-loss fraction bandwidths is that (1) can be used to calculate the input RF power with the assumption that the midband antenna gain is constant with frequency [34]. Therefore, the time-averaged input RF power P_{RF} is given by

$$P_{\mathrm{RF}} = S_{BA} \cdot A_{\mathrm{real}} \text{ and } A_{\mathrm{real}} \approx G(f_o)\frac{\lambda_o^2}{4\pi} \tag{1}$$

where A_{real} is the real aperture (or capture area) of the antenna, λ_o is the free-space wavelength at the midband frequency f_o, and $G(f_o)$ is the rectenna's antenna gain at f_o.

Substituting the measured banded input RF power densities recorded in Table III and the predicted midband antenna gains in Table IV into (1), realistic values for P_{RF} can be calculated for all four bands, with the results shown in Fig. 6. It can be seen that with all antenna gains being in the region of $\sim$ 4.5 dBi, the 2G GSM900/1800 harvesters will generate the highest input RF power levels, due to the high-banded input RF power density levels measured *in situ*. At the other extreme, the 3G harvesters will be the worst performers. As only a small fraction of the required frequency range is covered by the DTV antennas, the predicted values for P_{RF} represent an overestimation.

B. Rectifier Design and Measurements

Based on a previously reported analysis [35] and the predicted input RF power levels presented in Fig. 6, the zero-bias SMS7630 diode (in a series configuration) was selected as the optimal solution for our ambient RF energy harvesters, as shown in Fig. 7. In a series configuration, the junction capacitance $(C_j(V))$ of the diode dominates the detector's impedance, as long as $C_{\mathrm{out}} > C_j(V)$, and thus C_{out} has little or no effect on the matching circuit. This allows C_{out} to be large enough to provide a ripple-free output voltage. In contrast, C_{out} must be less than 1 pF to achieve a good impedance match with a shunt configuration as C_{out} appears in parallel with $C_j(V)$ and the packaging parasitic capacitance. However, C_{out} is too small to

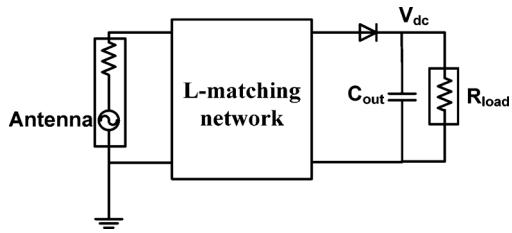

Fig. 7. Series detector configuration with L-matching network.

provide a ripple-free dc voltage to the load. This can be overcome with a matching network that will allow a good impedance match with a large output capacitor, but at the expense of introducing losses. Furthermore, as shown in [36], these issues start to become negligible with a shunt configuration as the shunt diode becomes more self-biased as the input power increases. Simulations were performed using Agilent Technologies' ADS software. Its Momentum package not only takes into account the losses from the low-cost FR4 substrate, but also calculates fringing fields, effects from which are passed on to the harmonic-balance package for simulating the nonlinear behavior of the rectifier.

A good impedance match was achieved by employing a simple matching network; a series lumped-element inductor was used to absorb part of the capacitive reactance from the series diode and an additional quarter-wavelength short-circuit shunt stub was employed to achieve the desired 50-Ω impedance [37]. Since the impedance of the diode varies with frequency and input RF power, impedance matching between the antenna and rectifier was first undertaken by finding the optimal output load resistance for an input RF power level of -20 dBm with a single-tone source at the midband frequency. After the optimal load was found, further broadband optimization was performed to the matching network and the load to ensure good impedance matching throughout the target frequency range and the measured P_{RF} for each band.

As with the antenna analysis, and unlike conventional RF circuits that adopt the more traditional half-power bandwidth definition, the rectifier should adopt the 10-dB-input return-loss bandwidth. The reason for this is that, for ambient RF energy harvesting applications, the input RF power is at a premium and so what little energy is available should not be wasted by being reflected back from avoidable impedance mismatches at either the antenna or rectifier.

Fig. 8 shows excellent agreement between predicted and measured input return loss results, within the -10-dB bandwidth, for the DTV and GSM900 rectifiers, having fractional bandwidths of 5.7% (below target) and 4.8%, respectively. With these lower frequency designs, the fundamental and higher order harmonics were below -55 dBm, ensuring a clean dc voltage at the load, without the need for any output filtering. Reasonable agreement was found with the GSM1800 and 3G rectifiers, having fractional bandwidths of 1.6% (below target) and 7.4%, respectively. It was found that with these two higher frequency designs, the higher order harmonics were -40 dBm at the output. This reduced performance, as illustrated in Fig. 8, is due to the higher series inductive reactance leads of the output shunt storage capacitor. For this reason, a

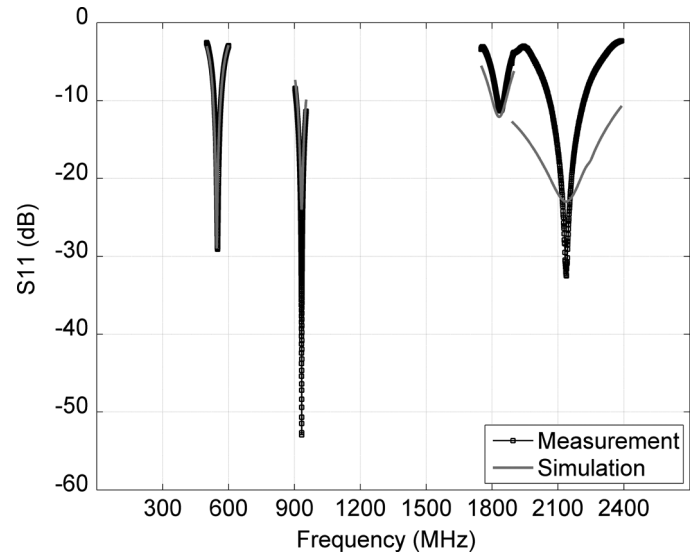

Fig. 8. Input return-loss predictions and measurements for all first prototype single-band rectifiers, with $P_{\mathrm{RF}} = -20$ dBm at the input and optimal load resistances at the output.

second prototype version (v2) was designed for the 3G rectifier, using distributed-element components for the input impedance matching stage and an additional output filter stage. With the lumped-element matching network, it was found that in order to achieve good input impedance matching to 50 Ω, all the microstrip transmission lines had to have a characteristic impedance of 92 Ω. With the distributed-element matching network, a simple shunt quarter-wavelength open-circuit stub, designed for operation at the fundamental frequency, was employed. A microstrip line was added between the cathode of the diode and the stub to absorb the capacitive reactance of the diode. The stub effectively filters to < -50 dBm the higher order harmonics. The microstrip design can be seen in Fig. 13.

C. PMM

Since the input RF power from ambient sources can be represented as a multi-tone source, with power levels fluctuating across the target frequency range, the output impedance of the rectifier is time varying. A power management module (PMM) capable of performing maximum power point tracking (MPPT) is required.

For our work, a low-power integrated-circuit PMM from Texas Instruments Incorporated (BQ25504) was selected, due to its low quiescent current ($<$ 330 nA) and low input voltage operation ($\sim$ 80 mV hot-start and 330-mV cold-start) [38]. It is worth noting that its startup voltage is lower than PMMs previously reported and realized using hybrid circuits for RF energy harvesting [13]. The BQ25504 PMM includes a boost converter that steps up its input voltage (having a 350-mV average value during ambient operation) to useful levels between 2.4–5.3 V. The BQ25504 also has a built-in battery management module, which is used to control the duty cycle of the output power to the load.

MPPT operation on the BQ25504 is achieved by periodically sampling the open-circuit voltage (OCV) at the input of the converter, which then draws a current causing the converter

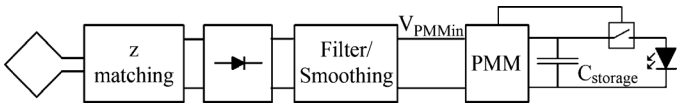

Fig. 9. System block diagram.

input voltage to fall and be held at a pre-programmed fraction of the OCV (set by a potential divider). In a simple dc circuit, with a resistive source impedance, the optimal ratio is 0.5. For the rectenna-based system, a ratio of 0.48–0.53 was found to maximize the power output of the system. The BQ25504 is designed to charge a storage element, and in this case, a capacitor C_{storage} was used. The programmed PMM continuously charges the storage capacitor, and the load (a low-power LED) was automatically connected to the storage capacitor when the capacitor voltage reaches an upper limit $V_{\mathrm{high}} = 2.84$ V and automatically disconnected when it reaches a lower limit $V_{\mathrm{low}} = 2.40$ V. The duty cycle of the LED can then be used to calculate the efficiency of the system, as will now be described. A diagram of the system is shown in Fig. 9.

IV. End-to-End Efficiency Analysis

The efficiency η of an RF energy harvesting system is

$$\eta = \frac{P_{\mathrm{dc}}}{P_{\mathrm{RF}}} \tag{2}$$

where P_{dc} is the time-averaged output (i.e., equivalent dc) power into the storage element (e.g., battery or supercapacitor) and load and P_{RF} is as previously defined. Measurements for this type of system are usually performed in a controlled environment (e.g., an anechoic chamber or TEM cell), using a dedicated constant or variable amplitude single-tone RF signal source [32], [39]. However, the former is not suitable for evaluating ambient RF energy harvesting operation, which has a much broader spectrum of nonconstant input frequencies and where the instantaneous input RF power is time variant. The use of a constant single-tone dedicated source provides a convenient stable reference power to the harvester; while the latter reflects a more realistic signal source having fluctuating power levels across a nonzero bandwidth, multipath, and reflection effects which are very difficult to emulate in a controlled environment.

Therefore, to determine the overall end-to-end efficiency $\eta_{\text{e-e}}$ for a complete ambient RF energy harvester, the input RF energy U_{RF} was calculated based on the harvester's antenna characteristics and the actual banded input RF power density measurements taken at the time of harvester operation, using the Agilent Fieldfox and the calibrated antenna. It is important to note that since the impedance mismatch between the antenna and detector is not taken into account, U_{RF} is higher than expected, providing an underestimate of end-to-end efficiency. The output dc energy U_{dc} was then calculated by measuring the charge–discharge cycle time, t_{cycle} of the storage capacitor between V_{high} and V_{low}, as the LED is repeatedly connected and disconnected. The output dc energy equation is already taking into account the efficiency of the PMM given the fact that the measurements

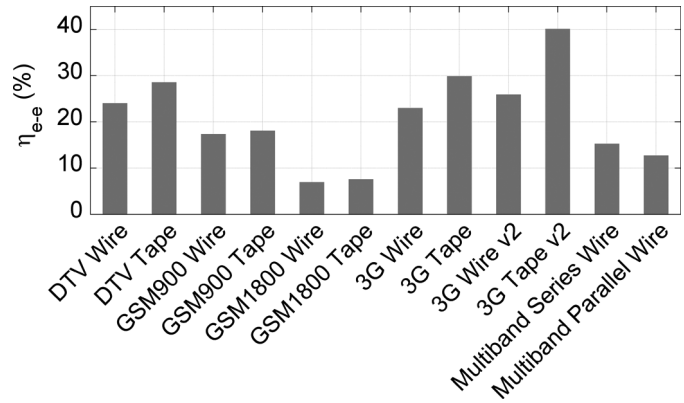

Fig. 10. End-to-end efficiencies for ambient RF energy harvesting at ICL.

are taken at its output voltage. The end-to-end efficiency of one charge–discharge cycle of C_{storage} is

$$\eta_{\text{e-e}} = \frac{U_{\mathrm{dc}}}{U_{\mathrm{RF}}} \tag{3}$$

where the input RF energy is given by integrating the time-averaged input RF power over a cycle time, as

$$U_{\mathrm{RF}} = \int_0^{t_{\mathrm{cycle}}} P_{\mathrm{RF}} dt \tag{4}$$

and the output dc energy is given by the energy supplied to the load, as follows:

$$U_{\mathrm{dc}} = C_{\mathrm{storage}} \frac{({V_{\mathrm{high}}}^2 - V_{\mathrm{low}}^2)}{2}. \tag{5}$$

A. ICL Field Trials

Four single-band ambient RF energy harvesters were assembled by connecting the rectifiers to the wire/tape antennas and PMMs programmed for the optimal load. A 100-μF shunt capacitor was employed as the storage element, providing $U_{\mathrm{dc}} = 115\ \mu$J. Our system is capable of cold-starting the boost converter and MPPT since the rectenna is capable of providing the minimum starting voltage of 330 mV. When the minimum voltage is reached, the boost converter and MPPT start to operate and the charge–discharge cycle at the load begins, causing the LED to flash. During field trials, t_{cycle} took up to 170 s for the harvester with lowest banded input RF power density, corresponding to 3G with the wire antenna. Table V summarizes the results where t_c and t_d are the charge and discharge times, respectively, and ΣV and ΣI are the multiband voltage and current summing array architectures, respectively. A detailed discussion on the multiband rectenna arrays will be presented in the following section. The end-to-end efficiency was calculated using (3) with data from Fig. 6 and measuring the charge–discharge cycle time during harvesting operation.

Fig. 10 shows the overall end-to-end efficiencies for all the harvester demonstrators, deployed and tested at ICL. As predicted by simulations, the improved 3G v2 demonstrator with

TABLE V
HARVESTERS CHARGE AND DISCHARGE TIMES (t_c, t_d, RESPECTIVELY) FOR A SPECIFIED LOAD

Band	Wire					Tape				
	t_c (s) load independent	t_d (s) load dependant	t_{cycle} (s) load dependant	P_{dc} (t_d) (μW)	P_{dc} (t_{cycle}) (μW)	t_c (s) load independent	t_d (s) load dependant	t_{cycle} (s) load dependant	P_{dc}(t_d) (μW)	P_{dc} (t_{cycle}) (μW)
DTV	26	12	38	9.6	3	14	18	32	8.2	3.6
GSM900	14	10	24	11.5	4.8	8	13	21	14.4	5.5
GSM1800	43	15	58	7.7	2	22	27	49	5.2	2.4
3G v2	167	3	170	38.4	0.7	96	5	101	1.2	1.1
Multiband ΣV	43	7	50	66	2.3	-	-	-	-	-
Multiband ΣI	55	5	60	92.2	2	-	-	-	-	-

tape antenna outperformed its original design by 11%; achieving an end-to-end efficiency of 40% with an input RF power of only −25.4 dBm.

It is believed that a much greater efficiency can be achieved for the DTV harvester if the fractional bandwidths for the first prototype circuits (i.e., 4.4/4.5% for the antennas and 5.8% for the rectifier) could be increased to match the much greater target value of 26%. Likewise, the reduced efficiency of the GSM1800 harvesters can be attributed to the detrimental effects of the narrowband input impedance matching of the rectifier (i.e., having a fractional bandwidth of only 1.6%, when compared to its target value of 4.1%). Finally, with all the harvesters, the end-to-end efficiencies can be enhanced through better antenna design and optimal polarization matching.

Table VI, shows the number of locations from the London RF survey that would be able to support our harvesters. Unlike the single-band 3G harvester, which can operate at 45% of the locations, our DTV harvester can only be used at two locations (one in zone 2 and the other in zone 3). Therefore, for the general deployment of an ambient RF energy harvester within an (semi-)urban environment, at street level, the single-band DTV harvester may not be practical

TABLE VI
NUMBER OF LOCATIONS FROM THE LONDON RF SURVEY CAPABLE OF SUPPORTING IDENTICAL HARVESTERS AT THE SAME EFFICIENCY LEVELS

	DTV	GSM900 (BTx)	GSM1800 (BTx)	3G (BTx)
Stations with higher S_{BA}	2	28	68	122

V. ARRAY ARCHITECTURES

Since ambient input RF power levels can be low (i.e., below −25 dBm) and dependent on both time and spatial considerations, harvesters could be designed to extract energy with spatial-diversity within the same frequency band or using different frequency bands. For example, with the former, at a particular location there may be only one band that has significant levels of RF energy worth harvesting. In this case, spatial-diversity array architectures may provide more usable output power. Alternatively, with the latter, multiband array architectures may provide more robust operation.

With both forms of parallel array architecture (i.e., spatial-diversity and multiband), a further classification can be seen through the use of either diversity/band switching or a summing node. With the former, physical switches automatically select whichever signal path delivers the highest input RF power level; with the latter, power from all signals is combined. Fig. 11 illustrates generic forms of parallel array architectures, showing that switching/summing can be performed electromagnetically at a single antenna or at the output from multiple antennas, rectifiers, or PMMs.

Multiband array architectures, similar to those in Fig. 11(c) and (d), capable of RF harvesting from the four previously identified bands, were selected as possible optimal solutions, given no size/cost constraints. Our objectives were to reach the minimum cold-start voltage at the lowest possible input RF power levels and increase the harvesters' operational capabilities within (semi-)urban environments.

To this end, two different multiple rectenna architectures were investigated. The first with a single shared PMM and the second with multiple PMMs, as illustrated in Fig. 12. To simplify assembly, the wire antennas were selected since they did not require a substrate. Unwanted coupling between the single-band antennas was minimized by placing them a minimum distance of $\lambda_L/5$ apart; where λ_L is the wavelength of the lowest frequency band antenna [40]. For example, the DTV and the 3G antennas were kept at least 11 cm apart, as shown in Fig. 13. This allowed S_{11} measurements to be the same as in Fig. 5 once all antennas were assembled into the array.

A. Multiple Rectennas With a Shared PMM

In order to improve the cold-start performance of the system, the outputs of multiple rectennas can be connected in series, as shown in Fig. 12(a). This increases the probability of the voltage on the input of the PMM reaching the cold-start level (330 mV for the BQ25504) under any given scenario. While cold-starting the PMM, each rectenna harvests (albeit not optimally). Once

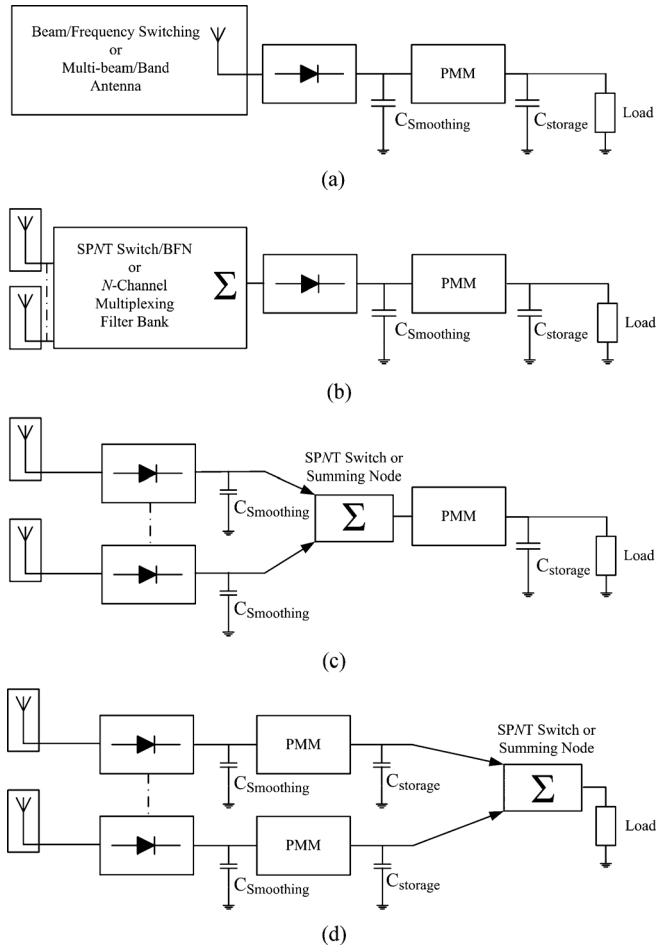

Fig. 11. Parallel array architectures with switching/summing at the: (a) antenna, (b) output of multiple antennas, (c) output of multiple rectifiers, and (d) output of multiple PMMs.

the PMM circuit starts, with the MPPT operating, the harvested power level increases.

The behavior of the series rectenna topology with a shared PMM requires some discussion. As the output impedance and the OCV for each rectenna is different, since they operate at different frequencies and input RF power levels, the rectennas are forced to share the same output current in a series configuration, which does not allow them all to operate at their individual maximum power points. This causes the voltage on each rectenna output, except the one having the highest input RF power, to collapse. This operation is analogous to the partial shading problem with a series string of solar panels [41] sharing a common boost converter. With this photovoltaic system, bypass diodes placed around individual cells stop the poorly lit cells contributing a negative voltage (and power) to the string. In our case, the series circuit formed by the loop antennas and rectifying diodes performs the same task. This means that while all rectennas contribute to system startup, only the rectenna with the highest input RF power contributes significant power for continuous operation once the PMM starts. Fig. 10 shows the end-to-end efficiency for the voltage summing multiband harvester array when tested at ICL. An efficiency of only 15% was achieved with a

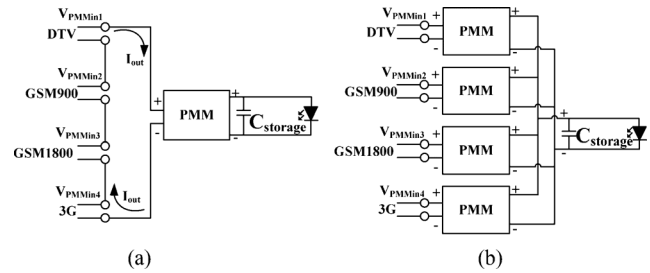

Fig. 12. Multiband array architectures (with $N = 4$ bands). (a) Voltage summing at the outputs of the single-band rectennas. (b) Current summing at the outputs of the single-band harvesters.

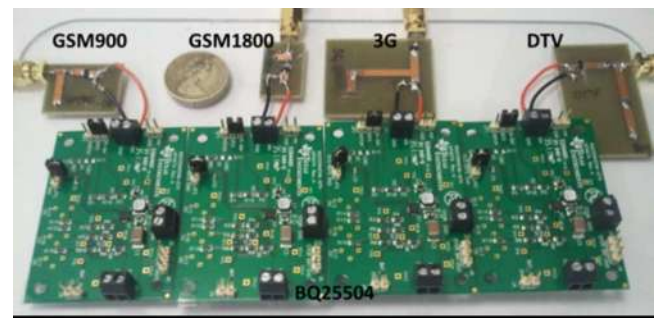

Fig. 13. Rectenna array architecture with individual PMMs for the four largest contributors with wire antennas.

combined input RF power of -12 dBm. The lower efficiency, when compared to a single-band harvester, is due to the imbalance of rectifier outputs, as discussed above. Here, the charge time was 43 s, compared to 167 s with the lowest contributing single-band 3G harvester with wire antenna.

B. Multiple Rectennas With Individual PMMs

In order to overcome the balancing issues when multiple rectennas share a common PMM, as discussed previously, each rectenna can have its own PMM, whose outputs can be connected to a common storage element (in this case, a 400-μF shunt capacitor, providing $U_{\rm dc} = 461$ μJ), as illustrated in Fig. 12(b) and shown in Fig. 13. Although not achieving cold-start as quickly as the series topology, this parallel topology has the advantage of being able to run each rectenna at its maximum power point. In addition, once one rectenna is able to harvest enough energy for a cold-start, all PMMs will start because they share a common storage element, allowing the rectennas with low-input RF power levels to harvest at levels below which they could not do so independently.

This parallel topology was tested and found to be capable of operating in many locations where the series array was unable to operate; e.g., if only one of the bands had $P_{\rm in} > -25$ dBm. As expected, the largest contributor hot-started the other PMMs, allowing them to harvest at an input RF power level down to -29 dBm.

However, as with the previous results for voltage summing, having a combined input RF power of -12 dBm, the efficiency using multiple PMMs is slightly lower, at 13%, as shown in Fig. 10. This is because useful dc output power from the cold-

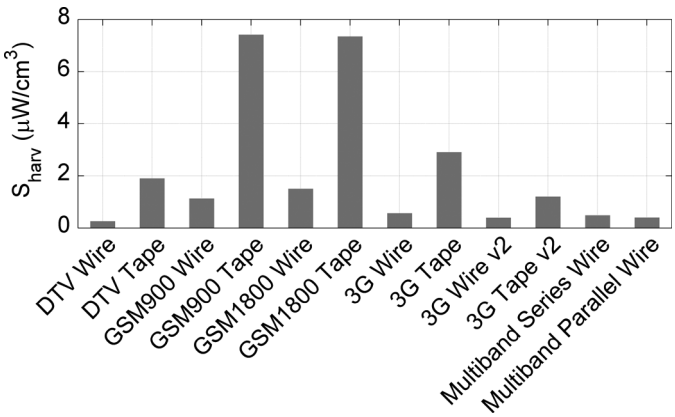

Fig. 14. Output dc power density for all harvesters at ICL.

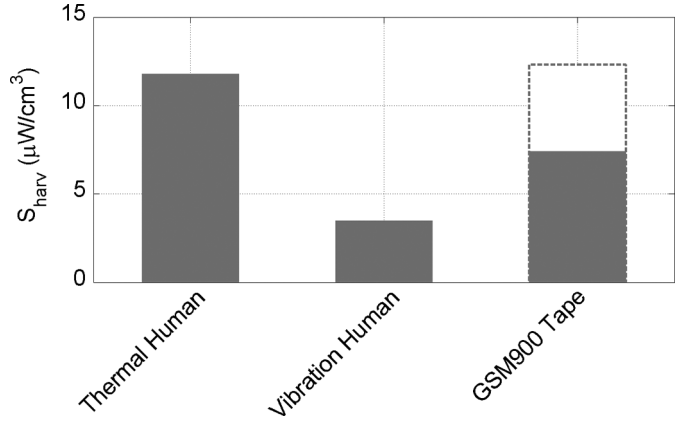

Fig. 15. Output dc power density comparison for alternative ambient harvesting technologies [40]–[43] against the best current generation of RF harvesters at ICL.

starting harvester is being supplied to the other harvesters for hot-starting, even though some of them may not actually be contributing any of their own harvested power.

VI. Output DC Power Density Comparison

The volumetric output dc power density S_{harv} $(\mu\mathrm{W/cm}^3)$ represents an important figure of merit for comparing alternative energy harvesting technologies. For ambient RF energy harvesting, the output dc power is calculated by multiplying the effective input RF power by the overall end-to-end-efficiency. The total volume (including that of the antenna, rectifier, and PMM; not including energy storage, as this does not directly affect the dc power output) must be determined. It is important to note that the volume for the antenna could effectively disappear if it is assembled onto a window or within a wall, furnishing, fixture, or fitting. Moreover, the required PMM printed circuit board (PCB) size used throughout these calculations was assumed to be ten times the size of the BQ25504 chip, to account for any necessary additional components.

Fig. 14 shows the output dc power density for all the harvesters demonstrated here. It can be seen that the 2G GSM900/1800 harvesters with tape antennas both have the highest value of $S_{\mathrm{harv}} = 7.4$ $(\mu\mathrm{W/cm}^3)$, when tested at ICL, due to the high-banded input RF power density S_{BA}. The value for the most efficient harvester (i.e., 3G v2 with tape antenna) was not the highest in terms of output RF power because S_{BA} in this band was more than an order of magnitude lower than with GSM900.

S_{harv} allows a direct and meaningful comparison to be made with other alternative energy harvesting technologies. Our best performing ambient RF energy harvester (i.e., GSM900 with tape antenna) was compared against alternative energy harvesting technologies, assuming they used the same PMM board size [42]–[44].

It can be seen in Fig. 15 that ambient RF energy harvesting has a low output dc power density when compared to alternative energy harvesting technologies, but only when the total volume of the first prototype demonstrator is considered. However, when the antenna is absorbed onto or into a background feature and when the PMM is fully integrated into the rectifier, it can outperform (as indicated by the dotted column) the alternative energy harvesting technologies, while providing a complimentary means of extracting energy from the environment. The RF harvesters, however, have the additional advantage in that they do not require a thermal gradient, and unlike vibration-driven devices, they have no moving parts.

VII. Conclusions

Our objectives were to reach the lowest possible ambient input RF power levels and extend the harvesters' operational capabilities within (semi-)urban environments. To this end, a comprehensive citywide RF spectral survey was undertaken, indicating that more than 50% of the 270 London Underground stations are suitable locations for the deployment of our ambient RF energy harvesters. It has been demonstrated that single-band harvesters can operate with efficiencies of up to 40% in a (semi-)urban environment, and can start to operate from power levels as low as -25 dBm.

To increase the freedom of operation, multiband array architectures were investigated. With the current summing harvester arrays, RF harvesting was achieved at an input RF power level as low as -29 dBm, without any external dc power supply to hot-start the PMM. Limitations on the multiband array architectures were discussed, highlighting the need for further work in balancing rectennas with voltage summing rectenna arrays when operating at lower input RF power levels.

Finally an output dc power density comparison against alternative energy harvesting technologies has shown that RF harvesting can represent a competitive solution within (semi-)urban environments, especially when the antenna can be absorbed into background features.

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A dual-band RF energy harvesting circuit using 4th order dual-band matching network

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Abstract: A novel compact rectifier for dual-band operation in the RF energy harvesting is presented. The circuit comprises a 4th order dual-band impedance matching and a single-series circuit with one double diode, both are integrating into a compact shape to occupy a small area of $30 \times 35\ \text{mm}^2$. The merit of the proposed rectifier circuit is that it can be extended to *n* number of the frequency band by using only $2 \times n$ matching elements. To validate the design method experimentally, a prototype of a dual-band rectifier is fabricated for two public telecommunication bands of GSM-900 and 1800. In order to reduce the circuit complexity and sensitivity arising due to lumped elements, the meander line and the open stub are used to realize the proposed circuit. A good agreement is obtained between the simulation and the measurement. The measured results show that the proposed rectifier circuit exhibits the conversion efficiency of 25.7 and 65% for an input power of −20 and 0 dBm, respectively. In addition, diode nonlinearity which affects the performance of the rectifier in terms of impedance matching is also investigated.

Subjects: Electromagnetics & Microwaves; Electronics; Circuits & Devices

Keywords: RF energy harvesting; dual band impedance matching; rectifier; RF-to-dc-conversion efficiency; frequency transformation

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PUBLIC INTEREST STATEMENT

With rapid growth in wireless communication, a huge amount of radio frequency (RF) energy broadcasted through billions of microwave sources such as mobile phones, handheld radios, and radio broadcast stations. Therefore, it is meaningful to collect and supply it to many electrical devices like mobile headsets, wearable medical sensors through RF energy harvesting. Since the ambient RF energy is distributed in multiple frequency bands, therefore the amount of energy harvested could increase if the circuit is designed for multiple frequency bands. In this work, we present a compact dual-band energy harvesting circuit to harvest energy from two most useful frequency bands, GSM-900 and 1800. The merit of the proposed rectifier circuit is it can be extended to *n* number of the frequency band by using only $2 \times n$ matching elements. A prototype is fabricated, and its performance is evaluated using Vector Network Analyzer (VNA). The total size of the rectifier is about $30 \times 35\ \text{mm}^2$.

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1. Introduction

A revolutionary growth in wireless technology attracts huge attention from research community to make the self-sustainable device feasible through RF energy harvesting. It exploits ambient electromagnetic energy transmitted from different RF systems to remotely feed the electronic devices (Nintanavongsa, Muncuk, Lewis, & Chowdhury, 2012). Compared to other harvesting techniques, RF energy harvesting provides relatively predictable energy supply owing to the features of easy availability and less dependency on environmental variations. The typical block diagram of RF energy harvesting circuit is shown in Figure 1. It consists of three major blocks viz; antenna, matching network (MN), diode detector followed by an energy storage. The first element, antenna is employed to capture the RF signals of different frequencies and polarization, while second MN is for maximum power transfer, and the last rectifier is used to convert the RF energy to dc voltage. It means harvesting circuit performance can be evaluated in terms of accessible ambient RF energy and its conversion rate (Agrawal, Pandey, Singh,& Parihar, 2014). These parameters are heavily influenced by surrounding terrain conditions as the multiple reflection and dissipation certainly deteriorate the level of available ambient RF energy. As a result, conversion efficiency and dc output voltage may degrade. Previously, the majority of available RF energy harvesting circuits focused on single frequency band hence offer low dc output voltage. As the multiple RF energy sources of different frequency bands are available, thus from an ambient RF harvesting perspective, the output dc voltage could be increased if the circuit is designed for multiple frequency bands rather than a single band. A wide-band energy harvester can also promise a high output voltage by accumulating the number of RF signals at a time. However, due to nonlinear behavior of the diode, harvesting circuit itself exhibits nonlinearity i.e. its input impedance varies with the received RF power. Thus, it is quite difficult to retain the impedance match and high conversion efficiency over a large frequency range (Song, Huang, Zhou, & Carter, 2014). The losses due to impedance mismatch over a large bandwidth can be illustrated in Collado and Georgiadis (2013), where only 8% conversion efficiency is achieved at −20 dBm.

To address this, it is preferable to harvest energy from several narrow frequency bands rather than a single large one. In literature, numerous topologies have been proposed to accomplish the multi-band energy harvesting (Bergès, Fadel, Oyhenart, Vigneras, & Taris, 2015; Hamano et al., 2016; Ho et al., 2016; Keyrouz, Visser, & Tijhuis, 2013; Kuhn, Lahuec, Seguin, & Person, 2015; Liu, Zhong, & Guo, 2015; Niotaki, Georgiadis, Collado, & Vardakas, 2014; Pinuela, Mitcheson, & Lucyszyn, 2013; Scheeler, Korhummel, & Popovic, 2014; Shariati, Rowe, Scott, & Ghorban, 2015; Sun, Guo, He, & Zhong, 2013). These topologies can be differentiated in terms of filter functionality i.e. how the antenna or source impedance is matched to the rectifier circuit. For instance, in Pinuela et al. (2013) and Keyrouz et al. (2013) several single-band rectennas (combination of antenna and rectifier circuit) were stacked to constitute a multi-band harvesting circuit. In this case, each rectenna was designed for a specific frequency band. Thus, for compact applications, this architecture is not suitable due to the number of antennas used. Moreover, in most of the reported works, the quality assessment of the output voltages combination was not taken into consideration. In Kuhn et al. (2015), the circuit complexity is reduced to a certain extent by replacing the multiple antennas with a single wide-band antenna. However, in this topology too, the number of rectifiers increases with the frequency bands, which leads to prolonging the circuit complexity.

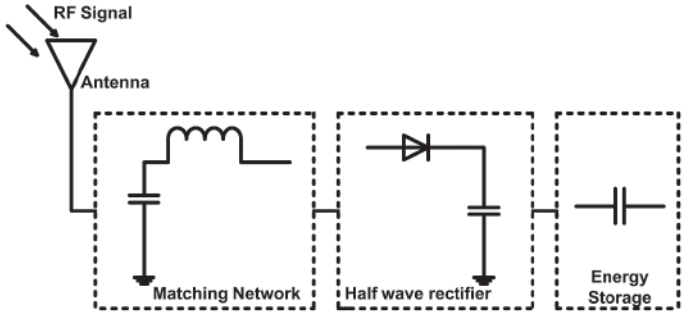

Figure 1. Typical block diagram of RF energy harvesting circuit.

Besides, a multi-band harvesting circuit can also be formed by simply embedding a multi-band matching network between the multi-band antenna and the rectifying circuit (Bergès et al., 2015; Hamano et al., 2016; Ho et al., 2016; Liu et al., 2015; Niotaki et al., 2014; Scheeler et al., 2014; Shariati et al., 2015; Sun et al., 2013). The multi-band matching network can be designed either by distributed or by lumped element. In general, the multi-band rectifier circuit experiences two types of losses: first due to shift in resonance frequency from the optimum frequency point, and second due to the filter complexity. Because of the diode nonlinearity, the input impedance of the circuit varies as a function of power and frequency which causes a shift in resonance frequency. The difficulty due to diode nonlinearity can be observed in Sun et al. (2013) where the dual-band rectifier circuit exhibits impedance matching for a small range of input power. The losses induced because of filter complexity can be observed in the recently reported works on dual band harvesting circuit (Niotaki et al., 2014; Scheeler et al., 2014; Shariati et al., 2015). In Niotaki et al. (2014), for $P_{\text{in}} = -15$ dBm, author achieved the conversion efficiency of 23% at the expense of increased filter complexity consisting two series and two shunt pairs of reactive elements. Thus, for more than dual band applications, the proposed circuit topology is not suitable due to excessive filtering components used. To obtain good conversion efficiency a dual-band rectenna reported in Scheeler et al. (2014). However, the rectenna was large in size and requiring a complex impedance tuning circuit. In Shariati et al. (2015) also, a dual-band matching network consisting nine reactive elements was employed to achieve the dual-band characteristics.

In order to reduce the filter complexity, this work proposed a compact dual-band harvesting circuit for GSM-900 and 1800. It consists of a 4th order dual-band matching network based on $1 - n$ frequency transformation, which is optimized for the energy harvesting circuit to reduce the complexity up to $2 \times n$ reactive elements (n is the number of frequency bands). Similar to frequency transformation method, the proposed dual-band rectifier circuit can be extended to n number of frequency bands by using the $2 \times n$ number of reactive elements. The detailed analysis and design guidelines of dual band rectifier circuit are discussed in Section 2.

2. Dual band rectifier design and analysis

This section presents the design and analysis of a dual-band harvesting circuit in terms of impedance matching, DC output voltage and RF-to-dc conversion efficiency. The topology of the proposed dual-band RF energy harvesting circuit is shown in Figure 2(a). As seen, the low-cost Schottky diode is used to transform the input RF power to DC voltage. The impedance matching at two frequency is achieved using a series and parallel combination of the *LC* pair. The main idea underlying the suggested multi-band matching network is $1 - n$ frequency transformation (one to many mapping of frequency), which transforms a single-band matching network to multi-band matching network (Nallam & Chatterjee, 2013). As the name ($1 - n$) suggests that for designing a multi-band matching network, primarily a single-band matching network is required whose resonant frequency is dependent on the frequencies for which multi-band matching network proposed to designed.

Moreover, this frequency transformation method depends on the type of load impedance, whether it is series or parallel combination of *RC* or *RL*. Since the selected diode (HSMS-2852) has capacitive behavior throughout the frequency, it can be represented in a series or parallel combination of *R* and *C*. In the case of parallel *RC* load, the following equations are used to transform the single-band matching network into multi-band matching network.

$$\omega = \frac{\omega_t^n + a_m \omega_t^{n-m} + a_{m+2} \omega_t^{n-(m+2)} + \cdots}{\omega_t^{n-1} + a_{m+1} \omega_t^{n-(m+1)} + a_{m+3} \omega_t^{n-(m+3)} + \cdots} \tag{1}$$

where, n is the number of bands and m varies from 2 to n. After substituting the value of n, Equation (1) can be expanded in partial fraction form using the causal foster analysis as:

$$\omega = \omega_t + \frac{1}{\frac{\omega_t}{a_2 - a_3} + \frac{1}{\cdots}} \tag{2}$$

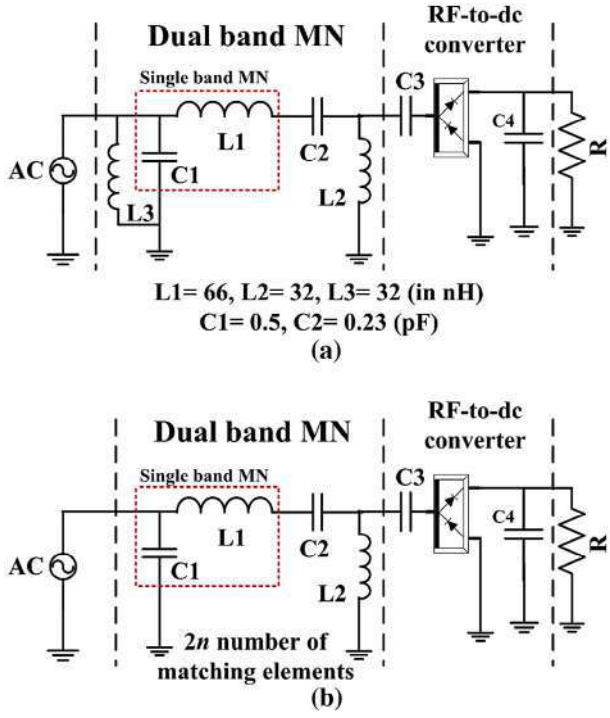

Figure 2. (a) Circuit diagram of the proposed dual-band rectifier circuit and (b) optimized dual-band rectifier circuit.

The coefficients a_2 and a_3 can be calculated as:

$$\omega_m = \sum_{i=1}^{n} (-1)^{i-1} \omega_i \tag{3}$$

$$a_m = (-1)^m \sum_{i,j=1,1\,\&\,i\neq j}^{n,n} (-1)^{i+j} \omega_i \omega_j \tag{4}$$

$$a_{m+1} = (-1)^{m+1} \sum_{i,j,k=1,1,1\,\&\,i\neq j\neq k}^{n,n,n} (-1)^{i+j+k} \omega_i \omega_j \omega_k \tag{5}$$

$$a_{m+n} = (-1)^{m+n} \sum_{i,j,k\ldots=1,1,1\ldots i\neq j\neq k}^{n,n,n\ldots} (-1)^{i+j+k+\cdots} \omega_i \omega_j \omega_k \ldots \tag{6}$$

$$a_n = \prod_{i=1}^{n} (-1)^n \omega_i \tag{7}$$

Equation (6) is similar to that presented in Nallam and Chatterjee (2013), except the term $(-1)^{m+n}$, which is included here to realize the multi-band matching network for more than three frequency bands i.e. for $n \geq 3$.

With this transformation, the capacitor of the matching network is transformed to the combination of prototype capacitor parallel with inductor whereas, an inductor is transformed into a combination of the same inductor with a series capacitor. Figure 3 shows the circuit schematic of transformation of a single-band matching network to the dual-band matching network. It can be seen that C_1 is transformed to $C_1 \| L_2$ and L_1 transformed to L_1 series with C_2. After successful usage of (1)–(7), the resultant multi-band matching network requires $3n - 1$ and $4n - 1$ reactive elements for L and Π-type topology, respectively.

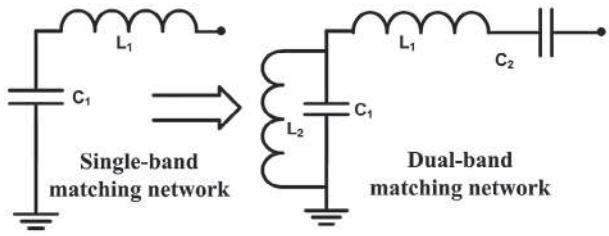

Figure 3. Conversion of a single-band matching network to dual-band matching network using $1-n$ frequency transformation.

As the aim is to design a dual-band harvesting circuit, therefore, we require here only 5 or 7 reactive elements with L and Π-type topologies, respectively. From Figure 2(a), it can be seen that the resultant matching network consists of five elements, where the inductor L_3 and capacitor C_2 results after the transformation of capacitor C_1 and inductor L_1, respectively. Besides, the inductor L_2 occurrs due to the diode reactive element, which is generally a capacitor.

In this work, two frequencies 0.9 and 1.8 GHz that correspond to the maximum signal strength are chosen for dual-band harvesting circuit. According to this method, it is necessary to assign the frequencies in descending order e.g. $\omega_1 = 1.8, \omega_2 = 0.9$. Therefore, from (3) single-band matching network frequency is equal to $\omega_1 - \omega_2 = 2\pi(1.8 - 0.9) \times 10^9 = 0.9 \times 2\pi \times 10^9$. In order to match the source impedance with the rectifier at the calculated frequency 0.9 GHz, the chosen matching topology is L-type as shown by the encircled portion in Figure 2(a). The corresponding element values can be approximated using the various methods some of which are described in Pozar (2010). Subsequently, this single-band matching network is transformed to dual-band matching network using (1)–(7). The detailed design steps of the dual-band rectifier circuit are summarized as follows:

(1) As we are interested in matching the diode to 50 Ω at two frequencies (0.9 and 1.8 GHz) so, the order of transformation is equal to 2 or $n = 2$.
(2) In the first step, single-band matching network is designed at the frequency f calculated as: $f = f_2 - f_1 = 1.8 - 0.9 = 0.9$ GHz. In this case, any matching topology that matches the diode to 50 Ω, at 0.9 GHz for an input power $P_{in} = -20$ dBm, and load resistance 4.7 kΩ can be used. The chosen single-band matching network is shown by the encircled portion in Figure 2(a).
(3) Afterwards, this single-band matching network is transformed into dual-band using the (1)–(7) as shown below:

Since $n = 2$ therefore, from (2)

$$\omega = \omega_t + \frac{1}{\frac{\omega_t}{a_2}} \tag{8}$$

From (4) a_2 can be calculated as:

$$a_2 = (-1)^{2+2} \sum (-1)^{1+2} \omega_1 \omega_2 = \omega_1 \omega_2 \tag{9}$$

$$a_2 = -1.62 \times 4\pi^2 \times 10^8 = 0.64 \times 10^{20} \tag{10}$$

Thus, inductor L_1 (=66 nH) is transformed to impedance as:

$$j66 \times 10^9 \omega = j66 \times 10^9 \omega_t + \frac{1}{j0.23 \times 10^{-12} \omega_t} \tag{11}$$

Similarly, capacitors (=0.5 pF) are transformed to the admittance as:

$$j5 \times 10^{-13} \omega = j5 \times 10^{-13} \omega_t + \frac{1}{j32 \times 10^{-9} \omega_t} \tag{12}$$

The circuit schematic of the dual-band harvesting circuit is shown in Figure 2(a). It can be seen that resultant matching network consists of five reactive elements according to $3n - 1$. In order to reduce the circuit complexity and sensitivity due to reactive elements, a parametric study has been carried out to eliminate the elements showing minimum influence on the circuit performance.

Figure 4 shows the simulated $|S_{11}|$ for the different combination of matching elements. The simulated results demonstrate that $|S_{11}|$ experiences maximum change when inductor L_2 and capacitor C_2 are removed from the circuit, whereas it remains almost unaffected when L_3 is not present in the circuit. Therefore, inductor L_3 can be extruded from the circuit and the resultant matching circuit requires only $2n$ and $3n$ reactive elements in place of $3n - 1$ and $4n - 1$ elements. In this way, for each topology, the proposed circuit reduces $n - 1$ elements compared to the conventional method. Figure 2(b) demonstrates the optimized circuit diagram of the dual-band rectifier. It can be observed that circuit requires large inductors value of 32 and 66 nH. Thus, it is quite difficult to realize the practical rectifier circuit whose response is similar to the response of simulated result. In order to avoid any impedance mismatch due to the small difference in elements value, the meander line inductor and open stub are used to realize the inductors and capacitors, respectively. In this case, not only fabrication and optimization process become so easy but the cost will also reduced.

Figure 5, shows the layout of the dual-band rectifier circuit. In Nintanavongsa et al. (2012) and Agrawal et al. (2014), it has been demonstrated that the number of rectifying diodes or equivalently voltage multiplier stages are very much sensitive to the RF-to-dc conversion efficiency. In low-power region (≤ -20 dBm), efficiency decreases if voltage multiplier stages increase, whereas in higher power region (≥ -20 dBm), an opposite effect occurs. As the demand is to harvest energy in low-power region, single-series circuit with a double diode is used to convert received RF energy into dc voltage. From the left side of the circuit, the first meander line corresponds to the inductor L_1, while the second meander line represents the inductor L_2, of the Figure 2(b). The shunt stub is accounted

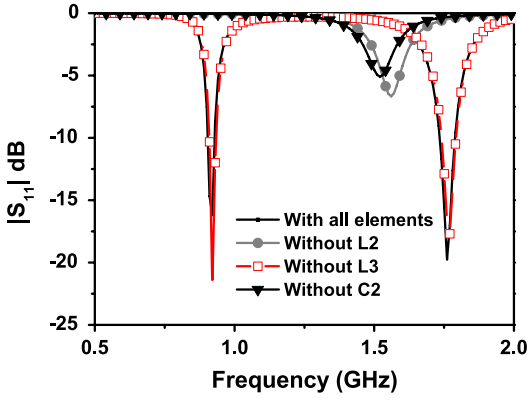

Figure 4. Simulated $|S_{11}|$ vs. frequency for different combination of circuit elements.

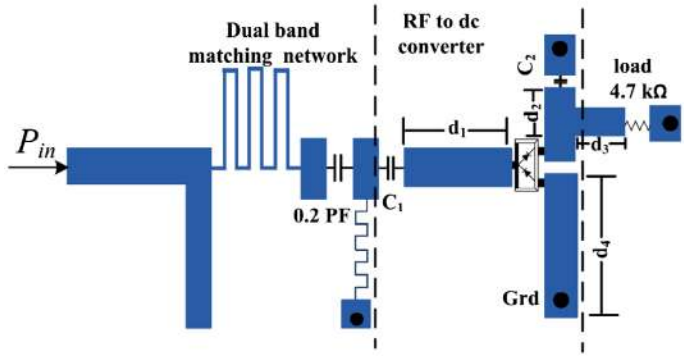

Figure 5. Layout of the proposed dual-band RF energy harvesting circuit.

for the shunt capacitor C_1 of Figure 2(b). The dimensions of each element are calculated according to their respective reactive element value and the substrate on which circuit has to be fabricated. In Assimonis, Daskalakis, and Bletsas (2016), it has been demonstrated that traces (microstrips) connected to the rectifier terminals (e.g. distance between the diode and via and diode and load) are highly sensitive for RF-to-dc efficiency. Therefore, traces d_1, d_2 between diode and capacitor C_1 and C_2, d_3 between diode and load and d_4 between diode and ground are adjusted to optimize the impedance matching as well as the conversion efficiency of the rectifier. Due to nonlinear behavior of the diode, harvesting circuit itself exhibits nonlinearity i.e. its input impedance varies with received RF power, therefore harmonic-balance (HB) and large signal analysis (LSSP) were employed to take into consideration the nonlinear behavior of the rectifier.

The photograph of the fabricated dual-band rectifier is shown in Figure 6. It is fabricated on a 1.54 mm thick FR-4 substrate with a dielectric constant (ϵ_r) of 4.3 using chemical etching method. The rectifier performance is evaluated in terms of $|S_{11}|$ and output voltage using the Agilent vector network analyzer (VNA). The simulated and measured $|S_{11}|$ is illustrated in Figure 7(a). The measured result shows reasonable agreement with the simulated one; the slight difference can be accounted for the fabrication imperfections. It is well known that impedance matching is a function of frequency and input power, due to the nonlinearity of the diode. Such a characteristic is examined in Figure 7(b), where the measured $|S_{11}|$ is demonstrated as a function of input power level for three different load impedance values. From results, it is clear that impedance matching of the harvesting circuit is greatly affected by the input power and the load impedance. Figure 7(b) demonstrates that as power increases, the impedance matching at 0.9 GHz degraded drastically, while at 1.8 GHz, it improves. Moreover, it is noticed that the impedance matching at higher power level is more sensitive to the variation of load impedance (*RL*).

The measured RF-to-dc conversion efficiency and output voltage vs. input power for both frequencies are demonstrated in Figure 8(a). For 0.9 GHz, efficiency is equal to 25.7 and 65.1% for an input power of -20 and 0 dBm, respectively. However, at 1.8 GHz the efficiency is relatively small that might be due to the increased parasitic losses in the rectifier diode. Figure 8(b) shows the relation between the output voltage and frequency for various input power levels at fixed load resistance value of 4.7 kΩ. It can be seen that maximum output voltage is achieved in the frequency range of 860–900 and 1770–1800 MHz, showing the rectifier's capability to harvest RF energy in the GSM-900 and 1800 bands.

Figure 9, depicts the measured conversion for various values of load resistance. It can be noticed that the circuit yields maximum efficiency when the load impedance is 4.7 kΩ. It starts decreasing as the load impedance varies from 4.7 kΩ. Table 1 shows the comparison of the conversion efficiency and the size of the proposed rectifier with the similar works reported previously. Only measured results are compared in Table 1. It can be seen that in low-power condition maximum efficiency is achieved in Sun et al. (2013), but the expense of bulky circuit size. However, the proposed rectifier offers an optimal conversion efficiency with compact circuit size.

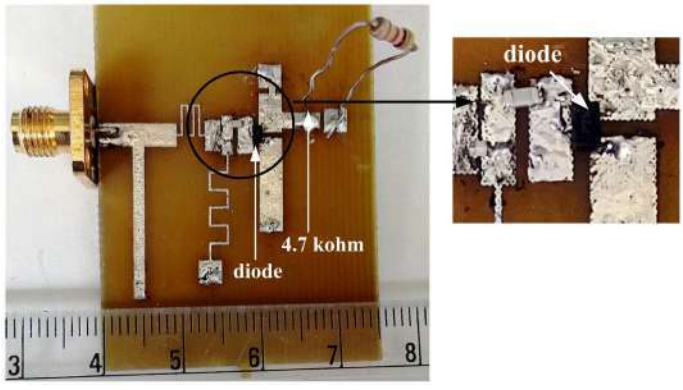

Figure 6. Photograph of the fabricated dual-band RF energy harvesting circuit.

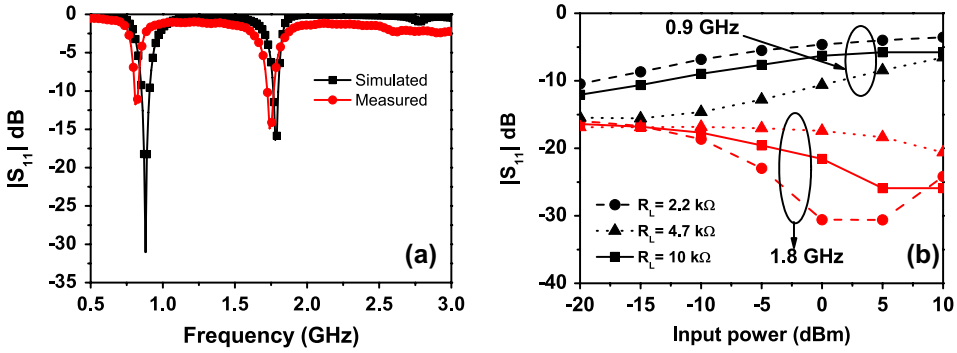

Figure 7. (a) Simulated and measured $|S_{11}|$ vs. frequency and (b) measured $|S_{11}|$ for various power levels.

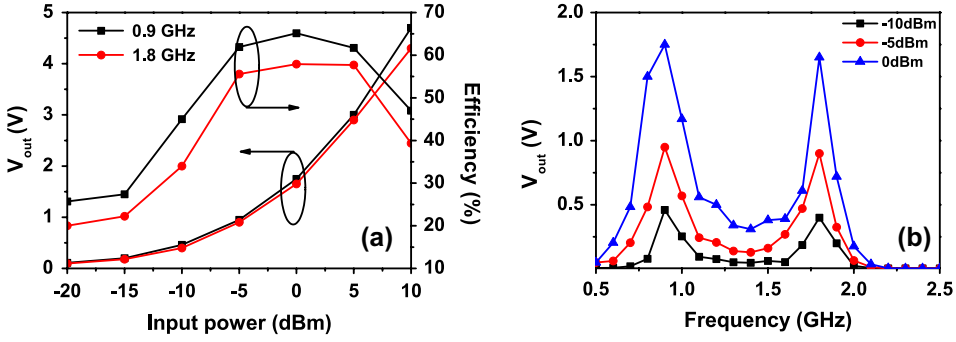

Figure 8. (a) Measured output dc voltage and RF-to-dc conversion efficiency and (b) measured dc voltage vs. frequency.

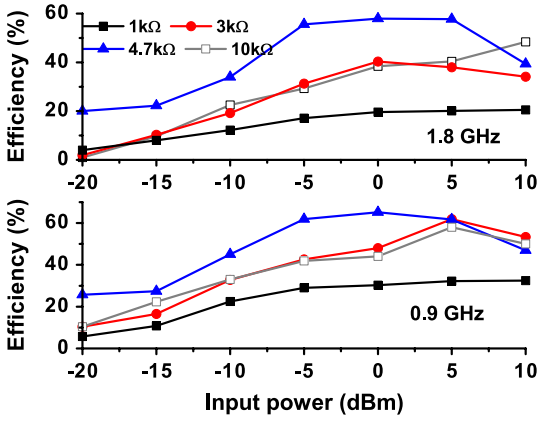

Figure 9. Measured RF-to-dc conversion efficiency for different load impedance.

Table 1. Performance comparison of the proposed dual rectifier with recently published works

Ref.	Measured rectifier efficiency (%)	Input power (dBm)	Rectifier size
Ho et al. (2016)	15.8 @ 0.89 GHz	−20	100 × 65 mm^2
	11.2 @ 1.76 GHz		
Hamano et al. (2016)	10 @ 2.15 GHz	−10	37 × 71 mm^2
	15 @ 5.84 GHz		
Bergès et al. (2015)	27 @ 0.91/2.4 GHz	−16	78 × 88 mm^2
Sun et al. (2013)	30 @ 2.14 GHz	−20	145 mm
	35 @ 1.84 GHz		
Liu et al. (15)	20 @ (0.91+1.8) GHz	−20	23 × 37 mm^2
This work	27.5 @ 0.9 GHz	−20	30 × 35 mm^2
	20 @ 1.8 GHz		

3. Conclusion

A new compact 4th order dual-band rectifier has been designed to harvest the RF power of GSM-900 and 1800 bands. In order to reduce the circuit complexity and sensitivity due to reactive elements, the meander line and the open stub are used to fabricate the matching network. For $P_{in} = -20$ dBm, the measured RF-to-dc conversion efficiency of 27.5 and 20% is achieved at 0.9 and 1.8 GHz, respectively. Further, more than 45 and 34% conversion efficiency is maintained from -10 to 10 dBm for 0.9 and 1.8 GHz, respectively.

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Optimization of the Voltage Doubler Stages in an RF-DC Convertor Module for Energy Harvesting

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ABSTRACT

This paper presents an optimization of the voltage doubler stages in an energy conversion module for Radio Frequency (RF) energy harvesting system at 900 MHz band. The function of the energy conversion module is to convert the (RF) signals into direct-current (DC) voltage at the given frequency band to power the low power devices/circuits. The design is based on the Villard voltage doubler circuit. A 7 stage Schottky diode voltage doubler circuit is designed, modeled, simulated, fabricated and tested in this work. Multisim was used for the modeling and simulation work. Simulation and measurement were carried out for various input power levels at the specified frequency band. For an equivalent incident signal of –40 dBm, the circuit can produce 3 mV across a 100 kΩ load. The results also show that there is a multiplication factor of 22 at 0 dBm and produces DC output voltage of 5.0 V in measurement. This voltage can be used to power low power sensors in sensor networks ultimately in place of batteries.

Keywords: Energy Conversion; RF; Schottky Diode; Villard; Energy Harvesting

1. Introduction

RF energy harvesting is one type of energy harvesting that can be potentially harvested such as solar, vibration and wind. The RF energy harvesting uses the idea of capturing transmitted RF energy at ambient and either using it directly to power a low power circuit or storing it for later use. The concept needs an efficient antenna along with a circuit capable of converting RF signals to DC voltage. The efficiency of an antenna mainly depends on its impedance and the impedance of the energy converting circuit. If the two impedances aren't matched then it will be unable to receive all the available power from the free space at the desired frequency band. Matching of the impedances means that the impedance of the antenna is the complex conjugate of the impedance of the circuit (voltage doubler circuit).

The concept of energy harvesting system is shown in **Figure 1**, which consists of matching network, RF-DC conversion and load circuits. The authors in [1], used a 2.4 GHz operating frequency with an integrated zero bias detector circuit using BiCMOS technology which produced an output voltage of 1 V into a 1 MΩ load at an input power level of 0 dBm. H. Yan and co-authors revealed that a DC voltage of 0.8 volts can be achieved from a –20 dBm RF input signal at 868.3 MHz through simulation results [2]. In [3], work was carried out on a firm frequency of 900 MHz by matching to a 50 Ω impedance and resonance circuit transformation in front of the Schottky diode which yields an output voltage of over 300 mV at an input power level of 2.5 µ. W. J. Wang, L. Dong and Y. Fu [4] used a Cockcroft-Walton multiplier circuit that produced a voltage level of 1.0 V into a 200 MΩ load for an input power level of less than –30 dBm at a fixed frequency of 2.4 GHz.

The energy conversion module designed in this paper is based on a voltage doubler circuit which can be able to output a DC voltage typically larger than a simple diode rectifier circuit as in [5], in which switched capacitor charge pump circuits are used to design two phase voltage doubler and a multiphase voltage doubler. The module presented in this can function as an AC to DC converter that not only rectifies the input AC signal but also elevates the DC voltage level. The output voltage of the

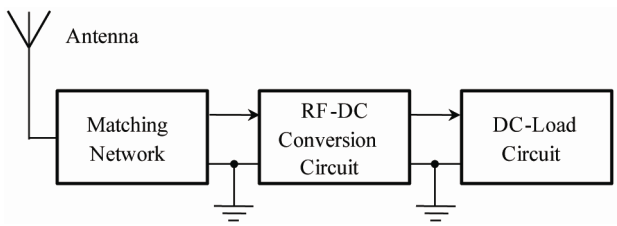

Figure 1. Schematic view of a RF energy harvesting system.

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energy conversion module can be used to energize the low power devices for example sensors for a sensor network in application to agriculture.

Section 2 of this paper discusses on the theoretical background of the voltage doubler circuit. Section 3 presents the simulation study and implementation of the circuit design. Section 4 provides the results and analysis. Section 5 concludes with a discussion on the findings from the simulated and measured results.

2. Voltage Multiplier

There are various voltage multiplier circuit topologies. The design used in this module is derived from the function of peak detector or a half wave peak rectifier. The Villard voltage multiplier circuit was chosen in the circuit design of this paper because it produces two times of the input signal voltage towards ground at a single output and can be cascaded to form a voltage multiplier with an arbitrary output voltage and its design simplicity.

2.1. Diode Modeling

The voltage multiplier circuit in this design uses zero bias Schottky diode HSMS-2850 from Agilent. The attractive feature of these Schottky diodes are low substrate losses and very fast switching but leads to a fabrication overhead. This diode has been modeled for the energy harvesting circuit which comes in a one-diode configuration. The modeling parameters for these diodes are given by Agilent in their data sheets. These parameters are used in Multisim for its own modeling purposes. The modeling is done by transforming the diode into an equivalent circuit using passive components which are described by the SPICE parameters in **Table 1** [6].

The diode used in this design is shown in **Figure 2** and its equivalent model is shown in **Figure 3**. The special features of HSMS-2850 diode is that it provides a low forward voltage, low substrate leakage and uses the non symmetric properties of a diode that allows unidirectional flow of current under ideal condition.

Table 1. SPICE parameters.

Parameters	Units	HSMS 2850
B_V	V	3.8
C_{J0}	pF	0.18
E_G	Ev	0.69
I_{BV}	A	3E–4
I_S	A	3E–6
N	No unite	1.06
R_S	Ω	25
P_B (V_J)	V	0.35
P_T (XTI)	No units	2
M	No units	0.5

Figure 2. Schottky diode.

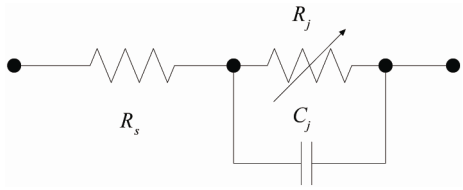

Figure 3. Linear circuit model of the Schottky diode [6].

The diodes are fixed and are not subject of optimization or tuning. This is described using the following derivations. By neglecting the effect of diode substrate, an equivalent linear model that can be used for the diode as shown in **Figure 3**. When C_j is the junction capacitance and R_j is the junction resistance, the admittance Y_z of the linear model is given by

$$Y_Z = Y_{C_j} + Y_{R_j} \tag{1}$$

Equation (1) related to the frequency of operation is given by

$$Y_Z = jwC_j + \frac{1}{R_j} \tag{2}$$

$$= \frac{jwC_jR_j + 1}{R_j} \tag{3}$$

The impedance Z of the linear model is given by

$$Z = \frac{R_j}{1 + jwR_jC_j} \tag{4}$$

The total impedance Z_T is given by

$$Z_T = R_S + \frac{R_j}{1 + jwR_jC_j} \tag{5}$$

where R_S is the series resistance of the circuit and R_j is given by

$$R_j = \frac{8.33 \times 10^{-5} \times N \times T}{I_b + I_S}$$

where:

I_b = bias current in μA;

I_s = saturation current in μA;

T = temperature (K);

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N = ideality factor.

In Equation (5), R_j and C_j are constants and the frequency of operation (w) is the only variable parameter. As the frequency increases, the value of Z is almost negligible compared to the series resistance R_S of the diode. From this it is concluded that the function of the diode is independent of the frequency of operation.

2.2. Single Stage Voltage Multiplier

Figure 4 represents a single stage voltage multiplier circuit. The circuit is also called as a voltage doubler because in theory, the voltage that is arrived on the output is approximately twice that at the input. The circuit consists of two sections; each comprises a diode and a capacitor for rectification. The RF input signal is rectified in the positive half of the input cycle, followed by the negative half of the input cycle. But, the voltage stored on the input capacitor during one half cycle is transferred to the output capacitor during the next half cycle of the input signal. Thus, the voltage on output capacitor is roughly two times the peak voltage of the RF source minus the turn-on voltage of the diode.

The most interesting feature of this circuit is that when these stages are connected in series. This method behaves akin to the principle of stacking batteries in series to get more voltage at the output. The output of the first stage is not exactly pure DC voltage and it is basically an AC signal with a DC offset voltage. This is equivalent to a DC signal superimposed by ripple content. Due to this distinctive feature, succeeding stages in the circuit can get more voltage than the preceding stages. If a second stage is added on top of the first multiplier circuit, the only waveform that the second stage receives is the noise of the first stage. This noise is then doubled and added to the DC voltage of the first stage. Therefore, the more stages that are added, theoretically, more voltage will come from the system regardless of the input. Each independent stage with its dedicated voltage doubler circuit can be seen as a single battery with open circuit output voltage V_0, internal resistance R_0 with load resistance R_L, the output voltage, V_{out} is expressed as in Equation (7).

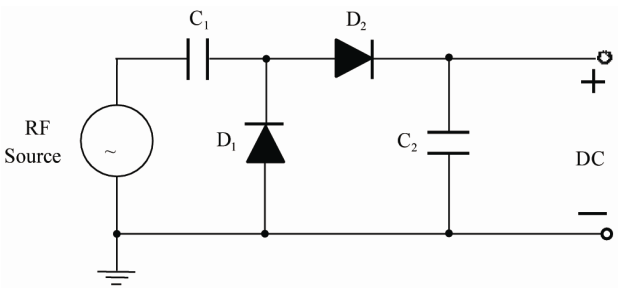

Figure 4. Single stage voltage multiplier circuit [7].

$$V_{out} = \frac{V_0}{R_0 + R_L} R_L \tag{6}$$

When n number of these circuits are put in series and connected to a load of R_L in Equation (6) the output voltage V_{out} obtained is given by this change in RC value will make the time constant longer which in turn retains the multiplication effect of two in this design of seven stage voltage doubler.

$$V_{out} = \frac{nV_0}{nR_0 + R_L} = V_0 \frac{1}{\frac{R_0}{R_L} + \frac{1}{n}} \tag{7}$$

The number of stages in the system has the greatest effect on the DC output voltage, as shown from Equations (6) and (7).

It is inferred that the output voltage V_{out} is determined by the addition of R_0/R_L and $1/n$, if V_0 is fixed. From this analysis it is observed that V_0, R_0 and R_L are all constants. Assume that V_0 = 1 V, R_0/R_L = 0.25, n = 2, 3, 4, 5, 6 and 7, the output voltage V_{out} = 1.33 V, 1.72 V, 2.0 V, 2.22 V, 2.43 V and 2.56 V respectively when substituted analytically in the Equation (7). This analysis can be compared with the results obtained in the circuit design of this module. In simulation at n = 4, V_{out} = 1.42 V, n = 5, V_{out} = 1.67 V; n = 6, V_{out} = 1.92; n = 7, V_{out} = 2.15 V; n = 8, V_{out} = 1.92 V; n = 9, V_{out} = 1.81 V. Also in measurement, for n = 4, V_{out} = 2.1 V; n = 5, V_{out} =2.9 V; n = 6, V_{out} = 3.72 V; and n = 7, V_{out} = 5 V. As n increases, the increase in output voltage will be almost double the input voltage up to some number of stages. But at some point, *i.e.* beyond seven stages, in this circuit the output voltage gained (8 and 9 stages) will be negligible as shown in **Figure 5**.

The capacitors are charged to the peak value of the input RF signal and discharge to the series resistance (R_s) of the diode. Thus the output voltage across the capacitor of the first stage is approximately twice that of the input signal. As the signal swings from one stage to other, there is an additive resistance in the discharge path of the

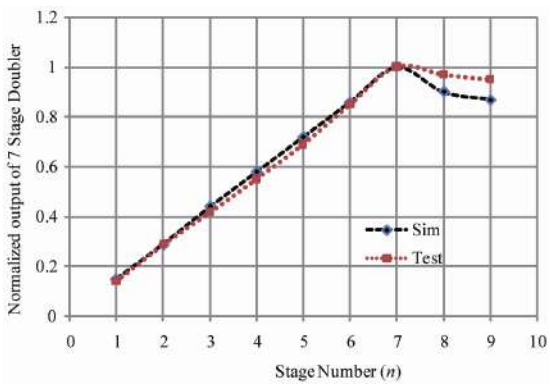

Figure 5. Normalized output voltage multiplier versus number of stages.

diode and increase of capacitance due to the stage capacitors.

2.3. Seven Stage Voltage Multiplier

The seven stage voltage multiplier circuit design implemented in this paper is shown in **Figure 6**. Starting on the left side, there is a RF signal source for the circuit followed by the first stage of the voltage multiplier circuit. Each stage is stacked onto the previous stage as shown in the **Figure 6**. Stacking was done from left to right for simplicity instead of conventional stacking from bottom to top.

The circuit uses eight zero bias Schottky surface-mount Agilent HSMS-285X series, HSMS-2850 diodes. The special features of these diode is that, it provides a low forward voltage, low substrate leakage and uses the non-symmetric properties of a diode that allows unidirectional flow of current under ideal conditions. The diodes are fixed and are not subject of optimization or tuning. This type of multiplier produces a DC voltage which depends on the incident RF voltage. Input to the circuit is a predefined RF source. The voltage conversion can be effective only if the input voltage is higher than the Schottky forward voltage.

The other components associated with the circuit are the stage capacitors. The chosen capacitors for this circuit are of through-hole type, which make it easier to modify for optimization, where in [8] the optimization was accomplished at the input impedance of the CMOS chip for a three stage voltage multiplier. The circuit design in this paper uses a capacitor across the load to store and provide DC leveling of the output voltage and its value only affects the speed of the transient response. Without a capacitor across the load, the output is not a good DC signal, but more of an offset AC signal.

In addition to the above, an equivalent load resistor is connected at the final node. The output voltage across the load decreases during the negative half cycle of the AC input signal. The voltage decreases is inversely proportional to the product of resistance and capacitance across the load. Without the load resistor on the circuit, the voltage would be hold indefinitely on the capacitor and look like a DC signal, assuming ideal components. In the design, the individual components of the stages need not to be rated to withstand the entire output voltage. Each component only needs to be concerned with the relative voltage differences directly across its own terminals and of the components immediately adjacent to it. In this type of circuitry, the circuit does not change the output voltage but increases the possible output current by a factor of two. The number of stages in the system is directly proportional to the amount of voltage obtained and has the greatest effect on the output voltage as explained in the Equation (7) and shown in **Figure 5**.

3. Simulation and Implementation

Multisim software was chosen for modeling and simulation which is a circuit simulation tool by Texas Instruments. The simulation and practical implementation were carried out with fixed RF at 945 MHz ± 100 MHz, which are close to the down link center radio frequency (947.5 MHz) of the GSM-900 transmitter. The voltages obtained at the final node V_{DC} of the multiplier circuit were recorded for various input power levels from –40 dBm - +5 dBm with power level interval (spacing) of 5 dBm.

The simulations were also carried out using same stage capacitance value (3.3 nF) and then with a varied capacitance value for all stages from 4 stages through 9 stages [9]. The capacitance value was varied in such a way that, from one stage to the next, it was halved. For example, if the first stage was 3.3 nF, the second stage was 1.65 nF, third stage was 825 pF, fourth stage was 415 pF and so on. But keeping in view of testing, the capacitance values were chosen to have a close match with the standard available values in the market.

Simulation was carried out through 4 to 9 voltage doubler stages. Based on results obtained a 7 stage doubler is best to implemented for this application.

The design of the printed circuit board (PCB) was carried out using DipTrace software. The material used to

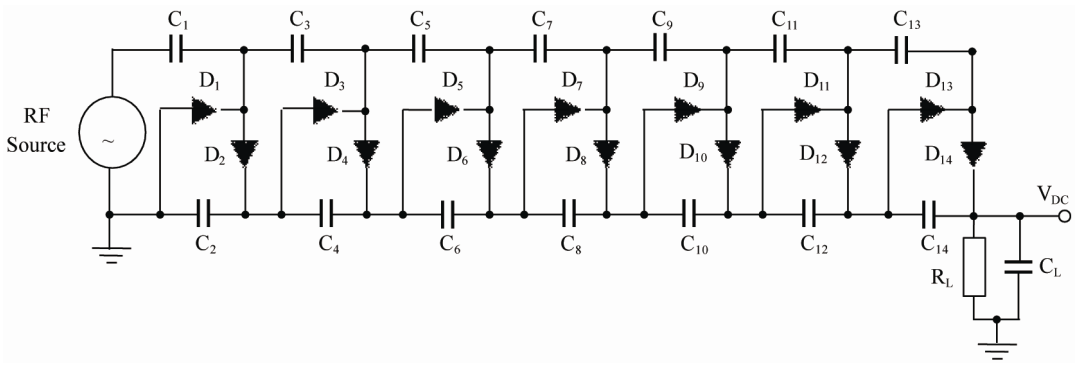

Figure 6. Schematic of 7 stage voltage multiplier.

manufacture the printed circuit board (PCB) is the standard Fiberglass Reinforced Epoxy (FR4), with the thickness of 1.6 mm and dielectric constant of 3.9. The topology is constructed on the PCB with the dimensions of 98 mm × 34 mm (W × H). The Sub Miniature version A (SMA) connectors are used at the input and output of PCB to carry out the measurements. The circuit components consist of active and passive components. The component used in circuit is shown in **Table 2**.

Special handling precautions have been taken to avoid Electro Static Discharge (ESD), while assembling of the surface-mount zero bias Schottky diodes. Also special attention has been given to mount other components and the SMA connectors on to the PCB. The Photograph of Assembled circuit board I shown in **Figure 7**.

4. Results and Analysis

The simulated and measured results at the output voltage of voltage multiplier circuit are shown graphically in **Figure 8**. From the graph analysis, the simulated and the measured results agree considerably with each other. The measured results are shown to be better than the simulation results. The reason behind this may be due to the uncertainty in series resistance value of the diode obtained from SPICE parameters in modeling as explained in Equation (5). This resistance vale of diodes in practical circuit may be lower than in the model, which provides fast discharge path, in turn rise in voltage as passes through the stages and reaches to final output. In this work, the DC output voltages obtained through simulation and measurement at 0 dBm re 2.12 V and 5.0 V respectively. These results are comparatively much better than in ref. [9], where in at 0 dBm, 900 MHz they achieved 0.5 V and 0.8 V through simulation and measurement respectively.

Figures 9 and **10** show the result of a 4 stage voltage doubler circuit with equal and varied capacitance values between the stages as described in Section 3.

From the analysis of these two simulations, it can be observed that the resulting output voltages are equal. The only difference between these two graphs is the rise time of the circuit with varied capacitance value is a little bit slower. But, overall result on the performance of rise time is still under 20 µs to 24 µs and the difference is negligible. From these results, the use of equal stage capacitance of each being 3.3 nF was hence considered for the design of the multiplier.

The results from **Figure 11**, shows that the output voltage reaches to 1.0 V within 20 µS and then uniformly increasing to 1.4 V, 1.67 V, 1.87 V and 2.12 V for 4, 5, 6 and 7 stages respectively compared to 2 mS as shown in [10]. **Figure 12** shows that the conversion ratio of 22 is achieved at 0 dBm input power and drops to 2.5 at –40 dBm. The highest value at 0 dBm is due to the innate characteristics of the zero bias Schottky diodes which conduct fairly well at higher input voltages.

5. Conclusion

From the experimental results, it is found that the pro-

Table 2. Component used in 7 stage voltage multiplier.

Name of component	Label	Value
Stage capacitors	C_1 - C_{14}	3.3 nF
Stage diodes	D_1 - D_{14}	HSMS 2850
Filter capacitor	C_L	100 nF
Load resister	R_L	100 kΩ

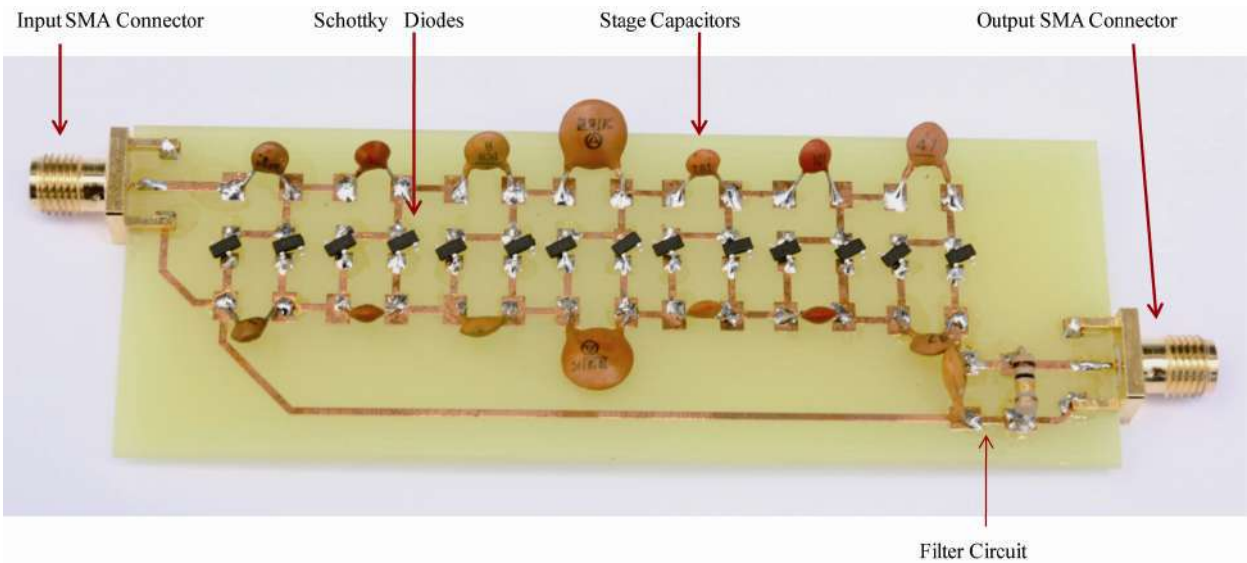

Figure 7. Photograph of assembled circuit board.

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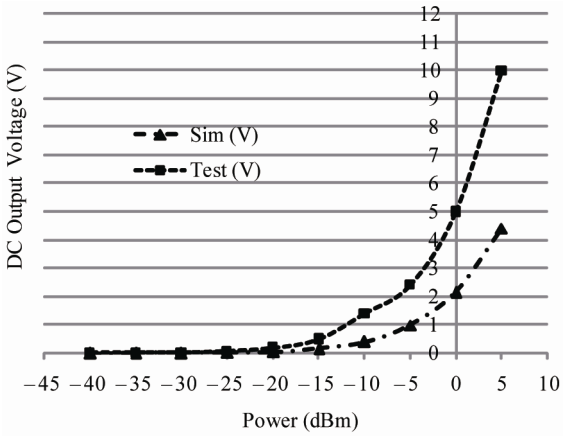

Figure 8. Simulated and test DC output voltage of multiplier as a function of input power.

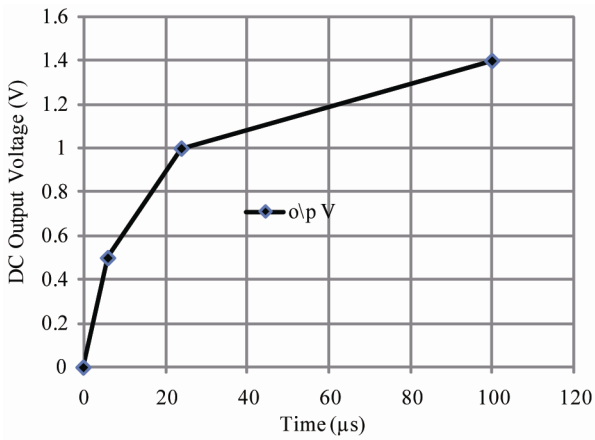

Figure 9. DC output voltage verses rise time of 4 stage voltage doubler circuit with equal stage capacitance [8].

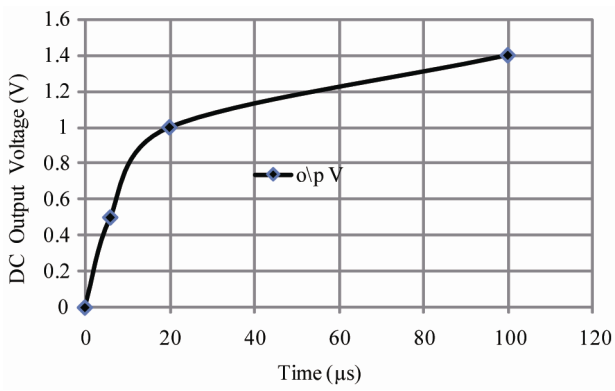

Figure 10. DC output voltage verses rise time of 4 stage voltage doubler with varied stage capacitance [8].

posed voltage multiplier circuit operates at the frequency of 945 MHz with the specified input power levels. The results have shown that there is multiplication of the input voltage. From **Figure 12**, it is shown that at 0 dBm input power, the multiplication factor is 22. This is sig-

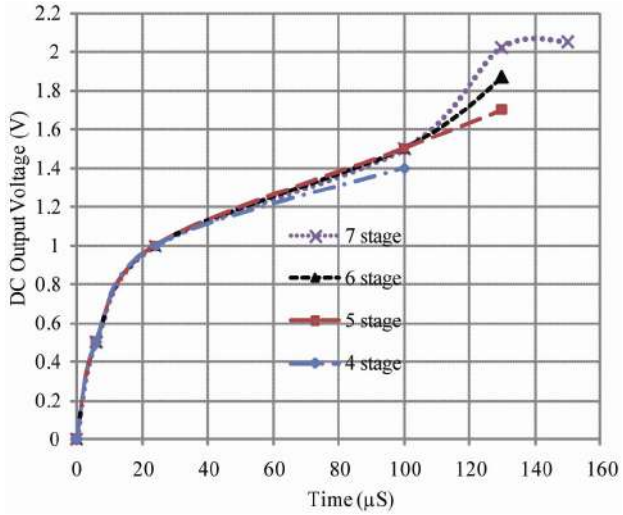

Figure 11. DC output voltage verses rise time of voltage doubler circuit through 4 - 7 stages with equal stage capacitance.

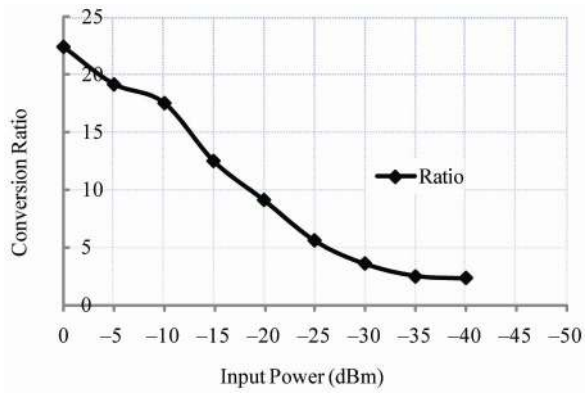

Figure 12. Conversion ratio as a function of input power.

nificant, as the work shows that RF energy in the GSM-900 band can be harvested from the ambient RF source using the Villard circuit topology. The power density levels from a GSM base station is expected from 0.1 mW/m^2 to 1 mW/m^2 for a distance ranging from 25 m - 100 m. These power levels may be elevated by a factor between one and three for the GSM-900 downlink frequency bands depending on the traffic density [10]. The next phase of the research work is to interface the voltage multiplier circuit through a matching network to the antenna at the input side and a low power device to power from the system at the output side to complete the RF energy harvesting system.

6. Acknowledgements

We would like to acknowledge and thank the Ministry of Higher Education Malaysia for funding this project under Fundamental Research Grant: FRGS/1/10/TK/UNITEN/02/13.

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Stop Guessing and Built This Simple Meter Making Measurements Easy to Take

Why a Hand Held RF Current Meter

There are two things that I wanted to do which would be made easy with a current meter... Both are related to the unusual nature of the antenna here at AC0C.

1. Checking common mode surface current on coax and control cables up in the attic antennas.

With the high cost of ferrites, placing them with the aid of a current meter is very helpful in that you can compare the before (no ferrite) and after (with ferrites attached) - and know that you have addressed the current problem on a given bit of line.

Otherwise, it seemed to me, that ferrite placement was more of a guess than a science.

2. Measuring relative antenna currents along an element

With the W8WWV RVM system, I can measure element currents where ever a current sensor is placed. This is typically at the center of a dipole element.

However, the center may or may not be the actual high-current point for the element depending on the frequency. My EZNEC models can indicate where the current peaks are - and by looking along these lines manually - comparing them with readings taken from the driven element, I can make current checks even in non-standard location of the array.

The meter described below accomplishes these two tasks very nicely.

Design Idea

The design follows an old RSGB design that I found on G3SEK's excellent web site:

http://www.ifwtech.co.uk/g3sek/clamp-on/clamp-on.htm

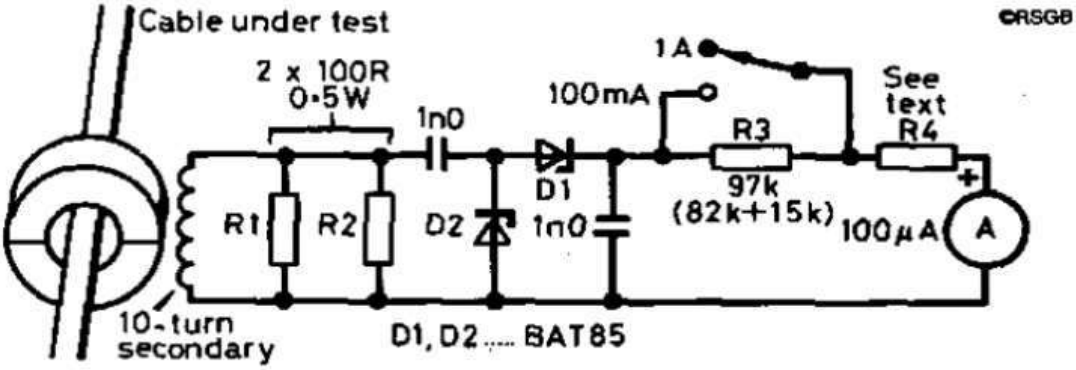

I followed this design pretty close except for the R3/R4 which I used variable trim pots. Due to the voltage-doubler nature of the circuit, it's capable of exceptional sensitivity.

The meter was calibrated for full-scale @ 1A on the higher scale, but I have left the lower scale set on a very high sensitivity setting which I find very handy for the common mode checking. Here, a sensitive meter providing a relative

current indication is needed.

Construction Details

Once parts were in hand, construction was very easy and took perhaps an hour.

No attempt was made to beautify the work - it's 100% orientated toward functionality and utility.

I had a 100 uA meter in the junk box along with the other parts needed and orienting them on the back-side of the meter was really the most time consuming aspect.

The switch is held in position with hot-glue. And a bit of hot glue is applied to the meter terminations as a safety precaution - just in case I were to brush the meter up against something carrying high levels of current.

Wraps around the toroid were made with wire-wrap type wire, 30 Gage.

Selection of the toroid used was based on what would physically fit around the RG-213 sized cable and could be easily opened and closed.

The rubber band shown in the picture makes for a very convenient closing mechanism - and in a lot of applications, I simply hold the toroid closed with my finger pressure which makes moving the meter along a wire - and moving from cable to cable - very quick and easy.

For more ideas, check out Frank N4SPP's very nice RF current meter found HERE.

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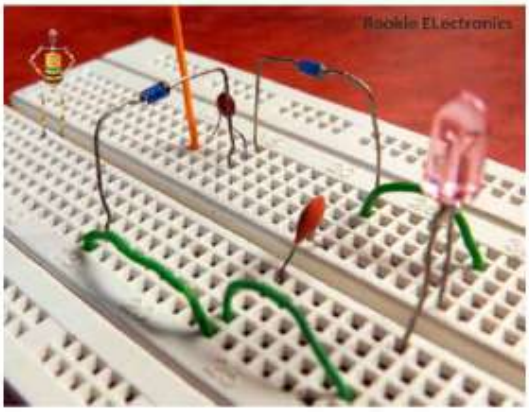

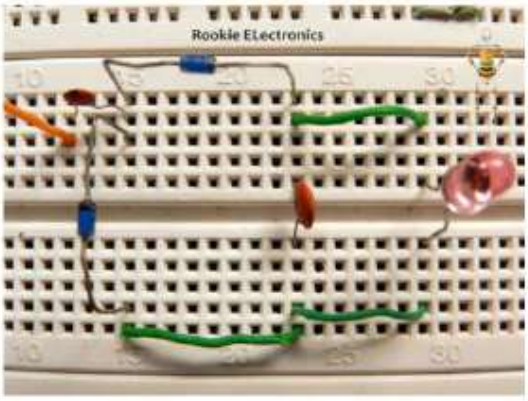

Strip Board:

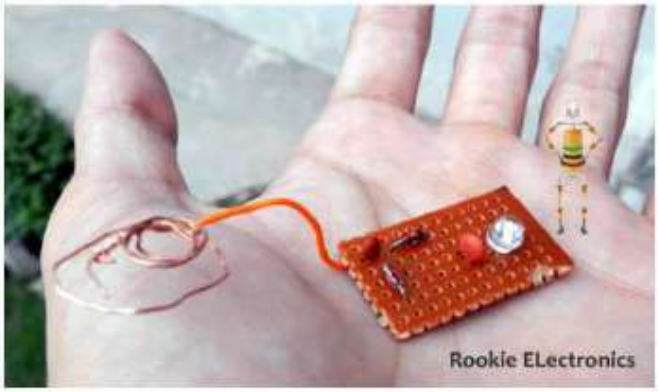

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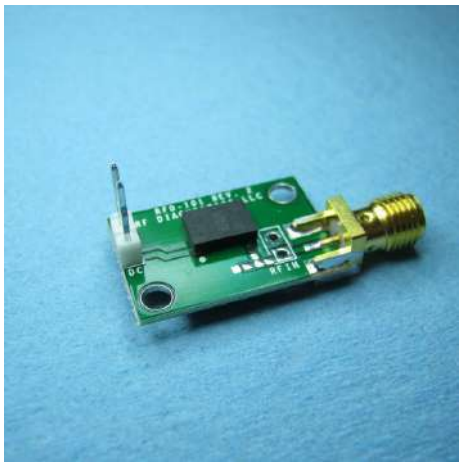

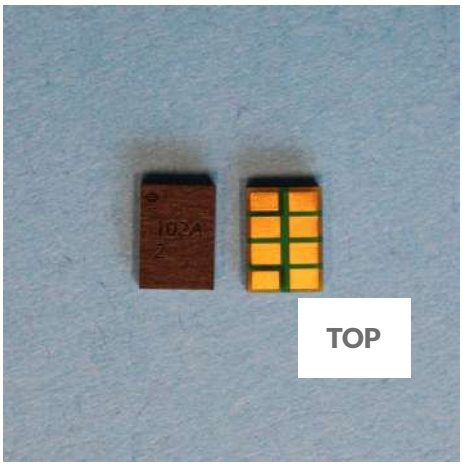

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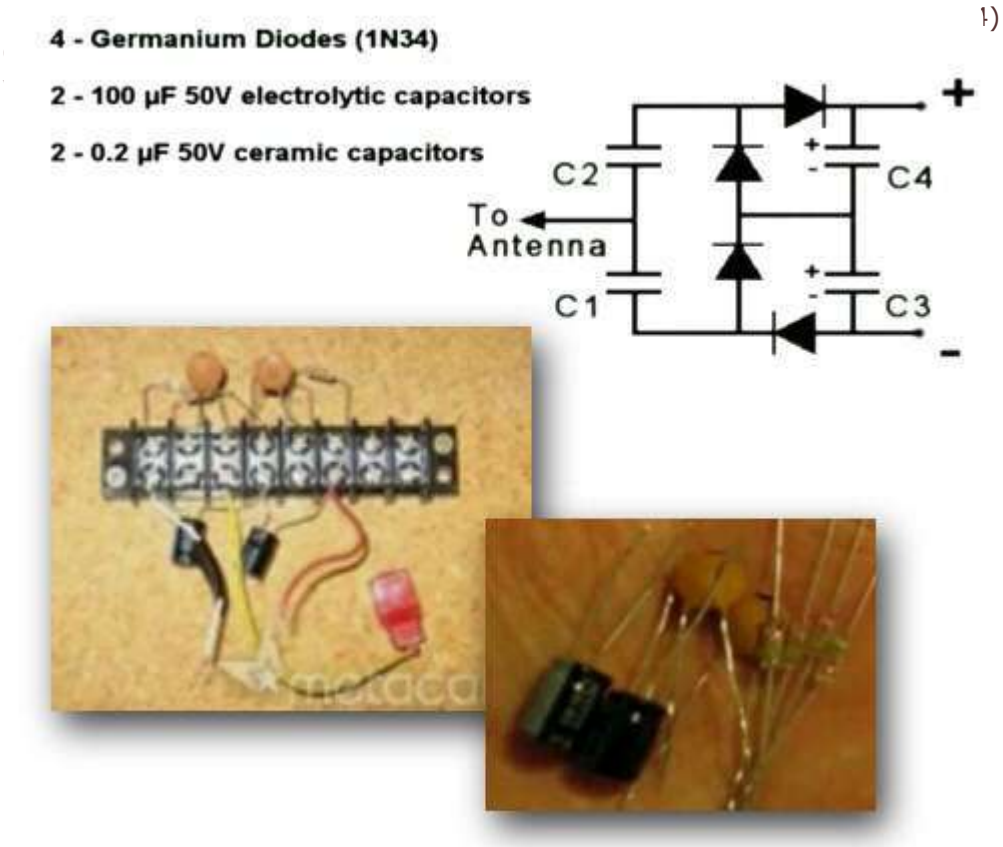

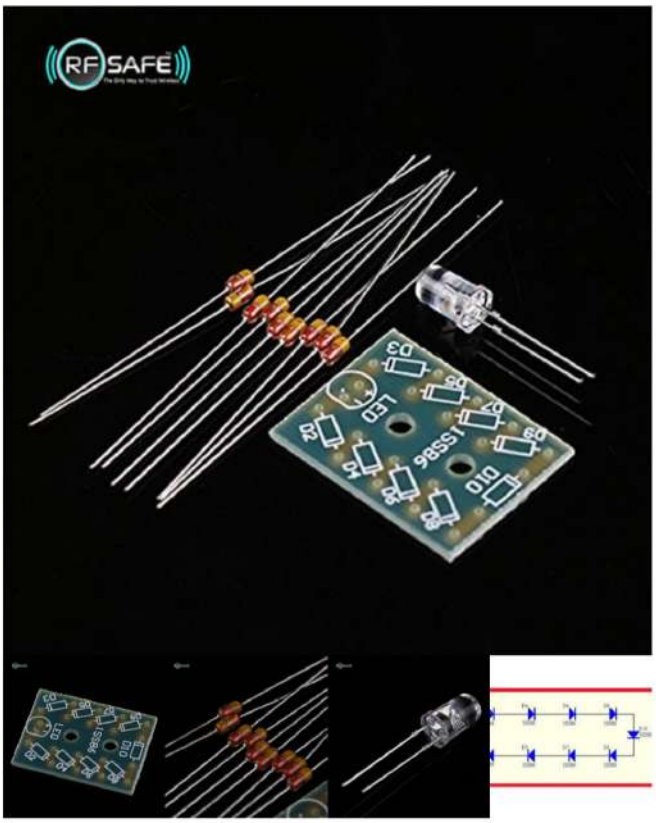

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A concurrent 915 MHz / 2440 MHz RF Energy Harvester

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This paper presents the development of two dual-band RF harvesters optimized to convert far-field RF energy to DC voltage at very low received power. The first one is based on a patch antenna and the second on a dipole antenna. They are both implemented on a standard FR4 substrate with commercially off-the-shelf (COTS) devices. The two RF harvesters provide a rectified voltage of 1V for a combined power respectively of -19.5 dBm at 915 MHz and -25 dBm at 2.44 GHz and of -20 dBm at 915 MHz and -15 dBm at 2.44 GHz. The remote powering of a clock consuming 1V/5µA is demonstrated, and the rectenna yields a power efficiency of 12 %.

Keywords: Antennas and Propagation for Wireless Systems, Applications and Standards (mobile, Wireless, networks), Circuit Design and Applications.

Corresponding author: email: ludivine.fadel@ims-bordeaux.fr; phone: +33 540 002 615

I. INTRODUCTION

Today's the society is evolving toward creating smart environments where a multitude of sensors and devices are interacting to deliver an abundance of useful information. Essential to the implementation of this Internet Of Things (IOT) is the design of energy efficient solutions aiming toward a low-carbon-emission, namely green, society. Within this context, the energy harvesting appears as an alternative to provide systems with self-sustained operation. Many electronic devices operate in conditions where it is costly, inconvenient, or impossible to replace the battery. Examples include sensors for health monitoring of patients [1],[2], aircraft or building structural monitoring [3],[4], sensors in natural, industrial or hazardous environments, etc. The scavenging of natural ambient energy requires some specific conditions such as: daylight for solar energy [5], breeze for wind energy or motion for kinetic energy [6] to name a few. As consequences the exploitation of natural source does not fit with many cases of applications. On the other hand the electromagnetic (EM) [7], or Radio-Frequency (RF), energy is a human made source that is not dependent of weather conditions nor the daytime. It is so very attractive for wireless powering of remote devices. Furthermore the ever growing of commercial and personal wireless installations opens up to a 24 hour a day available energy in the vicinity of any human activity areas. The schematic of a general Wireless RF Power Transmission (WPT) system is shown in Fig.1. We talk here about far-field RF energy transmission [8], which is different from near-field RF energy transmission [9]. This later including inductive, capacitive or resonant coupling is a close contact transmission and is not relevant for remote devices. In Fig. 1, the receiver antenna

collects the EM energy radiated by a RF source, and converts it into a RF signal. This RF signal is transferred to the rectifier by an impedance matching network, to be converted into DC power, which is further accumulated in a storage element. The main purpose in the deployment of WPT systems is the development of compact and efficient solutions. Most of the challenge concerns the implementation of harvesting modules, especially the antenna as its design defines the scavenging capability and the size of the RF harvester. At low frequency the transfer of energy is efficient, but the antenna footprint is large. To address the trade off between the efficiency of the WPT and the size of the modules, the frequency band located in the 433 MHz to 6 GHz frequency spectrums are preferred.

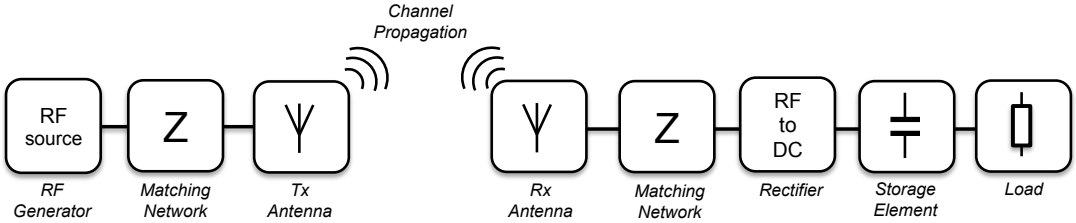

Fig. 1: Schematic of a Wireless RF Power Transmission (WPT) system

Over the last decade the research effort has focused on the development of WPT systems according two scenarios: the RF energy scavenging [10] and the RF energy transfer [11]. The two RF energy scavenging is an opportunistic collection of the RF ambient energy from the surrounding communication traffic. To improve the harvesting capability the scavenging RF harvesters are of wide-band type [12] and cover popular standards such as: DTV (470-610 MHz), GSM900, GSM1800, 3G (2.1GHz) and WiFi (2.4 GHz). Unfortunately these standards dedicated to convey wireless communications do not radiate a large RF power. As consequences the collected energy is weak, unpredictable and out of control. The RF energy scavenging remains a promising solution in the future as the increase of communication traffic could make it more reliable, and consistent with IOT applications. The second concept, namely RF energy transfer, assumes an identified source that is dedicated to perform the WPT. The amount of transmitted power is controlled by the source and the collected energy is larger than in scavenging approach. The licence-free Industry-Science-Medical (ISM) frequency bands located at 0.9, 2.4 and 5.8 GHz are usually exploited to support such a WPT scenario. Today the RF energy transfer in ISM Bands is not only promising, it becomes a reality as some pioneer companies propose some full kits: Powercast Corporation, AnSem and MicroChip to name a few. However there is still a lot of work to make the RF energy transfer an appropriate, low cost and easy-to-use solution for remote powering. One of the most critical point concerns the harvesting capability of the RF modules. So far the commercial kits referenced above only explore the 900 MHz ISM allocations to perform the WPT. This work proposes to demonstrate the interest of a concurrent harvesting at 915 MHz and 2.44 GHz. The design and implementation of a modified 4-stage doubler RF to DC converter, including a concurrent matching network, is first presented. The section III details the design of two types of multi-band antenna. The comparison between a single frequency and a multi-band WPT is exposed and the demonstration of the remote powering of a clock is reported as a case of application. To conclude a comparison of our results with the state of the art is exposed.

II. CONCURRENT RF TO DC CONVERTER

The Radio-Frequency IDentification (RFID) applications are the most popular systems exploiting the principle of RF energy transport. In passive RFID applications the reader transmits the RF power to the tag, and also sets up the communication. The RF to DC converter is designed to yield a maximum of power efficiency to the tag. Most of the time the reader and the tag are in line of sight and close to each other, these conditions improve the transmission of RF energy, the amount of power available at the tag antenna is large, typically between -15 dBm and -20 dBm. In RF energy harvesting the scenario is different. The distance between the RF source and the RF harvester ranges from 0.5 meter to 10 meters. The amount of collectable power is low, from -10 dBm to -25 dBm, and the remote powering is difficult. The RF harvesters are supposed to collect and to store the energy during a long period of time. Once the level of stored energy is large enough, it can be released to the application. For these reasons a rectifier dedicated to RF energy harvesting is first designed to yield a maximum of sensitive to increase its scavenging time and capability.

A) Rectifier Architecture

The rectifier architecture is based on voltage multipliers to provide an adequate output DC voltage. The architecture of the RF to DC converter, reported in Fig.2, includes a matching network based on a L-section, and a N-stage voltage multiplier based on Schottky diodes from Avago (HSMS285). The choice of the Schottky diode is very important in the design of the rectifier. A key parameter is its threshold voltage $V_{TH.}$ When only low power levels are available in the environment, the amplitude of the incident signal may be close to or even below this voltage. Below this voltage value, the diode will no longer conduct and the losses become predominant. For COTS devices the two Schottky diodes performing the best conversion efficiency in a 2.4 GHz range are HSMS-2850 from Avago and SMS-7630 from Skyworks [13].

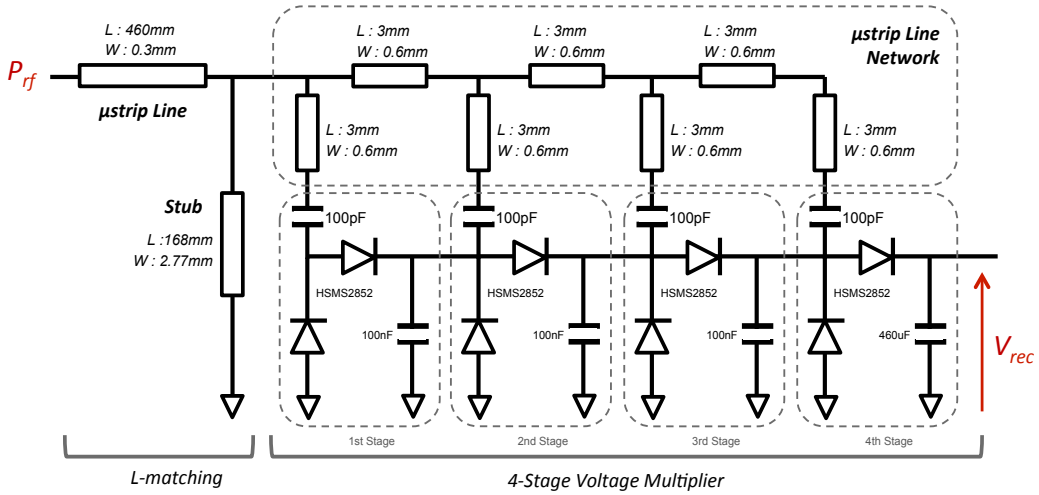

Fig. 2: Architecture of the RF to DC converter

Focusing on the sensitivity, the RF to DC converter is designed to maximize the rectified voltage for an input power close to -20 dBm. The optimum number of stage is fixed to four according [14]. The footprint of each voltage doubler imposes the micro-strip line network. The micro-strip lines namely "junction" is set to minimum length, the micro-strip lines "access" are used as an additional degree to tune the input-matching network. Indeed, the L section in combination with the micro-strip distributed network is equivalent to a T section (Fig.3). Many combinations of Z_1, Z_2, Z_3 can achieve input matching at 900 MHz or 2.4 GHz. Some of them are very close for each frequency, so we choose one that allows a return loss (< - 10 dB at least) both at 900 MHz and 2.4 GHz.

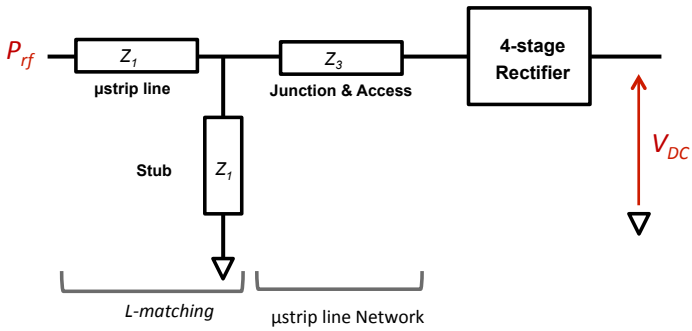

Fig. 3: Topology of the input-matching network

The equivalent narrow band model of the matching network is proposed for each frequency (Fig.4). At 915 MHz, the voltage multiplier, including the rectification stages and the micro-strip line network, is modelled with a shunt capacitor (5pF) and a shunt resistor of 270 Ω (Fig.4a). The stub, (Fig.3) is equivalent to an inductor (Fig.4a), which compensates the shunt capacitor. The input micro-strip line, (Fig.3), is a quarter wave impedance transformer, (Fig.4a) it converts the 270 Ω into 50 Ω. At 2.44 GHz the micro-strip line network distributing the RF signal to the voltage doublers (Fig.3), becomes inductive (Fig.4b). The stub is equivalent to a shunt capacitor of 120fF, its effect is negligible. The impedance transformation is actually performed by the input micro-strip line, which is modelled by a shunt capacitor (0,6 pF) and a series inductor of 5.6 nH.

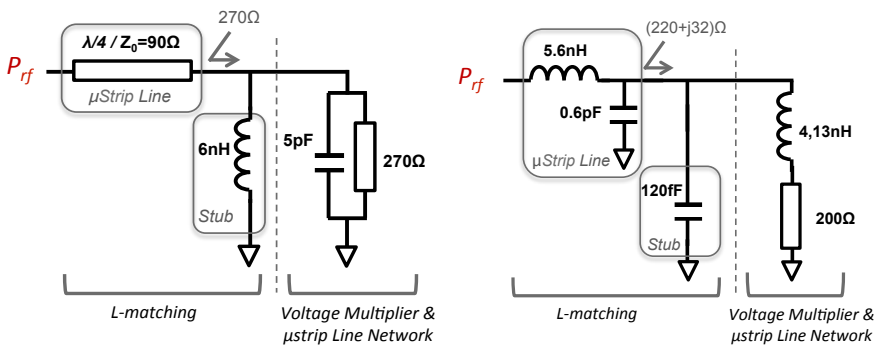

(a) *(b)*

Fig. 4: Equivalent model of the input matching network at 915 MHz (a) at 2,44 GHz (b)

To study the impact of the power on the diode, and input matching, behaviour the return loss of the 4-stage rectifier has been measured and plotted (Fig.5) for various input power P_{rf} at 9000MHz.

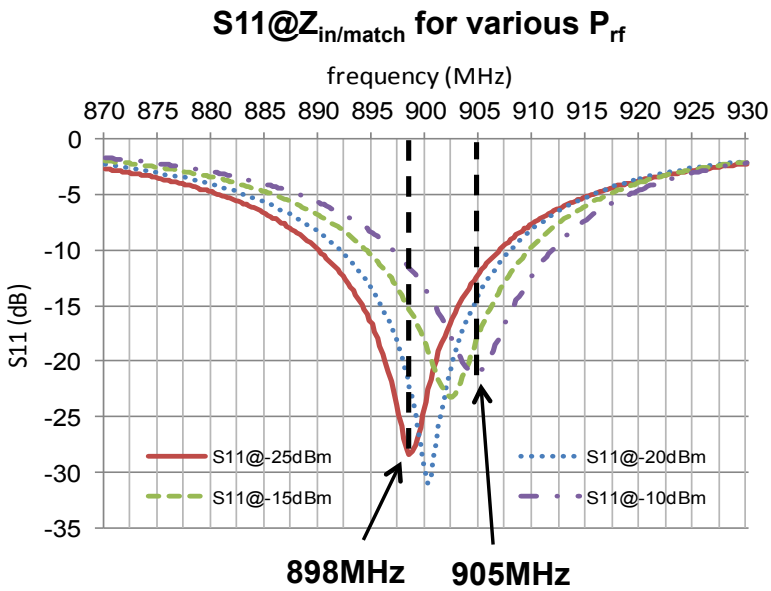

Fig. 5: Measured S_{11} of a 4-stage voltage multiplier with a L section at 900 MHz for various input power P_{rf}

As illustrated in the figure 5, the input return loss is not strongly affected by the input power if P_{rf} < -15 dBm. The RF harvesters developed in this work are dedicated to collect power from – 15 to – 25 dBm. Over this range the diode model can be considered as stable, and the slight frequency shift is still covered by the antenna bandwidth.

B) Rectifier Characterization

The power efficiency and the power sensitivity are two conversion characteristics of importance in RF harvesters. However, the RF harvester operating at low power level accumulates the energy in a storage element, to further release it to the application. In such accumulation mode the power sensitivity becomes more important than the power efficiency.

For the characterization the rectifier is not connected to a load. The load represents the equivalent impedance of the application (clock, sensor) to power. The effectiveness of RF-DC conversion of the rectenna and its DC ouput voltage varies depending on the load value. The rectifier is first characterized in a single tone mode, 915 MHz and 2.44 GHz respectively, and then in a dual-band mode. Measurements of the unloaded rectified voltage versus various input power P_{rf} are reported in Figure 6.

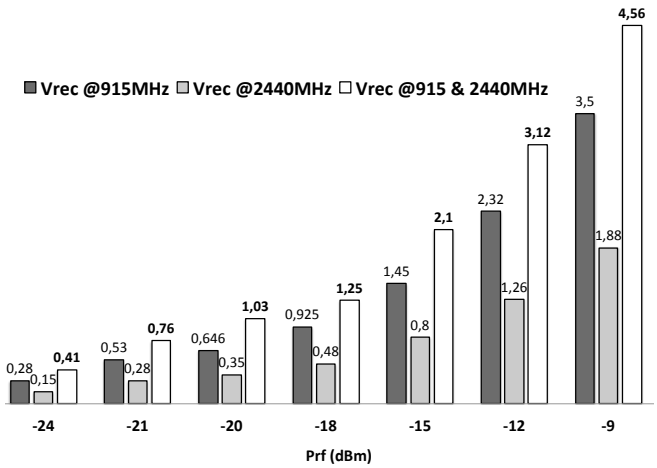

Fig. 6: Unloaded rectified voltage for various input power

To compare the results of the two considered tones, the target is fixed to a value of 1V. In a single tone mode, the required P_{rf} to rectify 1V is close to -18 dBm at 915 MHz, and would be larger than -15 dBm at 2.44 GHz. In a dual-band mode the circuit only needs a power P_{rf} of -20 dBm at each frequency. The dual-band rectification significantly improves the power sensitivity. The reverse breakdown voltage of the HSMS285 Schottky diode limits the input power to - 9 dBm, for which V_{rec} is 4,56 V.

III. ANTENNA DESIGN

To meet the low-cost constraints, the RF energy harvester will be implemented on a single low cost substrate, an FR4 PCB. For the antenna, there are more efficient substrates with a higher permittivity to reduce the size of the antenna or a lower losses but their cost is much higher than the improved performance. These powerful substrates fail to build low cost energy harvesters. This section exposes the design of two dual-band antennas implemented on a 1.6 mm FR4 printed circuit board. The fabrication uses a mechanical etching process with a 200µm resolution. We have chosen two complementary antenna topologies with a directional and omnidirectional radiation pattern.

A) Dual - band patch antenna

Emitting and receiving antennas do not usually meet the same constraints. Mobile devices such as smartphones and tablets use compact antennas (ifa, pifa…) to address the trade off between performance and size. Base stations can afford large efficient radiating elements (omnidirectional or directional antennas depending on the application). For energy harvesting purpose, micro-strip patch antennas are commonly used [15-17]. A rectangular micro-strip patch antenna (RMPA) is first developed to suit with both low cost technology of implementation and co-integration with the rectifier. Based on the cavity-model approximation, the resonant frequencies of the RMPA for the TM_{mn} mode is described in (1).

$$f_{mn} = \frac{c}{2\sqrt{\varepsilon_r}}\sqrt{\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2} \quad (1)$$

W, L are the patch dimensions, c = 3.10^8m/s

The antenna dimensions, 68 cm^2 (8.8 x 7.8 cm), described Fig.7a are dependent to the frequency bands and the feed location is selected to only excite the fundamental modes TM_{01} and TM_{10}. Those modes permit to obtain a large aspect ratio (W/L = 2,7) but reduce the performance of the RMPA. On the other hand, TM_{01} and TM_{30} modes require an aspect ratio close to one but offer beneficial radiation patterns for our application. The RMPA is fed by a probe whose position (x,y) adjusts the matching both at 915 MHz and 2.44 GHz. This two operating bands of the proposed antenna are on cross polarization planes. The geometric parameters of RMPA have been optimized with an approximate model, the TL model [18], and with a full wave method. Details of the two approaches have been studied in [19]. The return loss of the RMPA is better at 915 MHz than 2.44 GHz because the maximum impedance of TM30 mode is 31 Ω [19]. The TM30 mode does not achieve 50 Ω because it is not a fundamental mode. This antenna has a maximum gain of 1.3 dB at 915 MHz (Fig.7b) and 2.5 dB at 2.44 GHz (Fig.7c). This two operating bands of the proposed antenna are on cross polarization planes.

The realized gains of the dual band patch antenna are lower than the classical patch antenna because the radiating efficiency is low, 60% for the TM_{01} mode and 30% for the TM_{30} mode. The FR4 substrate has a loss tangent of 0.02. The radiation efficiency of the dual band patch antenna is highly dependent of the substrate losses.

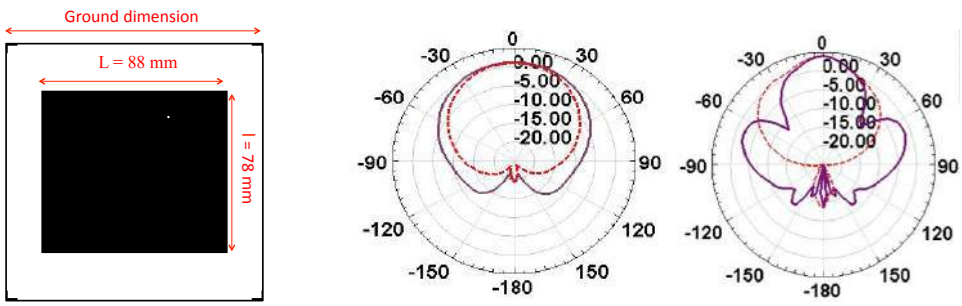

(a) *(b)* *(c)*

Fig. 7. Layout of the RMPA antenna (a) - Radiation pattern at 915MHz (b) and 2.44 GHz (c) Solid and dashed lines correspond to E-plane and H-plane respectively

B) Multi-band arm dipole antenna

The second antenna is a multi-band dipole type composed of three arms. Its dimension is about 23 cm^2 (11.1x2.1 cm), Fig.8a. Each arm is designed to work at one band of frequency. The longer one is for the 915 MHz, the middle one, not useful in our case, is for the 1.4 GHz and the last one, the smaller, is dedicated to 2.4 GHz [20].

All the geometric parameters have been optimized with a full-wave method in order to be matched both at 915/ 2440MHz. On Fig.6b and 6c, the radiation pattern is plotted for the elevation plane (orthogonal to substrate) of the simulated antenna. The maximum gain is 0.5 dB at 915 MHz and 3.4 dB at 2.44 GHz at 90°, on the substrate plane. The radiation efficiency is 99% at 915 MHz and 95% at 2.44 GHz.

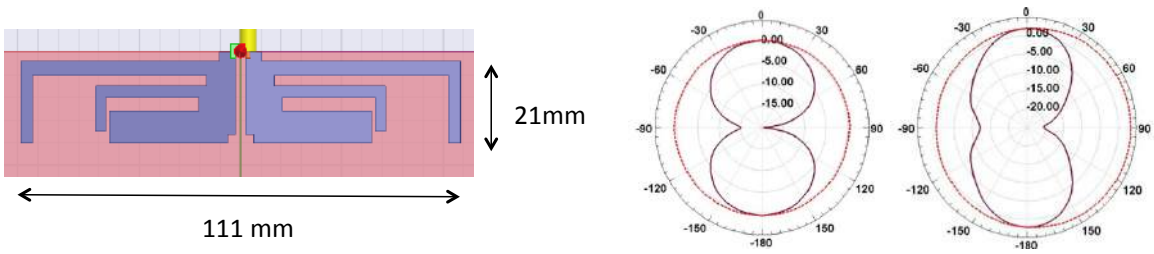

(a) *(b)* *(c)*

Fig. 8. Layout of the multi-band arms dipole antenna (a) - Radiation pattern at 915 MHz (b) and 2.44 GHz (c). Solid and dashed lines correspond to E-plane and H-plane respectively

It is interesting to compare the characteristics and performances of the two types of antennas. Although the radiation efficiency of the dipole antenna is better than the patch antenna, the antenna gains are similar because the high directivity of the RMPA antenna compensates the low values of radiation efficiency. When there are no cost constraints, it is interesting to use high performance substrates for the design of RMPA antennas because they improve the radiation efficiency and consequently antenna gain.

Moreover, the integration of the antenna with the rectifier will not be made in the same way. Considering the patch antenna, the rectifier can be integrated on the ground plane allowing a more compact solution. The dipole antenna, which is ground plane free, is less sensitive to the surrounding environment in our case. The performance of the dipole antenna and especially the radiation efficiency are very weakly dependent of the substrate characteristics. The design of a dipole antenna can be easily reuse with other material such as Kapton®, paper, Plexiglas to name a few.

IV. WIRELESS POWER TRANSMISSION

This part presents the measurement results of the assembled RF harvesters in the context of Wireless Power transfer. The two dual-band harvesters are realized with COTS devices such as HSMS diodes and capacitors. Those elements are reported by heat-treating. The RF to DC converter board, including the matching network and the rectifier, is reported on the backside and connected to the radiation part, on the front side, through a via (Fig.9a). The dipole antenna is connected to the rectifier circuit using SMA connector (Fig.9b).

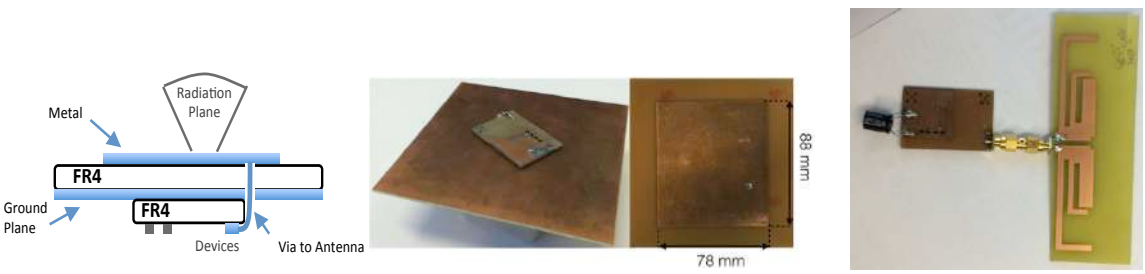

(a) *(b)*

Fig. 9. Dual-band RF harvesters based on patch antenna (a) – arms dipole antenna (b)

For the dual-band RF harvester based on patch antenna, the return loss, S_{11}, is measured for an input power of -20 dBm with a HP8720 network analyser. The patch antenna, the rectifier and the dipole antenna are centered at 915 MHz and 2.44 GHz with a low return loss ($S_{11} < -15$ dB), Fig.10. The return loss of the RMPA antenna is better at 915 MHz than 2.44 GHz because the maximum impedance of TM30 mode is 31 Ω (Fig. 6 and Fig. 7 of [16]). The TM30 mode does not achieve 50 Ω because it is not a fundamental mode.

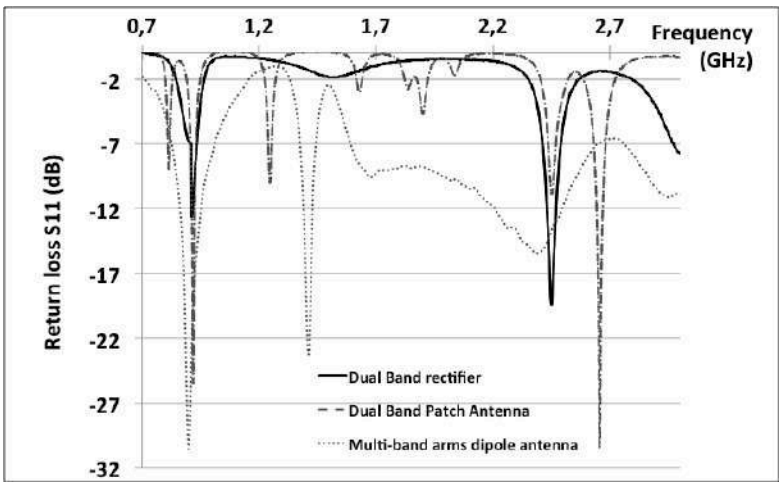

Fig. 10. Measured return loss S_{11} of the dual-band rectfier, patch and arms dipole antenna

A) Remote Powering and Power Efficiency

The rectenna is connected to a clock, which mimics a low power application. The remote powering of this clock is performed in a furnished room of the lab according the schematic of Fig.11. The distance between the source and the antenna is fixed to 2 m. The clock is turned on for different scenarios of transmitted power. For each combination of power proposed in Fig.12, the RF power is first measured with a calibrated antenna and a power meter. Then, the rectenna is measured and P_{eff} is the ration between the power delivered to the load (here the clock) and the power available at the antenna.

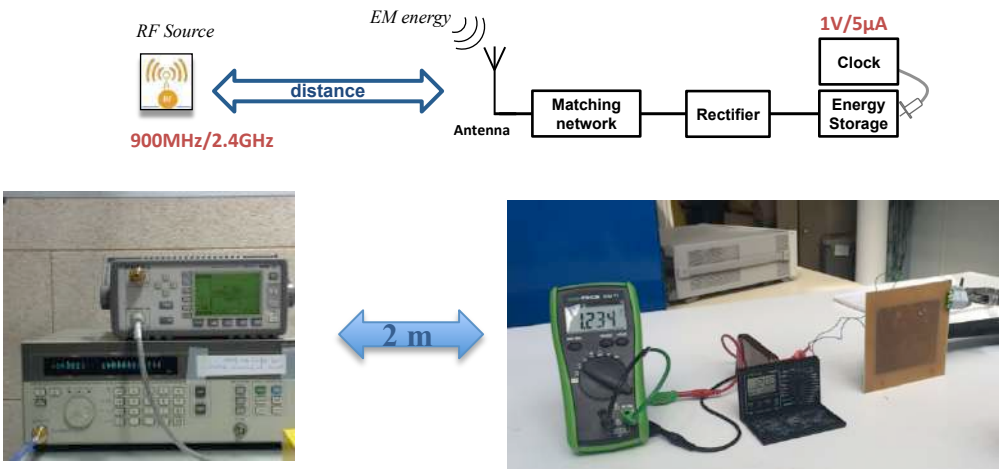

Fig. 11. Schematic and picture of the scene of remote powering of a clock

The power efficiency of the patch and the dipole rectenna is worked out from these experiments and reported in Fig.12. The power efficiency η is defined as the ratio between the DC power delivered to the clock and the RF power collected by the antenna.

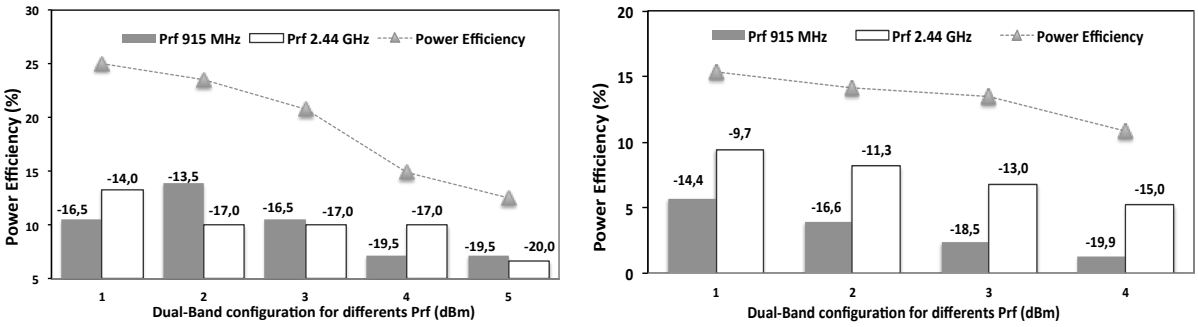

(a) *(b)*

Fig. 12. Power efficiency of the dual-band RF harvester based on the patch (a) and the arms dipole (b) antenna

The minimum power required to turn on the clock with the patch-based harvester, Fig. 10.a, is a two tone signal featuring: -19.5 dBm at 915 MHz and -20 dBm at 2.44 GHz. At this point, the power efficiency is 12.5 %, which corresponds to a DC output power of 2.7 µW/1V.

A maximum efficiency of 24 % occurs for a combined power of -16.5 dBm at 915 MHz and -14 dBm at 2.44 GHz. The harvester is able to deliver a DC ouput power of 15 µW. The harvester based on the arm dipole antenna needs a minimum power of -19.9 dBm at 915 MHz and -15 dBm at 2.44 GHz at the antenna to turn on the clock. For these conditions of remote powering, the efficiency of the harvester is 11 %. It delivers a DC power of 3.8 µW/1.15 V. The maximum power efficiency, 15.5 %, yields for an input power of -14.4 dBm at 915 MHz and -9.7 dBm at 2.44 GHz, the DC output power is 21 µW.

This scenario of remote powering figures out that the harvester based on the patch antenna exhibits a better power efficiency than the harvester combined with the dipole element. This difference is due to the antenna gains. Referring to Fig. 7 and Fig. 8, the gain of the patch antenna is larger (+0.8dB) at 915 MHz and lower (-0.9 dB) at 2.44 GHz than the dipole element. However the rectifier, referenced in [16], achieves a power efficiency of 17% at 915 MHz and only 5% at 2.44 GHz for an input signal of -15 dBm. As consequences the patch-based harvester is able to extract more power from a 915 MHz signal than the dipole-based harvester can do at 2.44 GHz. For this reason the overall efficiency of the patch harvester is better.

B) Power Sensitivity

The power sensitivity is measured with the same scenario of Fig.11 but the clock is disconnected. The output voltage is reported for different combination of collectable power at the antenna in a dual-band configuration.

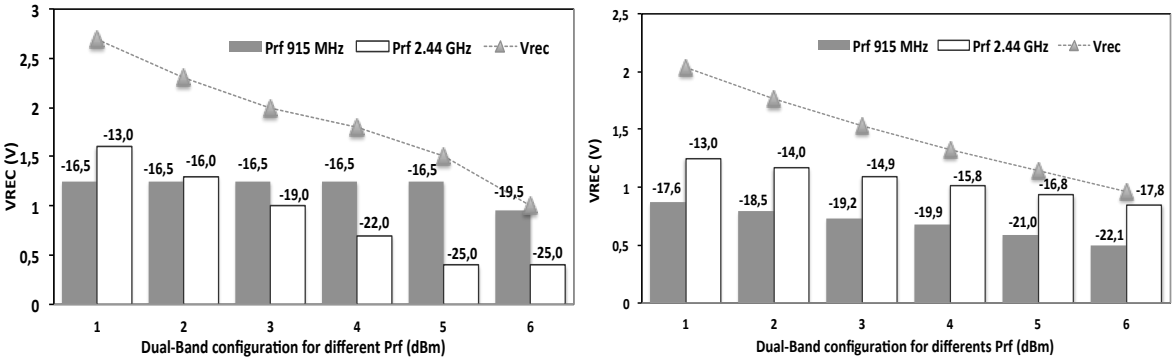

(a) *(b)*

Fig. 13. Rectified voltage of the RF harvester based on patch (a) and arm dipole (b) antenna

To rectify a 1V DC voltage, the patch-based harvester, Fig.13a, requires a two dual-band configuration: -19.5 dBm at 915 MHz and -25 dBm at 2.44 GHz, which is equivalent to an input power of -18.4 dBm (or 14 µW). For the same purpose the dipole-based harvester, Fig.13b, needs a dual-tone of -22.1 dBm at 915 MHz and -17.8 dBm at 2.44 GHz. The equivalent input power of this 2-tone signal is -16.5 dBm (or 22 µW). The patch-based harvester exhibits a better sensitivity than the dipole harvester for the same reason exposed in the part A of this section. In Fig.6, which reports the power sensitivity of the rectifier part only, the overall sensitivity is almost the same for the dipole harvester. It is improved by 1.8 dB for the patch harvester due to the additional gain of the antenna at 915 MHz.

C) Discussion and Comparison with the state of the art

An important characteristic of a remote powered device is its size. Indeed it is expected to be as small as possible to make it unobtrusive to our closest environment. In a scenario of RF harvesting the antenna footprint determines the compactness of a harvester operating Ultra High Frequency (UHF) bands. To complete the comparison between the two harvesting modules developed in this work, two figures of merit, FOM_{sens} and FOM_{eff}, including the size of the antenna, are proposed in (2) and (3).

$$FOM_{sens} = \frac{V_{REC@Psens}(V)}{\frac{P_{sens}(\mu W)}{100\mu W} \cdot \frac{A_{ant}(cm^2)}{100cm^2}} \quad (2)$$

With: P_{sens} the input RF power required to provide $V_{REC@Psens}$ the unloaded rectified output DC voltage, and A_{ant} the area of the antenna.

$$FOM_{eff} = \frac{\eta(\%)}{\frac{P_{eff}(\mu W)}{100\mu W} \cdot \frac{A_{ant}(cm^2)}{100cm^2}} \quad (3)$$

With: P_{eff} the input RF power required to achieve η the overall power efficiency.

FOM_{sens} and FOM_{eff} do not represent the same scenario of application. The FOM_{sens} illustrates the capability of the rectenna to start collecting energy and store it in an element such as a capacitor or a battery to further release it. FOM_{eff} demonstrates the capability of the RF harvester to yield "on time powering": the rectenna is connected to an application and

supply it on time. Both are reported in the Table I, which also includes some references of the state of the art. The ability of the proposed rectenna to simultaneously operate in two frequency bands, significantly improves the power sensitivity.

Table I. Comparison with the state of the art

Ref.	Freq (GHz)	Efficiency (%@P_{rf})	Sensitivity (V_{rec}@Prf)	Number of stage	Schottky diodes	Size (cm^2)	FOM Sens	FOM Eff
[21]	0.9	15% @ -10dBm	0.75V @ -10dBm	1	SMS-7630	15×15	1.9	6.6
[21]	2.4	9% @ -13dBm	0.9V @ -13dBm	1	SMS-7630	15×15	1.25	8
[22]	2.45	10.5% @ -20dBm	0.075V @ -20dBm	1	SMS-7630	3.4×3.4	6.5	905
[23]	0.915/ 2.45	14%@ -20/-20	0,36V@ -10/-10	1	SMS-7630	6×6	0.5	185
[24]	1.8/2.2 /2.5	55%@ -10dBm	300mV@ -32dBm 3tones	1	SMS-7630	7×7	20	112
This work Dipole	0.915/ 2.44	**11% @ -20/-15dBm**	**1V @ -22/-18dBm**	4	HSMS-2850	2.1×11	**19.8**	**136**
This work Patch	0.915/ 2.44	**12.5% @ - 19.5 dBm/ -20dBm**	**1V @ -19.5dBm/ -25dBm**	4	HSMS-2850	7.8×8.8	**10.5**	**100**

According the Table I, the patch-based harvester exhibits the highest sensitivity to rectify 1V with a dual-tone featuring: -19.5 dBm at 915 MHz and only -25 dBm at 2440 MHz. The FOM_{sens} represents the trade-off between the sensitivity performances of a rectenna and the antenna area. The FOM_{eff} rates the efficiency performances to the antenna area. For these two figures of merit, the rectenna based on the multi-arm dipole element yields the best trade-off, both for FOM_{sens} and FOM_{eff}, compared to the patch-based solution. This dual tone and multi-arm dipole harvester is close to the work proposed in [24] which exhibits the highest FOM_{sens} reported so far in the literature to our knowledge.

V. CONCLUSION

The range of power collectable in a scenario of RF harvesting varies from -15dBm to -25dBm. To address this purpose the rectenna proposed in this work are optimized to operate at a RF input power close to -20 dBm (or 10 µW). To further improve the ability to collect the RF energy, these rectenna, developed with Schottky diodes HSMS285 from Avago, perform a concurrent harvesting in the 915 MHz and 2.44 GHz ISM bands. The harvester including a patch antenna implemented on a 1.6mm FR4 PCB achieves the highest sensitivity. It provides a 1V-rectified voltage for a dual-tone excitation of -19.5 dBm at 915 MHz and -25 dBm at 2.44 GHz. For these conditions of operation the rectenna yields a power efficiency of 12.5%. To take into account the dimensions of the haverster, two figures of merit, FOM_{sens} and FOM_{eff} including the size of the antenna, respectively related to the power sensitivity and the power efficiency are proposed. The rectenna developed with the arm dipole element exhibits the highest figures of merit. A case of application is proposed with the remote powering of a

digital clock consuming 1V/5μA. The patch based harvester turns on the device with a dual tone excitation at the antenna of -19.5 dBm at 915 MHz and -20 dBm at 2.44 GHz. For the same scenario the harvester connected to the multi-arm dipole element needs a power of -22.1 dBm at 915 MHz and -17.8 dBm at 2.44 GHz.

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Valérie Vigneras is a full professor in the Polytechnic Institute of Bordeaux and conducts research in the IMS Laboratory on complex structures (mixtures, structured media, self-assembled media) both by simulation to predict or optimize their properties and by characterization before their integration in high frequency systems (antennas, electromagnetic compatibility, radar shieldness…).

Thierry Taris is a full professor at the Bordeaux Institute of Technolgy (Bx-INP). He joined the IMS lab in 2005 where is research interests are related to the Radio-frequency Integrated Circuits in Silicon technologies.

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Fig. 11. Schematic and picture of the scene of remote powering of a clock.
Fig. 12. Power efficiency of the dual-band RF harvester based on the patch (a) and the arms dipole (b) antenna.
Fig. 13. Rectified voltage of the RF harvester based on patch (a) and arm dipole (b) antenna.
Table I. Comparison with the state of the art.

Fun with Less Kilowatts: The Lectenna

By Vernon Trollinger, March 14, 2017, Energy Efficiency, Events & Fun, Family

Welcome to Fun with Less Kilowatts! We believe that science experiments at home can be a creative way to engage kids in learning while having fun. They can be educational AND great activities to keep your kids busy and away from the television. Each month, we'll feature a new science experiment that can be a great resource for parents and teachers.

The Lectenna

Did you know you that the energy from radio waves can be converted back into electric energy? It's true and you can make a *simple* two-component circuit that you and your kids can use to find 2.45 Ghz radio waves around your home. These are the same radio waves used by microwaves, WiFi network routers, bluetooth devices, smart phones, cordless phones, smart meters, and smart home systems that use Zigbee.

YouTuber pjaffeva posted this brilliant project showing how. Plus, there's also a link to a PDF set of instructions on Google Drive that you can download.

The Materials

- One HLMP-D150 Avago low current LED. Costs about 50¢/each. Available from: Amazon, Digikey, Mouser
- One Hitachi 1SS106 low capacitance Schottky diode. Pjaffeva recommends this Hitachi-made diode as being the only one in this shape that will work. But they're also hard to find. Currently, you can get them from LittleDiode's ebay store in the UK. Costs $6.38 but the bulk of that price is shipping from the UK.

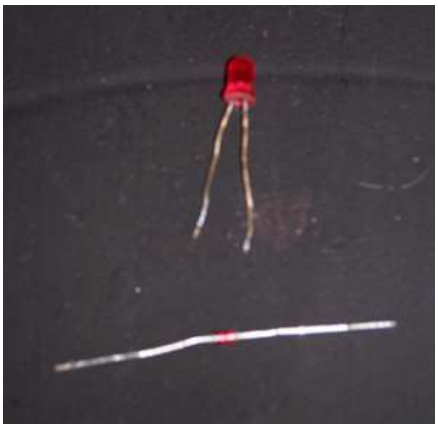

You'll also need:

- An operating WiFi router
- A bamboo kabob skewer
- Two pieces of tape

The Directions

1) Look on the base of the LED and find the side with the flat edge. This marks the negative or cathode side. Carefully splay the two wire leads away from each other as far as they will go. Make sure the one adjacent to the negative side gets bent over the flat edge so identify it. You can also mark it with a little spot of colored nail polish.

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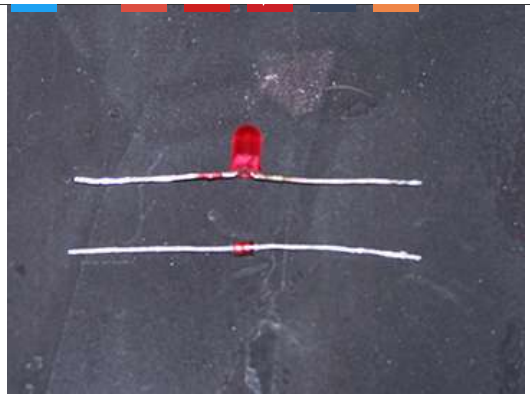

2) Next, find the band that runs around the Schottky diode. This identifies the negative end of this diode. The other end is the positive or anode end.

Using your fingers:

3) Twist the end of the negative or cathode wire from the LED onto to the positive or anode end of the Schottky diode.

4) Then twist the end of the negative or cathode end of the Schottky diode onto to the positive or anode end of the LED.

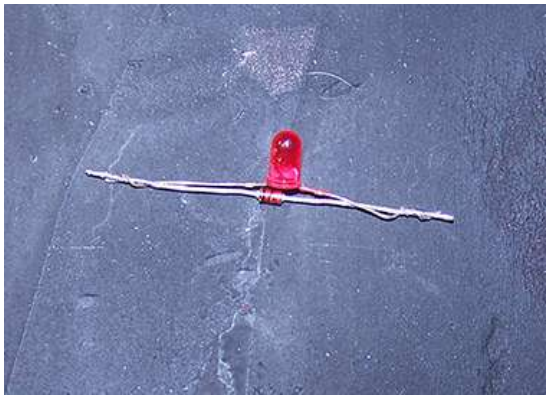

You have just made a “rectenna” and you’ll need to keep the assembly and the wires straight as possible. The length of the wires should be about 6 cm long (a hair short of 2 3/8 inches).

5) Tape the two diodes to one end of the bamboo skewer.

6) With a WiFi router on and running, hold the diode near an antenna on the WiFi router.

The Result

The LED should light up as it draws closer to the antenna (signal). The further away it is, the weaker the signal and the less it can grab to light up.

The Science

The WiFi routers uses radio waves to transmit data to and from computers and other devices in your home. Radio waves behave like water in a glass, they ripple or oscillate at a certain number of times or frequency per second. A radio wave’s wavelength is the distance covered by one complete cycle of a radio wave — from peak to valley.

Radio waves used by WiFi routers, bluetooth devices, microwaves, etc., broadcast signals in the 2.45 gigaherz (Ghz) range or 2.45 billion oscillations per second. That means the signal wavelength is about 12 cm. To pick up signal, however, you only need an antenna that’s half as big – 6 cm. When the radio waves strike this antenna, called a 1/2 dipole (“di”=two), the energy excites the antenna’s

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The "Rectenna": Because the radio waves cause voltage to flow one direction and then the opposite direction, the current is called an alternating current (AC). By connecting a diode to both poles of the antenna it converts the AC current to flow only in one direction, called direct current (DC). The antenna becomes a "rectenna".

How the diodes work: The diodes work as one-way valves for electricity, allowing voltage to flow forward but not back. In the case of the rectenna, AC current caused by the radio wave sends a positive charge down one of the antenna poles and then the other. By putting the Hitachi 1SS106 diode across both poles, the diode only lets the positive charge coming down one of the antenna poles through. The LED is actually a Light Emitting Diode and works the same way as a regular diode except that when it's on, it lights up. Meanwhile, Schottky diodes turn on at a lower voltage than other diodesand because the rectenna can only catch a fraction of the WiFi's broadcast power, the Schottky diode can rectify that little bit of AC to DC.

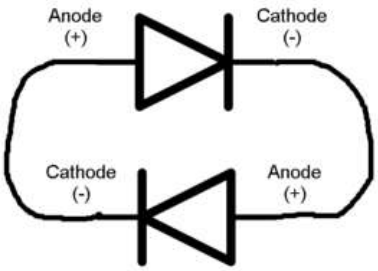

When we connected our diodes together, their polarity formed a loop that only allowed voltage to flow one way and thus light the LED. Brilliant job, pjaffeva!

Do you have any fun and kid-friendly science experiments you'd like to see us try for Fun with Less Kilowatts? Share with us in the comments!

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About Vernon Trollinger

A native of Wyomissing Hills, PA, Vernon Trollinger studied writing and film at the University of Iowa, later earning his MA in writing there as well. Following a decade of digging in CRM archaeology, he now writes about green energy technology, home energy efficiency, DIY projects, the natural gas industry, and the electrical grid.

Tags: family fun, Fun with Less Kilowatts, kids, science experiments

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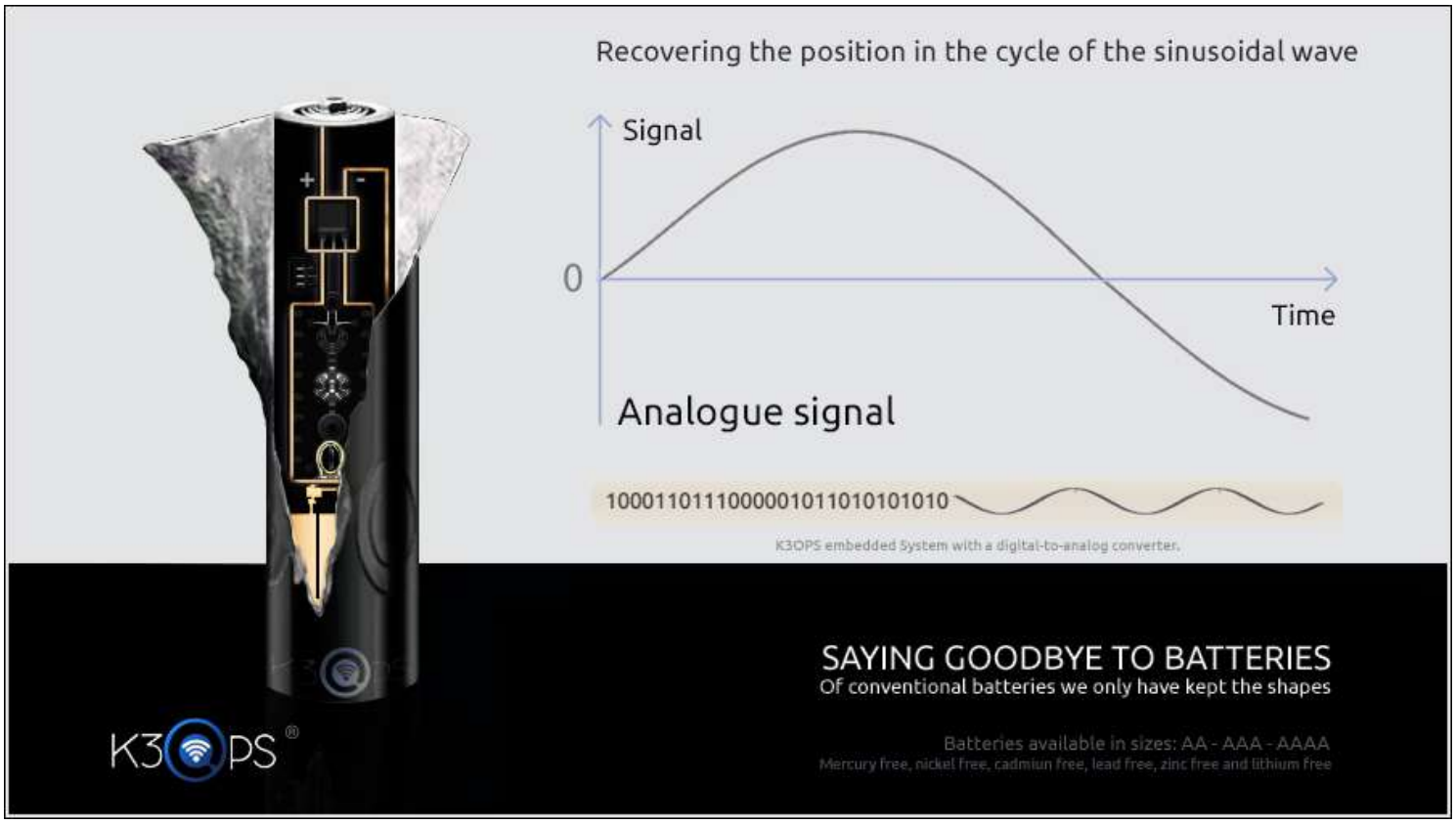

An electromagnetic field uses the photon as an elementary particle to transmit force. It combines:

- **A magnetic field** *force resulting from the movement of loads µT.*
- **An electric field** *force created by the attraction of repulsion loads, measured in volts per meter - V/m.*

With an energy determined according to the speed of light, the RF are by far the best medium to transmit any kind of information.

The multiplication of wireless communications systems in our environment ensures sufficient microwave leakages to harvest from the ambiant and enough energy to convert into DC electricity. Electromagnetic fields are everywhere and since they carry energy, they became the best candidate to deliver an endless source of renewable energy.

$\vec{B}$ is the magnetic induction expressed in T refered to **Nikola Tesla**, "Father of Free Energy", which is at the origin of the electromagnetism.

Using meta-materials combined with nanotechnology has deeply increased the performance and miniaturization of rectennas embedded in K3OPS system. Our products operate autonomously, offering an endless supply of green energy in a respectful and environment-friendly approach.

principles and beautiful sentences. At that point in time I would have simply been Xin, a child like any other...

But one day I dreamed. I woke up far away, somewhere else, in another past. I decided to change my destiny and even if I was supposed to become a mathematician, I eventually decided to create, because already as a child my heart was chasing the stars.

Of the hundreds of directions shown to me after graduating, only one captured my attention: a single goal... Build the impossible for a safer world. So, over the past 3 years, our real challenge to overcome for all RF Energy Harvesting technics was to optimize electricity conversion. The massive proliferation of wireless telecommunication systems since the past two decades brought a saturation of the electromagnetic fields with a constant growth of 15% every year in our environments. As a result, this situation reversed the base problem that makes today Harvesting RF Energy a game changer. The key was the Power Management System.

We are far beyond the conversion constraint and performance by controlling "RF-interferences", by harvesting different frequencies *from near and far*, by using Metamaterials combined with nanotechnologies. We dramatically have improved power conversion efficiency and reduced the size of our Energy Harvesting systems embedded in all K3OPS' products.

Thanks to Nikola Tesla, my inspiring mentor, K3OPS' products have reached by far their objectives in terms of converting and performance, offering an endless efficient source of green energy, reliable in an environmentally friendly approach.

Xin WEI Co-Founder of K3OPS technology with Alexandre Despallieres

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The Rectenna was invented in 1964 by William C. Brown, patented in 1969. It is a rectifying antenna used to convert microwave energy into DC. A simple Rectenna consists of a dipole antenna with an RF diode connected across the dipole elements. The diode rectifies the AC current induced in the antenna to produce DC power.

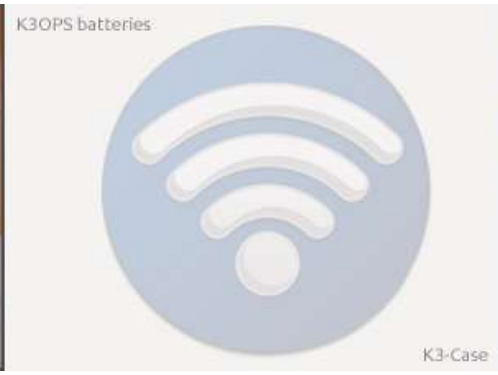

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Centre for Collaboration in Electromagnetics and Antenna Engineering is a centre for research collaboration established to foster research in electromagnetics and engineering conducted by Macquarie University researchers and prominent collaborators from external institutions, including people from industry and overseas ins We have state of the art research ficilities including a NSI-700S-50 spherical nearfield anechoic chamber, 3 Vector Network Analyzers (capable up to 22GHz, 50GHz, anc respectively), state-of-the-art embroidery machine DreamCreator-XE-VM5100 for embroided antennas, Dielectric Characterization Kit - High Temperature Probe (2(20GHz), as well as several in-house and commercial licenced softwares.

Our recent and ongoing research projects are:

- Wireless Implantable Bio-Telemetry System and Miniature Antenna Design
- Wireless Freedom for Lab Rats
- Flexible and Wearable Antennas for Biomedical and Healthcare Applications
- Characterizing Properties of Carbon nano Tubes at Microwave Frequencies
- Electromagnetic Band Gap (EBG) Resonator Antennas
- Leaky-Wave Antennas for Advanced Wireless Systems
- Shared Aperture Arrays for Space Borne Applications
- Novel Dielectric Resonator Antennas
- Super Wideband Antennas
- Focal Plane Arrays for Radio Astronomy
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- Antenna Technologies for Ultrawideband (UWB) Systems
- High Gain Antennas with Planar Surface-Mounted Short Horns
- Photonic Crystal/EBG Based Horn Antennas
- Broadband Microstrip Patch Antennas for Wireless Computer Networks
- Theoretical Analysis of Photonic Crystal Structures
- New Closed-form Green's Functions for Microstrip Circuits and other Layered Structures
- Integrated-design of Hybrid-resonator Antennas for Broadband Wireless and other Communication Systems
- Singularity-enhanced Finite-different Time-domain (FDTD) Method for Diagonal Metal Edges, Strips and Films
- Low-profile Dielectric-resonator (DR) Antennas

Wireless Implantable Bio-Telemetry System and Miniature Antenna Design

The two major challenges associated with the conversion of a wireless system operating in air to an implantable version, antenna detuning and biocompatibility, are a in a coherent way. An RFID-based biomedical telemetry system designed for free-space operation was chosen as the starting reference. A new, pin-compatible, spa antenna with a ground plane was designed, fabricated and tested, to replace the original “free-space” antenna in the active RFID tag without making any other chang tag circuit, such that the tag would function well when it is placed under rat skin and fat. Biocompatibility and potential antenna detuning due to rat tissue variati addressed in the design process, without significantly increasing the tag physical height, by applying a thin coating of biocompatible material directly over the ante operation of the medical telemetry system was successfully demonstrated, with the tag placed under rat skin and fat, and its range of 60-72 cm was found to be suf support medical research experiments conducted with rats in cages. Due to the biocompatible coating over the antenna, antenna matching is very insensitive to ch tissue dielectric constants and thickness. The footprint of the new antenna is 33% less than that of the original antenna, its measured 10 dB return-loss bandwidth is 1(11%, and overall efficiency is 0.82% at 920 MHz.

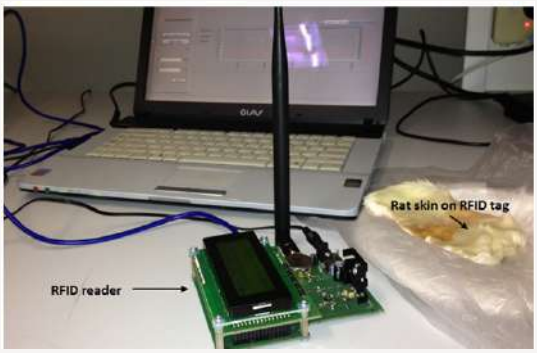

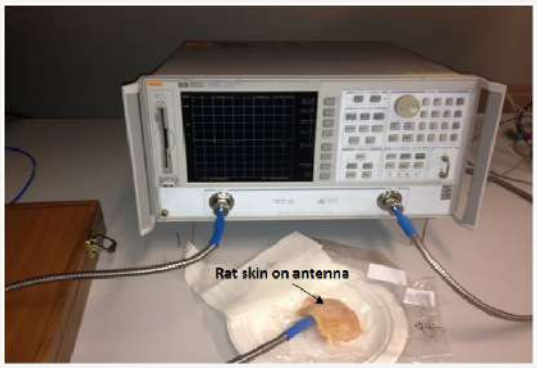

Wireless Freedom for Lab Rats

We are developing a fully implantable wireless telemetry system. This is a joint research project with BCS Innovations and the Australian School of Advanced Medicine (will be first used in the research conducted in ASAM, with rats, on hypertension. To date the major method of controlling hypertension is through the use o pharmaceuticals. The pathway to approval for most drugs for human use involves pre-clinical (animal) trials. Lab rats are considered biologically similar to humans, pa

in terms of their social behaviour. Therefore, it is very important to not compromise the pharmaceutical trials by unnecessarily stressing the rats by harnessing the monitoring equipment. One of the technical challenges of developing an implantable system that monitors the various signals, is the relatively small size requ implantable telemetry system is a miniature transceiver implanted in an animal that senses, processes and transmits data via a wireless link to monitor vital signals of c freely moving laboratory animals. This is crucial in giving researchers flexibility and reliability, especially in studies with special experimental settings using mazes wheels and treadmills. We have plans to develop a fully implantable telemetry system for subcutaneous or intraperitoneal placement in rats that monitors th parameters as well as blood pH and chemistry, nerve activity and circadian respiratory rate rhythms. The aim of this project is to eventually develop a system with e capabilities that costs less than what is currently available, to provide more universities and researchers with the opportunity to use this technology.

In this sequel, initially, when a module of our original system was placed under the skin of a rat, the wireless link failed completely. It could not send a temperature reac a centimetre! The point of failure was the commercial antenna in the module that had been designed to work outside the body, in air. Such antennas do not work unde because the electrical characteristics of skin (rat or human) are significantly different from that of air. Hence the main challenge was to design an antenna that works v placed under the skin. In addition, it was necessary to cover the module and the antenna by biocompatible material, which also affects antenna performance. Possible v of skin characteristics from one rat to another or one person to another were considered. Unlike the commercial antenna, we wanted our antenna to radiate less into th the rat/person and more away from the body because that not only increases the quality of the wireless link, maximum range (distance between implanted mo monitoring station) and battery life but also reduces the exposure of the body to radio-frequency waves. Indeed we had to consider the electromagnetic effects of fat a material around the antenna. We were able to meet all these requirements with a novel compact antenna design that is approx. one third the size of the original co antenna. We successfully demonstrated wireless telemetry transmission of temperature with the new module placed under rat skin and the monitoring station pl distance of up to 80 cm! This range is sufficient for our immediate target application supporting new medical research by Professor Paul Pilowsky's team. If necessary, further extended by increasing the power level at the monitoring station.

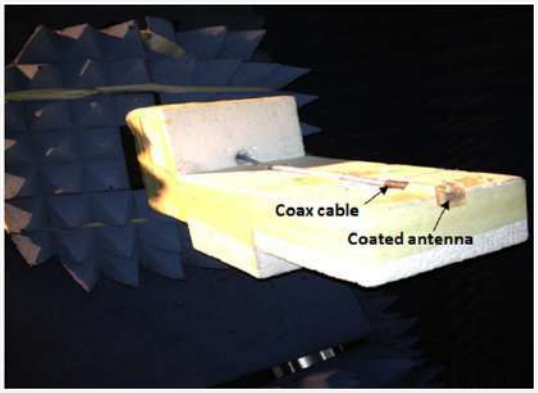

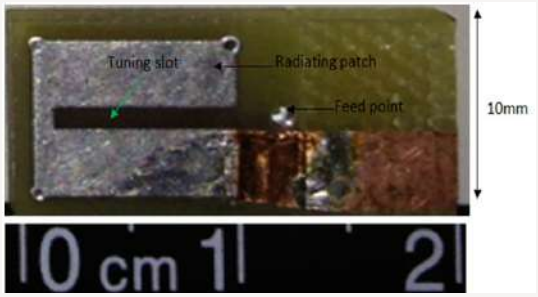

Flexible and Wearable Antennas for Bio-Medical and Healthcare Applications

Body Centric Wireless Communication is a rapidly growing research area targeted for medical, healthcare, public safety and defense applications. The need to address transceiver specifications and real-time scenarios in close proximity to human body is continuously evolving antenna system research. Several novel miniature antennas havi dual- and wide-band operations have been designed and tested for Wireless Body Area Network (WBAN). They have significant advantages of small size, wide radiation pat the human body for maximum coverage and are less sensitive to the gap variation between human body and antenna.

A compact ultra wideband antenna is shown below with strong notch-band rejections up to VSWR = 26, that is tunable over a wide frequency range from 3.55GHz to 6.8 been designed. To estimate the stub length to notch frequency for a given interfering application, analytical expressions for the normalized stub length which is indep substrate dielectric constant is also presented. This helps to avoid hit-an-trail method and gives a good estimate of initial design parameters for notch. Proposed antenna radiation patterns and yields a measured 10dB return-loss bandwidth from 3GHz to 10.5GHz.

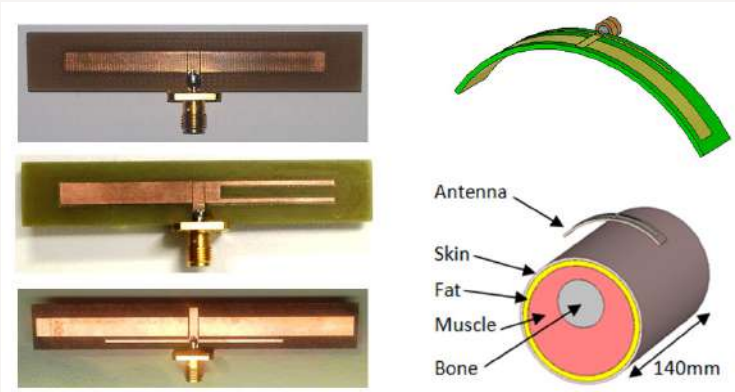

Characterizing Properties of Carbon Nano Tubes at Microwave Frequencies

Carbon Nanotube (CNT) yarns are novel CNT-based materials that extend the advantages of CNT from the nano-scale to macro-scale applications. We have modelled CNT potential data transmission lines. Test structures have been designed to measure electrical properties of CNT yarns, which are attached to these test structures using gold p testing and microwave S-parameter measurements have been conducted for characterisation. The observed frequency independent resistive behaviour of the CNT yarn promising indicator that this material, with its added values of mechanical resilience and thermal conductivity, could be invaluable for a range of applications such as B Networks (BAN). A model is developed for CNT yarn, which fits the measured data collected and agrees in general with similar data for non-yarn CNTs.

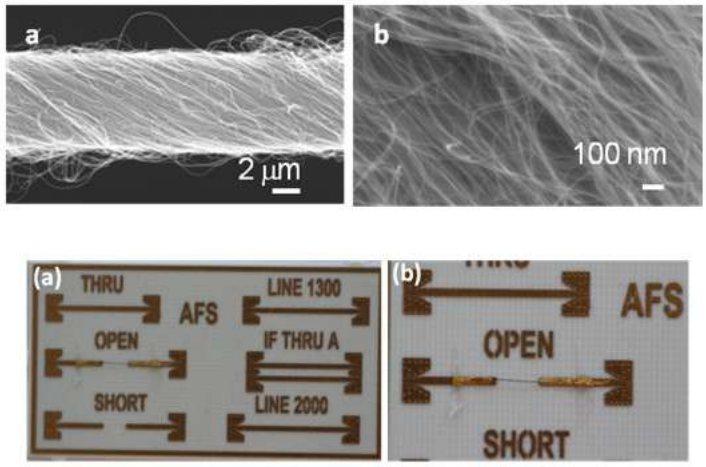

Electromagnetic Band Gap (EBG) Resonator Antennas (ERA)

We have designed, fabricated, and measured antennas based on 3D, planar and 1D EBG structures (i.e. photonic crystals). These flat microwave antennas, known as EBG antennas or Fabry-Perot cavity antennas, can give gains of about 20dB and very good efficiencies.

Enhancing Radiation Characteristics of ERAs by Improving Aperture Phase Distribution

This work focuses on achieving superior radiation characteristics of ERAs by improving their aperture phase distributions. A unique method, utilizing full-wave simula analytical analysis, has been developed to design Phase Correcting Structures (PCS) for ERAs. This method uses actual phase distribution on the physical aperture of ERAs relying on geometric optics. Several Phase Correcting Structures (PCSs) have been designed, which were later validated with the measurements of their fabricated p Tremendous improvement in the radiation performance is witnessed in both simulated and measured results. These exciting initial results validate our proposed method indicate an existence of a great potential to be explored. The figure below shows the field propagation above an ERA: (a) without PCS, and (b) with PCS. It is clear that the the PCS is much more uniform and the energy is focussed towards broadside direction, thus, resulting in increased directivity.

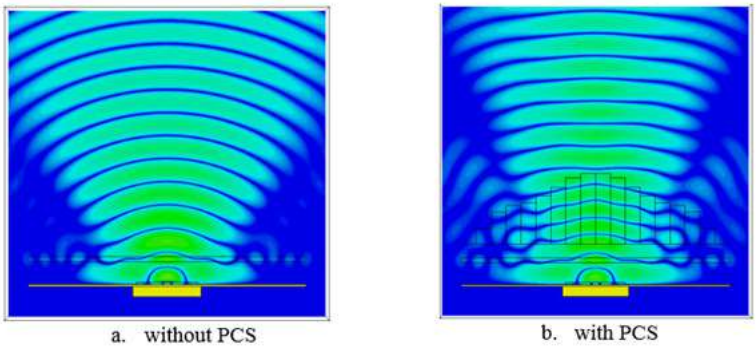

a. without PCS b. with PCS

Extremely Wideband High-Gain ERAs (Gain~15-20dBi, Bandwidths >50%)

In 2014-15, we invented an innovative class of electromagnetic band-gap (EBG) resonator antennas which provide high gain and wide bandwidth with an extremely footprint. One of the prototype developed has only 8% of the area as compared to conventional EBG resonator antennas but its performance (gain bandwidth) is a record hi for this class of antennas, while providing gain in the range of 15-20 dBi. This represents an improvement of nearly two orders of magnitude in the bandwidth compared to EBG resonator antennas. Thanks to its practical advantages of flat shape and low-cost manufacturability, it can be easily attached to a wall of a building, for example, to co building wirelessly to the National Broadband Network.

Our most recent results on such wideband high gain antennas can be found in: "Achieving high gain-bandwidth through flat GRIN superstrates in Fabry-Perot cavity antenn 2014 IEEE International Symposium on Antennas and Propagation (AP-S/USNC-URSI), pp. 1748 – 1749, Memphis, Tennessee, USA, July 6-11, 2014.

Detailed antenna design along with experimental data of another of our wideband EBG resonator antenna having composite multi-layer superstrate, is published in the pa "Wideband high-gain EBG resonator antenna with a small footprint and all-dielectric superstructures" in IEEE Transactions on Antennas and Propagation, vol. 62, no. 6, 201

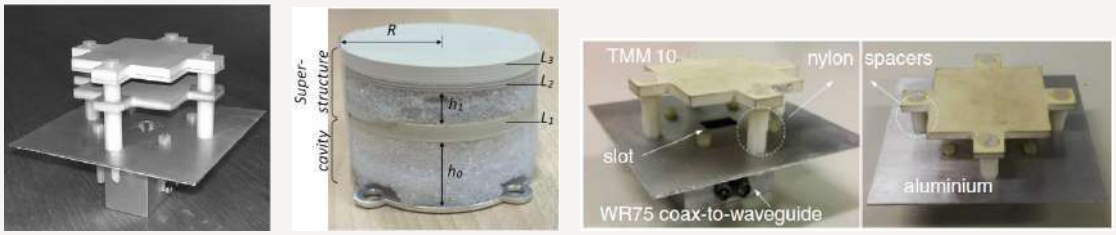

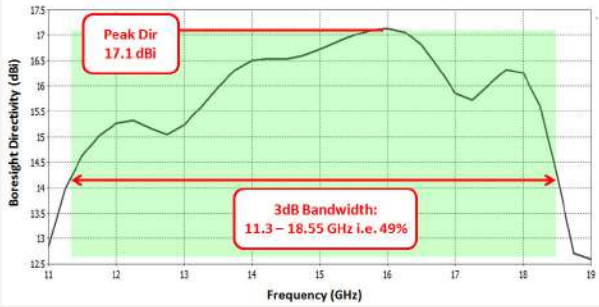

Frequency response of one of our Wideband ERA Prototypes

Simple Dual-Band ERAs

We developed a new method to obtain dual-band operation from a simple electromagnetic band gap resonator antenna. The antenna is based on a one-dimensional EBG made out of two low-cost unprinted dielectric slabs. The EBG structure is implemented as the antenna superstrate, which has been designed to provide a locally-inverted reflection phase gradient with high reflectivity, in two pre-determined frequency bands. The linearly polarised antenna design and experimental results are described in entitled: "A simple dual-band electromagnetic band gap resonator antenna based on inverted reflection phase gradient" published in IEEE Transactions on Antennas and Pro vol. 60, no. 10, pp. 4522-4529, 2012.

We have extended this concept for dual-band, dual-polarised and circularly-polarised antennas. We also designed a tri-band antenna following this concept. It needs only t cost unprinted dielectric slabs.

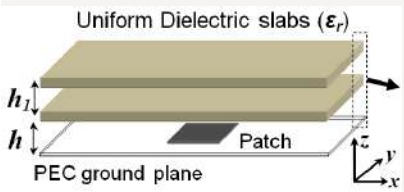

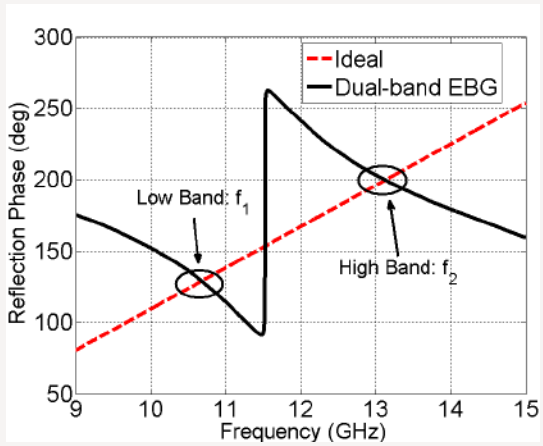

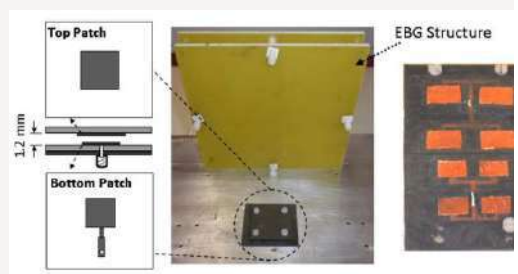

Low-Profile Wideband ERAs

We have designed and successfully tested wideband low-profile (thin) EBG resonator antennas. The breakthrough that contributed to this success is our design of a partially surface (PRS) with a positive reflection phase gradient. Thin single-dielectric-slab PRSs with printed patterns on both sides were investigated to minimise the PRS thickne simplify fabrication. Three such surfaces, each with printed dipoles on both sides, have been designed to obtain different positive reflection phase gradients and reflection r levels in the operating frequency bands. These surfaces, and the EBG resonator antennas formed from them, were analysed theoretically and experimentally to highlight t compromises involved and to reveal the relationships between the antenna peak gain, gain bandwidth, the reflection profile (i.e. positive phase gradient and magnitude) of th and the relative dimensions of dipoles. A small feed antenna, designed to operate in the cavity field environment, provides good impedance matching (|S11|< -10 dB) a operating frequency bands of all three EBG resonator antennas. Experimental results confirmed the wideband performance of a simple, low-profile EBG resonator antenna thickness is only 1.6mm, effective bandwidth is 12.6%, measured peak gain is 16.2 dBi at 11.5 GHz and 3dB gain bandwidth is 15.7%. Please find details in a paper entitled of Simple Thin Partially Reflective Surfaces with Positive Reflection Phase Gradients to Design Wideband, Low-Profile EBG Resonator Antennas," published in IEEE Tra on Antennas and Propagation in 2012.

Low-Profile Dual-Band ERAs

We have achieved dual-band operation in a low-profile EBGRA using a single dielectric superstate with a printed pattern only on one side. This also made use of our r inverting the gradient of the PRS reflection coefficient.

Woodpile EBG Material and Antennas

In 2003, we designed and built a woodpile 3D photonic crystal, also known as a EBG crystal, operating in microwave frequencies, and demonstrated experimentally the ex the electromagnetic band gap. The crystal is made out of cermain material.

Then we designed a planar EBG resonator antenna. Shown below, it has a resonant cavity between a ground place and a 3D woodpile photonic crystal. We employed both m and slots to feed the cavity, and investigated both linearly and circularly polarised antennas. The linearly polarised antenna design and experimental results are described in entitled "A planar resonator antenna based on a woodpile EBG material," published in IEEE Transactions on Antennas and Propagation,vol. 53, no. 1, pp. 216-223, January 2

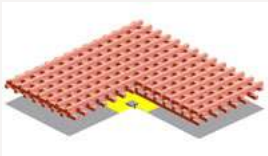
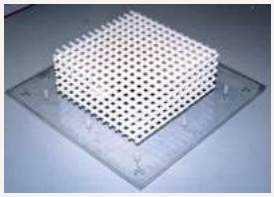
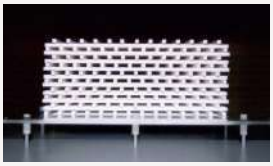
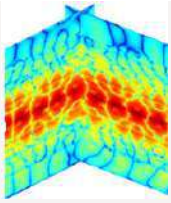

Leaky-Wave Antennas for Advanced Wireless Systems

Antenna beam steering can bring significant benefits to advanced wireless systems. Microstrip leaky-wave antennas (MLWAs) are of particular practical interest becaus planar low-profile configuration, ease of fabrication, and beam-scanning capabilities. In this research several planar MLWAs and arrays are developed to radiate at bores conical beam around the boresight, with simultaneous dual-side-beam scanning, dual-band forward and backward beam-scanning, and continuous beam scanning from the to the forward direction. Moreover, methods and antenna designs are proposed to steer the beam at a fixed frequency, shifting beam-steering range, and fixed-frequency bean in forward and backward directions.

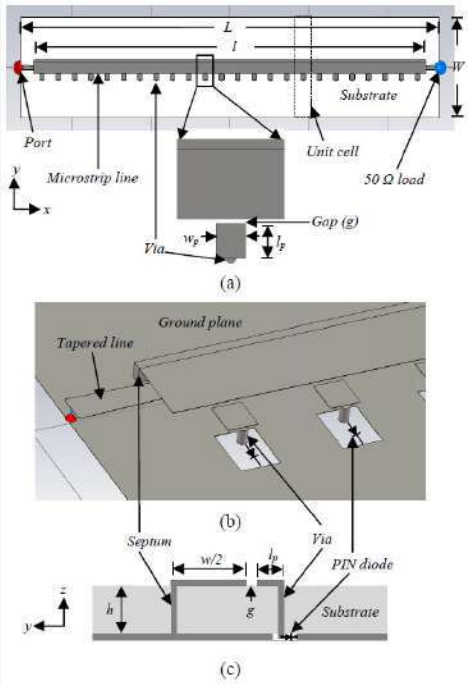

Figure 1. Proposed reconfigurable HW-MLWA: (a) top view, (b) perspective view, and (c) side view.

TABLE I. SWITCH CONFIGURATIONS AND CORRESPONDING MAIN BEAM DIRECTIONS AT 6.5 GHZ

	Switch Configuration	Main Beam Direction (θ)
1	111111111111111111111111	21°
2	111100111100111100111100	26°
3	000011000011000011000011	32°
4	000000000000000000000000	37°

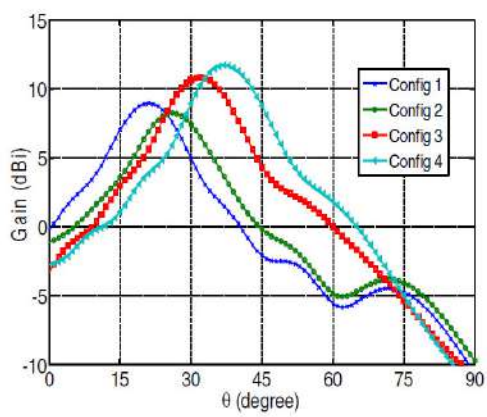

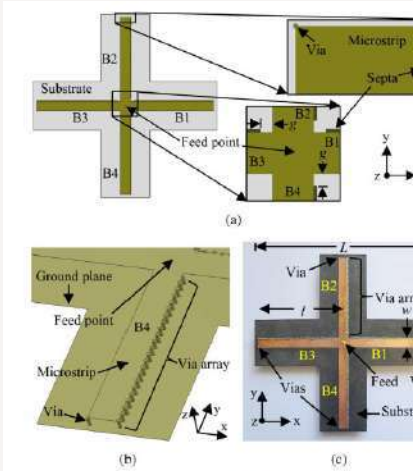

Fig. 1. HW-MLWA array design steps: (a) top view of the initial de septa, (b) perspective view of one branch of the final design with v (substrate omitted, not to scale), and (c) top view of the fabricated pro

Multi-band Dual-Polarized Shared Aperture Array

Multi-band dual-polarized shared-aperture (MBDP-SA) arrays are antenna arrays that operate in two (or more) frequency bands with dual-polarization in each band, a elements are integrated together into a common physical space by sharing the single aperture. The MBDP-SA array is of great interest in space-borne SAR system, bec technique can effectively reduce the payload and size of the antenna sub-system. In this research project, main efforts are focussed on three aspects: 1) improve the specifi current Dual-Band Dual-Polarized Shared-Aperture (DBDP-SA) array; 2) construct Tri-Band Dual-Polarized Shared-Aperture (TBDP-SA) array; and 3) explore some new for DBDP-SA antenna.

(a) Rear (b) Front

Fig.1 Improved DBDP-SA array.

(a) Rear (b) Front

Fig.2 Photos of the TBDP shared aperture prototype array.

Side view

Fig.3 Novel structure DBDP-SA array

Compact Dielectric Resonator Antennas with Ultra-Wide 60%-110% Bandwidths

We have recently made a significant achievement in the emerging ultra wide-band (UWB) wireless communication systems, which require antennas with bandwidths gr 106%. In the past, the only way antenna engineers knew how to get such a bandwidth from a thin antenna was by removing the metal sheet underneath the antenna (known a plane"). This is not an acceptable solution for practical systems because the lack of it allows the antenna to radiate both upwards and (unnecessarily) downwards (i.e. electronic device on which the antenna is installed), wasting about half of its power. Saving power is crucial in UWB systems due to the severe power limits imposed by regu 2011, we made a breakthrough in dielectric-resonator (DR) antenna research, by inventing a novel DR antenna with a full ground plane and a 110% bandwidth. This disp myth that such bandwidths cannot be achieved with full ground planes. This antenna, published in the prestigious IEEE Transactions on Antennas and Propagation in Decem is 29% smaller but has a 30% greater bandwidth than the next-best DR antenna, which does not even have a full ground plane. Hence it is ideal for next-generation ultra-fas and sensor applications.

We theoretically and experimentally demonstrated that, by introducing a lower-permittivity full-length insert between the ground plane and a higher-permittivity dielectric dielectric resonator antennas (DRA) with ultra-wide bandwidths, in the range of 60%-110%, can be designed. Furthermore, the volume of such DRAs is reduced by appr 50% using a finite planar conducting wall. Unlike vertical monopole-type hybrid UWB DRAs, these antennas radiate sufficiently in the upward direction. Unlike in printed UWB antennas, the power radiated into the lower hemisphere is significantly less. An example prototype antenna, designed to operate in the FCC UWB band, has a dielectri of 12 x 8 x 15.2 mm3 (or 0.124 x 0.083 x 0.157 lambda3 at 3.1 GHz), and an average measured gain of 5 dBi from 3.1 to 10.6 GHz. These antennas exploit multiple low- with overlapping bandwidths to form an ultra-wide contiguous bandwidth. With the proposed dielectric arrangement, it is possible to efficiently couple a sufficient numbe overlapping modes to a 50 ohm feedline using a single, simple feed.

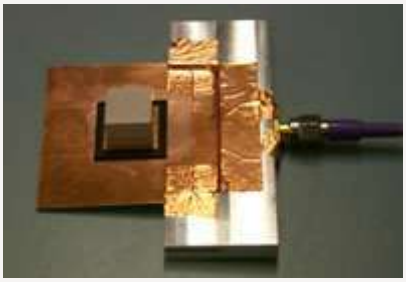

The antenna has a remarkably small footprint of 12x8 mm2 at 3.1 GHz - the lowest frequency of the FCC UWB band. Its dielectric volume is 1459 mm3, or 1.7x10-3 lamb lowest operating frequency of 3.1 GHz, and overall height is 15.2 mm or 0.157 lambda0. To place these results in perspective, it is worth comparing the new designs with wideband DR designs available in the literature. To the best of our knowledge, prior to this, the widest bandwidth ever obtained from a pure DRA design is 84% . The volu DR in that design is 0.225 x 0.172 x 0.062 lambda3 (= 2.4x10-3 lambda3) at its lowest operating frequency of 3.69 GHz. In that DRA, the DR is positioned in a non-traditi close to the edge of an orthogonal, "vertical" ground plane, which does not block radiation towards the lower hemisphere. The widest bandwidth demonstrated by a pure DI traditional "horizontal" ground plane, (which can be employed to shield the rest from the antenna, as discussed previously) is 78%. The dielectric volume of that design is 0. x 0.21 lambda3 (= 5.8x10-3 lambda3) at its lowest operating frequency of 6.7 GHz.

Super Wide-band Antennas

We have demonstrated that extremely wide bandwidths (ratio-bandwidths up to 1:25) can be obtained from a specially designed printed antenna with a tapered semi-ring design is described in "A Printed Elliptical Monopole Antenna with Modified feeding Structure for Bandwidth Enhancement," in IEEE Transactions on Antennas and Pro vol. 59, no. 2, pp. 667-670, Feb. 2011.

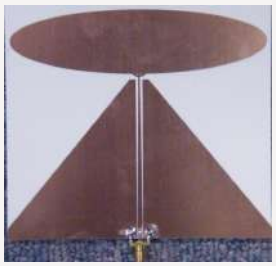

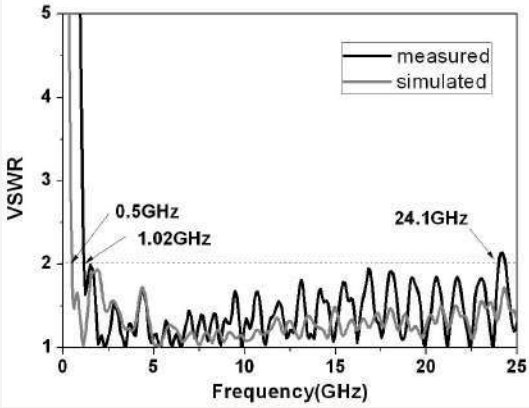

Focal Plane Arrays for Radio Astronomy

Dense focal plane arrays (FPAs) are a key technology for a new generation of Radio-telescopes. Their primary benefit is the rapid survey speed facilitated by the wide fiel provided by multiple beams. Recent advances have brought dense FPAs within reach of radio astronomy applications. A number of institutions have significant research pr this field. This technology is being considered for the Square Kilometre Array (SKA) (www.skatelescope.org). The PhD project of Douglas Hayman, conducted with CS Centre and Division of Astronomy and Space Science, investigated beamforming aspects of FPAs and evaluated their performance in Radio Astronomy. A prototype interf radiotelescope, built at CSIRO's Radiophysics Laboratory in Sydney, is used to demonstrate a suite of techniques forFPA beamforming and evaluation for this thesis. Bea solutions were experimentally demonstrated in our paper in IEEE Transactions on Antennas and Propagation, entitled “Experimental Demonstration of Beamforming Sol Focal Plane Arrays”.The THEA tile, shown below, is designed by ASTRON and used for the experimental component of this research.

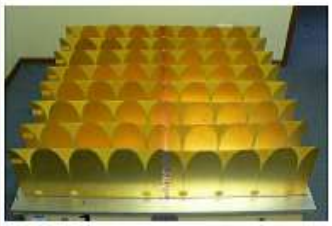

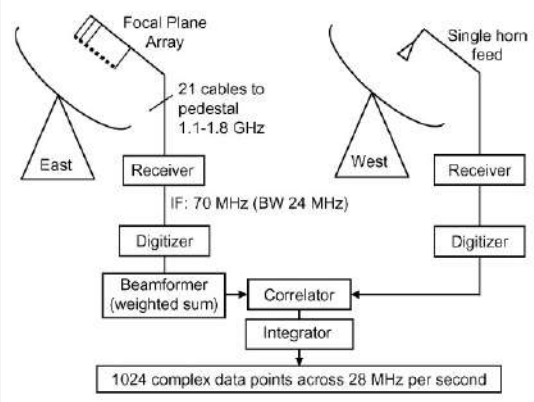

Negative Permeability of Spiral Metamaterials

Archimedean spirals and complementary Archimedean spirals are super-compact metamaterial particles. Thanks to their convoluted geometry, unit cells can be made electri small. We theoretically analysed monofilar, bifilar, trifilar and quadrifilar Archimedean spiral metamaterial particles using point group theory and crystallography. From the s properties electromagnetic response was determined. Magnetic, electric and magnetoelectric modes of the particles were identified along with their isotropy characteristics. shown that all the particles, except monofilar spiral, are nonbianisotropic. Further, effective medium theory was applied to extract the effective permeability of the spiral mec results indicated negative values for permeability in certain frequency ranges. Detailed theory and numerical simulation results are available in the paper entitled “Analysis metamaterials by use of group theory,” published in the Metamaterials Journal, vol. 3, no. 1, pp. 33-43, March 2009.

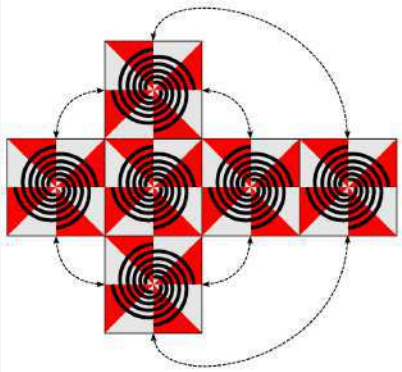

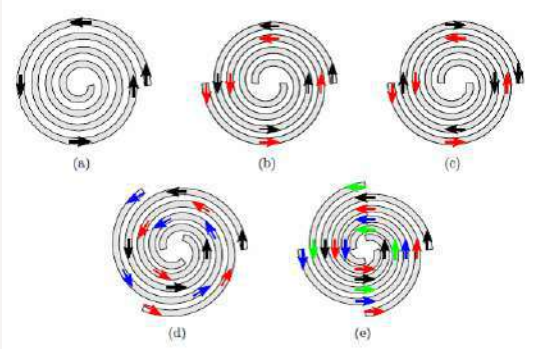

Archimedean Spiral Metamaterials and Backward Waves

We have shown backward wave propagation and double negative parameters over a 19% bandwidth in a microstrip line loaded with series gap discontinuities and super complementary Archimedean spiral resonator metamaterial particles. Moreover, our equivalent-circuit model for such unit cells almost perfectly described the structu practically important frequencies (by comparison with full-wave results). We also fabricated and tested compact filter circuits with only one or two complementary spiral met particles. Our results sre summarized in the paper entitled "Backward Wave Microstrip Lines with Complementary Spiral Resonators," published in IEEE Transactions on and Propagation, Vol. 56, Issue: 10, pp. 3173-3178, Oct 2008.

We derived design equations for Archimedean spiral resonators and tested them against full-wave simulations. The details are in the paper entitled "Design of monofilar a Archimedean spiral resonators for metamaterial applications," published in IET Microwaves, Antennas & Propagation, vol. 3, no.6, p. 929-935, Sep.2009.

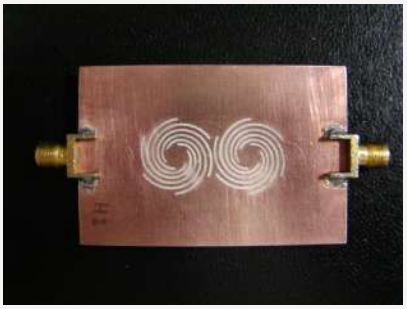

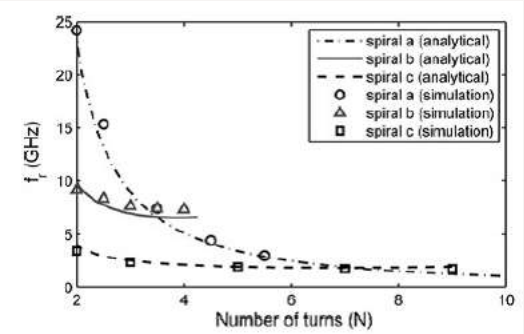

Frequency Selective Surfaces for Energy-Saving Glass Panel

Energy-saving glass is becoming very popular in building design due to their effective shielding of building interior against heat entering the building with infrared (IR) wave obtained by depositing a thin layer of metallic-oxide on the glass surface using special sputtering processes. This layer attenuates IR waves and hence keeps buildings summer and warmer in winter. However, this resistive coating also attenuates useful microwave/RF signals required for mobile phone, GPS and personal communication sy by as much as 30 dB. To overcome this drawback, we designed and tested a bandpass aperture type cross-dipole frequency selective surface (FSS), etched in the coatings c saving glass to improve the transmission of useful signals while preserving IR attenuation as much as possible. With this FSS, 15-18 dB peak transmission improveme achieved, for waves incident with 45 degrees from normal for both TE and TM polarizations.

Measurements and other results of this research, conducted in collaboration with the Lund University in Sweden, are available in the paper entitled "Cross-Dipole Frequency Selective Surface for Energy-Saving Glass Used in Buildings," published in IEEE Transactions on Antennas and Propagation, vol. 59, no. 2, pp. 520-525, Feb. 2 effect of these FSSs on the transmission of infrared and visible wavelengths through energy-saving glass was investigated theoretically and experimentally in another pap Microwaves, Antennas & Propagation, Vol. 4, Iss. 7, pp. 955–961, 2010.

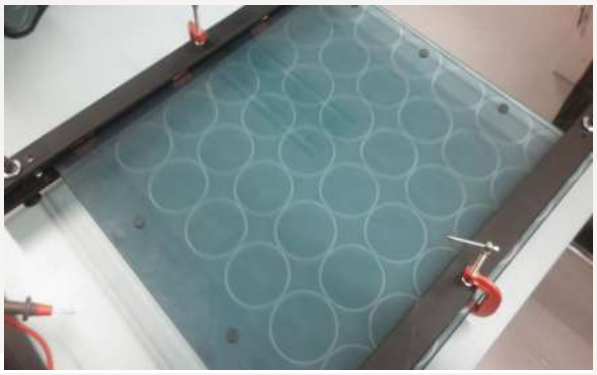

Switchable Frequency Selective Surfaces to Reconfigure Electromagnetic Architecture of Buildings

In large buildings and offices, frequency re-use methods will be required to enhance the spectral efficiency and capacity of wireless communication systems. This observatio to the concept of electromagnetic architecture of buildings. Passive bandstop FSSs can be used to enhance the electromagnetic architecture of a building, and hence to spectral efficiency and system capacity, but switchable FSSs can provide a better reconfigurable solution. If switchable FSSs are placed in strategic locations of a building, th reconfigured remotely and rapidly, which is not possible with passive FSSs.

With collaborators in UK and Sweden, we designed and successfully tested a single-layer active Frequency Selective Surface (FSS) that is electronically switchable between and transparent states. It can be used to provide a spatial filter solution to reconfigure the electromagnetic architecture of buildings. The FSS measurements show that the response of the filter does not change significantly when the wave polarization changes or the angle of incidence changes up to ±45º from normal. The FSS is based on sq aperture geometry, with each unit cell having four PIN diodes across the aperture at 90 degree intervals. Experiments demonstrated that almost 10 dB additional transmissio be introduced on average at the resonance frequency, for both polarizations, by switching PIN diodes to ON from OFF state.

For details, please refer to "Switchable Frequency Selective Surface for Reconfigurable Electromagnetic Architecture of Buildings," in IEEE Transactions on Ante Propagation, Vol. 58, Issue 2, pp 581-584, February 2010.

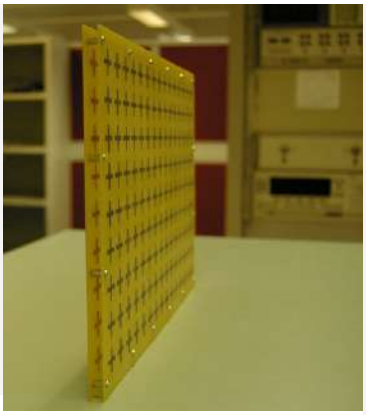

Absorb/Transit FSS

We designed and tested a novel absorb/transmit frequency selective surface (FSS) for 5-GHz wireless local area network (WLAN) applications. The novelty of the design i capable of absorbing, as opposed to rejecting, WLAN signals while passing mobile signals. The absorption of the WLAN signal is important to reduce additional multipa spread and resultant fading caused by typical reflect/transmit FSSs. Our FSS consists of two layers, one with conventional conducting cross dipoles and the other with resis dipoles. The FSS has good transmission characteristics for 900/ 1800/1900-MHz mobile bands and performs well for both horizontal and vertical polarizations.

Later we modified the FSS to obtain even better performance, for example, for both horizontal and vertical polarizations at oblique angles of incidence. The distance betwee layers has been successfully reduced to one eighth of free-space wavelength. This small distance makes it more compact as compared to the conventional Salisbury screen achieving an acceptable absorption in the stopband.

The details of our designs and test results can be found at "Oblique Incidence Performance of a Novel Frequency Selective Surface Absorber," in IEEE Transactions on Ant Propagation, Vol. 55, no. 10, pp. 2931 – 2934, Oct. 2007, and "A Novel Absorb/Transmit FSS for Secure Indoor Wireless Networks with Reduced Multi-path Fadin Microwave and Wireless Component Letters, Vol. 16 (6), pp. 378 - 380, June 2006.

Dual-Band Artificial Magnetic Conductor (AMC) Surfaces

AMC surfaces have many advantages and interesting properties due to their unique reflection characteristics, with near zero reflection phase. We have designed and pro novel dual-band AMC surface, which has a very wide upper AMC band and a narrow lower AMC band, and therefore suitable for multi-band wireless/mobile applications.

Fully Printed Quad-band Antennas for Wi-Fi IEEE802.11 and other WLAN Applications

Our fully-printed antennas can be fabricated and integrated to WLAN systems at almost zero cost by printing them on the same circuit board (e.g. FR4) with the radio circuit same standard fabrication methods. They are extremely compact: an antenna with a radiating element of 1cmx1cm covers all four IEEE standards (802.11a, 802.11b, 80 802.11n) as well as HiperLAN2 with a VSWR less than 2. We have also developed a packaging solution where the rest of the circuit can be shielded to satisfy EMC regulati leaving the antenna (on the same board) open for radiation. The advantages of the antennas based on this technology are: Lightweight; Radiates almost every direction in shadow region); Microstrip and co-planar waveguide (CPW) designs available; Compatible with all printed microwave circuits, including stripline circuits; Excellent because no cables, connectors, soldering or any mechanical attachments are required to connect the antenna to the radio; No protruding parts that are likely to break; Covers WLAN bands with one antenna (e.g. Wi-Fi IEEE 802.11 a, b, g, n, HiperLAN2 etc.); Excellent matching, i.e. input reflection < -10 dB (VSWR < 2) in all WLAN bands (e. GHz, 4.9-5.1 GHz, 5.15-5.35 GHz, 5.725 – 5.825 GHz); High efficiency (~60-70% on FR4; can be increased to over 90% on Duroid.); Ideal for internal mounting in a c device, to achieve very wide beam coverage; diversity reception or MIMO arrangements available; can be dsigned to cover other multiple bands (e.g. multiple mobile/c bands) and other applications.

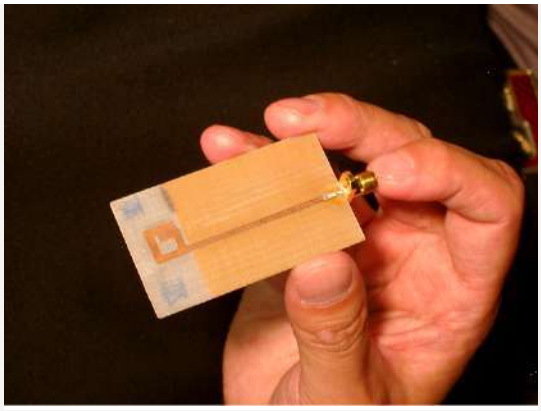

How can I optimise a UWB System to operate well over a range of directions?

Emerging ultra-wideband (UWB) communication devices will need to operate well, not just in one direction but over a range of directions. However previous UWB system optimisation techni been limited to one direction only. A system optimised in one direction may not work well in other directions due to pattern instability, or direction-dependent transfer function, of the an developed the concept of frequency-domain correlation patterns and proposed a figure of merit, the pattern stability factor (PSF), which can be determined from simulation of experimen With these new concepts, we have demonstrated the optimisation of UWB systems to operate well over a range of directions. The concepts and their applications are available in the PhD papers by Tharaka Dissanayake.

Antenna Techniques and Technologies for Ultrawideband (UWB) Systems

We developed antenna solutions for emerging UWB systems with very high data rates. Our research includes investigation of band-notching techniques to reduce UWB inference wi wireless systems and studies of antenna dispersion and pattern stability in the time domain.

High Gain Antennas with Planar Surface-Mounted Short Horns

In collaboration with University of Delhi, we have developed compact rectangular dielectric resonator antennas with surface mounted planar horns for gain enhancement. One configuration an aperture-fed rectangular dielectric resonator antenna and a planar surface mounted horn. We have achieved 10 dBi gain and a good efficiency from this configuration. The surface mou increases the gain of the standard dielectric resonator antenna by 4.9 dB. Total height of the prototype antenna shown in the figure is only 0.172 lambda and the aperture size is 0.96 lamb antennas can be easily adapted to low-profile, high-gain and array applications.

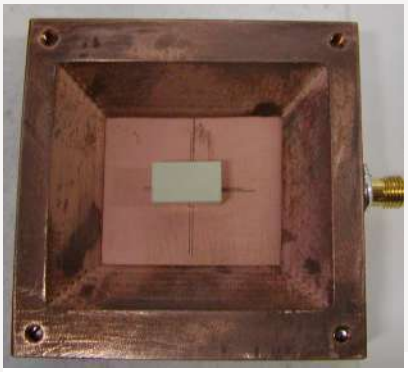

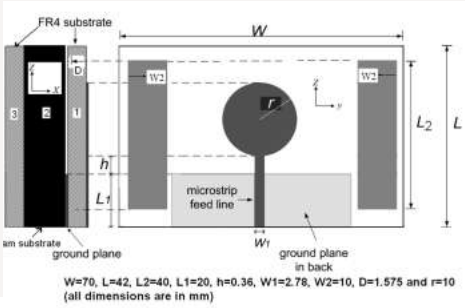

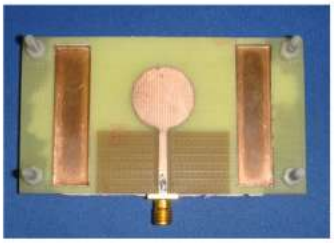

Photonic Crystal/EBG Based Horn Antennas

Waveguides and antennas made out of dielectric, as opposed to metal, are expected to perform better at Terahertz frequencies, as they do not suffer from the skin-effect loss of metal investigated horn antennas, horn arrays, waveguides, bends and junctions made out of 3D woodpile photonic crystals, which can be implemented at THz frequencies in high-resistivity S other materials. Our concepts have been tested by fabricating and measuring scaled-up prototypes operating in microwave frequencies. We have also designed a special broadband couple a photonic crystal waveguide to a rectangular waveguide or a coaxial cable, for example for testing using a vector network analyser. We demonstrated > 6% bandwidth both theore experimentally.

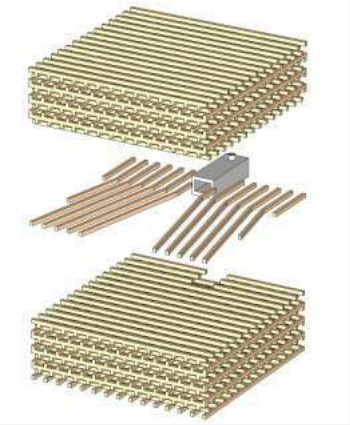

Broadband Microstrip Patch Antennas for Wireless Computer Networks

We have designed and tested broadband, compact E-shaped patch antennas for wireless communication networks, operating in frequencies from 4.9 GHz to 6.0 GHz. We made two achievements. First, we designed an E-shaped antenna, which is intrinsically compatible with a printed microstrip circuit. It can be made out of a single sheet of metal and can be mou microstrip circuit without expensive coaxial connector. Second, we designed a unique E-shaped antenna with corrugation to reduce the width of antenna. We successfully miniaturised the fit it inside a thin (4mm) PC (or PCMCIA) card extension. In fact, we were able to squeeze in two of these antennas into a single PC card of standard width (54mm), for diversity communica achieve excellent isolation (>20 dB) and matching (<-10 dB) over the whole WLAN frequency band.

Theoretical Analysis of Photonic Crystal Structures

We have developed and successfully implemented, in both personal computers and supercomputers, efficient theoretical methods to analyse and design complex electromagnetic (micro optical) circuits based on photonic crystals (PC). Among our novel techniques is a PC-based Perfectly Matched Layer (PML) absorbing boundary for use with the finite difference time doma method in the analysis of waveguides in 3D photonic crystals.

We have applied these techniques to model wave propagation in various guiding structures such as bends, junctions and tapers in 2D and 3D crystals. From this analysis, we can transmission and reflection coefficients, propagation characteristics, phase and delay response, etc., of a component or a system.

New Closed-form Green's Functions for Microstrip Circuits and other Layered Structures

When combined with the spatial-domain Method of Moments (MoM), our new closed-form functions now enable efficient and accurate analysis of microstrip circuits and antennas with approximations. The key feature in this new MoM is that the four-dimensional integrations in MoM matrix elements can be solved analytically, completely eliminating the need for expensive integrations. Our new closed-form functions are simpler and more flexible than previous such functions, and (unlike previous ones) they do not require additional (Taylor series approximations. The computer time required for the analysis of an example microstrip line using the new MoM was three times less than the next best method, which required some integrations.

Integrated-design of Hybrid-resonator Antennas for Broadband Wireless and other Communication Systems

Shown below is the first baby of our recent project on broadband hybrid-resonator antennas. This first prototype of a Dielectric Resonator on Patch (DRoP) antenna demonstrated a ba 24%. This design also proved, both theoretically and experimentally, that the electromagnetic fields in a dielectric resonator can be efficiently coupled to the fields in a patch resona perturbing the radiation characteristics of each resonator.

Singularity-enhanced Finite-different Time-domain (FDTD) Method for Diagonal Metal Edges, Strips and Films

We developed the world's first and still the only singularity-enhanced FDTD method for metal edges not parallel to the grid. The edges were assumed to be diagonal to cell faces. Compare conventional spit-cell model, the computer memory required for an FDTD analysis of a structure could be reduced by up to 27 times and the computing time could be reduced by up to without sacrificing the accuracy of results. On the other hand, when the same grid was used, the accuracy of results improved by a factor of more than 3 compared to the split-cell model, a of more than 7 compared to the staircase model. The new equations were stable in all tests, and even in most demanding tests when the computational speed was further maximised by the time step (Dt) to the maximum allowed by the FDTD method! (i.e. stability factor of 1!)

The key to this success was the derivation of enhanced FDTD equations for nodes near the edges by considering rigorously the singular nature of the electromagnetic fields. The table here improvement of accuracy achieved by using the enhanced FDTD equations. The new equations are simple to implement in a standard FDTD code. They are ideal for the analysis and microstrip components and high-speed digital circuits where thin metal films or strips with diagonal edges are encountered.

Low-profile Dielectric-resonator (DR) Antennas

We designed and tested the world's first low-profile, circularly polarised, rectangular dielectric-resonator antenna (DRA) in 1995. The radiating element of this antenna is shown in the photo have also designed many other dielectric-resonator antennas, including a low-profile linearly polarised DRA, for various applications (see publications). We pioneered the FDTD analy antennas and published the first radiation patterns of a DR antenna obtained using the FDTD method in 1995.

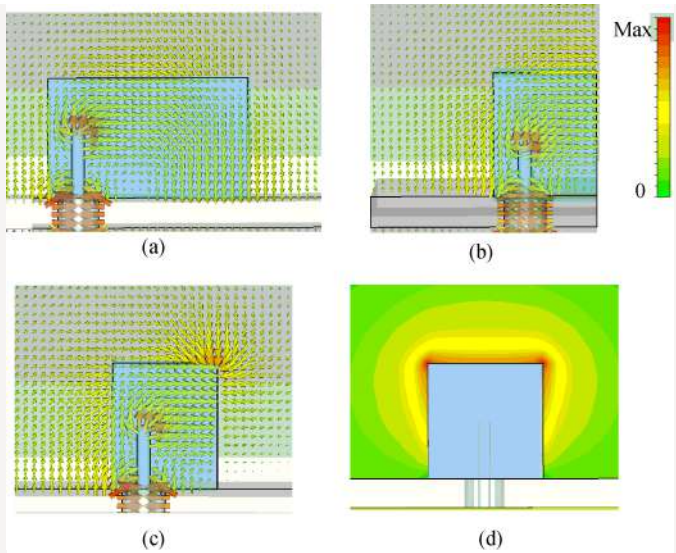

Australian Antenna Measurement Facility (AusAMF)

AusAMF is operated by a consortium of Australian Universities, Industry and CSIRO. The facility provides access to a shielded anechoic chamber offeri spherical near-field measurement capability for small antennas operating in the frequency range of 1-20 GHz, primarily for research purposes.

The facility was established under an ARC LIEF (Australian Research Council Linkage-Infrastructure Equipment and Facilities) grant and is hosted by C ICT Centre located in the Sydney suburb of Marsfield.

The facility currently consists of a spherical near-field turn-key NSI-700S-50 system within a 6m x 3.3m x 3.3m anechoic chamber. It has been designed to operate up to fre of 20 GHz, and uses an Agilent PNA (E8362B) as a receiver. The measurement system is capable of supporting a ~40kg antenna under test (AUT) up to a diameter of approximately 1.2m. I the standard gain horns and the probes available at AusAMF are as follows:

Waveguide Band	Frequency (GHz)	Probe	Standard Gain Horn
WR975	0.75 - 1.12	x	x
WR650	1.12 – 1.70	x	x
WR430	1.70 – 2.60	x	x
WR340	2.20 - 3.30	x	x
WR229	3.30 – 4.90	x	x
WR159	4.90 – 7.05	x	x
WR112	7.05 – 10.00	x	x
WR90	8.20 – 12.40	x	
WR75	10.00 - 15.00	x	x
WR51	15.00 - 22.00	x	x

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INVITED PAPER

Smart Surfaces: Large Area Electronics Systems for Internet of Things Enabled by Energy Harvesting

This paper focuses on large-area "smart surfaces," RFID systems, and wearable RF electronics that could substantially benefit from multisource energy harvesting.

By Luca Roselli, *Senior Member IEEE*, Nuno Borges Carvalho, *Senior Member IEEE*, Federico Alimenti, *Senior Member IEEE*, Paolo Mezzanotte, *Member IEEE*, Giulia Orecchini, Marco Virili, *Student Member IEEE*, Chiara Mariotti, *Student Member IEEE*, Ricardo Gonçalves, *Student Member IEEE*, and Pedro Pinho, *Member IEEE*

ABSTRACT | Energy harvesting is well established as one of the prominent enabling technologies [along with radio-frequency identification (RFID), wireless power transfer, and green electronics] for the pervasive development of Internet of Things (IoT). This paper focuses on a particular, yet broad, class of systems that falls in the IoT category of large area electronics (LAE). This class is represented by "smart surfaces." The paper, after an introductory overview about how smart surfaces are collocated in the IoT and LAE scenario, first deals with technologies and architectures involved, namely, materials, antennas, RFID systems, and chipless structures; then, some exemplifying solutions are illustrated to show the present development of these concurrent technologies in this area and to stimulate further solutions. Conclusions and future trends are then drawn.

KEYWORDS | Energy harvesting; green electronics; Internet of Things (IoT); large area electronics (LAE); radio-frequency identification (RFID) systems

I. INTRODUCTION

Looking at the telecommunication (TLC) market development worldwide in the last five years, we see an average decrease of about 5% per year, in both gross domestic product (GDP) contribution and employment [1]. Against this trend, the global information and communication technology (ICT) market has remained grossly constant. Some compartments, in fact, are experiencing an opposite trend. Beside some sectors related to new consumer products, such as tablets and smartphones, new Internet of Things (IoT) related products are growing at two digits per year and some estimations from big players report a market value in the order of trillions of dollars in the next decade [2], [3].

The vision behind IoT is in fact to connect objects directly to the Internet so as to allow them to provide information directly to the web without any human intermediation [4]. This vision will have a great impact on several electrical and electronic technologies, ranging from the basic physical layers (technology platforms) to the highest ones: communication protocols, software, human interface, and information management.

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In terms of physical layer, IoT actually inherits the technologies developed for wireless sensor networks (WSNs), bringing the distributed nature of that to the extreme. WSN, in fact, can be synthetically seen as a mesh of sensor nodes purposely conceived to build and communicate a sensed image of a monitored area. Within IoT, the sensing nodes are not purposely deployed to monitor something specific; instead, they are simply hosted by "objects" in order to provide the information they are able to collect and make it available on the web. Conceptually speaking, there is not a big difference, but in terms of related technological challenges, there is. Nodes must be hostable by objects; objects are of many types, and the better the nodes fit themselves transparently to the hosting objects, the denser and more reliable the information they are able to provide.

Several challenges can be envisioned in this evolution: first, electronic systems must be mechanically flexible, thin, and miniaturized in order to conform to the shape of as many objects as possible; second, the adopted materials have to be as recyclable as the hosting objects in order to avoid pollution from guest apparatuses; last but not least, hosted nodes must be autonomous, because they cannot be either connected to the grid or powered by life batteries.

A great technological paradigm shift is going to be pulled by the development of IoT; green materials, autonomous systems, ultralow-power circuits, energy saving protocols, and energy harvesting (EH) are concurrently mandatory.

Conversely, this technological evolution is pushing new solutions and architectures, so far constrained by the limits of conventional technologies. The development of inkjet printing techniques, the introduction of very cheap and eco-friendly materials compatible with roll-to-roll (R2R) circuit realization techniques [5] and so forth, open new horizons also to large area electronics (LAE).

LAE, first applied to printed photovoltaic and organic screens [6], is actually at the onset of its development. The development of R2R techniques and related materials, in fact, is allowing for tremendously increasing the dimensions of LAE circuits and systems, from the present tens of centimeters to meters and beyond. Along this evolutionary scenario, new configurations and architectures, based on massive integration of large circuits over conformable surfaces, can be envisioned, opening the way to what can be called the smart surfaces (SSs) approach.

SS, in turn, can be seen as a branch of IoT evolution. Large 2-D arrays of autonomous sensor nodes, for instance, make possible granular tracking of whatever parameter, ultimately providing augmented imaging of the environment; large 2-D arrays of tags can provide a very low-cost platform for precise localization and location-based services (LBS), thus enabling the realization, for instance, of smart floors [7] and smart wallpapers [8]; inheriting quasi-optical approach [9] contact-less electromagnetic (EM) wave processing (filtering, frequency conversion, selective shielding, etc.) can be conceived even at low frequencies.

On the one hand, SS is thus an approach stimulated by technologies pulled by IoT; on the other hand, it contributes to a class of architectures, within LAE, that can even widen the huge horizons of IoT applications in a sort of virtuous circle.

According to this wide vision, the paper is organized as follows. A review of the technologies suitable for distributed systems implementation to a large extent is given in Section II; then, the explanation about how radio-frequency identification (RFID) can be considered one of the most suitable technologies for the implementation of IoT architecture, and how it can be naturally integrated with SSs, is provided (Section III). In order to deal with the implications of the development of RFID systems compatible with SS and LAE evolution of IoT, two specific sessions have been provided: the first relates to antenna implications (Section IV), and the second relates to electronic architectures for RFID tags (mainly chipless ones; Section V). In order to smoothly bring the reader from relevant technologies to applications, quasi-optics, as an example of general approach concurrently exploiting the mentioned technologies to provide a platform suitable for LAE, is described in Section VI. After this, some application examples of how SS concept can be articulated, according to the IoT paradigm, are described; specifically, smart floor (Section VII), smart shoes as useful subsystems for the implementation of smart floors (Section VIII), and energy skin (Section IX). In order to have a vision of the logical links behind the many topics dealt with in this paper, a synoptic picture can be found in Fig. 1.

II. TECHNOLOGY FOR LAE DISTRIBUTED SYSTEMS

Given the described scenarios of SS, it is clear that the technologies involved have to be compatible with LAE

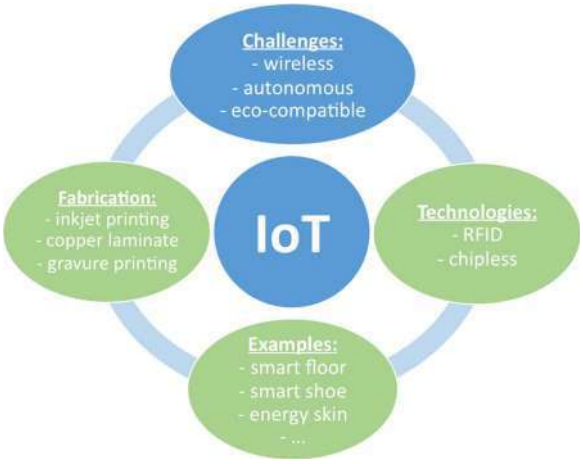

Fig. 1. ***Synoptic view of the paper structure reflecting the IoT vision described in the Introduction.***

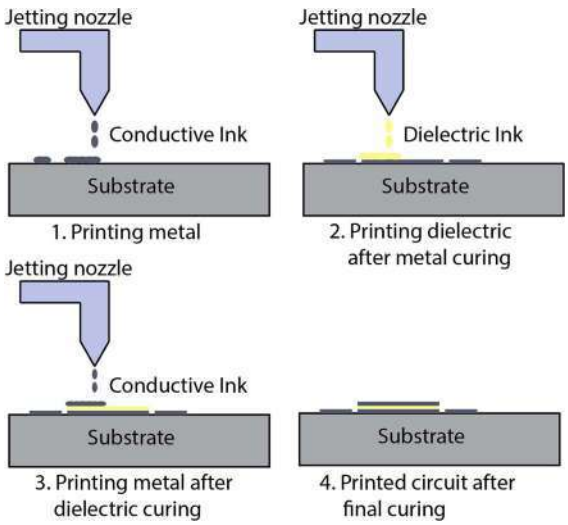

Fig. 2. ***Inkjet printing technique, synoptic description. The ink is deposited on the substrate with the desired pattern and after a curing procedure the next layer can be printed. The thickness of each film depends on the number of passes.***

approach, as described in the Introduction; according to [6], for example, the eco-compatibility of the materials, the mechanical flexibility of the substrates to make the device conformable to the hosting surface, and the life cycle (operability and biodegradability) have to be accounted for.

The new techniques proposed from different research groups [10]–[12] focus mostly on the printing techniques that can be industrialized easily with R2R methods, already investigated for the traditional printing on paper. Within the printing methods, one of the most attractive and investigated in the last decade is the inkjet printing of conductive and dielectric layers (Fig. 2). This technique allows circuits to be printed on almost any kind of substrate: from the photographic paper to liquid crystalline polymers (LCP) or Kapton, that are flexible, thin, and eco-compatible; to glass or poly methyl meta acrylate (PMMA, commonly referred to as Plexiglas) that are usually thicker but not flexible.

A first proof of concept for the inkjet printing technique at radio frequency (RF) and microwaves has been obtained on photographic paper by printing simple structures, such as antennas and other planar circuits and devices [10], [13]–[22], with a technology stack simply composed by the substrate and the conductive layer (usually realized by means of nanoparticle silver ink).

Recently, this method has been improved thanks to the development of new inks, usually composed by a polymer and a solvent (i.e., SU-8, PVP, PMMA, PEDOT, etc.); more complex fabrication procedures of multilayer structures are now possible, as shown in [23] and [24]. Another noticeable feature of this technology is represented by the resolution: conductive tracks of 50 μm of width and space gaps of 50 μm can be printed, allowing the design of millimeter-wave (mm-wave) frequency devices [25]. The combination of the quite high resolution (considering the simplicity of the technology) with the multilayer featuring also gives the opportunity to manufacture very easily matrix of passive and active devices that can be used in the SS development. It is worth noting that the process can be developed in a few steps based on the design and mostly on the number of layers needed. For example, a metal–insulator–metal (MIM) device can be realized by printing silver on the substrate [26], curing it in the oven in order to create a surface that, with the proper treatment (for instance, UV–Ozone exposure or preheating), is ready for the insulator printing. Then, the dielectric is cured as well and the last metal layer can be printed on top of it. The entire structure can be then cured at temperatures ranging between 130 °C and 200 °C.

In a perspective of industrialization of the inkjet printing technology, the hypothesis of R2R manufacturing of circuits is being investigated and some examples are already reported in literature for solar cells and other devices [27], [28].

Today, many pros have been mentioned for the inkjet printing method, and others can be found in the non-use of wasted chemicals (as is for the traditional lithographic technologies), in the no-need of clean-room environment for the fabrications, in the low-cost and rapidity of manufacture, and in a R2R perspective compatibility. However, the necessity of a curing procedure after the printing of a layer still represents the biggest inkjet limit for two main reasons: first, the time and type of curing are dependent on the inkjeted materials and on the material stack-up; second, especially on a laboratory level, the curing can cause misalignment issues, given the fact that the sample is removed and then replaced in the printer after the last layer curing.

Currently, the platform mostly used worldwide by researchers is the Dimatix 2800 DMP. In terms of inks, it is possible either to buy printable solutions or mix solutions in labs; for example, the combination of polymers and solvents allows layers to be printed with different electrical properties and thicknesses.

Besides the inkjet printing method, in [11], a new technique, suitable for LAE, has been proposed. It uses a metal (copper in that case) adhesive laminate technology based on the application of the standard etching process to an adhesive copper laminate material. This technique was already adopted to produce mm-wave circuits and to characterize the resulting compound substrates, as reported in [29]–[31]. A brief illustration of the metal laminate technique is here reported referring to Fig. 3.

The production process can be divided in five steps. The first step consists of the deposition of a (positive) photoresist film on the copper surface; then, the circuit layout is transferred to the photoresist by means of a photomask and ultraviolet exposure. After that, the unimpressed film of photoresist is removed using a NaOH

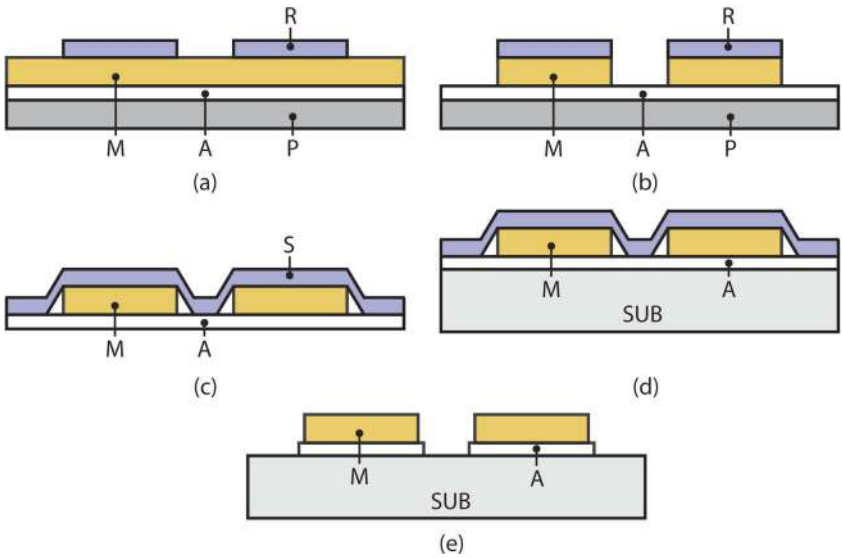

Fig. 3. ***Process steps for the circuit fabrication using the adhesive metal laminate. M: metal, A: adhesive, P: protection, R: photoresist, S: sacrificial layer, SUB: hosting substrate. After the standard lithographic procedure, the copper pattern can be transferred on top of any substrate by means of a sacrificial layer and exploiting the adhesive face of the copper tape.***

developer solution [Fig. 3(a)]. In the second step, the copper tape is wet etched. As can be seen in Fig. 3(b), in this way, the adhesive layer is exposed where the copper was removed, while it remains everywhere else covered by the original copper tape that serves as protection for the adhesive underneath.

The first two steps are, in this example, similar to those adopted in standard photolithographic technology. Moreover, different ways to remove the not needed metal can be used, as, for example, by means of numerical control pattern cutting plotters.

In the third step, depicted in Fig. 3(c), a sacrificial layer is stuck on the top copper side and, finally, the protection layer on the bottom is removed. The sacrificial layer is very important because it keeps the relative distances among the layout features constant even when these are not physically connected.

The fourth step is characterized by the transfer of the etched metal to the hosting paper substrate and, finally, the sacrificial layer can be removed [see Fig. 3(d) and (e)]. The last step is also useful to remove most of the exposed adhesive material.

With this method, quasi-fully-organic circuits and devices can be realized. The performance in terms of tracks width and pitch are, at present, a bit lower than what can be obtained with the inkjet printing, with the advantages of no curing processes, the possibility to fix devices on the circuit using standard soldering techniques, and a better conductivity (the conductivity of copper laminate, in fact, is one order of magnitude higher than that of the cured nanoparticle silver ink: 5.8×10^7 S/m versus about $6 \times 10^6 - 1 \times 10^7$ S/m obtained with at least five layers of silver).

To verify the validity of the metal laminate technology at microwave frequencies, a 50-Ω microstrip line was manufactured exploiting the Mitsubishi photografic paper as the substrate (thickness 250 μm, relative permittivity $\varepsilon_r = 3.2$, and loss tangent $\tan\delta = 0.08$). The line is 30 mm long, and the measured scattering parameters are shown in Fig. 4. The same graph also compares the performance of a similar transmission line manufactured with an inkjet printing process. The performance of the

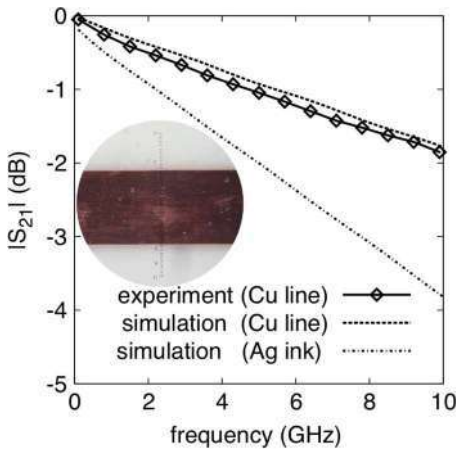

Fig. 4. ***Measured scattering parameters versus frequency for a 50-Ω microstrip line on paper substrate. The line, shown in the inset, is 30 mm long; the ruler division corresponds to 17.2 μm. The graph also reports a comparison with a microstrip line of equal dimensions made with an inkjet printing process (Ag ink, 3-μm thickness, $\sigma_{ink} = 1.1 \times 10^7$ S/m after curing). After [11].***

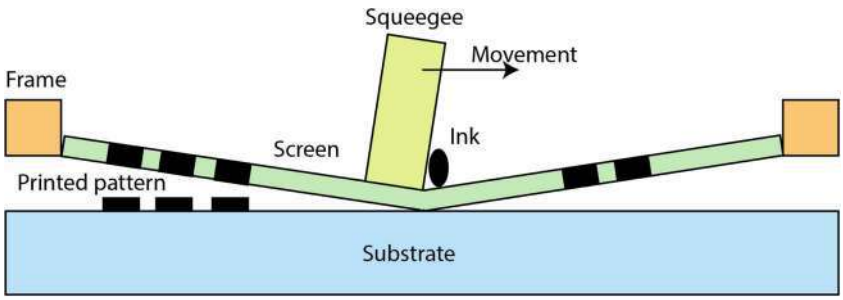

Fig. 5. ***Screen printing technique. The squeegee is used to press the screen with impressed pattern and transfer it on top of the substrate.***

metal laminate structure is superior compared to that of the inkjet printed line. At 10 GHz, the measured specific losses for the metal laminate microstrip are about 0.6 dB/cm [11]. Results at higher frequencies are also reported in [31]; in particular, an insertion loss of about 1.8 dBm/cm at 30 GHz is demonstrated.

The tradeoff is the adoption of a photolithographic step; it is worth mentioning, however, that the process is still compatible with R2R implementation.

Other possibilities for LAE are the screen printing [12] and the gravure printing [12], both of them adaptable to R2R industrialization techniques.

Screen printing consists of dragging a layer of ink across the surface of a screen and squeezing it through the open pores of the patterned mesh onto the substrate (Fig. 5). In general, the thickness of the printed layer and the achievable resolution depend on the density of the mesh and on the ink properties. Usually, the ink viscosity is in a range of 1–50 Pa $\times$ s, and this allows for printing with a resolution of about 100 μm and a thickness up to 100 μm. Until now screen printing has been adopted to realize low-resistance structures, solar cells, and field effect transistors (FETs), exploiting the possibility of printing very thick layers.

Gravure printing, also known as rotogravure, is considered a very high volume printing (Fig. 6) process, and it is being adopted to produce very conductive structures as, for example, capacitors, antennas, and organic devices such as pentacene-based diodes, organic light-emitting diodes (OLEDs), organic field effect transistors (OFETs), and organic thin film transistors (OTFTs).

The resolution can be of about 20 μm. The method is implemented by engraving the patterns into a metallic cylinder by a laser, by chemical etching, or electromechanically (as separate cells or intaglio trenches). Typically, the print pressure is high (1–5 MPa) in order to achieve a good ink transfer and to reduce the percentage of unprinted dots caused by the surface roughness of the flexible substrate. However, this high pressure of printing makes this technique suitable only for robust substrates with no soft, previously printed, layers that could be damaged.

To summarize, the technologies described in this section are characterized by some common features, such as: flexibility and conformability, compatibility with large area realization of circuits and interconnections, use of additive or mixed (subtractive/additive) deposition techniques, easy use of eco-friendly materials and, in some cases, compatibility with classical bond wiring as well as soldering techniques for electronic device placement.

Table 1 summarizes the main features of the described technologies.

III. RFID: A MIX OF CONCURRENT TECHNOLOGIES FOR SS IMPLEMENTATION

As mentioned in the outline paragraph at the end of the Introduction, after describing the technologies enabling SS development (Section II), here we illustrate RFID as a suitable means to transfer information through EM transmission between tags and readers to the Internet.

An RFID tag has a unique identification code and a memory used to store information, while the reader can

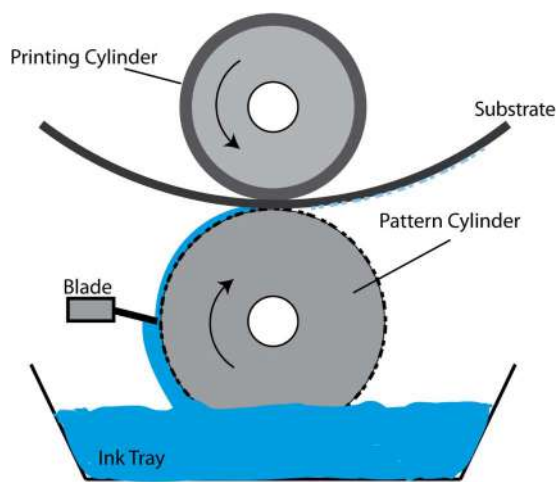

Fig. 6. ***Gravure printing process. Note that these machines can be from 20 cm to 3 m wide with a diameter ranging from 5 cm to 5 m.***

Table 1 Technologies Comparison

Technology	Resolution	Cost	Waste	Speed
Inkjet	50 μm	Low	Low	Fast
Copper	100 μm	Low	High	Medium
Gravure	20 μm	High	Medium	Very fast
Screen	100 μm	Medium	Low	Very fast

write or read data on and from the tag through RF transmissions. The tag is usually attached to an object that needs to be identified and monitored, or contains information to be read. In typical RFID applications [32], the main goal is to provide mapping of physical objects that are equipped with an RFID tag attached or embedded. In this way, RFID technology inherently leads to identifying, tracking, and localizing, but it can also enable the storage and transmission of information regarding object status and surrounding environments by embedding sensing capabilities.

As mentioned previously, IoT is most commonly described as a structured system of technologies concurrently working to capture meaningful data from objects and communicate them through networks to a decision-taking level. Useful keywords, whenever a definition of IoT is given, include: smart objects, autonomous logistics, machine-to-machine communication, RF technologies, centralized information, and so on.

In order to implement these functionalities, an IoT platform, an SS for instance, has to provide at least unique object identification together with wireless communication for data management.

The IoT physical layer can thus be naturally thought of as meshes of RFID and sensor nodes. The RFID tag that embeds a sensor can use the same working principles and protocols of the conventional RFID tags; a differentiation can be made, considering the way sensor tags are powered up, in active, semipassive, and passive tags; actually, the difference consists of the way they are powered.

Active tag sensors may use customarily conceived communication protocols or rely on RFID standards enabling the tag to be easily integrated into the existing wireless infrastructures so that they will not require expensive readers. In [33], a system architecture was developed to integrate WSNs and the RFID systems. Bluetooth and ZigBee technologies are adopted as the communication protocol of WSNs to meet the requirements of a large number of sensor nodes, large areas, and low cost.

Active tags with integrated sensors are used in several applications, including temperature and position monitoring, vibration detection, blood pressure, heart beat monitoring, and more. This type of sensor tags, besides having larger amount of energy provided by batteries, affords both a large range and multiple functionalities; some of them have also external buses that enable the use of connected external sensors [34].

Passive tags with an integrated sensor operate without battery, collecting the needed operational energy from external environment sources. The main requirements of this class are high energy conversion efficiency, large storage capability, and overall low-power consumption. Passive systems have usually low operating range and limited processing capability.

In this field, research activities are directed toward ultralow-power design of integrated sensor tags [35], antenna design for improving reading range [36], sensor overall performance optimization [37], and development of optimum protocols allowing for additional power saving [38], [39].

Typical applications are, for instance, temperature monitoring [40], photodetection [41], motion detections [42], etc.

Semipassive tags use both batteries and energy sources coming from the environment; they can integrate more operational capabilities than the passive ones, since they can exploit a higher amount of energy. For the same reason, semipassive RFID tags are more suitable to integrate a sensor; the operational methodology is similar to the passive one, using the reader signal to interrogate and cause a response from the tag. The primary difference is that the semipassive tag does have a battery used not to generate a response, but only to power electronics, like sensors incorporated in the tag, while exploiting RF circulation to reply to the reader interrogation. Just like passive tags, semipassive ones are limited in terms of slow reading speeds and short reading distances. In [43], the design, realization, and experimental validation of a battery-assisted RFID tag with sensing and computing capabilities, conceived to explore heterogeneous RFID-based sensor network applications, was presented.

Dealing with battery-less devices that are, by far, the most interesting ones for IoT, LAE, and SS applications, we can now focus on the typical energy sources adopted. No battery devices can exploit solar scavenging [44], [45], vibrational [46], [47], or RF radiations [48]–[52].

In many cases, wirelessly powered systems can harvest energy from the incident RF waves, thus generating the required direct current (dc) voltage to power the system. The EM energy present in the environment may be significant in some regions (some urban areas or indoor sites); here the use of proper conversion devices may allow enough energy to be scavenged. RF power harvesters usually consist of an antenna, an impedance transformation network, a rectifier, and a storage element. In [53], a design example of integrated rectifier antennas (rectennas) for wireless powering at low incident power densities, from 25 to 200 μW/cm^2, is given.

Regarding mechanical energy scavengers, they may be categorized upon the kind of energy source exploited; there are scavengers providing energy from a constant motion over extended periods of time (e.g., turbine air flow) or others based on intermittent motion (e.g., human

step). Particular attention is given to vibrational energy sources; in this case, the amount of energy that can be harvested depends mainly on the vibration amplitude and frequency and on the vibrating mass (mass of the harvesting device) [54]–[56].

In order to power the systems by using energy sources available in the working environment, proper energy transducers thus have to be chosen. Focusing on distributed systems (IoT, LAE, and SS), it is worth referring to typical parameters for optimum transducer design since, in these applications, the different kinds of energy available in the various scenarios may lead to the need of integrating more than one energy conversion system into the same device, in order to take advantage of all the accessible energies. The main design parameters are the available power output, the electrical impedance, and the operating voltage. Table 2 summarizes them for the most common energy transductions [57], [58].

To conclude this section, the mentioned reasons why RFID can be considered a useful technology for the implementation and development of LAE and, more specifically for SSs, are summarized. RFID systems, especially in the passive version of tags, are communication systems characterized by the following characteristics: compatibility with very low-power communication protocols, compatibility with the constrains posed by the hosting objects, especially when they are implemented by adopting the technologies described in Section II, inherent capability to gather information from the environment (sensor tags) and from the hosting objects, a low number of electronic devices (inherent circuital simplicity) and, finally, proven compatibility with printing technologies.

For all these reasons, RFID technology has to be considered the leading one to pursue the development of LAE and SSs as a communication platform for the evolution of IoT.

IV. ANTENNA DESIGN FOR NODES

Distributed systems for ubiquitous electronics (UE) and WSNs [59], [60] are, today, increasingly employed for monitoring and sensing applications. These systems can be seen as networks of nodes, massively distributed in the environment and communicating wirelessly with a base station. This massive deployment can be designed and structured to monitor a set of specified parameters by means of purposely conceived sensor nodes, as in the classical WSNs, or it can be obtained by integrating nodes into existing objects, which is the vision of IoT evolution. In general, the nodes can have different functionalities, however they have to provide information collected by embedded sensors (such as, for instance, identification codes, position and monitored environment parameters as well as object status) whenever it is required.

In this scenario, the RFID technology, summarized in Section III, is attractive. When RFID technology meets sensor nodes, information goes from the node to the Internet via a question-and-reply protocol between nodes, hosted by tagged objects, and readers.

Thinking about distributed systems and specifically SS, it is natural to think about radiative coupling in the available industrial–scientific–medical (ISM) frequency bands, including mainly the ultrahigh frequency (UHF) and microwave frequencies (around 0.9, 2.4, 5.8 GHz, and higher), exploiting the communication standard such as the WiFi [61]. Recently, also the ultrawideband (UWB) has been considered in order to minimize the limitations of narrowband systems (mainly localization accuracy and sensitivity to interference) [62].

Multistandard systems are often adopted for large compatibility and higher use flexibility. An example of this recent approach is given in [61] where near-field UHF nodes are combined with far-field transceivers. This allows application fields with compromised radiation capability,

Table 2 Transducer Characteristics for Several Forms of Ambient EH [57], [58]

Energy Source	Typical Electrical Impedance	Typical Voltage	Typical output power
Light	From low to 10s of KΩ	DC: 0.5 V to 5 V	Outdoors: 100s mW/cm^2 Indoors: < 500 μmW/cm^2
Vibrational	Constant Impedance 10s of kΩ to 100 kΩ	AC: 10s of Volts	100s μW/cm^2
Thermal	Constant Impedance 1 Ω to 100s of Ω	DC: 10s of mV to 10 V	10s μW/cm^2 (20° gradient)
Radio Frequency	Constant Impedance Low KΩs	AC: Varies with distance and power 0.5 V to 5 V	Wide-range

such as in proximity of metal and liquids at short ranges, to be improved.

It is clear that antenna systems are key elements in these apparatuses. The foundation of antenna design rules can be found in [63]. The antenna design specific for distributed systems, in turn, has to take into account several instances. Beyond the typical design criteria, other aspects are: the communication standard, the form and the size in agreement with the application, the communication range as a function of the equivalent isotropic radiated power (EIRP) limits, of the environment and of the orientation, the reliability under several conditions and processes, and the material cost considering massive production [64]–[67]. Among them, the operating environment is the most critical aspect that influences the node behavior [68].

As a consequence, antenna topology and materials for SS and IoT systems, in general, have to be chosen in order to make the antennas capable of operating in variable environmental conditions and to be integrated into objects. As an example, let us think about wearable antennas for body area networks (BANs): they must be washable, flexible, and able to shield the body from radiation [69].

In general, antennas for SS should be flexible, planar, and low profile; moreover, by adopting low-cost materials and technologies (see Section II), cost per unit surface is low, thus large arrays and big elements can be adopted more easily, ultimately allowing for easy developments of LAE distributed systems and SS, even at low frequency.

Materials compliant with SS implementations must be, in turn, mechanically robust, flexible, and very low cost, while exhibiting acceptable EM performance. These materials must also exhibit high tolerance levels in terms of bending repeatability. Flexible materials, often used, are polymers and polymer-ceramics composites such as the poly-di-methyl-siloxane (PDMS) and the titanate-based ceramic [68], which provide flexibility, robustness, and resistance to harsh environments in order to protect antenna and circuit. Moreover, when eco-compatibility has to be guaranteed, recyclable materials and related technologies have to be adopted; among them, cellulose substrates in combination with inkjet printing of conductive inks [18], [70] or with conductive adhesive laminate technology [11] are increasingly frequently adopted. The aforementioned techniques, compatible with the well-known industrial printing and the R2R processes [5], are in agreement with the low-cost fabrication and are expected to facilitate widespread and very low-cost electronics for distributed systems. These fabrication technologies can also be adopted for electronic devices on flexible polymeric substrates. An example of cellulose-based antenna for smart floor applications, such as indoor localization, is documented in [71]: a low-profile planar loop antenna is realized on cellulose substrate exploiting adhesive copper tape.

Although beyond the scope of this paper, which focuses on SS, it is worth mentioning here that this evolution toward the development of more and more sophisticated "unconventional" materials for electronics has a great impact on other IoT related developments such as, for instance, implantable systems.

When applications require devices with soft visual impact (think about SS, such as smart windows, glass integrated inside and outside buildings and glass for automotive applications, or smart skins [72]), transparent and conductive materials, such as transparent conducting oxides (TCOs), and in particular indium-tin-oxide (ITO) and ITO-based multilayers, have been proposed [73]. These materials afford a good compromise between minimum electrical resistivity and high optical transmittivity in the visible light spectrum when patterned on see-through materials such as glass or transparent polymers. A technique to improve the efficiency of the transparent antennas, without affecting their transparency, is the application of a layer of highly conductive coating or metallization strips on the antenna edges where the current density is high [72].

Among SSs, or in general distributed systems within the IoT vision, a fast growing field of research is represented by wearable electronics for BANs [74]. In this case, the integration of electronic devices in the garments requires the development of wearable and washable antennas and antenna arrays on fabrics. Washable antennas can be realized by covering textile antennas by a breathable thermoplastic polyurethane coating in order to protect the device against water absorption and corrosion [69].

Although dimension constraints are not very critical for distributed systems on cheap materials, they cannot be neglected thoroughly. At RF, for example, high permittivity materials [68] and magnetic composite substrates [75] can be adopted. Artificial magnetic conductors (AMC) can be employed alternatively to the magnetic composites with similar results [76]. These approaches are simply demonstrated from the wavelength equation: wavelength is a function of the relative permittivity and permeability and adopting suitable materials to increase these values, the effective wavelength, and therefore the antenna size, decreases. Anyway, the use of these materials introduces a tradeoff between dimensions and performance: generally the substrate losses decrease the antenna radiation efficiency, thus affecting the communication range of the overall wireless system, as documented in [68], [75], and [76].

In terms of design methodology, the introduction of unconventional materials as well as the environmental constraints posed by distributed systems and systems for IoT influence and drive the design strategies. Some solutions are proposed in the literature to cope simultaneously with these constraints; in [68], shielded configurations have been analyzed to mitigate environmental sensitivity. In [69], an example of robust patch antenna for BAN application that reduces the effect of the body on the performance is illustrated; in [77], the use of broadband antennas, such as the Chebyshev monopoles with a fractional bandwidth of about 40%, is proposed to reduce the frequency

shift introduced by the background materials or by the bending effects.

In SSs, and in general in IoT applications, antennas are used both to transmit and receive information and to harvest the necessary energy from the surrounding environment. Regardless of the fact that the available energy is randomly released in the environment by existing services (GSM, WiFi, and so on, in urban and semi-urban environments [78], [79]) or purposely delivered to empower a distributed population of nodes [80], antennas have to be able to harvest EM energy. This kind of "double effect" antenna is widely referred to in the literature as "rectenna": it combines rectifying circuitry with EM to electrical energy transduction.

The fundamental codesign techniques of antennas and rectifiers, focusing on the improvement of the conversion efficiency exploiting matching circuits, are described in [53]. Harmonic-balance and load-pull simulations are often used in order to find the optimal impedances that allow best efficiency to be obtained as a function of the EM incident power.

Multiband, broadband, and circularly polarized antennas are often adopted in EH applications to reduce the overall sensitivity to the environment. An example of planar antenna array for EH applications, in agreement with the SS principle, is documented in [81]: spiral antennas are proposed in order to provide a wide operating frequency band, and the rectification circuitry is optimized and characterized for low incident power levels. Similar antenna array for UWB EH is shown in Fig. 7.

A rectenna can be used in addition to the communication antenna or, alternatively, the same antenna can be used for both EH and data transmission. The use of different antennas is generally adopted if harvesting and communication are carried out at different frequencies and, mainly, in order to enhance harvesting efficiency without decreasing communication performance. In any case, this requires a codesign and can affect the node dimension and complexity. Alternatively, a single antenna can be a feasible compromise if communication and harvesting share the same frequency band and if the antenna harvesting efficiency is not the main issue; examples are the passive RFID tags empowered by the reader with a standard RFID antenna able to provide both EH and communication capability, as documented in [64] and [65].

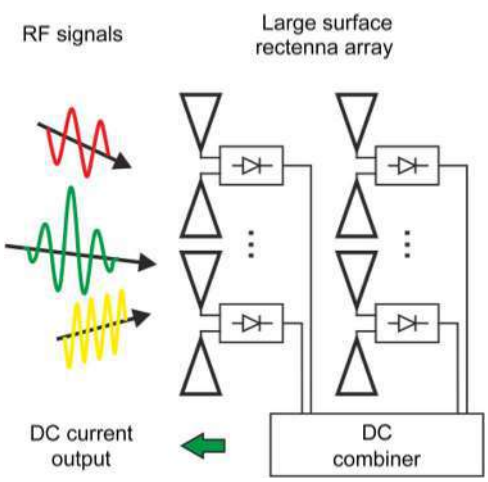

Fig. 7. *Scheme of the rectenna array able to collect RF energy even in a broadband (depending of the kind of receiving antenna element), according to the solution adopted in [81].*

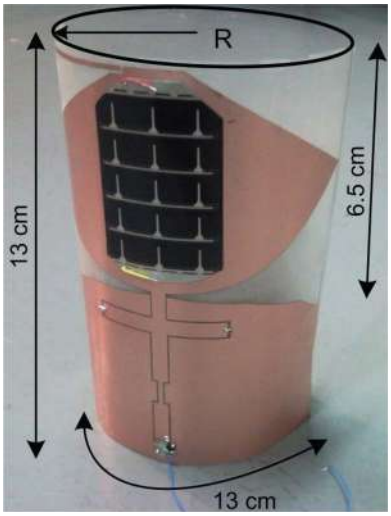

Fig. 8. *Hybrid rectenna for solar and EM–EH. The hybrid rectenna consists of a broadband antenna and a solar cell combined in the same structure. After [82].*

However, the EM–EH is not the only solution to energize nodes and SS elements: hybrid EH, in fact, can be performed by exploiting different energy sources; that is, combining the rectennas with other sources of energy.

Recently, a low-cost and conformal structure for hybrid EH, based on low-cost and flexible poly-ethylene terephthalate (PET) substrate and an amorphous silicon solar cell, has been proposed in [82]; other examples are discussed in [20] and [83]. The use of low-cost, printable photovoltaics deposited on flexible substrates to form part of the antenna radiating structure is documented in [84]. In all these contributions, the main challenge appears to be the codesign of the antenna and solar cell in order to avoid reciprocal detrimental effects. The antenna is designed with a solar cell integrated on top of the radiating surface to obtain good radiation characteristics and to incorporate connections for the extraction of the dc provided by the solar cell. In [82], it was demonstrated that, by adopting thin film solar cells and paying attention to not exceeding the perimeter of the RF antenna, the solar cell can be integrated so as not to significantly affect the performance of the antenna. The hybrid rectenna for solar and EM–EH documented in [82] is shown in Fig. 8.

In terms of industrial assembly, the use of new materials and the need for low-cost and large-scale fabrication techniques would be fostered by architectures more insensitive against geometrical errors and placement misalignments. Following this direction, EM coupling can be exploited instead of ohmic contact to connect antennas on a flexible substrate to Si chips or, more generally, to the active circuitry [85]. This technique exploits a planar heterogeneous transformer, with the primary and secondary windings implemented on the antenna substrate and the Si chip, respectively. In this way, the galvanic contacts and the soldering process are avoided, and the final structures have been proven much more robust to alignment errors than traditional ohmic techniques without any significant performance degradation. By artificially applying a misalignment of 150 μm, which is the common dimension of a soldering pad, the technology proposed in [85] causes a loss increment of only 0.1 dB, due to the applied misalignment, while the same misalignment, when adopting ball grid arrays, would have implied missing the contact. This approach is quite attractive especially in combination with nonrigid materials where mechanical stress can result in significant substrate deformations. Recent contributions show the application of the aforementioned approach to inkjet printed antenna on PET substrate coupled to the chip for wireless nodes [86] and a textile patch antenna, magnetically coupled to the active circuitry, suitable for garment integration (see Fig. 9) [87], the reflection coefficient of which is shown in Fig. 10.

In order to testify the robustness of the proposed solution against uncertainties inherent to textile and garment electronics assembly, the radiation efficiency of the antenna, as a function of horizontal and vertical misalignment of the two transformer windings, used to perform the magnetic coupling, is plotted in Fig. 11(a) and (b), respectively. This technique can be extended also to interlayer communications of multilayer devices, and an example is documented in [88], where the circuitry fabricated on different garments communicates by means of overlapped coils.

V. CHIPLESS APPROACH

It has already been discussed that SS represents a possible technology for the development of killer applications within the IoT paradigm. Thanks to the convergence of several technologies, ranging from EH and sensing to RFID and LAE, SS can afford complex functions. For example, SSs can be used in intelligent buildings for structural monitoring and alarms (fire, for instance). To achieve these goals, SS must be equipped with a huge number of tags, each one monitoring a small portion of the surface itself.

The passive RFID systems can be divided into two families, namely, chip-based and chipless tags. The first family usually exploits a low-power complementary metal–oxide–semiconductor (CMOS) chip to implement the main tag functions [RF carrier rectification, dc voltage regulation, amplitude shift-keying (ASK) demodulation, IDentification code (ID) decoding, load modulation, etc.] and thus can be adapted to sensor applications by a few additional circuit blocks [signal conditioning,

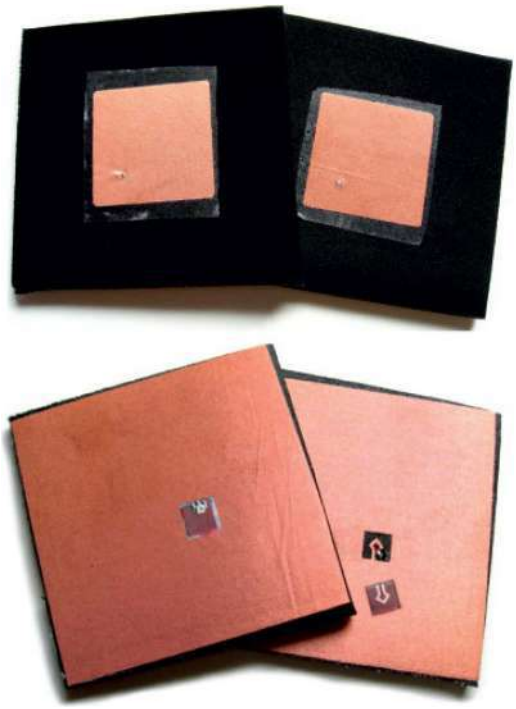

Fig. 9. *Example of textile patch antennas operating at 2.4 GHz. The antenna and the ground plane are made of Flectron, a conductive textile, and the substrate is black foam. These materials are flexible and integrable in the garments. Magnetic coupling is exploited to connect the antenna and the active circuitry on flexible substrate. After [87].*

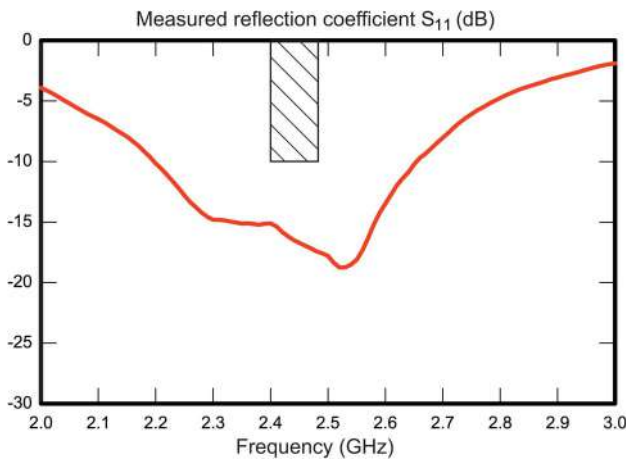

Fig. 10. *Measured reflection coefficient of the previous textile antenna in the frequency band 2.4–2.48 GHz. After [87].*

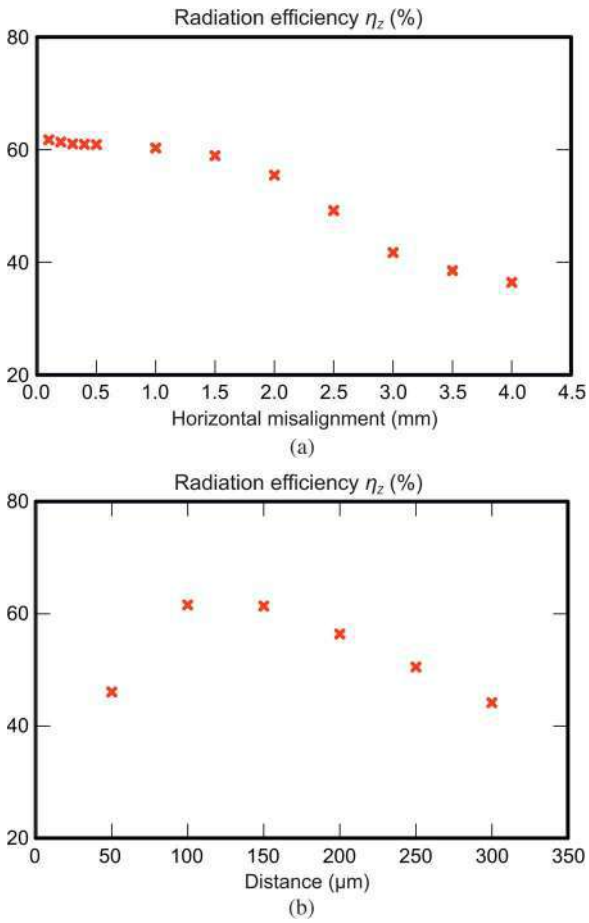

Fig. 11. ***Variation of the radiation efficiency evaluated versus (a) horizontal and (b) vertical misalignment between the antenna and the circuit windings. This test allows the robustness of the antenna performances against mounting uncertainties inherent to textile electronics to be evaluated at glance. After [87].***

analog-to-digital converter (ADC), etc.]. The main advantage of such an approach is the digital modulation of the transmitted signal, and thus the flexibility of the related data treatment, as shown in [89] and [90]. The production costs of chip-based tags are mostly associated with the heterogeneous integration of the silicon chip with the antenna [85], [91], the latter being manufactured typically on a flexible substrate or a textile substrate [92]–[97].

In order to reduce the aforementioned costs and to save as much energy as possible, solutions requiring minimum amount of electronics must be pursued. For this purpose, the chipless tag family was introduced and applied to wireless sensing in the recent years [98]–[103]. It is worth recalling here that the introduced buzzword "chipless" stands for a family of tags that are actually able to implement their functionalities by using only a few lumped components and passive distributed elements, without requiring any electronic integrated circuit (IC), the chip indeed, to be mounted.

The standard chipless tags (i.e., only coding and no sensing) exploit, basically, two mechanisms, namely, time-domain and frequency-domain scattering [64]. In the first case, the elapsed time between multiple reflections is used for coding. These reflections are obtained, at tag level, by connecting the antenna to a transmission line structure with several discontinuities. In the second case, instead, the tag has a specific frequency signature that is decoded at the reader level; to implement such a behavior, a coded series of resonators is realized on the tag antenna in order to reflect or not the corresponding frequency. Both approaches (time and frequency domain) lead to tag circuits that are not necessarily easy to miniaturize; nevertheless, it is worth noting that they are compliant with the LAE paradigm.

When dynamic sensor information has to be added to the static identification, we talk about chipless RFID sensor tags; these exploit an antenna, the electrical properties of which are controlled by the change of the physical parameter to be detected. There are, mostly, two proposed approaches for this. The first one is to induce a permanent change in the antenna property when a certain critical threshold (acceleration, temperature, fluid level, etc.) is exceeded [104]; this is useful for alarm type operations. The second one exploits a sensing load, i.e., a load the impedance of which is controlled by the sensed variable, connected to an antenna [105]. In both cases, the whole wireless sensor system (tag and reader) needs to have absolute accuracy, thus limiting the system performance with respect to both distance and fabrication tolerances.

A different method has been recently introduced in [106]. In this paper, a novel sensing principle is associated to the generation of an intermodulation signal from a tag, the latter being illuminated by two waves at different frequencies. The advantage of this idea is that the tag response is generated at a known frequency, thus the presence or the absence of such a signal can hardly be misinterpreted. Similar techniques have been used in harmonic radar systems [107] and in one-bit frequency doubling tags [108].

In line with the above ideas, a novel and completely original approach was proposed in [20] and [109] to solve the issue of absolute accuracy of the most of the passive chipless RFID sensors. The chipless tag described in [109] is based on the harmonic radar concept [110], [111], i.e., on a tag that, being illuminated by a carrier at frequency f_0, is capable of generating the second harmonic $2f_0$.

A simplified block diagram of the tag is illustrated in Fig. 12. For this purpose, the sensor information is encoded as the phase difference between two signals, one acting as the reference signal for the other one. First, the tag receives a carrier at frequency f_0. Then, two equal signals at frequency $2f_0$ are generated by means of a diode-based frequency doubler and a power divider. At this point, one of the two signals is phase-shifted using a passive sensing element. Finally, the $2f_0$ signals are reirradiated by

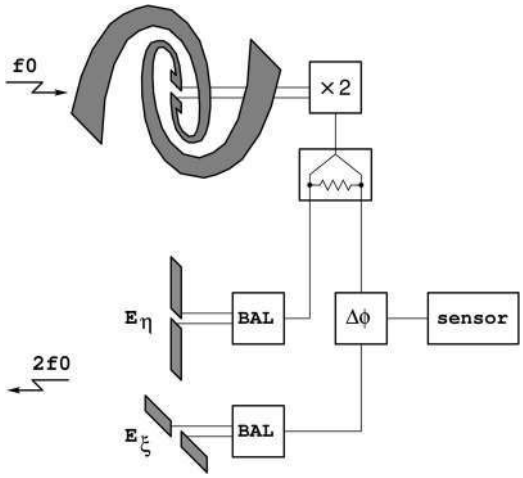

Fig. 12. ***Simplified block diagram of a harmonic chipless tag with sensing capabilities. After [109].***

exploiting two orthogonally polarized antennas. With this approach, the sensor information can be extracted by a suitable reader equipped with two complex (I/Q) receivers.

It must be observed that chipless tags, due to their inherent simplicity and extremely low number of lumped components, are easily realizable on flexible substrates by means of metal laminate [29], [30] and inkjet printing technologies. In particular, antennas [112], diodes [113], and passive sensing elements [114]–[117], i.e., all the main tag components, have already been experimented in cellulose-based materials. This will soon make SSs, equipped with sensing chipless tags, feasible at affordable prices.

VI. QUASI-OPTICS

"Quasi-optics concerns the propagation of EM radiation when the size of the wavelength is comparable to the size of the optical components (e.g., lenses, mirrors, and apertures) and hence diffraction effects become significant" [118].

In optics, operations are usually performed by using lenses. At EM frequencies, by following the quasi-optics analogy, lenses become large arrays, several wavelengths in size, of unconnected elements, each of them being able to get part of the signal incident on the array (usually focused by using a Gaussian beam), to carry out an operation and to irradiate the modified signal. The sum of the radiated signals modified by the array elements ends up in a radiated beacon elaborated with respect to the incident one [118]–[120]. From a historical point of view, quasi-optics was first introduced experimentally by Heinrich Hertz in the late 1880s [120] when he demonstrated the possibility of collimating EM signals on a multiwavelength surface by using cylindrical reflectors and studying effects that, until that time, were observed only at infrared and visible EM spectrum.

After more than 70 years, owing to the increasing demand for bandwidth and to the development of optical wavelength systems, quasi-optics experienced its palingenesis at the millimeter and submillimeter wavelengths.

We can classify the quasi-optical components into three main categories: frequency independent, frequency selective, and active devices. Frequency-independent surfaces include: delay lines, polarizing grids, hybrid junctions [121], attenuators [122], power dividers [123] and combiners [124], nonreciprocal devices [125], [126], absorbers, and calibration loads. Frequency-selective surfaces [127]–[129] include: inductive grids, capacitive grids, resonant grids, thick structures (perforated plates), and interferometers. Active devices include: oscillators [129], [130], amplifiers [131], [132], mixers [133], [134], phase shifters [135], [136], multipliers [108], [137]–[139], and switches [140]. This approach has been used so far mainly at millimeter and submillimeter frequencies because, being the size of the apparatuses proportional to the wavelength of the radiated wave, lower frequencies would have been prohibitive due to the very large size required. With the present development of technologies for LAE, however, quasi-optics has become a feasible approach even at RF and microwave bands, where large arrays of operational elements can be conceived.

Inheriting the quasi-optical approach, contact-less EM wave processing (filtering, frequency conversion, selective shielding, etc.) can be implemented even at low frequencies (in the order of megahertz). Two pioneer examples are switches [140] and the cross-dipole frequency doubler, proposed in [108], and implemented in [141], where, among various operating principles, the generation of harmonics is chosen to demonstrate the feasibility of such a component at microwave frequencies.

The layout of the proposed quasi-optical frequency doubler is shown in Fig. 13. The structure is inkjet printed on a cellulose-based substrate (a piece of photografic paper from Kodak). It consists of two crossed $\lambda/2$ dipoles. The longest dipole receives the incoming power at the fundamental frequency $f_0 = 3.5$ GHz, while the shortest one transmits the generated power at the doubled frequency $2f_0$ in an orthogonally polarized orientation. The length of the dipole operating at f_0 is 32 mm, while the $2f_0$ dipole is 16 mm long. The width of the tracks used to implement the dipoles is about 2 mm. The multiplication is provided by four diodes in a bridge configuration, thus forming a fully balanced multiplier unit.

Due to the omnidirectional nature of the dipole antenna, the harmonic signal is irradiated with the same intensity in the azimuthal plane (small differences are due to both the dielectric substrate and the planar nature of the dipole conductors). This means that the harmonic signal is reflected toward the reader and the transmitter toward other directions at the same time. A measurement of the received power at $2f_0 = 7$ GHz is reported in Fig. 13(b). Here the interrogation distance is 10 cm and the

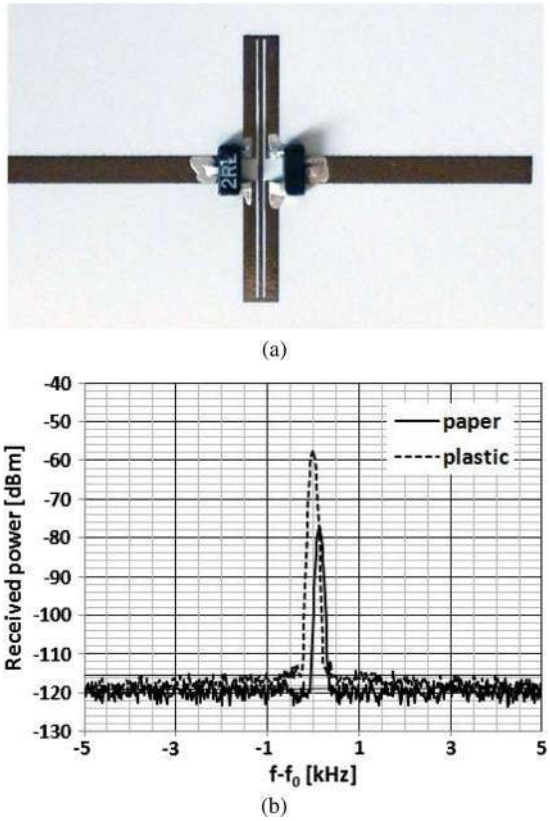

Fig. 13. ***Cellulose-based prototype of the (a) crossed-dipole frequency doubling tag and (b) measured second-harmonic response. The measurements have been carried out interrogating the tag at $f_0 = 3.5$ GHz and receiving the $2f_0 = 7$ GHz frequency component. The interrogation distance is 10 cm, and the transmitted power is equal to 20 dBm. The transmitter is equipped with a two-element Yagi antenna at f_0, while the receiver uses a helix antenna at $2f_0$. The fundamental frequency dipole is 32 mm long. After [141].***

transmitted power is equal to 20 dBm. The transmitter (reader side) is equipped with a two-element Yagi antenna at f_0, while the receiver (reader side) uses a helix antenna at $2f_0$. In these conditions, the power received from the cellulose-based (paper) tag prototype at $2f_0$ is about −80 dBm. The same structure implemented on a plastic substrate produces more power, mainly because of a better frequency tuning. An improved efficiency could be achieved by: 1) adopting a frequency multiplier with better harmonic terminations; and 2) using directive antennas in order to address the power only toward the reader.

In the frame of the IoT, the crossed-dipole tag is a very simple one-bit tag that can alarm a system when it is placed within the range of the reader. However, with very simple modifications, this idea can be used to implement a variety of on/off sensors (the paper substrate can be easily torn when a certain mechanical strain is exceeded).

The crossed-dipole structure can also be used as a building block to form arrays, an example being shown in Fig. 14. These arrays are mainly intended for LAE applications where a complete surface can be interrogated and answered by generating a harmonic signal. The fabricated prototype uses a Rogers substrate, thus it is not flexible. However, adopting a cellulose-based substrate, a flexible structure can be built. The bending capability of cellulose-based circuits is quite good and only limited by the discrete components mounted on them.

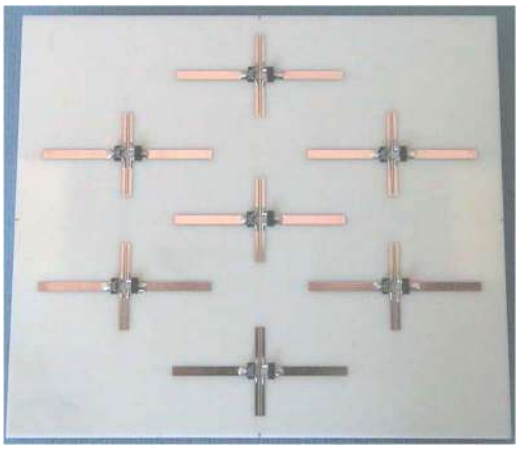

Fig. 14. ***Example of quasi-optical frequency doubler based on an array of crossed dipoles. This structure is implemented on a Rogers substrate, but this can be substituted with a cellulose-based material to reduce costs and obtain mechanical flexibility.***

The second example consists of a paper-based contactless frequency doubler for harmonic RFID applications [142]. The doubler, realized on paper substrate, generates the harmonic signal by means of a single Schottky diode. The system operates at 7.5 and 15 MHz, and these frequencies are chosen, without lack of generality, to accomplish the realization of a fully organic frequency doubler exploiting paper printed coils and organic diode (pentacene-based), the present frequency limit of which is around 15 MHz [143]. Fig. 15 shows a picture of the organic tag, while Fig. 16 shows the doubling efficiency of the organic tag versus transmitting/receiving (TX/RX) distance, assuming TX power as a parameter (for the sake of completeness, it is worth noting that TX and RX antennas of the reader are equal to the RX and TX antennas of the tag, respectively).

As a final remark, it is worth noting that, to the authors' knowledge, only planar developments of quasi-optical arrays have been proposed so far; reasonably, combining quasi-optics with LAE related technologies can lead, in the near future, to new SS solutions only in a limited planar extent.

VII. SMART FLOOR

The new concept of smart cities is generating a group of new scenarios that will impose a new way people interact with the environment. This immersion brings the IoT to a new level of relationship with people and environment,

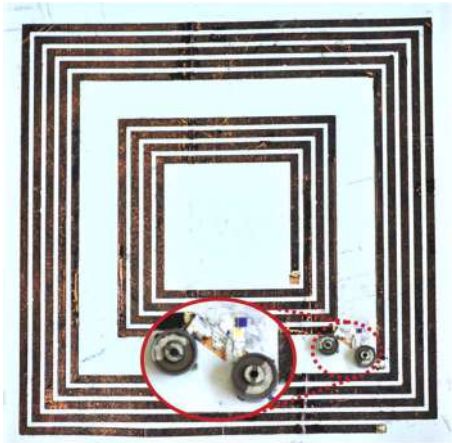

Fig. 15. ***Fully organic tag prototype of the frequency doubling tag operating at 7.5–15 MHz. After [142].***

where the scenario around is aware of people's needs and can interact with their way of living.

This new concept brings IoT to areas that cover broad topics, including transportation, energy distribution, data communications, and all technologies in a sense that they will become transparent to the normal users and citizens.

The growth of smart cities will significantly increase the quality of life, the reduction of energy waste, and the availability of information by using ICT. All these developments have, as a motivation, the overall inclusion of people into the city in a way that ICT should become completely embedded into our surroundings.

These new concepts are viable only if the smart environments are enabled by IoT. IoT is actually taking shape and is growing everyday through the number of devices that get connected to each other.

Nevertheless, most of these devices that team up with each other to build up the IoT world are powered by some kind of power sources. This is actually the main limitation of present IoT solutions. In order to be able to create real IoT environments, RFID, wireless power transfer (WPT), and EH devices appear as a major enabling technology for the IoT, due to their inherent simplicity and ability to provide sensing to remote objects without the need for constant powering.

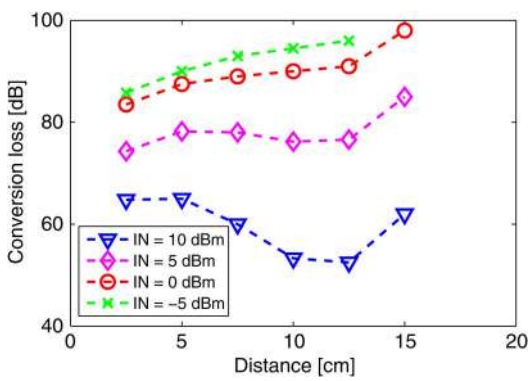

Fig. 16. ***Conversion (doubling) loss of the reader tag harmonic RFID system as a function of the reader tag distance, assuming the output reader power as a parameter. After [142].***

In this scenario, the concept of a smart floor becomes real. Smart floors should be capable of interacting with the environment seamlessly and be aware of persons and objects on top of them.

The focus of this section is going to be smart floors as an information system, where RFID capabilities are used to provide an identification and information source embedded into the floor. This massive RFID immersion will allow to create low-power high accuracy location, navigation, and, generally speaking, an information system that can team up with passers in a noninvasive way.

In this approach, the system uses passive RFID tags that are spread beneath a flooring in order to create a map that can be read with a mobile unit that might be self-powered through energy harvested from the movements of the subject to be located [144], [145].

This new location system based on smart floors can actually be extremely competitive when compared with existing solutions; among them, we can take into consideration those based on image processing [146]; they provide a high level of information at the price of high cost, power consumption, and intrusiveness. Another approach is based on pressure sensors [146], [147], providing actually a different type of smart floors; pressure sensors are nonintrusive and can be less expensive in terms of equipment when compared to the imaging systems; however, they can still be quite expensive to install into the floors; moreover, they do not allow for seamless identification of an individual in a given space. Eventually, ultrasounds [148] and RF localization system detection [149] have to be listed; although very flexible, they require dedicated communication infrastructures, additional complexity and costs, and they are mostly sensitive to environmental changes, both in terms of accuracy and functionalities.

The just mentioned smart-floor-based system tackles most of these challenges as it is very low cost, able to have a good, and precisely predictable, accuracy, and able to detect different users in a given space.

A. RFID-Based Smart Floor Including Material Aspects

Smart environments and floors should be completely seamless to the users. This entails the need to embed electronic devices into the environment in a noninvasive way. Nevertheless, this embedding of electronic devices, mainly wireless transceivers into the floor, is not a simple matter. Floors, in fact, have been made by almost the same kind of materials for centuries; tile industries are weakly available to introduce new materials to match

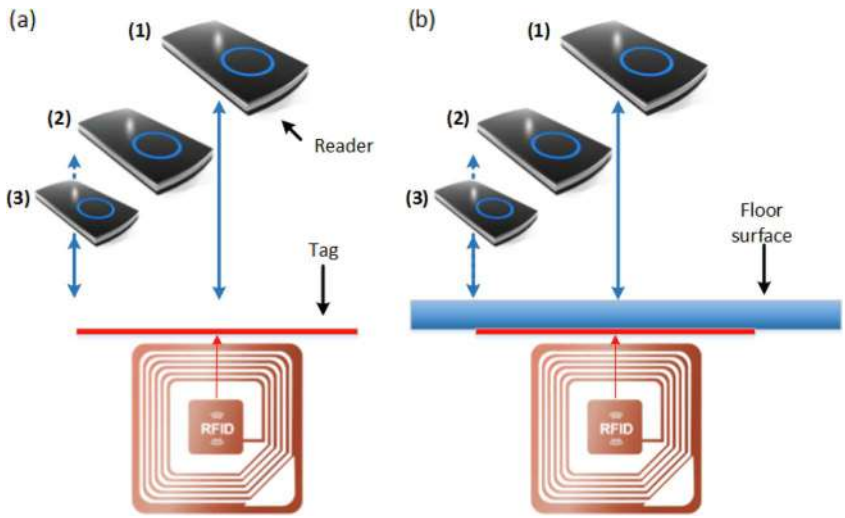

Fig. 17. ***Readable distance test scheme (a) without and (b) with tile. After [144].***

requirements posed by embedded electronics. Similar considerations can be made about the consolidated techniques to build apartments and houses: they are quite mature and whatever adaptation of them to embedded electronic systems is unrealistic. The consequence of this is that constitutive elements of SSs embedded into the floors must be suitable to materials and technologies already present: materials available are those adopted for tiles and SSs must be adapted to building constraints.

In this section, we focus on the most important approaches for the characterization of the EM properties of the materials, commonly adopted in floors, and their interactions with our electronic radio systems. As an example, ceramic tiles are going to be selected as the floor element where electronic tags have to be embedded.

Ceramic tiles have been used for ages to pave floors. These make up a great deal of most floor types in public buildings, from airports to banks, therefore, they are the most interesting flooring elements to investigate.

As the first approach, the study of the influence of some materials for floor surfaces, such as ceramic, cork laminates, and wood, in the communication between the transmitter and receiver devices has to be made; in this case, low-frequency (13 MHz) inductors are going to be used as the wireless interface.

In order to do the measurements, traditional RFIDs are used, which simplify the measurement approach significantly. A test setup is shown in Fig. 17, and experimental results are summarized in Table 3. What can be seen from the results presented in the table is that none of the tested materials affect the electrical characteristics of the RFID propagation significantly.

Another approach to the measurement is to evaluate the impact of the presence of metal inclusions beneath the ground; these can appear from pipes or from buildings supporting structures. In order to test this scenario, the presence of a metal sheet close to the coil was tested to verify its impact on the RFID reading distance. The test setup is presented in Fig. 18. In this case, when the reader is aligned (1) with the center of the coil beneath the tile, a minimum distance of 10 mm between the metallic sheet and the tag must be guaranteed in order to allow for the proper reading of the tag. In the other approach, the edge aligned scenario (2), the minimum distance between the metallic sheet and the tag increases to 30 mm to allow for communication.

Table 3 Results From Average Readable Distance Test

Tile type	Aligned (1)	Edge aligned (2)	Unaligned (3)
Without tile	4.5 cm	4.3 cm	2.4cm
Ceramic tile 4 mm thick	4.5 cm	4.3 cm	2.4cm
Ceramic tile 6 mm thick	4.5 cm	4.3 cm	2.4cm
Ceramic tile 7 mm thick	4.5 cm	4.3 cm	2.4cm
Cork laminate 5 mm thick	4.5 cm	4.3 cm	2.2cm
Wooden floor 8 mm thick	4.3 cm	4.2 cm	2.2cm

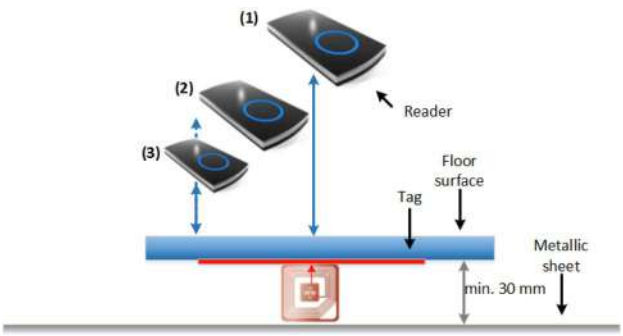

Fig. 18. ***Readable distance test scheme with metallic sheet presence. After [144].***

This test allows us to conclude that, in a real scenario, when considering the typical distance from the antenna to the floor, where the reader is usually embedded into a mobile device, a minimum distance from the tile to any metal inclusions in the ground has to be guaranteed. As seen, this safe distance should be at least 30 mm.

B. Navigation Approach Based on Smart Floors

A meaningful example of the applications of the smart floor concept is the demonstrator developed at the University of Aveiro, Aveiro, Portugal. It allows a nomadic RFID reader on top of it to be identified and localized by means of a smart floor.

The prototype in the present state is composed of four main components: a set of tagged tiles forming the smart floor, the nomadic reader, a wireless communication device to connect the reader to the information system, and a computer on which the location and navigation software is installed. A potential scenario of application for the monitoring of elderly housing is shown in Fig. 19. In the demonstrator presented, the RFID reader is connected to the radio unit and inserted into the user's shoes in order to read the passive tags as the user walks around a given area. The tile IDs are detected by the reader and sent to a centralized information system using, without lack of generality, a nonstandard wireless communication system, purposely developed in the laboratory.

Fig. 19. ***Example of smart floor application scenario.***

The software in the computer then decodes the ID of the smart tile, and correlates it with a preloaded referenced map, thus being able to provide the precise position of the walker in the environment.

The location can be subsequently translated to a navigation system, and combined with artificial intelligence to allow navigation, situation awareness, etc.

Plenty of applications and related solutions can be envisioned on the basis of this smart floor approach: robot control, automatic pallet managements, prevention in harsh environments, and so forth.

VIII. SMART SHOES AND BAN

The aforementioned smart floor (Section VII), initially proposed to localize moving subjects in a given area, actually allows for the implementation of a very low-cost, accurate, and reliable system able to provide each kind of detectable information from an equipped area to the Internet.

To exploit the potentiality of a smart floor, it is obvious that developing purposely conceived communication units acting, on the one hand, as readers for tag tiles and, on the other hand, as communication systems with the web is needed.

One of the investigated systems for this is the so-called smart shoe [21]. Smart shoes are intended as shoes incorporating a reader able to illuminate the tag embedded into the tile and a wireless interface to communicate data to the web. To this extent, smart shoes can be seen as hubs of BANs able, on the one hand, to get information from the surrounding environment (body included) and, on the other hand, to communicate the collected information to the Internet. According to common buzzwords, they can be seen as the second technological layer, just above the first physical one consisting of tagged objects, in a hierarchical picture of IoT. Alternatively, they provide the cloud of nomadic readers with networking capabilities required for the implementation of the so-called networked RFID (N–RFID) [150] strategies. In the referred structure [21], the necessary antenna system is inkjet printed on paper, thus exploiting the process described in Section II, and it is a trademark-logo-shaped dual-band antenna working at 900 MHz and 2.4 GHz. A block diagram and its equivalent realization are shown in Fig. 20: it is worth noting that the reader itself works at 13.5 MHz exploiting the near-field communication (NFC) concept, according to what is stated in the smart floor section; as a consequence, there are no issues about the interference between the dual-band antenna and the NFC reader. Moreover, an approach similar to [145] is proposed to power the reader: the idea here is as well to harvest the energy produced by the human walking by means of piezoelectric materials embedded into the sole of the shoe.

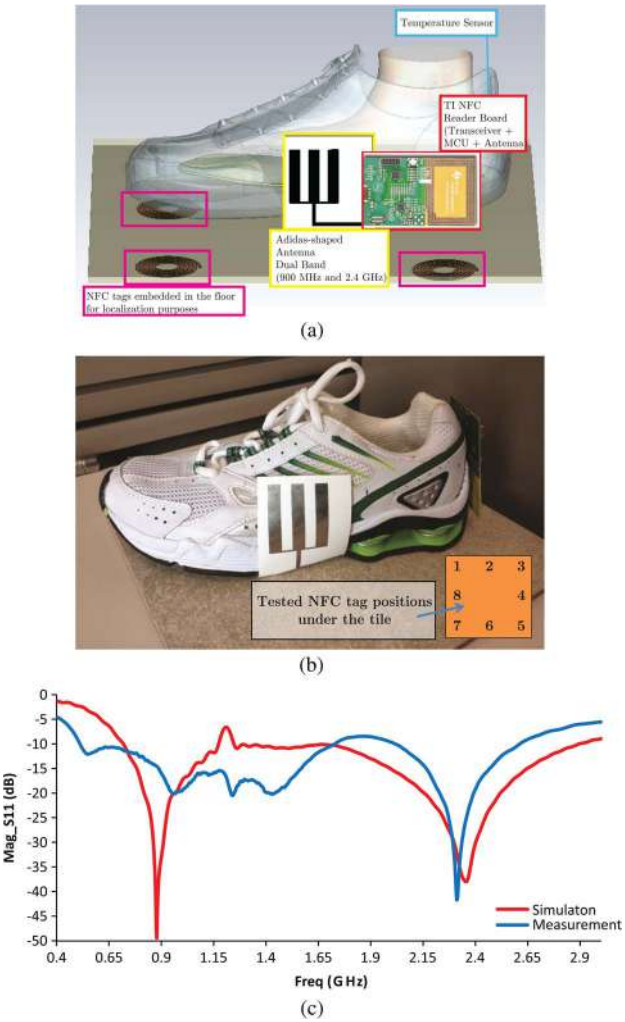

Fig. 20. ***(a) Block diagram, (b) photo, and (c) dual-band antenna results of the smart shoe that works as an energy autonomous reader for smart floors able to collect the localization data from the smart tiles and send them to a centralized system. After [21].***

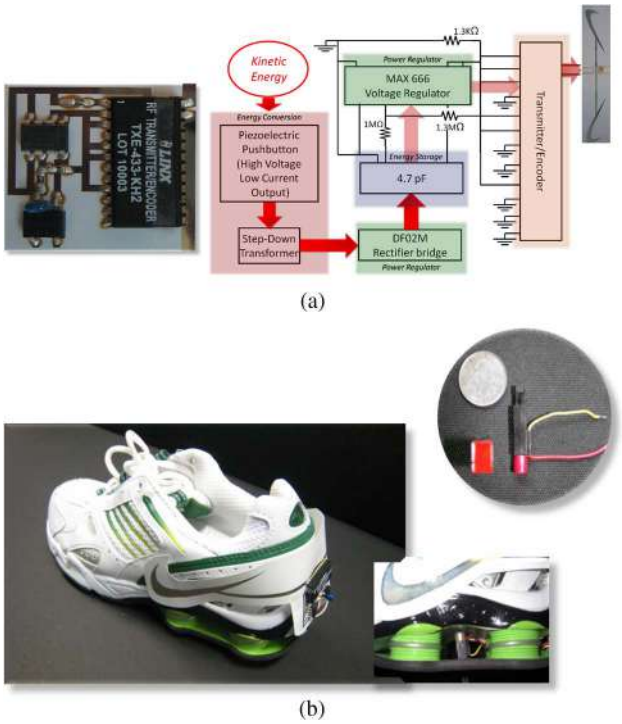

Fig. 21. ***(a) Mounted electronics on shoe with piezoelectric energy harvester and block diagram of the transmitting tag, driven by the EH unit. (b) Photograph of the assembled prototype showing the key components packaged on an organic flexible substrate. After [145].***

Fig. 21(a) shows the shoe with the mounted electronics consisting of a trademark-logo antenna inkjet printed on a flexible paper substrate together with the circuits in which the components [Fig. 21(b)] are fixed by conductive epoxy glue. A piezoelectric push button was embedded in the shoe to scavenge energy from human walking strike. This energy is then collected by a simple electronic circuit based on off-the-shelf components and used to supply the RFID transmitter. As reported in [145], the system is composed by the power-generator/energy-conversion device, the energy storage device, the power regulator circuit, and the RF transmitter that can broadcast the tag ID and the stored information.

When the push button is pressed, an inner spring is compressed and when the pressure exceeds a fixed threshold, the spring-loaded hammer will be released to deliver the dynamic mechanical force to the piezoelectric component; once the hammer strikes the piezoelectric element, a pressure wave is generated and reflected a few times between the hammer and the element, creating a mechanical resonance [151]. As a result, the generated output voltage follows closely an alternating current (ac) signal course. The signal out of the piezoelectric element is characterized by high voltage and low current; therefore, since this RF circuitry requires lower voltages at higher currents, a step-down transformer is used for better impedance matching to the following circuitry.

An energy storage device is adopted to collect the electrical energy and to provide it to the transmitter even when the external power source is temporarily unavailable; in fact, the RF transmitter takes tens of milliseconds to transmit one complete word, while the piezoelectric push button harvests energy in a transient time. To store the collected energy, a 4.7-μF tank capacitor was chosen. An ac–dc full wave diode bridge rectifier is used to convert the ac voltage from a piezoelectric element into a dc source and a dc linear regulator is added to adapt the dc voltage across the capacitor to 3-V transmitter operating voltage. For this purpose, a MAX666 low-dropout linear regulator, providing a stable 3-V supply until the tank capacitor charge is drained below the reference level of the dc linear regulator itself, is chosen. The transmitter used, the LINX

Table 4 Shoe Energy Performance Summary

Energy provided by the pushbutton	stored in the capacitor	848.4 μJ
Utilized energy	below 2.7 V capacitor voltage, the active RFID tag stops transmitting	17.1 μJ
Available energy	848.4 μJ − 17.1 μJ	831.3 μJ
Energy required by the circuit for a one-word transmission	Power Needed for 50 ms operation: 9 mW	450 μJ

TXE-433-KH2 [152], is able to combine a highly optimized RF transmitter with an onboard encoder.

The maximum voltage across the capacitor is 19 V; therefore, the energy stored in the capacitor can be calculated to be close to 850 μJ. After the strike, the regulator becomes active, providing power to the tag circuitry; its 3-V output remains constant before it starts to drop to zero according to the capacitor discharge rate. When the voltage across the capacitor drops below 2.7 V, the active tag stops transmitting. The resulting energy left in the capacitor and not used is about 17 μJ. The required time for successful completion has been measured to be close to 50 ms; the total circuit energy consumption for a 50-ms transmission is then approximately 9 mW (Section IV). Consequently, the energy required for a one word transmission is approximately 450 μJ, much less than the power collected by the energy conversion and regulation unit. The energy performance of the smart shoe is summarized in Table 4.

"Smart" solutions like smart shoes are suitable for smart floor interaction and for collecting information (position included) from them. The smart shoe has actually a double functionality: on the one hand, it is a means to collect information from the environment (smart floor included) and from the on-body sensors and apparatuses; on the other hand, it transfers data to the Internet, via WiFi, for instance, while likely receiving control and feedback signals. To this extent, it contributes to the development of wearable electronics for body-centric communication systems, according to the scheme of Fig. 22. This class of devices is based on the BAN concept (see Fig. 22): a network of wearable computational units, sensors, energy harvesters, and transceivers networked and implemented around the human body. The information is acquired by means of several sensors and, after processing and digital modulation, is transmitted by means of off-body transceivers. The most attractive application of BANs and wearable systems, so far, is probably health monitoring [88], but the number of foreseeable applications is constantly increasing (personal fitness monitoring, personal audio system, personal alarm set, and so on). Today, a big contribution to the BANs is being given by the interaction with portable devices such as smartphones which can be exploited as gateways.

Low-power ICs, sensors, and wireless communications are key elements of the BANs, and the use of EH techniques and mixed technologies such as RFID, as in the above described smart shoe, can contribute to the development of autonomous BANs. According to the notation adopted in [74] and [153], BANs can exploit wireless communication not only for off-body communications with other systems, but also for on-body and in-body communications to interconnect networked devices [wireless body area networks (WBANs)]. Generally, the proposed WBAN solutions are based on existing communication standards; but, recently, the IEEE 802.15.6 working group has provided a standard for short-range, wireless communications in the vicinity of, or inside, a human body based on ISM bands for BANs [154]. In this rapidly evolving scenario, smart shoes can be seen, in turn, as a promising mean to interface information coming from smart floors to the BANs and ultimately to the Internet, directly or via portable devices.

IX. ENERGY SKIN

Within SSs, another area is emerging, which requires dc energy. The availability of devices that can actually increase the battery life of our electronic gadgets [155] is the holy grail of IoT; the idea is actually to convert energy from

Fig. 22. ***BAN integrated with IoT: the data sensed on the human body and collected by smart devices are sent to the Internet through the standard protocols like third generation/fourth generation (3G/4G) and WiFi.***

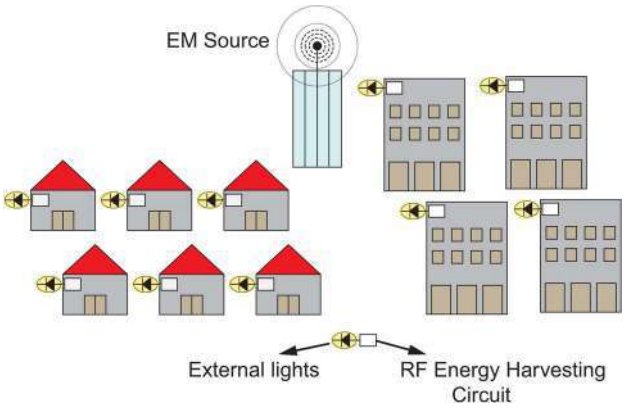

Fig. 23. ***EM source, likely supplied by solar energy in order to keep eco-friendliness, is used to broadcast energy to the urban neighborhood where houses are equipped with local RF–dc converters able to power supply local devices (external lamps in the example).***

different sources, as solar to dc [156], EM radio signals to dc, thermal to dc [156], vibration to dc [157], etc. [158].

Portable converters from solar to dc are today commonly available on the market at very low prize. Similar portable scavengers can be easily envisioned even for other energy converters. On this basis, plenty of sophisticated and more complex solutions are being proposed. Just as an example, we report the solution in Fig. 23, where the solar energy is used to supply an EM source that broadcasts RF energy in the surrounding urban environment; this energy is converted to dc energy at building level and, in turn, exploited to supply external local lamps. This approach was conceived for space applications [159], [160], but could be used in certain conditions in earth stations as well. The concept can actually move forward and be integrated into a smart skin, in the sense that all devices could be powered up by the skin energy conversion that a person can carry (vibrational, thermal, RF, etc.). This will become possible by integrating paper and textile radio electronic circuits in the smart skin surfaces of our clothes.

X. CONCLUSION

This paper focused on smart surfaces concept. This concept was introduced as a way to provide solutions to societal instances by means of technologies and techniques that today are gaining great momentum thanks to IoT development. The foreseeable IoT evolution, in fact, calls for systems and subsystems that are more and more energy conservative, fully autonomous (battery-less and not connected to the grid), as recyclable as possible (ultimately 100% biodegradable), flexible, and extremely low cost to be embedded in as many objects as possible. In order to meet these expectations, several technologies have to be implemented concurrently. This paper illustrates some of them, namely, recyclable and reliable materials, printing and R2R compatible techniques, conformal antennas on unconventional materials, and chipless RFID.

Subsequently, it has been shown how these technologies enable a fairly new branch of IoT development, represented just by SSs.

SSs are in their infancy; nevertheless, some examples, enabled by the aforementioned technologies, can be cited. Among them, the way to inherit "quasi-optics" and extend them to RF frequencies even below gigahertz is shown, and the smart floor implementation as a means to provide precise localization as well as assisted paths platforms has been reported. Energy skin as a means to convert several energy sources (solar, thermal, vibrational, EM, etc.) in electric one is described as well.

The reported examples must be researched as a new paradigm for potential promising developments aiming at providing new LAE solutions for the future networked society. ■

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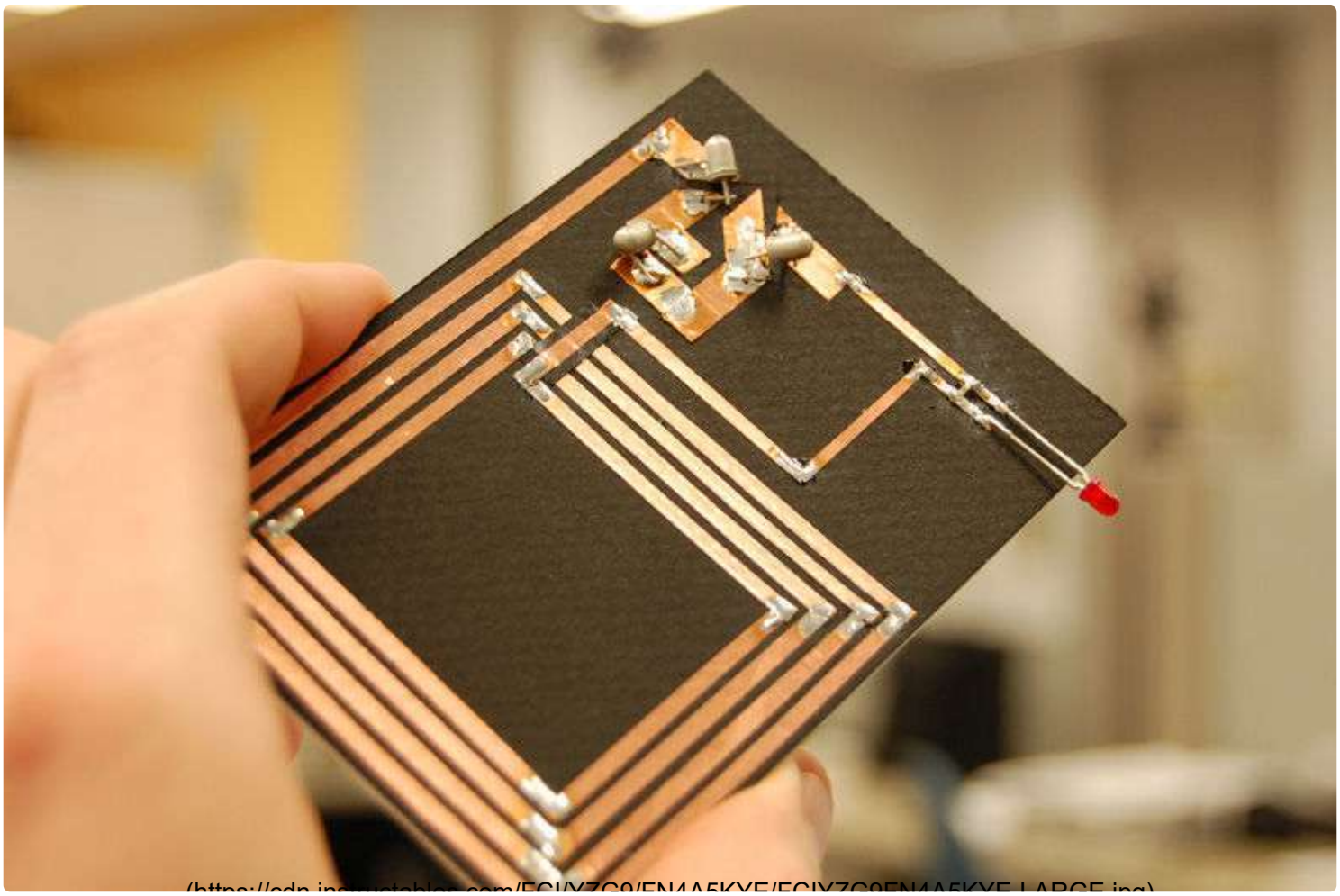

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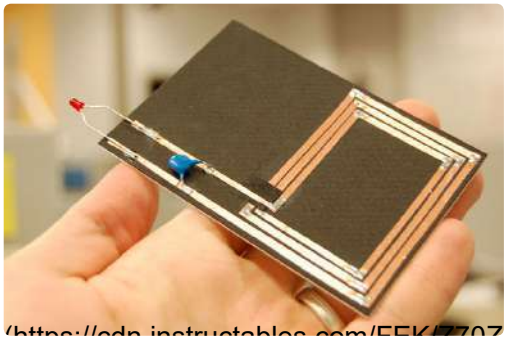

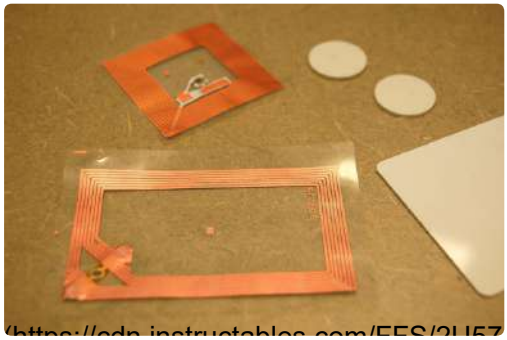

The 'rub' (http://www.usingenglish.com/reference/idioms/there%27s+the+rub.html)
Want to detect the presence of RFID readers? Want to control when a RFID tag is active or readable? We describe how to do both using bits of copper and card, and some readily available electronics hardware.

Longer preamble
Radio frequency identification (RFID (http://en.wikipedia.org/wiki/RFID)) is rapidly growing in popularity. RFID *tags* are found everywhere. They're attached to container freight, in those funny-looking white labels you find in newly purchased books, embedded in many corporate ID cards and passports, etc. The tags have a few common properties: they transmit a unique ID number, are optimized to be 'read' from predefined distances, and are usually small so they can remain unobtrusive or hidden.

RFID *readers* are used to track nearby tags by wirelessly reading a tag's unique ID (see Figure 4); a tag simply has to be brought into physical proximity with a reader to be read. Readers are mostly used for industrial or commercial purposes, e.g. asset tracking or electronic payment. Wal-mart use RFID tags and readers in their supply chain. The technology is also used in mass transit systems in cities like London (http://en.wikipedia.org/wiki/Oyster_card) and Hong Kong (http://en.wikipedia.org/wiki/Octopus_card). In Japan, many mobile phones incorporate readers to enable e-money payments in shops and vending machines.

For those of us who want to experiment with RFID, the problem is that the technology is almost always black boxed (http://en.wikipedia.org/wiki/Black_box).

That is, the inner workings of a tag and its interaction with a reader is hidden from view, and thus difficult to have much control over.

In the two exercises that follow (building a RFID reader detector (https://www.instructables.com/id/SX28QZ1FN4H8QCG/) and a tilt-sensitive RFID tag (https://www.instructables.com/id/SGW3J0SFN49WUIF/)), we offer an example of how you can start revealing some of the workings of RFID and thus gain some control over the technology. The two exercises also hopefully show that the technology is relatively simple and how it can be extended to support some interesting interactions. We offer some other possibilities that build on our examples at the end (https://www.instructables.com/id/SQKIRD4FN49ZUS1/).

Add Tip Ask Question

Step 1: Material and Tools

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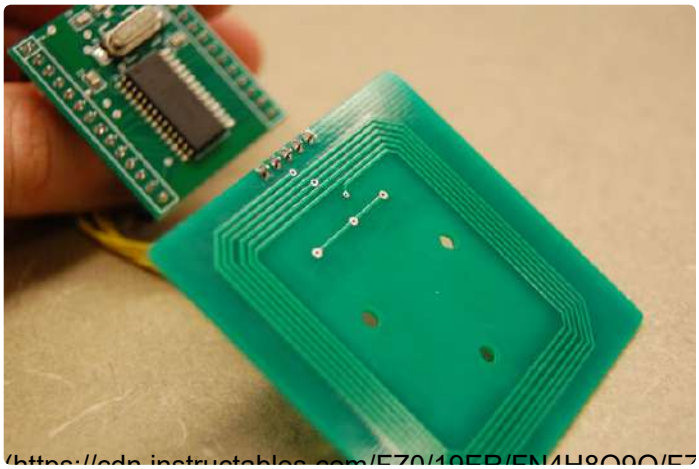
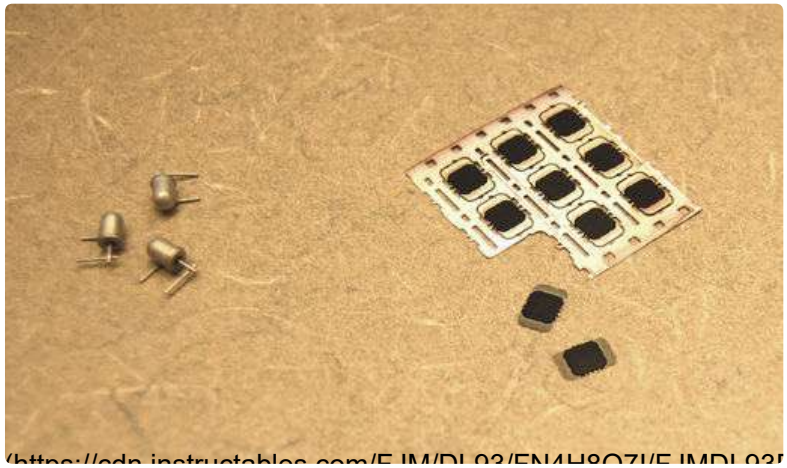

This section provides an overview of the necessary materials and tools.

Materials (see Figure 1):
We need the following material to built the basic RFID reader detector.
- Cardboard (around 100x70 mm)
- Conductive copper tape (e.g., order number 1218478 at www.farnell.com)
- Capacitor 82 pF (picofarad) (e.g., order number 1138852 at www.farnell.com)
- Low current LED (light-emitting diode) (e.g., order number 1003207at www.farnell.com)

Tools (see Figure 2 and 3):
- Craft knife and scissors
- Insulating tape (e.g., order number 1373979 at www.farnell.com)
- Soldering iron and solder

RFID reader for testing (see Figure 4):
To test our RFID tags we need an RFID reader that can operate at a frequency of 13.56 MHz.
There many readers for this widely used RFID standard, for instance the Sonmicro MIFARE USB reader (http://www.sonmicro.com/).
Note: The Phidget RFID reader does *not* work with the tags created in this project, as it uses a different frequency for communication with the tags (125 kHz).

Advanced material (see Figure 5):
The following material is necessary to build the second part of the project: the tilt-sensitive RFID tag.
- Micro tilt switches (e.g., www.digikey.com)
- RFID ICs (e.g., MIFARE Standard 1k, part no. 568-2219-1-ND at www.digikey.com)

Add Tip Ask Question

Step 2: Building the RFID Antenna

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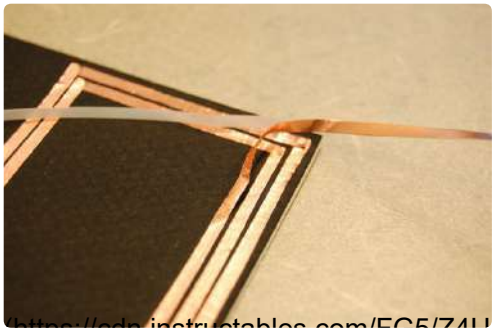
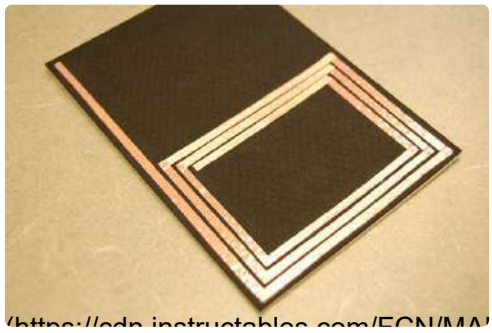
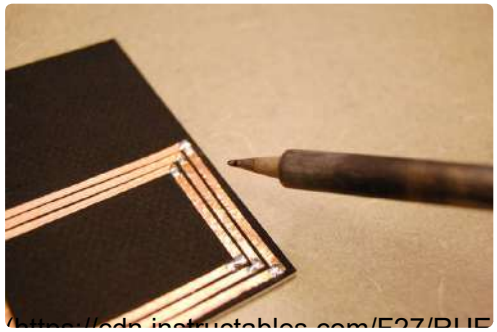

This step describes how to build the antenna for the RFID tag.

Building the RFID tag antenna

To build the tag's antenna follow these three steps.

1. Cut the conductive copper tape into thin stripes of around 2mm (see Figure 1).
2. Tape these stripes (see Figure 2) in loops around one half of the cardboard (see Figure 3 for the layout of the antenna). The tag should have between 3-4 loops for the antenna.
3. Solder all the connections between the copper tape. Sometimes, this isn't necessary as the tape's adhesive backing is conductive, but solder the connections if you want to be on the safe side.

Now we have created our RFID tag antenna, and we will add the "RFID reader detection" functionality in the following step.

A little background

RFID readers transmit an electromagnetic (EM) field with their reader antenna. This EM field induces a current in the antenna for all RFID tags within reading distance. This induced current activates the RFID chip that is connected to the tag's antenna. This chip then modulates a response (usually the unique ID number) that is transmitted back to the reader. The antenna of an RFID tag is usually a thin copper wire that is arranged in loops. The loops allow the emitted EM field of the RFID reader to induce current to the antenna of the tag.

Add Tip | Ask Question

Step 3: RFID Reader Detection

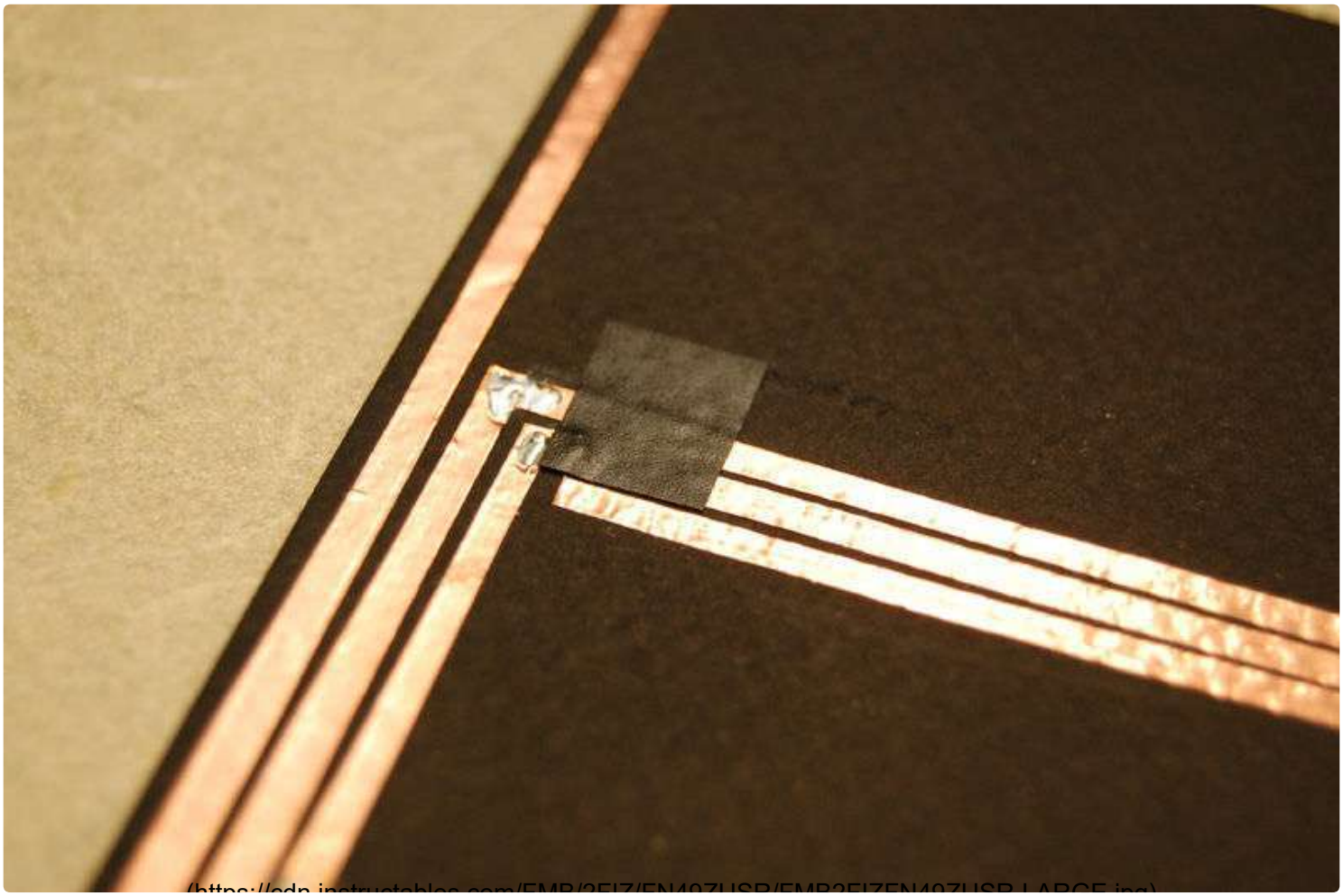

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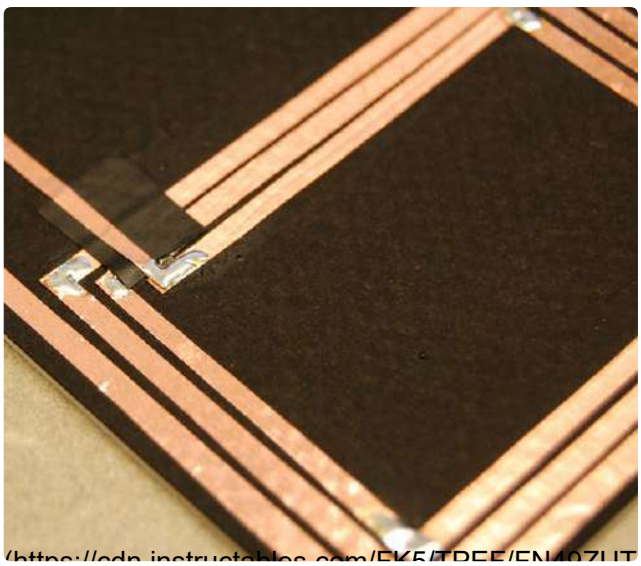

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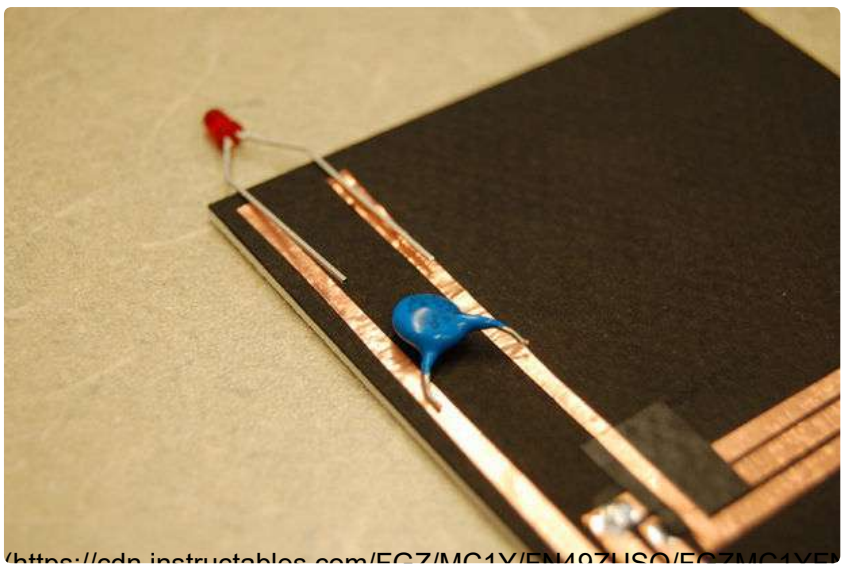

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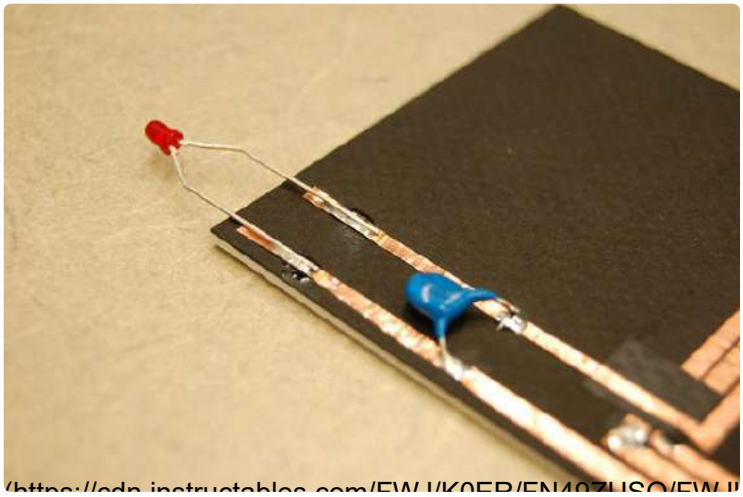

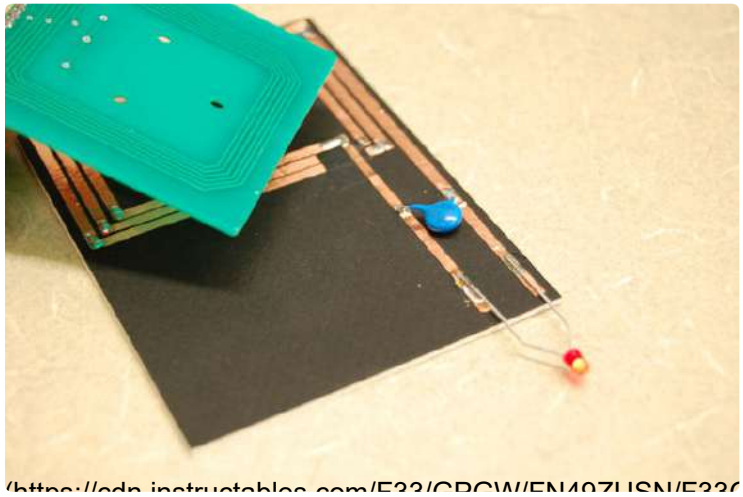

This step describes how to add a simple mechanism to the RFID tag antenna that allows us detect nearby RFID readers.

Antenna connection

First, we add a small piece of insulation tape for the connection of the inner end of the antenna loop (as illustrated in Figure 1). This is to insulate the outer loops. Then we add another copper tape strip to the inner end of the antenna as shown in Figure 2. Here again we solder the two ends of the conductive copper tape together.

Capacitor and LED

Next, we add the capacitor (82 pF) and the low current LED to the tag as shown in Figure 3. They are connected in parallel. We also solder these two components to the copper tape (see Figure 4).

Testing

With these simple steps, our RFID reader detector is finished! By bringing our DIY RFID detector close to an RFID reader (as shown in Figure 5), the connected LED lights up. With the Sonmicro reader hardware the distance to the reader has to be below 8-10 cm; however, there are RFID readers available with a stronger EM field and therefore a higher maximum reading distance.

In the next step of the instructable we will show how to extend a basic RFID tag and make it tilt-sensitive.

Add Tip Ask Question

Step 4: Tilt-Sensitive RFID Tag

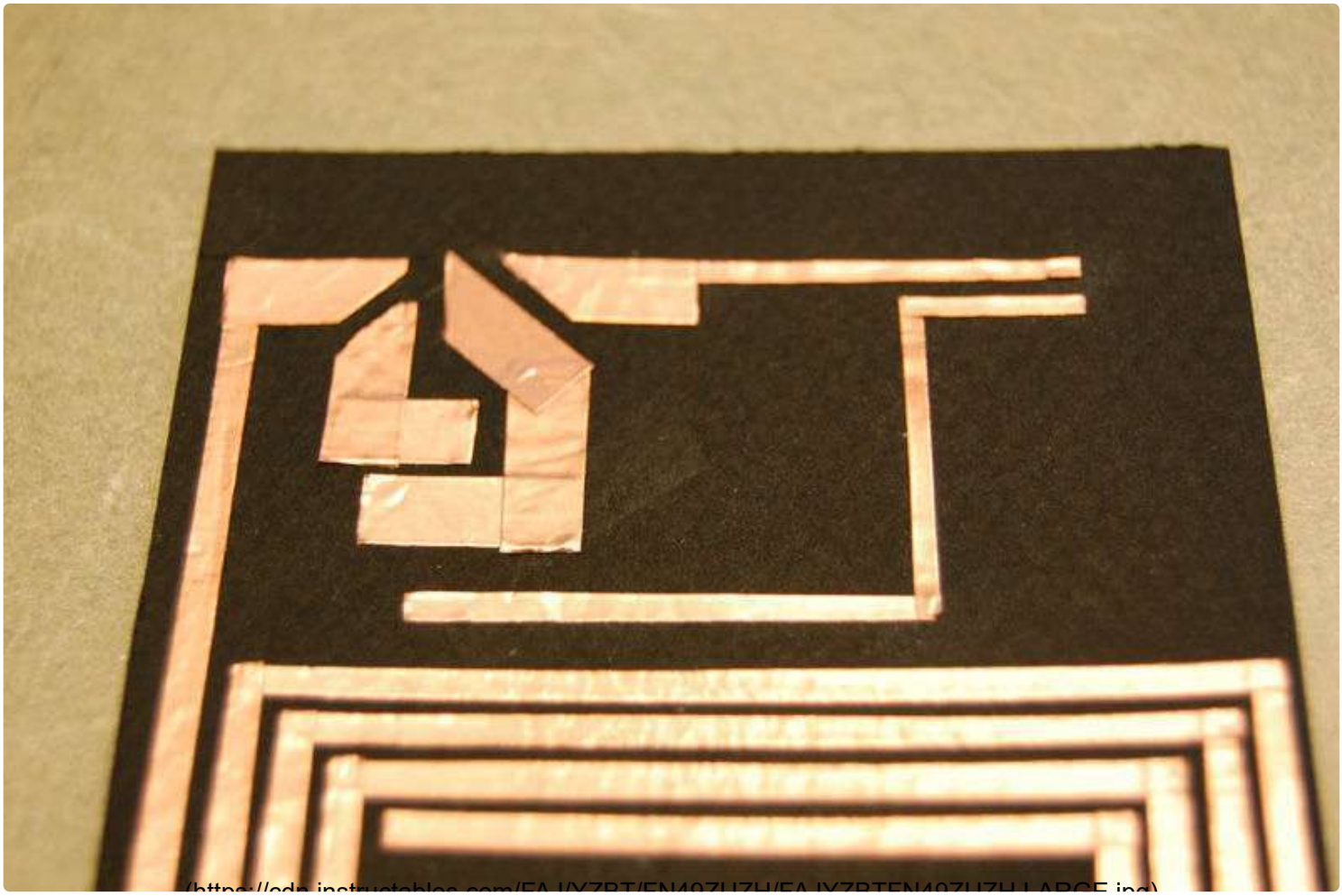

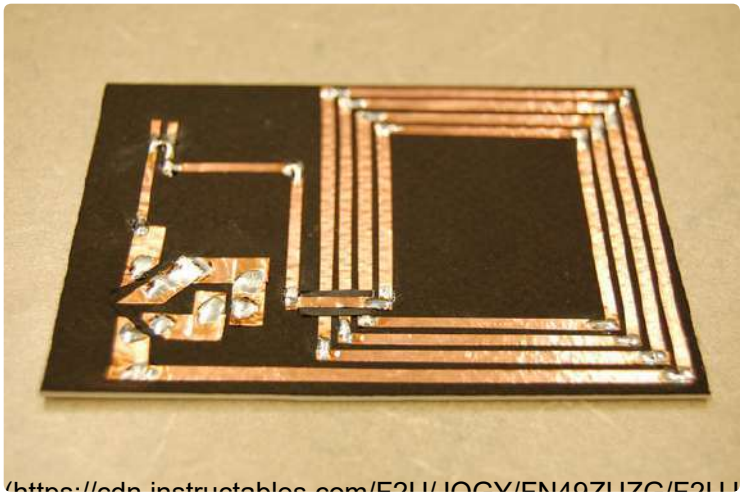

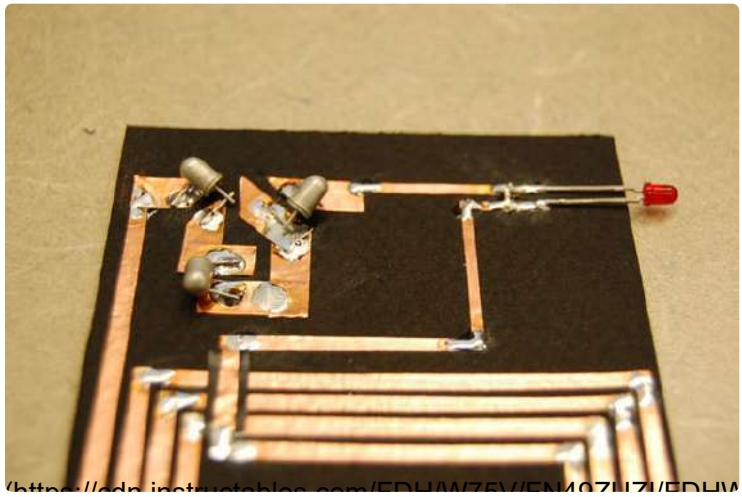

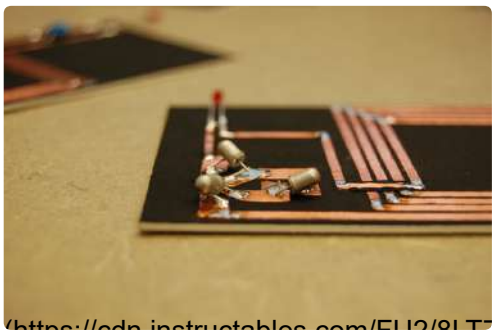

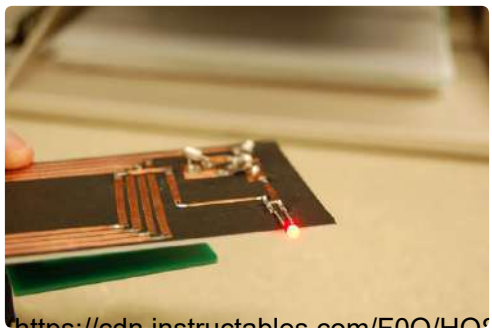

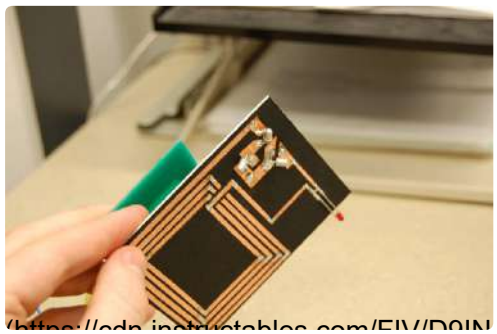

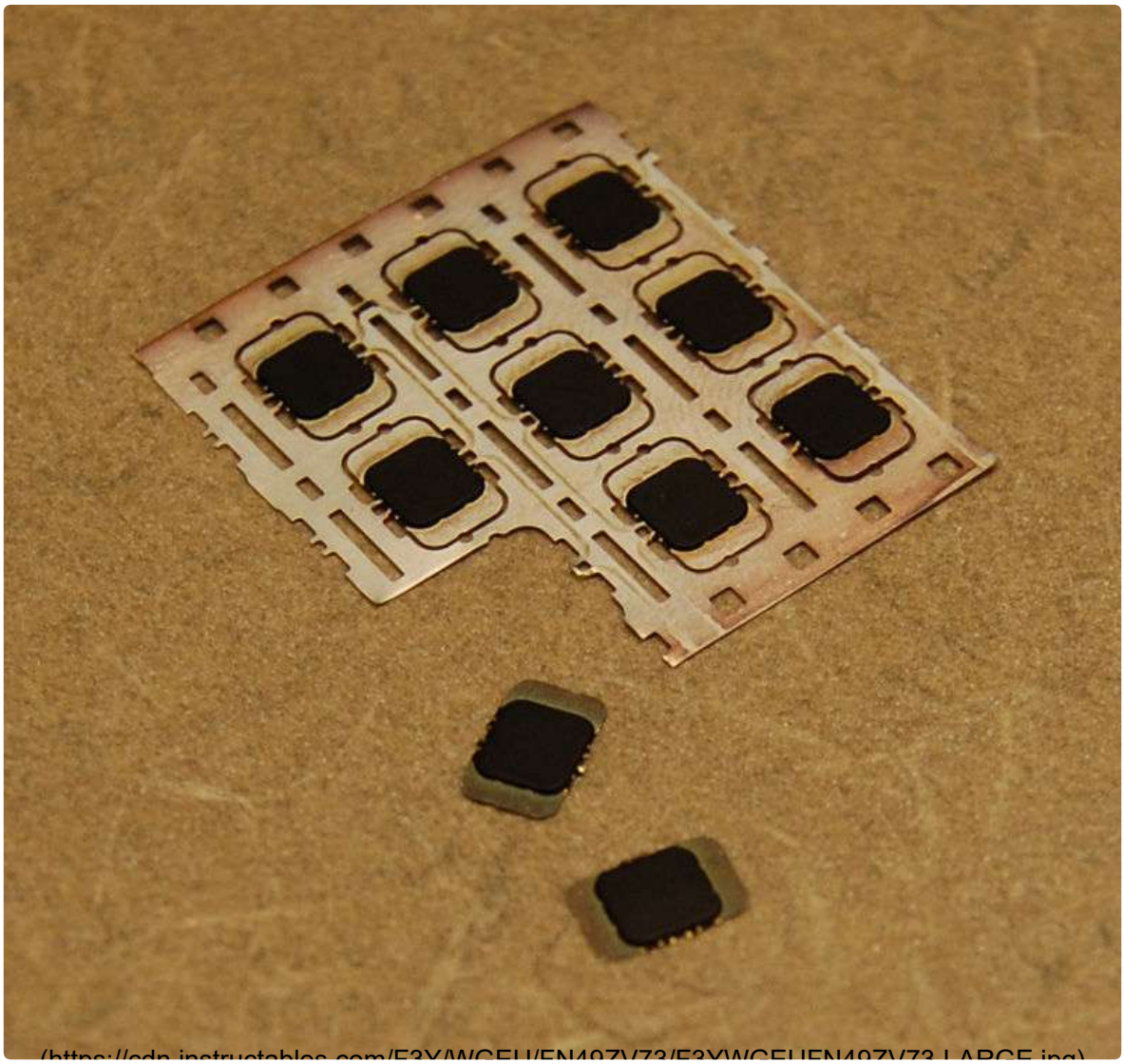

We now describe the process of how to build a tilt-sensitive RFID tag. This extends the previous exercise.

Antenna

The antenna for this second RFID tag is similar to the first antenna we built. We thus need another piece of cardboard and to repeat the steps described earlier in STEP 2 (https://www.instructables.com/id/S2YO8NWFN4H8Q8A/) of this instructable.

Tilt-sensitive tag

Next, we add additional copper tape connections to the tag, as shown in Figure 1. These connections allow us to connect three tilt switches, a capacitor, and the LED to the antenna. Again, all the connections of the copper tape are soldered together. We add the three tilt switches to the tag as shown in Figure 3. The tilt switches are soldered to the copper tape, and it is important to connect them in a slight angle (around 5-10 degrees) as shown in Figure 4. This makes sure that the silt switches are in a *closed* state while the RFID tag is in a horizontal position, and in a *open* state while the tag is in a vertical position.

Again, we also add an LED and a capacitor to the antenna as shown in Figure 3 (we use a different form factor of the capacitor here just to illustrate the alternative options).

Testing the tilt-sensitive tag

We can now use our Sonmicro RFID reader again to test our new tilt-sensitive RFID tag. The tag is activate while in a horizontal position as in Figure 5, and is inactive when in a vertical position as in Figure 6.

Using RFID chips

We can now replace the connected capacitor and LED from our tag with an RFID

MICROWAVE AND RADIO FREQUENCY ENGINEERING

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TRANSMISSION LINES

TELEGRAPHER'S EQUATIONS

$$(1)\quad \frac{\partial V}{\partial z} = -L\frac{\partial I}{\partial t} \qquad (2)\quad \frac{\partial I}{\partial z} = -C\frac{\partial V}{\partial t}$$

By taking the partial derivative with respect to *z* of equation 1 and partial with respect to *t* of equation 2, we can get:

$$(\text{i})\quad \frac{\partial^2 V}{\partial z^2} = LC\frac{\partial^2 V}{\partial t^2} \qquad (\text{ii})\quad \frac{\partial^2 I}{\partial z^2} = LC\frac{\partial^2 I}{\partial t^2}$$

SOLVING THE EQUATIONS

To solve the equations (i) and (ii) above, we guess that $F(u) = F(z \pm vt)$ is a solution to the equations. It is found that the unknown constant v is the wave propagation velocity.

$$\boxed{V_{total} = V_+(z - vt) + V_-(v + vt)}$$ where:

z is the position along the transmission line, where the load is at z=0 and the source is at z=-l, with l the length of the line.

v is the **velocity of propagation** $1/\sqrt{LC}$ or ω/β, the speed at which the waveform moves down the line; see p 2

t is time

THE COMPLEX WAVE EQUATION

The general solutions of equations (i) and (ii) above yield the complex wave equations for voltage and current. These are applicable when the excitation is sinusoidal and the circuit is under steady state conditions.

$$\boxed{V(z) = V^+ e^{-j\beta z} + V^- e^{+j\beta z}}$$

$$\boxed{I(z) = I^+ e^{-j\beta z} + I^- e^{+j\beta z}}$$

$$\boxed{I(z) = \frac{V^+ e^{-j\beta z} + V^- e^{+j\beta z}}{Z_0}}$$ where:

$e^{-j\beta z}$ and $e^{+j\beta z}$ represent wave propagation in the $+z$ and $-z$ directions respectively,

$\beta = \omega\sqrt{LC} = \omega / v$ is the **phase constant,**

$Z_0 = \sqrt{L/C}$ is the **characteristic impedance** of the line.

These equations represent the voltage and current **phasors**.

+/- WATCHING SIGNS

By convention z is the variable used to describe position along a transmission line with the origin z=0 set at the load so that all other points along the line are described by **negative** position values.

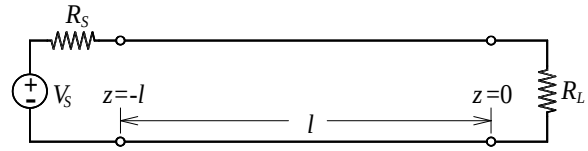

Ohm's law for right- and left-traveling disturbances:

$$V_+ = I_+ Z_0 \qquad V_- = -I_- Z_0$$

v_p VELOCITY OF PROPAGATION [cm/s]

The velocity of propagation is the speed at which a wave moves down a transmission line. The velocity approaches the speed of light but may not exceed the speed of light since this is the maximum speed at which information can be transmitted. But v_p may exceed the speed of light mathematically in some calculations.

$$\boxed{v_p = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{\varepsilon\mu}} = \frac{\omega}{\beta}}$$ where:

L = inductance per unit length [H/cm]
C = capacitance per unit length [F/cm]
ε = permittivity of the material [F/cm]
μ = permeability of the material [H/cm]
ω = frequency [radians/second]
β = phase constant

Phase Velocity The velocity of propagation of a TEM wave may also be referred to as the *phase velocity*. The phase velocity of a TEM wave in conducting material may be described by:

$$\boxed{v_p = \omega\delta = \frac{\omega}{k} = c\frac{2\pi\delta}{\lambda_0} = c\frac{1}{\sqrt{\varepsilon_{r\ \mathrm{eff}}}}}$$ where:

δ = skin depth [m]
c = speed of light 2.998×10^8 m/s
λ_0 = wavelength in the material [m]

Z_0 CHARACTERISTIC IMPEDANCE [Ω]

The **characteristic impedance** is the resistance initially *seen* when a signal is applied to the line. It is a physical characteristic resulting from the materials and geometry of the line.

Lossless line: $$Z_0 \equiv \sqrt{\frac{L}{C}} = \frac{V_+}{I_+} = -\frac{V_-}{I_-}$$

Lossy line: $$Z_0 \equiv \sqrt{\frac{R + j\omega L}{G + j\omega C}} = |Z_0| e^{j\phi_z}$$

L = inductance per unit length [H/cm]
C = capacitance per unit length [F/cm]
V_+ = the forward-traveling (left to right) voltage [V]
I_+ = the forward-traveling (left to right) current [I]
V_- = the reverse-traveling (right to left) voltage [V]
I_- = the reverse-traveling (right to left) current [I]
R = the line resistance per unit length [Ω/cm]
G = the conductance per unit length [Ω^{-1}/cm]
ϕ = phase angle of the complex impedance [radians]

y_0 CHARACTERISTIC ADMITTANCE [Ω^{-1}]

The **characteristic admittance** is the reciprocal of the characteristic impedance.

$$y_0 \equiv \sqrt{\frac{C}{L}} = \frac{I_+}{V_+} = -\frac{I_-}{V_-}$$

r REFLECTION COEFFICIENT

The **reflection coefficient** is the ratio of reflected voltage to the forward-traveling voltage, a value ranging from –1 to +1 which, when multiplied by the wave voltage, determines the amount of voltage reflected at one end of the transmission line.

$$\rho \equiv \frac{V_-}{V_+} = -\frac{I_-}{I_+}$$

A reflection coefficient is present at each end of the transmission line:

$$\rho_{source} = \frac{R_S - z_0}{R_S + z_0} \qquad \rho_{load} = \frac{R_L - z_0}{R_L + z_0}$$

t TRANSMISSION COEFFICIENT

The **transmission coefficient** is the ratio of total voltage to the forward-traveling voltage, a value ranging from 0 to 2.

$$\tau \equiv \frac{V_{total}}{V_+} = 1 + \rho$$

TOF TIME OF FLIGHT [s]

The **time of flight** is how long it takes a signal to travel the length of the transmission line

$$TOF \equiv \frac{l}{v} = l\sqrt{LC} = \sqrt{L_{TOT} C_{TOT}}$$

l = length of the transmission line [cm]
v = the velocity of propagation $1/\sqrt{LC}$, the speed at which the waveform moves down the line
L = inductance per unit length [H/cm]
C = capacitance per unit length [F/cm]
L_{TOT} = total inductance [H]
C_{TOT} = total capacitance [F]

DERIVED EQUATIONS

$$V_+ = z_0 I_+ = (V_{TOT} + I_{TOT} z_0)/2$$
$$V_- = -z_0 I_- = (V_{TOT} - I_{TOT} z_0)/2$$
$$I_+ = y_0 V_+ = (I_{TOT} + V_{TOT} y_0)/2$$
$$I_- = -y_0 V_- = (I_{TOT} - V_{TOT} y_0)/2$$

C_n FOURIER SERIES

The function $x(t)$ must be periodic in order to employ the Fourier series. The following is the exponential Fourier series, which involves simpler calculations than other forms but is not as easy to visualize as the trigonometric forms.

$$C_n = \frac{1}{T}\int_{t_1}^{t_1+T} x(t) e^{-jn\omega_0 t}\, dt$$

C_n = amplitude
T = period [s]
t = time [s]
n = the harmonic (an integer)
w_0 = frequency $2\pi/T$ [radians]

The function $x(t)$ may be delayed in time. All this does in a Fourier series is to shift the phase. If you know the C_ns for $x(t)$, then the C_ns for $x(t\text{-}\alpha)$ are just $C_n e^{-jn\omega 0\alpha}$. (Here, C_ns is just the plural of C_n.)

C CAPACITANCE [F]

$$v(t) = \frac{1}{C}\int_0^t i\,d\tau + v(0) \qquad I_{cap} = C\frac{dV_{cap}}{dt}$$

$$\boxed{v(t) = v_f + (v_0 - v_f)e^{-t/t}} \qquad i(t) = i_f + (i_0 - i_f)e^{-t/t}$$

$$P(t) = i_0^{\,2} R e^{-2t/\tau}$$

$v(t)$ = voltage across the capacitor, at time t [V]
v_f = final voltage across the capacitor, steady-state voltage [V]
v_0 = initial voltage across the capacitor [V]
t = time [s]
τ = the time constant, RC [seconds]
C = capacitance [F]
Natural log: $\ln x = b \Leftrightarrow e^b = x$

C PARALLEL PLATE CAPACITANCE

$$C = \frac{\varepsilon A}{h} \qquad C_{\text{per unit length}} = \frac{\varepsilon A}{lh} = \frac{\varepsilon wl}{lh} = \frac{\varepsilon w}{h}$$

ε = permittivity of the material [F/cm]
A = area of one of the capacitor plates [cm^2]
h = plate separation [cm]
w = plate width [cm]
l = plate length [cm]
C = capacitance [F]

CAPACITOR-TERMINATED LINE

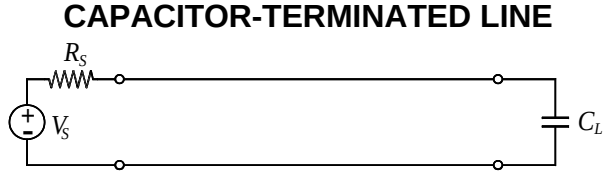

Where the incident voltage is $V_+ = V_0\left(1 - e^{-t/\tau_0}\right)$,

$$V_{cap} = V_+ + V_- = V_0\left(2 + \frac{2\tau_1}{\tau_0 - \tau_1}e^{-t/\tau_1} - \frac{2\tau_0}{\tau_0 - \tau_1}e^{-t/\tau_0}\right)$$

V_0 = final voltage across the capacitor [V]
t = time [s]
τ_0 = time constant of the incident wave, RC [s]
τ_1 = time constant effect due to the load, Z_0C_L [s]
C = capacitance [F]

SMITH CHART

First **normalize the load impedance** by dividing by the characteristic impedance, and find this point on the chart.

When working in terms of **reactance** X, an inductive load will be located on the top half of the chart, a capacitive load on the bottom half. It's the other way around when working in terms of **susceptance** B [Siemens].

Draw a straight line from the center of the chart through the normalized load impedance point to the edge of the chart.

Anchor a compass at the center of the chart and draw a circle through the normalized load impedance point. Points along this circle represent the normalized impedance at various points along the transmission line. Clockwise movement along the circle represents movement from the load toward the source with one full revolution representing 1/2 wavelength as marked on the outer circle. The two points where the circle intersects the horizontal axis are the voltage maxima (right) and the voltage minima (left).

The point opposite the impedance (180° around the circle) is the **admittance** Y [Siemens]. The reason admittance (or susceptibility) is useful is because admittances in parallel are simply added. (**Admittance** is the reciprocal of impedance; **susceptance** is the reciprocal of reactance.)

$$\boxed{\Gamma(z) = \Gamma_L e^{j2\beta z}}$$

$$e^{j2\beta z} = 1\angle 2\beta z$$

$$\mathbf{G}(z) = \frac{\mathbf{Z}(z) - 1}{\mathbf{Z}(z) + 1}$$

$$\mathbf{Z}_L = \frac{\Gamma_L - 1}{\Gamma_L + 1} \qquad \boxed{\mathbf{Z} = \frac{Z_L}{Z_0}}$$

z = distance from load [m]
$j = \sqrt{-1}$
ρ = magnitude of the reflection coefficient
β = phase constant
Γ = reflection coefficient
Z = normalized impedance [Ω]

SINGLE-STUB TUNING

The basic idea is to connect a line stub in parallel (shunt) or series a distance d from the load so that the imaginary part of the load impedance will be canceled.

Shunt-stub: Select d so that the admittance Y looking toward the load from a distance d is of the form $Y_0 + jB$. Then the stub susceptance is chosen as $-jB$, resulting in a matched condition.

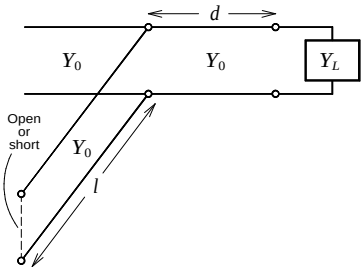

Series-stub: Select d so that the admittance Z looking toward the load from a distance d is of the form $Z_0 + jX$. Then the stub susceptance is chosen as $-jX$, resulting in a matched condition.

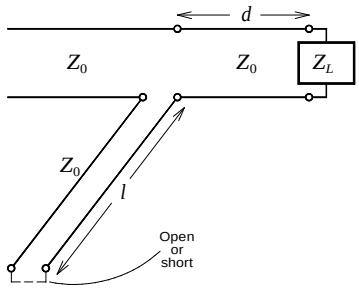

FINDING A STUB LENGTH

Example: Find the lengths of open and shorted shunt stubs to match an admittance of 1-j0.5. The admittance of an open shunt (zero length) is Y=0; this point is located at the left end of the Smith Chart x-axis. We proceed clockwise around the Smith chart, i.e. away from the end of the stub, to the +j0.5 arc (the value needed to match –j0.5). The difference in the starting point and the end point on the wavelength scale is the length of the stub in wavelengths. The length of a shorted-type stub is found in the same manner but with the starting point at Y=∞.

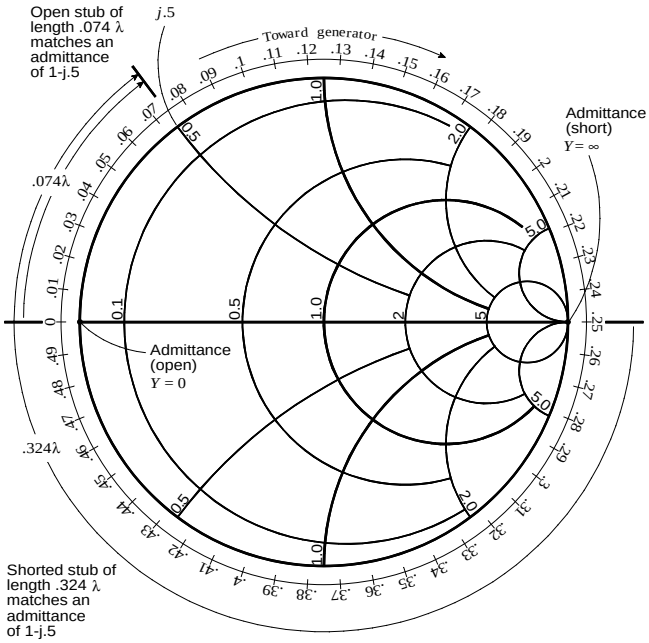

In this example, all values were in units of admittance. If we were interested in finding a stub length for a series stub problem, the units would be in impedance. The problem would be worked in exactly the same way. Of course in impedance, an open shunt (zero length) would have the value Z=∞, representing a point at the right end of the x-axis.

LINE IMPEDANCE [Ω]

The impedance seen at the source end of a lossless transmission line:

$$Z_{in} = Z_0 \frac{1+\rho}{1-\rho} = Z_0 \frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)}$$

For a lossy transmission line:

$$Z_{in} = Z_0 \frac{Z_L + Z_0 \tanh(\gamma l)}{Z_0 + Z_L \tanh(\gamma l)}$$

Line impedance is periodic with spatial period λ/2.

$Z_0 = \sqrt{L/C}$, the characteristic impedance of the line. [Ω]

ρ = the reflection coefficient

Z_L = the load impedance [Ω]

β = 2π/λ, phase constant

γ = α+*j*β, complex propagation constant

l WAVELENGTH [cm]

The physical distance that a traveling wave moves during one period of its periodic cycle.

$$\boxed{\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{k} = \frac{v_p}{f}}$$

β = $\omega\sqrt{LC}$ = 2π/λ, phase constant

k = $\omega\sqrt{\mu\varepsilon}$ = 2π/λ, wave number

v_p = velocity of propagation [m/s] see p 2.

f = frequency [Hz]

l/4 QUARTER-WAVE SECTION

A quarter-wave section of transmission line has the effect of inverting the <u>normalized</u> impedance of the load.

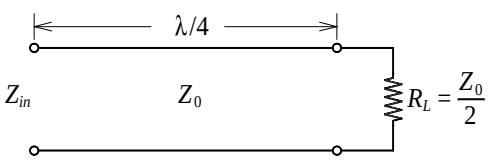

To find Z_{in}, we can normalize the load (by dividing by the characteristic impedance), invert the result, and "unnormalize" this value by multiplying by the characteristic impedance.

In this case, the normalized load is $\frac{Z_0}{2} \div Z_0 = \frac{1}{2}$

so the normalized input impedance is $\left(\frac{1}{2}\right)^{-1} = 2$

and the actual input impedance is $Z_{in} = 2Z_0$

g COMPLEX PROPAGATION CONSTANT

The propagation constant for lossy lines, taking into account the resistance along the line as well as the resistive path between the conductors.

$$\gamma = \alpha + j\beta = \sqrt{ZY} = \sqrt{(R + j\omega L)(G + j\omega C)}$$

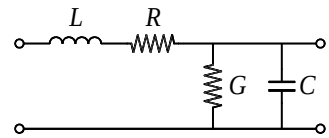

α = $\sqrt{RG}$ **attenuation constant**, the real part of the complex propagation constant, describes the loss

β = 2π/λ, **phase constant**, the complex part of the complex propagation constant

Z = **series impedance** (complex, inductive) per unit length [Ω/cm]

Y = **shunt admittance** (complex, capacitive) per unit length [Ω^{-1}/cm]

R = the resistance per unit length along the transmission line [Ω/cm]

G = the conductance between conductors per unit length [Ω^{-1}/cm]

L = inductance per unit length [H/cm]

C = capacitance per unit length [F/cm]

MODULATED WAVE

Suppose we have a disturbance composed of two frequencies:

$$\sin\left[\left(\omega_0 - \delta\omega\right)t - \left(\beta_0 - \delta\beta\right)z\right]$$

and $$\sin\left[\left(\omega_0 + \delta\omega\right)t - \left(\beta_0 + \delta\beta\right)z\right]$$

where ω_0 is the average frequency and β_0 is the average phase.

Using the identity $2\cos\left(\frac{A-B}{2}\right)\sin\left(\frac{A+B}{2}\right) = \sin A + \sin B$

The combination (sum) of these two waves is

$$\boxed{2\underbrace{\cos\left(\delta\omega t - \delta\beta z\right)}_{\text{envelope}}\underbrace{\sin\left(\omega_0 t - \beta_0 z\right)}_{\text{carrier}}}$$

The envelope moves at the group velocity, see p 7.

δ = "the difference in"…
ω_0 = carrier frequency [radians/second]
ω = modulating frequency [radians/second]
β_0 = carrier frequency phase constant
β = phase constant

So the sum of two waves will be a modulated wave having a **carrier** frequency equal to the average frequency of the two waves, and an **envelope** with a frequency equal to half the difference between the two original wave frequencies.

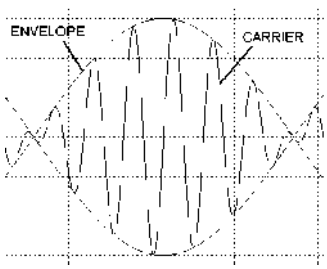

v_g GROUP VELOCITY [cm/s]

The velocity at which the envelope of a modulated wave moves.

$$\boxed{v_g = \frac{\delta\omega}{\delta\beta} = \frac{1}{\sqrt{LC_P}}\sqrt{1 - \frac{\omega_c^2}{\omega^2}}}$$ where:

L = inductance per unit length [H/cm]
C_P = capacitance per unit length [F/cm]
ε = permittivity of the material [F/cm]
μ = permeability of the material, dielectric constant [H/cm]
ω_c = carrier frequency [radians/second]
ω = modulating frequency [radians/second]
β = phase constant

Also, since β may be given as a function of ω, remember

$$v_g = \left(\frac{d\beta}{d\omega}\right)^{-1}$$

OMEGA - BETA GRAPH

This representation is commonly used for modulated waves.

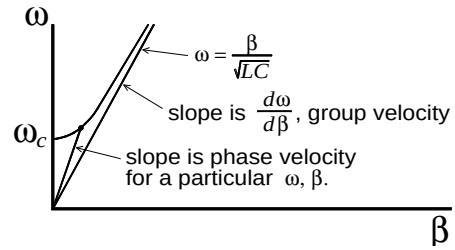

d SKIN DEPTH [cm]

The depth into a material at which a wave is attenuated by 1/e (about 36.8%) of its original intensity. This isn't the same δ that appears in the *loss tangent*, tan δ.

$$\boxed{\delta = \frac{1}{\alpha} = \sqrt{\frac{2}{\omega\mu\sigma}}}$$ where:

$\alpha = \sqrt{RG}$ **attenuation constant**, the real part of the complex propagation constant, describes loss
μ = permeability of the material, dielectric constant [H/cm]
ω = frequency [radians/second]
σ = (*sigma*) conductivity [Siemens/meter] see p12.

Skin Depths of Selected Materials

	60 Hz	1 MHz	1 GHz
silver	8.27 mm	0.064 mm	0.0020 mm
copper	8.53 mm	0.066 mm	0.0021 mm
gold	10.14 mm	0.079 mm	0.0025 mm
aluminum	10.92 mm	0.084 mm	0.0027 mm
iron	0.65 mm	0.005 mm	0.00016 mm

MAXWELL'S EQUATIONS

Maxwell's equations govern the principles of guiding and propagation of electromagnetic energy and provide the foundations of all electromagnetic phenomena and their applications. The time-harmonic expressions can be used only when the wave is sinusoidal.

	STANDARD FORM (Time Domain)	**TIME-HARMONIC** (Frequency Domain)
Faraday's Law	$\nabla\times\vec{\mathscr{E}} = -\dfrac{\partial\vec{\mathscr{B}}}{\partial t}$	$\nabla\times\vec{E} = -j\omega\vec{B}$
Ampere's Law*	$\nabla\times\vec{\mathscr{H}} = \vec{\mathscr{J}} + \dfrac{\partial\vec{\mathscr{D}}}{\partial t}$	$\nabla\times\vec{H} = j\omega\vec{D} + \vec{J}$
Gauss' Law	$\nabla\cdot\vec{\mathscr{D}} = \rho_v$	$\nabla\cdot\vec{D} = \rho_v$
no name law	$\nabla\cdot\vec{\mathscr{B}} = 0$	$\nabla\cdot\vec{B} = 0$

$\mathscr{E}$ = electric field [V/m]
$\mathscr{B}$ = magnetic flux density [W/m^2 or T] $\mathscr{B} = \mu_0\mathscr{H}$
t = time [s]
$\mathscr{D}$ = electric flux density [C/m^2] $\mathscr{D} = \varepsilon_0\mathscr{E}$
ρ = volume charge density [C/m^3]
$\mathscr{H}$ = magnetic field intensity [A/m]
$\mathscr{J}$ = current density [A/m^2]

*Maxwell added the $\dfrac{\partial\vec{\mathscr{D}}}{\partial t}$ term to Ampere's Law.

ELECTROMAGNETIC WAVES

MODELING MAXWELL'S EQUATIONS

This is a model of a wave, analogous to a transmission line model.

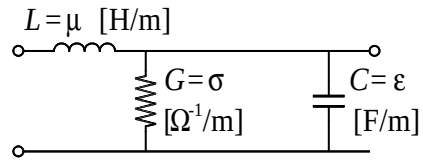

L = inductance per unit length [H/cm]
μ = permeability of the material, dielectric constant [H/cm]
G = the conductance per unit length [Ω^{-1}/cm]
σ = (*sigma*) conductivity [Siemens/meter]
C = capacitance per unit length [F/cm]
ε = permittivity of the material [F/cm]

propagation constant: $\gamma = \sqrt{(j\omega\mu)(j\omega\varepsilon+\sigma)}$

LOW FREQUENCY

At low frequencies, more materials behave as **conductors**. A wave is considered low frequency when

$\boxed{\omega \ll \dfrac{\sigma}{\varepsilon}}$ $\dfrac{\sigma}{\varepsilon}$ is the dielectric relaxation frequency

$\boxed{\eta = \dfrac{1}{\sigma\delta}(1+j)}$ intrinsic wave impedance, see p 12.

What happens to the complex propagation constant at low frequency? From the wave model above, gamma is

$$\gamma = \sqrt{(j\omega\mu)(j\omega\varepsilon+\sigma)} = \sqrt{j\omega\mu\sigma}\sqrt{1+\frac{j\omega\varepsilon}{\sigma}}$$

Since both ω and ε/σ are small

$$\gamma = \sqrt{j\omega\mu\sigma}\left(1+\frac{1}{2}j\omega\frac{\varepsilon}{\sigma}\right) = \sqrt{j\omega\mu\sigma}\,(1)$$

Since $\sqrt{j} = \frac{1}{\sqrt{2}} + j\frac{1}{\sqrt{2}}$

$$\gamma = \sqrt{\omega\mu\sigma}\left(\frac{1}{\sqrt{2}} + j\frac{1}{\sqrt{2}}\right) = \sqrt{\frac{\omega\mu\sigma}{2}} + j\sqrt{\frac{\omega\mu\sigma}{2}}$$

So that, with $\gamma = \alpha + j\beta$

we get $\boxed{\alpha = \sqrt{\dfrac{\omega\mu\sigma}{2}}}$, $\boxed{\beta = \sqrt{\dfrac{\omega\mu\sigma}{2}}}$ or $\boxed{\gamma = \dfrac{1}{\delta}(1+j)}$

α = **attenuation constant**, the real part of the complex propagation constant, describes the loss
β = **phase constant**, the complex part of the complex propagation constant
σ = (*sigma*) conductivity [Siemens/cm]
δ = skin depth [cm]
So the wave is attenuating at the same rate that it is propagating.

HIGH FREQUENCY

At high frequencies, more materials behave as **dielectrics**, i.e. copper is a dielectric in the gamma ray range. A wave is considered high frequency when

$$\boxed{\omega \gg \frac{\sigma}{\varepsilon}}$$

$\frac{\sigma}{\varepsilon}$ is the dielectric relaxation frequency

$$\boxed{\eta = \sqrt{\frac{\mu}{\varepsilon}}}$$

intrinsic wave impedance, see p 12.

What happens to the complex propagation constant at high frequency?

$$\gamma = \sqrt{(j\omega\mu)(j\omega\varepsilon + \sigma)} = \sqrt{j\omega\mu\, j\omega\varepsilon\left(1 + \frac{\sigma}{j\omega\varepsilon}\right)}$$

Since both $1/\omega$ and σ/ε are small

$$\gamma = j\omega\sqrt{\mu\varepsilon}\left(1 + \frac{1}{2}\frac{\sigma}{j\omega\varepsilon}\right) \qquad \boxed{\gamma = \frac{\sigma}{2}\sqrt{\frac{\mu}{\varepsilon}} + j\omega\sqrt{\mu\varepsilon}}$$

With $\gamma = \alpha + j\beta$

we get $\boxed{\alpha = \frac{\sigma}{2}\sqrt{\frac{\mu}{\varepsilon}}}$, $\boxed{\beta = \omega\sqrt{\mu\varepsilon}}$,

tan d LOSS TANGENT

The loss tangent, a value between 0 and 1, is the loss coefficient of a wave after it has traveled one wavelength. This is the way data is usually presented in texts. This is not the same δ that is used for skin depth.

$$\boxed{\tan\delta = \frac{\sigma}{\omega\varepsilon}}$$

Graphical representation of loss tangent:

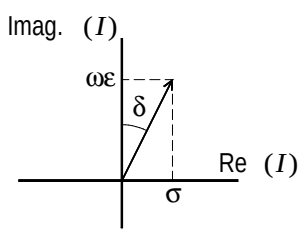

For a dielectric,
$\tan\delta \ll 1$.

$$\alpha \approx \frac{1}{2}(\tan\delta)\beta = \frac{\pi}{\lambda}\tan\delta$$

$\omega\varepsilon$ is proportional to the amount of current going through the capacitance C.
σ is proportional to the amount current going through the conductance G.

TEM WAVES

Transverse Electromagnetic Waves

Electromagnetic waves that have single, orthogonal vector electric and magnetic field components (e.g., $\mathscr{E}_x$ and $\mathscr{H}_y$), both varying with a single coordinate of space (e.g., z), are known as *uniform plane waves* or *transverse electromagnetic (TEM) waves*. TEM calculations may be made using formulas from electrostatics; this is referred to as *quasi-static* solution.

Characteristics of TEM Waves

- The velocity of propagation (always in the *z* direction) is $v_p = 1/\sqrt{\mu\varepsilon}$, which is the speed of light in the material
- There is no electric or magnetic field in the direction of propagation. Since this means there is no voltage drop in the direction of propagation, it suggests that no current flows in that direction.
- The electric field is normal to the magnetic field
- The value of the electric field is η times that of the magnetic field at any instant.
- The direction of propagation is given by the direction of $\mathbf{E} \times \mathbf{H}$.
- The energy stored in the electric field per unit volume at any instant and any point is equal to the energy stored in the magnetic field.

TEM ASSUMPTIONS

Some assumptions are made for TEM waves.

$\mathscr{E}_z = 0$ $\qquad$ $\mathscr{H}_z = 0$

$\sigma = 0$ $\qquad$ time dependence $e^{j\omega t}$

WAVE ANALOGIES

Plane waves have many characteristics analogous to transmission line problems.

Transmission Lines	Plane Waves
Phase constant $\beta = \omega\sqrt{LC} = \frac{\omega}{v_p} = \frac{2\pi}{\lambda}$	Wave number $k = \omega\sqrt{\mu\varepsilon} = \frac{\omega}{v_p} = \frac{2\pi}{\lambda}$
Complex propagation const. $\gamma = \alpha + j\beta = \sqrt{(R + j\omega L)(G + j\omega C)}$	Complex propagation constant $\gamma = \sqrt{(j\omega\mu)(j\omega\varepsilon + \sigma)}$
Velocity of propagation $v_p = \frac{1}{\sqrt{LC}} = \frac{\omega}{\beta}$	Phase velocity $v_p = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{\omega}{k} = \omega\delta = c\frac{2\pi\delta}{\lambda}$
Characteristic impedance $Z_0 = \sqrt{\frac{L}{C}} = \frac{V_+}{I_+}$	Intrinsic impedance $\eta = \sqrt{\frac{\mu}{\varepsilon}} = \frac{E_{x+}}{H_{y+}}$
Voltage $V(z) = V_+ e^{-j\beta z} + V_- e^{j\beta z}$	Electric Field $E_x(z) = E_+ e^{-jkz} + E_- e^{jkz}$
Current $I(z) = \frac{1}{Z_0}\left[V_+ e^{-j\beta z} - V_- e^{j\beta z}\right]$	Magnetic Field $H_y(z) = \frac{1}{\eta}\left[E_+ e^{-jkz} - E_- e^{jkz}\right]$
Line input impedance $Z_{in} = Z_0 \frac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)}$ $Z_{in} = Z_0 \frac{Z_L + Z_0 \tanh(\gamma l)}{Z_0 + Z_L \tanh(\gamma l)}$	Wave input impedance $\eta_{in} = \eta_0 \frac{\eta_L + j\eta_0 \tan(kl)}{\eta_0 + j\eta_L \tan(kl)}$ $\eta_{in} = \eta_0 \frac{\eta_L + \eta_0 \tanh(\gamma l)}{\eta_0 + \eta_L \tanh(\gamma l)}$
Reflection coefficient $\rho = \frac{Z_L - Z_0}{Z_L + Z_0}$	Reflection coefficient $\rho = \frac{\eta_L - \eta_0}{\eta_L + \eta_0}$

k WAVE NUMBER [rad./cm]

The phase constant for the uniform plane wave; the change in phase per unit length. It can be considered a constant for the medium at a particular frequency.

$$k = \frac{\omega}{v} = \omega\sqrt{\mu\varepsilon} = \frac{2\pi}{\lambda}$$

k appears in the phasor forms of the uniform plane wave

$E_x(z) = E_1 e^{-jkz} + E_2 e^{jkz}$, etc.

k has also been used as in the "*k* of a dielectric" meaning ε_r.

h (eta) INTRINSIC WAVE IMPEDANCE [Ω]

The ratio of electric to magnetic field components. Can be considered a constant of the medium. For free space, η = 376.73Ω. The units of η are in ohms.

$$\eta = \frac{E_{x+}}{H_{y+}} = -\frac{E_{y+}}{H_{x+}} \qquad -\eta = \frac{E_{x-}}{H_{y-}} = -\frac{E_{y-}}{H_{x-}}$$

at low frequencies	at high frequencies
$\eta = \frac{1}{\sigma\delta}(1 + j)$	$\eta = \sqrt{\frac{\mu}{\varepsilon}}$

When an electromagnetic wave encounters a sheet of conductive material it sees an impedance. K is the direction of the wave, **H** is the magnetic component and **E** is the electrical field. **E** × **H** gives the direction of propagation K.

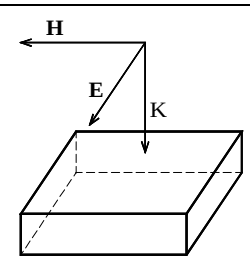

SHEET RESISTANCE [Ω]

Consider a block of material with conductivity σ.

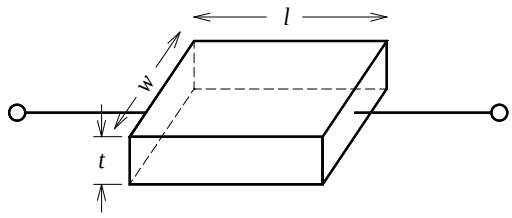

It's resistance is $R = \dfrac{l}{wt\sigma}$ Ω.

If the length is equal to the width, this reduces to

$$R = \frac{1}{t\sigma} \ \Omega.$$

And this is sheet resistance.

HIGH FREQUENCY RESISTANCE [Ω]

When a conductor carries current at high frequency, the electric field penetrates the outer surface only about 1 skin depth so that current travels near the surface of the conductor. Since the entire cross-section is not utilized, this affects the resistance of the conductor.

Cross-section of a conductor showing current flow near the surface:

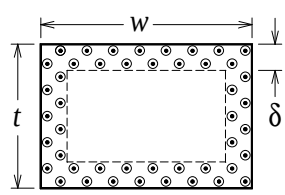

$$R \approx \frac{1}{\sigma\delta(\text{perimeter})} = \sqrt{\frac{\omega\mu_0}{2\sigma}}\,\frac{1}{2w+2t}$$

σ = (*sigma*) conductivity (5.8×10^5 S/cm for copper) [Siemens/meter]

ω = frequency [radians/second]

δ = skin depth [cm]

μ_0 = permeability of free space $\mu_0 = 4\pi\times10^{-9}$ [H/cm]

w = width of the conductor [cm]

t = thickness of the conductor [cm]

h_{in} WAVE INPUT IMPEDANCE [Ω]

The impedance seen by a wave in a medium.

For example, the impedance of a metal sheet in a vacuum:

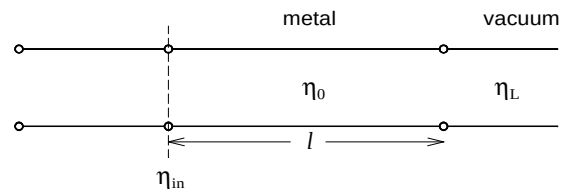

Note that a transmission line model is used here because it is analogous to a wave traveling in a medium. The "load" is the element most remote in the direction of propagation.

The input impedance is $\eta_{in} = \eta_0 \dfrac{\eta_L + \eta_0 \tanh(\gamma l)}{\eta_0 + \eta_L \tanh(\gamma l)}$ Ω.

In this example, *l* is the thickness of a metal sheet. If the metal thickness is much greater than the skin depth, then

$$\tanh(\lambda l) = \tanh\left[\frac{1}{\delta}(1+j)l\right] = \tanh[(\text{big number})(1+j)] \approx 1$$

If *l* is much less than the skin depth δ, then

$$\tanh(\lambda l) = \tanh\left[\frac{1}{\delta}(1+j)l\right] = \tanh[(\text{small number})(1+j)]$$

$$= (\text{same small number})(1+j) = \frac{l}{\delta}(1+j)$$

m MAGNETIC PERMEABILITY [H/m]

The relative increase or decrease in the resultant magnetic field inside a material compared with the magnetizing field in which the given material is located. The product of the permeability constant and the relative permeability of the material.

$$\mu = \mu_0\mu_r \quad \text{where } \mu_0 = 4\pi\times10^{-7} \text{ H/m}$$

Relative Permeabilities of Selected Materials

Air	1.00000037	Mercury	0.999968
Aluminum	1.000021	Nickel	600
Copper	0.9999833	Oxygen	1.000002
Gold	0.99996	Platinum	1.0003
Iron (99.96% pure)	280,000	Silver	0.9999736
Iron (motor grade)	5000	Titanium	1.00018
Lead	0.9999831	Tungsten	1.00008
Manganese	1.001	Water	0.9999912

e ELECTRIC PERMITTIVITY [F/m]

The property of a dielectric material that determines how much electrostatic energy can be stored per unit of volume when unit voltage is applied, also called the ***dielectric constant***. The product of the constant of permittivity and the relative permittivity of a material.

$$\varepsilon = \varepsilon_0 \varepsilon_r \quad \text{where } \varepsilon_0 = 8.85\times10^{-14} \text{ F/cm}$$

e_c COMPLEX PERMITTIVITY

$$\varepsilon_c = \varepsilon' - j\varepsilon'' \quad \text{where } \frac{\varepsilon''}{\varepsilon'} = \tan\delta_c$$

In general, both ε' and ε'' depend on frequency in complicated ways. ε' will typically have a constant maximum value at low frequencies, tapering off at higher frequencies with several peaks along the way. ε'' will typically have a peak at the frequency at which ε' begins to decline in magnitude as well as at frequencies where ε' has peaks, and will be zero at low frequencies and between peaks.

e_r RELATIVE PERMITTIVITY

The permittivity of a material is the relative permittivity multiplied by the permittivity of free space

$$\varepsilon = \varepsilon_r \times \varepsilon_0$$

In old terminology, ε_r is called the "*k* of a dielectric". Glass (SiO_2) at ε_r = 4.5 is considered the division between low *k* and high *k* dielectrics.

Relative Permittivities of Selected Materials

Air (sea level)	1.0006	Polystyrene	2.6
Ammonia	22	Polyethylene	2.25
Bakelite	5	Rubber	2.2-4.1
Glass	4.5-10	Silicon	11.9
Ice	3.2	Soil, dry	2.5-3.5
Mica	5.4-6	Styrofoam	1.03
most metals	~1	Teflon	2.1
Plexiglass	3.4	Vacuum	1
Porcelain	5.7	Water, distilled	81
Paper	2-4	Water, seawater	72-80
Oil	2.1-2.3		

NOTE: Relative permittivity data is given for materials at **low or static frequency conditions**. The permittivity for most materials varies with frequency. The relative permittivities of most materials lie in the range of 1-25. At high frequencies, the permittivity of a material can be quite different (usually less), but will have resonant peaks.

s CONDUCTIVITY [S/m] or [1/(Ω·m)]

A measure of the ability of a material to conduct electricity, the higher the value the better the material conducts. The reciprocal is *resistivity*. Values for common materials vary over about 24 orders of magnitude. Conductivity may often be determined from skin depth or the loss tangent.

$$\sigma = \frac{n_c q_e^2 \bar{l}}{m_e v_{th}} \text{ S/m} \quad \text{where}$$

n_c = density of conduction electrons (for copper this is 8.45×10^{28}) [m^{-3}]
q_e = electron charge? 1.602×10^{-23} [C]
$\bar{l}$ = $v_{th}t_c$ the product of the thermal speed and the mean free time between collisions of electrons, the average distance an electron travels between collisions [m]
m_e = the effective electron mass? [kg]
v_{th} = thermal speed, usually much larger than the drift velocity v_d. [m/s]

Conductivities of Selected Materials [1/(Ω·m)]

Aluminum	3.82×10^7	Mercury	1.04×10^6
Carbon	7.14×10^4	Nicrome	1.00×10^6
Copper (annealed)	5.80×10^7	Nickel	1.45×10^7
Copper (in class)	6.80×10^7	Seawater	4
Fresh water	$\sim10^{-2}$	Silicon	$\sim4.35\times10^{-4}$
Germanium	~2.13	Silver	6.17×10^7
Glass	$\sim10^{-12}$	Sodium	2.17×10^7
Gold	4.10×10^7	Stainless steel	1.11×10^6
Iron	1.03×10^7	Tin	8.77×10^6
Lead	4.57×10	Titanium	2.09×10^6
		Zinc	1.67×10^7

P POWER [W]

Power is the time rate of change of energy.

Power reflected at a discontinuity: $\%\text{ power} = |\rho|^2 \times 100$

Power transmitted at a discontinuity: $\%\text{ power} = \left(1 - |\rho|^2\right)\times 100$

MICROSTRIP CONDUCTORS

How fast does a wave travel in a microstrip? The question is complicated by the fact that the dielectric on one side of the strip may be different from the dielectric on the other side and a wave may travel at different speeds in different dielectrics. The solution is to find an **effective relative permittivity** $\varepsilon_{r\,\mathrm{eff}}$ for the combination.

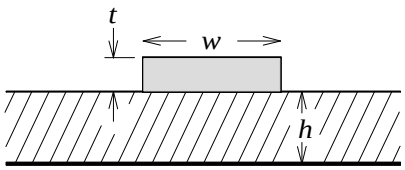

Some Microstrip Relations

$$Z_0^{\text{air}} = Z_0\sqrt{\varepsilon_{r\,\mathrm{eff}}} \qquad C^{\text{air}} Z_0^{\text{air}} = \sqrt{\varepsilon_0\mu_0}$$

$$L = Z_0^{\text{air}}\sqrt{\varepsilon_0\mu_0} = C^{\text{total}}\left(Z_0\right)^2 \qquad L\,C^{\text{air}} = \varepsilon_0\mu_0$$

$$Z_0 = \sqrt{\frac{L}{C^{\text{total}}}} \qquad Z_0^{\text{air}} = \sqrt{\frac{L}{C^{\text{air}}}}$$

$$\gamma = j\beta = j\omega\sqrt{\varepsilon_0\mu_0}\sqrt{\varepsilon_{r\,\mathrm{eff}}} \qquad \varepsilon_{r\,\mathrm{eff}} = \frac{C^{\text{total}}}{C^{\text{air}}}$$

$$v_p = \frac{1}{\sqrt{\varepsilon_0\mu_0\varepsilon_{r\,\mathrm{eff}}}} = \frac{1}{\sqrt{L\,C^{\text{total}}}}$$

It's difficult to get more than 200Ω for Z_0 in a microstrip.

Microstrip Approximations

$$\varepsilon_{r\,\mathrm{eff}} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2\sqrt{1 + 12h/w}}$$

$$Z_0 = \begin{cases} \dfrac{60}{\sqrt{\varepsilon_{r\,\mathrm{eff}}}}\ln\left[\dfrac{8h}{w} + \dfrac{w}{4h}\right], & \text{for } \dfrac{w}{h} \le 1 \\[2ex] \dfrac{120\pi}{\sqrt{\varepsilon_{r\,\mathrm{eff}}}\left[\dfrac{w}{h} + 1.393 + 0.667\ln\left(\dfrac{w}{h} + 1.444\right)\right]}, & \text{for } \dfrac{w}{h} > 1 \end{cases}$$

$$\frac{w}{h} = \begin{cases} \dfrac{8e^A}{e^{2A} - 2}, & \dfrac{w}{h} < 2 \\[2ex] \dfrac{2}{\pi}\left\{B - 1 - \ln\left(2B - 1\right) + \dfrac{\varepsilon_r - 1}{2\varepsilon_r}\left[\ln\left(B - 1\right) + 0.39 - \dfrac{0.61}{\varepsilon_r}\right]\right\}, & \dfrac{w}{h} > 2 \end{cases}$$

where $A = \dfrac{Z_0}{60}\sqrt{\dfrac{\varepsilon_r + 1}{2}} + \dfrac{\varepsilon_r - 1}{\varepsilon_r + 1}\left(0.23 + \dfrac{0.11}{\varepsilon_r}\right)$, $B = \dfrac{377\pi}{2Z_0\sqrt{\varepsilon_r}}$

STRIPLINE CONDUCTOR

Also called *shielded microstrip*. The effective relative permittivity is used in calculations.

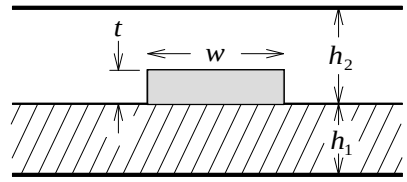

assuming $w \ge 10h$, $\varepsilon_{r\,\mathrm{eff}} = \dfrac{\varepsilon_{r1}h_1 + \varepsilon_{r2}h_2}{h_1 + h_2}$ where

ε_{r1} = the relative permittivity of the dielectric of thickness h_1.
ε_{r2} = the relative permittivity of the dielectric of thickness h_2.

COPPER CLADDING

The thickness of copper on a circuit board is measured in ounces. 1-ounce cladding means that 1 square foot of the copper weighs 1 ounce. 1-ounce copper is 0.0014" or 35.6 µm thick.

a_d DIELECTRIC LOSS FACTOR [dB/cm]

$$\alpha_d = 8.68\frac{\beta_0\varepsilon_r\left(\varepsilon_{r\,\mathrm{eff}} - 1\right)}{2\sqrt{\varepsilon_{r\,\mathrm{eff}}}\left(\varepsilon_r - 1\right)}\tan\delta$$

a_c CONDUCTOR LOSS FACTOR [dB/cm]

$$\alpha_c = 8.68\frac{R}{2Z_0}, \qquad R = \frac{1}{\sigma\delta(\text{perimeter})} = \sqrt{\frac{\omega\mu_0}{2\sigma}}\frac{1}{(\text{perimeter})}$$

WHEELER'S EQUATION

Another approximation for microstrip calculations is Wheeler's equation.

$$Z_0 = \frac{42.4}{\sqrt{1+\varepsilon_r}} \ln\left(1+\left\{\frac{4h}{w'}\left[\frac{14+\frac{8}{\varepsilon_r}}{11}\times\frac{4h}{w'}+\sqrt{\left(\frac{14+\frac{8}{\varepsilon_r}}{11}\times\frac{4h}{w'}\right)^2+\pi^2\frac{1+\frac{1}{\varepsilon_r}}{2}}\right]\right\}\right)$$

where $$w' = \frac{8h\sqrt{\frac{7+\frac{4}{\varepsilon_r}}{11}\left[\exp\left(\frac{Z_0}{42.4}\sqrt{\varepsilon_r+1}\right)-1\right]+\frac{1+\frac{1}{\varepsilon_r}}{0.81}}}{\exp\left(\frac{Z_0}{42.4}\sqrt{\varepsilon_r+1}\right)-1}$$

NETWORK THEORY

S_{ij} SCATTERING PARAMETER

$$S_{ij}$$

observation port → i, excitation port → j

A scattering parameter, represented by S_{ij}, is a dimensionless value representing the fraction of wave amplitude transmitted from port j into port i, provided that all other ports are terminated with matched loads and only port j is receiving a signal. Under these same conditions, S_{ii} is the reflection coefficient at port i.

To experimentally determine the scattering parameters, attach an impedance-matched generator to one of the ports (***excitation port***), attach impedance-matched loads to the remaining ports, and observe the signal received at each of the ports (***observation ports***). The fractional amounts of signal amplitude received at each port i will make up one column j of the **scattering matrix**. Repeating the process for each column would require n^2 measurements to determine the scattering matrix for an n-port network.

S_{ij} SCATTERING MATRIX

$$\begin{bmatrix} S_{11} & S_{12} & \cdots & S_{1N} \\ S_{21} & S_{22} & \cdots & S_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ S_{N1} & S_{N2} & \cdots & S_{NN} \end{bmatrix}$$

The scattering matrix is an $n \times n$ matrix composed of scattering parameters that describes an n-port network.

The elements of the diagonal of the scattering matrix are reflection coefficients of each port. The elements of the off-diagonal are transmission coefficients, under the conditions outlined in "SCATTERING PARAMETER".

If the network is **internally matched** or **self-matched**, then $S_{11} = S_{22} = \cdots = S_{NN} = 0$, that is, the diagonal is all zeros.

The sum of the squares of each column of a scattering matrix is equal to one, provided the network is lossless.

a_n, b_n INCIDENT/REFLECTED WAVE AMPLITUDES

The parameters a_n and b_n describe the incident and reflected waves respectively at each port n. These parameters are used for power and scattering matrix calculations.

The amplitude of the wave incident to port n is equal to the amplitude of the incident voltage at the port divided by the square root of the port impedance.	$a_n = \frac{V_n^+}{\sqrt{Z_{0n}}}$
Amplitude of the wave reflected at port n is equal to the amplitude of the reflected voltage at the port divided by the square root of the port impedance.	$b_n = \frac{V_n^-}{\sqrt{Z_{0n}}}$
The scattering parameter is equal to the wave amplitude output at port i divided by the wave amplitude input at port j provided the only source is a matched source at port j and all other ports are connected to matched loads.	$S_{\mathrm{ij}} = \frac{b_{\mathrm{i}}}{a_{\mathrm{j}}}$
The relationship between the S-parameters and the a- and b-parameters can be written in matrix form where **S** is the scattering matrix and **a** and **b** are column vectors.	$\mathbf{b} = \mathbf{Sa}$
Power flow into any port is shown as a function of a- and b-parameters.	$P = \frac{1}{2}\left(\lvert a\rvert^2 - \lvert b\rvert^2\right)$
The ratio of the input power at port j to the output power at port I can be written as a function of a- and b-parameters or the S-parameter.	$\frac{P_{in\,\mathrm{j}}}{P_{out\,\mathrm{i}}} = \frac{\lvert a_{\mathrm{j}}\rvert^2}{\lvert b_{\mathrm{j}}\rvert^2} = \frac{1}{\lvert S_{\mathrm{ij}}\rvert^2}$

RECIPROCITY

A network is reciprocal when $S_{\mathrm{ij}} = S_{\mathrm{ji}}$ in the scattering matrix, i.e. the matrix is symmetric across the diagonal. Also, $Z_{\mathrm{ij}} = Z_{\mathrm{ji}}$ and $Y_{\mathrm{ij}} = Y_{\mathrm{ji}}$. Networks constructed of "normal materials" exhibit reciprocity.

Reciprocity Theorem:

$$\oint_S \vec{E}_a \times \vec{H}_b \cdot ds = \oint_S \vec{E}_b \times \vec{H}_a \cdot ds$$

E_a and H_b are fields from two different sources.

LOSSLESS NETWORK

A network is lossless when

$$\underline{S}\ \ \underline{S}^{\dagger} = I$$

† means to take the complex conjugate and transpose the matrix. If the network is reciprocal, then the transpose is the same as the original matrix.

I = a unitary matrix. A **unitary matrix** has the properties:

$$\sum_{k=1}^{N} S_{ki} S_{ki}^* = 1 \qquad \sum_{k=1}^{N} S_{ki} S_{kj}^* = 0$$

In other words, a column of a unitary matrix multiplied by its complex conjugate equals one, and a column of a unitary matrix multiplied by the complex conjugate of a different column equals zero.

RAT RACE OR HYBRID RING NETWORK

The rat race or hybrid ring network is lossless, reciprocal, and internally matched.

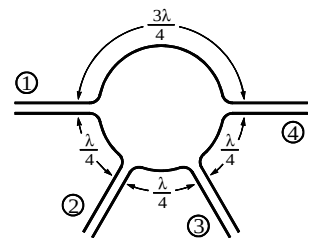

The signal splits upon entering the network and half travels around each side. A signal entering at port 1 and exiting at port 4 travels ¾ of a wavelength along each side, so the signals are in phase and additive. From port 1 to port 3 the signal travels one wavelength along one side and ½ wavelength along the other, arriving a port 3 out of phase and thus canceling. From port 1 to port 2 the paths are ¼ and 5/4 wavelengths respectively, thus they are in phase and additive.

DIRECTIONAL COUPLER

The directional coupler is a 4-port network similar to the rat race. It can be used to measure reflected and transmitted power to an antenna.

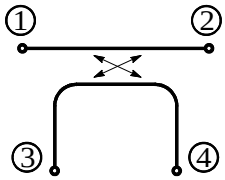

An input at one port is divided between two of the remaining ports. The **coupling factor**, measured in dB, describes the division of signal strength at the two ports. For example if the coupler has a coupling factor of –10 dB, then a signal input at port 1 would appear at port 4 attenuated by 10 dB with the majority of the signal passing to port 2. In other words, 90% of the signal would appear at port 2 and 10% at port 4. (-10 dB means "**10 dB down**" or 0.1 power, -6 dB means 0.25 power, and –3 dB means 0.5 power.) A reflection from port 2 would appear at port 3 attenuated by the same amount. Meters attached to ports 3 and 4 could be used to measure reflected and transmitted power for a system with a transmitter connected to port 1 and an antenna at port 2. The **directivity** of a coupler is a measurement of how well the coupler transfers the signal to the appropriate output without reflection due to the coupler itself; the directivity approaches infinity for a perfect coupler. $\text{directivity} = 10\log\left(p_3 / p_1\right)$, where the source is at port 1 and the load is at port 2.

The directional coupler is **lossless** and **reciprocal**. The scattering matrix looks like this. In a real coupler, the off-diagonal zeros would be near zero due to leakage.

$$\begin{bmatrix} 0 & p & 0 & -q \\ p & 0 & q & 0 \\ 0 & q & 0 & p \\ -q & 0 & p & 0 \end{bmatrix}$$

CIRCULATOR

The circulator is a 3-port network that can be used to prevent reflection at the antenna from returning to the source.

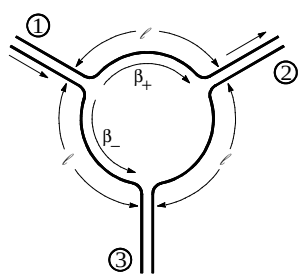

Port 3 is terminated internally by a matched load. With a source at 1 and a load at 2, any power reflected at the load is absorbed by the load resistance at port 3. A 3-port network cannot be both lossless and reciprocal, so the circulator is <u>not</u> reciprocal.

Schematically, the circulator may be depicted like this:

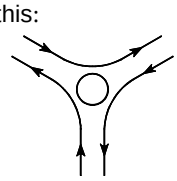

The circulator is **lossless** but is <u>not</u> **reciprocal**. The scattering matrix looks like this:

$$\begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

MAXWELL'S EQUATIONS, TIME HARMONIC FORM

$$\nabla \times \bar{\mathscr{E}} = -j\omega\mu\mathbf{H} \qquad \text{"curl on E"}$$

$$\nabla \times \bar{\mathscr{H}} = -j\omega\mu\mathbf{E} \qquad \text{"curl on H"}$$

$$\bar{\mathscr{E}} = \left[E_x(x,y)\hat{\mathbf{x}} + E_y(x,y)\hat{\mathbf{y}} + E_z(x,y)\hat{\mathbf{z}}\right]e^{j\omega t - \gamma z}$$

$$\bar{\mathscr{H}} = \left[H_x(x,y)\hat{\mathbf{x}} + H_y(x,y)\hat{\mathbf{y}} + H_z(x,y)\hat{\mathbf{z}}\right]e^{j\omega t - \gamma z}$$

From the curl equations we can derive:

(1) $\dfrac{\partial E_z}{\partial y} + \gamma E_y = -j\omega\mu H_x$ (4) $\dfrac{\partial H_z}{\partial y} + \gamma H_y = j\omega\varepsilon E_x$

(2) $-\dfrac{\partial E_z}{\partial x} - \gamma E_x = -j\omega\mu H_y$ (5) $-\dfrac{\partial H_z}{\partial x} - \gamma H_x = j\omega\varepsilon E_y$

(3) $\dfrac{\partial E_y}{\partial x} - \dfrac{\partial E_x}{\partial y} = -j\omega\mu H_z$ (6) $\dfrac{\partial H_y}{\partial x} - \dfrac{\partial H_x}{\partial y} = j\omega\varepsilon E_z$

From the above equations we can obtain:

(1) & (5) $H_x = \dfrac{1}{\gamma^2 + \omega^2\mu\varepsilon}\left(j\omega\varepsilon\dfrac{\partial E_z}{\partial y} - \gamma\dfrac{\partial H_z}{\partial x}\right)$

(2) & (4) $H_y = \dfrac{1}{\gamma^2 + \omega^2\mu\varepsilon}\left(j\omega\varepsilon\dfrac{\partial E_z}{\partial x} - \gamma\dfrac{\partial H_z}{\partial y}\right)$

(2) & (4) $E_x = -\dfrac{1}{\gamma^2 + \omega^2\mu\varepsilon}\left(-\gamma\dfrac{\partial E_z}{\partial x} + j\omega\mu\dfrac{\partial H_z}{\partial y}\right)$

(1) & (5) $E_y = -\dfrac{1}{\gamma^2 + \omega^2\mu\varepsilon}\left(-\gamma\dfrac{\partial E_z}{\partial y} + j\omega\mu\dfrac{\partial H_z}{\partial x}\right)$

This makes it look like if E_z and H_z are zero, then H_x, H_y, E_x, and E_y are all zero. But since $\infty \times 0 \neq 0$, we could have non-zero result for the TEM wave if $\gamma^2 = -\omega^2\mu\varepsilon \Rightarrow \gamma = j\omega\sqrt{\mu\varepsilon}$. This should look familiar.

WAVE EQUATIONS

From Maxwell's equations and a vector identity on curl, we can get the following wave equations:

$$\nabla^2 \overline{\mathscr{E}} = -\omega^2 \mu\varepsilon \overline{\mathscr{E}} \qquad \text{"del squared on E"}$$

$$\nabla^2 \overline{\mathscr{H}} = \omega^2 \mu\varepsilon \overline{\mathscr{H}} \qquad \text{"del squared on H"}$$

The z part or "del squared on E_z" is:

$$\nabla^2 E_z = \frac{\gamma^2 E_z}{\partial x^2} + \frac{\gamma^2 E_z}{\partial y^2} + \frac{\gamma^2 E_z}{\partial z^2} = -\omega^2 \mu\varepsilon E_z$$

Using the separation of variables, we can let:

$$E_z = X(x) \cdot Y(y) \cdot Z(z)$$

We substitute this into the previous equation and divide by $X \cdot Y \cdot Z$ to get:

$$\underbrace{\frac{1}{X}\frac{d^2X}{dx^2}}_{-k_x^2} + \underbrace{\frac{1}{Y}\frac{d^2Y}{dy^2}}_{-k_y^2} + \underbrace{\frac{1}{Z}\frac{d^2Z}{dz^2}}_{-k_z^2} = \underbrace{-\omega^2\mu\varepsilon}_{\text{a constant}}$$

Since X, Y, and Z are independent variables, the only way the sum of these 3 expressions can equal a constant is if all 3 expressions are constants.

So we are letting $\frac{1}{Z}\frac{d^2Z}{dz^2} = -k_z^2 \Rightarrow \frac{d^2Z}{dz^2} = -Zk_z^2$

A solution could be $Z = e^{-\gamma z}$

so that $\gamma^2 e^{-\gamma z} = -k_z^2 e^{-\gamma z}$ and $-k_z^2 = \gamma^2$

Solutions for X and Y are found

$$\frac{1}{X}\frac{d^2X}{dx^2} = -k_x^2 \Rightarrow X = A\sin(k_x x) + B\cos(k_x x)$$

$$\frac{1}{Y}\frac{d^2Y}{dy^2} = -k_y^2 \Rightarrow Y = C\sin(k_y y) + D\cos(k_y y)$$

giving us the general solution $k_x^2 + k_y^2 - \gamma^2 = \omega^2\mu\varepsilon$

For a particular solution we need to specify initial conditions and boundary conditions. For some reason, initial conditions are not an issue. The unknowns are k_x, k_y, A, B, C, D. The boundary conditions are

$$E_{\tan} = 0 \qquad \frac{\partial H_{\tan}}{\partial n} = 0$$

$E_{\tan}$ = the electric field tangential to a conducting surface
$H_{\tan}$ = the magnetic field tangential to a conducting surface
n = I don't know

TM, TE WAVES IN PARALLEL PLATES

TM, or transverse magnetic, means that magnetic waves are confined to the *transverse plane*. Similarly, TE (transverse electric) means that electrical waves are confined to the transverse plane.

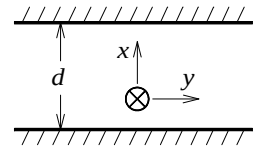

(z direction is into page)

Transverse plane means the plane that is transverse to (perpendicular to) the direction of propagation. The direction of propagation is taken to be in the z direction, so the transverse plane is the x-y plane. So for a TM wave, there is no H_z component (magnetic component in the z direction) but there is an E_z component.

$$\boxed{E_z = A\sin(k_x x)e^{-\gamma z}}$$

A = amplitude [V]

$k_x = \frac{m\pi}{d}$ The magnetic field must be zero at the plate boundaries. This value provides that characteristic. [cm^{-1}]

x = position; perpendicular distance from one plate. [cm]
d = plate separation [cm]
γ = propagation constant
z = position along the direction of propagation [cm]
m = mode number; an integer greater than or equal to 1

$$\boxed{\gamma = \sqrt{-\omega^2\mu\varepsilon + (kx)^2}}$$

Notice than when $(kx)^2 \geq \omega^2\mu\varepsilon$, the quantity under the square root sign will be positive and γ will be purely real. In this circumstance, the wave is said to be evanescent. The wavelength goes to infinity; there is no oscillation or propagation. On the other hand, when $(kx)^2 < \omega^2\mu\varepsilon$, γ is purely imaginary.

The magnitude of E_z is related to its position between the plates and the mode number m. Note that for m = 2 that $d = \lambda$.

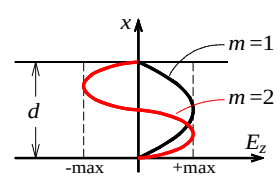

GENERAL MATHEMATICAL

COMPLEX TO POLAR NOTATION

j in polar notation:

$$j = e^{j\frac{\pi}{2}}$$

So we can find the square root of j:

$$\sqrt{j} = \sqrt{e^{j\frac{\pi}{2}}} = e^{j\frac{\pi}{4}} = \frac{1}{\sqrt{2}} + j\frac{1}{\sqrt{2}}$$

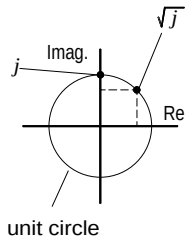

dBm DECIBELS RELATIVE TO 1 mW

The decibel expression for power. The logarithmic nature of decibel units translates the multiplication and division associated with gains and losses into addition and subtraction.

0 dBm = 1 mW
20 dBm = 100 mW
-20 dBm = 0.01 mW

$$P(\text{dBm}) = 10\log\left[P(\text{mW})\right]$$

$$P(\text{mW}) = 10^{P(\text{dBm})/10}$$

PHASOR NOTATION

To express a derivative in phasor notation, replace $\frac{\partial}{\partial t}$ with $j\omega$. For example, the

Telegrapher's equation $\frac{\partial V}{\partial z} = -L\frac{\partial I}{\partial t}$

becomes $\frac{\partial V}{\partial z} = -Lj\omega I$.

Ñ NABLA, DEL OR GRAD OPERATOR

Compare the ∇ operation to taking the time derivative. Where $\partial/\partial t$ means to take the derivative with respect to time and introduces a s^{-1} component to the units of the result, the ∇ operation means to take the derivative with respect to distance (in 3 dimensions) and introduces a m^{-1} component to the units of the result. ∇ terms may be called space derivatives and an equation which contains the ∇ operator may be called a vector differential equation. In other words $\nabla\mathbf{A}$ is how fast $\mathbf{A}$ changes as you move through space.

in rectangular coordinates: $\nabla\mathbf{A} = \hat{x}\frac{\partial A}{\partial x} + \hat{y}\frac{\partial A}{\partial y} + \hat{z}\frac{\partial A}{\partial z}$

in cylindrical coordinates: $\nabla\mathbf{A} = \hat{r}\frac{\partial A}{\partial r} + \hat{\phi}\frac{1}{r}\frac{\partial A}{\partial \phi} + \hat{z}\frac{\partial A}{\partial z}$

in spherical coordinates: $\nabla\mathbf{A} = \hat{r}\frac{\partial A}{\partial r} + \hat{\theta}\frac{1}{r}\frac{\partial A}{\partial \theta} + \hat{\phi}\frac{1}{r\sin\theta}\frac{\partial A}{\partial \phi}$

∇ GRADIENT

$$\boxed{\nabla\vec{\Phi} = -\mathbf{E}}$$

"The gradient of the vector Φ" or "del Φ" is equal to the negative of the electric field vector.

$\nabla\Phi$ is a vector giving the direction and magnitude of the maximum spatial variation of the scalar function Φ at a point in space.

$$\nabla\vec{\Phi} = \hat{\mathbf{x}}\frac{\partial\Phi}{\partial x} + \hat{\mathbf{y}}\frac{\partial\Phi}{\partial y} + \hat{\mathbf{z}}\frac{\partial\Phi}{\partial z}$$

Ñ· DIVERGENCE

$\nabla\cdot$ is also a vector operator, combining the "del" or "grad" operator with the dot product operator and is read as "the divergence of". In this form of Gauss' law, where $\mathbf{D}$ is a density per unit area, with the operators applied, $\nabla\cdot\mathbf{D}$ becomes a density per unit volume.

$$\boxed{\text{div}\,\mathbf{D} = \nabla\cdot\mathbf{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z} = \rho}$$

$\mathbf{D}$ = electric flux density vector $\mathbf{D} = \varepsilon\mathbf{E}$ [C/m^2]
ρ = source charge density [C/m^3]

Ñ² THE LAPLACIAN

∇^2 is a combination of the divergence and del operations, i.e. $\text{div}(\text{grad}\,\Phi) = \nabla\cdot\nabla\,\Phi = \nabla^2\,\Phi$. It is read as "the LaPlacian of" or "del squared".

$$\boxed{\nabla^2\mathbf{F} = \frac{\partial^2\Phi}{\partial x^2} + \frac{\partial^2\Phi}{\partial y^2} + \frac{\partial^2\Phi}{\partial z^2}}$$

F = electric potential [V]

GRAPHING TERMINOLOGY

With *x* being the horizontal axis and *y* the vertical, we have a graph of ***y* versus *x*** or ***y* as a function of *x***. The *x*-axis represents the **independent variable** and the *y*-axis represents the **dependent variable**, so that when a graph is used to illustrate data, the data of regular interval (often this is time) is plotted on the *x*-axis and the corresponding data is dependent on those values and is plotted on the *y*-axis.

HYPERBOLIC FUNCTIONS

$$j\sin\theta = \sinh(j\theta)$$

$$j\cos\theta = \cosh(j\theta)$$

$$j\tan\theta = \tanh(j\theta)$$

TAYLOR SERIES

$$\sqrt{1+x} \approx 1 + \frac{1}{2}x, \quad x \ll 1$$

$$\frac{1}{1-x^2} \approx 1 + x^2 + x^4 + x^6 + \cdots, \quad |x| < 1$$

$$\frac{1}{1\pm x} \approx 1 \mp x, \quad x \ll 1$$

ELECTROMAGNETIC SPECTRUM

FREQUENCY	WAVELENGTH (free space)	DESIGNATION	APPLICATIONS
< 3 Hz	> 100 Mm		Geophysical prospecting
3-30 Hz	10-100 Mm	ELF	Detection of buried metals
30-300 Hz	1-10 Mm	SLF	Power transmission, submarine communications
0.3-3 kHz	0.1-1 Mm	ULF	Telephone, audio
3-30 kHz	10-100 km	VLF	Navigation, positioning, naval communications
30-300 kHz	1-10 km	LF	Navigation, radio beacons
0.3-3 MHz	0.1-1 km	MF	AM broadcasting
3-30 MHz	10-100 m	HF	Short wave, citizens' band
30-300 MHz 54-72 76-88 88-108 174-216	1-10 m	VHF	TV, FM, police TV channels 2-4 TV channels 5-6 FM radio TV channels 7-13
0.3-3 GHz 470-890 MHz 915 MHz 800-2500 MHz 1-2 2.45 2-4	10-100 cm	UHF "money band"	Radar, TV, GPS, cellular phone TV channels 14-83 Microwave ovens (Europe) PCS cellular phones, analog at 900 MHz, GSM/CDMA at 1900 L-band, GPS system Microwave ovens (U.S.) S-band
3-30 GHz 4-8 8-12 12-18 18-27	1-10 cm	SHF	Radar, satellite communications C-band X-band (Police radar at 11 GHz) K_u-band (dBS Primestar at 14 GHz) K-band (Police radar at 22 GHz)
30-300 GHz 27-40 40-60 60-80 80-100	0.1-1 cm	EHF	Radar, remote sensing K_a-band (Police radar at 35 GHz) U-band V-band W-band
0.3-1 THz	0.3-1 mm	Millimeter	Astromony, meteorology
10^{12}-10^{14} Hz	3-300 μm	Infrared	Heating, night vision, optical communications
3.95×10^{14}- 7.7×10^{14} Hz	390-760 nm 625-760 600-625 577-600 492-577 455-492 390-455	Visible light	Vision, astronomy, optical communications Red Orange Yellow Green Blue Violet
10^{15}-10^{18} Hz	0.3-300 nm	Ultraviolet	Sterilization
10^{16}-10^{21} Hz		X-rays	Medical diagnosis
10^{18}-10^{22} Hz		γ-rays	Cancer therapy, astrophysics
> 10^{22} Hz		Cosmic rays	Astrophysics

GLOSSARY

anisotropic materials materials in which the electric polarization vector is not in the same direction as the electric field. The values of ε, μ, and σ are dependent on the field direction. Examples are crystal structures and ionized gases.

complex permittivity e The imaginary part accounts for heat loss in the medium due to damping of the vibrating dipole moments.

dielectric An insulator. When the presence of an applied field displaces electrons within a molecule away from their average positions, the material is said to be polarized. When we consider the polarizations of insulators, we refer to them as *dielectrics*.

empirical A result based on observation or experience rather than theory, e.g. *empirical data*, *empirical formulas*. Capable of being verified or disproved by observation or experiment, e.g. *empirical laws*.

evanescent wave A wave for which $\beta=0$. α will be negative. That is, γ is purely real. The wave has infinite wavelength—there is no oscillation.

isotropic materials materials in which the electric polarization vector is in the same direction as the electric field. The material responds in the same way for all directions of an electric field vector, i.e. the values of ε, μ, and σ are constant regardless of the field direction.

linear materials materials which respond proportionally to increased field levels. The value of μ is not related to $\mathbf{H}$ and the value of ε is not related to $\mathbf{E}$. Glass is linear, iron is non-linear.

overdamped system in the case of a transmission line, this means that when the source voltage is applied the line voltage rises to the final voltage without exceeding it.

time variable materials materials whose response to an electric field changes over time, e.g. when a sound wave passes through them.

transverse plane perpendicular, e.g. the x-y plane is *transverse* to z.

underdamped system in the case of a transmission line, this means that after the source voltage is applied the line voltage periodically exceeds the final voltage.

wave number *k* The phase constant for the uniform plane wave. k may be considered a constant of the medium at a particular frequency.

Abbreviations and Acronyms

The following abbreviations are used in this paper. Abbreviations are defined on first use.

1G – First Generation

1xEV-DO – One Carrier Evolution, Data Optimized

1xEV-DV – One Carrier Evolution, Data Voice

1XRTT – One Carrier Radio Transmission Technology

2G – Second Generation

3G – Third Generation (meeting requirements set forth by the ITU IMT project)

3GPP – Third Generation Partnership Project

3GPP2 – Third Generation Partnership Project 2

4G – Fourth Generation (meeting requirements set forth by the ITU IMT-Advanced project)

5GC – 5G Core

8-PSK – Octagonal Phase Shift Keying

AAS – Adaptive Antenna Systems

ABR – Allocation Retention Priority

AGW – Access Gateway

AMF – Access and Mobility Management Function

AMR – Adaptive Multi Rate

AMR-WB – Adaptive Multi-Rate Wideband

ANDSF – Access Network Discovery and Selection Function.

ANSI – American National Standards Institute

APCO – Association of Public Safety Officials

API – Application Programming Interface

APN – Access Point Name

ARP – Allocation Retention Priority

ARPU – Average Revenue per User

ARQ – Automatic Repeat Request

ATM – Asynchronous Transfer Mode

AWGN – Additive White Gaussian Noise Channel

AWS – Advanced Wireless Services

BCCH – Broadcast Control Channel

bps – bits per second

BRS – Broadband Radio Service

BSC – Base Station Controller

BTS – Base Transceiver Station

C/I – Carrier to Intermodulation Ratio

CAPEX- Capital Expenditure

CBF – Coordinated Beam Forming

CBRS – Citizens Broadband Radio Service

CBS – Coordinated Beam Switching
CSS3 – Cascading Style Sheets 3 (CSS3)
CDD – Cyclic Delay Diversity
CDF – Cumulative Distribution Function
CDMA – Code Division Multiple Access
CL – Closed Loop
CL-SM – Closed Loop Spatial Multiplexing
CMAS – Commercial Mobile Alert System
CMOS – Complementary Metal Oxide Semiconductor
CoMP – Coordinated Multi Point
cMTC – Critical Machine Type Communications
CP – Cyclic Prefix
CPC – Continuous Packet Connectivity
CPRI – Common Public Radio Interface
CQI - Channel Quality Indicators
C-RAN – Cloud Radio Access Network
CRM – Customer Relationship Management
CRS – Cell-specific Reference Signal
CS – Convergence Sublayer
CSFB – Circuit-Switched Fallback
CTIA – Cellular Telephone Industries Association
C-V2X – Cellular Vehicle-to-X
D-AMPS – Digital Advanced Mobile Phone Service
DAS – Distributed Antenna System
DAS – Downlink EGPRS2-A Level Scheme
dB – Decibel
DBS – Downlink EGPRS2-B Level Scheme
DC-HSPA – Dual Carrier HSPA
DFT – Discrete Fourier Transform
DL – Downlink
DNS – Domain Name Service
DPCCH – Dedicated Physical Control Channel
DPS – Dynamic Point Selection
DSL – Digital Subscriber Line
DSMIPv6 – Dual Stack Mobile IPv6
DTM – Dual Transfer Mode
DRX – Discontinuous Reception
D-TxAA – Double Transmit Adaptive Array
DVB-H – Digital Video Broadcasting Handheld

E-DCH – Enhanced Dedicated Channel
EBCMCS – Enhanced Broadcast Multicast Services
EC-GSM – Extended Coverage GSM
eCoMP – enhanced CoMP
EDGE – Enhanced Data Rates for GSM Evolution
EFTA – Enhanced Flexible Timeslot Assignment
EGPRS – Enhanced General Packet Radio Service
eICIC – Enhanced Inter-Cell Interference Coordination
eMBMS – Enhanced Multimedia Broadcast Multicast Services
eNodeB – Evolved Node B
EAP – Extensible Authentication Protocol
eLAA – Enhanced Licensed-Assisted Access
eNB – Evolved Node B
EPC – Evolved Packet Core
EPDCCH – Enhanced Physical Downlink Control Channel
eMBB – Enhanced Mobile Broadband
ePDG – Enhanced Packet Data Gateway
EPS – Evolved Packet System
ERP – Enterprise Resource Planning
eSaMOG – Enhanced S2a-based Mobility over GTP
ESC – Environmental Sensing Capability
eSRVCC – Enhanced Single-Radio Voice Call Continuity
ETRI – Electronic and Telecommunications Research Institute
ETSI – European Telecommunications Standards Institute
E-UTRAN – Enhanced UMTS Terrestrial Radio Access Network
EVS – Enhanced Voice Services (codec)
FE-FACH – Further Enhanced Forward Access Channel
EV-DO –Evolution, Data Optimized
EV-DV –Evolution, Data Voice
EVRC – Enhanced Variable Rate Codec
FBMC – Filter-Bank Multi-Carrier
FCC – Federal Communications Commission
FDD – Frequency Division Duplex
FeCoMP – Further Enhanced Coordinated Multi Point
feICIC – Further enhanced ICIC
FirstNet – First Responder Network Authority
Flash OFDM – Fast Low-Latency Access with Seamless Handoff OFDM
FLO – Forward-Link Only
FMC – Fixed Mobile Convergence

FP7 – Seventh Framework Programme
FTP – File Transfer Protocol
GAA – General Authorized Access
GAN – Generic Access Network
GB – Gigabyte
Gbps – Gigabits Per Second
GBR – Guaranteed Bit Rate
GByte – Gigabyte
GCS – Group Communication Service
GERAN – GSM EDGE Radio Access Network
GFDM – Generalized Frequency Division Multiplexing
GGSN – Gateway GPRS Support Node
GHz — Gigahertz
GMSK – Gaussian Minimum Shift Keying
gNB – NR NodeB
GPRS – General Packet Radio Service
G-Rake – Generalized Rake Receiver
GSM – Global System for Mobile Communications
GSMA – GSM Association
HARQ – Hybrid Automatic Repeat Request
HD – High Definition
HetNet – heterogeneous network
HLR – Home Location Register
Hr – Hour
HSDPA – High Speed Downlink Packet Access
HS-FACH – High Speed Forward Access Channel
HS-PDSCH - High Speed Physical Downlink Shared Channels
HS-RACH – High Speed Reverse Access Channel
HSPA – High Speed Packet Access (HSDPA with HSUPA)
HSPA+ – HSPA Evolution
HSS – Home Subscriber Server
HSUPA – High Speed Uplink Packet Access
Hz – Hertz
ICIC – Inter-Cell Interference Coordination
ICN – Information-Centric Networking
ICS – IMS Centralized Services
ICT – Information and Communication Technologies
IEEE – Institute of Electrical and Electronic Engineers
IETF – Internet Engineering Taskforce

IFFT – Inverse Fast Fourier Transform
IFOM – IP Flow and Seamless Offload
IM – Instant Messaging
IMS – IP Multimedia Subsystem
IMT – International Mobile Telecommunications
IMT-Advanced - International Mobile Telecommunications-Advanced
IRC – Interference Rejection Combining
IoT – Internet of Things
IPR - Intellectual Property Rights
IP – Internet Protocol
IPTV – Internet Protocol Television
IR – Incremental Redundancy
ISD – Inter-site Distance
ISI – Intersymbol Interference
ISP – Internet Service Provider
ITU – International Telecommunication Union
JCP – Java Community Process
JR – Joint Reception
JT – Joint Transmission
Kbps – Kilobits Per Second
kHz — Kilohertz
km – Kilometer
LAA – License-Assisted Access
LBT – Listen-Before-Talk
LDPC - Low-Density Parity Code
LIPA – Local IP Access
LMDS – Local Multipoint Distribution Service
LPWA – Low-Power Wide-Area
LTE – Long Term Evolution
LTE-A – LTE-Advanced
LTE-TDD – LTE Time Division Duplex
LTE-U – LTE-Unlicensed
LSTI – LTE/SAE Trial Initiative
LWA – LTE Wi-Fi Aggregation
LWIP – LTE WLAN Radio Level Integration with IPsec Tunnel
M2M – Machine-to-machine
MAC – Medium-Access Control
MAPCON – Multi-Access PDN Connectivity
MB - Megabyte

MBMS - Multimedia Broadcast/Multicast Service

Mbps – Megabits Per Second

MBR – Maximum Bit Rate

MBSFN – Multicast/broadcast, Single Frequency

MCPA – Mobile Consumer Application Platform

Mcps – Megachips Per Second

MCPTT – Mission-Critical Push-to-Talk

MCS – Modulation and Coding Scheme

MCW – Multiple Codeword

MDT – Minimization of Drive Tests

MEAP – Mobile Enterprise Application Platforms

MEC – Multi-access Edge Computing

MediaFLO – Media Forward Link Only

METIS – Mobile and wireless communications Enablers for the Twenty-twenty Information Society

MHz – Megahertz

MID – Mobile Internet Devices

MIMO – Multiple Input Multiple Output

MMSE – Minimum Mean Square Error

mITF – Japan Mobile IT Forum

MMDS – Multichannel Multipoint Distribution Service

MME – Mobile Management Entity

mMTC – Massive Machine Type Communications

MOS – Mean Opinion Score

MP-QUIC – Multipath Quick UDP Internet Connections

MP-TCP – Multipath TCP

MRxD – Mobile Receive Diversity

ms – millisecond

MS – Mobile Station

MSA – Mobile Service Architecture

MSC – Mobile Switching Center

MTC – Machine Type Communications

MTC-IWF – Machine-Type Communications Interworking Function (MTC-IWF)

msec – millisecond

MU-MIMO – Multi-User MIMO

MUST – Downlink Multiuser Superposition Transmission

NAICS – Network-Assisted Interference Cancellation and Suppression

NB-IoT – Narrowband Internet of Things

NENA – National Emergency Number Association

NGMC – Next Generation Mobile Committee

NGMN – Next Generation Mobile Networks Alliance
NG-RAN – New Generation Radio Access Network
NOMA – Non-Orthogonal Multiple Access
NR – New Radio
NTIA – National Telecommunications and Information Administration
OFDM – Orthogonal Frequency Division Multiplexing
OFDMA – Orthogonal Frequency Division Multiple Access
OL-SM – Open Loop Spatial Multiplexing
OMA – Open Mobile Alliance
ORI – Open Radio Equipment Interface
PA – Priority Access
PAL – Priority Access License
PAR – Peak to Average Ratio
PBCCH – Packet Broadcast Control Channel
PCH – Paging Channel
PCRF – Policy Control and Charging Rules Function
PCS – Personal Communications Service
PDCP – Packet Data Convergence Protocol
PDN – Packet Data Network
PGW – Packet Gateway
PHY – Physical Layer
PMI – Precoding Matrix Indication
PMIPv6 – Proxy Mobile IPv6
PNF – Physical Network Function
PoC – Push-to-Talk Over Cellular
PSH – Packet Switched Handover
PSK – Phase-Shift Keying
QAM – Quadrature Amplitude Modulation
QCI – Quality of Service Class Identifier
QLIC – Quasi-Linear Interference Cancellation
QoS – Quality of Service
QPSK – Quadrature Phase Shift Keying
QUIC – Quick UDP Internet Connections.
RAB – Radio Access Bearer
RAN – Radio Access Network
RCAF – RAN Congestion Awareness Function
RCLWI - RAN Controlled LTE WLAN Interworking
RCS – Rich Communications Suite
REST – Representational State Transfer

RF – Radio Frequency
RLC – Radio Link Control
RNC – Radio Network Controller
ROHC – Robust Header Compression
RRC – Radio Resource Control
RRH – Remote Radio Head
RRU – Remote Radio Unit
RTP – Real Time Transport Protocol
RTSP – Real Time Streaming Protocol
SAE – System Architecture Evolution
SaMOG – S2a-based Mobility over GTP
SAS – Spectrum Access System
SC-FDMA – Single Carrier Frequency Division Multiple Access
SCMA – Sparse Coded Multiple Access
SCRI – Signaling Connection Release Indication
SCW – Single Codeword
SDAP – Service Data Adaptation Protocol
SDMA – Space Division Multiple Access
SDN – Software-Defined Networking
SDP – Session Description Protocol
sec – Second
SFBA – Space Frequency Block Code
SFN – Single Frequency Network
SGSN – Serving GPRS Support Node
SGW – Serving Gateway
SIC – Successive Interference Cancellation
SIM – Subscriber Identity Module
SIMO – Single Input Multiple Output
SINR – Signal to Interference Plus Noise Ratio
SIP – Session Initiation Protocol
SIPTO – Selected IP Traffic Offload
SISO – Single Input Single Output
SMS – Short Message Service
SNR – Signal to Noise Ratio
SON – Self-Organizing Network
SPS – Semi-Persistent Scheduling
SRVCC – Single-Radio Voice Call Continuity
SU-MIMO – Single User MIMO
SVDO – Simultaneous 1XRTT Voice and EV-DO Data

SVLTE – Simultaneous Voice and LTE
TCH – Traffic Channel
TCP/IP – Transmission Control Protocol/IP
TD – Transmit Diversity
TDD – Time Division Duplex
TDMA – Time Division Multiple Access
TD-SCDMA – Time Division Synchronous Code Division Multiple Access
TD-CDMA – Time Division Code Division Multiple Access
TETRA – Terrestrial Trunked Radio
TIA/EIA – Telecommunications Industry Association/Electronics Industry Association
TISPAN – Telecoms and Internet Converged Services and Protocols for Advanced Networks
TSG-RAN – Technical Services Group Radio Access Network
TTI – Transmission Time Interval
UAS – Uplink EGPRS2-A Level Scheme
UBS – Uplink EGPRS2-B Level Scheme
UE – User Equipment
UFMC – Universal Filtered Multi-Carrier
UICC – Universal Integrated Circuit Card
UL – Uplink
UMA – Unlicensed Mobile Access
UMB – Ultra Mobile Broadband
UMTS – Universal Mobile Telecommunications System
UPCON – User-Plane Congestion Management
UPF – User Plane Function
URA-PCH – UTRAN Registration Area Paging Channel
URI – Uniform Resource Identifier
URLLC – Ultra-Reliable and Low Latency Communications
us – Microsecond
USIM – UICC SIM
UTRAN – UMTS Terrestrial Radio Access Network
V2X – vehicle -to-infrastructure
VAMOS – Voice Services over Adaptive Multi-User Channels on One Slot
VDSL – Very-High-Bit-Rate DSL
VEPC – Virtualized EPC
ViLTE – Video Over LTE
VoIP – Voice over Internet Protocol
VoHSPA – Voice over HSPA
VoLGA – Voice over LTE Generic Access
VoLTE – Voice over LTE

VNF- Virtual Network Function

VPN – Virtual Private Network

WAP – Wireless Application Protocol

WBA – Wireless Broadband Alliance

WCDMA – Wideband Code Division Multiple Access

WCS – Wireless Communication Service

WebRTC – Web Real-Time Communication

Wi-Fi – Wireless Fidelity

WiMAX – Worldwide Interoperability for Microwave Access

WLAN – Wireless Local Area Network

WMAN – Wireless Metropolitan Area Network

WMM – Wi-Fi Multimedia

WRC – World Radiocommunication Conference

Additional Information

5G Americas maintains market information, LTE deployment lists, and numerous white papers, available for free download on its web site: http://www.5gamericas.org.

If there are any questions regarding the download of this information, please call +1 425 372 8922 or e-mail Anushka Bishen, Public Relations Coordinator at info@5gamericas.org.

This white paper was written for 5G Americas by Rysavy Research (http://www.rysavy.com) and utilized a composite of statistical information from multiple resources.

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Select Language

Robert P. Duncan A.B., S.M., M.B.A., Ph.D.: Government warfare and surveillance system architect, author, and independent investigator..

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Project Soul Catcher Vol. 2: Secrets of Cyber and Cybernetic Warfare Revealed (click book image to buy)

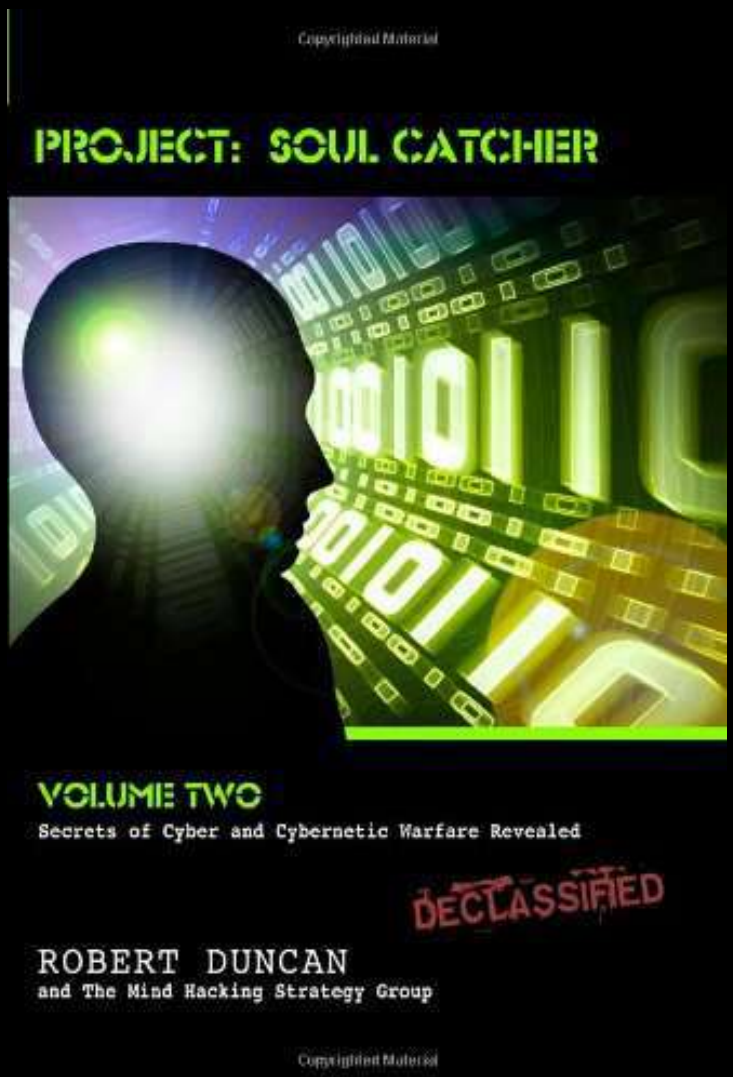

Volume 2 details the CIA's practices of interrogation and cybernetic mind control in their pursuit to weaponize neuropsychology. It covers the art of bio-communication war. Human beings are complex machines but their inner workings have been deciphered. Mind control and brainwashing have been perfected in the last 60 years. Hacking computers and hacking into individual minds are similar. The 21st century will be known as the age of spiritual machines and soulless men.

Check out Dr. Robert Duncan's other book, How to Tame a Demon: A short practical guide to organized intimidation stalking, electronic torture, and mind

control.

More information on Dr. Robert Duncan is available at drrobertduncan.com.

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Free eBook: The Matrix Deciphered by Dr. Robert Duncan, A.B., S.M., M.B.A., Ph.D., the book discloses secret details on government operations and gives a hint to what it's like to live like a victim targeted..

Bio of Dr. Robert Duncan, from his book The Matrix Deciphered:

"True nobility is exempt from fear".
– King Henry the Sixth, Part II (Act IV, Scene I).

Call me The Saint. I am the all American - prep school, Harvard College graduating with honors in computer science and a minor in premedical studies, and advanced degrees from Harvard and Dartmouth in business and science. My famous ancestors are President Lincoln, King Duncan of Scotland, and Governor William Bradford, the first governor of Massachusetts.

My research interests have been neural networks, virtual reality, and EEG controlled robotics. Before graduate school I worked for the Department of Defense, Navy, NATO, and various intelligence agencies computer science projects. I have done business consulting and computer consulting for the largest companies in the world. I have been a professor, inventor, artist, and writer. I am one of the last Renaissance men.

My projects have included algorithms for Echelon and CIA natural language parsing and classification of document content, IRS formula for red flagging audits, writing the artificial intelligence code to automate tracking of the Soviet Nuclear Submarine Fleet and all water vessels, work integrating HAARP with SIGINT SIGCOM and SPAWAR. I have worked on projects for the Justice Department connecting local, state, and federal databases for the tracking of terrorists. I developed a system for the FBI to track license plates past toll booths and other locations. I worked on the soldier 2000 program to create body networks for reading vital signs and other information. A system I worked on called Snyper is operational in Iraq which triangulates on intercity conflict gun shots. I have been to a couple secret bases in the so called free world. I have developed telemedicine robotic surgery and virtual reality applications for the Army. For DARPA, I have worked on satellite computer vision target tracking applications and tank simulation as well as integration of the land, sea, and air surveillance systems like SOSSUS, towed arrays, and others.

Projects that I have worked on outside of government contracts include my thesis on computer generated holography, a project making paralyzed people walk again using choreographed stimulated muscles movements, face recognition, voice identification and recognition, finger print recognition, and neural network robotic controller. My research interests moved to enhanced reality heads up displays and wearable computing systems. My current research involves finding a cure for the mind control directed energy weapons fiasco. The integrated global surveillance grid is actually part of the holy grail of weapons and human control systems.

My apologies to the human race for my contribution to tyranny. I was tricked into thinking it would not be misused by corrupt government especially in my beloved country. I was wrong. The Joint Non-Lethal Weapons Directorate has Skip Green on the governing board. One of my old colleagues at a technology think tank in Cambridge partly in charge of the radio frequency weapons testing for neurological disruption now torturing and killing people worldwide. Several other US Navy and UK Navy scientists have been knocked-off and that is why I have come forward. I know my time maybe near. I am currently a professor in computer science and business, helping to educate the public on government corruption, greed, and stupidity. Like my ancestor Lincoln, I am fighting against mental slavery in a new Civil War engineered by the same useless elements in over 80 government agencies who have tested radiological, drug, and viral weapons on unsuspecting Americans for over 45 years.

I have great pride in the fundamental and constitutional values of America and mean no disrespect by my blasting the incompetence, apathy, and stupidity of those involved in the conspiracy of involuntary biological, chemical, and psychotronic human effects testing. There are so many brave men and women serving in the armed forces who fight and protect us for the American values they believe in. But because of the silos of information called compartmentalization in the security agencies and the lack of accountability and oversight of black operations and some top secret projects, diabolical elements become rogue or worse destroying the very country they are tasked with protecting turning it into a hypocracy rather than a democracy.

My goal is to awaken Americans to the continued horrific acts of military and CIA weapons testers in this country and the other branches of government’s inability to stop them and hold them accountable.

All I ask from the reader is to listen to testimony and validate facts presented here and come to their own conclusion. Then fight to win back America from this silent overthrow. This has been my project for about two years, investigating government corruption, incompetence, and cover-up upon which I accidentally stumbled one day while looking at a reverse MRI scheme to inject electromagnetic signals into the brain for virtual reality applications. I have interviewed over two hundred people and worked on the highest level of military projects for the U.S., NATO, and U.K. and have given videotaped testimony to senators and representatives on this topic resulting in lip service since they have no real power to enforce. Two high level FBI agents and a couple CIA agents have come forward to validate the existence of a MKULTRA like project that continues to grab random people for mind control experimentation. Two of these have since become part of the program and endure daily psychotronic tortures. All the torture can be done using directed energy psychotronic weapons with the so called continental ballistic missile surveillance defense grids.

I apologize to the human race for any contribution to these 4th generation weapons that I may have worked on that are more horrific than the nuclear bomb and whose cover-up is more pervasive than the Manhattan Project. And because of the horrific acts of violence being committed on as many as two thousand Americans as far as my research has uncovered and many others in other countries, I understand the extreme risk to my own welfare that publishing this material will have. But freedom is so important to me that I know full heartedly that the human race

must have an open discussion on these weapons to decide their own fate before the point of decision is gone, that I am willing to risk divulging so called national secrets. All I offer you is the truth.

All information presented in this book was received through legitimate channels such as the Freedom of Information Act, military documents, victim testimony, and turned agents. I still hold valid the oath I took to keep secret the details of the projects that I worked on under DoD budgets. The majority of the proceeds of this book will go towards helping the psychotronic experiment survivors and surviving families of those that have perished. When the government fails, business and the citizens must look out for each other.

Dr. Robert Duncan in Energy Weapons & Testing, Coast to Coast AM broadcast December 5th 2006 (2.75+ million listeners weekly, syndicated in most cities and areas of the United States, and other places around the world.)..

0:57 / 1:53:43

Download - Dr. Robert Duncan, Coast to Coast AM interview - Energy Weapons & Testing.

Energy Weapons & Testing synopsis:

Independent investigator Robert Duncan discussed directed energy and neurological weapons and his contention that they've been tested on the public at large. While directed energy is used in microwaves, to remove kidney stones, and in non-invasive surgery, it's also been developed extensively for military purposes, he reported.

The civilian population was targeted for experiments, in programs such as MK-ULTRA, starting after WW II, when Nazi scientists were imported to the US, some working on scalar or gravity weapons, said Duncan. The town of Taos, NM, where a hum was heard by many citizens, was the subject of a directed energy experiment by the U.S. Navy, he claimed. And most recently the Active Denial System (see article below) was tested on human subjects.

Duncan said he interviewed over 600 mind control victims (Dec 5th 2006 report), and found some validity to their allegations. There are weapons that can project voices into people's heads such as one system known as "The Voice of God," he detailed. Blocking techniques include jamming the signals with electronic scramblers, and using shields with metal alloys or mylar. He recommended the following websites for further information/assistance: mindjustice.org, raven1.net, freedomfchs.com.

The Goodbye Weapon

A new non-lethal weapon, the Air Force's Active Denial System, or ADS, has been certified for use in Iraq, after extensive testing. The ADS shoots a beam of waves that causes extreme (but temporary) pain and induces what experimenters call the "Goodbye effect," or "prompt and highly motivated escape behavior." Wired News obtained documents about the weapon and has published two reports (article(1)/documentation(2)). Additionally, the report's author David Hambling has posted a commentary(3) on the subject at Defense Tech.

1. http://www.wired.com/news/technology/0,72134-0.html
2. http://www.wired.com/news/technology/0,72236-0.html
3. http://www.defensetech.org/archives/003036.html

Coast to Coast AM guest bio:

Dr. Robert Duncan holds multiple degrees from Harvard University and Dartmouth College amongst others. He has had the most expensive American education money can buy. He is an investigator, author, and soon be movie producer on the topics of directed energy, neurological weapons, psychological, and information warfare. His movie is called "The Enemy Within - Psychic Warfare". A book he is co-authoring will be out in a few months called "Hacking the Human Mind".

Dr. Duncan has worked as a business and information technology consultant to the Fortune 500. He has worked for companies like Oracle Corporation, BEA systems, HP, BBN, and as a professor at a college. For the department of defense he has written the artificial intelligence code to track the Soviet nuclear submarine fleet with passive and active acoustical arrays and has been to a couple secret NATA Navy underground bases in Europe.

-Todd Giffen
Target since birth as I was born into American enslavement, surveillance, and control, under attack with directed energy since 2008
503-967-5202
case@oregonstatehospital.net
obamasweapon.com

Copyright © 2015 Todd Giffen

"The Use of Psychotronic Weapons"
"What everyone should know"

(courtesy : http://www.mindjustice.org/cherkova.htm)

Definition:

Definition of psychotronic (psycho-physical) weapons.

Psychotronic Weapons (PF- weapons) this is the totality of all possible methods and means (techno-genic, suggestive, pharmacological, paranormal, complexes, and others) of hidden, forced influences on the psyche of a person for the purpose of modifying his consciousness, behavior and health for what is desired in the way of influencing aspects of control..."

Second definition of psychotronic weapons (as an epigraph): "Applications in military and for antisocial purposes are possibilities also for knowledge of psychotronics, its means, methods, systems, 'generators', and there is the path for the transformation of the humanitarian, essential attributes of life and society in the weapons. These are also psychotronic weapons. This is not only dangerous, this is deadly!"

Types of Weapons:

- Electromagnetic Weapons
- Microwave Weapons
- Non-Lethal Weapons
- ELF (Extremely Low Frequency) Weapons
- Directed Energy Weapons
- Acoustic Weapons
- Psychotronic Weapons
- RF (Radio Frequency) Weapons
- Soft Kill Weapons
- Less-Than-Lethal Weapons

How it affects (Physical & psycho-physical damages):

Physical damage, visible results achieved at the moment of influence.

* burns, pricks, cuts, wounds (ray weapons, laser)
* bleeding into the brain (laser ray with energy pulses of 40 joules) and on the skin energy in pulses: 3 - 100 joules)
* Blindness in the eyes, loping of eyelashes (laser ray)
* loss of memory (influence of frequency of up to 100Hz. and a reduction to 5 Hz.)
* destruction of the vestibulary [inner ear] apparatus, spatial orientation
* symptoms of [***] [with a large exposure and strength, paralysis (UBCh) in the area of the beginning of the spinal column
* irregular sleeping, heart-beating
* numbness of the hands; at night, cramping of the legs
* sharp decrease in hemoglobin, micro-burns to the skin, ionization of the blood and body fluids, an increase in the deterioration rate of clothing material, photographic material [illuminating], (thermal-electronic emissions from lamps in the room with the feeding units of electrical networks and fittings of the wall, [...]
* vibrations (separate organs can vibrate: the heart, kidneys, etc.), [...] (from

* vibrational technologies)
* pressure, coolness of the skin
* feelings of non-specific fear and panic (from the weapons) [...] tremors, tapping, destruction of fragile objects from the waves, from the impulses and from other manifestations of technological poltergeist

Psycho-physical damage depending on intensity and duration of effects. Damage in the physical sphere (up to programmed premature death).

Stage I.

* changes in the blood (early signs)
* overheating substances especially and increase in crystallization, leading to cataracts (early sign)
* ill reactions along the path of the bio-energetic potential from the effects [...]
* prickly sensations, tremors to the muscles of the feet
* aggravation of chronic illnesses
* internal bleeding (nose, stomach, gynecological)
* auditory tones of various frequencies
* sharp pain in the internal ear
* dull pains in the area behind the ears
* internal trembling, vibrations
* head pain in the temple and a warmness in that area, pain in the eye-sockets
* likelihood of miscarriage, an increase of 80% for chances of premature births, anomalous
* development of the fetus, often with defective brains

Stage II.

* "radio-sound" effect (before this is long-conducted the resonance-loosening of spinal and brain fluids at the frequency of 2-10 Hz. for maintaining the fluids of theskull and brain in stimulation
* steady reactions to all aspects of coding
* lowering of energy (observed with irradiation at the frequency carrying frequencies of ~780 Hz.and amplitude modulation ~71 Hz.)
* aggravation of dermatosis
* eye pains (cataracts, asymmetry in lenses of the eyes, puffiness [?] of the retinas)
* aggravation of the course of chronic illnesses
* destruction of the functions of the kidneys, liver, organs of digestion, circulatory system, bleeding in gingivae, gums, peridontal and others
* gauntness
* "sand" in the eyes, burning sensation, loss of hair, brittleness of nails
* compression pain in the heart fits of coughing
* changes of the color of the face (bronze shading of the skin)
* asymmetrical puffiness of the face
* disfiguration of the face, the intentional emaciation of separate muscles, cartilage
* syndromes of destruction to the external nerves of the thighs
* impotence

Stage III.

* destruction of the brain, irreversible changes to the structure of the brain (academician V.P. Vekhtereva)

* irreversible processes in the muscle material, in the bones of the skull, and in the structures of neurons "..minimalization of life" --external reaction to EMP appears as an illness, up to heavy, sharp, chronic, organic pathological processes (academician V.P. Kaznacheev)
* "..the entire speeding up of the aging process, sclerosis, oncogenesis (academician V.P. Kaznacheev)
* destruction of bio-chemical processes in the cells with distrophic changes in the organs (academician V.P. Kaznacheev)
* destruction of the cell membranes, chemical connections in the cells -leading to leukemia, cancer of the brain and prostate gland, breast cancer, (even with weak EMP, but of long duration "...the genetic apparatus is altered..." (academician V.P. Kaznacheev)
* the reflex activities are destroyed
* the functioning of the hormonal system is destroyed
* [....] Parkinson's disease (trembling of the hands) and Alzheimer's disease (from changes in the production of the hormone melanin ([...] gland) that causes degenerative changes in substances at the molecular level disfunctions of the sino-atrial node of the heart (even with a low frequency)
* infarction, cerebral thrombosis, osteo-[***], peridontal, sugar diabetes
* allergies
* epilepsy (especially caused by the multiple-rapid stimulation by a weak, low frequency waves)
* hypertension, hypotension
* programmed or instantaneous (with the subjection to extreme effects -up to the border of deadly conditions) premature death --it is well known by the experimentors that cases of death do occur (academician V.P. Kaznacheev)
* a decrease and dying off of the population, humanity, mankind

Damage in the mental sphere (up to the point of insanity).
Stage I.

* manifestations of depression
* lowering in the interest in perceived information
* shortness of temper (irritability)

Stage II.

* steady depression
* lowering of abilities for analytical thinking, some worsening of the memory
* symptoms of chronic fatigue
* superficial nature of sleep
* higher incidents of conflicts

Stage III.

* confusion in the accounting of events in real life
* loss of ability for analytical thinking
* lowering and a loss of memory
* feelings of the lack of sleep
* indifference to personal external appearance [...]
* lowering of self-control from the deficit of the hormone seratonin due to SVCh irradiation
* suicide (as the experimentors "practice" provocation techniques)
* "...invisible weak fields ...their ignoring that they are carrying with them a deadly danger"... "...people simply start going crazy and nobody understands why..." (academician V.P. Kaznacheev)

"Consequences of effects of micro-leptonic generators are described by the leading developer in this area [from the] V. Lab. of Micro-leptonic Technologies D. Okhatryym: in 1982 there began extremely unpleasant things with the health our co-workers. At first, there arose their feeling unwell, then the loss of logic, then after this, the loss of spatial orientation. Finally, a breakdown of diseased [affected] organs. The coming out of this condition -and this includes myself -was achieved with great difficulty."

(in the book by Ju. Vorob'evskii" Knock at the Golden Gate, Moscow, 1999.

Manipulation with the memory.

* Erasure
* Blockage
* Recording of information needed by the experimentor
* training -"prompting" (after erasure)
* comparison,
* reproduction of picture a from a prior testing as though bifurcated [?]
* a shifting of the effective frequency up to 100 Hz. or a lowering to 5 Hz., with memory loss

Control of Stimulation in the brain.

* by states of consciousness (up to the loss of these)
* in sleep
* emotions
* intellectual capabilities
* attention
* speech
* activeness
* muscle tone
* stimulation of one and the same zone with stimulations of:
o 30 -40 mV- activization of attention, memory, movement;
o 60-70 mV- "emotiono-genic" effects

Different methods:

Types of Psychotronic, psychotropic and other Psy-Influences.

* radio-waves
* laser-irradiation
* infra-red irradiation
* ultra-violet irradiation UF
* x-ray irradiation
* gravitational fields
* torsional fields (hypothetical)
* leptonic and other fields

Acoustic Waves.

* infra-sonic (IZ) from 0 Hz. to 15-20 KHz.
* ultra-sonic(UZ) from 15-20 KHz. to 10**9 Hz. (ranges for IZ and UZ)

see more similar information in -Table 3

Formation of fields:

* electro-magnetic charge
* gravitational-mass
* torsional (surrounding spin fields) -spin, with any rotating body
* micro-leptonic energy (in free aspect) -[over-abundance of stable particles]?

Operator is secretly brought in, or in a secret installation nearby

BG: Biogenerator (could be tomography)
A: Antenna (irradiation and reception)
D: operator for the gathering of information, transmission and control
ZU: reminding sytem on a magnetic strip, holographic
BIP: bio-informational [...]
KC: channel connections (IK, radio, telephone, telegraph)
E: screen display
O: operator
SP: light pen with which the operator indicates on the screen, the point of influence

Stress systems and methods of harassment.

* slander
* gestures, hand movements, expressions, tests, practical "jokes"
* taking off what is needed for the eyes (vision) [?]
* psychological pressure through family, neighbors or surrounding people, vehicle drivers
* discrediting: along 5 directions (often with the involvement of the police)
o irresponsibility
o spy
o drug dealer
o vagrant
o accomplice in a crime (in an alleged crime)
* torture, assault
* blackmail, threats
* attempts on their lives with PTOs
* death to someone close or in immediate surrounding life
* murder

Stages of Zombification (Substitution of consciousness with external control).

* programming, modeling of a cybernetic double
* conducting of programs according to non-differentiation of a proper and artificial "I"-"Not-I"
* extreme influencing, stress, harassment, irradiation, special-preparations [substances], chemicals
* taking to the limits of mental and physical capacities (survivability)
* loss of will, memory
* shutting off of his own consciousness
* replacement of consciousness with the control from his cybernetic twin

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ACQUISITION, AIR, INTEL & CYBER

Pentagon Studies Weapons That Can Read Users' Mind

By SYDNEY J. FREEDBERG JR.
on July 14, 2017 at 3:15 PM
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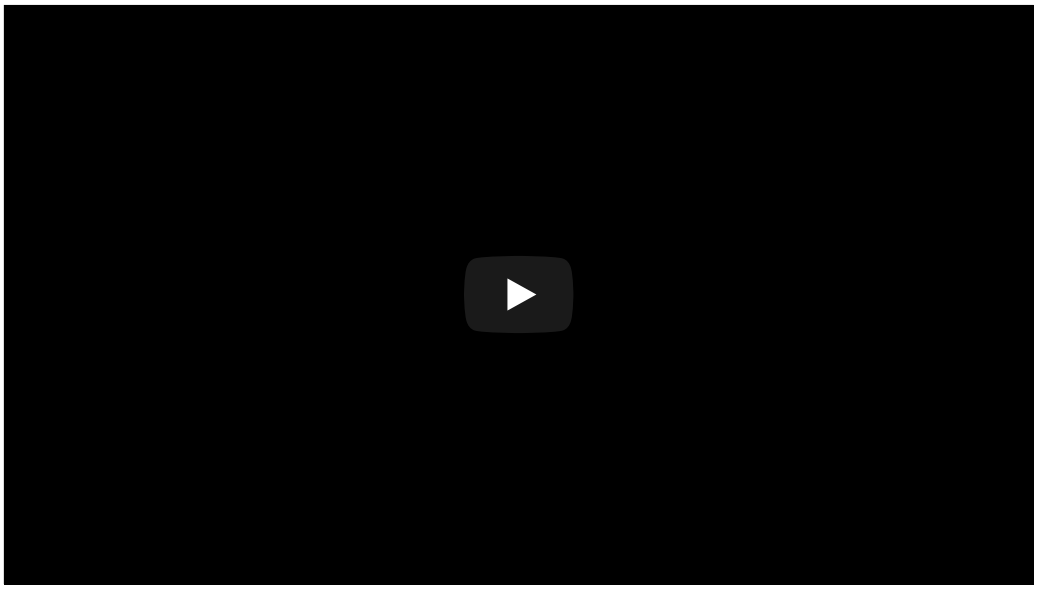

NEWSEUM: The troops of tomorrow may be able to pull the trigger using only their minds. As artificially intelligent drones, hacking, jamming, and missiles accelerate the pace of combat, some of the military's leading scientists are studying how mere humans can keep up with the incredible speed of cyber warfare, missiles and other threats.

One option: Bypass crude physical controls — triggers, throttles, keyboards — and plug the computer directly into the human brain. In one DARPA experiment, a quadriplegic first controlled an artificial limb and then flew a flight simulator. Future systems might monitor the users' nervous system and compensate for stress, fatigue, or injury. Is this the path to what the Pentagon calls human-machine teaming?

This is an unnerving scenario for those humans, like Stephen Hawking, who mistrust artificial intelligence. If your nightmare scenario is robots getting out of control, "let's teach them to read our minds!" is probably *not* your preferred solution. It sounds more like the beginning of a movie where cyborg Arnold Schwarzenegger goes back in time to kill someone.

Navy X-47B drone.

But the Pentagon officials who talked up this research yesterday at Defense One's annual tech conference emphasized the objective was to *improve* human control over artificial intelligence. Teaching AI to monitor its user's level of stress, exhaustion, distraction, and so on helps the machine adapt itself to better serve the human — instead of the other way around. Teaching AI to instantly detect its user's *intention* to give a command, instead of requiring a relatively laborious push of a button, helps the human keep control — instead of having to let the AI off the leash because no human can keep up with it.

Official Defense Department policy, as then-Secretary Ash Carter put it, is that the US will "never" allow an artificial intelligence to decide for itself whether or not to kill a human being. However, no less a figure than the Carter's undersecretary of acquisition and technology, Frank Kendall, fretted publicly that making our robots wait for human permission would slow them down so much that enemy AI without such constraints would beat us. Vice-Chairman of the Joint Chiefs, Gen. Paul Selva, calls this the "Terminator Conundrum." Neuroscience suggests a way out of this dilemma: Instead of slowing the AIs down, make the humans' orders come faster.

DARPA's Revolutionizing Prosthetics program is devising new kinds of artificial limbs — and new ways to control them.

Accelerate Humanity

"We will continue to have humans on the loop, we will have human input in decisions, but the way we go about that is going to have to shift, just to cope with the speed and the capabilities that autonomous systems bring," said Dr. James Christensen, portfolio manager at the Air Force Research Laboratory's 711th Human Performance Wing. "The decision cycle with these systems is going to be so fast that they have to be sensitive to and responsive to the state of the individual (operator's) *intent*, as much as overt actions and control inputs that human's providing."

In other words, instead of the weapon system responding to the human operator *physically* touching a control, have it respond to the human's brain cells forming the *intention* to use a control. "When you start to have a direct neural interface of this type, you don't necessarily need to command and control the aircraft using the stick," said Justin Sanchez, director of DARPA's Biological Technologies Office. "You could potentially re-map your neural signatures onto the different control surfaces" — the tail, the flaps — "or maybe any other part of the aircraft" — say landing gear or weapons. "That part hasn't really been explored in a huge amount of depth yet."

Reading minds, even in this limited fashion, will require deep understanding and close monitoring of the brain, where thoughts take measurable form as electrical impulses running from neuron to neuron. "Can we develop precise neurotechnologies that can go to those circuits in the brain or the peripheral nervous system in real time?" Sanchez asked aloud. "Do we have computational systems that allow us to understand what the changes in those signals (mean)? And can we give meaningful feedback, either to the person or to the machine to help them to do their job better?"

DARPA's Revolutionizing Prosthetics program hooked up the brain of a quadriplegic — someone who could move neither arms nor legs — to a prosthetic arm, allowing the patient to control it directly with their thoughts. Then, "they said, 'I'd like to try to fly an airplane,'" Sanchez recounted. "So we created a virtual flight simulator for this person, allowed this neural interface to interface with the virtual aircraft, and that person flew."

"That was a real wake-up call for everybody involved," Sanchez said. "We didn't initially think you could do that."

Tony Stark (Robert Downey Jr.) relies on the JARVIS artificial intelligence — exquisitely adapted to his personal strengths and weaknesses — to help pilot his Iron Man suit. (Marvel Comics/Paramount Pictures)

Adapting To The Human

Applying direct neural control to real aircraft — or tanks, or ships, or network cybersecurity systems — will require a fundamental change in design philosophy. Today, said Christensen, we give the pilots tremendous information on the aircraft, then expect them to adapt to it. In the future, we could give the aircraft tremendous information on its pilots, then have it use artificial intelligence to adapt itself to *them*. The AI could customize the displays, the controls, even the mix of tasks it took on versus those it left up to the humans — all exquisitely tailored not just to the preferences of the individual operator but to his or her current mental and physical state.

When we build planes today, "they're incredible sensor platforms that collect data on the world around them and on the aircraft systems themselves, (but) at this point, very little data is being collected on the pilot," Christensen said. "The opportunity there with the technology we're trying to build now is to provide a continuous monitoring and assessment capability so that the aircraft knows the state of that individual. Are they awake, alert, conscious, fully capable of performing their role as part of this man-machine system? Are there things that the aircraft then can do? Can it unload gees (i.e. reduce g-forces)? Can it reduce the strain on the pilot?"

"This kind of ability to sense and understand to the state and the capabilities of the human is absolutely critical to the successful employment of highly automated systems," Christensen said. "The way all of our systems are architected right now, they're fixed, they're predictable, they're deterministic" — that is, any given input always produces the exact same output.

Air Force MQ-9 Reaper operators in training. Today's drones require extensive human oversight and are hardly user friendly.

Predictability has its advantages: "We can train to that, they behave in very consistent ways, it's easier to test and evaluate," Christensen said. "What we lose in that, though is the real power of highly automated systems, autonomous systems, as *learning systems*, of being able to adapt themselves. "

"That adaptation, though, it creates unpredictability," he continued. "So the human has to adapt alongside the system, and in order to do that, there has to be some mutual awareness, right, so the human has to understand what is the system doing, what is it trying to do, why is that happening; and vice versa, the system has to has some understanding of

the human's intent and also their state and capabilities."

This kind of synergy between human and artificial intelligence is what some theorists refer to as the "centaur," after the mythical creature that combined human and horse — with the human part firmly in control, but benefiting from the beast's strength and speed. The centaur concept, in turn, lies at the heart of the Pentagon's ideas of human-machine teaming and what's known as the Third Offset, which seeks to counter (offset) adversaries' advancing technology with revolutionary uses of AI.

The neuroscience here is in its infancy. But it holds the promise of a happy medium between hamstringing our robots with too-close control or letting them run rampant.

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Topics: AFRL, air force, Air Force Research Laboratory AFRL, artificial intelligence, darpa, DefenseOne Tech Summit 2017, James Christensen, Justin Sanchez, neuroscience, offset strategy, War Algorithm

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Internet of Things (IoT) in 5G Wireless Communications

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GUEST EDITORIAL

Internet of Things (IoT) in 5G Wireless Communications

During the past decade, the Internet of Things (IoT) has revolutionized the ubiquitous computing with multitude of applications built around various types of sensors. A vast amount of activity is seen in IoT based product-lines and this activity is expected to grow in years to come with projections as high as billions of devices with on average 6-7 devices per person by year 2020. With most of the issues at device and protocol levels solved during the past decade, there is now a growing trend in integration of sensors and sensor based systems with cyber physical systems and device-to-device (D2D) communications. 5th generation wireless systems (5G) are on the horizon and IoT is taking the center stage as devices are expected to form a major portion of this 5G network paradigm. IoT technologies such as machine to machine communication complemented with intelligent data analytics are expected to drastically change landscape of various industries. The emergence of cloud computing and its extension to fog paradigm with proliferation of intelligent 'smart' devices is expected to lead further innovation in IoT. These developments excite us and form a motivation to survey existing work, design new techniques, and identify new applications of IoT. Researchers, scientists, and engineers face emerging challenges in designing IoT based systems that can efficiently be integrated with the 5G wireless communications.

We received enthusiastic response to our special issue call for papers. A total of nine high quality papers were received out of which only seven were selected after a thorough review process. Invited articles were sought from two highly cited and accomplished researchers. Dr. Mischa Dohler (Fellow IEEE, Kings College London, UK) and Dr. Mung Chiang (Fellow IEEE, Princeton University, USA).

The first article "MIMO-NOMA design for small packet transmission in the Internet of Things", written by a collaborative team of researchers Ding et al.,, opportunistic serving mechanism is designed as part of the effort in the novel paradigm of Multiple Input Multiple Output Non-Orthogonal Multiple Access transmission scheme. Under the proposed method, one user is completely served with their quality of service requirements completely taken care of whereas second user is served opportunistically under the NOMA paradigm. The main contribution of this article is a design with two sets of system parameters, precoding and power allocation coefficients, in order to ensure that the potential of NOMA can be realized even if the users' channel conditions are similar. Two types of power allocation policies are developed in this paper. One is to meet first user's QoS requirements in the long term. For example, in order to satisfy its targeted outage probability. The other is in which to realize second user's QoS requirements instantaneously, e.g., the power allocation coefficients are designed to realize its targeted data rate for each channel realization.

Machine to machine communication has a significant role to play in emerging internet of things paradigm in years and decades to come. The emerging IoT-5G scenario extends sensor based IoT capabilities to robots, actuators and drones for distributed coordination and low-latency reliable execution of tasks at hand. In the invited work titled "Enabling the IoT machine age with 5G: Machine-type multicast services for innovative real-time applications" by Condoluci et al., core attention is focused on the end-to-end reliability, latency, and energy consumption comprising both up and downlinks for 5G-IoT communication. The authors propose the definition, design, and analysis of machine-type multicast service (MTMS). They recommend different procedures that need to be redesigned for MTMS and derive the most appropriate design drivers by analyzing different performance indicators, such as scalability, reliability, latency, and energy consumption. Overall, a very interesting read complemented by open problems and future research directions to pursue.

Security is one of the biggest challenges faced by Internet of Things. With devices becoming ubiquitous and pervasive in day to day lives necessitate reliable and secure algorithms. The third article, "Security enhancement for IoT communications exposed to eavesdroppers with uncertain locations" by Xu et al., develops a secure framework for eavesdroppers with Uncertain Locations in IoT. With the assumption that the locations of eavesdroppers change independently from hop to hop, authors derive an expression for the secrecy outage probability of the two-hop transmission, which is shown to be the upper bound of the outage probability when the locations of eavesdroppers remain unchanged. Following this expression, the end users formulate a secrecy rate maximization problem with the secrecy-outage probability constraint. The optimal rate design for codebooks and power allocation between the source and relay are derived. By studying the performance of the optimal scheme in some special cases, we obtain several insights concerning the setting of system parameters.

In the article, "Enabling massive IoT in 5G and beyond systems: PHY radio frame design considerations" by Ayesha Ijaz et al., the authors propose a flexible frame structure and design for massive Internet of Things (IoT) devices working in 5G wireless network. The authors also discussed

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the interdependence of different frame design parameters, service requirements and characteristics of radio environment. Based on these interdependency, they provide guidelines for radio numerology design and elaborated on the frame design for IoT communications in 5G networks to support massive connection density of low-rate, low-power devices. The article concludes with some key research findings and challenges massive IoT in 5G wireless network.

It is estimated that in year 2020, 20 to 40 billion devices will be connected to the Internet as part of the Internet of Things. A critical bottleneck for realizing the efficient IoT is the pressure it puts on the existing communication infrastructures, requiring transfer of enormous data volumes. In the article "CONDENSE: A reconfigurable knowledge acquisition architecture for future 5G IoT", by Dejan Vukobratovic et al., the authors propose a architecture named 'Condense' which integrates the acquisition of IoT-generated data within the 3GPP MTC (machine type communications) systems. The proposed Condense architecture introduces a service within 3GPP MTC systems – computing linear and non-linear functions over the data generated by MTC devices This service brings about the possibility that the underlying communication infrastructure communicates only the desired function of the MTC- generated data (as required by the given application at hand), and not the raw data in its entirety. This transformational approach has the potential to dramatically reduce the pressure on the 3GPP MTC communication infrastructure. The article concludes by discussing challenges, provides insights, and identifies future research directions for implementing function computation and function decomposition within practical 3GPP MTC systems.

In the article, "Frequency-domain oversampling for cognitive CDMA systems: Enabling robust and massive multiple access for Internet of Things" by Su Hu et al., the authors utilize the concept of cognitive radio with dynamic non-continuous spectrum bands and code division multiple access to tackle the challenge of massive spectrum resource management in IoT. In order to suppress multiple access interference resulting from the non-orthogonality of partial available spectrum bins, carrier frequency offset, and spectrum sensing mismatch, the authors propose an enhanced receiver design that combines the frequency-domain oversampling scheme (FDO) and linear minimum mean square error (MMSE) method. The simulation results show that the cognitive-CDMA with FDO-MMSE receiver outperforms that with conventional per-user MMSE receiver in the presence of multipath fading channels, carrier frequency offset, and spectrum sensing mismatch.

In the invited article, "A survey of client-controlled HetNets for 5G" by Michael Wang et al., a comprehensive review is provided on spectrum of client-controlled HetNets for 5G networks: from the fully devolved distributed local control approach to the hybrid control approach where clients may make the decisions given some global information provided by the network. After giving a thorough review, the authors also provide future research directions and recommendations for evolution of 5G heterogeneous networks as an enabler for next generation internet of things.

To conclude, the Editors would like to thank all authors who submitted their manuscripts against this Special issue. There had been some very exciting submissions though we could only accept best seven high quality submissions. The editorial staff also thanks the reviewers for their timely comments on the manuscript which helped us improve the presentation and quality of the content manifold. All the associate editors thank the Editor in Chief Dr. Michael Pecht for his assistance in making this special issue a reality. We would also like to thank the publications editor Ms. Kimberly Shumard for her continuous follow up on timelines and management of articles to ensure timely completion of the review process. We complete this note by letting the readers know to stay tuned with IEEE Access as we expect even more exciting issues in months to come.

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5G RADIO ACCESS

CAPABILITIES AND TECHNOLOGIES

The capabilities of 5G wireless access must extend far beyond previous generations of mobile communication. Examples of these capabilities include very high data rates, very low latency, ultra-high reliability, energy efficiency and extreme device densities, and will be realized by the development of LTE in combination with new radio-access technologies. Key technology components include extension to higher frequency bands, access/backhaul integration, device-to-device communication, flexible duplex, flexible spectrum usage, multi-antenna transmission, ultra-lean design, and user/control separation.

WHAT IS 5G?

5G radio access technology will be a key component of the Networked Society. It will address high traffic growth and increasing demand for high-bandwidth connectivity. It will also support massive numbers of connected devices and meet the real-time, high-reliability communication needs of mission-critical applications.

5G will provide wireless connectivity for a wide range of new applications and use cases, including wearables, smart homes, traffic safety/control, critical infrastructure, industry processes and very-high-speed media delivery. As a result, it will also accelerate the development of the Internet of Things.

The overall aim of 5G is to provide ubiquitous connectivity for any kind of device and any kind of application that may benefit from being connected.

5G networks will not be based on one specific radio-access technology. Rather, 5G is a portfolio of access and connectivity solutions addressing the demands and requirements of mobile communication beyond 2020.

The specification of 5G will include the development of a new flexible air interface, NX, which will be directed to extreme mobile broadband deployments. NX will also target high-bandwidth and high-traffic-usage scenarios, as well as new scenarios that involve mission-critical and real-time communications with extreme requirements in terms of latency and reliability.

In parallel, the development of Narrow-Band IoT (NB-IoT) in 3GPP is expected to support massive machine connectivity in wide area applications. NB-IoT will most likely be deployed in bands below 2GHz and will provide high capacity and deep coverage for enormous numbers of connected devices.

Ensuring interoperability with past generations of mobile communications has been a key principle of the ICT industry since the development of GSM and later wireless technologies within the 3GPP family of standards. In a similar manner, LTE will evolve in a way that recognizes its role in providing excellent coverage for mobile users, and 5G networks will incorporate LTE access (based on Orthogonal Frequency Division Multiplexing (OFDM)) along with new air interfaces in a transparent manner toward both the service layer and users.

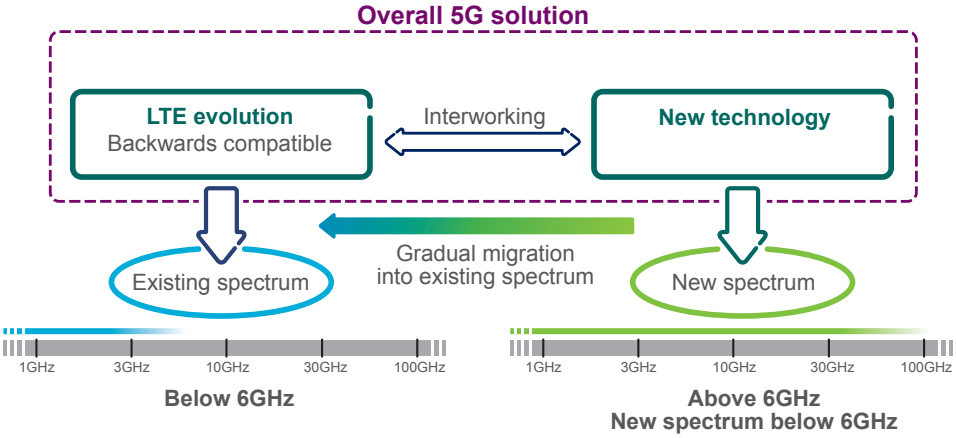

Figure 1: The overall 5G wireless-access solution consisting of LTE evolution and new technology.

Around 2020, much of the available wireless coverage will continue to be provided by LTE, and it is important that operators with deployed 4G networks have the opportunity to transition some – or all – of their spectrum to newer wireless access technologies. For operators with limited spectrum resources, the possibility of introducing 5G capabilities in an interoperable way – thereby allowing legacy devices to continue to be served on a compatible carrier – is highly beneficial and, in some cases, even vital.

At the same time, the evolution of LTE to a point where it is a full member of the 5G family of air interfaces is essential, especially since initial deployment of new air interfaces may not operate in the same bands. The 5G network will enable dual-connectivity between LTE operating within bands below 6GHz and the NX air interface in bands within the range 6GHz to100GHz. NX should also allow for user-plane aggregation, i.e. joint delivery of data via LTE and NX component carriers.

This paper explains the key requirements and capabilities of 5G, along with its technology components and spectrum needs.

5G – REQUIREMENTS AND CAPABILITIES

In order to enable connectivity for a very wide range of applications with new characteristics and requirements, the capabilities of 5G wireless access must extend far beyond those of previous generations of mobile communication. These capabilities will include massive system capacity, very high data rates everywhere, very low latency, ultra-high reliability and availability, very low device cost and energy consumption, and energy-efficient networks.

MASSIVE SYSTEM CAPACITY

Traffic demands for mobile-communication systems are predicted to increase dramatically [1] [2]. To support this traffic in an affordable way, 5G networks must deliver data with much lower cost per bit compared with the networks of today. Furthermore, the increase in data consumption will result in an increased energy footprint from networks. 5G must therefore consume significantly lower energy per delivered bit than current cellular networks.

The exponential increase in connected devices, such as the deployment of billions of wirelessly connected sensors, actuators and similar devices for massive machine connectivity, will place demands on the network to support new paradigms in device and connectivity management that do not compromise security. Each device will generate or consume very small amounts of data, to the extent that they will individually, or even jointly, have limited impact on the overall traffic volume. However, the sheer number of connected devices seriously challenges the ability of the network to provision signaling and manage connections.

VERY HIGH DATA RATES EVERYWHERE

Every generation of mobile communication has been associated with higher data rates compared with the previous generation. In the past, much of the focus has been on the peak data rate that can be supported by a wireless-access technology under ideal conditions. However, a more important capability is the data rate that can actually be provided under real-life conditions in different scenarios.

- 5G should support data rates exceeding 10Gbps in specific scenarios such as indoor and dense outdoor environments.
- Data rates of several 100Mbps should generally be achievable in urban and suburban environments.
- Data rates of at least 10Mbps should be accessible almost everywhere, including sparsely-populated rural areas in both developed and developing countries.

VERY LOW LATENCY

Very low latency will be driven by the need to support new applications. Some envisioned 5G use cases, such as traffic safety and control of critical infrastructure and industry processes, may require much lower latency compared with what is possible with the mobile-communication systems of today.

To support such latency-critical applications, 5G should allow for an application end-to-end latency of 1ms or less, although application-level framing requirements and codec limitations for media may lead to higher latencies in practice. Many services will distribute computational capacity and storage close to the air interface. This will create new capabilities for real-time communication and will allow ultra-high service reliability in a variety of scenarios, ranging from entertainment to industrial process control.

ULTRA-HIGH RELIABILITY AND AVAILABILITY

In addition to very low latency, 5G should also enable connectivity with ultra-high reliability and ultra-high availability. For critical services, such as control of critical infrastructure and traffic

safety, connectivity with certain characteristics, such as a specific maximum latency, should not merely be 'typically available.' Rather, loss of connectivity and deviation from quality of service requirements must be extremely rare. For example, some industrial applications might need to guarantee successful packet delivery within 1 ms with a probability higher than 99.9999 percent.

VERY LOW DEVICE COST AND ENERGY CONSUMPTION

Low-cost, low-energy mobile devices have been a key market requirement since the early days of mobile communication. However, to enable the vision of billions of wirelessly connected sensors, actuators and similar devices, a further step has to be taken in terms of device cost and energy consumption. It should be possible for 5G devices to be available at very low cost and with a battery life of several years without recharging.

ENERGY-EFFICIENT NETWORKS

While device energy consumption has always been prioritized, energy efficiency on the network side has recently emerged as an additional KPI, for three main reasons:

- Energy efficiency is an important component in reducing operational cost, as well as a driver for better dimensioned nodes, leading to lower total cost of ownership.
- Energy efficiency enables off-grid network deployments that rely on medium-sized solar panels as power supplies, thereby enabling wireless connectivity to reach even the most remote areas.
- Energy efficiency is essential to realizing operators' ambition of providing wireless access in a sustainable and more resource-efficient way.

The importance of these factors will increase further in the 5G era, and energy efficiency will therefore be an important requirement in the design of 5G wireless access.

MACHINE-TYPE COMMUNICATION

Fundamentally, applications such as mobile telephony, mobile broadband and media delivery are about information for humans. In contrast, many of the new applications and use cases that drive the requirements and capabilities of 5G are about end-to-end communication between machines. To distinguish them from the more human-centric wireless-communication use cases, these applications are often termed machine-type communication (MTC).

Although spanning a wide range of applications, MTC applications can be divided into two main categories – massive MTC and critical MTC – depending on their characteristics and requirements.

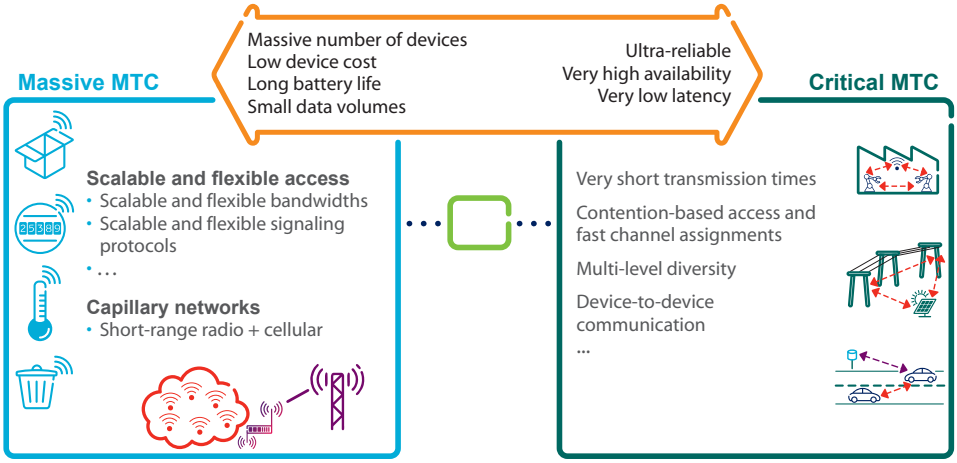

Figure 2: Massive MTC and critical MTC.

Massive MTC refers to services that typically span a very large numbers of devices, usually sensors and actuators. Sensors are extremely low cost and consume very low amounts of energy in order to sustain long battery life. Clearly, the amount of data generated by each sensor is normally very small, and very low latency is not a critical requirement. While actuators are similarly limited in cost, they will likely have varying energy footprints ranging from very low to moderate energy consumption.

Sometimes, the mobile network may be used to bridge connectivity to the device by means of capillary networks. Here, local connectivity is provided by means of a short-range radio access technology, for example Wi-Fi, Bluetooth [3] or 802.15.4/6LoWPAN [4]. Wireless connectivity beyond the local area is then provided by the mobile network via a gateway node.

Critical MTC refers to applications such as traffic safety/control, control of critical infrastructure and wireless connectivity for industrial processes. Such applications require very high reliability and availability in terms of wireless connectivity, as well as very low latency. On the other hand, low device cost and energy consumption is not as critical as for massive MTC applications. While the average volume of data transported to and from devices may not be large, wide instantaneous bandwidths are useful in being able to meet capacity and latency requirements.

There is much to gain from a network being able to handle as many different applications as possible, including mobile broadband, media delivery and a wide range of MTC applications by means of the same basic wireless-access technology and within the same spectrum. This avoids spectrum fragmentation and allows operators to offer support for new MTC services for which the business potential is inherently uncertain, without having to deploy a separate network and reassign spectrum specifically for these applications.

SPECTRUM FOR 5G

In order to support increased traffic capacity and to enable the transmission bandwidths needed to support very high data rates, 5G will extend the range of frequencies used for mobile communication. This includes new spectrum below 6GHz, as well as spectrum in higher frequency bands.

Specific candidate spectrum for mobile communication in higher frequency bands is yet to be identified by the ITU-R or by individual regulatory bodies. The mobile industry remains agnostic about particular choices, and the entire frequency range up to approximately 100GHz is under consideration at this stage, although there is significant interest in large contiguous allocations that can provide dedicated and licensed spectrum for use by multiple competing network providers.

The lower part of this frequency range, below 30GHz, is preferred from the point of view of propagation properties. At the same time, very large amounts of spectrum and the possibility of wide transmission frequency bands of the order of 1GHz or more are more likely above 30GHz.

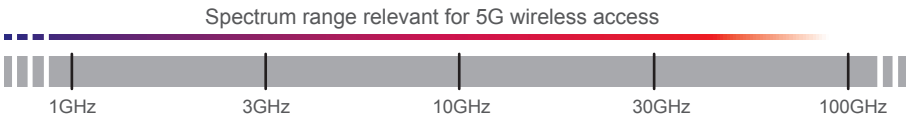

Figure 3: Spectrum relevant for 5G wireless access.

Spectrum relevant for 5G wireless access therefore ranges from below 1GHz up to approximately 100GHz, as Figure 3 shows.

It is important to understand that high frequencies, especially those above 10GHz, can only serve as a complement to lower frequency bands, and will mainly provide additional system capacity and very wide transmission bandwidths for extreme data rates in dense deployments. Spectrum allocations at lower bands will remain the backbone for mobile-communication networks in the 5G era, providing ubiquitous wide-area connectivity.

The World Radio Conference (WRC)-15 discussions have resulted in an agreement to include an agenda item for IMT-2020, the designated ITU-R qualifier for 5G, in WRC-19. The conference also reached agreement on a set of bands that will be studied for 5G, with direct applicability to NX. Many of the proposed bands are in the millimeter wave region and include:

- 24.25GHz to 27.5GHz, 37GHz to 40.5GHz, 42.5GHz to 43.5GHz, 45.5GHz to 47GHz, 47.2GHz to 50.2GHz, 50.4GHz to 52.6GHz, 66 GHz to 76GHz and 81GHz to 86GHz, which have allocations to the mobile service on a primary basis; and
- 31.8GHz to 33.4GHz, 40.5GHz to 42.5GHz and 47GHz to 47.2GHz, which may require additional allocations to the mobile service on a primary basis.

The mobile industry will strive to gain access to spectrum in the 6GHz to 20GHz range, but the policy directions being followed by regulators seem to be focused on frequency bands above 30GHz. In the US, the FCC has issued two Notices of Public Rule Making (NPRM) on bands above 24GHz. Ofcom has likewise indicated a preference for bands above 30GHz within the mobile industry.

The capacity needs of the mobile industry will continue to be served by licensed spectrum, although novel sharing arrangements for spectrum will become progressively more important as restricted opportunities for new spectrum start to impact incumbent services such as satellite communication and radio location. Two examples of sharing arrangements include LSA planned in Europe for the 2.3GHz band and the Citizens Band Radio Service for 3.5GHz in the US.

5G TECHNOLOGY COMPONENTS

Beyond extending operation to higher frequencies, there are several other key technology components relevant for the evolution to 5G wireless access. These components include access/backhaul integration, device-to-device communication, flexible duplex, flexible spectrum usage, multi-antenna transmission, ultra-lean design, and user/control separation.

ACCESS/BACKHAUL INTEGRATION

Wireless technology is already frequently used as part of the backhaul solution. Such wireless-backhaul solutions typically operate under line-of-sight conditions using proprietary radio technology in higher frequency bands, including the millimeter wave (mmW) band.

In the future, the access (base-station-to-device) link will also extend to higher frequencies. Furthermore, to support dense low-power deployments, wireless backhaul will have to extend to cover non-line-of-sight conditions, similar to access links.

In the 5G era, the wireless-access link and wireless backhaul should not therefore be seen as two separate entities with separate technical solutions. Rather, backhaul and access should be seen as an integrated wireless-access solution able to use the same basic technology and operate using a common spectrum pool. This will lead to more efficient overall spectrum utilization as well as reduced operation and management effort.

DIRECT DEVICE-TO-DEVICE COMMUNICATION

The possibility of limited direct device-to-device (D2D) communication has recently been introduced as an extension to the LTE specifications. In the 5G era, support for D2D as part of the overall wireless-access solution should be considered from the start. This includes peer-to-peer user-data communication directly between devices, but also, for example, the use of mobile devices as relays to extend network coverage.

D2D communication in the context of 5G should be an integral part of the overall wireless-access solution, rather than a stand-alone solution. Direct D2D communication can be used to offload traffic, extend capabilities and enhance the overall efficiency of the wireless-access network. Furthermore, in order to avoid uncontrolled interference to other links, direct D2D communication should be under network control. This is especially important for the case of D2D communication in licensed spectrum.

FLEXIBLE DUPLEX

Frequency Division Duplex (FDD) has been the dominating duplex arrangement since the beginning of the mobile communication era. In the 5G era, FDD will remain the main duplex scheme for lower frequency bands. However, for higher frequency bands – especially above 10GHz – targeting very dense deployments, Time Division Duplex (TDD) will play a more important role.

In very dense deployments with low-power nodes, the TDD-specific interference scenarios (direct base-station-to-base-station and device-to-device interference) will be similar to the 'normal' base-station-to-device and device-to-base-station interference that also occurs for FDD.

Furthermore, for the dynamic traffic variations expected in very dense deployments, the ability to dynamically assign transmission resources (time slots) to different transmission directions may allow more efficient utilization of the available spectrum.

To reach its full potential, 5G should therefore allow for very flexible and dynamic assignment of TDD transmission resources. This is in contrast to current TDD-based mobile technologies, including TD-LTE, for which there are restrictions on the downlink/uplink configurations, and for which there typically exist assumptions about the same configuration for neighbor cells and also between neighbor operators.

FLEXIBLE SPECTRUM USAGE

Since its inception, mobile communication has relied on spectrum licensed on a per-operator basis within a geographical area. This will remain the foundation for mobile communication in the 5G era, allowing operators to provide high-quality connectivity in a controlled-interference environment.

However, per-operator licensing of spectrum will be complemented with the possibility to share spectrum. Such sharing may be between a limited set of operators, or may occur in license-exempt scenarios. The

Citizens Band Radio Service in the US in the 3.5GHz band and the 5GHz unlicensed spectrum are examples of managed and unlicensed sharing regimes respectively.

New air interfaces like NX will likely be well served by more conventional licensed allocations of spectrum, mainly due to the need to establish a basic foundation for the technology to operate in an independent manner while interoperability is established with technologies like LTE. At some point, further allocations of spectrum for 5G may leverage the mobile industry's experience of sharing approaches in lower cellular bands.

MULTI-ANTENNA TRANSMISSION

Multi-antenna transmission already plays an important role in current generations of mobile communication and will be even more central in the 5G era, due to the physical limitations of small antennas. Path loss between a transmitter and receiver does not change as a function of frequency, as long as the effective aperture of the transmitting and receiving antennas does not change. The antenna aperture does reduce in proportion to the square of the frequency, and that reduction can be compensated by the use of higher antenna directivity. The 5G radio will employ hundreds of antenna elements to increase antenna aperture beyond what may be possible with current cellular technology.

In addition, the transmitter and receiver will use beamforming to track one another and improve energy transfer over an instantaneously configured link. Beamforming will also improve the radio environment by limiting interference to small fractions of the entire space around a transmitter and likewise limiting the impact of interference on a receiver to infrequent stochastic events. The use of beamforming will also be an important technology for lower frequencies; for example, to extend coverage and to provide higher data rates in sparse deployments.

ULTRA-LEAN DESIGN

Ultra-lean radio-access design is important to achieve high efficiency in 5G networks. The basic principle of ultra-lean design can be expressed as: minimize any transmissions not directly related to the delivery of user data. Such transmissions include signals for synchronization, network acquisition and channel estimation, as well as the broadcast of different types of system and control information.

Ultra-lean design is especially important for dense deployments with a large number of network nodes and highly variable traffic conditions. However, lean transmission is beneficial for all kinds of deployments, including macro deployments.

By enabling network nodes to enter low-energy states rapidly when there is no user-data transmission, ultra-lean design is an important component in delivering high network energy performance. Ultra-lean design will also enable higher achievable data rates by reducing interference from non-user-data-related transmissions.

USER/CONTROL SEPARATION

Another important design principle for 5G is to decouple user data and system control functionality. The latter includes the provisioning of system information; that is, the information and procedures needed for a device to access the system.

Such a decoupling will allow separate scaling of user-plane capacity and basic system control functionality. For example, user data may be delivered by a dense layer of access nodes, while system information is only provided via an overlaid macro layer on which a device also initially accesses the system.

It should be possible to extend the separation of user data delivery and system control functionality over multiple frequency bands and RATs. As an example, the system control functionality for a dense layer based on new high-frequency radio access could be provided by means of an overlaid LTE layer.

User/control separation is also an important component for future radio-access deployments relying heavily on beamforming for user data delivery. Combining ultra-lean design with a logical separation of user-plane data delivery and basic system connectivity functionality will enable a much higher degree of device-centric network optimization of the active radio links in the network. Since only the ultra-lean signals related to the system control plane need to be static, it is possible to design a system where almost everything can be dynamically optimized in real time.

An ultra-lean design combined with a system control plane logically separated from the user data delivery function also provides higher flexibility in terms of evolution of the RAT as, with such separation, the user plane can evolve while retaining system control functionality.

CONCLUSION

5G is the next step in the evolution of mobile communication and will be a key component of the Networked Society. In particular, 5G will accelerate the development of the Internet of Things. To enable connectivity for a wide range of applications and use cases, the capabilities of 5G wireless access must extend far beyond those of previous generations of mobile communications.

These capabilities include very high achievable data rates, very low latency and ultra-high reliability. Furthermore, 5G wireless access needs to support a massive increase in traffic in an affordable and sustainable way, implying a need for a dramatic reduction in the cost and energy consumption per delivered bit.

5G wireless access will be realized by the evolution of LTE for existing spectrum in combination with new radio access technologies that primarily target new spectrum. Key technology components of 5G wireless access include access/backhaul integration, device-to-device communication, flexible duplex, flexible spectrum usage, multi-antenna transmission, ultra-lean design, and user/control separation.

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GLOSSARY

D2D	device-to-device
FDD	Frequency Division Duplex
mmW	millimeter wave
MTC	Machine-Type Communication
NPRM	Notices of Public Rule Making
OFDM	Orthogonal Frequency Division Multiplexing
TDD	Time Division Duplex
WRC	World Radio Conference

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ERICSSON

CELLULAR NETWORKS FOR MASSIVE IOT

ENABLING LOW POWER WIDE AREA APPLICATIONS

With new standards specifically targeting the connectivity requirements of Massive Internet of Things (IoT) applications, cellular networks can deliver reliable, secure and diverse IoT services using existing network infrastructure.

DELIVERING NEW VALUE IN THE NETWORKED SOCIETY

In the future, all devices that benefit from an internet connection will be connected. In this Networked Society, every person and every industry will be empowered to reach their full potential. Internet of Things (IoT) technology is a key enabler of this vision by delivering machine-to-machine (M2M) and machine-to-person communications on a massive scale.

As shown in Figure 1, Ericsson predicts there will be around 28 billion connected devices by 2021, of which more than 15 billion will be connected M2M and consumer-electronics devices [1]. A large share of these will be applications served by short-range radio technologies such as Wi-Fi and Bluetooth, while a significant proportion will be enabled by wide area networks (WANs) that are primarily facilitated by cellular networks.

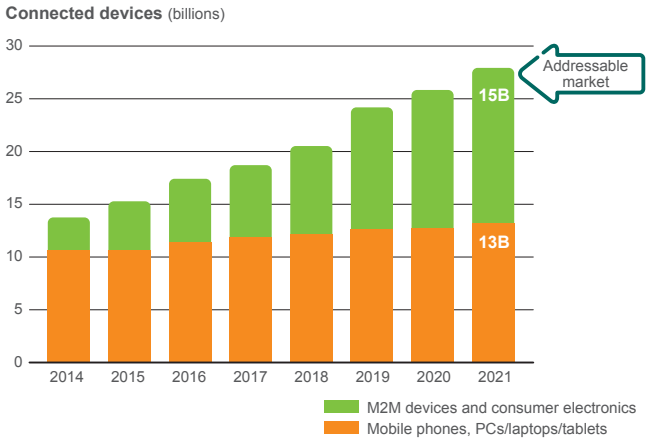

Figure 1: Growth in connected devices.

THE NEW IOT LANDSCAPE

The IoT revolution offers huge potential value in terms of improved efficiency, sustainability and safety for industry and society. Analysts predict that the total added value of the IoT will be USD 1.9 trillion by 2020 [2].

The variety of applications and solutions designed for individuals, business and industry is spurring the rapid expansion of the IoT market. The IoT is playing a major role across a variety of vertical sectors, generating cost savings, new revenue streams and other benefits.

Each IoT application needs a clear value proposition and business logic in line with the prevailing ecosystem, business models and value chains of the various stakeholders. For all applications, solutions need to be integrated on platforms that can scale and handle millions of devices efficiently. Business processes for administration, provisioning and charging will have to be streamlined to minimize costs and enhance the business case.

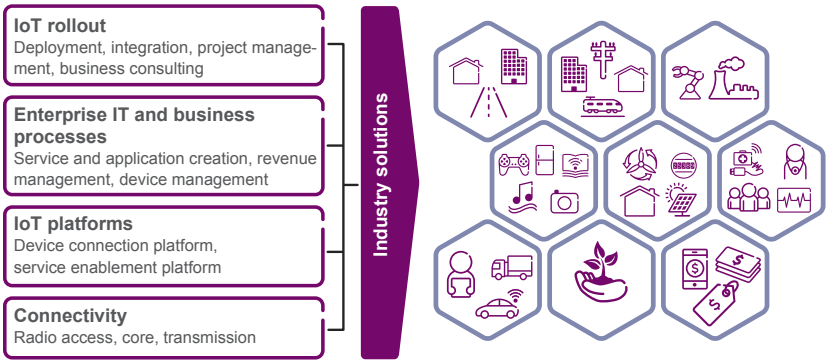

Figure 2: The new IoT landscape.

As they are largely responsible for wireless connectivity on a global scale, operators are in an excellent position to capture a share of the added value generated by the emerging IoT market. The size of this share will depend on the role that operators adopt in the value chain. This could range from being a straightforward connectivity provider (monetizing connectivity in new ways), all the way to being an end-to-end solution provider of turnkey solutions to vertical markets [3].

DIFFERENT IOT CONNECTIVITY ALTERNATIVES

Connectivity is the foundation for IoT, and the type of access required will depend on the nature of the application. Many IoT devices will be served by radio technologies that operate on unlicensed spectrum and that are designed for short-range connectivity with limited QoS and security requirements typically applicable for a home or indoor environment. Currently, there are two alternative connectivity tracks for the many IoT applications that depend on wide-area coverage:

Cellular technologies: 3GPP technologies like GSM, WCDMA, LTE and future 5G. These WANs operate on licensed spectrum and historically have primarily targeted high-quality mobile voice and data services. Now, however, they are being rapidly evolved with new functionality and the new radio access technology narrowband IoT (NB-IoT) specifically tailored to form an attractive solution for emerging low power wide area (LPWA) applications.

Unlicensed LPWA: new proprietary radio technologies, provided by, for example, SIGFOX and LoRa, have been developed and designed solely for machine-type communication (MTC) applications addressing the ultra-low-end sensor segment, with very limited demands on throughput, reliability or QoS.

One way to segment IoT applications is to categorize them according to coverage needs and performance requirements (such as data speed or latency demands).

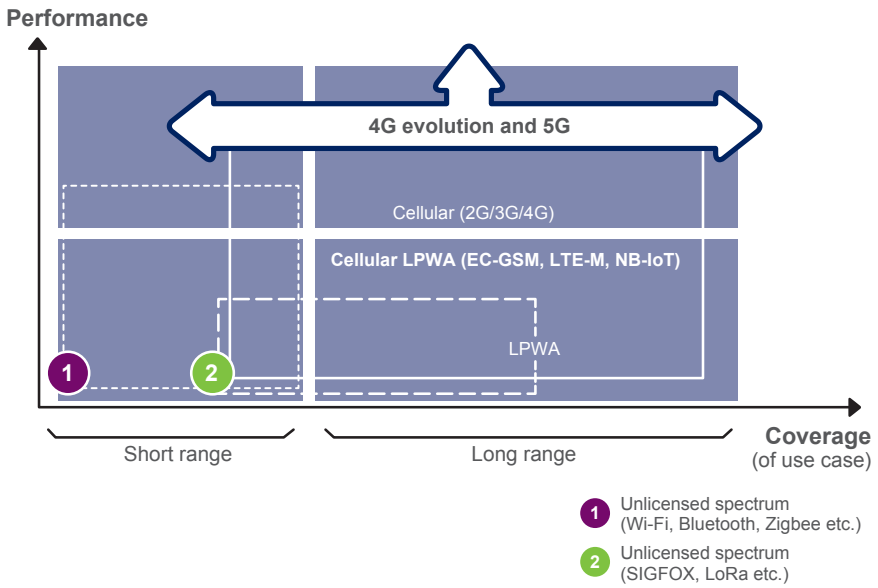

Figure 3: Technologies addressing different IoT segments.

The coverage needs of a particular use case may be highly localized (such as a stationary installation within a building), while other use cases require global service coverage (such as container tracking). 3GPP technologies already dominate use cases with large geographic coverage needs and medium- to high-performance requirements.

With new feature sets specifically tailored for LPWA IoT applications, 3GPP technologies are taking a large leap forward to cover segments with low-cost, low-performance requirements too.

CAPILLARY NETWORKS COMBINING CELLULAR AND UNLICENSED STRENGTHS

Even when existing 3GPP end-to-end connectivity is not feasible, cellular technology can still provide key benefits when used as a bridging option, i.e. as an aggregation and routing solution. This capillary network approach allows end devices to utilize varying access solutions from either the short range or LPWA domain and access the cellular networks via a gateway device. Capillary networks enable the reuse of cellular functions and assets such as security, device management, billing and QoS without requiring each end device to be cellular-enabled.

A WIDE RANGE OF IOT REQUIREMENTS

There will be a wide range of IoT use cases in the future, and the market is now expanding toward both Massive IoT deployment as well as more advanced solutions that may be categorized as Critical IoT, as shown in Figure 4.

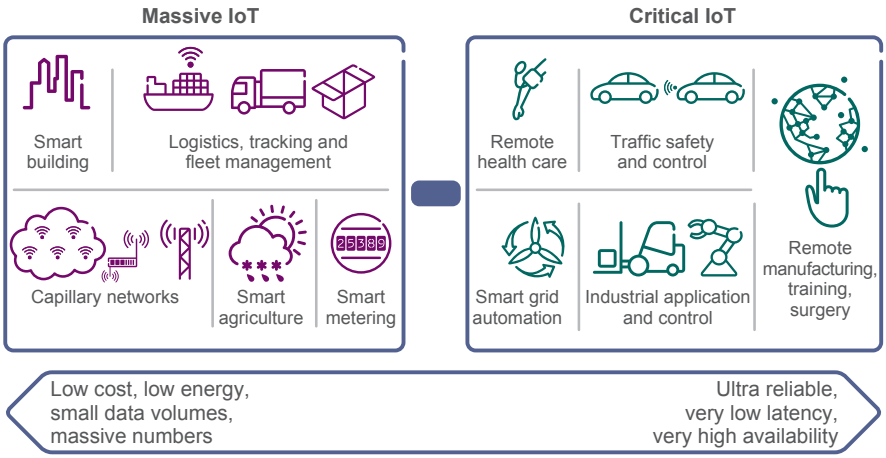

Figure 4: Differing requirements for Massive and Critical IoT applications.

At one end of the scale, in Massive IoT applications – typically sensors that report to the cloud on a regular basis – the end-to-end cost must be low enough for the business case to make sense. Here, the requirement is for low-cost devices with low energy consumption and good coverage.

At the other end of the scale, Critical IoT applications will have very high demands for reliability, availability and low latency. These use cases are enabled by LTE or 5G capabilities. Here, the volumes are typically much smaller, but the business value is significantly higher.

There are, however, many other use cases between the two extremes, which today rely on 2G, 3G or 4G connectivity.

MASSIVE IOT USE CASE DIVERSITY

The Massive IoT market segment includes several applications widely used in industries and societies, as shown in Figure 5.

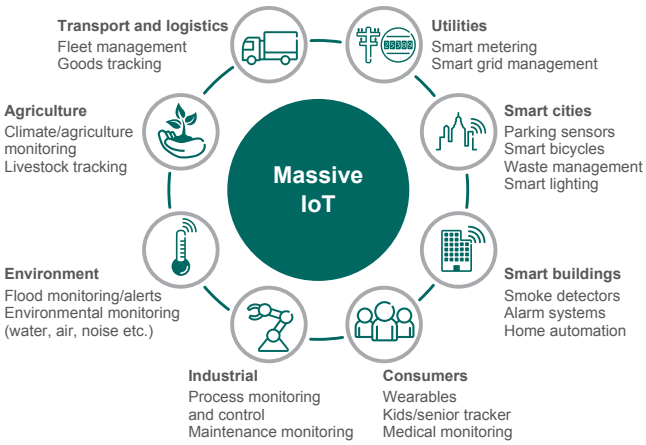

Figure 5: Industry and society applications enabled by LPWA.

The potential applications for the IoT run into the millions, with a huge variety of requirements regarding cost, battery life, coverage, connectivity performance (throughput and capacity), security and reliability. Figure 6 illustrates some such applications and their requirements regarding devices and connectivity.

Some devices will only send a few messages per day – such as status indicators for temperature – while others may need to transmit a video stream to guide a remote repair technician, for example. The difference in throughput requirements is huge. If operators or service providers handle several applications, it may be of great benefit to be able to harmonize communication modules, so that they all use the same underlying radio solution to reduce operational and fault management effort and complexity.

Many higher-value applications will require two-way communications – in other words, an uplink as well as a downlink – to enable monitoring and control of devices in systems like heating, ventilation and cooling plants. The long lifetime of many IoT applications makes it invaluable to be able to perform over-the-air device updates for new functionality or parameter settings. The amount of data sent for such updates can often be more demanding for the network than the monitoring or control application itself.

Relatively simple uplink-focused applications can benefit greatly from a bi-directional link to provide robustness. For example, a connected smoke detector must deliver a smoke alarm with absolute certainty. The ability of a network to provide acknowledgements of a received message enables better fault management and the required level of reliability. Positioning can be used to locate the sensor at the point it failed and simplify operations. For tracking applications, location information is essential.

In applications like building security, sensitive information could be reported over the air, which will require strict security. Furthermore, in the case of a break-in, it is crucial that the alarm information reaches the control center in time – making QoS and two-way communication vital.

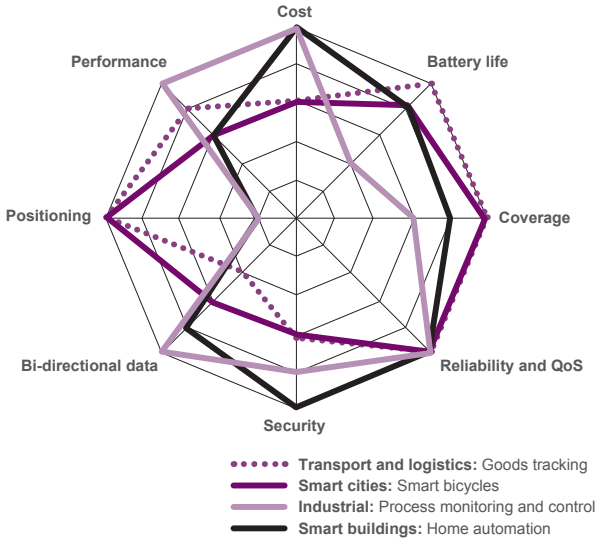

Figure 6: Device and connectivity requirements for sample IoT use cases.

KEY CHALLENGES FOR MASSIVE IOT

The key challenges to enabling large-scale uptake of Massive IoT include:

Device cost – clearly a key enabler for high-volume, mass-market applications, enabling many of the use cases.

Battery life – many IoT devices will be battery-powered, and often the cost of replacing batteries in the field is not viable.

Coverage – deep indoor connectivity is a requirement for many applications in the utility area. Furthermore, regional (or even national or global) coverage is a prerequisite for many use cases, especially within the transport area.

Scalability – in order to enable a Massive IoT market, networks need to scale efficiently. The initial investment required for supporting a limited number of devices has to be manageable, while on the other hand, the network capacity must be easy to scale to handle thousands – or millions – of devices.

Diversity – connectivity should be able to support diverse requirements from different use cases. One network supporting everything from simple static sensors to tracking services, to applications requiring higher throughput and lower latency is essential in terms of total cost of ownership (TCO).

THE ADVANTAGES OF CELLULAR TECHNOLOGIES

Each of the technologies available for IoT connectivity has its own advantages and disadvantages. However, the range of IoT connectivity requirements – both technical and commercial – means cellular technologies can provide clear benefits across a wide variety of applications, as summarized in Figure 7.

Figure 7: Advantages of cellular technologies.

In terms of global reach, cellular networks already cover 90 percent of the world's population. WCDMA and LTE are catching up, but GSM will offer superior coverage in many markets for years to come. Cellular networks have been developed and deployed over three decades, and they will be around for the foreseeable future.

The cellular mobile industry represents a huge and mature ecosystem, incorporating chipset, device and network equipment vendors, operators, application providers and many others. The global cellular ecosystem is governed by the 3GPP standardization forum, which guarantees broad industry support for future development.

When it comes to scalability, cellular networks are built to handle massive volumes of mobile broadband traffic; the traffic from most IoT applications will be relatively small and easily absorbed. Operators are able to offer connectivity for IoT applications from the start-up phase and grow this business with low TCO and only limited additional investment and effort. Operation in licensed spectrum also provides predictable and controlled interference, which enables efficient use of the spectrum to support massive volumes of devices.

Cellular connectivity offers the diversity to serve a wide range of applications with varying requirements within one network. While competing unlicensed LPWA technologies are designed solely for very low-end MTC applications, cellular networks can address everything from Massive to Critical IoT use cases.

QoS mechanisms will be essential for many IoT applications. Cellular systems have mature QoS functionality, and this enables critical MTC applications to be handled together with traffic from sensors, voice and mobile-broadband traffic on the same carrier. QoS, along with licensed spectrum as described above, provides a foundation for long-term Service Level Agreements with a specific grade of service.

Traditionally, the security mechanisms of cellular networks have been based on a physical SIM attached to the device, referred to as a Universal Integrated Circuit Card (UICC). This has also enabled roaming between operators, which has been one of the main factors behind the huge success of mobile networks. The SIM will also be essential in future IoT applications, with SIM functionality embedded in the chipset (eUICC) or handled as a soft-SIM solution running in a trusted run-time environment of the module.

With a straightforward rollout of new software, cellular networks will be able to support the full breadth of applications, ranging from low-end use cases in the LPWA segment, to the high-end segments of in-car entertainment and video surveillance. One network connecting the whole diversifying IoT market will guarantee the lowest possible TCO as well as fast time to market.

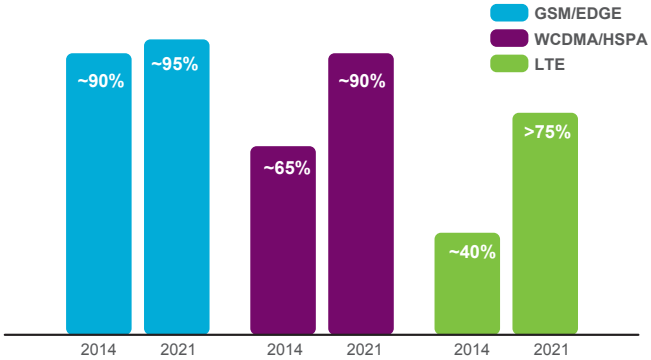

Figure 8: World population coverage by cellular 3GPP technology.

EVOLVING STANDARDS

To meet the new connectivity requirements of the emerging Massive IoT segment, 3GPP has taken evolutionary steps on both the network side and the device side.

The key improvement areas addressed in 3GPP up to Release 13 are:

- Lower device cost – cutting module cost for LTE devices by reducing peak rate, memory requirement and device complexity. The LTE module cost-reduction evolution started in Release 8 with the introduction of LTE for machine-type communication (LTE-M) Cat 1 devices with reduced peak rate to a maximum of 10Mbps, and continued in Releases 12 and 13 with reduced device complexity for lower performance and using less bandwidth or a narrowband IoT carrier to cut costs further.
- Improved battery life – more than 10 years of battery life can be achieved by introducing Power Saving Mode and/or extended discontinuous reception (eDRX) functionality. These features allow the device to contact the network – or to be contacted – on a per-need basis, meaning that it can stay in sleep mode for minutes, hours or even days.
- Improved coverage – an improvement of 15dB on LTE-M and of 20dB on NB-IoT and GSM, which translates into a seven-fold increase in the outdoor coverage area and significantly improved indoor signal penetration to reach deep indoors. This supports many IoT devices like smart meters, which are often placed in a basement.
- Support for massive numbers of IoT connections – specifically, one LTE cell site can support millions of IoT devices, depending on the use case. Core network enhancements include software upgrades for service differentiation handling, signaling optimization and high-capacity platforms (more than 30 million devices per node).

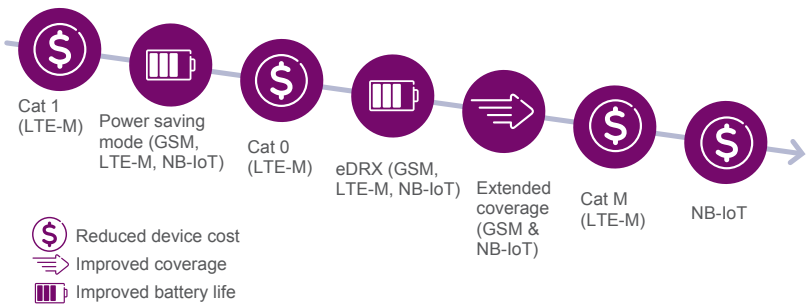

Figure 9: 3GPP evolution steps for Massive IoT.

A FULL RANGE OF CELLULAR LPWA SOLUTIONS

No single technology or solution is ideally suited to all the different potential Massive IoT applications, market situations and spectrum availability. As a result, the mobile industry is standardizing several LPWA technologies, including Extended Coverage GSM (EC-GSM), LTE-M and NB-IoT.

LTE-M, NB-IoT and EC-GSM are all superior solutions to meet Massive IoT requirements as a family of solutions, and can complement each other based on technology availability, use case requirements and deployment scenarios. LTE-M consisting of Cat 1, Cat 0 and Cat M supports a wide range of IoT applications, including those that are content-rich; NB-IoT covers ultra-low-end IoT applications with a cost and coverage advantage over LTE-M; and EC-GSM serves IoT services for all GSM markets.

For example, a smart city application such as waste management may use EC-GSM technology to provide LPWA connectivity in markets where it can be deployed on existing 2G networks; NB-IoT technology may be used for water-metering applications, which have some of the most extreme coverage requirements in underground locations. On the other hand, asset-tracking applications that can support a relatively high number of messages triggered by certain events may employ LTE-M.

EC-GSM – GLOBAL CELLULAR IOT FOR ALL GSM MARKETS

GSM is still the dominant mobile technology in many markets, and the vast majority of cellular M2M applications today use GPRS/EDGE for connectivity. GSM is likely to continue playing a key role in the IoT well into the future, due to its global coverage footprint, time to market and cost advantages.

Recognizing this – and identifying the requirements for Massive IoT discussed earlier in this paper – an initiative was undertaken in 3GPP Release 13 to further improve GSM.

The resulting EC-GSM functionality enables coverage improvements of up to 20dB with respect to GPRS on the 900MHz band.

This coverage extension is achieved for both the data and control planes by utilizing the concept of repetitions and signal combining techniques. It is handled in a dynamic manner with multiple coverage classes to ensure optimal balance between coverage and performance.

EC-GSM is achieved by defining new control and data channels mapped over legacy GSM. It allows multiplexing of new EC-GSM devices and traffic with legacy EDGE and GPRS. No new network carriers are required: new software on existing GSM networks is sufficient and provides combined capacity of up to 50,000 devices per cell on a single transceiver.

Initially part of EC-GSM but now a separate 3GPP item, eDRX improves the power efficiency – and therefore the battery life – for many use cases. eDRX improves the idle mode behavior by allowing the use of a number of inactivity timers, where the device can choose to tune in to the network and listen for downlink pages and traffic.

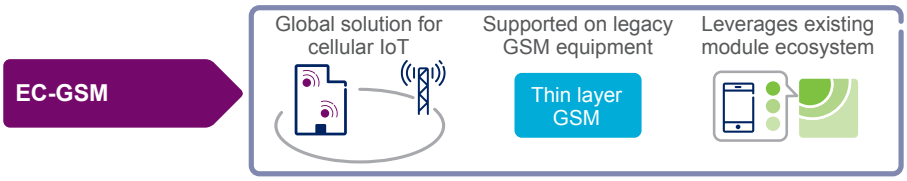

Figure 10: EC-GSM.

EC-GSM extends the data handling and power efficiency advantages that GSM/GPRS technology already offers for MTC, and it will help operators extend the service life of their huge 2G legacy base.

LTE-M – SUPPORTING A WIDE RANGE OF MASSIVE IOT USE CASES

LTE is the leading mobile broadband technology and its coverage is expanding rapidly. So far, the focus has been on meeting the huge demand for mobile data with highly capable devices that utilize new spectrum. With features like Carrier Aggregation, MIMO and Lean Carrier, the gigabit per second performance for LTE cell throughput is now reaching levels that result in an excellent mobile broadband user experience.

The advent of LTE-M signifies an important step in addressing MTC capabilities over LTE. LTE-M brings new power-saving functionality suitable for serving a variety of IoT applications; Power Saving Mode and eDRX extend battery life for LTE-M to 10 years or more. LTE-M traffic is multiplexed over a full LTE carrier, and it is therefore able to tap into the full capacity of LTE. Additionally, new functionality for substantially reduced device cost and extended coverage for LTE-M are also specified within 3GPP.

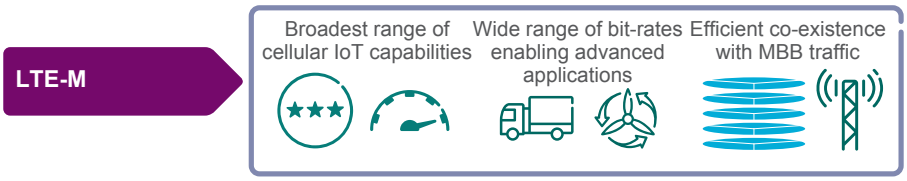

Figure 11: LTE M.

NB-IOT – SUPPORTING ULTRA-LOW-END MASSIVE IOT APPLICATIONS

In addition to LTE-M, NB-IoT technology is being standardized in time for 3GPP Release 13. NB-IoT is a self-contained carrier that can be deployed with a system bandwidth of only 200kHz, and is specifically tailored for ultra-low-end IoT applications. It is enabled using new network software on an existing LTE network, which will result in rapid time to market.

Figure 12: NB-IoT.

NB-IoT provides lean setup procedures, and a capacity evaluation indicates that each 200kHz NB-IoT carrier can support more than 200,000 subscribers. The solution can easily be scaled up by adding multiple NB-IoT carriers when needed. NB-IoT also comes with an extended coverage of up to 20dB, and battery saving features, Power Saving Mode and eDRX for more than 10 years of battery life.

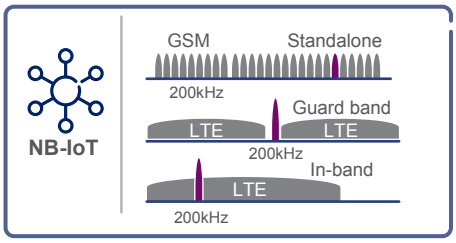

Figure 13: NB-IoT deployment.

NB-IoT is designed to be tightly integrated and interwork with LTE, which provides great deployment flexibility. The NB-IoT carrier can be deployed in the LTE guard band, embedded within a normal LTE carrier, or as a standalone carrier in, for example, GSM bands.

- Standalone deployment in a GSM low band: this is an option when LTE is deployed in a higher band and GSM is still in use, providing coverage for basic services.
- Guard band deployment, typically next to an LTE carrier: NB-IoT is designed to enable deployment in the guard band immediately adjacent to an LTE carrier, without affecting the capacity of the LTE carrier. This is particularly suitable for spectrum allocations that do not match the set of LTE system bandwidths, leaving gaps of unused spectrum next to the LTE carrier.
- Efficient in-band deployment, allowing flexible assignment of resources between LTE and NB-IoT: it will be possible for an NB-IoT carrier to time-share a resource with an existing LTE carrier. The in-band deployment also allows for highly flexible migration scenarios. For example, if the NB-IoT service is first deployed as a standalone deployment in a GSM band, it can subsequently be migrated to an in-band deployment if the GSM spectrum is re-farmed to LTE, thereby avoiding any fragmentation of the LTE carrier.

NB-IoT reduces device complexity below that of LTE-M with the potential to rival module costs of unlicensed LPWA technologies, and it will be ideal for addressing ultra-low-end applications in markets with a mature LTE installed base.

CONCLUSION

Uptake of Massive IoT is set to take off, and operators have a unique opportunity to drive the implementation of new IoT applications by offering affordable connectivity on a global scale.

For IoT applications, existing cellular networks offer distinct advantages over alternative WAN technologies, such as unlicensed LPWA. The global reach, QoS, ecosystem, TCO, scalability, diversity and security of cellular networks are all vital factors that can support the fast uptake and success of IoT. Enabled by new software in existing legacy networks, cellular networks can support a diverse range of IoT applications – ensuring the lowest possible TCO.

3GPP standardization work for GSM and LTE, and the recent addition of NB-IoT, is further improving the ability of cellular networks to address the Massive IoT market, where ultra-low end-to-end cost is a prerequisite.

GSM/GPRS, which already serves the majority of cellular-based MTC applications, is evolving with a new EC-GSM standard, which delivers significantly better energy efficiency and increased coverage. EC-GSM enhancements will cement GSM's position as a highly relevant connectivity platform for low-end, Massive IoT applications globally.

New downsized NB-IoT and LTE-M chipsets, designed for MTC, and features that improve both coverage and device battery life will boost the ability of LTE infrastructure to address the IoT market. One network that supports all applications – from advanced mobile broadband services, VoIP and all kinds of low- to high-end IoT use cases – creates a very strong value proposition.

Whether operators choose the GSM, NB-IoT or LTE-M track – or a combination of these – will depend on several factors such as technology coverage, future technology strategies and targeted market segments. Whichever path they take, they have a huge opportunity to benefit from the emerging IoT revolution. Operators can choose to continue offering telecom-grade connectivity as they do today, or they can evolve to become a platform or fully-fledged IoT service provider targeting a larger slice of future IoT revenues.

GLOSSARY

EC-GSM	Extended Coverage GSM
eDRX	extended discontinuous reception
eUICC	embedded Universal Integrated Circuit Card
IoT	Internet of Things
LPWA	low power wide area
LTE-M	LTE for machine-type communication
M2M	machine-to-machine
MIMO	multiple-input, multiple-output
MTC	machine-type communication
NB-IoT	narrowband IoT
TCO	total cost of ownership
UICC	Universal Integrated Circuit Card
WAN	wide area network

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THE Next Wave

The National Security Agency's review of emerging technologies

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THE Next Wave
The National Security Agency's review of emerging technologies

Editor's column

While the global mobile telecommunications industry has been attempting to keep pace with ever-changing technology and consumer needs, it has not had a strong development roadmap like the International Technology Roadmap for Semiconductors (ITRS). Instead, mobile technology's development has been characterized by multinational companies pushing proposed standards for adoption by international standards bodies. These standards are subsequently adopted in a haphazard, nation-by-nation process. However, consumer desire for faster, more fully featured mobile devices has proven to be as strong a driving force as the ITRS, and has led the industry to roll out generations of new technology on a roughly 10-year basis (approximate dates: 1G - 1981, 2G - 1992, 3G - 2001, and 4G - 2009). This decade-by-decade introduction of new mobile communication technology has led to the common prediction for fifth-generation (5G) mobile to appear around 2020, in keeping with the observed linear cadence.

But why create 5G mobile anyway? The push for 5G is not just a mad rush to keep pace and provide more bandwidth to services that can already stream high-definition video. The Internet of Things (IoT; see TNW Vol. 21 No. 2) is a major driving force (among several) behind technologies being developed for 5G mobile. As personal mobile devices are more enmeshed into machine-to-machine (M2M) communications and the number of IoT sensors explodes, 5G technologies must address several needs: high-speed data rates for many more users, increased density of users, greatly increased simultaneous connections, and reduced latencies. These needs will propel many of the technologies that Dr. Farroha et al. describe in their introduction to 5G article (page 2).

One of those technologies, virtualization, has been instrumental in making efficient use of servers (virtual machine or VM) and computer networking (software-defined networking or SDN). Over the course of continuing improvement to 4G implementations, the networks are evolving into an all-digital Internet protocol packet-switched system. This evolution means that those efficiencies developed for SDN and used in computing can be applied to mobile networking. We can see this application in more depth in the article on 5G virtualization (page 16).

Several markets have already taken advantage of 4G mobile technology, most notably media. This market is expected to expand with 5G as consumer desire for high-resolution video and augmented/virtual reality increases. Automotive, energy, health, and public safety are several areas of M2M that will be greatly enhanced by increased bandwidth and, most importantly, low-latency networks. On 13 December 2016, the US Department of Transportation proposed a rule for vehicle-to-vehicle communication and announced a vehicle-to-infrastructure communication rule to be proposed. The article on 5G and the automotive industry (page 20) provides insight into how this market segment is enhanced by 5G connectivity.

Although mobile technological developments are typically categorized into different generations, each generation covers a vast array of individual technologies and protocols that roll out as they mature. In practice, mobile service providers often work across a range of generations. This is highlighted by the fact that in many cases voice calling is handled by the 3G network while data is handled on the 4G network. Domestically, T-Mobile and AT&T did not enable voice over LTE (VoLTE) until May 2014, and did not meet the International Telecommunication Union (ITU) standard until Verizon launched LTE-Advanced in August 2016.

Many factors can impact the broad global deployment of 5G networks, such as existing technologies, geography, spectrum, and national interests. Some countries may jump to the current network generation while others may delay deployment because their current networks are considered to be "good enough." The decreased per-customer costs of updating networks in densely populated countries makes it more attractive to keep on the leading edge. The increased data rates and simultaneous connections require increased spectrum allocations, which are handled by national regulatory organizations. Several countries, most notably South Korea, have tied their technological identity to the increased

connectivity of next-generation wireless technologies. All these factors give rise to a patchwork international environment for 5G implementation.

Current forecasts for the rollout of 5G networks are in the 2020 time frame. Recent news indicates that it may be earlier than that. Samples of Qualcomm's new Snapdragon X50 4G/5G modem that uses the 27.5 gigahertz (GHz) to 28.35 GHz band—part of the spectrum opened by the Federal Communications Commission for 5G—will be available in the second half of 2017. Samsung and KT, one of South Korea's mobile providers, have announced that they will be the first to provide mobile 5G trial service at the PyeungChang 2018 Winter Olympic Games. Undoubtedly, this trial 5G service will not be fully compliant with 5G standards, which have yet to be adopted. However, we should expect things to advance quickly following the Korean introduction of 5G.

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Introducing 5G

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The evolution of modern cellular communications has been marked by a series of technology generations. Although the technology itself tends to evolve continuously, a new generation of standards marks a revolutionary step forward, with a substantial increase in system requirements to drive fundamentally new applications. With fourth-generation (4G) networks now widely deployed, the industry has turned its sights on "the next big thing." Fifth-generation (5G) networks are expected to enable a seamlessly connected society in the time frame beyond 2020 for both people and things, including vehicles, homes, smart cities, sensor networks, and the power grid. While the Long-Term Evolution (LTE) standard will continue to evolve and play a critical role in the wireless ecosystem, 5G represents an opportunity to architect a new system that is fundamentally different without the constraint of backward compatibility with existing technologies.

What is 5G?

Although there are as yet no standards for 5G mobile networks, a number of key technology trends have emerged. This article describes seven major technology trends that will pave the way to the next generation of 5G networks.

- **New Flexible Radio Access Technology (RAT):** A new, non-backward-compatible RAT will be defined for 5G that is distinct from previous generations, such as 4G LTE and its evolution. New multiple access schemes under consideration include various modified Orthogonal Frequency-Division Multiplexing (OFDM)-based solutions with improved spectral efficiency. The new RAT must be flexible enough to accommodate a variety of traffic types with often conflicting radio requirements. The concept of a unified air interface has been proposed for multiplexing multiple physical layer (PHY) regions with different characteristics [e.g., transmission time interval (TTI), subcarrier spacing] on a contiguous block of spectrum [1, 2, 3]. Spectrum for the new RAT will include existing bands below 6 gigahertz (GHz), as well as new centimeter-wave (cmWave) and millimeter-wave (mmWave) bands in the 6- to 100 GHz range [4]. The new RAT must also support significantly reduced latency, with as low as 100 microsecond (μs) transmission time interval (TTI) at the PHY for the ultra-reliable and low-latency communications (URLLC) use case [5]. Lastly, to further improve spectral efficiency, full-duplex transmission schemes have been proposed, potentially allowing the same time-frequency resources to be used for uplink and downlink transmissions simultaneously [6].
- **Virtualization:** Software-Defined Networking (SDN) and Network Function Virtualization (NFV) are two key architecture concepts in development to support the flexibility and mobility demands of the 5G network infrastructure [7, 8, 9]. Virtualization of network functions, which were traditionally implemented in hardware, will pave the way for commercial telecommunications operators and service providers to introduce new features and integrate new standards releases at an accelerated rate. NFV enables providers to move toward a decentralized network to increase flexibility, pushing core functions toward the edge to reduce latency, and virtualizing those functions on cloud-based servers. The proposed Cloud Radio Access Network (C-RAN) architecture, a specific use case of NFV applied to the RAN, uses a pooled architecture of baseband resources to increase scalability, physical layer flexibility, and spectral efficiency [7, 10].
- **Millimeter Wave (mmWave) Communications:** The term mmWave refers to carrier frequencies in the International Telecommunication Union (ITU) extremely high-frequency (EHF) band, from 30 to 300 GHz. Within the context

of 5G, the term has recently been loosely used by industry to refer to the higher frequencies from 6 to 100 GHz that are under consideration for new mobile spectrum [11, 12]. mmWave technologies are becoming an increasingly attractive solution to the problems of frequency reuse, cell density, raw data throughput, and antenna array size. This has led to a synergy between mmWave, small cell deployments, and massive multiple-input, multiple-output (MMIMO) techniques [13, 14].

- **Massive Multiple-Input, Multiple-Output (MMIMO) Techniques:** MMIMO is a new concept in antenna arrays that provides a number of advantages over traditional MIMO arrays currently deployed in 4G networks. Traditional MIMO arrays use only a few antenna elements (i.e., 2 to 16), whereas MMIMO uses a large number of elements in the array, currently considering a range of 128 to 512 at a minimum. Highly directional beamforming to multiple users simultaneously allows for increased user density and higher aggregate cell throughput [15]. So-called hybrid MMIMO has also been proposed; it combines beam steering with array processing techniques, such as spatial multiplexing, to increase single-user throughput [16].
- **Heterogeneous Networks (HetNets):** HetNets expand the mobile access network capacity by coordinating small cells with larger macro cells or offloading traffic to wireless local area network (WLAN) access points. There are two types of heterogeneity: 1) various cell sizes (e.g., macro, pico, femto) and 2) heterogeneous RATs [e.g., third-generation (3G), 4G, 5G, WLAN]. Small cells may include femto, pico, and micro cells, which can range in capacity from less than 10 to several hundred simultaneous active users. While HetNet deployments have already been introduced in 4G networks, network densification through the aggressive deployment of small cells is expected to increase significantly in future 5G networks [17, 18].
- **Native Machine-Type Communications (MTC) Support:** 5G networks are expected to incorporate a new model for connectivity specifically designed for MTC [19]. With the significant increase in connected machines over the last several years, a new 5G standard is seen as a prime opportunity to ensure new RATs can efficiently support a large number of connected devices with their own unique access constraints. Two categories of MTC are discussed: 1) general MTC and 2) vehicle-to-everything (V2X) MTC. General MTC devices have a few unique design and deployment considerations—namely, lower bandwidth needs, stringent power budgets, and relaxed latency requirements. V2X MTC devices, in contrast, require low-latency communications, out-of-coverage networks, and limited operation on a subscription-free basis [20].
- **Device-centric Architectures:** New network architectures will focus on a uniform quality of experience (QoE) for the user device, in contrast to traditional base-station-centric architectures. A number of new device-centric approaches are under consideration: decoupling the user plane and control plane, decoupling the uplink and downlink, and device-to-device communications [4, 21]. Another novel proposal is the user-centric cell or virtual cell model, which uses distributed beamforming and decoupled user/control planes to create a virtual cell around each user [2, 3]. Because the virtual cell follows the user, QoE variations are reduced and the cell-edge problem is mitigated. New device-centric architectures may significantly alter the traditional concept of cell handovers or eliminate it entirely.

Many of these technologies are already being added to the evolution of existing technologies beyond 4G, such as LTE-Advanced Pro [22].

In 2015, there was a significant increase in industry activities surrounding 5G networks. Major standards bodies, including the ITU and the Third-Generation Partnership Project (3GPP), reached important milestones in the early development of the eventual 5G standards. In September, the ITU published its vision for 5G networks [19]. The vision for International Mobile Telecommunications for 2020 and beyond (IMT-2020) defines three future-looking, high-level use cases for 5G:

- **Enhanced Mobile Broadband (eMBB):** This is generally a human-centric use case driven by the exponential increase in demand for mobile access to multimedia content, services, and data.

The eMBB use case will come with new application areas and requirements that go beyond existing mobile broadband applications for improved performance and increasingly seamless user experience. This use case covers a range of scenarios, including wide-area coverage and localized high-throughput spot coverage, which will have different requirements.

- **Massive Machine-Type Communications (mMTC):** This use case is characterized by a large number of connected devices typically transmitting a relatively low volume of nondelay-sensitive data. Devices are intended to be low cost and have a very long battery life.
- **Ultra-Reliable and Low-Latency Communications (URLLC):** This use case is characterized by stringent requirements for latency, throughput, and availability. Examples include wireless control of industrial manufacturing processes, remote medical surgery, distributed smart grid automation, and transportation safety [e.g., vehicle-to-vehicle (V2V) or vehicle-to-everything (V2X) communication]. Many companies have referred to this use case as critical MTC (cMTC) or ultra-reliable MTC (uMTC). However, based on the ITU definition in [19], this use case is not strictly limited to MTC applications.

It is important to consider that the applications that will use 5G technology do not necessarily correspond to a single use case but are more accurately described as a combination of multiple use cases. Figure 1 illustrates some examples of currently envisioned 5G applications and their relationship to these three IMT-2020 use cases [19]. Figure 2 illustrates eight key capabilities identified by ITU for IMT-2020 and their relative importance to the same three use cases [19]. Furthermore, additional future use cases are expected to emerge but cannot be accurately predicted (i.e., what will be the "killer app" in 2025?). Therefore, it is desired that 5G standards will provide the flexibility to adapt to new use cases.

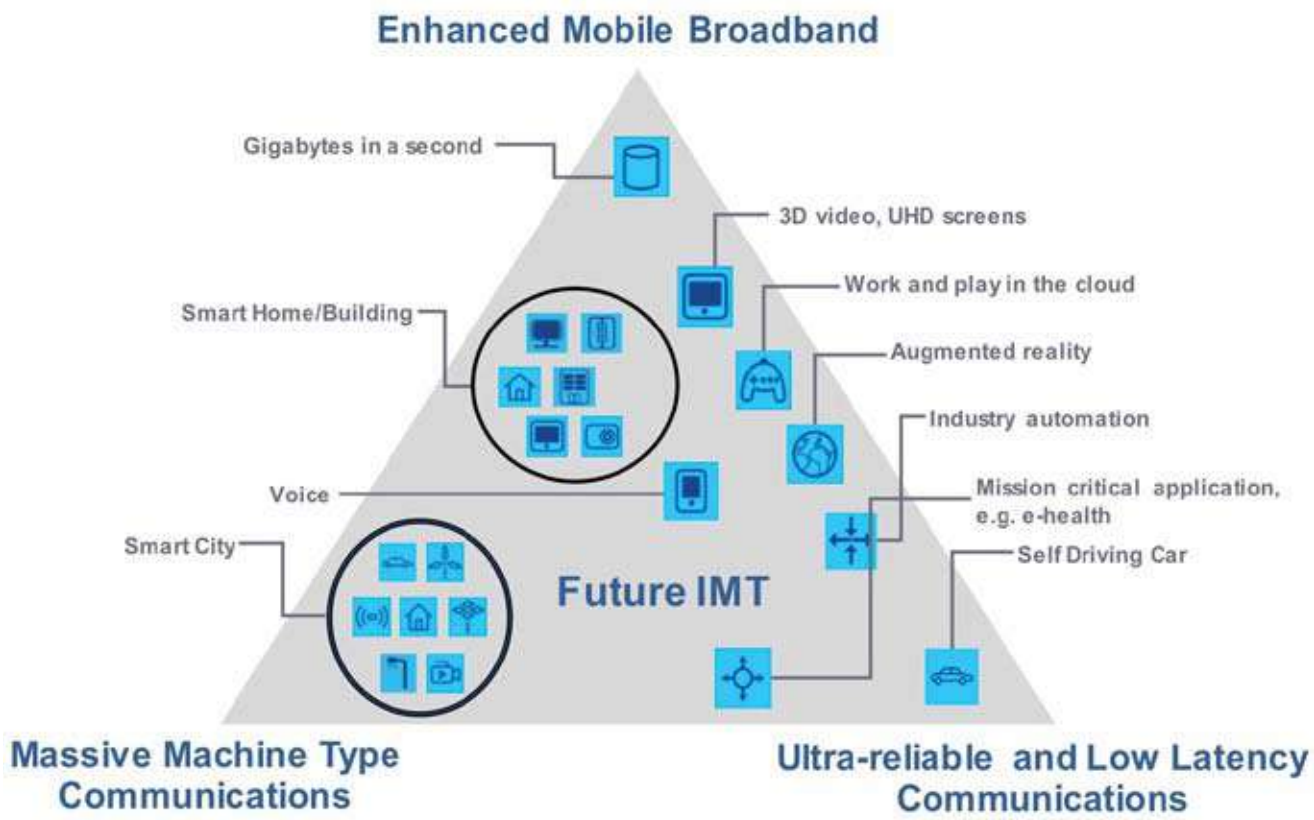

FIGURE 1. 5G use cases as defined by ITU for IMT-2020 [19].

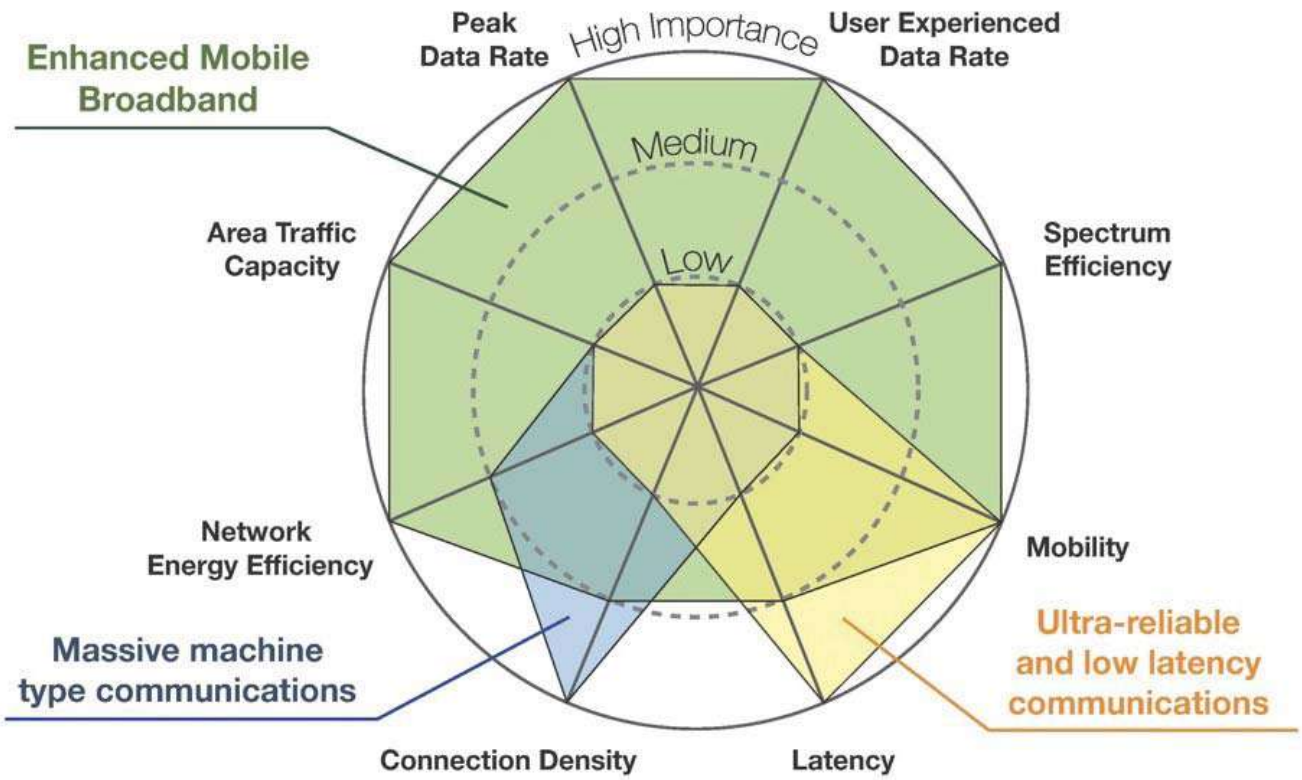

FIGURE 2. Eight key capabilities and their relative importance to 5G use cases [19].

5G Standardization

Development work toward 5G is well under way. Standards bodies are actively working on new 5G mobile technologies to be deployed in the 2020 time frame. This section summarizes the activities and corresponding 5G development timelines for three major standards bodies: ITU, 3GPP, and the Institute of Electrical and Electronics Engineers (IEEE).

Standardization in ITU

ITU is the United Nations agency responsible for promoting worldwide improvement and rational use of information and communication technology. Its members include industry, academia, and standards organizations from more than 190 member nations. The ITU Radiocommunication Sector (ITU-R) works toward worldwide consensus in the use of terrestrial and space radiocommunication services, including mobile communication technologies. Although compliance with ITU-R recommendations is not mandatory, they nevertheless have a high degree of adoption worldwide and hold the status of international standards [23].

International Mobile Telecommunications framework

ITU-R Working Party 5D (WP 5D) is responsible for overall radio aspects of terrestrial mobile systems, referred to as International Mobile Telecommunications (IMT). The purpose of IMT is to provide high-quality mobile services with a high degree of interoperability worldwide. Since 2000, the ITU has developed the IMT standards framework in a manner that parallels cellular generations from an industry perspective. Although ITU-R WP 5D defines the requirements for IMT, it does not develop the actual radio technologies. Rather, candidate radio technologies are submitted for inclusion by external standards bodies, such as 3GPP and IEEE. For this reason, ITU-R WP 5D maintains strong cooperation with the major global standards bodies.

The first family of standards derived from the IMT concept (IMT-2000) aligned with 3G cellular. Radio technologies accepted into IMT-2000 included 3GPP Wideband Code-Division Multiple Access (WCDMA), 3GPP2 cdma2000, and IEEE 802.16 [i.e., Mobile Worldwide Wireless Interoperability for Microwave Access (WiMAX)]. The next generation of IMT standards (IMT-Advanced) aligned with 4G cellular. Radio technologies accepted into IMT-Advanced included 3GPP LTE-Advanced and IEEE 802.16m [i.e., Wireless Metropolitan Area Network (WMAN)-Advanced].

Timeline for IMT-2020

In 2012, ITU embarked on a program to develop "IMT for 2020 and beyond," setting the stage for emerging 5G research activities around the world. The program has since adopted the name IMT-2020 and forms the framework for the next generation of mobile broadband standards. The timeline for the development of IMT-2020 is shown in figure 3 [24]. The IMT 2020 timeline will essentially follow the same process used in the development of IMT-Advanced.

The IMT-2020 program is well under way, with a number of key milestones completed. In September 2015, ITU published its vision of the 5G mobile broadband connected society [19]. This document defined three high-level use cases for 5G, described earlier in this article, which have already been widely adopted by 3GPP and industry in general. In the next phase, the 2016–2017 time frame, ITU-R WP 5D will define in detail the performance requirements, evaluation criteria, and methodology for the assessment of the new IMT radio interfaces. It is anticipated that the time frame for proposals will be focused in 2018. In the 2018–2020 time frame, independent, external groups will evaluate proposals and the definition of the new radio interfaces to be included in IMT-2020 will take place. ITU-R WP 5D also plans to hold a workshop in late 2017 to discuss the performance requirements and evaluation criteria for candidate technologies for IMT-2020, as well as to provide an opportunity for presentations by potential proponents for IMT-2020 in an informal setting. The whole process is planned to be completed in 2020, when a new draft of the ITU-R recommendation with detailed

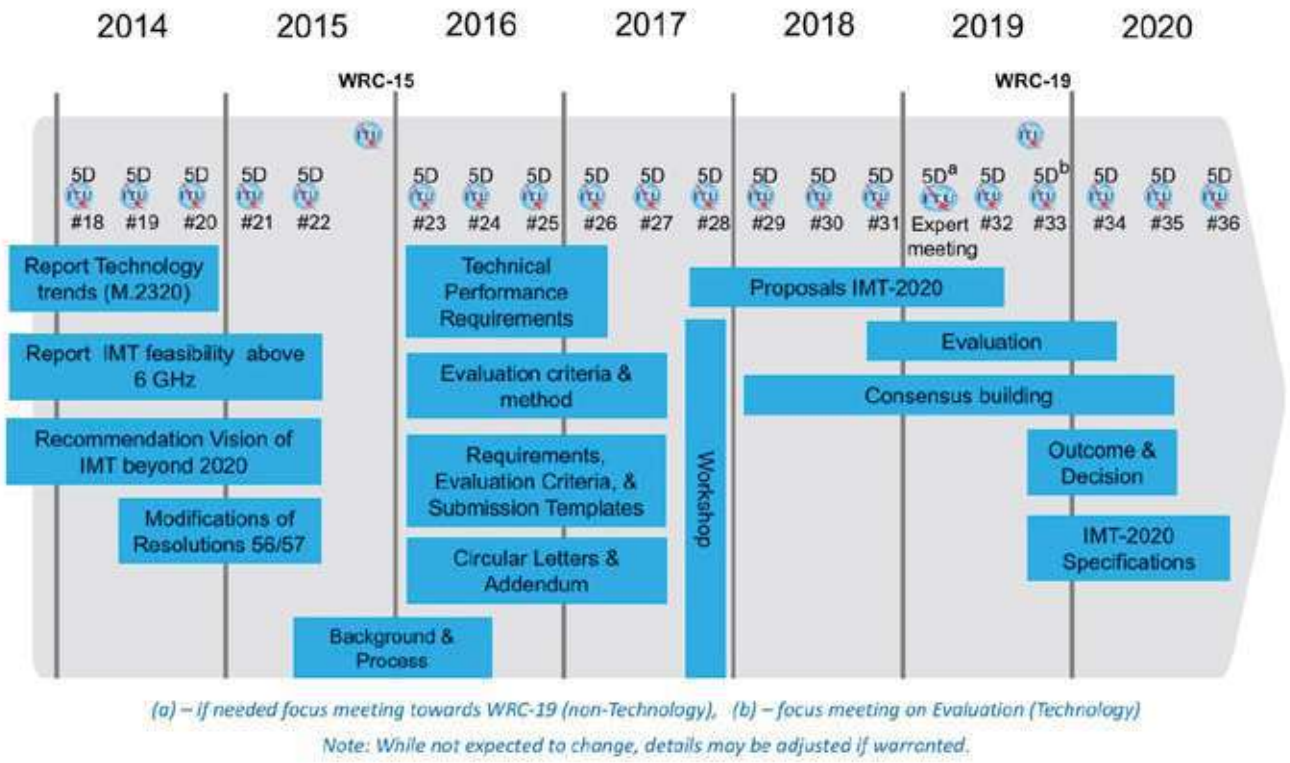

FIGURE 3. Detailed timeline and process for IMT-2020 in ITU-R [24].

specifications for the new radio technologies will be submitted for approval within ITU-R [24].

Standardization in 3GPP

3GPP is the international standards body responsible for the development and maintenance of major second-generation (2G), 3G, and 4G cellular standards. The purpose of the organization is to produce interoperable cellular communications standards, as well as studies and reports that define 3GPP technologies. The following technologies are currently maintained and evolved by 3GPP:

- Global System for Mobile Communications (GSM), General Packet Radio Service (GPRS), and Enhanced Data Rates for GSM Evolution (EDGE);
- Universal Mobile Telecommunications System (UMTS), WCDMA, High-Speed Packet Access (HSPA), and HSPA Evolution (HSPA+); and
- LTE, LTE-Advanced, and LTE-Advanced Pro.

These 3GPP technologies are constantly evolving through a series of backward-compatible releases. Since the completion of the first LTE and Evolved Packet Core (EPC) specifications, 3GPP has become the focal point for mobile systems beyond 3G. Therefore, 3GPP is expected to be a critical player in the development of 5G, and their timeline will have a direct influence on the timeline of the emerging 5G market.

3GPP is currently defining a new 5G RAT and corresponding network architecture. These are being developed within 3GPP under the working names "new radio (NR)" and "next-generation (NextGen) architecture," respectively [25]. In October 2016, 3GPP announced that the new 3GPP system will officially be known by the name "5G" from Release 15 onward [26]. Some initial standardization steps that have been taken to date include the following:

- **SMARTER study item:** In March 2015, 3GPP Technical Specification Group (TSG) System Aspects (SA) began a study item on technology enablers for new 5G services and markets, known as the SMARTER study item [27]. The objective of this study was to develop high-level use cases and identify the related high-level potential requirements to enable 3GPP network operators to support new services and markets in 5G. Phase 1 of the SMARTER study item was completed in March 2016; results are documented in 3GPP Technical Report (TR) 22.891 to be included in Release 14 [28]. A total of 74 use cases were identified. This work prompted four building block studies that grouped the use cases into families with common requirements: massive Internet of Things (IoT), critical communications, eMBB, and network operation. The building block studies were completed in June 2016; results are documented in 3GPP TRs 22.861, 22.862, 22.863, and 22.864 to be included in Release 14 [29]. The results of the SMARTER study will form the basis for a work item to define normative stage 1 requirements for the next-generation 5G system. The work item is scheduled for completion in March 2017; results will be documented in 3GPP Technical Specification (TS) 22.261 to be included in Release 15 [29].
- **Study item on channel model for frequency spectrum above 6 GHz:** The first 5G study conducted by TSG RAN focused on developing new channel models to support high-frequency spectrum from 6 GHz to 100 GHz. The models consider a variety of scenarios including urban, rural, and indoor, as well as the impact of line-of-sight (LOS) versus non-LOS (NLOS). The study was completed in June 2016, and results are documented in 3GPP TR 38.900 to be included in Release 14 [30].
- **Study item on architecture for next-generation system:** In December 2015, 3GPP TSG SA approved a study item to design a system architecture for the next generation of mobile networks. The new architecture will support at least the new 5G RAT(s), the evolution of LTE, and non-3GPP access types and will minimize access dependencies. The study considers new approaches such as NFV and network slicing. The study item was scheduled for completion in December 2016; results will be documented in 3GPP TR 23.799 to be included in Release 14 [31].
- **Study item on scenarios and requirements for next-generation access technologies:** In December 2015, 3GPP TSG RAN approved a study item to develop deployment scenarios and requirements of next-generation access

technologies. The study identifies 12 deployment scenarios that are more diverse than those originally envisioned for legacy RATs, such as LTE and its predecessors. It also identifies key performance indicators (KPIs) and other requirements for 5G NR. The bulk of the study was completed in September 2016 to provide guidance to the ongoing technical work being performed in the RAN working groups. However, the study item will remain open until March 2017 to match the IMT-2020 timeline and ensure all IMT-2020 requirements are captured. Final results are documented in 3GPP TR 38.913 to be included in Release 14 [32, 4].

- **Study item on NR access technology:** In March 2016, 3GPP TSG RAN approved a study item to develop the 5G NR access technology capable of meeting the broad range of use cases defined for 5G. The study seeks to develop a single technical framework capable of addressing all usage scenarios and requirements defined in TR 38.913 for eMBB, mMTC, and URLLC, with an emphasis on forward compatibility. The study is scheduled for completion in March 2017; results will be documented in 3GPP TR 38.912 to be included in Release 14 [1].

5G standardization activities in 3GPP will continue through 2020 and beyond, as described next.

Emerging 3GPP standardization timeline

In March 2015, 3GPP announced a tentative standardization timeline for 5G based on the ITU work plan timeline for IMT-2020 [33]. Since then, a more detailed timeline has come into focus as study items have commenced and completed, and as the 3GPP TSGs coordinate for the initial release of 5G. The timeline shown in figure 4 is a composite from multiple sources.

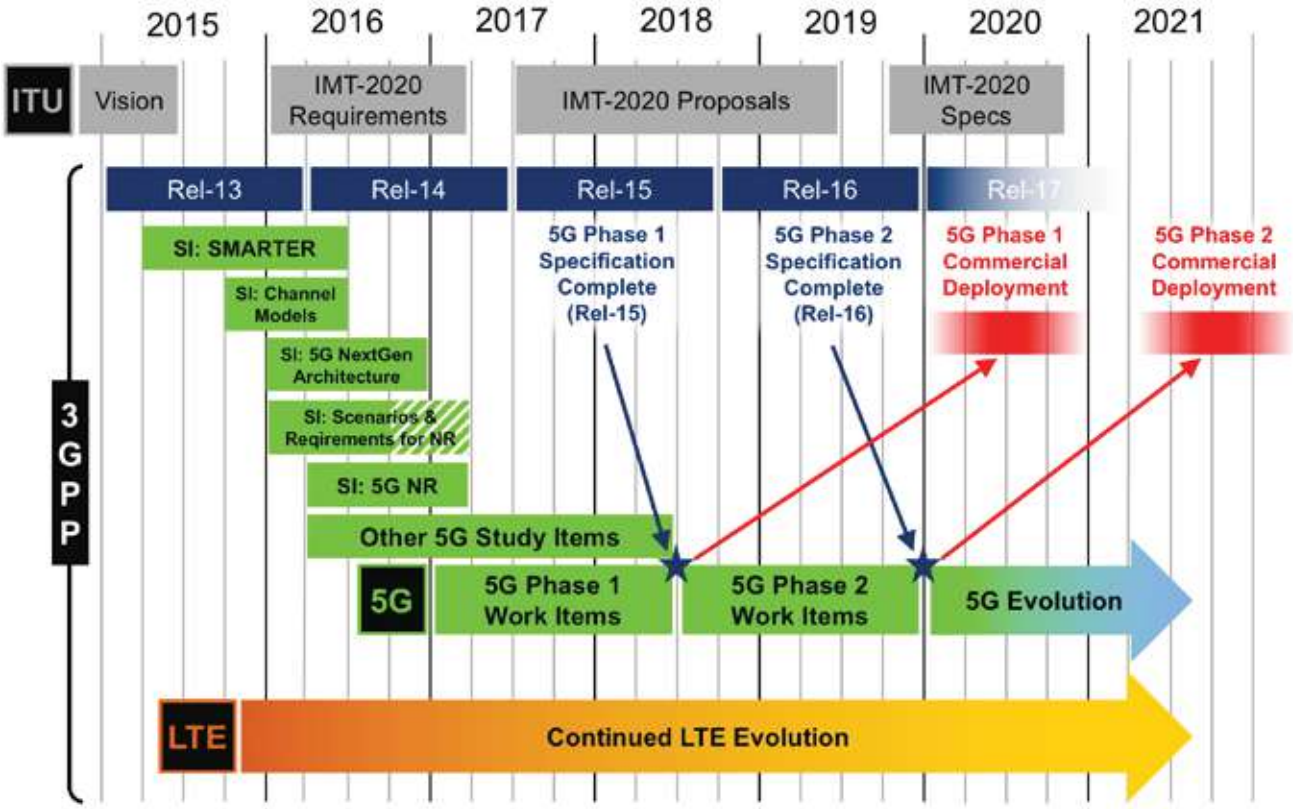

FIGURE 4. Emerging 5G standardization timeline for 3GPP. (Figure is a composite from [34] and [35] that includes additional data from various sources.)

The initial 5G study items in TSG SA and TSG RAN commenced in 2015 and 2016, as described previously. These initial 5G study items will be included in 3GPP Release 14. This work is carried out in parallel with ongoing LTE work. At the 3GPP plenary meeting in June 2016, the TSGs agreed on a work plan for the first release of 5G in 3GPP Release 15, including a clear work division between the TSGs [25].

5G work items were scheduled to begin in December 2016 for TSG SA and March 2017 for TSG RAN. The Phase 1 5G work items will fall into Release 15, with planned completion in June 2018. Additional 5G study items will continue during Release 15 in support of Phase 2. Subsequently, the Phase 2 5G work items will fall into Release 16, which will be completed around December 2019 in time for the final submission to ITU for IMT-2020. Phase 1 commercial deployments are expected to begin in 2020, followed by Phase 2 deployments in the 2021–2022 time frame. However, early pre-5G mmWave deployments may emerge in limited markets, such as South Korea or the United States, before 2020.

For example, Verizon Wireless has announced its plans to pilot a 28-GHz mmWave deployment in the United States for fixed wireless applications starting in 2017 [36]. To support this effort, the Verizon 5G Technology Forum (V5GTF)—an industry consortium led by Verizon—published an open radio interface specification in July 2016 [37]. The Verizon specification uses an OFDM-based PHY similar to time-division LTE (TD-LTE) with enhanced beamforming for operation in 28 and 39 GHz mmWave spectrum. However, with the initial focus on fixed wireless, the first release does not support user mobility. The Verizon specification can be considered pre-5G in the sense that it supports new mmWave capabilities beyond 4G but does not address all the use cases and associated requirements for 5G. The Verizon specification is expected to be incompatible with the eventual 3GPP 5G standard, potentially leading to market fragmentation [38].

3GPP phased approach to 5G standardization

3GPP TSG RAN will take a two-phased approach to developing the new 5G RAT [35]. The Phase 1 standard will define a new, non-backward-compatible 5G RAT. A subset of prioritized features and use cases will be addressed in Phase 1 to allow for early commercial deployments targeted for the year 2020. The Phase 2 standard will implement the full set of features and use cases necessary to meet the requirements for 5G. An initial proposal will be submitted to ITU as a candidate radio interface technology for IMT-2020 by the June 2019 submission deadline. The Phase 2 standard will later form the final submission around December 2019. The Phase 1 standard will be designed for forward compatibility with Phase 2 [35]. Forward compatibility means that Phase 1 must be designed from the beginning to optimally accommodate all of the features and use cases expected to be added later in Phase 2, even though those features are not yet fully implemented. Although the forward-compatibility requirement may sound straightforward, it represents a fundamental shift from the normal 3GPP standardization process, which historically has focused on a series of backward-compatible releases.

While prioritization of features between the two phases has been a topic of much debate, it is clear that the 5G Phase 1 standard will support tight interworking with LTE to simplify initial rollout. The phased approach and tight interworking with LTE means that elements of the LTE system architecture may persist in 5G deployments for some time to come. This implies that current and future work on LTE, LTE-Advanced, and LTE-Advanced Pro networks and technologies may have direct applicability to eventual 5G network deployments.

Standardization in IEEE

Initial 5G standards activities within the IEEE suggest that they do not intend to be a direct competitor with organizations like 3GPP on the radio interface between the RAN and the user equipment. Instead, IEEE has begun developing complementary technologies to support other communications requirements within the 5G ecosystem. In 2016, IEEE established two new working groups related to 5G: IEEE 1914 and IEEE 1918.

IEEE 1914 is the Next Generation Fronthaul Interface Working Group. This working group is currently developing two standards: the 1914.1 standard

for packet-based fronthaul transport networks and the 1914.3 standard for radio over Ethernet encapsulations and mappings [39, 40]. These standards focus on the fronthaul interface within the RAN between baseband units (BBUs) and remote radio heads (RRHs) to support novel RAN architectures like C-RAN, and antenna techniques like MMIMO and coordinated multi-point (CoMP) transmission and reception. The projected completion dates for these standards are August 2018 for 1914.1 and October 2017 for 1914.3.

IEEE 1918 is the Tactile Internet Working Group. This working group is currently developing the 1918.1 standard, which defines a framework for the Tactile Internet [41]. The purpose of this framework is to establish a basis for the rapid development of the Tactile Internet as a 5G and beyond application, with the expectation of additional IEEE 1918 standards to follow. The projected completion date for the 1918.1 standard is October 2018.

With respect to IMT-2020, IEEE may seek to expand the role of WLAN in 5G as a complementary radio interface for next-generation HetNets. In September 2016, the IEEE 802.11 working group sent a liaison statement to 3GPP TSG RAN and TSG SA inviting them to consider the use of IEEE 802.11-based WLAN in unlicensed spectrum as a complementary means of meeting the performance requirements of IMT-2020, potentially leading to inclusion in a joint submission to IMT-2020 [42]. This approach would be a logical extension of the increasing level of interworking between LTE and WLAN in recent standards releases. WLAN is already widely used in 3GPP networks for high data rate offloading.

Recent enhancements in radio-level interworking have increased the efficiency of these networks. Enhancements include LTE-WLAN Aggregation (LWA) and LTE WLAN Radio Level Integration with IPsec Tunnel (LWIP) in 3GPP Release 13, with further enhancements in 3GPP Release 14. Although 3GPP declined to make a decision at the September 2016 plenary meeting, the concept of a potential joint submission could represent a novel approach to IMT-2020. In contrast, previous generations of IMT saw IEEE in competition with 3GPP, with the submission of the IEEE 802.16 WiMAX family of standards to IMT-2000 and IMT-Advanced as a direct competitor in the 3G and 4G markets.

Conclusion

This article provided an introduction to major technology trends in the emergence of next-generation 5G mobile networks. These networks are expected to see initial commercial deployment starting around the year 2020. Early 5G standardization activities in the ITU, 3GPP, and IEEE were addressed.

For further information on the latest developments in 5G, the interested reader is directed to the following resources. ITU publications for IMT-2020 can be found on the IMT-2020 web page [24]. Notable documents include the ITU vision for IMT-2020 [19] as well as the technical performance requirements for IMT-2020 (scheduled for completion in February 2017). The 3GPP web site (www.3GPP.org) is the most direct source for 3GPP-related technical information. 3GPP press releases provide high-level summaries of ongoing standards activities and often include links to more detailed further reading. The latest versions of the 3GPP TR and TS documents mentioned in this article can be accessed there as well. Information on the IEEE 1914.1, 1914.3, and 1918.1 standards can be found in the approved project authorization request (PAR) documents [39, 40, 41] and the corresponding working group web pages. Lastly, the Verizon mmWave specification is available on the V5GTF website (www.5GTF.org). This pre-5G specification defines layers 1 to 3 of an open radio interface using a document structure similar to that of LTE.

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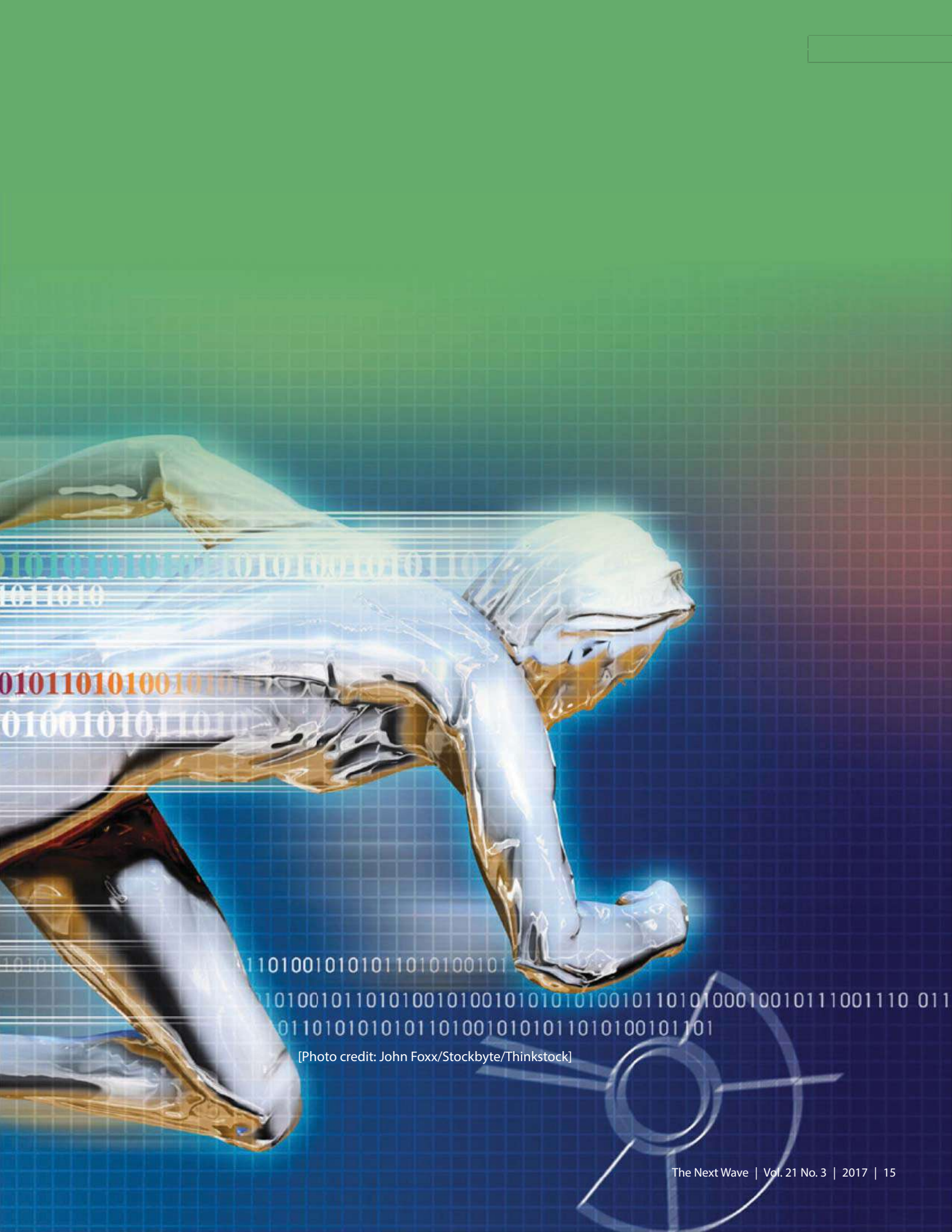

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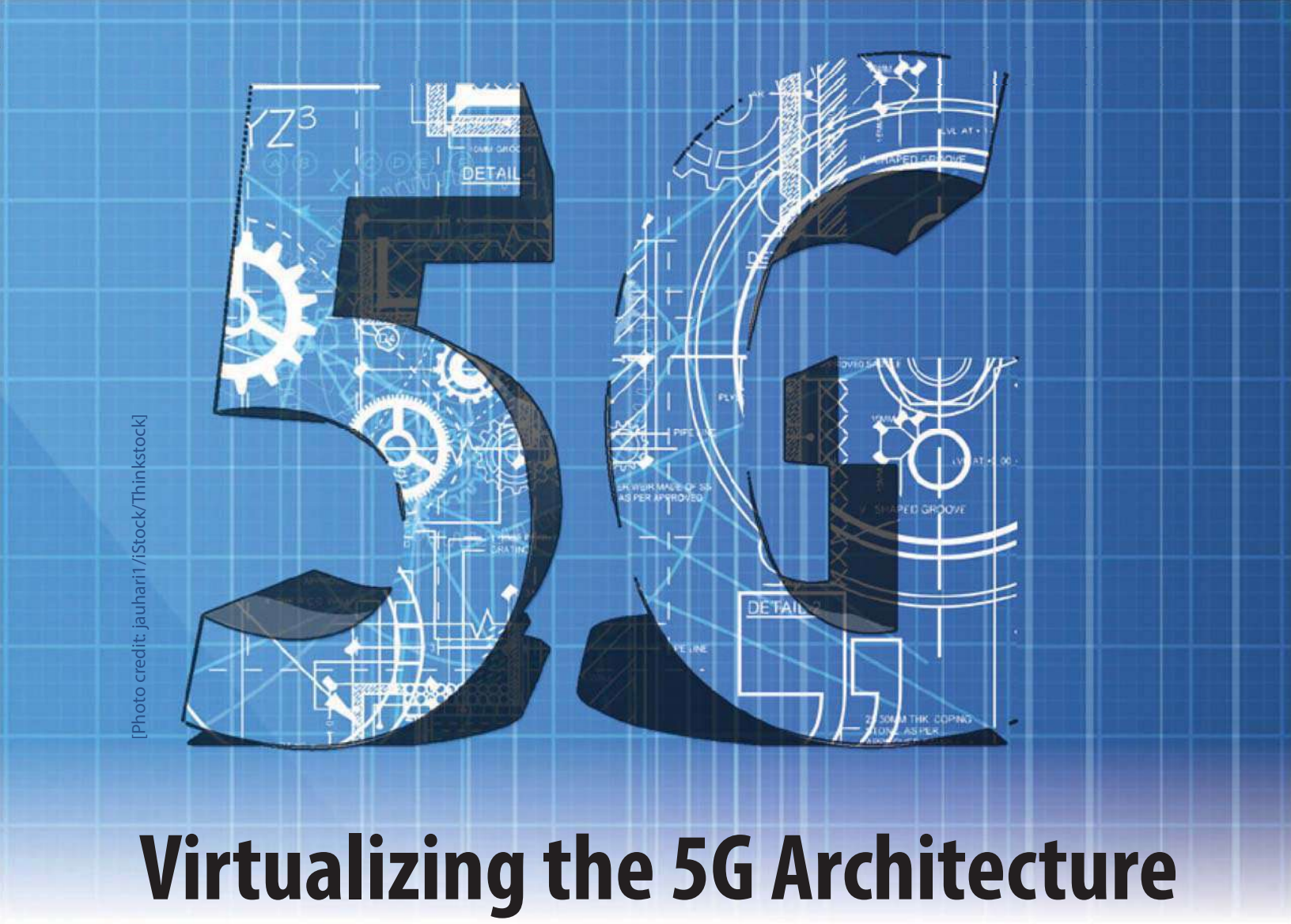

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Virtualizing the 5G Architecture

Staff Writer

Virtually changing the 5G architecture

Virtualization is set to play a major role in the evolution of the fifth-generation (5G) core network. According to industry experts, 5G will use software-centric networking technologies such as software-defined networking (SDN) and network functions virtualization (NFV), and will be natively cloud based. If correct, this will represent a major transition in system architecture and will require much greater collaboration across the networking ecosystem. The push to incorporate more cloud- or software-based components is driven by the need for greater flexibility and scalability to respond to the demands of radio access technologies that offer more bandwidth, reduced latency, and stringent quality of service (QoS) requirements. The new 5G core network must be adaptable and better equipped to handle various devices and manage capacity in near-real time. Mobile network operators see the advances in cost and efficiency that virtualization brings to other market segments and will use the emerging 5G technology to determine if these same advances can benefit the mobile market [1, 2].

SDN and NFV are two key architecture concepts in development to support the flexibility and mobility demands of the 5G network infrastructure. Virtualizing network functions that were previously implemented in hardware will allow providers to introduce new features and integrate new standards at a faster rate. SDN/NFV provides an avenue for providers to decentralize their networks, thereby increasing flexibility and reducing latency. Two areas where SDN/NFV will benefit 5G networks, and in some cases even fourth-generation (4G) mobile technology, are network slicing and cloud-radio access network (C-RAN).

Network slicing

Network slicing would promote end-to-end mobile network virtualization by "slicing" the network into virtual channels. These virtual channels would be autonomous and encompass a set of resources—physical or virtual—including bandwidth on a network link, processing capacity of servers, processing capacity of network elements, as well as operations support system (OSS) and business support system (BSS) processes. Operators could then use these channels to dynamically devote the appropriate network resources to create a "lane" in the network specifically designed for a particular use or service. This would accommodate the many use cases being put forth for 5G. The operator-led Next Generation Mobile Networks (NGMN) Alliance has sought to define categories of 5G use cases (i.e., service types) that have distinct performance characteristics and commercial potential. In a 2015 white paper, the NGMN listed eight application categories for 5G [3, 4, 5]:

1. Broadband access in dense areas,
2. Broadband access everywhere,
3. Higher user mobility,
4. Massive Internet of Things,
5. Extreme real-time communications,
6. Lifeline communications,
7. Ultra-reliable communications, and
8. Broadcast-like services.

Each of these service types demand different network requirements that are determined by the types of traffic being sent and even the types of devices sending the traffic. For example, someone downloading cat videos will not have the same bandwidth or low latency requirements as a doctor in Los Angeles performing surgery virtually on a patient in Mumbai. The end-to-end notion of network slicing could be key to 5G's ability to effectively accommodate all of these disparate use cases.

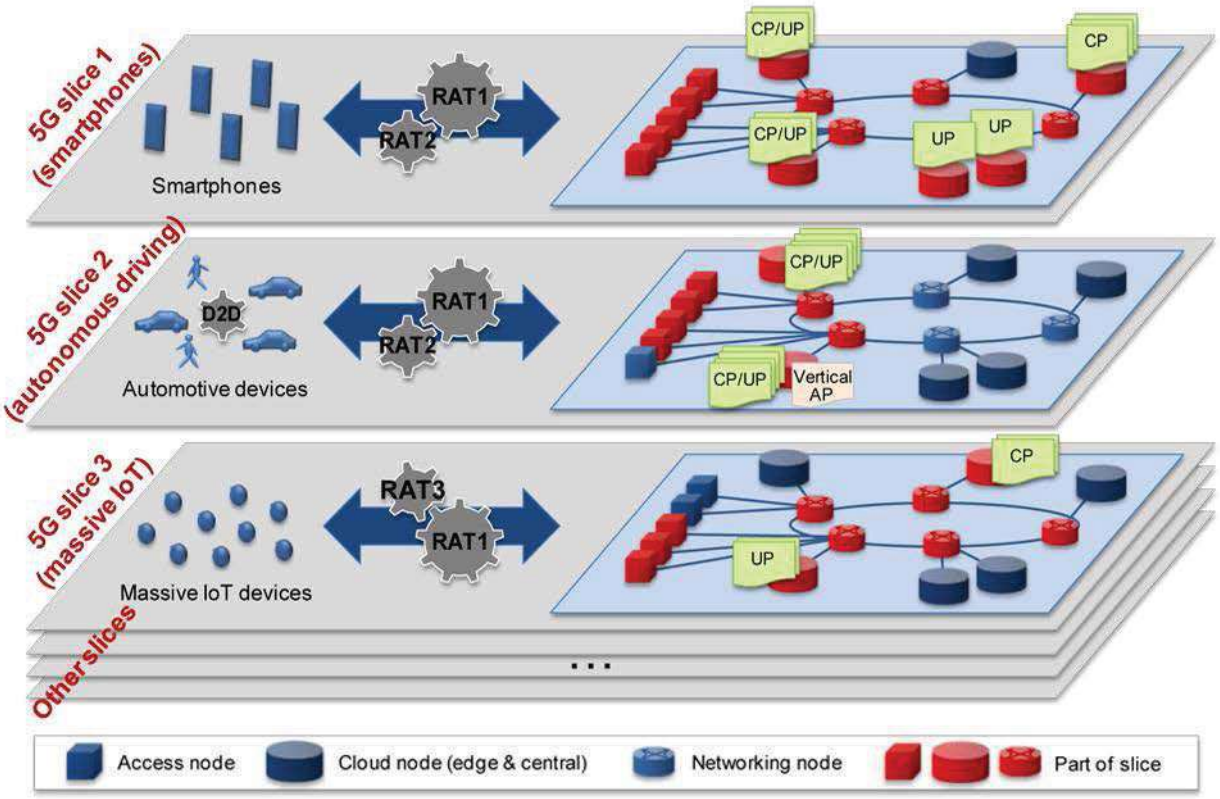

FIGURE 1. 5G's incorporation of SDN and NFV would allow network slices to be created dynamically and deployed as needed to accommodate a variety of scenarios [2].

The Open Networking Foundation, in an April 2016 white paper, called out SDN's ability to support multiple services over a common architecture as a key enabler for network slicing. SDN also allows for slices to be created dynamically and deployed as needed to accommodate a variety of scenarios (see figure 1). Currently, 4G mobile networks prioritize traffic to get a similar effect, but with more rigidity and limitations. However, as 4G networks incorporate SDN and NFV, network slicing will become an option.

C-RAN

There are more than six million base stations (excluding small cells) deployed worldwide across approximately five million different cell sites serving close to four billion users. The surge in demand for connectivity has network operators searching for ways to shrink their network footprint, lower operational expenditures (OPEX), and still meet users' demand for access. C-RAN meets these requirements and has either been implemented or trialed by several operators including Verizon, AT&T, KT (South Korea), and China Mobile. Radio base stations currently depend on special purpose-built hardware deployed at the cell site. The baseband processing unit (BBU) is the part of the RAN that is responsible for managing the radio functions (or all functions that require an antenna). The BBU is one of the parts of the RAN that can be moved to a central location, creating a pool of BBUs to serve multiple base stations. C-RAN aims to centralize and virtualize baseband processing to reduce cell site costs and enable coordinated scheduling of resource blocks across a coverage area [6].

Figure 2 illustrates the evolution from the classic RAN model to a C-RAN setup. On the left, the classic model has the BBU deployed at the cell site connecting to the core network over IP/Ethernet transport. Any coordination between cell sites takes place over the X2 interface, which allows two sites to communicate. In a C-RAN architecture, the BBUs are pooled at a location away from the cell site. Pooling BBUs negates the need for the X2 interface as communications between cell sites now takes place internally. This is one of the reasons for the increased performance in C-RANs. The C-RAN model also makes updating the waveform and protocols easier as it only requires a software upgrade at the centralized BBU and not at each individual cell site

The move to a C-RAN architecture increases the flexibility of the network by allowing providers to, in theory, even change the types of RANs used—from 3G to 4G. For instance, in an area that has a mix of 3G and 4G users, operators can rebalance radio frequency resources by shifting more resources to 4G when 4G

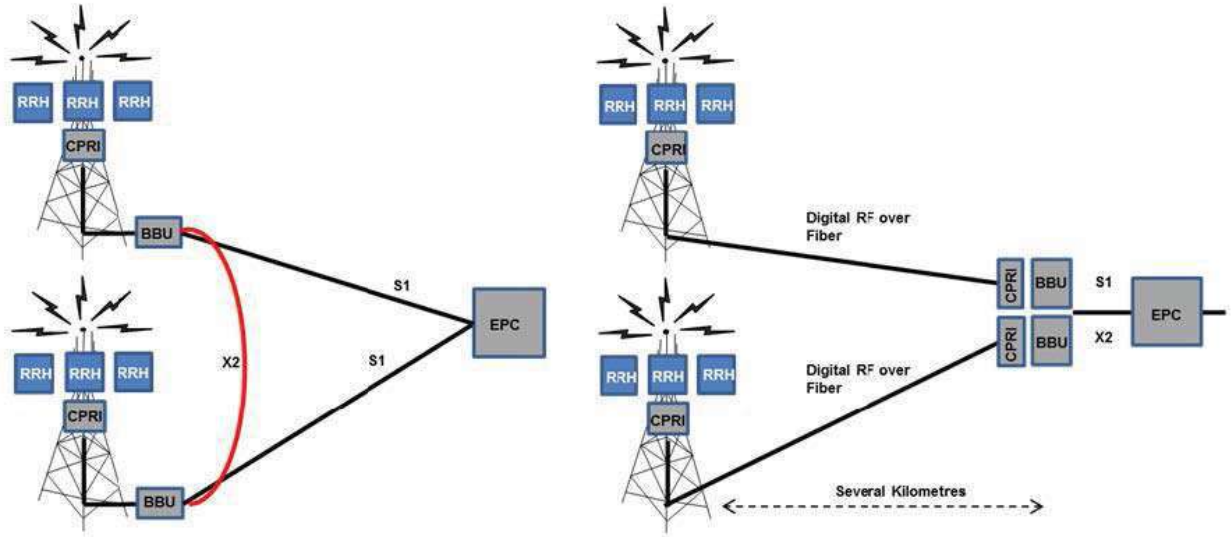

FIGURE 2. Unlike the traditional RAN model (on the left), C-RAN technology (on the right) pools the BBUs at a location away from the cell site offering an increase in performance and simpler upgrade path [6].

users are prevalent in the covered area. This shuffling of resources ensures that there is sufficient capacity for subscribers. C-RAN will also enable RAN-as-a-Service (RaaS), which will allow operators to rent RAN capacity to other operators.

Conclusion

On the face of it, virtualizing the 5G architecture seems like a necessary step towards preparing for the low latency requirements associated with 5G services. However, there are many uncertainties around 5G and a lack of visibility into what 5G will actually become through the standardization process, and at which phase different performance requirements will be supported or required. Phase II, the phase that is expected to meet International Mobile Telecommunication system for the year 2020 (IMT-2020) requirements, is expected in 2020. However, early versions or "pre-5G" offerings could be on the market before the final standard is approved. So, while these pre-5G solutions will have some 5G functionality, they will not field the full complement of improvements offered by an approved 5G system. For this reason, it is unclear to what degree virtualization techniques like C-RAN and network slicing will need to be implemented. It may come down to what the industry leaders in 5G implement in their "pre-5G" networks that will decide what a virtual 5G network will look like and when we can expect to see one.

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5G and the Auto

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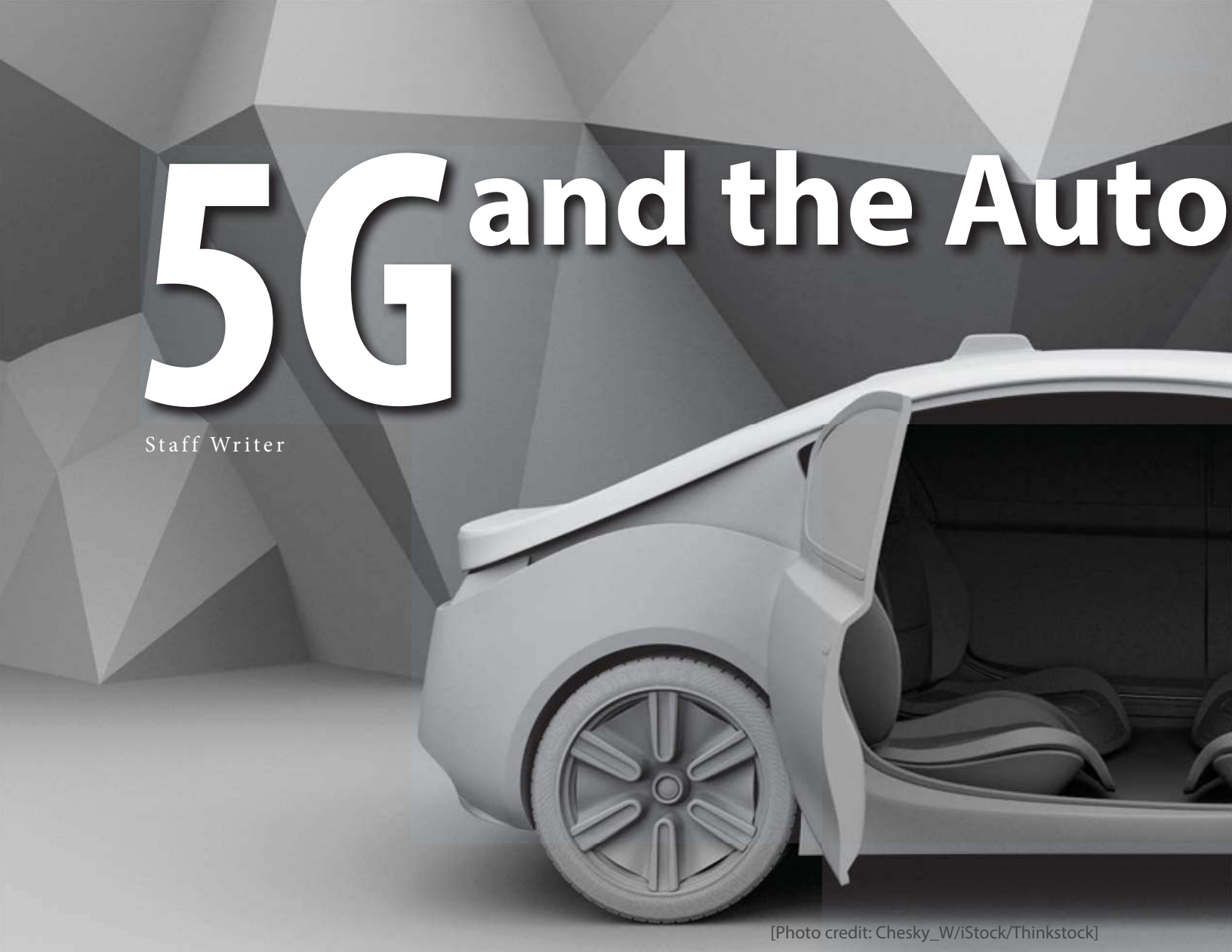

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Industry stakeholders envision 5G as a key enabler that allows network connectivity in vehicles to shift in status from an optional accessory to a core feature that supports not only the individual vehicle, but also communication with other vehicles and sensors that inform traffic, parking, and navigation—while also ensuring passenger safety and data security. For consumers, a connected vehicle provides a growing number of features and services that make the driving experience safer, convenient, and less costly. 5G connectivity will enable information from in-car sensors to continuously be passed to the cloud. By sharing information and alerts about micro-level weather, road temperature, surface conditions, and violent breaking ahead, more efficient and consistent traffic flows will be achieved that reduce congestion and emissions. The aggregated and interpreted data will provide more informed driving information, as well as alert and activate onboard safety systems to prevent accidents [1].

motive Industry

Autonomous vehicles

Autonomous vehicles—also referred to as driverless or piloted vehicles—are predicted to hit the market by 2020, but stable 5G infrastructure will play a key role, according to a white paper by ABI Research [2]. Estimates indicate that 5G latency could be as low as one millisecond (ms) over-the-air, and 5 ms end-to-end, enabling the following automotive use cases:

- Broadband multimedia streaming (driverless vehicles as mobile living rooms).
- Cloud services for vehicle lifecycle management, apps, security, and over-the-air updates (cloud-to-vehicle).
- Capturing or uploading huge volumes of sensor data for real-time traffic, weather, parking, and mapping services (vehicle-to-cloud).
- Cooperative mobility: low latency vehicle-to-vehicle and vehicle-to-infrastructure for active safety and autonomy [redundancy for advanced driver assistance systems (ADAS)] [2].

The current ADAS being delivered on 2016 vehicles already facilitate SAE Level 1 (see figure 1) and are beginning to incorporate features that would be considered Level 2. However, Level 4 and 5 capabilities may not be that far away. In October 2015, Robot Taxi, a joint venture between Japanese mobile Internet company DeNA and vehicle technology developer ZMP,

announced that it would offer driverless transportation to about 50 people in an area near Tokyo. Its goal is to commercialize the service by 2020, in time for the Tokyo Olympics [1]. While Robot Taxi is shooting for full automation (Level 5) in time for the games, it is likely that the use of such vehicles will initially be limited to shuttling passengers between Olympic venues. However, this venture is particularly notable because the technology is brand-agnostic and can be retrofitted to any vehicle [4].

Clearly, experimentation with autonomous vehicles is increasing, and 2020 as a date for some form of commercial implementation is certainly feasible from a technology perspective. Probably the best-known self-driving car project belongs to Google, which was started in 2009 and has clocked more than two million miles on public roads to date [5]. However, Google is not alone; Tesla, BMW, Audi, Mercedes, and most recently GM, have all showcased self-driving concept cars and demonstration projects. In mid-October 2016, Tesla announced that all cars currently being produced in their factories would include the hardware needed for full self-driving capability at a level of safety far greater than that of a human driver. However, the company added that the technology first needed to be tested and calibrated via "millions of miles of real-world driving" before the hardware would be activated on consumer vehicles [6]. In addition to traditional car manufacturers, companies such as Uber and Chinese search giant Baidu are also working on autonomous technology and self-driving cars [1].

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

FIGURE 1. SAE Levels of automation. The Society of Automotive Engineers (SAE) has defined levels of automation to clarify what role (if any) drivers have in operating a vehicle while a driving automation system is engaged. These levels are intended to establish a consistent framework that can be used across industries as the dialogue about autonomous vehicles continues. (Figure credit: SAE International J3016 [3].)

The motivations for creating an autonomous vehicle are beyond just technology. It's about reducing emissions through better fuel consumption, as well as addressing the demographic changes of an aging population that increase, rather than decrease, the potential for human error-induced accidents. It's also about leveraging the convergence of the shared economy and urban living, where young and old people no longer feel the need to own a car if there is a cost-effective and convenient alternative, such as Zip Car rentals, or on-demand ride-sharing services such as Uber [1].

Looking forward

Geographical coverage will be a key condition for 5G to have any relevance in the automotive sector. Initial 5G coverage can be supplemented by 4G and Wi-Fi connectivity on phones and other devices while the infrastructure is being built up, but these multimode, multiconnectivity solutions will not suffice for critical automotive use cases relying on the unique capabilities of 5G in terms of latency, reliability, and security [2]. Even once 5G is fully deployed, the adoption of self-driving technology will likely play out differently in the various markets in different regions since the forces shaping it are diverse at both the global and local level [1].

Government and industry cooperation

The continuous progression of ADAS-enabled cars and the gradual adoption of the autonomous vehicle will significantly reduce, and possibly eliminate, the number of crashes. This could, in turn, allow the removal of some regulations that relate to safety considerations, such as crumple zones, bumpers, and airbags. It also means that a review of laws relating to driving age, drunk driving, and speed restriction enforcement may be required, but not until all vehicles are compliant [1].

In September 2016, the US Department of Transportation (DOT) released the Federal Automated Vehicles Policy for highly automated vehicles (HAVs), or those intended to operate at Levels 3 to 5 as defined by SAE. The document—which is currently intended as guidance rather than formal policy—lays out standards for safe design, development, and testing of HAVs before they are commercially sold or operated on public roads. It also proposes guidelines for state governments to ensure a consistent national framework for regulation of motor vehicles with all levels of automated technology [7]. DOT's National Highway Traffic Safety Administration released additional nonbinding guidance in October 2016, outlining best cybersecurity practices for motor vehicle manufacturers and individuals and organizations involved in developing self-driving technology. The guidance aims to make cybersecurity a top priority for the automotive industry and proposes layered solutions to ensure that automated driving systems are designed to take appropriate and safe actions, even when an attack is successful [8].

A challenge yet to be addressed is that, historically, car manufacturers have completely controlled the design and development of vehicles. The advent of computers and software that effectively become the "mind" of the car means that manufacturers could lose control to technology and software companies, and yet still remain liable for any issues or catastrophes related to the car. It also remains to be seen how much and what type of data car manufacturers and network providers would be expected to share to improve overall safety and security of connected vehicles [1].

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CREATING & GROWING ECONOMIC IMPACT

NSA's Technology Transfer Program (TTP) is igniting innovation through collaborations with industry, academia, and other government agencies that introduce NSA technologies to the commercial marketplace. By fulfilling the legislative mandate to share government-patented technologies with industry, NSA's TTP plays a role in strengthening national security by contributing to the nation's economic growth.

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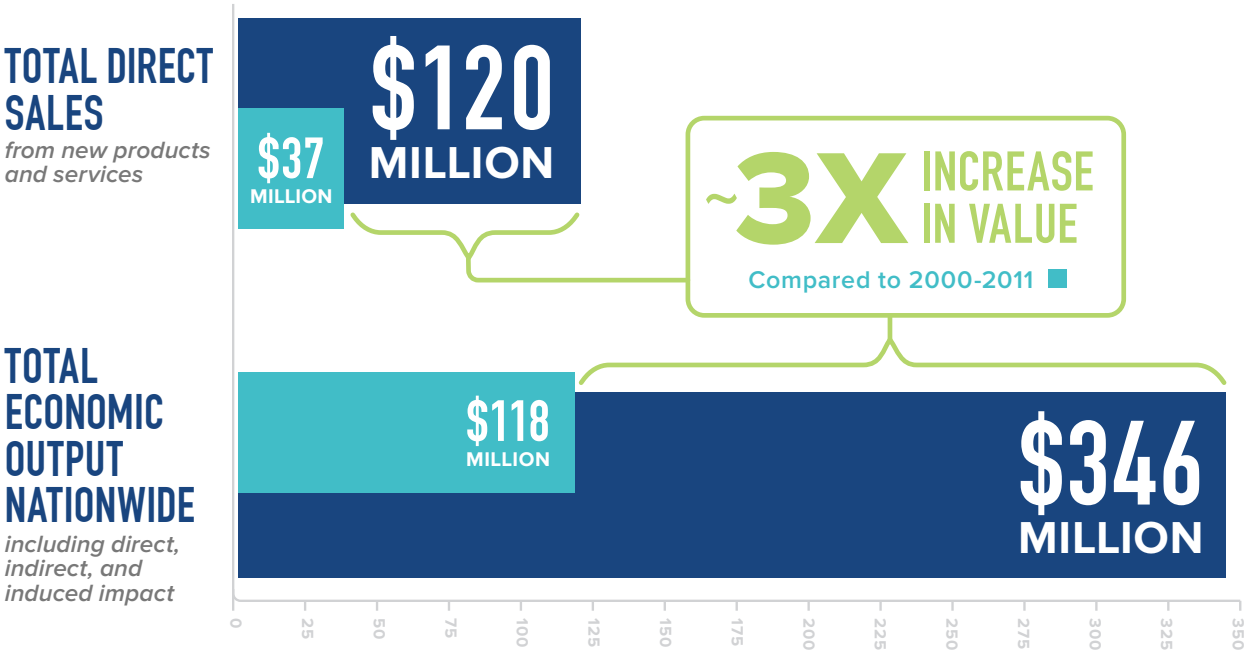

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SOURCE: *National Economic Impacts from DoD License Agreements With U.S. Industry*, TechLink and UC Business Research Division.

THE RESULTS

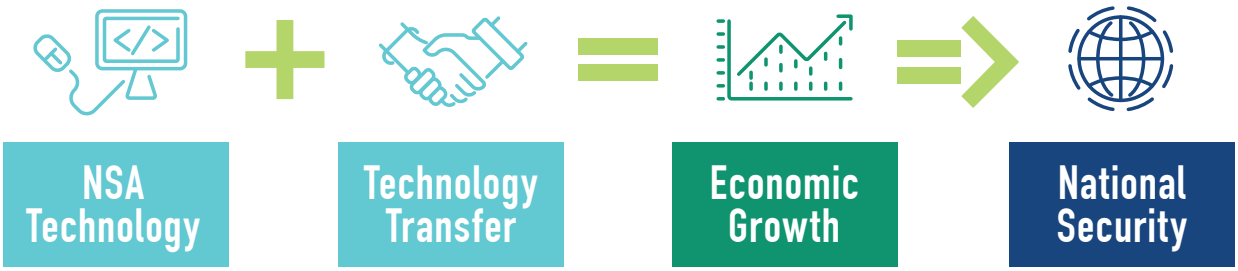

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Article

IoT's Tiny Steps towards 5G: Telco's Perspective

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Abstract: The numerous and diverse applications of the Internet of Things (IoT) have the potential to change all areas of daily life of individuals, businesses, and society as a whole. The vision of a pervasive IoT spans a wide range of application domains and addresses the enabling technologies needed to meet the performance requirements of various IoT applications. In order to accomplish this vision, this paper aims to provide an analysis of literature in order to propose a new classification of IoT applications, specify and prioritize performance requirements of such IoT application classes, and give an insight into state-of-the-art technologies used to meet these requirements, all from telco's perspective. A deep and comprehensive understanding of the scope and classification of IoT applications is an essential precondition for determining their performance requirements with the overall goal of defining the enabling technologies towards fifth generation (5G) networks, while avoiding over-specification and high costs. Given the fact that this paper presents an overview of current research for the given topic, it also targets the research community and other stakeholders interested in this contemporary and attractive field for the purpose of recognizing research gaps and recommending new research directions.

Keywords: 5G mobile communication; Internet of Things; applications classification; performance requirements; enabling technologies

1. Introduction

Telecom operators (telcos) had the most power and influence over business in the information and communication technology (ICT) industry during past decades. This dominance was the result of owning and provisioning communication infrastructures which nowadays have become more of a commodity than a luxury. Telco's revenue streams were mainly based on the provisioning of traditional services, such as voice calls and short message services (SMS). Recent work of regulatory agencies and the appearance of alternative service providers have led telecom operators to form the opinion that alternative service providers have conflicting interests and provide competitive services, thus decreasing telco's revenue from traditional services [1]. However, the latest econometric analysis presented in [2] has shown that telecom operators and alternative service providers have aligned interests and their collaboration could be favorable to both parties. The interests of alternative service providers and telcos are not inevitably conflicting, since the economic growth of the alternative service providers are positively correlated with telco revenues and vice versa.

The development of a digital society has changed the traditional value chain and introduced new issues for telcos as they seek a way how to monetize new digital services [3]. These services

are diversified across various domains of industry, such as agriculture, construction, utilities, transportation, healthcare, finance, etc., and delivered to customers through connected devices building thereby the concept of Internet of Things (IoT).

IoT can be defined as an interconnected network of things/objects that are able to interact with each other and cooperate with other things/objects through wireless and wired connections in order to create new services/applications for the benefit of society. In this way, IoT brings almost limitless benefit's, which have the potential to radically change our daily life by saving time and resources while creating possibilities for growth and innovation [4]. IoT has disruptive potential in almost every application domain, which has created many challenges that need to be faced when implementing IoT-based solutions, such as prevailing over obstacles generated by the fragmentation of IoT, both in terms of application domains and in terms of technologies. Therefore, recognizing all potential IoT applications while having in mind the development of technology and the requirements of individuals, businesses, and society as a whole is quite challenging.

Telcos now have the opportunity to seize a share of the value that is generated by IoT implementation. The size of this share will depend on telco's role in the value chain that ranges from being a traditional provider of communication infrastructure to being an end-to-end solution provider [3]. In order to monetize IoT, telcos will have to address many challenges which can be summarized as follows: (1) strategic challenges relating to decisions on future directions; (2) business challenges relating to successful management, investment, partnerships; and (3) technical challenges relating to changing connectivity and performance requirements. This paper focuses on the technical challenges since connectivity and performance requirements of IoT objects/things cannot be fulfilled using existing cellular networks that limit numerous IoT applications. In order to overcome issues associated with the current cellular networks, new types of technologies are being introduced leading towards the fifth generation (5G) network [5–7].

The architecture of the 5G network has to seamlessly integrate the requirements of diverse IoT applications: from delay-sensitive video applications to ultra-low latency, from high-speed entertainment applications in a vehicle to mobility on demand for connected objects and from best effort applications to reliable and ultra-reliable ones for health and safety [8]. A full understanding of emerging IoT applications and the variability of their performance requirements can serve telecom operators as input for specifying 5G enabling technologies. These technologies should be flexible and scalable to meet the aforementioned requirements. Since IoT applications sometimes demand extreme requirements, the 5G network must simultaneously satisfy all of them, which can lead to over-specification and high cost. In order to avoid this, telecom operators first have to adequately classify IoT applications to facilitate the selection of 5G enabling technologies being capable to efficiently meet their performance requirements.

The 5G classification concept includes three different service classes [9], i.e., (1) extreme mobile broadband (xMBB); (2) massive machine-type communications (mMTC); and (3) ultra-reliable machine-type communications (uMTC). Nevertheless, this classification concept can be considered insufficient to properly select 5G enabling technologies to meet the diverse requirements of IoT applications. Furthermore, it will be challenging to classify the emerging IoT applications given that there is many criteria for their categorization. The definition of the IoT domain in many cases overlaps with the definition of IoT application, which may at the same time belong to another IoT domain. For example, Smart Buildings may either be considered as a standalone IoT application or as an element needed to form a Smart City application domain. IoT applications are usually classified according to spheres of human life [4,10–12] or performance requirements [9,13–15]. However, these classifications are not suitable for telecom operators which have to fulfil the performance requirements of particular IoT applications, since it is difficult to choose the most important one from a class containing a wide range of IoT applications.

Telecom operators can easily specify performance requirements for current communication services since traffic patterns generated by these services are driven by predictable activities, such as

making calls, receiving email, surfing the web, and watching videos. However, traffic patterns generated by emerging IoT applications are driven by less predictable activities. Hence, the idea is to determine a common set of activities based on customer service requests which describe the reasonably foreseeable function/purpose of emerging IoT applications. Then these activities can be used by telcos as a new classification criterion of IoT applications. The assumption is that such a classification can help telecom operators meet performance requirements of future IoT applications and select appropriate 5G enabling technologies. Therefore, the aims of this paper are to classify IoT applications according to relevant activities, specify and prioritize the performance requirements of each IoT application class, and consider enabling technologies used to accomplish specified demands on the radio access part of 5G networks, all according to telco's perspective. In addition, the intention is to provide a literature review which covers 258 references dominantly published in the period between 2012 and 2017. As this paper provides a state-of-the-art review of IoT applications, their performance requirements and 5G enabling technologies, it can also be of use to the research community and other stakeholders interested in this contemporary and attractive field in order to recognize the research gaps and recommend new research directions.

The remainder of the paper is thusly organized. In order to answer research questions, Section 2 describes the methodological approach in regard to the conducted research. Section 3 identifies a common set of activities as a new classification criterion for IoT applications and assigns them the relevant 5G service classes. This facilitates the determining of performance requirements of activity-based IoT application classes, which are summarized and prioritized in Section 4. The enabling technologies used to accomplish these requirements in 5G networks are contemplated in Section 5. Finally, Section 6 discusses the outcomes of the paper by clarifying the contribution of our research in identifying open issues for future work, while Section 7 concludes this paper.

2. Research Approach and Design

The main objectives of this paper can be summarized as follows: (1) to identify activities relevant to IoT customer service requests and use them as a new classification criterion of IoT applications; (2) to specify and prioritize performance requirements of such IoT application classes; (3) to analyze relevant literature in order to provide insight into 5G radio technologies used to fulfil the requirements of activity-based IoT application classes; (4) to recognize research gaps and directions.

The research questions posed in this study are: (1) Which activities can be used as classification criteria for IoT applications? (2) What are the performance requirements of such IoT application classes? (3) Which enabling technologies in the radio access part of the 5G network can be used to meet the requirements of IoT application classes?

Investigation of different criteria for the classification of IoT applications underlines to what extent various classification concepts have been covered by existing literature and provides a basis for the introduction of a new classification criterion called the activity. We thus surveyed and compared different studies contributing to the understanding of the scope and classification of a wide range of IoT applications. This approach has been motivated by the challenge to propose an activity-based classification of IoT applications, the determination and prioritization of performance requirements of such IoT application classes and the review of 5G enabling technologies used to meet them. These findings can be utilized by telecom operators and other interested parties (e.g., the research community, software network function providers, network infrastructure manufactures, etc.) depending on their interest and potential to utilize these findings towards 5G implementation and commercialization.

The methodological approach to research conducted in this paper is illustrated in Figure 1 and includes four phases.

Phase I included searching, identifying, and extracting papers from three categories, i.e., IoT in 5G service classification, IoT in 5G performance requirements and IoT in 5G enabling technologies. The keywords used to search relevant scholar databases are shown in Figure 2. This search has

resulted in the selection of 258 recently published papers, which can be categorized into three groups (i.e., review papers, technical papers, research effectiveness), as shown in Table 1. Review papers summarize the status of knowledge and outline future directions in a given area of research. Technical papers describe the process, progress, or result of research, whereas research effectiveness directly provides an answer to the research question raised for this study. The reference distribution by year of publication is shown in Figure 3a, while the total percentage of references per publication type is presented in Figure 3b.

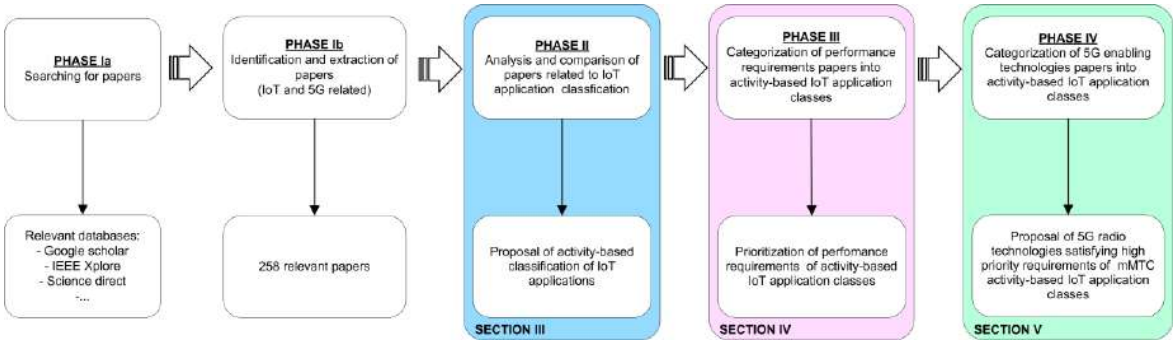

Figure 1. Methodological approach to research.

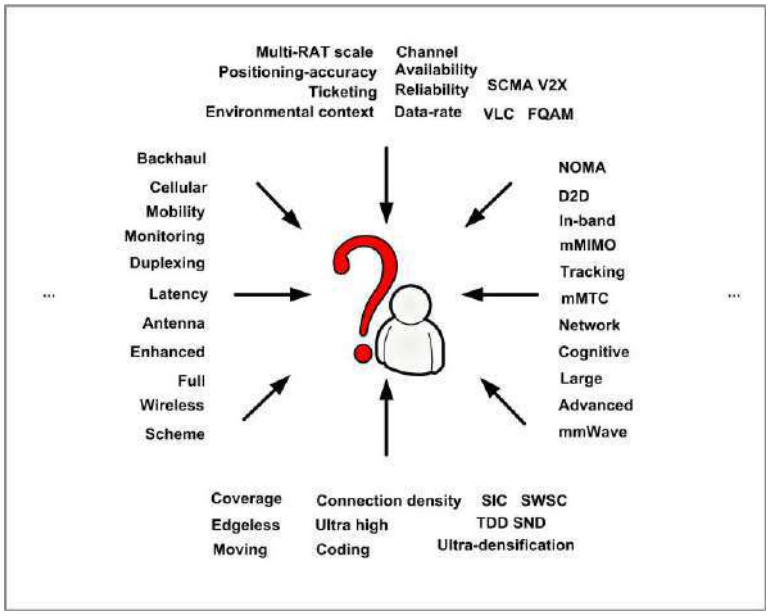

Figure 2. Keywords for searching relevant databases.

Table 1. Reference categorization.

Reference Type	Reference Number
Review paper	[1,2,10,12,14–88]
Technical paper	[8,89–197]
Research effectiveness	[3–7,9,11–13,29,52,198–258]

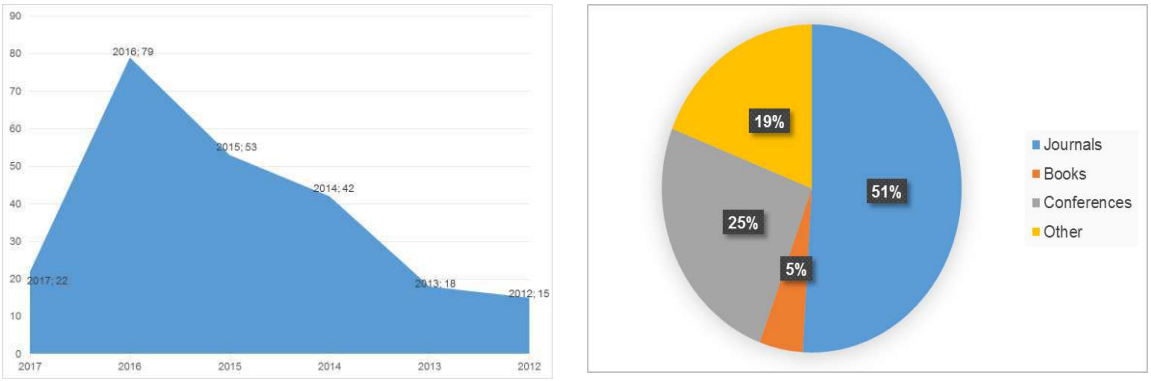

(**a**) (**b**)

Figure 3. Reference distribution by (**a**) year of publication; (**b**) type of publication.

Phase II included the analysis and comparison of papers related to the category of IoT in 5G service classification. Papers were first sorted according to the existing classification criteria of IoT applications in order to underline their deficiencies from telco's perspective. Since emerging IoT applications generate traffic driven by less predictable activities, specifying their performance requirements and enabling technologies is not an easy task from telco's point of view. Therefore, we have proposed a common set of activities to serve as classification criteria of IoT applications. Four activities were selected based on IoT customer service requests denoting the function/purpose of existing IoT applications. According to the authors' knowledge, existing IoT applications can be grouped around following activities: ticketing, tracking, monitoring, and managing/controlling. Such a classification makes it easier for telecom operators to associate particular IoT applications to the relevant 5G service class. Finally, Phase II has resulted in the proposal of an activity-based classification of IoT applications which was associated with the 5G service classification.

Phase III included the analysis of papers related to the category of IoT in 5G performance requirements. Papers were grouped according to eight key performance indicators, i.e., data rate, mobility, latency, connection density, reliability, positioning accuracy, coverage, and energy efficiency. These performance requirements were prioritized indicating high, medium, and low importance of each requirement for specific activity-based IoT application classes proposed in Phase II. Finally, Phase III resulted in the identification of highly important performance requirements for each activity-based IoT application class which can be utilized by telcos to identify 5G enabling technologies used to meet them.

Phase IV provided a review of papers from the category of IoT in 5G enabling technologies. Papers were first sorted according to eight technological groups used in the radio access part of 5G networks, i.e., wide and flexible bandwidth technology, advanced modulation and coding, duplexing, multiple access and waveform, advanced interface management, access architecture related radio technologies, energy related technologies, and other technologies. These technologies have been discussed in terms of their possibility to meet the high priority performance requirements of mMTC activity-based IoT application classes, since this area is more mature from telco's perspective. The results of Phase III were reflected in a proposal of technologies in the radio access part of 5G networks that can be used to meet the high priority performance requirements of the mMTC activity-based IoT class, as well as the identification of research gaps and directions for future work.

3. IoT in 5G Service Classification

As mentioned in the Introduction, various challenges awaiting telcos can be identified on the basis of the role that they will play in the IoT value chain. Regardless of this role, telcos will face many technical challenges, such as the necessity for global deployment, the need for rapid infrastructure scaling, unpredictable IoT application behavior, etc. Even now, existing IoT applications accelerate

the growth rate of traffic driven by less predictable activities which require new strategies towards 5G networks. These networks will be the key enabler for IoT applications by providing a unified infrastructure capable of meeting the high variability of their performance requirements [8,16]. Various stakeholders have recently described what 5G networks may be and grouped the major types of 5G services into three different classes: (1) xMBB—Requiring extremely high data rates and low-latency communication; (2) mMTC—Requiring scalable connectivity for an extremely large number of devices; and (3) uMTC—Requiring ultra-reliable low-latency and resilient communication [198]. This 5G service classification can be used by telcos to identify performance requirements of various IoT applications, and, as such, was used in this research study. However, emerging IoT applications will have extreme requirements, so an analysis based solely on 5G service classifications may not be sufficient. Therefore, telcos need a more precise classification of IoT applications which is an important precondition for meeting their diverse requirements.

IoT covers human-to-human (H2H), human-to-machine (H2M) and machine-to-machine (M2M) communication, which will be the main driving force towards 5G networks. In addition, the terms M2M communication (M2MC) and machine type communication (MTC) are used interchangeably as in [17–19,89–93,199,200]. Although IoT is a broader concept which evolves from M2M, this paper assumes that IoT and M2M are synonyms as in [94].

3.1. Existing Classifications of IoT Applications

In order to meet the requirements of a wide range of IoT applications, they have to be classified in an appropriate manner. The existing approaches to the classification of IoT applications are summarized in Table 2. IoT serves different user categories, including individuals, businesses, and society as a whole, and may span through a broad range of application domains [4,10–12], such as transportation and logistics, healthcare, smart environment, personal and social, futuristic applications, food sustainability, smart living, smart manufacturing, smart energy, smart city, etc. These application domains are created to be human-centric, which means that they cover different domains of human life. IoT applications belonging to these domains have diverse requirements for 5G networks, and should not be treated equally. Therefore, the acceptance of these domains as a classification criterion raises the issue of assigning IoT application to a particular domain. Moreover, the emergence of new applications of IoT may require defining new application domains, which makes this classification inappropriate from telco's perspective.

The M2M applications may be classified by the mobility and the amount of dispersion that needs to be supported into four categories [13]: (1) fixed and concentrated; (2) fixed and dispersed; (3) mobile and concentrated; and (4) mobile and dispersed. However, the mobility and amount of dispersion present very rough classification criteria and cannot meet the precise network requirements of individual IoT applications.

Additionally, M2M applications can be grouped according to delay tolerance into four categories [14]: (1) elastic (delay tolerant); (2) hard real-time (delay constraint); (3) delay-adaptive (delay sensitive but tolerant); and (4) rate-adaptive application (adjust their transmission rates according to available radio resource). However, the main drawback of this classification is the lack of consideration of other IoT application requirements except delay tolerance, although its importance as a classification criterion has been recognized.

According to data reporting mode, the M2M applications can be classified into five categories [91]: (1) time-driven; (2) query-driven; (3) event-driven; (4) continuous-based; and (5) hybrid-driven. This classification is specific for the former IoT concept, which is narrower in nature than the definition adopted in this study.

Another study considered the reliability, availability, and end-to-end latency in order to classify IoT applications into two groups [15]: (1) monitoring-based and mission-critical; (2) monitoring-based and non-mission critical; (3) control-oriented and mission-critical; and (4) control-oriented and non-mission critical. Monitor-based IoT applications periodically collect sensor data from smart

objects and transmit them. The majority of monitoring-based IoT applications are not mission-critical. Control-oriented IoT applications use sensor data to control actuators in real-time, and rely on mission critical communication. This classification is based on multiple criteria and represents the precursor of the Mobile and wireless communications Enablers for Twenty-twenty Information Society (METIS) 5G service classification.

Table 2. Internet of Things (IoT) application classification—summary.

Criteria for Classification	IoT Classes	References
Domains	(1) Transportation and logistics (2) Healthcare (3) Environment (4) Personal and social (5) Futuristic applications (6) Food/water monitoring (7) Living (8) Manufacturing (9) Energy (10) Building (11) Industry (12) City (13) Security and safety (14) Communication (15) e-society (16) Vehicular (17) Sport and leisure	[4,10–12]
Mobility and amount of dispersion	(1) Fixed and concentrated (2) Fixed and dispersed (3) Mobile and concentrated (4) Mobile and dispersed	[13]
Delay tolerance	(1) Elastic (2) Hard real time (3) Delay-adaptive (4) Rate-adaptive	[14]
Data reporting mode	(1) Time-driven (2) Query-driven (3) Event-driven (4) Continuous-based (5) Hybrid-driven	[198]
Reliability, availability, and end-to-end latency	(1) Monitoring-based and mission critical (2) Monitoring-based and non-mission critical (3) Control-oriented and mission critical (4) Control-oriented and non-mission critical	[15]
Characteristics and requirements	mMTC and uMTC	[12]

Legend: IoT (Internet of Things), mMTC (massive Machine Type Communication), uMTC (ultra-reliable Machine Type Communication).

Although it spans through a wide range of different applications, MTC can be divided in two main categories, i.e., massive and ultra-reliable MTC, which depend on their characteristics and requirements [89]. As mentioned above, this categorization is a part of 5G service classification which was used in this study as a basis to identify performance requirements of IoT applications and will be described in more detail in Section 4. Massive MTC (mMTC) typically involves a very large number of devices (tens of billions [9]), such as sensors, actuators, and similar devices [12], different in complexity and cost [9], and with varying quality of service (QoS) requirements. These devices should be of very low cost with very low energy consumption, enabling very long battery life [12]. At the same time, the amount of data generated by each device is normally very small, and very low latency is not a critical requirement [12]. Ultra-reliable MTC (uMTC) requires very high reliability and availability, and very low latency [9,12]. Low device cost and energy consumption are not as critical as they are for mMTC applications [12], and the number of devices and required data rates are relatively low [198].

The vision of a pervasive IoT requires the integration of various domains into a single and unified domain. It addresses the enabling technologies needed for these domains while taking into account the elements that form the third dimension like security, privacy, trust, and safety [11]. The current classification criteria and IoT application classes do not clearly differentiate IoT domains from IoT applications. IoT domains are usually viewed as a specific area of IoT applications that support a huge variety of use cases across industries impacting businesses and customers. Therefore, IoT domains overlap with IoT applications within existing IoT classifications. Moreover, IoT classification based on certain QoS parameters is difficult to apply from telco's perspective, because it is challenging to choose the most important parameter for the wide range of IoT applications. However, these problems need to be solved for upcoming 5G networks.

3.2. Activity-Based Classification of IoT Applications

The aforementioned issues motivated us to propose a new approach to the classification of IoT applications. This approach is based on "**the activity**", which primarily characterizes specific IoT application. In this sense, the activities are defined as new classification criteria, which denote a main function/purpose of specific IoT application observed from telco's point of view. Telecom operators observe the technical challenges of IoT through systems, tools, devices, and platforms because their availability and integration complexity determines the opportunity to capture a share of the value that is generated by IoT implementation. Based on the literature review, it was found that the most commonly mentioned terms in this sense were related to: (1) ticketing system [201]; (2) monitoring: devices [199,201–204]/services [199,201,202,205,206]/tools [207]/systems [11,12,199,201,205,206,208–210]/data [95,201]/framework [12,201]/solutions [20,205]/networks [211]/process [7]/activity [203,204,207]; (3) tracking technologies [4]/devices [204]/systems [204]/applications [11,210]/system [201]/services [202,205]; (4) managing/controlling applications [15,210,212]/operation [211]/services [4,208]/tools [208,211]/devices [204]/system [95,198,204,210]/concepts [211]/solutions [95]/platforms [95,199]. This has led us to identify four activities, i.e., ticketing, monitoring, tracking, and managing/controlling, as new classification criteria of IoT applications. According to the authors' knowledge, it was found that these activities can cover reasonably foreseeable functions/purposes of IoT in existing application domains. Using activities as classification criteria, telcos can specify IoT application performance requirements more easily, which are in that case dictated by the specific activity, not by the IoT application domain, and determine enabling technologies in the radio access part of 5G networks.

In addition, our classification approach allows better service differentiation and service delivery closer to customer expectations. According to BH Telecom's experience, customers typically come up with the following service requests when it comes to IoT: (1) they need to track their products and determine products' distribution across different regions based on their own data analysis; (2) they want to monitor their products since they do not have a department for supervision and analysis; (3) they need information panels about their outlets and working time to be downloaded by a scanning tab-ticket; (4) they want to manage/control their products according to market needs. This way of expressing customer needs has inspired us to propose the activity-based classification of IoT applications as it allows telcos to define performance requirements more precisely, and thereby improve the customer experience.

The activity-based classification of IoT applications is presented in Table 3. Each activity is associated with the application domain where that activity may be applied. The requirements of identified activities and associated application domains are then mapped to 5G service classes in order to be further able to identify their performance requirements and enabling technologies necessary to meet them. For example, according to Table 3, the managing/controlling activity can be realized in several domains, such as healthcare, food, energy, transportation and logistics. For each domain, we have identified an application example, such as remote surgery [213] in the healthcare domain, food processing facilities [96] in the food domain, energy distribution [12] in the energy domain and traffic/driving [12,213] in the transportation and logistics domain. According to diverse

performance requirements of these IoT applications [214], managing/controlling activity in healthcare, food, transportation, and logistic domains can be associated with the uMTC service class, while the energy domain can be mapped to the mMTC service class. A more detailed description of performance requirements for each activity-based class of IoT applications is provided in Section 4, while in Section 5 it is discussed how these requirements can be accomplished in the radio access part of 5G networks.

Table 3. Activity-based classification of IoT applications.

Activity	Domain Examples	5G Service Classification	Application Examples
Ticketing	Smart Transportation and Logistics	mMTC	POS Terminal [4]
Monitoring	Smart Healthcare	uMTC	Health condition [97]
	Smart Buildings	uMTC	Structures (buildings, tunnels, etc.) [12,25,213]
	Smart Buildings/Smart City	mMTC	Parking spaces
	Smart Buildings/Smart Environment	mMTC	Home video [12]
	Smart food/water monitoring	mMTC	Food growth condition [10]
Tracking	Smart Healthcare/Sport and Leisure	mMTC	Medical assets, wearables [200,213]
	Smart Transportation and Logistics	mMTC	Transport fleet [200,213]
	Smart Industry/Social Networking	mMTC	Shipping of products
	Smart Healthcare	mMTC	People in science museum
Managing/ controlling	Smart Healthcare	uMTC	Remote surgery [213]
	Smart food/water monitoring	uMTC	Food processing facilities [96]
	Smart Transportation and Logistics	uMTC	Traffic, driving [12,213]
	Smart Energy	mMTC	Energy distribution [12,98]

Legend: 5G (Fifth Generation), POS (Point Of Sale), mMTC (massive Machine Type Communication), uMTC (ultra-reliable Machine Type Communication).

As such, the activity-based classification of IoT applications can be used for the creation of new business models, which represent the stakeholder's plan to generate revenue and make a profit from operations, and thereby include many components and functions of the business [21]. However, there is no common opinion which components constitute a business model. The business model architecture can be illustrated by four dimensions [22]: (1) who, identifying the definition of the target customer as one central dimension in designing a new business model; (2) what, describing what is offered to the target customer; (3) how, referring to the construction and distribution of the value proposition; (4) value, explaining why the business model is financially viable. Answering these four questions allows the creation of IoT business models. According to this business model definition, the activity-based classification of IoT applications affects the who and the how dimensions in the following manner. In terms of the who dimension, it directly allows customer segmentation according to considered activities as a way to express their requirements (e.g., customers that require tracking or monitoring of their products). Being aware of the current customer requirements, the proposed classification of IoT applications around four activities (i.e., ticketing, monitoring, tracking, and managing/controlling) can be considered complete. At the same time, the activity-based classification of IoT applications is flexible since additional activities as classification criterion can be concerned with emerging customer requirements. On the other hand, the activity-based classification of IoT applications indirectly impacts the how dimension of new business models which among others includes relevant resources and capabilities in the focal stakeholder's internal value chain. This indicates that the proposed activity-based classification of IoT applications can be easily applied to IoT business models.

Various categories of IoT business models can be identified according to eight IoT architectural layers [23], i.e., collaboration and processes layer, application layer, service layer, abstraction layer, storage layer, processing layer, network communication layer, physical layer. Along with IoT architectural layer, the IoT business model needs also to address the IoT value proposition [24] and

IoT stakeholders that can participate in more than one layer. Based on their role in the IoT ecosystem, telecom operators usually take a part in the network communication layer. In this regard, they follow four evolutionary business models [23]: (1) selling connectivity services only; (2) selling third-party products; (3) selling internal products; (4) providing a broad menu of IoT products. Each of these IoT business models includes traditional telcos strength, i.e., connectivity which determines the how dimension of the IoT business model. In this sense, our activity-based classification of IoT applications indirectly allows the construction and distribution of performance as IoT value proposition using enabling technologies as IoT resources in telco's internal value chain.

3.3. Summary of IoT in 5G Service Classification

The previous discussion has shown that the classification of IoT applications is a complex task due to their numerosity and diversity. The existing classifications of IoT applications pose some drawbacks that can be summarized as follows. The domain-based classification does not allow clear differentiation between IoT domains and IoT applications due to either an imprecise classification criterion or the diversity and unpredictability of IoT applications. On the other hand, QoS-based classifications need to identify the common and most important performance metric for a broad range of IoT applications. Therefore, on the basis of the literature review and IoT customer service requests, we have proposed a new approach to the classification of IoT applications. It is based on the activity as new classification criterion, which denotes a main function/purpose of specific IoT application observed from telco's point of view. According to the authors' knowledge, four activities, i.e., ticketing, monitoring, tracking, and managing/controlling, have been identified to cover reasonably foreseeable functions/purposes of existing IoT applications. The resulting activity-based IoT application classes have been associated with 5G service classes in order to determine and prioritize their performance requirements as described in next section. Finally, the proposed classification of IoT applications was discussed in terms of its completeness, flexibility, and applicability to new business models.

4. IoT in 5G Performance Requirements

This section provides an insight into performance requirements of activity-based classes of IoT applications proposed in Section 3. The analysis is based on eight key performance indicators identified in [5,207] as shown in Table 4: data rate, mobility, latency, connection density, reliability, positioning accuracy, coverage, and energy efficiency. These performance indicators are usually well described for specific IoT applications. However, one of the main challenges of 5G is to support a variety of performance requirements for numerous IoT applications in a flexible, reliable, and cost-effective way [15]. Hence, there is a need for a comprehensive understanding of these requirements for activity-based IoT application classes. The 5G service classification defined the performance requirements for mMTC and uMTC [9]. We have assigned these requirements to the activity-based IoT application classes introduced in Section 3 for the purpose of proposing priorities of each requirement for a specific class. Three levels of priorities (high, medium, low) are associated with the performance requirements of activity-based classes of IoT applications as shown in Table 4. The prioritization of performance requirements is inspired by analysis of related work undertaken in [213]. Some activity-based classes of IoT applications may demand optimization of multiple performance requirements. Table 4 illustrates the main differences between activity-based IoT application classes, and therefore, the need for a 5G network that enables support of optimal configurations for a variety of, sometimes opposite, requirements. For example, the mMTC tracking-based IoT application class requires support for high mobility, high positioning accuracy, and high connection density, while the mMTC monitoring-based IoT application class also requires high connection density but low mobility and low positioning accuracy. A more detailed description of considered performance requirements is contained in the following subsections.

Table 4. Activity-based classes of IoT applications—performance requirements.

5G Service Classification	Activity	User Experienced Data Rate [Gbps] Outdoor: 0.1 [5] Indoor: 1 [5]	Mobility [km/h] Required: 500 [5]	Latency [ms] Control Plane: 50 [5] User Plane: 1 [5]	Connection Density [Connections/km^2] Required: 10^6 [5]	Reliability [%] Required: 99.999 [207]	Positioning Accuracy Required: A Few cm [5]	Coverage/ Availability [%] Required: 99.999 [207]	Energy Efficiency [bits/J]
mMTC	Ticketing	L to M	L	L	H	M	H	H	H
	Tracking	M	H	L	H	M	H	H	M to H
	Monitoring	M to H	L	L	H	L to M	L	H	M
	Managing/controlling	L	L	L	H	M	L	M to H	M
uMTC	Monitoring	L	L to M	H	H	H	M to H	H	M
	Managing/controlling	L	M to H	H	L	H	H	M to H	M

Legend: 5G (Fifth Generation), mMTC (massive Machine Type Communication), uMTC (ultra-reliable Machine Type Communication), L (Low), M (Medium), H (High).

4.1. Data Rate

Data rate is the most important evaluation factor for generations of wireless communication networks [6]. It is contemplated in two ways: (1) peak data rate—defined as the maximum achievable data rate by the user; and (2) minimum guaranteed user data rate—defined as the minimum experience data rate by the user [16]. New mobile technologies are primarily driven by users' needs for higher data rates, as discussed in [8,16,99,215,216]. The expected values in 5G networks are 10 Gbps for minimum peak data rate and 100 Mbps as minimum guaranteed user data rate [5]. High data rate requirements are mainly posed by xMBB related use cases [9] like hotspots [214] or dense urban areas where in 95% of locations and time experience data rate by user should be 300 Mbps in downlink and 60 Mbps in uplink [100]. High data rate is also important in some activity-based classes of IoT applications, as shown in Table 4. Medium (e.g., monitoring of parking spaces) to high (e.g., monitoring of home video) data rate is needed in cases of mMTC monitoring activities. High data rate can be achieved by using a millimeter wave (mmWave) spectrum to share multi-gigabit data in the surrounding environment (i.e., mMTC monitoring with high data rate requirement) and to recognize an object via cloud in real time to find the optimal driving strategy instantaneously for IoT—autonomous vehicles application [101]. Data rates generated during transmissions of tracked medical assets, transport fleets, and ticked point of sale (POS) terminals is low (e.g., medium importance for ticketing and tracking activities in mMTC). In addition, low data rates are needed in uMTC monitoring and controlling (e.g., monitoring of health condition, control of driving).

4.2. Mobility

Mobility is defined as relative velocity between the receiver and the transmitter [16]. The applications of IoT pose very diverse requirements for mobility in 5G networks, which range from static to high mobile, even up to 500 km/h [16,102,207]. Use cases in which except ultra-high mobility, ultra-high traffic volume density, and ultra-high connection density are needed may be quite challenging for 5G networks [215], like V2X communication [5]. High mobility is a very important requirement for mMTC tracking activity (e.g., tracking of assets in high speed trains [214]). Moreover, the support for high mobility is needed in uMTC management activities, if the monitor/control object is moving (e.g., high speed trains [207]). Low mobility is needed for ticketing, monitoring, and managing/controlling activities in the mMTC class, as shown in Table 4. This is the reason why 5G networks should not assume mobility for all devices and services but rather provide mobility on demand [8].

4.3. Latency

Latency requirements are usually expressed in terms of end-to-end (E2E) latency perceived by the end user [8]. 5G networks should enable "zero latency" [103] represented by the millisecond level of E2E latency [16,26,27,213] through significant enhancements and new technology in architecture aspects [6,28,214], such as device-to-device (D2D) communication [5]. The IoT applications associated with uMTC monitoring and managing/controlling activities require low latency, as they tend to be real time. Required latency levels depend on the particular IoT application [8,16,28], being the narrowest in uMTC managing/controlling activity with a value that should not exceed 1 ms [8]. For example, the tolerable delay for use case mobile health [215] and remote surgery application is in order of sub-milliseconds [213]. For V2X communications, latencies should be ultra-low for some warning signals [8].

4.4. Connection Density

Connection density is defined as the number of connected devices per unit area [16]. It can usually be expressed in terms of an extremely high number of simultaneous active connections, such as 1 million connections per square meter [207,215], or 10 to 100 times higher number of connected

devices [29]. The performance values of connection and traffic density for various 5G services are listed in [8,212]. This performance requirement is highly correlated with identified activity-based classes of IoT applications, since it is the main characteristic of mMTC. High device density brings the need for rapid internet protocol version 6 (IPv6) deployment, and high quality security algorithms and techniques, which lead to new system design and implementation, as described in [104].

4.5. Reliability

Reliability is the maximum tolerable packet loss rate at the application layer [105]. 5G must bring a reliability of 99,999% [27,30,31,212], or higher for specific use cases [212], (e.g., tele-protection in a smart grid network [207] or driverless cars [106]). Reliability is the main characteristic of uMTC monitoring and managing/controlling activities. Reliability will be a particularly challenging task in high-speed trains because of speed, load, and cell distance [16,107].

4.6. Position Accuracy

Position accuracy is the maximum positioning error tolerated by the application [105]. 5G should ensure accurate positioning of the device outdoors [108] with accuracy from 10 m to <1 m on 80% of occasions and better than 1 m in indoor deployment [212]. Accuracy positioning is very important in uMTC monitoring-based activities (e.g., monitoring remote cameras), and uMTC managing/controlling-based activities (e.g., driving) [213]. Moreover, the mMTC tracking-and ticketing-based activities pose high performance requirements in terms of position accuracy.

4.7. Coverage

Coverage requirements in 5G should provide connectivity anytime and anywhere with a minimum user experience data rate of 1 Gbps [32]. However, the perception of 100% coverage is rather a technical decision than a business one [33], which could be extended through ultra-cell deployment [31] and vehicle-to-infrastructure (V2I) communications [30]. Almost every activity-based IoT application class requires very high levels of coverage (99,999% availability) [207]. Total coverage will enable new unmanned aerial vehicles (UAV) to use single network connection, instead of connection steering mechanism, as one described in [109].

4.8. Energy Efficiency

Energy efficiency is defined as the number of bits that can be transmitted per joule of energy [216]. Compared with current wireless technologies, the energy efficiency (measured in b/J) of the 5G network may need to be improved by a factor of 1000 [4,7,34,110,217]. High energy efficiency is important in case of ticketing- and in some cases of tracking-based activities (e.g., smart industry [205] or implantable medical devices [35]). Other activities, such as both mMTC and uMTC monitoring- and managing/controlling-based activities (e.g., health condition [205]) and some tracking-based activities (e.g., sports wearables [205]) require medium energy efficiency. Energy efficiency is very important design objective for the reduction of operating costs of telecom operators, as well as for minimizing the environmental impact of the wireless domain [217]. On a higher layer of the network protocol stack, adaptive base station switch on/off algorithms use renewable energy sources to save energy [218] along with an energy scheduler, as in the with heating, ventilation and air conditioning (HVAC) [111]. However, at the physical layer, adaptively switching off unused carriers is a key strategy that can be used to save energy from the radio-frequency (RF) transceiver chain of base stations [218].

4.9. Spectrum Efficiency

Spectrum efficiency is defined as the data throughput per unit of spectrum resource per cell or per unit area (bps/Hz/cellar bps/Hz/km^2) [216]. In order to achieve network sustainability, required for 5G networks [216], spectrum efficiency needs to be improved 3–5 times [20,32,216]. Minimum

peak spectrum efficiency is 30 bps/Hz for downlink and 15 bps/Hz for uplink [32]. This is mostly important for the xMBB services class [212,214]. Since this performance requirement is not relevant for activity-based IoT application classes which are associated with the mMTC and uMTC service class, it has not been further considered herein.

4.10. Summary of IoT in 5G Performance Requirements

Activity-based classes of IoT applications are associated with performance requirements of 5G service classes, i.e., mMTC and uMTC. On the basis of the literature review, each activity-based class (ticketing-, tracking-, monitoring-, and managing/controlling-based class) is associated with mMTC service class, while the monitoring- and managing/controlling-based classes are the only ones linked to the uMTC service class. According to the authors' best knowledge, there is no available literature concerning the uMTC ticketing- and tracking-based classes of IoT applications or such IoT customer service requests.

Activity-based IoT application classes pose many performance requirements, which have been discussed in terms of data rate, mobility (speed), latency, connection density, reliability, positioning accuracy, coverage, and energy efficiency. These performance requirements have been assigned three-level priorities (high, medium, low) for the purpose of facilitating identification of the enabling technologies used to fulfill them. Based on the literature review, it was found that each activity-based IoT application class poses high requirements in terms of connection density except the uMTC managing/controlling-based IoT application class. Moreover, ticketing- and tracking-based IoT application classes have high requirements in terms of positioning accuracy, coverage, and energy efficiency. Additionally, positioning accuracy is a highly important performance requirement for the uMTC managing/controlling-based IoT application class, whereas coverage is important for both uMTC and mMTC monitoring-based IoT application classes. Finally, latency and reliability represent highly important performance requirements for uMTC monitoring- and managing/controlling-based IoT application classes. A deep and comprehensive understanding of performance requirements of each activity-based IoT application class may facilitate the selection of 5G enabling technologies needed to meet them as described in the following section.

5. IoT in 5G Enabling Technologies

Activity-based classification of IoT applications proposed in Section 3 allows telecom operators to identify performance requirements of each class relying on 5G service classification, as discussed in Section 4. However, these performance requirements cannot be satisfied for many IoT applications with current cellular (2nd, 3rd, and 4th generation) network technologies, since they limit their potential due to many issues [3], i.e., protocol implementation complexity, poor coverage in non-urban environments, high cost of networking equipment and data transmission. In order to overcome these issues, many dedicated communication technologies are being installed.

From the very beginning of IoT, many proprietary technologies, such as radio-frequency identification (RFID), wireless highway addressable remote transducer (WirelessHART) or Z-Wave, have first appeared, and then, more generic ones, such as Bluetooth, IEEE 802.15.4, IPv6 over low-power wireless personal area networks (6LoWPAN). However, none of these technologies have become a market leader mainly because of technology shortcomings and business model uncertainty [219]. Hence, new solutions, such as low-power wireless fidelity (LP Wi-Fi), low-power wide area (LPWA) or several improvements for cellular M2M communications have become serious candidates for IoT implementation. LP Wi-Fi is an IEEE 802.11ah standard designed to extend the application area of Wi-Fi networks in order to meet IoT requirements (i.e., large number of devices, large coverage range, energy constrains). First performance studies indicate that this standard will support a broad range of M2M scenarios with a required QoS level, and enable scalable and cost-effective solutions. In addition, LPWA networks have been deployed for some time in the form of many different proprietary solutions (e.g., Amber Wireless, Coronis, Huawei's CIoT, LoRa, M2M Spectrum Networks, Sigfox, Weightless,

etc.), but only the LoRa Alliance, Sigfox and Weightless are involved in LPWA standardization activities. Despite some drawbacks which are mainly related to use of an unlicensed spectrum, LPWA networks are expected to become a key enabler for IoT deployment in early market rollouts and for limited IoT applications [219].

The appearance of these IoT communication technologies was considered as competition to current cellular networks from the telco's point of view from the start. But, in the meanwhile, telcos have realized that the aforementioned communication technologies can be utilized to meet the changing connectivity and performance requirements of IoT applications. Therefore, many dedicated communication technologies have already been deployed in various IoT applications. For example, Orange, Swisscom and South Korea (SK) Telecom have built nationwide networks based on LoRa [3], whereas Deutsche Telekom (DT), Vodafone and all three Chinese operators have completed the rollout of narrowband IoT (NB-IoT), as another LPWA standard utilizing existing long term evolution (LTE) networks [36]. In this context, standardization and interoperability becomes critical because there is a need to consider a broad range of connectivity solutions as presented in Figure 4 [37]. One of those solutions includes satellite technologies which integrated with 5G radio technologies form the 6th generation (6G) standard for providing global coverage [38].

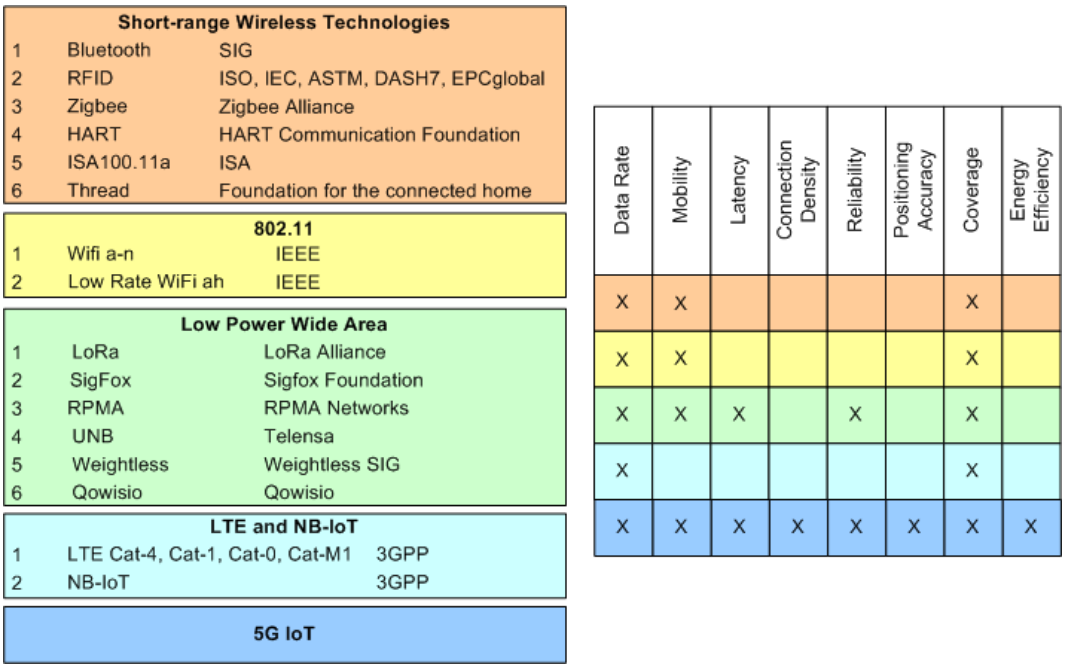

Figure 4. IoT performance requirements and enabling technologies.

In this regard, standardization activities of 5G and beyond are being undertaken by several standards bodies, such as the Institute of Electrical and Electronics Engineers (IEEE), the 3rd Generation Partnership Project (3GPP), the Internet Engineering Task Force (IETF), ITU Radiocommunication Sector (ITU-R), and ITU Telecommunication Standardization Sector (ITU-T). An overview on these standards bodies and their effort to develop communication standards for 5G and beyond are provided in [112]. Due to the envisioned 5G applicability, these standards have defined an air interface that can significantly improve the performance, and network architectures that allow the deployment and coexistence of various 5G technologies. A detailed discussion of these technologies regarding both technological and standardization aspects indicates that 5G can be perceived as the main driving force for enabling the vision of a truly global IoT [219].

In this sense, the technologies described in this section will allow 5G networks to form a unified communication infrastructure for the realization of a wide range of IoT applications. These technologies

will bring performance enhancement which will trigger a complete revolution in almost all spheres of human life creating a new "everything connected" era. Future 5G networks in such an era will face a serious problem regarding a huge number of different service types [220]. To meet the diverse requirements for a huge number of IoT applications, 5G introduces the concept of network slicing to offer programmable network instances [220]. Using network slicing, multiple independent and dedicated network instances can be created within the same infrastructure to run services that have completely different requirements for latency, reliability, throughput, and mobility [220]. This technology primarily targets a portion of the 5G core network, but also indicates that 5G radio access network (RAN) functionalities can be different for each network slice [221]. To deploy network slices, network functions need to be enabled on an on-demand basis, which has driven the use of virtualization and softwarization in 5G core network [221]. Network function virtualization (NFV) is a paradigm that enables that 5G network functions to run in a virtual environment instead of dedicated hardware [221]. The software define networking (SDN) paradigm facilitates isolation of network slices avoiding the traffic of one slice affecting the performance of another slice [221]. These two paradigms make the network much more dynamic, agile, on-demand, and flexible [222,223]. Since the aforementioned technologies are used to deal with a variety of 5G applications, they will not be further discussed. This paper will focus on technologies used to meet performance requirements for specific applications (inter slice performance) which are implemented in the radio access part of 5G networks.

These technologies are briefly described and discussed in terms of their advantages, disadvantages, and research gaps. Given the fact that the realization of particular technology affects multiple performance requirements, tiny steps towards its implementation will allow telcos to deploy 5G networks, and thereby provide a performance improvement in terms of more capacity, lower latency, more mobility, more position accuracy, increased reliability, and availability [6,214,224]. In other words, 5G networks will accommodate many more users and devices while delivering more data [113,114] to each user requiring high data rates [108] in a more energy-efficient way [115,116].

Table 5 summarizes considered radio technologies used to implement future 5G networks being capable of achieving performance requirements identified in Section 4. On the basis of the literature review, one may conclude that the 5G radio access network is crowded with multiple technologies, and there seems to be a duplication of technologies, all eager to grab telco's attention and convince them to buy into the particular choice. As Table 5 shows, multiple technologies and techniques can be used to meet each performance requirement. Since the mMTC activity-based IoT classes are more mature, we have primarily focused on technologies used to fulfil their high performance requirements (i.e., connection density, positioning, and coverage). We have selected 5G enabling technologies considered from telco's perspective as the most representative and promising candidates to meet these requirements. The implementation of these technologies will also significantly affect the fulfillment of uMTC service class requirements, which will lead to complete automation in all spheres of human life. Therefore, the following subsections will discuss these technologies in more detail with the final goal of identifying research gaps and providing recommendations for future work, which are summarized in Table 6.

Table 5. IoT in 5G enabling radio technologies.

Enabling Technologies		IoT in 5G Service Requirements								
		Data Rate	Mobility	Latency	Connection Density	Reliability	Positioning	Coverage	Energy Efficiency	Spectrum Efficiency
Wide and flexible bandwidth technology	mmWave Band Communication and large-scale antenna	[7,202,225–227]		[202]			[233]	[5]	[202]	[7,29,214]
	Heterogeneous Multi-RAT Integration	[5,217,228–232]						[5]		
	Cognitive Radio and Spectrum Sharing							[5]		
Advanced modulation and coding	Advanced Modulation	[52,234–236]	[237,238]	[239]		[237,239]		[237]		
	Advanced Channel Coding	[235]		[235]						[216]
Duplexing	In-band FD			[124]				[5]		[7,29,214]
	Dynamic TDD	[240]		[240]						[9]
Multiple access and waveform	Multiple access			[216]					[218]	[7,9,29,216,256,257]
	New waveform				[5]					[7,9,29,216,256,257]
Advanced interface management	SND and SWSC	[5]								
Access architecture related radio technologies	Advanced small cell	[7,202]					[5]	[5,251]	[7,202,217]	[202,257]
	MN	[202]	[202]					[5]	[202]	
	Enhanced wireless backhaul							[5]		
	D2D	[202,248]	[7,241,244]					[245–247]	[7,202,215]	[7,9,29,202,252]
Energy related technologies	Energy harvesting						[100,253]			
	UAV	[254]				[254]		[183–185]		
Other important technologies	mMIMO	[7,202,249]		[13,202]		[249]		[200]	[217]	[7,9,214,216,257]
	VLC	[202,250]		[202]					[202,258]	
	SIC		[202]	[202,236]						
	V2X			[255]				[255]		

Legend: IoT (Internet of Things), 5G (Fifth Generation), mmWave (Milimeter-wave), RAT (Radio Access Technology), FQAM (Frequency Quadrature Amplitude Modulation), FD (Full Duplexing), TDD (Time Division Duplexing), SND (Simultaneous Non-unique Decoding), SWSC (Sliding Window Superposition Coding), MN (Moving Network), D2D (Device-to-Device), mMIMO (massive Multiple Input Multiple Output), VLC (Visible Light Communication), SIC (Self Interference Cancelation), V2X (Vehicle to Everything), UAV (Unmanned Aerial Vehicles).

Table 6. 5G enabling technologies—research directions.

5G Enabling Technologies		Research Gaps and Directions	References
Wide and flexible bandwidth technology	mmWave band communication and large-scale antenna	(1) 3D channel modeling; (2) dynamic power control; (3) user scheduling and congestion control; (4) hardware limitation and adaptive beam-steering technique; (5) design of mobility management and admission control for mmWave-based dense HetNet; (6) design of frequency management schemes for mmWave; (7) Tactile Internet; (8) effective and efficient mmWave implementation in HetNets (access and networking).	[7,87,217]
	Heterogeneous multi-RAT integration	(1) cell-association; (2) traffic-offloading algorithms; (3) interference management schemes in case of inter user and inter cell interference; (4) cross-tier handover, access admission, and mobility management schemes of a multi-tier HetNets.	[196,217]
	Cognitive radio and spectrum sharing	(1) Spectrum sensing (design of cooperative frameworks, choose cooperative secondary users and transmit cooperative information); (2) develop framework and algorithms for group handoff of secondary users and security; (3) simulation of different attacks and scenarios to enhance security; (4) in-depth performance analysis between GFDM and UFMC in CR settings.	[29,110]
Duplexing	In-band full duplexing	(1) Redesign of network and management; (2) antenna and circuit design and development of the theoretical foundation; (3) analyze the throughput of a network of randomly deployment terminals sing stochastic geometry; (4) characterize the capacity advantage due to IFDB in various network scenarios; (5) guidelines to practical design: coding, modulation, power allocation, beamforming, channel estimation, equalization, digital interference cancellation and decoding, (6) design of a MAC layer.	[55,197]
Multiple access and waveform	New waveform	(1) Performance of SIC cancelation or filtering on f-OFDMA; (2) balance of time and frequency dispersion and design an efficient filter prototype for UFMC.	
Access architecture related radio technologies	Advanced small cell	(1) Expect of wireless backhauling on user experience; (2) exploitation of location data and fingerprints in optimizing small cell discovery in terms of time and energy- efficiency; (3) interference management when integrating D2D and small cells.	[34,80]
	Enhanced wireless backhaul	(1) TDD multi-flow coordination schemes to avoid bottlenecks in the downlink backhaul; (2) Backhaul aware association in ultra-dense deployment; (3) reliability and security of the backhaul.	[34,88,198]
	Moving network	(1) Resource allocation and interference in the mobile relay when trains are moving from opposite directions; (2) handover decision of users (more than one train arrive or depart, stop or pass); (3) group mobility for users on board very high-speed vehicles; (4) design od cooperative communication schemes; (5) deployment of moving networks in various vehicle environments, not just on fixes route railways.	[5]
	D2D communication	(1) Interference management (mode selection, resource allocation and power control); (2) integration of novel reputation-based mechanism for identify and avoid malicious users from multiple users in multi-hop D2D communications; (3) testing of D2D interference management schemes in 5G scenarios (mmWave, cell densification).	[29,208,209]
Energy related technologies	Energy harvesting	(1) Improving energy harvesting schemes; (2) simulation of proposed models; (3) integration with other 5G technologies.	[100,182,253]
	UAV	(1) Optimal deployment, mobility and energy-efficient use of UAVs; (2) integration with other 5G technologies.	[81]
Other technologies	mMIMO	(1) Performance of practical mMIMO.	

Legend: IoT (Internet of Things), 5G (Fifth Generation), mmWave (Milimeter-wave), RAT (Radio Access Technology), D2D (Device-to-Device communication), mMIMO (massive Multiple Input Multiple Output), 3D (Three Dimensional), HetNet (Heterogeneous Network), GFDM (Generalized Frequency Division Multiplexing), UFMC (Universal Filtered Multi Carrier), CR (Cognitive Radio), IFDB (In-band Full Duplexing), MAC (Medium Access Control), f-OFDMA (filtered Orthogonal Frequency Division Multiple Access), TDD (Time Division Duplexing), UAV (Unmanned Aerial Vehicle).

5.1. Wide and Flexible Bandwidth Technology

mmWave band communication and large-scale antennas are promising technologies for future 5G networks. The mmWave band covers frequencies from 30 GHz to 300 GHz [202], and from an industry and wireless academia point of view, it is a unique solution for solving 5G capacity requirements [96]. mmWave band communications will provide high data rates [7,202,225–227] utilizing a much larger spectrum bandwidth that can reach up to 5 GHz [39] and by using directional antennas and high attenuation [40]. To provide sufficient antenna gain mmWave requires implementation of large-scale antennas at the transmitter and receiver side [96]. Deployment of large antenna arrays with mmWave will also bring high spectral efficiency, high throughput and channel gain [7]. Despite all of its advantages, mmWave needs line of sight (LOS) operation [41], while the effective communication distance of mmWave signals is within 200 m due to the propagation characteristic of this frequency band [29]. Open problems associated with mmWave include three dimensional (3D) channel modeling, dynamic power control, user scheduling and congestion control, hardware limitation and the adaptive beam-steering technique, as described in [7]. The problem of high power consumption of a large number of antennas in an array [7], high efficiency low complexity adaptive antenna array processing algorithms [29] and innovative hardware architecture of large-scale antenna transmitters [29] still remain unsolved. A proposal of design guidelines in architectures and protocols for mmWave communications is presented in [42]. It is demonstrated that new mmWave technologies, which are under investigation for 5G communications systems, will be able to provide indoor centimeter (cm)-accuracy localization in a robust manner, ideally suited for Assisted Living (AL) [228].

Heterogeneous multi-radio access technologies (multi-RAT) integration is specific to 5G networks radio design that coexists with existing networks. Since 5G networks will not be developed to replace current wireless networks, but rather to advance and integrate existing network infrastructures with new ones [217], we refer to 5G as a heterogeneous network. Multi-RAT is defined as the capability of a mobile network to support multiple radio access technology with seamless interworking among them [229]. When deployed in heterogeneous networks (HetNets), with traffic offloading among different RATs, multi-RAT improves capacity [230], supports better communication rates [34,117–119,231,232], better energy efficiency [34,117–119,231,232], and ensures seamless connectivity with higher QoS [230]. In designing a heterogeneous RAT, researches are finding solutions for cell-association and traffic-offloading algorithms [217].

Cognitive radio with spectrum sharing is a new software defined technology, which is expected to improve the utilization of the congested radio frequency (RF) spectrum [43]. In 5G networks, it is used for designing multi-tier architectures, removing interference among cells, and minimizing energy consumption in the network [44–47,120,233]. Moreover, a spectrum sharing technique can be used along with the CR technology to integrate the 5G spectrum [48,121]. During the practical implementation of the CR and spectrum sensing (SS) technique researchers had to design cooperative frameworks, choose cooperative secondary users and transmit cooperative information during the spectrum sensing, further developing the framework and algorithms for the group handoff of secondary users and enhancing security [29]. Researchers are already working on designs of protocols for different IoT application, based on cognitive radio, and some of them are presented in [49–51,122]. Technologies in this group are used together to optimize 5G performance requirements (e.g., a prototype of mmWave integrated HetNet in [123] and HetNet that incorporates massive multiple-input and multiple-output (mMIMO) and mmWave technologies [217]).

5.2. Advanced Modulation and Coding

This technological group involves advanced modulation (i.e., frequency and quadrature amplitude modulation (FQAM)) and advanced channel coding schemes.

Advanced modulation schemes group includes FQAM, Amplitude and Phase Shift Keying (APSK), Unitary Space-Time Modulation (USTM), Spatial Modulation (SM), Wave Modulation

(WAM), and Orthogonal Time Frequency and Space (OTFS). The FQAM is a combination of frequency shift keying (FSK) and quadrature shift keying (QAM) [124–126]. This modulation can achieve a higher transmission rate for cell edge users reducing interference at cell edge [52,234–236]. FQAM also improves energy efficiency, which makes it adequate for MTC devices with stringent energy consumption requirements [124]. Due to performance advantages in terms of Frame Error Rate (FER) [53,236], FQAM is an ideal candidate for services with high coverage and reliability requirements [237]. APSK is another modulation which draws a lot of attention. It is shown that its main performance gain (i.e., to achieve a channel capacity very close to Shannon's) relies on advanced channel coding and demodulation algorithms [237]. This adds more complexity at the APSK transmitter and receiver. Another modulation, which does not need Channel State Information (CSI) to enable high throughput, is called USTM [237]. USTM and its extension (see [238]) is very useful for 5G services with high mobility [127] or latency and reliability constraints [239]. Other modulation schemes involve SM [128], and proprietary WAM and OTFS [237]. On the basis of the foregoing, researches have analyzed and compared many modulation forms, but still have not found a practical guide on how to choose modulation in any of the 5G use cases.

Advanced channel coding techniques are used for correcting the communication errors caused by noise, interference, and poor signal strength [129]. Authors in [54,129,130] compared turbo, low density parity check (LDPC) and polar codes in decoders in contrast to 5G requirements: (1) maturity; (2) throughput and latency; (3) error correction capability; (4) flexibility; (5) computation complexity; (6) interconnect complexity; (7) high-performance flexible implementation complexity; and (8) backward compatibility. This comparison showed that turbo codes hold the greatest promise for offering high performance throughputs, latencies and error correction capabilities, as well as high degrees of flexibility at the lowest implementation complexity [129] in most 5G use cases. However, further work is needed to implement a decoder based on this code followed by detail analysis.

5.3. Duplexing

This technological group includes in-band full duplexing (FD) and dynamic time division duplexing (TDD).

In-band FD or simultaneous data transmission and reception will provide a 1000-fold increase in throughput [131,240], double spectral efficiency [132,240], and reduce the air interface delay [240]. The central research problem for the practical implementation of an in-band full-duplex radio is the attenuation of the self-interference signal by an adequate amount [132]. For the practical implementation of an in-band full-duplex radio, many aspects of network design and management need to be restructured, where terminals antenna and circuit design and the development of theoretical foundation are in focus [55]. One practical implementation of the full-duplex radio is shown in [133]. Authors in [134] commented that for the design of a full-duplex radio, it is necessary to unify researches from three domains, i.e., RF circuit and system design, digital signal processing and networking.

Dynamic TDD is the predecessor of FD transmission technology and a candidate for 5G [133,135]. It represents a scheduling technique in which every base station (BS) is free to choose its own uplink/downlink (UL/DL) split [136–139]. This technique is used to adapt the allocation of network resources to variable traffic requirements [139,140], often found in ultra-densely deployed networks [141]. The dynamic TDD can significantly increase bandwidth efficiency [142] and provide higher throughput and low latency [141]. However, it is characterized by the severe co-channel interference (CCI) [141–143]. Dynamic TDD could be used in combination with D2D communication and in the self-backhauling scenario, as described in [55].

5.4. Multiple Access and Waveforms

Multiple access techniques are becoming an important technology in 5G because of their ability to support mMTC activity-based IoT classes with urgent deploy demand [144]. They include several non-orthogonal multiple access (NOMA) forms: multi-user shared multiple access (MUSA) [145–148],

resource spread multiple access (RSMA) [149], sparse code multiple access (SCMA) [150–152], pattern division multiple access (PDMA) [153–155], interleave-division multiple access (IDMA) [156,157], and NOMA by power domain [158]. The NOMA is a radio access technology design for enabling greater spectrum efficiency [56,159–162,207], higher cell-edge throughput, relaxed channel feedback, and low transmission latency [99]. NOMA can be employed to enhance user fairness and to support massive connections with diverse QoS requirements [163]. In NOMA, there are several challenges and open issues, such as dynamic user pairing, the impact of transmission distortion, the impact of interference, resource allocation, NOMA with multiple antennas, heterogeneous networks, outage probability analysis, practical channel model, uniform fairness, NOMA with antenna selection, carrier aggregation and other challenges as discussed in [216]. There are still many challenging issues for SCMA, which need to be solved in future work. For example, there are several open issues in SCMA transceiver design [57], the optimization of algorithms for user grouping and power allocation [164], and further enhancement of the SCMA and MIMO combination.

New waveforms have become a serious candidate for 5G being studied in terms of: (1) modulation based on pulse shaping: filter bank multicarrier (FBMC) [58], generalized frequency division multiplexing (GFDM) [59], pulse shaped OFDM [165] and QAM-FBMC [241]; (2) modulation based on sub-band filtering: universal filtered multi carrier (UFMC) [242], filtered OFDM (f-OFDM) [243] and resource block f-OFDM (RB-f-OFDM) [244]; other modulation format: guard interval discrete Fourier transform spread OFDM (GI DFT-s-OFDM) [245], spectrally-precoded OFDM (SP-OFDM) [246] and orthogonal time frequency and space (OTFS) [247]. The f-OFDM is seen as a potential candidate for IoT applications [60]. Due to narrow sub-bands and thereby pure detection performance, additional processing is needed [60]. Performance of self-interference cancellation (SIC) or filtering on f-OFDMA [60] remains a topic for further study. Additionally, it is interesting to consider the balance of time and frequency dispersion in UFMC, as well as the design of an efficient prototype filter according to application scenarios [60].

5.5. Advanced Interface Management

This technological group includes receiver advances in terms of simultaneous non-unique decoding (SND) and sliding-window superposition coding (SWSC).

SND follows a rule that implies that each receiver attempts to recover the code words from intended and interfering senders [248]. The combination of advanced receivers and joint scheduling provides an improvement of over 50% in cell edge throughput without sacrificing the cell average throughput [5]. This gain demonstrates that if 5G networks incorporate advanced interference management, they will provide a virtually edgeless end-user experience [5].

SWSC [61,62] combines the theory concept from superposition coding without rate splitting [63], block Markov coding [166,167], successive cancellation decoding [63,64,168], and sliding-window decoding [65,169,249]. The sliding-window coded modulation (SWCM) aims to mitigate inter cell interference at the physical layer by achieving simultaneous decoding performance with point-to-point channel codes, low-complexity decoding, and minimal coordination overhead [170]. The realization of the theoretical concept to the practical transmission coding scheme is an important research direction in SWSC [5].

5.6. Access Architecture Related Radio Technology

This technological group includes ultra-densification, enhanced wireless backhaul, moving networks, and D2D communication.

Advanced small cell [66,123] deployment is considered to be one of the key enablers for achieving many of the requirements currently envisioned for 5G [67], with higher data rates [68,171,250] and more capacity [171–174], as most important. Higher data rates and smaller battery consumption can be achieved using short distances in the small cell [69]. Solving the capacity and data rate challenge with network densification could be very expensive in terms of equipment, maintenance,

and operations [200]. With denser cell deployment come significant challenges in the design of a high-performance backhauling system for RAN and the impact of backhaul on radio resource management (RRM) [70]. However, there are in existence many interesting topics to be further investigated which can be grouped around several problem areas [34]: user association, backhauling, interference management, energy efficiency, and propagation modelling.

Moving networks (MN) are the combination of multi-hop and vehicular communications concepts [69,71]. The MN deploys one or several moving relay node(s) (MRNs) [175,176,251] on vehicles that form their own cell(s) inside the vehicle to serve vehicular users [72]. Challenges in using MRN are efficient backhauling, design of efficient resource allocation and interference management techniques, as well as mobility management schemes to exploit the benefit of group handovers for vehicular user equipment (UE) devices served by the same MRN [72]. The main research challenges related to MN concept are associated with complexity management due to the mobility of access points and providing a high-rate wireless backhaul link from the moving cell to the fixed network [69].

Enhanced wireless backhaul is one of the main challenges in hyper-dense 5G networks [34,217]. The performance of wireless backhaul is dictated by the environment and traffic profile of the intended use case [9]. In UDN except mmWave, new approaches are needed, e.g., interface aware routing and intelligent resource allocation [9], as these links may occupy part of the spectrum used in the access network [73]. Latency and reliability of this link are important issues to be considered being prone to blocking and fading [69]. In any case, further research is necessary to explore TDD multi-flow coordination schemes to avoid bottlenecks in the downlink backhaul [9]. The guidelines for deploying future 5G wireless backhaul networks in economical and highly energy-efficient ways are provided in [74].

D2D communication is defined as a direct route of data traffic between spatially closely located mobile UE [75,177,178]. The advantages of D2D communication compared with the traditional cellular method include the reduction of transmission latency [73,75] and power consumption [75], improvements in coverage [71,76,179], spectral and energy efficiency [77], and throughput, when power control and resource allocation methods are used [78]. The use of D2D communications has an overall positive impact on system capacity in cellular environments. D2D communication brings challenges and complexities related to interference management [79,80], QoS requirements [79], and resource allocation [34,215]. The design of D2D direct communication link is still a hot topic [29].

5.7. Energy Related Technologies

IoT applications span a broad range of domains including home automation, healthcare, surveillance, transportation, smart environments, etc. One of the most important obstacles for implementing such an impressive scheme is supplying adequate energy to operate the network in a self-sufficient way without compromising QoS [180]. Since energy efficiency is of most importance to battery constrained IoT devices, researches have focused their work on the development of the device energy saving mechanisms.

Energy harvesting is a new paradigm which uses solar, thermal, wind and kinetic energy sources to power sensor nodes and consequently prolong network lifetime [181]. Among different energy harvesting methods, wireless energy harvesting (WEH) has proven to be one of the most promising solution for energy aware IoT devices, because of its simplicity, ease of implementation, and availability [180]. This concept will improve some of the 5G high network communication requirements, like reliability of IoT communications, as presented in [182]. Authors in [252] have shown that the integration of social awareness and energy harvesting in D2D communication results in higher system capacity. Network architectures proposed in [100,253] have shown better energy efficiency in 5G wireless network. Researchers could work on improving this architecture and integration with various 5G technologies in the future.

UAV implies a flying vehicle without the driving presence of a human pilot to control it on-board [113]. Drones are a possible example of UAVs, although many other robotics related

applications could be part of this application group [113]. UAVs can play a vital role in IoT scenarios where devices are unable to transmit over a long distance due to their energy constraints. In this case UAVs play the role of moving aggregators which fly toward one IoT devices, collect the data, and transmit it to other devices [81]. In [183] authors presented UAV–based floating relay (FR) for cell dynamic and coverage improvement. Deployment of unmanned aerial base stations in 5G heterogeneous architecture can improve throughput [254], coverage [183–185,254], connectivity [184,185], and 5th percentile spectral efficiency [254]. On-demand wireless systems with low-altitude UAVs are in faster to deploy, more flexibly reconfigured, and likely to have better communication channels due to the presence of short-range line-of-sight links [186] when compared to terrestrial communications or those based on high-altitude platforms. The utilization of highly mobile and energy-constrained UAVs for wireless communication introduces many new challenges [186], some of them are listed in [82]. To effectively use UAVs for IoT, several challenges must be addressed such as optimal deployment, mobility and energy-efficient use of UAVs [81].

5.8. Other Technologies

Along with the aforementioned technologies, a lot of research attention is devoted to technologies, such as mMIMO, visible light communication (VLC), SIC, vehicle-to-everything (V2X), etc.

mMIMO technology [73,123] promises significant gains in data rate and link reliability [187], reduces latency and energy [13], simplifies media access control (MAC) layer [13], shows robustness against intentional jamming [13], unintended man-made interface [83], and increases capacity [127,198] due to spatial multiplexing [123]. Reliable links are provided by benefiting from spatial diversity and the mitigating effects of fast fading, beamforming, and zero forcing caused by multi-user interference [203]. The mMIMO can be exploited to extend the coverage of higher frequency bands by relying on beamforming gains [200]. Other specific benefits of mMIMO system are: increased capacity 10 times or more with simultaneous improvement in radiated energy efficiency in the order of 100 times, the possibility to use inexpensive, low-power components, the reduction of latency on the air interface, and multiple access layer simplification [83]. The low complexity mMIMO uplink scheme for IoT lightweight devices is presented in [188]. The performance of practical mMIMO system needs to be investigated, since the research community pays attention to analyzing the performance of mMIMO in an ideal channel state information assumption [73].

VLC is a growing technology for short range, high capacity LOS optical links [189]. It uses a visible range of the electromagnetic spectrum (370–780 nm) which provides data transmission and room illumination using light emitting diodes (LEDs). Prominent features of VLC are an abundant license-free spectrum, the ability to provide multiple gigabit-per-second data rates, low energy consumption, and low implementation costs [190]. VLC is sensitive to sunlight and is not able to work long range without LOS. Since VLC coverage is LOS limited [84,191], this is known as LOS blocking [192]. With poor performance in non-line-of-sight scenarios, VLC networks fail to provide convenient UL coverage at the current state-of-the-art, and each AP illuminates only a small confined cell compared to cellular RF networks [192]. VLC applications are expected to include IoT, wireless Internet access, and vehicle-to-vehicle (V2V) communications, broadcast from LED, M2M communications, positioning systems, and navigation. The problem of how to provide mobile applications over VLC is still quite an open one [189].

SIC implementation enables low-latency applications in a cost effective manner [132]. SIC can be used to increase link capacity, spectrum virtualization, any-division duplexing, novel relay solutions, and enhanced interface coordination [132]. Practical SIC implementation is still in the investigation phase.

V2X is the communication between a vehicle and everything with which it might interact (e.g., other vehicles, traffic operators and service providers). It is used in conjunction with D2D for coverage extension and latency reduction in 5G networks [255]. V2X communication might play a vital role in terms of implementing smart and efficient traffic solutions [193], improving road safety, traffic efficiency,

and driver convenience. To reduce traffic congestion one may use an intelligent route management system based on V2X communication [7]. Since it has big potential in autonomous driving application, the localization of vehicles in dense urban areas is difficult, so several algorithms are proposed to solve the problems [194]. Many V2X applications are described in existing literature [85,195]. However, there is still a need to design vehicular mobility management strategies in next UDN networks and to find a way to enhance existing connected vehicle services with V2X [86].

These technologies are highlighted as the main 5G driver in existing literature [5–7,96,207]. Authors compare these technologies and try to implement them through prototypes, or test the combination of these technologies. However, other technologies exist, such as cloud-RAN [7], Coordinated Multi-Point (CoMP), White Space Spectrum [208], which are not in the scope of this paper.

5.9. Summary of IoT in Enabling Technologies

Performance requirements of activity-based IoT application classes have served to identify the enabling technologies in the radio access part of 5G networks, which are summarized in Table 5. Various 5G enabling technologies have been sorted into eight technological groups:

1. Wide and flexible bandwidth technology: mmWave band communication and large-scale antennas, heterogeneous multi-RAT integration, cognitive radio, and spectrum sharing;
2. Advanced modulation and coding: advanced modulation schemes, advanced channel coding;
3. Duplexing: in-band FD, dynamic TDD;
4. Multiple access and waveform: multiple access, new waveforms;
5. Advanced interface management: SND, SWSC;
6. Access architecture related radio technologies: advanced small cell, MN, enhanced wireless backhaul, D2D;
7. Energy related technologies: energy harvesting, UAV;
8. Other technologies: mMIMO, VLC, SIC, V2X.

These technologies have been discussed in terms of their possibilities to meet performance requirements of activity-based IoT application classes and identify research gaps and directions, which are summarized in Table 6.

We have highlighted technologies only used to satisfy high priority performance requirements of mMTC activity-based IoT application classes, i.e., connection density, positioning accuracy, and coverage. We have focused on these technologies from telco's perspective, since the area of mMTC activity-based IoT classes is more mature, as its development has already started within LTE, while uMTC poses new research questions to be answered in order to achieve unprecedented levels of reliability needed for new applications in 5G.

The new waveform technology may be used to fulfil the requirements of almost every activity-based IoT application class in terms of connection density. This technology affects the connection density by definition. Analysis of different modulation formats indicates that f-OFDM is the most suitable candidate for IoT applications with high connection density requirements. In this regard, a deeper and more comprehensive analysis of f-OFDM is needed in the context of different mMTC activities (i.e., ticketing, tracking, monitoring, and managing/controlling). The result of the analysis to be performed should be the discovery of an optimal waveform for each activity-based IoT class which has to be integrated with other 5G service classes.

Large scale antennas and advanced small cell technologies can be used to satisfy the requirements of ticketing-, tracking-, and uMTC managing/controlling-based IoT application classes in terms of positioning accuracy. Fulfilling these performance requirements is rather a business than a technical decision. The size of the 5G cell must be planned to meet the desired position accuracy since it is very important for future IoT applications, such as automated driving, remote surgery, robotics, taxis, etc.

Wide and flexible bandwidth technologies, in-band full duplex technologies, access architecture related radio technologies, and mMIMO can be used to achieve the high requirements of ticketing-,

tracking-, and monitoring-based IoT application classes in terms of coverage. The combination of these technologies should be tested to find the optimal solution to meet these performance requirements. Since small cell deployment has an impact on required position accuracy, they should serve as a basis for achieving the desired level of coverage. Along with small cell deployment, mMIMO and mmWave technologies are present in almost every 5G prototype.

Since this section discusses radio technologies used to accomplish performance requirements of mMTC activity-based IoT application classes, it can serve telecom operators and other interested parties depending on their interest and potential to utilize these findings towards IoT implementation and monetization. It describes each technology in terms of definition, advantages, disadvantages, and the possible impact on the performance requirements of a broad range of IoT applications that drive the deployment of 5G networks. Moreover, this section can be useful to the research community interested in this attractive field to address recognized research gaps and directions.

6. Discussion

Telecom operators have the opportunity to capture a share of the revenue that is generated by IoT implementation depending on their role in the IoT value chain. Regardless of their role, telcos have to face many technical challenges in order to meet the changing connectivity and performance requirements. Since current cellular networks limit numerous IoT applications, new technologies are being introduced leading towards 5G networks. Therefore, telcos have to focus on deploying these network technologies in order meet the changing requirements necessary to achieve success in IoT.

In this regard, writing this paper was motivated by the challenge of providing an enhanced understanding of the scope and classification of the broad range of IoT applications in order to determine and prioritize their performance requirements with the goal of specifying the enabling technologies towards 5G networks. The aim has been to propose a new classification of IoT applications, define and prioritize the performance requirements of such IoT application classes, and give insight into state-of-the-art technologies used to meet these requirements from telco's point of view. The motivation that led to the focus of this paper being on IoT applications classification, performance requirements, and 5G enabling technologies could be explained by telco's need for added value from IoT services. Hence, an analysis of IoT customer service requests inspired us to propose an activity-based classification of IoT applications as it can, according to authors' best knowledge, has allowed telcos to more precisely specify their performance requirements and 5G enabling technologies, thereby improving customer experience.

In this regard, the paper fulfilled the following four objectives: (1) the identification of activities relevant to IoT applications and their usage as a new criterion for IoT application classification; (2) the specification and prioritization of performance requirements of such IoT applications classes; (3) the analysis of the radio technologies used to accomplish IoT application requirements; and (4) the identification of the research gaps and the recommendation of new research directions.

Through fulfilling these objectives, we reviewed literature from the fields of IoT in 5G service classifications, IoT in 5G performance requirements, and IoT in 5G enabling technologies. Since the first aim of this paper was to propose a new classification of IoT applications, the existing approaches have been summarized to serve as a basis to identify their drawbacks and formulate the appropriate solution to overcome them. In this context, we proposed a new approach to IoT applications classification, which was based on the activity as a new classification criterion denoting the main function/purpose of specific IoT application. This approach enabled a clearer and more precise positioning of particular application in the IoT application spectrum, as well as the determination of performance requirements and enabling technologies from telco's point of view. The activity-based IoT application classification facilitated the specification of the performance requirements and determination of technologies which enable these requirements to be fulfilled. In this context, the proposed approach served as a basis for the simplification of the realization of particular IoT application. For example, although the monitoring- and tracking-based applications seem to be similar, they set different performance requirements on the

network, thereby allowing the proposed approach to precisely grade the IoT applications from the same IoT application domain.

Furthermore, we associated the activity-based IoT application classes with the 5G service classes, i.e., mMTC and uMTC, in order to specify and prioritize their performance requirements. It was determined that almost each activity-based IoT application class poses high requirements in terms of connection density, whereas ticketing-based and tracking-based IoT application classes additionally require high positioning accuracy and coverage. In order to analyze these performance requirements, we have summarized the radio technologies used to implement the future 5G networks. The focus was on the technologies used to meet the aforementioned performance requirements of mMTC activity-based IoT application classes, since mMTC is more mature, as its deployment has already started, while uMTC requires further research to achieve incomparable levels of reliability needed to enable new applications in 5G.

The analysis showed that new waveform technology can be used to meet the requirements in terms of connection density; large-scale antennas and advanced small cell technologies can be used for the purpose of satisfying the requirements in terms of positioning accuracy; while wide and flexible bandwidth technologies, in-band full duplexing technologies, and access architecture related radio technologies (i.e., advanced small cell, enhanced wireless backhaul, moving network, and D2D communication) can be used to achieve high requirements in terms of coverage. In addition, the conducted research study allowed us to highlight a number of open research issues that could serve the research community and other stakeholders interested in this contemporary and attractive field. In this context, we have recognized research gaps and directions which mostly relate to network redesign and optimization in order to accommodate large-scale IoT applications.

7. Conclusions

The IoT paradigm has the potential to revolutionize all areas of daily life of individuals, businesses, and society as a whole. Telcos enjoy a central role in the paradigm of IoT because of owing communication infrastructure which is exposed to the numerous technical challenges due to changing connectivity and performance requirements of various IoT applications. These requirements cannot be met with the current cellular networks which create the need to introduce new types of technologies leading toward 5G networks as the main driver for enabling numerous IoT applications. In this context, this paper proposed the activity-based classification of IoT applications and specification of their performance requirements in order to identify 5G radio technologies used to meet them, all from telco's perspective. Activity-based classification of IoT applications indirectly allowed the construction and distribution of performance, as IoT value proposition, while using 5G enabling technologies, as IoT resources in telco's internal value chain. In this context, high performance requirements of each activity-based IoT application class (i.e., connection density, positioning accuracy, coverage) served as a basis to analyze various enabling technologies in radio access part of 5G network in terms of advantages, disadvantages, and research gaps.

On the basis of the conducted analysis, we concluded that the following technologies can meet the high performance requirements of mMTC activity-based IoT application classes: new waveform technology (in terms of connection density), large scale antennas (in terms of positioning accuracy), wide and flexible bandwidth technologies, in-band full duplexing technologies, and access architecture related radio technologies (in terms of coverage). According to the identified research gaps, one may conclude that the optimal solutions for each technology are still in its infancy. This implies that any 5G enabling technology should be first implemented and tested through prototype construction before the deployment of specific IoT application. Thereafter, the technology combination that meets the performance requirements of each activity-based IoT class should first be found. Finally, the practical implementation of different technological combinations may further lead to a deep and comprehensive analysis of QoS and QoE in the context of IoT applications.

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5G VISION

DMC R&D Center, Samsung Electronics Co., Ltd.

Date : February 2015

Samsung envisions the fifth Generation (5G) mobile communication era to be the beginning of a full scale Internet of Things (IoT). Billions of connected devices autonomously interconnect with one another while ensuring personal privacy. The unprecedented latencies offered by 5G Networks will enable users to indulge in gigabit speed immersive services regardless of geographical and time dependent factors. This white paper introduces you to future services, key requirements, and enabling technologies that will herald in the 5G era that is expected to revolutionize the way we experience mobile services.

Dawn of the 5G Era

Fuelled by the unprecedented growth in the number of connected devices and mobile data, and the ever-fast approaching limits of the 4G technologies to address this enormous data demand, industry efforts and investments to define, develop and deliver the systems and specifications for the fifth-Generation (5G) mobile system and services are well under way - signaling the dawn of the 5G Era.

As shown in Figure 1, the number of connected Internet of Things (IoT) is estimated to reach 50 Billion by 2020 [1], while the mobile data traffic is expected to grow to 24.3 Exabytes per month by 2019 [2].

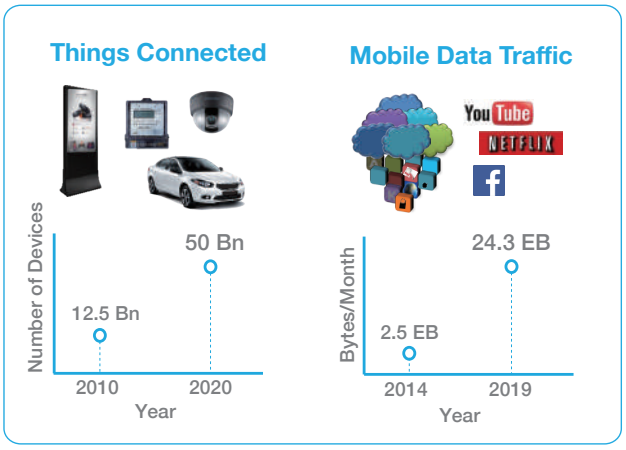

Figure 1 Growth in Mobile Traffic and Connected Devices

Add to it, the impact of higher cell capacity and end-user data rate requirements due to emerging new services such as Ultra-High-Definition (UHD) multimedia streaming and extremely low latency requirements for cloud computing and storage/retrieval, and it soon becomes evident that the current 4G systems, which are already stretched to near-breaking points (despite massive Wi-Fi offload), will be stretched too thin to deliver the quality of experience (QoE) necessary to support mobile experience that 5G is set to deliver.

5G Era can be expected to revolutionize the way we communicate by supporting immersive applications that demand exceptionally high-speed wireless connections, a fully-realized IoT, experience lower latency and promote both spectrum and energy efficiency. To realize these benefits, 5G systems will differ fundamentally from their predecessors fueling a series of groundbreaking innovations. Let's look at the services and the requirements that 5G is expected to address.

5G Service Vision

5G services have the potential to revolutionize the mobile experience. Here's how:

Internet of Things

5G will make the "Internet of Things" a reality. With 5G technology, a device will be able to maintain network connectivity regardless of time and location, and open the possibility to connect all the connected devices without human intervention. For this, the basic fabric of the 5G system design is expected to provide support for up to a million simultaneous connections per square kilometer, enabling a variety of machine-to-machine services including wireless metering, mobile payments, smart grid and critical infrastructure monitoring, connected home, smart transportation, and telemedicine. Intelligent devices will communicate with each other autonomously in the background and share information freely. This ubiquitous connectivity - a basic tenet of the 5G services, will truly enable IoT services which in turn is expected to profoundly change human lives by connecting virtually everything.

– Smart Home

Dishwashers will fix themselves using information from peers of the same model while home appliances at home and in the neighboring homes may cooperate to extinguish a fire. A smart refrigerator, recommending a recipe of cuisine to be cooked with ingredients that are already in your refrigerator, is yet another plausible scenario.

– Fitness & Healthcare

Connected Health and Fitness related wearable devices such as The Samsung Gear™ Fit will record your athletic performance while you exercise and recommend the type of exercise, its duration and frequency per day. These connected healthcare devices will also send vital signs such as brainwave, blood pressure and heartbeat to an expert system in the hospital in real-time to prevent medical emergencies before they occur. Such time critical applications put unprecedented requirements on latency.

– Smart Store

In large shopping malls, while many people walk around window shopping, vicinity to products is continuously tracked, usually by a server somewhere in the cloud. Customized alerts for low priced product can be sent to the user's device as the user is detected in the vicinity of that low-priced product, or information of other lower prices in the nearby stores can be sent to the device as the customer spends more time in the vicinity of a certain product class.

Such a system can be tailored to deliver a highly customized experience thereby greatly enhancing a user's shopping experience. To support such a scenario, massive connectivity and low latency technologies are inevitable.

– Smart Office

In smart office environments, office appliances are connected with one another and will share information. Nearby computers and input/output devices can recognize a user and change the settings using the user's preferences stored in the IoT cloud. Printers will print out the relevant documents when the user passes by the printer. Almost all the office appliances will connect wirelessly, while exchanging massive data through wireless medium without noticeable delay. Alerts on the upcoming meetings, materials and documents relevant to that meeting will instantaneously become available to the user's device, while documents and tasks that are modified will be automatically updated.

– Connected Car

Many of us use navigation services via in-car navigation systems or our smart phones to find the most efficient route to our destination. Vehicle diagnostic services are becoming attractive to obtain the information such as battery level, fuel level or engine status on our smartphones. The 'eCall' system that automatically calls emergency services in case of an emergency exemplifies such a service. By 2020 and beyond, more attractive services that wirelessly connect 'cars' around us with 'things' will emerge and make people in the vehicles very comfortable, and provide an enjoyable driving experience. For safer driving, sensor and camera data in a vehicle as well as supplementary information from the neighboring vehicles will be collected using mobile networks so that a potential emergency situation can be reliably informed to a driver in real-time and timely steps can be taken to avoid an actual emergency situation. This operation will eventually be applied to self-driving cars, which can be viewed as an important type of 'things'.

Immersive Multimedia Experience

In a 5G environment, users will experience life-like multimedia streams anytime and anywhere. Users will feel as if they are part of the scene when they watch videos on their smart devices. To provide such an immersive experience, many obstacles will need to be overcome. Agility to instantaneously respond to the user's thought and behavior will be necessary. An upcoming service that is expected to provide life-like experience in 5G system is UHD video streaming with its greatly enhanced resolution and clarity. Currently, UHD services over terrestrial broadcast are already being standardized in some countries. In addition, some smart phones in the market are now equipped with a camera module

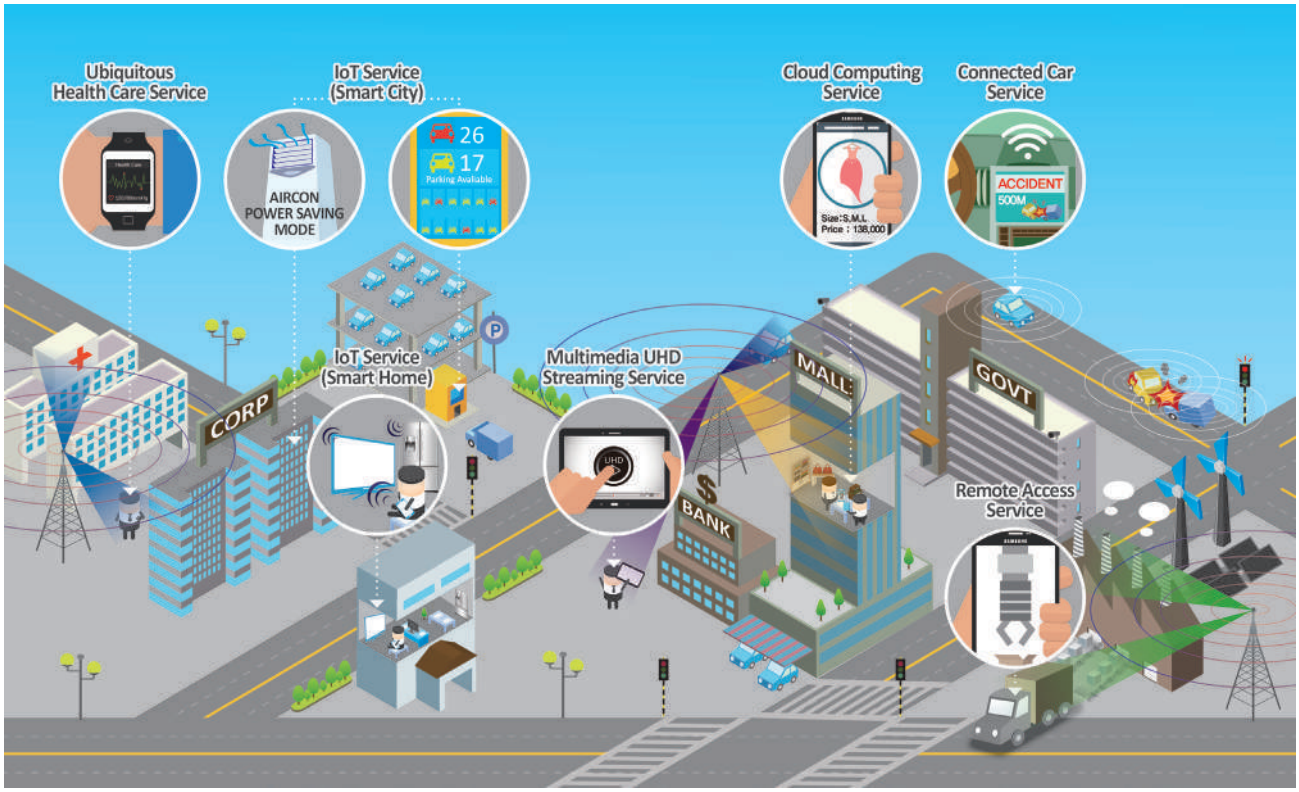

Figure 2 Major Service Scenarios with 5G

that can record video with 4K UHD quality. It is expected that UHD services are likely to go mainstream by 2020 raising an acute need for performance enhancement of cellular systems to support such services.

Other examples of "immersive" services that will fundamentally revolutionize entertainment, health, education, and other industry sectors are Virtual Reality (VR) and Augmented Reality (AR).

VR provides a world where physical presence is simulated by computer graphics, and the user can actively interact with the simulated elements, as in immersive sports broadcasting for instance (See Figure 3). Other interesting VR service scenarios are interactive 360° movies, online games, remote education, and virtual orchestra. Samsung's recently launched VR headset called (called Gear VR), virtual reality video service platform (called Milk VR) and 'Project Beyond,' (a 360° 3D camera with 17 Full HD (FHD) camera modules, optimal for generating contents for Milk VR) indicate the humble beginnings of the truly immersive experience that is to come in the 5G Era.

Figure 3 Watching Sport Events with VR

In an AR service scenario, computer-aided real-time information based on user context is graphically augmented to the display, delivering added value for the user. In the future the service desk attendant no longer needs to memorize the tiresome details of the products. Instead, AR services will help to inform the price, popularity, and details of a given product. Figure 4 illustrates another service scenario - AR navigation on windshield, where navigation information and other helpful notifications (refuel reminder and nearby shop location) are displayed on the windshield of a car, so that the user can continue to focus on driving while getting subtle context-aware notifications about potential services at the same time.

Samsung is actively involved in the development of 5G technologies to support these immersive VR and AR services, which will entertain users and provide a truly life-like experience on the move.

Figure 4 Driving a Car with AR Navigation

Everything on the Cloud

5G will provide users with a desktop-like experience based on cloud computing. With everything stored and processed on the cloud and immediately accessed with low latency, only simple input and output interfaces on mobile devices are needed, making them lighter, thinner, fancier, and more eco-friendly.

As an example, when you go shopping, the smart device can notify you about the arrival of new dresses that you might like, or let you know how well a dress in the newly incoming inventory matches with your liking based on your purchase history. This notification can be triggered, for instance, as you step into a shop, or take a picture of the dress, while the necessary computation to come up with the dress recommendation through crowd sourcing is done on a cloud server that is potentially half a world away.

Intuitive Remote Access

Users will be able to control remote machines and appliances as if they are right before them, even from thousands of miles away. Thanks to the reliable connections and near-zero latency of 5G, users will be able to control heavy industrial machines remotely, or access hazardous site remotely. It will also help mankind in exploring areas on the earth that are as yet unexplored, such as the Polar Regions or parts of the ocean floor.

5G Requirements

In order to realize such a demanding and unprecedented service vision, Samsung proposes the 5G rainbow requirements consisting of 7 Key Performance Indices (KPIs) as shown in Figure 5.

5G systems will be required to deliver an order of magnitude cell capacities and per-user data rate compared to its predecessors. Specially, 5G systems are expected to support data rates of 10-50 Gbps for low-mobility users. As a baseline, 5G sys-

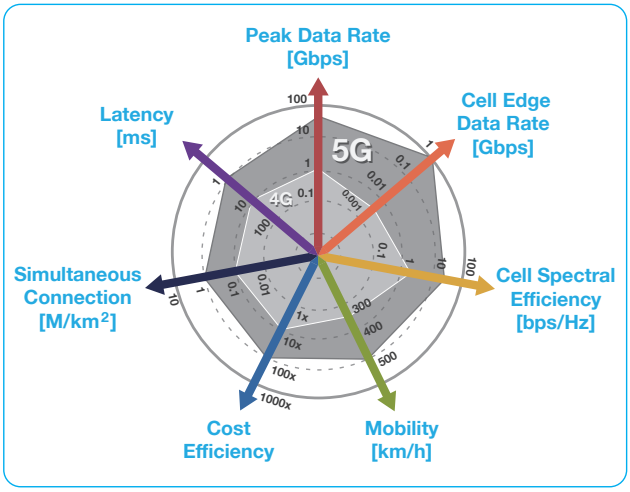

Figure 5 5G Rainbow Requirements

tems will provide gigabit-rate data services regardless of a user's location as shown in Figure 6 and Figure 7. To provide this uniform QoE, 5G network deployments are expected to be much denser compared to 4G networks, so making cost-effective deployment is a very important requisite.

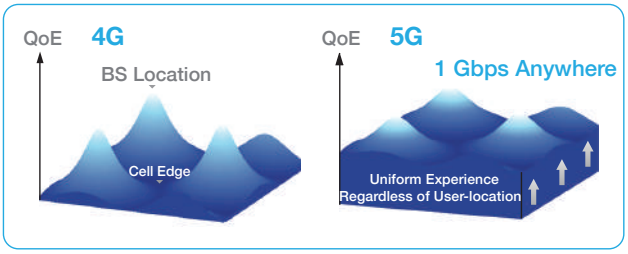

Figure 6 Edgeless RAN - 1 Gbps Anywhere

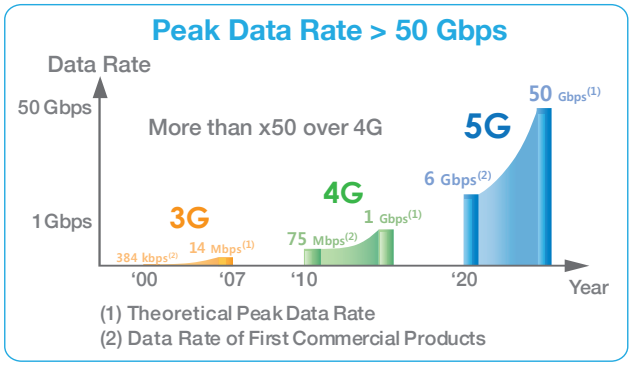

Figure 7 Data Rate Comparison of 5G with 3G and 4G

To fundamentally support the cloud storage/computing infrastructure of the future, 5G networks will deliver an end-to-end latency of less than 5 milliseconds and over-the-air latency of less than one millisecond (see Figure 8) - which is one-tenth compared to the latency of a 4G network. Critical infrastructure monitoring, for example, currently requires service levels achievable only on dedicated wireline networks while 5G technologies offer the promise of making these service levels achievable over wireless networks. Likewise, low-latency networks will allow pre-crash sensing, enabling vehicles to sense imminent collisions and exchange relevant data that could salvage the situation and/or mitigate adverse impact of the collision. Other challenging low-latency services that could be enabled by 5G could include self-driving cars, public safety communications systems, augmented reality, and "tactile internet" [3].

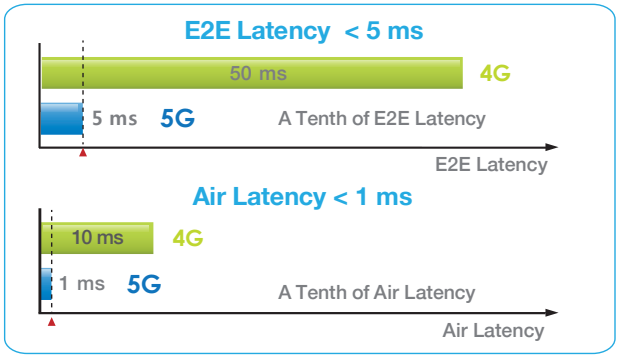

Figure 8 Ultra Low Latency of 5G

With spectral efficiency requirements set to 10 bps/Hz levels (in contrast to the 1-3 bps/Hz on 4G networks), 5G is also expected to deliver an efficient use of the spectrum by using MIMO, advanced coding and modulation schemes and new waveform design (more on this in the enabling technology section)

To address the ever-widening revenue gap that the operators and service providers are experiencing, 5G systems are targeted to be 50 times more efficient than 4G by delivering reduced cost and energy usage per bit. This sequentially requires low-cost network equipment, lower deployment costs, and enhanced power saving functionality on the network and user equipment sides.

5G technologies will be required to cope efficiently with all degrees of mobility by providing "mobility on demand" based on each device's and service's needs. On one hand, the mobility of user equipment should be guaranteed to be at least the same level as the current 4G system - that is the baseline. On the other hand, Samsung envisions that specialized 5G systems will support mobility at speeds ranging from 300 to 500 km/h.

To make the IoT Vision come true, the number of simultaneous connections in the 5G system is expected to be over 10^6 per unit square kilometer, which is much higher than that of the legacy system.

5G Key Enabling Technologies

Groundbreaking innovations will drive 5G technologies to meet the unprecedented speeds, near-wireline latencies, ubiquitous connectivity with uniform QoE, and the ability to connect massive amounts of devices with each other, all working in unison to provide the user with an immersive experience, even while the user is on the move. Future 5G systems will encompass fundamentally new designs to boost wireless capacity utilizing new frequency bands, advanced spectrum efficiency enhancement methods in the legacy band, and seamless integration of licensed and unlicensed bands.

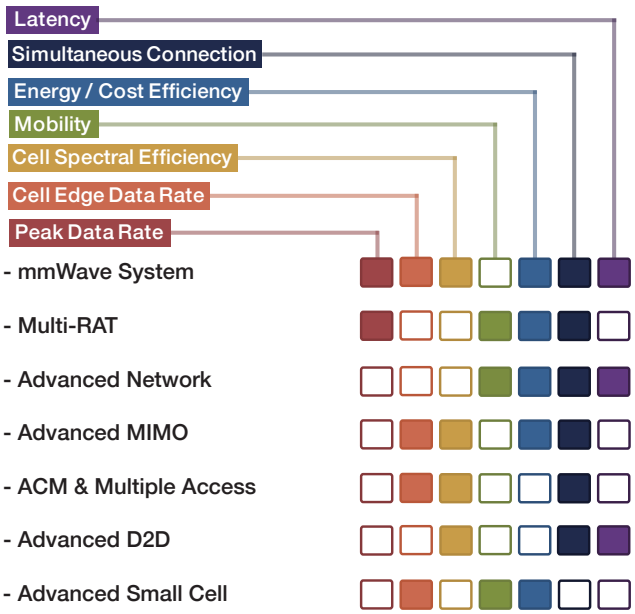

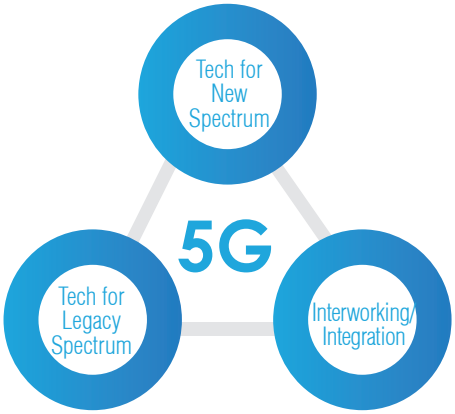

Figure 9 shows an overview of the 5G key enabling technologies. The massively higher capacity needs of the 5G systems will be addressed by new mmWave systems, high-density small cells, advanced Multiple-Input and Multiple-output (MIMO) and new multiple access schemes like Filter-Bank Multi-Carrier (FBMC). Adaptive Coding and Modulation like Frequency and Quadrature Amplitude Modulation (FQAM) can significantly improve the cell edge performance and combined with higher density deployments with multi-BS cooperation will help to deliver on the promise of "Gbps anywhere" and Uniform QoE. Multi-Radio Access Technology (Multi-RAT) integration including carrier

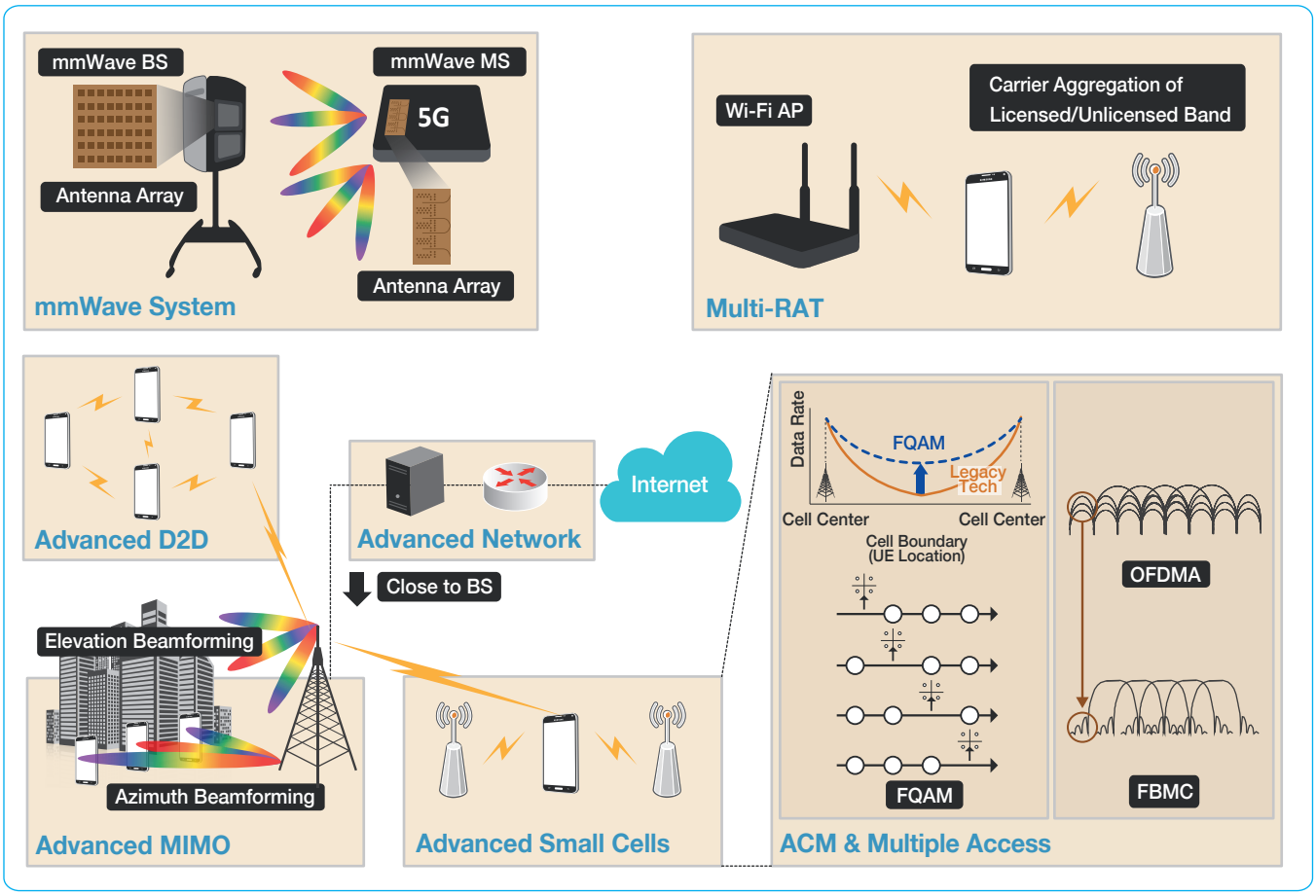

Figure 9 Overview of 5G Key Enabling Technologies

aggregation of licensed and unlicensed bands will inevitably help in increasing the available system bandwidth. On the network side, novel topologies including application servers placed closer to the network edge will contribute to significantly reducing the network latency. Advanced Device-to-Device (D2D) technology can help reduce the communications latency and support larger number of simultaneous connections in a network.

These 5G key enabling technologies are described in more detail in the following sections.

mmWave System

The mmWave bands provide 10 times more bandwidth than the 4G cellular-bands, as illustrated in Figure 10. Therefore, the mmWave bands can support the higher data rates required in future mobile broadband access networks.

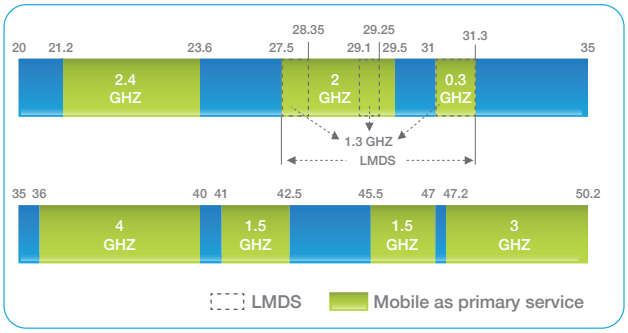

Figure 10 Potential Bands in 20-50 GHz (US)

Unlike the below 6GHz bands, in the mmWave bands we have to carefully consider the wireless conditions such as rainfalls, snowfalls, and fogs. However, the amount of loss is mild for the expected range of a 5G communication link. For example, atmospheric absorption loss due to H_2O and O_2 at 28 GHz would be around 0.02 dB at a distance of 200 meters. Intensive rainfall (110 mm/h) results in about 4 dB loss at 200 meters distance. Loss due to heavy snow (10 mm/h) or heavy fog (visibility distance under 50 meters) will be less than 0.1 dB, at all distance of 200 meters [4][5].

In Figure 11, we show mmWave channel measurements from extensive experiments in Daejeon, Korea [6][7]. These channel measurements were carried out at 28 GHz with a channel bandwidth of 250 MHz, transmission power of 29 dBm and the horn antenna gain of 24.5 dBi for both the transmitter and the receiver [6][7].

The path loss exponents (based on 8 meters distance free space path loss) is 3.53 in Non Line of Sight (NLoS) links [6]. The mild path loss exponent from measurement results strongly suggests that mmWave communication links can be supported

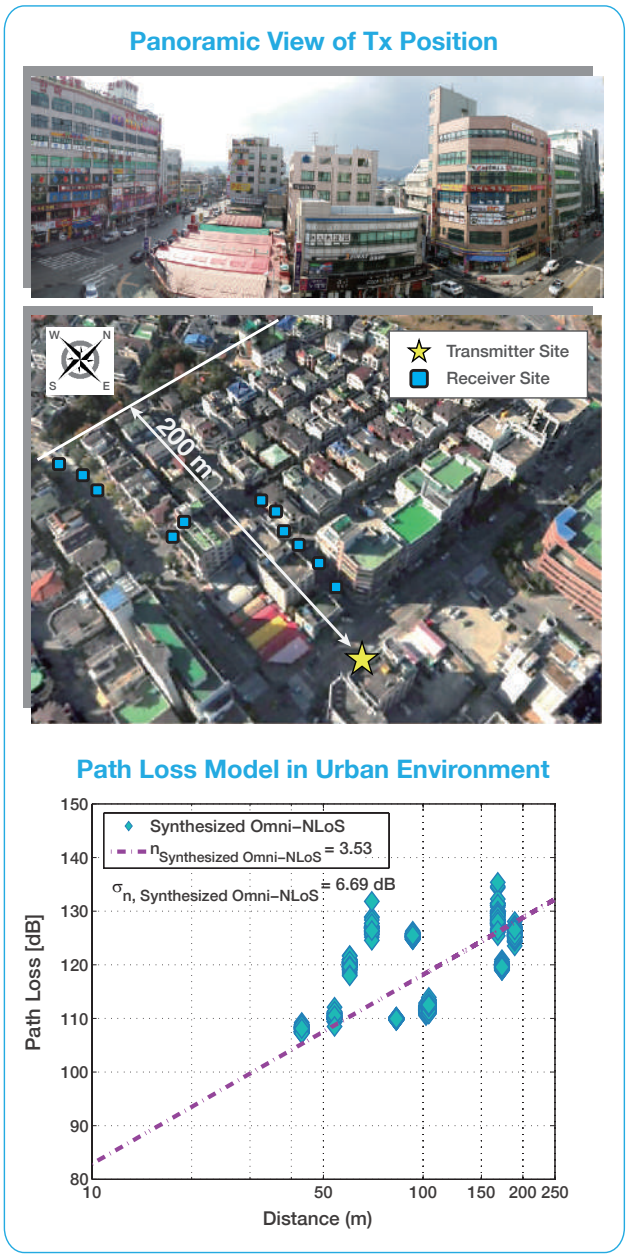

Figure 11 mmWave Channel Measurements in Urban Area, Daejeon (Korea)

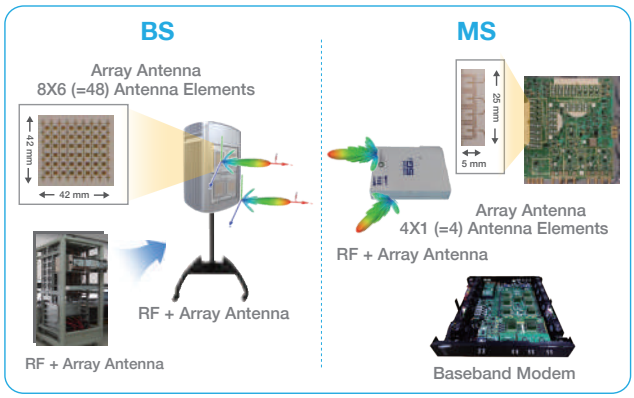

Figure 12 Adaptive Pencil Beamforming (Example)

over 200 meters of distance, even in dense urban outdoor NLoS environments. Similar results are also reported in ray-tracing-based mmWave propagation model [8], confirming the fact that mmWave

bands can be successfully utilized for future IMT systems. Moreover, based on the ray-tracing, mmWave 3D-channel model in urban scenario is proposed in [9]. Higher path-loss and the resulting fragile link is largely due to weak diffractions in the mmWave bands. We need to overcome these challenges in order to make outdoor mmWave communication a reality [10][11]. Fortunately, the small mmWave wavelength also means highly directional beamforms can be obtained using a large number of antenna elements in a smaller form factor. These adaptive directional beams with large antenna array gain are key in combating the large propagation loss in the mmWave [12][13][14][15], as illustrated in Figure 12.

We have developed a mmWave beamforming prototype at the DMC R&D Center, Samsung Electronics, Korea, in order to demonstrate the feasibility of using mmWave bands for cellular services. We showed that mmWave system can meet the two key requirements of cellular services: sufficiently large geographical coverage and support for mobility in NLoS environments.

With the prototype, we tested outdoor coverage to demonstrate the service availability in a typical outdoor environment for both LoS and NLoS sites. The tests were performed at sites surrounded by tall buildings where various channel propagation effects such as reflection, diffraction, and penetration were present, as shown in Figure 13. We observed that reliable communication links are formed even for NLoS sites that are more than 200 meters away from the base station.

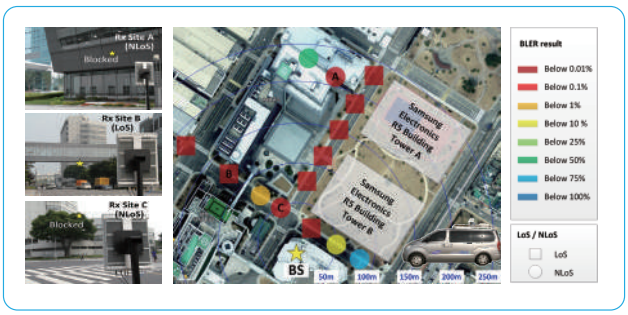

Figure 13 Exemplary Outdoor Coverage Test Results

Advances in semiconductor technology have made commercial mmWave systems readily available. Recent technologies of Silicon-based Complementary Metal Oxide Semiconductor (CMOS) processes are capable of integrating mixers, Low Noise Amplifiers (LNAs), Power Amplifiers (PAs), and Inter-Frequency (IF) amplifiers, all in a single package. A good example is the 60 GHz commercialized products with the label of Wireless Gigabit Alliance (WiGig) [16], and it is well recognized that cost effective implementations of sub-100nm CMOS process made it possible to utilize the 60 GHz bands [17].

GaAs Monolithic Microwave Integrated Circuit (MMIC) technologies are maturing fast, and they are becoming a dominant choice for components in the RF chain including PAs, LNAs, switches for digital attenuators and phase shifters, Voltage Controlled Oscillators (VCOs), and passive components from a few GHz to 100 GHz. As illustrated in Figure 14, it is projected that the Power Added Efficiency (PAE) of a 5G Front End Modules (FEM) will soon match the PAE of today's commercial 4G system. Meanwhile, a good Effective Isotropic Radiated Power (EIRP) can be achieved with the help of high antenna gains from a large number of antenna elements [18][19].

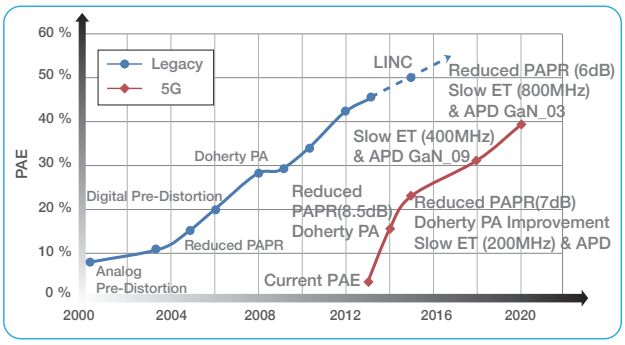

Figure 14 Projections of 5G FEM PAE

High performance antenna solution is an important piece of the 5G puzzle. The constantly varying LoS and NLoS propagation environment demands a novel antenna which exhibits high gain as well as wide spatial coverage capacity. The antenna array comprising of multiple antenna elements must fit within the small form factor of a 5G mobile handset.

Samsung has been developing innovative 5G phased array antennas that have near zero-footprint and reconfigurable antenna modes, as shown in Figure 15.

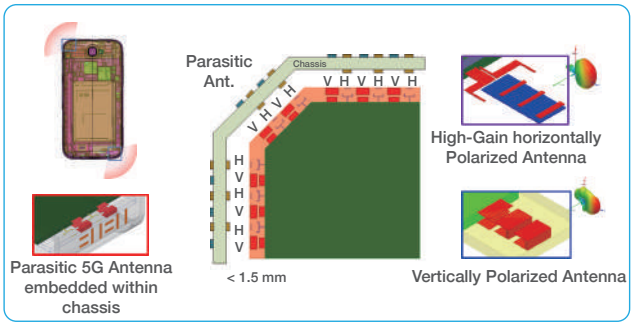

Figure 15 The Reconfigurable 5G Phased-array Antenna

Characterizing the biological implications on a user's body imposed by cellular handset devices is one of the most important aspects that need to be verified prior to its commercial release. The Signal Absorption Rate (SAR) regulated by worldwide gov-

ernmental bodies is used as a guideline to assess the effect of mmWave bands on a user's body. The SAR of an envisioned 5G (28 GHz) cellular handset is analyzed and illustrated in Figure 16.

When optimally configured, the 5G beamforming technology enables the peak radiation of the Mobile Station (MS) antenna to steer away from the user's head. As a result, the average SAR can be reduced by more than a factor of 10 compared to that of the present day 4G cellular handsets.

The maximum SAR is expected to be further minimized in the future, as 5G antenna technology continues to evolve.

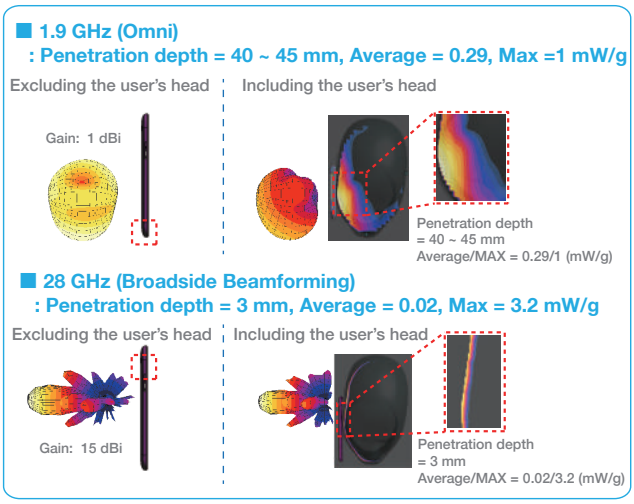

Figure 16 Biological Implications on the User's Body

Multi-RAT

To realize the envisioned 5G services, significant enhancement of per-user throughput and overall system capacity is required, compared with those of the 4G system. Such an enhancement can be achieved through advanced PHY/MAC/network technologies and efficient methods of cell deployment and spectrum management. In particular, utilizing a larger amount of system bandwidth guarantees an increase in the capacity by allocating more frequency resources to each user in the system. Therefore, utilizing the spectrum where huge bandwidth is available can be considered to be the most critical issue for the 5G system.

Currently, the 4G system specifies its operating frequency bands and some of them are assigned to cellular operators. These deployments can be beneficial since the existing 4G system will not interfere with other RATs.

However, obtaining the licensed spectrum requires not only considerable financial investment, but also a significantly long period of time spent on regulatory procedures. More importantly, a substantial portion of the licensed spectrum around 2 GHz is already being used. Therefore, finding a bandwidth that is wide enough to support the 5G system is very challenging.

The recent trend in spectrum management is to aggregate both the licensed and unlicensed spectrums to extend available system bandwidth, as shown in Figure 17.

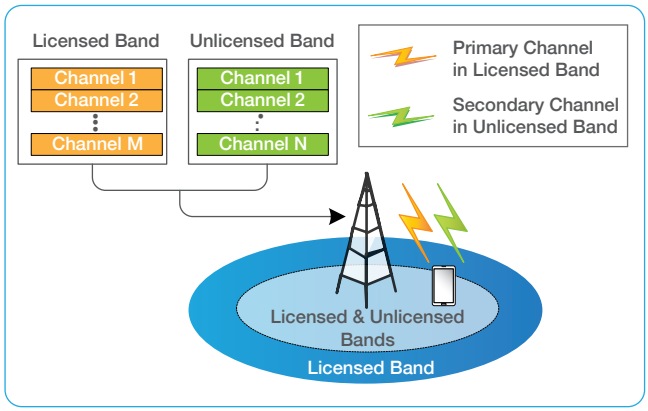

Figure 17 Integration of Licensed and Unlicensed Bands

The unlicensed spectrum has plenty of bandwidth. For instance, approximately 500 MHz and 7 GHz bandwidths are available in the 5 GHz and 60 GHz bands, respectively. In order for the 5G system to utilize the unlicensed spectrum, regulations imposed on each frequency band should be carefully reconsidered. Representative examples of the regulations are the Transmit Power Control (TPC), Dynamic Frequency Selection (DFS), and Listen Before Talk (LBT).

To efficiently utilize the unlicensed spectrum, we will develop the 5G system with the following characteristics.

First, we will design PHY/MAC/network algorithms suitable for the nature of the unlicensed spectrum. Since a wide range of frequency bands are included in the unlicensed spectrum, each frequency band has its own characteristics. Hence, band-specific solutions will be provided.

Second, efficient coexistence mechanisms that take into account other RATs (e.g., WiFi or WiGig) operating in the unlicensed spectrum will be suggested.

Finally, techniques for interworking and integrating the 5G system with other RATs will be developed. By taking advantage of multiple RATs, the 5G system will be able to take advantage of the unique characteristics of each RAT and improve the practicality of the system as a whole. For instance, the 4G system is used for exchanging the control messages to maintain the connection, to perform handover, and to provide real-time services such as VoLTE. The technology operating in mmWave unlicensed frequency band would support the gigabit data rate service. Multiple mmWave cells can be overlaid on top of the underlying 4G macro cells, as shown in Figure 18.

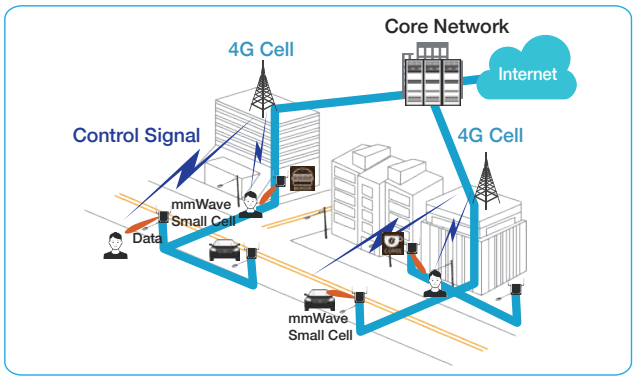

Figure 18 Overlaid Network of mmWave Small Cell Integrated with the Underlay 4G System

Advanced Network

In order to meet the 5G key requirements such as latency and the large number of simultaneous connections, and to support new business models and scenarios for operators, technologies above the radio access level should also be considered. Therefore, we need to develop technologies at the system architecture level from the network point of view. To accomplish the 5G key requirements and support the increased data rate of new 5G radio access, 5G network will have to evolve towards a distributed and flat architecture.

Current mobile network architectures designate a dedicated node in the core network (e.g., PGW - Packet Data Network Gateway in 3GPP) as a mobility anchor that allocates an IP address to the terminal, tracks terminal location in the IP topology, and ensures terminal's reachability by tunneling its traffic to wherever it goes. All terminal traffic is tunneled through the centralized node in the mobile core network. However, the undesirable consequences of this design include the following:

- Increase in end-to-end transmission latency due to elongated data paths.
- Additional load of backhauling and network processing in the core networks.
- Low network reliability due to introduction of a single point of failures.

In the 5G flat network architecture, as illustrated in Figure 19, user mobility is managed efficiently and in a dynamically scalable fashion by pushing the functionality to the edges of the network and even onto the mobile terminals [20].

The three important benefits of this approach include the followings:

First, such a distributed mobility management always provides the shortest data path between MS and the Internet without traversing the core network. This distributed mobility management leads to a significant reduction of signaling and data transmission delay. Also, low end-to-end latency requirements of 'less than 5 ms' for new 5G services such as immersive UHD video streaming, cloud gaming, and virtual reality, cannot be archived solely by reducing radio access latency but would also require a flatter network architecture design. In the flat network architecture, services which require low latency transmission can be provided by Edge Servers and they can benefit from advanced network features which utilizes network information for optimal operations.

Second, it provides a highly scalable solution compared to the centralized architecture, in which a single core network gateway maintains the whole traffic from MSs or to MSs.

Third, it easily avoids the risk of having a single point of failure. In flat network architecture, the breakdown of one network gateway would not significantly interfere with the operations of the other gateways.

Flexibility is considered as another key requirement of 5G network architecture. Software-Defined Networking (SDN) and Network Function Virtualization (NFV) provide promising examples of programmable design technologies for realizing a flexible 5G network architecture.

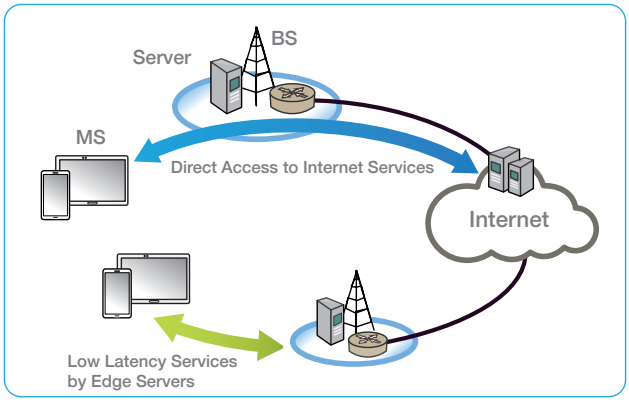

Figure 19 5G Flat Network Architecture

Advanced MIMO

One promising technology for meeting the future demands is massive MIMO transmission/reception [21]. When used with multi-user precoding schemes such as Maximum Ratio Transmission (MRT) precoding, also known as channel conjugate precoding, massive MIMO systems experience small inter-user and inter-cell interferences, and consequently achieve significantly higher throughput than the state-of-the-art MIMO systems.

One of the main challenges to build massive MIMO systems in practice is the limitation in the number of antennas that can be equipped at a BS, caused by the BS form factors and operating carrier frequencies.

For example, to horizontally install a large number of antenna elements (e.g., > 8) at the top of a BS tower operating with the lowest 4G system frequency bands of 700 MHz, eight antenna elements with 0.5 λ spacing require up to 1.7 m width, where λ is the carrier wavelength. For the typical 4G system frequency bands of 2.5 GHz, fitting 32 antenna elements with 0.5 λ spacing require up to 1.9 m width, which is still not feasible in many BSs that have only limited room on the tower. This practical limitation has motivated Full-Dimension MIMO (FD-MIMO) cellular communication systems, which place a large number of active antenna elements in a two dimensional grid at the BSs.

A typical FD-MIMO deployment scenario is illustrated in Figure 20, for a macro BS with 3 sectors equipped with 2D Active Antenna Array (AAA) panels.

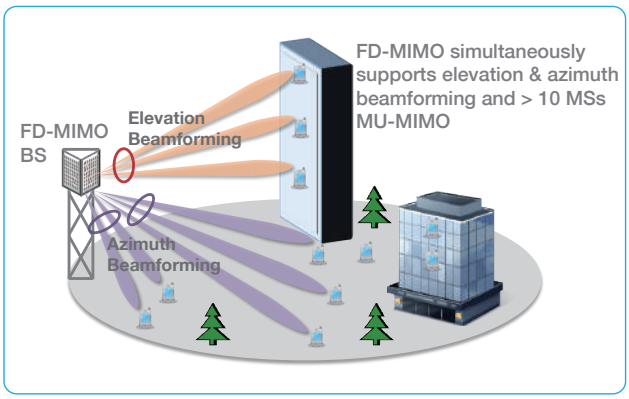

Figure 20 Example of FD-MIMO Deployment

FD-MIMO system can support high-order Multi-User MIMO (MU-MIMO), while fully exploiting the elevation as well as the azimuth dimension, thereby generating improved system throughput.

In full buffer system-level evaluations, it has been found that 64-antenna-port FD-MIMO system achieves 243% average-cell and 244% cell-edge performance gain, compared to those of the 8-antenna-port legacy MIMO system. In order to achieve the promising gain of FD-MIMO in practice, we need accurate beam steering and tracking in three Dimensions (3D).

To steer and track the MU beams toward serving MSs, FD-MIMO BS should be equipped with multiple transceivers (TRX) feeding 2D array elements, in which the number of TRX doubles or even quadruples compared to that of the conventional BS.

Having a large number of TRX poses new challenges, such as antenna calibration and complexity issues associated with Channel State Information (CSI) acquisition and precoding.

On the other hand, high-order MU-MIMO introduces another set of new challenges, such as scheduling complexity and link adaptation. Furthermore, in Frequency Division Duplex (FDD) systems, other new challenges emerge such as pilot overhead, CSI estimation complexity, CSI quantization and feedback overheads.

ACM & Multiple Access

– FBMC

As cellular IoT has been one of key driving forces to 5G, spectrally efficient support for heterogeneous services that have quite different requirements is becoming ever so important. Accordingly, several enabling methods such as multi-RAT coexistence and flexible spectrum sharing have been actively investigated.

Recently, FBMC has drawn much attention as an enabling technology for enhancing the fundamental spectral efficiency, though its theory has a long history similar to that of Orthogonal Frequency Division Multiplexing (OFDM).

Because of the well-localized time/frequency traits adopted from a pulse shaping filter per subcarrier, the FBMC system can reduce the overhead of guard band required to fit in the given spectrum bandwidth, while meeting the spectrum mask requirement.

Furthermore, the effectively increased symbol duration is suitable for handling the multi-path fading channels even without Cyclic Prefix (CP) overhead. Consequently, the FBMC system can reduce the inherent overheads such as CP and guard-bands in CP-OFDM. FBMC is also attractive in specific asynchronous scenarios, including Coordinated Multi-Point Transmission and Reception (CoMP) and Dynamic Spectrum Access (DSA) in a fragmented spectrum.

However, to maintain the transmission symbol rate, the conventional FBMC system generally doubles the lattice density either in time or in frequency compared with OFDM while adopting Offset Quadrature Amplitude Modulation (OQAM). In OQAM, in-phase and quadrature-phase modulation symbols are mapped separately with half symbol duration offset. Thus, so-called OQAM-FBMC or Staggered Multi-Tone (SMT) causes intrinsic interference that makes it difficult to apply conventional pilot designs and corresponding channel estimation algorithms as well as MIMO schemes as in CP-OFDM systems [22].

With a base-filter that takes the spectrum confinement and the orthogonality among adjacent subcarriers into consideration, the QAM-FBMC system performs comparable to the CP-OFDM system even without the CP overhead, while the guard-

band overhead reduction is also available from the well-confined spectrum. Sophisticated receiver algorithms including channel estimation and equalization can further mitigate the multi-path fading channel impact without the CP.

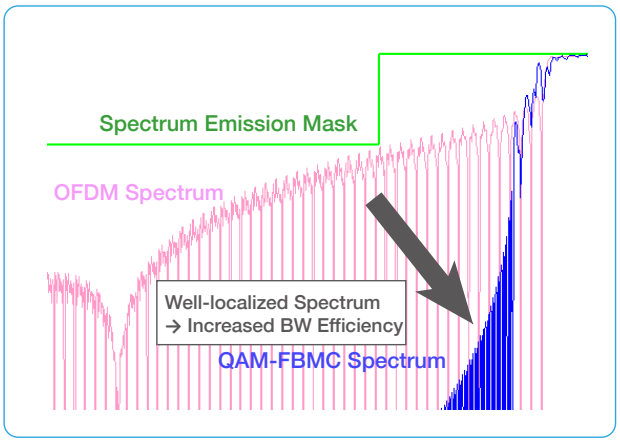

Figure 21 One QAM-FBMC Symbol Generation

– FQAM

One of key requirements for 5G is enhancement of cell-edge performance, which means that every user should be supported with Gigabit experience anywhere. Conventional approaches to enhance the cell-edge performance mainly focus on managing interference (e.g., interference cancellation, interference avoidance), by dealing with interference as a Gaussian. However, it is proved that the worst-case additive noise in wireless networks with respect to the channel capacity has a Gaussian distribution. From this observation, one can expect that the channel capacity can be increased by a non-Gaussian interference design which makes Inter-Cell Interference (ICI) non-Gaussian. The distribution of ICI depends on the modulation schemes of the interfering BSs. Therefore, an active interference design for improved cell-edge performance can be achieved by applying a new type of modulation.

FQAM, a combination of Frequency Shift Keying (FSK), and Quadrature Amplitude Modulation (QAM) can be used as an active interference design scheme. Figure 22 shows the signal constellation of 16-ary FQAM that is a combination of 4-ary FSK and 4-ary QAM.

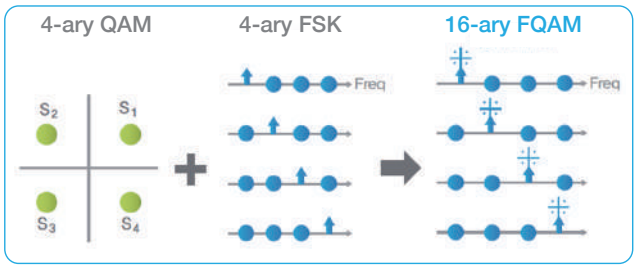

Figure 22 Example of 16-ary FQAM

With FQAM, the statistical distribution of ICI is likely to be non-Gaussian, especially for cell-edge users. As a result, the transmission rates for the cell-edge users can be significantly improved.

The statistics of ICI and the performance enhancement possibility have been proven by practical implementation of a system which uses FQAM. FQAM system environment for cellular downlink OFDMA networks is shown in Figure 23 and 24. Our experimental results show that the transmission rates for interference-limited users in FQAM-based OFDMA networks are around 300% higher than those in QAM-based OFDMA networks [23][24].

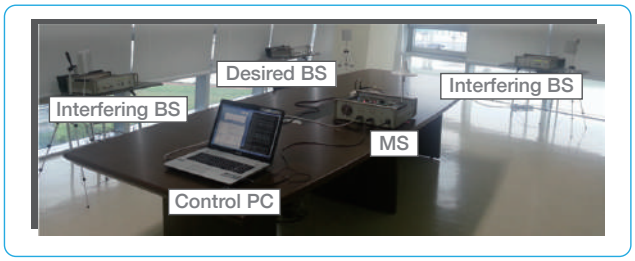

Figure 23 3 Cell Structure with MS and BSs

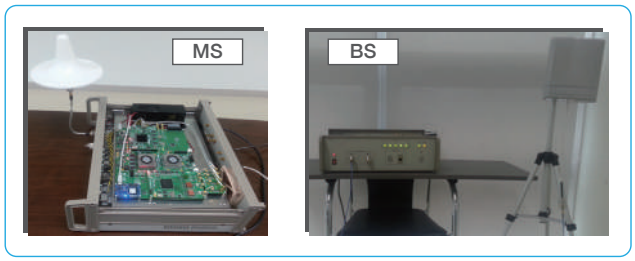

Figure 24 Implemented MS and BS

Advanced D2D

Advanced D2D communication is an attractive technology that enhances spectral efficiency and reduces end-to-end latency for 5G. Not entirely depending on the cellular network, D2D devices can communicate directly with one another when they are in close proximity. Hence, D2D communication will be used for offloading data from network so that the cost of processing those data and related signaling is minimized. Moreover, enhanced version of D2D communication was suggested lately for being used as special purpose such as Mission Critical Push-To-Talk (MCPTT) communication and Vehicle-to-Anything (V2X) communication.

In advanced D2D communication, a single radio resource can be reused among multiple groups which want to communicate with each other if the interference incurred between groups is tolerable. Hence, we can increase the spectral efficiency and the number of the simultaneous connection by utilizing D2D communication in 5G. Moreover, since the data is directly transmitted and not going through the core network, the end-to-end latency can be

considerably reduced. Therefore, advanced D2D communication is quite well aligned with IoT services as shown in Figure 25. The cars can communicate with each other to exchange the information for safety alarm and infotainment without cellular base station. The home appliances communicate with each other for home automation service. Many objects in proximity region can be connected to each other so that IoT services can be accomplished.

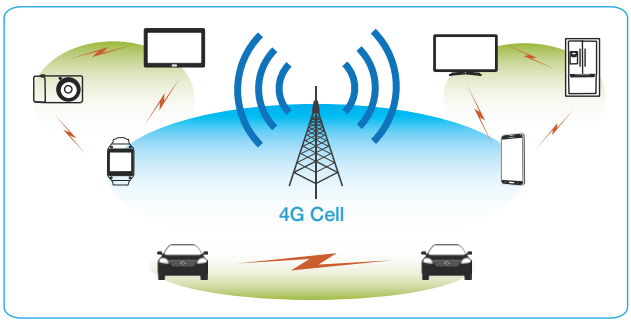

Figure 25 Advanced D2D Communications

Advanced Small Cell

To achieve significant throughput enhancement in a practical manner, it is necessary to deploy a large number of cells in a given area and to manage them intelligently. The 5G system is expected to utilize higher frequencies to take advantage of the vast bandwidth in the mmWave bands. Hence, the considerably high propagation loss of mmWave makes it suitable for dense small cell deployment, which leads to higher spatial reuse.

Moreover, Figure 26 shows the concept of a user-centric virtual cell. Conventional static network topologies with a central controller have an "edge", the reach of the central controller. However, a user-centric virtual cell that consists of a group of cooperating BSs is continuously reformed so that any user will always find himself/herself at the "center" of the cell.

Distributed and self-configuring network technologies will make it easy to deploy many small BSs in urban and suburban areas. In-band wireless backhaul can be used between BSs for cooperative communication, reducing the cost and complexity of backhaul network deployment.

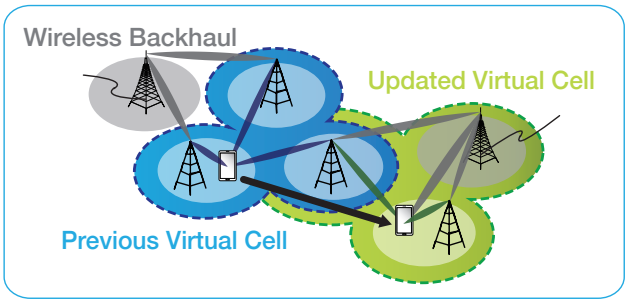

Figure 26 User Centric Virtual Cellular Network

5G Deployment Scenario

In order to provide the ubiquitous high QoE gigabit accessibility, we envision an overlaid deployment of 5G in conjunction with the existing 4G macro cells. The 5G small cells can be coupled with the overlaid 4G macro cells, and the 4G macro cells will control the operations of the associated 5G small cells, as illustrated in Figure 27. In the figure, 5G BS primarily provides multi-gigabit per second throughput with high QoE to mobile users over the legacy spectrum or higher spectrum like the 5 GHz unlicensed band and bands above 6 GHz. Meanwhile, the 4G BS can serve as a control channel to 5G MSs for supporting seamless connection anywhere over the legacy 4G spectrum.

5G system will need enhanced RAN technologies that not only utilize the legacy frequency bands assigned to IMT and IMT-Advanced systems, but also use new frequency bands. At the same time, 5G system will also need to support seamless interworking with other RATs operating in unlicensed bands.

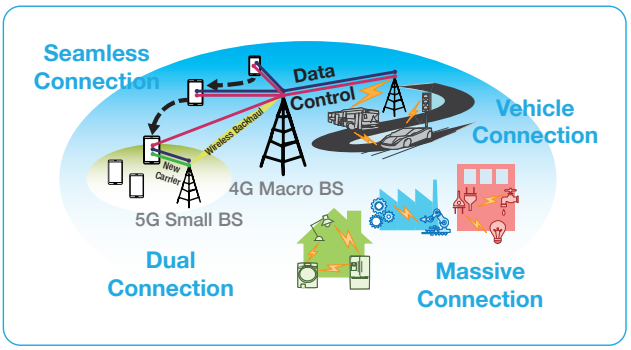

Figure 27 5G Deployment Scenario

Standardizations and Regulations

As shown in Figure 28, 5G is planned to be commercialized in year 2020. ITU-R WP 5D is preparing timelines in the vision document for standardization, spectrum allocation, and commercialization, in order to be on time. From the perspective of commercialization, standards for 5G should be ready by the year 2017 to allow 2 or 3 years for the development of 5G products. Considering average periods of previous standardization, 5G standards need to get started in 2015 to make 5G standards available by the end of 2017.

New frequency bands may be required to achieve the target performance of 5G. World Radio communication Conference (WRC)-15 agenda item 1.1 made in WRC-12 indicates consideration for additional spectrum allocations to mobile services on a primary basis and for identification of additional frequency bands for IMT purposes.

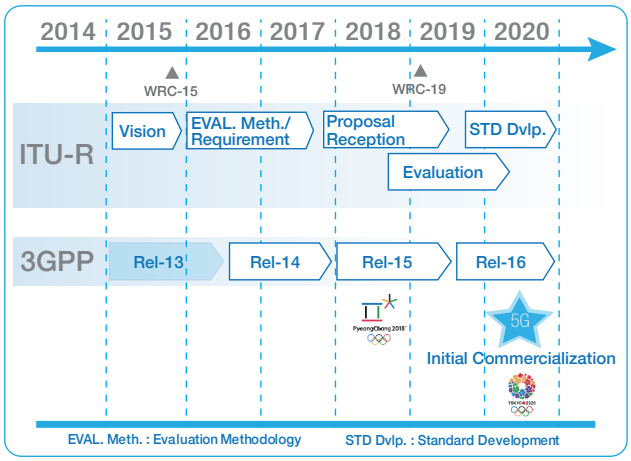

Figure 28 5G Timelines

In light of this agenda item, various frequency ranges had been proposed and discussed in ITU-R WP 5D in July 2013, and Joint Task Group (JTG) 4-5-6-7 had performed compatibility studies among various technologies in each candidate frequency band until July 2014.

Although bands above 6 GHz were not included in JTG 4-5-6-7's candidate frequency bands, WP 5D has been developing a new report on IMT systems in bands above 6 GHz, including channel characteristics and the potential usage of the bands for IMT systems.

WP 5D may also provide JTG 4-5-6-7 with the necessary information regarding bands above 6 GHz in order to be referenced as appropriate in the draft text of Conference Preparatory Meeting (CPM). The possibility and further necessity to study the bands are captured in the report from JTG 4-5-6-7 to CPM as follows:

"The demand of high bit rate, especially in densely populated area could be accommodated in higher frequency bands (e.g. above 6 GHz) than those currently being considered in studies, however the technical information required for compatibility studies has yet to be developed and these studies and proposals are being explored for future work, beyond WRC-15."

This report implies that new frequency bands can be added to the IMT frequency bands toward WRC-19, and it is likely that bands above 6 GHz can be one of candidate frequency bands.

In addition, Licensed Assisted Access (LAA) study item has been accepted in 3GPP LTE in the second half of 2014, acknowledging the use of unlicensed bands for cellular system.

Recently, as FCC relieves 5GHz band regulations for various unlicensed band usage, related coexistence technology between LTE and WLAN will be standardized in both standards.

Further, as shown in Figure 29, Samsung is actively engaging in the most of global 5G research initiatives, such as European 5G PPP projects of Horizon 2020, 5G Innovation Centre (5GIC) in UK, NYU Wireless Center in US, Giga KOREA project and Chinese 836 project.

Samsung is leading various collaborations with industries and academics over the world. In particular, Samsung has played an important role as the full member of 5G PPP Infrastructure Association, the executive board member of 5G Forum in Korea and the chair of vision sub-working group for Future IMT (5G) in ITU-R WP5D.

In order to have a consistent perspective on 5G with those of other academic institutes, we are vigorously developing 5G core technologies with several outstanding universities around the world.

Figure 29 Global 5G R&D Activities

Conclusion

5G will usher in a revolutionary generation of mobile communication that provides ubiquitous multi-Gbps data rate regardless of the user's location.

Significantly increased system capacity and real-time responsiveness of the 5G system will introduce life-changing services providing the users with a truly immersive and rich experience. The profoundly life-alternating world of billions of interconnected devices, the IoT, will require something as revolutionary as 5G to be fully realized in its fullest extent. And finally 5G promises to reverse the widening revenue gap and make it worthwhile for operators and service providers to invest again in innovative new services, and continue to propel increased productivity and efficiency.

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Samsung Demonstrates World's First 5G Data Transmission at Highway Speeds

Record-breaking 1.2Gbps data transmission at over 100km/h, and 7.5Gbps in stationary conditions using 28GHz spectrum

SEOUL, Korea – October 15, 2014 – Samsung Electronics Co., Ltd today announced the record-breaking demonstration of super-fast data transmission targeted for fifth generation (5G) mobile networks using 28 GHz spectrum. Samsung researchers confirmed the world's first data rate of 1.2 Gbps, or 150 MB per second on a vehicle cruising at over 100 km/h. This marks a significant step towards the utilization of millimeter wave frequency bands for 5G mobile networks

Figure A Achieved Data Rate in Mobile Condition (1.2Gbps)

The achievement was bolstered by another record-breaking demonstration in which Samsung achieved data transmission speed up to 7.5 Gbps, or 940 MB per second when the vehicle came to a complete stop. The peak data rate is more than thirty times faster compared to the state-of-the-art 4G LTE technology.

Back in May, 2013, Samsung revealed the world's first 28 GHz based 5G data transmission speed of 1Gbps at pedestrian speeds. Since then researches at Samsung were able to increase the maximum data rate by more than 7-fold and support mobility up to highway speeds. The continued ground breaking success underlines the company's leadership in next-generation mobile communications.

"The expectations for 5G communications will continue to grow based on the rising demands for smart devices, cloud services, smart home technology, and Internet of Things" , said ChangYeong Kim, Head of DMC R&D Center of Samsung Electronics. "We are committed to developing innovative 5G technologies and will continue to utilize our exceptional R&D capabilities as well as our diverse partnerships with leading companies and research centers around the world".

While 5G standard has yet to be ratified, 5G networks are expected to feature data rates and capacity that are hundreds times larger compared to 4G LTE.

Figure B Achieved Data Rate in Stationary Condition (7.5Gbps)

In order to achieve such high data rates, 5G networks will inevitably exploit frequencies much higher and less congested than those of which are currently used for cellular networks (typically under 3 GHz). However, difficulties such as large propagation loss at these frequency bands have prohibited the industry from utilizing these bands for cellular applications. To address these challenges, Samsung has applied 'Hybrid Adaptive Array Technology' at 28 GHz frequency bands.

In addition, Samsung has revealed its '5G Rainbow' – seven technical requirements which are pillars to ensure a truly differentiating 5G user experience. The list comprises of maximum data rate, spectral efficiency, speed of mobility, data transmission rate at the cell boundary, the number of simultaneous connections, communication delays, and cost. To meet these requirements, Samsung has been developing key technologies including transmission technologies for high frequency bands, multiple access schemes and low latency networks among others.

The company is committed to developing innovative technologies that will enable the 5G era and plans to demonstrate its capabilities at the upcoming 2018 PyeongChang and 2020 Tokyo Olympics.

Australian Government
Department of Communications and the Arts

5G—Enabling the future economy

October 2017

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Australia's 5G vision

5G is the next step in the evolution of mobile wireless communications technology, promising improved connectivity, greater network speeds and bandwidth, and very low latency. It is the fifth generation in mobile technology which, at each step, has seen significant developments in communications networks:

- 1G—The first generation of mobile phone networks were deployed in the early 1980s, providing a basic voice service using analogue transmission.
- 2G—In 1991, second generation networks were deployed, making the switch to digital standards with improved voice messaging and the introduction of the short message service (SMS).
- 3G—The third generation launched in 2001 and introduced data services in addition to voice and SMS.
- 4G—In 2009, the fourth generation protocol, Long Term Evolution (LTE), was introduced, supporting improved mobile broadband which saw increased capacity and speed for data.

New capabilities of mobile communications networks enabled by 5G technology will allow for a variety of 'use cases':

- higher quality and more video services provided to multiple users with full mobility, even at high speed
- massive scale automation delivered through widespread sensor networks and multiple connected devices
- delivery of critical communications assured by low latency and ultra-reliable networks, and
- improved productivity assisted by high quality, real time data analytics.

Unlike existing mobile communications networks, 5G networks have the potential to allow tailoring of requirements for each of these different use cases within the same network.

The Government considers that 5G is more than an incremental change for mobile communications. Instead, it provides the underlying architecture that will enable the next wave of productivity and innovation across different sectors of the Australian economy. Efficient rollout of 5G and uptake of the services it supports has the potential to produce far-reaching economic and social benefits and support growth of Australia's digital economy. This will be supported by the rollout of the National Broadband Network (NBN) allowing greater capabilities for the seamless delivery of services across high speed mobile, fixed line and fixed wireless networks.

The Government wants to create an environment that allows Australia's telecommunications industry to be at the forefront of seizing the benefits of 5G across the economy. The communications sector will lead the rollout of 5G networks in Australia. However, the Government can create the policy and regulatory environment to support a more efficient rollout, given its potential benefits to the economy.

The Government's direction will be to support the timely rollout of 5G in Australia to enable the next wave of broad-based industry productivity, and support the growth of Australia's digital economy.

This includes immediate actions by Government that enable the communications market to introduce new 5G technologies in line with international developments. These include:

- making spectrum available in a timely manner
- actively engaging in the international standardisation process
- streamlining arrangements to allow mobile carriers to deploy infrastructure more quickly, and
- reviewing existing telecommunications regulatory arrangements to ensure they are fit-for-purpose.

The Government recognises that as 5G continues to develop, other issues relating to the technology will likely emerge which may require future Government action. In particular, while there are opportunities for 5G to create economy-wide transformation, this will require a broader examination of sectoral regulatory frameworks.

To that end, the Government will work collaboratively with industry to foster an ongoing dialogue on 5G beyond the launch of this paper to identify and remove sectoral barriers to its successful and timely rollout. Through this dialogue, the Government will also look at opportunities to build on other Government activities, such as the national Digital Economy Strategy which will more broadly focus on building the productivity of sectors across the economy.

What is 5G?

The International Telecommunication Union (ITU) is the United Nations specialised agency for information and communications technologies. This body decides global spectrum allocation frameworks and harmonises international spectrum to ensure networks and connected devices can communicate seamlessly. The ITU will undertake the formal, international process to identify bands for 5G by 2020. It has developed draft technical specifications for 5G which include:[1]

- high data rates (1 Gbps for hotspots, 100 Mbps download and 50 Mbps upload for wide-area coverage)
- massive connectivity (1 million connections per square kilometre)
- ultra-low latency (1 millisecond)
- high reliability (99.999% for mission critical 'ultra-reliable' communications), and
- mobility at high speeds (up to 500 km/h i.e. high speed trains).

In working towards these specifications, 5G represents a significant leap from the capabilities of previous generations and introduces a range of new technological possibilities. The success of 5G in delivering new technologies and services will be supported by existing communications infrastructure, including the NBN. This convergence of high-speed fixed-line and mobile services will collectively produce a consistent and ubiquitous user experience.

The 5G economics case

Unlike early generations of mobile networks, 5G will represent a significant shift in the telecommunications industry's focus away from voice and more towards mobile broadband and increased industrial applications. These new use cases are expected to create benefits across a range of sectors—including transportation, health, manufacturing and agriculture—and have varying networking requirements. These use cases, as identified by the industry, can be divided into the following categories:

- enhanced Mobile Broadband
- massive Machine Type Communications, and
- critical communications.

Enhanced Mobile Broadband (eMBB)

eMBB will deliver improved capacity to a greater number of devices. This will enable higher rates and volumes of data transmission per device and improve coverage to a broader range of locations. eMBB will likely be the focus of early 5G deployments as it can immediately support the growing communications requirements for the digital economy.

An improved mobile experience for consumers

5G networks will give consumers a better mobile experience in more locations. Increased network capacity will support more users, even in crowded areas, such as large public events, and at peak times. Faster network speeds will also enable consumers to view rich content in more places, supporting the streaming of live events and high resolution media.

[1] ITU, 23 February 2017, 'Press Release: ITU agrees on key 5G performance requirements for IMT-2020'.

Massive machine type communications (mMTC)

As 5G networks mature, they will support the widespread and dense deployment of sensors and other network-connected devices by significantly reducing their power requirements and providing flexible coverage across different spectrum bands. This proliferation of the Internet of Things (IoT) across industries is expected to produce significant productivity benefits and support integration between sectors.

Supporting productivity and innovation

The term Industry 4.0 describes the next step in the advancement of the manufacturing sector (the 'fourth industrial revolution'). Industry 4.0 introduces autonomous systems supported by a combination of technologies such as IoT, artificial intelligence, continued technological improvements and digitalisation in manufacturing.

Australia stands to benefit from Industry 4.0, given our world-class manufacturing sector, which includes several high-value industries such as medical technology and aerospace. Australian manufacturers can improve their productivity and international competitiveness through Industry 4.0 processes by supporting their participation in global value chains. This is of particular benefit to SME manufacturers, opening them up to new markets and opportunities. 5G can support Industry 4.0, by providing communications infrastructure that is more accessible and flexible to suit specific industry needs.

5G can enable innovation in other sectors such as agriculture. A challenge for Australia's agricultural sector is identifying how to improve productivity while balancing environmental and commercial constraints. Precision agriculture, which focuses on improving yields and minimising economic risks, seeks to provide more control in the management of agricultural production. While precision agriculture requires a range of enablers—including data analysis, sensor networks and geographical information systems—5G can provide the supporting infrastructure for these technologies.

Critical communications

Low latency and 'ultra-reliable' communications networks will support the delivery of critical communications, i.e. to support public safety use and playing role in the technology ecosystem supporting autonomous vehicles. In addition to automation, critical communications will also help to support technological advancement in areas including robotics and artificial intelligence.

The social benefits from autonomous vehicles

5G networks are expected to play a role in the technology ecosystem supporting the development of autonomous vehicles, which will enable a number of social benefits for transportation. Traffic congestion, which is estimated to cost Australia $53 billion by 2031,[2] could be proactively reduced by smart city traffic management systems that are informed by machine-to-machine communications with autonomous vehicles.

Improved road safety is also expected to be a key outcome of autonomous vehicles, as the majority of car accidents involve human error. In the 12 months to July 2017, there were 1,235 deaths on Australian roads with road trauma costing the Australian community an estimated $27 billion annually.[3] Autonomous vehicles can have a valuable role not just in terms of financial savings, but in saving human lives.

[2] Infrastructure Australia, 2015, 'Australian Infrastructure Audit'.
[3] Bureau of Infrastructure, Transport and Regional Economics, August 2017, 'Road deaths—monthly bulletins'.

Figure 1—Outline of the relationship between the technical requirements of 5G and expected services and applications it will deliver

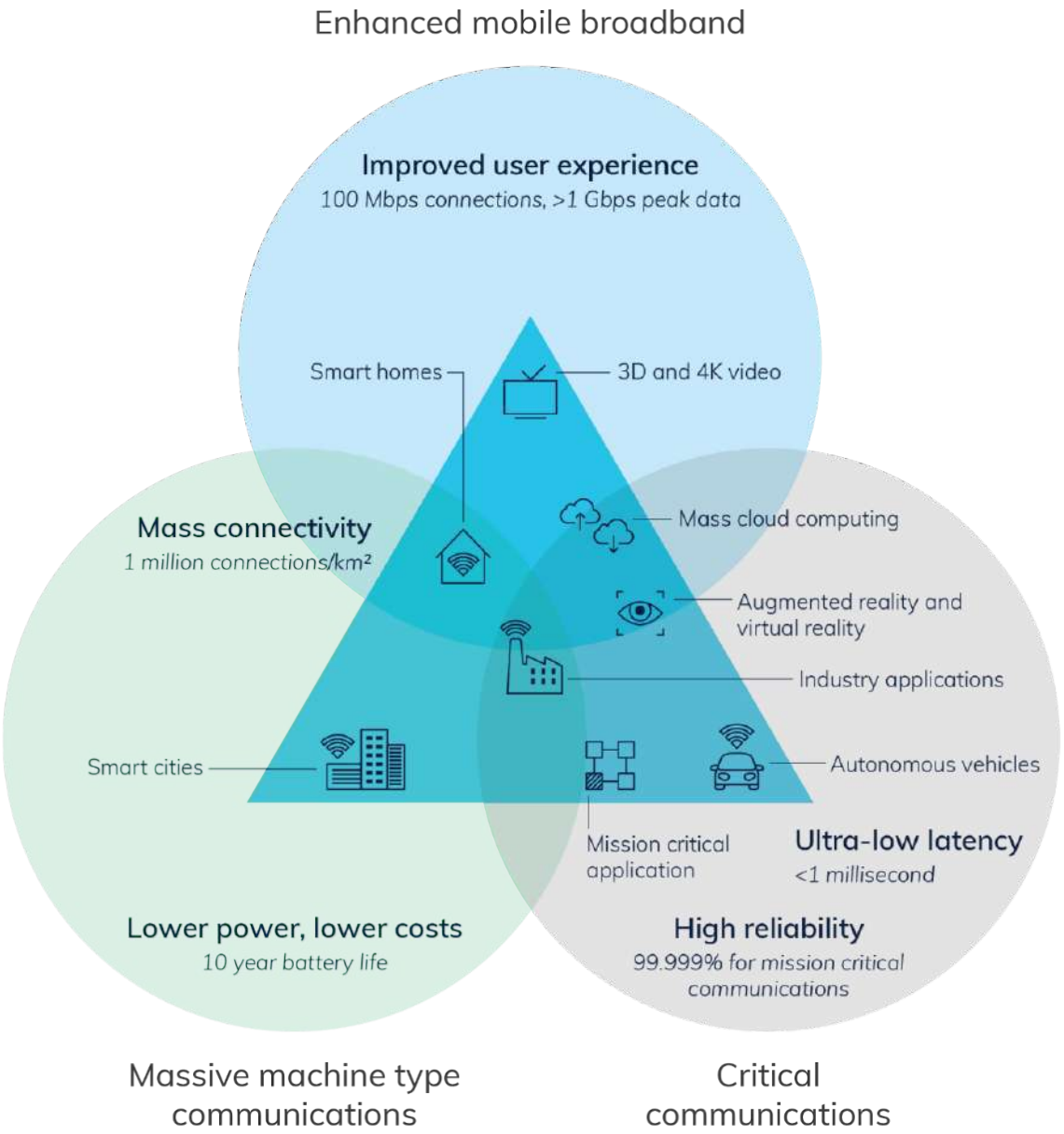

Source: Based on figure 2 from the ITU paper, '[IMT Vision—Framework and overall objectives of the future development of IMT for 2020 and beyond](#).'

What is different about 5G?

5G is expected to enable productivity outcomes across key verticals of the economy as a result of a range of characteristics, such as **network slicing** and **mesh networks**. However, it will need to overcome deployment challenges such as **spectrum acquisition** and **coverage**. This is expected to lead to new approaches for deployment to enable widespread 5G coverage in Australia. The industry will also need to develop a robust **business case** for 5G rollout, which will likely be demand driven, to support the significant capital expenditure required.

Network slicing

Network slicing allows operators to split their network into separate sub-networks (also referred to as slices), enabling them to dedicate network resources to different users and applications. Sub-networks can 'slice' the infrastructure resources from the physical network to create virtual independent networks. This is a significant development from previous mobile network generations, as it enables an operator to deliver many different capabilities by creating slices that can be tailored for the intended usage. For example, an operator could create a network slice for IoT devices, or alternatively, a network slice for higher security for a higher quality of service for government or public safety uses.

Network slicing also provides a model for infrastructure sharing between network operators. In this case, a single transmitter's network could be shared with more than one operator. Given the capital expenditure that will be associated with 5G rollout, network slicing can provide a cost effective, short-term solution for operators.

Figure 2—5G network slicing enables operators to create separate virtual networks to meet application requirements

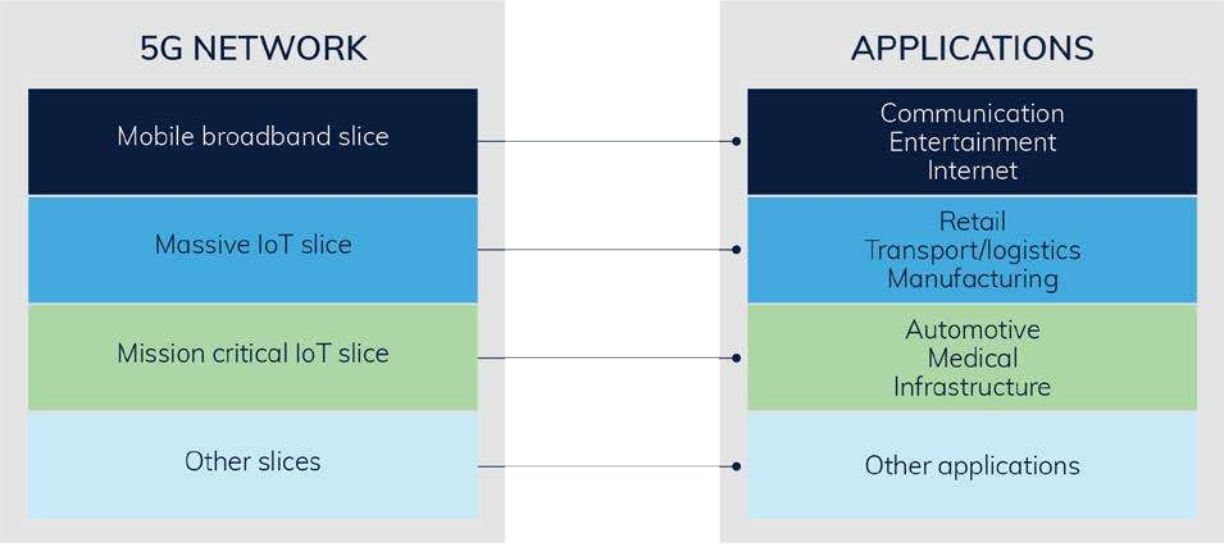

Source: Based on figure 2 from the ITU article, '[Why end-to-end network slicing will be important for 5G](#).'

Mesh networks

Mesh networks can be utilised to increase the range of coverage, where the 'mesh' is an interconnection among a network of devices. Only one device in the mesh needs to be connected to the network, which can then relay data to other nearby devices.

Mesh networks not only provide the opportunity to support 5G deployment but also have the additional benefit of providing efficient network speeds. Through dynamic routing, devices on a mesh network are able to seek the fastest and most reliable pathway to send and receive data. As such, this architecture can provide a cost effective solution for coverage in more remote areas. For example,

primary industries would benefit from this network approach by simplifying network connections and costs associated with deploying and managing an IoT sensor network. However, the application of mesh networks is still highly speculative as the industry considers how they will operate in practice and in different environments. This may contribute to the development of new business models for 5G.

Spectrum sharing

Spectrum is a critical enabler of Australia's current and future communications infrastructure. The specific spectrum bands and quantity of spectrum required for 5G are still being considered. However, 5G will likely require a mix of low, medium and high frequency spectrum to meet different scenarios relating to coverage, connectivity, and latency:

- Low frequency (less than 1GHz)—providing widespread coverage across urban, suburban and rural areas and supporting IoT for low data rate applications.
- Medium frequency (1–6GHz)—providing good coverage and high speeds, and including the expected initial 5G range of 3.3–3.8GHz which has been identified as the most likely band for launching 5G globally.
- High frequency (above 6GHz)—providing ultra-high broadband speeds for advanced mobile broadband applications, and most suitable for applications in dense traffic hotspots.

5G technologies can be expected to deliver improvements in spectral efficiency (the data rate that can be supported per unit of spectrum). However, the use of 5G networks for applications such as widespread industrial applications is likely to require significantly more amounts of contiguous spectrum to be made available.

While some of the potential bands for 5G currently have unused spectrum, other bands would need to be 'refarmed', noting that it is likely that bands currently used for 2G, 3G and 4G in Australia will transition over time to 5G. Refarming enables spectrum to be transitioned to the highest value use as required. The refarming of spectrum already held by mobile broadband operators is a commercial decision for those operators. 5G is also expected to provide the opportunity for 'soft-refarming' where 4G and 5G technologies can both be supported simultaneously, minimising the impact to legacy devices during transition periods.

Spectrum sharing, that is spectrum accessed by numerous users on a shared basis, has also been identified as an option for 5G technology. Spectrum sharing encompasses a range of different aspects of spectrum management. Spectrum can be shared by geography, time, economic priority schemes, code modulation, polarisation, directionality or power. Access to spectrum is divided between users so it can be used without interference issues.

5G opens up new opportunities for increased spectrum sharing, through mechanisms such as network slicing. 5G technology is also designed to support shared arrangements, and allows for the sharing of the same spectrum ('unlicensed Wi-Fi' spectrum) with other technologies. Operators can augment their holdings in situations where existing exclusive holdings are insufficient to meet customer needs. Spectrum sharing in the 5G context is also supported by the expected use of highly directional antenna technology which would enable operators to operate in closer proximity without interference.

Antenna technology and network topology

5G will require radically different structures of networks if it is to achieve successful deployment in Australia. As 5G will likely utilise different frequencies, new equipment will be necessary. Additionally, the higher frequency 5G spectrum can only travel a small distance and will need more cells to ensure adequate coverage. However, antennas and equipment will be smaller, making it easier to attach these cells to existing infrastructure such as street lights and buildings.

The more dense deployment of cells will also give rise to other approaches that improve the reliability of data transmission across a 5G network. Data may be divided into individual streams and transmitted through multiple antenna segments in a process called Multiple Input Multiple Output (MIMO) which allows for more information to be transmitted simultaneously. This technique is further empowered by 'beamforming' which allows base stations to direct focused beams of energy to a specific area rather than dissipate the available power of a larger area. These developments will enable more efficient transmission and increase overall throughput.

5G is also expected to assist the adoption of IoT by further reducing power consumption through extended discontinuous reception. In this scenario, IoT devices shift between active and inactive cycles, transmitting only when required. This will allow connected devices to operate for extended periods on a single charge, reducing operational costs.

5G will also increase the support for a greater density of devices that would have otherwise been limited by the capacity on 3G and 4G networks. They will also enhance IoT deployment through the use of network slicing to create virtual network configurations that are optimised for the low power and coverage requirements of IoT networks.

Business case

For Australians to experience the benefits of 5G, the communications sector will need to explore and develop new business cases to attract investment and support the rollout of 5G services. As 5G becomes an integral part of the communications ecosystem, the sector will need to be agile to respond to the needs and expectations of other sectors which will be seeking to take advantage of these next generation networks.

While residential consumers will inevitably be attracted to the enhanced mobile broadband services offered by 5G, it is the industrial applications for 5G where industry expects to see the greatest opportunity for new business models.

Compelling industrial applications are still to be developed. For example, industry sectors can be expected to seek tailored solutions for their business needs such as enhancing their local area network or enabling autonomous systems, and small businesses will look for low cost deployments of IoT.

It is therefore expected that the model for 5G will be demand driven and will require the communications industry to foster new business opportunities.

How are countries preparing for 5G?

In preparation for 5G, many countries have been taking steps to test the technology and review their spectrum arrangements.

Examples of 5G work being undertaken by other countries

The United States is clearing the 600MHz band through an incentive auction for the potential early deployment of 5G. The United States has also identified reforms to infrastructure deployment as a priority for 5G rollout. Mobile network operators are also conducting trials of low-band spectrum for use in 5G services.

The Asia-Pacific Telecommunity (APT), the regional arm of the ITU, approved a recommendation for the use of the 700MHz band for 5G, with 26 countries in the Asia-Pacific region identifying this band for this use, including Australia, Japan, South Korea and New Zealand.

Korea and Japan have stated their intention to use some or all of the 26.5 to 29.5GHz range to trial enhanced mobile broadband applications ahead of the 2018 Winter and 2020 Summer Olympics respectively. It is expected that these trials will lead to commercial availability of 5G services.

The European Communications Commission (ECC) identified the 3.4–3.8 GHz and 26GHz band (from 24.25 to 27.5GHz) bands for the deployment of 5G in Europe. All European countries are expected to select at least part of this range to launch 5G by 2020.

In the United Kingdom, the government launched its 5G strategy in March 2017. It is funding testbeds to understand the different deployment requirements and security considerations for 5G. The United Kingdom is also working to make suitable spectrum available in the high (24.25 GHz–27.5 GHz, and other bands above 30 GHz), medium (3.4–3.8 GHz) and low frequency (700 MHz) bands.

Industry 5G preparations in Australia

Australia is well positioned to harness the opportunities of 5G. Australia has an effective and competitive mobile communications market, with voice and data coverage available to more than 99 per cent of the population.[4] It is the top performer internationally in terms of having in place effective enablers—infrastructure, affordability, consumer readiness and content availability—to support mobile internet adoption.[5]

5G trials have already commenced in Australia, with each of the main carriers working with mobile equipment suppliers in testing the application and limits of the technology. These trials will continue and will inform the communications sector on how 5G can be effectively deployed for the Australian environment.

[4] Department of Communications and the Arts, accessed 1 September 2017, 'Mobile phone towers'.
[5] GSM Association, 24 June 2016, 'Global Mobile Connectivity Index'.

The Government's direction for 5G

The Government has made significant investments to improve telecommunications infrastructure in Australia, through the NBN and the Mobile Black Spot Program. The Government is also working to create a policy and regulatory environment that supports a competitive and innovative communications market.

The Government recognises that 5G will enable innovation and productivity across industry sectors and can significantly contribute to Australian's growth and future prosperity. Therefore, the Government will focus on enabling the early deployment of this new generation of mobile networks in Australia and encourage its use in delivering new services and applications.

The Government will support the timely rollout of 5G in Australia to enable the next wave of broad-based industry productivity, and support the growth of Australia's digital economy.

Industry expects and needs to lead the deployment of 5G. However, the Government has a role in supporting network rollout by modernising policy and regulatory frameworks and removing barriers that would delay rollout and adoption unnecessarily.

In the first instance, the Government will support the early deployment of 5G in Australia by:

- making spectrum available in a timely manner
- actively engaging in international spectrum harmonisation activities
- streamlining arrangements to allow mobile carriers to deploy infrastructure more quickly, and
- reviewing existing telecommunications regulatory arrangements to ensure they are fit-for-purpose.

Making spectrum available in a timely manner

A clear, efficient and flexible regulatory framework governing spectrum access will be essential to support the timely deployment of 5G networks in Australia.

The Government is currently undertaking work to modernise Australia's spectrum management framework to ensure it remains fit-for-purpose. In May 2017, it outlined its proposed reforms to the framework which are designed to simplify and streamline the processes for spectrum allocation and provide a transparent, efficient and flexible spectrum management framework. This will be the most significant change to the Australian spectrum management framework in the last 25 years.

The reforms will remove barriers between licence types, and enable flexible licensing issue and allocation processes. This strategic approach will remove outdated processes and support the Australian Communications and Media Authority (the ACMA) to more effectively respond to market demands and new technologies, such as 5G. This will help Australia remain internationally competitive with a modern, innovative economy over the coming decades.

The Government will put in place its new spectrum management framework by 2019.

In addition, the ACMA will continue to work on making spectrum available for 5G. The ACMA has been investigating the use of 1.5GHz and 3.6GHz and high frequency mmWave bands in considering additional spectrum for mobile broadband services. The ACMA has decided to prioritise refarming of the 3.6GHz band over the 1.5GHz band, citing industry submissions noting this band is likely to be a pioneer band for early 5G deployments and the need to provide greater clarity and investment certainty for incumbents and potential new band entrants alike. The ACMA is currently engaging with industry on which parts of the 3.6GHz band should be reallocated and on what terms. This approach also follows international trends which have seen the 3.6GHz band commonly used for 5G trials.

The ACMA will work to bring 3.6GHz spectrum to auction in 2018.

Actively engaging in international spectrum harmonisation activities

There is already significant work underway globally with several countries trialling 5G, but standards for this new generation technology are yet to be finalised. The formal, international process to define 5G is led by the ITU. The ITU's Working Party 5D is responsible for shaping the standard for "futuristic mobile technologies" to support International Mobile Telecommunications (IMT) for 2020 and beyond.[6] This process is known as IMT-2020.

Stakeholders such as regulatory and policy setting bodies, hardware manufacturers and governments of countries in which they are based will be seeking to influence the international dialogue. A key body is the industry-driven 3GPP which undertakes technology standardisation. Collectively, the ITU and 3GPP will drive spectrum harmonisation activities: the ITU, led by administrations, will focus on the spectrum requirements; and the 3GPP, led by industry, will concentrate on equipment and device standards.

Industry is well-placed to lead the standardisation process particularly given its role identifying the application of 5G technologies. However, there is also an important role for the Government in these processes. This is particularly the case in the harmonisation of international spectrum arrangements which will have significant impact on the availability and cost of 5G devices in Australia and can be strongly contested.

In the past, Australia and the Asia-Pacific region have been influential in contributing to standards and spectrum plans that have been adopted across the world. This ensured that Australia was able to adopt new technologies quickly and that the Australian market could take advantage of the economies of scale and have a greater choice of mobile handset equipment.

The Government will ensure strong participation by Australian in domestic and international discussions about 5G spectrum harmonisation. Our continued involvement provides the opportunity to contribute to this dialogue and secure outcomes that will benefit the adoption of 5G in Australia.

Streamlining arrangements to allow mobile carriers to deploy infrastructure more quickly

The design and deployment of mobile networks will be radically different from those of today. 5G is expected to require additional infrastructure in new forms, including smaller cells and more densely-located antennas, particularly in the use of high-band spectrum.

Carriers have specific powers and immunities relating to telecommunications infrastructure deployment and installation. These laws help carriers to rollout telecommunications infrastructure quickly in a nationally-uniform way, rather than having to follow state, territory and local government requirements. These laws have existed in their current form since 1997.

The Government has recently consulted on proposed new arrangements that take account of technology developments and changes in operating practices as well as identifying opportunities to streamline deployment processes. Under these new proposed arrangements, mobile carriers would be able to rollout new communications technologies such as 5G more efficiently.

The Government understands that some members of the community have expressed concerns about the impact on public amenity from increased telecommunications infrastructure. The Government considers that telecommunications providers should work with local communities to address concerns about their infrastructure plans and is encouraging industry to consider consultation requirements for future 5G networks.

The Government continues to work with stakeholders and will implement the first tranche of changes to carrier powers and immunities following the conclusion of the consultation process.

[6] ITU, accessed 1 September, ITU towards "IMT for 2020 and beyond."

Reviewing existing telecommunications regulatory arrangements to ensure they are fit-for-purpose

The pace of change in the communications sector is impacting on the effectiveness of the existing telecommunications regulatory framework. In response, the Government is progressively working to modernise the regulatory architecture to ensure that the regulatory and policy settings flexibly respond to the current and future needs of the communications sector.

In undertaking reform, the Government is cognisant that the communications regulatory framework will need to be sufficiently flexible to address the emergence of new technologies and business models.

5G deployment will benefit from the Government's reform efforts, including updates to the regulatory framework for telecommunications and radio spectrum and modernising the ACMA. In these cases, the Government has been revising regulation to shift it away from the traditional vertical telecommunications sectors to principles based, flexible arrangements. This will provide the versatility necessary to account for 5G developments and services.

The Government will continue to work with industry to modernise current telecommunications regulatory arrangements to ensure they encourage competition and innovation in the sector.

As with previous mobile networks, cybersecurity will be a critical consideration as 5G is deployed. Security will be even more so a challenge for 5G, as the reliability of communications will be pivotal in the technology's ability to deliver benefits, particularly in the case of critical communications.

Additionally, in providing the architecture for automation, 5G networks will trigger an ever-increasing volume of data. While the bulk of data will be machine-to-machine communications, users will want assurance that their personal information is protected. User consent will be an area of growing complexity due to the intersection between autonomous systems and the individual.

Industry has strong incentives to address cybersecurity risks in 5G's new types of network deployments and systems. However, **the Government will continue to assess cybersecurity and privacy issues as they evolve to ensure Australians have confidence in using 5G.**

Next steps

The Government recognises the opportunities presented by 5G for economy-wide transformation, creating productivity benefits in sectors such as transportation, health, manufacturing and agriculture. However, realising the benefits of 5G in sectors other than communications will need the right sectoral regulatory settings.

The Government will work to ensure that sectoral regulatory frameworks are updated to take advantage of 5G. The communications portfolio is well-placed to facilitate an ongoing strategic dialogue on 5G that will support sectors to identify and work towards unlocking the potential benefits of the technology. This dialogue would provide a starting point for greater engagement across Government and with industry and the community.

To that end, **the Government will establish a 5G working group that will bring together representatives from across Government and industry.** The working group will create a platform for this strategic dialogue with a mandate to seek out opportunities and emerging issues on 5G. This will provide better coverage across Government of the evolving policy and regulatory challenges associated with 5G.

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Energy Efficient Switched Parasitic Array Antenna for 5G Networks and IoT

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***Abstract*—This paper includes design and implementation result of an adaptive beam forming antenna for upcoming 5G and Internet of Things (IoT). Switched parasitic array antennas are low cost, small sized and compact circular array antennas that steer beam in a desired direction by variation in switching pattern of parasitic elements. The proposed antenna design has an active center element, which is surrounded by several symmetrically placed parasitic elements. The designed antenna has a gain of 8 dB and is capable of 360 degrees beam steering in steps of 60 degrees each. Simulations are validated with results of the fabricated antenna. Antenna beam is steered by controlling parasitic elements. Future application of Electronically Steerable Parasitic Array Radiator (ESPAR) antennas and switched parasitic array antennas in next generation communication networks and methods for reducing size of the antenna are also highlighted.**

***Index Terms*—Internet of Things, 5G, circular array, reconfigurable, smart antenna, adaptive beamforming, Switched-Parasitic Array**

I. Introduction

Smart antennas are capable of adaptive beam forming in accordance with the environment. Over the last three decades wireless communication has made rapid progress due to better modulation schemes and better error correction schemes. Wireless communication systems are replacing the wired ones. Antenna is an integral part of wireless devices. To meet the ever-increasing demand of higher data rate, smart antennas capable of adaptive beam forming are introduced as a potential solution to increasing data rate and improving signal-to-noise ratio (SNR) in upcoming 5G and Internet of Things (IoT) [1]. By using smart antennas Equivalent Isotropically Radiated power (EIRP) can be increased. EIRP denotes product of the transmit power (P_t) and transmit antenna gain (G_t), i.e.

$$EIRP = P_t \times G_t \tag{1}$$

From (1), it is observed that by using a smart antenna G_t increases, which in turn leads to the increase in the EIRP. The beam of an antenna can be steered by means of mechanical movement of a directional antenna or by electronic beam steering. Electronic beam steering is resilient and provides more accurate approximation of the desired signal source. Moreover electronic beam steering antenna does not involve moving parts. Therefore, there is less wear and tear on the antenna as compared to mechanical beam steering. Generally electronic beam forming is achieved by using phase shifters coupled with an array of antenna elements. The phase of an individual phase shifter is varied such that there is net constructive interference in the intended direction of the antenna beam and destructive interference in all other directions [2]. Hence, electronic beam steering is preferred over mechanical beam steering.

Electronically Steerable Parasitic Array Radiator (ESPAR) antennas use mutual coupling between antenna elements to steer the beams instead of phase shifters. Design of parastic array radiator antennas is discussed in [3], [4] in which there is a center active element surrounded by a circular array of passive elements, where each passive element is loaded with a specific reactance. ESPAR antennas are smaller in size as compared to phase array antennas because elements have to be placed at a quarter of wavelength or less distance from each other for effective mutual coupling. Hence, ESPAR antennas are cost effective and space efficient. In such antennas we have only one active element, therefore, only one feed is required. Consequently, ESPAR antennas have lower losses (due to single feed) as compared to phase array antennas [3].

Previously designed antenna Electronically Steerable Parasitic Raidator(ESPAR) antennas have all cylindrical element, including the feed element [6], [7]. In this paper we have proposed design of seven element ESPAR antenna with conical center(active element)[1]. Length of conical element is optimized using optimetrics in HFSS. Our proposed antenna has higher bandwidth as compared to previously designed ESPAR antennas. [6], [7]. In multiple-input-multiple-output (MIMO)

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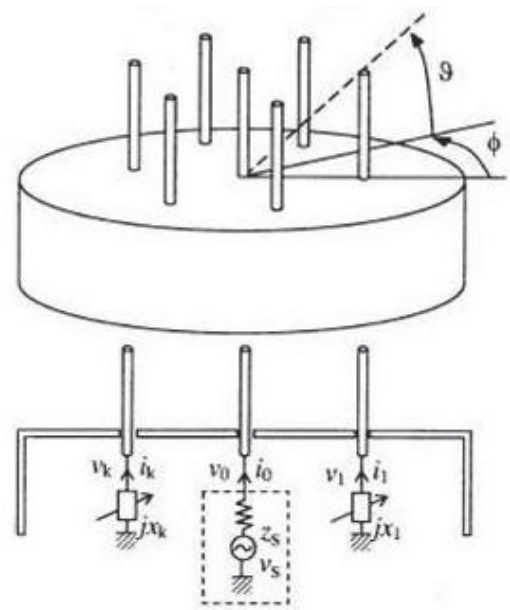

Fig. 1. Seven Element switched parasitic array antenna, ϕ is azimuth angle and θ is elevation angle.

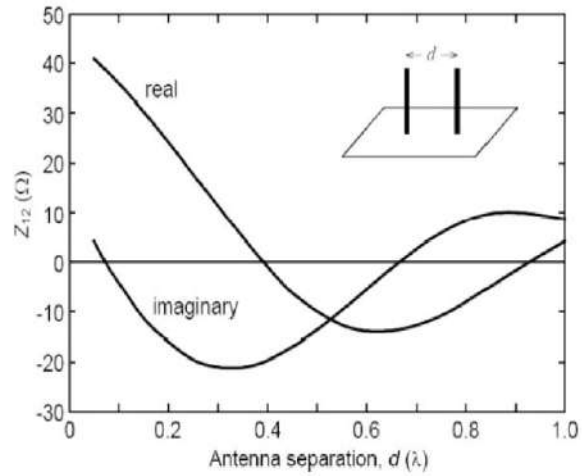

Fig. 2. Z_{21} versus separation distance.

systems there are multiple transmit and and receive antennas. Each receive antenna receives signal over different propagation channels yielding diversity gain. The MIMO technique can increase system throughput and reduce propagation losses. Similarly diversity gain can also be achieved by using smart antennas. In particular, we can transmit the same signal in multiple directions through directional beams, such that they experience different propagation channels [4]. Our proposed antenna is more suited for MIMO applications compared to previously designed model because of its higher gain and improved bandwidth efficiency.

This paper focuses on the design of a seven element switched parasitic array antenna. The antenna is first simulated and then it is fabricated. Simulation results are validated with the hardware results. Previously done work on ESPAR and switched array antennas involve cylindrical monopole elements mounted on a ground plain [8] due to cylindrical nature bandwidth of active monopole is confined, subsequently bandwidth of switched array and ESPAR antennas is limited. Instead on cylindrical monopole element we have used tapered conical monopole. Due to tapered design bandwidth is enhanced.

II. Switched Parasitic Array Antenna Concept

The conceptual overview of the switched parasitic array antenna is given in Fig. 1. We have first simulated the antenna with seven monopole elements. There is one element at center which is surrounded by a circular array. Feed is applied to the center element and it is termed as active element, whereas elements in the circular array are parasitic elements. Parasitic array antennas do not involve phase shifters, so that the manufacturing cost is less as compared to the phase array antennas. Each element is separated from other element by a quarter of wavelength, thus mutual coupling phenomena comes into account and there is a shift in phase of current in each element because of this mutual coupling phenomenon. Since switched parasitic array antennas offer adaptive beamforming solution with compact size and low cost, they are likely to be used in future communication devices to increase data-rates [6], [7]. Parasitic array antennas have vast potential for usage in laptops, cell phones, WLANs etc.

A. Mutual Coupling

Mutual Coupling is basically the interaction between antenna elements in an array. Since parasitic elements are placed closer to each other (at a distance of λ/4) there will be mutual coupling.This mutual coupling phenomenon is responsible for a shift in phase of current induced in each element [8].The current induced by one antenna element in another antenna element [9] is given by (3)

$$I_2 = \frac{Z_{21}}{Z_{22}} \times I_0 \tag{2}$$

$$Z_{21} = \left|\frac{V_2}{I_1}\right|_{I_2=0} \tag{3}$$

$$Z_{21} = \left|\frac{V_2}{I_2}\right|_{I_1=0} \tag{4}$$

Here Z_{22} is constant as it is open-circuit output impedance. Z_{21} is open-circuit transfer impedenace from port 2 to port 1 and it can be approximated by graph shown in Fig. 2. From equation (3), beam can be steered in the desired direction by varying the phase of current I_2 [10].

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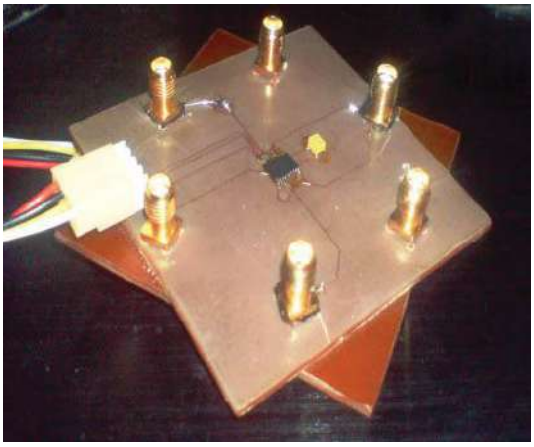

Fig. 3. RF PCB with Analog devices ADG 904 RF switches.

TABLE I
DESIGN PARAMETERS

Parameters	Values
Ground Skirt length	lambda/4
Monople Length	lambda/4
Frequency	2.45 GHz
Ground Radius	lambda/2
Monopole Radius	lambda/200
Ground Thickness	3 mm

B. Beam Steering Mechanism

In this work the designed antenna is capable of 360^0 beam steering in steps of 60^0. The beam steering is achieved by using two sets of 4:1 Analog devices multiplier switch ADG 904. Fig.3 shows RF PCB designed for beam steering. Beam is steered towards an element which is open. The open element behaves as a director and shorted elements act as reflectors. In order to achieve a maxima at 0^0, we make the element 1 open by using RF switch IC while other elements (i.e., elements 2,3,4,5 and 6) are shorted. This mechanism is similar to Yagi-Uda antenna where elements with shorter lengths in front of feed element act as directors and elements at rear of feed element acts as reflectors [11]. In Yagi-Uda antenna feed element is often a dipole or folded dipole.

III. PARASITIC ARRAY ANTENNA DESIGN

Design parameters and mechanical design of antenna is included in this section.

A. Design Parameters

Antenna design parameters are tabulated and the results are optimized using antenna simulation tools. Ground is skirted, since skirted ground provides mechanically sound model for PCB assembly to mount at back of antenna [12]. Skirt is $\lambda/4$ in length similarly each monopole element is lambda/4 in length and $\lambda/200$ is its radius.Table I shows the design parameters for the seven-element switched parasitic array antenna.

Fig. 4. Designed seven element parasitic switched array antenna.

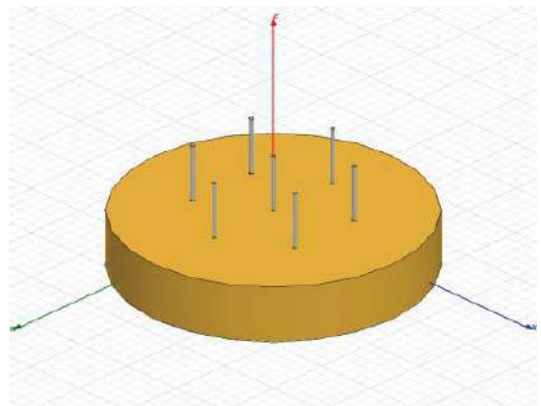

Fig. 5. Simulated antenna model.

B. Mechanical Design

Monopole elements are made by cutting copper wire of desired gauge i.e lambda/200 in radius [13] and these elements are soldered on pin of SMA connectors.Aluminum is used as ground plane. Electromagnetic waves are reflected by the ground. Instead of using seven dipole elements we have used seven monopole elements mounted on the ground plane [14]. Ground is made hollow in order to create space for mounting control circuitry [15]. Fig. 4 shows designed hardware.

IV. ANTENNA SIMULATION AND PLOTS

The antenna is first simulated and then simulated results are compared with the measured results of fabricated antenna. Simulated results were in line with the hardware results and 8 dB gain was observed in simulated results as well as in fabricated antenna. In simulation each of the parasitic element is loaded with lumped port excitation, simulating opening and shorting [16] of monopole elements. Fig. 5 shows simulated model.

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TABLE II
MAXIMA PATTERN

Azimuth Angle	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6
0 degree	Open	Short	Short	Short	Short	Short
30 degree	Open	Open	Short	Short	Short	Short

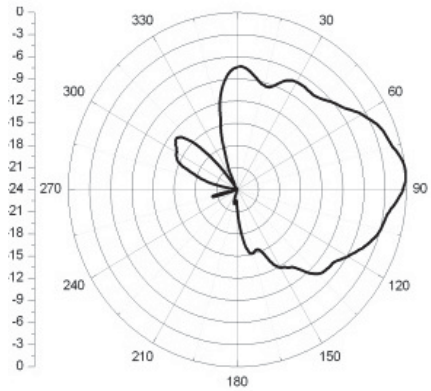

Fig. 6. Anechoic chamber results for θ=90^0 (Beam in elevated because we are using monopole elements with finite ground).

Two dimension polar plots depicts the beam steering in the direction of given elevation angle, theta (θ) and azimuth angle, phi (ϕ). Anechoic chamber results for θ=90 and ϕ=0 and 30 degrees are shown in Fig. 7 and 8 respectively. Using large ground plane angle of elevation is reduced closer to 90^0. Fig. 6 shows anechoic chamber result for θ=90 one can observe small elevation form desired x-y axis because of ground skirt [17].In simulations elevation angle of 85^0 is observed. Fig. 6(a) shows antenna simulated plot for elevation angle θ and Fig. 6(b) shows anechoic chamber results.Anechoic chamber plot of Fig. 7 shows maxima at ϕ=0^0, in order to get maxima at 0^0 elements from element number 2-6 are shorted and the element 1 is opened. Similarly Anechoic chamber plot of Fig. 8 shows maxima at ϕ=30^0, in order to get maxima at 30^0 elements from element number 3-6 are shorted and element 1 and element 2 are open.

Traditional ESPAR antenna and switched parasiric array antenna have all cylindrical elements, including the active element [3], [4]. We have made center element conical instead of cylindrical. Due to conical nature of active element response our frequency range and improved. In order to validate the gain enhancement both models were simulated and results were compared. Fig 9. (a) shows conventional design and Fig. 9(b) shows simulated antenna with conical center element. Fig. 10 shows S_{11} plot for cylindrical active element. Considering -8_{dB} as cut off point bandwidth range from 2.358 GHz to 2.51 GHz (0.152 GHz). Fig. 11 shows $S-11$ plot for centre conical element, considering 8_{dB} as cut off point bandwidth ranges from 2.36 GHz to 2.555 GHz (0.195 GHz). Therefore my making center element conical we have improved bandwidth as compared to traditional switch array

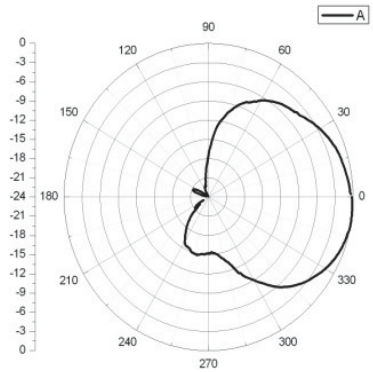

Fig. 7. Anechoic chamber results for ϕ=0^0.

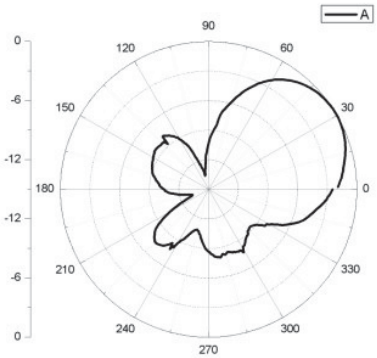

Fig. 8. Anechoic chamber results for ϕ=30^0.

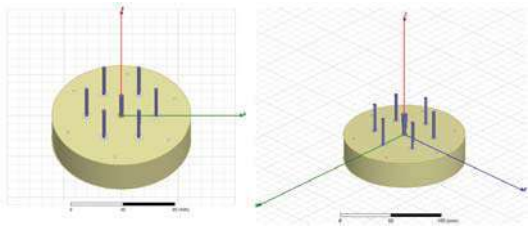

Fig. 9. (a) Conventional ESPAR antenna model with cylindrical Center Element, Fig. 9 (b) Designed ESPAR antenna with conical element for Bandwidth Enhancement.

parasitic antennas. Low profile design for switched parasitic array antennas in also highlighted in [18].

V. FUTURE WORK AND CONCLUSION

5G networks will be designed for device to device, device to human and human to human interactions. High data rates are required to meet demands of 5G systems. One of proposed bands for 5G is in mm-Waves range i.e from 30GHz to 60GHz for such high frequencies path losses are considerable and beam steering antennas are way forward to overcome path

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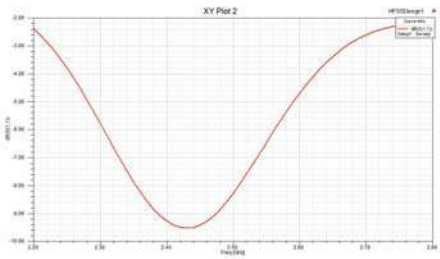

Fig. 10. S_{11} plot for conventional switched array antenna.

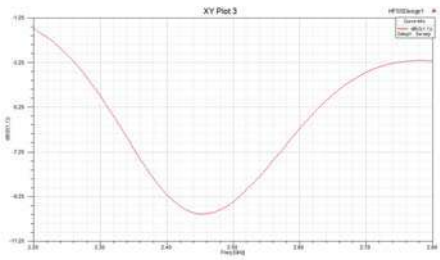

Fig. 11. S_{11} plot for center conical element switched array antenna.

losses [19]. ESPAR and switched parasitic array antennas provide a cost effective way of incorporating adaptive beamforming in future 5G and internet of Things (IoT) devices [20]. However for the efficient use of ESPAR antennas in mobile terminals the size of the antenna system must be reduced, for this further research on dielectric switched parasitic array antennas is underway. Seven element switched parasitic array antenna is designed that is capable of dynamic beam steering. Gain of 8dB is achieved practically. Simulated results are in line with the anechoic chamber results. Designed antenna increase the channel capacity by improving signal to noise ratio. Gain of 8dB was achieved in specified directions of elevation angle ,theta (θ) and azimuth angle, phi (ϕ). Antenna is optimized in terms of interference reduction for its use in wireless ad hoc networks, operating at frequency of 2.45 GHz. Bandwidth of designed antenna is 450 MHz and beam is steered in 360^0.

Acknowledgement

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Recent Antenna System Technologies for Next-generation Wireless Communications

Koichi Tsunekawa†

Abstract

This paper describes the requirements of the antennas or antenna systems in recent high-speed and high-capacity wireless communication systems and the key technologies for satisfying them. It also explains the antennas and antenna systems being researched and developed for next-generation wireless communication systems. The antenna in such a system requires high gain, high-efficiency antenna elements and a multi-antenna design. This paper introduces a high-efficiency antenna created by integrating it with a monolithic microwave integrated circuit (MMIC) in a millimeter-wave frequency-band system, a multi-antenna system for the multiple-input multiple-output (MIMO) technique that enables multiple data transmission for land mobile communication systems, and a beam-scanning antenna for satellite communication systems. It also explains the general research and development trend of antenna systems and technical problems in each wireless system as an introduction to the other selected papers in this issue.

1. Introduction

Wireless access technologies have advanced rapidly [1] and broadband wireless communication systems have become popular in our daily lives. An antenna is a very important component of a wireless system because it acts as the input and output interface for wireless equipment, as shown in **Fig. 1**. However, system performance is determined by the total performance of each component, such as the antenna and the radio-frequency (RF), intermediate-frequency (IF), and baseband (BB) units. For recent high-performance wireless systems, overall system design has been essential. Accordingly, the antenna must not

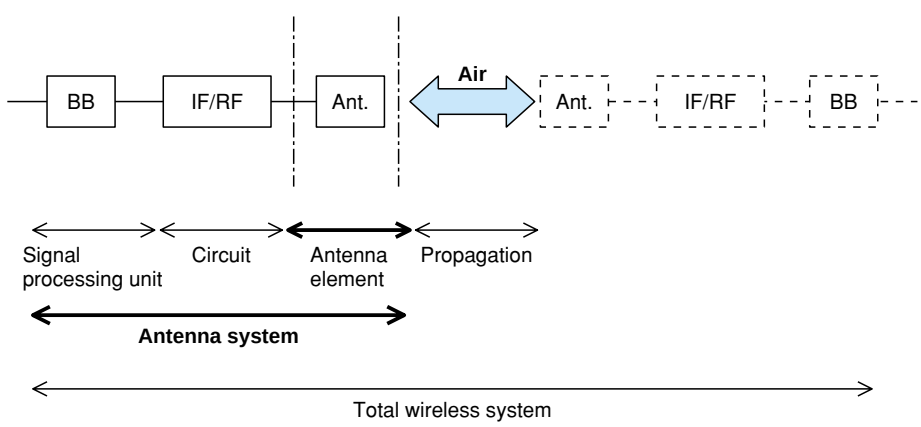

Fig. 1. Wireless and antenna system.

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only have antenna elements with high-performance characteristics, but must also perform effectively as an antenna system in conjunction with the RF, IF, and BB units. New functions can be added through antenna system design: for example, appropriate radiation pattern control provides a large system capacity by using baseband signal processing and an antenna element with an integrated RF circuit provides high gain without feeder loss.

The selected papers in this issue describe the latest antenna and antenna system technologies for achieving high performance. Two of the papers present beam-scanning antenna systems in satellite broadband communication. Beam scanning is carried out using by two methods: one [2] uses a variable active device or tunable reactance device incorporated into the antenna element, which has high-speed electronic control while the other [3] uses mechanically controlled antenna movement, which has a very precise direction control function. Another paper [4] introduces an active integrated antenna system with an RF circuit, which provides high gain and high efficiency, for a high-capacity millimeter-wave transmission system. And two papers describe a multiple-input multiple-output (MIMO) antenna system for obtaining high-speed transmission and high system capacity in the land mobile communication system from the viewpoints of beamforming techniques [5] and implementation methods [6].

As an introduction to these advanced antenna techniques, this paper provides a general explanation of the requirements of antennas and antenna systems in recent high-speed and high-capacity wireless communication systems and the key technologies for satisfying these requirements. It also describes current antenna systems and NTT's antenna research results for typical wireless systems.

2. Antenna requirements in recent wireless communication systems

The trend of wireless systems is shown in **Fig. 2**. This indicates the typical system transmission speed and number of antennas needed to achieve a particular system performance for each operating frequency. Wireless communication systems are moving towards high transmission speeds and high capacity by using higher system frequencies to enable a wide frequency

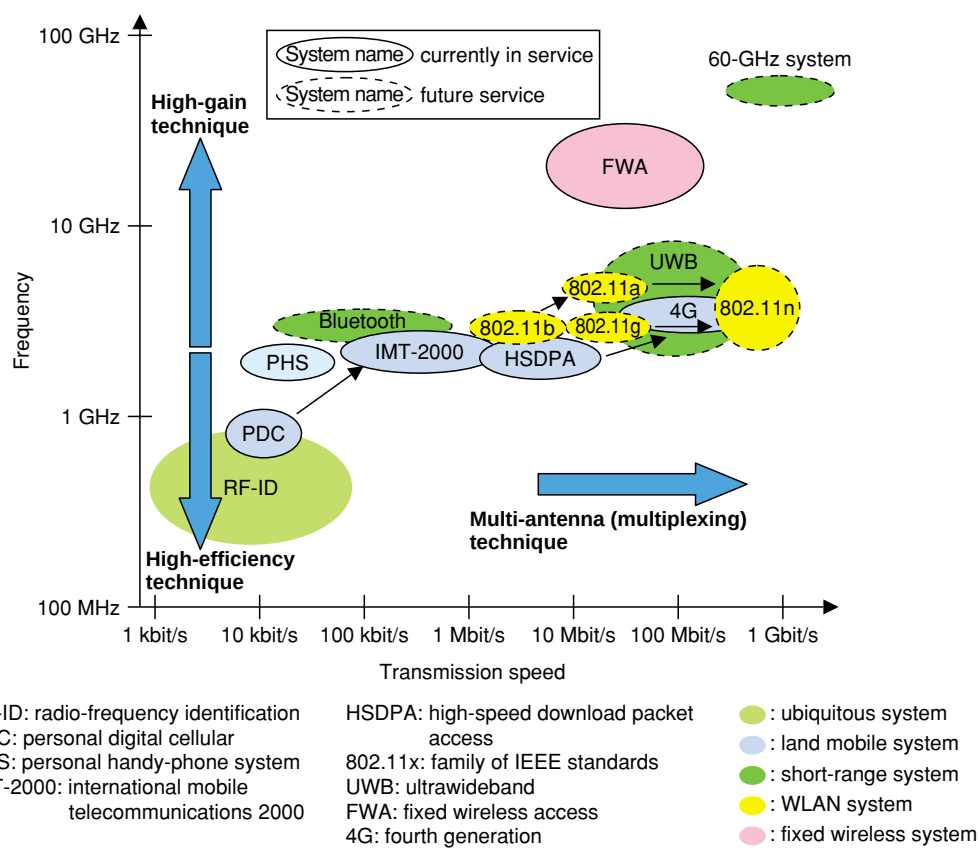

Fig. 2. Advances of terrestrial wireless communication systems and their relationship to antenna technologies.

band and using advanced system technology to achieve high quality and signal multiplexing. The antenna requirements for these system properties are:

- High-gain and high-efficiency technology
- Multi-antenna technology

Increases in the gain and efficiency of an antenna are offset by higher propagation loss at high frequencies, so the received signal level needs to be higher. High gain is an age-old problem in antenna research and development. Multi-antenna technology improves the receiving signal quality and provides multiplexed signal transmission by using an antenna system that includes RF circuits, BB units, and antenna elements.

2.1 High-gain and high-efficiency antenna

Theoretical and experimental antenna gain and efficiency characteristics are shown in **Fig. 3**. The dependences of gain and beamwidth on horn dimension L(λ) in a relatively large antenna are explained in Fig. 3(a) [7]. When L is more than 0.5 times the wavelength, the antenna's efficiency is about 100%; a larger antenna provides higher gain. However, the high-gain radiation pattern leads to a narrow beamwidth. Therefore, a mobile terminal needs to use beam-scanning or beam-tracking techniques to follow the transmitter while the terminal moves. On the other hand, the efficiency decreases if the antenna size is less than 0.5 wavelengths. The bandwidth of a linear dipole antenna versus its efficiency for various antenna sizes (D: diameter) is shown in Fig. 3(b). This graph was estimated from theoretical limits [8] and many experimental results. The antenna efficiency becomes approximately –5 dB when antenna bandwidth of 10% is provided using a linear dipole antenna with a length of 0.3 wavelengths. This figure shows that the efficiency and bandwidth have a tradeoff relationship and that the efficiency drops greatly as the antenna size decreases. Therefore, some clever ideas for the antenna element structure are needed to overcome these weak points.

2.2 Multi-antenna system

A multi-antenna system has several antenna elements, but it does not merely work as an ordinary array antenna. The performance requirements are satisfied because the antenna system includes RF circuits, BB units, and antenna elements. The antenna element technologies and the multi-antenna system are shown in **Fig. 4**. In the antenna element, a high gain can be achieved by improvements to the antenna element structure, for example, by using a new material, adding a parasitic element, or integrating an RF circuit (Figs. 4(a)–(c)). The antenna shown in Fig. 4(c) is called an integrated antenna. It can control the radiation pattern as well as provide high gain by eliminating feeder loss. In a multi-antenna system (Fig. 4(d)), the radiation pattern is controlled by baseband signal processing, so the pattern of each wireless channel can be controlled by each baseband channel. Furthermore, it is possible to get multiplexed signal transmission in the space domain by baseband signal processing. Multi-antenna systems are generally called smart antennas or active antennas [9].

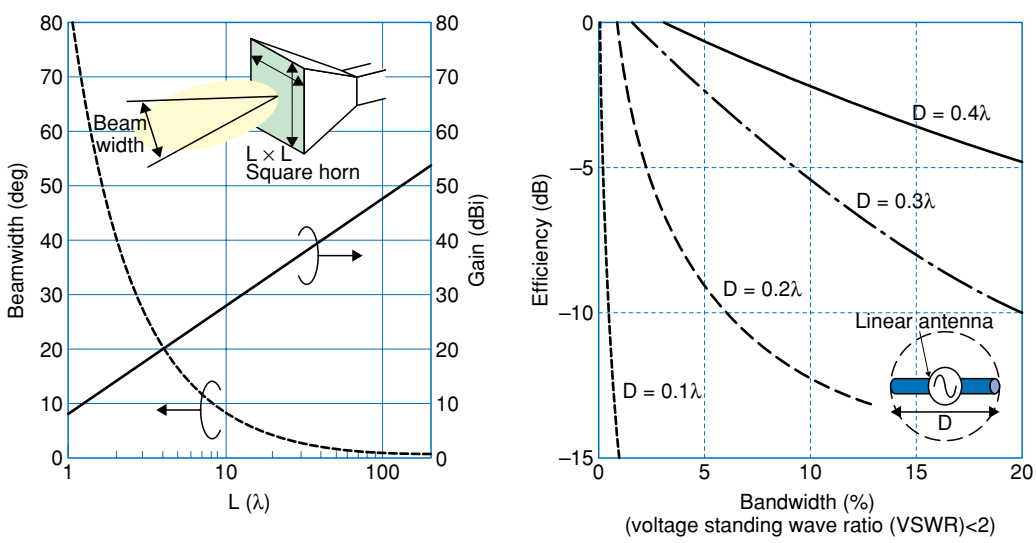

(a) Aperture antenna gain characteristics

(b) Dipole antenna efficiency characteristics

Fig. 3. Antenna gain and efficiency characteristics.

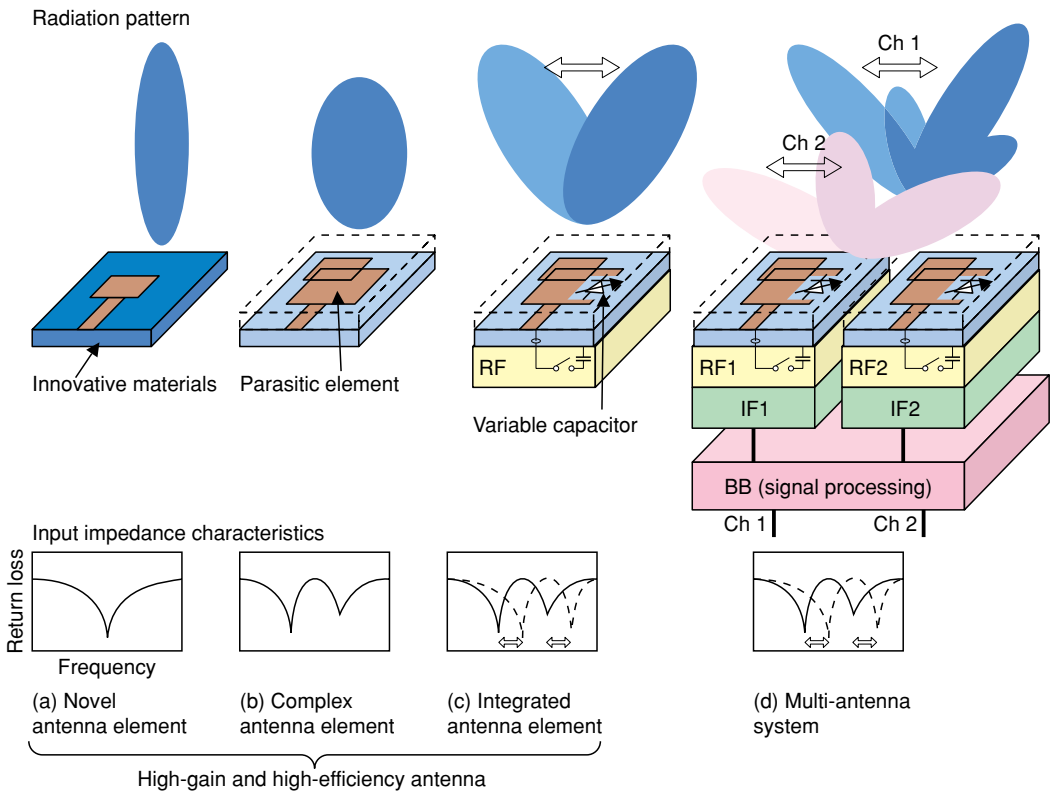

Fig. 4. Antenna elements and system.

An example of a mobile communication system using a smart antenna in the base station is shown in **Fig. 5**. Independent information can be sent to the terminals, which are spatially separated, using the same frequency at the same time because each beam is generated for a specific terminal by using the space division multiple access (SDMA) technique. Furthermore, N multiplexed transmissions can be sent to a terminal with N antennas by utilizing the slight difference in antenna locations in the terminal. MIMO is representative of this kind of technology. The latest smart antenna systems can increase the antenna gain even in a mobile system and expand the service area. The designed system capacity can be increased by using multiplexing techniques based on baseband signal processing. Multi-antenna systems can achieve very high performance with high-level functions corresponding to the wireless system requirements.

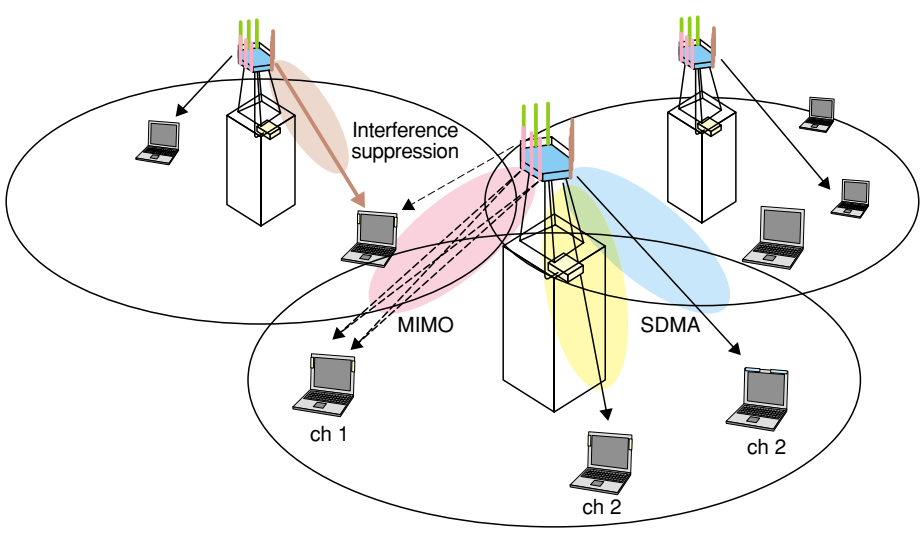

Fig. 5. Smart antenna system (land mobile telecommunication).

2.3 Key antenna technologies

The key technologies for achieving a high-gain,

high-efficiency, multi-antenna system are shown in **Table 1**. Antennas for the latest wireless communication systems are required to achieve high gain and high efficiency. The multi-antenna systems are designed to make maximum use of system resources, especially space.

3. Wireless systems and suitable antenna systems

The kinds of wireless systems that we can expect to find around us in the near future are illustrated in **Fig. 6**. RF-ID (radio-frequency identification) tags will be attached to various kinds of objects in a ubiquitous network and a large quantity of information will be gathered to provide useful knowledge to each person. High-speed data transmission ranging from a few megabits per second to 1 Gbit/s will be possible in mobile satellite systems, land mobile systems, and wireless local area network (WLAN) systems. In home networks, individual items of electronic equipment will be connected to each other at very high

Table 1. Key technologies to meet antenna requirements.

Requirements	Key technologies
1) High gain and high efficiency	a. Innovative materials (meta-material, high magnetic material, …) b. Element design (parasitic element, fractal element, …) c. Integrated antenna (antenna with RF circuit or RF device, …) d. Active antenna (antenna within variable reactance or switch, ….)
2) Multi-antenna techniques	a. Beam scanning antenna b. Sector antenna (fixed narrow multi-beam system) c. Diversity antenna d. SDMA antenna e. MIMO antenna

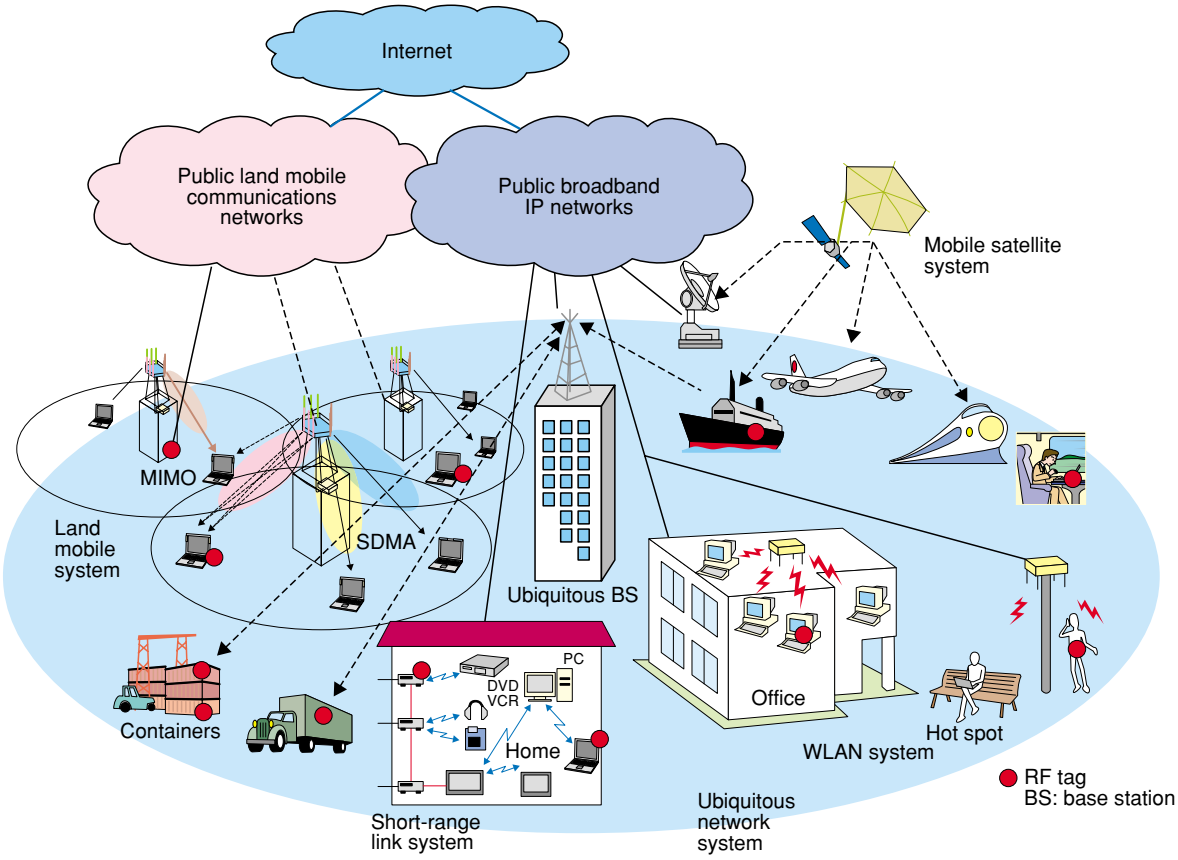

Fig. 6. Wireless communication systems.

Table 2. Wireless systems and NTT's antenna system approaches.

	System features	Main technical trends (example system, standard, or equipment)	NTT's antenna approaches (using technologies in Table 1)
Ubiquitous RF-ID	Multiple access Low rate	Active tags Sensor network Mesh network (802.15.5)	Compact high-efficiency tag antenna High-gain beam tilting base station antenna (1a, 1b, 1c)
Short-range communication	Short range Ultrahigh speed Link transmission	High frequency band (millimeter-wave system) Ultrawideband (UWB) Infrared rays (IrDA)	Active integrated antenna system (millimeter wave) (1b, 1c, 2a, 2b)
Land mobile and WLAN	Medium range High speed/capacity Many subscribers	MIMO-OFDM (802.11n,802.16a/e) MC-CDMA (4G, Beyond 3G) HSDPA (3.5G,1xEV-DO/V)	MIMO-OFDM antenna system Compact mobile terminal antenna system (1b, 1d, 2b, 2c, 2d, 2e)
Mobile satellite	Very long range Medium to high speed Various mobile stations	S/Ku band high-speed mobile comm. (N-Star/ETS-VIII) Broadband (Internet) (WINS) Millimeter wave/optical comm. (MILSTAR, GeoLITE)	Multi-beam antenna Large deployable antenna Beam-tracking antenna system (1c, 1d, 2a, 2e)

(discussed in papers in this issue)

speed (several gigabits per second) wirelessly instead of by cables. In these wireless systems, highly functional and high-performance antennas will be essential. **Table 2** explains the main features and technical trend of the systems and also shows NTT's approaches to antennas and antenna systems for each high-performance wireless system. The technologies in Table 1 that are used are indicated in parentheses. Each antenna system must satisfy severe specifications and also provide high functionality, as shown in Figs. 4(c) and (d). The antennas discussed in the selected papers in this issue are shown in blue in Table 2. The present status of each antenna system and research and development in NTT are explained below.

3.1 Ubiquitous network antenna system

Tag antenna elements have the same problems as pagers or portable telephone systems that use the LF, UHF, and VHF bands. The antenna element must be as small as possible and have high efficiency in a small volume and in the neighborhood of various objects. Most antennas for passive tags using the LF band (13 MHz) are spiral, helical, N-turn loop, or meander line antennas [10] for achieving an electromagnetic induction area and their gains are considered to be very low. Bent and spiral monopole or dipole antennas are used in personal computer card wireless communication systems or in small square film tags using UHF-band systems [11]. The approach is to design the antenna and RF-IC as one system; in other words, the connection impedance between the antenna and RF-IC is designed as a freely selectable value instead of being restricted to 50 Ω. The same kind of technique is currently being investigated in NTT in a study of active integrated antennas [12]. On the other hand, the base station antenna can be designed by applying techniques developed for pagers or land mobile antennas because it has high-gain and beam-tilting characteristics.

3.2 Millimeter-wave frequency band communication antenna system

A high-speed wireless communication system is achieved by using wideband technology, so millimeter-wave frequencies, which provide a very wide bandwidth, are attracting attention. The use of high frequencies also requires high output power to compensate for the huge propagation loss and passive circuit losses, so high-gain and high-efficiency antennas are very important in system design [13]. Millimeter-wave systems mainly use horn, reflector [14], or lens antennas [15]. Horn or reflector antennas are used in relatively long-range communication where the range is several hundred meters. A lens type antenna, which is integrated with monolithic microwave integrated circuits (MMICs) to achieve high efficiency without a feeding line, is mainly used for short-range transmission, e.g., for a home link system. Active integrated antenna technology in which an amplifier for transmitting and receiving is mounted without using a connector or cables is suitable for a high-frequency-band system [16]. Typical antenna types for millimeter-wave frequency systems are shown in **Table 3**. Horn or reflector antennas provide very high gain but cannot be integrated with MMICs. The lens antenna provides high gain and can be made into an integrated antenna but requires adjustment to correct its

Table 3. Antenna types for millimeter-wave systems.

Antenna	Gain	Integration with MMIC	Mounting adjustment
Horn or reflector	Very high (over 20 dBi)	No	(Feeder)
Lens	High (10 to 20 dBi)	Yes	Needed
Single patch	Low (2 dBi)	Yes	No
Parasitic element patch	High (10 dBi)	Yes	No

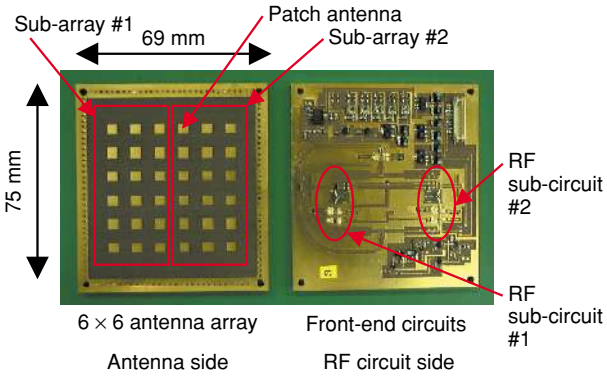

Fig. 7. Active integrated antenna for 25-GHz system.

mounting error. The patch antenna is a good element for integration with MMICs because it can be made on the same material substrates, so it does not need antenna adjustment. We have developed an active integrated antenna designed for broadband mobile wireless access systems using the 25-GHz band, as shown in **Fig. 7** [12]. It exhibited output power of 14.6 dBm and a noise figure of less than 5 dB. The only weakness of this integrated antenna is that high gains cannot be provided with one patch antenna. The third selected paper in this issue describes a high-gain integrated active antenna and high-efficiency RF circuit for the millimeter-wave frequency band for a millimeter-wave communication system [4]. A high-gain integrated patch antenna is investigated as a parasitic element to obtain a wide antenna aperture. The millimeter-wave frequency-band link system was first proposed for application to the transmission of uncompressed HDTV (high-definition television) signals in the home or in a studio.

3.3 Land mobile and WLAN antenna systems

The number of subscribers to land mobile systems, especially cellular systems, has increased rapidly, and users are now demanding high-speed transmission for broadband Internet access. To meets these demands, many improvements to the land mobile system have been proposed such as wideband code division multiple access (W-CDMA), adaptive modulation, and *ad hoc* transmission. Recently, the utilization of space has become as desirable as frequency and time utilization [17]. Space utilization is achieved using a multi-antenna system with a radiation control mechanism, which is accomplished by a smart antenna system.

3.3.1 Typical multi-antenna techniques for mobile systems

The application areas of multi-antenna techniques depend qualitatively on the system characteristics, as shown in **Fig. 8**. A fixed high-gain beam antenna does not always need antenna elements, but the other techniques are achieved through various combinations of antenna elements, so they are provided by adaptive or integrated multi-antenna systems, as shown in Figs. 4(c) and (d). A narrow-beam or high-gain antenna is used in the line-of-sight situation (where there are no obstacles between the transmitting and receiving antennas and there are few paths in the multipath transmission), so a beam-scanning mechanism is needed when a terminal moves fast, and multiple beams or sector beams are required when there are many terminals in the service area. The diversity antenna technique can provide a stable signal level in a multipath mobile environment. Beam scanning (with a sector beam or multiple beams) and diversity antenna techniques have been used fairly extensively from the early days of mobile communication service because they use only simple signal processing. However, with the rapid progress of signal processing technology, a desired signal can now be distinguished from a mixture of many signals in a multipath environment. The SDMA technique distributes signals among the terminals communicating in the service area. MIMO techniques enable very-high-data-rate communication with multiplexed transmission in each antenna of the multi-antenna system of the base station or mobile terminal. These techniques require more calculation as the movement speed of the mobile terminal increases. In these wireless systems, signal processing ability and superior algorithms are more important than the performance of antenna elements.

3.3.2 Research results and developed antenna systems

A very small and thin planar six-sector antenna using a patch Yagi-Uda array with common directors for mobile terminals has been proposed (**Fig. 9**) [18],

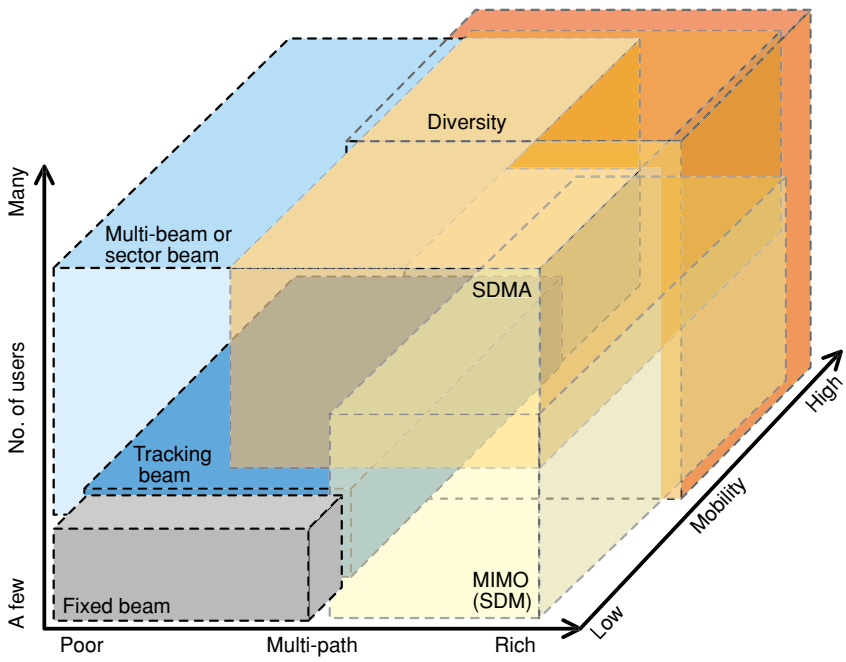

Fig. 8. Dependence of multi-antenna techniques on system characteristics.

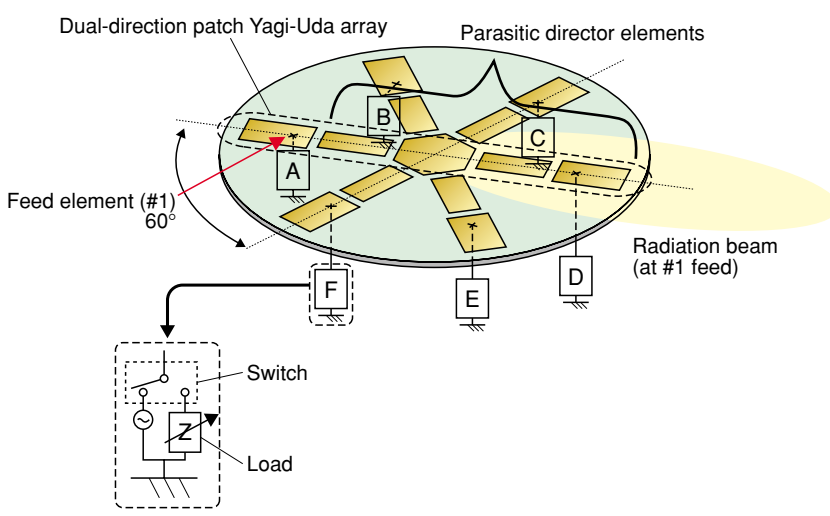

Fig. 9. Thin and small sector beam antenna.

[19]. It has square parasitic director elements that are shared by two sector arrays that face in opposite directions, and it has a hexagonal central director element that is shared by all six sectors. These elements form three line arrays, which intersect at 60°. These shared elements enable the sector antenna to be compact. Experimental results showed that the fabricated antenna had a conical plane beam width of 63° and high front-back ratio of 17 dB. The creation of adaptive (smart) antenna hardware has been investigated [20]. A novel beam combination method for wideband digital indoor communication systems such as WLANs has been proposed [21] in NTT. Crossed fan beams are used at the base station and mobile terminal. The beam combination method provides better transmission quality than the traditional pencil-beam combination and eliminates the need for complex beam control in the base station. Maximum dispersion distributions in the transmission frequency bandwidth have been calculated using a three-dimensional indoor propagation delay simulation algorithm. A method of designing adaptive antennas including an

antenna configuration that is suitable for street microcells, considering the propagation environment, has been described. An automatic calibration method at the transmitters and receivers using the transmitting signal (ACT), which enables realtime calibration, has been presented [22]. An SDMA technique using polarization has also been studied [23]. The transmission quality of an SDMA scheme that uses vertical pattern and polarization control was investigated in an actual cellular environment. For a sector cell system, this configuration was shown to be effective based on an evaluation of the spatial correlation characteristics. We also found that the output carrier-to-interference-plus-noise power ratio (CINR) of the proposed configuration was from 10 to 17 dB higher than that of the conventional SDMA configuration when the number of users was greater than four. The proposed configuration can reduce the antenna size compared with conventional SDMA. Moreover, MIMO techniques enable very-high-data-rate transmission using a limited frequency band. We have studied technologies based on the eigenmode-space division multiplexing (E-SDM) [24] scheme because it provides the theoretically maximum channel capacity and reduces the terminal's calculation load. The selected papers in this issue introduce both theoretical and practical technologies. The fourth paper describes new MIMO methods with beamforming to overcome problems of calculation complexity and low MIMO effect in the line-of-sight scenario [5]. The fifth paper describes the configuration of an 8 × 4 MIMO-OFDM transceiver and presents experimental results for the propagation characteristics, bit error rate (BER), and frequency utilization [6].

3.4 Satellite broadband communication system

If we want to create a seamless and flexible wireless network system, then a satellite communication system is very important because it provides a wide service area. However, it has the inherent problem that the distance between the transmitter and receiver is long, so the terminal needs a larger antenna than ones in the land mobile system to provide high-speed transmission. The effective solution is to make the satellite dish larger to provide high gain and multibeam transmission. We have studied multibeam communication satellite technology and onboard large deployable antennas for creating a broadband mobile satellite communication system [25]. An MMIC-based beamforming network equipment for a multibeam feeder whose weight is only 1/3 that of the conventional type was developed. We are also developing a large, highly precise deployable antenna with a diameter in the over-10-m range. The mobile terminal acting as an earth station is also an important component of a broadband mobile satellite communication system. Typical existing antennas in earth stations are shown in **Table 4**. Various mobile terminals are accommodated in the satellite communication system by different transmission rates, and these terminals use various antenna methods and locations. A comparatively large terminal antenna is required to handle high data transmission rates in a satellite system to mitigate the huge propagation loss. The high gain and narrow beam of a large antenna make a beam-scanning mechanism necessary to enable the antenna to follow the satellite direction as the terminal moves. The sixth selected paper describes a highly accurate and cost-effective auto-tracking antenna system for earth stations onboard vessels, using a novel inclinometer that is highly accurate in acceleration disturbance environments and a new systematic stabilization controller design process based on H_∞ control [3].

Table 4. Typical antennas in earth stations.

Satellite category	Typical satellite system	Current typical earth station antenna (size or length, gain)
LEO	Iridium Globalstar	Helical (0.1 m, 2 dBi) Linear whip (0.1 m, 0 dBi) Patch (0.1 m^2, 3 dBi)
MEO GEO	ICO N-STAR INMARSAT	Parabola (0.6 – 0.9 m, 18 – 21 dBi) Phased patch array (0.5 m^2, 14 dBi) Helical (0.3 m, 2 dBi) Patch array (0.3 m^2, 12 dBi) Patch (0.1 m^2, 3 dBi)

LEO: low earth orbit
MEO: medium earth orbit
GEO: geostationary earth orbit

4. Conclusion

This paper gave an overview of the requirements of antennas and antenna systems in recent high-speed and high-capacity wireless communication systems and the key technologies for satisfying these requirements to create next-generation wireless communications. It also described current antenna systems and NTT's antenna research results for typical wireless systems.

Antennas for next-generation wireless communications require high gain, high efficiency, and a multi-antenna design. A high-gain antenna can be made

using a relatively large antenna aperture, but a beam-scanning mechanism is needed for mobile communications. A high-efficiency antenna can be made using an active integrated antenna, which integrates an MMIC with the antenna element. Multi-antenna technology is the innovative technology that enables multiple data transmission in space. In MIMO-type multi-antenna systems, the most important key technologies are the beamforming algorithm and the implementation method. The solution technologies for NTT's advanced antenna systems are explained in detail in the following selected papers in this issue. The technological background and the current research and development situation are also described to make the papers easy to understand.

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The Roles of 5G Mobile Broadband in the Development of IoT, Big Data, Cloud and SDN

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Abstract

The fast technology development of 5G mobile broadband (5G), Internet of Things (IoT), Big Data Analytics (Big Data), Cloud Computing (Cloud) and Software Defined Networks (SDN) has made those technologies one after another and created strong interdependence among one another. For example, IoT applications that generate small data with large volume and fast velocity will need 5G with characteristics of high data rate and low latency to transmit such data faster and cheaper. On the other hand, those data also need Cloud to process and to store and furthermore, SDN to provide scalable network infrastructure to transport this large volume of data in an optimal way. This article explores the technical relationships among the development of IoT, Big Data, Cloud, and SDN in the coming 5G era and illustrates several ongoing programs and applications at National Chiao Tung University that are based on the converging of those technologies.

Keywords

5G, Internet of Things (IoT), Software Defined Networks (SDN), Big Data Analytics, Cloud Computing

1. Introduction

The roles of SDN, Cloud, IoT, and Big Data in 5G Networks have raised great interest recently [1]. According to the IEEE Computer Society (IEEE CS 2022 Report [2]), Cloud Computing (Cloud), Big Data Analytics (Big Data), Internet of Things (IoT), and Software Defined Networks (SDN) are among 4 of 20+ emerging technologies as illustrated in **Table 1**. In the meantime, based on the report in IEEE Communications Society (IEEE ComSoc Technology News [3]), among top 10 trends in 2015 as listed in **Table 2**, 5G, Virtualization (SDN & NFV), everywhere connectivity for IoT & IoE, and Big Data are also included. Combining both reports, we can identify 5G, Cloud, IoT/IoE, Big Data, and SDN as the five most worthwhile ICTs (information & communica-

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Table 1. IEEE computer society 2022 report.

Technology & Indexing Terms		
1. Security Cross-Cutting Issues	9. Multicore	17. 3D Printing
2. Open Intellectual Property Movement	10. Photonics	18. Big Data and Analytics
3. Sustainability	11. Networking and Interconnectivity	19. Machine Learning and Intelligent Systems
4. Massively Online Open Courses	12. Software Defined Networks	20. Life Sciences
5. Quantum Computing	13. High Performance Computing	21. Computational Biology and Bioinformatics
6. Device and Nanotechnology	14. Cloud Computing	22. Robotics
7. 3D Integrated Circuits	15. Internet of Things	
8. Universal Memory	16. Natural User Interfaces	

Table 2. IEEE communications society top 10 trends 2015.

1)	5G
2)	FIBER EVERYWHERE
3)	VIRTUALIZATION, SDN & NFV
4)	EVERYWHERE CONNECTIVITY FOR IoT & IoE
5)	BIG DATA, COGNITIVE NETWORKS
6)	CYBERSECURITY
7)	GREEN COMMUNICATIONS
8)	SMARTER SMARTPHONES, CONNECTED SENSORS
9)	NETWORK NEUTRALITY, INTERNET GOVERNANCE
10)	MOLECULAR COMMUNICATIONS

tions technologies) to watch out up to 2020 in term of their potential, convergence and applications. **Figure 1** depicts the overlapping of these five major ICT trends. It also illustrates how the infrastructure deployment of 5G mobile broadband and the architectural integration of Cloud Computing strongly impact the development of IoT, Big Data, and SDN. This paper explores the technical relationships of these five areas and discusses several ongoing programs and applications currently under development at NCTU based on these technologies.

2. The Roles of 5G, IoT, Big Data, Cloud, and SDN till 2020

Although so far the 5G mobile broadband requirements and standard specifications are not ready yet, 5G technology research & development are already started and some 5G features or subsystems are readily available. By Year 2020 the commercial 5G will be available and IoT applications will be deployed everywhere with mobile broadband technology. Moreover, the Big Data generated by IoT applications will become a norm and Cloud will be largely utilized to compute, store and virtualize network functions (NFV). Also, the underlying network infrastructure will adopt SDN to reduce both capital expense (CAPEX) and operational expense (OPEX). **Figure 2** further illustrates the roles of 5G, IoT, Big Data, Cloud and SDN and their relationships. This figure is modified based on the reference [4] by inserting 5G mobile broadband in the center.

3. Technical Relationships among IoT, Big Data, Cloud, & SDN in 5G Era

Based on **Figure 2**, we develop **Figure 3** to better explain the technical relationships among IoT, Big Data, Cloud, and SDN in the 5G mobile broadband services (5G MBS) [5]. First, IoT is capable of generating Big Data with four Vs: volume, velocity, variety and veracity. Then, Cloud is brought in for Big Data storage and processing. Finally, SDN is employed to provide more efficient and flexible networks for inter-Cloud data transport. Out of Big Data, Cloud, and SDN, advanced technologies such as machine learning analytics, Cloud

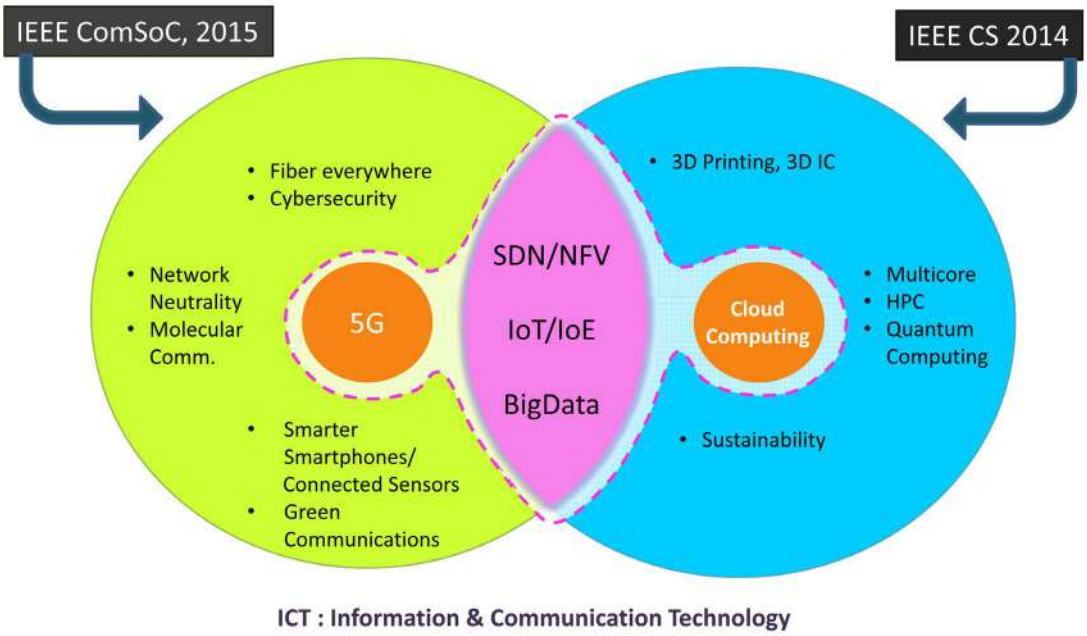

Figure 1. ICT major trends for 2015-2020.

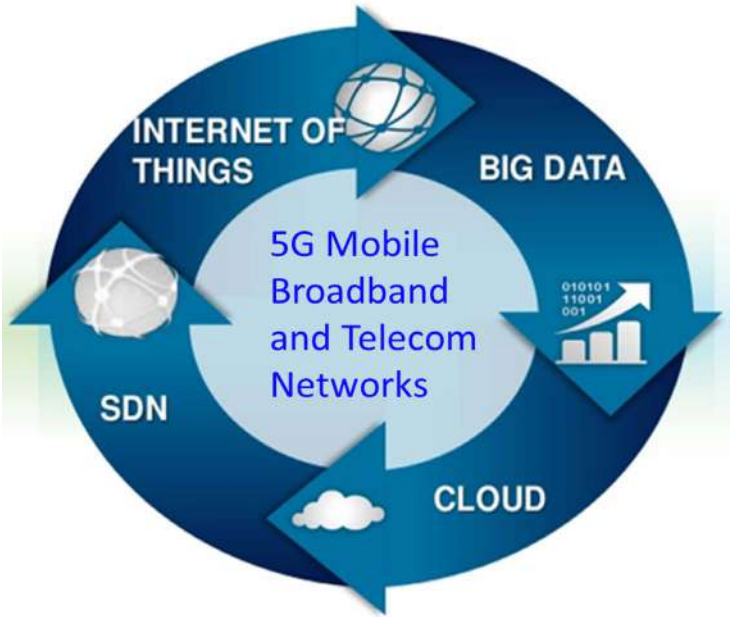

Figure 2. Relationship among 5G, IoT, Big Data, Cloud and SDN based on [4].

RAN and softwarized 5G then are developed.

As illustrated in **Figure 4**, 5G will serve as a better gateway and transport network for IoT applications so that IoT data can be delivered more efficiently and economically. In addition, IoT will become one of the major sources of Big Data by producing large volume, fast velocity, and many varieties of data [6] as illustrated in **Figure 5**.

Finally, **Figure 6** shows that Cloud can be adopted in the 5G Radio Access Network (RAN) and turns it to a Cloud-based RAN (C-RAN). Both SDN and NFV have been applied to data center in the cloud to enable better load balance and resource allocation of the cloud. SDN has also been applied to 5G mobile broadband core networks to enable smart routing, better traffic management and improve network resource utilization.

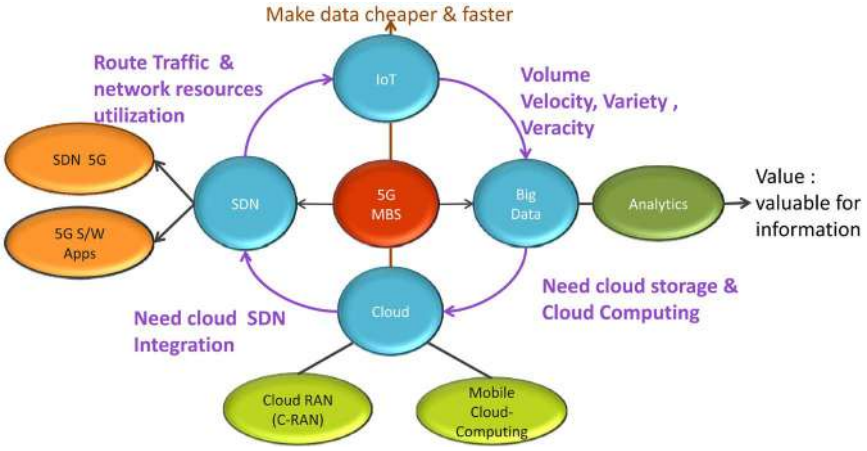

Figure 3. Technical relationships among 5G & IoT, Big Data, Cloud, and SDN.

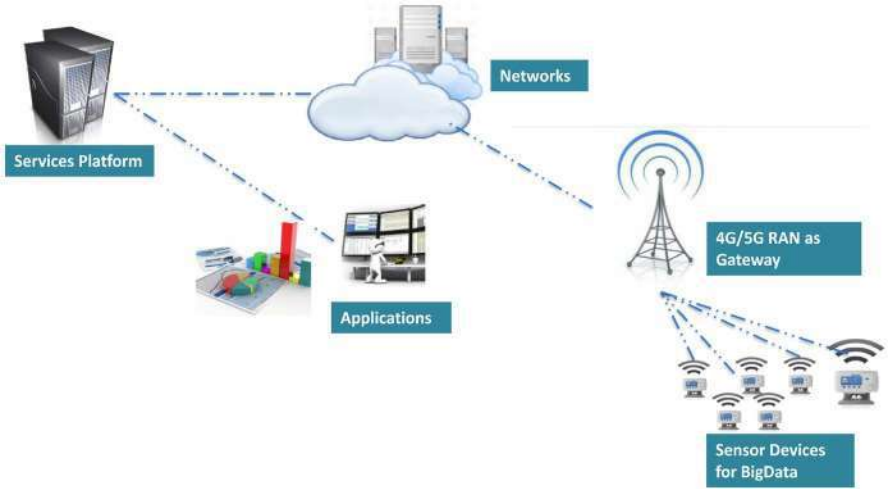

Figure 4. 4G/5G as the gateway for IoT applications.

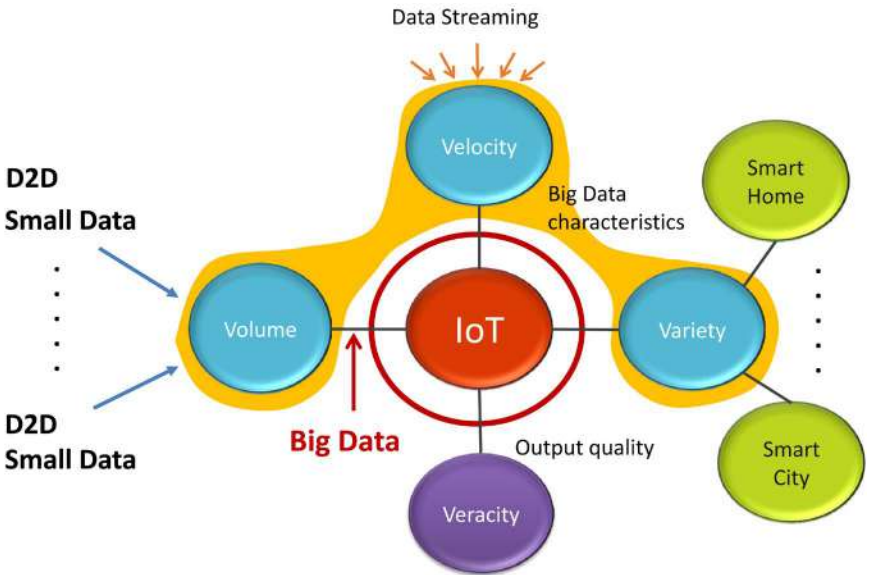

Figure 5. Relationships between IoT and Big Data.

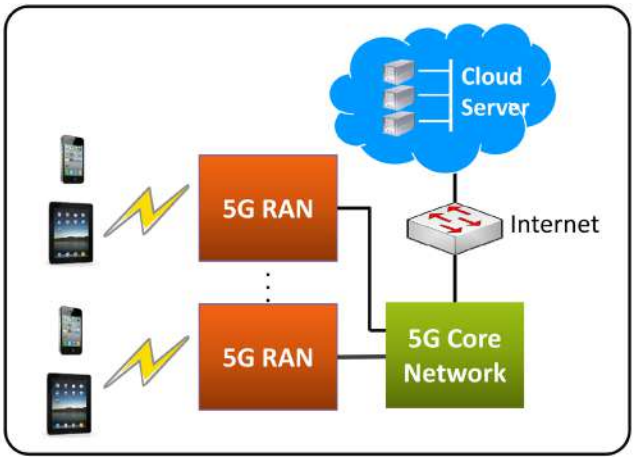

Figure 6. C-RAN architecture in 5G mobile network.

4. Ongoing Programs and Applications at National Chiao Tung University (NCTU)

In this section, we describe five ongoing programs and applications at NCTU that are closely related to the SDN, Cloud, Big Data, IoT, and 5G technologies [7]-[17].

4.1. Program on SDN-Enabled Cloud-Based Broadband and Wireless Network Technologies and Services

This program is a national program to support the SDN Industry-Academia Cooperation, led by both NCTU and CHT (Chunghwa Telecom, the largest mobile & telecom operator in Taiwan) with 5 other networking and communications companies in Taiwan. This is a multi-year program with the target to set up a testbed for end-to-end testing and to help establish an ecosystem for local SDN industry.

Figure 7 shows the scope of this program that covers mobile access, WiFi access, broadband core and data center cloud end-to-end application systems.

Figure 8 further shows both the structure of the program and its network configuration across NCTU, CHT and another university National Tsing Hwa University (NTHU).The program includes research and development involving 4G/LTE, B4G/5G, SDN, Cloud, SDN for Wi-Fi, and SDN for WAN technologies. There are five sub-programs: 1) SDN broadband network technologies and services, 2) SDN mobile/wireless network technologies and services, 3) SDN and cloud integration services and management, 4) SDN switch-related devices and systems and 5) SDN system integration and field trials.

The program is intended to construct an SDN network in NCTU, CHT and NTHU, respectively. These SDN networks then will be interconnected to form a wide area SDN network in Taiwan. Eventually, we plan to have this end-to-end system connected to the global network. The SDN switches deployed in this testbed will be mostly small or medium scale due to their experimental nature. Also included in this testbed are SDN-based Wi-Fi access points. Cloud-based data centers will be deployed in each location of NCTU, CHT and NTHU. Three types of SDN controllers including OpenDaylight, Ryu and Floodlight are currently under trial in the experimental network. Our architecture assumes the scenario of multiple SDN controllers with a hierarchical topology on which useful SDN APPs such as load balancer, network optimizer for video delivery, network coordinator (including visualization), dynamic flow configuration, end-to-end service configuration, dynamic policy-based traffic engineering, and multitenant network automation can be developed and deployed.

4.2. Program on Big Data Analytics for Network Traffic and Management Data

In this program, we address the network performance issues with two experimental networks: BML at NCTU campus and ITRINET of ITRI.

The architecture of the BML experimental network is illustrated in the lower part of **Figure 9** that consists of a 4G RAN, a 4G Core and a Cloud environment. For the 4G RAN, both indoor and outdoor environment are taken into consideration. The left upper part of **Figure 9** shows the scope of the ITRINET experimental network

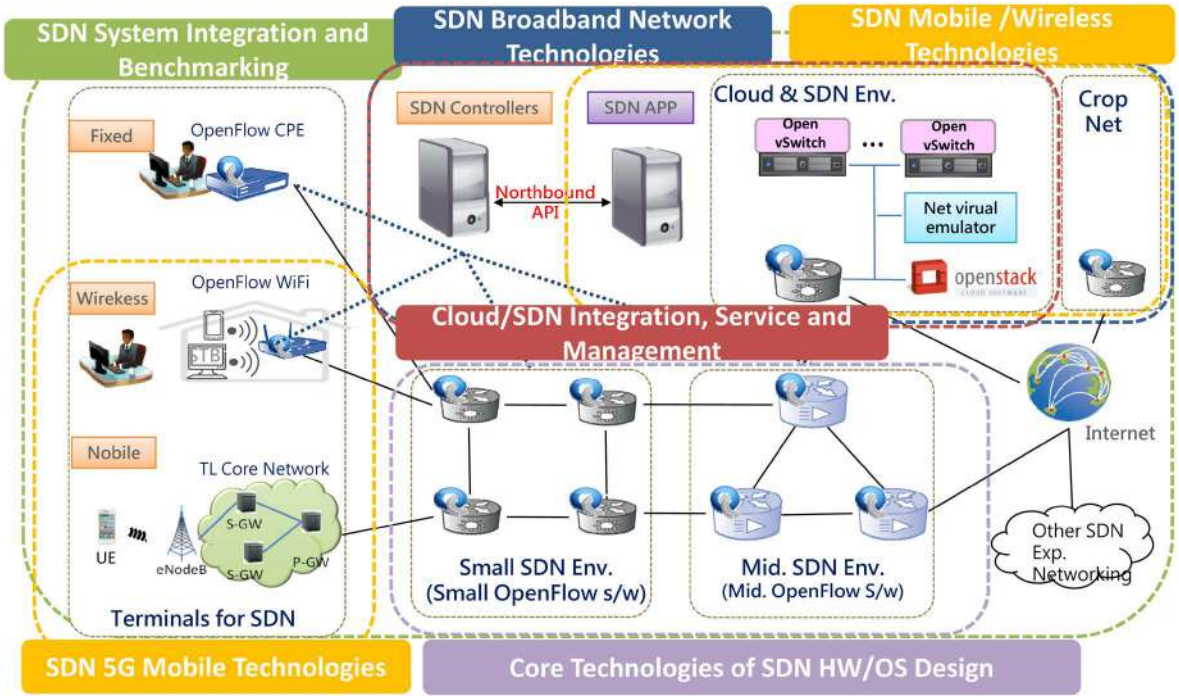

Figure 7. Applications of SDN & cloud in 4G/LTE & 5G wireless networks.

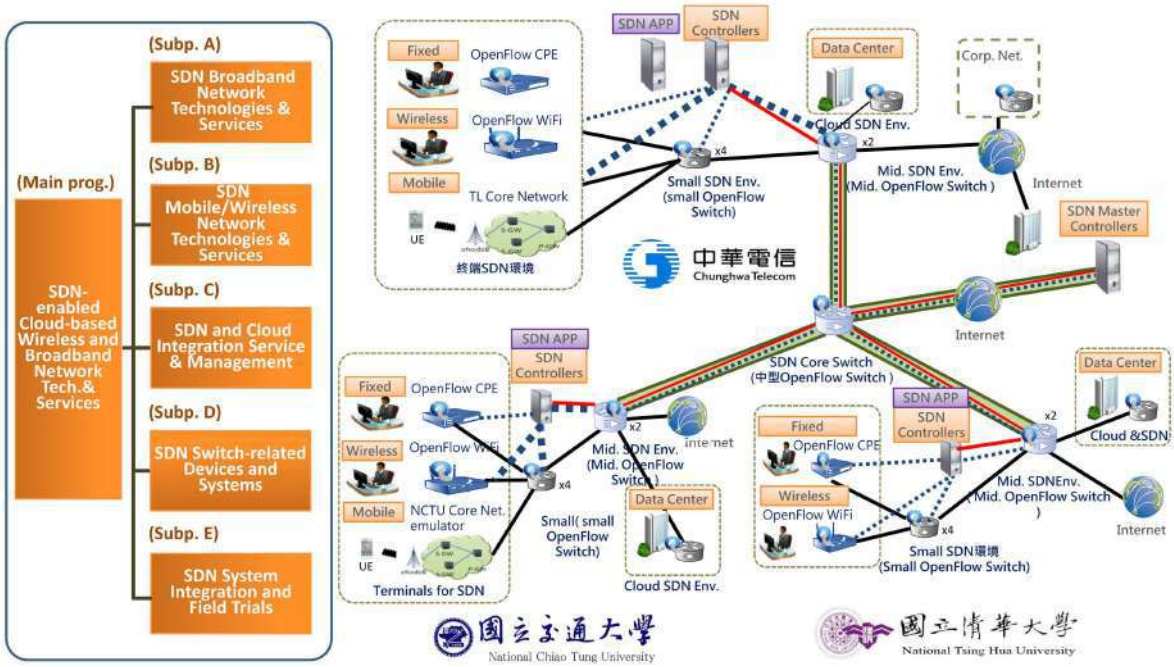

Figure 8. SDN technical R&D center and projects at NCTU.

that covers a much greater area of Hsinchu County than NCTU and includes additionally ITRI (Industrial Technologies Research Institute), HSIP (Hsinchu Science Industrial Park) and THR (Taiwan High-speed Rail, Hsinchu station). The right upper part of **Figure 9** illustrates how ITRINET covers various R&D buildings in the corporate campus of ITRI such as B11, B12, B51, etc.

Figure 10 illustrates how Big Data analytics based on InfoSphere or Spark is performed on ITRINET for the purpose of network optimization. First, network traffic measurement and network management data are collected.

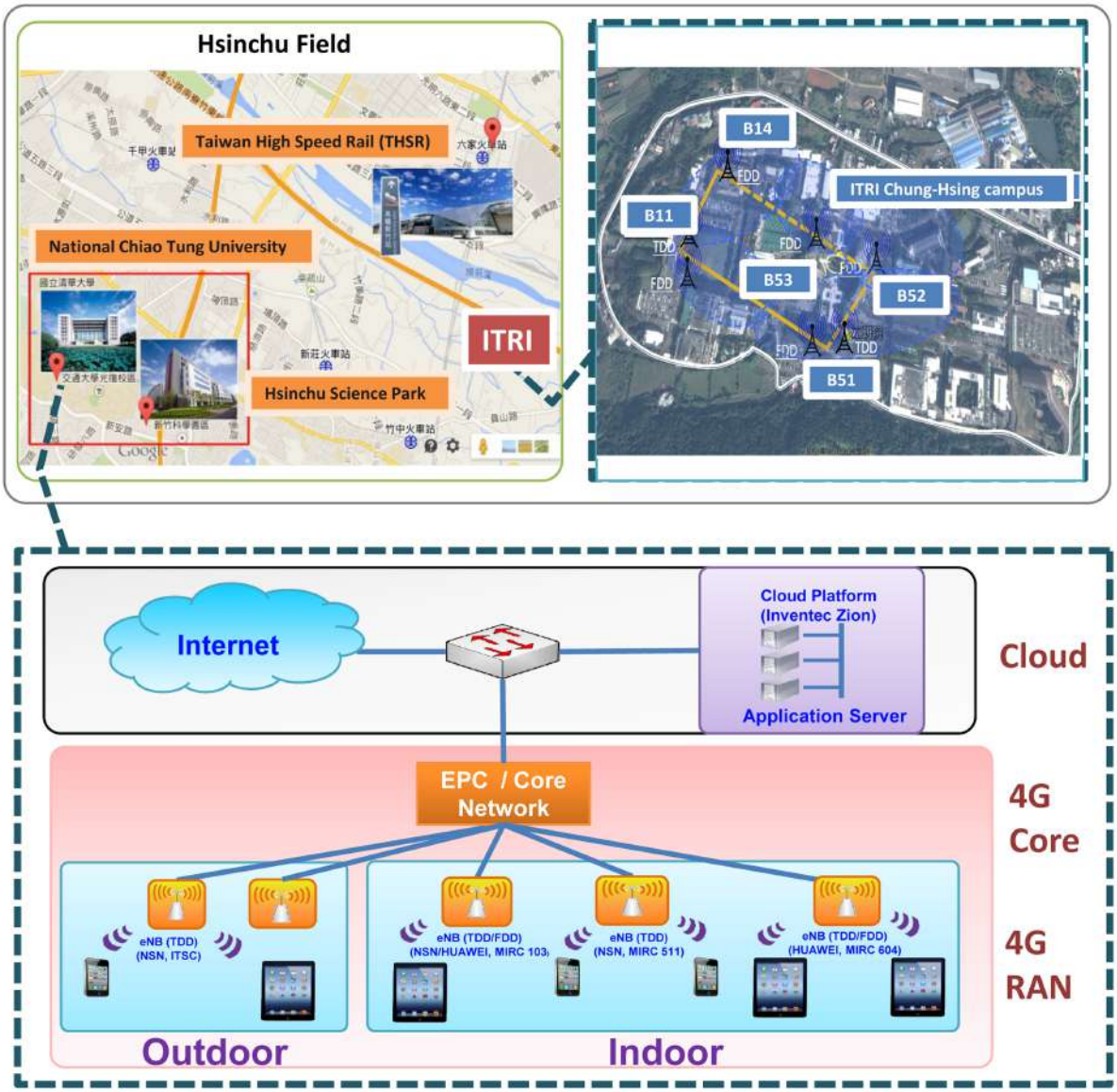

Figure 9. Greater Hsinchu 4G/LTE & Future 5G experimental network ITRINET (include ITRI, NCTU, THR & HSIP).

Then, data analytics methods based on machine learning, data mining and statistical modeling are applied to analyze the collected data. Finally, we apply the results thus generated to network performance evaluation and optimization by providing a feedback loop for system re-configuration. The whole operational cycle includes the technologies of 4G/LTE, B4G/5G, Big Data Analytics, Cloud, and Traffic Engineering.

4.3. Application on IoT Platform Integrated with Data Generation and Data Analytics

This is an application where we set up an IoT platform integrated with data generator and data analytics capabilities as illustrated in **Figure 11**. A common challenge for IoT/M2M service providers is how to test their large scale IoT/M2M applications with the near realistic data that the system will handle in a production environment. As such tests may involve not only a large number but also a large variety of sensors, deploying a testing environment that contains all the necessary sensors turns out to be an infeasible, if not impossible job. To tackle this problem, we develop a data generation method (illustrated in the lower part of **Figure 11**) based on streams generation capabilities of IBM InfoSphere and Spark to emulate data from a large number and a large variety of sensors. Such generated data will be sent into and processed by the applications residing on the IoT/M2M

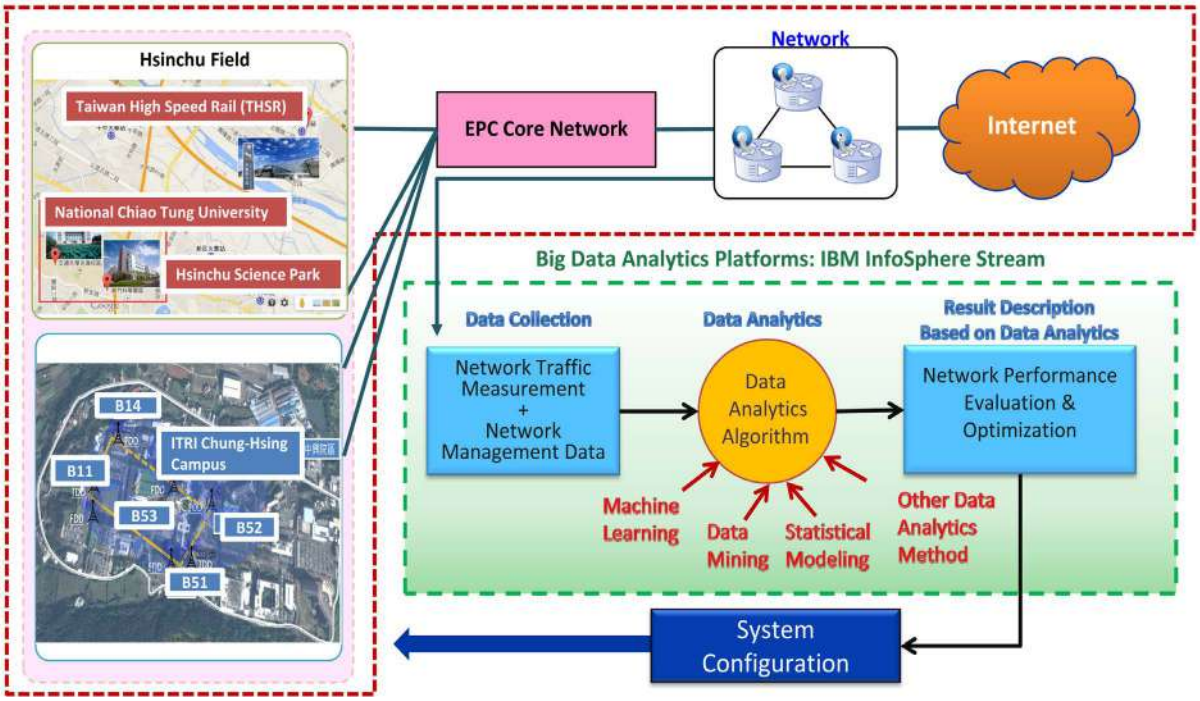

Figure 10. Big Data analytics for Traffic engineering of ITRINET.

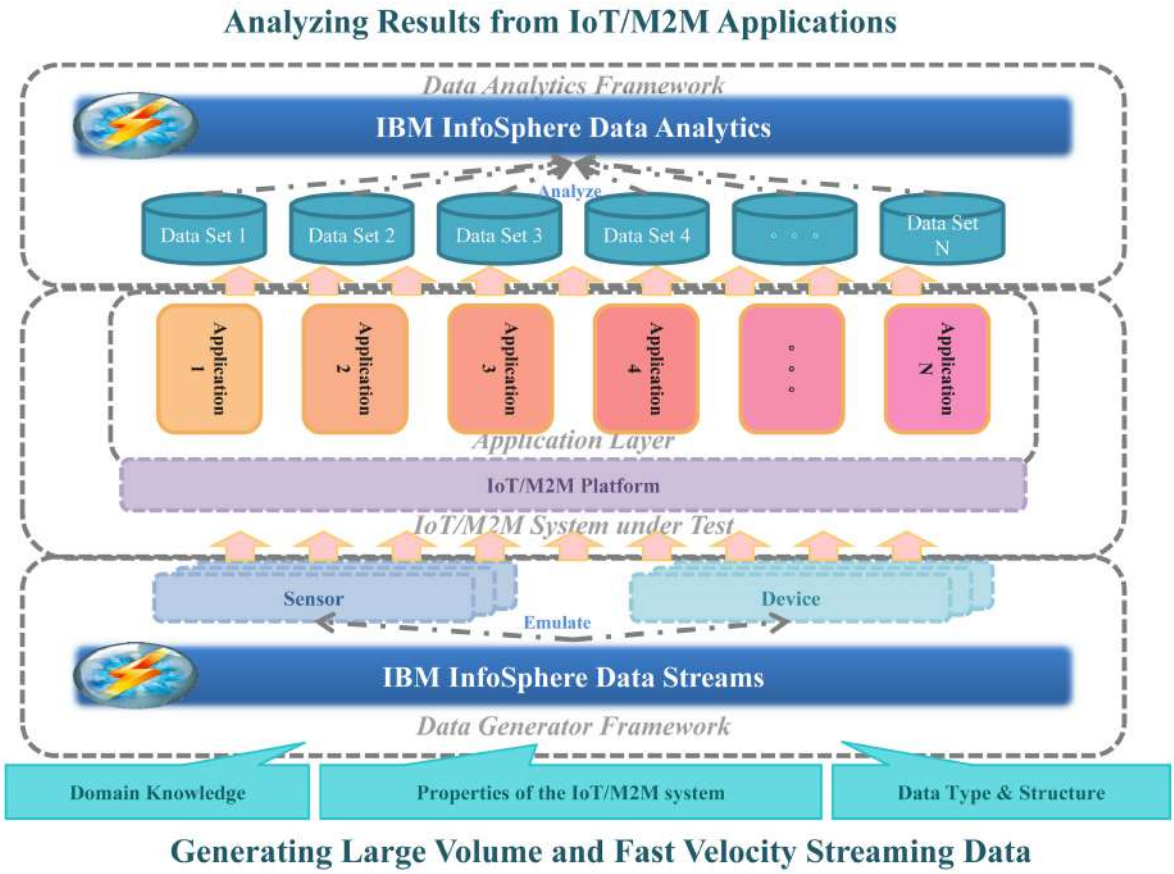

Figure 11. IoT platform integrated with data generation and data analytics.

platform (illustrated in the middle part of **Figure 11**). Finally, the data sets produced by the IoT/M2M applications are analyzed by data analytics engines in IBM InfoSphere and Spark (illustrated in the upper part of **Figure 11**).

The effectiveness of our data generation methodology is first verified in a people management system of a large factory environment. With our methodology, we are able to test our factory management IoT/M2M application more efficiently without actually deploying a large number and a large variety of sensors. This application development uses both IoT and Big Data Analytics.

4.4. Application on Data Analytics for Traffic Generated by Testing & Measurement

The automatic Testing & Measurement (T&M) of DUT (Device under Test, including 4G/LTE SD, UE/CPE) for 4-Stage (namely, conformance, interoperability, operator-IOT and field trials) testing is shown in **Figure 12**.

We apply the data analytics learning techniques for the classification of the DUT types by series numbers or id. Once the type is identified, the parameters for feature extraction can be measured by the testing and measurement equipment. An example for DUT classification is shown in **Table 3**. In this example, the DUT type relational table is a 4 × 4 table with 4 fields: 1) DUT Device Type, 2) UE capability Information (FGI), 3) DNS (TTL), and 4) HTTP (User Agent). This device relational table is created by applying multivariate statistical analytics on the network traffic flow and LTE UE connection related information. Then by extracting specific features, we are able to identify the types of DUT such as Dongle, Smartphone, CPE, etc.

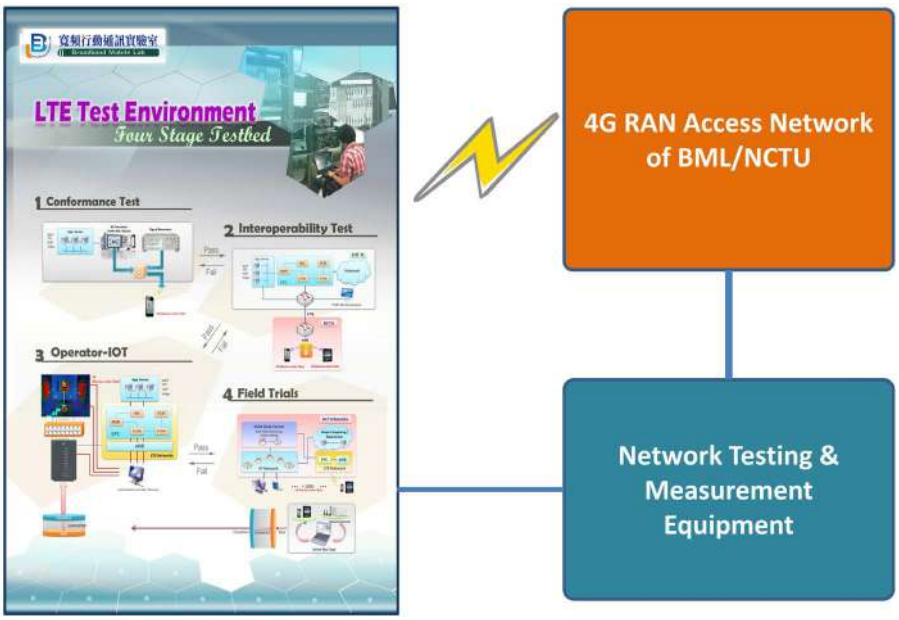

Figure 12. Data generation by endpoints from testing & measurement.

Table 3. DUT relational table.

DUT Device Type	UE FGI	DNS-TTL	HTTP-User Agent
Dongle A	0100 0110 0000 0101 0001 1000 0000 0000	128	Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/43.0.2357.134 Safari/537.36\r\n
Dongle B	0101 1111 0000 1111 1111 1100 1000 0000	63	Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/43.0.2357.134 Safari/537.36\r\n
Smart Phone	0101 1110 0000 1101 1101 1000 1000 0000	43	iPhone6,2/8.3 (12F70)\r\n
CPE	0101 1111 0000 1111 1111 1100 1000 0000	127	Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/43.0.2357.134 Safari/537.36\r\n

Another example of applying data analytics in T&M traffic is to evaluate LTE QoS. When evaluating LTE QoS, it is required to setup testing scenarios with different QoS levels. Traffic Flow Template (TFT) (as shown in **Table 4**) is designed to filter packets into correspondent bearers, either a default bearer or dedicated bearer, in LTE network. Each bearer has its own QoS level. We can establish a dedicated bearer of guarantee bit rate (GBR) for applications such as VoIP, or a default bearer of basic QoS level for applications like file transfer.

What TFT does is to filter packets into correspondent bearers according to packets' IP address, port number, protocol, direction. The information, however, is insufficient to differentiate among web file download, FB news browsing, and Line chat. We are unable to give different QoS levels to these applications. To tackle this problem, we propose a new architecture which integrates deep packet inspection (DPI) with TFT to provide a higher granularity of QoS levels for applications. When some traffic flow has been identified as a certain application type, TFT will be informed to update rules of packet filters. With this improved method, the traffic flow can be delivered through the bearer of suitable QoS level.

4.5. Applications on Data Analytics for Traffic Flow Created by APP's of SD

To fulfill the Quality of Service (QoS) requirements from users, it is important to make effective use of the network resource. We can optimize the performance of a network by applying data analytics to traffic engineering. In particular, it is important to classify mobile applications traffic intended by the user with data analytics.

We propose a HMM-based (Hidden Markov Model) model to classify the mobile applications. By surveying related work, we have realized that there are different handshake patterns of well-known application protocols. Also, according to the observation of some specific mobile applications, we discover that every mobile Internet service has its unique negotiation process at the beginning when service starts. HMM was widely used to recognize time-dependent sequences and find out unknown patterns of data, such as speech recognition, handwriting recognition.

Table 4. Traffic Flow Template (TFT): Use to specify the packet filters associated.

UL Packet Filter ID	DRB	Packet Filter Evaluation Precedence	Protocol Number (IPv4)/ Next Header (IPv6)	Remote Address and Subnet Mask	Single Local Port (UE)	Local Port Range (UE)	Single Remote Port Range (NW)	Remote Port Range (NW)	IPSec SPI Range	Type of Service (IPv4)/ Traffic Class (IPv6) and Mask	Flow Label (IPv6)
1	DRB2	6	6 (TCP)	IPv4: 172.168.8.0 [255.255.255.0] IPv6: 2001:0ba0::[ffff:ffff::]	60051	-	-	-	-	-	-
2	DRB2	2	17 (UDP)	-	-	-	60201	-	-	-	-
3	DRB3	7	6 (TCP)	IPv4: 172.168.8.0 [255.255.255.0] IPv6: 2001:0ba0::[ffff:ffff::]	-	60100:60200	-	-	-	-	-
4	DRB3	3	17 (UDP)	-	-	-	-	60300: 60400	-	-	-
5	DRB3	5	50 IPSec (ESP)	-	-	-	-	-	0x0F80F0000	-	-
6	DRB3	1	-	-	-	-	-	-	-	00101000, Mask = 11111100	-
7	DRB3	6	-	-	-	-	-	-	-	-	-
8	DRB1 (default bearer)	255	6 (TCP)	-	-	-	-	-	-	-	-

In our method, we extract the packet size sequence and packet transmission direction sequence of the first 20 packets to train the HMM model. **Figure 13** shows our designed model structure of HMM. X_n is the hidden variable. It represents the transmission states which cannot be observed directly. Because of the unknown transmission states, we need to use observation variable O_n^1 and O_n^2 as training features to build the mobile application models. Here, "*n*" is the sequence number of packets in a traffic flow. O_n^1 is the observation symbol of packets transmission direction. O_n^2 is the observation of packet size that quantizes to a certain range of packet size. We quantize smallest packet size to number 1 and largest packet size to number 8. The rest of packet sizes are then divided into six groups.

Figure 14 shows the main process of our classification system. First, we process the collected packets by reading from original PCAP files, and extract the necessary field of packet header, including source IP, destination IP, source port number, destination port number, packet timestamp, and packet size. Second, we use packet

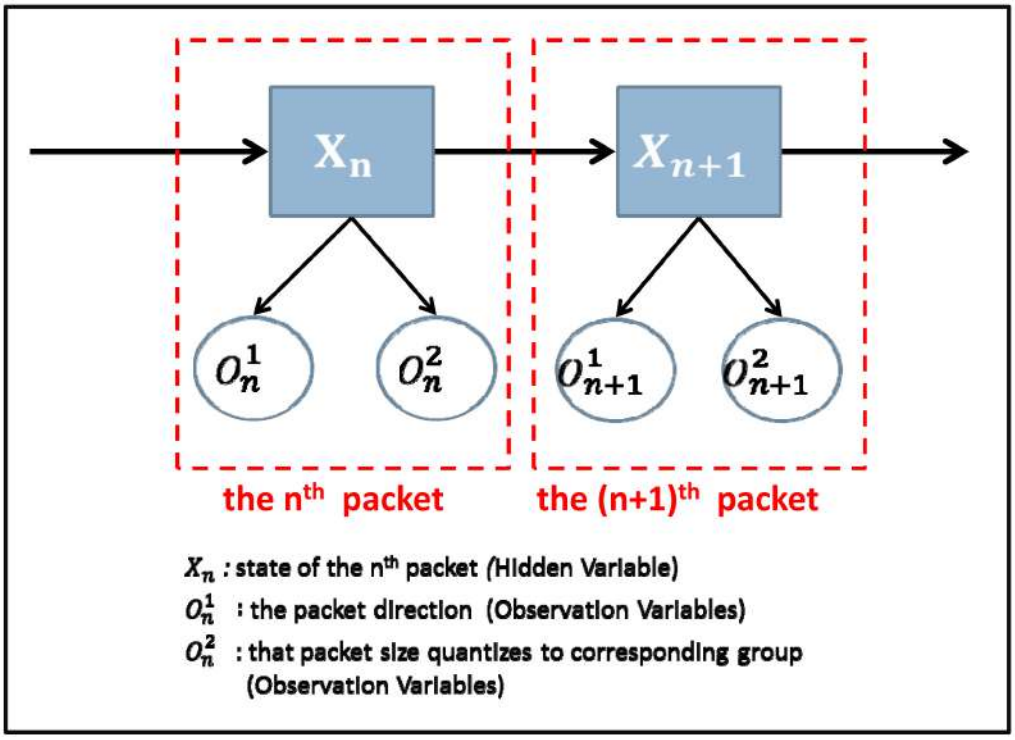

Figure 13. Classification model of Internet application traffic.

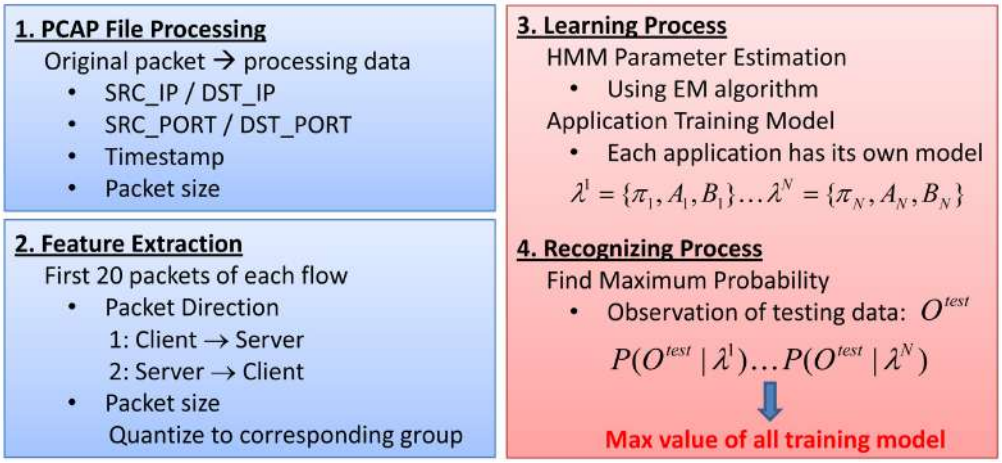

Figure 14. The process of our proposed classification system.

header information (5-tuple: source IP, destination IP, source port number, destination port number, and protocol) to process packets with the same 5-tuple information into a unit of mobile application traffic flow, and extract the features of each application flow. Third, in learning process, we use the extracted features which are quantized into corresponding symbol sequence to training the HMM-based application models for different applications. Finally, we can identify the new traffic flow by finding out the maximum value of log likelihoods derived from different application models.

5. Conclusion

This paper presents a forward looking view of the convergence of IoT, big data, cloud, SDN technologies along with the arrival of 5G mobile broadband networks. We intend to demonstrate the technical relationships of those technologies and the compelling programs and applications that can be created when two, three or more of those technologies converge. Due to the nature of fast evolution of ICT and the ongoing innovation of those five technologies, this paper should be updated on annual basis to keep the related information up to day with the ICT major trends.

Acknowledgements

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Research Article

A Model of Socially Connected Web Objects for IoT Applications

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The Internet of Things (IoT) is evolving with the connected objects at an unprecedented rate, bringing about enormous opportunities for the future IoT applications as well as challenges. One of the major challenges is to handle the complexity generated by the interconnection of billions of objects. However, Social Internet of Things (SIoT), emerging from the conglomeration of IoT and social networks, has realized an efficient way to facilitate the development of complex future IoT applications. Nevertheless, to fully utilize the benefits of SIoT, a platform that can provide efficient services using social relations among heterogeneous objects is highly required. The web objects enabled IoT environment promotes SIoT features by enabling virtualization using virtual objects and supporting the modularity with microservices. To realize SIoT services, this article proposes an architecture that provides a foundation for the development of lightweight microservices based on socially connected web objects. To efficiently discover web objects and reduce the complexity of service provisioning processes, a social relationship model is presented. To realize the interoperable service operations, a semantic ontology model has been developed. Finally, to evaluate the proposed design, a prototype has been implemented based on a use case scenario.

1. Introduction

The Internet of Things (IoT) envisions billions of objects connected to the Internet that continuously generate data about the physical environment. Several state-of-the-art applications can be built using the information and services provided by the pervasive and heterogeneous IoT objects. However, building applications based on these objects raises some challenges. Examples include how the growing number of objects will interact or coordinate to render valuable services, how the complexity generated by the coordination of objects can be handled, and how a large amount of diverse data sensed from the surroundings can be managed properly.

Numerous promising solutions have been provided to handle the complexity and the heterogeneity of IoT objects. One of the prominent approaches is to develop virtual environments to resolve the issues caused by the heterogeneous objects. Virtualization has become a key component in many IoT architectures, in the form of either virtual objects or virtual entities. A virtual object (VO) is defined as a digital representation of a real-world object [1] and provides a way for the IoT services to discover and compose features that cannot be achieved directly with a real-world object (RWO). It has been realized that issues such as heterogeneity of dissimilar objects and scalability can be effectively resolved using VOs. Hence, a crucial role of a VO is to bridge the gap between the physical world and the virtual world by hiding the physical characteristics of an IoT device and acquiring and interpreting its data and context.

Another way to reduce the complexity caused by a large number of objects is to link these objects in a social network [2], which provides a more exact solution than using a sole individual object. This principle has given birth to the concept of Social Internet of Things (SIoT), which is emerging as a new paradigm with the merger of social networks and IoT [3–7]. It has been realized as an efficient way to facilitate the development of complex future IoT applications. It supports sharing of information generated by

the people and the devices based on the social relationships. These relationships further promote efficient discovery of the objects and effective service compositions.

Let us have a glimpse of the application scenarios in which SIoT will make a profound effect on our daily life in the near future. Imagine a group of vehicles that form a mobile social network on the move when heading towards the same location or when they are bound in a common relationship. Vehicles may form diverse social communities; for example, small cars create a social network to share available parking space information or bicycles share information about the vacant paths using a network [8]. Vehicles commuting from home to office can join a social network to share traffic congestion experience, accident warnings, or other common information (e.g., a meeting plan) with colleagues by accessing their vehicles' social network. Let us analyze another SIoT use case where a user enters a public museum with an IoT environment, which incorporates smart objects that exploit social relationships to share information. At the entrance to the premises, the user's smartphone is prompted with a beacon signal to recommend a service app installation. When the user grants the permission, an app is installed and a social agent acquires his profile and friendship details. The app incorporates a microservice which uses a smartphone object to establish a social relationship with the museum visit service. The museum is equipped with a network of smart objects that monitor the user's location and provide services to enhance his/her experience such as personalizing the displays, assisting in the navigation, and recommending the relevant services.

To support the above-mentioned use cases, most of the current IoT architectural approaches are not suitable as they are based on the traditional monolithic approaches, which further hinder the development of efficient, modular, and independent services that cannot scale well with the increasing user's service demands, as already witnessed in many studies [9–12]. Using monolithic approaches, we cannot fully achieve the benefits offered by SIoT including efficient information discovery, improved scalability, and simplified interconnection of objects.

These limitations motivate the current paper to define a design for the development of SIoT based services with efficient and lightweight mechanisms to exploit SIoT features for improved service provisioning. The proposed design is based on the microservices concept which promises a more solid practice of SOA. There is no particular definition of microservices architectural style; however, it is explained in [13] by Martin Fowler as "an approach to developing a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms, often an HTTP resource API." Following the microservices based proposed design, SIoT applications can be developed, deployed, and maintained more efficiently and independently, which will promote system modularity and interoperability.

Moreover, a SIoT design needs to facilitate the efficient information discovery based on the social relationships among objects. To achieve this, incorporating the existing social relationship models in the proposed design can be useful. However, applications with intelligent service features require dynamic object selection. Therefore, objects need to acquire the ability to infer new relationships for interconnection with other objects in the system. This view further motivates the present article to develop a social relationship model based on the semantic ontology. The utilized ontology-based approach is highly useful to dynamically infer new social relationships for efficient service provisioning.

Furthermore, to fully achieve the benefits of both, the SIoT and microservices, selecting an IoT environment is necessary where not only can the social interconnection among heterogeneous objects be utilized but also the lightweight services can be developed to apply these relationships for effective IoT service provisioning. To fulfill this goal, the Web of Objects (WoO) [14] platform has been selected. According to the ITU recommendation (ITU-T Y.4452) [15], "the Web of Objects (WoO) is a realization way of the IoT services, where virtualized objects (i.e., virtual objects (VOs) and composite virtual objects (CVOs)) are connected, controlled, and incorporated with resources to facilitate the development, deployment, and operation of IoT services on the World Wide Web."

To exploit the opportunities provided by the above discussed technological advancements, the main contributions are highlighted as follows:

(i) This article contributes a novel design based on the microservices concept with lightweight and modular services to support the development of SIoT applications. The proposed design involves mechanisms to enhance object discovery and to reduce the magnitude of complexity generated due to the huge number of objects.

(ii) A social relationship ontological model is developed, which helps identify the hidden and unidentified relationships among objects with reasoning mechanisms.

(iii) A use case with the implementation prototype based on the WoO platform is developed to exploit the social relationship model, supporting the proposed design for efficient IoT service provisioning.

Further, to support the above contributions, virtual objects, serving on real-world objects, have been developed, which can be reusable in other services as well. CVOs are implemented, where each update of the information in the real-world object is reflected in the VO and propagated to the CVO. Also, the Social IoT notion is incorporated into virtual objects to provide easy discovery and efficient execution while maintaining collaboration using social connections. Moreover, an experimental analysis has been carried out to evaluate the discovery time of VOs and the time required for service execution, with or without social relationships among virtual objects.

The remainder of this article is organized as follows. In Section 2, the related work is described. Section 3 presents the proposed design of the social web objects accompanied by the social interaction model. In Section 4, an IoT environment

use case is explained with the details of the prototype implementation and discussion of the performance evaluation. Finally, Section 5 provides a conclusion of this paper.

2. Related Work

This section presents the related work with respect to the SIoT and microservices. Further, the significance of both technologies pertaining to the IoT environment has been discussed.

2.1. Social Internet of Things (SIoT). The concept behind SIoT is to enable smart objects to create a social network similar to a human social network. The objective is to exploit the social relationships among objects in an IoT environment to facilitate the effective information discovery, to promote the scalability, to enhance the interactive communication between objects that are friends, and to achieve trustworthiness [3].

The initial notion of a social network of objects was proposed by [16], which discussed how the wireless devices form social connections on the temporary bases that are controlled by the node owners. As the work was carried out before the introduction of IoT, it did not consider the SIoT concept. Later studies [5] investigated the objects' social interaction where objects formed social networks and communicated with each other based on the rules already set.

The idea of using the Web of Things in a social ecosystem was presented by [17, 18], where things were shared using the social network infrastructures, for example, Twitter, Facebook, and LinkedIn. These implementations consisted of objects that communicated either through the built-in embedded servers or through smart gateways. Further, in these settings, the web-enabled things owned by a person provided an interface to his/her social group of friends so that they can interact with the things using a social network.

Lysis [19] is another good example of Social IoT platform based on cloud infrastructure. It uses the platform as a service (PaaS) model and focuses on the deployment of applications in the cloud space. However, dynamic inferencing of new social relationships from existing relationships is not supported by this system. Moreover, making a modular interoperable design by employing concepts like microservices and semantic web technologies is not considered in this work.

Paraimpu [20] provided a social Web of Things platform to connect virtual and physical things to the web. In this system, the social concept only relates to humans by providing them with the capability to share things with each other using a human social network. Also, virtual things are not considered as VOs but rather viewed as services on other IoT platforms.

Using SIoT at the edge of the network was investigated by [21]. In this system, an approach was proposed to cope with the communication delay due to the objects being remotely located in the cloud. This approach exploits the computing resources at the network edge to deploy virtual objects.

The ThingSpeak solution was used as the basis for the implementation of an early SIoT platform [22]. This platform provided the object social behavior functions incorporated at the centralized server. In this implementation, functions such as the creation and the management of the social relationships were developed. However, VO concept was limited only to the records in the remote database.

Another featured SIoT framework was contributed by [4]. This work presented how to combine services, devices, users, and their social interaction to enable interactivity, discovery, and recommendation of services. Social relationships have also been investigated in communities [23], where a proposed framework enables the identification of communities in the social networks.

Although most of the research contributions in the SIoT domain incorporate a notion of the social association of objects, however, limited information has been provided about the social relationship model and the details on how that can be used by IoT services. Furthermore, existing approaches are lacking lightweight and modular mechanisms which can be utilized by services to exploit social relationships efficiently. In our approach, we have developed a semantic ontology-based social relationship model that provides the capability to infer new connections in a network of social objects. Another distinction of the proposed system is a microservices based design that utilizes the developed social model to provide lightweight, modular, simple, and interoperable IoT services.

2.2. Microservices. The microservices architecture is emerging as a new trend among the practices of developing distributed web applications. To develop SOA based systems, microservices have become a prominent approach in real-world settings [24]. In the microservices based architectural pattern, each application incorporates a collection of small services which execute independently and use lightweight communication mechanisms [9]. The microservices are targeted for doing one thing well at a time based on the principle of single responsibility [25], as defined by Robert C. Martine: "Gather together those things that change for the same reason and separate those things that change for different reasons" [26]. Also, the microservices are conceived as autonomous entities, which means they can be changed and deployed independently of each other without requiring their consumers to change [24].

In the last few years, several IoT architectural designs were proposed and developed. Some of these designs provided innovative features such as the European FP7 project iCore [27] which proposed a cognitive framework for IoT application development. This project provided an architecture with the concept of virtual objects and their composites. However, in iCore, services are designed using a traditional SOA based monolithic style, whereas the microservices based architecture provides a better option to develop IoT services. Furthermore, in iCore, VOs lack the mechanisms to semantically represent real-world objects (RWOs), which limits extensibility and interoperability.

To support IoT applications, microservices based architectures are being proposed in many research initiatives and applied in several research projects. In [28], microservices are used for M2M applications, realizing the fact that monolithic approaches for M2M cannot provide a real solution. Another

work [10] provided an analysis of using microservices architecture for large-scale distributed applications. This work demonstrated that significant benefits can be achieved as compared to generic SOA approaches when using microservices in an IoT platform for smart city applications.

Moreover, Almanac FP7 EU Project [29] provides smart city services based on the IoT environment. The project uses microservices to employ scalability in a horizontal and vertical fashion. Also, in the industry, microservices have become a solution for developing large-scale applications. Netflix, Pivotal [30], and Amazon use microservices in their software bases.

The increased importance of microservices for the IoT applications is due to the fact that they simplify complex systems. By dividing a system into smaller parts, higher cohesion and lower coupling can be achieved, which makes it highly scalable. In scenarios where requirements keep changing continuously, microservices can help make a system easily modifiable. Moreover, the major benefits that are envisaged when using microservices in an IoT environment are as follows: Microservices leverage scalability to provide a highly decoupled pattern and can allow scaling individually. Their usefulness can be realized as when the demand for the requirement increases the system complexity also rises. In this case, a system can be supported by creating new instances of existing services. Microservices scalability [9] fits in three-dimensional space, that is, horizontal scalability (typical scalability), vertical scalability (splitting different individual microservices), and z-axis scalability (splitting similar things, such as DB partitioning). Microservices architecture supports a plug-and-play behavior where system components become loosely coupled. To acquire new functionality or replace a failed service, pull the plug from one microservice and plug into a new microservice [31]. One of the major problems that IoT is facing today is how to deal with the heterogeneity of incompatible solutions. To harmonize the heterogeneity, semantic web technologies with microservices are leveraged to provide interoperable exchange and communication of data. Microservices realize a decentralized and autonomous behavior, operating on their own priorities and schedule. This way, they provide several benefits for being utilized in an IoT design.

3. The Proposed Design of Social Web Objects

Recently, there have been several research efforts [3–6, 17, 20, 32] for defining the Social IoT. This new aspect minimizes the complexity generated by the communication of billions of real-world objects and enables sharing of information. The social notion can be incorporated into the WoO platform to provide a semantically rich base for IoT applications that can utilize real-world object relationships for efficient information discovery. Moreover, this section provides a brief introduction of WoO reference architecture in Section 3.1. A classification of social relationships among web objects (virtual objects and composite virtual objects) is discussed in Section 3.2 and a social relationship model is presented in Section 3.3. Further, the details of functional components for the proposed architecture are explained in Section 3.4.

3.1. Web of Objects (WoO) Reference Architecture. To enable the deployment of IoT services on the World Wide Web, WoO provides a reference framework. In other words, it realizes the IoT services in such a way that virtualized objects are interwoven with resources to support the development, deployment, and operations of IoT services [33, 34]. The WoO platform provides service functionality by merging VOs and features of web applications. Moreover, the WoO platform uses semantic web technologies to enable interoperability among heterogeneous resources. This realization provides the basis for the composition and harmonization of objects to provide smart services in an IoT domain. Building services based on WoO platform using diverse technologies, including microservices [35], social networks, and semantic web, helps reduce the complexity and fosters the easy and efficient development of IoT applications.

Virtualization has become a major concept in IoT to address the heterogeneity of diverse types of physical objects. VO is a digital representation of a real-world object that can be anything, living or nonliving, mobile or stationary, concrete or immaterial. In WoO, VO is defined as domain-specific semantic ontology based on the VO information model [36]. It is uniquely identified using URI and provides information updates on the representative real-world object. On the other hand, WoO also provides a notion of CVO which aggregates one or more VOs to enable service features that satisfy the application requirements. CVOs chain semantically interoperable VOs together. The WoO platform incorporates features to efficiently reuse existing VOs and handles the complexity generated by self-management and control mechanisms [37]. In the WoO, service level decides which CVOs and VOs will take part in creating an object mashup to fulfill service objectives. The service logic is saved in the form of templates and stored in the template repository [38–40]. The domain expert or knowledge engineer defines the service templates that are used to instantiate new services.

WoO reference architecture is shown in Figure 1. In this architecture, the service layer handles requests and provides several management functions, whereas the CVO level consists of functions to manage and instantiate CVOs or reuse the existing ones based on the provided service execution logic. New objects such as sensors are registered in the WoO platform using a registration function and their templates are generated to make them digitally available in the form of VOs. Another most important aspect is the semantic representation of data at three-layered WoO architecture [23, 39]. The database at each layer is supported with semantic web technologies.

3.2. Types of Social Relationships. Previous research [3] on SIoT has derived some basic relationship types among objects. These relationships are characterized as follows. *Parental Object relationship* (POR) exists between the objects that belong to the same batch, such as objects that are created in the same production process or at the same time by a common manufacturer. *Cowork object relationship* (CWOR) is the relationship among objects that are grouped together based on some commonly shared job to be done by them. Similarly, *colocation object relationship* (CLOR) is established

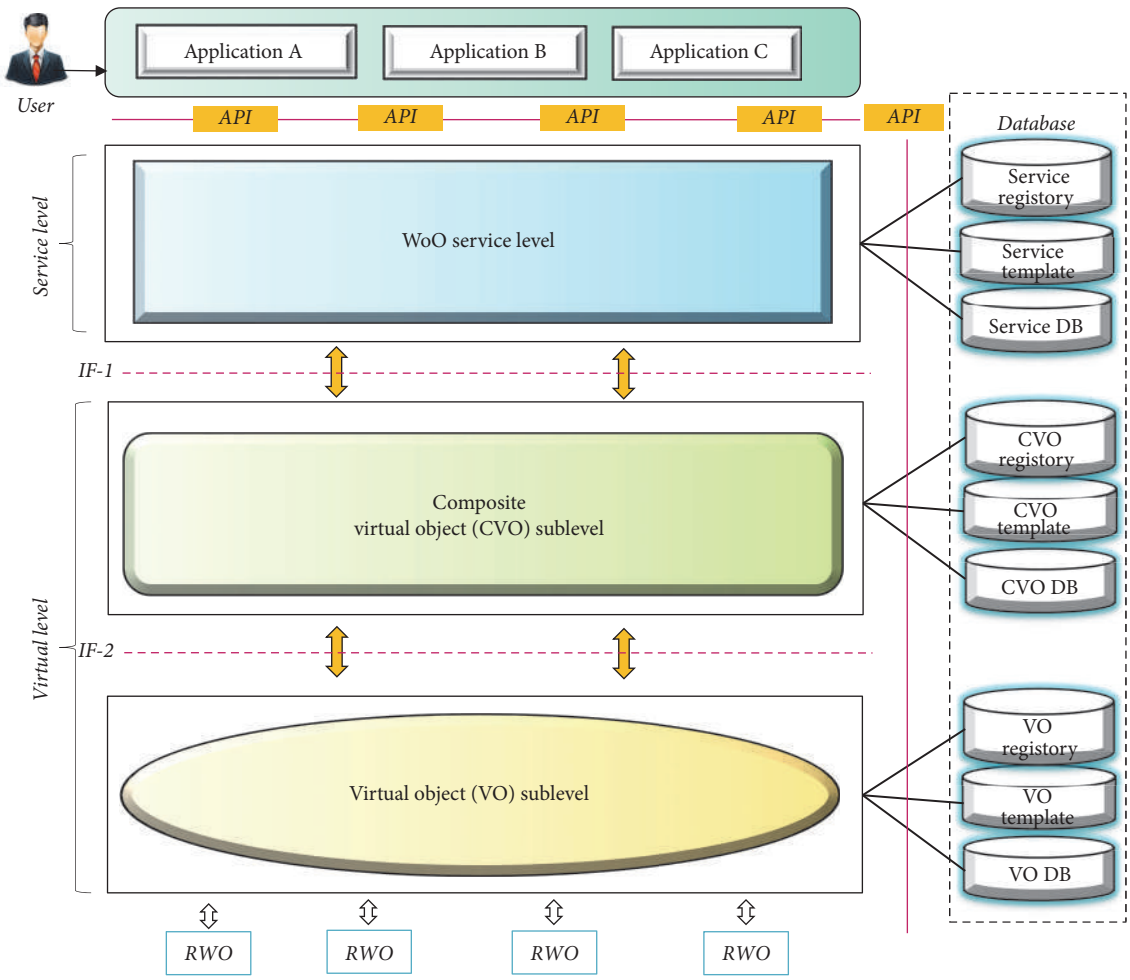

Figure 1: Web of Objects reference architecture.

between objects belonging to the same location such as home or office. Different or same types of objects can be combined based on the common location or premises. On the other hand, *Ownership Object Relationship* (OOR) is formed among objects belonging to the same owner. *Social Object Relationship* (SOR) is another kind of relationship that is created among objects when they come close to each other, either random in time or periodically. This relationship can be envisaged when the owners of objects come into contact with each other. Apart from the above relationships, in [41], the authors define the *Guardian Object Relationship* (GOR) in the Internet of Vehicles (IoV) scenario where on-board units of vehicles become children in relation to the super nodes of Road Side Units. This child and parent association gives a special meaning to a new hierarchical relationship.

In addition to the relationships defined in other studies, we have identified few more relationships suitable for some diverse scenarios. These include *Sibling Object Relationship* (SIBOR) that is created among objects that belong to a group of friends or family members. This relationship among objects extracts the property of trustworthiness based on the relationship of their owners. Another relationship type is the *guest object relationship* (GSTOR) which is formed between objects that belong to the users in the guest role, for example, when a person visits a friend's home and gets the privilege as a guest. The same can be applied to the objects that move in guest relation (GSTOR) from one place to another; they will have some privilege of accessibility of information as compared to other objects. *Stranger Object Relation* (STGOR) applies to objects that encounter the presence of each other in an anonymous environment such as on the go or in the public environment. Similar to people who meet each other sometimes regularly but are anonymous to each other or are not fully aware of each other, this relationship can be used among objects to form different trust levels or to form strict restrictions to promote secure connections. Moreover, in *service object relationship* (SVOR), objects form a relationship while coordinating in the same service composition to fulfill a service request. Generally, in the proposed scheme, service request execution generates a mashup of objects, and objects that belong to the same mashup are assumed to be in SVOR.

We believe that the above defined new social relationships are beneficial in several distinctive scenarios. For example, SIBOR is more useful in scenarios where trust is highly important for establishing a connection. Unlike the more generalized relation POR, SIBOR is established

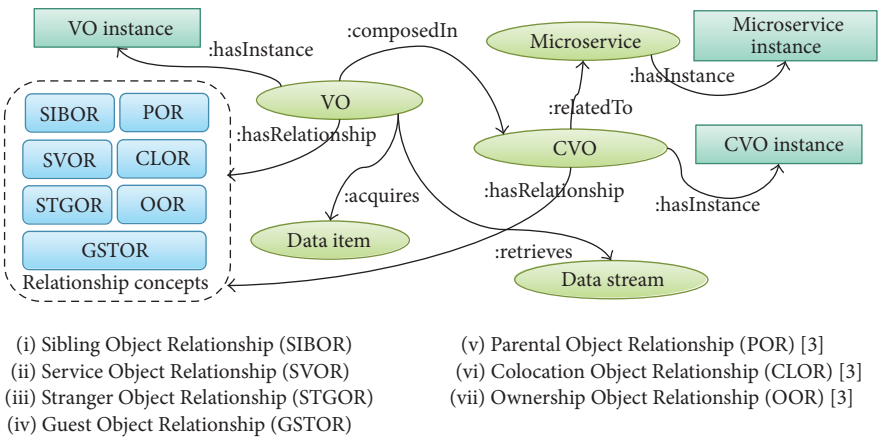

Figure 2: Ontological model representing web objects' relationships.

among objects from the same manufacturer having similar features but different behaviors. Similarly, GSTOR is suitable in scenarios where objects use relationships for privileged services. Imagine a person as a guest speaker in a conference with his smart devices, where he can connect to the network easily, and his personal devices are recognized as a guest (with GSTOR) in the venue network to avail free services like high-speed Internet, special notifications, and others. Stranger Object Relation (STGOR) is used in scenarios where objects are on the go, and to get some information, they have to compromise with a limited trust level. For instance, in a public transit system, one mobile node on the move wants to use crowdsourced information from another mobile node which is not fully trusted. Also, SVOR is useful in service composition specific scenarios, where object mashups are formed to facilitate service requirement, and it is also useful in a particular orchestration of objects.

To model information about microservices, social web objects, and their relationships, a semantic ontological model has been developed as depicted in Figure 2. Conceptualization of objects and their social relationships in semantic structures are highly beneficial to infer new connections among a network of objects with the help of reasoning techniques. The ontology facilitates the representation of objects, as well as what they measure in terms of observations, their processing, and functions. Web objects' relationship ontology contains the concepts that define each object in terms of a class. The data properties are used to represent object values and the object properties are defined to identify the link between two objects in the ontology. Major concepts in the ontology are microservices, CVOs, VOs, and their social relationships. Further, microservices have an individual instance that uniquely defines a microservice object and associated data with it. Similarly, CVOs and VOs are also instantiated and contain data properties to retain their values. With the increasing number of objects, a semantic ontology model is used to perform reasoning function that helps identify new connections. Further, to analyze the social relationship among objects (such as VOs and CVOs), their properties are provided in Table 1.

3.3. Social Relationship Model for Web Objects. At each level of service life cycle, objects form a social relationship with each other to accomplish a service task. Codifying the relationship among web objects can provide many benefits, such as efficient information discovery from related objects and better composition and reuse. To perceive social interaction between web objects, we assume every service is based on one or more microservices and other objects including CVOs and VOs. At VO level, VOs create several relationships with each other based on the RWO they represent. CVOs associated with microservices are incorporated in relationships as well.

Object-to-object associations are categorized as either vertical associations (interobject relations) or horizontal associations (intraobject relations) as shown in Figure 3. The relationships that flow from the bottom to the top in WoO based architecture are known as interobject relations (i.e., from VO to CVO or vice versa). On the other hand, relationships are known as intraobject relations if they are generated within objects at each level such as between one VO and another, or within one CVO to a relative CVO. The newly defined relationships among objects are maintained at different levels, which enables information discovery more efficiently. It is considered that not only will the relationships be maintained when two objects (i.e., VOs) are used in the same CVO or service, but also they will be maintained if objects are used in different CVOs or services.

As depicted in Figure 3, VO1 and VO2 bind in the SIBOR relationship, considering the fact that they belong to the same family of CVO1. Similarly, VO4, VO5, and VO6 are combined in a CWOR, as they are used in the same service. However, all of them do not have a common family relation that makes their trustworthiness restrictive to some level as compared to SIBOR. Moreover, though VO7 and VO8 are not used together in a service setup, still they form a STGOR relationship. This relationship also helps codify those VOs that have similarity in premises during a certain point in time regularly but they had never combined in any service scenario before. For example, if a person visits a subway regularly but stays very shortly, in such scene, the user's smartphone VO and subway station point

Table 1: Social relationship attributes.

Social object relationships types	Attributes/properties
Sibling object relation (SIBOR)	O_x *has relationship* with O_y → SIBOR, if objects' *ownership* is defined as: == SameFamily
Service object relationship (SVOR)	O_x *has relationship* with O_y → SVOR, if objects' *serviceStatus* is defined as: == SameServiceComposition
Stranger object relation (STGOR)	O_x *has relationship* with O_y → STGOR, if objects' *authentication* is defined as: == Anonymous
Guest object relationship (GSTOR)	O_x *has relationship* with O_y → GSTOR, if objects' *ownership* is defined as: !=SameFamily && == GuestFriend
Parental object relationship (POR)	O_x *has relationship* with O_y → POR, if objects' *creation* is defined as: == SameBatch ‖ == SameProduction
Colocation object relationship (CLOR)	O_x *has relationship* with O_y → CLOR, if objects' *proximity* is defined as: == Neighborhood ‖ *location* is defined as: == SameLocation
Ownership object relationship (OOR)	O_x *has relationship* with O_y → OOR, if objects' *proprietorship* is defined as: == SameOwner

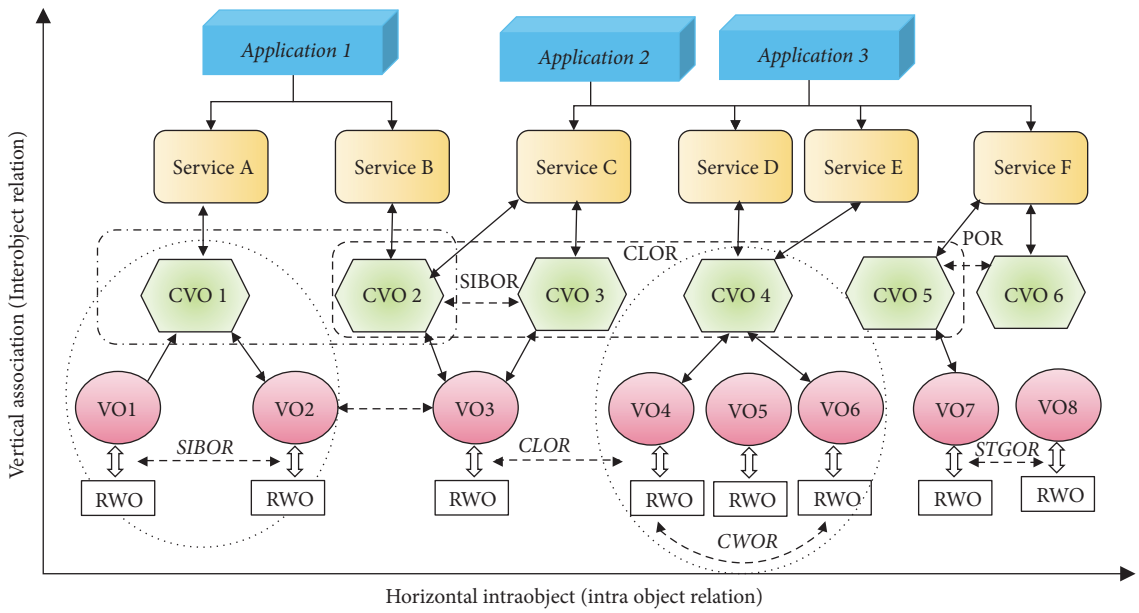

Figure 3: Hierarchical social relationships of web objects.

VO or subway security camera VO may establish STGOR. This may help reuse VOs in service scenarios where only for short duration a VO object is required. At CVO level, CVO2 forms two different relationships, which increases the level of connectivity of the CVO. CVO2 first shares a CLOR with CVO1 and CVO3, CVO4, and CVO5 together. Secondly, CVO2 is combined in a SIBOR with CVO3 and becomes in the same service family. Further, in the selected use case scenario described in Section 4, several other social interactions have also been elaborated.

3.4. Social Web Objects Architecture. SIoT envisages a system where the social framework will bring smart devices and people to interact with each other. By incorporating web technologies like SOA based microservices, IoT services can be rendered on top of the social framework. The proposed social web objects architecture (as shown in Figure 4) has been decomposed into three levels: service level, object virtualization level, and aggregated object virtualization level. At the service level, to support social relationships within web objects, several microservices have been designed, which are discussed further in the following section. Moreover, the data management function in the proposed design helps each layer to interconnect with semantic databases. The SPARQL endpoints have been defined at the service and the object virtualization levels that expose interfaces to retrieve, store, and modify RDF graphs. Several interfaces allow the knowledge engineer, domain expert, and the developer to create service templates and VOs, as well as update the RWK model, user profile, and policies.

3.4.1. Service Level Functional Components. The service level functions handle operations from the request inception to the execution of services. This level is supported by some core functions common to be used in each service life cycle. These include the management function to handle service

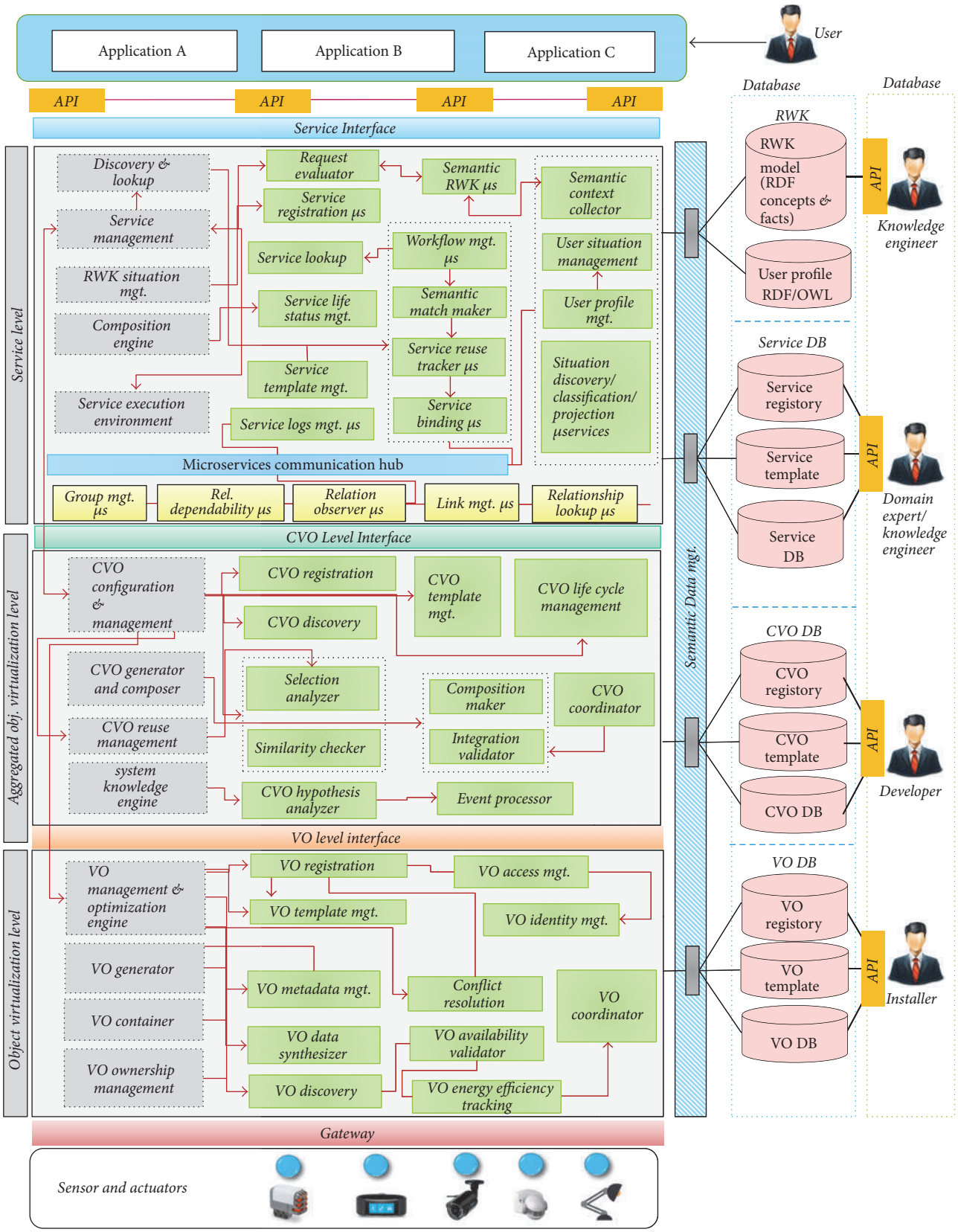

Figure 4: Social web objects functional architecture.

requests and initiate service provisioning processes, the service discovery function to select the available services, the composition engine to enable service mashups, and the Real-World Knowledge (RWK) and situation management function to acquire RWK and continuously maintain it. Besides these core functions, several microservices have been used to provide the plug-and-play feature in the proposed design; that is, in case of service failure, it is replaced with another one. These services include the Request Evaluator microservice which interprets a service request and matches a request query to the service template. The registration microservice registers newly added service objects to the registry. When a new template is instantiated, objects are put in service, and to know the existence of available service instances, they are recorded in the service registry. The lookup microservice is defined to search for the required service objects using the semantic representation. The representations available in RDF/OWL format are queried from the registry based on the request parameters. Service life cycle management keeps track of the states of service objects during their life cycle, whereas RWK management microservice is a semantic data processing service which processes facts about user preferences, profile, and situational information.

To realize service provisioning, it is always not possible to satisfy the service requirement with a single service function. Service composition and harmonization features are required to fulfill a demanding service request. Service composition is not a single operation; many microservices are used to compose the individual features. One of the major components of the composition is the Workflow Management (WFM) microservice which is responsible for decomposing the service requirement if no single service is available to satisfy the task. WFM microservice identifies the service objects using input and output interfaces. In this concern, it uses the matchmaking microservice to identify the approximate matches that can serve the required service functionality. Here, service objects are semantically represented in the form of ontologies. The semantic ontology alignment algorithm is used to match the service up to a certain threshold level that is defined by the matchmaking microservice. The reuse tracker microservice is used to identify the current service instance usage by the application; it incorporates a coordination mechanism before instantiating any new instance, and this helps in service reuse by many clients. Binding microservice enables tying of services selected by WFM; this function synchronizes input and output of services in a workflow to produce a single service output based on the generated composition plan.

Furthermore, user characterization is another important element to support the IoT services by matching user requirements more closely. The User Profile Manager microservice handles many facts related to the human user. These include user profile, preference, context, and policies. Semantic Context Collector microservice organizes the services requested by the user and the context in which these services were requested. This helps in identifying user interest with respect to the service context. User context or situation helps in service selection more efficiently if a user requests again with a similar service requirement. Some microservices have been designed to handle user situation information; these microservices include situation discovery, classification, and recognition functions. Situation discovery is used to process sensor data that is provided by CVOs to prompt a situation, whereas machine learning algorithms are applied to remove the false values and data normalization is performed in case inappropriate triggers in the data exist. Situation classification incorporates the reasoning methods and rules to generate a relationship over detected events and refine the missing knowledge between the events. Situation projection analyzes the events data with the help of machine learning methods and provides an output in the form of predicted facts that are related to the situation being detected. Moreover, all the microservices coordinate using a communication hub to share information with each other.

A flow of service inception to service execution in the proposed architecture is depicted in Figure 5 where service management is responsible for initiating the above-mentioned functionalities and instantiating the microservices. This process further results in the generation of CVO/VO mashup graphs to be handled by CVO management (discussed in Section 3.4.2). Situational information has also been used to improve request analysis and service provisioning, whereas VO management (discussed in Section 3.4.3) acquires and aggregates data from sensors and other RWOs.

Social Relationship Management Microservices. To support the social relationships among web objects at each layer of the proposed system, relationship management microservices are defined, which support the codification of relationships among web objects (VOs and CVOs) and their management. These microservices are defined as follows. Group management microservice identifies the grouping of objects into specific sets based on the type and interaction of objects; it builds a social graph of the object relationships. Link management microservice incorporates mechanisms to maintain relationships among different objects and it includes several other subfunctions. The first subfunction is object selection which involves choosing candidate objects that are likely to form a particular association. The second subfunction is matchmaking service which provides exact relationship match based on the type of objects. The third subfunction is the association life cycle manager, which maintains the relationship status between objects; it checks whether they are in active relation or not. It keeps track of relationship validity and also the duration of relationships. Relationship observer microservice enables the object activities to be observed, and it also handles the mutual sharing, which defines what information an object is allowed to share or use of another object based on the relationship among them. Relationship dependability recognizer microservice identifies, maintains, and continuously improves the level of reliability among objects. If objects A and B are frequently interacting and always perform a task together that leads to successful execution of an application to serve the requirements, then they are more likely to form a reliable relationship with each other. The consistency of the relationship allows objects to share their information with fewer constraints as compared to unpredictable association among objects. Relationship

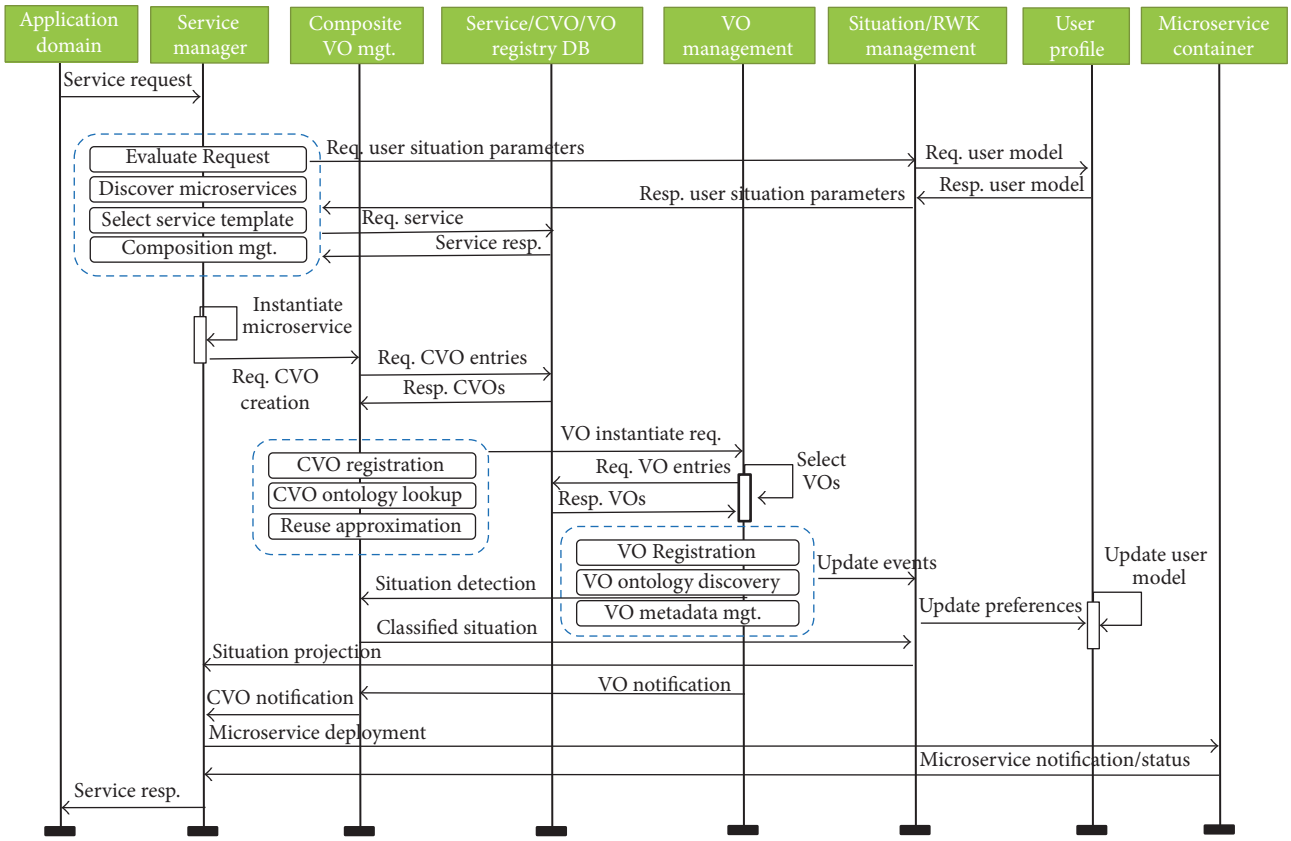

Figure 5: Request initiation and service execution flow in the proposed architecture.

lookup microservice incorporates the discovery algorithm (as given in listing of Algorithm 1) to discover the social relationships and maintains the list of all objects and their potential association rating. The rating defines the opportunity for objects to form a relationship with each other.

Moreover, the operation flow of social microservices has been illustrated in Figure 6, where VO management retrieves the social relationship among objects this is queried using link management, which uses a lookup service. Associations are maintained in a social relationship graph using semantic ontology and queried using the relation observer service. The social graph is also updated and maintained continuously with respect to changing links among objects, on the basis of which VOs are selected.

3.4.2. Functional Components in Aggregated Object Virtualization Level. Aggregated object virtualization (AOV) level involves all the necessary functions to instantiate, manage, and continuously monitor CVOs. Besides, it includes the interface required by the service level to interact with CVO components. Service level provides the mashup graphs of CVOs and VOs that are required to fulfill a service request. Aggregation level also supports some core functions; these are categorized as CVO configuration and management to decompose requests from service level and manage CVO instances, CVO generator to instantiate CVOs, composition function to form CVO and VO mashups, reuse management to select existing CVOs that approximately match service requirement, and system knowledge engine to grow knowledge for the optimal use of CVO resources. Further, other aggregation level functionalities are as follows: registration function records the CVO entry into the semantic CVO registry in the form of RDF/JSON format. CVO includes ontologies that specify conditions to be applied on the VO data. Also, at this level, templates are created by a domain expert or knowledge engineer, which consist of functionalities associated with each CVO type. Template management module provides an interface to include templates to the CVO template repository and also supports the modification mechanism. CVOs are discovered using their semantic annotation via the discovery function. CVO selection analyzer function provides estimated selection of a CVO for reuse if there is no single CVO that can exactly provide the required service. This is supported by similarity checking mechanism to analyze the level of similarity before recommending for reuse. At aggregation level, another important function is event processing; event streams generated by object virtualization level are highly valuable to infer situational awareness and building RWK that is used by high-level functions. Event processing module facilitates processing of events and provides generated facts as output. Event processing is supported by CVO hypothesis analyzer that incorporates several hypotheses which are trained over data to build system level knowledge. Aggregation level also

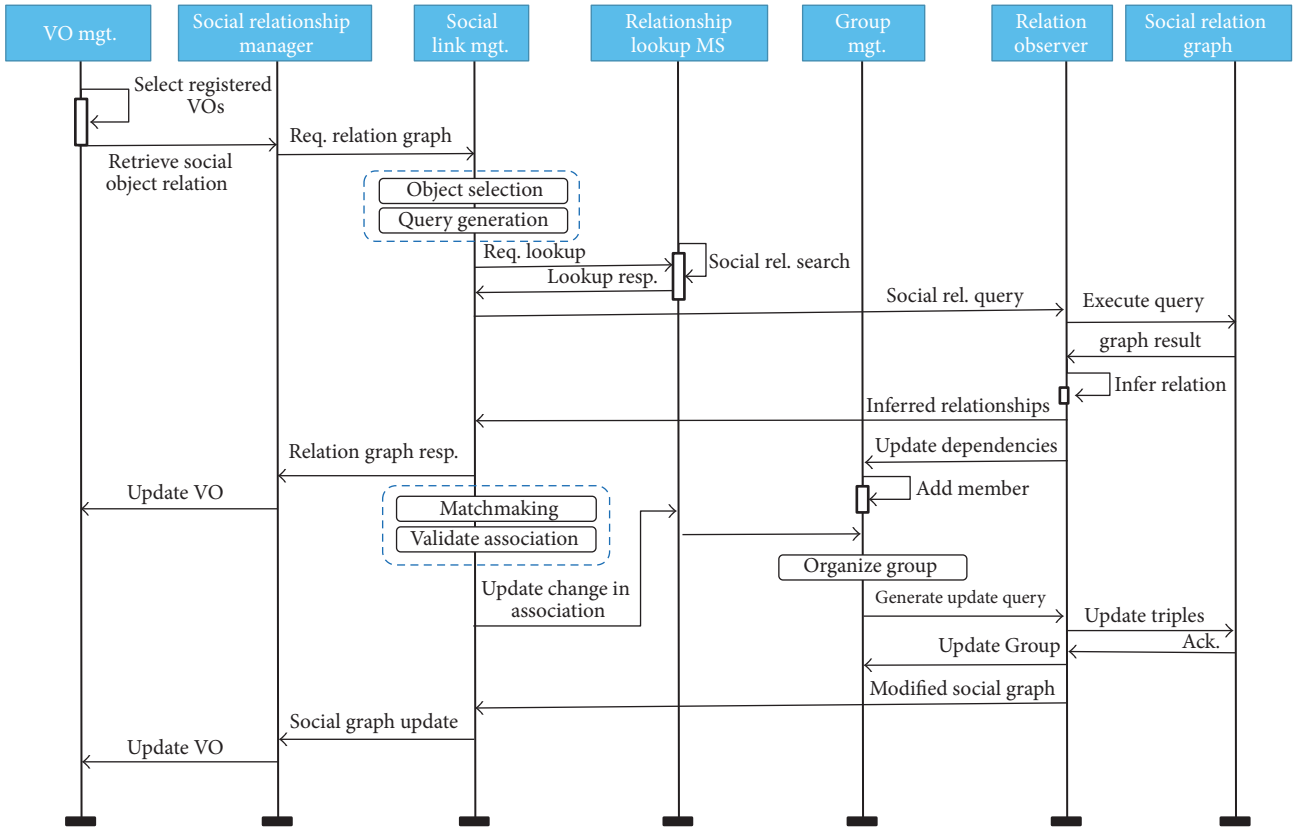

Figure 6: Sequence of operation required to establish a social relationship among objects.

provides composition function which provides the basis for merging multiple VOs to generate single service feature and validation function to validate the compositions of multiple VOs. Moreover, the coordinator helps in resolving conflicts in case of simultaneous access of single CVO by multiple services together.

3.4.3. Functional Components in Object Virtualization Level. Although IoT middleware virtualizes sensors and actuators in some form of virtual entities, however, in WoO, every living or nonliving thing can be represented in the virtual world. VOs are supported by an information model [14, 15] which includes the representation of RWO that can be ICT or non-ICT. In the proposed architecture, object virtualization level includes functions to create, maintain, and coordinate VOs such as VO generator, VO management, and optimization engine. VO registration function provides an interface to register VOs with the help of VO ownership management function where the VO ownership is maintained. Template management function handles templates or loads updated ones as provided by the domain expert. Metadata management maintains data associated with VOs; as VO is a digital representative of real-world entities, there is a high need to store metadata information to recognize the class of sensed data. Use of metadata provides the real value of the data in the form of the context stored within it. Furthermore, VO data synthesizer service handles the discrepancies if found in the data corresponding to VO; this includes data manipulation and missing value rectifications. Conflict resolution function helps in case the same VO is used by multiple service instances, to resolve the conflicts. Also, VO access management function controls access for VOs in case access right information has been defined by the VO owner, whereas identification management module maintains identification information about VOs so that each VO can be uniquely identified in the system.

3.4.4. Social Relationship Discovery and Composition. To identify associations among web objects within a social relationship graph, an algorithm is elaborated briefly. In the following algorithm, the microservices that are in execution are retrieved first, represented as $\Sigma M\mu$; next, all the CVOs associated with each of those microservices are recovered in ΣMc and, further, the corresponding VO model ΣMv is iterated. In the next step, executing the query statement routine returns the results denoted as $\overline{\mathbb{T}}$. The process of finding the relationships is carried out through lines (6)–(19) in multiple nested iterations as shown in the pseudocode of Algorithm 1 listing.

Algorithm 2 facilitates the composition of objects based on social association types. This algorithm takes as input the set of object social relationships denoted by $\mathbb{Z}$ and registry entries of the objects that are currently available in the system, represented as $\mathbb{R}e$. After the object model denoted

Require: $(\Sigma\phi)$, $(\mathbb{R}_e)$
(1) **Output:** $\hat{\mathbf{S}}$ (social relationship graph of objects)
(2) $\Sigma M_{\mu} \leftarrow$ Load Microservices in model
(3) $\Sigma M_c \leftarrow$ Load CVOs in model
(4) $\Sigma M_v \leftarrow$ Load VOs in model
(5) $\overline{\mathrm{T}} \leftarrow$ *executeQueryStatement* (M_{μ}, M_c, M_v, Q)
(6) **for All** μ in $\mu\overline{\mathrm{T}}$ **do** (iterate Microservice instance being used)
(7) **for All** $O \in \mu$ **do** (check CVO and VOs used by the Services)
(8) **if** O_i == output of C_R in a relationship set R_c **then**
(9) add C_R to $\mathbb{III}_L$
(10) **else**
(11) **if** O_i == output of V_R in relationship set R_v **then**
(12) add V_R to $\mathbb{III}_L$
(13) $\mathbb{N}_i \leftarrow$ tag (Assign relationship tag to each object entry)
(14) **else**
(15) add O_i to $\mathbb{III}_U$
(16) **end if**
(17) **end if**
(18) **end for**
(19) **end for**

Algorithm 1: Social relationship discovery.

Require: $(\Sigma\phi)$, $(\mathbb{R}_e)$, $(\mathbb{Z})$
(1) **Output:** $\mathbb{C}$ **(Composite Service)**
(2) $\Sigma M \leftarrow$ List all objects available (Microservices, CVOs, VOs) in model
(3) $\overline{\mathrm{T}} \leftarrow$ *executeQueryStatement* $(\Sigma M, Q)$
(4) $\mathbb{Z} \leftarrow$ *executeQueryStatement* $(\Sigma M, Q')$
(5) **for All** $\sigma i \in \overline{\mathrm{T}}$ **do**
(6) **for All** $\boldsymbol{\lambda} i \in \sigma$ **do**
(7) **if** $\boldsymbol{\lambda} i$ == *any* z in $\mathbb{Z}$ **then**
(8) add $\boldsymbol{\lambda} i$ to $\mathbb{III}_{\mathrm{Lm}}$
(9) store $\mathbb{III}_{\mathrm{Lm}}$
(10) **end if**
(11) **end for**
(12) **for All** $\boldsymbol{\varpi}\mathbf{i} \in \mathbb{III}_{\mathrm{Lm}}$ **do**
(13) **if** $\boldsymbol{\varpi}\mathbf{i}$ == *any* $\boldsymbol{\varpi}\mathbf{i}$ in $\mathbb{III}_{\mathrm{Lm}}$ **then**
(14) $\partial \leftarrow$ ranking (Assign rank to each service)
(15) add $\boldsymbol{\varpi}\mathbf{i}$ **to** $\mathbb{III}_{\mathrm{LR}}$
(16) store $\mathbb{III}_{\mathrm{LR}}$
(17) **end if**
(18) **end for**
(19) **for All** $\sigma j \in \mathbb{III}_{\mathrm{LR}}$ **do**
(20) **if** $\sigma j(\mathrm{R}\partial) > \kappa$ **then**
(21) add σj to Wf
(22) Pq $\leftarrow$ assign to queue
(23) Sort Pq
(24) Formulate Wf
(25) **end if**
(26) **end for**

Algorithm 2: Composition of objects based on social relationship.

as ΣM is loaded, the first step is to compose objects based on their relationship types. This way, the SPARQL queries are executed; the first query is denoted as Q to retrieve the available service templates and the second query is represented as Q' to extract the relationships associated with the services. From line (5) to (11), first, the social relationship is searched among objects and then the found relative objects are composed in groups. The design philosophy employed over here is to assign a ranking to each selected group based on the relationship type that helps in a more efficient

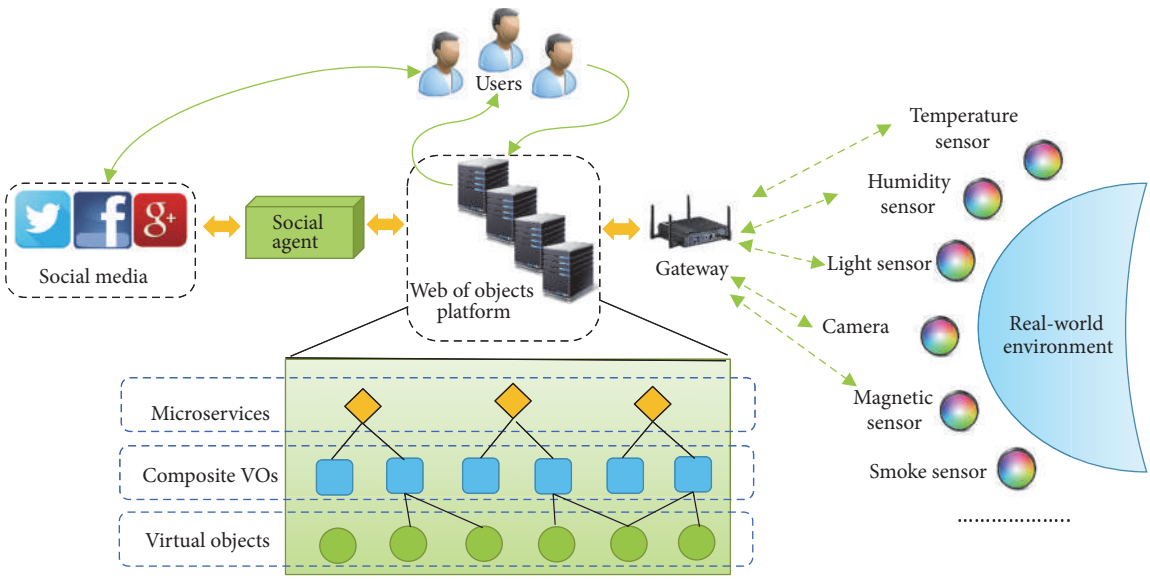

Figure 7: Use case scenario.

composition of service objects (from line (12) to (18)). The last part of Algorithm 2 will continue to iterate to compose the object composition workflow by checking first the assigned relationship ranking with the defined threshold, and then the selected composition workflow graphs are sorted and stored in queues for service execution.

4. Use Case and Prototype Implementation

In this section, first, to realize IoT service provisioning based on social web objects, a use case about IoT enabled museum environment has been presented and then the details on the prototype implementation are furnished.

4.1. Use Case Scenario. This use case is based on a user experience in a public museum where the IoT environment is already set up with the WoO platform incorporating web objects that use social relationship model and a social agent which obtains the user's profile and his friendship details from social media (as shown in Figure 7). The user enters the premises of the museum and his smartphone is prompted with a beacon signal to recommend service app installation where he accepts the request. The phone app incorporates a microservice which establishes a social relationship (GSTOR) with museum visit service objects. The system monitors the interaction of the user in the museum environment; the installed camera network and motion detectors detect the user presence and this feed is collected by the museum visit service. The user shares his current location with the system, which is used by the location navigator service to assist him in moving around the museum by providing the direction to the locations where different museum items are situated. It is worth noticing that the VOs for museum visit service and location navigator service are bound in CLOR relationship due to the same location points. The user shares his social network profile which is used to acquire the list of friends and choices for things the user is interested in. This information is acquired by the recommendation service which suggests the best things to do with respect to the user's interests, making his visit most enjoyable. Recommendation service suggests facilities available in the museum such as places a user should visit, cafeteria food menu, and prices for the day. This service also shares with the user the past experiences of his friends at the museum to help him get most out of his visit. Moreover, personalization service provides special features such as adjusting contents on displays or optimizing the luminosity, to support users with disabilities. To enable these service features, objects exploit the SVOR relationship. Also, the fire management service maintains the status of all VOs that can detect an unusual fire situation in the museum. The temperature VOs acquire readings from temperature sensors and smoke detector VOs get a feed from smoke detection sensors. These VOs form a CLOR relationship with each other in the common proximity. Fire situation monitoring CVO acquires VOs data. One or more CVOs are managed by the fire management service. In case of a fire breakout, the fire management service executes with the data from the fire detection CVOs and the temperature and smoke detector VOs. Meanwhile, services incorporate high-level functionality to react on the data provided by virtual entities in the system. It is important to notice that sharing of information based on social relationships has become easy in the proposed use case. That is because the user information and device information are communicated with social links of web objects and are utilized by the services.

4.2. Proof-of-Concept Details. To evaluate the proposed design, a proof of concept has been furnished, which realizes services based on web objects as considered in the above use case. These objects include, for instance, fire situation monitoring CVO to handle emergency fire breakout situations, location navigator CVO to find the shortest path to the user

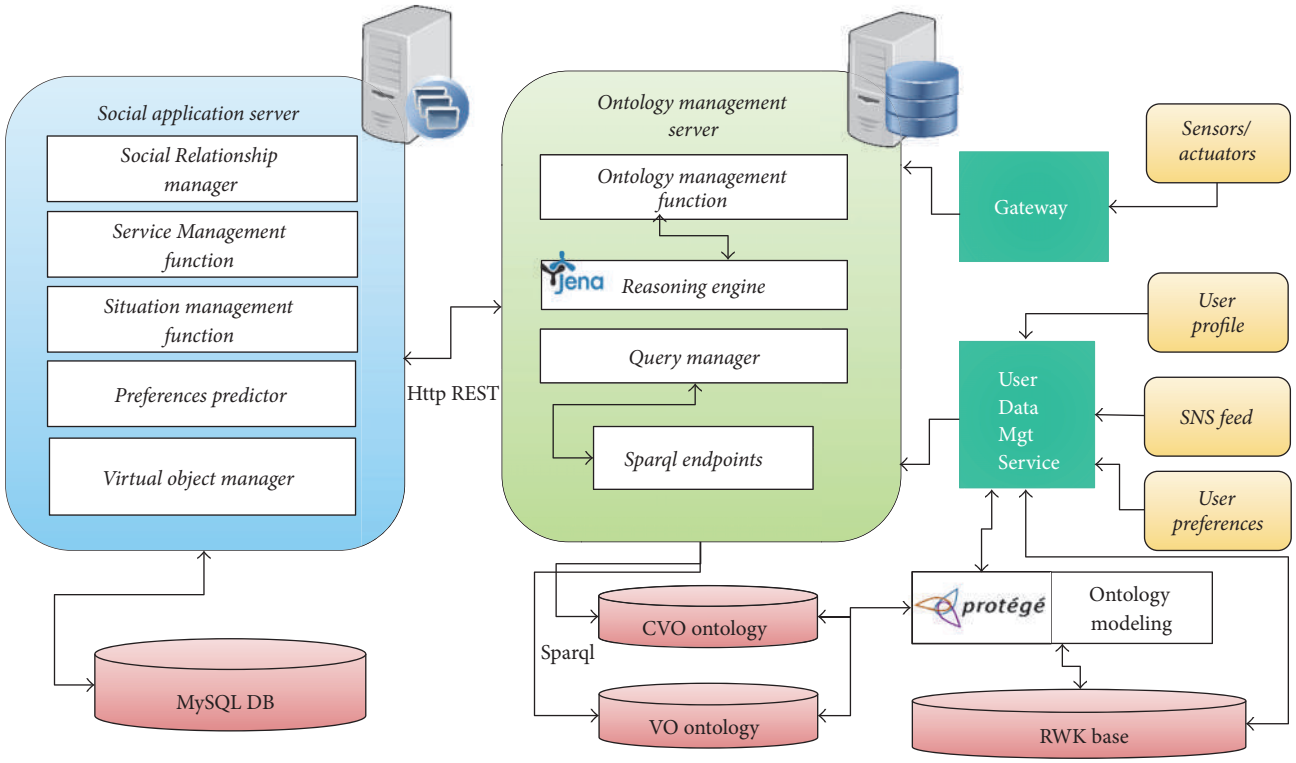

Figure 8: Prototype implementation components.

intended destinations, and user profile reader CVO which acquires user personal information from the social media profile. Several other CVOs have been developed that acquire diverse data and metadata from VOs where each represents a different RWO. These VOs include a user VO, smartphone VO, camera VO, wristband VO, motion detector VO, and others that are associated with the chosen environment (such as CO_2 sensor VO, humidity VO, temperature VO, and light VO). Each VO has several instances; for example, temperature sensor instances are represented as temperatureSesor0001 and temperatureSesor0002. Further VO data is collected and analyzed by CVOs with the rules incorporated in the ontologies. CVOs composed in microservices help analyze different situations and initiate inference over data using inference engines. Considering the system requirement, several aspects have been evaluated, including identification of web objects for effective IoT service provisioning, finding the social relationships among web objects, efficient discovery of web objects based on these relationships, and composition and harmonization of web objects.

4.3. Prototype Implementation Details. To analyze the feasibility of the proposed architecture, a prototype on the discussed use case has been implemented. Figure 8 illustrates the components of the prototype, which constitute social application server (SAS), ontology management server (OMS), and databases to hold VO and CVO graphs that are supported with SPARQL endpoints. The gateway connecting sensors and actuators has been incorporated in the implementation. Additionally, user data management services are implemented to get user profile and preferences history along with social network data.

The application server comprises five major components: social relationship manager (SRM), service management function (SMF), situation/context management function (CMF), preference predictor, and virtual object manager (VOM). The SMF is an entry point for the service request; it interprets and evaluates the service request. It is also responsible for matching the service request with the available template. SMF communicates with VOM to check the VO or CVO availability. A compiled list of VOs is provided to SMF which generates object mashups to satisfy the service request. The execution of VO mashup graph is done using microservices. The second function, VOM, maintains instances of CVOs and associated VOs and coordinates with OMS to use available ontologies in the system. It records the association of services and VOs and enables the reuse of VOs by more than one service; it also resolves conflicts using conflict resolution mechanism. VOM is implemented using RESTful web services. Further, SRM is implemented to maintain object relationships in the form of RDF concepts represented in ontologies. It also involves several microservices, each implemented for a specific task. For example, group management microservice is developed to group objects that have similar characteristics. Similarly, other tasks are distributed in different microservices; for example, link management microservice is used to identify the dependency among objects. Relationship observer microservice is implemented to monitor the objects when they change their state at runtime, whereas to search a web

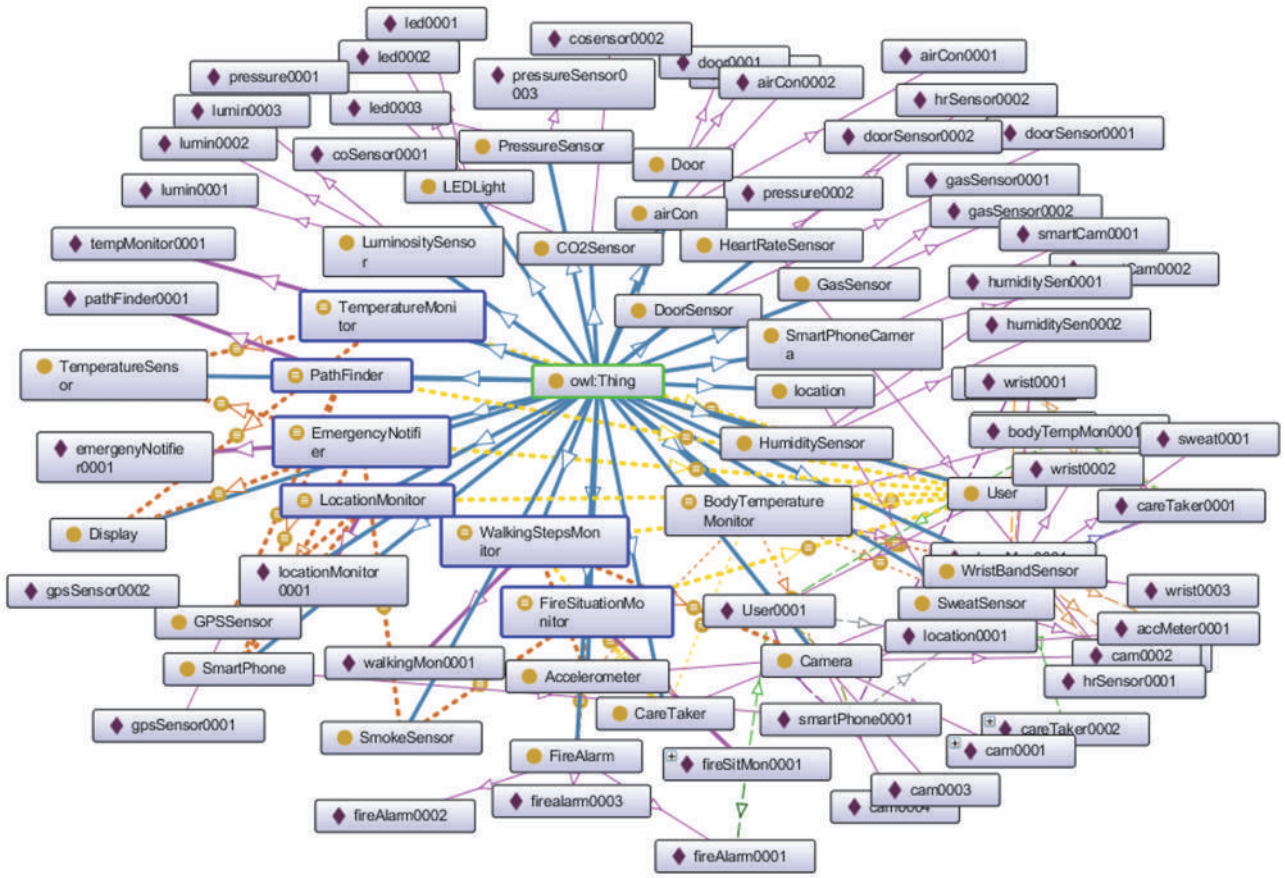

Figure 9: Ontological model of social web objects.

object relationship, the lookup microservice is used. The CMF function has been developed to process the situational information and it selects the most suitable VOs based on the context. The situational information contains the current location of the user, location of the RWOs, and the area under observation. CMF helps form a VO configuration specific to the user current situation. Additionally, to incorporate the real-world facts about the user and the situation, RWK base has been developed which is updated continuously. This also helps in adapting services according to the current situation. VOs provided data is accumulated in RWK model and the reasoning engine is used to infer new facts based on the existing data. The last function of social application server is the preference predictor which provides predictions by using machine learning methods. To implement the learning function, Weka Library [42] has been used. For the objective of demonstration, user preference patterns are collected from the social data and user preference history is used to predict the future patterns.

On the other hand, OMS deals with the semantic representation of VOs. The first functional component of OMS is the ontology management service, which is used to handle VO and CVO ontologies and provides an interface to use VO graphs. Further, to manage ontologies in the developed system, we have used Apache Jena framework [43], and to model VO and CVO ontologies, Protégé [44] has been used. Models generated in Protégé are utilized by ontology management service and stored in OWL format in semantic data stores. To take full advantage of ontology-based implementation, a reasoning engine has also been used to get extra facts related to the modeled concepts. Reasoning engine helps to grow RWK facts stored in VO and CVO ontologies. For the proof of concept, the prototype has used Apache Jena inference engine along with Jena provided reasoner. For the deployment of persistent storage of the RDF data, Jena TDB has been used in our prototype, which is the Jena native high-performance triple store with API support [43]. Query manager is another important component of OMS which provides an interface to query CVO and VO ontologies saved in RDF/XML format, using SPARQL. Also, web services are implemented for the execution of SPARQL queries such as extracting and updating RDF triples in the database. Other than SPARQL query processing, semantic matching of existing concepts is also performed.

Moreover, to achieve interoperable relationships among web objects, a semantic ontology model has been developed as shown in Figure 9. The model constitutes the VO and CVO ontologies and their relationships. Several CVOs have been instantiated, for example, the location navigator, fire situation monitor, emergency notification, and many others that are

```
<!-- http://www.webofobjects.com/hufs/smartservice#01 -->
 <owl:Class rdf:about="http://www.webofobjects.com/hufs/smartservice#01#SmartMuseumService">
     <!-- http://www.webofobjects.com/hufs/smartservice#01#fireSitMon0001 -->
     <owl:NamedIndividual rdf:about="http://www.webofobjects.com/hufs/smartservice#01#fireSitMon0001">
         <rdf:type rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#FireSituationMonitor"/>
         <smartservice:CapturedBy rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#cam0001"/>
         <smartservice:NotifyTo rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#fireAlarm0001"/>
         <smartservice:NotifyTo rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#smokeSensor0001"/>
         <smartservice:checkedBy rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#User0001"/>
     </owl:NamedIndividual>

     <!-- http://www.webofobjects.com/hufs/smartservice#01#PathFinder0001 -->
     <owl:NamedIndividual rdf:about="http://www.webofobjects.com/hufs/smartservice#01#PathFinder0001">
         <rdf:type rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#PathFinder"/>
         <smartservice:checkedBy rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#User0001"/>
         <smartservice:checkedBy rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#surveillanceSystem0001"/>
         <smartservice:notifiedBy rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#location0001"/>
         <smartservice:notifiedBy rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#smartPhone0001"/>
         <smartservice:notifiedBy rdf:resource="http://www.webofobjects.com/hufs/smartservice#01#motionDetector0002"/>
     </owl:NamedIndividual>
 </owl:Class>
```

Figure 10: CVOs and VOs used in the ontology.

```
<!-- http://www.webofobjects.com/hufs/smart-service-ontology#smartPhone0001 -->

<rdf:Description rdf:about="http://www.webofobjects.com/hufs/smart-service-ontology#smartPhone0001">
    <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>
    <rdf:type rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#SmartPhone"/>
    <hasLocation rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#location0001"/>
    <hasOwner rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#User0001"/>
    <batteryStatus rdf:datatype="http://www.w3.org/2001/XMLSchema#string">70%</batteryStatus>
    <deviceName rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Samsung-S5</deviceName>
    <modelNumber rdf:datatype="http://www.w3.org/2001/XMLSchema#string">SHV-E77OS</modelNumber>
    <networkStatus rdf:datatype="http://www.w3.org/2001/XMLSchema#string">WIFI</networkStatus>
    <osVersion rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Andriod version 5.0.1</osVersion>
    <smartPhoneId rdf:datatype="http://www.w3.org/2001/XMLSchema#string">S5-00:33:55:11:00</smartPhoneId>
    <smartPhoneManufacturer rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Samsung</smartPhoneManufacturer>
</rdf:Description>
```

Figure 11: Smartphone VO used in the ontology.

based on the composition of numerous VOs. This development has been supported by OMS and semantic web tools such as Jena. Using OMS, CRUD operations are performed like create, update, and delete on CVOs and VOs using SPARQL. In the developed semantic relationships, two CVO instances, namely, "FireSitMon0001" and "PathFinder0001," have been used in the code snippet provided in Figure 10, for fire situation monitoring and location navigation, respectively. We can see the data properties and object properties associated with each object to maintain the relationship with other objects in the system. Further, to understand the VO representation, a smartphone VO "SmartPhone0001" is shown in Figure 11 with the defined properties. A list of VOs used in our prototype has been given in OWL description as shown in Figure 12.

In the test bed environment, the sensor to the gateway connectivity is enabled using ZigBee and BLE. Another source of information that has been incorporated to provide user-centric service capability is SNS feed, which consists of Twitter and Facebook data collected using social media APIs. On the other hand, user profile and preferences are updated using data management service, and this information is used to grow RWK base.

To test the prototype, an android application has been developed. After the user logs in to the app for WoO based assisted services, the app starts the configuration of services according to the user profile. A list of services is presented on the user's screen from which the user can select any service. These services include museum visit service, location navigator service, recommendation service, and emergency notification. The selected service starts collecting information with the interaction of the user or when the devices start pushing values about any change in the observed environment. Based on these observed parameters, alerts are generated by the app; for example, the museum visit service generates alerts about the available facilities in the museum and the environmental conditions including the indoor and outdoor temperatures. On the other hand, the location navigator service helps the user to navigate around the museum by showing directions to several visitor attractions. Moreover, the emergency notification service triggers alerts when a temporary fire is created to mimic an unusual situation such as fire breakout. The resulting fire increases the temperature reading which is detected by the temperature sensor. This change in reading is forwarded through the gateway and analyzed by the fire situation monitor CVO which checks its threshold value and generates an emergency notification on the user's app screen. Also, the recommendation service is used to generate suggestions about the museum events and the places to visit.

```
<!-- http://www.webofobjects.com/hufs/smart-service-ontology#deviceName -->

<rdf:Description rdf:about="http://www.webofobjects.com/hufs/smart-service-ontology#deviceName">
    <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#CO2Sensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#Camera"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#DoorSensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#FireAlarm"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#GPSSensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#GasSensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#HeartRateSensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#HumiditySensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#LEDLight"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#LuminositySensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#PressureSensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#SmartPhone"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#SmartPhoneCamera"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#SmokeSensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#SweatSensor"/>
    <rdfs:domain rdf:resource="http://www.webofobjects.com/hufs/smart-service-ontology#WristBandSensor"/>
    <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
</rdf:Description>
```

Figure 12: List of VOs used in the ontology.

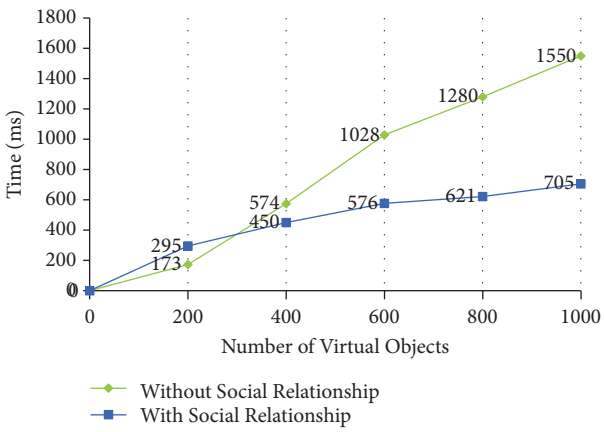

Figure 13: VO discovery time with the increasing number of virtual objects.

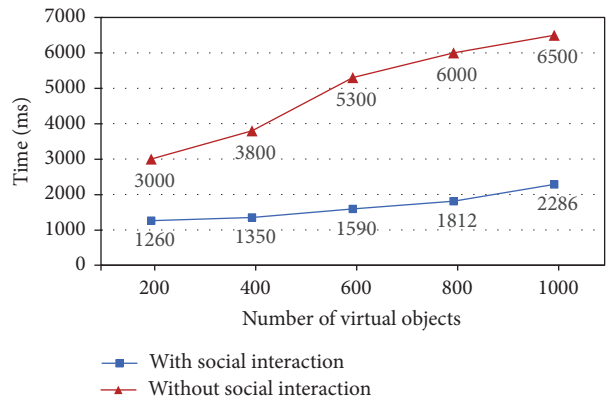

Figure 14: Service execution time with the increasing number of virtual objects.

4.4. Performance Evaluation. The proposed architecture has been analyzed from two different perspectives: system scalability and resource consumption. The results with respect to the experiments and the performance criterion are discussed in this section. The first experiment involves the analysis of the time required to discover the virtual objects in the proposed system with or without social relationship criterion as shown in Figure 13. As it is apparent from the results, initially, to form a social graph, VO discovery process incurs delay due to the communication for establishing social relationship links. However, direct lookup for VOs in the registry at the start of the discovery process comparatively requires less time, but as the number of VOs increases, the delay rises. Traversing the social links to discover objects as the number of virtual objects grows considerably reduces the total lookups in the registry database.

The second experiment provides an analysis of the execution time required for the CVOs as shown in Figure 14. To test this in a real environment, an android application has been developed. The app allows access to the parameters from the available VOs. When the app requires retrieving observations, it iterates through VOs in the repository using a query interface. This requires high CPU utilization with more execution time required to retrieve the sensor values against each app generated request. This is due to the fact that the decision for the selection of VOs has been done at runtime; it requires more time to select the VO graphs, execute them, and get the relevant data from the VOs. However, when object interaction is based on the social relationship, it requires less time for the retrieval as friends in the social network share the data on other friends' requests, which results in less computation as compared with the previous scheme.

Moreover, Figure 15 depicts the time to discover VOs in four different types of services. These services are the museum visit service, the location navigator service, the emergency notification service, and the recommendation service. The discovery time varies from one service to another depending on the number of VOs used. However, as compared with the impact of social connections, it can be

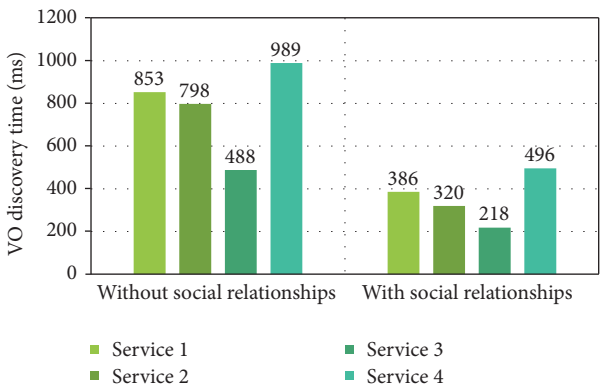

Figure 15: VO discovery time for four different services with or without social relationship utilization.

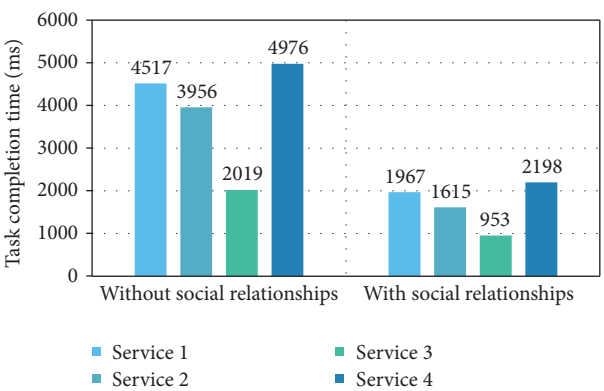

Figure 16: Task completion time required for each service with or without social relationship exploitation.

realized that the services can considerably reduce the time of object discovery and execution by using the relationship model. This is due to the fact that with social association among web objects a service does not have to query the registry for all VOs and rather VOs in the same social graph are utilized. Also, VOs collected observations are shared to save the service time for probing each VO. To view this, Figure 16 shows the overall time required for services to execute their tasks. An important factor to notice here is that the overall task completion time is also affected when social links are used to collect observations from VOs that are used in the service execution.

5. Conclusion

The Internet of Things is bringing the next technological revolution by connecting billions of objects on the earth and providing intelligent IoT services. However, it also carries two most important challenges: the first one is the complexity of handling a huge number of heterogeneous objects and the second one is how to deal with the monolithic approaches for providing services over existing IoT infrastructure. To address these challenges, we have proposed an integrated design based on the principles of SIoT, where the complexity has been handled using socially connected web objects; to overcome the monolithic approaches, microservices that can compose new service features independently have been adopted. In the proposed design, a social relationship model has been presented, which enables the efficient discovery of web objects and reduces the complexity of service provisioning process with the algorithms to discover and compose web objects. A semantic ontology model has also been developed to realize the interoperable social interaction among heterogeneous objects. Finally, a prototype implementation based on a use case scenario has been demonstrated; to evaluate the system with respect to the performance issues, experimental results pertaining to the VO discovery and service execution time have been rendered.

Details of Notations Used in Algorithms

$\mathbb{\Sigma}\phi$: Service object ontologies based on semantic representation where ϕ is a replacement for M_μ which represents microservices M_c which represents CVO and M_v are VO ontologies

$\mathbb{\Pi}_L$: Collection or list of all relationships that are retrieved from service objects

$\mathbb{\Pi}_U$: List of the objects that do not have a relationship or are not associated

$\hat{S}$: Social relationship graph of objects

U: Correlation union of templates

$\underline{\mu}\overline{\mathrm{T}}$: All service objects returned in response to the query request

$\overline{\mathrm{T}}$: All objects returned in response to the query request

μ: The single instance iterated from the collection of microservices

M: Data model based on the specified ontology, where $\mathbb{\Sigma}M_s$ represents service data model, $\mathbb{\Sigma}M_c$ represents context data model, and user profile model is represented as $\mathbb{\Sigma}M_u$

Q: SPARQL query to retrieve the available service templates for user rating

Q': SPARQL query to retrieve the relationship associated with services

$\mathbb{R}_e$: Registry entries of service objects

C_R: Relationship associated with CVO

V_R: Relationship associated with VO

R_c: All possible relationships that can be associated with CVO

R_v: All possible relationships that can be associated with VO

O_i: Iterator object instance for iterating the list of CVO and VO objects

$\mathbb{Z}$: Set of objects' social relationships

σi: Iteration item of the list of service objects

λi: An instance of iteration items in the list of service objects

$\mathbb{\Pi}_{Lm}$: List of all matched service items

ϖi: An instance of iteration items in the list of matched service items

$\mathbb{III}_{LR}$: List of all matched ranking
∂: Ranking value assigned to a service object
σj: Iterator item for the ranking list
κ: Threshold to rank a service object
Wf: Workflow for the composition of service objects
Pq: Priority queue to store ranked object instances
R∂: Assigned relationship ranking.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

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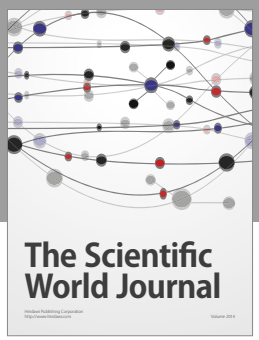

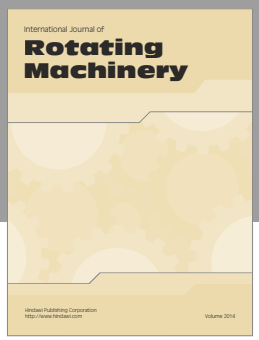

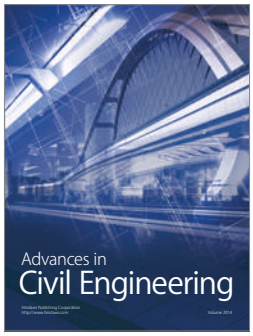

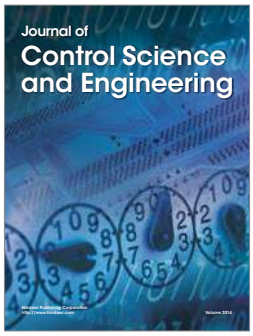

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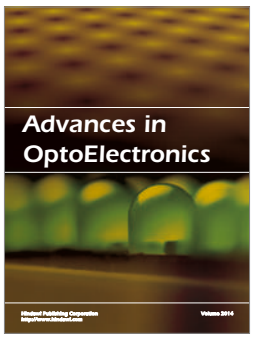

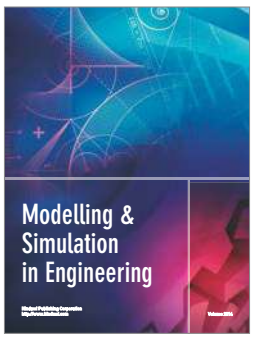

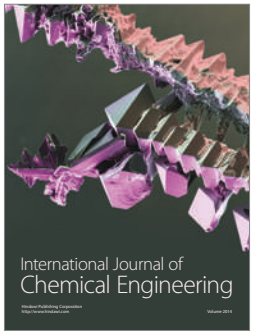

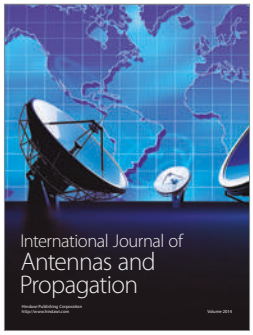

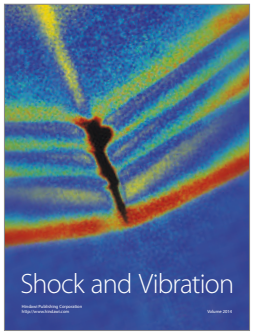

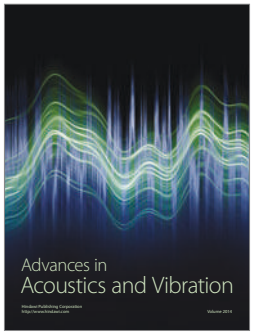

Multiple Antenna Technologies

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ABSTRACT

Multiple antenna technologies have received high attention in the last few decades for their capabilities to improve the overall system performance. Multiple-input multiple-output systems include a variety of techniques capable of not only increase the reliability of the communication but also impressively boost the channel capacity. In addition, smart antenna systems can increase the link quality and lead to appreciable interference reduction.

I. Introduction

Multiple antennas technologies proposed for communications systems have gained much attention in the last few years because of the huge gain they can introduce in the communication reliability and the channel capacity levels. Furthermore, multiple antenna systems can have a big contribution to reduce the interference both in the uplink and the downlink by employing smart antenna technology.

To increase the reliability of the communication systems, multiple antennas can be installed at the transmitter or/and at the receiver. Alamouti code is considered as the simplest transmit diversity scheme while the receive diversity includes maximum ratio, equal gain and selection combining methods. Recently, cooperative communication was deeply investigated as a mean of increasing the communication reliability by not only considering the mobile station as user but also as a base station (or relay station). The idea behind multiple antenna diversity is to supply the receiver by multiple versions of the same signal transmitted via independent channels.

On the other hand, multiple antenna systems can tremendously increase the channel capacity by sending independent signals from different transmit antennas. BLAST spatial multiplexing schemes are a good example of such category of multiple antenna technologies that boost the channel capacity.

In addition, smart antenna technique can significantly increase the data rate and improve the quality of wireless transmission, which is limited by interference, local scattering and multipath propagation. Through shaping the antenna radiation pattern and adaptively adjusting the antenna weight vector, smart antennas improve the communication link quality by increasing the received signal power and suppressing the interference.

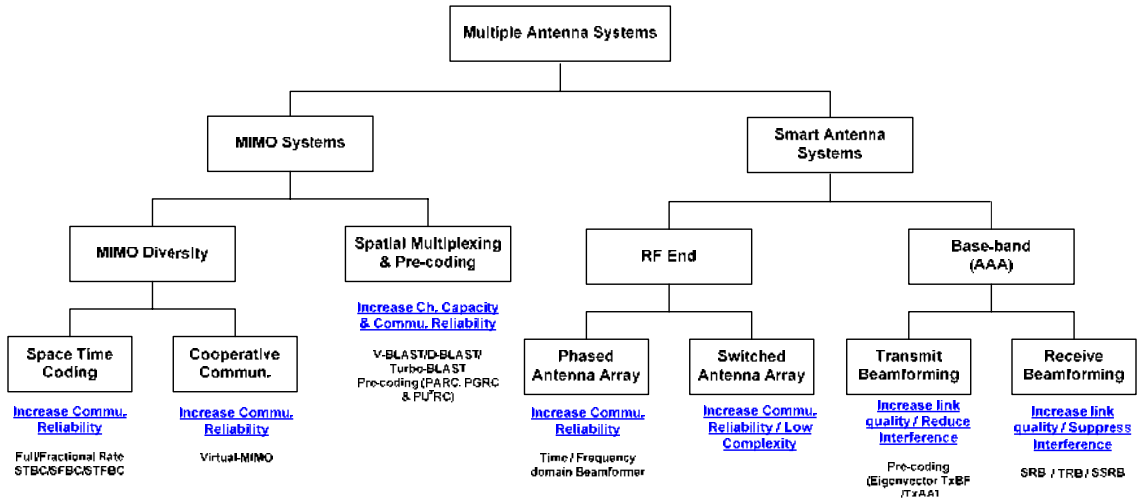

Fig. 1. Multiple antenna technologies.

Besides, on-line calibration technique is also adopted to correct the errors due to the distortions and nonlinearity of the radio frequency components in the antenna array system.

Fig. 1 summarizes the different multiple antenna technologies and gives some examples of these technologies.

This paper is organized as follows: in section II we present multiple antenna diversity schemes employed at the transmitter or/and at the receiver. Spatial multiplexing presented by BLAST schemes is detailed in section III. Section IV is dedicated to some advanced multiple input multiple-output (MIMO) systems including multi-user MIMO and cooperative communications. While techniques related to the smart antennas such as phased antenna array, switched beam antenna array, and adaptive antenna array are described in Section V. Finally, we conclude in Section VI.

II. **MIMO Diversity**

In communication systems, we have to increase the reliability of the communication operation between transmitter and receiver while maintaining a high spectral efficiency. The ultimate solution relies in the use of *diversity*, which can be viewed as a form of redundancy [1]. There are many diversity techniques that can be applied to communication systems; we mention herein time diversity, frequency diversity, and spatial diversity or any combination of these three diversities. In *time diversity*, the same information-bearing signal is transmitted in different time slots where a good gain can be achieved when the duration between the two slots, in which the same symbol is transmitted, is greater than the coherence time of the channel. In *frequency diversity*, the same information-bearing signal is transmitted on different subcarriers where a good diversity gain can be achieved when the separation between subcarriers is greater than the coherence bandwidth.

Finally, in *spatial diversity*, the same information-bearing signal is transmitted or received via different antennas where the maximum gain can be achieved when the fading occurring in the channel is independent (or low correlated). In the receiver, diversity gain can be achieved by combining the redundant signals arriving via independent (or lowly correlated) channels.

Fig. 2 shows some possible combinations of transmit diversity which can be achieved when employing multiple transmit antennas.

In the following section, we present some famous space-time block codes applied at the transmitter side. We present also the combining techniques used when different versions of the information-bearing signal are received. Finally, we present a scheme that includes transmit and receive diversities.

2.1 Space Diversity at the Transmit Side

The basic idea of the use of transmit diversity is to reduce the mobile station (MS) receiver complexity while improving the detection performance.

The pioneering work in the transmit diversity was done by Alamouti where he proposed his famous 2×1 space-time code. Alamouti scheme achieves diversity gain while requiring only a linear decoder.

Later on, Tarokh et al. proposed a generalized theory of the complex orthogonal space-time codes. Based on Tarokh work, more than two antennas can be used and the code rate can be fractional.

In the following we present the two different types of space-time codes.

2.1.1 Complex Orthogonal Space-Time Codes

For this type of space time codes, the following conditions must be satisfied

- Square transmission matrix (number of transmit antennas N_t equal to number of used time slots m)
- A unity code rate (number of used time slots m equals to number of transmitted symbols l)
- Orthogonality of the transmission matrix in the time and space domains ($SS^H = S^H S$) where S^H is the conjugate transpose of S.

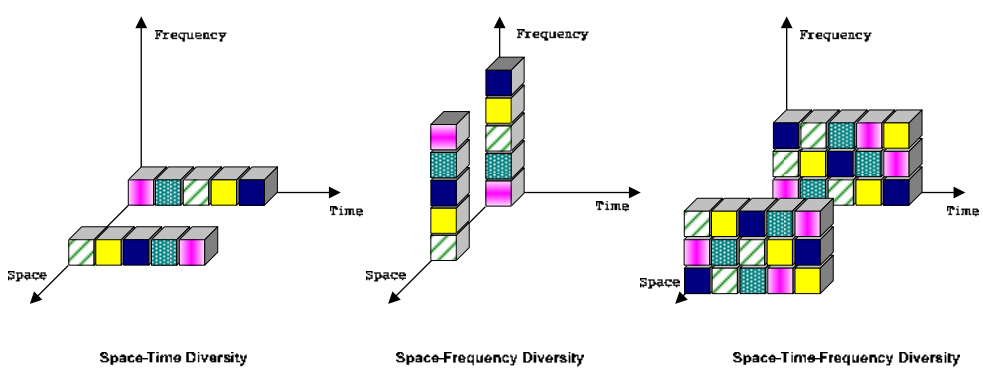

Fig. 2. Transmit diversity.

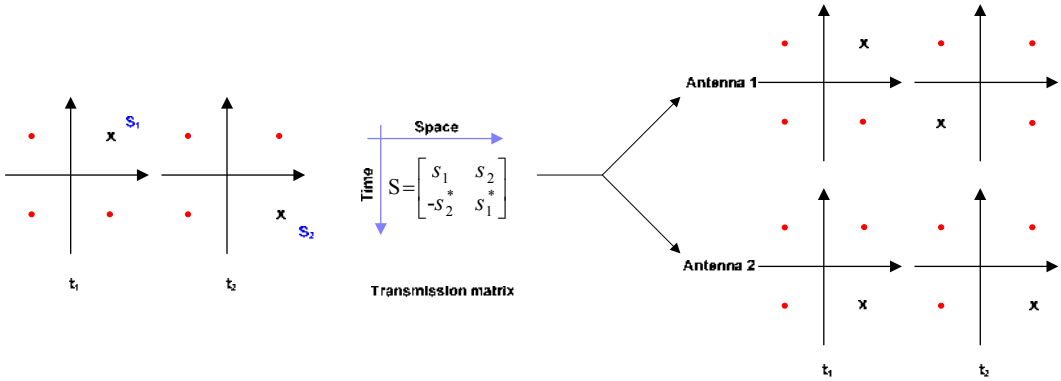

Fig. 3. Alamouti scheme example with QPSK modulation.

As said before, the simplest complex orthogonal space-time code is the Alamouti code which uses two transmit antennas and one receive antenna. Furthermore, Alamouti scheme requires that the fading channel envelope remains constant over two time slots.

Fig. 3 shows an example of the encoding process of Alamouti scheme with QPSK modulation [2], [3].

Fig. 4 shows the receiver structure used for decoding the combined received symbols.

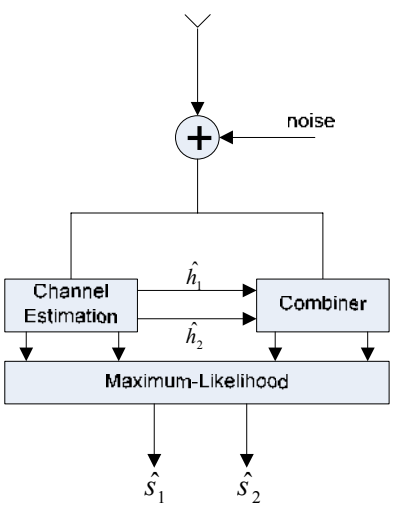

Fig. 4. Alamouti code receiver.

At the receiver the following signals are received (with applying the complex conjugate to the received signal at t_2)

$$\begin{bmatrix} y_1 \\ y_2^* \end{bmatrix} = \begin{bmatrix} h_1 & h_2 \\ h_2^* & -h_1^* \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2^* \end{bmatrix} \qquad (1)$$

The linear combiner multiplies the received symbols by the Hermitian transpose of the channel matrix (for simplicity, we consider that channel is perfectly estimated). The output of the linear combiner is then given by

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \left[h_1^2 + h_2^2 \right] \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} + \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} \qquad (2)$$

Maximum-Likelihood (ML) decoder is then applied to get the transmitted symbols. As one can see, the simplicity of the receiver is due to the spatio-temporal orthogonality of the transmission matrix.

A complex orthogonal space-time code using 4 or 8 antennas was proposed by Tarokh et al. in [4].

2.1.2 Generalized Complex Orthogonal Space-Time Codes

The search for space-time codes with more than two antennas was started by Tarokh, Jafarkhani, and Calderbank. Their work

has built the basis for a theory of generalized complex orthogonal designs.

Generalized complex orthogonal designs are distinguished from Alamouti code by the following

- A non-square transmission matrix (number of used time slots ≠ number of Tx antennas)
- A fractional code rate (number of transmitted symbols < number of used time slots)
- Orthogonality of the transmission matrix is only guaranteed in the time sense.

As a consequence of these characteristics, the spectral efficiency is reduced and the number of time slots over which the channel should be constant is increased.

The transmission matrix of a generalized complex space-time code with 3 antennas, 4 transmitted symbols and 8 used time slots is given by [5]

$$\mathbf{G_3} = \begin{bmatrix} s_1 & s_2 & s_3 \\ -s_2 & s_1 & -s_4 \\ -s_3 & s_4 & s_1 \\ -s_4 & -s_3 & s_2 \\ s_1^* & s_2^* & s_3^* \\ -s_2^* & s_1^* & -s_4^* \\ -s_3^* & s_4^* & s_1^* \\ -s_4^* & -s_3^* & s_2^* \end{bmatrix} \qquad (3)$$

In the literature, more research was done to increase the rate of the space-time codes. For more details refer to [6].

Table 1 summarizes the difference between Alamouti and space-time code characterized by the transmission matrix $\mathbf{G_3}$.

These shown coding schemes can be transmitted in the space-time domains, space-frequency domains or in space-frequency-Time domains. These coding schemes are thus known as ST, SF, and STF coding, respectively [7].

2.1.3 Cyclic Delay Diversity (CDD)

CDD can be considered as a very simple transmit diversity scheme. CDD can achieve transmit artificial frequency diversity by selecting appropriate transmit delays. In this method, multiuser diversity, obtained by scheduling based on frequency domain channel response, can be improved by adjusting the delay spread (at the transmitter) which is done by controlling the delay values dependent on the channel condition [8], [9].

2.2 Space Diversity at the Receive Side

In space diversity at the receive side, multiple antennas are used in the receiver with sufficient spacing between antennas in such a way mutual correlation between antennas is reduced and as consequence diversity gain is increased [10]. To get diversity gain at the receiver, received signals from different antennas are combined. There are four combining methods, namely, select combining (SC), maximal-ratio combining (MRC), equal-gain combining (EGC), and square-law combining. The first three schemes are linear while the last requires a non-linear receiver.

Fig. 5 shows a simplified block diagram of the linear combining schemes which differ in the weighting vector **w.** In SC, the signal at the branch with maximum signal to noise ratio (SNR) is selected and other received signals are discarded.

The weighting vector $\mathbf{w} = (w_1, w_2, \ldots, w_M)$ is the Nth column of the identity matrix of size M where the Nth branch has the maximum SNR.

Table 1. Comparison between Alamouti and generalized complex space-time codes.

Space-time code	Number of Tx antennas	Number of transmitted symbols, *l*	Number of used time slots, *m*	Orthogonality of Tx matrix	Rate = *l/m*
S	2	2	2	Spatio-temporal sense	1
G_3	3	4	8	Only temporal sense	1/2

Table 2. Comparison between diversity combining schemes.

Scheme	Requiring CSI	Outage Probability F(x)	Application
SC	No	$\left[1-e^{-x/\bar{y}_c}\right]^M$	No constraints
MRC	Yes	$1-e^{-x/\bar{y}_c}\sum_{k=0}^{M-1}\frac{1}{k!}\left(\frac{x}{\bar{y}_c}\right)^k$	No constraints
EGC	Yes	No closed form for M > 2	No constraints
SLC	No	-	FSK or DS-CDMA

As one can see, the SC scheme does not require any channel information except that of SNR. On the other hand, MRC and EGC schemes require the channel state information (CSI) or a part of it (channel envelope, phase, delay). MRC scheme weights the received signals according to their reliability; a more reliable signal has a high weight while a less reliable signal has a small weight. Also, the channel phase distortion is compensated. Finally, signals are aligned then combined. On the other hand, EGC scheme can be viewed as a simplified version of MRC where signals are weighted equally (i.e. the weighting vector $\mathbf{w} = [1, 1, \ldots, 1]_M$) then aligned before being combined coherently. In practice, the phase at different branches can't be often estimated. So, EGC and MRC can't be employed. In such situations, square law combining (SLC) can be applied to obtain spatial diversity without requiring phase estimation. Unlike linear combining schemes, SLC scheme can only be applied to modulation schemes which preserve some sort of orthogonality including frequency-shift keying (FSK) or direct-sequence CDMA [5], [11].

Table 2 summarizes a comparison between combining schemes. It is known that, from a performance point of view, MRC is optimum and gives the best performance among the pre-described combining schemes.

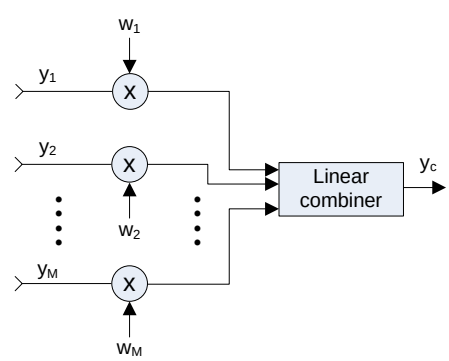

Fig. 5. Simple block diagram of linear combining schemes.

2.3 Combined Transmit/Receive Diversity

Spatial diversity schemes explained in the previous two sections can be combined together to achieve diversity at both receive and transmit sides. An example of such a hybrid spatial diversity scheme is

the 2×2 Alamouti/MRC MIMO system [12].

III. Spatial Multiplexing

As shown in the previous section, MIMO diversity can be used in the transmitter or the receiver sides or in both to increase the reliability of the communication. In this section we talk about spatial multiplexing schemes which are for goal to increase the channel capacity.

The most known spatial multiplexing schemes are the BLAST family which includes Vertical-BLAST, Diagonal-BLAST, and Turbo-BLAST. The acronym BLAST stands for "*Bell Laboratories Layered Space-Time*".

3.1 Diagonal-BLAST

D-BLAST was originally proposed by Foschini [13]. In D-BLAST, the symbols to be transmitted are arranged on the diagonals of the space-time transmission matrix where elements under the diagonal are padded with zeros. Fig. 6-a depicts the structure of the D-BLAST transmitter for four transmit antennas. At first, the bit stream is de-multiplexed into four parallel streams which are encoded and modulated independently. Encoded-modulated streams are cycled over time. Equation (4) is an example of the transmission matrix when using four transmit antennas.

$$S = \begin{bmatrix} s_{1,1} & s_{1,2} & s_{1,3} & s_{1,4} & \cdots & s_{1,K-1} & s_{1,K} & 0 & 0 & 0 \\ 0 & s_{2,1} & s_{2,3} & s_{2,4} & \cdots & s_{2,K-2} & s_{2,K-1} & s_{2,K} & 0 & 0 \\ 0 & 0 & s_{3,1} & s_{3,2} & \cdots & s_{3,K-3} & s_{3,K-2} & s_{3,K-1} & s_{3,K} & 0 \\ 0 & 0 & 0 & s_{4,1} & \cdots & s_{4,K-4} & s_{4,K-3} & s_{4,K-2} & s_{4,K-1} & s_{4,K} \end{bmatrix} \quad (4)$$

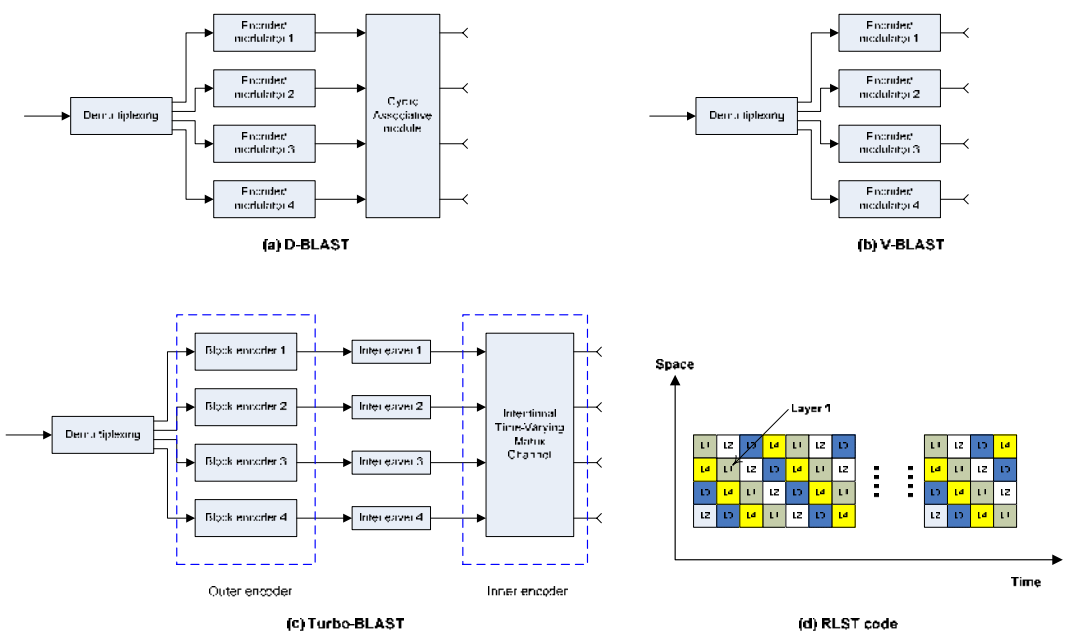

Fig. 6. Transmitter block diagrams for BLAST family using four transmit antennas.

Table 3. MIMO systems diversity orders.

MIMO Configuration	Diversity order
STBC	$N_t \times N_r$
BLAST	$N_r - N_t + 1$

The first diagonal of S is transmitted via the first antenna; the second diagonal is transmitted via antenna 2, and so on.

3.2 Vertical-BLAST

A simplified version of D-BLAST was proposed by Wolniansky known as Vertical-BLAST or V-BLAST [14]. In V-BLAST, incoming data stream is de-multiplexed into N_t streams each of which is encoded and modulated independently and sent on an antenna of its own. V-BLAST high-level diagram is depicted in Fig. 6-b where four antennas are used at the transmit side. Compared to D-BLAST, V-BLAST does not include cycling over time, the complexity is significantly reduced. In addition, unlike D-BLAST, V-BLAST does not include any space-time wastage. At the receiver, transmitted symbols can be decoded using *ordered serial interference-cancellation (OSIC) detector*. For the OSIC to work properly, the number of receive antennas N_r must be at least as large as the number of transmit antennas.

3.3 Turbo-BLAST

Turbo-BLAST was first described by Sellathurai and Haykin [15]. The Turbo-BLAST transmitter structure is depicted in Fig. 6-c. The data stream bits are firstly demultiplexed into N_t parallel streams which are encoded independently using the block encoder (outer encoder) (i.e. channel coding). The output streams of the outer encoder are interleaved independently and passed to the inner encoder. The mission of the outer encoder is to achieve *random-layered space-time* (RLST) coding.

The structure of the RLST encoder, with periodical cyclic space-time interleaving is depicted in Fig. 6-d. For optimal performance of the RLST code, the receiver should employ the *maximum a posteriori probability (MAP)* decoding algorithm. Nevertheless, the complexity of the MAP decoding algorithm is very high (increases exponentially with N_t). To decrease the complexity of the receiver, the near-optimal turbo-like receiver can be used. This near-optimal turbo-like receiver is known as *iterative detection and decoding (IDD) receiver*.

Before going further, we list in Table 3 a comparison between diversity order of the different space-time coding and the BLAST family schemes.

IV. Advanced Topics

4.1 Single and Multi CodeWord MIMO

In single codeword (SCW) MIMO, an encoded packet is distributed across many streams to form the MIMO transmission. Feedback is used to control the rank of the MIMO transmission (number of streams used) as well as the overall rate of transmission. In multiple codeword MIMO, several separately encoded packets are transmitted independently over the multiple streams. Here the rate of each stream can be controlled with feedback [16] and [17].

4.2 Single-User MIMO and Multi-User MIMO

In single-user MIMO, already explained techniques in previous sections are used where the channel capacity grows linearly with *min(Nt, Nr)* [18].

For multi-user MIMO, which is of high interest research topic, it was shown that for N_t transmitting antennas (at the base station) and N_r users, the same overall capacity can be achieved. This later work was encouraged by applying dirty paper coding [19] where results showed that if the transmitter knows the interfering signal, then the channel capacity will not be affected by the presence of the interference [20]. On the other hand, multi-user MIMO can integrate beamforming to apply spatial division multiple access (SDMA).

4.3 Cooperative Communication and Virtual MIMO

In cooperative communication, a mobile can act as both a user and relay. As consequence, mobile sends to the base station its own data bits and some of other mobiles (sometimes called partner) information bits. Fig. 7 shows a cooperative cellular system where for simplicity we consider three cooperative users and one base station [21]. As depicted in Fig. 7, user 1 cooperates with users 2 and 3 to send its own information. As a result, the overall cooperative system can be seen as virtual-MIMO (V-MIMO) and in the above example it is $3\times N_{BS}$ MIMO system (for the uplink) where N_{BS} is the base station's number of receive antennas. Users 2 and 3 can simply amplify and forward user 1 received information or detect and forward [22]. Another method of cooperation is the coded cooperation where different coded portions are sent via different fading channels [23].

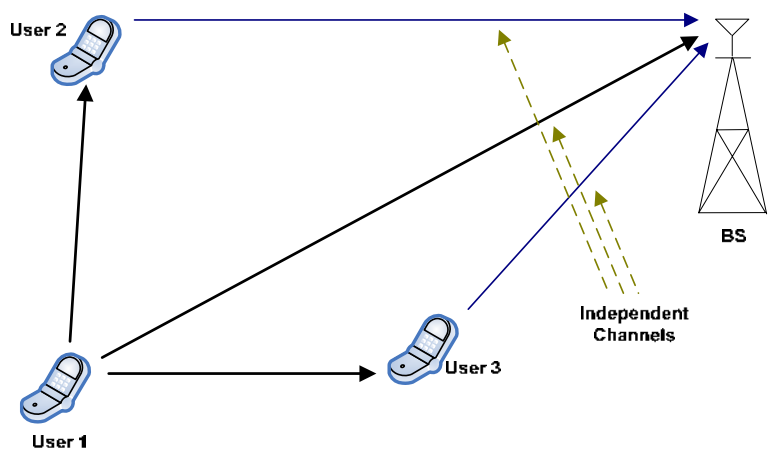

Fig. 7. Cooperative communication and virtual-MIMO.

4.4 Pre-Coded MIMO with Rank Adaptation

4.4.1 Per Antenna Rate Control (PARC)

PARC can be considered as a closed-loop MIMO system where transmitter uses *channel quality indication* (CQI) fed by the receiver to select the best modulation and coding schemes per antenna. Fig. (8) shows a general PARC transmitter structure with 4 transmit antennas [24].

4.4.2 Per Group Rate Control (PGRC)

In PARC, a CQI feedback is necessary for each transmit antenna. This increases the uplink overhead.

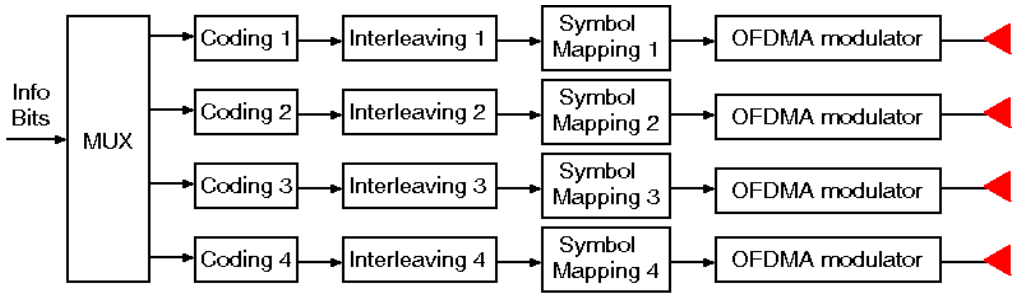

Fig. 8. Per Antenna Rate Control (PARC).

To solve this problem, PGRC is used where a feedback is required per group of antennas. This reduces the feedback information while maintaining almost the same performance of PARC [24].

4.4.3 Per User Unitary Rate Control (PU^2RC)

PU^2RC is a multi-user closed-loop MIMO system. Each user feeds back the CQI to the base station. The base station uses the CQI to determine the modulation and coding schemes per user. In addition, base station can apply unitary pre-coding and adaptively select the number of transmit antennas (rank adaption) [25].

V. Smart Antennas

5.1 Introduction

Smart antenna was born in the early 1990s when well developed adaptive antenna arrays originate from Radar system. Later, Smart antenna technique is applied in wireless communications system. Recently, Smart antenna technique has been proposed as a promising solution to the future generations of wireless communication systems, such as the Fourth-Generation mobile communication systems, broadband wireless access networks, where a wide variety of services through reliable high-data rate wireless channels are expected. Smart antenna technique can significantly increase the data rate and improve the quality of wireless transmission, which is limited by interference, local scattering and multipath propagation [26], [27]. Smart antennas offer the following main applications in high data-rate wireless communication systems [28], [29]:

- Spatial Diversity
- Co-channel interference reduction
- Angle reuse or space division multiple access (SDMA)
- Spatial multiplexing

Smart antenna system can be categorized into three main groups: Phased antenna array system, switched beam systems, and adaptive antenna array system. To match the characteristics in each radio frequency chain of the transmitter and receiver, on-line calibration is required in smart antenna systems. On-line calibration technique can compensate the errors such as the distortions of radio frequency components due to small environment changes, the nonlinear characteristics of mixer, amplifier and attenuator, I/Q imbalance errors, etc.

5.2 Phased Antenna Array System

Phased antenna array is a group of antennas in which the relative phases of the respective signals feeding the antennas are varied in such a way that the effective radiation pattern of the array is reinforced in a desired direction and suppressed in undesired directions.

Phased antenna array system is usually utilized in *radio frequency* (RF) or *intermediate frequency* (IF) with the system central frequency larger than 10 GHz, such as satellite communication system [30]. There are two main different types of phased arrays, also called beamformers. There are time domain beamformers and frequency domain beamformers.

5.3 Switched Beam System

The switched beam method is considered as an extension of the current sectorization scheme. In the switched beam approach, the sector coverage is achieved by multiple predetermined fixed beam patterns with the greater gain placed in the centre of a beam [30]. When a mobile user is in the vicinity of a beam, then the signals at the output ports will be given as in (5). This enables the switched beam system to select the signal from the output port corresponding to that beam. As the mobile moves to the coverage of another beam during the call, the system monitors the signal strength and switches to other output ports as required. A basic switched beam antenna architecture is shown in Fig. 9. And Fig. 10 illustrates the produced antenna pattern with 4 antennas.

$$y_i(t) = s_i(t)G_i(t)\sum_{l=1}^{L} I_l(t)G_{li}(\theta_l) \qquad (5)$$

where $y_i(t)$ is the total signal appearing at port i, $s_i(t)$ is the signal source, $I_l(t)$ is the interfering signal source located at arbitrary angles θ_l, G_i is the transfer function between signal source along the main beams and their corresponding output ports, G_{li} is the transfer function between interference signal l and port i.

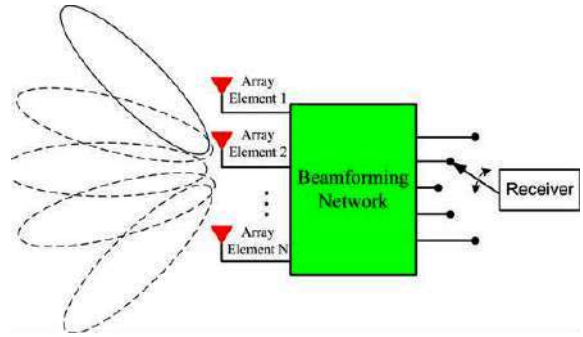

Fig.9. Functional block diagram of switched beam system.

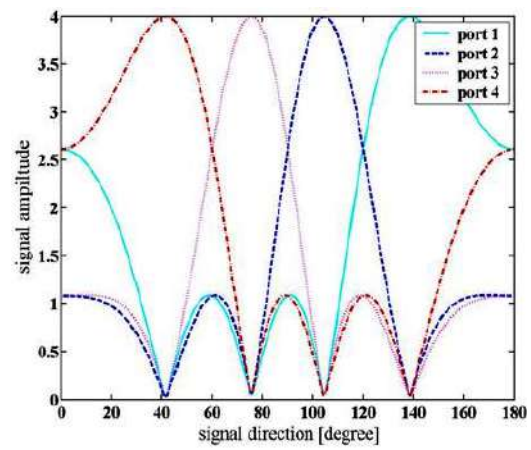

Fig.10. Produced antenna pattern of switched beam system with 4 antennas.

Switched beam systems can offer several advantages, including

- Low complexity and cost. Since switched beam system only requires a beamforming network, RF switches, and simple control logic, they are relatively easy and cheap to implement.
- Moderate interaction with base station receivers. In practice, switched beam system can simply replace conventional sector antennas without requiring significant modifications to the radio base station antenna interface or the baseband algorithms implemented at the receiver.
- Coverage extension. The antenna array aperture gain will boost the link

budget, which could be translated to a coverage extension.

5.4 Adaptive Antenna Array System (AAA)

Adaptive antennas date back to 1959. The original work was attributed to L. C. Van Atta's work, Electromagnetic Reflection. Since then, adaptive beamforming techniques have been employed to remove unwanted noise and jamming from the output, mainly in military applications. With the thriving commercial wireless communication industry and the advancing microprocessor technologies, the adaptive beamforming techniques have found their applications in commercial wireless communications. With powerful *digital signal processing* (DSP) hardware at the base-band, algorithms could control antenna beam patterns adaptively to the real signal environment, forming beams towards the desired signals while forming nulls to co-channel interferers. Thus, the system performance is optimized in terms of link quality and system capacity [31].

Adaptive antenna array can be utilized in the transmitter side, which is known as *transmit beamforming* (TxBF) or in the receiver side, which is called *receive beamforming* (RxBF).

5.4.1 Transmit Beamforming (TxBF)

The implementation of adaptive antenna array technique in a handset is difficult with today`s hardware due to its limitations in size, cost, and energy storage capability, while it is feasible to adopt antenna arrays at base stations. Transmit beamforming provides a powerful method for increasing downlink capacity [32]-[35]. The idea of TxBF is similar to the pre-coded MIMO technique but with different strategies to calculate the transmit weight vector. TxBF adjusts the antenna main lobe towards to the desired user and reduce the interference to other users. A simple illustration of TxBF is shown in Fig. 11.

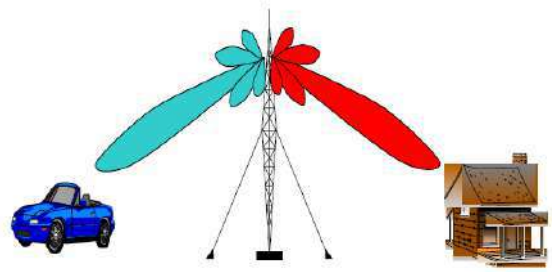

Fig.11. An illustration of TxBF.

Eigenvector TxBF Algorithm

Eignenvector TxBF algorithm is widely used for TxBF. The eigenvector of the spatial covariance channel matrix is calculated as

$$\mathbf{R}_{ss} = \boldsymbol{\lambda}\mathbf{H} \qquad (6)$$

where $\mathbf{R}_{ss}$ is the autocovariance matrix of the desired user`s signal, and $\mathbf{H}$ is the spatial covariance channel matrix. The eigenvector $\boldsymbol{\lambda}_{max}$ which corresponds to the largest eigenvalue will be selected as the weight vector [36]. One example of beam pattern for 4 uniform linear array elements is shown in Fig 12.

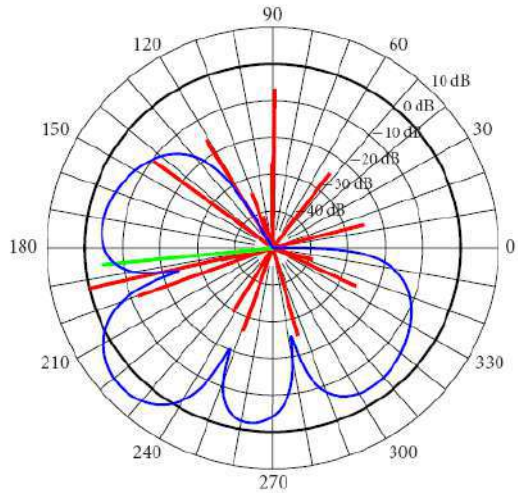

Fig. 12. Example beam pattern of 4 antenna elements in a sectorized system for a single sector (main beam direction is 240°).

Transmit Adaptive Array (TxAA) Algorithm

Transmit adaptive array (TXAA) is a technique in which the user periodically sends quantized estimates of the optimal transmit weights to the BS via a feedback channel. The transmitter weights are optimized to deliver maximum power to the user. The optimal transmit weights are given by

$$\mathbf{w} = \mathbf{H}^H / \mathbf{H}\mathbf{H}^H \qquad (7)$$

where **w** is the transmit weight vector and **H** is the channel matrix.

The weights are normalized so that the total transmitted power is not altered. In the case of multipath channels emanating from each antenna, the optimal weights will be given by the principal eigenvector of the channel correlation matrix $\mathbf{H}^H\mathbf{H}$.

5.4.2 Receive Beamforming (RxBF)

Beamforming also can be applied in the uplink to improve the link quality and suppress the co-channel interference, which is known as *receive beamforming* (RxBF). Through RxBF, smart antenna system can receive predominantly from a desired direction (direction of the desired source) compared to some undesired directions (direction of interfering sources). This implies that the digital processing has the ability to shape the radiation pattern to adaptively steer beams in the direction of the desired signals and put nulls in the direction of the interfering signals. This enable low co-channel interference and large antenna gain to the desired signal.

Based on the reference signals adopted in the beamforming algorithms, RxBF can be classified into *spatial reference beamforming* (SRB), *temporal reference beamforming* (TRB), and *signal structure reference beamforming* (SSRB).

Spatial Reference Beamforming (SRB)

Spatial reference beamforming method is sometimes referred as *direction of arrival* (DoA) method. SRB estimates the direction of arrival of the signal based on the spatial reference signal, using any of the techniques like *multiple signal classification* or *estimation of signal*

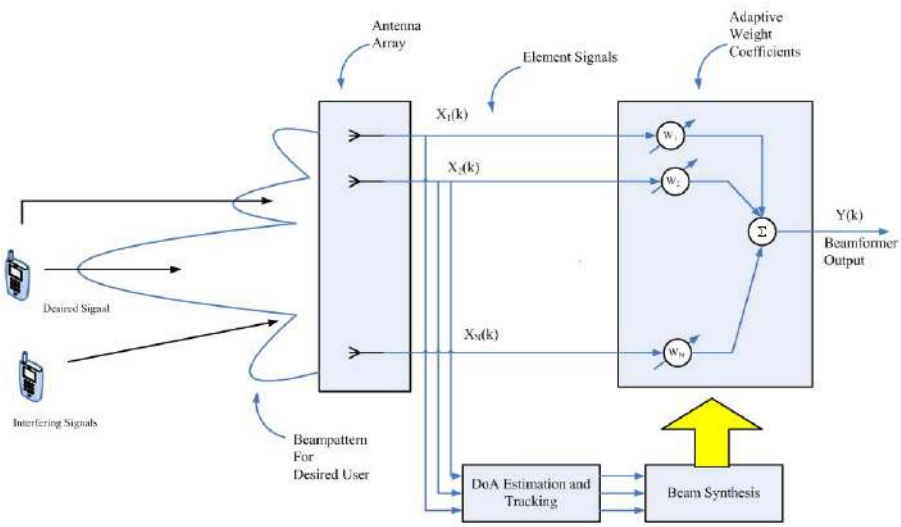

Fig. 13. A general structure of SRB.

parameters via rotational invariance techniques algorithms or their derivatives. They involve finding a spatial spectrum of the antenna/sensor array, and calculating the DoA from the peaks of this spectrum [37]. A general architecture of SRB algorithm is shown in Fig. 13. The general steps of SRB method are shown as follows:

- DoA Estimation
  - Arbitrary Array: MUSIC, etc.
  - Linear Array: ESPRIIT, etc.
- Beam Synthesis
  - Gram-Schmidt, etc.
- Combining
  - EGC, MRC, Wiener Filter, etc.

Multiple signal classification (MUSIC) algorithm estimates the DoA of the desired signal by using an eigen-space method based on a spatial reference signal. MUSIC requires intensive calculation of eigenvalues and eigenvectors of an autocorrelation matrix of the input vectors from the receiving antenna array. A general step of MUSIC algorithm is shown below:

- Collect received samples and estimate the covariance matrix of the received samples.
- Perform eigen-decomposition of the covariance matrix.
- Calculate spatial spectrum.
- Estimate DoA by locating peaks in the spectrum.

Estimation of signal parameters via rotational invariance techniques (ESPRIT) is also well known for the SRB method. In addition, ESPRIT has many important advantages over MUSIC algorithm [38]:

- No knowledge of the array geometry and element characteristics are required.
- Much less complex on computation.
- No calibration of the array is required.
- The algorithm simultaneously estimates the number of sources and DoA`s

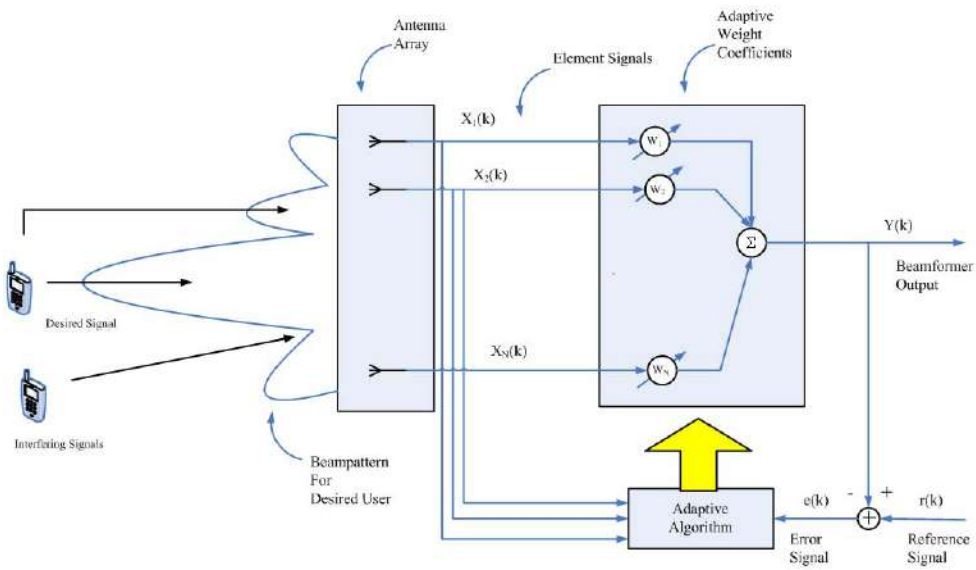

Fig. 14. A general structure of TRB.

Temporal Reference Beamforming (TRB)

Temporal Reference Beamforming shown in Fig. 14, is a method used to create the radiation patter of the antenna array by adding constructively the phases of the signals in the DoA of the desired user, and nulling the pattern of the interfering users based on the temporal reference signal [39]. Based on the temporal reference signal and some predefined adaptive weight calculation criterion, some adaptive algorithms such as LMS (Least Mean Square), RLS (Recursive Least Squares), and DSMI (Direct Sample Matrix Inverse) algorithms, are used to adjust the weight vector of the antenna array to improve the link quality. The general characteristics of TRB are as follows:

- Good performance in multipath channel environment
- Computationally inexpensive
- Requiring Training sequence
- Difficult to apply TxBF because of the absence of DoA information

Criterion of Adaptive Weight Calculation

In the *minimum mean-square error* (MMSE) criterion, the weights are chosen to minimize the *mean-square error* (MSE) between the beamformer output and the temporal reference signal. While in the *maximum signal-to-interference ratio* (MSIR) criterion, the weights are chosen to directly maximize the signal-to-interference ratio (SIR). And The *minimum variance* (MV) criterion chooses the weights that minimize the variance of the output power. All the above three criterions has the same form of

$$\mathbf{w}_{opt} = \beta \mathbf{R}_i^{-1} \mathbf{v} \qquad (8)$$

where $\mathbf{R}_i^{-1}$ is the inverse of the covariance matrix of the interference signals received in the antenna array and $\mathbf{V}$ is the antenna array propagation vector [40].

Let us assume that *d(t)* is the transmitted temporal reference signal and $\mathbf{R}_u$ is the covariance matrix of interference signals at the output of the beamformer. The calculation of β for MMSE, MSIR

Table 4. β Calculation.

Criterion	MMSE	MSIR	MV
$\boldsymbol{\beta}$	$\frac{E\{d^2(t)\}}{1+E\{d^2(t)\}\mathbf{v}^H\mathbf{R}_i^{-1}\mathbf{v}}$	$\frac{E\{d^2(t)\}}{SIR}\mathbf{v}^H\mathbf{w}_{opt}$	$\frac{g}{\mathbf{v}^H\mathbf{R}_u^{-1}\mathbf{v}}$

and MV criterions are summarized in Table 4.

Adaptive Beamforming Algorithm

The *least mean square* (LMS) algorithm uses the temporal reference signal to update the weights at each iteration. In the LMS algorithm, we are searching for the optimal weight that would make the array output either equal or as close as possible to the reference signal, which is the weight that minimizes the MSE. Since the MSE has a quadratic form, moving the weights in the negative direction of the gradient of the MSE should lead us to the minimum of the error surface. The weight update equation is shown in (9) [30].

$$\mathbf{w}(t+1)=\mathbf{w}(t)-\mu\mathbf{x}(t+1)\varepsilon^* \quad (9)$$

where μ is a constant, called the step size, which determines how close the weights approach the optimum value after each iteration and it controls the convergence speed of the algorithm. And ε is the error signal between the temporal reference signal and the received signal at the beamformer output. **x**(t+1) is the received signal vector at the antenna array at time *t+1*.

The main drawback of the LMS algorithm is that it is sensitive to the scaling of its input. This makes it very hard (if not impossible) to choose a step size μ that guarantees stability of the algorithm. The *normalized least mean square* (NLMS) algorithm is a variant of the LMS algorithm that solves this problem by normalizing with the power of the input. The weights updating function of NLMS algorithm is shown as

$$\mathbf{w}(t+1)=\mathbf{w}(t)+\frac{\hat{\mu}}{a+\|x(t)\|^2}\mathbf{x}(t)\varepsilon^* \quad (10)$$

Recursive least square (RLS) algorithm is derived to overcome the drawback of slow convergence speed in the LMS algorithm, when the eigenvalue spread of the correlation matrix R of received signal vector **x** is large. RLS algorithm replaces the step size μ with the inverse of R. The weights are then updated using (11).

$$\mathbf{w}(t+1)=\mathbf{w}(t)-\mathbf{R}^{-1}\mathbf{x}(t+1)\varepsilon^* \quad (11)$$

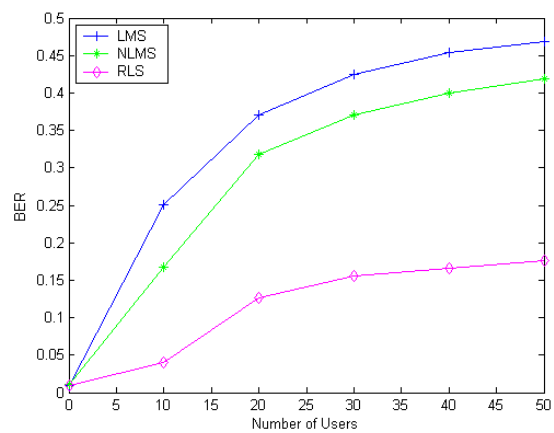

Fig. 15. Performance comparison among LMS, NLMS, and RLS algorithms.

Fig. 15 shows a simple performance comparison of the above three algorithms in OFDMA system under the Rayleigh fading channel with 8 antenna elements [41]. From this figure, we see that RLS algorithm performs best due to its faster

convergence speed than LMS and NLMS algorithms.

Signal Structure Reference Beamforming (SSRB)

SSRB method is based on inherent structure of the transmit signal of the implicit kind reference signal. Algorithms such as blind beamforming, least squares, and constant modulus algorithms, are based on the SSRB method. SSRB method is robust against different propagation conditions and does not require the array manifold knowledge. But the convergence problem becomes the main drawback of the SSRB method.

VI. Conclusions

In this paper we introduced the multi antenna technologies which can be considered as one of the most vivid area of research. Multiple antenna technologies were categorized into two main groups where in the first group we introduced some techniques related to spatial diversity and spatial multiplexing by outlining the gain achieved by these schemes. Furthermore, we introduced the smart antenna techniques and the up-to-date research progress in this field.

The advantages of multiple antenna systems make of them a very strong candidate to increase link reliability, increase channel capacity and reduce interference in both uplink and downlink.

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Introduction: the vision for 5G, creating an ultra-connected society

5G wants to be the disruptive generation, the generation that no longer only caters to the needs of mobile operators and consumer communications, but which opens up new prospects and enables an extremely wide diversity of applications and use, unified within a single technology. 5G is setting itself up as an enabler of the digitisation of society and the economy.

The idea that is starting to take shape behind the notion of 5G is that it will not mean just an increase in transmission speeds, as has been the case with previous generations.

Consumer mobile communications, video downloads and the use of mobile apps account for the bulk of 4G networks' radio resources usage today. With 5G, the goal will be to enable a much broader spectrum of uses and a much greater diversity of users.

5G is targeting a wide variety of sectors, which will not necessarily have anything other than this technology in common, but which are central pillars in a society: energy, healthcare, media, industry and transportation.

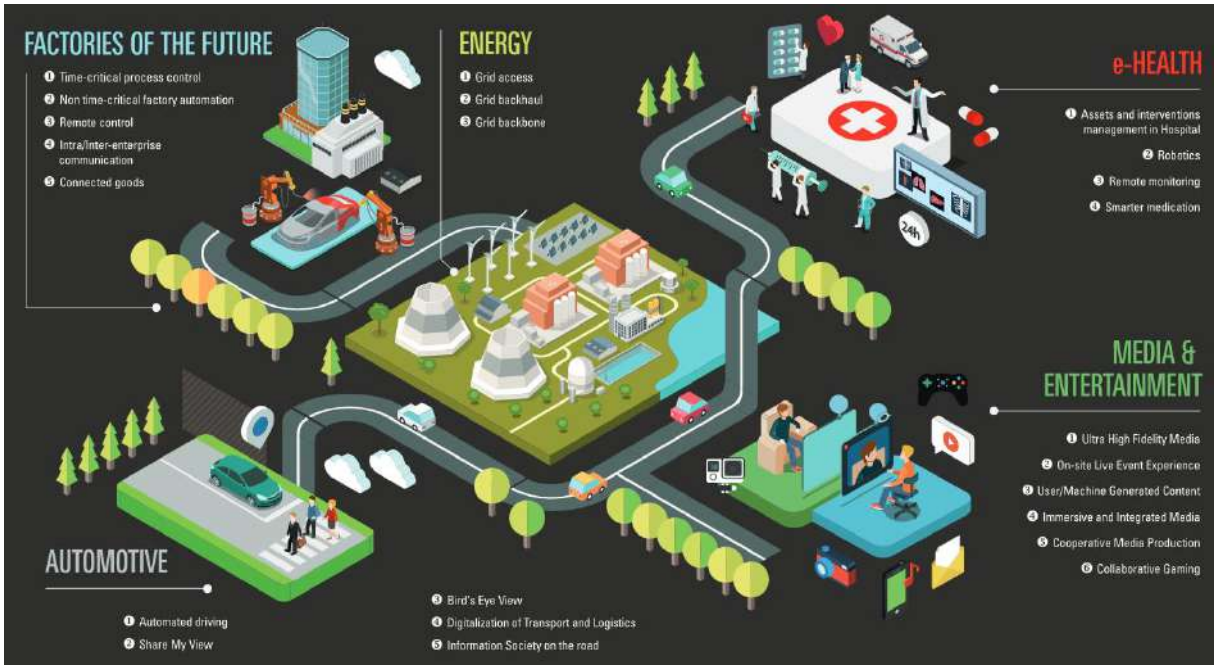

Figure 1. 5G driving industrial and societal changes[1]

The energy sector, for instance, has undergone a great many changes and developments over the past several years in terms of energy production, storage and transport. Rising fossil fuel costs, the introduction of renewable energy sources and markets being opened up to competition have all helped usher in new kinds of energy product and new stakeholders – both independent companies and ordinary citizens – to the energy marketplace. The objective with 5G will thus be to enable better management of these networks (smart grids, smart agriculture, factories of the future) and their interconnections, to achieve more efficient and more agile distribution.

[1] 5G Empowering vertical industries. White Paper, 2016, https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

Healthcare, transportation and media are sectors that are bound up with our fellow citizens' daily lives: any improvements in these sectors thus have a clearly visible impact. The introduction of robots to perform specialised surgical operations, of video on demand or the advent of new connected features in cars have already improved our daily lives. 5G is promising to go several steps further in all of these areas: it would enable remote medical diagnoses and operations in real time, it would democratise streaming of 360° 3D video, it would provide users with a vast selection of video content with a picture quality better than ultra high-definition (4K, 8K…). The automotive universe could rely on these new networks to help cars make decisions without human involvement, and also communicate with one another (this is already possible, for instance, with the first experimental fleet of fully autonomous taxis being tested on the streets of Singapore by the firms nuTonomy and Grab[2]), with reaction times that are compatible with the demands of high-speed travel.

In terms of factories of the future, the improvements brought by 5G are primarily targeting the introduction of new generations of connected robots, the interconnection of production sites and the much heavier use of smart sensors to improve industrial processes. Generally speaking, the aim is to achieve ubiquitous communication between machines, a process that is already well underway.

One thing that it is crucial to understand, through the few examples listed above whose demands might seem mutually incompatible, is that depending on the sector or the application, the network properties and the functionalities required will not be the same. Service providers – whether they are today's mobile operators or other market players – will need to be capable of adapting their network to demand, occasionally in real time. 5G will thus be not so much a universal technology as a polymorphous, or multi-faceted technology, capable of adapting to any use, up to and including the most demanding ones.

[2] http://nutonomy.com/

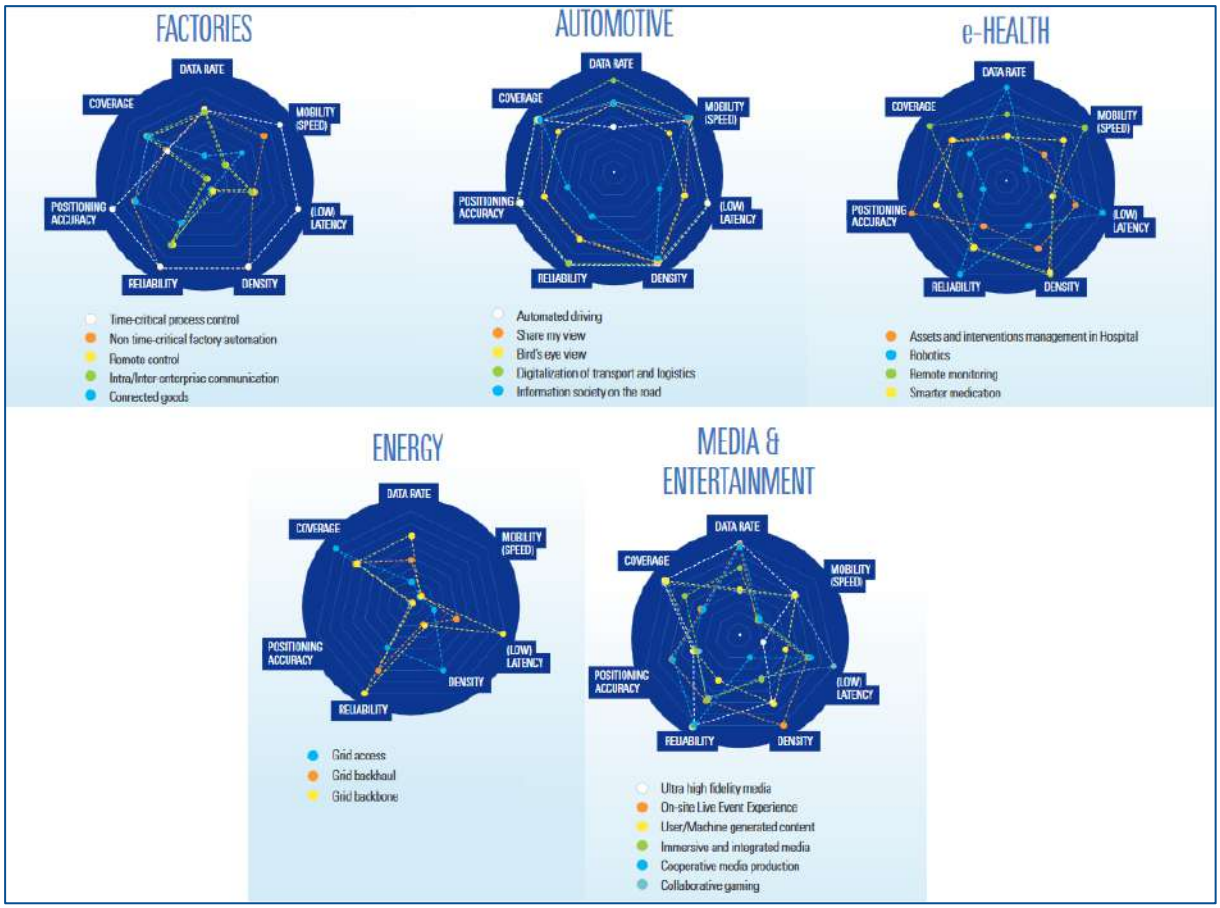

Figure 2. Performances required by vertical sectors[3]

[3] 5G Empowering vertical industries. White Paper, 2016, https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

1 5G objectives

Ever since the first real mobile telephone call, 44 years ago[4], mobile technologies have been evolving steadily and their performances have improved exponentially: as mentioned earlier, calling services and later texting and finally the mobile internet and the use of multi-service mobile applications have characterised the evolution of mobile networks and the transition from one generation to the next. The birth of LTE technology and the fourth generation (4G), coupled with the widespread use of smartphones and tablets, have driven a massive increase in the amount of mobile data traffic being relayed over the networks.

The use of a mobile handset and its applications is now an integral part of our fellow citizens' daily habits. Portable connected devices are increasingly powerful: in many instances they have replaced users' landline telephones, cameras, computers and even televisions. Today, 5 million videos are watched on YouTube and 67,000 images uploaded to Instagram every minute (see Figure 3).

Figure 3. What we do over the network today in one minute[5]

The latest *Mobility Report*[6] from Ericsson indicates that traffic on mobile networks almost doubled in a single year, and that over the next five years it will have increased to 10 times what it is today. New solutions must therefore be found to meet this demand, and to optimise how resources are used.

The increase in the number of applications available, their diversification and the improved quality of mobile networks have all contributed to driving up demand, the emergence of new uses (connected objects, drones, etc.) and new users.

[4] On 3 April 1973, Motorola's Martin Cooper made a call from the corner of 56th street in New York City with the first mobile phone.

[5] https://www.ericsson.com/res/docs/2014/5g-what-is-it-for.pdf

[6] https://www.ericsson.com/assets/local/mobility-report/documents/2016/ericsson-mobility-report-november-2016.pdf

5G is at the crossroads of these news uses; it aims to better and simultaneously satisfy this tremendous variety of needs and these new demands, through a unified technology that takes this diversity into account at the design stage.

The advent of 5G could have a significant impact not only in the technical realm, but also on different countries' economic and social development. As indicated in the introduction, 5G targets a very large number of sectors and, through society's digitisation, is expected to contribute to countries' economic growth.

To give an example, according to a report produced by InterDigital Europe, Real Wireless, Tech4i2 and Connect (Trinity College Dublin)[7], this new technology will require a great deal of money and a great deal of work, but will generate €113.1 billion in profits per annum for the European economy by 2025.

1.1 Technical specifications of 5G

The specifications for a new generation of mobile telephony are set primarily by two bodies: ITU (International Telecommunication Union) and 3GPP (3rd Generation Partnership Project).

ITU is the United Nations agency devoted to information and communications technologies. It carries out research and studies through its Working Party 5D, the sub-group responsible for the overall radio system aspects of international mobile telecommunications (IMT). In 2013, this group began working on defining the characteristics of the new IMT standard, IMT-2020 (5G) (cf. 1.3), as it had done back in the early 2000s to define 4G (IMT-Advanced). Further details on the roadmap established for this work can be found in Annex 1, the objective set by ITU-R being to complete its analyses by 2020.

Parallel to the work being done by ITU are the studies being conducted by 3GPP. The 3rd Generation Partnership Project was created in 1998, and its members include seven standardisation bodies, several hundred industry players, associations and public organisations. It is responsible for developing and maintaining technical specifications for mobile telephony standards[8]. When a new standard is being defined by ITU, 3GPP works on the technical solutions that make it possible to achieve the objectives set by ITU.

Although 5G is one of the most widely debated topics inside international and European bodies today, no standard has yet been defined by 3GPP. The draft of Release 15, the first 5G standard from 3GPP, is still in the works: definition of the new architecture began in December 2016 and work on the New Radio (NR) interface is set to begin in March 2017. A first Release of the standard should be validated in September 2018 to meet the more urgent demands; a second Release (3GPP Release 16) will then be published in March 2020. All of these elements are addressed in more detail in Annex 1.

It should also be said that the transition from one generation to the next takes place gradually. LTE will continue to evolve alongside NR, and these two standards will likely be very complementary initially. In particular, for pioneer 5G rollouts LTE shall probably remain the master of the network and control the NR antennae. Moreover, some of the objectives set for 5G could be achieved thanks to functionalities or technologies introduced in 3GPP Releases 13, 14 and 15 that will not be proper to 5G, but rather evolutions of 4G (which some refer to as 4.9G or LTE Advanced Pro).

[7] http://ir.interdigital.com/file/Index?KeyFile=36051369

[8] GSM for 2G, UMTS for 3G and LTE for 4G

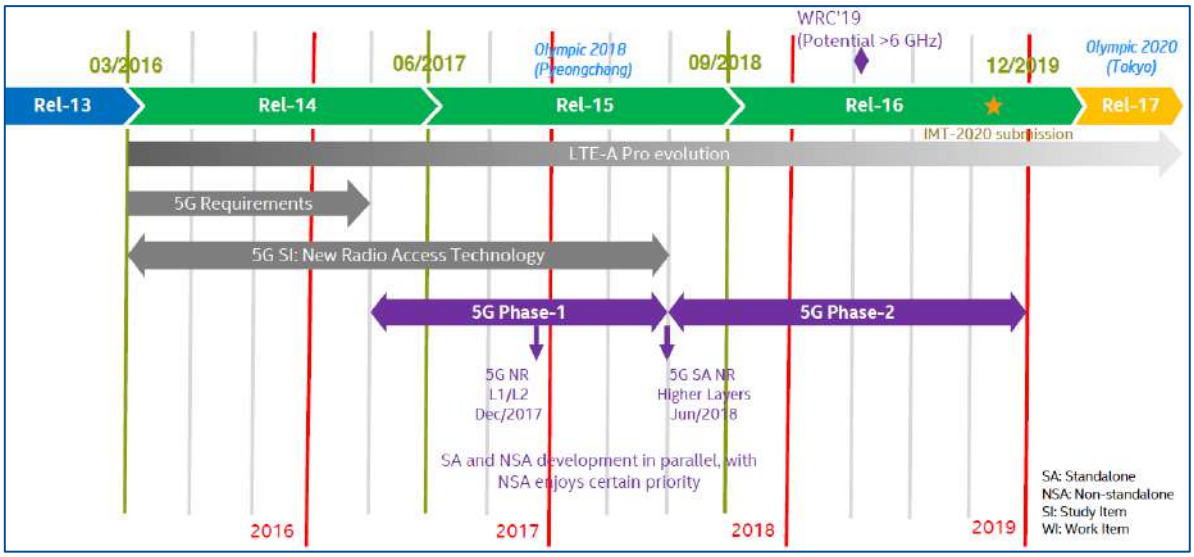

Figure 4. 3GPP timeline for 5G[9]

This same momentum occurred when making the transition from 3G (Release 4) to 4G (Release 10, first Release of IMT-Advanced): the first LTE specifications (Releases 8 & 9) do not achieve all of the ITU targets for 4G, and reprised many of the characteristics of the most advanced form of 3G at the time.

The synergies between the successive generations, the absence in most instances of a great initial jump in performances between generations, and the race between competitors to outperform one another and be the most innovative, can often lead operators and equipment suppliers to give a "commercial" name to each generation of mobile telephony. For instance, in the United States AT&T had called its HSPA network 4G, while in France it is a 3G+ network.

So in all likelihood the first 5G networks deployed on a large scale will be 4.9G systems, using carrier aggregation, massive MIMO (Multiple-Input Multiple-Output) and Network Function Virtualization, or NFV (cf. trials conducted in in France, detailed in Section 1.5.3). These technologies, which will be explored in greater detail further on, represent more of an evolution of the fourth generation than an actual transition to 5G, which will occur when disruptive technologies such as NR carriers in millimetre bands, non orthogonal multiple access (NOMA*)* and mobile edge computing (MEC) can be put into place.

In addition to this commercial race, equipment suppliers – often backed by their respective government at home, notably in the United States, Japan and South Korea – want to get a head start in defining and testing 5G technologies, in the hope of establishing themselves as the technological leaders in international standardisation bodies. Here, the precocity of the first rollouts announced in South Korea (5G deployment for the Winter Olympics in 2018 in Pyeongchang) and Japan (5G deployment for the Summer Olympics in Tokyo) would justify the supposition that only a small portion of 5G technologies will be used, and that these rollouts will be based more on 4.9G or pre-5G technologies.

[9] http://gsacom.com/paper/intel-5g-technology-mm-wave-frequencies/

1.2 5G use cases

Three main use cases (defined by ITU, under IMT-2020), with their respective – and potentially mutually incompatible – demands are in the process of taking shape, and will make it possible to meet the sector-specific needs referred to in the introduction.

1. **mMTC – Massive Machine Type Communications**: A very large number of connected devices with disparate quality of service requirements. The objective of this category is to provide a response to the exponential increase in the density of connected objects;
2. **eMBB – Enhanced Mobile Broadband**: ultra high-speed connection indoors and outdoors, with uniform quality of service, even on the edges of a cell;
3. **uRLLC – Ultra-reliable and Low Latency Communications**: this use case has stringent requirements for capabilities such as latency and packet-loss, to ensure increased reactivity.

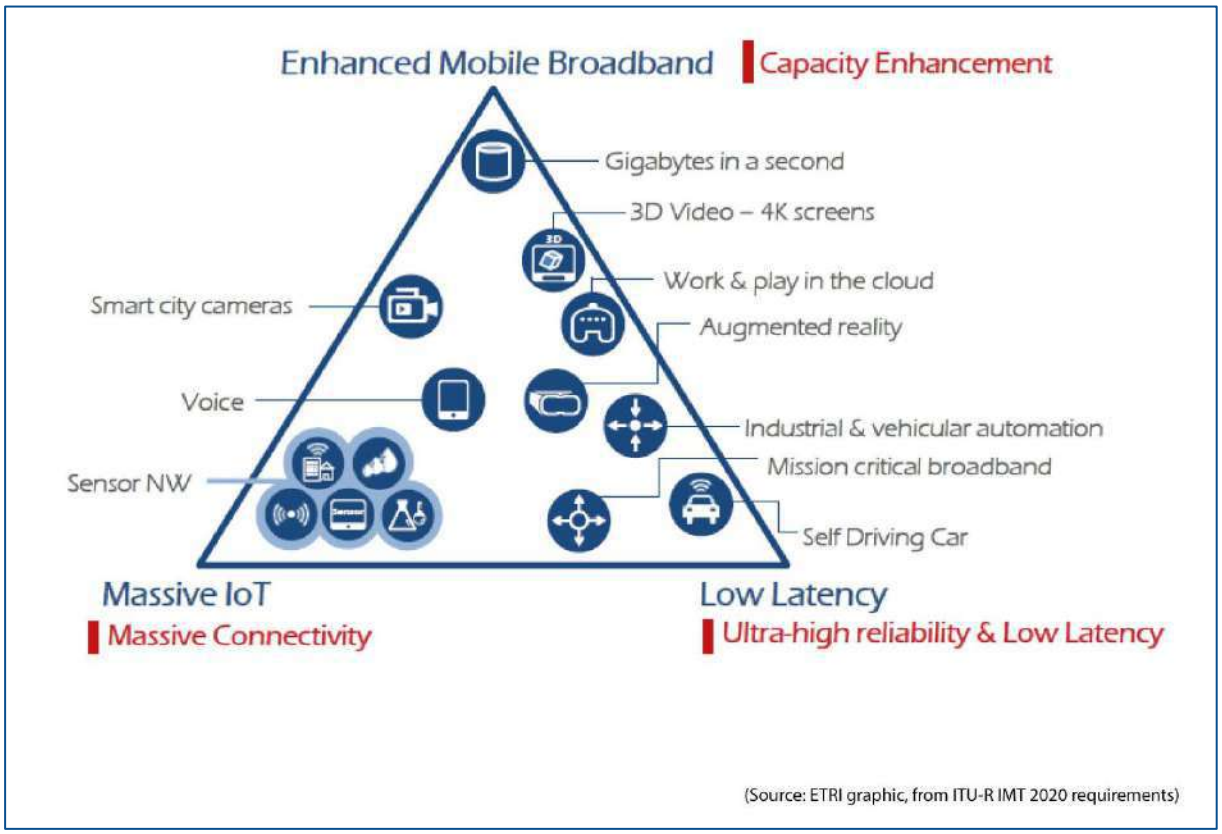

Figure 5. 5G use cases[10]

The first group (mMTC) primarily encompasses all Internet of Things related uses. These services require broad coverage, lower energy consumption and relatively slow transmission speeds. What 5G will deliver compared to existing technologies is the ability to connect objects that are spread out in a very dense fashion across a given area.

Enhanced mobile broadband (eMBB) concerns all of the applications and services that require increasingly fast connections, for instance to watch ultra high-definition (8K) videos or to stream virtual or augmented reality applications wirelessly.

[10] http://5g.ieee.org/standards

Ultra-reliable and Low Latency Communications (uRLLC) include all of the applications that require an extreme reactivity and very strong message transmission guarantees. The sectors where these requirements are particularly prevalent are transportation (reaction time when an accident occurs, for instance) and medicine (telesurgery), and when digitising manufacturing processes in general.

To implement these three use case, ITU established eight key performance indicators[11] (KPI) to specify, quantify and measure the characteristics of IMT-2020 (5G) systems:

- Peak data rate (Gbit/s);
- User experienced data rate (Mbit/s);
- Spectrum efficiency (bit/Hz);
- Device mobility (km/h);
- Latency (ms);
- Connection density (number of connected/accessible objects per km²);
- Network's energy efficiency;
- Area traffic capacity (Mbit/s/m²).

[11] Added to these eight classes, five new indicators were defined and are currently being examined: reliability, mobility interruption time, bandwidth, maximum spectrum efficiency, 5th percentile spectrum efficiency.

1.3 Jump in performance compared to 4G networks

As mentioned in Paragraph 1.1, the deployment of 5G is likely to take place in two stages:

1. The first 5G rollouts will deliver better performances, but as a continuation of what is being provided at the time by 4G systems which will continue to evolve as well (4.5G, 4.9G);
2. Performances will continue to improve with the gradual introduction of disruptive technologies, such as the use of millimetre wave frequencies.

This gradual rollout is very similar to the way in which 4G was introduced, as the performances obtained with pioneer deployments were relatively similar to those supplied by existing 3G networks.

ITU defines the 4th generation of technologies, called IMT-Advanced, by the values for the eight KPI listed above, as indicated in the following chart. The 5th generation, called IMT-2020, is represented as well. Here, it should be noted that the official ITU definition of 4G in fact corresponds to what commercial rollouts supplied later on, under the name 4G+ or LTE-Advanced.

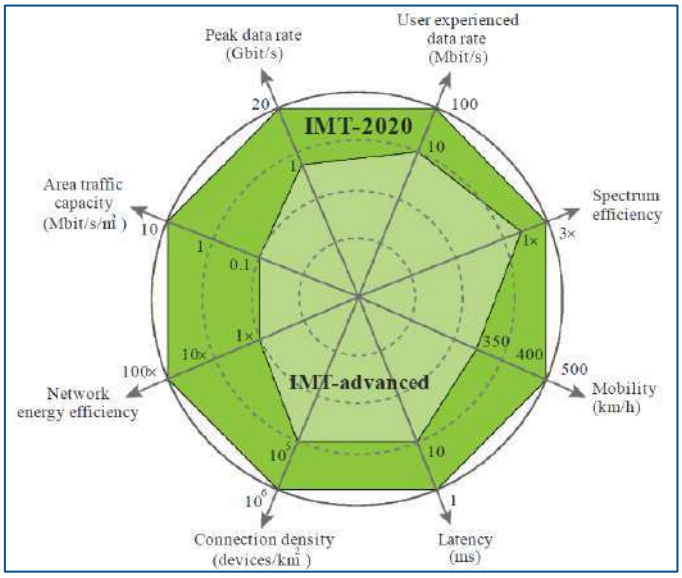

Figure 6. Comparison between 4G and 5G with respect to the eight key performance indicators[12]

According to these objectives, 5G must be able to provide a user experienced data rate and a peak data rate that is respectively 10 and 20 times higher than what is currently available. The maximum connection density will be multiplied by 10 and latency divided by at least 10 (the target point-to-point latency is 1 ms, compared to 30 to 40 ms today).

[12] Recommendation ITU-R M.2083-0 (09/2015), https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2083-0-201509-I!!PDF-E.pdf

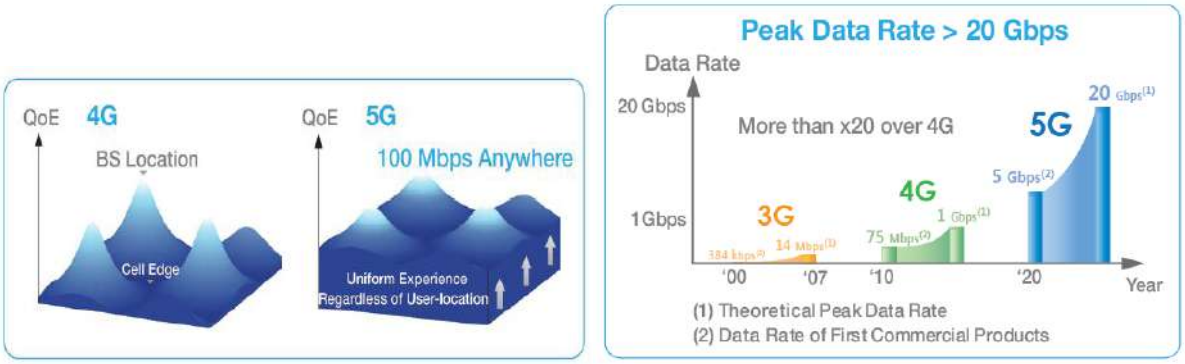

Figure 7. Representation of the "average user experience data rate" KPI for 4G and 5G and "Peak data rate" KPI for 3G, 4G and 5G[13]

As the successor to 4G, the objective for 5G will also be to provide:

- An extremely reliable network, with more consistent performances regardless of the user's position with respect to the base station;
- A stable connection, even when travelling (at speeds of up to 500 km/h);
- Greater network energy efficiency (with batteries that consume up to 100 times less power).

The following table summarises the target performances for 5G and those currently available with 4G:

Performances/Generation	4G	5G
1. Peak data rate (Gbit/s)	1	20
2. User experience data rate (Mbit/s)	10	100
3. Spectrum efficiency	1x	3x
4. Speed (km/h)	350	500
5. Latency (ms)	10	1
6. Connection density (number of objects/km²)	10^5	10^6
7. Network energy efficiency	1x	100x
8. Area traffic capacity (Mbit/s/m²)	0.1	10

Table 1. Comparisons between 4G and 5G performances

[13] http://www.samsung.com/global/business-images/insights/2015/Samsung-5G-Vision-0.pdf

1.4 Network slicing and software-defined networks

It is vital to understand that the set of indicators listed in Section 1.3 determine a set of peak performances for 5G. It will not, however, be possible to achieve all these peak values simultaneously: not every requirement or use case is compatible, so a trade-off will need to be made when defining categories of use that each have their own performance envelope, notably for the use cases described in Section 1.2 (mMTC, eMBB and uRLLC). This is the principle of network slicing: each slice has its own set of KPI, which is a trade-off tied to the target use. On a 5G system, the network properties will need to adapt to the chosen environment.

The following diagram positions the three main use cases listed in Section 1.2. with respect to the eight key performance indicators listed above.

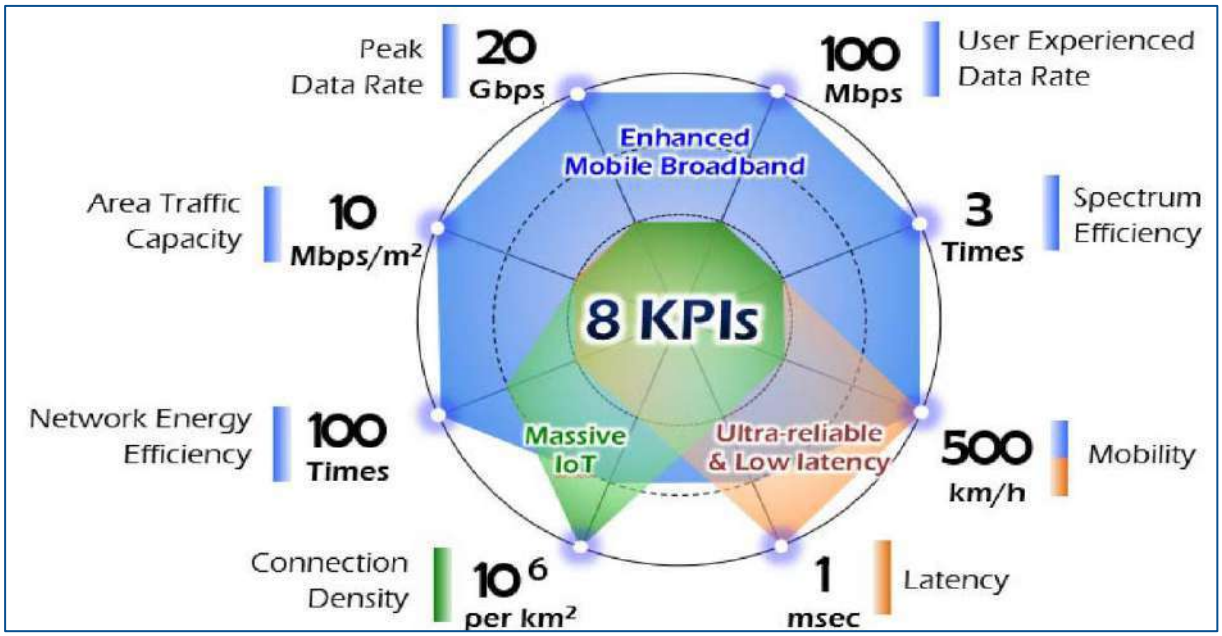

Figure 8. Key performance indicators for the three 5G use cases[14]

So for applications that require enhanced mobile broadband (eMBB), such as 4K, 8K or 3D video or virtual reality, a certain number of performance indicators, such as spectrum efficiency, peak data rate and area traffic capacity, can be reached only at the expense of others, such as latency or connection density.

On the flipside, when a massive simultaneous connection of connected objects (mMTC) needs to be managed, the network will concentrate its resources and use the technologies required to achieve this task, but will not be able, for instance, to use spectrum as efficiently or to guarantee low latency.

Lastly, when ultra-reliable and low latency communications (uRLLC) are required, the number of simultaneous connections, data rates and spectrum efficiency may be reduced.

This flexibility, or ability to adapt, that network slicing brings can only be achieved thanks to the softwarisation and virtualisation of a sizeable number of network components (cf. 1.5.2) – a process referred to as Software-Defined Networking (SDN) and Network Function Virtualisation (NFV). Behind these acronyms is a common idea, namely to use as many generic and reconfigurable components as possible, rather than bespoke ones that are permanently dedicated to very specific

[14] https://5g-ppp.eu/wp-content/uploads/2016/11/06_10-Nov_Session-3_Lee-JunHwan.pdf

tasks. This evolution towards software-based systems has been in the works for several years, but is now becoming possible thanks to improved performances from all of these reconfigurable components, including those that are the closest to the elementary tasks of wireless communications (detection, baseband coding, bitstream management, frequency handover, signal processing, etc.).

1.5 Technological building blocks to achieve the objectives

1.5.1 Air interface

Several, sometimes competing radio access technologies are currently being examined. Some have already been pre-implemented by equipment manufactures and can be used in trials, notably massive MIMO and NFV. Others, such as NOMA modulation and mobile edge computing (MEC), will no doubt take longer before they are ready to be used. In any event, a consensus – which could be painful for certain suppliers whose investments will be lost – will need to be found when defining 5G standards, to ensure the systems' interoperability.

The technologies currently being examined are the following:

- **Millimetre wave frequencies**: the use of millimetre wave frequencies constitutes one of the disruptive 5G technologies. The term refers to the frequencies above 6 GHz which have never been considered for mobile fronthaul network rollouts, for reasons of technological maturity and propagation quality. To meet the demand for ever increasing data rates and traffic volumes, new bands with very wide channels (over 100 MHz per user) will need to be employed: millimetre wave frequencies could provide this spectrum resource, and in certain cases their use would make it possible to achieve the data rates listed in Table 1. Comparisons between 4G and 5G). In exchange, to be able to use these frequencies all of the required, miniaturised low-cost technologies will need to be developed, and ensure a level of energy consumption that is compatible with portable devices (amplifiers, coders, signal processing, antennae, etc.). In particular, because of millimetre waves' poor propagation quality, each cell will have limited coverage and so require the use of beamforming (described below) to better focus the power transmitted by the antenna.
- **Massive MIMO** (Multiple Inputs – Multiple Outputs): this technology involves the use of a large number of smart micro-antennae, located on the same panel (between eight and 128 today, but the number will increase with the use of frequencies above 6 GHz). The appeal of using massive MIMO is twofold: first, the technology makes it possible to increase data rates, thanks to spatiotemporal multiplexing; second, it makes it possible to focus energy on a device to improve its link budget, thanks to beamforming.

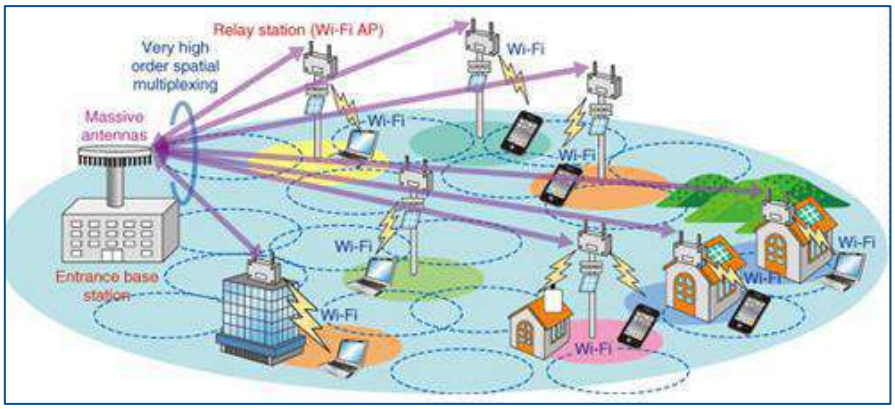

Figure 9. Example of the use of a beamforming antenna to connect Wi-Fi access points[15]

- **Full Duplex**: in classic systems, transmission and reception takes place either on different frequency bands, i.e. frequency division duplexing (FDD) used on all mobile network bands in France, or at different times: time division duplexing (TDD), the top contender for LTE wireless local loop networks in France. The full duplex is intended to enable the simultaneous transmission and reception of data, on the same frequencies, at the same time and in the same location.[16]

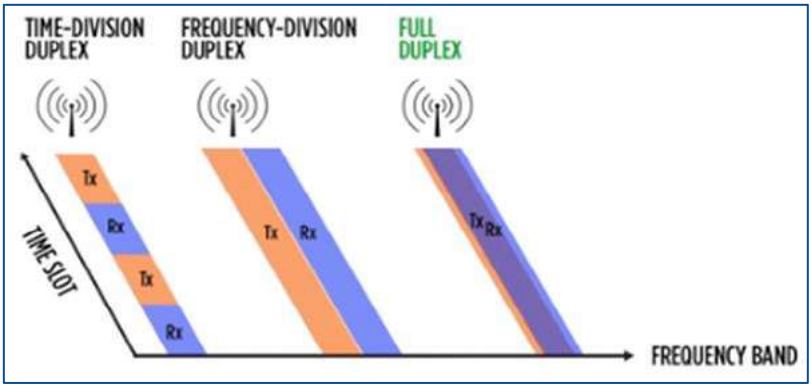

Figure 10. Illustration of full-duplex, compared to FDD and TDD[17]

- **NOMA Multiplexing** (Non Orthogonal Multiple Access): LTE uses what is referred to as orthogonal multiplexing, with each device using a portion of the resource blocks in a unique fashion at any given time. For 5G to provide improved spectrum efficiency compared to 4G, the plan is to use non-orthogonal multiplexing methods, whereby several users can use the same frequencies at the same time. A distinction can be made between several users by assigning different codes to each user – referred to as SCMA or sparse code multiple access – a combination of 3G's code division multiple access (CDMA) and 4G's orthogonal frequency

[15] https://www.slideshare.net/100001290086432/massive-mimo

[16] The basic operating principle is the following: an antenna sends a signal at the same time as it is receiving signals coming from devices in the cell. However, the signal received by the antenna is a combination of the signal sent by itself and signals coming from the devices (everyone is "talking" at once). As it knows which signal it itself has sent, the antenna can subtract it during digital processing from the ones it received. So only the signals received from the devices remain.

[17] http://compeng.columbia.edu/biggest-component-full-duplex-wi-fi-radio-antenna

division multiple access (OFDMA) or by playing on the difference in users' signal to noise ratios (power domain NOMA[18], illustrated below). These are the two methods chosen for NR.

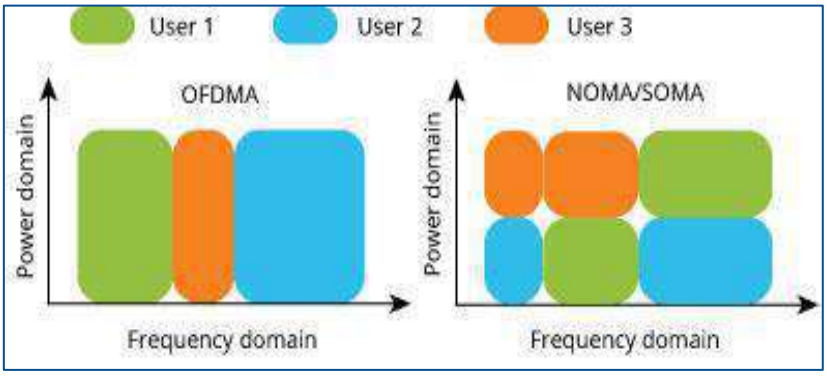

Figure 11. Illustration de multiplexing *power domain* NOMA[19]

- **QAM256**: as with many modern communication systems, 4G uses quadrature amplitude modulation (QAM). In 4G this modulation can achieve QAM64, which means that six bits of information are being transmitted ($2^6 = 64$) at any given time. On wireless systems, the main limitation on QAM order is the signal to noise ratio: when a large amount of information is sent all at once, its transmission will be very sensitive to disruptions (a bit like trying to talk in a noisy environment: it is easy to understand "yes" or "no" but harder to understand more complex sentences). Thanks to an improved link budget, via antenna or signal processing technologies, 5G modulation could reach QAM256, i.e. eight bits of information being transmitted at any given time, which translates into a 33% increase in maximum capacity under ideal conditions. This improved modulation will also be deployed on advanced 4G systems.
- **IoT waveforms**: new waveforms are being explored for the future deployment of 5G IoT in mobile bands. But although mass market IoT is one of the main challenges put forth for 5G, no concrete results have yet been made public. Operators[20] are starting to deploy new standards (EC-GSM or Extended Coverage GSM, LTE-(e)MTC or enhancements for Machine-Type Communications, NB-IoT or NarrowBand IoT) which were defined by 3GPP in Release 13 but, as they are based on 2G and 4G, they do not deliver the performance levels, notably in terms of autonomy, coverage and density, that are compatible with the targets set for future 5G networks.

1.5.2 Network architecture

As with air interfaces, new network architectures are also being explored:

- **Software-defined networking (SDN) and network functions virtualisation (NFV)**: these two functionalities extend beyond the scope of 5G networks per se. They are part of an overall

[18] The basic operating principle is the following: either User 1 (U1) with a good signal to noise ratio and User 2 (U2) with a less good signal to noise ratio. The antenna sends a high power Signal 2 to U2, and superimposes a weaker Signal 1 aimed at U1. U2 will only see S2 as S1 is drowned out by the noise. U1 will decrypt S2 then delete it from the signal received, to create a higher quality S1, thanks to a better signal to noise ratio.

[19] https://www.anritsu.com/en-AU/test-measurement/technologies/5g-everything-connected/5g-everything-connected-detail

[20] http://www.vodafone.com/content/index/what/technology-blog/nbiot-commercial-launch-spain.html

process of network upgrades taking place today and already available with 4G technology (4.9G). The nevertheless remain a key enabler of 5G:

- SDN (Software-Defined Network) is designed to disassociate the network's control plane from its data plane, these two planes traditionally being linked and distributed in a set fashion in the network (see diagram below). Controlling the network, a task previously assigned to specialised and unscalable hardware components, is centralised in the form of software on more powerful servers and, in theory, free of equipment manufacturer specifications. This enables the deployment of high value-added services (load balancing, smart routing, dynamic configuration, etc.) in disparate environments.

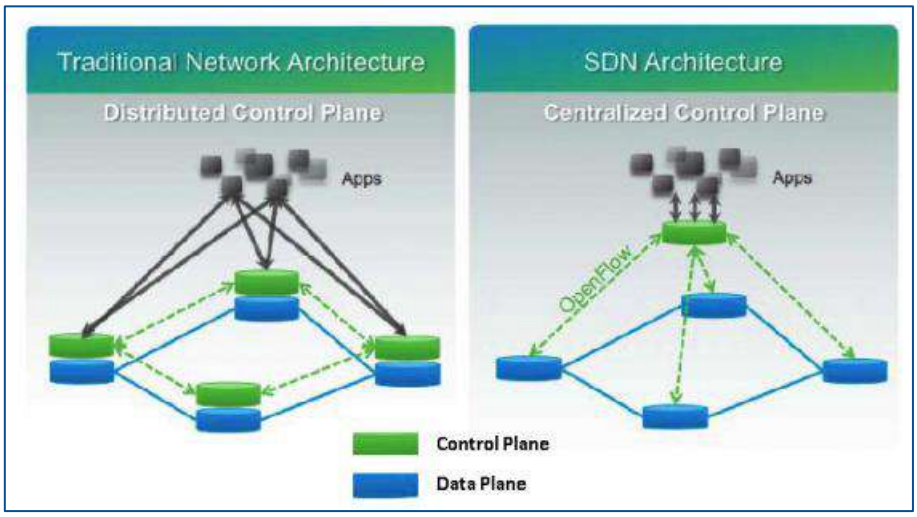

Figure 12. Centralisation of the control plane in a software-defined network[21]

- NFV, which builds upon SDN, is used to virtualise, in other words to replace hardware designed specially to perform certain key network functions (firewall, network core, interfaces between different systems…) with software on a server, to accelerate rollouts and enable rapid changes and upgrades.

- **CloudRAN**: this functionality, also know as centralized-RAN, requires a very different network architecture to what we find today. It is an evolution of SDN: the base stations' signal processing units, currently installed at the base station level, are moved to the cloud and centralised. They communicate with the network radio heads, located closer to the antenna, over an optical fibre network (Radio over fibre technology). This centralisation makes it possible to obtain a complete overview of all of the stations deployed and to coordinate signal processing and manage interference between cells and devices

[21] http://www-igm.univ-mlv.fr/~dr/XPOSE2014/software-defined_networking/sdn.html

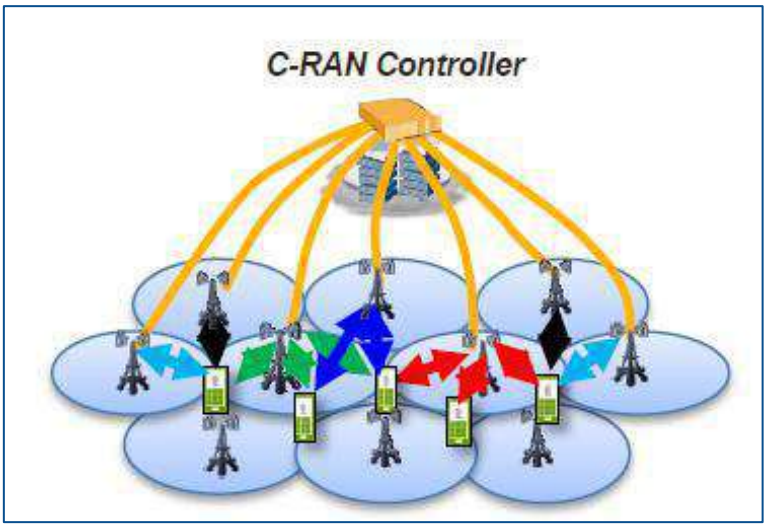

Figure 13. Illustration of CloudRAN[22] network architecture

- **Optimised content delivery, using a mobile content delivery network (mobile CDN)**: corresponds to a set of servers working together in a transparent fashion to optimise the delivery of content to end users over wireless (mobile or Wi-Fi) networks, with high availability and performance. With 5G, the objective for these CDN is to cache content close to users, notably thanks to predictive algorithms, to offload traffic from the networks and decrease latency.
- **MEC (mobile edge computing)**: MEC is an evolution of mobile CDN whose purpose, in addition to bringing data closer to devices, is to provide devices with an accessible computing power with very low latency, within a very specific area for demanding applications. This technology makes it possible to locate a portion of the network's intelligence (managing local critical applications and performance analysis) at the base station level. The "antennae" will be capable of analysing a certain number of data, and so to make decisions very quickly.
- **Device-to-device**: D2D is a direct form of communication between two nearby devices, which does not require the data to travel over the cellular network. Device-to-device communication is not new, as technologies such as Bluetooth and Wi-Fi direct already enable it. But a new mesh networking technology will be introduced with 4.9G and later 5G network rollouts: LTE-direct. Far more energy-efficient than its predecessors, this technology will have a range of up to 500 metres and geolocation capabilities to enable communications. This technology will be very useful for low latency V2V (vehicle-to-vehicle) or V2X (vehicle-to-everything) communications and for certain public-security related uses.

1.5.3 5G: a multi-technology generation cohabitating with existing networks

As stated earlier, 5G is not meant to replace 4G overnight. In practice, the devices will undoubtedly be multi-modal: still connected to the 4G network, which will provide extended coverage for pioneer rollouts, then transitioning to 5G networks when they become available.

While 4G and 5G frequencies will probably be initially segregated, in all likelihood devices will rapidly become capable of aggregating 4G and 5G carriers and, further down the road, 4G carriers will be encapsulated in 5G ones.

[22] https://5g-ppp.eu/wp-content/uploads/2016/11/04_10-Nov_Session-3_Takaharu-Nakamura.pdf

4G is still being deployed, and its technological evolution and certain building blocks will be used by both the first 5G networks and advanced 4G networks. To wit, the latest trials conducted in France are allowing 4G networks to perform better thanks to the use of pre-5G technologies:

- Bouygues Telecom, in partnership with Huawei, managed to achieve a peak data rate of 1 Gbps thanks to the simultaneous use of four-carrier aggregation (800 MHz, 1800 MHz, 2100 MHz, 2600 MHz) and more powerful modulation (256 QAM)[23];
- In the coming weeks, Orange will be launching a massive MIMO (16x16) trial with Nokia[24].

In addition to the strong integration between 4G and 5G, the new generation will no doubt also continue convergence efforts between frequency bands governed by exclusive licences – i.e. bands that are allocated exclusively to an operator, such as mobile operators – and unlicensed frequency bands, governed by a system of general authorisation (e.g. Wi-Fi bands), which already began in 4G with LTE-LAA (Long Term Evolution – License Assisted Access) and LTE-LWA (Long Term Evolution – Wi-Fi Link Aggregation).

LTE-LAA is characterised by the aggregation of one or several LTE carriers, used in licensed bands, with other LTE carriers employing unlicensed 5 GHz Wi-Fi bands. To guarantee cohabitation with very widespread Wi-Fi networks whose deployment pattern is unpredictable, it uses LBT (Listen Before Talk) technology to listen to the radio channel before transmitting, in order to determine whether or not a frequency is available.

LTE-LWA consists of an aggregation of LTE carriers in licensed bands with Wi-Fi traffic. To achieve this, the LTE cell and Wi-Fi access point need to be connected: the Wi-Fi traffic is sent to the cell which sends back the entire aggregated link on the 4G core network. This technology is particularly well suited to indoor environments with small cells, a system which, as detailed in paragraph 3.3 below, will lend itself well to 5G deployments.

[23] https://www.corporate.bouyguestelecom.fr/wp-content/uploads/2016/05/Communiqu%C3%A9-Bouygues-Telecom-et-Huawei-Technologies-r%C3%A9alisent-un-test-de-d%C3%A9bit-4G-%C3%A0-plus-de-1-Gbps-pour-la-premi%C3%A8re-fois-en-Europe-de-lOuest.pdf

[24] https://networks.orange.fr/actualites/actualites-des-networks/orange-et-nokia-partners-pour-developper-les-futurs-services-5g

2 5G development initiatives

With a view to keeping the many promises being made for 5G, a number of initiatives are currently underway around the globe to promote its development. Below, we detail the foremost initiatives put forth by the players with which Arcep met as part of its investigation.

2.1 Government initiatives

The prospect of significant socio-economic repercussions generated by 5G (possible revenue of close to $225 billion a year[25] by 2025) combined with many countries' desire to establish themselves as technological leaders and make their companies more competitive, have propelled a multitude of government initiatives around the globe, aimed at encouraging the mobile ecosystem to begin the work and make the investments required to drive the rapid construction of the first 5G networks.

A selection of the largest initiative is detailed below.

2.1.1 In Europe

5G-PPP

The 5G Public Private Partnership (5G-PPP) is dedicated to 5G research and development, created on the initiative of the European Commission in 2013, with a budget de €700 million in public funding. The main objectives set by 5G-PPP are:

- Create stronger ties between the economic players and academic bodies devoted to the telecommunications sector over R&D projects, along the entire value chain;
- Reduce technological dependence on the United States and Asia while sustaining a strong global market;
- Regain technological leadership, notably in disruptive technologies, by promoting standards in international bodies;
- Allow innovative business models to emerge;
- Facilitate large-scale experimentation.

The results of this work will help clarify the 5G action plan (see below), and fuel the standardisation work that is currently underway.

To achieve its ambitions, 5G-PPP has initiated three stages of work, financed by the European Union, whose roadmap is in sync with the main international initiatives (3GPP and ITU, cf. Figure 14):

- The first stage which is currently underway, will last until mid-2017;
- A second stage focused on systems optimisations, from the end of 2017 to mid-2019;
- And finally a full-size trial stage from 2019 to 2020.

Deploying 5G by 2020 will require Europe to develop leading edge technologies, globally approved standards and especially to achieve consensus over the most suitable frequency bands. This funding and these projects – involving a great many researchers from more than a hundred companies and the finest R&D centres in Europe – are thus vital.

[25] https://www.abiresearch.com/press/abi-research-projects-5g-worldwide-service-revenue

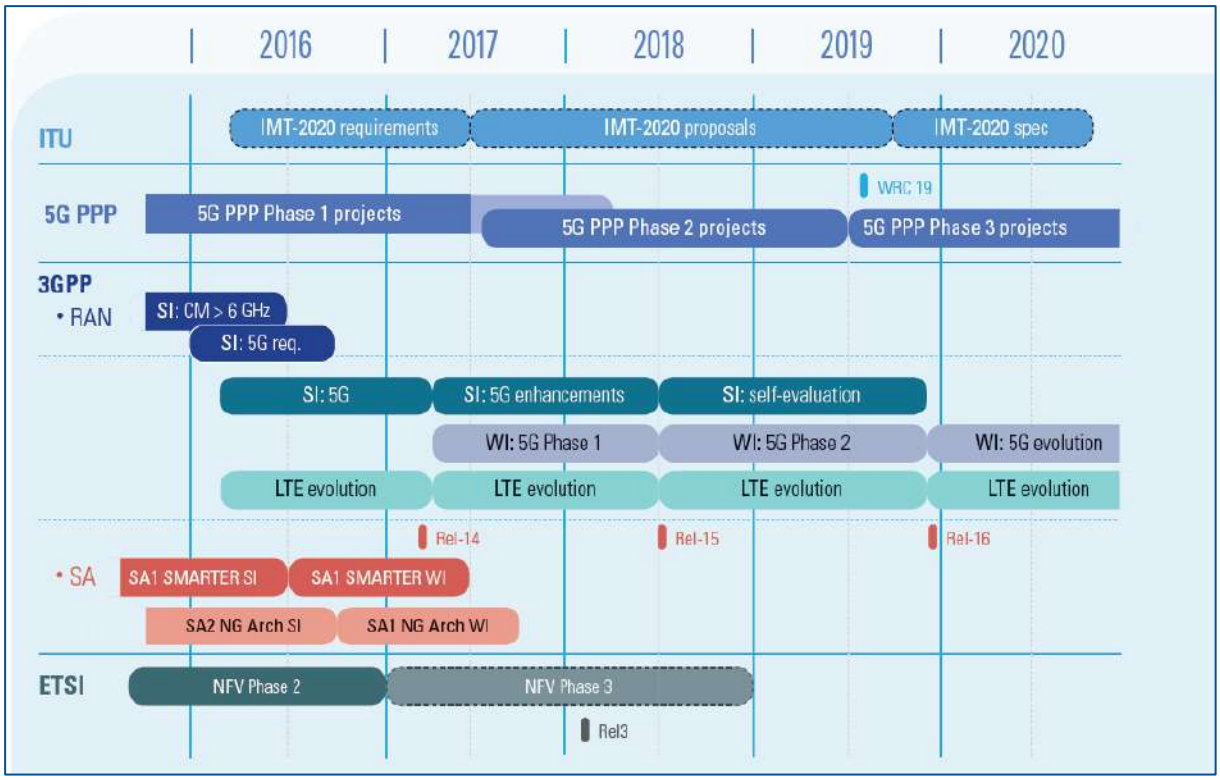

Figure 14. 5G PPP vs. 3GPP and ITU roadmaps[26]

5G action plan

As a complementary measure, on 14 September 2016 the European Commission launched its *5G for Europe Action Plan* to bolster investments in 5G infrastructure and service rollout efforts in the Digital Single Market between now and 2020. This action plan sets out a clear roadmap for public and private 5G investments inside the EU.

The Commission has proposed the following measures to achieve this plan:

- Align roadmaps and priorities for a coordinated 5G deployment across all EU Member states, targeting early network introduction by 2018, and moving towards commercial large scale introduction by the end of 2020 at the latest.
- Make provisional spectrum bands available for 5G ahead of the 2019 World Radio Communication Conference (WRC-19), to be complemented by additional bands as quickly as possible, and work towards a recommended approach for the authorisation of the specific 5G spectrum bands above 6GHz.
- Promote early deployment in major urban areas and along major transport paths.
- Promote pan-European multi-stakeholder trials as catalysts to turn technological innovation into full business solutions.
- Facilitate the implementation of an industry-led venture fund in support of 5G-based innovation.
- Unite leading actors in working towards the promotion of global standards.

[26]5G Empowering vertical industries. White Paper, 2016, https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

The European Commission has given every EU country a certain number of ambitious, numerical targets. One core objective for 5G is thus to have at least one major city in every European country outfitted with this new generation mobile system by 2020, and coverage of every city, motorway and high-speed railway lines by 2025. This comes in response to announcements from South Korea and Japan which are both promising large-scale 5G demonstrations, respectively, at the Winter Olympics in Pyeongchang in 2018 and the Summer Olympics in Tokyo in 2020.

2.1.2 Worldwide (examples in the US, South Korea, Japan and China)

The race is already underway between countries to be the first to begin large-scale 5G trials, and later to introduce commercially available services, so much so that they are willing to employ pre-standard technical specifications.

Several countries are therefore working on standards and seeking to reach a consensus with one another to achieve international backing for the technical specifications that will satisfy their needs, and earn them the best possible return on the investments made thus far. This in turn is creating a certain turmoil, for instance, over the frequency bands that would be the best candidates for 5G.

The United States[27]

5G is seen as an unprecedented opportunity for economic growth, with a tremendous impact on education, job, transportation, etc. According to the US federal regulator, the FCC (Federal Communications Commission), the following three elements in particular need to be the prime focus of attention: spectrum, infrastructure and the backhaul network:

- **Spectrum**: in July 2016, the FCC voted to free up and to open up nearly 11 GHz of high frequency spectrum to be used for fixed and mobile broadband applications: 3.85 GHz of licensed spectrum in the 27.5 – 28.35 GHz and 37 - 40 GHz bands, as well 7 GHz of unlicensed spectrum from the 64 - 71 GHz band. The FCC's stated goal was to provide the assurance and clarity for investments in the telecoms sector. Verizon welcomed this decision, and plans on achieving the first rollouts in 2017, with trials already underway in several cities around the country (cf. 3.3).
- **Infrastructures**: The FCC believes that 5G must be underpinned by a robust infrastructure network capable of handling already heavy traffic that could potentially increase exponentially in the coming years. It will interact in a hybrid fashion between traditional towers with macro cells and small cell deployments, as well as distributed antenna systems. With an eye on the deployment of new towers, the FCC resolved to reduce, or eliminate in certain cases, the regulatory restrictions on installing facilities and antennae that will have very little impact "on historic properties" (tower re-use, small antennae, indoor installations, etc.)[28].
- **Backhaul network**: Because 5G systems will require very high-power backhaul networks, the FCC is in the process of reforming and updating the regulations governing data services markets, including wireless backhaul solutions. The FCC is seeking to protect this market while also creating competition, so that competitive and high quality backhaul network solutions can emerge.

[27] Forging Our 5G Future – Federal Communications Commission: https://www.fcc.gov/5G

[28] https://apps.fcc.gov/edocs_public/attachmatch/DA-16-900A1_Rcd.pdf

Japan

Japan wants to demonstrate its 5G leadership by deploying the first commercial 5G network that complies with international technical specifications, in time for the Summer Olympic Games in Tokyo in 2020.

According to the *Radio Policies Towards 2020*[29] report, published in June 2016 by Japan's Ministry of Internal affairs and Communications (MIC), the 3600 - 4200 MHz, 4400 - 4900 MHz and 27.5 – 29.5 GHz bands were selected to be the 5G candidate bands on a national scale. Although other bands are also being investigated, with a view to WRC19, 5G rollouts are already planned in the 3600 - 4100 MHz, 4405 - 4895 MHz and 27.5 - 28.28 GHz bands as early as 2017 in Tokyo, and will be built out in 2018 and 2019.

China

Like Japan, China too wants to prove its leadership with the first commercial rollouts in 2020. The first trials will be conducted that year in the 3400 – 3600 MHz band. The 3300 - 3400 MHz, 4400 - 4500 MHz and 4800 - 4990 MHz bands are also under consideration and currently being investigated. For higher speeds, the country plans on using spectrum around the 25 GHz and 40 GHz frequencies.

South Korea

South Korea, meanwhile, has set its sights on a pre-commercial 5G service that would be ready in time for the 2018 Winter Olympics in Pyeongchang. Several trials are already underway to prepare for full scale demonstrations in several South Korean cities, including Pyeongchang and Seoul. The country's three national mobile operators are hoping for spectrum in the 26.5 – 29.5 GHz bands.

South Korea's largest mobile operator, SK Telecom, has announced a plan for conducting interoperability tests with Qualcomm and Ericsson, as well as outdoor trials of the new air interface based on the 3GPP NR standards that are being developed today. These trials and experiments will be carried out in the second half of 2017.

If the goal of these trials is to help accelerate the specification of the new NR air interface, which is part of the work being done on 3GPP Release 15, it has not yet been specified which frequency bands will be used for these trials.

2.2 A host of private initiatives – a few examples

5G Open Trial Specification Alliance

In early 2016, South Korean operators KT and SK Telecom, Japanese carrier NTT DoCoMo and American carrier Verizon formed the 5G Open Trial Specification Alliance to carry out collaborative 5G trials.

Due to be conducted between 2016 and 2018, the aim for these trials is to provide a common platform for operators, for exchanging results and shared assessments of the different 5G network components and elements. One of the operators' objectives is to help accelerate the definition of standards and specs, and to enable economies of scale. The findings of these evaluations will provide input for 3GPP discussions, adding simulations to the experimental data produced by the partnership.

[29] http://www.gsma.com/spectrum/wp-content/uploads/2016/08/MIC_Spectrum-for-5G-MIC-Kuniko-OGAWA.pdf

The alliance's founders hope to attract a number of industrial partners to the platform, including other carriers, equipment suppliers, chipset makers, etc. Several of the founding operators' equipment suppliers are already involved in the scheduled trials.

The trials will cover multiple frequency bands, both above and below 6 GHz.

Verizon 5G Technical Forum

The Verizon 5G Technology Forum (V5GTF) was created in late 2015 by Verizon, in cooperation with its partners Cisco, Ericsson, Intel, LG, Nokia and Qualcomm. The goal of the collaboration is to provide a platform for testing radio interface specifications in the 28 and 39 GHz bands.

The first fruit of this collaboration, in July 2016 Verizon announced the completion of the first specifications of their 5G radio interface. These specs should enable the different parties involved to develop interoperable solutions and so to help drive forward the definition pre-standards.

Even though they run the risk of developing solutions that are not compatible with 3GPP or ITU standards, Verizon believes it has a solid enough grasp of the overall concepts being discussed in those bodies. The tests carried out in several US cities were thus able to validate substantially greater capacities than 4G.

Orange/Ericsson

Orange and Ericsson have been working together since October 2016 on developing 5G use cases and services, as well as demonstrations. The purpose is to develop technological building blocks, conduct trials and pilot projects for a range of use cases, including multi gigabits/s wireless internet access in suburban and rural environments, the Internet of Things and connected cars.

Their collaboration made it possible to achieve 15 Gb/s in a laboratory environment, notably thanks to the use of massive MIMO and beamtracking using centimetre waves. The collaboration will also focus on the transition from 4G to 5G solutions, notably in terms of reducing costs and improving energy efficiency, and on the use of SDN and NFV technologies.

Since January 2017, the partnership has included PSA (Peugeot) to carry out trials on connected cars.

5G-ConnectedMobility

5G-ConnectedMobility is a consortium formed by Ericsson, BMW, Deutsche Bahn, Germany's three mobile operators, Deutsche Telekom, Telefonica Deutschland and Vodafone, the 5G TU Dresden laboratory, the BAST research institute and BnetzA, with the goal of galvanising and accelerating 5G R&D in Germany.

5G-ConnectedMobility thus plans on supplying a digital motorway infrastructure and real application environment to be able to test V2V (vehicle-to-vehicle) technologies as well as solutions for digitising railway infrastructure.

To this end, 5G-ConnectedMobility operates with the help of an independent network infrastructure that is not connected to any commercial network. The Ericsson mobile network devoted to this project makes it possible to run live tests: Ericsson thus obtained permission from regulator BNetzA to employ spectrum in the 700 MHz band in the Nuremberg area.

3 The challenges of 5G

In this part we explore the different challenges that lie ahead for 5G, which emerged from the interviews that Arcep conducted over the past several months.

3.1 New business models focused on vertical markets

3G and especially 4G technologies were designed primarily for the superfast mobile internet. 5G continues on in this direction, but also wants to target what are known as vertical markets, which encompass several segments, including:

- Connected vehicles, not only to deliver entertainment and information to passengers, but also to guarantee safety via communications both between vehicles and between vehicles and infrastructure;
- Factories of the future;
- Smart cities with requirements in the areas of public transportation (similar to the needs of connected vehicles), the environment, managing buildings and energy consumption;
- Medicine, healthcare and robot-assisted telesurgery;
- Smart grid flow monitoring and management (electricity, gas, water, etc.).

This section will focus in particular on the connected car and factories of the future segments. Because of their current and future macro-economic context, along with the plurality and effervescence of the pioneer work being done in these areas, these two segments constitute the main avenues of 5G development in vertical markets. Smart cities and smart grids have already begun to soar through existing Internet of Things (IoT) technologies.

3.1.1 The automotive sector

The car is an extremely common form of transportation, and safe driving is a fundamental consideration: human error is the number one cause of all transport accidents. The transportation sector wants to use technological innovations to tackle this problem, and to continue to make transportation more efficient, more sustainable and safer.

There are three areas in which technological progress could help improve automotive transportation. 5G could have a role to play in all three, but particularly in the first two:

- Provide in car internet connectivity, to deliver entertainment to passengers;
- Provide access to driver assistance information, to reduce accidents and improve the fluidity of traffic;
- And, finally, the ability to make cars autonomous, thanks to artificial intelligence algorithms.

The first area is just an extension of the developments occurring today around 4G. The aim is to give passengers access to their messaging services, to the internet, to multimedia content, online gaming, etc. The increased connection speeds promised by 5G will improve the use of all of these services.

The second area aims to make cars more intelligent by using information that was not previously available to them. This in turn will help improve the safety and efficiency of the networks as well as help drivers make the right decisions, and adapt to driving conditions. Such connected vehicles could have access to information about dangers on the road (slow or stopped cars, traffic jam warnings, indications of where construction is taking place on the roads, weather conditions, emergency braking, emergency service vehicles approaching, etc.) or regarding signage (signalling/signage on-

board vehicles, speed limits on vehicles, failure to heed signage/safety precautions at crossings, request for right-of-way at traffic lights for designated vehicles, green light optimal speed advisory, etc.). Other services, such as information on refuelling or recharging stations, vulnerable road user protection, managing street parking and traffic information, and smart guidance, could also prove useful. It is still not clear whether, to achieve this, vehicles will simply exchange information with each other or if connectivity with infrastructure will be required along the roads to optimise vehicles' behaviour. In both instances, 5G could have a role to play.

Of the many initiatives that are already underway we can begin with an example from France: the SCOOP@F[30] (cooperative intelligent transport systems) project coordinated by the Ministry of the Environment, Energy and the Sea, and which unites local authorities and R&D centres. Launched in February 2014, new partners subsequently joined the initiative, including Orange and Austrian, Spanish and Portuguese partners. As it is a European project, it receives 50% of its financing from the European Commission, and cross-tests are conducted with Austria, Spain and Portugal. SCOOP@F is a pilot rollout project for cooperative intelligent transport systems; it aims to deploy 3,000 vehicles on 2,000 km of roadway spread across five locations: Ile-de-France, the A4 motorway, the Isère, and ring roads in Bordeaux and Brittany. Its main objectives are to improve road safety and the safety of roadway workers, achieve more efficient traffic management, reduce pollution, streamline infrastructure management costs and participate in defining the car of the future.

In addition, in early 2017, mobile carrier Orange, equipment supplier Ericsson and car-maker PSA Group signed a partnership agreement[31], as part of the "*Towards 5G*" initiative, to conduct technical trials relating to 5G. The aim of this alliance is to test the different paths of technological evolution from 4G to 5G to meet the needs of connected cars, notably in terms of intelligent transport systems (ITS), for safer driving and new on-board services.

The third area concerns the emergence of autonomous vehicles. A number of projects are underway in this area. The first step is to outfit vehicles with algorithms that enable it to make decisions quickly based on their environment. This requires a large number of sensors to deliver a full "understanding" of what is happening around the vehicle. Without pre-judging the technologies that will ultimately be employed to achieve this, as with a human driver (see above), the car could take advantage of connections with other vehicles on the road and with an infrastructure, to have access to all of the aforementioned information.

3.1.2 Industry 4.0

Competitiveness does not depend solely on innovation and the evolution of products, but also on modernising businesses and their means of production. According to certain studies carried out in 2015[32], the digital transition in Europe will enable enterprises to increase their revenue by more than 110 billion euros a year over a five-year period.

A great many countries have set out a strategy for modernising their manufacturing infrastructure (*l'industrie du futur* in France[33], Industry 4.0 in Germany…) of which one aspect will involve digitising processes and trade. The European Commission itself introduced measures in 2016 for strengthening

[30] http://www.scoop.developpement-durable.gouv.fr/spip.php?page=sommaire

[31] http://www.orange.com/fr/Press-Room/communiques-2017/Ericsson-Orange-et-le-groupe-PSA-partners-pour-la-voiture-connectee-en-5G

[32] PwC, "Industry 4.0: Opportunities and challenges of the industrial internet" (2015), and Boston Consulting Group, "Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries" (2015)

[33] http://www.economie.gouv.fr/files/files/PDF/industrie-du-futur_dp.pdf

competitiveness in Europe, in which 5G could play a significant role. This included earmarking 500 million euros for the Horizon-2020[34] research programme.

The advent of new technologies (4G, fibre and soon 5G) and new services (the Internet of Things, the cloud, big data) should facilitate businesses' digital transition. 5G in particular is expected to be a very versatile technology, capable of undergirding a very wide array of uses, and could go a long way in furthering companies' transition to digital technologies and solutions.

3.2 Spectrum harmonisation

5G is emerging as a technology that will use both low frequencies (f < 1 GHz), high frequencies (1 GHz < f < 6 GHz) and, for the first time ever in consumer networks, very high frequencies referred to as "millimetre wave" frequencies (f > 6 GHz).

This spectrum diversity is entirely bound up with the promises of 5G: extended coverage (low frequencies), ultra high speeds (very large channels in very high frequency bands), low power consumption. Furthermore, satellite services will also contribute to the development of this new technology, especially in areas that are difficult to cover and to provide backhaul solutions. The satellite industry is thus taking an interest in 5G, and wants to be involved in defining these new generation network.

3.2.1 Millimetre wave frequencies

The "millimetre" band, also referred to as millimetre wave spectrum, aka frequencies above 6 GHz, are essential to enabling 5G to mark a departure from 4G, for the reasons cited in Section 1.5.1.

At the latest World Radiocommunications Conference (WRC-15 in Geneva), a conference under the aegis of ITU whose objective is to change the way frequencies are allocated between users, discussions over the definition of future mobile bands made it possible to focus future 5G studies, for millimetre wave frequencies, on a certain number of bands situated between 24 GHz and 86 GHz (33.25 GHz identified in total): 24.25 - 27.5 GHz, 31.8 - 33.4 GHz, 37 – 43.5 GHz, 45.5 - 50.2 GHz, 50.4 - 52.6 GHz, 66 - 76 GHz, 81 - 86 GHz.

It is important to stress that, even if the above-listed bands have been identified as "5G bands", at this stage there is no way to know whether they can actually be used to deploy this new generation system: only the results of technical studies will make it possible to establish the constraints and rules of compliance, and to validate the feasibility of these hypotheses.

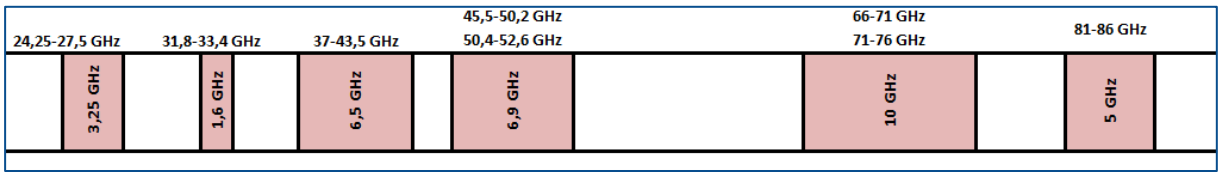

Figure 15. Millimetre wave frequencies identified at WRC-15

Contrary to the conclusions of the Conference, which reflect European recommendations, the United States and certain Asian countries (South Korea, Japan) have decided to perform 5G trials in the 28 GHz band, and equipment suppliers such as Qualcomm and Samsung, have begun manufacturing 28 GHz- band products.

[34] https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

Meanwhile Europe, following the publication of an RSPG (Radio Spectrum Policy Group within which France is represented by ANFR) opinion[35], decided to focus its first studies on the 26 GHz band (pioneer band), then on the 32 GHz and 42 GHz bands. Later, studies will be carried out on introducing 5G in all of the other bands identified by WRC-15.

The rapid choice of the 26 GHz band as the pioneer band was made to enable economies of scale for equipment production, since it is very likely that dual-mode equipment, i.e. compatible with both the 26 GHz and 28 GHz band, will be available for pioneer rollouts[36].

In France, the 26 GHz band is already being employed for a variety of uses: mobile operators' wireless fixed links (4G infrastructure links), fixed satellite service systems and ground stations for space services. Studies will therefore need to be conducted to take these services into account, and define either the cohabitation or migration of applications to other millimetre wave frequencies.

3.2.2 Frequency bands below 6 GHz

a) The 3.4-3.8 GHz band

It will not be possible for 5G to run entirely on millimetre wave frequencies: the propagation qualities of these bands make it difficult to achieve widespread coverage, particularly in more sparsely populated areas. In addition, these bands are still lacking in technological maturity when it comes to delivering consumer market communication services. As a result, a "core" band below 6 GHz needs to be identified: one that provides sufficiently large channels to enable future 5G operators to provide innovative services and a higher quality of service than with 4G.

The 3400 - 3800 MHz band appears to be a good candidate.

First, it has already been harmonised for ultrafast mobile services inside the European Union. Initially the 3400 - 3600 MHz band and later the 3600 - 3800 MHz band were identified as the "IMT" bands (for high-speed mobile). Second, they have a great deal of available spectrum (up to 400 MHz). Lastly, technological advancements (antenna and signal processing) make these frequencies compatible with their use to establish macro cells, and not only microcells. To give an example, it emerged from the interviews conducted by Arcep that coverage with this band could be similar to coverage with the 2.6 GHz band, the core 4G frequency band.

This analysis has been confirmed by the European Commission (in its 5G mandate to RSCOM[37]) and by RSPG[38] which consider the 3.4 - 3.8 GHz band as the only credible 5G band for deployments taking place before the end of 2020.

In France, the band is assigned to Arcep, in a priority fashion, for the 3400 - 3600 MHz frequencies (and in a non-priority fashion to the Ministry of the Interior and the Ministry of Defence), and exclusively for the 3600 - 3800 MHz frequency bands. It is used for wireless local loop and satellite applications.

The compatibility of future uses with current applications is being examined by the Electromagnetic Compatibility Advisory Committee, which is chaired by the National Frequency Agency and of which

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[35] http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf

[36] The tuning range is vital here: a system capable of regulating its frequency from 26 to 28 GHz appears entirely technologically achievable within the timeframe for the first 5G millimetre wave deployments. This would have been less true if a switch between 28 and 32 GHz were required.

[37] https://circabc.europa.eu/sd/a/448dc765-51de-4fc8-b6e0-56ed6a1d0bca/RSCOM16-40rev3%205G%20draft_mandate_CEPT.pdf

[38] http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf

Arcep is a member: exclusion zones, protecting certain locations tied to long-term use of satellite solutions, need to be set up. Military radiolocation systems operating below 3.4 GHz also need to be protected.

b) Other bands below 6 GHz

The bands being used today for 2G, 3G and 4G could be used for future 5G deployments.

Refarming 2G, 3G and 4G could be a delicate undertaking, however, because of the duplexing methods they use. Most mobile communications in Europe use FDD (Frequency Division Duplexing)[39] to exchange information. Technical discussions over 5G are nevertheless anticipating that TDD (Time Division Duplexing)[40] will be the chief, if not sole, form of duplexing used for this new generation, notably because it makes it possible to adjust bandwidth to data rates and because it is particularly efficient when beamforming is used.

For 5G networks, using already harmonised mobile bands will thus require in-depth technical studies to define the terms and conditions of use and sharing with existing services. On this point, the ECC (Electronic Communications Committee[41]) decided to assess the potential of certain already harmonised bands, notably the 700 MHz and the L band (1427-1492 MHz).

In France, Arcep allocated the 700 MHz band to mobile operators in late 2015. Even if the country's four operators all obtained frequencies in this band, only Free Mobile, which has no blocks of 800 MHz spectrum, decided to begin its rollouts in the band using LTE (4G) technology.

Arcep is currently analysing the contributions to its public consultation, addressing among other the 3.5 GHz band, that ended recently.

The L band (1427 - 1518 MHz), which was defined to be used exclusively in SDL (Supplemental DownLink) mode, could be considered to meet the constant demand for ever higher data rates and the greater increase in downlink traffic, compared to uplink traffic. In France the band is used by wireless fixed links authorised by Arcep, by the Ministry of Defence for mobile services (excluding aeronautical) and by the Ministry of the Interior. Using it for 4G or 5G would therefore suppose moving the above-mentioned uses over to other bands.

3.3 Increasingly small cells

Today, mobile network rollouts are essentially based on the use of macro base stations: installations that are equipped with high-power antennae deployed to guarantee coverage for a relatively wide area, providing good quality of service. Network configurations are evolving constantly: new radio base stations are installed on a regular basis to increase the networks' capacity, to better meet users' needs in terms of indoor and outdoor coverage, and to improve quality of service.

However, this continually growing demand for capacity already requires operators to increase the density of their networks with smaller and smaller cells.

5G – which will probably bring about a sizeable increase in data traffic, and which will use millimetre wave frequencies whose propagation capabilities are weak – will no doubt require the widespread deployment of low-power base stations (small cells).

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[39] A technique that consists of sending and receiving data simultaneously, but on two different frequency bands.

[40] A technique that consists of sending and receiving data on the same frequency band but at different times.

[41] The European body that specifies the technical terms and conditions governing the use of frequency bands, which are then set by European Commission decisions.

To satisfy demand and enable the introduction of 5G, estimates indicate at least 10 small cells per macro base station in urban settings[42], where cells are already today relatively tightly meshed to handle traffic density.

Here, the players that met with Arcep raised several questions that will no doubt need to be answered when considering the ubiquitous deployment of small cells.

3.3.1 Taxation

The current regulatory framework stipulates that base stations whose power requires an opinion, an agreement or a statement from the National Frequency Agency (ANFR) are subject to a flat tax on network companies (IFER[43]). The amount of the tax varies according to transmission power, the type of installation and the deployment location. For a deployment in an urban area, the tax stands at €1,607/year/installation for a base station with an effective isotropic radiated power (EIRP) of more than 5W (a COMSIS agreement from ANFR is required to be able to transmit) and €160.70 €/ year/installation for an EIRP of between 1W and 5W (declaration to ANFR is required to be able to transmit).

5G small cells will likely use variable transmission powers of between 1W and 25W. In light of rollout density forecasts, hence the number of small cells to install, some of the stakeholders that Arcep met with raised the question of possibly adapting this tax in such a way as to enable massive small cell deployments without generating an equally massive increase in the total tax amount.

This process is already underway, notably with a view to decreasing taxes on base stations in locations that are hard to cover: Act No. 2016-1888 of 28 December 2016 on the modernisation, development and protection of mountain regions thus exonerates mobile base stations built in mountain regions between 1 January 2017 and 31 December 2020 from paying the IFER tax.

3.3.2 Access to elevated and “semi-elevated” locations

To perform their deployments successfully, mobile operators have traditionally needed to install their base stations in elevated locations (towers, rooftops, etc.). This will continue to be true with 5G networks, but will be even more challenging for two main reasons:

1. 5G antennae will probably be larger (in the m^2 range for some) than current 2G, 3G or 4G antennae, because of the above-mentioned massive MIMO processing that will require the use of a very large number of radiating elements. Moreover, additional antennae compatible with new 5G bands will no doubt also need to be deployed. So the re-use of existing masts could very well be problematic, and new (possibly collocated) transmission sites will need to be found.
2. This search for new sites will also need to be carried out to install small cells in semi-elevated locations, but with extra care as the density of these installations will undoubtedly be high: operators will thus be required to deploy their equipment on urban furniture and infrastructures such as bus shelters, lampposts, public buildings, billboards, etc.

As a result, public authorities will need to keep a close eye on the matter and, if necessary, adopt measures that will facilitate 5G rollouts.

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[42] http://www.lemag-numerique.com/wp-content/uploads/2015/10/WP_-Souverainete_Telecoms_PetitesCells_FINAL.pdf

[43] IFER = *Imposition forfaitaire sur les enterprises de réseaux*

3.3.3 5G networks' regional coverage and backhaul

Ensuring regional connectivity will be one of the challenges for this new generation of mobile networks.

The diversity of use-cases envisioned for future 5G networks, the geographical distribution of which is not yet precisely known, must be factored in when addressing coverage issues.

The higher frequency bands that are being put forth for future 5G networks, along with the potentially very substantial bandwidth consumed by these new uses, pose the question of the regional foothold of these networks. As a matter of fact, mobile networks have never before employed such high frequencies whose use will require a large number of relay antennae to be installed.

Moreover, connecting the 5G installations to the network will push to the fore the question of the cost of connecting them via optical fibre, which will no doubt be necessary in most instances to ensure the expected quality of service. The industry needs to design the technologies that will make it possible to minimise the cost of 5G rollouts in rural areas.

3.4 Net neutrality issues

European regulation on safeguarding an Open Internet[44], adopted by the European Parliament and Council on 25 November 2015, for which European regulators required an additional nine months to specify the rules governing its application, introduces the principle of net neutrality as one of the top priorities in the standardisation hierarchy.

Net neutrality is an overriding principle that guarantees equal treatment for all data traffic on the internet. In particular, it excludes any form of discrimination with respect to the source, the destination or the content of data flows.

On 30 August 2016, BEREC (the Body of European Regulators for Electronic Communications) published guidelines for national regulators on the enforcement of the European Open Internet regulation[45].

During the BEREC public consultation[46] on its draft net neutrality guidelines, several enterprises and electronic communications sector stakeholders took the opportunity to deliver a clear-cut point of view in their *"5G manifesto for timely deployment of 5G in Europe"*[47]. This manifesto aims at warning public authorities against a too restrictive approach to traffic management, and especially of the supposedly negative effects that, in their opinion, an overly strong enforcement of net neutrality could have on the 5G rollout roadmap.

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[44] Regulation (EU) 2015/2120: http://eur-lex.europa.eu/legal-content/FR/TXT/PDF/?uri=CELEX:32015R2120&from=EN

[45] Internet service providers (ISP) can employ reasonable traffic management measures for certain categories of traffic, under non-discriminatory conditions and provided they are transparent, proportionate and justified by objective technical requirements, and not used to serve their own commercial interests. ISPs can also distinguish certain services, called specialised services, from their internet access service, without them affecting the latter, provided these services have specific, objective transit requirements.

[46] http://www.berec.europa.eu/

[47] http://telecoms.com/wp-content/blogs.dir/1/files/2016/07/5GManifestofortimelydeploymentof5GinEurope.pdf

BEREC's opinion[48], in response to the contributions to the aforementioned public consultation, recalls that the rules of net neutrality are technology neutral and therefore apply to 5G networks. Moreover, BEREC guidelines clarify that network slicing which networks will need to use to respond to the different use cases (mMTC, eMBB, uRLLC) planned for this new generation (cf. 1.4) system, may be used to deliver specialised services[49].

The subject of net neutrality as it applies to future 5G networks is still very much open and unexplored, but new analyses could be performed parallel to the work being done on defining 5G. Arcep is open to discussion and will also work, within BEREC, towards bringing the required clarity to the ecosystem.

[48] http://berec.europa.eu/eng/document_register/subject_matter/berec/download/0/6161-berec-report-on-the-outcome-of-the-publi_0.pdf

[49] http://berec.europa.eu/eng/document_register/subject_matter/berec/download/0/6160-berec-guidelines-on-the-implementation-b_0.pdf - footnote 26

Annexes

Annex 1 Definition and standardisation work

A new generation of mobile telephony is defined primarily by two bodies: ITU (International Telecommunication Union) and 3GPP (3rd Generation Partnership Project). These two, respectively public and private, organisations are dedicated to defining the objectives, standards and technical specifications of the new technology in question.

ITU

The first large-scale 5G commercial rollouts are expected to take place in 2020. As mentioned earlier, the exploratory phase – which provides an opportunity to determine demands and identify the most promising techniques and technologies for these future 5G networks – has already begun. Although a number of organisations and consortia are involved in defining 5G, 3GPP will very probably be the central standardisation body for its technical specifications.

Whatever the case may be, ITU (International Telecommunication Union) is vital to defining the technologies and standards that govern any new generation of IMT (International Mobile Telecommunications) at the global level.

These IMT standards are established with the involvement of public authorities and industry players, and have provided the framework for the evolution of mobile communication services around the world, since the beginning of IMT standardisation, with IMT-2000 (3G, UMTS), then IMT-Advanced (4G, LTE-A) and more recently IMT-2020 (5G).

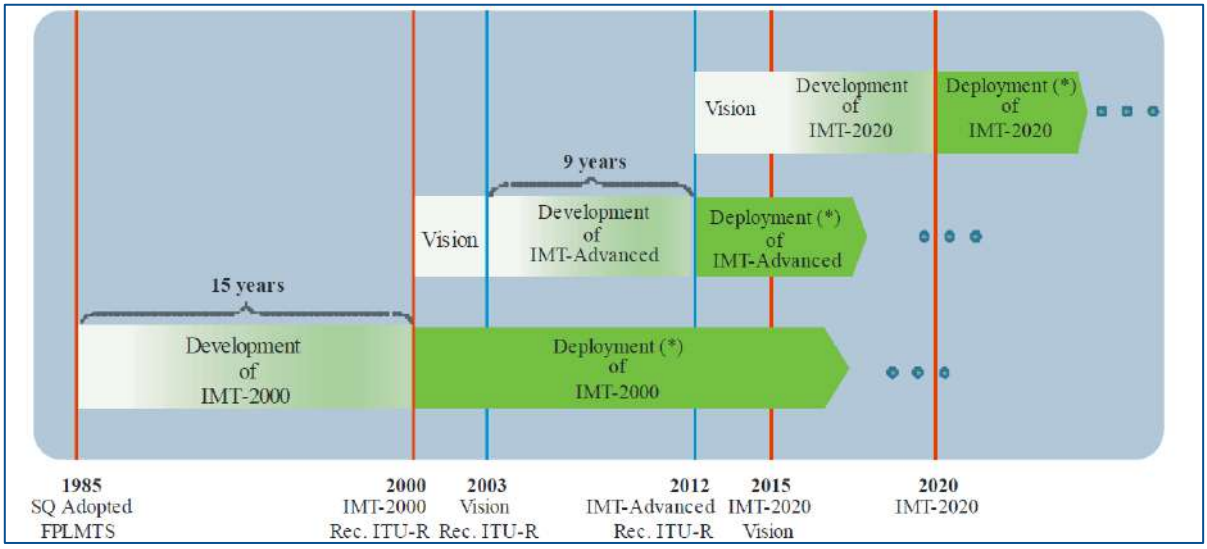

Figure 16. Timeline of IMT developments and deployments[52]

The advent of an IMT standard typically occurs in three main stages : a vision stage, a development stage and a deployment stage.

The vision stage – whose completion is marked by a document that is usually called a Vision Recommendation – is the stage during which ITU sets the framework and objectives for the future technology. The aim of this document is generally to define what the new technology will be in a more or less concrete fashion, what its characteristics will be, the uses it will enable, etc. Whether for

[52]Recommendation ITU-R M.2083-0 (09/2015), https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2083-0-201509-I!!PDF-E.pdf

IMT-Advanced, the commonly used technical abbreviation attributed to the definition of 4G, or IMT-2020, the abbreviation attributed to definition of 5G, the vision stage lasts around three years.

Recommendation ITU-R M.2083-0 was published in September 2015, bringing to a close three years of work performed by ITU-R (Working Party 5D) on defining the framework and objectives for IMT for 2020 and beyond. It is this document that today serves as the basis of the different 5G research and standardisation work being done around the globe.

Next comes the standards development stage, based on the conclusions of the vision stage. Regarding IMT-2020, this development and standardisation work is already underway, and ITU plans on having completed it by 2020 to be able to satisfy the most pressing needs of the ITU members and organisations that want to deploy 5G as quickly as possible. This is all the more challenging as the development stage will last only five years, compared to 15 years for IMT-2000 and nine years for IMT-Advanced.

The different deadlines set for IMT-2020 within ITU can be found in Figure 17. The spectrum identification phases (indicated by the black triangles) coincide with the World Radiocommunications Conferences, of which the latest was WRC-2015 and the next is WRC-2019 (see 3.2).

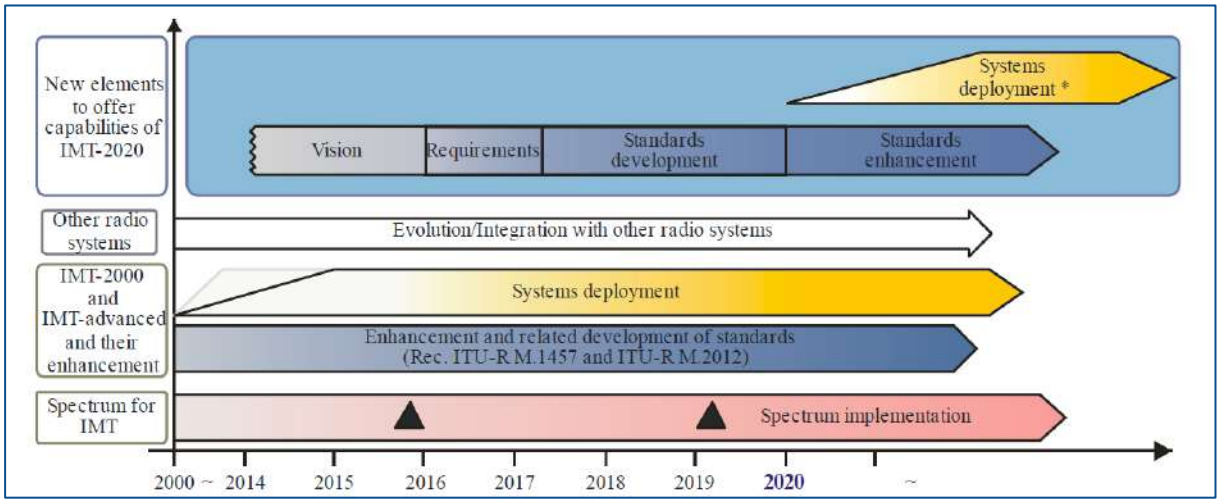

Figure 17. Stages and expected deadlines for IMT-2020[53]

All of the work that ITU is conducting on IMT-2020 is following a roadmap that is detailed in Figure 18, with the completed stages indicated in green and those to come in blue. The work that is underway today concerns 5G spectrum aspects, prerequisites and assessment criteria, along with the different technical studies and proposals, which are a prerequisite to the standardisation phase of the work.

[53]Recommendation ITU-R M.2083-0 (09/2015), https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2083-0-201509-I!!PDF-E.pdf

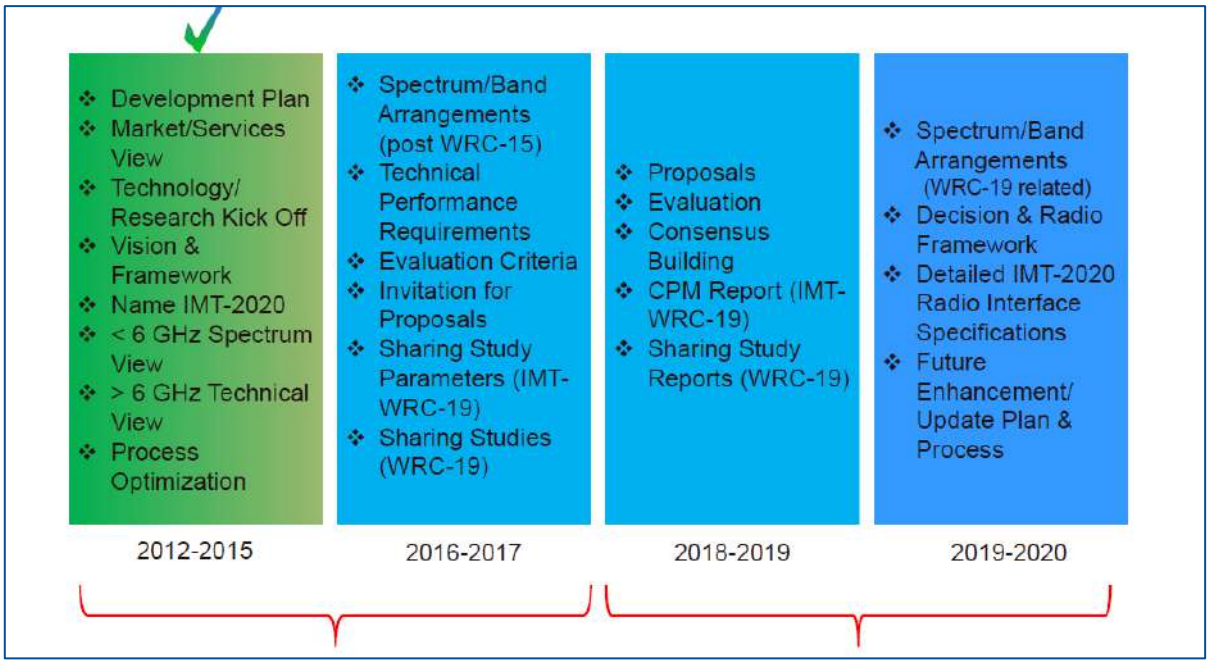

Figure 18. WP 5D[54] work programme

3GPP

Based on ITU Recommendations, 3GPP has played a major role in the success of LTE over the past several years, which has been the fastest growing cellular technology to date: never before has a new radio standard been adopted and deployed as rapidly and as widely from the finalisation of the first version of its standardisation (for LTE Release 8, in December 2008).

For the first time, under the LTE acronym, the entire mobile industry agreed on a single new technology (contrary to 3G where 3GPP and 3GPP2 co-exist, each backing their version of 3G standardisation that complies with IMT-2000 criteria), and so enabling unprecedented economies of scale and momentum in the ecosystem.

After Release 8, the work performed by 3GPP has been centred on the following strategic areas:

- Enhancing LTE radio standards to further improve capacity and performance;
- Enhancing system standards to make LTE and EPC (Evolved Packet Core, the core LTE network technology) available to new business segments;
- Introducing improvements for system robustness, especially for handing exponential smartphone traffic growth.

These areas of focus have made it possible to map out the general path of evolution from LTE to LTE-Advanced (Releases 10 to 12) and later LTE-Advanced Pro (Releases 13 and 14) while awaiting 5G.

The ambitiousness of 5G requirements, the tight timeline "imposed" by the market, along with the different national tendencies have pushed 3GPP to define two stages of specification work:

1. A first stage that will end in the second half of 2018, with the termination of Release 15, and which will address the most urgent matters with respect to commercial requirements;

[54] https://www.itu.int/en/membership/Documents/missions/GVA-mission-briefing-5G-28Sept2016.pdf

2. A second stage that will end in December 2019, which marks the end of Release 16, which will address the other use cases and prerequisites identified in the IMT-2020 Vision Recommendation.

The Work Plan for Release 15, the first set of 5G specifications, was ratified at the plenary meeting of the TSG#72 (Technical Specification Group #72) 3GPP working groups in June 2016. This plan includes a set of intermediate tasks and checkpoints to steer ongoing work in the different groups. This Work Plan sets out the transition from current studies to the standardisation phase of the work:

- Starting in December 2016: beginning of standardisation work by TSG SA2 (Technical Specification Group System Architecture);
- Starting in March 2017: specification begins for the 5G NR (New Radio) interface in the TSG RAN (Technical Specification Group Radio Access Network).

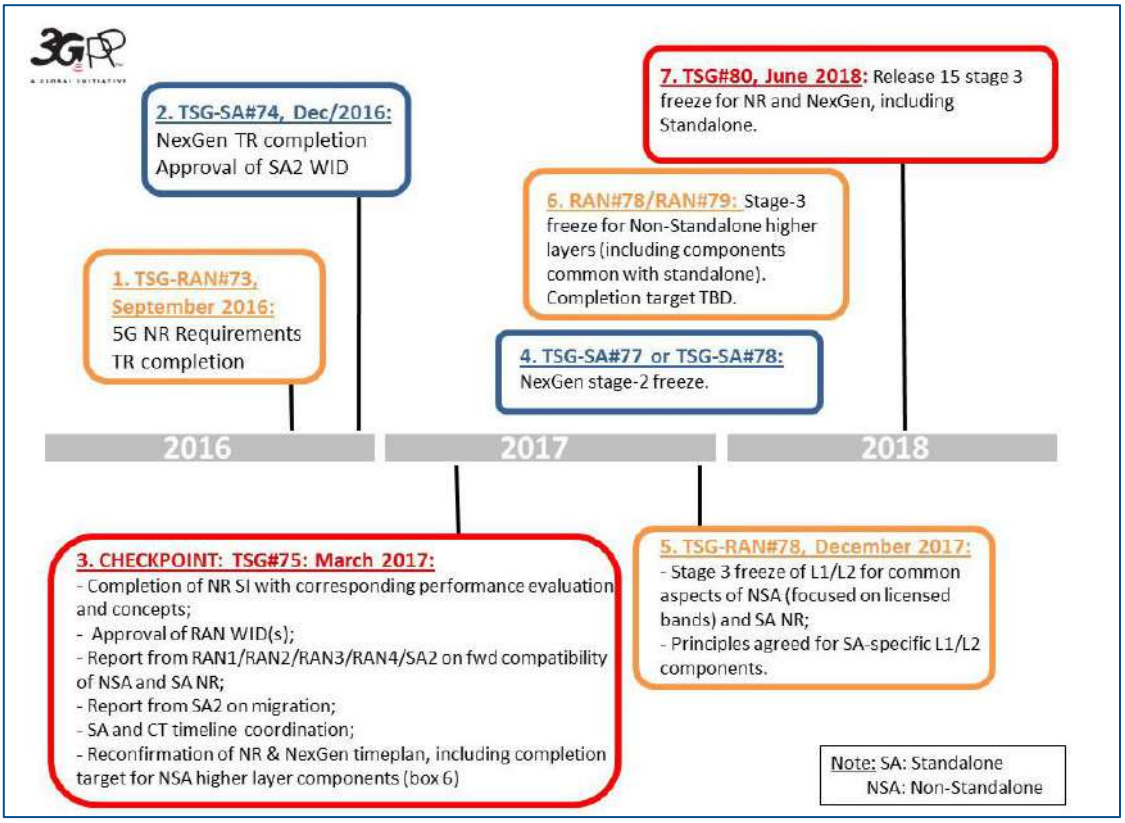

Figure 19. Roadmap for 3GPP standardisation groups[55]

If 5G is viewed as the technology capable of transforming society, and even of ushering in the next industrial revolution by impacting multiple (vertical) sectors with new business models and in a way that benefits the economy, notably in Europe, in all likelihood it will initially be driven forward by eMBB (Enhanced Mobile Broadband, cf. 1.2).

With this in mind, 3GPP defined the framework for Release 15, stage 1 specifications of 5G standardisation, as detailed earlier, whose work will focus on the following:

- Standalone and Non-Standalone NR operation: the Standalone version to work independently of LTE technology, and the Non-standalone NR being highly interoperable with LTE[56].

[55] https://5g-ppp.eu/wp-content/uploads/2016/11/01_10-Nov_Session-3_Dino-Flore.pdf

- Target use cases: starting with Enhanced Mobile Broadband (eMBB) as well as Low Latency and High Reliability to enable some URLLC (Ultra-reliable and Low Latency Communications, cf. 1.2) use cases.
- Simultaneous examination of frequency ranges below 6 GHz and above 6 GHz.

Release 16, the second phase of 5G specifications, will then focus more on other segments such as mMTC (Massive Machine Type Communications, cf. 1.2), for instance, to tackle IoT use cases that require higher quality of service than what LPWAN (Low-Power Wide-Area Network)[57] can provide.

[56] In its non-standalone version, the NR control plane is LTE's. in other words, the 4G network controls the 5G carriers and spreads users across the different bands and technologies.

[57] Sigfox and LoRa LPWAN

Annex 2 Entities Arcep met with

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White Paper

Designing 5G-Ready Mobile Core Networks

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September 2016

5G Core Service & Performance Requirements

An industry "Vision for 5G" is now established and supported worldwide. Services and performance requirements have been identified, and the industry is moving into the development and implementation phases with a view to commercial launch of 5G mobile service around 2019 and fixed wireless access using mmWave radio from 2017. To meet these schedules, leading operators – especially Tier 1s with high expectations and aggressive deployment timelines – are working to make their networks 5G-ready ahead of commercial deployment.

This white paper argues that with a 5G-ready technology strategy, operators can prepare for rapid 5G service launch in a way that optimizes their investment in next-generation IP and mobile core platforms over the next three years. Specifically, it discusses 1) how 5G services drive a requirement for an IP services fabric to connect the distributed data centers that will host 5G network functions, content and applications and 2) the development of cloud-native, service-orientated core networks for advanced 4G and 5G networks.

5G Services Dimensions

Development of the 5G system architecture, and associated core network, is being led by 5G service requirements. **Figure 1** shows the output from the 3GPP SMARTER study group that has investigated the service dimensions of 5G.

Figure 1: Service Dimensions in Future 5G Networks

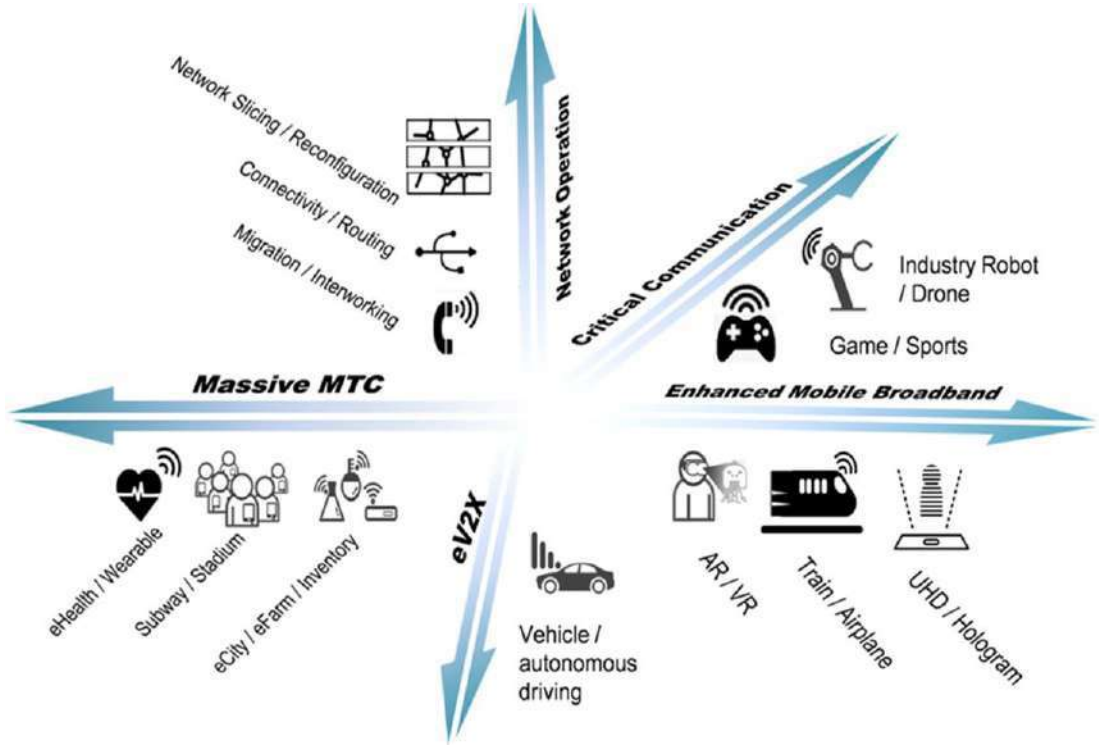

Source: 3GPP SMARTER

The chart maps closely to the now famous triangle representation of 5G services made up of enhanced mobile broadband (eMBB), low latency and mission critical communications and massive machine-type services (mMTC). However, it adds two important axes: a dedicated eV2X axis for vehicular services and, significantly, a network operations axis.

The dedicated operations axis is important because it makes explicit that automation is fundamental to 5G. To address new commercial opportunities, operators need the ability to create service-specific "network slices" that extend end to end across the infrastructure. Automating set up and management of these "network slices," including configuration of the underlying IP network, is critical to the 5G business case.

These service dimensions incorporate many different performance requirements. **Figure 2** shows IMT-2020 performance targets, developed by the ITU, for 5G. To the left, these are shown in comparison to IMT Advanced (4G). To the right, performance requirements are mapped to the three major use-case categories.

Figure 2: IMT-2020 Performance Targets

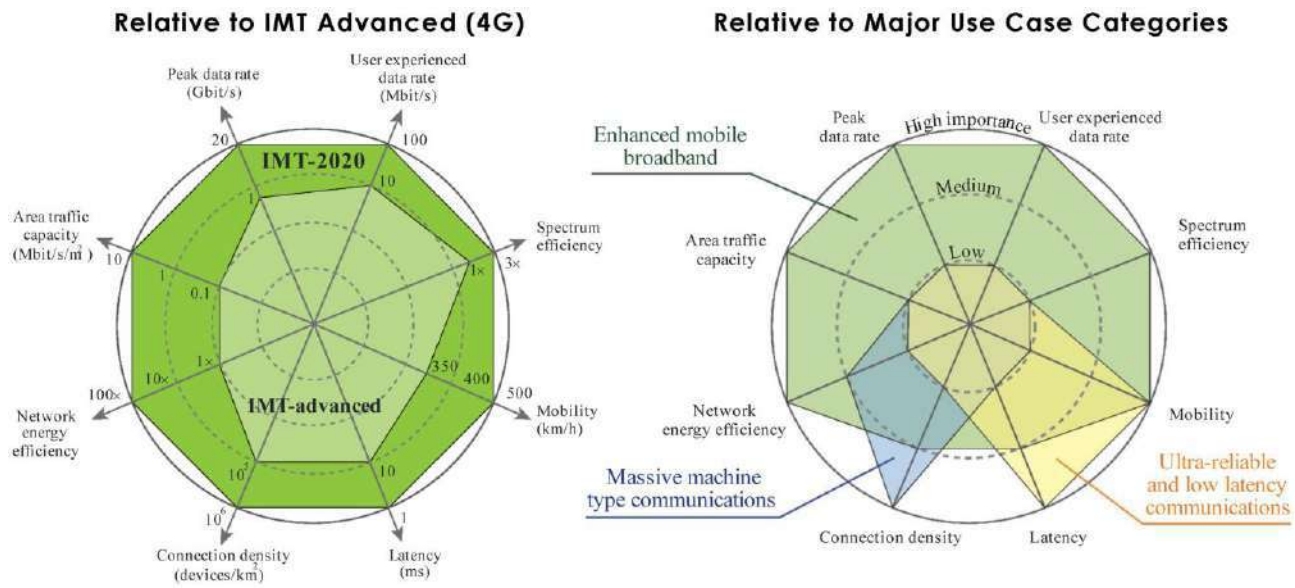

Source: ITU Recommendation ITU-R M.2083-0, September 2015

Probably the most influential factor on 5G physical network deployment will be the low-latency requirement. To deliver services over a wide-area network (WAN) with a consistent 5-10ms roundtrip time is extremely challenging and will drive a new system architecture deployed on a distributed cloud infrastructure.

A 5G-Ready Network Investment Strategy

Operators now have a good idea of what 5G will look like in scope and a reasonable view into the initial deployments models. Development of normative standards for 5G new radio (NR) and the next-generation core network (NG Core) is underway

with the first specifications – and the first "compatible" pilot deployments – expected in mid 2018. Although there is uncertainty about the details of the specifications under development, the industry has already undertaken significant R&D work on 5G candidate technologies, making it is possible for operators to pursue a 5G-ready network strategy with a reasonable degree of confidence that they will be able to rapidly deploy 5G, at scale, as the technology becomes commercially available.

From an IP and core network perspective, five tiers of a 5G-ready investment strategy are, from the ground up, as follows:

1. **Develop a distributed data center footprint**. The Central Office Re-architected as Data Center (CORD) model provides a good reference. The idea is for operators to develop physical assets located close to the edge and transform them into distributed data centers. The edge location is critical for low-latency 5G services and, as Mobile Edge Computing (MEC) shows, the edge-cloud is valuable in many networking scenarios – it is not solely a 5G investment. In time, the distributed data center will also come to support Cloud RAN (C-RAN) and Virtual RAN (V-RAN) hub sites and will host core network functions, such as distributed user-plane nodes.
2. **Create an "IP Services Fabric" for 5G with software-defined networking (SDN) control**. Edge-cloud locations running 5G network functions and services will require high-performance, secure connectivity. Investment in wide-area SDN is already underway to create an "IP services fabric" that connects centralized data centers, distributed cloud locations and cell sites. This IP services fabric provides routing, security, service chaining, redundancy and orchestration. Again, this investment is, in many aspects, not unique to 5G, but common to high-performance networking at the cloud edge.
3. **Invest in cloud-based Evolved Packet Core (EPC) and NG Core.** With a distributed cloud infrastructure, it is logical to redesign core network functions to take advantage of this asset to meet the strict latency requirements of 5G services and efficiently manage data traffic. Some aspects of NG Core are already reasonably well understood, (for example, control- and user- plane separation or "CUPS"), while others remain works in progress (for example, mobility and session management). In general, expect control-plane separation to apply across the 5G architecture, from radio to core.
4. **Use network slicing for a service-optimized core.** Network slicing is an important bridge from a 4G core to a new 5G core and is a key component of a 5G-ready network investment strategy. In this model, virtual network functions (VNFs) are created per service and data is routed via an optimized processing path across the network. By isolating services into virtual network slices, operators can offer better security, more efficient transport, optimized core network processing and appropriate service quality. A network slice created for an Internet of Things (IoT) customer, for example, may support both 4G and 5G access networks.
5. **Automation and service orchestration.** Automating network operations provides the ability to launch new services rapidly, to reach new market segments, to evaluate success/failure quickly, and then to modify, scale and repeat. Significant progress is being made in applying service orchestration to 4G-Long Term Evolution (LTE) networks, especially where software-based core networks are deployed. Network slicing is a good example of the need for automation because there will be many more logical entities to commission, provision and manage. "Automated service orchestration" is a good, tangible example of 5G-ready functionality.

The 5G Core Network

The new 5G core network is now reasonably well understood: It will be "cloud-native," it will make extensive use of network slicing, and it will operate in concert with a new model-driven service orchestration layer. The industry can therefore start to develop NG Core products that can be adapted as standards emerge and solidify.

From a practical perspective, for the initial deployment, operators can support 5G radio access on a "5G-ready" EPC and then migrate to a new NG Core over time. In both cases, the "IP services fabric" provides SDN-controlled connectivity and related IP services, across a distributed cloud infrastructure.

Virtualized & Cloud-Native Mobile Core

Operators have made good progress on virtual EPC over the past couple of years. The largest networks now support more than 15 million subscribers (AT&T has discussed this publicly); some progressive operators have started to refresh their main EPC networks using multivendor network functions virtualization (NFV) (e.g., Docomo, Etisalat); and others (e.g., Vodafone) have deployed virtual core elements for IoT services.

Figure 3 shows two migration paths to a "cloud-native" 5G core. The blue line shows a virtualized 4G core as a stepping stone to a "5G-ready" core and then a full 5G core. The grey line shows a more conservative option where the operator scales the classic EPC in the near-term and then makes a bigger leap to 5G later.

Figure 3: A Preliminary Cloud-Based 5G Architecture

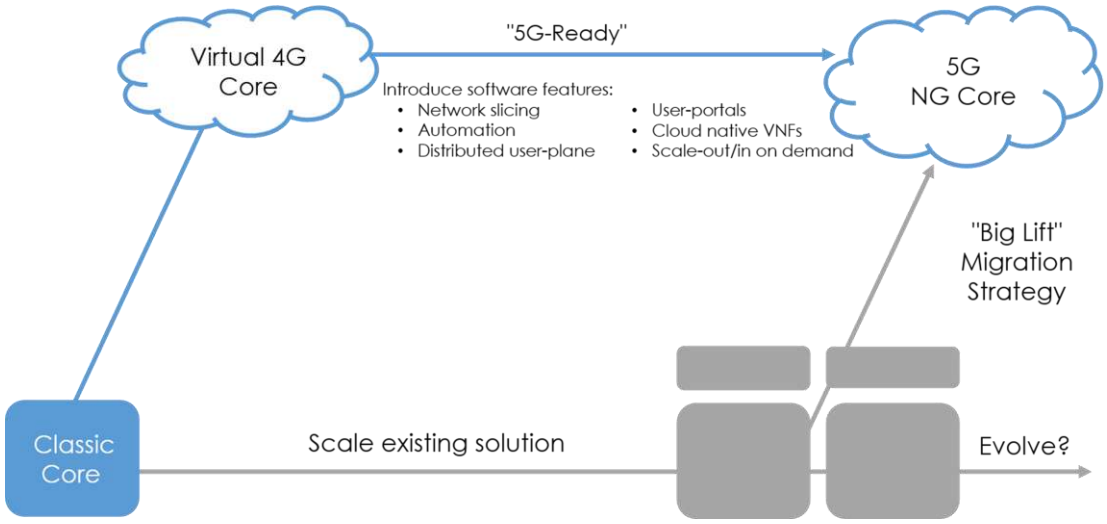

Source: Heavy Reading

There is debate about what exactly "cloud native" means, particularly in the context of stateful telecom network functions. Nevertheless, Heavy Reading's established view is that operators that deploy virtual EPC – even at small scale – gain experience in how these systems work, how to operate them, and how to evolve them, and that in turn will give them a sustainable advantage in the longer-term transition to software-centric 5G mobile networks.

Migrating 5G RAN From EPC to NG Core

A 5G-ready core strategy is determined, in part, by how the operator plans to introduce 5G radio. There are two basic possibilities: operate 5G RAN using an EPC or using a new NG Core. In practice, operators with plans to launch 5G early are likely to start with an EPC and migrate to NG Core over time, as shown in **Figure 4** below.

Figure 4: Migrating 5G RAN from EPC to NG Core

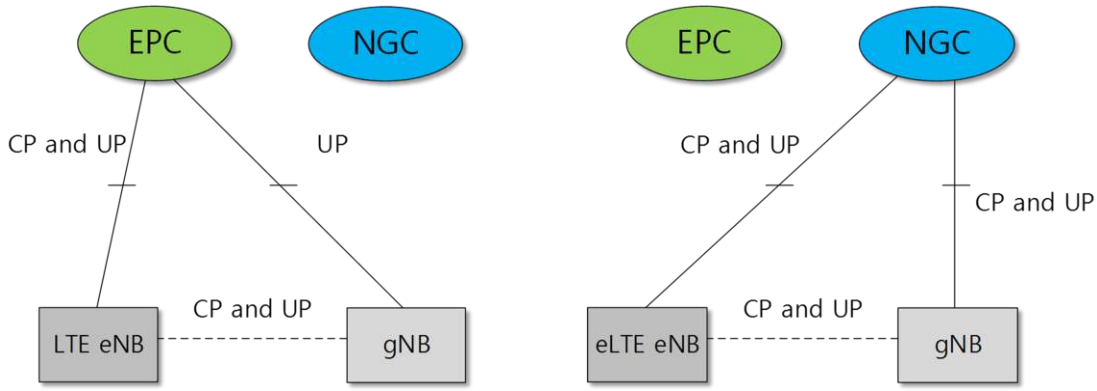

Source: 3GPP TR 38.801 v0.4.0

The diagram is taken from the most recent version of the 3GPP "Study on New Radio Access Technology" (TR 38.801), which will inform development of standards in Release 15. Several permutations of the architecture are under consideration; however, in simple terms, to the left, the new 5G base station (gNB) user-plane interface connects directly to a 4G EPC, while the control-plane functions, such as tracking, paging, etc., are provided by an evolved 4G base station (eNB), which in turn also connects to the EPC. In this scenario, the EPC requires little or no modification, making this a fast and simple way to deploy 5G radio from a core perspective.

Over time, both 4G and 5G base stations can migrate to a new NG Core, which will provide both control- and user-plane functions. At this stage, NG Core becomes the primary core network for 4G and 5G access, as shown to the right in the diagram. This is conceptually similar to how EPC supports 3G and 4G access networks.

Note that in cases where 5G radio is deployed for fixed wireless access, there is no need for an LTE RAN to provide control-plane functions to the 5G user device; a standard EPC is sufficient, although it would need to provide session management for the 5G access. Some of the first 5G deployments are expected to use this model.

Network Slicing: A Key Bridge to 5G

Network slicing is one of the key bridges between the 4G and 5G core. To support diverse service types, operators will use multiple core networks deployed as "network slices" on a common IP services infrastructure. The idea, shown in **Figure 5**, is to create virtual core network instances (or "slices") dedicated to different services. Each slice can be optimized for the traffic profile and the commercial context of the associated service – for example, IoT, public safety, mobile virtual network operator (MVNO), connected car, voice over WiFi or enterprise services. Network slices can be two dimensional in the sense that they can be both service- and customer-specific.

Figure 5: Dedicated Packet Core Network Slices

- Virtualization enables multi-tenant and single-tenant private core networks
- "Slices" configured according to service type & traffic profile
- Multiple options to steer user traffic into a core network processing path
- Mechanisms in 3G/4G include APN routing, MoCN, DECOR

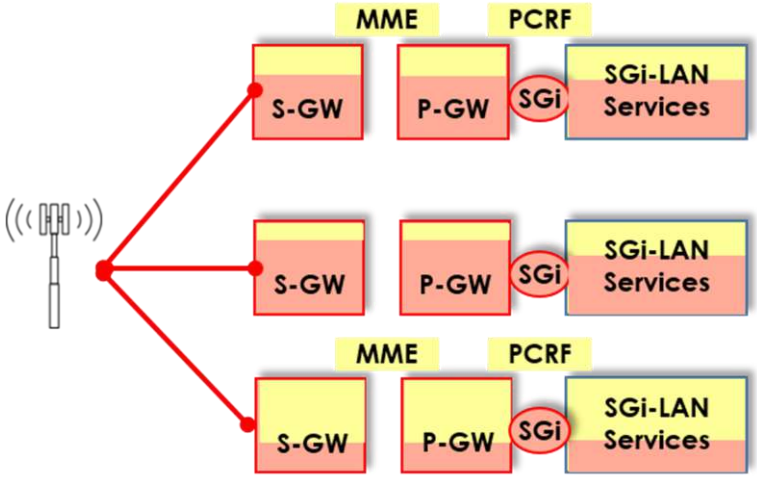

Source: Heavy Reading

IoT is an example of how operators can use "slicing" to support a 5G-ready core strategy. Since many of the core network design parameters are similar between 4G and 5G, investment in a software-based IoT core network can be made with the expectation that the same core (with software updates) will also support IoT services on 5G in future. Moreover, because devices from both access types will connect to a common IoT core, operators will be able to develop integrated 4G/5G IoT strategies that optimize investment and enable them to go to market with narrowband IoT services before 5G specifications are released and radio equipment is deployed.

5G will, naturally, bring more capabilities to network slicing. Most importantly, it is expected that the slice will run end to end across the RAN, core and transport network. Radio is typically deployed as a shared resource, which means that 5G slicing will involve advanced self-organizing network (SON) capabilities and hierarchical, slice-aware scheduling on the air interface. On the network side, the operator can use SDN to reserve resources for the network slice on the IP services fabric.

NG Core for 5G

A new core network offers important benefits, particularly for services with demanding performance requirements, and is an important part of the 5G architecture. The high-level view of the NG core network architecture, as it looks in September 2016, according to TR 23.799 (the Technical Report on the NextGen System Architecture) is shown in **Figure 6**.

The chart shows the primary elements of the new 5G system architecture, including the device (UE), the radio access network (NG-RAN) and the core network that comprises the control-plane (NG-CP) and user-plane (NG-UP) functions. The separation of control and user planes is a direct extension of the "CUPS" concept being developed for advanced EPCs in 4G networks and is another example of how operators can invest in 5G-ready core network designs in the near term.

Figure 6: High Level View of NG Core Architecture (Proposed)

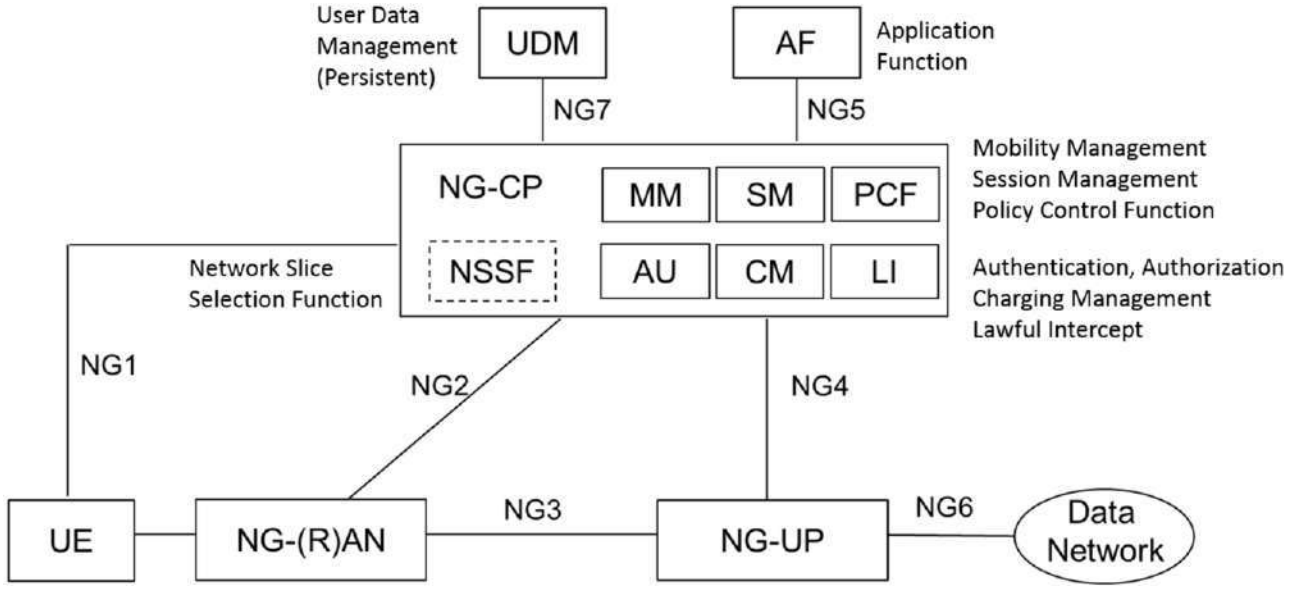

Source: 3GPP, Adapted from TR 23.799 v0.8.0, September 2016 (Figure 7.2.4-1)

It is interesting to compare this new functional architecture with the existing EPC. **Figure 7** maps the new NG Core elements to their equivalent in EPC. It shows significant overlap between the EPC and NG Core and provides confidence that today's state-of-the-art EPC is reasonably close to the next-generation core in terms of functionality, albeit that the interfaces and protocols will change/evolve.

Figure 7: Mapping NG Core & EPC Functions

NG Core Network Function	Approximate Equivalent EPC Function
UDM (User data management)	SPR
AF (Application function)	AF
NSSF (Network slice selection function)	MME (DECOR) + HSS
MM (Mobility management)	MME + SGW / MME + SGW-C
SM (Session management)	PGW/PGW-C
PCF (Policy control function)	PCRF
AU (Authentication & Authorization)	HSS/AAA
CM (Charging management)	PGW + PCRF, OCS, OFCS
LI (Lawful intercept)	LI
NG-UP (User-plane function)	SGW + PGW / SGW-U + PGW-U

Source: Heavy Reading, Affirmed, Juniper

Key Capabilities of the Next-Gen System Architecture

In addition to proposed architectures, the Technical Report provides guidance on the features and services NG Core should support. It identifies 19 key issues for the Next-Gen System Architecture, which can be grouped into four categories:

- **Flexible Deployment**: Including network slicing, user-plane network selection, network function granularity (e.g., decomposition of VNFs and service chains), interworking and migration, a policy and charging framework.
- **Flexible Access Support**: Including variable core/access splits, a flexible authentication framework (with varying credentials according to device-type, use case and policy), support for relays and multi-hopping, improved network discovery and selection mechanisms.
- **Connectivity**: Including session management, mobility management, a quality-of-service (QoS) framework and service and session continuity (e.g., across accesses).
- **Adapting Existing Capabilities**: Including network/service capability exposure, multicast and broadcast, IP Multimedia Subsystem (IMS) support, off-network communications (e.g., *ad hoc* networks for public safety).

Implementation of these capabilities is tightly linked to both the design of the NG Core and the underlying IP service infrastructure. The 3GPP specifications do not reference connectivity services, but, in practice, there is a close relationship.

A Distributed 5G Services Fabric

The infrastructure onto which 5G will be deployed should support multiple, demanding use cases. This drives a need for a high-performance wide-area IP services fabric controlled (or "orchestrated") by SDN. This IP services fabric should provide connectivity between many different distributed data centers in a meshed architecture that provides resiliency and scalability, and should be programmable such that it can support dynamic, service-specific network slices. In effect, the IP services fabric makes distributed centers act in a unified manner – i.e., behave as one integrated data center. The concept is shown in **Figure 8**.

The design of the distributed IP services fabric is formed by the variety of use cases, the requirement for low latency and high availability, and the need to scale efficiently. In tandem, the mobile network architecture will evolve to a more distributed model. To meet 5G service requirements, NG Core will be deployed using the "CUPS" model, with user-plane nodes hosted at distributed data center locations, and control-plane nodes at more centralized locations, interconnected by the IP services fabric.

Service orchestration will generally be domain specific, with SDN-controlled IP services, cloud resource management, NFV lifecycle management and end-user service orchestration, all operating quasi-independently in a layered architecture. Coordination between the layers will use "cross domain orchestration" to ensure a network slice contains all the networking components needed to deliver the service.

Depending on how the architecture evolves, there will be a need to support highly accurate, 1588v2-based timing (frequency and phase) within this IP services fabric. Virtual RAN/Cloud RAN is an example on the network side that benefits from accurate network timing. On the customer side, it is expected that some market segments, such as the financial industry, will also require timing to be incorporated into network slices.

Figure 8: IP Services Fabric for 5G Networks

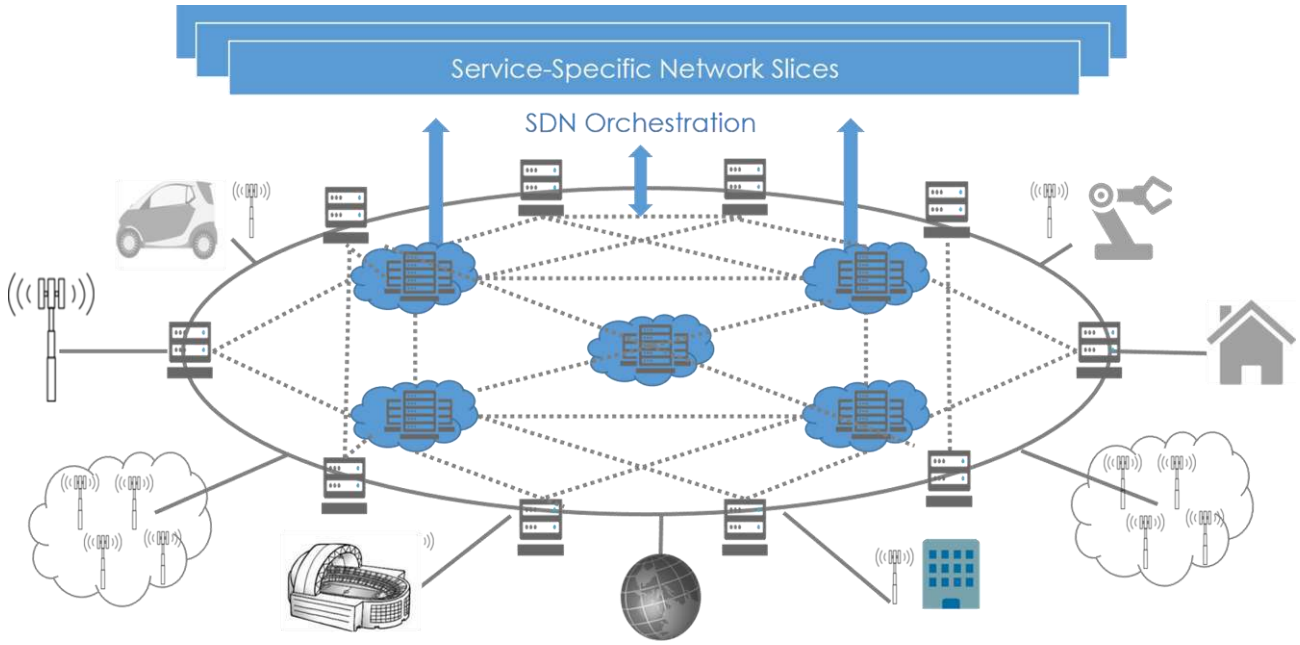

Source: Heavy Reading

Distributed Data Centers

To provide access network services, telecom operators have a physical footprint – in the form of central offices, base station controller sites and transport aggregation sites – that they can convert into distributed or micro data centers.

Depending on the service requirements, these data centers can be used to terminate access connections using virtualized edge functions and become the obvious place to host latency-sensitive content and applications. For centralized cloud providers, this capability is harder to replicate unless they build out an extensive physical footprint or partner with an access provider, and, therefore, this strategy provides operators with a potentially important and sustainable competitive advantage.

The "edge cloud" model will be critical to 5G and is the subject of detailed R&D across the industry. As an example, a preliminary architecture developed by the SuperFluidity project (a European 5G research project) is shown in **Figure 9**. Work on this particular project, which is academic in focus but contains several industrial partners, is scheduled to finish by the end of 2017.

As the name implies, the project aims to achieve superfluidity in the network: the ability to instantiate services on the fly, run them anywhere in the network (core, aggregation, edge) and shift them transparently to different locations. This is the essence of the "IP Services Fabric" for 5G. In this new network, operations will also need to move from a "red light, take action" model to an automated model where the orchestration and associated next-gen operations support system (OSS) detect and fix problems with the IP and NFV layers, and re-optimize the network accordingly.

Figure 9: A Preliminary Converged Cloud-Based 5G Architecture

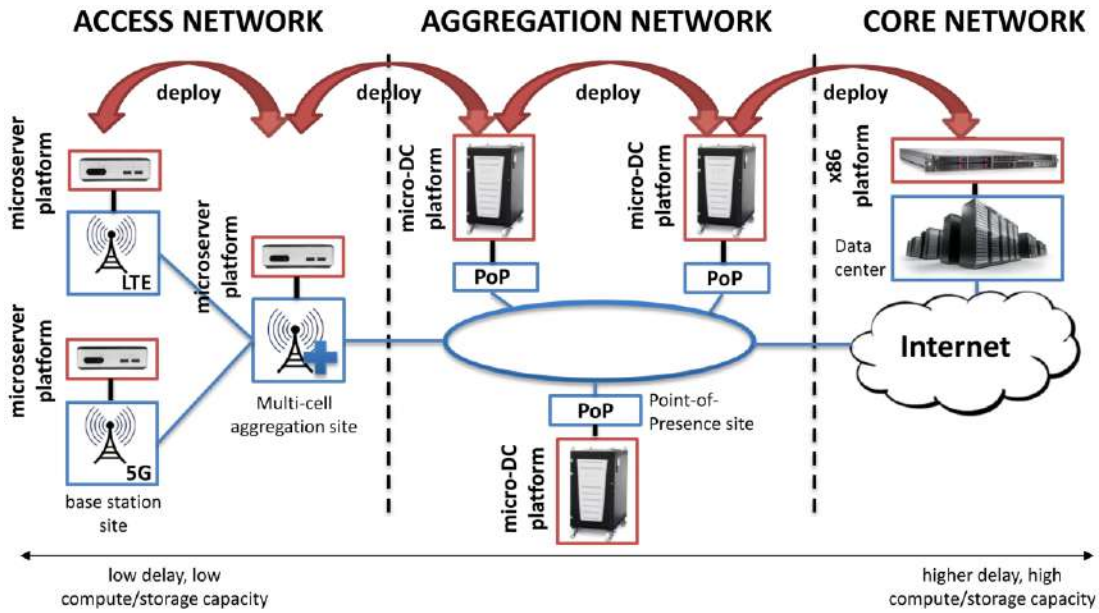

Source: SuperFluidity

Central Office Re-architected as a Data Center (CORD)

There are several industry and service provider initiatives to define the architecture for SDN-enabled distributed data centers. The Central Office Re-architected as a Data Center (CORD) initiative hosted by the Linux Foundation is one example of how operators aim to make better use of these assets.

According to the CORD initiative, AT&T alone operates 4,000 to 5,000 central offices, each serving 10,000 to 100,000 residential, enterprise and mobile customers. These central offices contain fragmented vendor hardware with multiple physical appliances installed per site (AT&T said it has 300+ unique appliances deployed in its central offices nationwide). The opportunity is to re-architect these central offices to support edge cloud infrastructure and deploy VNFs in place of appliances.

Each CORD location will be connected using an SD-WAN, making it possible to load-balance content and NFV workloads across the distributed cloud using the same SuperFluidity concepts discussed above. In the CORD case, the focus is on the ONOS controller, but in the sense that this is a generic architecture, multiple SDN controller options are viable and attractive. Note that for I/O-intensive workloads, the selection of an edge location should consider the physical transport resources available at the site. It would not make sense, for example, to deploy a 5G user-plane node for fixed wireless access in a central office that does not have a high bandwidth connection to the Internet.

In March 2016, the Linux Foundation announced the M-CORD initiative for mobile operators, backed by AT&T, SK Telecom, Verizon, China Unicom and NTT Communications. It highlighted three key aspects of the architecture, saying that it:

- Will use the same CORD principles of elastic commodity cloud and SDN to bring data center economies and cloud agility to the mobile edge.
- Will demonstrate integration of disaggregated/virtualized RAN, disaggregated/virtualized EPC and mobile edge services.
- Will partner with the SDN controller groups to accelerate adoption of open source SDN and NFV solutions and realize the benefits of the cloud.

Given the timing of the work, we expect M-CORD and similar initiatives to turn their focus toward "5G-ready" core networks as the architecture, interfaces and protocols for NG Core become more clear. A common CORD and M-CORD implementation, with the same architecture and foundational technologies, will create a good foundation for fixed-mobile network convergence, enabling access agnostic services – an important objective of many operators pursuing 5G.

Mapping Mobile Core to Distributed Cloud

The NG Core for 5G and EPC for advanced 4G networks must be mapped to the distributed cloud architecture. One approach would be to simply deploy more packet gateways (and mobility controllers) at the edge of the network to meet capacity and performance demands.

The challenge with this is that today's centralized packet core deployments are characterized by complex integration with surrounding network functions, such as policy, charging, IMS, SGi-LAN and routing services. By moving this model to the edge, the operator would, in effect, have to "distribute complexity," which is costly to deploy and, in particular, to manage. To meet 5G performance, scalability and automation requirements, a new architecture for packet core is needed that will make operation in the edge cloud infrastructure simpler and faster.

There are many aspects to this new architecture. Part of the solution is CUPS, as is currently being developed for 4G-LTE core networks. This involves extracting the control-plane functions from the gateway to leave a simpler, user-plane node. The gateway thus is "split" into S/PGW-U and S/PGW-C components that can that can scale independently, as shown in **Figure 6** above. A key benefit of the architecture is that the control plane, and all the associated complex interactions, can be centralized, while the user plane is distributed across the IP services fabric and scaled as required by the traffic load. This is shown in **Figure 10**.

Depending on the scaling needs, the S/PGW-U functions deployed at the edge data center can be implemented in several different ways: on a router, on a white box switch (potentially), on an existing PGW platform, as a virtualized function, or as part of a vRouter. Virtualized user-plane nodes can more easily be placed at the optimal location, as determined by the use case and this flexibility is a strong argument to deploy S/PGW-U nodes as VNFs rather than as hardware functions.

The S/PGW-C components would similarly be deployed as virtualized functions on a cloud platform, typically at a more centralized location. There may be an opportunity to collapse MME, SGW-C, PGW-C functions and perhaps other 3GPP control-plane functions into some form of unified "mobility controller" node. This has the potential to simplify operations and this same model is being pursued for NG Core.

In this architecture, virtualized SGi service LAN components can be placed where appropriate for the traffic coming from the distributed user-plane nodes. For example, some SGi functions could be on router-based compute blades, or on COTS x86

servers deployed at the distributed site, while others could be in the central data center or close to Internet peering points. The selection of the site for the SGi functions is carried out by the central orchestration system, which steers traffic into service chains on a per subscriber, application, bearer, device or combination basis.

Figure 10: Distributed User-Plane at Edge Data Centers

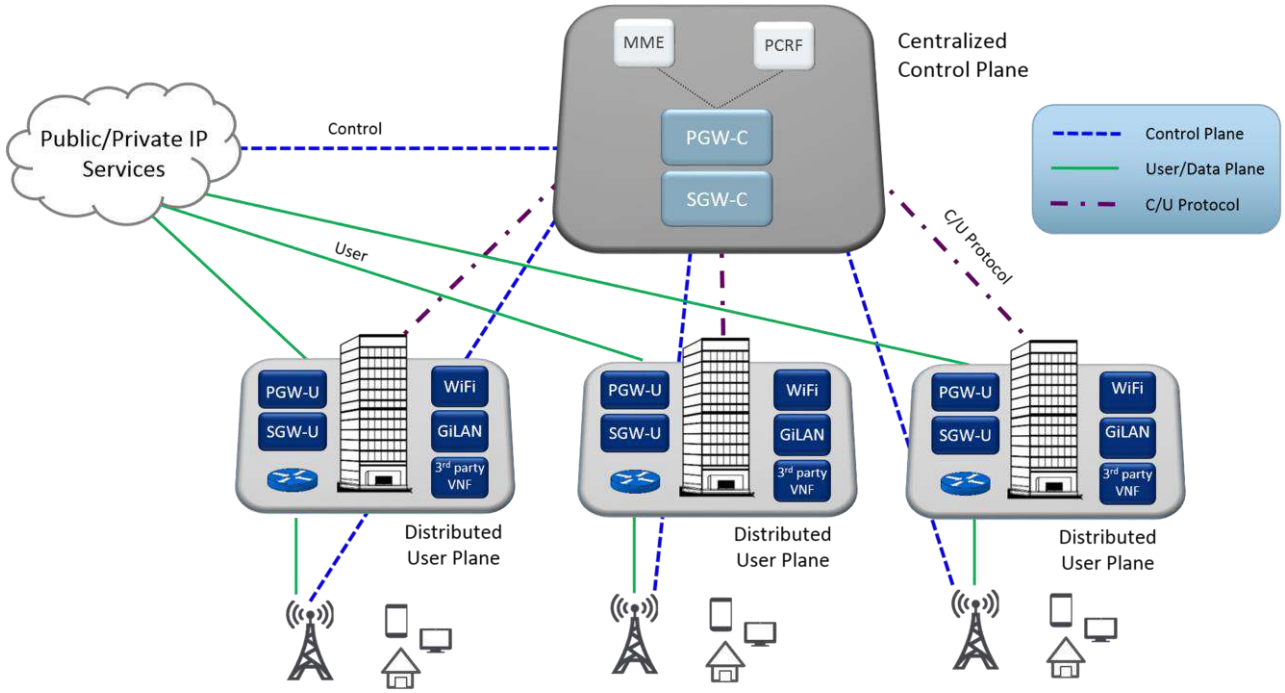

Source: Affirmed Networks

This model of discrete control- and user-plane functions is expected to be fundamental to 5G and the NG Core. In this sense, CUPS can be viewed as an important part of a 5G-ready investment strategy.

A 5G-Ready Core Is Now a Priority

The industry now has a reasonable view of 5G service requirements, and progressive operators with aggressive deployment timelines are now working to prepare their networks for rapid deployment of 5G when equipment is available. This is driving investment in the critical IP services network needed to connect the edge cloud locations that will run 5G network functions, content and services.

On the mobile core side, development of cloud-native, service-orientated core networks for advanced 4G and 5G networks is underway. Network slicing provides a conceptual bridge between 4G and 5G investment and facilitates a faster insertion of new services into the network. Similarly, CUPS provides a reference for NG Core and the new 5G network architecture. With a 5G-ready technology strategy, operators can prepare for 5G service launch in a way that optimizes their investment in next-generation IP and mobile core platforms over the next three years.

About Affirmed Networks

Affirmed Networks' NFV solution has become the standard for the world's top mobile operators, who are embracing new business models and building new revenue streams by making the transition to virtualized architectures. The company's technology portfolio includes the Affirmed Mobile Content Cloud, the Affirmed Wi-Fi Gateway (serving as a TWAG/TWAP and an ePDG), Affirmed Service Automation Platform (ASAP) and Affirmed Virtual Probe and Analytics Solution. These virtualized solutions have come to represent the present and the future of virtualized mobile networks with extreme scalability, remarkable flexibility, comprehensive network orchestration and future-proof solutions for a 5G-ready architecture. Please find more information at www.affirmednetworks.com.

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Energy harvesting power for the Internet of Things

Energy harvesting wireless technology easily interconnects thousands of individual devices in a system, opening up unlimited processing and monitoring applications.

Laurent Giai-Miniet, EnOcean, Oberhaching (Munich), Germany
09/30/2013

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Energy is everywhere within reach; it just needs to be harvested. This is the principle of energy harvesting. Today, energy harvesting wireless solutions are already well established in the commercial building automation sector. But the technology is just getting started. New application fields for batteryless, wireless communication will be found to further enhance the world around us.

Based on energy harvesting wireless technology, a wide range of energy-autonomous applications are currently available for connected buildings that use motion, light, or temperature differences as their energy source such as batteryless switches; intelligent window handles; temperature, moisture, and light sensors; presence detectors, heating valves; and smart home systems. However, building automation is by no means where energy harvesting wireless ends.

Multiple interconnections

Everybody's talking about the Internet of Things (IoT). But how should billions of communicating devices be powered? The answer is by energy harvesting, and the reason is simple: Liberating sensors from external power, making them energy-autonomous, opens up unlimited processing and monitoring applications where cables or batteries represent an insurmountable hurdle. These features make energy harvesting wireless technology the ideal communication standard to easily and reliably interconnect thousands of individual devices in a system, as well as network them with other wireless protocols.

Today, energy harvesting wireless technology is widespread, providing M2M solutions in the building automation sector and bridging the control of light, HVAC, and other fields of building technology to smart buildings, smart metering, and energy management systems. This is the starting point to actuate further applications that lead to the IoT in the long term. The following four categories show what this could look like.

Monitoring and control

Wireless and batteryless technology significantly eases energy monitoring and control in buildings with little intervention into the existing systems. The wireless devices are highly flexible to install so that individual components, wall switches, sensors, and relay receivers can be easily networked to form an intelligent system without complex cabling. In addition, dispensing with batteries eliminates the burden of maintaining the devices' energy supply in a regular time period, which can be up to each year.

An example for such a flexible automation system is HVAC control. Here, a thermostat, VAV (variable air volume), or fan coil controller receives information related to occupancy, temperature, humidity, window position, or CO_2 from the respective batteryless sensors and controls the opening and closing of valve actuators for radiators, or dampers for VAV systems. At the same time, the controller sends status information to a central building automation system, and receives control messages from the BAS. This enables the building to be monitored from a central location that can be remote from the building itself, and building-wide settings, such as holiday shutdown, to be implemented. Enormous progress is also being made on the product side, leveraging advancements in energy harvesting. Self-powered radiator valves generate energy from the difference in temperature between the hot water and the surrounding air. This energy powers the communication with a controller or BAS system, and turns the valve itself. Without cables or batteries, these wireless devices are especially easy to install, and they require no maintenance.

In further optimized systems, central equipment such as boilers or air handling units are integrated into the wireless communication system, enabling scalable HVAC generation, visible and controllable over the Internet on a PC, tablet, or

smartphone.

Performing tasks

Alarm systems are a second field that batteryless wireless technology is opening up, due to its specific features. Here, the reliability requirements are much more stringent than those required for lighting controls. A system failure not only means a malfunction but also can cause much more serious consequences for other systems that depend upon the equipment being monitored. It's a fact that more malfunctions are caused by battery failures than by the electronics, especially in large systems. Energy harvesting overcomes this issue.

There are already various batteryless wireless water detectors available that use miniaturized solar cells or motion energy converters to power wireless signals that report water leaks in areas such as water supply networks in spacious industrial facilities. In the AFRISO universal module, for example, the EnOcean wireless signal immediately sends the leakage information to a gateway controller or directly to a valve, causing the main water pipeline or the affected supply line to be shut off. A notification is sent to the user's smartphone or smartpad at the same time to inform the user about the incident. In addition, the water valve can be opened and closed, independent of leakage notifications, by GSM connection via smartphone or smartpad.

Embedded processing

A major requirement of today's and the future energy supply is the Smart Grid. It's intended to network centralized and decentralized energy suppliers, including private homes producing electricity by photovoltaic installations, to an intelligent system that provides energy only when needed, updating in real time. This requires continuous data flow and processing from all involved parties, which means from millions of information points.

A key component is smart metering systems. To work reliably and cost-efficiently, interoperability between the meters is supplied by different manufacturers; this is why smart metering calls for standardized technologies. Consequently, the members of the EnOcean Alliance have defined a specific device communication protocol, the Automated Meter Reading (AMR) profile for batteryless wireless devices. Smart meter systems based on this open protocol are already available from a number of manufacturers. For example, Eltako meter components read and transmit the current electricity, water, and gas consumption, including accumulated meter figures, by means of energy harvesting wireless technology located at a variety of points inside a building. BSC software monitors and displays the current meter readings and compares them against default values. This makes all relevant data available for systems processing for intelligent energy management on demand.

Bridge to the cloud

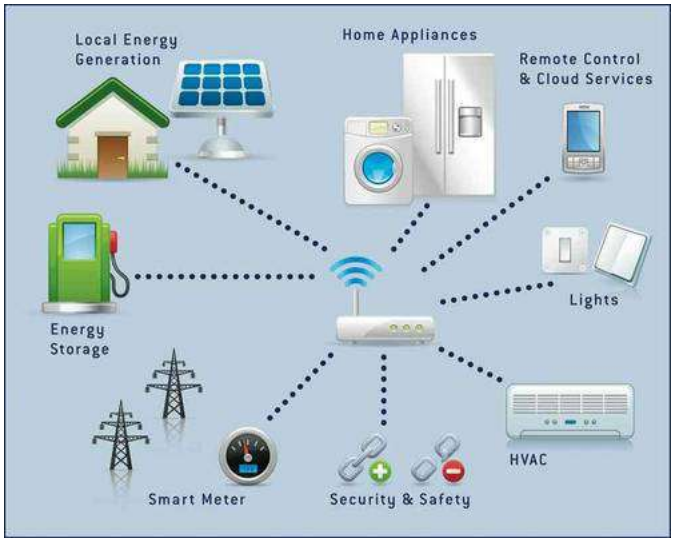

Via similar gateways, the standard-based energy harvesting technology can also communicate with Ethernet, Wi-Fi, GSM/UMTS/CDMA, and other networks for integration in cloud services. Here, all data collected by batteryless wireless sensors is encrypted and transmitted to a cloud service over the Internet. The gateways connected to a control and visualization software by TCP/IP that can be used to control all relay receivers and sensors bidirectionally. Some manufacturers have developed a cloud solution that offers energy management as a service. Therefore, facility managers, building owners, and businesses can monitor important inventory, equipment, assets, and energy-related information from anywhere at any time, via the cloud. Critical building-related data is automatically pushed to the cloud, freeing owners and managers from the often-challenging coordination and expense of hosting on-site servers.

One of the major advantages of such a cloud-based solution is that the management system arrives completely precommissioned from the manufacturer and ongoing device commissioning is expertly done on behalf of the client and pushed out from the cloud. The users are granted unlimited access to their remote, dedicated virtual server with their own IP address, accessible from a desktop or smartphone — the perfect precondition for a deeply connected world of an IoT.

The energy harvesting market is growing and multiplies on a year-by-year basis. Forecasts show that this trend will continue, especially as the next generation of energy harvesting wireless solutions is just around the corner to pave the way to the Internet of Things.

Laurent Giai-Miniet is CEO of energy harvesting wireless solutions provider EnOcean and previously spent 20 years with Texas Instruments (TI), where he held several management positions including General Manager for Low Power RF Products (LPRF).

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The Basic Soldering Guide

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Alan Winstanley

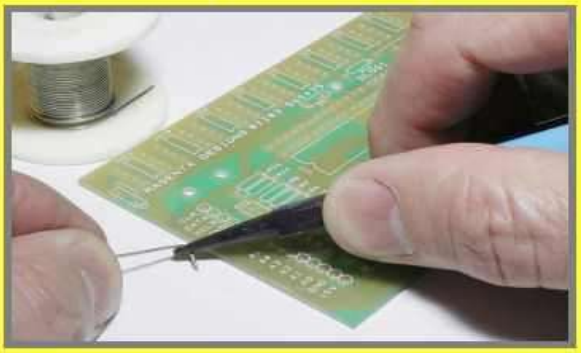

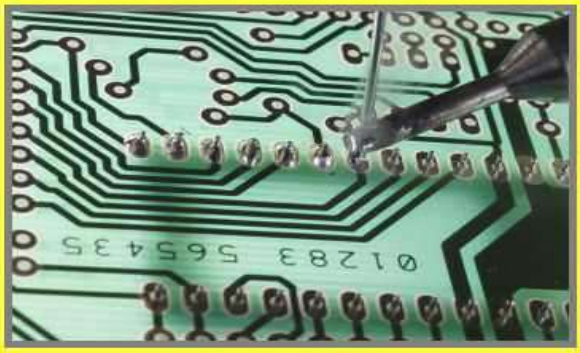

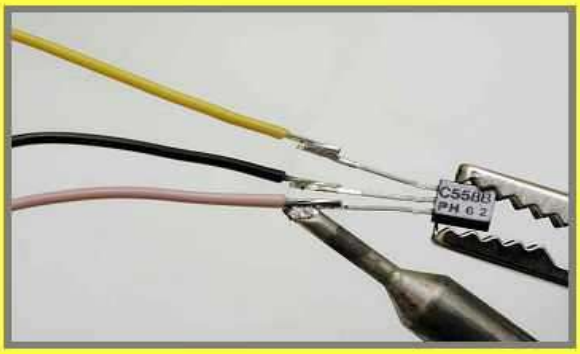

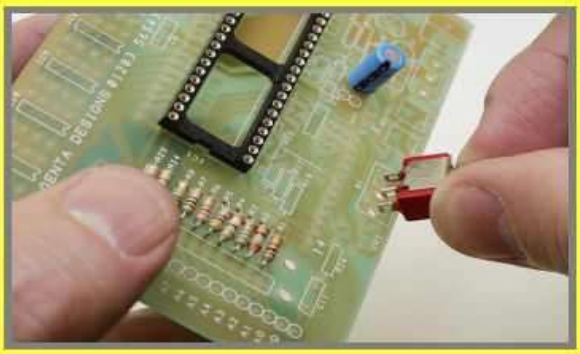

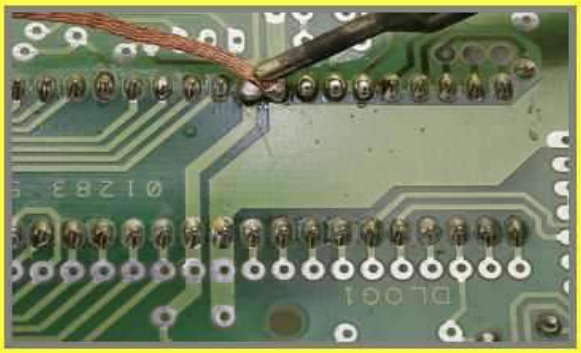

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The Basic Soldering Guide

by Alan Winstanley
***EPE Magazine* Online Editor**

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Where mentioned, the U.K. mains voltage supply is 230V a.c. and you should amend ratings for your local conditions.

Preface

In 1996 when the world wide web was still very young, I launched the first and most detailed website ever describing the practical skills of electronic soldering, and my **Basic Soldering Guide** quickly became the #1 web site of its kind in the Google search engine.

Thanks to its in-depth reference text and the unequalled high-quality close-up photography showing soldering step by step, many quickly learned the essential stages needed to make a solder joint successfully. Even novices who had never tried soldering before, gained the skills and confidence needed to acquire this skill.

My Basic Soldering Guide became a key *go-to* online guide for soldering, and I've enjoyed receiving encouraging feedback ever since from the likes of the US Air Force, US Marines, US Coastguard, Honeywell trainers, Atomic Energy authorities, Australian aeronautical suppliers, UK colleges and universities, trainees and many more around the world.

In association with Antex (Electronics) Ltd., the leading UK manufacturer of electronic soldering equipment, I'm delighted to bring you this updated Basic Soldering Guide containing over 80 all-new colour photographs, more background, more detailed information and lots more practical hints and tips.

I've revisited various areas of the guide and refreshed them, taking onboard readers' queries and nearly 17 years of online feedback, experiences and answering reader's questions. With the help of all-new photography, I'm sure you'll master the skills needed to solder electronics successfully using this updated guide.

I welcome feedback and comments, and readers can reach me via my website **www.alanwinstanley.com** or Email me at **alan@epemag.demon.co.uk**

Alan Winstanley

July 2013

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Introduction

The first and most important aspect of assembling any electronic project is that of *soldering,* which is a delicate and precise skill that can be mastered with experience. Sometimes called "soft soldering", there's no shortcut to acquiring the necessary expertise, and producing a consistently satisfactory solder joint takes a little practice. However, like riding a bicycle, soldering is an art which once learnt is never forgotten, and the purpose of this new and updated guide is to explain the techniques of soldering and desoldering for beginners, which I hope will set the hobbyist or trainee technician firmly on the road to successful electronic assembly or repairs in the future.

Soldering is the least "aggressive" way of joining non-ferrous metals together, and is used universally in electronics, air conditioning and refrigeration circuits, household plumbing and more besides – applications where the precise joining together of components at fairly moderate temperatures is needed. Further up the scale, **brazing** involves using higher temperatures to melt brazing rods onto larger metal parts, perhaps to repair a metal chair, lawnmower or to fabricate metal components or jewellery into intricate shapes. Lastly, **welding** is a very aggressive way of fabrication using welding rods or wire; steel girders, oil rigs and ships are all welded together, or robotic spot-welding is used for the mass production of, say, washing machines or car bodyshells using sheet steel to make strong rigid assemblies.

Due to the lower temperatures used and the need to make consistently good electrically conductive and mechanically sound joints with precision, soldering is used to connect components together when manufacturing electronic circuits. Small components would quickly be destroyed by brazing or welding, although tiny spot-welding joints do appear in electronics, perhaps to weld a metal tag onto a button battery.

This guide therefore deals with the soldering techniques used in electronics at hobbyist or trainee educational level. It explains what to look for before buying a soldering iron, describes ways of making various solder joints on circuit boards and other electronic components, and also how to *desolder* – removing solder in order to repair a circuit board or replace an electronic component.

You'll also find more details of other aspects of soldering, including an outline of typical solder types and fluxes. In short, everything you need to get started in electronics soldering is here, so let's get started!

First steps

The principle behind soldering sounds quite simple: the idea is to join components together to form an electrical connection, by using a mixture of lead and tin solder or alternatively “lead-free” solder (an alloy of tin and copper), which is melted onto the joint using a *soldering iron*. If you have never picked up a soldering iron before, then this guide will show you everything to help you start soldering with confidence. I also hope that the guidance will help those working in other areas — computer technicians or audio enthusiasts, for example, who may be faced with electronic repairs or modifications using a soldering iron for the first time.

If you’re an electronics hobbyist or trainee, before embarking on any form of ambitious electronic project, it is recommended that you practice your soldering technique on some *brand new* components using *clean* strip board (or protoboard) or a printed circuit board, and select a simple and straightforward constructional design as a starting point. Become acquainted and comfortable with your chosen soldering iron, which likely to become as familiar to you as a favourite pen. Learn how to balance it and handle it with precision. Try soldering an assortment of resistors, capacitors, diodes, transistors and integrated circuits with it, and then try your hand at *desoldering* – removing the solder again to make a repair or modification.

A really good place to start learning is by building a simple electronics kit, such as a Velleman kit that contains a good quality printed circuit board. You’ll learn some of the basic skills of successful soldering this way, and it’ll be a great confidence booster too.

Did you know? In the USA and elsewhere, the letter L in “solder” is silent and they say “soda” or “sodder” – but here in Britain we do pronounce the L and we say “sole-der”.

Soldering iron choices

Search any electronics catalogue or website and you'll see a bewildering array of soldering equipment on sale, including irons, controllers, work stations and desoldering equipment too. A large range of soldering irons is readily obtainable - which one is suitable for you depends on your budget and how serious your interest in electronics is, but there's something for every pocket distributed by a variety of retail, industrial and mail-order outlets.

The Antex range of soldering equipment has been very popular with industry, education and the electronics hobbyist for 60 years; I grew up with an Antex iron and a trusty 15W Antex iron was an everyday part of my hobby electronics all the way through the 1980's. An industrial user or a more dedicated hobbyist – with a bigger budget! – will be interested in a soldering station instead and again Antex offers a range of British-made products for industry or home use.

A very basic mains electric soldering iron can cost from under £5 (US$ 8), but I find that these very cheap irons, as sold on auction websites, are pretty crude and imprecise. They are best suited for simple electrical repairs and DIY rather than precision electronics or printed circuit boards discussed here. They tend to be bulky and uncomfortable for extended use, and they may not have suitable "bits" or tips of various sizes to suit different tasks.

^^ *This classic Antex XS25 "pencil style" 25W mains-powered soldering iron has exchangeable tips or "bits" and is great for general hobbyist or educational use. Stands are also available to store them safely in between use.*

A quality pencil-style electric soldering iron such as the Antex XS25 (photo) will be approximately £20 (US$18 tax free) - though it's possible to spend into three figures on a

soldering iron “station” if you’re really serious about the subject! Don’t be tempted to over-spend on an elaborate workstation though, unless you are really very serious about becoming involved in electronics. You will usually obtain perfectly satisfactory results using a fairly modest “pencil” iron model, and you can upgrade to something more sophisticated should your needs change in the future.

^^ For enthusiasts or industry, this Antex 660TC soldering station has a separate mains-powered control unit and a matching low-voltage soldering iron rated at 24 Volts, 50 Watts so it’s suited to a wider range of tasks than a lower powered one.

When choosing your soldering iron, certain factors to bear in mind include:

Voltage: for the British market, “mains” electric irons run directly from the mains at 230V a.c. or will be set for other voltages (110V a.c.) depending on the country. However, **low voltage types** (e.g. 12V or 24V) usually form part of a “soldering station” for use with a matching controller made by the same manufacturer. Some low-voltage irons run off batteries (e.g. a car battery or Ni-cads) but these are uncommon.

Wattage: this is an extremely important factor to think about when choosing your iron. Typically, irons for general electronics work may have a power rating of between 15-25 watts or so, which is fine for most electronic assembly tasks, printed circuit boards and inter-wiring. It’s important to note that a higher wattage does *not* mean that the iron runs hotter - it simply means that there is more power “in reserve” for coping with larger joints. The maximum electric iron wattage generally available is about 100W, which is OK for DIY electrical repairs but is far too high for general electronics or circuit board use.

A higher wattage iron offers you more flexibility for tackling a wider range of tasks. It has a better “recovery rate” which makes it more “unstoppable” when it comes to

heavier-duty work, because it won't be drained of its heat so quickly. So check the power ratings carefully, and anything between 15–40W is fine for general electronics soldering.

Temperature Control - the simplest and cheapest types don't have any form of temperature "regulation". Simply plug them into the mains and switch them on! Thermal regulation is "designed in" (by physics, not electronics!). Sometimes they are described as "thermally balanced" as they have some degree of temperature "matching" – in other words, they warm up as quickly as they lose heat during use, so in a primitive way they maintain roughly a constant temperature. This type of iron is perfectly acceptable for hobby or less demanding professional use. It's essential to use the manufacturer's specified tips (see later) to maintain proper temperature matching, otherwise the iron may not heat up enough – or it may overshoot in temperature.

These unregulated irons form an ideal general-purpose iron for most users, and they cope reasonably well with printed circuit board soldering and general interwiring. However, most of these "miniature" types of iron will be of little use when attempting to solder large joints (e.g. very large terminals or very thick copper wires) because the components being soldered will draw or "sink" heat away from the tip of the iron, cooling it down too much and preventing solder from flowing properly. That's when a higher wattage iron is needed.

A proper **temperature-controlled iron** will be quite a lot more expensive - retailing at say £40 (US$ 60) or more - and will have some form of built-in thermostatic control, to ensure that the temperature of the "bit" (the tip of the iron) is maintained at a fixed level within reasonable limits. This is desirable during frequent use, since it helps to ensure that the temperature will be relatively stable regardless of the workload. Some irons have a bimetallic strip thermostat built into the handle which gives an audible "click" in use, and some may include an adjustable screwdriver control within the handle as well. Others may have electronic controls built in.

^^ An Antex 660TC soldering station with matching iron and bench stand.

More expensive still, **soldering stations** cost from £70 (US$ 115) upwards (the iron may be sold separately, so you can pick the type you prefer), and consist of a complete bench-top control unit into which a special *low-voltage* soldering iron is plugged. Some versions might have a built-in digital temperature readout, and a control knob to vary the setting. The temperature could be boosted for soldering larger joints, for example, or for using higher melting-point solders (e.g. lead-free or silver solder). These are designed for the discerning user, or for continuous production line or professional use. A thermocouple will be built into the tip or shaft, which monitors temperature.

The best soldering stations have irons which are well balanced, with comfort-grip handles which remain cool all day, and silicone-based cables which are burn proof. Antex produces a range of irons with silicone cables specially for education use, to help avoid accidents caused by careless use by students.

Anti-static protection: if you need to solder a lot of static-sensitive parts (e.g. CMOS chips or MOSFET transistors), more advanced and expensive soldering iron stations use static-dissipative materials in their construction to avoid static charges accumulating on the iron itself, which could otherwise damage or “zap” some semiconductors. Such irons are listed as “ESD safe” (electro-static discharge proof). The cheapest irons are not classed as ESD-safe but they still perform well enough in most hobby or educational applications provided you take the usual anti-static precautions when handling these components. The iron would need to be well earthed (grounded) in these circumstances, to carry away any static.

^^ *Just part of the range of spare tips or "bits" produced by Antex for their soldering irons. Use only tips intended for a particular iron, to avoid thermal matching problems.*

Tips or Bits: it's often useful to have a small selection of manufacturer's bits (soldering iron tips) available with different diameters or shapes, which can be changed depending on the type of work in hand. You will probably find that you become accustomed to, and work best with, one particular shape of tip for the majority of your work. Usually, tips are iron-coated or plated to preserve their life and to maintain good tip "hygiene". Be sure only to use tips that are specifically designed for your iron, otherwise thermal problems may arise. I show separately some typical tips, courtesy of Antex.

^^ Useful accessories from Antex including solder, tips and tip cleaner, desoldering braid and a heatshunt.

Spare parts: it's always reassuring to know that spares are available in the future if required, so if the element blows, you don't need to replace the entire iron. This is especially the case with expensive irons. Check some websites or mail-order catalogues to see whether spare parts are listed. One drawback is that you may need another soldering iron when exchanging a broken heating element!

^^ Gascat 40 gas-powered soldering iron kit by Antex, with spare tips and cleaning sponge.

Gas or electric? So far I've discussed electric soldering irons, but **gas-powered** soldering irons are sold which use butane propellant rather than mains electricity to operate. They have a flint lighter or (better still) a built-in piezo for ignition, and have a catalytic element which, once warmed up, continues to glow hot when gas passes over them. They tend to be big and bulky compared to electric pencil irons.

Field service engineers use gas-powered irons for working on repairs where there may be no power available, or where a joint is tricky to reach with a normal electric iron, so they are really for occasional “on the spot” use, rather than for mainstream construction or assembly work. I use one when I just need to do a quick repair and can’t be bothered getting the electric soldering iron going!

Gas irons can have higher power equivalents than electric ones (eg 125 watts or more) but some gas-powered irons are nothing more than miniaturised blowtorches, which may or may not be useful for occasional heavier duty soldering. In the author’s experience they can be difficult to use in confined areas. *Extreme care is needed at all times to ensure hot gas emitted from the iron’s exhaust port doesn’t damage nearby materials, plastics or wiring.* Gas irons can have useful accessories to convert them into e.g. a hot knife for sealing nylon rope, or a hot-air blower for use with heatshrink tubing. Almost every electronics constructor uses an electric-powered iron though.

A **solder gun** is a pistol-shaped iron, typically running at 100W or more, and is completely unsuitable for soldering modern electronic components: they’re too hot, heavy and unwieldy for micro-electronics use, nor are they designed for that. Plumbing or DIY, maybe..!

^^ *A heat resistant soldering iron stand with cleaning sponge. (Antex)*

Soldering irons are best used along with a **heat-resistant bench stand**, where the hot iron can be safely stored in between use (photo). It is extremely important that a hot

soldering iron is safely “parked” ready for action, and a bench stand is really a necessity. Soldering stations usually have such a feature, otherwise a separate soldering iron stand is essential, ideally one that’s supplied with a tip-cleaning sponge. You can make your own cleaning sponges using *cellulose* sponge only.

^^ *A benchtop fume extractor fan for hobbyist use. A replaceable carbon filter helps remove particles and air is vented out the back.*

Other equipment worth considering includes the use of **fume extractors**, which are compulsory in the industrial workplace. Solder fumes and flux smoke are not known to be toxic but they can cause irritation. A basic fume extractor (photo) consists of a small bench-top fan which draw fumes and irritating smoke away from the operator’s face and filters out some of the smoke particles, before exhausting the air back out through the fan. The carbon-impregnated foam filters are replaceable. Such devices are quite effective and users soon find them indispensable, even though they can be a bit noisy at close range.

Professional fume extraction systems draw the smoke and fumes directly from the work area via a clip-on tube fitted to the soldering iron, then vent the fumes away through a large filter pump. It is definitely worth considering a small bench top unit for regular hobby or occasional professional use, as having decent ventilation can only be a good thing.

^^ *A soldering accessory toolkit by OK Industries, including probes, scrapers and wire brush*

A variety of specialist **hand tools** are available that assist with soldering, and a good supplier's catalogue will offer a range of small brushes, scrapers and cleaning tools in a handy kit, together with the usual types of wire cutters, pliers and so forth, which are necessary for handling components and tidying up as required. Some specialist service aids (aerosols etc.) are also described later.

Now let's look at how to use soldering irons properly, and later on we will describe the techniques for putting things right when a joint somehow goes wrong — and don't worry, even the experts get it wrong sometimes!

How to solder

This guide will show you step by step how to solder successfully and plenty of photographs are provided to help explain the techniques needed.As you read through the guide I'll explain all the stages in more detail, but let's look at the basics first.

First of all, successful soldering requires that the items being soldered together are held with as little movement as possible. So it's best to *secure the work* as needed, so that your accuracy isn't affected should the workpiece move accidentally.

In the case of a printed circuit board, various holding frames are useful especially when densely populated boards are being soldered: the idea is to insert all the parts on one side (a process called "stuffing the board"), hold them in place with a suitable pad to prevent them falling out again, turn the board over and then snip off the wires with cutters before soldering the joints. The frame saves an awful lot of turning the board over and back again, especially with large boards: all the soldering can be performed in one pass.

^^ The ever-popular "Helping Hands" (left) helps support sundry parts, wires etc. during soldering.
A modeller's vice (right) holds parts firmly. A vacuum base fixes it onto smooth surfaces.

Only the more serious constructor will purchase a holding frame, and hobbyists can retain parts in place by improvising in a variety of ways – the ever popular "Helping Hands" stands cost a few pounds and is widely sold. They have adjustable crocodile clips to grip parts, and maybe a magnifying glass or soldering iron stand as well. The cast iron base provides stability. Other parts could be held firm in a modeller's small vice, for example.

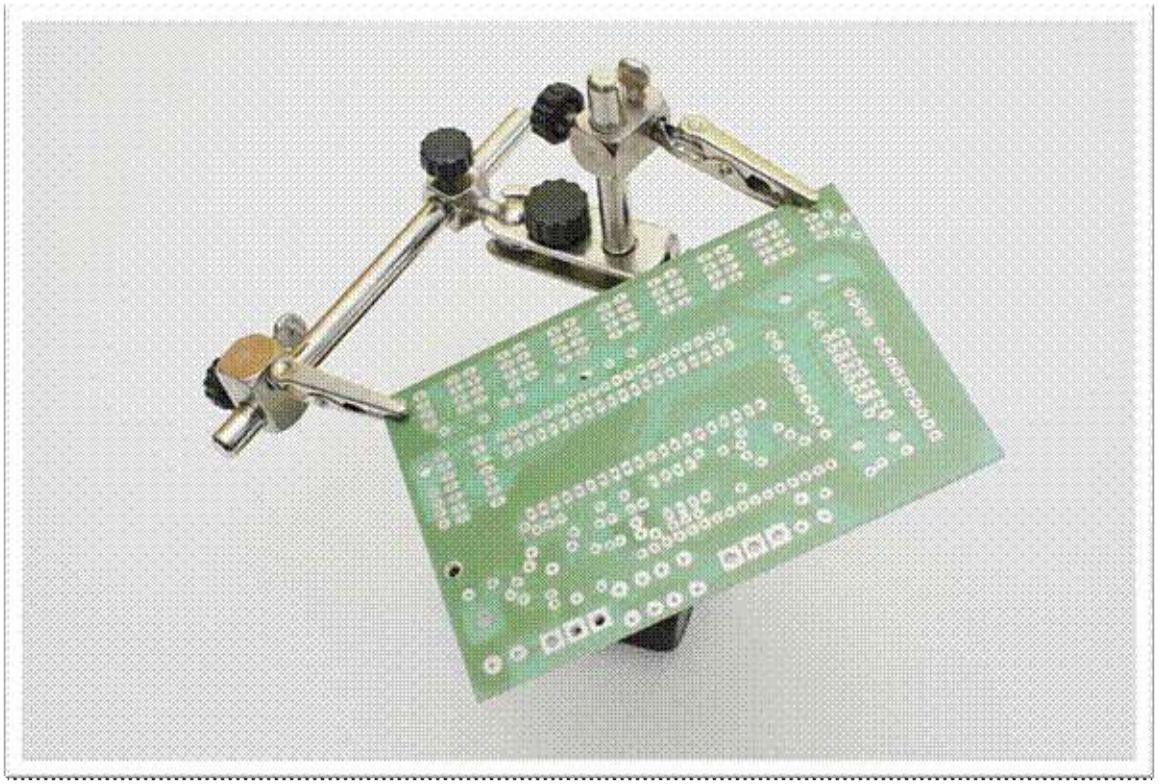

^^ *"Helping Hands" uses crocodile clips to grip parts during soldering. Or just place parts flat on the bench.*

When soldering parts onto an ordinary circuit board, components' wires can simply be bent to the correct pitch (distance apart) to fit through the board, insert the part flush down against the board's surface, splay the wires a little so that the component grips the board under spring tension, and then solder it. This technique is universally used in manual **through-hole soldering,** which is explained in full later.

In the author's view - opinions vary – it's generally better to snip off the surplus wires leads first, to make the joint and neighbouring joints more accessible and also to reduce the mechanical shock transmitted to the p.c.b. copper foil. However, in the case of diodes and transistors the author tends to leave the snipping until after the joint has been made, since the excess wire will help to "sink" heat away from the heat-sensitive semiconductor junction.

A special clip-on heatsink is available which also helps stop excess heat from reaching temperature-sensitive semiconductors like these. I've always managed without one but beginners might find them reassuring. Integrated circuits can either be soldered directly into place if you are confident enough, or better, use a dual-in-line socket to prevent heat damage. The chip can then be swapped out at a later date if needed.

Parts which become hot in operation (e.g. some power resistors), should be raised above the board slightly to allow air to circulate. Some components, especially large electrolytic capacitors, may require a mounting clip to be screwed down to the board first, otherwise the part may eventually break off due to vibration. It's a good idea to bolt such components firmly into place before soldering their terminals, in order not to strain the soldered joints or the components when fasteners are tightened.

By securing the workpiece as much as possible to prevent movement, you have a

much higher chance of producing good-quality reliable solder joints.

Next steps

Let's get to grips with actual soldering techniques in more detail. The soldering of electronics components utilises **lead/ tin** or **lead-free solder** and the process is compatible with many non-ferrous metals. You can solder copper, lead, brass, gold plate, silver, nickel, tin and tin plate, zinc and more besides but some metals such as nichrome, galvanised or stainless steel require a highly specialist "flux" (see later) to solder them and aren't discussed here. Some materials such as beryllium, chromium, magnesium and titanium are non-solderable in any case, according to solder manufacturers Multicore.

In electronics we're mainly concerned with soldering parts or wires onto printed circuit boards or terminals that are usually already "tinned" with solder or plated, ready for soldering with flux-cored solder. The key factors affecting the quality of a solder joint are:

- **Cleanliness** – dirt or impurities drastically hinder good solder coverage.
- **Temperature** – the right level to enable the solder to flow freely!
- **Time** – apply heat for just the right amount of time!
- **Adequate solder coverage** – enough to form a good joint without touching neighbouring areas.

A little effort spent now in soldering the perfect joint may save you — or somebody else —a considerable amount of time in troubleshooting a defective joint in the future. Let's discuss the basic principles outlined above in more depth.

Cleanliness and “Tinning” the bit

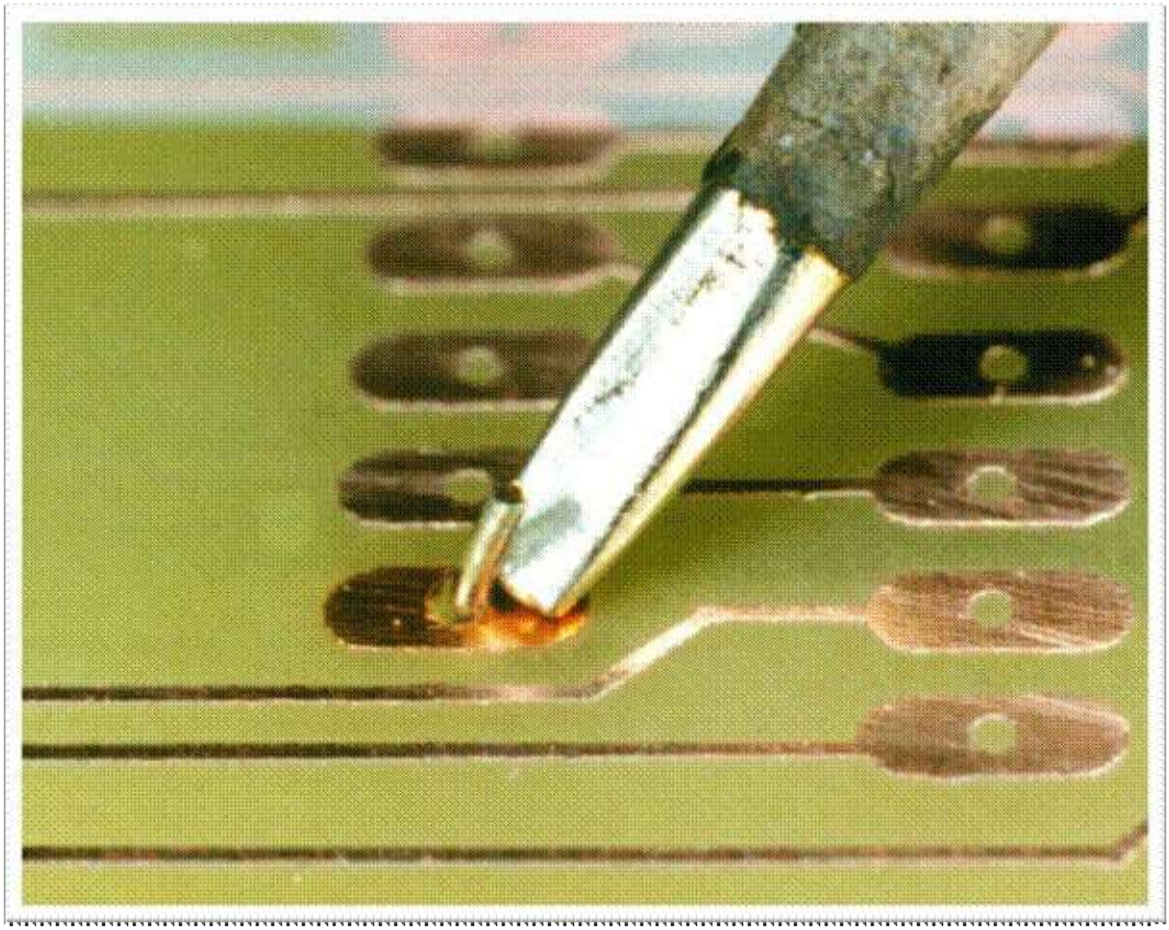

^^ A clean and shiny soldering tip or “bit” is essential for each and every solder joint you make.

Firstly, and without exception, all parts - including the soldering iron’s tip itself - must be clean and free from contamination. Fact is, solder just will not “take” to dirty parts! Old components or copper board can be impossible to solder because of oxidation that builds up on the surface of the leads. This repels the molten solder and will soon become evident because the solder will “bead” into shiny globules looking like mercury, going everywhere except where you need it. *Dirt and contamination are the enemies of a good quality soldered joint!*

When all the conditions are right for soldering, materials are said to be “wettable” and will accept molten solder, which should flow readily over their surfaces. Hence, it’s **really necessary** to ensure that parts are free from grease, oxidation and other contaminants. Note that in any case, some incompatible materials or surface finishes just cannot be soldered using ordinary lead-free solder, no matter how hard you try – e.g. aluminium parts would require special aluminium solder and fluxes (see later) to be used.

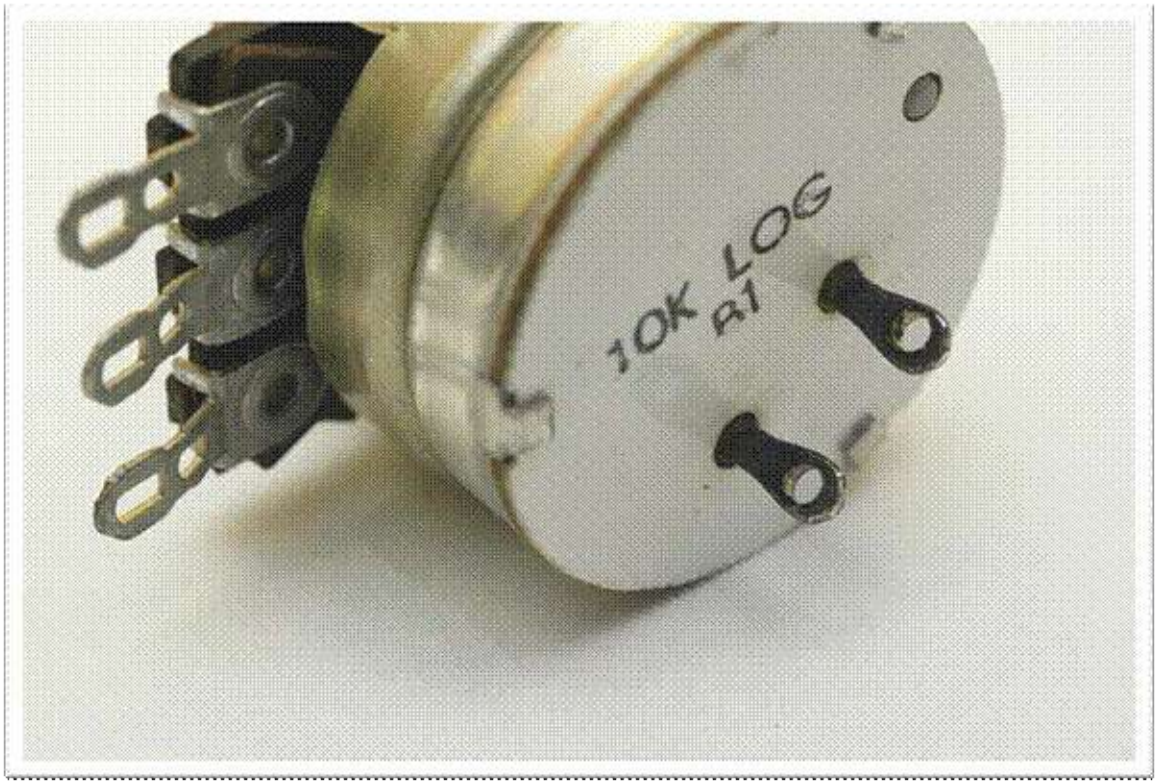

^^ *The two tags on this switched potentiometer have blackened with age and oxidation. They must be cleaned before they can be soldered…*

In the case of old components that have been stored a long time, where the leads have blackened and oxidised, use a small hand-held file or perhaps fine emery cloth to reveal fresh metal underneath. Stripboard and copper printed circuit board will generally oxidise after a few months, especially where it has tarnished due to fingerprints, so the copper strips could be cleaned using e.g. an abrasive rubber block made for the purpose. Also available is a fibre-glass filament brush (photo), which is used propelling-pencil-like to remove contamination. They're OK for general cleaning but best avoided on fine surfaces (e.g. gold plated switch contacts). These produce tiny particles which can irritate the skin, so avoid accidental contact with any debris.

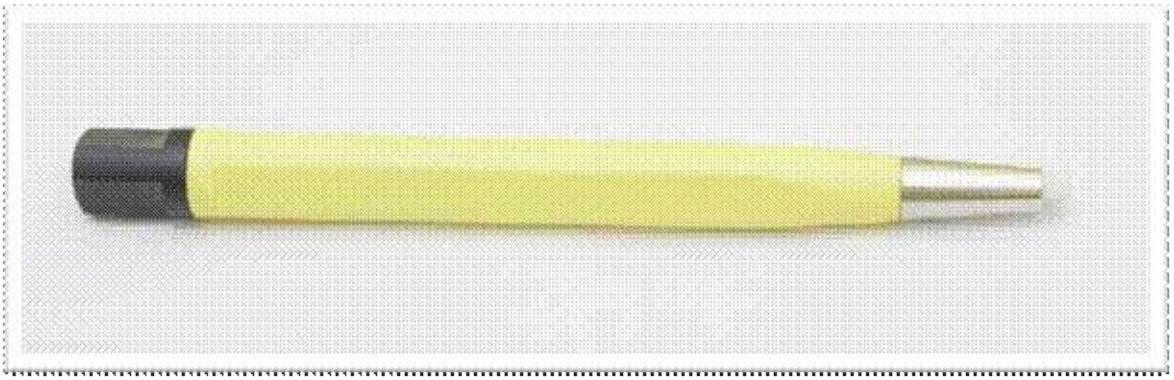

^^ *A glass-fibre filament brush like this is useful for cleaning oxidised parts.*

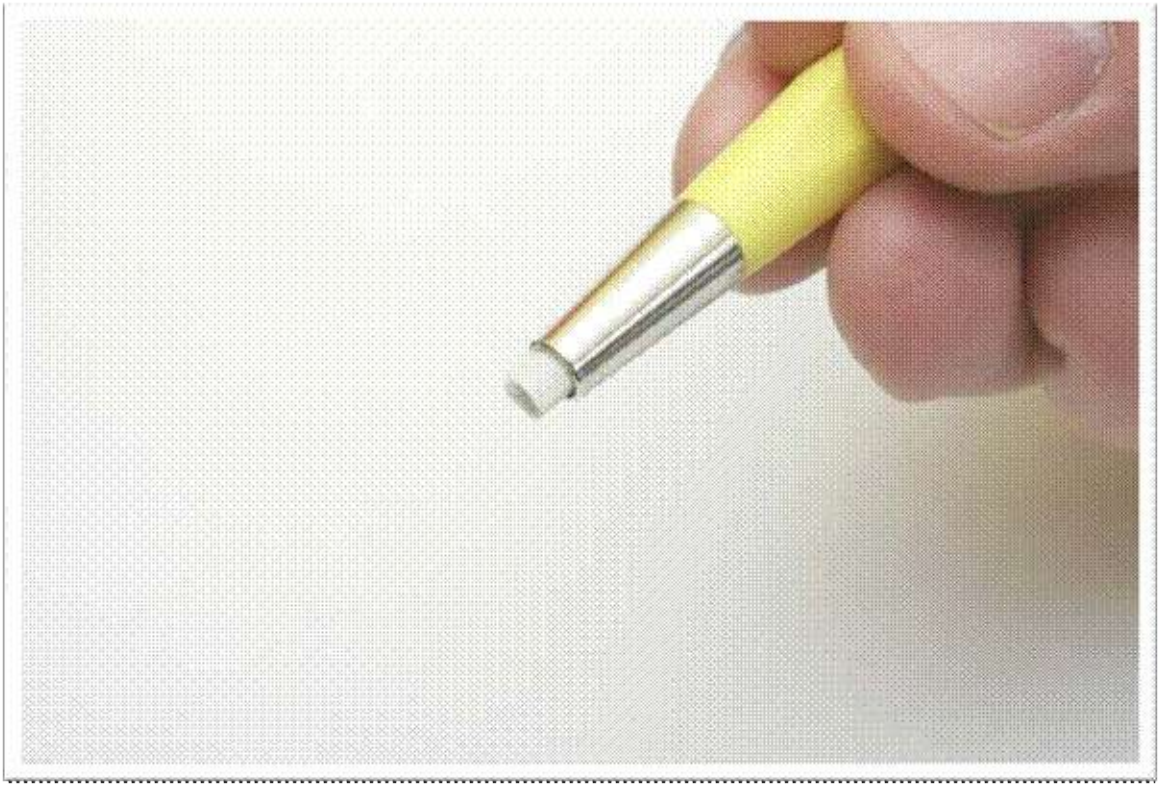

^^ *The glass-fibre brush works like a propelling pencil and produces irritating dust.*

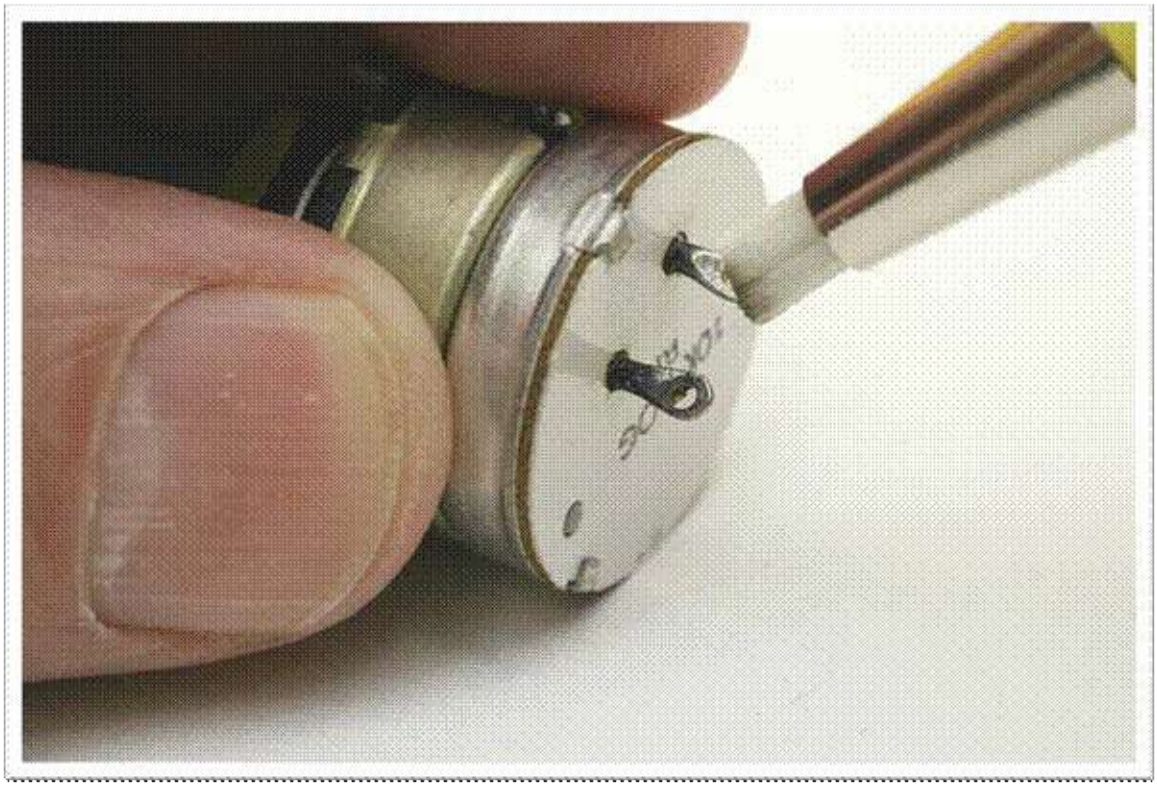

^^ *Cleaning oxidised tags with a glass fibre brush to make them nice and shiny, ready for soldering*

Afterwards, a wipe with a rag soaked in cleaning solvent will remove most grease marks and fingerprints. After preparing the surfaces, avoid touching any parts as far as possible.

Another side effect of trying to solder contaminated or incompatible materials is the tendency to apply more heat and “force the solder to take”. As the materials aren’t

wettable the molten solder won’t flow where you want it to flow. This can do more harm than good, because it may be impossible to burn off any contaminants anyway, and the component or the printed circuit board may be overheated and damaged in the process. Semiconductors may be harmed by applying excessive heat for more than a few seconds, and extreme heat applied to printed circuit board tracks can cause irreparable damage, because the tracks will be lifted away from the substrate especially on a delicate or badly designed board. You can avoid trouble by ensuring the surfaces to be soldered are clean and wettable to begin with.

Getting Ready

As already explained, cleanliness in soldering is a major factor in obtaining successful results. A soldering iron stand usually has a sponge that is dampened – it wants to be quite damp but not running wet, so squeeze out any excess.

^^ *Dampen the sponge but don't soak it unduly. Note the hole, which gives an edge to wipe tip with.*

^^ *An Antex soldering iron tip. It simply slides onto the iron's heating element. Only the extreme end is wettable and will accept solder: the tip should be kept nice and shiny.*

Soldering iron bits are typically iron-plated to resist wear, then chrome-plated to prevent molten solder being deposited on them, with the extreme tip being "wettable" to work with molten solder. Before using the iron to make a joint, the hot tip must be "tinned" with a few millimetres of solder*: you should always flood a brand new tip with plenty of solder to tin it immediately, when using it for the first time*.

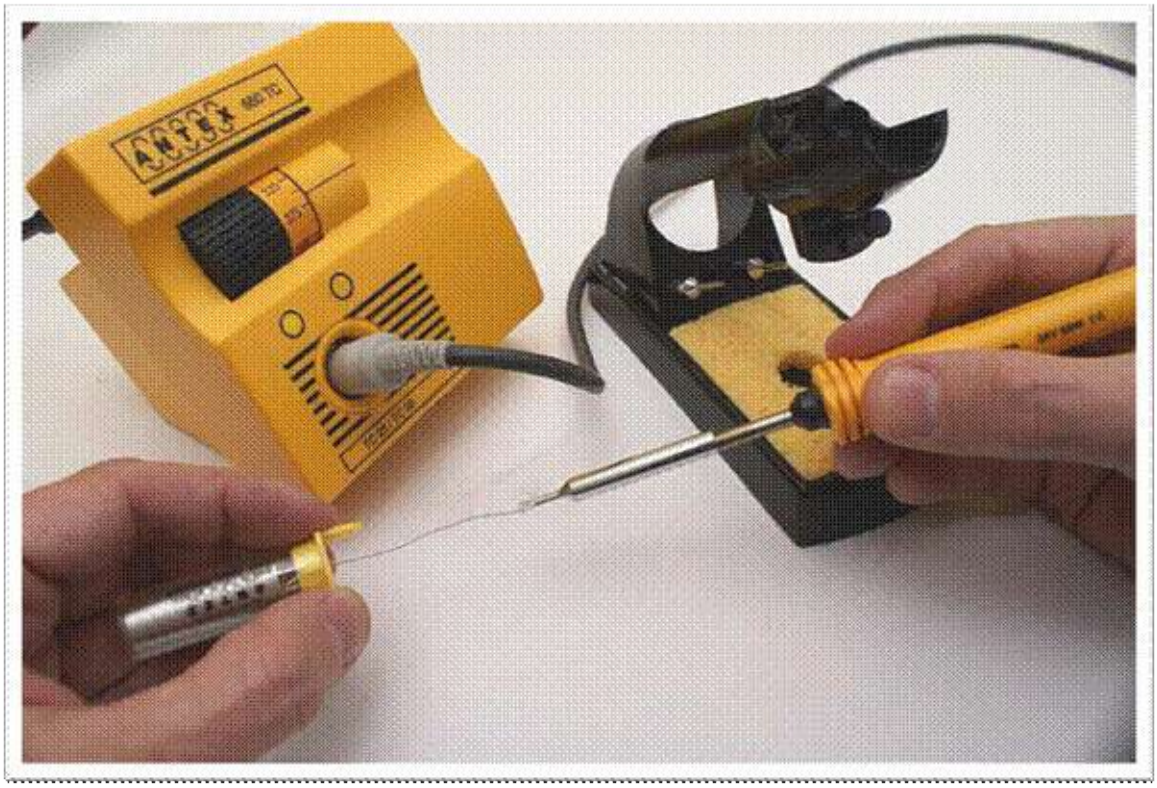

^^ *Tinning the tip ready for use: apply a few millimetres of solder to the hot tip.*

Wipe off excess solder using a damp sponge and it's ready to use. That's why sponges have a hole or well in them – the edge acts as a wiper and the hole catches excess solder.

A useful tip: after tinning the bit, just before using the iron it helps to re-apply a small amount of solder to a clean tip, to improve the thermal contact between the tip and the joint. The molten solder fills the void between the materials and the iron tip, to help transfer heat better so that the solder flows more quickly and easily.

^^ *A tinned tip should look like this, ready to make the next joint.*

It's sometimes better to tin larger parts as well before making the joint itself, but this is not generally necessary with p.c.b. work. Small tinlets of special paste are available onto which you dab a hot iron - the product cleans and tins the iron ready for use. It's useful in extreme cases where the bit has some stubborn contamination.

I find special Tip Tinner &Cleaner products to be very useful: gently abrasive in action, they help to clean dirty bits and keep them in good condition. Use them for removing stubborn contaminants, but don't overdo it.

^^ Tip Tinner and Cleaner is a useful aid to maintaining a soldering iron bit …

^^ Just press the hot iron onto the solid paste and scrub it around a little. The tip will be cleaned, tinned, and made ready for use.

The move to lead-free solders (see next chapter) has had some effect on the life of soldering iron bits, with increased wear and corrosion noted due to the higher temperatures and the fluxes found in tin-based solders. You can therefore expect bits to wear out over time. Once the iron-plating is damaged due to oxidation or erosion, the bit is fast approaching its end of life. Never use an abrasive or file to sand down a tip: the iron-coating will be damaged and the iron's core exposed, so the tip will soon be made useless due to erosion.

Having prepared the soldering iron tip ready for use, in the next chapter solder and fluxes are discussed.

Solder and Fluxes

In recent years there's been a move towards using more environmentally-friendly materials in electronic products. EU legislation such as *Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment* (RoHS) aims to reduce toxic heavy metals being sent to landfill. (Look for the RoHS symbol on equipment to indicate compliance.) Due to RoHS compliance, the electronics industry had to change the type of solder it uses in electronic production.

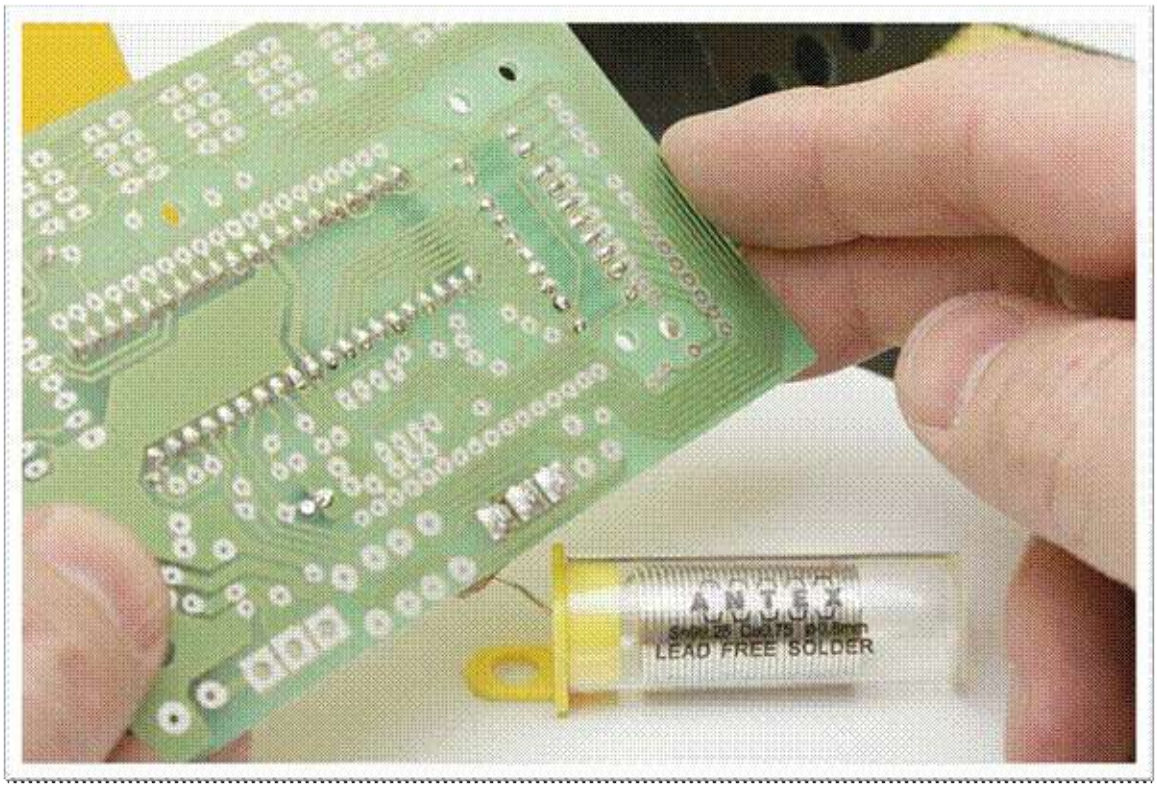

^^ *Electronics solder is supplied in reels or handy dispensers like this.*

Solder comes in various forms including solid bars or pellets for melting in small electric 'solder pots' used for treating the ends of wires with solder. Traditional general-purpose electronics-grade solder is in wire form – starting with so-called "60/40" which contains 60% tin (symbol Sn) and 40% lead (symbol Pb) and is sold in handy dispensers or reels. Although tin-lead solder is now banned in industry, there's nothing to stop the hobbyist from using it but best practice is to use lead-free solder in our work: my advice is to try both, and see which you prefer to work with. "40/60" tin-lead produces lower quality results but is slightly cheaper and perfectly acceptable in hobby circles.

Various diameters of solder wire are marketed. In the UK they're sold in Standard Width Gauge (SWG) sizes, typically as 18SWG (1.2mm) or 22SWG (0.7mm). The latter is fine for almost all hand-soldering of printed circuit boards or general electronics. For larger solder joints (e.g. larger switch or motor terminals), 18SWG solder would be better as more solder can be dispensed more quickly.

Lead-free solder is universally available and contains typically 99.7% pure tin and 0.3% copper (symbol Cu). It needs a higher melting point which makes it slightly more difficult to work with, but standard soldering irons will cope with it well. Antex lead-free

solder (Sn 99.25 / Cu 0.75) is a good compromise at 0.8mm diameter and is sold in small dispensers.

Other solders are produced for specialist work, including aluminium solder (Alu-Sol®) and another solder variant used by professionals is Multicore “Smart” wire which contains a small amount of pure silver (symbol Ag). It produces very clean results and is often associated with SMD (surface mount devices), though some engineers also use it for routine p.c.b. work for producing the best possible finish by hand. As “Smart” wire contains lead it is not RoHS compliant.

An interesting variant is **Eutectic** solder, which is 63/37 Tin/Lead. It goes instantly from solid to liquid when melted and is particularly good for hand-soldering. An almost-equivalent lead-free product would be Stannol Flowtin TC or TSC solder.

The low-down on fluxes

When melting solder with a soldering iron, oxides of metal are produced as a result of the high temperatures involved. Unfortunately, these oxides contaminate the metal surfaces being soldered, which interferes with the flow of molten metal and the production of a good quality solder joint.

All electronics-grade solder wire therefore contains an additive called “flux” which helps the molten solder to flow more easily over the joint. It does this by scrubbing away the oxides which arise naturally during heating, and it will often be seen as a pungent brown fluid bubbling away on the joint, accompanied by some fumes.

Those coming into electronics from other industries should note that flux is already contained within “cored” electronics solder and on no account should any acidic flux be applied separately before using the soldering iron. Plumbers, for example, apply flux paste to copper pipes before soldering them, but electronics-grade solder wire already contains a flux and extra flux is almost never needed. Electronics is no place for acid fluxes!

^^ *A close-up of electronics-grade multi-cored solder. Five cores of rosin flux can be seen running through it.*

For almost all electronic hand assembly, solder wire containing “Rosin flux” is used. Cores of flux run through the solder wire like letters running through seaside candy, and they prevent the hot area from being contaminated by oxides, otherwise solder would never flow properly and the result would be an incomplete and unreliable joint.

Flux dispensers and Colophony

Flux dispenser pens are sold that allows special liquid flux to be applied separately onto a work area. These might be handy for difficult or challenging jobs to help solder to flow better: adding more flux this way won't do any harm and may help a solder joint to be made more quickly and reliably. In my hobby electronics, there's hardly ever been a time when I felt the need to apply extra flux but it's useful for some very tricky or demanding jobs.

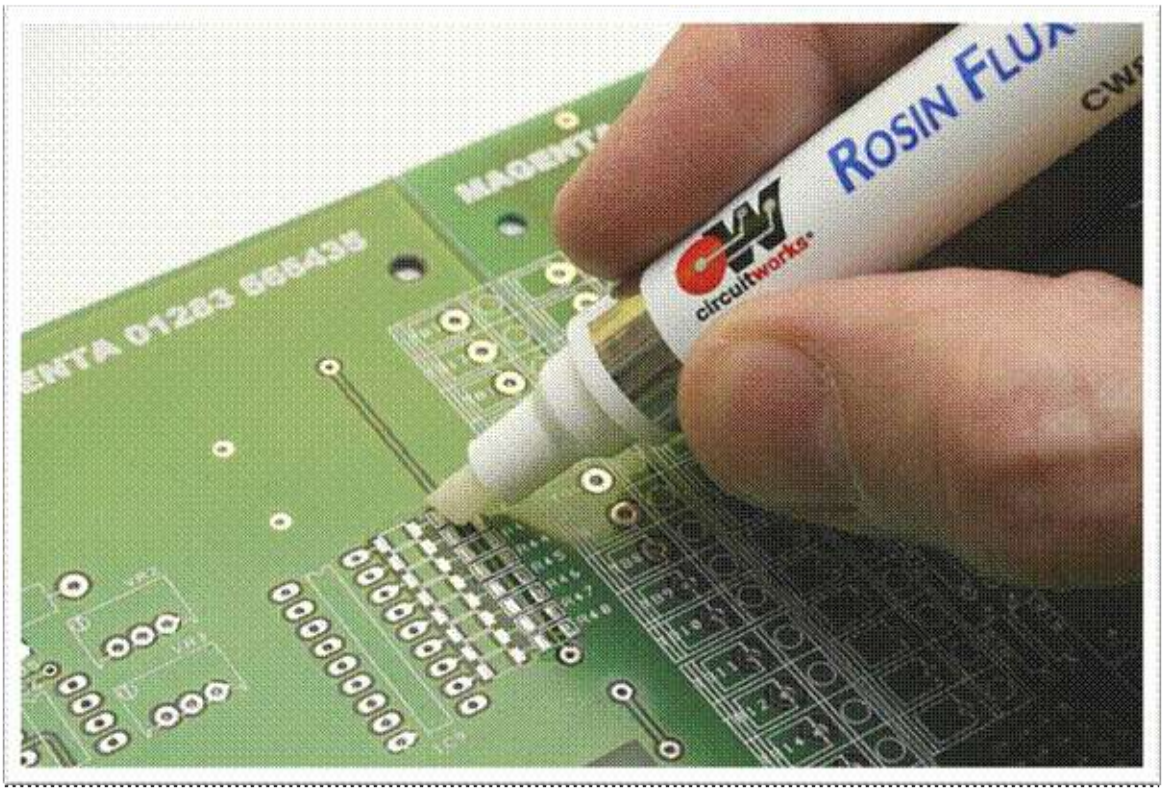

^^ *For more demanding work, a flux dispenser pen allows additional flux to be applied*

For example I've used specialist Chemtronics flux dispenser pens on tricky, extra-large solder joints involving very thick wires for lead-acid battery connections where I really struggled to make the solder flow properly. You might also use them in micro-electronic surface-mount work. The extra flux can only help, but for the rest of the time rosin-flux core solder wire contains sufficient flux and that's all that you'll need.

^^ *Colophony or rosin flux is available in small tinlets if you want to prepare your own liquid flux.*

One thing that many seasoned electronics enthusiasts will recognise is the distinctive smell of rosin flux: its intense woody pine smell is not unpleasant, and flux fumes themselves are not known to be harmful but solder smoke can be an irritant, especially if you suffer from asthma or other respiratory conditions. (I dealt with solder fume extraction earlier when soldering irons were outlined.)

Rosin flux is also known as **Colophony.** It's an amber resin that's glassy and brittle like sugar candy, distilled from the resins of conifers (mainly pine trees) and it's worth knowing about. For electronics use, Colophony is available in individual tinlets of solid resin (e.g. *Kolophonium* in 20g tins by Donau Elektronik GmbH, sold by Westfalia or Conrad).

As an aside, the resins of various trees are used in incense burners: placing a few fragments on a charcoal burner produces intense delicious fragrances of pine, frankincense or forest but you still wouldn't want to inhale the smoke or fumes directly.

Solids of Colophony can be dissolved to make a semi-liquid flux, for dipping or applying manually prior to soldering. To make your own rosin flux from solids of Colophony, chip off some fragments and crush them into a small tinfoil dish, then apply some isoproponal alcohol (start with 2 parts solvent to 1 part Colophony) and let it dissolve over about 20-30 minutes or more.

^^ *Chip off some solids of colophony and put them in a small tin foil dish*

^^ *Add e.g. x 2 volume isopropanol alcohol and allow the solids to dissolve. Experiment as needed.*

^^ *The resulting flux can be very sticky so handle with care and do not spill.*

In this form it can be applied directly with a brush or dropper to areas prior to soldering. In an open dish, after a day or two the solvent will mostly have evaporated to leave an extremely sticky resin that should be handled carefully: it's no co-incidence that Colophony is also used in adhesives and varnishes, and different grades of Colophony resins are used to treat violin or double-bass bows to add friction to bow hairs! Try experimenting with different ratios of solvent and making some up and storing it in an old nail varnish bottle with brush, or generally do what works for you.

Unused Colophony crystals can be reformed into their storage tinlet by warming carefully with a hot air gun, but don't overdo it. You can also use flux cleaners or PCB solvent cleaners if you want to remove traces of excess rosin flux after soldering: these are left behind as a brown deposit and are otherwise harmless.

The subject of using your soldering iron to raise the temperature of the materials is discussed next.

Temperature flow

This aspect takes a bit more understanding, but with practice you'll soon understand how temperature flows within a workpiece being soldered and how you have to harness it properly. After ensuring all parts are clean and the soldering iron is ready to go, the next step to successful soldering requires that the **temperature** of **all** the parts is raised to roughly the same level, before solder can be applied.

Imagine the most basic task of soldering a simple resistor onto a printed circuit board: the copper p.c.b. and the resistor lead should both be heated *together* so that the solder will flow readily over the joint. Later I'll show the precise stages step by step.

A beginner will often mistakenly just heat one part of the joint (e.g. a resistor's wire protruding through a printed circuit board) and hope that the resultant "blob" of solder will be enough to tack everything together. That's completely wrong, because the remaining metal in the joint is cold when molten solder is flooded on to it. The joint will be weak, incomplete or unreliable. Flux will not have flowed properly either, so the joint could be contaminated internally.

Another beginner's mistake is to use a soldering iron to carry blobs of molten solder over to the joint, as if to daub solder over it. The secret of success is to control the iron accurately and apply the hot tip onto the workpiece so that it's in contact with *all the parts*. Within a fraction of a second, heat will conduct from the iron and raise the temperature of the entire joint, after which solder can be melted over it. Remove the iron and let the joint cool naturally. It takes some practice with your chosen soldering iron tip to obtain the best heating action, making sure the tip is clean and tinned properly to begin with.

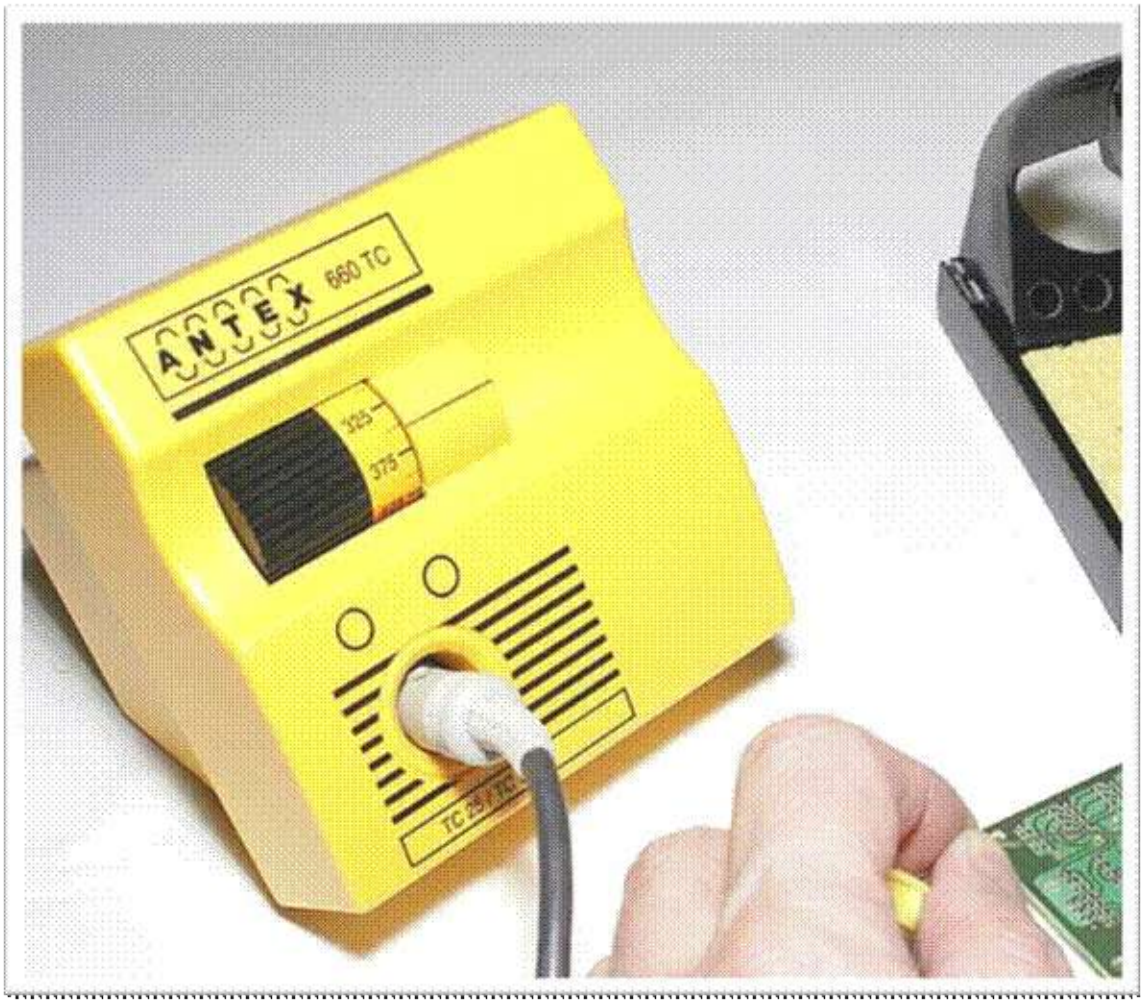

^^ Set a typical temperature of 330-350 ºC (626-662 ºF) or more, if you have a soldering station.

The melting point of traditional tin-lead solders is about 190ºC (374ºF) but lead-free tin-based solders require higher temperatures, having melting points of typically 201-227 ºC. As Antex reminds us, the melting point is *not* the temperature of the soldering iron tip: instead you should set a temperature that ensures the solder melts *instantly* onto the tip. Fixed-temperature soldering irons have no adjustability but they'll cope just fine with either type of solder. A soldering station usually has a variable control that gives more control in different circumstances. In practice the iron tip temperature should be set for typically 330-350 ºC (626-662 ºF) or maybe a little more if using lead-free solder.

Now is the time…

The next diagram shows what would happen if you applied a hot soldering iron to an imaginary metal block. In step (1) heat travels out of the iron into the cold metal block, which starts to warm up starting at the edges. Gradually (2), the whole metal block's temperature rises until the middle of the block finally rises in temperature as well. In effect heat is now travelling back "towards" the iron tip, until finally (3) the whole block is at the same temperature as the iron. At this point solder could now be applied.

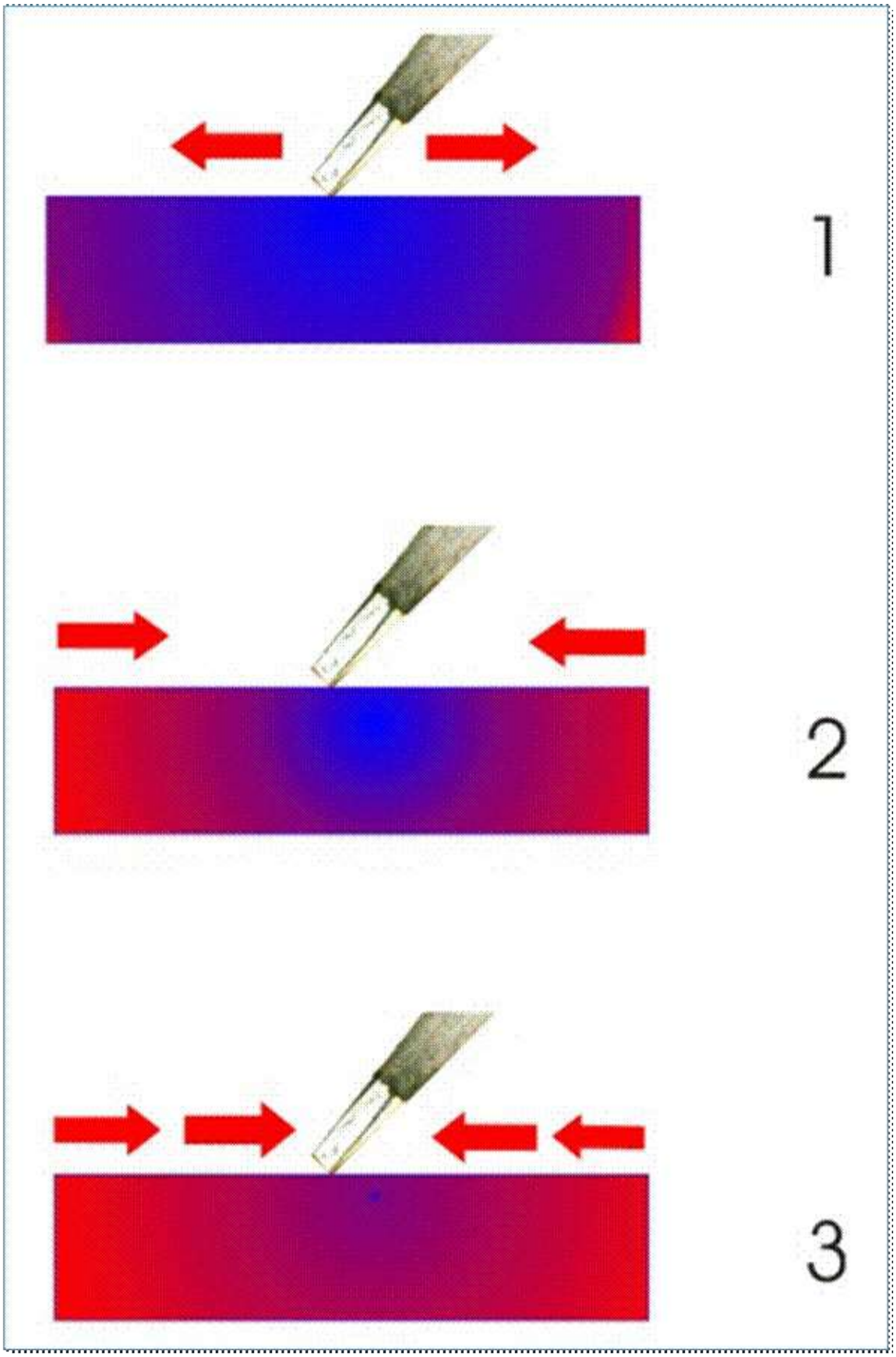

^^ How metal in the joint actually "sinks" heat away from the tip to begin with. Then heat moves back towards the tip until the solder's melting point is finally reached.

You'll notice this effect as a time delay when soldering any joint. The "working area" of the iron's tip gets **cooled** to begin with, because the metal in the rest of the joint is sinking heat away from where it's most wanted. Only after the whole joint has risen in temperature can solder be melted onto it.

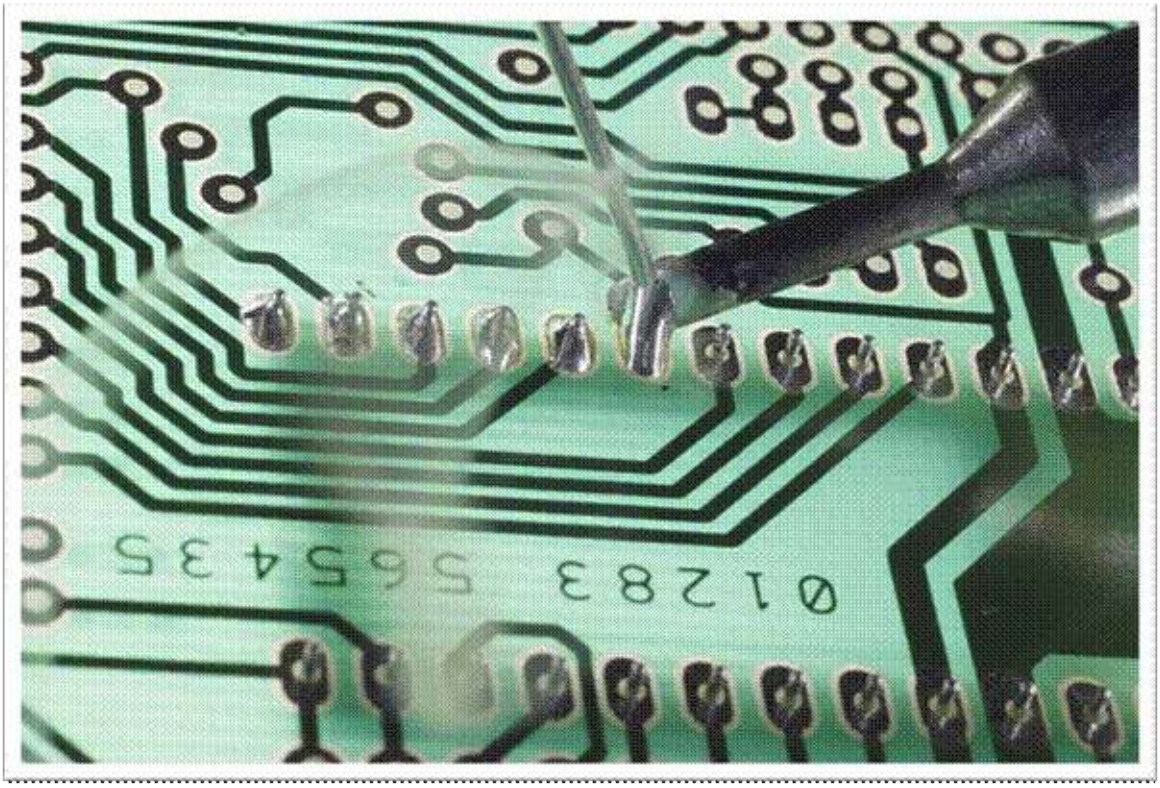

^^ *Soldering a small p.c.b. joint*

With experience, you'll get a feel for how long it takes before you can apply solder. The more metal that is present in the joint, the longer period that heat must be applied for. A small p.c.b. joint takes well under one second to complete. A large metal terminal could take quite a few seconds or more to heat up. As I explained earlier, higher power (wattage) irons cope better with larger workpieces because they recover more quickly and are more "unstoppable", making it easier for them to heat larger workpieces without cooling down so much.

If you apply solder too early, it won't melt properly and the result will be a grey, crystalline joint caused by the solder's melting point temperature not being reached and the flux not having flowed properly. Semiconductors must be soldered as rapidly as possible as they are heat-sensitive, but they're a lot more robust than they used to be.

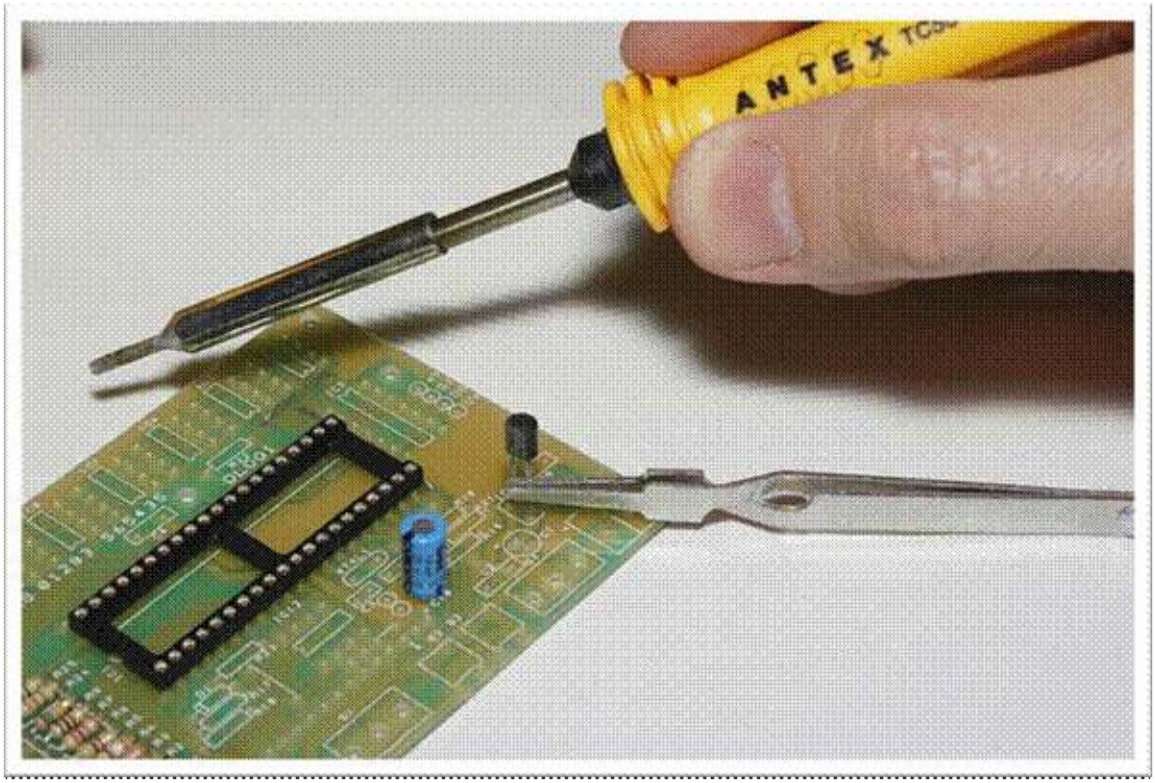

^^ *A clip-on Antex heat shunt fitted to a transistor leg, helps prevent thermal damage due to overheating when soldering it in place. Less essential these days, but beginners find them re-assuring.*

Until they have gained some practice, novices sometimes buy a small clip-on heat-shunt (photo) which resembles a pair of aluminium tweezers. In the example of, say, a transistor, the shunt is attached to one of the leads near to the transistor's body. Any excess heat then diverts up the heat shunt instead of into the transistor junction, thereby avoiding the risk of thermal damage. Applying far too much heat may destroy the part or damage the p.c.b. foil which may lift away from the board.

In due course constructors learns to judge how much solder should be applied to any particular joint. An ideal p.c.b. joint is very slightly concave in shape. If not enough solder is used, the result may be an incomplete joint which may cause an intermittent fault later on. An excess of solder – shaped like a ball bearing - is an unnecessary waste and in extreme cases may cause short circuits, especially on densely-populated boards. There is no need to add more solder "for luck". Professionally-produced p.c.b.s have a green *solder resist* coating which helps to ensure that solder does not stray onto adjacent pads. As a finishing touch, I usually spray the solder-side of a circuitboard with aerosol spray lacquer afterwards. It keeps the solder joints nice and shiny and helps prevent corrosion.

Some components can create hazards during a soldering operation:

Coin cells and button batteries are commonly used as power, clock or memory backups. If heated excessively they can explode without warning due to the build-up of internal pressure. Spot-welders are used in industry to connect tags to them, but if you need to solder wires to such a cell then it should be done as quickly as possible.

Some **memory back-up capacitors** or **electrolytic capacitors** remain energised for a while even when the circuit is powered down. Molten solder is a perfect electrical

conductor and in some cases the component's contacts could be shorted during the soldering (or desoldering) operation. If molten solder shorts it out then the arcing may cause globules of solder to be spattered outwards without warning, potentially risking eyesight damage.

Always ensure that powered components are electrically inert and discharged before soldering. Cells, batteries and battery packs should not be accidentally shorted during the soldering process, to avoid arcing and solder spatter. Note that electrolytic capacitors can also explode after a while if reverse-connected, so observe polarity closely.

Let's now consider the practical stages of soldering components and wires successfully.

Soldering Step by Step

Earlier I explained the individual factors that affect the quality of a solder joint. These are:

- **Cleanliness** – dirt or impurities drastically hinder good solder coverage.
- **Temperature** – the right level to enable the solder to flow freely!
- **Time** – apply heat for just the right amount of time!
- **Adequate solder coverage** – enough to form a good joint without touching neighbouring areas.

These rules apply whether soldering a p.c.b. or performing other tasks such as interwiring (hooking everything together with connecting wire).

We'll now summarise the stages of making a typical solder joint – soldering components onto a printed circuit board (through-hole soldering). Most people insert components into the circuit board and simply splay the wires out to hold them in place under spring tension. I find it best to snip excess wire leads off at this stage, to improve accessibility.

- All parts must be bright, clean and free from dirt and grease.
- Try to secure the work firmly to stop parts moving around.
- "Tin" the soldering iron tip with a small amount of solder. Do this immediately, with new tips being used for the first time.
- Wipe the tip of the hot soldering iron on a damp cellulose sponge to remove excess solder or contamination.
- Many people then add a tiny amount of fresh solder to the cleansed tip just before using it.
- Heat all parts of the joint with the iron typically for under a second or so, until it's heated throughout.
- While heating, then apply sufficient rosin-core solder to form an adequately-covered joint.
- It only takes a second or two at most, to solder the average p.c.b. joint this way.
- Do not move parts until the solder has cooled.
- Remove and return the iron safely to its stand.

This special photo sequence illustrates these stages. It's best to start with the smallest, fiddliest parts first when soldering a blank p.c.b., because that's when you've got the most access on the board. Accessibility will be reduced as more components are added, so we'll start with a simple wire link on a professionally designed p.c.b.

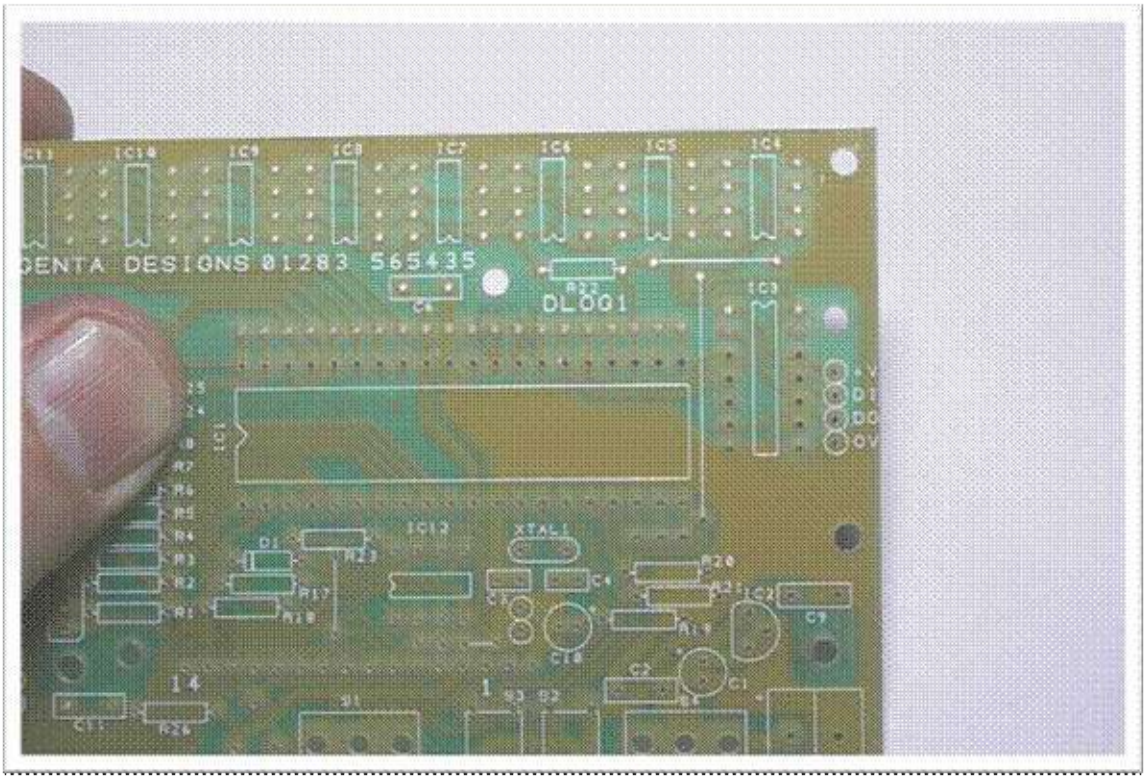

^^ *A typical professional blank p.c.b. – silk-screen printing shows what goes where. The underside has been treated with a green solder resist coating, and the solder pads are ready-tinned to help with soldering.*

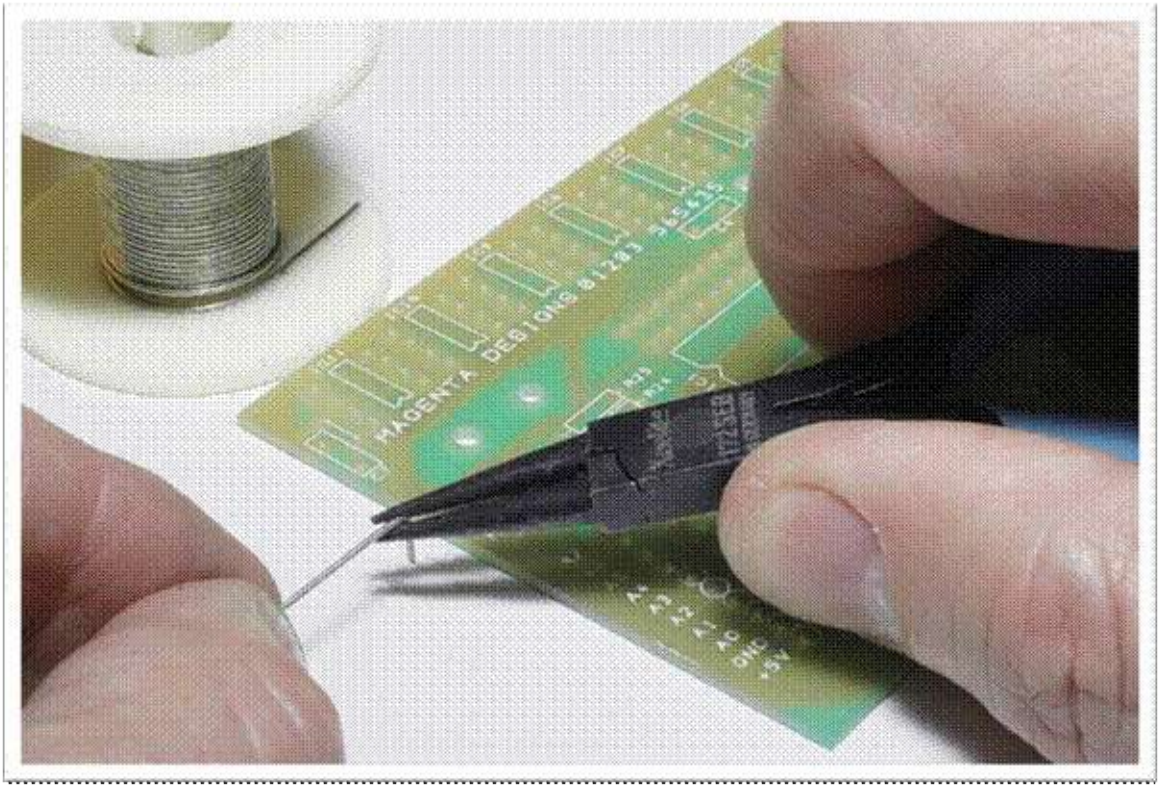

^^ *Preparing a wire link for soldering – cut off some tinned copper wire and bend the ends to fit the p.c.b. correctly. Round-nose pliers (shown) are perfect for this, but ordinary electronics or "radio" pliers will do.*

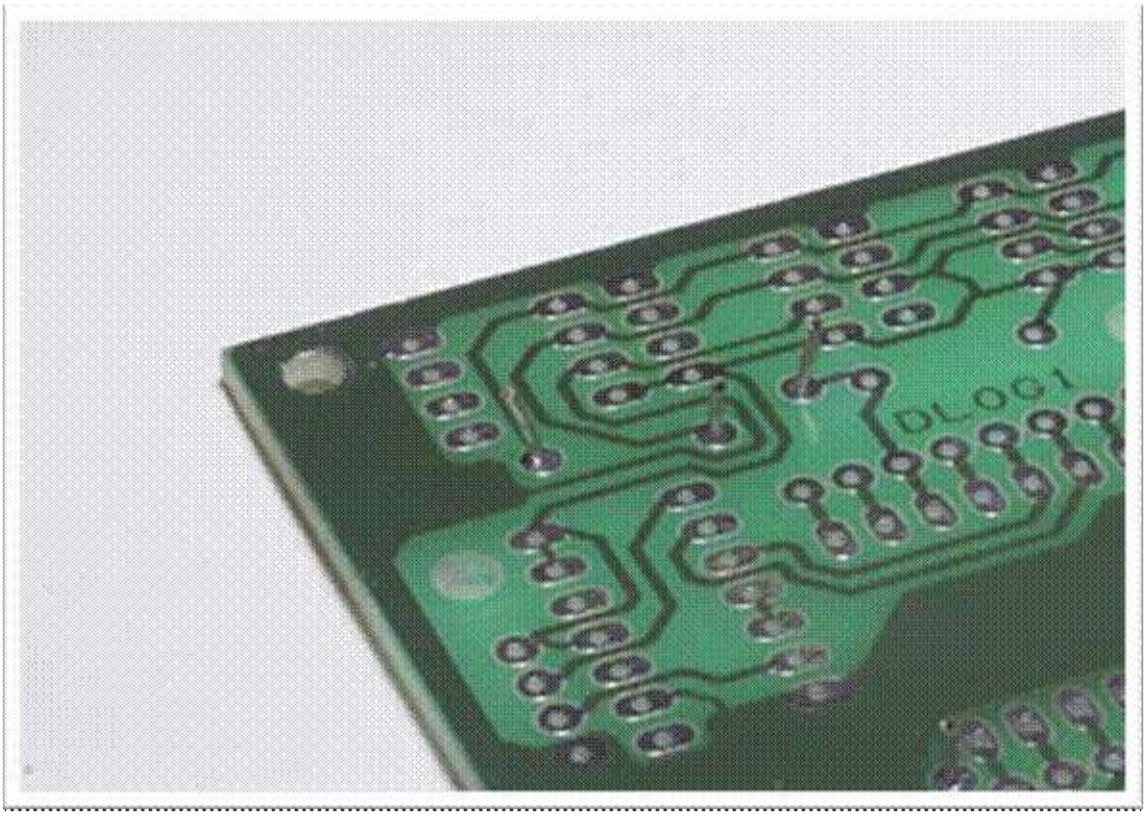

^^ *Wires are prodded through the holes in the board, then turn it upside down to view the solder side. You can then "spring" or splay the ends apart slightly, so they are held in place while you solder them.*

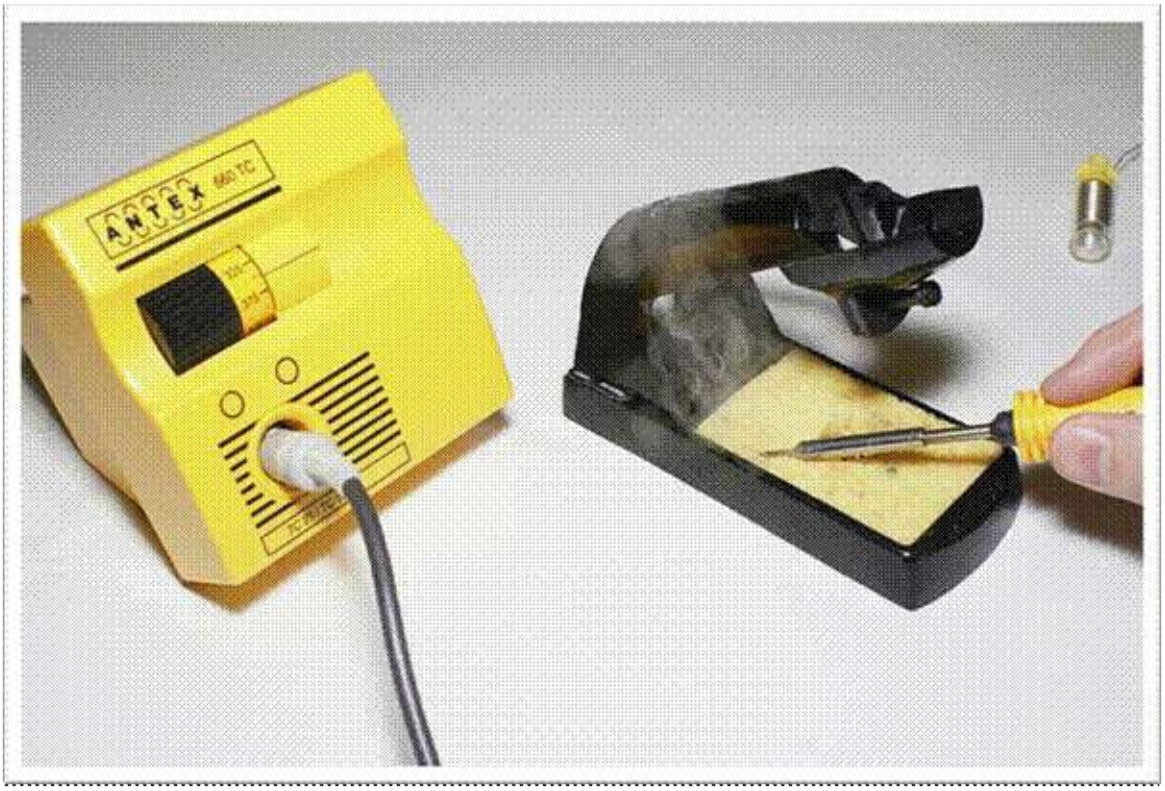

^^ *Wipe the hot soldering iron on the damp sponge to clean the tip. Do this periodically when contamination, flux deposits etc. build up on the iron to keep the tip nice and shiny. Tip Tinner & Cleaner helps too.*

^^ *It often helps to dab a tiny amount of solder wire onto the tip, to improve heat transfer.*

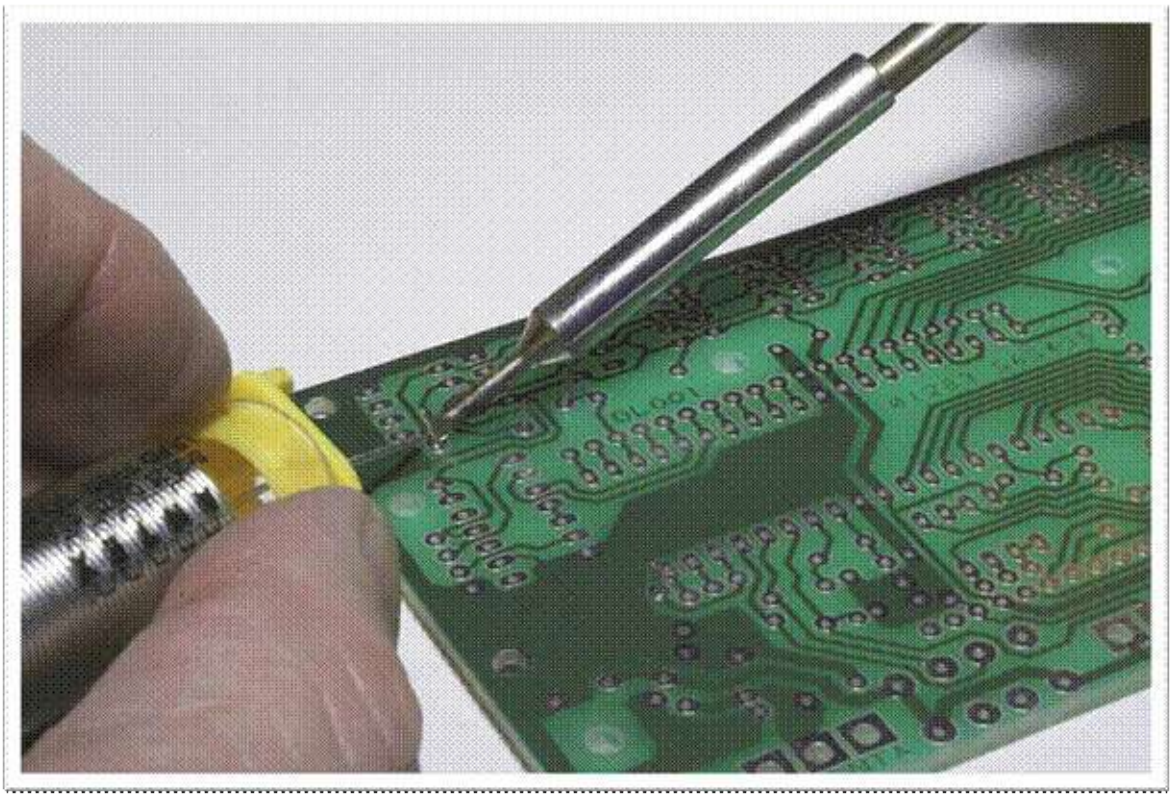

^^ *Then apply the soldering iron to heat both the solder "pad" and the wire end at the same time (say <1 second). Apply a few millimetres only, of solder. Then remove the soldering iron immediately and allow the joint to cool down by itself. The green solder-resist coating ensures solder doesn't flow onto neighbouring pads.*

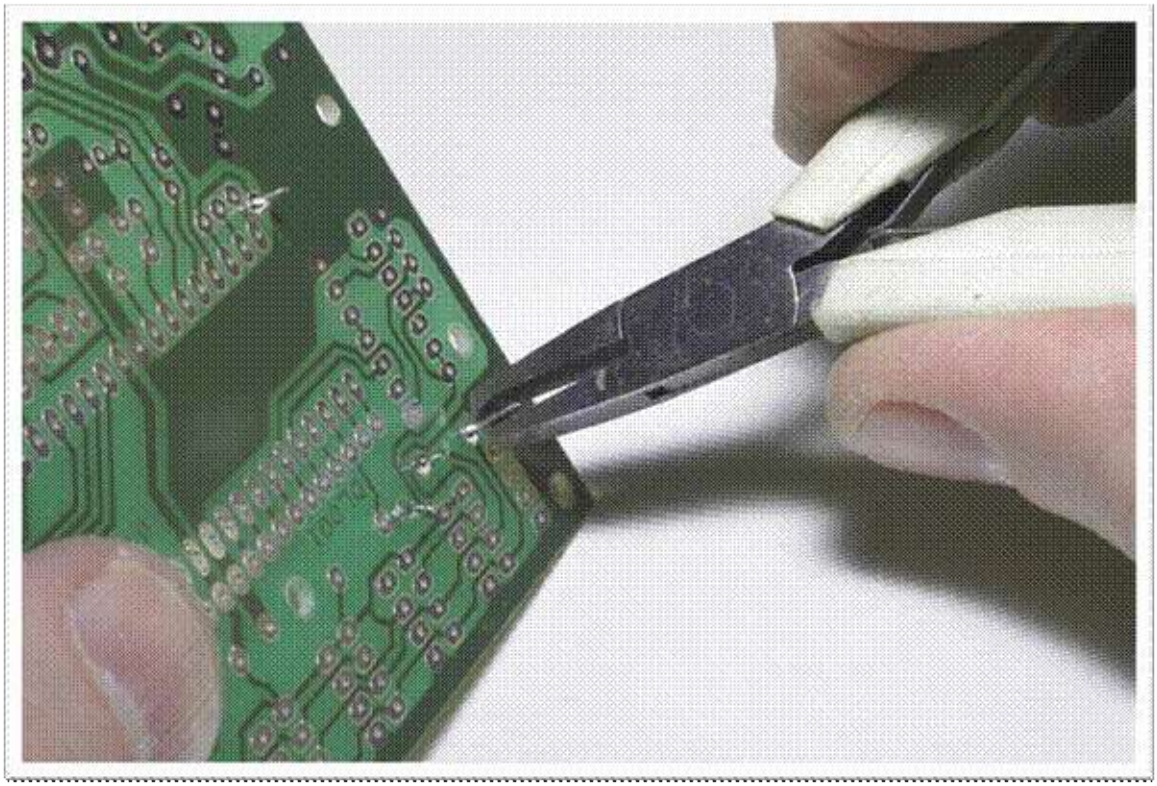

^^ *These "end cutters" can then be used to snip off excess wire after soldering….*

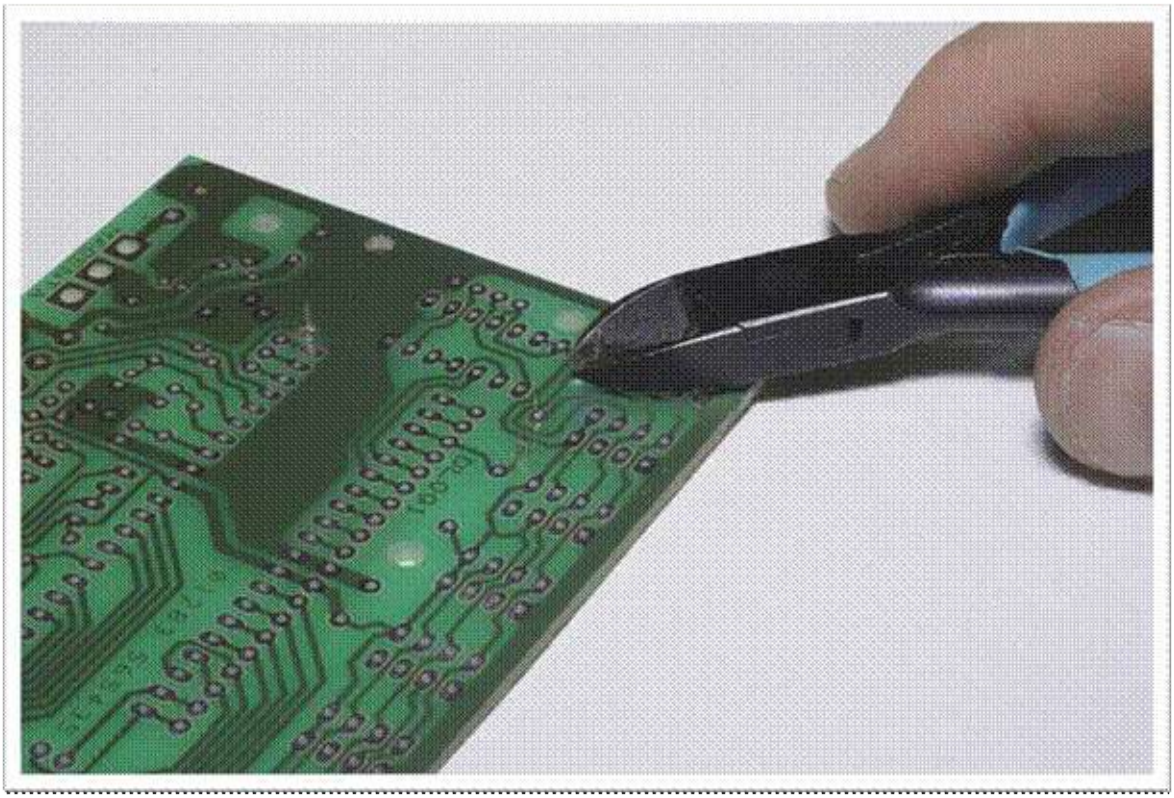

^^ *… but ordinary electronics "side cutters" are fine for trimming or snipping wires.*

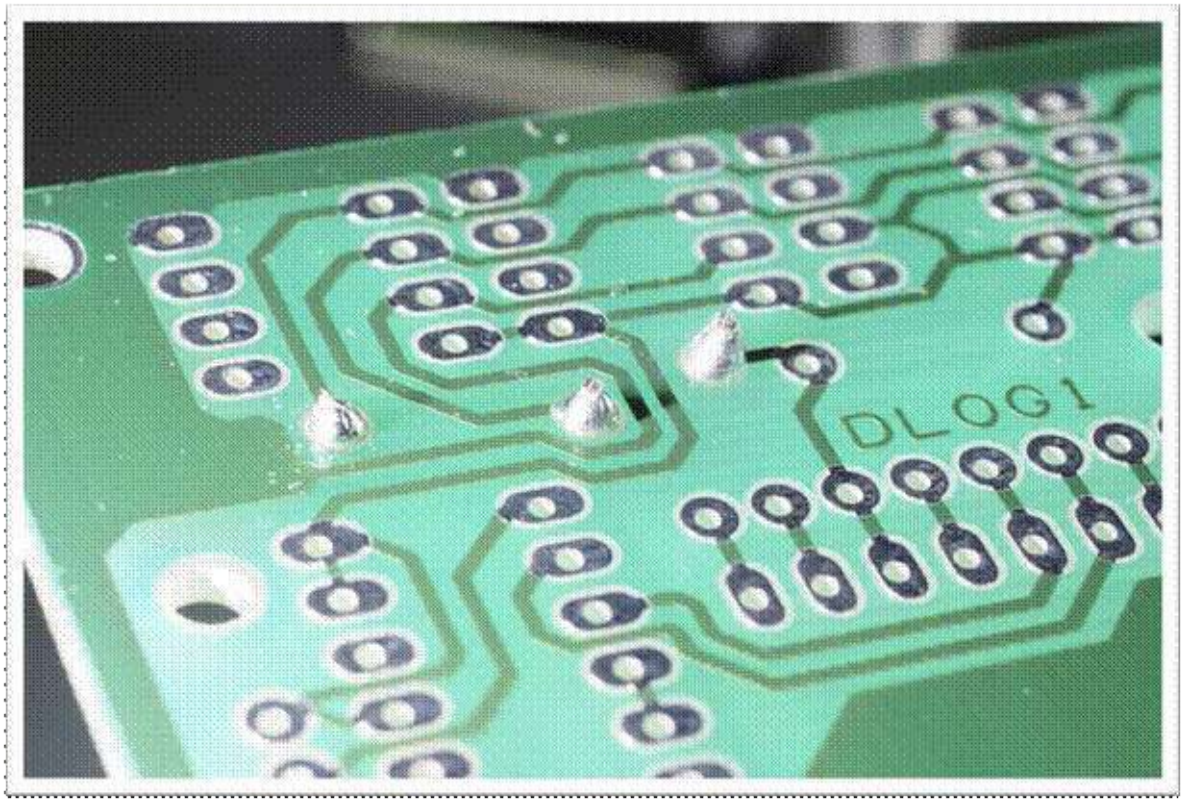

^^ *The ideal solder joint should be smooth and slightly concave, quite shiny, not dull or crystalline-looking nor ball-bearing shaped.*

Try to get consistent results in your soldering, but don't worry too much about the lack of uniformity – this is soldering by hand after all, not by precision machinery, and some slight variation is OK provided the solder coverage is good and the soldering is generally clean and effective. You'll improve with practice, that's for sure!

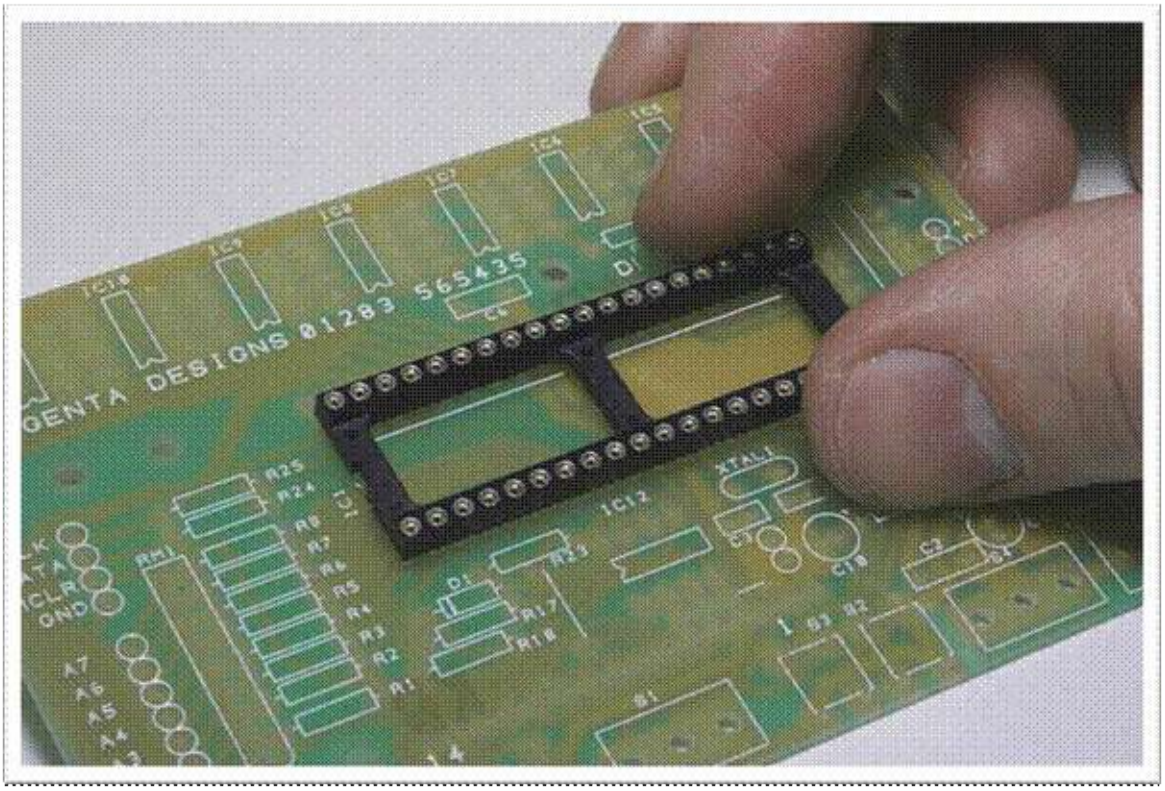

^^ *A large i.c. socket can be added next…*

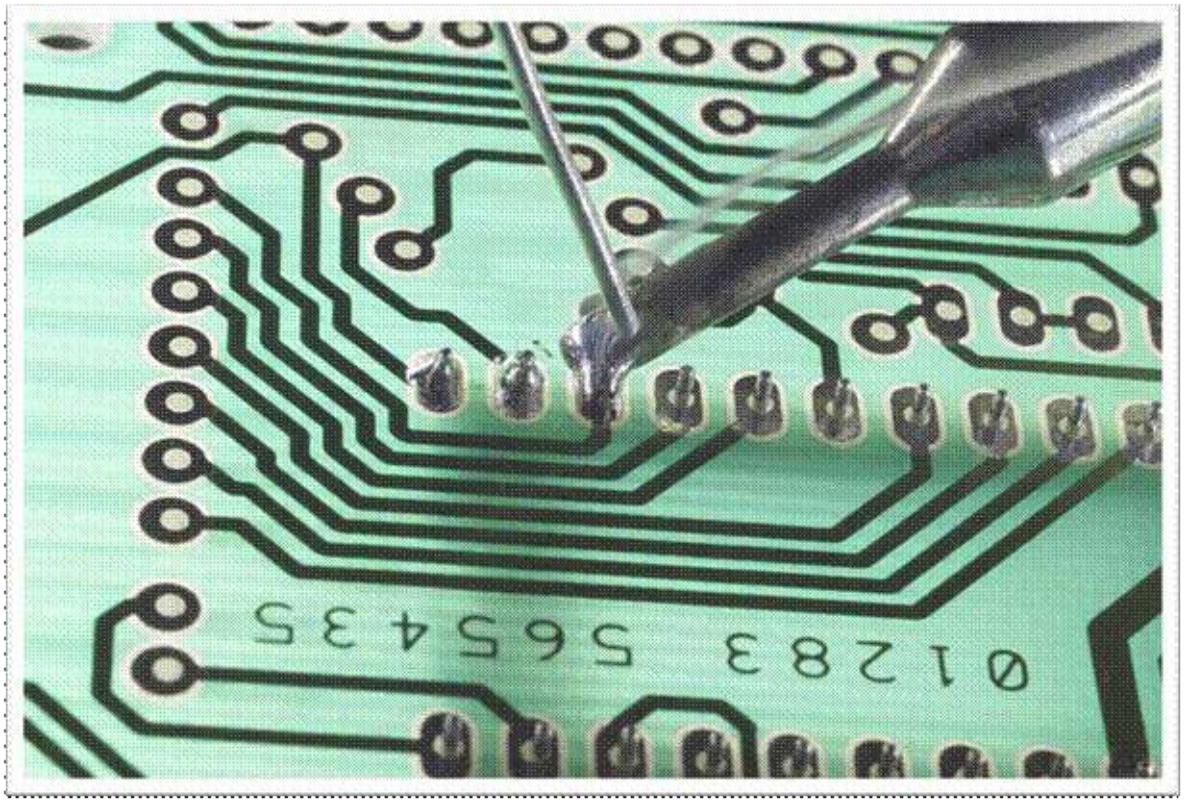

^^ Go along the rows of pins and solder them one at a time. See how simple it is! Heat both the solder pad and pin with the iron, and dab on a little solder wire to ensure full coverage. Ensure the socket is flush against the board.

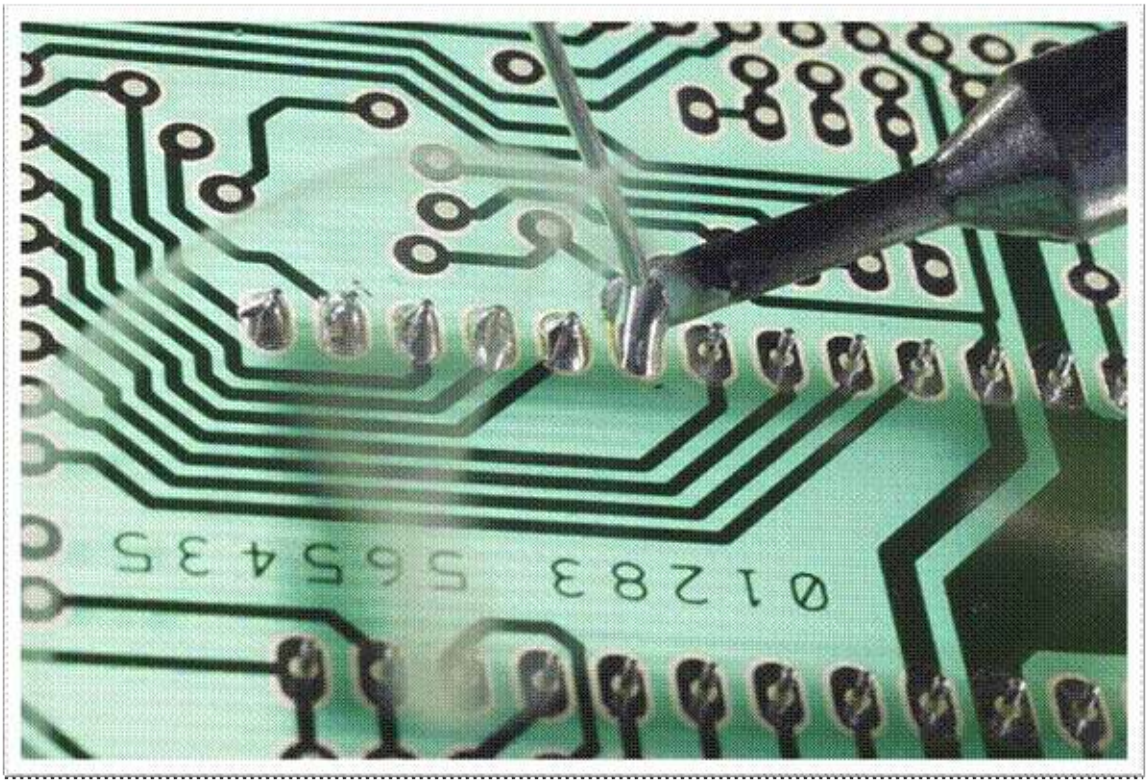

^^ As hardly any metal is involved each pin should take well under a second to solder at most.

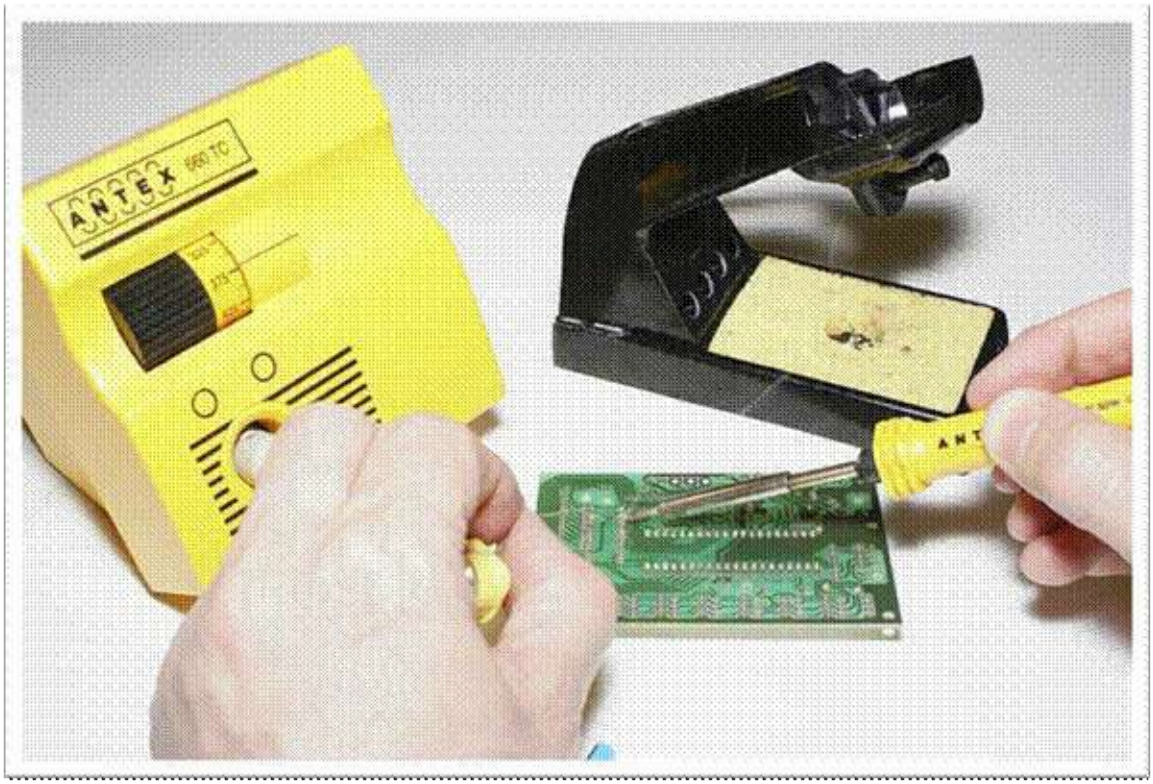

^^ *Continue until the i.c. socket is soldered.*

Once the smallest parts are soldered into place, you can continue to solder the remaining components. It's easiest to handle the smallest so-called "discrete" parts first while you still have plenty of room on the board. I usually solder resistors and capacitors next. The principle of soldering them is just the same as a simple wire link: insert them from above till they are flush on the board, then splay their wires a little to hold them in place, and preferably snip off at least some of the wire to give you more access.

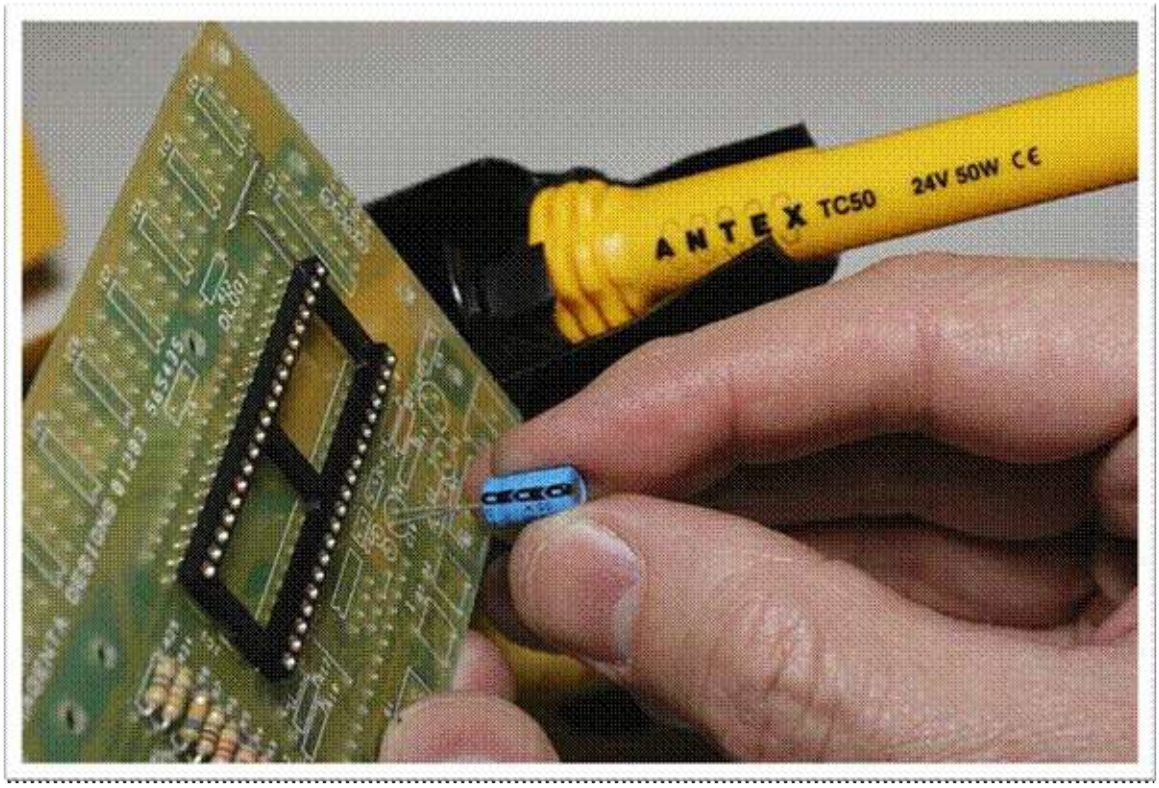

^^ *Continue by inserting "discrete" components from above, splay their wires out*

underneath to secure them in place, then snip and solder the joints exactly as before. Some parts like this blue electrolytic capacitor are polarity sensitive (note the – sign), and must be inserted the right way round. Same is true of every semiconductor.

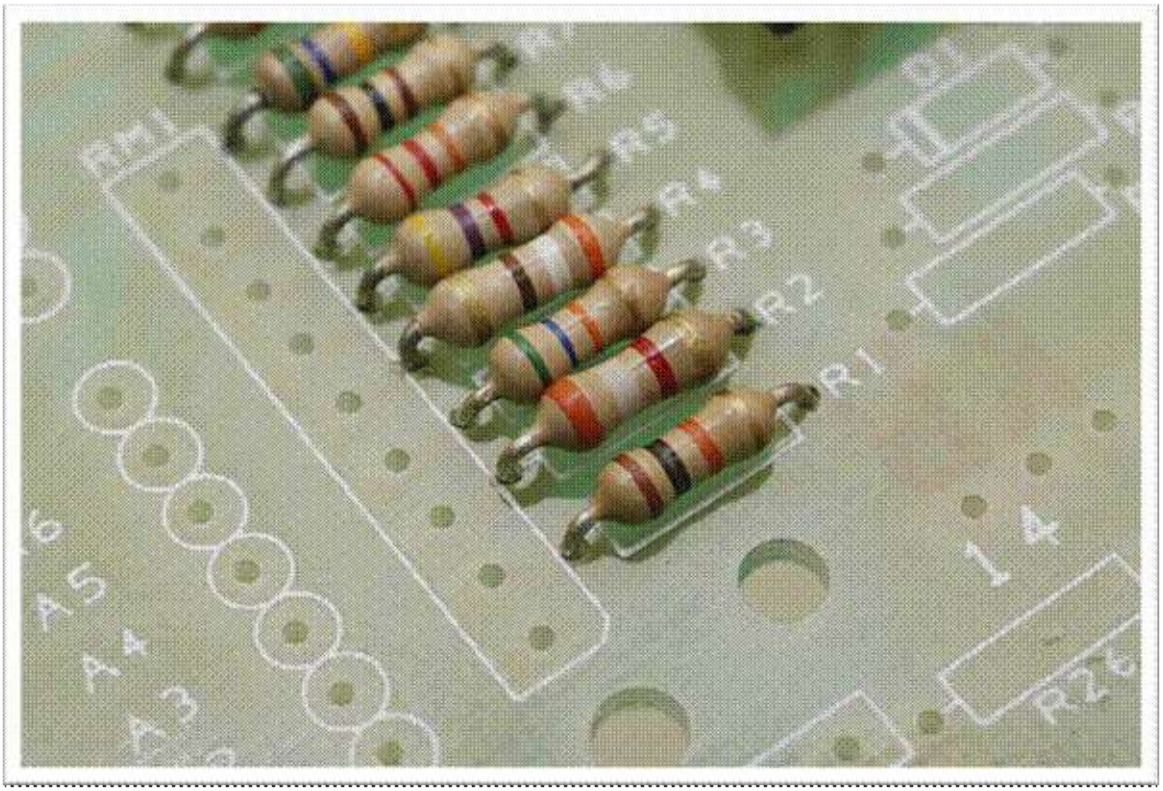

^^ This row of ¼ watt resistors was next. I like to show the colour codes all the same way round, with gold or silver (tolerance bands) on the right for consistency.

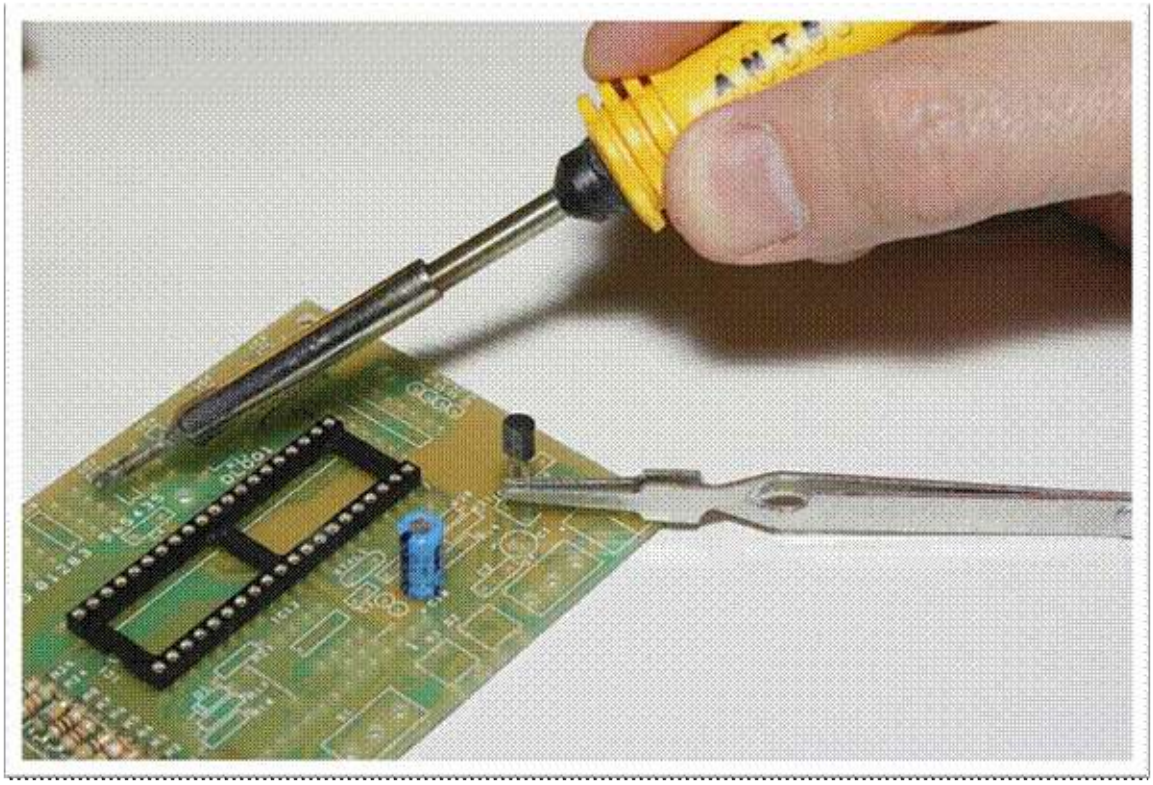

^^ This transistor was next. Solder it quickly to avoid damage, and observe polarity correctly, so it is the right way round on the p.c.b. The heatshunt is optional.

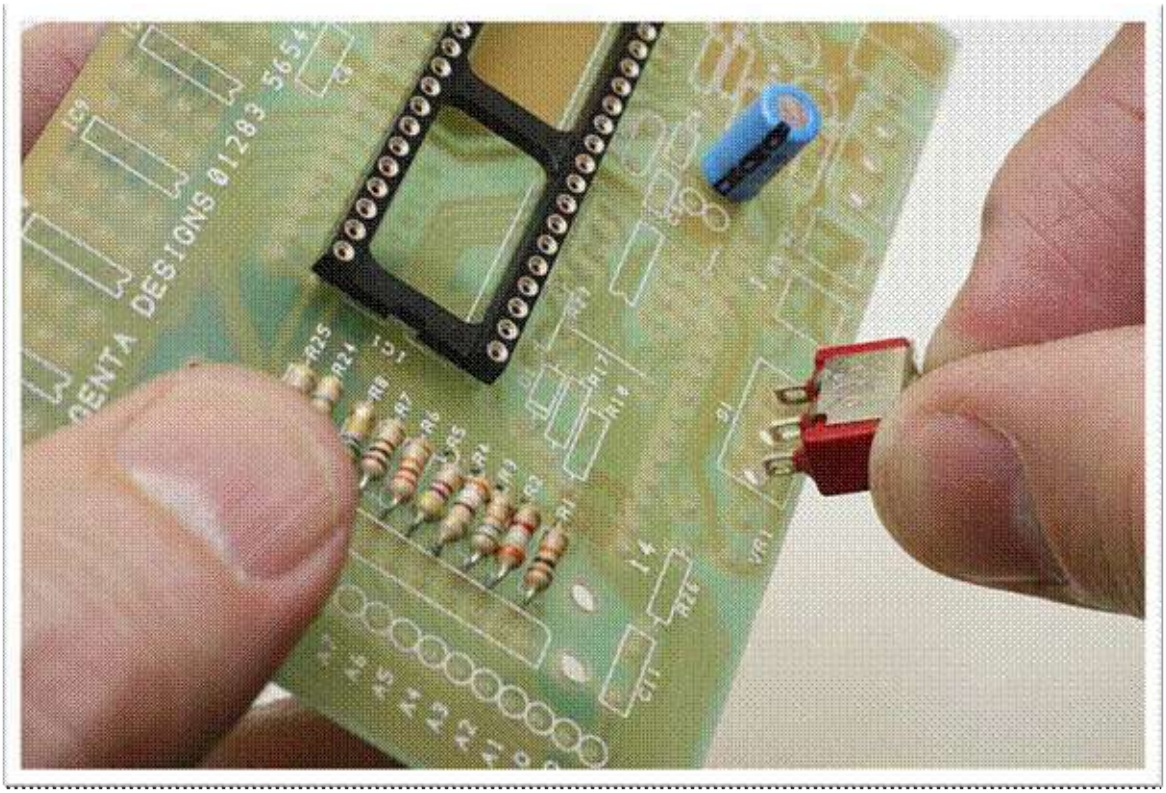

^^ Unusually, this toggle switch fitted directly onto the board as well which saved wiring it up. Neat idea!

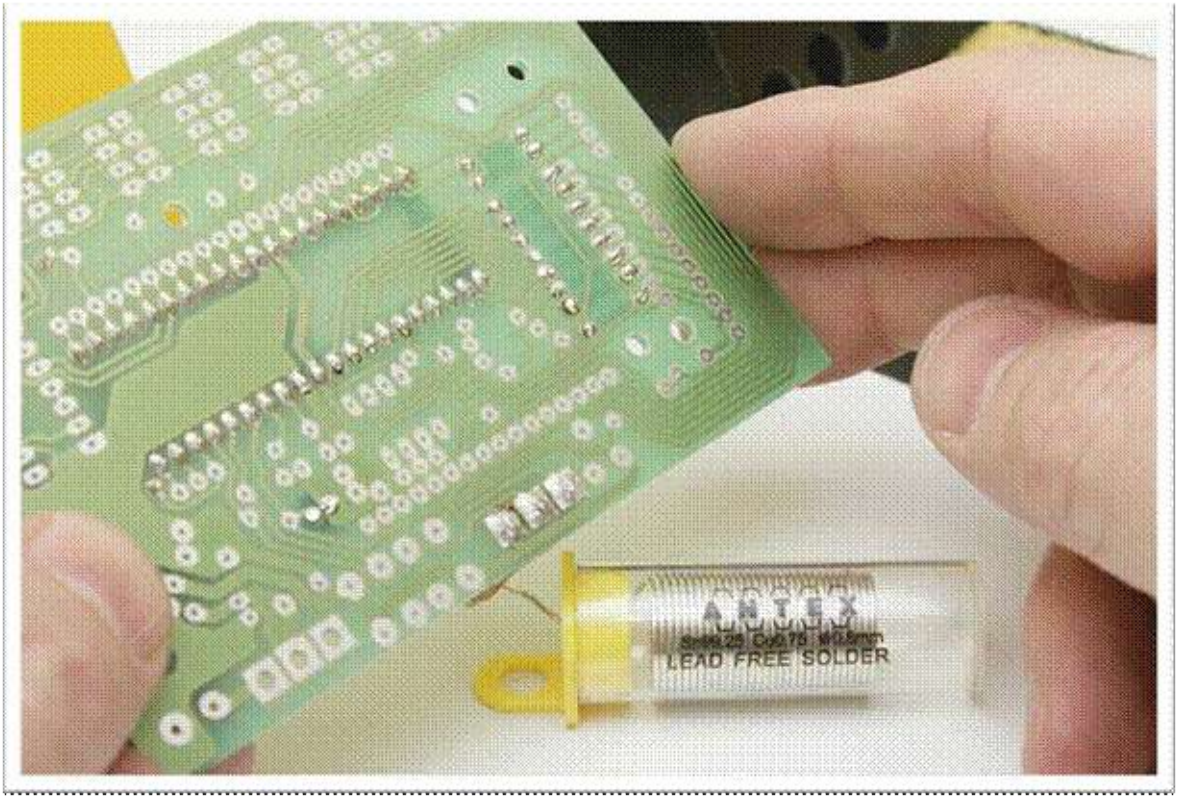

^^ As there is comparatively more metal to heat up, it'll take longer to solder the switch terminals, and you'll need more solder as well. Thicker gauge solder is useful at such times. Allow say 2-3 seconds to solder each terminal.

Don't forget to clean the soldering iron tip on its damp sponge every now and then, to ensure the bit is kept clean and shiny. Later on I'll show you how to correct any problems by desoldering using various techniques. Next, we'll move on from printed circuit board "through-hole" soldering and look at how to handle wires and leads.

Interwiring – get hooked up!

With practice, through-hole soldering of p.c.b.s will become second nature. There's no substitute for tackling some soldering jobs though, particularly trying a simple kit based on a quality p.c.b. which will boost your confidence enormously.

Most electronic devices need connecting up to external components such as battery packs, speakers, l.e.d.s or switches. Usually, multi-stranded connecting wire is used to connect circuit boards and external parts together. Unlike single solid-core wire, *multi-stranded wire* is flexible and vibration-resistant. Hobbyists mainly use 7/0.2mm wire (7 strands, each 0.2mm diameter) for low-voltage hook-ups although much Chinese equipment uses much thinner wires than this. So let's look at some aspects of soldering this type of wire.

In a separate photo sequence I show how a potentiometer (a panel-mounted variable resistor) and a light-emitting diode (l.e.d.) are connected using multi-stranded wire. The same principles of soldering apply to most other components including panel-mounted switches, loudspeakers, buzzers, audio sockets and more.

Components usually have terminals or "tags" to which wires can be soldered. Start by ensuring the component's tags are clean: otherwise solder will not wet properly and the joint will be impossible to solder, so all contamination must be removed. This is especially true of parts that have been in storage a long time. The connections often oxidise or blacken, so clean the solder tags with e.g. an abrasive glass-fibre brush, or a needle file or abrasive paper. Using a glass fibre brush was shown earlier in "Cleanliness and Tinning the Bit".

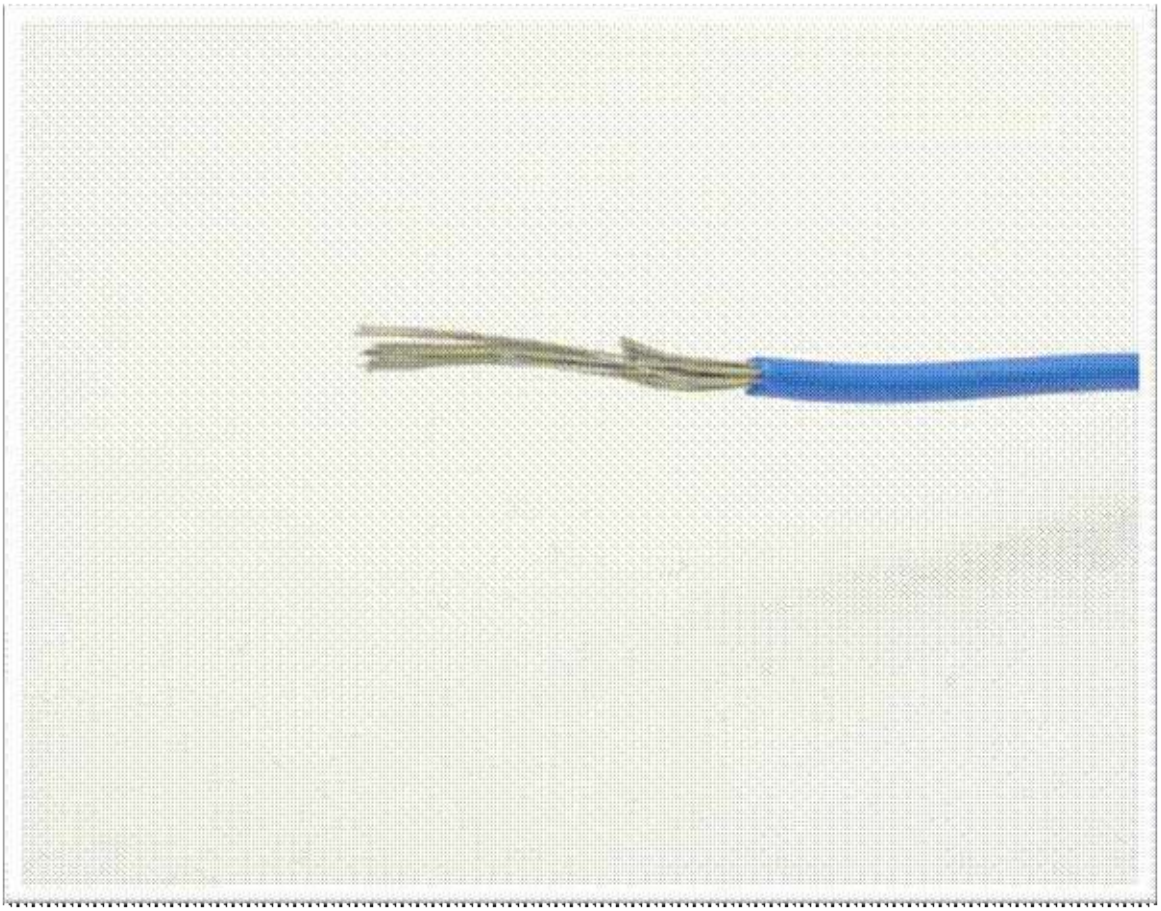

^^ How not to strip insulation off wire: some of the cores have also been cut – avoid doing this!

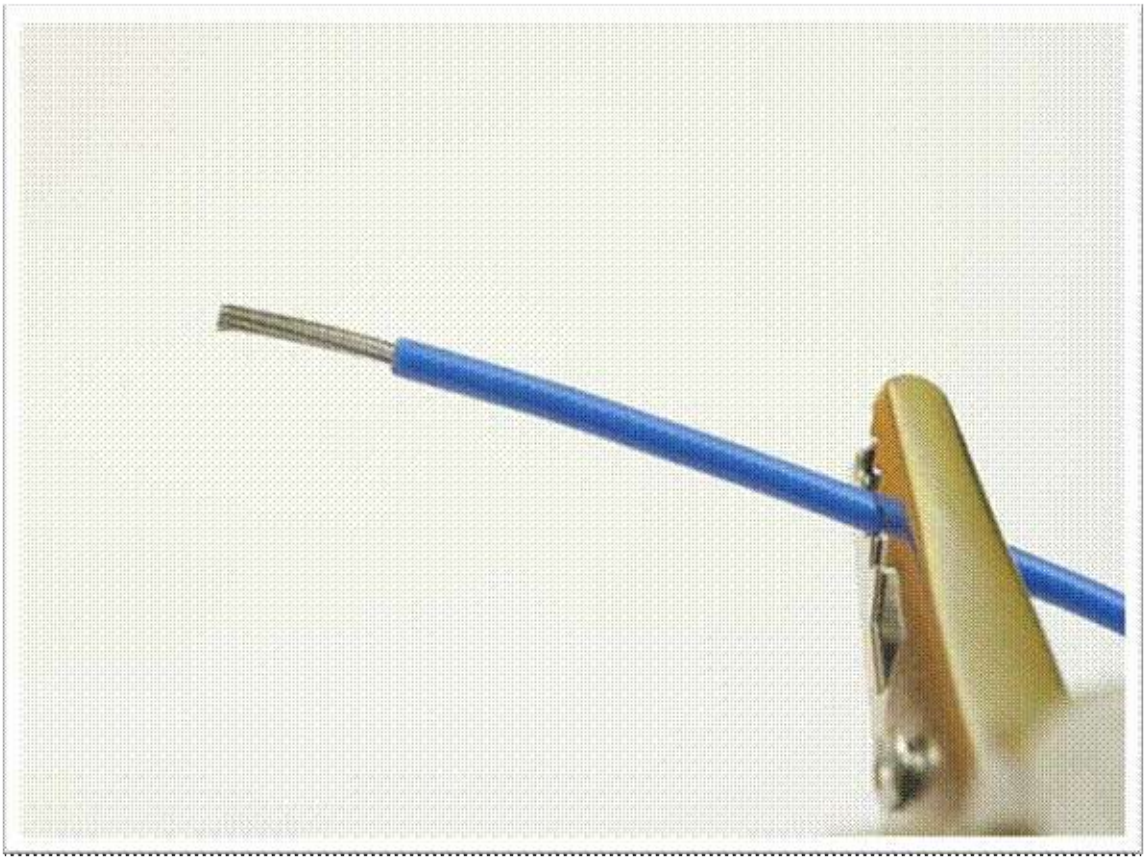

^^ Gripping a wire end in a "Helping Hand" croc clip can help with soldering.

After stripping a short length of insulation from the connecting wire, there are two ways to solder it to a component's solder tag. The first way is to "*tin" the stripped wire end to solidify it* - just heat it with the iron and melt a little solder on it, and let it cool. Poke the wire end through the solder tag, apply the hot iron to both parts and solder them together using a few millimetres of solder.

Although the assembly doesn't hold itself together so well during soldering (consider a Helping Hands jig if needed) this is quicker and easier to make and also easy to desolder again, and is perfectly adequate for most joints of this kind. The majority of commercial wire joints seem to be made this way.

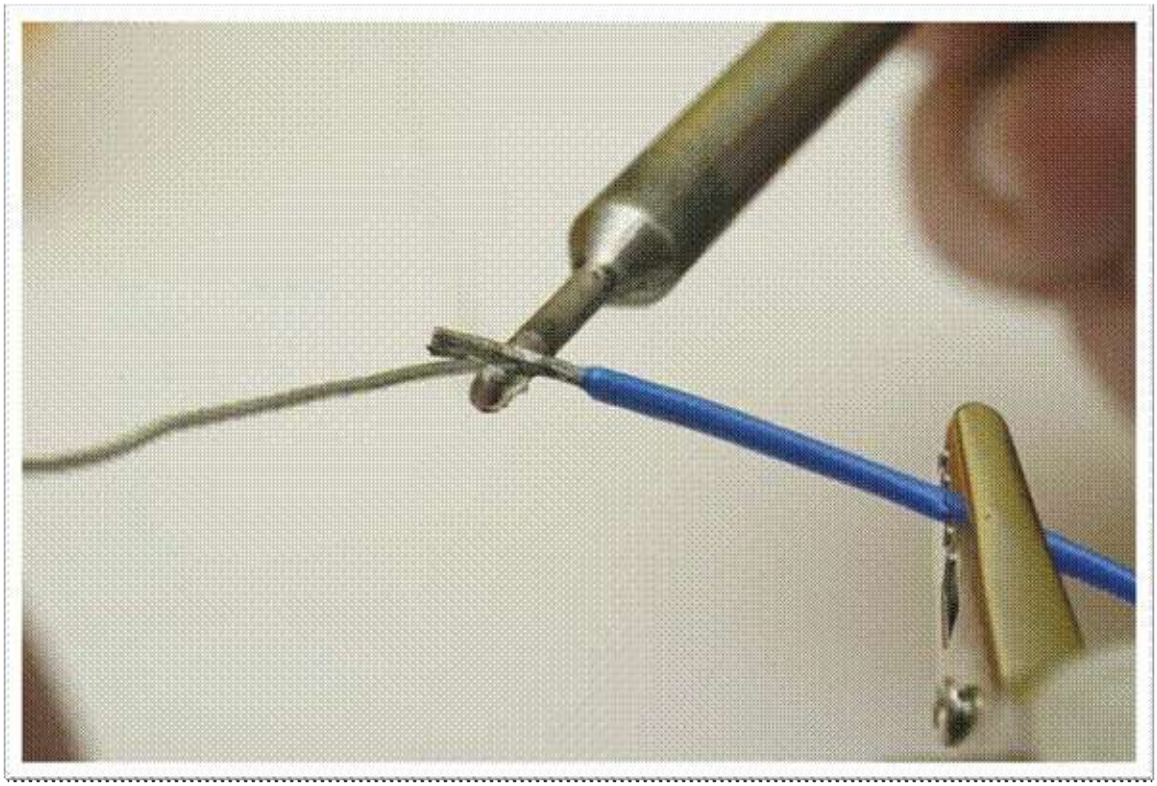

^^ *Apply a hot iron and solder, in order to "tin" the wire ends. This makes them into a solid.*

^^ *Then feed the tinned wire through the hole in the solder tag. Crop the wire with cutters if needed…*

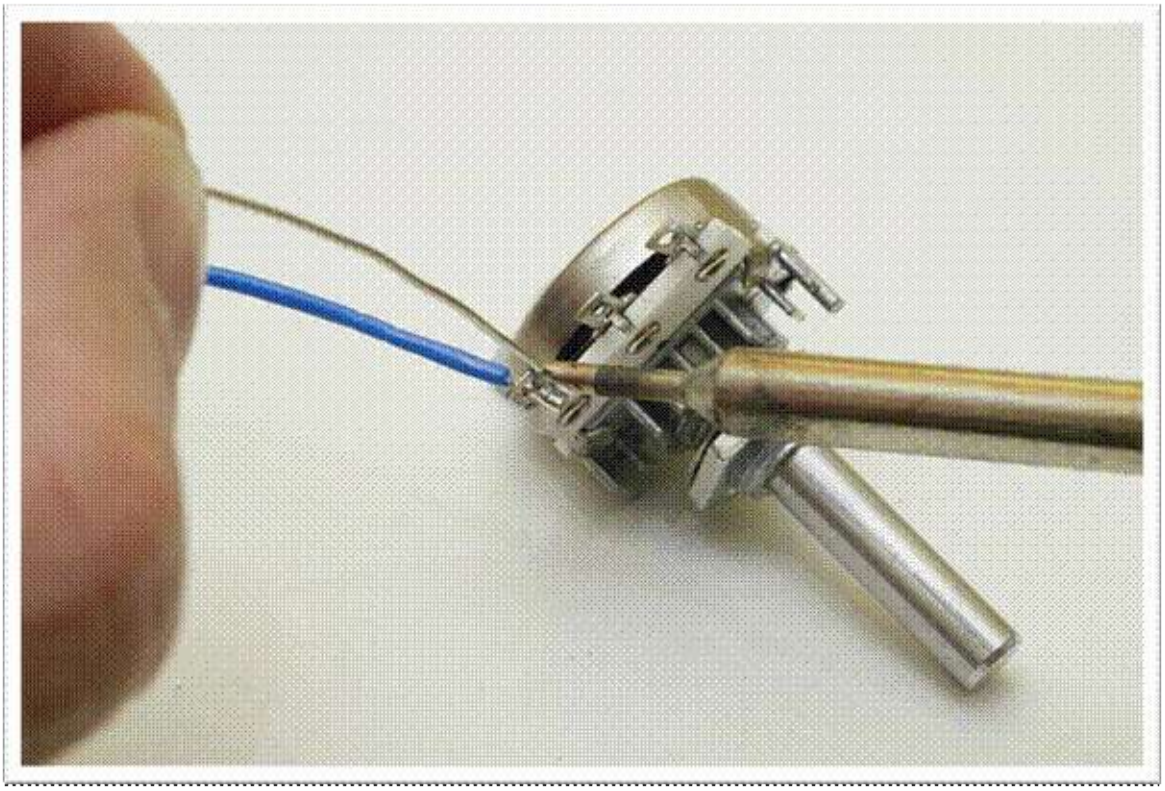

^^ *... and apply the iron to heat the joint. As there's quite a lot of metal to heat, allow several seconds to heat it up and then simply solder the wire and solder tag together with a dab of solder wire.*

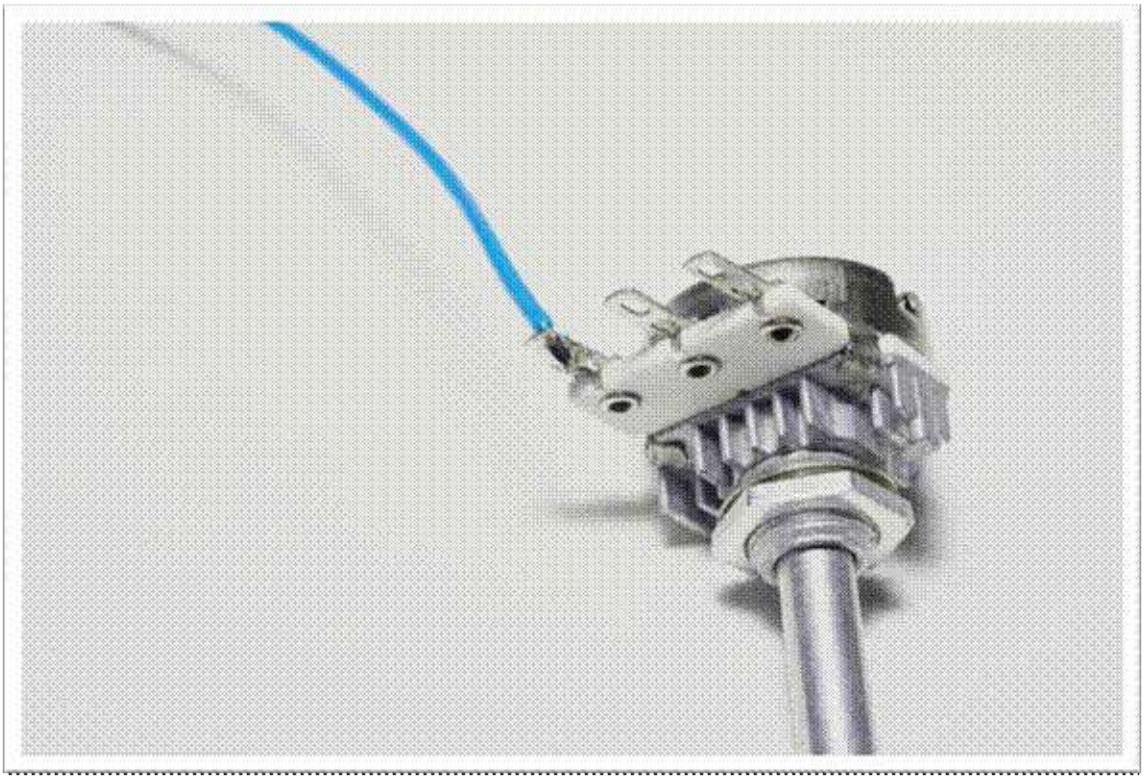

^^ *The result is a perfectly satisfactory solder joint.*

The second way is to loop the **untinned** wire through the tag a few turns and then solder it. This secures the wire during soldering, but it's messier to desolder if things go wrong (see later):

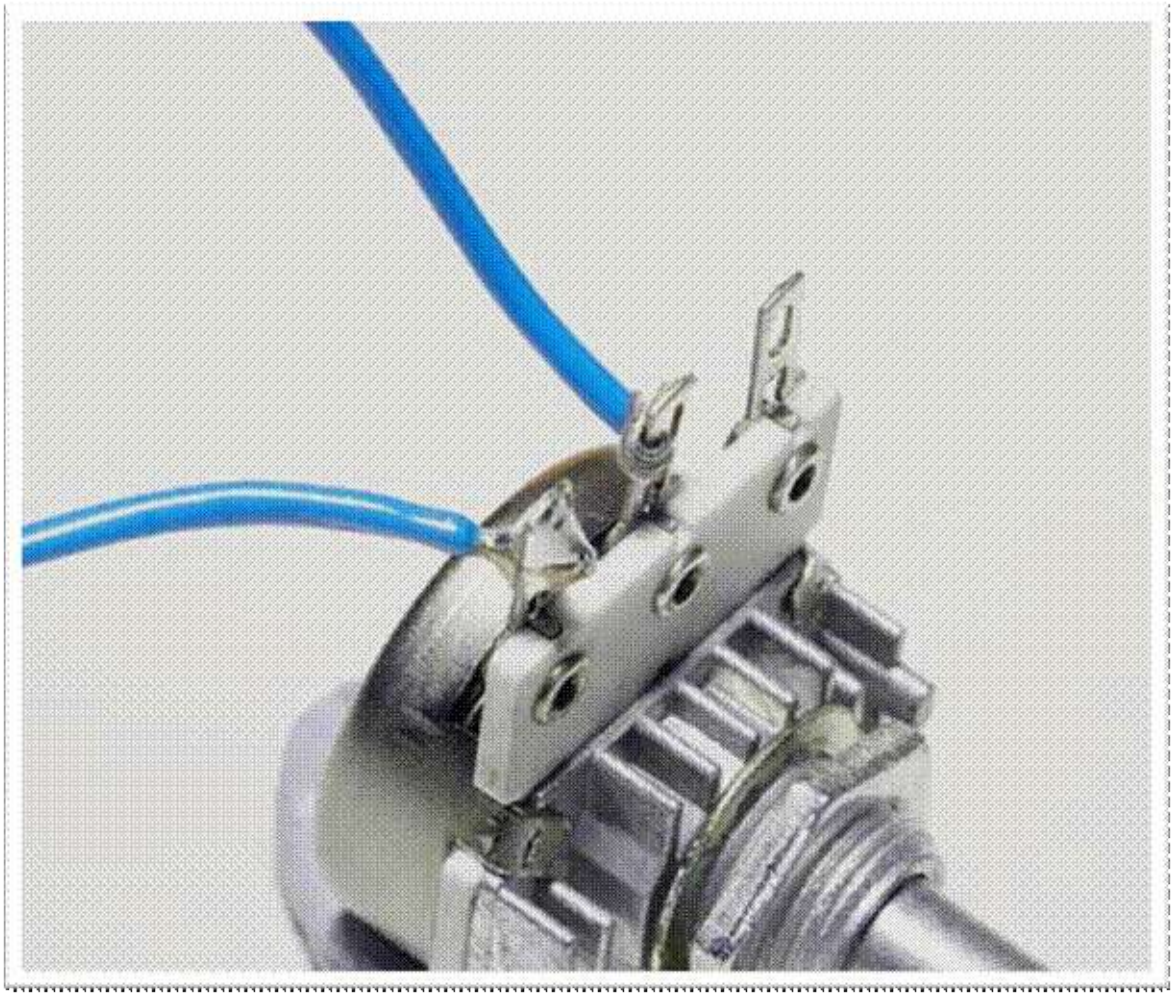

^^ *The centre wire (potentiometer wiper terminal) has been wrapped around to secure it before soldering.*

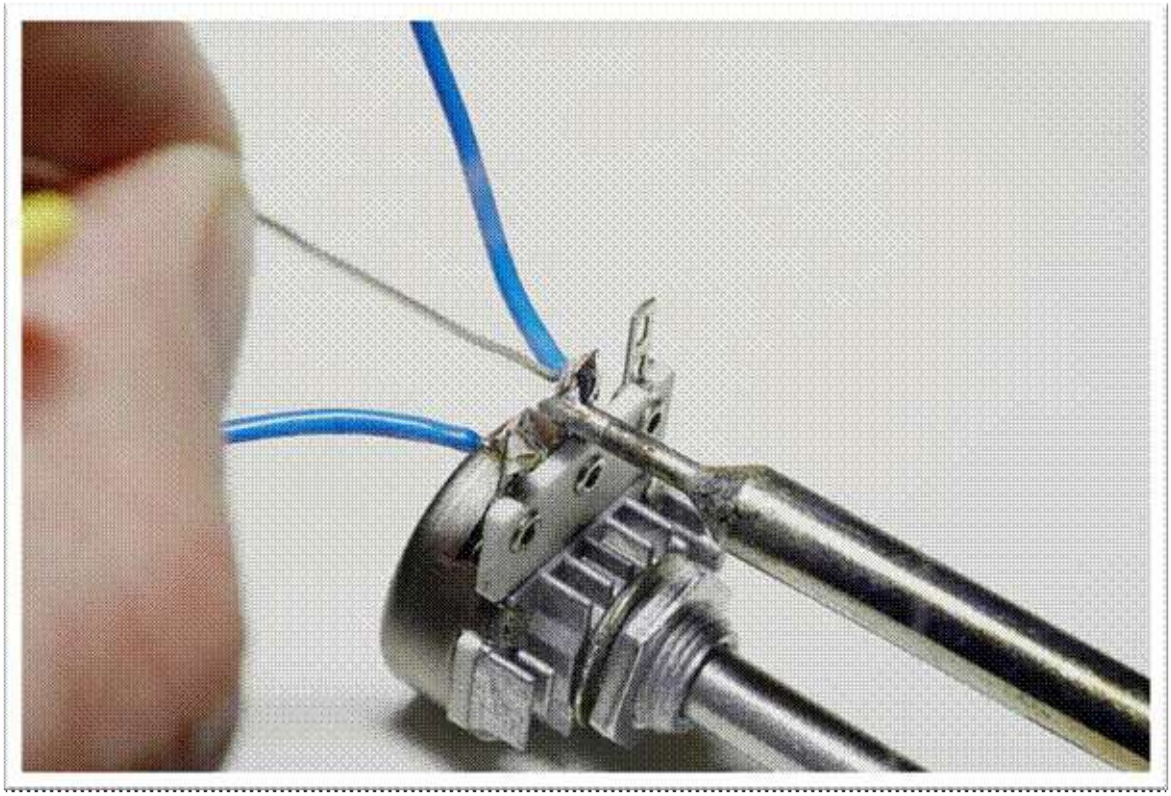

^^ *Solder the joint in just the same way – heat it up and dab on some solder wire.*

Much electronic equipment is connected or inter-wired this way and soldering everything together is a key stage in assembling any electronic project. I'll explain some refinements you can try, later.

Wire joints

Soldering isn't always the best solution to some problems, for reasons that I explain in the next section called Fatigue and Breakage. However you can solder wires together to join them simply and cheaply, and next I show a classic wire joint of this kind, sometimes called a **Western Union** joint.

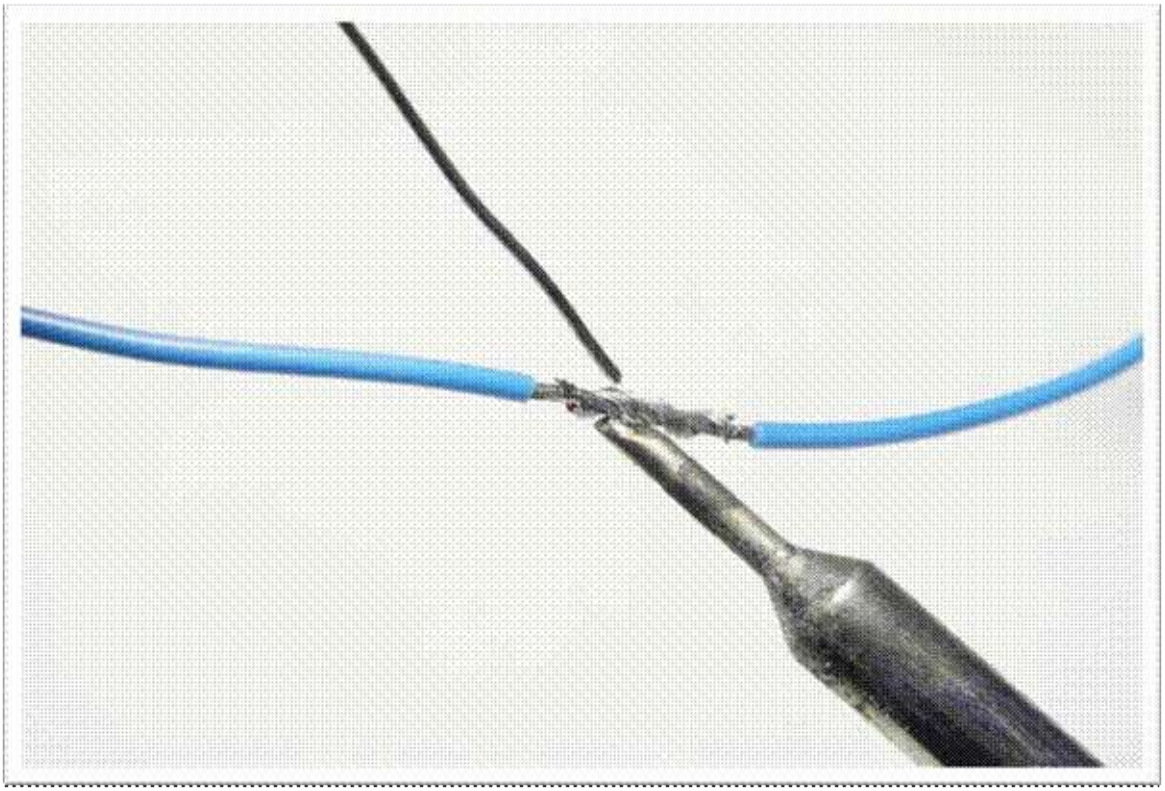

^^ *Soldering a Western Union wire joint.*

Strip the ends from each wire using wire strippers, and try not to cut any of the stranded cores or this will create a weakness. (Stray strands of wire can also be a hazard.) Then twist the wires securely together several times, ideally four or five. Apply a soldering iron to the exposed joint and dab on some solder until it flows fully over the joint, then remove the iron and allow the joint to cool.

The wire's plastic insulation may shrink back a little due to the heat, but try not to overheat it excessively. If you have the resources you can finish off by insulating the joint with some heatshrink tubing (slide it over a wire before you make the solder joint!). Otherwise use ordinary PVC tubing or insulation tape if you have any.

A solder tag can be soldered easily enough, and it's probably best to feed a stripped wire end through the tag and twist it over several times before soldering it, so it's held together when soldering.

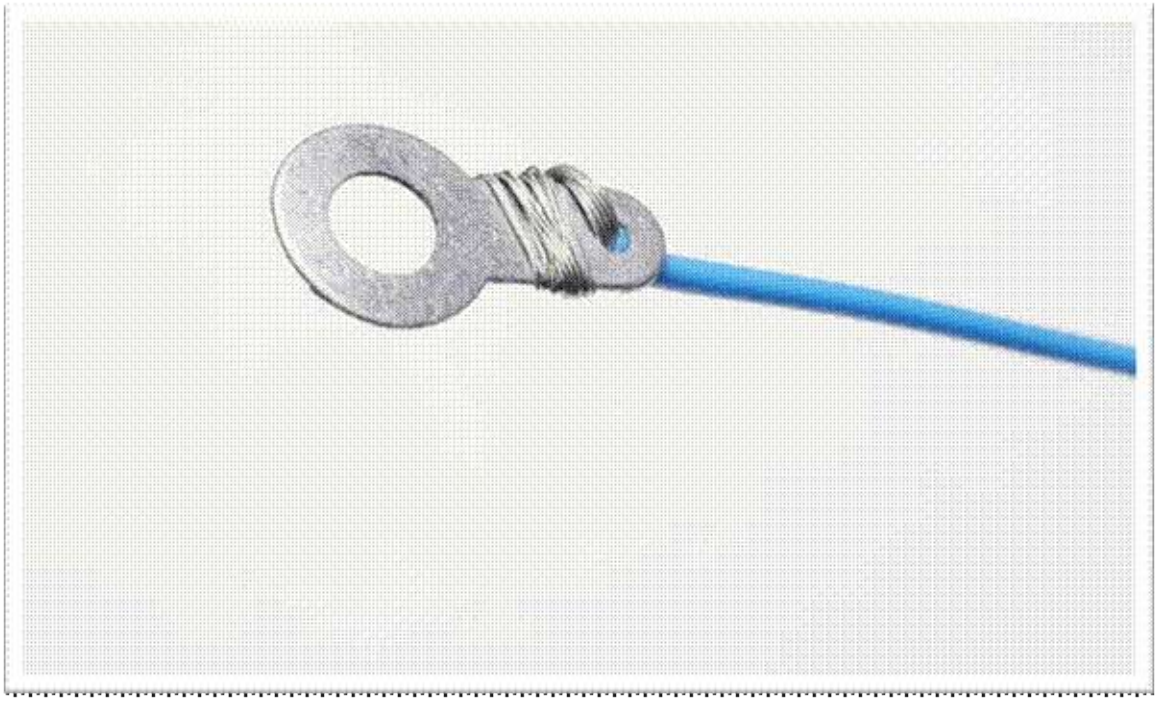

^^ *A solder tag is soldered by wrapping a stripped wire end through the hole and round again, to secure it.*

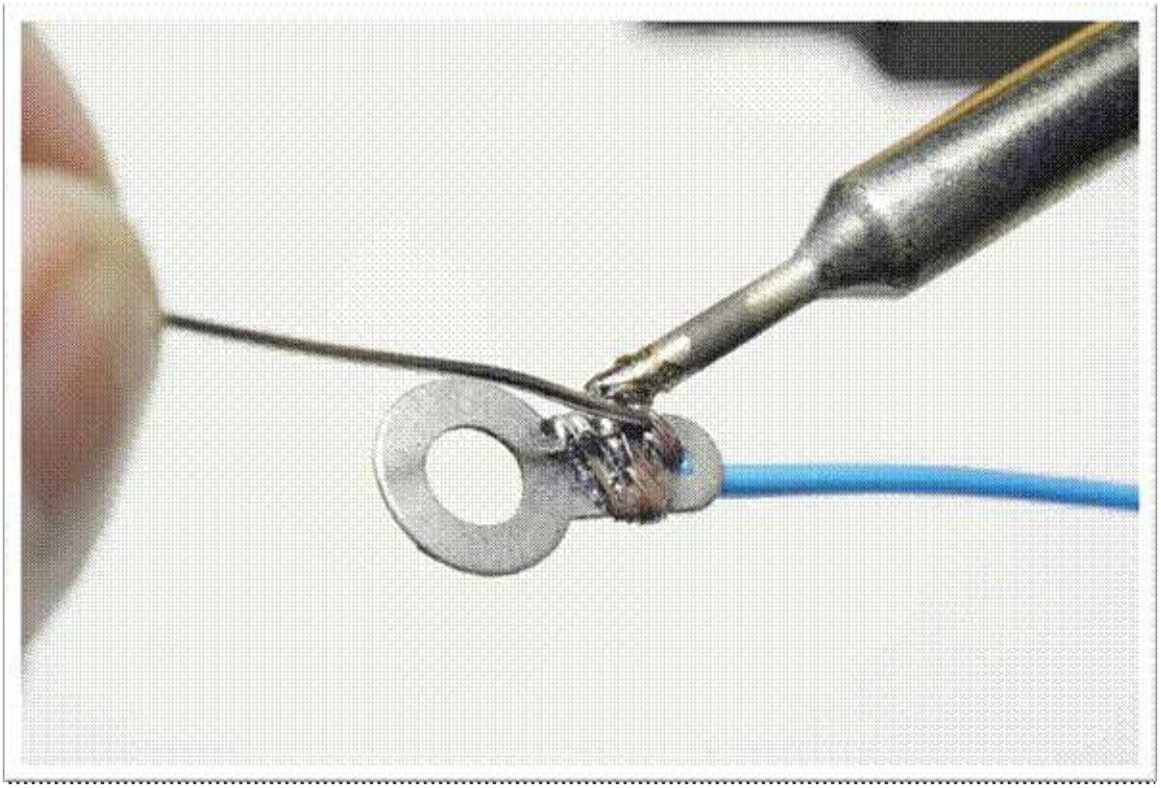

^^ *Apply plenty of heat and solder for a few seconds.*

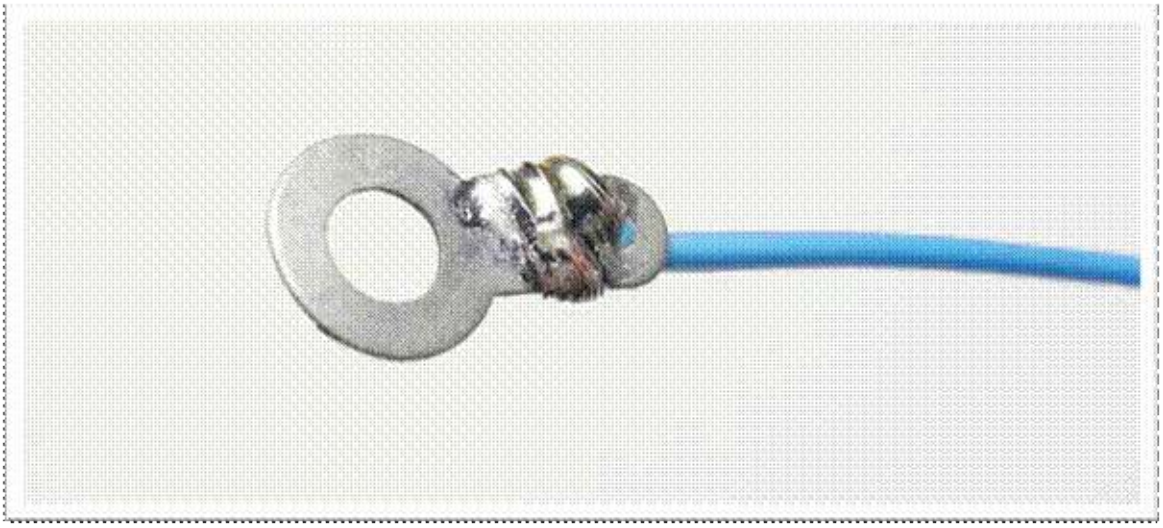

^^ *The completed solder tag*

The next sequence show how the same basic principles of soldering wires are used to connect up a device such as a panel-mounting l.e.d.. A series resistor can be wrapped around and soldered directly to one of the l.e.d. solid wires, and then two multi-stranded connecting leads are soldered to the l.e.d. and resistor. It's best to use heatshrink tubing or PVC sleeve to insulate the solder joints and prevent short circuits afterwards.

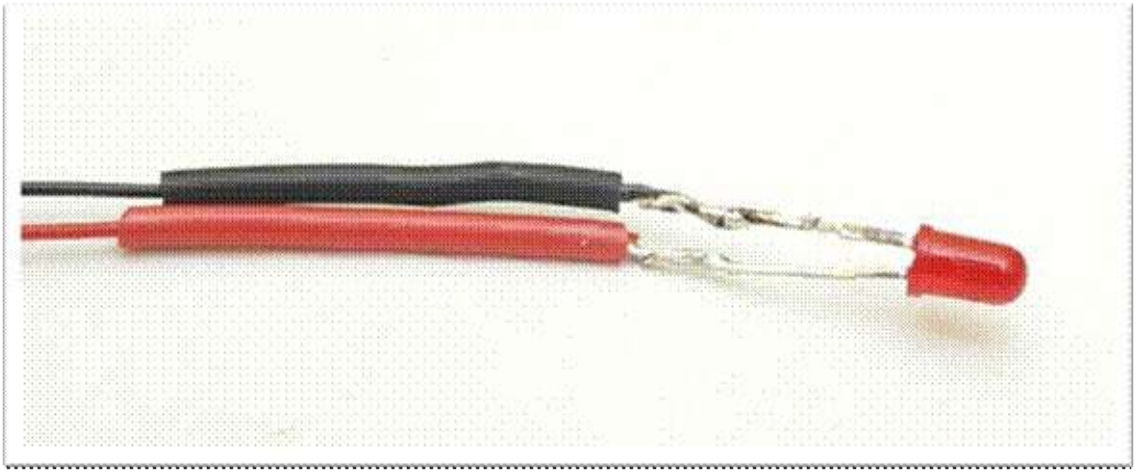

^^ *Multi-stranded wires can be soldered to the solid leads of an l.e.d.: insulate them afterwards. Different coloured wires identify the polarity of anode and cathode.*

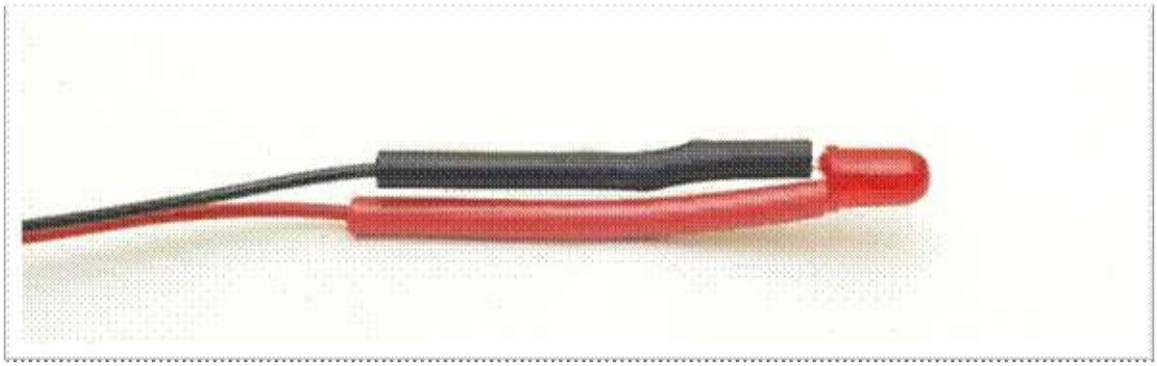

^^ *PVC sleeving or heatshrink is needed to prevent short circuits.*

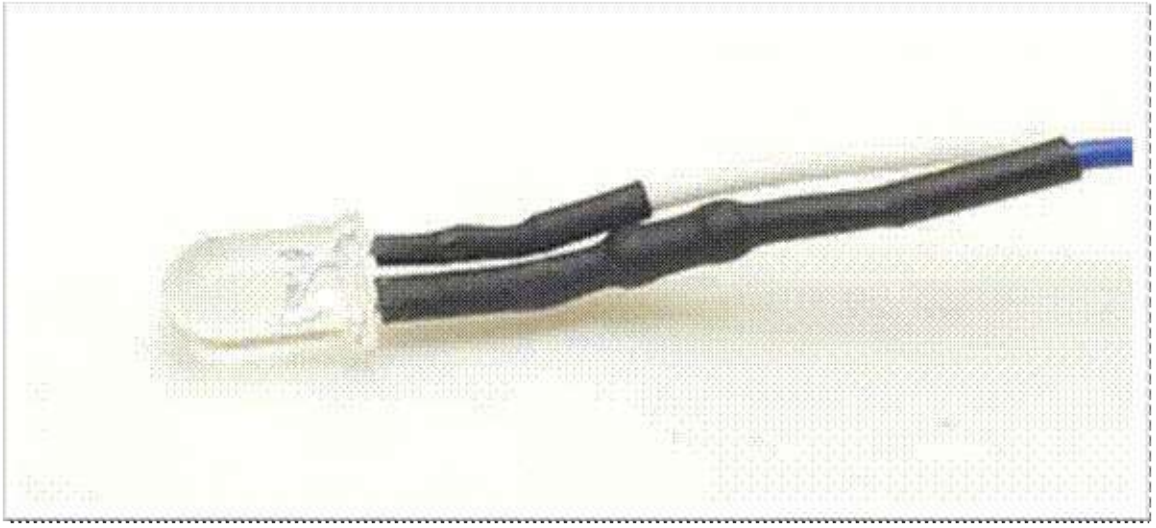

^^ *A commercial l.e.d.– the series resistor can be made out in the sleeving.*

Wires can also be soldered directly to printed circuit boards by stripping and tinning the ends, provided they fit through the holes in the p.c.b. It's a very common and cheap way of hooking up a board using "flying leads" and you'll see this all the time in consumer electronic equipment. For convenience so-called "solder pins" can be used, onto which flying leads may be soldered from the component-side instead.

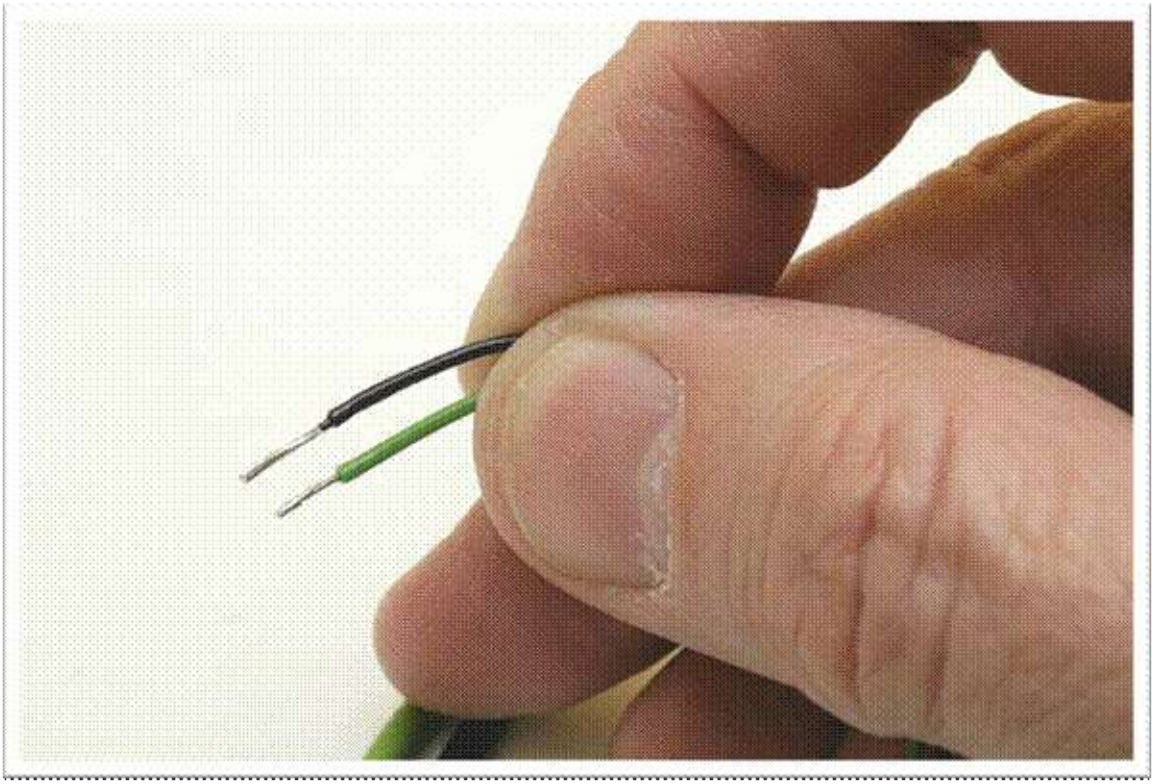

^^ *A set of l.e.d.s connecting wires, stripped, tinned and ready to be soldered to the p.c.b.*

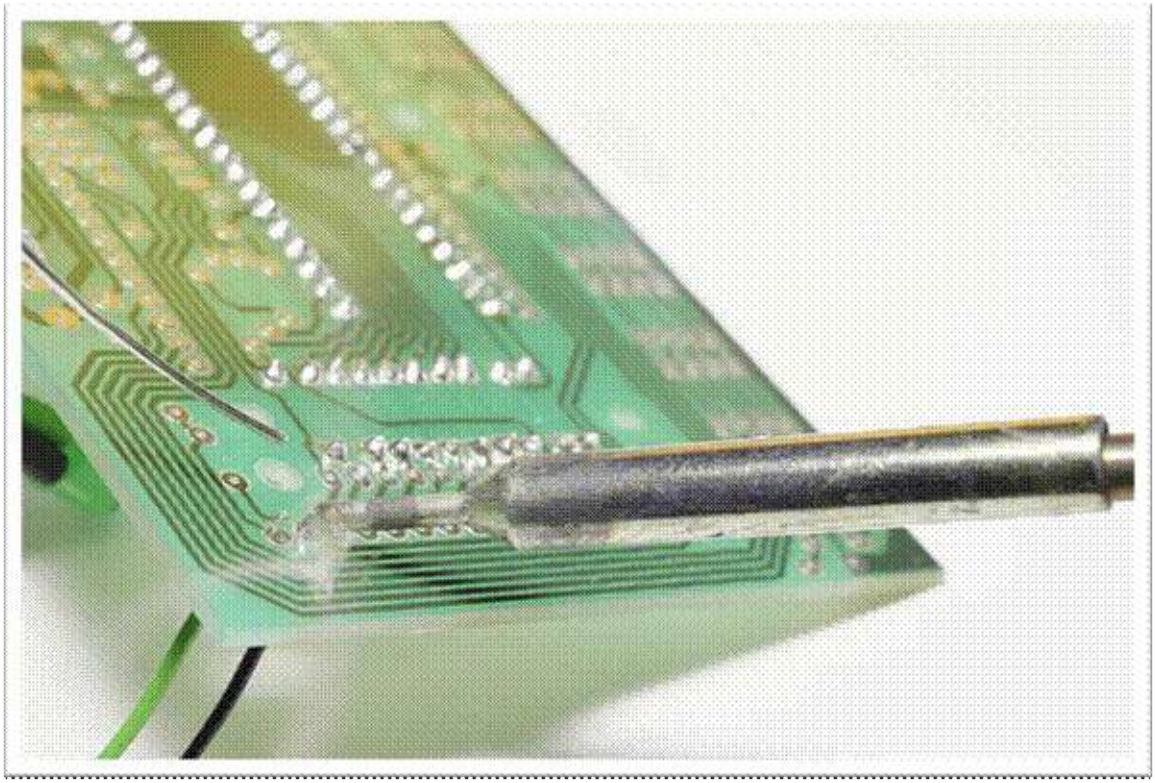

^^ Solder the two "flying leads" to the copper pads in the usual way. Hopefully the holes are big enough for the wires!

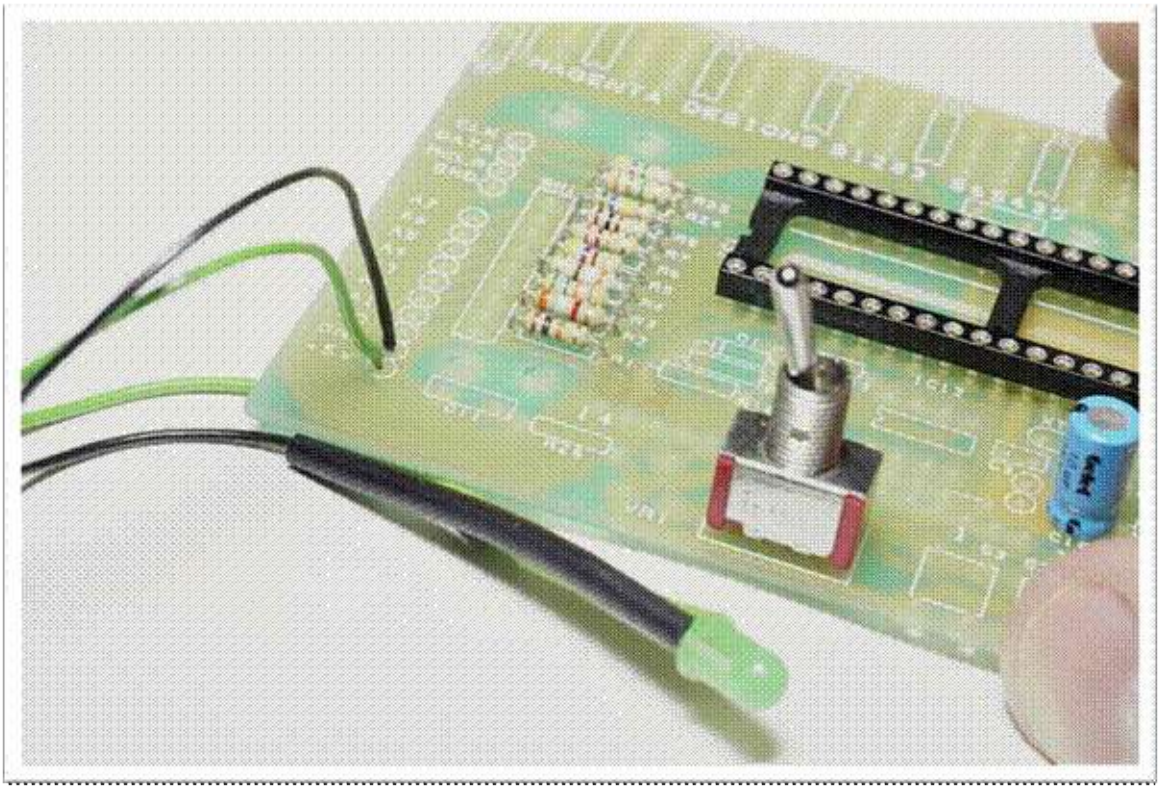

^^ Connecting an l.e.d. to a circuit board with flying leads.

Wires can also be attached to the underside (solder-side) of circuit boards, tacking them onto existing solder joints by re-melting them and absorbing the tinned wire end into it ("reflow soldering" – see later). This is a cheap and cheerful, semi-reliable way of rigging wires to a circuit board, and it's used all the time in imported consumer electronics.

Tidying up

I'll leave it to readers to decide whether they should cut off excess wire before or after soldering. After the soldering is complete, I prefer to tidy up the joint by snipping any excess wire from the joint using a pair of "end cutters" shown earlier. These expensive hand tools have specially angled blades that snip the joint neatly down to the top of the solder joint. Ordinary side cutters will do fine.

It's worth taking time out to inspect the work closely, looking for any missing solder joints, whiskers of solder or swarf shorting out any solder pads, and all such potential problem areas should be dealt with prior to testing the board. Faultfinding goes beyond the scope of this guide, but it's true to say that almost always, any problems noticed after powering up the circuit are due to soldering faults or wrong components being used.

Reflow technique

Another technique often used is “reflow” soldering. This is used to “tack” devices or wires together, especially if very small, sensitive or fiddly parts are involved. There might be no room to make a “proper” sturdy joint, or it might just not be necessary to have any mechanical strength in the joint, especially if tiny parts are used.

As an example, imagine a small temperature sensor (I used a transistor) for use in a thermometer project. It could be quite tricky to solder flying leads onto the sensor’s leadouts, so a good approach is to tin both the flying leads and the sensor’s leads, and then simply touch them together and re-melt the solder with the iron. There’s no need to add any more solder, because the solder that’s already there will re-melt and the joint will be made. Sometimes this is called a butt joint.

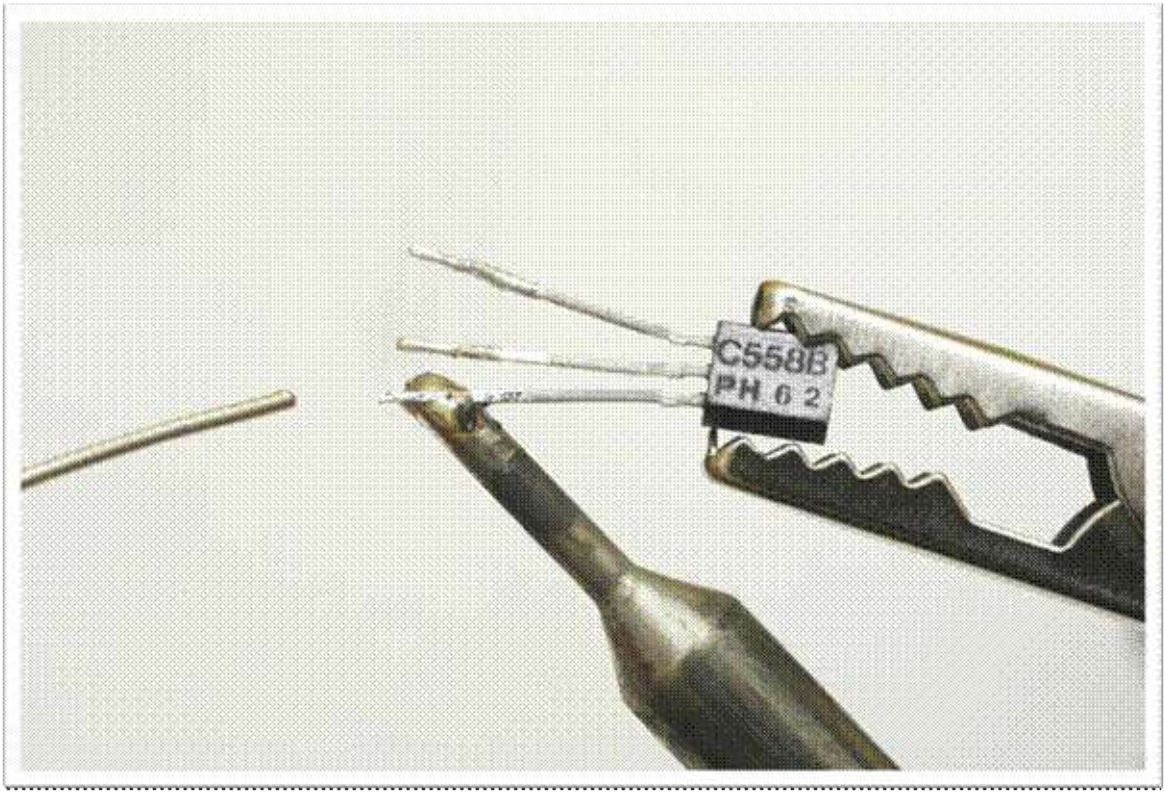

^^ The leads of this sensor (transistor) have been tinned, ready for flying leads to be tacked onto them with a reflow method. A Helping Hands jig might help!

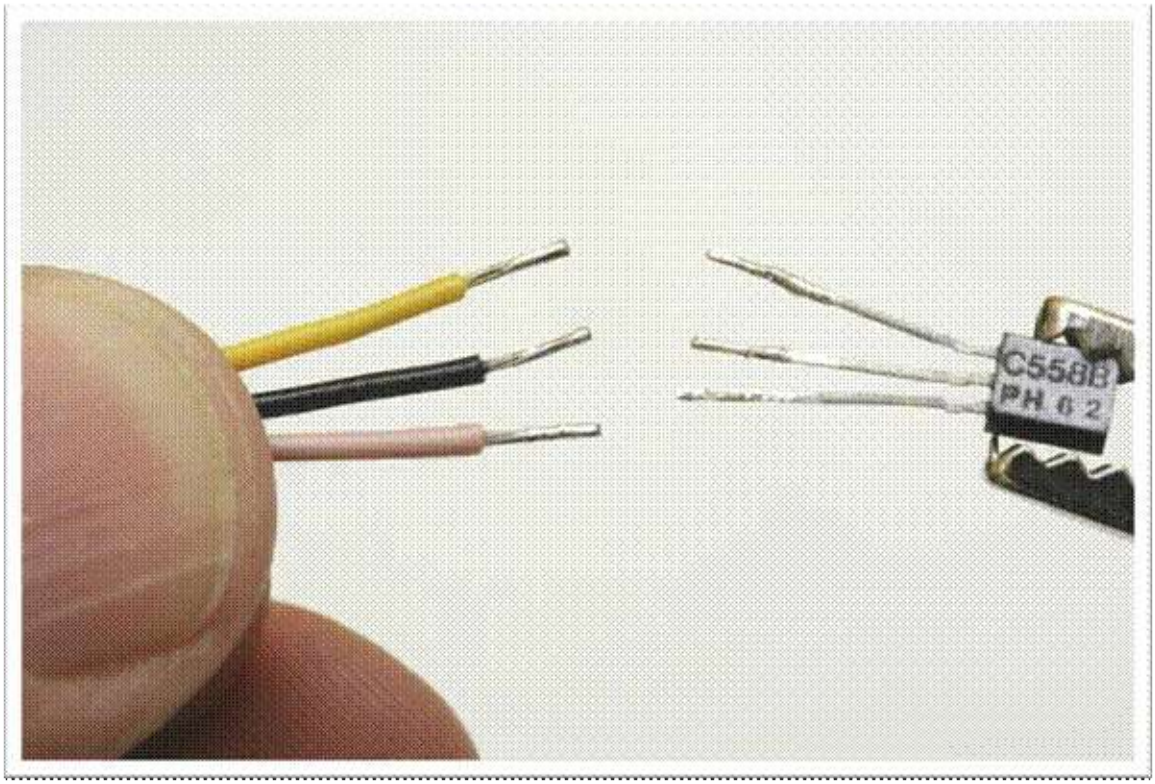

^^ *The three flying leads stripped, tinned and ready to be reflow-soldered onto the device.*

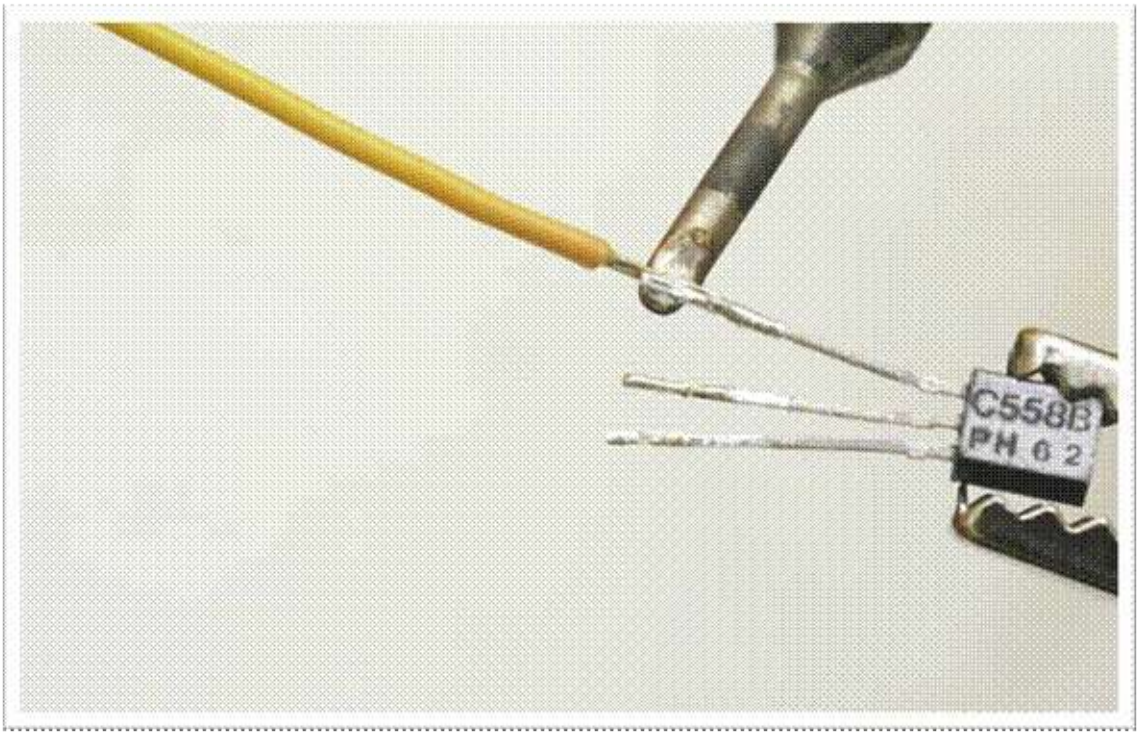

^^ *To reflow solder them, simply hold the two leads together while re-melting the solder with the iron.*

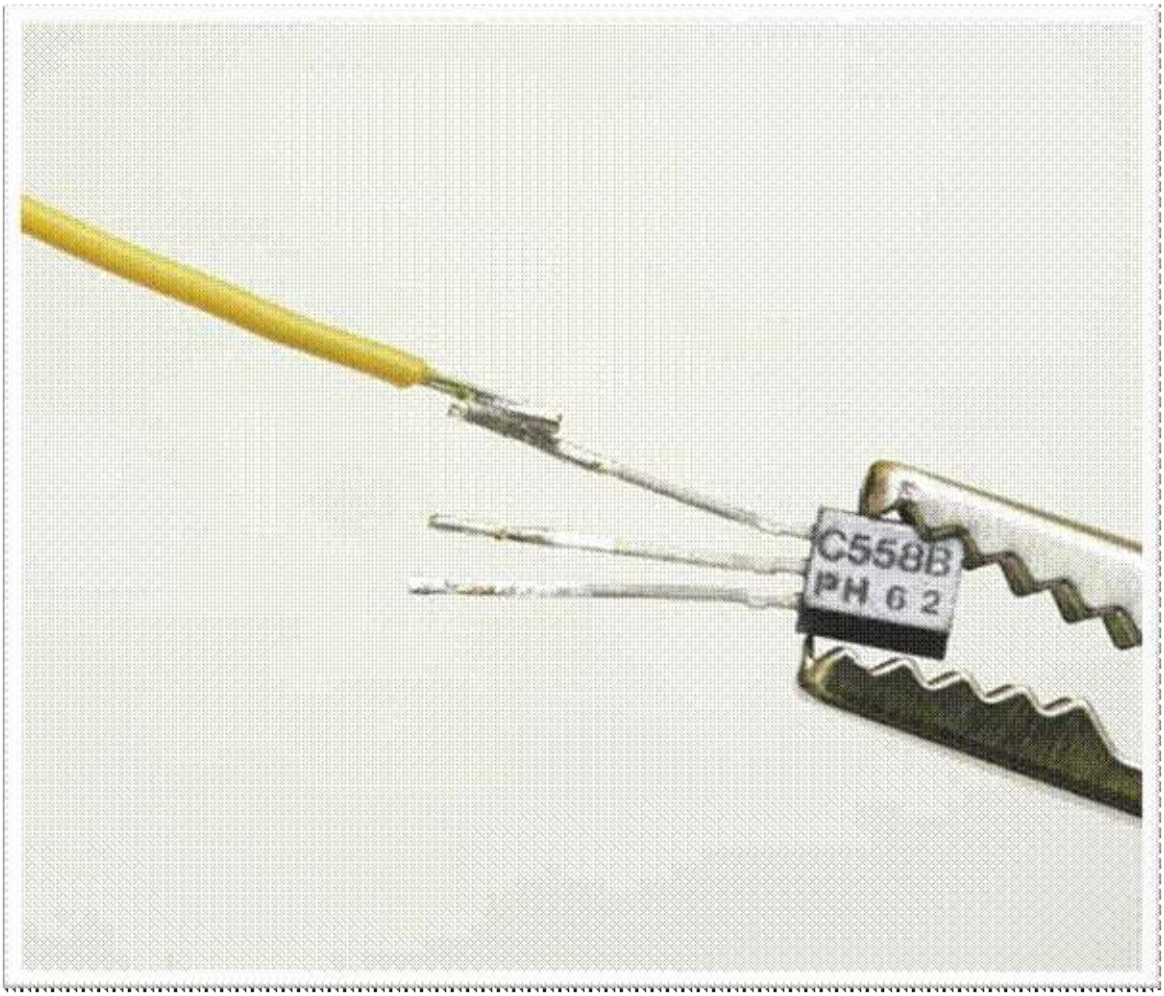

^^ *Remove the iron and let the solder cool. The wire is tacked on.*

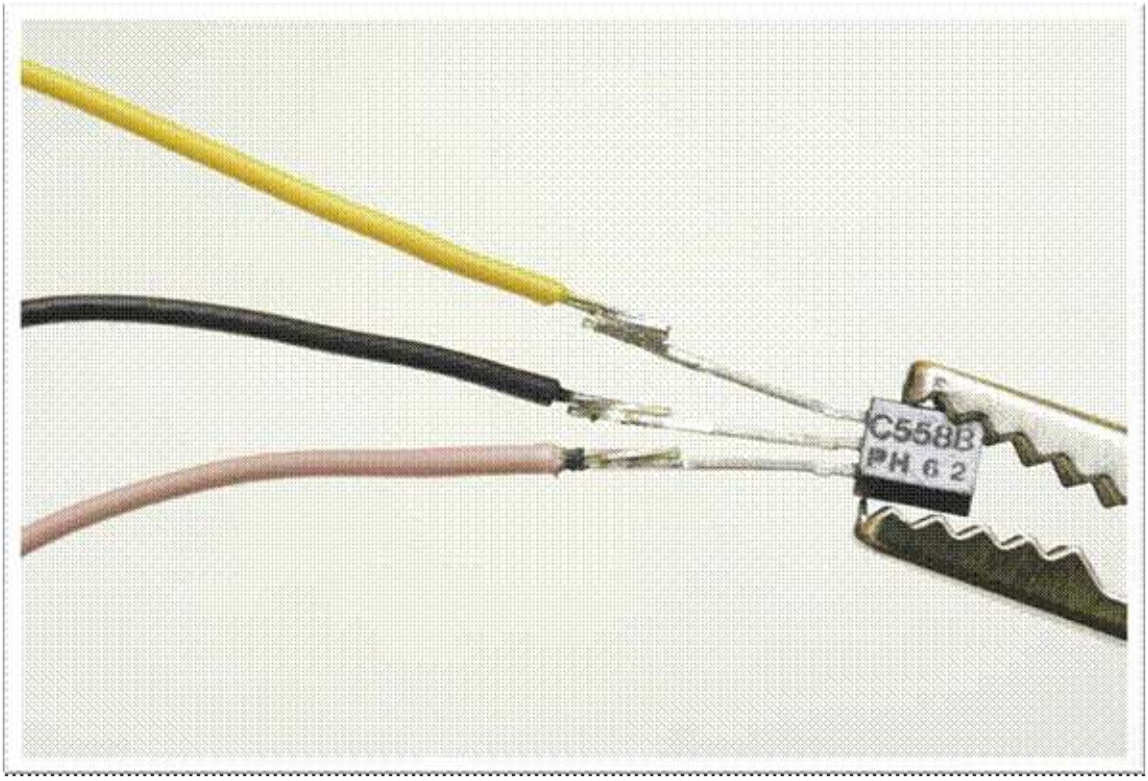

^^ *Repeat for the other leads. They just need insulating with sleeving, then job done!*

Depicted next is a typical “tag strip”, an insulated panel with metal solder tags used for making sundry connections. (Entire TVs and radios used to be hand-built with them, in

the early-mid 20th Century!) The principles of soldering are exactly the same, but more time is needed when applying the soldering iron because more metal is present, which needs more heat. You'll need more solder for bigger joints like these, so larger diameter solder makes a quicker job of it. Consider adding more flux (see earlier) to see if it helps.

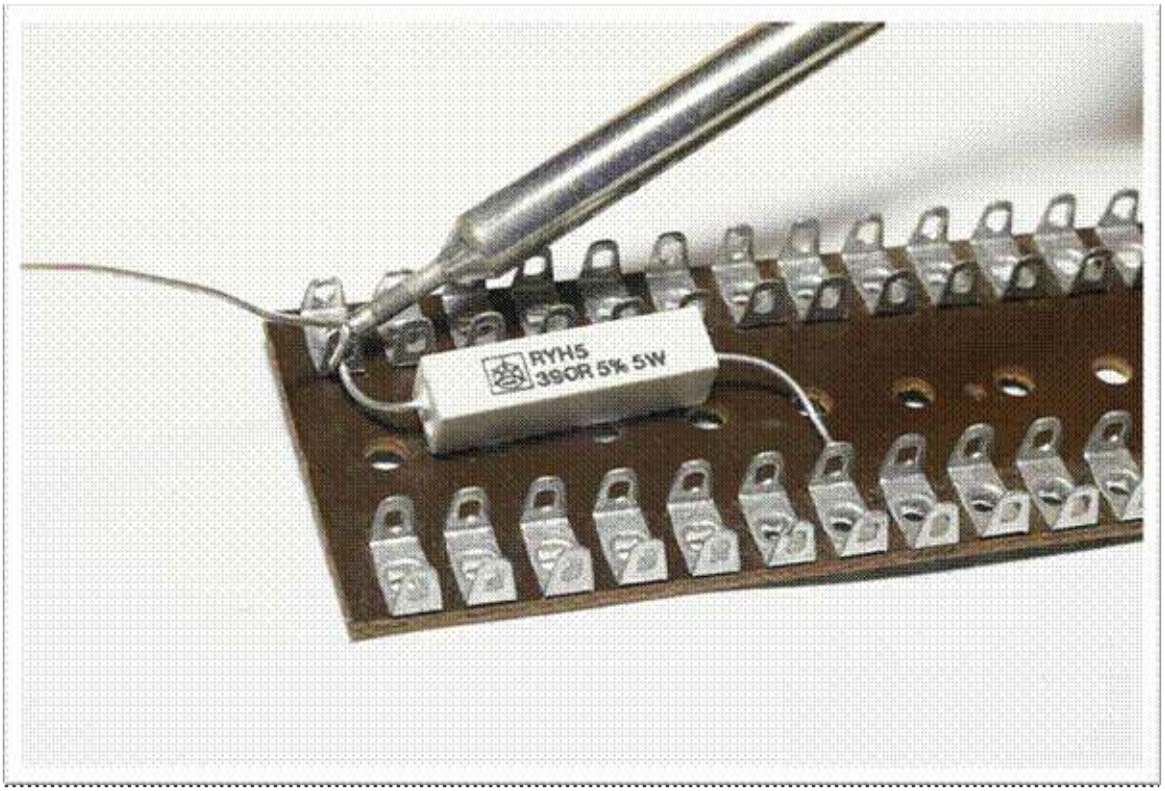

^^ *Wrap wires through the terminals and arrange everything neatly, then solder as normal.*

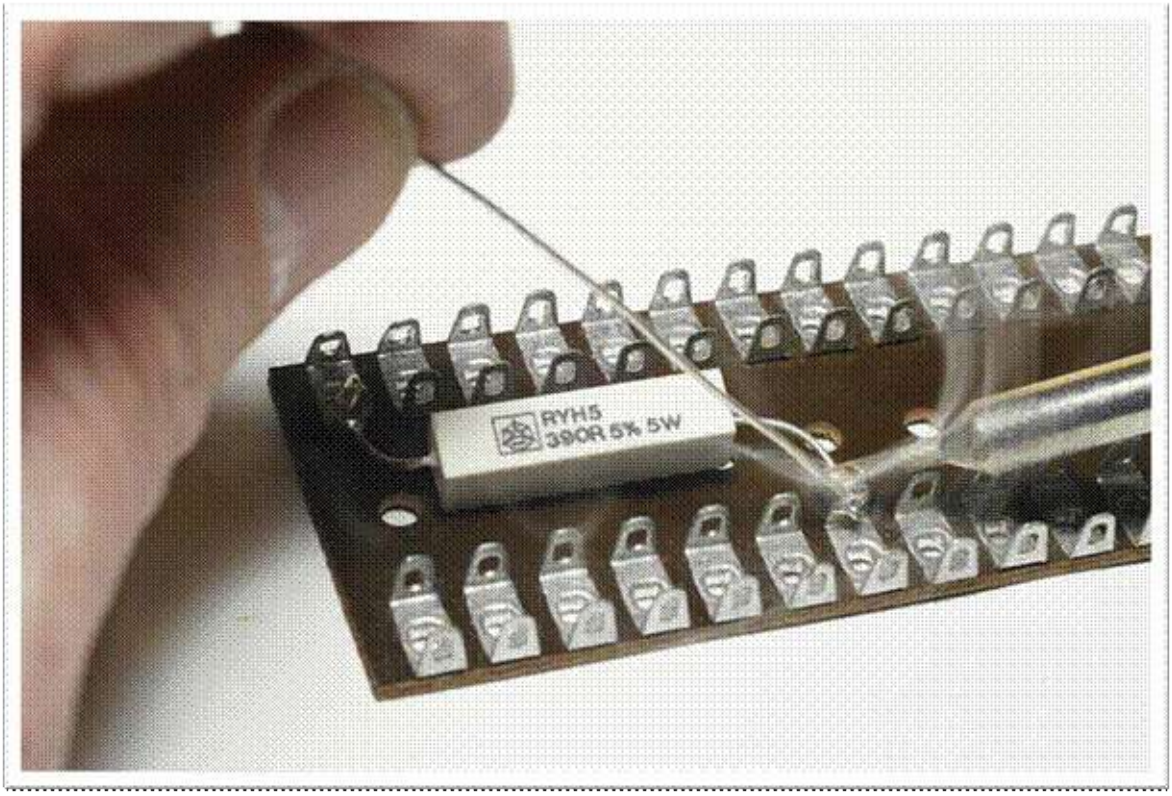

^^ *Don't be afraid to apply more heat with larger assemblies like these: they contain more metal than, say, an ordinary p.c.b so allow more time for the solder to flow over*

everything properly.

Fatigue & Breakage

Earlier I explained how multi-stranded hookup wire is flexible, which also makes it vibration proof – that's why a car's electrics are full of multi-stranded wiring, and test equipment probes use ultra-flexible multi-stranded wire for the same reason. Solid-core wire can be bent and will stay in shape (called "plate wiring") but if it's repeatedly bent or vibrated then it may eventually break somewhere due to fatigue.

The same is true of wires that have been soldered or tinned. No longer is the wire 100% multi-cored and flexible – instead it's been turned into a *single core wire* at the point where it's been soldered. This is potentially a weak spot and could eventually fracture due to fatigue, if subjected to continued vibration (e.g. in a car engine bay or in motorised equipment).

In a lot of equipment problems can be avoided by adding *strain reliefs* of some sort, to stop the wire being flexed where it's been soldered. Heatshrink tubing, or a dab of hot-melt glue, are ways of taking the pressure off the joint and ensuring soldered wires won't snap off due to vibration.

One of the reasons that higher-quality equipment and cars etc. use crimp terminals and connectors is that crimped (as opposed to soldered) connections retain all the flexibility of multi-core stranded wire from end to end, avoiding problems of wires breaking off. A *ferrule* is a very neat way of tidying wire ends and preventing stray strands of wire doing damage. Ferrules can be used to connect wires into screw terminal blocks etc. Simply clamp the terminal block down onto it and the screw will grip the ferrule.

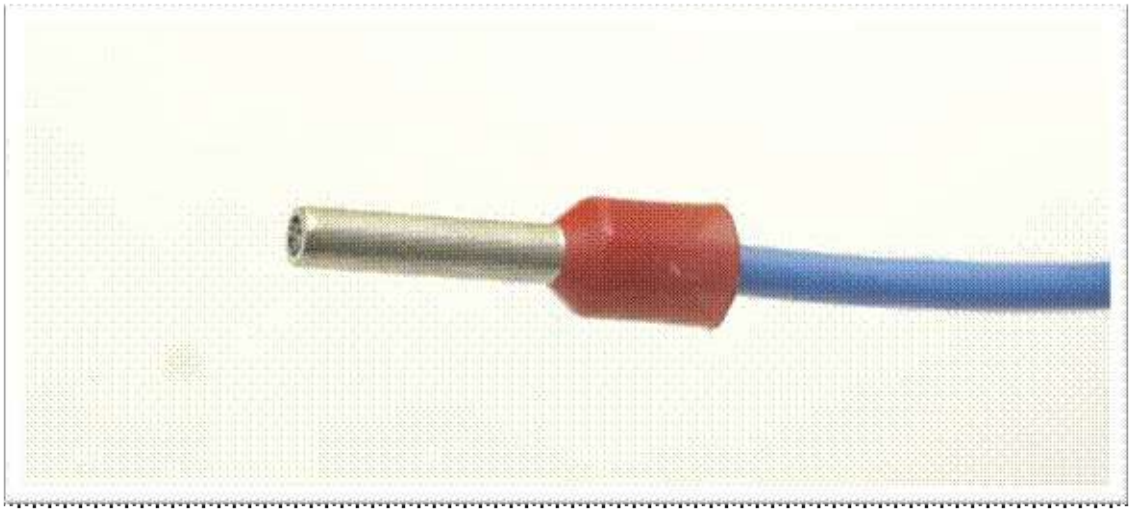

^^ *Instead of soldering them, wires can be terminated with ferrules prior to fitting to e.g. screw terminal blocks. This makes them vibration-proof and also avoids any problem of stray wires poking out.*

Faults & Desoldering techniques

By putting into practice the guidelines in my *Basic Soldering Guide* practice, there's no reason at all why you should not obtain perfect results and eliminate any potential problems. Hopefully the information gives you plenty of guidance to tackle various soldering projects with confidence. There's no substitute for getting some hands-on experience though, so I'd repeat the advice to try assembling a simple high quality electronic kit or two, such as those produced by Velleman and see how you get on. Powering up your first project successfully is a great thrill as every electronics hobbyist knows.

^^ *Popular desoldering products, a pump and various widths of desolder braid.*

Let's now look at reversing the soldering procedure – what to do if things go wrong, or maybe you have to repair a circuit by replacing a faulty component.

A solder joint which is badly made is likely to be electrically "noisy", unreliable and will probably worsen over time. Expansion and contraction of the joint due to heating and cooling can also throw up intermittent problems later down the line. The joint may look OK but underneath it may have a poor electrical connection, or could work initially and then cause the equipment to fail at a later date! These intermittent problems can be maddening to fix. TV repair technicians have an uncanny ability to go straight to a faulty solder joint because they see the same problem all the time, especially on equipment that has a "reputation".

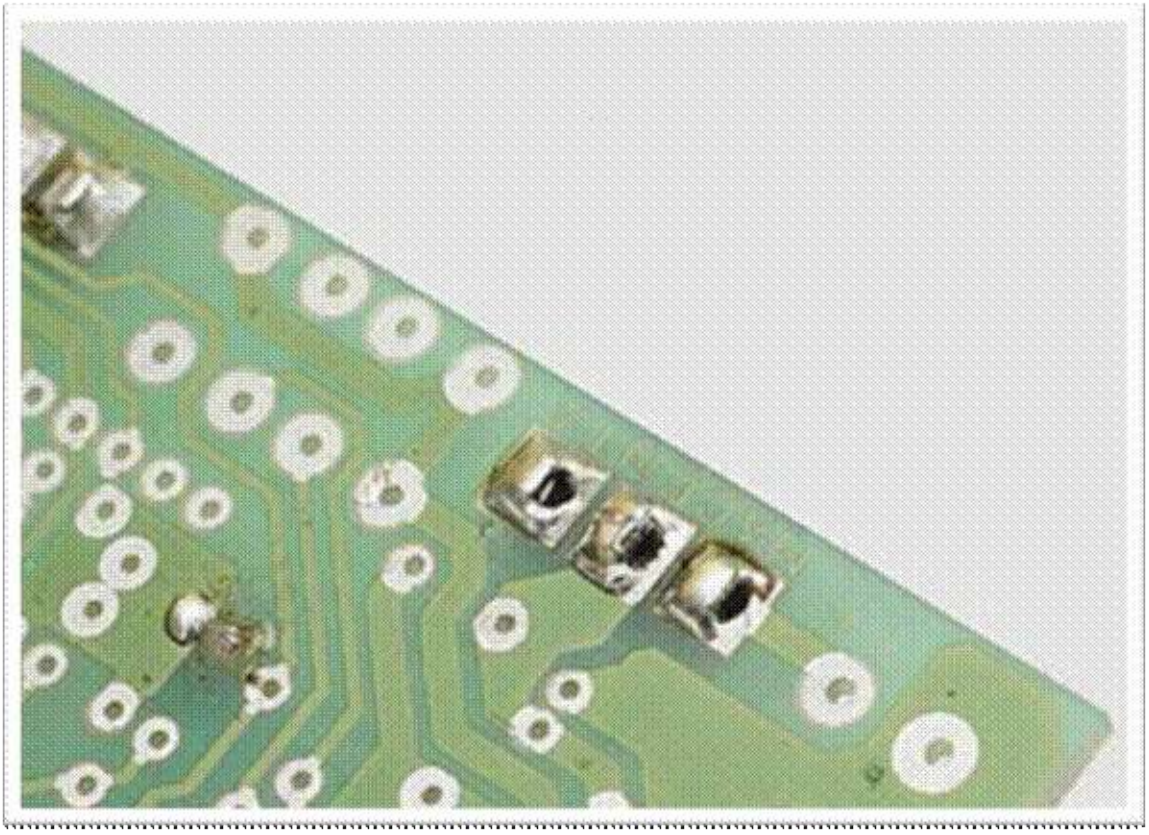

^^ *These dry or grey/ gray joints were caused by dirty parts, poor heating and inadequate solder coverage*

A solder joint that's poorly formed is called a "dry joint" or "cold joint" or a "grey/ gray" joint. Usually it results from inadequate heating, dirt or grease preventing the solder from melting onto the parts properly, and is often noticeable because the solder tends not to wet the surface properly. Instead it forms beads or globules. Alternatively, if it seems to take a very long time for the solder to wet the joint, that's another sign of contamination and that the joint may be a dry one, or the material is incompatible anyway. A matt, crystalline appearance instead of a shiny joint points to inadequate heating: the solder cooled down far too quickly and didn't flow properly.

Whether you want to replace a faulty component or fix a dry or poor-quality solder joint, it's usually necessary to remove the troublesome solder and then re-solder it afresh. Naturally, there are tools and techniques that make the job easy. It's very bad practice to simply re-melt the joint and then lash out with the board, whiplash style, hoping that the molten solder will be flicked off the board.

The usual way of removing solder from a joint is to use a *desoldering pump*. These work like a small spring-loaded bicycle pump, only in reverse! A plunger is pressed down until it locks into position. It's released by pressing a button which sucks air back through a pointed nozzle, carrying any molten solder with it. It may take one or two attempts to clean up a joint this way, but a small desoldering pump is an invaluable tool especially for p.c.b. work and they are widely available now.

^^ *A hobby desoldering pump primed for use*

Desoldering pumps often have a heatproof P.T.F.E. nozzle which may need replacing occasionally. Each time the button is pressed, a plunger clears the nozzle but sometimes solder particles and swarf will be ejected in the process; when you prime the pump, point the nozzle into a small pot or old aerosol top to catch any debris. Remove the spout and clean out the pump from time to time.

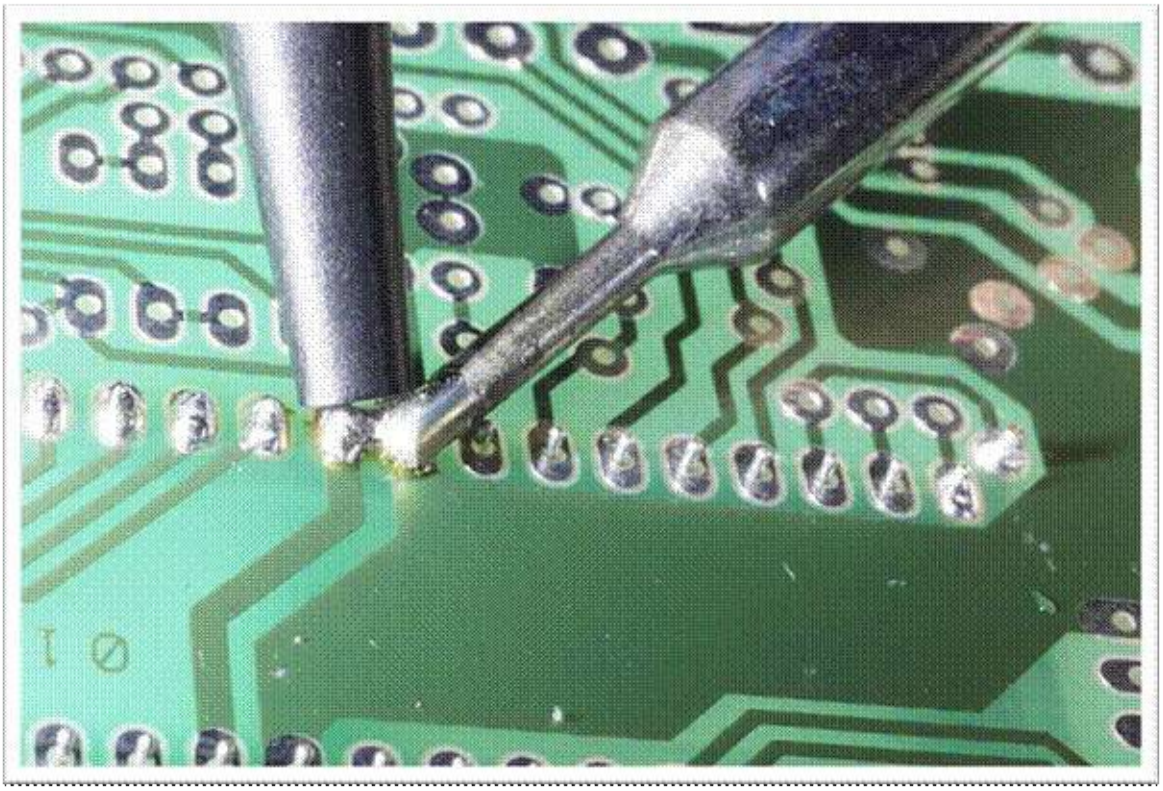

^^ *Suck up molten solder using a desoldering pump*

With very stubborn joints where the last traces of molten solder just can’t be shifted,

it sometimes helps to actually *add* more solder and then desolder the whole lot again with a pump.

Desolder Braid

An alternative to a pump is to use *desoldering braid* which arrives in small dispenser reels. It's a flux-impregnated fine copper braid which is applied to the molten joint, and the solder is then drawn up into the wick by capillary action. It's remarkably effective and for certain tasks, it can be more thorough than a pump. I recommend that a small reel is bought (start with 1.5mm width) for the toolbox, to tackle larger or difficult joints which would take several attempts with a pump.

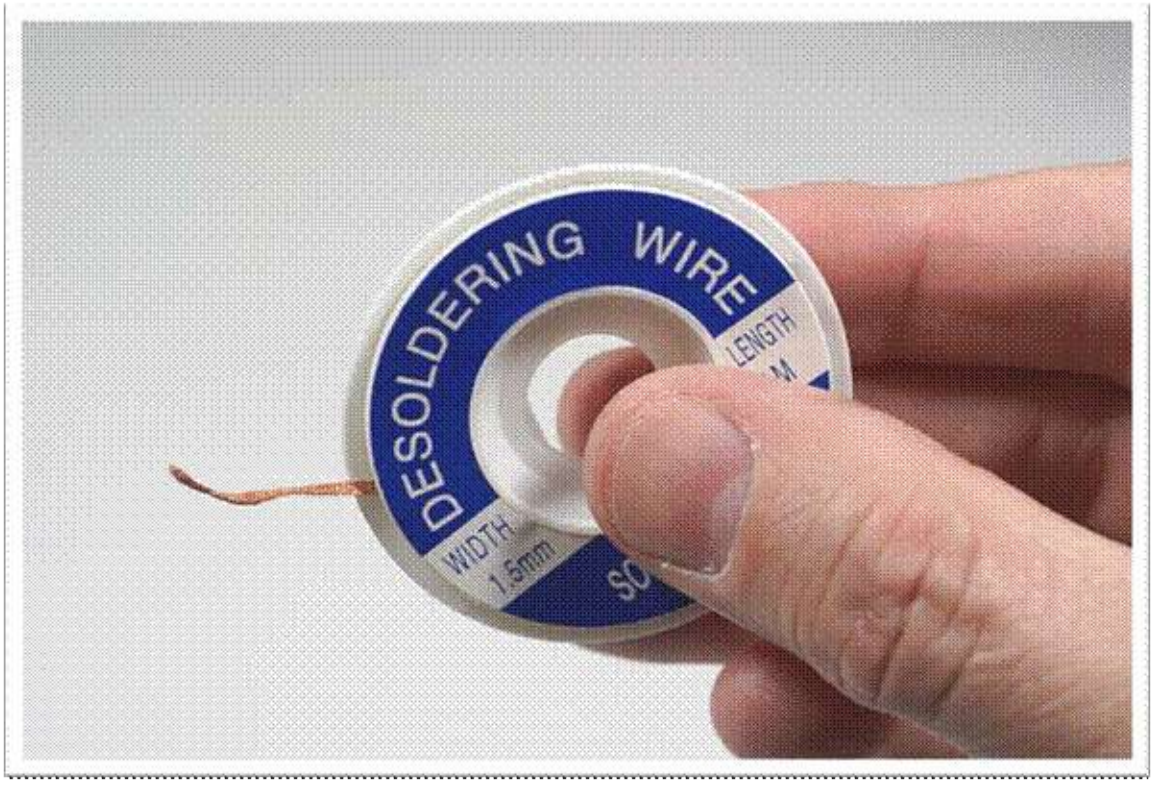

^^ *Desolder braid is also handy and can sometimes be more effective than a desolder pump. It comes in various widths to suit the scale of work being tackled.*

To use desolder braid, press the end of the braid down onto the joint using the tip of an iron, and let the solder melt underneath: the braid will then absorb the solder. The braid becomes hot so beware of burns. Once the solder's solidified on the braid, cut it off and discard.

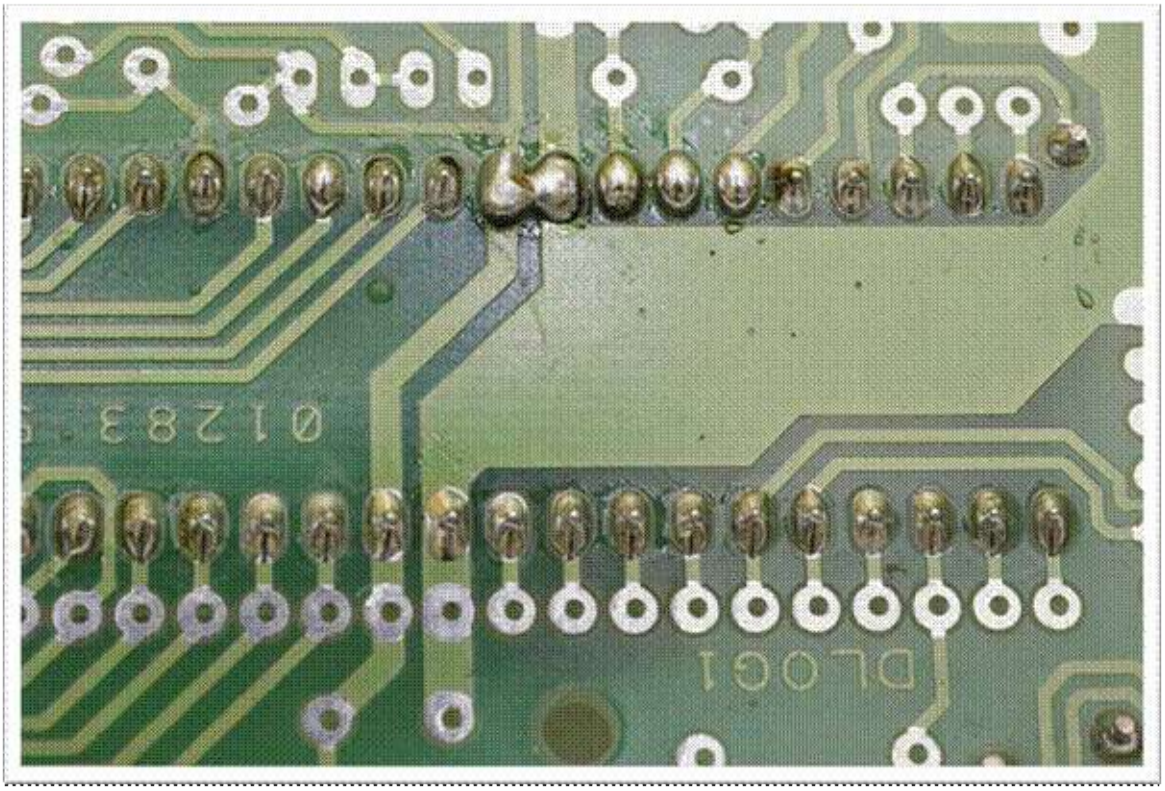

^^ Desolder braid can also be used to remove excess solder, e.g. two i.c. pins shorted together.

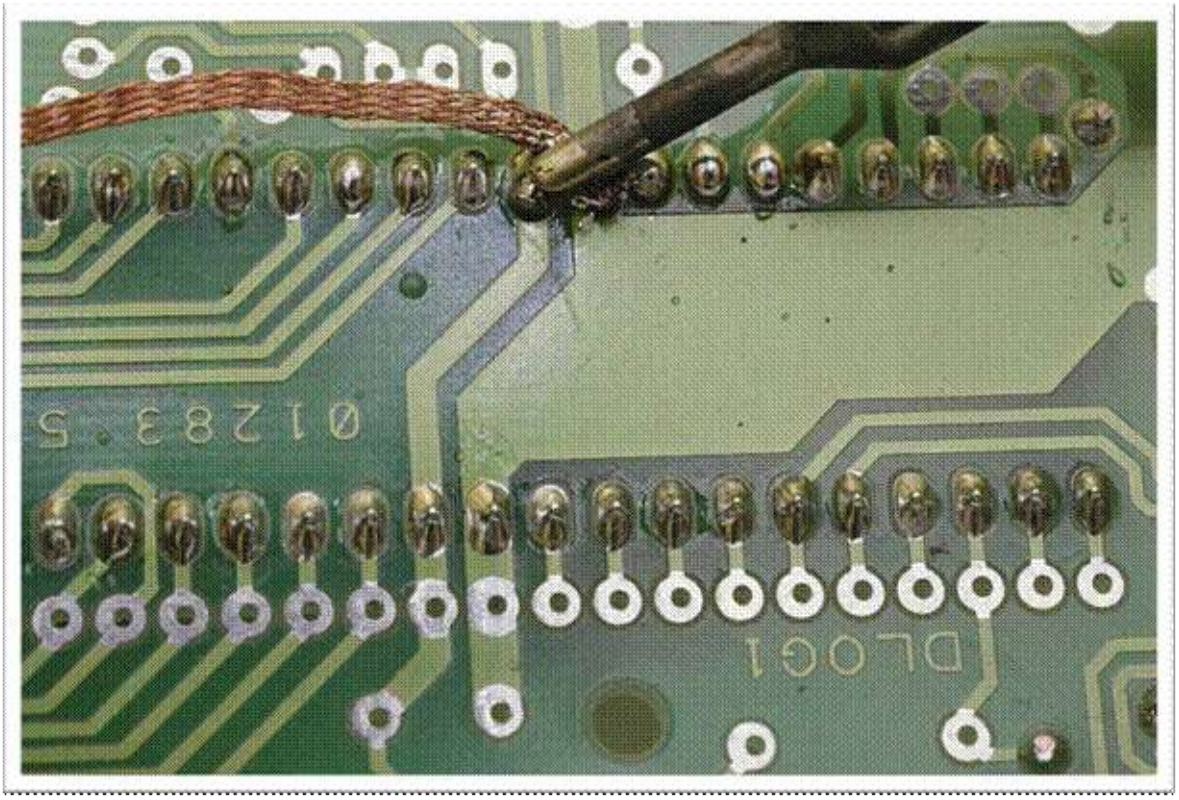

^^ Press some desolder braid over the joint, then melt it with an iron to draw molten solder up the braid.

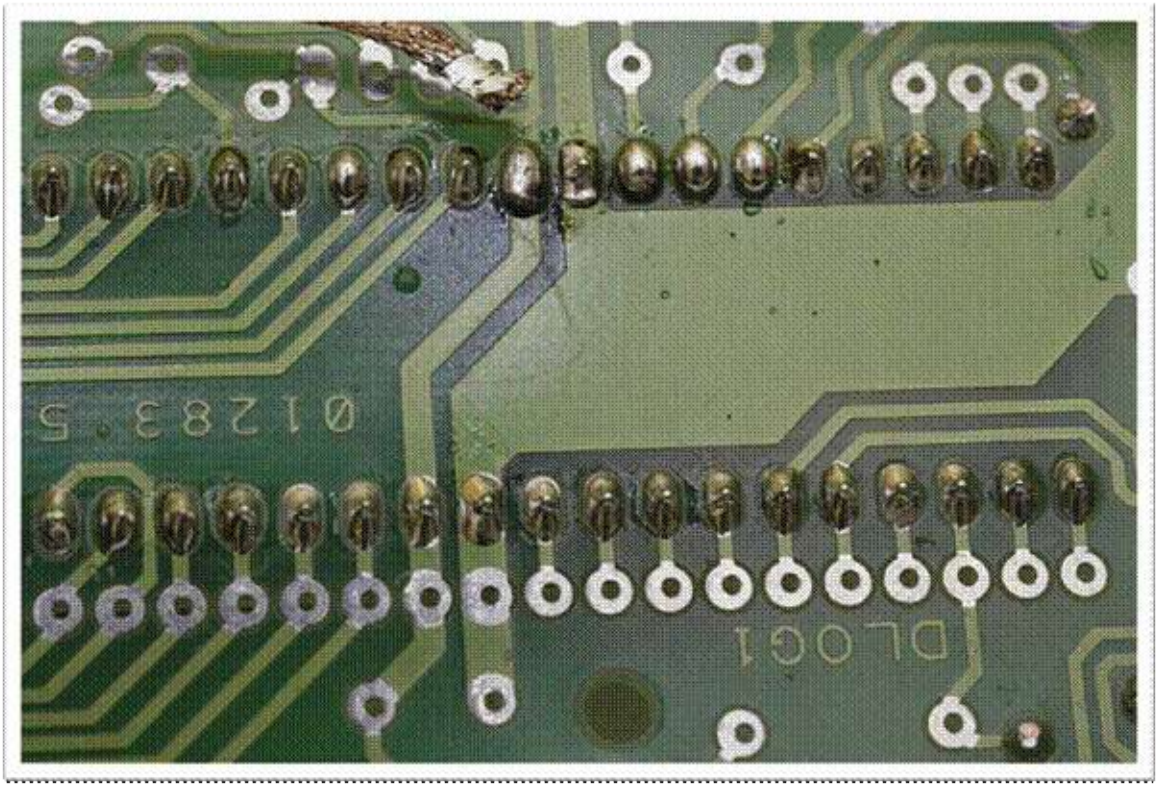

^^ *Remove the braid immediately and don't drag "whiskers" of molten solder around. The excess solder is absorbed by the braid, which is snipped off ready for the next job.*

Be aware that you can damage a printed circuit board accidentally when removing the desolder braid if it's not removed *quickly enough*. The solder will soon solidify, which effectively solders the braid to the printed circuit board! A careless tug may yank copper tracks or pads away from the board, stuck to the braid. You can also drag solder "whiskers" onto neighbouring pads unless the braid is removed cleanly. Why not practice using desolder braid with an old circuit board?

Whichever desoldering method you use, care is needed to ensure that the boards and parts are not damaged by excessive heat. It's not that difficult to apply so much heat when desoldering that the adhesive holding the copper foil tracks on the p.c.b. eventually fails, causing the copper track to lift away – everyone's worst nightmare.

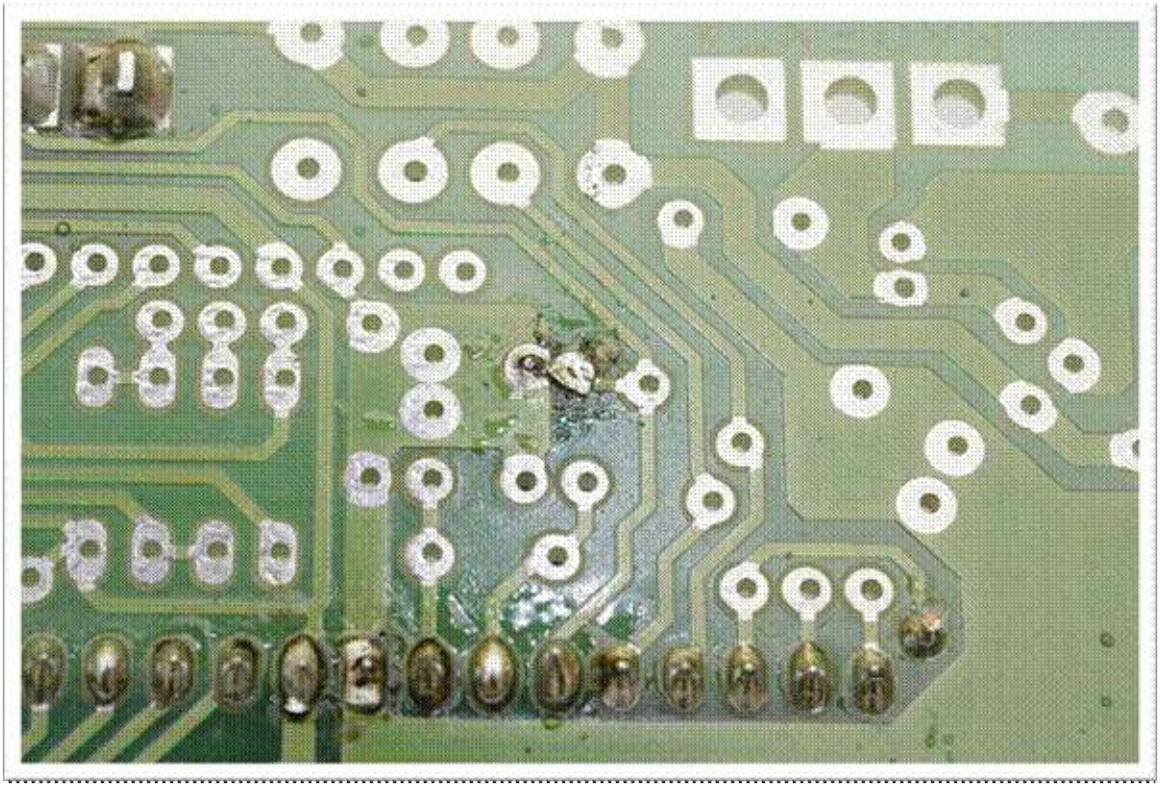

^^ *Typical copper track damage (centre) caused by overheating during soldering or desoldering. The track has lifted off, but you can try repairing it by adding extra wiring or SuperGlue it if the track isn't broken.*

If this should ever happen, remove the iron immediately and permit the area to cool (a freezer aerosol is valuable at such times). If you're lucky, you can maybe repair the lifted track using a droplet or two of Super Glue, or add "jumper wires" to bypass the damage.

^^ *A Freezer aerosol can give rapid cooling where excess heat has been applied*

during soldering. Also used in circuit faultfinding to identify overheating parts.

You now know everything you need to know about making the ideal solder joint, and desoldering it in case you need to make a repair. Just to remind you, a Quick Summary guide follows.

Quick Summary Guide

To round off the Basic Soldering Guide, let's summarise how to make the perfect solder joint.

- Ensure materials to be soldered are compatible with tin/ lead or lead-free solder.
- All parts must be clean and free from dirt and contaminants.
- Try to secure the workpiece firmly during soldering.
- Brand new soldering iron tips must be flooded with solder immediately, the first time they are used.
- Wipe the tip of the hot soldering iron on a damp cellulose sponge at frequent intervals. Then "tin" the iron tip by applying a small amount of solder.
- Aim to heat all parts of the joint with the iron for under a second or so, to bring them up to the same temperature.
- Continue heating and apply sufficient rosin-core tin/ lead or lead-free solder to form a complete joint.
- It only takes a second at most, to solder the average p.c.b. joint. It should be smooth and shiny, and through-hole joints should be slightly convex in shape.
- Remove the iron and return it safely to its stand.
- Do not move parts until the solder has cooled.
- Tin the soldering iron tip and clean it well, when switching it off, ready for next time.
- Consider using e.g. electronics flux dispenser pens or Colophony (rosin) to help with difficult joints.

Sometimes solder joints don't go quite to plan, and sooner or later everyone is faced with the need to problem-solve or troubleshoot, so a simple Troubleshooting Guide follows next.

Troubleshooting Guide

This troubleshooting guide may help fix common problems encountered with troublesome solder joints.

SYMPTOMS	LIKELY CAUSES	REMEDY
Solder won't "take" (wet) and won't flow properly over the joint — molten solder forms beads or "ball bearings" instead of flowing properly.	Grease or contaminants present; Material may not be suitable for soldering with standard lead/tin or lead-free solder, e.g chromium.	Treat contaminated parts with abrasive cleaners etc. as required to expose base metal. Some metals can't be soldered with electronics-grade solder.
Solder doesn't melt or flow very well — the joint is crystalline or grainy-looking - a grey or dry joint.	Joint has been moved before being allowed to cool naturally, or: Joint was not heated adequately. Too large a joint – too much metal present – and/ or the soldering iron temperature or power rating are too low.	Desolder and remake. Apply heat for a longer period, or use a higher power soldering iron, or check the temperature setting and raise it if possible.
Solder joint forms a "spike" and applying the iron again makes it even worse!	Probably overheated, burning away the flux. The iron, when removed, would cause the solder to stand up in a spike.	It is usually best to desolder and remake the joint freshly again.
The copper foil of my p.c.b. has lifted off the circuit board!	Excessive use of heat has damaged the adhesive. Provided the track hasn't broken, it may be repairable.	You can sometimes repair it with Super Glue, or re-wire the board with jumper wires.
Brown varnish-like deposits are left behind after I finish soldering.	These are the remains of rosin flux and are nothing to worry about.	It can be removed with PCB cleaners or some solvents, if you want to tidy up the board and inspect your work.

Possible Hazards and simple First Aid

It's extremely rare that soldering iron operators receive any burns or other injuries from the use of hot soldering irons. Soldering is perfectly safe provided that common sense precautions are taken during the soldering operation. Here are some of them:

- Components are very hot after soldering, so let them cool before handling them to avoid skin burns.
- Beware of splashes of molten solder caused by careless handling of a hot soldering iron.
- Beware of energised components (capacitors, batteries etc.) being shorted by molten solder and ejecting solder splashes due to arcing.
- Always park a hot iron safely on a stand in between use — never hang it vertically next to the bench.
- Keep a hot soldering iron away from its mains cable (silicone cables reduce the risk of accidental damage).
- Beware of wire offcuts flying off (danger to eyesight) when snipping wires to length before or after soldering.
- Avoid inhalation of solder and flux fumes as this can irritate the respiratory tracts, especially in sensitive cases (e.g. asthma).

Should you receive a more serious skin burn which requires attention, then:

- **Cool the affected area immediately.** Use plenty of cooler running water – but avoid ice cubes etc. as they can cause nerve damage after a time or inhibit the flow of blood to the affected area.
- Remove any **objects** which may be constrictive, before any swelling starts (rings, watches, bracelets).
- Do not prick blisters nor apply ointments, salves or lotions at this stage.
- Local pain relief for small burns can be obtained by spraying *Burneze* aerosol onto unbroken skin.
- Seek medical attention for more serious burns.

Eyesight problems are exceptionally rare, e.g. pieces of wire offcuts or solder splashes lodging in the eye area, and should be treated by a qualified first-aider or A&E. The best you can do is bathe the affected area with e.g. a first-aid eyewash bottle or fresh water. Then seek professional medical help straight away.

Useful resources

Details of the Antex range of soldering equipment, solder tips and spare parts can be obtained from www.antex.co.uk. UK and international distributors are also listed on the Antex (Electronics) web site.

If you're interested in hobby electronics then why not try **EPE Magazine**, the No. 1 UK magazine for hobby electronics enthusiasts, students, trainees and technicians around the world. You can buy a printed edition from newsstands, download a PDF version (for Windows) or try a tablet/ smartphone version from Pocketmags. More details at www.epemag.com

You can learn more about the writer at his website http://www.alanwinstanley.com/

Some mail order suppliers of soldering equipment and electronic parts include:

- ESR Electronic Components Ltd. (soldering equipment, Velleman kits)
- Bowood Electronics (Antex irons and spares, electronic parts)
- Rapid Electronics (components, tools, equipment)
- Cricklewood Electronics (CCTV, Antex soldering irons and spares, components)
- Maplin Electronics (UK electronics retailer and mail order)
- Farnell Electronic Components (major UK industrial supplier)
- RS (UK electronics industrial supplier)
- Brewsters Ltd (soldering equipment mail order specialists)
- Velleman UK (electronic kits)
- Quasar Electronics (Velleman kit mail order retailers)
- Kemo Kits (Germany, trade only)
- Hobbytronics (UK hobby mail order supplier)
- Multicore Solders (now a Henkel brand)

These links were correct at the time of going to press, July 2013.

Acknowledgements

Antex (Electronics) UK generously provided samples of their ever popular British-made soldering equipment, materials and accessories for use in the Basic Soldering Guide. When starting out as a 1970's teenage schoolboy electronics hobbyist, I and my trusty Antex soldering iron shared many adventures in electronics together, and it has been a pleasure to use the latest Antex soldering irons throughout this guide.

Also I would like to thank Brian Brooks of Magenta Electronics Ltd. (www.magenta2000.co.uk) for supplying me with a variety of their professionally-designed printed circuit boards and a range of components which were the subjects used in the photographs.

Photography

All photographs were taken by the author using Sony Alpha DSLRs and 50mm macro lens with extension tubes, and a Sony macro flash. High-resolution versions of these and more technical photos are available for commercial or educational royalty-free use. Please contact me with any enquiries.

Conclusion

I really hope the Basic Soldering Guide will give you the confidence to try your hand at electronic soldering. It's really a lot easier than it sounds, and armed with the guide's advice and photographs, the next thing to do is invest in a decent-quality soldering iron such as the excellent range manufactured by Antex that will serve you well for years to come.

Soldering an electronics kit together such as the professional designs produced by Velleman is a great way of testing out your new skills. Start with a small, simple kit costing a few pounds to gain confidence and experience, and avoid the temptation to tackle something too complex until you're ready to extend yourself further.

Feedback is welcomed by email to alan@epemag.demon.co.uk

You can learn more about me at www.alanwinstanley.com or read my column in EPE Magazine.

Good luck with your soldering!

Alan Winstanley

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Play fair and support writers who share their skills and expertise

Preparing a resource like this takes months and is based on four decades of practical experience which I gladly share with readers. It costs a small fortune in time, experience, IT and photographic equipment to put an ebook like this together, and the Royalties that you pay to buy the book puts food directly on my table. You paid for your copy (thank you!) so if you see any unauthorised versions of my work anywhere in circulation, I'd really appreciate being told about it. Thank you! A.R.W.

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Learn to Solder

Tools and Techniques for Assembling Electronics

Brian Jepson,
Tyler Moskowite
& Gregory Hayes

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Project Book

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- **Use the best methods for soldering components in place**
- **Experience the perfect solder joint**
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Learn to Solder

Brian Jepson, Tyler Moskowite, and Gregory Hayes

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by Brian Jepson, Tyler Moskowite, and Gregory Hayes

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Welcome

Welcome to MAKE's Getting Started with Soldering Kit, and congratulations on taking a big step into the world of DIY electronics. Once you get the hang of soldering, you can put together some of the many great kits that are available, fix electronics that are broken, and build inventions of your own. With this kit, you'll learn how to:

- Prepare and clean your soldering iron
- Assemble electronic circuits from kits
- Transfer circuit designs from a solderless breadboard to a prototyping PCB
- Correct soldering mistakes you've made

Basic Tools

There's a lot of great stuff in the box, and before you start using it, here's a tour of what you'll find in there. Figure 0-1 shows the soldering tools you'll be using most of the time.

Figure 0-1. *Basic soldering tools*

Deluxe soldering iron
(Top left) This soldering station includes a variable temperature controller, a cleaning sponge, soldering iron, and a ringed holder.

Crosscut pliers
(Left) You'll use these to trim away excess leads after you solder components in place.

Solder tube
(Bottom) This is enough solder to get you started and keep you busy over many projects.

Helping hands
(Right) For those times when you need a third or fourth hand, the helping hands let you hold items steady while you solder.

Advanced Tools

Most of the time, you'll only need the basic tools to get things done. But when you need to replace your soldering iron tip, correct a mistake you made while soldering, or need a tool to help keep components from overheating, you'll need the items shown in Figure 0-2.

Figure 0-2. *Advanced soldering tools*

Heat sink
: (Left) Clip this to sensitive components to help dissipate heat.

Desoldering wick
: (Bottom left) Use this to wick away excess molten solder.

Desolder pump
: (Center left) This pump will suck up molten solder when you have a lot of solder to remove.

Soldering tools
: (Center right) The scrapers, brush, and slotted probe come in handy when you need to move solder around or precisely position a component.

Replacement tips
: (Right) Tips don't last forever. When you've worn out your tip, use one of these as a replacement.

Project 1: Learn to Solder Skill Badge

Our Learn to Solder Skill Badge Kit (the 2011 model is shown in Figure 0-3) has been used to teach thousands of people of all ages how to solder at Maker Faires across the country. It's a simple, fun way to learn how to solder and also how to teach others to solder. After you build the one included in the box, you can order more from *makershed.com* and teach others how to solder.

Figure 0-3. *Learn to Solder Skill Badge, 2011 model*

Blinking or Color Change LED

(Top left) This is an LED (Light-Emitting Diode) with a twist. Normal LEDs give off a single color, and keep shining as long as you give them power. Also, normal LEDs require a specific voltage to operate: don't give it enough power, it won't light at all; give it even a little too much, and you could burn it out.

This LED is different in both respects: it has three elements (red, green, and blue) that are under the control of a small integrated circuit (IC) embedded within the LED. The IC causes the elements to change color in a repeating pattern. Because the IC controls the voltage that it delivers to the individual color elements, it's more tolerant of variations in the voltage you give it. For example, even though red LED color elements typically operate at around 2 volts, you're able to use a 3 volt battery with the pin.

The 2012 model uses two self-blinking LEDs instead of one self-color changing RGB LED.

CR1220 battery

(Lower left) This "coin cell" battery supplies power to the pin.

Printed Circuit Board (PCB)

(Center) The 2011 Learn to Solder Skill Badge features a friendly robot. The 2012 model will also have a robot, every bit as friendly.

Pin and clutch

(Top right) This is what holds the pin to your clothing.

Battery holder

This keeps the battery on the PCB.

Project 2: 555 Timer Blinky

The 555 timer blinky is a simple circuit that makes two LEDs flash in an alternating pattern. When one is on, the other is off. Figure 0-4 shows the components for this project, and Figure 0-5 shows the finished project. This is a slightly more challenging project than the skill badge.

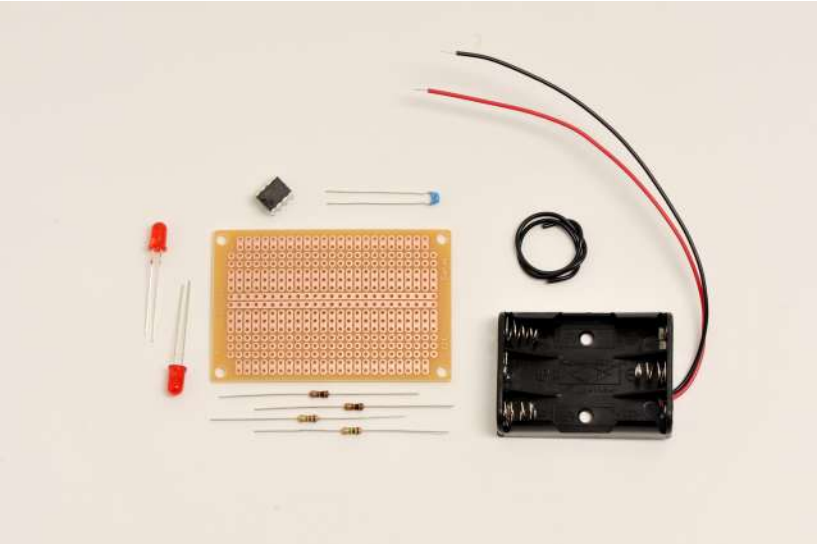

Figure 0-4. *555 blinky parts*

LEDs
: (Left) Unlike the LEDs used in the skill badge, these are your normal, run of the mill LEDs.

Protoboard
: (Center) Look back at the skill badge PCB. Notice how it was custom designed for a single purpose. Now look at this protoboard PCB: it's got a lot of different holes in convenient locations. You can build many kinds of simple electronics projects on a board like this.

555 Timer
: (Top left) The 555 timer is a special type of integrated circuit that can turn electrical current on and off in a repeating pattern. It's just what you need to blink an LED.

Capacitor
: (Top right) To customize the 555 timer, you need to connect certain components to it. The value (capacitance or resistance) of the component determines how quickly the 555 turns things on and off.

Hookup/Jumper Wire

(Top right) You'll need this to connect one thing to another.

Resistors

(Bottom) Resistors serve two purposes here: two are used to make sure the LEDs don't get too much current; the other two work with the capacitor to control the behavior of the 555 timer.

Battery Box

(Right) This holds 3 AAA batteries.

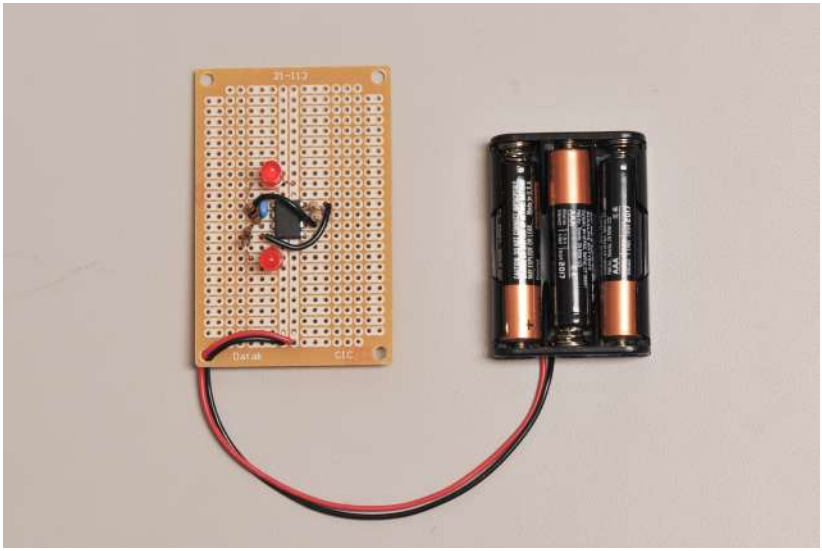

Figure 0-5. *Finished 555 blinky*

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1/Getting the Workspace Ready

Before you can start soldering, you need to get your iron ready. This involves a few steps. First, you'll have to attach the tip to the soldering iron. Then, you'll need to prepare the station: make sure your sponge is moistened, set the temperature, and "tin" the tip by applying some solder to it.

At the end of this chapter, your soldering iron will be assembled, clean, and hot enough to begin soldering.

Solder contains harmful chemicals. Wash your hands after soldering as well as after handling solder or the solder station sponge. Though it may be tempting to snack while you're working, keep any food or drink away from your soldering area.

1: Attach the Tip

Locate the soldering iron (make sure it's unplugged and cool), a soldering iron tip, and the tip nut that holds the tip in place. Insert the tip into the soldering iron as shown in Figure 1-1, and push it in as far as it will go. It will not require much force to insert it.

WARNING: Make sure the soldering iron is unplugged and cool.

Figure 1-1. *Inserting the tip into the tube*

2: Secure the Tip

Slide the tip nut over the tip, and screw it in place. You can use pliers to tighten it (see Figure 1-2). Be careful not to overtighten it, since you will eventually need to replace it when the tip gets worn from all the projects you'll be making with it.

Figure 1-2. *Making sure the tip stays put*

WARNING: Over time, the tip nut might become loose. Let the iron cool down before you tighten it.

3: Wet the Soldering Station Sponge

You'll need to perform this step (and the remaining ones in this chapter) at the beginning of each soldering session.

As you use the soldering iron, you're going to be wiping the tip a lot, so you need to keep the solder station sponge moist. Pour a little clean, fresh water on the sponge as shown in Figure 1-3. Don't soak it, but make sure it's completely moistened.

NOTE: If your water has a high mineral content, use distilled water for wetting the sponge.

Figure 1-3. *Wetting the sponge*

4: Set the Station's Temperature

Plug your soldering iron in, and set the heat setting to the mark shown in Figure 1-4 (pointing at the 3 o'clock position on the dial). Give the iron a couple minutes to warm up.

Figure 1-4. *Setting the temperature*

WARNING: The iron will get very hot, and certainly hot enough to burn you. Don't touch the tip and don't touch the tip to anything other than solder or components you are soldering together.

5: Wipe the Iron's Tip

Wipe the tip on the sponge as shown in Figure 1-5, being sure to turn the iron a few times as you wipe it, so you wipe all of its surfaces. It will make a sizzling sound as the water in the sponge comes into contact with the tip. The figure shows a sponge that's been used a few times. Notice the little blobs of solder that have come off the tip over time. A clean tip is critical to successful soldering. Even a small layer of oxidized material or other crud will limit the amount of heat that's transferred to the component you're soldering. Wipe the tip often, and keep the tip clean.

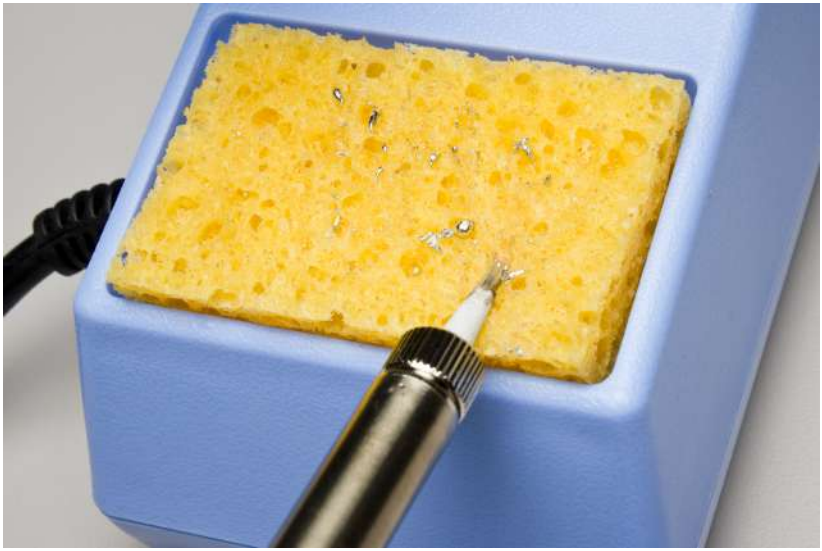

Figure 1-5. *Wiping the tip clean*

6: Tin the Iron's Tip

Before you begin soldering components, you should put a thin layer of solder on the tip as shown in Figure 1-6. This will have two effects: burning off any crud that shouldn't be there, but also providing a thin layer of liquid solder. This layer makes for a very effective heat transfer between the soldering iron and whatever you're soldering. Give the tip one more quick wipe on the iron and place the soldering iron into the holder until you need it.

Figure 1-6. *Tinning the soldering iron tip*

NOTE: A small puff of smoke will appear as the *rosin flux* in the center of the solder is activated. The rosin serves two purposes: to clean the soldering iron (and the joint that you are soldering) and to help the solder flow freely. Avoid inhaling this smoke.

Go Make Your Learn to Solder Skill Badge

With your workstation all set up, you're ready to try your hand at soldering. The Learn to Solder Skill Badge ("Project 1: Learn to Solder Skill Badge" on page viii) is a great place to start. It's so simple, we think you can even try it before you read any more. But before you try the second project ("Project 2: 555 Timer Blinky" on page x), you should definitely give the rest of this guide a read.

2/How to Solder

With your soldering iron prepped, you're ready to begin soldering. This chapter has many helpful tips and techniques for soldering effectively, safely, and neatly.

Working with Solder

Solder is made of metal with a core that contains flux, which cleans the connection as you solder. When the metal melts, the flux begins to flow onto the joint. Some solder lead-based, but the solder in this kit is lead-free. To melt solder, heat it with the soldering iron as shown in Figure 2-1.

Figure 2-1. *Melting some solder*

Try melting some solder, but be careful not to drip it on yourself or anything other than a work surface. You can try pushing tiny balls of solder around on your work surface to see how it flows. If you have some bare hookup wire or similar metal, try heating it up by holding the soldering iron to it (don't hold the wire while you're heating it). Touch a piece of solder to the wire, but

choose a point that's an inch or so from where the soldering iron is touching. How close do you have to get to the soldering iron tip before it melts?

Keeping the Circuit Board from Moving

When you're soldering, you've got a lot to juggle: the soldering iron, the solder, and the two things you are connecting to each other. The helping hands let you place the items you're soldering in a stable position. Use the clips to hold the item in place as shown in Figure 2-2. But once you start inserting items into the board, you need some way to keep them from moving. "Placing a Component in the Board" on page 11 shows you how to do that.

Figure 2-2. *Holding a PCB in the helping hands*

Tinning Solder Pads

You'll sometimes come across things that need a layer of solder to work right. For example, on the Learn to Solder Skill Badge, you need to put a bump of solder in place to give the battery a snug fit. With solder pads that are this big, you need to heat the pad with the iron really well; the pad is so large that it's going to take longer to heat. It's best if you melt the solder by pushing it onto the pad rather than pushing it directly against the iron. This makes sure that the solder flows thoroughly over the pad. If the solder doesn't melt, try tinning the tip again first.

Start with a little blob as shown in Figure 2-3, and spread it around evenly. When you've got the desired thickness, first pull the solder away, then pull the soldering iron away. Doing it in this order will avoid leaving chunks of solder behind.

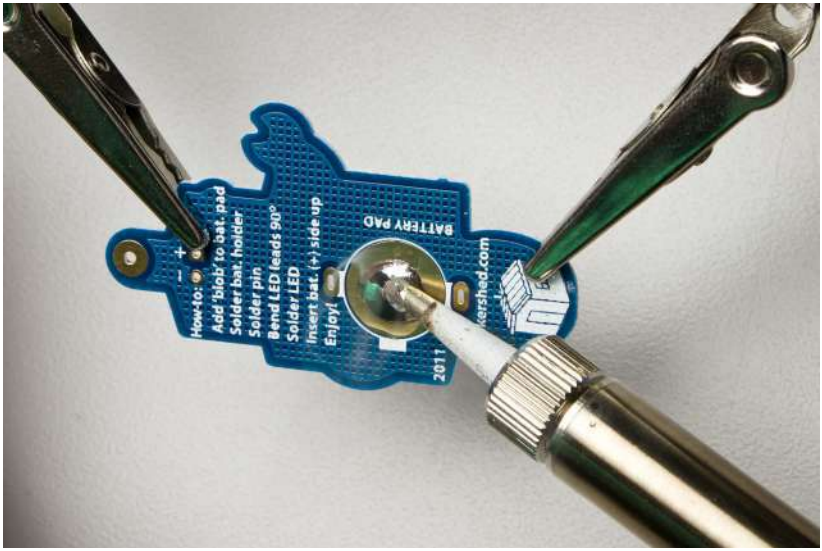

Figure 2-3. *Laying down some solder*

Placing a Component in the Board

You don't want components falling out of the board while you're soldering. In fact, you'll often insert a component with the board upside down (see Figure 2-4), then flip the board over when you put it in the helping hands. So the components have plenty of opportunity to fall out. To keep the component in place, bend the leads out as shown in Figure 2-5.

In some cases, you may need to quickly tack a component in place to keep it from moving. See "Stabilizing and Straightening Components" on page 14.

Don't try to place every component at once. Start with low-profile (shorter) components, solder them in one at a time, and move on to higher-profile components.

Figure 2-4. *Inserting an LED*

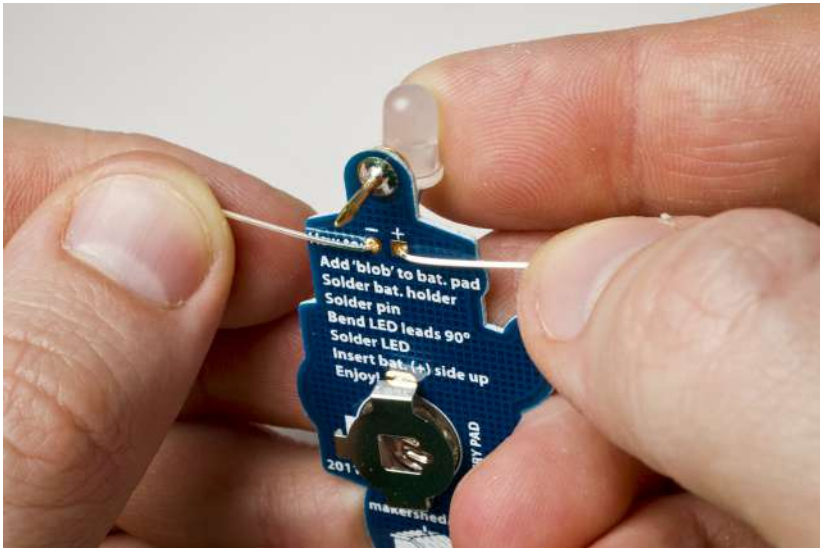

Figure 2-5. *Bending out the leads*

Knowing Which Way a Component Goes In

Some components don't care which way you put them in: resistors, some capacitors (such as the one that comes with this kit), and many other components fall into that category. On the other hand, LEDs are *polarized*; electrical current will only flow through them in one direction. So if you put your LED in backwards, it won't light up at all. You can determine an LED's polarity in a couple of ways: First, the longer of the two leads is the positive (+), and the shorter is negative (-).

Second, look closely at the bottom of the LED and examine the ring that bulges out around it. There is a flattened part of that ring that indicates the side of the LED that's negative (-). You can see this flattened side on the right in Figure 2-6.

With ICs, this also matters. Every pin has a specific function, and there will be one or more pins for positive (+) and one or more pins for negative (-).

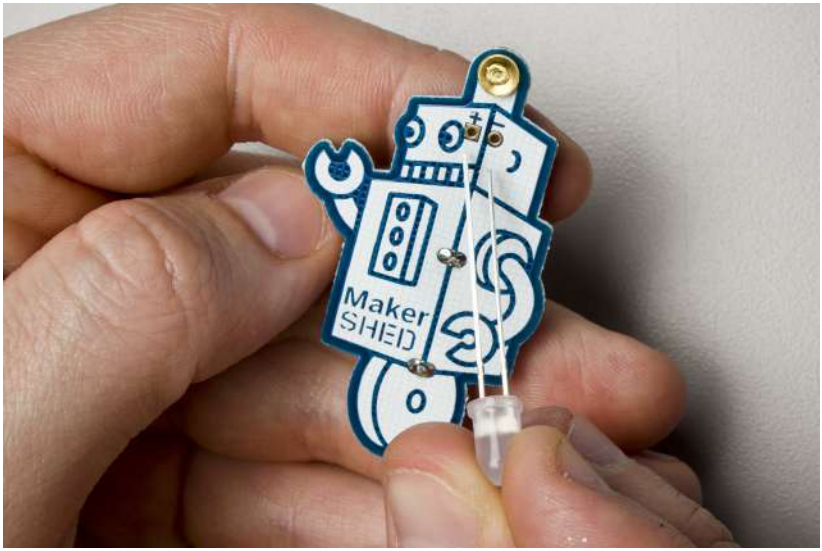

Figure 2-6. *Polarity—LEDs have it*

Stabilizing and Straightening Components

ICs present a unique problem. They don't have long enough leads for you to bend out effectively, which means they are more likely to slip and slide while you're soldering them. So do the best you can with that (see Figure 2-7), but flip the board back over after you solder the first joint. In most cases, you'll find that the IC has shifted. But since you only have one joint soldered, you can easily move the IC into the position you want. Once you've done this, flip the board over and solder the remaining connections.

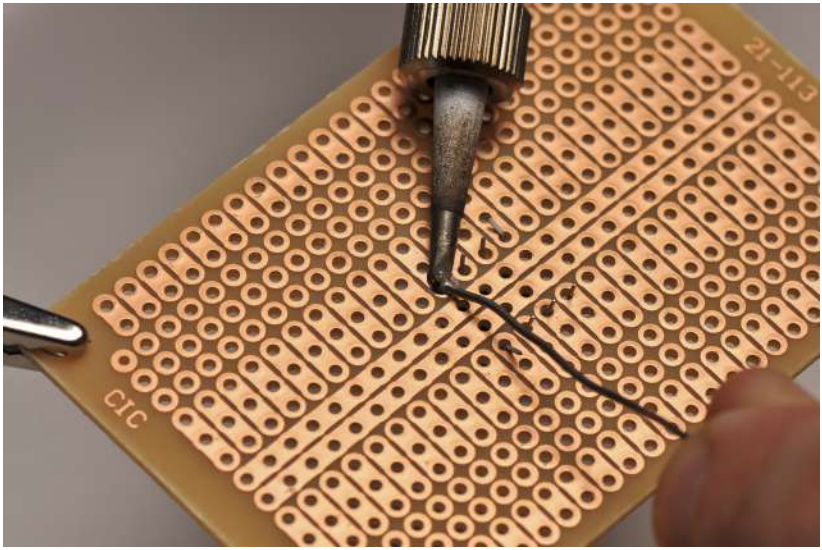

Figure 2-7. *Tacking down an IC*

Safely Soldering Sensitive Components

You need to avoid applying too much heat to a component, or you might damage it. One way to help avoid this is to clamp the heatsink to the component as shown in Figure 2-8. This will draw heat away from the component, protecting it somewhat.

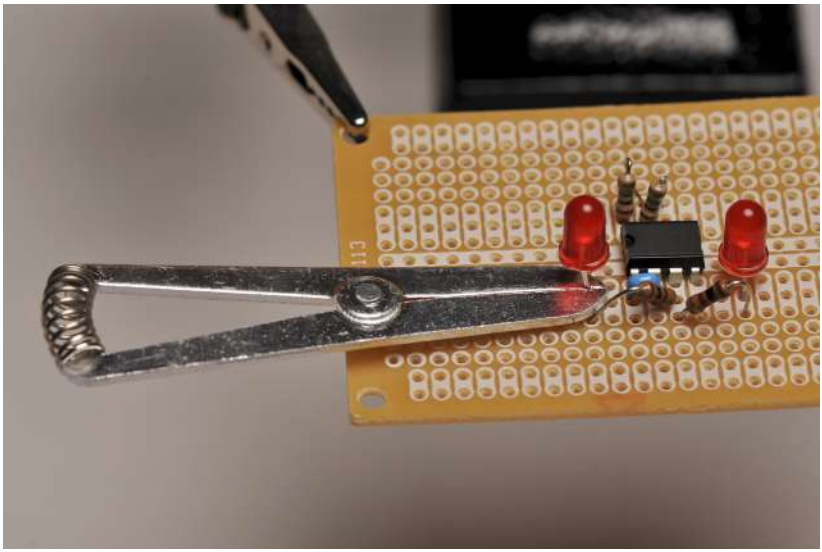

Figure 2-8. *Keeping heat away from the component*

Soldering a Component in Place

Wipe the soldering iron on the sponge and hold it so it's touching both the solder pad and the lead that protrudes through. Avoid using the soldering iron to melt the solder. Instead, heat up both the lead and the pad so that the solder melts when you touch it to them.

This must all be done quickly: within a second of touching the iron to the joint, push a small amount of solder into the joint, and let it flow around the joint as shown. Give it a second to flow, take the solder away, then wait a second, and take the iron away. With practice, you should be able to do all of this in three to four seconds per joint. Figure 2-9 shows how you'd solder the pin to the skill badge. Figure 2-10 shows an LED being soldered.

If you hold the iron to the component too long, you run the risk of damaging either the component or the solder trace on the PCB.

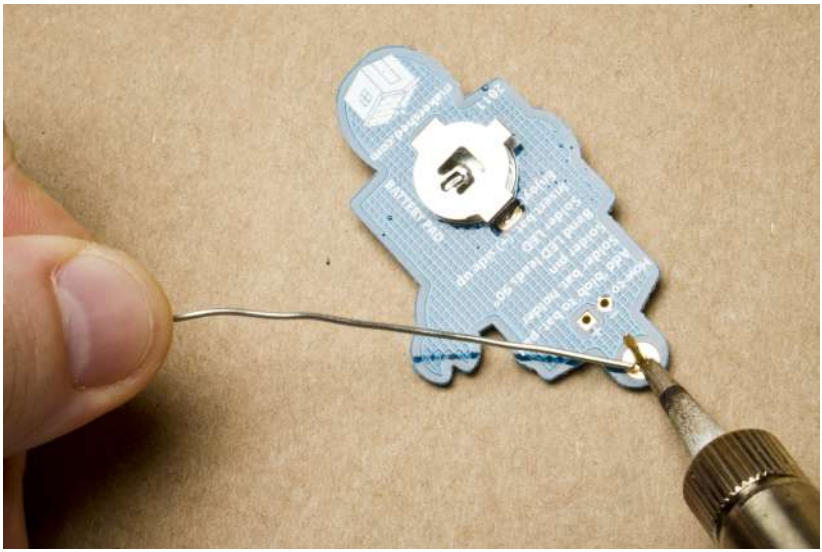

Figure 2-9. *Soldering a pin*

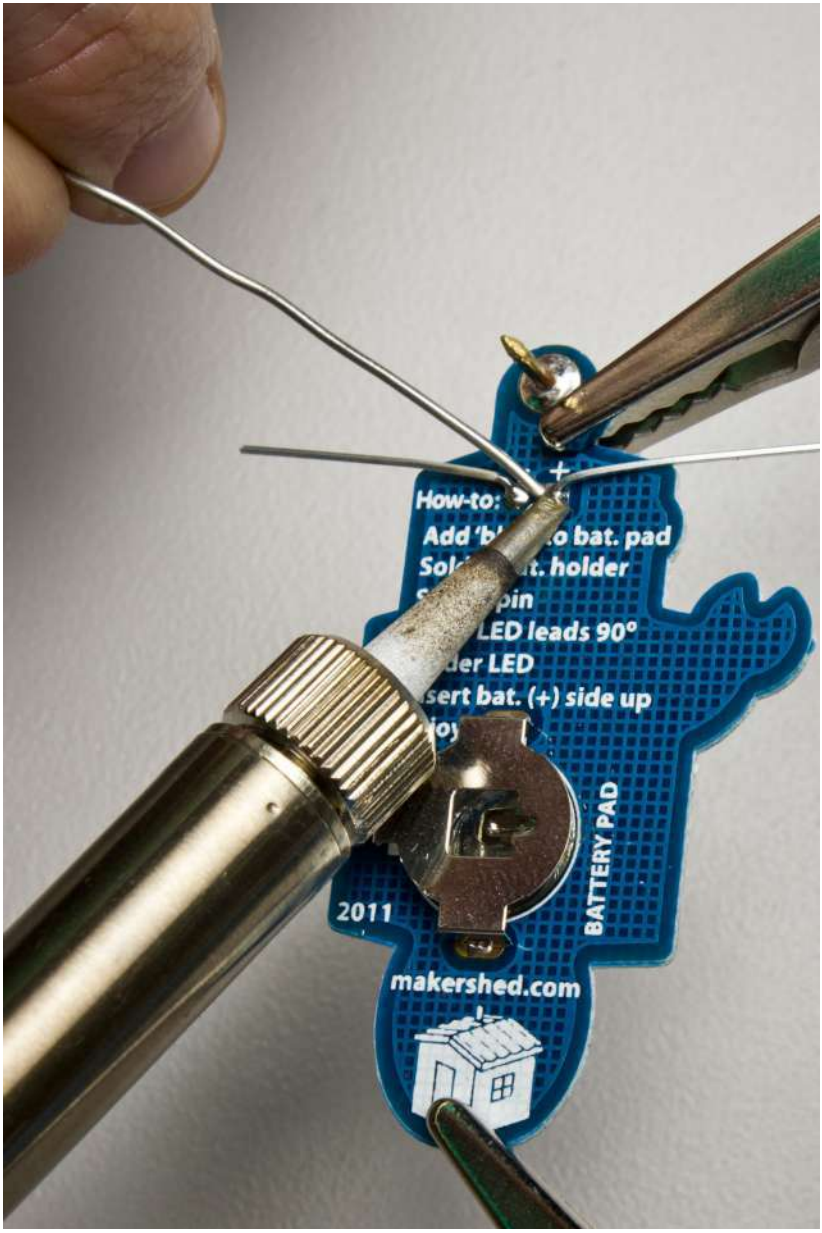

Figure 2-10. *Soldering an LED*

Trimming Your Leads

After you solder a component in place, you need to tidy things up. Grab the cutters from your kit, and trim the leads as close to the solder joint as possible (see Figure 2-11 and Figure 2-12). Don't cut into the solder joint; the idea is to trim the excess wire lead.

When you clip it, the wire lead will fly away from the clippers very fast, and could injure someone. The best way to keep this from happening is to use one or two fingers to hold the lead you're clipping. With one finger, you can put enough pressure on it to keep it from flying away.

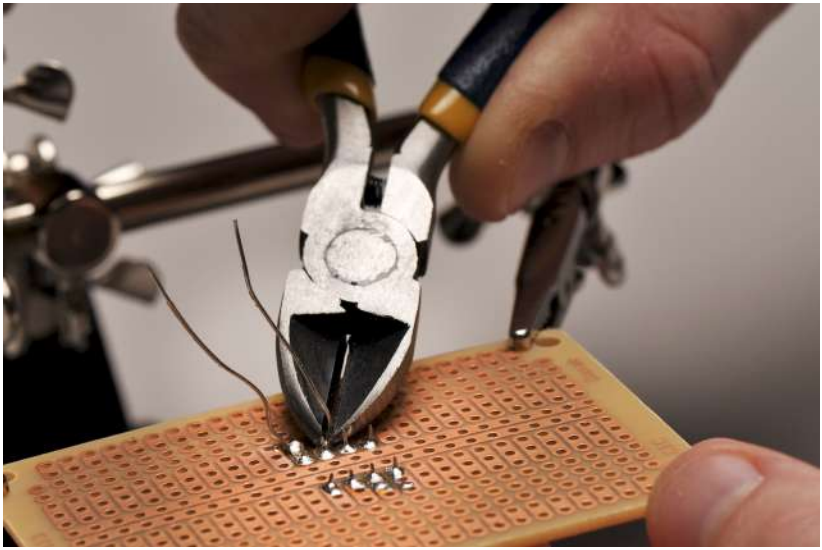

Figure 2-11. *Trimming leads on the 555 blinky*

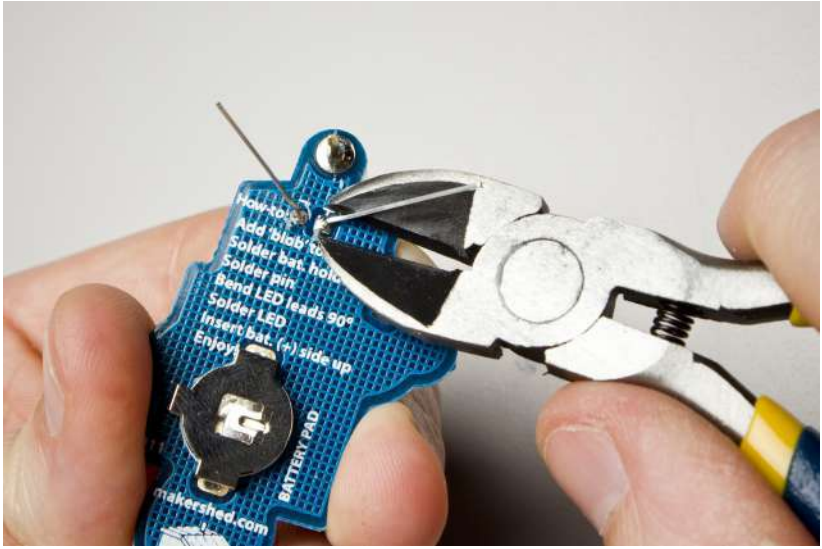

Figure 2-12. *Trimming leads on the Learn to Solder Skill Badge*

Going From Solderless Breadboard to PCB

The beauty of protoboard is that it mirrors the layout of a solderless breadboard, which is used for prototyping electronic circuits. Once you have your project laid out and working on a breadboard, you can easily transfer it to the protoboard. As with a solderless breadboard, the protoboard has rows and columns that are tied together. The layout is slightly different, though. Where the breadboard has two rails (one for positive, one for negative) on both the top and bottom as shown in Figure 2-13, the protoboard that comes with this kit has its rails in the center of the board.

Figure 2-14 shows the project from Figure 2-13, but laid out on a protoboard instead of the solderless breadboard.

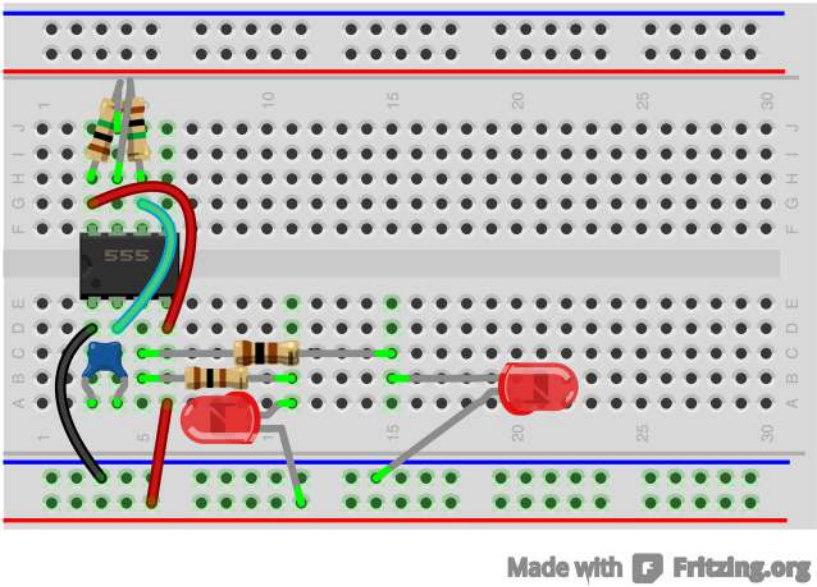

Figure 2-13. *The 555 blinky project on a breadboard*

NOTE: The breadboard diagram in Figure 2-13 was made with Fritzing, an open-source initiative to support designers, artists, researchers and hobbyists to work creatively with interactive electronics. For more information, see *http://fritzing.org/*.

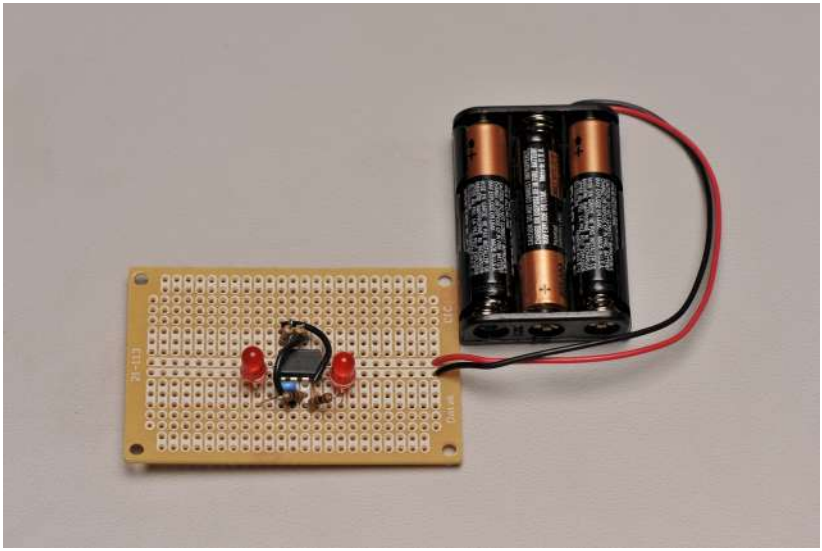

Figure 2-14. *The 555 blinky project on a protoboard*

Soldering Jumper Wire

Jumper wire can be treated a lot like other components (see "Placing a Component in the Board" on page 11): make sure there's enough bare wire poking through so you can bend it outward enough to hold it in place. The notched probe included with this kit can be helpful with placing jumper wire in the right place (see Figure 2-15).

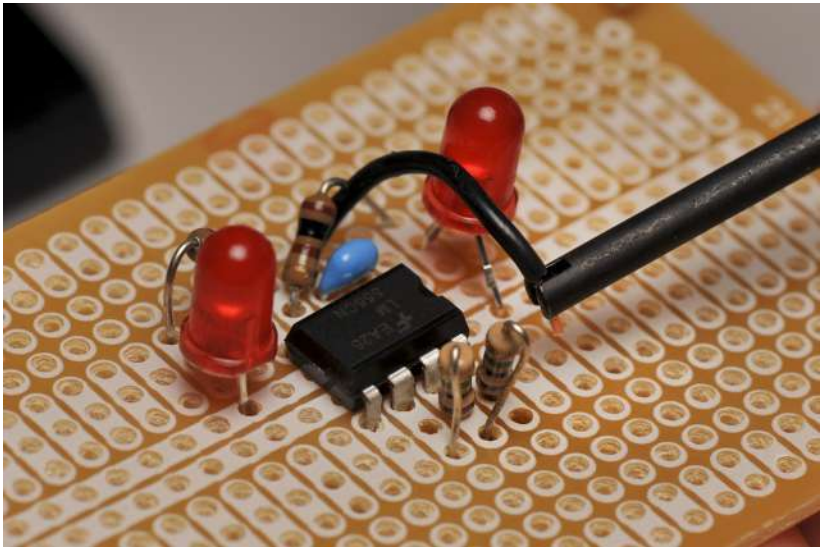

Figure 2-15. *Placing the jumper wire*

Bridging Joints with Solder

When you're working with the protoboard, you will sometimes need to bridge joints that are close to each other. This is preferable to using jumper wire since your board remains uncluttered on the top. It doesn't always look great on the bottom, though, because you end up with a lot of solder in some places. Figure 2-16 shows the start of a bridge: feeding the solder into the gap between solder joints. Figure 2-17 shows a bridge being formed.

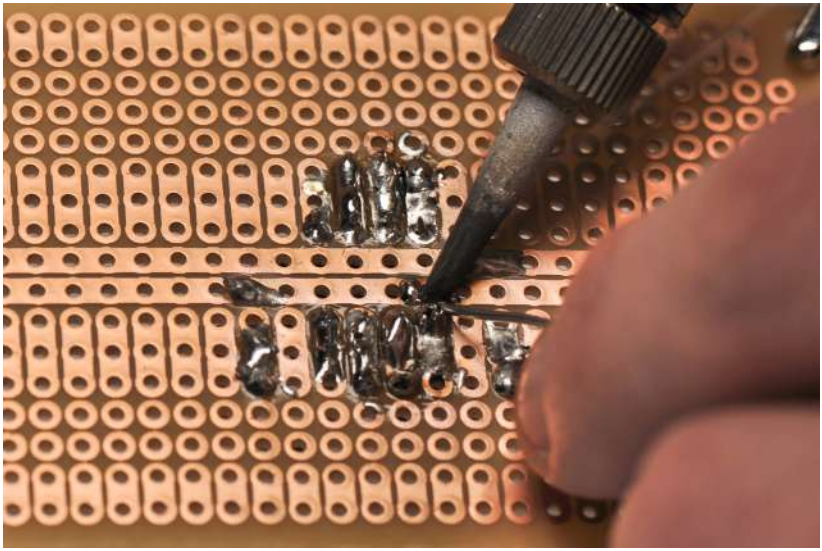

Figure 2-16. *Feeding solder into a gap*

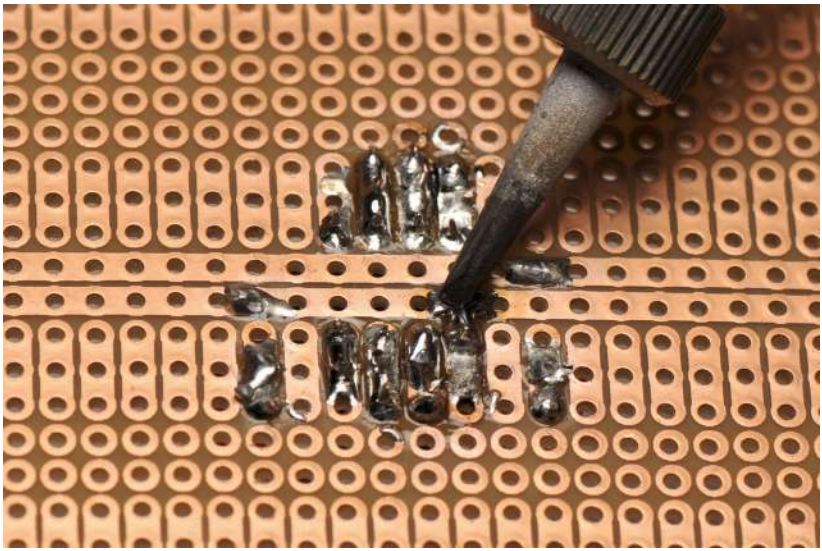

Figure 2-17. *Forming a bridge across the gap*

Relieving Strain on Cables

If you have something heavy dangling off your board, such as a battery box, it's very likely that the solder joints will come undone. If you pass the wires through the large holes on the board before soldering them down (Figure 2-18), you can add some strain relief (Figure 2-19) that will help prevent this from happening. If you have a small drill, you can also drill out a couple of holes close to where you are going to solder the connection, and loop the wire through there. This will be even more rugged than using the larger holes.

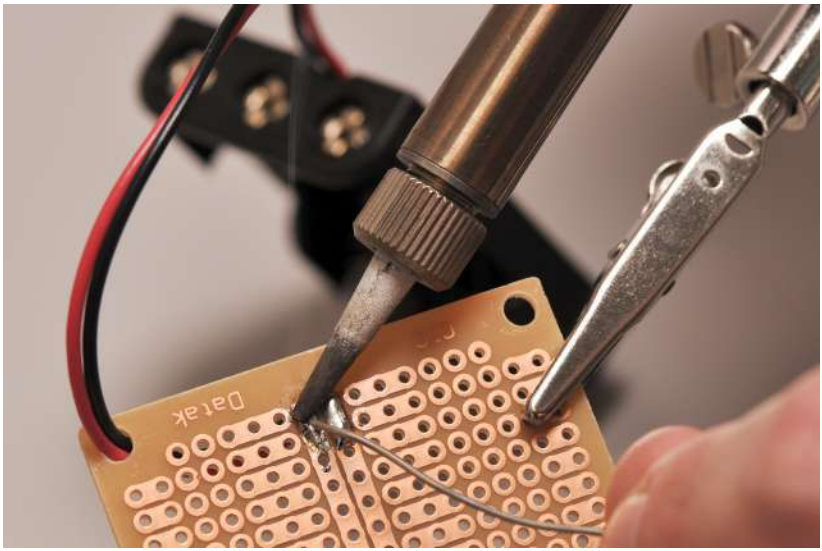

Figure 2-18. *Soldering the battery holder wires*

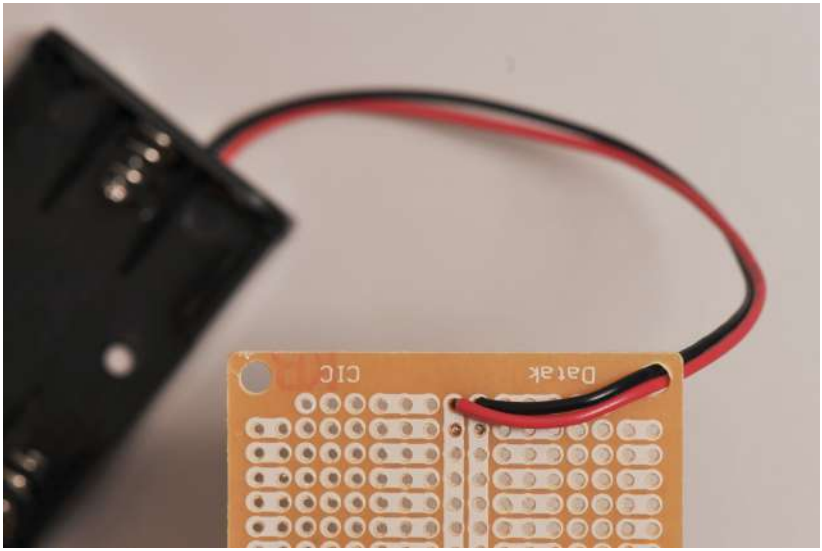

Figure 2-19. *Strain relief*

Getting the Perfect Solder Joint

It's not hard to get a great solder joint, but it's also easy to be sloppy. Here are some pictures of good and bad joints to help you out.

Figure 2-20

Here's a good solder joint on the positive (+) pad: solder surrounds the joint and makes a little peak. This joint had just the right amount of solder and just the right amount of heat.

Figure 2-21

The joint on the negative (-) pad is sloppy. The solder didn't flow around the joint, and some of it is spread out across the lead. You can try to fix it by holding the iron to the joint for a couple seconds; the solder should flow down the lead and onto the joint.

Figure 2-22

The joint on the positive (+) pad has too much solder, and it's balled up. You can use the desoldering wick or solder sucker to remove the excess. After you do that, hold the iron to the joint for a couple seconds to get the solder to flow around it.

Figure 2-23

Here are two joints for comparison: one good, one blobby.

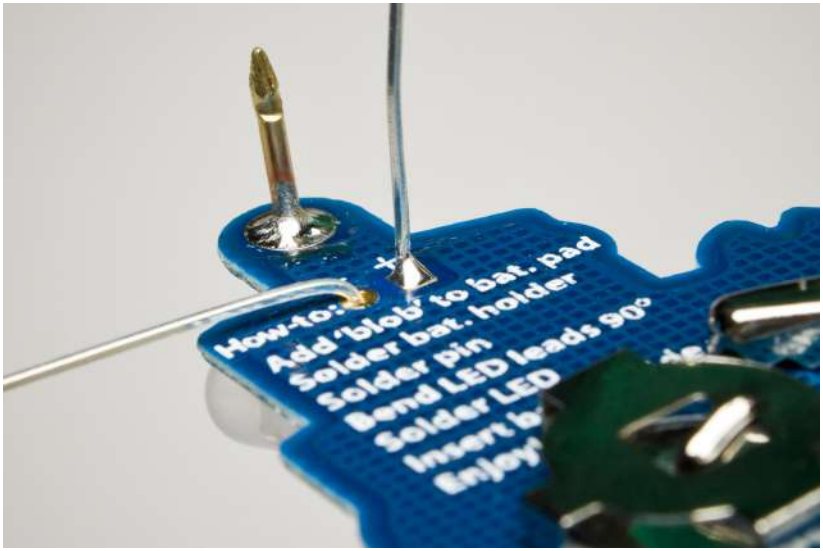

Figure 2-20. *A good solder joint*

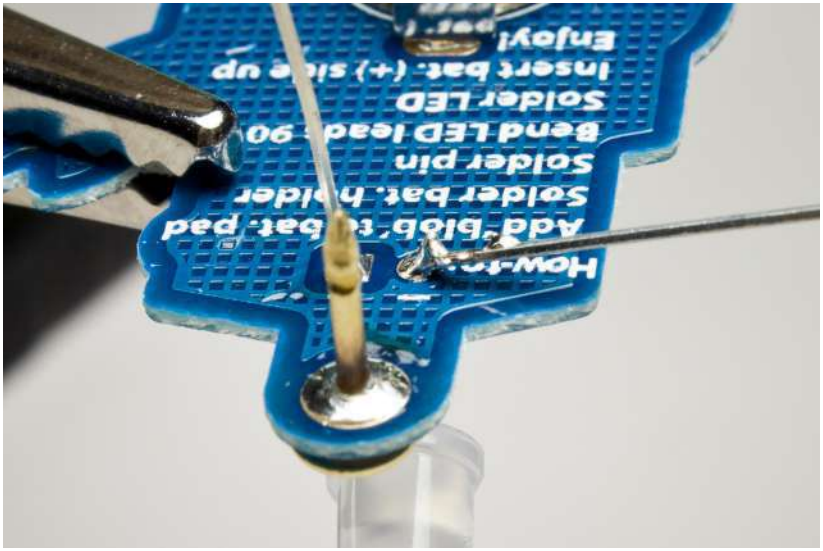

Figure 2-21. *A messy solder joint*

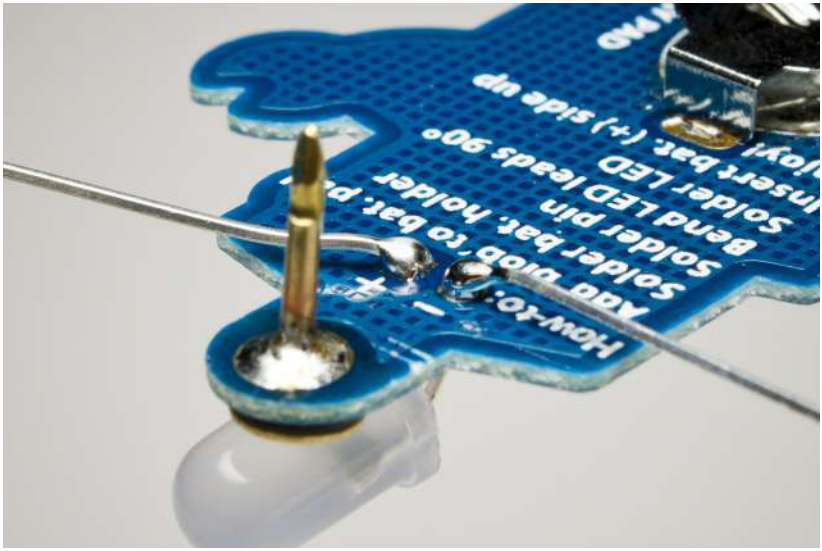

Figure 2-22. *A blobby solder joint*

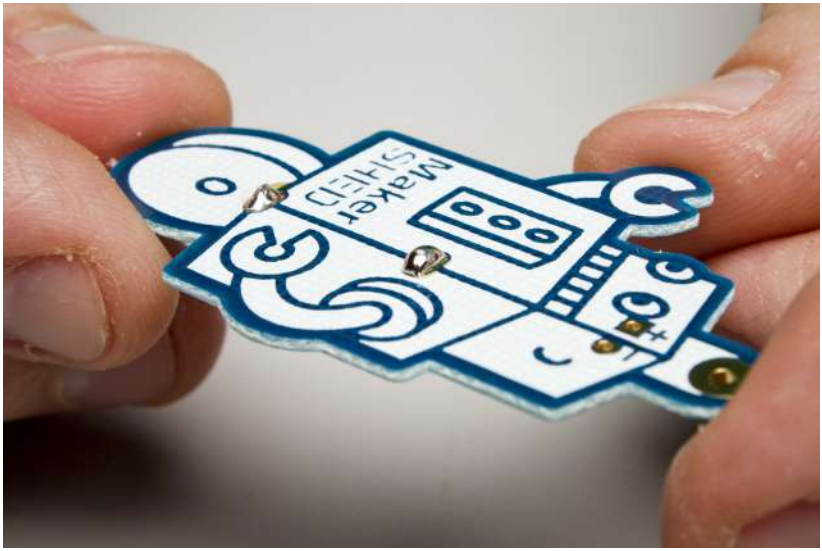

Figure 2-23. *Comparing two joints*

3/Desoldering

If everything went right the first time, you'd never learn anything. This section shows you how to recover from little soldering mistakes, and also includes a gallery of various solder joints so you can compare your work.

Desoldering is the "undo" command for soldering. With this technique, you can remove solder from a joint, allowing you to free the component so you can reorient it as needed. There are two tools for this: the *desoldering wick* (sometimes called *desoldering braid*) and the *solder sucker*.

The Desoldering Wick

Pull a small length of wick out of its spool (Figure 3-1). You don't need much, but if you don't use it all, you can wind the wick back into its spool.

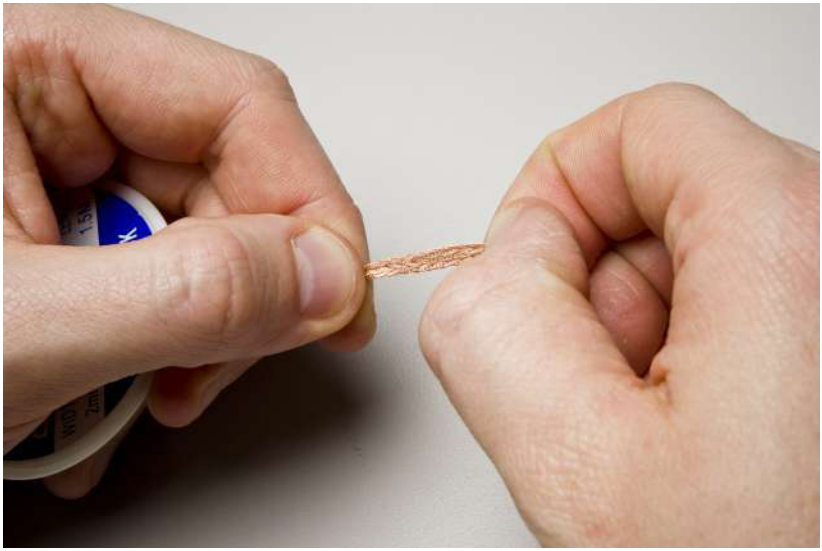

Figure 3-1. *Pulling out some wick*

Preparing the Wick

Before you use the wick, hold it as shown in Figure 3-2, and push inward. This will cause the wick to spread out, giving you more surface area to work with.

Figure 3-2. *Spreading the wick*

Desoldering with the Wick

Position the wick over the joint, and press down on the wick with the soldering iron as shown in Figure 3-3. The heat will pass through the wick and melt the solder. As this happens, the wick will soak up the solder, removing it from the joint. When you're done, you can trim off the used portion of wick with your wire snips.

Figure 3-3. *Desoldering*

WARNING: The wick will get very hot, so take your hands off it as soon as you press the soldering iron to it (the soldering iron will hold it in place).

Desoldering with the Solder Sucker

The solder sucker is another tool for removing solder. It's best for removing excess solder, and you can use it to clean things up a bit before you use the wick. To use the solder sucker, press the plunger down until it locks. Use the soldering iron to melt the solder around the joint, and quickly bring the solder sucker's nozzle to the joint (Figure 3-4). Press the button on the sucker, and it will pull the solder right up into the tube. When you press the plunger again, any solder in the tube will be ejected.

Figure 3-4. *Using the solder sucker*

4/What's Next?

Now that you've learned the ins and outs of soldering, it's time to do more. You can share this book with a friend so they can learn, or you can teach them yourself. And the world is full of wonderful things you can make now that you know how to solder.

Teach the World to Solder

Before you can teach someone to solder, you need to figure out what you want them to try making. You can purchase more Learn to Solder Skill Badge Kits from *http://makershed.com*. Here are a few tips for teaching soldering to others:

Keep Your Hands Off the Tools
: You're there to teach, not to solder. And your students will learn best if they always have their hands on the tools. If you grab the tools from them and do part of the work, they won't learn from it.

Be Patient
: Try to remember what you went through the first time you tried to solder. It takes time, and you did things incorrectly, and maybe you even made mistakes that required desoldering. Let your students learn from their mistakes, and let them take their time.

No Food or Beverages
: Even with lead-free solder, there are chemicals in the flux that aren't good for you. If you allow food or drink near the work area, it could get contaminated. Keep food and drink away from where you're working.

Make Sure There's Plenty of Light
: The components you work with while you solder are small, and hard to see. Make sure to use a well-lit workspace for teaching.

Keep Spare Parts Around
: Beginners will break things. Pick up some spare resistors, LEDs, and other common components, and have them on hand in case you need to replace a damaged component.

Make More Things

Maker Shed (*http://makershed.com*) carries many electronic kits that you can apply your newly-learned soldering skills to. Here's just a few of them:

Supercap Racer Kit

One of the latest in our popular Mintronics line of DIY kits is this tiny race car designed by George Albercook. Once assembled, this little racer (Figure 4-1) will run around getting its juice from a supercapacitor. Capacitors are like little batteries. Supercaps store and release power faster than ordinary ones, so they're great for making quick-charge gadgets and power-on-demand circuits.

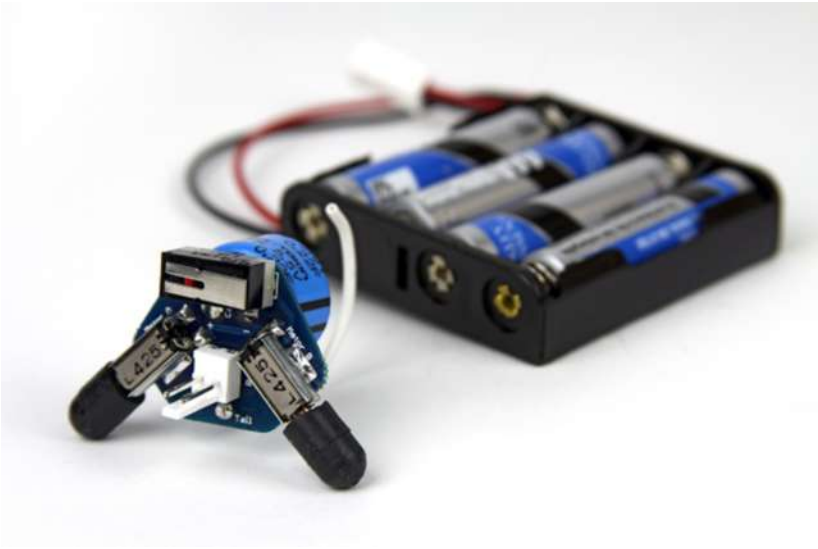

Figure 4-1. *Supercap Racer Kit*

Wee Blinky Kit

The Wee Blinky kit (Figure 4-2) is an easy-to-solder two (2) LED blinker circuit. It comes with a 9V battery snap, but will work with almost any voltage from 3V to 12V. A 9V battery is required but not included. It's tiny, it blinks, and it's a great kit to hone your soldering skills since it's cheap too!

Figure 4-2. *Wee Blinky Kit*

MintyBoost

The MintyBoost (Figure 4-3) is a small and simple USB charger for your iPod or other MP3 player, your camera, cellphone, and any other gadget you can plug into a USB port to charge.

Figure 4-3. *MintyBoost USB Charger Kit*

About the Authors

Brian Jepson is an O'Reilly editor, hacker, and co-organizer of Providence Geeks and the Rhode Island Mini Maker Faire. He's also been involved in various ways over the years with AS220, a non-profit arts center in Providence, Rhode Island. AS220 gives Rhode Island artists uncensored and unjuried forums for their work and also provides galleries, performance space, fabrication facilities, and live/work space.

Tyler Moskowite, a programmer, engineering intern at Make Magazine, and student at Santa Rosa Junior College, has been tinkering with electronics for almost half his life. He picked up Arduino, then Android, and with the release of the ADK he has found his niche.

As a photographer for Make Magazine, Gregory Hayes has ruined more clothes than he ever did as a handyman, hiked more miles with a heavier load than he did as a backpacker, done more research than he did as a writer, and gotten closer to more human hands than advised by any epidemiologist. Taught to solder at the age of seven and forced to solder for his supper at the age of nine, he's now content to let others enjoy the lion's share while he stands by watching safely from behind glass.

How to solder

This pdf refers on informations from the site: http://store.curiousinventor.com/guides/
Have also a look to the 7min. Tutorial video on: http://store.curiousinventor.com/guides/How_to_Solder

Select a Soldering Iron

A 25 or 30 Watt iron should suffice for most small electronics work.

1. Most **soldering "guns" are vastly overpowered for electronics soldering** and can easily overheat components or expose them to harmful voltages. However, some people cleverly use them to solder multiple leads on surface mount devices. Soldering "guns" are for plumbing and much heavier duty applications, and are usually over 100 Watts. The "guns" work by passing high currents through the tips, and these currents can generate voltages that damage electronic components. Also, magnetic fields from guns with transformers can damage some electronics.By forming the heating element in the shape of of the chip, a soldering gun can be used to heat many leads simultaneously.

2. **How much wattage do you need for a particular application and how does wattage relate to tip temperature?**

   A loose analogy: Imagine a car tire has a leak, but you're trying to keep it inflated by pumping air into the tire at the same time it's escaping out the leak. The bigger the leak, the more air you have to pump into it to keep the pressure up. If the tire pressure represents tip temperature and the air lost through the leak represents heat lost through the tip, then wattage represents the maximum amount of air your pump could supply. Once more air escapes through the leak than your pump can replace, the tire pressure (or tip temperature) starts to drop.

   If you had a very small leak and a huge pump (say a 100 Watt iron equivalent), you might be afraid that the pump would cause the tire to explode since so much more air is going in and so little going out. But if you have a nozzle to regulate the pump's air, you could only allow just the right amount of air in to replace what's lost through the leak. This is how "temperature controlled" soldering irons work. As long as you aren't losing more heat out of the tip than the iron can replace (up to its rated wattage), it will automatically regulate just the right amount of heat into the tip to maintain the same temperature.

   However, typical plug-in irons have no such regulation. A 15 Watt iron always delivers 15 Watts of heat to the tip, and the tip temperature stops increasing only when 15 Watts of heat escape through the air. When the tip touches a part, its temperature drops, and if the part you're soldering can dissipate enough heat, the temperature will keep dropping until it won't melt solder any more. After the iron is pulled away from the joint, the temperature will climb again. There is some amount of natural regulation: as the tip gets hotter, it dissipates more heat, and as it gets cooler, it dissipates less.

   Usually, the bigger the component the more heat it can absorb and dissipate, so the general rule is that you need more wattage for larger parts. If you're just soldering small resistors and ICs, 15 Watts will probably suffice, but you may have to wait a bit in between joints for the tip to recover. If you're soldering larger components, especially ones with heat sinks (like voltage regulators), or doing a lot of soldering, you'll probably want a 25 or 30 Watt iron. For soldering larger things like 10 gauge copper wire, motor casings, or large heat sinks, you may need upwards of a 50 Watt iron or more. The following video shows what happens to tip temperature as 15, 25, and 40 Watt irons solder various sizes of wires and components. For cheap irons, higher wattage does indeed mean higher temperatures!

- What is the difference between cheap RadioShack® irons and more expensive ones like Wellers®? What do $100+ and $400+ soldering "stations" have over the cheaper kinds that plug straight into the wall? expand Among the irons that plug straight into a wall and don't have a separate station, the dirt cheap kinds will work satisfactorily for many applications. From personal experience, the tips on RadioShack® irons often come loose and sometimes can be impossible to remove. The irons can also get uncomfortably hot to hold after several hours of use. The more professional Weller (or other) lines are made for longer, continuous use and have insulation on the handles that keeps them cooler. They

can also take a wider variety of tips.
Soldering iron "stations" usually provide some control over the heat being supplied to the iron tip. Ones that are temperature controlled automatically control the amount of heat delivered to the tip so that it remains at a set temperature. In every iron, when the tip touches a component, some heat is lost and the temperature drops. One measure of quality is the time needed for the tip to regain its temperature. A nice feature of many soldering stations is that the tip heats up in seconds after you turn it on.
Many stations also allow you to hot-swap the iron tip, which can be very helpful if you're alternating between surface mount joints and larger components.

- If standard tin-lead solder melts below 400 °F (and lead free below 500 °F), why do most soldering irons have tip temperatures between 600 and 800 °F? Just what is the right **soldering temperature**? expand The basic reason that tips are so much hotter than solder's melting point is because that difference helps to transfer heat faster to the joint. What is the "correct" temperature is a debatable topic, but a common rule of thumb is to start off at 600 °F and increase from there until acceptable results are achieved. Typical Kester (a solder manufacturer) datasheets recommend 600-700 °F for lead-based solder, and 700-800 °F for lead-free solder. "No-clean" or "low solids" fluxes will burn off before a joint can be made with higher temperatures, so low temperatures (below 700) may be essential for these fluxes.
  From Kester's hand-soldering knowledge base: "When hand soldering with a rosin flux such as the Kester #44 or the # 285 the recommended iron tip temperature is 750°F. If you are soldering with a low residue no clean solder such as the #245or # 275 we recommend a tip temperature of 600-650°F.
  What are acceptable results? The goal is to heat up the parts enough so that solder will adhere to them and form a good bond. The higher the iron temperature, the faster it will heat up the parts, so why not set it extremely high to work faster?
  Besides the obvious increased risk of overheating components and the board, higher temperatures cause the iron tip to oxidize faster and can significantly reduce its life. Some claim a 10 °C rise reduces tip life by half (ref p.33). For occasional use, though, tip life may not be much of a factor, especially if the tip is kept covered with solder at all times.

- **Tip size and shape:** a basic guide is to pick a tip that's slightly smaller than the pad you're soldering to. From there, you want a tip with a large thermal mass and short stroke (why?) In most soldering irons, the tip is not actually the heater, but sits in between your work and the heater. You can think of it like a heat bucket that empties into your work and gets filled again by the heater. Typically touching a component empties heat out of the tip much faster than the iron can replace it, and if you have a small bucket (tip), the temperature will quickly drop to an ineffective level.
  Especially if you have a small wattage iron (15 Watts or less), the temperature will drop before you can heat up a larger part, or you'll have to wait a bit in between joints for the tip temperature to recover. With a bigger bucket (tip), you can handle larger joints with smaller wattage, but eventually you'll need to step up the wattage.
  The "stroke", or length of the tip should be minimized to get the heater closer to the work; it takes some time for heat to transfer through the tip. This is balanced with the need to get into tight places where you need a longer tip.
- What do common tip shapes look like and what applications are they best for?

Screwdriver, spade, and conical are some of the more common tip shapes. Personal preference is the biggest factor when choosing a tip, but the goal is to get as much surface area contact between the tip and work as possible. Chisel and spade tips have more surface area at their ends, and also "hold" solder at their tips more readily than conical tips, which have a tendency to draw solder away. Even for fine pitch surface mount soldering, having a small flat at the end can be helpful.

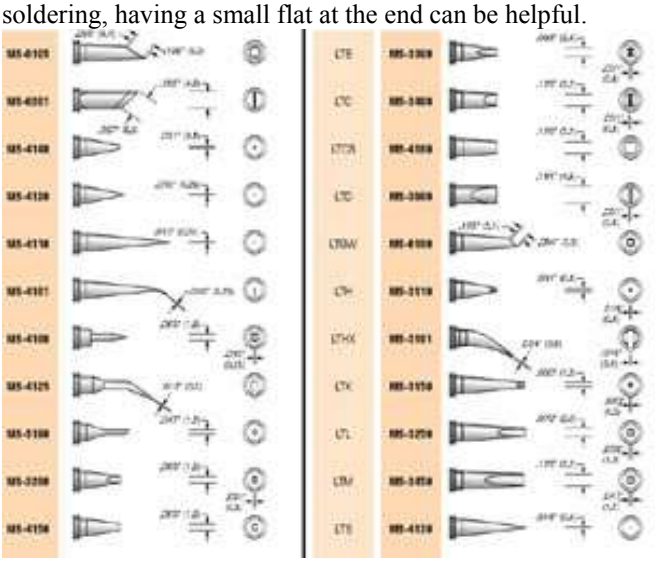

- There are myriad other tip shapes and sizes. The picture to the right shows one Plato catalog page of many. Some other non-standard shapes include a knife-blade (useful for fine pitch leads) and a surface mount desoldering tip.

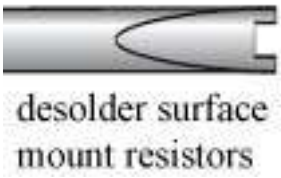

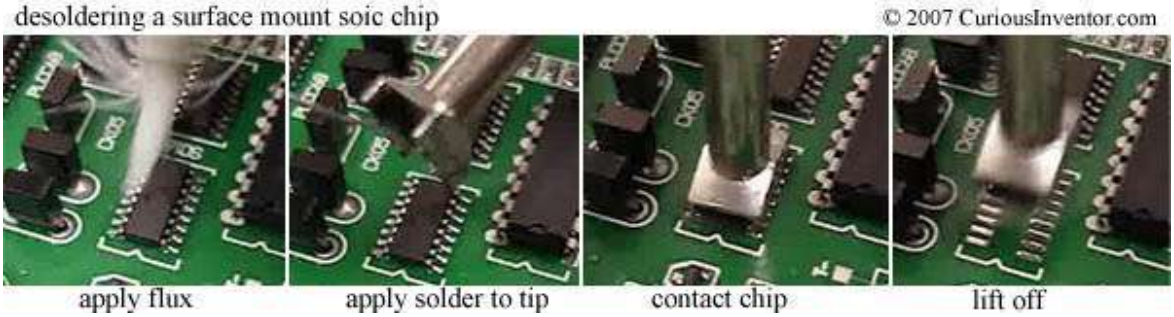

To preserve tip life, the number one thing you can do is reduce the tip temperature (if your iron allows this). After that, ALWAYS keep a layer of solder on the tip to prevent the tip itself from oxidizing, and clean it in between uses. Put a glob of solder whenever you put it back in the stand, and before you turn it off. When heating up a new tip for the first time, hold solder against it so the tip can be covered as soon as the iron gets hot enough.
The longer flux residues and oxides are left on the tip, the harder they are to clean off. They also can drastically reduce the tip's ability to heat up a part, and prevent solder from "wetting" the tip. Regular cleaning of the tip before use is one of the best ways to prolong tip life and make soldering easier. It's important that solder "wet" or cling to the surface of the iron--without solder in between the tip and work the tip's ability to heat is drastically reduced.

- What about gas powered irons and the Cold Heat® iron that is supposedly touchable 1 sec. after use? Butane (and other gas) powered irons are mainly used in situations where electrical power isn't

available. Weller sells some battery powered irons as well.
Everyday Practical Electronics gives a pretty damning review of the Cold Heat iron here, in addition to having one of the better how-to guides out there. To summarize, the Cold Heat® iron has a forked end that you must bridge with the work or solder to turn on the iron, so it can be hard to hold it in a place that keeps it on and also effectively heats the part. Many people complain about pushing harder to make a good connection and then having the brittle tips break. Running power through your work to heat it may not be the greatest idea with some parts. Finally, the iron doesn't get hot enough for a lot of jobs, or cool enough to do anything like throwing it in your pocket right after use. But for something that's portable and cordless, heats up and down in under a few seconds, maybe it's worth the price ($20). Weller's battery powered ($20) iron doesn't have a forked end and supposedly heats up in under 15 seconds, but I don't know about cool-down time.

What kind of solder (rosin cored, etc. lead-free)? What is flux and when is it necessary?

As a starting place, for most small electronics soldering, 1/32 inch (.03) rosin-cored, 60/40 (tin-lead) or 63/37 solder should work fine. Rosin-cored lead-free is fine, too. Unless you have reason otherwise, don't use "no-clean" solder--it's very likely that you don't need to clean the regular rosin-cored solder. The solder should be thin enough to prevent accidentally applying too much (and causing a solder bridge), but thick enough so that more doesn't have to be gathered from the coil too often.

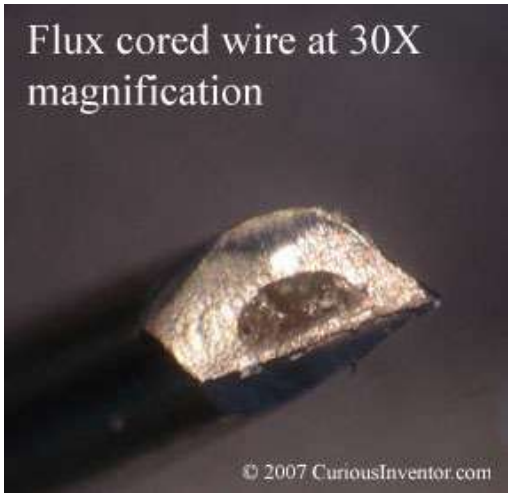

Besides affecting your feed-rate and convenience, the solder thickness also relates to the amount of flux that is delivered. Flux is basically a weak acid that removes oxides so that solder can adhere to the metal, and is so essential to the soldering process that it's built into the core of common wire-solder. It also helps the solder spread out (reduces surface tension), transfer heat, and acts as a protective blanket to keep oxygen away from the metal until solder displaces it.

For the most part, manufacturers include a sufficient amount of flux in the wire, but if you use an extremely thin wire there may not be enough to clean the joint OR the iron tip. Consider using a thicker gauge for cleaning the tip periodically if you're using especially thin solder. Liquid flux is helpful for SMD soldering, too.

When picking a wire-solder, there are 4 features to decide on: flux type and amount (% weight), alloy (tin-lead, lead free, silver bearing, etc.), thickness and total amount (1oz, 1lb?).

- **Flux:** Just what is flux, what kinds are there, and when do I need liquid flux?

  Why it's needed: Solder doesn't just freeze on a joint, it actually forms a metallurgical bond by dissolving and chemically reacting with the base material. Unfortunately, almost all metals oxidize in air and form an oxidized layer that prevents solder from wetting and bonding to them. What is oxidation?

  Oxidation, is when Oxygen (or other oxidizing agents like sulfur) atoms combine with base materials, stripping loosely attached electrons and forming new compounds like iron(III) oxide. It is what happens when apple slices turn brown, iron rusts, copper turns black / green and unsolderable. (read references for more accurate/complete explanation)

  Results vary significantly. When iron rusts, the oxides flake off until no iron is left. Alternatively, aluminum oxidizes extremely rapidly, but is then protected from additional oxidation by the oxide layer. This layer makes Al impossible to solder without using special solder and extremely aggressive flux, or plating the surface with a solderable metal, like nickel. The chromium in stainless steel fulfills the same function, oxidizing to form a protective barrier that is difficult to solder. Gold remains shiny

because it doesn't oxidize, and is easy to solder to, but forms brittle joints. Heat, moisture, and salt all increase the rate of oxidation.

Oxidation can add a hidden cost to components and boards that may have been sitting on the shelf for long periods of time, or have been exposed to hot, humid environments. Copper pads on PCBs (printed circuit boards) are covered with solder or are plated to prevent oxidation, but given enough time, oxygen can still penetrate these barriers. Surplus parts in particular may need a bit of steel wool.

Some interesting references:
rusting chemical reaction
fairly understandable explanation of oxidation
wiki/Corrosion
wiki/Oxidation

Oxidation occurs much faster at higher temperatures, so even if you somehow had clean metals to start with, you would still need flux to prevent new oxides from forming while soldering.

The main choice to make when deciding on a flux, whether it comes in a cored wire or a liquid or paste form, is how aggressive it should be. The more aggressive or "active" the flux, the harder the oxides it can remove, and the faster it can remove them. Going from weakest to strongest, typical choices for hand soldering applications include: "no clean", RMA (Rosin Mildly Activated), RA (Rosin Activated), and water soluble. A newer classification system (J-STD-004) has recently been adopted and classifies fluxes not by rosin content, but by activity, material, and halide presence.

The new system classifies flux by material (RO=rosin, RE=resin, OR=organic, IN=inorganic), activity level (Low, Moderate, High), and halide presence (0 or 1). No-clean, rosin-based no-clean fluxes might be labeled ROL0 or ROL1. Although there is no direct translation between the old system and new, most R and RMA fluxes fall under Low activity level, RA are generally labeled as Moderate activity, and water soluble are High activity. (source IPC-HDBK-001 www.ipc.org)

The downside to choosing a more aggressive flux is that the residues left over after soldering MAY be corrosive, conductive, or enable fern-like growths called "dendrites" to grow between connections. A brief description (p.29) of dendrite growth and some great pictures at the end of this paper.

Because of the risk of corrosion and dendrite growth, most manufacturers clean off the residue from RMA and RA fluxes, and some even clean "no-clean" residues. The question of what flux to use and whether / how to clean it is quite involved.

Rosin flux is quite an interesting animal. Made from pine tree sap, at room temperature, it's an excellent insulator and non-corrosive. When it hits 226 °F it begins to turn acidic and attack oxides, but then when it cools it supposedly leaves residues that are again inert. Kester's data sheet for "44" flux (classified as RA and ROM1) claims no cleaning whatsoever is necessary. I haven't read of any manufacturers that would use a RA (or even an RMA) flux and not clean it--the military won't even use a RA flux WITH cleaning because of the risk that some will be left behind. This Chemtronics author recommends cleaning even the "no-clean" fluxes. He also points out that even if the residue is non-corrosive and non-conductive, it might be tacky and attract dust that causes a short.

To add one more piece to the puzzle, flux generally gets used up during the soldering process. This is why no-clean fluxes are oftentimes ineffectual for lead-free soldering, which can require slightly higher temperatures and longer heating because the lead-free solder "wets" slower. The no-clean flux can burn off before the joint is complete. Alternatively, if you apply liquid flux far from a joint, it may still be active (corrosive) if it never got heated.

I'm not making missile guidance electronics, I'm making a robot that pours a beer, what flux should I use and do I really need to clean? Even manufacturers of non-life critical electronics have much more stringent reliability requirements than an individual. They must ensure that tens of thousands of products will work for multiple years, not a single project.

The safe advice is to use the least aggressive flux that enables solder to quickly wet or cling to the surfaces, and then clean off the residues with alcohol and lint-free wipes (don't just spread the flux around). Try starting with a rosin-based mildly activated flux: RMA. I am inclined to trust Kester's spec sheet for "44" (RA) flux that says it does not actually require cleaning. Other flux manufacturers may have RA or RMA level fluxes that do indeed need to be cleaned, so if you don't know what you're using, cleaning is probably prudent. If you are going to clean rosin fluxes, do it soon after soldering because they quickly harden (see pics under 'Cleaning'). Finally, I would personally avoid no-clean fluxes and solder unless you have a critical application and very clean parts.

Lead-free solder generally requires a made-for-lead-free flux designed to be used under slightly higher temperatures.

Liquid flux can greatly help with surface mount soldering and desoldering components, but the flux inside cored-solder should be sufficient for through hole components. When soldering SMD components and desoldering pretty much anything, liquid flux acts as a blanket that helps to spread heat and also keep oxygen away from the metals. Finally, flux lowers the surface tension of solder, helping it to spread out and wick into connections.

A water-soluble flux may be necessary for heavily oxidized parts or difficult metals like nickel. Without question, clean these fluxes. Special fluxes and solders exist for aluminum and stainless steel and these also certainly require cleaning. Never use acid-core solder; it deposits zinc chloride into the solder that cannot be cleaned out. A final reason to clean flux residues is if you'd like to apply a conformal coating and aren't sure whether it will adhere to those residues.

Some more references:

- Never use acid-core and how to solder to stainless steel (Kester)
- White residue and all about rosin (more Kester)
- Good mini-class on fluxes: Bolton University
- To clean or not to clean and a brief history of electronics cleaning: more Bolton
- The Kester catalog provides good info on the solderability and flux requirements of various materials (see p.14).
- Flux residues and what to do about them. This explains a bit about cleaning options and the health risks of rosin and non-rosin fluxes.

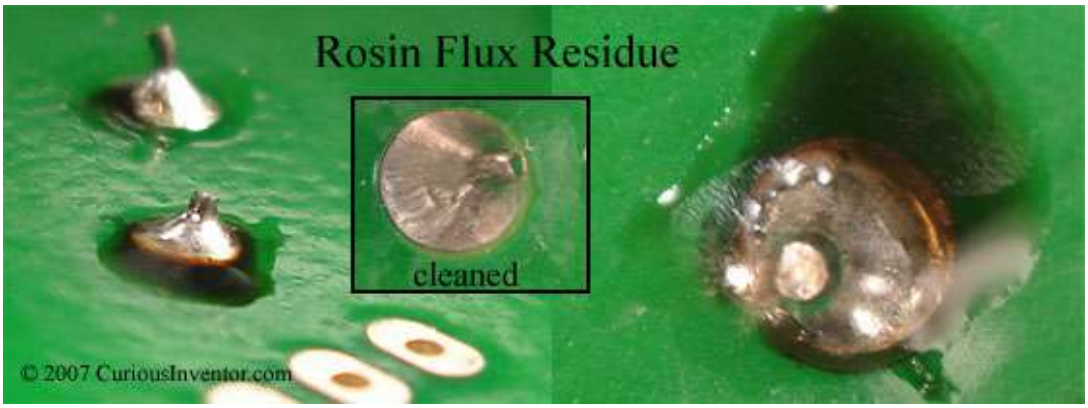

- **Alloy:** 60/40, 63/37, tin-lead, lead-free, silver bearing, RoHS, eutectic, oh my...

- **Standard lead-based solder** is made of tin and lead. When you see 60/40 or 63/37, it means 60% tin by weight, 40% lead. Either once of these alloys should be fine for typical small electronics soldering. 63/37 in bulk is slightly more expensive because of additional tin, but has the special property of being a "eutectic" alloy, which transitions from liquid to solid at one temperature (like water) instead of range of temperatures. Basically, in non-eutectic alloys like 60/40, there is a "pasty" region of temperature where portions of the solder are frozen and other portions are liquid. What does this mean for soldering and is 63/37 really that much better?

  Alloy metals have some interesting properties that are different from the metals comprising them. In tin-lead solder, the mixture has a lower melting point than either lead or tin alone, and the melting point varies depending on the portions. The mixture that yields the lowest melting point is called eutectic. This is also the only mix where all the constituents melt and freeze at the same temperature.

  If the tin-lead alloy isn't eutectic (ie, if it is not 63% tin), it will go through a "pasty" phase while it freezes. Unlike water, which freezes entirely at 0 °C, some parts of a non-eutectic mixture of tin-lead freeze at higher temperatures than other parts. For a somewhat simplified explanation, if you held the temperature of 60/40 slightly above 361 °F, the "extra lead" would solidify and be floating in a liquid 63/37 eutectic mix. For a more exact and great explanation of this process, look here.

  How is it that the mixture of two elements somehow lowers the melting point? And I quote: "increased entropy." Chew on this. (Another great phase-diagram explanation with a bonus of why ice and salt can get almost 30 °F below freezing--enough to freeze ice cream) And one last great explanation--talks a bit about grain structure and how solder isn't a simple homogeneous mixture of tin and lead.

  This compares the difference between eutectic freezing in tin-lead and eutectic freezing in more complex 3 element lead-free alloys.

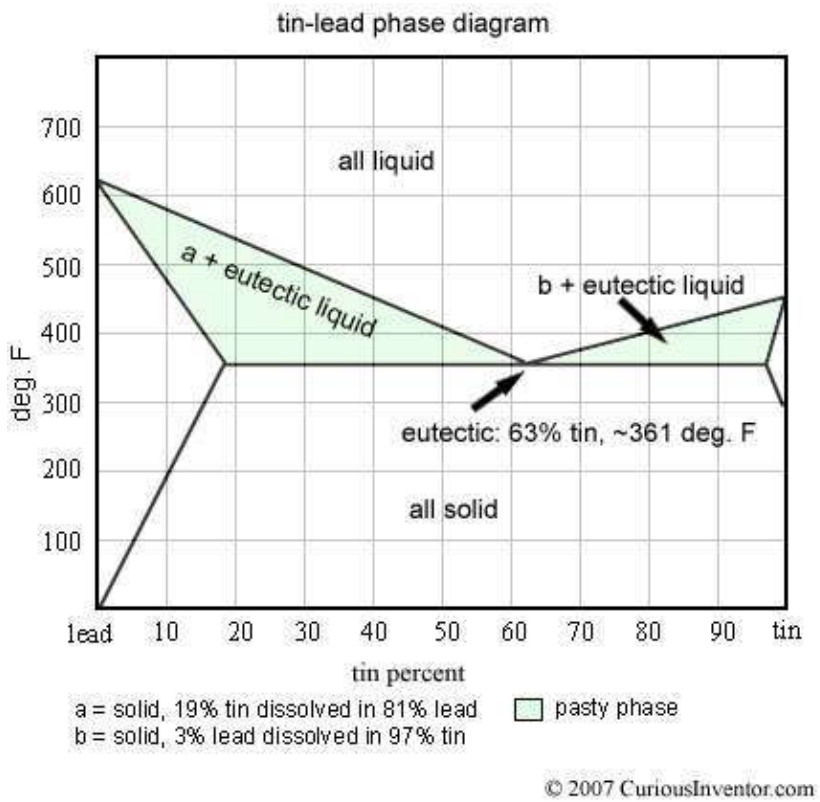

So which is better, 60/40 or 63/37? A decade or so back (before the lead-free movement), most manufacturers incurred about a 5% increase in cost to switch from 60/40 to 63/37. 63/37 flows slightly easier, makes shinier joints, and has a faster total freezing time which means there is less risk the joints will be "distrubed," which is what happens when the joint moves during solidification. This can lead to internal fractures that cause poor electrical connections and unreliable mechanical joints. Note that 63/37 doesn't freeze instantly (just like water)--it still has a window of time during which the joint can be disturbed, too.

I think most would say that the enhanced properties of 63/37 really only matter for mass soldering operations like wave or reflow soldering, and that there is little difference for hand soldering. A dull joint is more often caused by insufficient heat, dirt or oxides, or lack of flux rather than alloy makeup. (A no-clean flux may burn off before the joint is complete) Holding everything else constant, the difference in shininess between 60/40 and 63/37 is completely cosmetic. If you'd like to see a shiny 60/40 joint, try using Kester 60/40 with #44 flux.

- **Silver bearing solder:** (that is, contains silver, not for roller bearings) Silver is used in one of the leading alloys for lead free solder (An96.5% Ag3.0% Cu.5%) and also as an addition to tin-lead solder, usually in the 2-4% range (when you se 62/36/2 this means Sn64Pb36Ag2).

  People claim that it flows better, has a lower melting point, is stronger, and has a higher conductivity. According to Indium's solder wire data sheet, their 2% silver solder has an electrical conductivity that is 11.9% of Cu compared to 11.5% of 63/37 tin-lead solder, a shear strength of 7540psi vs. 6200psi, and a tensile strength of 7000psi vs. 7500psi for 63/37. So, yes, the claims are true, and also mostly insignificant. Silver was initially added to solder to prevent silver platings on component leads from dissolving into the solder ("silver migration") and forming brittle joints. Having silver in the solder reduces migration, so you may want to use it on silver joints. (Note: this logic doesn't entirely make sense to me. If silver getting in the solder caused embrittlement, how does adding *more* silver prevent this?)

  Audiophiles seem to be enamored by 4% silver bearing solder, namely some from WBT, Cardas, and WonderSolder. Are these really better for audio?

  The superior claims include things like higher purity, eutectic alloys, higher conductivity, and better flux. I haven't found any controlled studies showing that a group of people can actually hear the difference, so I'm skeptical. Although additional silver does increase conductivity, the increase is small and the joint distance over which that conductivity applies is also extremely small. For what it's worth, here's a forum discussion that discusses a bit about solder in high-end audio and also a FAQ (scroll down)concerning solder on Cardas Audio's site. Another decent discussion.

  Bad joints made with any solder can create a high-resistance connection, especially if the underlying components were heavily oxidized initially. My advice: if it makes you feel better, get it, but be wary of sellers that don't provide spec sheets.

- **Lead-free Solder:** As of July 1st, 2006, European laws mandated that new electronics be almost entirely lead free. As of yet, there are no US laws (outside CA) mandating the removal of lead, but most manufacturers are switching over for competitive reasons. More on RoHS, WEEE, and lead risks:

  The European Union passed directives in 2003 stating that no equipment sold in Europe should, by July 2006, have more than .1% lead in any homogenous component (like a solder joint). The directives are known as the WEEE (Waste Electrical and Electronic Equipment) and RoHS (Restriction of Hazardous Substances) (wiki). There are corresponding laws in China, Korea, and California. Japan manufacturers actually voluntarily begin switching to lead

free years before RoHS or WEEE for competitive reasons. IPC's informative lead-free website: here.

Although only .5% of lead used in the US gets embedded in electronics (verses 80% in batteries), there is concern that the lead from those electronics will leach into ground water supplies from landfills. Why the concern over solder joints when batteries contain so much more lead? For the most part, lead containing batteries are recycled and regulated, whereas electronics are routinely just thrown away. The EPA claims that 1% of municipal waste is electronics. Interestingly, according to this publication by IPC, no studies have found any evidence of lead getting into the ground water from landfills.

Lead health risks: Lead does not get absorbed through the skin, and is actually not present in solder fumes to any appreciable degree (fumes are still bad for you, see fumes section below). The greatest risk of hand soldering with lead comes from ingesting lead by eating or smoking without first washing. Health risks include increased blood pressure, fertility problems, nerve disorders, muscle and joint pain, irritability, and memory or concentration problems. The latest health data indicates that there is no amount of lead that will not be detrimental to health. Google lead or start with this link.

Some great lead-free joint pictures: here.

The most popular lead-free alloy seems to be Tin 96.5% Silver 3.0% Copper .5%. The wiki page on solder mentions several different lead-free varieties.
-AIM lead-free solders.
-Huge list of Indium lead-free solders and their properties.

Lead-free solder generally melts at a higher temperature, and doesn't wet as quickly to metals. (Eutectic tin-lead solder melts at 361 °F and the SnAg3Cu.5 melts at 423 °F.) Manufacturers generally recommend setting soldering iron temperatures between 700-800 °F for lead-free instead of 600-700 °F for tin-lead soldering. The 15 Watt RadioShack® iron I had operated a bit below 500 °F, so soldering should be possible with it, but maybe slow. Technique wise, since lead-free wets slower, joints will take longer (upwards of 4-7 seconds), but this doesn't mean the soldering iron temperature should be turned up excessively--patience is better than higher temperatures. If you're going to use a lead-free solder, get a flux that's designed for the higher temperatures--the regular no-clean fluxes will likely burn off before doing their job.

A quick word on reliability. Some say that lead-free joints are stronger, and while the material is indeed stronger, it's less flexible than lead-based solder, so expansion and contraction due to temperature change has been shown to break components held by lead-free solder. It seems true mechanical reliability of lead-free vs. lead depends heavily on the situation (see p.30). There is also concern of something called "tin whiskers." These are extremely thin crystalline growths that grow perpendicularly out from surfaces. These took down some space systems and NASA has a great page here. These are different from dendrites (which grow on the surface) and appear to be more likely on bright all-tin platings. Most component platings used to consist of a tin-lead mixture, and since all-tin platings are a common lead-free replacement, people are concerned. I have yet to find any literature that points to TinSilverCopper solder as a risk factor, though. I believe it is a plating issue, only.

One more link: -Why tin or silver?

- **Thickness and Amount:** As a general guide, .032" thick solder (21 gauge) should be suitable for through hole soldering and some surface mount soldering. For finer pitch surface mount devices, use .02" or .015", and if you're soldering a lot of switch terminals, or tinning thick gauge wire you may want .05". If you use .015" solder consider having some thicker solder on hand to re-tin your tip, since the amount of flux in .015" may not be enough to remove tip oxides. The picture below shows how the various thicknesses compare next to the standard .1" spaced DIP pins.

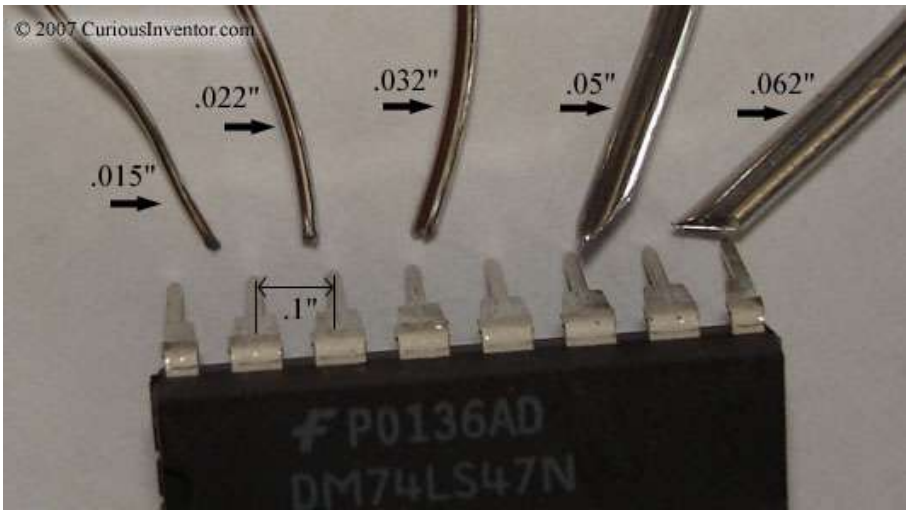

Expand to see how .032" and .015" solder compare to a SOIC surface mount chip and fine pitch (.02") device.

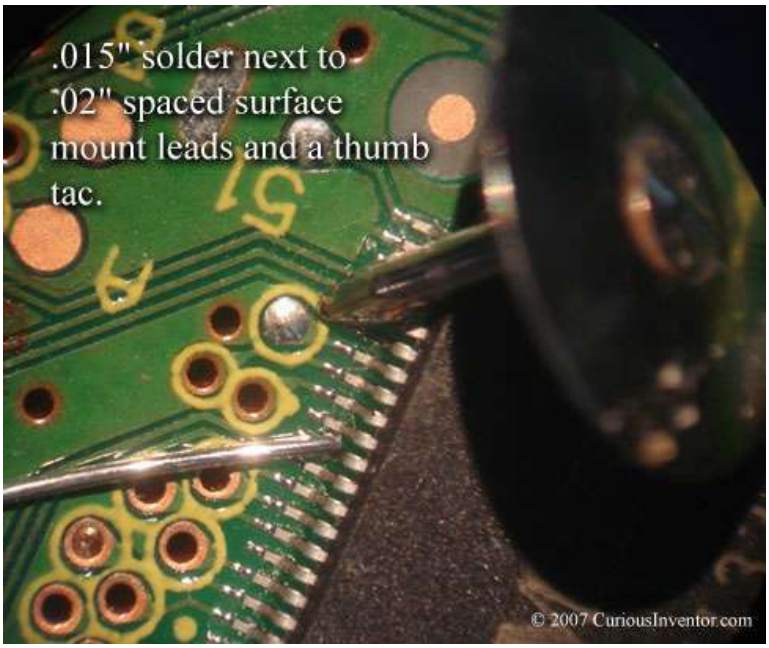

How much solder do I really need? An ounce? A pound? How long will a pound last?

To get a very approximate feel for just how much solder is in an ounce vs. a pound, I measured how much .032" solder it took to attach ten 16 pin DIPs. Trying to provide an upper bound, the soldering is excessive, and a generous glob was placed on the tip in between each chip to account for solder used to tin and protect the tip during normal use.

The ten chips took about 15" of generously applied .032" solder that weighed in approximately at .052oz. This particular solder weighed about .00348oz/in. At about 3.27e-4 oz/joint, a 1 oz spool should last 3060 joints, a half pound should last 25 thousand joints, and a pound should last about 50 thousand joints. Mileage will certainly vary with different sized solders, joints, tinning wires, and highway vs. city driving, but if you're not in a production environment, a half pound should last a while.

Solder Fumes:

What is exactly in solder fumes? Am I safer using lead-free solder?

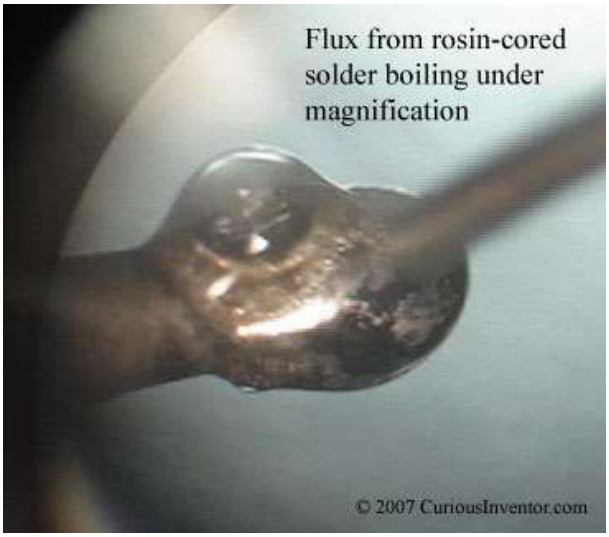

Lead boils at over 3000 °F, and in most cases soldering tips should be kept below 750 °F, so it is highly unlikely that gaseous lead is present in the fumes. The fumes are actually from the flux boiling, which still isn't great for you--many of the chemicals found in cigarette smoke are found in flux fumes: formaldehyde, toluene, alcohols, and hydrochloric acid to name a few. Most of the public health literature indicates that asthma is the major health risk from soldering fumes (not cancer or lead poisoning). When acquired, it is permanent and can cause hyper sensitivity so that even small amounts of fumes bring on attacks. Surprisingly, scientists have not been able to determine what exactly in the fumes cause the health defects, nor what amounts are harmful. Yet, the British health department has set exposure limits of .05 mg/m^3 over 8 hours and .15 mg/m^3 over 15 minutes. I believe these limits have been shown to provide a safe work environment and also one for which the necessary systems / filters are financially reasonable.

Some informative links:

- Solder Fumes and You A British health department pamphlet explaining the health hazards of rosin-based flux fumes (irritation, headaches, dermatitis, asthma) and what precautions employees and employers should take. Note the total lack of any mentioning of lead poisoning.
- Workplace Exposure to Rosin-based Solder Flux Fume During Hand Soldering A study done by the UK Health and Safety Laboratory measuring exposure levels and also the effectiveness of various exhaust, ventilation, and filter systems.
- Measurement of the Performance of Air Cleaners Against the Particulate Element of Rosin-based Solder Flux Fume Another UK Health study investigating the effectiveness of various fume extraction and filter systems. Most interesting finding: although activated carbon filters can remove gaseous hazards, they are largely ineffective for fine particulate in the fumes which they believe to cause much of the harm. Some combination of carbon and HEPA filter is needed, and even these are useless without sufficient air flow.

Returning to the topic of lead, it is widely agreed that eating, smoking and drinking without first washing is the greatest risk factor. Despite the high boiling point of lead, there is also agreement that at least a small amount of lead particles are indeed present in the fumes. The conspicuous lack of

emphasis on lead poisoning in all the research done by the UK health department implies that these particles are of little concern. Sentry Air Systems has a brief page that is one of the very few sources I found to claim that lead particles under normal soldering conditions are harmful. The company sells fume extraction technology.

The material safety data sheet for Kester #44 cored solder says under the fire fighting section: "Melted solder above 1000 °F will liberate toxic lead and/or antimony fumes."

According to IPC's DVD-11, "General Safety in Electronic Assembly," when solder is heated past 850 °F the lead can become atomized and end up in the fumes. video link (if link breaks, you may have to search for DVD-11 at www.ipc.org).

Useful comments from someone in the manufacturing world regarding lead.

It would seem that, for typical lead-based, rosin cored solder, the risks are probably not that great from the fumes if you only solder occasionally, don't use abnormally high temperatures, and are in a well ventilated area. If ventilation isn't too good, and you're soldering for long periods of time, the cheaper foam-type carbon filters may not be good enough.

But what about lead-free solder? Lead-free solder often requires higher temperatures and more active fluxes, and both of these factors lead to significantly worse fumes.

Fume Extraction Becomes More Important in a Leadfree Environment - from the Weller blog

Another excellent article on the increased risk of lead-free fumes from OK International.

Instructables has all sorts of home-made fume extractors.

Prepare the Work

- **Start with clean components:** Flux can remove small amounts of oxides, but will be of little help for heavy oxidation, grease, oil or dirt. Notice how the solder in the adjacent picture has been repelled by the heavily oxidized pin. It may be necessary to lightly use steel wool or fine grit sand paper to remove especially bad oxides. Some people say that you should not do this because it creates scratches that can promote future oxidation... sand at your own risk. Use Silicon Carbide sandpaper (black) as opposed to Garnet (brown, for woodworking) sandpaper because the Garnet paper will shatter and become embedded in the metal. An effective and gentle alternative is to use a pink eraser, especially for copper traces.
- **Clamp your work:** PanaVise makes a popular clamp that accepts several different attachments for holding different sized circuit boards. It's by far the most popular clamp and is also very sturdy. Having the work held in place is especially helpful for desoldering when it's necessary to push or pull a bit. The alligator hands are a cheap alternative.

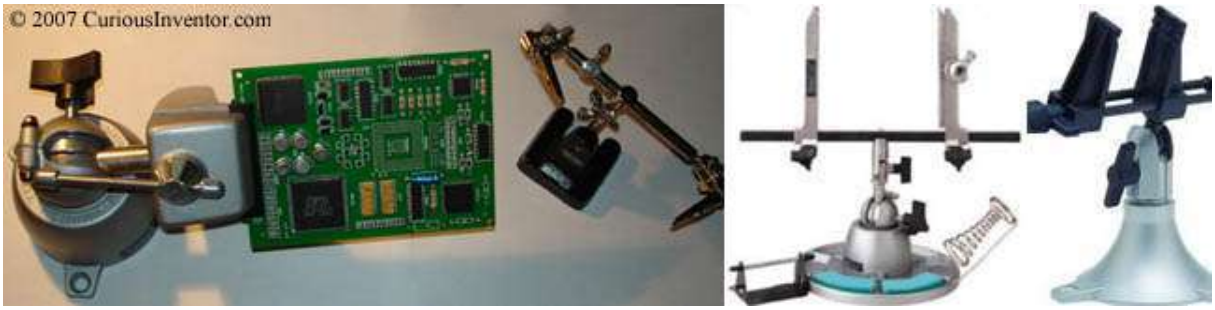

- **Wire preparation:** Tin stranded wires so they don't "bird-cage," or bend out from their original lay. Expand for instructions on the correct way to strip a wire manually, use an automatic stripper, and tin wire.

- **Manual wire stripping:** The natural way you would think to use the wire strippers is to first cut the insulation, and then use the same cutting hole to push off the insulation slug. In production environments where reliability is critical, this is not allowed because it's very easy to nick the wires this way. The pliers at the tip of the stripper are actually meant to remove the insulation slug. First score the insulation with the cutting hole, and then pull it off with either the pliers or by hand. If removing by hand, twist slightly while pulling to keep the strands in place. This is the "right" way to strip a wire, if you're careful, pulling the insulation off with the cutting hole is probably fine.

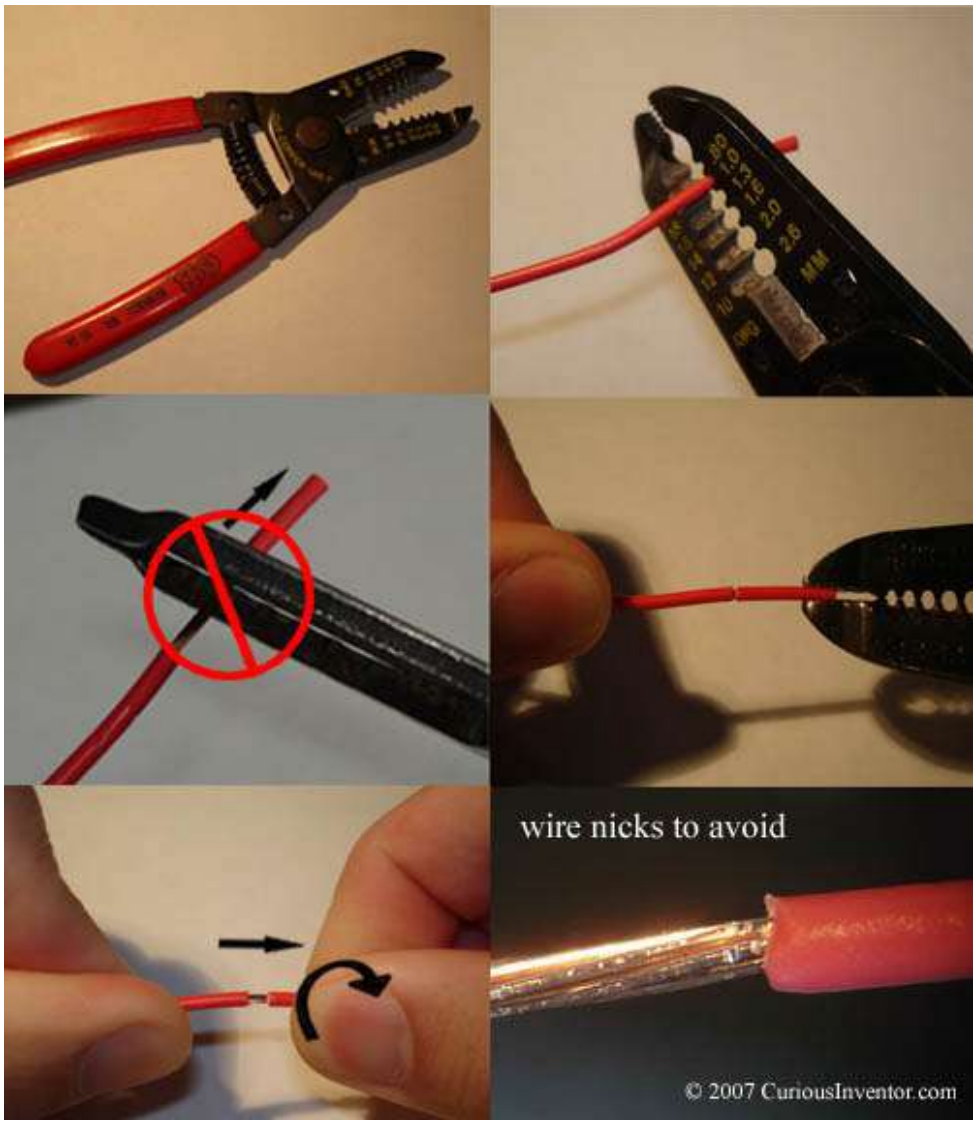

- **Automatic stripping:** With one squeeze these cut and pull off insulation.

- **Tinning:** Just like soldering a joint, the key here is to apply solder to the wire, not the iron tip. If the wire is hot enough to melt the solder directly, then it's hot enough to form a good bond with the solder. Hold the iron against one side of the wire and apply a small amount of solder in between the tip and wire to form a heat bridge (if there isn't already enough solder from tinning the tip). Now apply solder to the opposite side. The solder should wick into the strands. Move the iron and solder as necessary to coat the surfaces. You should still be able to clearly see the individual strands when it's complete.

  Don't tin wires that are going to be held in clamping terminals since the solder will slowly deform under pressure and cause the connection to come loose.

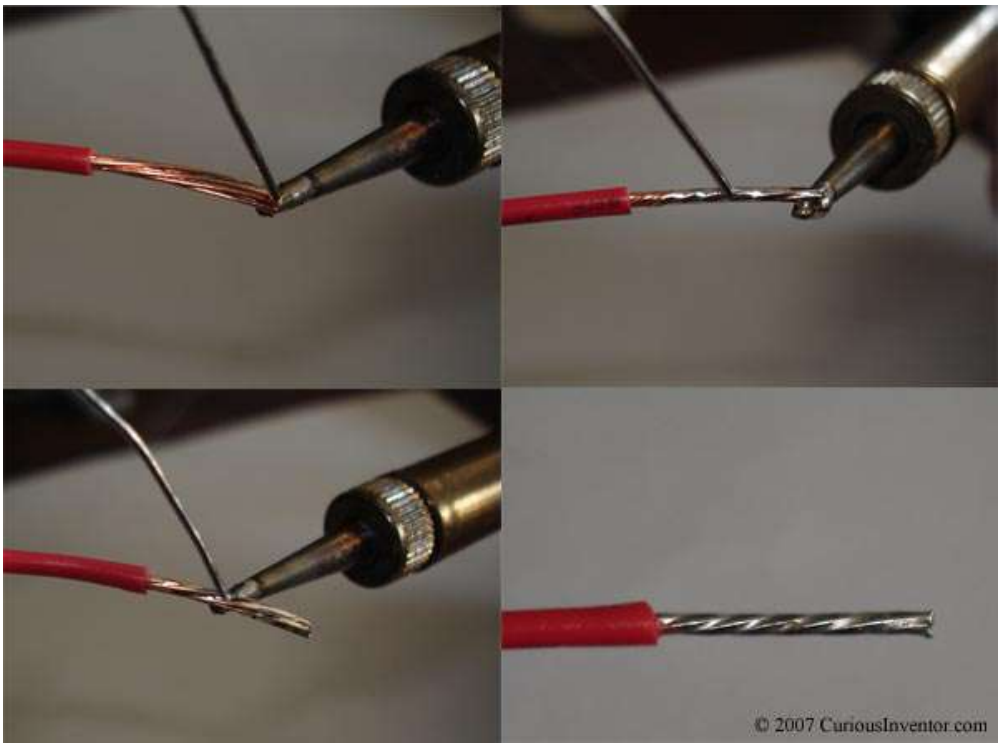

Got a lot of tinning to do? For under $300 you can get a vat of molten solder to speed up the process. The only catch is that there's no flux in the vat, so you need to dip the end of the wires in liquid flux before dunking them in the molten solder. Only dip the very end of the wire in the flux; capillary action will draw it further up the strands. If you dipped more than just the

end into the flux, the capillary action would draw flux beyond the insulation where it can't be cleaned, and would eventually corrode the wire.

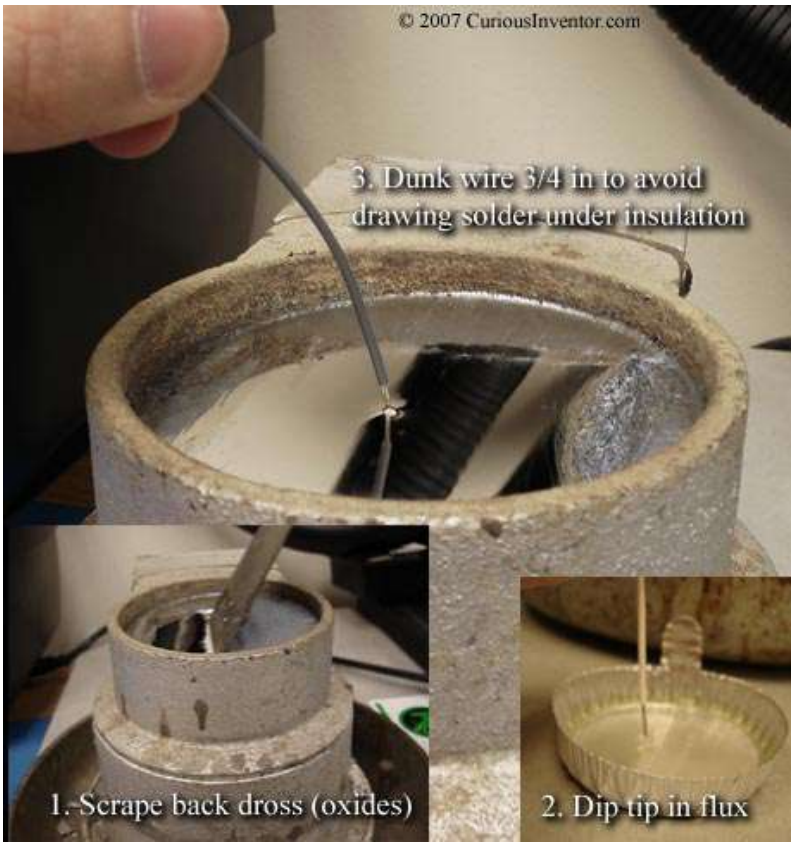

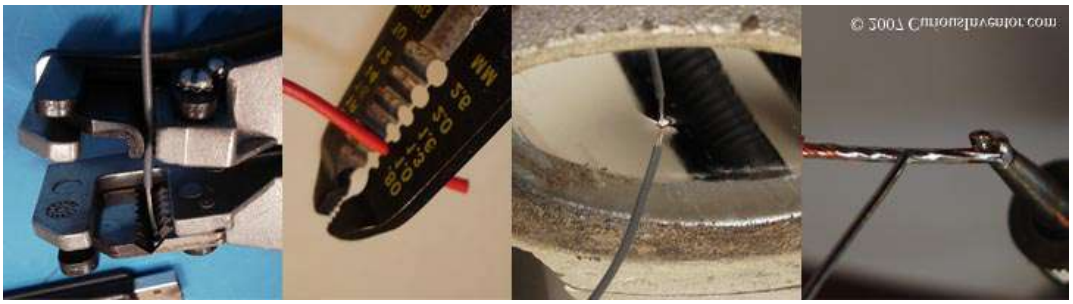

- **Insert, clinch and trim components:** First, make bends *before* inserting the components. Avoid stressing the connection between lead and component by bracing the lead with pliers while bending. Pliers with serrated tips aren't used in high-reliability production because the grooves can create nicks in the leads that eventually cause a break after a lot of vibration and thermal changes. Round nose pliers make it easy to make any sized radius.

  Unless the component has a metal casing or needs clearance for air flow to keep cool, insert it until it's flush with the board. This doesn't apply to some transistors, and also capacitors that have plastic coverings that need to be kept out of the solder joint. Clinch or bend out the leads so the component is held in place during soldering, and finally trim the leads to about the radius of the pad. Trim the leads before soldering since doing so afterwards can shock and crack the joint. Wearing safety glasses for this process is not at all excessive--those leads can get you. Everything else about proper component installation: NASA guide.

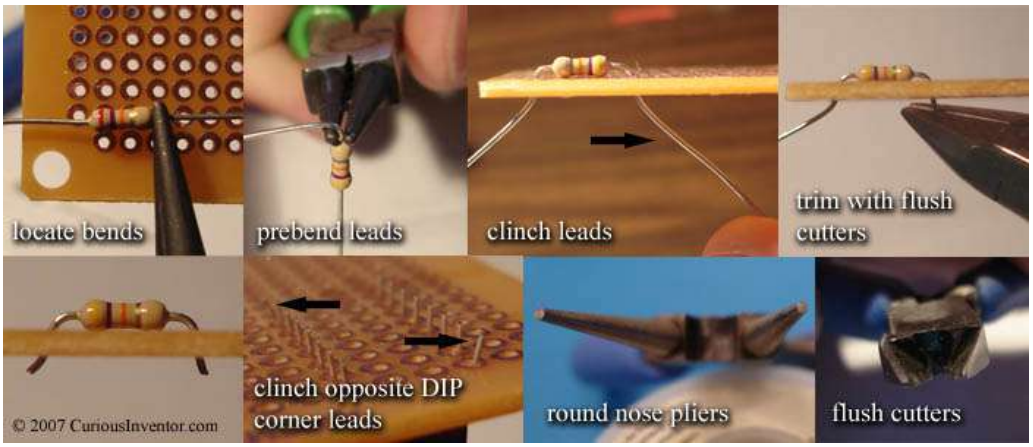

- **Add heat sink:** Some semi-conductors (some transistors and diodes) are especially heat sensitive. This clip acts a heat shunt to keep the transistor protected.

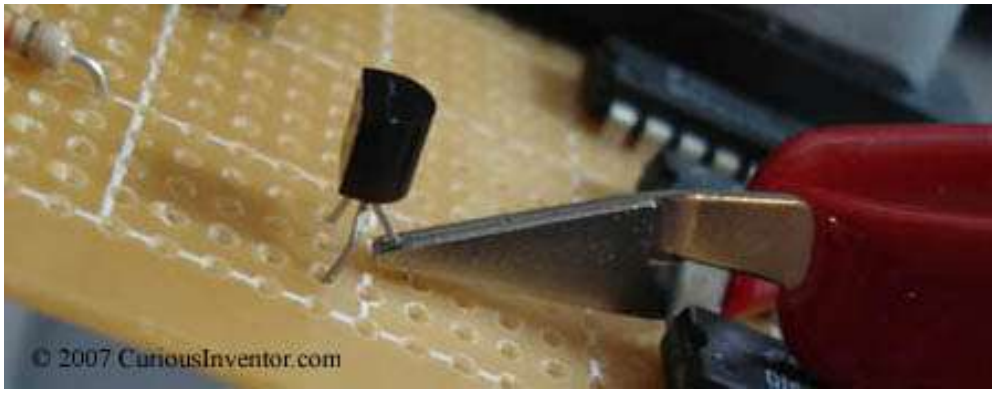

Clean and tin the Tip

· **Regular cleaning = easier soldering and longer tip life:**The iron tip's ability to transfer heat is drastically reduced when it gets covered in oxides and burnt flux residues. Not only does heat not transfer as well through this debris, but the contaminants also prevent solder from wetting or sticking to the tip. Most heat transfer actually goes through a fluid solder "heat bridge" that lies between the iron tip and components, so an iron tip that repels solder will be very ineffective.

The longer oxides and charcoaled flux residues remain on the tip, the harder they become to remove, so it's a good idea to clean the tip every time you pick up the iron.

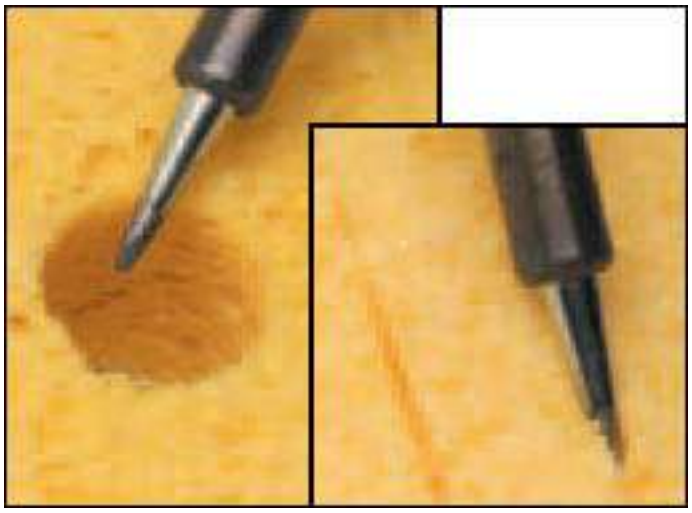

Wiping the iron on an edge of a hole cut into a sponge can help to remove oxides easier, and also allows waste to fall away. A dry cleaner can also be used. It consists of soft metal shavings that are coated with flux. You clean by thrusting the iron into the shaving a few times. By avoiding the thermal shock of touching a damp sponge, these cleaners help to increase tip life, and in our opinion, do a better, faster job.

Usually touching the tip with rosin-cored solder will supply enough flux so that oxides can be removed with a damp sponge. If this isn't sufficient, you can purchase "tip tinners and cleaners" that are a mixture of solder paste and flux. The flux is oftentimes stronger (more activated) to help remove oxides.

Finally, when that doesn't work, special polishing bars to can be used to salvage extremely bad tips. Another last resort is to gently rub the oxides off with an emery cloth or soft steel brush. Cover the tip immediately with solder after cleaning to prevent further oxidation. Never file the tip to clean it or form a different shape. The tips are mostly copper with a protective iron plating, and once that plating is pierced, the tip will die quickly. Copper is used because it's an excellent heat conductor, but if exposed to solder, it will quickly dissolve into the solder.

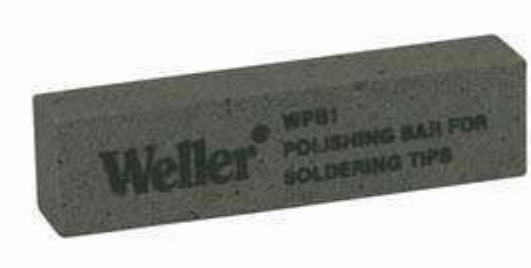

Tin the tip: Add a small amount of solder back onto the tip. This helps to protect the newly cleaned and exposed tip, and also helps to transfer heat to components.

Heat and Solder the Joint

- **Heat the joint:** Place the iron tip so that it touches both the component lead and pad--the goal is to get as much surface area contact between the iron tip and joint as possible. Almost no heat will travel through the point.

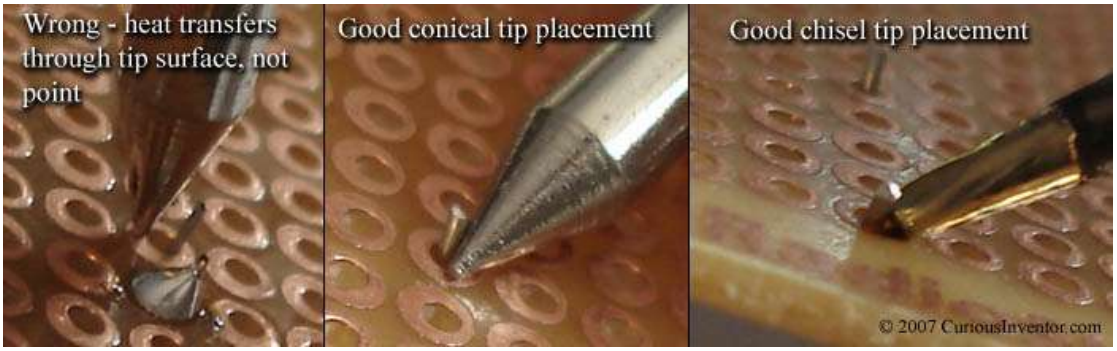

- **Make heat bridge:** Add a small amount of solder between the tip and the work--heat transfers much faster through the liquid solder than dry surface contact. This is why a tip that won't "wet" is so difficult to use. Pressing hard should not be necessary. This step may not be necessary if there's enough solder already on the tip from tinning it after cleaning.

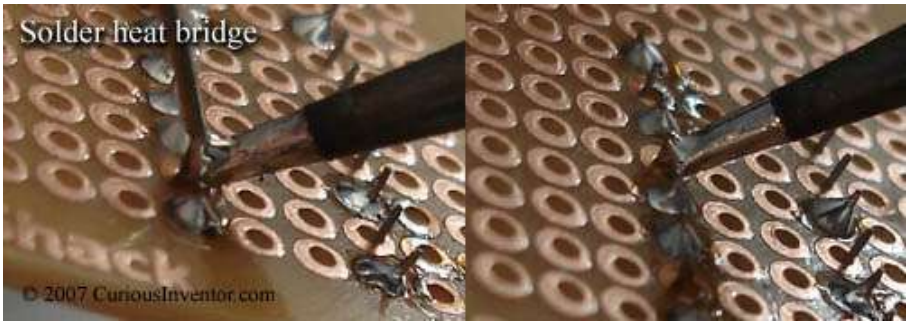

- **Apply solder to opposite side:** Apply solder to the parts, *not* the iron. By doing this, you ensure the parts are hot enough for the solder to "wet" and bond with them. Also, solder will run towards the heat source, so applying solder opposite from the iron helps to spread it out and cover the joint.

  For larger joints, rather than dumping in all the solder quickly, continuously pulse in small amounts to keep a fresh supply of active flux available.

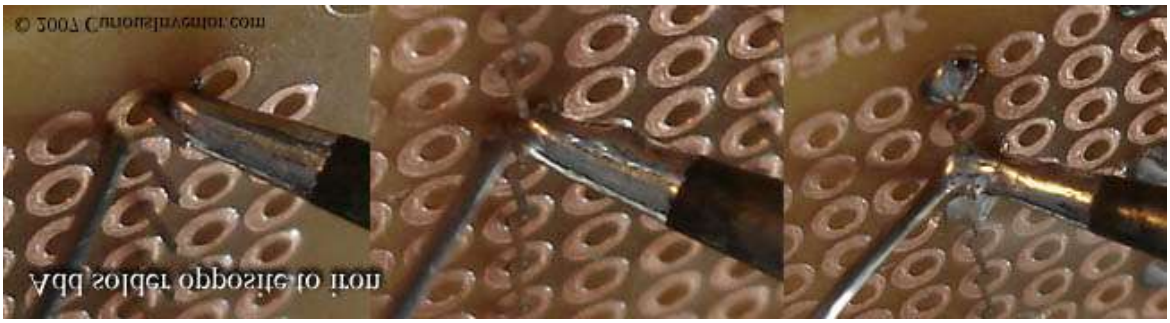

- **Time:** The joint should take about 2-5 seconds total time for standard 60/40, 63/37 lead based solder and a non- no-clean flux, and up to 7 seconds for lead-free solder. Lead-free solder just takes longer to "wet" the metal.

  Wetting is how easily and quickly solder spreads out over a surface. A water droplet on a freshly waxed car shows poor wetting, as does solder on a heavily oxidized soldering iron tip. It basically comes down

to how attracted the liquid molecules are to each other verses the surface (see surface tension). In industry, tests are done to determine the "solderability" of materials by measuring the time it takes solder to spread out over a surface, or measuring how much force a pot of liquid solder will pull down on a component partially submerged.

Good pictures and description of wetting and surface tension. Contains a video of a razor blade floating on the surface of water until a drop of soap is added.

A brochure for a solderabiliy testing station. Scroll down a few pages to see some great pictures of this machine holding one lead of a surface mount chip in a drop of solder.

Another related wiki: wiki/Surface_energy

In general, the goal is to make the joint as quickly as possible. Longer times can char and damage the board, lift pads, overheat components, burn off and polymerize flux (making it harder to remove), and finally lead to a more brittle joint. Solder doesn't just freeze on a joint, tin in the solder dissolves and chemically reacts with copper in the connection to form a new bonding material, called an "intermetallic layer". While this layer is what makes an excellent thermal and electrical bond, it is also extremely brittle; a doubling of its thickness reduces joint tensile strength by half (ref 1). Since this layer grows faster with higher temperatures, joints should be made using the coolest temperature and shortest soldering time possible. This layer is also why re-heating joints has been shown to weaken them. Having said all this, I have to admit that I don't know just how long is *too* long for projects that don't need to operate for 30 years with 100% reliability. After 10 seconds there's a good chance the flux has been used up.

- **Remove solder, then iron:** Pull the iron out fairly quickly to avoid leaving a solder spike.

- **Good and bad joint gallery:** The solder should smoothly ramp to meet surfaces and be shiny in appearance if it's lead-based. Lead-free solder will have a duller and grainier surface, but will still be a good joint as long as there are no signs of non-wetting. The important thing to look for is any solder that looks like it didn't cling to a surface, or is just sitting on top or next to a surface.

Gallery of joints:

A NASA gallery of every possible joint / board defect you could ever imagine. Here's another great gallery of defects.

Great comparison pictures between lead-based and lead-free joints. p. 34

Good joints:

Great joints:

What's the right amount? A large amount of solder is not needed, just enough to cover the pad and lead without any gaps (actually, only 270° is required by IPC J-STD-001). The measure for too much solder is whether or not you can see the outline of the lead in the solder. This is important because you need to be able to see whether the solder adhered or "clung" to the lead (indicating a true bond), and

didn't just freeze around it. This applies to all types of joints: tinning wires, soldering to connectors, surface mount components... the solder should never completely hide the underlying wires or leads.

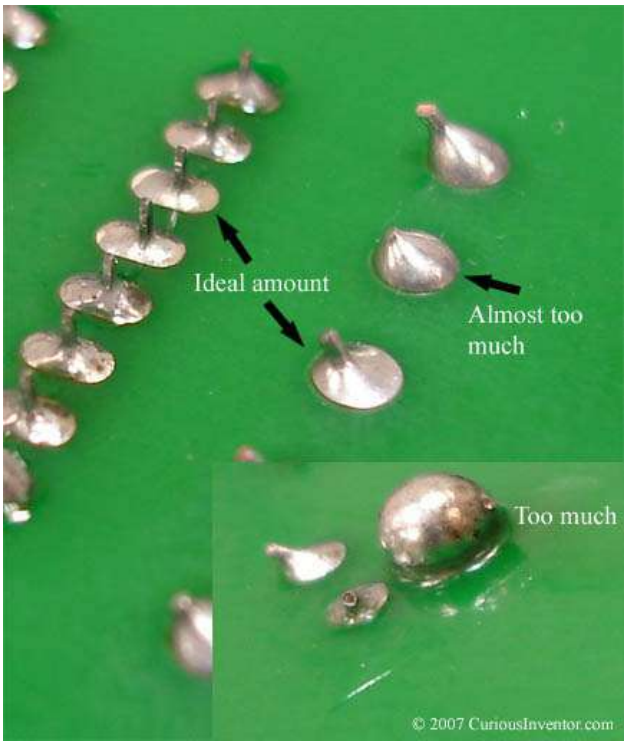

Disturbed joint (bad): If the component moves during solidification, the internal structure of the solder will have fractures, leading to a high resistance or unreliable electrical connection, as well as a fragile mechanical one. The solder also appears dull and grainy--typical signs of a "cold" joint that doesn't actually bond with the underlying surfaces.

"Cold" joints are often formed when the underlying pad or lead didn't get hot enough for the solder to wet it.

Awful joints:

© 2007 CuriousInventor.com
Extreme over-heating
and pad lifting
No adhesion to lead--oxidized lead
Resting on and not adhering to
pad--insufficient pad heating
Solder resting on pad, not adhereing
Solder was applied to iron first and
then transfered to joint

Clean Up

Most manufacturers will clean off residues from any flux that isn't labeled "no-clean," despite flux datasheets like Kester's that say even some of the more active fluxes do not need to be cleaned. For short life-span hobby projects, it probably doesn't matter unless you're using a solder/flux labeled "organic" or "water-soluble"--these fluxes leave behind very aggressive acids that will quickly eat away circuits. Cleaning may be necessary if you're applying a protective coating that won't adhere to flux residues. Finally, some rosin residues are tacky and may attract dust that can short a circuit.

The fact that a flux is made from rosin doesn't tell you much about how strong it is or whether it should be cleaned. What matters is how concentrated the mix is and how much acidic (halides) activators were added. RadioShack® doesn't supply any information on the flux in their standard rosin-cored solder, but it's probably weak enough that the residues do not need to be cleaned off.

Isopropyl alcohol works decently on rosin-based residues, but clean shortly after soldering because the residues quickly harden. Use water for water-soluble fluxes. This pump containing bottle dispenses a little alcohol when you push down on the top with a brush, and keeps the rest from evaporating. If you are going to clean, make sure you wipe up the remnants with a lint-free cloth--don't just spread them around the board with a brush and alcohol.

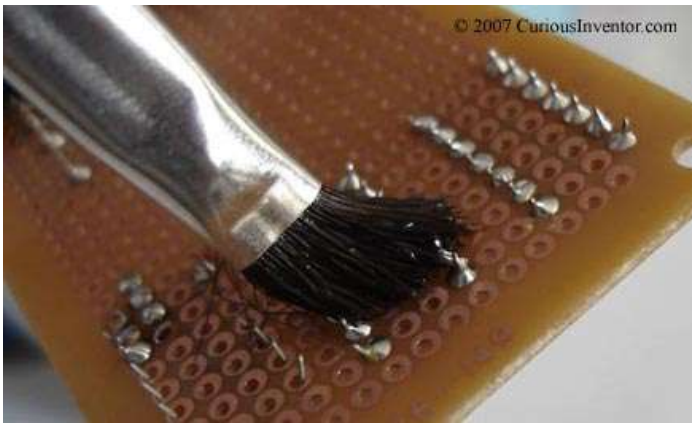

Desoldering

The three most common inexpensive ways to remove solder include a "solder sucker", solder wick, and an iron with an attached desoldering bulb.

- **Solder Sucker:** To use, press in the plunger, heat up the joint, and as quickly as possible, pull out the iron, place the sucker's nozzle over the joint and press the release button. It may take a few iterations to clean out a joint enough to wiggle free a component. On plated through holes it may actually be easier to add *more* solder to the joint before sucking, since the sucker won't be able to create a vacuum with too little solder remaining.

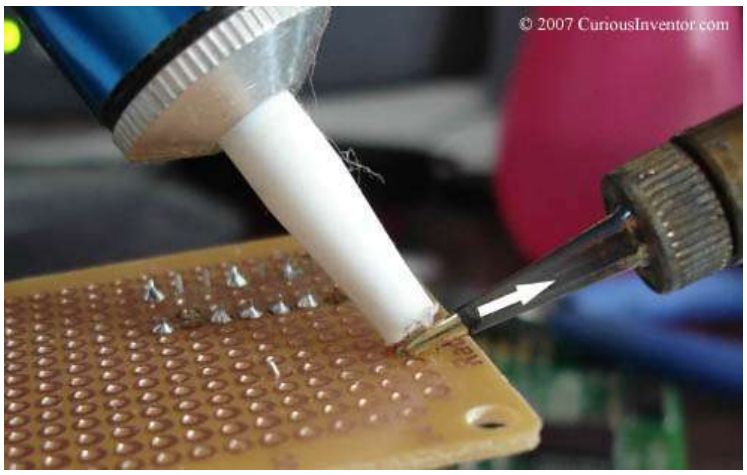

- **Desoldering Iron:** This works just like the solder sucker, but is much easier to use because there's no race to suck out the solder before it freezes, as with the "solder sucker".

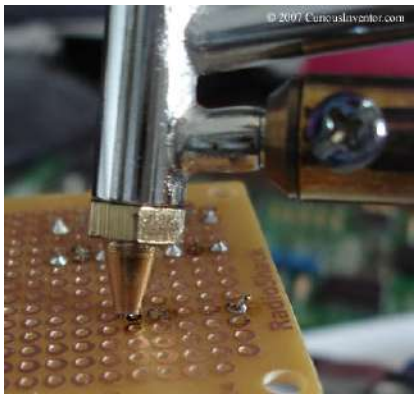

- **Solder Wick (desoldering braid):** The above two tools will often not be able to completely remove all the solder. Many people use the sucker devices above to remove most of the solder, and then get the rest with solder wick, which absorbs solder through capillary action. It's a fine weave of copper wires that are coated in flux. Place it over a joint and then heat from the opposite side with a soldering iron. It may help to have a bit of solder already on the iron's tip to speed heat transfer.

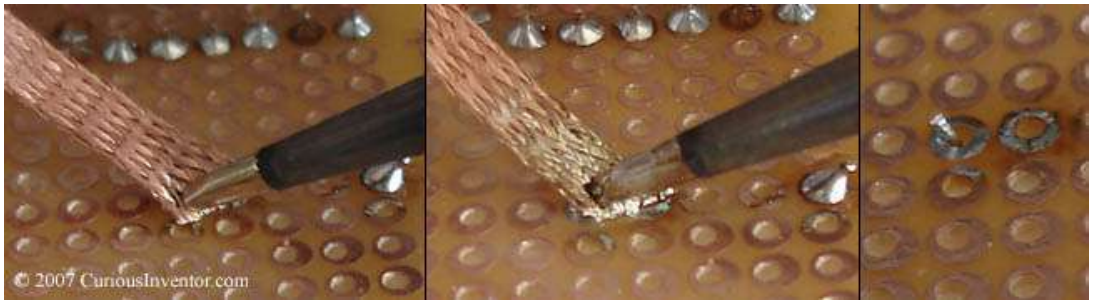

Surface mount desoldering: Surface mount chips are especially hard to desolder because it's very difficult to completely remove all the solder pin by pin, and avoid overheating the board and lifting a pad. Professional shops use expensive hot air guns or special tips (shown below) to heat all the joints at once.

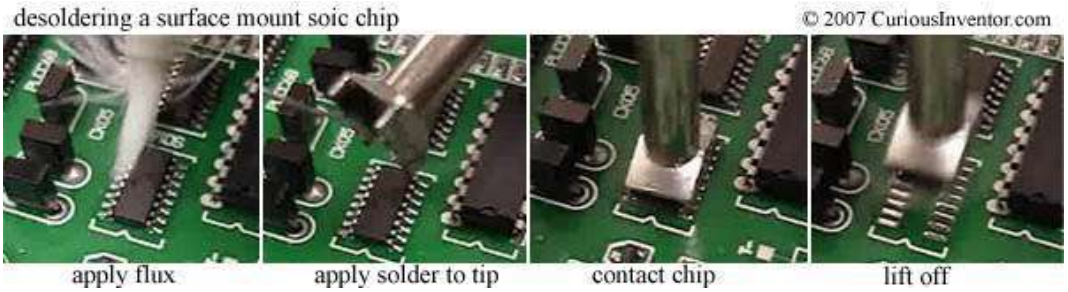

There are fortunately a few cheap ways to desolder surface mount chips.

- ChipQuik provides an interesting solder that when melted over existing joints produces a new low-melting point alloy (under 200 °F) with a much longer solidification time. The longer solidification time enables you to melt all the joints at once and then flick off the chip.
- There are many guides for making a DIY hot air gun with the RadioShack® desoldering iron and a fish tank air pump. Engadget has one of the better how-to guides. Here and here are some more plus the supposed original.

The Ersa soldering primer

Soldering made easy

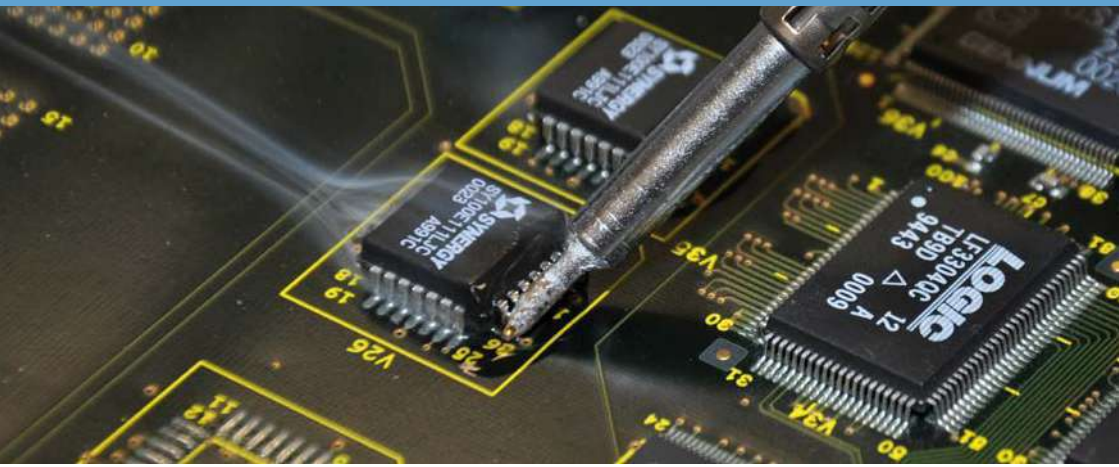

kurtz ersa

Soldering – a never-ending story

for more than 5,000 years already

Man had scarcely learned how to use metals for his purposes when the desire to join them arose in him. Many of the pieces of jewelry, tools and weapons we know from the Bronze Age owe their usefulness and beauty to the art of soldering.

Today, it is difficult to say who first discovered how to "glue" metals. One thing is certain - the goldsmiths of ancient Egypt knew how to join gold and silver already more than 5,000 years ago. Their colleagues in Troy were also master craftsmen long before the ancient Teutons could even dream of such handicraft. Soldering really "came of age" when tin was discovered

as a joining metal. And that was, after all, already 4,000 years ago!

From then on, soldering technology was on its way. It first spread around the Mediterranean. The Cretans showed it to the Etruscans who then taught it to the Romans, Tunisians, Spaniards, followed by many others, including the less developed cultures of the time – the Swiss, Bohemians, Hungarians, Teutons and Scandinavians. From culture to culture, from generation to generation, the craft of soldering was continuously improved and refined.

The ancient Romans already laid down and soldered 400 km of leaden water pipes, conjured up stoves and bathtubs from bronze sheets, not to mention the excellent craftsmanship of their armorers and goldsmiths. Apart from craftsmanship in soldering, our understanding of the science of soldering has grown and has been refined over the centuries.

Today, soft soldering in the electronics industry has developed into a full-fledged production technology, encompassing the fields of mechanics, chemistry, physics and metallurgy. Ernst Sachs, the founder of Ersa (the company name consists of the initial letters of his first and last name) contributed to this development. In 1921 he developed the first electrically operated soldering iron for the industry that was manufactured in series. Since that time, Ersa has committed itself to the further development and perfection of soldering technology with great passion and extending its full power of innovation.

Today, Ersa stands for the most comprehensive product range in the soft soldering technology worldwide and for more than 90 years of industry experience and innovation, know-how and highest product quality.

The Ersa soldering iron product range covers ultra-fine soldering tips, classical soldering irons powered from the standard power net and special soldering tools up to the 550 W hammer soldering iron. Ersa's electronically temperature-controlled soldering stations represent the industry standard, as does the extensive range of rework and

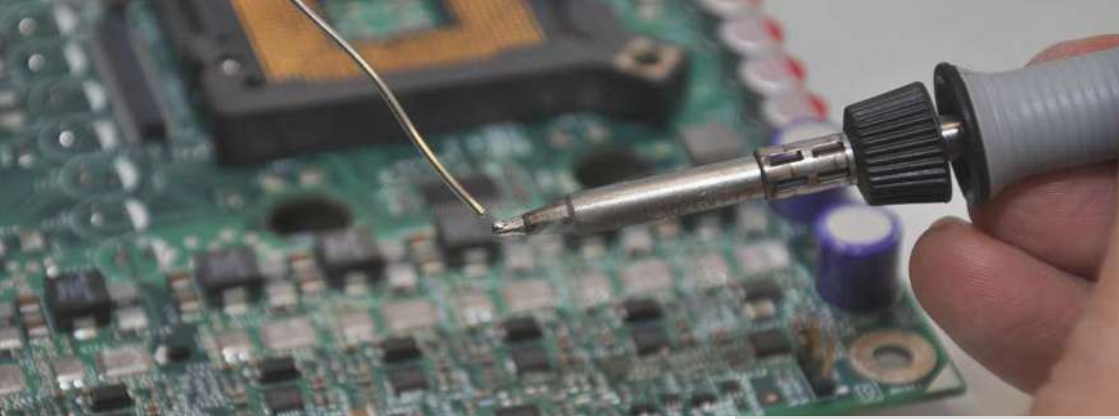

inspection systems, wave-, reflow- and selective soldering systems. The line of Ersa screen printers complements the product range.

Ersa's quality soldering tools are used in the hobby area, such as, for example, in model-making or tiffany soldering, in the craft sector, in laboratories and in industrial electronics manufacturing.

New challenges for the soldering technology were raised by the ban on certain hazardous substances (RoHS) in 2006. Since 1 July 2006 electric and electronic equipment may not contain any lead, mercury, hexavalent chromium, PBB (Polybrominated biphenyls) or PBDE (Polybrominated diphenyl ethers).

In many cases this restriction entailed having to depart from the use of the well-known soft solders based on tin and lead.

By publication of this small primer, Ersa would like to facilitate your entry into the "World of Soldering", and raise your enthusiasm for a modern technology with a long history.

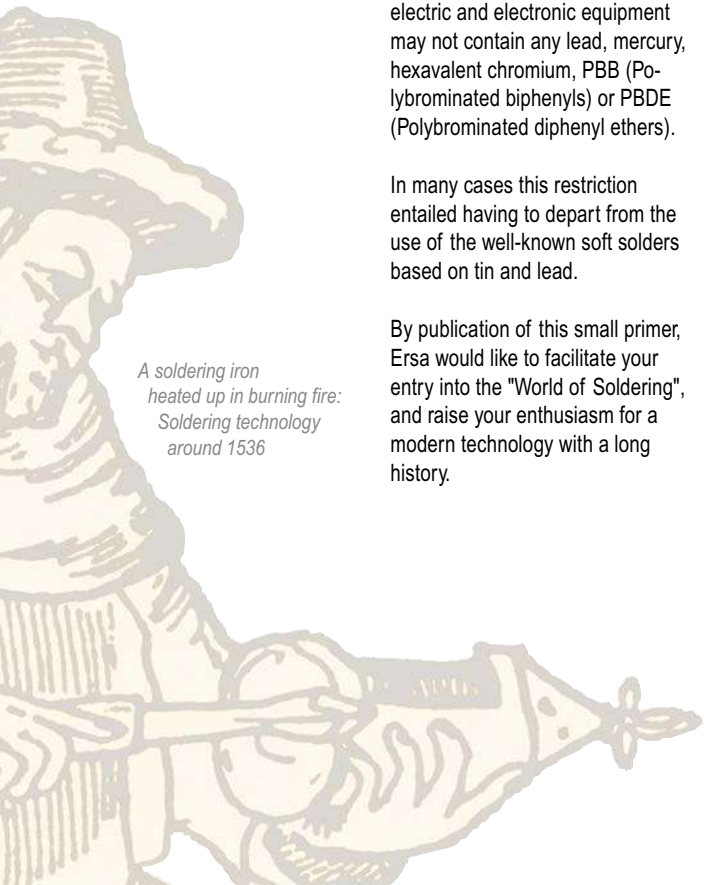

A soldering iron heated up in burning fire: Soldering technology around 1536

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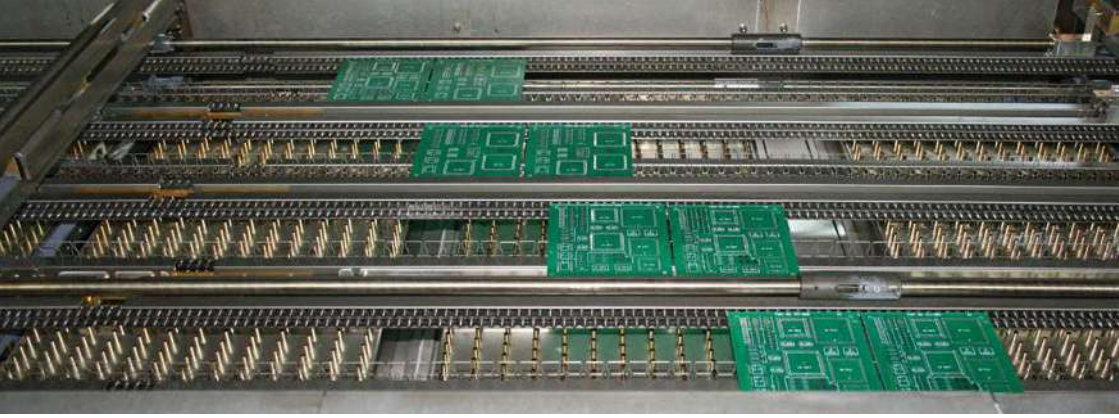

Solder joints hold the world together

Connecting pacemakers and solar parks

To imagine today's world without soft soldering is not possible. It is the means to fabricate safely functioning, electrically conducting connections. Regardless of whether we talk about power technology, drive technology, telecommunications, automation or electronic controls – in all those fields soldered connections have a decisive share that everything functions in a way as has been foreseen and planned by the developers and

visionaries of the products. Today, soft soldering is such a common place occurrence, that no one wastes any further thought on it. We take the daily use of our computers, mobile phones and play stations for granted, the modern comforts provided for by electronics found in modern automobiles is expected as a matter of course, and we fly – privately or on business – to the farthest spots in the world.

Consequential damage because of the failure of a solder joint in an iPod is relatively limited. It is a different matter altogether, though, if the electronics in an airplane full of vacationers, in a space shuttle, or in an implanted pacemaker fails.

Such failures are immanently life-threatening. But not to worry – the highest quality demands apply for those applications, and rightfully so!

Aside from soldering in consumer electronic products, there are numerous other applications such as, to name but a few, alternative power generation with wind turbines or solar parks, R&D departments and in work performed by craftsmen such as electricians and plumbers. Let us not forget the many part-time and hobby users for whom there are no limits curtailing their phantasies and artistic freedom when handling a soldering iron and solder.

The art of soldering

What's behind it?

In a soldering process two metal parts are joined by means of a molten metallic bonding agent (solder), whereby the melting point of the bonding agent is always lower than that of the metal parts to be joined. If the melting point is below 450 ºC, then it is a soft soldering process, if it is above, it is called hard soldering or brazing. Welding, on the other hand, is the process where two metals will be heated up to their melting point, at which time they will, together with a filler material, form a pool of molten material causing coalescence. In soft soldering, the seams between the metals to be joined will be filled with a tin alloy. It is important that the alloy does not simply stick to the foreign metals' surface after cooling but unites with the metal. For this purpose, a small quantity of the foreign metals must dissolve and unite with the tin alloy forming a mix of crystals – the so called diffusion zone. That is the task of the tin, whereas the alloy's other components are responsible for the solder liquefaction and the joint's mechanical stability. A solder joint consists of the following layers:

① Base metal
② Diffusion zone
③ Solidified solder
② Diffusion zone
① Base metal

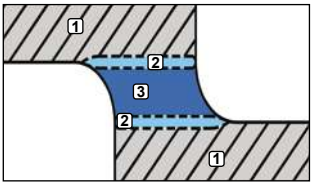

Cross section of a solder joint

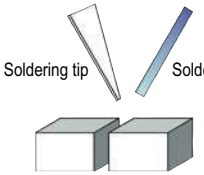

The prepared parts and the solder are heated

The liquid solder flows into the gap and fills it

The solidified solder joins the parts together

To achieve the highest mechanical stability, i.e. to assure the durability of the solder joint, the diffusion zone may neither be too thick nor too thin. Its ideal thickness is 0.5 µm. The formation of the diffusion zone depends on the temperature, the solder time and the alloy used. If the diffusion zone is too thick, the solder joint will be brittle and porous, whereas the formation of a zone which is too thin indicates that an insufficient connection or no mechanical connection at all has been formed.

Reaction of the flux during manual soldering on a PCB using flux cored solder wire

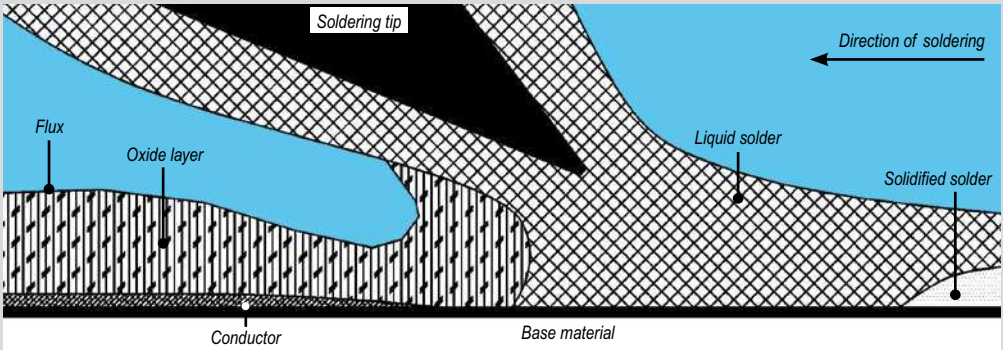

What do you need for soldering?

The basics – the 5 essential factors

1. The soldering iron

to provide the heat required

Heat is required to melt the solder. This is the soldering iron's job.

Temperatures of 200 ºC – 450 ºC are required depending on solder joint and solder alloy. In the field of electronics, the usual temperature lies between 250 ºC and 375 ºC.

In order to have the proper temperature for any soldering application, the soldering iron's thermal output and an efficient heat transfer to the solder joint to be made is decisive. One either selects a soldering iron that performs within the temperature range required, or a soldering station with temperature control is used. Temperature-controlled soldering stations enable the user to work on different applications without loss of solder joint quality, because of the precise control of the preset temperature at the soldering iron tip.

Both the soldering station's registration of the actual tip temperature should be highly precise, and the heating element should be powerful and recover quickly in order to avoid over-heated or cold solder joints.

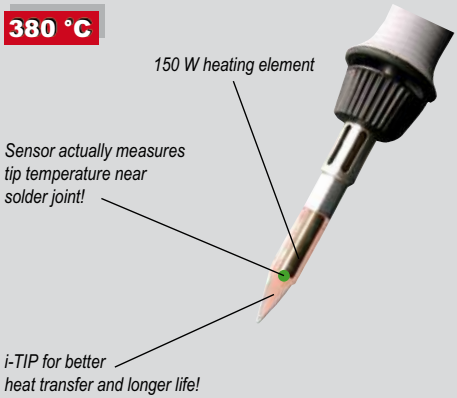

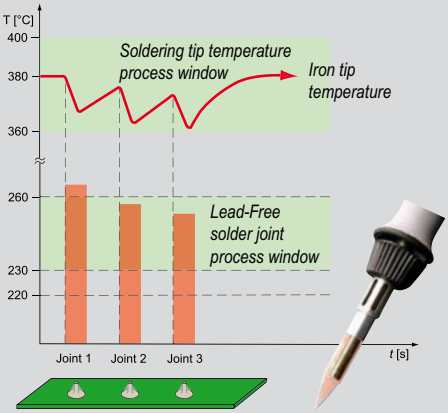

Temperature curve of controlled tip temperature when soldering multiple joints

2. The soldering tip

to transfer the heat from the heating element to the tip

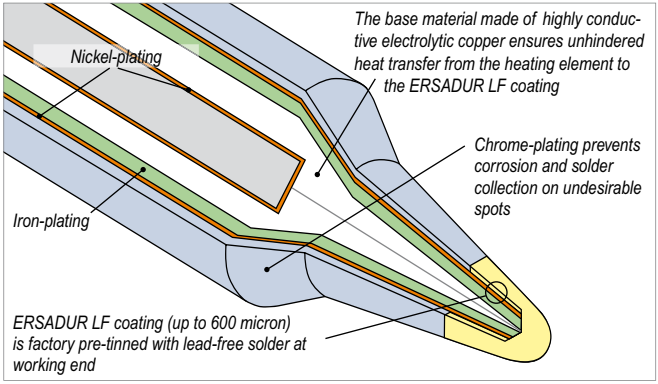

Cross-section of an ERSADUR soldering tip, non-scale representation

The soldering tip is the "heart" of the soldering iron and responsible for the heat transfer from the heating element via the solder to the solder joint. Depending on the soldering iron and the application, different types of tips are available. Prerequisites for good solder joints are the correct soldering iron tip shape, perfect heat transfer, a good condition of the tip and a reliable performance over time. In addition, the soldering tip has to convey also the necessary amount of sensitivity back to the operator.

How to take solder joint quality to its peak – ERSADUR long-life soldering tips

Traditional soldering tips are made of copper which conducts heat well and is inexpensive, but the tip oxidizes heavily when heated and releases copper particles into the solder until it has been "corroded" entirely. To maintain the tip in operational shape, it requires intensive care. Today, only coated soldering tips are used in electronics production – the largest field of application for soft soldering.

ERSADUR long-life tips have been conceived for continuous operation and for high-quality results. They are galvanically plated with an iron coating and protected against corrosion and oxidation by an additional chrome layer in a very special manufacturing process, developed and used exclusively by Ersa. And their perfect thermal conductivity protects the heating element from overheating and premature wear. Ersa offers a comprehensive range of soldering tips for the diverse requirements.

Proper tip care increases tip lifetime considerably:

- Never clean the long-life tip before putting the soldering iron into its holder, since the solder remaining on the tip prevents oxidation of the solder track.
- Always keep the long-life soldering tip covered with solder, as otherwise it becomes passive and will no longer wet properly.

Passive tips can be reactivated by the application of the lead- and halogen-free Ersa TIP REACTIVATOR. All that is needed is to wipe the hot tip on the surface of the regeneration compound. Furthermore, the hot tips should regularly be cleaned with a moist viscose sponge before soldering. Alternatively the tips can be dry cleaned using the Ersa "dry sponge", a sponge made of special metal wool. Dry cleaning has proven to be advantageous in lead-free soldering. The soldering tips are not cooled abruptly, and contaminated tips resulting from dirty sponges are avoided. Due to the slightly abrasive properties of the special wire mesh, passive layers that accumulated on the tip can easily be removed. Tip life is thus increased considerably in lead-free hand soldering.

Ersa TIP REACTIVATOR. A comprehensive range of accessories is available at ***www.ersa.com***

What do you need for soldering?

The basics – the 5 essential factors

3. The solder

for the connection

Metallic bonding agents (solders), mostly in the shape of a wire or a bar, are available as diverse alloys.

Soft solders consisted mostly of a mix of tin (Sn) and lead (Pb). Since the implementation of the RoHS directives on 01 July 2006 the use of solders containing lead is prohibited. Lead-free solders are usually alloys containing silver (Ag) and copper (Cu).

The alloy's composition determines melting temperature and physical properties of the joint. Criteria for the choice of an alloy are: production process, specification of the product, field of application, cost of the alloy.

Prerequisites for good soldering results are:

- Suitable soldering iron
- Clean surfaces of where to solder
- Sound soldering tip
- Suitable fluxes
- Suitable solder alloy
- Correct soldering time

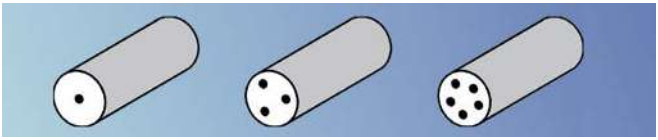

Solder wire with one or with multiple flux cores

4. The flux

for the ability to wet

Fluxes are used to attain the best possible bonding between solder and metal. They provide for metallically clean surfaces of the parts to be soldered, remove the oxides as well as other flow-inhibiting contaminations and prevent the formation of new oxides during the soldering process. A difference is made between acidic (as used in plumbing) and acid-free products (as used in electrical and electronic applications). It is most common to use solder wire with one or more flux cores in electronics production, whereas bar solder is the form of choice in plumbing as well as in the radiator and auto body work.

Examples of some common alloys

Alloy	Flux type	Melting point / range
L-Sn60Pb40	EN 29454/1.1.2 (F-SW 26/DIN 8511)	183 °C – 190 °C
L-Sn60Pb38Cu2	EN 29454/1.1.2 (F-SW 26/DIN 8511)	183 °C – 190 °C
L-Sn63Pb37	EN 29454/1.1.3 (F-SW 32/DIN 8511), free of halogen	183 °C eutectic
L-Sn62Pb36Ag2	EN 29454/1.1.3 (F-SW 32/DIN 8511), free of halogen	178 °C – 190 °C
Alloy – lead-free / complying RoHS-WEEE		
L-Sn95,5Ag3,8Cu0,7	EN 29454/1.1.2 (F-SW 26/DIN 8511)	217 °C eutectic
L-Sn96,5/Ag3,5	EN 29454/1.2.3 (F-SW 33/DIN 8511), free of halogen	221 °C eutectic
L-Sn99,3Cu0,7	EN 29454/1.2.3 (F-SW 33/DIN 8511), free of halogen	227 °C eutectic

5. A safe and clean working environment

to ensure quality and health

Safety first, especially while soldering. The VDE and GS emblems ensure the electrical safety of soldering equipment. The use of the VDE sign obligates the manufacturer to monitor production accordance with test guidelines and to conduct tests according to the regulations determined by the VDE testing institute.

Noxious gases develop in every soldering process

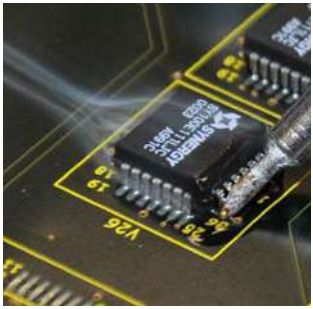

Health protection during soldering

- The breathing zone is very close to the soldering process during manual soldering, and the solder is added by hand. Thus there is the danger of contaminated air and hands or items which may have been touched
- Flux vapors can be damaging to the operator's health and should be kept out of the breathing area. Suitable devices for this purpose are solder fume extractions, which extract the smoke and associated vapors from the workplace and remove particles and gases. Modern fume extractions can be programmed to operate only when the soldering process is taking place, thus saving energy.
- One should never eat, drink or smoke in rooms where soldering is preformed. Contaminations which remain on the hands can enter the human organism through food or cigarette smoke.
- Hands should be washed thoroughly after soldering.

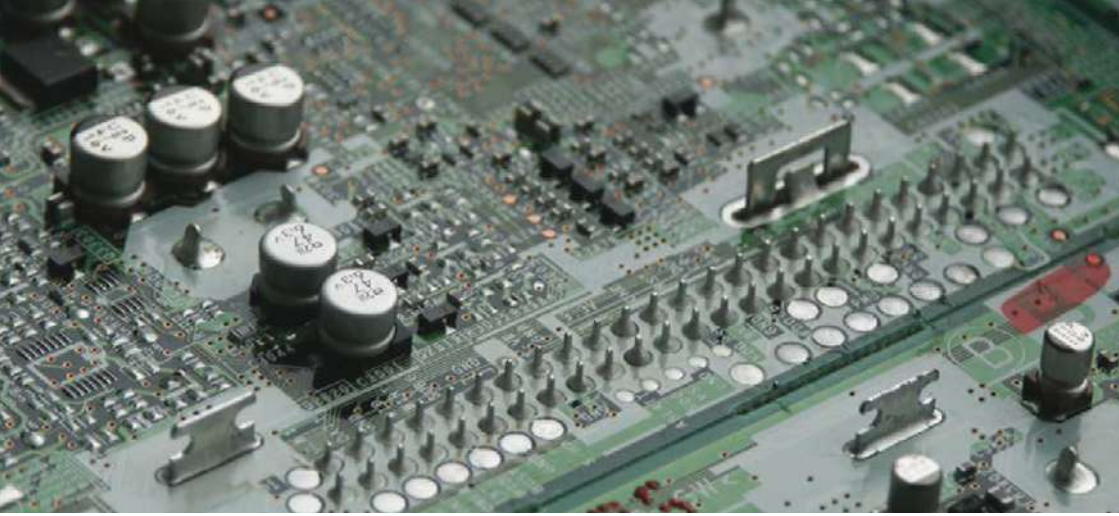

Best solder quality

due to the right preparation and correct soldering parameters

Preparation

The most important prerequisite for a good solder joint is absolute cleanliness. Conductor and component must be free of dirt, oil and oxides. They can be removed with solvents or flux.

Prior to soldering ERSADUR soldering tips should be cleaned while hot with a moist sponge or with a metallic dry sponge. Do not file the tip as you would copper tips, because this would damage the protective coating and render the tip unusable.

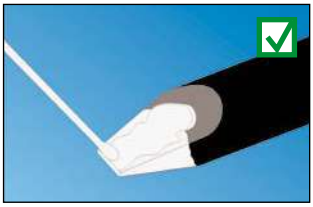

Wetting the soldering iron tip

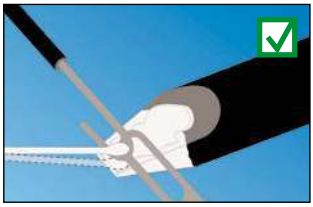

Soldering a joint

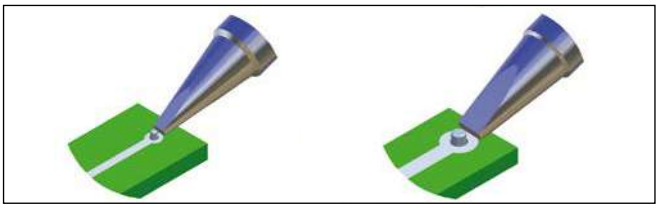

The selection of the right soldering tip is decisive for good soldering results

Soldering process

The soldering process has three phases: wetting, flowing, and bonding, whereas the working temperature is the most important criterion. It is best to work at the lowest temperature at which the three phases can progress smoothly. This requires some experience. A temperature-controlled soldering station will definitely facilitate this work. Place the tip on the joint to be soldered after cleaning and heat up the joint. Then feed the flux-cored solder wire between the soldering tip and the joint and melt as much solder as is required to wet the complete joint. Then remove the solder wire first and right after that the soldering tip to prevent overheating the solder. Allow the solder to solidify, avoiding any vibrations or jarring during this time.

Soldering time

The soldering process should be completed within 2 to maximum 5 seconds with a correctly dimensioned soldering tip. When soldering electronic components with lead-free solders, experience shows that more time is required. But even here requiring more than 5 seconds is not permissible, and it indicates that either the temperature setting is too low or the soldering iron lacks the necessary power.

Solder joint quality

When the leads of the components mounted on the board are crimped, a good solder joint has been formed when the contour of the soldered lead is still visible. This will not be the case, if an excessive amount of solder has been used to form the joint.

A further quality attribute is the wetting angle. This consideration is based on the fact that good wetting of the pad, discernible through a small wetting angle, has given rise to the formation of a diffusion zone (intermetallic zone). Wetting angles of up to 25º identify a good joint, wetting angles of up to 50º are still tolerable in manual soldering.

Another quality indicator is what the solder surface actually looks like. It should be smooth and shiny, without any porous areas visible. Grainy surfaces indicate either overheating of the solder or an excessive soldering time. Using lead-free solders, especially silver loaded alloys, matt surfaces may form.

The only absolute quality indicator for a sound and strong solder joint is the formation of the diffusion zone. In the diffusion zone, intermetallic compounds of copper and tin are formed, whose presence is the final proof of quality (mixed crystals, see page 5). Unfortunately, the only way to make this zone visible is through a destructive test (sectioning of the joint). If the diffusion zone is too thick, the solder joints have no tensile strength and become brittle. The higher the soldering temperature and the longer the soldering duration, the thicker the diffusion zone will be. Therefore the joint should be made at the lowest suitable temperature and within shortest soldering times.

As soon as the last solder joint has been made, the soldering iron is placed securely into the holder. At this time, the tip should not be cleaned, because the remaining solder on the tip prevents oxidization.

Correct!

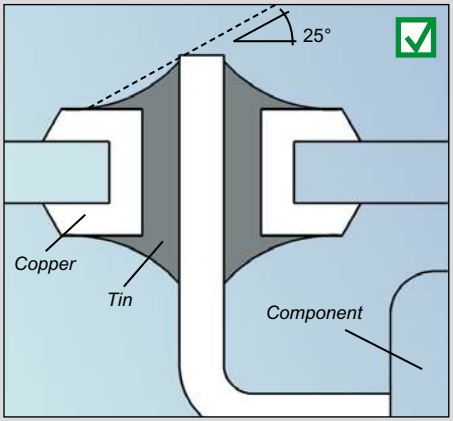

Wrong!

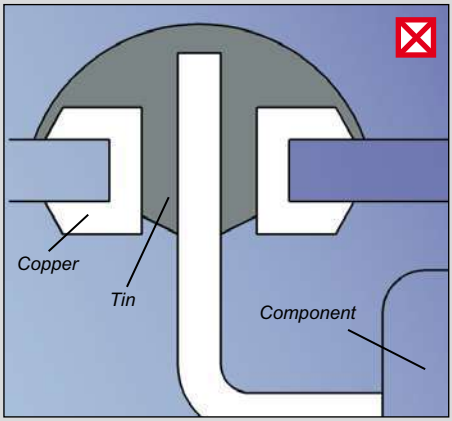

Desoldering with a solder wick

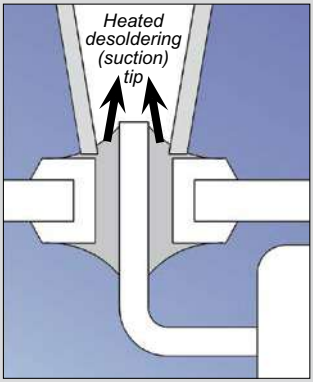

Desoldering with a temperature-controlled soldering iron

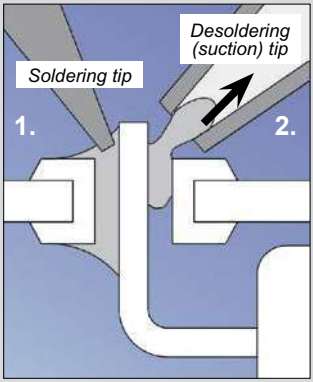

Desoldering with a desoldering pump

To achieve good results in desoldering, it is essential to select the right equipment. One can choose between desoldering wicks (desoldering using the principle of capillary action), mechanical desoldering pumps or electronically temperature-controlled desoldering systems. These are divided in desoldering systems with conductive heat or those with hot air.

Correct desoldering made easy

The right tool for each application

Desoldering

Reheating is not recommended for repairing a faulty solder joint. It is better to remove the solder and to resolder the joint. When using a desoldering pump, the solder joint has to be heated with the soldering iron until the solder has molten. Then the tip is removed and the desoldering pump is placed on the joint to extract the solder.

Using a heated desoldering tool, the hollow desoldering tip is placed on the joint to be repaired, making certain that there is good thermal contact. Once the solder has molten, it is extracted.

Desoldering is also dependent on proper tip selection. For example, the desoldering tip's inner diameter should be the same size as the diameter of the through-hole or even slightly larger (by max. 0.3 mm, see above drawing). The best desoldering results with least damage to PCB or the components can be achieved with temperature-controlled desoldering irons (also see pages 24/25). Please note that basically it has to be distinguished between the desoldering of through-hole components and the desoldering of SMD components.

Temperature-controlled desoldering iron

Sucking up the old, molten solder remnants with a mechanical solder sucker (desoldering pump)

Some examples of SMD components

C.CAPAC./MELF

SOT&DPAK

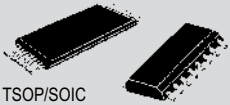

TSOP/SOIC

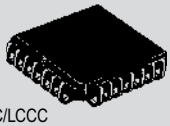

PLCC/LCCC

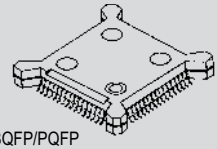

BQFP/PQFP

Ever smaller, ever finer

SMD technology, a true challenge

SMD Soldering

SMD technology (Surface Mount Device Technology) is currently the standard process in electronics manufacturing. Ever smaller and highly integrated surface mount components place growing demands on SMD soldering equipment.

Single solder joints, for example on resistors, are made with ERSADUR long-life soldering tips starting with a diameter of 0.2 mm. Fine-pitch connections with a high pin-out, i.e. IC's, are most efficiently soldered with Ersa PowerWell soldering tips.

Ersa PowerWell technology for soldering fine pitch components within seconds

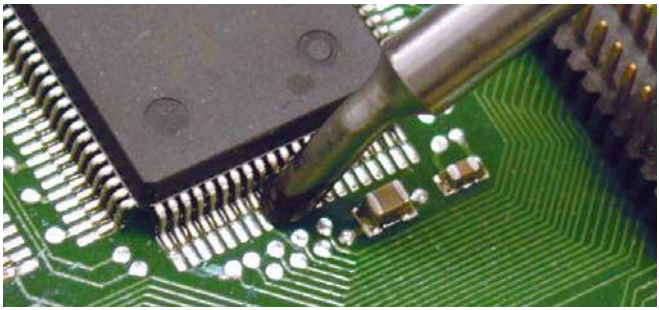

Soldering fine-pitch components

Process guide description

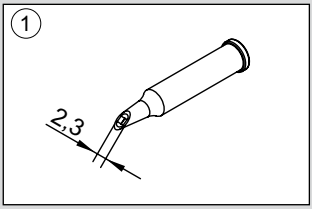

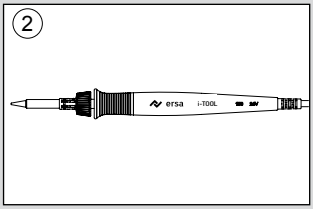

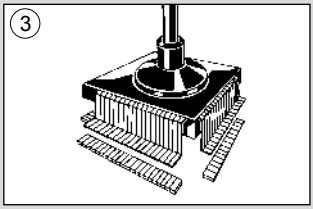

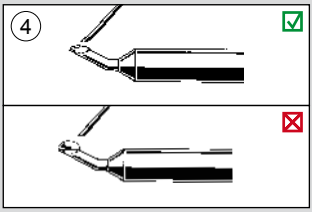

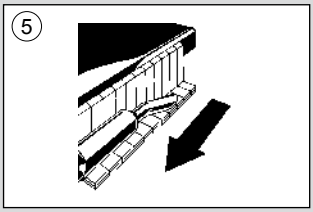

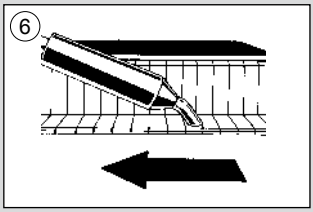

At first glance, soldering fine-pitch components by hand seems to be a tough job. Yet it is easy, with the right equipment at hand:

Insert an Ersa PowerWell i-TIP (1) into the i-TOOL soldering iron (2) and set a tip temperature of 285 ºC to 360 ºC (depending on the alloy used – tin/lead or lead-free).

Then position the component (3) and fix two corner pins.

Add flux cream (also see page 30) to the pins on all 4 sides. Clean the front and concave portion of the PowerWell tip with a damp sponge or the Ersa dry sponge.

Fill the concave portion with solder to slightly above the rim by melting the solder wire, until a small dome occurs (4). Take care not to add too much solder.

Place the i-TOOL lightly on the flat section of the pins (5), and pull the tip across the pins towards you (6) without exercising pressure.

Repeat steps (4) to (6) to solder the remaining sides.

Good solder joint, sufficient solder and good fillet

Wrong: insufficient solder

Wrong: too much solder

SMD desoldering in 3 seconds – with the Ersa desoldering tweezers

Some examples of different desoldering tip shapes:

to desolder and remove MELF's

to desolder and remove SOIC's

to desolder and remove QFP and PLCC components

SMD Desoldering

To desolder or rework a damaged SMD component, the suitable tools are required to remove the component from the board. When using desoldering tweezers, it is extremely important to select the proper pair of desoldering tips. After having desoldered the component, the pad has to be cleared of the residual solder (e. g. with a suitable soldering tip and a no-clean desoldering wick). Afterwards the new component can be positioned and soldered. An optional IR heating plate is a very useful addition – particularly in lead-free hand soldering applications.

More comprehensive instructions on SMD desoldering is available in the process description "SMD desoldering" on our website at www.ersa.com. For the soldering and desoldering of BGAs or other high pin-out SMDs, particularly those with hidden joints, we recommend the semi-automatic Ersa rework stations (see page 31).

Solder melting and removal with a desoldering wick

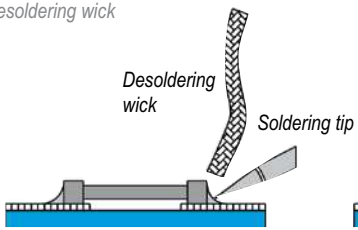

Ersa desoldering tweezers

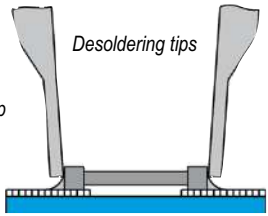

The compact CHIP TOOL VARIO desoldering tweezers are perfect for precise desoldering of very small SMDs.

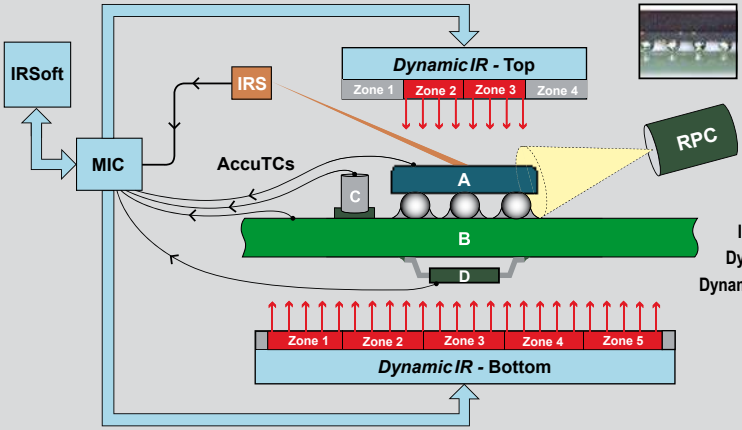

A: Component for rework
B: PCB
C: Adjacent component (top side)
D: Adjacent component (bottom side)
AccuTCs: Thermocouples (4 each)
IntelligentIRS: Non-contact infrared sensor
DynamicIR Top: Top IR radiator (4 zones)
DynamicIR Bottom: Bottom IR radiator (5 zones)
RPC: Reflow Process Camera
IRSoft: Control & documentation software
MIC: Microprocessor controls the DynamicIR heating system

Principle of a rework station

Rework or repair soldering

The rework process demonstrated on the example of a BGA (Ball Grid Array)

Rework designates the repair or touch-up of electronic components such as Ball Grid Arrays (BGAs) or SMTs. This chapter describes the process steps for BGA rework:

1. Desoldering the BGA

The rework station heats the printed circuit board from the bottom, whereas the BGA body itself is heated from the top.

The real-time temperature of the component controls the pre-set temperature curve so that all solder joints melt at the same time. Then the vacuum suction cup is placed on the BGA and once all joints have molten the BGA is lifted off.

2. Removal of residual solder, cleaning

Solder remaining on the pads is removed with a soldering iron. To do so the residual solder is coated with flux. Then a flat soldering tip (e. g. 0102ADLF40 or 0102ZDLF150) is moved over the pad without applying any force. The solder adheres to the larger surface area of the tip, thereby levelling off the remaining solder of the connection pads. Flux residues are finally cleaned off (e. g. using Ersa FLUX-REMOVER).

3. Reballing – Reusing the BGA

Desoldered BGA's can be refit with new solder balls and re-attached to the board. This process is referred to as reballing. Residual solder is removed from the BGA by means of a soldering station. Lying on its back, the component is coated with flux first. Then the new solder balls are attached, for example by means of a stencil. These solder balls are heated up to the melting point with the rework station to firmly connect with the BGA body. Now the BGA is ready to be re-attached.

4. Application of flux or solder paste

The component and the connection pads are now fluxed, or, as the case may be, solder paste is added through stencil printing. The type of technique applied depends on the application, components and the skill level of the operators. For the commonly used PBGA's the application of flux is mostly sufficient.

5. Placing the component

Once the pad has been prepared, the component has to be placed. Since all solder joints of a BGA are hidden under the component body, a component placement unit is required. Successful visual placement by hand requires an operator with extensive experience and excellent skills. If the component is placed on solder paste deposits, great care has to be taken not to squash the solder depot, since doing so may lead to shorts after soldering.

6. Resoldering the BGA

The component is heated to the melting temperature of the solder alloy used via a controlled temperature curve. The heating continues until all solder joints have melted and remained so for some seconds.

During this time durable and lasting solder joints are formed. After resoldering, the board is cooled in a similar fashion as had been done after desoldering.

These process steps are generally applicable for all surface mount components. Subject to the type of connections (wired, hidden) they may slightly vary.

Rework – Repair of high-terminal count IC's
to successfully repair SMT assemblies, the several points must be observed:

- Dimensions and properties of the assembly have an influence on its temperature requirement
- PCB holders and supports keep the assembly flat and prevent warpage
- A gentle and controlled heating process, continuously monitored, prevents damage of components or the board
- Accurate component placement is a prerequisite for a good soldering result
- Operators that are well trained will understand the process and ensure good results

Rework process steps

1. Remove BGA

2. Remove residual solder from the pads of the board

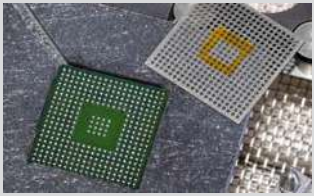

3. Reballing – addion of new solder balls

4. Application of flux or solder paste

5. Placement of the new or reballed component

6. Resolder the BGA on the prepared surfaces of the board

Miniature soldering iron

Ersa MINOR S

MINOR S, 5 W

Ersa MINOR S (5 W), a featherweight at 6 g for ultrafine soldering applications

The **MINOR S** miniature soldering iron with a rating of 5 W and a maximum tip temperature of 440 ºC is an ideal tool for ultrafine soldering applications on micro IC's and under a microscope. It can either operate with a 6 V transformer or a 6 V battery.

Besides electronics the MINOR S can also be used in watch repair, in the photographic industry and in dental technology.

Micro soldering irons

Ersa MULTITIP Series

MULTITIP series, 15/25 W

Ersa MULTITIP (15/25 W) internally heated soldering iron for small to medium solder joints

The **MULTITIP** soldering irons are especially short, light and easy-to-handle soldering irons with minimal distance between soldering tip and the handle's front part. They are ideally suited for small solder joints. Its internally heated soldering tip provides an enhanced degree of efficiency.

The MULTITIP is available for 15 W and 25 W which makes it suitable for micro soldering joints and medium-sized joints, as for example, on distributor strips or in the hobby sector.

Universal soldering iron

ERSA 30 S, MULTI-PRO, ERSA 15+ and ERSA 25+

The proven **ERSA 30 S,** available with a 30 or 40 W rating, is a very robust and durable soldering iron. Its improved ergonomics is further enhanced by the practical stick-on rubber support disk. This universal soldering iron is designed for multi-purpose use in the crafts, service and hobby sector.

The **MULTI-PRO** with its heat-resistant power supply cord is extremely flexible, as it can be operated with a wide range of different tips. Therefore, it is suitable for almost all conventional soldering applications.

The **ERSA 15+** universal soldering iron is the ideal tool for cost-effective soldering. Internally heated soldering tips guarantee an outstanding performance. The ERSA 15+ can be operated with diverse fine tips of the 832 and 842 tip series. Its ergonomic handle assists in the safe processing of fine soldering joints.

The **ERSA 25+** is perfect for soldering applications with increased heat requirements. The internally heated, larger soldering tips of the 832 and 842 tip series ensure good heat transfer at a high thermal performance. The ergonomic handle provides a safe grip for every soldering application.

Ersa universal soldering irons – for almost all applications

Standard and hammer soldering irons

ERSA 50 S, 80 S and 150 S / ERSA 200, 300 and 550

ERSA 50 S, 80 S, 150 S, 50/80/150 W

ERSA 200/300, 200/300 W

ERSA 550, 550 W

The **ERSA 50 S/80 S** or **150 S** series is designed for applications where a large amount of heating capacity is required, as, for example, on copper conductors with cross-sections of 2.5 mm to 6 mm.

The **ERSA 200, 300** and **550** hammer soldering iron series are particularly suited for sheet metal processing and installation work and for soldering commutators and copper bus bars.
Hammer soldering irons have also proven their merit in leveling applications during body work and lead glazing.

High-speed soldering iron

Ersa MULTI-SPRINT

The **Ersa MULTI-SPRINT** is an ergonomically designed and extremely light-weight, pistol-type soldering iron with up to 150 W power which does not require a transformer. Its PTC heating element, together with the internally heated ERSADUR long-life soldering tip, ensures its exceptionally high efficiency. Due to its very short heat-up time, it is ideally suited for making quick single soldering joints. The MULTI-SPRINT is powered only as long as the button is pressed. Depending on the heat requirement of the solder joint to be made, additional energy can be supplied by periodically pressing the button. The large variety of soldering tips of the 832 / 842 series make the MULTI-SPRINT suitable for more than only the use in repair and service applications.

Ersa MULTI-SPRINT, 150/75 W

Power soldering iron

Ersa MULTI-TC and PTC 70

Ersa MULTI-TC, 75 W

Ersa PTC 70, 75 W

The **MULTI-TC** and **PTC 70** are powerful and robust, temperature-controlled soldering irons. Both tools offer an outstanding heat-up rating.

Due to their high thermal performance, and because of the large selection of soldering tips, the MULTI-TC and PTC 70 are suitable for fine soldering joints in electronics as well as for joints with medium heat requirements. The MULTI-TC is furthermore also used anywhere else where standard irons with 150 W power are in use, including, for example, lead glass and Tiffany soldering.

Gas soldering irons

Ersa INDEPENDENT 75 and INDEPENDENT 130

Ersa INDEPENDENT 75, 15 – 75 W

Ersa INDEPENDENT 130, 25 – 130 W

Ersa gas soldering irons are fueled with commercially available lighter gas and are fired up through the piezo ignition. Compared with electrical soldering irons, the **INDEPENDENT 75** has between 15 – 75 W, and the **INDEPENDENT 130** between 25 – 130 W performance. Both irons are available in the BASIC-SET and PROFI-SET versions.

Aside from handling the usual types of electronic components, the selection of tips available enables the INDEPENDENT to also handle SMD soldering, micro-welding, forming and cutting of synthetic materials and the processing of shrink sleeves.

The basic soldering station

Ersa ANALOG 60

The electronically temperature-controlled ANALOG 60 is Ersa's basic soldering station model. It has the tried and proven RESISTRONIC temperature control technology with the PTC heating element serving as the temperature sensor. The high heat-up rating of 190 W guarantees the immediate supply of heat and a heat-up from room temperature to 280 ºC within 60 seconds. The BASIC TOOL 60 soldering iron uses the internally heated ERSADUR long-life soldering tips of the 832/842 series and provides very high performance.

Due to the wide range of 832/842 soldering tips, the Ersa ANALOG 60, which is also available as an antistatic version, covers a wide range of applications with the most varied soldering requirements.

Digital soldering station

Ersa RDS 80 – high performance for low cost

The digital soldering station Ersa **RDS 80** offers the proven and tested Ersa RESISTRONIC temperature control technology with a strong heating power of 80 W. The ceramic PTC heating element (Positive Temperature Coefficient) acts as the temperature sensor in this control system. Due to its very high ramp-up capability of up to 190 W, the station reaches operating temperature very fast.

RT 80: sleek soldering iron with a large selection of soldering tips

Multifunctional soldering stations

Ersa i-CON NANO and i-CON PICO – small, powerful and versatile

adjustment of operating temperature as well as the setting of stand-by time and calibration value.

Further adjustments such as fixed temperatures, power level, interlock and shutdown functions are available with the free PC software and an optionally available micro smart SD card.

Micro-SD card with SD-card and USB adapter

The soldering stations **i-CON NANO** and **i-CON PICO**, two models of the i-CON product family, fulfill all the needs of today's electronics manufacturing while requiring minimal space. They are designed for continuous operation in the electronic manufacturing environment as well as for special applications in laboratories and R&D departments.

Due to the simple and user-friendly operating concept, the factory settings provide for a variable

The concept of the Ersa i-CON stations ensures that each application is processed with the optimal parameters. They stand for the highest level of process safety and quality control at low investment and operating cost.

Ersa i-CON PICO

- Small footprint (145 x 80 mm) – saves valuable space
- Antistatic as per MIL-SPEC/ESA (only i-CON NANO)
- Three fixed temperature settings or continuously adjustable temperature settings from 150 °C to 450 °C
- Three selectable power levels
- Ultra-light and ergonomic soldering tool with max. 80 W power
- Wide range of low-cost exchangeable long-life soldering tips
- Automatic stand-by and sleep function for low energy consumption and longer tip life
- Password interlock for maximum process control
- Calibration function for a precise tip temperature
- Complete parameterization through PC software and Micro-SD card

High-end soldering and desoldering stations

The Ersa i-CON product family for highest productivity and process safety

Ersa *i*-CON2 with *i*-TOOL and CHIP TOOL

The stations of the i-CON product family are Ersa's innovative solution for intelligent manual soldering. The need to be able to cope with higher working temperatures and with progressively smaller process windows when working with lead-free solders, poses no problem whatsoever for the i-CON product family.

The i-CON is available as a single station or as double iron station. The single station **i-CON1** is delivered together with the i-TOOL soldering iron. The i-TOOL is extremely small, ultra-light and ergonomic. It is powered by a 150 W micro heating element, which realizes short heat-up times (within 9 seconds up to 350 ºC!) and rapid heat recovery.

The microprocessor which stores the temperature calibration of the iron is located in the PCB which is installed in the handle. This now allows for each individual i-TOOL to be calibrated independent of the soldering station.

In contrast to the concept followed by the cartridge-type soldering tips, only the tip itself is exchanged at the i-TOOL. The cost-intensive heating element remains.

The double iron soldering station **i-CON2** can be operated either with a second i-TOOL or with the SMD desoldering tweezers CHIP TOOL

Soldering miniature and densely placed SMD components with the i-TOOL and i-TIPS, starting at a 0.2 mm diameter.

i-CON1 with i-TOOL soldering iron with high-performance micro heating element

- i-TOOL soldering iron with 150 W micro heating element technology
- Low-cost exchangeable long-life tips of the i-TIP series
- User friendly “One-Touch” operation
- Three power levels – no overshoot
- Process window and alarms
- Interface to control peripheral equipment on the workplace, such as heating plate and solder fume extraction systems
- Stand-by control for tools, heating plate and solder fume extraction system
- i-TOOL calibration
- Tools for SMT and conventional soldering applications
- Automatic tool recognition

1. *Low-cost i-TIP long-life soldering tips*
2. *i-TIP tip fastener*
3. *High-power heating element (stick-on type, long-life)*

Ersa i-TOOL: The ideal soldering iron – ultra light (only 30 g), ultra short (only 155 mm), and ultra short tip-to-grip (only 45 mm) and extremely powerful.

respectively with the desoldering irons X-TOOL or X-TOOL VARIO.

The CHIP TOOL facilitates safe and quick desoldering, of the smallest chips up to large PLCC's. To remove the residual solder and to desolder wired components – also on multilayer boards – the X-TOOL or X-TOOL VARIO desoldering iron is the right tool.

User-friendly controls: quick programming & lock, huge multi-functional display with i-Op controls, menu in 7 languages, online help

High-mass through-hole desoldering with the X-TOOL VARIO

The C-line of the i-CON stations was developed, so that peripheral equipment could be controlled or to communicate with them. Via a serial interface, the i-CON1 C or the i-CON2 C controls the Ersa IR heating plates or the Ersa solder fume extraction systems.

i-CON VARIO 4 multi-channel station with X-TOOL VARIO desoldering iron, i-TOOL soldering iron, i-TOOL AIR S hot-air iron and CHIP TOOL VARIO desoldering tweezers.

Top Tips

i-TIPS for all applications

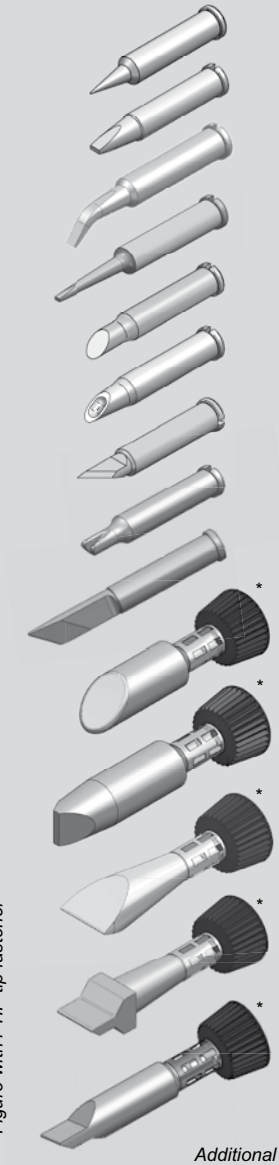

**Figure with i-TIP tip fastener*

Additional soldering tips for the i-TOOL and the i-CON soldering stations is available on our web site:
www.ersa.com

Hybrid Rework Station

Ersa HR 100 A – The innovative combination of hot air and infrared radiation

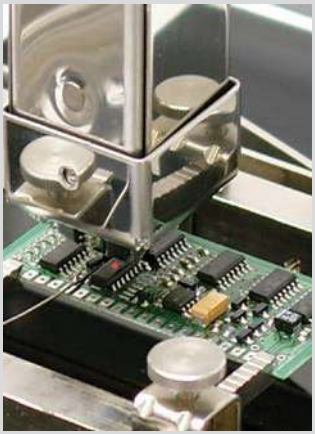

The Ersa **HR 100 A** applies the Ersa Hybrid Rework Technology for a safe desoldering and replacement of small SMD components. Its medium wave length IR radiation, combined with a safe stream of hot air ensures optimal heat transfer to the component.

The HYBRID TOOL offers a gentle and homogeneous warming of all sizes of components, from 0201 chips up to 20 x 20 mm SMD's and larger. Exchangeable hybrid adapters target the thermal energy available (up to 200 W) on to the component, all the while protecting neighboring areas and not blowing away or moving adjacent chips.

Its user-friendly handling permits even operators with little experience to safely and efficiently operate the HR 100. More experienced operators, on the other hand, can not only variably adjust the air flow as well as the heat output, but also record and run profiles. A positioning laser whose laser point makes it possible to keep track of the component worked on through the complete process is integrated in the grip of the ergonomic hybrid tool.

Complete system with HR 100 A, IR heating plate, stand for HYBRID TOOL and PCB holder.

- HYBRID TOOL with 200 W heating element, positioning laser integrated in grip
- 3 exchangeable hybrid adapters (6 x 6 mm, 10 x 10 mm and 20 x 20 mm)
- Silent rework fan (below 40 dB)
- Integrated vacuum pump and vacuum pen; tool holder and K-type thermocouple input socket; USB interface; LED display
- 2-channel temperature recording:
  TC & IRS; AccuTC and Flexpoint thermocouple holder
- Tool holder with z-axis height adjustment
- x-y PCB holder (290 mm x 250 mm)
- 800 W IR heating plate with glass cover:
  125 mm x 125 mm IR high-performance heating element
- Rework profile and documentation software Ersa IRsoft

CLEAN-AIR solder fume extractions

Ersa EASY ARM 1 and EASY ARM 2 – protecting environment, health and resources

Ersa EASY ARM 1

Ersa EASY ARM 2

The Ersa **EASY ARM 1** is a compact yet powerful filter unit to efficiently clean the process air at the workplace. Both i-CON1 C, i-CON2 C and i-CON VARIO can be connected to the EASY ARM 1 with an interface cable. The solder fume extraction has three filtration levels to remove noxious gases.

With the solder fume extraction **EASY ARM 2**, Ersa offers the user a further compact and highly efficient fume extraction unit for either one or two workplaces. One or two units i-CON1 C / i-CON2 C / i-CON VARIO can be connected to the EASY ARM 2 via interface cable.

Both EASY ARM systems are provided with a stand-by mode and operate only when the soldering stations they are connected to are being used. The EASY ARM 1 and 2 are easy to install and can be placed very flexibly. Due to their very low noise level, they can be operated in virtually all environments, be it repair shops, development facilities or laboratories.

To accommodate different working conditions and applications, a variety of extraction arms and nozzle shapes which can easily and quickly be exchanged are available to meet different working conditions.

Noxious gases develop in every soldering process.

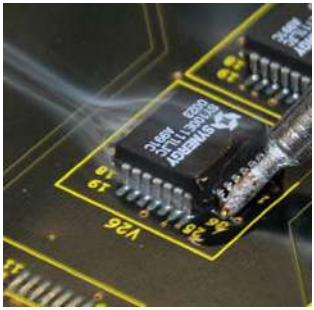

Q&A 1: So, how can you get rid of them? By using a solder fume extraction unit to clear the air from particles and gases.

Q&A 2: How does that work? Active carbon in the filters absorbs harmful gas molecules; result: a clean working environment.

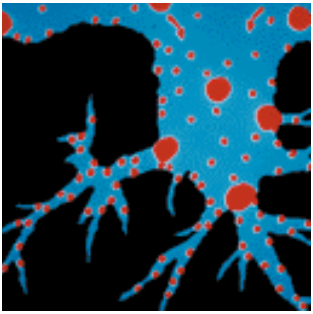

Tiffany soldering

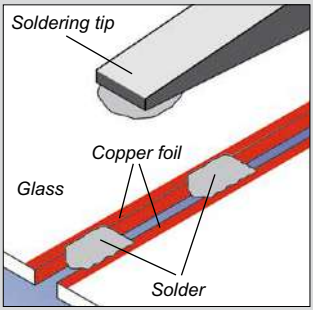

Step 1: spot soldering

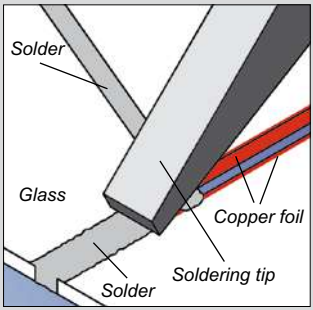

Step 2: rough soldering

Tiffany or sheet metal soldering

Soldering beyond the field of electronics

Tiffany soldering (Lead glass soldering)

Soldering a Tiffany object generally involves three individual steps:

- Spot soldering
- Rough soldering
- Finishing

Prior to the actual soldering process, copper foil is glued on the glass edges. The next step is spot soldering, i. e. the glass parts are fastened or connected by taking a drop of solder with the tip of the soldering iron and carefully applying it to the solder joint. Each spot soldering operation should only take about a second. During rough soldering the gap between the glass is filled with solder after flux has been applied. For this purpose the tip and solder are moved together along the joint. Always drag the soldering iron, never push it. Only if this procedure is accurately followed, and if a sufficient amount of solder is applied, the desired, half-round and convex seams are achieved. The lack of visual quality of the seam at this stage is optimized during the finishing soldering step, in which the soldering tip is dragged slowly and from the beginning of the seam until the end at an even speed. The seam worked on should always lie flat on the bench.

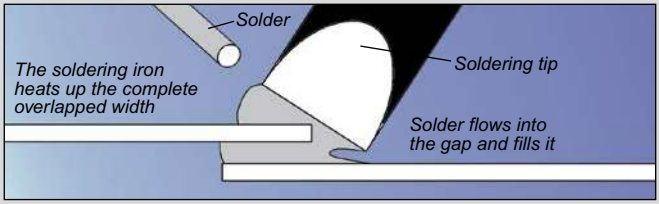

Guiding the soldering iron when soldering a broad seam

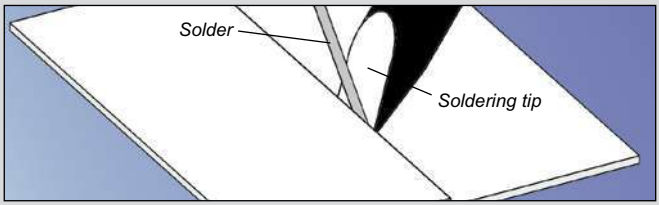

Guiding the soldering iron when soldering a narrow seam

Plumbing and tinsmith work

For the joining of sheet metal and metal pipes, the joints to be soldered have to be bare. This calls for a good prior cleaning.
After this, the flux – either solder grease or solder fluid, a zinc chloride solution – is applied. Then the area to be soldered is heated with the tip of the soldering iron.
Once the soldering area is sufficiently hot, solder is added and the solder gap is filled.
The aggressive flux residues are removed after cooling to avoid the risk of future corrosion.

832 GDLF

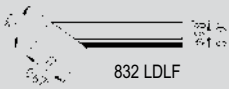
832 LDLF

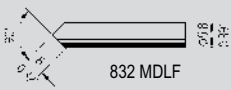
832 MDLF

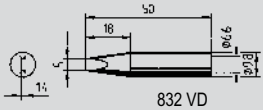

832 VD

ERSADUR Tiffany soldering tips

The types VD, GDLF, LDLF and MDLF of the comprehensive 832 tip series are particularly suited for Tiffany work. On account of their shapes and their high mass (excellent because of the ensuing heat retention capacity), the seams between the glass parts can quickly and easily be filled with solder. And the ERSADUR finish warrants a long tip lifetime.

ERSADUR Tiffany soldering tips

Ersa DIGITAL 2000A, Ersa MULTI-TC and ERSADUR soldering tips

Tiffany lamp

The **MULTI-TC** soldering iron is very light, robust and powerful. The Ersa SENSOTRONIC Control with the PT-1000 temperature sensor in the tip reacts immediately when heat is withdrawn.

The MULTI-TC is provided with a 2.2 mm wide, chisel-shaped soldering tip. Together with the Tiffany soldering tips, the slim MULTI-TC is superbly suited for the use in Tiffany work.

Due to its precise temperature control, the **DIGITAL 2000 A** soldering station completely eliminates the possibility to overheat any glass components or the copper foil, and the station has tremendous power reserves, making it comparable and putting it on an equal level with unregulated 150 W soldering irons.

The Ersa SENSOTRONIC control with its internally heated soldering tip, where the temperature sensor is mounted directly below the tip, provides for precise temperature control and ensures uniform temperature levels at the soldering joint.

The long-life ceramic PTC heating element provides up to 290 W heat-up rating which means that the powerful soldering iron is ready for use in only 60 seconds.

The DIGITAL 2000 A is provided with a 2.2 mm wide, chisel-shaped soldering tip. Particularly good results are achieved with the optionally available tip versions 832 VD, 832 GDLF, 832 CDLF and 832 MDLF, which are specifically offered for Tiffany applications.

Ersa MULTI-TC, 75 Watt

Ersa DIGITAL 2000 A with POWER TOOL

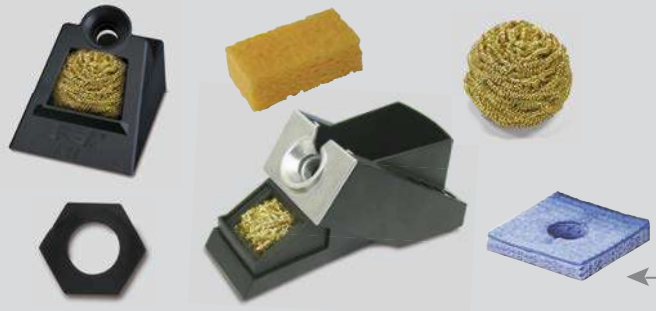

Ersa tool holders or stick-on rubber supports to safely and ergonomically put down the soldering iron during work stoppages or during heat-up.

Ersa viscose cleaning sponges for moist or special metal wool for dry cleaning of the hot soldering tip prior to the soldering process.

Auxiliary products and practical accessories

Everything for your soldering needs from one source

Ersa solder baths

Ersa solder wire and solder wire dispenser

Ersa DTM 100 tempera-ture measuring device

Ersa SOLDAPULLT desoldering pump

Ersa VAC X desoldering pump

Ersa SMD flux and flux cream

Ersa tip exchanger

Ersa FLUX-REMOVER

Ersa desoldering wicks

Ersa TIP-REACTIVATOR

Further peripherals and accesso-ries can be obtained from your local Ersa distributor and at **www.ersa.com**. Or just ask for our catalog!

IR rework stations

Ersa IR/PL 550, IR/PL 650 and HR 600 – from mobile phone boards up to XXL boards

Ersa HR 600

More than 5,000 customers worldwide use Ersa's patented IR-Rework technology.

Ersa rework stations deploy the DynamicIR Heating Technology, programmable top and bottom heating zones as well as the accurate, user-friendly and motorized "Auto Pick & Place" feature. System control, process documentation and visualization is handled by the Ersa rework software IRSoft/ HRSoft.

Optical solder joint inspection

ERSASCOPE inspection systems – the patented original

Since its introduction over 10 years ago more than 3,000 customers worldwide profit from the possibility to non-destructively inspect hidden solder joints.

Regardless of whether the joints are under a flip-chip, or whether areas are to be inspected where other microscopes have come to their limits – the ERSASCOPE technology offers a considerable added value to any quality assurance program!

Ersa Know-How Seminars

Expert knowledge for professional users comprehensively imparted

Today more than ever, cost-effective production and highest quality in the electronics manufacturing industry is the basis for profitable competitiveness. A key ingredient for being competitive is a well-qualified staff, which is up-to-date on current technology and process.

Ersa Know-How Seminars are ideal for transmitting this knowledge to those of your staff members with process responsibility in electronic manufacturing. In these seminars, theoretical and practical knowledge is presented in a neutral fashion in workshops and presentations by reputed experts in their field.

For further information go to our website **www.ersa.com** and click "Events".

Ersa Electronics Production Equipment

Technical data and further detailed information on our range of hand soldering equipment is available in our "Soldering Tools" catalog. This is available in printed form and as PDF, as are the "Rework & Inspection" catalog.

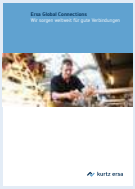

Aside from the extensive selection of hand soldering tools, rework stations and inspection systems for non-destructive inspection, Ersa, as Europe's largest manufacturer of soldering systems, also offers a complete range of selective, wave and reflow soldering systems, as well as stencil printers for the industrial electronic manufacturing industry.

Please refer to our brochures and our website **www.ersa.com** for further information.

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kurtz ersa

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Soldering Guide

Safety Precautions

- **Never touch the element or tip of the soldering iron.**
  They are very hot (about 400°C) and will give you a nasty burn.
- **Take great care to avoid touching the mains flex with the tip of the iron.**
  The iron should have a heatproof flex for extra protection. Ordinary plastic flex melts immediately if touched by a hot iron and there is a risk of burns and electric shock.
- **Always return the soldering iron to its stand when not in use.**
  Never put it down on your workbench, even for a moment!
- **Allow joints a minute or so to cool down before you touch them.**
- **Work in a well-ventilated area.**
  The smoke formed as you melt solder is mostly from the flux and quite irritating. Avoid breathing it by keeping you head to the side of, not above, your work.
- **Wash your hands after using solder.**
  Solder contains lead.

Treatment for minor burns

Most burns from soldering are likely to be minor and treatment is simple:

- **Immediately cool the affected area under gently running cold water.**
  Keep the burn in the cold water for at least 5 minutes (15 minutes is recommended). If ice is readily available this can be helpful too, but do not delay the initial cooling with cold water.
- **Do not apply any creams or ointments.**
  The burn will heal better without them. A dry dressing, such as a clean handkerchief, may be applied if you wish to protect the area from dirt.
- **Seek medical attention if the burn covers an area bigger than your hand.**

Preparing the soldering iron

- **Place the soldering iron in its stand and plug in.**
  The iron will take a few minutes to reach its operating temperature of about 400°C.
- **Dampen the sponge in the stand.**
  The best way to do this is to lift it out the stand and hold it under a cold tap for a moment, then squeeze to remove excess water. It should be damp, not dripping wet.
- **Wait a few minutes for the soldering iron to warm up.**
  You can check if it is ready by trying to melt a little solder on the tip.
- **Wipe the tip of the iron on the damp sponge.**
  This will clean the tip.
- **Melt a little solder on the tip of the iron.**
  This is called 'tinning' and it will help the heat to flow from the iron’s tip to the joint. It only needs to be done when you plug in the iron, and occasionally while soldering if you need to wipe the tip clean on the sponge.
- **You are now ready to start soldering!**
  Please turn the page for further instructions...

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Making soldered joints

- **Hold the soldering iron like a pen, near the base of the handle.**
  Imagine you are going to write your name!
  Remember to never touch the hot element or tip.
- **Touch the soldering iron onto the joint to be made.**
  Make sure it touches both the component lead and the track.
  Hold the tip there for a few seconds and...
- **Feed a little solder onto the joint.**
  It should flow smoothly onto the lead and track to form a volcano shape as shown in the diagram below. Make sure you apply the solder to the joint, not the iron.
- **Remove the solder, then the iron, while keeping the joint still.**
  Allow the joint a few seconds to cool before you move the circuit board.
- **Inspect the joint closely.**
  It should look shiny and have a 'volcano' shape. If not, you will need to reheat it and feed in a little more solder. This time ensure that both the lead and track are heated fully before applying solder.

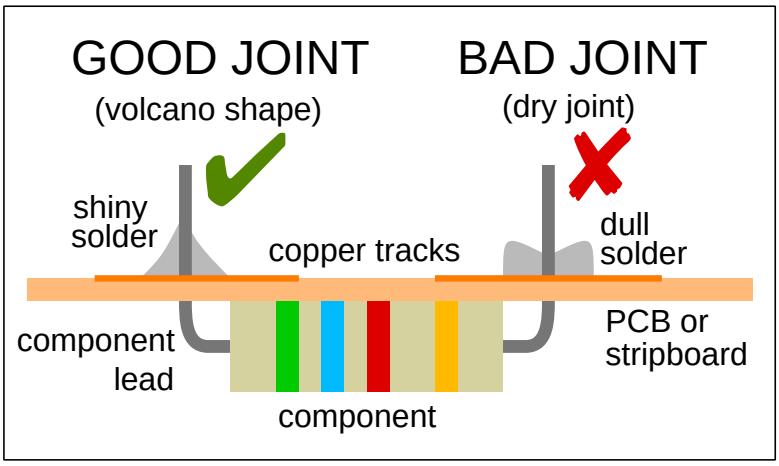

Using a heat sink

Some components, such as transistors, can be damaged by heat when soldering. It is wise to use a heat sink clipped to the lead between the joint and the component body, as shown in the picture. You can buy a special tool, but a standard crocodile clip works just as well and is cheaper!

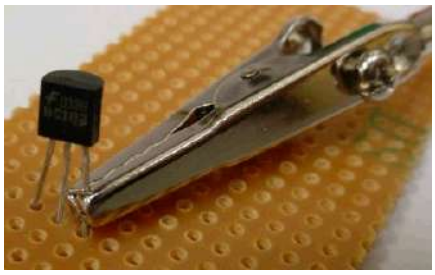

Soldering advice for components

Some components require special care when soldering. Many must be placed the correct way round and a few are easily damaged by the heat from soldering. Appropriate warnings are given in the table on the next page, together with other advice which may be useful when soldering.

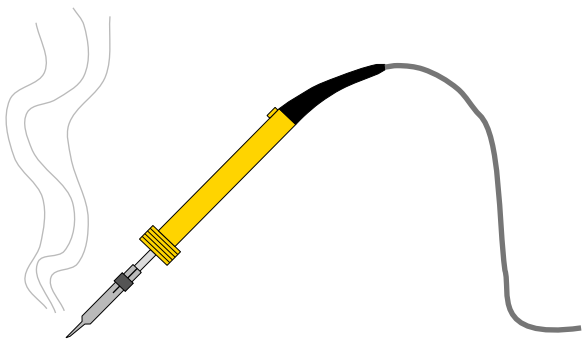

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Components	Pictures	Soldering advice
Resistors		No special precautions are required. Connect either way round.
Diodes		Diodes must be connected the correct way round: a = anode, k = cathode. Use a heat sink with germanium diodes.
IC holders (DIL sockets)	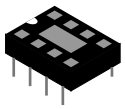	Ensure the notch is at the correct end. Do **not** insert the IC at this stage to prevent it being damaged by heat.
Presets (small variable resistors)		No special precautions are required. On stripboard take care to ensure you insert them the correct way round.
Capacitors, non-polarised (less than 1µF)	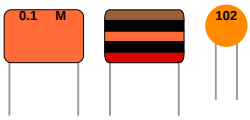	No special precautions are required. Connect either way round. Take care to identify their value.
Capacitors, electrolytic (1µF and greater)	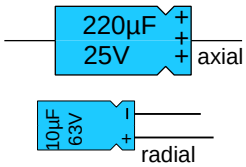	Electrolytic capacitors must be connected the correct way round, they are marked with + or - near one lead.
LEDs (Light Emitting Diodes)	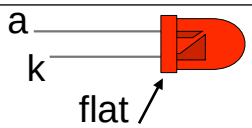	LEDs must be connected the correct way round: a = anode, k = cathode. Use a heat sink with small (3mm) LEDs.
Transistors	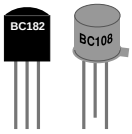	Transistors have three leads and must be connected the correct way round. Use a heat sink clipped to each lead in turn between the joint and the transistor.
Wire links between points on the board		Use tinned copper wire (such as the offcut from a resistor lead) or single-core plastic-coated wire.
Other parts mounted on the board		No special precautions are required for most parts, but make sure they are the correct way round.
Battery clips, buzzers and other parts with wires		Red (+) and black (-) wires must be connected the correct way round.
Wires to parts off the board such as switches		Use plastic-coated stranded wire which is flexible, single-core wire is likely to break at the joint.
Integrated Circuits (ICs or 'chips')	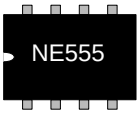	When all soldering is complete, carefully insert ICs the correct way round in their holders. Make sure all the pins are lined up before pushing in firmly.

For further information about electronic components please see: www.kpsec.freeuk.com

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Desoldering

At some stage you will probably need to desolder a joint to remove or re-position a wire or component. There are two ways to remove the solder:

1. With a desoldering pump (solder sucker)

- Set the pump by pushing the spring-loaded plunger down until it locks.
- Apply both the pump nozzle and the tip of your soldering iron to the joint.
- Wait a second or two for the solder to melt.
- Then press the button on the pump to release the plunger and suck the molten solder into the tool.
- Repeat if necessary to remove as much solder as possible.
- The pump will need emptying occasionally by unscrewing the nozzle.

2. With solder remover wick (copper braid)

- Apply both the end of the wick and the tip of your soldering iron to the joint.
- As the solder melts most of it will flow onto the wick, away from the joint.
- Remove the wick first, then the soldering iron.
- Cut off and discard the end of the wick coated with solder.

After removing most of the solder from the joint(s) you may be able to remove the wire or component lead straight away (allow a few seconds for it to cool). If the joint will not come apart easily apply your soldering iron to melt the remaining traces of solder at the same time as pulling the joint apart, taking care to avoid burning yourself.

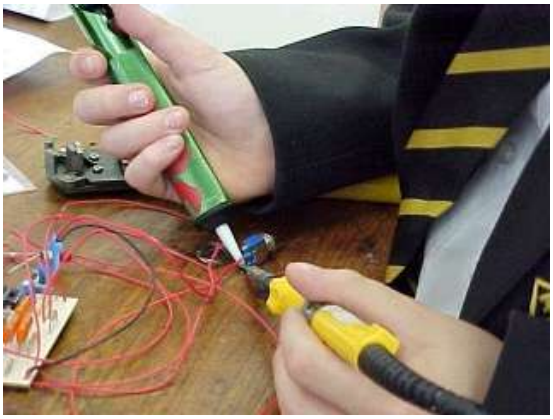

Using a desoldering pump (solder sucker)

What is solder?

Solder is an alloy (mixture) of tin and lead, typically 60% tin and 40% lead. It melts at a temperature of about 200°C. Coating a surface with solder is called ‘tinning’ because of the tin content of solder. Lead is poisonous and you should always wash your hands after using solder.

Solder for electronics use contains tiny cores of flux, like the wires inside a mains flex. The flux is corrosive, like an acid, and it cleans the metal surfaces as the solder melts. This is why you must melt the solder actually on the joint, not on the iron tip. Without flux most joints would fail because metals quickly oxidise and the solder itself will not flow properly onto a dirty, oxidised, metal surface.

The best size of solder for electronic circuit boards is 22swg (swg = standard wire gauge).

For plugs, component holders and other larger joints you may prefer to use 18swg solder.

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Safety Rules for Soldering

Department of Electrical, Computer and Biomedical Engineering, University of Rhode Island

1. Wear goggles for eye protection. When trimming off leads or excess solder dross, be careful of the flyaway that could injury yourself as well as other people nearby.
2. Work in a well-ventilated area and use a fume extractor. Do not inhale fumes from the soldering processes.
3. Always return the soldering iron to its stand when not in use. Never put it down on your workbench. The soldering iron tip is very hot (about 400°C). Avoid touching plastic, wire insulator, or any flammable material in the working area with the soldering iron. Turn the soldering station to standby or off if not used for more than few minutes. Turn unit off or unplug it when done.
4. Use a third hand, a circuit board vice, pliers, tweezers, or clamps for holding components to avoid burns. Legs and arms should be covered to avoid burns from splashed hot solder.
5. Do not have food or drink near the working area. The solder is usually a tin/lead alloy and lead is toxic. The flux is a chemical used to help metal parts soldered together. It is acidic and toxic. Clean up spilled flux immediately. Wash hands after soldering. Flux can cause acid burns to the skin or damage clothing. In case of acid burns, flush immediately with water.
6. Wash hands thoroughly after handling flux and solder containing lead. Use lead-free solder whenever possible.
7. Clean up the area when finished. Discard lead and silver solder and dross in a container with a lid. Label the container: “Lead/Silver Solder Waste for Recycling”. Used solder sponges and contaminated rags must be disposed of as hazardous waste.

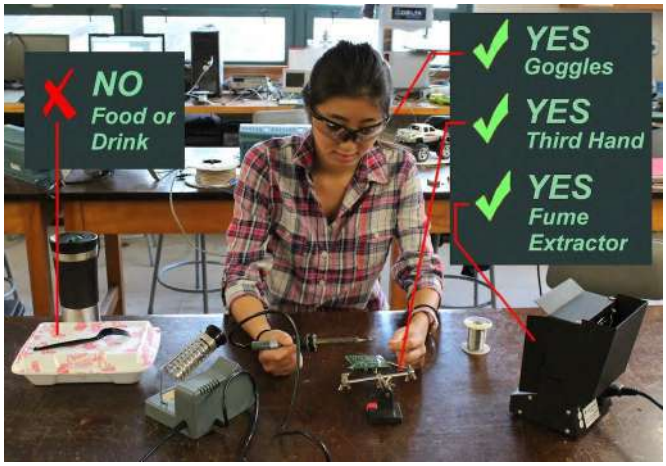

Soldering Techniques

1. Basic tools include an electric soldering station (a temperature-adjustable type preferred), solder, a pair of needle-nose pliers, a wire stripper, a flush cutter, a desoldering bulb, a utility blade, and a third hand or a vice.
2. Workspace should be as uncluttered as possible. Clear the path between the soldering station stand and the project to be soldered.
3. Prepare the soldering iron tip. Scrape off oxides with a utility blade if necessary. Adjust to an appropriate temperature. It won't work if you can't get the solder melt onto the soldering tip. Tinning the soldering tip by coating it with a thin coat of solder. This helps heat transfer between the tip and the components. The cleaning sponge should be soaking wet. Quickly run the soldering tip over the wet sponge to get rid of excess solder.
4. Clean the contact surfaces of the metal parts if necessary. Scrape off oxides with a utility blade. In some cases, it is easier to tin the individual components first before joining them.
5. Position the components using a third hand or a vice. Avoid holding the metal part of a component with your fingers.
6. Timing is important for soldering the components together. The solder needs to be completely melt at the joint to avoid a “cold solder point.” However, too much heat could damage a sensitive electronic component or melt the insulator of a wire. The required time depends on the heat transfer, which is affected by the temperature of the soldering tip, the mass of the components, the presence of flux or rosin, and how clean the contact surfaces are.
7. Start over when an attempt fails. Old solder has impurities. Remove old solder completely with a desoldering bulb or pump. Clean up flux/rosin residuals. Try again.

Examples: www.leadsdirect.co.uk/technical/perfectsolderjoint.html

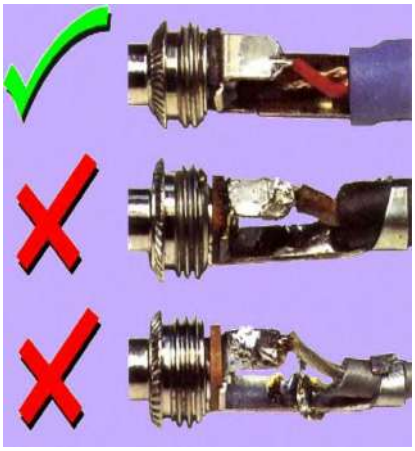

Good – clean, shiny, and just the right amount of solder.

Bad – too much solder which is uneven, has sharp points in places, and was probably overheated.

Worse – uneven texture, and the flux remaining on the joint.

Soldering

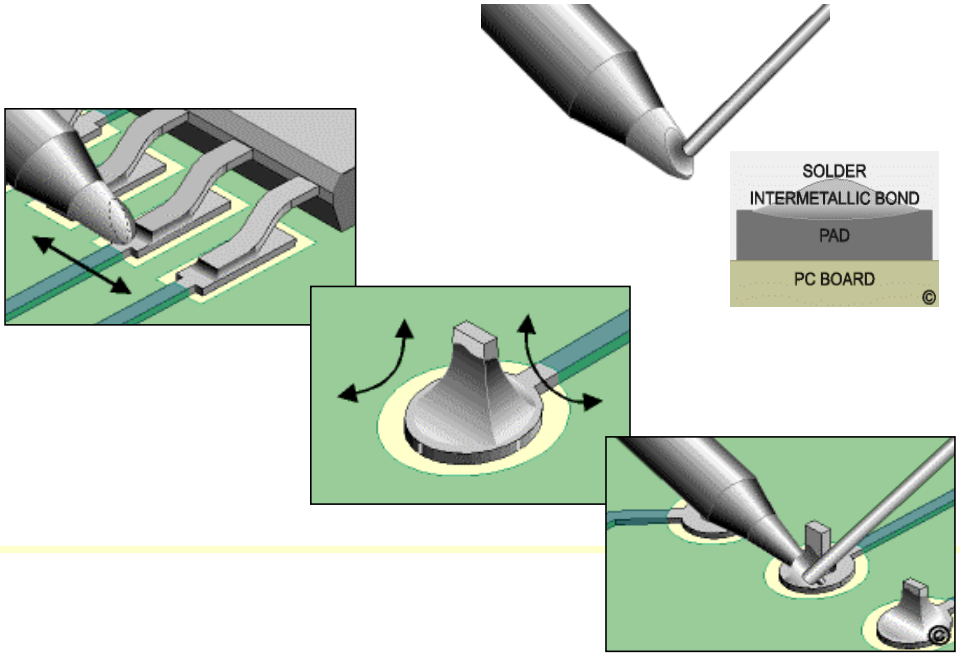

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SOLDERING

Theoretical background for technicians

1. Introduction :

Progress within the electronics industry would not have resulted in the mass production of electronic appliances as we know them today, without a similar progress in the field of soldering technology.

To be able to understand how soldering techniques are used in the electronics industry, we first have to get familiar with the materials used during the soldering process, and we have to learn how a soldering connection is created on a molecular level.

Soldering is an old technique for creating permanent electrical and mechanical connections between metals. In contrast to ordinary glueing, which makes only a physical connection between materials (although electrically conducting glue also exists) soldering causes a chemical reaction with other materials, creating a new alloy.

There are several soldering techniques, which all have a few things in common: basic metals, soldering flux, solder and heating.

2. Basic metals :

When we place electronic components on a PCB, the legs of the components and the soldering lands on the PCB, are the basic metals that will connect with the solder.
Several metals like copper, bronze, silver and some types of steel react with solder and make a strong chemical and physical connection.
Other materials like aluminium, titanium, etc. are difficult or even impossible to solder.
The fact that materials exist which can not be soldered is very important, as these materials can be used for making soldering machines and soldering irons. These materials can also be used for covering components during soldering.

There is a direct relationship between how strongly the surface of the basic metal oxidizes and how the soldering reacts on this: When there is more oxidation present, the soldering connection will be weaker.
The fact that most metals oxidize very quickly when heated, is a specific problem, because if one wants to obtain a chemical soldering reaction, a high temperature is necessary…
Flux is used to counteract this oxidation problem.

3. Soldering flux :

Although the soldering surface looks clean, there is always a thin layer of oxide on the metals. This layer always arises as soon as the metal is exposed to air. Reliable soldering connections can only be made on "clean" surfaces. "Clean" surfaces could be accomplished using cleaning product, but this would be insufficient as metal oxidizes incredibly fast when heated.
To prevent the creation of the layer of oxide, the use of soldering flux is necessary.

Using soldering flux on the basic metals before the soldering starts has various reasons and advantages:

The main reason of the use of flux is to stop the oxidation of the basic metals during heating.
The flux makes sure that the air can't reach the soldering surface, and therefore prevents the formation of oxidation during warming up.
Most of the different flux types have acid components which are used to remove the oxidation that is already present on the basic metal.
If a very strong acid is active in the flux, theoretically it would be possible to remove all the oxides.
This however is in practice not possible, as the acid would also affect the PCB and the components, which of course is not the intention.

Therefore there will always be a search for the balance between a flux that contains strong acids, and as a consequence also removes the oxidates more effectively (but also affects the PCB), and a flux that contains a less strong acid and therefore removes less oxides. (but does not affect the PCB).

Most fluxes though use types of acid. Therefore it generally is necessary to remove the flux residues after soldering.

When solder is applied, the flux needs to flow off so that the solder can make direct contact with the basic metal. During this process it is however impossible to avoid the flux mixing with the solder.
Flux developers make use of this fact to develop a flux that has the property to reduce the surface tension of the solder on contact, as a result of which better "wetting" arises.

Flux consists of natural or synthetic resin and chemical additives, called activators.
In PEM a "no clean" flux of Tamura is used (for the placement of Flat-Package-IC's). Consequently it is not necessary to remove the flux after soldering.
Furthermore it is not necessary to add extra flux when doing easy manual soldering because the soldering wire contains flux (3.3 %), like a resin core.

4. Solder :

There several existing metals and metal alloys that can be used for soldering.
The choice for using a certain metal is based on the properties of the metal:
Is the metal flexible or fragile? How well does it conduct heat?
Does it expand rapidly when heated? What is the electrical resistance of the metal?
How strong is it? Is it toxic? And not unimportant: what does it cost?
Although it is not perfect, an alloy of tin and lead is most often used traditionally.
Pure tin melts at 203°C and pure lead melts at 330°C. A mixture of both metals has a lower melting point.
By using a different mixture the melting temperature of the soldering alloy can be changed.
A alloy of tin and lead (e.g. 60/40) has a relatively low melting point (183°C) and can be produced at a relatively low price, in comparison to other alloys with similar properties.
Lead is a very cheap and can be found in a lot of places. Therefore the cost of the tin-lead alloy is mainly determined by the cost of tin.

When this alloy is warmed up, it goes through several phases:
the alloy goes from a "fixed" condition, to a "paste" condition (semi-liquid), and finally becomes totally liquid. It is difficult to solder with an alloy that is in a "paste" condition: because there is little movement or vibration during this "paste" condition, this can cause bad soldering.
If the alloy is of 50% tin and 50 % lead, it starts to melt at a temperature of 193°C, and will be totally melted at a temperature of 216°C.

To prevent bad soldering during the "paste" condition, "eutectical" solder is used.
An "eutectical" alloy is an alloy that, when heated, goes immediately from a fixed condition to a liquid condition: the "paste" stage is effectively skipped.
An "eutectical" tin-lead alloy contains 63% tin and 37% lead.
Often a tin-lead alloy with 60% tin and 40% lead is used. This alloy can be produced cheaper than the eutectical solder because it contains less tin. But because this alloy is almost "eutectical", it can effectively be used for soldering.
During soldering, be careful to make no sudden movements whilst the solder is cooling.
This can cause "interrupted connections" and therefore unreliable soldering.
An "interrupted" soldering connection has a rough and irregular surface and appears dim instead of clear and shiny.
It is also very important that no impurities get into the solder.
If small metal particles from the components get into the soldering "cup" of the soldering machine.
This can result in a serious change to surface tension, and consequently bad soldering connections.
These metal impurities could even change the melting temperature of the solder.

5. Heat, generation of soldering connection

If the solder gets in contact with a copper surface,
the solder dissolves and penetrates the copper layer.
The molecules of the solder and the copper get mixed and a new
alloy is created, consisting partially of copper and partially of solder.
This reaction is called "wetting" and has as a result an "inter-metallic" connection
between the components. "Wetting" can only take place if the surface of the copper does not contain
oxides. The solder and the surface of the copper also have to be at the right temperature before the
"wetting" can take place.

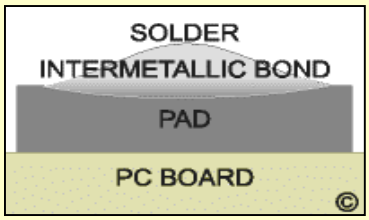

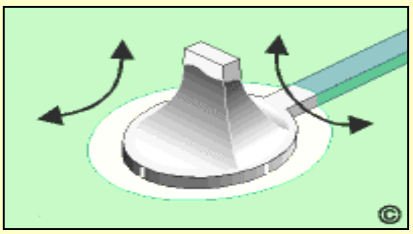

6. Soldering with a soldering iron:

The following 4 factors determine the quality of the soldering connection:

- clean surfaces
- temperature
- time
- quantity of solder

a) Clean surfaces:

"dirt is the enemy of a good soldering connection!"

It is enormously important that there are no impurities on all of the components (including the soldering bit). Soldering on "dirty" components is not possible!
Old PCB's or components sometimes can not be soldered due to a
large layer of oxide on the islands and the legs of the components.
In such cases the solder is rejected and goes to everywhere, except for where we want it to go.
In a desperate attempt to solder in such a situation, a common reaction is to raise the
soldering temperature. However, this is certainly not a solution. On the contrary!
The only correct solution is thorough cleaning. (e.g. with a brush of glass fibre)

Before the soldering iron can be used, the soldering bit first has to be coated with tin.
Some solder has to be melted onto the bit. Afterwards the bit has to be cleaned.
For cleaning the soldering bit, it is best is to use a slightly moistened sponge
(with demineralized water). The use of ordinary tap water is not reccomended, because the
silver layer on the bit gets affected by calcium in the tap water, which results in less thermal
contact. This diminished thermal contact runs the risk of cold soldering, etc.
To improve the thermal contact between the bit and the soldering surface, it is advisable
to coat the soldering bit with a little bit of solder before every soldering action.

b) Temperature & time :

The temperature of the soldering bit is not the most determining factor for successful soldering:
the heating cycle (combination of temperature of the bit and the time the heating takes) is!
How fast the soldering components warm up, how warm they get and how long they stay warm, are
the most important factors that have to be controlled to make a reliable soldering
connection.

The time soldering takes is very important. A soldering task may only take a couple of
seconds: when heated too long, the components and the soldering lands can be damaged.

It is also totally wrong to use the soldering bit to rub melted solder across the soldering surface.

Although the temperature of the bit is not the most determining factor, it is advisable to
to do soldering at the lowest possible temperature.

The first that has to be examined before the soldering starts in the 'thermal mass" of the components.

Every soldering task has its own specific "thermal mass" which is determined by the heat absorption of the components. For soldering e.g. the component pins and solder lands.
For components on a heat sink there will be a large thermal mass. In other words: the heat will be "absorbed " by the heat sink, as a result of which more warmth will have to be added than e.g. for soldering the leg of an IC.
Secondly it is very important that the temperature of all the components that will be soldered have more or less the same temperature.
An example: it is necessary that the leg and the soldering land have had at the same time the necessary warming up before the solder is added.
We have to take care that, while warming up, the soldering bit gets in contact with both the leg and the soldering land.
"Thermal contact" is therefore very important.

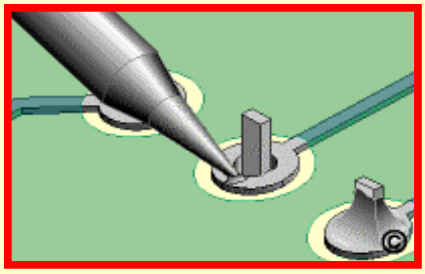

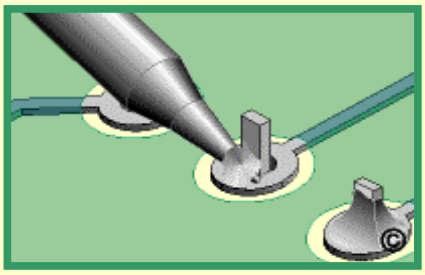

The thermal contact is low
The warmth is transmitted by means of the bit.
to the leg and the soldering land

The thermal contact is higher
by adding a bit of solder
to the point of contact

The size and the shape of the soldering bit, as well as the position of the bit, will determine whether or not it makes a good thermal contact. For being able to make a good thermal contact in all circumstances, different types of soldering bits exist (different shapes).
Normally the soldering bit has to be placed on the "largest mass point" of the soldering connection that needs to be made.
This will make fast heating possible.

c) Adding solder & quantity

The last factor necessary for a high quality soldering connection, is adding the correct quantity of solder.
Too much solder is an unnecessary waste and can aid the formation of "bridges" across legs
If not enough solder is added, this can cause an "insufficient soldering" or "dry soldering"
Adding the correct quantity of solder takes a lot of exercise and experience

Melted solder always flows from a "colder" area to a "warmer" area.
Before the solder is added, the surface temperature of the components to be soldered has to be higher than the melting temperature of the solder.
Never let the soldering wire melt by holding it against the soldering bit. This may cause the solder to fall on a surface where the temperature is lower than the melting temperature
This can result in a cold soldering, with almost no or insufficient "wetting".
If the solder is added to a clean, fluxed and sufficiently heated surface, then the solder will melt and flow nicely without direct contact with the heat source. (soldering bit)
Therefore it is advisable to put the soldering wire on the sufficiently heated surface so that the solder melts as a consequence of the contact with the heated surface

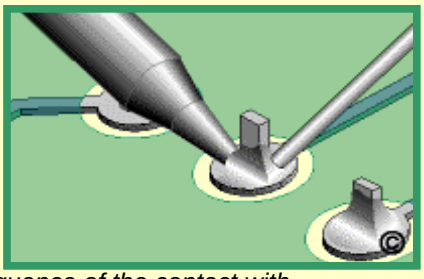

The solder is melted as a consequence of the contact with the heated surface. No contact with the soldering bit is necessary.

d) Soldering : 7 steps

1. Cleaning of the soldering bit:
For soldering to be effective, the soldering bit has to be clean: no dirt and no oxides are allowed on the soldering bit.
The soldering bit needs to be cleaned before soldering.

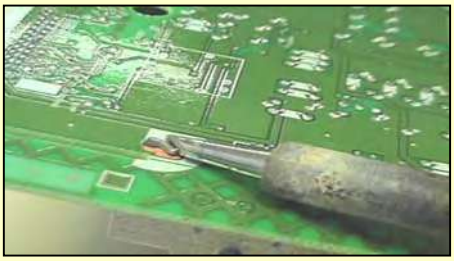

2. Heating of the components that will be soldered.
For soldering to be effective, the components which have to be connected, have to be heated (in this case the pin and the solder lands) to a temperature that at least equals the temperature of the melting point of the soldering alloy. (183 °C)
Bear in mind the "thermal mass", the type of bit and the position of the bit!

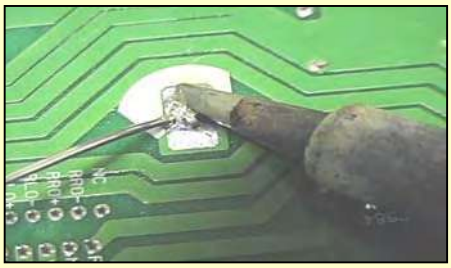

3. Adding the solder:
After both components are heated sufficiently, solder can be added.
Let the solder melt as a consequence of the contact with the heated surface. In other words: don't make any direct contact with the soldering bit.

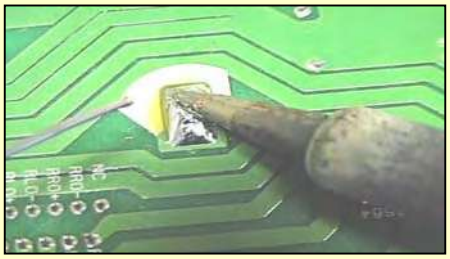

4. Quantity of the solder to be added and letting the solder flow.
Let the solder flow nicely between both components and add solder until the right quantity is reached.

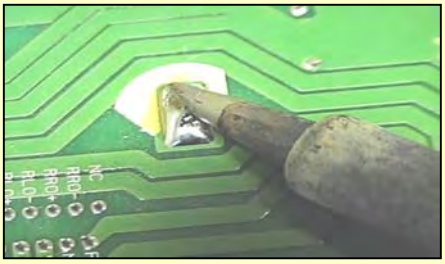

5. Remove the soldering wire
When sufficient solder is added, the soldering wire may be removed.

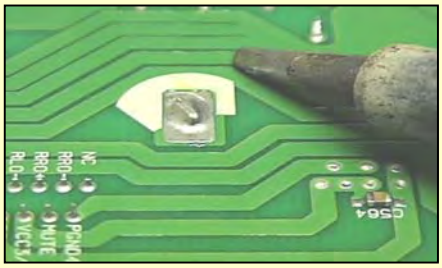

6. Remove the soldering bit.
When the solder has nicely flowed open, and there is "wetting", the soldering bit may be removed so that the solder can solidify.
Pay attention for possible sudden movements during this operation. (risk of "disturbed" soldering)

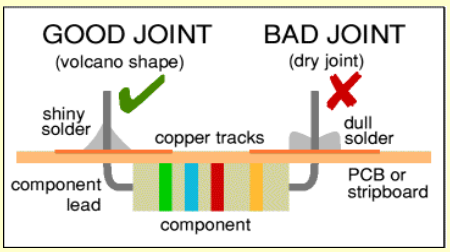

7. Check the soldering connection
Check the soldering connection.
Nicely formed soldering is shining and even. Also pay attention to the shape: a spherical shape is not good!

e) Soldering of a flatpackage IC

For soldering a "Flat-package IC" (gull wing type) one can use, beside the ordinary point soldering, (= leg by leg), a special soldering technique: the DRAGGING TECHNIQUE.
For this technique, one must use a special soldering bit that will, after filling-up, act as a kind of "mini-soldering-wave", and with which one can solder a whole row of legs in one ongoing movement

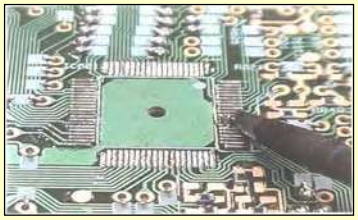

1. Cleaning of the soldering surface:
Remove all possible soldering residues (caused by desoldering) and make all the paths nicely even by going over those paths with the soldering bit. (without adding solder)

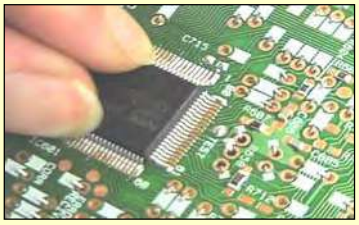

2. Positioning of the IC:
Position the IC on the patterns.
This has to be very precise.
A little movement can cause serious problems.

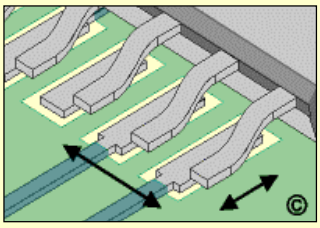

3. Fixing of the IC:
Fix the IC on the PCB, by "temporarily" soldering some legs on both sides.

4. Add sufficient flux on all sides.

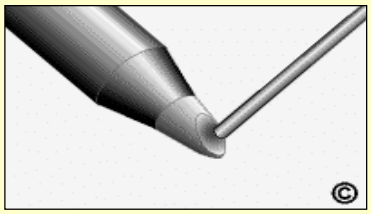

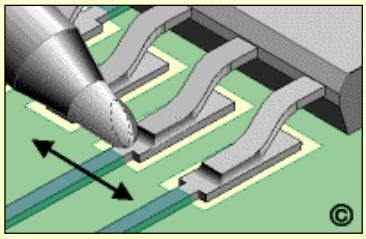

5. Filling of the bit and start of the soldering:
Fill the special (concave) soldering bit with solder.

Now start a slow dragging movement from one leg to another.
Pay attention that the solder nicely moves up on the legs of the IC.

If the PCB is equipped with a "soldering thief" (a soldering land that is positioned next to the last leg), one has to solder in the direction of the soldering thief, so that at the end the possible surplus of solder flows on this soldering thief and no short circuit is created on the last two legs of the row.

f) Incorrect soldering :

For certain soldering problems or soldering mistakes, specific terms are used:

SOLDER BRIDGE

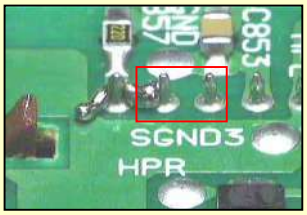

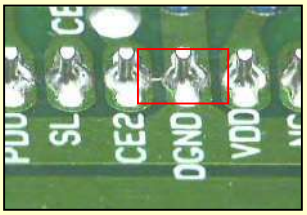

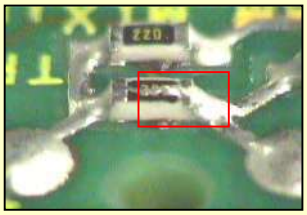
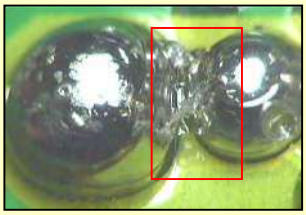

COLD SOLDERING

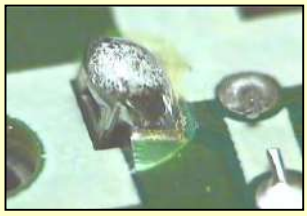

HALF SOLDERING OR DRY SOLDERING

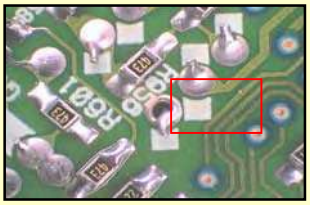
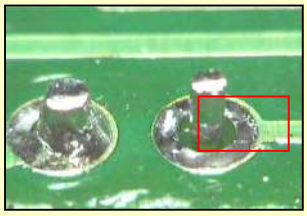
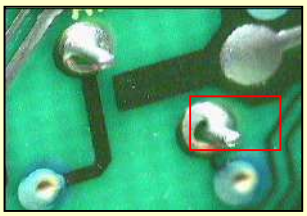
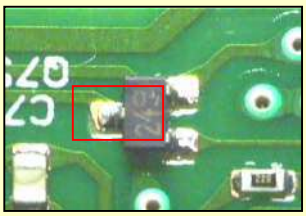

NO SOLDERING

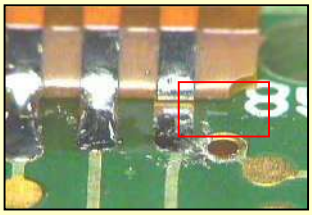
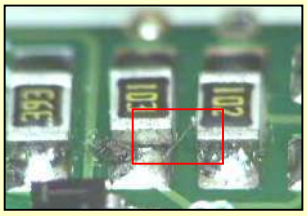

SOLDERING HORN

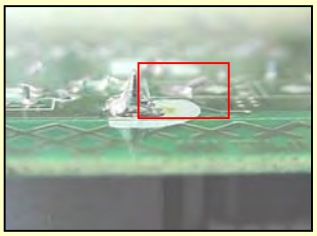
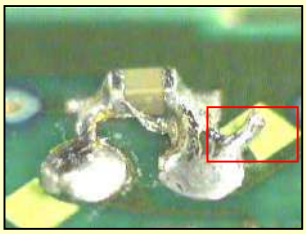

SOLDERING BALL OR SOLDERING SPLASH

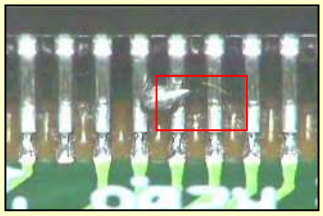

SOLDERING WIRE SHORT CIRCUIT

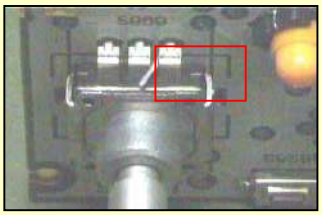

7) (De)soldering with warm air and soldering paste:

In some cases it is impossible to solder or desolder certain components with a classical soldering iron or a normal desoldering station.

This is often the case for SMT components, with contact legs (partly) underneath the component.
In such a case one has to use a (de)soldering appliance that uses warm air or infra-red heat.

SMT component with contact surfaces beneath the component

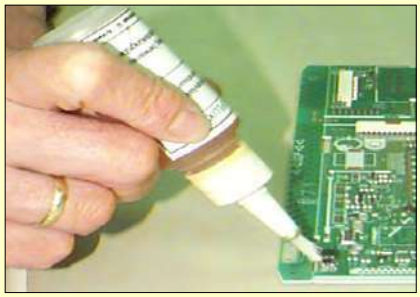

1. Fluxing of the component:
To have a good temperature conductance during warming up, the soldering surfaces need to be moistened with flux.
If these surfaces are parly underneath the component, flux can be put on the borders of the component.

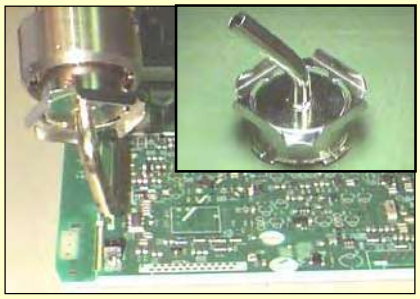

2. Warming-up of the soldered surfaces:
Use a "pointing nozzle" and point it at the component you want to remove. Keep a distance of 1 cm between the nozzle and the surface you want to warm up. Choose the temperature of the warm air e.g. +/- 340°C. (dependant on the temperature profile of the compents.)
Pay attention : if the contact surfaces are partly under the component, it is necessary to warm up the body of the component. Often the component is not useable afterwards.

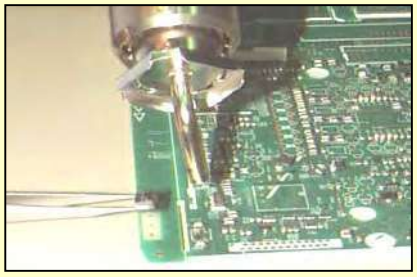

3. Removal of the component
When the solder (paste) has melted, the component can be removed with a pair of tweezers.

4. Cleaning of the soldering surfaces:
Remove all redundant soldering paste with a classical desoldering station.

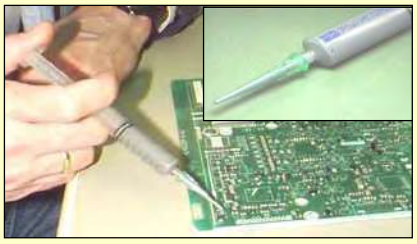

5. Adding soldering paste:
Add with a measured squirt the necessary soldering paste on the soldering lands.
Pay attention: soldering paste needs to be stored in strict circumstances. (see the instructions of the supplier)

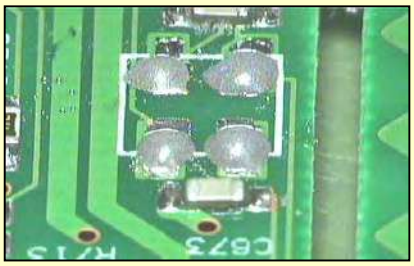

6. Checking the quantity of soldering paste:
Check the quantity of the added soldering paste.
Only the contact surfaces should be covered with soldering paste.
Too much soldering paste can cause a short circuit during "re-flowing".

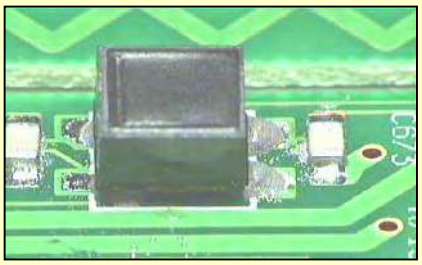

7. Positioning of the component

Position the new component carefully with the contact surfaces in the soldering paste with a pair of tweezers.
Position the component by the guide lines on the PCB.

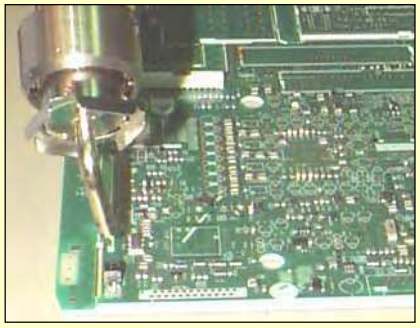

8. Reflowing of the component:

Use a "pointing nozzle" and point it on the component you want to remove. Keep a distance of 1 cm between the nozzle and the surface you want to warm up. Choose the temperature of the warm air e.g. +/- 340°C. (dependant on the temperature profile of the component.) Warm up until one sees that the soldering paste is active or flowing. The result should be a good soldered joint.
Pay attention: For most of the warm air soldering appliances one can choose the air pressure. The speed should be minimum, otherwise there is a possibility of blowing the component away.

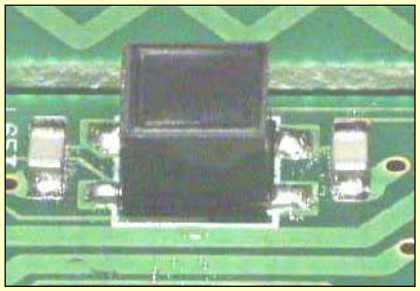

9. Checking of the soldering:

If possible, check the soldered joints.
Good soldering shines and has flowed evenly.

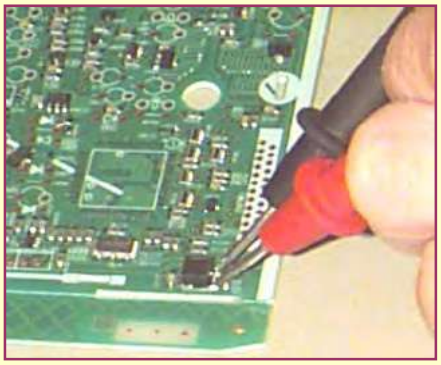

10. Checking of the electrical connection

If possible check the electrical connection with a meter.

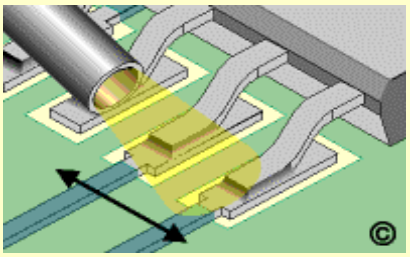

Example of a "warm air soldering appliance": PACE.

8) Lead free soldering

Introduction.

Normally all solderings (mechanical - and hand soldering) were executed with soldering material that contained lead. (40 % lead / 60 % tin)
But lead is toxic and therefore damaging for humans and for nature.
Hence European directives were made in which companies will be obliged to use soldering techniques without lead after July 2006.

Soldering without lead is relatively new in the world of electronics.

Lead-free solder:

If no lead is present in the soldering wire, this has to be replaced. The soldering wire needs to contain another metal, like SILVER & COPPER. (96,5 % tin / 3% silver / 0,5 % copper)

This new composition has the advantage that it is no longer toxic and that the soldering connections are stronger. (lead is relatively weak). But this new composition also has some negative consequences:

1) The cost is higher (silver and copper alloys are more expensive than lead)
2) The joints look different (more granular instead of shining)
3) The melting temperature is higher

One of the main points of interest is the higher melting temperature. One would think that as a consequence of the higher melting temperature of the solder, also the soldering temperature needs to be raised. This however is not always allowed! Some components are only able to handle a certain maximum temperature for a certain time.

In practice:

- You can use your original soldering station if you can reach the correct temperature at the soldertip
- The soldering bit has to be a bit larger than a soldering bit for soldering with lead.

Pay attention: **Solder with lead and solder without lead can never be mixed.**

9) Temperature specifications of the soldering bit

Solder with lead

Process	Bit Type	Solder	Min	Center	Max
Pins	ETB / ETCC/ 1121-0519	UOS-014	340°C	**380°C**	400°C
LCD	ETF / ETCC	UOS-005	320°C	**340°C**	360°C
OEL Display	ETCC	UOS-004	280°C	**290°C**	300°C
Connector	ETL / ETF	UOS-005	320°C	**340°C**	360°C
Flexible PCB	ETF	UOS-004	280°C	**300°C**	320°C
IC's & QFP IC's	1121-0490	UOS-005	280°C	**300°C**	320°C
Removal bridge	ETB / ETCC	UOS-005	320°C	**340°C**	360°C
Lights	ETF / ETB /1121-0519	UOS-005	280°C	**300°C**	320°C
SMT/SMD repair	ETL / ETF	UOS-005	280°C	**300°C**	320°C

Temp. specifications Pioneer standard ZES-A015 & ZES-B016

Solder without lead

Process	Bit Type	Solder	Min	Center	Max
Pins	LTB / LTCC	UOS-026	400°C	**410°C**	420°C
LCD	LTF / LTCC	UOS-027	320°C	**340°C**	360°C
OEL Display	LTCC	UOS-028	280°C	**300°C**	320°C
Connector	LTL / LTF	UOS-027	320°C	**340°C**	360°C
Flexible PCB	LTF	UOS-028	280°C	**300°C**	320°C
IC's & QFP IC's	1121-0490	UOS-027	280°C	**300°C**	320°C
Removal bridge	LTB / LTCC	UOS-027	320°C	**340°C**	360°C
Lights	LTF / LTB	UOS-027	280°C	**300°C**	320°C
SMT/SMD repair	LTL / LTF	UOS-027	280°C	**300°C**	320°C

Temp. specifications Pioneer standard ZES-A043

Types of soldering wire:

With lead	UOS-014 (1 mm) + UOS-005 (0.8 mm) + UOS-004 (0.5mm)
Without lead	UOS-026 (1 mm) + UOS-027 (0.8 mm) + UOS-028 (0.5 mm)

10) Types of soldering bits:

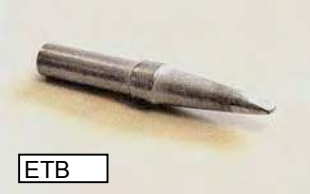

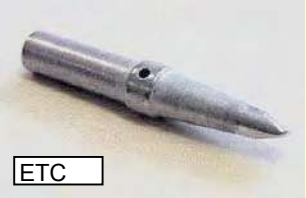

11) Soldering devices:

"Clean-o-point": for automatic cleaning of the soldering bit with 2 rotating sponges

"Flux dosing bottle": for easy adding of flux (with brush)

"Bit cleaner": for drying and cleaning of the soldering bit

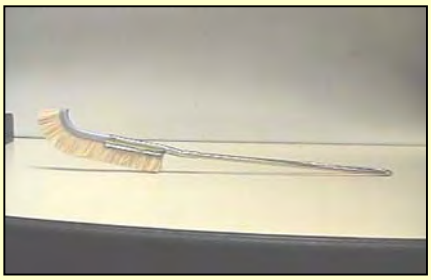

" Brush " : for removal of possible soldering residues after soldering

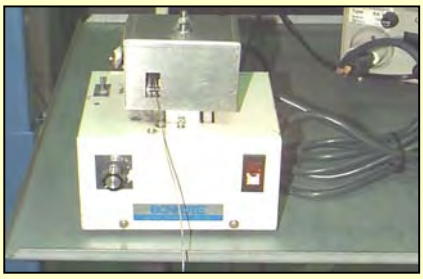

"V-cutter" : for making a cut in the soldering wire, in order to reduce the formation of little soldering balls

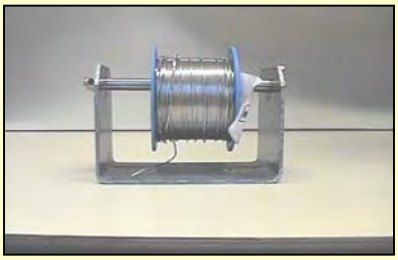

"Solder dispenser" : for a simple supply of soldering wire

"Tweezer-copper bit": handy tool for the removal of SMD/SMT components.

"Warm air desoldering appliance": for easy desoldering of flat-package IC's

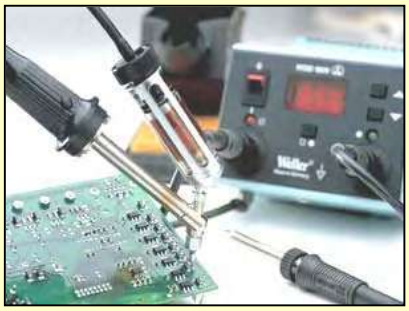

"Desoldering appliance": for easy desoldering of point solderings

"Soldering magnifying glass": for a good view during soldering

The Basic Soldering Guide

http://www.epemag.wimborne.co.uk/solderfaq.htm (for text in this document)

basics for wire (Good intro) : http://www.youtube.com/watch?v=BLfXXRfRIzY
The Happy Soldering Iron: http://www.youtube.com/watch?v=AL-_RGbyf1s
basics: http://www.youtube.com/watch?v=I_NU2ruzyc4
Watt/temp comparison http://www.youtube.com/watch?v=Vh9pWu6K6tc&NR=1
tip sizes: http://www.youtube.com/watch?v=Sfb1Ve52ztY&NR=1
types of solder: http://www.youtube.com/watch?v=COqGkYMOA44
maintenance: http://www.youtube.com/watch?v=krxTfZCFptk&NR=1

Good overview with some odd bits: http://www.youtube.com/watch?v=AOdnGUMi7lQ

Desoldering overview: http://www.youtube.com/watch?v=j-_pnc-Qqm8
2nd good overview: http://www.youtube.com/watch?v=8UN3D2-f64A
Hot air pencil/gun: http://www.youtube.com/watch?v=AxYhF6Ab2CU
Desoldering gun (short): http://www.youtube.com/watch?v=8Z6MvZz_uNc

Crazy Guy from Make Electronics: http://www.youtube.com/watch?v=3N3ApzmyjzE
Not Soldering!! – Bread board: http://www.youtube.com/watch?v=oiqNaSPTI7w

This written guide will help beginners and novices to obtain effective results when soldering **electronic components**. If you have little or no experience of using a soldering iron, then EPE *(Everyday Practical Electronics* magazine) recommends that you practice your soldering technique on some fresh surplus components and clean stripboard (protoboard), before experimenting with a proper constructional project. This will help you to avoid the risk of disappointment when you start to assemble your first prototypes. If you've never soldered before, then read on!

Soldering irons

The most fundamental skill needed to assemble any electronic project is that of ***soldering***. It takes some practice to make the perfect joint, but, like riding a bicycle, once learned is never forgotten! The idea is simple: to join electrical parts together to form an electrical connection, using a molten mixture of lead and tin (solder*) with a soldering iron. A large range of soldering irons is available - which one is suitable for you depends on your budget and how serious your interest in electronics is.

[*Note: the use of lead in solder is now increasingly prohibited in many countries. "Lead free" solder is now statutory instead.]

Electronics catalogues often include a selection of well-known brands of soldering iron. Excellent British-made ones include the universally popular Antex, Adcola and Litesold makes. Other popular brands include those made by Weller and Ungar. A very basic mains electric soldering iron can cost from under £5 (US$ 8), but expect a reasonable model to be approximately £10-£12 (US$ 16 - 20) - though it's possible to spend into three figures on a soldering iron "station" if you're really serious! Check some suppliers' catalogues for some typical types. Certain factors you need to bear in mind include:-

Voltage: most irons run from the mains at 240V. However, low voltage types (e.g. 12V or 24V) generally form part of a "soldering station" and are designed to be used with a special controller made by the same manufacturer.

Wattage: Typically, they may have a power rating of between 15-25 watts or so, which is fine for most work. A higher wattage does ***not*** mean that the iron runs hotter - it simply means that there is more power in reserve for coping with larger joints. This also depends partly on the design of the "bit" (the tip of the iron). Consider a higher wattage iron simply as being more "unstoppable" when it comes to heavier-duty work, because it won't cool down so quickly.

Temperature Control: the simplest and cheapest types don't have any form of temperature regulation. Simply plug them in and switch them on! Thermal regulation is "designed in" (by physics, not electronics!): they may be described as "thermally balanced" so that they have some degree of temperature "matching" but their output will otherwise not be controlled. Unregulated irons form an ideal general purpose iron for most users, and they generally cope well with printed circuit board soldering and general interwiring. Most of these "miniature" types of iron will be of little use when attempting to solder large joints (e.g. very large terminals or very thick wires) because the component being soldered will "sink" heat away from the tip of the iron, cooling it down too much. (This is where a higher wattage comes in useful.)

A proper temperature-controlled iron will be quite a lot more expensive - retailing at say £40 (US$ 60) or more - and will have some form of built-in thermostatic control, to ensure that the temperature of the bit (the tip of the iron) is maintained at a fixed level (within limits). This is desirable especially during more frequent use, since it helps to ensure that the temperature does not "overshoot" in between times, and also guarantees that the output will be relatively stable. Some irons have a bimetallic strip thermostat built into the handle which gives an audible "click" in use: other types use all-electronic controllers, and some may be adjustable using a screwdriver.

Yet more expensive still, ***soldering stations*** cost from £70 (US$ 115) upwards (the iron may be sold separately, so you can pick the type you prefer), and consist of a complete bench-top control unit into which a special *low-voltage* soldering iron is plugged. Some versions might have a built-in digital temperature readout, and will have a control knob to enable you to vary the setting. The temperature could be boosted for soldering larger joints, for example, or for using higher melting-point solders (e.g. silver solder). These are designed for the most discerning users, or for continuous production line/ professional

use. The best stations have irons which are well balanced, with comfort-grip handles which remain cool all day. A thermocouple will be built into the tip or shaft, which monitors temperature.

Anti-static protection: if you're interested in soldering a lot of static-sensitive parts (e.g. CMOS chips or MOSFET transistors), more advanced and expensive soldering iron stations use static-dissipative materials in their construction to ensure that static does not build up on the iron itself. You may see these listed as "ESD safe" *(electrostatic discharge proof)*. The cheapest irons won't necessarily be ESD-safe but never the less will still probably perform perfectly well in most hobby or educational applications, if you take the usual anti-static precautions when handling the components. The tip would need to be well earthed (grounded) in these circumstances.

Bits: it's useful to have a small selection of manufacturer's bits (soldering iron tips) available with different diameters or shapes, which can be changed depending on the type of work in hand. You'll probably find that you become accustomed to, and work best with, a particular shape of tip. Often, tips are *iron-coated* to preserve their life, or they may be bright-plated instead. Copper tips are seldom seen these days.

Spare parts: it's nice to know that spare parts may be available, so if the element blows, you don't need to replace the entire iron. This is especially so with expensive irons. Check through some of the larger mail-order catalogues.

A ***solder gun*** is a pistol-shaped iron, typically running at 100W or more, and is completely unsuitable for soldering modern electronic components: they're too hot, heavy and unwieldy for micro-electronics use. Plumbing, maybe..!

Soldering irons are best used along with a heat-resistant ***bench-type holder***, so that the hot iron can be safely parked in between use. Soldering stations already have this feature, otherwise a separate soldering iron stand is essential, preferably one with a holder for tip-cleaning sponges. Now let's look at how to use soldering irons properly, and how to put things right when a joint goes wrong.

The Basic Soldering Guide Photo Gallery

Soldering is a delicate manual skill which only comes with practice. Remember that your ability to solder effectively will determine directly how well the prototype or product functions during its lifespan. Poor soldering can be an expensive business - causing product failure and downtime, engineer's maintenance time and customer dissatisfaction. At hobbyist level, bad soldering technique can be a cause of major disappointment which damages your confidence. It needn't be like that: soldering is really easy to learn, and like learning to ride a bike, once mastered is never forgotten!

These photos illustrate the basic steps in making a perfect solder joint on a p.c.b. If you're a beginner, our advice is that it's best to practice your soldering technique using some clean, new parts with perhaps some new stripboard (protoboard). Be sure to avoid using old, dirty parts; these can be difficult if not impossible to solder.

(Left) Printed circuit board copper tracks must be clean to begin with, especially if they're not previously "tinned" with solder. Clean any raw p.c.b. copper tracks gently with e.g. an abrasive rubber block available from electronics suppliers. **(Right)** Clean the iron "bit" (soldering iron tip) using a damp sponge. The soldering iron featured is an Ungar Concept 2100 Soldering Station. Other popular brands of soldering equipment include Weller and Antex.

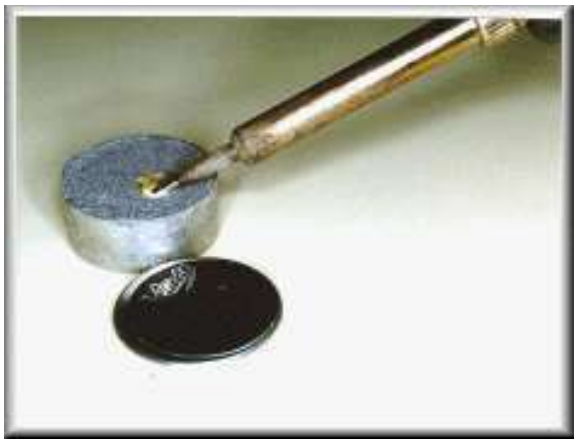

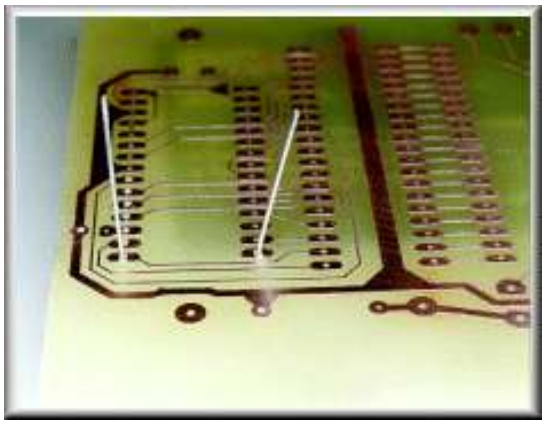

(Left) A useful product is Multicore's Tip Tinner Cleaner (TTC) - a 15 gramme tin of special paste which cleans and "tins" the soldering iron iron, in one go. New tips must be tinned **immediately** when used for the first time. **(Right)** Insert components and splay the leads so that the part is held in place.

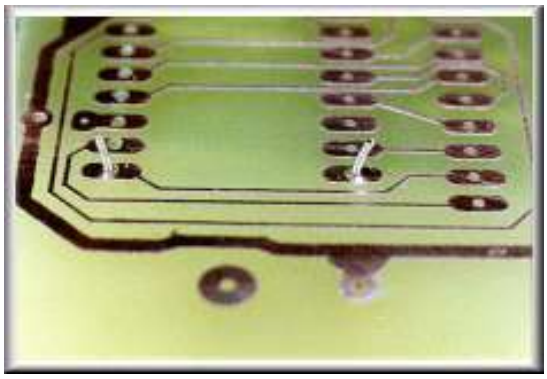
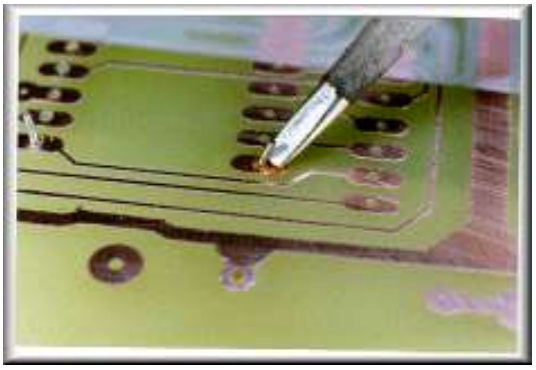

(Left) It's usually best to snip the electronic component wires to length prior to soldering. This helps prevent transmitting mechanical shocks to the copper foil.**(Right)** Apply a clean soldering iron tip to the copper solder pad and the component lead, in order to heat *both* items at the same time.

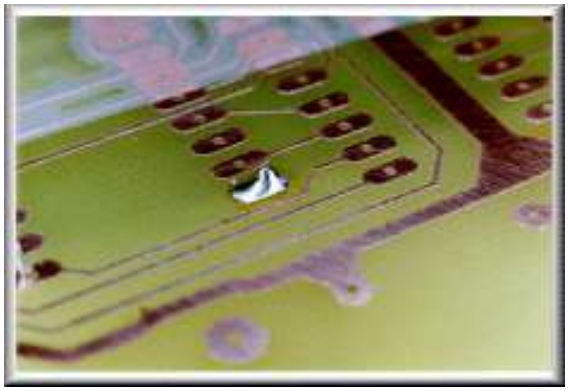

(Left) Continue heating and apply a few millimetres of solder. Remove the iron and allow the solder joint to cool naturally. **(Right)** It only takes a second or two, to make the perfect joint, which should be nice and shiny. Check the Guide for troubleshooting help.

An example of a "dry" or "gray" soller joint - the solder failed to flow, and instead beaded to form globules around the wire.

How to solder

Turning to the actual techniques of soldering, firstly it's best to *secure the work* somehow so that it doesn't move during soldering and affect your accuracy. In the case of a printed circuit board, various holding frames are fairly popular especially with densely populated boards: the idea is to insert all the parts on one side ("stuffing the board"), hold them in place with a special foam pad to prevent them falling out, turn the board over and then snip off the wires with cutters before making the joints. The frame saves an awful lot of turning the board over and over, especially with large boards. Other parts could be held firm in a modeller's small vice, for example.

Solder joints may need to possess some degree of mechanical strength in some cases, especially with wires soldered to, say, potentiometer or switch tags, and this means that the wire should be looped through the tag and secured before solder is applied. The down side is that it is more difficult to *de-solder* the joint (see later) and remove the wire afterwards, if required. Otherwise, in the case of an ordinary circuit board, components' wires are bent to fit through the board, inserted flush against the board's surface, splayed outwards a little so that the part grips the board, and then soldered.

In my view - opinions vary - it's generally better to snip the surplus wires leads off *first*, to make the joint more accessible and avoid applying a mechanical shock to the p.c.b. joint. However, in the case of semiconductors, I often tend to leave the snipping until *after* the joint has been made, since the excess wire will help to sink away some of the heat from the semiconductor junction. Integrated circuits can either be soldered directly into place if you are confident enough, or better, use a dual-in-line socket to prevent heat damage. The chip can then be swapped out if needed.

Parts which become hot in operation (e.g. some resistors), are raised above the board slightly to allow air to circulate. Some components, especially large electrolytic capacitors, may require a mounting clip to be screwed down to the board first, otherwise the part may eventually break off due to vibration.

The perfectly soldered joint will be nice and shiny looking, and will prove reliable in service. I would say that:

- cleanliness
- temperature
- time
- adequate solder coverage

are the key factors affecting the quality of the joint. A little effort spent now in soldering the perfect joint may save you - or somebody else - a considerable amount of time in troubleshooting a defective joint in the future. The basic principles are as follows.

Really Clean

First, and without exception, all parts - including the iron tip itself - must be clean and free from contamination. Solder just will not "take" to dirty parts! Old components or copper board can be notoriously difficult to solder, because of the layer of oxidation which builds up on the surface of the leads. This repels the molten solder and this will soon be evident because the solder will "bead" into globules, going everywhere except where you need it. Dirt is the enemy of a good quality soldered joint!

Hence, it is an absolute necessity to ensure that parts are free from grease, oxidation and other contamination. In the case of old resistors or capacitors, for example, where the leads have started to oxidise, use a small hand-held file or perhaps scrape a knife blade or rub a fine emery cloth over them to reveal fresh metal underneath. Stripboard and copper printed circuit board will generally oxidise after a few months, especially if it has been fingerprinted, and the copper strips can be cleaned using an abrasive rubber block, like an aggressive eraser, to reveal fresh shiny copper underneath.

Also available is a fibre-glass filament brush, which is used propelling-pencil-like to remove any surface contamination. These tend to produce tiny particles which are highly irritating to skin, so avoid accidental contact with any debris. Afterwards, a wipe with a rag soaked in cleaning solvent will remove most grease marks and fingerprints. After preparing the surfaces, avoid touching the parts afterwards if at all possible.

Another side effect of having dirty surfaces is the tendency for people to want to apply *more heat* in an attempt to "force the solder to take". This will often do more harm than good because it may not be possible to burn off any contaminants anyway, and the component may be overheated. In the case of semiconductors, temperature is quite critical and they may be harmed by applying such excessive heat.

Before using the iron to make a joint, it should be "tinned" (coated with solder) by applying a few millimetres of solder, then wiped on a damp sponge preparing it for use: you should always do this immediately with a new bit, anyway. Personally, I always re-apply a very small amount of solder again, mainly to improve the thermal contact between the iron and the joint, so that the solder will flow more quickly and easily. It's sometimes better to tin larger parts as well before making the joint itself, but it isn't generally necessary with p.c.b. work. (All *EPE* printed circuit boards are "roller-tinned" to preserve their quality and to help with soldering.) A worthwhile product is Weller's *Tip Tinner & Cleaner*, a small 15 gram tinlet of paste onto which you dab a hot iron - the product cleans and tins the iron ready for use. An equivalent is Adcola *Tip-Save*.

Normal electronics grade solder is now "lead free" and typically contains Sn 97 Ag 2.5 Cu 0.5 (i.e. 97% tin, 2.5% silver and 0.5% copper). **It already contains cores of "flux"** which helps the molten solder to flow more easily over the joint. Flux removes oxides which arise during heating, and is seen as a brown fluid bubbling away on the joint. The use of separate acid flux paste (e.g. as used by plumbers) should NEVER be necessary in normal electronics applications because electronics-grade solder already contains the correct grade of flux! Other solders are available for specialist work, including

aluminium and silver-solder. Different solder diameters are produced, too; 20-22 SWG (19-21 AWG) is 0.91-0.71mm diameter and is fine for most work. Choose 18 SWG (16 AWG) for larger joints requiring more solder.

Temperature

Another step to successful soldering is to ensure that the **temperature** of *all* the parts is raised to roughly the same level before applying solder. Imagine, for instance, trying to solder a resistor into place on a printed circuit board: it's far better to heat *both* the copper p.c.b. *and* the resistor lead at the same time before applying solder, so that the solder will flow much more readily over the joint. Heating one part but not the other is far less satisfactory joint, so strive to ensure that the iron is in contact with *all* the components first, before touching the solder to it. The melting point of most solder is in the region of 188°C (370°F) and the iron tip temperature is typically 330-350°C (626°-662°F). The latest lead-free solders typically require a higher temperature.

Now is the time

Next, the joint should be heated with the bit for just the right amount of time - during which a short length of solder is applied to the joint. Do not use the iron to carry molten solder over to the joint! Excessive time will damage the component and perhaps the circuit board copper foil too! Heat the joint with the tip of the iron, then continue heating whilst applying solder, then remove the iron and allow the joint to cool. This should take only a few seconds, with experience. The heating period depends on the temperature of your iron and size of the joint - and larger parts need more heat than smaller ones - but some parts (semiconductor diodes, transistors and i.c.s), are sensitive to heat and should not be heated for more than a few seconds. Novices sometimes buy a small clip-on heat-shunt, which resembles a pair of aluminium tweezers. In the case of, say, a transistor, the shunt is attached to one of the leads near to the transistor's body. Any excess heat then diverts up the heat shunt instead of into the transistor junction, thereby saving the device from over-heating. Beginners find them reassuring until they've gained more experience.

Solder Coverage

The final key to a successful solder joint is to apply an appropriate amount of solder. Too much solder is an unnecessary waste and may cause short circuits with adjacent joints. Too little and it may not support the component properly, or may not fully form a working joint. How much to apply, only really comes with practice. A few millimetres only, is enough for an "average" p.c.b. joint, (if there is such a thing).

Here's a summary of how to make the perfect solder joint.

1. All parts must be clean and free from dirt and grease.
2. Try to secure the work firmly.
3. "Tin" the iron tip with a small amount of solder. Do this immediately, with new tips being used for the first time.
4. Clean the tip of the hot soldering iron on a damp sponge.
5. Many people then add a tiny amount of fresh solder to the cleansed tip.

6. Heat all parts of the joint with the iron for under a second or so.
7. Continue heating, then apply sufficient solder only, to form an adequate joint.
8. Remove and return the iron safely to its stand.
9. It only takes two or three seconds at most, to solder the average p.c.b. joint.
10. Do not move parts until the solder has cooled.

Troubleshooting Guide

- Solder won't "take" - grease or dirt present - desolder and clean up the parts. Or, material may not be suitable for soldering with lead/tin solder (eg aluminium).
- Joint is crystalline or grainy-looking - has been moved before being allowed to cool, or joint was not heated adequately - too small an iron/ too large a joint.
- Solder joint forms a "spike" - probably overheated, burning away the flux.

Desoldering methods

A soldered joint which is improperly made will be electrically "noisy", unreliable and is likely to get worse in time. It may even not have made any electrical connection at all, or could work initially and then cause the equipment to fail at a later date! It can be hard to judge the quality of a solder joint purely by appearances, because you cannot say how the joint actually formed on the *inside*, but by following the guidelines there is no reason why you should not obtain perfect results.

A joint which is poorly formed is often called a "dry joint". Usually it results from dirt or grease preventing the solder from melting onto the parts properly, and is often noticeable because of the tendency of the solder not to "spread" but to form beads or globules instead, perhaps partially. Alternatively, if it seems to take an inordinately long time for the solder to spread, this is another sign of possible dirt and that the joint may potentially be a dry one.

There will undoubtedly come a time when you need to *remove* the solder from a joint: possibly to replace a faulty component or fix a dry joint. The usual way is to use a ***desoldering pump*** or vacuum pump which works like a small spring-loaded bicycle pump, only in reverse! (More demanding users using CMOS devices might need a pump which is ESD safe.) A spring-loaded plunger is released at the push of a button and the molten solder is then drawn up into the pump. It may take one or two attempts to clean up a joint this way, but a small desoldering pump is an invaluable tool especially for p.c.b. work.

Sometimes, it's effective to actually *add more* solder and then desolder the whole lot with a pump, if the solder is particularly awkward to remove. Care is needed, though, to

ensure that the boards and parts are not damaged by excessive heat; the pumps themselves have a P.T.F.E. nozzle which is heat proof but may need replacing occasionally.

An excellent alternative to a pump is to use *desoldering braid*, including the famous American "Soder-Wick" (sic) or Adcola "TISA-Wick" which are packaged in small dispenser reels. This product is a specially treated fine copper braid which draws molten solder up into the braid where it solidifies. The best way is to use the tip of the hot iron to press a short length of braid down onto the joint to be de-soldered. The iron will subsequently melt the solder, which will be drawn up into the braid. Take extreme care to ensure that you don't allow the solder to cool with the braid adhering to the work, or you run the risk of damaging p.c.b. copper tracks when you attempt to pull the braid off the joint. See my photo gallery for more details.

I recommend buying a small reel of de-soldering braid, especially for larger or difficult joints which would take several attempts with a pump. It is surprisingly effective, especially on difficult joints where a desoldering pump may prove a struggle.

The Basic De-soldering Guide Photo Gallery (and Black Museum of Bad Soldering)

De-soldering is required when electronic components need to be removed from a circuit, usually because they are faulty. It may sometimes be necessary during testing or assembly, if a wrong part has been fitted or a modification has to be made. In the field, it's not uncommon for faulty electronic components to be swapped out, or poor joints (perhaps "dry" or gray joints) to need re-making properly, months or years after manufacture. Experienced engineers can often diagnose a particular faulty joint immediately, because they may have seen the same problem on similar electronic equipment before, especially if the equipment has a "reputation". A proper desoldering technique can soon be acquired with practice - all you need to do is buy some scrap boards to have a go with, and desolder to your heart's content!

The next photo sequence illustrates the basic steps for desoldering a printed circuit board, in order to remove a faulty part. Both the technique for using a desoldering suction pump as well as desolder braid are illustrated. Some real-life examples of poor soldering are shown too, in my *Black Museum of Bad Soldering*!

Remember - it costs just as much to get it right as it does to get it wrong! Practice makes perfect.

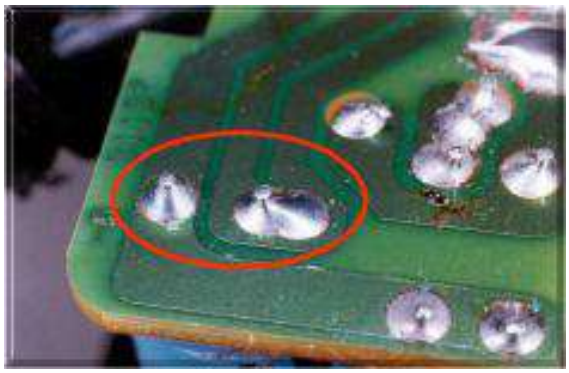

(Left) The two solder joints to be desoldered, to enable a faulty electrolytic capacitor to be removed from the printed circuit board.

(Right) If using a suction-type desoldering pump, apply the soldering iron tip first to melt the solder joint (say for 1-2 seconds). Ensure the spring-loaded desoldering pump is 'primed' and ready to go...

(Left) The PTFE nozzle of the desoldering pump is applied to the molten solder and the spring-loaded plunger is then immediately released, drawing the molten solder up into the pump. Remove the soldering iron tip. Repeat the process if needed. *Handy tip*: sometimes it helps to add some fresh solder and then desolder the whole joint.

(Right) The first p.c.b. joint, now desoldered. The second joint will be desoldered using traditional desoldering braid.

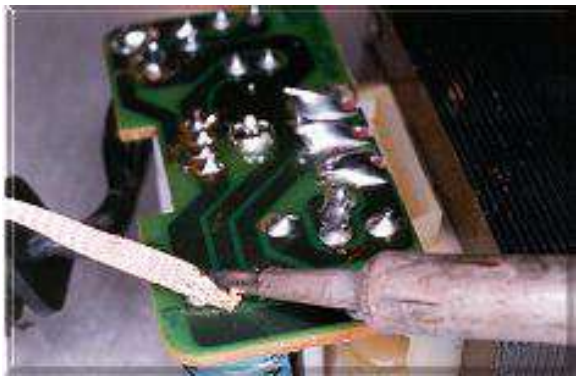

(Left) Select a suitable width of desoldering braid, and **press it down** onto the **COLD** joint using the hot tip of the iron. A flat soldering iron bit is preferable.

(Right) The molten solder is drawn up by capillary action into the desoldering braid. Take care not to overheat the board (the p.c.b. copper track may lift off), nor 'drag whiskers' of solder over the board, nor let the braid solidify onto the joint! Remove the braid while the joint is still molten.

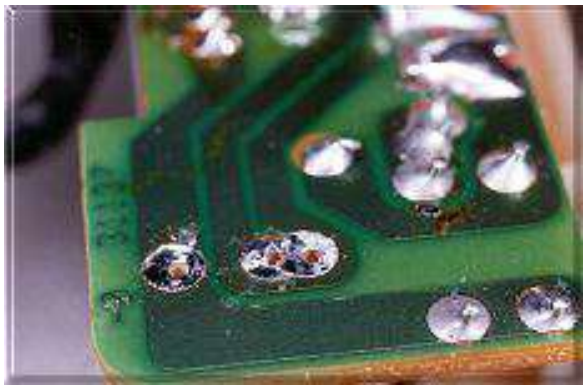

(Left) The faulty electrolytic capacitor dropped out of the board after desoldering. Sometimes, it may need persuading with pliers.... but don't overdo this or you risk damaging the copper tracks on the p.c.b.

(Right) Close-up photograph of both joints, now desoldered and ready for the replacement component to be fitted.

The Black Museum of Bad Soldering

These are all genuine examples which have not been retouched or reworked in any way.

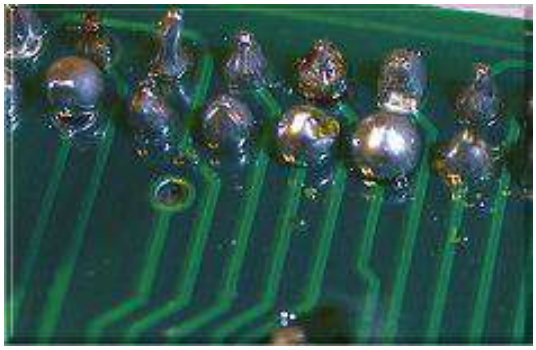

(Left) A tenfold excess of solder on this hand-soldered printed circuit board, and (extreme left) an incomplete solder joint with poor coverage. There is no need to add more solder "for luck".

(Right) An example of a dry (or gray) solder joint found inside a commercial PSU for a computer peripheral. The wire had been fed through the hole in the brass terminal, and merely tacked on with a blob of solder. This is a fire hazard (risk of arcing and overheating).

(Left) Hmmmm... this joint looks somewhat suspect as well... it's the earth (ground) wire in the same PSU

(Right) A close-up reveals the terrible standard of soldering (and quality control), with a fracture visible on this ground/ earth joint.

(Left) How **not** to make a mains voltage soldered joint. This solder joint went "dry" and starting arcing, nearly destroying the attached equipment. It is also a fire hazard.

(Right) The same mains connection, the wire merely being 'tacked on' with a blob of solder.

First Aid

If you are unlucky enough to receive burns which require treatment, here's what to do :-

1. Immediately cool the affected area with cold running water for several minutes.
2. Remove any rings etc. before swelling starts.
3. Apply a sterile dressing to protect against infection.
4. Do not apply lotions, ointments etc., nor prick any blisters which form later.
5. Seek professional medical advice where necessary.

A Few Hints about soldering on a Ground Plane

Before starting

- Always remove any grease and water from your hands. This will reduce the extent to which you oxidise and contaminate the board.
- Avoid touching the copper surface with your hands, always hold a board by its edges.
- Ensure all power and signal inputs are turned off (the soldering iron will short anything you touch to ground!!!)

Soldering a component

- Consider the circuit pathway from input to output in order to minimise the distance. This is especially important between ICs.
- Use the cleaning rubbers or solutions to clean away the oxidised surface where you are going to mount the component. This will help improve the electrical characteristic and improve solder flow
- Where you intend to place solder, VERY LIGHTLY scratch a cross-hatch pattern on the copper plate with a sharp tool. This will increase the friction thereby preventing your soldering iron skating across the board surface
- Apply heat to the copper surface first then add the solder so it smoothly flows on to the copper.
- Use pliers to bend the wire/chip legs to form small feet as this will increase the stability and make them much easier to solder. All wire bends should be done with pliers!
- Tin the legs before trying to mount them on the board
- When using wire, devise a colour coding system and stick to it i.e. red +ve rail, black GND rail, yellow –ve rail, blue input etc. This will make debugging so much easier
- If you are soldering an IC, two good techniques are:
    - Bend its legs with pliers so they are all horizontal and the chip can sit flat on the GND plane surface. Then place a bend just after where the pin leg narrows and bend again slightly further down so the leg it touching the ground plane (see image below). This way the IC is firmly held in place.

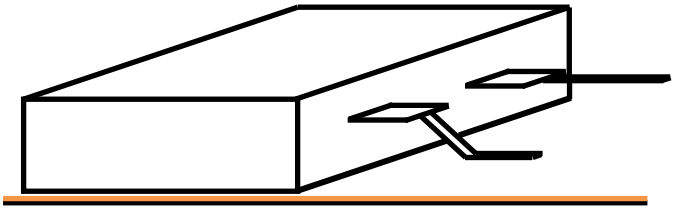

    - Bend legs touching the copper plane at the end to make small feet, then bend all other legs so that they are horizontal. This will result in the chip hovering just off the GND plane reducing the stability, but increasing the space to connect further components.
- Keep component leads as short as possible. This will reduce parasitics, improve mechanical robustness and reduce the chance of accidental shorts

These rules should be followed in conjunction with Dr Clarke's Soldering Guidelines found on the EE2 lab website.

Here is a good copper board layout. Notice the neat leads with none left loose above the circuit, and the way that the layout looks like a schematic. See the web copy (on the AMP handout page) of this picture for more detail.

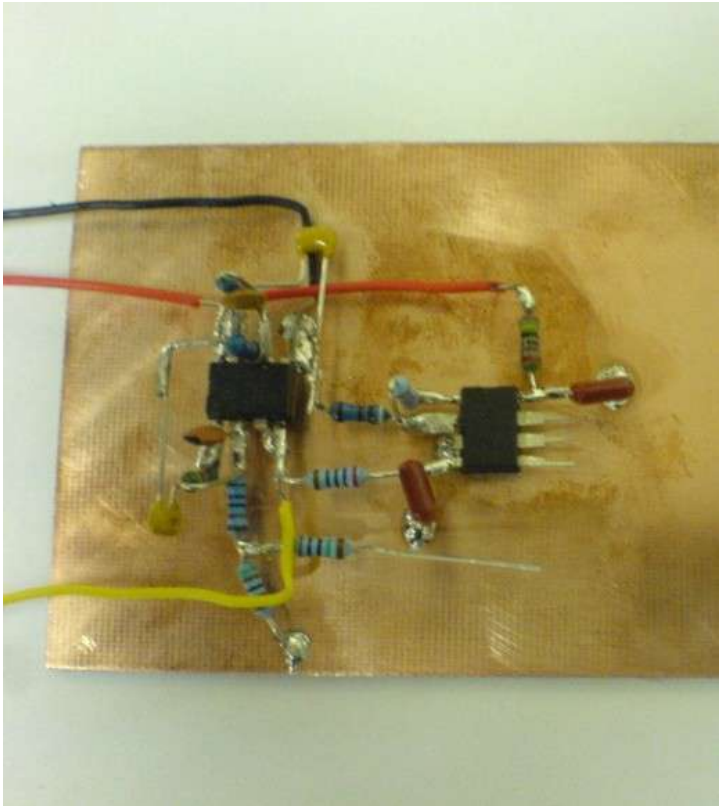

Soldering and Desoldering Instruction

Soldering is defined as "the joining of metals by a fusion of alloys which have relatively low melting points". In other words, you use a metal that has a low melting point to adhere the surfaces to be soldered together. Soldering is more like gluing with molten metal than anything else. Soldering is also a must have skill for all sorts of electrical and electronics work. It is also a skill that must be taught correctly and developed with practice.

Remember that when soldering, the rosin in the solder releases fumes. These fumes are harmful to your eyes and lungs. Therefore, always work in a well-ventilated area. Hot solder is also dangerous. Be sure not to let is splash around because it will burn you almost instantly. Eye protection is also advised.

The Tools

Soldering Iron – Even the cheapest of them will do the job. They may not last as long, but they do get hot enough to melt solder and that is the goal. You only need to make sure that the one you buy has a suitable tip on it. The most typical tip is the one that is about the size of a 1/8" stereo mini-plug.

Solder – Get Rosin Core solder. Rosin will help the solder to flow onto the wires. Solder comes in different thickness. Buy what is appropriate for your job.

Desoldering Gun – This tool will make life a lot easier when you need to rework a previous solder job.
Solder Wick – Braided copper with rosin coating used to draw solder off of circuit boards.

SMD Rework station— Basically this is a high temp hair dryer with special nozzle attached. It heats up entire pins of the SMD device so you can remove them.

The Methods

Soldering – There is not art to soldering, it takes patience and practice to get it right. If you are doing it right, it will be easy and very fast. First, make sure that your soldering iron tip is clean. If it is dirtier than just a light gray color, you need to clean it. You can do this with sandpaper or a Scotch Brite pad. Next, turn your iron on and give it plenty of time to heat up. To test the heat, use a piece of solder touched to the tip. If it melts immediately, it is ready.

The most common way to mess up a solder job is to let the soldering iron stay on the parts to be soldered too long. What this does is oxidize the metal, making it too dirty to attract solder. If you are working with a circuit board, too much heat can damage the board, rendering it useless and in need of repair. You should only hold the soldering iron to the parts to be joined for no more than 10-12 seconds. Any longer and you will melt insulation on wire or damage a circuit board.

It has been said that soldering is a two-person job. You need two hands to hold the parts together, one hand to hold the iron, and another to feed the solder. The correct method for applying solder is to hold the joint perfectly still while heating with the soldering iron. After a few seconds, introduce the end of the solder at the point where the iron meets the parts

If the solder does not melt immediately and flow onto the joint, pull the solder away and try again after a couple seconds longer. If you exceed 10 seconds, pull the iron off and try again after it all cools down. You probably didn't have the iron touching enough of the parts to be soldered. Sometimes, the parts to be soldered are so big that they conduct the heat away very quickly and make it difficult to solder. In this case, it is OK to put some solder on each part individually and then put them together later by melting the solder on each one while they are touching.

Joining Two Wires - Strip off about 3/8" of insulation from the two wire ends to be joined. Place a ½" length of heat shrink tubing over one wire and push it back so that the heat from soldering won't shrink it prematurely. Fold each bare wire end back on itself so that the tip of the wire now comes back to the end of the insulation. Link both wires together using the bends like hooks. Now, twist the ends of the wires around themselves tightly. This type of connection is called a Western Union and it is the strongest method of joining two wires together. Now, heat the connection with the iron and allow solder to flow over the entire joint. Wait a few seconds for it to cool off and then slide the heat shrink tubing down over the connection and heat it with a match or heat gun.

Soldering a Wire to a Circuit Board – This is delicate work that you will do while soldering. Too much heat and your board will be damaged. If you are attaching a wire to an existing hole on the board, make sure that the hole is clean and free of any excess solder (see de-soldering for more detail). The best advice when soldering to a circuit board is to angle your soldering iron tip so that it makes good contact with the pad on the circuit board and the wire or part to be soldered at the same time. Heat the parts up and touch the solder at the point where the tip meets the part and the pad. If the solder does not flow immediately, pull everything off and wait for it to cool down and try again later.

Step 1

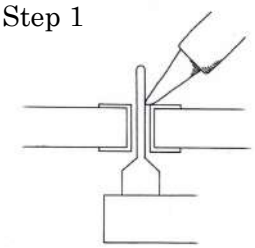

Apply heat to both pin and pad on the circuit board. Make sure tip of the soldering iron is touching both pin and pad.

Step 2

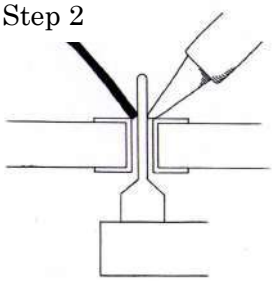

When the both pin and pad are heated enough, apply solder to the pin and pad. Solder should starts to flow.

Step 3

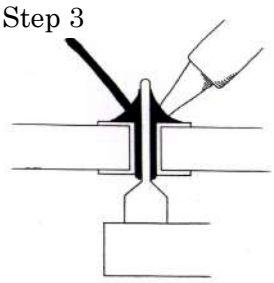

Apply enough but not too much solder. While applying the solder, do not move the tip of iron.

Step 4

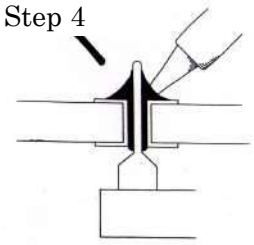

Remove solder away.

Step 5

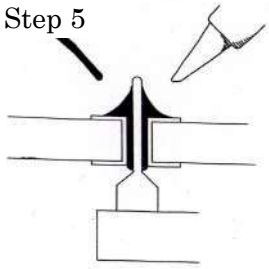

Remove tip of soldering iron also.

Step 6

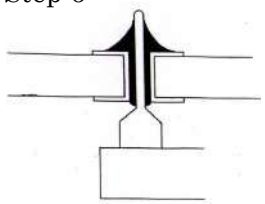

Done! Check the joint to make sure the connection.

Good soldering and Bad soldering Joints

Here are some example of Good soldering and Bad soldering joint.
For Japanese, we often say, “Good soldering joint should look like Mt. Fuji.”

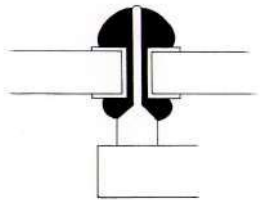

Too much soldering

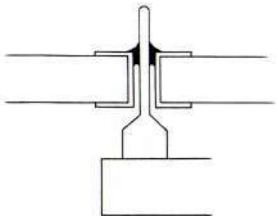

Too little soldering

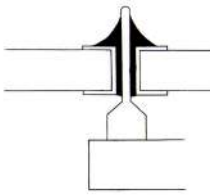

Good soldering

Cold Solder Joints

A cold joint is a joint in which the solder does not make good contact with the component lead or printed circuit board pad. Cold joints occur when the component lead or solder pad moves before the solder is completely cooled. Cold joints make a really bad electrical connection and can prevent your circuit from working.

Cold joints can be recognized by a characteristic grainy, dull gray color, and can be easily fixed. This is done by first removing the old solder with a desoldering tool or simply by heating it up and flicking it off with the iron. Once the old solder is off, you can re-solder the joint, making sure to keep it still as it cools.

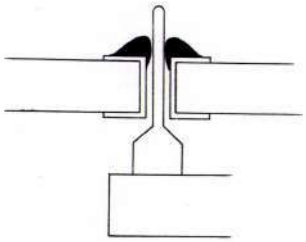

Cold soldering joints

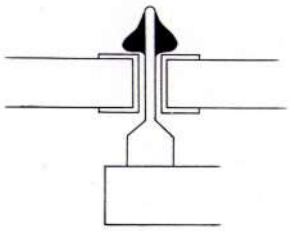

Tips and Tricks

Soldering is something that needs to be practiced. These tips should help you become successful so you can stop practicing and get down to some serious building.

1. Use heat sinks. Heat sinks are a must for the leads of sensitive components such as ICs and transistors. If you don't have a clip on heat sink, then a pair of pliers is a good substitute.

2. Keep the iron tip clean. A clean iron tip means better heat conduction and a better joint. Use a wet sponge to clean the tip between joints.

3. Double-check joints. It is a good idea to check all solder joints with an ohmmeter after they are cooled. If the joint measures any more than a few tenths of an ohm, then it may be a good idea to re-solder it.

4. Use the proper iron or temperature. Remember that bigger joints will take longer to heat up with an 30W iron than with a 150W iron. While 30W is good for printed circuit boards and the like, higher wattages are great when soldering to a heavy metal chassis.

Desoldering

Desoldering is extremely difficult compare to soldering. In the process of RomBoard installation, the parts and circuit board must be in the good shape to re-use them. The tool we use is Desoldering Gun. This device has vacuum pump built in with heater tip. Process of desoldering it self is very simple, but there are some tricks to do clean and safe desoldering job.

Step 1

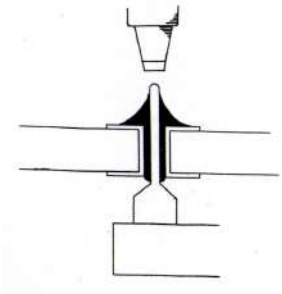

Put the desoldering gun's tip over to the soldering joint. Make sure nozzle is 90° angle from circuit board.

Step 2

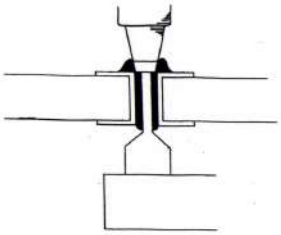

Apply the enough heat to melt entire solder. Multi-layer board or ground pin may take while to transfer heat.

Step 3

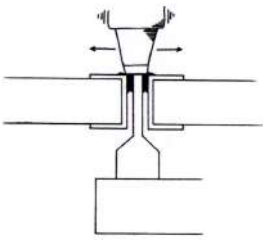

While applying vacuum, move the tip around the pin to get all the solder of around the pin out. At this time, you can also feel pin moves freely, so you know pin is free from circuit board.

Step 4

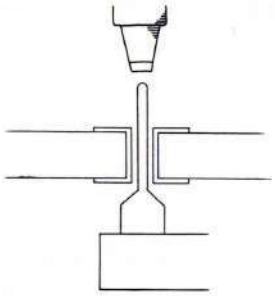

When you can hear air flow sound from hole, you should be done. Stop applying vacuum and remove the gun from the pin. Inspect hole and pin.

When you done with desoldering, the parts that you are trying to remove should move freely. If it doesn't, find which pin is still has solder left, and re-apply fresh solder to it and try desoldering process again. The multi-layer circuit board require more heat to get solder to melt. Make sure pin start to move freely by moving the tip of soldering gun before you apply vacuum to it.

SMD device soldering and removal

In the process of RomBoard installation, chance of handling SMD devices is becoming higher and higher due to ECU configuration change.
Soldering of SMD devices are not much different from regular through hole soldering.
Important thing is positioning of the device is very critical.
Start with applying little solder to two of the each corner of the pads on the circuit board.
Then, place the SMD device and re-heat a one of the solder you just applied to connect a SMD device pin to the pad. Check the position of the device, if position is right re-heat the other end of solder to secure the device completely. If you didn't get position right, re-heat the pin that you just soldered and while heating a pin, move the device to the right position.
Once you positioned the device in the right position, apply Rosin Flux to both pins and pads. This will help your soldering job by keeping solder separate from each pin.
Here is how the joint on SMD device pin should look like.

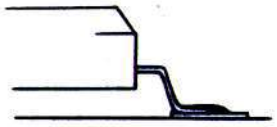

QFP and SOP chip

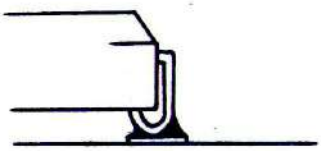

PLCC chip

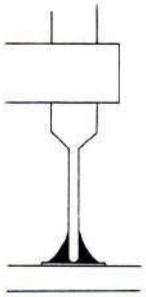

RomBoard adapter socket

Removing SMD device will be the probably the most difficult process. SMD rework station is used to do this. Make sure all the pins are completely heated otherwise you will be removing a pad from the circuit board along with device. Also, you should note, when you are applying heat to the device, some parts around the device is also heated and moves around when you touch. It is good idea to take a note of location of the devices near the target device.

Step 1
Apply pre-heat from back side of the target device. Keep applying heat until you can't touch the chip. By this time, circuit board should have enough heat.

Step 2
Apply heat from top of the target device. Nozzle should cover entire chip. You can check if chip is free from solder by sliding the nozzle left and right. Make sure you don't move other parts. If the chip moves freely, it is ready to be removed.

Step 3
Remove the chip straight up to avoid making solder bridge between pins. Chip is extremely hot! Unless you have skin of steel, avoid imitating the picture.

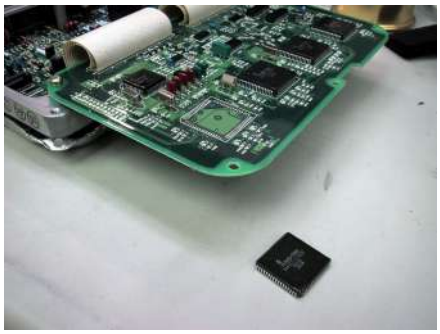

Step 4
After remove the chip, cool down both circuit board and chip.

Step 5
Clean the pads on the circuit board with desoldering gun.
Do not apply too much heat to the pad. Pad might peel off from circuit board. Clean the chip by desoldering gun also.
Check for any bridge between pins. If the chip has too much protective coating on it, use solvent to clean it up.

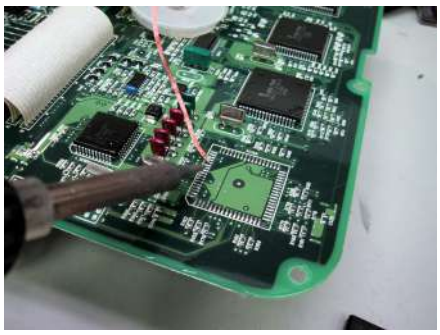

Step 6
If the pads on the circuit board is too small to use desolding gun, try cleaning by solder wick with rosin flux. This may take time but it is much better than peeling pads off.
Once again, do not apply too much heat.

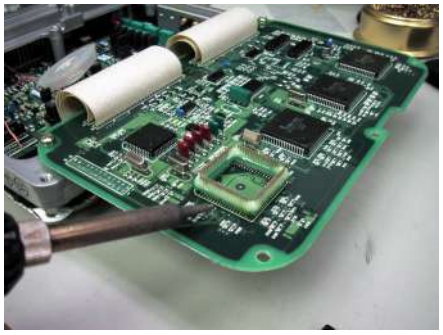

Step 7
Solder the RomBoard adapter where the chip was.
Refer SMD device soldering section for how to solder adapter.

The Final Word

Soldering, desoldering, and working with SMD device will take some effort to learn. You should be relaxed and concentrated when you work.
Keeping every thing clean (tip of iron, gun, work surface, etc) will help you also.
Once you get comfortable to work with soldering you may find your own tips and tricks.
Experience is all bout soldering.

EOF

Strain Gages and Instruments | Tech Tip TT-609

Strain Gage Soldering Techniques

Introduction

The most common method of making electrical connections in strain gage circuits is by means of soft solders, in wire form. Other methods, such as spot welding, brazing, compression bonding, paste solders, and conductive epoxies, are also available, but find only limited application. Solders have many advantages for strain gage use — they are low in cost, readily available in various alloy compositions to provide a range of melting temperatures, and are easily obtained in the form of either solid wire or wire with a core of flux. They are convenient to use, and offer an excellent combination of electrical and mechanical properties.

Although soldering is basically a simple procedure, it must be done with appropriate tools, supplies, and techniques to assure accurate strain measurement. This is particularly true when test requirements are severe in the sense of approaching the limits of the strain gage circuit capabilities; e.g., long-term stability, high-elongation measurements, fatigue endurance, etc. Use of improper materials or techniques can significantly degrade strain gage performance.

The purpose of this Tech Tip is to outline recommended procedures and materials for attaching leadwires to strain gage solder tabs or to bonded printed-circuit terminals. These reliable, experience-proven methods are based on the use of a professional quality soldering station, in conjunction with Micro-Measurements solders and installation accessories.

Soldering Station and Pencil

For precision soldering of strain gages, it is always necessary to use a temperature- or power-controlled soldering station that provides low voltage and adjustable temperature to the soldering iron tip. An unregulated soldering iron, connected directly to the power line, is not ordinarily suitable for strain gage use because the tip temperature is apt to be far too high. This tends to oxidize the tip, and to instantly vaporize the flux, making soldering much more difficult. In addition, the unnecessarily high temperature may damage the strain gage, the bonding adhesive, or even the test specimen. For these reasons, the soldering station should incorporate provision for adjusting the soldering temperature to suit varying installation conditions and requirements. The temperature must be adjusted, of course, to accommodate the melting points of the different solders commonly used for strain gage connections, but also to allow for environmental conditions such as drafts or outdoor soldering in cold weather. Moreover, the temperature controller should be carefully designed to ensure that it does not generate electrical noise that could adversely affect nearby measuring instruments when both are in use.

Design of the soldering pencil also requires special consideration. It should be light in weight, with a very flexible power cord, and with the gripping area thermally insulated from the heating element. These characteristics contribute to the comfort, ease, and precision of soldering, and minimize operator fatigue during long periods of use. The soldering tip itself should be of the flat, chisel, or screwdriver type. Pointed tips should not be used, because they tend to draw solder away from the work area, and thus make it more difficult to achieve a proper joint. In contrast, flat tips act to confine the solder, while offering greater surface area for better heat transfer and more effective soldering, generally.

Micro-Measurements soldering units incorporate all of the above features and a number of others, designed to help the user easily make consistent, reliable solder joints. These soldering units are widely used by professional strain gage installers everywhere, in both stress analysis laboratories and in transducer manufacture.

Solder Selection

The Micro-Measurements Division stocks a broad range of solder types to meet various installation and test requirements. While solders are sometimes selected to provide specific electrical or mechanical properties, the most common basis for selection is simply the melting-temperature range. Low-melting-point solders, for example, are generally used for strain gage installations on nonmetallic test parts to avoid damaging the gage, bonding adhesive, or test material due to overheating. In contrast, high-temperature solders are normally selected only when necessary to satisfy elevated-temperature testing requirements. These solders are somewhat more difficult to handle because the higher working temperature

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rapidly vaporizes the flux, and oxidizes the soldering tip, both of which tend to impede the soldering process. Specially designed soldering tips are recommended for high-temperature use.

For routine applications, where test conditions do not dictate the use of either a low- or high-temperature solder, an alloy with an intermediate melting temperature is the normal selection. The 63/37 tin-lead alloy (Type 361A-20R) is an excellent choice for general-purpose strain gage soldering. As an eutectic alloy, it has a sharply defined melting temperature — a characteristic that largely eliminates "cold" solder joints. The addition of a trace of antimony provides superior performance when the soldered connections will be exposed to very low (cryogenic) temperatures for long periods of time.

The general-purpose solders are supplied with a core of activated rosin flux. This makes soldering much more convenient, and is particularly useful in field applications where accessory liquid rosin flux (M-Flux AR) may not be available. Solid-wire solder, with externally applied acid flux (M-Flux SS), is recommended for making soldered connections to Micro-Measurements K- and D-alloy (modified Karma and isoelastic) strain gages. Rosin-core solders should not be used in conjunction with acid flux.

Silver solder (Type 1240-FPA) is available for applications where leadwire connections will be exposed to temperatures above about +550°F (*+290°C*). This solder, in paste form, is not suitable for attaching wires directly to strain gage solder tabs or to bondable terminals, but is intended for connecting instrument leads to preattached strain gage leads, as with WK-Series gages using a special resistance soldering unit. Techniques for making leadwire connections with silver solder are described in Micro-Measurements Tech Tip TT-602, *Silver Soldering Technique for Attachment of Leads to Strain Gages*.

Soldering Flux

The function of a soldering flux is to remove oxidation from the members being joined (solder tabs, terminals, leadwires), and to prevent further oxidation during soldering. For making leadwire splices, or soldering directly to constantan foil or copper terminals, the flux contained in a rosin-core solder is usually sufficient. With higher temperature solders, however, it may be necessary to supply additional flux. A liquid activated-rosin flux such as M-Flux AR is recommended for this purpose.

Acid fluxes should never be used on constantan strain gages or copper terminals, or for splicing copper leadwires; and paste fluxes, containing chlorides, should not be used under any circumstances for strain gage soldering. When tinning bare (without soldering options) solder tabs of Micro-Measurements K- and D-alloy strain gages, a liquid acid flux (M-Flux SS) is recommended. After the tinning operation, the residual flux must be completely neutralized within one to two minutes; and then the leadwire joint can be completed using the same solder and M-Flux AR rosin flux or a rosin-cored solder.

Preparation of the Soldering Tip

New soldering tips should always be tinned with solder prior to initial use. This is easily accomplished by wrapping one to two in (*25 to 50 mm*) of solder wire around the working portion of the tip while the soldering iron is cold, before applying power to the soldering station. If rosin-core solder is used, no external flux is required. With solid-wire solder, however, the wrapped tip should be dipped into liquid rosin flux (M-Flux AR) to provide sufficient flux for initial tinning. Set the control on the soldering station to the appropriate temperature range for the solder, and apply power to the unit. Allow the soldering pencil to heat until the solder wrapped around the tip melts completely. Remove excess melted solder from the tip with a dry gauze sponge. Never knock the heated soldering pencil against any object to remove excess solder, since this may result in personal injury or damage to the soldering pencil.

Note: Cross-alloying of solders can change the electrical, chemical, thermal and mechanical properties of the solder being used. To prevent cross-alloying, it is recommended that only one type of solder be used with each soldering tip. Of course, if one type of solder is incorporated in a gage with solder dots and another type is added, a mixture is produced. This mixture cannot be expected to have melting and strength properties any better than those of the lower temperature component.

Oxidation of the soldering tip seriously hinders the soldering operation. The tendency for oxidation can be minimized by ensuring that excess melted solder remains on the tip at all times when it is not actually in use. Negligent maintenance practices, or wiping the hot tip with materials that char on the surface, will produce a buildup of oxide that prevents proper soldering. If the tip does become oxidized, the following procedure is effective for cleaning and re-tinning:

1. Set the soldering station to the appropriate temperature range for the solder in use.
2. Place several drops of M-Flux SS on a glass plate. Re-tin the soldering surface by holding the heated tip in the SS flux while feeding solder onto the tip. A generous amount of solder is essential for proper tinning.

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3. Wipe the excess solder from the tinned tip with a dry gauze sponge. For severely oxidized tips, it may be necessary to repeat this operation several times to obtain a properly tinned surface. The soldering tip should never be filed or sanded, since this may remove the plating on the tip, accelerating the oxidation and leading to the early deterioration of the tip. After the cleaning operation, remove excess solder, re-tin and clean the tip several times, using rosin-core solder, or solid-wire solder withM-Flux AR.

Tinning Solder Tabs and Bondable Terminals

All strain gage solder tabs, terminals, and leadwires must be properly tinned before making soldered connections. This helps ensure active surface wetting and good heat transfer during the soldering operation. Tinning stranded leadwires to produce a formable solid conductor will also greatly simplify the leadwire attachment procedure.

Before tinning the solder tabs on open-face (unencapsulated) strain gages, the measuring grid should be protected with PDT drafting tape. The drafting tape is positioned to cover the entire grid and the upper portion of the solder tabs, as shown in Figure 1. This not only shields the grid from soldering flux and inadvertent solder splash, but also restricts the flow of solder on the tabs. The tinned area on the solder tabs should be only large enough to easily accommodate the leadwire size in use. The latter consideration is particularly important when making installations for dynamic applications or large-strain measurement.

The tinning procedure for strain gage tabs and terminals consists of first cleaning and reapplying a small amount of solder to the hot soldering iron tip. Next, apply a drop of M-Flux AR to the tab or terminal (this step can be omitted if a rosin-core solder is used). When soldering directly to bare Karma or isoelastic foil, use M-Flux SS on the gage tabs only. Hold the soldering pencil in a nearly horizontal position (<30°), with the flat surface of the tip parallel to the solder tab or terminal. Place the solder wire flat on the gage tab, and press firmly with the tinned hot soldering tip for about one to two seconds, while adding approximately 1/8 in (*3 mm*) of fresh solder at the edge of the tip. This procedure assures that there is sufficient solder and flux for effective tinning. Simultaneously lift both the soldering pencil and solder wire from the tab area.

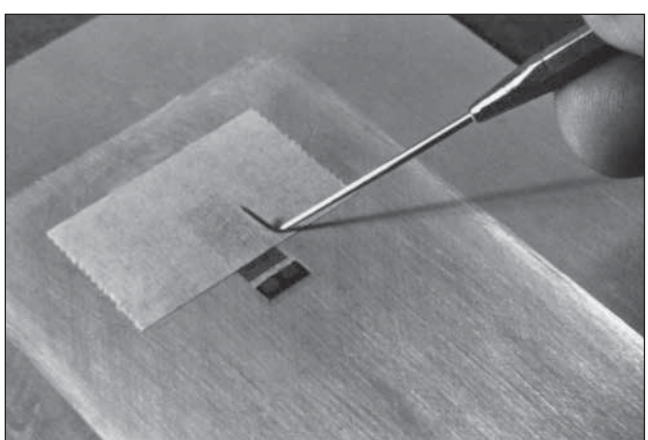

Figure 1 – Gage grid and upper portion of solder tabs masked with drafting tape.

NOTE: Lifting the soldering iron before lifting the solder may result in the end of the solder wire becoming attached to the tab; lifting them in the reverse order can leave a jagged (spike) solder deposit on the tab. When the operation is performed properly, it will produce a small, smoothly tinned area on the tab or terminal.

If M-Flux AR or a rosin-core solder is used in the tinning, it is not necessary to remove the residual soldering flux at this time. However, when M-Flux SS is employed to tin the bare solder tabs of K- or D-alloy gages, the acidic flux residue must be removed immediately following the tinning operation. To remove the residue, apply M-Prep Conditioner A liberally, and wash the area with a soft brush; then blot dry with a clean gauze sponge. Next, wash again with freely applied M-Prep Neutralizer 5A, and blot dry with a clean gauze sponge.

NOTE: Special procedures for tinning and wiring strain gages supplied with preattached solder dots are described in Micro-Measurements Tech Tip TT-606, *Soldering Techniques for Lead Attachment to Strain Gages with Solder Dots*.

Tinning and Attaching Leadwires

Of course, leadwire ends must be stripped of insulation before tinning, and this should be done with a thermal wire stripper to avoid the damage to the wire that often occurs when mechanical wire strippers are used. After the wires are stripped, the ends of stranded conductors should be twisted tightly together before tinning. The bare leadwire ends can then be tinned easily with the following procedure:

1. Remove excess solder from the soldering tip, using a dry gauze sponge. Then melt fresh solder on the hot tip to form a hemisphere of molten solder about twice the diameter of the wire to be tinned.

2. If rosin-core solder is used, slowly draw the bare wire through the molten solder while continuously adding fresh solder to the interface of the wire and soldering tip. With solid-wire solder, apply M-Flux AR to the

Strain Gage Soldering Techniques

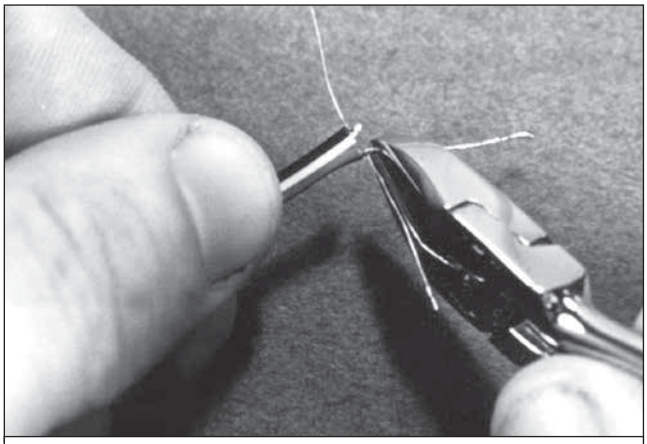

Figure 2 – Trimming leadwire ends before taping in place.

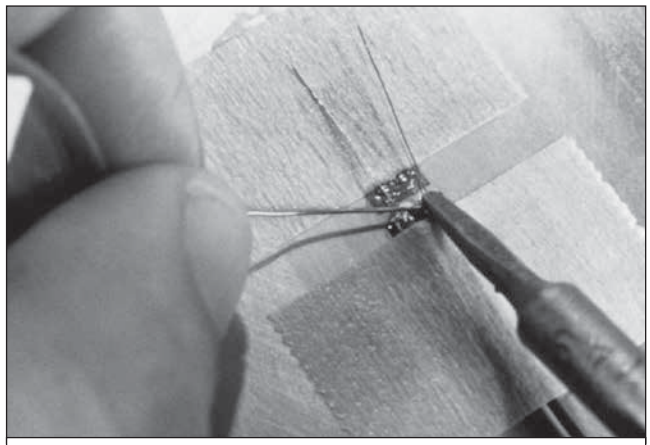

Figure 3 – Leadwire end taped to surface in preparation for soldering.

wire end before starting to tin, and proceed in the same manner. This will produce a smooth, shiny coating of solder over the bare wire.

For applications employing bondable terminal strips and stranded instrumentation wire, it may be convenient to use a single strand of the wire as a jumper between the terminal and the strain gage solder tab. In such cases, the single wire strand should be separated out before twisting and tinning the remaining strands (see Micro-Measurements Tech Tip TT-603, *The Proper Use of Bondable Terminals in Strain Gage Applications*).

Leadwires should be formed and routed to the strain gage or terminal strip, then firmly anchored to the test-part surface with drafting tape before making the soldered connection. Attempting to route the leadwires after completing the solder joint will often result in damage to the gage or terminals. Routing into the connection area should be along a minimum strain direction (such as the "Poisson" direction in a uniaxial stress field) particularly for high elongation or dynamic tests. The tinned leadwire end should be trimmed short enough so that it will not protrude through the connection area, and cannot inadvertently make electrical contact with the test-part surface or adjacent solder connections. Figure 2 illustrates this stage in the procedure. In the final preparatory step, bend the leadwire end slightly to form a spring-like loop, and tape the wire firmly in place over the connection area, using PDT drafting tape. The tape should be within about 1/8 in (*3 mm*) of the connection area, as shown in Figure 3.

Clean and re-tin the soldering iron tip with fresh solder. The temperature of the iron should be adjusted so that the solder is easily melted, without rapidly vaporizing the flux. If the iron temperature is either too low or too high, it may cause poor solder connections, or it may damage the strain gage, terminal, or bonding adhesive. Apply a small amount of M-Flux AR to the joint area and, holding the soldering pencil nearly horizontal, firmly press the flat surface of the tip on the junction for about one second; then lift the tip from the soldered joint. If needed, additional flux can be provided during the joining operation by feeding a little fresh solder into the joint from a spool of rosin-core solder. This procedure should result in a smooth, hemispherical solder joint, without any peaks or jagged areas. If the solder joints are not smooth and uniform in size, repeat the soldering procedure, using additional flux and/or solder as necessary.

Cleanup and Inspection of Soldered Joints

After completing the soldering operation, it is imperative that all traces of residual flux be completely removed with RSK Rosin Solvent. The same solvent is used to soften the mastic of the drafting tape, permitting its easy removal. Do not try to pull away the tape with tweezers or other tools, because this may result in damage to the soldered connections or the strain gage grid. Thoroughly clean the entire installation area with generously applied rosin solvent and a soft-bristled brush. Clean the solder connection area until no visible signs of residual flux remain, and blot the area dry with a clean gauze sponge. Any traces of residual flux can cause gage instability and drift, and will inhibit bonding of the installation's protective coating. Incompletely removed soldering flux is the most common cause of degraded performance in strain gage installations. Residual flux mixed with a protective coating application can completely destroy the coating objective.

Visually inspect the soldered joints for any gritty or jagged joint surfaces, and for traces of flux. Solder connections

Strain Gage Soldering Techniques

should be smooth, shiny, and uniform in appearance. Any soldered joints that look questionable should be re-soldered, and flux removed. Check the resistance-to-ground of the completed gage installation, using the Model 1300 Gage Installation Tester. Low or marginal resistance readings suggest a leakage path between the soldered connections and the test-part surface. This condition usually results from residual soldering flux, or from bare leadwire conductors partially shorting the gage tabs or terminals to the test part. Soldered joints should not be tested by pulling on the leadwire, or by probing at the joint area. These practices frequently cause lifting or tearing of the solder tab from the gage backing material.

Summary

The ability to make consistently good soldered joints is essential for precision strain gage measurements. The techniques described here are straightforward and easily mastered, but they are most effective when used with professional soldering equipment which is specially designed for making soldered connections in strain gage circuits. The soldering pencil should be lightweight, with a flat chisel or screwdriver tip, and it should be connected to the soldering station with a very flexible power cord. Requirements for the soldering station include low-voltage operation of the soldering pencil, and provision for temperature adjustment to suit the type of solder and the application conditions. The equipment should not generate electrical interference that could affect sensitive measuring instrumentation. Solder selection is based primarily on the expected operating temperature range of the strain gage installation; and all solder tabs, bondable terminals, and leadwire ends should be tinned before soldering the joints. Soldered joints should always be smooth and shiny, with no jagged or irregular edges, and all traces of residual flux must be thoroughly removed prior to the application of protective coating. Use of the recommended materials and techniques, with careful attention to detail, will result in consistently proper and reliable soldered connections.

Soldering & De-soldering

Digital Electronics

Soldering & De-soldering

This presentation will…

- Review the tools needed to solder and de-solder electronic components.
- Demonstrate how to *tin* a soldering iron tip.
- Demonstrate the soldering process.
- Show the characteristics of a good solder connection.
- Review classic soldering mistakes.
- Demonstrate the de-soldering process.

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Soldering Tools

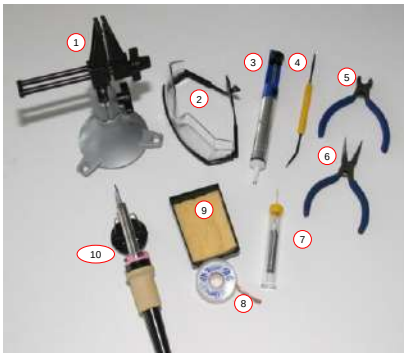

1) Vise
2) Safety glasses
3) Solder sucker
4) Solder tool
5) Diagonal cutters
6) Needle nose pliers
7) Solder
8) Solder wick
9) Damp sponge
10) Soldering iron

3

Soldering Iron

Typically 25-30 watts

Tip Temperature ≈750°F (400 °C)

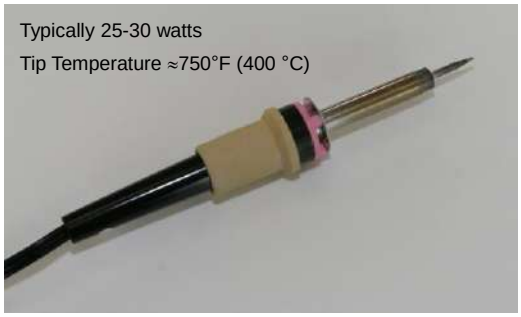

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Solder

- Solder is an alloy of tin and lead.
- The solder used for electronics is frequently called 60/40 solder because it is made of 63% tin and 37% lead.
- 60/40 solder melts at 361° F.
- Lead-free solder**:** As of July 1st, 2006, European laws mandated that new electronics be entirely lead-free. As of yet, no such laws exist in the United States.

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Soldering Iron Care & Maintenance

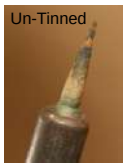

- A soldering iron must be coated with a thin coat of solder. This will allow for the transfer of heat to the work piece.
- This procedure is called tinning.
- The tip must be kept coated with a shiny layer of solder by occasional wiping and applying solder directly to the tip.

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Tinning Process

Apply Solder to Soldering Iron Tip

Roll Tip on Damp Sponge

Properly Tinned Soldering Iron Tip

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Solder Process

Heat both items at the same time by applying the soldering iron to the copper pad and the component lead.

Continue heating and apply a few millimeters of solder. Remove the iron and allow the solder joint to cool naturally.

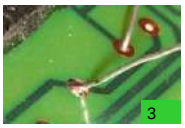

It only takes a second or two to make the perfect joint, which should appear shiny.

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A Good Solder Joint

- Smooth
- Bright
- Shiny
- Clean
- Concave fillet

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Bad Solder Connections

Too Much Solder

Too Little Solder

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Bad Solder Connections

Cold Solder Joint

Not Soldered

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Bad Solder Connections

Solder Bridge

Lifted Trace/Pad

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De-Solder Process: *Solder Sucker*

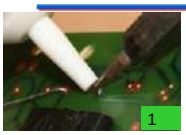

Apply heat to the connection to be de-soldered. When the solder melts, trigger the solder sucker.

Repeat de-soldering as needed until all solder is removed. Remove soldering iron & solder sucker from area.

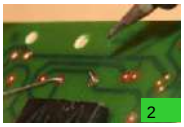

Remove component lead.

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De-Solder Process: *Solder Wick*

Solder wick is finely braided copper that is used to *wick away* excess solder from a de-soldered connection.

Apply the solder wick and soldering iron to the de-soldered connection. The solder wick will draw the excess solder off of the PCB pad.

De-soldered PCB pad

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Soldering Safety

- Wear safety glasses when soldering. This includes all individuals in the vicinity of someone who is soldering.
- Place soldering iron in an approved holder when not in use. The iron is hot and can cause burns.
- Place the soldering iron so that the cord does not get caught up in your arms or on others.
- Ensure access to proper ventilation.
- Verify that the type of solder is safe to use in your working environment.
- Secure the components to be soldered before beginning the soldering process.

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Soldering Safety

- Provide plenty of space to work.
- Use a properly-sized point for the soldering job to be completed.
- Verify that the tip on the soldering iron has a sharp point and has not been damaged in any way.
- Check the power cord for burned or melted sections that show bare wires. Label those cords DO NOT USE and ask the instructor to repair or replace.
- Do not to touch molten solder - it is hot!
- Make sure that the solder strand is long enough to keep fingers away from the hot iron.

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Soldering Safety

- Tie back long hair and remove or tuck loose clothing.
- Use heat sinks for heat-sensitive parts. Provide sufficient cooling time before removing parts.
- Do not flick solder off of the iron. Flicking can cause solder to spray and hit skin or eyes.
- Hold the scrap end when cutting excess leads so that the scrap lead is not thrown into the air.
- Cut leads evenly with wire cutters.
- Make sure that leads do not short across other traces or leads.
- Thoroughly wash your hands after handling solder.

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How to Solder Like a Pro

Detailed instruction, helpful hints, safety tips, and a comprehensive troubleshooting guide

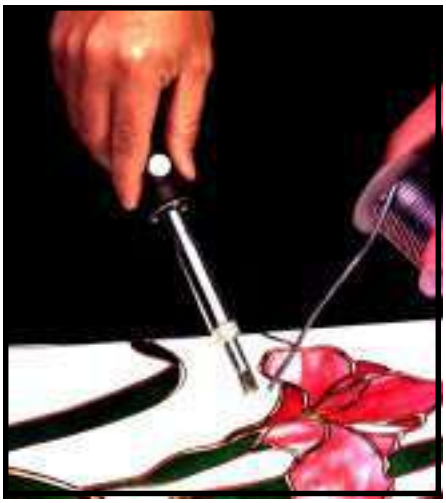

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Safety

The Importance of Safety

One of the most important aspect of soldering any stained glass project is to take the proper measures to safeguard your health. Soldering involves working with potentially hazardous materials like lead, flux and harmful fumes. By observing specific safety precautions and using informed common sense, working in stained glass can be a safe and enjoyable past time. The following is intended to serve as a general rule of thumb. Since each person and situation is unique, you should use this information as a starting point to help you make informed safety decisions concerning your soldering habits.

Fumes

Solder only in a well ventilated area, and use an exhaust device that moves solder fumes away from your face. It's preferable to exhaust outside (check local/state building codes and restrictions on venting to outside air). If you don't exhaust to the outside, use a bench top fan or intake device with a replaceable smoke/fume absorber made for stained glass artists. It should draw solder fumes into the replaceable filter. The filter should be activated charcoal and designed to remove particles smaller than 1/2 micron from the air. There are also several OSHA approved respirators available for fumes. Consider wearing one in conjunction with a venting system, especially if you plan on soldering for several hours every day.

Lead

Most popular solders used in stained glass are lead based. When you are using them, follow these precautions:

- Never eat, drink, or smoke in any area where soldering takes place.
- Always thoroughly wash your hands after soldering.
- Make sure your soldering equipment and supplies are kept out of the reach of children.
- Do not discard lead or solder scraps into the trash. Find a means or place to recycle them.
- Never use lead based solders or cames on items that will come in contact with food or children, or will be frequently handled. If you are making kaleidoscopes, jewelry or napkin holders, use lead free solder.
- Consider having your blood lead level checked by your physician on a regular basis to help you monitor your handling practices.
- If you are pregnant, or considering it, you should check with your doctor before using lead or solder.

Heat

Soldering tools operate at high temperatures, so these safeguards are important:

- Wear safety glasses! Solder and flux can "pop" and "spit."
- Solder on a fire resistant surface. Homosote, or dry wall are good .
- Never leave your iron plugged in and unattended.
- Do not overload a wall outlet with too many electric appliances.
- Never set your hot iron down on anything other than an iron stand.
- Replace the cord of your iron if it becomes worn or gets burnt.
- To prevent burning your fingers, use needle nose pliers or heat resistant gloves to hold small pieces.
- Never cut off a grounding prong on an iron plug to make it fit an ungrounded receptacle.

Soldering Irons

Choosing a Soldering Iron

There is a lot to consider when you choose an iron for stained glass. The handle should be heat resistant and comfortable for you to hold. You may be holding it for several hours at a time, so consider the weight and balance of the iron. Carefully check the wattage of the iron that you are considering. It must be able to continuously generate enough heat to melt all of the types of solder you plan to work with and be compatible with the type of construction you use (i.e.-copper, foil, lead came, rebar, etc.). You will need an iron that is at least 60 watts, with chisel type tips, and a way to control the temperature.

Types of Temperature Controls

A broad range of soldering irons are available. Most irons, which we will call "conventional irons," are made with wound wire heaters in a barrel with mica insulation. They are often inexpensive, but they do not offer the ability to control operating temperature. A separate temperature controlling device must be used with these irons to achieve the best results. There are three types of soldering irons that are easier to use for stained glass projects, because they allow you to control temperatures more effectively:

Irons with temperature controlled tips.

Irons used with temperature controlling devices.

Irons with ceramic heaters.

Irons with Temperature Controlled Tips

These irons are supplied with an internal regulator in the tip that does not allow the iron to exceed a predetermined temperature. An example would be a 600°F tip. The iron heats to that temperature then "shuts off." When heat is required, the iron "turns on" again. Tips are available in predetermined temperatures up to 800°F. These irons are easy for beginners to use, because the temperature is automatically maintained for you, however, as your skills increase, you may prefer to control the amount of heat yourself for different soldering situations. The limited amount of control may become frustrating as your soldering skills increase. With this type of iron you will likely encounter "cold spots" where the iron will not melt your solder. These cold spots occur when heat is being drawn out of the tip faster than it is being replenished. You will need an iron with a minimum of 100 watts.

Ceramic Heating Element Irons

These irons are relatively new to the stained glass trade. They are made with highly efficient ceramic heating elements. Like a ceramic room heater, they produce a consistent temperature using less electrical wattage during operation. When initially heating and when reheating during "recovery" periods, they can draw a "burst" of power exceeding 100 watts and then efficiently reduce electrical consumption, often below 60 watts, during the soldering process. The result is efficiency and economy.

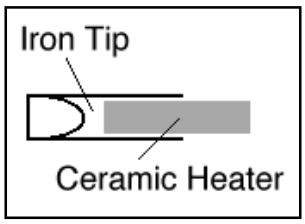

A remarkable feature of ceramic heater irons is they generally reach operating temperature in less than 60 seconds. Of the three types of noncoventional irons, the ceramic heater type best maintains consistent tip temperature over extended periods of time. Problems with slow heat recovery generally don't exist. A ceramic heater iron offers excellent flexibility and can be used with a temperature controller if you like.

Temperature Controlling Devices

A temperature controller is a device that operates similarly to a light dimmer switch. By dialing the control to a higher or lower setting, more or less electricity is fed to the iron. This increases or decreases the iron temperature, allowing the tip temperature to be controlled. You can establish the maximum temperature without changing tips.

A temperature control/iron combination offers you greater control and flexibility than a temperature controlled tip iron when working with different metals and solder mixes. Look for one that is at least 85 watts. Since the flow of electricity to the tip is consistent and never completely stops, encounters with cold spots are nearly eliminated. A temperature control/iron combination is suitable for all types of stained glass construction.

Temperature controllers are generally separate units that the iron plugs into. They are small, easy to use and relatively inexpensive. There are also irons that have controls built into the handle of the iron, which generally cost less than buying an iron and a separate control. Never plug an iron into a temperature control unless the manufacturer specifically states it is suitable for use with it.

Tip Sizes, Styles and Uses

Stained glass irons are generally sold with a "chisel" style tip. There are a variety of tip sizes and styles available for nearly every iron used in the stained glass industry. Different tips can expand the versatility of your soldering iron, so select an iron that offers more than one size replacement tip.

The standard tip size that comes with an iron is usually from 1/4" to 3/8" wide. This size works well for soldering either copper foil or lead came projects.

A smaller chisel tip, 3/16" wide, can be useful when soldering small pieces or when soldering in a tight area, such as a narrow inside part of a kaleidoscope. It is also very effective for decorative soldering.

Very small tips, 1/8" or narrower, are usually used for decorative soldering. They allow you to create very fine details and designs with the solder.

Iron and Tip Maintenance

The Importance of Proper Care

Your soldering iron may very well be one of your biggest tool investments, so you will want to do everything possible to ensure that it gives you many years of service. Well maintained soldering irons and tips perform better and make the job of soldering much easier. Always place your soldering iron in a stable iron stand whether it is being used or not.

The Cord

- Make sure you plug the iron into the correct type of outlet.
- Try not to use an extension cord. If you must, use a heavy duty one.
- Don't drop or bang the iron. Ceramic heaters are especially easy to crack or break.
- Regularly check the cord for burns or cracks and have a professional electrician replace worn cords before using the iron.
- Make sure that the cord is not hanging in such a way that it can be pulled off of the table.

The Heating Element

- Do not allow the iron to idle at operating temperatures for extended periods. This could burn out the heater element. Unplug the iron or, if you are using a rheostat, turn it down to a low "idle" setting.
- Occasionally, remove the tip and **lightly** tap the barrel of wire wound heater irons to remove debris.
- If you will not be using your iron for an extended period of time, you may want to store it (after it has fully cooled) in a zipper type bag to protect it from corrosion and humidity.

The Tips

- When you are finished using your iron, remove the tip from the barrel. Removing the tip is essential to preventing "seizing" which can occur if it is left in the iron for extended periods. (If your tip seizes, you can easily damage the heating element trying to remove it. It is best to return you iron to the manufacturer for removal.)

- When reinserting tips, make sure they are properly seated in the barrel.
- Never dip your tip into flux in order to clean it. Instead, use a clean damp sponge to wipe all sides of the tip periodically as you solder. Doing this removes impurities the tip has accumulated from the solder and the environment. It will ensure that you are receiving the maximum heat at the tip surface.
- Properly cleaned tips are bright and shiny. If your tip becomes "blackened," you can usually remove the buildup with a wet sponge, a tinning block or by gently using a brass brush. A “tinning block” (sal-amoniac) is used by placing a small amount of flux on the block and rubbing the tip of your hot iron in it. Wipe the tip on a damp sponge to remove debris. You may need to repeat this several times if your tip is very dirty.)

- Never use sandpaper or any abrasive material to clean a tip.
- The best way to minimize your tip maintenance is to find a good quality solder. Use one that has a high tin content and high metal purity.

Solder

Why Do We Use Solder?

Solder is a combination of tin and lead used to create a strong bond between other metals. Since solder won't stick to glass, we apply a copper foil tape (our metal) to the edges of the glass. This is refered to as the copper foil method of stained glass construction. Solder is melted over the copper foil, creating a structure that holds the pieces of glass together. The other option is to set the glass into channels of lead or metal, and solder the channels together. This is refered to as the lead came method.

The Advantages of Solder

Some of the advantages of soldering versus other bonding methods are:

- Solders are easy to use and relatively inexpensive.
- Low energy is required to solder.
- Properly soldered joints are highly reliable.
- Solder joints are easy to rework or repair.
- Experienced craftpersons can exercise a high degree of control over the soldering process.
- Solder joints age very well. They can last for years, decades and centuries.

Types of Solder

Stained glass solders are usually a mixture of tin and lead, designated by two numbers representing the percentages of each metal in that specific mix. The first number always refers to the percentage of tin, the second is the percentage of lead. The most commonly used solders in stained glass are 60/40, (60% tin/40% lead) 50/50 and 63/37. "Lead-free" solders have no number designation and are a mixture of tin and small amounts of other metals. Avoid solders containing antimony, a very toxic element. Instead look for lead-free solders containing silver, or copper. They are safer and easy to use. (Note they are, however, more difficult to patina.)

In North America, you will find solder is generally sold in solid core wire form on a spool. The common spool size is one pound. In Europe, you will find solders primarily sold in a bar form. Never use acid-core or rosin-core solders for stained glass work. Look for solders that are sold as "free of impurities" in the component metals. Impurities cause a "scum" on your solder bead, degrade soldering iron tips, and interfere with the proper reaction of patina chemicals resulting in undesired finishes.

An important term for solders is the "working range" or "pasty range." This is the range of temperature between which solder transitions from liquid back to solid.

Characteristics of Solder Types

60/40 Solder: Composed of 60% tin and 40% lead, this solder melts at 374°F, but doesn't become completely solid until it cools to 361°F. This means it has a "pasty range" or "working range" of 13 degrees. This solder is your best choice for copper foil work. The liquid temperature and narrow "pasty range" make it easy to form and maintain consistent high, rounded, beaded seams. Because of its relatively low melting point, "60/40" solder is easy to rework to maintain a smooth finish solder bead.

50/50 Solder: This is composed of 50% tin and 50% lead. It is liquid at 421°F, solid at 361°F and has a pasty range of 60 degrees. This solder will produce a much "flatter" bead than 60/40. Because of its higher melting point, 50/50 solder is often used on the back (or inside) of a stained glass project to protect against "melt through" when soldering the front. Because it spreads and flattens out, 50/50 solder is often used when soldering lead came joints.

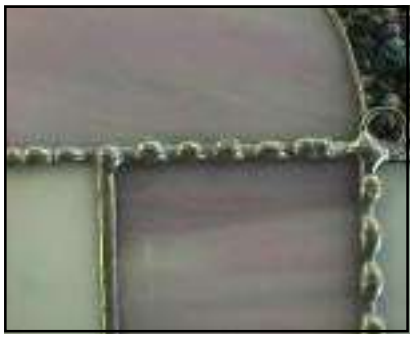

63/37 Solder: This solder is 63% tin and 37% lead. It becomes liquid at 361°F, and solid at 361°F, with a pasty or working range of 0 degrees. This solder is called a eutectic alloy which means at 361°F, you can go instantly from solid to liquid to solid just by applying or removing the heat source. You will often find "63/37" solder referred to as decorative or quick set solder. It is primarily used to create dimensional effects in the solder itself and can be "pulled" and manipulated to produce a variety of textures and designs. 63/37 solder also makes an excellent solder to bead up the outside rim of copper foiled pieces.

Lead-Free Solder: Depending on the specific mix of metals, lead free will produce differing liquid, solid, and pasty range temperatures. Check with the solder manufacturers for these specifics. Lead-free solders will perform similar to a 50/50 mix. Lead-free solders require more practice in order to obtain a smooth bead on copper foiled pieces and should not be used on lead came projects. Lead-free solder is the most expensive solder, but is the solder of choice when constructing pieces that will contact food, that will be handled frequently, or that will be used in a child's play area or room.

Solder Composition Reference Table

Alloy	Tin%	Lead%	Solid to	Liquid at	Pasty Range
50/50	50	50	361^0	421^0	60^0
60/40	60	40	361^0	374^0	13^0
63/37	63	37	361^0	361^0	0^0

Flux

Why Do We Use Flux?

Flux is a chemical compound that is used to promote the bonding of metals by removing the oxide residue simultaneously with the soldering process. Most metals left exposed to the air around us react with the air to form residue on the surface of the metal. The process is oxidization and the residues are oxides. Each mix of metals being joined has a specific flux that best promotes this bonding process. In stained glass, the metals being joined are primarily copper to tin/lead solder and lead, brass or zinc to tin/lead solder.

Types of Flux

Selecting the correct flux for your application is as critical as any other step of the soldering process. The proper flux will assure less soldering problems and a satisfactory solder bond. The best fluxes do three things:

- They remove all the residue that has formed on the surface of the metals you are going to solder.
- They prevent oxides from forming while you are soldering.
- Any post-soldering residue they leave is noncorrosive and easily cleaned off.

Fluxes are available in organic and inorganic forms. If you touch the flux and your skin seems to have a sensitivity to one type of flux, an inorganic type for example, try an organic variety. Often you will find that you are less sensitive to irritation by using the opposite type flux. Organic fluxes are generally some form of oleic (fatty) acids, while inorganic fluxes are most often zinc chloride based.

Characteristics of Fluxes

Liquid flux is the most widely used. It may or may not be water soluble. Water soluble fluxes clean up very easily, but are thinner and some have a tendency to evaporate quickly and require repeat applications. Some liquid fluxes are thinner than others and have a tendency to run or spread out from their point of application.

Gel Flux is generally water soluble and "adheres" well to the surface being soldered. Gels tend not to evaporate as readily as liquid flux, but if you apply too much, they produce more "spitting" and "popping" as you solder.

Paste Flux is very thick, stays where it’s applied, and doesn't evaporate easily. It's effective when soldering 3-D forms such as lamps. Paste fluxes can be difficult to clean. Be very careful not to over apply a paste flux as it will also spit and pop, leaving pits on your solder seams.

Getting the Most From Your Flux

It is important to keep your flux clean and free of impurities. This will ensure the purest possible solder joint. One way to keep your flux clean is to avoid dipping in and out of the original container. Pour out the amount you will need for your current project into a separate, smaller container. Don’t leave the flux bottle sitting around with the cover off. Never pour leftover flux back into the original container. Fluxes often will produce fumes as you solder. Make sure you are aware of and follow the precautions suggested in the health and safety section of this guide.

Soldering Basics for Copper Foil

The quality of the solder job can make or break your project, yet it is the step that takes the most practice to become good at. Soldering is more difficult than the other steps in stained glass because there are so many things that can effect it: the amount of heat, the amount of solder, the type of flux, the rate at which you move, gaps in the project, etc. The following step-by-step instructions will give you the basics of soldering. If you are just starting out, you will learn a lot. If you are experienced, you may just find the trick that makes it all come together. Great soldering takes a little bit of knowledge and a lot of practice.

Before You Start

Preparation is the key to producing a good solder bead. Here are some suggestions to help you get of to a great start!

- Make sure that the foil is seated properly over the glass.
- Trim all overlaps in the foil using a sharp craft blade.
- Assemble all the tools you will need so they are at hand.
- Wear safety glasses.
- Have a proper ventilation set up.
- Make sure the foil is well burnished and sealed smoothly to the glass surface.
- Secure the glass pieces using pins, or squaring blocks made for this purpose before soldering.

Set aside enough time to solder your entire project all at once. If you don't, dried flux and solder residues on the unfinished parts will make further soldering difficult. Flux allowed to remain on a project can compromise the strength of the solder joints.

Cleaning Before Soldering

Sometimes the surface you are going to solder needs cleaning to remove visible grime, dirt, residue or oxidization. In this case, use 000 or 0000 steel wool to clean the surface of copper foil. For lead came or excessive oxidation carefully use a soft brass brush. If you won't be able to solder your project immediately after it is copper foiled, store it in a plastic bag to help reduce oxidation. If you partially solder the project and have to stop before it is complete, be sure to clean off all of the flux and store the project in a plastic bag until you are ready to continue. You will probably still need to use steel wool on the joints when you are ready to solder, but the clean up should be minor.

Getting Started

Begin the soldering process by fluxing all intersections of the glass project. Then "flat tack" solder these intersections together by using a very small amount of solder and the flat face of the iron tip. The solder should lay flat on the intersection and you shouldn't have any beads or bumps of solder on the piece. Hence the name "flat-tack" soldering.

Now, fill any gaps between the glass pieces by melting solder into them until the solder is level with the surface of the glass. If you have large gaps, you can ball up some copper foil, with the sticky sides together, and fill the gaps. This will help keep the solder from seeping out the other side.

"Tin" the entire perimeter making sure to work some solder into seams that intersect the perimeter. (Tinning is the process of coating a surface with a thin layer of solder. Apply just enough solder to turn the foil to the silver color of the solder.) This creates a "dam" that prevents solder from spilling over the edge when you solder the interior seams.

Next, flux an area you can comfortably finish soldering before the flux can evaporate. Start at the top of the piece and work down. This prevents you from dragging your sleeves and hands through the flux.

Running The Solder Bead

Hold your soldering iron in your writing hand. Position the iron comfortably so the face of the iron tip is perpendicular to the seam. If you hold your iron like a carving knife you will automatically put the tip in the best position for soldering. It will also keep you from "painting" with the iron. You will hold the solder in the opposite hand. Start soldering by placing the iron tip down on the foil seam with the wider face perpendicular to the seam and facing you. Touch the solder to the tip of the iron, just above the point where the iron tip touches the copper foil. Allow the solder to flow down the tip face onto the seam as you move the iron along the seam. Feed the solder at a continuous, even rate to create a consistent, rounded bead of solder over the seam. This takes practice!

If you apply too little solder or move too quickly, your seam will be flat. To correct this problem, allow the solder to cool, then resolder the joint applying more solder. On the other hand, be careful not to feed the solder too fast or move the iron too slowly, as this will cause the solder seam to bulge and flow out over the glass.

Fixing Imperfections

If you have too little solder, just add more, being sure to remelt the previous solder line as you apply another coat. If you applied too much solder the first time, it's easy to remove the excess with the following procedure. Clean your iron tip thoroughly on a sponge. With the iron tip positioned with the flat face down, move it across the seam, "pulling" the excess solder onto the glass. Clean your tip and repeat the process until all excess solder is removed. Another method for removing excess solder is to wait until all the seams have been soldered. Then place your project up on edge and run the tip through the seam allowing the excess to run off. Lay the piece flat, reflux, and rework the seam, adding additional solder as needed.

When you solder, work slowly enough to produce a good bead, but not so slowly that solder melts through seams to the back side of the project. Here's a hint: one way to prevent this is to put damp paper towel under your panel before you start soldering. Moving too slow also increases the likelihood of causing heat fractures on your glass.

Other Things To Consider

Always keep your tip clean by frequently wiping all sides of the tip on your damp sponge. Wait momentarily for the tip to reheat before continuing to solder. A clean tip maintains proper heat and removes impurities.

To achieve a smooth solder line, solder the longest continuous seam possible. Don't start or stop a solder seam at an intersection with another seam. As you meet an intersection, allow the solder to break or "y" out over the intersecting seam about 1/2" and then return to the original path you were soldering in one continuous motion. As you continue to solder seams, you will connect these branches, thus preventing pulling out at intersections of seams (which is a noticeable sign of a beginner). When you encounter a "v" type joint. Solder in a direction that moves up into the "v" point, instead of coming down onto the point. This keeps a nice clean "v" joint without excess solder obscuring it. Do this by soldering up one leg of the "v" and as you approach the apex, drop your iron tip down flatter on the glass, so that it crosses over both seams. Then continue soldering into and out of the point of the "v."

Avoid a "painting" motion when soldering. Visualize your iron as a magnet pulling along a metal strip. Maintain a small puddle of solder at the base of the tip as you solder. When two adjacent pieces of glass vary in thickness, ride the tip on the higher piece of glass as you solder.

Effects of using the iron like a paint brush

A big advantage of using copper foil is that not-so-perfect solder seams can be reworked. Allow the seam to cool, reflux it, then resolder. Be careful because reworking a seam too many times (more than 2-3) can cause the adhesive on the foil to loosen and bubble.

Solder one side of your project completely, then turn it over and repeat the process on the other side. Some of the flux from the first side you soldered will have seeped to the other side. You may encounter more "spitting," so use flux very sparingly. To achieve a smooth, beaded solder seam: practice! practice!

Ending A Bead

When you are ready to end your seam, pull off across the face of the glass making sure you are in a liquid section of the solder seam and do not lift straight up. This technique leaves a smooth exit point that is virtually unnoticeable. You may notice that this is the same photo used for removing extra solder. It’s not a mistake. The action is very much the same.

Practice!

Creating perfect solder seams takes practice. One good way is to make a practice board. Make sure to include all types of intersections and lines (curvy and straight). Foil the piece and flat solder it on the front and back. Practice each different soldering technique. When you are finished, you can hold the piece vertical and melt the solder off. Now you are ready to start again. Many people use the practice board before they start soldering each project, just to get the feel of soldering again.

Cleanup After Soldering

After soldering, you will need to remove all flux and solder residues from your solder lines and glass. The best cleaners to use are ones that neutralize the acid property of fluxes. To properly clean your project, you will need a good flux cleaner, very warm water and a soft scrub brush. Thoroughly brush the cleaner into every corner of your project, front and back. Follow this with a long rinse in clean, warm water and then towel the project dry. This step is very important because any flux that remains will continue to react with the solder, causing oxidation. If your project looks good after the initial cleaning, but the solder lines have a white or green growth on them after a few weeks, it generally means that all of the flux was not removed from the project. You can use 000 steel wool to remove the patina and finishing compound and thoroughly clean the project. Then reapply the patina and finishing compound.

A small stiff scrub brush is the best way to clean the entire project. After the initial cleaning, you may find some areas that need additional attention.

You may find small pieces of solder stuck to the glass. You can easily remove these using your fingernail, or 000 steel wool. Be careful not to scratch the glass.

An old toothbrush can be helpful for cleaning in tight intersections and right up against the solder line.

Occasionally you may find that after applying patina, certain types of glass acquire a “rainbow” effect. This is most likely to occur on hot colors, black, white and iridized glass. It is one of those things that is unpredictable and difficult or impossible to remove. You can try to remove it by using a paste made from baking soda, but it doesn’t always work. The only way to prevent this occasional problem is to be very careful not to get patina on your glass. Use a cotton swab to apply the patina only to the solder lines of the project. If you have this problem, it is a good idea to make note of it on any remaining glass, so you can be more careful the next time you use that particular glass.

Finishing

After cleaning your project you should use a finishing wax or compound to keep it looking it’s best. A good quality carnauba wax or pre-mixed wax and cleaner should be applied to all of the solder lines. A nice side effect is that the wax also enhances the color of the patina making it either rich black or shinny copper. You may find it helpful to reapply the wax after a few months. (If you would like to change the color of the solder, see the section about patina on page 16.)

Soldering Basics for Metal Cames

Lead came construction requires a different soldering technique than that used for copper foil. You can use the same iron and flux, but the preparation and actual soldering will differ. You will be soldering only the joints, instead of running an entire bead. With a little knowledge and some practice, you will be able to make perfect solder joints on lead or other metals.

Getting Started

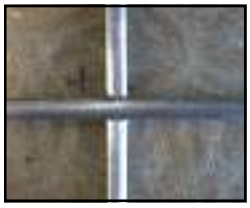

First, make sure that all joints are in line with each other and butt against each other with no gaps. Use a triangle and/or square to check the squareness of the panel and make sure that your lines run true across the panel in all directions. Make any adjustments that are needed. Thoroughly clean surface oxidation from intersections with a soft brass brush.

Soldering

The most desirable solder to use when constructing a lead project is 50/50. It flows out from the point of contact, leaving a nice joint. Do a "lead" test to check the heat of your iron. Allow the iron tip to heat for several minutes. Then, place the flat face of the tip on a scrap of lead. If the lead melts, the iron is too hot. Lower the temperature or change to a lower temperature tip. (This is where a rheostat iron is great.) Now test the tip with 50/50 solder to make sure it can melt it. If it does, your tip temperature is adjusted correctly. If not, raise tip temperature just until you melt the solder. Recheck the tip temperature and test it on the lead again. Now flux all the joints on your panel.

Begin by holding the solder on the joint. Move in to the joint across the glass, not from across the came. The wide face of the tip should be down toward the joint. Coming into the joint over the glass prevents leaving a solder trail on the lead came at one end of the solder joint. Techniques like these are the signature of an accomplished craftsperson.

Melt only a small amount of solder and move the tip in a slight circular motion allowing it to flow out over the joint a distance equal to the width of the came being used. Pull the iron tip straight up off the center of the joint. The desired end result is that intersections of the lead cames are not visible through the solder and the solder on them is smooth, not beaded. You should be able to run a fingernail over the came and into the soldered joint without it catching or clicking. Solder the joints on the front of the project. Then turn the project over and repeat the same process on the back.

Finishing

Lead projects need to be finished by applying a cement. The cement will weatherproof the project and secure the glass in the channels. This step is necessary on any came project to ensure a strong, secure panel. Cement is easily applied to the panel by using a small scrub brush to work the cement under the channels both on the front and back of the project. After the cementing process is complete, whiting sprinkled over the entire surface and allowed to absorb excess moisture for a few minutes. Using a stiff brush, vigerously brush the lead channels, removing excess cement from the glass. The brushing process allows a natural patina to form on the lead, so it is not necessary to apply patina to the project. Allow the project to dry thoroughly, usually for a few days, before installing or hanging the project.

Soldering Basics for Other Metals

Vase Caps

Vase caps are generally made from spun brass. The cap must be very clean of all dirt and oils for the solder to adhere. Use 0000 steel wool to clean the areas that you will be soldering. The cap also needs to be quite hot in order to achieve a good bond between the solder and the brass. An easy way to get the cap hot is to heat it in a hot oven for about 15 minutes. Use pliers to carefully remove the cap from the oven. Center the vase cap on the lamp. Flux all areas you will be soldering. (Paste flux is easy to use for this purpose, because it doesn't drip.) Get a small amount of solder on your iron and hold it on the vase cap for a minute or so at the area you want to make a connection to the lamp. When the cap is hot enough, the solder will spread out instead of lumping up. Add more solder to make a connection to the lamp. (Some vase caps have a lacquer finish on them. This must be removed at the areas you need to solder. Use a craft knife to gently scrape the lacquer in these areas.

Spiders

Spiders are made from brass as well. You can either cut the legs to fit, or bend them. Like a vase cap, you need to get the brass quite hot in order to create a good bond with the solder. Unlike vase caps, you can get the smaller area of the spider hot enough using just your soldering iron. Simply hold your iron tip on the area that you need to solder for a minute or so. Apply flux and a little solder, and continue to heat the spider with your iron. When it is hot enough, the solder will smooth out around the spider leg and adhere to the lamp. If the solder is globed up, the spider leg isn't hot enough. Continue in this manner for all of the legs.

Metal Outer Channels

When attaching a zinc, copper or brass edge to a project, use this solder technique: Cut the zinc, copper or brass came vertical members to overlap the horizontal members in a "butt" type joint. A butt joint provides structural stability and distributes weight. Before you solder the butt joints, you can use masking tape to contain the size of the solder joint.

Clean and flux these joints and solder them to each other using the flat tip of the iron on the metal. The metal channel will take a little longer to get hot than copper foil. If the metal is not hot enough the solder will not smooth out. The metal frame should be attached to the panel by soldering it to any lead lines that it touches.

On leaded projects, solder from the outer metal edging onto the lead came, pulling the iron tip straight up over the point of intersection when completing the solder joint. This simple technique will level the solder smoothly over the joint.

For copper foil pieces, stop your solder bead about 1/4-1/2" from the outer edge to allow room for the metal edging to fit onto the perimeter of the project. If you forget to do this initially, flatten the solder bead so the outer edging fits onto the project. After fitting the outer edging material, flux and solder the corners as outlined above. Connect the copper foil beads that intersect with the outer edging metal by continuing the solder bead into the edging making sure that the

solder adheres securely to the metal edge.

As you work more with your iron, different solders, lead came, and copper foiled projects, your skills will increase. You will quickly develop the techniques that will make you more confident in tackling increasingly complex projects.

Hanging Hardware

There are many ways to hang your project. You will want to make sure that the method you choose will support the weight of the project. You can purchase pre-made hardware from your stained glass store, or make your own using any type of solderable wire. If you are using wire look for 16 to 18 gauge.

Rings can be added to the metal border of the project if it is not too heavy. A general rule of thumb is about one square foot. Hold the ring with pliers and solder rings to the metal border of the piece wherever they allow it to hang properly. Just like soldering the channel together, if you don't allow the metal to get hot enough, the solder will not adhere well. This will result in your hanging rings failing.

A stronger type of hardware is made using wire. Twist together four strands of 16 -18 gauge wire, leaving a loop at the end. Cut the wire to about 1/2". Insert the wire into the opening of the metal channel, bending the loop the direction you need it to be. Solder the hanger to the channel and fill the opening with solder.

Another option is to make a loop from twisted wire and solder it to the front and back of the metal channel, with the loop extending above the project. Be sure to solder the hanger into an existing solder joint, not just to the channel. This will prevent the weight of the project from pulling the channel away from the glass.

By the way, the joint on the hanger at the right was painted to match the brass channel using a gold paint pen.

Patina

Solder and lead change color naturally over time, but you can change their color instantly by using patinas. There are several different formulas producing a variety of colors. Patinas are easy to use. Make sure that your project is thoroughly clean and free of solder, flux and cutting residues. Use a brush or soft rag to apply the patina to the solder until you reach the desired color. Wash the panel again to remove any patina from the glass.

- When using antique brass patina, first scrub your solder seams with fine steel wool. Apply the patina sparingly with a clean brush, using only a few strokes. Over use will produce a coppery finish.
- Never mix patinas and always use proper ventilation and skin protection.
- To get a nice black finish on brass, add a dash of table salt to a little black patina in a glass or plastic jar. Mix well, apply and allow to dry. Clean and finish a usual.

Trouble Shooting

Problem: The solder won't adhere to the foil or came.

Solutions/Explanations:

1) Did you apply any flux?
2) Did you apply enough flux?
3) Was your iron too cool?
4) Is the foil or lead came too oxidized for flux to activate the surface?
   A) Buff copper foil with 000 or 0000 steel wool.
   B) Clean lead came with brass brush.

Problem: Solder is melting through to the backside of my project.

Solutions/Explanations:

1) Your iron is too hot. Depending on what type of iron you are using, either turn the temperature controller down or change to a lower temperature tip.
2) You may be soldering too long in each area. Move on and let the solder cool. Return to those spots later.
3) The gaps between your glass are too wide. Try to fill the gaps with solder and let it cool. Then go back and solder a bead on top of the filled gaps.
4) Try placing a wet paper towel under the project to provide cooling.

Problem: My solder is "stiff." I am unable to get a smooth bead.

Solutions/Explanations:

1) Your iron is too cool. Depending on what type of iron you are using, either turn the temperature controller up or change to a higher temperature tip.
2) You may not be using enough flux.
3) Is the tip of the iron getting hot? Check to see that the tip is seated correctly down in the barrel of the iron.
4) Are you "painting" with solder, instead of running a long bead with a steady, even, one directional movement? This is one of the most common mistakes that beginners make. In order for the solder to create a bead, it has to get molten. If you are using the iron as a “paint brush”, the solder is not getting hot enough to melt thoroughly.
5) You may be soldering with just a corner of the iron tip. Check for proper positioning of your iron.
6) Try a different solder with a lower melting point.

Problem: My iron seems to be hot, but the solder isn't melting as fast as normal.

Solutions/Explanations:

1) Check your tip. Is it loose?
2) Is your tip too dirty?
   A) Clean it on a wet sponge.
   B) Clean it on a tinning block.
3) Your tip is too corroded or defective. Replace it.
4) Your rheostat may be malfunctioning.
   A) Plug the iron into the outlet you are using without the temperature controller. If the iron works, the controller is malfunctioning. If the iron doesn’t work, the problem may be with the iron itself.
   B) With some types you can check the temperature controller by plugging a lamp into it. Turn on the lamp and see if the controller dims and brightens the lamp.

Problem: My solder seams are flat.

Solutions/Explanations:

1) You are not using enough solder. Reflux your project and add more solder.
2) You are soldering too fast. Move at a speed that lets the solder bead.
3) If the bead was there, but disappeared, you may be working too long in one area causing the solder to melt through to the other side. Allow the area to cool down before trying again. Another option is to place a damp paper towel under the seam you are working on. This will help keep the glass cool, allowing you a little more time to work.
4) Check the type of solder mix you are using. For copper foil work, 60/40 will help produce a higher, more rounded bead. Don't make the mistake of buying 40/60 solder. It has an even longer pasty range than 50/50, and is not recommended for stained glass work.

Problem: My solder seam is too wide.

Solutions/Explanations:

1) Do you have large gaps between the pieces you are soldering?
   A) You may have to recut some pieces.
2) You may be using too much solder causing the seam to bulge over onto the glass. "Pull" or "bleed" the excess solder from the seam.
3) Is the copper foil too wide? This is another common mistake for beginners. Remember that the width of the solder seam is determined by the width of the foil. An attractive solder seam is accomplished by using a foil that shows about 1/16" on both sides of the glass.

Problem: My solder seams are irregular in width.

Solutions/Explanations:

1) You may have poorly fitting pieces that create different size gaps in your project. Recut these pieces.
2) Your foil may be applied unevenly on each side of the glass in some places. You may try to correct this by trimming the foil with a craft knife. If that does not work, remove the foil and start again.

Problem: My glass fractured while I was soldering.

Solutions/Explanations:

1) Your iron is too hot. Depending on what type of iron you are using, either turn the rheostat down or change to a lower temperature tip.
2) You "worked" too long in one location with the iron.
3) There could have been a small chip or crack in the glass which was expanded when it was heated by the iron.

Problem: My solder bead is not bright and shiny. It appears dull and splotchy.

Solutions/Explanations:

1) The solder was applied too cold, so it never fully reached its "liquid state." Turn up the temperature if you are using a rheostat or change to a higher temperature tip if you are using a temperature controlled tip.
2) You may not be using enough flux to "wet" your foil or lead and create a proper solder condition.
3) If you're using 50/50 solder, try 60/40. Because solder crystallizes as it cools through the pasty range, 50/50 is more prone to having a textured look on its surface because of its considerably larger pasty range.
4) The solder you are using may be of inferior quality.

Problem: My solder is "spitting" as I work. What's wrong?

Solutions/Explanations:

1) You are likely using too much flux. It is literally boiling when you apply the solder. Wipe some of the flux off with a paper towel and try soldering again. You may find areas that now need a little more flux, because you removed too much.
2) If the spitting only occurs on the back side of your project (or the second side you are soldering), the problem is still too much flux, but the cure is different. When you use too much flux on the front side of the project, the excess to flows through the panel, so the spitting isn't as bad as it could be. When you use too much flux on the back side of the project, it can't flow through to the front, because the front is already sealed. The obvious cure for this problem is to use less flux the next time. But what about now, when you already have too much and can't remove it from between the glass? The only good solution is to apply your solder, and allow the flux to boil up and out of the seam. (Keep your face as far away from the project as you can.) Once it stops spitting, you can remelt the solder and make it look as good as new.

Problem: I have gooey, glue residue along my solder seams that won't wash away.

Solutions/Explanations:

1) Adhesive from foil may be working up and out onto your glass. This can be caused by poor foiling or burnishing of the copper foil, which allowed flux to seep underneath the foil. To correct this use a cuticle stick or soft toothbrush to clean adhesive away.
2) Your iron is too hot, causing the adhesive on the back of the foil to melt and seep out onto the glass. Depending on what type of iron you are using, either turn the rheostat down or change to a lower temperature tip.
3) If you reworked a seam too often, it may have loosened the foil. Allow the seam to cool to the touch and gently press the foil back down to the glass.

Problem: Attached hooks and rings are pulling away from my project.

Solution/Explanations:

1) Hooks and rings should never be attached to just a foiled edge. Attach hooks/rings to vertical seams in the piece or at a juncture between a vertical seam and the perimeter.
2) If there is no vertical seam or intersection, then attach the ring/hook to a horizontal seam in the piece.

Problem: My solder has a white chalky growth on it. What did I do wrong?

Solution/Explanations:

1) All of the flux was not washed off of the project after it was soldered.
2)The project was not sealed with a finishing compound or wax, or it has worn off. Use 000 steel wool to remove the patina and any remaining wax. Clean the project thoroughly paying special attention to the corners and edges. Reapply the patina and wax.
3) The project has been exposed to the outside elements. Most waxes are intended for indoor use only. Others can be used outside, but must be reapplied regularly. Projects that will be exposed to the elements are better constructed using the lead came method.

Glossary of Soldering Terms

Antimony

An element used in the production of some solders. It should be avoided for use in stained glass.

Ceramic Heater

A type of heating element comprised primarily of ceramic, noted as extremely fast heating and efficient.

Chisel Tip

A soldering iron tip shaped like a chisel tool. This is the most common shape used for soldering stained glass. Chisel tips are made in a variety of sizes, the most common being 1/8”, 1/4” and 3/8”.

Heat Sink

A device used to draw or absorb heat being generated by another source. For example, an object being soldered acts as a heat sink to the soldering iron.

Decorative Soldering

Any decorative effects created in solder. These effects are created with a soldering iron, usually with a very narrow tip. Special solder, like 63/37 or QuickSet, make it easier to create special effects because it has a “zero” pasty range.

Eutectic Point

An exact single temperature point at which an alloy goes from solidus to liquidus with no pasty range. For example, the eutectic point of lead and tin is 361^0 F. This point is obtained only by 63/37 tin/lead alloy.

Flux

A chemical agent used to remove compounds from the surface of metals during the soldering process. (See organic and inorganic flux.)

Idle Temperature

A very low temperature at which the iron is on, maintaining the capability of a more rapid heat up than if the iron was off or “cold”. This is usually between 200^0F and 300^0F.

Inorganic Flux

A flux comprised of one or more inorganic salt such as zinc chloride or ammonium chloride. Inorganic fluxes are more corrosive and conductive than organic fluxes,. They are effective on all common metals.

Leaded Solder

A material used to join metals comprised of tin and lead.

Liquidus

The temperature at which a pure metal becomes completely molten or liquid.

Mica

A mineral based material used as a construction component in wire wound type heaters of soldering irons.

Organic Flux

Organic fluxes are not as corrosive as inorganic fluxes. They are often used when the surface of the glass may be effected by the flux, such as painted glass.

Oxides

Debris on the surface of a metal which is the result of the reaction with chemicals in its environment. Oxides must be removed mechanically (with steel wool or a brass brush) and chemically for proper wetting to occur.

Pasty Range of Solder

The temperature range which is the difference between the solidus and the liquidus temperatures. This is sometimes referred to a the “working range”.

QuickSet™

Another name for 63/37 solder. See decorative solder.

Recovery Time

The time required for a soldering iron to reach soldering temperature after it has hit a “cold spot”.

Rheostat

The term applied to a soldering iron control which is used to vary the temperature of the heater in the iron.

Solder

An alloy of two or more metals with a liquidus temperature of less than 800^0 F.

Solder Bead

The term used to describe the look of solder when it has been properly applied to a copper foil seam.

Solidus

The temperature at which a pure metal or alloy goes from liquid to solid (or “freezes”).

Temperature Control

An electrical or electronic device into which a soldering iron is plugged, or which is within a soldering iron. The device is used to vary the temperature of the soldering iron heater.

Tinning

Applying a thin layer of solder to a metal surface. Most commonly used in reference to the copper foil technique.

Tinning Block

A block of sal-ammoniac on which a soldering tip is cleaned and resurfaced with a layer of solder. It is not actually used for soldering.

Tip Tinning

The process of renewing a soldering iron tip using a sal-ammoniac (tinning) block.

Wetting

The term used to describe the proper flow of liquid solder, promoted by flux, on the surface of another metal. “Wetting” is necessary to form a proper soldering joint.

Wire Wound Heaters

Soldering iron heaters constructed with heating wires wound in a coil around Mica.

Soldering & Desoldering

Soldering/Desoldering Tools & Accessories

Soldering Station with LCD Display, ESD Safe 400 Series

17400

- High-quality sensor and heat exchange system guarantee precise temperature control at the soldering tip
- Soldering iron tool heats rapidly from room temperature to 350C in 30 seconds
- Suitable for general purpose soldering as well as specialized lead-free soldering applications
- Sponge and coiled brass tip cleaner ensure a clean soldering tip free from debris and corrosive material
- Strong, deluxe iron holder provides safe secure place to store heated iron between uses

Product ID	Description
17400	Soldering Station with LCD Display, ESD Safe 400 Series

Soldering Station with LCD Display, ESD Safe 405 Series

17405

- LCD temperature control display with blue backlight
- Long lasting, durable high - quality ceramic heater
- Sponge and recessed area provides a convenient method for cleaning the tip
- Suitable for general purpose soldering as well as specialized lead-free soldering applications
- Safety guard iron holder

Product ID	Description
17405	Soldering Station with LCD Display, ESD Safe 405 Series

Soldering Kit - 6pc

17501

- 40 Watt Soldering Iron heats up to 900° F
- Ideal for use on electrical/electronic components, audio equipment, etc.
- Includes desoldering pump for removing liquid solder
- Provides basic tools needed for many soldering projects
- 6 Pc kit comes complete with replaceable fine tip

Product ID	Description
17501	Soldering Kit - 6pc

Soldering Kit - 7pc

17502

- 40 Watt Soldering Iron heats up to 900° F
- Ideal for use on electrical/electronic components, audio equipment, etc.
- Includes desoldering pump for removing liquid solder
- Provides basic tools needed for many soldering projects
- 6 Pc kit comes complete with replaceable fine tip

Product ID	Description
17502	Soldering Kit - 7pc

Soldering Iron 80W with Fine Tip

17510

- Ideal for general purpose soldering applications including metal board, tube or large components
- Round, soft grip, non-slip handle
- Durable cord with a 5-foot reach
- Fitted with long life replaceable fine tip

Product ID	Description
17521	Soldering Iron 40W with Fine Tip

Soldering Iron 40W with Fine Tip

17521

- Ideal for general purpose soldering
- Round, soft grip, non-slip handle
- Durable cord with a 5-foot reach
- Fitted with long life replaceable fine tip

Product ID	Description
17521	Soldering Iron 40W with Fine Tip

N-Series Soldering Iron Tips

- Long life, lead-free soldering iron tips
- Replacement tips for soldering the different components of PCBs
- Five different sizes
- Includes two tips
- For use with 17400 & 17405 ESD Safe Soldering Stations with LCD Display

Product ID	Description
17400-N9-1	N-Series Soldering Iron Tips (N9-1)
17400-N9-2	N-Series Soldering Iron Tips (N9-2)
17400-N9-3	N-Series Soldering Iron Tips (N9-3)
17400-N9-4	N-Series Soldering Iron Tips (N9-4)
17400-N9-5	N-Series Soldering Iron Tips (N9-5)

C-Series Soldering Iron Tips

- Long life, lead-free soldering iron tips
- Replacement tips for soldering the different components of PCBs
- Four different sizes
- Includes two tips
- For use with 17521 Soldering Iron 40W

Product ID	Description
17521-C1-1	C-Series Soldering Iron Tips (C1-1)
17521-C1-2	C-Series Soldering Iron Tips (C1-2)
17521-C1-3	C-Series Soldering Iron Tips (C1-3)
17521-C1-4	C-Series Soldering Iron Tips (C1-4)

B-Series Soldering Iron Tips

- Long life, lead-free soldering iron tips
- Includes two tips
- For use with 17510 Soldering Iron 80W

Product ID	Description
17510-B5-1	B-Series Soldering Iron Tips (B5-1)

SMD Soldering

Your reference guide to soldering with surface mount devices

Edited by Lim Siong Boon, last dated 06-May-09.

email: mail@siongboon.com
website: http://www.siongboon.com

Short cut to your reference guides and charts

1. Introduction to SMD soldering
2. SMD soldering (prototyping board)
3. SMD soldering (prototyping PCB socket 2.54mm pitch)

1. Introduction to SMD soldering

SMD IC stands for surface mount device integrated circuit, or commonly known as SMT surface mount technology. Why go into SMD? Small in size, light in weight. This is the advantage of smd. Being small, engineer is able to design small electronics gadget that people can carry around. It is quite obvious that people prefer small mobile phone.

The ultimate advantage will be lower cost to consumer. Being small in size, the printed circuit board (pcb) can be small, meaning low cost. Transportation cost can be reduce because it is now lighter and more products can be packed into the same box. Space required is less, meaning cost saving on the warehouse storage. PCB board is easy to route without the through hole. Better signal integrity. Easily assembled by machine. There is too much advantages. Going SMT is certainly the way forward.

Technology evolution, from big to small.

A phone small enough to carry around.

Smaller mobile phone

Even smaller phone

Mobile phone as thin as biscuit.

I used to build circuits using dual in-line package (DIP or DIL) IC only. I hardly thought of using surface mount device/component (SMD) because I have great doubt that I can solder the fine legs of the IC chip. The pitch for the older DIP IC package are 2.54mm. Pitch is the distance between adjacent pins as illustrated in the picture. Most IC comes with a variety of packages. The IC that I know of, offer both the SMD and DIP packages. I

Through hole packages

	DIP - 8 pins

thought that I will never ever need to use smd packages until one day, I have no more choice. I managed to pick up new circuit designs, and discover more and more new IC chips. Most new IC chips design do not have DIP packages. You can hardly find one. I realised that in order to implement better circuits, I need to learn to use new IC chip. In order to use the new chip, I have to find ways to solder smd components. That's where I venture into the world of smd.

Nowadays people prefer to use smd, because they are small in size, which turns out to be cost efficient fabricating small PCB. With smaller PCB, space & weight is saved, resulting in lower cost for the transportation/distribution and storage.

Research and research, I got to know from other electronics guru that smd is in fact easier to work with than through hole. I try it out and from that day onwards, I am in love with smd components. Small to solder, but it save me the effort to cut the lead for through hole component. I managed to store my component using minimum box and space. There are many many advantage to work with smd.

Many people might think that you need special tools like a rework station or fine tip iron to solder the small smd components with small pitches. With the correct technique, you can use your soldering iron to do the soldering. In fact my 60W goot TQ-95 soldering iron has quite blunt tip. So thick that most people think that it is not possible to solder smd IC with fine pitches. Fine tip iron is easy to reach the fine lead, but I find that it is not as hot as the same iron with blunt tip. If you prefer fine tip, I will recommend hotter soldering iron or those which can allow you to adjust the temperature, they can be hot. I managed to solder smd package TQFP, SSOP QSOP with pitch as small as 0.5mm. Width of the lead of about 0.3mm.

Dealing with SMD components do not necessary requires you to fabricate a professional pcb board. You can also mount smd components on low cost prototyping board. To start off implementing smd components, you might like to try using the soic package. Quite common at this point in time, but may just phase out as what has happened to the dip packaging. SOIC has a pitch of 1.27mm, which is exactly half of DIP packages. This size is great because I can solder the IC to the same old 2.54mm pitch prototyping donut padded board. What I usually do is to cut the donut pad into half. Soldered onto each pad is two pins 1.27mm apart.

You can refer to the following article, for further illustration.

"SMD soldering (prototyping board)"

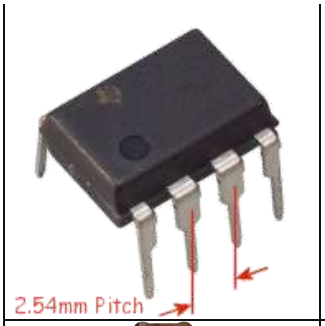	
	resistor
	capacitor
	inductor
	diode

SMD packages

	SOIC - 8 pins
	TQFP - 44 pins
	resistor
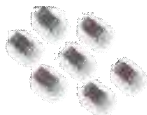	capacitor
	inductor
	diode

With so much advantage there is indeed a disavantage. SMD IC comes with many type of packages with different pitches. Unlike DIP IC, the pitch is typical 2.54mm. I can easy purchase a prototype board with 2.54mm, and almost all the DIP will fit to the board. SOIC package can still be mounted onto the 2.54mm prototype board. The rest of the SMD IC chip has quite a wide range of completely different packaging. This make them difficult to start with, without having to fabricate a PCB.

There are actually solution to this. Most IC company usually introduce their IC chip together with a prototype board for the IC.

Another solution will be to use a pre-fabricated prototyping board that allows mounting of various smd footprint. You can search for the various names such as

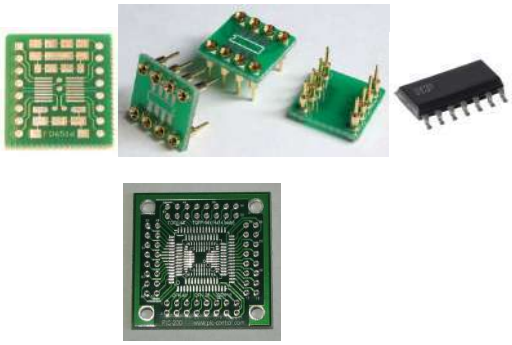

Various distributor for the prototyping adaptor

- prototype adaptor
- chip adaptor
- smd prototyping board
- smd to dip adaptor
- smd socket
- smd adaptor
- smd to 2.54mm converter
- SMD to DIP converter
- chip carrier

You can refer to the following article, for further illustration.

"SMD soldering (prototyping PCB socket 2.54mm pitch)"

In prototyping with DIL IC, pcb mount IC socket is usually used, so that the IC can be removed easily if damaged. Some sockets are designed for programming used where the chip can be inserted and remove easily for programming purpose. To remove the component, you need not have to do de-soldering. Like DIL package, smd also comes with their own IC socket. There are many variety of smd packaging, and getting the socket for your smd components is not going to come cheap & easy compare to DIL. Therefore I usually built prototype without any sockets for smd design. After numerous attempts designing and building of circuits, you will definitely attain a certain level of confident on your design without considering IC socket. Without the socket, cost and space are saved significantly.

DIL IC sockets/ holder. Turn pins designs is of better quality.

Various distributor for SMD socket

SMD IC sockets:

The headache will come when you really need to removed the smd IC. How do you remove the IC from the PCB? For de-soldering of smd component more than 3 leads, you can add in more solder to connect up the IC pins heat pins on all the sides of the IC and eventually pull out the component. It is easier to use the rework station or IR heater to de-solder smd components. The rework station uses hot sir to melt down the solder on the board. You will need to aim the hot air at the solder joint.

Rework Station

If you do not have the lurxy of getting the rework station, another possible method might be to use a special solder that has lower melting point. LowMelt® DeSolder Wire. A lower melting point means that the solder will takes a longer time to cool down to a solid. This allows you more time to remove the IC after heating up the solder. The solder is flooded onto the pins of the IC. The pins are heated up together using a soldering iron and the smd IC can then be removed easily with a tweezer.

Various type of smd packaging

* SOT, SC
* SOIC, ExposedPad™
* SSOP, ExposedPad™
* TQFP, ExposedPad™
* TSOP
* TSSOP, ExposedPad™

Low melt solder wire

* PLCC

* LQFP, ExposedPad™

* LGA

* PBGA

* PSOP

* Dual Row MicroLeadFrame®

* LQFP PowerQuad®

* MicroLeadFrame® (MLF®)

* MQFP PowerQuad®

* PSvfBGA

* SuperBGA®

* TapeArray® BGA

* tsCSP

* Ultra CSP™

* CABGA, CTBGA, CVBGA

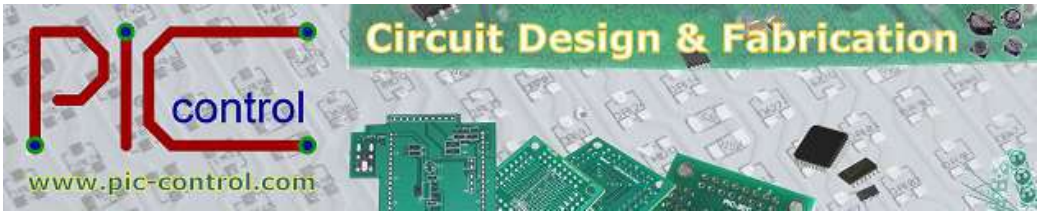

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2. SMD soldering (prototyping board)

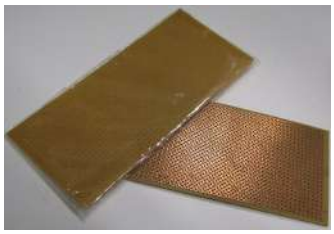

The prototype board above has pad with 2.54mm pitch and is designed for DIL and through hole components. The board is easily available from local store. Dealing with smd components on this 2.54mm pitch board is not difficult as well. I have been using this board to solder quite a number of surface mount components.
- SOIC
- DPAK
- SOT23-6, SOT-3
- TO-263
- PSOP

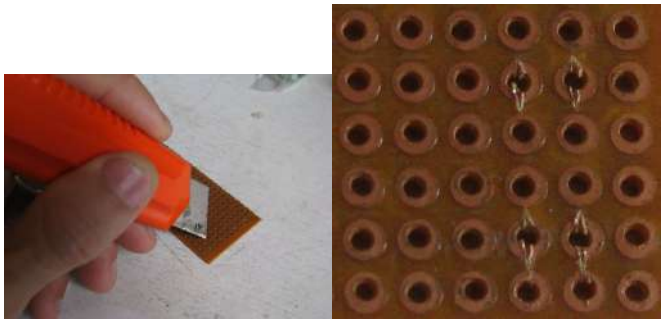

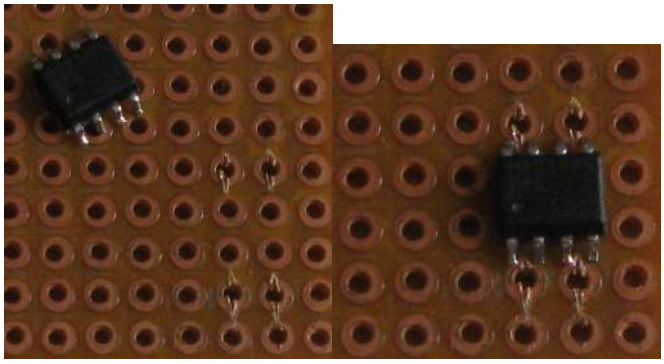

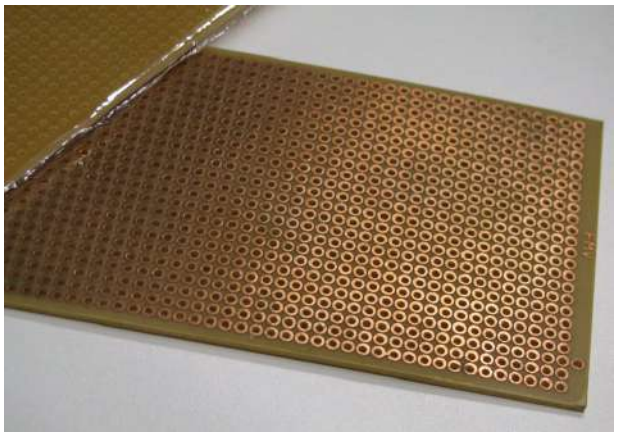

High pin count component with pitch less than 1.27mm will not be suitable to mount onto this board. For passive smd component like resistor, capacitor or inductor which only have 2 pin, mounting is simpler. Size is not an issue soldering onto the board.

Align the SMD IC to the position on the pad. Mark out the pad for the cutting to be done.

Use a penknife to cut the donut pad into half. Ensure that the half pad does not short circuit using your multi-meter. Sometimes the cut may not be deep enough or conductive reside between the gap resulting in a short circuit. Remember to ensure that each is proper cut before you start to solder.

Align the smd with your finger or tweezer and begin soldering one of the pin. Check if the IC is still properly align after soldering the first pin. If not, heat up the soldered pin and realign again. After the ICis align, solder all the rest of the pin. If the solder bridge across to the adjacent pin, use a soldering sucker to remove the excess solder.

The cut between the pad usually make the solder harder to bridge across the adjacent pin. Bridging is still possible, and it is quite easy to have it removed.

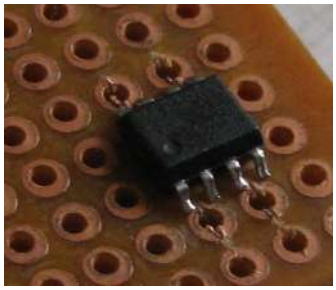

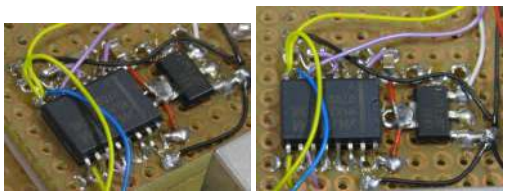

SMD ribbon cable connector being soldered onto the 2.54mm pitch prototype board.

Example of building the circuit using surface mount component on the prototyping board with 2.54mm pitch pads. As shown above, the pins are being wired by fine wire wrapping wire. The single core wire is very flexible and comes in a variety of color, making it easy to identify the type of signal being carried by the wire.

3. SMD soldering (prototyping PCB socket 2.54mm pitch)

What you need...

List of items:
- Surface IC chip (TQFP package)
- Surface mount IC adaptor or converter
- Soldering Iron
- Tweezer or Pincer
- Solder with flux core
- Soldering Flux
- Stick for coating flux
- Wiping paper
- Tinner

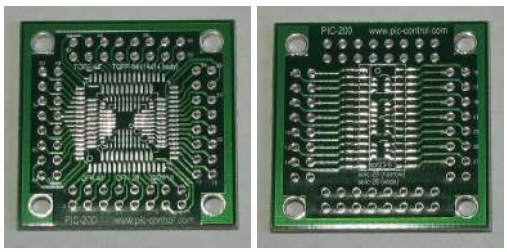

PIC-200 smd to 2.54mm pitch adaptor

from PIC control.

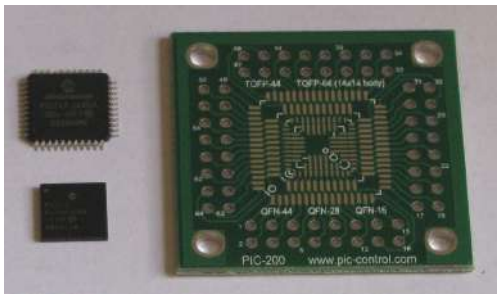

INTRODUCTION

In this setup, I am going to solder a surface mount microcontroller (TQFP 44 pins) onto a smd adaptor. The adaptor will then be used on the commonly available prototyping board, so that I can try out my new design for circuit control.

TQFP, QFN and SOIC are quite some common footprint for prototyping smd microcontroller from 18 to 64pins. This prototyping adaptor pic-200 (on the left) that I have is an ideal adaptor for my microcontroller. Converting the smd device into 2.54mm, I can easily mount the smd unit onto my 2.54mm pitch prototyping board. It is available locally.

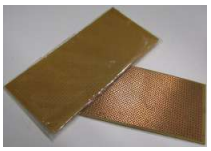

Prototyping board with 2.54mm pitch donut pads.

The pic-200 smd adaptor originate from PIC-CONTROL and is well documented. Commonly used smd footprint can be found on either the top or bottom side of the pcb adaptor. These are some of the smd packages that can be mounted onto pic-200 adaptor.

IC	Front	Back
TQFP-44		

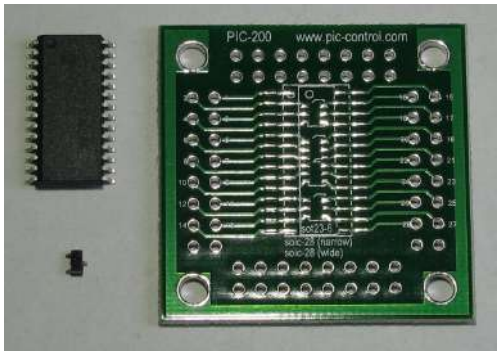

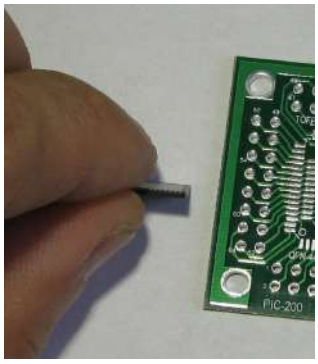

Holding onto the side view of the QFN package IC.

QFN-44

SOIC-28

SOT-3

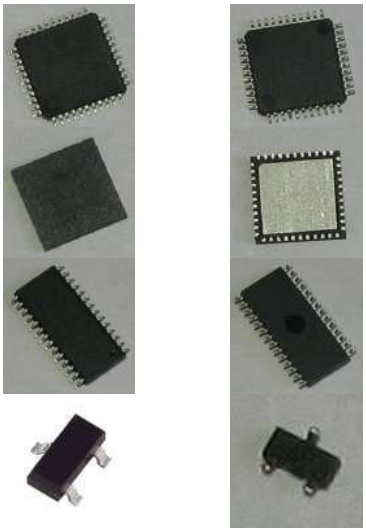

With a wide range of smd components that can be mounted, it is easier to stock up this pcb adaptor for future prototyping use.

The following article is about getting my smd microcontroller PIC24FJ64G004 soldered onto this board. After which I will be on my way to do prototyping for my new control circuit.

This smd adaptor origined from PIC-CONTROL. For other type of adaptors, you can also refer to other manufacturer as mention above.

click here to

Buy this SMD Adaptor Now at the PIC-store

PIC-store

<Step 1>

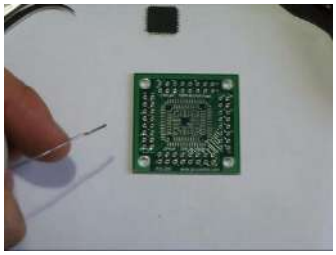

Before soldering, ensure that the soldering pad on the PCB is free of oxidation. PCB is usually tinned to protect the copper surface from oxidation. In cases where the surface is oxidized, you can try cleaning the surface with a contact cleaner. Apply the solution with tissue paper or toothbrush to clean up the contact. This solution make the PCB board rather oily, which I don't quite appreciate.

Contact cleaner.

Let us start our smd soldering here. Soldering surface mount component. The first important thing to introduce would be the solder.

There are many type of solder. Choosing the correct solder takes a bit of some knowledge too. Leaded or lead free solder? The industries is moving towards Pb free components & PCB, calling for unleaded product. Lead is toxin and not environmental friendly. I would advise ou to wash your hand after soldering or

handling pcb board. A soldering fume extractor to vacuum the smoky fume would be quite comfortable for your soldering. The smoke is quite choking and a health hazard if you breath that in.

soldering fume extractor.

Solder also comes with a variety of metal alloy combination. Nowadays it is common in solder core to contain flux. If the solder do not have the flux in the core, the flux have to be manually applied onto the metal surface before the soldering beginning. The flux cleans up the soldering surface, and also make the solder flow rather smooth like liquid. One of the important ingredient to make a good solder joint lays in the soldering flux.

Solder wire also comes in a wide range of diameter to choose from. Generally I use 0.8mm soldering wire roll with flux at the core. Smaller diameter solder wire allows you a better control of the amount of solder to apply. For soldering larger pins or connector component thicker diameter wire will be preferred. Wire too thin is rather troublesome, because you need to feed in a longer length of solder in order to solder the large surface/lead. For general purpose PCB board soldering 0.8mm wire fits somewhere in the middle. Not too thick nor too thin. For smd components, diameter smaller than 0.8mm is preferred. Using 0.8mm for smd soldering is not of any issue.

Solder wire 2mm

1.2mm

1.0mm

0.8mm

0.5mm

<Step 2>

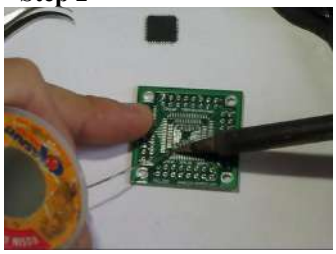
One of the pad being tinned.

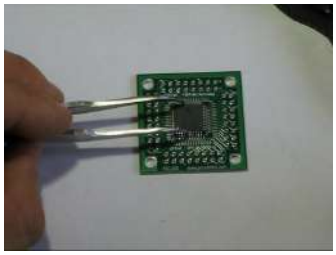
Align smd IC to the respective pad.

My microcontroller TQFP package has 44pins around the square package. To secure the package to the adaptor, I will need to solder one of the pin to the board first. It is important to solder only one pin. In case of mis-alignment, we can correct it easily. If more pins are soldered, it will be more difficult to correct any alignment.

Pin 1 of the adaptor pad is first tinned with a layer of solder. A tweezer is then used to align the IC chip on the pad. The IC is secure to the board with a slight touch from my soldering iron, soldering the IC pin to the pad.

The important factor to consider would be the heat generated by the iron. I prefer to use a 60W iron, which still works well in air-con room. A lower wattage or fine tip iron will not heat up that well in colder environment.

Goot TQ95 60W

If you prefer a fine tip, perhaps the soldering station will be more suitable. The iron temperature can be adjusted to a higher or precise temperature for the component that you want to solder. Component with thick metal contact like connector, heat sink, for thick cables should be solder with a

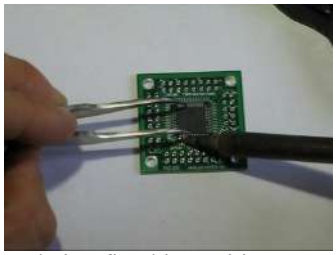
IC being fixed in position

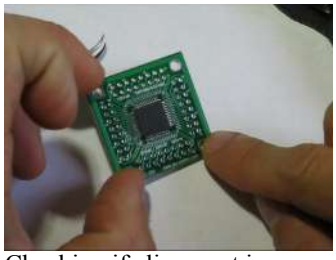
Checking if alignment is correct.

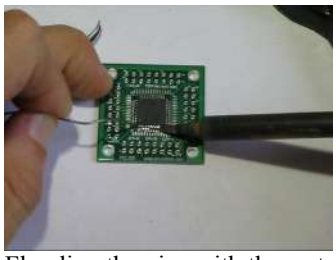
Flooding the pins with the rest of the solder.

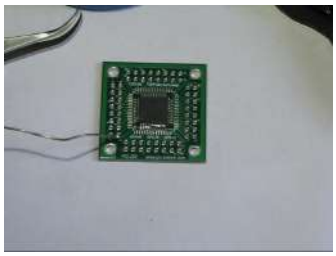
Pins flooded with solder

<Step 3>

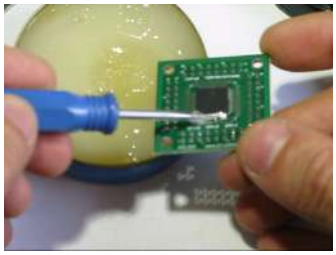

higher temperature. The iron should be held on longer, in order to have the component fully heated up before any solder is applied.

Solder Station

For soldering the IC pin to the pad, you can start off by heating up the pad. Then while heating up the pad, touch the IC pin and apply the solder wire directly to the pad or IC pin, allowing the solder to flow like liquid. The IC pin is heated last to minimize the chance of over heating the pin. If it doesn't flow very well, you can manually some flux to the joint. The solder wire should not touch the iron directly, because this will vaporize the flux, and solder flow will be restricted.

Heat up the lead and pad longer allows the solder to flow and form a good joint. Not for too long as it can also damaged your IC. You should be able to see the solder flow eventually onto the lead & pad. With a bit of practice, you will see the difference between a quick solder touch and another one with lead & pad heat up a little bit longer. It takes a number of practice to get a good joint with minimum amount of heating time.

The soldering iron that I use has rather thick tip, but that does not matter when I do soldering for the smd microcontroller. All we do is to flood the pins with solder. They can be be suck up later.

There is a technology known as ultrasonic soldering. The soldering iron tip has this micro vibration which helps the solder to flow more easy without much use of flux. It can also solderthose difficult to solder material. The following is one article that I found that describe about it. - Soldering the unsolderable.

I have applied more flux at this stage. It should have been applied before flooding the pin, but it doesn't matter too much. The flux will make the solder rather liquid so that it is easier to suck up the excess solder.

solder flux paste

Baker Soldering Fluid

<Step 4>

The flooded solder is being heated up, and the excess solder are being sucked up.

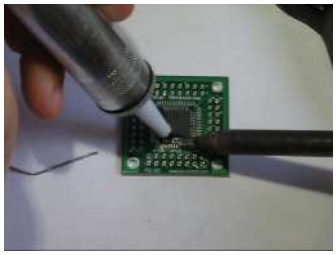

<Step 5>

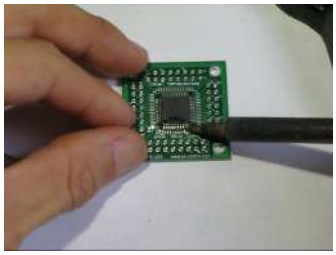

Each pins is being touch up, ensuring that the pin is solder to pad and that they are not bridged across to the adjacent pins.

Now we have got our smd component soldered onto the board.

<Step 6>

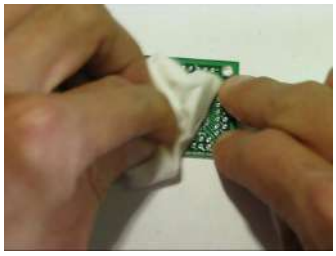

The flux helps a lot in doing a good solder but it often leaves the board with tiny dots of transparent strain, a bit sticky, also known as grease or flux residue. The board looks untidy with these tiny bits of grease.

These are the various recommended cleaning solution for pcb.
- 50% Alcohol + 50% Water
- Thinner
- Flux remover
- Multicore Prozone MCF800
- Solvent-> Bromopropane; propane, 1-bromo-; propyl bromide (Chemical Formula: C3H7Br)

Alcohol MSDS (Material Safety Data Sheet)

Thinner MSDS (Material Safety Data Sheet)

Electrolube, FLU Fluxclene Cleaning Solvent, pdf file

MG Chemicals 413B Heavy Duty Flux Remover

Brush for the crush

Flux Remover

Multicore Prozone MCF800

Besides using chemical, or after using chemical, there may still be some white blur stain. Those are flux spread dry up on the surface. Using a hot air blower, or heater on the surface can melt the dry up flux, and recover the smooth shiny PCB board surface again. Clean away the melt flux immediate after the heat.

Using alcohol is strongly recommended. Thinner is not suitable for certain plastic/material. Care is required when using thinner for cleaner. Using thinner on the PCB, copper pads and soldering joint isn't a problem. When use on plastic, you are advise to do a trial to ensure that the material is able to with stand thinner solution. Flux remover is commercially ready mixed solution. From what I learn in the manufacturer website, they are non-flammable chemical solution.

Alcohol & thinner has a lower flash point, and catch fire easily. You have to be extremely in handling and storing these flammable chemical. Do not store or work on the chemical near electrical appliances, hot area or things that can cause spark. Keep your windows open to allow air to circulate while working with these chemical. They may cause headache, dizziness and uncomfortable when inhaled.

Chemical comes in different level of grade. A slight different in the chemical concentration or purity can results in a large difference in cost. Alcohol can be expensive. For pcb cleaning purpose, request for technical grade alcohol. Higher grade alcohol is typically used for consumption or lab experiment purpose. Since we are using it for cleaning, there is not much advantage in using high quality chemical which is expensive. Dickson chemical is specialized in high graded chemical for laboratory use. They do sell lower cost technical grade alcohol. They are not suitable for consumption but is ok for cleaning application.

Dickson Chemical selling Technical grade alcohol

You can easily buy thinner from your local hardware. Typically used for cleaning your brushes after all the wall painting works.

Non-flammable Flux remover

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These are other recommendation in the web. After researching further, I would advise not use them. These chemical are of health hazard. Exposure will have severe adverse health effects.

- 50% isopropanol + 50% water
- Trichloroethylene
- Carbon tetrachloride

Isopropanol (true chemical name) is also known as Isopropyl alcohol or 2-propanol. 2- is refer as Iso. Other chemical may starts with 1- refer as N. These are some jargon used in the chemical industrial. I managed to learn a few of the terms from the vendor.
Trichloroethylene (true chemical name) is typically used for degreasing the metal. It is an extraction solvent for oil. Another name for Trichloroethylene is Trielin. Based on some read up, they can cause cancer.
http://www.answers.com/topic/trichloroethylene

Carbon tetrachloride can harm our environment, producing CFC which deplete the earth's ozone layer. http://en.wikipedia.org/wiki/Carbon_tetrachloride

Initially I tried using contact cleaner to clean the stain off. I use cloth or tissue but the fabric is often tear by the component sharp edges. Most corners are not easy to reach. Later on I tried using a toothbrush, the result is better.

For mass cleaning job, you can try using the ultrasonic pcb cleaner. It is a deep metal container for the solution, using micro vibration to shake off the dirt. I have never tried on it before, and I believe it is the same machine people used for cleaning their jewelry. Basically, you will need to dip the pcb board into the solution, and the ultrasonic will be activated to do it's job. The solution used is the same as manual cleaning, requiring 3-5 minutes of cleaning.

Ultrasonic cleaner

Ultrasonic jewelry cleaner

There is also a flux that does not leave residue on the PCB. I found it on the internet, and have not try it before.

INTERFLUX, IF 2005M No-Residue™ flux, pdf file

Article relating to removing flux residue:

- pcb cleaning - Aqueous Cleaning Process.pdf
- pcb cleaning - Flux Removal, nuxx.pdf
- pcb cleaning - pcb cleaning article.pdf
- pcb cleaning - PCB Cleaning, Printed Circ.pdf
- pcb cleaning - pcb washing chemical composite.txt
- pcb cleaning - remove solder flux.pdf
- pcb cleaning - Solvent washing PCB boards.pdf
- pcb cleaning - washing the board using alcohol.pdf
- pcb cleaning - PCB cleaning article Inventec_S24_03.pdf

<Step 7>

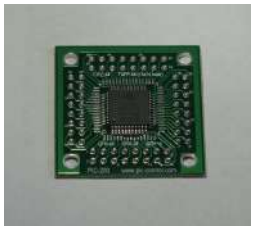
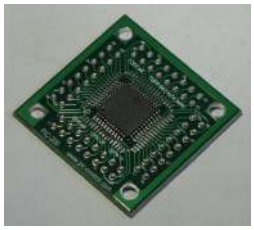

A close up view of the clean and neatly soldered surface mount IC on the prototyping adaptor. Soldering smd components is simple and fast with a bit of practice. Small and easy to clean up. There are too many advantage in working with surface mount, compared to through hole components.

This is the end of the short demonstration on smd soldering. I hope these article can provide you some insight and confident to start experimenting circuits using surface mount components.

Video available. Please click here,

smd soldering.mpg (25MB)

smd cleaning pcb.mpg (5.5MB)

Article on smd soldering.
- 2010-07 How to Solder Surface-Mount Devices.pdf

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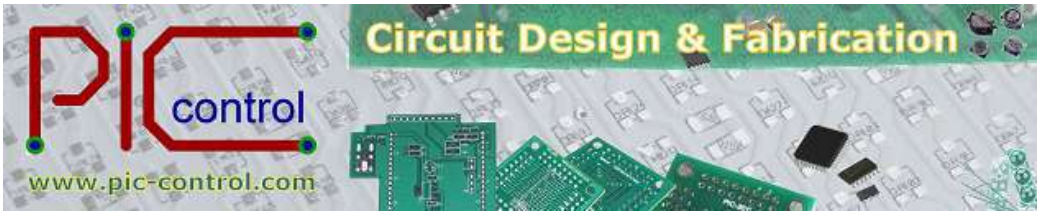

Singapore Customized, custom made Electronics Circuits & Kits

Various Chemical Reference:

Alcohol 70% + Distill Water 30%
MDX4-4159
7MHFE-71DE

Cyclohexanone
Methylethylketone
ethylacetate,
Silicon Wacker
Wacker M4503, General purpose mould making silicon (Using Two Part Silicon Mold Putty to Make Molds)
http://www.kirkside.com.au/, Mould Material Specialist

Propanol, used to clean PCB. (close to white electric oil)
Acetone, remove away ink printed on PVC stickers
n-Hexane (white electric oil)

smd glue for surface mount component mounting / soldering use
Seal-glo NE series, NE3000S, NE8800T, more Seal-glo

email: mail@siongboon.com
website: http://www.siongboon.com

Keyword: surface mount soldering, smd adaptor, smd to 2.54mm convertor

Surface Mount Soldering Procedure

We believe that the following procedures describe the simplest way to reliably assemble surface mount components without special tools. The only tools required are a pair of fine-tip tweezers, a rosin based flux pen, rosin core solder (.025” dia. preferred), and a soldering iron with a small, clean tip. A spool of fine (0.075”) solderwick will come in handy if you need to rework connections. You will need isopropyl alcohol, cotton balls, and cotton swabs for cleanup. If you have access to hot air rework tools and the skill to use them, feel free to use them instead.

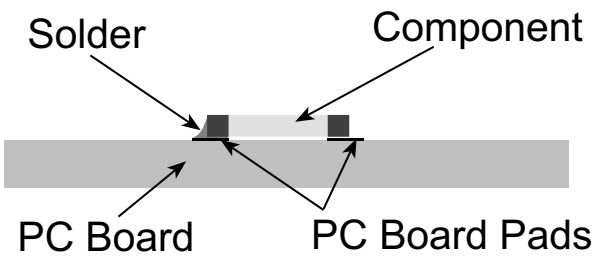

A proper solder joint with fillet

Proper joints

Poor joints

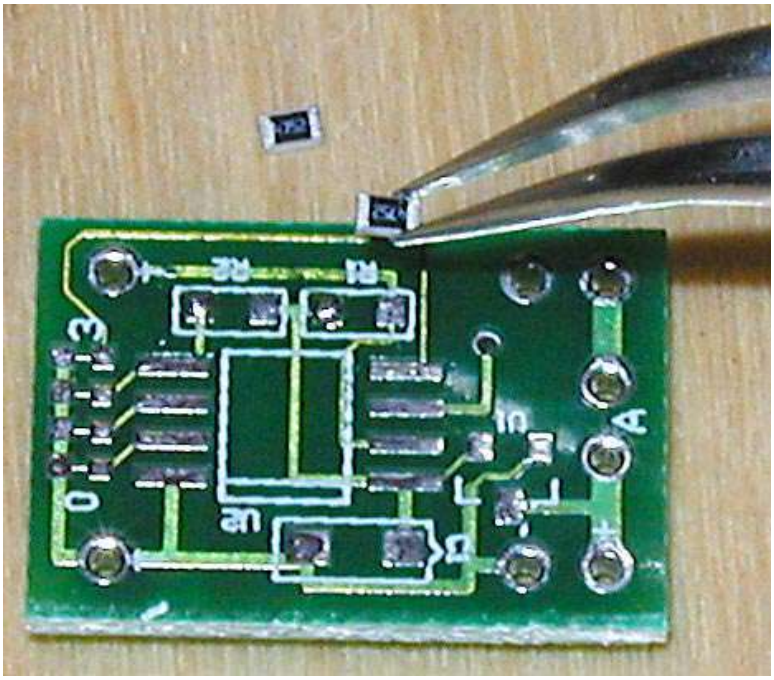

Placing the component

Soldering surface mount components is not difficult, but it does require good eyes, a steady hand, and a soldering iron with a small, clean tip. The illustrations at the left show a proper and a poor solder joint. In the proper joint, the flux has “wetted” both mating surfaces, allowing the molten solder to adhere to both the printed circuit board pad and the component lead. In the illustration of the poor connection, insufficient heat or flux has forced the solder to ball up on the end of the component, without making it to the PCB pad. The component is not attached properly, and the electrical connection will be intermittent at best. This connection can be salvaged by applying flux and heat to the PCB pad to get the solder to flow to the area between the pad and the component.

The most important characteristic of your soldering iron is that it must be equipped with a *small, clean* tip. If the tip is too large or is covered with oxidation, creating a well-flowed solder joint will be nearly impossible. Wipe your tip on a sponge before each joint - it must be shiny and well-tinned in order to transfer its heat properly.

You will find it easiest to work on your board if you clamp it in a moveable vise or stick it to a small block of wood with double-stick tape. This will allow you to rotate the board to whatever angle is most comfortable for access to the component being installed. If you try to hold the tiny parts at awkward angles, you will not have good results!

The first step is to apply a small bead of solder to <u>one</u> of the PCB pads for the component to be installed (the left-hand pads of R1 and R2 in the photo at right). The bead should be approximately 0.020” to 0.030” high (you may want to reevaluate your bead size after you have completed several joints). Apply some liquid *rosin based* flux from a flux pen to the solder bead and to the other pad(s) for the component.

Next, using a pair of tweezers, pick up the component to be installed and place it over the appropriate pads.

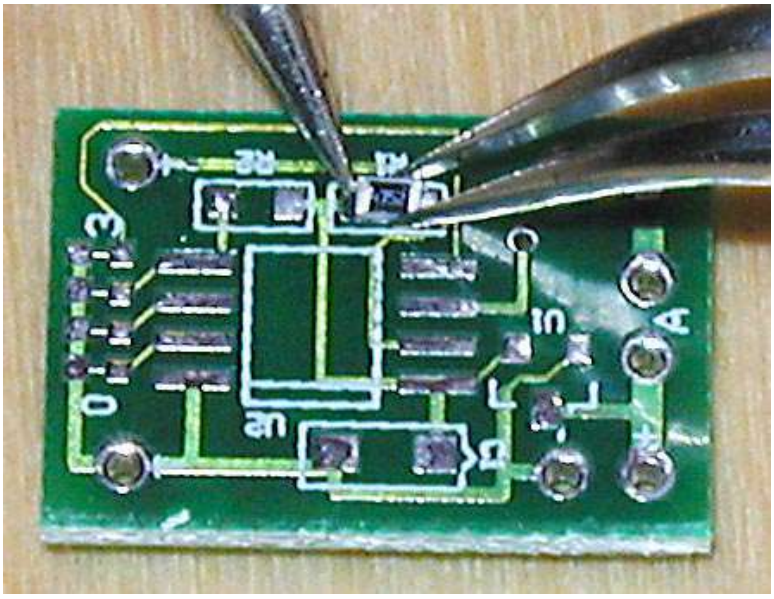

Affix the part by reflowing the first solder bead

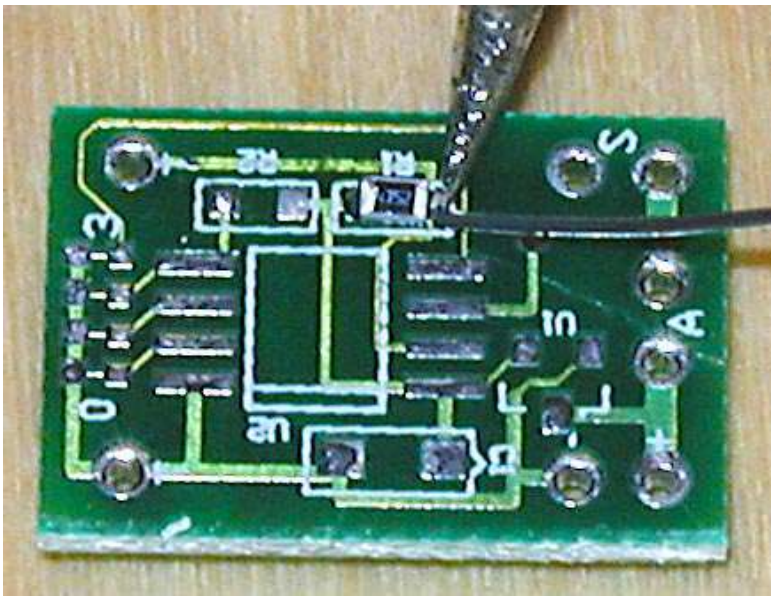

With the part in position, solder the other end

With the part in position, move the soldering iron to the solder bead on the PCB pad. Apply a small amount of heat from the iron to flow the bead, simultaneously lowering the part against the board and correcting for any rotational misalignment. Remove the iron and allow the solder to cool. Inspect the joint -- at this point you are not concerned about the quality of the actual solder joint, just the positioning of the component. The part should be flush against the PCB, with both ends properly contacting the pads. The part should be straight, and centered between the two pads.

Apply a liberal amount of liquid flux (again, a flux pen is the ideal applicator) to both ends of the component. Heat the currently unsoldered end of the component and the adjacent pad with the soldering iron, and carefully wipe on a small amount of solder. You want a small fillet as shown in the earlier illustration, not a large glob of solder. Make sure that the solder has flowed onto the pad as well as the component lead - don't be fooled by a lump of solder on the end of the component that doesn't flow under the component and onto the PCB pad.

After the second end is soldered, go back to the original solder joint and reheat the solder. The flux will allow the solder to flow freely, and a good fillet should be observed. If there seems to be insufficient solder, add a little more. If either of the ends appears to have an excessive amount of solder (a large blob sticking up above the part) it can be removed with solder wick. Apply flux to the blob and the wick, position the wick over the blob, and press lightly on the wick with your iron. As the heat is conducted through the wick the solder blob will melt and be drawn off by the wick. You may end up removing too much of the solder, in which case you can reapply a *small* amount of fresh solder to the joint.

After the joints have cooled, inspect them carefully to make sure that they are solid and make contact with the board. If you have any doubt about the quality of the connections, apply more flux and reflow the joints until you are satisfied.

The same procedure is also used for installing components with three or more leads (transistors, ICs, etc.). Start with a bead of solder on one pad, position and "tack" the part, then add more flux and solder the remaining leads. Don't forget to reflow/improve the first "tacked" connection if necessary.

Electrical Wire soldering For Beginners

by Randy Glass

DISCLAIMER- First, soldering can be dangerous. This lesson is not meant to be everything you need to know. Your safety is up to you, and you take full responsibility for any damage or injury caused by these instructions, whether as an act of omission or commission on your part or mine. Be aware that an improperly soldered wire can lead to fire, loss of vehicles, injury, and even death. By reading and/or using these instructions you take full responsibility and release me from all liability. Second, I took these photos as I did the work, pressing the remote control for my camera with one finger as I held the soldering pencil in one hand and the solder in the other. I apologize for any images that might be out of focus or poorly composed.

If Yogi Berra ever wrote a book on motorcycles he would probably say, "We seem to spend around forty percent of our time taking things apart, and the other seventy-five percent of the time putting them back together." Some things are easy to put together. We use specialized fasteners like nuts, bolts and screws to hold things together that, some day, we might want to take apart again. But there are some things that, once put together, we would like to know that, to some degree, our fastening system is permanent. One of those places is in electrical wiring. When a wire breaks or needs to be fastened to a connector or another wire in such a way as to be dependable, then the very best way is to solder.

soldering is a method to attach one metal part to another. It is part of a family that uses molten metal to do this job. At the top of the ladder is welding. This is a very high temperature method that actually melts the parts a bit where they are attached, along with some other metal, usually in the form of welding rods. Next is brazing. This melts some hard metal, usually brass, into the gap between two pieces of metal. Normally, the surface of the material being joined is not melted in this process, but it gets very, very hot. Finally there is soldering. soldering flows some molten metal between metal parts at relatively low temperatures.

For our purposes I am going to speak of the type of soldering that attaches two wires together or one wire to a connector- the sort of soldering that any backyard mechanic might need to do when working on any electrical component or the wires that connect them together in almost any type of vehicle.

WHY solder?

Although there are methods that can be used to make these connections without soldering, they are usually inferior. soldering does a lot of things:

1) It Is Strong- You are connecting two metal parts with a liquid metal that becomes solid after it fills the joint and cools. When properly done it leaves no voids so the joint is very strong and the wire is well supported.

2) It Slows or Stops Oxidation - Because solder fills the joint it excludes air and moisture so the metal in the joint will not oxidize. This maximizes electrical flow over time.

3) It Makes An Excellent Electrical Connection- because the solder is a conductor it gives the wire more area from which it can flow electrons to whatever it is connected.

4) Non-permanent - Although soldering is very strong, it can be removed and the joint taken apart in the future if necessary.

5) Connectors do Not Need to be Crimped - Those little metal connectors that are designed to be crimped have a terrible habit of coming loose as well as breaking the little copper wires in the conductor making a weak joint as well as one that does not conduct as well as it should. They easily let air and moisture in which causes corrosion and that leads to poor and broken connections.

MATERIAL LIST

It doesn't take much to set yourself up as a soldering wizard. Here is a list (numbers refer to image to the left):

*1) **soldering Pencil -** Something around 25 to 40 watts would probably be fine for most electrical work. You don't need a huge soldering gun to do electrical work. A little smaller is actually better than too big, as we shall see. Get a brand-named pencil so that down the line you will still be able to

get replacement tips for it. A chisel tip as seen in the pictures that follow is best for most work but you might also need a pointed tip for more delicate work. Those old soldering guns are nice for making battery cables, but are generally too large for what we are doing. it would be like using a sledge hammer to make a picture frame- it would have to be a REALLY big picture frame!

There are also cordless, rechargeable soldering irons available. They generally run about $35-75 or so. Although these cost substantially more than a corded iron, and the replacement tips are more expensive as well, there is no cord to get in the way when working and as they can be carried along on trips. These generally have a built-in light as well making repairs at night easier. I normally loosen the lamp so that it does not light, so the battery lasts longer in use.

There are soldering tools that are actually little, refillable, butane-powered torches with a soldering tip at the end which is heated by the flame. As they are about the size of a fat ball point pen, they are another good way to get a portable soldering tool. These generally are available for less cost than the rechargeable irons mentioned above. I have used electric irons to solder around a gas tank on an automobile- something that I would never consider with one of these.

And a **soldering Pencil Holder** - Most soldering pencils come with a holder or a rest as seen here, but if not, get one. These metal stands are very handy and will help avoid melted parts and burned hands and work surfaces.

*2) **solder** - Resin core solder is what you want. NEVER use acid core solder on electrical components. The acid will stick around and continue to eat into components and wiring well after the soldering job is over.

Resin core solder can be had in various quantities, but I buy the one pound roll for around $12-15 which will be a lifetime supply for most folks. I use Kester brand "44" Resin Core solder in the .031 diameter size. This is about the size of mechanical pencil lead and works quite well for what you will be doing.

It use to be that a standard part of a soldering kit was a little tub of flux. This paste would be spread on the joint ahead of time to help clean the joint chemically as it was heated by the iron. It was necessary as flux-core solder was unavailable. If your wires are clean and you are using a quality, resin core solder, additional flux is not necessary.

*3) A**n Old kitchen sponge** or two

* **Tools** to work on wires such as a (4) wire stripper and a (5) wire cutter, and possibly needle nosed pliers and a small vise (not shown).

* 6) A few bits of **insulated wire** and an old spade connector or two on which to practice. Two or three feet of wire will do.

*7) **Heat Shrink Tubing** - I rarely use electrical tape any more. Heat shrink is really great! I usually buy it in three foot lengths in two or three sizes. This is a sort of memory tubing that, I believe, is made by heating a special tubing and stretching it and allowing it to cool while still stretched. it maintains that size. When heat is applied once again the tubing will shrink back down to its original size.

*8) Protection for the work surface like an old piece of 1/4" plywood about 12" square or such. An old piece of counter-top lamination works also.

* Wicking material (not shown)- You can purchase some special copper wick that is used to unsolder joints. This is usually not necessary, but handy at times, and inexpensive.

* **Eye protection**

* A Ventilated workspace

SOME WARNINGS

HEAT - A soldering pencil as well as molten solder are both really hot. They will burn you and it will hurt. It can hurt a lot. It can make your skin give off smoke and that smells bad. If left unattended a hot soldering pencil can cause fires, melt carpeting, burn workbenches, and make the cat dance like never before. An unsuspecting person can pick up a hot soldering iron and get a nasty burn (trust me on this one!). Never leave a soldering tool warming or hot and unattended.

Additionally, a hot soldering iron can almost instantly melt plastic parts and upholstery in a hurry. Use care when soldering as well as when moving the iron to and from the solder joint. If the cord gets caught when moving the iron it can easily cause you to drop the hot tool onto something expensive or painful. NEVER place a soldering iron on saddles, luggage, body work, painted surfaces, or on or near any heat-sensitive surface.

LEAD and VAPORS- solder contains a good amount of lead and handling it over a long period of time may have negative health consequences. The vapors caused by soldering can, over time, cause health problems as well. Work in a well ventilated area. I usually work out doors and use a fan to blow the vapors away from me. The smoke that is given off by the flux in the solder is also not a good thing to breathe.

MOLTEN METAL - When soldering (and particularly when un-soldering) it is very possible to flick bits of melted solder about. As this stuff is quite hot, even a small drop in the eye can cause permanent damage. Wear eye protection and do not wear your good glasses, or wear them under goggles. The dripped solder can melt plastic parts and permanently damage auto carpeting as well. Be aware of other folks or critters who may be in the area as well.

ELECTRICITY - You will be soldering on wires that, if shorted out, could cause a blown fuse, damaged electrical components, or melting wires and a fire. Always disconnect the battery when soldering wires on a vehicle and remove connectors from heat-sensitive components before soldering on them.

LETS GO

I could spend a lot of time talking about how it all works, but jumping right in is the best way to learn how to solder and I will explain as I go

Begin by creating a safe work area. One free of clutter, with sufficient light, and protected from the soldering iron and melting solder. Set the soldering pencil in its stand and plug it in. be sure that the cord is placed in a way that it will not be accidently pulled or tripped on, upsetting the soldering pencil.

While that is heating up, prepare your sponge. Wet it, squeeze out the excess water, then fold it in

half and rubber band it about half-way down.

Pull out about a foot or two of solder from the roll and touch it to the tip of the soldering iron. Always apply the solder to the flat parts of the tip and not to the sides. When the solder melts fairly easily, melt an amount all over the tip. There will be some smoke from the resin in the solder.

The solder you bought is actually a bit hollow. Inside of the metal there is a channel (or in some cases, channels) that make it sort of like a little garden hose. The channel is filled with a resin. When heated it melts and some of it burns off. The action of the resin when it is heated helps clean the surface to be soldered which helps the solder stick a lot better. Unfortunately, the burned resins can also leave deposits on the soldering pencil, and over time will make it difficult to solder. That's where the sponge comes in. After you have melted some solder onto the tip (about a quarter inch or so of the thin stuff) wipe the soldering pencil's tip off on the damp sponge a few times.

If you examine the tip of the soldering pencil carefully you will see that it is now covered with a thing coat of shiny, silver metal- the solder. You have successfully "tinned" the tip of the pencil. This keeps the metal tip from oxidizing and will assist you in soldering from now on. Always do this before starting a soldering job and occasionally during a larger job.

Place the soldering pencil back into its holder and let's prepare the wires. We are going to solder two wires together, making believe they have broken or need extending.

We start by "stripping" some of the plastic insulation away from where we want to connect the wires. The thicker the wire the more insulation we remove. For most common wires on a motorcycle or in a car, removing about 3/8 to ⅛ inch works fine. You will get a

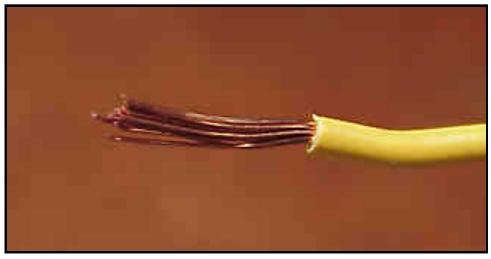

feel for how much in a short period of time. When stripping wire be very careful not to cut the strands of the conductor.

There are special tools available for stripping wire that can save a lot of time. These can be as simple as a carefully wielded razor blade to fancy and somewhat expensive automatic strippers.

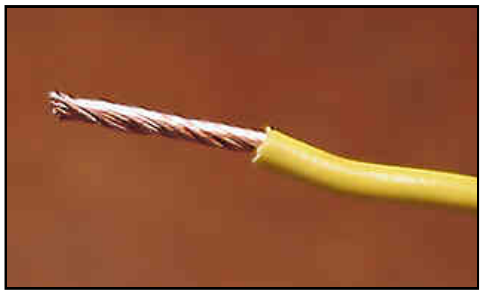

Once stripped, twist the strands together into a neat little bundle.

The exposed wires should look fairly clean and in most cases, shiny, but certainly not green or cruddy. If corroded, then the wires should be cut back and re-stripped until clean wire is found.

Now cut a length of heat shrink tubing off about an inch long. It should be of a large enough diameter that at least two of the wires you are soldering can easily fit into it at the same time. Slide the length of the tubing over one of the stripped wires- it doesn't matter which here, but in real life we would slide it over the lower wire or the one which slopes most downward away from the joint so it will tend to slide out of the way. make sure it is at least three or four inches away from the joint.

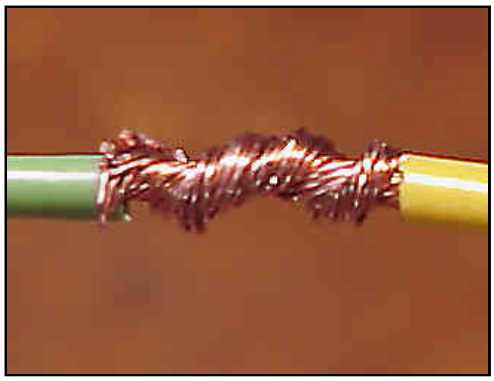

Now, twist the two wires together into a tight, neat pair. This is important because it helps create a good electrical connection. You also do not want any little wires sticking out. Start by crossing the wires about mid-strip, crossing them at about 45 degrees or so, and twisting in opposite directions. When done, the joint should be fairly strong on its own, holding the two wires together tightly. The connected pair of wires should be in line as if they are a single wire and not two joined together.

It's time to solder. Place the roll of solder on your left (if you are right handed) with a good length of solder hanging out of the roll. With the solder in your left hand and the soldering iron in your right hand, check to see that the tip is still tinned and shiny. If not, repeat the process with a bit of solder melted to the tip, then wipe the tip off on the sponge.

Melt a little ball of solder onto the iron....

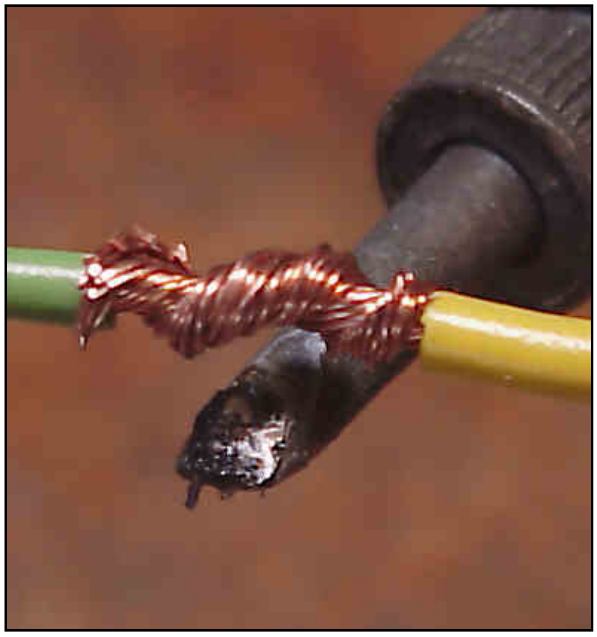

...and immediately place the soldering iron under the twisted wires (if possible) so that the little ball of solder fills much of the gap between the soldering pencil and the wire. Since heat rises, placing the iron under the joint will heat it faster. The little ball of solder works as a heat conductor and will very rapidly conduct the heat from the soldering pencil's tip into the wires. If the ball of solder does not seem like it is contacting the wire very well, without removing the pencil from the joint, melt just a bit more solder in there by feeding the end of the solder wire into the tip. This will not only increase the contact area of the solder to the wire but it will also add a bit of flux that helps the solder adhere to the wire at this time.

After about two or three seconds, start to feed solder, slowly at first, into the void between the pencil and the wire. You should soon see the solder is flowing into the twisted wires. WHen that happens, increase the feed rate of the solder into the joint, and you can now also feed a little into the top of the joint. Don't move the iron's placement, jut take the end of the solder wire and touch it to the tip of the joint. Continue to feed solder until the individual wires are almost filled with solder and the entire joint has turned silver. When that happens, stop feeding the solder in and immediately but gently remove the soldering iron.

How long do you wait until feeding in solder? One way to test how long to wait is to touch the solder on top of the joint and wait until that area is hot enough to melt the solder. The amount of time it takes varies with the size of the wires to be soldered, the size of the solder, the wattage of the iron, the size of the irons's tip, the ambient air temperature, and other factors. Experience will teach you how long this takes.

The problem comes from waiting too long and putting too much heat into the joint. When you do that it begins to melt the insulation on the wires around the joint (you can see that beginning to happen above at the end of the insulation of the green wire next to the soldered joint). That is why I like tho flow the solder in from where the iron's tip touches the wire. This is the place that will come up to soldering temperature first, and then the flowing solder will more easily flow solder into the joint as it carries heat with it. The larger the wires, the longer it takes and the more important it

becomes to feed in some solder from the top of the joint as well. Again, experience will teach you when that is necessary.

How much solder is enough? Too much? The correct amount of solder is used when the joint is fairly all silver colored but still shows the "outlines" of the individual strands of wire in the joint. If there is very much in the way of copper colored wire showing then you probably didn't use enough solder or the wires weren't clean and would not accept the solder. If there are big blobs and drips of hardened solder on the joint then you probably had either too cool of a joint or used too much solder.

After soldering, let the joint cool for about thirty seconds to a minute or so before handling. If you were successful you should have:

* A pair of wires tightly joined together

* The joint between them is very shiny, looking like polished sterling silver.

* No hardened dribbles or drops of solder hanging off the joint

* No little wires sticking out of the joint.

* A union only slightly larger than each of the wires themselves.

If you were NOT successful you might see:

* Large blobs or possibly a long, pointy finger of hardened solder hanging off the joint. Sometimes, after cleaning the iron, these can be removed by simply heating the joint until the solder melts, then removing the iron which will pull away some of the excess solder with it. This may need to be repeated a few times to remedy the situation.

* Wires that are not soldered together and has movement within it. Re-heat the joint and add some more solder.

* Melted insulation. This can be so bad that the wires are revealed with the insulation dripping off the wires. At this point you will probably need to cut the wires and begin again, or unsolder the joint and add a long piece of heat-shrink tubing to cover the exposed wires.

* Little ends of the copper wires sticking out. These can sometimes be cut off with a wire cutter and/or pressed down with a pair of smooth-jaw pliers, possibly needle nose pliers.

Now it is time to cover the joint with the heat shrink tubing. You DID remember to slide on the heat shrink tubing before beginning, didn't you? Once the joint is cool enough to touch, slide the tubing so it is centered over the joint and gently touch the meaty part of the soldering iron's heating element to the center of the tubing.

Continue this around the center of the tubing until it tightly grips the wire joint, then work outwards until the entire piece of tubing has shrunk tightly around the joint.

Attaching An Electrical Connector

Besides connecting two wires together, soldering is the best way top attach some sort of connector to the end of a wire. The connection is strong as well as fairly well sealed against the elements. It works pretty much the same way as above...

Remember when we "tinned" the tip of the soldering pencil? We did this to apply a film of solder to the tip so it wouldn't oxidize and thus be able to more easily transfer heat. Now I am going to do the same with a piece of wire.

Here I am applying a good amount of solder ahead of time to this wire because I am planning on soldering it to a fairly heavy connector. This way, the wire will be "pre-soldered" and easier to attach, and will have less of a chance of melting the insulation.

When soldering a connector to the end of a piece of wire it is very helpful to use some sort of vise to hold the connector. A small pair of locking pliers or a pair of needle nose pliers with a rubber band around the handles to hold the jaws shut works well. Here I have locked a pair of locking pliers into a small vise to work as a "hands-free" holder. This not only allows me to use both hands to work but isolates me from the heat of the soldering process.

Remember that the heavy metal pliers will work as a heat sink, pulling heat away from the soldering joint, so it might take longer to achieve the proper heat level in the joint. That is why I have gripped the connector as far away from the area to be soldered as possible,

Be careful as the pliers may get hot near the tips and you might overheat the wire as well. Be sure to slide the heat shrink tubing over then wire BEFORE beginning to solder! If you leave it off and finish soldering, you will be left with the soldering job in one hand, the heat shrink tubing in the other hand, and a stupid look on your face. We call this, "Heat Shrink Tubing Syndrome."

Additionally, if you apply too much solder, particularly with a small connector, it is very possible to fill the connector with solder and thus make it difficult or impossible for the connector to function properly. There are ways to

get the solder out, but they are generally more difficult (or dangerous) than just chucking it and starting over. To keep this from happening:

* Never touch the area of the connector where you don't want solder to flow
* Orient the connector with the part where solder shouldn't flow, upwards (or Higher than the end where solder will flow).
* Apply solder sparingly and slowly
* Use a lower wattage soldering pencil
* Use a smaller tip on the soldering pencil

I sometimes use two pieces of heat shrink, one over the other, shrunk one at a time, in areas where extra protection is needed. This is particularly useful when soldering a connector to the end of a wire. I first shrink a small diameter piece about an inch long over the wire up to where it joins the connector as shown here. This acts as a strain relief as well as insulation.

Notice the small amount of flux on the connector ring left over from the soldering process. If you use resin core solder, this stuff is harmless to the electrical device. It can be brushed off with a small wire brush if you wish.

I then shrink another larger diameter piece about ⅓ an inch long over the connector to act as an insulating cover. In the case of something like a female spade connector, the entire connector except for the opening can be covered and protected in this way. If the heat shrink interferes with the connection, simply cut the offending part away with a razor blade being careful not to damage anything else including yourself!

In areas where the joint needs to be protected from corrosion, slather the terminal with petroleum jelly, or the special grease for this application.

Following these directions you will become a "master solderer" in a short period of time. It takes some practice to get a feel of how hot for how long with how much solder it takes to create to make a good solder joint, so get some scrap wire and practice before attempting to solder on anything important.

If there are any questions or comments, please feel free to E-mail me at frcn@cncnet.com.

Note by Duane; If you appreciate articles like this, I suggest that you thank Randy at the email address above.

More BMW info

Home page

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Soldering and Desoldering Instruction

Soldering is defined as "the joining of metals by a fusion of alloys which have relatively low melting points". In other words, you use a metal that has a low melting point to adhere the surfaces to be soldered together. Soldering is more like gluing with molten metal than anything else. Soldering is also a must have skill for all sorts of electrical and electronics work. It is also a skill that must be taught correctly and developed with practice.

Remember that when soldering, the rosin in the solder releases fumes. These fumes are harmful to your eyes and lungs. Therefore, always work in a well-ventilated area. Hot solder is also dangerous. Be sure not to let is splash around because it will burn you almost instantly. Eye protection is also advised.

The Tools

Soldering Iron – Even the cheapest of them will do the job. They may not last as long, but they do get hot enough to melt solder and that is the goal. You only need to make sure that the one you buy has a suitable tip on it. The most typical tip is the one that is about the size of a 1/8" stereo mini-plug.

Solder – Get Rosin Core solder. Rosin will help the solder to flow onto the wires. Solder comes in different thickness. Buy what is appropriate for your job.

Desoldering Gun – This tool will make life a lot easier when you need to rework a previous solder job.
Solder Wick – Braided copper with rosin coating used to draw solder off of circuit boards.

SMD Rework station— Basically this is a high temp hair dryer with special nozzle attached. It heats up entire pins of the SMD device so you can remove them.

The Methods

Soldering – There is not art to soldering, it takes patience and practice to get it right. If you are doing it right, it will be easy and very fast. First, make sure that your soldering iron tip is clean. If it is dirtier than just a light gray color, you need to clean it. You can do this with sandpaper or a Scotch Brite pad. Next, turn your iron on and give it plenty of time to heat up. To test the heat, use a piece of solder touched to the tip. If it melts immediately, it is ready.

The most common way to mess up a solder job is to let the soldering iron stay on the parts to be soldered too long. What this does is oxidize the metal, making it too dirty to attract solder. If you are working with a circuit board, too much heat can damage the board, rendering it useless and in need of repair. You should only hold the soldering iron to the parts to be joined for no more than 10-12 seconds. Any longer and you will melt insulation on wire or damage a circuit board.

It has been said that soldering is a two-person job. You need two hands to hold the parts together, one hand to hold the iron, and another to feed the solder. The correct method for applying solder is to hold the joint perfectly still while heating with the soldering iron. After a few seconds, introduce the end of the solder at the point where the iron meets the parts

If the solder does not melt immediately and flow onto the joint, pull the solder away and try again after a couple seconds longer. If you exceed 10 seconds, pull the iron off and try again after it all cools down. You probably didn't have the iron touching enough of the parts to be soldered. Sometimes, the parts to be soldered are so big that they conduct the heat away very quickly and make it difficult to solder. In this case, it is OK to put some solder on each part individually and then put them together later by melting the solder on each one while they are touching.

Joining Two Wires - Strip off about 3/8" of insulation from the two wire ends to be joined. Place a ½" length of heat shrink tubing over one wire and push it back so that the heat from soldering won't shrink it prematurely. Fold each bare wire end back on itself so that the tip of the wire now comes back to the end of the insulation. Link both wires together using the bends like hooks. Now, twist the ends of the wires around themselves tightly. This type of connection is called a Western Union and it is the strongest method of joining two wires together. Now, heat the connection with the iron and allow solder to flow over the entire joint. Wait a few seconds for it to cool off and then slide the heat shrink tubing down over the connection and heat it with a match or heat gun.

Soldering a Wire to a Circuit Board – This is delicate work that you will do while soldering. Too much heat and your board will be damaged. If you are attaching a wire to an existing hole on the board, make sure that the hole is clean and free of any excess solder (see de-soldering for more detail). The best advice when soldering to a circuit board is to angle your soldering iron tip so that it makes good contact with the pad on the circuit board and the wire or part to be soldered at the same time. Heat the parts up and touch the solder at the point where the tip meets the part and the pad. If the solder does not flow immediately, pull everything off and wait for it to cool down and try again later.

Step 1

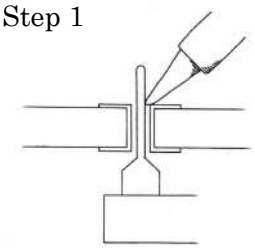

Apply heat to both pin and pad on the circuit board. Make sure tip of the soldering iron is touching both pin and pad.

Step 2

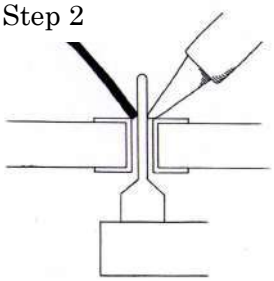

When the both pin and pad are heated enough, apply solder to the pin and pad. Solder should starts to flow.

Step 3

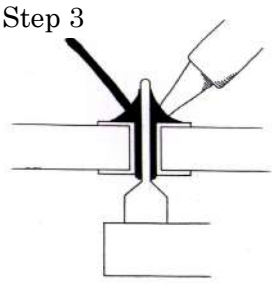

Apply enough but not too much solder. While applying the solder, do not move the tip of iron.

Step 4

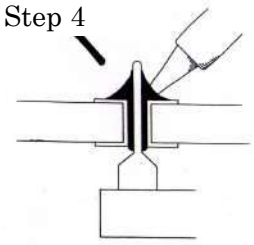

Remove solder away.

Step 5

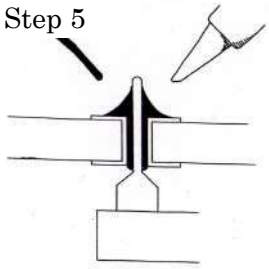

Remove tip of soldering iron also.

Step 6

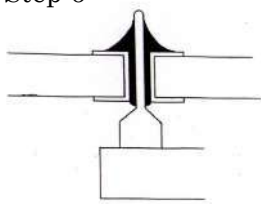

Done! Check the joint to make sure the connection.

Good soldering and Bad soldering Joints

Here are some example of Good soldering and Bad soldering joint.
For Japanese, we often say, “Good soldering joint should look like Mt. Fuji.”

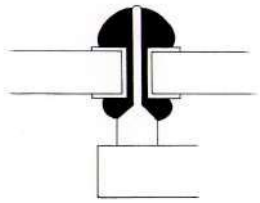

Too much soldering

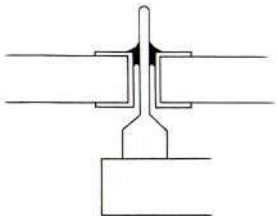

Too little soldering

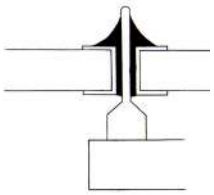

Good soldering

Cold Solder Joints

A cold joint is a joint in which the solder does not make good contact with the component lead or printed circuit board pad. Cold joints occur when the component lead or solder pad moves before the solder is completely cooled. Cold joints make a really bad electrical connection and can prevent your circuit from working.

Cold joints can be recognized by a characteristic grainy, dull gray color, and can be easily fixed. This is done by first removing the old solder with a desoldering tool or simply by heating it up and flicking it off with the iron. Once the old solder is off, you can re-solder the joint, making sure to keep it still as it cools.

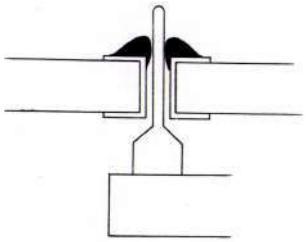

Cold soldering joints

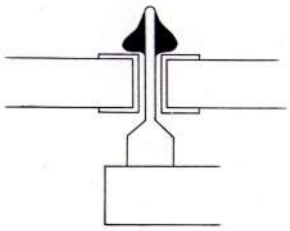

Tips and Tricks

Soldering is something that needs to be practiced. These tips should help you become successful so you can stop practicing and get down to some serious building.

1. Use heat sinks. Heat sinks are a must for the leads of sensitive components such as ICs and transistors. If you don't have a clip on heat sink, then a pair of pliers is a good substitute.

2. Keep the iron tip clean. A clean iron tip means better heat conduction and a better joint. Use a wet sponge to clean the tip between joints.

3. Double-check joints. It is a good idea to check all solder joints with an ohmmeter after they are cooled. If the joint measures any more than a few tenths of an ohm, then it may be a good idea to re-solder it.

4. Use the proper iron or temperature. Remember that bigger joints will take longer to heat up with an 30W iron than with a 150W iron. While 30W is good for printed circuit boards and the like, higher wattages are great when soldering to a heavy metal chassis.

Desoldering

Desoldering is extremely difficult compare to soldering. In the process of RomBoard installation, the parts and circuit board must be in the good shape to re-use them. The tool we use is Desoldering Gun. This device has vacuum pump built in with heater tip. Process of desoldering it self is very simple, but there are some tricks to do clean and safe desoldering job.

Step 1

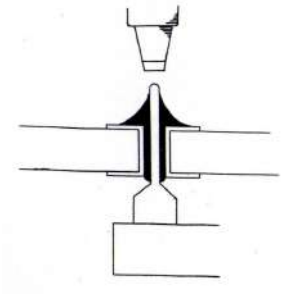

Put the desoldering gun's tip over to the soldering joint. Make sure nozzle is 90° angle from circuit board.

Step 2

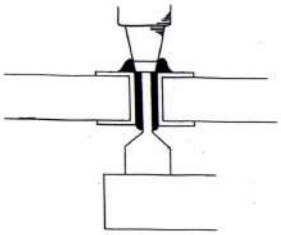

Apply the enough heat to melt entire solder. Multi-layer board or ground pin may take while to transfer heat.

Step 3

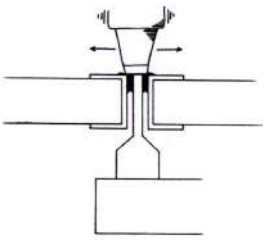

While applying vacuum, move the tip around the pin to get all the solder of around the pin out. At this time, you can also feel pin moves freely, so you know pin is free from circuit board.

Step 4

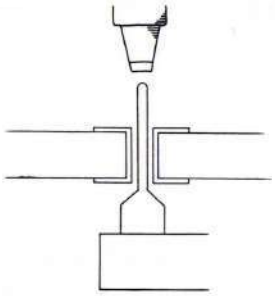

When you can hear air flow sound from hole, you should be done. Stop applying vacuum and remove the gun from the pin. Inspect hole and pin.

When you done with desoldering, the parts that you are trying to remove should move freely. If it doesn't, find which pin is still has solder left, and re-apply fresh solder to it and try desoldering process again. The multi-layer circuit board require more heat to get solder to melt. Make sure pin start to move freely by moving the tip of soldering gun before you apply vacuum to it.

SMD device soldering and removal

In the process of RomBoard installation, chance of handling SMD devices is becoming higher and higher due to ECU configuration change.
Soldering of SMD devices are not much different from regular through hole soldering.
Important thing is positioning of the device is very critical.
Start with applying little solder to two of the each corner of the pads on the circuit board.
Then, place the SMD device and re-heat a one of the solder you just applied to connect a SMD device pin to the pad. Check the position of the device, if position is right re-heat the other end of solder to secure the device completely. If you didn't get position right, re-heat the pin that you just soldered and while heating a pin, move the device to the right position.
Once you positioned the device in the right position, apply Rosin Flux to both pins and pads. This will help your soldering job by keeping solder separate from each pin.
Here is how the joint on SMD device pin should look like.

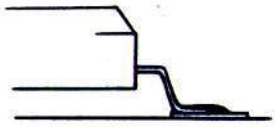

QFP and SOP chip

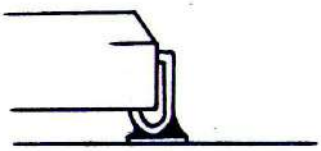

PLCC chip

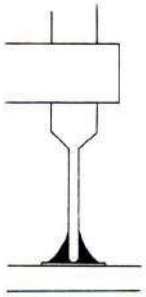

RomBoard adapter socket

Removing SMD device will be the probably the most difficult process. SMD rework station is used to do this. Make sure all the pins are completely heated otherwise you will be removing a pad from the circuit board along with device. Also, you should note, when you are applying heat to the device, some parts around the device is also heated and moves around when you touch. It is good idea to take a note of location of the devices near the target device.

Step 1
Apply pre-heat from back side of the target device. Keep applying heat until you can't touch the chip. By this time, circuit board should have enough heat.

Step 2
Apply heat from top of the target device. Nozzle should cover entire chip. You can check if chip is free from solder by sliding the nozzle left and right. Make sure you don't move other parts. If the chip moves freely, it is ready to be removed.

Step 3
Remove the chip straight up to avoid making solder bridge between pins. Chip is extremely hot! Unless you have skin of steel, avoid imitating the picture.

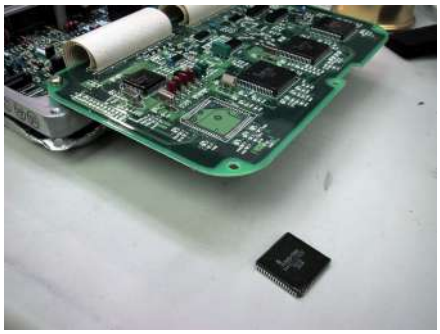

Step 4
After remove the chip, cool down both circuit board and chip.

Step 5
Clean the pads on the circuit board with desoldering gun.
Do not apply too much heat to the pad. Pad might peel off from circuit board. Clean the chip by desoldering gun also.
Check for any bridge between pins. If the chip has too much protective coating on it, use solvent to clean it up.

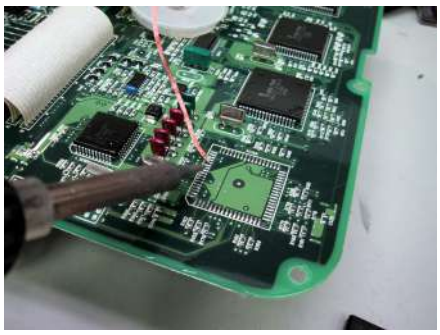

Step 6
If the pads on the circuit board is too small to use desolding gun, try cleaning by solder wick with rosin flux. This may take time but it is much better than peeling pads off.
Once again, do not apply too much heat.

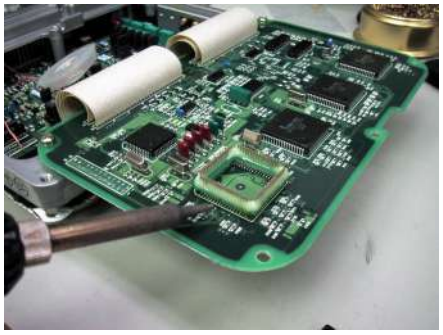

Step 7
Solder the RomBoard adapter where the chip was.
Refer SMD device soldering section for how to solder adapter.

The Final Word

Soldering, desoldering, and working with SMD device will take some effort to learn. You should be relaxed and concentrated when you work.
Keeping every thing clean (tip of iron, gun, work surface, etc) will help you also.
Once you get comfortable to work with soldering you may find your own tips and tricks.
Experience is all bout soldering.

EOF

How To Solder - Soldering Tutorial

Soldering is defined as "the joining of metals by a fusion of alloys which have relatively low melting points". In other words, you use a metal that has a low melting point to adhere the surfaces to be soldered together. Consider that soldering is more like gluing with molten metal, unlike welding where the base metals are actually melted and combined. Soldering is also a must have skill for all sorts of electrical and electronics work. It is also a skill that must be taught correctly and developed with practice. This tutorial will cover the most common types of soldering required for electronics work. This includes soldering components to printed circuit boards and soldering a spliced wire joint. This presentation came from http://www.aaroncake.net/electronics/solder.htm

Soldering Equipment

The Soldering Iron/Gun

The first thing you will need is a soldering iron, which is the heat source used to melt solder. Irons of the 15W to 30W range are good for most electronics/printed circuit board work. Anything higher in wattage and you risk damaging either the component or the board. If you intend to solder heavy components and thick wire, then you will want to invest in an iron of higher wattage (40W and above) or one of the large soldering guns. The main difference between an iron and a gun is that an iron is pencil shaped and designed with a pinpoint heat source for precise work, while a gun is in a familiar gun shape with a large high wattage tip heated by flowing electrical current directly through it.

A 30W Watt Soldering Iron

A 300W Soldering Gun

For **hobbyist electronics** use, a soldering iron is generally the tool of choice as its small tip and low heat capacity is suited for printed circuit board work (such as assembling kits). A soldering gun is generally used in heavy duty soldering such as joining heavy gauge wires, soldering brackets to a chassis or stained glass work.

You should choose a soldering iron with a 3-pronged grounding plug. The ground will help prevent stray voltage from collecting at the soldering tip and potentially damaging sensitive (such as CMOS) components. By their nature, soldering guns are quite "dirty" in this respect as the heat is generated by shorting a current (often AC) through the tip made of formed wire. Guns will have much less use in hobbyist electronics so if you have only one tool choice, an iron is what you want. For a beginner, a 15W to 30W range is the best but be aware that at the 15W end of that range, you may not have enough power to join wires or larger components. As your skill increases, a 40W iron is an excellent choice as it has the capacity for slightly larger jobs and makes joints very quickly. Be aware that it is often best

to use a more powerful iron so that you don't need to spend a lot of time heating the joint, which can damage components.

A variation of the basic gun or iron is the soldering station, where the soldering instrument is attached to a variable power supply. A soldering station can precisely control the temperature of the soldering tip unlike a standard gun or iron where the tip temperature will increase when idle and decrease when applying heat to a joint. However, the price of a soldering station is often ten to one hundred times the cost of a basic iron and thus really isn't an option for the hobby market. But if you plan to do very precise work, such as surface mount, or spend 8 hours a day behind a soldering iron, then you should consider a soldering station.

The rest of this document will assume that you are using a soldering iron as that is what the majority of electronics work requires. The techniques for using a soldering gun are basically the same with the only difference being that heat is only generated when the trigger is pressed.

Solder

The choice of solder is also important. There several kinds of solder available but only a few are suitable for electronics work. Most importantly, you will only use *rosin core solder*. *Acid* core solder is common in hardware stores and home improvement stores, but meant for soldering copper plumbing pipes and not **electronic circuits**. If acid core solder is used on electronics, the acid will destroy the traces on the printed circuit board and erode the component leads. It can also form a conductive layer leading to shorts.

For most printed circuit board work, a solder with a diameter of 0.75MM to 1.0MM is desirable. Thicker solder may be used and will allow you to solder larger joints more quickly, but will make soldering small joints difficult and increase the likelihood of creating solder bridges between closely spaced PCB pads. An alloy of 60/40 (60% tin, 40% lead) is used for most electronics work. These days, several lead-free solders are available as well. **Kester "44" Rosin Core** solder has been a staple of electronics for many years and continues to be available. It is available in several diameters and has a non-corrosive flux.

Large joints, such as soldering a bracket to a chassis using a high wattage soldering gun, will require a separate application of brush on flux and a thick diameter solder of several millimeters. Remember that when soldering, the flux in the solder will release fumes as it is heated. These fumes are harmful to your eyes and lungs. Therefore, always work in a well-ventilated area and avoid breathing the smoke created. Hot solder is also dangerous. It is surprisingly easy to splash hot solder onto yourself, which is a thoroughly unpleasant experience. Eye protection is also advised.

Preparing To Solder

Tinning the Soldering Tip

Before use, a new soldering tip, or one that is very dirty, must be tinned. "Tinning" is the process of coating a soldering tip with a thin coat of solder. This aids in heat transfer between the tip and the component you are soldering, and also gives the solder a base from which to flow from.

Step 1: Warm Up the Iron

Warm up the soldering iron or gun thoroughly. Make sure that it has fully come to temperature because you are about to melt a lot of solder on it. This is especially important if the iron is new because it may have been packed with some kind of coating to prevent corrosion.

Step 2: Prepare A Little Space

While the soldering iron is warming up, prepare a little space to work. Moisten a little sponge and place it in the base of your soldering iron stand or in a dish close by. Lay down a piece of cardboard in case you drip solder (you probably will) and make sure you have room to work comfortably.

Step 3: Thoroughly Coat the Tip in Solder

Thoroughly coat the soldering tip in solder. It is very important to cover the entire tip. You will use a considerable amount of solder during this process and it will drip, so be ready. If you leave any part of the tip uncovered it will tend to collect flux residue and will not conduct heat very well, so run the solder up and down the tip and completely around it to totally cover it in molten solder

.

Step 4: Clean the Soldering Tip

After you are certain that the tip is totally coated in solder, wipe the tip off on the wet sponge to remove all the flux residue. Do this immediately so there is no time for the flux to dry out and solidify.

Step 5: You're Done!

You have just tinned your soldering tip. This must be done anytime you replace the tip or clean it so that the iron maintains good heat transfer.

Soldering a Printed Circuit Board (PCB)

Soldering a PCB is probably the most common soldering task an electronics hobbyist will perform. The basic techniques are fairly easy to grasp but it is a skill that will take a little practice to master. The best way to practice is to buy a simple electronics kit or assemble a simple circuit (such as an **LED chaser**) on a perf-board. Don't buy that expensive kit or dive into a huge project after only soldering a few joints.

Soldering components onto a PCB involves preparing the surface, placing the components, and then soldering the joint.

Step 1: Surface Preparation:

A clean surface is very important if you want a strong, low resistance solder joint. All surfaces to be soldered should be cleaned well. **3M Scotch Brite pads** purchased from the home improvement, industrial supply store or automotive body shop are a good choice as they will quickly remove surface tarnish but will not abrade the PCB material. Note that you will want *industrial* pads and not the kitchen cleaning pads impregnated with cleaner/soap. If you have particularly tough deposits on your board, then a fine grade of steel wool is acceptable but be very cautious on boards with tight tolerances as the fine steel shavings can lodge between pads and in holes.

Once you have cleaned the board down to shiny copper you can use a solvent such as acetone to clean any bits of the cleaning pad that may remain and to remove chemical contamination from the surface of the board. Methyl hydrate is another good solvent and a bit less stinky then acetone. Be aware that both these solvents can remove ink, so if your board is silk screened, test the chemicals first before hosing down the entire board.

A few blasts with compressed air will dry out the board and remove any junk that may have built up in the holes.

Step 2: Component Placement

After the component and board have been cleaned, you are ready to place the components onto the board. Unless your circuit is simple and only contains a few components, you will probably not be placing all the components onto the board and soldering them at once. Most likely you will be soldering a few components at a time before turning the board over and placing more. In general it is best to start with the smallest and flattest components (resistors, ICs, signal diodes, etc.) and then work up to the larger components (capacitors, power transistors, transformers) after the small parts are done. This keeps the board relatively flat, making it more stable during soldering. It is also best to save sensitive components (MOSFETs, non-socketed ICs) until the end to lessen the chance of damaging them during assembly of the rest of the circuit.

Bend the leads as necessary and insert the component through the proper holes on the board. To hold the part in place while you are soldering, you may want to bend the leads on the bottom of the board at a 45 degree angle. This works well for parts with long leads such as resistors. Components with short leads such as IC sockets can be held in place with a little masking tape or you can bend the leads down to clamp onto the PC board pads.

In the image below, a resistor is ready to solder and is held in place by slightly bent leads.

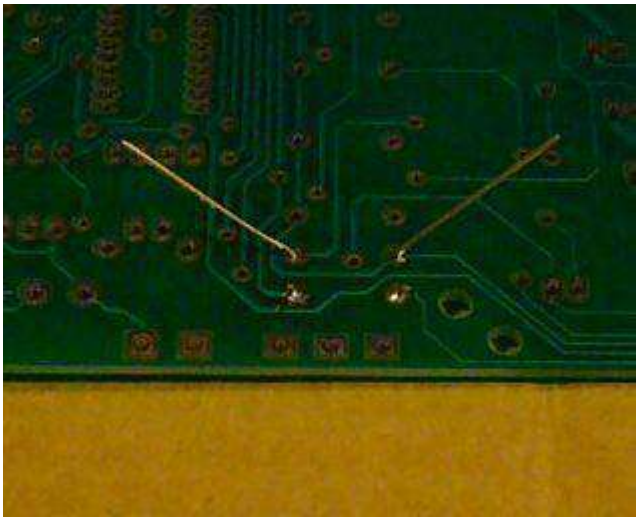

Step 3: Apply Heat

Apply a very small amount of solder to the tip of the iron. This helps conduct the heat to the component and board, but it is **not** the solder that will make up the joint. To heat the joint you will lay the tip of the iron so that it rests against both the *component lead* and the *board*. It is critical that you heat the lead and the board, otherwise the solder will simply pool and refuse to stick to the unheated item. The small amount of solder you applied to the tip before heating the joint will help make contact between the board and the lead. It normally takes a second or two to get the joint hot enough to solder, but larger components and thicker pads/traces will absorb more heat and can increase this time.

If you see the area under the pad starting to bubble, **stop** heating and remove the soldering iron because you are overheating the pad and it is in danger of lifting. Let it cool, then carefully heat it again for much less time.

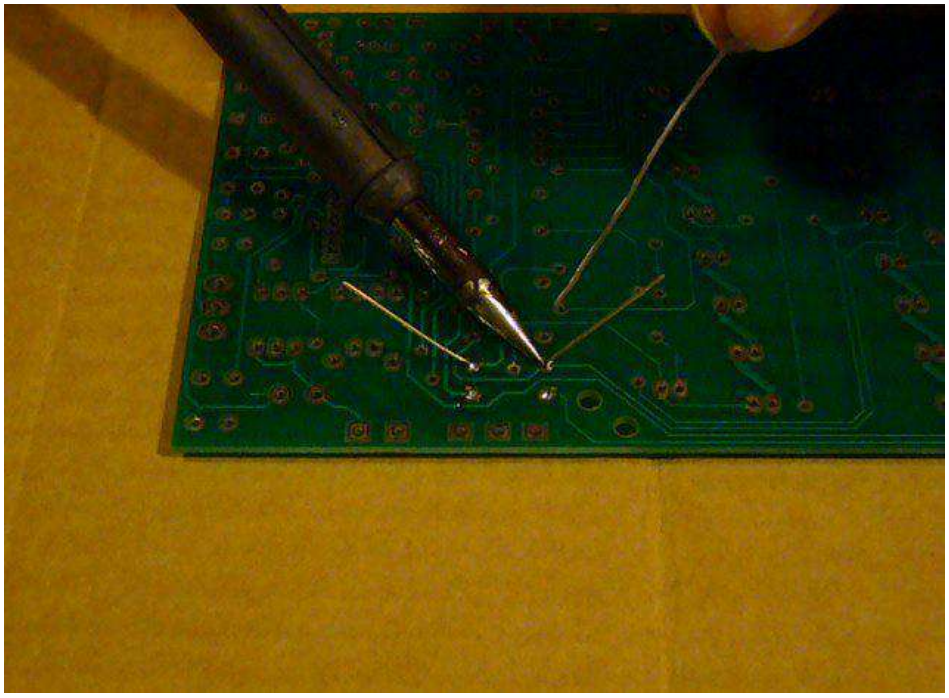

Step 4: Apply Solder to the Joint

Once the component lead and solder pad has heated up, you are ready to apply solder. Touch the tip of the strand of solder to the component lead and solder pad, but **not** the tip of the iron. If everything is hot enough, the solder should flow freely around the lead and pad. You will see the flux melt liquefy as well, bubble around the joint (this is part of its cleaning action), flow out and release smoke. Continue to add solder to the joint until the pad is completely coated and the solder forms a small mound with slightly concave sides. If it starts to ball up, you have used too much solder or the pad on the board is not hot enough.

Once the surface of the pad is completely coated, you can stop adding solder and remove the soldering iron (in that order). Don't move the joint for a few seconds as the solder needs time to cool and solidify. If you do move the joint, you will get what's called a "cold joint". This is recognized by it's characteristic dull and grainy appearance. Many cold joints can be fixed by reheating and applying a small amount of solder, then being allowed to cool without being disturbed.

Step 5: Inspect the Joint and Cleanup

Once the joint is made you should inspect it. Check for cold joints (described a little above and at length below), shorts with adjacent pads or poor flow. If the joint checks out, move on to the next. To trim the lead, use a small set of side cutters and cut at the top of the solder joint.

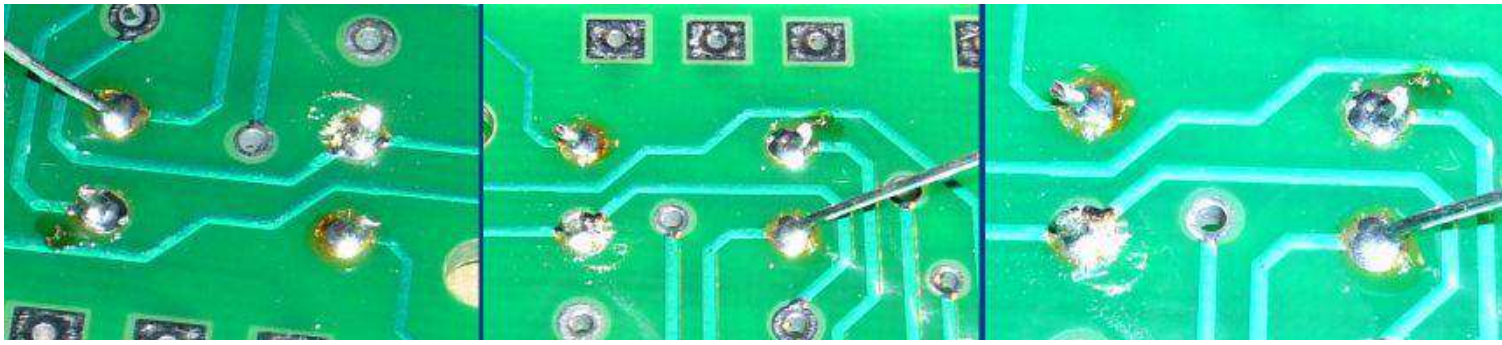

After you have made all the solder joints, it is good practice to clean all the excess flux residue from the board. Some fluxes are hydroscopic (they absorb water) and can slowly absorb enough water to become slightly conductive. This can be a significant issue in a hostile environment such as an automotive application. Most fluxes will clean up easily using methyl hydrate and a rag but some will require a stronger solvent. Use the appropriate solvent to remove the flux, then blow the board dry with compressed air.

Cold Solder Joints

A "cold solder joint" can occur when not enough heat is applied to the component, board, or both. Another common cause is a component moving before the solder has completely cooled and solidified. A cold joint is brittle and prone to physical failure. It is also generally a very high resistance connection which can affect the operation of the circuit or cause it to fail completely.

Cold joints can often be recognized by a characteristic grainy, dull gray color, but this is not always the case. A cold joint can often appear as a ball of solder sitting on the pad and surrounding the component lead. Additionally you may notice cracks in the solder and the joint may even move. Below is the shocking image of every example of a bad solder joint you will ever see. It appears that this **FM transmitter kit** was assembled using the technique of "apply solder to iron then drip onto joint". If your joints are looking like this, then **stop** and practice after rereading this page. Note that not a single of of these joints is acceptable, but amazingly, the circuit worked.

Most cold solder joints can be easily fixed. Generally all that is required is to reheat the joint and apply a little more solder. If there is already too much solder on the joint, then the joint will have to be **desoldered** and then soldered again. This is done by first removing the old solder with a desoldering tool or simply by heating it up and flicking it off with the iron. Once the old solder is off, you can resolder the joint, making sure to heat it thoroughly and keep it still as it cools.

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HOW TO SOLDER - THE QUICK, THOROUGH GUIDE

Technology (/technology/) > Soldering | by IoTalabs (/member/IoTalabs/) Follow

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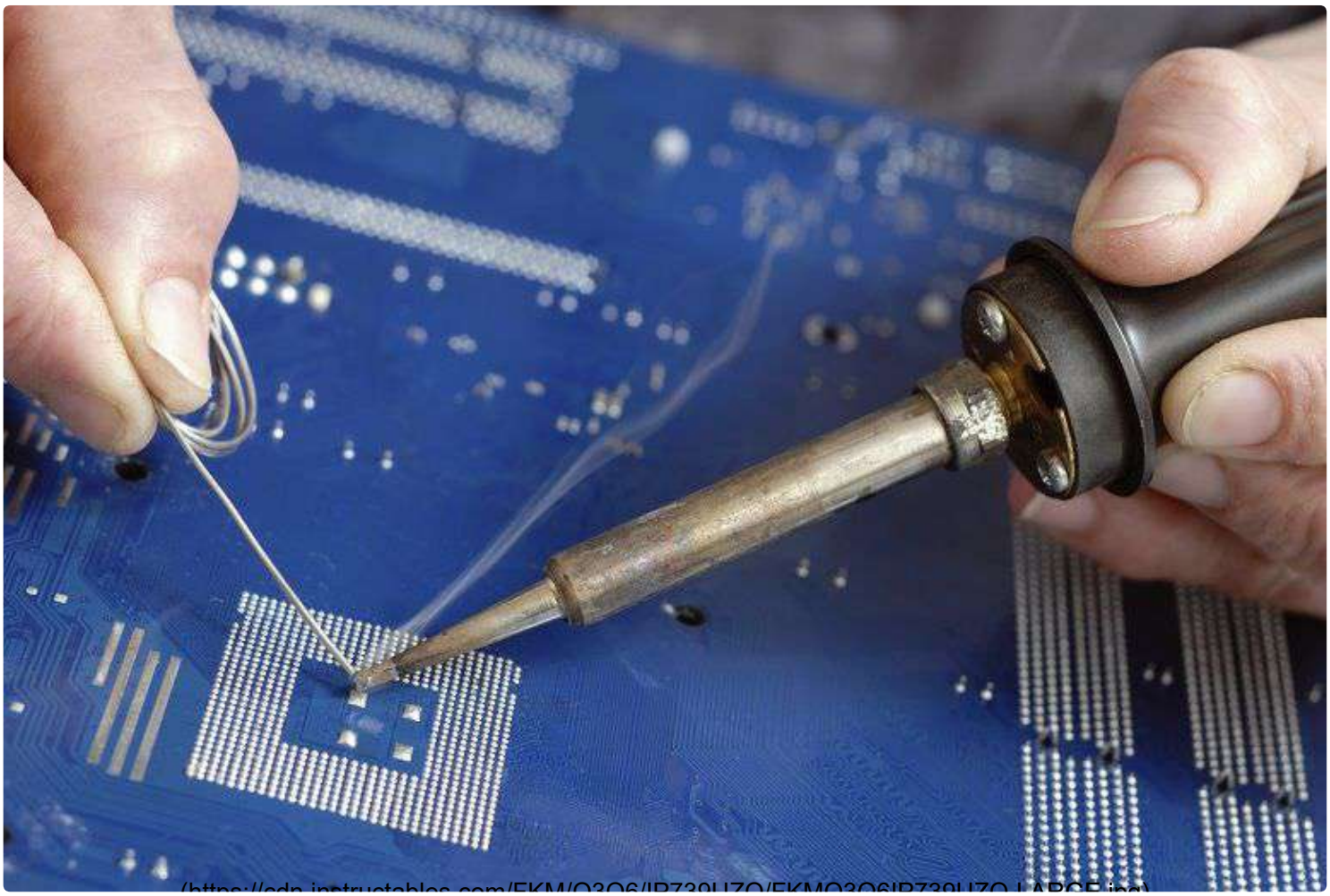

We are IoTalabs and we are a group of Internet of Things enthusiasts that love hacking together different devices. Over the past few months we have immersed ourself in the wonderful world of hardware! In our journey, we learned the best soldering practices around.

We've been working on many projects (check out our current project http://doteverything.co/) and we wanted to share our experience on safely and correctly soldering connections!

Add Tip Ask Question

Step 1: What Is Soldering?

Soldering accomplishes a strong bond between two pieces of metal by joining them together. In this procedure, a material called solder, an alloy mixture of tin and lead, flows over two pre-heated pieces of metal and holds them together. The process is similar to welding but differs because when you weld you are fusing and melting two pieces together to make one. When you solder you are essentially ‘gluing’ two parts together with molten metal. Most metals with the exception of aluminum, white metal and porous cast iron can be soldered. Below, you will find instructions and illustrations that show you how to use a soldering iron.

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Step 2: Materials for Soldering

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Soldering Iron

Modeler’s Vise or Frame (optional)

Solder

Damp Sponge

Flux to remove oxides

Add Tip | Ask Question

Step 3: Prepare Your Workspace

Make sure your table or bench top is clear and free of obstructions. You will want as much freedom as possible to move your hand around and make adjustments.

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Step 4: Turn on the Soldering Iron

The soldering iron needs to be warmed up properly before it can be used to ensure clean application of the solder. Some soldering irons heat up in seconds while others take minutes. Turn it on and leave it in the stand for 2-3 minutes to be safe.

Add Tip Ask Question

Step 5: (Optional) Secure the Items You Are Soldering

Because we only have two hands, it would be nice to stabilize the item we want to solder. This is where a vice or clamp that can hold your item sturdily would come in handy. This is not required, but can greatly increase the ease and quality of your solder joints.

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Step 6: Cleaning the Soldering Iron

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Because soldering irons get so hot, they oxidize and become dirty quickly. They key to reliable connections is clean components so make sure that your soldering tip and parts you are joining are clean. To accomplish this, pass the tip of your soldering iron on a wet sponge until it shines.

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Step 7: Apply Flux

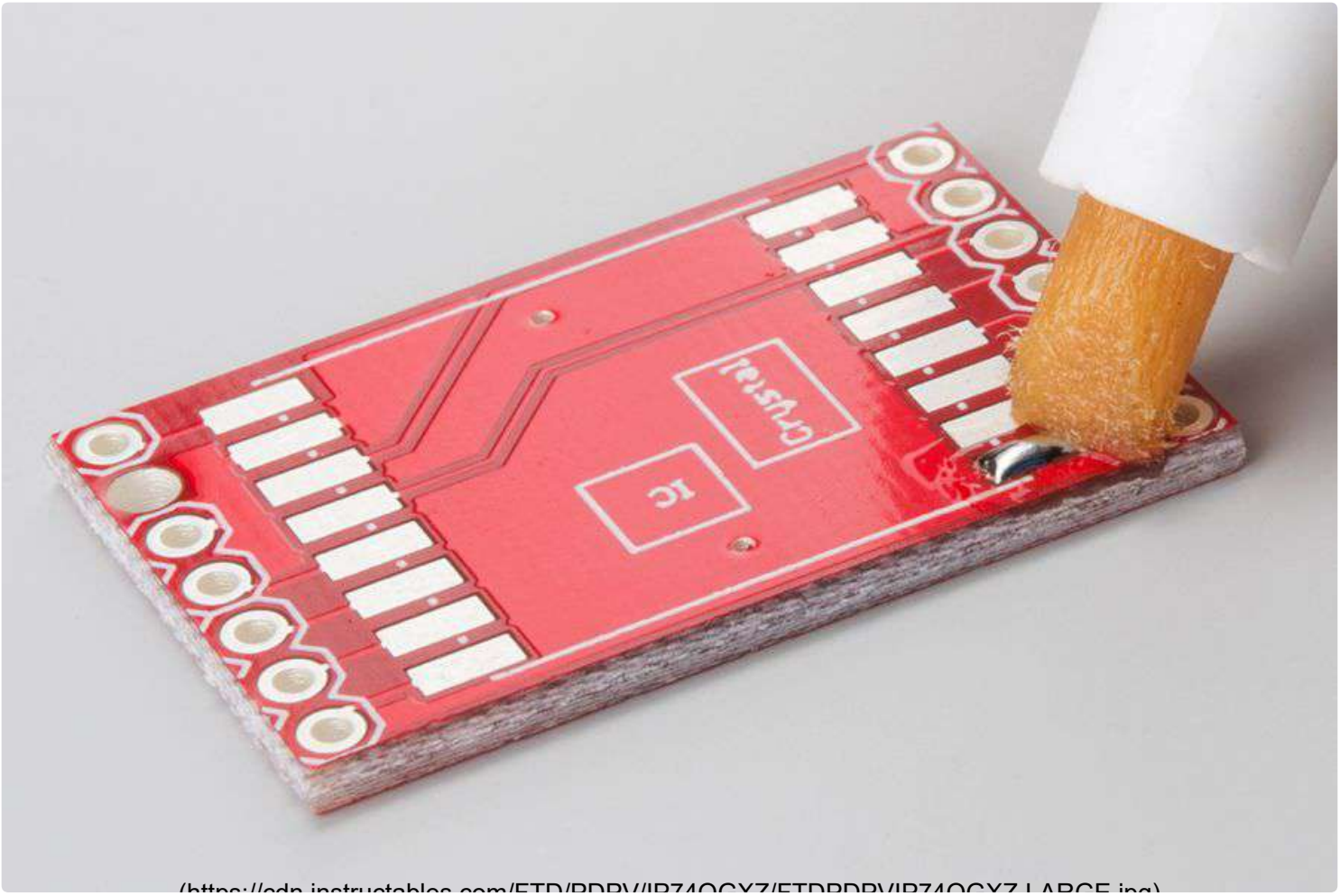

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In soldering it often becomes necessary to use materials called fluxes to help remove oxides and keep them absent while you solder. Flux needs to melt at a temperature lower than solder so that it can do its job prior to the soldering action. There are different methods to apply flux. The method you choose will be dependent on the items you are soldering.

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Step 8: Tin the Soldering Iron

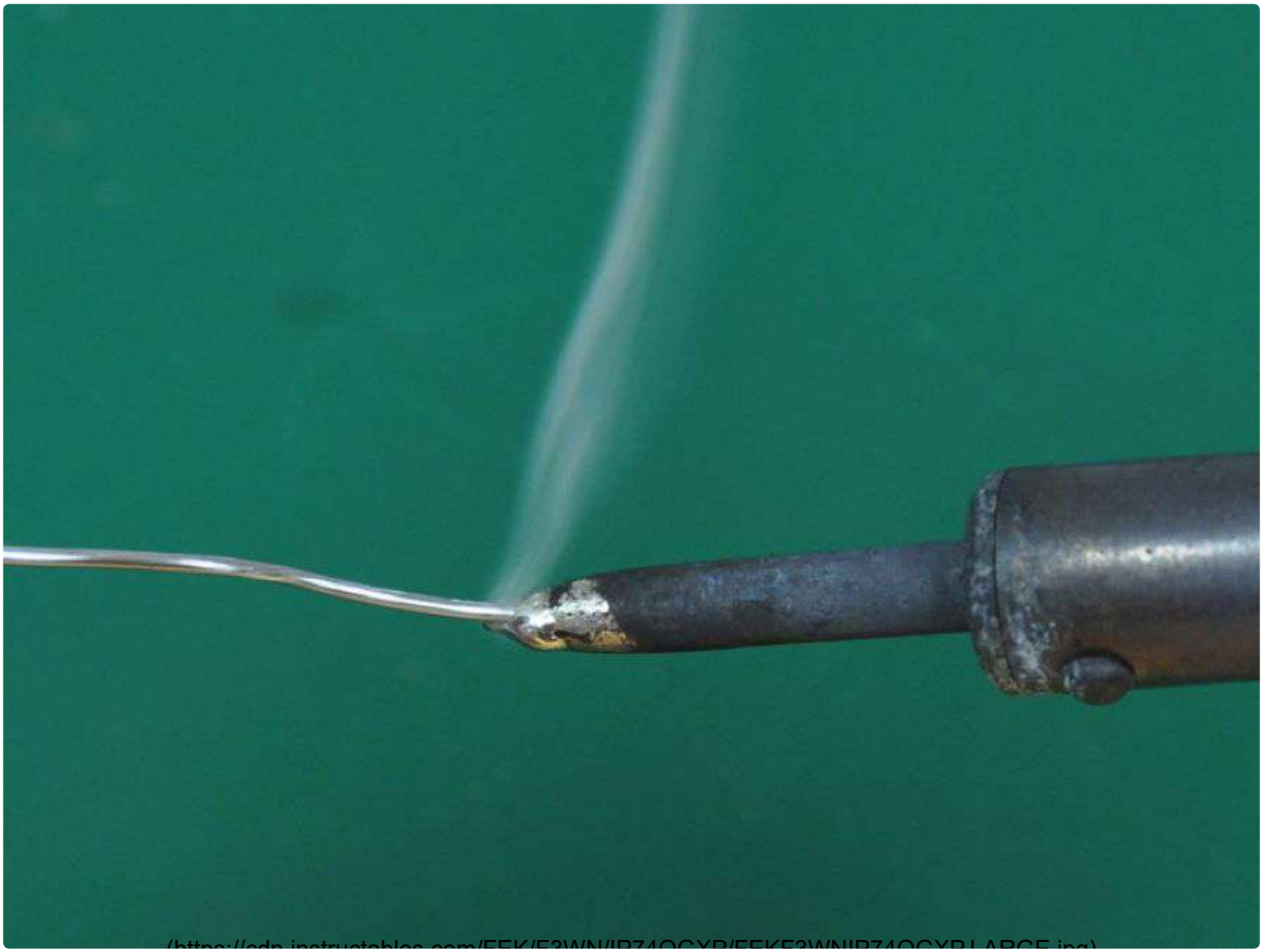

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If you want to know everything there is to know about how to use a soldering iron, you'll need to know how to tin. Tinning is the process of coating a soldering tip with a thin coat of solder. Melt a thin layer of solder on your iron's tip. This aids in heat transfer between the tip and the component you are soldering, and also gives the solder a base from which to flow from. This process may need to be repeated as you solder. You will only touch the tip of the soldering iron to the solder when you tin. Do not touch the tip of the iron to the solder while you are actually soldering.

Add Tip | Ask Question

Step 9: Start Soldering

Hold the soldering iron like you would a pen in the hand you write with and the solder in the other. Then place the tip of the soldering iron. The tip needs to touch both the wire lead and the surface so they achieve the same temperature.

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Step 10: Feeding the Solder

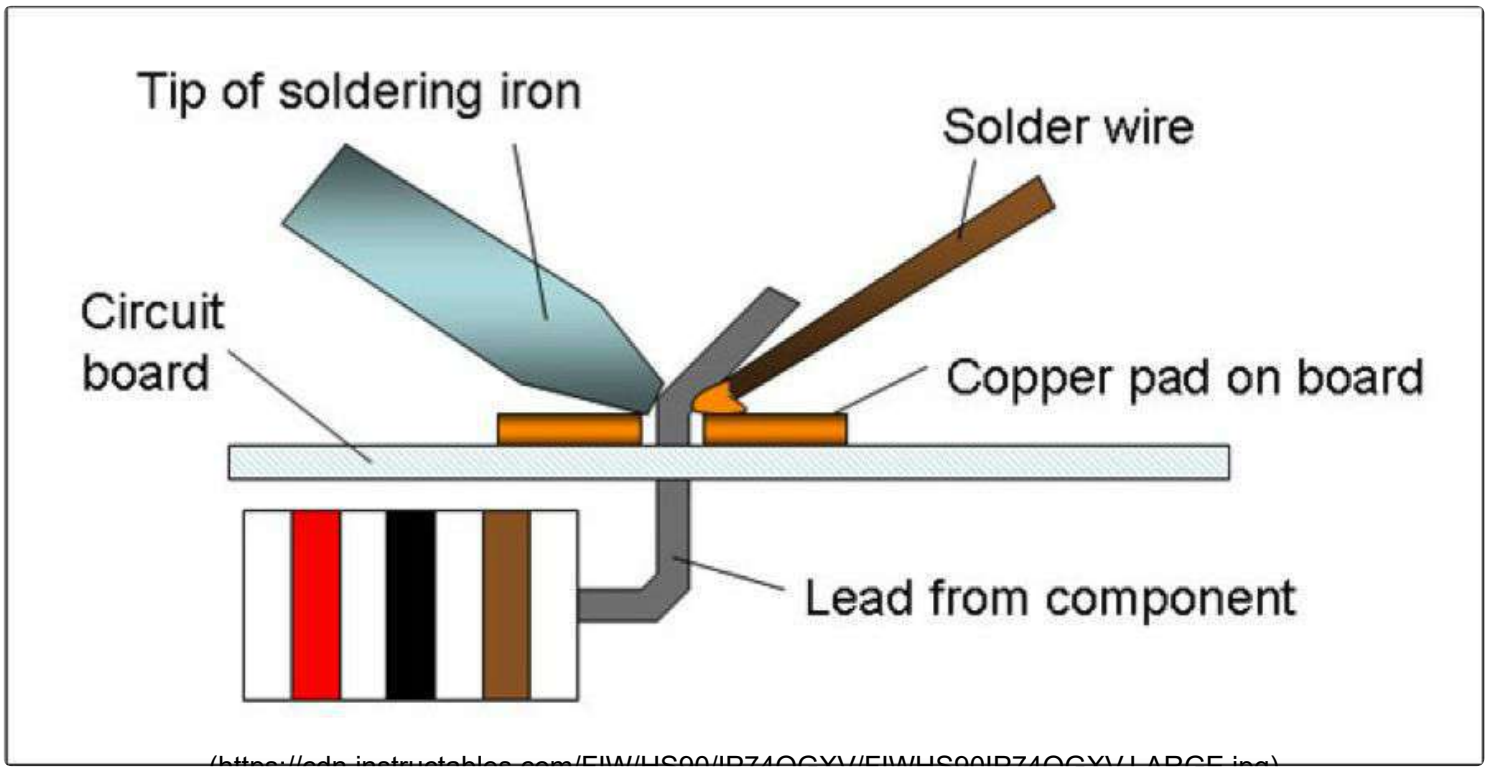

Touch the solder to the side of the connection opposite the soldering iron after heating the area for 2-3 seconds. Then, let the solder flow only until the connection is covered.

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Step 11: Removing the Solder

Remove the solder first, then the iron otherwise your solder will get stuck to your connection point without the appropriate heat. Make sure the joint remains stationary while it cools.

Add Tip Ask Question

Step 12: Check to See If the Connection Is Solid

A smooth, shiny and volcano shaped joint is what you are looking for. If this isn't what you see, you'll need to reheat and feed in more solder.

Add Tip Ask Question

Step 13: Warnings

- DO NOT lay a soldering iron down on any surface. A soldering iron should either be placed on a stand or sealed with a heat resistant cap after every use.
- Soldering should be completed in a well ventilated area.
- Lead is present in most solders. Be sure to wash your hands after your project, or better yet wear gloves.
- Try not to inhale any of the solder smoke that comes off the solder. This is lead and can be dangerous.
- The tip of a soldering iron is very hot. Contact with the tip of a soldering iron would result in a nasty burn.
- Your soldering iron will perform better if kept clean. A damp sponge can be used to clean residue caused by flux material. A very small skim of flux should be applied to the iron after the cleaning.

THE BASICS OF HOW TO SOLDER

Soldering Tutorial for Beginners: Five Easy Steps

Table of Contents:

- Before you begin
- Step 1: Heat your iron to the appropriate temperature
- Step 2: Make your connection mechanically stable
- Step 3: Clean the tip of your iron
- Step 4: Apply heat and solder
- Step 5: Inspect the joint
- Common mistakes

Before you begin

You will need the following equipment:

A temperature-controlled soldering iron of 25W or more
A tip cleaner such as a brass sponge or a wet sponge

Solder (leaded is easier to work with than lead-free)
(Optional) Helping hands
Safety glasses

Note: molten solder is extremely hot! Irons heat up to around twice the boiling point of water, so be extremely careful. Wear safety glasses when soldering.

Step 1: Heat your iron to the appropriate temperature

For through-hole components in a circuit board, you will want 600-700 degrees fahrenheit.

If you're soldering a larger connections, with more copper that's dissipating heat, then you may want a slightly higher temperature. With a temperature-adjustable iron you can see what works and adjust accordingly.

Step 2: Make your connection mechanically stable

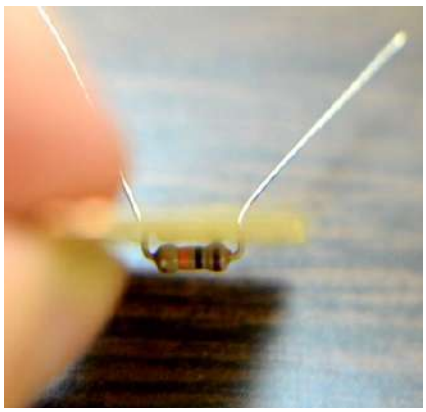

While your iron is heating up, you can work on making your components stay in place without your help. This is where your helping hands may come in handy. Use them to help you arrange your components to be stable without you needing to hold anything. If you're soldering a through-hole component in a circuit board, you can bend the leads of the component into a V-shape so that it stays in place flush against the board. For components without long leads, you can use a piece of tape to hold them in place.

Step 3: Clean the tip of your iron

You can check whether your iron is close to its final temperature by touching your solder to the end of the iron and seeing if it melts. When you do this, you'll see some smoke come out. This is not the metal vaporizing, but rather the flux inside of it is burning. Flux is a mild acid that eats away at the oxidation layer that forms on the surface of hot metals. Without flux in the solder to clean your surfaces, you would have a very hard time getting the solder to wet.

Clean your iron using a brass sponge or a wet sponge to remove any oxidation or excess solder from the tip. Remember to always keep your tip clean while you're soldering. A dirty tip is covered in metal oxides that transfer heat badly and can result in poorly soldered joints.

mouser

Step 4: Apply heat and solder

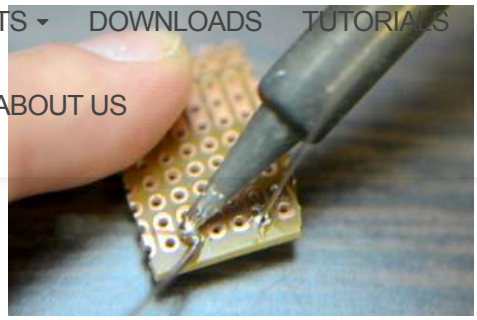

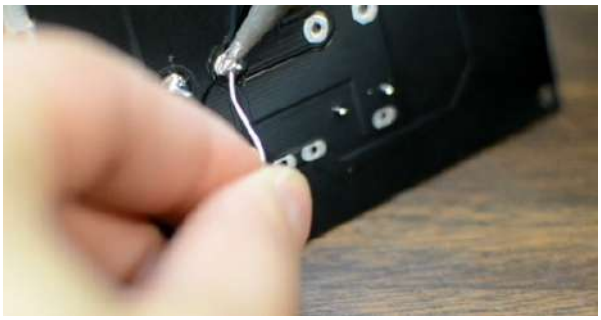

Touch the flat part of your iron's tip to one side of the joint, while feeding solder from the other side of the joint. The idea is to heat up the entire joint to the melting temperature of solder, so when you touch the solder to the surfaces it melts right on. The only way you can ensure a good electrical connection is by letting the solder flow over the components you're joining. Don't apply the solder directly to the tip of the iron. For through-hole components, hold the iron against both the lead and the pad.

Small joints can heat up within a few seconds, but larger joints can take a minute or two. Keep the joint steady for a few seconds after removing the iron, as the solder needs time to cool. Remember that the joint is hot now! don't touch it with your fingers right away.

Step 5: Inspect the joint

The solder should have wetted to both surfaces. On pads of a printed circuit board, the solder should be covering the entire pad, and it should make a volcano shape between the pad and the lead, indicating good adhesion. Once the joint is perfect, clip the leads of through-hole components.

Common mistakes, or what NOT to do

Now that we've gone over what to do, let me tell you what NOT to do.

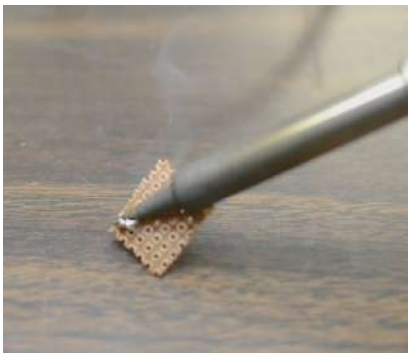

Don't put a blob of solder on the iron and then try to transfer it to your joint. This burns away all of the flux in the solder, which prevents the flux from cleaning the metal surfaces. Furthermore, it's easy to transfer the solder blob away from the iron without actually making it wet to the joint. I guarantee you that this will result in an awful electrical connection, so don't do it.

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How To Solder: A Beginner's Guide

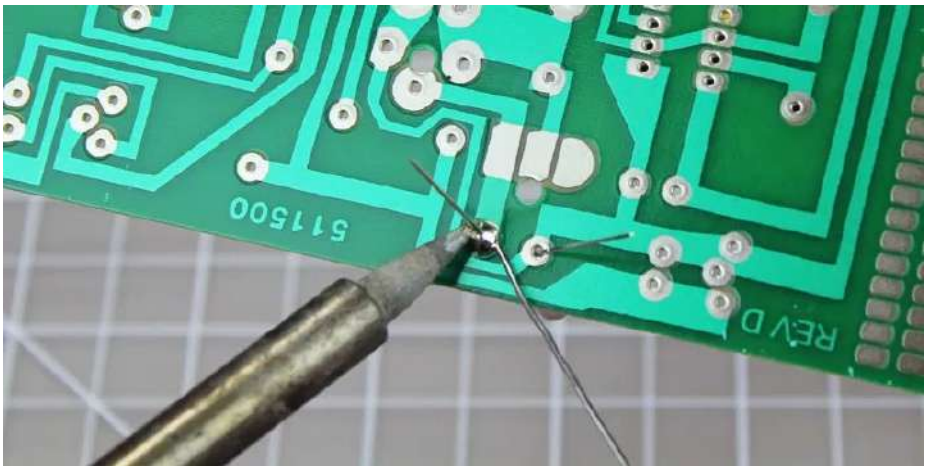

Learning how to solder w/ proper soldering techniques is a fundamental skill every maker should master. In this tutorial, we outline the basics of soldering irons, soldering stations, types of solder, desoldering and safety tips. Whether you're building a robot or working with Arduino, knowing how to solder will come in handy.

FREE EBOOK (PDF) – Learn To Solder Guide (17 pages)

What Is Soldering?

If you were to take apart any electronic device that contains a circuit board, you'll see the components are attached using soldering techniques. Soldering is the process of joining two or more electronic parts together by melting solder around the connection. Solder is a

using a desoldering tool as described below.

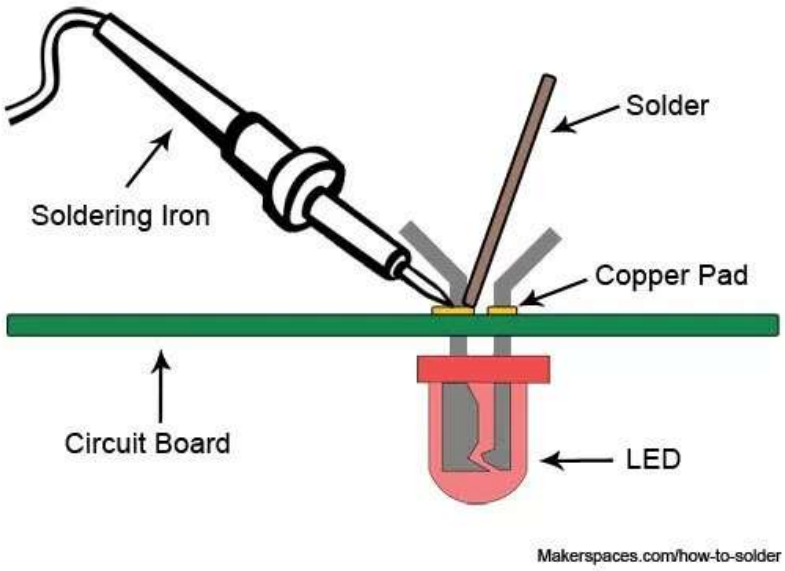

Soldering Tools

The good thing about learning how to solder is the fact that you don't need a lot to get started. Below we'll outline the basic tools and materials you will need for most of your soldering projects.

Soldering Iron

A soldering iron is a hand tool that plugs into a standard 120v AC outlet and heats up in order to melt solder around electrical connections. This is one of the most important tools used in soldering and it can come in a few variations such as pen or gun form. For beginners, it's recommended that you use the pen style soldering iron in

type of soldering iron because it can heat up to 896′ F which is extremely hot.

Soldering Station

A soldering station is a more advanced version of the basic standalone soldering pen. If you are going to be doing a lot of soldering, these are great to have as they offer more flexibility and control. The main benefit of a soldering station is the ability to precisely adjust the temperature of the soldering iron which is great for a range of projects. These stations can also create a safer workspace as some include advanced temperature sensors, alert settings and even password protection for safety.

Soldering Iron Tips

At the end of most soldering irons is an interchangeable part known as a soldering tip. There are many variations of this tip and they come in a wide variety of shapes and sizes. Each tip is used for a specific purpose and offers a distinct advantage over another. The most common tips you will use in electronics projects are the conical tip and the chisel tip.

Conical Tip – Used in precision electronics soldering because of the fine tip. Because of its pointed end, it's able to deliver heat to smaller areas without affecting its surroundings.

Chisel Tip – This tip is well-suited to soldering wires or other larger components because of its broad flat tip.

Image Credit – Sparkfun.com

Brass or Conventional Sponge

it did when it was new. You could use a conventional wet sponge but this tends to shorten the lifespan of the tip due to expansion and contraction. Also, a wet sponge will drop the temperature of the tip temporarily when wiped. A better alternative is to use a brass sponge as shown on the left.

Soldering Iron Stand

A soldering iron stand is very basic but very useful and handy to have. This stand helps prevent the hot iron tip from coming in contact with flammable materials or causing accidental injury to your hand. Most soldering stations come with this built in and also include a sponge or brass sponge for cleaning the tip.

Solder

Solder is a metal alloy material that is melted to create a permanent bond between electrical parts. It comes in both lead and lead-free variations with diameters of .032″ and .062″ being the most common. Inside the solder core is a material known as flux which helps improve electrical contact and its mechanical strength.

For electronics soldering, the most commonly used type is lead-free rosin core solder. This type of solder is usually made up of a Tin/Copper alloy. You can also use leaded 60/40 (60% tin, 40% lead) rosin core solder but it's becoming less popular due to health concerns. If you do use lead solder, make sure you have proper ventilation and that you wash your hands after use.

When buying solder, make sure NOT to use acid core solder as this will damage your circuits and components. Acid core solder is sold at home improvement stores and is mainly used for plumbing and metal working.

As mentioned earlier, solder does come in a few different diameters. The thicker diameter solder (.062″) is good for soldering larger joints more quickly but it can make soldering smaller joints difficult. For this reason, it's always a good idea to have both sizes on hand for your different projects.

Helping Hand (Third Hand)

A helping hand is a device that has 2 or more alligator clips and sometimes a magnifying glass/light attached. This clips will assist you by holding the items you are trying to solder while you use the soldering iron and solder. A very helpful tool to have in your makerspace.

Soldering Safety

Now that you know what tools and materials are required, it's time to briefly discuss ways of staying safe while soldering.

Soldering irons can reach temperatures of 800′ F so it's very important to know where your iron is at all times. We always recommend you use a soldering iron stand to help prevent accidental burns or damage.

Make sure you are soldering in a well ventilated area. When solder is heated, there are fumes released that are harmful to your eyes and lungs. It's recommended to use a fume extractor which is a fan with a charcoal filter that absorbs the harmful solder smoke.

It's always a good idea to wear protective eye wear in case of accidental splashes of hot solder. Lastly, make sure to wash your hands when done soldering especially if using lead solder.

Tinning The Tip

Before you can start soldering, you need to prep your soldering iron by tinning the tip with solder. This process will help improve the heat transfer from the iron to the item you're soldering. Tinning will also help to protect the tip and reduce wear.

Step 1: Begin by making sure the tip is attached to the iron and screwed tightly in place.

Step 3: Wipe the tip of the soldering iron on a damp wet sponge to clean it. Wait a few seconds to let the tip heat up again before proceeding to step 4.

Step 4: Hold the soldering iron in one hand and solder in the other. Touch the solder to the tip of the iron and make sure the solder flows evenly around the tip.

You should tin the tip of your iron before and after each soldering session to extend its life. Eventually, every tip will wear out and will need replacing when it becomes rough or pitted.

How To Solder

To better explain how to solder, we're going to demonstrate it with a real world application. In this example, we're going to solder an LED to a circuit board.

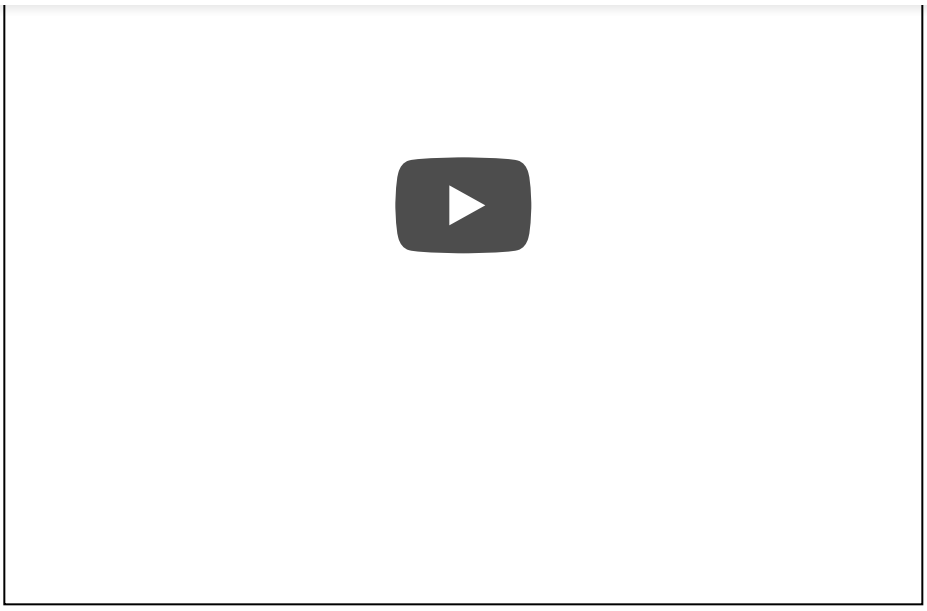

Step 1: Mount The Component – Begin by inserting the leads of the LED into the holes of the circuit board. Flip the board over and bend the leads outward at a 45′ angle. This will help the component make a better connection with the copper pad and prevent it from falling out while soldering.

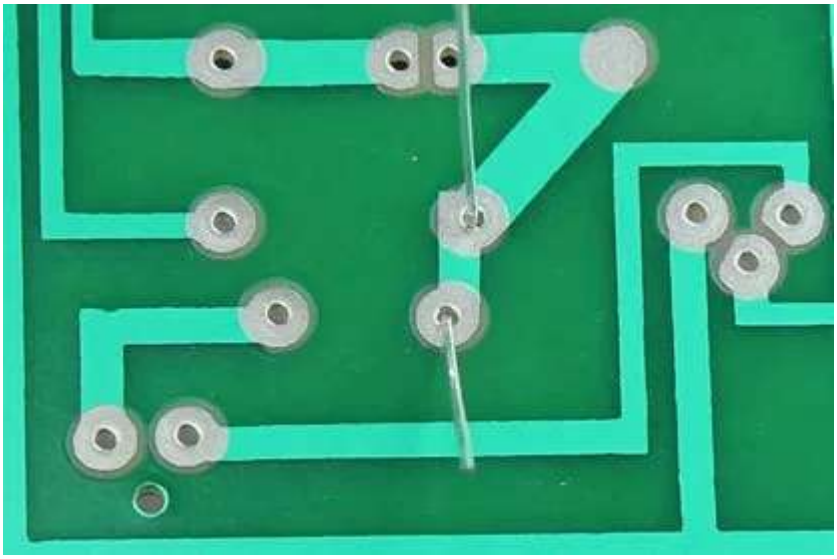

resistor lead at the same time. You need to hold the soldering iron in place for 3-4 seconds in order to heat the pad and the lead.

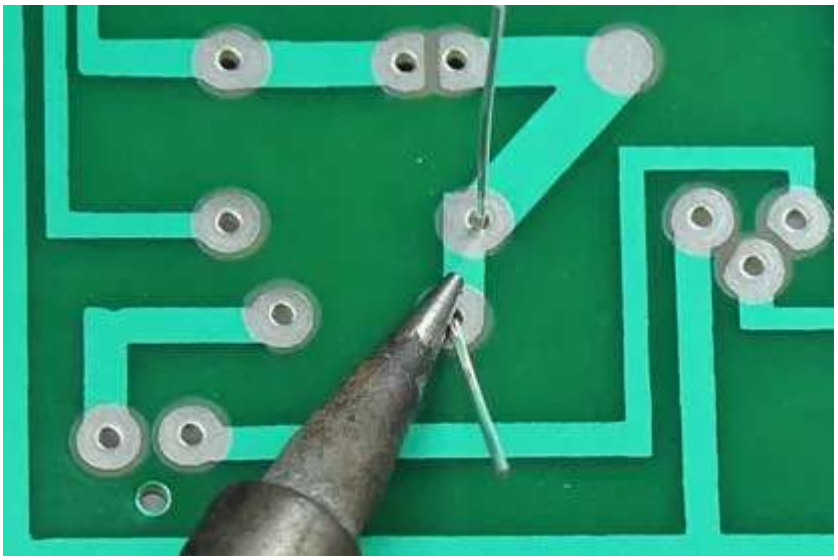

Step 3: Apply Solder To Joint – Continue holding the soldering iron on the copper pad and the lead and touch your solder to the joint. **IMPORTANT** – Don't touch the solder directly to the tip of the iron. You want the joint to be hot enough to melt the solder when it's touched. If the joint is too cold, it will form a bad connection.

Step 4: Snip The Leads – Remove the soldering iron and let the solder cool down naturally. Don't blow on the solder as this will cause a bad joint. Once cool, you can snip the extra wire from leads.

A proper solder joint is smooth, shiny and looks like a volcano or cone shape. You want just enough solder to cover the entire joint but not too much so it becomes a ball or spills to a nearby lead or joint.

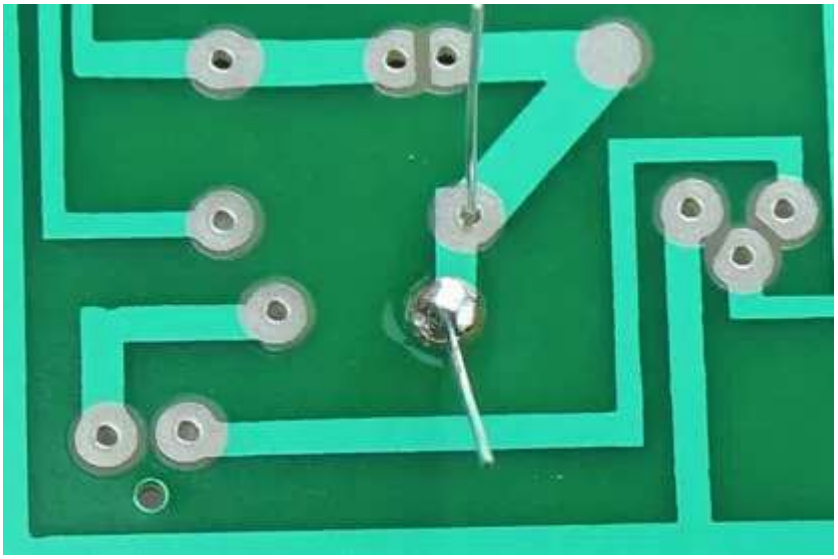

How To Solder Wires

Begin by removing the insulation from the ends of both wires you are soldering together. If the wire is stranded, twist the strands together with your fingers.

Make sure your soldering iron is fully heated and touch the tip to the end of one of the wires. Hold it on the wire for 3-4 seconds.

Keep the iron in place and touch the solder to the wire until it’s fully coated. Repeat this process on the other wire.

Hold the two tinned wires on top of each other and touch the soldering iron to both wires. This process should melt the solder and coat both wires evenly.

Remove the soldering iron and wait a few seconds to let the soldered connection cool and harden. Use heat shrink to cover the connection.

Desoldering

The good thing about using solder is the fact that it can be removed easily in a technique known as desoldering.

To desolder a joint, you will need solder wick which is also known as desoldering braid.

Step 1 – Place a piece of the desoldering braid on top of the joint/solder you want removed.

Step 2 – Heat your soldering iron and touch the tip to the top of the braid. This will heat the solder below which will then be absorbed into the desoldering braid. You can now remove the braid to see the solder has been extracted and removed. Be careful touching the braid when you are heating it because it will get hot.

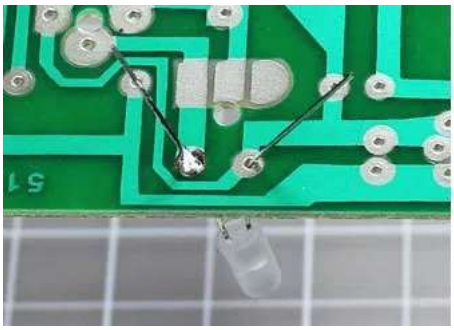

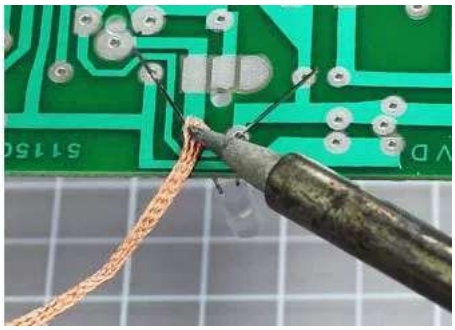

solder with a press of a button.

To use, press the plunger down at the end of the solder sucker. Heat the joint with your soldering iron and place the tip of the solder sucker over the hot solder. Press the release button to suck up the liquid solder. In order to empty the solder sucker, press down on the plunger.

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Adafruit Guide To Excellent Soldering

Created by Bill Earl

Last updated on 2014-06-28 08:30:54 PM EDT

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Tools

Building a Soldering Toolkit

If you are just getting started in Electronics, Ladyada's Electronics Toolkit (http://adafru.it/136) (pictured above) is a great kit full of quality tools - including everything you need to make great solder joints. If you would rather build your toolkit piece-by-piece, read on:

Choosing a Soldering Iron

There are many types of soldering irons. For most Adafruit kits and projects, you will want a pencil-style soldering iron with 25 watts or more.

An under-powered iron is a poor investment. It will end up costing you more in ruined kits and damaged components.

- It will take longer to heat the joint, allowing heat to spread to the component being soldered - potentially overheating and damaging the component.
- Longer heating times will also give more time for oxides to form on the surfaces being soldered. This will prevent the solder from flowing and result in a poor joint.
- Longer recovery times between joints can result in frustration, 'cold joints' or both.

You don't need to spend a fortune to get a good iron. Advanced features such as temperature control and interchangeable tips are nice to have, but not essential for hobbiest-level work.

Basic Irons

There are many basic pencil style irons that are suitable for hobbiest use. But you will need one that is capable of heating the joints quickly enough. Choose an iron with 25 watts at a minimum.

Better Irons

An adjustable temperature iron with a little more power will give you a bit more control and allow you to work faster. The Adjustable 30W 110v Soldering Iron (http://adafru.it/180) in the store is an excellent choice.

This iron is also available as part of Ladyada's Electronics Toolkit (http://adafru.it/136), which contains many other essential soldering tools.

Best Irons

A professional-style temperature-controlled iron with interchangeable tips and 50 watts or more of power is a joy to work with. Feedback control keeps the tip temperature at precisely the level you set. The extra watts speed recovery time so that you can work faster. Interchangeable tips let you select the ideal tip shape for specialized work.

The 65 watt Hakko FX-888 (http://adafru.it/303) is an excellent professional quality soldering iron. The Weller WES51 or WESD51 are also excellent choices for serious electronics work.

Irons to avoid

In addition to underpowered irons, there are several types of irons to avoid for general circuit-board work.

For emergencies only:

These irons are handy for occasions when you have no place to plug in a regular soldering iron. But they are not the best choice for a primary soldering tool:

- **Butane Powered Irons** have plenty of power but are difficult to control.
- **Battery Powered Irons** are generally underpowered for most work.

Not for circuit board use:

These tools are not suitable for circuit board work:

- **Torches** of any kind are not suitable for electronics work and will damage your circuit boards.
- **Soldering Guns** are OK for working with heavy gauge wires, but don't have the precision necessary for soldering delicate electronics components.
- ***Cold-Heat™*** Irons inject current into the joint to heat the tip. This current can be damaging to sensitive electonic components. Avoid these irons for electronics work.

Essential Tools and Supplies:

These tools are the bare-minimum essentials required for soldering:

Stand

If your soldering iron does not have a built-in stand, you will need a safe place to rest the hot iron between uses. A Soldering Iron Stand (http://adafru.it/150) will keep your iron from rolling around and protect both you and your work surface from burns.

Most stand holders come with a sponge and tray for cleaning your soldering iron.

Solder

Standard 60/40 lead/tin Rosin Core Solder (http://adafru.it/145) is the easiest type to work with.

Diagonal Cutters

You will also need a pair of Diagonal Cutters (http://adafru.it/152) for trimming component leads after soldering.

Other Handy Tools and Supplies

These are some other tools and supplies you might find useful when working on soldering projects.

Vise

A vise holds your work steady as you solder. This is important for both safety and sound joints. The Panavise Jr (http://adafru.it/151) is an ideal size for most Adafruit kits and projects.

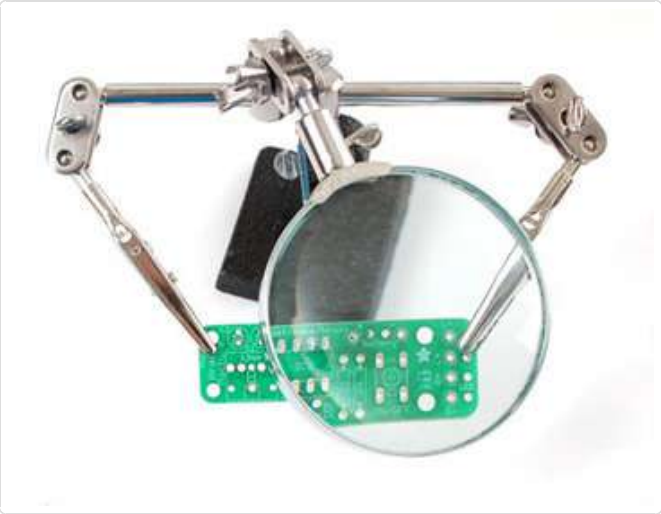

Third Hand

A Helping Third Hand (http://adafru.it/291) Tool is a good for smaller boards, or to hold things in place while terminating or splicing wires.

Solder Sucker

A Solder Sucker (http://adafru.it/148) is a very helpful tools for removing excess solder or when you need to de-solder a joint. As the name implies, this device literally sucks the solder out of the joint.

Solder Wick

Solder Wick (http://adafru.it/149) is another way to clean excess solder from a joint. Unlike the solder sucker, the wick soaks up the molten solder.

Preparation

Heat the Iron

Plug an and/or turn on your soldering iron to warm up. If you are using a temperature controlled iron, set it to 700F/370C for 60/40 or 750F/400C for lead-free solder.

While the iron is heating dampen the sponge with a little bit of water.

Clean the Iron

Wipe the tip of the hot iron on the damp sponge to clean off any oxidation.

Do not use files or abrasives to clean the tip. It will damage the plating and ruin the tip.

Tin the Tip

Apply a small amount of solder to the tip and wipe again to tin the tip. You should have a thin, shiny layer of molten solder on the tip of your iron.

If the tip is badly oxidized and difficult to tin, it can usually be reconditioned with some tip-tinning paste.

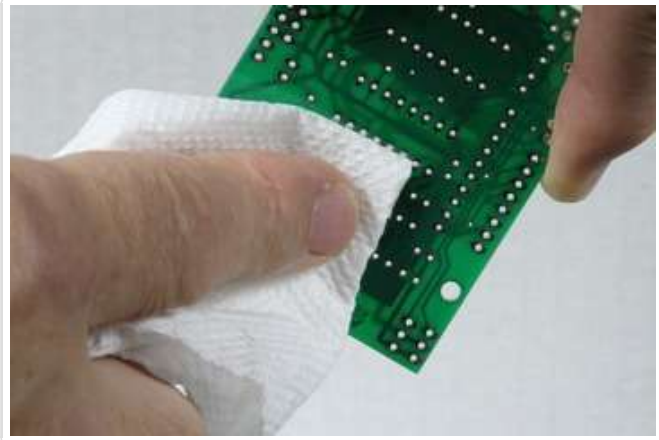

Make sure that the joint is clean

Dirt, oxidation and oily fingerprints can prevent the solder from wetting the solder-pad to create a solid joint. All Adafruit boards are plated to prevent oxidation, but if your board appears dirty from storage or handling, wipe it down with a little isopropyl alcohol.

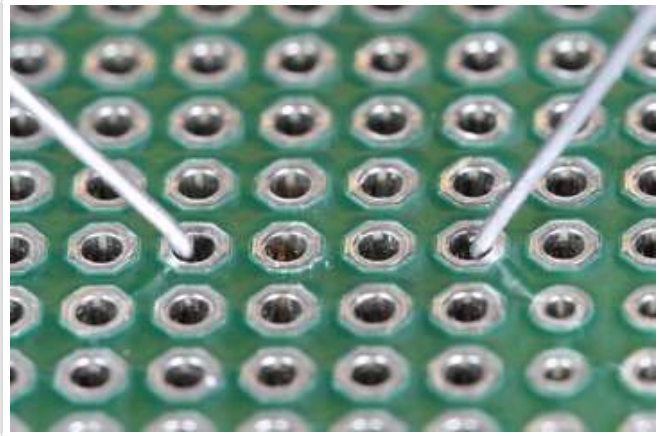

Immobilize the Joint

This is very important! The parts being joined must not move during the soldering process. If there is any movement as the molten solder is solidifying, you will end up with an unreliable 'cold joint'.

Most through-hole components can be immobilized by simply bending the leads on the solder-side of the hole.

Steady the Board

A vise is a good way to keep the board from moving around while you try to solder it.

Once the joint is clean and immobilized, you are ready to apply the solder.

Making a good solder joint

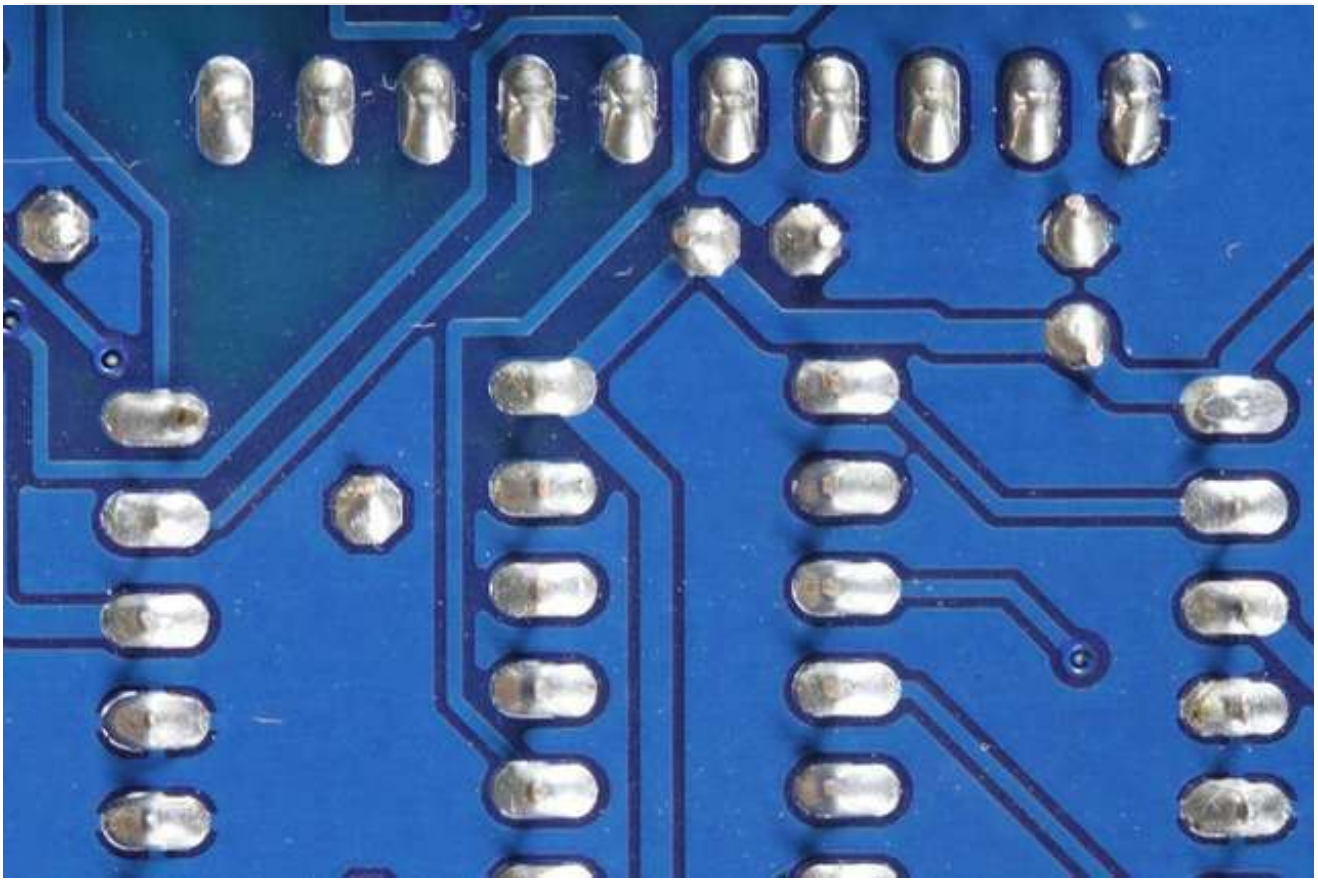

Once you have prepared the your tools and the joint to be soldered, making a good solder joint requires just a few simple steps.

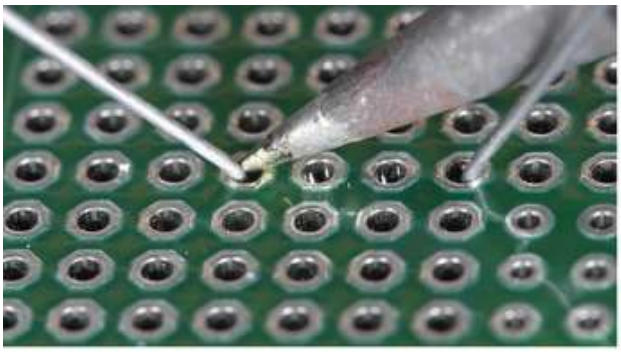

Heat the joint

Heat the joint with the tip of the iron. Be sure to heat both the solder pad and the component lead or pin. A small drop of solder on the tip will help to transfer the heat to the joint quickly.

Apply the solder

Touch the end of the solder to the joint so that it contacts both the solder pad and the component lead or pin. It should melt and flow smoothly onto both the pin and the pad. If the solder does not flow, heat the joint for another second or two and try again.

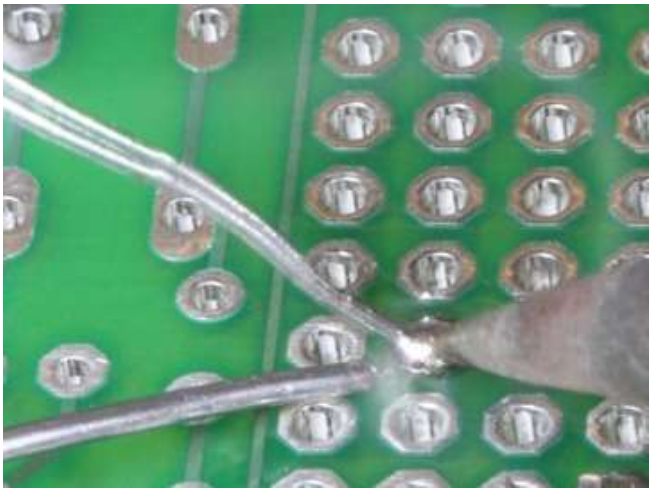

Let It Flow

Keep heating the solder and allow it to flow into the joint. It should fill the hole and flow smoothly onto both the solder pad and the pin or component lead.

Let It Cool

Once enough solder has been added to the joint and it has flowed well onto both the component lead and the solder pad, remove the iron from the joint and allow it to cool undisturbed.

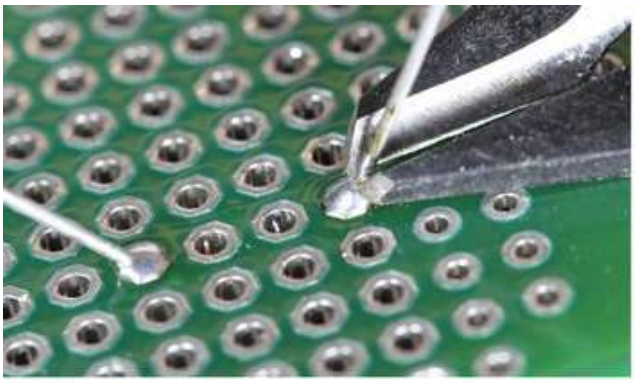

Trim the Lead

Use your diagonal cutters to trim the lead close to the board.

Note: This step applies only to components with wire leads. It is not necessary to trim the pins on Integrated circuit chips or sockets.

Congratulations!

Reward yourself with a Soldering Badge (http://adafru.it/465).

Problems?

The last page of this guide illustrates a number of common soldering problems with advice on prevention and repair.

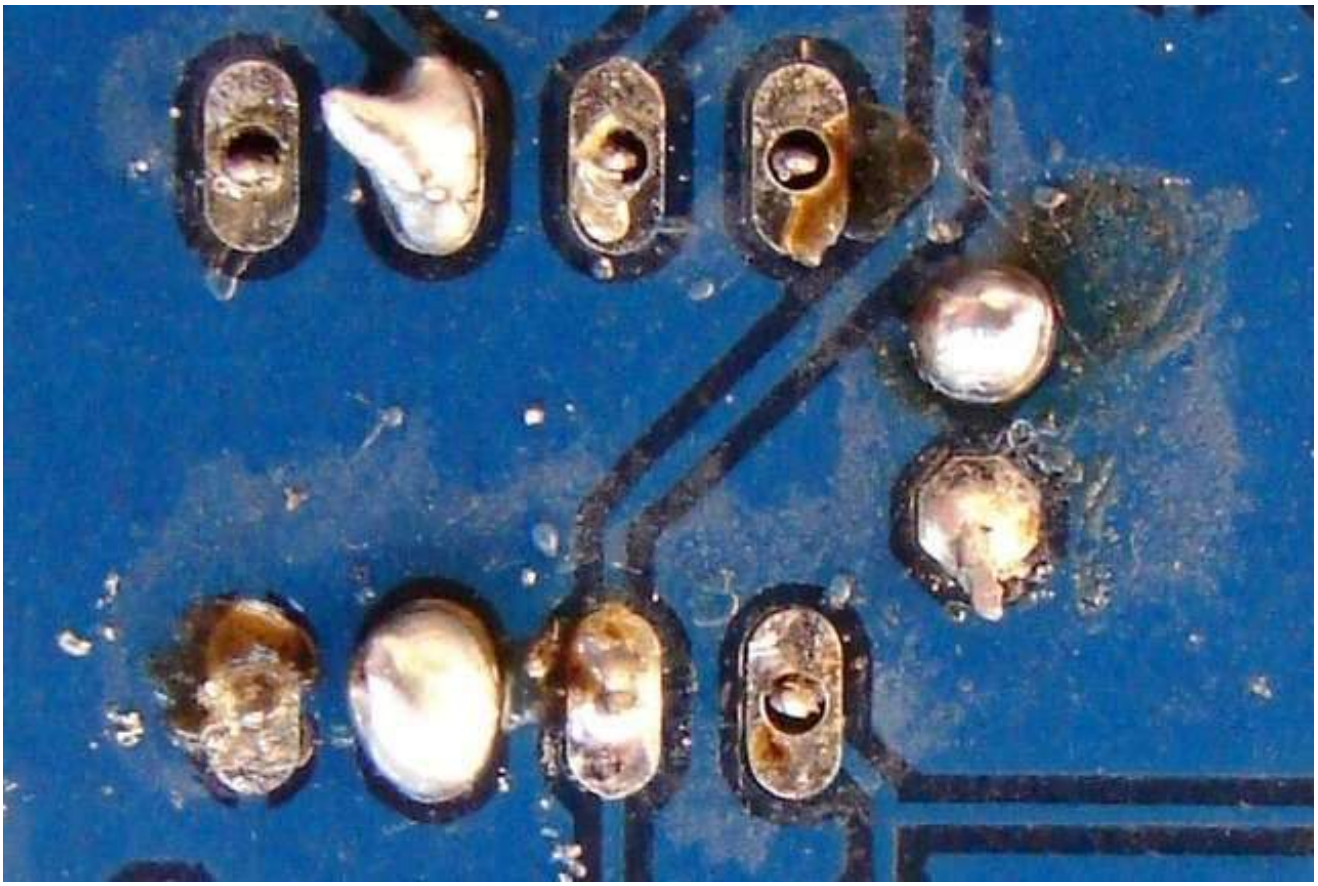

Surface Mount Components

The previous page showed how to make a good through-hole joint. But more and more components are only available in surface mount form these days. Not all surface mount packages are easily worked by hand, but there are plenty that can be managed with the same basic tools used for through-hole soldering.

Let's start with a surface-mount part common to several Adafruit kits: The SD Card Holder:

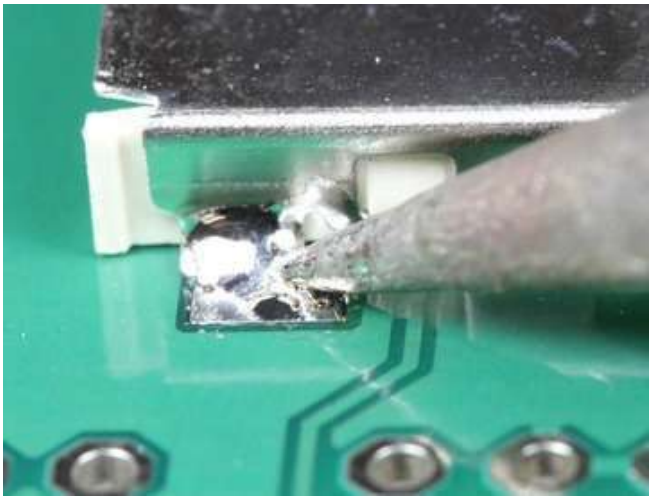

Immobilize the Joint

Unlike many surface mount components, immobilizing the SD card holder is relatively easy. There are small pegs on the back that fit into positioning holes in the board. Once it is in place, solder the four small corner tabs to make it permanent.

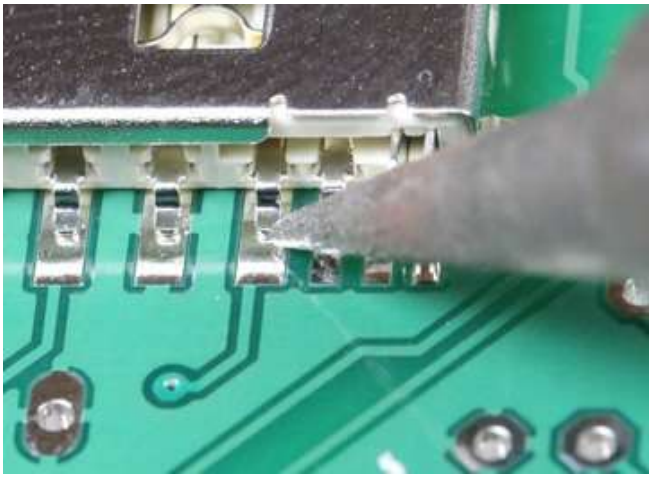

Heat the Joint

Start by putting the tip of the hot iron on the solder pad adjacent to the pin. The pad will take longer to heat, so we apply most of the heat to the pad to start.

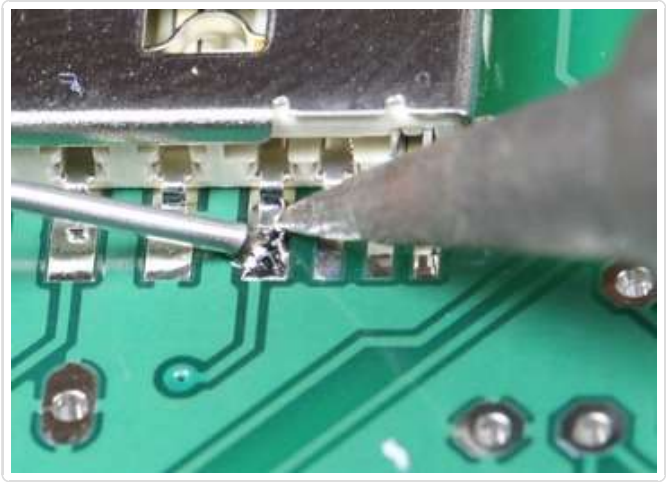

Apply the Solder

When the joint is hot, apply solder to the side opposite the iron. The solder should melt and start to flow into the joint.

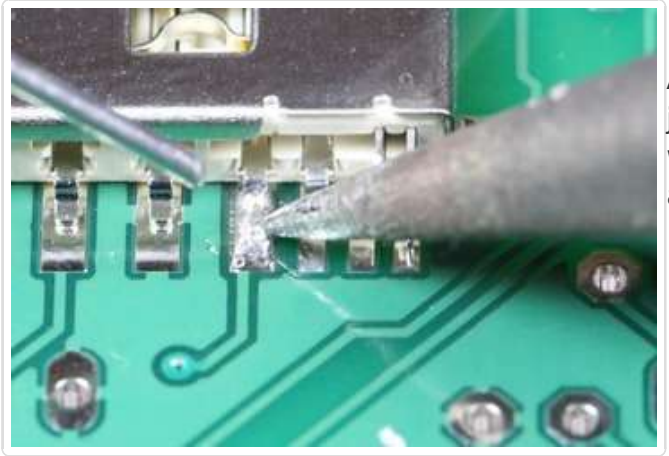

Let it Flow

Apply just enough solder to ensure a good joint, then keep the heat on while the solder wicks up between the pin and the pad to make a good electrical bond.

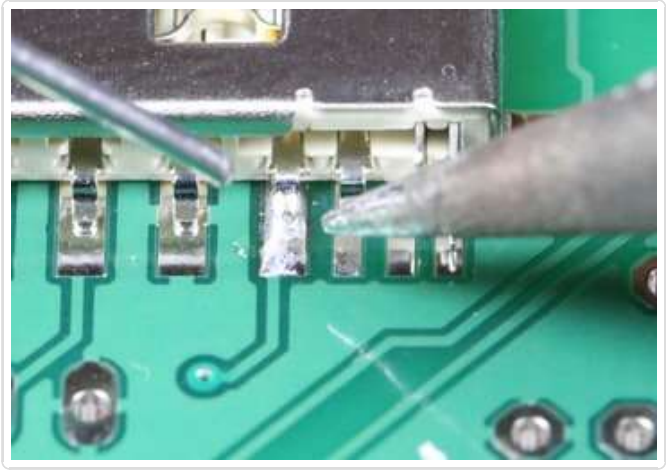

Let it Cool

Remove the iron and allow the joint to cool undisturbed.

Problems?

The last page of this guide illustrates a number of common soldering problems with advice

on prevention and repair.

Common Soldering Problems

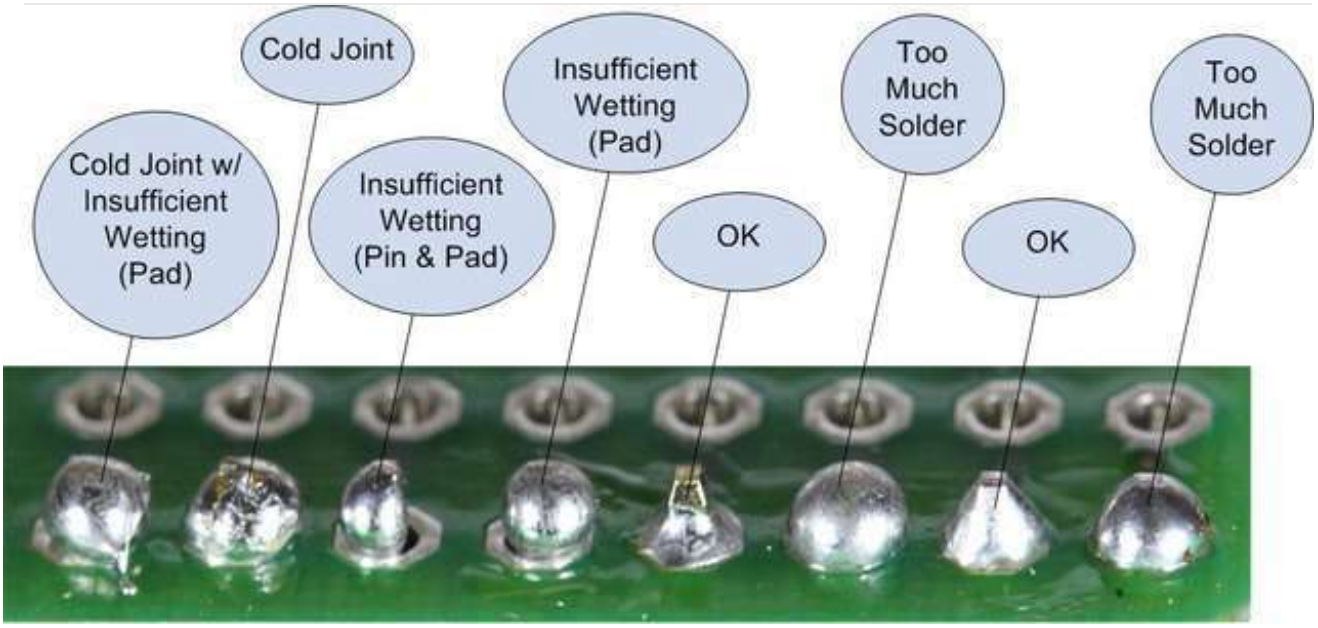

The Ideal Solder Joint

The ideal solder joint for through-hole components should resemble the diagram below.

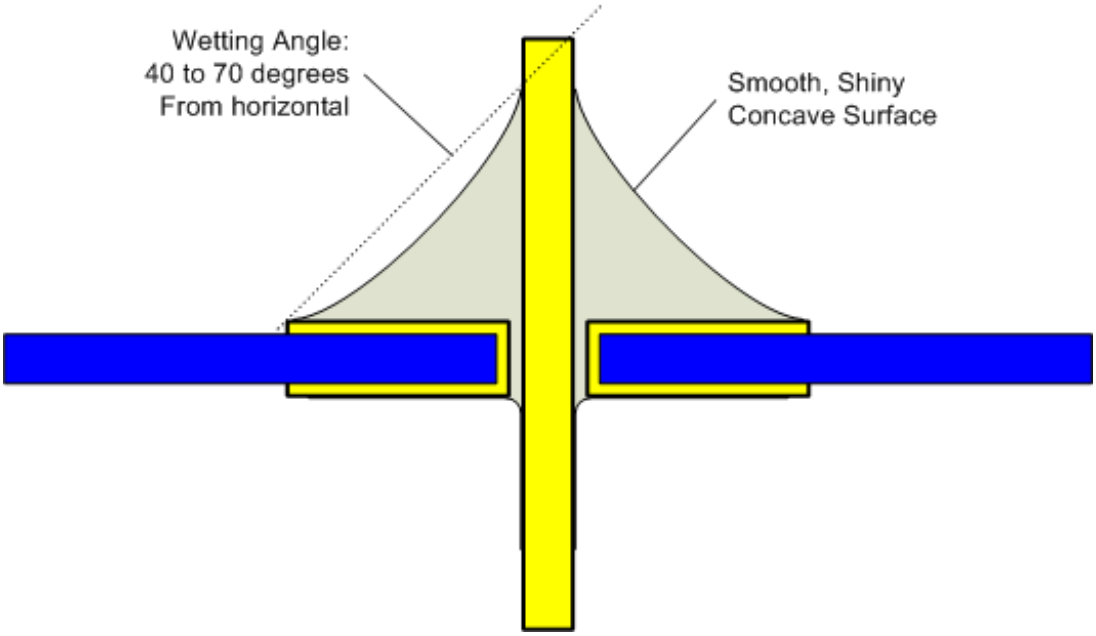

The photos that follow show some common soldering problems, with suggestions for repair and prevention:

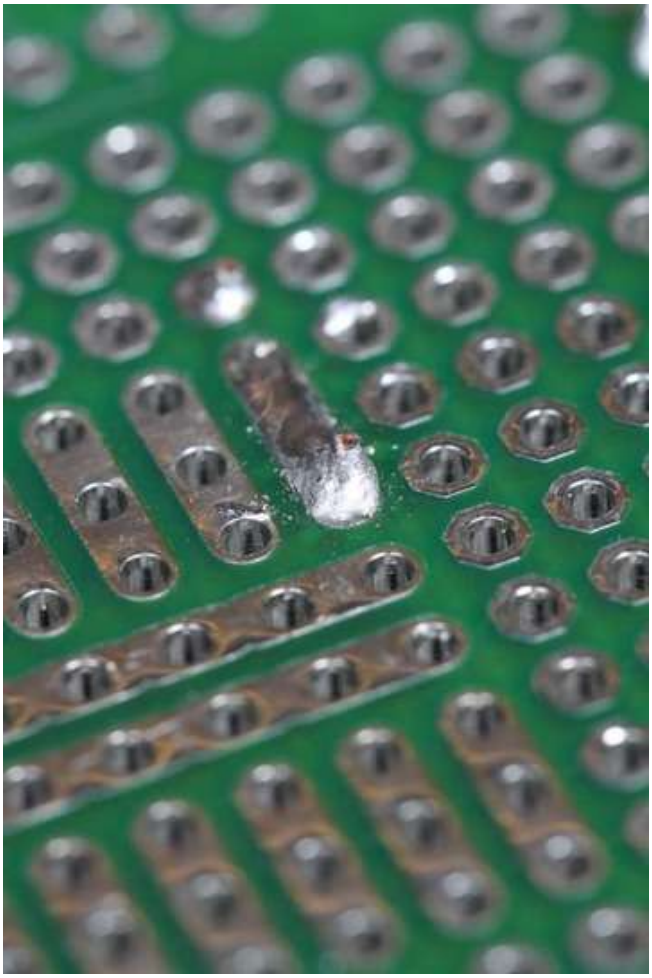

Disturbed Joint

A Disturbed joint is one that has been subjected to movement as the solder was solidifying. The surface of the joint may appear frosted, crystalline or rough.

Often called a 'Cold Joint'. They can look similar to a true cold joint, but the cause is different.

Repair: This joint can be repaired by reheating and allowing it to cool undisturbed.

Prevention: Proper preparation, including immobilizing the joint and stabilizing the work in a vise can prevent disturbed joints.

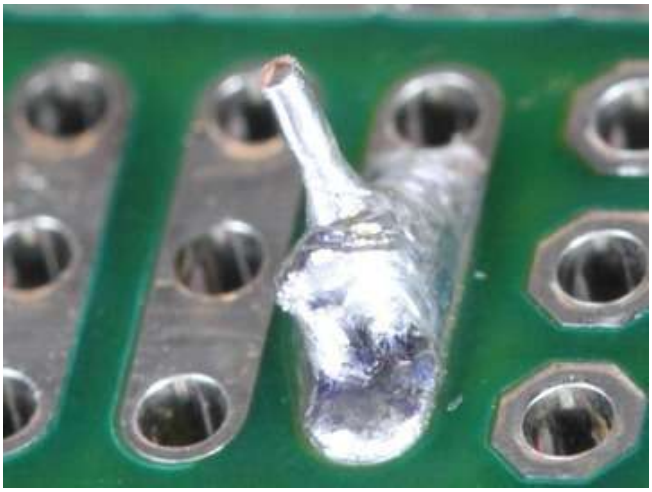

Cold Joint

A 'Cold Joint' is one where the solder did not melt completely. It is often characterized by a rough or lumpy surface. Cold joints are unreliable. The solder bond will be poor and the cracks may develop in the joint over time.

Repair: Cold joints can usually be repaired by simply re-heating the joint with a hot iron until the solder flows. Many cold joints (such as the one pictured) also suffer from too much solder. The excess solder can usually be drawn-off with the tip of the iron.

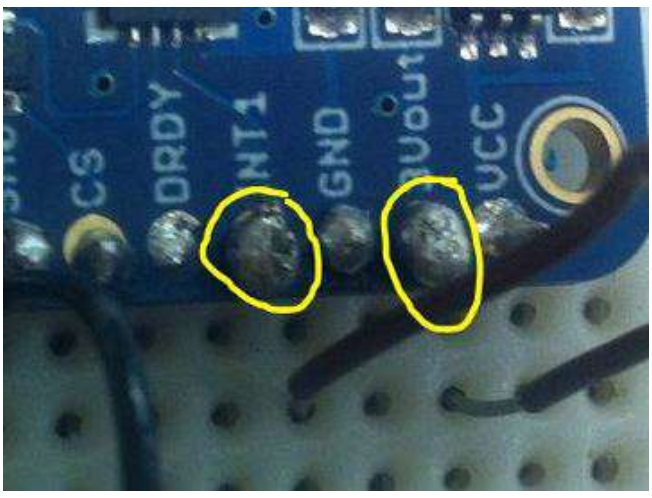

Prevention: A properly pre-heated soldering iron with sufficient power will help prevent cold joints.

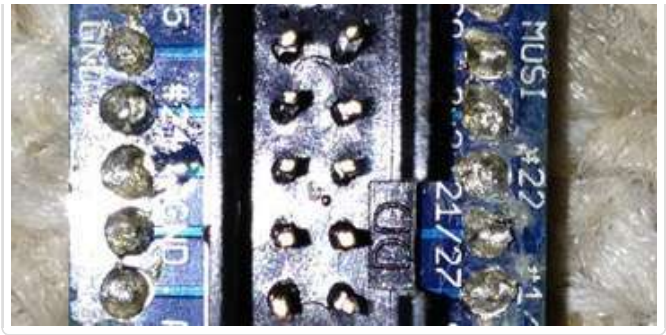
MUSI #22 #1
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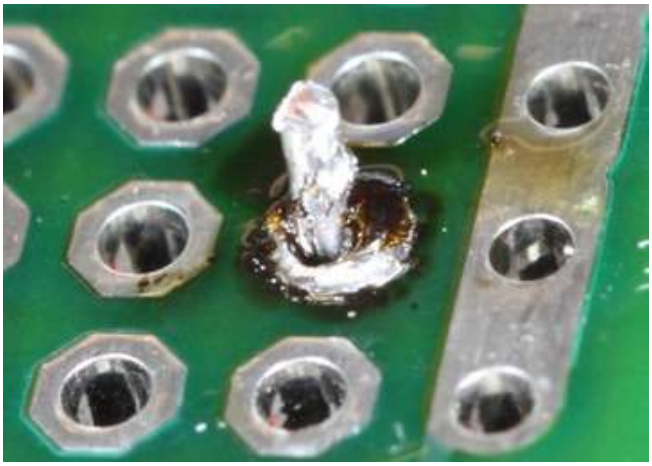

Overheated Joint

At the other extreme, we have the overheated joint. The solder has not yet flowed well and the residue of burnt flux will make fixing this joint difficult.

Repair: An overheated joint can usually be repaired after cleaning. Careful scraping with the tip of a knife, or little isopropyl alcohol & a toothbrush will remove the burnt flux.

Prevention: A clean, hot soldering iron, proper preparation and cleaning of the joint will help prevent overheated joints.

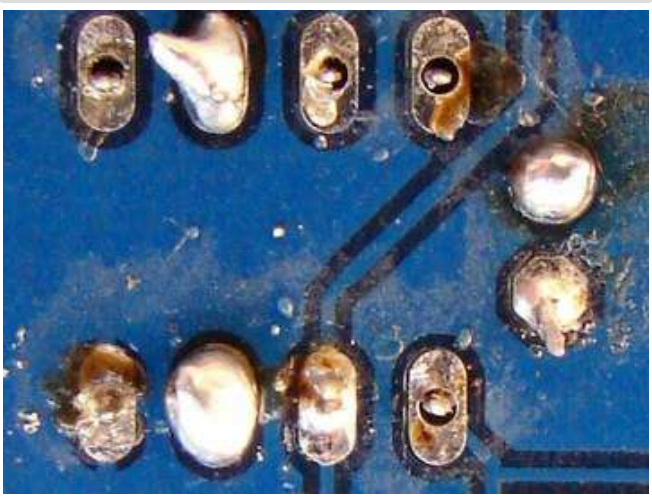

Insufficient Wetting (Pad)

These two joints both show signs of insufficient wetting of the solder pad. The solder has wetted the leads nicely, but it has not formed a good bond with the pad. This can be caused by a dirty circuit board, or by failing to apply heat to the pad as well as the pin.

Repair: This condition can usually be repaired by placing the tip of the hot iron at the base of the joint until the solder flows to cover the pad.

Prevention: Cleaning the board and even heating of both the pad and the pin will prevent this problem.

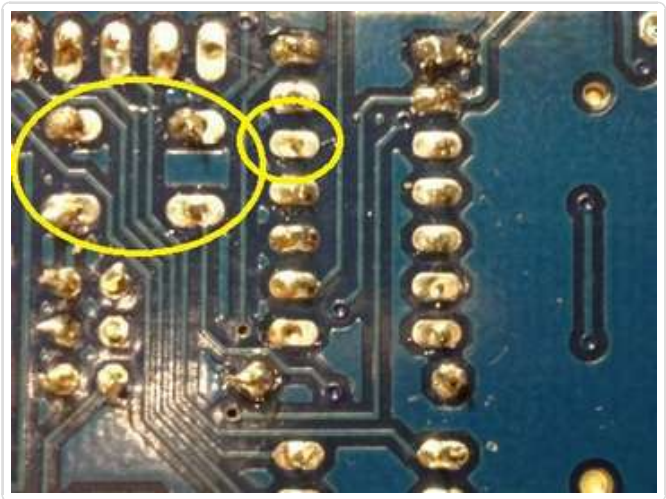

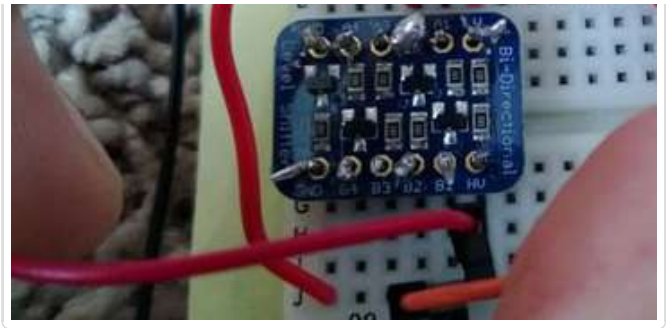
Bi-Directional

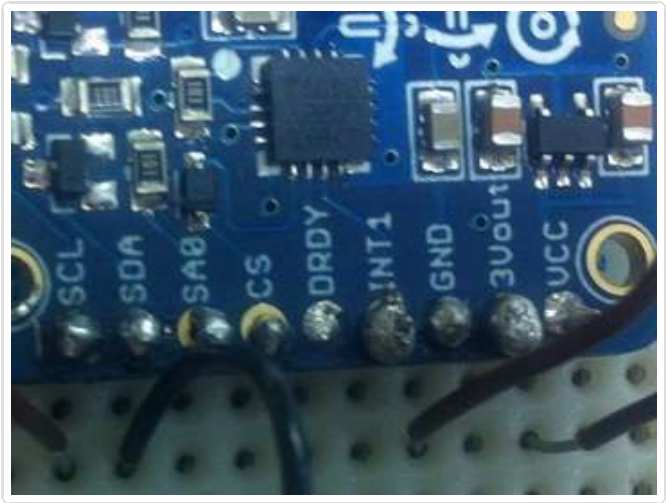
SCL
SDA
SA0
CS
DRDY
INT1
GND
3VOut
VCC

Insufficient Wetting (Pin)

This solder in this joint has not wetted the pin at all and has only partially wetted the pad. In this case, heat was not applied to the pin and the solder was not given adequate time to flow.

Repair: This joint can be repaired by re-heating and applying more solder. Be sure that the tip of the hot iron is touching both the pin and the pad.

Prevention: Even heating of both the pin and the pad will prevent this problem.

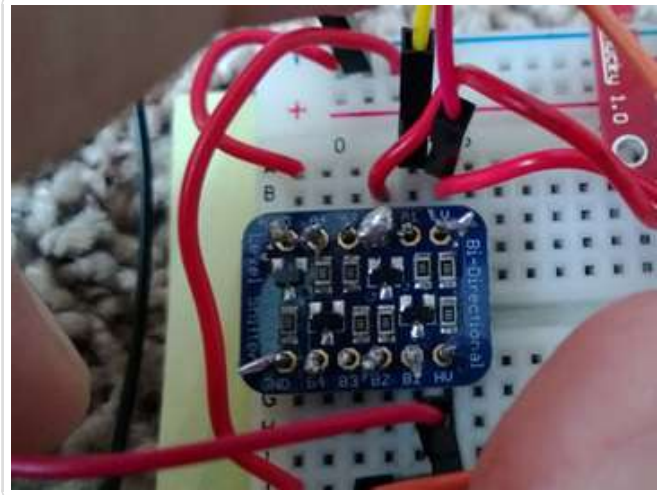

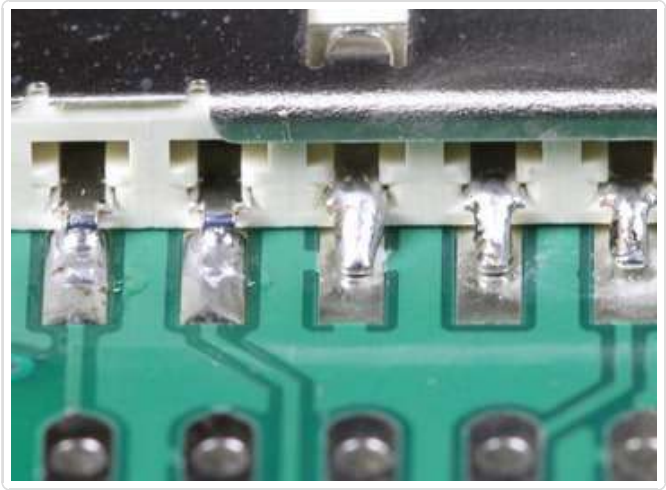

Insufficient Wetting (Surface Mount)

Here we have three pins of a surface mount component where the solder has not flowed onto the solder pad. This is caused by heating the pin instead of the pad.

Repair: This is easily repaired by heating the solder pad with the tip of the iron, then applying solder until it flows and melts together with the solder already on the pin.

Prevention: Heat the pad first.

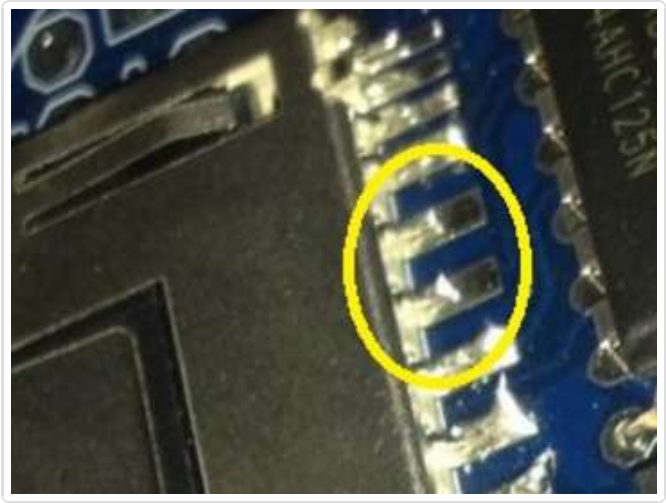

Solder Starved

A solder starved joint simply does not have enough solder. It may make good electrical contact, but it is hard to verify by inspection. In any case, it is not a strong joint and may develop stress cracks and fail over time.

Repair: Re-heat the joint and add more solder to make a good strong joint.

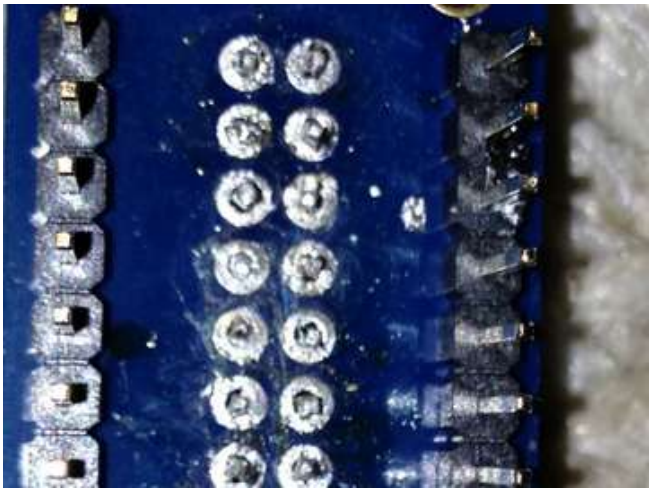

Too Much Solder

This might be a perfectly good joint, but we can't tell for sure. It is entirely possible that this blob of solder wets neither the pin nor the pad and is not a reliable electrical connection. The best evidence of proper wetting (and good electrical contact) is a nice concave surface as on the joint on the far left.

Repair: It is usually possible to draw off some of the excess solder with the tip of a hot iron. In extreme cases, a solder-sucker or some solder wick can be helpful as well.

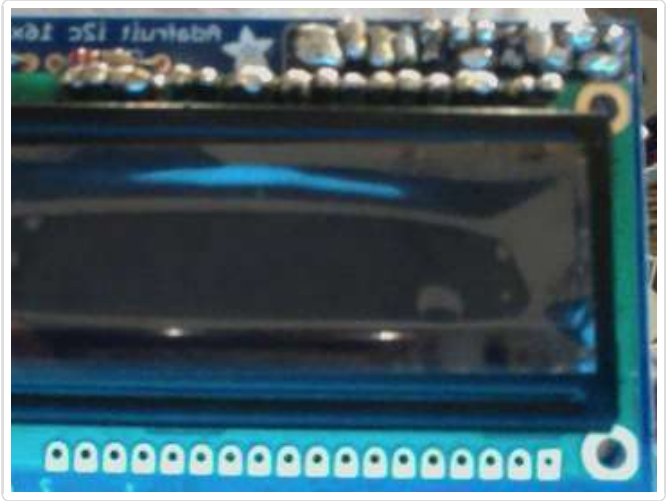

Untrimmed Leads

Leads that are too long are potential short circuits. The two joints on the left are an obvious danger of touching. But the one on the right is long enough to be dangerous as well. It would not take much force to bend that lead over to touch an adjacent trace.

Repair: Trim all leads just at the top of the solder joint.

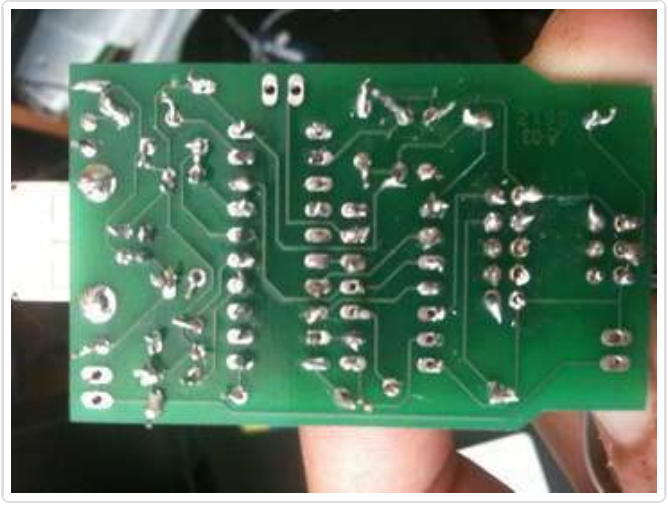

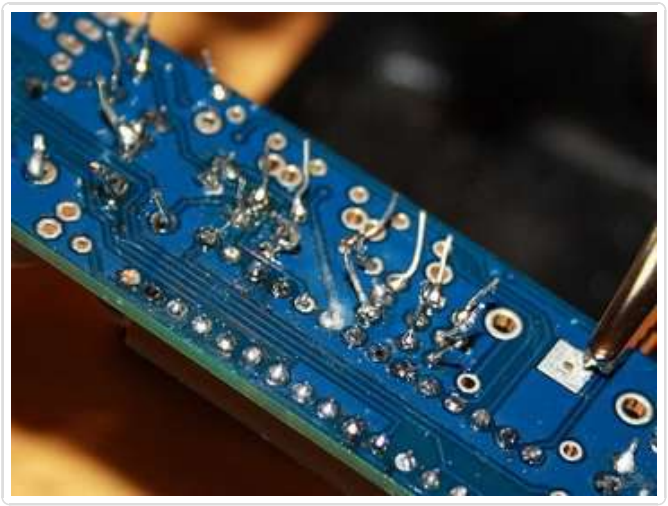

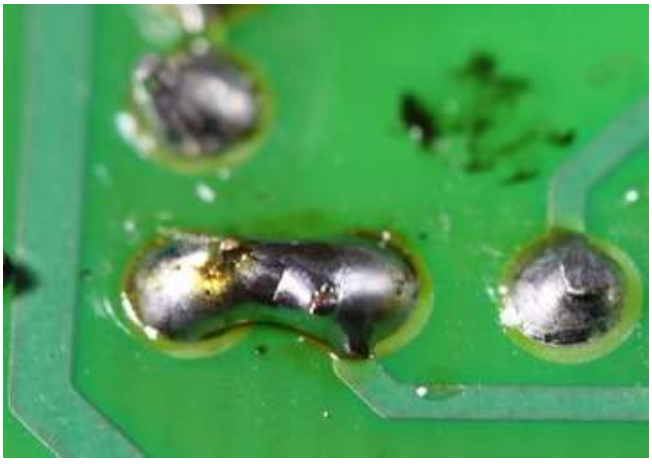

Solder Bridge

The left two solder joints have melted together, forming an unintended connection between the two.

Repair: Sometimes the excess solder can be drawn off by dragging the tip of a hot iron between the two solder joints. If there is too much solder, a solder sucker or solder wick can help get rid of the excess.

Prevention: Solder bridges most often happen between joints with too much solder to begin with. Use only enough solder to make a good joint.

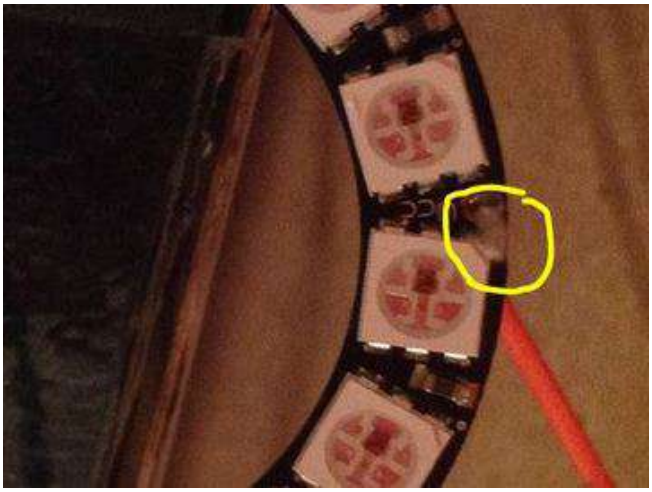

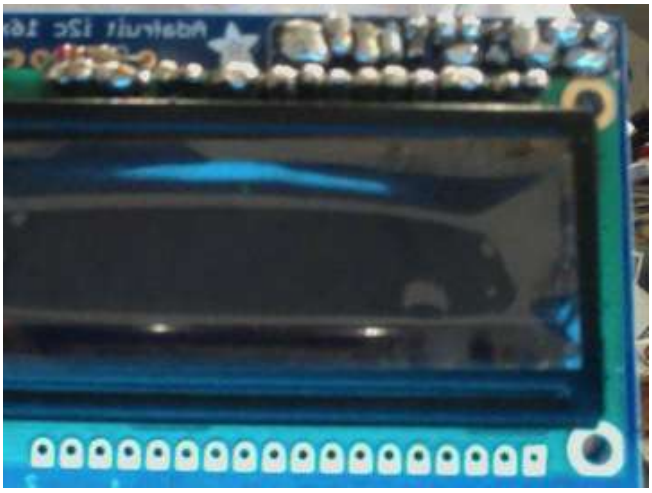

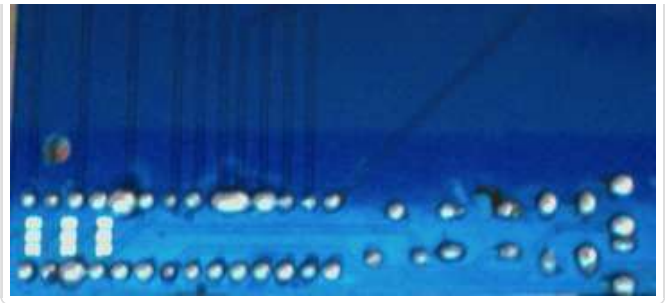

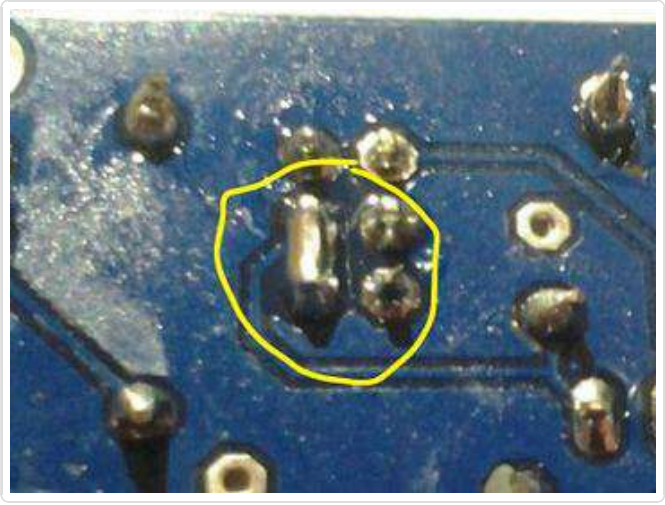

Lifted Pad

This photo shows a solder pad that has become detached from the surface of the circuit board. This most often occurs when trying to de-solder components from the board. But it can result simply from overworking the joint to the point where the adhesive bond between copper and the board is destroyed.

Lifted pads are especially common on boards with thin copper layers and/or no through-plating on the holes.

Repairing a Lifted Pad

It may not be pretty, but a lifted pad can usually be repaired. The simplest repair is to fold the lead over to a still-attached copper trace and solder it as shown to the left. If your board has a solder-mask, you will need to carefully scrape off enough to expose the bare copper.

Other alternatives are to follow the trace to the next via and run a jumper to there. Or, in the worst case, follow the trace to the nearest component and solder your jumper to the leg of that. Not exactly pretty, but functional.

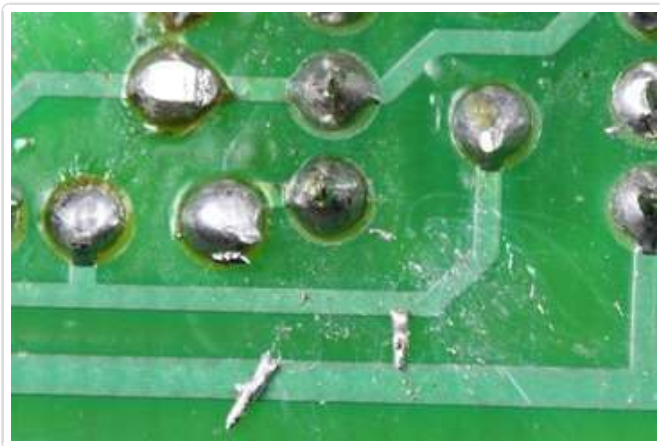

Stray Solder Spatters

These bits of solder are held to the board only by sticky flux residue. If they work loose, they can easily cause a short circuit on the board.

Repair: These are easy to remove with the tip of a knife or tweezers.

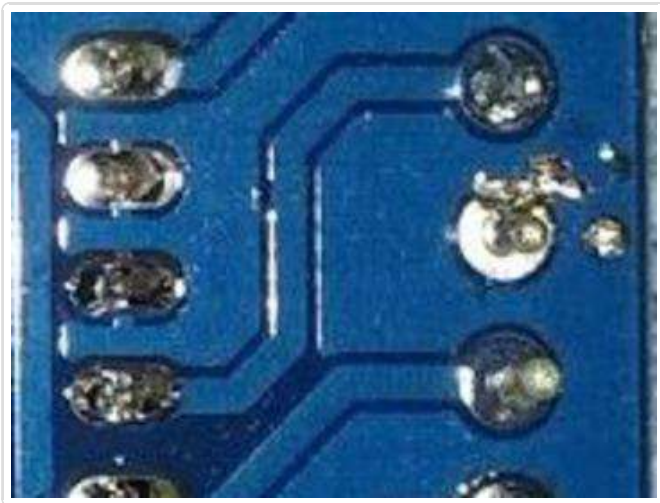

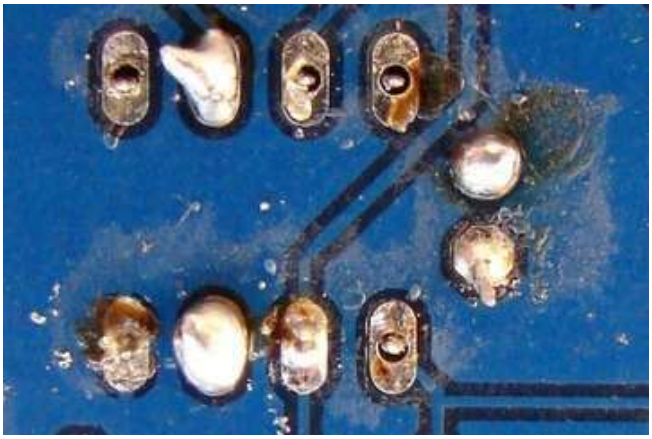

All of the Above!

Don't panic. Take your time. Most joints can be repaired with patience. If the solder refuses to flow the way you want it to:

1. Stop and let the joint cool.
2. Clean and tin your iron.
3. Clean off any burnt flux from the joint.
4. Let the iron come back up to temperature.
5. Then reheat the joint and try again.

HAND SOLDERING TUTORIAL FOR FINE PITCH QFP DEVICES

Scope

This document is intended to help designers create their initial prototype systems using Silicon Lab's TQFP and LQFP devices where surface mount assembly equipment is not readily available. This application note assumes that the reader has at least basic hand soldering skills for through-hole soldering. The example presented will be the removal, cleanup and replacement of a TQFP with 48 leads and 0.5 mm lead pitch.

Safety

Work should be done in a well-ventilated area. Prolonged exposure to solder fumes and solvents can be hazardous. There should be no presence of sparks or flames when solvents are in use.

Materials

The right materials are key to a good solder job. The list below are the recommendations from Silicon Labs. Other materials may work, so the user should feel free to substitute and experiment. The use of organic solder is highly recommended.

Required

1. Wire wrap wire (30 gauge) *
2. Wire strippers for wire wrap wire *
3. Soldering station - variable temperature, ESD-safe. Should support temperatures 800°F (425°C). This example uses a Weller model EC1201A. The soldering wand should have a fine tip no more than 1 mm wide.
4. Solder - 10/18 organic core; 0.2" (0.5 mm) diameter
5. Solder flux - liquid type in dispenser
6. Solder wick - size C 0.075" (1.9 mm)
7. Magnifier - 4X minimum. An inexpensive headset OptiVISOR by Donegan Optical Co. is used for this example.
8. ESD mat or tabletop and ESD wrist strap - both grounded
9. Tweezers with pointed (not flat) tips
10. Isopropyl Alcohol
11. Small stiff bristle brush for cleaning (nylon or other non-metallic material). Cut off hair to approximately 0.25" (6 mm)

* Required for device removal only.

Optional

1. Board vise to hold printed circuit board
2. Dental pick (90 degree bend)
3. Compressed dry air or nitrogen to dry boards

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4. Optical inspection stereo microscope 30-40X

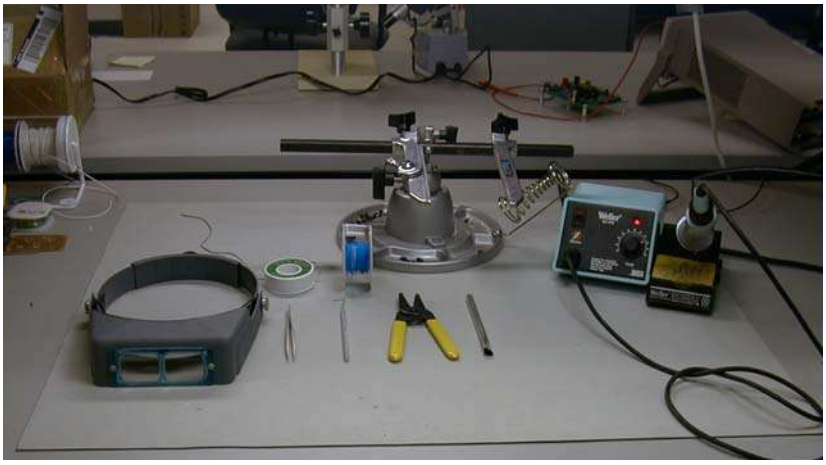

Figure 1. Some of the materials to get started...

Figure 2. clock-wise from left: 4X magnifying headset, solder wick, wire wrap wire, stiff cleaning brush, wire strippers, and pointed tweezers

Figure 3. Solder wick and wire wrap wire

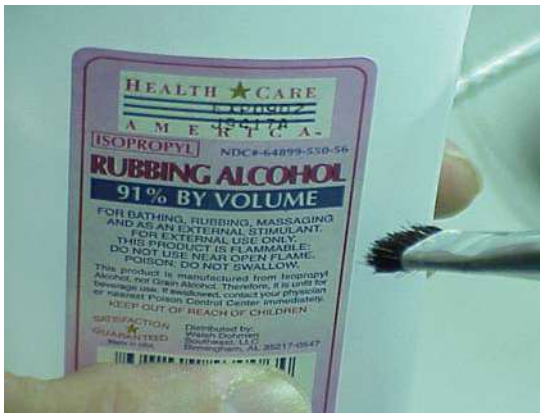

Figure 3. Isopropyl Alcohol

Figure 4. ESD safe soldering station with fine tip wand. This one is Weller model EC1201A

Figure 5. Optional equipment includes a PCB vise and an inspection microscope 7-40X

Procedure

The following procedures cover the replacement of a TQFP 48 pin device with 0.5 mm lead pitch. The lead shape is the standard gullwing associated with JEDEC standard QFPs. This procedure section is divided into three parts:

A. Part Removal

B. Board Cleanup

C. Soldering a new device.

If you are soldering parts to a new printed circuit board, skip part A and refer to the new board cleanup section in part B.

A. Part Removal

Preparation:

- Board with IC to be removed is mounted in a holder or vise. A PCB holder/vise is optional but it is required that the PCB is held steady for the part removal.
- The soldering station is warmed up to 800°F (422°C) and the solder tip is clean.
- ESD precautions have been taken.

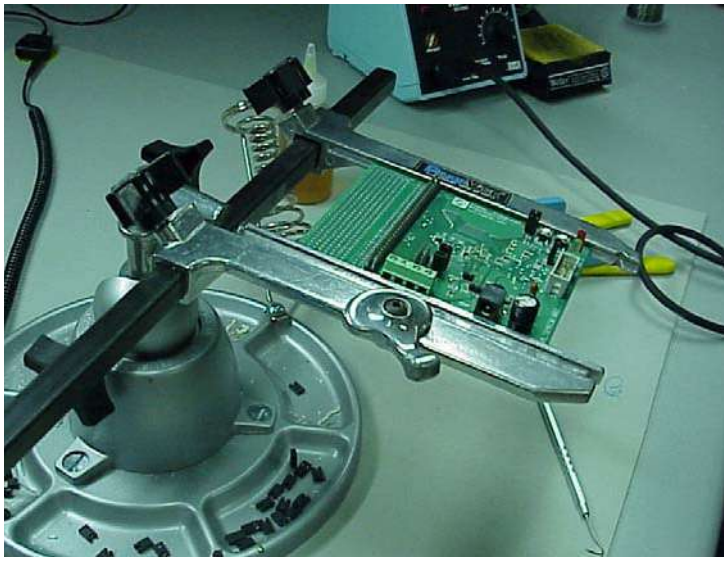

Figure 6. Ready to get started

Begin by wetting all the leads with flux to enhance the initial solder wicking cleanup. Wick up solder as much as possible from the QFP leads. Be careful not to scorch the PCB board with prolonged solder heat.

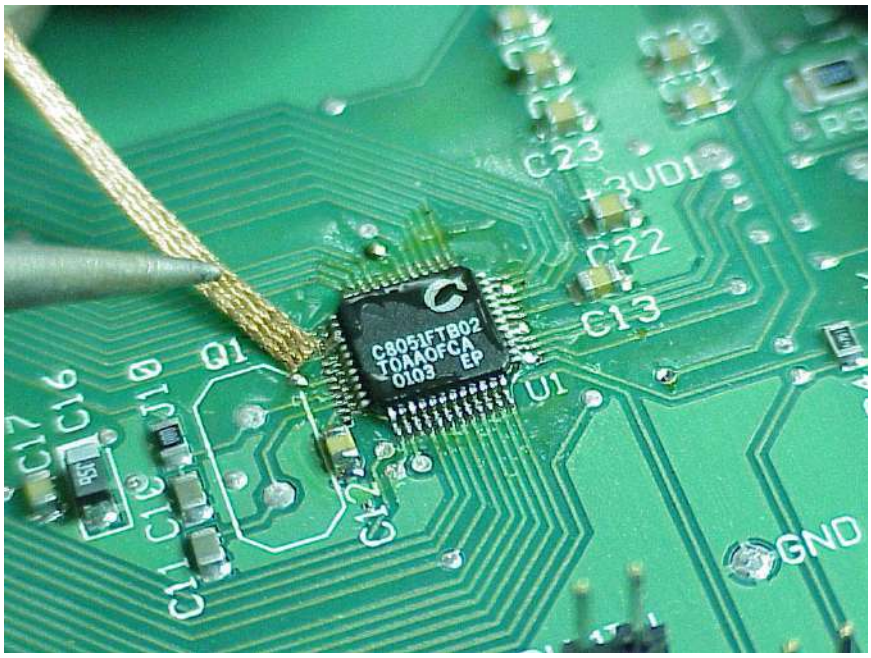

Figure 7. Apply flux; wick excess solder from pins

Next, strip off approximately 3 inches of insulation from a piece of the 30 gauge wire wrap wire. Cut the wire at a comfortable 12 inch length or so.

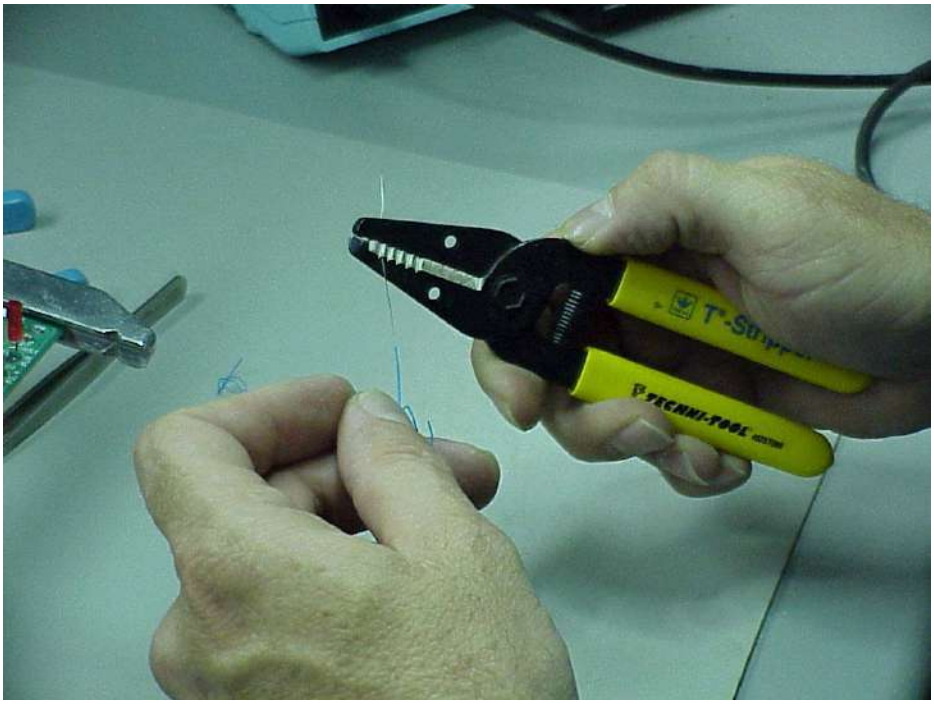

Figure 8. Wire stripping

Feed the wire behind and under the leads on one side of the IC as shown in Figure 9.

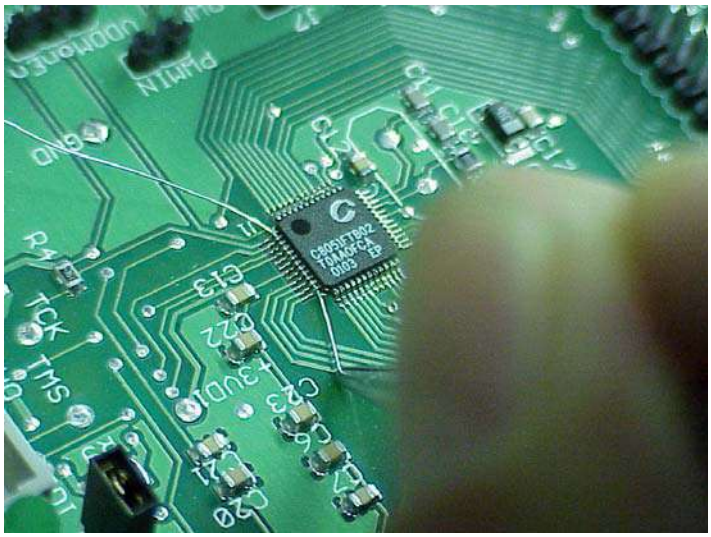

Figure 9. Feeding wire under QFP leads

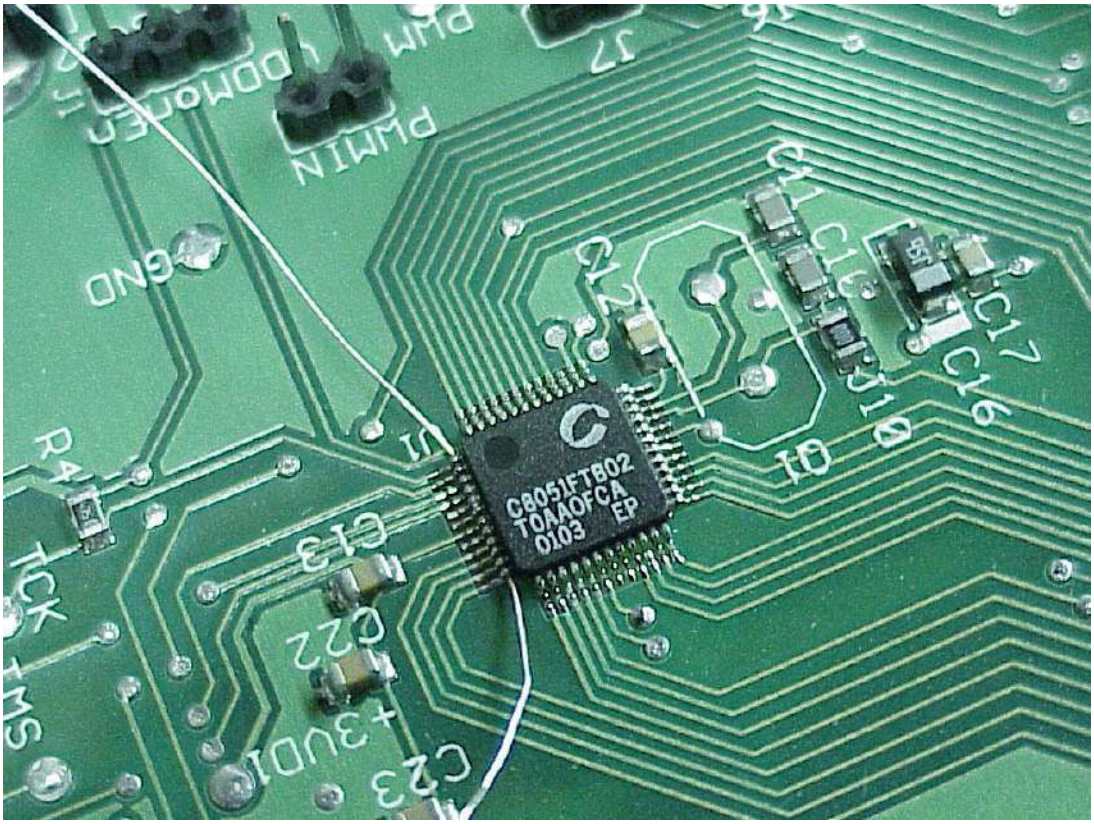

Figure 9. Wire with one side anchored to nearby component

Solder tack (anchor) one end of the 3 inch wire to a nearby via or component on the PCB. The anchor point should be in a location similar to that should in Figure 10.

Dispense a small amount of liquid flux across the leads.

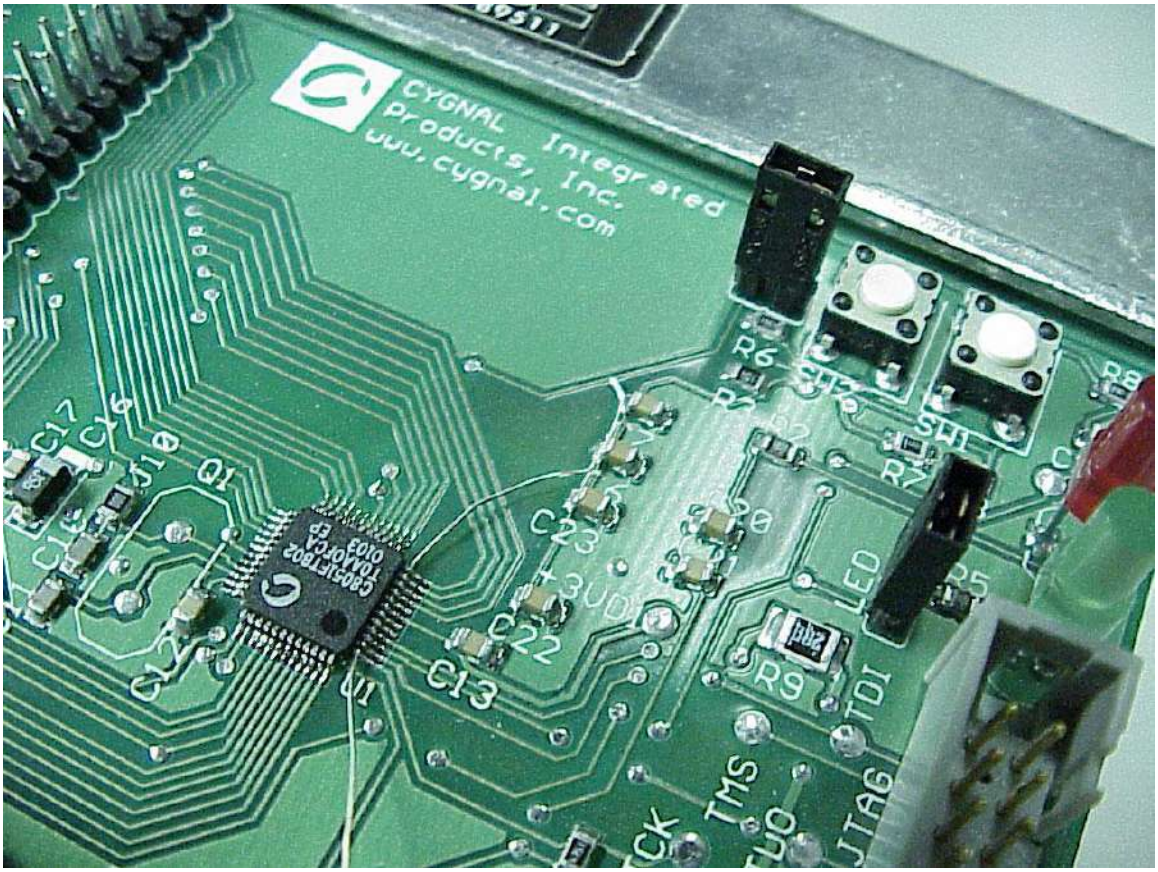

Figure 10. Bus wire is anchored on C6

Hold the loose (non-anchored) end of the wire with tweezers in close proximity to the device as shown in Figure 11.

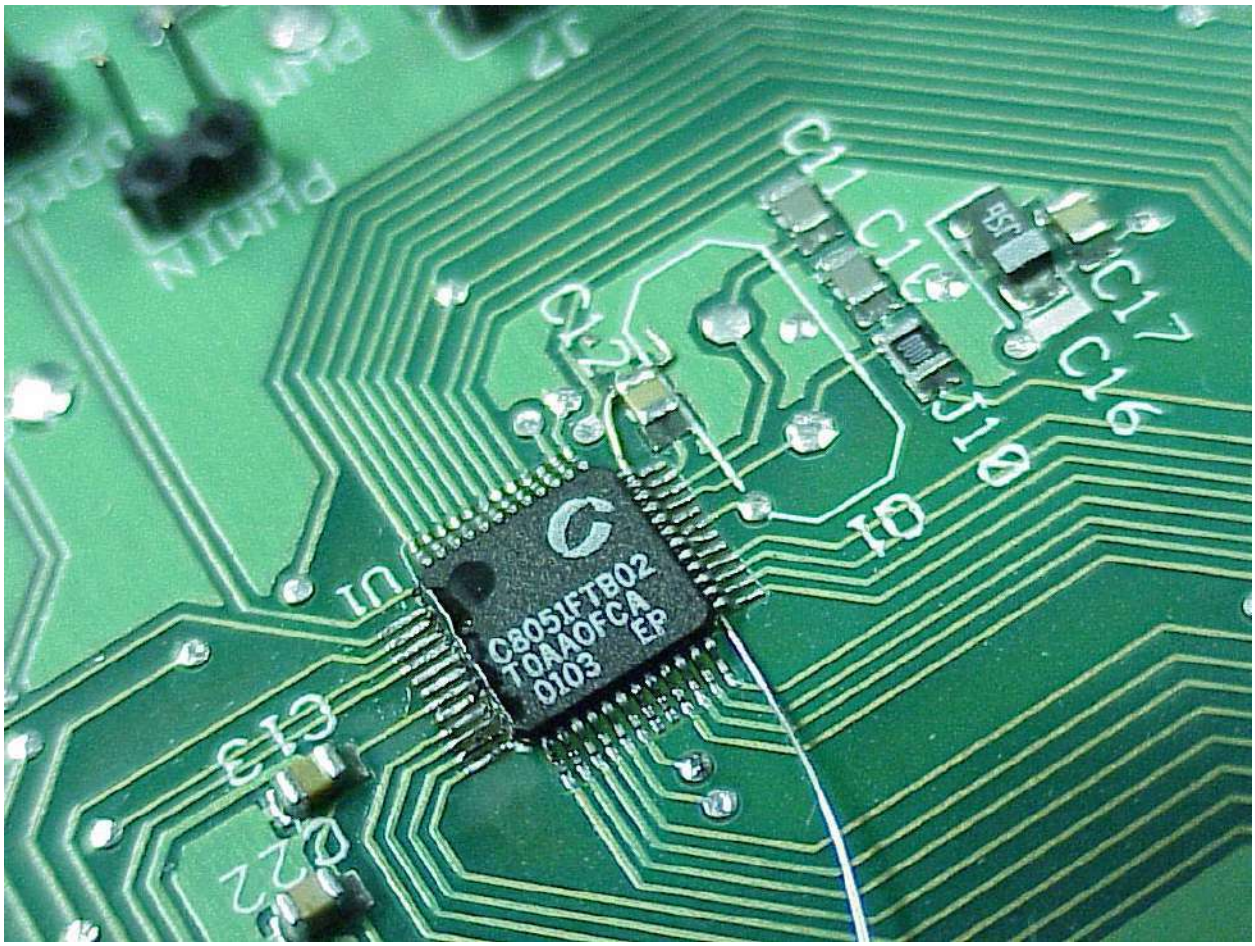

Figure 11. Side 2 anchored and ready for solder heat

You will now need to simultaneously apply solder heat and pull the wire away from the QFP, pulling at a slight upward angle from the board surface. Apply solder heat beginning at the lead closest to your tweezers. As the solder melts, gently pull the wire away from the QFP while continuing to move the solder heat from pin to pin to the right. You should not pull very hard. Pull as the solder melts. Do not leave the solder heat on any lead for more than necessary. The first lead will take the longest to heat, and after the wire gets hot, solder on the other leads will melt quickly. Excessive heat will damage the IC device and the PCB pad. The removal of 12 pins from a 48TQFP should take about 5 seconds total. Signs of excessive heat are:

- Melted plastic on the IC device
- PCB pads that lift off
- Brown scorch marks on the PCB

With one side of the QFP completed, repeat the same procedure on the other three sides of the QFP. Cut off the dirty part of the wire wrap wire or use a new piece for each side. Dispense flux again for each side.

Note that in the following pictures, the old IC device is not being saved. There is slightly more heat being applied here than necessary to speed up the process. This result is some melted plastic and missing gull-wing leads. These are visible in the pictures that follow. If you are trying to save the IC being removed, then you must be very careful to apply as little heat as possible during the removal process such that the QFP leads remain intact in the plastic QFP body. This will require some experimentation with solder heat settings and timing.

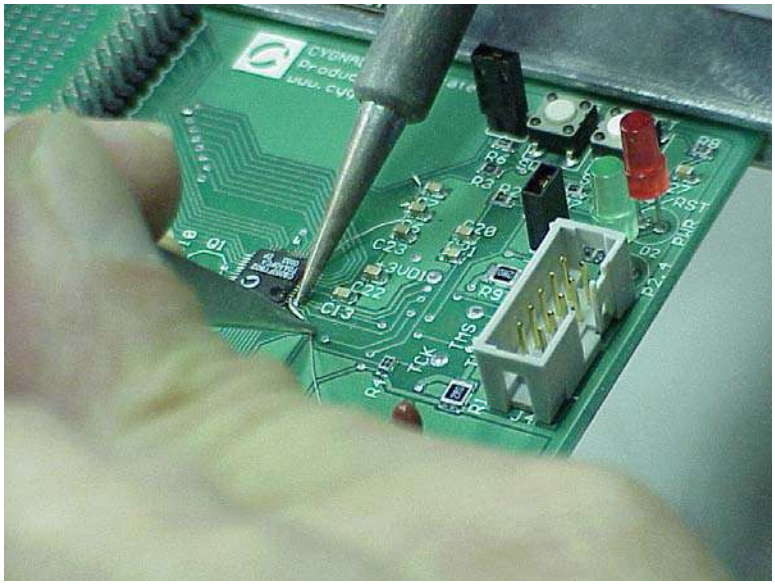

Figure 12. Hold tweezers close to device

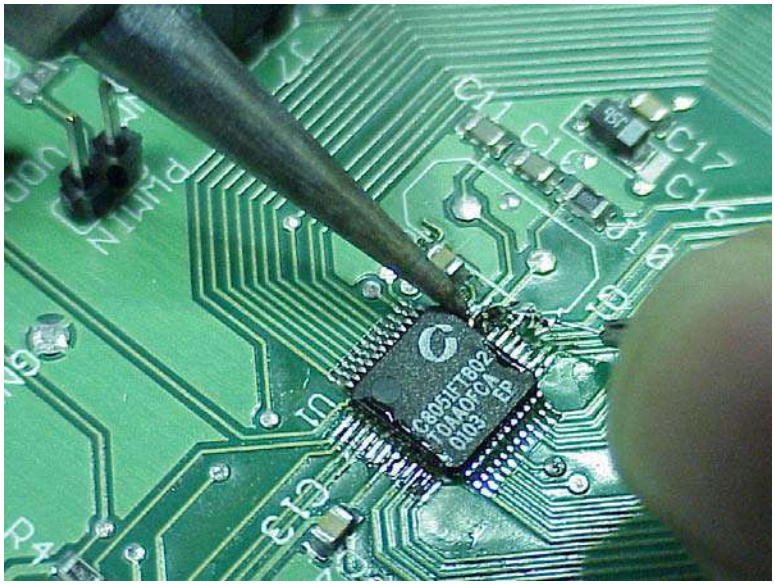

Figure 14. Side 2 almost complete

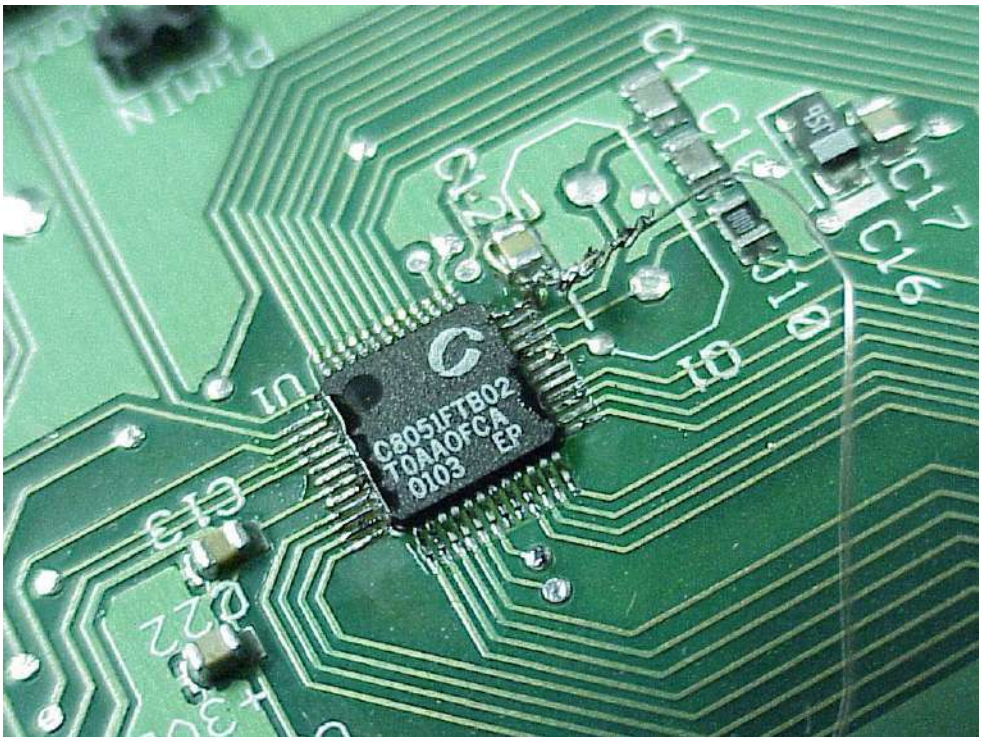

Figure 15. Side 2 is done

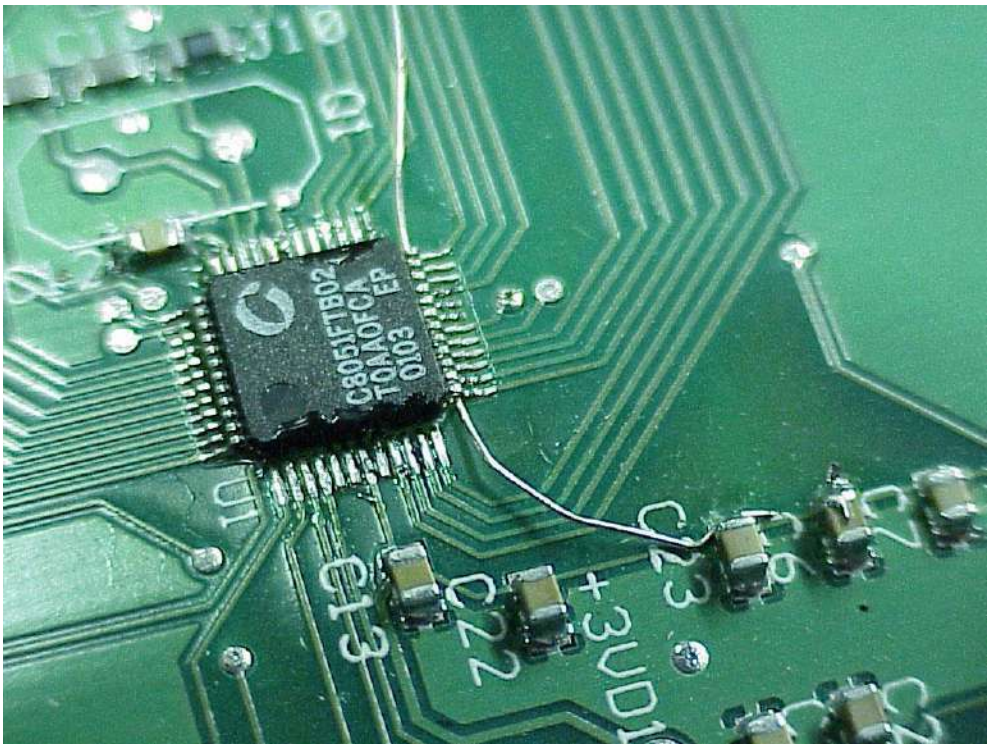

Figure 16. Side 3 anchored and ready

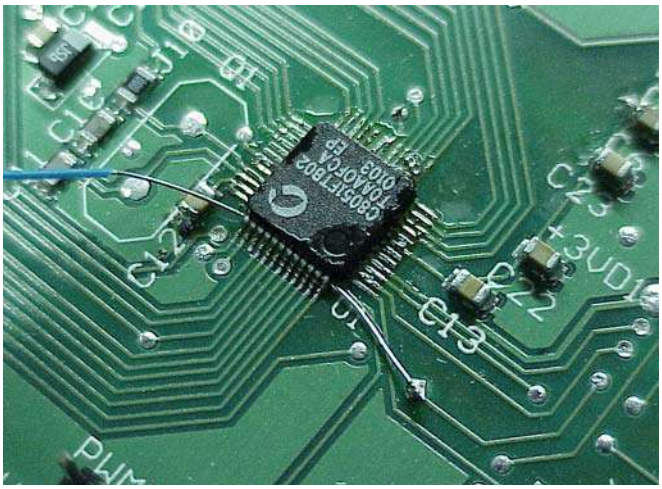

Figure 17. Side 4 anchored to a via

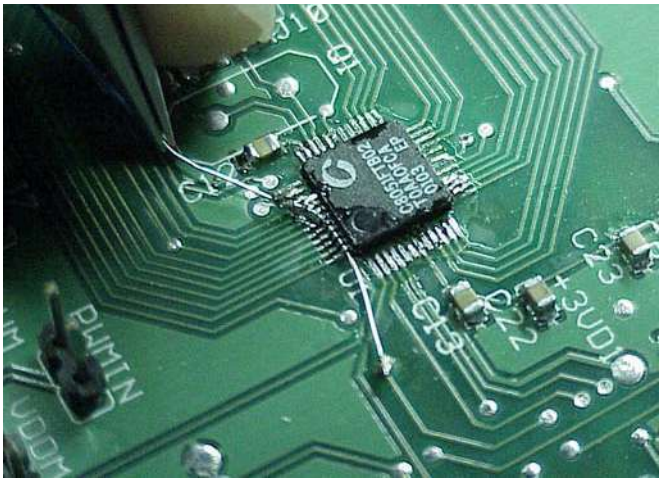

Figure 18. Side 4 removal started

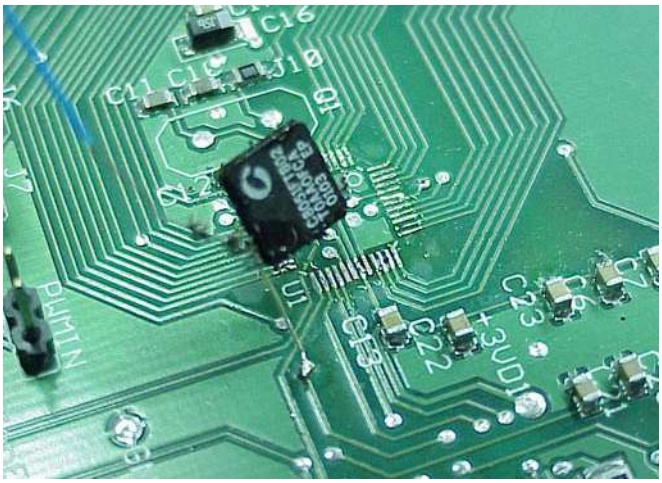

Figure 19. QFP removal a second before completion

B. Board Cleanup

New PCBs

For mounting a device to a new PCB, the amount of cleanup should be minimal. On a new PCB, there should be no solder on the pads. Brushing the pads with isopropyl alcohol (Figure 33) and drying the board should be enough preparation to begin the mounting procedure.

Reworked PCBs

The following section is the cleanup sequence that follows the QFP removal in the previous section. After removing the device, the solder pads will need cleanup. The idea is to clean the pads so that they are flat and free or solder and flux. Solder wick the pads until they are flat and dull. A clean pad appearance should be a dull silver color.

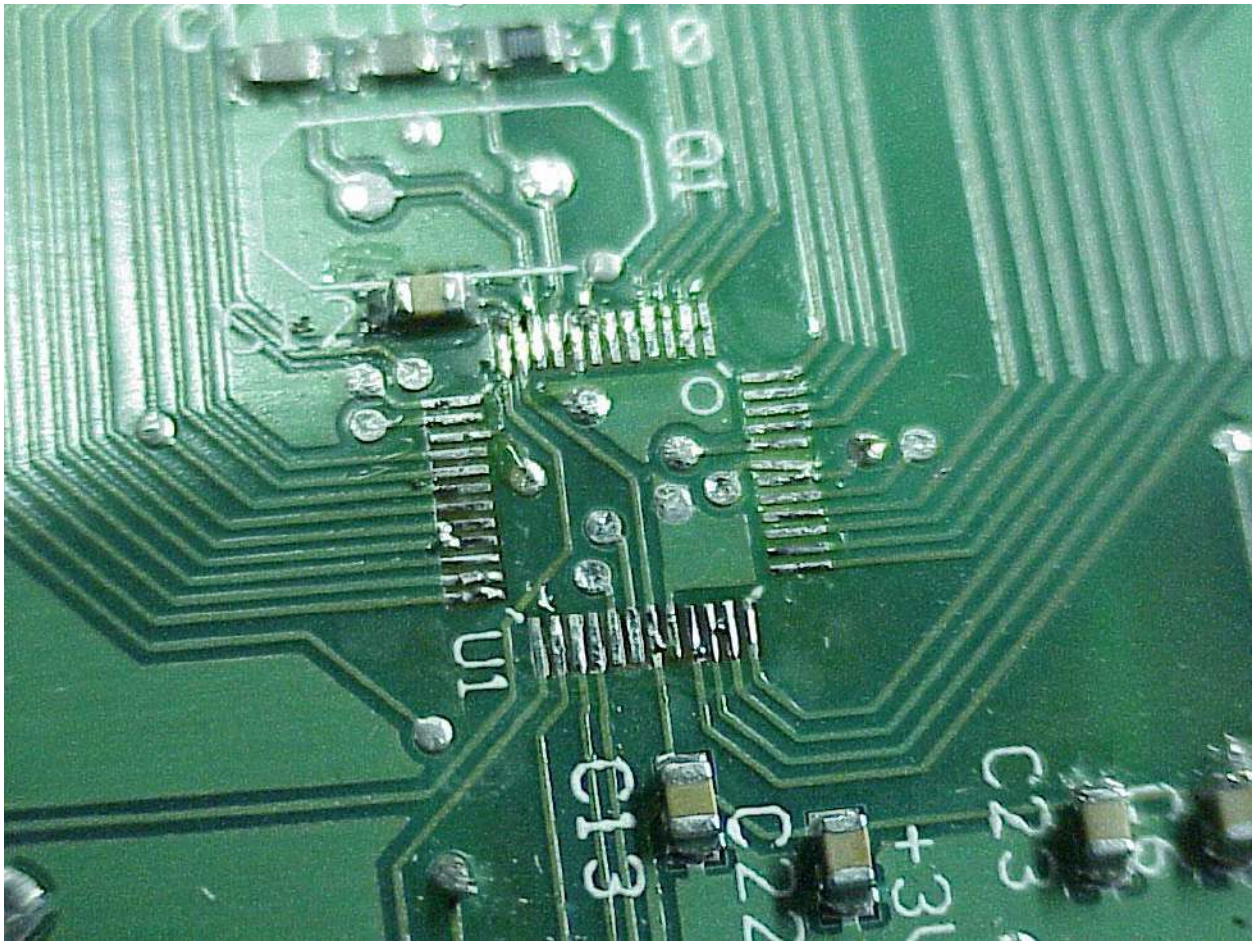

Figure 20. Pads after QFP removal procedure

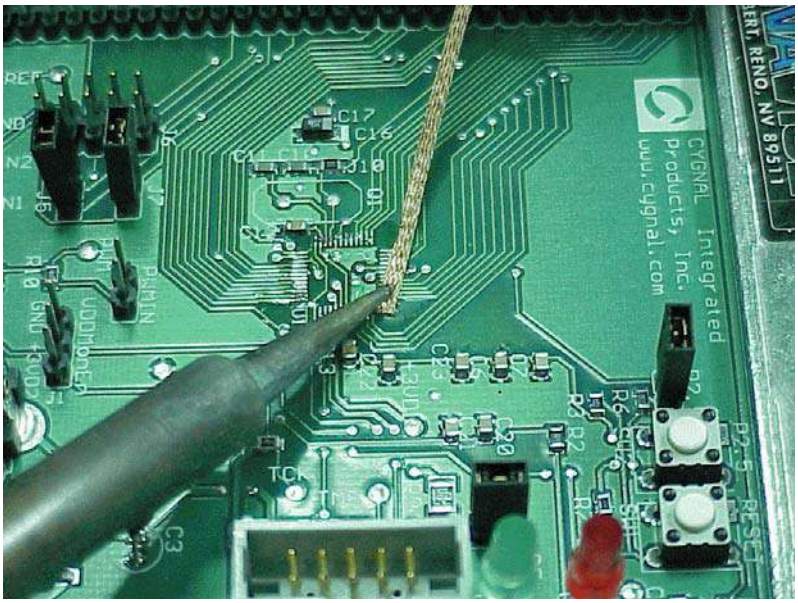

Figure 21. Solder wick to remove solder on the pads

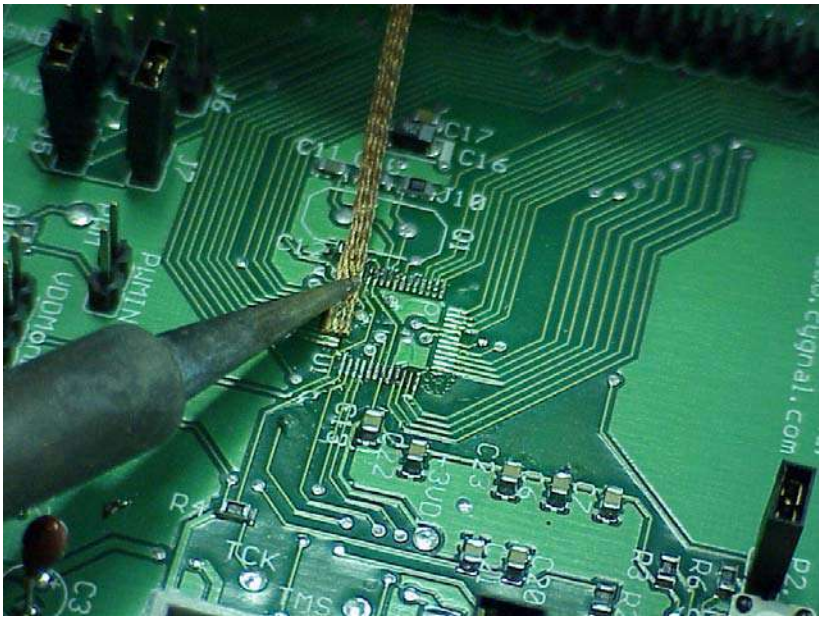

Figure 22. Repeat for all pads

If any pads become loose from the PCB, use a dental pick or other pointed object to re-align the pad (Figure 23 and Figure 24).

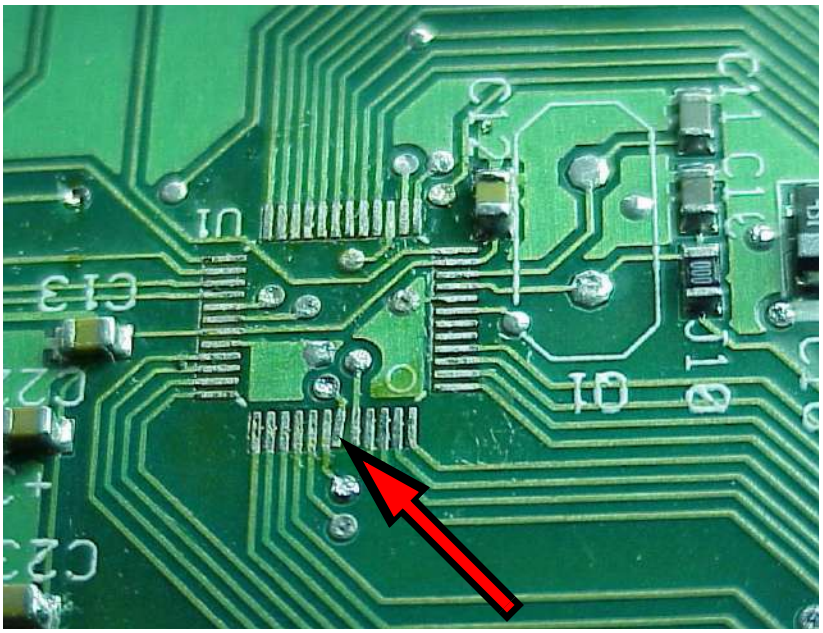

Figure 23. Clean pads but one pad is slightly crooked

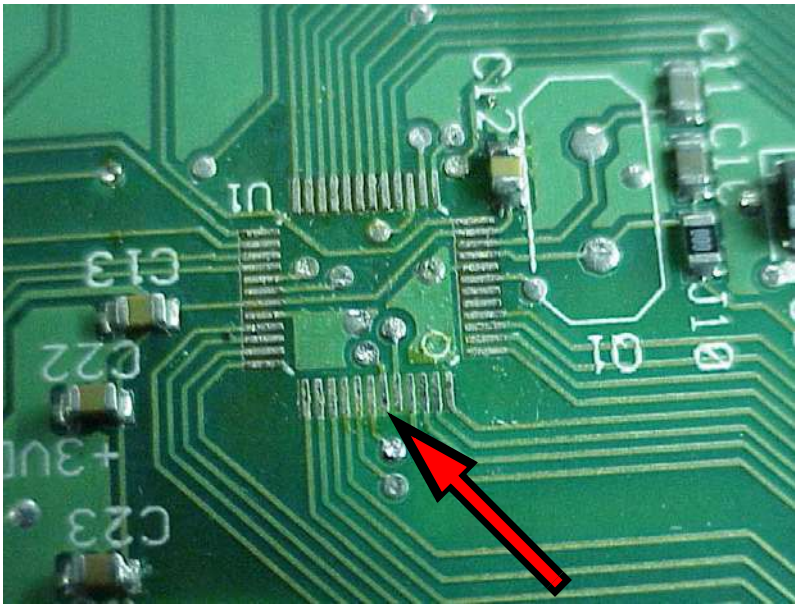

Figure 24. Pad straightened out

B. Soldering a new QFP

The pads on the PCB should be clean and free of any solder.

Carefully place the new QFP device on the PCB using tweezers or another safe method. Make sure the part is not dropped as the leads can be easily damaged.

Align the part over the pads using a small pick or similar tool to push the part. Get the alignment as accurate as you can. Also, make sure that the part is oriented correctly (pin 1 orientation).

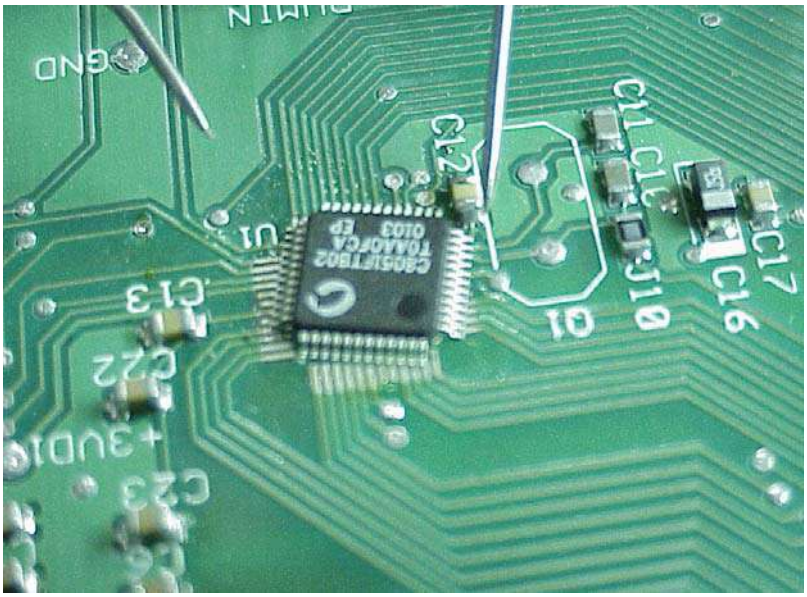

Figure 25. New QFP near pads, ready for alignment

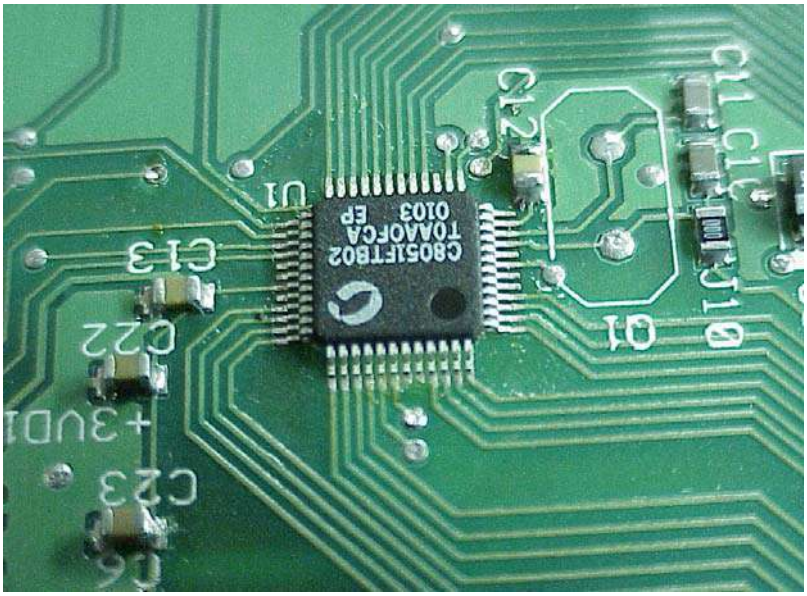

Figure 26. QFP aligned

Adjust the soldering station temperature to 725°F (385°C). Put a small amount of solder on the tip of the solder iron. While holding down the aligned QFP with a pick or other pointed tool, add a small amount of solder flux to the corner leads in two opposite corners. While still holding the part down with the pick, solder down two opposite corner leads on the QFP. Do not worry about excess solder or shorts between adjacent leads at this time. The idea is to anchor down the aligned QFP with solder so it does not move.

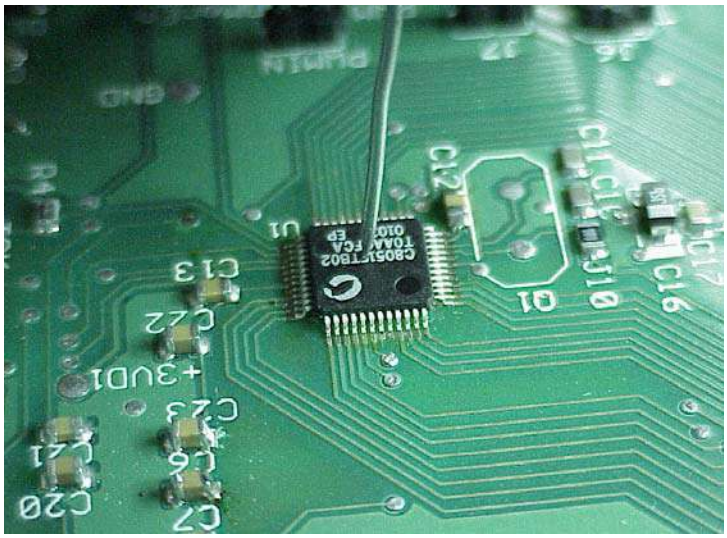

Figure 27. Aligned QFP ready for solder anchoring

Re-check the QFP alignment after soldering the corners. If necessary, make adjustments or remove and start over to get good QFP to PCB alignment.

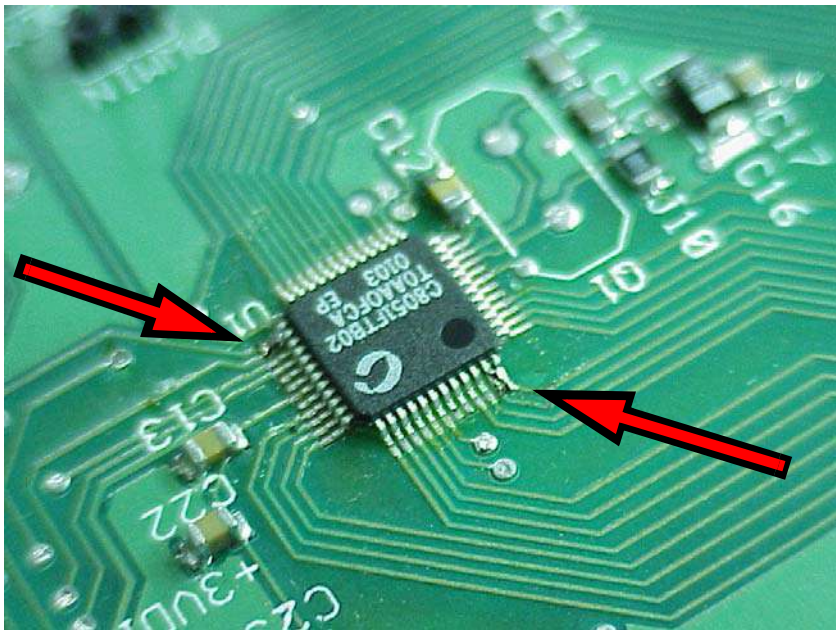

Figure 28. Aligned QFP with corners soldered down

Now you are ready to solder all the leads. Add solder to the tip of the soldering iron. Dispense flux over all the leads to keep them wet.

Touch the solder iron tip to the end of each QFP lead until the solder is seen running up the lead. Repeat for all the leads. Add small amounts of solder as needed to the soldering iron tip. Again, do not worry if you see some solder bridging as you will clean that up in the next step.

When soldering, keep the soldering iron tip parallel with the pins being soldered to prevent excessive solder shorts.

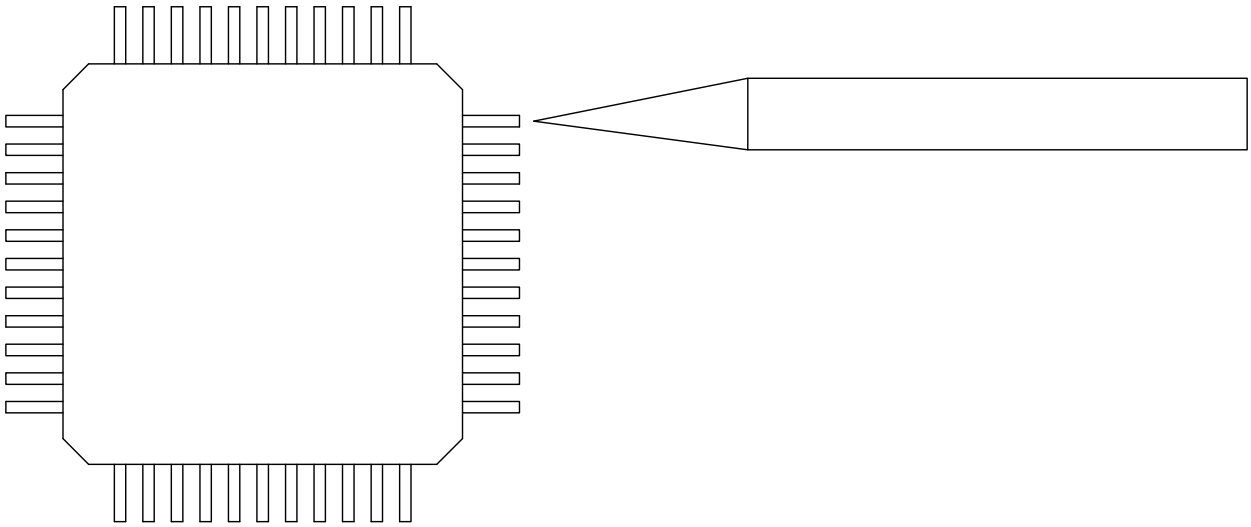

Figure 29. Keep iron tip parallel to pins being soldered

After soldering all the leads, wet all the leads with flux to enhance the solder wicking cleanup. Wick up solder where needed to eliminate any shorts/bridging.

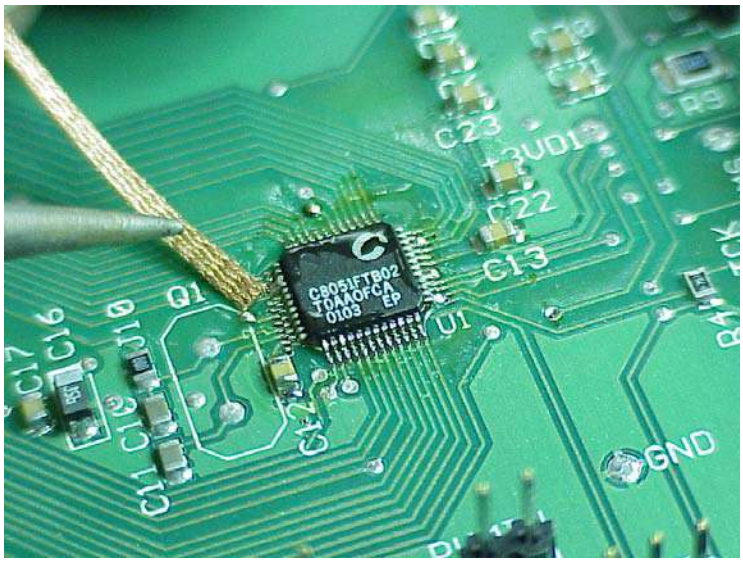

Figure 30. Wicking Solder #1

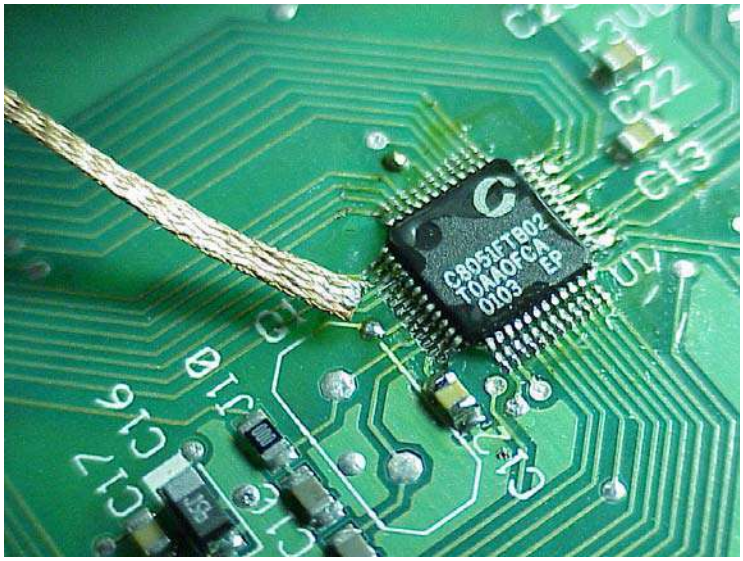

Figure 31. Wicking Solder #2

Hand inspect the board using 4X magnification (or higher) for shorts or marginal solder joints. Solder joints should have a smooth melt transition between each device pin and the PCB. Rework any pins as needed

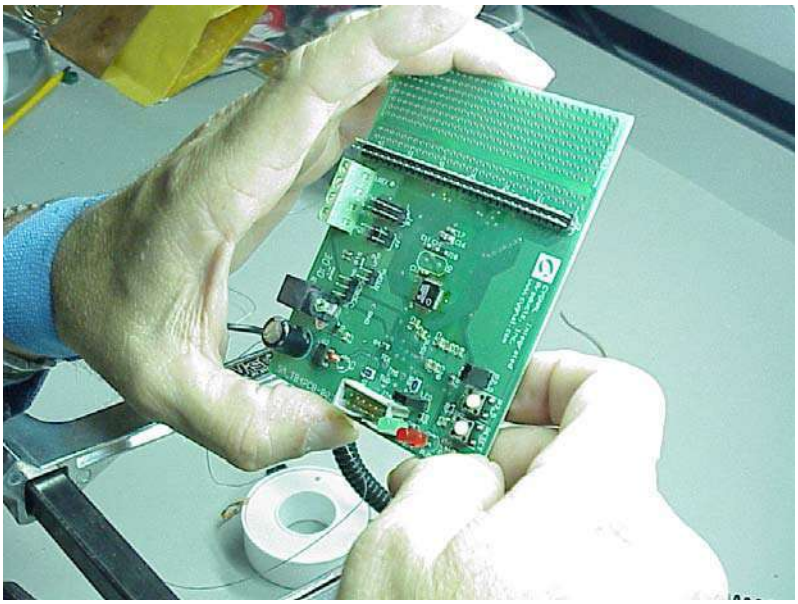

Figure 32. Visual Inspection

After the inspection passes, it is time to clean the flux off the board. Dip the stiff bristle brush into alcohol and wipe in the direction of the leads. Use moderate, but not excessive pressure. Use liberal amounts of alcohol and brush well between the QFP leads until the flux disappears.

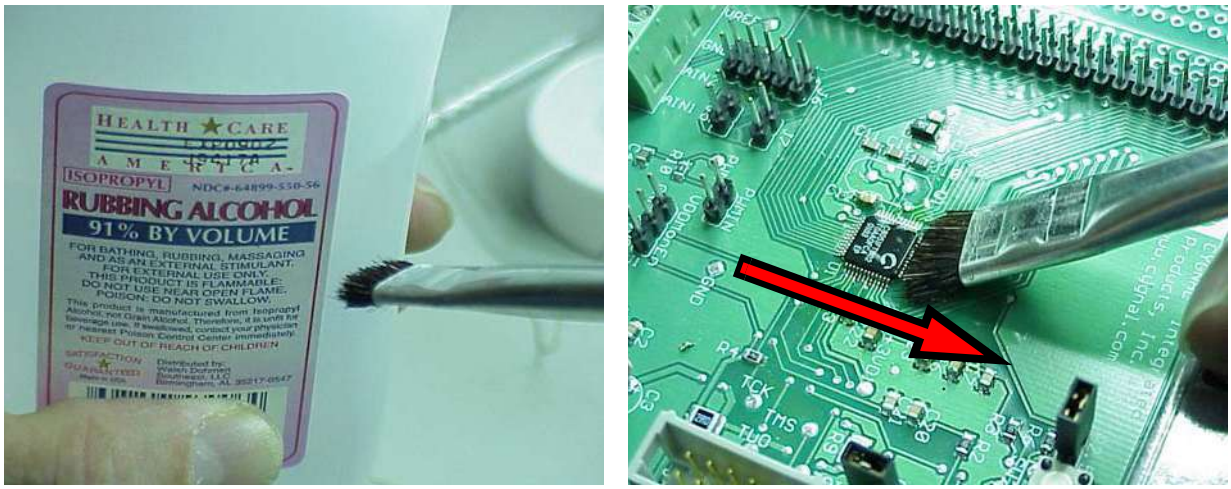

Figure 33. Isopropyl Alcohol and stiff brush used for cleanup. Brush only in direction of leads

Dry the board with compressed dry air or nitrogen. If this is not available, let the board dry for 30 minutes or more to let the alcohol evaporate under the QFP. The QFP leads should look bright and there should be no flux residue.

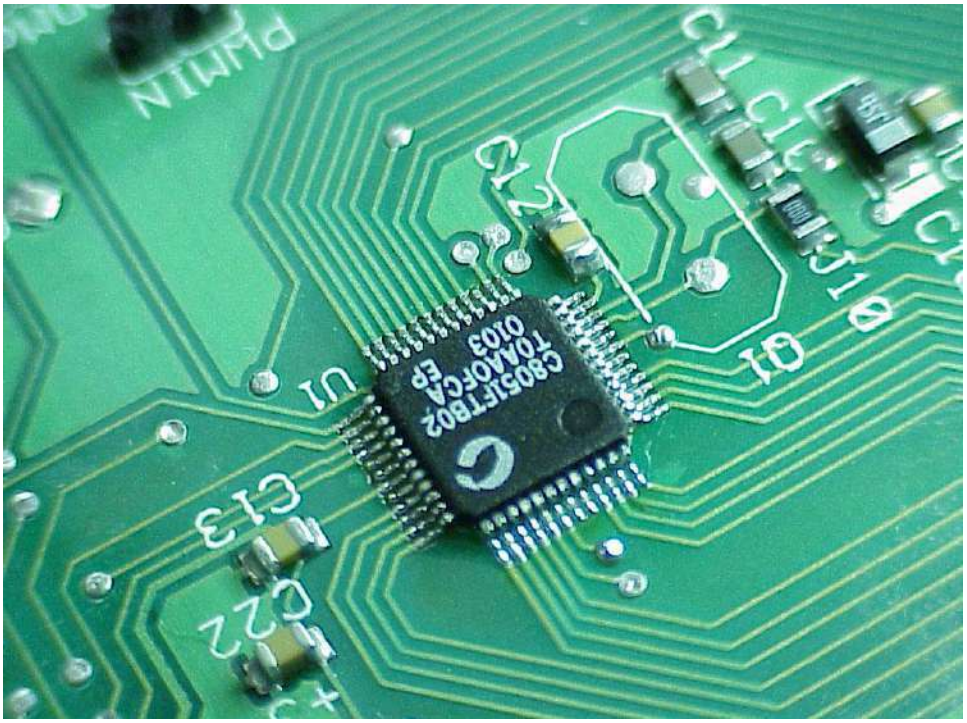

Figure 34. Clean and Pristine

Re-inspect the board for workmanship. Rework any leads if needed.

Figure 35. Stereo zoom inspection station (7X to 40X magnification) helps to inspect solder joint workmanship

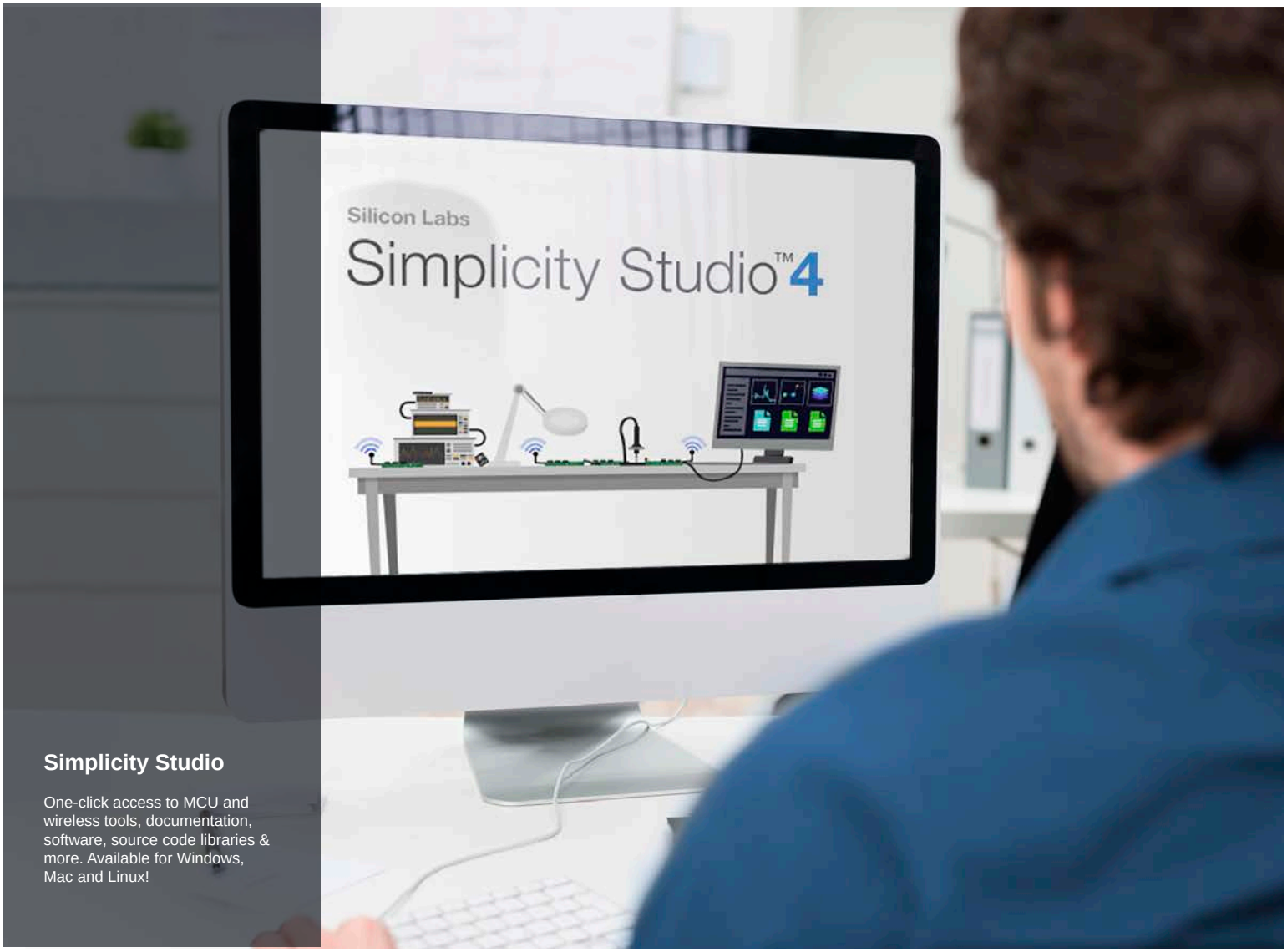

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Soldering Guidelines

Solder0 R0.1

EE400/1
Design

Revision History

Rev.	Date	Contributor	
0.1	September 2005	L. Wyard-Scott	Updates to reflect changed Capstone Design Course format and new de/soldering equipment.
0.0	January 2004	V.J. Sieben, L. Wyard-Scott, E. Tiong	Creation.

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Chapter 1

Soldering Technique

This guide is intended to give an introduction to basic soldering technique. If the reader desires to pursue advanced soldering techniques, there are several books as well as technical institutions that offer detailed courses in the area of soldering.

1.1 Required Tools

Before discussing soldering techniques, one should must set up a "soldering work station". The following is a list of tools for a typical soldering station. See Appendix A for pictures of the various parts listed below.

1. **Variable temperature soldering iron:** used for applying heat to joints during the soldering process.
2. **Damp sponge:** for cleaning soldering iron tip.
3. **Rosin-core solder:** to electrically and mechanically bond a component to the PCB.
4. **Wire cutters or side cutter:** for trimming component leads and stripping insulation from wires.
5. **Needle nose pliers:** for holding, placing and shaping components.
6. **Desoldering pump and/or desoldering braid:** for removing solder.
7. **Scotch tape and/or a "Third Hand":** for securing components.

8. **Safety glasses:** for eye protection. These are mandatory in the lab.
9. **Magnifier:** to provide more detail during intricate work. A magnifying glass is convenient, but an illuminated magnifier is better.
10. **Light source:** to prevent eye-strain.
11. **Ventilation:** to extract and dispel fumes generated during the soldering process.
12. **Flux:** to clean components and PCB pads.
13. **Acid brush:** to assist in the removal of flux residue.

Prior to soldering it is a good idea to have all components organized as it will make populating the PCB more efficient. Make a BOM (bill of materials) for the PCB, and ensure before soldering that the components have been collected. The schematic and PCB layout will also be referred to when populating the board.

1.2 Important Soldering Tips

The following tips provide a quick guideline on how to make proper joints.

Cleanliness: All parts, including the soldering iron tip, must be clean and free from grease, oxidation and contamination. Solder does not flow over contaminated areas; moreover, solder is repelled by dirt. Severe contamination is evident when solder begins to "bead". A common source of contamination is oxidation. Old components and copper boards will often have an oxide layer that prevents a good solder joint. Ensure all components have shiny leads and the PCB has clean traces. An abrasive such as a blue or pink eraser, emery paper, or stell wool can be used to remove the oxidized layer from the PCB board and components.

Tinning: In addition to being clean, the soldering iron tip must also be tinned (coated with solder). Tinning the tip allows solder to flow on the components more quickly rather than the soldering iron tip itself. Tinning involves adding a few millimetres of solder to the tip and then wiping and rotating the tip on the damp sponge to reveal a shiny surface on the tip of the soldering iron: a thin layer of solder will coat or "tin" the tip of the soldering iron. **When done soldering,**

tinning the iron is required to protect the tip from oxidation thereby dramatically increasing its life.

Temperature: Ensure that both the component leads and the PCB's copper layer are heated at the same time. The soldering iron tip should contact both the component and the PCB pad. This will ensure that each surface is relatively close in temperature resulting in a good joint. If there is a temperature difference between the two surfaces, the solder will form a "dry" joint. Soldering irons are typically set around 650 Fahrenheit, depending on the lead-tin ratio of the solder being used. Too much heat causes excessive "sputtering" of flux, and too little doesn't melt the solder in a timely manner.

Duration: The duration that the iron is in contact with the component and PCB is dependent on the size of the joint and your soldering iron temperature. For the typical PCB through-hole joint, it should take a few seconds to heat the joint and apply the solder. This will require practice, so don't expect to be fast if you are a beginner. Excessive heat (several seconds in duration) will damage sensitive semiconductors. If this is a concern, use a heat sink attached to the component leads: sometimes as simple as an alligator clip. These concerns can sometimes be avoided by soldering sockets instead of the semiconductor itself.

Adequate solder coverage: If too little solder is applied, the joint will not make a secure connection and will cause erratic behaviour. However, if too much solder is applied, the joint may bridge with adjacent joints resulting in electrical shorts. How much solder to apply comes with experience. Figs. 1.4 through 1.7 show good and bad solder joints.

Handling: Most modern electronics systems contain static-sensitive devices. Use proper handling procedures to minimize the likelihood of damage: grounding wrist-straps, grounded soldering irons, grounding mats, etc.

1.3 Precautions

Soldering Irons get very hot (600-800^{0}F, 315-425^{0}C), please ensure you follow precautions during use. Basic safety precautions are listed below.

- Never leave your iron turned on while unattended.

- Turn the soldering iron off when it is not being used. If the iron is left on for long periods of idle time, the soldering iron tip will be destroyed through oxidation.
- Eye protection must always be worn when soldering. Hot flux can spit up and into an unprotected eye. **In the Capstone Design Lab, use of eye protection is mandatory.**
- If the cord of the soldering iron is damaged, inform the lab staff who will ensure it is replaced.
- Never set the soldering iron down on anything other than an iron stand.
- To prevent burning your fingers, use needle nose pliers, heat resistant gloves, or a third hand tool to hold small pieces.
- Familiarize yourself with the safe handling of all materials used during the soldering process. This includes solder, flux, alcohol, and desoldering braid. Each has a Material Safety Data Sheet (MSDS) and can be found in the lab or online. "Safe Operating Procedures" are found posted on the wall close to the soldering facilities.

1.4 How to Solder Through-Hole Components

Most of the soldering done in the Capstone Design Lab is through-hole. A through-hole joint is a type of soldering joint in which the component joins with the PCB pad through a physical hole in the board. The following steps will illustrate how to make a proper through hole solder joint on a PCB.

1. Ensure that the printed circuit board and all components are clean. Cleaning can be achieved with a mild abrasive and/or the application of flux.
2. Plug in the soldering iron, turn it on, and let it warm up for 2–3 minutes.
3. Wet the soldering station sponge with the water provided in the lab. Do not wet the sponge in the bathroom or the water fountain.
4. Clean the tip of the soldering iron and tin it with solder.

5. Insert the component into the holes. Ensure that the component is secure by taping the component or by using a third hand. Optionally, the component leads can be clinched as shown in Fig. 1.1. This technique, however, is not recommended for two-sided boards as the flow of solder to the component side is restricted.

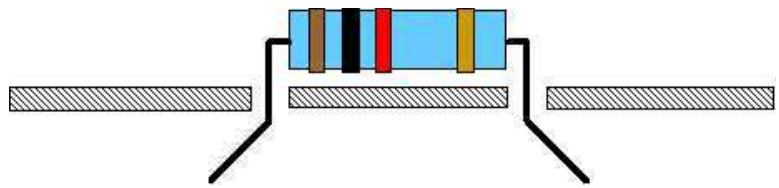

Figure 1.1: Clinched Component Leads

6. Apply the soldering iron tip to one side of joint making contact with the component lead and the board copper foil, ensuring that both are heated up to the same temperature as shown in Fig. 1.2 and Fig 1.3. Notice the tinned tip in Fig. 1.3.

7. Slowly add a few millimetres of solder to the other side of the joint. DO NOT apply solder to the soldering iron tip. If enough heat was applied to the PCB pad and component wire, the solder will flow freely onto the joint.

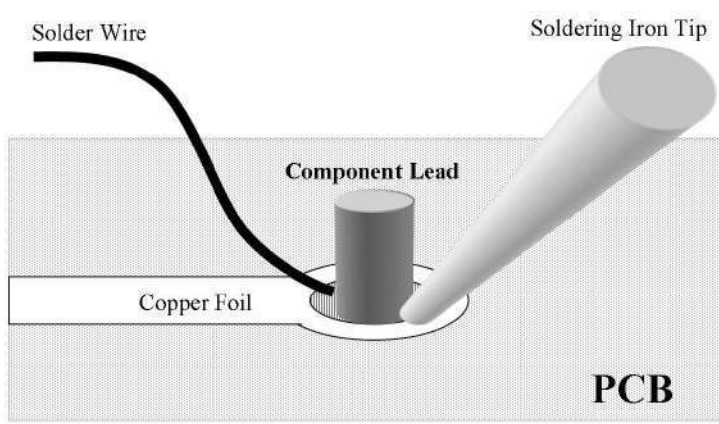

Figure 1.2: Method of Soldering Through Hole Joints

8. Remove the solder when the joint is suitably covered as shown in

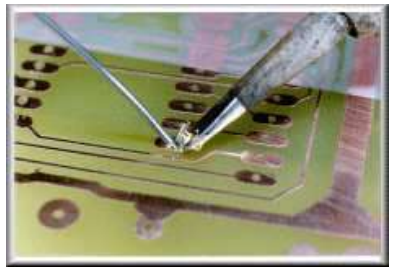

Figure 1.3: Method of Soldering Through Hole Joints, [8]

Fig. 1.4. The goal is to get the joint to be a "fillet": a curve as shown in Fig. 1.4.

9. If the PCB is double-sided, the solder should flow through the hole around the component lead and make a bond on the component side of the board (opposite to the side that the solder was applied). If this "wicking" does not occur, the hole may be undersized, clinching could be blocking the solder's path, or the component lead is not clean.

10. Remove the soldering iron and allow the joint to cool naturally.

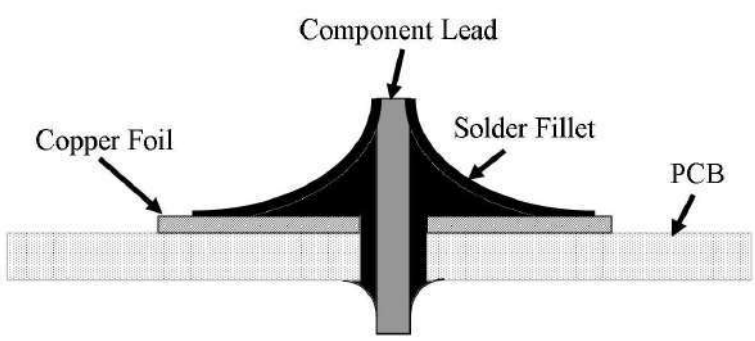

Figure 1.4: Good Solder Joint - Solder Fillet

11. Cut the lead of the component, if necessary.

Fig. 1.6 and Fig. 1.7 below are pictures showing good and bad solder joints.

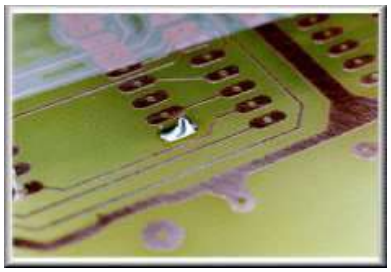

Figure 1.5: Good Solder Joint, [8]

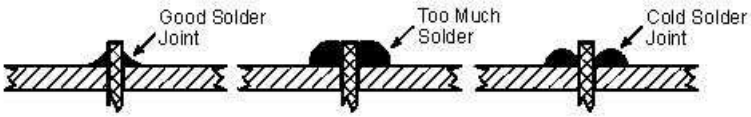

Figure 1.6: Joint Examples, [3]

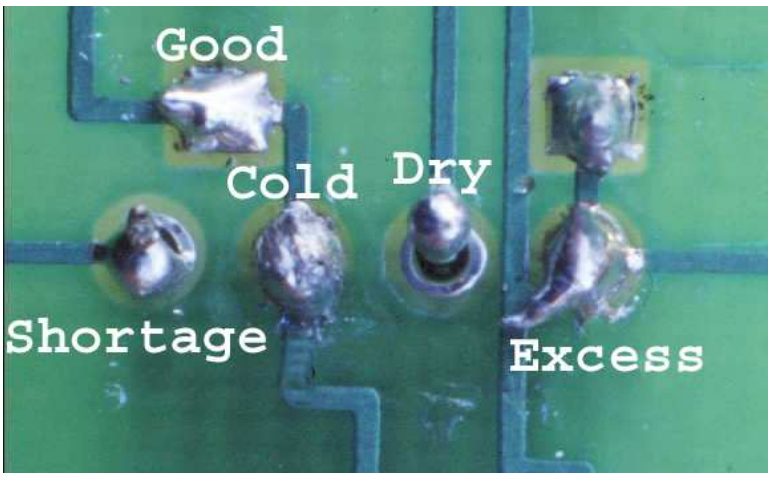

Figure 1.7: Joint Examples, [2]

1.5 How to Solder Surface-Mount Components

Surface mount soldering requires more experience and skill than through hole. It is recommended that one practices with through-hole prior to attempting any surface mount soldering. As the name suggests, surface mount involves soldering a component to either the top or bottom surface of a PCB. Depending on the footprint, the pads are usually a spaced closer together (finer pitch), making the soldering more susceptible to solder bridges, etc.

Figs. 1.8 and 1.9 show examples of good surface-mount solder joints.

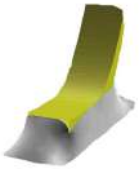

Figure 1.8: Surface Mount Good Solder Joint, [6]

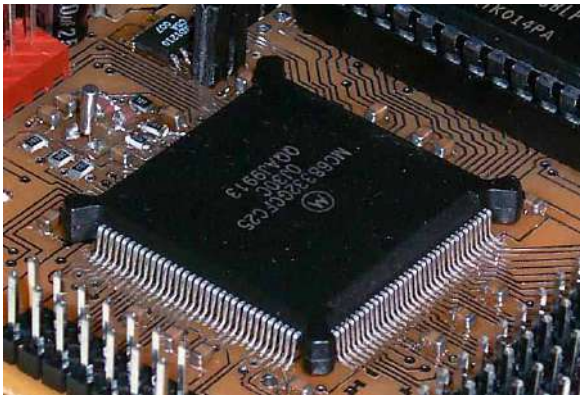

Figure 1.9: Surface Mount IC with Good Solder Joints, [5]

The actual soldering of the joints is similiar to the through-hole method. One difficulty, however, is maintaining the part's alignment on the PCB pads. A good technique is outlined here:

1. Align the component on the PCB pads. This can be aided with the use of tweezers and dental picks.
2. Secure the component to the PCB by applying a small amount of pressure onto the top of the component using a small slot screwdriver.

An index finger resting on the end of the screwdriver provides enough force to secure the device.

3. Solder one of the corner component leads to the PCB pad.
4. Align the remaining pads and solder the opposite corner PCB pad.
5. Solder the remaining pads in a pattern that does not build-up too much heat in the device.

1.6 Wire Connectors and Headers

When PCBs are manufactured they often have connectors to peripheral devices. These connectors are like other components in how they are soldered onto the PCB. However, the plug that matches the connector usually also requires some soldering. **Please note that with very few exceptions, the wire used for cabling is stranded (rather than solid-core) due to its higher strength and flexibility.** Below are procedures for a few of the more common plug types.

1.6.1 Crimp Connectors and Pins

1. Strip off about 1cm of the wire insulation.
2. Place the exposed wire into the crimp-style connector or pin. The wire should just barely show coming out the other side. Some crimp pins have two crimping areas – one for the stripped wire, and the other for the wire *with* the insulation.
3. Crimp the connector with the appropriate crimping tool. Note that the connectors are colour coded to settings on the crimping tool, try and match the correct colour.
4. As added insurance, apply solder to the joint to solidify the connection.

Before crimping all pins destined for a connector housing, start with one and ensure that it fits successfully into the housing. If the crimp is made too tightly, or otherwise mis-shaped, the pin may no longer fit.

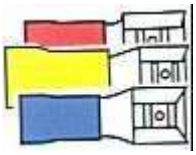

Figure 1.10: Colour Coded Crimp Connectors

Figure 1.11: Crimp connector without shrink wrap, [1]

1.6.2 DB Connectors (Solder Cup Type)

1. Strip off about 5mm of the wire insulation.
2. Tin the wire.
3. Slide shrink wrap on the wire.
4. Place the wire into the DB - connector solder end.
5. Apply the soldering iron tip to the connector and wire.
6. Apply a few millimetres of solder until the joint is adequately covered.
7. Let the joint cool.
8. Slide the shrink wrap over the joint and heat the shrink wrap with a heat gun (or other heat source) until the wrap shrinks around the joint.

1.6.3 Joining Two Wires

1. Slide shrink wrap on one of the wires.
2. Tin or coat each wire with some solder.
3. Join the wires in a way that provides a good mechanical connection (such as twisting together) and apply the soldering iron tip and some solder.

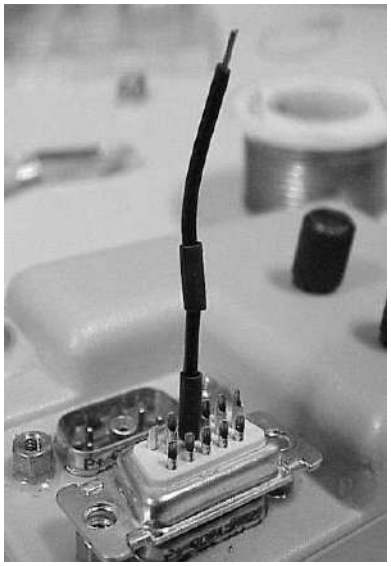

Figure 1.12: DB Connector with shrink wrap, [7]

4. Let the joint cool.
5. Slide shrink wrap over the joint and heat the shrink wrap with a heating gun or a heat source until it the the wrap shrinks around the joint.

Figure 1.13: Two wire joint insulated by shrink wrap, [4]

1.7 Testing Connections

After completely soldering a component to a PCB, it is good practice to ensure connectivity between the component wire leads and the PCB pads they are soldered to. A DMM (Digital Multi-Meter) is sufficient to deter-

mine connectivity; many DMMs include an audible connectivity setting, but failing this, measure the joint resistance.

1.8 Milled Board Soldering

In-lab manufacture of PCBs uses a technique known as "milling". The milling technique involves cutting out the PCB tracks and pads from the copper-clad board.

Due to its construction, a milled PCB is susceptible to solder-bridging across the milled grooves, particularly when an excess of solder is used. Finding a short caused by a bridge is a difficult task, particularly when many solder joints exist. To this end, make a limited number of solder connections and then test for bridges using a multimeter.

1.9 Post-Soldering Cleanup

1.9.1 PCB Cleanup

The flux left behind by rosin-core solders, or perhaps as part of the cleaning process, needs to be removed from the PCB. Due to the flux's sticky nature, dirt gathers and contributes to short-circuiting problems. The most frustrating part of this situation is that a short does not necessarily occur immediately. Weeks, or even years later, a short can develop.

To remove flux, alcohol is used. Apply the alcohol liberally and then brush away with an acid brush, starting at the center of the PCB and working out toward the edges. This is a time-consuming task, but a clean board is well-worth the effort.

1.9.2 Work Area Cleanup

The importance of keeping your work area clean cannot be emphasized enough. When clear of obstructions and garbage, handling a hot soldering iron is safer. The soldering process itself involves chemicals and substances which are known to have ill-effects in humans. Wiping-down the work-area surfaces with a moist paper towel will help reduce some contamination. When you are done soldering, **wash your hands with soap and water** to get rid of contamination. The primary concern here is accidental ingestion of the chemicals. For more information, please refer to the Safe Operating Procedures, posted in the lab's soldering area.

Chapter 2

Desoldering Technique

Desoldering may be required for several reasons:

- a component may have failed
- a wrong part was installed;
- a design modification necessitates a change; or
- if a board contains expensive components that can be salvaged.

Whatever the reason, there are three common techniques to remove solder from a joint: using a desoldering pump, a desoldering wick, or desoldering iron.

Regardless of the method used, if it is permissible to destroy the part during removal, then a lot of time and effort can be saved. For instance, using wire cutters to trim off all the pins of a through-hole IC so they can be removed individually makes the removal process much easier. In most cases, avoiding damage to the PCB is of paramount importance.

2.1 Solder Pump/Sucker

A desoldering pump is exactly what it sounds like: a pump that sucks up solder. Usually the pump is spring-loaded and provides a recoil when released. The four steps below outline how to desolder a joint using a desoldering pump.

1. Prime the desoldering pump. This involves depressing the desoldering pump spring. The pump will click when correctly depressed.

2. Heat the joint from one side with the soldering iron tip. Wait 1-2 seconds until the solder begins to melt from the soldering iron heat.

3. Put the pump tip on the other side of the joint. Don't be afraid to actually touch the joint.

Figure 2.1: Desoldering with a Solder Pump, [8]

4. Press the desoldering pump spring-release button to suck up the solder.

This procedure should be repeated if the joint has a significant amount of solder. If done correctly the joint should eventually look as shown in Fig. 2.2 shown below.

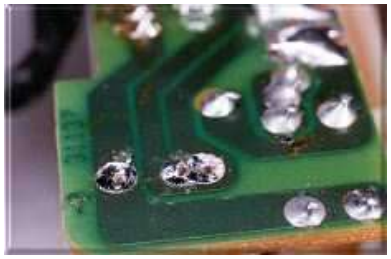

Figure 2.2: Clean Joint from Desoldering with a Solder Pump, [8]

2.2 Desoldering Braid/Wick

A desoldering braid removes solder from a joint using a technique known as "wicking". Desolder braid is a piece of material that sponges up molten solder by capillary action that draws solder away from the joint the braid. The following procedure outlines the basic steps involved in desoldering a joint using desoldering braid.

1. Place the desoldering braid over the joint.
2. Press the desoldering braid onto the joint with the soldering iron tip. This will apply heat to the desoldering braid and the joint allowing the molten solder to flow.
3. Wait for the solder to melt. The solder should flow onto the braid and away from the joint.

Figure 2.3: Desoldering with a Solder Wick, [8]

4. Cut off the solder coated portion of the desoldering braid. **There should be no copper visible in the portion that is removed: braid is very expensive.**

2.3 Desoldering Iron

Using a desoldering iron, available with higher-end soldering stations, is similar to using a solder sucker. The desoldering iron is essentially a soldering iron with a built-in vacuum.

1. Make contact between the iron and the joint to be desoldered, ensuring the vacuum opening is not blocked.
2. Once the solder on the joint has become molten, depress the button on the iron to activate the vacuum.

It is very important for the life of the desoldering iron that the vacuum assembly be cleaned after every session of use. Please ask the lab personnel for a description of the cleaning procedure.

As with a normal soldering iron, the desoldering iron tip should be tinned before and after every use.

2.4 Removing Components Effectively

To remove a component with little or no damage to the PCB or component takes practice and **patience**. Often when removing a component, PCB pads and tracks may be damaged by "lifting" off the board. Below are some tips that may be useful when removing components from a PCB.

- Desolder all joints pertaining to a component prior to removal. It may be necessary to go over the joints several times before all the solder is removed. Practice patience.
- Use pliers and *gently* pull on components while applying heat to the joints. The assistance of a friend can help with this.
- Do not pull with force, because the PCB pads and tracks will be damaged.
- Do not try and remove components by prying them.
- Do not try to push the component out of the holes with the soldering tip. This will certainly lift the copper pad off of the PCB and ruin the iron tip.
- In order to get better thermal conductivity between the iron and the solder joint, it is sometimes effective to *add* a small amount of solder.

Chapter 3

Glossary

BOM: Bill of Materials, which contains a list of all components and values contained on a particular PCB. Used as a "shopping list".

Desoldering Braid: A material used to remove solder with capillary action.

Desoldering Pump: A device used to remove solder with a swift vacuum action.

Flux: Cleans the surfaces that are being heated by bringing contaminants to the surface. Most solders include flux in their core. For excessive contamination use a flux pen.

Footprint: The spacing pattern or layout of pads for a particular component or integrated chip, as used on a PCB.

PCB (Printed Circuit Board): A fibreglass board upon which copper traces are laminated to make connections between various components. The copper traces serve as flat wires connecting various components.

Shrink Wrap: A tube that fits over a wire, that when heated shrinks to provide insulation and support for the joints.

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[8] A. Winstanley. The basic electronics soldering and desoldering guide. Technical report, Feb 1999. http://www.epemag.wimborne.co.uk/solderfaq.htm.

Appendix A

Pictures of Tools

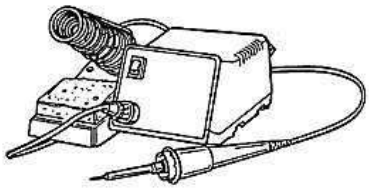

Figure A.1: Soldering Iron

Figure A.2: Solder Wire

Figure A.3: Desolder Pump

Figure A.4: Desolder Braid

Figure A.5: Third Man

Soldering

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Introduction

Soldering is a process used for joining metal parts to form a mechanical or electrical bond. It typically uses a low melting point metal alloy (solder) which is melted and applied to the metal parts to be joined and this bonds to the metal parts and forms a connection when the solder solidifies. It is different to welding in that the parts being joined are not melted and are usually not the same material as the solder.

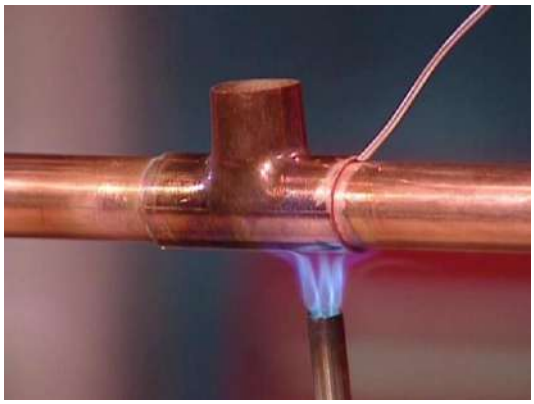	
Soldering copper pipe	Sheet metal fabrication

Figure 1 – Different Types of Soldering

Soldering is a common practice for assembling electrical components and wiring. Although it can be used for plumbing, sheet metal fabrication or automotive radiator repair the techniques and materials used are different to those used for electrical work. This document is intended to provide guidance on the safe working methods and proper tools and techniques for soldering of electrical components.

1 Soldering Printed Circuit Boards

Soldering may be used to join wires or attached components to a printed circuit board (PCB). Wires, component leads and tracks on circuit boards are mostly made of copper. The copper is usually covered with a thin layer of tin to prevent oxidization and to promote better bonding to other parts with solder. When soldering bare copper wires they are often “tinned” by applying molten solder before making a joint.

	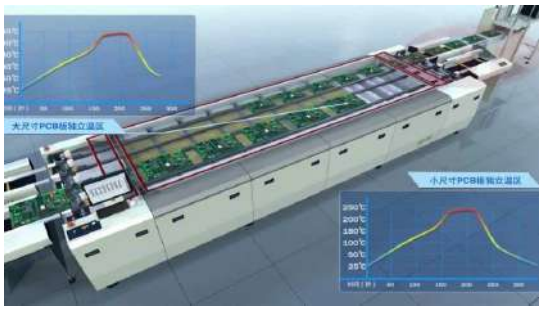
Hand soldering components on PCB	Industrial oven for surface mount

Figure 2 – Different Types of PCB Soldering

2 Types of Solder

There are different types of solder used for electrical work. They are broadly classified as tin/lead solders or lead free solders. Tin/lead solders have been used for many years because of their ease of use however they have been phased out of commercial use due to the harmful effects on humans and the environment. Tin/lead solder is still available and is used by “hobbyists” and other non-commercial users as it is still easier to use than lead free types. When using tin/lead (or leaded) solder there are additional safety precautions that must be observed.

Different gauges of solder wire	Solder composition is labelled (Lead free on left)

Figure 3 – Different Types of Solder

3 Types of PCB

Printed circuit boards (PCBs) are populated by electronic components and these may be “surface mount” or “through-hole” types.

3.1 Through-Hole Components

As the description “through-hole” suggests, the leads of the component are passed through holes in the PCB and then soldered to a “pad” on the reverse side of the PCB. Soldering is accomplished by heating the component lead and PCB pad with a soldering iron and melting solder wire into the joint. This type of construction was common from the 1960’s until early 2000’s and is still used by hobbyists and in small scale production where manual assembly is preferred.

3.2 Surface Mount Components

Commercial circuits are mostly of the surface mount type as these are cheaper to make, more compact and easier to automate assembly. For surface mount construction the component’s pads are on the same side of the PCB as the component and the component connections sit onto these pads. Soldering is accomplished by applying solder paste onto component pads on the PCB, placing the component onto the paste and then heating the entire assembly to melt the solder. Commercial assembly uses ovens to heat the boards. Hobbyists can also use surface mount components and soldering can be accomplished by applying solder paste and melting with a hot plate, small oven or soldering iron. Some surface mount joints can be soldered using a soldering iron and solder wire.

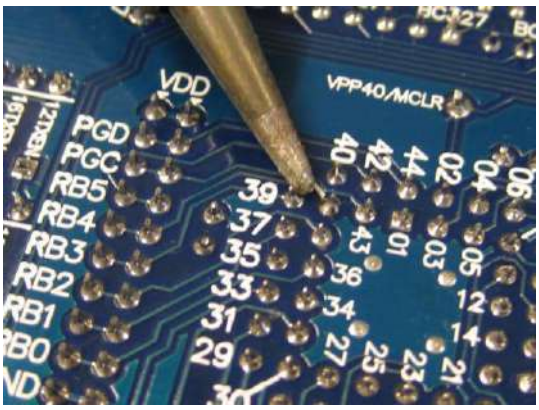	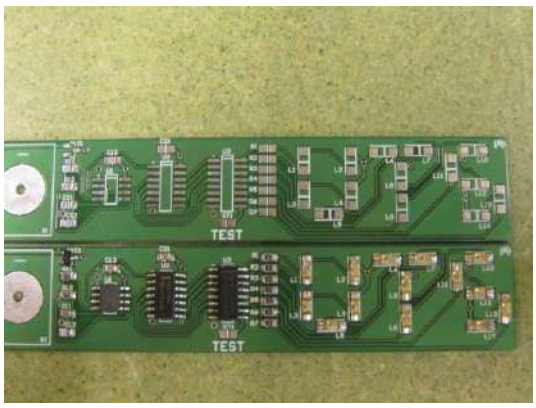
Through-hole PCB (non-component side)	Surface mount PCB (component side)

Figure 4 – Different Types of PCB

4 Flux

For electrical soldering both solder wire and solder paste contain flux. This helps to clean the surfaces being soldered and prevent oxidization of the hot solder. The composition of the flux will vary depending on whether it is in a paste or wire, leaded or unleaded solder. Solder wire usually contains a flux called “rosin”. Most fluxes will produce fumes when the solder is heated and these fumes are likely harmful to your health. For occasional soldering it may be sufficient to have a well-ventilated workspace but for longer or repeated exposure a fume extractor should be used. Solder flux can also cause solder to spatter and eye protection should be worn when soldering.

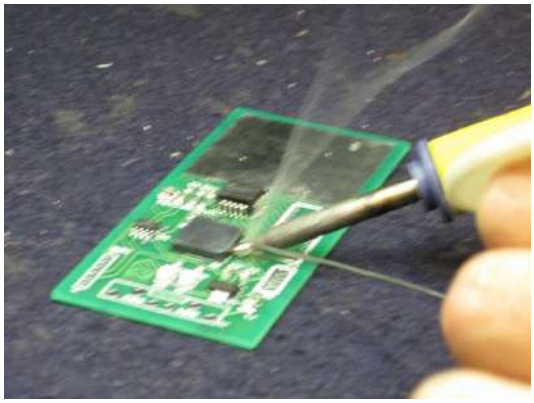	
Fumes produced when soldering	Workstation with fume extraction system

Figure 5 – Fumes and Fume Extraction Systems

5 Soldering Irons

Soldering irons come in many varieties and sizes. Soldering irons may be electric, gas powered or externally heated. Most common types are electric. Simple electric soldering irons have no controls and you simply plug them in and wait for them to heat up. Their temperature is regulated by the power of the heating element and heat loss to the environment. Some soldering irons have temperature controls which allow the user to set a desired operating temperature for the soldering iron. This is useful if the soldering iron is being used for different types of solders which have different melting points or if the soldering iron is being used for other purposes such as heating heatshrink. It also introduces a problem if the user does not set an appropriate temperature for the work, solder can be overheated and decompose. Hotter is not better! A temperature of around 320 °C works well for 60/40 leaded solder. Some temperature controlled soldering irons use interchangeable tips to change the temperature at which they operate.

	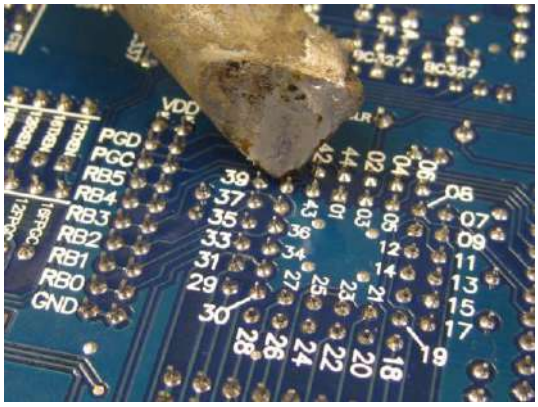
A range of electric soldering irons	Choose an iron appropriate for your task!

Figure 6 – Types of soldering irons

Adjustable temperature soldering stations	Different tips set the temperature for this station

Figure 7 – Types of soldering stations

5.1 Tips

Heat is transferred from the tip of the soldering iron to the joint by thermal conduction enabled by metal to metal contact between the tip and joint. The tips of soldering irons come in various shapes and sizes to enable the best contact to be made. Most tips are either conical or chisel shapes. The shape is largely a personal preference and you can use whichever type works best for you. The size of the tip should be selected to allow the tip to be placed against the joint being soldered without interfering with adjacent parts. The tip should be large enough to conduct sufficient heat into the joint to allow the solder to melt and flow properly. The choice of tip size is not a precise calculation and a “normal” size tip will work for most joints on a PCB.

5.2 Tip Contamination and Cleaning

The thermal conduction from the tip to the joint may be inhibited by contamination on the tip. This contamination can be formed by burnt solder flux or oxidized solder. To make best thermal contact the tip should be cleaned using a tip cleaner(!). Two types are a wet sponge or a brass wire wool. The wet sponge removes the contaminated material when the tip is wiped across it, the water in the sponge cools the solder and the mechanical abrasion removes the contamination leaving a thin coating of clean solder on the tip. This method can cause the tip temperature to dip momentarily. The brass wire wool type removes the contamination by mechanical abrasion and bonding contaminated solder to the brass. The tip is pushed into the brass wool and when it is withdrawn the tip is clean with a thin coating of solder. You must not “wipe” the tip on the brass wool type because the springiness of the brass wool may flick molten solder which may cause burns to people or objects. You should never “flick” excess solder from the soldering iron as this may also cause burns or damage.

Tip contaminated with old solder and burnt flux	Brass wool type tip cleaner

Figure 8 – Dirty tip and brass wool cleaner

6 Ovens and Hot Plates

For surface mount soldering the heat is usually applied to the whole PCB and all components soldered at the same time. For commercial work this is done in large ovens, often with conveyors to move the boards through the oven. For small scale work simple infrared ovens are available. Another technique uses a hotplate. The same considerations for temperature apply, although because the heat source does not come into contact with the solder or flux, contamination is less likely. Time and temperature are considerations with these methods as the components are exposed to the high temperature for the period required for the solder paste to melt and flow.

Infrared oven for surface mount soldering	Hotplate for surface mount soldering

Figure 9 – Oven and hot plate used for surface mount soldering

7 Desoldering

If a part that has been soldered needs to be replaced it needs to be “de-soldered”. Depending on the part and type of joint it may be possible to simply re-melt the solder and remove the part, or it may be necessary to remove the solder from the joint so the part can be freed. Some methods for removing solder are solder wick, solder sucker or de-soldering tool. Solder wick is a copper braid which is applied to the joint and heated with a soldering iron. As the solder in the joint is melted it is drawn into the solder wick like a sponge and is removed from the joint. A solder sucker is a spring loaded syringe or rubber bulb. The tip of the solder sucker is placed near the joint as the joint is melted by a soldering iron. When the sucker is operated a vacuum is created which draws the molten solder from the joint into the body of the sucker. A de-soldering tool is a type of soldering iron with a hollow tip and is connected to a pump or vacuum source. The tip of the de-soldering tool is placed onto the joint, typically over a component lead, and once the solder has melted the pump is operated to draw the molten solder away.

Solder wick, syringe type sucker, vacuum de-soldering tool	Hot tweezers or Hot air nozzle are options for SMDs

Figure 10 – Desoldering tools and tweezers for surface mount devices

8 Hazards involved in soldering

8.1 Heat

Although solder has a relatively low melting point this temperature is more than high enough to cause serious burns to people or objects. It is important to hold the soldering iron only by the insulated handle, never touch the heating element or tip when the soldering iron is on. The soldering iron will remain hot for some time after it is turned off so always check that it has cooled down before touching it, e.g. if changing the tip. When you are not soldering always keep the soldering iron in a proper holder so that you don't touch it accidently and it doesn't heat or burn other objects such as the benchtop. Don't hold parts being soldered with your hands as these will also be heated when being soldered. Don't flick molten solder from the soldering iron or wipe the tip on brass wool type tip cleaners.

If using a hot plate for surface mount soldering do not touch the hot plate. Use utensils such as pliers to place and remove PCB's from the hotplate. If using hot air tools for soldering, de-soldering or rework, do not direct the hot air stream onto yourself or other people. If using an oven allow the PCB to cool before handling or use utensils. Don't place hot PCB's on temperature sensitive surfaces.

If burns occur they should be treated by holding under cold running water for several minutes and assistance sought if burns are severe. Incidents should be reported.

8.2 Toxic materials

Leaded solder contains lead which is a harmful material. Use of this type of solder will probably involve handling it and your skin may become contaminated by it. Although it is unlikely that the lead can be absorbed directly through your skin it may be ingested indirectly if it is transferred by handling food whilst your skin is contaminated. Always wash your hands thoroughly before eating or handling food.

Solder flux creates fumes when heated during soldering which may be harmful if inhaled. Use a fume extractor to avoid inhaling fumes.

8.3 Spattering

Solder and flux can spit or spatter when heated. Always wear eye protection (safety glasses) when soldering.

8.4 Electrical Safety

Electric soldering irons are plugin appliances and must have a current safety test tag. The test will confirm that the soldering iron conforms to electrical safety standards and has not been damaged at the time of the test. Before use you should visually check that the soldering iron does not have damage such as melted insulation on the lead, broken or cracked handle or exposed conductors. Don’t use damaged equipment and report the damage.

For electrical safety the exposed metal parts such as the tip and heating element are earthed. Don’t solder on any live equipment as contact with the earthed tip may cause damage to the equipment or soldering iron.

SMD Soldering

Information & Instructions

This is a walkthrough of a SMD Soldering Workshop. The following information and instructions can be used as a simple method for soldering SMD components. The recipient of this information should acknowledge the danger of soldering *(written on the back page of this pamphlet)* before attempting to solder.

Recommended Tools:

- Soldering Iron
- Solder
- Tweezers
- Solder Wick
- Flux Pen

1 Add solder to one pad.

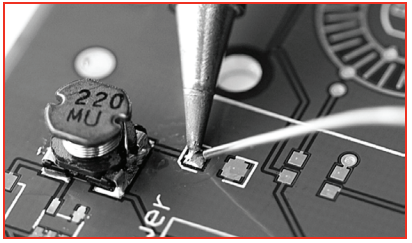

2 While that pad is molten, slide the component into place. Do not push down from the top - slide the component into the blob of solder horizontally.

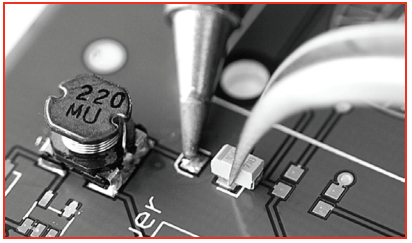

3 Align the component while connection is still molten.

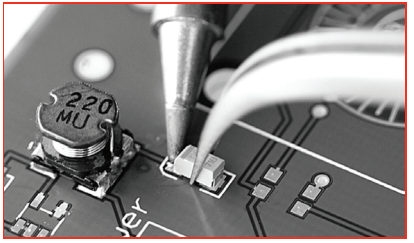

4 Once you have good alignment, continue to hold the component in place, and remove your iron. Continue to hold component for 1-2 seconds while the solder joint solidifies.

5 From above, the alignment looked good. From the side, you can see the rear pad is hovering slightly above the PCB. This can lead to problems on multi-pin components (open connections). Be sure the component is flush up against the PCB before soldering more connections. Re-grip the component, re-heat pad 1 and push the component flush against the PCB.

6 This is how a tantalum capacitor should look after making both solder connections.

7 If alignment is not good, do not solder more than 1 pad! Re-heat the joint, re-adjust component until aligned correctly, then move on to soldering other connections.

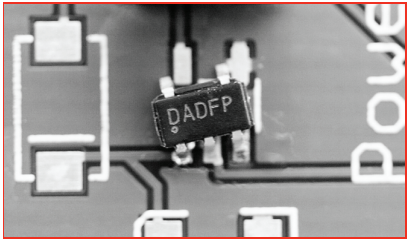

8 This is bad. It would be nearly impossible to finish the connections on this part. Make sure you have the component flush against the PCB.

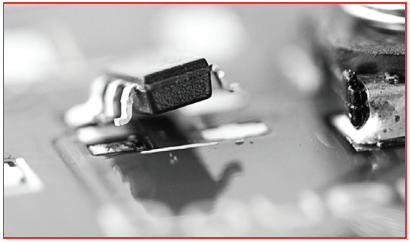

9 If you solder multiple pins together, don't worry about it! It can be easily fixed. Do not worry about jumpers! There are actually three pins under that blob.

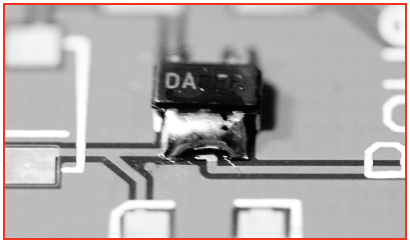

10 Pull out some solder wick. Put a small amount of solder on the end of your iron (this will transfer heat from iron to wick to the jumper). Sandwich the wick in between the iron and the solder jumper.

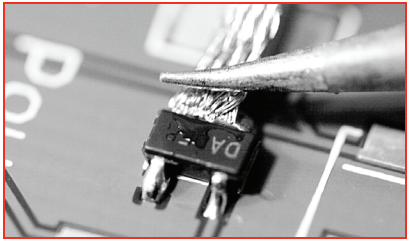

11 Hold still for 2-3 seconds. You will see solder start to flow up the wick. Once the excess solder has flowed into the wick, carefully lift up the wick and your iron in one fluid motion.

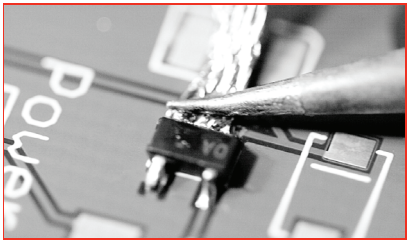

12 Nice and clean!

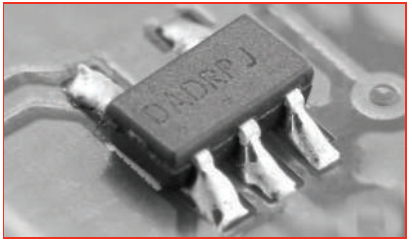

13 Bad bad bad. There was not enough solder for the connection on the left. Middle pin is lacking solder and should have been heated for longer. Right pin has had solder applied by an iron rather than applied to two metal contacts (the board and the pin).

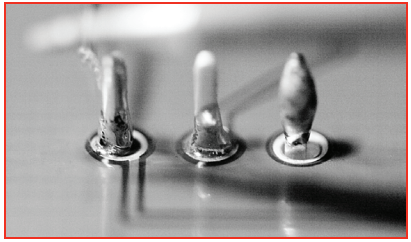

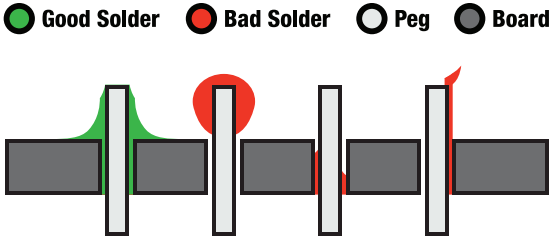

TIPS & TRICKS

A Solder flows smooth all the way to the bottom.

B Error: Solder balls up on top of pad, not connecting pin to pad.
Solution: Flux then wick. If you wick too much add solder.

C Error: Too little solder makes for weak connection.
Solution: Flux then add solder.

D Error: Bad Connection... and ugly... oh so ugly.
Solution: Flux then add solder.

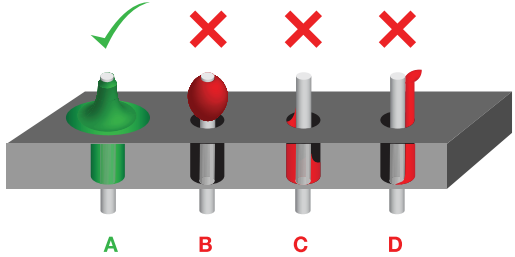

Safety Issues

Soldering

The tip of the iron is normally 700 °F, hot enough to melt metal. It is normal for the handle of the soldering iron to heat up a bit. Hold it like a pencil and move your hand further away from the tip if the heat is uncomfortable. The solder smokes because the rosin inside the solder is burning off - it's not harmful.

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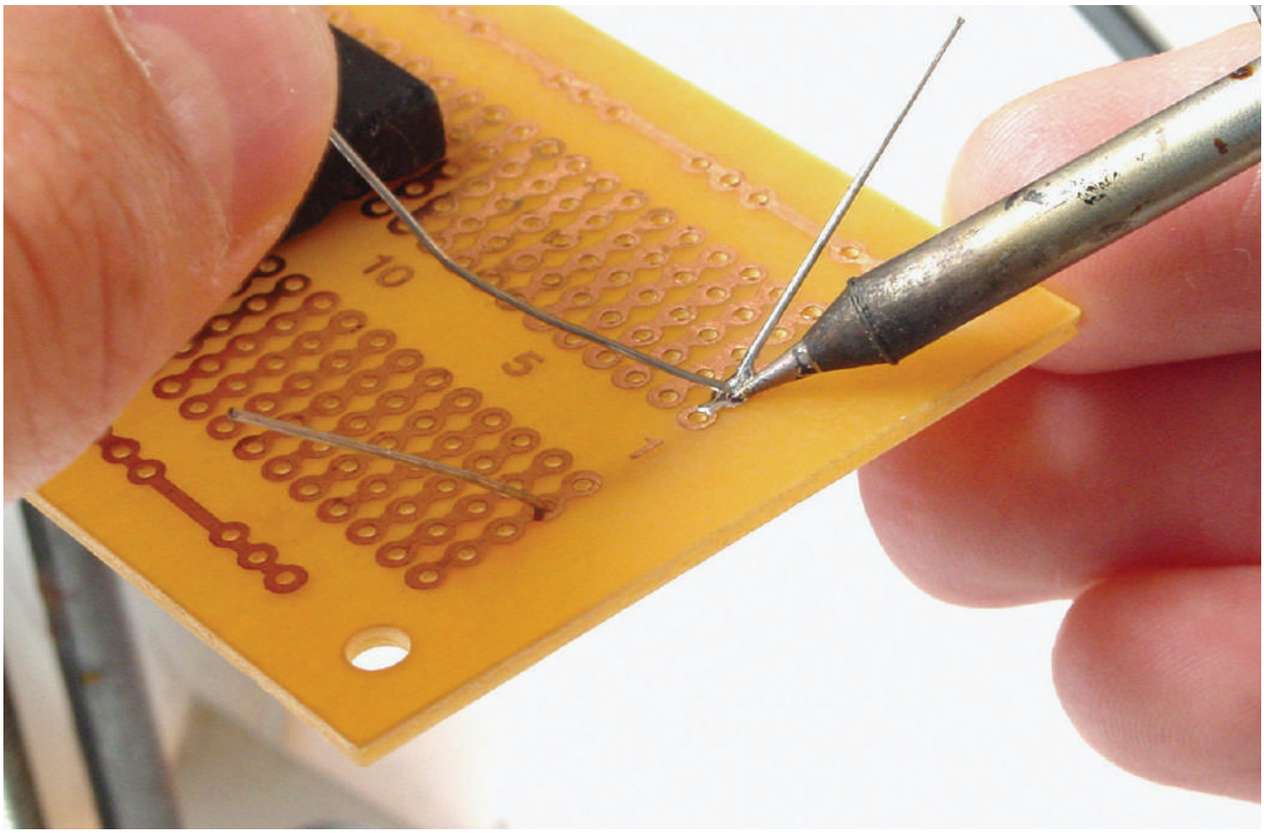

Soldering and Desoldering

Step-by-step instructions for making (and unmaking) the perfect solder joint.

By Joe Grand

The two key parts of soldering are good heat distribution and cleanliness of the soldering surface and component. With practice, you'll become comfortable and experienced with the process.

In this primer, I'll explain how to solder a component onto a printed circuit board (PCB). I'll also provide desoldering tips and show you how to remove a surface-mount component from a printed circuit board using a Chip Quik kit. And I'll show you how to remove a component by removing the solder in a way that won't damage the components or the circuit board.

Photography by Joe Grand

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Tools of the Trade

Soldering iron You could pay as little as $10 or as much as $1,000 for a soldering iron. I recommend a fine-tip, 700°F, 50W soldering stick iron. A good general-purpose iron for hardware hacking is the Weller W60P Controlled-Output Soldering Iron, which sells for under $70.

Solder Should be thin gauge (0.032" or 0.025" diameter) 60/40 rosin core.

Desoldering tool (aka solder sucker) A manual vacuum device that pulls up hot solder, useful for removing components from circuit boards. I like the one RadioShack sells (#64-2098, $10).

IC extraction tool Helps lift integrated circuits from the board during removal/desoldering.

Chip Quik SMD Removal Kit Allows you to remove surface mount components quickly and easily. Chipquik.com offers the kit for $16.

Sandpaper A very fine-grit sandpaper is useful for removing oxidation from component and circuit board surfaces.

Desoldering braid Woven metal material used to wick up melted solder.

Small, flat-tip screwdriver Comes in handy for removing some types of components.

Needlenose pliers, wire cutters, and vise These common tools will make your job easier.

The Chip Quik SMD Removal Kit

The Chip Quik SMD Removal Kit allows you to quickly and easily remove surface-mount components such as PLCC, SOIC, TSOP, QFP, and discrete packages. The main component of the kit is a low-melting-temperature solder (requiring less than 300°F) that reduces the overall melting temperature of the solder on the SMD pads. Essentially, this enables you to just lift the part right off the PCB.

INCLUDES

- Alcohol pads for cleaning the circuit board after device removal
- A special low-melting-temperature alloy
- Standard no-clean flux
- Application syringe

Desoldering Tips

FOR STANDARD THROUGH-HOLE COMPONENTS

- First grasp the component with a pair of needlenose pliers. Heat the pad beneath the lead you intend to extract and pull gently. The lead should come out. Repeat for the other lead.
- If solder fills in behind the lead as you extract it, use a spring-loaded solder sucker to remove the excess solder.

FOR THROUGH-HOLE ICs OR MULTI-PIN PARTS

- Use a solder sucker or desoldering braid to remove excess from the hole before attempting to extract the part.
- You can use a small, flat-tip screwdriver or IC extraction tool to help loosen the device from the holes.
- Be careful to not overheat components, since they can become damaged and may fail during operation.

BEFORE YOU START

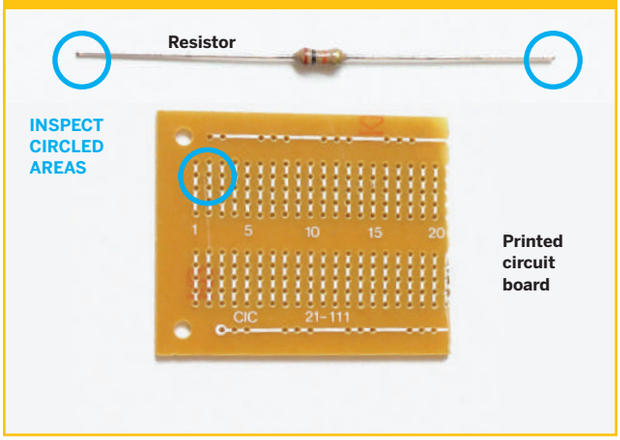

Joe Grand is the president of Grand Idea Studio, Inc. (joe@grandideastudio.com), a product-development and intellectual-property licensing firm. He specializes in embedded system design, computer security research, and inventing new concepts and technologies. He is also a host on The Discovery Channel's *Prototype This*.

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SOLDERING

SOLDERING A RESISTOR TO A CIRCUIT BOARD

BEFORE YOU START

Inspect the leads or pins for oxidation. If the metal surface is dull, sand with fine sandpaper until shiny. In addition, use the sandpaper to clean the oxidation and excess solder from the soldering iron tip to ensure maximum heat transfer.

This simple example shows the step-by-step process to solder a through-hole component to a printed circuit board (PCB). I used a piece of prototype PCB and a single resistor.

DANGER: It's important to consider safety precautions. Improper handling of the soldering iron can lead to burns or other physical injuries. Wear safety goggles and other protective clothing when working with solder tools. With temperatures hovering around 700°F, the tip of the soldering iron, molten solder, and flux can quickly sear through clothing and skin. Keep all soldering equipment away from flammable materials and objects. Be sure to turn off the iron when it's not in use and store it properly in its stand.

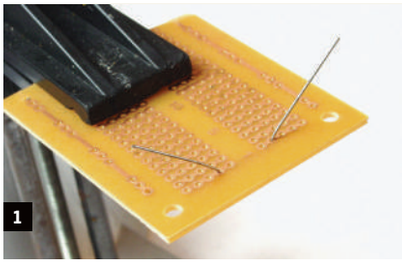

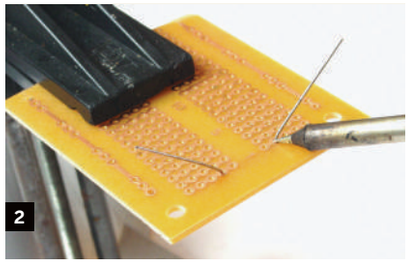

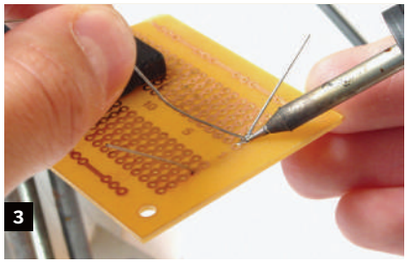

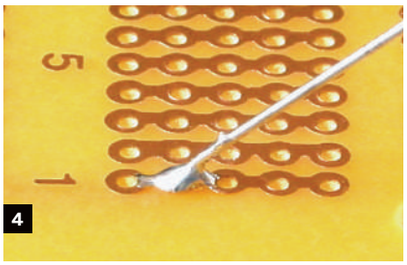

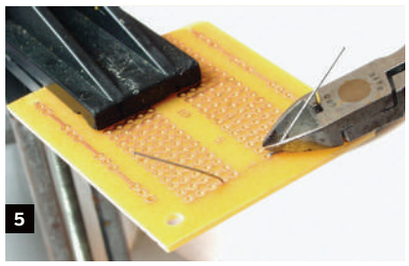

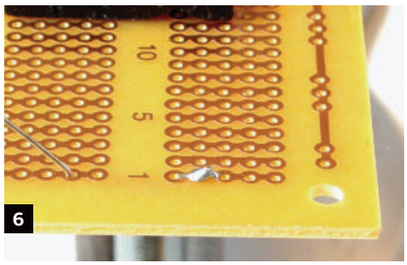

1. Bend and insert the component leads into the desired holes on the PCB. Flip the board to the other side. Slightly bend the lead you'll be soldering to prevent the component from falling out when the board is turned upside down.

2. To begin the actual soldering process, allow the tip of your iron to contact both the component lead and the pad on the circuit board for about 1 second before feeding solder to the connection. This will allow the surface to become hot enough for solder to flow smoothly.

3. Next, apply solder sparingly and hold the iron in place until solder has evenly coated the surface. Ensure that the solder flows all around the 2 pieces (component lead and PCB pad) that you're fastening together.

Don't put solder directly onto the hot iron tip before it has made contact with the lead or pad; doing so can cause a cold-solder joint (a common mistake that can prevent your hack from working properly). Soldering is a function of heat, and if the pieces aren't heated uniformly, solder may not spread as desired. A cold-solder joint will loosen over time and can build up corrosion.

4. When it appears that the solder has flowed properly, remove the iron from the area and wait a few seconds for the solder to cool and harden. Do not attempt to move the component during this time.

The solder joint should appear smooth and shiny, resembling the image above. If your solder joint has a dull finish, reheat the connection and add more solder.

5. Once the solder joint is in place, snip the lead to the desired length. Usually, you'll simply cut the remaining portion of the lead that isn't part of the actual solder joint. This prevents any risk of short circuits between leftover component leads on the board.

6. Here's a completed soldering example.

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DESOLDERING

SMD REMOVAL WITH CHIP QUIK

BEFORE YOU START

Use a rubbing alcohol pad to remove any residue from the solder pads. Verify that the solder pads are clean and free of cuts or solder jumps before proceeding. Desoldering, or removing a soldered component from a circuit board, is typically trickier than soldering because you can easily damage the device, the circuit board, or surrounding components. For surface mount devices (SMDs) with more than a few pins, the easiest method to remove the part is the Chip Quik SMD Removal Kit, as shown in the following step-by-step example.

PLEASE READ through this example completely before attempting SMD removal on an actual device. When removing the device, be careful not to scratch or damage any of the surrounding components or pull up any PCB traces.

THREE PRIMARY FUNCTIONS OF FLUX

- **Cleans metal surfaces to assist the flow of *filler metals* (solder) over *base metals* (device pins).**
- **Assists with heat transfer from heat source (soldering iron) to metal surface (device pins).**
- **Helps in the removal of *surface metal oxides* (created by oxygen in the air when the metal reaches high temperatures).**

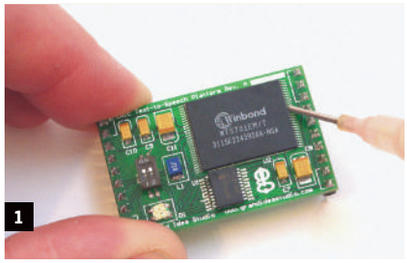
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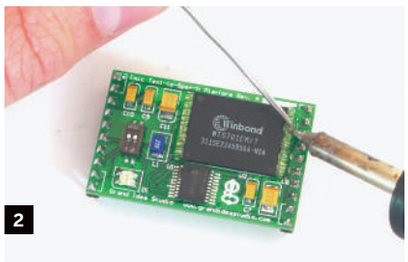
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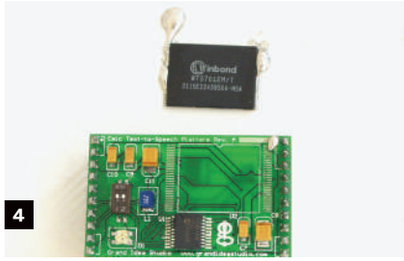
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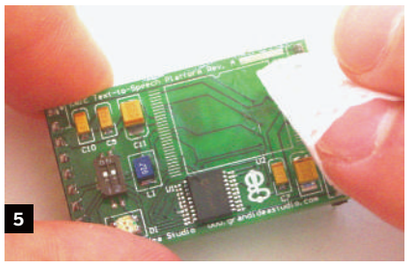
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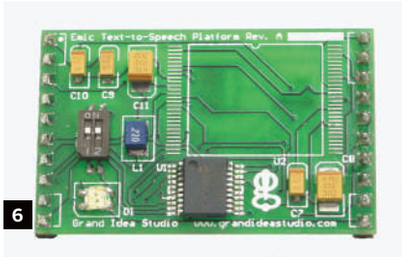

6

1. The first step is to assemble the syringe, which contains the no-clean flux. Simply insert the plunger into the syringe and push down to dispense the compound. The flux should be applied evenly across all the pins on the package you'll be removing. (Flux is a chemical compound used to assist in the soldering or removal of electronic components or other metals.)

2. Once the flux is evenly spread over the pins of the target device, the next step is to apply the special Chip Quik alloy to the device. This step is just like soldering: apply heat to the pins of the device and the alloy at the same time. The alloy has a melting point of approximately 300°F, which is quite low. You shouldn't have to heat the alloy with the soldering iron for very long before it begins to melt. The molten alloy should flow around and under the device pins. Starting at one end of the device, simply heat and apply the alloy. Repeat for the other side(s) of the device.

3. Flux will help ensure a nice flow of the alloy onto the device pins. Make sure the alloy has come in contact with every single pin by gently moving the soldering iron around the edges of the device. Avoid touching nearby components on the PCB with the soldering iron.

4. Now that the alloy has been properly applied to all pins of the device, it's time to remove the device from the board. After making sure that the alloy is still molten by reheating all of it with the soldering iron, gently slide the component off the board. You can use a small, jeweler's flat-tip screwdriver to help with the task. If the device is stuck, reheat the alloy and wiggle the part back and forth to help the alloy flow underneath the pads of the device and loosen the connections.

5. The final step in the desoldering process is to clean the circuit board. This step is important because it will remove any impurities left behind from the Chip Quik kit and get you ready for the next step.

First, use the soldering iron to remove any stray alloy left on the device pads or anywhere else on the circuit board. Next, apply a thin, even layer of flux to all of the pads that the device was just soldered to. Use the included alcohol swab or a flux-remover spray to remove the flux and clean the area.

6. The desoldering process is now complete. The surface-mount device has been removed and the circuit board cleaned.

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TECHNOLOGY IN ACTION™

Building Your Own Electronics Lab

A Guide to Setting Up Your Own Gadget Workshop

Dale Wheat

For your convenience Apress has placed some of the front matter material after the index. Please use the Bookmarks and Contents at a Glance links to access them.

Apress®

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Introduction

We're surrounded by electronics these days. Did you ever wonder how it all worked? Do you know just enough about electricity to be dangerous? Would you like to learn more? Then this book is for you.

There are many excellent textbooks on how electricity works. This is not one of them. This book helps you get started learning about electricity and electronics by showing you how to set up your own electronics laboratory. You might have guessed that from the title.

Along the way, several simple exercises are presented to show you some basic concepts about how electricity works in the real world—not just in a lecture hall. By the time you get done reading this short book, you'll have a good idea of where to begin and what kinds of tools and components you might need, and you'll have some excellent advice about how to keep it all organized.

Once you've got your own space set up to perform your electronic experiments, the sky is the limit.

Here's what you have to look forward to in this book, one chapter at a time.

Chapter 1: Planning Your Electronics Workshop

Your very own electronics laboratory is a great place to build, repair, invent, and learn more about electronics. We seem to be surrounded by electronics more and more every day. We can easily become dependent upon them, without even understanding how they work. Having your own electronics lab can help you gain some control over your electronic minions. Here you can learn about their inner mysteries, including how to repair them when possible or, better yet, improve them with your own custom modifications. You can also turn your own ideas into reality by building electronic circuits from scratch.

What will you need to plan your lab? What if you already have a basic understanding of electronics and the beginnings of a workshop at your disposal? This chapter helps get you going in the right direction.

Chapter 2: Building Your Tool Chest

You're going to need some tools in your lab, as well as the skills to use them effectively. This chapter will get you started.

If you're starting from scratch, don't worry. There's not a whole lot you absolutely *must* have to get started. Some basic hand tools and a place to keep them organized is all you will need. You don't even have to spend a lot of money at first. As you progress in your hobby, you will most likely want to add to your tool chest and upgrade some of those tools. Electronics can be the perfect hobby because it can take up (1) all your spare time and (2) all your discretionary income. What more could you ask for?

Chapter 3: Components

You're going to need some components to play with, as well as the knowledge to use them effectively. This chapter will introduce you to some of the bits and pieces that make up modern electric and electronic circuits. You'll also learn a little bit about how to identify components from their appearance and markings, when available.

Once you've got an idea about what these parts do in a circuit, you'll learn a little more about how to measure their electrical properties and put them to use. You'll also be shown what *not* to do, in some select examples.

Chapter 4: A Portable Mini-Lab

Having a portable (or at least (*trans*portable) electronics lab comes in handy in several circumstances. Maybe you don't have a place (yet) for a permanent home for all that equipment. Maybe you need to bounce at a moment's notice, heading off on electronic adventures at the drop of a hat. Or maybe you like to keep everything where you can find it in a hurry, without having to rummage through shelves and boxes, looking for just the right tool or component.

Whatever your motivation for wanting a portable lab at your disposal, this chapter should help you get started.

Chapter 5: The Cozy Corner Lab

You don't need an entire garage or extra office for a functional laboratory for your electronic endeavors. It's certainly nice if these areas are available to you, but you might be surprised at how much you can do in just a small space, if you set it up properly and maintain it with determination.

Chapter 6: The Small Group Lab and Classroom

The first part of this book deals with how to get along with electrons and make them do your bidding. In this chapter, you'll explore a completely different topic: other people, and how to get along with them.

You might not ever figure out how to get *them* to do your bidding, but at least you can keep them from stealing your tools. Maybe.

Appendix A: Getting Started with Tool Building

Once you've become comfortable in your lab and had time to play with a few circuits, you might start to notice that some of the "tools" you've been using are just simple electronic circuits themselves. Good examples are power supplies and meters. These are great tool-building projects because you can see useful results early.

This appendix takes a look at building a couple of simple electronic tools that might be of use in your lab. Hopefully you will develop a better understanding of how these tools work. Ideally, you will progress from the basic question of "Does it work?" to the more involved questions of "How well does it work and what can I do to improve it?"

CHAPTER 1

Planning Your Electronics Workshop

Are you interested in electronics? Would you like to set up your own "electro lab" to conduct amazing experiments, build crazy gizmos, and repair or modify your existing electronics? Then this book is for you!

Your very own electronics laboratory is a great place to build, repair, invent, and learn more about electronics. We seem to be surrounded by electronics more and more every day. We can easily become dependent upon them, without even understanding how they work. Having your own electronics lab can help you gain some control over your electronic minions. Here you can learn about their inner mysteries, including how to repair them when possible or, better yet, improve them with your own custom modifications. You can also turn your own ideas into reality by building electronic circuits from scratch.

What will you need to plan your lab? What if you already have a basic understanding of electronics and the beginnings of a workshop at your disposal? This chapter helps get you going in the right direction.

What to Expect

This book can't teach you everything about electronics, and it doesn't try. That would take several lifetimes. What it can do is introduce you to the tools and the skills you will need to set up your own electronics lab. This will include a very basic introduction to electricity, a little bit of theory, some safety tips, and a whole lot of example projects. It's a great starting place. Where it will lead you is mostly determined by you and what you're wanting to do with electronics.

If you're already familiar with electricity and electronic concepts, there is still plenty of fun and interesting stuff waiting for you to explore. The field of electronics itself is constantly expanding. From the time this book was written to the time that you've finished reading this sentence, many advances will have occurred in both our understanding of electronics as well as the development of new applications and electronic devices. This is one of the many things that makes the study of electronics so interesting and exciting.

Every lab is different. Your lab will reflect not only your immediate electronics goals but also your personality. Feel free to pick and choose from all the ideas presented in this book and add in some of your own. The repair shop and the design studio are necessarily going to be arranged differently. There really is no right or wrong way to go.

Even the best laid plans, so the saying goes, end up somewhere unexpected. When planning your electronics lab for the first time, or for the tenth time, keep in mind that your interests, resources, and reasons for wanting to work on electronics are going to change over time. Please feel free to reinvent yourself and your lab as conditions permit. You might also be forced to reconsider your priorities when

other factors in your life exert themselves. That being said, stay tuned for "A Cautionary Tale" at the end of this chapter.

Some configurations are more appropriate for certain endeavors, and nothing replaces the right tool for the job. This book should at least give you an idea of what is involved and get you pointed down the right road.

It Starts with a Plan

Most of the decisions you'll make when planning your laboratory will depend on what *you're* interested in doing there. Having a good plan at the beginning is like having a clear map when taking a long journey. It helps you from getting lost and also is handy for figuring out when you've arrived.

■ **Note** If you fail to plan, you plan to fail.

Remember, at this point in the game, you don't have to make any final decisions about what you want to be able to do in your lab. This book is all about illustrating possibilities and giving you the information and advice necessary to branch out into the areas that hold the most interest for *you*.

A Broad Outline

Here's what you need to get started: a little time, a small amount of space, some basic tools, and a few components. Those are the boring parts. The fun stuff includes your ideas, goals, and inspiration. Combine all that with some fundamental information about how electricity and electronics work, and you're in business.

A Little Time

Like any good hobby, setting up your electronics lab and conducting experiments there is going to take up some of your time. For some, this is the *main reason* for getting started in electronics and building a lab: a place to escape, unwind, and tinker with ideas, prototypes, and complex systems. Maybe it's your job. Maybe it's your passion. Perhaps it's a bit of both.

You're going to need time to plan and build your lab. This book will spell out several specific arrangements for various-sized labs, but they are just examples and not hard-and-fast rules. More time will be required for obtaining the proper tools and materials that you will use there. Time will be spent not only *doing* things in your lab, but also in just *thinking* about doing things in your lab. For example, you might build a clever little gizmo that ought to do a simple task, only to find out that it refuses to work. You might need to spend a little bit of time thinking of ways of testing it to find out where the problem lies. This is sometimes called *troubleshooting* or *debugging*.

This is the basis of the scientific method. To help understand how something works, you first form a theory that would explain its behavior. Next you prepare one or more experiments that will demonstrate the accuracy of your theory. The experiments are conducted and their results are analyzed. If the results are in agreement with your theory's predictions, then your theory is more than likely correct. If not, you may need to modify or extend your theory to accommodate the behavior observed. All of these things take time, which helps explain why we don't have jet packs or time machines yet.

A Little Space

You don't have to start out with a cavernous underground bunker for your electronics lab. If you already have one, that's great. You might have an extra classroom available, some unused warehouse space, or an empty bench in a garage.

Then again, you might only have a corner of the dining-room table, and then only between mealtimes. That's plenty of room when you're just getting started! Once you learn more about electronics, and especially when you learn more about what it is that *you* want to do with electronics, then you can start looking for a more permanent home for your toys, tools, and spare parts.

The main points that will be stressed throughout this book when planning and working in your space are safety, good lighting, and organization, in that order.

- Your lab needs to be relatively safe for you, and *very* safe for your visitors and neighbors. The "Go Away!" sign on the door does not guarantee that you will be free from curious visitors, pesky and otherwise. People are naturally attracted to the creative and mysterious activities going on in your lab.
- Be prepared to buy, build, or borrow more lighting, because you're going to need it. Proper lighting improves the quality of your doodlings and tinkering enormously. You might think you already have enough light, and unless you were a photographer in a previous life, you don't. (Photographers understand that you can never have too much light.)
- An organized lab is a productive lab. Don't waste time looking for parts or tools when it would have only taken mere moments to put them in their proper places in the first place. A place for everything, and everything in its place. You get to decide where all these tools and bits get to live, so spend some time and do it wisely.

These three tenets will be repeated throughout the book, so you might as well get used to hearing about them.

Basic Tools

You really don't need a lot of tools to get started. There is a tendency to want to be a bit overprepared before tackling any new project, but it really isn't necessary when it comes to planning and building a new electronics lab. This is also true when sorting out a lab that's gone badly out of control.

You're going to be working with wire quite often. Claude Debussy has been quoted as saying that music is the space between the notes. It's the connections between the various electronic components that make the magic happen in an electronic circuit, in the same way that it's the relationships between people that make their lives so interesting.

The connections between all the various imaginable electronic components almost always start out as bits of wire. These connections can then be optimized into copper traces etched on a printed circuit board or even as metallization links in an integrated circuit. You're going to be working with a lot of wires in this hobby, and that usually boils down to two basic hand tools: *wire cutters* and *wire strippers*.

A wire cutter does what it says and says what it does: it cuts wire. A wire stripper is a more specialized tool that helps remove the outer layer of insulation from a wire. Ever more specialized versions of both tools abound. Some tools aim to perform both tasks at once, while never perfecting the art of either.

Resist the temptation to use your teeth for cutting and stripping wire. If you're caught in a situation without proper tools, use your fingernails. They grow back faster than teeth.

■ **Tip** Use the right tool for the job. Knowing which tool is the right tool is half the battle.

If you're performing detailed work on smaller circuits, you might benefit from having some small needle-nosed pliers, a small vise, clip, or helping-hands jig, and possibly a magnifying glass.

A popular and handy skill in the electronic arena is *soldering*. Soldering is the process of making electrical and mechanical connections. This is done by heating the items to be joined together and adding solder. The solder melts and fills in all the gaps between the items being joined. Once cooled, the solder forms a solid, conductive link.

■ **Note** Soldering is similar to welding, with the exception that welding actually melts the parts being joined.

A suitably sized soldering iron and the right kind of solder are indispensible for many projects, including repair, prototyping, and production. Picking up the skill to make quality connections is obtained in the same way as all worthwhile skills: with lots of practice.

Besides these basic fabrication tools, you will also want some *test and measurement equipment*. These are devices used to measure various aspects of electrical circuit behavior. These range from the very simple, such as voltage meters, current meters, and continuity testers, to the very exotic (and sometimes expensive), which include oscilloscopes and various logic, network, and signal analyzers. See the Appendix for information about building your own simple test equipment for your lab.

This is just a quick summary of the kinds of tools you might want in your electronics lab. Chapter 2 goes into much more detail about the tools you will probably need or want in your lab, as well as the skills needed to operate them safely and effectively.

Fundamental Components

As mentioned in the previous section, you're more than likely going to be wiring up various contraptions and rewiring others. This is probably going to involve a lot of wire.

For small voltages and currents, small-gauge insulated copper wire is often used. It's easy to handle, cut, and splice. This can be done with mechanical connectors such as wire-nuts or screw terminals, as well as with soldering.

Back in the day when computers were all connected using fat cables, lots of tiny wires were bundled up into cables and snaked all over a typical desktop computer installation. With the increasing popularity of wireless devices, those fat, juicy cables are lying around, discarded, unwanted, and just waiting to be harvested for their valuable conductors. You can also buy various kinds of wire in all colors and sizes from most hardware stores and from online suppliers.

Now consider the types of projects you'll be working on:

- If you're most interested in building your own lighting, you're going to want some lightbulbs, sockets, and LEDs, or whatever lighting technology appeals most to you. Don't forget that you're also going to need switches, knobs, dimmers, housings, plugs, and *more wire*.

- If you like to work with things that move, you're going to need motors, relays, solenoids, servos, and fans. You'll probably be needing some gears, pulleys, chains, belts, shafts, and couplings, along with connectors, switches, controllers, position sensors, and *more wire*.
- If you're into making lots and lots of sound, you'll be needing speakers, headphones, microphones, pickups, transducers, transformers, amplifiers, connectors, jacks, plugs, and, you guessed it, *more wire*.
- Are computers and digital devices more to your liking? Be thinking about getting yourself a wide variety of chips, microcontrollers, software, cables, sockets, connectors, and still *more wire*.

Now you've got an idea of some of the different components you might want to have on hand, depending on what kind of inspiration happens to strike. You're going to need a place to keep all these different parts sorted. This will play a big part in the overall planning phase of your lab. Maybe your old fishing tackle box has enough room for your basic hand tools and enough secret compartments to hold an interesting variety of components. On the other end of the spectrum, maybe you need to start thinking about some industrial-grade shelving units or pallet racks. Now is the time to think about all these factors and start making the right kind of plans to help make your lab a successful one.

Again, this is just a quick summary of some of the types of components you might want to work on in your lab. Chapter 3 is going to take you much farther into understanding many of the more common electrical and electronic components that you are likely to encounter in your lab.

Ideas

Admit it: you've already got some ideas for cool projects that you'd like to be working on in your own electronics lab. That's great! You're well on your way to making those dreams a reality.

The best possible thing you could do with your ideas is to write them down somewhere. It can be as simple as a sketch on a piece of scrap paper or as formal as a complete set of project documentation. The important thing is that you actually get the idea across using either words or pictures in a form that you will be able to revisit in the future. This will be of immense benefit to you, as well as anyone else that might be interested in your ideas.

It's also a great idea to keep a log as you work on your projects. That's the perfect place to jot down those ideas as they come popping out of your brain. Be as detailed as you can be. You will thank yourself later.

Even if you don't already have a backlog of ideas jostling for your attention in the lab, it's still a good idea to keep a log and explore the things that interest you. Leonardo da Vinci kept detailed notebooks on almost every possible subject. Anything that interested him got written down, sketched, or diagrammed in his notes. Even today, people are still getting inspiration from his doodles (see Figure 1-1).

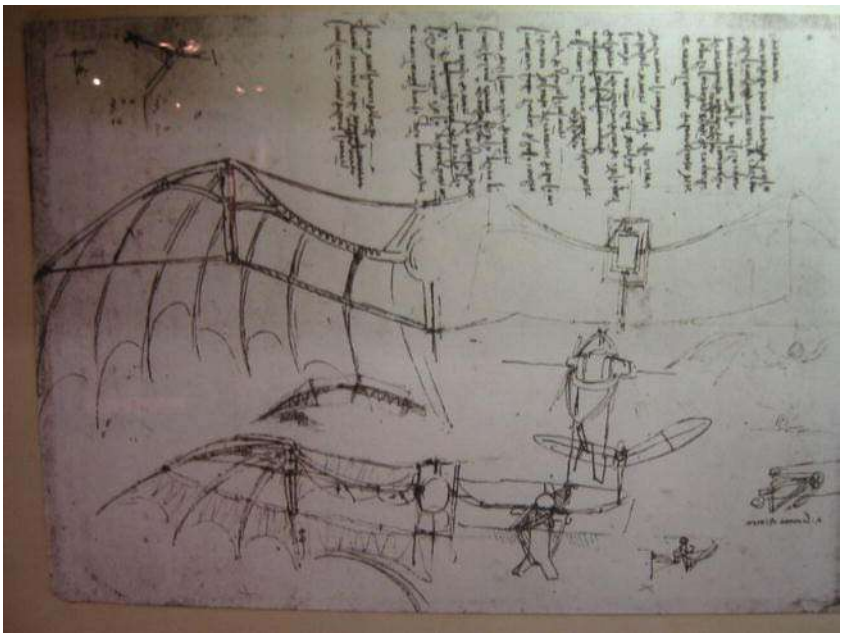

Figure 1-1. *Sketches and notes for a "flying machine" by Leonardo da Vinci. Photograph by Arnaud 25 (public domain), via Wikimedia Commons.*

Writing down your ideas also helps you pick which projects you want to work on first. It just isn't possible to work on all of them at the same time! Narrowing down the list helps get you focused and lets you concentrate all of your talents and energies on the most important projects.

When you're just beginning, the "most important projects" are the ones that provide the most positive reinforcement in the shortest amount of time. Plan a few simple, straightforward projects with a high probability of success at first. You can become more ambitious and take greater risks when you've built up a good reserve of self-confidence and techniques. Remember, the only experiments that fail are the ones from which you don't learn anything. Sometimes learning how *not* to do something is just as important as learning how to do it correctly.

Goals

The best way to turn great ideas into spectacular projects is to have a plan. Set some achievable goals for yourself. When you're first starting, don't be afraid to take those baby steps. You have to crawl before you can teleport.

Project planning is its own art form, and a dark and mysterious art it can be sometimes. It really helps to have clearly defined goals and expectations early in a project. Otherwise, how will you know when you're finished?

Any large, complex problem or project can be broken down into smaller, more manageable subprojects. Unfortunately, this can be carried too far. You don't need to reinvent the wheel every time you start a new project. There's a saying that suggests, "Don't build anything you can buy." The counterpoint to this wisdom is the equally ancient saying, "Don't buy what you can build." You'll have to be the judge as to which one applies best to you and your situation.

Do you have lots of time and very little money? This is good news! This helps simplify the decision-making process enormously. Design and build everything yourself, from scratch. This can include your own tools as well as custom-made components. The trick to this approach is not get lost in all the inevitable details that will arise.

No time to spare, but there's a bit of a budget available? This is likewise good news. With few exceptions, there's someone out there that's willing to part with just what you need for a reasonable price. The trick here is to find them and make that connection.

Inspiration!

Remind yourself what your inspiration is. What initially prompted you to start thinking about building your own electronics lab? Why did you want to get into electronics as a hobby or a career in the first place? Do you even remember?

It really helps to have a firm grasp on what your underlying motives are (or were) when faced with the challenges that regularly present themselves along the way. While it's true that some things just need doing, does it really have to be *you* that does them? Could you farm out some of the work and still feel a sense of satisfaction in the completion of the project? Or do you feel the need to take the do-it-yourself mind frame to its utmost limit?

Whatever your inspiration is, or wherever it came from, do your best to keep it in your sights while pursuing your dreams and goals. It makes it that much more satisfying when you eventually attain them.

How Electricity Works

There are two ways to go about learning how electricity actually works. The first involves just a whole bunch of *fascinating* theoretical information about atoms, electrons, fairies, and dragons. The second way is to just assume that it does indeed work, and spend some time actually putting it to work.

You don't need to know everything about electricity to have fun with it. A passing understanding is sufficient to get you started. As your technical requirements grow more elaborate, you will find yourself going back to revisit some of the basic concepts, until your comprehension is sufficient to carry you forward.

The Theoretical Approach

The prevailing theories about how electricity works center around the orbits of negatively charged subatomic particles called *electrons*. Electrons are quite small, even when compared to individual atoms. Electrons normally whiz around the *nucleus* of the atom, which is usually made up of other subatomic particles called *protons* and *neutrons*. The exception is hydrogen, whose most common isotope has only a single proton and no neutrons. Protons have a positive electrical charge and neutrons have no electrical charge.

When an atom has a balance of protons and electrons, it is said to be electrically neutral. If an atom has more electrons than protons, it has a negative electrical charge. Conversely, if there are more protons than electrons, the atom has a positive charge. An atom that has either a positive or negative electrical charge is called an *ion*.

While flying round and round the nucleus, electrons tend to cluster into well-defined orbits, or *shells*. The innermost shell of an atom can hold as many as 2 electrons. Once this orbit is "full," up to 8 more electrons can be accommodated in the next larger shell. The next shell holds up to 18 electrons, and the one after that can contain up to 32 electrons. After that, the shells get smaller again, stepping back down symmetrically from 18 to 8 to 2.

Each unique combination of electrons and protons represents one of the chemically distinct *elements*. Each element has its own particular chemical characteristics, and cannot be further subdivided by conventional chemical or mechanical means. Toward the end of the *periodic table*, which arranges all the known elements into meaningful rows and columns, you'll start to find some exceptions to the shell symmetry. These heavier elements, however, don't usually turn up in most electronics labs, so we'll not be spending a lot of time there.

Individual atoms can combine into more complex structures called *molecules*. One popular molecule is water, which is made up of two hydrogen atoms and one oxygen atom. Each of the hydrogen atoms has a single electron. The oxygen atom has eight electrons. The first two electrons in the oxygen atom occupy the first shell, leaving six electrons in the next outer shell. That leaves two "open" places in the second shell, which is where the two electrons from the two hydrogen atoms come into play. The electrons are shared by the three atoms, linking them all together and forming a *covalent bond*. Water has vastly different physical properties than either hydrogen or oxygen.

It's also possible to bump an electron out of orbit around a nucleus. When this happens, the atom becomes an ion and is electrically positive. This makes it especially attractive to any loose electrons that happen to be in the vicinity. This is because electrons are negatively charged, and in the case of electrical charges, opposites attract. This movement of electrons is how an electric charge flows through a substance.

Some materials are very good at slinging those electrons around, and as such are called good *conductors* of electrical energy. Examples of good conductors are copper and silver. Some materials resist the flow of electrical charge, and can be used as *insulators*.

An important concept to understand about the flow of electricity is that it is based on the movements of tiny, *negatively charged particles*. This is referred to as the flow of *electron current*, but this term is rarely used. For some reason, the more popular, or conventional, idea of electric current flow is from the more positive point to the more negative point in a circuit. This is referred to as *conventional current* and is the standard used throughout this book.

The fairies and the dragons come into the picture when you start to look any deeper into how the building blocks of matter are actually (or allegedly) constituted. The previous quick summary of how electricity works covers less than 1 percent of the physics needed to understand even how basic atomic principles operate. Even then there are various schools of thought as to how, *exactly*, all that tiny stuff works together to produce rainbows and cousins and moon rocks. A proton, once thought to be an indivisible *elementary particle*, is now thought to be built out of a "down" quark and two "up" quarks. There are also "strange" and "charmed" quarks flitting about, along with an entire pantheon of mythological particles. Go figure.

Now all of that *fascinating* information only scratched the surface of how *electricity* works. Electricity does a lot of work for us. We use it for lighting, heating, motion; just all kinds of things. *Electronics* is where we start to get into some really bizarre physics involving semiconductors, transistors, computer chips, and other miracles of the modern age. Explaining even the basic ideas about how *electronics* works is way beyond the scope of this little book. It's certainly possible to learn and understand it, but for the purposes of setting up a lab and building some example projects, we can just assume that it does indeed work. We can start from there and have some fun with it.

If your curious mind just can't stand *not knowing* how electronics works, the interwebs are your friends, and so are the helpful folks at your local library.

A Practical Approach

An easier way to think about electricity is to skip over *why* it flows and concentrate on *how* it flows. That's what we'll be doing in the remainder of this book, for the most part.

■ **Note** Electricity flows in a circle.

Any continuous flow of electrical current travels in a circle. There are exceptions to this broad generalization, but most of the example circuits encountered in this book will have a definite circular arrangement, if you know how to look for it.

Here are some technical terms that will be used throughout this book. You don't have to memorize any of them right now (there will *not* be a test), but you should at least take a glance at them so you know where to come back when you want to know more.

Circuit: A circuit is anything that forms a continuous loop or circle. The term *circuit* is formed from the same Latin word that means *circle* or *wheel*.

Amps: The *intensity* of an electrical current is measured in units called *amperes*, named after André-Marie Ampère. This is usually shortened to *amp* in popular usage. The symbol for amperage in a circuit is *I* (for intensity), while the unit is abbreviated *A*. For example, you could say that the intensity of the electrical current (I) in a circuit was measured to be 3.75A (amperes). Electrical current is measured with an *ammeter*.

Volts: The voltage in a circuit is the measure of the difference in electrical *potential*, or how much work it *could* do. The unit of voltage is the volt (V), named after Alessandro Volta. This is sometimes referred to as pressure or tension. For example, a "high-tension wire" means a high-voltage line, not necessarily one that has been pulled really, really tight. Voltage is, not surprisingly, measured with a *voltmeter*.

Watts: Electrical power is measured in watts (W), named after James Watt. The easy way to calculate watts, or the amount of energy that is converted into work (either useful or not) is to multiply the voltage across the circuit by the current flowing through the circuit. For example, if a 12V battery is connected to a lightbulb that draws 2A, the bulb converts the electrical energy into both light and heat (mostly heat) to the tune of 24W (12V × 2A = 24W).

Ohms: The resistance to the flow of electrical current is measured in *ohms*, named after Georg Ohm. A *resistor* is a simple electronic component that exhibits a fixed resistance to the flow of electrical current. The symbol for resistance is *R* and the unit of measure is the capital Greek letter omega, Ω.

Safety

Make no mistake: electricity can kill you. It bears repeating, as well as emphasis.

■ **Warning** Electricity can kill you.

Working safely with electricity is like working safely with a sharp knife, for example. A good knife is a useful tool. Life would be cumbersome and crude (not to mention short) without good tools. However, when using *any* tools it's important to understand their proper use and operation. The same goes for electricity.

The point here is not to be overdramatic about the dangers of electricity. Billions of people are safely and peacefully coexisting with electricity, largely due to wise safety rules and well-designed electrical appliances. However, there are three major ways that you can be harmed when working around electricity, and it is important that you be aware of them:

- Your body uses tiny amounts of electricity to send nerve impulses to and from your brain. Sending relatively giant shocks of electricity through your body is a good way to stop your heart from beating or your lungs from breathing. You need to keep doing both of those things, so be careful.
- Since your body is not a very good conductor of electricity, it converts the electrical current into heat, which can produce very damaging burns, both on the inside and the outside of your body.
- Additionally, many electrically related injuries are sustained while trying to *get away* (i.e., your body's involuntary reflex when exposed to dangerous voltages).

Yet working safely with electricity is easy. Observe the following rules and you'll be relatively safe, both in your lab and outside of it:

- Always assume a circuit is "live." Electrical devices can retain lethal voltages even when completely disconnected from power.
- Don't work with high voltage (more than 36 volts) unless you're specifically trained. Reading this book does *not* mean you're "specifically trained," even if you read it *twice*.
- Don't short-circuit batteries (i.e., deliberately connect the positive and negative terminals together). Even very small batteries can hold dangerous amounts of power and can produce enough heat to burn you. Even worse, it can start a fire, which is yet another unpleasant way to die.
- Be careful when using metal (conductive) tools around battery terminals so that you don't accidentally short the terminals together or to other circuitry.
- Don't assume other people are aware of these dangers.

Lighten Up!

Now it's time to have a little fun with electricity, don't you think? While it's important to keep safety in mind, it's just as important to be curious and willing to try new things. Don't let the (important) safety rules immobilize your creativity. Use these rules, like any tool, to leverage your enjoyment of this fun and exciting hobby.

Let's start with a simple circuit that is almost guaranteed to lighten things up. Let's take apart a flashlight (or *torch* for you metric types) and see how it works.

First, find a typical household flashlight. The flashlight in Figure 1-2 was purchased for $3, and it included two new D-cell batteries. Put the batteries in the flashlight and make sure it lights up when you turn on the switch. If the bulb is burned out or the batteries are dead, then this experiment is not going to be much fun at all.

Figure 1-2. *A typical household flashlight will be the ~~victim~~ subject of our first electrical experiment.*

Once we've established that the flashlight works as intended, we can begin the experiment.

DISSECTING A FLASHLIGHT

We don't need most of the pieces of the flashlight body. Let's take it apart and have a look inside.

1. Open the flashlight be unscrewing the end with the lightbulb in it.
2. Remove the batteries. Set them aside for the moment. We'll use them in a bit.
3. Remove the plastic retainer that holds the bulb in the reflector.
4. Take out the bulb.
5. We'll need to replace the wiring that was contained within the flashlight's body. Find a short piece of wire 8" to 12" long. A specialized jumper wire with alligator clips on the end was used in the photos for this exercise, but almost any kind of wire will do. See Figure 1-3.

Figure 1-3. *All the pieces you'll need to light up the bulb.*

6. If you're using plain, insulated wire, you'll need to remove a small bit of it from both ends of the wire to expose the *conductor*, or metal wire part inside.
7. This step can be tricky. Try to hold both batteries in one hand, along with the bulb. The batteries need to be pointed in the same direction. If this is too hard to do, try it with just one battery.

8. The positive end of the battery has a small cap on it. Touch the bottom point of the bulb to the top of the battery.
9. Now, using your other hand, connect the wire from the bottom of the battery to the metal base of the bulb.
10. The lightbulb should start to glow. See Figure 1-4.

■ **Caution** If you have a super-bright bulb, it can get hot. Don't burn yourself!

Figure 1-4. *The completed circuit, showing the glowing bulb. Electricity is flowing!*

Several important things are going on in this very simple circuit. Electrical current is flowing, producing useful work (in this case, light). Can you see the "circle"? When you *break* the circuit, the bulb stops glowing. This is exactly how the switch in the flashlight body works. Peek inside the flashlight and see if you can tell how it works. By connecting and disconnecting the wire, you can make the bulb flash. If you only use one battery, the bulb turns on, but is not as bright. Why do you think that happens?

Environmental Impact

You affect your environment every day, and your environment affects you, as well. As you learn more about electronics and all the interesting and wonderful things it can teach you, be mindful of what kind of trail you're leaving behind for others to clean up.

A good way to get a feel for your environmental impact is to take a look at your garbage. It doesn't sound that interesting or fun, but it *will* teach you a lot about yourself and your habits. What are you throwing away? Could you have found either another use for it, or perhaps another home? Is it going to be a nuisance to someone else, or even worse, a hazard?

A good example is the use of "disposable" batteries. We used batteries (technically *cells*, but that distinction will be spelled out in more detail in Chapter 3) in our very first experiment. We buy new batteries and plug them into our devices, and when they run out of power we take them out and throw them away. Where do they go? How do they then interact with the environment? They don't just "go away."

Disposable batteries are very convenient. They are generally inexpensive, compact, self-contained, and reliable. This *convenience*, however, comes with a price all its own. Consider using *rechargeable* batteries whenever possible in your lab. They cost a little more than their disposable counterparts, but can easily and cheaply be refilled with electrical goodness over and over again.

You should also be aware of any hazardous materials that you use or store in your lab. For example, lead is a very common material used in many electrical devices, even though its use is being reduced worldwide. It is found in older-technology rechargeable batteries, solder, and printed circuit boards.

Some of the chemicals used to etch printed circuit boards can be dangerous if not used, stored, and disposed of properly. Take the time to understand what, exactly, you're working with when you're conducting your experiments in your laboratory.

Just like the captain of a seagoing vessel, you're in charge of what happens in *your* lab. With this authority come important responsibilities that rest squarely upon your shoulders. Please take these responsibilities seriously.

Budgeting

How much is all this stuff going to cost? A lot of it depends on how creative you want to be in stocking your lab with tools and parts.

If your budget is small, then start small. If your budget is nonexistent, then you'll just have to start even smaller. You should generally approach acquisitions for your lab under one of these three headings:

- Buying new
- Finding used
- Harvesting or recycling

Buying New

Buying everything new is obviously the most expensive approach, at least from the *money* side of it. What a lot of people fail to take into account is that their *time* is also a very valuable commodity. Try to balance the one with the other, as befits your particular situation.

Except for the folks in the most *dreadful* of hurries, it always makes sense to shop around for the tools, equipment, and components that you are going to need in your lab. You'll find that a lot of "professional-grade" equipment carries an enormous price premium compared with "consumer-" or

"hobby-grade" alternatives. This is generally to be blamed on the fact that there is a correspondingly enormous amount of money to be made in the field of electronics.

New components are almost always more desirable to use, especially when you're looking at a production environment and you need to make sure everything produced is of the highest possible quality and reliability. New, unused components are also more appropriate when conducting complex experiments, as this helps to reduce, if not eliminate, many variables in the testing and analysis phases. You don't have to worry that someone (probably you) might have "borrowed" some parts for a quick fix or some other temporary usage and then surreptitiously replaced them back in inventory, having possibly compromised them in some unseen way.

Finding Used

A prudent way to fill up a new lab, especially when first starting out, is to look for bargains on used tools and components. This is especially true of the fixtures, shelves, cabinets, benches, and other furniture that belongs in a lab.

Tools wear out. Tools are replaced. This is a fact of life when you're in the business of working with tools. The good news is that "one man's trash is another man's treasure." If we consider the possibility of women participating, we get three more potential combinations, all of which can end up in a win-win situation.

Many used tools can be retrofitted and placed back into service in your lab. On the other hand, there are a lot of tools that are simply used up and can not feasibly be brought back into useful service. Either their repair is cost prohibitive or they are no longer supported by their original manufacturers.

Another factor working in favor of the patient and observant collector of discarded tools is the inevitable march of progress. What was shiny and top-of-the-line a year ago might be intolerable or insufficient next year, from the standpoint of the original purchaser. Many bargain opportunities arise from this simple understanding.

This can sometimes be applied to the purchase of components that have never been used, but have been sitting somewhere waiting for their chance. A commonly used phrase to describe these parts, which are often sold at a discount, is *new old stock (NOS)*. Sometimes these parts are sold this way because of overstock or because a manufacturing run was cancelled or cut short.

Harvesting or Recycling

There's an absurdly large amount of perfectly good equipment, tooling, fixtures, and components sitting out there, looking for a new home. A lot of companies, as well as individuals, either outgrow their present fittings or turn toward other interests and endeavors. This can be an excellent opportunity to acquire the furnishings you need to populate your lab.

On the other hand, please don't go crazy. You don't have to pick up every discarded appliance or chair you see sitting by the roadside. Why pay rent for something you can easily and cheaply obtain when you actually need it? Are you really wanting to pay the heating and air-conditioning bill for that box full of odd-sized capacitors that are probably past their prime? Don't fall into the trap of the *false economy* when it comes to bargain-hunting for your lab. The most important ingredient in your lab is *you*. Leave a little room to move around a bit.

Another factor to keep in mind is *shelf life*. Not all parts (or tools) last forever, especially when not being used. Batteries are the worst. You can prolong the shelf life of nonrechargeable batteries by storing them in your refrigerator, as this slows down the electrochemical processes within them that produce the electricity. Even solar panels will wear out with either constant use or constant disuse, although this can take years to happen.

Some Example Workshops

Here's a little peek into some actual electronic laboratories, each with its own personality and history. Each one grew from something small into something, well, not so small.

A Fresh Start

Harold Timmis is an electronic engineer, software developer, and author. His curiosity about how things worked started as a small child, which led him from taking apart everything in his parents' house to studying engineering at the Florida Institute of Technology.

Harold keeps a lab in his home where he can work on gadgets in his spare time. Harold recently moved, and used the opportunity to "clean house" and set up everything in his lab exactly the way he wanted things.

He took this photo of his new lab after working on a couple of projects (see Figure 1-5). Note that everything is within easy reach when sitting at the desk. It's still quite tidy, as you can see.

Figure 1-5. *The reorganized home lab of Harold Timmis (photo by Harold Timmis)*

The Robot Clubhouse

The Dallas Personal Robotics Group (`http://dprg.org`) is the world's oldest personal robotics group known to man. From 2002 to 2009, Mike Dodson of Modern Assemblies donated the use of a portion of one of his warehouses to DPRG. This gave DPRG a permanent home for meetings, contests, and social gatherings.

Robot builders enjoyed a spacious and comfortable area for working on robot projects, among other pursuits. Over the years, members contributed time, equipment, and lots of hard work to improving the space. The photo in Figure 1-6 shows one end of the available space, after an extensive remodeling. Several workstations along the wall are in the process of being set up. That good-looking fellow seated at the table is the author.

When Mike retired in 2009, DPRG began a search for another home.

Figure 1-6. *DPRG's world headquarters from 2002 to 2009 (photo by R. Steve Rainwater)*

A Cautionary Tale

It's relatively easy to go from a well-designed and effective lab to something, let's say, less desirable. This doesn't happen overnight, but it can happen. Let this be a warning to you about how even the best of intentions can still produce embarrassing and unproductive confusion (see Figure 1-7).

Unfinished projects and leftover parts and tools compete for the limited space available in this photo. Not only is a lot of time wasted in searching for both components and tools, but the limited space restricts the scale of projects that can be entertained.

Don't let this happen to you.

Figure 1-7. *It's not safe. It's not pretty. It's not even properly "eccentric." You have been warned.*

Summary

So now you know a little something about electricity and electronics. Hopefully this chapter has covered your very basic questions about how all this magic stuff actually works.

Now you're ready to start poking around some circuits. You're going to need the right tools for the job. Chapter 2 will get you started. You'll learn about some basic hand tools that are very useful in the lab, as well as some fairly high-tech machines that you might require in the future.

CHAPTER 2

Building Your Tool Chest

You're going to need some tools in your lab, as well as the skills to use them effectively. This chapter will get you started. If you're starting from scratch, don't worry. There's not a whole lot you absolutely *must* have to get started. Some basic hand tools and a place to keep them organized is all you will need. You don't even have to spend a lot of money at first. As you progress in your hobby, you will most likely want to add to your tool chest and upgrade some of those tools. Electronics can be the perfect hobby because it can take up (1) all your spare time and (2) all of your discretionary income. What more could you ask?

The very basic hand tools, such as screwdrivers and tweezers, are mostly self-evident in their usage. Try not to poke yourself in the eye. Where some helpful advice is appropriate, it will be given.

Here's an excellent example of a simple safety rule that will absolutely improve and extend your life: when using any kind of cutting tool, always direct the cutting motion away from yourself. For example, you might receive a package in the mail, and get all excited about opening it. You then discover it's sealed up with indestructible packing tape and can't simply be ripped open with your bare hands. Use a small knife or box cutter and make a single cut at a time, starting from the point closest to you on the package and cutting outward. Using this method, should the knife slip for any reason, the blade will travel away from you. This allows your blood and other bits to stay inside you, where they can do the most good. Never cut toward yourself.

If you've already got some tools (or even a *lot* of tools), it never hurts to review their proper usage. Also, if you're suffering from an *overabundance* of tools, to the point where you can no longer keep them organized, this chapter might help you to prioritize them, at least as far as permanent residency in your lab is concerned.

■ **Tip** Every tool in your shop must *earn* its place there. It must *deserve* to be there. *No exceptions*.

The Most Important Tool Ever

The most important tool you'll ever use is your mind. Every other tool you will ever work with depends on the correct and proper functioning of your mind. If you're careful with it, you won't misplace it, neglect it, damage it, or use it for the wrong job. Your mind is a wonderful asset when cared for properly, and a terrible liability when ill-treated.

Your mind is in many ways like a muscle. The more you use it, the stronger it gets. Learning new things does not "push out" the old things you've already learned. Your brain is capable of forging new neural pathways when challenged, and there's plenty of extra capacity in that old noggin of yours to handle whatever may arise.

■ **Tip** Try to learn something new every day.

Take care of that brain of yours. Just like you wouldn't use a dull drill bit or a rusty saw, don't try to work on electrical or electronic projects when your mind is not in the right place. Ideally, you should never try to get any work done in your lab when you are sleepy, distracted, angry, upset, medicated, or overly tired. Deal with whatever problems you're facing in a responsible manner and then get back to work in the lab.

- Are you sleepy? Take a nap or head off to bed for the night. Really bad mistakes are made when the brain does not get enough sleep. Sleep deprivation is notorious for being obvious (and obnoxious!) to everyone else except you. "Really bad mistakes" made while working with electrical or electronic projects can produce very hazardous conditions for you and everyone around you, such as fire, damaged equipment, injuries, and even death.
- Are you angry or upset? Then your mind is not going to be adequately focused on what you need to do in the lab. "Fools! I'll destroy them all!" are famous last words *for a reason*. Give yourself some time to calm down from whatever has angered or upset you. Also, it's OK for you to give yourself permission to admit that you are angry or upset about something in the first place. Ignoring it probably won't make it go away, and probably won't make your feelings about it go away, either. Walk away, count to ten, or whatever works for you.
- Feeling distracted? Then now is *not* the time to be conducting electronic experiments in the lab. You need to be *present* in the lab, both bodily and mentally. There are just too many ways to make simple blunders that have far-reaching and sometimes overly expensive consequences.
- Have your cognitive functions been compromised? This can happen from taking certain medicines or even recreational intoxicants. If the little bottle says, "Don't operate machinery or drive an automobile," then you probably shouldn't be making important decisions or working with dangerous circuits in your lab, either. Wait until you're clear-headed enough to proceed with your plan for world domination, adding blinking eyes to a plush doll, or what have you.

The worst thing about cognitive impairment is that the first thing that gets impaired is the ability to judge the level of your cognitive impairment!

Care and Feeding of Your Brain

Here are a few tips to keep your brain (and the rest of you) in good working order:

- Stay hydrated. Drink more water than you think you need. This might result in more trips to the bathroom, but this is much more desirable than the alternative. A good flow of water through your systems helps your body feed and repair itself, as well as aiding in the elimination of toxins. Drink more water.
- Avoid excess consumption of coffee, tea, sodas, and especially "energy" drinks. These contain ingredients that stress both your body and your mental capacity. They do not contain energy, but trick your body into going into overdrive by triggering a stress reaction.
- Take frequent breaks. Get up and walk around, if possible. Raise your arms over your head and hold them there as you count to ten. This redirects blood flow and helps restore a balance within your peripherals.

All Those Other Bits, Too

Just as your mind is the most important tool you'll ever use, the rest of your bodily bits and personal pieces are vital and important in your work in the lab. For the most part, there are no spare parts laying around for things like your eyes, your ears, your hands, or your skin.

Should you wear eye protection in the lab? Yes, you should. Are you always going to do so? Probably not. It's true, it can be inconvenient or perhaps a tad uncomfortable. Consider the cost, however. Even the tiniest scratch on your eyeball can take weeks to heal and leave you susceptible to infection or vision loss. It's just not worth it to be lazy. Ask the next one-eyed person you see. If you're a bit uncomfortable asking one-eyed people, "Hey, what's with the one eye?" then perhaps you can just try to imagine them advocating or encouraging you along the same path they took, whether intentionally or accidentally. They won't do it.

Invest in quality eye protection that is comfortable and properly sized for you. Provide eye protection for visitors to your lab as well, if they will be present when soldering, welding, machine tooling, or wire clipping is being performed. Then invest in the habit of wearing your eye protection whenever it is appropriate.

■ **Note** Don't pretend that your prescription glasses with polycarbonate lenses are "safety glasses." They aren't. They do not protect either your eyes or your face from impact or objects entering from the side, as proper safety glasses should. If you usually wear glasses, use safety glasses that comfortably accommodate your glasses when worn.

Will you be working with really loud noises? These could be from powerful audio amplifiers ("it goes to 11") or power tools. Hearing loss from exposure to excessively loud noises is cumulative. This means it slowly (or suddenly) chips away at your hearing, bit by bit. Why do you think old people turn up the TV so loud?

Hearing protection is both affordable and comfortable. For temporary protection, you can use disposable earplugs. If you need protection all day, consider earmuffs designed for hearing protection. Don't let "Hey, y'all, check this out" be the last thing you ever hear.

It's hard to work with hand tools with no hands. It's possible; just really hard. Take care of your hands. There are a hundred ways to burn, tear, cut, or otherwise mangle those mitten-fittings of yours. Have a variety of work gloves on hand to handle the different needs of your lab. The choice will be ultimately determined by the particular hazards present in your lab. Are you working with chemicals as well as electronics? How about sharp edges or glassware? Normally, you won't need to wear gloves for soldering small electronics, but if you start working with really large-scale projects, such as sculptures or plumbing, you might.

Make sure you are still "handy" when wearing the proper gloves for the job. Make sure the gloves fit you properly and allow you the adequate dexterity you need.

■ **Tip** Be safe. Don't be lazy.

Basic Hand Tools

Assuming that you're going to start small and build toward bigger things, you should also start small with some small hand tools. These tools will make it much easier to work on small parts and wires.

Good hand tools increase your effective strength and improve the accuracy and precision of your motions. They allow you to focus a great deal of your strength on exactly the part that needs it, without wasting a lot of effort. Good hand tools also insulate you from sharp, hot, or otherwise unpleasant objects when you work on them.

Take care of your hand tools. Put them up when you're done with them. Make sure they are clean and ready to be used again the next time you need them. Few things are more frustrating than attempting to start a quick repair job and finding out that you need to spend twice as much time preparing your tools for use.

Have some sort of methodical plan or reasoning involved with the storage of your tools. They need a safe and comfortable home, just like you do. You need to be able to find them quickly when you want them. Try out different organizational strategies until you find one that works for you and your lab. This is an easy task when you have just a few tools to organize. Once you've accumulated a large collection of hand tools, this is no longer optional. You *must* know what tools are available and where they are located.

Frequently used tools should be within easy reach of your primary workstation. If your tools need any sort of adjustment or setup before use, make sure you've got all the proper bits handy. For example, a drill press will often have a chuck key used to tighten and loosen the chuck that holds a drill bit in place. That key needs to be in the immediate vicinity of the drill press, as well as easy to locate. Don't spend a lot of time needlessly hunting for tools. Decide for yourself on some safe and practical policies for where you keep your tools.

■ **Tip** Don't waste time guessing where your tools are located. *Decide* where they are located.

Just like everything else, hand tools have a limited useful lifetime. While some tools can easily outlast you, it's up to you to keep track of exactly how much utility you can continue to expect from your tools. This doesn't mean that you have to trash your hand tools once they develop some tiny flaw. If it's beyond your capabilities to repair the tool, then consider replacing it and reassigning it to the second string or backup tool chest. Having a spare tool, even a slightly imperfect one, on hand when you need it can make the difference between success and failure in a project.

Bear in mind, however, that some tools are simply too dangerous to keep around once they've outlived their useful life span. A dull cutting tool that cannot be reasonably resharpened is a good example of a tool that has lost its honored place among your other tools. Thank it for its service, wipe away that little tear, and then figure out a good way to recycle any of its bits that are still functional.

Wire Cutters and Wire Strippers

As you might have picked up from Chapter 1, you can spend a lot of time working with wire in this hobby. Understanding a little bit about how wire is made and how it functions in a circuit will aid you in your experiments.

How Wire is Made—The Very Short Version

Most wire is made of copper or a copper alloy. Some wire used for electrical wiring in houses is made of aluminum. The wire itself starts out as a fairly thick strand and is stretched and pulled—a process called *drawing*—until the desired diameter is obtained. This strand is then wrapped up on spools or bobbins.

- Some wire is made of a single strand of copper (or aluminum). This is called *solid-core* or *single-strand* wire. It is a single strand of wire, usually circular in cross-section.
- Multiple, thinner strands of wire are often bundled or twisted together to make larger-diameter wire. Stranded wire is much more flexible than solid-core wire, but is more expensive to produce because of the extra manufacturing steps required. Because stranded wire has a larger surface area per unit of length, it is more susceptible to environmental hazards such as corrosion.

Most electrical wire is covered with an insulating jacket, usually made of plastic or rubber. This sheathing must be removed to make electrical connections. There is sometimes more than one layer of insulation on a wire, depending on what its final application is destined to be.

More information about wire as a *component* will be presented in Chapter 3. For now, the emphasis is on the characteristics of wire that help determine the best tools to use when working with wire.

Selecting the Correct Tool

Both copper and the aluminum alloys used for electrical wiring are fairly soft metals and can be easily cut or formed with simple hand tools. Wire *cutters* are specialized tools made to make a clean cut through the wire's strand or stands. Wire *strippers* are another kind of specialized tool used to remove the insulation from a wire.

Figure 2-1 shows two rows of commonly available wire cutters.

Figure 2-1. *Commonly available wire-cutting tools. The top row shows three styles of diagonal cutters, which are the preferred tools for cutting small-gauge copper wire. The bottom row shows some tools that offer wire cutting as a secondary facility, and should only be used when proper wire cutters are not available.*

The top row of cutting implements in Figure 2-1 are various forms of what are known as diagonal cutters, side cutters, or flush cutters. These cutters have beveled cutting edges that meet in the middle of the wire being cut. One side of the cutters is flat, or *flush*, allowing wires to be cut with some precision. These are the preferred cutters for small-gauge copper wire, as well as for clipping excess component leads from a printed circuit board (PCB). See Figure 2-2.

Compare the cutting action of the side cutters to the other, less optimized wire cutters in the second row of cutters in Figure 2-1. These cutters either use a shearing action to cut the wire or include a flush-cutting area as a secondary feature.

Figure 2-2. *A close-up look at the business end of a pair of side cutters. When the two cutting edges meet in the middle, the bottom side is flat, or flush, allowing the user to get quite close to where a wire or component lead emerges from a solder joint.*

Use caution when clipping component leads or small wires with any wire cutters. The cut lead can easily fly away at sufficient velocity to poke you right in the eye or other sensitive area. If possible, hold *both* ends of a wire being cut or direct the cut leads *away* from your face.

■ **Caution** Use eye protection when clipping leads. Don't say you weren't warned about this hazard.

Wire Strippers

Wire strippers are tools that allow you to easily strip the nonconductive insulation from wires. You can try chewing it off with your remaining teeth, but this is not recommended.

Wire strippers usually consist of a pair of hinged blades with some sort of machined notch. The notch allows the blades to cut the insulation around the wire without cutting or nicking the underlying conductor. A good example is shown in Figure 2-3.

Figure 2-3. *The popular T-Stripper combination wire cutter and stripper tool from Ideal Industries has been around for over half a century. Note the wire gauge sizes stamped into the face of the cutter blade. New models feature laser-engraved text.*

The wire strippers in Figure 2-3 can easily strip the insulation from wires with a conductor diameter, or *gauge*, between 16 (0.0508" or 1.291 mm) and 26 (0.0159" or 0.405 mm). The higher-numbered wire gauges represent *smaller*-diameter wires. Once upon a time, the gauge number represented the number of *drawing* operations that were performed on a wire when being manufactured. The more times it was drawn through the processing equipment, the thinner the wire became. Today, the wire-manufacturing industry in the United States and Canada has adopted the American Wire Gauge standard (AWG). See Table 2-1.

Table 2-1. *The AWG. A more complete listing is available at http://en.wikipedia.org/wiki/American_wire_gauge, from which this partial list was obtained.*

AWG	Diameter Area			Copper Resistance	
	Inch mm		mm^2	Ω/km mΩ/m	Ω/1000 ft mΩ/ft
0000 (4/0) 0.46 00	11.684 107			0.1608	0.04901
000 (3/0)	0.4096	10.404	85.0 0.20	28	0.06180
00 (2/0)	0.3648	9.266	67.4 0.25	57	0.07793
0 (1/0)	0.3249	8.252	53.5 0.32	24	0.09827
1 0.28	93	7.348	42.4 0.40	66	0.1239
2 0.25	76	6.544	33.6 0.51	27	0.1563
3 0.22	94	5.827	26.7 0.64	65	0.1970
4 0.20	43	5.189	21.2 0.81	52	0.2485
5 0.18	19	4.621	16.8 1.02	8	0.3133
6 0.16	20	4.115	13.3 1.29	6	0.3951
7 0.14	43	3.665	10.5 1.63	4	0.4982
8 0.12	85	3.264	8.37 2.06	1	0.6282
10 0.10	19	2.588	5.26 3.27	7	0.9989
12 0.08	08	2.053	3.31 5.21	1	1.588
14 0.06	41	1.628	2.08 8.28	6	2.525
16 0.05	08	1.291	1.31 13.1	7	4.016
18 0.04	03	1.024	0.823 20.9	5	6.385
20 0.03	20	0.812	0.518 33.3	1	10.15

22 0.02	53	0.644	0.326 52.9	6	16.14
24 0.02	01	0.511	0.205 84.2	2	25.67
26 0.01	59	0.405	0.129	133.9	40.81
28	0.0126 0.32	1	0.0810 212.	9	64.90
30	0.0100 0.25	5	0.0509 338.	6	103.2

We'll return to this table again in Chapter 3 when the electrical properties of wire are discussed. For now, note that as the wire gauge number goes *up*, the wire's physical diameter goes *down*. Similarly, as a conductor's physical size goes down, its ability to carry current also goes down, and its electrical *resistance* goes up.

■ **Note** Other standards exist throughout the world. Steel-wire manufacturers use a different scale, as their interest is more on the tensile strength of the wire, not its electrical properties.

Note that the AWG is for single-strand copper wire. Equivalent gauges in stranded wire are physically a bit larger, although they have the same effective cross-sectional area and can carry the same amount of current.

When using wire strippers, keep in mind that your goal is to cut and remove only the nonconductive insulation from the wire, leaving the internal conductor intact. Even a small nick can result in a weak point in the wire, both electrically and mechanically.

Practice Makes Perfect

The best way to attain proficiency with a new tool is with practice—lots and lots of practice. This is true for working with your hands as well as with that big brain of yours. Ideally, any task worth doing will involve at least a little bit of both manual dexterity and focused brain power.

Cutting and stripping wires is an excellent example. For your first practice assignment, spend some time turning long, beautiful lengths of wire into little bits of wire with stripped ends.

CUTTING AND STRIPPING WIRE

For this exercise, you're going to need the following:

- Wire cutters
- Wire strippers
- Much wire
- A comfortable, well-lit location

Cut the Wire into Segments

Don't watch TV or be otherwise distracted. Pay attention to what you are doing.

Begin by cutting the wire into various-sized segments from 2" to 6" in length. Accuracy in length is not critical at this point. You need to get a good feel for your wire cutters and how much force is needed to cut the wire, without cutting yourself or others.

Collect the cut wire segments into a bowl or small container for the next step.

Strip the Wire Segments

Using your wire strippers, remove about 1/4" (6 mm) of insulation from both ends of each wire. Try not to cut or nick the wire core. The insulation that you remove can either be discarded or collected for use in some sort of art or craft project.

Once you've completed the cutting and stripping portion of this exercise, sort the wires according to their length, or their color if you used different colors of wire. Compare the quality and consistency of your work by looking at the first few wires and the last ones you did. Do you see any improvements in your work?

If you spend about an hour working on your wire-cutting and wire-stripping technique, you will perhaps master a skill that will prove useful for the rest of your life, as well as prepare a big pile of wires that you can use in many of the sample projects illustrated in this book.

Pliers and Tweezers

Every day, the size of the "typical" electronic component gets smaller and smaller. This miniaturization process has brought about a world where you can carry a phenomenally powerful computer in your pocket, and sometimes even make phone calls with it. The individual transistors, resistors, capacitors, and other components inside such modern marvels are literally microscopic in size. You need a fairly powerful microscope to be able to see them at all.

In your typical home electronics lab, and even in many professional labs, you will not be dealing with these tiny things, except as large clumps all tied together inside a chip or other framework. Still, the typical components you will use are often a bit too small for all but the tiniest of fingers. That's where pliers and tweezers come into play. They are an extension of your own hands and fingers, increasing your precision and allowing you to perform delicate tasks with tiny parts.

There are several types of pliers and tweezers that you may use on a daily basis in your lab. See Figure 2-4.

Figure 2-4. *Pliers and tweezers aid in working with small parts. On the left is a pair of needle-nosed pliers with cushioned grips and leaf springs. In the center is a pair of slip-joint pliers that can be adjusted to accommodate two different ranges of gripping action. On the right is a pair of needle-sharp tweezers, which can be used to pick up and place even the tiniest of electronic components—if your hand is steady enough!*

Screwdrivers, Nut Drivers, Wrenches, and Ratchets

A lot of electrical connections can be made using only a screwdriver. Figure 2-5 shows an electrical connection using a *barrier strip*. A specialized connector is crimped onto the end of the wire and held in place with a screw. A variety of crimp-on connectors are available and should be installed using the appropriate tool, as indicated by the connector's manufacturer. Just smashing the connector onto the wire with some pliers is not recommended.

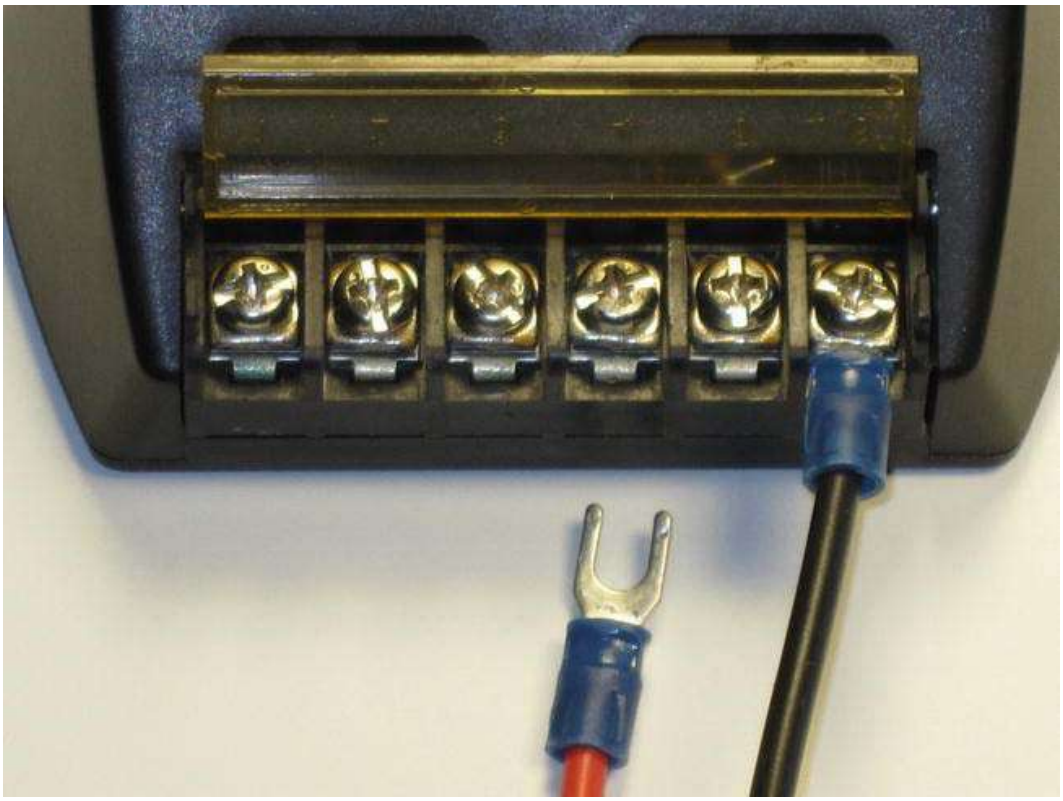

Figure 2-5. *A barrier strip on a low-cost solar-charge controller. No soldering required! The specialized connector is held in place with a screw. The connector is affixed to the end of the wire by deformation using a specially designed crimping tool. You can see the indentations in the insulating collar around the connector.*

Another type of connector that is tightened with a screw is called a *terminal block*. Unlike a barrier strip, no specialized connector is required on the wire. You can simply insert a stripped wire into the terminal block and tighten the connector using a screwdriver. Try to strip the wire only enough to allow the bare conductor to enter the terminal block, without leaving any noninsulated wire exposed that could accidentally short out against another wire. See Figure 2-6.

Figure 2-6. *A terminal block uses a screw for tightening the connection with a bare wire.*

Besides being useful for making electrical connections using barrier strips and terminal blocks, screwdrivers are also quite handy in their original function, which is to tighten and loosen mechanical fastening devices such as screws and bolts. See Figure 2-7.

Figure 2-7. *A variety of screwdrivers. The four on the left are standard, or straight-bladed, screwdrivers. The three on the right are Phillips-style screwdrivers. Other specialty bits are also available.*

You should only use screwdrivers to drive screws and bolts. Don't try to use them as levers, pry bars, chisels, punches, or other tools. When you need a chisel, use a chisel. Keep your screwdrivers clean and dry. Put them back where they belong when you're done with them. You get to decide where they belong.

Screws, Bolts, and Nuts

There are a *very* large number of different kinds of screws and bolts. Some screws, such as wood screws, are made to be driven directly into wood and create their own threads in the material as they are installed. Other screws, largely referred to as machine screws, mate with a premachined or tapped hole, or a machine nut.

Nuts are often shaped with four or six sides that allow them to be held in place while the screw is turned. Alternately, the nuts themselves are turned while the screw is held in place. Some screws and bolts have a similarly shaped head that allows them to be turned with a wrench or nut driver instead of a traditional screwdriver.

Please resist the urge to overtighten screws and bolts. The mechanical advantage gained by the inclined plane of the screw thread multiplies the force used to turn the screw into a terrific amount of pressure on the screw itself. You can easily damage either the screw or the threads in the material to be fastened by overtightening a screw.

More Specialized Hand Tools

A good set of wire tools, pliers, and screwdrivers will go a long way when working with electronics. However, sometimes you need a more specialized tool for more specialized work.

Here are some of the more common tools that are a little more focused on a particular task than they are for general-purpose usage.

Wire Crimpers

As mentioned previously in this chapter, you can make solid electrical and mechanical connections using barrier strips and specially terminated wires. The optimized connectors used for this purpose require optimized tools for best performance.

Figure 2-8 depicts some examples of specialized crimp tools for electrical connections.

Figure 2-8. *Some common crimping tools for affixing electrical connectors to wire*

Referring again to Figure 2-8, the crimpers on the left are for crimping tiny pins to the ends of tiny wires that are then inserted into plastic connector bodies. The center crimp tool is for crimping modular jacks onto telephone cables. It also includes a wire-cutter blade (bottom) and a pair of controlled-depth stripper blades for removing only the outside layer of insulation from silver-satin flat telephone cord, without disturbing the individually insulated wires contained within. The crimp tool on the right features a ratcheting action that increases the crimping force applied to the connectors. This is the tool used to crimp the connectors show previously in Figure 2-5.

Computers

You might not think about computers as being "power tools" in your toolbox. As the size of computers, laptops, tablets, and smart phones decreases, and their computing power, networking ability, and storage capacities increase, they become much better candidates for use in the lab.

Traditional "desktop" personal computers (PCs), laptops, netbooks, and tablets can perform multiple roles in your laboratory setting. If you are lucky enough to have Internet access on your computer, it can become a conduit for all types of useful electronics information, in addition to its more accepted role as a source of funny cat videos. See Figure 2-9.

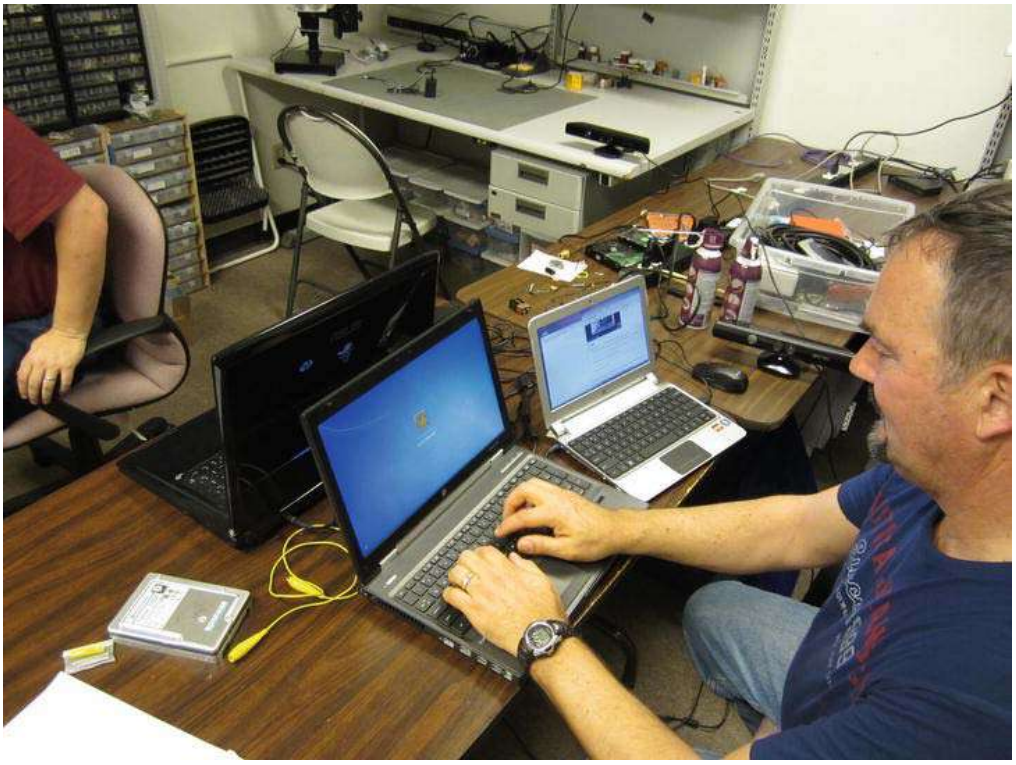

Figure 2-9. *Computers being used in the lab. Paul Bouchier of DPRG uses two laptops at once when testing new robot software with the Microsoft Kinect (just to the right of his mouse).*

Here are just a few of the many possible areas of practical knowledge, learning opportunities, and bits of interesting information that you can access using your computer:

Data sheets: Almost all electronics manufacturers provide online access to a library of technical data sheets and application notes for their products. These should be your first choice for information about how and when to use their products. These sources also contain important product *errata*, which contains corrections and updates for products that have been made since their first publication.

Online tutorials: The Web abounds with detailed and thought-provoking tutorials and background information on every topic imaginable, including, not surprisingly, mountains of information on computers and electronics.

User forums: People tend to cluster around others with similar interests. Once upon a time when people where geographically limited and unable to communicate or interact with folks around the world, this severely restricted a lot of the more specialized areas of knowledge. Today, you can find user groups centered on every conceivable human endeavor (and some inconceivable ones, too) that are filled with helpful, knowledgeable members that are more than happy to answer questions and share experiences with you. Do try to be courteous, respectful, and fair when asking for help with your projects, and always try to repay in kind by helping those with similar questions that you've had to master.

Sharing/collaboration web sites: As the cost and complexity of publishing your work on the Internet becomes more manageable, it becomes faster and easier to let others know about your progress, as well as your problems. You can easily set up your own web page for little or no cash, or join many of the available user groups that allow their members to post, browse, and otherwise benefit from the works of other similarly minded individuals.

Design tools: You can find many free or reasonably priced electronic design and simulation tools online. Some manufacturers also provide free tools specifically for optimizing designs for their products.

Online suppliers: Where you once had to walk (or drive) down to the store and see what was available in your area as far as electronic components and tools went, now you can browse through the catalogs of suppliers from all over the world, from the comfort of your own lab. Not only does this provide a much larger field from which to choose, it also levels the playing field, so to speak, forcing worldwide competition for your hard-earned cash. Bonus: Some manufacturers offer a limited numbers of free samples. Yip!

This list only scratches the surface of the kinds of information you can access using a computer. You can also use a computer as part of your electronic projects, and several examples of doing this are included later in the book.

Tools for Soldering

You don't have to learn how to solder to work with electronics, but it helps. It really does. It opens a whole new world of possible projects, repairs, and custom modifications to existing equipment. Just remember, as always, to keep your work area clean and safe. See Figure 2-10.

Figure 2-10. *A Weller controlled-temperature soldering station. What a mess!*

Like any worthwhile skill, soldering is best mastered with lots and lots of practice. The best way to learn this useful skill is to have someone show you how it's done. It's difficult, but not impossible, to learn proper soldering techniques from a book. That being said, have a look at Figure 2-11.

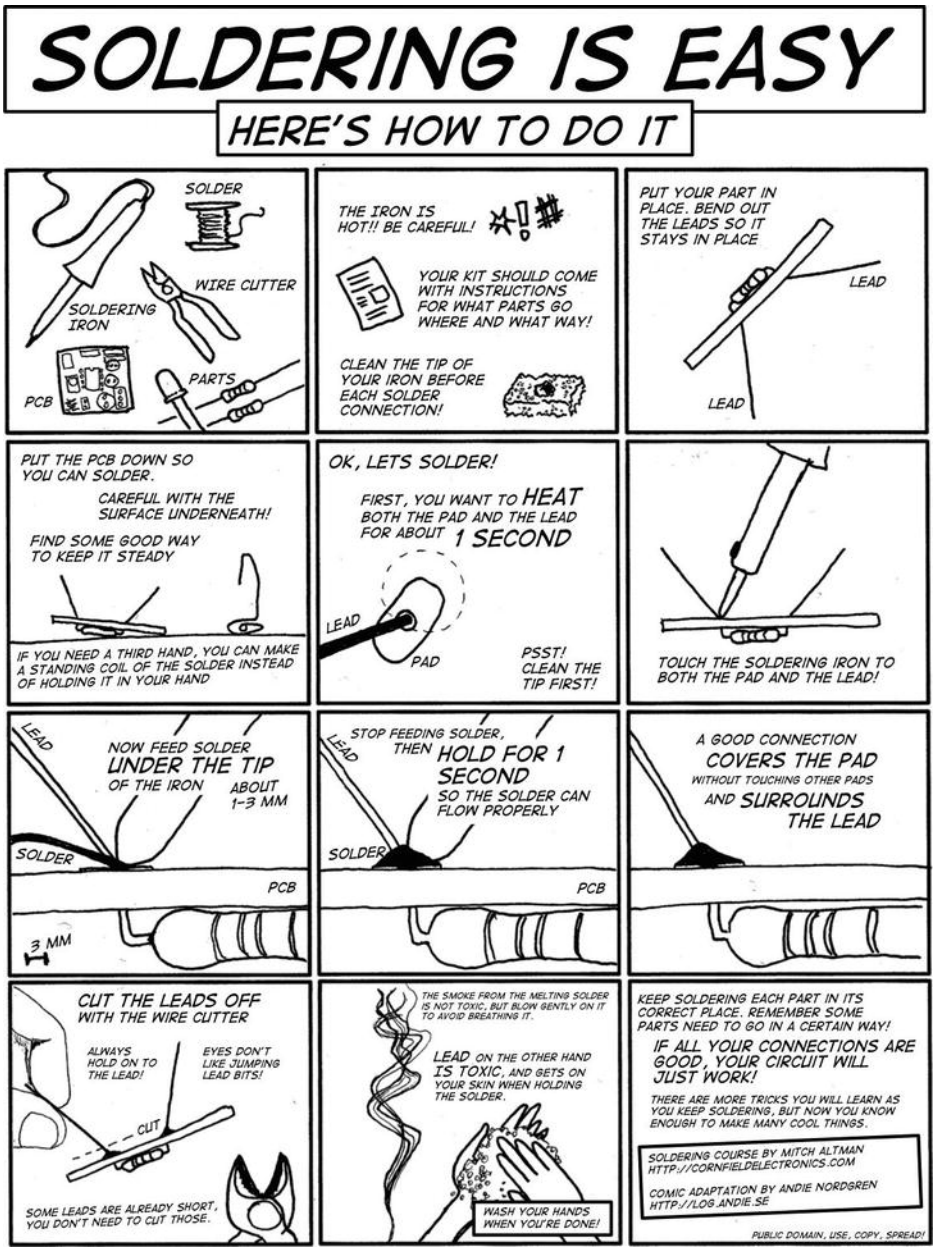

Figure 2-11. *Instructions for soldering. This delightful illustration by Andie Nordgren captures the basics of soldering as taught by soldering guru Mitch Altman (http://log.andie.se/post/397677855/soldering-is-easy).*

To solder, you will need a soldering iron. You will also need some solder and probably some wire cutters. That's just the tip of the iceberg, however. Like any good tool, your soldering station will soon accumulate many *accessories* to enhance your soldering prowess.

To begin your soldering adventure, you will need a *small* soldering iron, some solder, and a damp sponge. The big, pistol-grip style of soldering irons are for much larger projects, such as plumbing. Ideally you want something in the 15W to 50W range. See Figure 2-12.

Figure 2-12. *The pencil-grip style of soldering irons is better suited for working on small electronics projects.*

The soldering iron in Figure 2-12 has a replaceable, conical tip. These tips are generally interchangeable for a particular model of soldering iron, but unfortunately not interchangeable between different models or manufacturers. Different tip shapes are also available, depending on what types of things you're wanting to solder.

The tip is usually made of copper, which is an excellent conductor of heat. Since copper really likes to combine with other metals at high temperatures (which is exactly what happens when soldering), most tips are coated in a thin layer of steel to give them much longer useful lifetimes. Tips still wear out, however, and should be replaced.

In this particular soldering iron, the next part of the iron is the removable barrel that holds the tip in place. This barrel is where the heating element is housed, so remember that it is just as hot as the tip! Try not to touch it. You will probably not want to make that mistake more than once.

The next section is the padded and insulated handle of the soldering iron, which is made of dense plastic foam. A quality soldering iron will be comfortable in your hand and won't produce excessive fatigue, even after hours of use. Lower-quality and lower-priced models will more rapidly take their toll on your hands.

Not shown in Figure 2-12 is the flexible power cord running back to the soldering iron's base. This cord supplies the electrical power that is converted to heat in the barrel, as well as some wires for a

temperature sensor. This allows the unit to control the temperature of the tip with great accuracy. Note the temperature dial in Figure 2-10. Lower-cost units omit the temperature control features and run at a constant power output.

It will take some amount of time for the soldering iron tip to reach a working temperature. Likewise, it will also take some time to cool off once you've turned off the soldering iron.

■ **Caution** Soldering irons are very hot in use and can cause painful burns. Always treat them with respect!

The solder you use will be determined by what kind of soldering you want to do. For most small, electronics-related soldering projects, a small-gauge tin-lead or lead-free solder can be used. Bear in mind that lead is a poisonous material that slowly accumulates in your system, should you come into contact with it, as your body has no good way of eliminating it. Wash your hands before and after soldering, just to be safe.

Soldering works best when everything being soldered is sparklingly clean. To help facilitate this cleanliness, chemical compounds known as soldering rosin are used. These compounds chemically clean the surfaces being soldered when exposed to high levels of heat. Some types of solder have rosin incorporated into them. You can also obtain rosin as a paste into which you can dip wires and component leads before soldering. Other types can be applied with a dispensing pen.

■ **Caution** Don't breathe the smoke emitted during the soldering process. If possible, use a fan or fume extractor to redirect the soldering fumes away from you.

Once your soldering iron is up to its proper operating temperature, clean the tip by wiping it gently on a damp sponge. Your tips will last longer if you resist the urge to clean them before replacing the soldering iron in its holder. Even though it seems counterintuitive to "put it up dirty," this will more than double the life of your soldering iron tips. Just be sure to clean the tip *before* you solder anything.

Power Tools

Everybody loves power tools, don't they? Sometimes it's enough to just *imagine* that you might need one to justify a trip to the store and subsequent purchase. While this may be human nature (or perhaps only the nature of one particular gender), it doesn't fully justify having one of each in the lab, *just in case*.

Drills and Drill Bits

You will, however, find a few particular tools to be especially useful in your lab. A good hand drill or drill press is one of those tools. There seems to be no end of things electronical that need a few more holes drilled into them. Electronic enclosures and control panels need good, clean holes drilled into them. If you make your own PCBs at home, you will find that they need *lots* of holes drilled into them.

Like any power tool, an electric drill needs and deserves your respect. You'd be surprised how much unintentional damage you can cause with such a simple device. Observe these simple safety rules when operating a power drill:

- Keep your work area clean and well illuminated.
- Remove any watches or jewelry you might be wearing.
- If you have long hair, keep it pulled back and tied out of the way.
- Always clamp down any work to be drilled on a drill press.
- Always remove drill bits from the drill chuck after use.
- Discard dull or rusted drill bits that cannot be resharpened.
- Always wear safety glasses when operating power tools.

Hand drills come in all shapes, sizes, and price ranges. Some are powered by hand cranks and some are electric. Rechargeable batteries make for very portable drills that you can carry almost anywhere. See Figure 2-13. The only drawback is their limited charge time. That's why you should always have at least one spare battery charged up and ready to go. Electric drills with wires attached don't have this problem. Just don't trip over the cord!

Figure 2-13. *A rechargeable hand drill. This model is both variable speed and reversible, which are two very desirable features in a hand drill.*

■ **Note** Power drills are also very handy when used with screwdriver bits. They can save you time and many blisters!

Drill bits likewise come in all sizes and shapes. You can buy sets with a variety of sizes, and these will usually come with a handy storage container that conveniently labels all the sizes for you. This only works, however, if you take the time to return the drill bits to their proper location once you've finished working with them.

A drill press has a large frame that facilitates drilling a precisely aligned hole, over and over again. You can make spindle-speed adjustments to drill presses (even small ones, such as the one pictured in Figure 2-14) either through an electronic speed control or by changing up the belts and pulleys that drive the spindle. There are even small frames for mounting handheld drills or rotary tools, such as the Dremel brand of tools. You can often, however, find actual, dedicated drill presses on sale for about the same price as the daintier Dremel tools.

Figure 2-14. *A small tabletop drill press*

■ **Caution** When working with drills and presses, always keep your work area clear. Always wear safety glasses when using power tools. Try to keep the chuck key handy. Don't leave drill bits mounted in the chuck when not in use. Many chuck keys have built-in springs that prevent them from remaining in the chuck. Those that don't risk being accidentally left in the chuck when the drill its turned on, which can either fling the chuck across the workshop or make a big mess of your favorite hands.

Laser Cutters and 3D Printers

While not everyone can afford some of the more expensive and esoteric tools that are available, some of these tools are getting more popular than others; excellent examples are laser cutters and 3D printers. See Figures 2-15 and 2-16.

Laser cutters and engravers use a powerful carbon-dioxide laser to cut through wood and non-chlorine-based plastics. The laser beam is focused onto the work surface using mirrors that are mounted in an XY gantry, allowing the cutting area to be controlled by a computer. Typical installations require venting to the outside because of the various aromas produced in the process, as well as a water-cooling system for the laser tube itself.

There are also some newer laser cutters being built by hobbyists from scratch.

Figure 2-15. *A laser cutter. A powerful 40W carbon-dioxide laser is used to cut through wood and non-chlorine-based plastic, all under computer control. It can also be used as an engraver. This model is manufactured by Full Spectrum Engineering.*

3D printers seem to be all the rage these days. We're all pretty accustomed to the idea of printing on paper with a computer, although it's still a pretty recent innovation, as far as the history of printing goes. The idea of printing a solid object, on the other hand, is considered to be something of a game-changer.

The simplest 3D printers use a plastic extrusion and a motorized gantry to operate as a kind of a robotic glue gun. A plastic filament is fed into a heated fixture that is moved around a print bed, leaving a trail of cooling, gooey plastic. Either the extruder or the print bed is moved using motors under computer control to build up a layer at a time of the desired object.

Higher-technology 3D printers use this and other techniques to produce tangible, solid objects. Some use layers of fine powder that is glued together with a binder dispensed from a print head, similar to an inkjet printer. As each layer is printed, the object is lowered and another layer is deposited. This can even be done with sugar, as in the case of the CandyFab 4000, designed by the clever folks at Evil Mad Scientist Laboratories (`www.evilmadscientist.com/article.php/candyfab`). A stream of heated air is used to fuse a layer of sugar into a single solid structure, and an object is built up of successive layers.

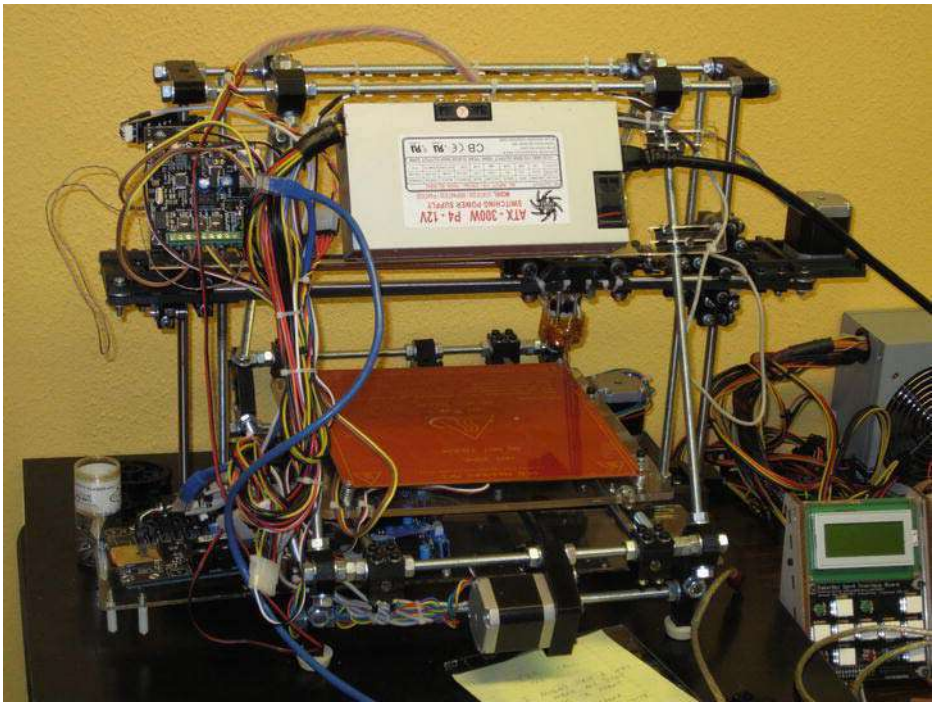

Figure 2-16. *A 3D printer at Dallas Makerspace. This machine uses a heated extruder to build 3D objects out of plastic.*

Basic Test and Measurement Equipment

When it is behaving itself, electricity is generally invisible. To "see" what it is doing, or not doing, you will need some specialized tools. These fall into the two general categories of *test* and *measurement* equipment.

The line between testing and measuring is sometimes blurry. One possible distinction might be that testing verifies proper operation within acceptable parameters, while measurement actually assigns

values to those parameters. An example of testing is, Does that flashlight work? The answer is yes or no, arrived at by the simple expedient of turning it on and observing the results. An example of measurement is, How much current does that flashlight draw? The answer might be 0.78A, and this would be determined using the appropriate measurement device, which in this case could be an ammeter.

Inspection Equipment

Sometimes, however, measuring things isn't hard at all, especially when the things being measured are actual, tangible items that you can hold in your hand. What you will need are some basic tools, primarily to be able to *see* what it is that you are measuring, and secondarily to take accurate measurements of them, at least in regard to their physical dimension. This comes in very handy when trying to identify components during repair or equipment upgrades, when the original technical documentation is not at hand.

Even the youngest and finest of eyeballs will need help with the teeny-tiny components that are available nowadays. You should try to find at least a small magnifying glass to examine fine details. If your budget allows, you might want to consider a microscope of modest power to look at your handiwork. Careful shopping will result in finding some older microscopes at bargain prices. Expect to pay a premium price for the shiny, new stuff. See Figure 2-17.

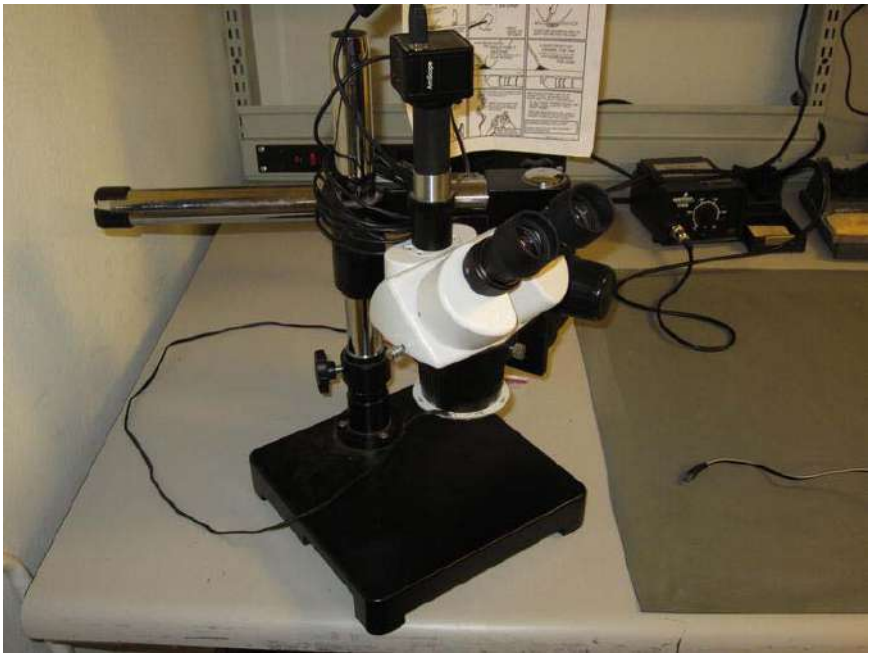

Figure 2-17. *A very nice stereo microscope. The power cord running to the white ring (partially hidden) supplies power to a ring of white LEDs that help illuminate the field of view. The base is very heavy to help stabilize the microscope.*

Even a humble magnifying lens can be very helpful in the lab, especially if it has a built-in light. See Figure 2-18.

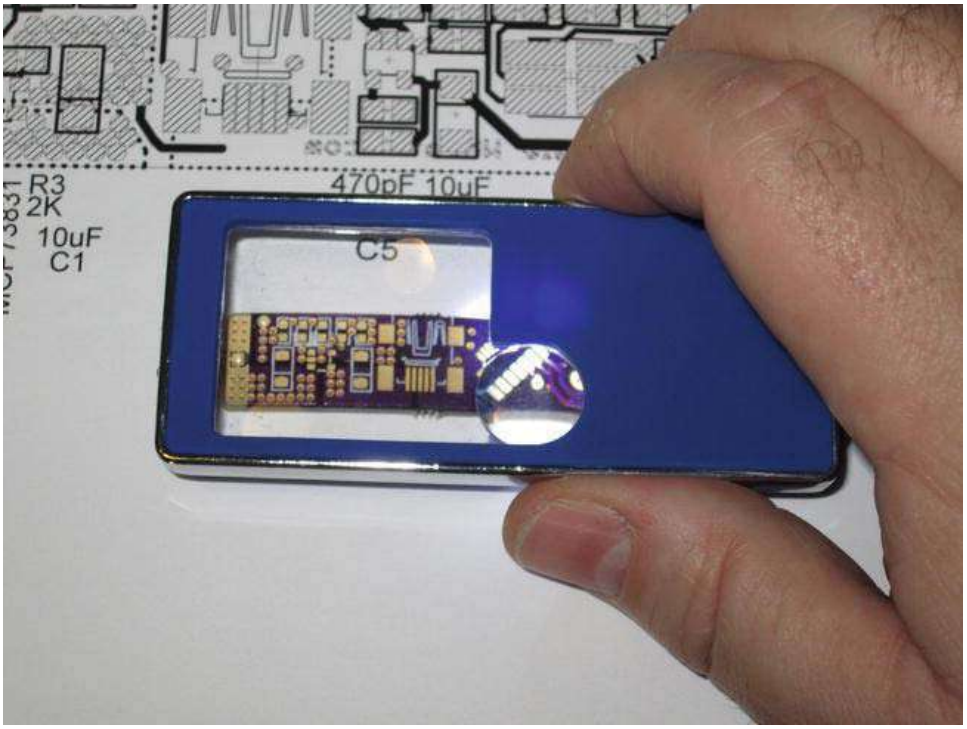

Figure 2-18. *A small, handheld magnifier with a built-in LED light is very handy for examining small features and details, such as are found on many PCBs.*

Physical Measurement Devices

Once you know what something looks like, at extreme close-ups, can you describe in absolute terms how big it is?

Take a look at Figure 2-19. Here we have, from the top to the bottom, a traditional tape measure, marked in both English and metric units (fractional inches and decimal centimeters), a digital caliper that can render measurements in either system at the touch of a button, and an architect's scale. While it may not be evident in the top-down view, the architect's scale is triangular in cross-section, resulting in not two but *six* different measurement options. This is mostly due to architects liking to draw things to scale, instead of full-sized.

The digital caliper is interesting in that it also provides a computer interface so that its readings can be pulled in by a computing device of some sort. These devices used to be quite expensive, but mass production has brought their prices down significantly.

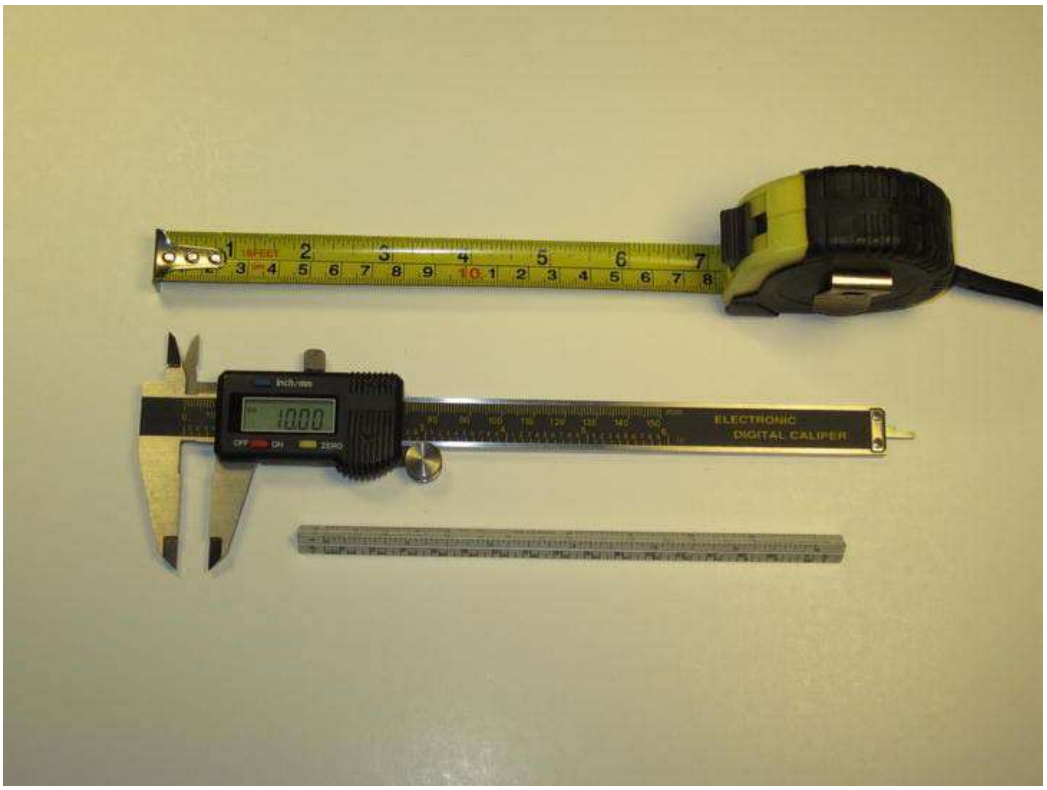

Figure 2-19. *From top to bottom, a tape measure, a set of digital calipers, and an architect's scale.*

Simple Electronic Measurement Tools

Now that you've got the tools to examine what these things look like and how big or small they are, let's move on to the more mysterious art of measuring their electrical properties.

Voltmeters

Voltage is a measure of electromotive force, and the standard unit of measure is the *volt*, named after Alessandro Volta, an Italian physicist. Voltage is sometimes compared to the pressure of water flowing through a garden hose, while amperage is compared to the amount of water flowing through the hose at any given time. It's not particularly useful to push this water analogy too far, but it's helpful in the beginning.

Voltage can be accurately measured with, you guessed it, a voltmeter. See Figure 2-20.

Figure 2-20. *A panel-mount analog voltmeter (left) and a digital version (right)*

A voltmeter measures the voltage, or *potential difference*, in a circuit across two points. Sometimes one of the points is a fixed reference point, such as the electrical *ground* mentioned in many circuits. This is often just a convenience for the purpose of measuring things, as the ground in an electrical circuit may or may not be connected to the ground under your feet.

A voltmeter will have two terminals, labeled positive (+) and negative (–). Looking at the analog voltmeter in Figure 2-20 (the one on the left), we see a needle that can swing from 0 on the left to 30 on the right. The prominent capital *V* on the dial indicates that the unit of measure is the volt. This indicates that you can use this meter to directly read from 0 to 30 volts, just by placing its terminals across a voltage. The meter itself is electromechanical in design, and creates a magnetic field that works against a spring and a fixed magnet. This action causes the needle to move to a point generally corresponding to the labeled voltage on the dial. These needles are not especially accurate, but can be corrected using the screwdriver adjustment at the bottom of the meter.

An analog panel meter such as this one does not require a separate power supply for proper operation. It draws all the power it needs from the signal being measured. This makes it unsuitable for measuring low-power circuits, where the current draw from the meter would unduly influence the reading.

The panel meter on the right is a digital circuit that measures the voltage and displays it on the built-in liquid crystal display (LCD). It requires a separate power supply for normal operation.

Ammeters

An *ammeter* looks and operates just like a voltmeter, except that it measures electrical current flow instead of voltage. The flow of electrical current is measured in units called *amperes* (A). The basic mechanism is almost identical to a voltmeter. To convert a current flow into a voltage, an electrical device known as a *shunt* is used. The shunt is simply a fixed-value resistor that produces a voltage across its terminals in relation to the amount of current that is flowing through it and its inherent resistance to the flow of current.

This relationship between voltage, current, and resistance is elegantly expressed in *Ohm's Law*. If you know two of the measurements in a circuit, you can calculate the third, based on their fixed and proportional relationship to each other. You will find this law to be exceedingly helpful to you when designing, repairing, and upgrading electronics.

To avoid using fractions, which seem to terrify so many people for no good reason, you can use Ohm's Law thusly:

- Voltage (volts) = current (amps) × resistance (ohms)
- Current (amps) = voltage (volts) ÷ resistance (ohms)
- Resistance (ohms) = voltage (volts) ÷ current (amps)

That's all there is to it, if you're just working with volts, amps, and ohms. Things can get weird, however, when you start to work with alternating current (AC), which is the kind of electricity you find in wall outlets and audio circuits.

Ohmmeters

An excellent application of Ohm's Law is found in building a resistance meter, also called an ohmmeter, because it measures resistance. Resistance is measured in units called ohms, often abbreviated with the capital Greek letter omega (Ω).

There are two ways to do measure resistance. One is to pass a known voltage though the unknown resistance and measure the current that is flowing in the circuit. The other is to pass a fixed current though an unknown resistance and measure the voltage across it. This second method is the one most commonly used.

You're most likely going to use a multimeter to measure resistance, as this is one of the more common functions of these handy devices. Mutlimeters are covered in the very next section.

Advanced Test and Measurement Equipment

It would seem that for simple circuits, having just a voltmeter, an ammeter, and an ohmmeter would be all you need. For the most part, this is correct. However, have you considered what would happen if you applied 100V to the 30V meter shown in Figure 2-20? What if you simply reversed the polarity of the signal by accident? Something bad for the meter, that's for sure. It might not actually catch on fire *right away*, but it would certainly damage the delicate, spring-loaded mechanism, possibly rendering it useless as a reliable measuring instrument.

The same can be said for an unprotected ammeter or ohmmeter. Luckily, the nice people that make good test equipment stay up late at night, thinking of the stupid things we might do with their products, and protect them accordingly. Let's look at some meters that measure multiple electrical characteristics, which strangely enough are called *multimeters*.

Multimeters

Multimeters will almost always allow you to measure various ranges of DC (direct current) volts, AC volts, current, and resistance. More advanced meters also measure things like frequency and duty cycle or even temperature. Some meters will even directly measure capacitors, inductors, and transistors using specialized connectors.

As with most tools, you generally get what you pay for with multimeters. The meter on the left in Figure 2-21 was purchased for under $3, including shipping from China. It arrived DOA (dead on arrival) and was not deemed important enough to return. It will make an interesting clock or fake lie detector someday. The unit on the right was purchased new for nearly $400 and has provided over a decade of useful service. The unit in the center is modeled after the unit on the right, it would seem, but can be bought new for between $10 and $20. The unit in the photo was bought wholesale for $4, because sometimes you get lucky. It's often handy to have a second meter in the lab—for example, when you need to measure the voltage *and* the current flowing in a circuit simultaneously, which you just can't do with a single meter.

Figure 2-21. *Examples of some multimeters. The meter on the left features an analog display that is easy to read and acommodates several readout scales simultaneously. The remaining two meters have digital readouts and offer more accuracy. All the meters use a large rotary knob for selecting the proper function. The higher-cost unit on the right features auto-ranging, intellignetly deciding what range to use. The right two units also have high-impact boots to help protect them in the event of a fall.*

Your present budget will help determine what level of multimeter you might want to obtain. If you're wanting to sink less cash into a multimeter right now, consider looking for used equipment in good shape. As with any good tool, you can spend as much as you like on these. The sky really is the limit here.

Most all-in-one meters protect their inputs using fuses. You will have to disassemble your meter to replace these fuses, so think twice and measure once (to paraphrase the old carpenter's saying, "Measure twice and cut once").

■ **Tip** Be sure to set up your meter for the proper function and range *before* taking measurements.

Oscilloscopes

Once you've gone beyond measuring simple DC and AC voltages and move on to more complex signals and waveforms, you'll have to lay aside your trusty meter and fire up your favorite oscilloscope. This instrument is more complex than your traditional multimeter, and offers a different perspective on what's going on in your circuit.

While many modern oscilloscopes have many modes of operation, their basic function is to draw a picture of your signal on a small screen. In the olden days, this was done with a moving dot that was swept across a phosphorescent screen, leaving a residual, fading line of light. If this pattern was repeated over time, a visual representation of the signal could be seen on the screen. See Figure 2-22.

Modern oscilloscopes use a computer monitor or built-in screen display to draw the signal. This saves space, weight, and power requirements.

When purchasing an oscilloscope, the features you pay most for are the number of available channels and the bandwidth. The least expensive oscilloscopes will have a single channel. Having multiple channels allows you to "see" multiple signals simultaneously, which is often helpful in understanding what is going on in a circuit.

Bandwidth refers to the range of frequencies that can accurately be measured by the oscilloscope. Lower bandwidth scopes require much simpler electronics, and are thus cheaper to produce.

Figure 2-22. *A Tektronix 475A oscilloscope. This piece of vintage test equipment is considered by some to be the best analog oscilloscope ever made. It also has a digital multimeter built in along the top edge.*

The Golden Age

Once upon a time, not so long ago, a quality oscilloscope weighed 40 pounds and had a folding handle to make it, if not portable, at least *transportable*. It also had its own line of furniture to place it on, so that you could wheel it around the lab as you needed. Oh, and it also cost about three months' salary, and that's if you had a *good* job.

The good news? That same scope still works today. It can be repaired or calibrated to the exact same standards as when it was brand new, *plus* you can buy it on eBay for a few hundred dollars, sometimes less. That's because when these devices were designed back in the 1970s, they were made to be the best in the world, and cost was not a factor.

Modern Oscilloscopes

Today you can buy a quality oscilloscope for a few hundred to a few thousand dollars. These scopes not only display your signal on a large, colorful screen, but they can also analyze the signal and tell you all kinds of interesting things about it. For an example of such an oscilloscope, see Figure 2-23.

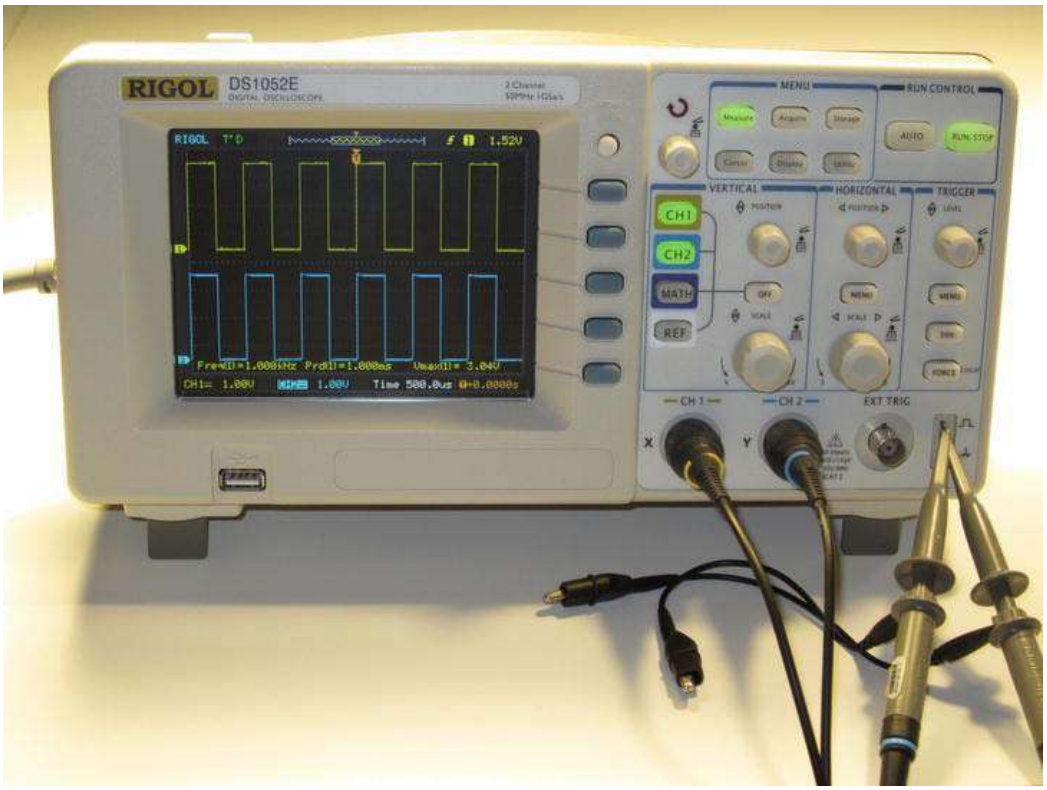

Figure 2-23. *A modern digital storage oscilloscope. The RIGOL DS1052E is an affordable scope that will handle most troubleshooting and design challenges that you might encounter in your lab.*

This new breed of digital storage oscilloscope (DSO) can even connect to your PC to be remotely operated and allow you to capture screen shots that can then be pasted into books about how to build your own electronics lab. It's true. See Figure 2-24.

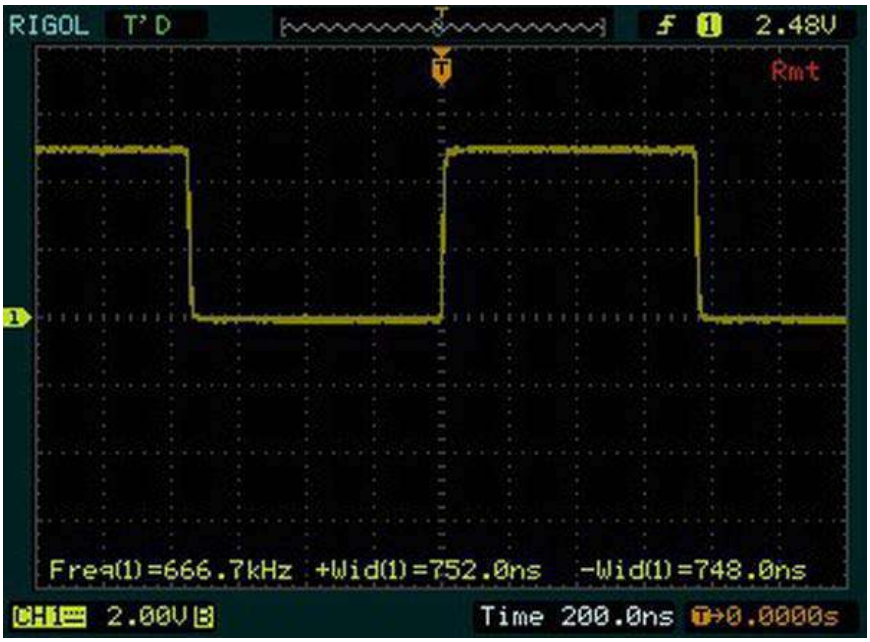

Figure 2-24. *A screen capture made with the RIGOL DS1052E oscilloscope.*

Tiny Oscilloscopes

The march of electronic miniaturization never stops, and so it is with oscilloscopes. If both your needs and your budget are modest enough, perhaps you can get by with something like the pocket-sized wonder shown in Figure 2-25.

While little scopes like this lack the accuracy and bandwidth of their larger relatives, they are definitely handy to have when you need to look at a signal. If you can keep your expectations in check when it comes to the user interface, you can get a lot of utility from such a small package.

Additionally, one of the benefits of a device such as this is that the hardware and internal software (yes, there's a little computer in there, somewhere) is all open source. This means that you have access to all the schematics and source code. And what does that mean? It means that if you have the skills and the right equipment, you can redesign the entire apparatus to fit your own requirements, assuming that you understand the basic limitations of the electronics. The sky is the limit. You are empowered.

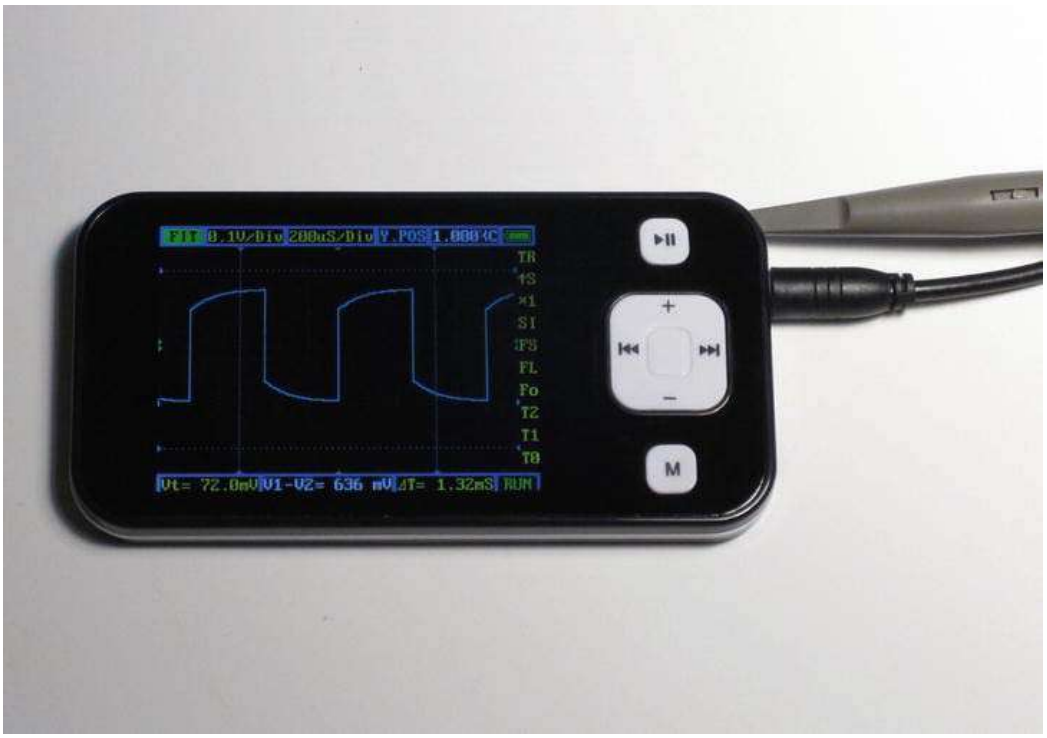

Figure 2-25. *A handheld oscilloscope, which can also fit in your pocket. This is the DSO201, which has been discontinued by the manufacturer, but can still be snapped up for a song from various online distributors, as well as eBay. This unit was purchased new for $60 and features a single channel with a bandwidth of 1 MHz.*

Power Supplies

One of the most important pieces of test equipment in your lab is a reliable power supply. Building a good bench power supply is an excellent first or second electronics project (see Chapter 5 for more on adding power supply to your lab and Appendix A for more on building your own). This is because the basic design is very simple and easy to build, yet allows you to add any number of additional features later.

Once you get tired of throwing away spent 9V batteries and grow weary of waiting for the red light on the battery charger to go out, it's time to invest (either time or money or both) in a decent bench power supply.

It doesn't have to be fancy. In fact, the simpler the better at first. What you're aiming for primarily at this point is reliability. You want to know that when you turn on your 5V supply, it's putting out 5 volts, not 2 or 11, no matter what you do to it. If it's overloaded, it needs to deal with it and not be catching on fire. If it's underloaded, or not loaded at all, it still needs to maintain a nice, clean output.

Want a cheap or free power supply? Do you have any dead or discarded electrical gizmos that came with a charger? These make excellent starter supplies for the new lab. Do you have any extra USB

chargers? These are even better, because they supply up to 2.5W (and sometimes more) of *regulated* 5V. We'll use some of these in experiments in Chapter 3.

Organizing Your Tools

So now you have an idea about some of the tools you want (or already have) for your lab. Where are they all going to live? This is a big question, and deserves a big answer.

One way to look at this book is that the entire latter half is dedicated to answering this question. There are, obviously, many possible arrangements that will work for most people. But we're talking about *your* lab, with *your* tools, arranged and ordered to meet, specifically, *your* needs.

As you progress through Chapter 3 (the very next chapter in this book), you'll get a chance to play with both your tools and some interesting electronic components, all in the interest of getting you familiar with some basic concepts. These concepts and ideas are not new, but they may be new to you. The good news is that time invested today and in the very near future should pay off big dividends to you later in life. Who knows what you'll devise in that electronics lab of yours?

Summary

Starting with your brain and working outward, this chapter has covered some of the tools and devices you might use in your electronics lab. These include basic hand tools, computers, tools for soldering, some common power tools you might find handy, as well as some fancy-schmancy tools you might only find in a hackerspace, school, or electronics clubs, such as laser cutters and 3D printers.

You also learned about some of the basic test and measurement tools you'll be needing when working on electronic circuits in your lab. These include magnifying glasses, measuring tapes, and meters (oh my!), as well as oscilloscopes and power supplies.

Additionally, *lots* of advice on safety was presented. These topics were learned the hard way. Do try to learn from the mistakes of others, won't you?

Just a hint was given about how you might want to organize your tools within your lab. Take care of your tools and they will most certainly take care of you. The details about possible organizational scenarios is left for the second half of the book, where you will learn about setting up labs big and small, as befits your needs, budget, and interests.

Chapter 3 ties in much that you have learned here in Chapter 2 by introducing you to not only some of the basic electronics components and their uses and characteristics, but also how to use a good number of the tools described in this chapter. Hopefully this chapter has whetted your appetite and readied you to dive into some circuits and see what kind of mischief you can wreak on the world.

CHAPTER 3

Components

You're going to need some components to play with, as well as the knowledge to use them effectively. This chapter will introduce you to some of the bits and pieces that make up modern electric and electronic circuits. It will also teach you a little bit about how to identify components from their appearance and markings, when available.

Once you've got an idea about what these parts do in a circuit, you'll learn a little more about how to measure their electrical properties and put them to use. You'll also be shown what *not* to do, in some select examples.

There are an enormous number of both manufacturers and vendors of electronic components these days. Trying to list even a few of them here in print doesn't really make much sense, as a good percentage of that information will be incorrect or obsolete as soon as the ink dries on the page.

Having a variety of basic components readily available is convenient, until your collection grows beyond your ability to house or organize it. This happens far too often, in reality. Most common electronic parts can be obtained within a day or two from local sources, unless you live in a really secluded part of the planet. Also, most of the more common parts will typically cost only a few pennies apiece, so there aren't a lot of reasons to stockpile random parts. Keep a few of each on hand for experimentation, but hold off on pointless hoarding . . . if you can.

Conductors and Interconnects

In any electrical or electronic circuit, there are just as many connections between components as there are components. These include wires, cables, connectors, plugs, sockets, and all those other pieces that help the little electrons zip around the circuit.

First, let's take a look at wires and interconnects in a very abstract way. We can think of wires as connections between other components, without having to get into a lot of detail about the wire itself. We just want a way to indicate that there is an electrical connection among all the bits, and using an electrical schematic diagram is an easy and effective way to do this.

Electrical Schematics

A *schematic* diagram is any kind of stylized drawing that represents a simplified view of something. Usually some sorts of symbols are used to represent the parts that make up the whole, as well as the connections or relationships that exist between them and possibly the outside world. You can have schematics for plumbing, hiking trails, or tribbles, a well as electrical and electronic circuits. Let's talk about electronic schematics for a little bit.

The electrical symbol for a wire is almost always just a plain, solid line. If there's something really special about the wire that needs to be used, it is usually indicated in a note somewhere on the schematic. This can be used to indicate what color the wire needs to be, what size is appropriate,

whether there are any special requirements for the insulation, and so forth. Most of the time it's just a plain, solid line. For an example of just how simple it can be to draw a wire in a schematic, see Figure 3-1.

Figure 3-1. *A very simple electrical schematic diagram, showing how to get from point A to point B with a single wire. Drawing wires in schematics is easy!*

If a wire starts in just one place and ends in just one place, everything stays nice and easy. If multiple wires need to converge on a single point, or one signal wire needs to split up to go to more than one destination, it gets just a little more complicated, but not too much. See Figure 3-2.

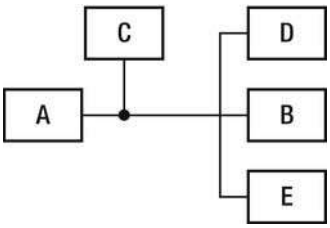

Figure 3-2. *Wires that are connected to each other usually have a dot at their intersection. If there is no dot, there is no connection between overlapping wires.*

In the figure, points A, B, and C are connected together. Points D and E are connected together, but are not connected to points A, B or C, even though the wires look like they are crossing. In a professional schematic, a careful draftsperson would route the wire from point D to point E on the right side of the components to avoid any possible confusion.

Some folks like to draw a little bump, or bridge, when two unconnected wires cross in a schematic, just to make sure that everyone knows that the wires aren't connected. This gets to be a bit tedious once you've got more than two or three components in your schematic, and it can look a bit unsightly. Feel free, however, to draw your schematics however you see fit. Just remember that others might not share your particular drafting sensibilities.

Wire and Cables

Chapter 2 took a quick look at wire and how it is made to help you pick out the best wire-cutting and wire-stripping tools. Now it is time to consider wire as an electrical component within your circuits. Knowing what a wire can and cannot do will help you pick the right kind of wire to use. Yes, wire has limits! This is important both for building new circuits from scratch as well as repairing, replacing, or upgrading wiring in existing circuits.

Wire can be used for all sorts of artsy and craftsy purposes. Copper wire is the most common wire used in electronics. Sometimes the copper conductor is *tinned* with another conductive metal with a low melting point to make it easier to solder. When you cut this wire, you can see the copper on the inside.

Pure copper wire is getting very expensive these days. Unscrupulous people try to pass off copper alloy with inferior electrical properties as the real deal. A quick way to test is with a magnet. Copper is not attracted to magnets.

As mentioned in Chapter 2, wire comes in two major categories: solid core and stranded. Solid core wire is just a single piece of copper wire, while stranded wire is made up of many smaller strands of copper wire, usually twisted together. Stranded wire is generally more flexible than solid core wire.

Copper wire is measured using a gauge system. Different systems exist around the world. A common system used in the United States and Canada is the American Wire Gauge (AWG) standard. It uses a series of single numbers to denote the relative size of the wire, with larger numbers representing smaller-diameter wires. These numbers go all the way down to zero (0 gauge), but they don't stop there. Larger wires than 0 gauge are called 00 gauge, double-ought, or sometimes 2/0. There are also three- and four-digit versions, but after that, those giant wires are specified with their actual cross-sectional diameter.

Using Wire: The Very Short Version

Fatter wires carry more current with less heat being generated due to resistance. The wire's insulation is rated for a maximum voltage and temperature. If this temperature is exceeded, the insulation will soften, melt, or catch on fire. Avoid this by using the right sized wire for the job. Exceeding the maximum voltage can cause more problems if the current arcs through the insulation. This can cause a short circuit and may even cause a fire. It is also likely to give off noxious fumes. Choose wisely!

For low voltages (under 36V) and small current loads (under 1A), you can use whatever you want. It doesn't matter. Pick something pretty. A thing of beauty is a joy forever.

For higher-voltage applications, make sure the wire's insulation is rated *far in excess* of what you anticipate. The rating should be visibly printed on the insulation itself. See Figure 3-3.

Figure 3-3. *The wire's insulation only works up to a point. That point is usually printed on the insulation itself, but you may need to put on your good reading glasses to see it. This wire states, "LL33911 CSA TEW 105°C 600V FTT 14AWG," which translates to the manufacturer's part number, Canadian Standards Association certified thermoplastic equipment wire, maximum temperature of 105°C, 600V insulation dialectric strength, 14 gauge.*

For higher-current applications, you really need to use the highest-gauge wire that is necessary to carry the required current. Hot wires cause fires.

Using Wire: The Longer Version

If you will spend some time learning about the properties of wire, you will be able to make *much* better decisions regarding its use and application. Assuming that the overall shape of the cross section of the wire is round, the gauge of the wire determines how much resistance to the flow of electrical current the wire will exhibit over a given distance. This resistance, in turn, helps determine the amount of electrical current that the wire can safely carry.

When electric current meets resistance, the electrical power is converted into some other form of energy. Usually this energy is given off as heat, or thermal energy. It can also produce magnetic fields, sound, light, and radio waves.

A good example of this is demonstrated by the heater coils on an electric stovetop. When the stove's switch is turned on, current flows through the coil. Most of the current is converted directly into heat. Electric heaters are very efficient this way. A small amount of the electrical power is converted into light. You can see this as a red glow coming from the heater coil when it is hot. The coil also creates a magnetic field.

If you know the gauge of a wire, you can look up the wire's characteristic resistance. These numbers will be close but perhaps not exact, as there will always be small variations in wire diameter, conductor purity, and other factors. Generally, however, the numbers are pretty close.

Let's take another look at the AWG table (see Table 3-1), and look at a few simple examples to help understand what these wires can do for us. (A more complete listing is available at `http://en.wikipedia.org/wiki/American wire gauge`, from which this partial list was obtained.)

Table 3-1. *The AWG*

AWG	Diameter Area			Copper Resistance	
	Inch mm		mm^2	Ω/km mΩ/m	Ω/1000 ft mΩ/ft
0000 (4/0) 0.46 00 11.6 84			107	0.1608	0.04901
000 (3/0)	0.4096	10.404	85.0 0.20	28	0.06180
00 (2/0)	0.3648	9.266	67.4 0.25	57	0.07793
0 (1/0)	0.3249	8.252	53.5 0.32	24	0.09827
1 0.28	93	7.348	42.4 0.40	66	0.1239
2 0.25	76	6.544	33.6 0.51	27	0.1563
3 0.22	94	5.827	26.7 0.64	65	0.1970
4 0.20	43	5.189	21.2 0.81	52	0.2485
5 0.18	19	4.621	16.8 1.02	8	0.3133
6 0.16	20	4.115	13.3 1.29	6	0.3951
7 0.14	43	3.665	10.5 1.63	4	0.4982

8 0.12	85	3.264	8.37 2.06	1	0.6282
10 0.10	19	2.588	5.26 3.27	7	0.9989
12 0.08	08	2.053	3.31 5.21	1	1.588
14 0.06	41	1.628	2.08 8.28	6	2.525
16 0.05	08	1.291	1.31 13.1	7	4.016
18 0.04	03	1.024	0.823 20.9	5	6.385
20 0.03	20	0.812	0.518 33.3	1	10.15
22 0.02	53	0.644	0.326 52.9	6	16.14
24 0.02	01	0.511	0.205 84.2	2	25.67
26 0.01	59	0.405	0.129	133.9	40.81
28	0.0126	0.32 1 0	08 10	212.9	64.90
30	0.0100	0.25 5 0	05 09	338.6	103.2

Conductivity

The first thing you need to know is that copper wire really, really wants to conduct electricity. It wants to conduct electricity more than it wants to *resist* the flow of electrical current. Even so, copper is not a perfect conductor, and it has a certain amount of inherent resistance. This resistance causes the energy carried by the electrical current to be sidetracked, or converted into heat and other forms of energy. The higher the resistance in the wire, the more heat will be produced.

Normally this heat is a very small thing and is easily dissipated into the surrounding air. You usually can't even tell by touching that a wire is a fraction of a degree warmer than its surroundings—but this is only true when the amount of energy is relatively small, like in our rewired flashlight example. When you start to push a *lot* of power through a wire, the heat buildup can outpace the cooling-off provided by the surrounding air, and the temperature of the wire increases.

Again, this is no big deal as long as that temperature stays within a comfortable range. But what happens when the temperature gets really high?

First, the insulation will get soft, melt, or even catch on fire. After the insulation, if any, has burned off, the wire will glow red hot and eventually melt. This is known as *catastrophic wire failure*, which can result in what electrical engineers refer to as an unauthorized thermal event, which we call a fire. Yikes!

But look around you. You're probably sitting right next to some wires right now, very few of which (hopefully) are on fire, even though they are carrying variously large loads. How do they keep from burning up? The answer is in the proper selection of the right *size* of wire for the job. Bigger wires have less resistance to the flow of electricity, so they are able to carry more power with less heat being produced.

Now, you don't want to have to wire up all of your electronic circuits using jumper cables from your car's trunk, as that gets to be cumbersome after a while. Let's look at some good guidelines for what size wire to use for your projects.

In Chapter 2 you learned about (or were reminded of) Ohm's Law, which illustrates the relationships between voltage, current, and resistance in any electrical circuit. In summary, $V = I \times R$, where V is volts, I is current in amps, and R is resistance in ohms. It's not just a good idea, it's the law!

So how much electricity will we lose going through a foot or so of 16-gauge wire? If we know that one foot of 16-gauge wire has a resistance of 4mΩ (and we know this from looking it up in the chart), and we build a circuit that pushes 1A of current through this wire, we can figure out a couple of interesting things using Ohm's Law and a calculator.

Applying Ohm's Law

If you know two of the three variables used in Ohm's Law, you can calculate the third variable. Since we know R and I, we can calculate V. Since V = I × R, we can substitute our values of 1A and 4mΩ (0.004Ω) into the equation, and get 0.004V, or 4 millivolts.

That's not very many volts at all! In this case, that's a good thing. The voltage we just calculated is the *voltage drop* across the length of the wire. Those millivolts never make it from one end of the wire to the other—they're lost. Poor millivolts, they never had a chance.

OK, let's not let their heroic sacrifice be in vain. If we know volts, and we know amps, we can also calculate power, which is the rate at which energy is converted to work. The unit of measure for electrical power is *watts*, and is also the same as Joules per second (J/s), but that's another story. We usually use the capital letter *W* to abbreviate wattage, but we use the capital letter *P* to represent the *value* in equations.

Calculating power is simple if you know the volts and the amps. Just multiply them together: P = V × I. Easy.

So in our example so far, we have 4mV, 1A, and 4mΩ. How much power is being dissipated (wasted) in this circuit? P = 0.004V × 1A = 0.004W, or 4 milliwatts, which is just four-thousandths of a watt. That's just about enough power to light up a dim LED, and not much else. So you're not going to be starting any fires with these numbers. You most likely would not even be able to measure the rise in temperature that is occurring in the wire (oh yes, it's occurring, but it's very, very small).

Let's put 10A through a foot of 30-gauge wire. On second thought, let's not, and just do the math instead. The voltage drop will be V = I × R, or 10A × 0.1032Ω = 1.032V. The power dissipated would be P = V × I, or 1.032V × 10A = 10.32W. That wire would be a crispy critter in no time. Ten watts doesn't sound like much when you're talking about a home stereo or a lightbulb or a hair dryer, but that skinny little wire has almost no surface area with which to dissipate the generated heat. This means that the temperature goes up, quickly. Bye-bye, little piece of wire.

As a side note, you just learned how most current-limiting fuses operate. The conductor within the fuse literally *fuses*, or evaporates, when the internally generated heat produced from an "overcurrent" situation rises beyond its melting point. Poof, the circuit is opened, and property and lives are saved.

■ **Warning** Never circumvent the protection afforded by a fuse.

Ideally what you want is the smallest wire that will carry the required amount of current with an acceptable rise in temperature. Remember that any rise in temperature is in addition to the *ambient* temperature. If you're sitting in a room that is "room temperature," which is assumed to be 25°C or 77°F (the same thing, if you want to check it), and you're expecting a 50°C rise in temperature due to waste heat, your wire is going to be 75°C, which is far too hot to touch. Remember that 100°C is the boiling point of (pure) water (at sea level). Hot!

One more thing that complicates the thermal calculations is that copper, as a conductor, has a *positive thermal coefficient*, meaning that the characteristic resistance of a piece of wire (which we can look up in the AWG table) goes *up* by a known amount as the temperature increases. You need to

consider this when you build circuits that are *supposed* to get hot, such as electric heaters. In most other cases, it's best to keep the heat to a minimum, as it represents wasted power, plain and simple.

Testing Your Wires

Can something as simple as a wire go bad? Yes, it most certainly can. How can you tell? Usually, it's because something doesn't work the way you think it should, or *worse*, it works sometimes and not others. A great deal of time, the problem is right at the end of the wire, where it is trying to make a connection with something else. However, it's possible for a wire to develop a problem right in the middle. This can be caused by a tiny nick in the insulation that lets in nasty elements such as rain and dirt, allowing the inner conductor to corrode. This type of problem takes time to make itself apparent, but it can certainly happen, especially in equipment that is exposed to the outside world for any length of time.

A quick way to test a wire is with a piece of test equipment called a *continuity tester*. This simple device usually is battery powered and has two probes. When you connect the probes together, the tester makes a noise, lights up a light, or maybe does both. Make sure your continuity tester's batteries are fresh and that the probes, if they are removable, are firmly seated in their sockets. Even test equipment needs testing from time to time.

■ **Note** A continuity tester is one of the easiest pieces of test equipment to cobble together yourself. See Appendix A for more information about building your own tools.

As mentioned previously, the problem is almost always at the very end of the wire. This is a good thing to know, so you can start looking in the most likely places first, saving valuable troubleshooting time.

A much better way to test a wire is with an ohmmeter. Using an ohmmeter, you can determine the *exact* amount of resistance in a wire, which under ideal circumstances should be very low. One ohm or less is typical for most normal-sized wires that you are likely to encounter. Super-long wires can have higher resistance, and that's where you can consult the handy AWG table to find out what the resistance is *supposed* to be.

When testing wires, especially wires with attached connectors, it's a good idea to wiggle the wire about vigorously, as this will reveal some intermittent connections for you.

Storing Your Wire

If you're buying new wire, it will probably come on a reel. It's often handy to keep common sizes and colors on your bench, if you have room. A paper towel–holder makes an excellent wire dispenser rack, although you can also spend more time or money buying a prebuilt one or designing and fabricating your own.

A custom red-and-black wire dispenser is shown in Figure 3-4. You might use a fixture like this if many pairs of identical-length wires are needed for a project. Not having to chase the wire spools all over the bench really saves a lot of time. This structure was built using a MicroRax miniature slotted aluminum extrusion (*http://www.microrax.com*), which is perhaps a bit of overkill, but was a lot of fun to plan and build. A coat hanger, artfully bent, would have also done the trick.

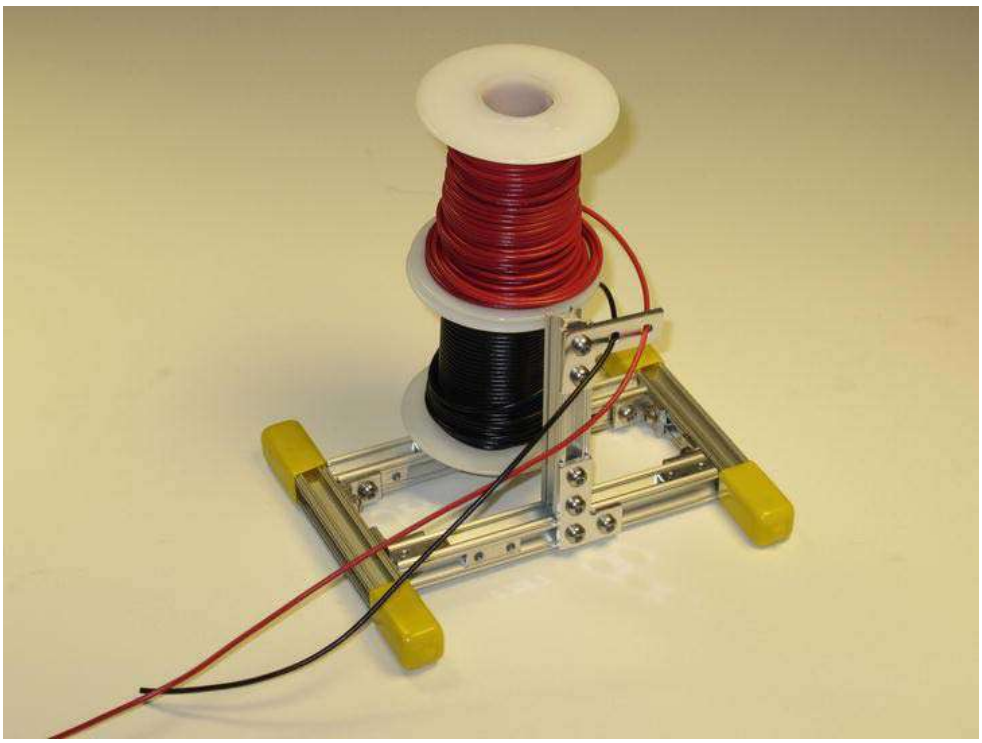

Figure 3-4. *A custom wire-dispensing frame made from modular aluminum extrusion. This kind of fixture makes it easier to cut both a red and a black wire to almost exactly the same length, which happens a lot when you use red and black wire for positive and negative power connections, respectively.*

Connectors

Connectors make life easier for the casual wiring enthusiast. The hardcore types solder everything together, but that is not always practical or even the right thing to do in every circumstance.

Keep in mind that every connector, just like every wire, has some sort of electrical limits. These limits must be respected.

Clip Leads

Also called *alligator clips* or *test leads*, you can buy ready-made wires or build your own from individual connectors. The flexible rubber or plastic boot extends the insulation of the wire. A spring-loaded jaw, often with serrated teeth, is used to clamp down on the wire, lead, or electrical terminal desired (see Figure 3-5).

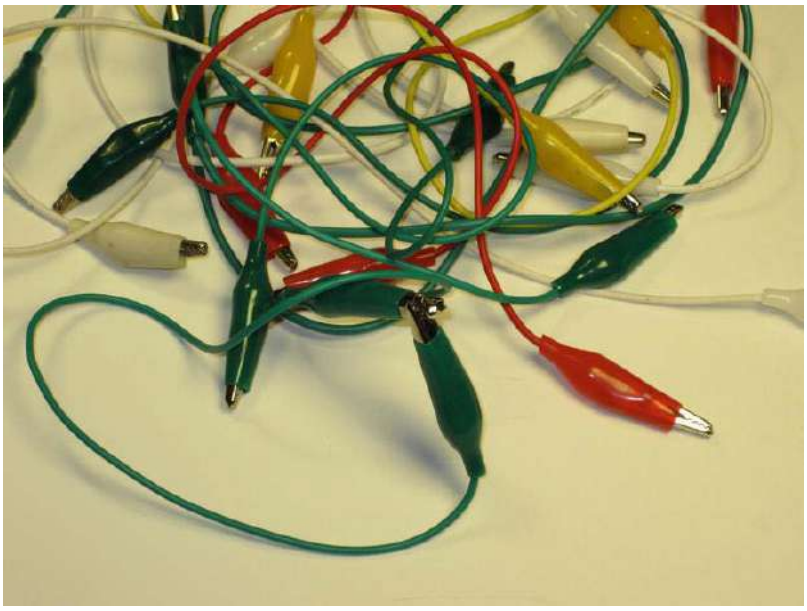

Figure 3-5. *Clip leads come in all sizes, gauges, colors, and terminal types. They are handy for making quick electrical connections.*

Clip leads are quite handy to have around your bench, if you've got the room for them. They tend to get tangled up, so some people hang them from a specially slotted rack, making them easier to pluck at a moment's notice.

Keep in mind that clip leads are generally for *temporary* electrical connections, such as when you're testing something or trying out a prototype circuit. They don't make very good long-term solutions to your electrical connection needs for a variety of reasons.

The first problem is that even when the spring-loaded jaws make a solid, low-impedance connection when first attached, this electrical connection will deteriorate over time as oxidation inevitably forms on the contacts.

Another problem is that many mass-produced clip leads are inexpertly smashed onto the ends of wires, without taking advantage of the alligator clips' built-in features, such as strain reliefs and soldering points. This leads to additional resistance in your circuit at both ends of the clip lead, where you would probably never think to look. The next time you buy some brand-new clip leads, hook them up to your ohmmeter and see just how conductive they really are. A good practice is to carefully remove the insulating boot and make a proper electrical connection yourself, so that you've got one less thing to worry about.

Solderless Breadboards

A very versatile prototyping platform is the solderless breadboard. Once upon a time, people would tack together simple electrical circuits using wires, small nails, and a hammer, utilizing a wooden plank or small board as the substrate. The kitchen breadboard was often just right in size and weight and would mysteriously disappear into the workshop. You can still cobble together simple circuits using this technique.

The solderless breadboard is a miracle of modern manufacturing techniques. A body made of precision-molded plastic has an array of small openings built in, and within each opening is a row of small spring clips that are just the right size to grasp and hold a small-gauge (22–26 AWG) wire. Adjacent points within the array are electrically connected together, which lets you easily connect small components into a circuit using your bare hands, with no soldering required. About all you would normally need would be some solid-core wire (preferably), some wire cutters, and some wire strippers. You can even buy precut jumper wires specifically made for use with solderless breadboards. They're terrifically handy! See Figure 3-6.

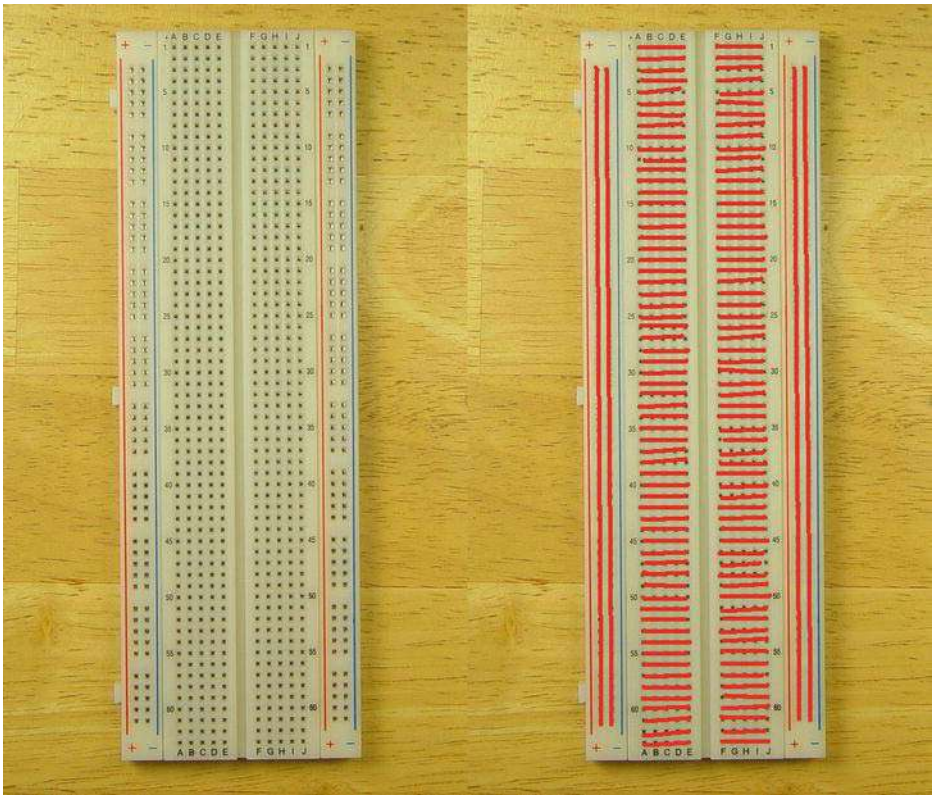

Figure 3-6. *On the left is a solderless breadboard with 830 tie points. Each hole has a spring clip inside that can hold a small wire or component lead. On the right, the underlying electrical connections between the tie points are illustrated.*

The spacing between adjacent tie points is exactly 0.1", which corresponds to many common “footprints” for electronic components. You can easily build simple circuits in just a few minutes. You can even build fairly complex circuits using integrated circuits and other components. Figure 3-7 shows a complete Arduino-compatible microcomputer that you can build with your bare hands and then program using your PC and the free Arduino software.

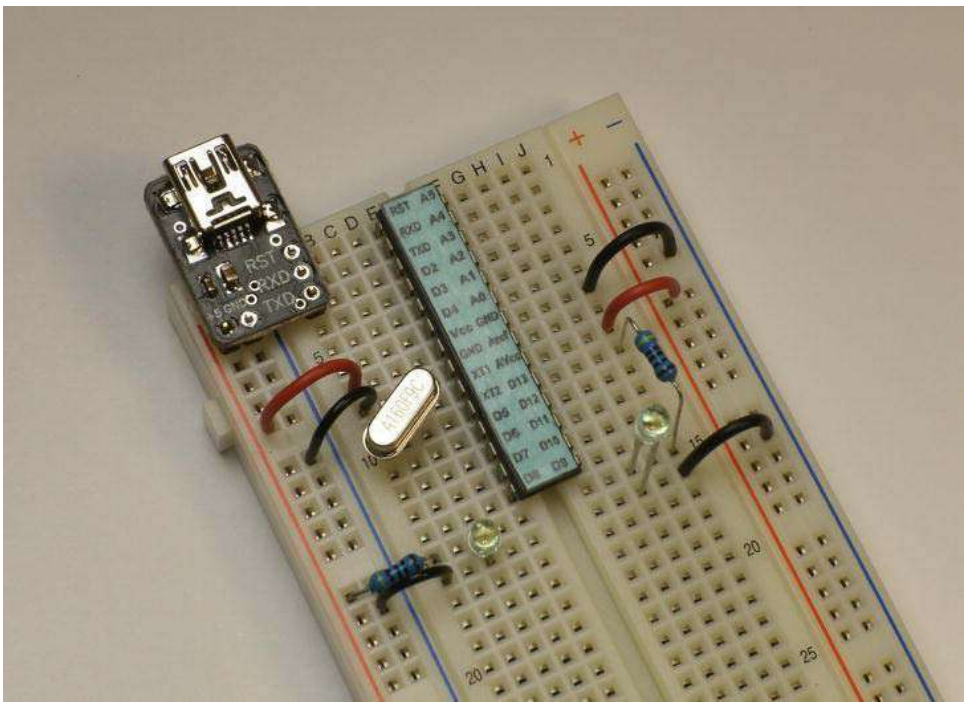

Figure 3-7. *A breadboard Arduino, which is compatible with the popular Arduino Duemilanove microcontroller, can be built using just a handful of components on a solderless breadboard, leaving plenty of room for more experimentation. The black, rectangular component in the upper-left corner is a miniature USB adapter that supplies power, and provides communication and control signals for the microcontroller.*

You’ll find that projects tend to expand to fill the available area (and budget). See Figure 3-8.

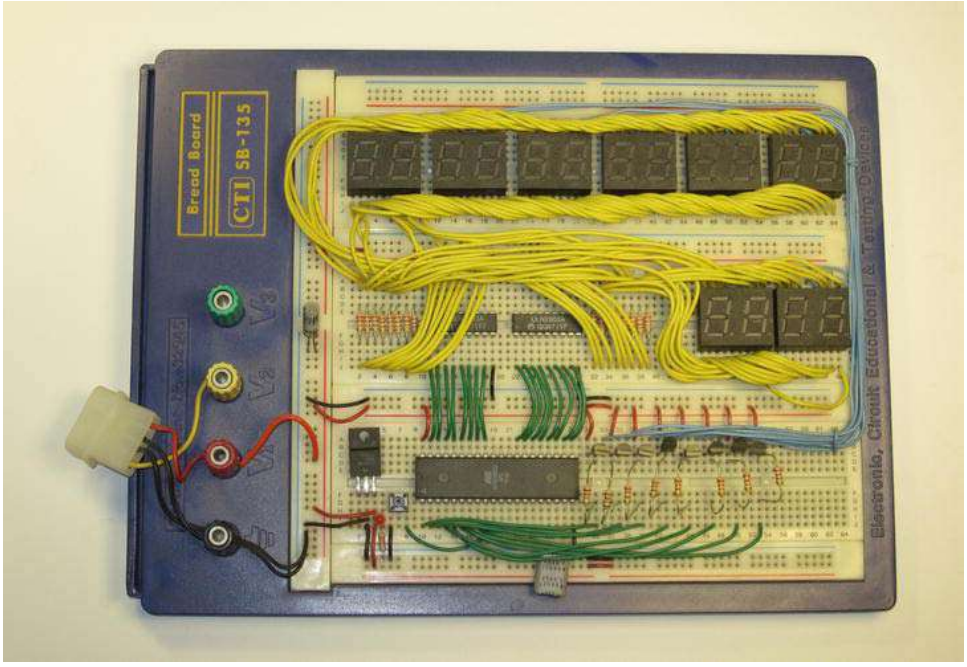

Figure 3-8. *A prototype LED display with computer control, built on a solderless breadboard. That's a lot of wires!*

Passive Components

Most electronic components fall into one of two different categories: *passive* and *active*. There are a few different ideas floating around as to what, exactly, is the difference between passive and active components. For the purposes of this book, we will use the simple definition that an *active* component requires a power source to work properly, while a *passive* component does not.

Resistors

A good example of a passive component is a *resistor*. You've already learned a lot about resistance in an electronic circuit. Resistance is measured in ohms, and it converts electricity into heat. When you're working with wires, cables, and other conductors, resistance is usually a *bad thing*. You want the least amount of resistance possible. However, there are times when you both want and need resistance in a circuit.

One example of when you would want resistance in a circuit is when you want to light up an LED. Unlike an incandescent lightbulb, an LED has no built-in current-limiting ability. Without a fixed amount of external resistance added to the circuit, an LED would self-destruct in a very short time, because it would overheat from excessive current flowing through it. A resistor would limit the amount of current flowing and control the brightness of the LED.

The exception to this dire prediction is when the power source that is lighting up the LED has insufficient gumption to blow up anything, such as with a small coin-cell battery. Anything bigger than

that normally has no trouble convincing the LED to release its magic smoke, without which it can no longer function.

A typical resistor has a fixed resistance and a maximum power rating. The resistance is determined by the material from which the resistor is made. The value of a resistor, as you already know, is measured in ohms, and can range from just a fraction of an ohm (often expressed as milliohms) up to millions of ohms.

Through-Hole and Surface-Mount Resistors

Resistors come in all shapes and sizes. Generally speaking, the larger the surface area of the resistor, the more power it can safely dissipate. A typical resistor that you might work with on a solderless breadboard or on an older PCB is shown in Figure 3-9. These are called *through-hole* components because their extended leads are meant to be formed and threaded through holes that are drilled into PCBs. Also in Figure 3-9, for comparison, are some teensy-weensy *surface-mount* resistors. Surface-mount resistors have no leads and are meant to be soldered directly to pads laid out on the surface of the PCB.

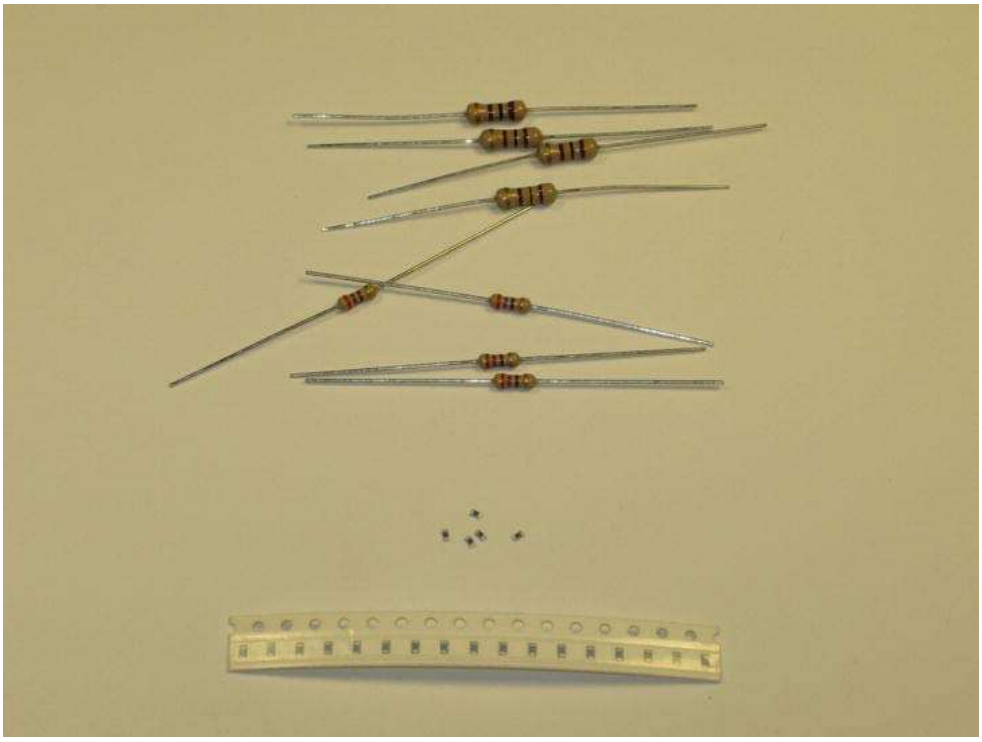

Figure 3-9. *Some through-hole resistors (top) and surface mount resistors (bottom). The surface mount resistors are so small that they are shipped packaged in tape, which is usually wound on reels for automated placement in PCB assembly.*

You can easily form the leads of through-hole resistors by hand or by using a *lead-bending jig*, a small tool with accurately spaced notches. Traditionally, these resistors have their leads formed so as to be threaded through holes in a PCB, and then soldered to the PCB. The extra lead length on the bottom of the PCB is then clipped off. See Figure 3-10.

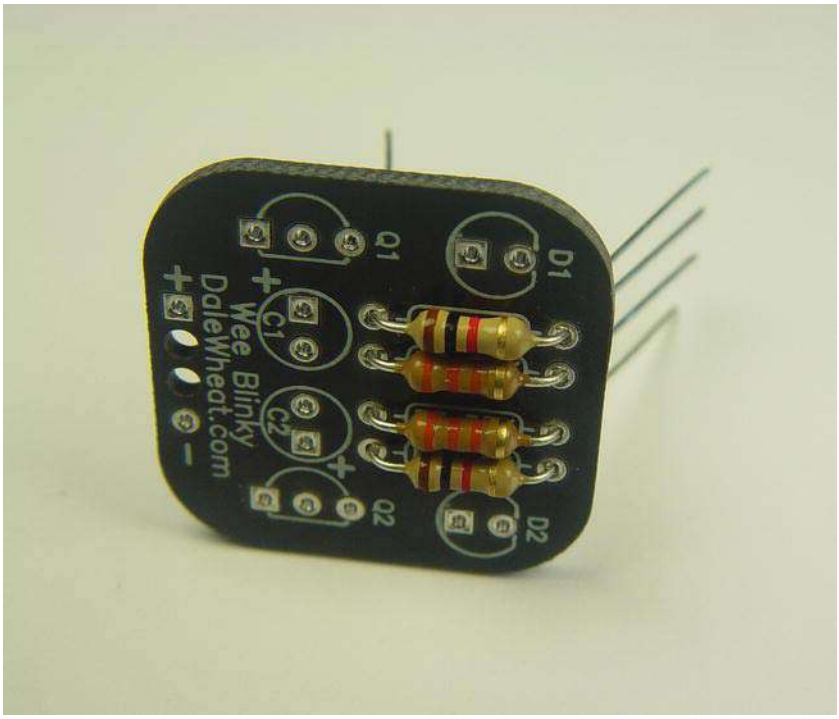

Figure 3-10. *Resistor leads are bent at right angles and inserted into holes in the PCB to be soldered.*

Schematic Symbols and Reference Designators

The schematic symbol for a fixed-value resistor is a zigzag line. See Figure 3-11. Every component in your circuit should have a name, which is also called a *reference designator*. Typically, most reference designators will have a short letter abbreviation to describe what kind of part it is (*R* is for *resistor*) and a sequential number assigned as more parts are added to the schematic. R1 would be the first resistor, R2 would be the second resistor, and so on.

If there is only one resistor in your circuit, then you don't have to number them, do you? You can just called it *R*, or *Galactic Emperor R the Mighty*, or whatever strikes your fancy. Most people stick to simple numbers.

Your numbering scheme depends a lot on the complexity of your schematic. If you only have a few resistors in your circuit, you can start at one and go up as needed. If you have a complex circuit with many subcircuits, you might allocate R101, R102, R103, and so on, to the first subcircuit (e.g., a power supply), and then assigned R201, R202, and so on, to a different section, such as a display. It's entirely up to you. Use a system that helps *you* keep track of things.

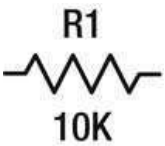

Figure 3-11. *The schematic symbol for a fixed-value resistor is a zigzag. The reference designator for this resistor is R1 and its value is 10,000 ohms, or 10KΩ. A simple rectangle symbol is also used to represent resistors, although many components are available in this physical form factor. Use the symbol you like best.*

Standard Resistor Values and Tolerances

Remember how wires have their own peculiar numbering scheme to describe their basic characteristics (i.e., the AWG, which uses *smaller* numbers to represent *larger* wires)? Well, resistors have their own peculiar numbering system as well to describe their electrical properties, or *value*. Even though the *value* of a resistor is measured in ohms and succinctly describes its characteristic resistance, not every possible value is readily available.

Some smart cookies at the Electronics Industries Alliance (EIA; see `http://www.ecaus.org/eia/site/index.html#`) have come up with some standard values that fill in most of the commonly used values for resistors and other components. Their scale is not linear but logarithmic, meaning that it takes larger steps as the values go up. This makes a little more sense once you understand how component value *tolerances* work.

You can buy, for example, a 1Ω resistor and expect it to be pretty close to being 1Ω at room temperature, but it's not going to be *exactly* 1Ω. It's going to be pretty close. How close? Well, that mostly depends on how much money you're willing to spend on this single resistor. If the answer is "not that much," then "pretty close" is going to mean within 5 percent of the stated value. That means your 1Ω resistor could actually measure as little as 0.95Ω or as much as 1.05Ω and still be "within tolerance." Five-percent resistors cost only a few cents even in small quantities.

Given that there's a little wiggle room for each resistor value, people who can tolerate their resistor values being off by as much as 5 percent don't need to be ordering 50 resistors of 0.99Ω and another 50 of 1.01Ω when they could just as easily (and certainly less expensively) order 100 resistors of 1Ω with a 5 percent tolerance.

This overlap in the values of the resistors allows us to skip from 1.0Ω to 1.1Ω without having to keep track of all the little resistors in between. This is because a 1.1Ω resistor could measure as little as 1.05Ω or as much as 1.15Ω and still be in tolerance.

With a standard resistor tolerance of 5 percent, we can use just 24 values to cover the range between 1Ω and 10Ω. The same multiples can then be used to cover the range between 10Ω and 100Ω, and so on. Aren't logarithms fun? See Table 3-2.

Table 3-2. *The E24 Standard Values for 5 Percent Resistor Value Tolerances (Higher and Lower Decades Are Also Available)*

1.0 10		100	1.0K	10K	100K	1.0M
1.1 11		110	1.1K	11K	110K	1.1M
1.2 12		120	1.2K	12K	120K	1.2M
1.3 13		130	1.3K	13K	130K	1.3M
1.5 15		150	1.5K	15K	150K	1.5M

1.6	16	160	1.6K	16K	160K	1.6M
1.8	18	180	1.8K	18K	180K	1.8M
2.0	20	200	2.0K	20K	200K	2.0M
2.2	22	220	2.2K	22K	220K	2.2M
2.4	24	240	2.4K	24K	240K	2.4M
2.7	27	270	2.7K	27K	270K	2.7M
3.0	30	300	3.0K	30K	300K	3.0M
3.3	33	330	3.3K	33K	330K	3.3M
3.6	36	360	3.6K	36K	360K	3.6M
3.9	39	390	3.9K	39K	390K	3.9M
4.3	43	430	4.3K	43K	430K	4.3M
4.7	47	470	4.7K	47K	470K	4.7M
5.1	51	510	5.1K	51K	510K	5.1M
5.6	56	560	5.6K	56K	560K	5.6M
6.2	62	620	6.2K	62K	620K	6.2M
6.8	68	680	6.8K	68K	680K	6.8M
7.5	75	750	7.5K	75K	750K	7.5M
8.2	82	820	8.2K	82K	820K	8.2M
9.1	91	910	9.1K	91K	910K	9.1M

Color Codes

Even the old-fashioned through-hole parts are a bit too small to legibly label with a numeric value and tolerance factor. A system of color codes was developed to designate resistor values, using colors to represent both single digits, a power-of-ten multiple, and the resistor's tolerance. These colors are painted on the resistors in bands. A little memorization and careful practice will have you reading resistor color codes in no time.

For 5 percent tolerance resistors, only four bands are needed to completely specify the resistor's value and tolerance. The first two bands represent the first two significant digits of the value. The next value is the multiplier. The final value is a special case to tell the resistor's tolerance.

The first two bands, as well as the multiplier value, use the color codes shown in Table 3-3 to represent the digits 0 through 9. (Unfortunately, these colors were chosen before the subtleties of colorblindness were widely understood.)

Table 3-3. *The Resistor Color Codes for the Significant Digits and Multiplier Digit of the Resistor's Value*

Digit	Color
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Gray
9	White

The last band indicates the tolerance of the resistor using a different set of colors, as shown in Table 3-4. The most common are 5 percent (gold) and 1 percent (brown). There is supposed to be a slightly larger gap between the digits and the tolerance bands, but this is sometimes hard to see.

Table 3-4. *Resistor Color Codes for the Final Color Band*

Tolerance	Color
0.05%	Orange
0.25%	Blue
0.5%	Green
1%	Brown
2%	Red
5%	Gold
10%	Silver
20%	None

The multiplier digit can be thought of as either the number of 0s after the specified digits or as the exponent to which the number 10 is raised, as in scientific notation. Some examples make this easy to understand and remember.

A resistor marked with brown, black, red, and gold stripes has a resistance of 1KΩ with a tolerance of 5 percent. An easy way to decipher this code is to do a simple substitution for the first two digits (brown is 1 and black is 0, so we have 10 so far). Next decipher the multiplier band and write down that many 0s after the first two digits. Red is 2, so write down two 0s. That gives us 1000 so far. The final band is gold, and that means a 5 percent tolerance; 1,000 ohms is usually abbreviated as 1.0KΩ or simply 1KΩ.

■ **Note** *K* stands for *kilo*, the Greek prefix for 1,000. Likewise, *M* stands for *mega*, the prefix for 1 million.

This method works for most values from 10Ω to 10MΩ. A problem occurs, however, when we need to specify a value less than 10, as a negative multiplier value must be used to get an exponent of less than 0. For the value 1 and those less than 10Ω, a gold band is used for the multiplier. For values less than 1Ω, a silver band is used.

To save even more precious space on our schematics, another convention is to replace the decimal point with the multiplier. For example, 4.7KΩ would be written as just 4K7. 1.8MΩ would become 1M8 and 1.5Ω would be 1E5. 10KΩ would still be 10K using this method. If it is clearly understood that the unit of measure is the ohm, then even the Ω can be omitted.

Resistor Power Ratings

Any resistor has a maximum power-handling capability. This rating is usually expressed in watts or fractions of a watt. The larger through-hole resistors shown previously in Figure 3-9, for example, have a power rating of 1/2W (or 0.5W, if you prefer). This means that if you attempt to dissipate more than half a watt of power through the resistor, it is most likely going to quickly overheat and fail.

Thermal failure in a resistor starts with a thin curl of smoke, and then results in the discoloration of the resistor itself and sometimes actual flames. In any case, it gets dangerously hot, so do try to avoid this situation.

If you know the voltage across the resistor, as well as the current, you can easily calculate the power being dissipated using the simple formula P = V × I. Remember that P is the power value in watts, V is the voltage in volts, and I is the current in amps. One volt at one amp is one watt, which is way more than enough to smoke our little resistors. Be careful! Any time you calculate the correct value for a resistor in ohms, be sure to also calculate the required power-handling capability.

Variable Resistors

So far we've only looked at *fixed*-value resistors. They usually exhibit the same resistance day in and day out. That's what we love about them. But what if you need to vary the resistance in a circuit? We have resistors for that, too! A good example is a volume control on an amplifier. Turn it to the left (down), and the volume goes down. Turn it to the right (up), and the volume goes up. How does that work?

One kind of variable resistor is called a *potentiometer*. Potentiometers are sometimes abbreviated as *pots*. Pots usually have three terminals instead of two. Two of the terminals connect to the fixed resistor that is inside the potentiometer. Instead of being all sealed up like the fixed resistors you've been studying, the internal, resistive conductor is exposed along a track or groove. The third terminal, which is often physically in the center, between the two other terminals, is called the *wiper*, and can be moved from one end of the fixed resistor to the other end, making electrical connection to the inner part of the fixed resistor as it goes. As the wiper moves along the length of the resistive element, it taps into the resistor at a different point, varying the resistance. This is how a potentiometer can be used as a variable resistor.

Figure 3-12 shows a typical three-terminal potentiometer with a round body. The shaft can be turned to adjust the resistance. There are many variations on this basic design.

Figure 3-12. *A typical potentiometer, or variable resistor. Image by BG Micro (http://bgmicro.com).*

The schematic symbol for a potentiometer looks suspiciously like a resistor with an extra terminal, which happens to be exactly what it is. The extra terminal is the wiper, shown as the upward-pointing arrow. See Figure 3-13.

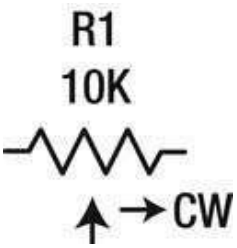

Figure 3-13. *The schematic symbol for a potentiometer is a fixed resistor with a wiper terminal. The "CW" arrow indicates which way the wiper goes when the shaft is rotated clockwise.*

Potentiometers generally come with two distinctive *response curves*, or *tapers*:

- A *linear* curve means that every equal step of rotation about the axis changes the resistance by the same amount. For example, if you were to center the shaft in the middle of its rotation, the resistance from the wiper contact to either of the end contacts would be nearly exactly half of the total resistance between the two end contacts. This is quite useful for when you need to adjust a voltage up or down in a relatively straight line. This is sometimes indicated by adding a capital *B* to the end of the resistance value (e.g., 10KΩB).
- In many audio circuits, however, it has been discovered that the human ear is anything *but* linear. A special response curve that more accurately describes this sensitivity is called an *audio* curve or taper. An *A* is used as a suffix to indicate that an audio taper is used for a potentiometer.

Note that linear and audio tapers are *not* interchangeable. If you find some random potentiometers in a parts bin, you can get a quick idea of what you've got by centering the shafts and seeing if the resistance is "symmetrical" or not, using an ohmmeter. Equal resistance to either end terminal indicates a linear taper, and anything else is mostly probably an audio taper.

Just like any other resistor, a potentiometer has a maximum power rating as well as a tolerance. These are usually either printed on the body of the potentiometer, if there is room, or hidden away in a product data sheet somewhere.

Specialty Resistors

There are many different kinds of resistors made for many special kinds of applications. High-power resistors are built out of sturdier materials that can take the thermal stress required to dissipate large amounts of heat. See Figure 13-14.

Figure 13-14. *A power resistor can handle much more heat dissipation than the smaller though-hole or surface-mount varieties. They are often so big that they need special mounting hardware. Image by BG Micro (http://bgmicro.com).*

Another popular option is the *multiturn* potentiometer. These potentiometers have an internal gear system that allows their shafts or wipers to be moved slowly across their internal resistive tracks by multiple turns of the control element. Increasing the number of turns allows the user much finer control of the resistance adjustment. It also takes the user longer to get from one point to another along the scale.

Capacitors

The basic definition of a *capacitor* is two conductors separated by an insulator. By itself, it doesn't sound like that would be a very interesting configuration at all. It turns out, however, that there's a lot more to it.

When a voltage is applied across a capacitor, no steady current flows through it. Remember, there is an *insulator* in the middle of that capacitor. Any insulator, just like the insulation on a piece of wire, *does not conduct electricity*.

What happens is that an *electric field* is created between the two conductors, or *plates*, as they are called when they are part of a capacitor. Now we get back to the fairies and dragons and molecules and so forth, way down deep at the heart of the problem. This electric field is a form of energy. Once it is built up by the difference in voltage, or *potential*, between the two conductors, it has nowhere to go, so there it stays . . . at least until something else in the circuit changes.

For this reason, capacitors are sometimes used as *reservoirs* of electrical energy in a circuit, holding a bit of spark here and there as needed. Just as it takes electrical energy to build up this electric field, a certain amount of electrical energy will be released when the field collapses. This will happen when the voltage between the two conductors drops.

Using capacitors as tiny electric batteries in a circuit is only one of many applications for this versatile part. While a capacitor will not conduct a *steady* flow of electric current between its terminals, it will often *appear* to conduct *alternating current* (as opposed to *direct current*), which is why you see them so often in audio circuits. As a charge builds up on one plate within the capacitor, it then attracts electrons from the other side, pulling them in from the other side. Even though they don't "jump the gap" of the central insulator, it looks like a tug-of-war is going on from both sides.

This behavior can also be used to send the higher-frequency components of a signal one way in a circuit and the lower-frequency components of a signal in another direction. This is one way that analog filters are built, and it has all kinds of useful and interesting applications.

Capacitors come in all shapes and sizes. They are made of many different materials, depending on what particular characteristics are needed. See Figure 3-15.

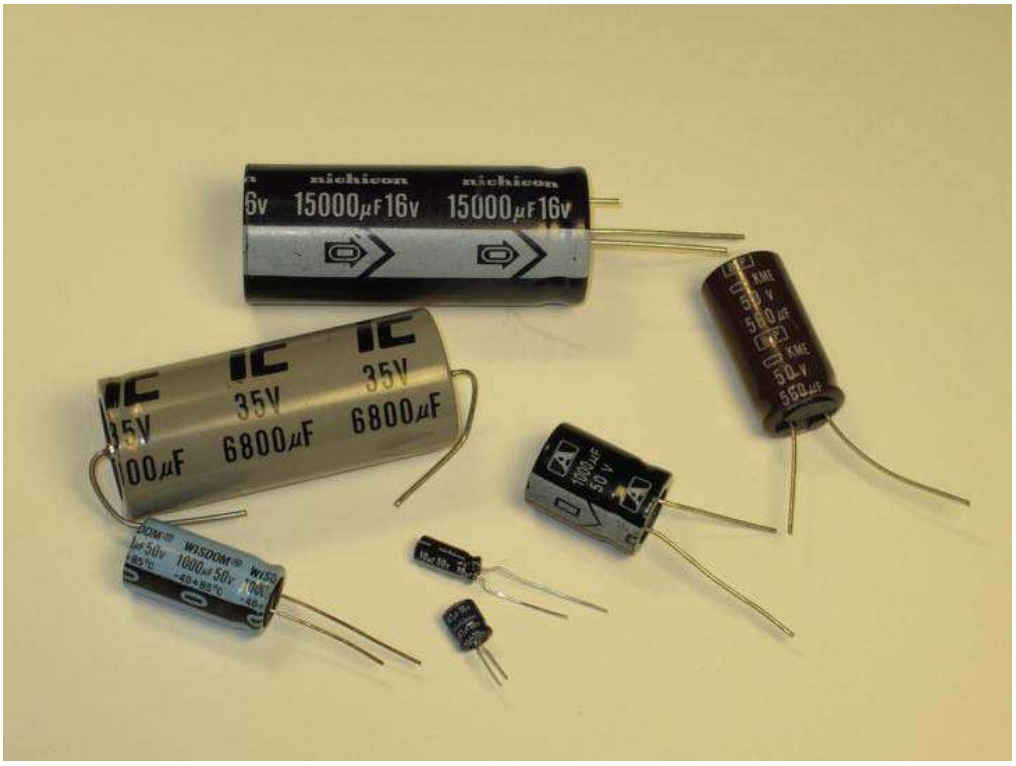

Figure 3-15. *Some electrolytic capacitors of various sizes and capacities. Both much larger and much smaller capacitors exist and are very common in electronics.*

Schematic Symbols

While there are a large number of special-purpose capacitors that are custom made for certain applications, a very large number of capacitors fall into two broad categories: polarized and nonpolarized. The schematic symbols for both types of capacitors display the fundamental construction of two conducting plates separated by an insulator. See Figure 3-16.

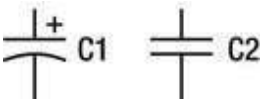

Figure 3-16. *The schematic symbols for polarized capacitors (left) and nonpolarized capacitors (right)*

C1 is a *polarized* capacitor, meaning one terminal is more positive than the other. In practice, this is indicated on the part itself in a variety of ways. One convention is that the *anode*, or more positive lead, is physically a little bit longer than the *cathode*, or negative lead. There is generally some sort of mark made on the capacitor body itself. Usually this is a stripe on the *negative* side of the capacitor.

What's really odd and potentially confusing is that one type of capacitor, specifically that made primarily of tantalum, has a stripe that indicates the *positive* lead of the polarized capacitor. Know your capacitors!

A polarized capacitor that is installed backward will experience terrible physical and thermal stresses and can sometimes explode, sending bits of itself all over the place.

C2 in Figure 3-16 illustrates a *nonpolarized* capacitor. It doesn't matter which way it is installed in a circuit. It is electrically symmetrical and works just as well in either orientation.

Inductors

An inductor is almost always made out of coils of wire. Sometimes inductors are quite large, as with transformers, while other times they are as small as a speck. An inductor would appear, electrically, as a simple short-circuit if it weren't configured to take advantage of certain principles of *electromagnetism*, or the tendency for the flow of electric current in a conductor to form a *magnetic field* around the conductor. The shape and orientation of the loops of wire that compose the inductor determine its electrical characteristics.

In many ways, an inductor is the opposite or complement of the capacitor. While a capacitor does not conduct direct current from one terminal to another, an inductor will happily do so, at least for a time. While a capacitor will resist a change in voltage across its terminal as it builds up its electric field, an inductor will resist a change in current flow across its terminal once it has established a magnetic field.

Because of their complementary natures, the two components can be used together to form a *tuned circuit*—one that resonates at a particular frequency, or allows the passage of only a certain range of frequencies, with the capacitor shuffling the high-frequency portions and blocking the low-frequency portions, while the inductor does the opposite, blocking the high-frequency components and passing the low-frequency ones. This is how many older radios and televisions worked before the advent of low-cost solid-state electronics.

Once an inductor has built up a magnetic field, any drop in the current flow across its terminals will result in the collapse of the field and the generation of a very-high-voltage spike. This is the basic electrical circuit that was used in automobile engines to create the high-voltage spark needed to ignite the fuel-and-air mixture in the combustion chamber.

Inductors can also be used to efficiently pass alternating current via a magnetic field from one inductor to another. This is how the primary windings of a power transformer *induce* a current in the neighboring secondary coil, which, depending on the ratio of windings and a few other factors, determines if the transformer *steps up* the voltage or *steps down* the voltage. It can even keep the voltage the same, for when electrical isolation is needed between two different systems.

Most electric motors employ some sort of inductor that alternately attracts and repels another electromagnet or permanent magnet. The most basic direct-current (DC) motors require a fairly complex mechanical arrangement to perform the necessary switch-swap to alternate the fields. This process is called *commutation*. In other types of electric motors, such as brushless motors and stepper motors, this commutation process is done electronically, externally to the motor itself, and requires more complex circuitry to control the speed and direction of the motors. See Figure 3-17.

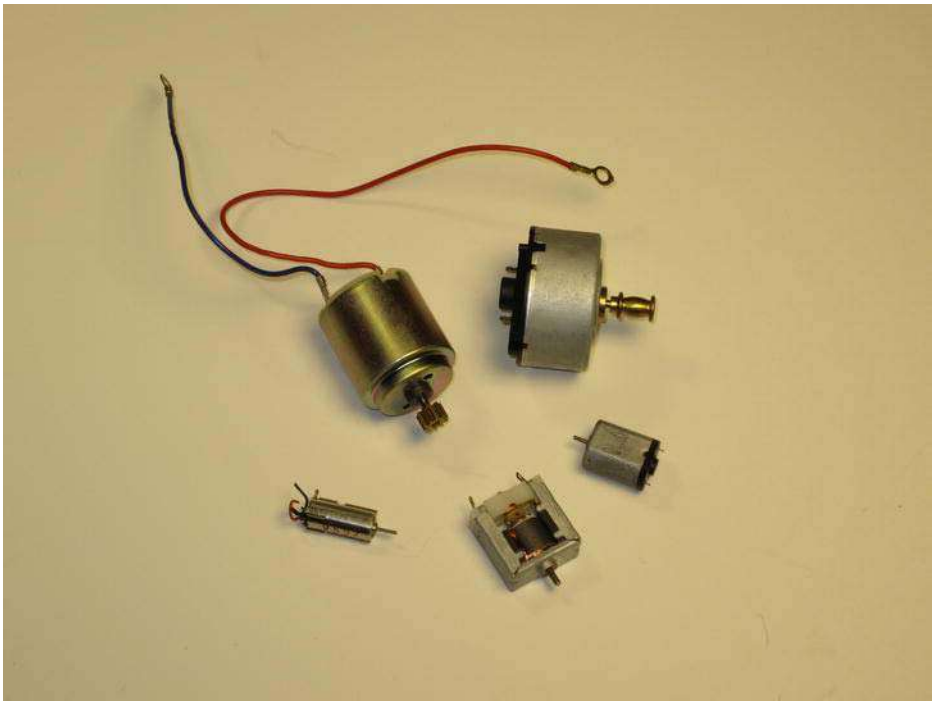

Figure 3-17. *Some simple DC motors. When direct current is applied to their terminals, they spin. The magic happens with an electrical and mechanical arrangement inside that performs the necessary commutation of the magnetic fields.*

Switches

The most basic way to control the flow of electric current in a circuit it to literally *break* the circuit. This means that instead of forming a conductive loop from power source to components and back again, a gap is introduced somewhere in the loop.

This gap can come anywhere in the loop. It can be right next to the battery, for example, or somewhere off in the middle—as long as the circle is broken, no current will flow.

If you perform the lightbulb experiment in Chapter 1, you can see how this works. When everything is lined up properly and the final connection is made, the lightbulb lights up. When any of the connections are broken, the light goes out. It's really as simple as that.

Most of the electrical switches that you operate every day are really mechanical in nature. Their main function is to physically move two conductors either together or apart.

In the lightbulb experiment, you could use the wire as a switch, by physically touching either the battery terminal or the lightbulb (depending on how you were holding everything together). With a little practice, you could probably send Morse code, or at least a variation on "one if by land, two if by sea."

There are many kinds of switches for many kinds of switching tasks. The most basic are *momentary action* switches. These are usually push buttons, and only conduct electricity when pressed. Alternately, they can be built so that they conduct electricity all the time, *except* when pressed:

- The first option is called *normally open*. When a circuit is open, it is not conducting electricity. When you *close* the circuit, by completing the loop, electricity can flow. A normally open switch would be welcome in a doorbell circuit. When no one is pressing the button, no bells are ringing. It would be annoying the other way around.
- A *normally closed* switch acts like a solid piece of wire (being a conductor of electricity) until it is activated, when it ceases to provide a path for the electricity to follow. This type of switch can be used as a *kill switch* on a gasoline-powered engine, such as a lawn mower, for example. By interrupting the flow of electricity generated by the magneto and powering the spark plug, you interrupt the internal combustion cycle, which will eventually cause the engine to slow down and then stop.

This type of switch is called a *single-throw* switch. It's either on or it's off—conducting electricity or not conducting electricity.

■ **Note** For almost every possible configuration of switches, there is a corresponding *opposite* configuration that is almost as popular.

Another useful configuration for a switch is to switch from one circuit to another circuit, and not just on and off. This is referred to as a *double-throw* circuit. A switch like this normally has three terminals. A *common* terminal is usually, but not always, in the center. At any rate, the common terminal is electrically connected to the moving part of the switch that is going to make contact with one or the other two remaining contacts. The *normally closed* contact is the one that will be making contact with the common terminal when the switch is not activated, or at rest. The *normally open* contact is simply the other terminal. This assumes that the switch has some sort of bias or mechanical spring action that returns it to a certain orientation when no one is activating it.

Some double-throw switches can remain in either state indefinitely. A typical light switch used in indoor lighting is a good example. It's just as happy to stay on as off.

Switches can have more than one circuit built into them. These switches are called *double pole*, *triple pole*, and so forth. They're like two or more single-pole switches physically taped together, so that when one is switched, they all are switched. Usually these poles are electrically isolated from each other.

We'll play with switches again in Chapter 5, where you'll learn some interesting ways to wire them up.

Active Components

While it could truthfully be said that *all* electronic components require some electricity to do anything, the distinction made in this book between *passive* and *active* components is that *active* components need a little more power to be really interesting.

First we'll look at sources of this magical electricity, and then we'll move on to some of the fascinating and complex components that will happily use it all up for you.

Power Supplies

You're going to need some sort of power source for any electric or electronic circuit you run across. If it doesn't use electricity in some structured form, it's not really electronics, now is it?

Batteries

You can use regular batteries to power a lot of your circuits, but they eventually wear out, and then you have no real recourse other than to throw them away or recycle them, if possible. If you're going to be using batteries, at least get some good ones. Many of the bargain brands are terribly inferior in their manufacture and are only providing you with a false economy. Spend a little more and get higher-quality parts, and you will be rewarded with longer life and more reliable operation.

A great way to work with batteries is to use the appropriate battery connectors or battery holders. Sometimes you can remove these from obsolete electronic devices that have outlived their useful lifetime. Always observe the proper orientation and polarity of batteries. Even smaller batteries contain an annoying amount of power, especially when it all decides to come out at once, such as when you accidentally plug something in backward or short something out. This can result in damaged parts, burns, or even fires. Be careful with batteries.

Having a fuse holder wired inline with your battery-powered supply is an excellent and cheap way to prevent such "unauthorized thermal events." Keep several spare fuses on hand as well. Fuses cost little and save much.

Rechargeable batteries are becoming more common, and they keep coming down in price while improving in longevity and power capacity, and decreasing in size and weight. Any rechargeable battery technology beats any kind of primary, or nonrechargeable, battery in the long run.

■ **Caution** The same warnings about battery polarity and fuses apply to rechargeable batteries as well.

Since there's no easy way to "turn off" a battery, it would be a good idea to include a power switch in your supply, if possible. Just make sure that whatever switch you select can stand up to the maximum current you will want to be extracting from your power supply. You should also make your switch large and easy to see, so that you can find it quickly when you need it. An obvious power-on indicator is also a great plus for a homemade power supply. This can be as simple as a green LED (with appropriate current-limiting resistor—see below) or as complex as a voltage meter indicating how much juice is left.

Transformers

Another great power supply that you probably already own is a power adapter or transformer from another electronic appliance. You should use caution, of course, with anything that plugs into the wall for power, especially if you're planning on monkeying around with the other end of it.

Almost all commercially produced power adapters have a slew of certifications plastered on them. Somewhere in there should be the basic data concerning what type of power input it expects, what it is going to try to produce, and what the maximum limits are on the output. Make sure that whatever it is that you're going to plug into your wall is specifically designed to plug into *your* wall, as electrical power standards vary from one location to another.

Make sure that any repurposed power supply you use does not get overly warm when in use. This is an indication that it is presently or has been overloaded in the past. Such a device is a fire-starter waiting for its magic moment.

You need to know how much voltage is coming out of your power supply. Even if it is clearly printed on the device itself, if you have access to a voltmeter, you need to verify the output voltage before connecting it to anything. Many lower-cost power adapters are *unregulated* and will produce an output voltage that will vary wildly depending on the load applied to it. A *regulated* voltage output, on the other hand, will provide consistent voltage levels on the output, even with varying loads.

USB adapters and chargers are becoming quite common and can provide *regulated* +5V at up to 1/2A and sometimes more. These are great devices to use for small electronic experiments. They are generally small, lightweight, and reliable.

A dedicated bench power supply is a very handy piece of test and measurement gear to have available in your lab. A good supply will have a variable voltage and a readout to show you what's going on (or coming out). A step up and you get to set the maximum current that it will supply (to keep things from getting out of control too fast). Additional desirable features include multiple outputs and remote control from your PC.

No matter what kind of power supply you use, use it responsibly. Don't leave equipment powered up if you're not using it. Don't attempt to bypass safety measures that are in place for *your* protection.

Diodes

A diode is a semiconductor device that will conduct current in one direction only. That's the simple story. Of course, the reality is much more complex. A typical diode is composed of two pieces of a semiconductor material, usually silicon, but sometimes germanium or some other exotic substance. The diode action occurs in the *junction* between the two types of semiconductors, which have been specially manufactured to contain the exact right balance of impurities required. This is generally not the kind of thing you can build in your lab, unless you're Jeri Ellsworth.

These two bits of semiconductor, called the *N region* and the *P region* (for negative and positive, respectively), are sealed up in either a glass or plastic enclosure. A standard diode has two terminals—an *anode* and a *cathode*—which represent the positive and negative leads, again respectively. Conventional current (i.e., current flowing from the more positive voltage to the more negative voltage) can flow through the diode from the anode to the cathode, but not the other way around. It's magic! Well, technically it's semiconductor physics, but either answer will serve for our purposes.

Diodes come in all sizes. Generally speaking, the more power a diode is expected to handle, the larger it is going to be. *Small-signal* diodes are the same size or smaller than typical resistors. Power diodes, often called *rectifiers*, depending on their application, can be so large they have to be mounted with large bolts.

The two most important electrical characteristics for the happy care and feeding of diodes are their maximum reverse voltage and forward current capability. You don't want to exceed either one.

Since a diode is, at best, only ever going to have a cryptic part number written on it, you'll need to consult the manufacturer's data sheet to find out all the necessary information. Many semiconductor producers offer "commodity" parts that conform to standard part numbering schemes. That way, you know that a 2N4148 diode from one manufacturer is going to be pretty close to a 2N4148 diode from any other manufacturer, but you should always check to make sure.

Diodes typically have a *forward voltage* that must be exceeded before current will flow. This voltage is essentially lost and is dissipated as waste heat from the device. Silicon diodes will have an average forward voltage around 0.7V and up. Germanium diodes will have a smaller forward voltage, in the area of 0.3V. Schottky diodes use a metal-to-semiconductor interface region and achieve substantially lower voltage drops, making them much more suitable for higher-power applications.

LEDs

One special kind of diode is the popular *light-emitting diode*. You see these little guys everywhere these days. In fact, some folks go around with black tape, just trying to cover them all up so they can get their darkness back at night.

The reason that they are everywhere is that they are cheap, reliable, and easy to use. They don't take up much room, don't take up much power, and don't generate that much heat. The exceptions to these admirable qualities, of course, are in the newer generation of LED lighting products that emit tremendous amounts of light and produce tremendous amounts of heat. Every month it seems that a new record is set for efficiency. Let's hope that trend continues.

Being essentially diodes, LEDs have both an anode and a cathode. LEDs only conduct current in a single direction. You'll need to make sure you limit the amount of current flowing through your LEDs, because the LEDs themselves sure aren't going to do it.

LEDs designed to be indicator lights can be powered with as little as 1mA. High-efficiency LEDs can be used for illumination purposes and still only draw 20–30mA each. These very modest power requirements make LEDs a favorite for microcontroller projects, as these output power levels are easily handled by most popular chips.

The forward voltage drop across LEDs is typically much higher than for a rectifier or signal diode. In fact, the voltage goes up as the emitted color of the LED goes from the infrared and red end of the spectrum (1.2–2V) up to the blue and ultraviolet end of the spectrum (3–3.6V).

Transistors

A true modern miracle, the semiconductor transistor ushered in the age of solid-state electronics. More than a million individual transistors can be used to build modern computer processors, all on a single chip.

The first types of transistors to be built and used were called *bipolar junction transistors (BJTs)*. This type of transistor is similar in construction to the diode, except that there are two semiconductor junction areas inside.

This arrangement of magic beans allows a small amount of electrical current to be applied to one of the three terminals of the transistor, called the *base*, which in turn allows a much greater amount of electrical current to flow between the remaining two terminals, known as the *collector* and *emitter*.

Two complementary types of BJTs are made, depending on the way that the positive and negative semiconductors are sandwiched together. NPN transistors will conduct conventional current from the collector to the emitter when current flows from the base to the emitter. The opposite variety, called the PNP transistor, does precisely the opposite, conducting conventional current from the emitter to the collector when the base is negatively biased.

Transistors can be used to make amplifiers, switches, current limiters, voltage regulators, oscillators, and any number of other useful circuits. They are generally very low cost, lightweight, and reliable.

As with any other electrical components, you need to be aware of the electrical limitations of your transistors. Even when a transistor is fully saturated and conducting very efficiently, it's still dissipating a certain amount of its energy as heat. Too much heat and say goodbye to your transistor.

A newer type of transistor is becoming quite popular in power circuit applications, and uses a different type of semiconductor property to accomplish its mission. The *MOSFET (metal-oxide–semiconductor field-effect transistor)* has three terminals, just like the BJT. Each terminal performs a similar job, but does it in a different way. The *gate* of a MOSFET is electrically isolated from the conduction *channel* between the *drain* and *source* terminals. However, when a proper voltage is applied to the gate, it creates an electrical field that influences the conductivity of the channel between the drain and the source.

The important differences between BJTs and MOSFETs lie in the type of signal needed to drive each of the transistors and how much power is wasted by being converted to heat. A BJT is a current-controlled device, where more current into (or out of) the base results in more current flow through the device. The MOSFET is a voltage-controlled device, where more voltage applied to the gate increases the current flowing through the channel.

Additionally, MOSFETs typically have much lower on-state resistance than BJTs, meaning they can more efficiently switch higher currents. Finally, MOSFETs have a *positive temperature coefficient*, meaning that they conduct less power as they heat up—which is a good thing. BJTs are subject to *thermal runaway*—conducting more current as they heat up, which in turn generates more heat, and so on, until something snaps, crackles, or pops.

Integrated Circuits

As parts get more specialized, they become less fun. There are a hundred ways to wire up some transistors, resistors, and capacitors, but there's generally only one way to hook up a thermocouple interface chip.

The good news is that it has become much easier for companies to design and build vastly complex chips that can do things for us that, honestly, most people cannot comprehend. And that's OK. We need airplanes that can, mostly, fly themselves. If we had to depend on humans to get everything done, you can imagine what kind of world we'd live in. Humans are notoriously sleepy, hungry, distracted, and forgetful. A voltage comparator chip does nothing but compare two voltages, all day, every day, perfectly, all the time.

Integrated circuits come in an unbelievably wide range of functions, packages, and capabilities. The first integrated circuits were amplifiers. Integrated circuits allowed manufacturers to make chips that have dozens or hundreds of transistors and other parts *all at once*. Just plop that little silicon chip into a plastic package with legs on it, and you're done.

What kind of chips do you need in your lab? Well, that's going to depend heavily on what kind of circuits you're wanting to design, build, or repair.

Many older chips had a standard 0.1" pin spacing that made them easy to plug into a solderless breadboard for prototyping purposes. Most newer chips have been considerably shrunk, because phones and tablet computers are all the rage these days. It's still possible to work with these newer chips, but it almost always requires mounting them to some sort of breakout board or expander that brings out their tiny leads to a more reasonable, and reachable, size.

Acquiring Components

Where do components come from? The same place as everything else—the store—just like food, just like money.

The electronic component manufacturing industry spans the globe. If someone's not putting something electronic together, they're taking something electronic apart.

Once upon a time it took some hunting to find sources for electronic parts. Swap meets and "ham fests" were great places to find components, assemblies, and entire appliances just ready to be hacked, studied, improved, or rebuilt. Now you have to spend time looking for places to *get away* from all the electronic hustle and bustle.

One of the great things about today's Internet is that it takes almost no effort to find both electronic parts and the information needed to use them. The real trick these days is finding the best deal.

If you're strictly a hobbyist, looking to spend some quality time alone or with your kids, learning about electronics and building fun projects, then it just about doesn't matter if you get the absolute, rock-bottom price on every component and tool. Even if you're a budding entrepreneur, you're still in a much better position today to leverage those brilliant ideas floating around in that noggin of yours than you would have been even ten years ago, all because of the ubiquitous nature of electronics and technology saturating our lives. Not only can you get the right tools and the best parts shipped right to your door for a song, you can easily network with knowledgeable folk from all over the globe, contributing ideas and brainstorming across time zones and borders.

Buying New Components

It would be more than a full-time job just keeping up with all of the new tools, parts, software, and hardware that are available today. Even if you could, it would take many lifetimes to make and grow the connections and relationships you need to successfully compete in the global economy.

That being said, a good place to start is in your own backyard. If at all possible, you should deal locally for the things you need. When what you want or need cannot be obtained locally, expand outward until you find it.

While it's certainly nice to be able to find all your needs met close to home, it's also good to know that the world is shrinking every day. The sort of deals and relationships that couldn't possibly have existed in your parents' time are happening right now.

If you are in a position to spend some money on quality tools and components, then by all means do so. You will not regret it. Buying questionable items is like buying your groceries out of some guy's van in a parking lot. Maybe he'll be there next week and maybe he won't.

Even the small fry can get treated like an honored guest when dealing with the right people. The trick is finding the right people. The best way to find them is to ask your friends and others with similar interest where they trade. Ask them how they feel about their relationships with their vendors. Are they just a number? Or are they a partner?

Recycling Used Components

It's really a bad idea to waste anything. In a more perfect world, there'd be no "other" category at the recyclers. Everything would have an exit strategy, especially the complex and fragile toys we're so addicted to these days.

Until that day, try to look at your trash with new eyes. Is it conceivable that someone else might be able to use this equipment, or is it truly past its useful life? Or are you just being lazy?

You can do your part, and you should believe that others are doing their part as well. Take the time to find them, find out what they can offer you, and find out what you have that they might be able to use. You won't know until you ask.

Be careful when harvesting components with which you are unfamiliar. Novice recyclers should give yesterday's cathode ray tube (CRT) TVs and monitors a wide berth. They can retain *lethal* voltages for considerable periods of time after being retired from service. Just leave them on the side of the road. The same goes for microwave ovens, or any equipment that has refrigerant in it. The stuff they use nowadays is quite toxic.

There is a growing surplus of both components and "last year's models" available to the student of electronics these days. Sometimes it's worth your time and money just to take something apart to see how it works. Then sometimes you find some useful parts inside that you can use in projects of your own.

Component Data Sheets

Every component ever manufactured has a data sheet. This data sheet contains everything you ever wanted or needed to know about this particular component. It's probably available right now on the manufacturer's web site, along with a dozen application notes. If not, then it's probably available on a university's computer system in a project folder.

This isn't always the case, sadly. Past a certain point, it doesn't make sense to allocate resources to information that no one wants or needs anymore. That point varies with each company, with some diligently archiving their information and others tossing it out the window at the end of the quarter.

When possible, collect and maintain your own private set of data sheets. When you acquire a new piece of equipment, get everything you can find in electronic form and stash it away somewhere where you can find it when you need it. If you're experimenting with some new components, squirrel away those data sheets, just in case you strike gold.

Have you built something cool? Write up your own data sheet for it! Pretend that you're still going to be interested in this project next year. Better yet, imagine that *someone else* could take an interest in your work. You'll be pleasantly surprised at how useful you'll find this information in the future, after you've slept a bit.

Summary

This chapter has covered a lot of different types of electronic components, but it has only scratched the surface of what is presently available.

It's perfectly possible to spend a lifetime pleasantly tinkering with electronics and never have a clue how any of the underlying principles work. Sometimes all you need is a *practical* understanding of what the different components do in a circuit. Hopefully this chapter has given you a rough outline of what is involved. Ideally, your interest has been sparked enough to pursue more detailed study elsewhere. Good luck and happy discovering!

Now that you're armed with some basic tools and some ideas about some of the available components, it's time to get busy building your own lab, one experiment at a time.

The remainder of this book will take you on a journey of trial, error, and experimentation that will help you build the best possible lab for your needs, both for now and in the future.

CHAPTER 4

A Portable Mini-Lab

Having a portable (or at least (*trans*portable) electronics lab comes in handy in several circumstances. Maybe you don't have a place (yet) for a permanent home for all that equipment. Maybe you need to bounce at a moment's notice, heading off on electronic adventures at the drop of a hat. Or maybe you like to keep everything where you can find it in a hurry, without having to rummage through shelves and boxes, looking for just the right tool or component.

Whatever your motivation for wanting a portable lab at your disposal, this chapter should help you get started.

Have Lab, Will Travel

First, a note or two is in order concerning *travelling* with your electronics lab. Nothing makes security screeners at an airport or customs inspectors at border crossings more nervous than a bunch of mysterious devices, especially devices that are tangled up in a rat's nest of wires.

Do what you can to keep your collection of tools and components tidy and in working order. You will most likely be asked to at least turn on any questionable items and demonstrate that they are not hollowed-out shells for transporting questionable items. It also doesn't hurt to clearly label equipment as to its function and ownership, which makes sense in any case, not just travel scenarios.

The Compact Executive Model

"A full mongoose is a slow mongoose." This is an important lesson learned from Rudyard Kipling's *Rikki-Tikki-Tavi*. Rikki, a mongoose, has to stay fast on his feet to be able to combat Nag the cobra and hope to win. Therefore, Rikki learns to only take a few bites at a time when eating and never gorge himself.

Although hopefully not in a life-or-death situation like Rikki's, you can learn a thing or two from this simple philosophy. Only take what you absolutely need when travelling, and never take something you can obtain at your destination. These things will only slow you down. Don't be a slow mongoose.

■ **Tip** Travel light.

A slim and lightweight briefcase or attaché can hold many of the tools and components you might need for your mobile electronic experimentations. The main advantage is that you will only need one hand to carry it (leaving one hand free to open doors, bribe guards, or fend off ninja—assuming you have two hands to begin with). See Figure 4-1.

Figure 4-1. *The compact executive mobile electronics laboratory. There's plenty of room for lots of tiny things, but not much else. Also handy for transporting big stacks of cash, should the situation arise.*

Let's take a look at what all you can take with you without a lot of heavy lifting. Starting on the left and moving to the right, we have

- Netbook PC with AC charger and USB mouse (it might be hard to see in Figure 4-1 because it's upside down and covered by other stuff)
- Arduino Uno programmable microcontroller (or *physical computing platform*)
- Folding multitool
- Lighted magnifier
- Digital camera
- Solderless breadboard with lots of precut jumper wires
- Digital multimeter and probes
- Compact single-channel oscilloscope with probe
- AC-powered USB charger—can also be used as a stand-alone regulated 5V power supply
- USB cable
- A variety of LEDs in all shapes and sizes
- Additional passive components
- A variety of batteries, both rechargeable and otherwise, and various battery holders (not shown)
- Static-sensitive integrated circuits and modules stored in antistatic bags
- Notebooks, writing implements, blank media, and documentation
- Your contact information in case of loss

One of the interesting features of this lab is that it is completely self-contained, power-wise. While it's nice to have access to AC power, it's not strictly required, at least for a while. The Arduino and the attached breadboard are powered by the battery in the netbook, via the USB cable. The multimeter has its own 9V battery, while the mini-oscilloscope can be recharged from a spare USB connector. With an extended-life battery, you can expect four to five hours of on-location electronic experimentation.

If your netbook or PC has Wi-Fi or other connectivity to the Internet, you can browse tutorials, data sheets, user forums, and even this book, unless you've already downloaded these items to the internal hard drive.

Have a look at this particular lab deployed and ready for action in Figure 4-2.

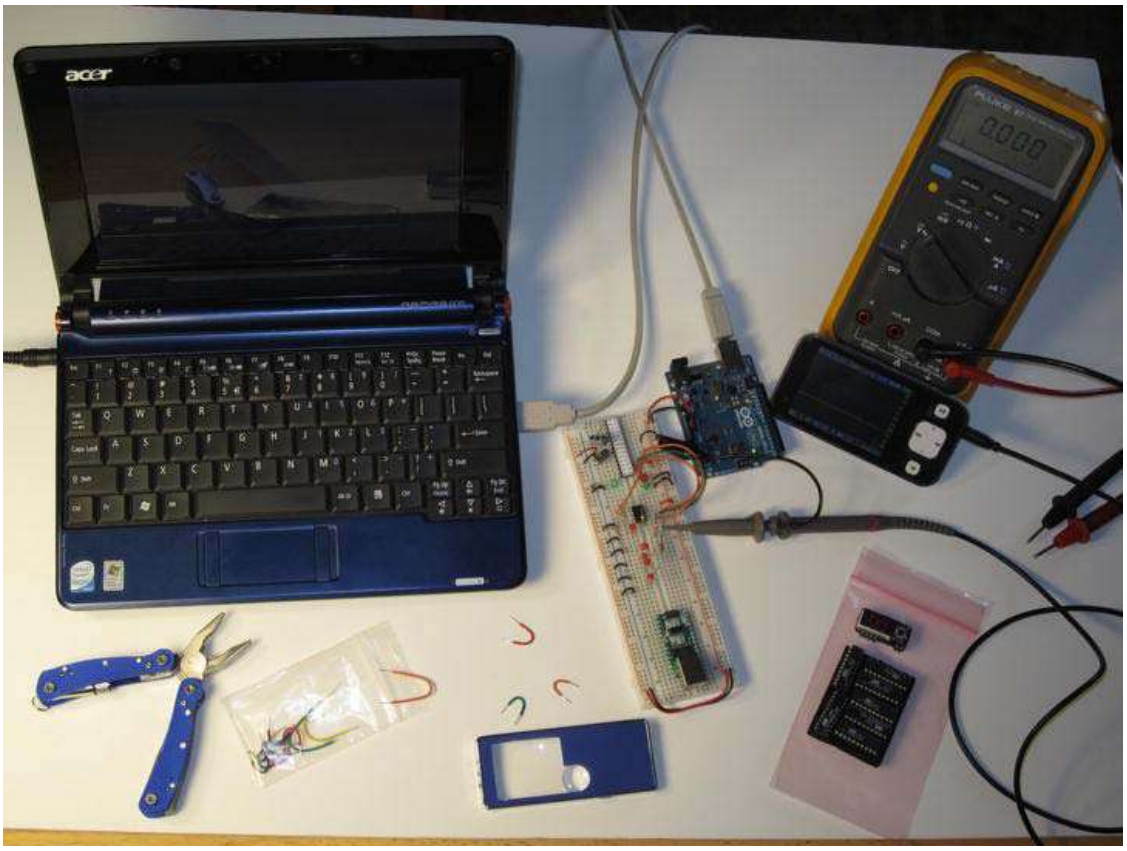

Figure 4-2. *The compact executive lab is deployed on a desktop. You have access to lots of electronic building and debugging capabilities in a small area. Using a solderless breadboard helps reduce the number of fabrication tools that you need to carry with you on your adventures.*

The Arduino was included for its small size, popularity, and ease of use. There's a whole world waiting for you inside that little board, waiting to be explored, but that's a story for another day.

You can use the USB cable to extract a regulated +5V supply from your PC for your low-voltage-experimenting pleasure. You can also use an inexpensive USB charger to do the same thing, if you don't feel like hauling a whole PC around with you. Just don't try to draw more than half an amp of current, which is the "official" USB limit for supplying power to USB devices. Technically, *unenumerated* devices (i.e., just a USB cable with nothing intelligent enough to identify itself to your computer) can only draw up to 100 mA (0.1A) of current. A USB charger, on the other hand, is not so picky.

No Soldering Required

One notable omission from this particular configuration is any sort of soldering tool. You could certainly add a small soldering iron, some solder, and a few more hand tools. You'll either need to boot out some of the bulkier items, such as the PC or the full-sized multimeter, or get a slightly bigger carrying case.

The Ever-Shrinking Computing Device

One option that will be gaining momentum in the very near future is the use of tablet computers or smart phones instead of the physically larger laptops or netbooks. They already have a lot of the computing capabilities of reasonably powered portable computers. Also, you can look forward to innovative hardware and software interfaces that will make them more useful in the lab as programmable test and measurement devices. While name-brand products still command a premium price, many no-name or OEM (original equipment manufacturer) products are being sold for a fraction of the cost.

Electrical Experiments You Can Perform

Here are some simple electronic experiments that you can perform using only the tools and components found in the compact executive mobile electronics lab. Start out with something simple and incrementally build on your success. Don't try the most complex problems first. What you want is to build up both your knowledge *and* your confidence at the same time.

Lighten Up, 20th Century Style

Here's an easy experiment that will teach you several interesting things about electronics, believe it or not. You can light up a typical LED using only a lithium coin cell. It needs to be a lithium coin cell that produces at least three volts (marked "3V"), not one of the smaller batteries that only supplies 1.5V, such as a watch or hearing-aid battery, as these will not produce enough voltage to light up a typical LED.

Slide the coin cell between the leads of your LED. There are four possible outcomes, three of which are "nothing interesting happens." Let's start with the least likely possibility, in which the LED lights up. Sometimes you just get lucky.

First Possible Outcome: The LED Lights Up When Attached to the Coin Cell

Figure 4-3 shows the results of this outcome. Notice that the longer lead of the sLED (the positive, or anode, lead) is touching the side of the coin cell marked with a +. No current-limiting resistor is required in this circuit because the battery's internal resistance is sufficient to keep from blowing up the LED. It just happens to work out that way, this time. Most other times, you will need to add a current-limiting resistor to the circuit.

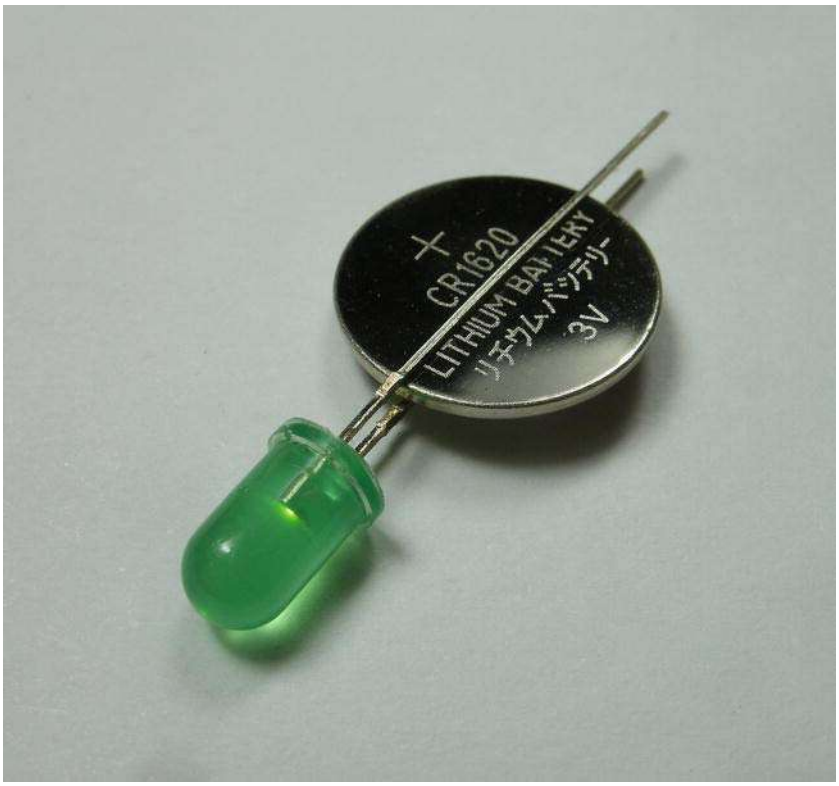

Figure 4-3. *A typical LED lights up when attached to a lithium coin cell. No extra wires needed!*

The other three scenarios? Let's look at them one at a time.

Second Possible Outcome: Nothing Interesting Happens

Why? Because the LED has been installed backward. Alternatively, the coin cell has been installed backward. Remember from Chapter 2 that LEDs are light-emitting diodes, and diodes only carry current in one direction. Therefore, when connected backward, they block the flow of electric current, preventing anything interesting from happening in the rest of the circuit.

Typical lithium coin cells have one broad, flat side that usually has something printed or etched on it, almost always with a + to indicate the positive polarity of the cell. The other side is often textured or rippled in some way to help make better electrical contact when installed in a device. This other side is the negative terminal of the battery.

The LED, being a diode, is *polarized*. It will only work when installed in the proper orientation inside the circuit. Most LEDs will offer one or more ways of easily identifying which lead is which (see Figure 4-4).

- Brand-new LEDs will have extended leads about an inch or so long. One lead will be slightly longer than the other one. The longer lead is the *anode*, or positive lead. The shorter lead is the *cathode*, or negative lead. This information is lost when the leads of the LED are trimmed—for example, after being installed in a PCB.
- Another industry standard for identifying the polarity of an LED is to look at the small ridge or shoulder at the base of the LED body. There will be a flat portion molded into the otherwise circular outline. This flat spot marks the cathode, or negative terminal of the LED.

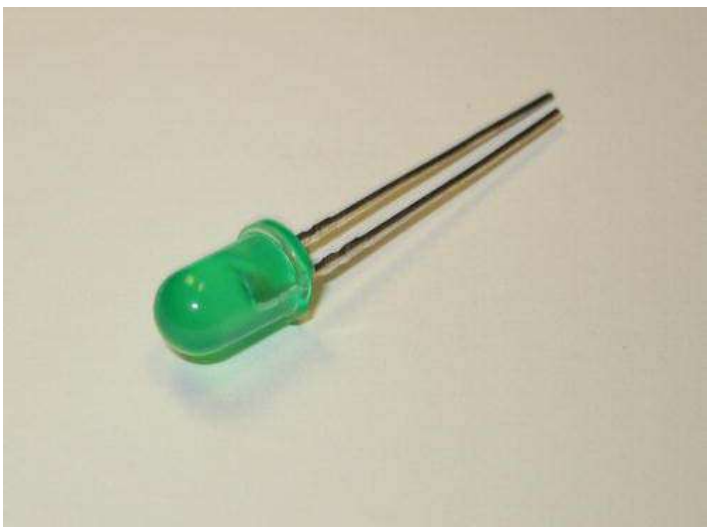

Figure 4-4. *Typical LEDs in the 3mm, 5mm, 8mm, and 10mm sizes almost always have two polarity indicators. The first is that the longer lead is the positive lead, or anode (top). The second is that the flat side on the base indicates the negative lead, or cathode (bottom).*

On really tiny LEDs, there may be an even tinier mark printed or etched onto the LED to indicate the cathode. You will sometimes need a magnifying glass just to see it!

The quick and easy fix for this problem is to swap the direction of either the LED or the battery. If this still produces no good results, we have to consider some more possibilities.

Third Possible Outcome: Nothing Interesting Happens

This time, after establishing that the LED has been properly oriented with respect to the polarity of the battery, we must entertain the possibility that the battery has been previously depleted. Coin cells have a limited amount of energy stored within them, and this can be easily drained in normal use over time.

A quick way to measure a battery's electrical goodness is to use a voltmeter. See Figure 4-5.

Figure 4-5. *Measuring a coin cell's electrical goodness using a digital multimeter. This one is chock-full of goodness!*

If you have a multimeter, be sure to set it to read DC voltage, in the appropriate voltage range (unless you have a fancy "autoranging" meter). Touch one of the meter's probes to one side of the battery and the other probe to the other side of the battery, and see how much voltage is measured. Anything below 3V should be considered depleted and of no further use, as far as electronic-type projects are concerned. The batteries are shiny and round, so they may have a second career in some sort of art project, but otherwise they should be disposed of in a responsible manner.

Also, perhaps because of their very shininess and roundness, they like to be eaten by small children. Don't let this happen! Take whatever steps are necessary to prevent small children from handling or even touching your electronic tools and components. Use extra care when your lab is mobilized.

■ **Caution** No unsupervised children, no matter how adorable, are allowed in the lab!

Fourth Possible Outcome: Nothing Interesting Happens Because the LED Is Defective

This can happen when an LED is subjected to too much current and the tiny, tiny wires within the plastic body overheat and fail. It can also occur when the LED has been exposed to the elements and moisture has penetrated the casing, allowing the internal connections to oxidize. This scenario, while within the realm of possibility, is certainly the least likely of the four, unless you are habitually cruel to your LEDs. It's also easy to test, if you have a known-good lithium coin cell handy.

Where's the Resistor?

You might be wondering where the current-limiting resistor can be found in this circuit. It's in there, all right, but it's hidden within the battery, so to speak. Coin cells are designed to provide tiny amounts of current over a long period of time. You're not going to arc-weld or start your car with one. As such, they have a much higher *internal resistance* than most any other kind of battery. We use this "feature" to our advantage when testing LEDs using just a coin cell, as the maximum amount of current that will normally flow out of the battery is below that necessary to destroy the LED.

A Slightly More Permanent Circuit

You can build a more permanent circuit for the coin cell and LED using a solderless breadboard. If you recall from the "Solderless Breadboards" section of Chapter 3 (see Figure 3-6), a solderless breadboard is an array of spring-loaded tie points, which serve to both physically hold electronic components and provide electrical connections between certain points. Let's build an LED circuit on a solderless breadboard using an LED, a coin cell, a resistor, a jumper wire, and a custom battery holder (see Figure 4-6). Later on, in Figure 4-7, you can see details of the custom battery holder.

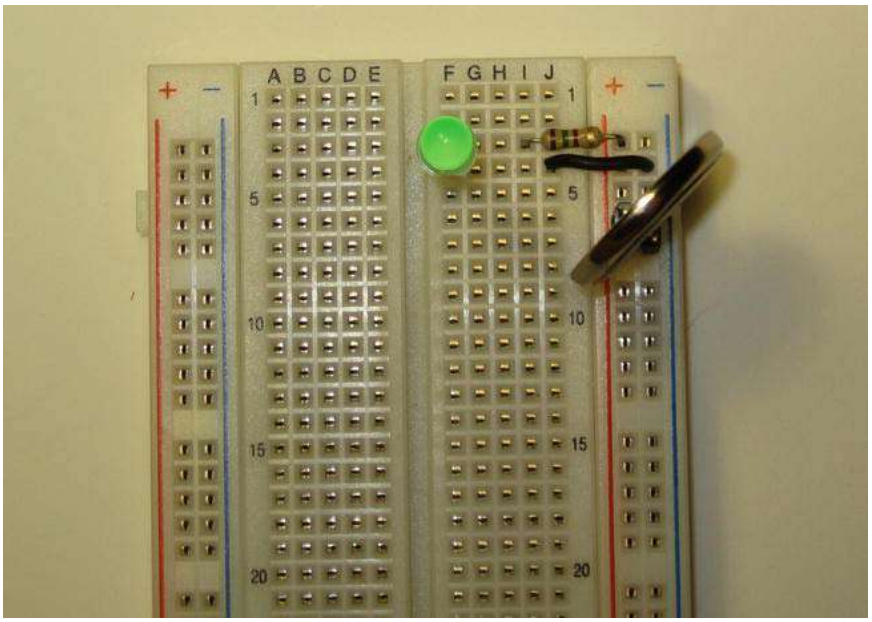

Figure 4-6. *A slightly more permanent LED circuit, built on a solderless breadboard. The tie points on the breadboard are labeled left to right with the letters A–E and F–J for the columns. The rows are numbered starting at 1 at the top. The LED's anode, for example, is installed in tie point F3. The power rails on either side are simply marked with + for positive and – for negative.*

Referring again to Figure 4-6, you can see the overall layout of the LEDcircuit. The power rails along both sides of the breadboard are just longer versions of the electrical connections that connect each of the groups of five tie points together. In this example, the right-hand power rails are used, but the left-hand side is not.

The schematic diagram of this circuit shows how simple it is, at least in principle (see Figure 4-7). Can you see the circle?

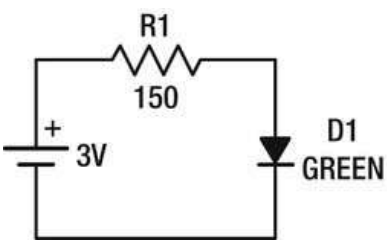

Figure 4-7. *The schematic diagram of the LED circuit as built on the solderless breadboard. Schematics are intentionally simpler than reality (most of the time) in order to help convey the very basic idea of how things are to be wired and the relationships between the components, without bogging you down in all the inevitable details that are involved.*

The Battery

The symbol for the battery actually looks like the battery in this case. The same symbol is used for most single-cell batteries, even when they are of completely different shapes or proportions. Multicell batteries are usually represented with repeated stacks of long and short lines.

The battery symbol's long line represents the positive terminal of the battery, and the short line represents the negative terminal. Again, it's just a coincidence that the wide side of the lithium coin cell is the positive terminal. The addition of the + sign in the schematic is redundant, but you'd be surprised how many people accidentally reverse this symbol. Better safe than sorry when it comes to electricity!

The Resistor

The battery's positive terminal is connected via a wire (drawn as a simple, solid line) to one side of the resistor. The schematic symbol for the resistor is a zigzag line.

The resistor is labeled "R1" (resistor 1) in this schematic, even though it's the only resistor and could just as well have been labeled "RESISTOR #1," or just plain "resistor." The numeric value underneath the resistor is the component's primary electrical characteristic, at least as far as we're concerned when looking at the schematic. In this case, it indicates a resistor whose *value* is 150Ω. In this simple example, the value of the resistor is quite flexible. A larger value, such as 1KΩ (1,000 ohms) or more, would also work, except that the LED would not shine as brightly. This is because *more* resistance results in *less* current flow, and it's the current flow that makes the LED shine. More current, more shiny.

We haven't specified any of the other important characteristics of the resistor, such as the tolerance or the power-handling capacity. Because this is such a low-power circuit, almost anything will do. When you start to work with really big LEDs that require correspondingly really big power supplies, this becomes a much more critical issue. For now, we start simply.

The LED

The other side of the resistor is connected, again, with a simple, solid line, to the anode of the LED, whose *reference designator* in this schematic is D1 (for diode 1). You could have called it "LED," and future generations would probably have understood your intentions, which should be your overriding goal. Its characteristic "value" in this case is "green." Of course, any color will do, as long as you have the eyes to see it.

The LED's schematic diagram effectively communicates its polarized nature. The arrow indicates the flow of *conventional current*. The flat bar indicates the cathode, or negative terminal of the LED. This corresponds to the flat side of the LED body in this example. The cathode is connected via a wire back to the negative terminal of the battery, completing the circuit.

Can you see the circle yet? Hint: It's disguised as a rectangle. The important point is that it forms a complete loop.

Building the Actual Circuit

Comparing the schematic to the photograph of the completed circuit might not immediately click in your head. Take a look at Figure 4-8 for a slightly different angle, where you can see some more details, such as how the battery is being mounted.

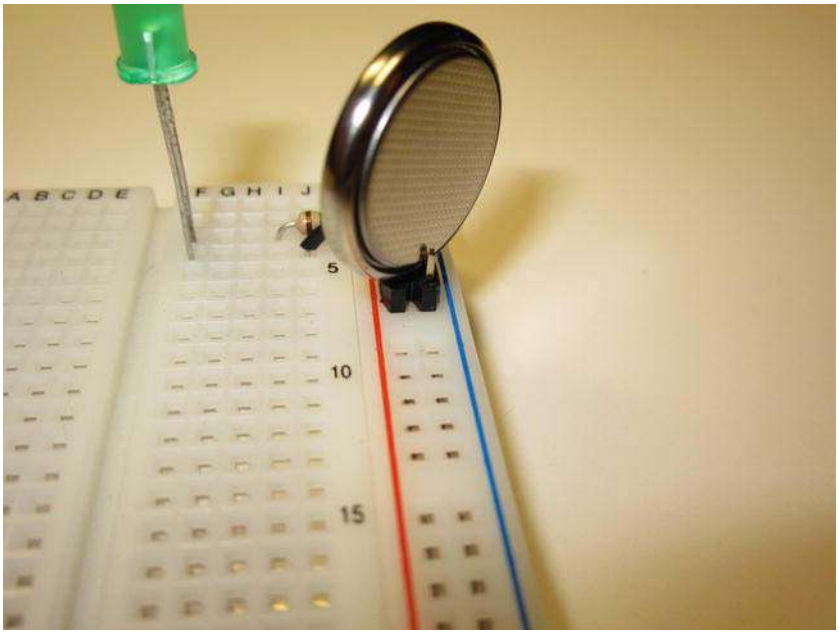

Figure 4-8. *Another view of the LED circuit as built on a solderless breadboard. The battery holder is a modified pin block that has had a couple of its pins removed, allowing the coin cell to fit in on the diagonal. A thinner coin cell could have fit without your having to remove the corner pins. A proper coin cell holder is inexpensive and would provide a much more robust solution to the problem.*

Looking at Figure 4-8, you can see how the positive side of the battery is making physical and electrical contact with the gold-plated pin of the pin block. The remainder of the pin emerges underneath the black plastic molding to make contact with the spring-loaded tie point within the body of the solderless breadboard, which in this case is the negative power rail. The positive terminal, in a similar fashion, makes contact with the positive power rail.

By attaching the battery directly to the right-side power rails, you ensure that your circuits are only a short jumper away from power, no matter where along the breadboard you decide to build them. Handy!

Note that the left-side and right-side power rails are not connected at this time. If you would like them to be, you can easily attach them using jumper wires. See Figure 4-9.

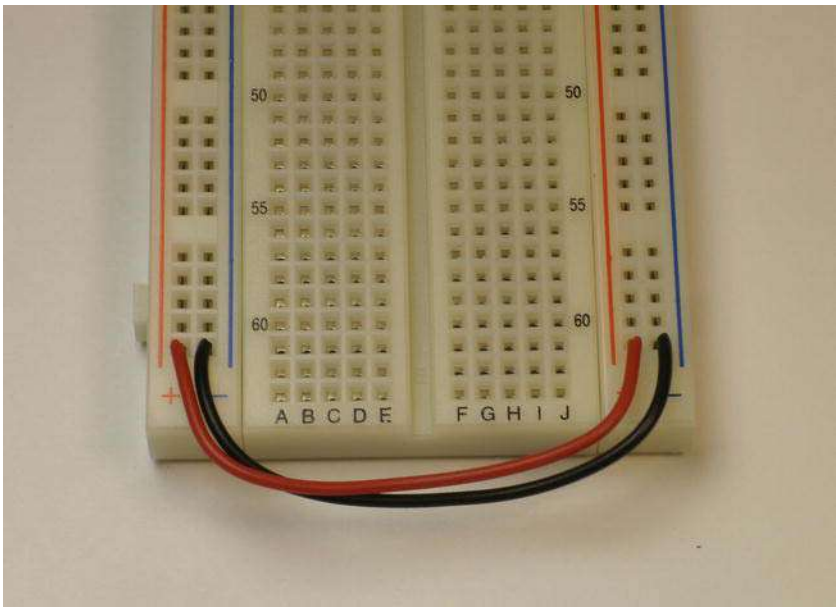

Figure 4-9. *Attaching the left- and right-side power rails using jumpers. By default, the power rails are not connected. There are some situations where you need them to not be connected, such as when using multiple supply voltages within a single circuit. These things happen.*

Now, referring *all the way back* to Figure 4-6 (sorry about that), you should be able to see how the positive terminal of the battery is indeed connected to one side of the resistor. The other side of the resistor, then, makes an electrical connection with the anode of the LED (the non-flat side, when seen from above). The cathode is connected to the negative power rail using a short jumper wire. The negative power rail then completes the circuit back to the battery. The circle is complete.

Note that the resistor could have been placed either before the LED in the circuit (as shown in the photographs) or after the LED. The only important points are that it is in the same circuit, or circle, and that the current must flow through *both* the LED and the resistor. It really doesn't matter which one comes first, especially in this simple circuit. It will only make a difference when you start to do fancy stuff, like adding switches and such to complicate things.

If you're using a different kind of solderless breadboard (and there are a few distinct varieties), you may or may not have power rails available. If so, fret not. You can still make point-to-point connections using more jumper wires. Now you're starting to understand why you were assigned to cut and strip so many jumper wires back in Chapter 2! They should start to be coming in handy just about now.

Multiple Uses for the LED

Now we've moved from the 19th century incandescent bulb to the 20th century LED. What kind of lighting devices will we encounter in the centuries ahead?

One of the nice features of LEDs is that they don't typically require a great deal of power to operate. This is certainly true of indicator-style LEDs, whose only purpose is to be seen as either on or off. We can leave this LED installed right where it is and use it as a handy power-on indicator for future projects. You might be surprised how many heads get scratched in puzzlement, wondering why a newly wired prototype isn't working, only to find out after exhaustive investigation that the power wasn't turned on! Then again, you might not be surprised by this.

Now let's take this perfectly working circuit and break it—on purpose. If we interrupt the circuit, for example, by removing any of the components or their connections, the circuit stops working. To that end, remove the short jumper wire and replace it with two longer jumper wires. Plug in each of the new, longer jumper wires where the two ends of the short jumper were installed. See Figure 4-10.

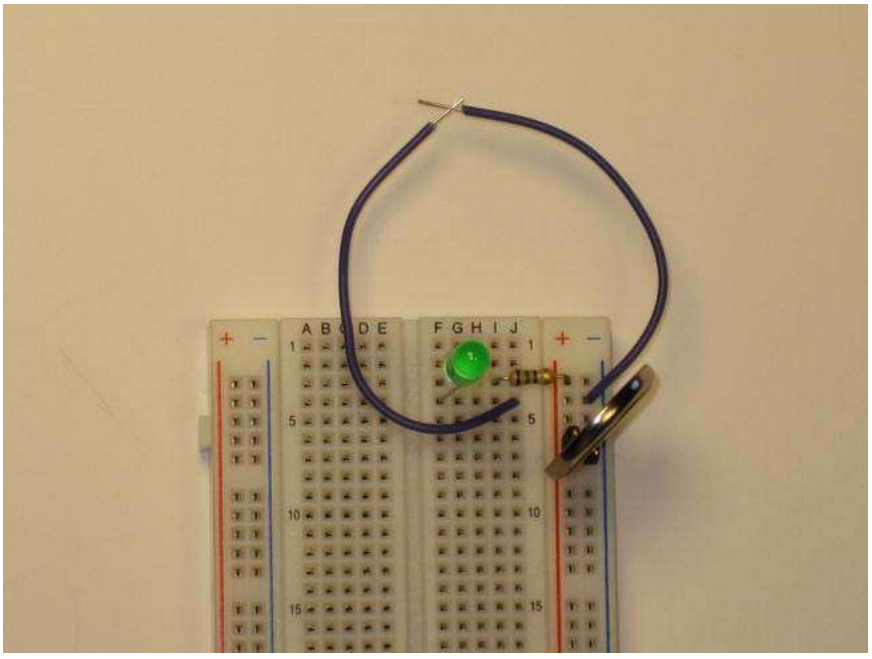

Figure 4-10. *By intentionally breaking the circuit, we stop the flow of electricity through the components, extinguishing the LED. By reconnecting the longer jumpers (or just touching them together), we reestablish the circuit, and the LED should light back up again. We can use this mechanism to test whether there is continuity in another circuit.*

Now, by touching the two probe wires together, you recomplete the circuit, and the LED should glow in happiness. This is exactly how a switch works. You can use this basic idea to build a continuity tester that lights up the LED when the current flows in the circuit. This is very handy for testing cables and wiring in a more complex assembly.

More electronic experiments, including how to both calculate and measure what's happening in a circuit, can be found in Chapter 5.

The Special Project Portable Laboratory

When you move past the simple joys of lighting LEDs and wiring up tutorial circuits, where do you go and what do you build? How about a robot?

Doug Paradis is an award-winning writer and robot builder. When Doug wants to work on one of his robots, he packs up a small kit of tools and heads over the local robot club, which in Doug's case is the Dallas Personal Robotics Group (DPRG). They meet every Tuesday at the Dallas Makerspace for an informal evening of robot building and socializing. See Figure 4-11.

Figure 4-11. *Doug Paradis of DPRG, arriving at the Dallas Makerspace for an evening of robot building. Doug uses the club's laser cutter and other specialized tools to give his robots that winning edge. He brings his own set of hand-picked tools along with him.*

Figure 4-12 shows what Doug brings with him to work on his robots.

Figure 4-12. *The contents of Doug's portable workshop. A variety of hand tools, precison measurement devices, and fasteners (including tape, tie wraps, and super glue) are easily stored in a small tool bag for easy transport. The comparmentalized storage containers at the upper right contain a large assortment of screws, washers, and nuts.*

Doug has learned the lesson of travelling light. The electronic portions of his robotic creations evolve slowly over time, but the mechanical aspects get a lot of tweaking along the way.

Not everyone has perfected the art of light travelling. See Figure 4-13.

Figure 4-13. *A sort-of-portable robotics lab, with lots of tools and spare parts. One way of looking at this bounteous splendor is "three trips to the car."*

This caravan of tools, parts, and miscellaneous supplies forms the entourage of Kyle the Robot. Kyle is very much a work-in-progress. The basic framework is made of hand-tooled aluminum. The large wheels use O-rings for tires and are driven by 24V gear motors. The 24V supply is made up of two 12V, 5Ah rechargeable lead-acid batteries. Ah stands for amp hours, and represents the capacity of the battery. In this case, it can deliver an amp of current for five hours, or five amps for one hour. The custom PCB holds the electronics for the drive motors and will be controlled by a separate microcontroller that has yet to be added. See Figure 4-14.

Figure 4-14. *Kyle the Robot is a work-in-progress who requires a wide range of specialized tools and components. Some new components are being fitted, including dedicated battery voltmeters, fuses, a circuit breaker, and a master power switch. Once the sharp corners are filed off, Kyle will be able to roll around the house, looking for chores to do.*

Summary

As we come to the end of this chapter, you should have some good ideas bouncing around in your head about how you want to pack your mobile electronics lab, what tools and components you *absolutely* must have with you, and how you want them organized. The best way to find out for sure what works for you is to make a few field trips, paying careful attention to what was actually used compared to what you anticipated needing. This will help you whittle down your cargo to the bare essentials, which is what you want. Remember, travel light. Excess baggage is a purely optional curse.

In the next chapter, we'll look at some suggestions for organizing and working in a more permanent setting. This could be a domain as small as the corner of a desk or as large as a warehouse. You will soon discover, if you haven't already, that this hobby, like many other projects, will quickly expand to fill the space available. Try to keep in mind that *you* are the one that ultimately makes the decisions. Effort spent planning ahead of time will help keep the sprawl to a minimum, while helping you stay focused on what you wanted to be able to do in the first place.

CHAPTER 5

The Cozy Corner Lab

Chapter 4 focused on the needs of the travelling electronic adept. Here in Chapter 5 you can come home to a lab that is always ready and waiting for some electrical fun and doodling. Nice!

You don't need an entire garage or extra office for a functional laboratory for your electronic endeavors. It's certainly nice if these areas are available to you, but you might be surprised at how much you can do in just a small space, if you set it up properly and maintain it with determination.

The first part of this chapter will deal with the task of rehabilitating a small, dedicated work area that has succumbed to years of poor organizational habits. These things happen. The second half of the chapter explores the possibilities of starting afresh with a nice, clean space—either something brand new or just newly cleaned. Some more projects help break in your new work area, as well as familiarize you with more interesting information about some of the basic electronic components reviewed in Chapter 3.

The Rehabilitation of a Small but Useful Area

Let's perform a little magic, in the form of a complete makeover for a small workstation. Have a look at Figure 5-1. Don't let this happen to you!

Figure 5-1. *A workstation that has been in continuous use for several years. Not much planning went into the original organization of this work area. Such a space can often accumulate flotsam and jetsam that might have at one time seemed appropriate, but now just competes for precious space. The effective work area is down to only a few dozen square inches! This limits the scope of projects that can be comfortably undertaken. It also causes unnecessary delays in rooting around for tools and parts. It's not pretty and it's not safe.*

Where to begin? Like any other project, this big project is made up of many smaller projects, none of which are especially difficult, if approached in the right order and with the right attitude.

If you're starting from scratch with your electronics lab and don't want to wade through this mess, jump on over to the "Adding a Power Source" section of this chapter.

Science to the Rescue!

Let's use the science of *taxonomy* to help break down this task into smaller, more manageable jobs. Taxonomy comes from the Greek words for "arrangement" (*taxis*) and "method" (*nomia*). That sound like *exactly* what is needed here! An "arrangement method" would assist in building up a plan for attacking this project.

■ **Tip** Method plus rigor equals success! Have a plan, pursue it with determination, and you will succeed.

Let's break down the overall category of "big mess on table" into two major *taxa* (singular: *taxon*), or categories. Ideally, what we will find here are *tools* and *components*. There will be other bits and pieces that don't easily fit into one category or the other (or will maybe fit into both), but it gives us a place to start.

Organization

Divide and *conquer*! These are the two words that will help us through the ordeal of rehabilitating this workspace. We'll get to do a lot of dividing here, and end up as conquerors. The spoils will be a useful (and tidy!) work area that will encourage you to begin new electronic adventures, instead of scaring small children.

The Great Divide

It would be possible to reorganize this workspace *in situ* (i.e., in place), but it would require a great deal of inner peace and lots of patience. Lacking these, a complete reboot is in order. Let's clear off the entire table and start afresh. This will provide the excellent opportunity to arrange things in exactly the best possible order.

First, get two big containers. These can be cardboard boxes or plastic storage bins—it really doesn't matter. We'll just be using them as temporary staging areas as we make like an embryo (and divide and divide again). See Figure 5-2.

Figure 5-2. *Two large cardboard boxes are enlisted to help with the initial organization of the contents of the tabletop. One will be for tools and the other one for components. Further subdivisions will be made later.*

Now, the first thing you will want to do is remove any items that really don't belong in the lab at all, such as coffee cups, personal effects, and any obvious trash. Everything that is about to go into one of the two boxes should eventually find its way back to the work area, so now is the time to omit the things just don't belong here.

Is it a tool? Is it a component? How do we tell? Ask five people and you will get five different answers. For the purposes of this little endeavor, a *component* is something that will become a part of a project, while a *tool* is something that is used to modify or manipulate a component. Another way of looking at it is that components get used up quickly, while tools get used up slowly. If you build enough projects, you will be lucky enough to see exceptions to these guidelines.

Here are some examples. Wire is a component. Wire cutters are tools. That was easy. A flashlight is a "visual inspection aid," so it goes under the category of tools. Batteries for the flashlight are consumable, so they are components. There's no real need to be ultra-precise at this point. Use your best judgment and make up policies that make sense to *you*.

It might help, from a physical logistics standpoint, to use smaller subcontainers to hold the really small bits as you're lumping them into the two broad categories. Folding cardboard bin boxes are handy both on the tabletop as well as on shelves, if you have them. The cardboard bin boxes shown in Figure 5-3 are from Uline (`http://uline.com`), part numbers S-16268 (4" wide) and S-16269 (6" wide).

Figure 5-3. *Folding cardboard bin boxes help contain some of the smaller bits and pieces during the Big Sort. You can use whatever happens to be available. Some preliminary subsubdivision is going on here. For the most part, the tools are on the left and the components are on the right.*

After everything is removed from the table and the cardboard boxes are nearly full, the table itself should get a good washing. Behold the *tabula rasa* (blank slate) depicted in Figure 5-4.

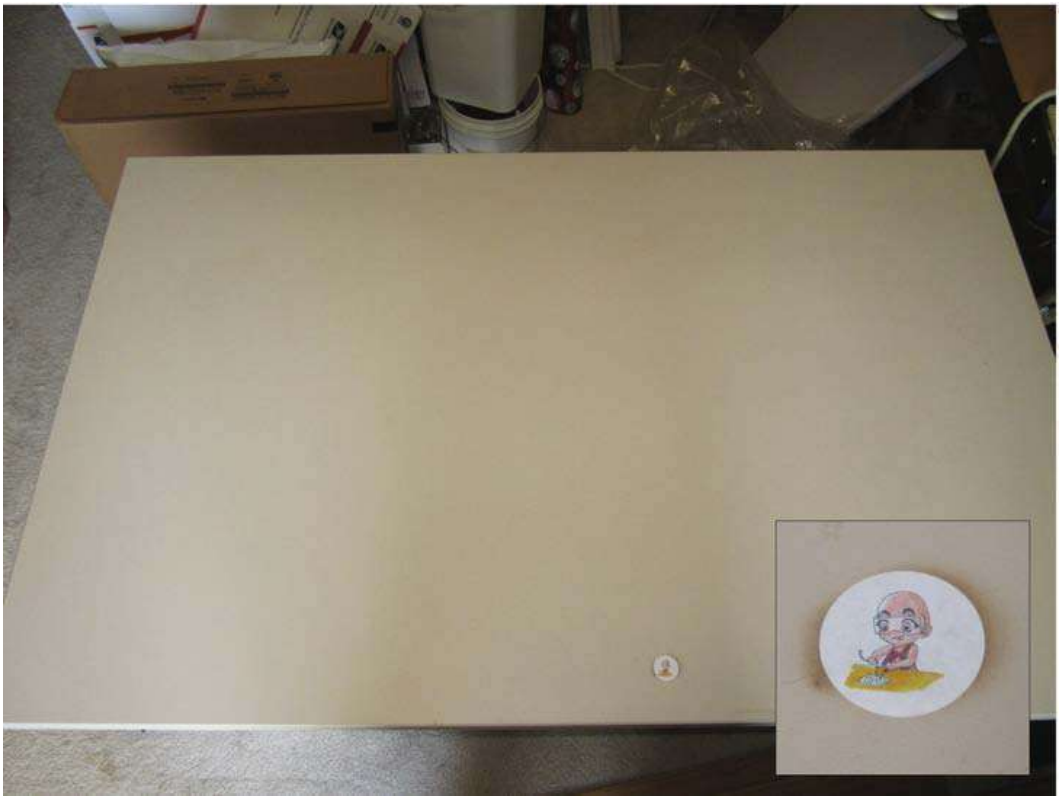

Figure 5-4. *The tabletop has been cleared of tools, components, and various bits of debris. A good washing with soap and water completes the cleansing. A burned spot (the result of a poorly supervised thermal test) is covered with a small sticker (see inset).*

Adding a Power Source

Here's where a bit of planning will save you a lot of headaches in the future. What you never seem to have enough of in any laboratory, especially electronics labs, are lots of conveniently located power outlets. Let's take care of that issue right away, before building anything else onto the tabletop. See Figure 5-5.

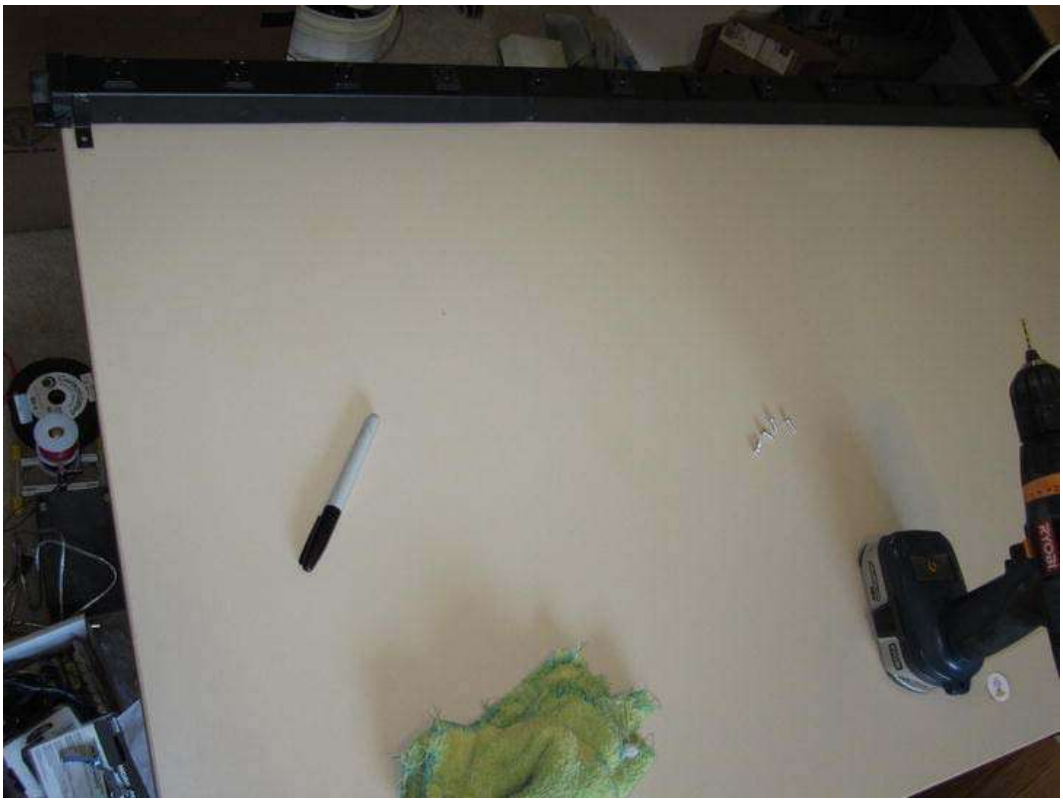

Figure 5-5. *A 12-outlet power strip is attached to the back edge of the tabletop. This will provide a safe and convenient source of power for all those gadgets you'll eventually want on your bench. Tools needed for the job include a drill motor to drill out some small pilot holes for the brackets, a small drill bit, and a felt-tipped marker. Before drilling the pilot holes, align the brackets where you want them to go and use the marker to put a dot where the pilot hole should be drilled. Make sure the power strip is not plugged in when you're drilling right next to it!*

Having lots of extra power outlets is a nice bonus, but is not absolutely required. What you want to avoid, however, is excessive daisy-chaining of power strips and extension cords. This is a fire hazard. Remember from Chapter 3 that every conductor has a certain amount of resistance. This resistance turns electricity into heat. Enough heat makes things catch on fire.

If you do have the luxury of being able to mount a permanent power strip (which, technically, remains a temporary power tap as far as the manufacturer is concerned), then be sure to install it securely using the hardware provided. See Figure 5-6.

Figure 5-6. *The power strip is fastened securely to the table using the provided hardware. You do not want your power strip wiggling around, or worse yet, falling off the table, dragging all of your power tools with it!*

■ **Tip** Test every outlet of your power strip before permanently mounting it to your workbench.

A Clean, Well-Lighted Space

You can never have enough light, it seems. What passes for normal room illumination might be sufficient for such adventurous undertakings as finding your way to the door or looking for the remote control for the television. For anything more demanding, you're going to have to add some more lighting, and probably lots of it.

At a minimum, you are going to want some *task lighting*, which helps illuminate the immediate area of your focus. In this case, where a small table is being used as a workbench, an articulated fluorescent lamp with a built-in magnifier will do a great job, at least until more lighting can be strung up. See Figure 5-7.

Figure 5-7. *You will need some task lighting for your bench. This desk lamp also includes a handy magnifier for really close work.*

Tools

Now we're ready to bring some of the tools back in to the lab. Here's where you get to decide which tools get a *permanent* home on the bench and which ones get put up and stored when not in use.

The permanently deployed tools on your workbench should be the ones that you find that you are using the most. The ones that get put up after every use are the ones that either only get used infrequently or pose some sort of hazard, such as sharp edges or hot surfaces. Again, you get to decide. It's your lab.

Tools for Soldering

An activity that is practiced frequently in many electronics labs is soldering. If you haven't learned how to solder yet, you are strongly encouraged to do so. Here's a handy setup for soldering, sitting in one corner of the newly refurbished workbench. See Figure 5-8.

Figure 5-8. *A temperature-controlled soldering station with a stand for the soldering iron, a water bottle to wet the tip-wiping sponge, and some different kinds of solder. Some people prefer to have the soldering station nearer to the front edge of the table. Use whatever configuation makes the most sense in your lab.*

■ **Caution** Soldering irons are hot and can cause serious burns. Do not place a soldering iron where you might accidentally knock it off the work table or brush against it.

Hand Tools and Some Test Equipment

No matter what you work on at the bench, you will most likely discover the need for some common hand tools. When working with electronics, especially, you will often need wire cutters, wire strippers, and small pliers. These tools have been laid out conveniently (for a right-handed person) at the lower-right-hand side of the bench, while the less-often-used hand tools can reside in a box.

A regulated, adjustable bench power supply is also very handy when working with electronics of all kinds. A good, reliable multimeter can also claim a permanent home on the bench, as these will get a lot of use. See Figure 5-9.

Figure 5-9. *A clean bench with just enough tools to have some fun. Extra soldering supplies, including more kinds of solder , extra soldering iron tips, soldering flux, and an emergency backup soldering iron, sit in a box adjacent to the soldering station. Hand tools and basic test-and-measurement equipment complete the set of "most-useful tools." There's still room for a few more, when you need them.*

Under the Desk

If your workbench has the luxury of drawers, by all means use them! Try to keep your under-desk environment as free of clutter as possible. It's not really a very convenient place to store unused tools or components. You're going to drop the occasional item from time to time, so having to dig out a bunch of junk just to find it is just going to be more frustrating for you. Keep it clean!

You *should* keep a medium-sized trash can under or near your work area, as you will inevitably generate some waste products in this hobby. By minimizing the amount of food-related garbage deposited in your laboratory trash receptacle, you can postpone the invasion of little critters looking for a free meal. Also, bits of wire and old components don't tend to stink after a few days, but a half-eaten sandwich might.

■ **Tip** Copper easily recycles at a premium price. Collect your copper wire snippings and cash them in someday.

A nice addition to the under-the-table accessories you might consider is some low-wattage strip lighting. LEDs are especially good for this. You will appreciate this more once you conduct your first search-and-rescue mission for that teensy-tiny component that dropped off the edge of your table and into the carpet.

Components

Most of our tools are now ready to go. The most frequently used tools are permanently set up, ready for action. The less frequently used tools are carefully stored where we can get to them when we need them, but are not in the way the rest of the time. This is a big improvement over the situation you saw back in Figure 5-1.

Now we need some components with which to work, using our scientifically arrayed tools. Have a look at Figure 5-10 to see one example of how to keep your parts organized yet within easy reach.

Figure 5-10. *Parts bins are used to organize components. This style of container is available in many sizes with different numbers and sizes of drawers. Even more parts are stored on a shelf behind the work area. The most commonly used hand tools are laid out on the right. The other hand tools are collected in a small toolbox on the left.*

Where to Go from Here

This work space could be further augmented with shelving, both above the work surface and underneath. More lighting wouldn't hurt, either. However, this is plenty to get started. Let's build some electronics projects on this squeaky-clean table and see if we can dirty it up a bit.

Projects

Let's look at a few smaller circuits you can easily build on your tidy, new work area using a solderless breadboard. Expanding on the LED-and-coin-cell experiments in Chapter 4, we'll add a few more components and hopefully start to see how they all interact.

There are any number of different types of solderless breadboards available today. A range of them is shown in Figure 5-11.

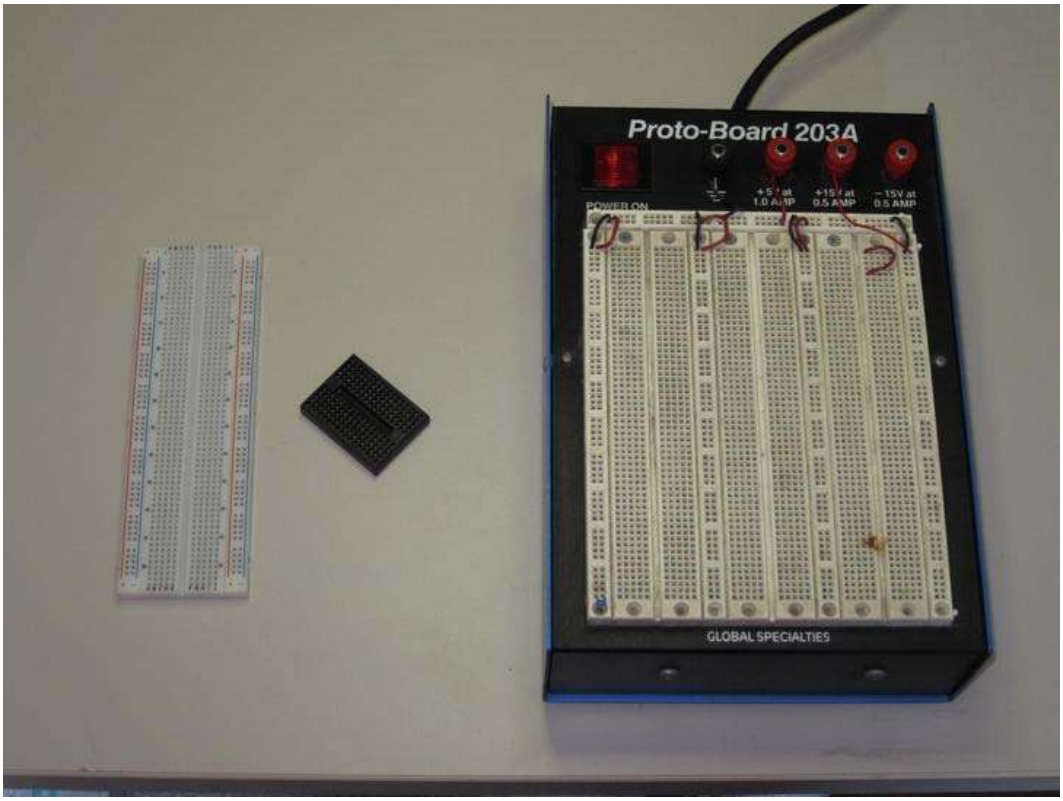

Figure 5-11. *Different sizes of solderless breadboards, all with the same lead pitch and internal connections. The small black unit in the center is perfect for little circuits with only a few small components. The white unit on the left has more tie points and offers power rails along each side. The deluxe, powered unit on the right adds even more space, as well as multiple regulated power supplies for all your tinkering requirements.*

Parallel and Series Circuits

The circuits presented so far have all illustrated the "loop" characteristic of electrical circuits. Electricity generally flows in a circle. It's possible to have more than one path through a circuit, however. What happens then?

Like most good questions, the answer is, "It depends." Let's hook up *two* LEDs at once and try to figure out exactly what's going on. Figure 5-12 shows how it's put together. See Figure 5-13 for the schematic diagram.

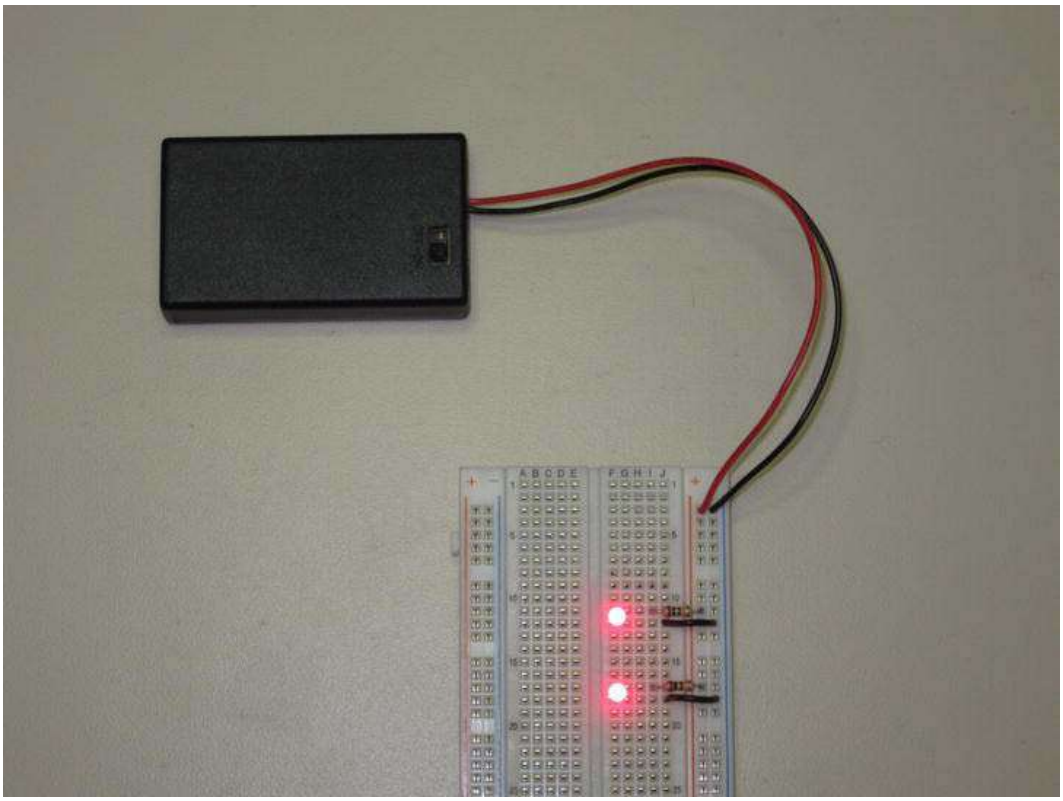

Figure 5-12. *Two LEDs are illuminated at the same time. This simple circuit demonstrates both parallel and series electrical circuits. A 3×AAA battery holder with an integrated power switch is used to provide power to the circuit.*

To build this circuit as shown, you will need the following components:

- A solderless breadboard with power rails
- A 3×AAA battery holder (which holds three AAA cells) and three fresh AAA cells—rechargeable cells are better
- Two LEDs (any visible color will do
- Two 100Ω 1/4W resistors
- Two short jumper wires

Using the letters printed on the breadboard to find the columns across the top and the numbers to find the rows, we can describe each of the tie points using a single letter and a number, such as A-1 or B-2. The following exercise shows how to put it all together.

ASSEMBLY INSTRUCTIONS

1. Install the top LED with its anode (longer lead) in tie point F-11 and the cathode in tie point F-12.
2. Insert one of the resistors from the red power rail on the right at row 11 across to tie point I-11.
3. Connect the right-hand blue power rail at row 12 to tie point J-12 using a short jumper wire.
4. Install another LED just below the top LED, with its anode in tie point F-17 and the cathode in F-18.
5. Install the other resistor from the right-hand power rail at row 17 across to tie point I-17.
6. Use another short jumper wire to connect the blue power rail on the right at row 18 to tie point J-18.
7. Install three fresh AAA cells into the battery holder.
8. Insert the red wire (positive) coming from the battery holder to the red power rail on the right at row 3 (the top).
9. Insert the black wire (negative) from the battery holder to the blue power rail on the right at row 3.
10. If your battery holder has a power switch, turn it on now.

The circuit is now complete. Please verify that both LEDs are illuminated, as shown in Figure 5-12.

Troubleshooting

If both LEDs are not shining at this point, you're going to have to do some troubleshooting.

- The first thing to do is double-check your wiring. Does your breadboard look like the one in Figure 5-12?
- Next, make sure you're using good batteries. If you have a voltmeter, you can test the batteries by measuring their voltage. New alkaline or carbon zinc cells should read 1.5V or more. Rechargeable nickel-cadmium (NiCd) or nickel–metal hydride (NiMH) batteries should read around 1.2V each when completely charged.
- Are the cells properly installed in the holder? Are they in the proper orientation and firmly seated?

- Is the power switch (if available) not in the On position? This happens more frequently than anyone would like to admit. Wiggle the switch back and forth and see if it's only making intermittent connection.
- Check the orientation of the LEDs. They will only work if installed in the correct orientation. It only takes a second to unplug them, swap them around, and try them the other way. At these low voltages, it won't hurt them to be installed backward.
- Are your resistors the right value? The 100Ω value is not critical. Anything from 100Ω to 1KΩ will do nicely. Don't use smaller values, as this will allow too much current to flow through the circuit, perhaps damaging the LEDs. How much current? We'll figure that out in just a bit. Larger-value resistors will decrease the amount of light emitted by the LEDs, down to the point where you can't see them anymore.
- Are you sure your LEDs emit visible light? Millions of infrared LEDs are manufactured every month for use in remote controls and night-vision gear. This light is not visible with the human eye, although some digital cameras can see it. Just because it looks like an LED doesn't mean it *is* an LED.

A Different View of the Same Thing

Your version of the circuit in Figure 5-12 might look a little different, and that's just fine. The important point is that both LEDs are lit up at the same time when you apply power.

Let's look at the traditional schematic for this circuit to get an idea of what's going on here. See Figure 5-13.

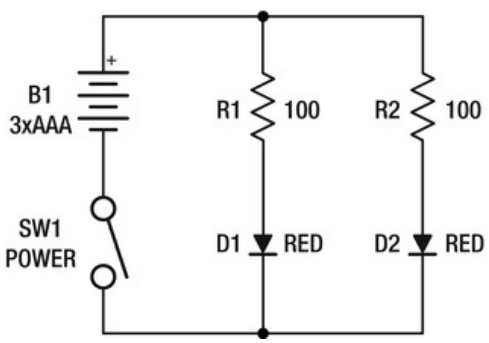

Figure 5-13. *The traditional schematic diagram of the two-LED circuit. This diagram should convey the very basic information needed to build the circuit, as well as understand the important aspects of how the circuit is supposed to work, without going into much detail at all about the actual implementation or assembly of the components.*

By now you should be able to look at the schematic and see the loop formed by the circuit. The only new twist is that there are *two* paths along which the electricity can flow, either through R1 and D1 (the top LED on the breadboard) or through R2 and D2 (the bottom LED, or the initials of a certain adorable robot from the movies).

The three AAA cells in the battery holder are shown as B1 in the diagram. The power switch, labeled SW1, is shown as a separate component to remind us that the circuit can easily be broken, halting the flow of electricity, which is something we want to happen from time to time. The connections between the two resistors and the two LEDs should be somewhat obvious. I'll discuss the details for the parallel and series connections momentarily.

Remember that an electronic schematic diagram is an abstract representation, boiled down to only the essential items involved and the relationships among them. As such, it doesn't need to resemble the final product, but it could. See Figure 5-14.

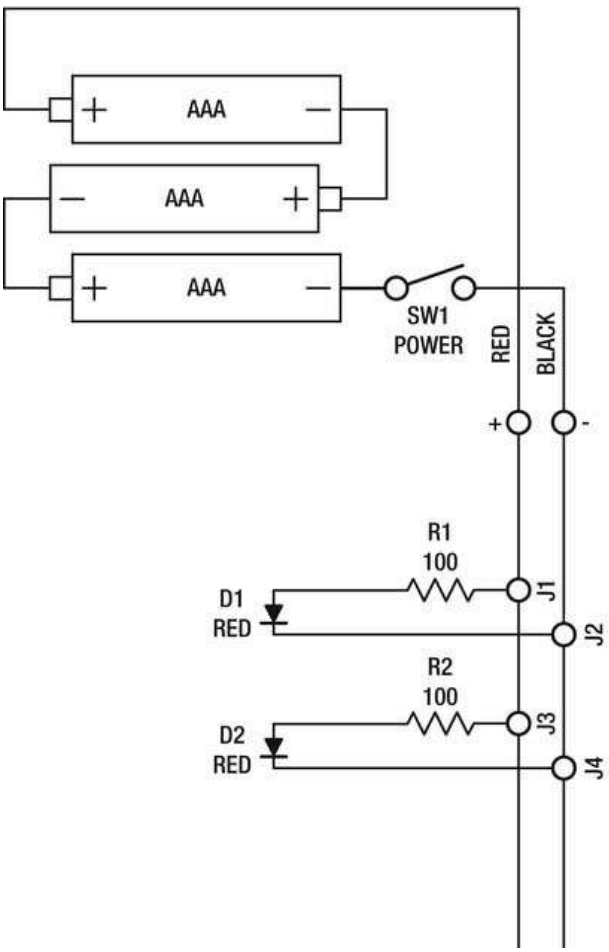

Figure 5-14. *Another schematic diagram of the two-LED circuit, showing the approximate physical layout of the components on the solderless breadboard. This style of schematic is often used when describing how to actually build a circuit, showing the constraints of the actual, physical components and the connections between them. It conveys more specific information than the previous example in Figure 5-13.*

Batteries in Series and Parallel

Let's look at the batteries first. Technically, as mentioned in Chapter 1, there is one *battery* in this circuit, and it happens to be composed of three *cells*. The term *battery* is very often used interchangeably with *cells*, and the distinction is minor. It's better to avoid confusion than it is to be exactly, precisely *correct*—usually.

We see three cells sitting side by side in both the schematic in Figure 5-14 and the actual battery holder shown in Figure 5-12. The cells are connected *in series*, meaning that one connects to another that connects to another, and so forth. They are like beads on a single wire. You should be able to trace the wiring (the solid lines) that connects the individual cells in the schematic.

Note the polarity of each of the cells within the battery. The positive terminal of the bottom-most cell is wired to the negative terminal of the center cell. The positive terminal of the center cell is connected to the negative terminal of the topmost cell.

The negative terminal of the bottom-most cell is connected to one side of an *SPST (single-pole, single-throw)* switch. The other side of the switch emerges from the battery holder's body as the black, or negative, lead from the battery pack. The positive terminal of the topmost cell connects directly to the red, or positive, lead coming out of the battery pack.

The switch could have just as easily been installed in the positive lead, and it would have worked exactly the same. The battery holder used in the photograph happens to switch the negative lead, as was revealed by examining the internal wiring using a multimeter as a continuity tester.

When the switch is *open* (i.e., in the Off position), the circle is broken and no electricity is going to flow. When the switch is *closed*, the circuit is complete and power is made available to the remainder of the LED circuit, assuming that it is wired up correctly.

The amount of *voltage* being supplied by the battery holder depends on the electrical characteristics of the individual cells. If alkaline batteries are used, each cell will provide 1.5V, assuming that the cells are relatively fresh. Rechargeable NiCd or NiMH cells will provide around 1.2V when fully charged.

When batteries like these are connected in series, the total voltage available is the sum of each of the cells. Just add all the voltages together. For example, using fresh alkaline batteries, the total voltage would be 3 × 1.5V = 4.5V. Rechargeable cells would provide 3 × 1.2V = 3.6V when fully charged.

If the cells were wired *in parallel*, with all of the positive terminals being connected together and all of the negative terminals wired together, the total output voltage would only be 1.5V for alkaline cells. The total output *current*, however, would be triple the capacity of each individual cell. See Figure 5-15 for a comparison of series, parallel, and combination circuits using batteries.

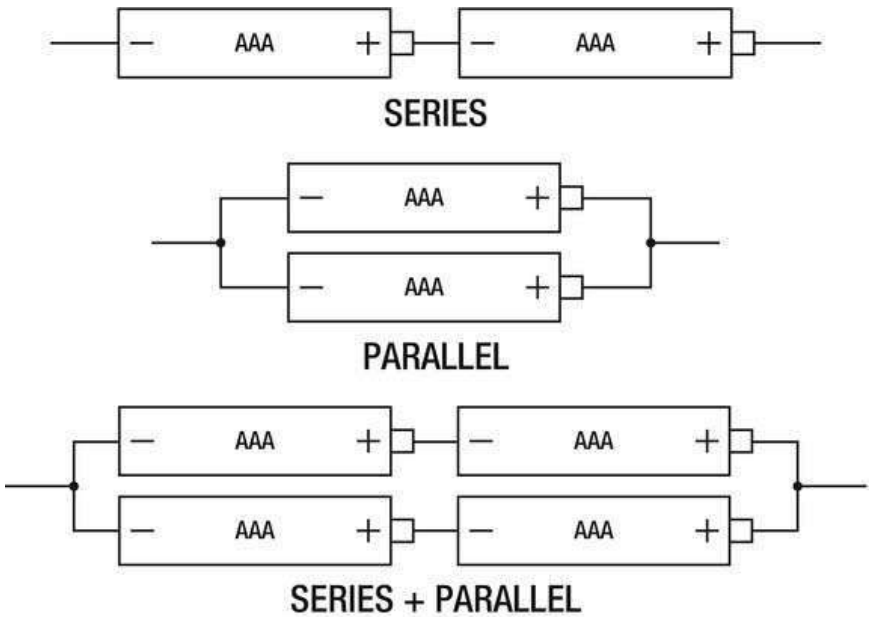

Figure 5-15. *Different arrangements of the wiring of the batteries produce different results. The top two cells are arranged in series. Their respective voltages are added together. The center circuit consists of two cells arranged in parallel. This configuration doubles the current that can be delivered. The bottom drawing shows a combination of both series and parallel circuits, doubling both the voltage and the current.*

When connected in series, the total current output is the same as the current capacity of each individual cell.

In summary, if you need more voltage, stack the cells end to end. If you need more current, stack them side by side. Even more complex arrangements are possible, using both parallel and series circuits to achieve the desired power output characteristics. This practice is very common in hobby model aircraft and battery-powered vehicles. A designation such as 3S2P means that there are two parallel circuits (2P) of three cells in series (3S).

Looking back at the circuit in Figures 5-13 and 5-14, we see that the "battery" used in this circuit consists of three cells in series. This means that if alkaline batteries of 1.5V each are used, the total voltage available to the circuit is 4.5V. If typical rechargeable cells (NiCd or NiMH) are used, we can expect 3.6V to flow through the circuit.

Switches in Series

The power switch, labeled SW1 in the schematic, is *in series* with the rest of the circuit. As mentioned in the previous section, when this switch is open, no current flows through the circuit at all. The switch is intentionally placed at this location in this circuit to act as a bottleneck. When the power switch is turned off, no power flows through the circuit. That seems like a good idea, considering the desired operational goal.

The schematic symbol for SW1 shows a pretty good likeness to the internal wiring of any simple SPST switch. There are two terminals, and a conductor that can be moved to either electrically connect them or electrically isolate them. As drawn, the switch is in the open position.

If we added another identical switch in series with the existing switch, what would happen? Take a look at Figure 5-16.

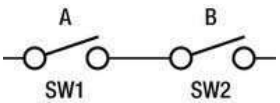

Figure 5-16. *Two switches in series. Both switches must be closed for electricity to flow through this part of the circuit. If either switch is open, the circuit is broken and no current will flow.*

Both switch A (SW1) and switch B (SW2) must be moved to the closed position for any electricity to flow through the circuit. If either switch is opened, then no current will flow. This is sometimes referred to as an *AND* circuit. Both A *and* B must be on for the circuit to operate.

A circuit just like this is often used in security systems. Switches are attached to doors and windows. All of the switches are wired in series, forming a large loop. The switches are all configured to be closed when the doors and windows are closed, and to open when doors or windows are opened.

If all the doors and windows are closed, then the loop of switches will allow the flow of electricity. Although it sounds exactly *backward*, when electricity is flowing in the circuit, this keeps the security alarm *turned off*. When any one of the switches is opened, the circuit is broken. The alarm then sounds.

Most real security systems are more complex than this, of course. The main advantage of this particular configuration is that it is easy to install and requires the least amount of wiring. The chief disadvantage is that when the alarm is triggered, you have no idea exactly *which switch* caused it.

Switches in Parallel

Just like with batteries, switches behave differently when configured in a different manner. Let's connect two switches *in parallel* this time and see what happens. See Figure 5-17.

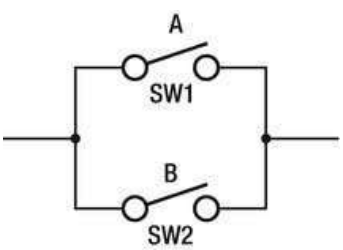

Figure 5-17. *Two SPST switches in parallel. If either one of the switches is closed, then power can flow through this part of the circuit. Both switches must be opened to stop the flow of current.*

The circuit in Figure 5-17 will conduct electricity if switch A (SW1) *or* switch B (SW2) are closed. To stop the flow of current, you have to open both switches. This can be used as a simple *OR* circuit. If switch A *or* switch B is closed, then power can flow through the circuit.

Looking back at the schematics in Figures 5-13 and 5-14, we see that SW1 is in series with the rest of the circuit. This makes it a very effective way to turn power on and off from a single location. Handy!

The Three-Way Switch

You might think that the circuit shown in Figure 5-17 could be used to turn lights on and off from two different locations. You would be partly correct. You could turn lights *on* from either switch location, since flipping either switch to On will cause current to flow and lights (or other appliances) to operate.

Unfortunately, you would not be able to turn *off* the light from either switch if the other switch were on. So this configuration is good for turning lights on but not off. A slightly more complex arrangement is required to do both.

We will need two switches, as before, but they will need to have a little more functionality to accomplish what we've set out to do. Instead of a switch that's either open or closed, we need a switch that alternates between two different routes, depending on how it is positioned. This type of switch is called a *double-throw* switch, as it connects a *common* terminal to either one of two different terminals. It can be *thrown* in two different directions. This should be much easier to understand when looking at a schematic symbol. See Figure 5-18.

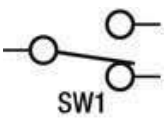

Figure 5-18. *A single-pole, double-throw (SPDT) switch. The common terminal on the left side is connected to either the top or bottom terminal on the right. Variations of this type of switch have a neutral position in the middle. Push-button (i.e., momentary contact) versions of this switch will label the two right-side terminals as either "normally open" or "normally closed," depending on the physical configuration of the switch.*

Now comes the clever bit. We'll connect a pair of these switches together by tying the two non-common terminals on one switch to their counterparts on the other switch. This results in four possible combinations of switch positions (both down, one up, the other up, and both up). Two possibilities turn the light on, and the other two turn the light off. The important point is that the "on" or "off" state of the entire circuit can be changed from either location, independently of the state of the other switch. Problem solved! Again, this should be easier to see when presented as a diagram. See Figure 5-19.

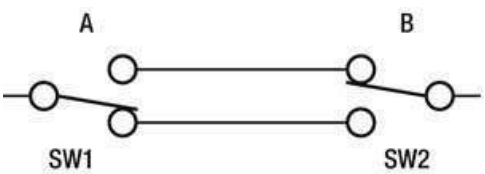

Figure 5-19. *A three-way switch circuit built using two SPDT switches. Power is either carried by the upper wire or the lower wire, as long as both switches are in the same position. If not, then no power flows across this part of the circuit. As shown, the three-way switch is effectively off. Flip either switch to turn it on.*

If you ask a real electrician how to wire a three-way switch, you'll get several answers, or more likely, you'll get, "It depends." That's because *it really does* depend on the actual wiring situation. Sometimes the power is routed through one or the other of the two switches, and sometimes the power is routed through the load. Each of these scenarios requires a different routing of wires and connections.

You are strongly advised to consult a real electrician concerning wiring in your house, where your family, pets, and all your stuff live. Less-than-perfect wiring causes fires or electrocution, which are both very unpleasant ways to die.

■ **Caution** This book does *not* teach you how to wire electricity in your home. Consult a professional.

Resistors in Series

Just like batteries and switches, resistors perform different functions in a circuit depending on their configuration. Let's look at using resistors *in series* first, and then consider using them in parallel later. Both combinations have their uses, as you will see.

Let's look at just a small part of the schematic that we've been working with so far in this chapter. See Figure 5-20.

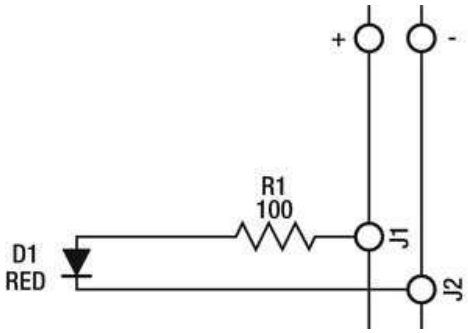

Figure 5-20. *One part of the circuit showing an LED, a resistor, and the power rails from our solderless breadboard. The resistor and LED are connected in series. The battery and power switch are not shown.*

LED Curiosities

D1 is an LED. It is a polarized component and will only work when installed in the proper orientation. The schematic indicates a red LED should be used, but feel free to use whatever color LED you like or happen to have available. The triangle shape of the schematic symbol helps remind us of the direction of *conventional current* through the device. The actual flow of electrons is the other way, but that's only because electrons are negatively charged particles and do everything backward. Apparently this was not well understood when electricity was first being tamed for our use.

LEDs are fascinating devices, emitting light in a wide range of colors, coming in an astounding array of shapes and sizes, and generally requiring very little power to operate. They are almost as easy to use as incandescent bulbs and are certainly more power efficient.

Being semiconductors, however (which leads to their being semimagical in their inner workings), LEDs generally only operate correctly within tightly bounded parameters. For example, a typical LED will only need between 2 and 3V to shine quite brightly. Incandescent lightbulbs, on the other hand, can operate from less than 1V to many hundreds of volts, depending on their construction and intended purpose.

While LEDs have a minimum *forward voltage* requirement that must be met for them to work at all, the brightness of an LED is determined solely by the amount of current flowing through it.

LEDs Have No Self-Control

In addition, LEDs have no internal, inherent mechanism to limit the amount of current flowing through them. Incandescent bulbs, when cold, have a low internal resistance, allowing much current to flow through them when connected to the right power supply. Remember that less resistance means more current can flow, and vice versa. This resistance almost instantly goes way up as the filament of the bulb glows white hot. The filament itself then becomes the limiting factor in how much current flows through the bulb, usually stabilizing at the proper power level.

LEDs have no such sense of self-control. They will conduct as much current though themselves as you are willing to provide, up to and beyond the point where the internal heat generated by the small amount of resistance they do possess causes them to literally burn up. In general, it's usually the tiny, almost microscopic internal bond wires that fizzle out, not the actual LED chip itself. However, dead is dead, and LEDs are generally considered to be "unrepairable" subassemblies. (Believe it or not, that's the correct technical term, even though it's not the correct English word—*irreparable* is the correct term when speaking of non-electrical things).

Care and Feeding of LEDs

The simplest possible solution to this ~~problem~~ opportunity for excellence is the use of a *current-limiting resistor* in series with the LED. Recall that a resistor will resist the flow of current in a circuit. The resistor used in this circuit, R1, is indicated to exhibit a resistance of 100Ω.

Let's say that D1, the red LED in our circuit, requires 2V in normal operation. This is pretty common for red LEDs. Generally speaking, the forward voltage requirement for LEDs goes up as you get farther up the color spectrum. Blue LEDs, for example, often require 3.0V to 3.6V to operate.

If we're using rechargeable cells in our prototype (and we really should be, you know), we can expect 3.6V to be made available to the resistor-plus-LED loop within our circuit. If 2V is needed for the LED, where are the rest of those volts going?

The answer is that they are being used to heat up the current-limiting resistor R1. Resistors turn current into heat. That's what they do. They do it, however, in a very precise and predictable way, which makes it easy for us to calculate how much current, voltage, and heat will be churning around in our circuits.

■ **Caution** Third-grade arithmetic ahead: Addition, subtraction, multiplication, and (shudder) division. You have been warned.

If we started with 3.6V, and two of those volts are being used by the LED, then our good friend Subtraction tells us that we've got 1.6V flowing through R1. For a thorough explanation of why this happens the way it does, feel free to look up Kirchhoff's Voltage Law. It basically says that all the voltages in a circuit end up being equal. The voltage across the resistor and LED will equal the battery voltage. The voltages within the LED-in-series-with-resistor circuit add up, just like battery voltages add up in series.

If we know the voltage across R1 (1.6V) and the resistance of R1 (100Ω), then we can use Ohm's Law to calculate the current flowing through R1. Reviewing what you learned in Chapter 3 about the predictable and inviolable relationships between voltage, resistance, and current, you can see that I = E / R (i.e., current equals voltage divided by resistance), where I is the current in amps, E is the voltage in volts. and R is the resistance in ohms.

It's not that hard! It sounds much worse than it actually is. The answer is 0.016A, or 16mA (1.6V/100Ω). That's the teeny-tiny amount of current needed to light up a typical red LED. Most small LEDs can handle up to 25mA safely, and some can handle much more than that, especially if they are intended for illumination purposes.

One quick side trip to multiplication land and we'll know everything we need to know about R1 in this circuit. While the schematic specified the resistance of R1 as 100Ω (the primary characteristic or component *value*), nothing was said about the power-handling capability of this component.

Power is calculated as voltage multiplied by current. That's all there is to it. We know the voltage: 1.6V. We know the current: 16mA. We multiply them together to get 0.0256W (watts), or almost 26mW. Remember that you have to enter the current as 0.016 because the formula calls for the number of *amps*, not milliamps.

Not quite 26mA is not quite much of anything. You will not be able to tell that the resistor is shedding all those extra volts as heat with your fingertip. It might not even register with a sensitive thermometer. It's just a really tiny amount of power. A typical small resistor (a 1/4W resistor) will handle 250mW of power, which is almost ten times what is needed in this application.

■ **Tip** It's always a good idea to calculate the power requirements of your components, just so you're not *too* surprised when the magic smoke leaves the circuit, rendering it crispy and nonfunctional.

OK, we're back from the frightening land of multiplication. It wasn't *that* bad was it? The remainder of understanding resistors in series depends only upon the science of addition. Counting on your fingers will be good enough.

We can change the brightness of the LED by changing the amount of current flowing through it. We can change the amount of current flowing through the LED by either raising the supply voltage or by changing the resistance of R1. Since we can easily substitute any other value of resistor for the 100Ω resistor with which we began, this is easy to do. Just don't go *too low* in resistor value, as this will allow *too much* current to flow through the LED, possibly damaging it permanently.

Adding resistors in series adds their resistances together. For example, if you placed two 100Ω resistors end to end, the total resistance across them would be 200Ω. That's really all there is to it: 100Ω + 100Ω = 200Ω.

If you perform this experiment with the LED circuit we built on the breadboard, you can see that the LED will not shine as brightly as it did before. This is because the resistance has doubled, which means, all other factors remaining the same, that the current through the LED has been cut in half. Half the current results in half the brightness, since LEDs are controlled by the amount of current flowing through them.

What's interesting about this arrangement is that the power-handling capacity of the two resistors is *also* double what it was when only one resistor was in the circuit. This is because each resistor is now dissipating half the power when compared with the previous scenario. If two 1/4W resistors are used in series, they can together safely dissipate up to 1/2W of power, although pushing any component to 100 percent of its capacity is just asking for trouble, especially when heat is concerned.

By connecting resistors end to end, you add their resistances together, as well as their power-handling capabilities. By keeping a small variety of basic values on hand (e.g., 1Ω, 10Ω, 100Ω, 1KΩ, 10KΩ, etc.), you can easily stack up the right combination needed for almost any electronic application. This is the method used in the very handy device known as a *decade resistor* or *decade box*, which has dials for each digit in the desired resistance, allowing you to dial up any value of resistor needed.

Extra credit: If you've followed along this far, consider researching voltage dividers built using only resistors.

Resistors in Parallel

What happens when resistors are connected side by side instead of end to end? That's where things get interesting, at least from a mathematical point of view.

An easy way to look at parallel resistors is to think about the amount of current flowing through each one, and then add them all up. See Figure 5-21.

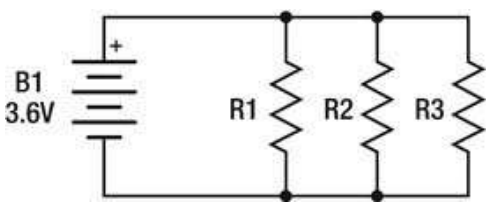

Figure 5-21. *Parallel resistors each conduct a portion of the total current flow through the circuit. Each resistor allows a certain amount of current to flow. The sum of their currents can be calculated if their individual resistances are known.*

Let's assume that R1, R2, and R3 have resistances of 100Ω, 200Ω, and 300Ω, respectively. The total resistance of the circuit across the battery terminals is *not* 600Ω, as would be the case if they were in series instead of parallel. The total resistance is less than 100Ω, which is the least of the resistors. How can this be?

First, let's think in terms of how much current is flowing in each of the three parallel pathways within this circuit. If B1 is putting out 3.6V, and R1 is 100Ω, then we know to use Ohm's Law to calculate the current, with I = E / R. In this case, I = 3.6V / 100Ω = 0.036A, or 36mA. *In addition*, the path through R2 is drawing half that (because R2 is double the value of R1—get it?), or 18 mA. *In addition*, the final pathway is drawing one-third as much current as the first one, or 12 mA. Just to verify: I = 3.6 / 300Ω = 0.012A, or 12mA. Everything checks out.

Now add all those currents together: 36mA + 18mA + 12mA = 66mA. That's the total current, using this method. Again, since we know both the voltage and the current, we can find the *effective* or *equivalent resistance* of all three resistors in parallel, as if they were one single resistor. Rearranging the formula for Ohm's Law, we find that R = E / I. In our case, R = 3.6 / 0.066A = ~54.55Ω. See? Smaller than 100Ω, somehow.

Thinking about the individual *currents* flowing through each resistor is the same as adding the current-supplying capacity of battery cells together when arrayed in parallel. Just add them together. However, we had to calculate each current separately and then add them together. There is a more direct way, depending upon how you look at things, but beware: it involves not only *fractions*, but *fractions upon fractions*. Oh, the horror.

■ **Note** Some people don't dig math. Weird, but true.

Here is the equation for calculating the total resistance (R_T) of three resistors in parallel (R_1, R_2, R_3):

$$R_T = \frac{1}{\left(\frac{1}{R_1}\right) + \left(\frac{1}{R_2}\right) + \left(\frac{1}{R_3}\right)}$$

The good thing about this equation is that you don't need to know what the supply voltage is to get the correct answer. All you need to know are the values of the resistors. If you need to use more resistors, just add more terms to the equation.

Calculating the value of parallel resistors occurs quite frequently when designing electronics. Some special cases are simple enough to do in your head. For example, if two identical-value resistors are placed in parallel, their combined resistance is half the value of each individual resistor. That is, if you placed two 100Ω ohm resistors in parallel, their effective resistance would be 50Ω. Similarly, if you have three identical resistors, the net resistance is one-third the value of each constituent resistor. Make sense? These are special cases of the general equation just shown.

This happens so much that an alternate notation method has been developed: $R_T = R_1|R_2|R_3$. This is not often used for hobby electronics, however.

The power-handling ratings of resistors are added together, so if you have two 10W resistors in parallel, the net power-handling capacity is now 20W. At least that part was easy.

Capacitors in Series and Parallel

Capacitors are completely different from resistors. When calculating their values in series and in parallel, you have to use *exactly the opposite* methods. Isn't electronics interesting?

The values of capacitors *in parallel* are added together. This makes them much more like batteries in parallel than resistors. However, you still have to use the fractions-upon-fractions method to calculate the value of capacitors in series.

Again, some shortcuts are available. Two identical capacitors in series have *half* the capacitance of each individual capacitor, but *double* the working voltage, which is the maximum voltage they were designed to withstand before failing.

Inductors in Series and Parallel

It gets more interesting, believe it or not. Inductors act like resistors as far as adding their values together in series and taking the reciprocal of the sum of the reciprocals of their values in parallel, but *only* when the magnetic fields of all of the inductors involved do not interfere with each other. If the magnetic fields generated when current flows though the inductors overlap, then you have to factor in their *mutual inductance*, which starts to get complicated.

Extra credit: Figure out how all that works and let me know.

LEDs in Series and Parallel

You learned (or were reminded of) a few of the basic characteristics of LEDs in the previous section, although it was really to help illustrate the operation of resistors in series and parallel. A couple of major oversimplifications were introduced to help concentrate on the resistor. We'll address a couple of these issues here.

Lighting up a single LED using a battery and a fixed current-limiting resistor is fun, but it's pretty basic stuff. Lighting up a *lot* of LEDs is where it gets to be a *lot* of fun. To do so, you need to learn a little more about the weirdness that is *semiconductor*.

LEDs are diodes (*LED* stands for *light-emitting diode*, after all). Diodes are semiconductors and are made by elves in a hollow tree. Semiconductors do not have nice linear voltage-to-current curves.

For the purposes of simplicity, in the previous section, it was suggested that LEDs have a certain minimum voltage that they need to operate. This is called their *forward voltage*, and is sometimes referred to as their *voltage drop* within a circuit. So far, this is all true. You can find an LED's forward voltage specification in the data sheet published by the manufacturer.

What you'll find, when you look, is that every manufacturer only publishes a *range* of voltages, such as 1.8V–2.2V, giving a minimum and a maximum voltage. This is what they are contractually obligated to deliver in their product. Anything outside of this range is considered *defective*, or at least out of tolerance. You might get a good deal on "rejects" that fall outside these parameters but still light up quite nicely. Such is the provenance of many of the penny LEDs available from overseas. Yes, they exist. And yes, you get what you pay for.

There are two reasons why LED manufacturers are being so deliberately vague in their specifications. The first is that process variations are going to produce a certain randomness to these values. One batch might be identical to the next batch, but then the third batch might be all over the place. Such things happen.

The second reason is where the real weirdness begins. Forward voltage is not a fixed value in any given device, but instead increases as the current increases. Again, this increase is *nonlinear* and cannot be calculated with a simple formula.

The best way to demonstrate this to yourself is to connect an LED to a power source via a variable resistor, such as a potentiometer. For the protection of your LED, add a fixed resistor in series with the potentiometer so that you establish a maximum current level, even when the potentiometer is turned all the way up (i.e., has almost zero resistance).

Now apply power and adjust the potentiometer until the LED just barely lights up. Now measure the voltage across the terminals of the LED, using a voltmeter. It should be in the neighborhood of 2V–3V. For extra credit, measure the current flowing *through* the LED, using an ammeter. This measurement will most likely be less than 1mA.

Compare these readings to what you find when the LED is at full brightness. The forward voltage across the LED goes up as the current goes up. To map the nonlinearity of this function, you would need to record many readings of both voltage and current, and then plot them in a graph.

Just as you can wire resistors, capacitors, and inductors in series and in parallel, you can do the same with LEDs. As with resistors, the forward voltage of the LEDs are added together when arranged in a series circuit. This raises the minimum voltage required to light up a string of LEDs in series. This means that you can't light up ten LEDs in a single string using a 9V battery. You have to first overcome the minimum forward voltage just to get any current at all flowing. Then you have to up the current to get the desired brightness, which simultaneously raises the total forward voltage through the circuit. You still need a current-limiting resistor in this circuit—but only one is needed. You don't have to have one for each LED.

The amount of current flowing through the string of LEDs is determined by the supply voltage, the cumulative forward voltage of all the LEDs, and the resistance of the current-limiting resistor. The same

amount of current is flowing in every part of the circuit. If 25mA is being drawn from the power supply to light up your single string of LEDs, that means that each and every LED has 25mA of juice flowing through it—more than enough to light them up quite nicely.

If you have a 12V power supply (or a car battery), you could string up to five or maybe six red LEDs in series, with a small current-limiting resistor. That's because each red LED will typically have a forward voltage between 1.8V and 2.2V. Other colors higher up the rainbow might need more voltage per LED, meaning fewer can be lit at once using a single string of LEDs in series.

But don't fret. You can light up as many LEDs as you want by placing multiple strings of LEDs in parallel with each other. Each additional string of LEDs adds to the total current draw, so you will eventually find a limit along that dimension as well. For an example of a small LED array using both parallel and series circuits, see Figure 5-22. The schematic is shown in Figure 5-23.

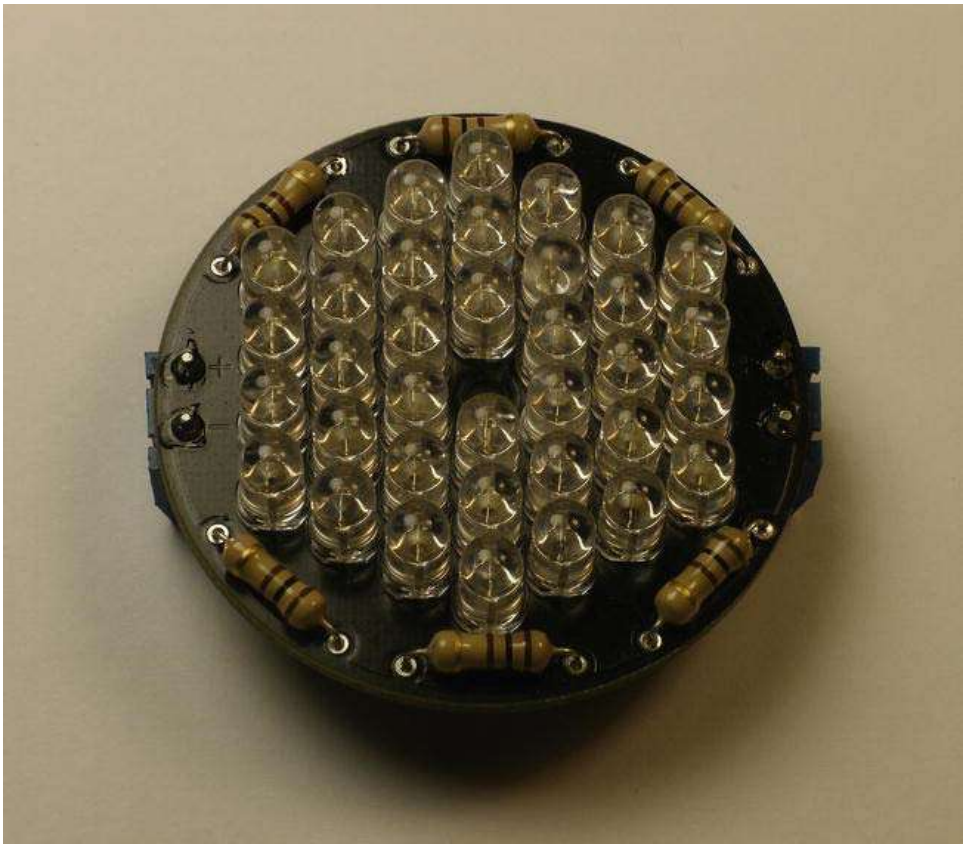

Figure 5-22. *An array of six parallel strings of six infrared LEDs in series. These infrared spotlights are used for covert surveillance and security applications.*

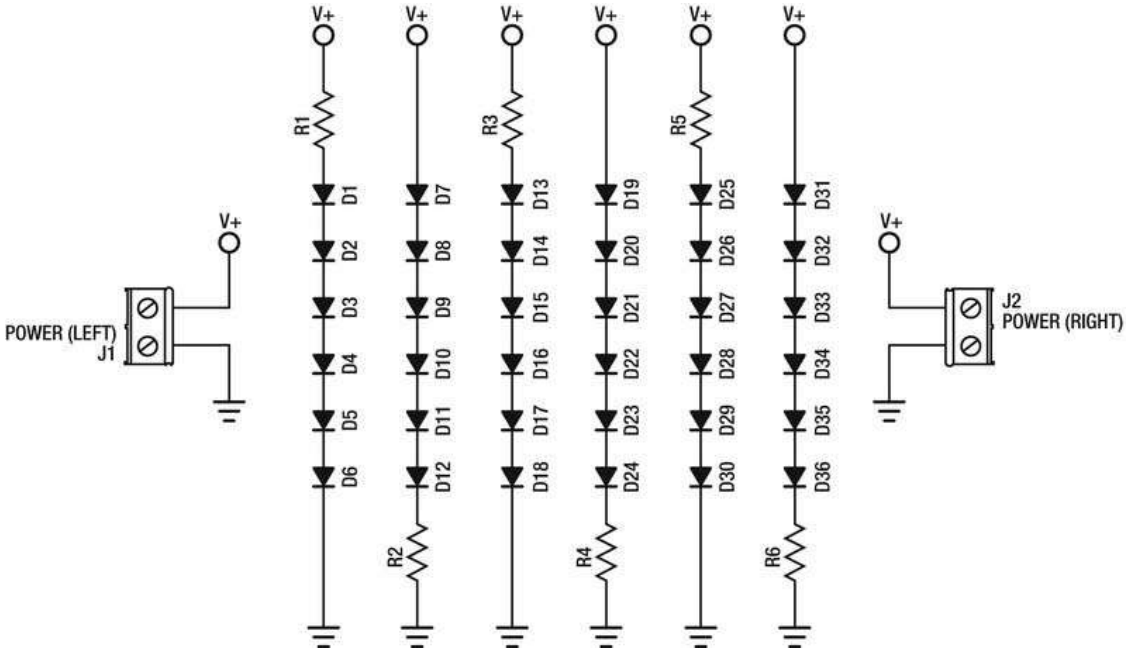

Figure 5-23. *The schematic of the LED array, showing both parallel and series circuits. The circuit offers two power connectors to make it easy to wire multiple LED arrays using the same power supply.*

Summary

Even if your workbench doesn't look as bad as the one presented at the beginning of this chapter (or even if it looks *worse*), hopefully you've learned a thing or two about the importance of they saying, "A place for everything and everything in its place." Since *you* get to decide where everything goes, you can either make it easy or hard on yourself as the years go by.

The workspace in this chapter extended to a total of 10 square feet. If this is what you have to work with, you can certainly set up a comfortable, safe, and productive area for your electronic projects. If you have even more space available (adding a shelf either above or below the desk is a great way to do this), then even better.

Hopefully some of the more detailed descriptions of how electronic components can be wired up have given you some ideas for projects of your own. The very best possible way to learn more about electronics is to think up some simple experiments and try to build them in your lab. Have a goal, take lots of notes, and have some fun—even your failures can be used as stepping stones to more ambitious and creative projects in the future.

Have a *lot* more room? Then perhaps you should be thinking about setting up a group lab or classroom. Chapter 6 will give you some helpful advice about what you are going to need to get started. See you there!

CHAPTER 6

The Small Group Lab and Classroom

The first part of this book covered what you need to know to build your own personal electronics lab. Now it's time to share the love with your fellow electronics enthusiasts. Where to begin?

Like most important questions, the answer remains, "It depends." What resources are available to you and your group? How many folks will likely want to be working together, and for how long? How well do you really know these people? And these are just a few of the questions you're going to encounter along the way.

Take the time to understand exactly who "you" (plural; in Texas, *y'all*) are and what your requirements and goals could be. By doing so, you map out the future of your successful facility. Likewise, *not* planning ahead or making reasonable assumptions about your needs is simply an invitation to problems, problems, and more problems. Who wants *more* problems?

■ **Tip** If you fail to plan, you plan to fail.

Know Yourself

The ancient Greek maxim "know thyself" has as many definitions as it has authors, it seems. Plato indicated in several of his dialogues that Socrates would use this phrase to admonish his students to learn more about themselves and their own characters and capabilities before attempting to figure out the rest of the universe. Wise advice then and now.

As far as knowing yourself in relation to setting up a shared electronics lab, you should first think about what role *you* are going to play in this endeavor. Yes, *you*. Here are some of the major ones, and you might end up being all of them at some point.

Facilitator or Coordinator

In the role of the facilitator, you plan on providing an environment for others to use for their projects and explorations in electronics. You may or may not partake in these activities yourself, but have been tasked with (or volunteered for) the organization and coordination of the lab.

It's critically important to understand the needs of your intended ~~lab monkeys~~ users. See the "Know Your Group" section later in the chapter for more information on this topic.

As the lab facilitator, lab workers will come to you with questions, requests, comments, and complaints. Be prepared to address their needs in a responsive and professional manner—even if they're just your cousin.

Your responsibilities will include

- Communicating the scope of the lab (i.e., deciding what *is* and what *is not* acceptable or expected)
- Publishing any important information or updates regarding location, available times, features, rules, and possibly ongoing projects
- Crafting policies involving safety, proper tool usage and training, and participant conduct
- Maintaining supplies of commonly used materials
- Inspecting and repairing tools as the need arises

To balance out your responsibilities, you should be granted adequate authority in the following areas:

- Characterizing the scope of the lab, based on present and anticipated future needs
- Enforcing the policies of the lab
- Budgetary discretion in acquiring, provisioning, and maintaining lab assets
- Granting or revoking access to the lab based on established parameters

If you're going to be the Keeper of the Lab, then you should have both a personal interest in keeping it in good shape as well as the wherewithal to decide how things should be done.

Good luck finding the right balance there.

Teacher or Presenter

Let's assume that your lab has already been set up (or can be set up in a jiffy), and your main goal is to present information or teach classes there. Again, it should be apparent that a good knowledge of your intended audience will play a vital part in your success. See the "Know Your Group" section for more information.

Once you understand the needs of your class and the goals of your presentation, the next step is to leverage the existing facilities to your best advantage. Will you need specialized presentation equipment or materials? If so, see what is already available, and then make a shopping list of everything else you will need. Examples include lighting, a projector, specialized power distribution, and test equipment.

Are you making an interactive presentation? If so, what materials will you need to provide for your students to be able to fully participate in your presentation?

What will be your optimum teacher-to-student ratio? If you have a simple message that's easily communicated and reinforced, a single speaker can effectively address a rather large crowd. Once you start adding layers of complexity to the subject matter, you're going to have to be prepared to backtrack and explain things in more detail from time to time. If you're leading a group through a technical exercise, it's often profitable to have assistants available to help just those individuals that need a little more help, without having to stop the class in its tracks. These assistants need to be up to speed on the subject matter as well as have good communication and troubleshooting skills.

Remember that students look to the teacher for leadership, not only as a subject-matter expert. Take the lead, set a good example, and share your enthusiasm for your topic with your students.

A successful teacher leads a class on a journey of discovery. Make sure you don't lose too many along the way.

Participant

Your goal as primarily a group lab participant is to make effective use of the facilities at hand, making the most of your time and energy. Having access to a well-stocked lab with a good array of tools can be a decided advantage for both your immediate project goals, and it can be an excellent opportunity to accelerate your knowledge of electronics and other mysterious arts.

Imagining yourself as an active participant is the best perspective when laying out the flow of your lab. Set up workstations that have almost everything you need, leaving room for the complex or specialized stuff elsewhere. There are more suggestions about specific workstation configurations in the "Workstations" section of this chapter.

While the active-participant model helps you squeeze out the maximum utilization of your lab, be sure to consider the sort-of-working-but-also-sort-of-goofing-off model. Not everyone wants to be working full-tilt all of the time. Leave room for a certain amount of idleness, contemplation, and whimsy. You might be surprised at the results.

Observer

You want to be in on the action, but not necessarily working on anything in particular. That's great! Don't underestimate the importance of the purely social aspects of technical gatherings.

Some people just like to hang out with other like-minded individuals. This is a good thing—when resources and circumstances allow it. Watching creative, talented, and driven folks working on projects with passion is very often the best kind of inspiration. Let your kids see you having fun and making cool stuff in your lab, and the next thing you know, they are going to want to be there whenever you are. Pretty soon, they are going to want to start working on projects of their own—and that is its own special reward.

Know Your Group

Now you know a little bit about who you are and what your expectations of your lab may be. Now it's time to get to know the group of people who will most benefit from access to the lab.

Identify the needs and requirements of your group by first identifying *precisely* who your intended audience is going to be. Knowing this one item, up front, before any big plans are laid, is the best way to ensure success down the road.

There are several broad categories for which you might need to prepare. The more you know about your particular group, the better. Let's start fairly close to home and expand outward.

Your Family

Once you've established your own electronics lab at home, it's great to be able to share some of the fun with those that are closest to you. This might be your children, parents, siblings, or extended family. A well-planned and well-maintained electronics lab is going to generate some interest, or at least some curiosity. Here's how you can carve out some room for them, while still being able to get things done yourself.

It's very natural to want to share your hobbies and interest with others, and a safe and well-stocked electronics lab is a great place to do so. This is an especially ripe opportunity for parents to pass on their knowledge, skills, values, and work ethic to the next generation.

The family lab can be a logical extension of the family home. Everything is shared, including responsibilities and privileges. In more agrarian societies, this is already well understood at an early age, where chores around the farm and in the fields and a respect for the tools being used help enhance a sense of group belonging and worth. Everyone has a stake in the prosperity of the family endeavor.

Do you want your kids to appreciate what you give them? Then give them chores before you give them presents. Let them clean up the lab, put away tools, inventory parts, and take out the trash before spoiling them with all the fun stuff you get to do in the lab. This will help foster a sense of ownership in the long-term success of the lab, whether you're there to supervise or not.

It bears repeating (from Chapter 4) that no unsupervised children, no matter how adorable, should be allowed in the lab. Would you allow unsupervised cooking in the kitchen? It's the same basic scenario. When everything goes well, everyone has a good time. It only takes a split-second distraction to go from a good time to a trip to the emergency room in either case. Have rules and enforce them, even if it's your elders that you are protecting by doing so.

Sometimes having a resource like a shared electronic laboratory is the first opportunity people have to assert some sort of control over their relationships. Use the opportunity to make friends with your relatives, while you still can.

Your Friends

Unlike your family, as the saying goes, you get to *pick* your friends. Now you have the opportunity to provide a cool place to hang out as well as build all manner of awesome gizmos. It's only natural to want to share some of the fun with your like-minded friends.

The basic framework of rules and accountability apply to the friendly lab as well as any other group endeavor. Let your friends know up front what your expectations of them are in regard to use of the lab. Can they use your tools? Can they store artwork-in-progress at your place? When is it cool to come over to tinker, and when is it not? These kinds of questions should be dealt with early in the game; otherwise, these issues can flare up and become trouble spots. There's no substitute for good communication.

Once you extend your laboratory's hospitality to those outside your immediate family, it's a good idea to clearly designate what is your personal property and what belongs to the lab and all its participants. This can be as simple as putting name tags on all your tools and marking shared resources appropriately.

This is where *trust* really factors into the success or failure of a group lab. Just like in math, you want to eliminate as many variables as possible to ensure that a good time is had by all, and to ensure the long-term safety and viability of the facility itself. Which of your friends do you *trust* in your lab? Think about these things at length before opening the doors to just anybody.

Coworkers and Fellow Students

So you've been tasked with organizing or supervising a lab for a school class or university department. You may or may not have any choice in who will be granted access, or even when they can avail themselves to the facilities.

The balance of responsibility and authority is crucial in this scenario, just like in most other situations in life. Hopefully you will be in a position to enforce whatever rules are already in place. Ideally, you will have some say in crafting new rules as they become necessary, or adjust existing rules when they need it. In either case, it's just not fair for someone to expect you to do a good job, yet not provide you the tools to get it done.

Positions like this become available from time to time in most schools. Sometimes there's an opportunity for a small paycheck, and other times all you are going to get are points with the administration. Hopefully, at least you will also enjoy lab privileges. That's got to be worth something, yes?

If you are helping to run an existing lab, there are probably others you can consult who have had this particular honor in the past. Try to find out who these folks might be and see if you can get any helpful advice from them about your lab and its care and feeding.

If you're starting from scratch, you will enjoy the double-edged sword of setting things up the way you want, as well as setting things up the way everyone else wants it. You *get* to establish whatever level of functionality you want, with the caveat that you then must maintain that level. It's a freedom, like most freedoms, that comes with a price.

Special-Interest Groups

Are you a member of club that has a special interest in electronics? Several popular interests, such as ham radio operators, remote-control model flyers or drivers, robot builders, and computer users, have a love-hate relationship with electronics. Having a dedicated electronics lab available to the membership is a great way to build up the love as well as work out the hate.

Given a highly specialized crowd, such as the members of a university or trade school, you might even find people organized into an electronics club, especially these days when almost every aspect of our lives is touched by this technology in one way or another.

The specialized nature of your group helps focus what areas of electronics are of most practical interest, at least from a lab point of view. This cascades into easier choices when it comes to stocking the lab with workstations, tools, and components.

The Dallas Personal Robotics Group (DPRG; see `http://dprg.org`), for example, had the use of an 1,800-square-foot warehouse for over six years, rent free, due to the generosity of one of the members, Mike Dodson of Modern Assemblies. Having access to an excellent industrial setting allowed the club members to dream of and then realize much more ambitious robot projects than could be attempted at home. After Mike's retirement, the DPRG went into a nomadic phase and finally spun off a dedicated workshop and meeting area, now called the Dallas Makerspace.

The General Public

A lot of people see the popularity of do-it-yourself (DIY) and *maker-movement* projects and envision themselves as entrepreneurs, seeing a need and being able to meet it. Unfortunately, most of these people are wrong.

Building a lab dedicated to public use sounds like a great and noble aim. The realities of such an undertaking, including the financial, logistical, and business related, are not to be underestimated. While it seems to work well in certain areas and at certain times, it's almost always the result of the right combination of people coming together at the right time.

Hackerspaces (a terribly unfortunately chosen label) are springing up all over the world. The term *hacker*, while understood within some technical communities to mean a person of respectable skills, has a decidedly *unrespectable* taint to it when viewed from the outside. To the vast majority of the English-speaking world, a hacker is a rogue computer jockey, a criminal intent on breaking and entering into computer systems for nefarious purposes.

The term *maker*, on the other hand, leaves a more positive first impression. The Dallas Makerspace members deliberately made this decision when naming themselves, while they were still just a subcommittee within the board of directors of the nomadic DPRG, looking for a new home. It was important to them to maintain the very positive image that the DPRG had established and built over its long history, while still looking to the future.

If you're going to set up a lab for use by the general public, whether you decide to call it a hackerspace, a makerspace, or something entirely different, you get to make almost *no* assumptions about the good intentions of your membership. It's a sad state of affairs, to be sure, but it seems to be the prevailing wisdom of the day.

Some popular and successful organizations—such as Noisebridge (`www.noisebridge.net`), in San Francisco, California, which was incorporated in the state as a "non-profit educational corporation for public benefit"—operate almost entirely on a "consensus basis," sometimes known as "anarchic chaos." Noisebridge's overriding motto is "Be excellent to each other," very often shortened to just "Be excellent." Its very real success and sense of community among members is based on what seems to be a very local tolerance that is not to be found in many parts of the globe. If you ever get a chance, do stop by and prepare to be impressed. It's an amazing place.

A good parallel would be to visit your local public library. In the areas that still maintain libraries (shockingly, they are on the decline), you will find a finely tuned machine that meshes well with the surrounding locality. Are there bars on the windows? If so, you're going to need some bars on your windows. Are there metal detectors at the entrance? Oh, dear. Do you see any uniformed security forces present? These are not good signs.

Don't be completely discouraged, however. Sometimes a community in decline needs a little boost of energy and an injection of esprit de corps. This can often be accomplished by introducing some new alternatives for people's spare time. An ancient Muslim saying reads, "Trust in Allah, but tie your camel."

A Shared Resource

Do you have a dedicated space available? If so, you are way ahead of the game. Finding a good location is half the battle. If your space is truly dedicated to your pursuits and activities (i.e., a private home, club, or makerspace), you have the advantage of being able to leave tools, components, and projects in place, returning to them (and finding them still there!) when the opportunity arises. "Truly dedicated" in this sense can be equated with having your own key to the door and reasonably free access. While a 24-hour facility sounds like a great idea, there are a lot of logistical problems associated, such as security, utility costs, scheduling, and parking, just to name a few.

If your space is not-so-dedicated, such as a school lab or friend's garage, you can still make it a home away from home if you are able to arrange for secure storage of all your shiny toys. This could take the form of individual lockers or a storage closet.

No matter what the logistical arrangements, the main challenge to providing a versatile and effective setting for electronic and other kinds of tinkers is basically a social one. Once it's more than just you, it can start to get complicated.

Luckily, there are some time-tested methods for making these types of things run smoothly.

Be a Hospitable Host

If you are taking the lead in arranging a shared work space, please remember that you are responsible for extending the appropriate hospitality to your present and future guests. This single factor will greatly determine the vibe, feeling, or ambiance of the facility, even more than having the latest and greatest tools and gizmos on hand.

This task may or may not fall entirely on your shoulders. Many hands make light work. If you are able to delegate some of the duties of a hospitable host to other members of your group, consider doing so.

Think of your task in the same light as planning a successful party, even if it's one that you anticipate will last for days on end. These basic ideas are as old as civilized living. Think about fabulous parties or memorable events that you have been privileged to attend in the past, and then plan on taking it up a notch.

Try to anticipate the human needs of your attendees as well as their technological expectations. People have what seems like an endless list of requirements, some of which you can address, some not.

Make your location known. Make this information easy to find to those interested, and easy to update when the venue changes. A web site is trivial to set up these days, and even a post to a popular

forum will tend to be accessible via Internet search engines, in time. There's a new social media outlet popping up every third Tuesday, so avail yourself to what makes sense for your audience. Word of mouth only goes so far these days.

Once you've gone to the trouble of publishing your location, go the extra mile and put out some sort of actual sign or indicator that your arriving guests have found the right spot. If you have an identifiable logo or symbol associated with your group, be sure to proudly wave that flag. People don't like feeling lost, or unsure whether they're entering a welcoming space or about to trespass on private property.

Let everyone know when they are expected as well as when they are *not* expected. Post your regular meeting times, if you have them. Alternatively, make known the appropriate hours of operation. It's disappointing to be turned away at the door just because it's 1:00 a.m. on a school night.

When possible, welcome your guests. This makes a big impression on both newcomers as well as the regulars. Being part of a group is supposed to *enhance* a feeling of inclusiveness and belonging. We are social animals at heart, and even a simple hello is often the prelude to an interesting and productive time together.

Have rules. Make these rules known. A sign on the front door is not out of place, as long as it's not too negative or off-putting. Rules should *prevent* problems from occurring, and not be enacted as a spontaneous reaction when problems inevitably occur.

Ensure your guests' comfort when attending. Is there enough room for the largest (and the smallest) participant to safely enter and exit the facilities? Is there adequate lighting in the common areas, if they exist? Is there a place for everyone to sit? Who has dominion over the thermostat?

Do you plan on making refreshments available? Will this duty rotate among the membership? Keep track of such things, if only to keep from overextending yourself in all the myriad details of hosting a successful meeting. While massive banqueting and consumption of yummies make for a festive and enjoyable association, these activities are not always aligned with maintaining an effective laboratory. Separate the feeding trough from the work areas. Stay focused on what you're trying to accomplish here.

Will everyone have access to restrooms, and whose job is it to keep these areas tidy?

And the most important question of all: Who takes out the trash?

Be a Courteous Guest

Just as it's important to play the role of the hospitable host, it is likewise critical to be a courteous guest when visiting a facility, whether you are a paid-up member in good standing or an invited guest. Again, these guidelines will vary according to the intents and purposes of your lab, but the basics will always remain the same.

If possible, and when appropriate, let your host know if you are planning on attending. This won't apply in a causal, drop-in type of laboratory. Even so, by making your intentions of attending known ahead of time, you might influence (one way or the other) the attendance of other potential participants. Nothing succeeds like success. A well-attended party has a better potential for awesomeness than a sparsely peopled event.

Arrive on time or within the established time frames set forth by your host. Similarly, unless you have been granted special access, plan on leaving at a reasonable time as well. Benjamin Franklin wrote in his *Poor Richard's Almanack* (1736) that "Fish & Visitors stink in 3 days." Don't be a stinker.

Try to contribute something. Don't show up empty-handed, expecting to be fed, entertained, and enlightened.

Workstations

Now it's time to talk about your workstations. Even if it's just you in the lab, having a separate workstation for each type of activity is a great idea. For example, you might have one workstation set up for programming a computer, another for soldering electronics, and another for working with power tools, such as a drill press or a saw.

Workstations dedicated to a particular task should have everything within easy reach, including tooling, supplies, power, and lighting. Don't waste time by forcing people to wander around the lab looking for the right drill bit or magnifying glass. Keep everything close so you can find what you need, when you need it.

Having a place for everything ahead of time is the best way to follow the wise adage, "A place for everything and everything in its place." You get to decide where everything lives. It doesn't hurt to go ahead and label everything conspicuously so that others can find their way around the lab.

If you have several people wanting to work on the same kinds of projects at the same time, you're going to need multiple, nearly identical workstations. The exact number depends on your available space and the number of people you expect to want to participate simultaneously, as well as your budget.

Most indoor-oriented work can often be performed at a work table. Exceptions include giant-scale mechatronics, pyrotechnics, and underwater robotics. Some of their constituent bits and pieces, however, can be crafted on an adequately prepared work table.

Make sure each work area has plenty of power outlets available. You're almost guaranteed to run short at some point. Take care not to overload your circuits, however. If you anticipate needing a lot more power than is presently provisioned, you're going to have to consider the real possibility of having your facility expanded by qualified, *licensed* professionals. These requirements will vary from one location to the next. Check with your local building codes to be sure.

As repeated often in previous chapters, you can never have *too much* lighting available, especially for the more detail-oriented chores. Typical indoor room lighting is just about adequate for finding your way out of the room, and that's about all. You'll need area lighting for each workstation, and possible additional task lighting, depending on your particular requirements.

Providing network access to each workstation can be challenging. Wireless networking is a good way to accommodate a relatively small number of users at once. More than a handful of computers trying to access the Internet at the same time can bring many wireless routers to a slow crawl. Dedicated high-speed Ethernet connectivity is more expensive and takes more effort to deploy, but offers much greater bandwidth to your lab-folk.

If you're especially cramped (or *dimensionally constrained*) in your lab, you'll need to get inventive. For example, a table placed in the center of the room can be approached from multiple sides. There's no reason all the workbenches have to be pushed up against a wall, allowing access from only a single side. Get creative!

Safety Planning

While it's tempting to fill up all the available space in a lab with workstations, especially when the budget permits it, do try to leave a bit of common area here and there. You always want to be able to walk *away* from a workstation with the same (or sometimes even more) rapidity you approached it with. Fire is an excellent example of such a motivator.

■ **Tip** Keep a properly selected and maintained fire extinguisher at each workstation, if possible.

Post emergency procedures prominently, where everyone, including visitors, can see. Have an evacuation plan, complete with map and "You are here" indicator posted at each workstation. Hopefully you will never need it.

Presentations

Are you excited about your latest project? Have you just learned a great new skill? Setting up your lab for group presentations is an excellent way to communicate these ideas to your friends, family, and coworkers.

Make your ~~victims~~ guests comfortable. Have adequate seating for everyone, with plenty of room between the rows (if you have more than one row of chairs). Ensure that everyone has a good view of what you intend to present.

Will the attendees be expected to take notes? Then perhaps you should set up tables where they can comfortably jot down some of the more spectacular aspects of your presentation. If you will be providing a handout or other documentation packages, make sure you have enough for the anticipated demand. Will you be entertaining questions or comments either during the presentation or afterward? Then make sure that not only can your audience see *you*, but that *you* can see *them*.

If you're going to be using some sort of projector for your presentation, by all means set aside some time to get to know the equipment ahead of time. Nothing ever seems to work just exactly as you imagined that it should. This seems to be an invariant law of presentation physics. No one is really sure why.

Your audience's time is just as valuable as your own. In fact, if there are only two people attending, then their collective time is worth approximately *twice* as much as yours. Think about it. Have all your ducks in a row, so to speak. Wasting time figuring out which cable goes where is not a good use of your time together.

Summary

Wow! You can really go crazy setting up a shared electronics lab, can't you?

Before you even flip on the light in your shiny new group lab, you should already have an insightful idea of who is going to be using it and why. You should also have some honest expectations of what your own expectations are going to be, and how you would like to interact with both the lab itself and its population.

The details, of course, are always going to be specific to your particular situation. Be on guard, however, for the future. It's going to sneak up on you, someday. Not too long ago, for example, it took a fairly hefty desk to keep a modern personal computer up off the floor. That kind of computing power now fits in a pocket. Think of what better uses you could dream up for that space these days!

That kind of forward thinking is exactly what turns the dreams of today into the reality of tomorrow. It's forward-thinking people like you, dear reader, that help map out those realities. Take the opportunity you have right now to spend some quality time daydreaming about how things *could* be. Then take those steps necessary to make it happen. Your family, your society, and your world expect great things from you. You can do it!

APPENDIX A

Getting Started with Tool Building

Once you've become comfortable in your lab and have had time to play with a few circuits, you might start to notice that some of the "tools" you've been using are just simple electronic circuits themselves. Good examples are power supplies and meters. These are great tool-building projects because you can see useful results early.

Let's take a look at building a couple of simple electronic tools that might be of use in your lab. Hopefully you will develop a better understanding of how these tools work. Ideally, you will progress from the basic question of "Does it work?" to the more involved questions of "How well does it work and what can I do to improve it?"

Please bear in mind that these exercises, while hopefully useful, are to illustrate what needs to go into the building of practical, reliable tools. At every stage you should be thinking about what design choices you have and which choices will enhance the usefulness of your tool-building process.

A Very Simple Power Supply

Almost all electronic projects need electricity to work. Having a good, dependable power supply at your disposal on your bench will get you started faster on new projects. You won't have to worry about dead batteries and flaky power adapters. See Figure A-1.

Figure A-1. *A professional bench power supply. This device allows both the voltage and the maximum current to be adjusted. It provides two dedicated meters to show how much power is flowing: one for voltage and the other for current. It also provides a modular set of plugs (banana plugs) for easily connecting and disconnecting power leads.*

A bench power supply such as the one shown in Figure A-1 has many features and includes extra circuitry to make it safe and easy to use. It will also set you back a good chunk of change (i.e., cost money). We're going to build something a bit simpler to start. Feel free to add more bells and whistles as your needs arise.

■ **Caution** Anything plugged into the wall has the potential to shock, burn, or kill you. Do not defeat their safety features!

An Easy 2.5 Watts

You probably have a spare USB charger lying around somewhere. If you don't already, you more than likely will at some point in the near future, as these are becoming more common with smaller electronic devices. If not, you can obtain one relatively cheaply if you do some smart shopping. The USB charger shown in Figure A-2 was obtained from overseas via eBay for less than $1. You will also need a USB cable about 3 or 4 feet long. Again, don't spend a lot of money on a new cable. If you don't already have one floating around in a drawer somewhere, you probably know someone that does.

Figure A-2. *A USB charger that plugs into the wall and provides a regulated +5V supply. This plug is intended for US wiring, but will operate from 110AC to 240VAC at 50 or 60Hz, which pretty much covers the whole world, if you have the right adapter plug.*

It doesn't matter what type of USB cable you find, because we're going to cut off the smaller end and use the bare wires inside the cable. It just has to have the USB A–style plug shown on the left side of Figure A-2. The plug will fit into the socket of the charger. You do not need to open or modify the USB charger at all, and you are seriously advised not to do so for any reason.

Let's take a closer look at the label on the charger to find out exactly what it's supposed to be doing for us. See Figure A-3.

Figure A-3. *The label of the USB charger tells us that it accepts anything from 110VAC to 240VAC at either 50Hz or 60Hz. This wide range of input power allows the same internal electronic design to be used worldwide. Only the prongs that plug into the wall vary from location to location. The label also tells us that the USB charger will output +5V at up to 500mA. That's 2.5W!*

The "OUTPUT: 5.0V ⎓ 500mA" marking tells us what we need to know about the flavor of the power coming out of the adapter. The "5.0V" is the measure of the voltage. This is a very useful voltage level for small projects. Many digital chips require a 5V supply, although 3.3V is also becoming quite popular.

The ⎓ symbol represents *direct current (DC)* voltage. The symbol for *AC (alternating current)* voltage is the tilde, or wavy line symbol ~. The "500mA" is the maximum current that can be supplied by this charger (500 milliamps, or 0.5A), although you are cautioned not to expect a low-cost item such as this one to produce 100 percent of its rated power 100 percent of the time.

While this USB charger will most likely work for our intended purposes, it's best to keep those expectations in check. Note that "Model:" is misspelled ("Mode:"); and also note the absence of the magic letters *USB* or the USB logo. Also, there is a complete lack of any safety certifications present on this humble device, as befits its ~~cheap~~ economically optimized provenance. Compare this with the veritable constellation of safety certifications on the name-brand laptop charger shown in Figure A-4.

Figure A-4. *A name-brand laptop charger with several international safety certifications. Every one of these certifications costs money to obtain, and shows that the device was demonstrated to be safe for use in a typical home or business application.*

Next we adapt the USB cable to our needs. In the words of the Red Queen, "Off with his head!"

■ **Caution** Make sure the USB charger is not plugged into the wall or a power strip when making modifications to the cable.

First, plug the USB cable into the USB charger. Now cut off the *other* end of the cable. See Figure A-5.

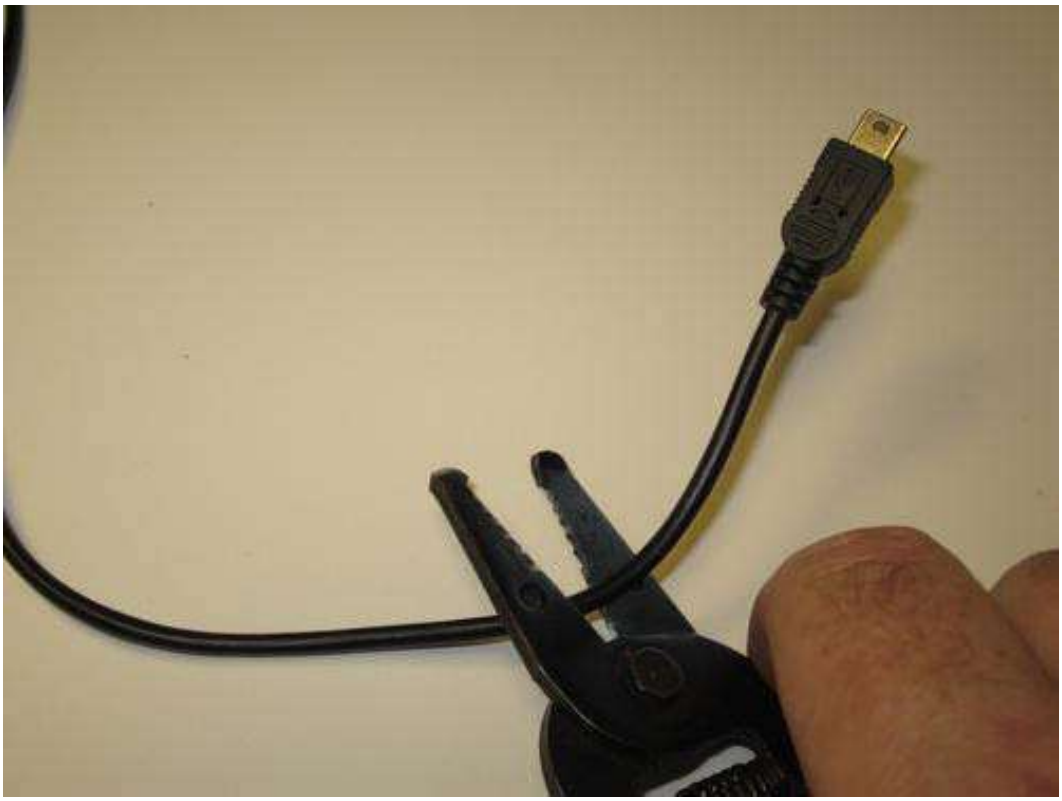

Figure A-5. *Cut off the device end of the USB cable. If you cut off the wrong end, you're not going to be able to plug it back into the charger, at least not without a considerable amount of effort. To ensure you cut the correct end, plug the host end of the cable into the USB charger before snipping, and then cut off the other end.*

Now carefully strip off about an inch of the cable's insulating jacket. Do your best to not nick the insulation on the wires inside. Within the jacket you should find four wires. Two of these wires carry the +5V and ground from the power supply. The other two wires carry the data on the USB connection. Since we're only interested in the power, we can ignore the other two wires for now. See Figure A-6.

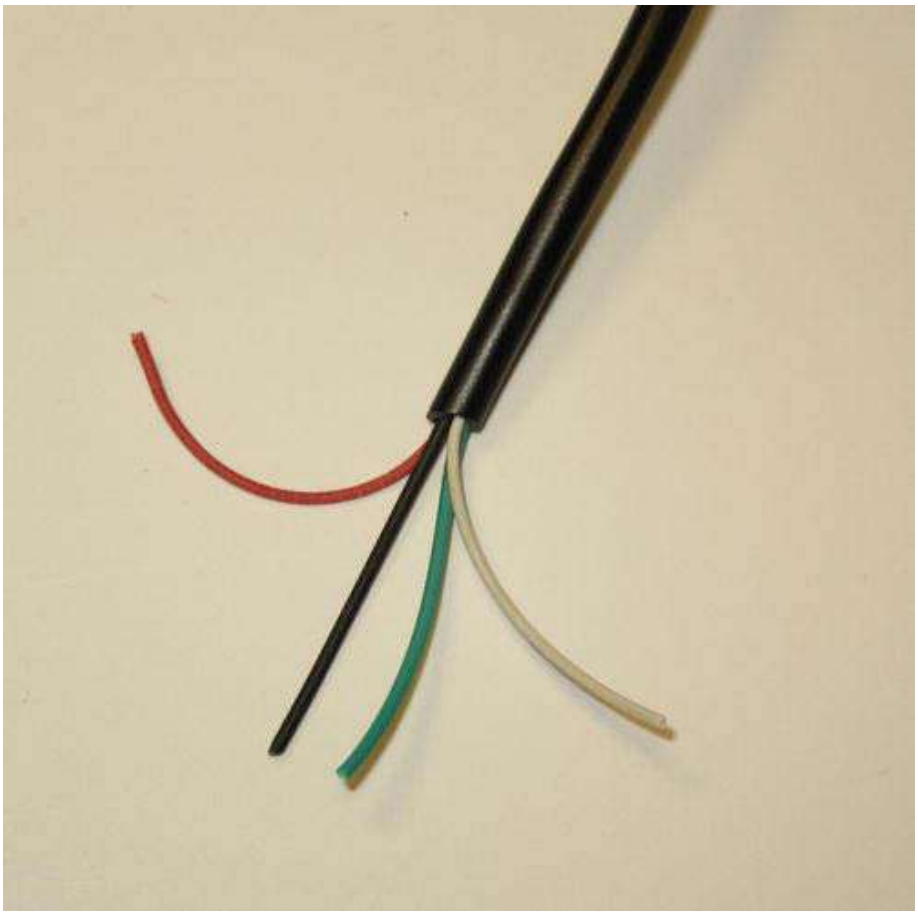

Figure A-6. *The four internal wires within the USB cable. From left to right they are red (VBUS or +5V), black (ground), green (USB D+), and white (USB D–). Use the red and black wires to pull a regulated +5V from the charger.*

The USB standard specifies every little detail about how to build and mark USB cables, even down to the colors of the internal wires in the cable that you're not ever supposed to see! That's dedication.

■ **Note** Apple violates the USB standard by not having a raised USB symbol molded into its cables.

However, sometimes cable manufacturers fudge a bit and use whatever four-conductor cable they happen to have lying around. A very common substitute cable uses red, blue, yellow, and brown wires internally. See Table A-1 for a list of which wires go where.

Table A-1. *Standard USB Wire Colors and Their Functions, Along with Popular Alternate Colors*

Function	Pin Number	Standard USB Color	Alternate Color
VBUS (+5V)	1	Red	Red
D– 2		White	Blue
D+ 3		Green	Yellow
GND 4		Black	Brown

Now is the time to verify the wiring before we get much further. Even if your cable has the official wire colors within the insulating jacket, you are strongly advised to double-check both the voltage and the polarity coming out of the charger before connecting it to your tender, sensitive circuits. Minimize your assumptions about the compliance of others. Testing proves testing works!

Strip about 1/4 inch of the insulation from the ends of the red and black wires. Get out your meter and set it up to read voltage at or above the 5V range. If your fancy meter has autoranging, then just set it to read DC voltage. Plug the USB cable into the charger, if it's not already installed. Make sure the red and black wires are not touching, and then plug the charger into the wall or a convenient power strip.

Now measure the voltage between the red and black wires. Hopefully you should see a reading at or near 5.0V. The USB standard specifies a tolerance of ±10 percent, so anything between 4.5V and 5.5V is considered OK. See Figure A-7.

Figure A-7. *Measure the voltage coming from the USB charger before connecting it to any of your circuits. This one reads 5V on the dot! This is a much safer method than trial by fire (i.e., plugging it into your circuit and looking for a fire).*

Now that you've confirmed that the red and black wires do indeed carry the regulated +5V from the USB charger, you can clip off the unused green and white wires. At this point you can either use the bare, stripped wires of the USB cable or solder on a more robust connector. Since this power supply is destined to be used with a solderless breadboard, a small, two-pin connector with the appropriate spacing will be attached. See Figure A-8.

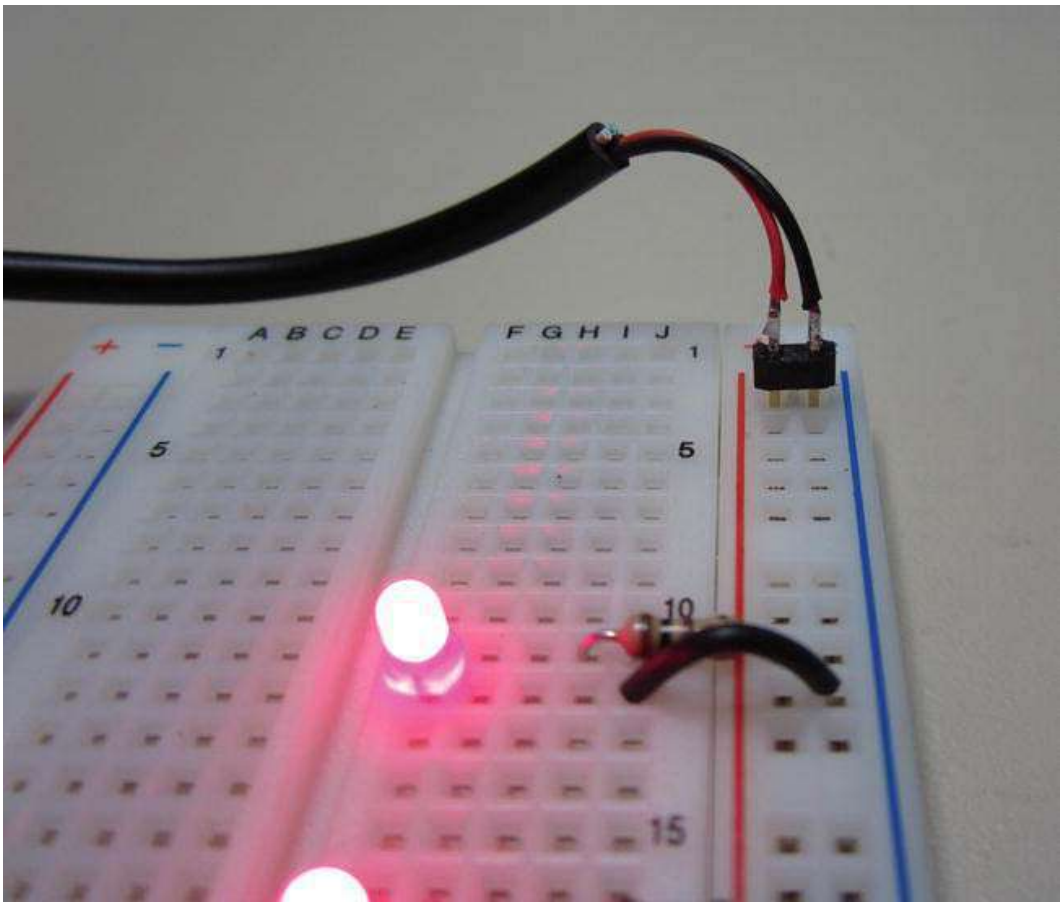

Figure A-8. *A gold-plated pin connector is soldered to the modified USB cable. The red and black insulation is left visible to be a polarity indicator when installing the cable to the solderless breadboard. Another happy LED!*

Adding Features

This power supply works just fine for most projects. If your requirements are, "Translate AC power from the wall into regulated DC power I can use for small projects, without spending a lot of money," then this contraption fits the bill precisely.

You can see for yourself in Figure A-8 that it does indeed work as advertised. Looking back at Figure A-7, you can see that the charger itself has a power-on indicator LED built into the housing. What it doesn't have is a power control or a switch. The power to the circuit is controlled by the switch on the power strip. This works just fine as long as you don't mind turning on and off everything else that happens to be plugged into the same power strip.

Various Indicators

Not all USB chargers have a power indicator, however. Some have both a power indicator LED as well as a *charge status indicator*, which can tell you at a glance if your USB device is fully charged or still charging. A charge status indicator is usually implemented by measuring the amount of current being drawn from the supply. If more than a preset current is flowing, the power supply assumes a battery is still being charged. When that current drops below a certain level, it assumes that the battery has been completely (or maybe just mostly) charged. Some chargers use a red or orange LED to indicate charging, and a green or blue LED to show that the battery is finished charging. Again, this type of charge status display is provided to give the user a quick status update with a single glance. You don't need to consult the product manual to interpret the status code, if you can remember that red means "charging" and green means "charged."

Let's rearrange some of the parts on the solderless breadboard to make room for some new features. See Figure A-9.

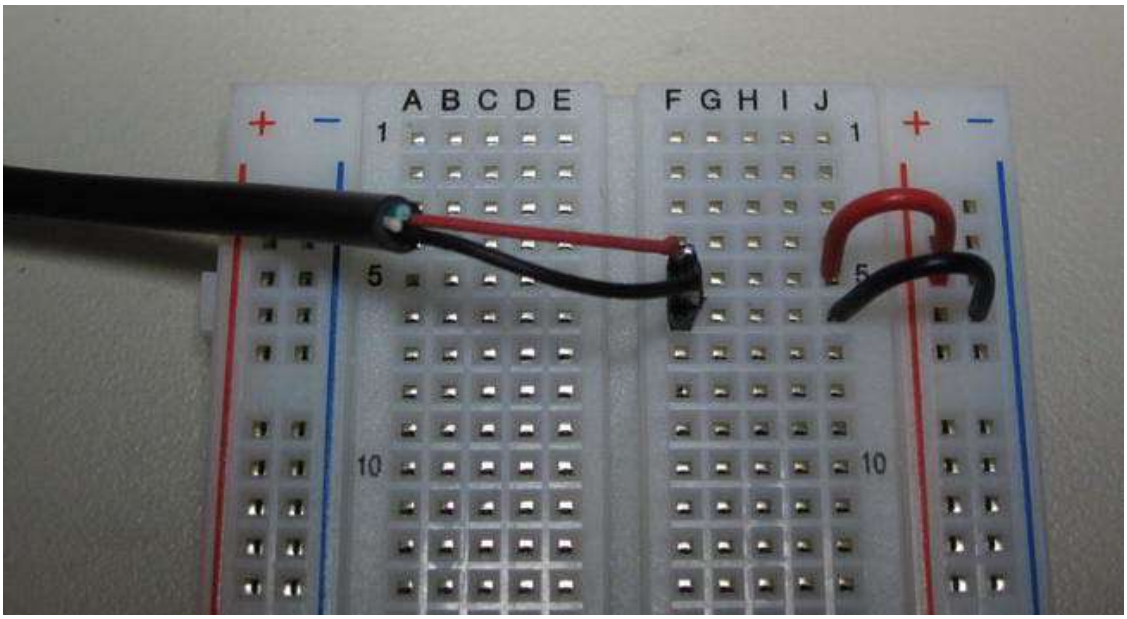

Figure A-9. *The regulated power coming from the USB charger is no longer directly connected to the breadboard's power rails. Instead, it is routed to some internal tie points and then connected to the power rails via two short jumpers.*

Power-On Indicator

First, we add a local power-on indicator by reinstalling the LED and current-limiting resistor used in the previous experiments. While this duplicates the function of any LEDs that might be present on the USB charger itself, it brings the indicator closer to the area of interest, which in this case is the circuitry onboard the solderless breadboard.

The anode of the LED goes into tie point F-3, with the cathode being installed at tie point F-4. The current-limiting resistor spans the gap between tie point I-3 and the right-hand positive (red) power rail. A short jumper connects tie point J-4 and the right-hand negative power rail. See Figure A-10.

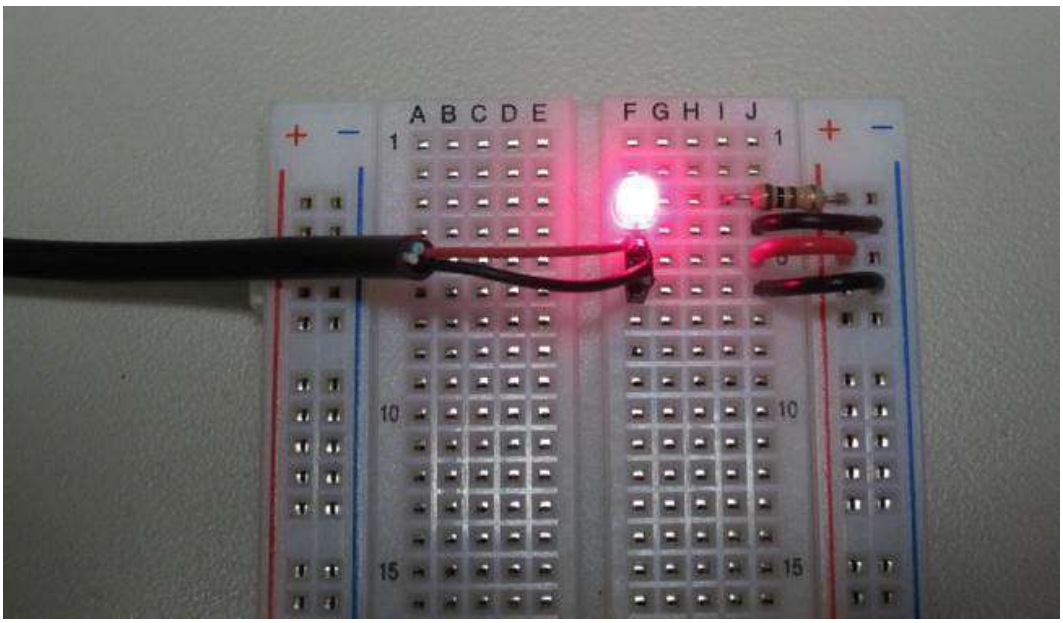

Figure A-10. *Add an LED and a current-limiting resistor across the power rails of the solderless breadboard to give an at-a-glance power indicator, right where the action is taking place.*

Now we have a good power-on indicator, right where we need it. It may or may not be redundant, depending on the features of your USB charger. This type of indicator is digital in the sense that it tells us that the circuit is either on or off, without giving us a lot of precise information about anything in between. For a lot of applications, however, this is more than enough information.

Power Supply Voltage

What if you *did* either want or need more precise information about the power supply? One method would be to permanently connect your multimeter to the circuit so that you can see how many volts are being delivered. That method assumes that you're not going to need your multimeter for anything else, ever.

A practical variation of that method, however, it to provide convenient *test points* in your circuit so that you can quickly and easily take a voltage reading when the need arises. Be sure to position the test points so that they are easy to access. Having a nice, big, readable label wouldn't hurt, either. Also, try to arrange things so that it's not likely that contact with a metal object, such as a tool or your wristwatch, will accidentally short out the power supply by touching both test points at the same time. Even simple "features" get complicated quickly, it seems!

If you want an accurate (and permanent) voltage reading on your circuit, consider adding a voltmeter. Small panel meters are relatively inexpensive and reasonably accurate. A DC voltmeter has two leads, positive and negative, that are attached across the voltage to be measured. See Figure A-11.

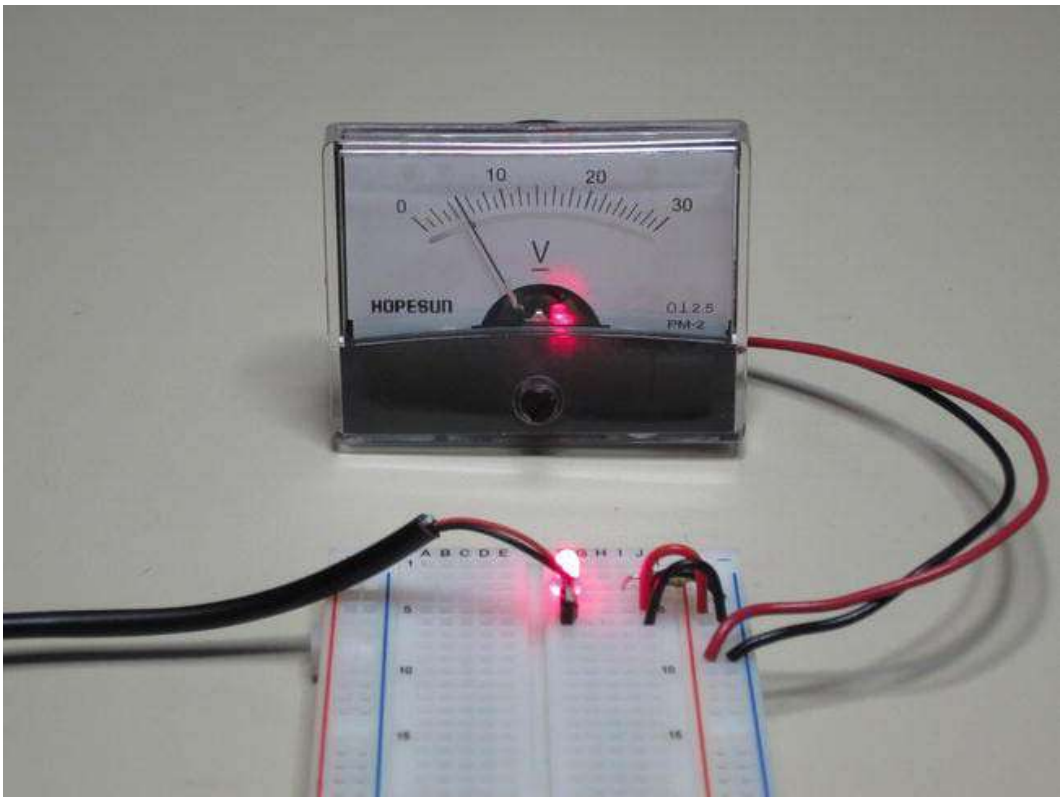

Figure A-11. *A DC voltmeter is attached to the circuit to accurately measure the supply voltage. The V on the meter's legend stands for voltage. The underline beneath the V indicates that it is designed to measure DC voltages, as opposed to AC voltages.*

The panel meter shown in Figure A-11 has a range of 0–30VDC. That's a bit more than we need, since our little power supply is only supposed to produce 5.0VDC ±10 percent. Since the meter's range does not accurately match the expected range of supply voltages, we lose a bit of precision when attempting to read the display. All the action is crowded together on the left side of the meter.

It might seem that a 0–5VDC meter would be preferable, but that would not allow for any overvoltage conditions at all. Remember, the USB standard allows for up to 5.5VDC to be delivered over the cable. A 0–6VDC meter, if available, would be more suitable. The meter introduced in Figure A-11, however, would be perfect when used with the laptop supply shown in Figure A-4, because its output voltage is 19.0V. That leaves a bit of room for overvoltage conditions and gives a wide enough swing of the needle to produce fine detail.

Power Supply Current

Measuring the *voltage* at any point in a circuit is easy. Just put a voltmeter between two points and voilà! In our previous example, we measured the VBUS power supply voltage with reference to GND, the ground potential of the circuit. Many voltage measurements are made with respect to ground.

To measure the current flowing through a circuit, we have two options. The first option is the most direct route. Install an ammeter (a meter that measures *amps* of current) inline with the circuit you want to measure. This requires that you *break* the circuit to make room for the meter. Once installed, the current flowing in the circuit actually flows through the ammeter as well.

The second option involves using a bit of trickery and some math. Instead of installing an ammeter directly inline with the current flow to be measured, we install a resistor of known resistance and measure the *voltage* that develops across the resistor.

Since we know that the values of volts, ohms, and amps are always related in any circuit, we can use Ohm's Law to determine how much current is flowing through a circuit by measuring the voltage across a known resistance.

To make things very easy, let's use a 1Ω resistor in series with the power supply, inserted in the circuit between where the positive lead of the power supply arrives at the circuit and where it is connected to the rest of the circuitry.

Unlike our previous use of Ohm's Law to calculate the missing value based on two known values, we only use *one* known value (the value of the resistor, called a *shunt resistor* when used in this manner). This one known value (resistance) then establishes the relationship between the two other values, voltage and current. As the current increases in the circuit, so does the voltage across the resistor. The two values will mirror each other—as one increases or decreases, the other will follow.

Since we used a 1Ω resistor in the circuit, this sets the relationship between current through the circuit and voltage across the resistor at a 1:1 ratio. For every ampere of current through the circuit, for example, 1V will be measured across the resistor.

Our power supply is only supposed to be able to deliver 0.5A of current, maximum, so we'll be dealing with voltages of less than 0.5V, unless something terribly unexpected happens.

Again, we could permanently attach a multimeter across the leads of a 1Ω resistor inserted into the circuit, or we could attach a voltmeter that is sensitive enough to give accurately readable information in the range we need. The 0–30VDC meter used before is much too large in range to do us any good here. We might see a tiny wiggle in the needle, but that's all.

Instead, we'll use a different kind of meter entirely. A digital voltmeter contains its own dedicated measurement circuitry and a numeric display to indicate the voltage reading. It also requires its own separate power supply. See Figure A-12.

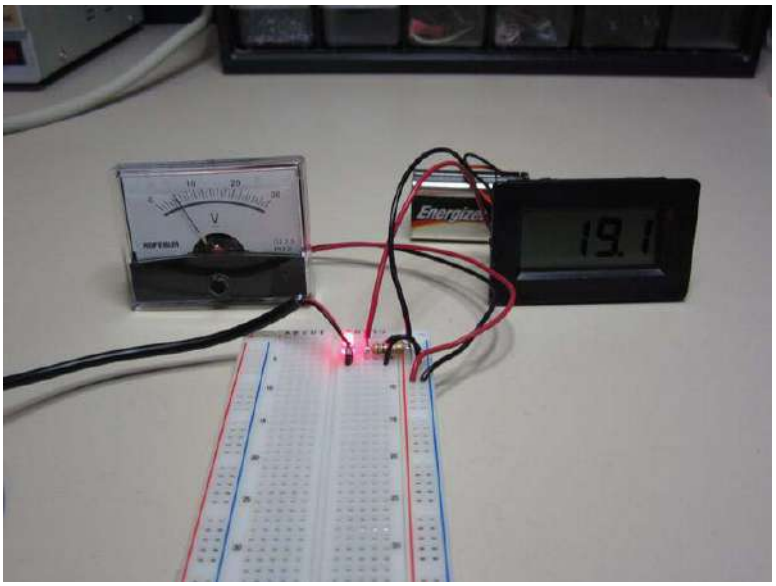

Figure A-12. *A digital voltage meter is used to read the voltage across the shunt resistor installed in the circuit. Because the shunt resistor has a 1.0Ω value, Ohm's Law dictates that the reading in millivolts on the digital meter correspond exactly to the number of milliamps flowing through the circuit. Math is useful, sometimes.*

The jumper wire connecting the incoming power supply directly to the power rail has been replaced with a 1Ω resistor. Leads from both ends of the resistor have been connected to the input terminals of the digital voltage meter on the right. The digital meter, unlike the analog meter on the left, requires an independent power supply to operate, in this case a 9V battery.

So now we've added some features to our simple power supply, including a power-on indicator, a supply voltage reading, and a supply current reading.

These are very useful features to have on any power supply. However, at this point in the prototyping stage, we've just barely covered what the added circuitry is supposed to do. Packaging all this up into an easy-to-use and reliable device takes as much if not more thought and effort.

First, you have to rebuild this entire circuit in a more permanent fashion. Next, you will have to wedge all that clever gadgetry into some sort of enclosure to protect the delicate bits while still permitting access to the inputs, outputs, and controls, if any. Then you get to label everything so that you can remember how to use it in the future.

Summary

So now you just might be developing a certain respect for how much work goes into building even the simplest tools—tools that are useful, accurate, reliable, and an asset to your toolbox. Remember, every tool on your workbench has to earn its place there. This applies to tools you design and build yourself, as well.

Good luck with your tool-building projects. Sometimes it's just as much fun to work on your tools as it is to work *with* your tools.

VOL. 1

Charles Platt

Encyclopedia of Electronic Components

Power Sources & Conversion

Resistors ▪ Capacitors ▪ Inductors
Switches ▪ Encoders ▪ Relays ▪ Transistors

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How to Use This Book

1

To avoid misunderstandings regarding the purpose and method of this book, here is a quick guide regarding the way in which it has been conceived and organized.

Reference vs. Tutorial

As its title suggests, this is a reference book, not a tutorial. In other words, it does not begin with elementary concepts and build sequentially toward concepts that are more advanced.

You should be able to dip into the text at any point, locate the topic that interests you, learn what you need to know, and then put the book aside. If you choose to read it straight through from beginning to end, you will not find concepts being introduced in a sequential, cumulative manner.

My book *Make:Electronics* follows the tutorial approach. Its range, however, is more circumscribed than that of this encyclopedia, because a tutorial inevitably allocates a lot of space to step-by-step explanations and instructions.

Theory and Practice

This book is oriented toward practicality rather than theory. I am assuming that the reader mostly wants to know how to use electronic components, rather than why they work the way they do. Consequently I have not included any proofs of formulae, any definitions rooted in electrical theory, or any historical background. Units are defined only to the extent that is necessary to avoid confusion.

Many books on electronics theory already exist, if theory is of interest to you.

Organization

The encyclopedia is divided into entries, each entry being devoted to one broad type of component. Two rules determine whether a component has an entry all to itself, or is subsumed into another entry:

1. A component merits its own entry if it is (a) widely used or (b) not-so-widely used but has a unique identity and maybe some historical status. A widely used component would be a **bipolar transistor**, while a not-so-widely-used component with a unique identity would be a **unijunction transistor**.
2. A component does not merit its own entry if it is (a) seldom used or (b) very similar in function to another component that is more widely used. For example, the *rheostat* is sub-

sumed into the **potentiometer** section, while *silicon diode*, *Zener diode*, and *germanium diode* are combined together in the **diode** entry.

Inevitably, these guidelines required judgment calls that in some cases may seem arbitrary. My ultimate decision was based on where I would expect to find a component if I was looking for it myself.

Subject Paths

Entries are not organized alphabetically. Instead they are grouped by subject, in much the same way that books in the nonfiction section of a library are organized by the Dewey Decimal System. This is convenient if you don't know exactly what you are looking for, or if you don't know all the options that may be available to perform a task that you have in mind.

Each primary category is divided into subcategories, and the subcategories are divided into component types. This hierarchy is shown in Figure 1-1. It is also apparent when you look at the top of the first page of each entry, where you will find the path that leads to it. The **capacitor** entry, for instance, is headed with this path:

power > moderation > capacitor

Any classification scheme tends to run into exceptions. You can buy a chip containing a *resistor array*, for instance. Technically, this is an *analog integrated circuit*, but should it really be included with solid-state relays and comparators? A decision was made to put it in the **resistor** section, because this seemed more useful.

Some components have hybrid functions. In Volume 2, in the *integrated circuit* subcategory, we will distinguish between those that are *analog* and those that are *digital*. So where should an **analog-digital converter** be listed? It will be found under *analog*, because that category seems better associated with its primary function, and people may be more likely to look for it there.

Primary Category	Secondary Category	Component Type
power	source	battery
	connection	jumper
		fuse
		pushbutton
		switch
		rotary switch
		rotational encoder
	moderation	relay
		resistor
		potentiometer
		capacitor
		variable capacitor
	conversion	inductor
		AC-AC transformer
		AC-DC power supply
		DC-DC converter
		DC-AC inverter
	regulation	voltage regulator
electro-magnetism	linear output	electromagnet
		solenoid
	rotational output	DC motor
		AC motor
		servo motor
		stepper motor
discrete semi-conductor	single junction	diode
		unijunction transistor
	multi-junction	bipolar transistor
		field-effect transistor

Figure 1-1. *The subject-oriented organization of categories and entries in this encyclopedia.*

Inclusions and Exclusions

There is also the question of what is, and what is not, a component. Is wire a component? Not for

the purposes of this encyclopedia. How about a **DC-DC converter**? Because converters are now sold in small packages by component suppliers, they have been included as components.

Many similar decisions had to be made on a case-by-case basis. Undoubtedly, some readers will disagree with the outcome, but reconciling all the disagreements would have been impossible. Speaking personally, the best I could do was create a book that is organized in the way that would suit me best if I were using it myself.

Typographical Conventions

Throughout this encyclopedia, the names of components that have their own entries are presented in **bold type.** Other important electronics terms or component names are presented in *italics* where they first appear in any one section.

The names of components, and the categories to which they belong, are all set in lower-case type, except where a term is normally capitalized because it is an acronym or a trademark. *Trimpot*, for instance, is trademarked by Bourns, but *trimmer* is not. **LED** is an acronym, but *cap* (abbreviation for **capacitor**) is not.

Where formulae are used, they are expressed in a format that will be familiar to computer programmers but may be unfamiliar to others. The * (asterisk) symbol is used in place of a multiplication sign, while the / (slash symbol) is used to indicate division. Where pairs of parentheses are nested, the most deeply nested pair identifies the operations that should be performed first.

Volume Contents

Practical considerations relating to book length influenced the decision to divide *The Encyclopedia of Electronic Components* into three volumes. Each volume deals with broad subject areas as follows.

Volume 1

Power, electromagnetism, and discrete semiconductors.

The *power* category includes sources of power and methods to distribute, store, interrupt, and modify power. The *electromagnetism* category includes devices that exert force linearly, and others that create a turning force. *Discrete semiconductors* include the main types of diodes and transistors.

Volume 2

Integrated circuits, light sources, sound sources, heat sources, and high-frequency sources.

Integrated circuits are divided into analog and digital components. *Light sources* range from incandescent bulbs to LEDs and small display screens; some reflective components, such as liquid-crystal displays and e-ink, are also included. *Sound sources* are primarily electromagnetic.

Volume 3

Sensing devices.

The field of sensors has become so extensive, they easily merit a volume to themselves. *Sensing devices* include those that detect light, sound, heat, motion, pressure, gas, humidity, orientation, electricity, proximity, force, and radiation.

At the time of writing, volumes 2 and 3 are still in preparation, but their contents are expected to be as described above.

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battery

2

This entry covers electrochemical power sources. Electricity is most often generated electromagnetically, but since these sources cannot be classified as components, they are outside the scope of the encyclopedia. Electrostatic sources are excluded for similar reasons.

A battery is sometimes referred to as a *cell* or *power cell*, but can actually contain multiple cells, as defined in this entry. It used to be called an *accumulator* or a *pile*, but those terms are now archaic.

OTHER RELATED COMPONENTS

- **capacitor** (see Chapter 12)

What It Does

A battery contains one or more *electrochemical cells* in which chemical reactions create an electrical potential between two immersed terminals. This potential can be discharged as *current* passing through a *load*.

An electrochemical cell should not be confused with an *electrolytic cell*, which is powered by an external source of electricity to promote *electrolysis*, whereby chemical compounds are broken down to their constituent elements. An electrolytic cell thus consumes electricity, while an electrochemical cell produces electricity.

Batteries range in size from *button cells* to large *lead-acid* units that store power generated by solar panels or windmills in locations that can be off the grid. Arrays of large batteries can provide bridging power for businesses or even small communities where conventional power is unreliable. Figure 2-1 shows a 60KW, 480VDC self-watering battery array installed in a corporate data center, supplementing wind and solar sources and providing time-of-day peak shaving of energy usage. Each lead-acid battery in this array measures approximately 28″ × 24″ × 12″ and weighs about 1,000 lb.

Figure 2-1. *A battery array providing 60KW at 480VDC as backup for a corporate data center. (Photo by permission of Hybridyne Power Systems, Canada, Inc., and the Hybridyne group of companies. Copyright by Hybridyne, an internationally registered trademark of Hybridyne Power Systems Canada Inc. No right of further reproduction unless specifically granted by Hybridyne.)*

Schematic symbols for a battery are shown in Figure 2-2. The longer of the two lines represents the positive side of the battery, in each case. One way to remember this is by imagining that the longer line can be snipped in half so that the two segments can combine to form a + sign. Traditionally, multiple connected battery symbols indicate multiple cells inside a battery; thus the center symbols in the figure could indicate a 3V battery, while those on the right would indicate a voltage greater than 3V. In practice, this convention is not followed conscientiously.

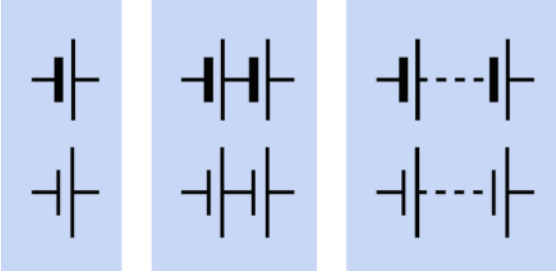

Figure 2-2. *Schematic symbols for a battery. Each pair of symbols within a blue rectangle is functionally identical.*

How It Works

In a basic battery design often used for demonstration purposes, a piece of copper serves as an *electrode*, partially immersed in a solution of copper sulfate, while a piece of zinc forms a second electrode, partially immersed in a solution of zinc sulfate. Each sulfate solution is known as an *electrolyte*, the complete battery may be referred to as a *cell*, and each half of it may be termed a *half-cell*.

A simplified cross-section view is shown in Figure 2-3. Blue arrows show the movement of electrons from the zinc terminal (the *anode*), through an external load, and into a copper terminal (the *cathode*). A *membrane separator* allows the electrons to circulate back through the battery, while preventing electrolyte mixing.

Orange arrows represent positive copper *ions*. White arrows represent positive zinc ions. (An ion is an atom with an excess or deficit of electrons.) The zinc ions are attracted into the zinc sulfate electrolyte, resulting in a net loss of mass from the zinc electrode.

Meanwhile, electrons passing into the copper electrode tend to attract positive copper ions, shown as orange arrows in the diagram. The copper ions are drawn out of the copper sulfate electrolyte, and result in a net accumulation of copper atoms on the copper electrode.

This process is energized partially by the fact that zinc tends to lose electrons more easily than copper.

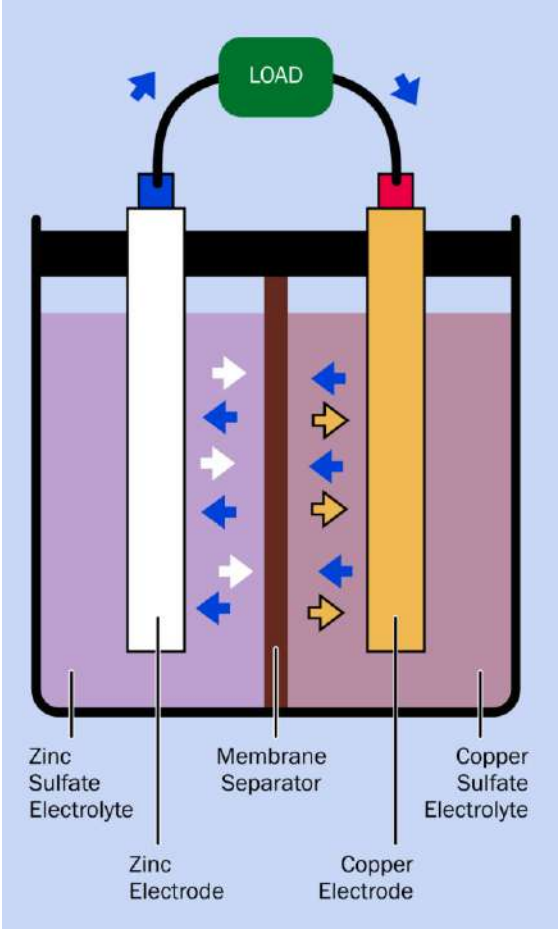

Figure 2-3. *A classically simple electrochemical cell. See text for additional details.*

Batteries for use in consumer electronics typically use a paste instead of a liquid as an electrolyte, and have been referred to as *dry cells*, although this term is becoming obsolete. The two half-cells may be combined concentrically, as in a typical 1.5-volt C, D, AA, or AAA alkaline battery (see Figure 2-4).

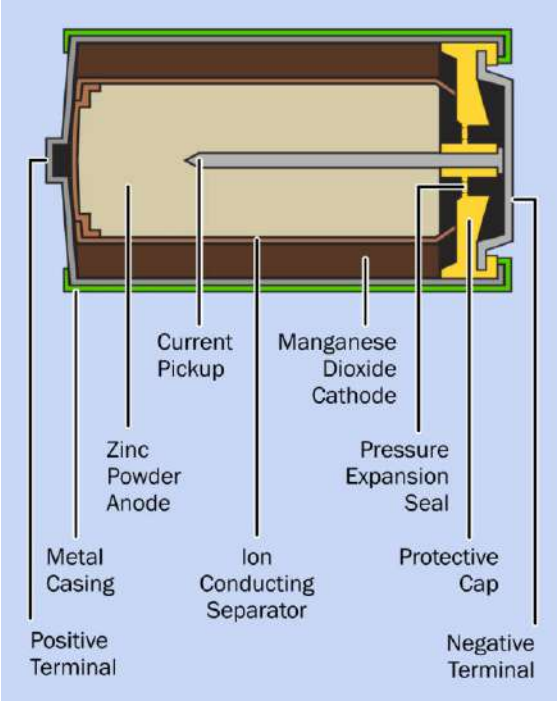

Figure 2-4. *Cross-section view of a typical 1.5-volt alkaline battery.*

A 1.5V battery contains one cell, while a 6V or 9V battery will contain multiple cells connected in series. The total voltage of the battery is the sum of the voltages of its cells.

Electrode Terminology

The electrodes of a cell are often referred to as the *anode* and the *cathode*. These terms are confusing because the electrons enter the anode inside the cell and leave it outside the cell, while electrons enter the cathode from outside the cell and leave it inside the cell. Thus, the anode is an electron emitter if you look at it externally, but the cathode is an electron emitter if you look at it internally.

Conventional current is imagined to flow in the opposite direction to electrons, and therefore, outside the cell, this current flows from the cathode to the anode, and from this perspective, the cathode can be thought of as being "more positive" than the anode. To remember this, think of the letter t in "cathode" as being a + sign, thus: ca+hode. In larger batteries, the cathode is often painted or tagged red, while the anode may be painted or tagged black or blue.

When a reusable battery is recharged, the flow of electrons reverses and the anode and the cathode effectively trade places. Recognizing this, the manufacturers of rechargeable batteries may refer to the more-positive terminal as the anode. This creates additional confusion, exacerbated further still by electronics manufacturers using the term "cathode" to identify the end of a **diode** which must be "more negative"(i.e., at a lower potential) than the opposite end.

To minimize the risk of errors, it is easiest to avoid the terms "anode" and "cathode" when referring to batteries, and speak instead of the negative and positive terminals. This encyclopedia uses the common convention of reserving the term "cathode" to identify the "more negative" end of any type of diode.

Variants

Three types of batteries exist.

1. *Disposable batteries*, properly (but infrequently) referred to as *primary cells*. They are not reliably rechargeable because their chemical reactions are not easily reversible.
2. *Rechargeable batteries*, properly (but infrequently) known as *secondary cells*. They can be recharged by applying a voltage between

the terminals from an external source such as a *battery charger*. The materials used in the battery, and the care with which the battery is maintained, will affect the rate at which chemical degradation of the electrodes gradually occurs as it is recharged repeatedly. Either way, the number of charge/discharge cycles is limited.

3. *Fuel Cells* require an inflow of a reactive gas such as hydrogen to maintain an electrochemical reaction over a long period. They are beyond the scope of this encyclopedia.

A large **capacitor** may be substituted for a battery for some applications, although it has a lower energy density and will be more expensive to manufacture than a battery of equivalent power storage. A capacitor charges and discharges much more rapidly than a battery because no chemical reactions are involved, but a battery sustains its voltage much more successfully during the discharge cycle. See Figure 2-5.

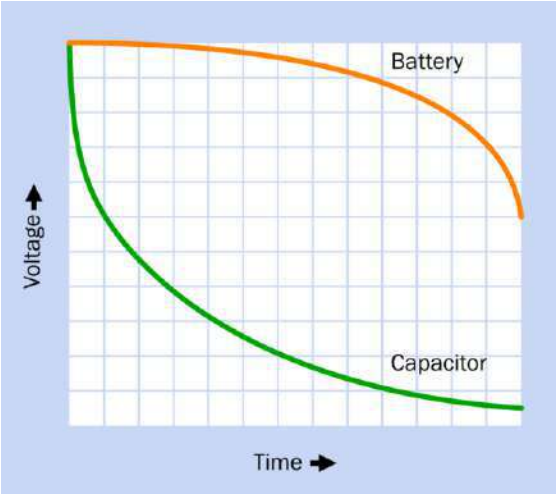

Figure 2-5. *The voltage drop of a discharging capacitor is much steeper initially than that of a battery, making capacitors unsuitable as a battery substitute in many applications. However, the ability of a capacitor to discharge very rapidly at high amperage can sometimes be a significant advantage.*

Capacitors that can store a very large amount of energy are often referred to as *supercapacitors.*

Disposable Batteries

The energy density of any disposable battery is higher than that of any type of rechargeable battery, and it will have a much longer shelf life because it loses its charge more slowly during storage (this is known as the *self-discharge rate*). Disposable batteries may have a useful life of five years or more, making them ideal for applications such as smoke detectors, handheld remotes for consumer electronics, or emergency flashlights.

Disposable batteries are not well suited to delivering high currents through loads below 75Ω. Rechargeable batteries are preferable for higher-current applications. The bar chart in Figure 2-6 shows the rated and actual capabilities of an alkaline battery relative to the three most commonly used rechargeable types, when the battery is connected with a resistance that is low enough to assure complete discharge in 1 hour.

The manufacturer's rating of watt hours per kilo is typically established by testing a battery with a relatively high-resistance load and slow rate of discharge. This rating will not apply in practice if a battery is discharged with a C-rate of 1, meaning complete discharge during 1 hour.

Common types of disposable batteries are *zinc-carbon cells* and *alkaline cells*. In a zinc-carbon cell, the negative electrode is made of zinc while the positive electrode is made of carbon. The limited power capacity of this type of battery has reduced its popularity, but because it is the cheapest to manufacture, it may still be found where a company sells a product with "batteries included." The electrolyte is usually ammonium chloride or zinc chloride. The 9V battery in Figure 2-7 is actually a zinc-carbon battery according to its supplier, while the smaller one beside it is a 12V alkaline battery designed for use in burglar alarms. These examples show that batteries cannot always be identified correctly by a casual assessment of their appearance.

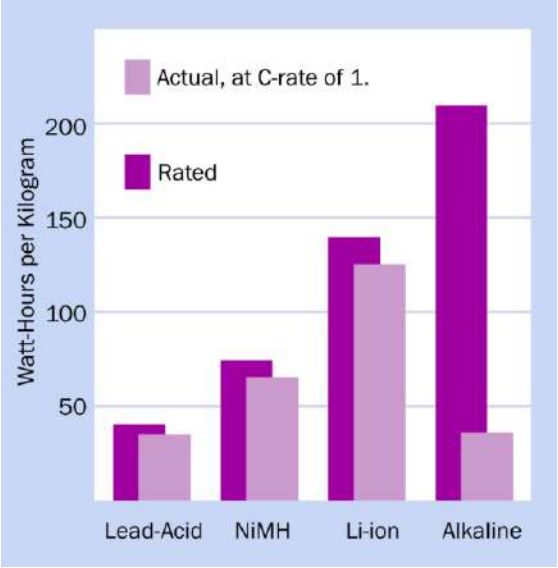

Figure 2-6. *Because of their relatively high internal resistance, alkaline batteries are especially unsuited to high discharge rates, and should be reserved for applications where a small current is required over a long period. (Chart derived from http://batteryuniversity.com.)*

Figure 2-7. *At left, a cheap carbon-zinc battery; at right, a 12V alkaline burglar-alarm battery. See text for additional details.*

In an alkaline cell, the negative electrode is made of zinc powder, the positive electrode is manganese dioxide, and the electrolyte is potassium hydroxide. An alkaline cell may provide between three to five times the power capacity of an equal size of zinc-carbon cell and is less susceptible to voltage drop during the discharge cycle.

Extremely long shelf life is necessary in some military applications. This may be achieved by using a *reserve battery*, in which the internal chemical compounds are separated from each other but can be recombined prior to use.

Rechargeable Batteries

Commonly used types are *lead-acid*, *nickel cadmium* (abbreviated *NiCad* or *NiCd*), *nickel-metal hydride* (abbreviated *NiMH*), *lithium-ion* (abbreviated *Li-ion*), and *lithium-ion polymer*.

Lead-acid batteries have existed for more than a century and are still widely used in vehicles, burglar alarms, emergency lighting, and large power backup systems. The early design was described as *flooded*; it used a solution of sulfuric acid (generically referred to as *battery acid*) as its electrolyte, required the addition of distilled water periodically, and was vented to allow gas to escape. The venting also allowed acid to spill if the battery was tipped over.

The *valve-regulated lead-acid* battery (*VRLA*) has become widely used, requiring no addition of water to the cells. A pressure relief valve is included, but will not leak electrolyte, regardless of the position of the battery. VRLA batteries are preferred for *uninterruptible power supplies* for data-processing equipment, and are found in automobiles and in electric wheelchairs, as their low gas output and security from spillage increases their safety factor.

VRLA batteries can be divided into two types: absorbed glass mat (AGM) and gel batteries. The electrolyte in an AGM is absorbed in a fiber-glass mat separator. In a gel cell, the electrolyte is mixed with silica dust to form an immobilized gel.

The term *deep cycle battery* may be applied to a lead-acid battery and indicates that it should be more tolerant of discharge to a low level—perhaps 20 percent of its full charge (although manufacturers may claim a lower number). The plates in a standard lead-acid battery are composed of a lead *sponge*, which maximizes the surface area available to acid in the battery but can be phys-

ically abraded by deep discharge. In a deep cycle battery, the plates are solid. This means they are more robust, but are less able to supply high amperage. If a deep-discharge battery is used to start an internal combustion engine, the battery should be larger than a regular lead-acid battery used for this purpose.

A sealed lead-acid battery intended to power an external light activated by a motion detector is shown in Figure 2-8. This unit weighs several pounds and is trickle-charged during the daytime by a 6″ × 6″ solar panel.

Figure 2-8. *A lead-acid battery from an external light activated by a motion sensor.*

Nickel-cadmium (*NiCad*) batteries can withstand extremely high currents, but have been banned in Europe because of the toxicity of metallic cadmium. They are being replaced in the United States by *nickel-metal hydride* (*NiMH*) types, which are free from the *memory effect* that can prevent a NiCad cell from fully recharging if it has been left for weeks or months in a partially discharged state.

Lithium-ion and lithium-ion polymer batteries have a better energy-to-mass ratio than NiMH batteries, and are widely used with electronic devices such as laptop computers, media players, digital cameras, and cellular phones. Large arrays of lithium batteries have also been used in some electric vehicles.

Various small rechargeable batteries are shown in Figure 2-9. The NiCad pack at top-left was manufactured for a cordless phone and is rapidly becoming obsolete. The 3V lithium battery at top-right was intended for a digital camera. The three batteries in the lower half of the photograph are all rechargeable NiMH substitutes for 9V, AA, and AAA batteries. The NiMH chemistry results in the AA and AAA single-cell batteries being rated for 1.2V rather than 1.5V, but the manufacturer claims they can be substituted for 1.5V alkaline cells because NiMH units sustain their rated voltage more consistently over time. Thus, the output from a fresh NiMH battery may be comparable to that of an alkaline battery that is part-way through its discharge cycle.

Figure 2-9. *Top left: NiCad battery pack for a cordless phone. Top right: Lithium battery for a digital camera. The other batteries are rechargeable NiMH substitutes for everyday alkaline cells.*

NiMH battery packs are available to deliver substantial power while being smaller and lighter than lead-acid equivalents. The NiMH package in Figure 2-10 is rated for 10Ah, and consists of ten

D-size NiMH batteries wired in series to deliver 12VDC. This type of battery pack is useful in robotics and other applications where a small motor-driven device must have free mobility.

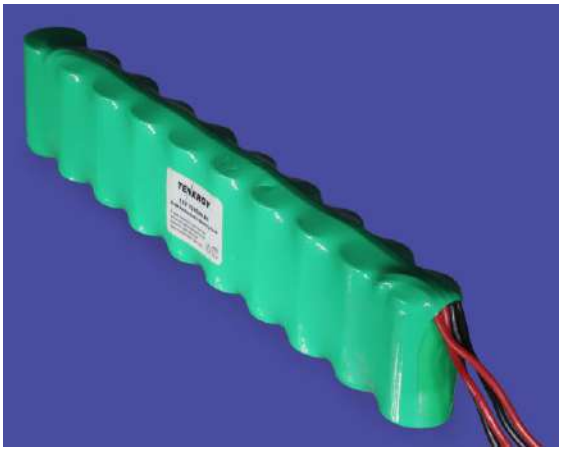

Figure 2-10. *This NiMH battery pack is rated at 10Ah and delivers 12 volts from ten D-size cells wired in series.*

Values

Amperage

The current delivered by a battery will be largely determined by the resistance of the external load placed between its terminals. However, because ion transfer must occur inside the battery to complete the circuit, the current will also be limited by the *internal resistance* of the battery. This should be thought of as an active part of the circuit.

Since a battery will deliver no current if there is no load, current must be measured while a load is attached, and cannot be measured by a meter alone. The meter will be immediately overloaded, with destructive results, if it is connected directly between the terminals of a battery, or in parallel with the load. Current must always be measured with the meter in series with the load, and the polarity of the meter must correspond with the polarity of the battery. See Figure 2-11.

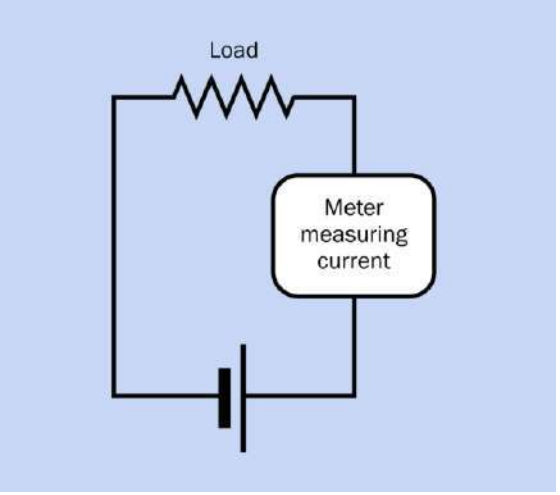

Figure 2-11. *When measuring current using an ammeter (or a multimeter configured to measure amps), the meter must be placed in series with the battery and a load. To avoid damaging the meter, it must never be applied directly across the terminals of the battery, or in parallel with a load. Be careful to observe the polarity of the meter.*

Capacity

The *electrical capacity* of a battery is measured in *amp-hours*, abbreviated *Ah*, *AH*, or (rarely) *A/H*. Smaller values are measured in *milliamp-hours*, usually abbreviated *mAh*. If I is the current being drawn from a battery (in amps) and T is the time for which the battery can deliver that current (in hours), the amp-hour capacity is given by the formula:

```
Ah = I * T
```

By turning the formula around, if we know the amp-hour rating that a manufacturer has determined for a battery, we can calculate the time in hours for which a battery can deliver a particular current:

```
T = Ah / I
```

Theoretically, Ah is a constant value for any given battery. Thus a battery rated for 4Ah should provide 1 amp for 4 hours, 4 amps for 1 hour, 5 amps for 0.8 hours (48 minutes), and so on.

In reality, this conveniently linear relationship does not exist. It quickly breaks down as the

current rises, especially when using lead-acid batteries, which do not perform well when required to deliver high current. Some of the current is lost as heat, and the battery may be electrochemically incapable of keeping up with demand.

The *Peukert number* (named after its German originator in 1897) is a fudge factor to obtain a more realistic value for T at higher currents. If n is the Peukert number for a particular battery, then the previous formula can be modified thus:

$$T = Ah / I^n$$

Manufacturers usually (but not always) supply Peukert's number in their specification for a battery. So, if a battery has been rated at 4Ah, and its Peukert number is 1.2 (which is typical for lead-acid batteries), and I=5 (in other words, we want to know for how long a time, T, the battery can deliver 5 amps):

$$T = 4 / 5^{1.2} = \text{approximately } 4 / 6.9$$

This is about 0.58 hours, or 35 minutes—much less than the 48 minutes that the original formula suggested.

Unfortunately, there is a major problem with this calculation. In Peukert's era, the amp-hour rating for a battery was established by a manufacturer by drawing 1A and measuring the time during which the battery was capable of delivering that current. If it took 4 hours, the battery was rated at 4Ah.

Today, this measurement process is reversed. Instead of specifying the current to be drawn from the battery, a manufacturer specifies the time for which the test will run, then finds the maximum current the battery can deliver for that time. Often, the time period is 20 hours. Therefore, if a battery has a modern 4Ah rating, testing has probably determined that it delivered 0.2A for 20 hours, not 1A for 4 hours, which would have been the case in Peukert's era.

This is a significant distinction, because the same battery that can deliver 0.2A for 20 hours will not be able to satisfy the greater demand of 1A for 4 hours. Therefore the old amp-hour rating and the modern amp-hour rating mean different things and are incompatible. If the modern Ah rating is inserted into the old Peukert formula (as it was above), the answer will be misleadingly optimistic. Unfortunately, this fact is widely disregarded. Peukert's formula is still being used, and the performance of many batteries is being evaluated incorrectly.

The formula has been revised (initially by Chris Gibson of SmartGauge Electronics) to take into account the way in which Ah ratings are established today. Suppose that AhM is the modern rating for the battery's capacity in amp-hours, H is the duration in hours for which the battery was tested when the manufacturer calibrated it, n is Peukert's number (supplied by the manufacturer) as before, and I is the current you hope to draw from the battery. This is the revised formula to determine T:

$$T = H * (AhM / (I * H)^n)$$

How do we know the value for H? Most (not all) manufacturers will supply this number in their battery specification. Alternatively, and confusingly, they may use the term *C-rate*, which can be defined as 1/H. This means you can easily get the value for H if you know the C-rate:

$$H = 1 / \text{C-rate}$$

We can now use the revised formula to rework the original calculation. Going back to the example, if the battery was rated for 4Ah using the modern system, in a discharge test that lasted 20 hours (which is the same as a C-rate of 0.05), and the manufacturer still states that it has a Peukert number of 1.2, and we want to know for how long we can draw 5A from it:

$$T = 20 * (4/(5 * 20)^{1.2}) = \text{approximately } 20 * 0.021$$

This is about 0.42 hours, or 25 minutes—quite different from the 35 minutes obtained with the old version of the formula, which should never be used when calculating the probable dis-

charge time based on a modern Ah rating. These issues may seem arcane, but they are of great importance when assessing the likely performance of battery-powered equipment such as electric vehicles.

Figure 2-12 shows the probable actual performance of batteries with Peukert numbers of 1.1, 1.2, and 1.3. The curves were derived from the revised version of Peukert's formula and show how the number of amp-hours that you can expect diminishes for each battery as the current increases. For example, if a battery that the manufacturer has assigned a Peukert number of 1.2 is rated at 100Ah using the modern 20-hour test, but we draw 30A from it, the battery can actually deliver only 70Ah.

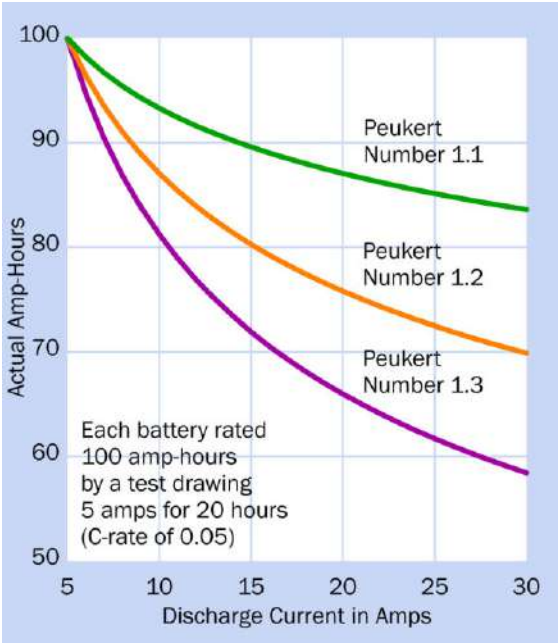

Figure 2-12. *Actual amp-hour performance that should be expected from three batteries of Peukert numbers 1.1, 1.2, and 1.3 when they discharge currents ranging from 5 to 30 amps, assuming that the manufacturer has rated each battery at 100Ah using the modern system, which usually entails a 20-hour test (a C-rate of 0.05).*

One additional factor: For any rechargeable battery, the Peukert number gradually increases with age, as the battery deteriorates chemically.

Voltage

The rated voltage of a fully charged battery is known as the *open circuit voltage* (abbreviated *OCV* or V_{oc}), defined as the potential that exists when no load is imposed between the terminals. Because the internal resistance of a volt meter (or a multimeter, when it is used to measure DC volts) is very high, it can be connected directly between the battery terminals with no other load present, and will show the OCV quite accurately, without risk of damage to the meter. A fully charged 12-volt car battery may have an OCV of about 12.6 volts, while a fresh 9-volt alkaline battery typically has an OCV of about 9.5 volts. Be extremely careful to set a multimeter to measure DC volts before connecting it across the battery. Usually this entails plugging the wire from the red probe into a socket separately reserved for measuring voltage, not amperage.

The voltage delivered by a battery will be pulled down significantly when a load is applied to it, and will decrease further as time passes during a discharge cycle. For these reasons, a **voltage regulator** is required when a battery powers components such as digital integrated circuit chips, which do not tolerate a wide variation in voltage.

To measure voltage while a load is applied to the battery, the meter must be connected in parallel with the load. See Figure 2-13. This type of measurement will give a reasonably accurate reading for the potential applied to the load, so long as the resistance of the load is relatively low compared with the internal resistance of the meter.

Figure 2-14 shows the performance of five commonly used sizes of alkaline batteries. The ratings in this chart were derived for alkaline batteries under favorable conditions, passing a small current through a relatively high-ohm load for long periods (40 to 400 hours, depending on battery type). The test continued until the final voltage for each 1.5V battery was 0.8V, and the final voltage for the 9V battery was a mere 4.8V. These voltages were considered acceptable when the

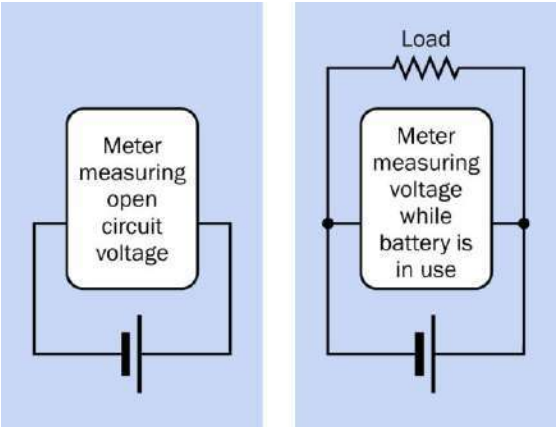

Figure 2-13. *When using a volt meter (or a multimeter configured to measure voltage), the meter can be applied directly between the battery terminals to determine the open-circuit voltage (OCV), or in parallel with a load to determine the voltage actually supplied during use. A multimeter must be set to measure DC volts before connecting it across a battery. Any other setting may damage the meter.*

Ah ratings for the batteries were calculated by the manufacturer, but in real-world situations, a final voltage of 4.8V from a 9V battery is likely to be unacceptable in many electronics applications.

Battery type	Rating (Ah)	Final voltage	Load (ohms)	Current (mA)
AAA	1.15	0.8	75	20
AA	2.87	0.8	75	20
C	7.8	0.8	39	40
D	17	0.8	39	40
9V	0.57	4.8	620	14

Figure 2-14. *The voltage delivered by a battery may drop to a low level while a manufacturer is establishing an amp-hour rating. Values for current, shown in the chart, were calculated subsequently as estimated averages, and should be considered approximate. (Derived from a chart published by Panasonic.)*

As a general rule of thumb, if an application does not tolerate a significant voltage drop, the manufacturer's amp-hour rating for a small battery may be divided by 2 to obtain a realistic number.

How to Use it

When choosing a battery to power a circuit, considerations will include the intended shelf life, maximum and typical current drain, and battery weight. The amp-hour rating of a battery can be used as a very approximate guide to determine its suitability. For 5V circuits that impose a drain of 100mA or less, it is common to use a 9V battery, or six 1.5V batteries in series, passing current through a **voltage regulator** such as the LM7805. Note that the voltage regulator requires energy to function, and thus it imposes a voltage drop that will be dissipated as heat. The minimum drop will vary depending on the type of regulator used.

Batteries or cells may be used in series or in parallel. In series, the total voltage of the chain of cells is found by summing their individual voltages, while their amp-hour rating remains the same as for a single cell, assuming that all the cells are identical. Wired in parallel, the total voltage of the cells remains the same as for a single cell, while the combined amp-hour value is found by summing their individual amp-hour ratings, assuming that all the batteries are identical. See Figure 2-15.

In addition to their obvious advantage of portability, batteries have an additional advantage of being generally free from power spikes and noise that can cause sensitive components to misbehave. Consequently, the need for smoothing will depend only on possible noise created by other components in the circuit.

Motors or other inductive loads draw an initial surge that can be many times the current that they use after they start running. A battery must be chosen that will tolerate this surge without damage.

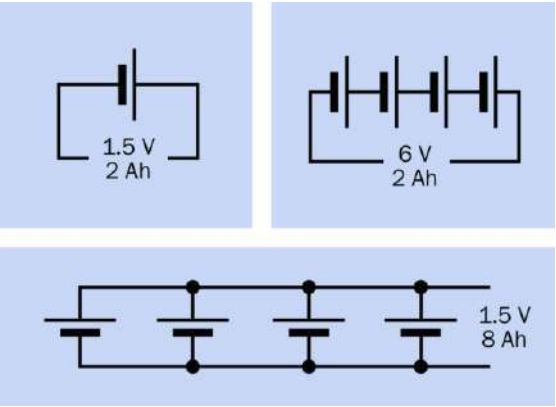

Figure 2-15. *Theoretical results of using 1.5V cells in series or in parallel, assuming a 2Ah rating for one cell.*

Because of the risk of fire, United States airline regulations limit the amp-hour capacity of lithium-ion batteries in any electronic device in carry-on or checked passenger baggage. If a device may be carried frequently as passenger baggage (for example, emergency medical equipment), NiMH batteries are preferred.

What Can Go Wrong

Short Circuits: Overheating and Fire

A battery capable of delivering significant current can overheat, catch fire, or even explode if it is short-circuited. Dropping a wrench across the terminals of a car battery will result in a bright flash, a loud noise, and some molten metal. Even a 1.5-volt alkaline AA battery can become too hot to touch if its terminals are shorted together. (Never try this with a rechargeable battery, which has a much lower internal resistance, allowing much higher flow of current.) Lithium-ion batteries are particularly dangerous, and almost always are packaged with a current-limiting component that should not be disabled. A short-circuited lithium battery can explode.

If a battery pack is used as a cheap and simple workbench DC power supply, a **fuse** or circuit breaker should be included. Any device that uses significant battery power should be fused.

Diminished Performance Caused by Improper Recharging

Many types of batteries require a precisely measured charging voltage and a cycle that ends automatically when the battery is fully charged. Failure to observe this protocol can result in chemical damage that may not be reversible. A charger should be used that is specifically intended for the type of battery. A detailed comparison of chargers and batteries is outside the scope of this encyclopedia.

Complete Discharge of Lead-Acid Battery

Complete or near-complete discharge of a lead-acid battery will significantly shorten its life (unless it is specifically designed for deep-cycle use —although even then, more than an 80% discharge is not generally recommended).

Inadequate Current

Chemical reactions inside a battery occur more slowly at low temperatures. Consequently, a cold battery cannot deliver as much current as a warm battery. For this reason, in winter weather, a car battery is less able to deliver high current. At the same time, because engine oil becomes more viscous as the temperature falls, the starter motor will demand more current to turn the engine. This combination of factors explains the tendency of car batteries to fail on cold winter mornings.

Incorrect Polarity

If a battery charger or generator is connected with a battery with incorrect polarity, the battery may experience permanent damage. The **fuse** or *circuit breaker* in a charger may prevent this from occurring and may also prevent damage to the charger, but this cannot be guaranteed.

If two high-capacity batteries are connected with opposite polarity (as may happen when a clumsy attempt is made to start a stalled car with jumper cables), the results may be explosive. Never lean over a car battery when attaching cables to it, and ideally, wear eye protection.

Reverse Charging

Reverse charging can occur when a battery becomes completely discharged while it is wired (correctly) in series with other batteries that are still delivering current. In the upper section of the schematic at Figure 2-16 two healthy 6V batteries, in series, are powering a resistive load. The battery on the left applies a potential of 6 volts to the battery on the right, which adds its own 6 volts to create a full 12 volts across the load. The red and blue lines indicate volt meter leads, and the numbers show the reading that should be observed on the meter.

In the second schematic, the battery on the left has become exhausted and is now a "dead weight" in the circuit, indicated by its gray color. The battery on the right still sustains a 6-volt potential. If the internal resistance of the dead battery is approximately 1 ohm and the resistance of the load is approximately 20 ohms, the potential across the dead battery will be about 0.3 volts, in the opposite direction to its normal charged voltage. Reverse charging will result and can damage the battery. To avoid this problem, a battery pack containing multiple cells should never be fully discharged.

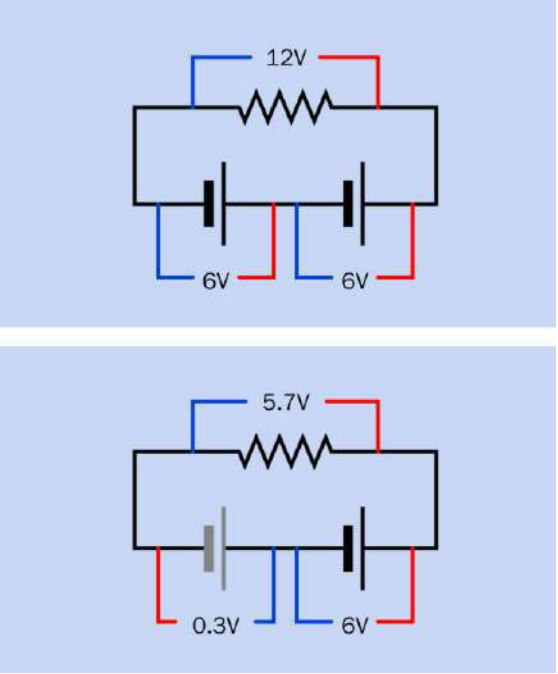

Figure 2-16. *When a pair of 6V batteries is placed in series to power a resistive load, if one of the batteries discharges completely, it becomes a load instead of a power source, and will be subjected to reverse charging, which may cause permanent damage.*

Sulfurization

When a lead-acid battery is partially or completely discharged and is allowed to remain in that state, sulfur tends to build up on its metal plates. The sulfur gradually tends to harden, forming a barrier against the electrochemical reactions that are necessary to recharge the battery. For this reason, lead-acid batteries should not be allowed to sit for long periods in a discharged condition. Anecdotal evidence suggests that even a very small trickle-charging current can prevent sulfurization, which is why some people recommend attaching a small solar panel to a battery that is seldom used—for example, on a sail boat, where the sole function of the battery is to start an auxiliary engine when there is insufficient wind.

High Current Flow Between Parallel Batteries

If two batteries are connected in parallel, with correct polarity, but one of them is fully charged while the other is not, the charged battery will attempt to recharge its neighbor. Because the batteries are wired directly together, the current will be limited only by their internal resistance and the resistance of the cables connecting them. This may lead to overheating and possible damage. The risk becomes more significant when linking batteries that have high Ah ratings. Ideally they should be protected from one another by high-current **fuses.**

jumper

3

A jumper may also be referred to as a *jumper socket* or a *shunt*. A jumper should not be confused with *jumper wires*, which are not considered components for the purposes of this encyclopedia.

OTHER RELATED COMPONENTS

- **switch** (See Chapter 6)

What It Does

A jumper is a low-cost substitute for a **switch,** where a connection has to be made (or unmade) only a few times during the lifetime of a product. Typically it allows a function or feature on a circuit board to be set on a semipermanent basis, often at the time of manufacture. A *DIP switch* performs the same function more conveniently. See "DIP" (page 43).

There is no standardized schematic symbol to represent a jumper.

How It Works

A jumper is a very small rectangular plastic tab containing two (or sometimes more) metal sockets usually spaced either 0.1″ or 2mm apart. The sockets are connected electrically inside the tab, so that when they are pushed over two (or more) pins that have been installed on a circuit board for this purpose, the jumper shorts the pins together. The pins are usually 0.025″ square and are often part of a *header* that is soldered into the board. In a parts catalogue, jumpers may be found in a section titled "Headers and Wire Housings" or similar.

Three jumpers are shown in Figure 3-1. The blue one contains two sockets spaced 0.1″ and is deep enough to enclose the pins completely. The red one contains two sockets spaced 2mm and may allow the tips of the pins to emerge from its opposite end. The black one contains four sockets, each pair spaced 0.1″ apart.

Figure 3-1. *Three jumpers containing two sockets spaced 2mm (left), two sockets spaced 0.1″ (top right), and four sockets, each pair spaced 0.1″ (bottom right).*

The set of pins with which a jumper is used is often referred to as a *header*. Headers are available with pins in single or dual rows. Some headers are designed to be snapped off to provide the desired number of pins. A dual 28-pin header is shown in Figure 3-2 with a black jumper pushed onto a pair of pins near the midpoint.

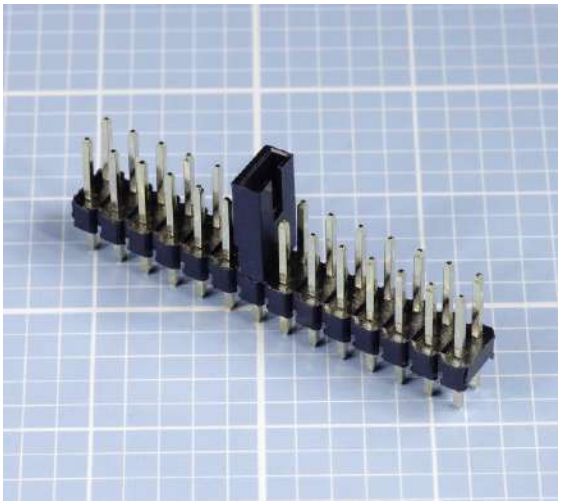

Figure 3-2. *A jumper pushed onto a pair of pins midway along a dual 28-pin header.*

Variants

A *jumper assembly* may be a kit containing not only the jumper but also the array of pins with which it is intended to be used. Check the manufacturer's datasheet to find out exactly what is included.

The most common types of jumpers have two sockets only, but variants are available with as many as 12 sockets, which may be arranged in one or two rows. *Header sockets* may be used as a substitute for purpose-made jumpers, with the advantage that they are often sold in long strips that can be snapped off to provide as many sockets as needed. However, the pins attached to header sockets must be manually connected by soldering small lengths of wire between them.

In some jumpers, the plastic tab extends upward for about half an inch and functions as a finger grip, making the jumper much easier to hold during insertion and removal. This is a desirable feature if there is room to accommodate it.

The sockets inside a jumper are often made from phosphor-bronze, copper-nickel alloy, tin alloy, or brass alloy. They are usually gold-plated, but in some instances are tin-plated.

Rarely, a jumper may consist of a metal strip with U-shaped connections suitable for being used in conjunction with screw terminals. Two jumpers of this type are shown in Figure 3-3. They should not be confused with high-amperage fuses that look superficially similar.

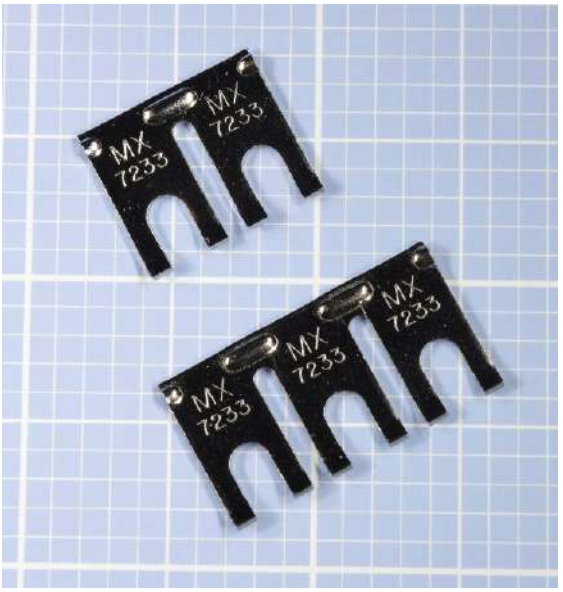

Figure 3-3. *These jumpers are designed to short together two or three screw terminals.*

Values

The spacing between the sockets in a jumper is referred to as its *pitch*. As previously noted, 0.1" and 2mm are the most popular values.

A typical maximum rating for a jumper of 0.1" pitch is 2A or 2.5A at 250V.

How to Use it

A jumper may activate a "set it and forget it" circuit function. An example would be the factory configuration of a product to work with 115VAC or 230VAC power input. End users were expected to set jumpers in some computer equipment sold during the 1980s, but this is no longer the case.

What Can Go Wrong

Jumpers are easily dropped, easily lost, and easily placed incorrectly. When purchasing jumpers, buy extras to compensate for their fragility and the ease of losing them.

Any location where a jumper may be used should be clearly labelled to define the function of each setting.

Cheap, poorly made jumpers may self-destruct from mechanical stresses when removed from their pins. The plastic casing can come away, leaving the sockets clinging naked to the pins protruding from the circuit board. This is another reason why it is a good idea to have a small stock of spare jumpers for emergencies.

Oxidation in jumpers where the contacts are not gold- or silver-plated can create electrical resistance or unreliable connections.

fuse

4

The alternate spelling *fuze* is seldom used.

OTHER RELATED COMPONENTS

- None

What It Does

A fuse protects an electrical circuit or device from excessive current when a metal element inside it melts to create an open circuit. With the exception of *resettable fuses* (discussed separately in "Resettable Fuses" (page 24)), a fuse must be discarded and replaced after it has fulfilled its function.

When high current melts a fuse, it is said to *blow* or *trip* the fuse. (In the case of a resettable fuse, only the word *trip* is used.)

A fuse can work with either AC or DC voltage, and can be designed for almost any current. In residential and commercial buildings, *circuit breakers* have become common, but a large cartridge fuse may still be used to protect the whole system from short-circuits or from overcurrent caused by lightning strikes on exposed power lines.

In electronic devices, the **power supply** is almost always fused.

Schematic symbols for a fuse are shown in Figure 4-1. Those at the right and second from right are most frequently used. The one in the center is approved by ANSI, IEC, and IEEE but is seldom seen. To the left of that is the fuse symbol understood by electrical contractors in architectural plans. The symbol at far left used to be common but has fallen into disuse.

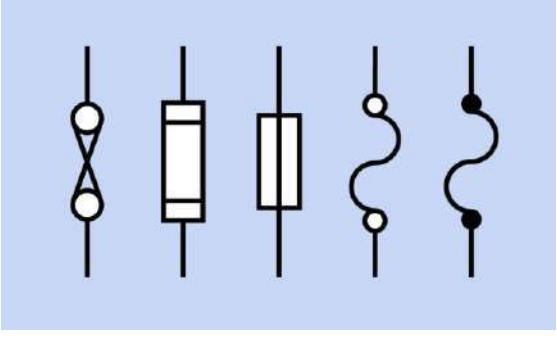

Figure 4-1. *Alternate schematic symbols for a fuse. See text for explanation.*

How It Works

The *element* in a fuse is usually a wire or thin metal strip mounted between two terminals. In a cartridge fuse, it is enclosed in a glass or ceramic cylinder with a contact at each end, or in a small metallic can. (Old-style, large, high-amperage fuses may be packaged in a paper or cardboard tube.) The traditional glass cartridge allows visual inspection to confirm that the fuse has blown.

A fuse responds only to current, not to voltage. When choosing a fuse that will be reliable in conditions of steady current consumption, a safe rule is to figure the maximum amperage when all components are functioning and add 50%. However, if current surges or spikes are likely, their duration will be relevant. If I is the current surge

in amps and t is its duration in seconds, the surge sensitivity of a fuse—which is often referred to verbally or in printed format as I2t—is given by the formula:

$$I2t = I^2 * t$$

Some semiconductors also have an I2t rating, and should be protected with a similarly rated fuse.

Any fuse will present some resistance to the current flowing through it. Otherwise, the current would not generate the heat that blows the fuse. Manufacturer datasheets list the voltage drop that the internal resistance of a fuse is likely to introduce into a circuit.

Values

The *current rating* or *rated current* of a fuse is usually printed or stamped on its casing, and is the maximum flow that it should withstand on a continuous basis, at the ambient temperature specified by the manufacturer (usually 25 degrees Centigrade). The ambient temperature refers to the immediate environment of the fuse, not the larger area in which it may be located. Note that in an enclosure containing other components, the temperature is usually significantly higher than outside the enclosure.

Ideally a fuse should function reliably and indefinitely at its rated maximum amperage, but should blow just as reliably if the current rises by approximately 20% beyond the maximum. In reality, manufacturers recommend that continuous loading of a fuse should not exceed 75% of its rating at 25 degrees Centigrade.

The *voltage rating* or *rated voltage* of a fuse is the maximum voltage at which its element can be counted on to melt in a safe and predictable manner when it is overloaded by excess current. This is sometimes known as the *breaking capacity*. Above that rating, the remaining pieces of the fuse element may form an arc that sustains some electrical conduction.

A fuse can always be used at a lower voltage than its rating. If it has a breaking capacity of 250V, it will still provide the same protection if it is used at 5V.

Four differently rated glass cartridge fuses are shown in Figure 4-2. The one at the top is a slow-blowing type, rated at 15A. Its element is designed to absorb heat before melting. Below it is a 0.5A fuse with a correspondingly thinner element. The two smaller fuses are rated at 5A each. The center two fuses have a maximum voltage rating of 250V, while the one at the top is rated at 32V and the one at the bottom is rated at 350V. Clearly, the size of a fuse should never be used as a guide to its ratings.

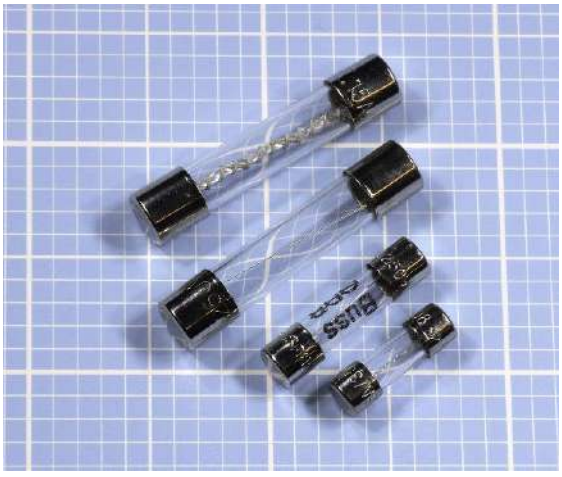

Figure 4-2. *Four glass cartridge fuses. See text for details.*

Variants

Early power fuses in residential buildings consisted of bare nichrome wire wrapped around a porcelain holder. In the 1890s, Edison developed *plug fuses* in which the fuse was contained in a porcelain module with a screw thread, compatible with the base of an incandescent bulb. This design persisted in some U.S. urban areas for more than 70 years, is still found in old buildings, and is still being manufactured.

Small Cartridge Fuses

Small cartridge fuses for appliances and electronics equipment—such as those shown in Figure 4-2--are available in sizes tabulated in Figure 4-3. With the exception of the 4.5mm diameter fuse (a European addition), these sizes were originally measured in inches; today, they are often described only with the equivalent metric measurement. Any cartridge fuse is usually available with the option of a lead attached to it at each end, so that it can be used as a through-hole component.

Fuse type	Diameter (inches)	Diameter (metric)	Length (inches)	Length (metric)
1AG	1/4"	6mm	5/8"	16mm
2AG	0.177"	4.5mm	0.588"	15mm
3AG	1/4"	6mm	1-1/4"	32mm
4AG	9/32"	7mm	1-1/4"	32mm
5AG	13/32"	10mm	1-1/2"	38mm
7AG	1/4"	6mm	7/8"	22mm
8AG	1/4"	6mm	1"	25mm

Figure 4-3. *The approximate physical sizes of commonly used small glass or ceramic cartridge fuses are shown here with the codes that are often used to identify them.*

Fuses may be fast acting, medium acting, or slow-blowing, the last of which may alternatively be referred to as *delay fuses*. Extra-fast–acting fuses are available from some manufacturers. The term *Slo-Blo* is often used but is actually a trademark of Littelfuse. None of the terms describing the speed of action of a fuse has been standardized with a specific time or time range.

Some cartridge fuses are available in a ceramic format as an alternative to the more common glass cylinder. If accidental application of extremely high current is possible (for example, in a multimeter that can be set to measure amps, and may be accidentally connected across a powerful battery), a ceramic cartridge is preferable because it contains a filler that will help to stop an arc from forming. Also, if a fuse is physically destroyed by application of very high current, ceramic fragments may be preferable to glass fragments.

Automotive Fuses

Automotive fuses are identifiable by their use of blades designed for insertion in flat sockets where the fuse is unlikely to loosen as a result of vibration or temperature changes. The fuses come in various sizes, and are uniformly color-coded for easy identification.

A selection of automotive fuses is shown in Figure 4-4. The type at the top is typically described as a "maxi-fuse" while the type at bottom-left is a "mini-fuse." Here again, size is irrelevant to function, as all three of those pictured are rated 30A at 32V.

Figure 4-4. *Three automotive fuses. All have the same rating: 30A at 32V.*

In Figure 4-5, the largest of the fuses from Figure 4-4 has been cut open to reveal its element.

Figure 4-5. *The largest fuse from the previous figure, cut open to reveal its element.*

Usually automotive fuses are mounted together in a block, but if aftermarket accessory equipment is added, it may be protected by an inline fuse in a holder that terminates in two wires. This is shown with two sample fuses in Figure 4-6. Similar inline fuse holders are manufactured for other types of fuses.

Strip Fuses

High-amperage fuses for vehicles may be sold in "strip fuse" format, also known as a *fusible link*, designed to be clamped between two screw-down terminals. Since some **jumpers** may look very similar, it is important to keep them separate. A strip fuse is shown in Figure 4-7.

Through-Hole Fuses

Small fuses with radial leads, which seem appropriate for through-hole insertion in printed circuit boards, are actually often used in conjunction with appropriate sockets, so that they can be easily replaced. They are described in catalogues as "subminiature fuses" and are typically found in laptop computers and their power supplies, also televisions, battery chargers, and air conditioners. Three examples are shown in Figure 4-8. All have slow-blowing characteristics.

Figure 4-6. *Two blade-type fuses, commonly used for automotive applications, shown with an inline fuse holder. The plastic cap, at right, is closed over the holder when a fuse has been installed.*

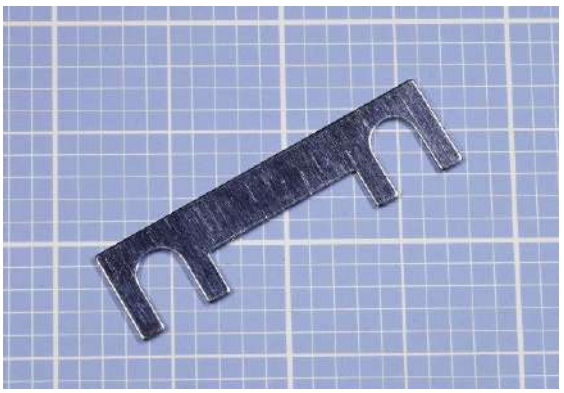

Figure 4-7. *This strip fuse is intended for use in diesel vehicles. The example shown is rated 100A at 36V.*

Resettable Fuses

Properly known as a *polymeric positive temperature coefficient* fuse (often abbreviated *PTC* or *PPTC*), a *resettable fuse* is a solid-state, encapsulated component that greatly increases its resistance in response to a current overload, but gradually returns to its original condition when the flow of current is discontinued. It can be thought

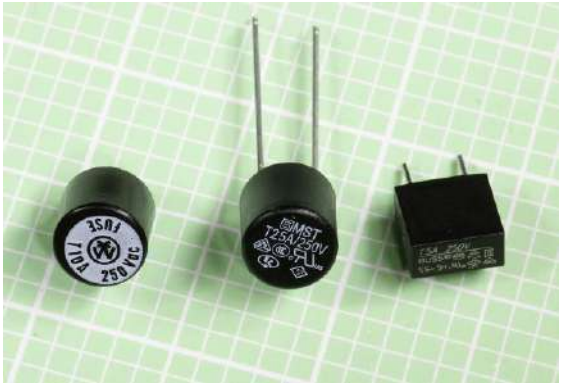

Figure 4-8. *Three subminiature fuses terminating in wire leads. From left to right: 10A at 250V, 2.5A at 250V, and 5A at 250V.*

of as a **thermistor** that has a nonlinear response. Three through-hole examples are shown in Figure 4-9. While different sizes of cartridge fuse may share the same ratings, differently rated resettable fuses may be identical in size. The one on the left is rated 40A at 30V, while the one on the right is rated 2.5A at 30V. (Note that the codes printed on the fuses are not the same as their manufacturer part numbers.) The fuse at the top is rated 1A at 135V.

When more than the maximum current passes through the fuse, its internal resistance increases suddenly from a few ohms to hundreds of thousands of ohms. This is known as *tripping* the fuse. This inevitably entails a small delay, but is comparable to the time taken for a slow-blowing fuse to respond.

A resettable fuse contains a polymer whose crystalline structure is loaded with graphite particles that conduct electricity. As current flowing through the fuse induces heat, the polymer transitions to an amorphous state, separating the graphite particles and interrupting the conductive pathways. A small current still passes through the component, sufficient to maintain its amorphous state until power is disconnected.

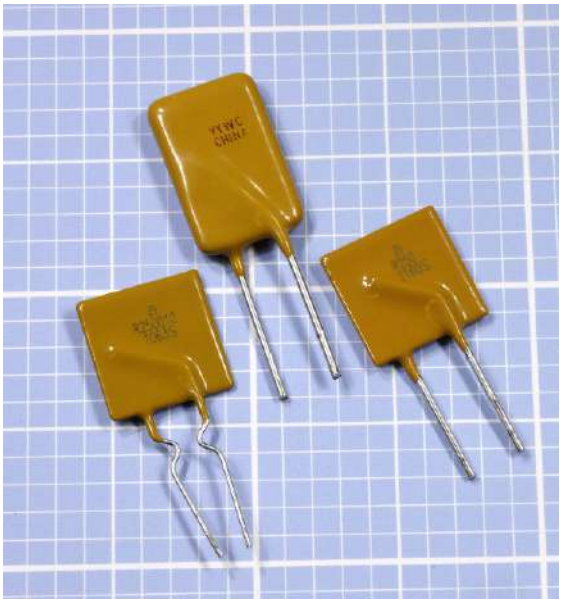

Figure 4-9. *Some through-hole resettable fuses. See text for details.*

After the resettable fuse cools, it gradually recrystallizes, although its resistance does not fall back completely to its original value for more than an hour.

The maximum safe level of current for a resettable fuse is known as the *hold current*, while the current that triggers its response is termed the *trip current*. Resettable fuses are available with trip-current ratings from 20mA to 100A. While conventional appliance and electronics fuses may be rated as high as 600V, resettable fuses are seldom rated above 100V.

Typical cartridge fuses are affected only to a minor extent by temperature, but the current rating of a resettable fuse may diminish to 75% of its normal value at 50 degrees Centigrade and may drop to 50% of its normal value at 80 degrees Centigrade. In other words, a fuse that is rated for 4A at 25 degrees may tolerate a maximum of only 3A when it operates at twice that temperature. See Figure 4-10.

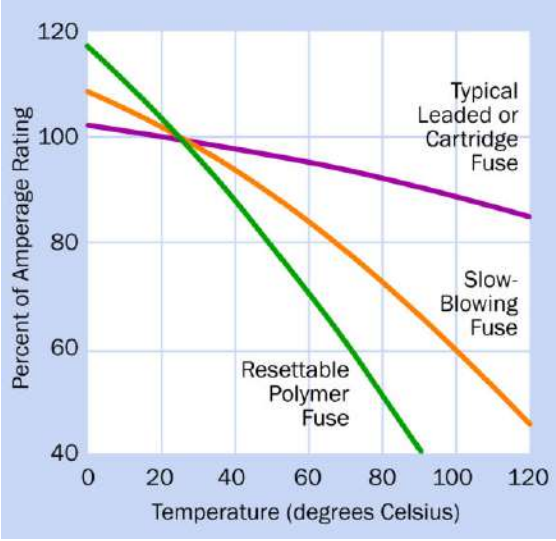

Figure 4-10. *The three curves give a very approximate idea of the temperature sensitivity of three types of fuses commonly used to protect electronic equipment. The left-hand scale provides an approximate value for the amperage which will trip the fuse.*

Conventional slow-blowing fuses are temperature-sensitive, but to a lesser degree than resettable fuses.

Resettable fuses are used in computer power supplies, USB power sources, and loudspeaker enclosures, where they protect the speaker coils from being overdriven. They are appropriate in situations where a fuse may be tripped relatively often, or where technically unsophisticated users may feel unable to replace a fuse or reset a circuit breaker.

Brand names for resettable fuses include PolySwitch, OptiReset, Everfuse, Polyfuse, and Multifuse. They are available in *surface-mount* (SMT) packages or as *through-hole* components, but not in cartridge format.

Surface Mount Fuses

Because surface-mount fuses are difficult or impossible to replace after they have been soldered onto the board, they are often resettable.

A surface-mount resettable fuse approximately 0.3" square is shown in Figure 4-11. It is rated for 230V and has an internal resistance of 50 ohms. Its hold current is 0.09A and its trip current is 0.19A.

Figure 4-11. *A surface-mount resettable fuse. See text for details.*

How to Use it

Any equipment that may be plugged into a wall outlet should be fused, not only to protect its components but also to protect users who may open the box and start investigating with a screwdriver.

Equipment that contains powerful motors, pumps, or other inductive loads should be protected with slow-blowing fuses, as the initial surge of current when the equipment is switched on is likely to rise well above the rating of the fuse. A slow-blowing fuse will tolerate a surge for a couple of seconds. Other fuses will not.

Conversely, fast-acting fuses should be used with electronic equipment, especially integrated circuits that are quickly and easily damaged.

Any device using substantial **battery** power should be fused because of the unpredictable and generally bad behavior of batteries when they are short-circuited. Parallel connections between multiple large batteries should be fused

to avoid the possibility that a highly charged battery may attempt to recharge its neighbor(s). Large "J size" fuses rated from 125A to 450A have become common in the solar power community, where banks of lead-acid batteries are often used. These fuses have a thick brass tab at each end, drilled so that they can be bolted into place. Alternatively, they will push-fit into an appropriate *fuseholder*.

For cartridge fuses up to 1/4" in diameter that don't have leads attached, appropriately sized fuseholders are available in several formats:

Panel mounted fuse enclosure is probably the most common, consisting of a plastic tube with a spring-contact at the bottom, and a plastic cap with a second contact inside. The cap either screws onto the tube of the fuse, or is pushed down and turned to hold it in place. A nut is provided to secure the fuseholder after it has been inserted into a hole drilled in the panel. The fuse is dropped into the tube, and the cap is applied. This type of holder is available in full-length or shorter, "low profile" formats. A low-profile holder is shown in Figure 4-12. It is shown assembled at right, with its component parts disassembled alongside.

Figure 4-12. *A low-profile panel-mounted fuse holder shown disassembled (left) and assembled (right).*

Circuit board mounted fuse enclosure is basically the same as the panel-mounted version, but with through-hole solder pins attached.

Fuse block is a small plastic block with two clips on its upper surface for insertion of a cartridge fuse.

Fuse clips can be bought individually, with solder pins for through-hole mounting.

Inline fuse holder is designed to be inserted in a length of wire. Usually made of plastic, it will either terminate it, wires or will have metal contacts to crimp or solder at each end. See Figure 4-6.

Through-hole fuse holders are available for subminiature fuses.

What Can Go Wrong

Repeated Failure

When a fuse in a circuit blows frequently, this is known as *nuisance opening*. Often it can result from failure to take into account all the aspects of the circuit, such as a large filtering capacitor in a power supply that draws a major surge of current when the power supply is switched on. The formally correct procedure to address this problem is to measure the power surge, properly known as *peak inrush current*, with an oscilloscope, calculate the $I^2 * t$ of the wave form, and select a fuse with a rating at least 5 times that value.

A fuse should never be replaced with an equivalent length of wire or any other conductor.

Soldering Damage

When a through-hole or surface-mount fuse is soldered into place, heat from the soldering process can cause the soft metal element inside the fuse to melt partially and reflow. This is likely to change the rating of the fuse. Generally, fuses should be treated with the same caution as semiconductors when they are fixed in place with solder.

Placement

A fuse should be placed close to the power source or power input point in a circuit, so that it protects as much of the circuit as possible.

pushbutton

5

Often referred to as a *pushbutton switch* and sometimes as a *momentary switch*. In this encyclopedia, a pushbutton is considered separately from a **switch**, which generally uses a lever-shaped actuator rather than a button, and has at least one *pole* contact where a pushbutton generally has contacts that are not distinguishable from each other.

OTHER RELATED COMPONENTS

- **switch** (See Chapter 6)
- **rotary switch** (See Chapter 7)

What It Does

A pushbutton contains at least two contacts, which close or open when the button is pressed. Usually a spring restores the button to its original position when external pressure is released. Figure 5-1 shows schematic symbols for pushbuttons. The symbols that share each blue rectangle are functionally identical. At top is a normally-open single-throw pushbutton. At center is a normally-closed single-throw pushbutton. At bottom is a double-throw pushbutton.

Unlike a **switch**, a basic pushbutton does not have a primary contact that can be identified as the *pole*. However, a single pushbutton may close or open two separate pairs of contacts, in which case it can be referred to, a little misleadingly, as a double-pole pushbutton. See Figure 5-2. Different symbols are used for slider pushbuttons with multiple contact pairs; see "Slider" (page 31).

A generic full-size, two-contact pushbutton is shown in Figure 5-3.

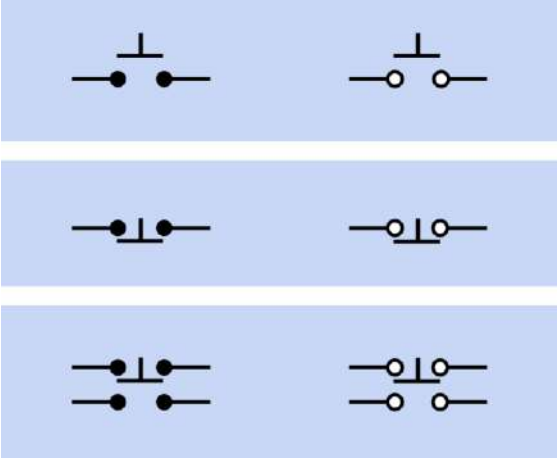

Figure 5-1. *Commonly used schematic symbols to represent a simple pushbutton. See text for details.*

How It Works

Figure 5-4 shows a cross-section of a pushbutton that has a single steel return spring, to create resistance to downward force on the button, and a pair of springs above a pair of contacts, to hold each contact in place and make a firm connection when the button is pressed. The two upper contacts are electrically linked, although this feature is not shown.

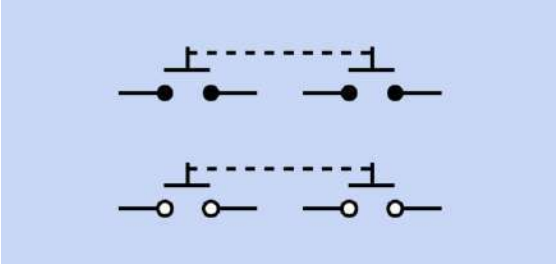

Figure 5-2. *Commonly used schematic symbols to represent a double-pole pushbutton.*

Figure 5-4. *Cross-section of a pushbutton showing two spring-loaded contacts and a single return spring.*

Variants

Poles and Throws

Abbreviations that identify the number of poles and contacts inside a pushbutton are the same as the abbreviations that identify those attributes in a **switch**. A few examples will make this clear:

SPST, also known as 1P1T
: Single pole, single throw

DPST also known as 2P1T
: Double pole, single throw

Figure 5-3. *The simplest, traditional form of pushbutton, in which pressing the button creates a connection between two contacts.*

SPDT also known as 1P2T
: Single pole, double throw

3PST also known as 3P1T
: Three pole, single throw

While a switch may have an additional center position, pushbuttons generally do not.

On-Off Behavior

Parentheses are used to indicate the momentary state of the pushbutton while it is pressed. It will return to the other state by default.

OFF-(ON) or (ON)-OFF
: Contacts are normally open by default, and are closed only while the button is pressed. This is sometimes described as a *make-to-make* connection, or as a *Form A* pushbutton.

ON-(OFF) or (OFF)-ON
: Contacts are normally closed by default, and are open only while the button is pressed. This is sometimes described as a *make-to-break* connection, or as a *Form B* pushbutton.

ON-(ON) or (ON)-ON
: This is a double-throw pushbutton in which one set of contacts is normally closed. When the button is pressed, the first set of contacts

is opened and the other set of contacts is closed, until the button is released. This is sometimes described as a *Form C* pushbutton.

For a single-throw pushbutton, the terms NC or NO may be used to describe it as *normally closed* or *normally open*.

Slider

This type, also known as a *slide* pushbutton, contains a thin bar or rod that slides in and out of a long, narrow enclosure. Contacts on the rod rub across secondary contacts inside the enclosure. Closely resembling a slider switch, it is cheap, compact, and well adapted for multiple connections (up to 8 separate poles in some models). However, it can only tolerate low currents, has limited durability, and is vulnerable to contamination.

A four-pole, double-throw pushbutton is shown in Figure 5-5. A variety of plastic caps can be obtained to press-fit onto the end of the white nylon actuator.

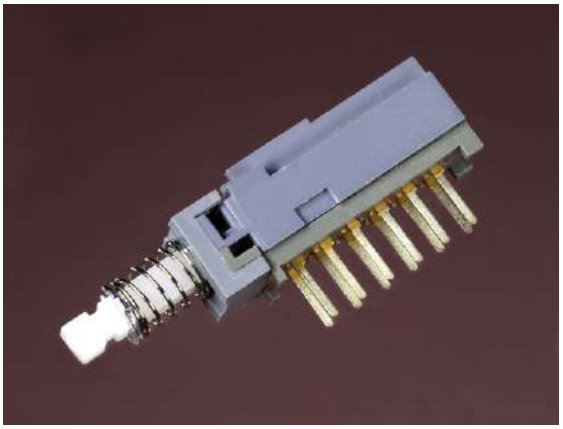

Figure 5-5. *A 4PDT slider pushbutton, shown without the cap that can be snapped onto the end of the actuator.*

Figure 5-6 shows schematic symbols for two possible slide pushbuttons, with a black rectangle indicating each sliding contact. The lead that functions as a pole is marked with a P in each case. Standardization for slide pushbutton schematic symbols does not really exist, but these examples are fairly typical. An insulating section that connects the sliding contacts internally is shown here as a gray rectangle, but in some datasheets may appear as a line or an open rectangle.

Since the symbols for a slide pushbutton may be identical to the symbols for a slide switch, care must be taken when examining a schematic, to determine which type of component is intended.

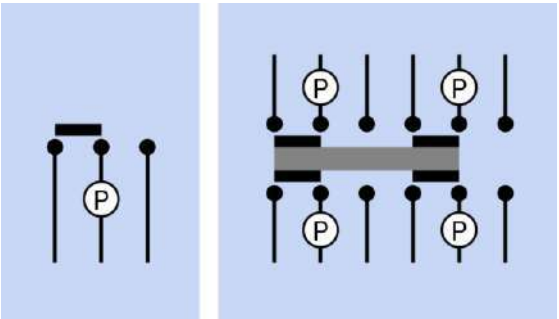

Figure 5-6. *Left: schematic symbol for a simple SPDT slide pushbutton, where a movable contact shorts together either the left pair or right pair of fixed contacts. Right: A 4PDT pushbutton in which the same principle has been extended. The movable contacts are attached to each other mechanically by an insulator. Each pole terminal is marked with a P.*

Styles

Many pushbutton switches are sold without caps attached. This allows the user to choose from a selection of styles and colors. Typically the cap is a push-fit onto the end of the rod or bar that activates the internal contacts. Some sample caps are shown in Figure 5-7, alongside a DPDT pushbutton. Any of the caps will snap-fit onto its actuator.

An *illuminated* pushbutton contains a small *incandescent bulb*, *neon bulb*, or **LED** (*light-emitting diode*). The light source almost always has its own two terminals, which are isolated from the other terminals on the button housing and can be wired to activate the light when the button is pressed, when it is released, or on some other basis. Pushbuttons containing LEDs usually

Figure 5-7. *Caps (buttons or knobs) that may be sold as separate accessories for some pushbuttons, shown here alongside a compatible pushbutton switch.*

require external series resistors, which should be chosen according to the voltage that will be used. See the **LED** entry in Volume 2 for additional commentary on appropriate series resistors. An example of an illuminated pushbutton is shown in Figure 5-8. This is a DPDT component, designed to be mounted on a printed circuit board, with an additional lead at each end connecting with an internal LED underneath the translucent white button.

Termination and Contact Plating

These options are the same as for a **switch** and are described in that entry.

Mounting Style

The traditional panel-mounted button is usually secured through a hole in the panel by tightening a nut that engages with a thread on the bushing of the pushbutton. Alternatively, a pushbutton housing can have flexible plastic protrusions on either side, allowing it to be snapped into place in an appropriate-sized panel cutout. This style is shown in Figure 5-4.

Figure 5-8. *This pushbutton contains an LED underneath the white translucent button.*

PC pushbuttons (pushbuttons mounted in a printed circuit board, or PCB) are a common variant. After the component has been installed in the circuit board, either the button must align with a cutout in the front panel and poke through it when the device is assembled, or an external (non-electrical) button that is part of the product enclosure must press on the actuator of the pushbutton after assembly.

Surface-mount pushbuttons that allow direct fingertip access are uncommon. However, about one-quarter of tactile switches are designed for surface mount at the time of writing. They are typically found beneath membranes that the user presses to activate the switch beneath—for example, in remotes that are used to operate electronic devices.

Sealed or Unsealed

A sealed pushbutton will include protection against water, dust, dirt, and other environmental hazards, at some additional cost.

Latching

This variant, also known as a *press-twice* pushbutton, contains a mechanical ratchet, which is rotated each time the button is pressed. The first press causes contacts to latch in the closed state. The second press returns the contacts to the open state, after which, the process repeats. This press-twice design is typically found on flashlights, audio equipment, and in automotive applications. While *latching* is the most commonly used term, it is also known as *push-push*, *locking*, *push-lock push-release*, *push-on push-off*, and *alternate*.

In a latching pushbutton with *lockdown*, the button is visibly lower in the latched state than in the unlatched state. However, buttons that behave this way are not always identified as doing so on their datasheets.

A six-pole double-throw pushbutton that latches and then unlatches each time it is pressed is shown in Figure 5-9.

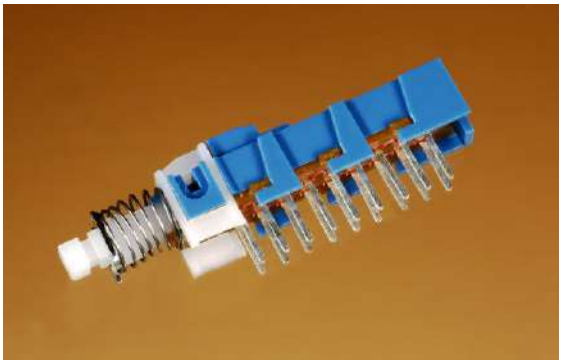

Figure 5-9. *This 6PDT pushbutton latches and then unlatches, each time it is pressed.*

Two more variants are shown in Figure 5-10. On the right is a simple DPDT latching pushbutton with lockdown. On the left is a latching pushbutton that cycles through four states, beginning with one "off" state, the remaining three connecting a different pair of its wires in turn.

A simple OFF-(ON) button may appear to have a latching output if it sends a pulse to a **microcontroller** in which software inside the microcontroller toggles an output between two states. The microcontroller can step through an unlimited number of options in response to each button press. Examples are found on cellular phones or portable media players.

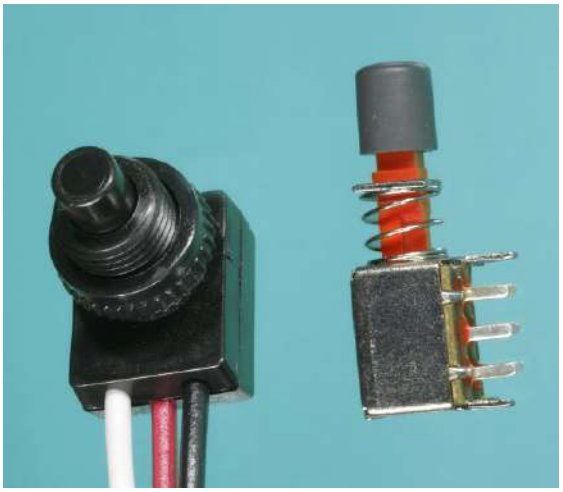

Figure 5-10. *At right, a simple DPDT latching pushbutton with lockdown. At left, this pushbutton cycles through four states, one of them an "off" state, the others connecting a different pair of its wires in turn.*

A mechanically latching pushbutton has a higher failure rate than a simple OFF-(ON) button, as a result of its internal mechanism, but has the advantage of requiring no additional microcontroller to create its output. Microcontrollers are discussed in Volume 2.

Foot Pedal

Foot pedal pushbuttons generally require more actuation force than those intended for manual use. They are ruggedly built and are commonly found in vacuum cleaners, audio-transcription foot pedals, and "stomp boxes" used by musicians.

Keypad

A keypad is a rectangular array of usually 12 or 16 OFF-(ON) buttons. Their contacts are accessed via a *header* suitable for connection with a ribbon cable or insertion into a printed circuit board. In some keypads, each button connects with a

separate contact in the header, while all the buttons share a common ground. More often, the buttons are *matrix encoded*, meaning that each of them bridges a unique pair of conductors in a matrix. A 16-button matrix is shown in Figure 5-11. This configuration is suitable for polling by a **microcontroller**, which can be programmed to send an output pulse to each of the four horizontal wires in turn. During each pulse, it checks the remaining four vertical wires in sequence, to determine which one, if any, is carrying a signal. Pullup or pulldown resistors should be added to the input wires to prevent the inputs of the microcontroller from behaving unpredictably when no signal is present. The external appearance of two keypads is shown in Figure 5-12.

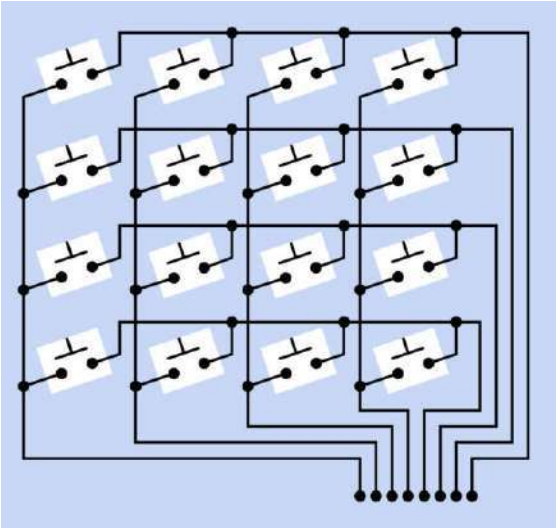

Figure 5-11. *Buttons in a numeric keypad are usually wired as a matrix, where each button makes a connection between a unique pair of wires. This system is suitable for being polled by a microcontroller.*

Tactile Switch

Despite being called a switch, this is a miniature pushbutton, less than 0.4" square, designed for insertion in a printed-circuit board or in a solderless breadboard. It is almost always a SPST device but may have four pins, one pair connected to each contact. Tactile switches may be PC-mounted behind membrane pads. An example is shown in Figure 5-13.

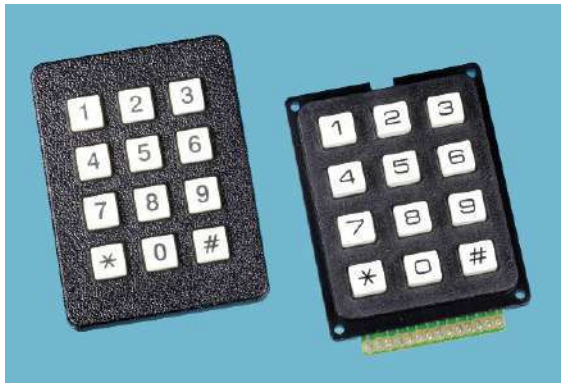

Figure 5-12. *The keypad on the left is matrix-encoded, and is polled via seven through-hole pins that protrude behind it. The keypad on the right assigns each button to a separate contact in its header. See the text for details about matrix encoding.*

Figure 5-13. *A typical tactile switch.*

Membrane Pad

Typically found on devices such as microwave ovens where contacts must be sealed against particles and liquids. Finger pressure on a membrane pad closes hidden or internal pushbuttons. They are usually custom-designed for specific product applications and are not generally available as generic off-the-shelf components. Some surplus pads may be found for sale on auction websites.

Radio Buttons

The term *radio buttons* is sometimes used to identify a set of pushbuttons that are mechanically interlinked so that only one of them can make an electrical connection at a time. If one button is pressed, it latches. If a second button is pressed, it latches while unlatching the first button. The buttons can be pressed in any sequence. This system is useful for applications such as component selection in a stereo system, where only one input can be permitted at a time. However, its use is becoming less common.

Snap-Action Switches

A snap-action switch (described in detail in the **switch** section of this encyclopedia) can be fitted with a pushbutton, as shown in Figure 5-14. This provides a pleasingly precise action, high reliability, and capability of switching currents of around 5A. However, snap-action switches are almost always single-pole devices.

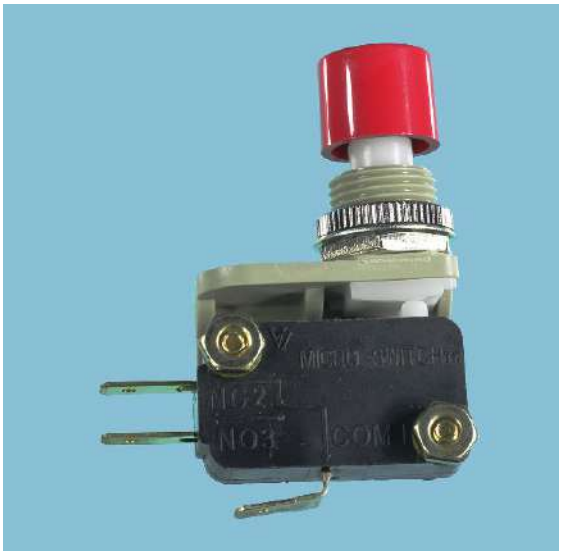

Figure 5-14. *A pushbutton mounted on top of a SPDT snap-action switch.*

Emergency Switch

An emergency switch is a normally-closed device, usually consisting of a large pushbutton that clicks firmly into its "off" position when pressed, and does not spring back. A flange around the button allows it to be grasped and pulled outward to restore it to its "on" position.

Values

Pushbutton current ratings range from a few mA to 20A or more. Many pushbuttons have their current ratings printed on them but some do not. Current ratings are usually specified for a particular voltage, and may differ for AC versus DC.

How to Use it

Issues such as appearance, tactile feel, physical size, and ease of product assembly tend to dictate the choice of a pushbutton, after the fundamental requirements of voltage, current, and durability have been satisfied. Like any electromechanical component, a pushbutton is vulnerable to dirt and moisture. The ways in which a device may be used or abused should be taken into account when deciding whether the extra expense of a sealed component is justified.

When a pushbutton controls a device that has a high inductive load, a *snubber* can be added to minimize arcing. See "Arcing" (page 47) in the **switch** entry of this encyclopedia, for additional information.

What Can Go Wrong

No Button

When ordering a pushbutton switch, read datasheets carefully to determine whether a cap is included. Caps are often sold separately and may not be interchangeable between switches from different manufacturers.

Mounting Problems

In a panel-mount pushbutton that is secured by turning a nut, the nut may loosen with use, allowing the component to fall inside its enclosure when the button is pressed. Conversely, overtightening the nut may strip the threads on the

pushbutton bushing, especially in cheaper components where the threads are molded into plastic. Consider applying a drop of Loc-Tite or similar adhesive before completely tightening the nut. Nut sizes vary widely, and finding a replacement may be time-consuming.

LED Issues

When using a pushbutton containing an LED, be careful to distinguish the LED power terminals from the switched terminals. The manufacturer's datasheet should clarify this distinction, but the polarity of the LED terminals may not be clearly indicated. If a diode-testing meter function is unavailable, a sample of the switch should be tested with a source of 3 to 5VDC and a 2K series resistor. Briefly touching the power to the LED terminals, through the resistor, should cause the LED to flash dimly if the polarity is correct, but should not be sufficient to burn out the LED if the polarity is incorrect.

Other Problems

Problems such as arcing, overload, short circuits, wrong terminal type, and contact bounce are generally the same as those associated with a **switch**, and are summarized in that entry in this encyclopedia.

switch

The term **switch** refers here to a physically operated mechanical switch, controlled by flipping a lever or sliding a knob. Although there is some overlap of function, **rotary switches** and **pushbuttons** have their own separate entries. Solid-state switching components are described in entries for **bipolar transistor**, **unijunction transistor**, and **field-effect transistor**. Integrated-circuit switching devices will be found in Volume 2. *Coaxial switches* are used for high-frequency signals, and are not included in this encyclopedia. *Multidirectional switches* differentiate up, down, left, right, diagonal, rotational, and other finger inputs, and are not included in this encyclopedia.

OTHER RELATED COMPONENTS

- **pushbutton** (See Chapter 5)
- **rotary switch** (See Chapter 7)

What It Does

A switch contains at least two contacts, which close or open when an external lever or knob is flipped or moved. Schematic symbols for the most basic type of on-off switch are shown in Figure 6-1.

The most fundamental type of switch is a *knife switch*, illustrated in Figure 6-2. Although it was common in the earliest days of electrical discovery, today it is restricted to educational purposes in schools, and (in a more robust format) to AC electrical supply panels, where the large contact area makes it appropriate for conducting high amperages, and it can be used for "hot switching" a substantial load.

How It Works

The *pole* of a switch is generally connected with a movable contact that makes or breaks a connection with a secondary contact. If there is only one pole, this is a *single-pole* switch. If there is an additional pole, electrically isolated from the first, with its own contact or set of contacts, this is a *two-pole* switch, also known as a *double-pole* switch. Switches with more than 4 poles are uncommon.

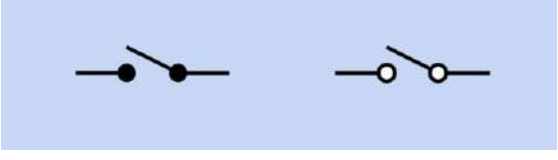

Figure 6-1. *The two most common schematic symbols for a SPST switch, also known as an on-off switch. The symbols are functionally identical.*

If there is only one secondary contact per pole, this is a *single-throw* or *ST* switch, which may also be described as an *on-off* or *off-on* switch. If there is an additional secondary contact per pole, and the pole of the switch connects with the second contact while disconnecting from the first, this is a *double-throw* or *DT* switch, also known as a *two-way* switch.

Figure 6-2. *A DPST knife switch intended for the educational environment.*

A double-throw switch may have an additional center position. This position may have no connection (it is an "off" position) or in some cases it connects with a third contact.

Where a switch is spring-loaded to return to one of its positions when manual pressure is released, it functions like a **pushbutton** even though its physical appearance may be indistinguishable from a switch.

Variants

Float switch, *mercury switch*, *reed switch*, *pressure switch*, and *Hall-effect switch* are considered as sensing devices, and will be found in Volume 3.

Terminology

Many different types of switches contain parts that serve the same common functions. The *actuator* is the lever, knob, or toggle that the user turns or pushes. A *bushing* surrounds the actuator on a toggle-type switch. The *common contact* inside a switch is connected with the *pole* of the switch. Usually a *movable contact* is attached to it internally, to touch the secondary contact, also known as a *stationary contact* when the movable contact is flipped to and fro.

Poles and Throws

Abbreviations identify the number of poles and contacts inside a switch. A few examples will make this clear:

SPST also known as 1P1T
: Single pole, single throw

DPST also known as 2P1T
: Double pole, single throw

SPDT also known as 1P2T
: Single pole, double throw

3PST also known as 3P1T
: Three pole, single throw

Other combinations are possible.

In Figure 6-3, schematic symbols are shown for double-throw switches with 1, 2, and 3 poles. The dashed lines indicate a mechanical connection, so that all sections of the switch move together when the switch is turned. No electrical connection exists between the poles.

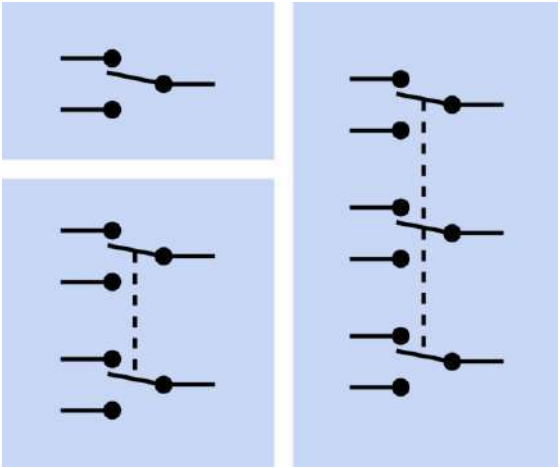

Figure 6-3. *Schematic symbols to represent three types of double-throw switch. Top left: Single-pole. Bottom left: Double-pole. Right: Triple-pole, more commonly known as 3-pole.*

On-Off Behavior

The words ON and OFF are used to indicate the possible states of a switch. The additional word NONE is used by some manufacturers to indicate that a switch does not have a center position. Some manufacturers don't bother with the word NONE, assuming that if the word is omitted, a center position does not exist.

ON-OFF or ON-NONE-OFF
: A basic on-off SPST switch with no center position.

ON-ON or ON-NONE-ON
: A basic SPDT switch with no center position.

ON-OFF-ON
: A double-throw switch with center-off position (no connection when the switch is centered).

ON-ON-ON
: A triple-throw switch where the center position connects with its own set of terminals.

Parentheses are used in descriptions of spring-loaded switches to indicate a momentary state that lasts only as long as pressure is applied to the actuator.

(ON)-OFF or OFF-(ON)
: A spring-loaded switch that is normally off and returns to that position when pressure is released. Also known as *NO* (normally open), and sometimes described as *FORM A*. Its performance is similar to that of a push-button and is sometimes described as a *make-to-make* connection.

ON-(OFF) or (OFF)-ON
: A spring-loaded switch that is normally on and returns to that position when pressure is released. This is sometimes described as a *make-to-break* connection. Also known as *NC* (normally closed), and sometimes described as *FORM B*.

(ON)-OFF-(ON)
: A spring-loaded double-throw switch with a no-connection center position to which it returns when pressure on its actuator is released.

Other combinations of these terms are possible.

Most double-throw switches break the connection with one contact (or set of contacts) before making the connection with the second contact (or set of contacts). This is known as a *break before make* switch. Much less common is a *make before break* switch, also known as a *shorting switch*, which establishes the second connection a moment before the first connection is broken. Use of a shorting switch may cause unforeseen consequences in electronic components attached to it, as both sides of the switch will be briefly connected when the switch is turned.

Snap-Action

Also known as a *limit switch* and sometimes as a *microswitch* or *basic switch*. This utilitarian design is often intended to be triggered mechanically rather than with finger pressure, for example in 3D printers. It is generally cheap but reliable.

Two snap-action switches are shown in Figure 6-4. A sectional view of a snap-action ON-(ON) limit switch is shown in Figure 6-5. The pole contacts are mounted on a flexible strip which can move up and down in the center of the switch. The strip has a cutout which allows an inverted U-shaped spring to flip to and fro. It keeps the contacts pressed together in either of the switch states.

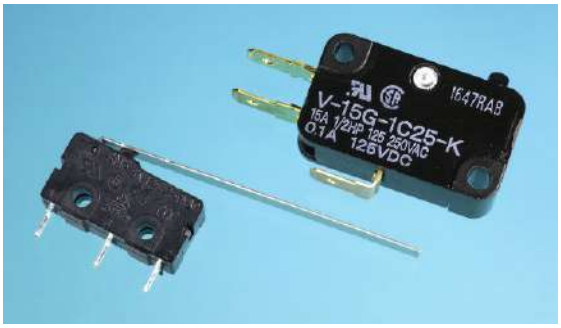

Figure 6-4. *Two SPDT snap-action switches, also known as limit switches. The one on the right is full-size. The one on the left is miniature, with an actuator arm to provide additional leverage. The arm may be trimmed to the required length.*

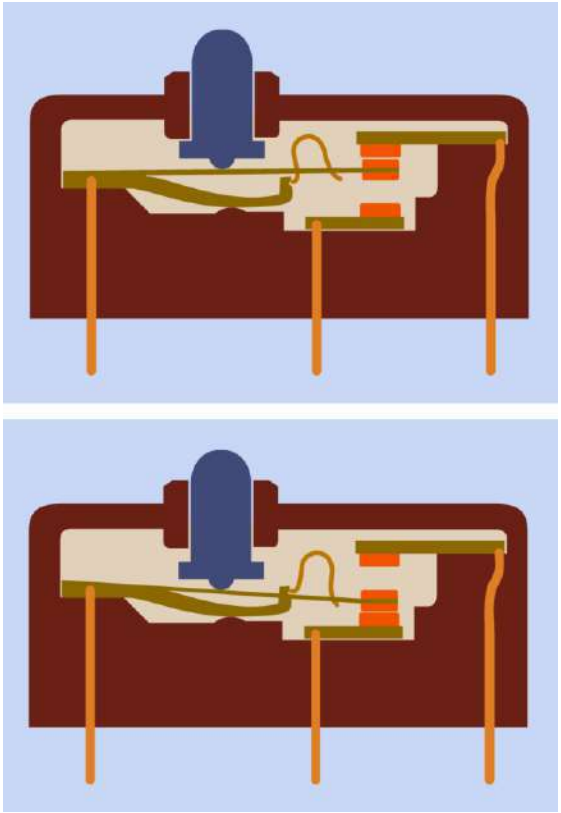

Figure 6-5. *Top: Two contacts inside this limit switch are touching by default. Bottom: When the external button is pressed, it pushes a flexible metal strip downward until it connects with the lower contact. The inverted-U–shaped component is a spring that rests inside a cutout in the flexible strip and resists motion through the central part of its travel.*

The term *snap action* refers to a spring-loaded internal mechanism which snaps to and fro between its two positions. This type of switch is usually SPDT and has a momentary action; in other words, it functions in ON-(ON) mode, although OFF-(ON) and (less often) ON-(OFF) versions are available. The body of the switch is sealed, with a small button protruding through a hole. A thin metal arm may provide additional leverage to press the button. A roller may be mounted at the end of the arm so that the switch can be activated as it slides against a moving mechanical component such as a cam or a wheel. The switch is commonly used to limit the travel or rotation of such a component. Literally thousands of variants are available, in different sizes, requiring different amounts of force for activation. Subminiature snap-action switches can often be actuated by a pressure of only a few grams.

Rocker

Three rocker switches are shown in Figure 6-6. A sectional view of a rocker switch is shown in Figure 6-7. In this design, a spring-loaded ball bearing rolls to either end of a central rocker arm when the switch is turned. Rocker switches are often used as power on-off switches.

Slider

Many types of slider switch (also known as *slide switch*) are widely used as a low-cost but versatile way to control small electronic devices, from clock-radios to stereos. The switch is usually mounted on a circuit board, and its knob or cap protrudes through a slot in the panel. This design is more vulnerable to dirt and moisture than other types of switch. It is usually cheaper than a toggle switch but is seldom designed for use with a high current.

Most slide switches have two positions, and function as SPDT or DPDT switches, but other configurations are less commonly available with more poles and/or positions. A subminiature slide switch is shown in Figure 6-8, while some schematic representations are shown in Figure 6-9,

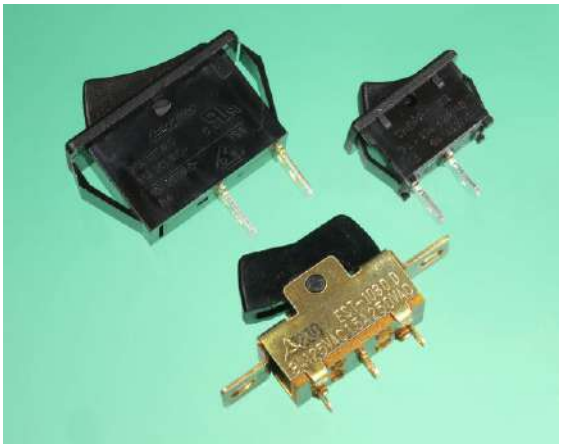

Figure 6-6. *Three rocker switches, the upper two designed for push-insertion into a suitably sized rectangular hole in a panel. The switch at front-center is intended to be screwed in place, and is more than 20 years old, showing that while the choice of materials has changed, the basic design has not.*

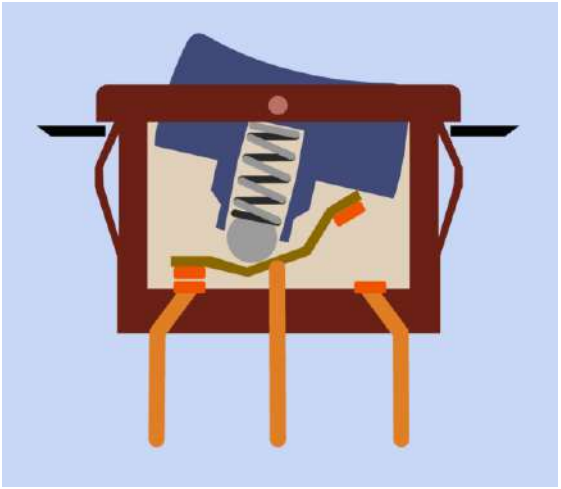

Figure 6-7. *This sectional view of a rocker switch shows a spring-loaded ball-bearing that rolls to and fro along a rocker arm, connecting either pair of contacts when the switch is turned.*

where a black rectangle indicates a sliding internal contact, and a terminal that functions as a pole is identified with letter P in each case. Top left: A SPDT switch using a two-position slider. Top right: A 4PDT slide switch. Bottom left: There are no poles in this switch, as such. The slider can short together any of four pairs of contacts. Bottom right: The slider shorts together three possible pairs of contacts out of four. Here again, there is no pole.

Note that the schematic representation of a slide switch may be identical to that of a slide **push-button**. A schematic should be inspected carefully to determine which type is intended.

Figure 6-8. *This subminiature slide switch is less than half an inch long, rated 0.3A at 30VDC. Larger versions look almost identical, but can handle only slightly more current.*

The representation of sliders in schematics has not been standardized, but the samples shown are common.

Toggle

A *toggle switch* provides a firm and precise action via a lever (the *toggle*) that is usually tear-drop shaped and nickel plated, although plastic toggles are common in cheaper variants. Formerly used to control almost all electronic components (including early computers), the toggle has declined in popularity but is still used in applications such as automobile accessory kits, motorboat instrument panels, and industrial controls.

Three miniature DPDT toggle switches are shown in Figure 6-10. Two full-size, heavy-duty toggle switches are shown in Figure 6-11. A full-size, four-pole, double-throw heavy-duty toggle switch is shown in Figure 6-12. Toggle switches with more poles are extremely rare.

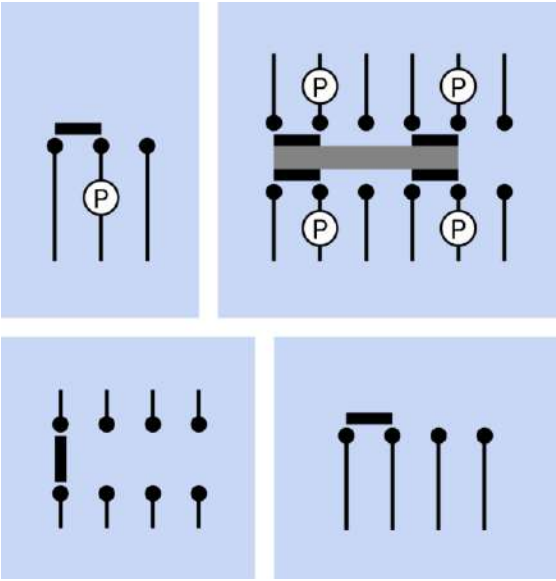

Figure 6-9. *Slide switch schematics. Each black rectangle represents a movable contact that connects two pairs of fixed contacts at a time. Detailed commentary on these variants will be found in the body of the text. Manufacturers may use variants of these symbols in their datasheets (for example, the gray rectangle indicating an insulating contact carrier, at top right, may be represented as a single line, or a black outline with a white center).*

Figure 6-10. *Three miniature toggle switches with current ratings ranging from 0.3A to 6A at 125VAC. Each small square in the background grid measures 0.1" x 0.1".*

An automotive toggle switch is shown in Figure 6-13. Its plastic toggle is extended to minimize operating error.

Figure 6-11. *Two full-size toggle switches capable of handling significant current. At left, the switch terminates in quick-connect terminals. At right, the switch has solder terminals (some of them containing residual traces of solder).*

Figure 6-12. *A 4PDT full-size toggle switch with solder terminals, capable of switching 25A at 125VAC. Four-pole switches are relatively unusual.*

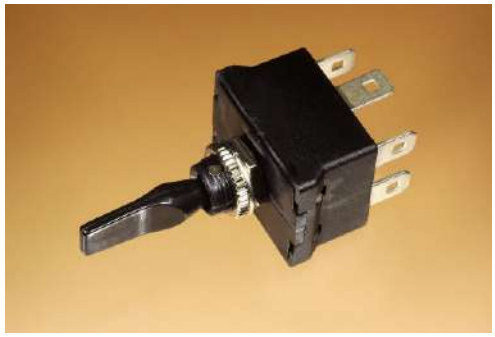

Figure 6-13. *A toggle switch intended for control of automotive accessories.*

High-end toggle switches are extremely durable and can be sealed from environmental

contamination with a thin *boot* made from molded rubber or vinyl, which screws in place over the toggle, using the thread on the switch bushing. See Figure 6-14.

Figure 6-14. *A rubber or vinyl boot can be used to protect a toggle switch from contamination with dirt or water. Each boot contains a nut that screws onto the threads of a toggle switch, as shown at left.*

A *locking toggle switch* has a toggle that must be pulled out against the force of a retaining spring, before the toggle can be moved from one position to another. The toggle then snaps back into place, usually engaging in a small slot in the bushing of the switch.

DIP

A DIP switch is an array of very small, separate switches, designed for mounting directly on a circuit board, either in through-hole or surface-mount format. Through-hole DIP switches have two rows of pins with a 0.1" pitch, the rows being spaced 0.3" apart to fit a standard DIP (dual-inline package) socket or comparable configuration of holes in the board. Surface-mount DIP switches may have 0.1" or 0.05" pitch.

Most DIP arrays consist of SPST switches, each of which can close or open a connection between two pins on opposite sides of the switch body. The switch positions are usually labelled ON and OFF. Figure 6-15 shows a selection of DIP switches. Figure 6-16 shows the internal connections in a DIP switch.

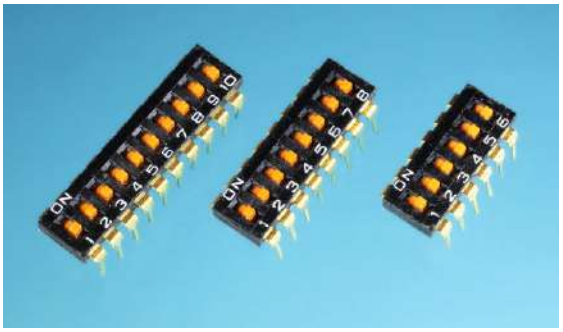

Figure 6-15. *As shown here, DIP switches are available with a variety of "positions," meaning the number of switches, not the number of switch states.*

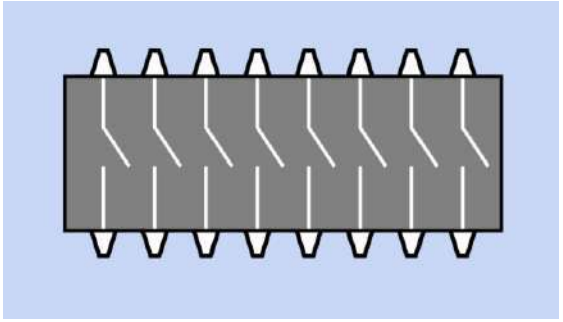

Figure 6-16. *The interior connections of a 16-pin DIP switch.*

The number of switches in a DIP array is usually referred to as its number of "positions." This should not be confused with the two positions of each physical switch lever. SPST DIP switches are made with 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, and 16 positions.

Early IBM-compatible desktop computers often required the user to set the position of an internal DIP switch when making routine upgrades such as installing an additional disk drive. While this feature is now obsolete, DIP switches are still used in scientific equipment where the user is expected to be sufficiently competent to open a cabinet and poke around inside it. Because of the 0.1" spacing, a small screwdriver or the tip of a pen is more appropriate than a finger to flip individual levers to and fro.

DIP switches may also be used during prototype development, as they allow a convenient way to test a circuit in numerous different modes of operation.

Most DIP switches have wire terminals which are just long enough for insertion into a standard breaboard.

DIP switch package options include standard, low-profile, right-angle (standing at 90 degrees relative to the circuit board), and piano (with switch levers designed to be pressed, like tiny rocker switches, instead of being flipped to and fro).

Some SPDT, DPST, DPDT, 3PST, and 4PST variants exist, but are uncommon. Multiple external pins connect with the additional internal switch contacts, and a manufacturer's datasheet should be consulted to confirm the pattern of internal connections. A surface-mount, 0.1" pitch, DPST DIP switch is shown in Figure 6-17, with a plastic cover to protect the switches from contamination during wave soldering (at left), and with the cover peeled off (at right).

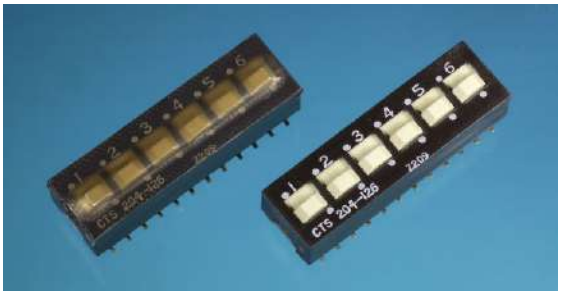

Figure 6-17. *A SPDT surface-mount double-throw DIP switch, sold with a plastic cover (shown at left) to protect it during wave soldering. The cover has been removed at right.*

SIP

A SIP switch is an array of small, separate switches, identical in concept to a DIP switch, but using only one row of pins instead of a double row. The applications for SIP switches are the same as DIP switches; the primary difference is simply that the SIP switch occupies a little less space, while being perhaps slightly less convenient to use.

One terminal of each switch usually shares a common bus. The internal connections in a typical 8-pin SIP array are shown in Figure 6-18. Pin spacing is 0.1", as in a typical DIP switch.

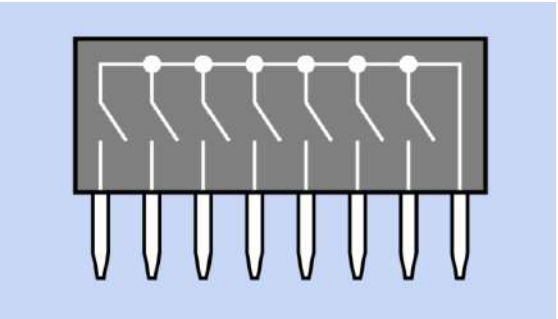

Figure 6-18. *The interior connections of an 8-pin SIP switch incorporating a common bus.*

Paddle

A paddle switch has a flat-sided tab-shaped plastic actuator, relatively large to allow a firm, error-free grip. Internally it is often comparable with a rocker switch, and is generally used with AC power. Some toggle-switch bodies are also sold with paddle-shaped actuators. A subminiature paddle switch is shown in Figure 6-19.

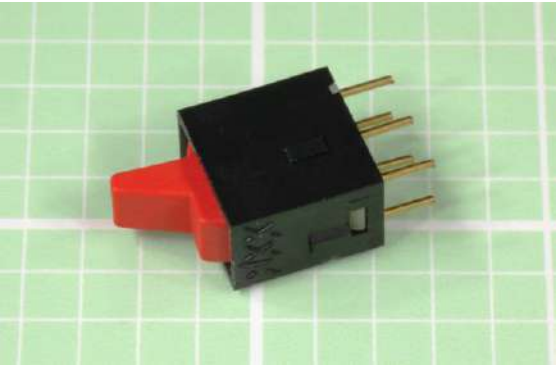

Figure 6-19. *A subminiature paddle switch. Full-size versions are often used as power switches.*

Vandal Resistant Switch

Typically fabricated from stainless steel, this is designed to withstand most types of abuse and is also weather-proof. The pushbuttons that allow pedestrians to trigger a traffic signal are a form of vandal-resistant switch.

Tactile Switch

This is considered to be a **pushbutton**, and is described in that entry. See "Tactile Switch" (page 34).

Mounting Options

A *panel mount* switch generally has a threaded bushing that is inserted from behind the front panel of a product, through a hole of appropriate size. It is supplied with a lockwasher and a nut (often, two nuts) that fit the thread on the switch bushing.

Front panel mount usually means that screws visible from the front of the panel are attached to a bracket on the switch behind the panel. The actuator of the switch is accessible through a cutout in the panel. This mounting style is mostly used for rocker switches and sometimes for slide switches.

Subpanel mount means that the switch is attached to a separate plate or chassis behind the control panel. The actuator of the switch is accessible through a cutout.

Snap-in mount requires a switch with flexible plastic or metal tabs each side, designed to push through a cutout in the panel, at which point the tabs spring out and retain the switch.

PC mount switches have pins that are soldered into a printed circuit board. They may have additional solderable lugs to provide mechanical support.

Surface mount switches are attached to a board in the same manner as other surface-mount components.

Termination

Switches (and pushbuttons) are available with a variety of terminals.

Solder lugs are small tabs, each usually perforated with a hole through which the end of a wire can be inserted prior to soldering.

PC terminals are pins that protrude from the bottom of the switch, suitable for insertion in a printed circuit board. This style is also known as a *through-hole*. The terminals may have a right-angle bend to allow the component to be mounted flat against the board, with the switch actuator sticking out at the side. This termination style is known as *right-angle PC*. Many manufacturers offer a choice of straight or bent pin terminals, but the component may be listed in a catalog under either of those options, with no indication that other options exist. Check manufacturer datasheets carefully.

Quick connect terminals are spade-shaped to accept push-on connectors, commonly used in automotive applications. Hybrid quick-connect terminals that can also function as solder lugs are sometimes offered as an option.

Screw terminals have screws premounted in flat terminals, for solderless attachment of wires.

Wire leads are flexible insulated wires, often with stripped and tinned ends, protruding at least an inch from the body of the component. This option is becoming uncommon.

Contact Plating Options

The internal electrical contacts of a switch are usually plated with silver or gold. Nickel, tin, and silver alloys are cheaper but less common. Other types are relatively rare.

Values

Switches designed for electronic devices vary widely in power capability, depending on their purpose. Rocker switches, paddle switches, and toggle switches are often used to turn power on and off, and are typically rated for 10A at 125VAC,

although some toggle switches go as high as 30A. Snap-action or limit switches may be similarly rated, although miniature versions will have reduced capability. Slide switches cannot handle significant power, and are often rated around 0.5A (or less) at 30VDC. DIP and SIP switches have a typical maximum rating of 100mA at 50V and are not designed for frequent use. Generally they are used only when the power to the device is off.

How to Use it

Power Switches

When a simple SPST switch is used to turn DC power on and off, it conventionally switches the positive side of the power supply, also sometimes known as the *high side*. The primary reason for following this convention is that it is widely used; thus, following it will reduce confusion.

More importantly, an on-off switch that controls AC power must be used on the "live" side of the supply, not the "neutral" side. If you have any doubts about these concepts (which go beyond the scope of this book), consult a reference guide on this subject. Using a DPST component to switch both sides of an AC supply may be a worthwhile additional precaution in some applications. The ground wire of an AC supply should never be switched, because the device should always be grounded when it is plugged into an electric outlet.

Limit Switches

An application for two limit switches with a DC motor and two rectifier **diodes** is shown in Figure 6-20. This diagram assumes that the motor turns clockwise when its lower terminal is positive, and counter-clockwise when its upper terminal is positive. Only two terminals are used (and shown) in each limit switch; they are chosen to be normally-closed. Other terminals inside a switch may exist, may be normally-open, and can be ignored.

The motor is driven through a dual-coil, DPDT latching **relay**, which will remain in either position indefinitely without drawing power. When the upper coil of the relay receives a pulse from a pushbutton or some other source, the relay flips to its upper position, which conducts positive current through the lower limit switch, to the lower terminal of the motor. The motor turns clockwise until the arm attached to its shaft hits the lower limit switch and opens it. Positive current is blocked by the lower diode, so the motor stops.

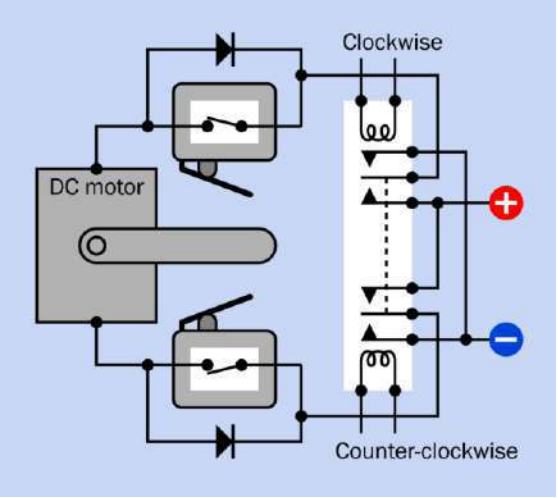

Figure 6-20. *In this schematic, normally-closed limit switches are opened by pressure from an arm attached to a motor, thus switching off its power at each end of its permitted travel and preventing overload and burnout. A two-coil latching relay activates the motor. Rectifier diodes allow power to reach the motor to reverse its rotation when a limit switch is open.*

When the lower coil of the relay is activated, the relay flips to its lower position. Positive current can now reach the upper side of the motor through the upper limit switch. The motor runs counter-clockwise until its arm opens the upper limit switch, at which point the motor stops again. This simple system allows a DC motor to be run in either direction by a button-press of any duration, without risk of burnout when the motor reaches the end of its travel. It has been used for applications such as raising and lowering powered windows in an automobile.

A DPDT pushbutton could be substituted for the latching relay if manual control, only, is acceptable. However, in this scenario, sustained pressure on the pushbutton would be necessary to move the motor arm all the way to the opposite end of its travel. A DPDT switch might be more appropriate than a pushbutton.

Logic Circuits

Logic circuits that depend purely on switches can be constructed (for example, to add binary numbers) but are rare and have no practical applications. The most familiar and simplest example of manually switched logic is a pair of SPDT switches in house wiring, one positioned at the top of a flight of stairs and the other at the bottom, as shown in Figure 6-21. Either switch will turn the light on if it is currently off, or off if it is currently on. To extend this circuit by incorporating a third switch that has the same function as the other two, a DPDT switch must be inserted. See Figure 6-22.

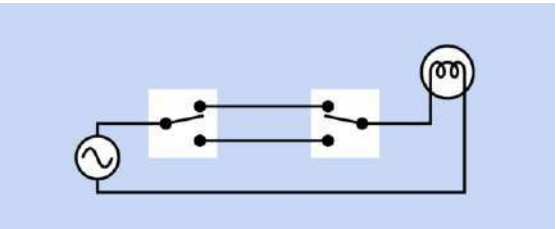

Figure 6-21. *SPDT switches are commonly used in house wiring so that either of them will turn a shared light on if it is off, or off it is on.*

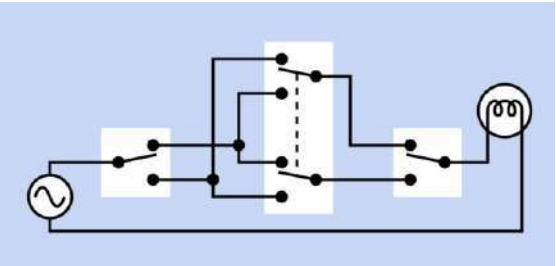

Figure 6-22. *A DPDT switch must be inserted if three switches must have identical function to control the on-off state of a single light bulb.*

Alternatives

As **microcontrollers** have become cheaper and more ubiquitous, they have taken over many functions in electronic products that used to be served by switches. A menuing system driven by a microcontroller can use one **rotational encoder** with a SPST pushbutton built into it to select and adjust numerous parameters in a device such as a car stereo, where functions were once selected and adjusted by individual switches and potentiometers. The rotational-encoder option takes up less space, is cheaper to build (assuming a microcontroller is going to be used in the device for other purposes anyway), and can be more reliable, as it reduces the number of electromechanical parts. Whether it is easier to use is a matter of taste. Cost and ergonomics may be the primary factors to consider when choosing where and how to use switches.

What Can Go Wrong

Arcing

The contacts inside a switch will be rapidly eroded if *arcing* (pronounced "arking") occurs. An electric arc is a spark that tends to form when a switch is opened while conducting a high current or high voltage (typically 10A or more and 100V or more). The most common cause is an inductive load that generates back-EMF when it is switched on and forward-EMF when it is switched off. The surge can be many times the amperage that the load draws during continuous operation. In DC circuits, arcing can be reduced by using a rectifier **diode** in parallel with the load (with its polarity blocking normal current flow). This is often referred to as a *flyback diode* or *freewheeling diode*. In AC circuits, where a diode cannot be used in this way, a *snubber* (a simple combination of capacitor and resistor) may be placed around the load. A snubber can also be used around the switch itself, in DC circuits. See "Snubber" (page 108).

When switching an inductive load, it is generally prudent to use switches rated for twice as much current as the circuit will normally draw.

Dry Joints

Switches that control significant current will have substantial terminals, and these terminals will be attached to heavy-gauge wire. When using solder to make this type of connection, the combined heat capacity of the wire and the terminal will sink a lot more heat than a small component on a circuit board. At least a 30W soldering iron should be used. Lower-wattage irons may be incapable of melting the solder completely (even though they seem to), and a "dry joint" will result, which can have a relatively high electrical resistance and will be mechanically weak, liable to break later. Any good solder joint should withstand flexing of the wire attached to it.

Short Circuits

Because many switches are still wired in with solder tabs, screw terminals, or quick-connect terminals, wires that become accidentally detached can be a significant hazard. Heat-shrink tubing should be applied to enclose wires and terminals at the rear of a power switch, as an additional precaution. Power switches should always be used in conjunction with appropriate **fuses**.

Contact Contamination

Sealed switches should be used in any environment where dirt or water may be present. Slide switches are especially vulnerable to contamination, and are difficult to seal. Switches used in audio components will create "scratchy" sounds if their contacts deteriorate.

Wrong Terminal Type

Because switches are available with a wide variety of terminal types, it's easy to order the wrong type. Switches may be supplied with pins for through-hole insertion in circuit boards; screw terminals; quick-disconnect terminals; or solder lugs. Variants may also be available for surface mount. If a project requires, for example, the insertion of pins in a printed circuit board, and a switch is supplied with solder lugs, it will be unusable.

Part numbers generally include codes to identify each terminal variant, and should be studied carefully.

Contact Bounce

Also known as *switch bounce*. When two contacts snap together, extremely rapid, microscopic vibrations occur that cause brief interruptions before the contacts settle. While this phenomenon is not perceptible to human senses, it can be perceived as a series of multiple pulses by a **logic chip**. For this reason, various strategies are used to *debounce* a switch that drives a logic input. This issue is explored in detail in the entry on logic chips in Volume 2 of the encyclopedia.

Mechanical Wear

Any toggle or rocker switch contains a mechanical pivot, which tend to deteriorate in harsh environments. Friction is also an issue inside these switches, as the design often entails the rounded tip of a lever rubbing to and fro across the center of a movable contact.

The spring inside a snap switch or limit switch may fail as a result of metal fatigue, although this is rare. A slide switch is far less durable, as its contacts rub across each other every time the switch changes position.

In any application that entails frequent switching, or where switch failure is a critical issue, the most sensible practice is to avoid using cheap switches.

Mounting Problems

In a panel-mount switch that is secured by turning a nut, the nut may loosen with use, allowing the component to fall inside its enclosure. Conversely, overtightening the nut may strip the threads on the switch body, especially in cheaper components where the threads are molded into

plastic. Consider applying a drop of Loc-Tite or similar adhesive after moderately tightening the nut. Note that nut sizes vary widely, and finding a replacement may be time-consuming.

Cryptic Schematics

In some circuit schematics, the poles of a multi-pole switch may be visually separated from each other, even at opposite sides of the page, for convenience in drawing the schematic. Dotted lines usually, but not always, link the poles. In the absence of dotted lines, switch segments are often coded to indicate their commonality. For example, SW1(a) and SW1(b) are almost certainly different parts of the same switch, with linked poles.

rotary switch

7

Not to be confused with **rotational encoder**, which has its own entry in this encyclopedia.

OTHER RELATED COMPONENTS

- **switch** (See Chapter 6)
- **rotational encoder** (See Chapter 8)

What It Does

A rotary switch makes an electrical connection between a *rotor*, mounted on a shaft that is turned by a knob, and one of two or more stationary contacts. Traditionally, it was the component of choice to select wavebands on a radio receiver, broadcast channels on a television or inputs on a stereo preamplifier. Since the 1990s, it has been substantially superceded by the **rotational encoder**. However it still has applications in military equipment, field equipment, industrial control systems, and other applications requiring a rugged component that will withstand heavy use and a possibly harsh environment. Also, while the output from a rotational encoder must be decoded and interpreted by a device such as a microcontroller, a rotary switch is an entirely passive component that does not require any additional electronics for its functionality.

Two typical schematic symbols for a rotary switch are shown in Figure 7-1. They are functionally identical. A simplified rendering of the interior of a traditional-style rotary switch is shown in Figure 7-2. A separate contact (not shown) connects with the rotor, which connects with each of the stationary contacts in turn. The colors were chosen to differentiate the parts more clearly, and do not correspond with colors in an actual switch.

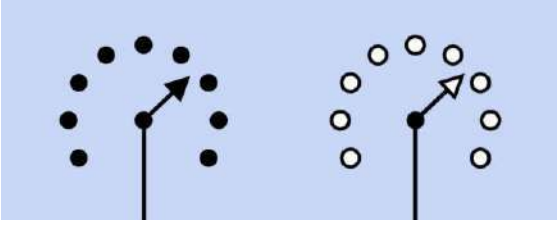

Figure 7-1. *Typical schematic symbols for a rotary switch. The two symbols are functionally identical. The number of contacts will vary depending on the switch.*

A selection of rotary switches is shown in Figure 7-3. At top-left is an *open frame* switch, providing no protection to its contacts from contaminants. This type of component is now rare. At top-right is a twelve-position, single-pole switch rated 2.5A at 125VAC. At front-left is a four-position, single-pole switch rated 0.3A at 16VDC or 100VAC. At front right is a two-position, two-pole switch with the same rating as the one beside it. All the sealed switches allow a choice of panel mounting or through-hole printed circuit board mounting.

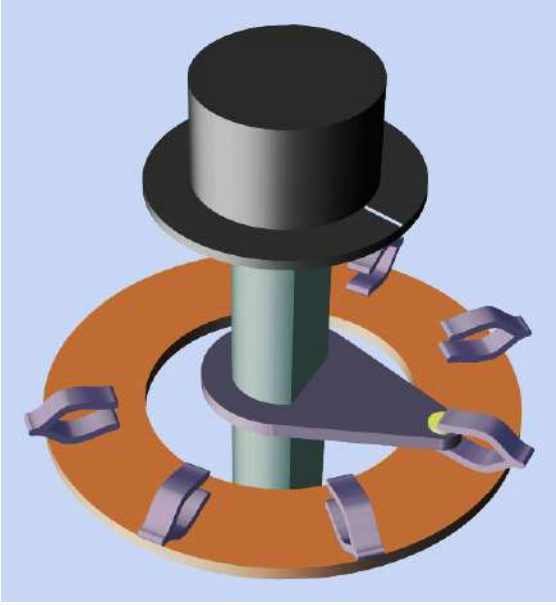

Figure 7-2. *A simplified rendering of interior parts in a basic SP6T rotary switch. Arbitrary colors have been added for clarity.*

How It Works

A switch may have multiple poles, each connecting with its own rotor. The rotors are likely to be on separate *decks* of the switch, but two, three, or four rotors, pointing in different directions, may be combined on a single deck if the switch has only a small number of positions.

Rotary switches are usually made with a maximum of twelve positions, but include provision for limiting the number of positions with a *stop*. This is typically a pin, which may be attached to a washer that fits around the bushing of the switch. The pin is inserted into a choice of holes to prevent the switch from turning past that point. For example, an eight-position rotary switch can be configured so that it has only seven (or as few as two) available positions.

A specification for a rotary switch usually includes the angle through which the switch turns between one position and the next. A twelve-position switch usually has a 30-degree turn angle.

Figure 7-3. *A selection of rotary switches. See text for details.*

Variants

Conventional

The traditional style of rotary switch is designed to be panel-mounted, with a body that ranges from 1″ to 1.5″ in diameter. If there is more than one deck, they are spaced from each other by about 0.5″. The switch makes an audible and tactile "click" as it is turned from one position to the next.

A rugged sealed five-deck rotary switch is shown in Figure 7-4. It has five poles (one per deck), and a maximum of 12 positions. The contacts are rated 0.5A at 28VDC. This type of heavy-duty component is becoming relatively rare.

If the rotor in a switch establishes a connection with the next contact a moment before breaking the connection with the previous contact, this is known as a *shorting* switch, which may also be described as a *make-before-break* switch. In a *nonshorting* or *break-before-make* switch, a tiny

Figure 7-4. *A five-pole, twelve-position rotary switch.*

interval separates one connection from the next. This can be of significant importance, depending on the components that are connected with the switch.

The shaft may be round, splined, or D-shaped in section. A knob is seldom supplied with a switch and must be chosen to match the shaft. Some shaft dimensions are metric, while others are measured in inches, with 1/4" diameter being the oldest standard. Some switches with a splined shaft are supplied with an adapter for a knob of D-shaped internal section; the adapter can be slipped onto the shaft in any of 12 or more positions, to minimize the inconvenience of positioning the body of the switch itself so that the knob is correctly oriented in relation to positions printed on the face of the panel.

Miniature rotary switches may be as small as 0.5" diameter, and usually terminate in pins for through-hole mounting on a PC board. Miniature switches usually have lower current ratings than full-size switches.

Rotary switches must be securely anchored to resist the high turning forces that can be inflicted upon them by users. In a panel-mount design, a nut is tightened around a thread on the bushing of the switch. Through-hole versions can be secured to the PC board with the shaft protruding loosely through a cutout in the panel. To minimize mechanical stress on the circuit board, the detents in a PC-board switch are usually weaker than in a full-size switch, and the knob is usually smaller, allowing less leverage.

Rotary DIP

A conventional *DIP switch* is a linear array of miniature SPST switches designed to fit a standard DIP (dual-inline package) layout of holes in a circuit board. It is described in the **switch** entry of this encyclopedia. A *rotary DIP* switch (also known as an *encoded output rotary switch* or a *coded rotary switch*) does not conform with a DIP layout, despite its name. It is approximately 0.4" square and usually has five pins, one of which can be considered the input or common pin while the other four can function as outputs. The pins are spaced at 0.1" pitch from one another. Pin function and layout are not standardized.

A dial on top of the switch has either 10 positions (numbered 0 through 9) or 16 positions (0 through 9 followed by letters A through F). One switch of each type is shown in Figure 7-5.

Each position of the dial closes pairs of contacts inside the component to create a unique binary-coded decimal pattern (in a 10-position switch) or binary-coded hexadecimal pattern (in the 16-position switch) on the four output pins. The pin states are shown in Figure 7-6. A rotary DIP switch is a relatively flimsy device, and is not designed for frequent or heavy use. It is more likely to be a "set it and forget it" device whose state is established when it is installed in a circuit board.

Because each position of the switch is identified with a unique binary pattern, this is an example of *absolute encoding*. By contrast, a typical **rotational encoder** uses *relative encoding*, as it merely generates a series of undifferentiated pulses when the shaft is turned.

Figure 7-5. *A rotary DIP switch, also known as an encoded output rotary switch, may be used as a substitute for a DIP switch in some applications.*

A *real-coded* rotary DIP makes a connection between input and output pins wherever a binary 1 would exist. In the *complement-coded* version, the output is inverted. The switch is primarily intended for use with a **microcontroller**, enabling only four binary input pins on the microcontroller to sense up to sixteen different switch positions.

A six-pin rotary DIP variant is available from some manufacturers, with two rows of three pins, the two center pins in each row being tied together internally, and serving as the pole of the switch.

Rotary DIPs are available with a screw slot, small knurled knob, or larger knob. The screw-slot version minimizes the height of the component, which can be relevant where circuit boards will be stacked close together. A *right-angle PC* variant stands at 90 degrees to the circuit board, with pins occupying a narrower footprint. The switch on the left in Figure 7-5 is of this type.

While most rotary DIPs are through-hole components, surface-mount versions are available.

Most rotary DIPs are sealed to protect their internal components during wave-soldering of circuit boards.

Switch Position	Pin 1	Pin 2	Pin 3	Pin 4
0	●	●	●	●
1	●	●	●	●
2	●	●	●	●
3	●	●	●	●
4	●	●	●	●
5	●	●	●	●
6	●	●	●	●
7	●	●	●	●
8	●	●	●	●
9	●	●	●	●
A	●	●	●	●
B	●	●	●	●
C	●	●	●	●
D	●	●	●	●
E	●	●	●	●
F	●	●	●	●

Figure 7-6. *Positive and negative states of the four output pins of a real-coded 16-position rotary DIP switch, assuming that the common pin of the switch is connected with a positive supply voltage. A ten-position rotary DIP switch would use only the states from 0 through 9. In a complement-coded switch, the positive and negative states would be reversed.*

Gray Code

A Gray code (named after its originator, Frank Gray) is a system of absolute encoding of a switch output, using a series of nonsequential binary numbers that are chosen in such a way that each number differs by only one digit from the preceding number. Such a series is useful because it eliminates the risk that when a switch turns, some bits in the output will change before others, creating the risk of erroneous interpretation. A minority of rotary switches or rotational en-

coders are available with Gray-coded outputs. Typically, a microcontroller must use a lookup table to convert each binary output to an angular switch position.

PC Board Rotary Switch

Miniature switches with a conventional, non-encoded output are available for printed-circuit board mounting, sometimes requiring a screwdriver or hex wrench to select a position. A single-pole eight-position switch of this type is shown in Figure 7-7. Its contacts are rated to carry 0.5A at 30VDC, but it is not designed to switch this current actively.

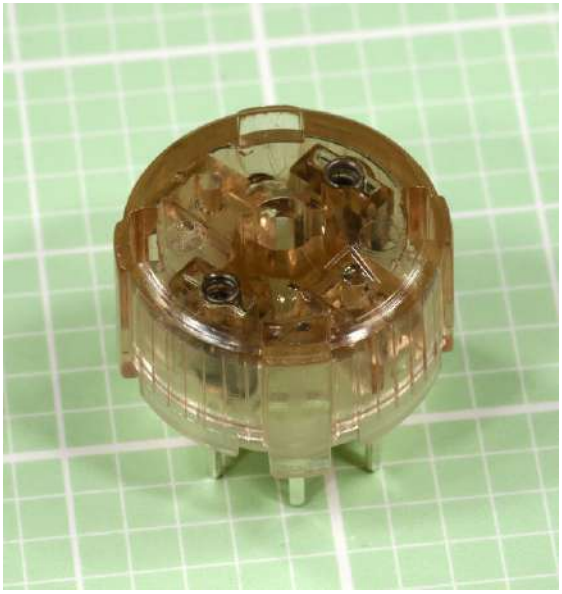

Figure 7-7. *This miniature switch is designed for insertion on a printed circuit board. It can be used to make a setting before a device is shipped to the end user.*

Mechanical Encoder

A *mechanical encoder* functions similarly to a rotary DIP switch but is intended for much heavier use. It outputs a binary-coded-decimal value corresponding with its shaft position, is typically the size of a miniature rotary switch, and is designed for panel mounting. The Grayhill Series 51 allows 12 positions, each generating a code among four terminals. The Bourns EAW provides 128 positions, each generating a code among 8 terminals.

Pushwheel and Thumbwheel

A *pushwheel switch* is a simple electromechanical device that enables an operator to provide a code number as input to data processing equipment, often in industrial process control. The decimal version contains a wheel on which numbers are printed, usually in white on black, from 0 through 9, visible one at a time through a window in the face of the switch. A button above the wheel, marked with a minus sign, rotates it to the next lower number, while a button below the wheel, marked with a plus sign, rotates it to the next higher number. A connector at the rear of the unit includes a common (input) pin and four output pins with values 1, 2, 4, and 8. An additional set of pins with values 1, 2, 3, and 4 is often provided. The states of the output pins sum to the value that is currently being displayed by the wheel. Often two, three, or four pushwheels (each with an independent set of connector pins) are combined in one unit, although individual pushwheels are available and can be stacked in a row.

A *thumbwheel switch* operates like a pushwheel switch, except that it uses a thumbwheel instead of two buttons. Miniaturized thumbwheel switches are available for through-hole mounting on PC boards.

Hexadecimal versions are also available, with numbers from 0 through 9 followed by letters A through F, although they are less common than decimal versions.

Keylock

A *keylock switch* is generally a two-position rotary switch that can be turned only after insertion of a key in a lock attached to the top of the shaft. This type of switch almost always has an OFF-(ON) configuration and is used to control power.

Keylock switches are found in locations such as elevators, for fire-department access; in cash registers; or on data-processing equipment where switching power on or off is reserved for a system administrator.

Values

A full-size rotary switch may be rated from 0.5A at 30VDC to 5A at 125VAC, depending on its purpose. A very few switches are rated 30A at 125VAC; these are high-quality, durable, expensive items.

A typical rotary DIP switch is rated 30mA at 30VDC and has a carrying current rating (continuous current when no switching occurs) of no more than 100mA at 50VDC.

How to Use it

In addition to its traditional purpose as a mode or option selector, a rotary switch provides a user-friendly way to input data values. Three ten-position switches, for instance, can allow user input of a decimal number ranging from 000 to 999.

When used with a **microcontroller**, a rotary switch can have a *resistor ladder* mounted around its contacts, like a multi-point *voltage divider*, so that each position of the rotor provides a unique potential ranging between the positive supply voltage and negative ground. This concept is illustrated in Figure 7-8, where all the resistors have the same value. The voltage can be used as an input to the microcontroller, so long as the microcontroller shares a common ground with the switch. An analog-digital converter inside the microcontroller translates the voltage into a digital value. The advantage of this scheme is that it allows very rapid control by the user, while requiring only one pin on the microcontroller to sense as many as twelve input states.

For a ladder consisting of 8 resistors, as shown, each resistor could have a value of 250Ω. (The specifications for a particular microcontroller

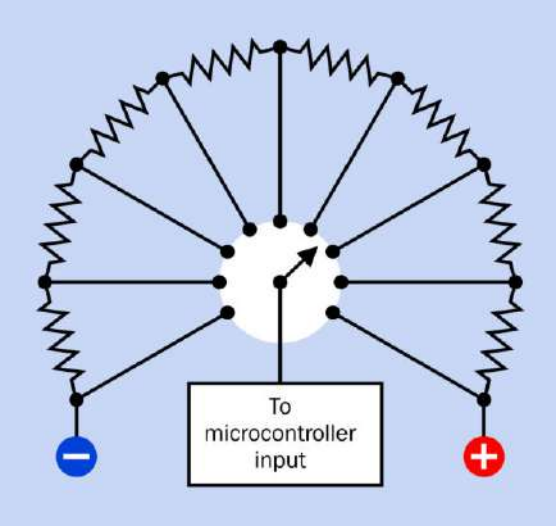

Figure 7-8. *A resistor ladder can be formed around the contacts of a rotary switch, with the pole of the switch connected to a microcontroller that has an analog-digital converter built in. The microcontroller converts the voltage input to an internal digital value. Thus, one pin can sense as many as twelve input states.*

might require other values.) To avoid ambiguous inputs, a nonshorting rotary switch should be used in this scheme. A *pullup resistor* of perhaps 10K should be added to the microcontroller input, so that there is no risk of it "floating" when the switch rotor is moving from one contact to the next. The code that controls the microcontroller can also include a blanking interval during which the microcontroller is instructed to ignore the switch.

Because the rotary switch is an electromechanical device, it has typical vulnerabilities to dirt and moisture, in addition to being bulkier, heavier, and more expensive than a **rotational encoder**. Rotary switches have also been partially replaced by pushbuttons wired to a microcontroller. This option is found on devices ranging from digital alarm clocks to cellular phones. In addition to being cheaper, the pushbutton alternative is preferable where space on a control panel, and behind it, is limited.

What Can Go Wrong

Vulnerable Contacts

Most modern rotary switches are sealed, but some are not. Any switch with exposed contacts will be especially vulnerable to dirt and moisture, leading to unreliable connections. This was an issue in old-fashioned TV sets, where periodic contact cleaning of the channel selector switch was needed.

Exposed contacts are also more vulnerable to side-effects from temperature cycling (when a device warms up and then cools down).

Contact Overload

The contacts on a cheap rotary switch are especially vulnerable to arcing, as the user may turn the switch slowly, causing gradual engagement and disengagement of contacts instead of the snap-action that is characteristic of a well-made toggle switch. If a rotary switch may control significant currents or current surges, it must be appropriately rated, regardless of the extra expense. For more information on arc suppression in switches, see "Arcing" (page 47).

Misalignment

Most knobs for rotary switches consist of a pointer, or have a white line engraved to provide clear visual indication of the position of the switch. If this does not align precisely with indications printed on the panel, confusion will result. For hand-built equipment, the switch can be installed first, after which the control-panel indications can be glued or riveted in place on a separate piece of laminated card, plastic, or metal for precise alignment. If the switch is not secured tightly, its body may turn slightly under repeated stress, leading to erroneous interpretation of the knob position.

Misidentified Shorting Switch

If a shorting switch is used where a nonshorting switch was intended, the results can be disconcerting or even destructive, as one terminal will be briefly connected with the adjacent terminal while the switch is being turned. Multiple functions of a circuit may be activated simultaneously, and in a worst case scenario, adjacent terminals may be connected to opposite sides of the same power supply.

User Abuse

The turning force that must be applied to a full-size conventional rotary switch is significantly greater than the force that is applied to most other types of panel-mounted switches. This encourages aggressive treatment, and the turning motion is especially likely to loosen a nut holding the switch in place. The lighter action characteristic of miniature rotary switches does not necessarily solve this problem, as users who are accustomed to older-style switches may still apply the same force anyway.

Rotary switches should be mounted in expectation of rough use. It is prudent to use Loc-Tite or a similar compound to prevent nuts from loosening, and a switch should not be mounted in a thin or flimsy panel. When using a miniature rotary switch that has through-hole mounting in a circuit board, the board must be sufficiently robust and properly secured.

Wrong Shaft, Wrong Knobs, Nuts That Get Lost, Too Big to Fit

These problems are identical to those that can be encountered with a **potentiometer**, which are discussed in that entry in this encyclopedia.

rotational encoder

The term *rotational encoder* used to be reserved for high-quality components, often using optical methods to measure rotation with precision (more than 100 intervals in 360 degrees). Cheaper, simpler, electromechanical devices were properly referred to as *control shaft encoders*. However, the term *rotational encoder* is now applied to almost any device capable of converting rotational position to a digital output via opening and closing internal mechanical contacts; this is the sense in which the term is used here. It is sometimes distinguished from other types of encoder with the term *mechanical rotary encoder*. Magnetic and optical rotary encoders do not contain mechanical switches, are classified as *sensors* by this encyclopedia, and will appear in Volume 3. They are found in a device such as an *optical mouse*.

OTHER RELATED COMPONENTS

- **rotary switch** (See Chapter 7)

What It Does

A rotational encoder has a knob that a user can turn to display a series of prompts on an LCD screen, or to adjust the input or output on a product such as a stereo receiver. The component is almost always connected to inputs on a **microcontroller** and is usually fitted with *detents* that provide tactile feedback suggesting many closely spaced positions. The encoder often allows the user to make a selection by pushing the knob in, which closes an internal momentary switch. Thus, this type of encoder functions as a pushbutton as well as a switch.

A rotational encoder is an *incremental* or *relative* device, meaning that it merely creates and breaks internal switch connections when rotation occurs, without providing a unique code to identify each absolute rotational position. An *absolute* encoder is discussed in the **rotary switch** entry of this encyclopedia.

No schematic symbol exists to represent a rotational encoder.

How It Works

An encoder contains two pairs of contacts, which open and close out of phase with each other when the shaft rotates. In a clockwise direction, the A pair of contacts may be activated momentarily before the B pair; in a counter-clockwise direction, the B pair may be activated before the A pair. (Some encoders reverse this phase difference.) Thus if one contact from each pair is connected with two inputs of an appropriately programmed microcontroller, and if the other contact of each pair is connected with negative ground, the microcontroller can deduce which way the knob is turning by sensing which pair of contacts closes first. The microcontroller can then count the number of pulses from the contacts and interpret this to adjust an output or update a display.

A simplified schematic is shown in Figure 8-1. The two buttons inside the dashed line represent the two pairs of contacts inside the encoder, while the chip is a microcontroller. The knob and shaft that activate the internal switches are not shown. The schematic assumes that when a contact closes, it pulls the chip input to a low state. A pullup resistor is added to each input of the chip to prevent the pins from "floating" when either pair of contacts is open.

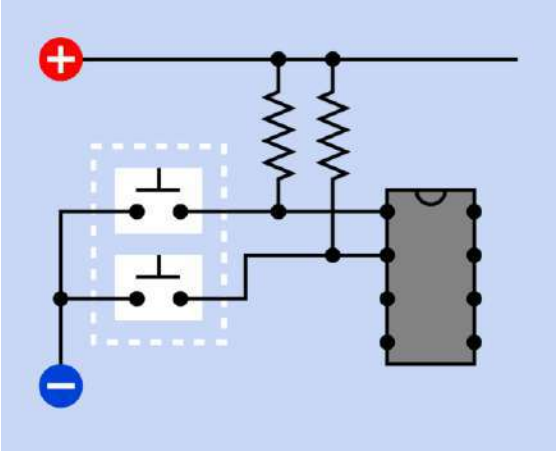

Figure 8-1. *Simplified schematic showing the typical set-up for a rotational encoder. The pushbuttons inside the dashed line represent the contacts inside the encoder. The chip is a microcontroller.*

Figure 8-2 gives a conceptual view of the outputs of an encoder that is turned clockwise (top) and then counter-clockwise (bottom). Some encoders may reverse this phase sequence. Red and black colors have been assigned to the pin states on the assumption that the terminals that are common to both pairs of contacts are connected with negative ground. Thus a "high" pulse in the graphical representation actually indicates that the encoder is grounding its output.

Microcontrollers have become so ubiquitous, and rotational encoders are so cheap, they have displaced rotary switches in many applications where a low current is being switched. The combination of a rotational encoder and a microcontroller is very versatile, allowing display and control of an almost unlimited number of menus and options.

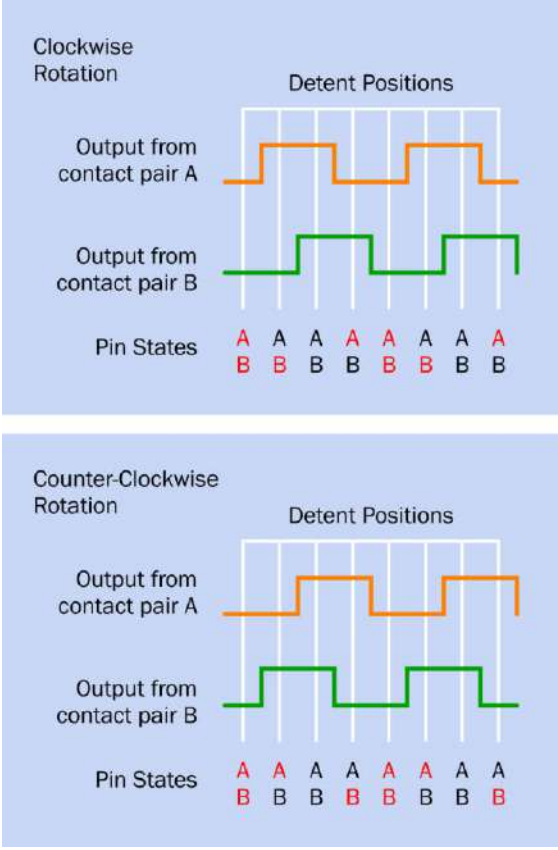

Figure 8-2. *Hypothetical outputs from a rotational encoder, assuming that the common terminals of the contact pairs are connected to negative ground. A high pulse in the graphical representation therefore indicates that the contact pair is grounded. The number of detents relative to the number of pulses per rotation varies from one type of encoder to another.*

Variants

There are two types of rotational encoders containing mechanical contacts: absolute and relative. An absolute encoder generates a code corresponding with each specific rotational position. The code is usually a binary output among

four or more pins. It is discussed under *mechanical encoder* in the **rotary switch** section of this encyclopedia. The variants listed here are all relative encoders.

Pulses and Detents

Rotational encoders from different manufacturers may have as few as 4 or as many as 24 pulses per rotation (PPR), with 12 to 36 detents (or no detents at all, in a few models.) The relationship between pulses and detents shown in Figure 8-2 is typical but is far from being universal. The number of detents may be equal to, greater than, or less than the number of pulses per rotation.

Format

Rotational encoders are generally panel-mounted or through-hole devices. In the latter category, most are horizontally mounted, with a minority being at 90 degrees to the board.

Output

In an encoder containing two switches, four switch-state combinations are possible: OFF-OFF, ON-OFF, OFF-ON, and ON-ON. This is known as a *quadrature* output. All of the rotational encoders discussed here conform with that system.

Rotational Resistance

Rotational encoders vary widely in the resistance that they offer when the user turns the knob. This is largely a function of the detents, if they are included. Still, all rotational encoders generally offer less rotational resistance than a rotary switch, and do not have the kind of heavy-duty knobs that are typically used with rotary switches. Since an encoder creates only a stream of pulses without any absolute positional information, a knob with any kind of pointer on it is inappropriate.

Values

Virtually all rotational encoders are designed to work with a low-voltage supply, 12VDC or less. All of them are intended for low currents, reflecting their purpose to drive microcontroller inputs. Some sample rotational encoders are pictured in Figure 8-3. At rear: nine pulses per rotation (PPR), 36 detents, 10mA at 10VDC. Far left: 20PPR, 20 detents, with switch. Far right: 24PPR, no detents, 1mA at 5VDC. Center (blue): 16PPR, no detents, 1mA at 5VDC. Front: 12PPR, 24 detents, 1mA at 10VDC, requires Allen wrench or similar hexagonal shaft to engage with the rotor.

Figure 8-3. *Rotational encoders with a variety of specifications. See text for details.*

Contact Bounce

Any mechanical switch will suffer some degree of *contact bounce* when its contacts close. Datasheets for rotational encoders may include a specification for bounce duration ranging from around 2ms to 5ms, which is sometimes known as the *settling time*. Naturally, a lower value is preferred. The microcontroller that interprets the positional information from the encoder can include a debouncing routine that simply disregards any signals during the bounce period following switch closure.

Sliding Noise

Sliding noise is the opposite of contact bounce. When two contacts have made a connection and then rub across each other (as occurs inside a rotational encoder while the knob is being turned), the connection may suffer momentary lapses. Datasheets for rotational encoders generally do not supply ratings for this.

How to Use it

As noted above, a rotational encoder can only be used in conjunction with a microcontroller or similar device that is capable of interpreting the phase difference between the pairs of contacts, and is capable of counting the number of opening/closing events while the knob is being turned. (Some dedicated chips are designed for this specific purpose.)

It can be adapted to be driven by a **stepper motor**, to provide feedback regarding the rotation of the motor shaft, and its output can also be interpreted to calculate angular acceleration.

Programming the microcontroller is the most significant obstacle. Generally the program should follow a sequence suggested by this pseudocode:

Check:

- If the encoder contains a pushbutton switch, check it. If the pushbutton is being pressed, go to an appropriate subroutine.
- The status of contacts A.
- The status of contacts B.

Compare their status with previously saved states for A and B. If the status has not changed, repeat from Check.

Debounce:

- Recheck the contacts status rapidly and repeatedly for 50ms, and count the states for contacts A and B. (The 50ms duration may be adjusted for different encoders, as an encoder with a higher number of pulses per rotation will tend to create shorter pulses.)
- Compare the total number of changed states with unchanged states.

If the changed states are in a small minority, probably the signal was erroneous, caused by bounce or sliding noise. Go back to Check and start over.

Interpret:

- Deduce the rotational direction from these four possibilities:
  - — Contacts A were open and have closed.
  - — Contacts A were closed and have opened.
  - — Contacts B were open and have closed.
  - — Contacts B were closed and have opened. (The specific type of encoder will determine how these transitions are interpreted.)
- Revise the variable storing the direction of rotation if necessary.
- Depending on the direction of rotation, increment or decrement a variable that counts pulses.
- Take action that is appropriate to the direction of rotation and the cumulative number of pulses.
- Go back to Check again.

What Can Go Wrong

Switch Bounce

In addition to a debouncing algorithm in the microcontroller, a 0.1µF bypass capacitor can be used with each of the output terminals from the encoder, to help reduce the problem of switch bounce.

Contact Burnout

Rotational encoders are TTL-compatible. They are not generally designed to drive even a small output device, such as an LED. The contacts are extremely delicate and will be easily damaged by any attempt to switch a significant current.

relay

Properly known as an *electromagnetic armature relay* to distinguish it from a *solid-state relay*. However, the full term is very rarely used. It may also be described as an *electromechanical relay*, but the term **relay** is normally understood to mean a device that is not solid state.

OTHER RELATED COMPONENTS

- **solid state relay** (Volume 2)
- **switch** (See Chapter 6)

What It Does

A relay enables a signal or pulse of electricity to switch on (or switch off) a separate flow of electricity. Often, a relay uses a low voltage or low current to control a higher voltage and/or higher current. The low voltage/low current signal can be initiated by a relatively small, economical switch, and can be carried to the relay by relatively cheap, small-gauge wire, at which point the relay controls a larger current near to the load. In a car, for example, turning the ignition switch sends a signal to a relay positioned close to the starter motor.

While solid-state switching devices are faster and more reliable, relays retain some advantages. They can handle double-throw and/or multiple-pole switching and can be cheaper when high voltages or currents are involved. A comparison of their advantages relative to **solid state relays** and **transistors** is tabulated in the entry on **bipolar transistor** in Figure 28-15.

Common schematic symbols for single-throw relays are shown in Figure 9-1 and for double-throw relays in Figure 9-2. The appearance and orientation of the coil and contacts in the symbols may vary significantly, but the functionality remains the same.

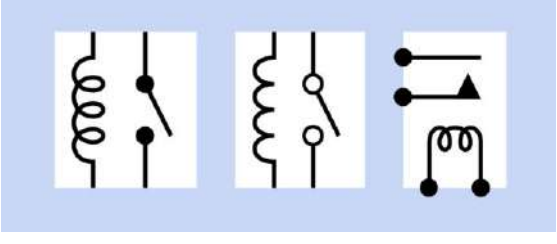

Figure 9-1. *Commonly used schematic symbols for a SPST relay. The symbols are functionally identical.*

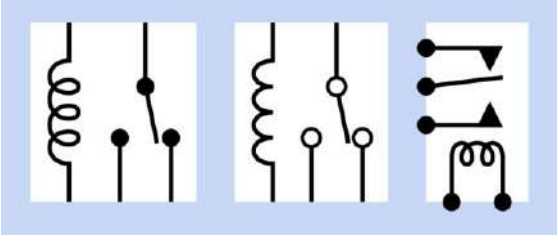

Figure 9-2. *Commonly used schematic symbols for a SPDT relay. The symbols are functionally identical.*

How It Works

A relay contains a *coil*, an *armature*, and at least one pair of *contacts*. Current flows through the coil, which functions as an **electromagnet** and generates a magnetic field. This pulls the armature, which is often shaped as a pivoting bracket that closes (or opens) the contacts. These parts are visible in the simplified rendering of a DPST relay in Figure 9-3. For purposes of identification, the armature is colored green, while the coil is red and the contacts are orange. The two blue blocks are made of an insulating material, the one on the left supporting the contact strips, the one on the right pressing the contacts together when the armature pivots in response to a magnetic field from the coil. Electrical connections to the contacts and the coil have been omitted for simplicity.

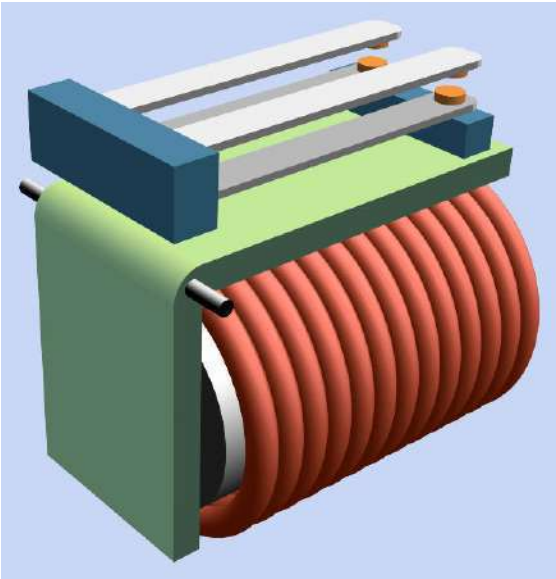

Figure 9-3. *This simplified rendering shows the primary parts of a DPST relay. See text for details.*

Various small relays, capable of handling a variety of voltages and currents, are pictured in Figure 9-4. At top-left is a 12VDC automotive relay, which plugs into a suitable socket shown immediately below it. At top-right is a 24VDC SPDT relay with exposed coil and contacts, making it suitable only for use in a very clean, dry environment. Continuing downward, the four sealed relays in colored plastic cases are designed to switch currents of 5A at 250VAC, 10A at 120VAC, 0.6A at 125VAC, and 2A at 30VDC, respectively. The two blue relays have 12VDC coils, while the red and yellow relays have 5V coils. All are nonlatching, except for the yellow relay, which is a latching type with two coils. At bottom-left is a 12VDC relay in a transparent case, rated to switch up to 5A at 240VAC or 30VDC.

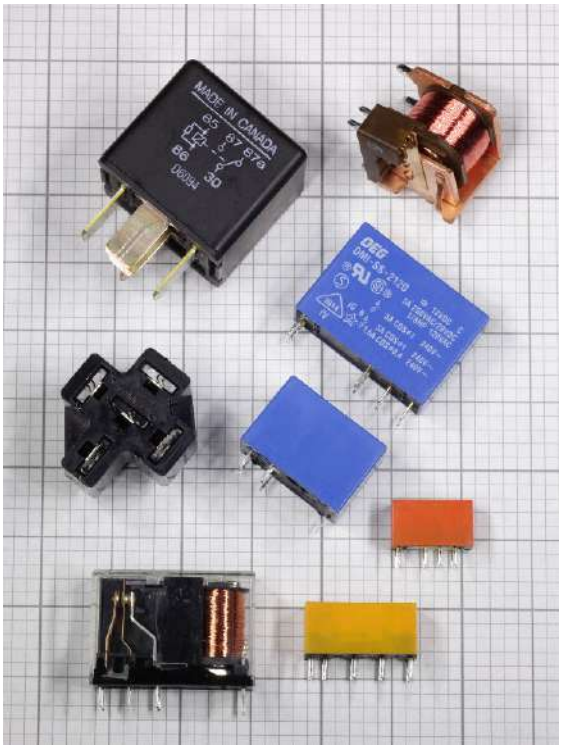

Figure 9-4. *An assortment of small DC-powered relays. See text for details.*

The configuration of a relay is specified using the same abbreviations that apply to a **switch**. SP, DP, 3P, and 4P indicate 1, 2, 3, or 4 poles (relays with more than 4 poles are rare). ST and DT indicate single-throw or double-throw switching. These abbreviations are usually concatenated, as in 3PST or SPDT. In addition, the terminology Form

A (meaning normally open), Form B (normally closed), and Form C (double-throw) may be used, preceded by a number that indicates the number of poles. Thus "2 Form C" means a DPDT relay.

Variants

Latching

There are two basic types of relay: *latching* and *nonlatching*. A nonlatching relay, also known as a *single side stable* type, is the most common, and resembles a *momentary switch* or **pushbutton** in that its contacts spring back to their default state when power to the relay is interrupted. This can be important in an application where the relay should return to a known state if power is lost. By contrast, a latching relay has no default state. Latching relays almost always have double-throw contacts, which remain in either position without drawing power. The relay only requires a short pulse to change its status. In semiconductor terms, its behavior is similar to that of a *flip-flop*.

In a *single-coil* latching relay, the polarity of voltage applied to the coil determines which pair of contacts will close. In a *dual-coil* latching relay, a second coil moves the armature between each of its two states.

Schematic symbols for a dual-coil latching relay are shown in Figure 9-5. Some symbol styles do not make it clear which switch position each coil induces. It may be necessary to read the manufacturer's datasheet or test the relay by applying its rated voltage to randomly selected terminal pairs while testing for continuity between other terminal pairs.

Polarity

There are three types of DC relay. In a *neutral relay*, polarity of DC current through the coil is irrelevant. The relay functions equally well either way. A *polarized relay* contains a diode in series with the coil to block current in one direction. A *biased relay* contains a permanent magnet near the armature, which boosts performance when

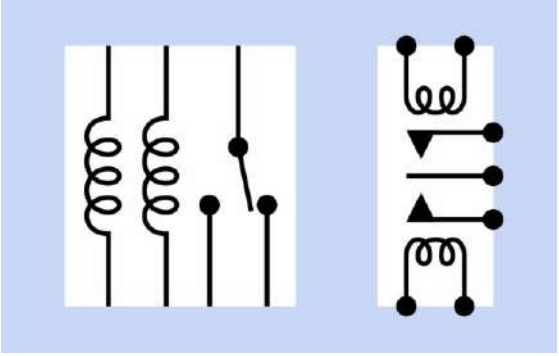

Figure 9-5. *Schematic symbols for a two-coil latching relay. The symbols are functionally identical.*

current flows through the coil in one direction, but blocks a response when the current flows through the coil in the opposite direction. Manufacturers' datasheets may not use this terminology, but will state whether the relay coil is sensitive to the polarity of a DC voltage.

All relays can switch AC current, but only an *AC relay* is designed to use AC as its coil current.

Pinout Variations

The layout and function of relay pins or quick connects is not standardized among manufacturers. Often the component will have some indication of pin functions printed on it, but should always be checked against the manufacturer's datasheet and/or tested for continuity with a meter.

Figure 9-6 shows four sample pin configurations, adapted from a manufacturer's datasheet. These configurations are functionally quite different, although all of them happen to be for DPDT relays. In each schematic, the coil of the relay is shown as a rectangle, while the pins are circles, black indicating an energized state and white indicating a non-energized state. The bent lines show the possible connections between the poles and other contacts inside the relay. The contacts are shown as arrows. Thus, pole 4 can connect with either contact 3 or contact 5, while pole 9 can connect with either contact 8 or contact 10.

Top-left: Polarized nonlatching relay in its resting condition, with no power applied. Top right: Single-coil latching relay showing energized contacts (black circles) when the coil is powered with the polarity indicated. If the polarity is reversed, the relay flips to its opposite state. Some manufacturers indicate the option to reverse polarity by placing a minus sign alongside a plus sign, and a plus sign alongside a minus sign. Bottom-left and bottom-right: Polarized latching relays with two coils, with different pinouts.

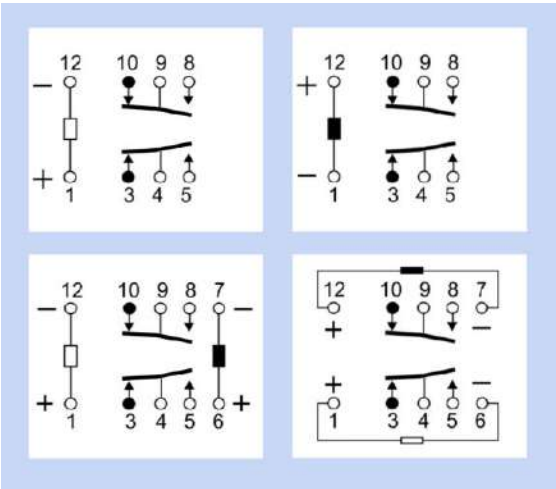

Figure 9-6. *Relay pinouts depicted in the style commonly found in manufacturers' datasheets, showing different relay types. Top-left: Single coil, nonlatching. Top-right: Single coil, latching. Bottom left: Two-coil, latching. Bottom right: Two-coil, latching, alternate pinouts. (Adapted from a Panasonic datasheet.)*

In these diagrams, the relay is seen from above. Some datasheets show the relay seen from below, and some show both views. Some manufacturers use slightly different symbols to indicate interior functions and features. When in doubt, use a meter for verification.

Reed Relay

A *reed relay* is the smallest type of electromechanical relay with applications primarily in test equipment and telecommunications. With a coil resistance ranging from 500 to 2000 ohms, these relays consume very little power. The design consists of a *reed switch* with a coil wrapped around it. Figure 9-7 shows a simplified rendering. The two black contacts are enclosed in a glass or plastic envelope and magnetized in such a way that a magnetic field from the surrounding coil bends them together, creating a connection. When power to the coil is disconnected, the magnetic field collapses and the contacts spring apart.

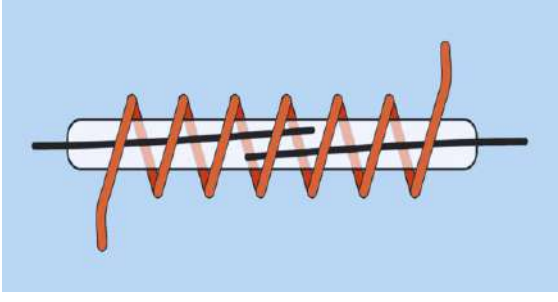

Figure 9-7. *This simplified rendering shows a reed relay, consisting of a magnetized reed switch inside a glass or plastic pod, activated by a coil wrapped around it.*

In Figure 9-8, two reed relays are shown, at top-left and center-right. At bottom-left, the type of relay on the right has been opened by a belt sander to reveal its copper coil and inside that, a capsule in which the relay contacts are visible.

Surface-mount reed relays can be smaller than 0.5″ × 0.2″. Through-hole versions are often around 0.7″ × 0.3″ with pins in two rows, though some are available in SIP packages.

Reed relays have limited current switching capacity and are not suitable to switch inductive loads.

Small Signal Relay

A *small signal relay* is also known as a *low signal relay*. This type may have a footprint as small as a reed relay but generally stands slightly taller, requires slightly more coil current, and is available in versions that can switch slightly higher

Figure 9-8. *Three reed relays, one of which has had its packaging partially removed by a belt sander to reveal its copper coil and internal contacts.*

voltages and currents. There are usually two rows of pins, spaced either 0.2″ or 0.3″ apart. The red and orange relays in Figure 9-4 are small signal relays.

Automotive Relays

An *automotive relay* is typically packaged in a cube-shaped black plastic case with quick-connect terminals at the bottom, typically plugged into a socket. Naturally they are designed to switch, and be switched by, a 12VDC supply.

General Purpose/Industrial

These relays cover a very wide range and are usually built without significant concern for size. They may be capable of switching high currents at high voltages. Typically they are designed to plug into a socket such as an *octal base* of the type that was once used for **vacuum tubes**. The base, in turn, terminates in solder tabs, screws, or quick connects and is designed to be screwed to a chassis. It allows the relay to be unplugged and swapped without resoldering.

Two industrial relays are shown in Figure 9-9. Both are DPDT type with 12VDC coils and rated to switch up to 10A at 240VAC. The one on the left has an octal base. An octal socket that fits an octal base is shown in Figure 9-10.

Figure 9-9. *Two relays powered by 12VDC, capable of switching up to 10A at 240VAC.*

Figure 9-10. *An octal socket with screw terminals, designed to accept a relay with an octal base.*

Time Delay Relay

Generally used to control industrial processes, a *time delay relay* switches an output on and off at

preset time intervals that can be programmed to repeat. The example in Figure 9-11 has a 12VDC coil and is rated to switch up at 10A at 240VAC. It has an octal base.

Figure 9-11. *The control switches on a time-delay relay, allowing separately configured "on" and "off" intervals.*

Contactor

A contactor functions just like a relay but is designed to switch higher currents (up to thousands of amperes) at higher voltages (up to many kilovolts). It may range from being palm-sized to measuring more than one foot in diameter, and may be used to control heavy loads such as very large motors, banks of high-wattage lights, and heavy-duty power supplies.

Values

Datasheets usually specify maximum voltage and current for the contacts, and nominal voltage and current for the coil, although in some cases the coil resistance is stated instead of nominal coil current. The approximate current consumption can be estimated, if necessary, by using Ohm's Law. The minimum voltage that the relay needs for activation is sometimes described as the *Must Operate By* voltage, while the *Must Release By* voltage is the maximum coil voltage that the relay will ignore. Relays are rated on the assumption that the coil may remain energized for long periods, unless otherwise stated.

While the contact rating may suggest that a relay can switch a large load, this is not necessarily true if the load has significant inductance.

Reed relays

Usually use a coil voltage of 5VDC and have a contact rating of up to 0.25A at 100V. Through-hole (PCB) versions may have a coil voltage of 5VDC, 6VDC, 12VDC, or 24VDC and in some cases claim to switch 0.5A to 1A at up to 100V, although this rating is strictly for a noninductive load.

Small signal/low signal relays

Usually use a coil voltage ranging from 5VDC to 24VDC, drawing about 20mA. Maximum switching current for noninductive loads ranges from 1A to 3A.

Industrial/general purpose relays

A very wide range of possible values, with coil voltages ranging up to 48VDC or 125VAC to 250VAC. Contact rating is typically 5A to 30A.

Automotive relays

Coil voltage of 12VDC, and contact rating often 5A at up to 24VDC.

Timer relays

Usually these specify a coil voltage of 12VDC, 24VDC, 24VAC, 125VAC, or 230VAC. The timed interval can range from 0.1 sec to 9999 hours in some cases. Common values for contact ratings are 5A up to 20A, with a voltage of 125V to 250V, AC or DC.

How to Use it

Relays are found in home appliances such as dishwashers, washing machines, refrigerators, air conditioners, photocopy machines, and other products where a substantial load (such as a motor or compressor) has to be switched on and off by a control switch, a thermostat, or an electronic circuit.

Figure 9-12 shows a common small-scale application in which a signal from a microcontroller (a few mA at 5VDC) is applied to the base of a transistor, which controls the relay. In this way, a logic output can switch 10A at 125VAC. Note the rectifier diode wired in parallel with the relay coil.

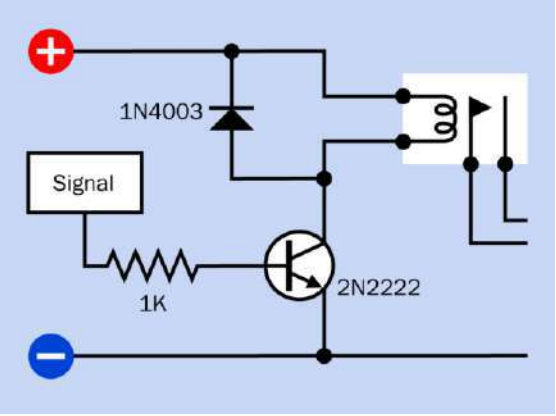

Figure 9-12. *A signal from a digital source such as a microcontroller can switch substantial voltage and current if it is applied to the base of a transistor that activates a relay.*

A latching relay is useful wherever a connection should persist when power is switched off or interrupted, or if power consumption must be minimized. Security devices are one common application. However, the circuit may require a "power reset" function to restore known default settings of latched relays.

A circuit including every possible protection against voltage spikes is shown in Figure 9-13, including a snubber to protect the relay contacts, a rectifier diode to suppress back-EMF generated by the relay coil, and another rectifier diode to protect the relay from EMF generated by a motor when the relay switches it on and off. The snubber can be omitted if the motor draws a relatively low current (below 5A) or if the relay is switching a noninductive load. The diode around the relay coil can be omitted if there are no semiconductors or other components in the circuit that are vulnerable to voltage spikes. However, a spike can affect components in adjacent circuits that appear to be electrically isolated. A severe spike can even be transmitted back into 125VAC house wiring. For information on using a resistor-capacitor combination to form a snubber, see "Snubber" (page 108).

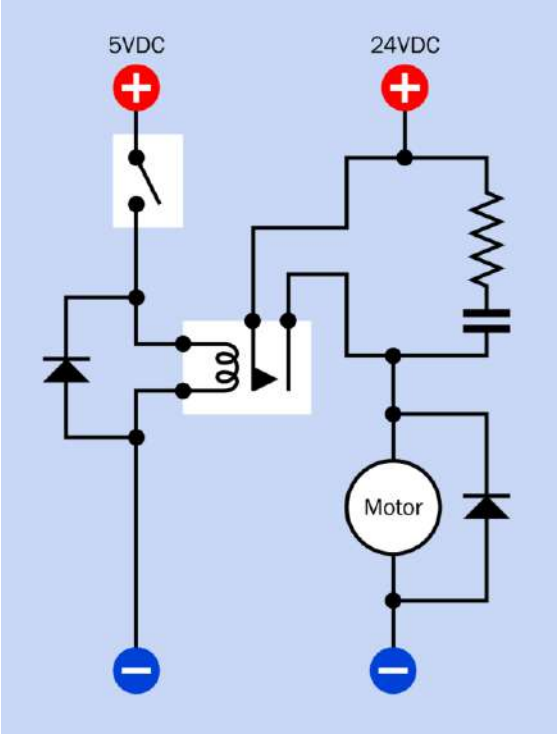

Figure 9-13. *This hypothetical schematic shows three types of protection against voltage spikes induced by an inductive load (a motor, in this instance) and the coil of the relay.*

What Can Go Wrong

Wrong Pinouts

The lack of standardization of relay pinouts can cause errors if one relay is replaced with another that appears to be the same, but isn't. In particular, the pins that connect with normally-closed contacts may trade places with pins connected with normally-open contacts, in relays from different manufacturers.

Pinouts are also confusing in that some datasheets depict them from above, some from below, and some from both perspectives.

Wrong Orientation

Small relays of through-hole type usually have pins spaced in multiples of 0.1". This allows them to be inserted the wrong way around in a perforated board. Almost all relays have an identification mark molded into one end or one corner of the plastic shell. Manufacturers do not standardize the position and meaning of these marks, but they are usually replicated in datasheets. When using a relay of a type that you have not used before, it is a sensible precaution to test it with a meter to verify the functions of its terminals before installing it.

Wrong Type

A latching relay may have exactly the same appearance as a nonlatching relay from the same manufacturer, and the same two pins may energize the coil. However, in a latching relay, the contacts won't spring back to their non-energized position, causing functional errors that may be difficult to diagnose. The part numbers printed on latching and nonlatching versions of the same relay may differ by only one letter or numeral and should be checked carefully.

Wrong Polarity

A relay with a DC-energized coil may require power to be applied with correct polarity and may malfunction otherwise.

AC and DC

A relay coil designed to be powered by DC will not work from AC and vice-versa. The contact rating of a relay is likely to be different depending whether it is switching AC or DC.

Chatter

This is the noise created by relay contacts when they make rapid intermittent connection. Chatter is potentially damaging to relay contacts and should be avoided. It can also create electrical noise that interferes with other components. Likely correctible causes of chatter include insufficient voltage or power fluctuations.

Relay Coil Voltage Spike

A relay coil is an inductive device. Merely switching a large relay on and off can create voltage spikes. To address this problem, a rectifier diode should be placed across the coil terminals with polarity opposing the energizing voltage.

Arcing

This problem is discussed in the **switch** entry of this encyclopedia. See "Arcing" (page 47). Note that because the contacts inside a *reed relay* are so tiny, they are especially susceptible to arcing and may actually melt and weld themselves together if they are used to control excessive current or an inductive load.

Magnetic Fields

Relays generate magnetic fields during operation and should not be placed near components that are susceptible.

The reed switch inside a reed relay can be unexpectedly activated by an external magnetic field. This type of relay may be enclosed in a metal shell to provide some protection. The adequacy of this protection should be verified by testing the relay under real-world conditions.

Environmental Hazards

Dirt, oxidation, or moisture on relay contacts is a significant problem. Most relays are sealed and should remain sealed.

Relays are susceptible to vibration, which can affect the contacts and can accelerate wear on moving parts. Severe vibration can even damage a relay permanently. **Solid-state relays** (discussed in Volume 2) should be used in harsh environments.

resistor

10

OTHER RELATED COMPONENTS

- **potentiometer** (See Chapter 11)

What It Does

A resistor is one of the most fundamental components in electronics. Its purpose is to impede a flow of current and impose a voltage reduction. It consists of two wires or conductors attached at opposite ends or sides of a relatively poor electrical conductor, the resistance of which is measured in ohms, universally represented by the Greek omega symbol, Ω.

Schematic symbols that represent a resistor are shown in Figure 10-1 (Left: The traditional schematic symbol. Right: The more recent European equivalent). The US symbol is still sometimes used in European schematics, and the European symbol is sometimes used in US schematics. Letters K or M indicate that the value shown for the resistor is in thousands of ohms or millions of ohms, respectively. Where these letters are used in Europe, and sometimes in the US, they are substituted for a decimal point. Thus, a 4.7K resistor may be identified as 4K7, a 3.3M resistor may be identified as 3M3, and so on. (The numeric value in Figure 10-1 was chosen arbitrarily.)

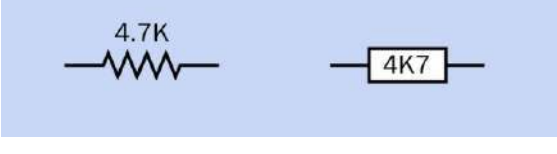

Figure 10-1. *Resistor symbols. The left one is more common in the United States, while the right one is widely used in Europe. The 4.7K value was chosen arbitrarily.*

A resistor is commonly used for purposes such as limiting the charging rate of a **capacitor**; providing appropriate control voltage to semiconductors such as **bipolar transistors**; protecting **LED**s or other semiconductors from excessive current; adjusting or limiting the frequency response in an audio circuit (in conjunction with other components); pulling up or pulling down the voltage at the input pin of a digital logic chip; or controlling a voltage at a point in a circuit. In this last application, two resistors may be placed in series to create a *voltage divider*.

A **potentiometer** may be used instead of a resistor where variable resistance is required.

Sample resistors of various values are shown in Figure 10-2. From top to bottom, their power dissipation ratings are 3W, 1W, 1/2W, 1/4W, 1/4W, 1/4W, and 1/8W. The accuracy (tolerance) of each resistor, from top to bottom, is plus-or-minus 5%, 5%, 5%, 1%, 1%, 5%, and 1%. The beige-colored body of a resistor is often an indication that its tolerance is 5%, while a blue-colored body often indicates a tolerance of 1% or 2%. The blue-bodied resistors and the dark brown resistor contain metal-oxide film elements, while the beige-bodied resistors and the green resistor contain carbon film. For more information on resistor values, see the upcoming *Values* section.

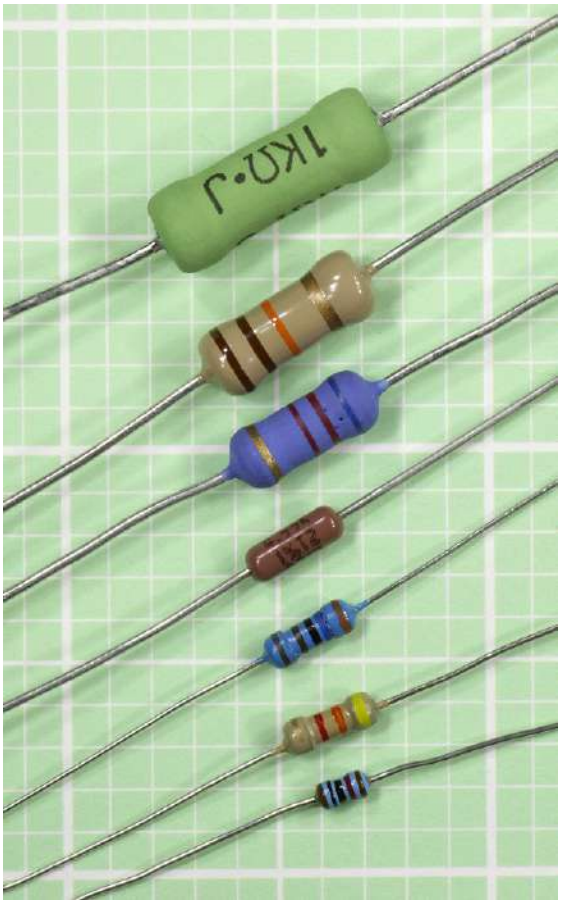

Figure 10-2. *A range of typical resistors. See text for details.*

How It Works

In the process of impeding the flow of current and reducing voltage, a resistor absorbs electrical energy, which it must dissipate as heat. In most modern electronic circuits, the heat dissipation is typically a fraction of a watt.

If R is the resistance in ohms, I is the current flowing through the resistor in amperes, and V is the voltage drop imposed by the resistor (the difference in electrical potential between the two contacts that are attached to it), Ohm's law states:

$$V = I / R$$

This is another way of saying that a resistor of 1Ω will allow a current of 1 amp when the potential difference between the ends of the resistor is 1 volt.

If W is the power in watts dissipated by the resistor, in a DC circuit:

$$W = V * I$$

By substitution in Ohm's law, we can express watts in terms of current and resistance:

$$W = I^2 / R$$

We can also express watts in terms of voltage and resistance:

$$W = V^2 * R$$

These alternates may be useful in situations where you do not know the voltage drop or the current, respectively.

Approximately similar relationships exist when using alternating current, although the power will be a more complex function.

Variants

Axial resistors have two leads that emerge from opposite ends of a usually cylindrical body. *Radial resistors* have parallel leads emerging from one side of the body and are unusual.

Precision resistors are generally defined as having a tolerance of no more than plus-or-minus 1%.

General-purpose resistors are less stable, and their value is less precise.

Power resistors are generally defined as dissipating 1 or 2 watts or more, particularly in power supplies or power amplifiers. They are physically larger and may require *heat sinks* or fan cooling.

Wire-wound resistors are used where the component must withstand substantial heat. A wire-wound resistor often consists of an insulating tube or core that is flat or cylindrical, with multi-

ple turns of resistive wire wrapped around it. The wire is usually a nickel-chromium alloy known as *nichrome* (sometimes written as *Ni-chrome*) and is dipped in a protecting coating.

The heat created by current passing through resistive wire is a potential problem in electronic circuits where temperature must be limited. However, in household appliances such as hair dryers, toaster ovens, and fan heaters, a nichrome element is used specifically to generate heat. Wire-wound resistors are also used in 3D printers to melt plastic (or some other compound) that forms the solid output of the device.

Thick film resistors are sometimes manufactured in a flat, square format. A sample is shown in Figure 10-3, rated to dissipate 10W from its flat surface. The resistance of this component is 1K.

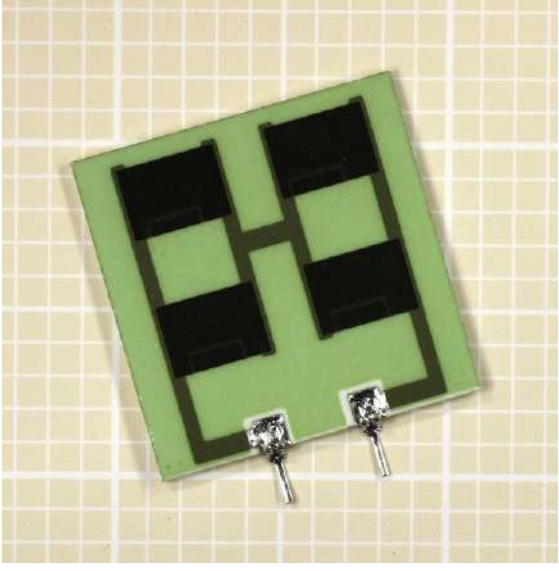

Figure 10-3. *A thick-film resistor measuring about 1" square and 0.03" thick.*

Surface-mount resistors generally consist of a resistive ink film printed on top of a tablet of aluminum oxide ceramic compound, often approximately 6mm long, known as a 2512 form factor. Each surface-mount resistor has two nickel-plated terminations coated in solder, which melts when the resistor is attached to the circuit board. The upper surface is coated, usually with black epoxy, to protect the resistive element.

Resistor Array

This is also known as a *resistor network* or *resistor ladder*, and consists of a chip containing multiple equal-valued resistors.

A resistor array in a *single-inline package* (or *SIP*) may have three possible internal configurations: isolated, common bus, and dual terminator. These options are shown at top, center, and bottom, respectively, in Figure 10-4. The isolated variant is commonly available in SIPs with 6, 8, or 10 pins. The common-bus and dual-terminator configurations generally have 8, 9, 10, or 11 pins.

In the isolated configuration, each resistor is electrically independent of the others and is accessed via its own pair of pins. On a common bus, one end of each resistor shares a bus accessed by a single pin, while the other ends of the resistors are accessed by their own separate pins. A dual-terminator configuration is more complex, consisting of pairs of resistors connected between ground and an internal bus, with the midpoint of each resistor pair accessible via a separate pin. The resistor pairs this function as voltage dividers and are commonly used in emitter-coupled logic circuits that require termination with -2 volts.

A *dual-inline package* (*DIP*) allows a similar range of internal configurations, as shown in Figure 10-5. At top, isolated resistors are commonly available in DIPs with 4, 7, 8, 9, or 10 pins. At center, the common bus configuration is available in DIPs with 8, 14, 16, 18, or 20 pins. At bottom, the dual-terminator configuration usually has 8, 14, 16, 18, or 20 pins.

The external appearance of SIP and DIP resistor arrays is shown in Figure 10-6. From left to right, the packages contain seven 120Ω resistors in

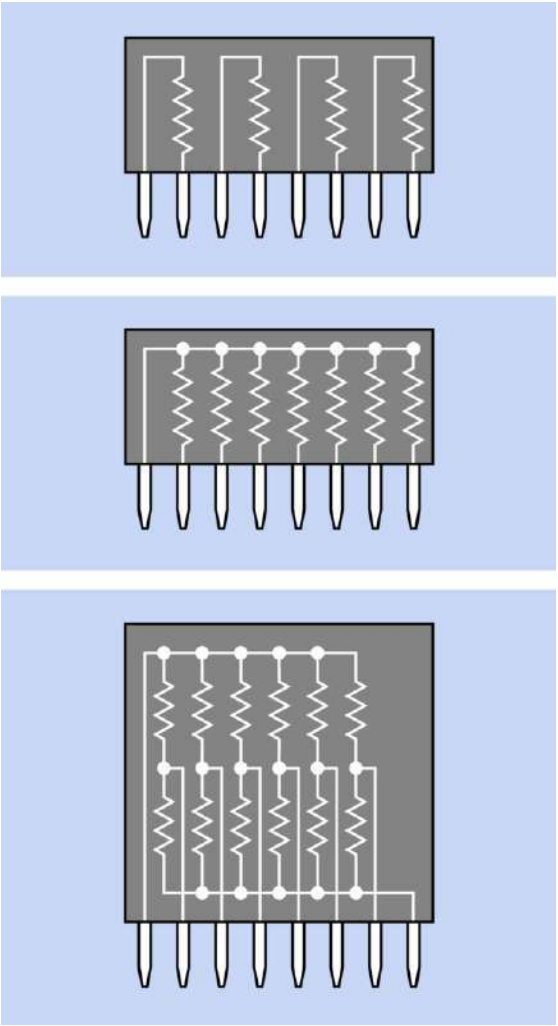

Figure 10-4. *Multiple resistors can be embedded in a single-inline package (SIP) in a variety of formats. See text for additional details.*

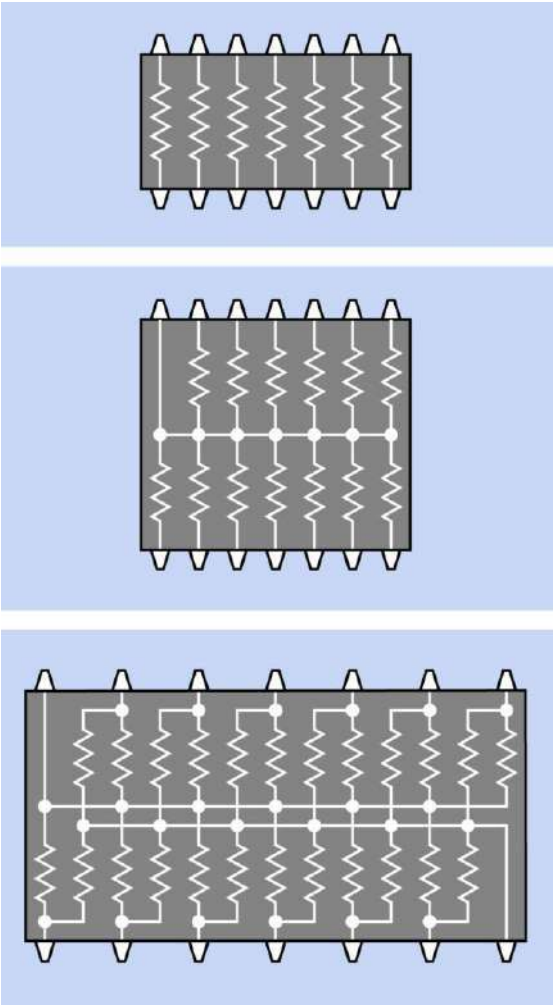

Figure 10-5. *Multiple resistors can be obtained embedded in a dual-inline package (DIP). See text for additional details.*

isolated configuration; thirteen 120Ω resistors in bussed configuration; seven 5.6K resistors in bussed configuration; and six 1K resistors in bussed configuration.

Resistor arrays with isolated or common-bus configurations are a convenient way to reduce the component count in circuits where pullup, pulldown, or terminating resistors are required for multiple chips. The common-bus configuration is also useful in conjunction with a 7-segment **LED display**, where each segment must be terminated by a series resistor and all the resistors share a common ground or common voltage source.

Surface-mount chips are available containing a pair of resistors configured as a single voltage divider.

Chips containing multiple *RC circuits* (each consisting of a capacitor and a resistor in series) are available, although uncommon. A package containing a single RC circuit may be sold as a

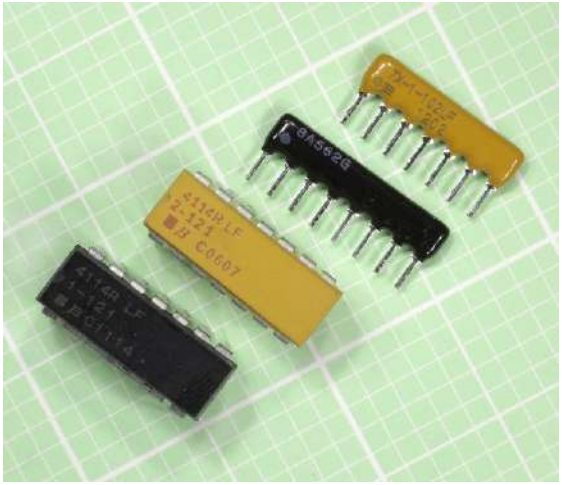

Figure 10-6. *Resistor arrays in DIP and SIP packages. See text for values.*

snubber to protect contacts in a **switch** or **relay** that switches a large inductive load. More information on snubber circuits is in the **capacitor** entry of this encyclopedia; see "Snubber" (page 108).

Values

1 *kilohm,* usually written as 1K, is 1,000Ω. 1 *megohm,* usually written as 1M or 1 meg, is 1,000K. 1 *gigaohm* is 1,000 megs, although the unit is rarely used. Resistances of less than 1Ω are uncommon and are usually expressed as a decimal number followed by the Ω symbol. The term *milliohms* (thousandths of an ohm) is used in special applications. Equivalent resistor values are shown in Figure 10-7.

A resistance value remains unchanged in DC and AC circuits, except where the AC reaches an extremely high frequency.

In common electronics applications, resistances usually range from 100Ω to 10M. Power ratings may vary from 1/16 watt to 1000 watts, but usually range from 1/8 watt to 1/2 watt in most electronic circuits (less in surface-mount applications).

Ohms	Kilohms	Megohms
1	0.001	0.000001
10	0.01	0.00001
100	0.1	0.0001
1,000	1	0.001
10,000	10	0.01
100,000	100	0.1
1,000,000	1,000	1

Figure 10-7. *Equivalent values in ohms, kilohms, and megohms.*

Tolerance

The tolerance, or precision, of a resistor may range from plus-or-minus 0.001% up to plus-or-minus 20%, but is most commonly plus-or-minus 1%, 2%, 5%, or 10%.

The traditional range of resistor values was established when a tolerance of 20% was the norm. The values were spaced to allow minimum risk of a resistor at one end of its tolerance range having the same value as another resistor at the opposite end of its tolerance range. The values were rounded to 10, 15, 22, 33, 47, 68, and 100, as illustrated in Figure 10-8 where each blue diamond represents the possible range of actual values of a 20% resistor with a theoretical value shown by the white horizontal line at the center of the diamond.

Resistor factors repeat themselves in multiples of 10. Thus, for example, beginning with a resistor of 100Ω, subsequent increasing values will be 150, 220, 330, 470, 680, and 1K, whereas the range of resistors beginning with 1Ω will be 1.5, 2.2, 3.3, 4.7, 6.8, and 10Ω.

Resistance multiplication factors are now expressed as a list of preferred values by the International Electrotechnical Commission (IEC) in their 60063 standard. Intermediate factors have been added to the basic sequence to

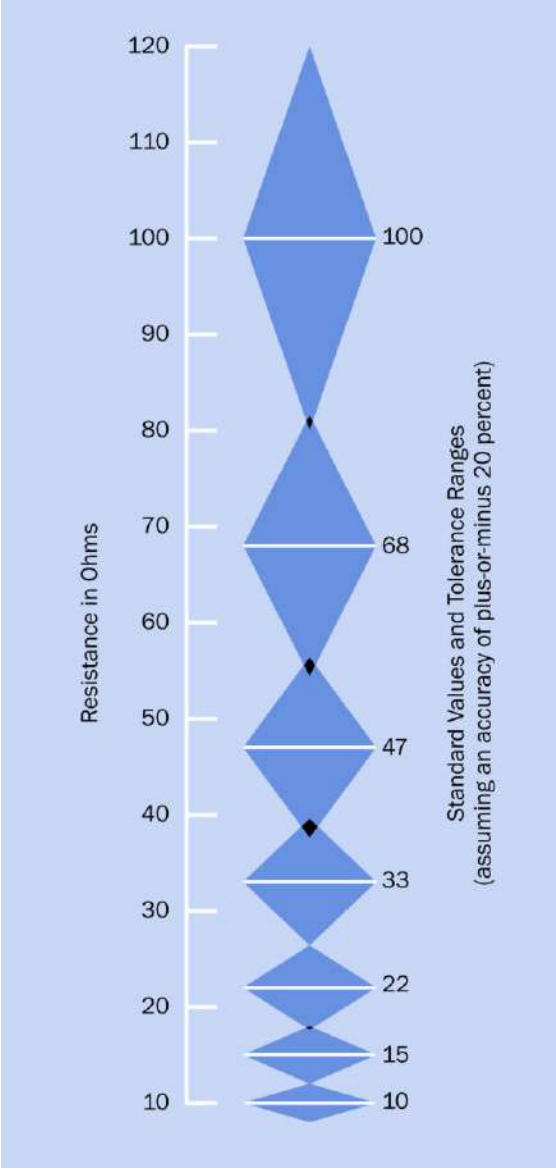

Figure 10-8. *Graphical representation of standard resistor values (white lines) established by the International Electrotechnical Commission, showing the acceptable range of actual values (dark blue areas) assuming precision of plus-or-minus 20%. The overlap, if any, between each range and the next is shown in black.*

Standard Resistor Values	Resistor Tolerances (plus or minus) 20%	10%	5%
	100	100	100
			91
		82	82
			75
	68	68	68
			62
		56	56
			51
	47	47	47
			43
		39	39
			36
	33	33	33
			30
		27	27
			24
	22	22	22
			20
		18	18
			16
	15	15	15
			13
		12	12
			11
	10	10	10

Figure 10-9. *Standard values for resistors of different precisions. For resistors outside the range shown, values can be found by multiplying or dividing (repeatedly, if necessary) by a factor of 10.*

accommodate better tolerances. A table showing resistor values for tolerances of plus-or-minus 20%, 10%, and 5% appears in Figure 10-9. Resistors with a tolerance of 5% have become increasingly common.

The IEC has established 3-digit preferred values for resistors with values accurate to plus-or-minus 0.5%.

Because many capacitors still have a tolerance no better than 20%, their values also conform with

the old original set of resistance values, although the units are expressed in farads or fractions of a farad. See the **capacitors** entry in this encyclopedia for additional information.

Value Coding

Through-hole axial resistors are traditionally printed with a sequence of three colored bands to express the value of the component, each of the first two bands representing a digit from 0 through 9, while the third band indicates the decimal multiplier (the number of zeroes, from 0 to 9, which should be appended to the digits). A fourth band of silver or gold indicates 10% or 5% tolerance respectively. No fourth band would indicate 20% tolerance, although this has become very rare.

Many resistors now have five color bands, to enable the representation of intermediate or fractional values. In this scheme, the first three bands have numeric values (using the same color system as before) while the fourth band is the multiplier. A fifth band, at the opposite end of the resistor, indicates its tolerance.

In Figure 10-10 the numeric or multiplier value of each color is shown as a "spectrum" at the top of the figure. The tolerance, or precision of a resistor, expressed as a plus-or-minus percentage, is shown using silver, gold, and various colors, at the bottom of the figure.

Two sample resistors are shown. The upper one has a value of 1K, indicated by the brown and black bands on the left (representing numeral 1 followed by a numeral 0) and the third red band (indicating two additional zeroes). The gold band at right indicates a precision of 5%. The lower one has a value of 1.05K, indicated by the brown, black, and green bands on the left (representing numeral 1 followed by numeral 0 followed by a numeral 5) and the fourth band brown (indicating one additional zero). The brown band at right indicates a precision of 1%.

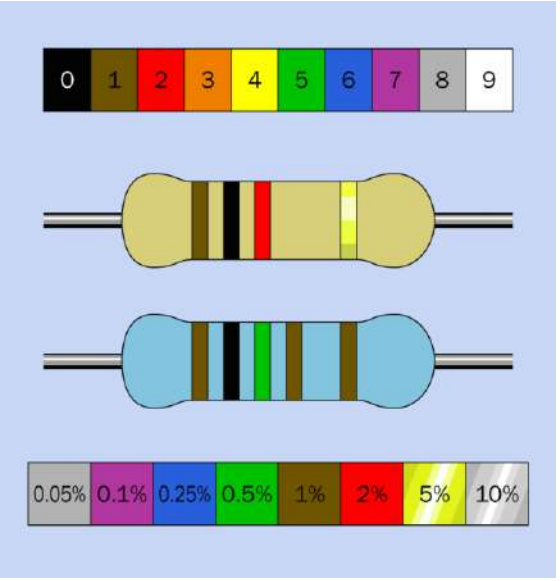

Figure 10-10. *Color coding of through-hole resistors. See text for details.*

In extremely old equipment, resistors may be coded with the body-tip-dot scheme, in which the body color represents the initial digit, the end color represents the second digit, and a dot represents the multiplier. The numeric identities of the colors is the same as in the current color scheme.

In all modern schemes, the three or four bands that show the resistance value are spaced close together, while a larger gap separates them from the band that shows the tolerance. The resistor value should be read while holding the resistor so that the group of closely-spaced numeric bands is on the left.

Confusingly, some resistors may be found where the first three bands define the value, using the old three-band convention; the fourth band indicates tolerance; and a fifth band at the opposite end of the component indicates reliability. However, this color scheme is uncommon.

Other color-coding conventions may be found in special applications, such as military equipment.

It is common for through-hole carbon-film resistors to have a beige body color, while through-hole metal-film resistors often have a blue body color. However, in relatively rare instances, a blue body color may also indicate a *fusible* resistor (designed to burn out harmlessly like a fuse, if it is overloaded) while a white body may indicate a *non-flammable* resistor. Use caution when replacing these special types.

Some modern resistors may have their values printed on them numerically. Surface-mount resistors also have digits printed on them, but they are a code, not a direct representation of resistance. The last digit indicates the number of zeroes in the resistor value, while the preceding two or three numbers define the value itself. Letter R is used to indicate a decimal point. Thus a 3R3 surface-mount resistor has a value of 3.3Ω, while 330 would indicate 33Ω, and 332 indicates 3,300Ω. A 2152 surface-mount resistor would have a value of 21,500Ω.

A surface-mount resistor with a single zero printed on it is a *zero ohm* component that has the same function as a **jumper** wire. It is used for convenience, as it is easily inserted by automated production-line equipment. It functions merely as a bridge between traces on the circuit board.

When resistor values are printed on paper in schematics, poor reproduction may result in omission of decimal points or introduction of specks that look like decimal points. Europeans have addressed this issue by using the letter as a substitute for a decimal point so that a 5.6K resistor will be shown as 5K6, or a 3.3M resistor will be shown as 3M3. This practice is followed infrequently in the United States.

Stability

This term describes the ability of a resistor to maintain an accurate value despite factors such as temperature, humidity, vibration, load cycling, current, and voltage. The *temperature coefficient* of a resistor (often referred to as T_{cr} or T_c, not to be confused with the time constant of a charging capacitor) is expressed in parts per million change in resistance for each degree centigrade deviation from room temperature (usually assumed to be 25 degrees Centigrade). T_c may be a positive or a negative value.

The *voltage coefficient* of resistance—often expressed as V_c—describes the change of a resistor's value that may occur as a function of changes in voltage. This is usually significant only where the resistive element is carbon-based. If V1 is the rated voltage of the resistor, R1 is its rated resistance at that voltage, V2 is 10% of the rated voltage, and R2 is the actual resistance at that voltage, the voltage coefficient, V_c, is given by this formula:

$$V_c = (100 * (R1 - R2)) / (R2 * (V1 - V2))$$

Materials

Resistors are formed from a variety of materials.

Carbon composite. Particles of carbon are mixed with a binder. The density of the carbon determines the end-to-end resistance, which typically ranges from 5Ω to 10M. The disadvantages of this system are low precision (a 10% tolerance is common), relatively high voltage coefficient of resistance, and introduction of noise in sensitive circuits. However, carbon-composite resistors have low inductance and are relatively tolerant of overload conditions.

Carbon film. A cheap and popular type, made by coating a ceramic substrate with a film of carbon compound. They are available in both through-hole and surface-mount formats. The range of resistor values is comparable with carbon-composite types, but the precision is increased, typically to 5%, by cutting a spiral groove in the carbon-compound coating during the manufacturing process. The carbon film suffers the same disadvantages of carbon composite resistors, but to a lesser extent. Carbon film resistors generally should not be substituted for metal film resistors in applications where accuracy is important.

Metal film. A metallic film is deposited on a ceramic substrate, and has generally superior char-

acteristics to carbon-film resistors. During manufacture, a groove may be cut in the metal film to adjust the end-to-end resistance. This may cause the resistor to have higher inductance than carbon-composite types, though it has lower noise. Tolerances of 5%, 2%, and 1% are available. This type of resistor was originally more expensive than carbon-film equivalents, but the difference is now fractional. They are available in both through-hole and surface-mount formats. They are available in lower-wattage variants (1/8 watt is common).

Thick-film resistors are spray-coated, whereas thin-film resistors are sputtered nichrome. Thin-films enjoy a flatter temperature coefficient and are typically used in environments that have a huge operational temperature range, such as satellites.

Bulk metal foil. The type of foil used in metal film resistors is applied to a ceramic wafer and etched to achieve the desired overall resistance. Typically these resistors have axial leads. They can be extremely accurate and stable, but have a limited maximum resistance.

Precision wire-wound. Formerly used in applications requiring great accuracy, but now largely replaced by precision metal foil.

Power wire-wound. Generally used when 1 or 2 watts or more power dissipation is required. Resistive wire is wrapped around a core that is often ceramic. This can cause the resistor to be referred to, inaccurately, as "ceramic." The core may alternatively be fiberglass or some other electrically insulating compound that actively sinks heat. The component is either dipped (typically in vitreous enamel or cement) or is mounted in an aluminum shell that can be clamped to a heat sink. It almost always has the ohm value printed on it in plain numerals (not codes).

Two typical wire-wound resistors are shown in Figure 10-11. The upper resistor is rated at 12W and 180Ω while the lower resistor is rated at 13W and 15K.

Figure 10-11. *Two wire-wound resistors of greatly differing resistance but similar power dissipation capability.*

A larger wire-wound resistor is shown in Figure 10-12, rated for 25W and 10Ω.

Figure 10-12. *A large wirewound resistor rated to dissipate 25W.*

In Figure 10-13, two resistors encapsulated in cement coatings are shown with the coatings removed to expose the elements. At left is a 1.5Ω 5W resistor, which uses a wire-wound element. At right is a very low-value 0.03Ω 10W resistor.

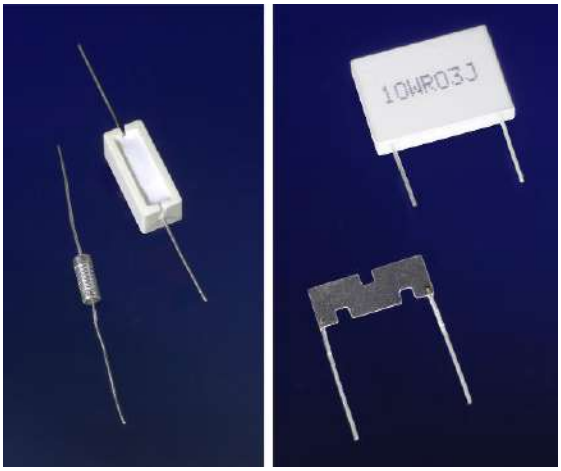

Figure 10-13. *Two low-value resistors with their cement coatings removed to show the resistive elements.*

In Figure 10-14, the resistor at right has an exposed 30Ω element while the resistor at left is rated 10W and 6.5Ω, enclosed in an anodized aluminum shell to promote heat dissipation.

Figure 10-14. *A 30Ω resistor (right) and 6.5Ω resistor (left).*

In power resistors, heat dissipation becomes an important consideration. If other factors (such as voltage) remain the same, a lower-value resistor will tend to pass more current than a higher-value resistor, and heat dissipation is proportional to the square of the current. Therefore power wire-wound resistors are more likely to be needed where low resistance values are required. Their coiled-wire format creates significant inductance, making them unsuitable to pass high frequencies or pulses.

How to Use it

Some of the most common applications for a resistor are listed here.

In Series with LED

To protect an LED from damage caused by excessive current, a *series resistor* is chosen to allow a current that does not exceed the manufacturer's specification. In the case of a single through-hole LED (often referred to as an *indicator*), the forward current is often limited to around 20mA, and the value of the resistor will depend on the voltage being used. (See Figure 10-15.)

When using high-output LEDs (which may contain multiple elements in a single 5mm or 10mm package), or LED arrays that are now being used for domestic lighting, the acceptable current may be much greater, and the LED unit may contain its own current-limiting electronics. A datasheet should be consulted for details.

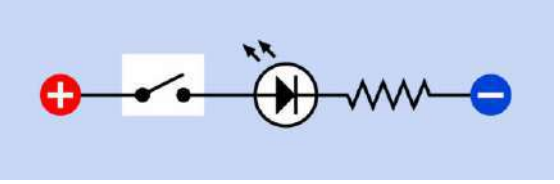

Figure 10-15. *A series resistor is necessary to limit the current that passes through an LED.*

Current Limiting with a Transistor

In Figure 10-16, a transistor is switching or amplifying current flowing from B to C. A resistor is used to protect the base of the transistor from excessive current flowing from point A. Resistors are also commonly used to prevent excessive current from flowing between B and C.

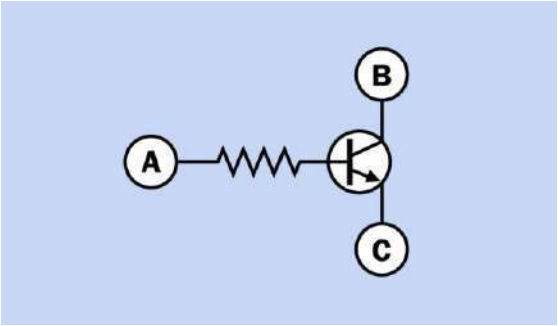

Figure 10-16. *A resistor is typically necessary to protect the base of a transistor from excessive current.*

Pullup and Pulldown Resistors

When a mechanical switch or pushbutton is attached to the input of a logic chip or **microcontroller**, a *pullup* or *pulldown* resistor is used, applying positive voltage or grounding the pin, respectively, to prevent it from "floating" in an indeterminate state when the switch is open. In Figure 10-17, the upper schematic shows a pulldown resistor, whereas the lower schematic shows a pullup resistor. A common value for either of them is 10K. When the pushbutton is pressed, its direct connection to positive voltage or to ground easily overwhelms the effect of the resistor. The choice of pullup or pulldown resistor may depend on the type of chip being used.

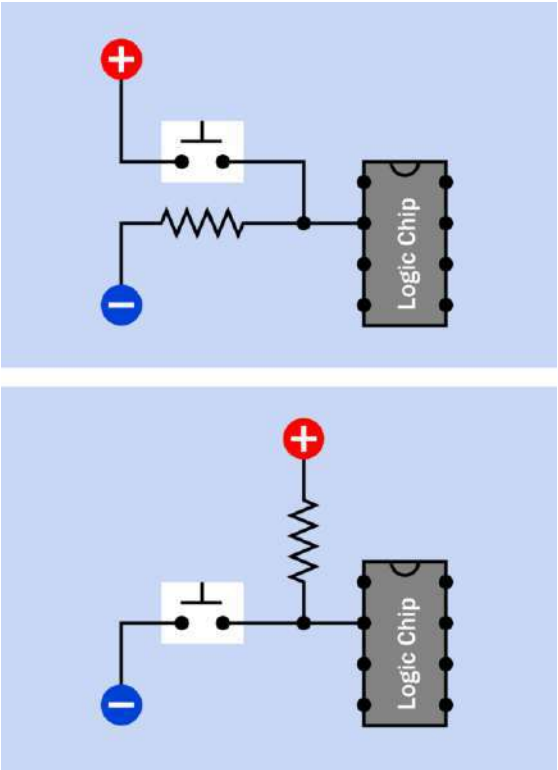

Figure 10-17. *A pulldown resistor (top) or pullup resistor (bottom) prevents an input pin on a logic chip or microcontroller from "floating" in an indeterminate state when the button is not being pressed.*

Audio Tone Control

A resistor-capacitor combination can limit the high-frequency in a simple audio tone-control circuit, as shown in Figure 10-18. Beneath a signal travelling from A to B, a resistor is placed in series with a capacitor that passes high frequencies to ground. This is known as a low-pass filter.

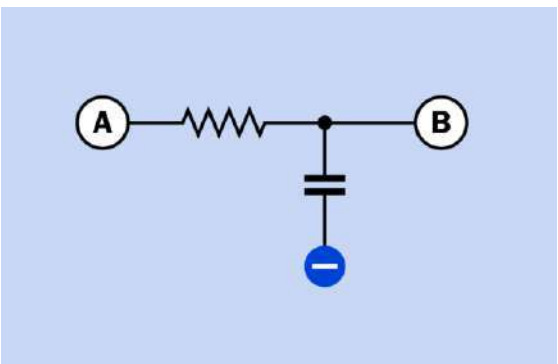

Figure 10-18. *This configuration may be used to remove high frequencies from an audio signal. It is known as a low-pass filter because low frequencies are passed from A to B.*

RC Network

A resistor will adjust the charge/discharge time when placed in series with a capacitor, as in Figure 10-19. When the switch closes, the resistor limits the rate at which the capacitor will charge itself from the power supply. Because a capacitor has an ideally infinite resistance to DC current, the voltage measured at point A will rise until it

is close to the supply voltage. This is often referred to as an *RC* (*resistor-capacitor*) network and is discussed in greater detail in the **capacitor** section of this encyclopedia.

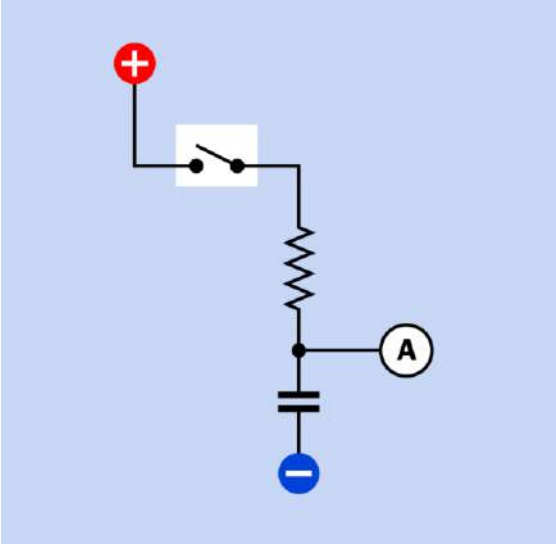

Figure 10-19. *In an RC (resistor-capacitor) network, a resistor limits the rate of increase in potential of the capacitor, measured at A, when the switch is closed.*

Voltage Divider

Two resistors may be used to create a voltage divider (see Figure 10-20). If V_{in} is the supply voltage, the output voltage, V_{out}, measured at point A, is found by the formula:

$$V_{out} = V_{in} * (R2 / (R1 + R2))$$

In reality, the actual value of V_{out} is likely to be affected by how heavily the output is loaded.

If the output node has a high impedance, such as the input to a logic chip or comparator, it will be more susceptible to electrical noise, and lower-value resistors may be needed in the voltage divider to maintain a higher current flow and maintain stability in the attached device.

Resistors in Series

If resistors in series have values R1, R2, R3 . . . the total resistance, R, is found by summing the individual resistances:

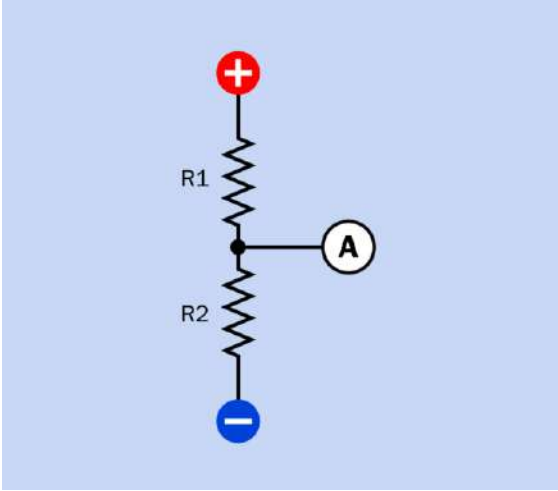

Figure 10-20. *In a DC circuit, a pair of resistors may be placed in series to function as a voltage divider. The voltage measured at A will be lower than the supply voltage, but above ground potential.*

$$R = R1 + R2 + R3. . .$$

The current through each of the resistors will be the same, whereas the voltage across each of them will vary proportionately with its resistance. If the supply voltage across the series of resistors is VS, and the total of all the resistor values is RT, and the resistance of one resistor is R1, the voltage across that resistor, V1, will be given by the formula:

$$V1 = VS * (R1 / RT)$$

Resistors in Parallel

Where two or more resistors (R1, R2, R3 . . .) are wired in parallel, their total resistance, R, is found from the formula:

$$1/R = (1/R1) + (1/R2) + (1/R3). . .$$

Suppose that R1, R2, R3 . . . all have the same individual resistance, represented by RI, and the number of resistors is N. Their total resistance, RT, when wired in parallel, will be:

$$RT = RI / N$$

If each resistor has an equal resistance and also has an equal individual rating in watts (represented by WI), the total wattage (WT) that they can handle when wired in parallel to share the power will be:

```
WT = WI * N
```

Therefore, if an application requires high-wattage resistors, multiple lower-wattage, higher-value resistors may be substituted if they are wired in parallel—and may even be cheaper than a single high-wattage wire-wound resistor. For example, if a 5W, 50Ω resistor is specified, 10 resistors can be substituted, each rated at 0.5W and 500Ω. Bear in mind that if they are tightly bundled, this will interfere with heat dissipation.

What Can Go Wrong

Heat

Resistors are probably the most robust of all electronic components, with high reliability and a long life. It is difficult to damage a resistor by overheating it with a soldering iron.

The wattage rating of a resistor does not necessarily mean that it should be used to dissipate that amount of power on a constant basis. Small resistors (1/4 watt or less) can overheat just as easily as big ones. Generally speaking, it is safe practice not to exceed 75% of a resistor's power rating on a constant basis.

Overheating is predictably more of a problem for power resistors, where provision must be made for heat dissipation. Issues such as component crowding should be considered when deciding how big a heat sink to use and how much ventilation. Some power resistors may function reliably at temperatures as high as 250 degrees Centigrade, but components near them are likely to be less tolerant and plastic enclosures may soften or melt.

Noise

The electrical *noise* introduced by a resistor in a circuit will vary according to the composition of the resistor, but for any given component, it will be proportional to voltage and current. Low-noise circuits (such as those at the input stage of a high-gain amplifier) should use low-wattage resistors at a low voltage where possible.

Inductance

The coiled wire of a wire-wound resistor will be significantly inductive at low frequencies. This is known as *parasitic inductance*. It will also have a resonant frequency. This type of resistor is unsuitable for applications where frequency exceeds 50KHz.

Inaccuracy

When using resistors with 10% tolerance, imprecise values may cause greater problems in some applications than in others. In a voltage divider, for instance, if one resistor happens to be at the high end of its tolerance range while the other happens to be at the low end, the voltage obtained at the intersection of the resistors will vary from its expected value. Using the schematic shown in Figure 10-20, if R1 is rated for 1K and R2 is rated for 5K, and the power supply is rated at 12VDC, the voltage at point A should be:

```
V = 12 * (( 5 / (5 + 1)) = 10
```

However, if R1 has an actual value of 1.1K and R2 has an actual value of 4.5K, the actual voltage obtained at point A will be:

```
V = 12 * (( 4.5 / (4.5 + 1.1)) = 9.6
```

If the resistors are at opposite ends of their respective tolerance ranges, so that R1 has an actual value of 900Ω while the lower resistor has an actual value of 5.5K, the actual voltage obtained will be:

```
V = 12 * (( 5.5 / (5.5 + 0.9)) = 10.3
```

The situation becomes worse if the two resistors are chosen to be of equal value, to provide half of the supply voltage (6 volts, in this example) at their intersection. If two 5K resistors are used, and the upper one is actually 4.5K while the lower one is 5.5K, the actual voltage will be:

```
V = 12 * (( 5.5 / (4.5 + 5.5)) = 6.6
```

Whether this variation is significant will depend on the particular circuit in which the voltage divider is being used.

Common through-hole resistors may occasionally turn out to have values that are outside their specified tolerance range, as a result of poor manufacturing processes. Checking each resistor with a meter before placing it in a circuit should be a standard procedure.

When measuring the voltage drop introduced by a resistor in an active circuit, the meter has its own internal resistance that will take a proportion of the current. This is known as *meter loading* and will result in an artificially low reading for the potential difference between the ends of a resistor. This problem becomes significant only when dealing with resistors that have a high value (such as 1M), comparable with the internal resistance of the meter (likely to be 10M or more).

Wrong Values

When resistors are sorted into small bins by the user, errors may be made, and different values may be mixed together. This is another reason for checking the values of components before using them. Identification errors may be nontrivial and easily overlooked: the visible difference between a 1 megohm resistor and a 100Ω resistor is just one thin color band.

potentiometer

11

Also known as a *variable resistor*; may be substituted for a *rheostat*.

OTHER RELATED COMPONENTS

- **rotational encoder** (see Chapter 8)
- **resistor** (see Chapter 10)

What It Does

When a voltage is applied across a potentiometer, it can deliver a variable fraction of that voltage. It is often used to adjust sensitivity, balance, input, or output, especially in audio equipment and sensors such as motion detectors.

A potentiometer can also be used to insert a variable resistance in a circuit, in which case it should really be referred to as a *variable resistor,* although most people will still call it a potentiometer.

It can be used to adjust the power supplied to a circuit, in which case it is properly known as a *rheostat*, although this term is becoming obsolete. Massive rheostats were once used for purposes such as dimming theatrical lighting, but solid-state components have taken their place in most high-wattage applications.

A full-size, classic-style potentiometer is shown in Figure 11-1.

Figure 11-1. *A generic or classic-style potentiometer, approximately one inch in diameter.*

Schematic symbols for a potentiometer and other associated components are shown in Figure 11-2, with American versions on the left and European versions on the right in each case. The symbols for a potentiometer are at the top. The correct symbols for a variable resistor or rheostat are shown at center, although a potentiometer symbol may often be used instead. A preset variable resistor is shown at the bottom, often referred to as a *trimmer* or *Trimpot*. In these examples, each has an arbitrary rated resistance of 4,700Ω. Note the European substitution of K for a decimal point.

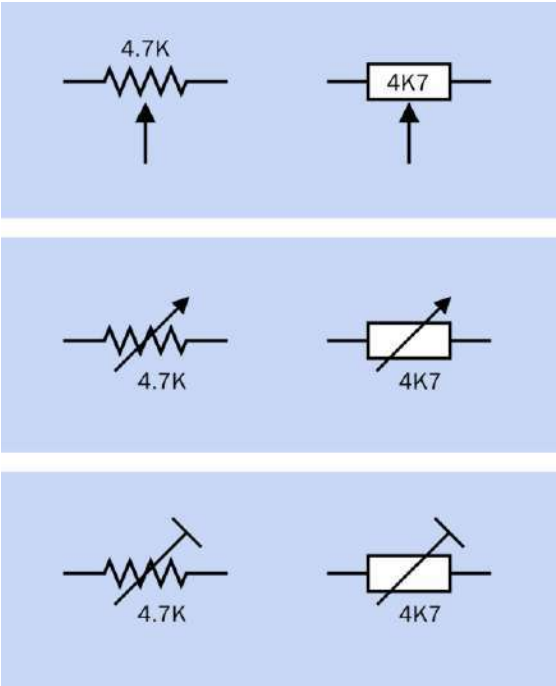

Figure 11-2. *American (left) and European (right) symbols for a potentiometer, a rheostat, and a trimmer potentiometer, reading from top to bottom. The 4.7K value was chosen arbitrarily.*

How It Works

A potentiometer has three terminals. The outer pair connect with the opposite ends of an internal resistive element, such as a strip of conductive plastic, sometimes known as the *track*. The third center terminal connects internally with a contact known as the *wiper* (or rarely, the *pick-off*), which touches the strip and can be moved from one end of it to the other by turning a shaft or screw, or by moving a slider.

If an electrical potential is applied between opposite ends of the resistive element, the voltage "picked off" by the wiper will vary as it moves. In this mode, the potentiometer works as a resistive voltage divider. For example, in a potentiometer with a linear taper (see "Variants," coming up), if you attach the negative side of a 12V battery to the right-hand end terminal and the positive side to the left-hand end terminal, you will find an 8V potential at the center terminal when the potentiometer has rotated clockwise through one-third of its range. In Figure 11-3, the base of the shaft (shown in black) is attached to an arm (shown in green) that moves a wiper (orange) along a resistive element (brown). The voltages shown assume that the resistive element has a linear taper and will vary slightly depending on wire resistance and other factors.

Because a potentiometer imposes a voltage reduction, it also reduces current flowing through it, and therefore creates waste heat which must be dissipated. In an application such as an audio circuit, small currents and low voltages generate negligible heat. If a potentiometer is used for heavier applications, it must be appropriately rated to handle the wattage and must be vented to allow heat to disperse.

To use a potentiometer as a *variable resistor* or *rheostat*, one of its end terminals may be tied to the center terminal. If the unused end terminal is left unconnected, this raises the risk of picking up stray voltages or "noise" in sensitive circuits. In Figure 11-4, a potentiometer is shown adjusting a series resistance for an *LED* for demonstration purposes. More typically, a trimmer would be used in this kind of application, since a user is unlikely to need to reset it.

Variants

Linear and Log Taper

If the resistive element in a potentiometer is of constant width and thickness, the electrical potential at the wiper will change in ratio with the rotation of the wiper and shaft (or with movement of a slider). This type of potentiometer is said to have a linear taper even though its element does not actually taper.

For audio applications, because human hearing responds nonlinearly to sound pressure, a potentiometer that has a linear taper may seem to have a very slow action at one end of its scale and an abrupt effect at the other. This problem used to be solved with a non-uniform or tapered re-

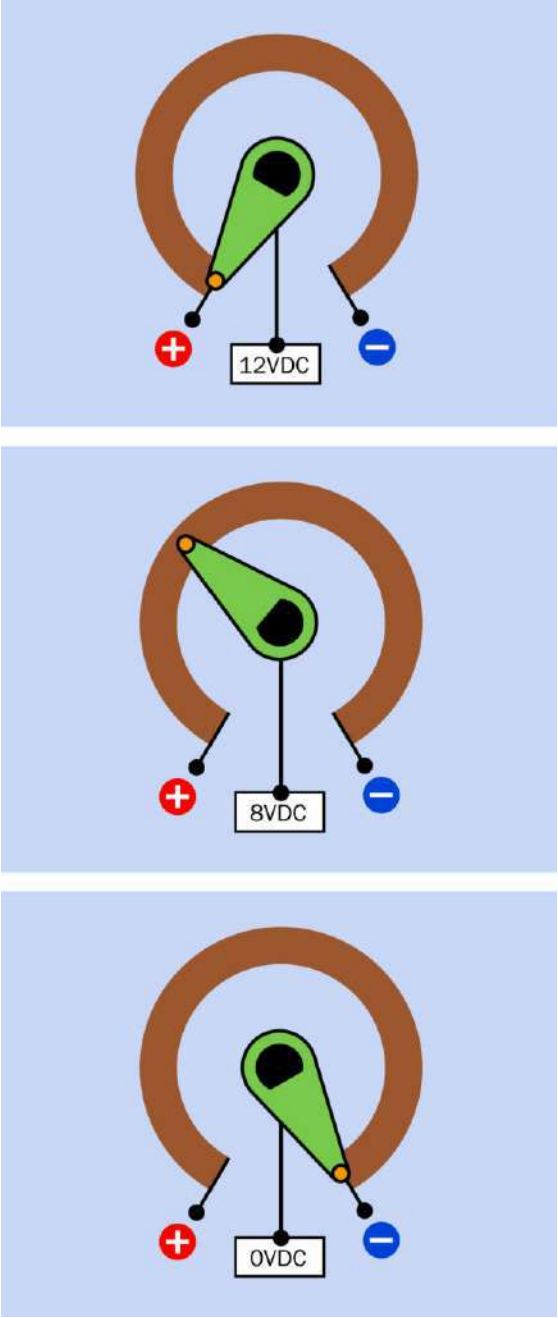

Figure 11-3. *Inside a potentiometer. See text for details.*

sistive element. More recently, a combination of resistive elements has been used as a cheaper option. Such a potentiometer is said to have an audio taper or a log taper (since the resistance

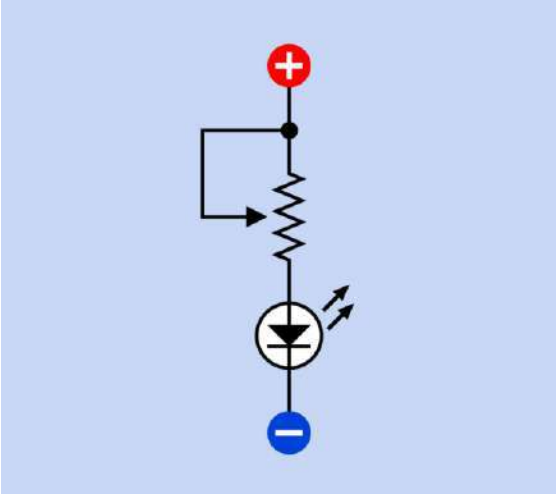

Figure 11-4. *A potentiometer can be used to adjust a series resistance, as shown in this schematic. Tying the wiper to one of the end terminals reduces the risk of picking up electrical noise.*

may vary as a logarithm of the angle of rotation). A reverse audio taper or antilog taper varies in the opposite direction, but this type has become very uncommon.

Classic-style Potentiometer

This consists of a sealed circular can, usually between 0.5″ and 1″ in diameter, containing a resistive strip that is shaped as a segment of a circle. A typical example is shown in Figure 11-1, although miniaturized versions have become more common. A shaft mounted on the can turns the internal wiper that presses against the strip. For panel-mount applications, a threaded bushing at the base of the shaft is inserted through a hole in the front panel of the electronics enclosure, and a nut is tightened on the bushing to hold the potentiometer in place. Often there is also a small offset index pin that, when paired with a corresponding front panel hole, will keep the pot from spinning freely.

Many modern potentiometers are miniaturized, and may be packaged in a box-shaped plastic

enclosure rather than a circular can. Their power ratings are likely to be lower, but their principle of operation is unchanged. Two variants are shown in Figure 11-5.

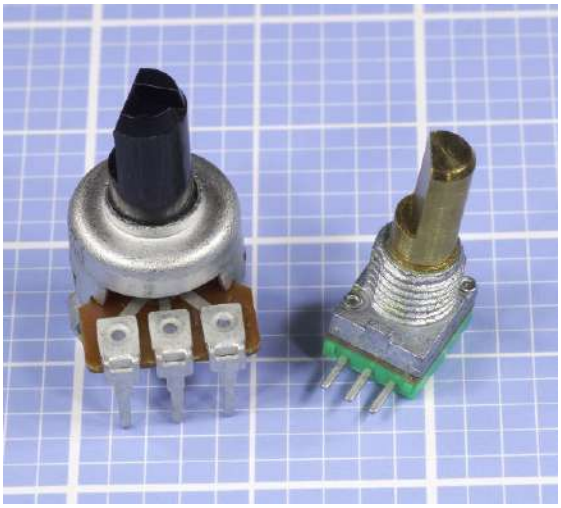

Figure 11-5. *Two modern miniaturized potentiometers. At left: 5K. At right: 10K. Both are rated to dissipate up to 50mW.*

The three terminals on the outside of a potentiometer may be solder lugs, screw terminals, or pins for direct mounting on a circuit board. The pins may be straight or angled at 90 degrees.

The resistive element may use carbon film, plastic, cermet (a ceramic-metal mixture), or resistive wire wound around an insulator. Carbon-film potentiometers are generally the cheapest, whereas wire-wound potentiometers are generally the most expensive.

Wire-wound potentiometers may handle more power than the other variants, but as the wiper makes a transition from one turn of the internal wire element to the next, the output will tend to change in discrete steps instead of varying more smoothly.

In a potentiometer with detents, typically a spring-loaded lever in contact with notched internal wheel causes the shaft to turn in discrete steps that create a stepped output even if the resistive element is continuous.

The shaft may be made of metal or plastic, with its length and width varying from one component to another. A control knob can be fitted to the end of the shaft. Some control knobs are push-on, others have a set screw to secure them. Shafts may be splined and split, or round and smooth, or round with a flat surface that matches the shape of a socket in a control knob and reduces the risk of a knob becoming loose and turning freely. Some shafts have a slotted tip to enable screwdriver adjustment.

Some shaft options for full-size potentiometers are shown in Figure 11-6.

Figure 11-6. *Three shaft options for potentiometers.*

Multiple-Turn Potentiometer

To achieve greater precision, a track inside a potentiometer may be manufactured in the form of a helix, allowing the wiper to make multiple turns on its journey from one end of the track to the other. Such multiple-turn potentiometers typically allow 3, 5, or 10 turns to move the wiper from end to end. Other multiple-turn potentiometers may use a screw thread that advances a wiper along a linear or circular track. The latter is com-

parable with a trimmer where multiple turns of a screwdriver are used to rotate a worm gear that rotates a wiper between opposite ends of a circular track.

Ganged Potentiometer

Two (or rarely, more) potentiometers can be stacked or combined so that their resistive elements and wipers share the same shaft but can use different voltages or have different taper. Each resistance-wiper assembly is known as a *cup*, and the potentiometers are said to be *ganged*.

Flat ganged potentiometers combine two resistive elements in one enclosure. Some *dual ganged* potentiometers are concentric, meaning that the pots are controlled separately by two shafts, one inside the other. Suitable concentric knobs must be used. You are unlikely to find these potentiometers sold as components in limited quantities.

Switched Potentiometer

In this variant, when the shaft is turned clockwise from an initial position that is fully counterclockwise, it flips an internal switch connected to external terminals. This can be used to power-up associated components (for example, an audio amplifier). Alternatively, a switch inside a potentiometer may be configured so that it is activated by pulling or pushing the shaft.

Slider Potentiometer

Also known as a *slide potentiometer*. This uses a straight resistive strip and a wiper that is moved to and fro linearly by a tab or lug fitted with a plastic knob or finger-grip. Sliders are still found on some audio equipment. The principle of operation, and the number of terminals, are identical to the classic-style potentiometer. Sliders typically have solder tabs or PC pins. In Figure 11-7, the large one is about 3.5" long, designed for mounting behind a panel that has a slot to allow the sliding lug to poke through. Threaded holes at either end will accept screws to fix the slider behind the panel. A removable plastic finger-grip (sold separately, in a variety of styles) has been pushed into place. Solder tabs underneath the slider are hidden in this photo. The smaller slider is designed for through-hole mounting on a circuit board.

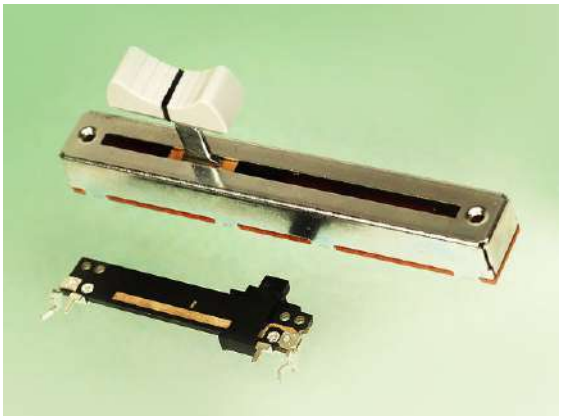

Figure 11-7. *Slider potentiometers.*

Trimmer Potentiometer

Often referred to as Trimpots, this is actually a proprietary brand name of Bourns. They are usually mounted directly on circuit boards to allow fine adjustment or trimming during manufacturing and testing to compensate for variations in other components. Trimmers may be single-turn or multi-turn, the latter containing a worm gear that engages with another gear to which the wiper is attached. Trimmers always have linear taper. They may be designed for screwdriver adjustment or may have a small knurled shaft, a thumb wheel, or a knob. They are not usually accessible by the end user of the equipment, and their setting may be sealed or fixed when the equipment is assembled. In Figure 11-8, the beige Spectrol trimmer is a single-turn design, whereas the blue trimmer is multi-turn. A worm gear inside the package, beneath the screw head, engages with an interior gear wheel that rotates the wiper.

In Figure 11-9, a 2K trimmer potentiometer has a knurled dial attached to allow easy finger adjustment, although the dial also contains a slot for a flat-blade screwdriver.

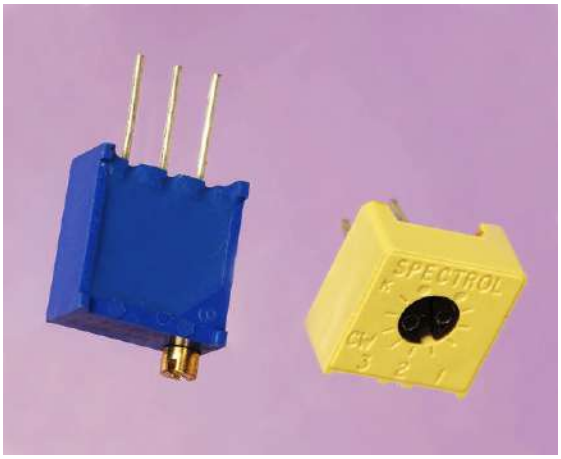

Figure 11-8. *Like most trimmers, these are designed for through-hole mounting on a circuit board.*

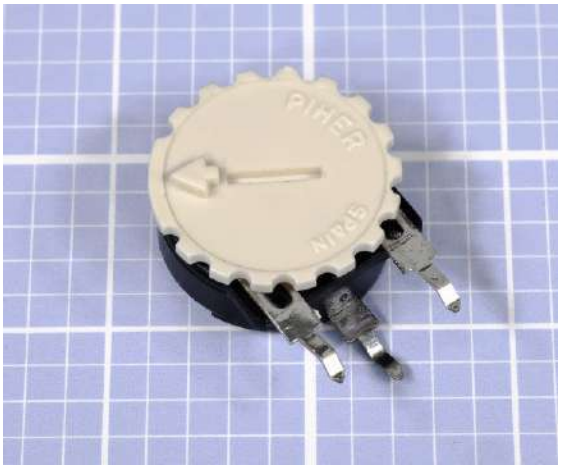

Figure 11-9. *A trimmer potentiometer with a knurled dial to facilitate finger adjustment.*

How to Use it

The classic-style potentiometer was once used universally to control volume, bass, and treble on audio equipment but has been replaced increasingly by digital input devices such as **tactile switches** (see "Tactile Switch" (page 34)) or **rotational encoders** (see Chapter 8), which are more reliable and may be cheaper, especially when assembly costs are considered.

Potentiometers are widely used in lamp dimmers and on cooking stoves (see Figure 11-10). In these applications, a solid-state switching device such as a **triac** (described in Volume 2) does the actual work of moderating the power to the lamp or the stove by interrupting it very rapidly. The potentiometer adjusts the duty cycle of the power interruptions. This system wastes far less power than if the potentiometer controlled the lighting or heating element directly as a rheostat. Since less power is involved, the potentiometer can be small and cheap, and will not generate significant heat.

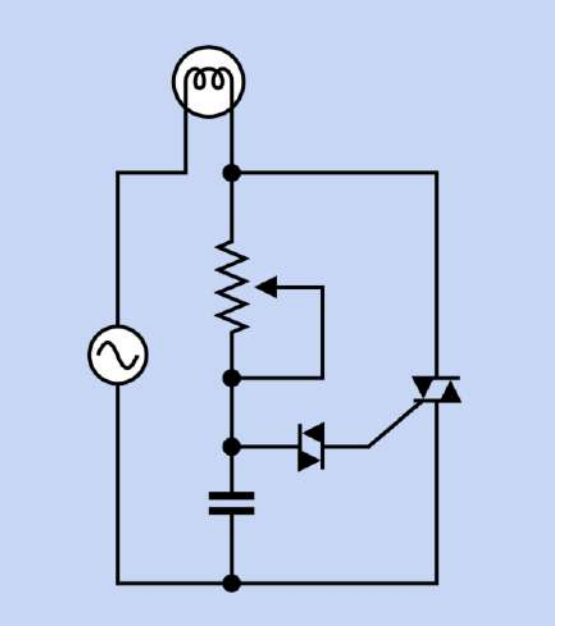

Figure 11-10. *Typical usage of a potentiometer in conjunction with a diac, triac, and capacitor to control the brightness of an incandescent bulb, using an AC power supply. Diacs and triacs are discussed in Volume 2.*

Because true logarithmic potentiometers have become decreasingly common, a linear potentiometer in conjunction with a fixed resistor can be used as a substitute, to control audio input. See Figure 11-11.

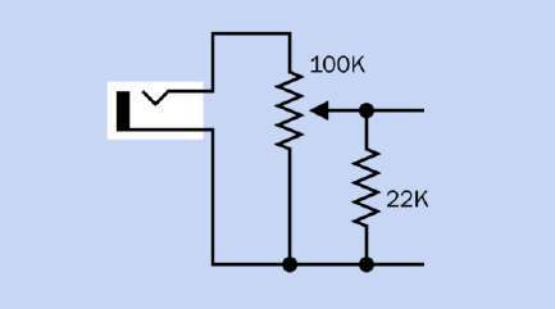

Figure 11-11. *In this circuit, a 100K linear potentiometer is used in conjunction with a 22K resistor to create an approximately logarithmic volume control for an audio system with input coming from a mono jack socket at left.*

A potentiometer may be used to match a sensor or analog input device to an analog-digital converter, or it can calibrate a device such as a temperature or motion sensor.

What Can Go Wrong

Wear and Tear

Since classic-style potentiometers are electromechanical devices, their performance will deteriorate as one part rubs against another. The long open slot of a slider potentiometer makes it especially vulnerable to contamination with dirt, water, or grease. Contact-cleaner solvent, lubricant-carrying sprays, or pressurized "duster" gas may be squirted into a potentiometer to try to extend its life. Carbon-film potentiometers are the least durable and in audio applications will eventually create a "scratchy" sound when they are turned, as the resistive element deteriorates.

If the wiper deteriorates to the point where it no longer makes electrical contact with the track, and if the potentiometer is being used as a variable resistor, two failure modes are possible, shown in Figure 11-12. Clearly the right-hand schematic is a better outcome. This is an argument for always tying the wiper to the "unused" end of the track.

If you are designing a circuit board that will go through a production process, temperature variations during wave soldering, and subsequent washing to remove flux residues, create hostile conditions for potentiometers, especially sliders where the internal parts are easily contaminated. It will be safer to hand-mount potentiometers after the automated process.

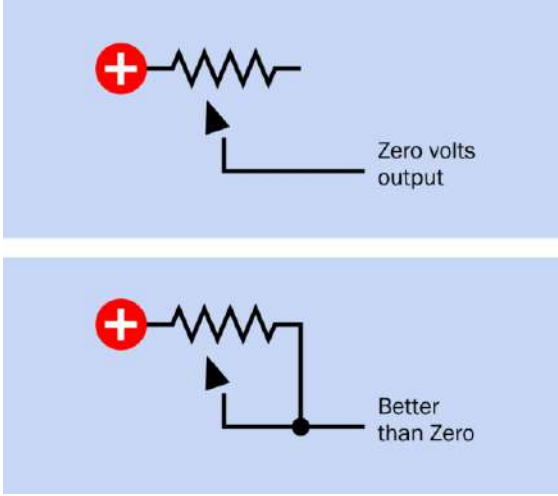

Figure 11-12. *If the wiper of a potentiometer breaks (indicated by the loose arrow head) as a result of wear and tear, and the potentiometer is being used as a variable resistor, the voltage from it will drop to zero (top schematic) unless the wiper has been tied to one end of the track (bottom schematic).*

Knobs that Don't Fit

Control knobs are almost always sold separately from potentiometers. Make sure the shaft of the potentiometer (which may be round, round-with-flat, or knurled) matches the knob of your choice. Note that some shaft diameters are expressed in inches, while others are metric.

Nuts that Get Lost

For panel-mounted potentiometers, a nut that fits the thread on the bushing is almost always included with the potentiometer; an additional nut and lock washer may also be supplied. Because there is no standardization of threads on potentiometers, if you lose a nut, you may have some difficulty finding an exact replacement.

A Shaft that Isn't Long Enough

When choosing a shaft length, if in doubt, buy a potentiometer with a long shaft that you can cut to the desired length.

Sliders with No Finger Grip

Slider potentiometers are often sold without a knob or plastic finger-grip, which must be ordered separately and may be available in different styles. The finger-grip usually push-fits onto the metal or plastic tab or lug that moves the slider to and fro.

Too Big to Fit

Check the manufacturer's datasheet if you need to know the physical size of the potentiometer. Photographs may be misleading, as a traditional-style potentiometer that is 0.5" in diameter looks much the same as one that is 1" in diameter. High-wattage potentiometers will be more costly and physically large (2 to 3 inches in diameter). See Figure 11-13.

Overheating

Be sure to leave sufficient air space around a high-wattage potentiometer. Carefully calculate the maximum voltage drop and current that you may be using, and choose a component that is appropriately rated. Note that if you use the potentiometer as a rheostat, it will have to handle more current when its wiper moves to reduce its resistance. For example, if 12VDC are applied through a 10-ohm rheostat to a component that has a resistance of 20 ohms, current in the circuit will vary from 0.4 amps to 0.6 amps depending on the position of the rheostat. At its maximum setting, the rheostat will impose a 4V voltage drop and will therefore dissipate 1.6 watts from the full length of its resistive element. If the rheostat is reset to impose only a 4-ohm resistance, the voltage drop that it imposes will be 2V, the current in the circuit will be 0.5 amps, and the rheostat will therefore dissipate 1 watt from 4/10ths of the length of its resistive element. A wire-wound potentiometer will be better able to handle high dissipation from a short segment of its element than other types of rheostat. Add a fixed resistor in series with a rheostat if necessary to impose a limit on the current.

Figure 11-13. *The large potentiometer is approximately 3" in diameter, rated at 5 ohms, and able to handle more than 4 amps. The small potentiometer is 5/8" diameter, rated at 2K and 1/4 watt, with pins designed for through-hole insertion in a circuit board, and a grooved shaft that accepts a push-on knob. Despite the disparity in size, the principle of operation and the basic features are identical.*

When using a trimmer potentiometer, limit the current through the wiper to 100mA as an absolute maximum value.

The Wrong Taper

When buying a potentiometer, remember to check the specification to find out whether it has linear or audio/log taper. If necessary, attach a meter, with the potentiometer set to its center position, to verify which kind of taper you have. While holding the meter probes in place, rotate the potentiometer shaft to determine which way an audio/log taper is oriented.

capacitor

12

Quite often referred to as a *cap*. Formerly known (primarily in the United Kingdom) as a *condenser*, but that term has become obsolete.

OTHER RELATED COMPONENTS

- **variable capacitor** (See Chapter 13)
- **battery** (See Chapter 2)

What It Does

A capacitor connected across a DC power source will accumulate a charge, which then persists after the source is disconnected. In this way, the capacitor stores (and can then discharge) energy like a small rechargeable battery. The charge/discharge rate is extremely fast but can be limited by a series resistor, which enables the capacitor to be used as a timing component in many electronic circuits.

A capacitor can also be used to block DC current while it passes pulses, or electrical "noise," or alternating current, or audio signals, or other wave forms. This capability enables it to smooth the output voltage provided by **power supplies**; to remove spikes from signals that would otherwise tend to cause spurious triggering of components in digital circuits; to adjust the frequency response of an audio circuit; or to couple separate components or circuit elements that must be protected from transmission of DC current.

Schematic symbols for capacitors are shown in Figure 12-1. At top-left is a nonpolarized capacitor, while the other two indicate that a polarized capacitor must be used, and must be oriented as shown. The variant at the bottom is most commonly used in Europe. Confusingly, the nonpolarized symbol may also be used to identify a polarized capacitor, if a + sign is added. The polarized symbols are sometimes printed without + signs, but the symbols still indicate that polarity must be observed.

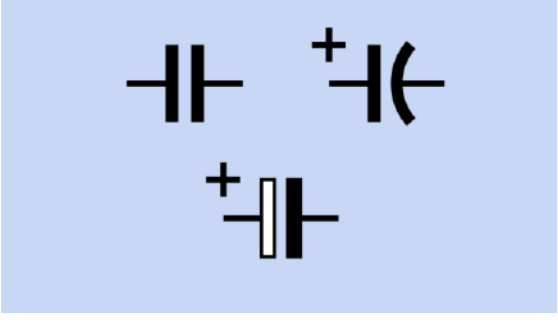

Figure 12-1. *Schematic symbols for polarized and nonpolarized capacitors. See text for details.*

How It Works

In its simplest form, a capacitor consists of two plates, each with a lead attached to it for connection with a DC power source. The plates are separated by a thin, insulating layer known as the *dielectric*, which is usually a solid or a paste but may be liquid, gel, gaseous, or vacuum.

The plates in most capacitors are made from thin metal film or metallized plastic film. To minimize the size of the component, the film may be rolled up to form a compact cylindrical package, or multiple flat sections may be interleaved.

Electrons from the power source will migrate onto the plate attached to the negative side of the source, and will tend to repel electrons from the other plate. This may be thought of as creating *electron holes* in the other plate or as attracting *positive charges*, as shown in Figure 12-2. When the capacitor is disconnected from the power source, the opposite charges on its plates will persist in equilibrium as a result of their mutual attraction, although the voltage will gradually dissipate as a result of *leakage,* either through the dielectric or via other pathways.

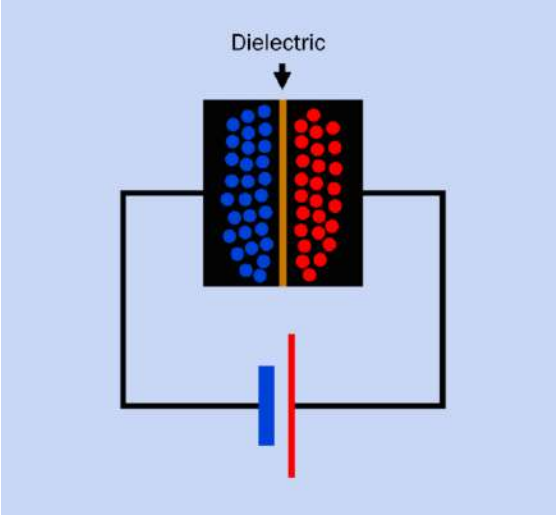

Figure 12-2. *Because the plates of a capacitor are electrically conductive, they will become populated with positive and negative charges when connected with a DC power source. As opposite charges attract each other, they will tend to congregate on either side of the dielectric, which is an insulating layer. The battery symbol is shown here colored for clarity.*

When a **resistor** is placed across the leads of a charged capacitor, the capacitor will discharge itself through the resistor at a rate limited by the resistance. Conversely, if a capacitor is charged through a resistor, the resistor will limit the charging rate.

A resistor in series with a capacitor is known as an *RC network* (Resistor-Capacitor network). In Figure 12-3, an RC circuit is shown with a SPDT switch that charges or discharges the capacitor via a series resistor. The voltage at point A increases nonlinearly (relative to the negative side of the power supply) while the capacitor is charging, and decreases nonlinearly while the capacitor is discharging, as suggested by the graphs. At any moment, the time that the capacitor takes to acquire 63% of the difference between its current charge and the voltage being supplied to it is known as the *time constant* for the circuit. See "The Time Constant" (page 105) for additional information.

When a capacitor is connected across an AC voltage source, each surge of electrons to one plate induces an equal and opposite positive surge to the other plate, and when polarity of the power supply reverses, the charges on the plates switch places. These surges may make it seem that the capacitor is conducting AC current, even though the dielectric that separates the plates is an insulator. See Figure 12-4. Often a capacitor is said to "pass" AC, even though this is not really happening. For convenience, and because the concept is widely established, this encyclopedia refers to capacitors as "passing" AC.

Depending on the size of the capacitor, it will block some AC frequencies while passing others. Generally speaking, a smaller capacitor will pass high frequencies relatively efficiently, as each little surge of current fills each plate. However, the situation is complicated by the *inductive reactance* (which creates the *effective series resistance*) of a capacitor, as discussed below. See "Alternating Current and Capacitive Reactance" (page 106).

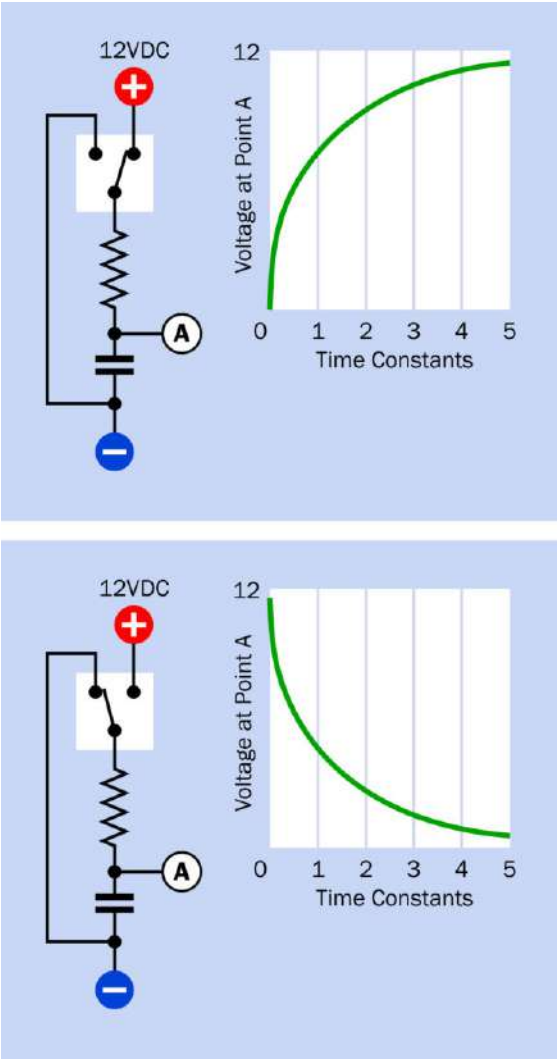

Figure 12-3. *An RC (Resistor-Capacitor) network with a switch to control charge and discharge of a capacitor. At top, the curve gives an approximate idea of the charging behavior of the capacitor. At bottom, the curve illustrates its discharging behavior.*

Variants

Format

The three most common packages for capacitors are cylindrical, disc, and rectangular tablet.

A *cylindrical capacitor* may have *axial leads* (a wire attached to each end) or *radial leads* (both wires emerging from one end). Radial capacitors are more widely used as they allow easy insertion into a circuit board. The capacitor is usually packaged in a small aluminum can, closed at one end, capped with an insulating disc at the other end, and wrapped in a thin layer of insulating plastic. Some samples are shown in Figure 12-5 and Figure 12-6.

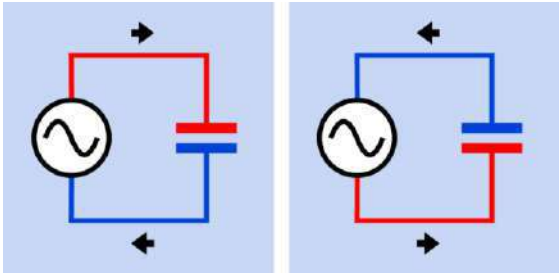

Figure 12-4. *In the left diagram, a source of alternating current charges the upper plate of a capacitor positively and the lower plate negatively. This process entails a flow of conventional current shown by the arrows. A moment later, when the AC current flow reverses, the flow also reverses, creating the impression that the capacitor "passes" AC current.*

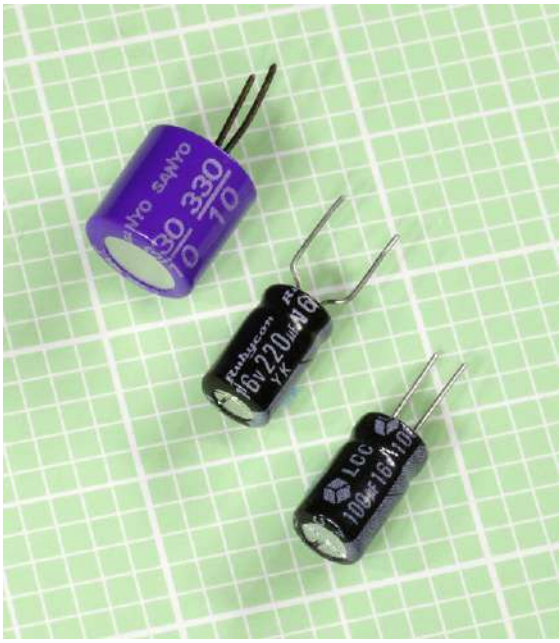

Figure 12-5. *Cylindrical capacitors with radial leads. All are electrolytic.*

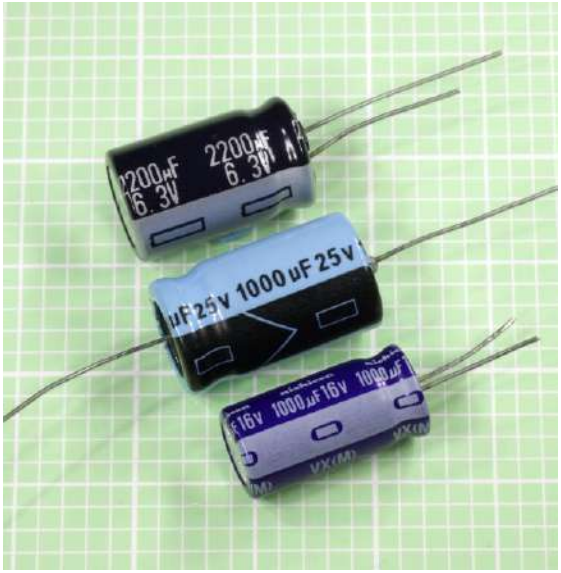

Figure 12-6. *Cylindrical capacitors with radial leads (top and bottom) and axial leads (center). All are electrolytic.*

A *disc capacitor* (sometimes referred to as a *button capacitor*) is usually encased in an insulating ceramic compound, and has radial leads. Modern small-value ceramic capacitors are more likely to be dipped in epoxy, or to be square tablets. Some samples are shown in Figure 12-7.

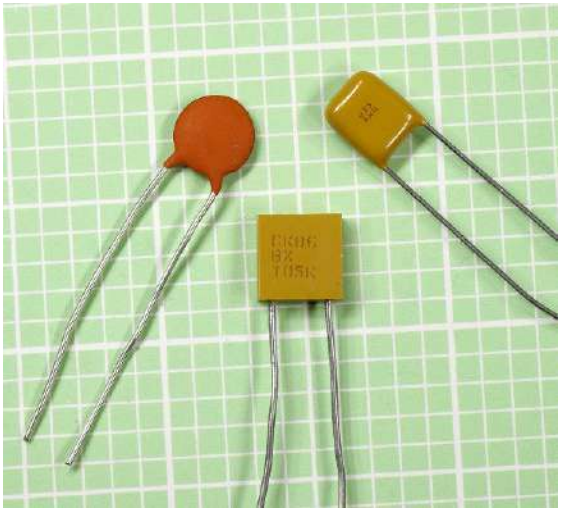

Figure 12-7. *Generic ceramic capacitors. Left: rated for 0.1µF at 50V. Center: 1µF at 50V. Right: 1µF at 50V.*

A *surface-mount capacitor* is square or rectangular, usually a few millimeters in each dimension, with two conductive pads or contacts at opposite ends. It appears almost identical to a surface-mount resistor. Larger-value capacitors are inevitably bigger but can still be designed for surface-mount applications. See Figure 12-8.

Figure 12-8. *Most surface-mount capacitors are as tiny as other surface-mount components, but this 4,700µF electrolytic (at 10V) has a base approximately 0.6" square. A solder tab is visible at the center of the nearest edge.*

Many capacitors are nonpolarized, meaning that they are insensitive to polarity. However, electrolytic and tantalum capacitors must be connected "the right way around" to any DC voltage source. If one lead is longer than the other, it must be the "more positive" lead. A mark or band at one end of the capacitor indicates the "more negative" end. Tantalum capacitors are likely to indicate the positive lead by using a + sign on the body of the component.

An arrow printed on the side of a capacitor usually points to the "more negative" terminal. In an aluminum can with axial leads, the lead at one end will have an insulating disc around it while the other lead will be integral with the rounded end of the can. The wire at the insulated end must be "more positive" than the wire at the other end.

A *capacitor array* contains two or more capacitors that are isolated from each other internally and accessed by external contacts. They are sold in surface-mount format and also in *through-hole* chips of DIP (dual-inline package) or SIP (single-inline package) format. The internal components may be connected in one of three configurations: isolated, common-bus, or dual-ended common bus. Technically the isolated configuration should be referred to as a capacitor array, but in practice, all three configurations are usually referred to as *capacitor networks*. See Figure 12-9 and Figure 12-10.

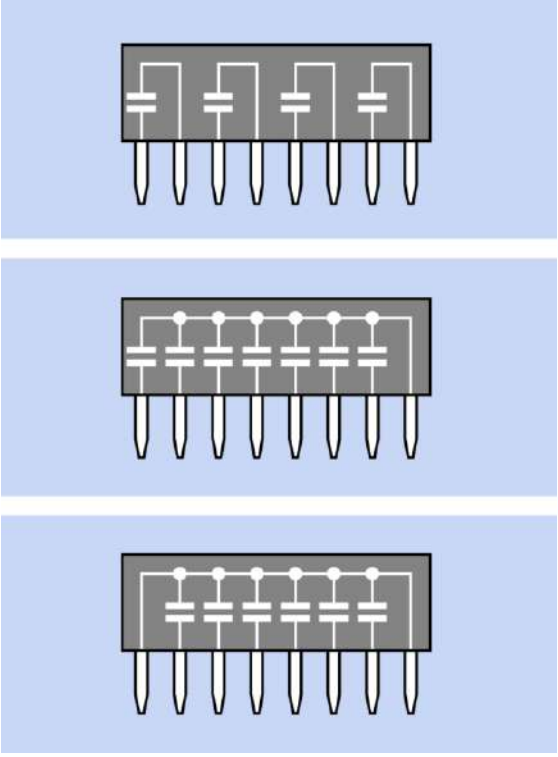

Figure 12-9. *A capacitor network most often consists of a single-inline package (SIP) chip containing multiple capacitors in one of three configurations shown here. Top: Isolated. Center: Common bus. Bottom: Dual-ended common bus. Individual capacitor values ranging from 0.001µF to 0.1µF are common.*

Capacitor networks can reduce the component count in circuits where digital logic chips require bypass capacitors. They are comparable in concept to *resistor arrays*.

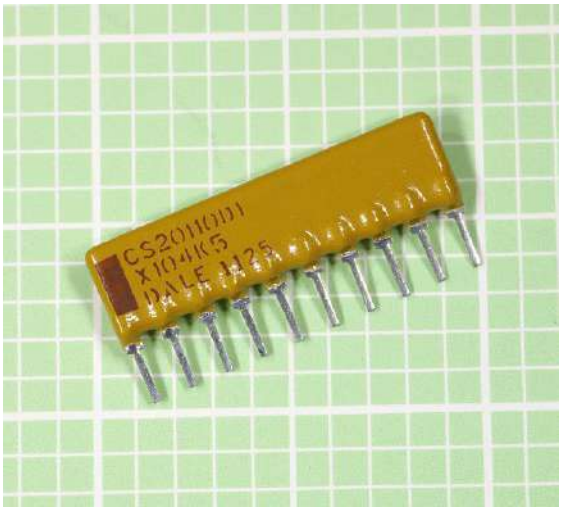

Figure 12-10. *A capacitor array in through-hole, SIP format.*

Chips containing *RC circuits* (multiple resistor-capacitor pairs) are available, although uncommon.

Principal Types

Electrolytic capacitors are relatively cheap, compact, and available in large values. These attributes have made them a popular choice in consumer electronics, especially for power supplies. The capacitive capability of an electrolytic is refreshed by periodic application of voltage. A moist paste inside the capacitor is intended to improve the dielectric performance when voltage is applied, but can dry out during a period of years. If an electrolytic is stored for 10 years or so, it may allow a short circuit between its leads when power is applied to it. The capacitors in Figure 12-5 and Figure 12-6 are all electrolytic. The capacitor in Figure 12-11 is at the high end of the scale.

A *bipolar electrolytic* is a single package containing two electrolytic capacitors in series, end-to-end, with opposed polarities, so that the combination can be used where the voltage of a signal fluctuates above and below 0VDC. See Figure 12-12 and Figure 12-13. This type of component is likely to have "BP" (bipolar) or "NP"

Figure 12-11. *This 13,000µF electrolytic capacitor is larger than would be required in most everyday applications.*

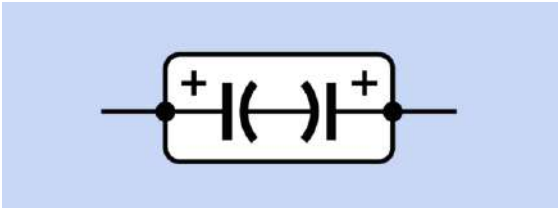

Figure 12-12. *Schematic view of the internal configuration of a bipolar electrolytic capacitor, also known as nonpolarized electrolytic capacitor. It consists of two electrolytics in series, with opposing polarities.*

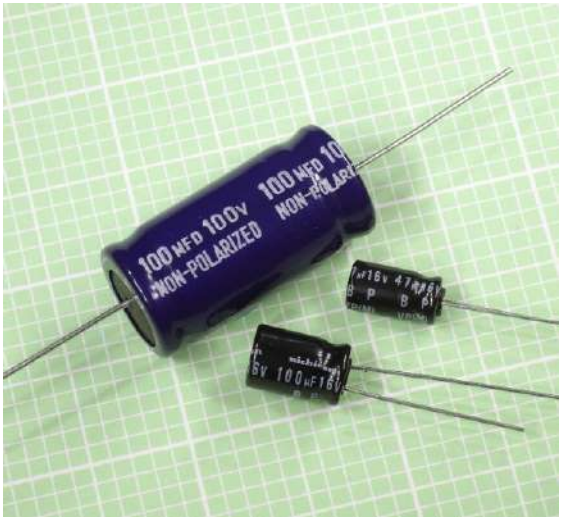

Figure 12-13. *Bipolar electrolytic capacitors. The larger size of the one at top-left is a consequence of its higher voltage rating. "BP" on the other two capacitors is an acronym for "bipolar," meaning that they have no polarity, even though one lead may be shorter than the other.*

(nonpolarized) printed on its shell. It may be used in audio circuits where polarized capacitors are normally unsuitable, and is likely to be cheaper than non-electrolytic alternatives. However, it suffers from the same weaknesses as all electrolytics.

Tantalum capacitors are compact but relatively expensive, and can be vulnerable to voltage spikes. They are sensitive to application of the wrong polarity. Typically they are epoxy-dipped rather than mounted inside a small aluminum can like electrolytics, and consequently the electrolyte may be less likely to evaporate and dry out. In Figure 12-14, two tantalum capacitors (rated 330µF at 6.3V, left, and 100µF at 20V, right) are shown above a polyester film capacitor (rated 10µF at 100V). Surface-mount tantalum capacitors are decreasing in popularity as large-value ceramic capacitors are becoming available, with smaller dimensions and lower equivalent series resistance.

Plastic-film capacitors are discussed in the following section.

Single-layer *ceramic* capacitors are often used for bypass, and are suitable for high-frequency or audio applications. Their value is not very stable with temperature, although the "NPO" variants are more stable. Multilayer ceramic capacitors are more compact than single-layer ceramic, and

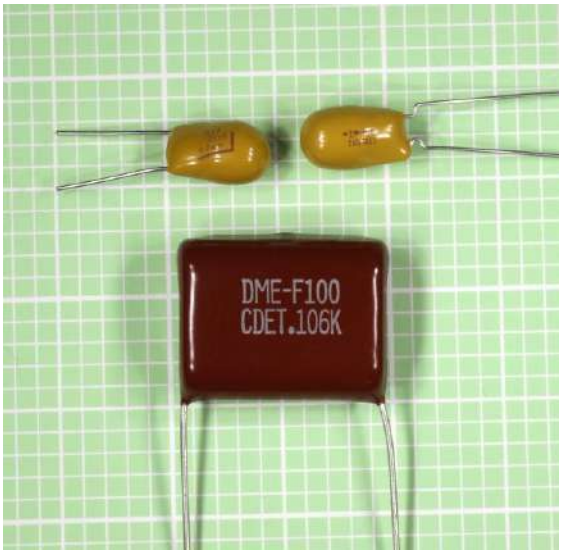

Figure 12-14. *Two tantalum capacitors are shown above a polyester film capacitor. The polarity of the tantalum capacitors is indicated by the plus signs adjacent to the longer lead, in each case. The polyester capacitor is nonpolarized.*

consequently are becoming increasingly popular. Three multilayer ceramic capacitors are shown in Figure 12-15. At bottom-right, even the largest (rated at 47µF at 16V) is only 0.2" square.

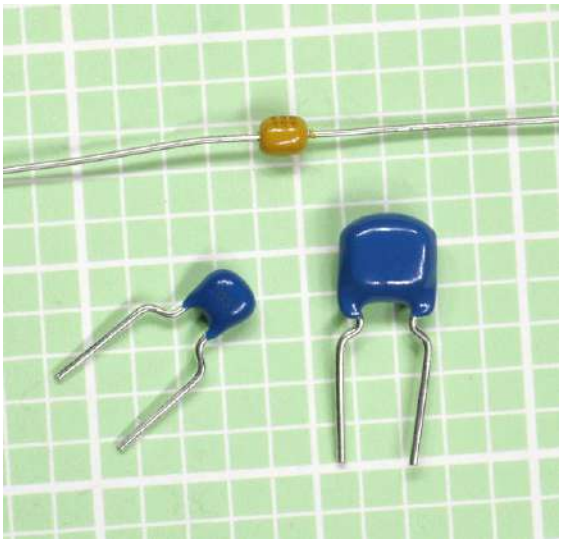

Figure 12-15. *Multilayer ceramic capacitors are extremely compact, and are nonpolarized. Top: 1,000pF (i.e. 1nF) at 100V. Bottom left: 1µF at 25V. Bottom right: 47µF at 16V.*

Dielectrics

The dielectric used in a capacitor most often consists of an electrolytic layer, a ceramic compound, a plastic film (polycarbonate, polypropylene, or polystyrene), or paper.

An *electrolytic layer* in an electrolytic capacitor traditionally consists of paper soaked in an electrolyte. It is interleaved with a thin film of aluminum on which is deposited a layer of aluminum oxide. The layers are rolled up to create a cylindrical component. The functioning dielectric is created when voltage is applied.

Polyester

This is the most common type of plastic film, with the highest dielectric constant, enabling highest capacitance per unit volume. Widely used in DC applications, but the rolled layers create parasitic inductance. Often used in decoupling, coupling, and bypass, but not so suitable for situations requiring stability and low leakage. May not be suitable for high current.

Polycarbonate

Thermally very stable, often specified for filters and timing circuits that require a fixed frequency. An excellent type of capacitor, compatible for mil-spec applications, but expensive.

Mylar, Polyester, and other plastic-film types are often used in audio circuits, where their voltage limitation (typically less than 100VDC) is not a problem, and their nonpolarized attribute is an advantage.

Polypropylene

Vulnerable to heat (a maximum of 85 degrees Centigrade is common), and less thermally stable than polycarbonate. A very low power dissipation factor allows it to handle higher power at higher frequencies. Available with tolerances down to 1%. These capacitors are a popular choice in crossover

networks for loudspeaker combinations, and are used in switching power supplies. They tend to be physically larger than other capacitors using film dielectric.

Values

Farads

The electrical storage capacity of a capacitor is measured in *farads,* universally represented by the letter F. A capacitor that can be charged with a potential difference between its plates of 1 volt, in a time of 1 second, during which it draws 1 amp, has a capacitance of 1 farad.

Because the farad is a large unit, capacitors in electronic circuits almost always have fractional values: *microfarads* (µF), *nanofarads* (nF), and *picofarads* (pF). The Greek letter µ (mu) should be used in the µF abbreviation, but a lowercase letter u is often substituted. Thus, for example, 10uF means the same as 10µF.

1F = 1,000,000µF, and 1µF = 1,000,000pF. Therefore, 1 farad is equivalent to 1 trillion picofarads —a very wide range of possible values. See Figure 12-16 and Figure 12-17 for charts showing equivalent values in different units.

pF	nF	µF
1	0.001	0.000001
10	0.01	0.00001
100	0.1	0.0001
1,000	1	0.001
10,000	10	0.01
100,000	100	0.1
1,000,000	1,000	1

Figure 12-16. *Equivalent values for picofards, nanofarads, and microfarads. The nF unit is used primarily in Europe.*

µF	F
1	0.000001
10	0.00001
100	0.0001
1,000	0.001
10,000	0.01
100,000	0.1
1,000,000	1

Figure 12-17. *Equivalent values for microfarads and farads. Because the farad is such a large unit, electronic circuits almost always use fractional values.*

The nF unit is more common in Europe than in the United States. A 1nF capacitance is often expressed in the US as 0.001µF or 1,000pF. Similarly, a 10nF capacitance is almost always expressed as a 0.01µF, and a 0.1nF capacitance is more likely to be expressed as 100pF.

European schematics may use value-symbols as a substitute for decimal points. For example, a 4.7pF capacitor may be shown as 4p7, a 6.8nF capacitor may be shown as 6n8, and a 3.3µF capacitor may be shown as 3µ3.

Commonly Used Values

The traditional range of capacitor values was established on the same basis as the traditional range of resistor values, by assuming an accuracy of plus-or-minus 20% and choosing factors that would minimize the possible overlap between adjacent tolerance ranges. The factors 1.0, 1.5, 2.2, 3.3, 4.7, 6.8, and 10 satisfy this requirement. See Chapter 10 for a more detailed explanation, including a graphical representation of values and overlaps in Figure 10-8. While many resistors are now manufactured with high precision, 20%

tolerance is still common for electrolytic capacitors. Other types of capacitors are available with an accuracy of 10% or 5%, but are more expensive.

While large-value capacitors are likely to have their actual value printed on them, smaller capacitors are identified by a variety of different codes. These codes are not standardized among manufacturers, and exist in various colors and abbreviations. A multimeter that can measure capacitance is a quicker, easier, and more reliable method of determining the value of a component than trying to interpret the codes.

In addition to capacitance, a large capacitor is likely to have its working voltage printed on it. Exceeding this value increases the risk of damaging the dielectric. In the case of electrolytic capacitors, a voltage that is much lower than the rated value should also be avoided, because these capacitors require an electrical potential to maintain their performance.

In common electronics applications, values larger than 4,700µF or smaller than 10pF are unusual.

Electrolytics are available at a moderate price in a wider range of values than other commonly used capacitors. They range from 1µF to 4,700µF and sometimes beyond. Working voltages typically range from 6.3VDC to 100VDC, but can be as high as 450VDC.

Tantalum capacitors are usually unavailable in sizes above 150µF or for voltages above 35VDC.

Single-layer ceramic capacitors have small values ranging from 0.01µF to 0.22µF, with working voltages usually not exceeding 50VDC, although very small-value capacitors may be rated much higher for special applications. Poor tolerances of +80% to -20% are common.

Some variants of multi-layer ceramic capacitors are capable of storing up to 47µF, although 10µF is a more common upper limit. They are seldom rated above 100VDC. Some are accurate to plus-or-minus 5%.

Dielectric Constant

If A is the area of each plate in a capacitor (measured in square centimeters), and T is the thickness of the dielectric (measured in centimeters), and K is the *dielectric constant* of the capacitor, the capacitance, C (measured in farads) will be obtained from the formula:

```
C = (0.0885 * K * A) / T
```

The dielectric constant of air is 1. Other dielectrics have different standard values. Polyethylene, for instance, has a constant of approximately 2.3. Thus a capacitor of 1 square centimeter plate area and polyethylene dielectric 0.01 centimeters thick would have a capacitance of about 20pF. A tantalum capacitor of equal plate area and dielectric thickness would have capacitance closer to 100pF, since the dielectric constant of tantalum oxide is much higher than that of polyethylene.

The Time Constant

When a capacitor is charged in series through a resistor (it is used in an RC network), and it begins with no charge on its plates, the *time constant* is the time, in seconds, required to charge the capacitor to 63% of the supply voltage. After an additional, identical interval of time, the capacitor will acquire 63% of the remaining difference between itself and the power supply. In theory the capacitor gets closer and closer to a full charge, but never quite reaches 100%. However, five time constants are sufficient for the capacitor to reach 99%, which is regarded as close enough to being fully charged for all practical purposes.

Refer to Figure 12-3 for a schematic of an RC network.

The time constant is a simple function of the resistance and the capacitance. If R is the value of the resistor (in ohms), and C is the value of the capacitor (in farads), the time constant, TC, will be obtained by the formula:

```
TC = R * C
```

If we multiply the R value by 1,000 while dividing the C value by 1,000, the time constant remains the same, and we can use the more convenient values of kilohms for the resistance and µF for the capacitance. In other words, the formula tells us that a 1K resistor in series with a 1,000µF capacitor has a time constant of 1 second.

The formula suggests that if the value of R diminishes to zero, the capacitor will charge instantly. In reality, the charging time will be rapid but finite, limited by factors such as the electrical resistance of the materials used.

Multiple Capacitors

When two or more capacitors are wired in parallel, their total capacitance is the sum of their separate capacitances. When two or more capacitors are wired in series, the relationship between their total capacitance © and their individual capacitances (C1, C2, C3 . . .) is given by this formula:

```
1 / C = (1/C1) + (1/C2) + (1/C3). . .
```

The formula to calculate the total capacitance of capacitors connected in series resembles the one used to calculate the total resistance of resistors connected in parallel. See Chapter 10.

Alternating Current and Capacitive Reactance

The apparent resistance of a capacitor to AC is properly known as *capacitive reactance*. In the following formula, capacitive reactance (X_C, in ohms) is derived as a function of capacitance (C, in farads) and AC frequency (f, measured in hertz):

$$X_C = 1 / (2 * \pi * f * C)$$

The formula shows that when frequency becomes zero, capacitive reactance becomes infinite; in other words, a capacitor has theoretically infinite resistance when DC current tries to flow through it. In reality, a dielectric has a finite resistance, and thus always allows some leakage.

The formula also shows that capacitive reactance diminishes when the size of the capacitor increases and/or the frequency being applied to it increases. From this it appears that an AC signal will be attenuated less at higher frequencies, especially if we use a small capacitor. However, a real-world capacitor also exhibits some degree of *inductive reactance*. This value will depend on its configuration (cylindrical vs. multiple flat plates), its physical length, the materials from which it is fabricated, the lengths of its leads, and other factors. Inductive reactance tends to *increase* with frequency, and since capacitive reactance tends to *decrease* with frequency, at some point the curves for the two functions intersect. This point represents the capacitor's *self-resonant frequency*, which is often referred to simply as its *resonant frequency*. See Figure 12-18.

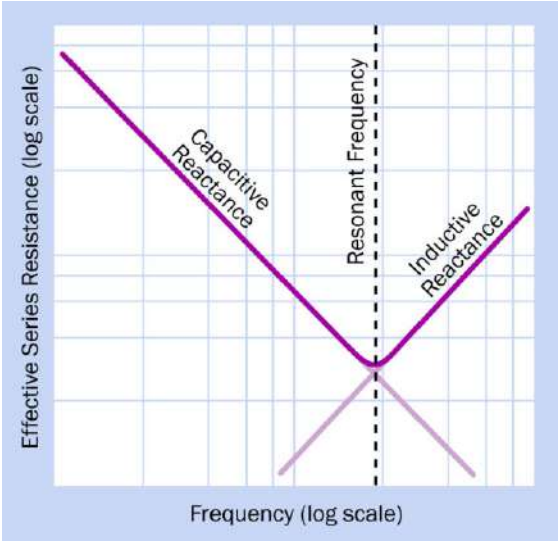

Figure 12-18. *As an AC current applied to a capacitor increases in frequency, the capacitive reactance of the component decreases, while its inductive reactance increases. The resonant frequency of the capacitor is found where the two functions intersect.*

Equivalent Series Resistance

A theoretically ideal capacitor would be purely reactive, without any resistance. In reality, capacitors are not ideal, and they have *equivalent series resistance,* or *ESR*. This is defined as the resistor

that you would have to place in series with an ideal version of the capacitor, so that the combination would behave like the real version of the capacitor on its own.

If X_c is the reactance of the capacitor, then its Q factor (which means its *quality factor*) is given by the simple formula:

$$Q = X_c \ / \ ESR$$

Thus, the quality factor is higher if the ESR is relatively low. However, the reactance of the capacitor will vary significantly with frequency, and this simple formula is only an approximate guide.

The Q-factor for capacitors should not be confused with the Q-factor for inductors, which is calculated quite differently.

How to Use it

The figures illustrate some simplified schematics for common applications.

Bypass Capacitor

In Figure 12-19, a low-value capacitor (often 0.1µF) is placed near the power input pin of a sensitive digital chip to divert high-frequency spikes or noise to negative ground. This *bypass capacitor* may also be described as a *decoupling capacitor*.

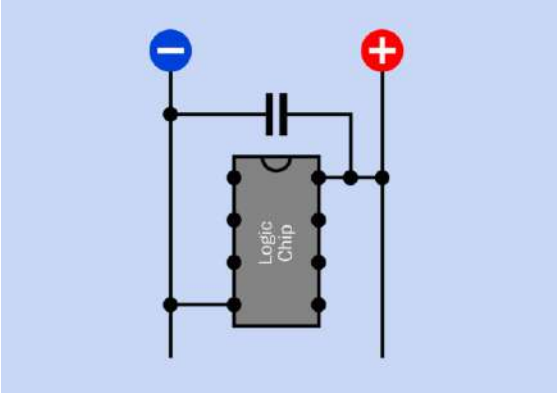

Figure 12-19. *A bypass capacitor (typically 0.1µF) configured to protect an integrated circuit logic chip from voltage spikes and noise in the power supply.*

Coupling Capacitor

In Figure 12-20, a 1µF *coupling capacitor* transmits a pulse from one section of a circuit to another, while blocking the DC voltage. Some reshaping of the waveform may occur.

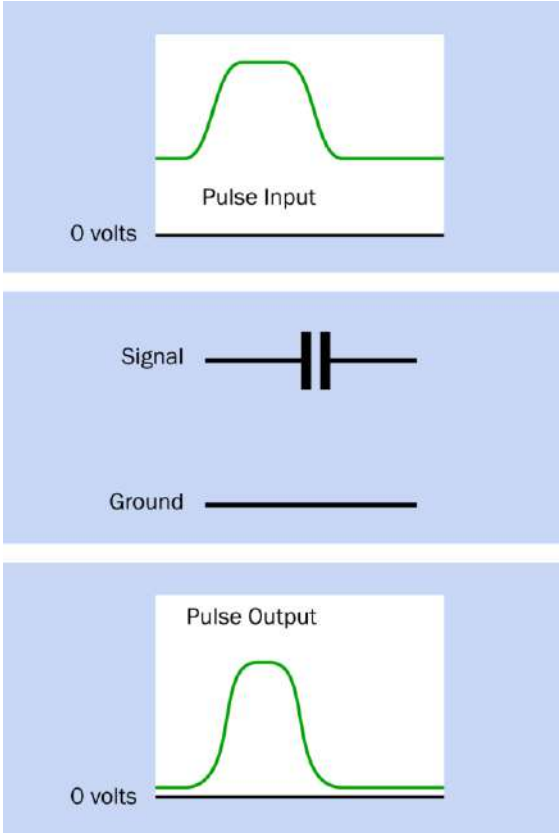

Figure 12-20. *A coupling capacitor (typically around 1µF) preserves DC isolation of one section of a circuit from another, while allowing a pulse to be transmitted.*

High-Pass Filter

In Figure 12-21, a 0.1µF capacitor blocks the low-frequency component of a complex waveform and transmits only the higher frequency that was superimposed on the low frequency.

Low-Pass Filter

In Figure 12-22, a 0.1µF decoupling capacitor diverts the higher frequency component of a complex waveform to negative ground, allowing only

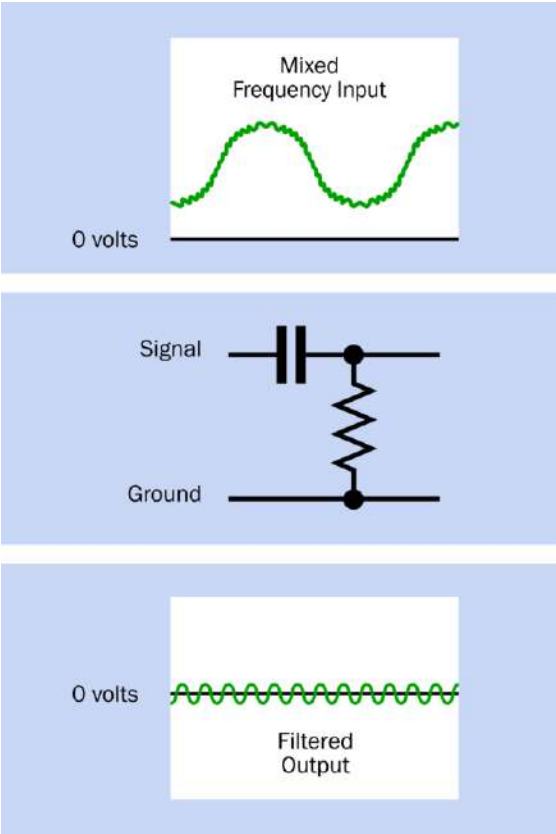

Figure 12-21. *A small capacitor (typically 0.1µF) can be used to create a high-pass filter, passing high frequencies while blocking low frequencies.*

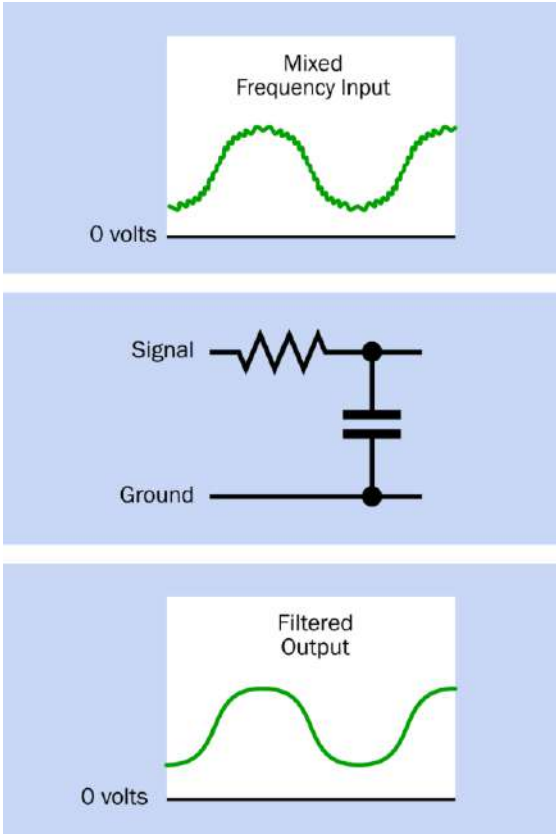

Figure 12-22. *A small capacitor (typically 0.1µF) in this configuration routes high frequencies to negative ground, filtering them out of an analog signal.*

the lower frequency to be preserved. A lower-value capacitor (such as 0.001µF) will bleed away high-frequency noise from an AM radio source without affecting audio frequencies.

Smoothing Capacitor

In Figure 12-23, a 100µF capacitor charges and discharges to smooth an AC signal after a diode has removed the negative portion.

Snubber

In Figure 12-24, an RC network (inside a white dashed line) is known as a *snubber* when used to protect a switch from the problem of *arcing* (pronounced "arking")—that is, a sustained spark that can quickly erode the switch contacts. Arcing may occur in switches, pushbuttons, or relays that control an inductive load, such as a large motor. This problem can become significant at high DC currents (10A or more) or relatively high AC or DC voltages (100V or more).

When the switch is opened, the magnetic field that has been sustained by the inductive load collapses, causing a surge of current, or *forward EMF*. The capacitor in the snubber absorbs this surge, thus protecting the switch contacts. When the switch is closed again, the capacitor discharges itself, but the resistor limits the outrush of current—again, protecting the switch.

A snubber placed around the switch in a DC circuit could typically use a 0.1µF capacitor (polypropylene or polyester) rated for 125VAC/200VDC, and a 100-ohm carbon resistor rated 0.5

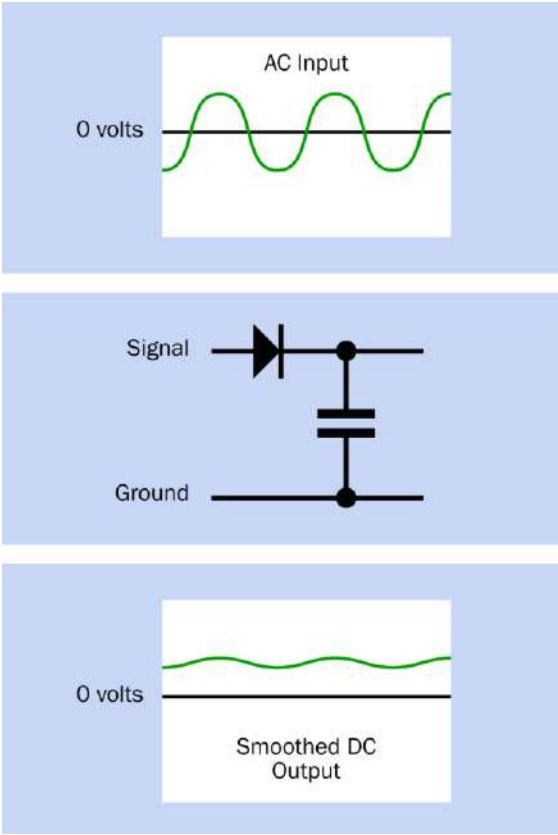

Figure 12-23. *A capacitor of 100µF or more smooths the upper half of an AC signal that has passed through a diode. The capacitor charges during each positive pulse and discharges to "fill the gaps" between them.*

watt or higher. Prepackaged snubbers containing appropriate capacitor-resistor pairs are available from some parts suppliers, primarily for industrial use.

In an AC circuit, a snubber can be placed around the inductive load itself. Although a **diode** is often used this way in a DC circuit, it cannot be used with AC.

Although solid-state switching devices such as a **solid state relay** contain no mechanical contacts, they may still be damaged by substantial pulses of back-EMF, and can be protected by a snubber where they are controlling inductive loads that take 10A or more at 100V or more.

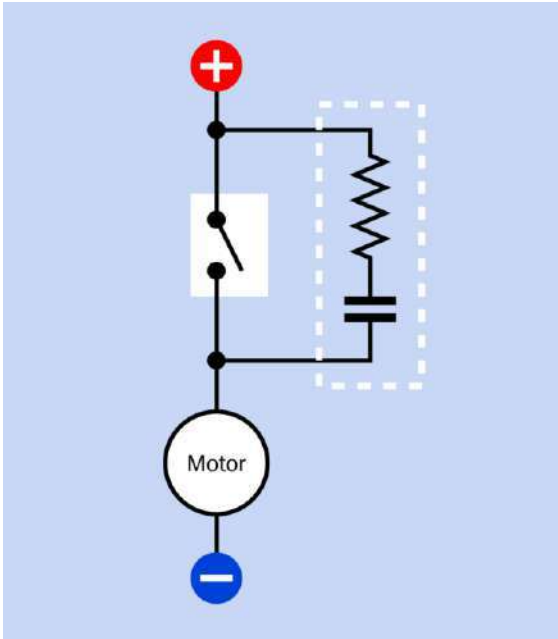

Figure 12-24. *An RC network (outlined with a white dashed line) protects a switch that controls a high inductive load. Used in this way, the RC network is known as a snubber.*

Capacitor as a Battery Substitute

A capacitor may be substituted for a battery for some applications, although it has a lower energy density and will be more expensive to manufacture. A capacitor charges and discharges much more rapidly than a battery because no chemical reactions are involved, but a battery sustains its voltage much more successfully during the discharge cycle.

Capacitors that can store a very large amount of energy are often referred to as *supercapacitors.*

What Can Go Wrong

Common problems associated with capacitors are age-related deterioration (especially in electrolytics), inductive reactance (especially in cylindrical formats), nonlinear response, resistivity, excessive current leakage, and dielectric memory. Some of these problems are discussed below. A manufacturer's datasheet should be consulted

carefully in conjunction with the notes regarding compositions in the preceding Variants section before making a commitment to a particular type of capacitor.

Wrong Polarity

A polarized capacitor may offer virtually no resistance if it is connected the wrong way around to a DC power source. A very high current can result, damaging the capacitor and probably other components in the circuit. Failing to observe the polarity of a tantalum capacitor can have destructive or even explosive consequences, depending on the amperage.

Voltage Overload

If the DC working voltage of a capacitor is exceeded, there is a risk of breaking down the dielectric and allowing a spark, or arc, that will form a short circuit. Note that the DC rating of a capacitor does not mean that it can be used safely with an equivalent AC voltage. The maximum AC voltage should be no greater than approximately 0.7 times the DC rated voltage. If a DC-rated capacitor is used directly across an AC power line, it will create an effective short circuit.

If capacitors are connected in series or in parallel, ideally the voltage rating for each capacitor should be the same, and certainly no less than the supply voltage.

Tantalum capacitors are easily damaged by current spikes that exceed their maximum working voltage, and are unsuitable for high-frequency coupling because of their inductance.

Leakage

Charge leakage is a problem especially associated with electrolytic capacitors, which are not suitable for storing a charge over a significant interval. Polypropalene or polystyrene film capacitors are a better choice.

Dielectric Memory

Also known as *dielectric absorption*, this is a phenomenon in which a capacitor's electrolyte displays some percentage of its former voltage after the capacitor has been discharged and then disconnected from the circuit. Single-layer ceramic capacitors especially tend to suffer from this problem.

Specific Electrolytic Issues

Electrolytic capacitors have high inductive reactance, are not manufactured to close tolerances, and deteriorate significantly with age. While other components may be stockpiled and used over a period of years, this is not a sensible policy with electrolytics.

The "capacitor plague" affecting many of these capacitors manufactured from 1999 onward provided a salutary lesson regarding their potential weaknesses. Faulty composition of the dielectric allowed it to deteriorate, liberating hydrogen gas, which eventually caused the aluminum shells of the capacitors to bulge and burst. Circuit boards from major manufacturers were affected. Because the problem took two years to become apparent, literally millions of boards with faulty capacitors had been sold before the fault was diagnosed and eventually corrected.

Unfortunately electrolytics cannot be easily replaced with other types of capacitors in applications such as power supplies, because substitutes will be considerably larger and more expensive.

Heat

The equivalent series resistance (ESR) of a large capacitor inevitably means that it must dissipate some power as heat during use. Ripple current can also create heat. Capacitor performance will change as the temperature increases. A common maximum component temperature for electrolytic capacitors is 85 degrees Centigrade.

Vibration

In a high-vibration environment, electrolytics should be protected by clamping them mechanically in place, using a *capacitor clamp*, also known as a *c-clamp*.

Misleading Nomenclature

Rarely, in the United States, the term "mF" may be used as a probable alternative to µF. This can be a source of confusion and risk because mF is properly (but very rarely) used to mean "millifarads." The term should always be avoided.

variable capacitor

13

Formerly known (primarily in the United Kingdom) as a *variable condenser*. The term is now obsolete.

OTHER RELATED COMPONENTS

- **capacitor** (See Chapter 12)

What It Does

A variable capacitor allows adjustment of capacitance in much the same way that a **potentiometer** allows adjustment of resistance.

Large variable capacitors were developed primarily to tune radio receivers, in which they were known as *tuning capacitors*. Cheaper, simpler, and more reliable substitutes gradually displaced them, beginning in the 1970s. Today, they are still used in semiconductor fabrication, in RF plastic welding equipment, in surgical and dental tools, and in ham radio equipment.

Small *trimmer capacitors* are widely available and are mostly used to adjust high-frequency circuits. Many of them look almost indistinguishable from *trimmer potentiometers*.

The schematic symbols commonly used to represent a variable capacitor and a trimmer capacitor are shown in Figure 13-1.

A *varactor* is a form of diode with variable capacitance, controlled by reverse voltage. See "Varactor Diode" (page 225) for this component.

How It Works

The traditional form of variable capacitor consists of two rigid semicircular plates separated by an air gap of 1mm to 2mm. To create more capacitance, additional interleaved plates are added to form a stack. One set of plates is known as the *rotor*, and is mounted on a shaft that can be turned, usually by an externally accessible knob. The other set of plates, known as the *stator*, is mounted on the frame of the unit with ceramic insulators. When the sets of plates completely overlap, the capacitance between them is maximized. As the rotor is turned, the sets of plates gradually disengage, and the capacitance diminishes to near zero. See Figure 13-2.

Figure 13-1. *Typical schematic symbols for variable capacitor (left) and trimmer capacitor (right).*

The air gaps between the sets of plates are the *dielectric*. Air has a dielectric constant of approximately 1, which does not vary significantly with temperature.

The most common shape of plate is a semicircle, which provides a linear relationship between capacitance and the angle of rotation. Other shapes have been used to create a nonlinear response.

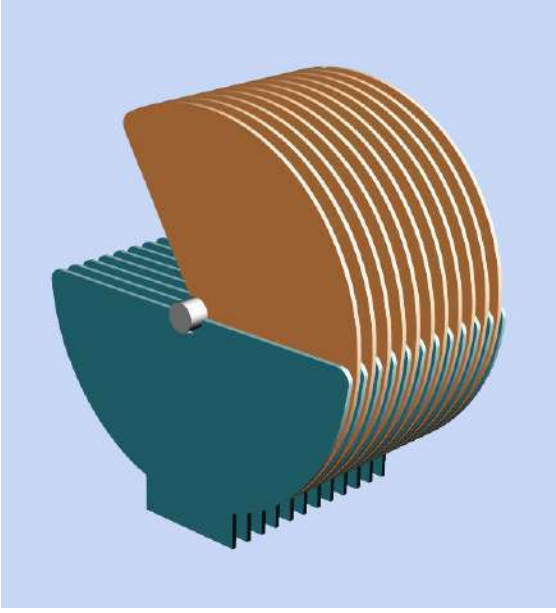

Figure 13-2. *In this simplified view of a variable capacitor, the brown plates constitute the rotor, attached to a central shaft, while the blue plates are the stator. The colors have no electrical significance and are added merely for clarity. The area of overlap between rotor and stator determines the capacitance.*

Reduction gears may be used to enable fine tuning of a variable capacitor, which means multiple turns of a knob can produce very small adjustments of the capacitor. At the peak of variable capacitor design, units were manufactured with high mechanical precision and included *anti-backlash gears*. These consisted of a pair of equal-sized gears mounted flat against each other with a spring between them that attempted to turn the gears in opposite directions from each other. The pair of gears meshed with a single pinion, eliminating the looseness, or backlash, that normally exists when gear teeth interlock. A vintage capacitor with a spring creating anti-backlash gearing (circled) is shown in Figure 13-3. This is a two-gang capacitor—it is divided into two sections, one rated 0 to 35pF, the other rated 0 to 160pF.

Figure 13-3. *A "traditional style" variable capacitor of the type designed to tune radio frequencies. The spring, circled, enables anti-backlash gearing.*

Variants

The traditional variable capacitor, with exposed, air-spaced, rigid, rotating vanes, is becoming hard to find. Small, modern variable capacitors are entirely enclosed, and their plates, or vanes, are not visible. Some capacitors use a pair of concentric cylinders instead of plates or vanes, with an external thumb screw that moves one cylinder up or down to adjust its overlap with the other. The overlap determines the capacitance.

Trimmer capacitors are available with a variety of dielectrics such as mica, thin slices of ceramic, or plastic.

Values

A large traditional capacitor can be adjusted down to a near-zero value; its maximum will be no greater than 500pF, limited by mechanical factors. (See Chapter 12 for an explanation of capacitance units.)

A maximum value for a trimmer capacitor is seldom greater than 150pF. Trimmers may have their values printed on them or may be color-coded, but there is no universal set of codes. Brown, for example, may indicate either a maximum value around 2pF or 40pF, depending on the manufacturer. Check datasheets for details.

The upper limit of a trimmer's rated capacitance is usually no less than the rated value, but can often be 50% higher.

Formats

All trimmer capacitors are designed for mounting on circuit boards. Many are surface-mount, with a minority being through-hole. Surface-mount units may be 4mm × 4mm or smaller. Through-hole are typically 5mm × 5mm or larger. Superficially, trimmer capacitors resemble single-turn trimmer potentiometers with a screw head in the center of a square package. A through-hole example is shown in Figure 13-4.

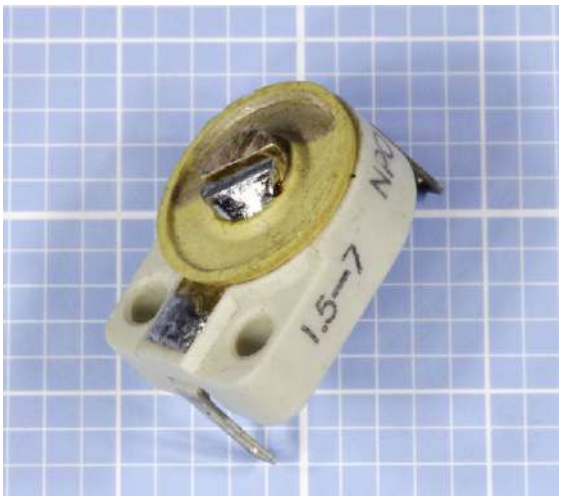

Figure 13-4. *A trimmer capacitor rated 1.5pF to 7.0pF.*

How to Use it

A variable capacitor is often used to tune an *LC circuit,* so called because a coil (with reactance customarily represented by letter L) is wired in parallel with a variable capacitor (represented by letter C). The schematic in Figure 13-5 shows an imaginary circuit to illustrate the principle. When the switch is flipped upward, it causes a large fixed-value capacitor to be charged from a DC power source. When the switch is flipped down, the capacitor tries to pass current through the coil—but the coil's *reactance* blocks the current and converts the energy into a magnetic field. After the capacitor discharges, the magnetic field collapses and converts its energy back into electricity. This flows back to the capacitor, but with inverted polarity. The cycle now repeats with current flowing in the opposite direction. A low-current **LED** across the circuit would flash as the voltage oscillates, until the energy is exhausted.

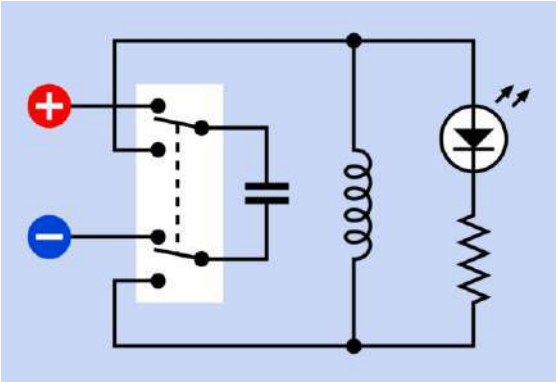

Figure 13-5. *In this imaginary circuit, the capacitor is charged through the double-pole switch in its upper position. When the switch is turned, the capacitor forms an LC (inductance-capacitance) circuit with the coil, and resonates at a frequency determined by their values. In reality, extremely high values would be needed to obtain a visible result from the LED.*

Because the oscillation resembles water sloshing from side to side in a tank, an LC circuit is sometimes referred to as a *tank circuit.*

In reality, unrealistically large values would be required to make the circuit function as described. This can be deduced from the following formula, where f is the frequency in Hz, L is inductance in Henrys, and C is capacitance in Farads:

$$f = 1 / (2\pi * \sqrt{(L * C)})$$

For a frequency of 1Hz, a massive coil opposite a very large capacitor of at least 0.1F would be needed.

However, an LC circuit is well-suited to very high frequencies (up to 1,000MHz) by using a very small coil and variable capacitor. The schematic in Figure 13-6 shows a high-impedance earphone and a diode (right) substituted for the LED and the resistor in the imaginary circuit, while a variable capacitor takes the place of the fixed capacitor. With the addition of an antenna at the top and a ground wire at the bottom, this LC circuit is now capable of receiving a radio signal, using the signal itself as the source of power. The resonant frequency of the circuit is tuned by the variable capacitor. The impedance peaks at the resonant frequency, causing other frequences to be rejected by passing them to ground. With suitable refinement and amplification, the basic principle of an LC circuit is used in AM radios and transmitters.

Because variable capacitors are so limited in size, they are unsuitable for most timing circuits.

Trimmer capacitors are typically found in high-power transmitters, cable-TV transponders, cellular base stations, and similar industrial applications.

They can be used to fine-tune the resonant frequency of an oscillator circuit, as shown in Figure 13-7.

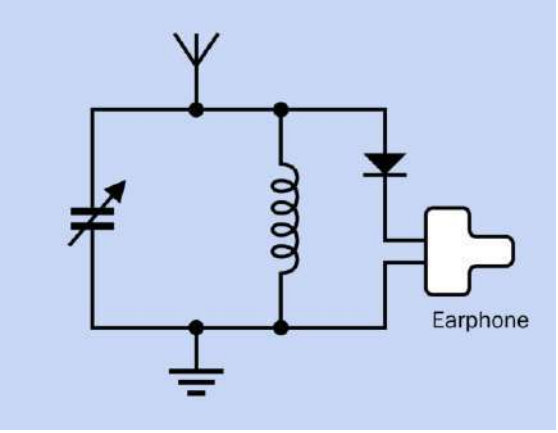

Figure 13-6. *The principle of an LC circuit is used here in a basic circuit that can tune in to a radio station and create barely audible sound through the earphone at right, using only the broadcast signal for power. The variable capacitor adjusts the frequency of the circuit to resonate with the carrier wave of the radio signal.*

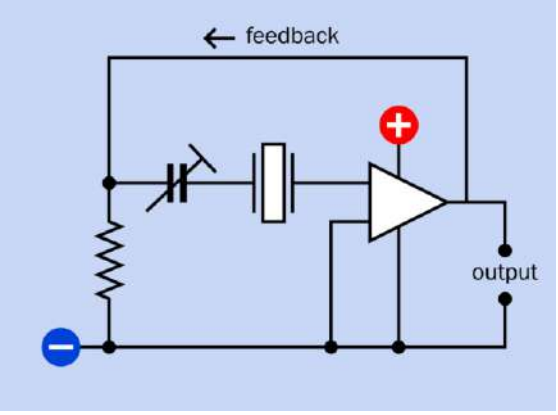

Figure 13-7. *A trimmer capacitor in series with a crystal fine-tunes the frequency of this basic circuit using an op-amp.*

In addition to tuning a circuit frequency, a trimmer capacitor can be used to compensate for changes in capacitance or inductance in a circuit that are caused by the relocation of wires or rerouting of traces during the development process. Readjusting a trimmer is easier than swapping fixed-value capacitors. A trimmer may also be used to compensate for capacitance in a circuit that gradually drifts with age.

What Can Go Wrong

Failure to Ground Trimmer Capacitor While Adjusting it

Although trimmer capacitors are not polarized, the manufacturer may mark one terminal with a plus sign and/or the other with a minus sign. If the capacitor is adjusted while its negative terminal is floating or ungrounded, a metal screwdriver blade will create erroneous readings. Always ground the appropriate side of a trimmer capacitor before fine-tuning it, and preferably use a plastic-bladed screwdriver.

Application of Overcoat Material or "Lock Paint"

Overcoat material is a rubbery adhesive that may be spread over assembled components to immunize them against moisture or vibration. *Lock paint* is a dab of paint that prevents a screw adjustment from turning after it has been set. Most manufacturers advise against applying these materials to a trimmer capacitor, because if penetration occurs, the capacitor can fail.

Lack of Shielding

Variable capacitors should be shielded during use, to protect them from external capacitive effects. Merely holding one's hand close to a variable capacitor will change its value.

inductor

14

The term **inductor** is used here to describe a coil that has the purpose of creating *self-inductance* in an electronic circuit, often while passing alternating current in combination with resistors and/or capacitors. A *choke* is a form of inductor. By comparison, the **electromagnet** entry in this encyclopedia describes a coil containing a center component of ferromagnetic material that does not move relative to the coil, and has the purpose of attracting or repelling other parts that respond to a magnetic field. A coil containing a center component of ferromagnetic material that moves as a result of current passing through the coil is considered to be a **solenoid** in this encyclopedia, even though that term is sometimes more broadly applied.

OTHER RELATED COMPONENTS

- **solenoid** (See Chapter 21)
- **electromagnet** (See Chapter 20)

What It Does

An inductor is a coil that induces a magnetic field in itself or in a *core* as a result of current passing through the coil. It may be used in circuits to block or reshape AC current or a range of AC frequencies, and in this role can "tune" a simple radio receiver or various types of oscillators. It can also protect sensitive equipment from destructive voltage spikes.

The schematic symbol for an inductor includes a coil that can be drawn in two basic styles, shown at the top and at the bottom of Figure 14-1. The style at the bottom has become more common. In each vertical section of the diagram, the functionality of the symbols is identical.

One or two parallel lines alongside the coil indicate that it is wound around a solid core of material that can be magnetized, while one or two dotted lines indicate that it is wound around a core containing metal particles, such as iron filings. Where no core is shown, this indicates an air core.

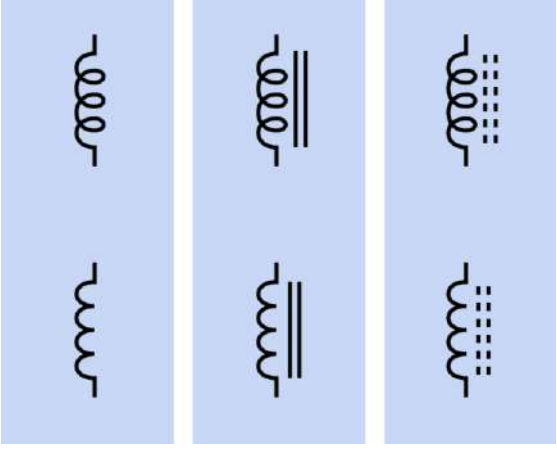

Figure 14-1. *The coil symbol for an inductor may be drawn in two styles which are functionally identical. Line(s) beside the coil indicate a solid core. Dotted line(s) indicate a core containing metal particles.*

A selection of inductors designed for through-hole mounting is shown in Figure 14-2.

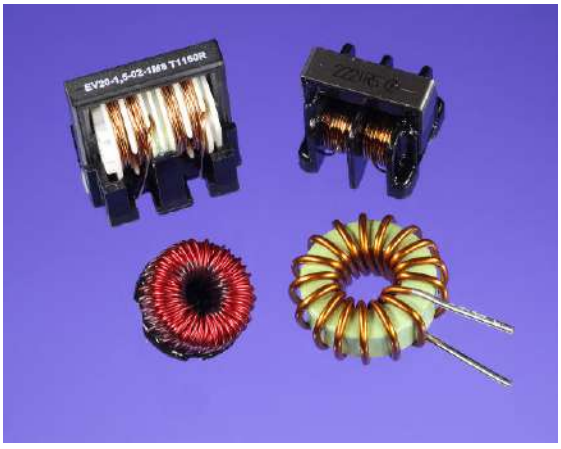

Figure 14-2. *Four inductors designed for through-hole insertion into printed circuit boards.*

How It Works

Direct current passing through an electrical conductor, such as a wire, creates a magnetic field around the conductor. In Figure 14-3, *conventional current* (flowing from positive to negative) is passing through a straight wire from left to right, as indicated by the red/blue arrow. The resulting magnetic field is indicated by the green arrows. If the wire is now bent into a curve, as shown in Figure 14-4, the magnetic field exerts an aggregate force downward through the curve. This magnetic force is conventionally said to flow from *south* to *north*.

If direct current could be induced to circulate through an unbroken circle of wire, the resulting magnetic field could exert a force through the circle as shown in Figure 14-5, assuming clockwise circulation of conventional current as suggested by the red/blue arrows.

Conversely, if a magnet was pushed through the center of the circle, it would induce a pulse of electric current in the circle. Thus, electricity passing through a wire can induce a magnetic field around the wire, and conversely, a magnet moving near a wire can induce an electric current

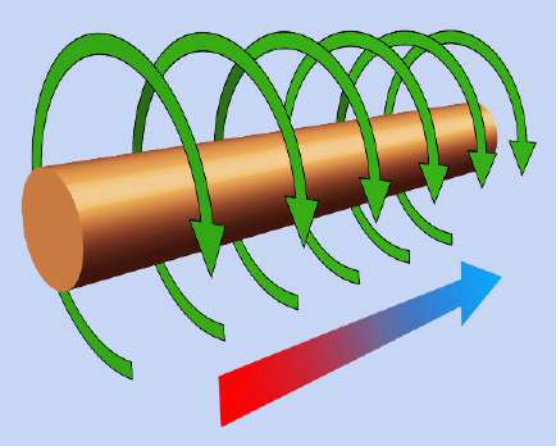

Figure 14-3. *Conventional current passing through a wire from left to right (as indicated by the red/blue arrow) induces a magnetic field around the wire (shown by the green arrows).*

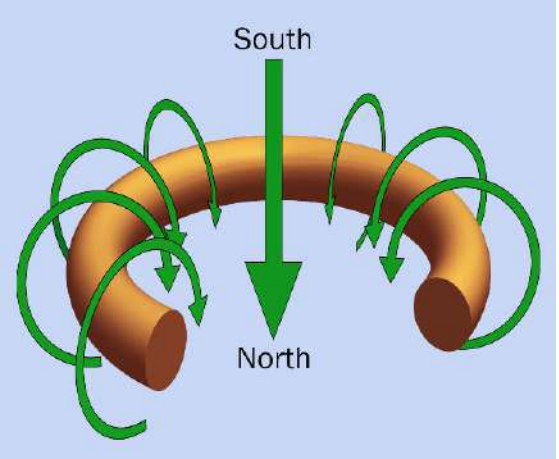

Figure 14-4. *If the wire is bent into a curve, the magnetic fields can create a net force shown by the large green arrow.*

in the wire. This principle is used in an electrical *generator*, and also in a **transformer**, where alternating current in the primary coil induces a fluctuating magnetic field in the core, and the field in the core is turned back into alternating current in the secondary coil.

Note that a static or unchanging magnetic field will not induce a flow of electricity.

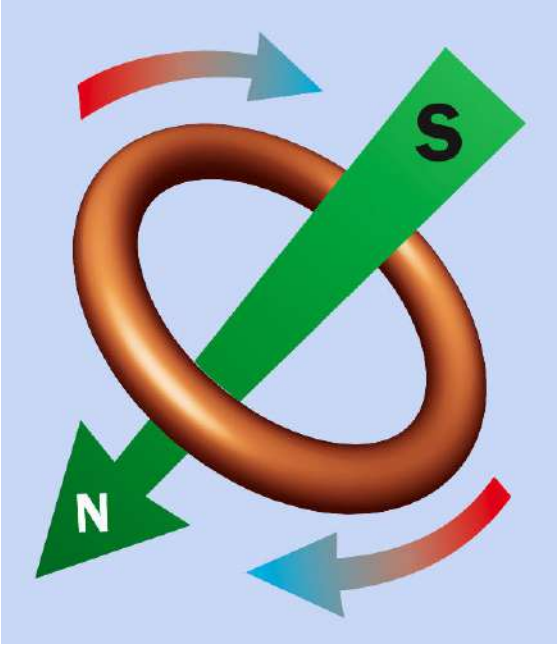

Figure 14-5. *Hypothetically, if conventional current flows around a circular conductor (as suggested by the red/blue arrows), it will create a magnetic field that can create a force as shown by the green arrow.*

DC Through a Coil

If the wire is formed into a helix (a series of approximate circles) as shown in Figure 14-6, and if DC current is passed through the wire, the aggregate of the magnetic fields can create a force in the direction of the green arrow in each example, depending whether the wire is wound clockwise or counter-clockwise, and depending on the direction of the current. The helix is usually referred to as a *coil* or a *winding*.

In actuality, a magnetic field is not open-ended, and its lines of force are completed by circling around outside the inductor, to complete a *magnetic circuit*. This completion of the field can be demonstrated by the traditional high-school experiment of positioning a compass or scattering iron filings on a sheet of paper above a magnet. A simplified depiction of lines of force completing a magnetic circuit is shown in Figure 14-7,

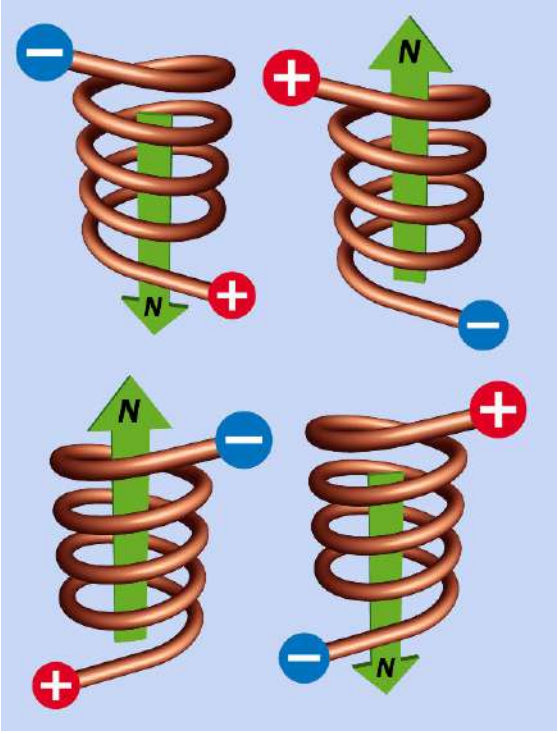

Figure 14-6. *When DC current flows through a coil, it creates magnetic fields that will exert a force whose direction depends on the direction of the current and on whether the coil is wound clockwise or counterclockwise. The force is shown by the green arrow in each case.*

where a coil is inducing the magnetic field. Note that throughout this encyclopedia, the color green is used to indicate the presence of magnetic force.

The completion of a magnetic field is not relevant to the primary function of the inductor. In fact the external part of the magnetic field is mostly a source of trouble in electronics applications, since it can interact with other components, and may necessitate the use of magnetic shielding. In addition, the field is weakened by completing itself through air, as air presents much greater *reluctance* (the magnetic equivalent of resistance) than the core of an electromagnet.

The polarity of a magnetic field created by a coil can be demonstrated by moving a small permanent magnet toward the coil, as shown in

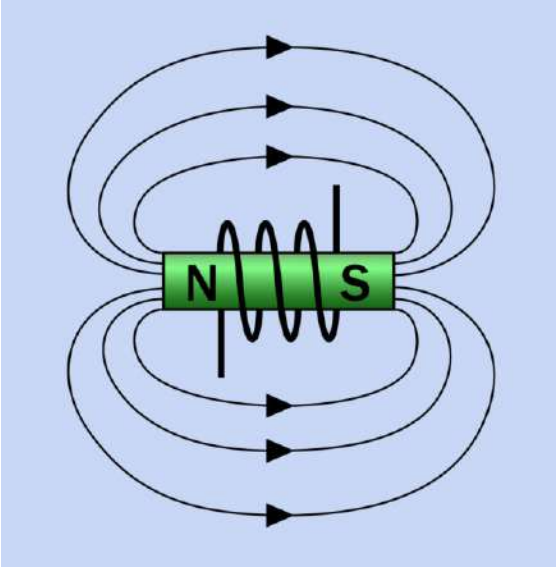

Figure 14-7. *A magnetic field in reality is not open-ended, and each line of force traveling through a rod-shaped magnet or electromagnet is completed outside of the magnet. The completion of magnetic fields has been omitted from other diagrams here for clarity.*

Figure 14-8. If the magnet has opposite polarity to the coil, it will tend to be repelled, as like poles repel. If it has the same polarity, it will tend to be attracted, because opposite poles attract. This principle may be used in **solenoids**.

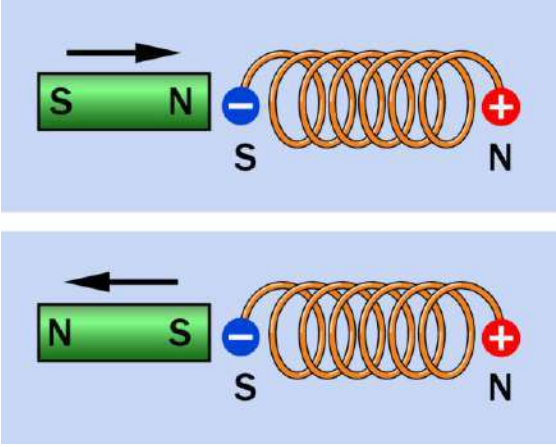

Figure 14-8. *A permanent magnet (left) will either be drawn toward a DC-energized coil or repelled from it, depending on the polarity of the two magnetic fields.*

Magnetic Core

The inductive power of a coil will be enhanced, and the saturation point will be reduced, by using a *magnetic core*. The term "magnetic" in this context does not mean that the core is a permanent magnet; it means that the core can be magnetized briefly by a transient pulse of electricity through the surrounding coil.

A core enhances the effectiveness of an inductor because it has a lower reluctance than that of air. In other words, magnetic flux will flow much more readily through the core than through air.

Roughly speaking, the *permeability* of a magnetic circuit is the opposite of reluctance; it is a measure of how easily a magnetic field can be induced, and is usually expressed relative to the permeability of air, which is approximately 1. The permeability of different core types is discussed in the following "Values" section.

The core of the coil contains *magnetic domains* that behave as tiny magnets, with north and south poles. In the absence of a polarizing magnetic field, the domains are randomly aligned. As a magnetic field is introduced around them and grows stronger, the domains align themselves with it, increasing the total magnetic force. When the domains are almost all uniformly aligned, the core approaches *magnetic saturation* and ceases adding to the net magnetic field. At this point the current in the inductor is said to be *continuous*.

When power to the coil is disconnected, the domains revert partially to their previous random orientation. Thus the core remains a weak permanent magnet. This effect is known as *hysteresis*, while the weak residual field is known as *remanent magnetism*.

EMF and Back-EMF

When DC current is connected through an inductor, the creation of a magnetic field takes a brief but measurable period of time. The field induces an *EMF* (*electro-motive force*) in the wire. Since this force opposes the supplied current, it

is referred to as *back-EMF*. It lasts only so long as the field is increasing to its full strength. After the field reaches a steady state, current flows through the coil normally.

This transient resistive effect is caused by the *self-inductance* of the coil, and is opposite to the behavior of a capacitor, which encourages an initial inrush of direct current until it is fully charged, at which point it blocks subsequent current flow.

When high-frequency alternating current attempts to flow through an inductor, if each pulse is too brief to overcome the back-EMF, the coil will block the current. A coil can thus be designed to block some frequencies but not others.

Even a simple electrical circuit that does not contain a coil will still have some self-inductance, simply because the circuit consists of wires, and even a straight length of wire induces a magnetic field when the power is switched on. However, these inductive effects are so small, they can generally be ignored in practical applications.

The transient electrical resistance to alternating current caused by either an inductor or a capacitor is known as *reactance*, although it occurs under opposite electrical conditions, as the coil impedes an initial pulse of DC current and then gradually allows it to pass, while a capacitor allows an initial pulse of DC current and then impedes it.

When a flow of DC current through a coil is switched off, the magnetic field that was created by the coil collapses and releases its stored energy. This can cause a pulse of forward EMF, and like back-EMF, it can interfere with other components in a circuit. Devices such as motors and large relays that contain substantial coils can create problematic spikes of back-EMF and forward-EMF. The forward-EMF that occurs when power to the coil is interrupted is typically dealt with by putting a diode in parallel with the coil, allowing current to circulate through it. This is known as *clamping* the voltage transient. A diode-capacitor combination known as a *snubber* is also commonly used. For a schematic and additional information on this topic, see "Snubber" (page 108).

A schematic to demonstrate EMF and back-EMF is shown in Figure 14-9. The coil can be a 100-foot spool of 26-gauge (or smaller) hookup wire, or magnet wire. It will function more effectively if a piece of iron or steel, such as half-inch galvanized pipe, is inserted through its center. When the button is pressed, current is briefly impeded by the back-EMF created by the coil, and is diverted through D1, making it flash briefly. Then the coil's reactance diminishes, allowing the current to flow through the coil and bypass the LED. When the pushbutton is released, the coil's magnetic field collapses, and the consequent forward-EMF circulates through D2, causing it to flash briefly. Note that the polarity of back-EMF and forward-EMF are opposite, which is why the LEDs in the circuit are oriented with opposite polarities.

The 220Ω resistor should be rated at 1/4 watt minimum, and the button should not be held down for long, as the electrical resistance of the coil is relatively low. The LEDs ideally should be rated for a minimal forward current of no more than 5mA.

Electrical and Magnetic Polarity

Various mnemonics and images have been created to assist in memorizing the polarity or direction of the magnetic field that will be created by a flow of electricity. The *right-hand rule* suggests that if the fingers of the right hand are curled around a coil in the same direction in which the turns of the coil were wound, and if conventional DC current also flows in this direction, the extended thumb will point in the direction of the principal force that can be created by the magnetic field.

By convention, the magnetic field is oriented from *south* to *north*, which can be remembered since the north end of the magnetic field will be

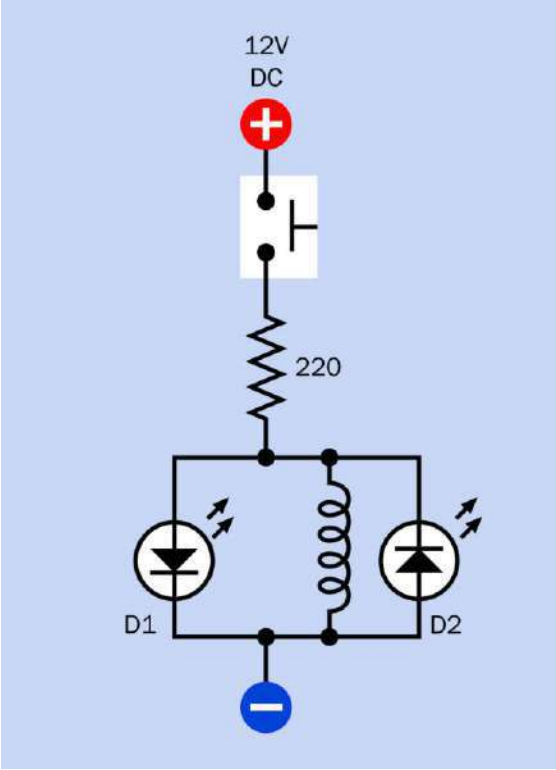

Figure 14-9. *A test circuit to demonstrate the EMF and back-EMF created when DC current starts and stops passing through a coil. See text for details.*

the negative end of the coil (north and negative both beginning with letter N). This mnemonic only works if conventional (positive) current flows through a coil that is wound clockwise.

Another model is the "corkscrew rule" in which we imagine conventional DC current flowing from the handle of a corkscrew, down through its metal section, toward the pointed end. If the corkscrew is turned clockwise, in the same direction as the electricity, the corkscrew will sink into the cork in the same as the direction as the resulting magnetic force.

Variants

Variants include core materials, core shapes, termination style (for through-hole mounting in perforated board, or for surface-mount), and external finish (some inductors are dipped in insulating material, while others allow their copper magnet wire to be exposed).

In addition there are two functional variants: variable inductors and ferrite beads. Their schematic symbols are shown in Figure 14-10.

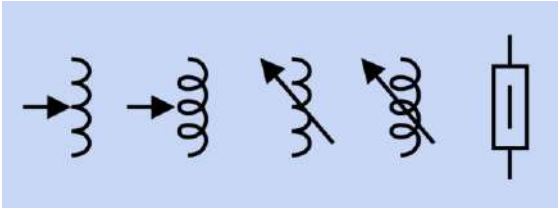

Figure 14-10. *Schematic symbols for a ferrite bead (farthest right) and variable inductors (all other symbols, which are functionally identical).*

Magnetic Cores

A magnetic core may be made from solid iron, plates of iron or steel separated by thin insulating material, powdered iron mixed with a binder, or a ferrite compound derived from nickel, zinc, manganese, or a combination. An iron core has at least 1,000 times the permeability of air, while some ferrites are 10,000 times as permeable.

One major disadvantage of a magnetic core is *hysteresis*, which in this context refers to the tendency of the core to retain some magnetic "memory" as a cycle of alternating current changes from positive to negative. This residual magnetism must be overcome by the next positive pulse of AC. The tendency of the core to retain magnetic polarity is known as its *retentivity*. Iron cores are especially retentive.

Another disadvantage of some magnetic cores is that they may host eddy currents induced by the magnetic field of the coil. These electrical currents tend to circulate through the core, reducing efficiency by generating waste heat, especially if coil currents are high. Forming a core from iron or steel plates, separated by thin layers of insulation, will inhibit these currents. Powdered iron

inhibits eddy currents because the particles have limited contact. Ferrites are nonconductive, and are therefore immune to eddy currents. They are widely used.

Hysteresis and eddy currents both incur energy losses with each AC cycle. Therefore, the losses increase linearly as the AC frequency increases. Consequently, inductor cores that suffer either of these problems are not well-suited to high frequencies.

Nonmagnetic Cores

The problems associated with magnetic cores may be avoided by winding the coil around a nonmagnetic core that may be hollow, ceramic, or plastic. A hollow core is referred to as an *air core*. The permeability of ceramic and plastic cores is close to that of air.

An inductor with a nonmagnetic core will be immune to eddy currents and retentivity, but will have to be significantly larger than a magnetic-cored coil with comparable inductance. In the case of a very primitive radio receiver, such as a crystal set, the air-cored coil that selects a radio frequency may be several inches in diameter. A basic circuit diagram for a crystal set (so-called because it uses a diode containing a germanium crystal) is shown in Figure 14-11. The antenna, at top, receives signals broadcast from radio stations. The coil can be tapped (as indicated by the black dots) as a simple way to select different inductance values, blocking all but a narrow range of frequencies. The T-shaped white component at right is a high-impedance earphone. The diode blocks the lower half of the alternating current in a radio signal, and since the signal is *amplitude-modulated*, the earphone responds to variations in intensity in the signal and reproduces the sound encoded in it.

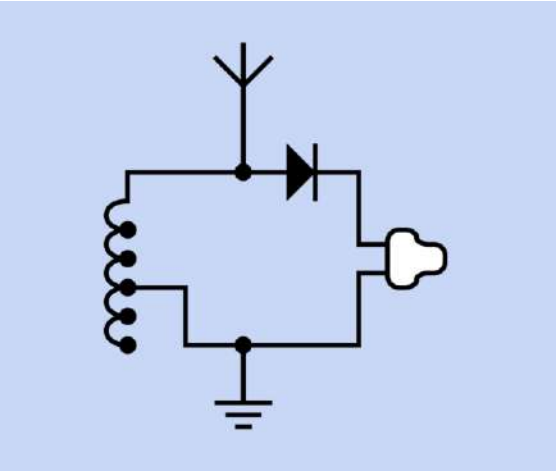

Figure 14-11. *An early and basic application for an inductor is to select radio-station frequencies, as in this schematic for a crystal set. See text for details.*

Variable Inductors

A *variable inductor*, also known as an *adjustable inductor*, is relatively uncommon but can be fabricated by using a magnetic core that penetrates the center of the inductor on an adjustable screw thread. The inductance of the assembly will increase as a larger proportion of the magnetic core penetrates into the open center of the coil. A photograph of a variable inductor is at Figure 14-12.

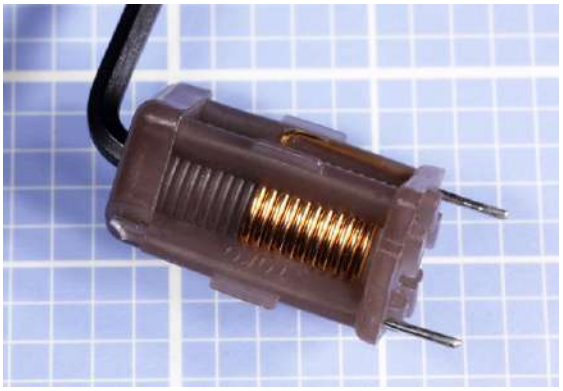

Figure 14-12. *A variable inductor. Its inductance is adjusted via a screw thread that varies the insertion of the core in the coil. In this component the core is turned by inserting a hex wrench, as shown. It is rated from 0.09μH to 0.12μH.*

Ferrite Beads

A *ferrite bead* inverts the design of a typical inductor by running a wire through a hole in the center of the bead, instead of coiling the wire around the core. Two ferrite beads are shown in Figure 14-13. At top, the bead is divided into two sections, each mounted in one-half of a plastic clam shell, which can be closed around a wire. At bottom, the bead must be threaded onto a wire. The purpose is either to limit radio-frequency radiation from a wire by absorbing it into the bead (where it is transformed into heat), or to protect a wire from external sources of radio-frequency radiation. Computer cabling to external devices; lamp dimmers; and some types of motors can be sources of radio frequency.

Figure 14-13. *Two examples of ferrite beads. They can inhibit radio-frequency radiation from a wire, or protect the wire from interference.*

Toroidal Cores

The magnetic circuit created by a rod-shaped core must be completed by the lines of force traveling back around from one end of the rod to the other, through the surrounding air. Since air has low permeability, this is a major source of inefficiency. By comparison, a torus (a geometrical shape resembling a donut) completes the entire magnetic circuit inside its core. This significantly increases its efficiency. Also, because its field is better contained, a toroidal inductor needs little or no shielding to protect other components from stray magnetic effects.

Two through-hole toroidal inductors are shown in Figure 14-2. Bottom left: Rated at 345µH. Bottom right: Rated at 15µH. The one at bottom-left has pins beneath it for insertion into a printed circuit board.

Surface-mount inductors often are toroidal to maximize the efficiency of a component that has to function on a very small scale. Examples are shown in Figure 14-14, Figure 14-15, and Figure 14-16.

Figure 14-14. *In a typical toroidal inductor, the coil is wrapped around a magnetic core shaped as a torus. This surface-mount component (viewed from the bottom, at left, and from the top, at right) is at the low end of the range of component sizes. It is rated at 750nH.*

Figure 14-15. *A medium-sized surface-mount toroidal inductor (viewed from the bottom, at left, and from the top, at right). It is rated at 25µH.*

Figure 14-16. *A larger-sized surface-mount toroidal inductor (viewed from the bottom, at left, and from the top, at right). It is rated at 3.8μH.*

A chart showing some types of inductor cores, their commonly available inductances, and their maximum frequencies is shown in Figure 14-17.

Gyrator

A *gyrator* is a small network, sometimes encapsulated in a silicon chip, using **resistors**, a semiconductor, and a **capacitor** to simulate some but not all of the behavior of a coil-based inductor. The semiconductor may be a transistor or a capacitor, depending on the specific circuit. A sample schematic is shown in Figure 14-18. Because no magnetic effects are induced, the gyrator is completely free from the problems of saturation and hysteresis, which affect coils with cores, and also produces no back-EMF. It simply attenuates a signal initially, and then gradually lowers its reactance, thus imitating this aspect of an inductor.

A gyrator may be used where a coil may be unacceptably large (as in a cellular phone) or where signal quality is of paramount importance—for example, in a graphic equalizer or other audio components that perform signal processing at input stages, such as preamplifiers.

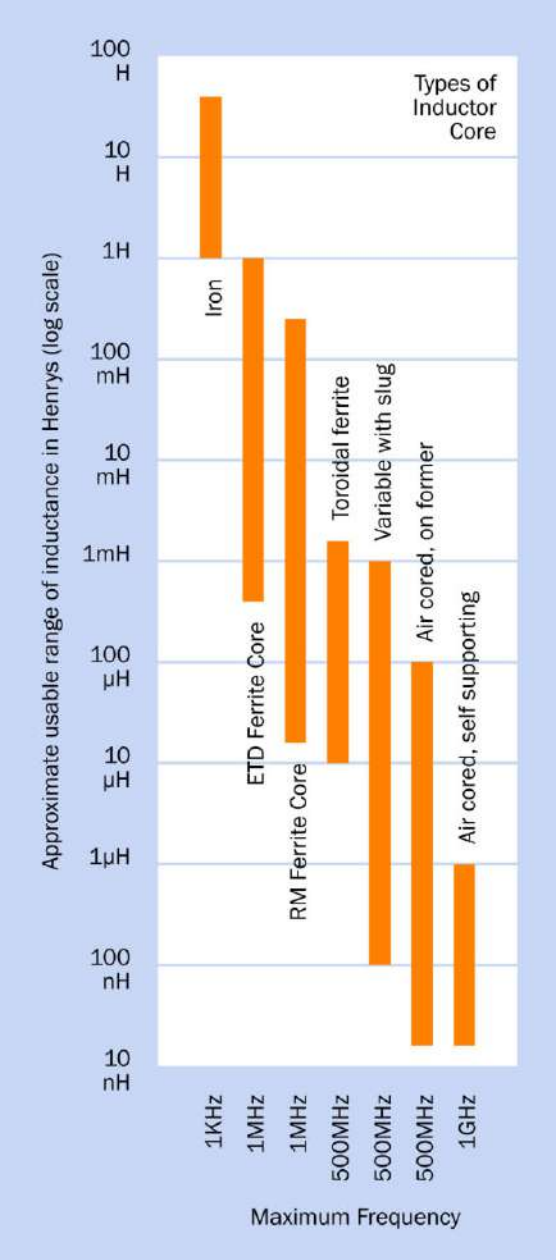

Figure 14-17. *Some commonly used inductor cores and their characteristics. Adapted from "Producing wound components" by R.Clark@surrey.ac.uk.*

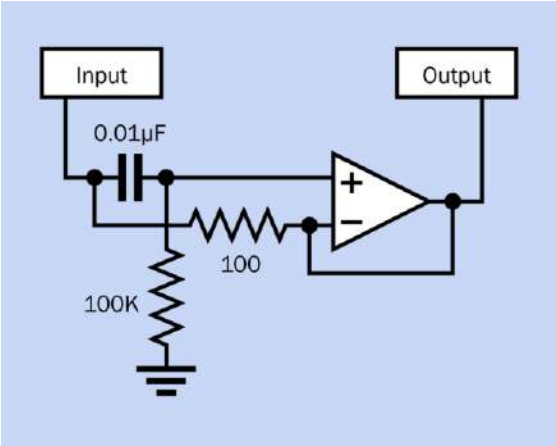

Figure 14-18. *A possible schematic for a coil substitute known as a gyrator, which may be used where a conventional coil would be unacceptably bulky.*

A gyrator does impose some limits on circuit design. While neither side of a real inductor needs to be at ground potential, a gyrator does require a ground connection. However, the performance advantages of gyrators are significant, as they can emulate high inductance without parasitic effects, can be more accurately calibrated (leading to more predictable performance), and do not create magnetic fields that can interfere with other components.

Values

Calculating Inductance

The magnetic inductance of a coil is measured with a unit known as the Henry, named after Joseph Henry, a pioneer in electromagnetism. It is defined by imagining a coil in which current is fluctuating, causing the creation of EMF. If the rate of fluctuation is 1 amp per second and the induced EMF is 1 volt, the inductance of the coil is 1 Henry.

The letter L is commonly used to represent inductance. To derive a useful formula, L will be expressed in microhenrys. If D is the diameter of a coil, N is the number of turns of wire, and W is the width of coil (when the windings are viewed from the side, as shown in Figure 14-19), the precise relationship of the variables is complex but can be reduced to an approximate formula:

$$L = \text{approx } (D^2 * N^2) / 18 * D) + (40 * W$$

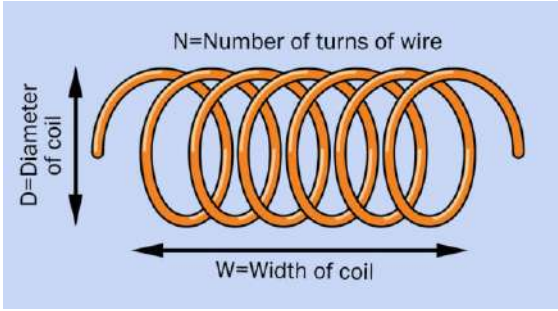

Figure 14-19. *Dimensions of a coil, referenced by a formula to calculate its approximate inductance. See text for details.*

From this, it is clear that inductance tends to increase with coil diameter, and also increases (more significantly) with the square of the number of turns. If the number of turns remains constant, inductance will be higher for a coil that is short and fat than for a coil that is narrow and long.

Because the Henry is a large unit, inductors in electronics circuits typically have their inductances measured in millihenrys (mH), microhenrys (µH), and nanohenrys (nH), where 1H = 1,000mH, 1 mH = 1,000µH, and 1µH = 1,000 nH. This relationship is shown in Figure 14-20.

Calculating Reactance

The reactance of an inductor (that is, its dynamic resistance to alternating current) varies with the frequency of the current. If f is the AC frequency (in Hertz), and L is the inductance (in Henrys), the reactance, X_L in ohms, is given by the formula:

$$X_L = 2 * \pi * f * L$$

From this equation, it's apparent that as the frequency tends toward zero (DC current), or if the inductance tends toward zero (a short piece of

nH	µH	mH
1	0.001	0.000001
10	0.01	0.00001
100	0.1	0.0001
1,000	1	0.001
10,000	10	0.01
100,000	100	0.1
1,000,000	1,000	1

Figure 14-20. *Inductance is typically measured in nanohenrys (nH), microhenrys (µH), and millihenrys (mH). Equivalent values in these units are shown here.*

straight wire), the reactance will tend toward zero. Conversely, the inductor will impede current increasingly as the frequency and/or the inductance increases.

Calculating Reluctance

The letter S is often used to represent reluctance, while Greek letter µ customarily represents permeability (not to be confused with the use of µ as a multiplication factor of 1/1,000,000, as in µF, meaning "microfarad"). If A is the area of cross-section of the magnetic circuit and L is its length:

```
S = L / µ * A
```

Datasheet Terminology

A typical manufacturer's datasheet should include an *inductance index* for an inductor, expressed in µH per 100 turns of wire (assuming the wire is in a single layer) for inductors with a powdered iron core, and mH per 1,000 turns of wire for inductors with ferrite cores.

The *DCR* is the DC resistance of an inductor, derived purely from the wire diameter and its length.

The *SRF* is the *self-resonant frequency*. An inductor should be chosen so that AC current passing through it will never get close to that frequency.

ISAT (or I_{sat}) is the saturation current, which results in a magnetic core losing its function as a result of magnetic saturation. When this occurs, inductance drops and the charge current rate increases drastically.

Series and Parallel Configurations

Because the inductance of a coil conducting DC current is proportional to the current, the calculations to derive the total inductance of coils in series or in parallel are identical to the calculations used for resistors.

In series, all the coils inevitably pass the same current, and the total inductance is therefore found by summing the individual inductances. When coils are wired in parallel, the current distributes itself according to the inductances; therefore, if L1 is the reluctance of the first coil, L2 is the reluctance of the second coil, and so on, the total reluctance L of the network is found from the formula:

```
1/L = 1/L1 + 1/L2 + 1/L3. . .
```

This is shown in Figure 14-21. In reality, differences between the coils (such as their electrical resistance), and magnetic interaction between the coils, will complicate this simple relationship.

Time Constant

Just as the *time constant* of a capacitor defines the rate at which it accumulates voltage when power is applied through a resistor, the time constant of an inductor defines the rate at which it gradually allows amperage to pass through it, overcoming the EMF generated by the coil. In both cases, the time constant is the number of seconds that the component requires to acquire approximately 63% of the difference between its current value and its maximum value. In the case of an inductor, suppose we assume zero internal resistance in the power source, zero resistance in

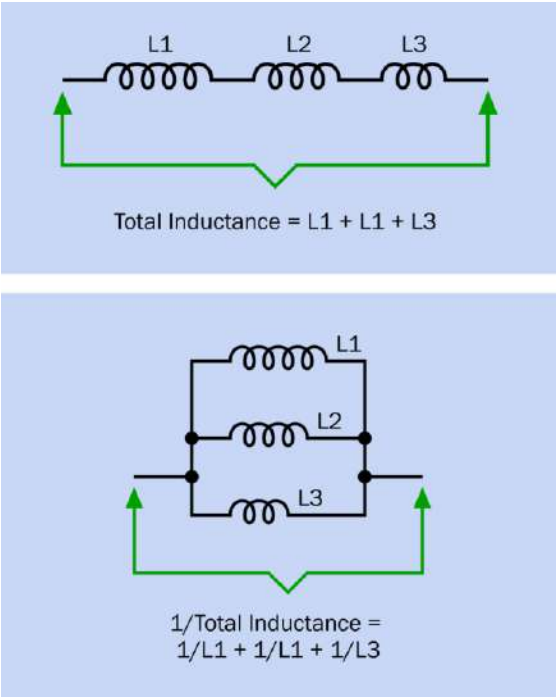

Figure 14-21. *Calculating the total inductance of inductors in parallel (top) and series (bottom).*

the coil windings, and an initial current of zero. If L is the inductance of the coil and R is the value of the series resistor, then the time constant—TC—is given in seconds by the formula

$$TC = L / R$$

Therefore a coil of 10 millihenrys (0.01 Henry) in series with a 100-ohm resistor will pass 63% of the full current in 0.0001 seconds, or 1/10 of a millisecond; it will take an equal additional amount of time for the current to rise by another 63% of the remaining difference between its charge and the maximum amperage of the circuit. In theory, the reactance of a coil can never diminish to zero, but in practice, five time constants are considered adequate to allow maximum current flow.

How to Use it

Because the inductance of an inductor peaks as current increases, and then gradually diminishes, an inductor can be used to block or attenuate high frequencies. A circuit that does this is often referred to as a *low-pass filter*. The schematic and a graph suggesting its performance are shown in Figure 14-22. A basic application could be the *crossover network* in a loudspeaker system, where high-frequency signals are blocked from a low-frequency driver and are diverted to a high-frequency driver.

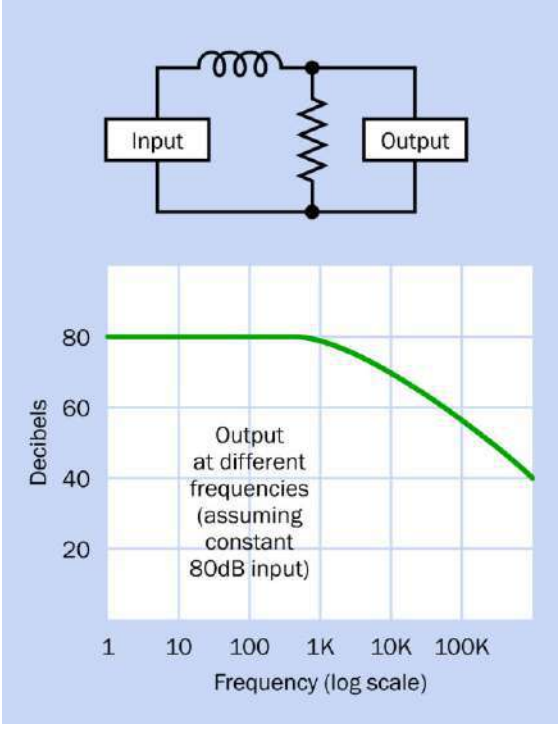

Figure 14-22. *By using the ability of an inductor to block a range of frequencies, a low-pass filter blocks higher frequencies.*

If the location of the inductor is shifted so that it shunts the signal away from the output, the results are reversed, and the circuit becomes a *high-pass filter*. The schematic and a graph suggesting its performance are shown in Figure 14-23.

Note that **capacitors** may also be used to create frequency filters, but because their function is roughly inverse to that of inductors, the place-

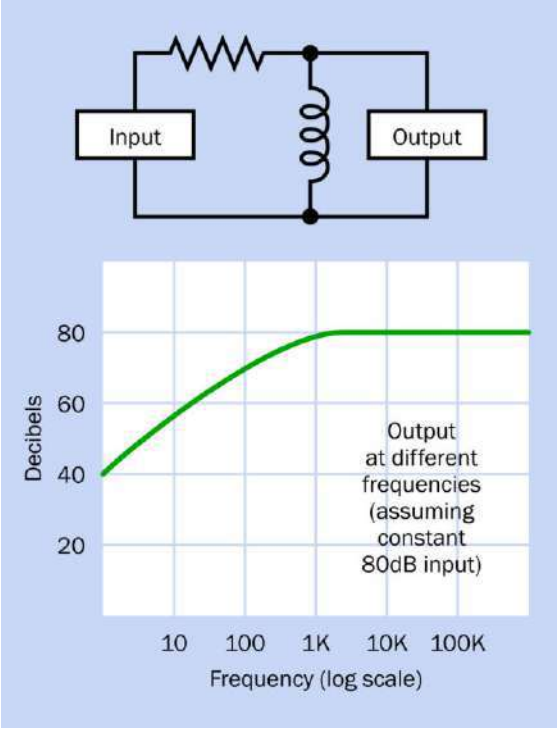

Figure 14-23. *Here the inductor diverts low frequencies away from the output, allowing high frequencies to pass through.*

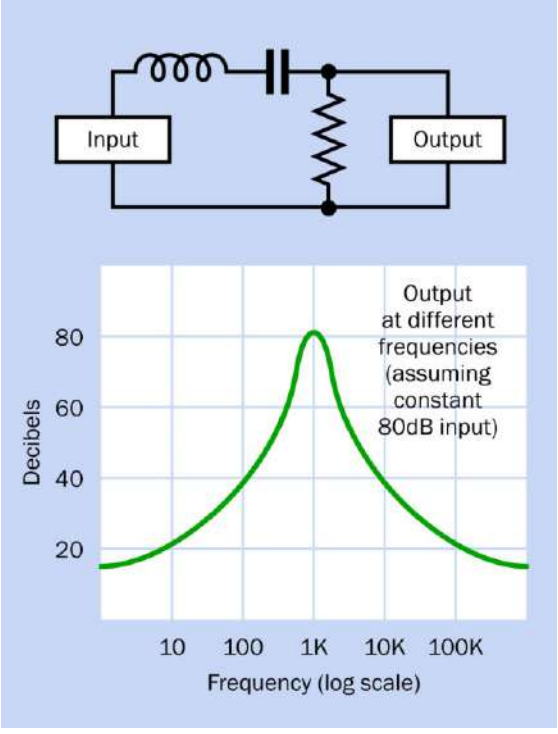

Figure 14-24. *If the values of a capacitor and an inductor are correctly chosen, and the components are placed in series, the inductor blocks high frequencies while the capacitor blocks low frequencies, creating a bandpass filter, in which only a narrow band of frequencies can get through.*

ment of a capacitor in a circuit would be opposite to the placement of the inductor. Examples of filter circuits using capacitors are found in the entry for that component in this encyclopedia.

An inductor can be combined with a capacitor to form a *bandpass filter*, as shown in Figure 14-24. In this configuration, the inductor blocks the high frequencies while the capacitor blocks the low frequencies, allowing only a limited band of frequencies to get through.

Once again if the location of the components is shifted to shunt the signal away from the output, the results are reversed, as shown in Figure 14-25. This is known as a *notch filter*.

The performance of these filters will depend on the component values, and in most applications, additional components will be necessary. Sophisticated filter circuits are outside the scope of this encyclopedia.

Inductors are of great importance in **DC-DC converters** and **AC-DC power supplies** where voltage changes are enabled by rapid switching. See the relevant entries of this encyclopedia for additional details.

Generally, as electronic equipment has become increasingly miniaturized, the unavoidable bulk of inductors has limited their application. However they may still be used to tune oscillators, to block sudden spikes in power supplies, and to protect equipment from sudden voltage spikes (they are used, for example, in surge suppressors for computing equipment).

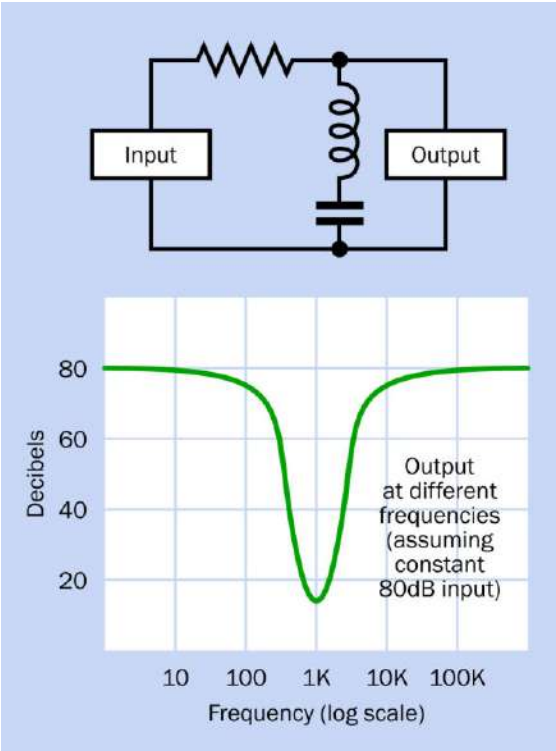

Figure 14-25. *Here the capacitor and inductor block all frequencies except a narrow band, which they divert from the output. The result is a notch filter.*

Core Choices

Air-cored inductors have relatively low inductance, because of their low permeability. However, they can be operated at very high frequencies up to the gigahertz range, and can tolerate higher peak currents.

Inductors with an iron core suffer increasing power losses due to hysteresis and eddy currents as the AC frequency passing through the inductor increases. Consequently, iron-cored inductors are not suitable for frequencies much above 10KHz.

Miniaturization

A low-value inductor can be formed by etching a spiral onto a circuit board, in applications where size must be minimized. They may also be incorporated in integrated circuit chips. However, in small devices such as cellular phones, it is more common to use a coil substitute such as a *gyrator*, as described previously.

What Can Go Wrong

Real-World Defects

The theoretically ideal inductor has no resistance or capacitance and suffers no energy losses. In reality, an inductor possesses both resistance and capacitance, also creates electrical noise, and may pick up electrical noise. It tends to create stray magnetic fields, and generally is more troublesome to deal with than its two cousins, the **resistor** and the **capacitor**.

Parasitic capacitance occurs between adjacent turns of wire. This capacitance becomes more significant at higher frequencies, leading ultimately to a situation where the coil becomes *self resonant*.

The workarounds for these problems involve coil geometries and choices of core material that go beyond the scope of this encyclopedia.

A *gyrator* should be considered as a possible substitute where inductors are troublesome or excessively expensive.

Saturation

Inductance increases as the current passing through a coil increases, but if a magnetic core is used, its contribution to inductance will stop abruptly when the core becomes magnetically *saturated*. In other words, when all of the randomly distributed *magnetic domains* in the core have been induced to align themselves with the pervasive magnetic field, the core cannot become more highly magnetized, and ceases to contribute to the inductance. Note that as a core approaches saturation levels, its hysteresis increases because reversing its magnetization requires greater energy. Antidotes to saturation would include a larger core, a lower current, a smaller number of turns in the coil, and using a core with lower permeability (such as air).

RF Problems

Radio frequencies (*RF*) introduce various problems affecting the efficiency of inductors. The *skin effect* is the tendency of high-frequency AC current to flow primarily on the surface of a strand of wire. The *proximity effect* refers to the tendency of the magnetic fields caused by adjacent wires to introduce eddy currents in the coil. Both of these effects increase the effective resistance of the coil. Various coil geometries have been developed to minimize these effects, but are outside the scope of this encyclopedia. The fundamental lesson is that coils specifically designed for RF are the only ones that should be used with RF.

AC-AC transformer

15

OTHER RELATED COMPONENTS

- **AC-DC power supply** (See Chapter 16)
- **DC-DC converter** (See Chapter 17)
- **DC-AC inverter** (See Chapter 18)

What It Does

A transformer requires an input of *alternating current* (AC). It transforms the input voltage to one or more output voltages that can be higher or lower.

Transformers range in size from tiny impedance-matching units in audio equipment such as microphones, to multi-ton behemoths that supply high voltage through the national power grids. Almost all electronic equipment that is designed to be powered by municipal AC in homes or businesses requires the inclusion of a transformer.

Two small power transformers are shown in Figure 15-1. The one at the rear is rated to provide 36VAC at 0.8A when connected with a source of 125VAC. At front, the miniature transformer is a Radio Shack product designed to provide approximately 12VAC at 300mA, although its voltage will be more than 16VAC when it is not passing current through a load.

Figure 15-1. *Two small power transformers. The one at the rear measures approximately 1" × 2" × 2" and is rated to provide 36VAC at 0.8A. The term "sec" on the smaller unit is an abbreviation for "secondary," referring to the rating for its secondary winding.*

Transformer schematic symbols are shown in Figure 15-2. The different coil styles at left and right are functionally identical. Top: A transformer with a magnetic core—a core that can be magnetized. Bottom: A transformer with an air core. (This type of transformer is rare, as it tends to be less efficient.) The input for the transformer is almost always assumed to be on the left, through the *primary* coil, while the output is on the right, through the *secondary* coil. Often the two coils will show differing numbers of turns to indicate whether the transformer is delivering a reduced voltage (in which case there will be fewer turns in the secondary coil) or an increased voltage (in which case there will be fewer turns in the primary coil).

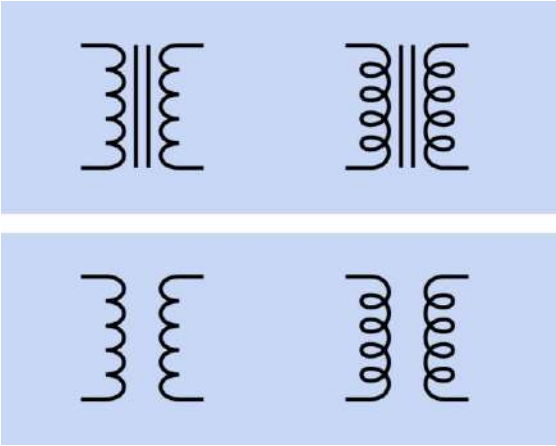

Figure 15-2. *Alternate symbols for a transformer with a ferromagnetic core (top) and air core (bottom). The differing coil symbols at left and right are functionally identical.*

How It Works

A simplified view of a transformer is shown in Figure 15-3. Alternating current flowing through the primary winding (orange) induces magnetic flux in a laminated core formed from multiple steel plates. The changing flux induces current in the secondary winding (green), which provides the output from the transformer. (In reality, the windings usually consist of thousands of turns of thin magnet wire, also known as enameled wire; and various different core configurations are used.)

The process is known as *mutual induction*. If a load is applied across the secondary winding, it will draw current from the primary winding, even though there is no electrical connection between them.

In an ideal, lossless transformer, the ratio of turns between the two windings determines whether the output voltage is higher, lower, or the same as the input voltage. If V_p and V_s are the voltages across the primary and secondary windings respectively, and N_p and N_s are the number of turns of wire in the primary and secondary windings, their relationship is given by this formula:

$$V_p / V_s = N_p / N_s$$

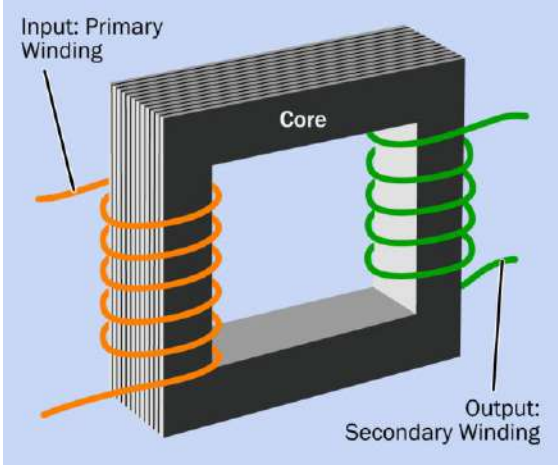

Figure 15-3. *Three basic parts of a transformer, shown in simplified form.*

A simple rule to remember is that fewer turns = lower voltage while more turns = higher voltage.

A *step-up transformer* has a higher voltage at its output than at its input, while a *step-down transformer* has a higher voltage at its input than at its output. See Figure 15-4.

In an ideal, lossless transformer, the power input would be equal to the power output. If V_{in} and V_{out} are the input and output voltages, and I_{in} and I_{out} are the input and output currents, their relationship is given by this formula:

$$V_{in} * I_{in} = V_{out} * I_{out}$$

Therefore, if the transformer doubles the voltage, it allows only half as much current to be drawn from the secondary winding; and if the voltage is cut in half, the available current will double.

Transformers are not 100% efficient, but they can be more than 98% efficient, and relationships between voltage, current, and the number of turns in the windings are reasonably realistic.

When the transformer is not loaded, the primary winding behaves like a simple inductor with reactance that inhibits the flow of current. Therefore a power transformer will consume relatively

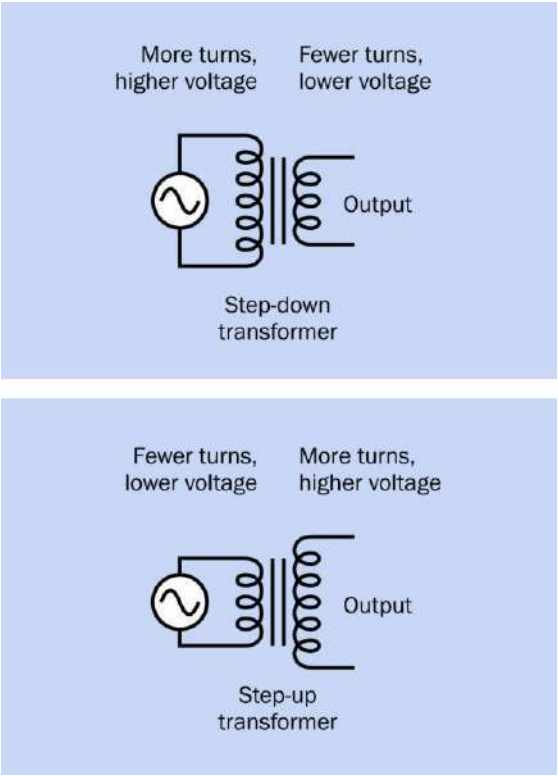

Figure 15-4. *The ratio of input voltage to output voltage is equal to the ratio of primary turns to secondary turns in the transformer windings, assuming a transformer of 100% efficiency.*

little electricity if it is left plugged in to an electrical outlet without any load connected to its output side. The power that it does consume will be wasted as heat.

The Core

The ferromagnetic core is often described as being made of iron, but in reality is more often fabricated from high permeability silicon steel. To reduce losses caused by eddy currents, the core is usually laminated—assembled from a stack of plates separated from each other by thin layers of varnish or a similar insulator. Eddy currents tend to be constrained within the thickness of each plate.

Because a DC voltage would cause magnetic saturation of the core, all transformers must operate with alternating current or pulses of current. The windings and geometry of a transformer are optimized for the frequency range, voltage, and current at which it is designed to operate. Deviating significantly from these values can damage the transformer.

Taps

A *tap* on a transformer is a connection part-way through the primary or (more often) the secondary coil. On the primary side, applying an input between the start of a coil and a tap part-way through the coil will reduce the number of turns to which the voltage is applied, therefore increasing the ratio of output turns to input turns, and increasing the output voltage. On the secondary side, taking an output between the start of a coil and a tap part-way through the coil will reduce the number of turns from which the voltage is taken, therefore decreasing the ratio of output turns to input turns, and decreasing the output voltage. This can be summarized:

- A tap on the primary side can increase output voltage.
- A tap on the secondary side can provide a decreased output voltage.

In international power adapters, a choice of input voltages may be allowed by using a double-throw switch to select either the whole primary winding, or a tapped subsection of the winding. See Figure 15-5. Modern electronics equipment often does not require a voltage adapter, because a **voltage regulator** or **DC-DC converter** inside the equipment will tolerate a wide range of input voltages while providing a relatively constant output voltage.

A transformer's secondary winding is often tapped to provide a choice of output voltages. In fact, most power transformers have at least two outputs, since the cost of adding taps to the secondary winding is relatively small. As an

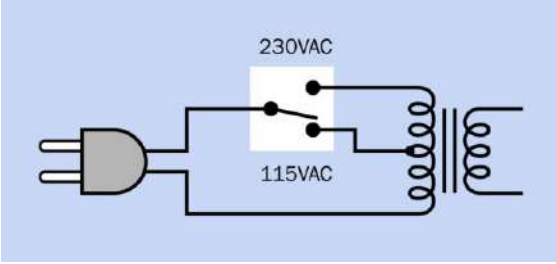

Figure 15-5. *An international power adapter can provide a fixed output voltage by using a double-throw switch to apply 230VAC voltage across a transformer's primary winding, or 115VAC to a tapped midpoint of the primary winding.*

alternative to tapped outputs, two or more separate secondary windings may be used, allowing the outputs to be electrically isolated from each other. See Figure 15-6.

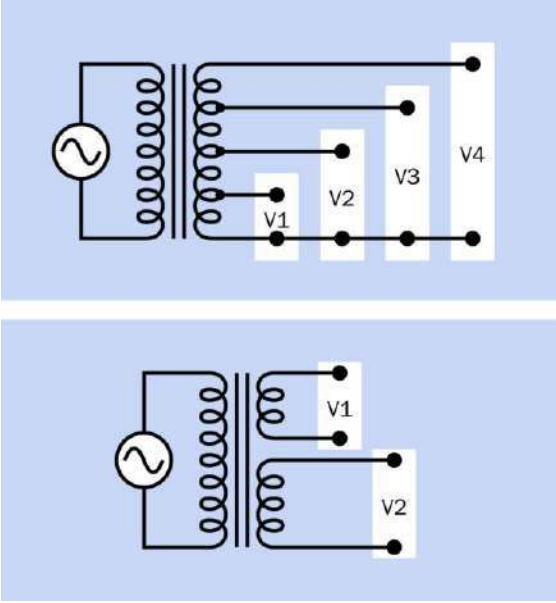

Figure 15-6. *Multiple output voltages may be obtained from a transformer by tapping into the secondary winding (top) or using two or more separate secondary windings (bottom), in which case the outputs will be electrically isolated from each other.*

If the winding on the primary side of a transformer is coiled in the same direction as the winding on the secondary side, the output voltage will be 180 degrees out of phase with the input voltage. In schematics, a dot is often placed at one end of a transformer coil to indicate where the coil begins. If the dots on the primary and secondary sides are at the same ends of the coils, there will be a 180 degree phase difference between input and output. For many applications (especially where the output from a power transformer is going to be converted to DC), this is immaterial.

If there is a center tap on the secondary winding, and it will be referenced as ground, the voltages relative to it, at opposite ends of the secondary winding, will be out of phase. See Figure 15-7.

Variants

Core Shapes

The *shell core* is a closed rectangle, as shown in Figure 15-3. This is the most efficient but most costly to manufacture. A C-shaped core is another option (three sides of the rectangle) and an E-I core is popular, consisting of a stack of E-shaped plates with two coils wound around the top and bottom legs of the E, or wound concentrically around the center leg of the E. An additional stack of straight plates is added to close the gaps in the E and form a magnetic circuit.

In Figure 15-8, the small transformer from Figure 15-1 has been sliced open with a band saw and a belt sander to reveal a cross-section of its windings. This clearly shows that its primary and secondary windings are concentric. It also reveals the configuration of its core, which is in the E-I format. In Figure 15-9, the E-I configuration is highlighted to show it more clearly.

Power Transformer

Typically designed to be bolted onto a chassis or secured inside the case or cabinet housing a piece of electrical equipment with solder tabs or connectors allowing wires to connect the transformer to the power cord, on one side, and a cir-

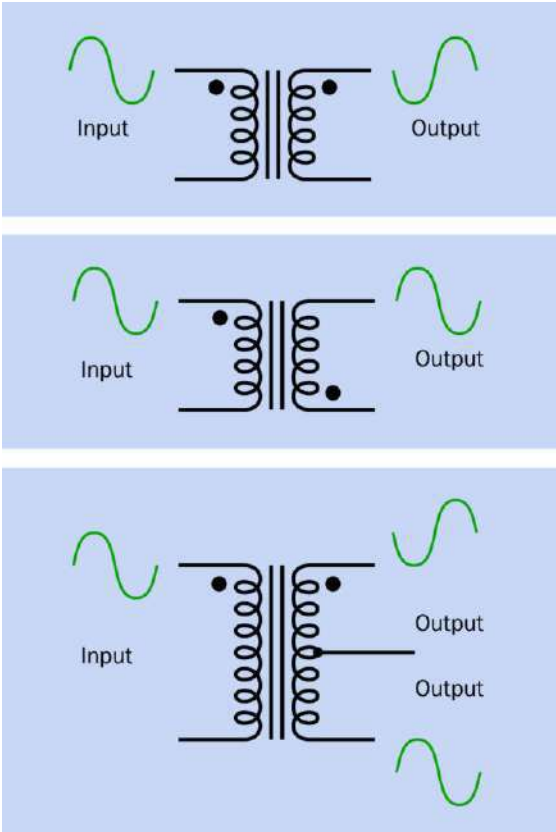

Figure 15-7. *A dot indicates the start of each winding. Where primary and secondary windings are in the same direction, the voltage output will be 180 degrees out of phase with the input. Where the dots indicate windings in opposite directions, the voltage output will have the same phase as the input. Where a center tap on the secondary winding serves as a common ground, the voltages at opposite ends of the secondary winding will be opposite to each other in phase.*

cuit board, on the other side. Smaller power transformers such as the one in Figure 15-1 have "through-hole" design with pins allowing them to be inserted directly onto circuit boards.

Plug-in Transformer

Usually sealed in a plastic housing that can be plugged directly into a wall power outlet. They are visually identical to **AC adapters** but have an AC output instead of a DC output.

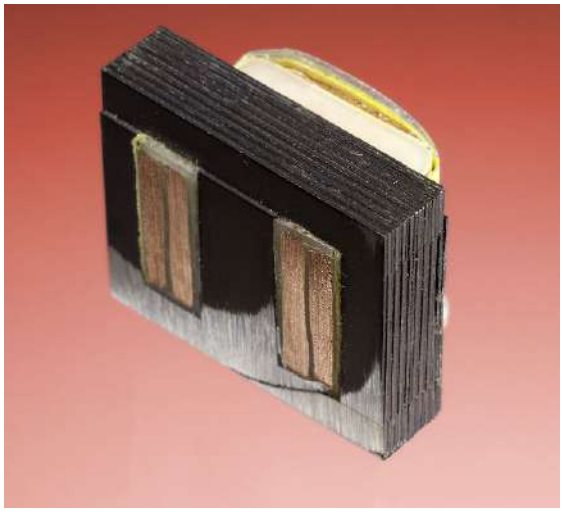

Figure 15-8. *The small transformer from the first figure in this entry is shown sliced open to reveal its internal configuration.*

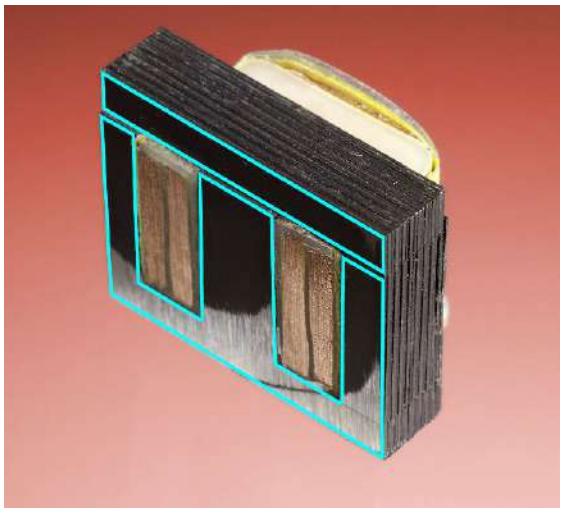

Figure 15-9. *The "EI" shaped plates that form the core of the transformer are outlined to show their edges.*

Isolation Transformer

Also known as a *1:1 transformer* because it has a 1:1 ratio between primary and secondary windings, so that the output voltage will be the same as the input voltage. When electrical equipment is plugged into the isolation transformer, it is separated from the electrical ground of AC power wiring. This reduces risk when working on

"live" equipment, as there will be negligible electrical potential between itself and ground. Consequently, touching a grounded object while also touching a live wire in the equipment should not result in potentially lethal current passing through the body.

Autotransformer

This variant uses only one coil that is tapped to provide output voltage. Mutual induction occurs between the sections of the coil. An autotransformer entails a common connection between its input and output, unlike a two-coil transformer, which allows the output to be electrically isolated from the input. See Figure 15-10. Autotransformers are often used for impedance matching in audio circuits, and to provide output voltages that differ only slightly from input voltages.

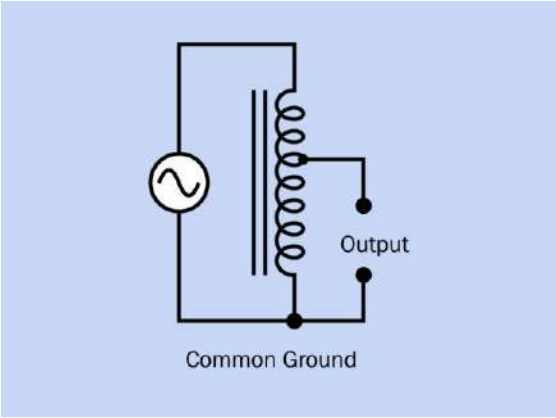

Figure 15-10. *An autotransformer contains only one coil and core. A reduced output voltage can be obtained by tapping into the coil. A common connection prevents the output from being electrically isolated from the input.*

Variable Transformer

A variable transformer, also known as a *variac*, resembles a wire-wound **potentiometer**. Only one winding is used. A *wiper* can be turned to contact the winding at any point, and serves as a movable tap. Like an autotransformer, a variable transformer entails a common connection between input and output.

Audio Transformer

When a signal is transmitted between two stages of a circuit that have different impedance, the signal may be partially reflected or attenuated. (Impedance is measured in ohms but is different from DC electrical resistance because it takes into account reactance and capacitance. It therefore varies with frequency.)

A device of low input impedance will try to draw significant current from a source, and if the source has high output impedance, its voltage will drop significantly as a result. Generally, the input impedance of a device should be at least 10 times the output impedance of the device that is trying to drive it. Passive components (resistors, and/or capacitors, and/or coils) can be used for impedance matching, but in some situations a small transformer is preferable.

If N_p and N_s are the number of turns of wire in the transformer primary and secondary windings, and Z_p is the impedance of a device (such as an audio amplifier) driving the transformer on its primary side, and Z_s is the impedance of a device (such as a loudspeaker) receiving power from the secondary side:

$$N_p / N_s = \sqrt{(Z_p / Z_s)}$$

Suppose that an audio amplifier with rated output impedance of 640Ω is driving a loudspeaker with 8Ω impedance. A matching transformer would be chosen with a ratio of primary turns to secondary turns give by:

$$\sqrt{(640/8)} = \sqrt{80} = \text{approximately } 9:1$$

The two transformers in Figure 15-11 are through-hole components designed for telecommunications purposes, but are capable of passing audio frequencies and can be used for impedance matching in applications such as a preamplifier.

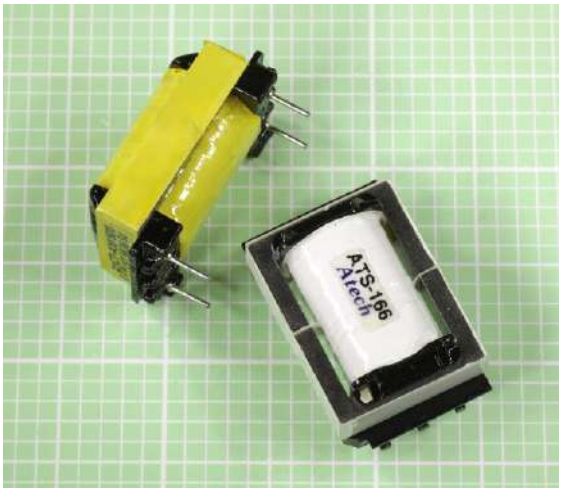

Figure 15-11. *Through-hole transformers. See text for details.*

In Figure 15-12, the transformers are designed for audio coupling. The one on the right has impedances of 500 ohms (primary) and 8 ohms (secondary). On the left is a fully encapsulated line matching transformer with a 1:1 turns ratio.

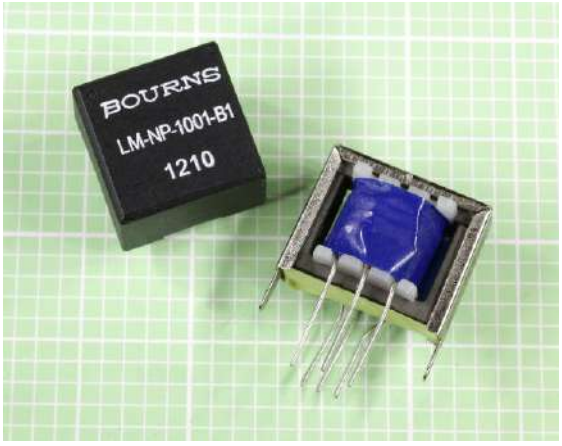

Figure 15-12. *Through-hole transformers. See text for details.*

Split-Bobbin Transformer

This variant has primary and secondary coils mounted side by side to minimize capacitive coupling.

Surface-Mount Transformer

May be less than 0.2" square and is used for impedance matching, line coupling, and filtering. Two surface-mount transformers are shown in Figure 15-13.

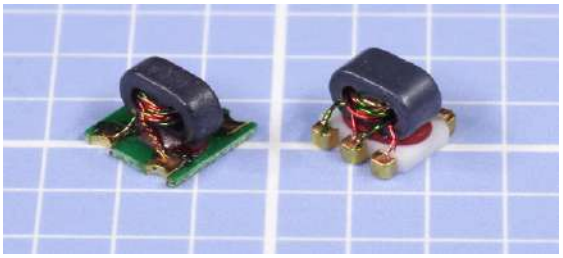

Figure 15-13. *Two surface-mount transformers, each measuring less than 0.2" square, typically used in communications equipment and suited for frequencies higher than 5 MHz.*

Values

When selecting a power transformer, its power handling capability is the value of primary interest. It is properly expressed by the term VA, derived from "volts times amps." VA should not be confused with watts because watts are measured instantaneously in a DC circuit, whereas in an AC circuit, voltage and current are fluctuating constantly. VA is actually the *apparent power*, taking reactance into account.

The relationship between VA and watts will vary depending on the device under consideration. In a worst-case scenario:

```
W = 0.65 VA (approximately)
```

In other words, the averaged power you can draw from a transformer should be no less than two-thirds of its VA value.

Transformer specifications often include input voltage, output voltage, and weight of the component, all of which are self-explanatory. Coupling transformers may also specify input and output impedances.

How to Use it

For most electronic circuits, a power transformer will be followed by a *rectifier* to convert AC to DC, and **capacitors** to smooth fluctuations in the supply. Using a prepackaged **power supply** or *AC adapter* that already contains all the necessary components will be more time-effective and probably more cost-effective than building a power supply from the ground up. See Chapter 16.

What Can Go Wrong

Reversal of Input and Output

Suppose a transformer is designed to provide an output voltage of 10 volts from domestic AC power of 115 volts. If the wrong side of the transformer is connected with 115VAC by mistake, the output will now be more than 1,000 volts—easily enough to cause death, quite apart from destroying components that are connected with it. Reversing the transformer in this way may also destroy it. Extreme caution is advisable when making connections with power transformers. A meter should be used to check output voltage. All devices containing transformers should be fused on the live side and grounded.

Shock Hazard from Common Ground

When working on equipment that uses an autotransformer, the chassis will be connected through the transformer to one side of 115VAC power. So long as a plug is used that prevents reversed polarity, the chassis should be "neutral." However, if an inappropriate power cord is used, or if the power outlet has been wired incorrectly, the chassis can become live. For protection, before working on any device that uses 115VAC power with an autotransformer, plug the device into an isolation transformer, and plug the isolation transformer into the wall outlet.

Accidental DC Input

If DC current is applied to the input side of a transformer, the relatively low resistance of the primary coil will allow high current that can destroy the component. Transformers should only be used with alternating current.

Overload

If a transformer is overloaded, heat will be generated that may be sufficient to destroy the thin layers of insulation between coil windings. Consequently, input voltage can appear unexpectedly on the output side. Transformers with a toroidal (circular) core are especially hazardous in this respect, as their primary and secondary windings usually overlap.

Some (not all) power transformers contain a thermal fuse that melts when it exceeds a temperature threshold. If the fuse is destroyed, the transformer must be discarded.

The consequences of moderate overloading may not be obvious, and can be cumulative over time. Ventilation or heat sinkage should be taken into account when designing equipment around a power transformer.

Incorrect AC Frequency

Single-phase AC power in the United States fluctuates at 60Hz, but Great Britain and some other countries use AC power at 50Hz. Many power transformers are rated to be compatible with either frequency, but if a transformer is specifically designed for 60Hz, it may eventually fail by overheating if it is used with a 50Hz supply. (A 50Hz transformer can be used safely with 60Hz AC.)

AC-DC power supply

16

Also known as an *AC adapter*. When packaged as a palm-sized plastic package that plugs directly into a power outlet, it is occasionally known colloquially as a *wall-wart*.

OTHER RELATED COMPONENTS

- **transformer** (See Chapter 15)
- **DC-DC converter** (See Chapter 17)
- **DC-AC inverter** (See Chapter 18)

What It Does

An AC-DC power supply converts *alternating current* (*AC*) into the *direct current* (*DC*) that most electronic devices require, usually at a lower voltage. Thus, despite its name, a power supply actually requires an external supply of power to operate.

Larger products, such as computers or stereo equipment, generally have a power supply contained within the device, enabling it to plug directly into a wall outlet. Smaller battery-powered devices, such as cellular phones or media players, generally use an external power supply in the form of a small plastic pod or box that plugs into a wall outlet and delivers DC via a wire terminating in a miniature connector. The external type of power supply is often, but not always, referred to as an *AC adapter*.

Although an AC-DC power supply is not a single component, it is often sold as a preassembled modular unit from component suppliers.

Variants

The two primary variants are a *linear regulated power supply* and *switching power supply*.

Linear Regulated Power Supply

A linear regulated power supply converts AC to DC in three stages:

1. A power **transformer** reduces the AC input to lower-voltage AC.
2. A *rectifier* converts the AC to unsmoothed DC. Rectifiers are discussed in the entry on **diodes** in this encyclopedia.
3. A **voltage regulator**, in conjunction with one or more **capacitors**, controls the DC voltage, smooths it, and removes *transients*. The regulator is properly known as a *linear voltage regulator* because it contains one or more **transistors**, which are functioning in linear mode—that is, responding linearly to fluctuations in base current, at less than their saturation level. The linear voltage regulator gives the linear regulated power supply its name.

A simplified schematic of a linear regulated power supply is shown in Figure 16-1.

This type of power supply may be described as *transformer-based*, since its first stage consists of a transformer to drop the AC input voltage before it is rectified.

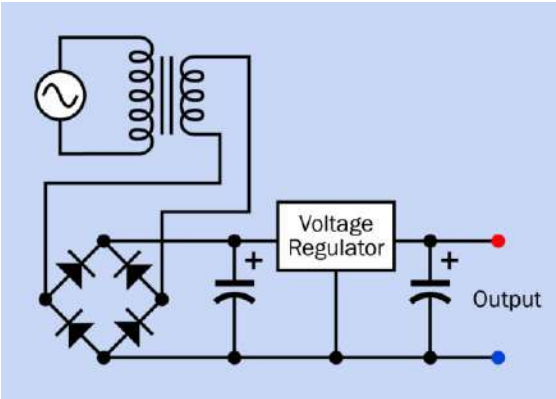

Figure 16-1. *A basic linear regulated power supply.*

Because the rectifier in a power supply generally passes each pulse of AC through a pair of silicon diodes, it will impose a voltage drop of about 1.2V at peak current. A smoothing capacitor will drop the voltage by about 3V as it removes ripple from the current, whereas a voltage regulator typically requires a difference of at least 2V between its input and its output. Bearing in mind also that the AC input voltage may fluctuate below its rated level, the output from the power transformer should be at least 8VAC higher than the ultimate desired DC output. This excess power will be dissipated as heat.

The basic principle of the linear regulated power supply originated in the early days of electronic devices such as radio receivers. A transistorized version of this type of power supply remained in widespread use through the 1990s. Switching power supplies then became an increasingly attractive option as the cost of semiconductors and their assembly decreased, and high-voltage transistors became available, allowing the circuit to run directly from rectified line voltage with no step-down power transformer required.

Some external AC adapters are still transformer-based, but are becoming a minority, easily identified by their relatively greater bulk and weight. An example is shown in Figure 16-2.

Figure 16-3 shows the handful of components inside a cheap, relatively old AC adapter. The output from a power transformer is connected directly to four diodes (the small black cylinders), which are wired as a full-wave rectifier. A single electrolytic capacitor provides some smoothing, but because there is no voltage regulator, the output will vary widely depending on the load. This type of AC adapter is not suitable for powering any sensitive electronic equipment.

Figure 16-2. *A simple transformer-based power supply can be encapsulated in a plastic shell, ready to plug into a power outlet. However, today this format more typically contains a switching power supply, which is usually lighter, smaller, and cheaper.*

Switching Power Supply

Also known as a *switched-mode power supply*, an *SMPS,* or *switcher*, it converts AC to DC in two stages.

1. A *rectifier* changes the AC input to unsmoothed DC, without a power transformer.
2. A DC-DC **converter** switches the DC on and off at a very high frequency using *pulse-width modulation* to reduce its average effective voltage. Often the converter will be the *flyback* type, containing a transformer, but the high-frequency switching allows the transformer to be much smaller than the power transformer required in a linear regulated power supply. See the DC-DC **converter** entry in this encyclopedia for an explanation of the working principles.

Figure 16-3. *A relatively old, cheap AC adapter contains only the most rudimentary set of components, and does not supply the kind of properly regulated DC power required by electronic equipment.*

A simplified schematic of a switching power supply is shown in Figure 16-4.

The interior of a relatively early switching power supply designed to deliver 12VDC at up to 4A is shown in Figure 16-5. This supply generated considerable waste heat, necessitating well-spaced components and a ventilated enclosure.

The type of small switching power supply that is now almost universally used to power laptop computers is shown in Figure 16-6. Note the smaller enclosure and the higher component count than in the older power supply shown in Figure 16-5. The modern unit also delivers considerably more power, and generates less waste heat. Although this example is rated at 5A, the

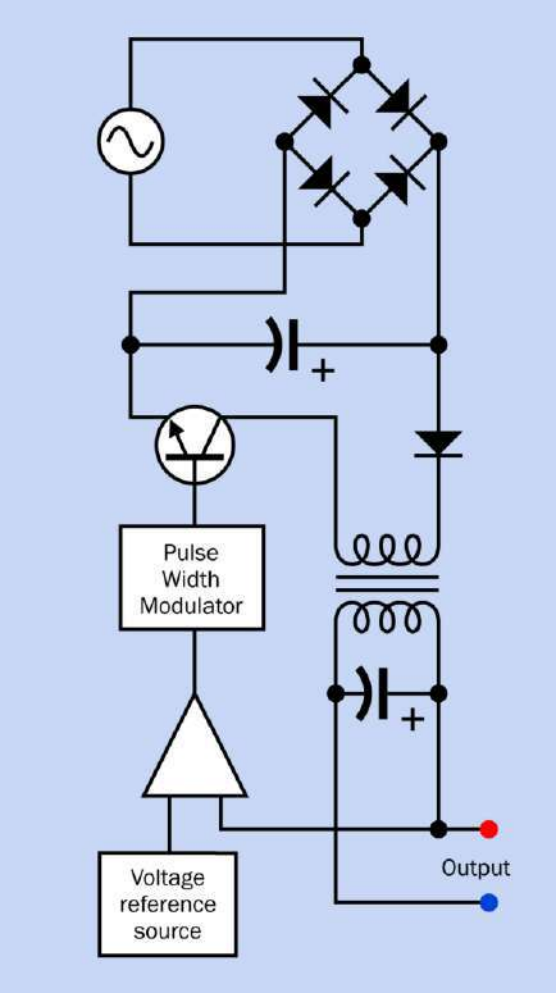

Figure 16-4. *Greatly simplified schematic showing the principal components of a switching power supply. Note the absence of a 115VAC power transformer. The transformer that is inserted subsequently in the circuit functions in conjunction with the high switching frequency, which allows it to be very much smaller, cheaper, and lighter.*

transformer (hidden under the yellow wrapper at the center of the unit) is smaller than the power transformer that would have been found in an old-style AC adapter delivering just 500mA.

The modern power supply is completely sealed, where earlier versions required ventilation. On

Figure 16-5. *The interior of an early switching power supply.*

the downside, the plastic case of the switching supply requires a metal liner (removed for this photograph) to contain high-frequency electromagnetic radiation.

Unregulated Power Supply

Typically this consists of a transformer and rectifying diodes with little or no smoothing or voltage control of the output.

Adjustable Power Supply

This is usually a linear power supply incorporating an adjustable **voltage regulator**. This type of supply has laboratory applications and is found as a benchtop item to power electronics design projects during their development.

Figure 16-6. *The interior of the type of switching power supply that powers a laptop computer.*

Voltage Multiplier

Devices such as photocopiers and laser printers, televisions, cathode-ray tubes, and microwave ovens require voltages significantly higher than those supplied by domestic AC power outlets. A voltage multiplier usually contains a step-up transformer followed by DC conversion components, but detailed consideration is outside the scope of this encyclopedia.

Formats

An *open frame* power supply consists of components on a circuit board, usually mounted on a metal chassis, with no enclosure or fan cooling.

A *covered* power supply is enclosed in a protective perforated metal box with a cooling fan if needed. Power supplies sold for desktop computers are usually in this format.

Power supplies are also available in rack-mount and DIN-rail formats.

How to Use it

Because a switching power supply contains no power transformer, it is lighter and smaller, and may be cheaper than a linear power supply. It is also more efficient and generates less waste heat. These advantages have made switching power supplies the most popular option to provide DC power for electronics devices. However, the high-frequency switching tends to create *electromagnetic interference* (*EMI*), which must be filtered to protect the output of the device and also to minimize the risk of this interference feeding back into AC power wiring. The high-frequency switched power may also generate harmonics, which must be suppressed.

High-quality linear regulated power supplies still find application in laboratory equipment, low-noise signal processing, and other niches where excellent regulation and low-ripple output are necessary. They are relatively heavy, bulky, and inefficient.

See Figure 16-7 for a chart comparing the advantages and disadvantages of linear and switching power supplies.

What Can Go Wrong

High Voltage Shock

One or more capacitors in a power supply may retain a relatively high voltage for some time after the unit has been unplugged. If the power supply is opened for inspection or repairs, caution is necessary when touching components.

Capacitor Failure

If *electrolytic capacitors* fail in a switching power supply (as a result of manufacturing defects, disuse, or age), allowing straight-through conduction of alternating current, the high-frequency switching semiconductor can also fail, allowing input voltage to be coupled unexpectedly to the output. Capacitor failure is also a potential problem in linear power supplies. For additional information on capacitor failure modes, see Chapter 12.

	Switching power supply	Linear power supply
Component count	High	Medium
Load regulation	0.05% to 0.5%	0.005% to 0.2%
Line regulation	0.05% to 0.2%	0.005% to 0.05%
Ripple (RMS)	10mV to 25mV	0.25mV to 1.5mV
Efficiency	70% to 85%	40% to 60%
EMI	High	Very low
Leakage	High	Low
Physical size	Small	Large
Weight	Light	Heavy
Heat management	Usually fan-cooled	Usually cooled by convection

Figure 16-7. *Comparison of attributes of linear regulated power supplies and switching power supplies. (Adapted from Acopian Technical Company.)*

Electrical Noise

If *electrolytic capacitors* are used, their gradual deterioration over time will permit more electrical noise associated with high-frequency switching in a switching power supply.

Peak Inrush

A switching power supply allows an initial inrush or surge of current as its capacitors accumulate their charge. This can affect other components in the circuit, and requires fusing that tolerates brief but large deviations from normal power consumption.

DC-DC converter

17

Often referred to as a *switching regulator*, and sometimes as a *switcher*, not to be confused with a *switching power supply*.

OTHER RELATED COMPONENTS

- **AC-DC power supply** (See Chapter 16)
- **voltage regulator** (See Chapter 19)
- **DC-AC inverter** (See Chapter 18)

What It Does

A DC-DC converter, often referred to simply as a *converter*, receives a DC voltage as its input and converts it to a regulated DC voltage as its output. The output voltage may be higher or lower than the input voltage, may be user-adjustable by adding an external resistor, and may be completely electrically isolated from the input, depending on the type of converter that is used. The overall efficiency is not greatly affected by the difference between input and output voltage, and can exceed 90%, minimizing waste heat and enabling the unit to be extremely compact.

A DC-DC converter is an integrated circuit package that includes a high-speed switching device (almost always, a *MOSFET*) in conjunction with an oscillator circuit, an inductor, and a diode. By comparison, a **linear regulator** is usually based around bipolar transistors. Its input must always be at a higher voltage than its output, and its efficiency will be inversely proportional with the voltage drop that it imposes. See the **voltage regulator** entry in this encyclopedia for additional information.

There is no single symbol to represent a DC-DC converter. Some simplified schematics showing the principles of operation of commonly used converters are referenced under the following Variants section.

A DC-DC converter is also typically found in the output stage of a switching **AC-DC power supply**.

How It Works

An internal oscillator controls a *MOSFET* semiconductor that switches the DC input on and off at a high frequency, usually from 50KHz to 1MHz. Output voltage is adjusted by varying the *duty cycle* of the oscillator—the length of each "on" pulse relative to each "off" interval. This is known as *pulse-width modulation*, or *PWM*. The duty cycle is controlled by sampling the output of the converter and using a comparator to subtract the output voltage from a reference voltage, to establish an error value. This is passed to another comparator, which subtracts the error voltage from an oscillator ramp signal. If the error increases, the oscillator signal is more heavily clipped, thus changing the effective ratio of on/off pulse

lengths. A simplified schematic of the PWM circuit is shown in Figure 17-1, which omits other components for clarity. The system of subtracting an error voltage from a ramp oscillator voltage to obtain a pulse-width modulated signal is illustrated in Figure 17-2.

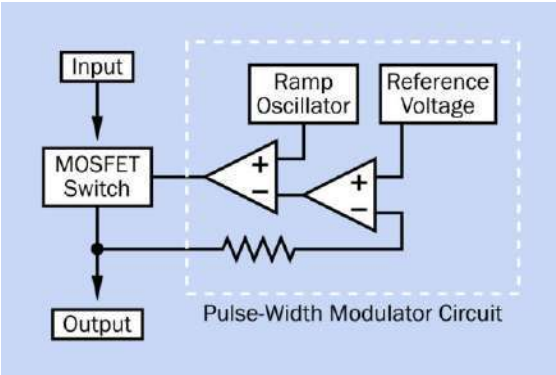

Figure 17-1. *The heart of a DC-DC converter is a MOSFET switch, which operates at a high frequency with pulse-width modulation used to create an adjustable DC output.*

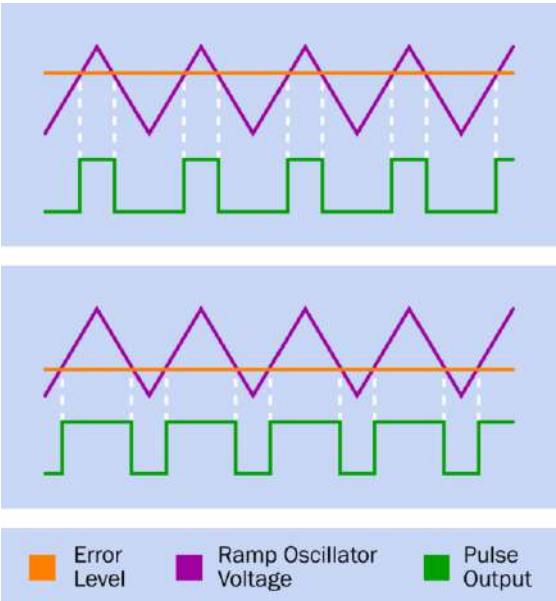

Figure 17-2. *To achieve pulse-width modulation, an error-level voltage is established by comparing the output from the converter with a reference voltage. The error level, shown as an orange line, is then subtracted from the output from a ramp oscillator. The pulse width varies accordingly.*

The key to the efficiency of a DC-DC converter is an inductor, which stores energy in its magnetic field during "on" pulse and releases it in the discharge phase. Thus, the inductor is used as a temporary reservoir and minimizes the ripple current. All converter variants use a coil for this purpose, although its placement varies in relation to the diode and capacitor that complete the basic circuit.

Variants

Four basic switching circuits are used in DC-DC converters and are defined in the coming sections, with a formula to determine the ratio between input voltage (V_{in}) and output voltage (V_{out}) in each case. In these formulae, variable D is the duty cycle in the pulse train generated through an internal MOSFET switch. The duty cycle is the fraction of the total on-off cycle that is occupied by each "on" pulse. In other words, if T_{on} is the duration of an "on" pulse and T_{off} is the "off" time:

$$D = T_{on} / (T_{on} + T_{off})$$

Buck Converter

See Figure 17-3. The output voltage is lower than the input voltage. The input and output share a common ground. For this circuit:

$$V_{out} = V_{in} * D$$

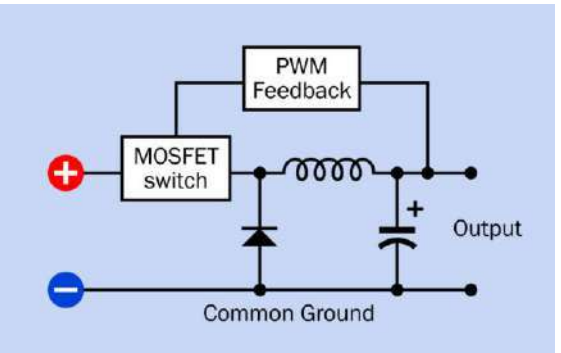

Figure 17-3. *Basic topology of a buck-type DC-DC converter.*

Boost Converter

See Figure 17-4. The output voltage is greater than the input voltage. The input and output share a common ground. For this circuit:

$$V_{out} = V_{in} / (1-D)$$

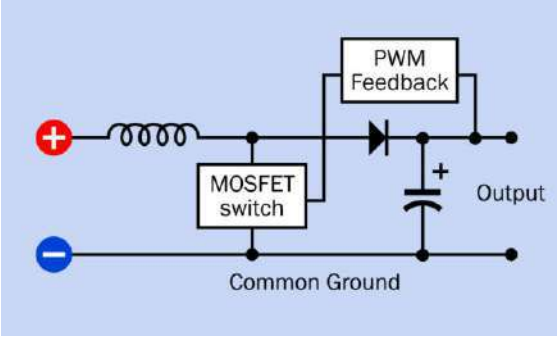

Figure 17-4. *Basic topology of a boost-type DC-DC converter.*

Flyback Converter with Inductor

Commonly known as a *buck-boost converter*. See Figure 17-5. The output voltage can be less than or greater than the input voltage. The input and output share a common ground. For this circuit:

$$V_{out} = V_{in} * (D / (1-D))$$

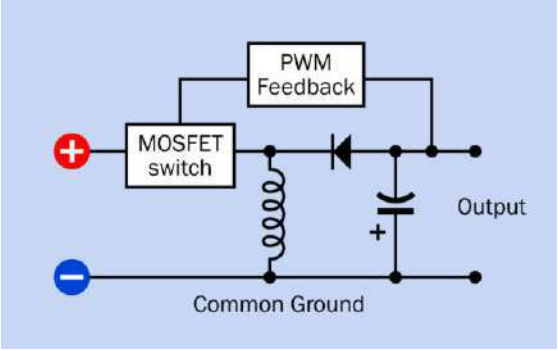

Figure 17-5. *Basic topology of a flyback-type DC-DC converter.*

Flyback Converter with Transformer

See Figure 17-6. The output voltage can be less than or greater than the input voltage. The input and output are isolated from one another. For this circuit:

$$V_{out} = V_{in} * (D / (1-D))$$

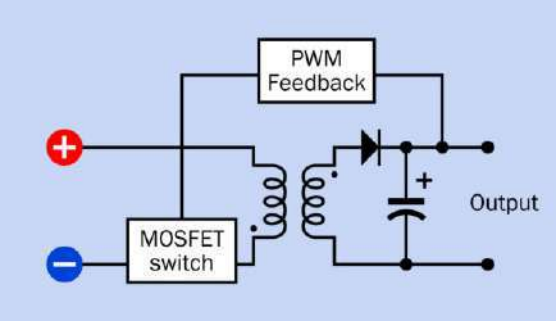

Figure 17-6. *Basic topology of a flyback-type DC-DC converter. (Buck, boost, and flyback topologies adapted from Maxim Integrated Products.)*

Using a transformer in the converter allows multiple outputs with different voltages, supplied through multiple transformer windings.

Formats

A converter may be packaged in a flat rectangular box that requires no additional heat sink and has pins for through-hole insertion into a PC board. Sizes usually range up to to 2″ × 2″. Power handling can range from 5 to 30 watts. Converters of this type are shown in Figure 17-7. (Top: Input range of 9 to 18VDC, fixed output of 5VDC at 3A completely isolated from the input. Typical efficiency of approximately 80%. The case is made of copper, providing good heat dissipation with electrical shielding. Center: Input range of 9 to 18VDC, fixed output of 5VDC at 500mA completely isolated from the input. Typical efficiency of approximately 75%. The manufacturer claims that external capacitors are only needed in critical applications. Bottom: SIP format, fixed input

of 12VDC, fixed output of 5VDC at 600mA completely isolated from the input. Typical efficiency of approximately 75%. Requires external capacitors for ripple rejection.)

Figure 17-7. *A selection of sealed DC-DC converters.*

Lower-power converters are also available as surface-mount devices.

Some adjustable-output converters are supplied as multiple surface-mounted components pre-installed on a mini-board that has pins for through-hole insertion in a printed circuit board. Their high efficiency enables them to handle a lot of power for their size. In Figure 17-8, the converter accepts a 4.5 to 14VDC input range and has an adjustable output of 0.6 to 6VDC. It is rated at a surprising 10A or 50W and is more than 90% efficient. However, it draws 80mA in a no-load state, causing it to become quite hot. A thermal cutout or automatic shutdown may be used if the converter will not be driving a consistent load.

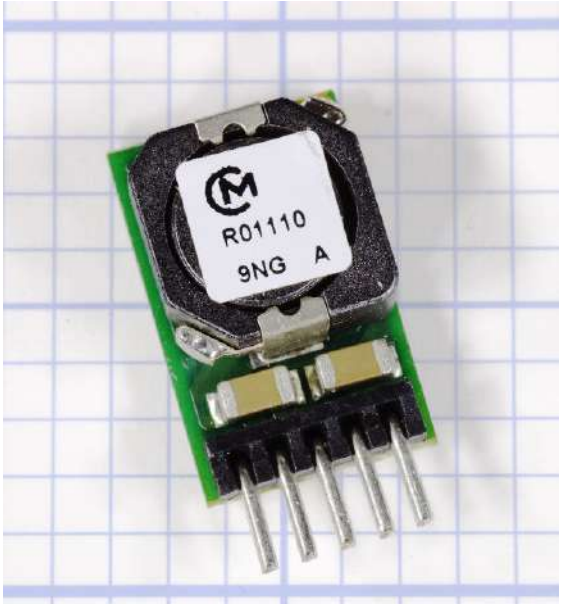

Figure 17-8. *An adjustable DC-DC converter rated for 10A or 50W. The output voltage is determined by adding an external resistor or trimmer potentiometer. External smoothing capacitors are required, as shown in the component's datasheet.*

The miniboard in Figure 17-9 accepts an input voltage from 7 to 36VDC and has an adjustable output ranging from 2.5 to 12.6VDC, at up to 6A. It is non-isolated (has a common negative bus) and claims to be more than 95% efficient at full load.

The miniboard in Figure 17-10 accepts an input voltage from 4.5 to 14VDC and has an adjustable output ranging from 0.6 to 6VDC at up to 20A. It is non-isolated (has a common negative bus) and claims to be more than 90% efficient at full load.

Values

Relevant values include:

Nominal Input Voltage and Frequency

A wide range of input voltages is often acceptable, as the PWM can vary accordingly. Converters

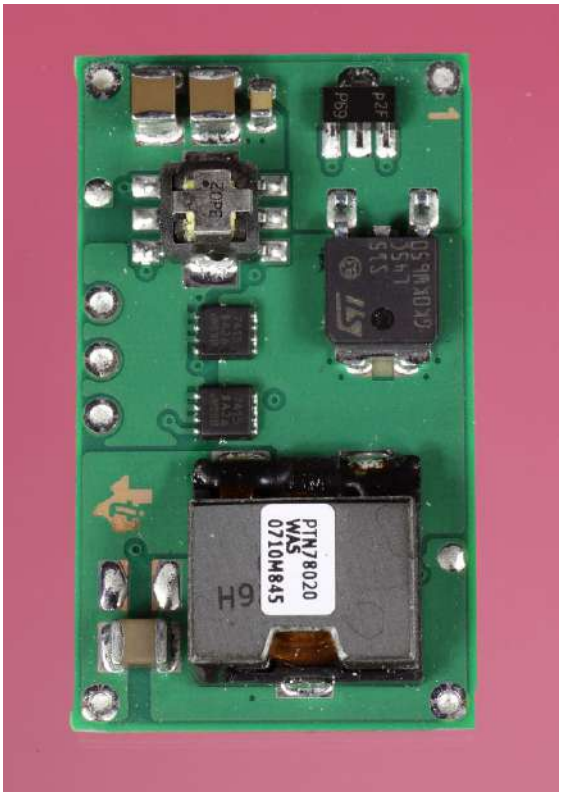

Figure 17-9. *Another adjustable DC-DC converter. The output voltage is determined by adding an external resistor or trimmer potentiometer. External smoothing capacitors are required, as shown in the component's datasheet.*

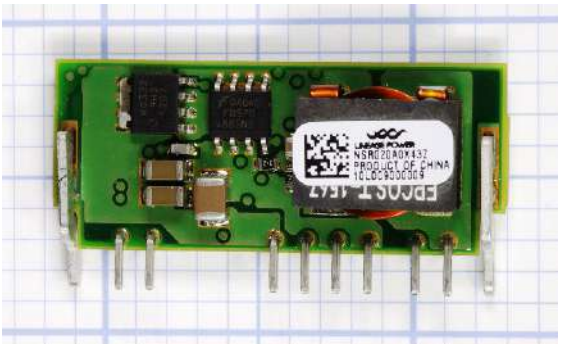

Figure 17-10. *Another adjustable DC-DC converter. The output voltage is determined by adding an external resistor or trimmer potentiometer. External smoothing capacitors are required, as shown in the component's datasheet.*

often allow equipment to be usable internationally, on any voltage ranging from 100VAC to 250VAC, at a fequency of 50Hz or 60Hz, without any adaptation.

Output Voltage

As previously noted, many converters allow the output voltage to be adjusted by adding an external resistor or potentiometer. Alternatively, there may be multiple fixed output voltages, accessible via different pins on the package. They may also provide a positive voltage and equally opposite negative voltage relative to a ground pin.

Input Current and Output Current

Because input voltage and output voltage are likely to be different, the current alone is not a reliable guide to power handling.

A datasheet should specify input current with no load (open circuit on the output side). This current will have to be entirely dissipated as heat.

Load Regulation

This is usually expressed as a percentage and suggests the extent to which output voltage may be pulled down when the load on a DC-DC converter increases. If V_{nil} is the measured output voltage with no load, and V_{max} is the measured output voltage with the maximum rated load:

$$\text{Load regulation} = 100 * (V_{nil} - V_{max})/V_{max}$$

However, note that some converters are designed with the expectation that they will never be used with zero load across the output. In these cases, V_{nil} will be the voltage at minimum rated load.

Efficiency

This is a measure of how much input current must be dissipated as heat. A converter with a 12-volt input, drawing a maximum 300mA input current, will consume 3.6 watts (3,600mW). If it is 80% efficient, it will have to dissipate roughly 20% of its power as heat, or 720mW.

Ripple and Noise

Sometimes abbreviated R/N, this may be measured in mV or as a percentage. Check the specification carefully to determine whether the ripple-and-noise values require use of external smoothing capacitors. Often, this is the case.

Isolated or Non-Isolated

This crucial piece of information is often found near the top of a datasheet, not in the detailed specifications.

How to Use it

Because a converter creates electrical noise, it should be prevented from affecting other components by adding substantial *bypass capacitors* as close as possible to its input and output pins. For most converters, external capacitors are mandatory, and their *effective series resistance* (ESR) should be as low as possible (see the **capacitor** entry in this encyclopedia for an explanation of ESR). Tantalum capacitors are preferable to electrolytics for this reason, and are also more durable. Some manufacturers recommend placing a tantalum capacitor in parallel with an electrolytic. A small ceramic capacitor, typically 0.1µF, is often recommended in an addition to larger-value capacitors on the output side.

The voltage rating of each capacitor should be twice the voltage at the point in the circuit where it is used. The capacitance value will usually be higher for higher-current converters. Values of 100µF are common, but for high amperage, a value may be as high as 1,000µF.

While datasheets are often inadequate for some types of components, datasheets for DC-DC converters usually include detailed instructions regarding bypass capacitors. Following these instructions is essential. In the relatively rare instances that a datasheet makes no mention of bypass capacitors for a converter, this does not necessarily mean that the capacitors are unnecessary. The manufacturer may assume that they will be used as a matter of course.

Converters are used in a very wide range of devices, supplying power ranging from a few milliamps to tens of amps. At the lower end of the scale, devices such as cellular telephones, portable computers, and tablets contain subcircuits that require different voltages, some of which may be higher than the voltage of a single battery or battery pack that powers the device. A converter can satisfy this requirement. Because a converter can be designed to maintain a fixed output in response to a range of input voltages, it can also compensate for the gradual decline in voltage that occurs during battery usage.

A boost-type converter can be used to double the voltage from a single 1.5V battery in an LED flashlight where 3 volts are required to power the LED. Similarly, a boost-type converter can provide the necessary voltage to run a cold-cathode fluorescent tube that provides backlighting in an LCD computer display.

On a circuit board that is primarily populated with 5VDC components and is fed by a single 5VDC power supply, a converter can be used to supply 12VDC for one special purpose, such as an analog-digital converter or a serial data connection.

If electromechanical **relays** or other inductive loads share a common ground with components ,such as *logic chips* or **microcontrollers**, it may be difficult to protect the sensitive components from voltage spikes. A A flyback converter with a transformer separating the output from the input can allow the "noisy" section of the circuit to be segregated, so long as the converter itself does not introduce noise. Since the electromagnetic interference (EMI) introduced by converters varies widely from one model to another, specifications should be checked carefully.

Very low-power components can pick up EMI from the wires or traces leading into and out of a converter. In this type of circuit, adequate noise suppression may be impossible, and a converter may not be appropriate.

What Can Go Wrong

Electrical Noise in Output

Electrolytic capacitors may be inadequate to smooth the high frequencies used. Multilayer ceramic capacitors or tantalum capacitors may be necessary. Check the manufacturer's datasheet for minimum and maximum values. Also check the datasheet for advice regarding placement of capacitors on the input side as well as across the output.

Excess Heat with No Load

Some converters generate substantial heat while they are powered without a load. The manufacturer's datasheet may not discuss this potential problem very prominently or in any detail. Check the input rating, usually expressed in mA, specified for a no-load condition. All of this current will have to be dissipated as heat, and the very small size of many converters can result in high localized temperatures, especially since many of them allow no provision for a heat sink.

Inaccurate Voltage Output with Low Load

Some converters are designed to operate with at least 10% of full rated load across their output at all times. Below this threshold, output voltage can be grossly inaccurate. Read datasheets carefully for statements such as this: "Lower than 10% loading will result in an increase in output voltage, which may rise to typically double the specified output voltage if the output load falls to less than 5%." Always use a meter to verify the output voltage from a converter at a variety of different loads, and perform this test before installing the converter in a circuit.

DC-AC inverter

18

A power inverter must not be confused with a *logic inverter*, which functions as a digital component in *logic circuits* to invert the state of a low-voltage DC input from high to low or low to high. Logic inverters are discussed in Volume 2.

OTHER RELATED COMPONENTS

- **AC-DC power supply** (See Chapter 16)
- **DC-DC converter** (See Chapter 17)

What It Does

A power inverter is included here as counterpoint to a **power supply** or *AC adapter*, since it has the opposite function. The inverter receives an input of *direct current* (typically 12VDC from a car battery) and delivers an output of *alternating current* (AC) in the range 110VAC-120VAC or 220VAC-240VAC, suitable to power many low-wattage appliances and devices. The interior of a low-cost inverter is shown in Figure 18-1.

Figure 18-1. *The interior components in a 175-watt inverter.*

How It Works

The first stage of an inverter typically raises a 12VDC input to a higher DC voltage via an internal **DC-DC converter**, then uses a switching circuit to create an approximation of the sinusoidal profile that is characteristic of AC voltage.

Digital switching components naturally tend to create square waves, whose simple appearance conceals the presence of higher frequencies, or *harmonics*, that are ignored by some devices (especially those that convert electricity into heat) but can be troublesome in consumer electronics equipment. A primary objective of inverter design is to adapt or combine square waves to emulate a classic AC sine wave with reasonable fidelity. Generally speaking, the more accurately an inverter emulates a sine wave, the more expensive it tends to be.

The most primitive inverter would create a plain square wave such as that shown in red in Figure 18-2, superimposed on a comparable sine wave (in green). Note that alternating current rated at 115 volts actually peaks at around 163 volts because the number 115 is the approximate *root mean square* (*RMS*) of all the voltage values during a single positive cycle. In other words, if the voltage is sampled x times during a cycle, an

RMS value can be derived by squaring each sample, adding all the samples, dividing by x, and then taking the square root of the result. The RMS value is important as a means to calculate actual power delivered because it can be multiplied by the current to obtain an approximate value in watts.

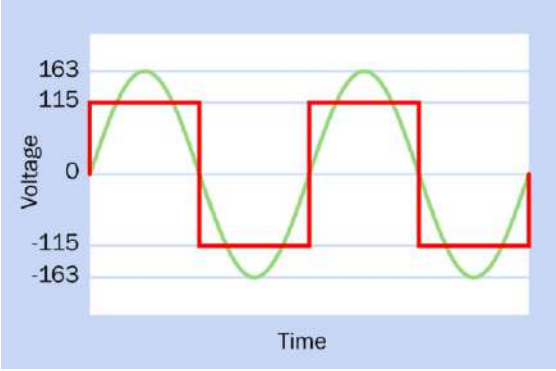

Figure 18-2. *Comparison of an AC voltage sine wave (green) and a square wave of the same frequency (red), both delivering a roughly similar amount of power.*

Variants

As a first step toward a better approximation of a sine wave, gaps of zero voltage can be inserted between square-wave pulses. This "gapped" square wave is shown in Figure 18-3.

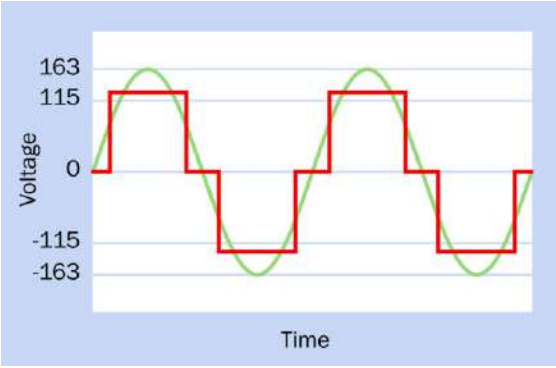

Figure 18-3. *Introducing pauses or gaps of zero voltage between square-wave pulses can produce slightly improved resemblance to a sine wave.*

A further improvement can be achieved if an additional, shorter pulse of higher voltage is added to each primary pulse, as shown in Figure 18-4. Outputs of this kind are referred to as *modified sine wave*, although they are actually square waves modified to emulate a sine wave. Their inaccuracy is expressed as *total harmonic distortion* (*THD*). Some authorities estimate that the THD of gapped square-wave output is around 25%, whereas the addition of shorter square waves reduces this to around 6.5%. This is a topic on which few people agree, but there is no doubt that a "stacked" sequence of square waves provides a closer emulation of a sine wave.

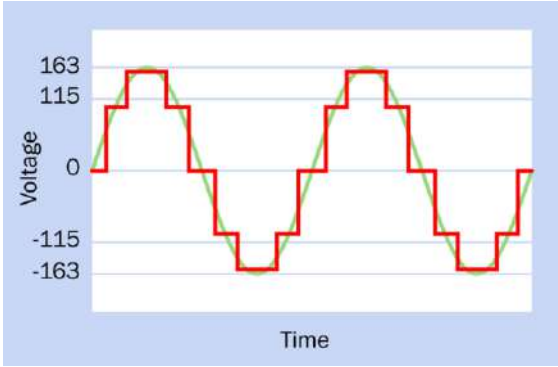

Figure 18-4. *A secondary stream of narrower square-wave pulses can improve the fidelity of an inverter's output.*

A *true sinewave inverter* typically uses *pulse-width modulation* (*PWM*) to achieve THD of less than 1%. It generates a stream of pulses much higher in frequency than that of the AC output, and varies their widths in such a way that their averaged voltage closely approximates the voltage variations in a sine wave. A simplified representation of this principle is shown in Figure 18-5.

Values

Small inverters are typically rated to deliver up to 100 watts and may be fitted with a 12VDC plug for insertion in a vehicle's cigarette lighter. Since a cheap inverter may be only 80% efficient, 100 watts at 135VAC will entail drawing as much as

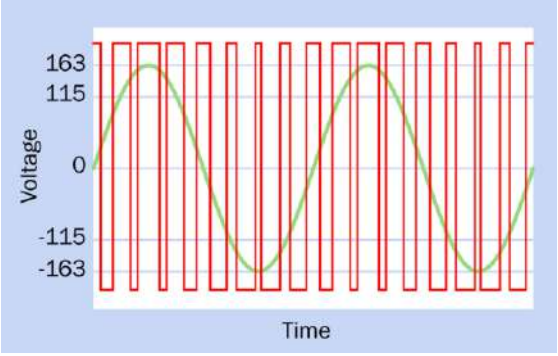

Figure 18-5. *Pulse-width modulation adjusts the widths of pulses delivered at a high frequency. The pulse widths can be averaged to generate voltage that follows a close approximation of a sine wave.*

10 amps at 12VDC. Cigarette lighters are usually fused at 15 or 20 amps, so 100 watts is a reasonable value. Inverters that are rated above 150 watts usually have cables terminating in oversize alligator clips for direct connection to the terminals of a 12V battery.

While the *cold cranking* rating of a car battery may be 100 amps or more, the battery is only designed to deliver that power for up to 30 seconds at a time. Inverters rated for as much as 500 watts will exceed the normal capacity of a single car battery, although if the battery is mounted in a vehicle, it can be supplemented by running the engine so that the alternator shares some of the load. A 500-watt inverter is better supplied by two or more 12-volt car batteries wired in parallel.

How to Use it

Small inverters are typically used in vehicles to run cellphone chargers, music players, or laptop computers. Large inverters are an integral part of off-the-grid solar and wind-powered systems, where battery power must be converted to AC house current. Uninterruptible power supplies contain batteries and inverters capable of running computer equipment for a brief period. Battery-driven electric vehicles with AC motors use inverters with an exceptionally high current rating.

There is a lack of consensus regarding possible harmful effects of powering electronics equipment with a low-cost modified sine wave inverter. Anecdotal evidence suggests that where the equipment uses its own *switching power supply* or uses an *AC adapter* (either mounted internally or as an external plug-in package), the filtering built into the power supply will block harmonics from the inverter.

Other evidence suggests that cheap inverters may have adverse effects on devices containing synchronous motors that run direct from AC. There are reports that fluorescent lighting and photographic electronic flash systems may be unsuitable for use even with modified sine wave inverters. However, differences in product design and component quality make it impossible to generalize. A cheaply made inverter may generate a wave form that is not even a close approximation of a square wave. See Figure 18-6.

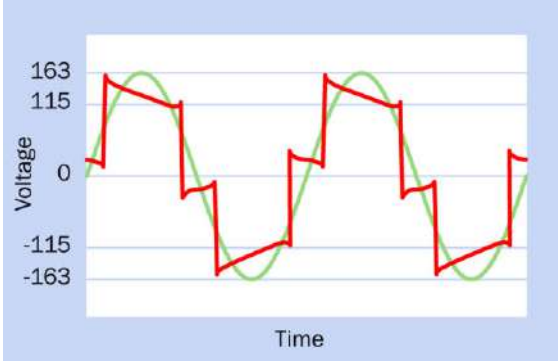

Figure 18-6. *A cheaply made inverter can generate a distorted wave form that is even higher in noise than a pure square wave. This sample is adapted from an actual oscilloscope trace.*

What Can Go Wrong

If multiple batteries are connected in parallel, using suitably heavy-gauge wire to power a large inverter, the batteries must be identical in specification and age, and must all be equally charged to prevent high and potentially dangerous flows of current among the batteries as they attempt to reach an equilibrium among themselves. Interconnections must be firmly clamped to clean battery terminals. For additional information, see the **battery** entry in this encyclopedia.

Problems associated with inverters are likely to be mundane. A 12V wiring to the inverter can overheat if items such as clothes or bedding are left on top of it; a high-wattage fan-cooled inverter can overheat if the fan is obstructed by poor placement or impaired by accumulated dirt; alligator clips may become dislodged from battery terminals; and power surges drawn by inductive loads such as motors may trigger the inverter's *breaker*, especially if they are used in conjunction with other equipment.

As always, high amperage should be treated with caution and respect, regardless of it being delivered at "only 12 volts."

voltage regulator

19

Correctly known as a *linear voltage regulator* to distinguish it from a *switching regulator* or **DC-DC converter**. However, the full term is not generally used, and "voltage regulator" is normally understood to mean a linear voltage regulator.

OTHER RELATED COMPONENTS

- **DC-DC converter** (See Chapter 17)
- **AC-DC power supply** (See Chapter 16)

What It Does

A linear voltage regulator provides a tightly controlled DC output, which it derives from an unregulated or poorly regulated DC input. The DC output remains constant regardless of the load on the regulator (within specified limits). It is a cheap, simple, and extremely robust component.

There is no single schematic symbol for a linear voltage regulator.

The general physical appearance of a commonly used type of regulator, rated for an output of around 1A DC, is shown at Figure 19-1. The LM7805, LM7806, LM7812, and similar regulators in the LM78xx series are encapsulated in this type of package, with pins that are spaced at 0.1" and have functions as shown. Other types of regulator may differ in appearance, or may look identical to this one but have different pin functions. Always check datasheets to be sure.

How It Works

All linear regulators function by taking some feedback from the output, deriving an error value by comparing the output with a reference voltage (most simply provided by a zener diode), and using the error value to control the base of a *pass transistor* that is placed between the input and the output of the regulator. Because the transistor operates below saturation level, its output current varies linearly with the current applied to its base, and this behavior gives the linear regulator is name. Figure 19-2 shows the relationship of these functions in simplified form; Figure 19-3 shows a little more detail, with a *Darlington pair* being used as the pass transistor. The base of the pair is controlled by two other transistors and a comparator that delivers the error voltage. This version of a voltage regulator is known as the *standard type*.

The voltage difference required between the base and emitter of an NPN transistor is a minimum of 0.6V. Because multiple transistors are used inside a standard-type voltage regulator, it requires a minimum total voltage difference, between its input and its output, of 2VDC. This voltage difference is known as the *dropout voltage*. If the voltage difference falls below this minimum, the regulator ceases to deliver a reliable output voltage until the input voltage rises again. *Low dropout regulators* allow a lower voltage difference, but are more expensive and less commonly used. They are described under the following Variants section.

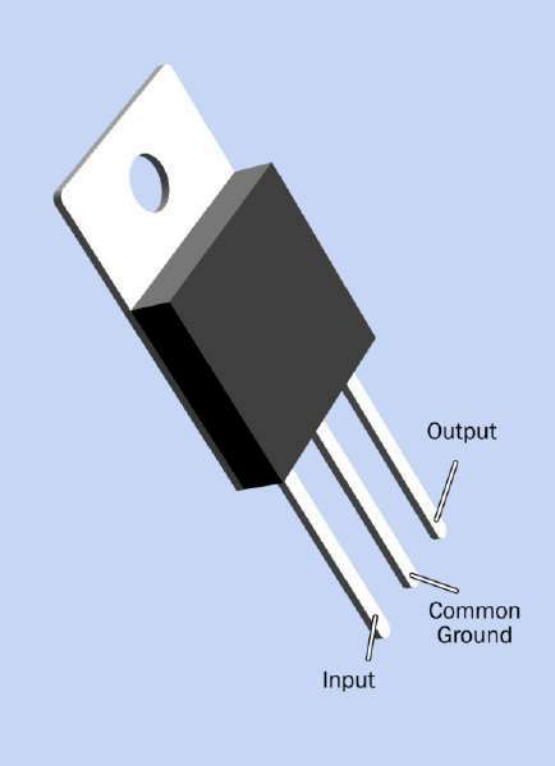

Figure 19-1. *The package design of a commonly used voltage regulator. Others may be significantly different, and the pin functions may vary. Check manufacturer datasheets for details.*

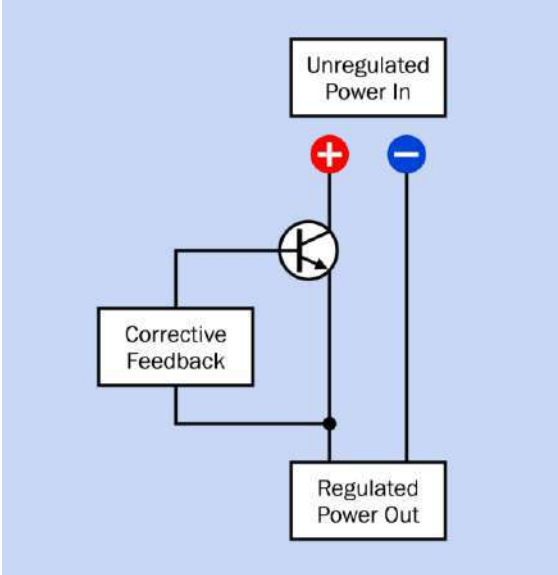

Figure 19-2. *A linear voltage regulator basically consists of a transistor whose base is controlled by corrective feedback derived from the output.*

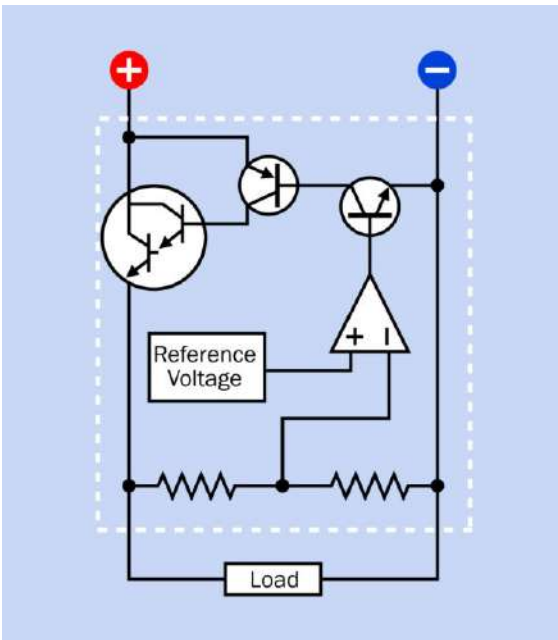

Figure 19-3. *The fundamental internal features of a standard-type voltage regulator, including a Darlington pair, two transistors, a voltage divider, comparator, and reference voltage source, shown inside the dashed white line.*

Discrete components could in theory be used to build a voltage regulator, but this ceased to be cost-effective several decades ago. The term is now understood to mean one small integrated package containing the basic circuit augmented with additional, desirable features, such as automatic protection against overload and excessive heat. Instead of burning out if it is overloaded, the component simply shuts down. Most voltage regulators also tolerate accidentally reversed power connection (as when batteries are inserted the wrong way around) and accidentally reversed insertion of the regulator in a circuit board.

Other components can satisfy the requirement to deliver power at a reduced voltage. Most simply, if two resistors in series are placed across a

power source, they form a *voltage divider*, which provides an intermediate voltage at the connection between them. However, this voltage will vary depending on fluctuations in the input voltage and/or load impedance. A voltage regulator is the simplest way to supply a voltage that remains stable regardless of excursions in the input or fluctuations in power consumed by the load.

The disadvantage of a standard-type voltage regulator is that it is inefficient, especially when a relatively high input voltage is used to deliver a relatively low output voltage. If V_{in} is the input voltage, V_{out} is the output voltage, and I_{out} is the output current, the average power loss, P, is given by the formula:

$$P = I_{out} * (V_{in} - V_{out})$$

For example, if the output current is 1A, the input voltage is 9VDC, and the output is 5VDC, 44% of the input power will be wasted, and the component will be only 56% efficient. The wasted power (about 4 watts, in this case) will be dissipated as heat. Even when a standard-type regulator runs at its minimum 2VDC dropout voltage, it must dissipate 1W when delivering 0.5A.

Variants

Packaging

The package for the LM78xx series of regulators, shown in Figure 19-1, incorporates an aluminum plate drilled with a hole so that it can be bolted to a heat sink. Voltage regulators with a lower rated maximum output current (typically, 100mA) do not have the same need for a heat sink, and are available in a package that resembles a small transistor.

Some integrated circuits are available containing two voltage regulators, electrically isolated from each other.

Popular Varieties

In the LM78xx series, the last two digits in the part number specify the output voltage, which is fixed. Thus the LM7805 delivers 5VDC, the LM7806 delivers 6VDC, and so on. For regulators with a fractional voltage output (3.3VDC being common), an additional letter may be inserted in the part number, as in the 78M33.

Many copies of the LM78xx series are made by different manufacturers, the copies being functionally identical, regardless of additional letters that are added to the part number to identify its source or other attributes.

The LM78xx regulators are mostly rated to be accurate within 4%, although actual samples almost always deliver voltages that are more precise than this range suggests.

Adjustable Regulators

While the majority of regulators have a fixed output, some allow the user to set the output by adding one or more resistors. The LM317 is a popular example. Its output voltage can range from 1.25VDC to 37VDC and is set via a resistor and a trimmer potentiometer, as illustrated in Figure 19-4. If R1 is the fixed-value resistor and R2 is the trimmer, as shown in the schematic, the output voltage, V_{out}, is given by the formula

$$V_{out} = 1.25 * (1 + (R2 / R1))$$

Typical values for R1 and R2 would be 240Ω and 5K, respectively. With the trimmer at the middle of its range, V_{out} would be 1.25 * (1 + (2500 / 240)) = approximately 15VDC, requiring an input of at least 17VDC. However, if the trimmer is reduced to 720Ω, the output would be 5VDC. In practice, the value of a trimmer should be chosen so that a mid-range setting provides approximately the desired output. This will enable fine adjustment of the output voltage.

While the versatility of an adjustable regulator is desirable, its overall power dissipation is still proportional to the difference between the input voltage and the output voltage. To minimize heat loss, this difference should not exceed the dropout voltage by a larger amount than is absolutely necessary.

An adjustable regulator may require larger bypass capacitors than a regulator with a fixed output. A manufacturer's recommendations for the LM317 are shown in Figure 19-4.

Negative and Positive Regulators

While most linear voltage regulators are designed for "positive input" (conventional current flow from input to output), some are intended for "negative input." In this variant, the common terminal is positive, and the input and output are negative in relation to it.

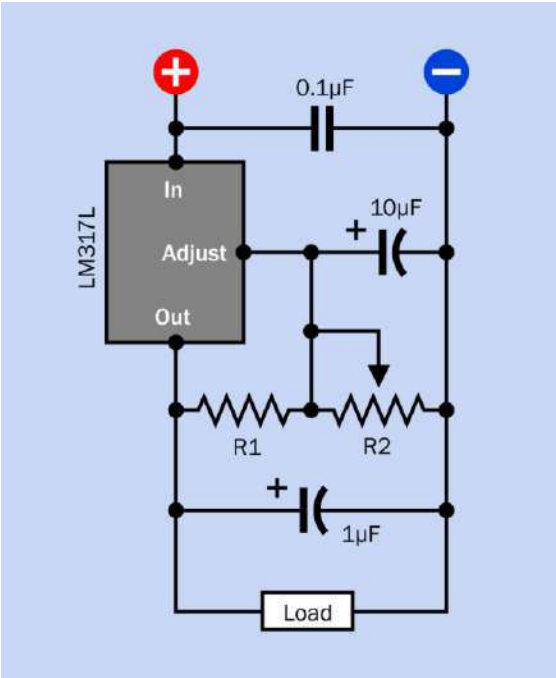

Figure 19-4. *Schematic for the LM317L adjustable voltage regulator, based on a circuit recommended by National Semiconductor, with bypass capacitors added for ripple rejection.*

Low-Dropout Linear Regulators

Low-dropout regulators (sometimes referred to as *LDO* regulators) allow a much lower dropout voltage by using a single PNP or MOSFET transistor. LDO regulators are popularly used in battery-powered devices where efficiency should be maximized and heat dissipation should be minimized. For example, the LM330 is a regulator with a 5VDC output, tolerating a dropout voltage of 0.6V, allowing it to be used with four AAA cells. In an LDO regulator the dropout voltage actually varies with load current and may diminish to as little as one-tenth of its rated value when the output current is minimal.

The majority of low-dropout regulators are sold in surface-mount packages, and are designed for maximum output of 100mA to 500mA. Only a few exceptions exist. They tend to be slightly more expensive than regulators with the typical 2V dropout rating.

Three voltage regulators are shown in Figure 19-5. From left to right, they are rated 5VDC at 1A, 12VDC at 1A, and 5VDC at 7.5A. The two smaller regulators are of the LM78xx series. The larger regulator claims a low maximum dropout voltage of 1.5VDC, and its output voltage can be adjusted with an external potentiometer and resistor.

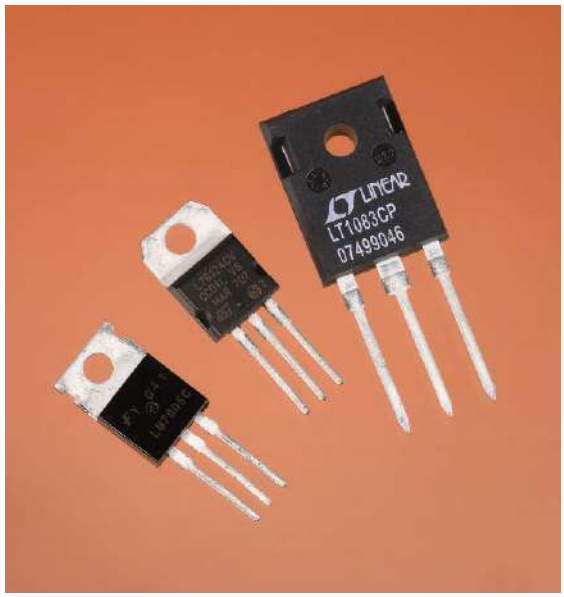

Figure 19-5. *Two voltage regulators from the LM78xx series, and a third high-current, low-dropout, adjustable regulator rated 5VDC (adjustable upward) at 7.5A.*

Quasi-Low-Dropout Linear Regulators

Where a standard regulator uses a Darlington pair as the pass transistor and an LDO uses a single PNP transistor, the so-called Quasi-LDO uses a combination of NPN and PNP transistors and has an intermediate dropout voltage, typically a maximum of 1.5VDC. However, the terms LDO and Quasi-LDO are not used uniformly in the industry. One manufacturer markets Quasi-LDO regulators as LDO regulators, and describes its LDO regulators as *Very Low Dropout* regulators. Consult datasheets to determine the actual specification of the product, regardless of its classification.

Additional Pin Functions

Some voltage regulators include an extra pin, typically known as an *enable pin*, which switches off the device in response to a signal from a microcontroller or logic gate.

Some regulators offer another option, an additional *status pin* that can signal a microcontroller that an error mode exists if the regulator output falls significantly below its rated value.

In battery-powered devices, a low-battery sensor is a desirable feature, since a regulator may simply shut down without warning if the input voltage is insufficient. A few regulators, such as the LP2953, provide a low-battery warning output via an extra pin.

Values

Linear voltage regulators with a single, fixed output are commonly available to supply DC outputs of 3.3, 5, 6, 8, 9, 10, 12, 15, 18, and 24 volts, with a few variants offering fractional values in between. The most commonly used values are 5, 6, 9, 12, and 15 volts. The input voltage may be as high as 35VDC.

Maximum output current is typically 1A or 1.5A, in the traditional three-pin, through-hole, TO-220 format. A surface-mount version is available. Other surface-mount formats have lower power limits.

Accuracy may be expressed as a percentage or as a figure for load regulation in mV. A typical load regulation value would be 50mV, while voltage regulation accuracy ranges from 1% to 4%, depending on the manufacturer and the component. While low-dropout regulators are generally more efficient, they do require more ground-pin current. This is not usually a significant factor.

How to Use it

Some components, such as many old-design CMOS chips or the traditional TTL version of the 555 timer, allow a wide range of acceptable input voltages, but most modern logic chips and microcontrollers must have a properly controlled power supply. Regulators such as the LM7805 are traditionally used to provide this, especially in small and relatively simple devices that draw a moderate amount of current, have a low component count, and are powered via a battery or an **AC adapter**. A fully fledged switching power supply is overkill in this kind of application.

A linear voltage regulator cannot respond instantly to changes in input voltage. Therefore, if the input supply contains voltage spikes, these spikes may pass through the regulator. Bypass capacitors should be applied preventively. A sample schematic showing an LM7805 regulator with bypass capacitors recommended by a manufacturer is shown in Figure 19-6.

In a battery-powered device where standby power is required for long periods and full power is only needed intermittently, the *quiescent current* drawn by a minimally loaded voltage regulator is important. Modern LDO regulators may draw as little as 100µA when they are very lightly loaded. Other types may consume significantly more. Check datasheets to find the most appropriate component for a particular application.

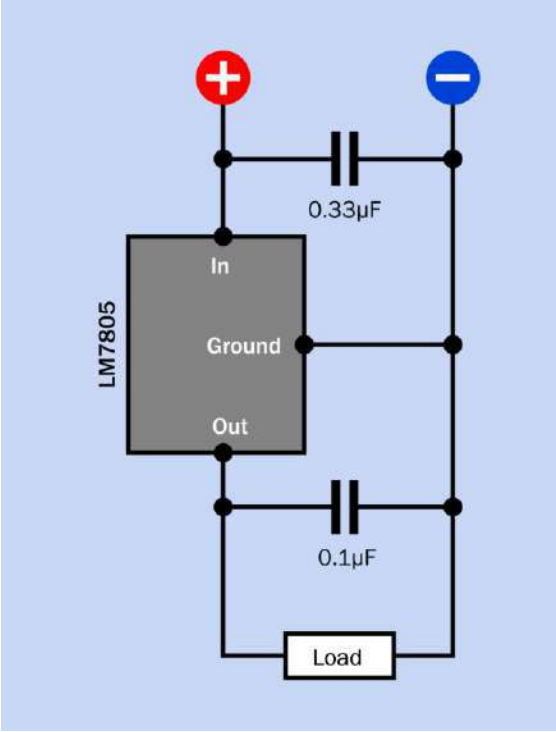

Figure 19-6. *Typical schematic for use of an LM7805 regulator, with capacitor values based on recommendations from Fairchild Semiconductor.*

Note that DC-DC power **converters** may draw a lot of current when they are lightly loaded, and will dissipate large amounts of heat as a result. An LDO is therefore preferable in this situation.

What Can Go Wrong

Inadequate Heat Management

The ability to "dial up" a wide range of voltages from an adjustable regulator such as the LM317 can be a temptation to use it on a "one size fits all" basis, to deliver any output ranging from 5VDC to 18VDC from a uniform 24VDC input. Assuming 1A output current, the worst-case power dissipation in this scenario would be almost 20W. To achieve reasonable efficiency and maintain waste heat at a manageable level, the input voltage should not exceed the output voltage by much more than the dropout voltage.

Even when a voltage regulator is used correctly, it can generate more heat than was expected if the requirements of a circuit are altered during development. An initial handful of components may draw only 100mA, but as more capabilities are requested and more parts are added (especially relays or LED displays) the power consumption can quickly add up, generating an unexpected amount of waste heat and raising the possibility of a sudden (and mysterious) shutdown if the regulator does not have an adequate heat sink.

Transient Response

When there is a major fluctuation in the demand by the load (for example, if an inductive device is switched on elsewhere in the circuit), the voltage regulator requires a finite time to adjust itself and maintain its specified output voltage. This time lag is known as its *transient response*. If a momentary fluctuation is likely, and other components may be sensitive to it, a larger capacitor should be used between the output of the voltage regulator and ground.

The transient response time may also be insufficient to block sudden, brief spikes in input voltage. This may occur, for example, when a low-cost AC adapter that does not have a properly smoothed output is used as the power source. Additional 1µF bypass capacitors may be added at the input and output of a regulator to provide better protection from power fluctuations.

Misidentified Parts

Many types of linear voltage regulators appear physically identical. Care is needed to distinguish those which have fixed output from those that allow a variable output. When using the LM78xx series, double-check the last pair of digits in the part number, which provide the only guide regarding the output. Using an LM7808 instead of an LM7805 may be sufficient to destroy all the 5VDC chips in a logic circuit. It is advisable to use a meter to check the output of any power supply before connecting it with a circuit.

Misidentified Pins

The LM78xx series of voltage regulators uses a very intuitively obvious and consistent scheme for the functions of its pins: input on the left, ground in the center, and output on the right, when looking at the regulator from the front, with its pins facing downward. Unfortunately the consistency of this scheme can encourage an unthinking habit for making connections. The LM79xx series of negative voltage regulators swaps the identity of the input and ground pins, whereas adjustable regulators use yet another different scheme. Good practice suggests checking a component against the manufacturer's datasheet before connecting it.

Dropout Caused by Low Battery

If a regulator rated to deliver 6VDC has a 2VDC dropout voltage and is powered from a 9V battery, the battery can easily drop below the minimum acceptable 8VDC if it becomes old or depleted. When this happens, the output from the regulator will tend to fall, or may oscillate.

Inaccurate Delivered Voltage

A voltage regulator maintains its output voltage between its output pin and ground pin. Thin traces on a circuit board, or a long run of very small-gauge wiring, can impose some electrical resistance, reducing the actual voltage delivered to a component. Ohm's Law tells us that the voltage drop imposed by a trace (or thin wire) will be proportional to the current flowing through it. For example, if the resistance between the output pin of a voltage regulator and a component is 0.5Ω and the current is 0.1A, the voltage drop will be only 0.05V. But if the current increases to 1A, the voltage drop is now 0.5V. Bearing this in mind, a linear voltage regulator should be positioned close to voltage-sensitive components. In printed circuit designs, the traces that deliver power should not have significant resistance.

When using linear voltage regulators with adjustable output, there may be a temptation to connect adjustment resistor R1 to the positive end of the load, to obtain a "more accurate" delivered voltage. This configuration will not produce the desired result. R1 should always be connected as closely as possible between the output pin and the adjustment pin of the voltage regulator, while R2 should connect between the adjustment pin and the negative end of the load. This is illustrated in Figure 19-7, where the gray wire in each schematic indicates that it possesses significant resistance.

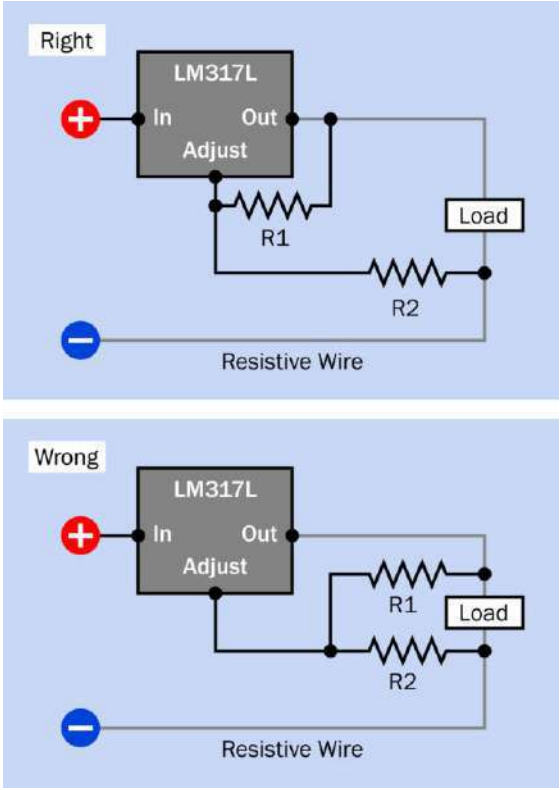

Figure 19-7. *When the connection between an adjustable-output voltage regulator and load components has a significant resistance (shown here as a gray "resistive wire"), R1 should always be connected as closely as possible to the pins of the regulator, as shown in the upper schematic. (Derived from schematics prepared by National Semiconductor.)*

electromagnet

20

The term **electromagnet** is used here to mean a coil containing a core of ferromagnetic material that does not move relative to the coil. The core is used solely to create a magnetic field that attracts or repels other parts that have appropriate inherent magnetic properties. Where a center component moves in response to the magnetic force created by current through a coil, this is discussed in the **solenoid** entry. By comparison, the **inductor** entry describes a coil that may or may not have a ferromagnetic core, and is used for the specific purpose of creating reactance, or self-inductance, in an electronic circuit, often in association with alternating current and in combination with resistors and/or capacitors. The **inductor** entry contains a basic discussion and explanation of magnetic force created by electricity.

OTHER RELATED COMPONENTS

- **solenoid** (See Chapter 21)
- **electromagnet** (See Chapter 20)
- **DC motor** (See Chapter 22)
- **AC motor** (See Chapter 23)

What It Does

An electromagnet consists of a coil that creates a magnetic field in response to an electric current. The field is channeled and reinforced by a core of magnetic material (that is, material that can be magnetized). Electromagnets are incorporated in motors, generators, loudspeakers, microphones, and industrial-sized applications such as mag-lev trains. On their own, they provide a means for electric current to hold, lift, or move objects in which a magnetic field can be induced.

A very small, basic electromagnet about 1 inch in diameter is shown in Figure 20-1. No specific schematic symbol for an electromagnet exists, and the symbol for an induction coil with a solid core is often used instead, as shown in Figure 14-1 (the center variant of each of the three) in the **inductor** entry of this encyclopedia.

Figure 20-1. *An electromagnet approximately 1 inch in diameter, rated to draw 0.25A at 12VDC.*

How It Works

Electric current flowing through a circle of wire (or a series of connected loops that form a helix

or *coil*) will induce a magnetic field through the center. This is illustrated in the **inductor** entry of this encyclopedia, specifically in diagrams Figure 14-3, Figure 14-4, Figure 14-5, and Figure 14-6.

If a stationary piece of ferromagnetic material is placed in the center of the circle or coil, it enhances the magnetic force because the *reluctance* (magnetic resistance) of the material is much lower than the reluctance of air. The combination of the coil and the core is an electromagnet. This is illustrated in Figure 20-2. For a lengthier discussion of this effect, see "Magnetic Core" (page 122).

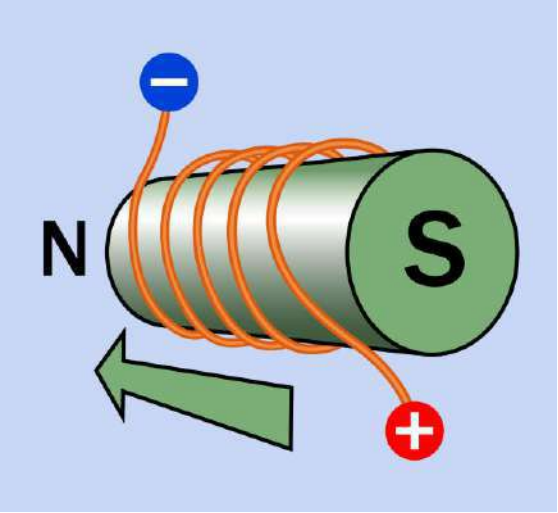

Figure 20-2. *Direct conventional current flowing through a wire coiled around a ferromagnetic rod induces a magnetic force in the rod, conventionally considered to flow from south to north.*

The magnitude of the electromagnetic *flux density* will be proportional to the current flowing through the coil, assuming a DC power source.

Variants

Electromagnet designs vary according to their application. The simplest design consists of a single coil wound around a rod which may terminate in a plate for applications such as lifting scrap metal. This design is relatively inefficient because the magnetic circuit is completed through air surrounding the electromagnet.

A more efficient, traditional design consists of a U-shaped core around which are wound one or two coils. If the U-shaped core is smoothly curved, it resembles a *horse-shoe magnet*, as shown in Figure 20-3. This design has become relatively uncommon, as it is cheaper to make windings across two separate, straight vertical cores and bridge them. However, the horseshoe configuration is extremely efficient, as the coils induce north and south magnetic polarities in the open ends of the U-shaped core, and the magnetic circuit is completed through any object that is attracted toward the open ends and links them. The attracted object is shown as a rectangular plate in Figure 20-3. Because a magnetic circuit will naturally attempt to limit its extent, and because this goal will be achieved when the circuit is completed, the attractive force of the U-shaped magnet is maximized.

An electromagnet powered by direct current naturally produces a consistently polarized, stable magnetic field. When AC current is applied, an electromagnet may still be used to exert an attractive force on a passive object that is not magnetized but is capable of being magnetized. The electromagnet will change its polarity at almost the same frequency as the AC, and will induce equal and opposite fluctuating polarity in the target, causing mutual attraction. The core of the magnet will be composed of plates separated by thin layers of insulation to inhibit the eddy currents induced by the AC, but still an AC-powered electromagnet will be less efficient than a comparable DC-powered electromagnet because it will also suffer from *hysteresis* as power is consumed by repeatedly reversing the polarity of the *magnetic domains* in the core.

Some electromagnets that are described as suitable for AC power actually contain *rectifiers* that convert the AC to DC.

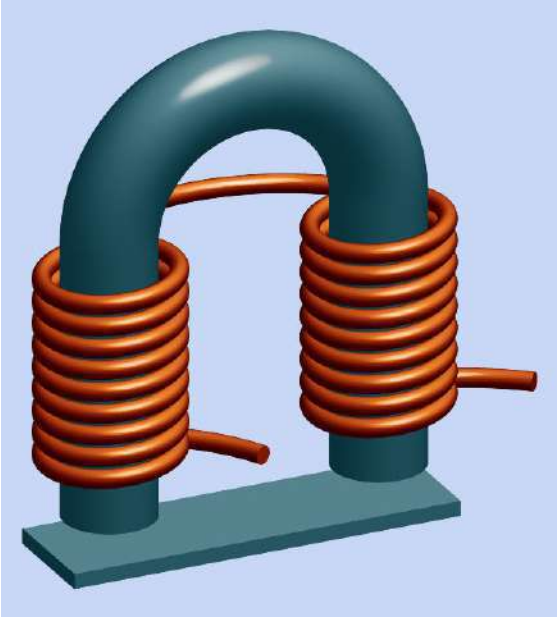

Figure 20-3. *This traditional design for an electromagnet has a pedigree stretching back for more than a century. It maximizes efficiency by completing a magnetic circuit through any object that the magnet attracts.*

Values

Electromagnets are typically calibrated in terms of their power consumption and retaining force (the weight of an iron target that they can support). The retaining force is usually measured in grams or kilograms.

How to Use it

Electromagnets are used mostly as subassemblies in other components, such as motors and generators, relays, loudspeakers, and disk drives. They have also been used in audio (and video) tape recorders to magnetize ferric oxide on tape, using a magnetic field of varying strength to record an audio signal. In this application, a form of horseshoe magnet with an extremely narrow gap is used, the width of the gap determining the highest frequency that the electromagnet can record, in conjunction with the speed of the tape moving past the head.

The tape recording process can be reversed when the electromagnet "reads" the tape and turns the signal back into a weak alternating current that can be amplified and reproduced through a loudspeaker.

A simple application for an electromagnet is in a traditional-style doorbell, where one or two coils attract a spring-loaded lever, at the top of which is a knob that hits a bell. When the lever is pulled toward the bell, it breaks a contact that supplies power to the electromagnet. This allows the lever to spring back to its original position, which re-establishes the circuit, repeating the process for as long as power is applied to the bell. The bulk and weight of the component parts in this type of doorbell are making it obsolete, as electronic versions containing small loudspeakers become relatively cheaper. However, a **solenoid** may still be used in the type of bell that creates a single chime or pair of chimes.

In any device using a *cathode-ray tube*, electromagnetic coils are used to form a *yoke* around the neck of the tube, to deflect the beam of electrons on its way to the screen. A similar principle is used in electron microscopes. In some cases, electrostatically charged plates are used to achieve the same purpose.

An electromagnet may be used to activate a *reed switch* (the diagram in Figure 9-7 shows such a switch). In this application, the combination of the electromagnet and the switch are functioning as a **relay**.

When an electromagnet is energized by alternating current, it can be used to *degauss* (in other words, to demagnetize) other objects. The AC is either applied with diminishing current, so that the alternating magnetic polarities gradually subside to zero, or the electromagnet is gradually moved away from the target, again reducing the magnetic influence to (virtually) zero. This latter procedure may be used periodically to demagnetize record and replay heads on tape recorders, which otherwise tend to acquire residual magnetism, inducing background hiss on the tape.

Traditional large-scale applications for electromagnets tend to involve lifting and moving heavy objects or scrap metal, such as junked cars. A more modern application is in magnetic resonance imaging (MRI), which has revolutionized some areas of medicine.

Very large-scale applications for electromagnets include particle accelerators, in which multiple magnetic coils are energized sequentially, and fusion-power generators, where high-temperature plasma is contained by a magnetic field.

What Can Go Wrong

Because an electromagnet requires constant power to maintain its magnetic force, yet it is not doing any actual work so long as its target remains stationary (in contact with the core of the magnet), the current running through the coil of the magnet must be dissipated entirely as heat. Further discussion of this issue will be found at "Heat" (page 177) in the **solenoid** section of this encyclopedia.

solenoid

21

The term **solenoid** was historically used to describe any coil without a magnetic core. More recently and more commonly it describes a coil inside of which a cylindrical plunger moves in response to the magnetic field generated by the coil. In this encyclopedia, the term **electromagnet** has its own entry, and describes a coil with a center component of ferromagnetic material that does not move relative to the coil. It is used solely to attract or repel other parts that have inherent magnetic properties. By comparison, the **inductor** entry describes a coil that is used for the specific purpose of creating reactance, or self-inductance, in an electronic circuit, often in association with alternating current and in combination with resistors and/or capacitors. The **inductor** entry contains a basic discussion and explanation of magnetic force created by electricity.

OTHER RELATED COMPONENTS

- **inductor** (See Chapter 14)
- **solenoid** (See Chapter 21)

What It Does

A typical solenoid consists of a hollow coil inside a *frame*, which may be a sealed cylinder or box-shaped with open sides. In the case of a cylinder, its opposite ends may be referred to as *pole faces*.

At least one of the pole faces has a hole through which a *plunger* (also known as an *armature*) is pulled or pushed by the solenoid. Thus, the solenoid is a device for applying a linear mechanical force in response to current passing through it. In most solenoids, current must be maintained in order to maintain the mechanical force.

A small open-frame solenoid is pictured in Figure 21-1. The upper section of the figure shows the three basic parts: frame, compression spring, and plunger. The lower part of the figure shows the parts assembled.

A larger, closed, cynlindrical solenoid is shown in Figure 21-2, with the plunger and spring removed.

A 3D rendering showing a simplified, imaginary, cylindrical solenoid cut in half appears in Figure 21-3. The diagram includes a gray cylindrical shell, often described as the frame; the coil, shown in orange; the plunger, which is pulled into the coil by its magnetic field; and the triangular stop, which limits the plunger's upward travel. The frame of the solenoid exists not merely to protect the coil, but to provide a magnetic circuit, which is completed through the plunger.

The lower end of the plunger is often fitted with a nonmagnetic yoke or perforated plate for connection with other components. Stainless steel can be used for this purpose. The stop may be fitted with a thrust rod (also fabricated from stainless steel) if the solenoid is intended to "push" as well as "pull." Springs to adjust the force of the plunger, or to return it to its initial position when the current through the coil is interrupted, are not shown in the rendering.

Figure 21-1. *A small 12VDC solenoid.*

Figure 21-2. *A larger solenoid rated for 24VDC.*

Because there is no standardized schematic symbol for a solenoid, and because this type of component is so widely used in conjunction with valves, any diagram involving solenoids is more likely to emphasize fluid or gas flow with symbols that have been developed for that purpose. In such circuits, a solenoid may be represented simply by a rectangle. However, the symbols shown in Figure 21-4 may occasionally be found.

How It Works

Current flowing through the coil creates a magnetic force. This is explained in the **inductor** entry of this encyclopedia, using diagrams in Figure 14-3, Figure 14-4, Figure 14-5, and Figure 14-6.

If the plunger is fabricated from a material such as soft iron, the coil will induce an equal and opposite magnetic polarity in the plunger. Consequently the plunger will attempt to occupy a position inside the coil where the ends of the plunger are equal distances from the ends of the coil. If a collar is added to the free end of the plunger, this can increase the pulling force on the plunger when it is near the end of its throw because of the additional magnetic pull distributed between the collar and the frame of the solenoid.

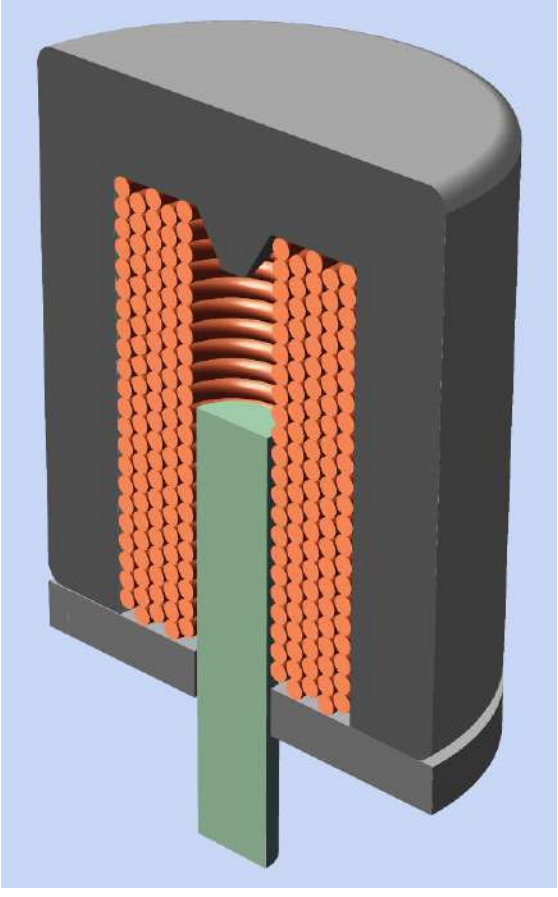

Figure 21-3. *A simplified view of a solenoid cut in half, showing the primary parts.*

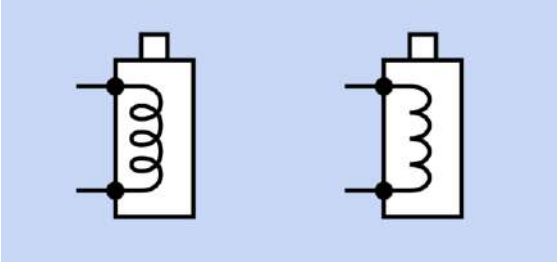

Figure 21-4. *Although no standard schematic symbol for a solenoid exists, these symbols may sometimes be found.*

A spring can be inserted to apply some resistive force to compensate for the increase in pulling force that occurs as a larger proportion of the plunger enters the coil. A spring may also be used to eject the plunger, partially at least, when current to the coil is interrupted.

If the plunger is a permanent magnet, reversing DC current to the coil will reverse the action of the plunger.

A solenoid with a nonmagnetized plunger may be energized by AC current, since polarity reversals in the magnetic field generated by the coil will induce equal and opposite reversals in the polarity of the plunger. However, the force curve of an AC-powered solenoid will be different from the force curve of a DC-powered solenoid. See Figure 21-5. The alternating current is likely to induce humming, buzzing, and vibration.

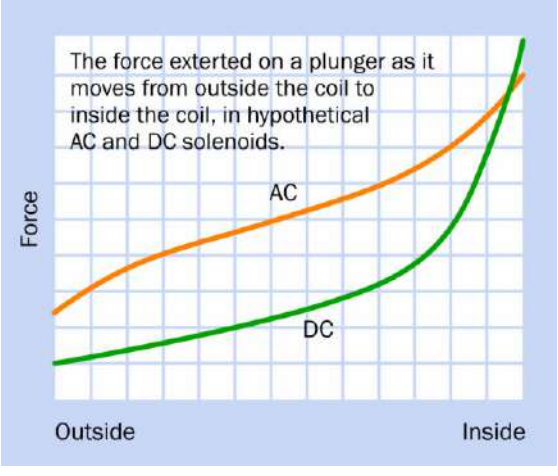

Figure 21-5. *A comparison of the force exerted on a plunger, relative to its position as it enters the coil, in hypothetical AC and DC solenoids.*

The frame of the solenoid increases the magnetic power that the coil can exert by providing a magnetic circuit of much lower *reluctance* than that of air (reluctance being the magnetic equivalent of electrical resistance). For a lengthier discussion of this effect, see "Magnetic Core" (page 122) in the **inductor** entry of this

encyclopedia. If current flowing through the coil increases to the point where the frame becomes magnetically *saturated*, the pulling power of the solenoid will level off abruptly.

The heat generated by a solenoid when it is maintained in its energized state may be reduced if the manufacturer includes a series resistor and a switch that functions as a *bypass switch*. The switch is normally closed, but is opened mechanically when the plunger reaches the end of its throw, thus diverting electricity through the series resistor. This itself will generate some heat as a result of the current flowing through it, but by increasing the total resistance of the system, the total heat output will be reduced. The resistor value is chosen to provide the minimum power needed to retain the plunger at the end of its throw.

Variants

The most common variant is tubular, with open-frame as a secondary option. A tubular solenoid has been shown in Figure 21-2.

Additional variants include:

Low Profile

A shorter, fatter solenoid which may be used if a short throw is acceptable.

Latching

A permanent magnet holds the plunger when it reaches the end of its travel, and continues to hold it after power to the solenoid is disconnected. The plunger itself is also a permanent magnet, and is released by running current of reverse polarity through the coil.

Rotary

This variant is similar in principle to a brushless DC motor and causes the armature to rotate through a fixed angle (typically ranging from 25 to 90 degrees) instead of moving linearly. It is used as a mechanical indicator in control panels, although it is being displaced by purely electronic indicators.

Hinged Clapper

Instead of a plunger, a small hinged panel (the "clapper") moves in when the solenoid is active, and springs back when the power is interrupted.

Values

The stroke length, duty cycle, and holding force are the most significant values found in solenoid datasheets.

Holding forces for DC solenoids can range from a few grams to hundreds of kilograms. The holding force will be inversely proportional to the length of the solenoid, if all other variables are equal. The force that the solenoid can exert on its plunger also varies depending on the position of the plunger in the length of its throw.

Duty cycle is of special importance because the solenoid continues to draw power and create heat so long as it is holding the plunger at the end of its throw (assuming the solenoid is not the latching type). The initial current surge in an AC solenoid generates additional heat.

The duty cycle is simply calculated. If T1 is the time for which the solenoid is on and T2 is the time for which the solenoid is off, the duty cycle, D, is derived as a percentage from the formula

```
D = 100 * (T1 / (T1 + T2))
```

Some solenoids are designed to withstand a 100% duty cycle, but many are not, and in those cases, there is a maximum value not only for D but for the peak "on" time, regardless of the duty cycle. Suppose a solenoid is rated for a 25% duty cycle. If the solenoid is appropriately switched on for one second and off for three seconds, the heat will be allowed to dissipate before it has time to reach overload levels. If the solenoid is switched

on for one minute and off for three minutes, the duty cycle is still 25%, but the heat that may accumulate during a one-minute "on" cycle may overload the component before the "off" cycle can allow it to dissipate.

Coil Size vs. Power

Because additional windings in a coil will induce a greater magnetic force, a larger solenoid tends to be more powerful than a smaller solenoid. However this means that if a larger and a smaller solenoid are both designed to generate the same force over the same distance, the smaller solenoid will probably draw more current (and will therefore generate more heat) because of its fewer coil windings.

How to Use it

Solenoids are primarily used to operate valves in fluid and gas circuits. Such circuits are found in laboratory and industrial process control, fuel injectors, aircraft systems, military applications, medical devices, and space vehicles. Solenoids may also be used in some electronic locks, in pinball machines, and in robotics.

What Can Go Wrong

Heat

Overheating is the principal concern when using solenoids, especially if the maximum "on" time is exceeded, or the duty cycle is exceeded. If the plunger is prevented from reaching the end of its throw, this can be another cause of overheating.

Because coil resistance increases with heat, a hot solenoid passes less current and therefore develops less power. This effect is more pronounced in a DC solenoid than an AC solenoid. A manufacturer's force curve should show the solenoid performance at its maximum rated temperature, which is typically around 75 degrees Centigrade, in a hypothetical ambient temperature of 25 degrees Centigrade. Exceeding these values may result in the solenoid failing to perform. As in all coils using magnet wire, there is the risk of excessive heat melting the insulation separating the coil windings, effectively shortening the coil, which will then pass more current, generating more heat.

AC Inrush

When an AC solenoid reaches the end of its travel, the sudden stop of the plunger results in forward *EMF* that generates additional heat. Generally speaking, a longer stroke creates a greater surge. Rapid cycling will therefore exacerbate coil heating.

Unwanted EMF

Like any device containing a coil, a solenoid creates back EMF when power is connected, and forward EMF when the power is disconnected. A protection diode may be necessary to suppress power spikes that can affect other components.

Loose Plunger

The plunger in many solenoids is not anchored or retained inside the frame and may fall out if the solenoid is tilted or subjected to extreme vibration.

DC motor

22

In this section, the term "traditional DC motor" is used to describe the oldest and simplest design, which consists of two *brushes* delivering power via a rotating, sectioned *commutator* to two or more electromagnetic coils mounted on the motor shaft. *Brushless* DC motors (in which DC is actually converted to a pulse train) are also described here because "brushless DC" has become a commonly used phrase, and the motor is powered by direct current, even though this is modified internally via *pulse-width modulation*.

OTHER RELATED COMPONENTS

- **AC motor** (See Chapter 23)
- **stepper motor** (See Chapter 25)
- **servo motor** (See Chapter 24)

What It Does

A traditional DC motor uses direct current to create magnetic force, which turns an output shaft. When the polarity of the DC voltage is reversed, the motor reverses its direction of rotation. Usually, the force created by the motor is equal in either direction.

How It Works

Current passes through two or more coils that are mounted on the motor shaft and rotate with it. This assembly is referred to as the *rotor*. The magnetic force produced by the current is concentrated via cores or poles of soft iron or high-silicon steel, and interacts with fields created by permanent magnets arrayed around the rotor in a fixed assembly known as the *stator*.

Power to the coils is delivered through a pair of *brushes*, often made from a graphite compound. Springs press the brushes against a sleeve that rotates with the shaft and is divided into sections, connected with the coils. The sleeve assembly is known as the *commutator*. As the commutator rotates, its sections apply power from the brushes to the motor coils sequentially, in a simple mechanical switching action.

The most elementary configuration for a traditional DC motor is shown in Figure 22-1.

In reality, small DC motors typically have three or more coils in the rotor, to provide smoother operation. The operation of a three-coil motor is shown in Figure 22-2. The three panels in this figure should be seen as successive snapshots of one motor in which the rotor turns progressively counter-clockwise. The brushes are colored red and blue to indicate positive and negative voltage supply, respectively. The coils are wired in series, with power being applied through the commutator to points between each pair of coils. The direction of current through each coil determines its magnetic polarity, shown as N for north or S for south. When two coils are energized in series without any power applied to their midpoint, each develops a smaller magnetic field than an individually energized coil. This is

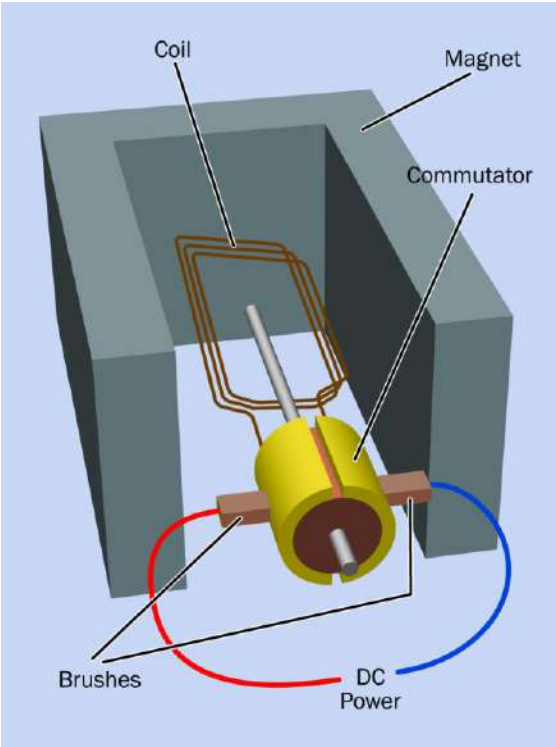

Figure 22-1. *The simplest traditional DC motor contains these parts. The combination of coil, shaft, and commutator is the rotor. The fixed magnetic structure in which it rotates is the stator.*

indicated in the diagram with a smaller white lowercase n and s. When two ends of a coil are at equal potential, the coil produces no magnetic field at all.

The stator consists of a cylindrical permanent magnet, which has two poles—shown in the figure as two black semicircles separated by a vertical gap for clarity—although in practice the magnet may be made in one piece. Opposite magnetic poles on the rotor and stator attract each other, whereas the same magnetic poles repel each other.

DC motors may be quite compact, as shown in Figure 22-3, where the frame of the motor measures about 0.7″ square. They can also be very powerful for their size; the motor that is shown disassembled in Figure 22-4 is from a 12VDC bilge pump rated at 500 gallons per hour. Its output was delivered by the small impeller attached to the rotor at right, and was achieved by using

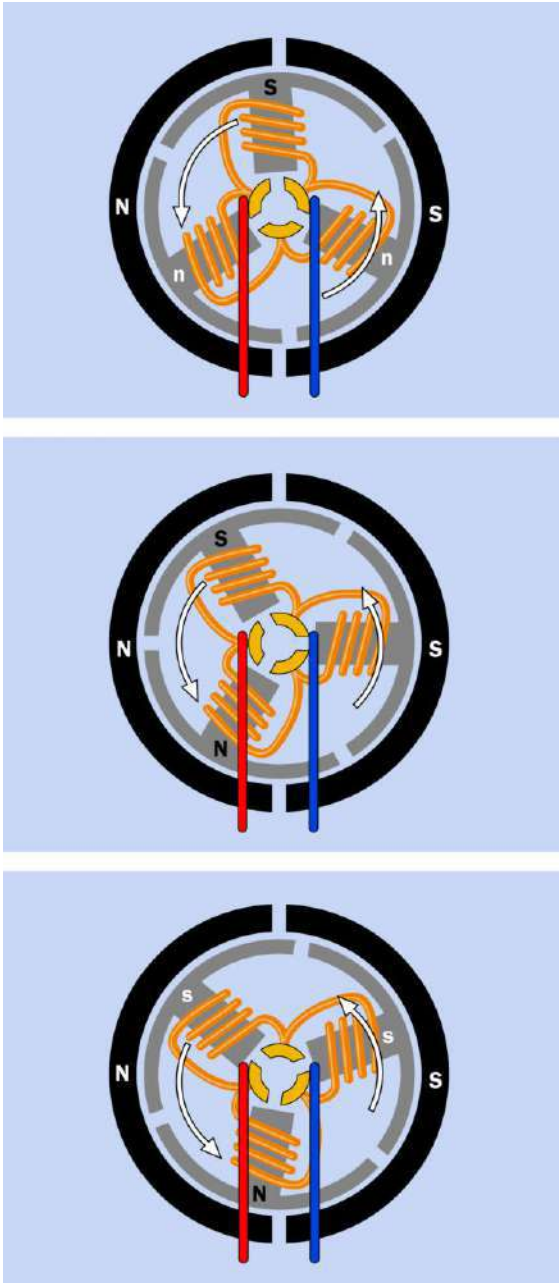

Figure 22-2. *Three sequential views of a typical three-coil DC motor viewed from the end of its shaft (the shaft itself is not shown). Magnetic effects cause the rotor to turn, which switches the current to the coils via the commutator at the center.*

two extremely powerful neodymium magnets, just visible on the inside of the motor's casing (at top-left) in conjunction with five coils on the rotor.

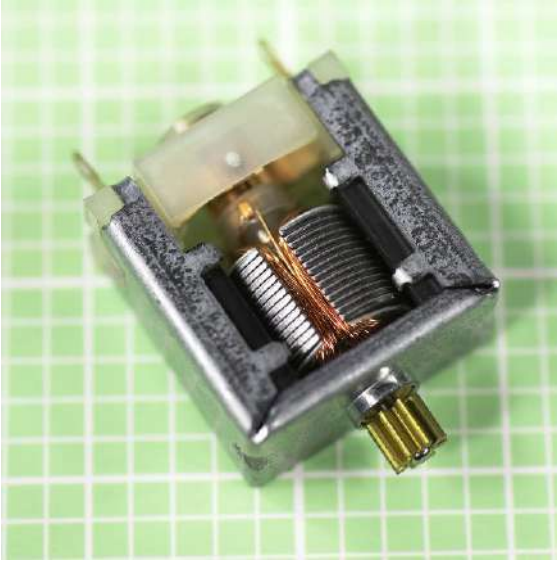

Figure 22-3. *A miniature 1.5VDC motor measuring about 0.7" square.*

Figure 22-4. *A traditional DC motor removed from its cylindrical casing. The brushes of the motor are attached to the white plastic end piece at bottom-left. Large squares on the graph paper in the background are 1" × 1", divided in 0.1" increments. The motor was used in a small bilge pump.*

Variants

Coil Configurations

The series connection of coils used in Figure 22-2 is known as the *delta configuration*. The alternative is the *wye configuration* (or *Y configuration*, or *star configuration*). Simplified schematics are shown in Figure 22-5. Generally speaking, the delta configuration is best suited to high-speed applications, but provides relatively low torque at low speed. The wye configuration provides higher torque at low speed, but its top speed is limited.

Gearhead Motor

A *gearhead motor* (also often known as a *gear motor*) incorporates a set of reduction gears that increase the torque available from the output shaft while reducing its speed of rotation. This is often desirable as an efficient speed for a traditional DC motor may range from 3,000 to 8,000 RPM, which is too fast for most applications. The gears and the motor are often contained in a single sealed cylindrical package. Two examples are shown in Figure 22-6. A disassembled motor, revealing half of its gear train under the cap and the other half still attached to a separate circular plate, appears in Figure 22-7. When the motor is assembled, the gears engage. As in the case of the bilge-pump motor, the stator magnets are mounted inside the cylindrical casing. Note that the brushes, inside the circular plate of white plastic, have a resistor and capacitor wired to suppress voltage spikes.

Spur gears are widely used for speed reduction. *Planetary gears* (also known as *epicyclic gears*) are a slightly more expensive option. Spur gears such as those in Figure 22-8 may require three or more pairs in series. The total speed reduction is

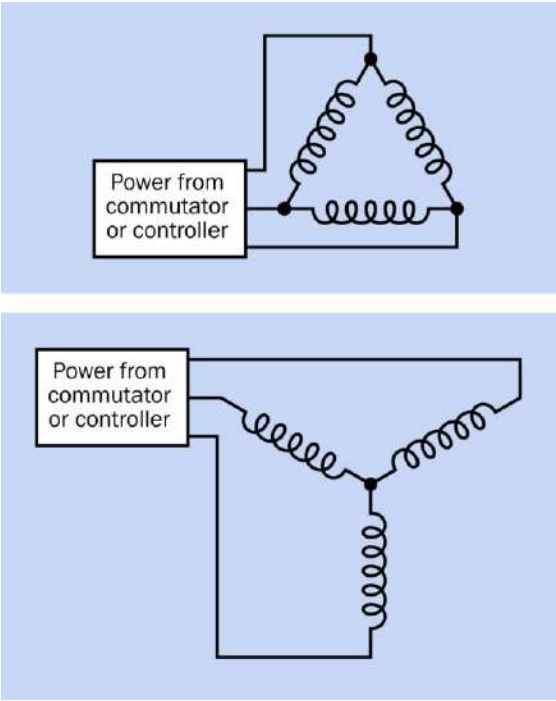

Figure 22-5. *Coils on the rotor of a traditional DC motor may be connected in delta configuration (top) or wye configuration (bottom).*

Figure 22-6. *Two typical small gearhead motors.*

found by multiplying the individual ratios. Thus, if three pairs of gears have ratios of 37 : 13, 31 : 15, and 39 : 17, the total speed reduction ® is obtained by:

```
R = ( 37 * 31 * 39 ) / ( 13 * 15 * 17 )
```

Figure 22-7. *Spur gears from a gearhead motor provide speed reduction and increased torque.*

Therefore:

```
R = 44733 / 3315 = about 13.5 : 1
```

Datasheets almost always express R as an integer. For example, the gear train shown in Figure 22-7 is rated by the manufacturer as having an overall reduction of 50:1. In reality, the reduction can be expected to have a fractional component. This is because if two gears have an integer ratio, their operating life will be shortened, as a manufacturing defect in a tooth in the smaller gear will hit the same spots in the larger gear each time it rotates. For this reason, the numbers of teeth in two spur gears usually do not have any common factors (as in the example above), and if a motor rotates at 500 RPM, a gear ratio stated as 50:1 is very unlikely to produce an output of exactly 10

RPM. Since traditional DC motors are seldom used for applications requiring high precision, this is not usually a significant issue, but it should be kept in mind.

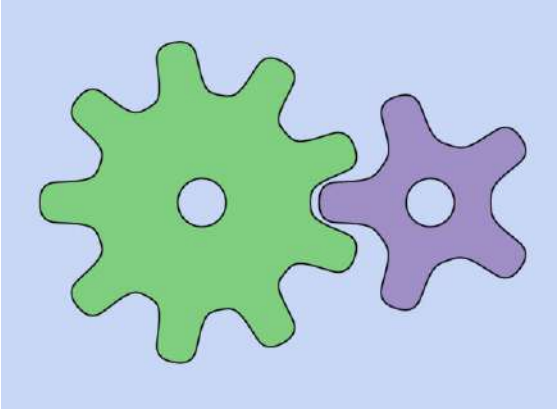

Figure 22-8. *A pair of spur gears.*

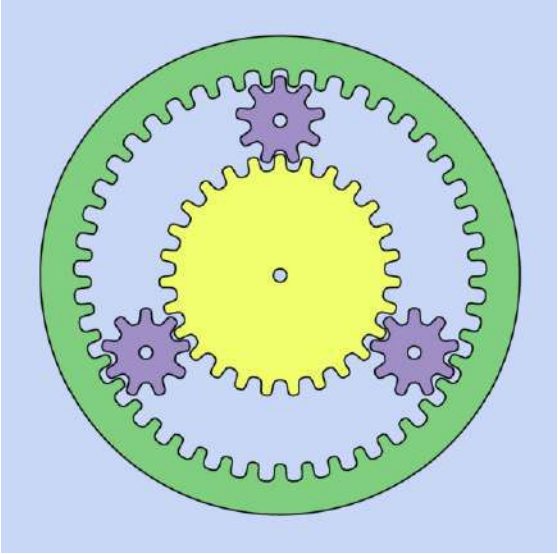

Figure 22-9. *Planetary gears, also known as epicyclic gears, share the torque from a motor among more teeth than simple spur gears.*

Figure 22-9 shows *planetary gears*, also known as *epicyclic gears*. The outer ring gear is properly referred to as the *annulus*, while the *sun gear* is at the center, and the intermediate *planet gears* may be mounted on a *carrier*. The greatest speed reduction will be achieved by driving the sun gear while the annulus is kept in a stationary position and the output is taken from the carrier of the planet gears. If A is the number of teeth in the annulus and S is the number of teeth in the sun gear, the total speed reduction, R, is given by the following formula:

```
R = (S + A) / S
```

Note that in this drive configuration, the number of teeth in each planet gear is irrelevant to the speed reduction. In Figure 22-9, the sun gear has 27 teeth whereas the annulus has 45 teeth. Therefore, the reduction is found by:

```
R = (27 + 45) / 27 = about 2.7 : 1
```

Successive reductions can be achieved by stacking planetary gear sets, using the carrier of one set to drive the sun gear in the next set.

Planetary gears are used primarily if a motor drives a heavy load, as the force is divided among more gear pairs, reducing wear and tear on gear teeth and minimizing the breakdown of lubrication. A planetary gear train may also be more compact than a train of spur gears. These advantages must be evaluated against the higher price and slightly increased friction resulting from the larger number of gears interacting with each other.

Brushless DC Motor

In a *brushless* DC motor, sometimes referred to as a *BLDC motor*, the coils are located in the stator and the permanent magnets are relocated in the rotor. The great advantage of this design is that power can be applied directly to the coils, eliminating the need for brushes, which are the primary source of failure in DC motors as a result of wear and tear. However, since there is no rotating commutator to switch the DC current to the coils, the current must be switched by electronic components, which add to the cost of the motor.

In the *inrunner* configuration the stator surrounds the rotor, whereas in the *outrunner* configuration the stator is located in the center of the motor while the rotor takes the form of a ring or

cup that spins around the stator. This is a common design for small cooling fans, where the blades are attached to the outer circumference of a cup that is lined with permanent magnets. An example is shown in Figure 22-10. In this picture, the stator coils are normally hidden from view, being fixed to the fan housing (shown at the top of the picture). Power is controlled by the surface-mount components on the green circular circuit board. The cup attached to the fan blades contains permanent magnets.

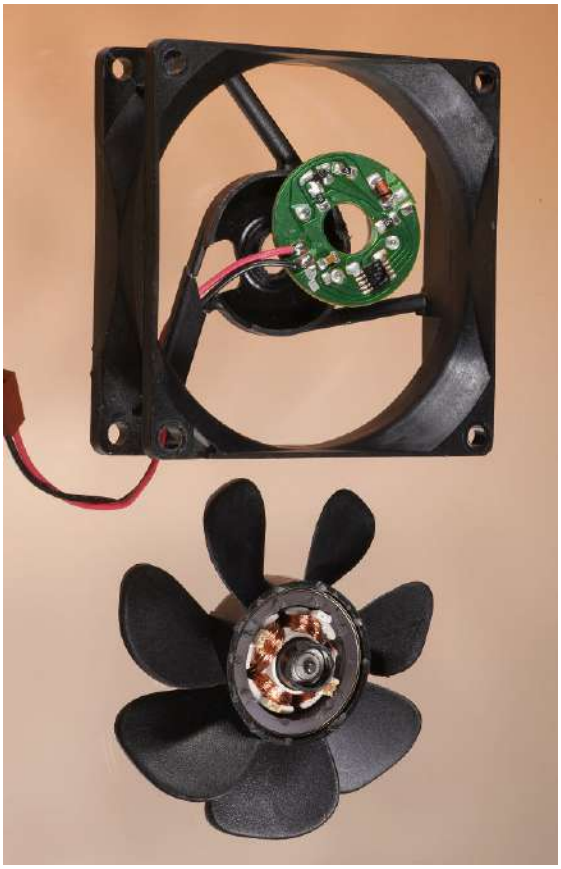

Figure 22-10. *A typical brushless DC cooling fan uses stationary coils, with permanent magnets rotating around them.*

The use of a solid-state switching system to energize the coils sequentially is known as *electronic commutation*. *Hall effect* sensors may be used to detect the position of the rotor and feed this information back to the frequency control circuit, so that it stays "one step ahead" of the rotor (when bringing it up to speed) or is synchronized with the rotor (for a constant running speed). The system is comparable to a *reluctance motor* or *synchronous motor.* These variants are described in the **AC motor** section of this encyclopedia.

While traditional DC motors have been commercially available since the late 1800s, brushless DC motors were not introduced until the 1960s, when the availability of solid-state control electronics began to make the motor design economically viable.

Linear Actuator

Linear actuator is a generic term for any device that can exert a pushing or pulling force in a straight line. In industrial applications, actuators may be powered pneumatically or hydraulically, but smaller-scale units are usually driven by a traditional DC motor. These are more properly (but not often) referred to as *electromechanical linear actuators*.

The rotational force of the motor is typically converted to linear motion by using a threaded motor shaft in conjunction with a nut or collar. The unit is often mounted in an enclosure containing *limit switches* that stop the motor automatically at the limits of travel. For an explanation of limit switches, see "Limit Switches" (page 46) in the **switch** entry in this encyclopedia.

Values

A manufacturer's datasheet should list the maximum operating voltage and typical current consumption when a motor is moderately loaded, along with the *stall current* that a motor draws when it is so heavily loaded that it stops turning. If stall current is not listed, it can be determined empirically by inserting an ammeter (or multimeter set to measure amperes) in series with the motor and applying a braking force until the motor stops. Motors should generally be protected with slow-blowing **fuses** to allow for the power fluctuations that occur when the motor starts running or experiences a change in load.

In addition, the *torque* that a motor can deliver should be specified. In the United States, torque is often expressed in *pound-feet* (or *ounce-inches* for smaller motors). Torque can be visualized by imagining an arm pivoted at one end with a weight hung on the other end. The torque exerted at the pivot is found by multiplying the weight by the length of the arm.

In the metric system, torque can be expressed as gram-centimeters, Newton-meters, or dyne-meters. A Newton is 100,000 dynes. A dyne is defined as the force required to accelerate a mass of 1 gram, increasing its velocity by 1 centimeter per second each second. 1 Newton-meter is equivalent to approximately 0.738 pound-feet.

The speed of a traditional DC motor can be adjusted by varying the voltage to it. However, if the voltage drops below 50% of the rated value, the motor may simply stop.

The power delivered by a motor is defined as its speed multiplied by its torque at that speed. The greatest power will be delivered when the motor is running at half its *unloaded speed* while delivering half the *stall torque*. However, running a motor under these conditions will usually create unacceptable amounts of heat, and will shorten its life.

Small DC motors should be run at 70% to 90% of their unloaded speed, and at 10% to 30% of the stall torque. This is also the range at which the motor is most efficient.

Ideally, DC motors that are used with reduction gearing should be driven with less than their rated voltage. This will prolong the life of the motor.

When choosing a motor, it is also important to consider the *axial loading* (the weight or force that will be imposed along the axis or shaft of the motor) and *radial loading* (the weight or force that will be imposed perpendicularly to the axis). Maximum values should be found in motor datasheets.

In the hobby field, motors for model aircraft are typically rated in watts-per-pound of motor weight (abbreviated w/lb). Values range from 50 to 250 w/lb, with higher values enabling better performance.

Relationships between torque, speed, voltage, and amperage in a traditional DC motor can be described easily, assuming a hypothetical motor that is 100% efficient:

If the amperage is constant, the torque will also be constant, regardless of the motor speed.

If the load applied to the motor remains constant (thus forcing the motor to apply a constant torque), the speed of the motor will be determined by the voltage applied to it.

If the voltage to the motor remains constant, the torque will be inversely proportional with the speed.

How to Use it

A traditional DC motor has the advantages of cheapness and simplicity, but is only suitable for intermittent use, as its brushes and commutator will tend to limit its lifetime. Its running speed will be approximate, making it unsuitable for precise applications.

As the cost of control electronics has diminished, brushless DC motors have replaced traditional DC motors. Their longevity and controllability provide obvious advantages in applications such as hard disk drives, variable-speed computer fans, CD players, and some workshop tools. Their wide variety of available sizes, and good power-to-weight ratio, have encouraged their adoption in toys and small vehicles, ranging from remote-controlled model cars, airplanes, and helicopters to personal transportation devices such as the Segway. They are also used in direct-drive audio turntables.

Where an application requires the rotation of a motor shaft to be converted to linear motion, a prepackaged *linear actuator* is usually more reliable and simpler than building a crank and

connecting rod, or cam follower, from scratch. Large linear actuators are used in industrial automation, while smaller units are popular with robotics hobbyists and can also be used to control small systems in the home, such as a remote-controlled access door to a home entertainment center.

Speed Control

A *rheostat* or **potentiometer** may be placed in series with a traditional DC motor to adjust its speed, but will be inefficient, as it will achieve a voltage drop by generating heat. Any rheostat must be rated appropriately, and should probably be wire-wound. The voltage drop between the wiper and the input terminal of the rheostat should be measured under a variety of operating conditions, along with the amperage in the circuit, to verify that the wattage rating is appropriate.

Pulse-width modulation (*PWM*) is preferable as a means of speed control for a traditional DC motor. A circuit that serves this purpose is sometimes referred to as a *chopper*, as it chops a steady flow of current into discrete pulses. Usually the pulses have constant frequency while varying in duration. The pulse width determines the average delivered power, and the frequency is sufficiently high that it does not affect smoothness of operation of the motor.

A **programmable unijunction transistor** or PUT can be used to generate a train of pulses, adjustable with a potentiometer attached to its emitter. Output from the transistor goes to a *silicon-controlled rectifier* (*SCR*), which is placed in series with the motor, or can be connected directly to the motor if the motor is small. See Figure 27-7.

Alternatively, a *555 timer* can be used to create the pulse train, controlling a *MOSFET* in series with the motor.

A **microcontroller** can also be used as a pulse source. Many microcontrollers have PWM capability built in. The microcontroller will require its own regulated power supply (typically 5VDC, 3.3VDC, or sometimes less) and a switching component such as an *insulated-gate bipolar transistor* (*IGBT*) to deliver sufficient power to the motor and to handle the flyback voltage. These components will all add to the cost of the system, but many modern devices incorporate microcontrollers anyway, merely to process user input. Another advantage of using a microcontroller is that its output can be varied by rewriting software, for example if a motor is replaced with a new version that has different characteristics, or if requirements change for other reasons. Additionally, a microcontroller enables sophisticated features such as pre-programmed speed sequences, stored memory of user preferences, and/or responses to conditions such as excessive current consumption or heat in the motor.

A PWM schematic using a microcontroller and IGBT is shown in Figure 22-11.

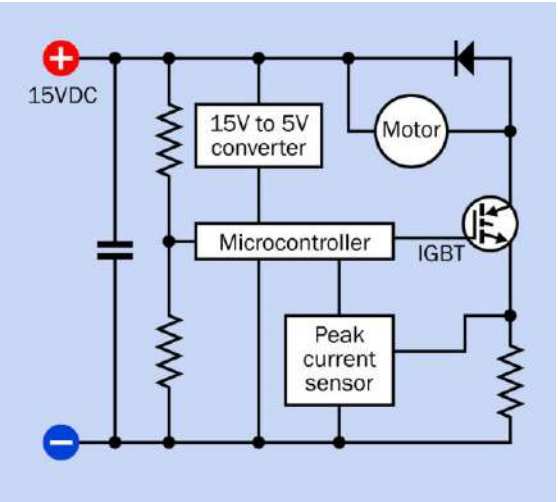

Figure 22-11. *A sample schematic for control of a DC motor via pulse-width modulation, using a microcontroller and an insulated-gate bipolar transistor.*

Direction Control

The *H bridge* is a very early system for reversing the direction of a DC motor simply by swapping the polarity of its power supply. This is shown in Figure 22-12. The switches diagonally opposite

each other are closed, leaving the other two switches open; and then to reverse the motor, the switch states are reversed. This is obviously a primitive scheme, but the term "H bridge" is still used when prepackaged in a single chip such as the LMD18200 H bridge motor controller from National Semiconductor.

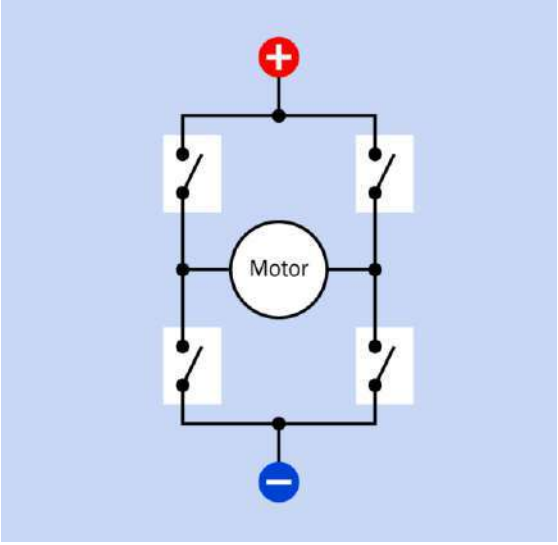

Figure 22-12. *A DC motor can be reversed by this very basic circuit, known as an H bridge, by opening and closing pairs of switches that are diagonally opposite each other.*

A double-throw, double-pole **switch** or **relay** can achieve the same purpose, as shown in Figure 22-13.

Limit Switches

When a traditional DC motor is used reversibly within a restricted range of motion, it can be fitted with *limit switches* to prevent the motor from stalling and burning out at either end of its permitted travel. Limit switches are explained in "Limit Switches" (page 46) in the **switch** entry in this encyclopedia.

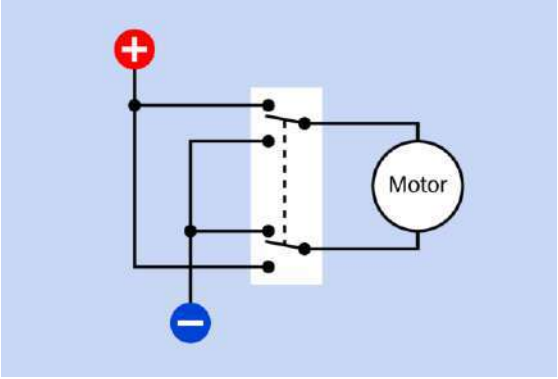

Figure 22-13. *A DPDT switch or relay can reverse the direction of a traditional DC motor simply by swapping the polarity of the power supply.*

What Can Go Wrong

Brushes and Commutator

The primary cause of failure in DC motors is abrasion of the brushes and wear and tear, oxidation, and/or accumulation of dirt on the commutator. Some motors are designed to allow replacement of the brushes; sealed motors and gearhead motors generally are not. High current and high speed will both tend to accelerate wear in the areas where the brushes meet the commutator.

Electrical Noise

The intermittent contact between the brushes and sections of the commutator of a traditional DC motor can induce voltage spikes that may travel back into the power supply for the motor and cause seemingly random effects in other components. Sparking in the commutator can be a significant source of *electromagnetic interference* (*EMI*), especially where cheap or poorly fitted brushes are used. Even if the commutator is running cleanly, the rapid creation of a magnetic field in a motor winding, following by collapse of the field, can create spikes that feed back into the power supply.

Wires that power a motor should be in twisted-pair configuration, so that their radiated EMI tends to cancel itself out. They should be routed

away from data lines or encoder outputs, and may be shielded if necessary. Data lines from sensors in brushless motors may also be shielded.

Installing a capacitor across the motor terminals can significantly reduce EMI. Some motors have capacitors preinstalled. If the motor is in a sealed casing, it may have to be disassembled to reveal whether a capacitor is present.

Heat effects

Since all motors in the real world are less than 100% efficient, some power is lost by the motor during normal operation, and will be dissipated as heat. The resistance of motor windings, and consequently the magnetic force that they generate, will decrease as the temperature rises. The motor becomes less efficient, and will try to draw more current, worsening the situation. A manufacturer's rating for maximum temperature should be taken seriously.

The insulation of the coil windings is usually the most vulnerable part of a motor if excess heat persists. Short circuits between adjacent coils as a result of insulation breakdown will degrade the performance of the motor while increasing its power consumption, which will create even more heat.

Where motor casings have protruding ridges, these cooling fins should be exposed to ambient air.

Frequent starting, stopping, and reversing will tend to generate heat as a result of power surges, and will reduce the lifetime of the motor.

Ambient Conditions

A warm, dry environment will tend to dry out bearing lubricants and graphite brushes. Conversely, a very cold environment will tend to thicken the bearing lubricants. If a motor will be used in unusual environmental conditions, the manufacturer should be consulted.

Wrong Shaft Type or Diameter

Motors have a variety of possible output shaft diameters, some measured in inches and others in millimeters, and shafts may be long or short, or may have a D-shaped cross section or splines to mate with appropriate accessories such as gears, pulleys, or couplings. Careful examination of datasheets and part numbers is necessary to determine compatibility. In the hobby-electronics world, retailers may offer purpose-built discs or arms for specific motor shafts.

Incompatible Motor Mounts

Mounting lugs or flanges may or may not be provided, and may be incompatible with the application for which the motor is intended. The same motor may be available with a variety of mount options, differentiated only by one letter or digit in the motor's part number. A mount option that was available in the past may become obsolete or may simply be out of stock. Again, examination of datasheets is necessary.

Backlash

Backlash is the looseness or "slack" in a gear train that results from small gaps between meshing gear teeth. Because backlash is cumulative when gears are assembled in series, it can become significant in a slow-output gearhead motor. When measured at the output shaft, it is generally in the range of 1 to 7 degrees, tending to increase as the load increases. If a geared motor is used as a positioning device, and is fitted with an encoder to count rotations of the motor shaft, control electronics may cause the motor to hunt to and fro in an attempt to overcome the hysteresis allowed by the backlash. A **stepper motor** or **servo motor** is probably better suited to this kind of application.

Bearings

When using a motor that is not rated for significant axial loading, the bearings may be damaged by applying excessive force to push-fit an output

gear or pulley onto the motor shaft. Even minor damage to bearings can cause significant noise (see the following section) and a reduced lifetime for the component.

In brushless DC motors, the most common cause of failure is the deterioration of bearings. Attempting to revive the bearings by unsealing them and adding lubricant is usually not worth the trouble.

Audible Noise

While electric motors are not generally thought of as being noisy devices, an enclosure can act as a sounding board, and bearing noise is likely to increase over time. Ball bearings become noisy over time, and gears are inherently noisy.

If a device will contain multiple motors, or will be used in close proximity to people who are likely to be sensitive to noise (for example, in a medical environment), care should be taken to insure that motor shafts are properly balanced, while the motors may be mounted on rubber bushings or in sleeves that will absorb vibration.

AC motor

23

The distinction between AC and DC motors has become blurred as controllers for DC motors make increasing use of *pulse-width modulation*, which can be viewed as a form of alternating current. All motors that consume DC power are referenced in the **DC motor** section of this encyclopedia, regardless of whether they modulate the power internally. **Stepper motors** and **servo motors** are considered as special cases, each with its own entry. AC motors, described here, are those that consume alternating current, usually in the form of a sine wave with a fixed frequency.

OTHER RELATED COMPONENTS

- **DC motor** (see Chapter 22)
- **stepper motor** (see Chapter 25)
- **servo motor** (see Chapter 24)

What It Does

An AC motor uses a power supply of alternating current to generate a fluctuating magnetic field that turns a shaft.

How It Works

The motor consists primarily of two parts: the *stator*, which remains stationary, and the *rotor*, which rotates inside the stator. Alternating current energizes one or more coils in the stator, creating fluctuating magnetic fields that interact with the rotor. A simplified representation is shown in Figure 23-1, where the coils create magnetic forces indicated by the green arrows, N representing North and S representing South.

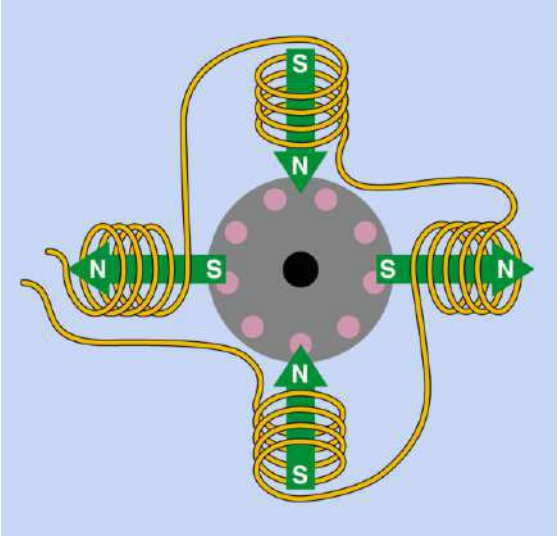

Figure 23-1. *A simplified representation of a basic AC motor. The green arrows indicate magnetic force.*

Stator Design

Plug-in electric fans typically use AC motors. The stator from a large electric fan is shown in Figure 23-2, where the large diameter of each coil maximizes its magnetic effect. The stator from a smaller electric fan is shown in Figure 23-3, in which only one coil is used. (The coil is wrapped in black electrical tape.)

Figure 23-2. *The stator from a large electric fan. Each coil of copper wire is centered on a lug pointing inward to the hole at the center, where the rotor would normally be mounted. The coils overlap because their diameter is maximized to increase their magnetic effect. Each coil is tapped to allow speed selection in steps via an external rotary switch.*

The core of a stator resembles the core of a **transformer** in that it usually consists of a stack of wafers of high-silicon steel (or sometimes aluminum or cast iron). The layers are insulated from one another by thin layers of shellac (or a similar compound) to prevent eddy currents that would otherwise circulate through the entire thickness of the stator, reducing its efficiency.

The coil(s) wound around the stator are often referred to as *field windings*, as they create the magnetic field that runs the motor.

Rotor Design

In most AC motors, the rotor does not contain any coils and does not make any electrical connection with the rest of the motor. It is powered entirely by induced magnetic effects, causing this type of motor to be known generally as an *induction motor*.

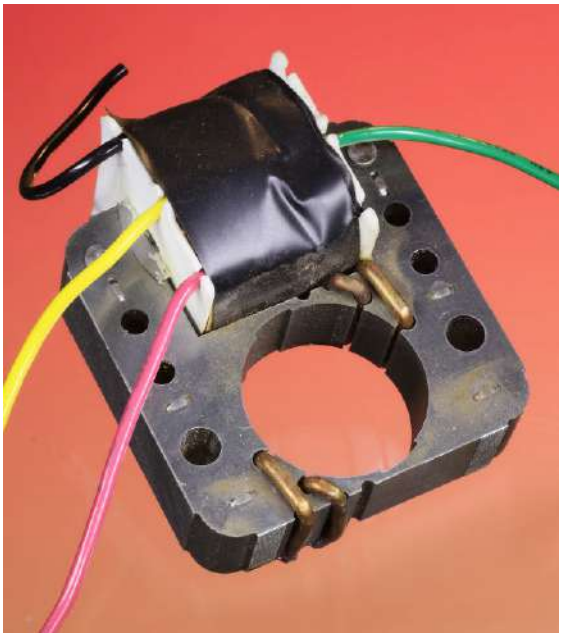

Figure 23-3. *This stator from a smaller electric fan uses only a single coil, wrapped in black tape. It is sufficient to induce a magnetic field but is generally less efficient than a motor using multiple coils.*

As the AC voltage changes from positive to negative, the magnetic force induced in the stator collapses and a new field of opposite polarity is created. Because the stator is designed to create an asymmetrical field, it induces a rotating magnetic field in the rotor. The concept of a rotating magnetic field is fundamental in AC motors.

Like the stator, the rotor is fabricated from wafers of high-silicon steel; embedded in the wafers are nonmagnetic rods, usually fabricated from aluminum but sometimes from copper, oriented approximately parallel to the axis of rotation. The rods are shorted together by a ring at each end of the rotor, forming a conductive "cage," which explains why this device is often referred to colloquially as a *squirrel cage* motor.

Figure 23-4 shows the configuration of a rotor cage with the surrounding steel wafers removed for clarity. In reality, the rods in the cage are almost always angled slightly, as shown in Figure 23-5, to promote smooth running and reduce *cogging*, or fluctuations in torque, which would otherwise occur.

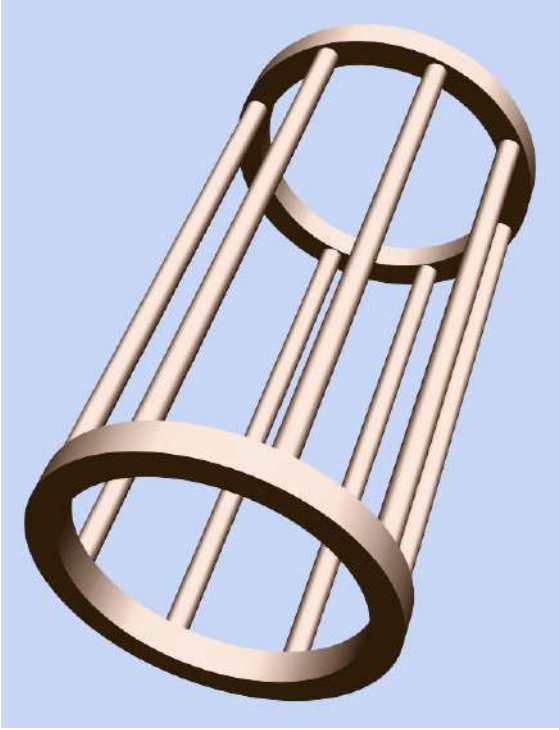

Figure 23-4. *The rotor of a typical AC motor contains a cage of aluminum (or sometimes copper) in which eddy currents occur, as a result of the rotating magnetic field inside the steel body of the rotor (which is omitted here for clarity). These currents cause their own magnetic fields, which interact with the fields generated by coils in the stator.*

In Figure 23-6, the steel wafers of a rotor are shown, with channels to accommodate an angled aluminum cage. Figure 23-7 shows a cross-section of a rotor with the cage elements in pale red and the steel wafer in gray.

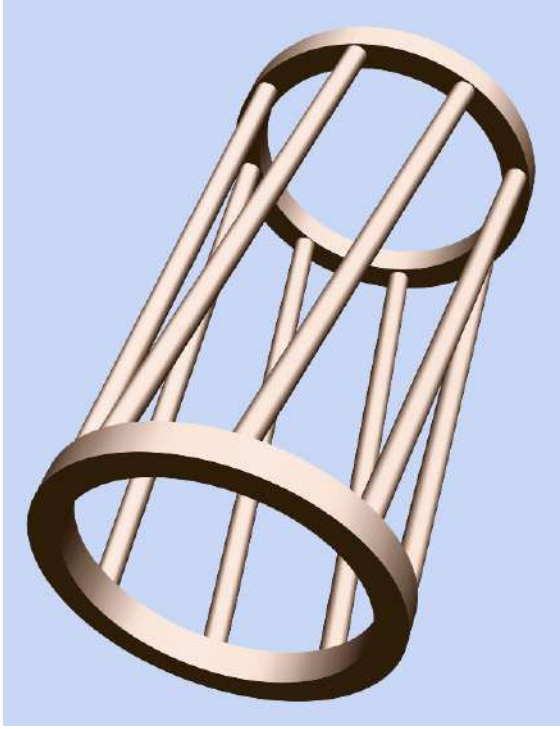

Figure 23-5. *To promote smooth running of the motor, the longitudinal elements of the cage are typically angled, as suggested in this rendering.*

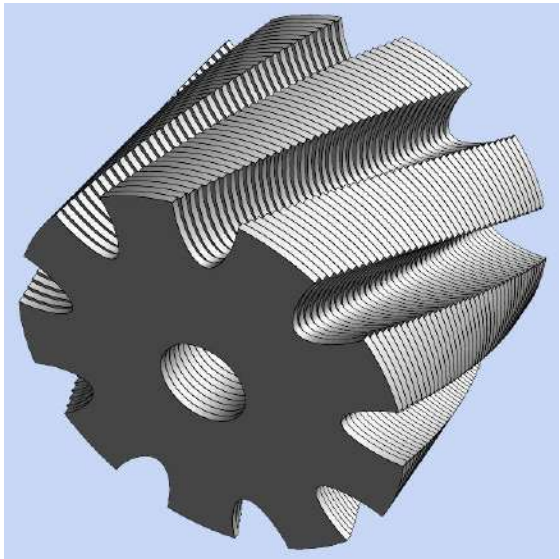

Figure 23-6. *The steel wafers in the rotor of an AC motor are typically offset as shown here. The channels are to accommodate a cage of aluminum or copper conductors.*

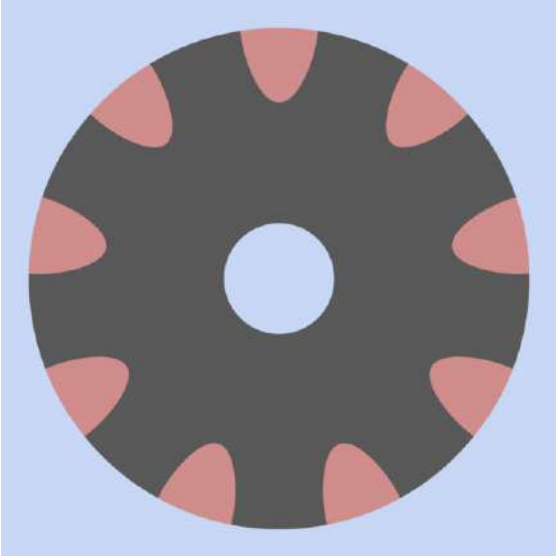

Figure 23-7. *Cross-section of a rotor with steel shown in gray and embedded elements of an aluminum cage shown in pale red.*

The actual rotor from an induction motor is shown in Figure 23-8. This rotor was removed from the stator shown in Figure 23-3. The bearings at either end of the rotor were bolted to the stator until disassembly.

Although the cage is nonmagnetic, it is electrically conductive. Therefore the rotating magnetic field that is induced in the steel part of the rotor generates substantial secondary electric current in the cage, so long as the magnetic field inside the rotor is turning faster than the rotor itself. The current in the longitudinal elements of the cage creates its own magnetic field, which interacts with the fields created by coils in the stator. Attraction and repulsion between these fields causes the rotor to turn.

Note that if the turning speed of the rotor rises to match the frequency of the alternating current powering the coils in the stator, the cage in the rotor is no longer turning through magnetic lines of force, and ceases to derive any power from

Figure 23-8. *The rotor from a small fan motor. The aluminum cage and its end pieces are the pale gray sections, steel plates are the darker sections.*

them. In an ideal, frictionless motor, its unloaded operating speed would be in equilibrium with the AC frequency. In reality, an induction motor never quite attains that speed.

When power is applied while the rotor is at rest, the induction motor draws a heavy surge of current, much like a short-circuited **transformer**. Electrically, the coils in the stator are comparable to the primary winding of a transformer, while the cage in the rotor resembles the secondary winding. The turning force induced in the stationary rotor is known as *locked-rotor torque*. As the motor picks up speed, its power consumption diminishes. See Figure 23-9.

When the motor is running and a mechanical load is applied to it, the motor speed will drop. As the speed diminishes, the cage of conductors embedded in the rotor will derive more power, as they are turning more slowly than the rotating magnetic field. The speed of rotation of the field is determined by the frequency of the AC power, and is therefore constant. The difference in rota-

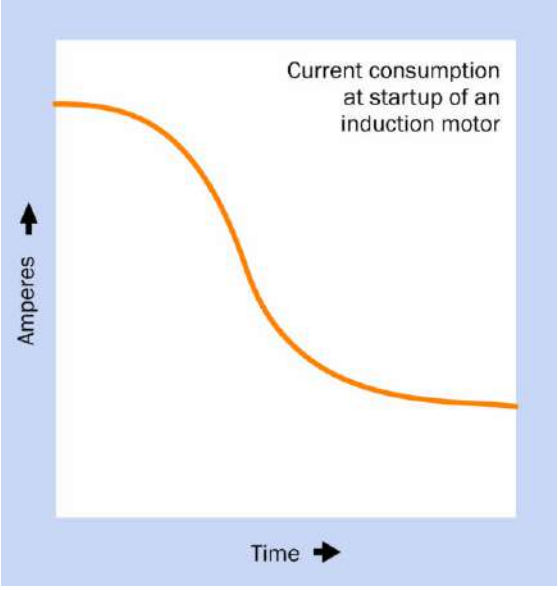

Figure 23-9. *An approximated graph showing the typical current consumption of an AC induction motor as it starts from rest and gains speed over a period of time.*

tional speed between the magnetic field and the rotor is known as *slip*. Higher levels of slip induce greater power, and therefore the induction motor will automatically find an equilibrium for any load within its designed range.

When running under full load, a small induction motor may have a slip value from 4 to 6 percent. In larger motors, this value will be lower.

Variants

Variants of the generic induction motor described above are generally designed to take advantage of either *single-phase* or *three-phase* alternating current.

A *synchronous motor* is a variant in which the rotor maintains a constant speed of rotation regardless of small fluctuations in load.

Some AC motors incorporate a *commutator*, which allows an external connection to coils mounted on the rotor, and can enable variable speed control.

A *linear motor* may consist of two rows of coils, energized by a sequence of pulses that can move a permanent magnet or electromagnet between the coils. Alternatively, the linear motor's coils may move as a result of magnetic interaction with a segmented fixed rail. Detailed description of linear motors is outside the scope of this encyclopedia.

Single-Phase Induction Motor

The majority of induction motors run on single-phase alternating current (typically, from domestic wall outlets). This type of motor is not innately self-starting because the stator coils and rotor are symmetrical. This tends to result in vibration rather than rotation.

To initiate rotation, the stator design is modified so that it induces an asymmetrical magnetic field, which is more powerful in one direction than the other. The simplest way to achieve this is by adding one or more *shorting coils* to the stator. Each shorting coil is often just a circle of heavy-gauge copper wire. This ploy reduces the efficiency of the motor and impairs its starting torque, and is generally used in small devices such as electric fans, where low-end torque is unimportant. Because the shorting coil obstructs some of the magnetic field, this configuration is often known as a *shaded pole* motor.

Copper shorting coils are visible in the fan motor shown in Figure 23-3.

A **capacitor** is a higher-cost but more efficient alternative to a shorting coil. If power is supplied to one or more of the stator coils through a capacitor, it will create a phase difference between these coils and the others in the motor, inducing an asymmetrical magnetic field. When the motor reaches approximately 80% of its designed running speed, a centrifugal switch may be included to take the capacitor out of the circuit, since it is no longer necessary. Switching out the capacitor and substituting a direct connection to the stator coils will improve the efficiency of the motor.

A third option to initiate rotation is to add a second winding in the stator, using fewer turns of smaller-gauge wire, which have a higher resistance than the main winding. Consequently the magnetic field will be angled to encourage the motor to start turning. This configuration is known as a *split-phase* induction motor, in which the starter winding is often referred to as the *auxilliary winding* and consists of about 30% of the total stator windings in the motor. Here again, a centrifugal switch can be incorporated, to eliminate the secondary winding from the circuit when the motor has reached 75 to 80 percent of its designed running speed.

The relationship between motor speed and torque of the three types of motors described above is shown in Figure 23-10. These curves are simplified and do not show the effect that would be produced by introducing a centrifugal switch.

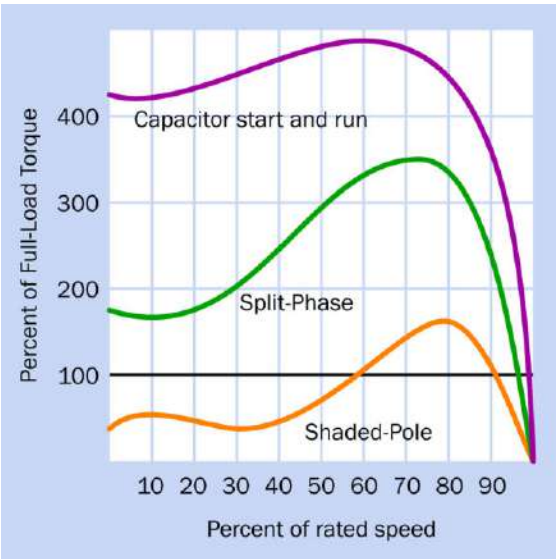

Figure 23-10. *Approximate curves showing the relationship between speed and torque for three types of single-phase induction motor. (Graph derived from AC Induction Motor Fundamentals published by Microchip Technology Inc.)*

Three-Phase Induction Motor

Larger induction motors are often *three-phase* devices. Three-phase AC (which is by far the most common form of *polyphase* AC) is delivered by a power utility company or generator via three wires, each of which carries alternating current with a phase difference of 120 degrees relative to the other two, usually for industrial applications. A common configuration of stator coils for a three-phase motor is shown in Figure 23-11. Since the three wires take it in turns to deliver their peak voltage, they are ideally suited to turn the stator of a motor via induction, and no shorting coil or capacitor is needed for startup. Heavy-duty 3-phase induction motors are extremely reliable, being brushless and generally maintenance-free.

Synchronous Motor

A synchronous motor is a form of induction motor that is designed to reach and maintain equilibrium when the rotor is turning in perfect synchronization with the AC power supply. The speed of the motor will depend on the number of poles (magnetic coils) in the stator, and the number of phases in the power supply. If R is the RPM of a synchronous motor, f is the frequency of the AC current in Hz, and p is the number of poles per phase:

```
R = (120 * f) / p
```

This formula assumes 60Hz AC current. In nations where 50Hz AC is used, the number 120 should be replaced with the number 100.

Two basic types of synchronous motors exist: *direct current excited*, which require external power to start turning, and *non-excited*, which are self-starting. Since non-excited synchronous motors are more common in electronic applications, this encyclopedia will not deal with direct current excited variants.

A *hysteresis motor* is a synchronous motor containing a solid rotor cast from cobalt steel, which has high coercivity, meaning that once it is magnetized, a substantial field is required to reverse the magnetic polarity. Consequently the polarity of the rotor lags behind the constantly changing

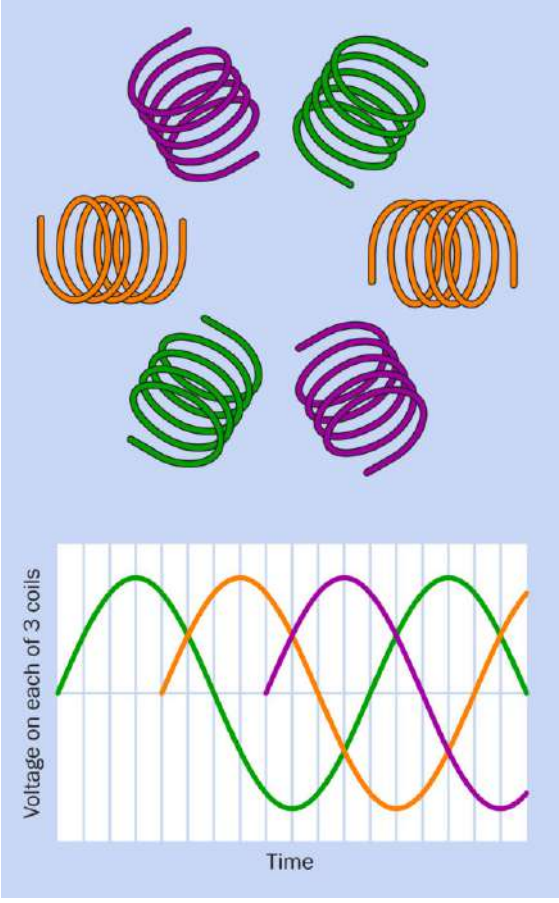

Figure 23-11. *The graph shows voltage delivered via three wires constituting a three-phase power supply. (The curve colors are arbitrary.) A three-phase motor contains a multiple of three coils—often six, as shown here diagrammatically. The three wires of the power supply are connected directly to the coils, which induce a rotating magnetic field.*

polarity of the stator, creating an attracting force that turns the rotor. Because the lag angle is independent of motor speed, this motor delivers constant torque from startup.

Reluctance Motor

Reluctance is the magnetic equivalent to electrical resistance. If a piece of iron is free to move in a magnetic field, it will tend to align itself with the field to reduce the reluctance of the magnetic circuit. This principle was used in very early reluctance motors designed to work from AC and has been revived as electronics to control variable frequency drives have become cheaper.

The simplest reluctance motor consists of a soft iron rotor with projecting lugs, rotating within a stator that is magnetically energized with its own set of inwardly projecting poles. The rotor tends to turn until its lugs are aligned with the poles of the stator, thus minimizing the reluctance.

A basic reluctance motor design is shown in Figure 25-2. It is located in the **stepper motor** section of this encyclopedia, as stepper motors are a primary application of the reluctance principle.

Although a reluctance motor can be used with polyphase fixed-frequency AC power, a variable frequency drive greatly enhances its usefulness. The timing of the frequency is adjusted by the speed of the motor, which is detected by a sensor. Thus the energizing pulses can remain "one step ahead" of the rotor. Since the rotor is not a magnet, it generates no back-EMF, allowing it to reach very high speeds.

The simplicity of the motor itself is a compensating factor for the cost of the electronics, as it requires no commutator, brushes, permanent magnets, or rotor windings. Characteristics of reluctance motors include:

- Cheap parts, easily manufactured, and high reliability.
- Compact size and low weight.
- Efficiencies greater than 90% possible.
- Capable of high start-up torque and high speed operation.

Disadvantages include noise, cogging, and tight manufacturing tolerances, as the air gap between the rotor and stator must be minimized.

A reluctance motor can function synchronously, if it is designed for that purpose.

Variable Frequency Drive

A basic induction motor suffers from significant problems. The surge of power that it draws when starting from rest can pull down the supply voltage enough to affect other devices that share the AC power supply. (Hence, the brief dimming of lights that may occur when the compressor in an air conditioner or refrigerator starts running.) While the motor is turning, it can introduce electrical noise, which feeds back into the power supply, once again causing potential problems for other devices. In addition, the narrow range of speed of an AC induction motor is a great disadvantage.

The advent of cheap solid-state technology encouraged the development of *variable-frequency power supplies* for induction motors. Because the impedance of the motor will diminish as the frequency diminishes, the current drawn by the motor will tend to increase. To prevent this, a variable frequency supply also varies the voltage that it delivers.

Wound-Rotor AC Induction Motor

The stator of this variant is basically the same as that of a single-phase induction motor, but the rotor contains its own set of coils. These are electrically accessible via a *commutator* and *brushes*, as in a **DC motor**. Because the maximum torque (also known as *pull-out* torque) will be proportional to the electrical resistance of the coils in the rotor, the characteristics of the motor can be adjusted by adding or removing resistance externally, via the commutator. A higher resistance will enable greater torque at low speed when the slip between the rotor speed and rotation of the magnetic field induced by the stator is greatest. This is especially useful in corded power tools such as electric drills, where high torque at low speed is desirable, yet the motor can accelerate to full speed quickly when the external resistance is reduced. Typically, the resistance is adjusted via the trigger of the drill.

Figure 23-12 shows a wound-rotor AC induction motor. The disadvantage of this configuration is the brushes that supply power to the rotor will eventually require maintenance. Much larger wound-rotor motors are also used in industrial applications such as printing presses and elevators, where the need for variable speed makes a simple three-phase motor unsuitable.

Figure 23-12. *A motor in a corded electric drill uses coils in a brushed rotor to enable variable speed output. In most AC motors, the speed is not adjustable and the rotor does not make any electrical connection with the rest of the motor.*

Universal Motor

A wound-rotor motor may also be described as a *universal motor* if its rotor and stator coils are connected in series. This configuration allows it to be powered by either AC or DC.

DC supplied to the rotor and the stator will cause mutual magnetic repulsion. When the rotor

turns, the brushes touching the split commutator reverse the polarity of voltage in the rotor coils, and the process repeats. This configuration is very similar to that of a conventional DC motor, except that the stator in a universal motor uses electromagnets instead of the permanent magnets that are characteristic of a **DC motor**.

When powered by AC, the series connection between stator and rotor coils insures that each pulse to the stator will be duplicated in the rotor, causing mutual repulsion. The addition of a shorting coil in the stator provides the necessary asymmetry in the magnetic field to make the motor start turning.

Universal motors are not limited by AC frequency, and are capable of extremely high-speed operation. They have high starting torque, are compact, and are cheap to manufacture. Applications include food blenders, vacuum cleaners, and hair dryers. In a workshop, they are found in routers and miniature power tools such as the Dremel series.

Because a universal motor requires commutator and brushes, it is only suitable for intermittent use.

Inverted AC Motors

Some modern domestic appliances may seem to contain an AC motor, but in fact the AC current is *rectified* to DC and is then processed with pulse-width modulation to allow variable speed control. The motor is really a **DC motor**; see the entry on this type of motor for additional information.

Values

Because a basic AC induction motor is governed by the frequency of the power supply, the speed of a typical four-pole motor is limited to less than 1,800 RPM (1,500 RPM in nations where 50Hz AC is the norm).

Variable-frequency, universal, and wound-rotor motors overcome this limitation, and can reach speeds of 10,000 to 30,000 RPM. Synchronous motors typically run at 1,800 or 1,200 RPM, depending on the number of poles in the motor. (They run at 1,500 or 1,000 RPM in locations where the frequency of AC is 50Hz rather than 60Hz).

For a discussion of the torque that can be created by a motor, see "Values" (page 184) in the **DC motor** entry in this encyclopedia.

How to Use It

Old-fashioned record players (where a turntable supports a vinyl disc that must rotate at a fixed speed) and electric clocks (of the analogue type) were major applications for synchronous motors, which used the frequency of the AC power supply to control motor speed. These applications have been superceded by CD players (usually powered by brushless DC motors) and digital clocks (which use crystal oscillators).

Many home appliances continue to use AC-powered induction motors. Small cooling fans for use in electronic equipment are sometimes AC-powered, reducing the current that must be provided by the DC power supply. An induction motor generally tends to be heavier and less efficient than other types, and its speed limit imposed by the frequency of the AC power supply is a significant disadvantage.

A simple induction motor cannot provide the sophisticated control that is necessary in modern devices such as CD or DVD players, ink-jet printers, and scanners. A **stepper motor**, **servo motor**, and **DC motors** controlled with *pulse-width modulation* are preferable in these applications.

A *reluctance motor* may find applications in high-speed, high-end equipment including vacuum cleaners, fans, and pumps. Large variable reluctance motors, with high amperage ratings, may be used to power vehicles. Smaller variants are being used for power steering systems and windshield wipers in some automobiles.

What Can Go Wrong

Compared with other devices that have moving parts, the brushless induction motor is one of the most reliable and efficient devices ever invented. However, there are many ways it can be damaged. General problems affecting all types of motors are listed at "Heat effects" (page 188). Issues relating specifically to AC motors are listed below.

Premature Restart

Large industrial three-phase induction motors can be damaged if power is reapplied before the motor has stopped rotating.

Frequent Restart

If a motor is stopped and started repeatedly, the heat that is generated during the initial surge of current is likely to be cumulative.

Undervoltage or Voltage Imbalance

A voltage drop can cause the motor to draw more current than it is rated to handle. If this situation persists, overheating will result. Problems also are caused in a three-phase motor where one phase is not voltage-balanced with the others. The most common cause of this problem is an open circuit-breaker, wiring fault, or blown fuse affecting just one of the three conductors. The motor will try to run using the two conductors that are still providing power, but the result is likely to be destructive.

Stalled Motor

When power is applied to an induction motor, if the motor is prevented from turning, the conductors in the rotor will carry a large current that is entirely dissipated as heat. This current surge will either burn out the motor or blow a fuse or circuit breaker. Care should be taken, in equipment design, to minimize the risk that an induction motor may stall or jam.

Protective Relays

Sophisticated protective relays are available for industrial 3-phase motors, and can guard against all of the faults itemized above. Their details are outside the scope of this encyclopedia.

Excess Torque

As has been previously noted, the torque of an induction motor increases with the slip (speed difference) between the rotation of the magnetic field and the rotation of the rotor. Consequently, if the motor is overloaded and forced to run more slowly, it can deliver more rotational force. This can destroy other parts attached to the motor, such as drive belts.

Internal Breakage

An overloaded induction motor may suffer some cracking or breakage of its rotor. This may be obvious because of reduced power output or vibration, but can also be detected if the motor's power consumption changes significantly.

servo motor

24

Should be referred to as an *RC servo* if it is intended for use in small devices that are remote-controlled and battery powered. However, in practice, the RC acronym is often omitted.

OTHER RELATED COMPONENTS

- **AC motor** (See Chapter 23)
- **DC motor** (See Chapter 22)
- **stepper motor** (See Chapter 25)

What It Does

A servo motor is actually a combination of a motor, reduction gearing, and miniaturized control electronics, usually packaged together inside a very compact sealed plastic case. The motor itself may be AC or DC, and if DC, it may be brushed or brushless. What distinguishes a servo from other types of motor is that it is not designed for continuous rotation. It is a position-seeking device. Its rotational range may be more than 180 degrees but will be significantly less than 360 degrees. Two typical RC servos are shown in Figure 24-1. A side view of a motor is shown in Figure 24-2.

The electronics inside the motor enclosure interpret commands from an external controller. The command code specifies the desired turn angle measured as an offset either side of the center position of the motor's range. The motor turns quickly to the specified position and stops there. So long as the command signal continues and power to the motor is sustained, the motor will hold its position and "push back" against any external turning force. In the absence of such a force, while the motor is stationary, it will use very little current.

Figure 24-1. *A typical RC servo motor is capable of more than 50 inch-ounces of torque yet can be driven by three or four AA alkaline cells in series, and weighs under 2 ounces.*

The electronics inside a typical RC servo motor are shown in Figure 24-3.

How It Works

Servo motors are generally controlled via *pulse-width modulation* (*PWM*).

Figure 24-2. *RC servo motors are mostly similar in size. This is a typical side view.*

An industrial servo typically requires a controller that is an off-the-shelf item sold by the manufacturer of the motor. The encoding scheme of the control signals may be proprietary. A heavy-duty servo may be designed to run from three-phase power at a relatively high voltage, and may be used in applications such as production-line automation.

The remainder of this encyclopedia entry will focus primarily on small RC servos rather than industrial servos.

For small RC servos, the stream of control pulses is at a constant frequency of 20ms, with the positive durations of each pulse being interpreted as a positioning command to the motor, and the gaps between the pulses being disregarded. A typical range of pulse widths for a small motor is 1ms to 2ms, specifying a range of -90 to +90 degrees either side of a center location. Many modern motors are capable of excursions beyond these limits, and can be calibrated to establish the precise relationship between pulse width and turn angle. The motor can then be controlled by a lookup table in microcontroller software, or by using a conversion factor between degree-angle and pulse width.

Figure 24-4 shows the typical range of pulse widths within the fixed 20ms period (a frequency of 50Hz) between the start of one pulse and the start of the next, and the meaning of each pulse width to the servo motor. Intermediate pulse widths are interpreted as instructions to rotate to intermediate positions.

Figure 24-3. *The electronics inside a servo motor decode a stream of pulses that specify the turn angle of the motor.*

Small servo motors require the user to provide a controller that will conform with the above specification. This is often achieved by programming a *microcontroller*, and some microcontroller chips make this especially easy by providing a PWM output specifically tailored to the requirements of an RC servo. Either way, the microcontroller can be directly connected to the servo, enabling an extremely simple and flexible way to manage a positioning device.

Alternatively, a simple pulse generator such as a *555 timer chip* can be used, or controller boards are available from hobbyist supply sources. Some controller boards have USB connections enabling a servo to be governed by computer software.

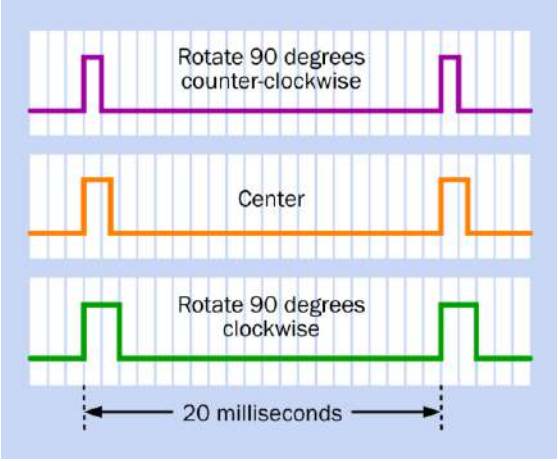

Figure 24-4. *The turn angle of a small RC servo motor is determined by a pulse width from a controller ranging from 1ms to 2ms in duration. The frequency of the pulses is constant at 50Hz.*

In Figure 24-5, a schematic illustrates the connection of a 555 timer with an RC servo, with component values to create a constant frequency of about 48Hz (slightly more than 20ms from peak to peak). The 1µF capacitor in the circuit charges through the 2.2K resistor in series with the diode, which bypasses the 28K resistor. This charging time represents the "on" cycle of the timer chip. The capacitor discharges through the 28K resistor, representing the "off" cycle. The 1K potentiometer, in series with the 5K resistors, acts as a voltage divider applied to the control pin of the timer, adjusting the timer's charge and discharge thresholds. Turning the potentiometer will lengthen or shorten the "on" time of each cycle, without changing the frequency. In practice, because capacitors are manufactured with wide tolerances, the frequency of the timer output cannot be guaranteed. Fortunately most servos will tolerate some inaccuracy.

Since the motor shares the power supply of the timer in this circuit, a protection diode and capacitor have been added between the power supply to the motor and negative ground, to suppress noise and back-EMF.

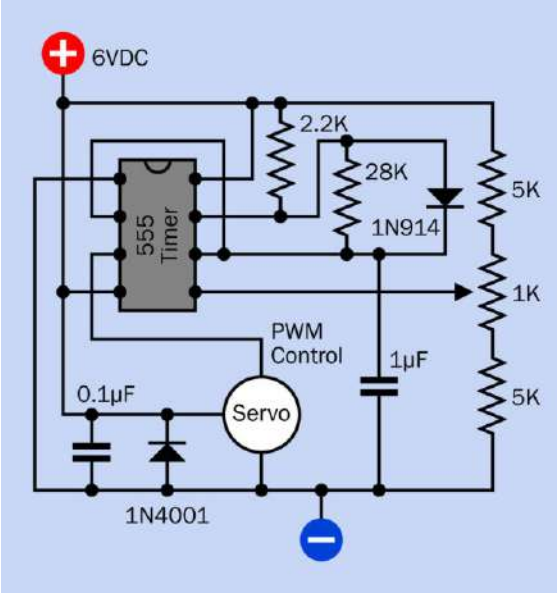

Figure 24-5. *An RC servo can be controlled via a 555 timer with appropriate component values. The potentiometer determines the angular position of the servo.*

Inside a servo motor's casing, the electronics include a **potentiometer** that turns with the output shaft, to provide feedback confirming the motor's position. The limited turning range of the potentiometer determines the turn limits of the motor output shaft.

Variants

Small servos may contain brushed or brushless DC motors. Naturally the brushless motors have greater longevity and create less electrical noise. See the **DC motor** entry in this encyclopedia for a discussion of brushed versus brushless motors.

Servos may use nylon, "Karbonite," or metal reduction gearing. The nylon gears inside a cheaper RC servo are shown in Figure 24-6.

Brushless motors and metal gears add slightly to the price of the motor. Metal gears are stronger than nylon (which can crack under load) but may wear faster, leading to *backlash* and inaccuracy in the gear train. The friction between nylon-to-nylon surfaces is very low, and nylon is certainly

Figure 24-6. *Nylon gearing inside a servo motor.*

adequate and may be preferable if a servo will not be heavily loaded. "Karbonite" is claimed to be five times stronger than nylon and may be a satisfactory compromise. If a gear set experiences a failure (for example, teeth can be stripped as a result of excessive load), manufacturers usually will sell a replacement set to be installed by the user. Installation requires manual dexterity and patience, and some skill.

Servos may have roller bearings or plain sintered bearings, the latter being cheaper but much less durable under side loading.

So-called *digital servos* use faster internal electronics than the older, so-called *analog servos*, and because they sample the incoming pulse stream at a higher frequency, they are more responsive to small, rapid commands from the controller. For this reason they are preferred by hobbyists using servos to control the flight of model airplanes. Externally, the control protocol for digital and analog servos is the same, although a digital servo can be reprogrammed with new code values establishing the limits to its range. A standalone programming unit must be purchased to achieve this.

The most popular manufacturers of small servo motors are Futaba and Hitec. While their control protocols are virtually identical, the motor output shafts differ. The shaft is typically known as the *spline*, and is grooved to fit push-on attachments. The spline of a Futaba motor has 25 grooves, while Hitec uses 24 grooves. Attachments must be appropriate for the brand of motor that has been chosen.

Values

A small servo typically weighs 1 to 2 ounces, has a rotation time of 1 to 2 seconds from one end of its travel to the other, and can exert a surprisingly robust torque of 50 ounce-inches or greater.

Voltage

Small servos were originally designed to run from 4.8V rechargeable batteries in model aircraft. They can be driven with 5VDC to 6VDC on a routine basis. A few servos are designed for higher voltages.

Amperage

The datasheets provided by most manufacturers often fail to specify the power that a servo will draw when it is exerting maximum torque (or indeed, any torque at all). Since small servos are often driven by three or four AA alkaline batteries in series, the maximum current draw is unlikely to be much greater than 1 amp. When the motor is energized but not turning, and is not resisting a turning force, its power consumption is negligible. This feature makes servos especially desirable for remote-controlled battery-powered devices.

Some motors that have a turning range exceeding 180 degrees will respond to pulses of less than 1ms or greater than 2ms. A newly acquired motor should be tested with a microcontroller

that steps through a wide range of pulse durations, to determine the limits empirically. Pulses that are outside the motor's designed range will generally be ignored and will not cause damage.

The *turn rate* or *transit time* specified in a datasheet is the time a servo takes to rotate through 60 degrees, with no load on the output shaft. A high-torque servo generally achieves its greater turning force by using a higher reduction gear ratio, which tends to result in a longer transit time.

How to Use it

Typical applications for a small servo include rotating the flaps or rudder of a model aircraft, steering a model boat, model car, or wheeled robot, and turning robotic arms.

A servo generally has three wires, colored red (power supply), black or brown (ground), and orange, yellow, or white (for the pulse train from the controller). The ground wire to the motor must be common with the ground of the controller, and consequently a ceramic bypass **capacitor** of 0.1µF or 0.01µF should be placed between the (red) power wire to the motor and ground. A protection **diode** should also be used. Neither a diode nor a capacitor should be attached to the wire carrying control signals, as it will interfere with the pulse train.

When powering the motor, an AC adapter should only be used with some caution, as its power output may be inadequately smoothed. A voltage regulator is not necessary, but bypass **capacitors** are mandatory. Figure 24-7 shows two hypothetical schematics. The upper section of the figure shows a battery-driven system, possibly using four 1.2V NiMH rechargeable batteries. Since batteries do not generally create voltage spikes, no capacitors are used, but a diode is included to protect the microcontroller from EMF when the servo stops and starts. The lower section of the figure shows the additional precautions that may be necessary when using DC power from an **AC adapter**. The DC-DC **converter**, which derives 6VDC for the motor requires smoothing capacitors (this should be specified in its datasheet), and so does the **voltage regulator**, which delivers regulated 5VDC power to the microcontroller. Once again, the protection diode is included. In both diagrams, the orange wire represents the control wire transmitting pulses to the servo motor.

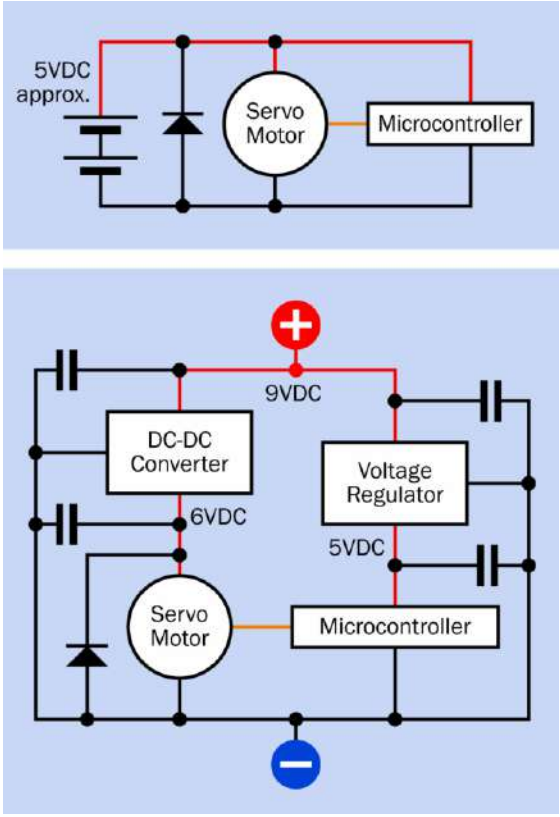

Figure 24-7. *Two possible schematics to run a small servo motor, the upper example using battery power (for example, from four 1.2V NiMH cells) and the lower example using a 9VDC AC adapter. See text for additional explanation.*

Various shaft attachments are available from the same online hobby-electronics suppliers that sell servos. The attachments include discs, single arms, double arms, and four arms in a cross-shaped configuration. A single-arm attachment is often known as a *horn*, and this term may be applied loosely to any kind of attachment. The

horn is usually perforated so that other components can be fixed to it by using small screws or nuts and bolts. Figure 24-8 shows a variety of horns.

Figure 24-8. *Various shaft attachments, known as horns, are available from motor manufacturers. The blue one is metallic; the others are plastic.*

After the horn is pushed onto the spline (the motor shaft), it is held in place with one central screw. As previously noted, the two major manufacturers of small servos, Futaba and Hitec, have incompatible splines.

Modification for Continuous Rotation

It is possible to modify a small servo motor so that it will rotate continuously.

First the motor case must be opened, and the potentiometer must be centered by using a controller to send some 1.5ms pulses. The potentiometer must then be glued or otherwise secured with its wiper in this precise center position, after which the potentiometer is disconnected from the drive train.

Mechanical stops that would limit the rotation of the motor shaft must be cut away, after which the motor is reassembled. Because the potentiometer has been immobilized, the motor's internal electronics will now "see" the shaft as being in its center position at all times. If the controller sends a pulse instructing the motor to seek a position clockwise or counter-clockwise from center, the motor will rotate in an effort to reach that position. Because the potentiometer will not provide feedback to signal that the motor has achieved its goal, the shaft will continue to rotate indefinitely.

In this mode, the primary distinguishing characteristic of the servo has been disabled, in that it can no longer turn to a specific angle. Also, stopping the servo may be problematic, as it must receive a command that precisely matches the fixed position of the potentiometer. Since the potentiometer may have moved fractionally during the process in which it was immobilized, some trial and error may be needed to determine the pulse width that corresponds with the potentiometer position.

The purpose of modifying a servo for continuous rotation is to take advantage of its high torque, small size, light weight, and the ease of controlling it with a microcontroller.

In response to the interest shown by hobbyists in modifying servos for continuous rotation, some manufacturers now market servos with continuous rotation as a built-in feature. Typically they include a trimmer potentiometer to calibrate the motor, to establish its center-off position.

What Can Go Wrong

Incorrect Wiring

The manufacturer's datasheet should be checked to confirm the color coding of the wires. While a simple DC motor can be reversed by inverting the polarity of its power supply, this is totally inappropriate for a servo motor.

Shaft/Horn Mismatch

Attachments for the spline of one brand of motor may not fit the spline of another brand, and cannot be forced to fit.

Unrealistically Rapid Software Commands

Microcontroller software that positions a servo must allow sufficient time for the servo to respond before the software specifies a new position. It may be necessary to insert delay loops or other wait times in the software.

Jitter

A servo arm that twitches unpredictably usually indicates that the pulse train is being corrupted by external electrical noise. The control wire to the servo should be as short as possible, and should not run closely adjacent to conductors carrying AC or high frequency current switching, or control wires for other servo motors.

Motor Overload

A servo capable of delivering 2 lbs of force 1 inch from its shaft can easily generate enough torque, when it stalls, to break itself free from its mounts, or bend or break any arm or linkage attached to its shaft. Ideally, a relatively "weak link" should be included so that if breakage occurs, it will be predictable and will be relatively easy and cheap to repair.

Unrealistic Duty Cycle

Small servos are designed for intermittent use. Constant cycling will cause wear and tear, especially if the motor has a brushed commutator or metal reduction gears.

Electrical Noise

Brushed motors are always a source of electrical interference, and any servo will also tend to create a voltage dip or surge when it starts and stops. A protection diode may be insufficient to isolate sensitive microcontrollers and other integrated circuit chips. To minimize problems, the servo can be driven by a source of positive voltage that is separate from the regulated power supply used by the chips, and larger filter capacitors may be added to the voltage supply of the microcontroller. A common ground between the motor and the chips is unfortunately unavoidable.

stepper motor

25

Also often referred to as a *stepping motor*, and sometimes known as a *step motor*. It is a type of *induction motor* but merits its own entry in this encyclopedia as it has acquired significant and unique importance in electronics equipment where precise positioning of a moving part is needed and digital control is available.

OTHER RELATED COMPONENTS

- **DC motor** (See Chapter 22)
- **AC motor** (See Chapter 23)
- **servo motor** (See Chapter 24)

What It Does

A stepper motor rotates its drive shaft in precise steps in response to a timed sequence of pulses (usually one step per pulse). The pulses are delivered to a series of coils or *windings* in the *stator*, which is the stationary section of the motor, usually forming a ring around the *rotor*, which is the part of the motor that rotates. Steps may also be referred to as *phases*, and a motor that rotates in small steps may be referred to as having a high *phase count*.

A stepper motor theoretically draws power for its stator coils at a constant level that does not vary with speed. Consequently the torque tends to decrease as the speed increases, and conversely, it is greatest when the motor is stationary or locked.

The motor requires a suitable control system to provide the sequence of pulses. The control system may consist of a small dedicated circuit, or a microcontroller or computer with the addition of suitable driver transistors capable of handling the necessary current. The torque curve of a motor can be extended by using a controller that increases the voltage as the speed of the control pulses increases.

Because the behavior of the motor is controlled by external electronics, and its interior is usually symmetrical, a stepper motor can be driven backward and forward with equal torque, and can also be held in a stationary position, although the stator coils will continue to consume power in this mode.

How It Works

The stator has multiple poles made from soft iron or other magnetic material. Each pole is either energized by its own coil, or more commonly, several poles share a single, large coil. In all types of stepper motor, sets of stator poles are magnetized sequentially to turn the rotor and can remain energized in one configuration to hold the rotor stationary.

The rotor may contain one or more permanent magnets, which interact with the magnetic fields

generated in the stator. Note that this is different from a *squirrel-cage* **AC motor** in which a "cage" is embedded in the rotor and interacts with a rotating magnetic field, but does not consist of permanent magnets.

Three small stepper motors are shown in Figure 25-1. Clockwise from the top-left, they are four-wire, five-wire, and six-wire types (this distinction is explained in the following section). The motor at top-left has a threaded shaft that can engage with a collar, so that as the motor shaft rotates counter-clockwise and clockwise, the collar will be moved down and up.

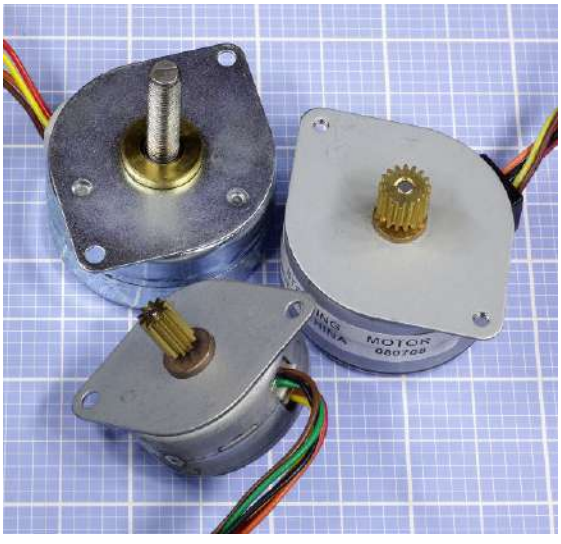

Figure 25-1. *Three small stepper motors.*

Reluctance Stepper Motors

The simplest form of stepper motor uses a rotor that does not contain permanent magnets. It relies on the principle of *variable reluctance*, reluctance being the magnetic equivalent of electrical *resistance*. The rotor will tend to align its protruding parts with the exterior source(s) of the magnetic field, as this will reduce the reluctance in the system. Additional information about variable reluctance is included in "Reluctance Motor" (page 197) in the section of this encyclopedia dealing with the **AC motor**.

A variable reluctance motor requires an external controller that simply energizes the stator coils sequentially. This is shown in Figure 25-2, where six poles (energized in pairs) are arrayed symmetrically around a rotor with four protrusions, usually referred to as *teeth*. Six stator poles and four teeth are the minimum numbers for reliable performance of a reluctance stepper motor.

In the diagram, the core of each pole is tinted green when it is magnetized, and is gray when it is not magnetized. In each section of this diagram, the stator coils are shown when they have just been energized, and the rotor has not yet had time to respond. External switching to energize the coils has been omitted for simplicity. In a real motor, the rotor would have numerous ridges, and the clearance between them and the stator would be extremely narrow to maximize the magnetic effect.

In a 6-pole reluctance motor where the rotor has four teeth, each time the controller energizes a new pair of poles, the rotor turns by 30 degrees counter-clockwise. This is known as the *step angle*, and means that the motor makes 12 steps in each full 360-degree rotation of its shaft. This configuration is very similar to that of a 3-phase AC *induction motor*, as shown in Figure 23-11 in the **AC motor** section of this encyclopedia. However, the AC motor is designed to be plugged into a power source with a constant frequency, and is intended to run smoothly and continuously, not in discrete steps.

Generally, reluctance motors tend to be larger than those with magnetized rotors, and often require feedback from a sensor that monitors shaft angle and provides this information to control electronics. This is known as a *closed loop* system. Most smaller stepper motors operate in an *open loop* system, where positional feedback is considered unnecessary if the number of pulses to the motor is counted as a means of tracking its position.

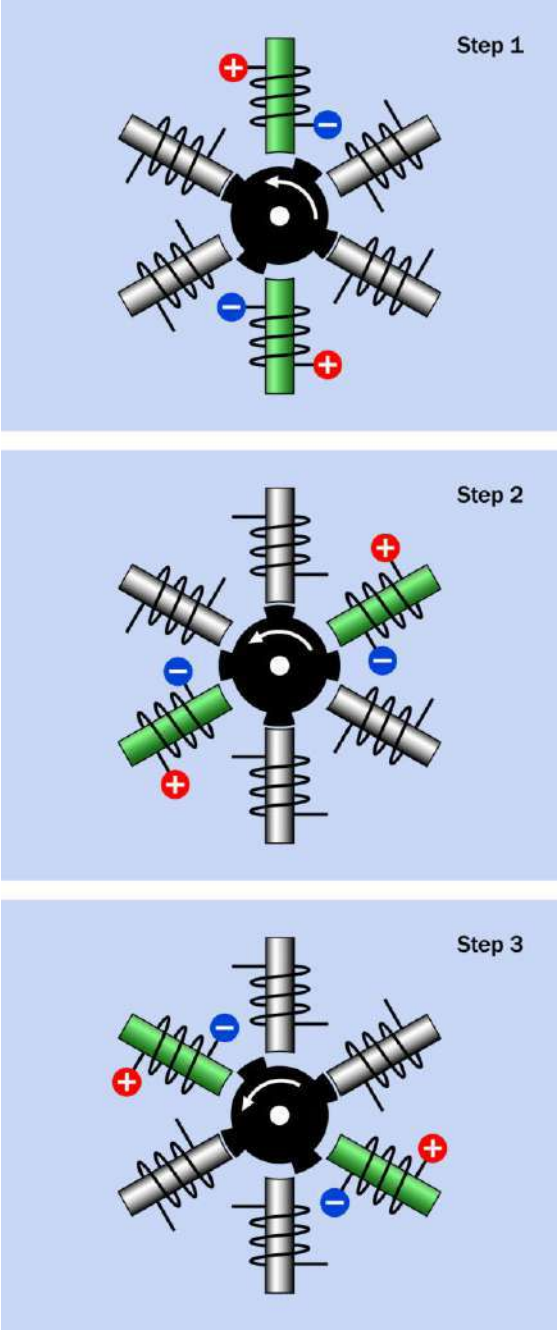

Figure 25-2. *In a variable reluctance stepper motor, the rotor moves to minimize magnetic reluctance each time the next pair of coils is energized. At each step, the coils have been energized a moment before the rotor has had time to respond.*

Permanent Magnet Stepper Motors

More commonly, the rotor of a stepper motor contains permanent magnets, which require the controller to be capable of reversing the magnetic field created by each of the stator coils, so that they alternately attract and repel the rotor magnets.

In a *bipolar* motor, the magnetic field generated by a coil is reversed simply by reversing the current through it. This is shown diagrammatically in Figure 25-3. In a *unipolar* motor, the magnetic field is reversed by applying positive voltage to the center tap of a coil, and grounding one end or the other. This is shown diagrammatically in Figure 25-4.

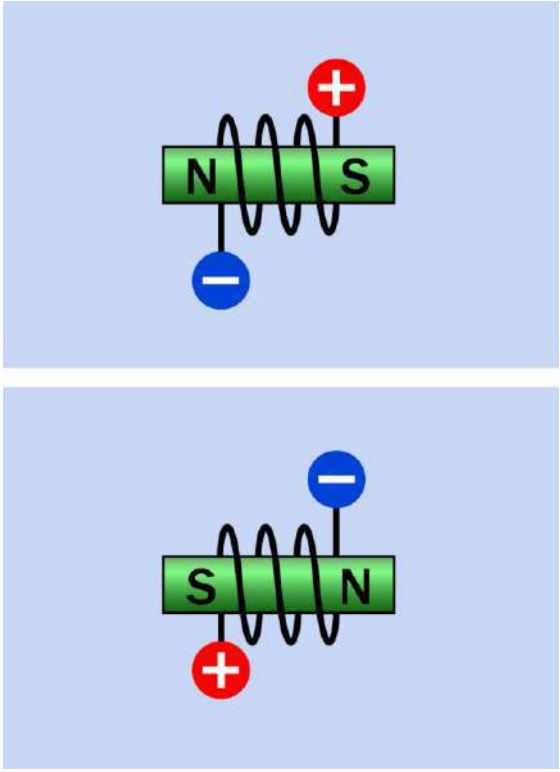

Figure 25-3. *In a bipolar motor, the magnetic field generated by each stator coil is reversed simply by reversing the current through the coil.*

Either type of motor is often designed with an upper and lower deck surrounding a single rotor,

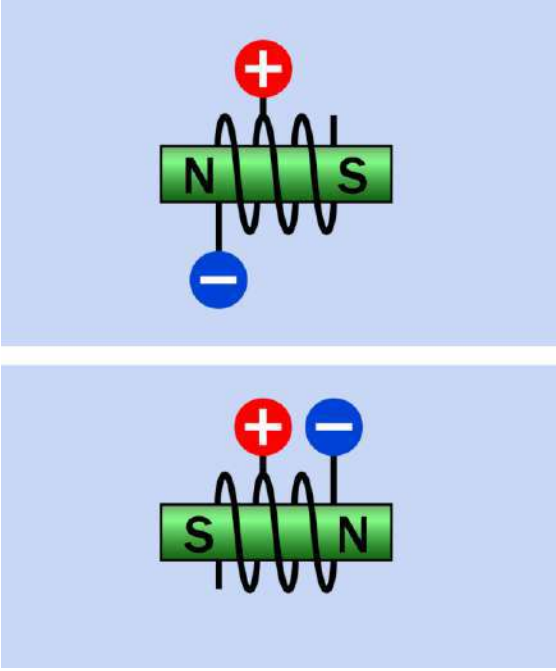

Figure 25-4. *The magnetic field of this coil is reversed by applying positive voltage constantly to a center tap and grounding one end of the coil or the other.*

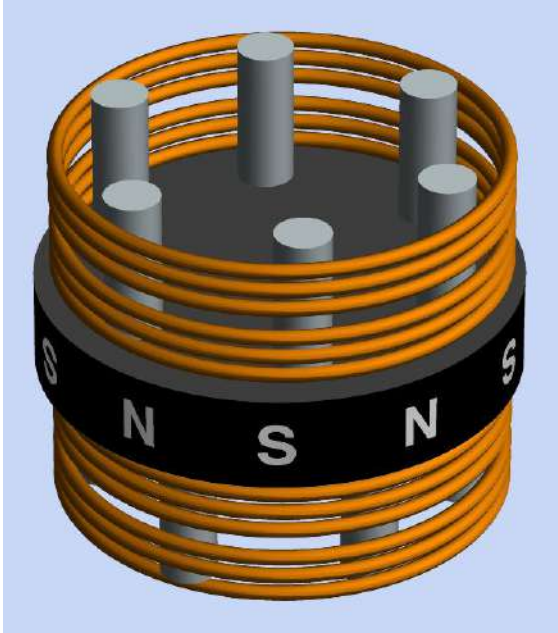

Figure 25-5. *A simplified rendering of the common "two deck" type of motor. See text for details.*

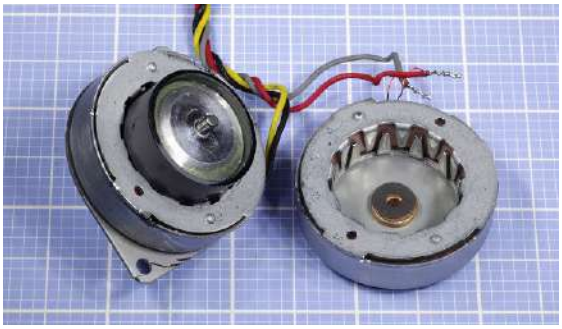

Figure 25-6. *A two-deck stepper motor split open to reveal its rotor (left) and one of the stators (right) encircled by a coil.*

as suggested in Figure 25-5. A large single coil, or center-tapped coil, induces a magnetic field in multiple poles in the top deck, out of phase by one step with a second set of poles, energized by their own coil, in the bottom deck. (All three motors shown in Figure 25-1 are of this type.) The rotor of the motor is tall enough to span both decks, and is rotated by each of them in turn.

In Figure 25-6, the decks of a two-deck four-wire motor have been split apart. The rotor remains in the left-hand section. It is enclosed within a black cylinder that is a permanent magnet divided into multiple poles. In the right-hand section, a coil is visible surrounding metal "teeth" that function as stator poles when the coil is energized.

In Figure 25-7, the same motor has been further disassembled. The coil was secured with a length of tape around its periphery, which has been removed to make the coil visible. The remaining half of the motor, at top-right, contains a second, concealed but identical coil with its own set of poles, one step out of phase with those in the first deck.

Because the field effects in a two-deck stepper motor are difficult to visualize, the remaining diagrams show simplified configurations with a minimum number of stator poles, each with its own coil.

Figure 25-7. *The stepper motor from the previous figure, further disassembled.*

Bipolar Stepper Motors

The most basic way to reverse the current in a coil is by using an *H-bridge* configuration of switches, as shown in Figure 25-8, where the green arrow indicates the direction of the magnetic field. In actual applications, the switches are solid-state. Integrated circuits are available containing all the necessary components to control a bipolar stepper motor.

Four sequential steps of a bipolar motor are shown in Figure 25-9, Figure 25-10, Figure 25-11, and Figure 25-12. The H-bridge control electronics for each coil are omitted for clarity. As before, energized coils are shown with the pole inside the coil tinted green, while non-energized coils are gray, and the rotor is shown before it has had time to respond to the magnetic field in each step.

Unipolar Motors

The control electronics for a unipolar motor can be simpler than those for a bipolar motor, as off-the-shelf switching transistors can ground one end of the coil or the other. The classic five-wire unipolar stepper motor, often sold to hobbyists and used in robotics projects and similar applications, can be driven by nothing more elaborate

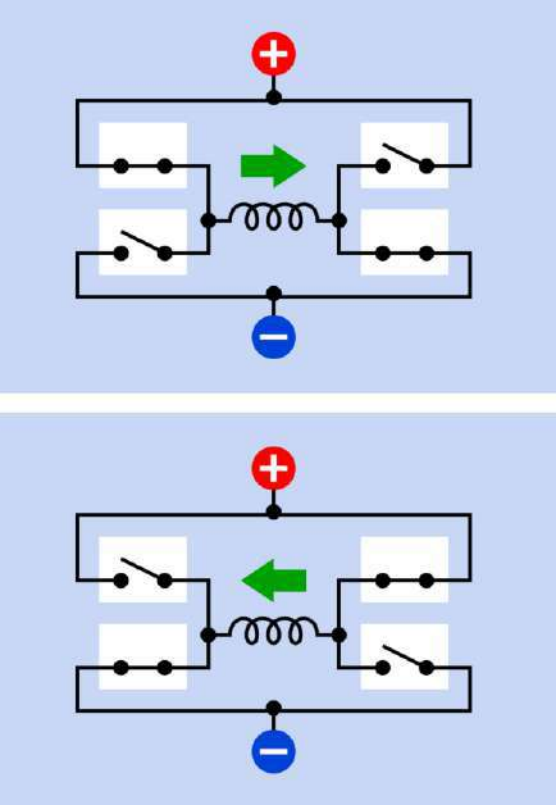

Figure 25-8. *The simplest and most basic way to reverse the current through a coil is via an H-bridge circuit. In practice, the switches are replaced by solid-state components.*

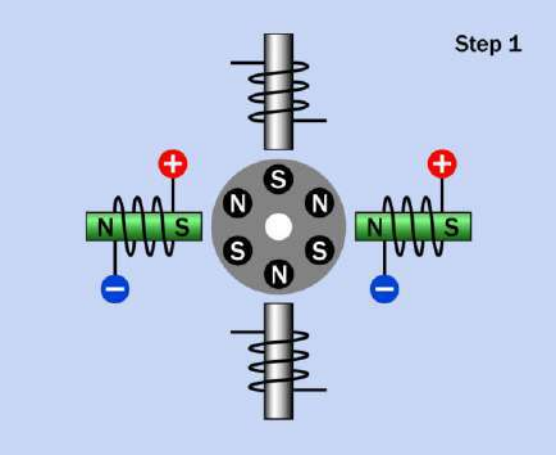

Figure 25-9. *A bipolar stepper motor depicted a moment before the rotor has had time to make its first step in response to magnetic fields created by the stator coils.*

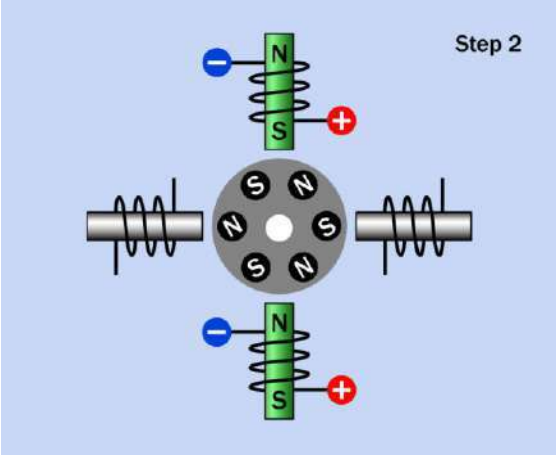

Figure 25-10. *The bipolar stepper motor from the previous figure is shown with its rotor having advanced by one step, and coil polarity changed to induce it to make a second step.*

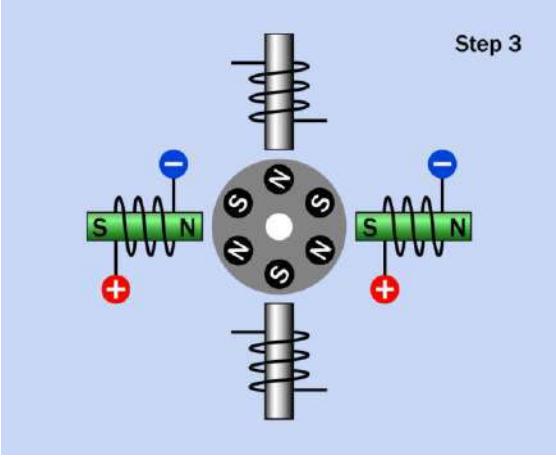

Figure 25-11. *The bipolar stepper motor after taking its second step, immediately before making its third step.*

than a set of *555 timer* chips. However, this type of motor is less powerful for its size and weight because only half of each coil is energized at a time.

In Figure 25-13, Figure 25-14, Figure 25-15, and Figure 25-16, the simplest configuration of a unipolar system is shown in diagrammatic form using four stator coils and a rotor containing six magnetic poles. Each figure shows the stator coils when they have just been energized, a moment before the rotor has had time to move in response to them. Coils that are energized are shown with the metal cores tinted green. Wires that are not conducting current are shown in gray. The open and closed positions of switches a, b, c, and d suggest the path that current is taking along the wires that are colored black.

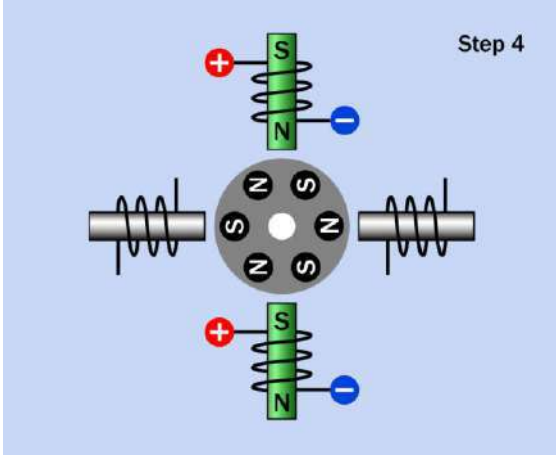

Figure 25-12. *The bipolar stepper motor after taking its third step. When the rotor responds to the new pattern of magnetic fields, its orientation will be functionally identical with that shown in the first step.*

Note that coils on opposite sides of the motor are energized simultaneously, while the other pair of coils is de-energized. Adjusting the controller so that it overlaps the "on" cycles of the coils can generate more torque, while consuming more power.

A motor containing more stator poles can advance in smaller steps, if the poles are separately energized. However, if the coils have individual windings, this will increase the cost of the motor.

Variants

In addition to bipolar and unipolar variants, previously described, three others are available.

High Phase Count

This term describes any type of stepper motor in which additional poles reduce the step size. The advantages of a high phase count include

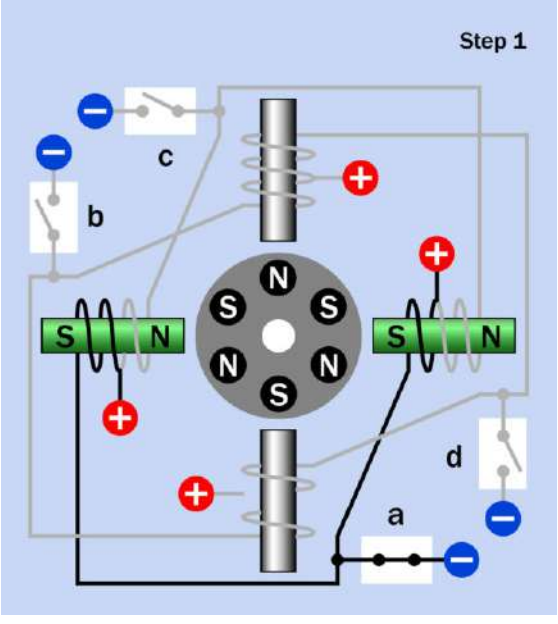

Figure 25-13. *The coils of this unipolar stepper motor are shown an instant after they have been energized, before the rotor has had time to respond by making its first step.*

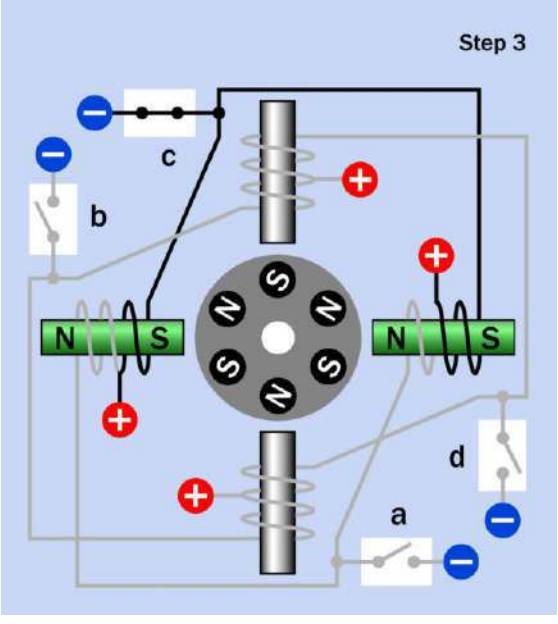

Figure 25-15. *The same motor from the previous figure is shown with coils energized to induce the rotor to make its third step.*

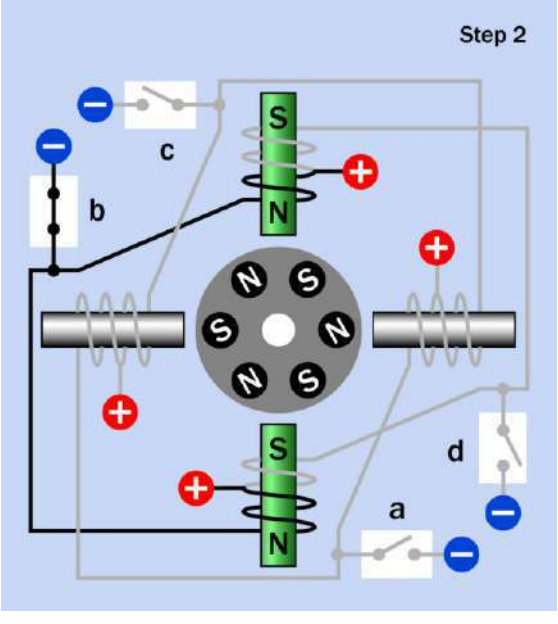

Figure 25-14. *The same motor from the previous figure is shown with coils energized to induce the rotor to make its second step.*

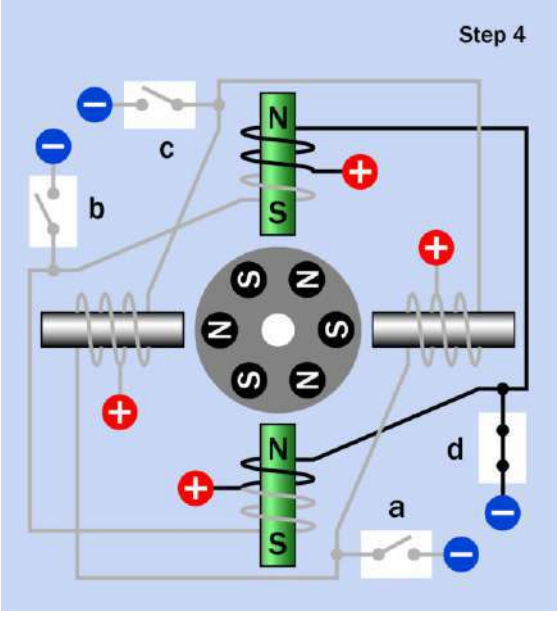

Figure 25-16. *When the rotor makes its fourth step, it will be back in an orientation that is functionally identical with the first figure in this series.*

smoother running at high speed and greater precision when selecting a desired motor position. The additional coils also enable higher power density, but naturally tend to add to the cost of the motor.

Hybrid

This type of motor uses a toothed rotor that provides variable reluctance while also containing permanent magnets. It has become relatively common, as the addition of teeth to the rotor enables greater precision and efficiency. From a control point of view, the motor behaves like a regular permanent-magnet stepper motor.

Bifilar

In this type of motor, also sometimes known as a *universal* stepper motor, two coils are wound in parallel for each stator pole. If there are two poles or sets of poles, and both ends of each winding are accessible via wires that are run out of the motor, there will be eight wires in total. Consequently this type is often referred to as an *8-wire motor*.

The advantage of this scheme is that it allows three possible configurations for the internal coils. By shorting together the wires selectively, the motor can be made to function either in unipolar or bipolar mode.

In Figure 25-17, the upper pair of simplified diagrams depicts one end of one coil connected to the beginning of the other, while positive voltage is applied at the midpoint, as in a unipolar motor. The magnetic polarity of the coil is determined by grounding either end of the coil. The section of each coil that is not conducting current is shown in gray.

The center pair of diagrams shows the adjacent ends of the coils tied together, so that they are now energized in parallel, with the magnetic polarity being determined by the polarity of the voltage, as in a bipolar motor.

The coils may also be connected in series, as shown in the lower pair of diagrams. This will provide greater torque at low speed and lower torque at high speed, while enabling higher-voltage, lower-current operation.

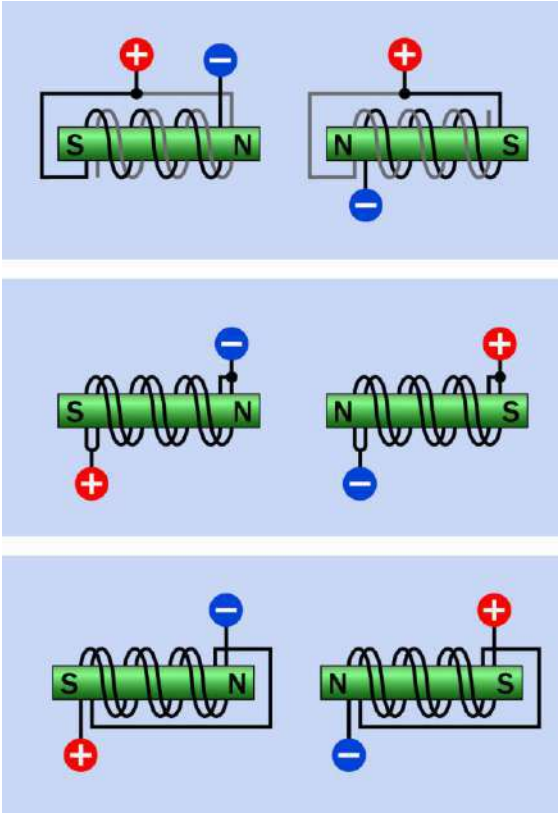

Figure 25-17. *In a bifilar motor, two coils are wound in parallel around each stator pole and can be connected with a center tap to emulate a unipolar motor (upper diagrams), or can be energized in parallel (middle diagrams) or series (lower diagrams) to emulate a bipolar motor.*

Multiphase

In a multiphase motor, multiple stator coils are usually connected in series, with a center tap applied between each pair. A possible configuration is shown in Figure 25-18, where the two diagrams show two consecutive steps in rotation, although the step angle could be halved by changing the voltage polarity in only one location at a time. The way in which the motor is wired

enables only one stator coil to be unpowered during any step, because its two ends are at equal potential. Therefore this type of motor is capable of high torque in a relatively small format.

In some multiphase motors, additional wires allow access to both ends of each coil, and the coils are not connected internally. This allows control of the motor to be customized.

Microstepping

An appropriately designed stepper motor can be induced to make very small, intermediate steps if the control voltage is modulated to intermediate levels. Step angles as low as 0.007 degrees are claimed by some manufacturers. However, a motor running in this mode is less able to generate torque.

The simplest form of microstepping is half-stepping. To achieve this in a unipolar motor, each coil passes through an "off" state before its magnetic polarity is reversed.

Sensing and Feedback

So long as the series of pulses to the motor allows the rotor ample time to respond, no feedback mechanism from the rotor is necessary to confirm its position, and an open-loop system is sufficient. If sudden acceleration, deceleration, load fluctuations, and/or rotation reversal will occur, or if high speeds are involved, a *closed loop system*, in which a sensor provides positional feedback, may be necessary.

Voltage Control

Rapid stepping of a motor requires rapid creation and collapse of magnetic fields in the stator windings. Therefore, self-inductance of the windings can limit the motor speed. One way to overcome this is to use a higher voltage. A more sophisticated solution is to use a controller that provides a high initial voltage, which is reduced or briefly interrupted when a sensor indicates that coil current has increased sufficiently to overcome the self-inductance of the windings and has reached its imposed limit. This type of controller may be referred to as a *chopper drive* as the voltage is "chopped," usually by power transistors. It is a form of *pulse width modulation*.

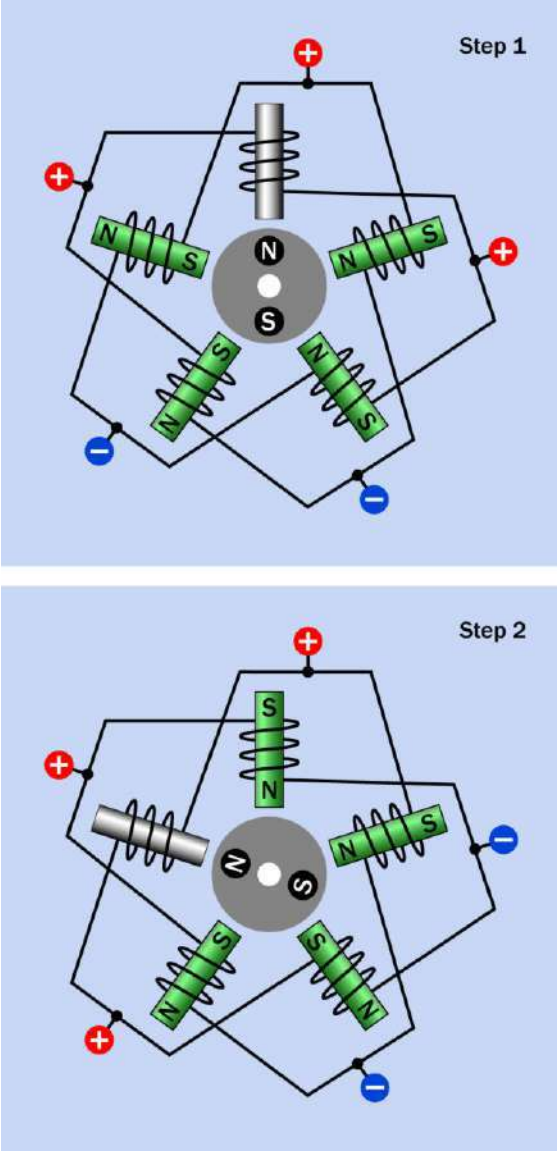

Figure 25-18. *A multiphase stepper motor. By applying voltage in the pattern shown, only one coil is not energized during each step. This enables high torque compared with the size of the motor.*

Values

The *step angle* of a stepper motor is the angular rotation of its shaft, in degrees, for each full step. This will be determined by the physical construction of the motor. The coarsest step angle is 90 degrees, while sophisticated motors may be capable of 1.8 degrees (without microstepping).

The maximum torque that a motor can deliver is discussed in "Values" (page 184) in the **DC motor** entry of this encyclopedia.

Motor weight and size, shaft length, and shaft diameter are the principal passive values of a stepper motor, which should be checked before it is selected for use.

How to Use it

Stepper motors are used to control the seek action in disk drives, the print-head movement and paper advance in computer printers, and the scanning motion in document scanners and copiers.

Industrial and laboratory applications include the adjustment of optical devices (modern telescopes are often oriented with stepper motors), and valve control in fluid systems.

A stepper motor may be used to power a *linear actuator*, usually via a screw thread (properly known as a lead screw) or worm gear. For more on linear actuators, see "Linear Actuator" (page 184). While the stepper motor will enable greater accuracy than a traditional DC motor, the gearing inevitably will introduce some imprecision.

Advantages of stepper motors include:

- Precise positioning, typically within 3 percent to 5 percent per step. The percentage step error does not accumulate as the motor rotates
- Able to run at a wide range of speeds, including very slow speeds without reduction gearing
- Trouble-free start, stop, and reverse action
- Cheap controller hardware where open-loop applications are acceptable
- High reliability, since no brushes or commutator are involved

Disadvantages include:

- Noise and vibration
- Resonance at low speeds
- Progressive loss of torque at high speeds

Protection Diodes

While a small stepper motor may be driven directly from power transistors, *darlington pairs*, or even *555 timers*, larger motors will create *back-EMF* when the magnetic field of each stator coil is induced or forward EMF when the field is allowed to collapse, and bipolar motors will also induce voltage spikes when the current reverses. In a unipolar motor, while only one-half of the coil is actually energized via its center tap, the other half will have an induced voltage, as the coil acts like a *linear transformer*.

A simplified schematic illustrating diode placement for a bipolar motor is shown in Figure 25-19.

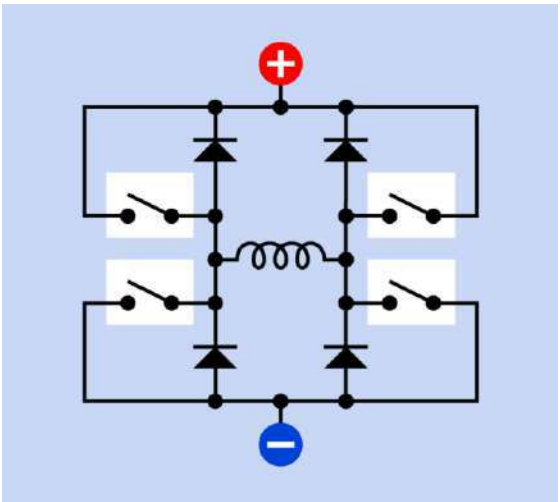

Figure 25-19. *The H-bridge circuit must be augmented with protection diodes to guard against back-EMF created by fluctuating current in the stator coil.*

Integrated circuit chips are available taht incorporate protection diodes, in addition to the necessary power transistors. Stepper motors may also have protection diodes built in. Consult the manufacturer's datasheet for details before attaching a motor to a power source.

Positional Control

The built-in control electronics of a **servo motor** typically turn the shaft to a precisely known position in response to pulse-width modulation from an exterior source such as a **microcontroller**, whereas the angle of rotation of a stepper motor in an open-loop system must be calculated by counting the number of steps from an initial, home position. This limitation of a stepper motor can be overcome by using a closed-loop system, but that will require monitoring the motor, adding complexity to the external controller. The choice between stepper and servo motors should be evaluated on a case-by-case basis.

What Can Go Wrong

General problems affecting all types of motors are listed in "Heat effects" (page 188). Issues relating more specifically to stepper motors are listed in the following sections.

Incorrect Wiring

Because a stepper motor is driven via multiple conductors, there is a significant risk of wiring errors, especially since many motors are not identified with part numbers. The first challenge, then, may be to determine what type of motor it is. When the motor is disconnected from any power, and the shaft is rotated with finger and thumb, a magnetized-rotor motor will not spin as freely as a reluctance motor, because the magnets in the rotor will provide intermittent turning resistance.

If a unipolar motor is relatively small and is fitted with five wires, almost certainly the motor contains two coils, each with a center tap, and their function can be determined by applying positive voltage to the red wire and grounding each of the other wires in turn. Attaching a small piece of tape to the motor shaft will assist in viewing its orientation.

A multimeter set to measure ohms can also be useful in deducing the internal coil connections of the motor, since the end-to-end resistance of a coil should be approximately twice the resistance between the center tap and either end of the coil.

A multiphase motor may have five wires, but in this case, the resistance between any two non-adjacent wires will be 1.5 times the resistance between any two adjacent wires.

Step Loss

In an open-loop system, if the motor skips or misses pulses from the controller, the controller no longer has an accurate assessment of the shaft angle. This is known as *step loss*. Since this can be caused by sudden changes in control frequency, the frequency should be increased (or decreased) gradually. This is known as *ramping* the motor speed. Stepper motors cannot respond instantly to changes in speed, because of inertia in the rotor or in the device that the motor is driving.

Where the motor turns one or more steps beyond its commanded stopping point, this is known as *overshoot*.

Step loss may also occur if the motor continues turning after power has been interrupted (either intentionally or because of an external fault). In an open-loop system, the controller should be designed to reset the motor position when power is initiated.

Excessive Torque

When the motor is stationary and not powered, *detent torque* is the maximum turning force that can be applied without causing the shaft to turn. When the motor is stationary and the controller does deliver power to it, *holding torque* is the maximum turning force that can be applied

without causing the shaft to turn, and *pull-in torque* is the maximum torque which the motor can apply to overcome resistance and reach full speed. When the motor is running, *pull-out torque* is the maximum torque the motor can deliver without suffering step loss (pulling it out of sync with its controller). Some or all of these values should be specified on the motor's datasheet. Exceeding any of them will result in step loss.

Hysteresis

When a controller directs a stepper motor to seek a specified position, the term *hysteresis* is often used to mean the total error between the actual position it reaches when turning clockwise, and the actual position it reaches when turning counter-clockwise. This difference may occur because a stepper motor tends to stop a fraction short of its intended position, especially under significant load. Any design that requires precision should be tested under real-world conditions to assess the hysteresis of the motor.

Resonance

A motor has a natural resonant frequency. If it is stepped near that frequency, vibration will tend to be amplified, which can cause positional errors, gear wear (if gears are attached), bearing wear, noise, and other issues. A good datasheet should specify the resonant frequency of the motor, and the motor should run above that frequency if possible. The problem can be addressed by rubber motor mounts or by using a resilient component, such as a drive belt, in conjunction with the drive shaft. *Damping* the vibration may be attempted by adding weight to the motor mount.

Note that if the motor has any significant weight attached directly to its shaft, this will lower its resonant frequency, and should be taken into account.

Resonance may also cause *step loss* (see preceding sections).

Hunting

In a closed-loop system, a sensor on the motor reports its rotational position to the controller, and if necessary, the controller responds by adjusting the position of the motor. Like any feedback system, this entails some lag time, and at certain speeds the motor may start *hunting* or *oscillating* as the controller over-corrects and must then correct its correction. Some closed-loop controllers avoid this issue by running mostly in open-loop mode, using correction only when the motor experiences conditions (such as sudden speed changes), which are likely to cause step loss.

Saturation

While it may be tempting to increase the torque from a stepper motor by upping the voltage (which will increase the current through the stator coils), in practice motors are usually designed so that the cores of the coils will be close to saturation at the rated voltage. Therefore, increasing the voltage may achieve very little increase in power, while causing a significant increase in heat.

Rotor Demagnetization

The permanent magnets in a rotor can be partially demagnetized by excessive heat. Demagnetization can also occur if the magnets are exposed to high-frequency alternating current when the rotor is stationary. Therefore, attempting to run a stepper motor at high speed when the rotor is stalled can cause irrevocable loss of performance.

diode

26

The term **diode** almost always means a semiconductor device, properly known as a *PN junction diode*, although the full term is not often used. It was formerly known as a *crystal diode*. Before that, **diode** usually meant a type of *vacuum tube*, which is now rarely used outside of high-wattage RF transmitters and some high-end audio equipment.

OTHER RELATED COMPONENTS

- **rectifier** (See "Rectification" (page 227))
- **unijunction transistor** (See Chapter 27)
- **LED** (light-emitting diode) (Volume 2)

What It Does

A diode is a two-terminal device that allows current to flow in one direction, known as the *forward direction,* when the *anode* of the diode has a higher positive potential than the *cathode*. In this state, the diode is said to be *forward biased*. If the polarity of the voltage is reversed, the diode is now *reverse biased*, and it will attempt to block current flow, within its rated limits.

Diodes are often used as *rectifiers* to convert alternating current into direct current. They may also be used to suppress voltage spikes or protect components that would be vulnerable to reversed voltage, and they have specialized applications in high-frequency circuits.

A *Zener diode* can regulate voltage, a *varactor diode* can control a high-frequency oscillator, and *tunnel diodes*, *Gunn diodes*, and *PIN diodes* have high-frequency applications appropriate to their rapid switching capability. An **LED** (*light-emitting diode*) is a highly efficient light source, which is discussed in Volume 2 of this encyclopedia. A **photosensitive diode** will adjust its ability to pass current depending on the light that falls upon it, and is included as a *sensor* in Volume 3.

See Figure 26-1 for schematic symbols representing a generic diode.

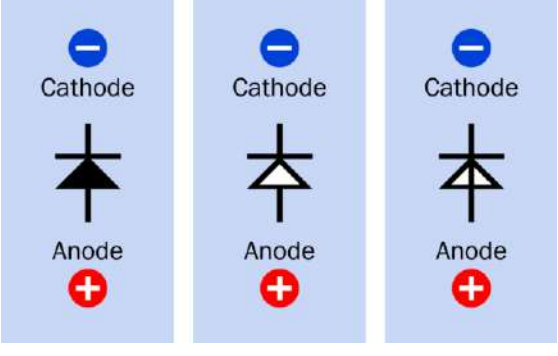

Figure 26-1. *Commonly used schematic symbols for a generic diode. All the symbols are functionally identical. The direction of the arrow formed by the triangle indicates the direction of conventional current (from positive to negative) when the diode is forward-biased.*

The basic diode symbol is modified in various ways to represent variants, as shown in Figure 26-2.

At top

Each symbol in the group of six indicates a Zener diode. All are functionally identical.

Bottom-left
Tunnel diode.

Bottom-center
Schottky diode.

Bottom-right
Varactor.

A triangle with an open center does not indicate any different function from a triangle with a solid center. The direction of the arrow always indicates the direction of conventional current, from positive to negative, when the diode is forward-biased, although the functionality of Zener diodes and varactors depends on them being reverse-biased, and thus they are used with current flowing opposite to the arrow symbol. The bent line used in the Zener symbol can be thought of as an opened letter Z, while the curled line used in the Schottky diode symbol can be thought of as a letter S, although these lines are sometimes drawn flipped left-to-right.

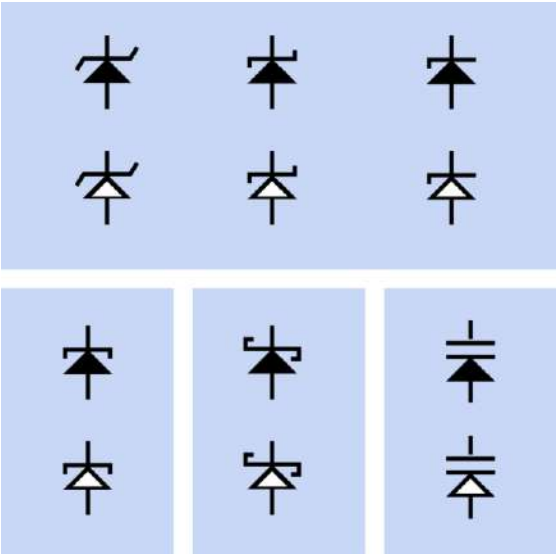

Figure 26-2. *Commonly used schematic symbols for specialized types of diodes. See text for details.*

A range of rectifier and signal diodes is shown in Figure 26-3. (Top: Rectifier diode rated 7.5A at 35VDC. Second from top: Rectifier diode rated 5A at 35VDC. Center: Rectifier diode rated 3A at 35VDC. Second from bottom: 1N4001 Rectifier diode rated 1A at 35VDC. Bottom: 1N4148 signal switching diode rated at 300mA.) All values are for forward continuous current and RMS voltage. Each cylindrical diode is marked with a silver stripe (a black stripe on the 1N4148) to identify its *cathode*, or the end of the diode that should be "more negative" when the component is forward biased. Peak current can greatly exceed continuous current without damaging the component. Datasheets will provide additional information.

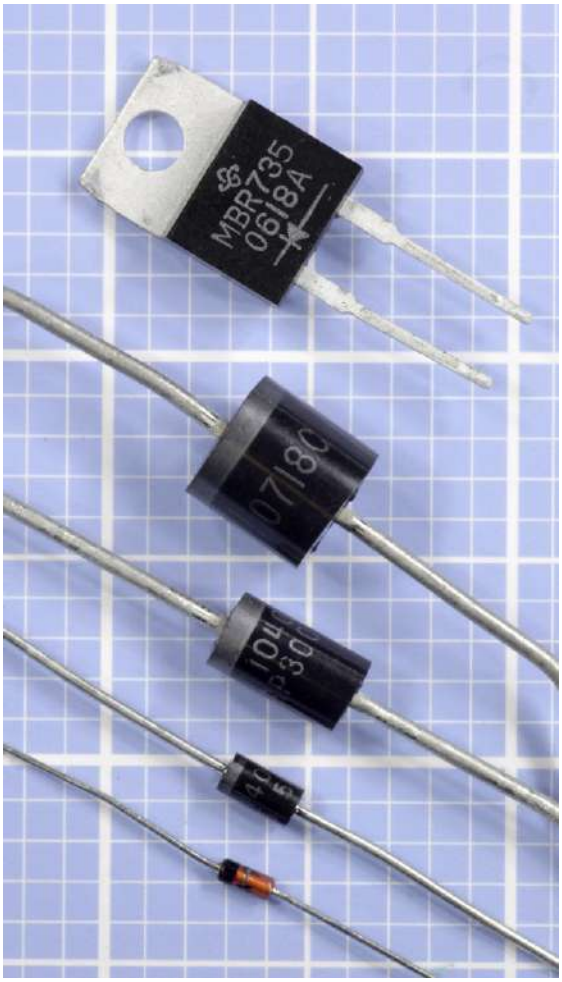

Figure 26-3. *Diodes ranging in continuous forward-current capability from 7.5A (top) to 300mA (bottom). See text for additional details.*

How It Works

A PN diode is a two-layer *semiconductor*, usually fabricated from silicon, sometimes from germanium, and rarely from other materials. The layers are doped with impurities to adjust their electrical characteristics (this concept is explained in more detail in Chapter 28). The *N layer* (on the negative, cathode side) has a surplus of electrons, creating a net negative charge. The *P layer* (on the positive, anode side) has a deficit of electrons, creating a net positive charge. The deficit of electrons can also be thought of as a surplus of "positive charges," or more accurately, a surplus of *electron holes*, which can be considered as spaces that electrons can fill.

When the negative side of an external voltage source is connected with the cathode of a diode, and the positive side is connected with the anode, the diode is forward-biased, and electrons and electron holes are forced by mutual repulsion toward the junction between the n and p layers (see Figure 26-4). In a silicon diode, if the potential difference is greater than approximately 0.6 volts, this is known as the *junction threshold voltage*, and the charges start to pass through the junction. The threshold is only about 0.2 volts in a germanium diode, while in a Schottky diode it is about 0.4 volts.

If the negative side of an external voltage source is connected with the anode of a diode and positive side is connected with the cathode, the diode is now reverse-biased, and electrons and electron holes are attracted away from the junction between the n and p layers. The junction is now a *depletion region*, which blocks current.

Like any electronic component, a diode is not 100% efficient. When it is forward-biased and is passing current, it imposes a small voltage drop of around 0.7V for a silicon-based diode (Schottky diodes can impose a drop of as little as 0.2V, germanium diodes 0.3V, and some LEDs between 1.4V and 4V). This energy is dissipated as heat. When the diode is reverse-biased, it is still not 100% efficient, this time in its task of blocking

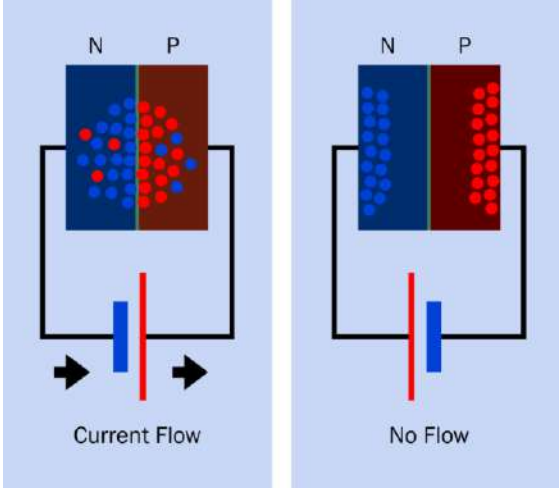

Figure 26-4. *Inside a PN junction diode. Left: in forward-biased mode, voltage from a battery (bottom, with plates colored for clarity) forces charges in the N and P layers toward the central junction of the diode. Current begins to flow. Right: in reverse-biased mode, charges in the N and P layers are attracted away from the central junction, which becomes a depletion region, unable to pass significant current.*

current. The very small amount of current that manages to get through is known as *leakage*. This is almost always less than 1mA and may be just a few µA, depending on the type of diode.

The performance of a theoretical generic PN diode is illustrated in Figure 26-5. The right-hand side of the graph shows that if a diode is forward-biased with a gradually increasing potential, no current passes until the diode reaches its junction threshold voltage, after which the current rises very steeply, as the *dynamic resistance* of the diode diminishes to near zero. The left-hand side of the graph shows that when the diode is reverse-biased with a gradually increasing potential, initially a very small amount of current passes as leakage (the graph exaggerates this for clarity). Eventually, if the potential is high enough, the diode reaches its intrinsic *breakdown voltage*, and once again its effective resistance diminishes to near zero. At either end of the curve, the diode will be easily and permanently

damaged by excessive current. With the exception of Zener diodes and varactors, reverse bias on a diode should not be allowed to reach the breakdown voltage level.

The graph in Figure 26-5 does not have a consistent scale on its Y axis, and in many diodes the magnitude of the (reverse-biased) breakdown voltage will be as much as 100 times the magnitude of the (forward-biased) threshold voltage. The graph has been simplified for clarity.

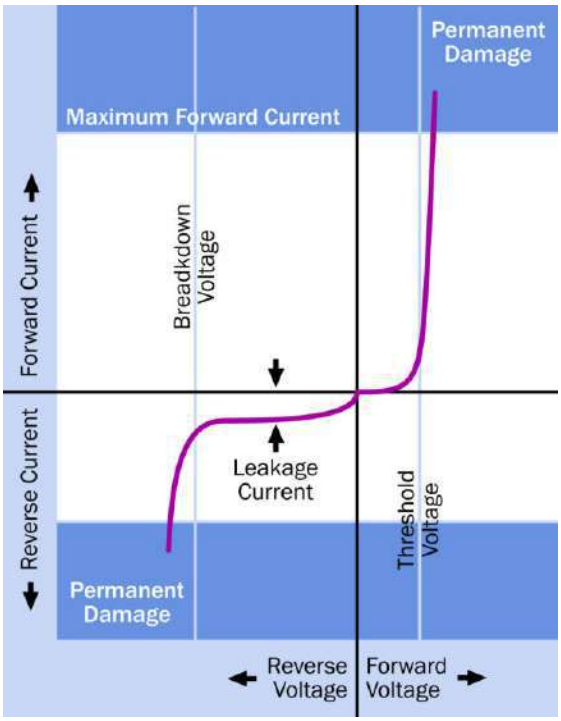

Figure 26-5. *As the forward voltage across a diode reaches the junction threshold, the diode begins passing current. If the voltage across the diode is reversed, initially a small amount of current leakeage occurs. Excessive forward or reverse voltage will create sufficient current to destroy the component.*

Variants

Packaging

Some diodes have no information at all printed on them, while others may have a part number. Any additional information is rare. No convention exists for indicating the electrical characteristics of the component by colors or abbreviations. If one terminal is marked in any way, almost certainly it is the cathode. One way to remember the meaning of a stripe on the cathode end of a rectifier diode or signal diode is by thinking of it as resembling the line in the diode schematic symbol.

Signal Diodes

Also known as *switching diodes* and *high-speed diodes*, their small size provides a low junction capacitance, enabling fast response times. They are not designed to withstand high currents. Signal diodes traditionally were packaged with axial leads for through-hole installation (like traditional-style resistors). Although this format still exists, signal diodes are now more commonly available in surface-mount formats.

Rectifier Diodes

Physically larger than signal diodes, and capable of handling higher currents. Their higher junction capacitance makes them unsuitable for fast switching. Rectifier diodes often have axial leads, although different package formats are used where higher currents are involved, and may include a heat sink, or may have provision for being attached to a heat sink.

There are no generally agreed maximum or minimum ratings to distinguish signal diodes from rectifier diodes.

Zener Diode

A Zener diode generally behaves very similarly to a signal or rectifier diode, except that its breakdown voltage is lower.

The Zener is intended to be reverse-biased; that is, conventional current is applied through it "in the wrong direction" compared with conventional diodes. As the current increases, the *dynamic resistance* of the Zener diode decreases. This relationship is shown in Figure 26-6, where the two colored curves represent the performance of different possible Zener diodes. (The curves are adapted from a manufacturer's data-

sheet.) This behavior allows the Zener to be used in simple voltage-regulator circuits, as it can allow a reverse current to flow at a voltage limited by the diode's breakdown voltage. Other applications for Zener diodes are described in "DC Voltage Regulation and Noise Suppression" (page 230). A typical Zener diode is shown in Figure 26-7.

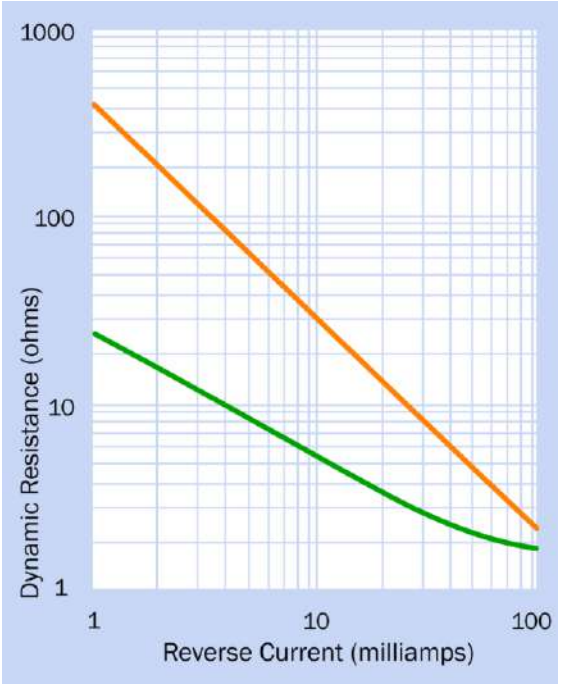

Figure 26-6. *A manufacturer's datasheet may include graphs of this kind, showing the variation in dynamic resistance of two reverse-biased Zener diodes in response to changes in current.*

Figure 26-7. *A 1N4740 Zener diode.*

Transient Voltage Suppressor (TVS)

A form of Zener diode designed to protect sensitive devices from transient voltage spikes by clamping them—in other words, diverting the energy to ground. A TVS can absorb as much as 30,000 volts from a lightning strike or static discharge. Typically the Zener diode is incorporated in a network of other diodes in a surface-mount integrated circuit chip.

Zener diodes can also be used in circuits to handle electrostatic discharge (ESD), which can occur when a person unknowingly accumulates an electrostatic potential and then grounds it by touching an electronic device.

Schottky Diode

This type has a low junction capacitance, enabling faster switching than comparable generic silicon diodes. It also imposes a lower forward voltage drop, which can be desirable in low-voltage applications, and allows less power dissipation when a diode is necessary to control current flow. The Schottky diode is fabricated with a semiconductor-to-metal junction, and tends to be slightly more expensive than generic silicon diodes with similar voltage and current specifications.

Varactor Diode

Also known as a *varicap*, this type of diode has variable capacitance controlled by reverse voltage. While other diodes may exhibit this same phenomenon, the varactor is specifically designed to exploit it at very high frequencies. The voltage expands or contracts the depletion region in the junction between the P and N regions, which can be thought of as analogous to moving the plates of a capacitor nearer together or farther apart.

Because the capacitance of a varactor has a low maximum of about 100pF, its uses are limited. It is used extensively in RF applications where its voltage-controlled variable capacitance provides a uniquely useful way to control the

frequency of an oscillator circuit. In almost all radio, cellular, and wireless receivers, a varactor controls a phase-locked loop oscillator. In ham radio receivers, it can be used to adjust the tuning of a filter that tracks an incoming radio frequency.

A varactor is always reverse-biased below its breakdown voltage, so that there is no direct conduction. The voltage that controls a varactor must be absolutely free from random fluctuations that would affect its resonant frequency.

Tunnel Diode, Gunn Diode, PIN Diode

Mostly used in very high frequency or microwave applications, where ordinary diodes are unacceptable because they have insufficiently high switching speeds.

Diode Array

Two or more diodes may be encapsulated in a single DIP or (more commonly) surface-mount integrated circuit chip. The internal configuration and the pinouts of the chip will vary from one device to another. Diode arrays may be used for termination of data lines to reduce reflection noise.

Bridge Rectifier

Although this is a diode array, it is commonly indexed in parts catalogues under the term *bridge rectifier*. Numerous through-hole versions are available with ratings as high as 25A, some designed for single-phase input while others process three-phase AC. Screw-terminal components can rectify more than 1,000 volts at 1,000 amps. The package does not usually include any provision for smoothing or filtering the output. See "Rectification" (page 227) for more information on the behavior of a bridge rectifier.

Values

A manufacturer's datasheet for a typical generic diode should define the following values, using abbreviations that may include those in the following list.

- Maximum sustained forward current: I_f or I_o or I_{Omax}
- Forward voltage (the voltage drop imposed by the diode): V_f
- Peak inverse DC voltage (may be referred to as maximum blocking voltage or breakdown voltage): P_{iv} or V_{dc} or V_{br}
- Maximum reverse current (also referred to as leakage): I_r

Datasheets may include additional values when the diode is used with alternating current, and will also include information on peak forward surge current and acceptable operating temperatures.

A typical signal diode is the 1N4148 (included at the bottom of Figure 26-3), which is limited to about 300mA forward current while imposing a voltage drop of about 1V. The component can tolerate a 75V peak inverse voltage. These values may vary slightly among different manufacturers.

Rectifier diodes in the 1N4001/1N4002/1N4003 series have a maximum forward current of 1A and will impose a voltage drop of slightly more than 1V. They can withstand 50V to 1,000V of inverse voltage, depending on the component. Here again, the values may vary slightly among different manufacturers.

Zener diodes have a different specification, as they are used with reverse bias as voltage-regulating devices rather than rectification devices. Manufacturers' data sheets are likely to contain the following terminology:

- Zener voltage (the potential at which the diode begins to allow reverse current flow when it is reverse-biased, similar to breakdown voltage): V_z
- Zener impedance or dynamic resistance (the effective resistance of the diode, specified when it is reverse-biased at the Zener voltage): Z_z

- Maximum or admissible Zener current (or reverse current): I_z or I_{zm}
- Maximum or total power dissipation: P_d or P_{tot}

Zener voltage may be defined within a minimum and maximum range, or as a simple maximum value.

Limits on forward current are often not specified, as the component is not intended to be forward-biased.

How to Use it

Rectification

A *rectifier diode*, as its name implies, is commonly used to rectify alternating current—that is, to turn AC into DC. A half-wave rectifier uses a single diode to block one-half of the AC sinewave. The basic circuit for a half-wave rectifier is shown in Figure 26-8. At top, the diode allows current to circulate counter-clockwise through the load. At bottom, the diode blocks current that attempts to circulate clockwise. Although the output has "gaps" between the pulses, it is usable for simple tasks such as lighting an LED, and with the addition of a smoothing capacitor, can power the coil of a DC relay.

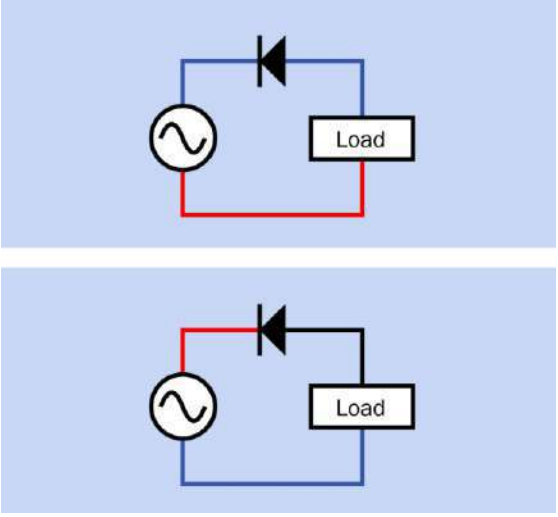

Figure 26-8. *A half-wave rectifier. In this configuration the diode allows AC current to circulate counter-clockwise but blocks it clockwise.*

A full-wave bridge rectifier employs four diodes to provide a more efficient output, usually filtered and smoothed with appropriate **capacitors**. The basic circuit is shown in Figure 26-9. A comparison of input and output waveforms for half-wave and full-wave rectifiers appears in Figure 26-10.

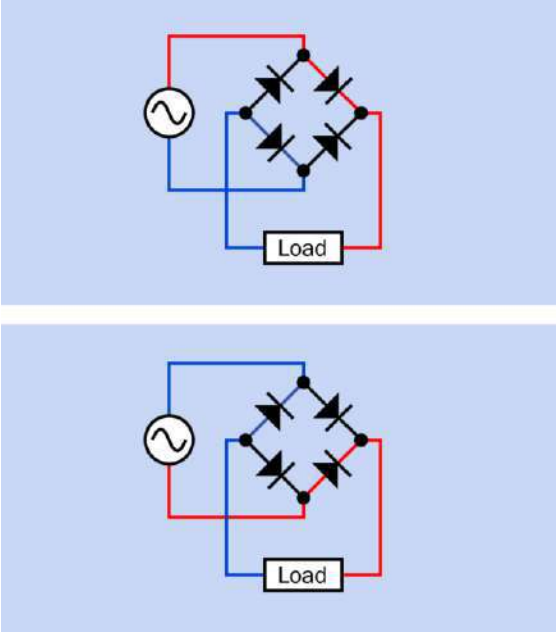

Figure 26-9. *The basic circuit commonly used to form a bridge rectifier, with color added to indicate polarity. Wires shown in black are not passing current because diodes are blocking it. Note that the polarity at the load remains constant.*

Discrete components are seldom used for this purpose, as off-the-shelf bridge rectifiers are available in a single integrated package. Rectifier diodes as discrete components are more likely to be used to suppress *back-EMF* pulses, as described below.

An old but widely used design for a full-wave bridge rectifier is shown in Figure 26-11. This unit measured approximately 2″ × 2″ × 1.5″ and was divided into four sections (as indicated by the solder terminals on the right-hand side), each

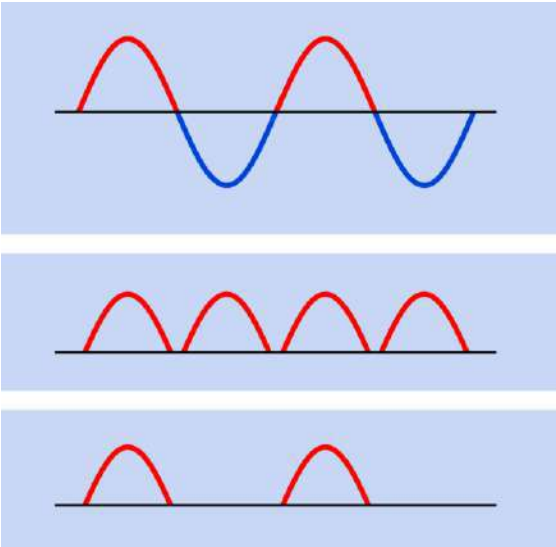

Figure 26-10. *Top: The voltage-amplitude sinewave of an alternating current source that fluctuates between positive voltage (shown red) and negative voltage (shown blue) relative to a neutral (black) baseline. Center: AC current converted by a full-wave rectifier. Because the diodes do not conduct below their threshold voltage, small gaps appear between pulses. Bottom: Output from a half-wave rectifier.*

section corresponding with the functionality of one modern diode. Figure 26-12 shows relatively modern rectifier packages, the one on the left rated at 20A continuous at 800V RMS, the one on the right rated 4A continuous at 200V RMS. In Figure 26-13, the one on the left is rated 4A continuous at 50V RMS, whereas the one on the right is rated 1.5A at 200V RMS.

DC output from rectifier packages is usually supplied via the outermost pins, while the two pins near the center receive AC current. The positive DC pin may be longer than the other three, and is usually marked with a + symbol.

Full-wave bridge rectifiers are also available in surface-mount format. The one in Figure 26-14 is rated for half an amp continuous current.

Back-EMF Suppression

A relay coil, motor, or other device with significant inductance will typically create a spike of voltage when it is turned on or off. This *EMF* can

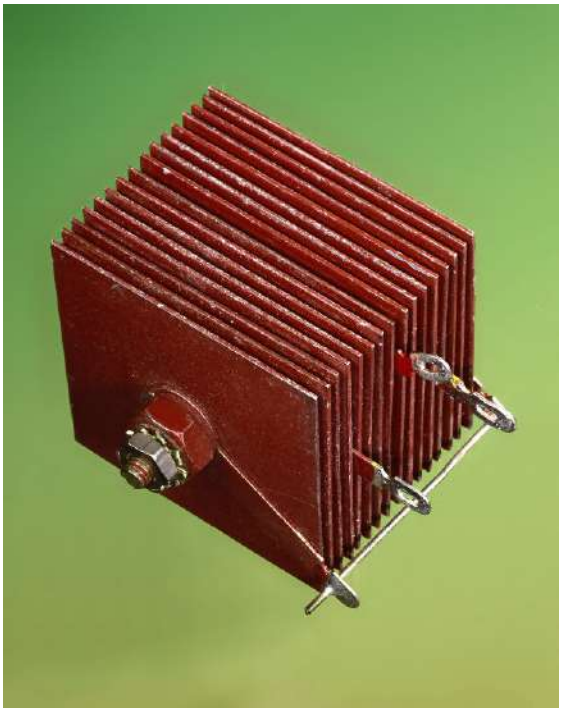

Figure 26-11. *Prior to the perfection of chip fabrication in the late 1960s, it was common to find silicon rectifiers of this type, measuring about 2" square.*

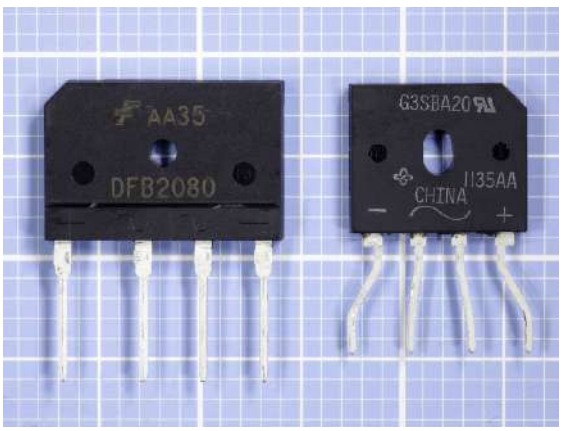

Figure 26-12. *Full-wave bridge rectifies are commonly available in packages such as these. See text for details.*

be shunted through a rectifier diode to safeguard other components in the circuit. A diode in this configuration may be referred to as a *protection diode*, a *clamp diode*, or *transient suppressor*. See Figure 26-15.

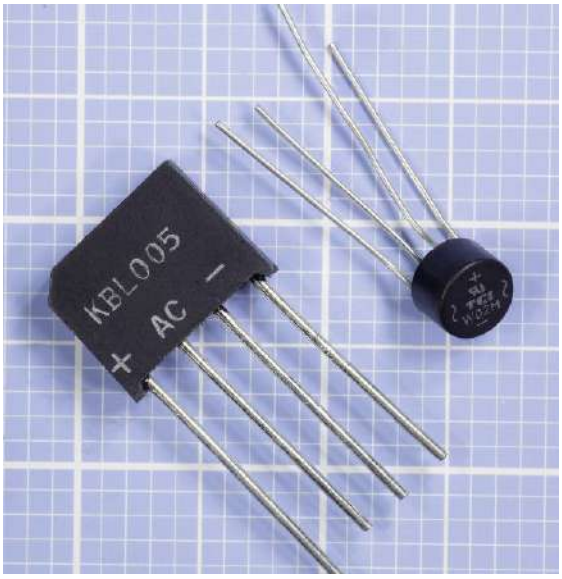

Figure 26-13. *Smaller full-wave bridge rectifiers capable of 1.5A to 4A continuous current.*

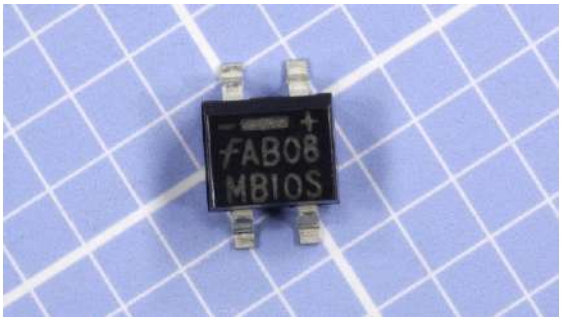

Figure 26-14. *This surface-mount component contains four diodes forming a full-wave bridge rectifier circuit, and can pass 0.5A continuous current. It measures approximately 0.2" square.*

Voltage Selection

A diode is sensitive to the relative voltage between its anode and cathode terminals. In other words, if the cathode is at 9V relative to the ground in the circuit, and the anode is at 12V, the 3V difference will easily exceed the threshold voltage, and the diode will pass current. (Actual tolerable values will depend on the forward voltage capability of the diode.) If the voltages are reversed, the diode will block the current.

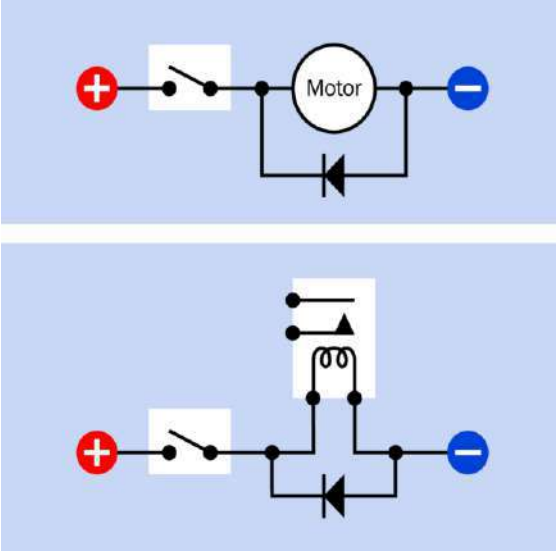

Figure 26-15. *A rectifier diode is very often placed across a motor (top), relay (bottom), or other device with significant inductance that creates a spike of reverse voltage when switched on or off. The surge is shunted through the diode, protecting other components in the circuit.*

This attribute can be used to make a device choose automatically between an AC adapter and a 9V battery. The schematic is shown in Figure 26-16. When an AC adapter that delivers 12VDC is plugged into a wall outlet, the adapter competes with the battery to provide power to a voltage regulator. The battery delivers 9VDC through the lower diode to the cathode side of the upper diode, but the AC adapter trumps it with 12VDC through the upper diode. Consequently, the battery ceases to power the circuit until the AC adapter is unplugged, at which point the battery takes over, and the upper diode now prevents the battery from trying to pass any current back through the AC adapter.

The voltage regulator in this schematic accepts either 12VDC or 9VDC and converts it to 5VDC. (In the case of 12VDC, the regulator will waste more power, which will be dissipated as waste heat.)

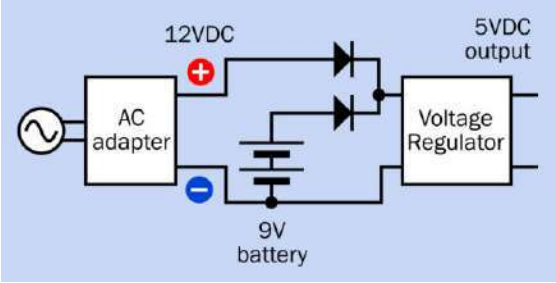

Figure 26-16. *Two diodes with their cathodes tied together will choose automatically between an AC adapter that delivers 12VDC and an internal 9V battery.*

Voltage Clamping

A diode can be used to *clamp* a voltage to a desired value. If an input to a 5V CMOS semiconductor or similarly sensitive device must be prevented from rising out of range, the anode of a diode can be connected to the input and the cathode to a 5V voltage source. If the input rises much above 5.6V, the potential difference exceeds the diode's junction threshold, and the diode diverts the excess energy. See Figure 26-17.

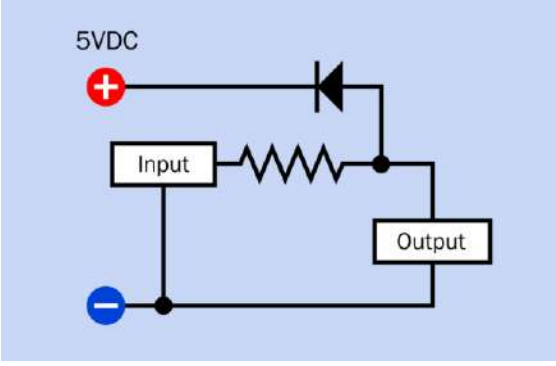

Figure 26-17. *A clamping diode can limit output voltage—in this example, to about 5.6V. If the input rises above that value relative to the common ground, the potential difference across the diode feeds the excess voltage back through it to the 5V source.*

Logic Gate

A signal diode is less than ideal as a logic gate, because it imposes a typical 0.6V voltage reduction, which can be significant in a 5V circuit and is probably unacceptable in a 3.3V circuit. Still, it can be useful on the output side—for example, if two or more outputs from a logic chip or microcontroller are intended to drive, or share, another device such as a single **LED**, as shown in Figure 26-18. In this role, the diodes wired in parallel behave similarly to an OR gate, while preventing either output from the chip from feeding current back into the other output.

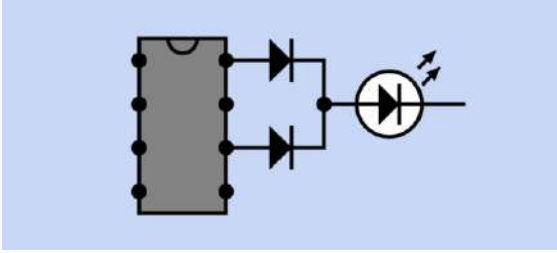

Figure 26-18. *Two or more outputs from a logic chip or microcontroller may be coupled with diodes to power another device, such as an LED, while protecting the chip from backflow of current. The diodes form a logical OR gate.*

DC Voltage Regulation and Noise Suppression

As previously noted, the dynamic resistance of a reverse-biased Zener diode will diminish as the current increases. This relationship begins at the point where breakdown in the diode begins—at its *Zener voltage*--and is approximately linear over a limited range.

The unique behavior of the Zener makes it usable as a very simple voltage controller when placed in series with a resistor as shown in Figure 26-19. It is helpful to imagine the diode and the resistor as forming a kind of voltage divider, with power being taken out at point A in the schematic. If a supply fluctuation increases the input voltage, this will tend to increase the current flowing through the Zener, and its dynamic resistance will diminish accordingly. A lower resistance in its position in the voltage divider will reduce the output voltage at point A, thus tending to compensate for the surge in input voltage.

Conversely, if the load in the circuit increases, and tends to pull down the input voltage, the current

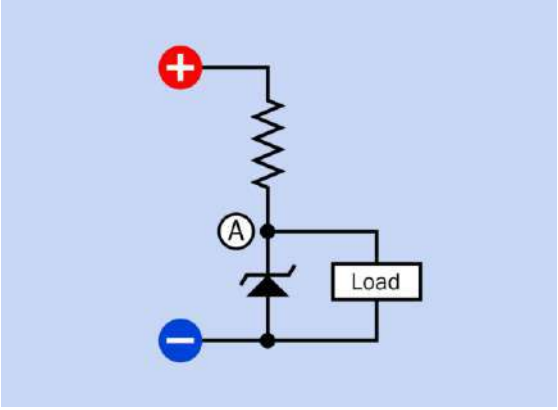

Figure 26-19. *A simplified, basic circuit illustrating the ability of a Zener diode to compensate for variations in the power supply or load in a circuit, creating an approximately constant voltage at point A.*

flowing through the Zener will diminish, and the voltage at point A will tend to increase, once again compensating for the fluctuation in the circuit.

As the series resistor would be a source of heat, a transistor could be added to drive the load, as shown in Figure 26-20.

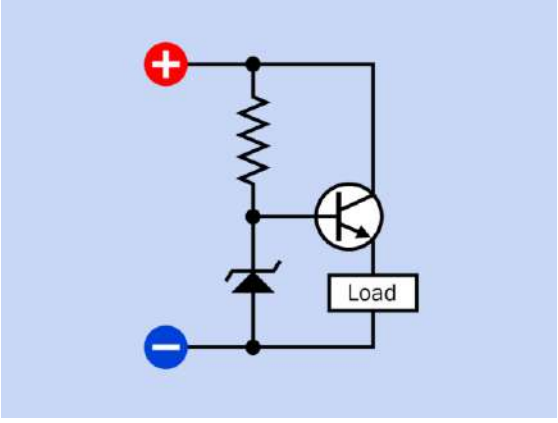

Figure 26-20. *A transistor could be added to the circuit in the previous figure to reduce power waste through the resistor.*

A manufacturer's datasheet may provide guidance regarding the dynamic resistance of a Zener diode in response to current, as previously shown in Figure 26-6. In practice, a packaged **voltage regulator** such as the LM7805 would most likely be used instead of discrete components, since it includes self-calibrating features, requires no series resistor, and is relatively unaffected by temperature. However, the LM7805 contains its own Zener diode, and the principle of operation is still the same.

AC Voltage Control and Signal Clipping

A more practical Zener application would be to limit AC voltage and/or impose clipping on an AC sinewave, using two diodes wired in series with opposed polarities. The basic schematic is shown in Figure 26-21, while clipping of the AC sinewave is illustrated in Figure 26-22. In this application, when one diode is reverse-biased, the other is forward-biased. A forward-biased Zener diode works like any other diode: it allows current to pass relatively freely, so long as the voltage exceeds its threshold. When the AC current reverses, the Zeners trade their functions, so that the first one merely passes current while the second one limits the voltage. Thus, the diodes divert peak voltage away from the load. The Zener voltage of each diode would be chosen to be a small margin above the AC voltage for voltage control, and below the AC voltage for signal clipping.

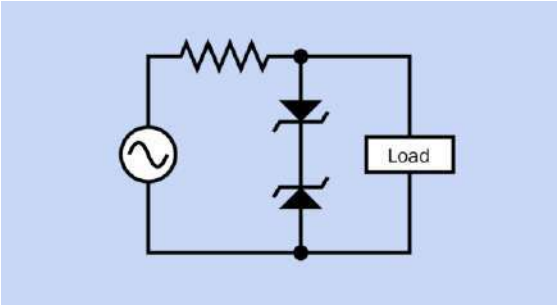

Figure 26-21. *Two Zener diodes placed in series, with opposite polarities, can clip or limit the voltage sinewave of an AC signal.*

Voltage Sensing

A Zener diode can be used to sense a small shift in voltage and provide a switched output in response.

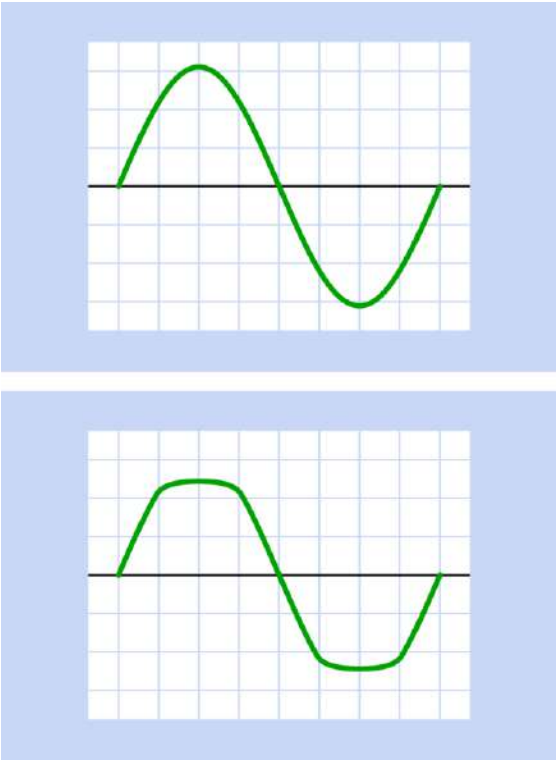

Figure 26-22. *AC input showing a pure sinewave (left) and a clipped version (right) created by Zener diodes wired in series, as in the previous figure.*

In Figure 26-23, the upper schematic shows a Zener diode preventing voltage from reaching the emitter of a PNP transistor while the divided input signal is below the Zener (breakdown) voltage of the diode. In this mode, the transistor is relatively non-conductive, very little current flows through it, and the output is now at near-zero voltage. As soon as the input signal rises above the Zener voltage, the transistor switches on and power is supplied to the output. The input is thus replicated in the output, as shown in the upper portion of Figure 26-24.

In Figure 26-23, the lower schematic shows a Zener diode preventing voltage from reaching the base of an NPN transistor while the input signal is below the Zener (breakdown) voltage of the diode. In this mode, the transistor is relatively non-conductive, and power is supplied to the output. As soon as the input signal rises above the Zener voltage, the transistor is activated, diverting the current to ground and bypassing the output, which is now at near-zero voltage. The input is thus inverted, as shown in the lower portion of Figure 26-24 (provided there is enough current to drive the transistor into saturation).

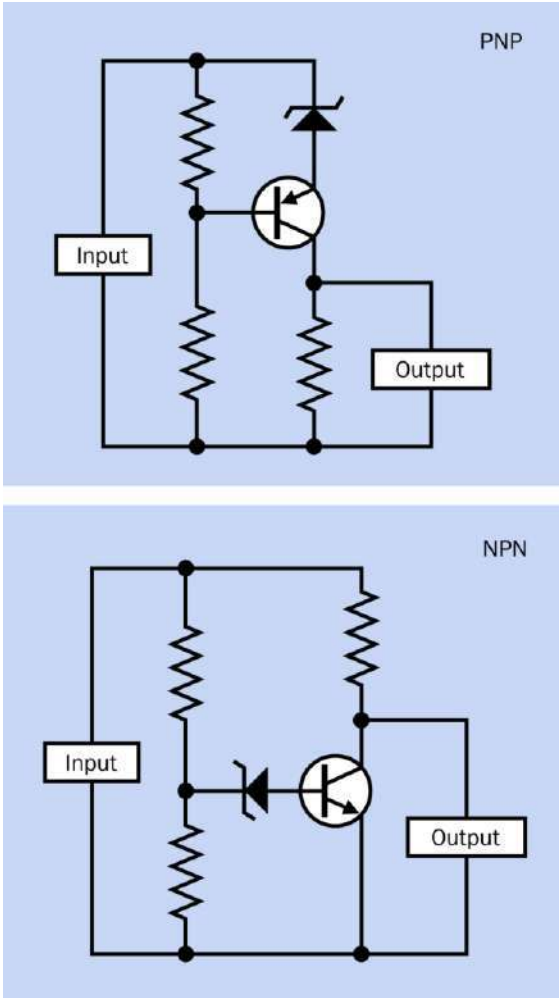

Figure 26-23. *A Zener diode can be used in conjunction with a PNP transistor. See text for details.*

What Can Go Wrong

Overload

If maximum forward current is exceeded, the heat generated is likely to destroy the diode. If the diode is reverse-biased beyond its peak in-

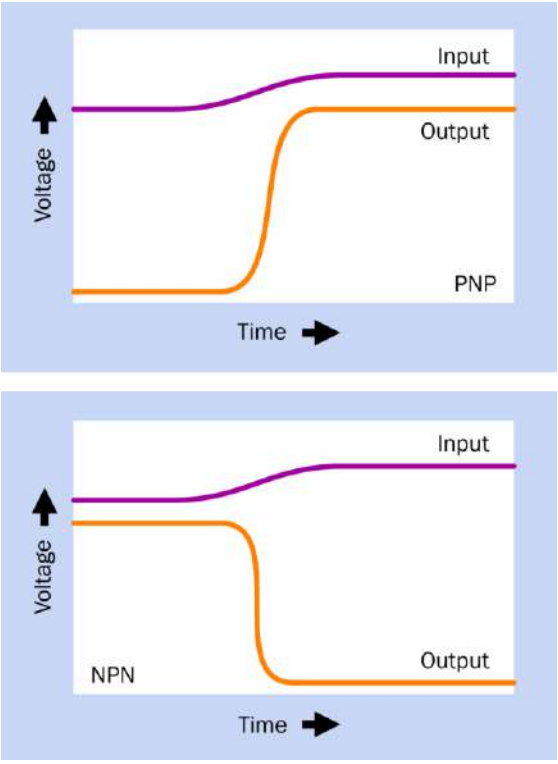

Figure 26-24. *Theoretical output from the transistors in the two previous schematics.*

verse voltage limit, the current will overwhelm the diode's ability to block it, and an *avalanche breakdown* will occur, once again probably destroying the component. The graph in Figure 26-5 illustrates the performance range of a hypothetical generic diode.

Reversed Polarity

Zener diodes look almost identical to other types, and all diodes share the same convention of marking the cathode for identification. Yet Zeners must be reverse-biased while others are forward-biased. This creates a significant risk of installing a diode "the wrong way around," with potentially destructive or at least confusing results, especially when used in a power supply. The very low resistance of a diode to forward current makes it especially vulnerable to burnout if installed incorrectly.

Wrong Type of Diode

If a Zener diode is used accidentally where a signal or rectifier diode is appropriate, the circuit will malfunction, as the Zener will probably have a much lower breakdown voltage, and therefore will not block reverse current. Conversely, if a signal or rectifier diode is used where the circuit calls for a Zener diode, reverse voltage will be clamped (or regulated at the diode's forward voltage value). Since diodes are often poorly marked, a sensible precaution is to store Zener diodes separately from all other types.

unijunction transistor

27

The unijunction transistor (UJT) and programmable unijunction transistor (PUT) are different internally, but are sufficiently similar in function to be combined in this entry.

OTHER RELATED COMPONENTS

- **diode** (See Chapter 26)
- **bipolar transistor** (See Chapter 28)
- **field-effect transistor** (See Chapter 29)

What It Does

Despite their names, the unijunction transistor (UJT) and programmable unijunction transistor (PUT) are not current-amplification devices like bipolar transistors. They are switching components that are more similar to diodes than to transistors.

The UJT can be used to build low- to mid-frequency oscillator circuits, while the PUT provides similar capability with the addition of more sophisticated control, and is capable of functioning at lower currents. The UJT declined in popularity during the 1980s after introduction of components such as the *555 timer*, which offered more flexibility and a more stable output frequency, eventually at a competitive price. UJTs are now uncommon, but PUTs are still available in quantity as through-hole discrete components. Whereas an integrated circuit such as a 555 timer generates a square wave, unijunction transistors in oscillator circuits generate a series of voltage spikes.

The PUT is often used to trigger a **thyristor** (described in Volume 2) and has applications in low-power circuits, where it can draw as little as a few microamps.

Schematic symbols for the two components are shown in Figure 27-1 and Figure 27-2. Although the symbol for the UJT is very similar to the symbol for a field-effect transistor (FET), its behavior is quite different. The bent arrow identifies the UJT, while a straight arrow identifies the FET. This difference is of significant importance.

The schematic symbol for a PUT indicates its function, as it resembles a diode with the addition of a gate connection.

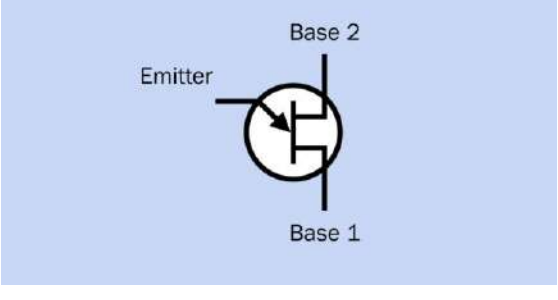

Figure 27-1. *Schematic symbol for a unijunction transistor (UJT). Note the bent arrow. The symbol for a field-effect transistor looks similar, but has a straight arrow. The functionality of the two components is very different.*

In Figure 27-3, the transistors at left and center are old-original unijunction transistors, while the one at right is a programmable unijunction transistor. (Left: Maximum 300mW, 35V interbase voltage. Center: 450mW, 35V interbase voltage. Right: 300mW, 40V gate-cathode forward voltage, 40V anode-cathode voltage.)

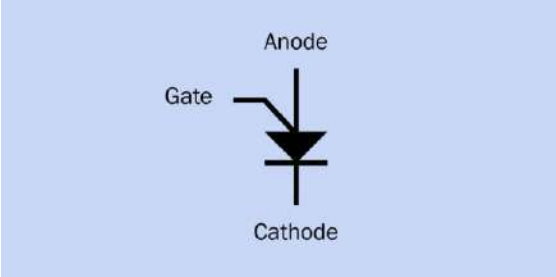

Figure 27-2. *Schematic symbol for a programmable unijunction transistor (PUT). The symbol accurately suggests the similarity in function to a diode, with the addition of a gate to adjust the threshold voltage.*

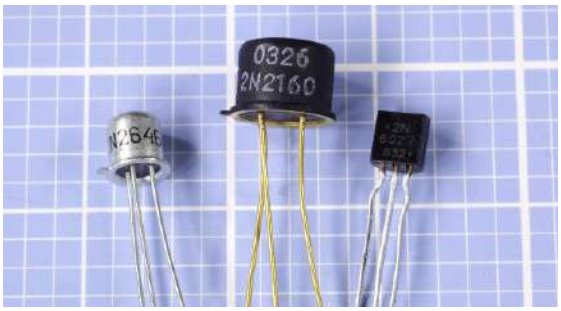

Figure 27-3. *The unijunction transistors at left and center are becoming obsolete; the one at the right is a programmable unijunction transistor (PUT), still readily available and widely used as a thyristor trigger.*

How It Works

The UJT is a three-terminal semiconductor device, but contains only two sections sharing a single junction—hence its name. Leads attached to opposite ends of a single channel of N-type semiconductor are referred to as base 1 and base 2, with base 2 requiring a slightly higher potential than base 1. A smaller P-type insert, midway between base 1 and base 2, is known as the emitter.

The diagram in Figure 27-4 gives an approximate idea of internal function.

When no voltage is applied to the emitter, a relatively high resistance (usually more than 5K) prevents significant current flow from base 2 to base 1. When the positive potential at the emitter increases to a *triggering voltage* (similar to the *junction threshold voltage* of a forward-biased diode), the internal resistance of the UJT drops very rapidly, allowing current to enter the component via both the emitter and base 2, exiting at base 1. (The term "current" refers, here, to conventional current; electron flow is opposite.) Current flowing from base 2 to base 1 is significantly greater than current flowing from the emitter to base 1.

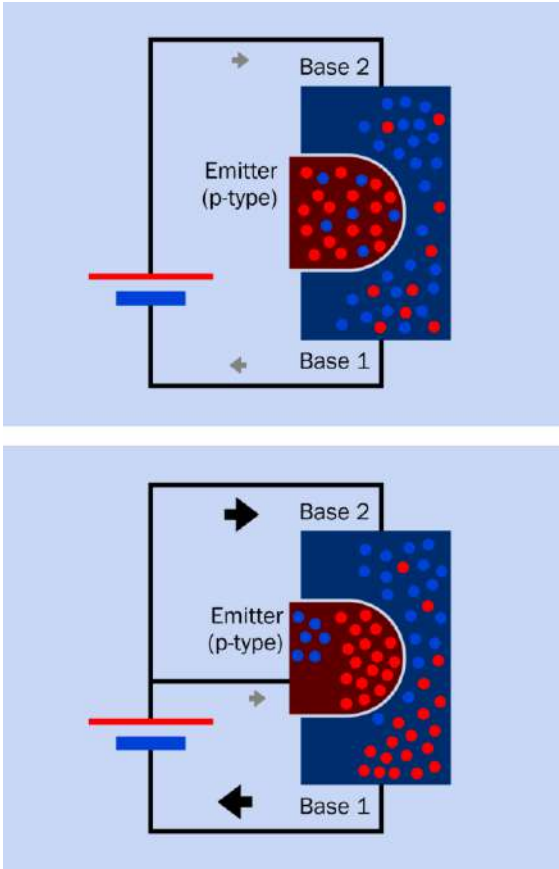

Figure 27-4. *Internal workings of a unijunction transistor.*

The graph in Figure 27-5 outlines the behavior of a UJT. As the voltage applied to the emitter increases, current flowing into the component from the emitter increases slightly, until the triggering voltage is reached. The component's internal resistance now drops rapidly. This pulls down the voltage at the emitter, while the current continues to increase significantly. Because of the drop in resistance, this is referred to as a *negative resistance* region. The resistance actually cannot fall below zero, but its change is negative. After emitter voltage drops to a minimum known as the *valley voltage*, the current continues to increase with a small increase in voltage. On datasheets, the peak current is often referred to as I_p while valley current is I_v.

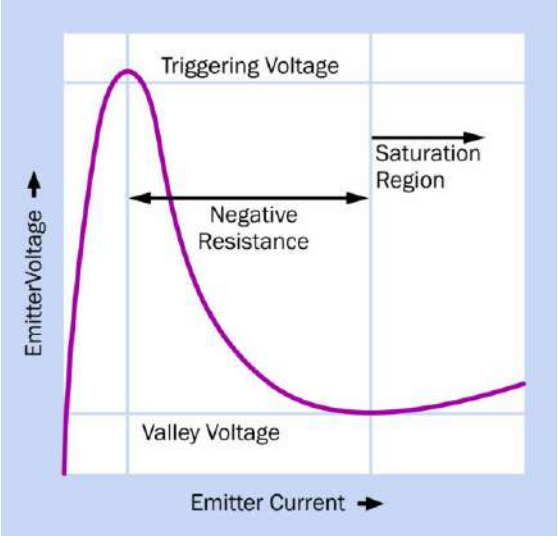

Figure 27-5. *Response curve of a unijunction transistor (UJT). When positive potential at the emitter reaches the triggering voltage, internal resistance drops radically and the component goes through a phase known as "negative resistance" as current increases.*

Figure 27-6 shows a test circuit to demonstrate the function of a UJT, with a volt meter indicating its status. A typical supply voltage would range from 9VDC to 20VDC.

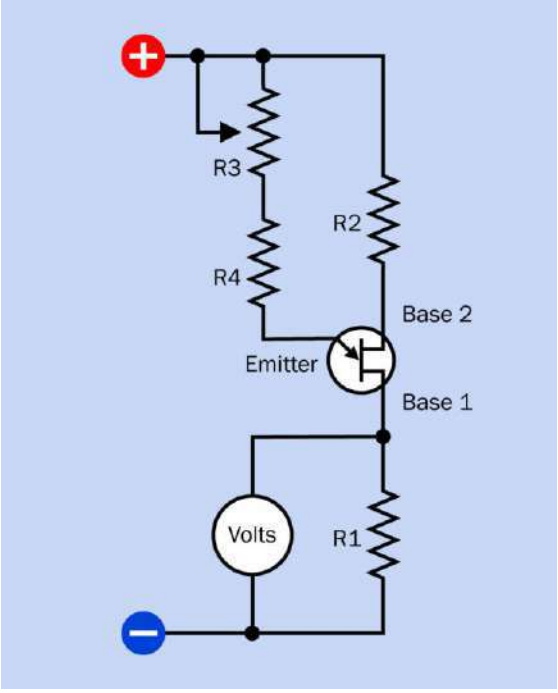

Figure 27-6. *A test circuit for a unijunction transistor (UJT) using a volt meter to show its response as a potentiometer increases the voltage applied to its emitter.*

A PUT behaves similarly in many ways to a UJT but is internally quite different, consisting of four semiconducting layers and functioning similarly to a thyristor.

The PUT is triggered by increasing the voltage on the anode. Figure 27-7 shows a test circuit for a PUT. This component is triggered when the voltage at its anode exceeds a threshold level, while the gate sets the threshold where this occurs. When the PUT is triggered, its internal resistance drops, and current flows from anode to cathode, with a smaller amount of current entering through the gate. This behavior is almost identical to that of a forward-biased diode, except that the threshold level can be controlled, or "programmed," according to the value of the positive potential applied at the gate, with R1 and R2 establishing that potential by functioning as a voltage divider.

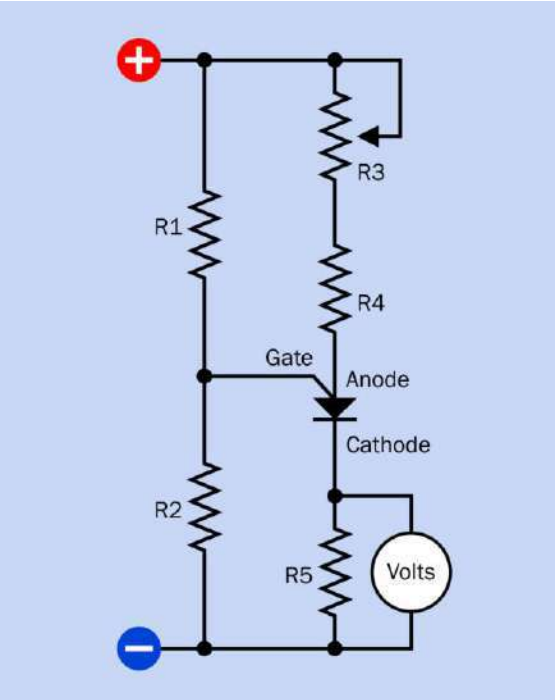

Figure 27-7. *A test circuit for a programmable unijunction transistor (PUT) using a volt meter to show its response as a potentiometer increases the voltage applied to its anode.*

The voltage output of a PUT follows a curve that is very similar to that shown in Figure 27-5, although current and voltage would be measured at the cathode.

Variants

PUTs and UJTs are not made as surface-mount components.

UJTs are usually packaged in black plastic, although older variants were manufactured in cans. PUTs are almost all packaged in black plastic. With the leads pointing downward and the flat side facing toward the viewer, the lead functions of a PUT are usually anode, gate, and cathode, reading from left to right.

Values

The triggering voltage of a UJT can be calculated from the values of R1 and R2 in Figure 27-7 and the voltage at base 1. The term R_{bb} is often used to represent the sum of R1 + R2, with V_{bb} representing the total voltage across the two resistors (this is the same as the supply voltage in Figure 27-6). V_t, the triggering voltage, is given by:

$$V_t = V_{bb} * (R1 / R_{bb})$$

The term ($R1/R_{bb}$) is known as the *standoff ratio*, often represented by the Greek letter ϱ.

Typically the standoff ratio in a UJT is at least 0.7, as R1 is chosen to be larger than R2. Typical values for R1 and R2 could be 180Ω and 100Ω, respectively. If R4 is 50K and a 100K linear potentiometer is used for R3, the PUT should be triggered when the potentiometer is near the center of its range. The emitter saturation voltage is typically from 2V to 4V.

If using a PUT, typical values in the test circuit could be supply voltage ranging from 9VDC to 20VDC, with resistances 28K for R1 and 16K for R2, 20Ω for R5, 280K for R4, and a 500K linear potentiometer for R3. The PUT should be triggered when the potentiometer is near the center of its range.

Sustained forward current from anode to cathode is usually a maximum of 150mA, while from gate to cathode the maximum is usually 50mA. Power dissipation should not exceed 300mW. These values should be lower at temperatures above 25 degrees Centigrade.

Depending on the PUT being used, power consumption can be radically decreased by upping the resistor values by a multiple of 100, while supply voltage can be decreased to 5V. The cathode output from the PUT would then be connected with the base of an NPN transistor for amplification.

How to Use it

Figure 27-8 shows a simple oscillator circuit built around a UJT, Figure 27-9 shows a comparable circuit for a PUT. Initially the supply voltage charges the capacitor, until the potential at the emitter of the UJT or the gate of the PUT reaches the threshold voltage, at which point the capacitor discharges through the emitter and the cycle repeats. Resistor values would be similar to those used in the test circuits previously described, while a capacitor value of 2.2µF would provide a visible pulse of the LED. Smaller capacitor values would enable faster oscillation. In the PUT circuit, adjusting the values of R1 and R2 would allow fine control of triggering the semiconductor.

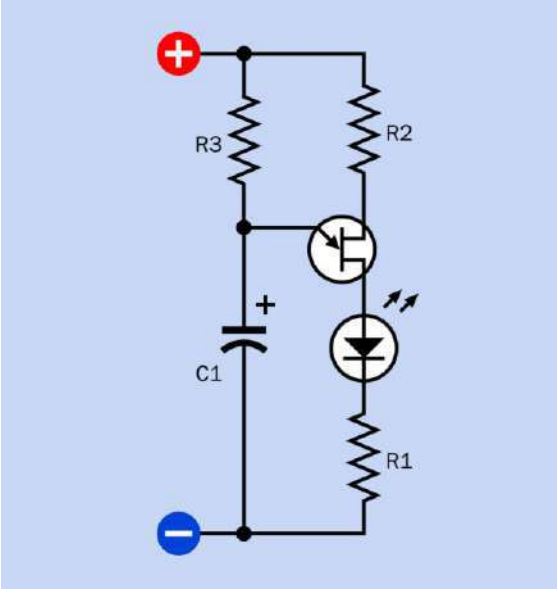

Figure 27-8. *A basic oscillator circuit using a unijunction transistor (UJT). As the capacitor accumulates charge, the voltage on the emitter increases until it triggers the UJT, at which point the capacitor discharges through the emitter.*

Probably the most common use for a PUT at this time is to trigger a **thyristor**.

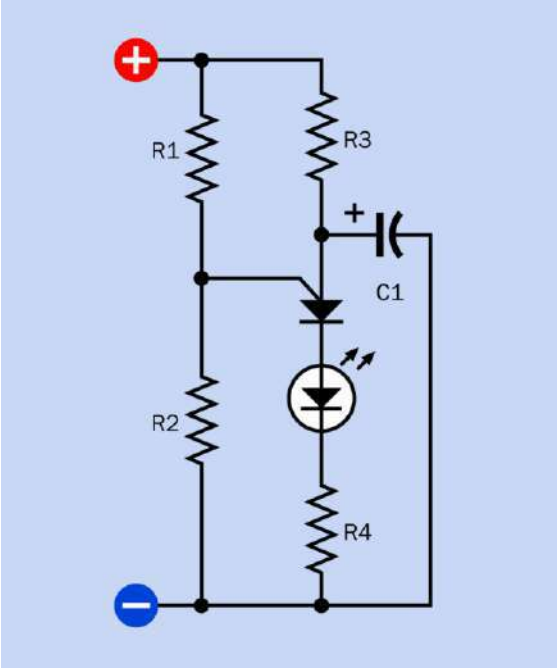

Figure 27-9. *A basic oscillator circuit using a programmable unijunction transistor (PUT). As the capacitor accumulates charge, the voltage on the anode increases until it triggers the PUT, at which point the capacitor discharges through the anode. The gate voltage is preset by R1 and R2 to adjust the triggering voltage.*

What Can Go Wrong

Name Confusion

A programmable unijunction transistor (PUT) is sometimes referred to simply as a "unijunction transistor" (UJT). Bearing in mind the totally different modes of operation of UJT and PUT, the PUT should always be identified by its acronym or by its full name. A circuit will not function if a UJT is substituted for a PUT, or a PUT is substituted for a UJT.

Incorrect Bias

Neither the UJT nor the PUT is designed to operate with reverse bias. In the UJT, a small forward bias should be applied from base 2 to base 1 (that is, base 2 should be at a higher potential relative to base 1) regardless of the voltage on the emitter. The emitter voltage may vary from 0 volts

upward. The PUT must be forward biased between its anode and cathode (the anode must have a higher potential relative to the cathode), with an intermediate positive voltage at the gate established by resistors R1 and R2 functioning as a voltage divider (see Figure 27-7). Failure to observe correct biasing will result in unpredictable behavior and possible damage to the component.

Overload

Like any semiconductor, the UJT and the PUT must be protected from excessive current, which can burn out the component. Never connect either of these components directly across a power source without appropriate resistances to limit current flow. Maximum continuous power dissipation for UJTs and PUTs is usually 300mW.

bipolar transistor

28

The word *transistor*, on its own, is often used to mean *bipolar transistor*, as this was the type that became most widely used in the field of discrete semiconductors. However, *bipolar transistor* is the correct term. It is sometimes referred to as a *bipolar junction transistor* or *BJT*.

OTHER RELATED COMPONENTS

- **unijunction transistor** (See Chapter 27)
- **field-effect transistor** (See Chapter 29)
- **diac** (Volume 2)
- **triac** (Volume 2)
- **relay** (Volume 2)
- **solid-state relay** (Volume 2)

What It Does

A bipolar transistor amplifies fluctuations in current or can be used to switch current on and off. In its amplifying mode, it replaced the *vacuum tubes* that were formerly used in the amplification of audio signals and many other applications. In its switching mode it resembles a **relay**, although in its "off" state the transistor still allows a very small amount of current flow, known as *leakage*.

A bipolar transistor is described as a *discrete* semiconductor device when it is individually packaged, with three leads or contacts. A package containing multiple transistors is an *integrated circuit*. A Darlington pair actually contains two transistors, but is included here as a discrete component because it is packaged similarly and functions like a single transistor. Most integrated circuits will be found in Volume 2 of this encyclopedia.

How It Works

Although the earliest transistors were fabricated from germanium, silicon has become the most commonly used material. Silicon behaves like an insulator, in its pure state at room temperature, but can be "doped" (carefully contaminated) with impurities that introduce a surplus of electrons unbonded from individual atoms. The result is an *N-type semiconductor* that can be induced to allow the movement of electrons through it, if it is *biased* with an external voltage. *Forward bias* means the application of a positive voltage, while *reverse bias* means reversing that voltage.

Other dopants can create a deficit of electrons, which can be thought of as a surplus of "holes" that can be filled by electrons. The result is a *P-type semiconductor*.

A bipolar NPN transistor consists of a thin central P-type layer sandwiched between two thicker N-type layers. The three layers are referred to as *collector*, *base*, and *emitter*, with a wire or contact

attached to each of them. When a negative charge is applied to the emitter, electrons are forced by mutual repulsion toward the central base layer. If a forward bias (positive potential) is applied to the base, electrons will tend to be attracted out through the base. However, because the base layer is so thin, the electrons are now close to the collector. If the base voltage increases, the additional energy encourages the electrons to jump into the collector, from which they will make their way to the positive current source, which can be thought of as having an even greater deficit of electrons.

Thus, the emitter of an NPN bipolar transistor emits electrons into the transistor, while the collector collects them from the base and moves them out of the transistor. It is important to remember that since electrons carry a negative charge, the flow of electrons moves from negative to positive. The concept of positive-to-negative current is a fiction that exists only for historical reasons. Nevertheless, the arrow in a transistor schematic symbol points in the direction of conventional (positive-to-negative) current.

In a PNP transistor, a thin N-type layer is sandwiched between two thicker P-type layers, the base is negatively biased relative to the emitter, and the function of an NPN transistor is reversed, as the terms "emitter" and "collector" now refer to the movement of electron-holes rather than electrons. The collector is negative relative to the base, and the resulting positive-to-negative current flow moves from emitter to base to collector. The arrow in the schematic symbol for a PNP transistor still indicates the direction of positive current flow.

Symbols for NPN and PNP transistors are shown in Figure 28-1. The most common symbol for an NPN transistor is shown at top-left, with letters C, B, and E identifying collector, base, and emitter. In some schematics the circle in the symbols is omitted, as at top-right.

A PNP transistor is shown in the center. This is the most common orientation of the symbol, since its collector must be at a lower potential than its emitter, and ground (negative) is usually at the bottom of a schematic. At bottom, the PNP symbol is inverted, allowing the positions of emitter and collector to remain the same as in the symbol for the NPN transistor at the top. Other orientations of transistor symbols are often found, merely to facilitate simpler schematics with fewer conductor crossovers. The direction of the arrow in the symbol (pointing out or pointing in) always differentiates NPN from PNP transistors, respectively, and indicates current flowing from positive to negative.

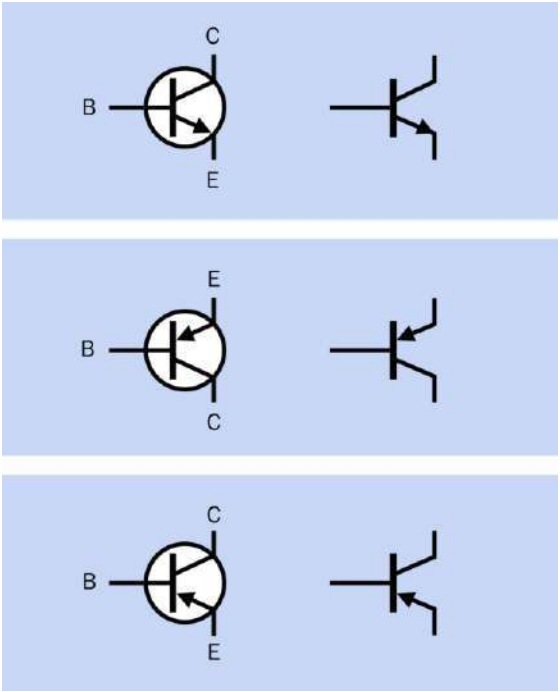

Figure 28-1. *Symbols for an NPN transistor (top) and a PNP transistor (center and bottom). Depending on the schematic in which the symbol appears, it may be rotated or inverted. The circle may be omitted, but the function of the component remains the same.*

NPN transistors are much more commonly used than PNP transistors. The PNP type was more difficult and expensive to manufacture initially, and

circuit design evolved around the NPN type. In addition, NPN transistors enable faster switching, because electrons have greater mobility than electron-holes.

To remember the functions of the collector and the emitter in an NPN transistor, you may prefer to think in terms of the collector collecting positive current *into* the transistor, and the emitter emitting positive current *out of* the transistor. To remember that the emitter is always the terminal with an arrow attached to it (both in NPN and PNP schematic symbols), consider that "emitter" and "arrow" both begin with a vowel, while "base" and "collector" begin with consonants. To remember that an NPN transistor symbol has its arrow pointing outward, you can use the mnemonic "N/ever P/ointing i/N."

Current flow for NPN and PNP transistors is illustrated in Figure 28-2. At top-left, an NPN transistor passes no current (other than a small amount of leakage) from its collector to its emitter so long as its base is held at, or near, the potential of its emitter, which in this case is tied to negative or ground. At bottom-left, the purple positive symbol indicates that the base is now being held at a *relatively* positive voltage, at least 0.6 volts higher than the emitter (for a silicon-based transistor). This enables electrons to move from the emitter to the collector, in the direction of the blue arrows, while the red arrows indicate the conventional concept of current flowing from positive to negative. The smaller arrows indicate a smaller flow of current. A resistor is included to protect the transistor from excessive current, and can be thought of as the load in these circuits.

At top-right, a PNP transistor passes no current (other than a small amount of leakage) from its emitter to its collector so long as its base is held at, or near, the potential of the emitter, which in this case is tied to the positive power supply. At bottom-right, the purple negative symbol indicates that the base is now being held at a *relatively* negative voltage, at least 0.6 volts lower than the emitter. This enables electrons and current to flow as shown. Note that current flows into the base in the NPN transistor, but out from the base in the PNP transistor, to enable conductivity. In both diagrams, the resistor that would normally be included to protect the base has been omitted for the sake of simplicity.

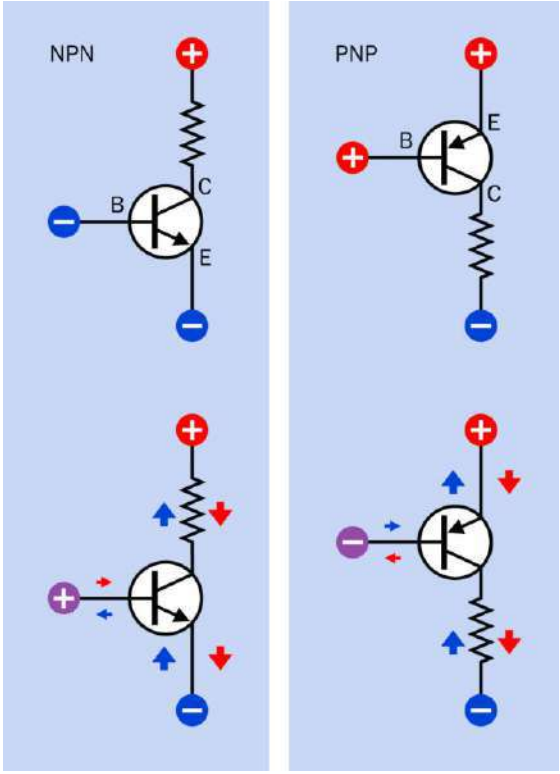

Figure 28-2. *Current flow through NPN and PNP transistors. See text for details.*

An NPN transistor amplifies its base current only so long as the positive potential applied to the collector is greater than the potential applied to the base, and the potential at the base must be greater than the potential at the emitter by at least 0.6 volts. So long as the transistor is biased in this way, and so long as the current values remain within the manufacturer's specified limits, a small fluctuation in current applied to the base will induce a much larger fluctuation in current between the collector and the emitter. This is why a transistor may be described as a *current amplifier*.

A *voltage divider* is often used to control the base potential and ensure that it remains less than the potential on the collector and greater than the potential at the emitter (in an NPN transistor). See Figure 28-3.

See Chapter 10 for additional information about the function of a voltage divider.

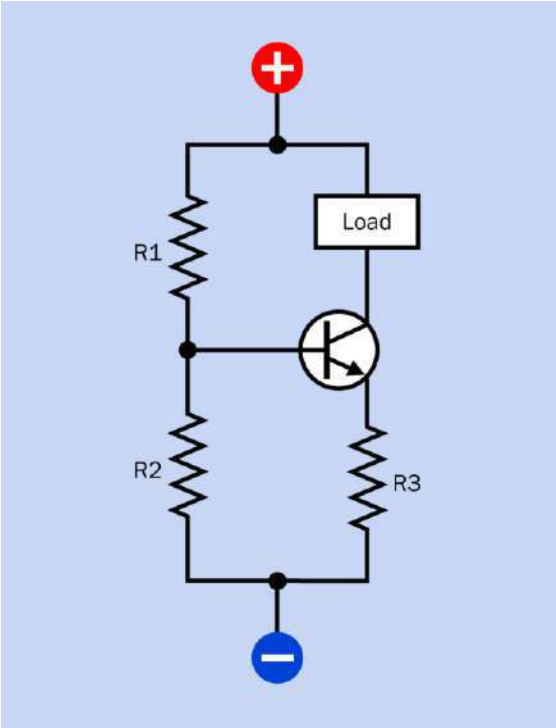

Figure 28-3. *Resistors R1 and R2 establish a voltage divider to apply acceptable bias to the base of an NPN transistor.*

Current Gain

The amplification of current by a transistor is known as its *current gain* or *beta value*, which can be expressed as the ratio of an increase in collector current divided by the increase in base current that enables it. Greek letter β is customarily used to represent this ratio. The formula looks like this:

$$\beta = \Delta I_c \ / \ \Delta I_b$$

where I_c is the collector current and I_b is the base current, and the Δ symbol represents a small change in the value of the variable that follows it.

Current gain is also represented by the term h_{FE}, where E is for the common Emitter, F is for Forward current, and lowercase letter h refers to the transistor as a "hybrid" device.

The beta value will always be greater than 1 and is often around 100, although it will vary from one type of transistor to another. It will also be affected by temperature, voltage applied to the transistor, collector current, and manufacturing inaccuracies. When the transistor is used outside of its design parameters, the formula to determine the beta value no longer directly applies.

There are only two connections at which current can enter an NPN transistor and one connection where it can leave. Therefore, if I_e is the current from the emitter, I_c is the current entering the collector, and I_b is the current entering the base:

$$I_e = I_c + I_b$$

If the potential applied to the base of an NPN transistor diminishes to the point where it is less than 0.6V above the potential at the emitter, the transistor will not conduct, and is in an "off" state, although a very small amount of leakage from collector to emitter will still occur.

When the current flowing into the base of the transistor rises to the point where the transistor cannot amplify the current any further, it becomes *saturated*, at which point its internal impedance has fallen to a minimal value. Theoretically this will allow a large flow of current; in practice, the transistor should be protected by resistors from being damaged by high current resulting from saturation.

Any transistor has maximum values for the collector current, base current, and the potential

difference between collector and emitter. These values should be provided in a datasheet. Exceeding them is likely to damage the component.

Terminology

In its *saturated mode*, a transistor's base is saturated with electrons (with no room for more) and the internal impedance between collector and emitter drops as low as it can go.

The *cutoff mode* of an NPN transistor is the state where a low base voltage eliminates all current flow from collector to emitter other than a small amount of leakage.

The *active mode*, or *linear mode*, is the intermediate condition between cutoff and saturated, where the beta value or h_{FE} (ratio of collector current to base current) remains approximately constant. That is, the collector current is almost linearly proportional to the base current. This linear relationship breaks down when the transistor nears its saturation point.

Variants

Small signal transistors are defined as having a maximum collector current of 500 mA and maximum collector power dissipation of 1 watt. They can be used for audio amplification of low-level inputs and for switching of small currents. When determining whether a small-signal transistor can control an inductive load such as a motor or relay coil, bear in mind that the initial current surge will be greater than the rated current draw during sustained operation.

Small switching transistors have some overlap in specification with small signal transistors, but generally have a faster response time, lower beta value, and may be more limited in their tolerance for collector current. Check the manufacturer's datasheet for details.

High frequency transistors are primarily used in video amplifiers and oscillators, are physically small, and have a maximum frequency rating as high as 2,000 MHz.

Power transistors are defined as being capable of handling at least 1 watt, with upper limits that can be as high as 500 watts and 150 amps. They are physically larger than the other types, and may be used in the output stages of audio amplifiers, and in switching **power supplies** (see Chapter 16). Typically they have a much lower current gain than smaller transistors (20 or 30 as opposed to 100 or more).

Sample transistors are shown in Figure 28-4. Top: A 2N3055 NPN power transistor. This type was originally introduced in the late 1960s, and versions are still being manufactured. It is often found in power supplies and in push-pull power amplifiers, and has a total power dissipation rating of 115W. Second row, far left: general purpose switching-amplification PNP power transistor rated for up to 50W power dissipation. Second row, far right: A high-frequency switching transistor for use in lighting ballast, converters, inverters, switching regulators, and motor control systems. It tolerates relatively high voltages (up to 700V collector-emitter peak) and is rated for up to 80W total power dissipation. Second row, center-left and center-right: Two variants of the 2N2222 NPN small signal switching transistor, first introduced in the 1960s, and still very widely used. The metal can is the TO-19 package, capable of slightly higher power dissipation than the cheaper plastic TO-92 package (1.8W vs. 1.5W with a collector temperature no greater than 25 degrees Centigrade).

Packaging

Traditionally, small-signal transistors were packaged in small aluminum "cans" about 1/4" in diameter, and are still sometimes found in this form. More commonly they are embedded in buds of black plastic. Power transistors are packaged either in a rectangular module of black

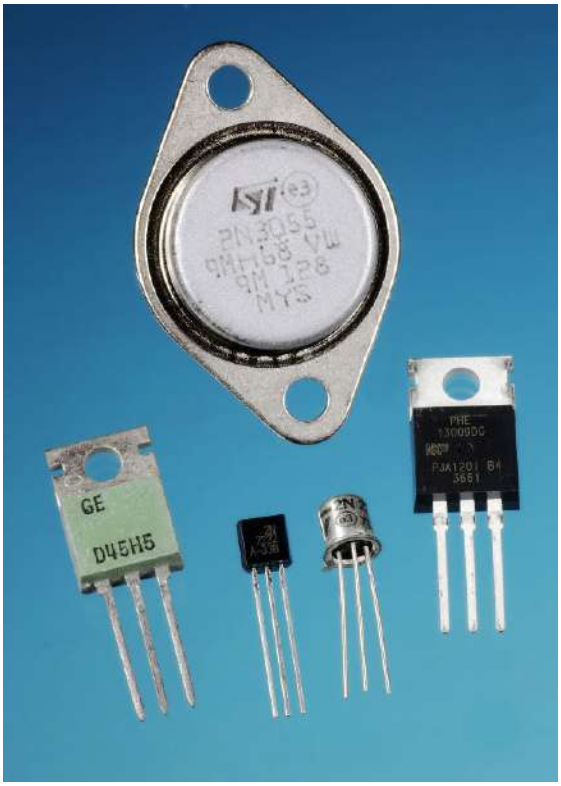

Figure 28-4. *Samples of commonly used transistors. See text for details.*

plastic with a metal back, or in a round metal "button." Both of these forms are designed to dissipate heat by being screw-clamped to a *heat sink*.

Connections

Often a transistor package provides no clue as to which lead is the emitter, which lead is the base, and which lead is the collector. Old can-style packaging includes a protruding tab that usually points toward the emitter, but not always. Where power transistors are packaged in a metal enclosure, it is typically connected internally with the collector. In the case of surface-mount transistors, look for a dot or marker that should identify the base of a bipolar transistor or the gate of a field-effect transistor.

A through-hole transistor usually has its part number printed or engraved on its package, although a magnifying glass may be necessary to see this. The component's datasheet may then be checked online. If a datasheet is unavailable, meter-testing will be necessary to confirm the functions of the three transistor leads. Some multimeters include a transistor-test function, which may validate the functionality of a transistor while also displaying its beta value. Otherwise, a meter can be put in diode-testing mode, and an unpowered NPN transistor should behave as if diodes are connected between its leads as shown in Figure 28-5. Where the identities of the transistor's leads are unknown, this test will be sufficient to identify the base, after which the collector and emitter may be determined empirically by testing the transistor in a simple low-voltage circuit such as that shown in Figure 28-6.

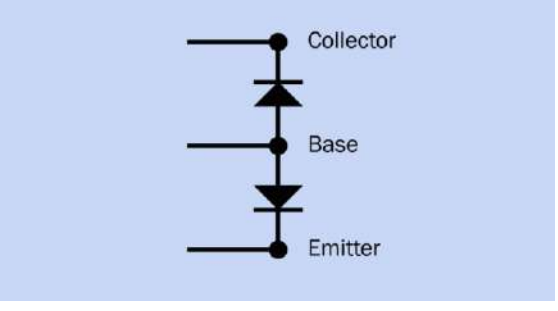

Figure 28-5. *An NPN transistor can behave as if it contains two diodes connected as shown. Where the functions of the leads of the transistor are unknown, the base can be identified by testing for conductivity.*

How to Use it

The following abbreviations and acronyms are common in transistor datasheets. Some or all of the letters following the initial letter are usually, but not always, formatted as subscripts:

h_{FE}
: Forward current gain

β
: Same as hFE

V_{CEO}
: Voltage between collector and emitter (no connection at base)

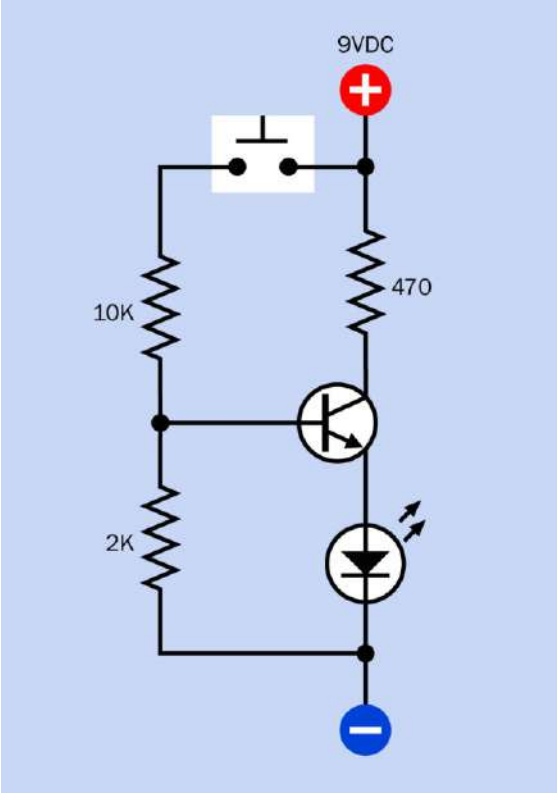

Figure 28-6. *This simple schematic can be used to breadboard-test a transistor empirically, determining its functionality and the identities of its collector and emitter leads.*

V_{CBO}
: Voltage between collector and base (no connection at emitter)

V_{EBO}
: Voltage between emitter and base (no connection at collector)

V_{CEsat}
: Saturation voltage between collector and emitter

V_{BEsat}
: Saturation voltage between base and emitter

I_c
: Current measured at collector

I_{CM}
: Maximum peak current at collector

I_{BM}
: Maximum peak current at base

P_{TOT}
: Total maximum power dissipation at room temperature

T_J
: Maximum junction temperature to avoid damage

Often these terms are used to define "absolute maximum values" for a component. If these maximums are exceeded, damage may occur.

A manufacturer's datasheet may include a graph showing the *safe operating area* (SOA) for a transistor. This is more common where power transistors are involved, as heat becomes more of an issue. The graph in Figure 28-7 has been adapted from a datasheet for a silicon diffused power transistor manufactured by Philips. The safe operating area is bounded at the top by a horizontal segment representing the maximum safe current, and at the right by a vertical segment representing the maximum safe voltage. However, the rectangular area enclosed by these lines is reduced by two diagonal segments representing the *total power limit* and the *second breakdown limit*. The latter refers to the tendency of a transistor to develop internal localized "hot spots" that tend to conduct more current, which makes them hotter, and able to conduct better—ultimately melting the silicon and causing a short circuit. The total power limit and the second breakdown limit reduce the safe operating area, which would otherwise be defined purely by maximum safe current and maximum safe voltage.

Uses for discrete transistors began to diminish when integrated circuits became cheaper and started to subsume multi-transistor circuits. For instance, an entire 5-watt audio amplifier, which used to be constructed from multiple components can now be bought on a chip, requiring just

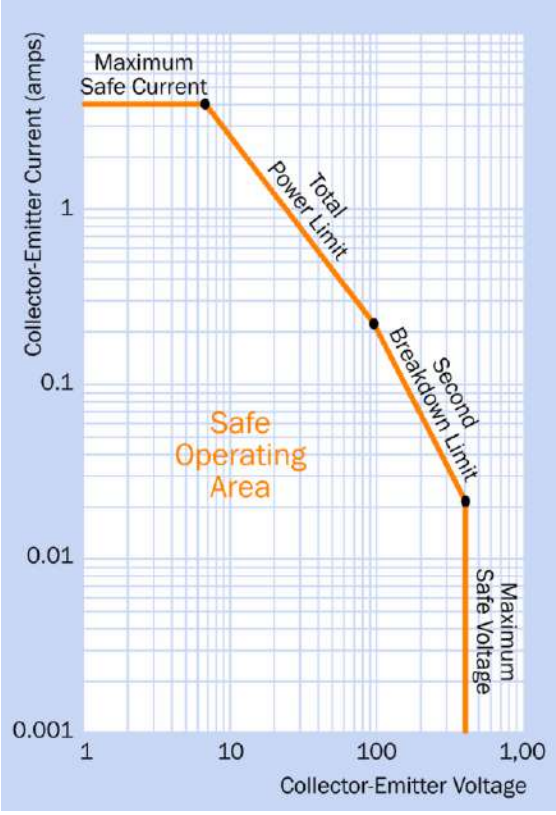

Figure 28-7. *Adapted from a Philips datasheet for a power transistor, this graph defines a safe operating area (SOA) for the component. See text for details.*

a few external capacitors. More powerful audio equipment typically uses integrated circuits to process inputs, but will use individual power transistors to handle high-wattage output.

Darlington Pairs

Discrete transistors are useful in situations where current amplification or switching is required at just one location in a circuit. An example would be where one output pin from a **microcontroller** must switch a small motor on and off. The motor may run on the same voltage as the microcontroller, but requires considerably more current than the typical 20mA maximum available from a microcontroller output. A *Darlington pair* of transistors may be used in this application. The overall gain of the pair can be 100,000 or more. See Figure 28-8. If a power source feeding through a potentiometer is substituted for the microcontroller chip, the circuit can function as a motor speed control (assuming that a generic DC motor is being used).

In the application shown here, the microcontroller chip must share a common ground (not shown) with the transistors. The optional resistor may be necessary to prevent leakage from the first transistor (when in its "off" state) from triggering the second. The diode protects the transistors from voltage transients that are likely when the motor stops and starts.

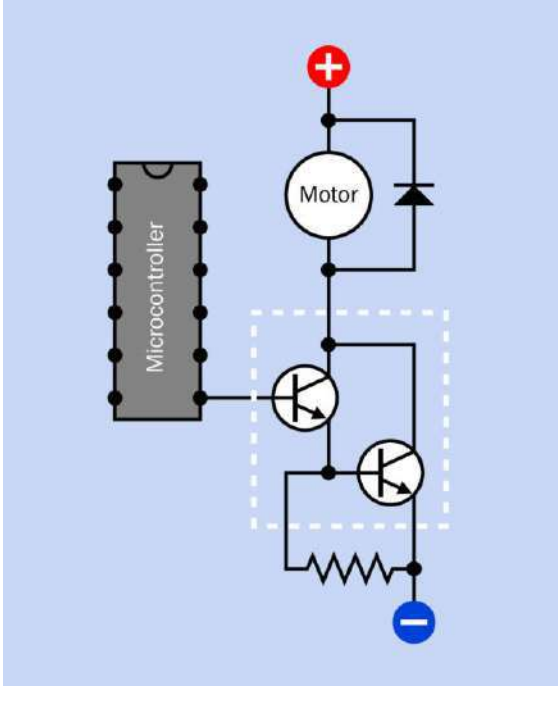

Figure 28-8. *Where the emitter of one NPN transistor is coupled to the base of another, they form a Darlington pair (identified by the dashed rectangle in this schematic). Multiplying the gain of the first transistor by the gain of the second gives the total gain of the pair.*

A Darlington pair can be obtained in a single transistor-like package, and may be represented by the schematic symbol shown in Figure 28-9.

Various through-hole Darlington packages are shown in Figure 28-10.

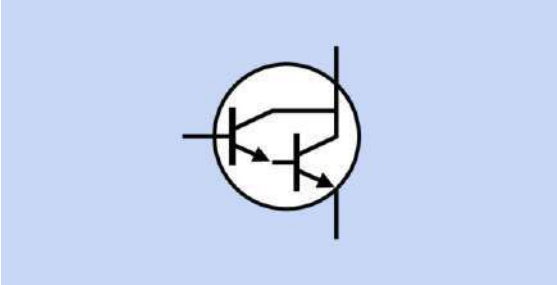

Figure 28-9. *When a Darlington pair is embedded in a single transistor-like package, it may be represented by this schematic symbol. The leads attached to the package can be used as if they are the emitter, base, and collector of a single NPN transistor.*

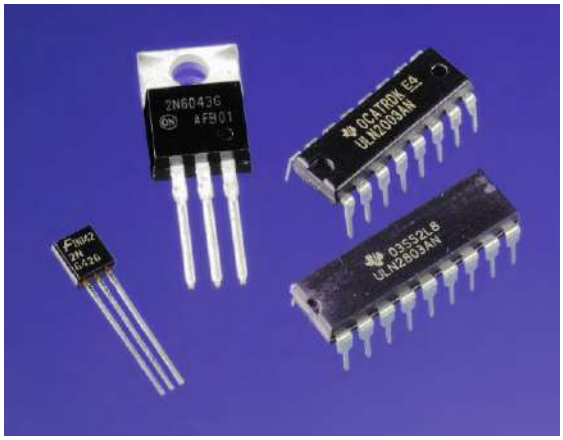

Figure 28-10. *Various packaging options for Darlington pairs. From left to right: The 2N6426 contains a Darlington pair rated to pass up to 500mA continuous collector current. The 2N6043 is rated for 8A continuous. The ULN2003 and ULN2083 chips contain seven and eight Darlington pairs, respectively.*

Seven or eight Darlington pairs can be obtained in a single integrated chip. Each transistor pair in these chips is typically rated at 500mA, but they can be connected in parallel to allow higher currents. The chip usually includes protection diodes to allow it to drive inductive loads directly.

A typical schematic is shown in Figure 28-11. In this figure, the microcontroller connections are hypothetical and do not correspond with any actual chip. The Darlington chip is a ULN2003 or similar, containing seven transistor pairs, each with an "input" pin on the left and an "output" pin opposite it on the right. Any of pins 1 through 7 down the left side of the chip can be used to control a device connected to a pin on the opposite side.

A high input can be thought of as creating a negative output, although in reality the transistors inside the chip are sinking current via an external device—a motor, in this example. The device can have its own positive supply voltage, shown here as 12VDC, but must share a common ground with the microcontroller, or with any other component which is being used on the input side. The lower-right pin of the chip shares the 12VDC supply because this pin is attached internally to clamp diodes (one for each Darlington pair), which protect against surges caused by inductive loads. For this reason, the motor does not have a clamp diode around it in the schematic.

The Darlington chip does not have a separate pin for connection with positive supply voltage, because the transistors inside it are sinking power from the devices attached to it.

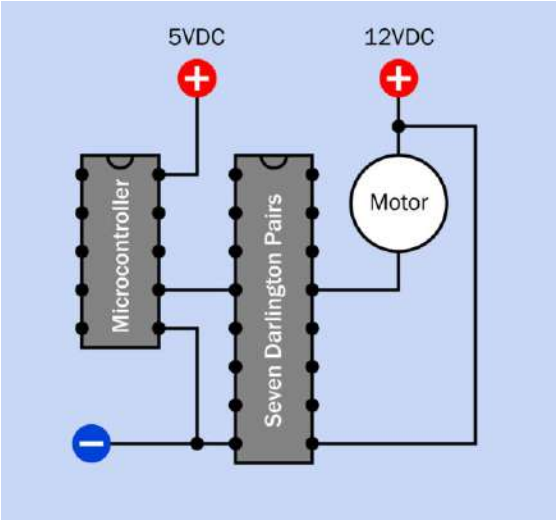

Figure 28-11. *A chip such as the ULN2003 contains seven Darlington pairs. It will sink current from the device it is driving. See text for details.*

A surface-mount Darlington pair is shown in Figure 28-12. This measures just slightly more

than 0.1″ long but is still rated for up to 500mA collector current or 250mW total power dissipation (at a component temperature no higher than 25 degrees Centigrade).

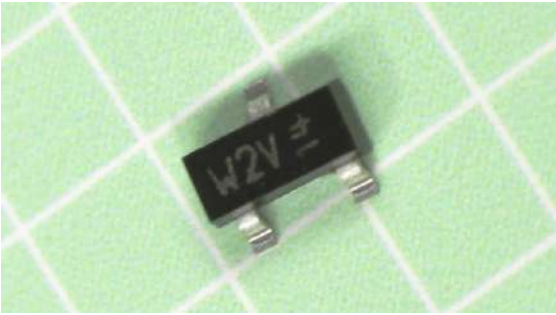

Figure 28-12. *A surface-mount package for a Darlington pair. Each square in the background grid measures 0.1″. See text for additional details.*

Amplifiers

Two basic types of transistor amplifiers are shown in Figure 28-13 and Figure 28-14. The *common-collector* configuration has current gain but no voltage gain. The capacitor on the input side blocks DC current from entering the amplifier circuit, and the two resistors forming a voltage divider on the base of the transistor establish a voltage midpoint (known as the *quiescent point* or *operating point*) from which the signal to be amplified may deviate above and below.

The *common-emitter* amplifier provides voltage gain instead of current gain, but inverts the phase of the input signal. Additional discussion of amplifier design is outside the scope of this encyclopedia.

In switching applications, modern transistors have been developed to handle a lot of current compared with earlier versions, but still have some limitations. Few power transistors can handle more than 50A flowing from collector to emitter, and 1,000V is typically a maximum value. Electromechanical relays continue to exist because they retain some advantages, as shown in the table in Figure 28-15, which compares switching capabilities of transistors, **solid-state relays**, and electromechanical **relays**.

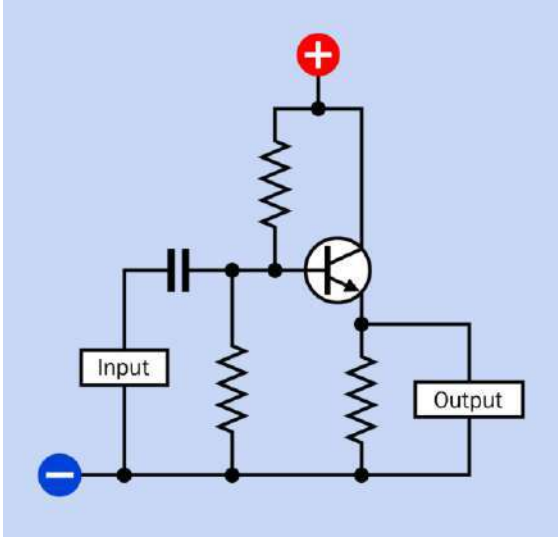

Figure 28-13. *The basic schematic for a common-collector amplifier. See text for details.*

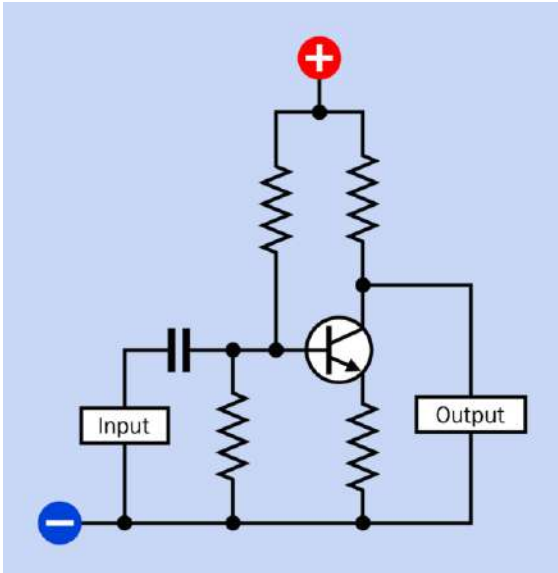

Figure 28-14. *The basic schematic for a common-emitter amplifier. See text for details.*

	Transistor	Solid-State Relay	Electro-Mechanical Relay
Long-term reliability	Excellent	Excellent	Limited
NC contacts?	No	Yes	Yes
DT contacts?	No	No	Yes
Ability to switch large current	Limited	Some	Good
Ability to switch AC	No	Yes	Yes
Can be triggered by AC voltage?	No	Yes	Yes
Suitability for miniaturization	Excellent	Poor	Poor
Vulnerable to heat	Yes	Yes	Not very
Vulnerable to corrosion	No	No	Yes
OK at high speed	Excellent	Good	Poor
Price advantage for low-voltage low-current	Yes	No	No
Price advantage for high-voltage high-current	No	No	Yes
Current leakage when "off"	Yes	Yes	No
Trigger circuit isolated from switched circuit	No	Yes	Yes

Figure 28-15. *A comparison of characteristics of switching devices.*

What Can Go Wrong

Wrong Connections on a Bipolar Transistor

Failing to identify a transistor's leads or contacts correctly can obviously be a potential source of damage, but swapping the collector and emitter accidentally will not necessarily destroy the transistor. Because of the inherent symmetry of the device, it will in fact function with collector and emitter connections reversed. Rohm, a large semiconductor manufacturer, has included this scenario in its general information pages and concludes that the primary indicator of transposed connections is that the β value, or h_{FE}, drops to about 1/10th of specification. If you are using a transistor that works but provides much less amplification than you expect, check that the emitter and collector leads are not transposed.

Wrong Connections on a Darlington Pair Chip

While a single-component package for a Darlington pair functions almost indistinguishably from a single transistor, multiple Darlington pairs in a DIP package may create confusion because the component behaves differently from most other chips, such as logic chips.

A frequent error is to ground the output device instead of applying positive power to it. See Figure 28-11 and imagine an erroneous connection of negative power instead of the 12VDC positive power.

Additional confusion may be caused by reading a manufacturer's datasheet for a Darlington pair chip such as the ULN2003. The datasheet depicts the internal function of the chip as if it contains logic inverters. While the chip can be imagined as behaving this way, in fact it contains bipolar transistors that amplify the current applied to the base of each pair. The datasheet also typically will not show the positive connection that should be made to the common-diode pin (usually at bottom-right), to provide protection from surges caused by inductive loads. This pin must be distinguished carefully from the common-ground pin (usually at bottom-left). The positive connection to the common-diode pin is optional; the common-ground connection is mandatory.

Soldering Damage

Like any semiconductor, transistors are vulnerable to heat and can be damaged while soldering, although this seldom happens if a low-wattage iron is used. A copper alligator clip can be applied as a heat sink to each lead before it is soldered.

Excessive Current or Voltage

During use, a transistor will be damaged if it is subjected to current or voltage outside of its rated range. Passing current through a transistor without any series resistance to protect it will almost certainly burn it out, and the same thing can happen if incorrect resistor values are used.

The maximum wattage that a transistor can dissipate will be shown in its datasheet. Suppose, for example, this figure is 200mW, and you are using a 12VDC supply. Ignoring the base current, the maximum collector current will be 200 / 12 = approximately 15mA. If the transistor's emitter is connected to ground, and the load applied to the transistor output has a high impedance, and if we ignore the transresistance, Ohm's Law suggests that a resistor that you place between the collector and the supply voltage should have a resistance of at least 12 / 0.015 = 800 ohms.

When transistors are used in switching applications, it is customary for the base current to be 1/5th of the collector current. In the example discussed here, a 4.7K resistor might be appropriate. A meter should be used to verify actual current and voltage values.

Excessive Leakage

In a Darlington pair, or any other configuration where the output from one transistor is connected with the base of another, leakage from the first transistor while in its "off" state can be amplified by the second transistor. If this is unacceptable, a bypass resistor can be used to divert some of the leakage from the base of the second transistor to ground. Of course the resistor will also steal some of the base current when the first transistor is active, but the resistor value is typically chosen so that it takes no more than 10% of the active current. See Figure 28-8 for an example of a bypass resistor added to a Darlington pair.

field effect transistor

29

The term **field-effect transistor** encompasses a family primarily consisting of the *junction field-effect transistor* (or *JFET*, which is the simplest generic type) and the *metal-oxide semiconductor field-effect transistor* (or *MOSFET*, also sometimes known as an *insulated-gate field-effect transistor*, or *IGFET*). Because the principles of operation overlap considerably, the entire -FET family is grouped in this entry.

OTHER RELATED COMPONENTS

- **bipolar transitor** (See Chapter 28)
- **unijunction transistor** (See Chapter 27)
- **diode** (See Chapter 26)

What It Does

A field-effect transistor creates an electric field to control current flowing through a channel in a semiconductor. MOSFETs of microscopic size form the basis of complementary metal oxide semiconductor (CMOS) *integrated circuit chips*, while large discrete MOSFETs are capable of switching substantial currents, in lamp dimmers, audio amplifiers, and motor controllers. FETs have become indispensable in computer electronics.

A **bipolar transistor** is generally thought of as a *current amplifier* because the current passing through it is controlled by a smaller amount of current passing through the base. By contrast, all FETs are considered to be *voltage amplifiers*, as the control voltage establishes field intensity, which requires little or no current. The negligible leakage through the gate of an FET makes it ideal for use in low-power applications such as portable hand-held devices.

How It Works

This section is divided into two subsections, describing the most widely used FETs: JFETs and MOSFETs.

JFETs

A *junction field-effect transistor* (or *JFET*) is the simplest form of FET. Just as a bipolar transistor can be of NPN or PNP type, a JFET can have an *N-channel* or *P-channel*, depending whether the channel that transmits current through the device is negatively or positively *doped*. A detailed explanation of semiconductor doping will be found in the **bipolar transistor** entry.

Because negative charges have greater mobility, the N-channel type allows faster switching and is more commonly used than the P-channel type. A schematic symbol for it is shown in Figure 29-1 alongside the schematic for an NPN transistor. These symbols suggest the similarity of the devices as amplifiers or switches, but it is important to remember that the FET is a primarily a voltage amplifier while the bipolar transistor is a current amplifier.

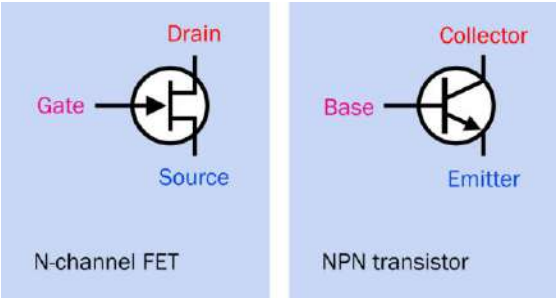

Figure 29-1. *A comparison between schematic symbols for N-channel JFET (left) and NPN bipolar transistor (right) suggests their functional similarity as switches or amplifiers, although their behavior is markedly different.*

Three JFETs are shown in Figure 29-2. The N-channel J112 type is supplied by several manufacturers, the figure showing two samples, one from Fairchild Semiconductor (left) and the other from On Semiconductor (right). Although the full part numbers are different, the specifications are almost identical, including a drain-gate voltage of 35V, a drain-source voltage of 35V, and a gate current of 50mA. The metal-clad 2N4392 in the center has similar values but is three times the price, with a much higher power dissipation of 1.8W, compared with 300mW and 350mW for the other two transistors respectively.

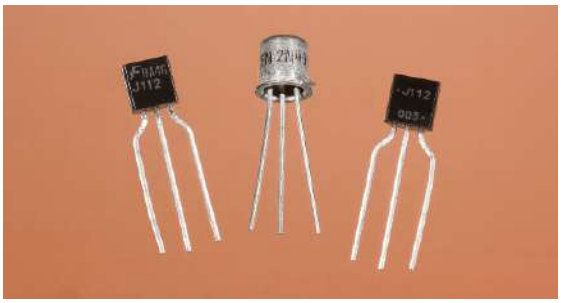

Figure 29-2. *Junction Field Effect Transistors (JFETs). See text for details.*

Schematic symbols for N-channel and P-channel JFETs are shown in Figure 29-3, N-channel being on the left while P-channel is on the right. The upper-left and lower-left symbol variants are both widely used and are functionally identical. The upper-right and lower-right variants likewise mean the same thing. Because the upper variants are symmetrical, an S should be added to clarify which terminal is the source. In practice, the S is often omitted, allowing some ambiguity. While the source and drain of some JFETs are in fact interchangeable, this does not apply to all types.

The circle around each symbol is occasionally omitted when representing discrete components, and is almost always omitted when multiple FETs are shown connected to form an integrated circuit.

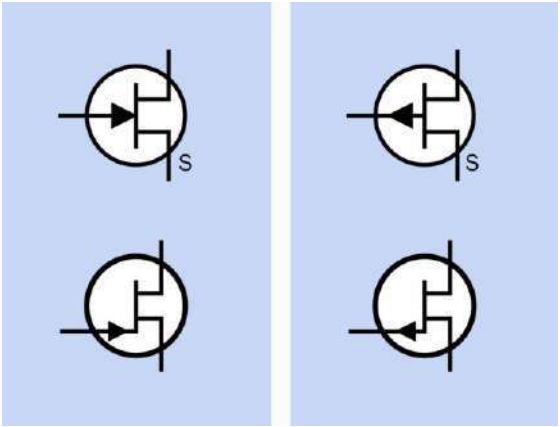

Figure 29-3. *Schematic symbols for junction field-effect transistors (JFETs). Left: N-channel. Right: P-channel. The symbols at top and bottom on each side are functionally identical. Circles may be omitted. Letter S may be omitted from the symmetrical symbol variants, even though this creates some ambiguity.*

The internal function of an N-channel JFET is shown diagrammatically in Figure 29-4. In this component, the source terminal is a source of electrons, flowing relatively freely through the N-doped channel and emerging through the drain. Thus, conventional current flows nonintuitively from the drain terminal, to the source terminal, which will be of lower potential.

The JFET is like a normally-closed switch. It has a low resistance so long as the gate is at the same potential as the source. However, if the potential of the gate is reduced below the potential of the source—that is, the gate acquires a more rela-

tively negative voltage than the source—the current flow is *pinched off* as a result of the field created by the gate. This is suggested by the lower diagram in Figure 29-4.

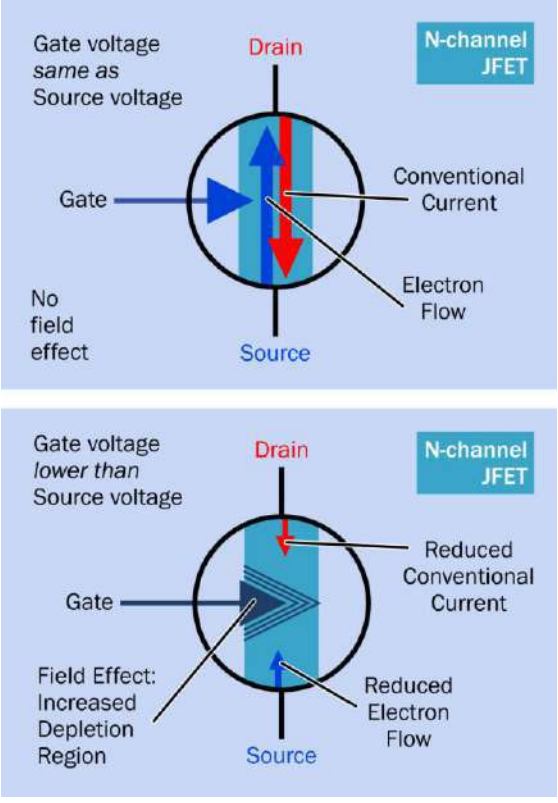

Figure 29-4. *At top, conventional current flows freely from drain to source through the channel of an N-doped JFET. At bottom, the lowered voltage of the gate relative to the source creates a field effect that pinches off the flow of current.*

The situation for a P-channel JFET is reversed, as shown in Figure 29-5. The source is now positive (but is still referred to as the source), while the drain can be grounded. Conventional current now flows freely from source to drain, so long as the gate is at the same positive potential as the source. If the gate voltage rises above the source voltage, the flow is pinched off.

A bipolar transistor tends to block current flow by default, but becomes less resistive when its base is forward-biased. Therefore it can be referred to as an *enhancement device*. By contrast, an N-channel JFET allows current to flow by default, and becomes more resistive when its base is reverse-biased, which widens the *depletion layer* at the base junction. Consequently it can be referred to as a *depletion device*.

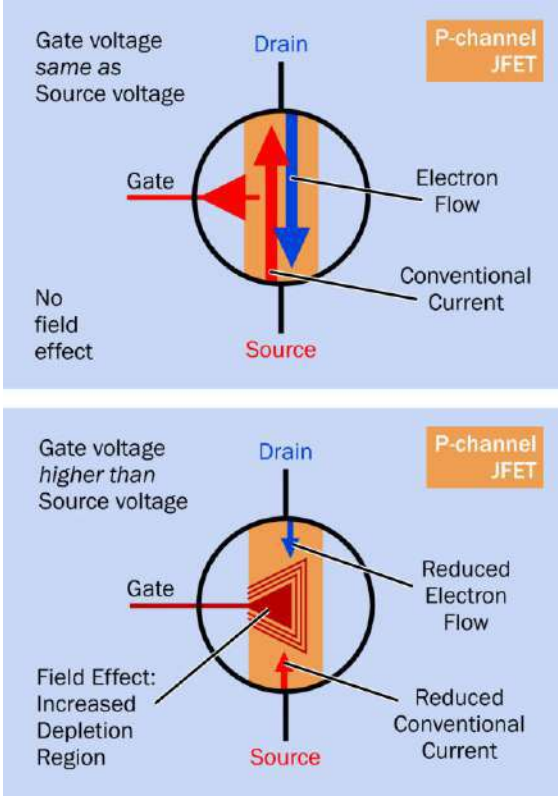

Figure 29-5. *At top, conventional current flows freely from source to drain through the channel of a P-doped JFET. At bottom, the higher voltage of the gate relative to the source creates a field effect that pinches off the flow of current.*

The primary characteristics of a junction field-effect transistor relative to an NPN bipolar transistor are summarized in the table in Figure 29-6.

JFET Behavior

The voltage difference between gate and source of a JFET is usually referred to as V_{gs} while the voltage difference between drain and source is referred to as V_{ds}.

	NPN Bipolar Transistor	N-Channel JFET
Type of amplifier	Current	Voltage
Active bias	Positive	Negative
Unbiased state	Nonconductive	Conductive
Biased state	More conductive	Less conductive

Figure 29-6. *This table contrasts the characteristics of an N-channel JFET with those of an NPN bipolar transistor.*

Suppose the gate of an N-channel JFET is connected with the source, so that V_{gs}=0. Now if V_{ds} increases, the current flowing through the channel of the JFET also increases, approximately linearly with V_{ds}. In other words, initially the JFET behaves like a low-value resistor in which the voltage across it, divided by the amperage flowing through it, is approximately constant. This phase of the JFET's behavior is known as its *ohmic region*. While the unbiased resistance of the channel in a JFET depends on the component type, it is generally somewhere between 10Ω and 1K.

If V_{ds} increases still further, eventually no additional flow of current occurs. At this point the channel has become *saturated*, and this plateau zone is referred to as the *saturation region*, often abbreviated I_{dss}, meaning "the saturated drain current at zero bias." Although this is a nearly constant value for any particular JFET, it may vary somewhat from one sample of a component to another, as a result of manufacturing variations.

If V_{ds} continues to increase, the component finally enters a *breakdown* state, sometimes referred to by its full formal terminology as *drain-source breakdown*. The current passing through the JFET will now be limited only by capabilities of the external power source. This breakdown state can be destructive to the component, and is comparable to the breakdown state of a typical **diode**.

What if the voltage at the gate is reduced below the voltage at the source—such as V_{gs} becomes negative? In its ohmic region, the component now behaves as if it has a higher resistance, and it will reach its saturation region at a lower current value (although around the same value for V_{ds}). Therefore, by reducing the voltage on the gate relative to the voltage at the source, the effective resistance of the component increases, and in fact it can behave as a *voltage-controlled resistor*.

The upper diagram in Figure 29-7 shows this graphically. Below it, the corresponding graph for a P-channel JFET looks almost identical, except that the current flow is reversed and is pinched off as the gate voltage rises above the source voltage. Also, the breakdown region is reached more quickly with a P-channel JFET than with an N-channel JFET.

MOSFETs

MOSFETs have become one of the most widely used components in electronics, everywhere from computer memory to high-amperage switching power supplies. The name is an acronym for *metal-oxide semiconductor field-effect transistor*. A simplified cross-section of an N-channel MOSFET is shown in Figure 29-8.

Two MOSFETs are shown in Figure 29-9.

Like a JFET, a MOSFET has three terminals, identified as drain, gate, and source, and it functions by creating a field effect that controls current flowing through a channel. (Some MOSFETS have a fourth terminal, described later). However, it has a metal source and drain making contact with each end of the channel (hence the term "metal" in its acronym) and also has a thin layer of silicon dioxide (hence the term "oxide" in its acronym) separating the gate from the channel, thus raising the impedance at the gate to at least

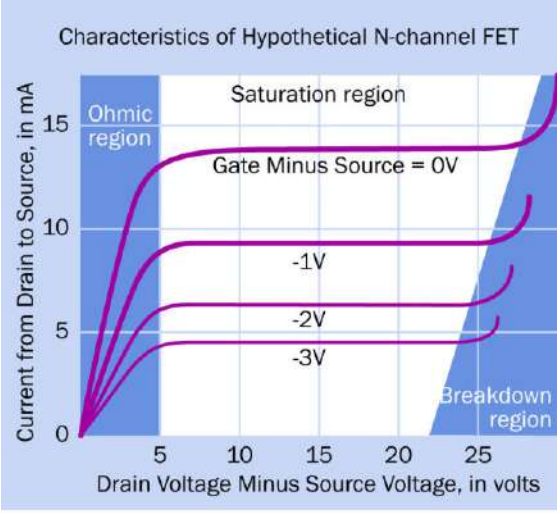

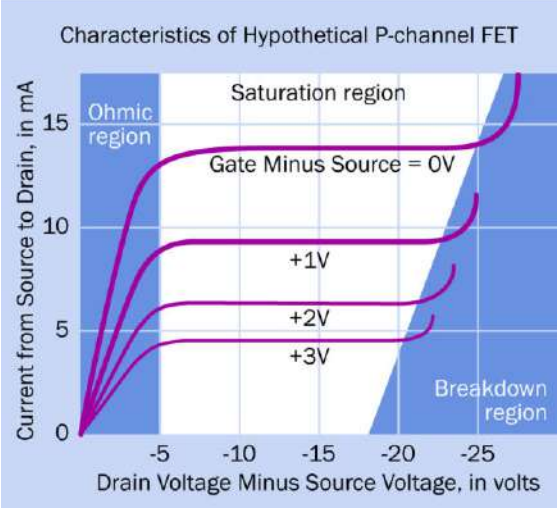

Figure 29-7. *The top graph shows current passing through the channel of an N-channel JFET, depending on gate voltage and source voltage. The lower graph is for a P-channel JFET.*

100,000 gigaohms and reducing gate current essentially to zero. The high gate impedance of a MOSFET allows it to be connected directly to the output of a digital integrated circuit. The layer of silicon dioxide is a *dielectric*, meaning that a field appled to one side creates an opposite field on the other side. The gate attached to the surface of the layer functions in the same way as one plate of a capacitor.

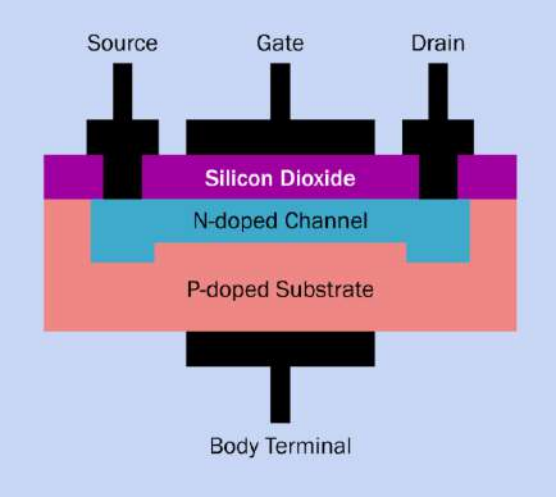

Figure 29-8. *Simplified diagram of an N-channel MOSFET. The thickness of the silicon dioxide layer has been greatly exaggerated for clarity. The black terminals are metallic.*

Figure 29-9. *Two MOSFETs. At left, the TO-220 package claims a drain current of up to 65A continuous, and a drain-to-source breakdown voltage 100V. At right, the smaller package offers a drain current of 175mA continuous, and a drain-to-source breakdown voltage of 300V.*

The silicon dioxide also has the highly desirable property of insulating the gate from the channel, thus preventing unwanted reverse current. In a JFET, which lacks a dielectric layer, if source voltage is allowed to rise more than about 0.6V higher than gate voltage, the direct internal connection between gate and channel allows negative

charges to flow freely from source to gate, and as the internal resistance will be very low, the resulting current can be destructive. This is why the JFET must always be reverse-biased.

A MOSFET is freed from these restrictions, and the gate voltage can be higher or lower than the source voltage. This property enables an N-channel MOSFET to be designed not only as a depletion device, but alternatively as an *enhancement device*, which is "normally off" and can be switched on by being forward-biased. The primary difference is the extent to which the channel in the MOSFET is N-doped with charge carriers, and therefore will or will not conduct without some help from the gate bias.

In a depletion device, the channel conducts, but applying negative voltage to the gate can pinch off the current.

In an enhancement device, the channel does not conduct, but applying positive voltage to the gate can make it start to do so.

In either case, a shift of bias from negative to positive encourages channel conduction; the depletion and enhancement versions simply start from different points.

This is clarified in Figure 29-10. The vertical (logarithmic) scale suggests the current being conducted through the channel of the MOSFET, while the green curve describes the behavior of a depletion version of the device. Where this curve crosses the center line representing 0 volts bias, the channel is naturally conductive, like a JFET. Moving left down the curve, as reverse bias is applied (shown on the horizontal axis), the component becomes less conductive until finally its conductivity reaches zero.

Meanwhile on the same graph, the orange curve represents an enhancement MOSFET, which is nonconductive at 0 volts bias. As forward bias increases, the current also increases—similar to a bipolar transistor.

To make things more confusing, a MOSFET, like a JFET, can have a P-doped channel; and once

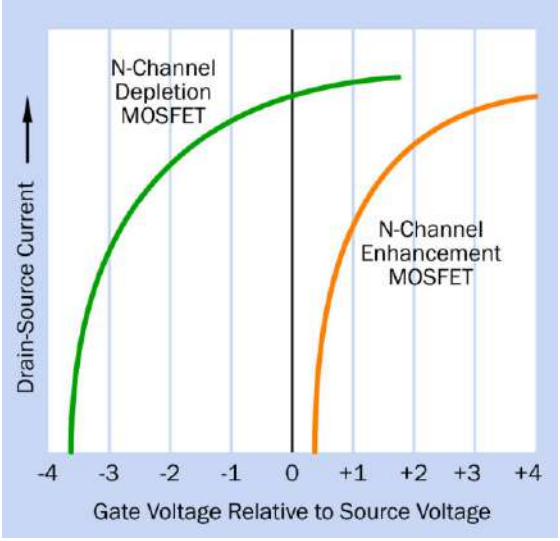

Figure 29-10. *The current conduction of depletion and enhancement N-channel MOSFETs. See text for details. (Influenced by The Art of Electronics by Horowitz and Hill.)*

again it can function in depletion or enhancement mode. The behavior of this variant is shown in Figure 29-11. As before, the green curve shows the behavior of a depletion MOSFET, while the orange curve refers to the enhancement version. The horizontal axis now shows the voltage difference between the gate and the drain terminal. The depletion component is naturally conductive at zero bias, until the gate voltage increases above the drain voltage, pinching off the current flow. The enhancement component is not conductive until reverse bias is applied.

Figure 29-12 shows schematic symbols that represent depletion MOSFETs. The two symbols on the left are functionally identical, representing N-channel versions, while the two symbols on the right represent P-channel versions. As in the case of JFETs, the letter "S" should be (but often is not) added to the symmetrical versions of the symbols, to clarify which is the source terminal. The left-pointing arrow identifies the components as N-channel, while in the symbols on the right, the right-pointing arrows indicate P-channel MOS-

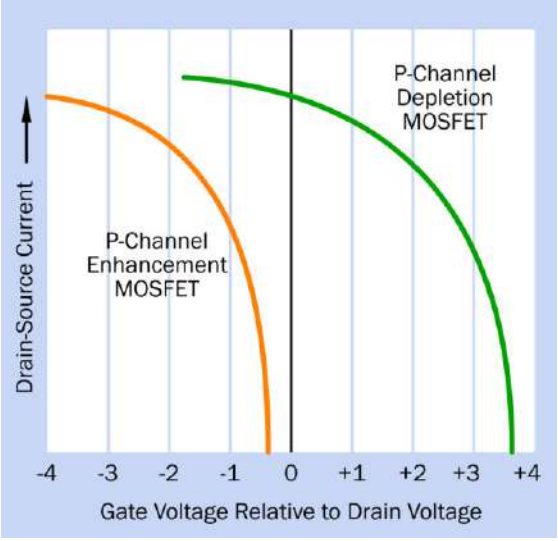

Figure 29-11. *The current conduction of depletion and enhancement P-channel MOSFETs. See text for details.*

FETs. The gap between the two vertical lines in each symbol suggests the silicon dioxide dielectric. The right-hand vertical line represents the channel.

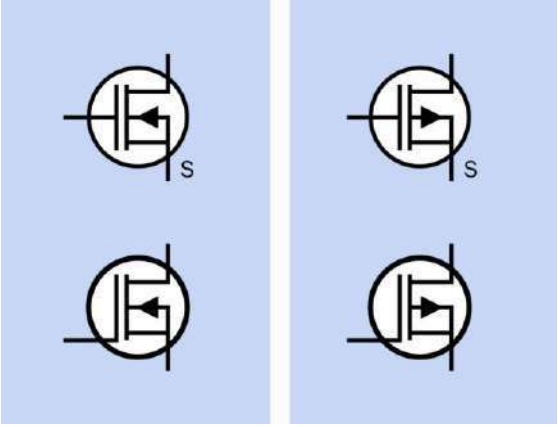

Figure 29-12. *Schematic symbols for depletion MOSFETs. These function similarly to JFETs. The two symbols on the left are functionally identical, and represent N-channel depletion MOSFETs. The two symbols on the right are both widely used to represent P-channel depletion MOSFETs.*

For enhancement MOSFETs, a slightly different symbol uses a broken line between the source and drain (as shown in Figure 29-13) to remind us that these components are "normally off" when zero-biased, instead of "normally on." Here again a left-pointing arrow represents an N-channel MOSFET, while a right-pointing arrow represents a P-channel MOSFET.

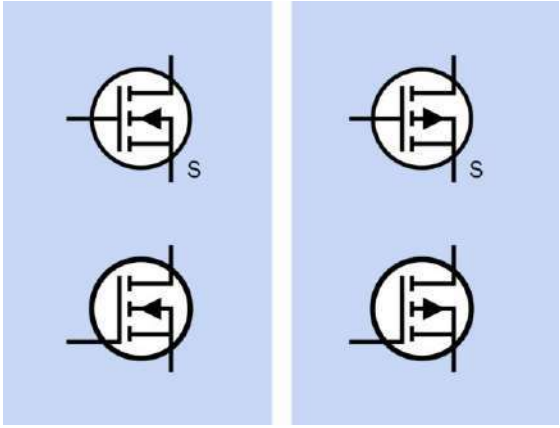

Figure 29-13. *Schematic symbols for enhancement MOSFETs. The two on the left are functionally identical, and represent N-channel enhancement MOSFETs. The two on the right represent P-channel enhancement MOSFETs.*

Because there is so much room for confusion regarding MOSFETs, a summary is presented in Figure 29-14 and Figure 29-15. In these figures, the relevant parts of each schematic symbol are shown disassembled alongside text explaining their meaning. Either of the symbols in Figure 29-14 can be superimposed on either of the symbols in Figure 29-15, to combine their functions. So, for instance, if the upper symbol in Figure 29-14 is superimposed on the lower symbol in Figure 29-15, we get an N-channel MOSFET of the enhancement type.

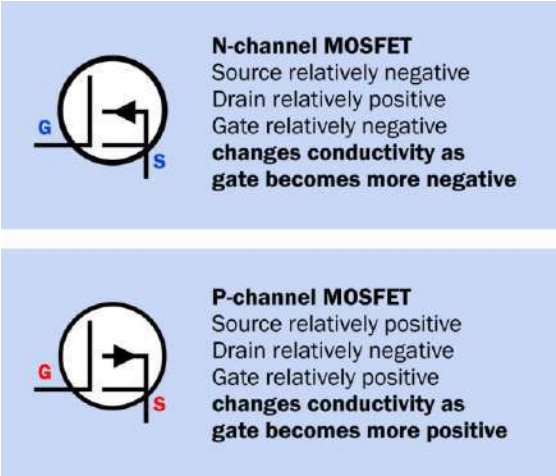

Figure 29-14. *Either of the two symbols can be combined with either of the two symbols in the next figure, to create one of the four symbols for a MOSFET. See text for details.*

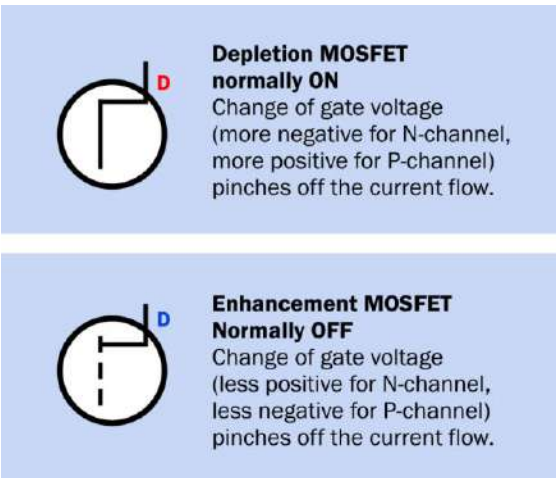

Figure 29-15. *Either of the two symbols can be combined with either of the two symbols from the previous figure, to create one of the four symbols for a MOSFET. See text for details.*

In an additional attempt to clarify MOSFET behavior, four graphs are provided in Figure 29-16, Figure 29-17, Figure 29-18, and Figure 29-19. Like JFETs, MOSFETs have an initial ohmic region, followed by a saturation region where current flows relatively freely through the device. The gate-to-source voltage will determine how much flow is permitted. However, it is important to pay close attention to the graph scales, which differ for each of the four types of MOSFET.

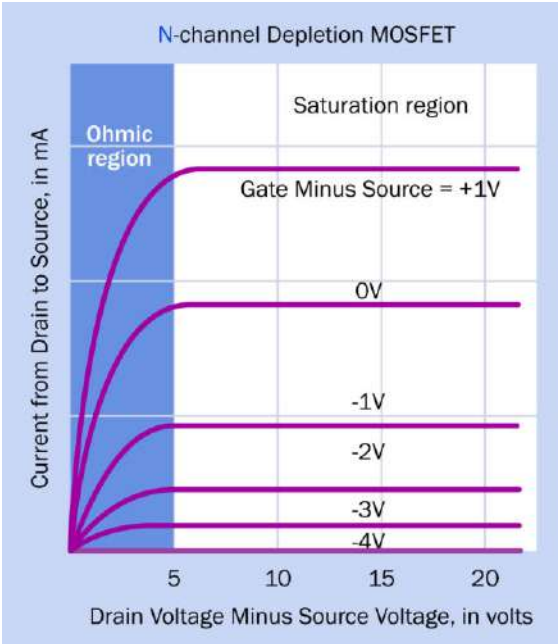

Figure 29-16. *Current flow through a depletion-type, N-channel MOSFET.*

In all of these graphs, a bias voltage exists, which allows zero current to flow (represented by the graph line superimposed on the horizontal axis). In other words, the MOSFET can operate as a switch. The actual voltages where this occurs will vary with the particular component under consideration.

The N-channel, enhancement-type MOSFET is especially useful as a switch because in its normally-off state (with zero bias) it presents a very high resistance to current flow. It requires a relatively low positive voltage at the gate, and effectively no gate current, to begin conducting conventional current from its drain terminal to its source terminal. Thus it can be driven directly by typical 5-volt logic chips.

Depletion-type MOSFETs are now less commonly used than the enhancement-type.

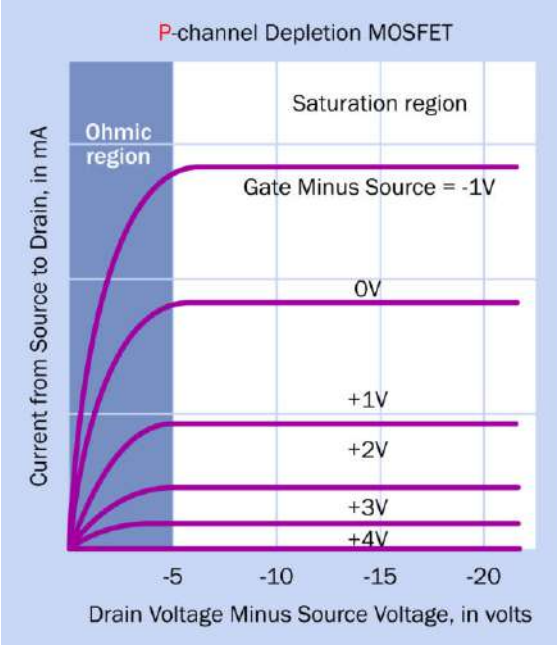

Figure 29-17. *Current flow through a depletion-type, P-channel MOSFET.*

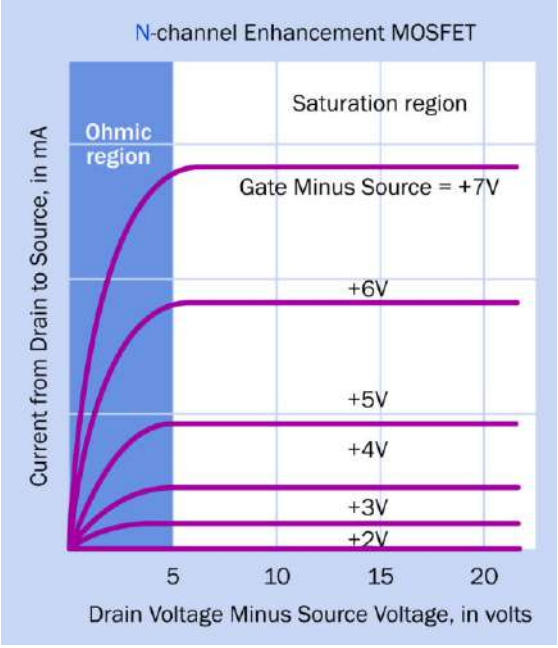

Figure 29-18. *Current flow through an enhancement-type, N-channel MOSFET.*

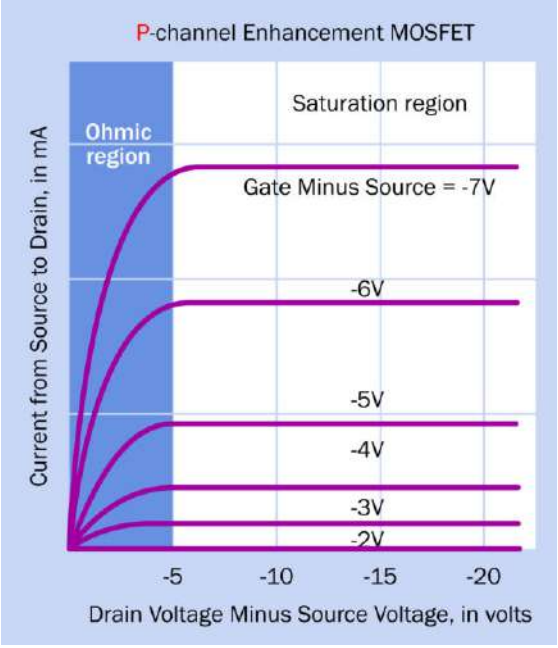

Figure 29-19. *Current flow through an enhancement-type, P-channel MOSFET.*

The Substrate Connection

Up to this point, nothing has been said about a fourth connection available on many MOSFETs, known as the *body terminal*. This is connected to the substrate on which the rest of the component is mounted, and acts as a diode junction with the channel. It is typically shorted to the source terminal, and in fact this is indicated by the schematic symbols that have been used so far. It is possible, however, to use the body terminal to shift the threshold gate voltage of the MOSFET, either by making the body terminal more negative than the source terminal (in an N-channel MOSFET) or more positive (in a P-channel MOSFET). Variants of the MOSFET schematic symbols showing the body terminal are shown in Figure 29-20 (for depletion MOSFETS) and Figure 29-21 (for enhancement MOSFETS).

A detailed discussion of the use of the body terminal to adjust characteristics of the gate is beyond the scope of this encyclopedia.

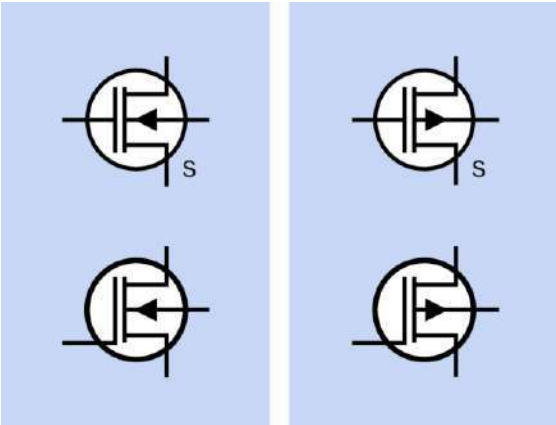

Figure 29-20. *Schematic symbol variants for depletion MOSFETs, showing the body terminal separately accessible instead of being tied to the source terminal.*

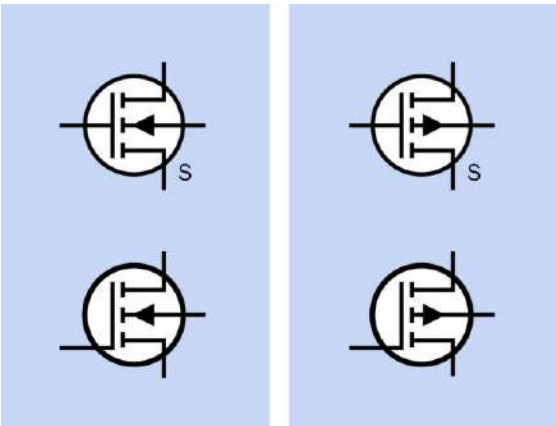

Figure 29-21. *Schematic symbol variants for enhancement MOSFETs, showing the body terminal separately accessible instead of being tied to the source terminal.*

Variants

A few FET variants exist in addition to the two previously discussed.

MESFET

The acronym stands for *MEtal-Semiconductor Field Effect Transistor*. This FET variant is fabricated from gallium arsenide and is used primarily in radio frequency amplification, which is outside the scope of this encyclopedia.

V-Channel MOSFET

Whereas most FET devices are capable of handling only small currents, the *V-channel MOSFET* (which is often abbreviated as a *VMOS FET* and has a V-shaped channel as its name implies) is capable of sustained currents of at least 50A and voltages as high as 1,000V. It is able to pass the high current because its channel resistance is well under 1Ω. These devices, commonly referred to as *power MOSFETs*, are available from all primary semiconductor manufacturers and are commonly used in switching power supplies.

Trench MOS

The TrenchMOS or Trenchgate MOS is a MOSFET variant that encourages current to flow vertically rather than horizontally, and includes other innovations that enable an even lower channel resistance, allowing high currents with minimal heat generation. This device is finding applications in the automobile industry as a replacement for electromechanical **relays**.

Values

The maximum values for JFETs, commonly found listed in datasheets, will specify V_{ds} (the drain-source voltage, meaning the potential difference between drain and source); V_{dg} (the drain-gate voltage, meaning the potential difference between drain and gate); V_{gsr} (the reverse gate-source voltage); gate current; and total device dissipation in mW. Note that the voltage differences are relative, not absolute. Thus a voltage of 50V on the drain and 25V on the source might be acceptable in a component with a V_{ds} of 25V. Similarly, while a JFET's "pinch-off" effect begins as the gate becomes "more negative" than the source, this can be achieved if, for example, the source has a potential of 6V and the gate has a potential of 3V.

JFETs and MOSFETs designed for low-current switching applications have a typical channel resistance of just a few ohms, and a maximum switching speed around 10Mhz.

The datasheet for a MOSFET will typically include values such as gate threshold voltage, which may be abbreviated V_{gs} (or V_{th}) and establishes the relative voltage at which the gate starts to play an active role; and the maximum on-state drain current, which may be abbreviated $I_{d(on)}$ and establishes the maximum limiting current (usually at 25 degree Centigrade) between source and gate.

How to Use it

The combination of a very high gate impedance, very low noise, very low quiescent power consumption in its off state, and very fast switching capability makes the MOSFET suitable for many applications.

P-Channel Disadvantage

P-channel MOSFETs are generally less popular than N-channel MOSFETS because of the higher resistivity of P-type silicon, resulting from its lower carrier mobility, putting it at a relative disadvantage.

Bipolar Substitution

In many instances, an appropriate enhancement-type MOSFET can be substituted for a bipolar transistor with better results (lower noise, faster action, much higher impedance, and probably less power dissipation).

Amplifier Front Ends

While MOSFETs are well-suited for use in the front end of an audio amplifier, chips containing MOSFETs are now available for this specific purpose.

Voltage-Controlled Resistor

A simple voltage-controlled resistor can be built around a JFET or MOSFET, so long as its performance remains limited to the linear or ohmic region.

Compatibility with Digital Devices

A JFET may commonly use power supplies in the range of 25VDC. However, it can accept the high/low output from a 5V digital device to control its gate. A 4.7K pullup resistor is an appropriate value to be used if the FET is to be used in conjunction with a TTL digital chip that may have a voltage swing of only approximately 2.5V between its low and high thresholds.

What Can Go Wrong

Static Electricity

Because the gate of a MOSFET is insulated from the rest of the component, and functions much like a plate of a capacitor, it is especially likely to accumulate static electricity. This static charge may then discharge itself into the body of the component, destroying it. A MOSFET is particularly vulnerable to electrostatic discharge because its oxide layer is so thin. Special care should be taken either when handling the component, or when it is in use. Always touch a grounded object or wear a grounded wrist band when handling MOSFETs, and be sure that any circuit using MOSFETs includes appropriate protection from static and voltage spikes.

A MOSFET should not be inserted or removed while the circuit in which it performs is switched on or contains residual voltage from undischarged capacitors.

Heat

Failure because of overheating is of special concern when using power MOSFETs. A Vishay Application Note ("Current Power Rating of Power Semiconductors") suggests that this kind of component is unlikely to operate at less than 90 degrees Centigrade in real-world conditions, yet the power handling capability listed in a datasheet usually assumes an industry standard of 25 degrees Centigrade.

On the other hand, ratings for continuous power are of little relevance to switching devices that have duty cycles well below 100%. Other factors also play a part, such as the possibility of power surges, the switching frequency, and the integrity of the connection between the component

and its heat sink. The heat sink itself creates uncertainty by tending to average the temperature of the component, and of course there is no simple way to know the actual junction temperature, moment by moment, inside a MOSFET.

Bearing in mind the accumulation of unknown factors, power MOSFETs should be chosen on an extremely conservative basis. According to a tutorial in the *EE Times*, actual current switched by a MOSFET should be less than half of its rated current at 25 degrees, while one-fourth to one-third are common. Figure 29-22 shows the real-world recommended maximum drain current at various temperatures. Exceeding this recommendation can create additional heat, which cannot be dissipated, leading to further accumulation of heat, and a thermal runaway condition, causing eventual failure of the component.

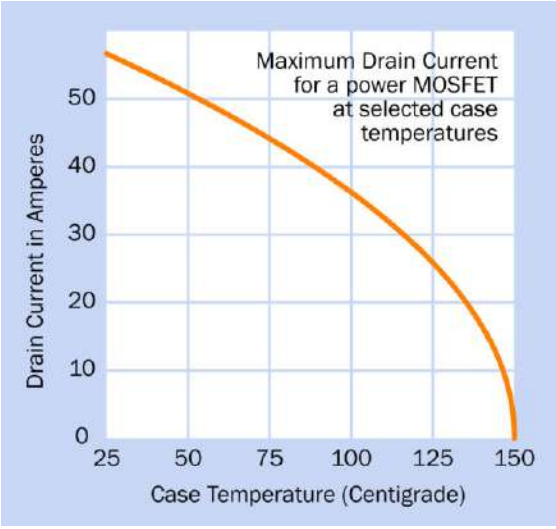

Figure 29-22. *Maximum advised drain current through a power MOSFET, related to case temperature of the component. Derived from EE Times Power MOSFET Tutorial.*

Wrong Bias

As previously noted, applying forward bias to a JFET can result in the junction between the gate and the source starting to behave like a forward-biased diode, when the voltage at the gate is greater than the voltage at the source by approximately 0.6V or more (in an N-channel JFET). The junction will present relatively little resistance, encouraging excessive current and destructive consequences. It is important to design devices that allow user input in such a way that user error can never result in this eventuality.

Schematic Symbols

A

This section contains a compilation of schematic symbols for components that have been described in this volume. They are sequenced primarily in alphabetical order, as this section is intended for use as an index. However, symbols that have a strong similarity are grouped together; thus **potentiometer** is found adjacent to **resistor**, and all types of transistors are in the same group.

The symbol variants shown in each blue rectangle are functionally identical.

Where a component has mandatory polarity or is commonly used with a certain polarity, a red plus sign (+) has been added for guidance. This sign is not part of the symbol. In the case of polarized capacitors, where a plus sign is normally shown (or should be shown) with the symbol, the plus sign is a part of the symbol and appears in black.

This is not intended to be an exhaustive compilation of symbol variants. Some uncommon ones may not be here. However, the list should be sufficient to enable identification of components in this volume.

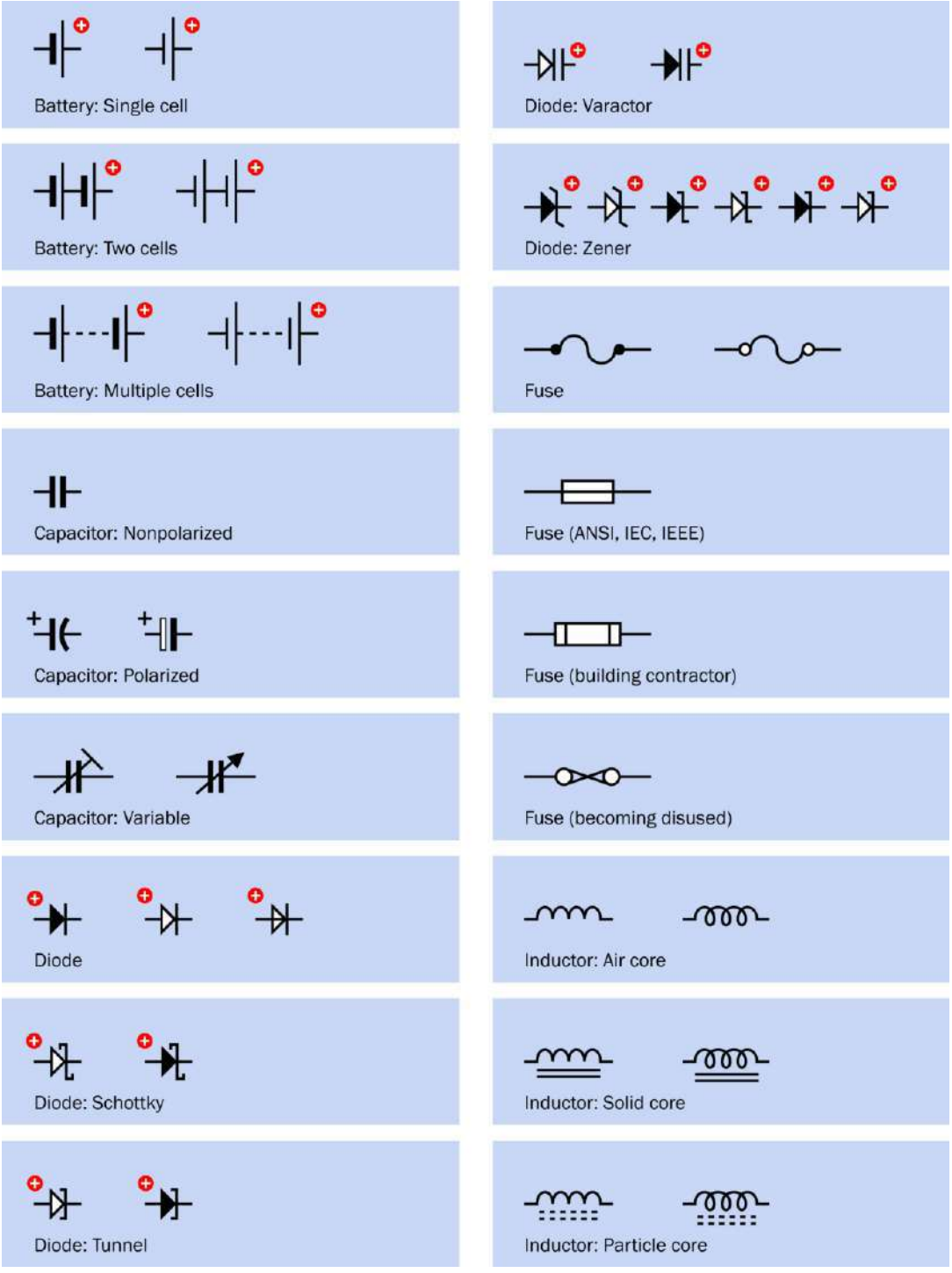

Figure A-1. *Schematic symbols*

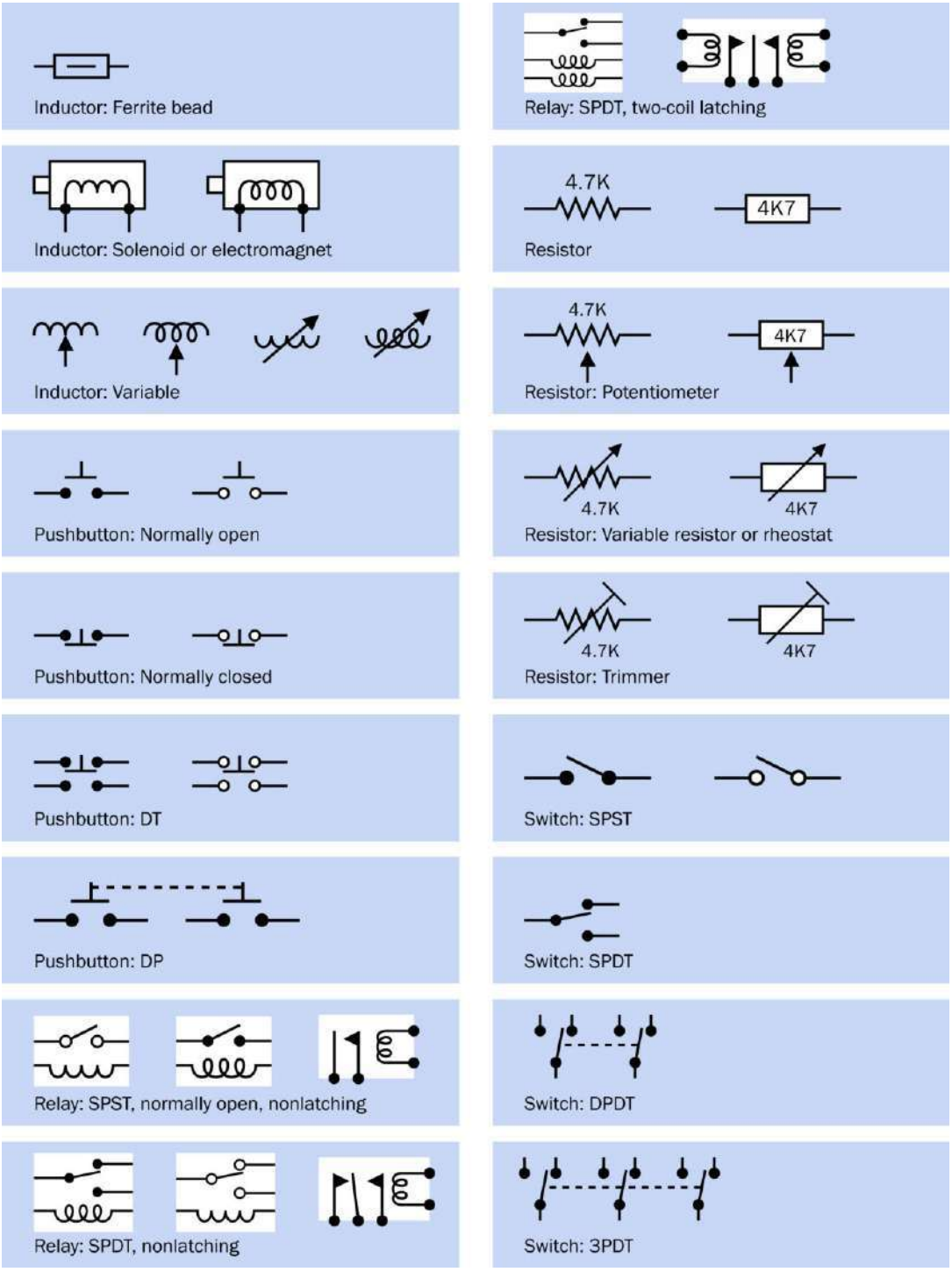

Figure A-2. *Schematic symbols, continued*

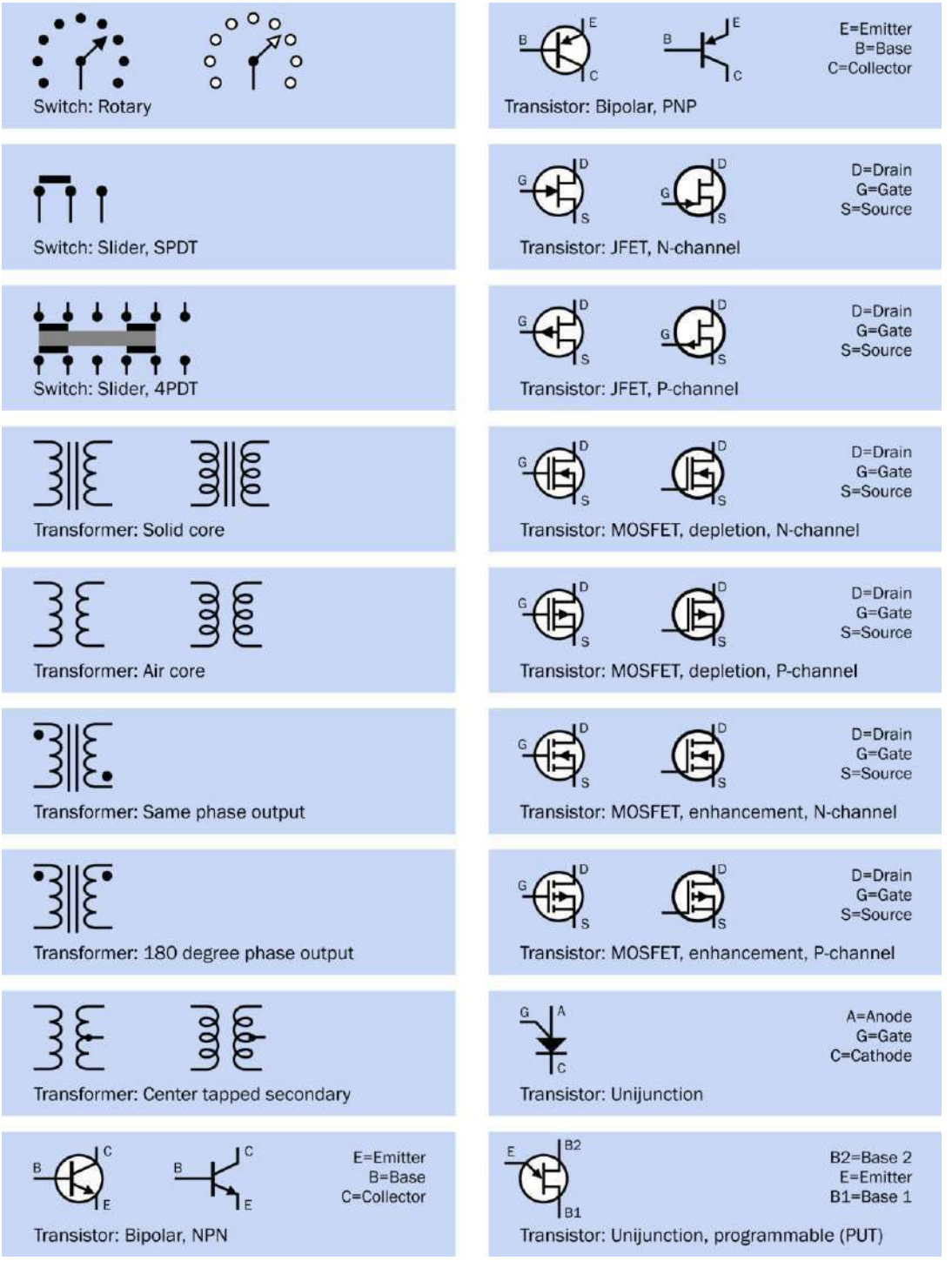

Figure A-3. *Schematic symbols, continued*

How to Use This Book

This is the second of three volumes. Its purpose is to provide an overview of the most commonly used electronic components, for reference by students, engineers, hobbyists, and instructors. While you can find much of this information dispersed among datasheets, introductory books, websites, and technical resources maintained by manufacturers, the *Encyclopedia of Electronic Components* gathers all the relevant facts in one place, properly organized and verified, including details that may be hard to find elsewhere. Each entry includes typical applications, possible substitutions, cross-references to similar devices, sample schematics, and a list of common problems and errors.

You can find a more detailed rationale for this encyclopedia in the Preface to Volume 1.

Volume Contents

Practical considerations influenced the decision to divide this encyclopedia into three volumes. Each deals with broad subject areas as follows.

Volume 1

Power; electromagnetic devices; discrete semiconductors

The *power* category includes sources of electricity and methods to distribute, store, interrupt, convert, and regulate power. The *electromagnetic devices* category includes devices that exert force linearly, and others that create a turning force. *Discrete semiconductors* include the primary types of diodes and transistors. A contents listing for Volume 1 appears in Figure P-1.

Volume 2

Thyristors (SCRs, diacs, and triacs); integrated circuits; light sources, indicators, and displays; and sound sources

Integrated circuits are divided into analog and digital components. *Light sources, indicators, and displays* are divided into reflective displays, single sources of light, and displays that emit light. *Sound sources* are divided into those that create sound, and those that reproduce sound. A contents listing for Volume 2 appears in Figure P-2.

Volume 3

Sensing devices

The field of sensors has become so extensive, they easily merit a volume to themselves. *Sensing devices* include those that detect light, sound, heat, motion, pressure, gas, humidity, orientation, electricity, proximity, force, and radiation.

At the time of writing, Volume 3 is still in preparation, while Volume 1 is complete and is available in a variety of formats.

Primary Category	Secondary Category	Component Type
power	source	battery
	connection	jumper
		fuse
		pushbutton
		switch
		rotary switch
		rotational encoder
	moderation	relay
		resistor
		potentiometer
		capacitor
		variable capacitor
	conversion	inductor
		AC-AC transformer
		AC-DC power supply
		DC-DC converter
		DC-AC inverter
	regulation	voltage regulator
electro-magnetism	linear output	electromagnet
		solenoid
	rotational output	DC motor
		AC motor
		servo motor
		stepper motor
discrete semi-conductor	single junction	diode
		unijunction transistor
	multi-junction	bipolar transistor
		field-effect transistor

Figure P-1. *The subject-oriented organization of categories and entries in Volume 1.*

Primary Category	Secondary Category	Component Type
discrete semi-conductor	thyristor	SCR
		diac
		triac
integrated circuit	analog	solid-state relay
		optocoupler
		comparator
		op-amp
		digital potentiometer
		timer
	digital	logic gate
		flip-flop
		shift register
		counter
		encoder
		decoder
		multiplexer
light source, indicator or display	reflective	LCD
	single source	incandescent lamp
		neon bulb
		fluorescent light
		laser
		LED indicator
		LED area lighting
	multi-source or panel	LED display
		vacuum-fluorescent
		electroluminescence
sound source	audio alert	transducer
		audio indicator
	reproducer	headphone
		speaker

Figure P-2. *The subject-oriented organization of categories and entries in Volume 2.*

Organization

Reference versus Tutorial

As its title suggests, this is a reference book, not a tutorial. A tutorial begins with elementary concepts and builds sequentially toward concepts that are more advanced. A reference book assumes that you may dip into the text at any point, learn what you need to know, and then put the book aside. If you choose to read it straight through from beginning to end, you will find some repetition, as each entry is intended to be self-sufficient, requiring minimal reference to other entries.

My books *Make: Electronics* and *Make: More Electronics* follow a tutorial approach. They don't go into as much depth as this Encyclopedia, because a tutorial inevitably allocates a lot of space to step-by-step explanations and instructions.

Theory and Practice

This book is oriented toward practicality rather than theory. I assume that the reader mostly wants to know how to use electronic components, rather than why they work the way they do. Consequently, I have not included proofs of formulae or definitions rooted in electrical theory. Units are defined only to the extent necessary to avoid confusion.

Many books on electronics theory already exist, if theory is of interest to you.

Entries

This encyclopedia is divided into entries, each entry being devoted to one broad type of component. Two rules determine whether a component has an entry all to itself, or is subsumed into another entry:

Rule 1

A component merits its own entry if it is (a) widely used, or (b) not so widely used but has a unique identity and maybe some historical status. The **bipolar transistor** entry is an example of a widely used component, whereas the **unijunction transistor** entry is an example of a not so widely used component with a unique identity.

Rule 2

A component does not merit its own entry if it is (a) seldom used, or (b) very similar in function to another component that is more widely used. For example, a *rheostat* is subsumed into the **potentiometer** section, while *silicon diode*, *Zener diode*, and *germanium diode* are combined together in the **diode** entry.

Inevitably, these guidelines required judgment calls which in some cases may seem arbitrary. My ultimate decision was based on where I would expect to find a component if I was looking for it myself.

Subject Paths

Entries are not organized alphabetically. They are grouped by subject, in much the same way that books in the nonfiction section of some libraries are organized by the Dewey Decimal System. This is convenient if you don't know exactly what you are looking for, or if you don't know all the options that may be available to perform a task that you have in mind.

Each primary category is divided into subcategories, and the subcategories are divided into component types. This hierarchy is shown in Figure P-2. It is also apparent when you look at the top of the first page of each entry, where you will find the path that leads to it. The **diac** entry, for instance, is headed with this path:

discrete semiconductor > thyristor > diac

Any classification scheme will run into exceptions. You can buy a chip containing a *resistor array*, for instance. Technically, this is an *analog integrated circuit*, but a decision was made to put it in the **resistor** section of Volume 1, because it can be directly substituted for a group of resistors.

Some components have hybrid functions. A **multiplexer**, for instance, may pass analog signals and may have "analog" in its name. However, it is digitally controlled and is mostly used in conjunction with other digital integrated circuits. This seemed to justify placing it in the digital category.

Inclusions and Exclusions

There is also the question of what is, and is not, a component. Is wire a component? Not for the purposes of this encyclopedia. How about a **DC-DC converter**? Because converters are now sold in small packages by component suppliers, they are included in Volume 1 as components.

Many similar decisions had to be made on a case-by-case basis. Some readers will disagree with the outcome, but reconciling all the disagreements would have been impossible. The best I could do was to create a book which is organized in the way that would suit me best if I were using it myself.

Typographical Conventions

Within each entry, **bold type** is used for the first occurrence of the name of a component that has its own entry elsewhere. Other important electronics terms or component names may be presented in *italics*.

The names of components, and the categories to which they belong, are all set in lowercase type, except where a term is normally capitalized because it is an acronym or a trademark. The term *Trimpot*, for instance, is trademarked by Bourns, but *trimmer* is not. **LED** is an acronym, but *cap* (abbreviation for **capacitor**) is not.

The European convention for representing fractional component values eliminates decimal points. Thus, values such as 3.3K and 4.7K are expressed as 3K3 and 4K7. This style has not been adopted to a significant degree in the United States, and is not used in this encyclopedia.

In mathematical formulae, I have used the style that is common in programming languages. The * (asterisk) is used as a multiplication symbol, while the / (forward slash) is used as a division symbol. Where some terms are in parentheses, they must be dealt with first. Where parentheses are inside parentheses, the innermost ones must be dealt with first. So, in this example:

```
A = 30 / (7 + (4 * 2) )
```

You would begin by multiplying 4 times 2, to get 8; then add 7, to get 15; then divide that into 30, to get the value for A, which is 2.

Visual Conventions

Figure P-3 shows the conventions that are used in the schematics in this book. A black dot always indicates a connection, except that to minimize ambiguity, the configuration at top right is avoided, and the configuration at top center is used instead. Conductors that cross each other without a black dot do not make a connection. The styles at bottom right are sometimes seen elsewhere, but are not used here.

All the schematics are formatted with pale blue backgrounds. This enables components such as switches, transistors, and LEDs to be highlighted in white, drawing attention to them and clarifying the boundary of the component. The white areas have no other meaning.

Photographic Backgrounds

All photographs of components include a background grid that is divided into squares measuring 0.1". Although the grid is virtual, it is equivalent in scale to physical graph paper placed immediately behind the component. If the component is photographed at an angle, the grid may be reproduced at a similar angle, creating perspective on the squares.

Background colors in photographs were chosen for contrast with the colors of the components, or for visual variety. They have no other significance.

Component Availability

Because there is no way of knowing if a component may have a long production run, this encyclopedia is cautious about listing specific part numbers. To find a specific part that has a narrow function, searching the websites maintained by suppliers will be necessary. The following suppliers were checked frequently during the preparation of the book:

- Mouser Electronics
- Jameco Electronics

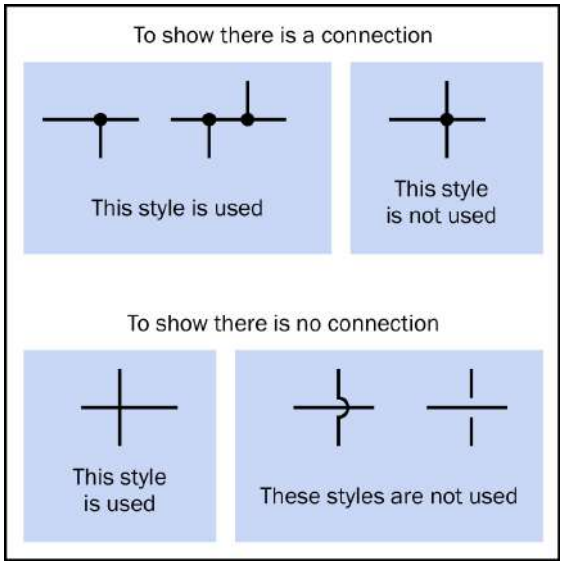

Figure P-3. *Visual conventions that are used in the schematics in this book.*

When seeking obsolete parts, or those that are nearing the end of their commercial life, eBay can be very useful.

Issues and Errata

If you believe you have found an error in this book, you will find guidance on how to report it here: *http://bit.ly/eec_v2_errata*.

Before posting your own erratum, please check those that have been submitted previously, to see if someone else already reported it.

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We have a web page for this book, where we list errata, examples, and any additional information. You can access this page at: *http://bit.ly/encyclopedia_of_electronic_components_v2*.

Acknowledgments

Any reference work draws inspiration from many sources. Datasheets and tutorials maintained by component manufacturers were considered the most trustworthy sources of information online. In addition, component retailers, college texts, crowd-sourced reference works, and hobbyist sites were used. The following books provided useful information:

Boylestad, Robert L. and Nashelsky, Louis: *Electronic Devices and Circuit Theory*, 9th edition. Pearson Education, 2006.

Braga, Newton C.: *CMOS Sourcebook*. Sams Technical Publishing, 2001.

Hoenig, Stuart A.: *How to Build and Use Electronic Devices Without Frustration, Panic, Mountains of Money, or an Engineering Degree*, 2nd edition. Little, Brown, 1980.

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Mims III, Forrest M.: *Timer, Op Amp, & Optelectronic Circuits and Projects*. Master Publishing, 2007.

Predko, Mike: *123 Robotics Experiments for the Evil Genius*. McGraw-Hill, 2004.

Scherz, Paul: *Practical Electronics for Inventors*, 2nd edition. McGraw-Hill, 2007.

Williams, Tim: *The Circuit Designer's Companion*, 2nd edition. Newnes, 2005.

I also made extensive use of information on vendor sites, especially:

- Mouser Electronics
- Jameco Electronics
- All Electronics
- sparkfun
- Electronic Goldmine
- Adafruit
- Parallax, Inc.

In addition, some individuals provided special assistance. My editor, Brian Jepson, was immensely helpful in the development of this book. Philipp Marek and Steve Conklin reviewed the text for errors. My publisher demonstrated faith in my work. Kevin Kelly unwittingly influenced me with his legendary interest in "access to tools." It was Mark Frauenfelder who originally brought me back to the pleasures of building things, and Gareth Branwyn who revived my interest in electronics.

Lastly, I should mention my school friends from decades ago: Patrick Fagg, Hugh Levinson, Graham Rogers, William Edmondson, and John Witty, who helped me to feel that it was OK to be a nerd building my own audio equipment, long before the word "nerd" actually existed.

—Charles Platt, 2014

SCR

1

The acronym **SCR** is derived from *silicon-controlled rectifier*, which is a gate-triggered type of *thyristor*. A thyristor is defined here as a semiconductor having four or more alternating layers of p-type and n-type silicon. Because it predated integrated circuits, and in its basic form consists of a single multilayer semiconductor, a thyristor is considered to be a discrete component in this encyclopedia. When a thyristor is combined with other components in one package (as in a **solid-state relay**), it is considered to be an integrated circuit.

Other types of thyristor are the **diac** and **triac**, each of which has its own entry.

Thyristor variants that are not so widely used, such as the *gate turn-off thyristor (GTO)* and *silicon-controlled switch (SCS)*, do not have entries here.

OTHER RELATED COMPONENTS

- **diac** (see Chapter 2)
- **triac** (see Chapter 3)

What It Does

In the 1920s, the *thyratron* was a gas-filled tube that functioned as a switch and a rectifier. In 1956, General Electric introduced a solid-state version of it under the name *thyristor*. In both cases, the names were derived from the thyroid gland in the human body, which controls the rate of consumption of energy. The thyratron and, subsequently, the thyristor enabled control of large flows of current.

The **SCR** (silicon-controlled rectifier) is a type of thyristor, although the two terms are often used as if they are synonymous. Text that refers loosely to a thyristor may actually be discussing an SCR, and vice versa. In this encyclopedia, the **SCR**, **diac**, and **triac** are all considered to be variant types of thyristor.

An SCR is a solid-state switch that in many instances can pass high currents at high voltages. Like a **bipolar transistor**, it is triggered by voltage applied to a gate. Unlike the transistor, it allows the flow of current to continue even when the gate voltage diminishes to zero.

How It Works

This component is designed to pass current in one direction only. It can be forced to conduct in the opposite direction if the reversed potential exceeds its *breakdown voltage*, but this mistreatment is likely to cause damage.

By comparison, the diac and triac are designed to be bidirectional.

The SCR has three leads, identified as anode, cathode, and gate. Two functionally identical versions of the schematic symbol are shown in Figure 1-1. Early versions sometimes included a circle drawn around them, but this style has become obsolete. Care must be taken to distinguish

between the SCR symbol and the symbol that represents a **programmable unijunction transistor** (PUT), shown in Figure 1-2.

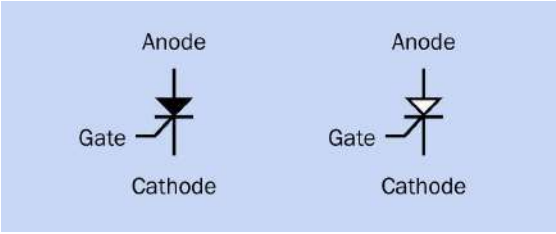

Figure 1-1. *Two functionally identical schematic symbols for an SCR (silicon-controlled rectifier). The symbol on the left is more common.*

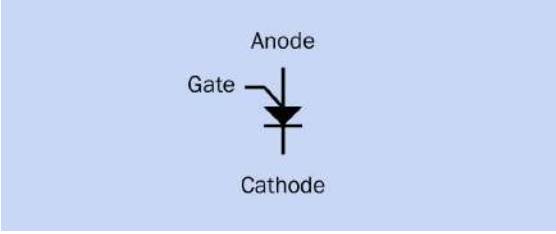

Figure 1-2. *The symbol shown here is for a programmable unijunction transistor (PUT). Care must be taken to distinguish it from the symbol for an SCR.*

Switching Behavior

When the SCR is in its passive or nonconductive state, it will block current in either direction between anode and cathode, although a very small amount of *leakage* typically occurs. When the SCR is activated by a positive voltage at the gate, current can now flow from anode to cathode, although it is still blocked from cathode to anode. When the flow reaches a level known as the *latching current*, the flow will continue even after the triggering voltage drops to zero. This behavior causes it to be known as a *regenerative* device.

If the current between anode and cathode starts to diminish while the gate voltage remains zero, the current flow will continue below the latching level until it falls below the value known as the *holding current*. The flow now ceases. Thus, the only way to end a flow of current that has been initiated through an SCR is by reducing the flow or attempting to reverse it.

Note that the self-sustaining flow is a function of current rather than voltage.

Unlike a transistor, an SCR is either "on" or "off" and does not function as a *current amplifier*. Like a diode, it is designed to conduct current in one direction; hence the term *rectifier* in its full name. When it has been triggered, the impedance between its anode and cathode is sufficiently low that heat dissipation can be managed even at high power levels.

The ability of SCRs to pass relatively large amounts of current makes them suitable for controlling the power supplied to motors and resistive heating elements. The fast switching response also enables an SCR to interrupt and abbreviate each positive phase of an AC waveform, to reduce the average power supplied. This is known as *phase control*.

SCRs are also used to provide *overvoltage protection*.

SCR packages reflect their design for a wide range of voltages and currents. Figure 1-3 shows an SCR designed for on-state current of 4A RMS (i.e., measured as the root mean square of the alternating current). Among its applications are small-engine ignition and *crowbar* overvoltage protection, so named because it shorts a power supply directly to ground, much like a crowbar being dropped across the terminals of a car battery (but hopefully with a less dramatic outcome). See Figure 1-15.

In Figure 1-4, the SCR can handle up to 800V repetitive peak off-state voltage and 55A RMS. Possible applications include AC rectification, crowbar protection, welding, and battery charging. The component in Figure 1-5 is rated for 25A and 50V repetitive peak off-state voltage. To assess the component sizes, bear in mind that the graph line spacing is 0.1".

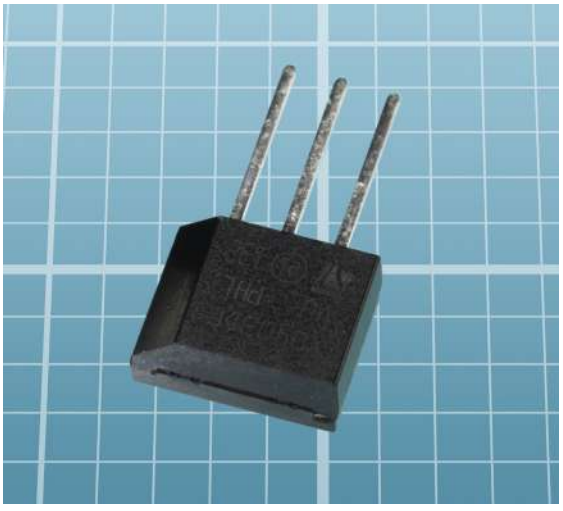

Figure 1-3. *SCR rated for 400V repetitive off-state voltage, no greater than 4A RMS.*

Figure 1-4. *SCR rated for 800V repetitive off-state voltage, no greater than 55A RMS.*

Internal Configuration

The function of an SCR can be imagined as being similar to that of a PNP transistor paired with an NPN transistor, as shown in Figure 1-6. In this simplified schematic, so long as zero voltage is applied to the "gate" wire, the lower (NPN) transistor remains nonconductive. Consequently, the upper (PNP) transistor cannot sink current, and this transistor also remains nonconductive. When voltage is applied to the "gate," the lower transistor starts to sink current from the upper transistor. This switches it on. The two transistors now continue to conduct even if power to the "gate" is disconnected, because they have created a positive feedback loop.

Figure 1-5. *Stud-packaged SCR rated for 50V repetitive off-state voltage, no greater than 25A RMS.*

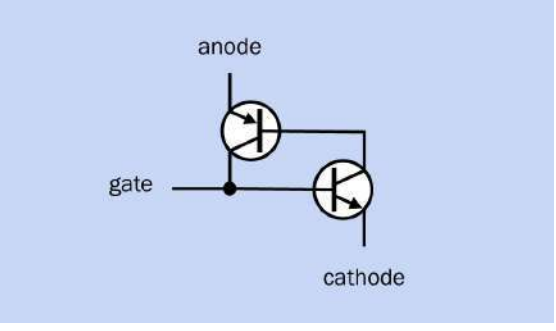

Figure 1-6. *An SCR behaves similarly to an NPN and a PNP transistor coupled together.*

Figure 1-7 shows the same two transistors in simplified form as sandwiches of p-type and n-type silicon layers (on the left), and their combination in an SCR (on the right). Although the actual configuration of silicon segments is not as simple or as linear as this diagram suggests, the SCR can be described correctly as a *PNPN device*.

An SCR is comparable with an electromagnetic **latching relay**, except that it works much faster and more reliably.

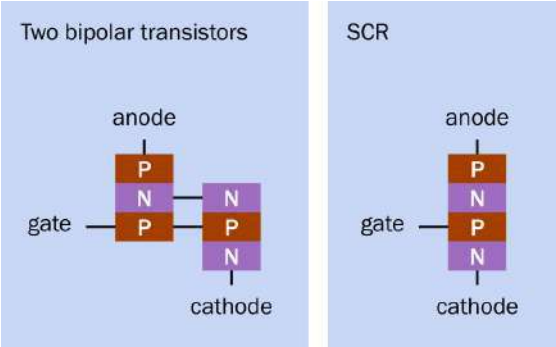

Figure 1-7. *The two transistors from the previous figure are shown here in simplified form as two stacks of p-type and n-type silicon layers. These layers are combined in an SCR, on the right.*

Breakdown and Breakover Voltage

The curves in Figure 1-8 illustrate the behavior of a hypothetical SCR, and can be compared with the curves shown for a diac in Figure 2-5 and a triac in Figure 3-10. Beginning with zero voltage applied between anode and cathode, and zero current flowing (i.e., at the center origin of the graph), if we apply a voltage at the anode that is increasingly negative relative to the cathode (i.e., we attempt to force the SCR to allow negative current flow), we see a small amount of leakage, indicated by the darker blue area (which is not drawn to scale). Finally the *breakdown voltage* is reached, at which point the negative potential overcomes the SCR and its impedance drops rapidly, allowing a surge of current to flow, probably damaging it.

Alternatively, starting once again from the center, if we apply a voltage at the anode that is increasingly positive relative to the cathode, two consequences are possible. The dashed curve assumes that there is zero voltage at the gate, and shows that some leakage occurs until the applied potential at the anode reaches the *breakover voltage*, at which point the SCR allows a large current flow, which continues even when the voltage decreases.

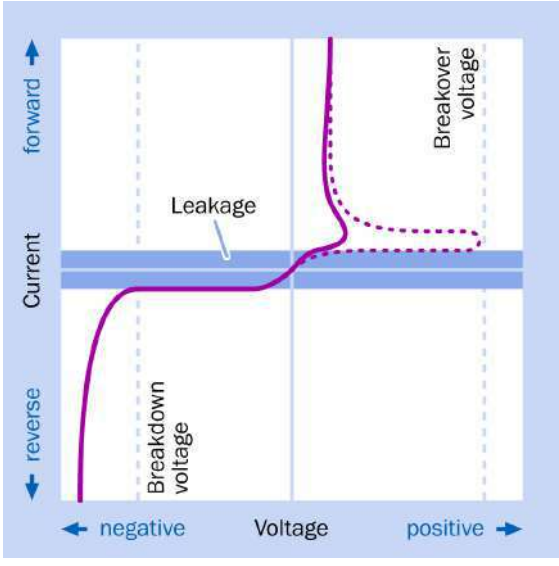

Figure 1-8. *The solid curve shows current passing between the anode and cathode of a hypothetical SCR for varying voltages, while a triggering voltage is applied to the gate. The dashed curve assumes that no triggering voltage is applied to the gate.*

In practice, the SCR is intended to respond to a positive gate voltage. Under these circumstances, its behavior is shown by the solid curve in the top-right quadrant in Figure 1-8. The SCR begins to conduct current without having to reach the breakover voltage at the anode.

- When used as it is intended, the SCR should not reach breakdown or breakover voltage levels.

SCR Concept Demo

In Figure 1-9, pushbutton S1 applies voltage to the gate of the SCR, which puts the SCR in self-sustaining conductive mode. When S1 is released, the meter will show that current continues to pass between the anode and the cathode. The X0403DF SCR suggested for this circuit has a holding current of 5mA, which a 5VDC supply should be able to provide with the 1K resistor in

the circuit. If necessary, this resistor can be reduced to 680Ω.

Now if pushbutton S2 is pressed, the flow is interrupted. When S2 is released, the flow will not resume. Alternatively, if pushbutton S3 is pressed while the SCR is conducting current, the flow is diverted around the SCR, and when the pushbutton is released, the flow through the SCR will not resume. Thus, the SCR can be shut down either by a normally closed pushbutton in series with it (which will interrupt the current), or a normally open pushbutton in parallel with it (which will divert the current).

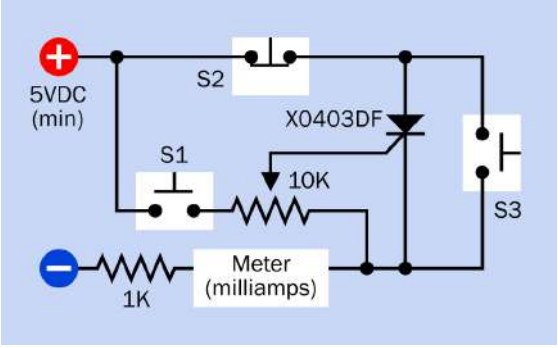

Figure 1-9. *In this test circuit, S1 triggers the SCR, while S2 or S3 will stop it. See text for additional details.*

The test circuit is shown installed on a breadboard in Figure 1-10. In this photograph, the red and blue wires supply a minimum of 5VDC. The two red buttons are tactile switches, the one at top left being S1 in the schematic while the one at bottom right is S3. The large switch with a rectangular button is S2; this is normally closed, and opens when pressed. The X0403DF SCR is just below it and to the right. The square blue trimmer is set to the midpoint of its range.

AC Current Applications

If the SCR is used with alternating current, it stops conducting during each negative cycle, and is retriggered in each positive cycle. This suggests one of its primary applications, as a controllable rectifier that can switch rapidly enough to limit the amount of current that passes through it during each cycle.

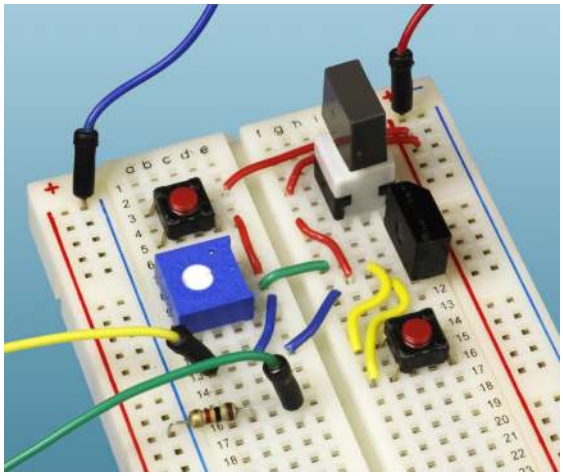

Figure 1-10. *A breadboarded version of the SCR test circuit. The two red buttons correspond with S1 and S3 in the schematic, while the large rectangular button at top right opens S2. See text for details.*

Variants

SCRs are available in surface-mount, through-hole, and stud packages, to handle increasing currents and voltages. Some special-purpose SCRs can control currents of hundreds of amps, while high-power SCRs are used to switch thousands of amps at more than 10,000V in power distribution systems. They are too specialized for inclusion in this encyclopedia.

Typical power ratings for SCRs in general use are summarized in the next section.

Values

Any SCR will impose a forward voltage drop, which typically ranges from around 1V to 2V, depending on the component.

Because SCRs are often used to modify AC waveforms, the current that the component can pass is usually expressed as the root mean square (RMS) of its peak value.

Commonly Used Abbreviations

- V_{DRM} Maximum repetitive forward voltage that may be applied to the anode while no voltage is applied to the gate (i.e., when the SCR is not in conductive mode).
- V_{RRM} Maximum repetitive reverse voltage that may be applied to the anode while no voltage is applied to the gate (i.e., when the SCR is not in conductive mode).
- V_{TM} Maximum on-state voltage while the SCR is in conductive mode. T indicates that this value changes with temperature.
- V_{GM} Forward maximum gate voltage.
- V_{GT} Minimum gate voltage required to trigger.
- V_{GD} Maximum gate voltage that will not trigger.
- I_{DRM} Peak repetitive forward blocking current (i.e., maximum leakage).
- I_{RRM} Peak repetitive reverse blocking current (i.e., leakage in the off state).
- I_{GM} Maximum forward gate current.
- $I_{T(RMS)}$ Maximum RMS current between anode and cathode while the SCR is in conductive mode. T indicates that this value changes with temperature.
- $I_{T(AV)}$ Maximum average current between anode and cathode while the SCR is in conductive mode. T indicates that this value changes with temperature.
- I_{GT} Maximum gate current required to trigger.
- I_H Typical holding current.
- I_L Maximum latching current.
- T_C Case temperature, usually expressed as an acceptable range.
- T_J Operating junction temperature, usually expressed as an acceptable range.

Surface-mount variants may tolerate maximum anode-cathode currents that typically range from 1A to 10A. Maximum voltages as high as 500V are allowed in some cases. Leakage in the "off" state may be as high as 0.5mA or as low as 5µA. Gate trigger voltage is likely to range from 0.8V to 1.5V, and trigger current of 0.2mA to 15mA is typical.

Through-hole variants may be packaged in TO-92 format (like discrete transistors) or, more commonly, in TO-220 format (like a typical 1A voltage regulator). They may be rated for a maximum of 5A up to 50A, depending on the component, with maximum voltages ranging from 50V to 500V. Leakage is similar to surface-mount variants. The gate trigger voltage is typically around 1.5V, and trigger current ranges from 25–50mA.

A stud-type SCR may have a maximum 50A to 500A current rating, although some components are capable of tolerating even higher values. Maximum voltages of 50V to 500V are possible. Leakage is likely to be higher than in other formats, with 5mA to 30mA being common. The gate trigger voltage is typically 1.5 to 3V, and trigger current may range from around 50mA to 200mA.

How to Use It

Although other applications are possible, in practice SCRs have two main applications:

- Phase control, which interrupts each positive phase of an AC power supply. It can moderate the speed of a motor or the heat generated by a resistive load.
- Overvoltage protection. This can safeguard sensitive components in a circuit where there is a DC power supply.

SCRs are often incorporated in ground-fault circuit interruptors (although not usually as discrete components) and in automotive ignition systems.

Phase Control

Phase control is a convenient way to control or limit the AC power delivered to a load by abbreviating each pulse in the AC waveform. This is done by adjusting the gate voltage so that the SCR blocks the first part of each positive phase, then conducts the remainder, and then stops conducting below its holding level. The SCR will then block the reversed flow in the negative phase of the AC waveform, but an additional SCR with opposite polarity can be added.

This is a form of *pulse-width modulation*. It is highly efficient, as the effective internal resistance of the SCR is either very high or very low, and the component does not waste significant energy in the form of heat.

On a graph showing the fluctuating voltage of an AC waveform, a single cycle is customarily divided into four stages: (1) zero voltage, (2) maximum positive voltage, (3) zero voltage, (4) minimum negative voltage, all measurements being made between the live side of the supply and the neutral side of the supply.

The cycle then repeats. Its transitions are often referred to as *phase angles* of 0 degrees, 90 degrees, 180 degrees, and 270 degrees, as shown in Figure 1-11.

The fluctuating voltage in an AC power supply is proportional with the sine of the phase angle. This concept is illustrated in Figure 1-12. If an imaginary point (shown as a purple dot) is moving in a circular path counterclockwise at a constant speed, its vertical distance (shown in green) above or below the X axis (horizontal centerline) can represent an AC voltage corresponding with the angle (shown as purple arcs) of the circle radius to the point, each angle being measured from at the center relative to a start position at right on the X axis.

When an SCR is used for phase control, the point at which it starts to conduct may be anywhere from 0 to almost 180 degrees. This is achieved by diverting a small amount of the AC power into an RC network attached to the gate of the SCR, as shown in Figure 1-13. The capacitor in this schematic introduces a delay that can be varied by the potentiometer. This enables the SCR to be triggered even after the peak of the AC power signal. In Figure 1-14, the AC power is shown by the center (green) curve, and the slightly delayed, reduced voltage at the gate is shown by the upper, purple curve. When the gate voltage rises to the trigger level, it causes the SCR to begin conducting current, creating an abbreviated output shown in the bottom curve. In this way, triggering from an AC phase angle of 0 degrees to almost 180 degrees is possible. The phase angle where the SCR begins to allow conduction is known as the *conduction angle*.

If two SCRs with opposite polarity are placed in parallel with each other, they can be used to provide phase control on both the positive-going and negative-going sections of an AC cycle. This configuration is used in high-powered devices. A **triac** is used for the same purpose with lower current.

Six SCRs may be used to control three-phase power.

Overvoltage Protection

The tolerance of an SCR for high current makes it suitable for use in a crowbar voltage limiting circuit.

In Figure 1-15, the SCR does not conduct current (other than a small amount of leakage) until the Zener diode senses a voltage above the maximum level considered safe. The diode then allows power to reach the gate of the SCR. Its impedance drops immediately, and the resulting surge of current trips the fuse. After the cause of the overvoltage condition is corrected, the fuse can be replaced and the circuit may resume functioning.

A capacitor is included so brief spikes in the power supply will be passed to ground without triggering the SCR. A resistor of around 100Ω ensures that the gate voltage of the SCR remains near zero during normal operation. When the Zener

diode starts to conduct current, the resistor acts as a voltage divider with the diode, so that sufficient voltage reaches the SCR to activate it.

This circuit may be unsuitable for low-voltage power supplies, because the Zener diode has to be chosen with a high enough rating to prevent small power fluctuations from tripping it. Bearing in mind that the real triggering voltage of the diode may be at least plus-or-minus 5% of its rated voltage, the diode may have to be chosen with at least a 6V rating in a 5V circuit, and it may not be activated until the voltage is actually 6.5V. This may be insufficient to protect the components being used with the power supply.

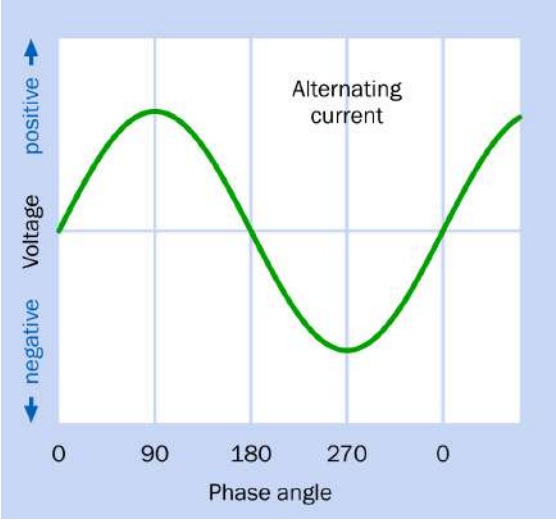

Figure 1-11. *An AC waveform is customarily measured in degrees of phase angle.*

What Can Go Wrong

Like other semiconductors, an SCR can be adversely affected by excessive heat. Usual precautions should be taken to allow sufficient ventilation and heat sinking, especially when components are moved from an open prototyping board to an enclosure in which crowding is likely.

Unexpected Triggering Caused by Heat

On a datasheet, the values for triggering current and holding current are valid only within a recommended temperature range. A buildup of heat can provoke unexpected triggering.

Unexpected Triggering Caused by Voltage

A very rapid increase in forward voltage at the anode can induce a triggering voltage in the gate by capacitive coupling. As a result, the SCR can trigger itself without any external application of gate voltage. This is sometimes known as *dv/dt triggering*. If necessary, a snubber circuit can be added across the anode input to prevent sudden voltage transitions.

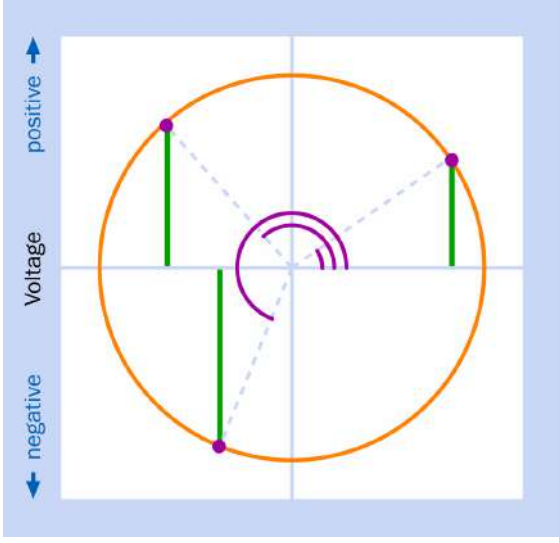

Figure 1-12. *The fluctuating voltage of an AC power supply (shown as vertical green lines) is proportional with the sines of the angles (purple arcs) in this diagram. The angles are referred to as phase angles.*

Confusion of AC and DC Ratings

The on-state current for an SCR is averaged only over the width of each pulse that the SCR actually conducts. It is not time-averaged over an entire AC cycle, and it will be different again from a DC rating. Care must be taken to match the current

rating with the way in which the component will actually be used.

Maximum Current versus Conduction Angle

Current-carrying capability will be very significantly affected by the length of the duty cycle when the SCR is being used to abbreviate each positive AC pulse. When the SCR imposes a 120-degree conduction angle, it may be able to handle twice the average on-state current as when it is imposing a 30-degree conduction angle. The manufacturer's datasheet should include a graphical illustration of this relationship. If an SCR is chosen for a high conduction angle, and the angle is later reduced, overheating will result, and damage is likely.

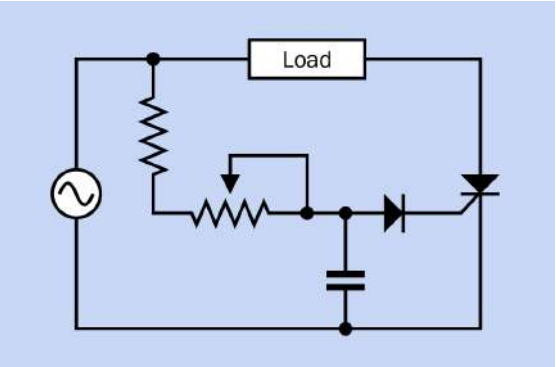

Figure 1-13. *In this schematic, an SCR is used to apply phase control, adjusting the power that passes through a load.*

Confusing Symbols

When reading a schematic, unfortunate errors can result from failure to distinguish between the symbol for a **programmable unijunction transistor (PUT)** and the symbol for an SCR. The characteristics of a PUT are described in Volume 1 of this encyclopedia.

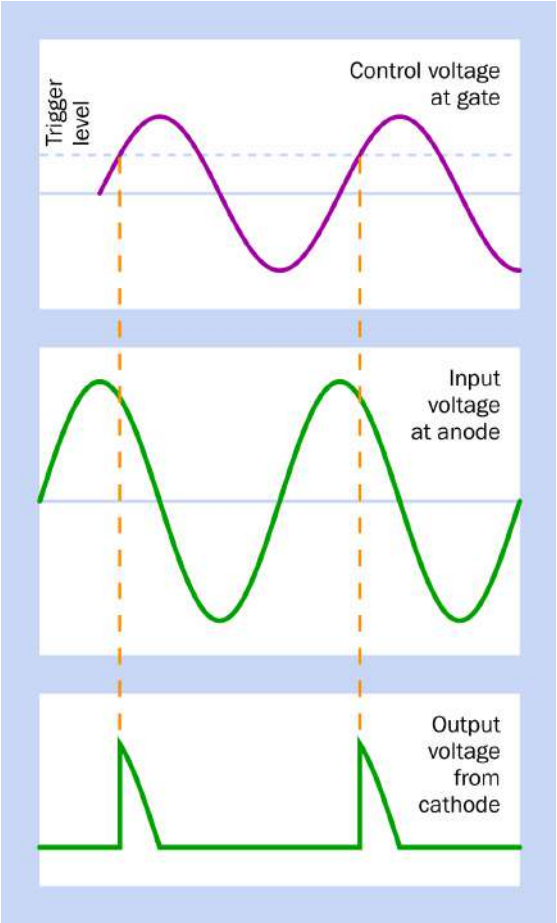

Figure 1-14. *If the AC power applied to the anode of an SCR (center) is reduced in voltage and delayed slightly by an RC network, it can trigger the SCR (top), causing it to pass only an abbreviated segment of each positive AC pulse (bottom).*

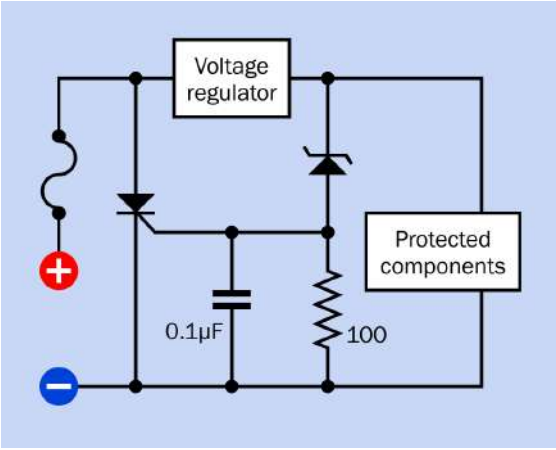

Figure 1-15. *In this schematic, an SCR is used to provide crowbar overvoltage protection for sensitive components.*

diac

2

A **diac** is a self-triggering type of *thyristor*. Its name is said to be derived from the phrase "diode for AC," and because it is not an acronym, it is not usually capitalized.

A thyristor is defined here as a semiconductor having four or more layers of p-type and n-type silicon. Because the thyristor predated integrated circuits, and in its basic form consists of a single multilayer semiconductor, it is categorized as a discrete component in this encyclopedia. When a thyristor is combined with other components in one package (as in a **solid-state relay**) it is considered to be an integrated circuit.

Other types of thyristor are the **SCR** (silicon-controlled rectifier) and the **triac**, each of which has its own entry in this encyclopedia.

Thyristor variants that are not so widely used, such as the *gate turn-off thyristor (GTO)* and *silicon-controlled switch (SCS)*, do not have entries here.

OTHER RELATED COMPONENTS

- **SCR** (see Chapter 1)
- **triac** (see Chapter 3)

What It Does

The **diac** is a bidirectional thyristor with only two terminals. It blocks current until it is subjected to sufficient voltage, at which point its impedance drops very rapidly. It is primarily used to trigger a **triac** for purposes of moderating AC power to an **incandescent lamp**, a resistive heating element, or an AC **motor**. The two leads on a diac have identical function and are interchangeable.

By comparison, a **triac** and an **SCR** are thyristors with three leads, one of them being referred to as the gate, which determines whether the component becomes conductive. A triac and a diac allow current to flow in either direction, while an SCR always blocks current in one direction.

Symbol Variants

The schematic symbol for a diac, shown in Figure 2-1, resembles two diodes joined together, one of them inverted relative to the other. Functionally, the diac is comparable with a pair of Zener diodes, as it is intended to be driven beyond the point where it becomes saturated. Because its two leads are functionally identical, they do not require names to differentiate them. They are sometimes referred to as A1 and A2, in recognition that either of them may function as an anode; or they may be identified as MT1 and MT2, MT being an acronym for "main terminal."

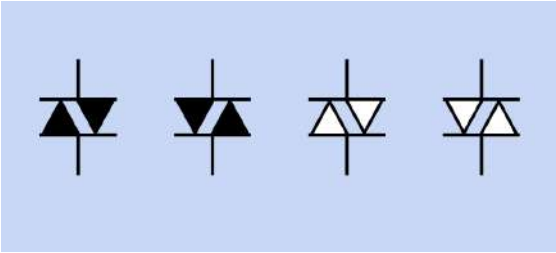

Figure 2-1. *Symbol variants to represent a diac. All four are functionally identical.*

The symbol may be reflected left to right, and the black triangles may have open centers. All of these variants mean the same thing. Occasionally the symbol has a circle around it, but this style is now rare.

When only a moderate voltage is applied (usually less than 30V) the diac remains in a passive state and will block current in either direction, although a very small amount of *leakage* typically occurs. When the voltage exceeds a threshold known as its *breakover level*, current can flow, and the diac will continue to conduct until the current falls below its *holding level*.

A sample diac is shown in Figure 2-2.

Figure 2-2. *Because a diac is not intended to pass significant current, it is typically packaged in a small format. The graph squares in the photograph each measure 0.1".*

How It Works

Figure 2-3 shows a circuit that demonstrates the conductive behavior of a diac.

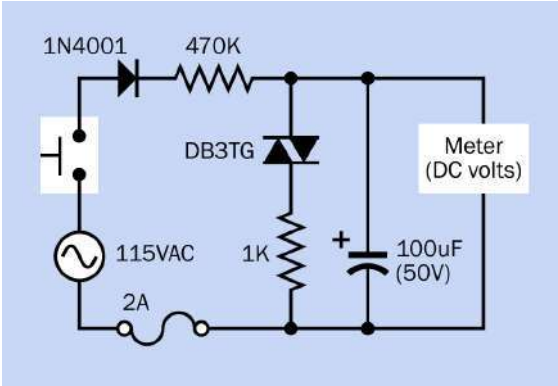

Figure 2-3. *A test circuit to demonstrate the behavior of a diac. See text for details.*

When the pushbutton is held down, current from the positive side of the AC supply flows through the diode and the 470K resistor to the capacitor. The diac is not yet conductive, so the capacitor accumulates a potential that can be monitored with the volt meter. After about 30 seconds, the charge on the capacitor reaches 32V. This is the breakover voltage for this particular diac, so it becomes conductive. The positive side of the capacitor can now discharge through the diac and the 1K series resistor to ground.

If the pushbutton is released at this moment, the meter will show that the capacitor discharges to a potential below the holding level of the diac. The capacitor now stops discharging because the diac has ceased being conductive.

If the pushbutton is held down constantly, the meter will show the capacitor charging and then discharging through the diac repeatedly, so that the circuit behaves as a *relaxation oscillator*. The 1K series resistor is included to protect the diac from excessive current. If a standard quarter-watt resistor is used, it should not become unduly warm because current passes through it only intermittently.

- Because this circuit uses 115VAC, basic precautions should be taken. The fuse should not be omitted, the capacitor should be rated for at least 50V, and the circuit should not be touched while it is connected to the power source. Breadboarding a circuit using this voltage requires caution and experience, as wires can easily come loose, and components can be touched accidentally while they are live.

Figure 2-4 shows the test circuit on a breadboard. The red and blue leads at the top of the photograph are from a fused 115VAC power supply. The live side of the supply passes through a diode to a pushbutton switch that has a rectangular black cap. A 470K resistor connects the other side of the switch to the positive side of a 100µF electrolytic capacitor, and also to the diac (small blue component). A 1K resistor connects the other end of the diac back to the negative side of the capacitor, which is grounded. The yellow and blue wires leaving the photograph at the left are connected with a volt meter, which is not shown.

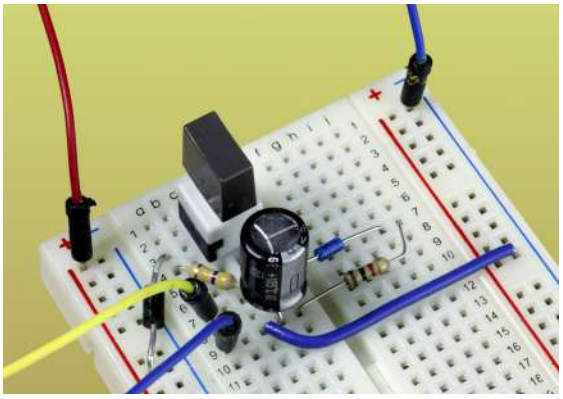

Figure 2-4. *A breadboarded version of the diac test circuit. See text for details.*

The behavior of a diac is also illustrated in Figure 2-5, which can be compared with the curves in Figures 3-10 and 1-8, depicting the behavior of a triac and an SCR respectively.

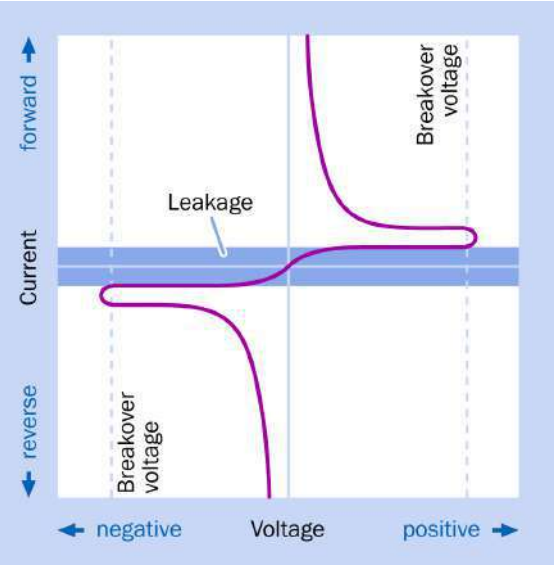

Figure 2-5. *The curve shows current passing through a diac when various voltages are applied.*

Switching AC

The diac cannot function as a switch, because it lacks the third terminal which is found in a triac, an SCR, or a bipolar transistor. However, it is well suited to drive the gate of a triac, because the behavior of a diac is symmetrical in response to opposite voltages, while the triac is not. If an AC voltage applied to a diac is adjusted with a potentiometer in an RC circuit, the diac will pass along a portion of each positive or negative pulse, and will delay it by a brief amount of time determined by the value of the capacitor in the RC circuit and the setting of the potentiometer. This is known as *phase control*, as it controls the *phase angle* at which the diac allows current to flow.

See Figure 3-13 for a schematic showing a diac driving a triac. See Figures 1-14 and 3-11 for graphs illustrating phase control. See "Phase Control" for a discussion of phase in AC waveforms.

Variants

Diacs are available in through-hole and surface-mount formats. Because they are not intended

to handle significant current, no heat sink is included.

A *sidac* behaves very similarly to a diac, its name being derived from "silicon diode for alternating current." Its primary difference from generic diacs is that it is designed to reach its breakover voltage at a higher value, typically 120VAC or 240VAC.

Values

When performing its function to trigger a triac, a diac is unlikely to pass more than 100mA.

The breakover voltage of a diac is usually between 30V and 40V, with a few versions designed for up to 70V. When the diac starts to conduct, its on-state impedance is sufficient to reduce the voltage significantly, with 5V being a typical minimum output voltage.

Although the rise time when a diac responds is very brief (around 1µs), the component is not expected to run at a high frequency. It will normally be used with 50Hz or 60Hz AC to trigger a triac. For this reason, its repetitive peak on-state current is usually specified at no more than 120Hz.

Abbreviations in datasheets are likely to include:

- V_{BO} Breakover voltage (sometimes may be specified as latching voltage, which for a diac is the same thing).
- V_{BO1} - V_{BO2} Breakover voltage symmetry. The hyphen is intended as a minus sign, so that this value is the maximum difference between breakover voltage in each direction.
- V_O Minimum output voltage.
- I_{TRM} Repetitive peak on-state current.
- I_{BO} Breakover current, usually the maximum required, and less than 20µA.
- I_R Maximum leakage current, usually less than 20µA.
- T_J Operating junction temperature, usually expressed as an acceptable range.

What Can Go Wrong

Like other semiconductors, a diac is heat sensitive. Usual precautions should be taken to allow sufficient ventilation and heat sinking, especially when components are moved from an open prototyping board to an enclosure in which crowding is likely.

Unexpected Triggering Caused by Heat

On a datasheet, a value for breakover current is valid only within a recommended temperature range. A buildup of heat can provoke unexpected triggering.

Low-Temperature Effects

A higher breakover voltage will be required by a diac operating at low temperatures, although the variation is unlikely to be greater than plus-or-minus 2% within a normal operating range. Temperature has a much more significant effect on a triac.

Manufacturing Tolerances

The breakover voltage for a diac is not adjustable, and may vary significantly between samples of the component that are supposed to be identical. The diac is not intended to be used as a precision component. In addition, while its breakover voltage should be the same in either direction, a difference of plus-or-minus 2% is possible (1% in some components).

triac

3

A **triac** is a gate-triggered type of *thyristor*. Its name was probably derived from the phrase "triode for AC," and because it is not an acronym, it is not usually capitalized.

A thyristor is defined here as a semiconductor having four or more layers of p-type and n-type silicon. Because the thyristor predated integrated circuits, and in its basic form consists of a single multilayer semiconductor, it is categorized as a discrete component in this encyclopedia. When a thyristor is combined with other components in one package (as in a **solid-state relay**) it is considered to be an integrated circuit.

Other types of thyristor are the **SCR** (silicon-controlled rectifier) and the **diac**, each of which has its own entry in this encyclopedia.

Thyristor variants that are not so widely used, such as the *gate turn-off thyristor (GTO)* and *silicon-controlled switch (SCS)*, do not have entries here.

OTHER RELATED COMPONENTS

- **SCR** (see Chapter 1)
- **diac** (see Chapter 2)

What It Does

The **triac** is ubiquitous in AC dimmers for **incandescent lamps**. It is also used to control the speed of AC motors and the output of resistive heating elements. It is a type of *thyristor* which contains five segments of p-type and n-type silicon and has three leads, one of them attached to a gate that can switch a bidirectional flow of current between the other two. Its name was originally a trademark, generally thought to be derived from the phrase "triode for AC." A triode was a common type of vacuum tube when thyristors were first introduced in the 1950s.

By comparison, a **diac** is a thyristor with only two leads, allowing current to flow in either direction when the component reaches a *breakover voltage*. Its name was probably derived from the phrase "diode for AC." It is often used in conjunction with a triac.

An **SCR** (silicon-controlled rectifier) is a thyristor that resembles a triac, as it has three leads, one of them a gate. However, it only allows current to flow in one direction.

Symbol Variants

The schematic symbol for a triac, shown in Figure 3-1, resembles two diodes joined together, one of them inverted relative to the other. While a triac does not actually consist of two diodes, it is functionally similar, and can pass current in either direction.

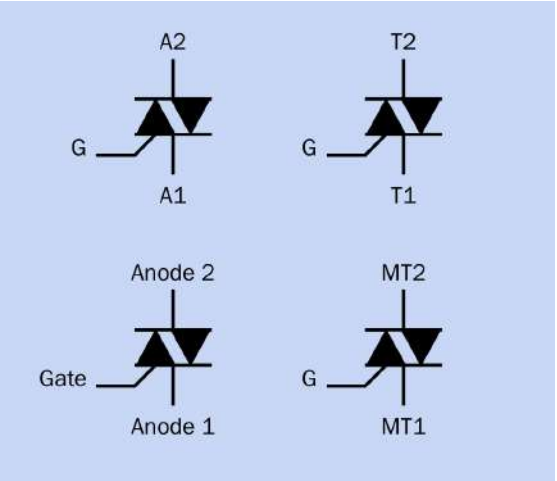

Figure 3-1. *The schematic symbol for a triac, with four naming conventions that are used for its leads. The different conventions do not indicate any functional difference.*

An appended bent line represents the gate. The labels for the other two leads are not standardized, and can be referred to as A1 and A2 (for Anode 1 and Anode 2), or T1 and T2 (for Terminal 1 and Terminal 2), or MT1 and MT2 (for Main Terminal 1 and Main Terminal 2). The choice of terms does not indicate any functional difference. In this encyclopedia entry, A1 and A2 are used.

The A1 terminal (or T1, or MT1) is always shown closer to the gate than A2 (or T2, or MT2). This distinction is important because although the triac can pass current in either direction, its behavior is somewhat asymmetrical.

- Voltages are expressed relative to terminal A1 (or T1, or MT1, if those terms are used).

The schematic symbol may be reflected or rotated, the black triangles may have open centers, and the placement of the bent line representing the gate may vary. However, terminal A1 is always nearer to the gate than terminal A2.

Figure 3-2 shows 12 of the 16 theoretical possibilities. All of these variants are functionally identical. Occasionally the symbol has a circle around it, but this style is now rare.

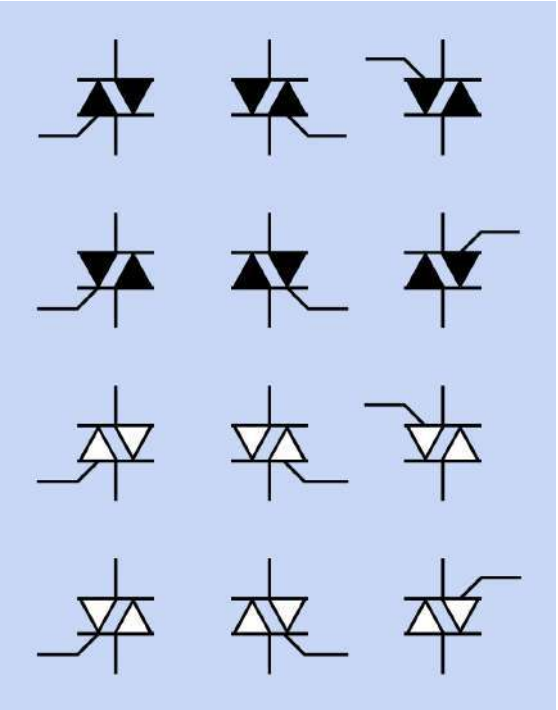

Figure 3-2. *Interchangeable variants of the schematic symbol for a triac.*

Triacs with various characteristics are shown in Figures 3-3, 3-4, and 3-5.

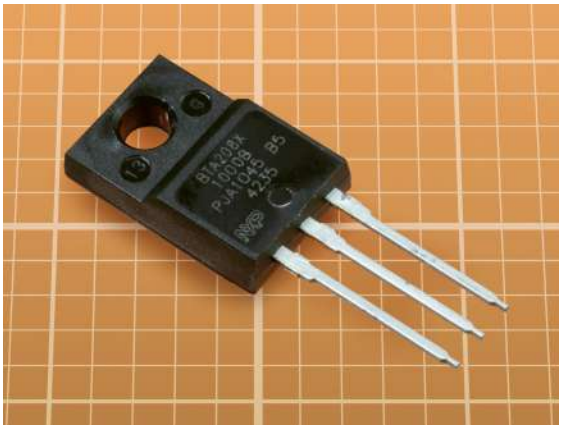

Figure 3-3. *The BTA208X-1000B triac can conduct 8A continuous on-state current RMS, and withstands peak off-state voltage of up to 1,000V. This is a "snubberless" triac.*

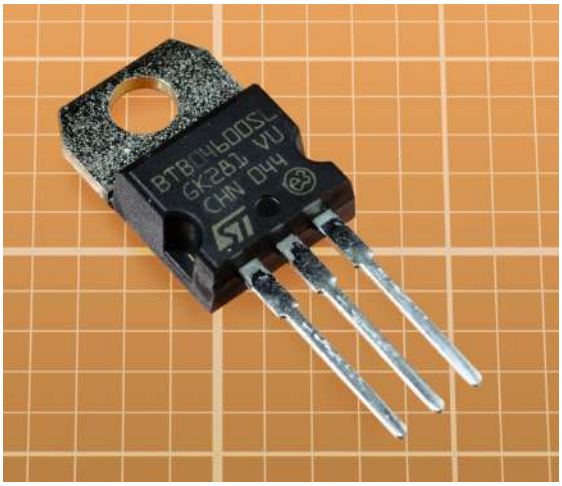

Figure 3-4. *The BTB04-600SL triac can conduct 4A continuous on-state current RMS, and withstands peak off-state voltage of up to 600V.*

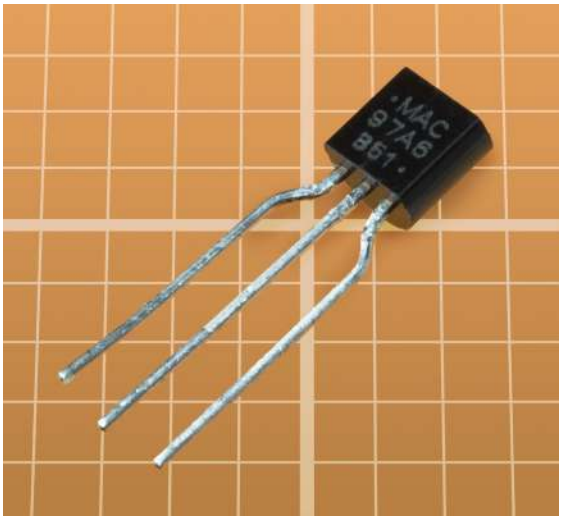

Figure 3-5. *The MAC97A6 triac can conduct 0.8A continuous on-state current RMS, and withstands peak off-state voltage of up to 400V.*

How It Works

When no gate voltage is applied, the triac remains in a passive state and will block current in either direction between A1 and A2, although a very small amount of *leakage* typically occurs. If the gate potential becomes sufficiently positive *or* negative relative to terminal A1, current can begin to flow between A1 and A2 in *either* direction. This makes the triac ideal for controlling AC.

Quadrants

While a gate voltage is applied, four operating modes are possible. In each case, A1 is the reference (which can be thought of as being held at a neutral ground value). Because the triac is conducting AC, voltages above and below ground will occur. The four modes of operation are often referred to as four *quadrants*, and are typically arranged as shown in Figure 3-6.

In some reference sources (especially educational text books), current is shown with an arrow indicating a flow of electrons moving from negative to positive. Because the type of current flow is often undefined, diagrams should be interpreted carefully. In this encyclopedia, current is always shown flowing from a more-positive location to a more-negative location.

Quadrant 1 (upper right)

A2 is more positive than A1, and the gate is more positive than A1. Conventional current (positive to negative) will flow from A2 to A1. (This behavior is very similar to that of an **SCR**.)

Quadrant 2 (upper left)

A2 is more positive than A1, and the gate is more negative than A1. Once again, conventional current (positive to negative) will flow from A2 to A1.

Quadrant 3 (lower left)

A2 is more negative than A1, and the gate is more negative than A1. Conventional current is reversed from A1 to A2.

Quadrant 4 (lower right)

A2 is more negative than A1, but the gate is more positive than A1. Conventional current is reversed from A1 to A2.

- Note that two positive symbols or two negative symbols in Figure 3-6 do not mean that both locations are of equal voltage. They simply mean that these

locations are at potentials that are significantly different from A1.

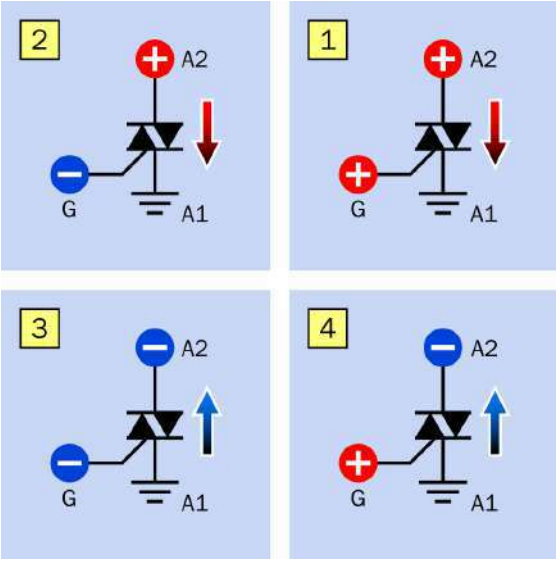

Figure 3-6. *The "quadrants" of triac behavior. Positive and negative symbols indicate which terminal is "more positive" or "more negative" than A1. The ground symbol represents a potential midway between positive and negative. See text for details.*

Suppose that gate current increases gradually. When it reaches the *gate threshold current* of the triac, the component starts conducting between A1 and A2. If the current between A1 and A2 rises above the value known as the *latching current*, it will continue to flow, even if gate current disappears completely.

If the self-sustaining current through the triac gradually diminishes, while there is no voltage applied to the gate, conduction between the main terminals will stop spontaneously when it falls below a level known as the *holding current*. This behavior is similar to that of an SCR. The triac now returns to its original state, blocking current until the gate triggers it again.

The triac is sufficiently sensitive to respond to rapid fluctuations, as in 50Hz or 60Hz AC.

Threshold, Latching, and Holding Current

Figure 3-7 shows the relationship between the gate threshold current, the latching current, and holding current. In the upper half of the figure, gate current is shown fluctuating until it crosses the threshold level. This establishes current flow between the main terminals, shown in the lower half of the figure. Prior to this moment, a very small amount of leakage current occurred (shown in the figure, but not to scale).

In this hypothetical scenario, the triac starts passing current between external components—and the current exceeds the latching level. Consequently, gate current can diminish to zero, and the triac remains conductive. However, when external factors cause the current between the main terminals to diminish below the holding level, the triac abruptly ceases to be conductive, and current falls back to the leakage level.

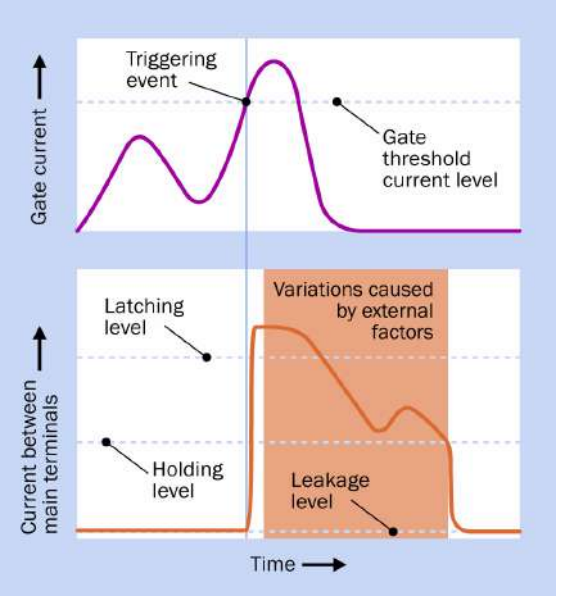

Figure 3-7. *The relationship between gate current of a triac and the current between its main terminals. See text for details.*

Unlike a **bipolar transistor**, a triac is either "on" or "off" and does not function as a *current ampli-*

fier. When it has been triggered, the impedance between A1 and A2 is low enough for heat dissipation to be manageable even at relatively high power levels.

Triac Testing

Figure 3-8 shows a circuit which can demonstrate the conductive behavior of a triac. For simplicity, this circuit is DC powered. In a real application, the triac is almost always used with AC.

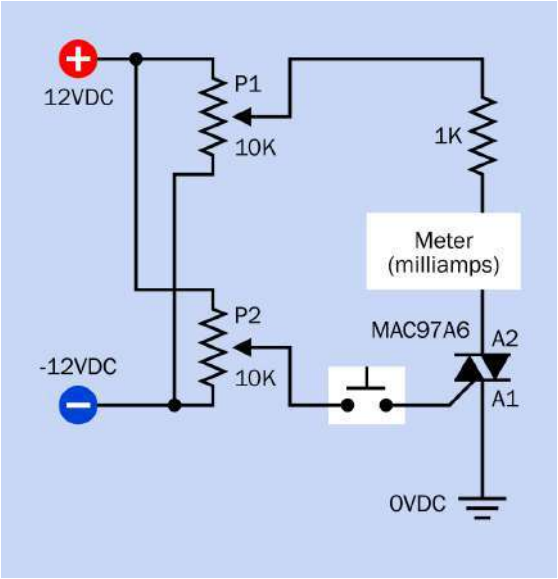

Figure 3-8. *A test circuit to show the behavior of a triac when varying positive and negative potentials are applied to the gate and to the A2 terminal, relative to A1.*

Note that this circuit requires at least a +12VDC and -12VDC power supply (higher values may also be used). The ground symbol represents a midpoint voltage of 0VDC, applied to terminal A1 of the triac, which is an MAC97A6 or similar. If a dual-voltage power supply is unavailable, the gate of the triac can be connected directly to +12VDC, omitting potentiometer P2; but in this case, only two operating modes of the triac can be demonstrated by turning potentiometer P1.

Each potentiometer functions as a voltage divider between the positive and negative sides of the power supply. P1 applies a positive or negative voltage to A2, relative to A1. P2 applies a positive or negative voltage to the gate, relative to A1.

If the test begins with both potentiometers at the top ends of their range, A1 and G both have a positive potential relative to A1, so that the triac is now in quadrant 1 of its operating modes. Pressing the pushbutton should cause it to start conducting current limited by the 1K resistor, and the meter should change from measuring 0mA to around 12mA. If the pushbutton is released, the triac should continue to conduct current, because 12mA is above this triac's latching level. If P1 is slowly moved toward the center of its range, the current diminishes, ceasing when it falls below the holding level. If P1 is now moved back to the top of its range, the current will not resume until the triac is retriggered with the pushbutton.

The test can be repeated with P1 at the top of its range and P2 at the bottom of its range, to operate the triac in quadrant 2; P1 at the bottom of its range and P2 at the bottom of its range, to operate the triac in quadrant 3; and P1 at the bottom of its range and P2 at the top of its range, to operate the triac in quadrant 4. The functionality should be the same in each case. The pushbutton will initiate a flow of current, which will diminish when P1 is turned toward the center of its range.

In any of these quadrants, P2 can be turned slowly toward the center of its range while the pushbutton is pressed repeatedly. This will allow empirical determination of the gate threshold current for this triac. The meter, measuring milliamps, will measure the current if it is inserted between the wiper of the potentiometer and the gate of the triac.

The test circuit is shown installed on a breadboard in Figure 3-9. In this photograph, the red and blue wires at left supply +12VDC and -12VDC relative to the black ground wire at top right. The yellow and green wires connect with a meter set to measure milliamps. The red button is a tactile switch, while the MAC97A6 triac is just above it

and to the left. The square blue 10K trimmers are set to opposite ends of their scales, so that the meter will show current flowing when the tactile switch is pressed.

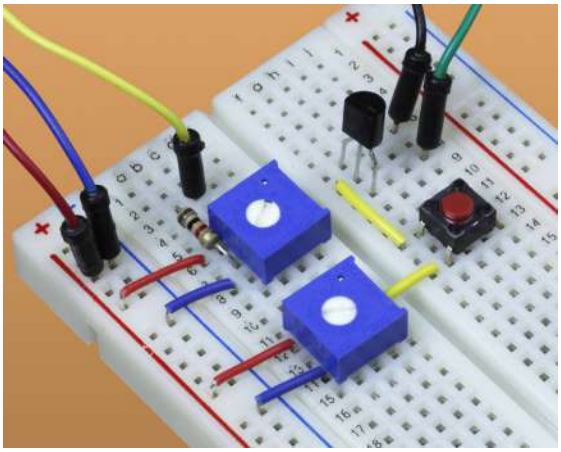

Figure 3-9. *A breadboarded triac test circuit.*

Breakover Voltage

If a much higher voltage is applied to A2, the triac can be forced to conduct current without any triggering voltage being applied to the gate. This occurs when the potential between A1 and A2 reaches the triac's *breakover voltage*, although the component is not designed to be used this way. The concept is illustrated in Figure 3-10, which can be compared with the behavior of an SCR illustrated in Figure 1-8 and the behavior of a diac shown in Figure 2-5. While the term *breakdown voltage* defines the minimum reverse voltage required to force a diode to conduct, *breakover voltage* refers to the minimum forward voltage that has this effect. Because a triac is designed to conduct in both directions, it can be thought of as having a breakover voltage in both directions.

In Figure 3-10, the numbers in yellow squares are the quadrants referred to in Figure 3-6. The solid curve represents current flow if a triggering voltage is applied to the gate while a positive or negative potential is applied to A2, relative to A1. If the gate is not triggered while the voltage between A1 and A2 gradually increases, the dashed section of the curve illustrates the outcome when the component reaches breakover voltage. Although this may not damage the triac, the component becomes uncontrollable.

- In normal usage, the voltage between A1 and A2 should not be allowed to reach breakover level.

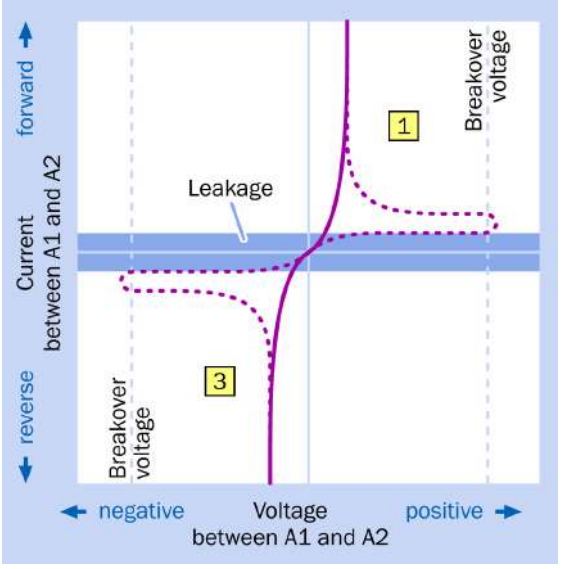

Figure 3-10. *The solid curve shows current passing between A1 and A2 in a hypothetical triac, for varying voltages, while triggering voltage is applied to the gate. The dashed curve assumes that no triggering voltage is applied to the gate. The numbers in yellow squares are the quadrants of triac operation.*

Switching AC

"Switching" AC with a triac means interrupting each pulse of current so that only a portion of it is conducted through to the load. Usually this is done with the triac functioning in quadrants 1 and 3. In quadrant 3, the polarity of the flow between A1 and A2 is opposite to that in quadrant 1, and the gate voltage is also reversed. This enables a relatively simple circuit to control the duration of each half-cycle passing through the triac. The theory of this circuit is shown in Figure 3-11.

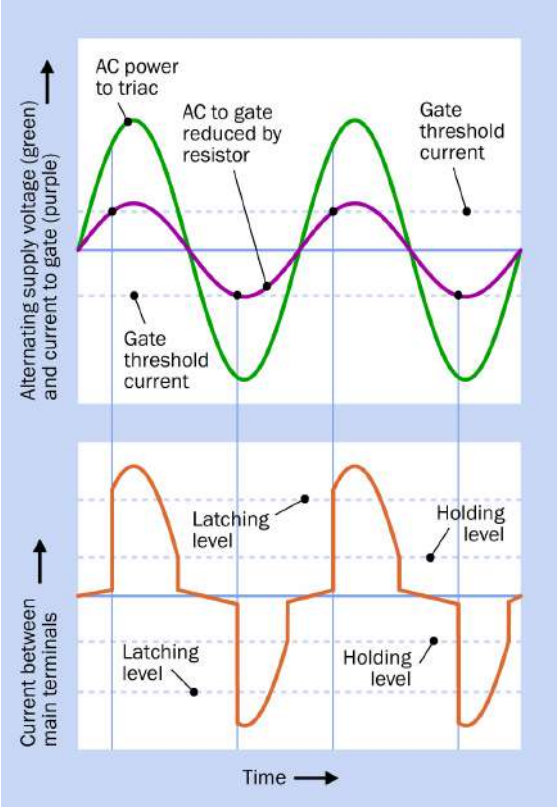

Figure 3-11. *To moderate the power of AC current, a triac can block a section of each AC pulse.*

The upper section of Figure 3-11 shows alternating voltage to the triac in green. The purple curve represents the gate current of the triac, reduced by a variable resistor. (The figure is for conceptual purposes only; the alternating power supply voltage and the fluctuating gate current cannot actually share the same vertical scale of a graph.)

Figure 3-11 can be compared with Figure 3-7, except that the negative threshold level for the gate is now shown as well as the positive threshold level. Remember, either a positive or negative voltage can activate the gate.

In Figure 3-11, initially the triac is nonconductive. As time passes, the gate current reaches the threshold level, and this triggering event enables current to flow between the main terminals of the triac, as shown in the lower part of the figure. This current exceeds the latching level, so it continues to flow, even though the gate current diminishes below its threshold level. Finally the current between the main terminals falls below the holding level, at which point the triac stops conducting. It waits for the next triggering event, which occurs as the power supply swings to negative.

This simple system blocks a section of each AC pulse, which will vary in length depending how much current is allowed to flow through the gate. Because the blocking process occurs rapidly, we notice only the reduced overall power passing through the triac (in terms of the brightness of a light, the heat emitted by a resistive element, or the speed of a motor).

Unfortunately, there is a problem in this scenario: the triac does not quite behave symmetrically. Its gate threshold level for positive current is not exactly equal and opposite to its gate threshold level for negative current. The upper part of Figure 3-11 shows this flaw in the differing vertical offsets of the positive and negative thresholds from the central zero line.

The result is that negative AC pulses through the triac are shorter than positive pulses. This asymmetry produces harmonics and noise that can feed back into power supply wiring, interfering with other electronic equipment. The actual disparities in gate response, in each quadrant of operation for two triacs, are shown in Figure 3-12.

Current capacity of triac	Ratio of gate current required to conduct, relative to quadrant 1		
	Quadrant 2	Quadrant 3	Quadrant 4
4 amp	1.6	2.5	2.7
10 amp	1.5	1.4	3.1

Figure 3-12. *Because the internal structure of a triac is asymmetrical, it requires a different trigger current in each of its operating quadrants. This table, derived from a Littelfuse technical briefing document, shows the ratio of the minimum trigger current in quadrants 2, 3, and 4 relative to quadrant 1.*

See Figure 1-14 for a graph illustrating phase control in the SCR. See "Phase Control" for a discussion of phase in AC waveforms generally.

Triac Triggered by a Diac

The problem of asymmetrical triggering can be overcome if the triac is triggered with a voltage pulse generated by another component that does behave symmetrically. The other component is almost always a diac, which is another type of thyristor. Unlike an SCR or a triac, it has no gate. It is designed to be pushed beyond its breakover voltage, at which point it latches and will continue to conduct until current flowing through it diminishes below its holding level. See Chapter 2 for more information about the diac.

In Figure 3-13, the diac is shown to the right of the triac, and is driven by a simple RC network consisting of a fixed resistor, a potentiometer, and a capacitor. (In an actual application, the RC network may be slightly more complex.) The capacitor takes a small amount of time to charge during each half-cycle of AC. The length of this delay is adjusted by the potentiometer, and determines the point in each AC half-cycle when the voltage to the diac reaches breakover level. Because the delay affects the phase of the AC, this adjustment is known as *phase control*.

As the voltage exceeds breakover level, the diac starts to pass current through to the gate of the triac, and triggers it. The holding level of the diac is lower than its latching level, so it continues to pass current while the capacitor discharges and the voltage diminishes. When the current falls below the holding level, the diac stops conducting, ready for the next cycle. Meanwhile, the triac continues to pass current until the AC voltage dips below its holding level. At this point, the triac becomes nonconductive until it is triggered again.

This chopped waveform will still create some harmonics, which are suppressed by the coil and capacitor at the left side of the circuit in Figure 3-13.

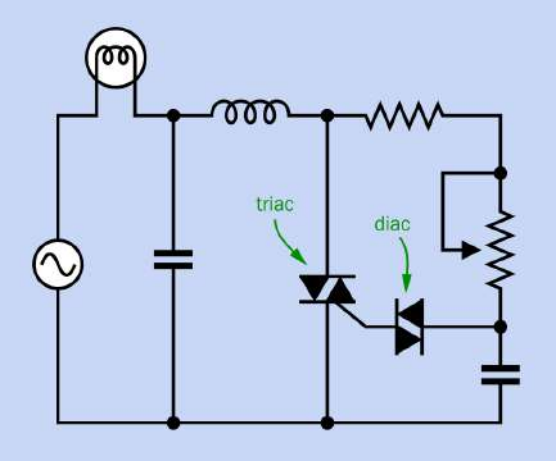

Figure 3-13. *A minimal schematic showing typical operation of a triac, with a diac supplying pulses to the triac gate. The potentiometer adjusts the delay created by the capacitor.*

Other Triac Drivers

It is possible, although unusual, to drive a triac from a source other than a diac.

Simple on-off control can be achieved by using a special optocoupler such as the MOC3162 by Fairchild Semiconductor. This emits a switching signal to a triac only when the AC voltage passes through zero. A *zero cross* circuit is desirable because it creates much less interference. The use of an optocoupler helps to isolate the triac from other components.(((“zero cross circuit”))

Phase control can be achieved using an optocoupler such as the H11L1, which can be driven by rectified but unsmoothed AC after it passes through a Zener diode to limit the voltage. The output from the optocoupler is logic-compatible and can be connected with the input to a timer such as the 555, set to one-shot mode. Each pulse from the timer passes through another optocoupler such as the MOC3023, which uses an internal LED to trigger the gate of a triac.

Yet another possibility is to use the programmed output from a microcontroller, through an optocoupler, to control the gate of a triac. An online

search for the terms "microcontroller" and "triac" will provide some additional suggestions.

Charge Storage

While switching AC, the internal charge between A1 and A2 inside the triac requires time to dissipate before the reverse voltage is applied; otherwise, *charge storage* occurs, and the component may start to conduct continuously. For this reason, the triac is normally restricted to relatively low frequencies such as domestic 60Hz AC power.

When a triac controls a motor, the phase lag between voltage and current associated with an inductive load can interfere with the triac's need for a transitional moment between a positive and negative voltage cycle. In a datasheet, the term *commutating dv/dt* defines the rate of rise of opposite polarity voltage that the triac can withstand without locking into a continuous-on state.

An RC *snubber network* is often wired in parallel with A1 and A2 to control the rise time of voltage to the triac, as shown within the darker blue rectangle in Figure 3-14, where a resistor and capacitor have been added just to the left of the triac. The highest resistance and lowest capacitance, consistent with trouble-free operation, should be chosen. Typical values are 47Ω to 100Ω for the resistor, and 0.01µF to 0.1µF for the capacitor.

Variants

Triacs are available in through-hole and surface-mount packages.

Some components that are referred to as triacs actually contain two SCR components of opposite polarity. The "alternistor" range from Littelfuse is an example. The SCR will tolerate faster voltage rise times than a conventional triac, and is more suitable for driving inductive loads such as large motors.

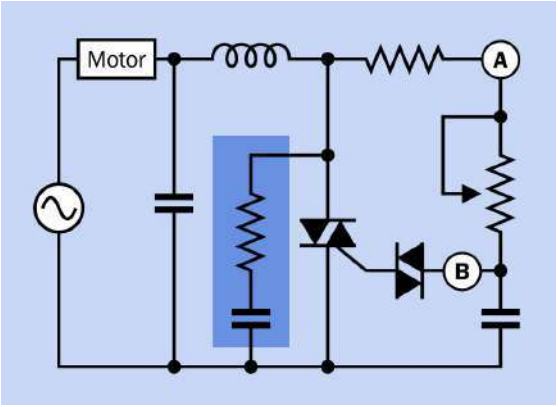

Figure 3-14. *To prevent a triac from locking itself into a continuous-on state while driving an inductive load such as a motor, a snubber circuit can be added (shown here as a resistor and capacitor in the darker blue rectangle to the left of the triac).*

A *snubberless triac*, as its name implies, is designed to drive an inductive load without need for a snubber circuit. An example is the STMicroelectronics BTA24. Datasheets for this type of component impose some limits that may be stricter than for a generic triac.

Values

Surface-mount triacs are typically rated between 2A to 25A of switched AC current (RMS), the higher-current versions being as large as 10mm square. The necessary gate trigger voltage may range from 0.7V to 1.5V. Through-hole packages may be capable of slightly higher currents (up to 40A), with gate trigger voltages of 1V to 2.5V being common.

As noted previously, the majority of triacs are restricted to relatively low frequency switching, 60Hz being very common.

Abbreviations in datasheets are likely to include:

- V_{DRM} or V_{RRM} Peak repetitive reverse off-state voltage. The maximum reverse voltage that the component will withstand in its "off" state without experiencing damage or allowing current to pass.

- V_{TM} The maximum voltage difference between A1 and A2, measured with a short pulse width and low duty cycle.
- V_{GT} Gate trigger voltage necessary to produce the gate trigger current.
- I_{DRM} Peak repetitive blocking current (i.e., maximum leakage).
- I_{GM} Maximum gate current.
- I_{GT} Minimum gate trigger current.
- I_H Holding current.
- I_L Latching current.
- $I_{T(RMS)}$ On-state RMS current. The maximum value passing through the component on a continuous basis.
- I_{TSM} Maximum non-repetitive surge current. Specified at a stated pulse width, usually 60 Hz.
- T_C Case temperature, usually expressed as an acceptable range.
- T_J Operating junction temperature, usually expressed as an acceptable range.

What Can Go Wrong

Like other semiconductors, a triac is heat sensitive. Usual precautions should be taken to allow sufficient ventilation and heat sinking, especially when components are moved from an open prototyping board to an enclosure in which crowding is likely.

Unexpected Triggering Caused by Heat

On a datasheet, a value for triggering current is valid only within a recommended temperature range. A buildup of heat can provoke unexpected triggering.

Low-Temperature Effects

Significantly higher gate current will be required by a triac operating at low temperatures. It is quite possible that the component will need twice as much current at 25° C compared with 100° C, junction temperature. If the triac receives insufficient current, it will not turn on.

Wrong Type of Load

If an **incandescent lamp** is replaced with a **fluorescent light** or **LED area lighting**, a pre-existing triac may no longer work as a dimmer. Fluorescent lamps will have some inductance, and may also provide a capacitive load, either of which will interfere with the normal behavior of a triac.

The light output of an LED varies very differently compared with the light output of an incandescent bulb, in response to reduction in power. Therefore an LED should be dimmed using pulse-width modulation that is appropriate for its output characteristics. A triac is generally not suitable.

Wrongly Identified Terminals

A triac is often thought of as a symmetrical device, because it is designed to switch AC current using either positive or negative voltage at the gate. In reality, its behavior is asymmetrical, and if it is installed "the wrong way around" it may function erratically or not at all.

Failure to Switch Off

As already noted (see "Charge Storage" on page 23), a triac will tend to suffer from *charge storage* if there is insufficient time between the end of one half-cycle and the beginning of the next. A component that works with a resistive load may cease to function if it is used, instead, to power an inductive load.

solid-state relay

4

A **solid-state relay** is less-commonly referred to by its acronym, *SSR*. It is sometimes regarded as an **optocoupler**, but in this encyclopedia the two components have separate entries. An optocoupler is a relatively simple device consisting of a light source (usually an **LED**) and a light sensor, in one package. It is used primarily for isolation rather than to switch a high current. A solid-state relay can be thought of as a substitute for an electromagnetic **relay**, usually has additional components in its package, and is intended to switch currents of at least 1A.

A component that works like a solid-state relay but only switches a 5V (or lower) logic signal may be referred to as a *switch*, even though it is entirely solid-state. This type of component is included in this entry because it functions so similarly to a solid-state relay.

OTHER RELATED COMPONENTS

- **electromagnetic relay** (see Volume 1)
- **optocoupler** (see Chapter 5)

What It Does

A **solid-state relay** (SSR) is a semiconductor package that emulates an electromagnetic **relay** (see Volume 1). It switches power on or off between its output terminals in response to a smaller current and voltage between its input terminals. Variants can switch AC or DC and may be controlled by AC or DC. An SSR functions as a *SPST switch*, and is available in normally open or normally closed versions. SSRs that function as an SPDT switch are relatively unusual and actually contain more than one SSR.

No single schematic symbol has been adopted to represent a solid-state relay, but some alternatives are shown in Figure 4-1:

Top
: An unusually detailed depiction of an SSR that switches DC current using MOSFETS. Symbols for this device often omit the diodes on the output side and may simplify the MOSFET symbols.

Bottom left
: An SSR that uses an internal **triac** to switch AC. The box labeled 0x indicates that this is a *zero-crossing* relay, meaning that it switches when alternating voltage crosses the 0V level from positive to negative or negative to positive.

Bottom right
: A generic SSR, showing a symbol for a normally open relay, although whether it is designed for AC or DC is unclear.

Advantages

- Great reliability and long life.
- No physical contacts that are vulnerable to arcing and erosion or (under extreme conditions) that could weld themselves together.

- Very fast response, typically 1µs on and 0.5µs off.
- Very low power consumption on the input side, as low as 5mA at 5VDC. Many solid-state relays can be driven directly from logic chips.
- Lack of mechanical noise.
- No contact bounce; a clean output signal.
- No coil that would introduce back EMF into the circuit.
- Safe with flammable vapors, as there is no sparking of contacts.
- Often smaller than a comparable electromagnetic relay.
- Insensitive to vibration.
- Safer for switching high voltages, as there is complete internal separation between input and output.
- Some variants work with input control voltages as low as 1.5VDC. Electromagnetic relays typically require at least 3VDC (or more, where larger relays are required to switch higher currents).

Disadvantages

- Less efficient; its internal impedance introduces a fixed-value voltage drop on the output side (although this may be negligible when switching higher voltages).
- Generates waste heat in its "on" mode, in accordance with the voltage drop.
- Passes some *leakage* current (usually measured in microamps) on the output side when the relay is supposed to be "off."
- A DC solid-state relay usually requires observation of polarity on the output side. An electromagnetic relay does not.
- Brief voltage spikes on the input side, which would be ignored by a slower electromagnetic relay, may trigger a solid-state relay.
- More vulnerable than an electromagnetic relay to surges and spikes in the current that is switched on the output side.

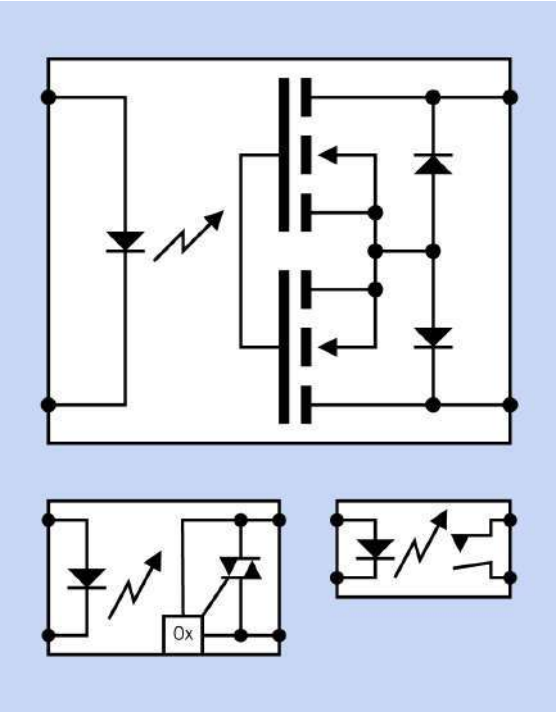

Figure 4-1. *Schematic symbols for solid-state relays have not been standardized. See text for details.*

How It Works

Almost all modern SSRs contain an internal **LED** (light-emitting diode, see Chapter 22) which is switched on by the control input. Infrared light from the LED is detected by a sensor consisting of one or more **phototransistors** or **photodiodes**. In a relay that controls DC current, the sensor usually switches a **MOSFET** (see Volume 1) or an **SCR** (silicon-controlled rectifier—see Chapter 1). In relays that control AC current, a **triac** (see Chapter 3) controls the output. Because the input side and the output side of the SSR are linked only by a light signal, they are electrically isolated from each other.

The MOSFETs require so little power, it can be provided entirely by light falling on an array of 20 or more photodiodes inside the SSR package.

Typical solid-state relays are shown in Figures 4-2 and 4-3.

Figure 4-2. *A solid-state relay capable of switching up to 7A DC. See text for a detailed description.*

The Crydom DC60S7 accepts a control voltage ranging from 3.5VDC to 32VDC, with a typical input current of less than 3mA. Maximum turn-on time is 0.1ms and maximum turn-off time is 0.3ms. This relay can switch up to 7A and tolerates a surge of up to twice that current. It imposes a voltage drop of as much as 1.7VDC, which can become a drawback when switching voltages that are significantly lower than its maximum 60VDC. The electronics are sealed in thermally conductive epoxy, mounted on a metal plate approximately 1/8" thick which can be screwed down onto an additional heat sink.

The Crydom CMX60D10 tolerates a more limited range of control voltages (3VDC to 10VDC) and requires a higher input current of 15mA at 5VDC. However, its very low maximum on-state resistance of 0.018Ω imposes a much smaller voltage drop of less than 0.2 volts when passing 10A. This results in less waste heat and enables a *single-inline package* (SIP) without a heat sink. The CMX60D10 weighs 0.4 ounces, as opposed to the 3 ounces of the DC60S7. Relays from other manufacturers use similar packaging and have similar specifications.

Figure 4-3. *A solid-state relay capable of switching up to 10A. Its lower internal resistance results in less waste heat and enables a smaller package. See text for a detailed description.*

Variants

Many solid-state relays have protective components built into the package, such as a varistor on the output side to absorb transients. Check datasheets carefully to determine how much protection from external components may be necessary when switching an inductive load.

Instantaneous versus Zero Crossing

A *zero crossing* SSR is one that (a) switches AC current and (b) will not switch "on" until the instant when the AC voltage crosses through 0V. The advantages of this type are that it does not have to be built to switch such a high current, and creates minimal voltage spike when the switching occurs.

All SSRs that are designed to switch AC will wait for the next voltage zero crossing before switching to their "off" state.

NC and NO Modes

Solid-state relays are SPST devices, but different models may have a normally closed or normally open output. If you require double-throw operation, two relays can be combined, one normally closed, the other normally open. See Figure 4-4. A few manufacturers combine a normally closed relay and a normally open relay in one package, to emulate a SPDT relay.

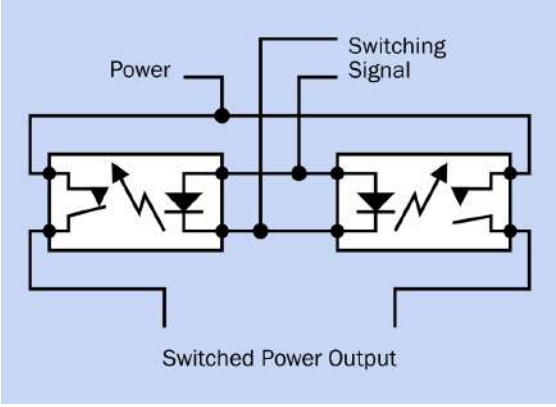

Figure 4-4. *A normally closed solid-state relay can be paired with a normally open solid-state relay to emulate a SPDT switch. This combination is available in a single package from some manufacturers.*

Packaging

High-current solid-state relays are often packaged with screw terminals and a metal base that is appropriate for mating with a *heat sink*. Some are sold with heat sinks integrated. Spade terminals and crimp terminals may be optional. The Crydom DC60S7 shown in Figure 4-2 is an example. This type of package may be referred to as *industrial mount.*

Lower-current solid-state relays (5A or less), and those with a very low output resistance, may be packaged with single-inline pins for through-hole mounting in circuit boards.

Solid-State Analog Switch

DIP packaging may be used for solid-state relays that are designed for compatibility with the low voltages and currents of logic chips. This type of component may be referred to simply as a *switch*. The 74HC4316 is an example, pictured in Figure 4-5.

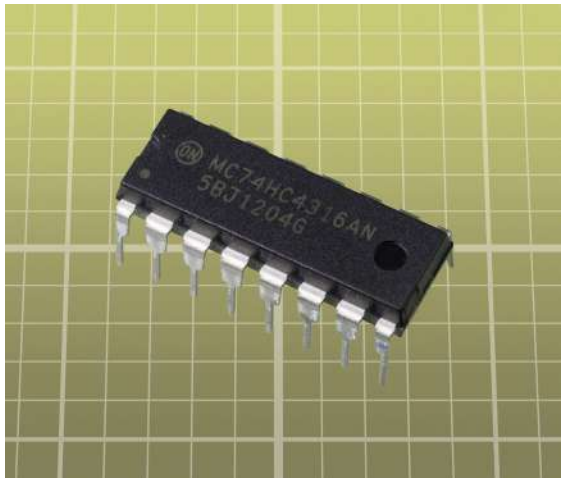

Figure 4-5. *This DIP package contains four "switches" that function as solid-state relays but are restricted to low voltages and currents, compatible with logic chips. See text for details.*

Typically the control voltage and the switched voltage are limited between +7V and –7V, with a maximum output current of 25mA. Each internal switch has its own Control pin, while an additional Enable pin forces all switches into an "off" state if its logic state is high. The simplified functionality of this component is illustrated in Figure 4-6, without showing internal optical isolation.

The "on" resistance of each internal pathway will be approximately 200Ω when the component is powered with +5VDC on the positive side and 0VDC on the negative side. This resistance drops to 100Ω if the negative power supply is -5VDC.

If all of the outputs from the chip are shorted together, it functions as a **multiplexer** (see Chapter 16). In fact, this type of switch component is often listed in catalogs as a multiplexer, even though it has other applications.

Because the component tolerates equal and opposite input voltages, it is capable of switching AC.

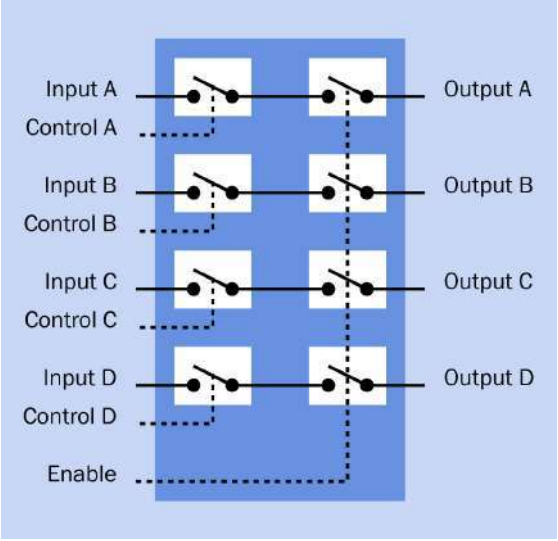

Figure 4-6. *The functionality of a chip containing four solid-state analog switches. A high state on a Control pin closes its associated switch. The Enable pin must be held low for normal operation; a high Enable state forces all the switches into the "off" position. If the outputs are tied together, this component can function as a multiplexer.*

Values

Industrial-mount solid-state relays typically can switch currents ranging from 5A to 500A, with 50A being very common. The higher-current relays mostly require DC control voltage; 4V to 32V are typical, although some versions can go much higher. They contain an SCR or triac to switch AC.

Smaller solid-state relays in SIP, DIP, or surface-mount packages often use MOSFETs on the output side, and are often capable of switching up to 2A or 3A. Some can switch either AC or DC, depending on the way the output is wired. The LED on the input side may require as little as 3mA to 5mA for triggering.

How to Use It

Solid-state relays find their primary uses in telecommunications equipment, industrial control systems and signalling, and security systems.

The component is very simple externally. Power on the input side can come from any source capable of delivering the voltage and current specified by the manufacturer, and any device that doesn't exceed maximum current rating can be connected to the output side, so long as provision is made for suppressing back-EMF from an inductive load, as shown in Figure 4-7. Often a solid-state relay can be substituted directly for an electromagnetic relay, without modifying the circuit.

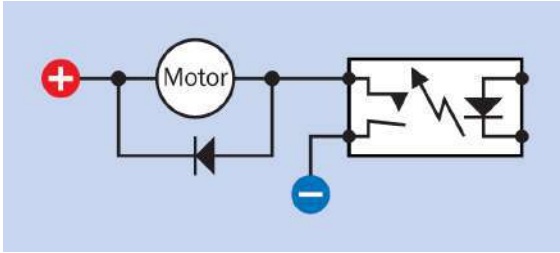

Figure 4-7. *Use of a diode around an inductive load, to protect a solid-state relay from back-EMF.*

Solid-state relays are heat sensitive, and their rating for switching current will diminish as their temperature increases. Manufacturer datasheets will provide specific guidance. Using a heat sink will greatly improve the performance. Bear in mind that the relay generates heat continuously while it is in its "on" mode—about 1 watt per ampere.

Because it requires so little current on the input side (typically no more than 15mA), a solid-state relay can usually be driven directly by chips such as *microcontrollers* that would not be able to activate an equivalent electromagnetic relay.

Applications may take advantage of the solid-state relay's reliability, immunity to vibration, lack of contact sparking, freedom from coil-induced surges on the input side, and lack of contact bounce on the output side. A solid-state relay is ideal within digital equipment that is sensitive to power spikes. It may switch a fuel pump that handles volatile, flammable liquids, or a wastewater pump in a basement subject to

flooding (where long-term zero-maintenance reliability is necessary, and contact corrosion could be a risk in electromagnetic relays). Small solid-state relays can switch motors in robots or appliances where vibration is common, and are often used in arcade games.

What Can Go Wrong

Overheating Caused by Overloading

Relays must be *derated* when used at operating temperatures above the typical 20 or 25° C for which their specification applies. In other words, the sustained operating current must be reduced, usually by an amount such as 20% to 30% for each 10-degree increase in ambient temperature. Failure to observe this rule may result in failure of the component. Burnout may also occur if a high-current solid-state relay is used without a heat sink, or the heat sink isn't big enough, or *thermal compound* is not applied between the solid-state relay and the heat sink.

Overheating Caused by Bad Terminal Contact

If the screw terminals on the output side of a high-current solid-state relay are not tightened sufficiently, or if there is a loose spade terminal, or if a crimped connection isn't crimped tightly enough, the poor contact will create electrical resistance, and at high currents, the resistance will create heat, which can cause the solid-state relay to overheat and burn out.

Overheating Caused by Changing Duty Cycle

If a high-current solid-state relay is chosen for an application where it is in its "on" state only half the time, but the application changes during product development so that the solid-state relay is in its "on" state almost all the time, it will have to dissippate almost twice as much heat. Any time the duty cycle is changed, heat should be considered. The possibility of the relay being used in an unconventional or unexpected manner should also be considered.

Overheating Caused by Component Crowding

Overheating increases dramatically when components are tightly crowded. At least 2cm (3/4") should be allowed between components.

Overheating in Dual Packaging

When a package contains two solid-state relays, the additive effects of the heat created by each of them must be considered.

Reverse-Voltage Burnout

Because a solid-state relay is more sensitive to *back-EMF* than an electromagnetic relay, greater care should be used to protect it from reverse voltage when switching inductive loads. A *protection diode* should be used, and a *snubber* can be added between its output terminals, if it is not included inside the relay package.

Low Voltage Output Current May Not Work

Unlike electromagnetic relays, solid-state relays require some voltage on the output side to enable their internal operation. If there is no voltage, or only a very low voltage, the SSR may not respond to an input. The minimum voltage required on the output side is usually specified in a datasheet.

To test a solid-state relay, apply actual voltages on input and output sides and use a load such as an incandescent light bulb. Merely applying a meter on the output side, set to measure continuity, may not provide sufficient voltage to enable the relay to function, creating the erroneous impression that it has failed.

Inability to Measure AC Output

When a multimeter is used to test continuity across the output of an AC-switching solid-state relay of zero-crossing specification, the meter will generate enough voltage to prevent the

solid-state relay from finding zero voltage across its output terminals, and consequently the solid-state relay won't switch its output.

Relay Turns On but Won't Turn Off

When a solid-state relay controls a relatively high-impedance load such as a small **solenoid** (see Volume 1) or a **neon bulb** (see Chapter 19), the relay may switch the device on but will seem unable to switch it off. This is because the leakage current of the solid-state relay, in its "off" state, may be just enough to maintain the load in its "on" state.

If an SSR containing a triac is used erroneously to switch DC, it will not be able to switch off the current.

Relays in Parallel Won't Work

Two solid-state relays usually cannot be used in parallel to switch twice as much current. Because of small manufacturing variances, one relay will switch on a moment before the other. When the first relay is on, it will divert the load current away from the second relay. The second relay needs a small amount of current on its output side, to function. Without any current, it will not switch on. This means the first relay will pass the total current without any help from the second relay, and will probably burn out, while the second relay does nothing.

Output Device Doesn't Run at Full Power

A solid-state relay imposes a voltage reduction on its output side. This will be a fixed amount, not a percentage. When switching 110V, this difference may be negligible; when switching 12V, it may deliver only 10.5V, which represents enough of a drop to cause a motor or a pump to run noticeably more slowly. The internal switching device inside the relay (MOSFET, triac, SSR, or bipolar transistor) will largely determine the voltage drop. Check the manufacturer's datasheet before using the relay.

Solid-State Relays and Safety Disconnects

Because a solid-state relay always allows some leakage in its "off" state, it can still deliver a shock when used to switch high voltages. For this reason, it may not be suitable in a safety disconnect.

optocoupler

5

Sometimes known as an *optoelectronic coupler*, *opto-isolator*, *photocoupler*, or *optical isolator*.

A **solid-state relay** is sometimes referred to as an **optocoupler**, but in this encyclopedia it has a separate entry. An optocoupler is a relatively simple device consisting of a light source (usually an LED) and a light sensor, both embedded in one package. It is used primarily for isolation rather than to switch a high current. A solid-state relay can be thought of as a substitute for an electromagnetic **relay**, usually has additional components in its package, and is intended to switch currents of at least 1A.

OTHER RELATED COMPONENTS

- **electromagnetic relay** (see Volume 1)
- **solid-state relay** (see Chapter 4)

What It Does

An optocoupler allows one section of a circuit to be electrically isolated from another. It protects sensitive components, such as logic chips or a microcontroller, from voltage spikes or incompatible voltages in other sections of a circuit. Optocouplers are also used in medical devices where a patient has to be protected from any risk of electric shock, and are used in devices which conform with the MIDI standard for digital control of music components.

In Figure 5-1, three possible applications for an optocoupler are suggested:

Top
: The output from a logic chip passes through an optocoupler to an inductive load such as a relay coil, which may create voltage spikes that would be hazardous to the chip.

Center
: The noisy signal from an electromagnetic switch passes through an optocoupler to the input of a logic chip.

Bottom
: The low-voltage output from a sensing device on a human patient passes through an optocoupler to some medical equipment, such as an EEG machine, where higher voltages are used.

Internally, an optocoupler works on the same principle as a **solid-state relay**. An LED is embedded on the input side, shining light through an interior channel or transparent window to a sensing component that is embedded on the output side. Because the only internal connection is a light beam, the input and output of the optocoupler are isolated from each other.

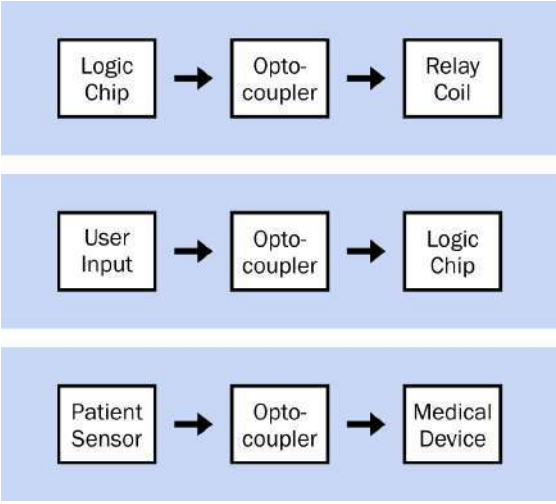

Figure 5-1. *Possible applications for a photocoupler. See text for details.*

Isolation transformers were traditionally used for this purpose prior to the 1970s, when optocouplers became competitive. In addition to being smaller and cheaper, an optocoupler can also pass slow-changing signals or on-off DC states which a transformer would ignore.

More recently, inductive and capacitive coupling components have become available in surface-mount packages that are competitive with optocouplers for high-speed data transfer. They also claim to be more durable. Because of the gradual reduction in output from an LED, the performance of an optocoupler degrades over time, and is typically rated for up to 10 years.

How It Works

The LED in an optocoupler almost always emits light in the near-infrared part of the spectrum, and is matched to the sensitivity of a **phototransistor**, or a **photodiode**, or (less often) a **photoresistor** that provides the output. Photosensitive **triacs** and **SCRs** are also sometimes used.

The most common type of optocoupler uses a bipolar phototransistor with an open-collector output. Schematic symbols for this type are shown in Figure 5-2:

Top left
: The most common generic form.

Top right
: Two diodes on the input side allow the use of alternating current.

Center left
: An additional terminal allows addition of bias to the photosensitive base of the output transistor, to reduce its sensitivity.

Center right
: An Enable signal can be used as the input to the NAND, suppressing or enabling the output.

Bottom left
: A *photodarlington* allows higher emitter current.

Bottom right
: Relatively uncommon, and is also used for a **solid-state relay**.

In each symbol, the diode is an LED, and the zigzag arrow indicates light that is emitted from it. A pair of straight arrows, or wavy arrows, may alternatively be used.

An optocoupler in through-hole DIP format is shown in Figure 5-3.

An *optical switch* can be thought of as a form of optocoupler, as it contains an LED opposite a sensor. However, the LED and the sensor are separated by an open slot, to allow a thin moving object to pass through, interrupting the light beam as a means of detecting the event. It is categorized as a *sensor* in this encyclopedia, and will be found in Volume 3.

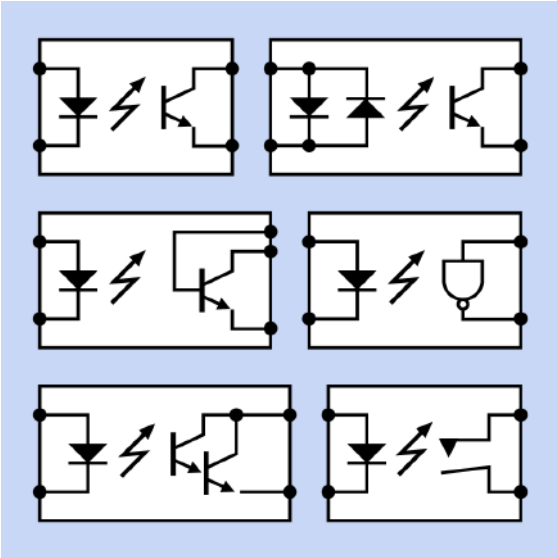

Figure 5-2. *Six variants of schematic symbols that may be used to represent an optocoupler. See text for details.*

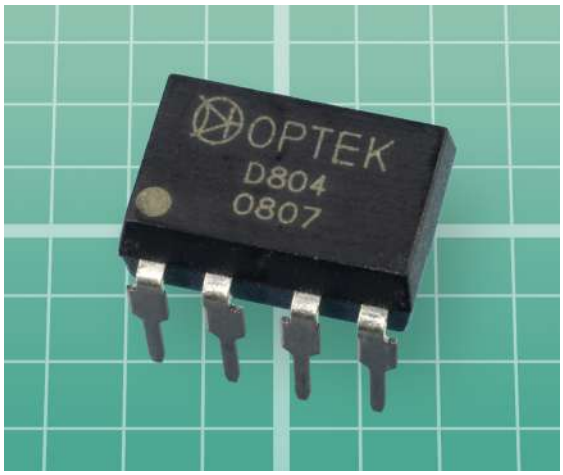

Figure 5-3. *An optocoupler in through-hole 8-pin DIP format.*

Variants

Internal Sensors

Historically, a photoresistor (often referred to as a *photocell*) was the first type of sensor to be used. It has a more linear response than other sensor types, but its response is much slower. It is still found in audio applications. "Stomp box" pedals used by guitarists typically contain an optocoupler that employs a photoresistor, and are valued for their linearity and their immunity from the mechanical wear, contamination, and "scratchiness" that builds up over time in a **potentiometer**. Optocouplers also eliminate *ground loops*, which tend to be induced by small differences in ground potential, introducing hum or buzz in audio applications when two or more power supplies are tied together.

The type of optocoupler that contains a photoresistor and is commonly used by musicians was initially trademarked as a *Vactrol*, and that term is still used generically. Vactrols have also been used to provide audio compression in telephone voice networks, and were used in photocopiers and photographic exposure meters, but these applications are now obsolete.

Photoresistors are becoming uncommon because of their cadmium content, which is unlawful in many countries (especially in Europe) because of its environmental toxicity.

A photodiode provides the fastest response time in an optocoupler, limited primarily by the characteristics of the LED that shines light upon it. A *PIN diode* can respond in less than a nanosecond; its acronym is derived from its fabrication from p-type and n-type semiconductor layers with an *intrinsic* layer connecting them. This additional layer can be responsive to light. When the diode is slightly reverse-biased, a photon entering the intrinsic layer can dislodge an electron, enabling current to flow. The reverse bias enlarges the active area and enhances the effect. In this mode, the PIN acts like a photoresistor, appearing to reduce its resistance in response to light.

When the PIN is used in *photovoltaic* mode, no bias is applied, and the component actually generates a small voltage (less than 1VDC), like a solar cell, in response to incoming light. Where an optocoupler uses a MOSFET on its output side, as many as 30 photodiodes may be connected in series to develop the necessary threshold volt-

age to trigger the transistor. This arrangement is common in **solid-state relays**.

A bipolar phototransistor is a slower-speed device but is still usually capable of a 5µs response time or better. Its open collector requires external voltage and a *pull-up resistor* to deliver a positive output so long as the phototransistor is nonconductive. When the LED turns on, the phototransistor sinks current, effectively creating a low output. In this way, the optocoupler functions like an *inverter*, although some variants include a noninverting output.

Basic Optocoupler Types

An optocoupler with *high linearity* will respond more proportionally to variations in current to its LED. *High Speed* optocouplers are used for high-frequency data transfer. *Logic-output* optocouplers have a clean high/low output transition, rather than an *analog output*, which varies with fluctuations in the input. Linearity is of importance only where an optocoupler is being used to transmit an analog signal with some fidelity. Some logic-output optocouplers provide the function of a Schmitt trigger on their output side.

While optocouplers are available in various package formats, the DIP style with six or eight pins remains popular, providing sufficient physical space for the LED, the sensor, and a light channel, while providing good electrical isolation.

Variants may have two or four optocouplers combined in one package. A *bidirectional* optocoupler may consist of two optocouplers in parallel, inverted with respect to each other.

Values

In a datasheet, the characteristics of primary importance in an optocoupler are:

- CTR is the Current Transfer Ratio, the ratio of maximum output current to input current, expressed as a percentage. With a bipolar phototransistor output, 20% is a typical minimum CTR. With a photodarlington output, the CTR may be 1,000% but the bandwidth is much lower—the response time may be measured in microseconds rather than nanoseconds. Optocouplers with a photodiode output have a very low CTR, and their output is in microamps. However, they provide the most linear response.
- $V_{CE(MAX)}$ is the maximum collector-emitter voltage difference (in an optocoupler with a bipolar phototransistor output). Values from 20 to 80 volts are common.
- V_{ISO} is the maximum potential difference, in VDC, between the two sides of the optocoupler.
- I_{MAX} is the maximum current the transistor can handle, generally in mA.
- Bandwidth is the maximum transmittable signal frequency, often in the range of 20kHz to 500kHz.

The LED in an optocoupler typically requires 5mA at a forward voltage of 1.5V to 1.6V.

The maximum collector current on the output side of an optocoupler is unlikely to be higher than 200mA. For higher output currents, a solid-state relay should be considered. It provides photo-isolation on the same basis as an optocoupler, but high-current versions tend to be considerably more expensive.

How to Use It

The primary purpose of an optocoupler is to provide protection against excessive voltage—from transients, incompatible power supplies, or equipment with unknown characteristics. If a device is designed to be plugged into a USB port on a computer, for instance, the computer may be isolated via an optocoupler.

A series resistor for the LED is not built into most optocouplers, because the value of the resistor will depend on the input voltage that is used. Care must be taken to determine what the maximum voltage on the input side will be, and a

series resistor should be chosen to reduce current appropriately. Allowance should be made for some degradation in the performance of the LED over time.

For an optocoupler with an open-collector output, a pull-up resistor is necessary in most applications. The voltage from the optocoupler must be matched to the input requirements of other components, and the collector current must remain within the specified limits. Some trial and error in resistor selection may be necessary.

In Figure 5-4, a schematic shows typical component values in a test circuit using a pushbutton as input. The separation of the two power supplies is emphasized by the different color shades used for the positive and negative symbols. Although the input side and the output side of an optocoupler may be used with a common ground, this defeats its purpose in providing complete isolation between the sections of the circuit.

The pinouts for an optocoupler must be checked carefully in the manufacturer's datasheet. While the input for an 8-pin DIP chip is usually applied to pins 2 and 3, the output pin functions are not standardized and will vary depending on the internal configuration of the chip. An optocoupler such as the Optek D804, with an enable function using an internal NAND gate, requires its own power supply.

Where an optocoupler allows an external connection to the base of its internal bipolar output phototransistor, reverse bias applied to this pin will decrease the sensitivity of the optocoupler but can increase its immunity to noise on the input side.

What Can Go Wrong

Overload conditions on the input or the output side of an optocoupler will be the most likely cause of failure.

Age

Because optocouplers are typically rated for only 10 years of average use, the age of a component may cause it to fail.

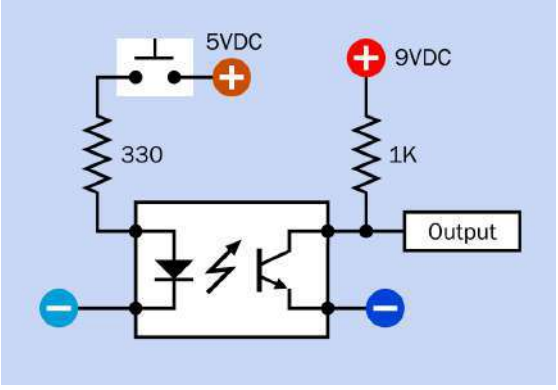

Figure 5-4. *Typical values for a series resistor (to protect the LED) and pull-up resistor (to control current and voltage on the output side) in an optocoupler test circuit.*

LED Burnout

Because the LED is hidden inside the component, there is no immediate indication of its performance. A meter can be inserted into the circuit on the input side to determine if current is passing through the LED. A meter set to measure volts can be used to discover whether the LED is imposing a normal voltage drop. While significant overload will cause immediate burnout, slightly exceeding the current rating of the LED may have more pernicious consequences, as the LED may not fail until days or weeks have passed without any sign of trouble. The failure of the optocoupler will be unexpected and difficult to determine.

Transistor Burnout

Here again the damage caused by excessive current may be progressive, occurring over a prolonged period. The easiest way to test an optocoupler that may have failed is by removing it from the circuit. A socketed DIP package is preferable for this purpose.

comparator

Although a **comparator** has the same schematic symbol as an **op-amp**, their applications differ and they are described in separate sections of this encyclopedia.

This entry describes an analog comparator. A *digital comparator* is very different, being a logic chip that compares two binary numbers that can be referred to as A and B. Outputs from the chip indicate whether A>B or A<B or A=B. The digital comparator does not have an entry in this encyclopedia.

OTHER RELATED COMPONENTS

- **op-amp** (see Chapter 7)

What It Does

A **comparator** is an integrated circuit chip that compares a variable voltage on one input pin with a fixed, reference voltage on a second input pin. Depending which voltage is higher, the output from the comparator will be high or low.

The output will make a clean transition between two fixed values, even if the input is infinitely variable. Thus the comparator can function as an *analog-digital converter*, as shown in Figure 6-1.

Because the output voltage range can be adjusted up or down independently of the input range, a comparator can also function as a *voltage converter*.

Hysteresis

If positive feedback is added through external resistors, *hysteresis* can be introduced. We may imagine a *hysteresis zone* extending above and below the reference voltage level. Small input variations that occur within the zone will be ignored. The comparator only reacts when the input signal emerges above or below the hysteresis zone. When the input signal returns into the hysteresis zone, this event also will be ignored. The concept is illustrated graphically in Figure 6-2. A circuit to create hysteresis is shown in Figure 6-10.

How It Works

The schematic symbol for a comparator is shown in Figure 6-3. This seems identical to the symbol for an op-amp, described in Chapter 7, but an op-amp is traditionally a *dual-voltage* device using positive and negative power sources that are equal and opposite, in addition to a zero value midway between the two. Modern comparators mostly use a conventional single voltage, and therefore the negative symbol used in comparator schematics throughout this section of the encyclopedia represents 0 volts. It has the same meaning as the ground symbol found in many schematics elsewhere.

The two inputs to a comparator are described as *inverting* and *noninverting* (for reasons explained later). Confusingly, these are identified with plus and minus symbols inside the triangle that represents the component. These plain black-and-

white symbols have nothing to do with the power supply.

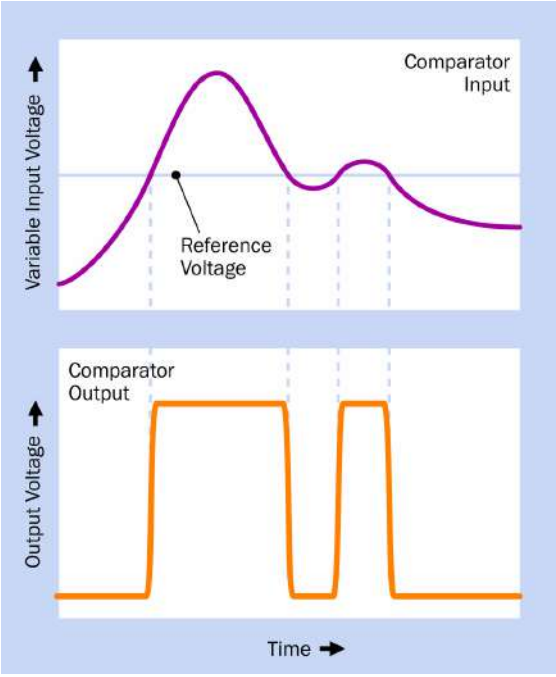

Figure 6-1. *The basic behavior of a simple comparator is shown here.*

Often, in schematics, the power supply is not shown, because it is assumed to be present. However, all comparators require a power supply in order to function.

The basic internal and external connections used in conjunction with a typical comparator are shown in Figure 6-4.

The potentiometer at top left is often a *trimmer*, to fine-tune a reference voltage. The variable input can come from a sensor or any other device capable of delivering a voltage up to the limit set by V1.

The output is often an *open collector* from an internal bipolar transistor, as shown in the figure.

Note that as many as three different voltages can be used, as indicated by the different colors associated with V1, V2, and V3. However, they must share a common ground to enable the comparator to make valid comparisons.

When the noninverting input exceeds the voltage of the inverting input, the output transistor goes into its "off" state, and blocks current from an external *pullup resistor*. Because the current from the resistor now has nowhere else to go, it is available to drive other devices attached to the comparator output, and the output appears to be high.

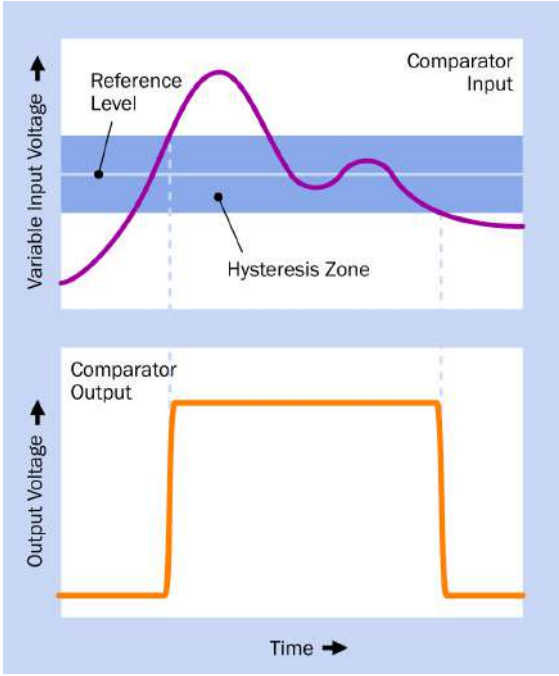

Figure 6-2. *The performance of a comparator shown in the previous figure can be modified by the addition of hysteresis. Small variations that occur within the hysteresis zone are ignored.*

When the noninverting input falls below the voltage of the inverting input, the transistor becomes conductive, and sinks almost all the current from the pullup resistor, assuming other devices attached to the output have a relatively high impedance. The output from the comparator now appears to be low.

This can be summed up as follows:

- When a variable voltage is applied to the noninverting input, and it rises *above* the reference voltage applied to the *inverting input*, the output transistor turns off, and the comparator delivers a *high* output.
- When a variable voltage is applied to the noninverting input, and it falls *below* the reference voltage applied to the *inverting input*, the output transistor turns on, and the comparator delivers a *low* output.

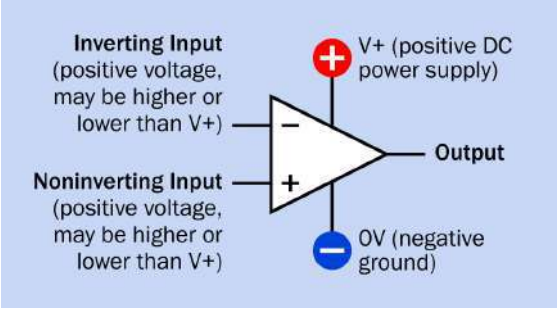

Figure 6-3. *The symbol for a comparator is the same as the symbol for an op-amp, even though they often require different types of power supply and their functions are significantly different.*

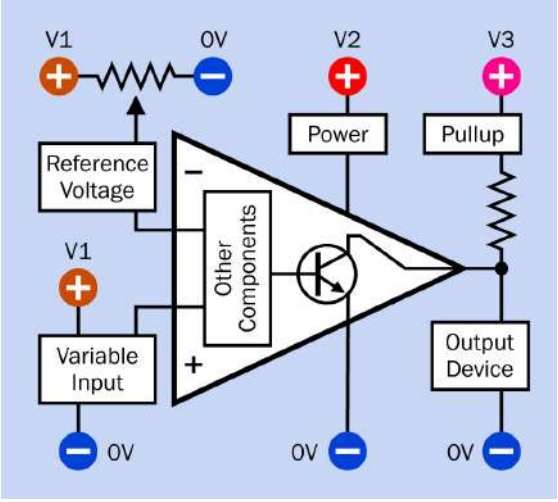

Figure 6-4. *Connections to a comparator, and their functions.*

If the reference voltage and the variable voltage are swapped between the input pins, the behavior of the comparator is reversed. This relationship is illustrated in Figure 6-5. When a voltage transition is applied to the *inverting* input, the transition is *inverted* at the output.

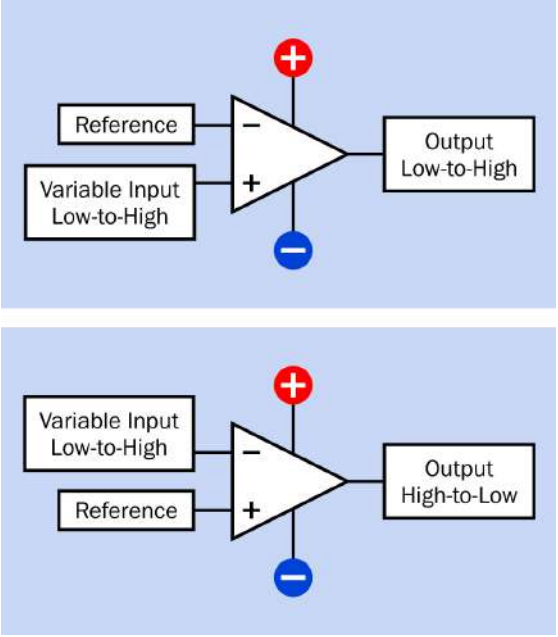

Figure 6-5. *Depending which input pin is used for the reference voltage, and which input carries a variable voltage, the comparator output either follows the variable voltage or inverts it.*

Placement of the plus and minus signs inside the comparator symbol may vary. Most often, the minus sign is above the plus sign, as shown in all the schematics here. Sometimes, however, for convenience in drawing a schematic, the plus sign may be shown above the minus sign. Regardless of their placement, the plus sign always identifies the noninverting input, and the minus sign always identifies the inverting input. To avoid misinterpretations, schematics should be inspected carefully.

Where a power supply for the comparator is shown, the positive side is always attached to the upper edge of the symbol, while 0V ground is always attached to the lower edge.

Differences from an Op-Amp

Saturation versus linearity

The output of a comparator is optimized for saturation (high or low, without intermediate levels, using positive feedback). The output of an op-amp is optimized for linearity (faithful reproduction of nuances in the input, using negative feedback).

Output mode

The majority of comparators have open-collector outputs (or open-drain outputs in CMOS devices) where the voltage is established by a pullup resistor. This can be adjusted for compatibility with other components, especially 5VDC logic. Only a minority have push-pull amplifier outputs that require no pullup resistor. By comparison, among op-amps, a push-pull output that functions as a voltage source is the traditional default.

Faster response

A comparator responds more quickly than an op-amp to changes in input voltage, if the op-amp is used in the role of a comparator. The comparator is primarily a switching device, not an amplifier.

Hysteresis

This is generally desirable in a comparator, for reasons already explained, and some components are designed with hysteresis built in. This feature is undesirable in an op-amp, as it degrades sensitivity.

Open-loop operation

(i.e., without feedback) this can be used with a comparator. An op-amp is intended for use in closed-loop circuits (i.e., with feedback), and manufacturers will not specify its performance in an open loop.

As previously noted, a comparator usually requires a single-voltage power supply, while an op-amp often requires a dual-voltage power supply.

Variants

Where a comparator uses a MOSFET output transistor, it may have an open-drain output, which requires a pullup resistor, as with an open-collector output.

Some comparators have a *push-pull* output, capable of supplying output current (usually a small amount). In these instances, no pullup resistor is necessary or desirable. The output voltage range will be closest to *rail-to-rail* values (i.e., the range of the power supply) where MOSFETs are used for the output, as MOSFETs impose a smaller voltage drop than bipolar transistors.

The advantage of an open collector (or open drain) relative to a push-pull output is that it allows the output voltage to be set independently of the power supply voltage. Another advantage is that multiple outputs can be connected in parallel, as in a *window comparator* circuit (described below).

Some comparators incorporate a reference voltage on the chip, based on the power supply to the chip. In this case, a separate reference voltage does not have to be supplied, and the component will draw less current.

Many chips are available containing two or more comparators. This is often expressed as the number of *channels* in the component. A *dual comparator* typically allows two different voltage sources for the outputs of the comparators. They will share the same 0V ground, however. Chips such as the LM139 and LM339 contain four comparators, and are available in through-hole or surface-mount formats. They have become a generic choice, costing less than $1 apiece.

An LM339 comparator chip is shown in Figure 6-6. This is a quad chip, meaning that it contains four comparators. They share a common power supply. The chip is TTL and CMOS compatible, is typically powered by 5VDC, but can be driven by up to 36VDC. The input differential voltage range also extends up to 36V.

Figure 6-6. *The LM339 quad comparator chip, shown here, was introduced long ago but remains widely used.*

Some comparators have an internal *latch* function that is accessed by a dedicated pin. The latch-enable signal forces the comparator to assess its inputs and hold an appropriate output which can then be checked by other components.

Values

In a datasheet, V_{IO} (also referred to as V_{OS}) is the *input offset voltage*. This is a small voltage, in addition to the reference voltage, which the comparator will require to *toggle* its output in either direction, up or down. Figure 6-7 shows this graphically. V_{IO} sets the limit of *resolution* of the comparator, which will not respond unless the input voltage exceeds the reference voltage by this amount. A smaller value for V_{IO} is better than a larger value. Common values for V_{IO} range from 1mV to 15mV. The actual offset voltage tends to vary between one sample of a component and another. V_{IO} is the maximum allowed value for a component.

Because the comparator will not respond until the reference voltage is exceeded by V_{IO}, the output pulse width will be narrower than if the comparator reacted at the point where the variable voltage input was precisely the same as the reference voltage.

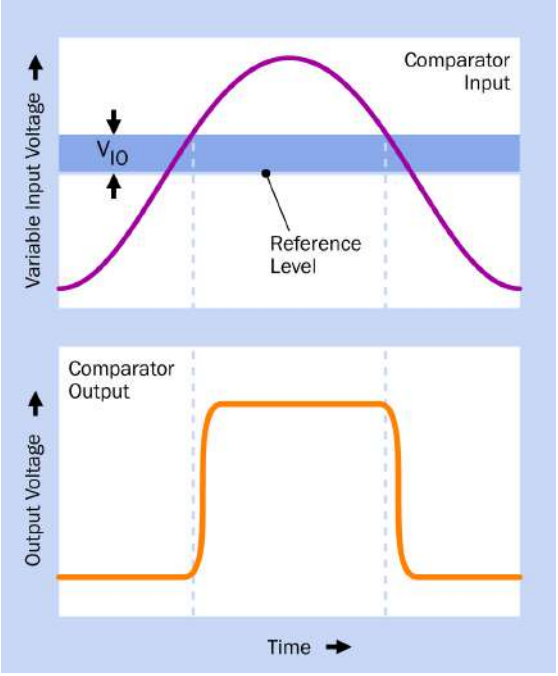

Figure 6-7. *The input offset voltage is the very small voltage that a comparator requires, additional to the reference input voltage, before it will toggle its output from low to high or high to low.*

V_{TRIP+} and V_{TRIP-} are the *rising* and *falling voltages*, respectively, that will trip the comparator output where the comparator exhibits some innate hysteresis without an external feedback loop. They are also referred to as *Lower State Transition Voltage* (LSTV) and *Upper State Transition Voltage* (USTV).

V_{HYST} is the *hysteresis range* defined as V_{TRIP+} minus V_{TRIP-}. The relationship is shown graphically in Figure 6-8.

A_{VD} is the *voltage gain* of a comparator, in which the letter "A" can be thought of as meaning "amplification." The gain is measured as a maximum ratio of output voltage to input voltage. Typically it ranges from 40 to 200.

Supply voltage for modern comparators is often low, as the components are used in surface-mount format for battery-powered devices where low power consumption is a primary con-

cern. Thus, 3VDC is common as a power requirement, and 1.5VDC comparators are available. Still, older chips can use as much as 35VDC.

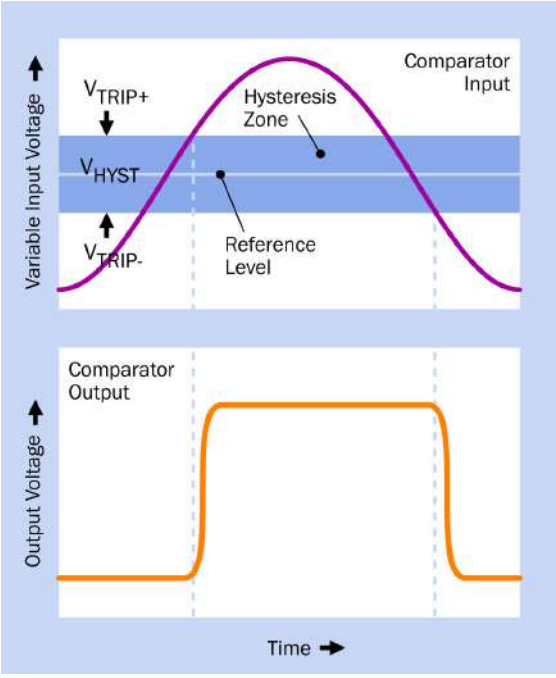

Figure 6-8. *The value of V_{TRIP} shows the hysteresis in a comparator—the range of input voltages, relative to the reference voltage, in which it will not respond.*

Supply current can range from 7mA down to below 1µA.

I_{SINK} is the recommended typical or maximum *sink current* that the component will tolerate, if it has an open-collector output. This value should be considered in relation to the power dissipation, P_D.

The *propagation delay* in a comparator is measured from the moment when an input (usually a square wave) reaches the triggering value, to the time when the consequent output reaches 50% of its final value.

When a comparator is driving CMOS logic using a 5VDC power supply, a typical value for a pullup resistor is 100K. It does not have to be lower, because CMOS has such a high input impedance.

How to Use It

In Figure 6-1, a hypothetical comparator responds immediately when the input voltage equals the reference voltage value. However, this is an idealized scenario. A magnified view, in Figure 6-9, suggests that the comparator is likely to respond with *jitter* when the input signal is very close to the reference voltage, because of tiny variations in heat, current, and other variables. This jitter will cause significant problems if the comparator is driving a device such as a relay, directly or indirectly.

Hysteresis eliminates this uncertainty around the transition level of the input, by telling the comparator to ignore small irregularities in the input voltage. Hysteresis is also useful in many situations where larger variations in a sensor input should be ignored. In Figure 6-2, for instance, suppose that the input voltage comes from a temperature sensor. The small bump in the right-hand section of the curve is probably unimportant; it could be caused by someone opening a door, or a person's body heat in brief proximity to the sensor. There's no point in responding to every little event of this type. In this application, the larger, longer-term temperature trend is what matters, and significant hysteresis is appropriate.

Also, if a comparator is being used as a thermostat, to switch a heating system on and off, we do not want the comparator to respond as soon as the temperature rises just a small amount. The heating system should run for a while before it elevates the temperature beyond the hysteresis zone.

The usual way to create hysteresis is with *positive feedback*. In Figure 6-10, a connection from the output of the comparator runs back through a 1M potentiometer to the variable (noninverting) input. The effect that this has is to reinforce the input voltage with the output voltage, as soon as the comparator input goes high. Now the input can diminish slightly without switching off the comparator. But if the input declines significant-

ly, even the feedback from the output voltage won't be sufficient to maintain the variable input at a higher level than the reference voltage. (Remember, the "high" output voltage from the comparator is a fixed value; it does not change in proportion with the input voltage.) Consequently, the output toggles to low. Now the variable input is deprived of help from the comparator output, so it will be low enough that it has to rise considerably to toggle the comparator back on again. During that period, once again, small variations will be ignored.

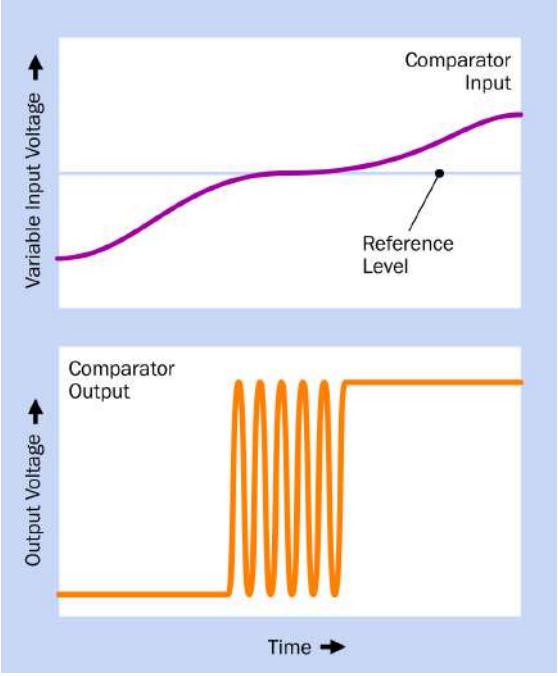

Figure 6-9. *In real-world applications, tiny variations where the variable input voltage crosses the reference voltage can induce jitter in the output from a comparator that has no hysteresis.*

In the schematic, a **phototransistor** (PT1, at left) is in series with a 3.3K resistor to adjust its voltage output to a suitable range. A 1M potentiometer at upper-left is wired as a voltage divider, so that it can establish a reference level that matches the light level that we wish to detect with the phototransistor.

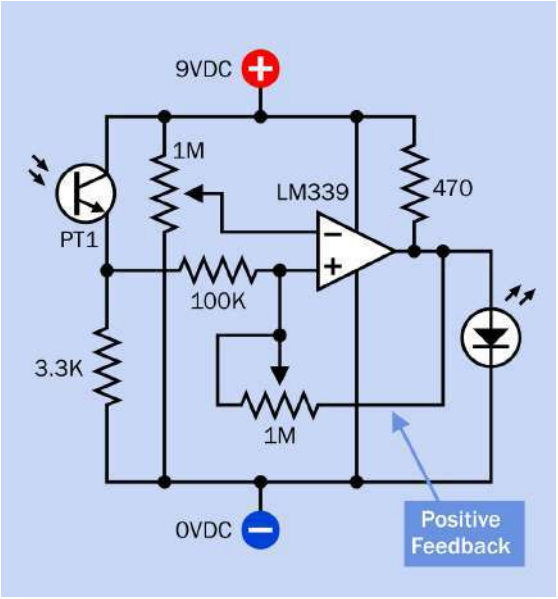

Figure 6-10. *A simple circuit to achieve hysteresis with positive feedback to the variable input of a comparator.*

The 470Ω resistor is the pullup resistor, which protects the LED from excessive current. The lower 1M resistor adjusts the amount of positive feedback, which determines the width of the hysteresis zone.

Values for components may have to be adjusted depending on the supply voltage, the variable input voltage, and other factors. But the principle will remain the same. Note that in the example shown, all the positive voltage sources are identical. In practice, different voltages could be used, so long as they share a common ground.

AND gate

A set of open-collector comparators can function jointly as an AND gate, when their outputs are tied together with one pullup resistor. So long as all the output transistors are nonconductive, the output will be high. If just one comparator toggles into conductive mode, the output will be low. See Figure 6-11.

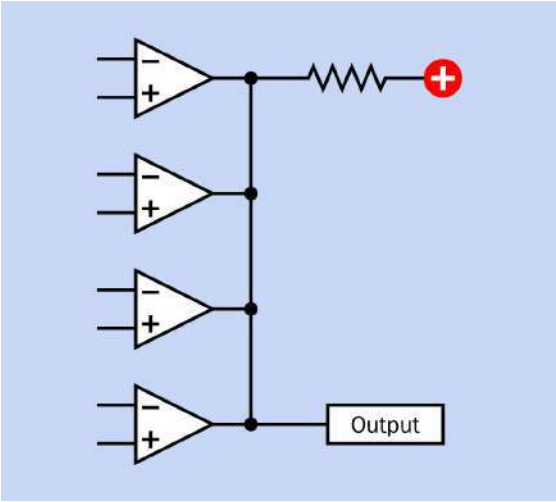

Figure 6-11. *If the outputs of multiple open-collector comparators are tied together with a suitable pullup resistor, they will function as an AND gate.*

Bistable Multivibrator

If positive feedback to the noninverting input of the comparator is sufficiently high, a voltage almost at 0V ground will be required to counter the high output from the comparator—after which, a voltage almost equal to the supply voltage will be needed to turn it back on. In other words, the comparator is behaving like a *bistable multivibrator*, or **flip-flop**.

Relaxation Oscillator

A *relaxation oscillator*, which is a form of *astable multivibrator,* can be created using direct positive feedback in combination with delayed negative feedback. In Figure 6-12, positive feedback goes to the noninverting input, as before, but negative feedback also passes through a 220K resistor to the inverting input of the comparator. A 0.47µF capacitor initially holds the inverting input low, while the capacitor charges. Gradually the capacitor reaches and exceeds the charge on the noninverting input, so the output from the comparator toggles to its low state. This means that its internal transistor is now sinking current, and it discharges the capacitor. Because the noninverting input is being held at a voltage midway between supply and ground by the two 100K resistors forming a voltage divider, eventually the voltage on the inverting input controlled by the capacitor falls below the noninverting voltage, so the cycle begins again.

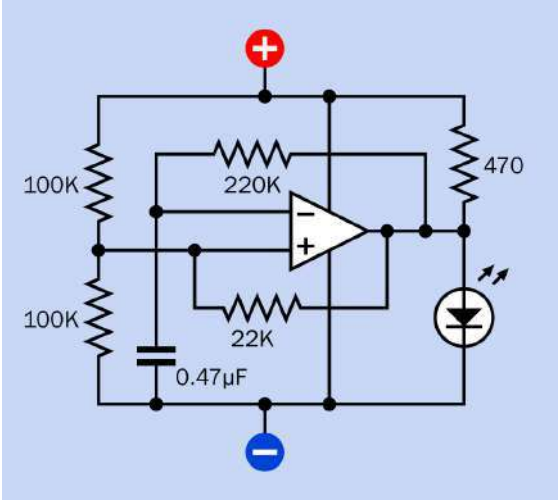

Figure 6-12. *A comparator can be used to create a relaxation oscillator.*

Level Shifter

Where a comparator is used simply to change the level of an input voltage, it can be referred to as a *level shifter*. An example of a level shifter is shown in Figure 6-13, in which a high/low 3VDC logic input is converted to a high/low logic output at 5VDC.

Window Comparator

A *window comparator* is a circuit (not a single component) that will respond to input voltages that deviate outside an acceptable "window" of values. In other words, the circuit responds anytime the variable input is either unacceptably low or unacceptably high.

An example could be an alarm that will sound if a temperature is either too low or too high. In Figure 6-14, two comparators are used to create a window comparator circuit, both sharing a variable voltage input from a sensor. A voltage divider is necessary to establish a higher voltage limit at the noninverting input of the upper com-

parator, while a separate voltage divider would establish a lower limit at the inverting input of the lower comparator. If an alarm has an appropriate resistance, it can be used instead of a pull-up resistor. The alarm will sound when the output from either comparator is low, which happens if the inverting input has a higher voltage than the non-inverting input.

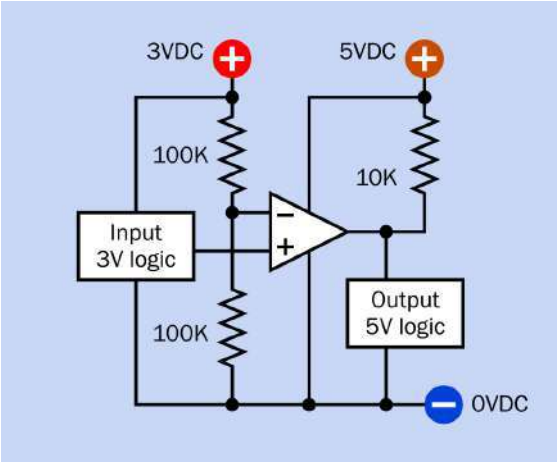

Figure 6-13. *A comparator can be used to convert high and low 3V logic inputs into high and low 5V logic outputs.*

Other Applications

As previously noted, a comparator can be used as a simple *analog-digital converter*. It has "one bit" accuracy (i.e., its output is either high or low).

A comparator can be used as a *zero point finder* when its variable voltage input is attached to an AC signal. The output from the comparator will be toggled whenever the AC signal passes through zero volts. The output will be a square wave (approximately) instead of a sine wave.

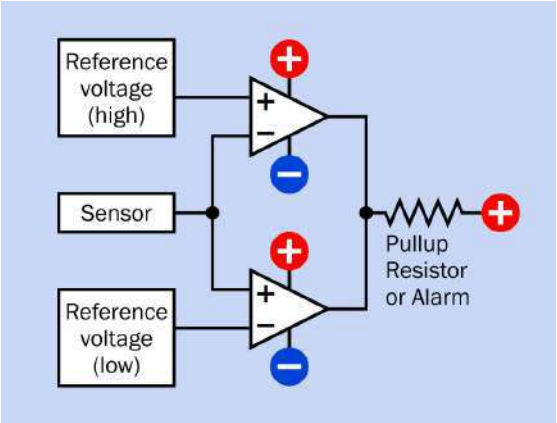

Figure 6-14. *A basic, simplified circuit for a window comparator. See text for details.*

A *continuous converter* changes its output promptly in response to a change in input. This requires continuous current consumption. Because many applications only need to check the output from a comparator at intervals, power can be saved by using a *clocked* or *latched* comparator.

What Can Go Wrong

Oscillating Output

The high input impedance of a comparator is vulnerable to stray electromagnetic fields. If the conductors leading to and from the comparator are relatively long, the output can couple capacitively with the input during voltage transitions, causing unwanted oscillations.

The commonly recommended solution to this problem is to add 1µF bypass capacitors to the power supply on either side of the comparator. However, some manufacturers recommend alternatives such as introducing just a small amount of hysteresis, or reducing the value of input resistors to below 10K.

If a chip contains multiple comparators, and one of them is unused, one of its input pins should be tied to the positive side of the voltage supply while the other should be tied to 0V ground, to eliminate the possibility of an oscillating output.

Confused Inputs

A comparator will function if its two inputs are swapped accidentally, but its high and low output states will be the inverse of what is expected. Also, if positive feedback is used, transposed inputs can create oscillations. Because the comparator symbol may appear in a schematic with the noninverting input either below or above the inverting input, the inputs are easily transposed by accident.

One way to remember which way the inputs should be connected is to use the mnemonic: "plus, high, positive." The *plus* input creates a *high* output when the input becomes *more positive* than the reference voltage on the other input. The opposite is less intuitively obvious: the *minus* input creates a *high* output when the input becomes *more negative* than the reference voltage on the other input.

Wrong Chip Type

Different comparators offer different outputs: open collector, open drain, and push-pull. While open collector and open drain function similarly, the pullup resistor value is likely to be different in each case. If a push-pull output is mistakenly connected as if it is open collector or open drain, it will not work correctly, if at all. Different types of comparators must be sorted and stored in clearly labeled bins.

Omitted Pullup Resistor

It is relatively easy to forget to include the pullup resistor on an open-collector output. In this case, when the transistor inside the comparator is in its nonconductive state, the output pin will be floating, with an indeterminate voltage that will create confusing or random results.

CMOS Issues

As usual when using CMOS chips, it is bad practice to allow unconnected, floating inputs. This is an issue where a chip contains multiple comparators, some of which are not being used. The solution recommended by some manufacturers is to tie one input of an unused comparator to the supply voltage, and the other input of the same comparator to ground.

Erratic Output

If positive feedback is insufficient, the comparator output may show signs of *jitter*. Conversely, if the positive feedback is excessive, the comparator may get stuck in an on state or an off state. Feedback must be chosen carefully.

Swapped Voltages

A comparator is often capable of controlling an output voltage that is much higher than that of its power supply. Because both voltages are applied to different pins on the same chip, mistakes can be made quite easily. The chip is likely to be damaged if the voltages are swapped accidentally between the relevant pins.

Heat-Dependent Hysteresis

Remember that the voltages at which the comparator turns on and off will vary slightly with the temperature of the component. This *drift* should be tested by running the comparator at higher temperatures.

op-amp

7

Although a comparator has the same schematic symbol as an **op-amp**, their applications differ and they are described in separate sections of this encyclopedia.

The unabbreviated name for an op-amp is an *operational amplifier*, but this term is seldom used.

OTHER RELATED COMPONENTS

- **comparator** (see Chapter 6)

What It Does

An op-amp is an *operational amplifier* consisting of multiple transistors packaged in an integrated circuit chip. It senses the fluctuating voltage difference between two inputs, uses power from an external supply to amplify that difference, and uses *negative feedback* to ensure that the output is an accurate replica of the input. Its amplification can be adjusted by changing the values of two external resistors.

Op-amps were developed originally using vacuum tubes, for use in analog computers, before the era of digital computing. Their implementation in integrated circuits dates from the late 1960s, when chips such as the LM741 were introduced (lower-noise versions of it still being widely used today). Multiple op-amps in a single package were introduced in the 1970s.

An LM741 is shown in Figure 7-1. Inside the 8-pin, DIP package is a single op-amp.

How It Works

In alternating current, voltages deviate above and below a zero value, which is sometimes referred to as the *neutral* value. This occurs in domestic power supplies and in audio signals, to name two very common examples. A *voltage amplifier* multiplies the positive and negative voltage excursions, using an external power source to achieve this. Most op-amps are voltage amplifiers.

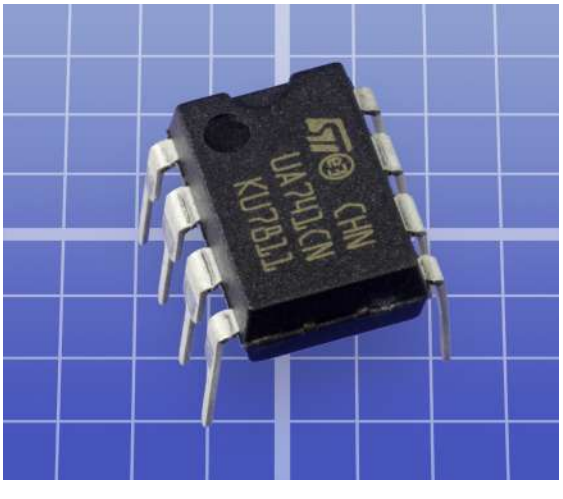

Figure 7-1. *The LM741, shown here, is still one of the most widely used op-amps.*

An ideal amplifier maintains a *linear relationship* between its input and its output, meaning that the output voltage values are a constant multiple of the input voltages over a wide range. This is

illustrated in Figure 7-2, where the lower curve is a duplicate of the upper curve, the only difference being that its amplitude is multiplied by a fixed amount (usually much greater than shown here). The ratio is properly known as the *gain* of the amplifier, usually represented with letter A (for amplification).

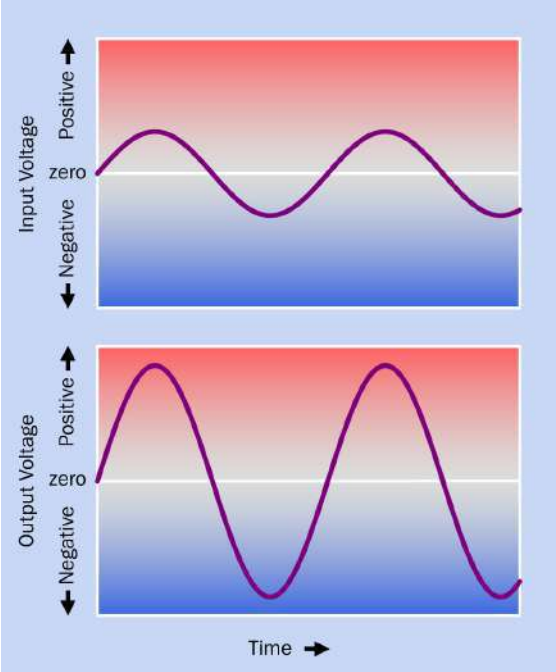

Figure 7-2. *In an ideal voltage amplifier, the output voltage will be a duplicate of the fluctuating input voltage, the only difference being that the amplitude of the output is multiplied by a fixed amount. This ratio is known as the gain of the amplifier.*

Figure 7-3 shows the triangular symbol for a generic single-input amplifier (not an op-amp). It may contain any number of components. The triangle almost always points from left to right, with its input on the left and its output on the right, and power attached above and below. This is often a *dual voltage* power supply, which is convenient for amplifying a signal that fluctuates above and below 0V. In some schematics, the power supply connections may not be shown, as they are assumed to exist.

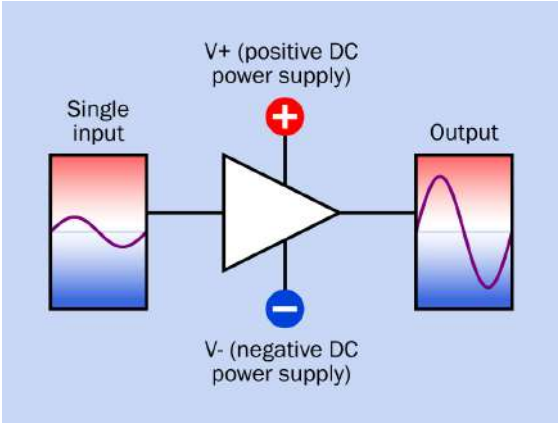

Figure 7-3. *The generic symbol for a single-input amplifier (not an op-amp), with the positive side of its power supply being equal and opposite in value to the negative side, and 0V being at the midpoint between them.*

- While the blue negative symbol is generally used throughout this encyclopedia to indicate 0V ground, it represents a voltage identified as V– in a dual voltage power supply, being equal in value but opposite in polarity to the positive side of the supply, V+. (Sometimes these voltages are indicated as V– and V+.)

The output from this imaginary generic amplifier is shown in the figure as a linear amplification of the input.

Dual Inputs

An op-amp has two inputs instead of one, and amplifies the voltage difference between them. Its symbol is shown in Figure 7-4. The upper input in this figure is held at 0V, midway between V+ and V–. Because the op-amp has so much gain, an accurate reproduction of its input would create an output exceeding the voltage of the power supply. Because this is not possible, the output tends to become saturated and consequently is *clipped* when it reaches its maximum value, as shown in the figure. The thumbnail graphs give only an approximate impression, as they are not drawn to the same scale.

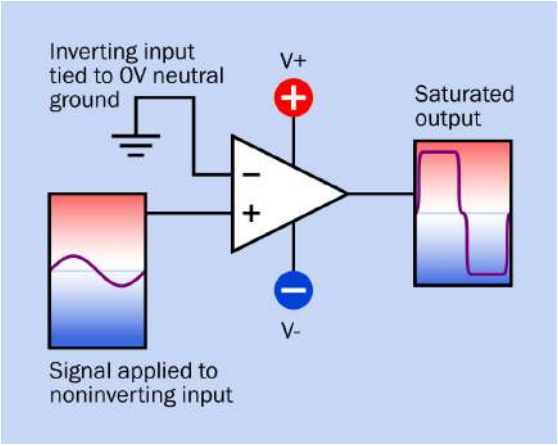

Figure 7-4. *An op-amp has so much gain, its output will tend to saturate, producing a square wave regardless of the shape of the input.*

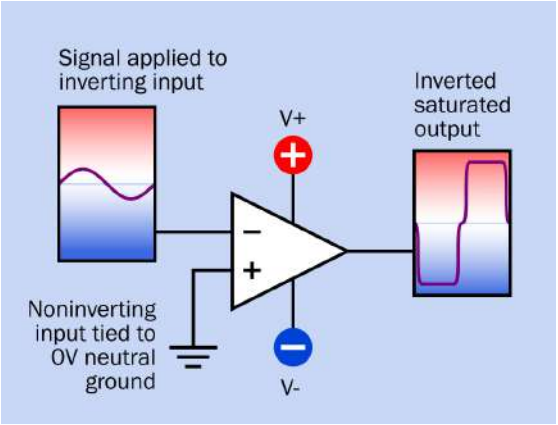

Figure 7-5. *When the incoming signal is applied to the inverting input of an op-amp while its noninverting input is held at 0V ground, the output is inverted.*

The small black plus and minus signs alongside the two inputs to the op-amp have nothing to do with the voltage supplied to the component. The "minus" input is properly referred to as the *inverting input* while the "plus" input is the *noninverting input*, in recognition of their functions.

The inputs are sometimes arranged with the minus above the plus, and sometimes with the plus above the minus. Schematics should be inspected carefully to note which arrangement is being used.

The positive and negative power connections to the op-amp may be omitted, but if shown, they always place V+ at the top, regardless of which way around the inputs are presented.

If a signal is applied to the noninverting input, while the inverting input is held at 0V ground, the op-amp provides an output in which the voltage is not inverted relative to the input.

If the input connections are swapped, so that the inverting input receives the incoming signal while the noninverting input is tied to 0V ground, the output from the op-amp is inverted (the gain remains the same). See Figure 7-5.

- An op-amp that is being used without any other components to moderate its output is functioning in *open loop* mode.

Negative Feedback

To create an output that is an accurate replica of the input, the op-amp must be brought under control with *negative feedback* to the input signal. This is illustrated in Figure 7-6. A resistor connects the output back to the inverting input, so that the input is automatically reduced to the point where the output is no longer saturated. The values of R1 and R2 will determine the gain of the op-amp, as explained in "How to Use It" on page 53. The op-amp is now functioning in its intended *closed loop* mode, meaning that the output is being tapped for feedback.

To obtain a linear output that is noninverted, connections are made as shown in Figure 7-7. The resistors form a voltage divider between the output and 0V ground, effectively increasing the comparison value on the inverting input.

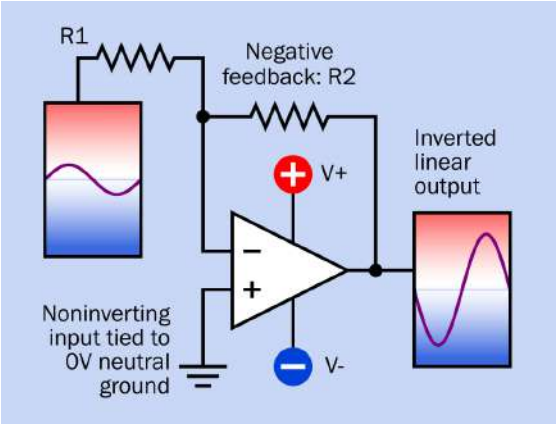

Figure 7-6. *A resistor applies negative feedback to the inverting input of an op-amp, and creates a linear output.*

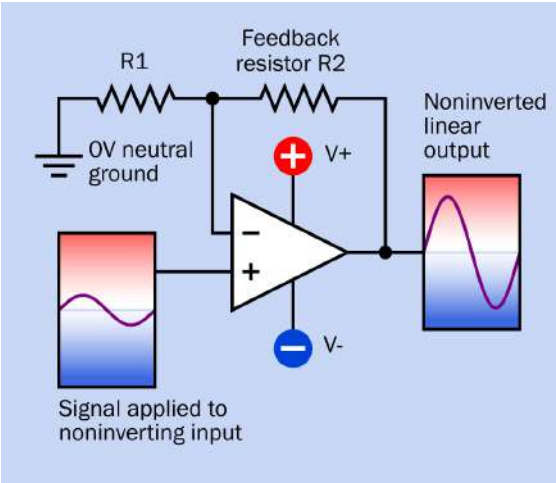

Figure 7-7. *Where the incoming signal is applied to the noninverting input, negative feedback is created by using a pair of resistors forming a voltage divider between the output and 0V ground.*

- Note that the gain of an op-amp is specific to a particular frequency range of AC signal. This is discussed in "How to Use It" on page 53.

Op-Amps and Comparators

A **comparator** can be regarded as a type of op-amp, and in fact an op-amp can be used as a comparator, comparing a variable DC voltage on one input with a reference voltage on another input. However, the two types of components have diverged in design to the point where they should be considered separately. The distinction is sufficiently important to have prompted Texas Instruments to issue an Application Report in 2001 titled "Op Amp and Comparators—Don't Confuse Them!".

Differences in function are summarized in the previous entry discussing comparators (see "Differences from an Op-Amp" on page 42).

Variants

Because op-amps are mostly low-current devices, they are widely available in very small surface-mount formats, in addition to the through-hole DIP packages which used to be more common.

Many chips are available containing two or more op-amps. This is often expressed as the number of *channels* in the component. A dual chip contains two op-amps, while a quad chip contains four op-amps. Usually all the op-amps in a chip share the same power supply. Bipolar or CMOS transistors may be used.

Because op-amps are widely available in dual and quad packages, it's quite common for a circuit designer to have one op-amp in a chip "left over." The designer may be tempted to use that spare unit as a comparator instead of installing an additional chip. To address this situation, some manufacturers offer hybrid op-amp chips containing an additional comparator. The Texas Instruments TLV2303 and TLV2304 are examples.

Values

The op-amps derived from 1970s designs often tolerate a wide range of power-supply voltages. Plus-or-minus 5VDC to plus-or-minus 15VDC is a common range. Modern op-amps are available that run from as little as 1VDC to as much as 1,000VDC.

Op-amps are available for frequencies ranging from 5KHz all the way up to 1GHz.

A "classic" op-amp such as the LM741, which is still widely used, will operate with a power supply ranging from plus-or-minus 5VDC to plus-or-minus 22VDC. Its output is rated for up to 25mA, and its input impedance is at least 2MΩ. The most current it will draw from an input is around 0.5µA.

V_{IO} is the *input offset voltage*. In an ideal component, the output from an op-amp should be 0V when its inputs have a voltage difference of 0V. In practice, the output will be 0V when the inputs differ by the offset voltage. V_{IO} is likely to be no greater than a couple of mV, and negative feedback can compensate for the offset.

V_{ICR} is the *common mode voltage range*. This is the range of input voltages that the op-amp will tolerate. This can never be more than the positive power supply voltage and will often be less, depending on the types of transistors that are used on the input side. If an input voltage goes outside the common mode voltage range, the op-amp will stop functioning.

V_{IDR} is the *input differential voltage range*—the maximum permissible difference between peak positive and peak negative input voltages. This is often expressed as plus-or-minus the power supply voltage, or slightly less. Exceeding the range can have destructive consequences.

I_B is the *input bias current*, averaged over the two inputs. Most op-amps have extremely high input impedance and consequently use very low input currents.

Slew rate at unity gain is the rate of change of the output voltage caused by an instantaneous change on the input side, when the output of the op-amp is connected directly back to the inverting input (during operation in noninverting mode).

How to Use It

In addition to being an amplifier for AC signals, an op-amp can serve as an oscillator, filter, signal conditioner, actuator driver, current source, and voltage source. Many applications require some understanding of the complexities of mathematics describing alternating current, which are not included this encyclopedia. Almost all the applications have a common starting point, however, which is to establish and control the gain of the feedback circuit.

Controlling the Gain

"A_{VOL} is the *open-loop voltage gain*, defined as the maximum voltage amplification that can be achieved when no feedback is applied from the output to an input. This remains constant until the AC frequency rises to a point known as the *breakover frequency*. If the frequency continues to rise, the maximum gain diminishes quite rapidly, until finally it terminates in 1:1 amplification at the *unity gain frequency*. This transition is shown by the orange line in Figure 7-8. The length of each purple line shows the frequencies which can be tolerated when the op-amp is used in closed-loop mode, and a negative feedback loop limits the gain. For example, where the gain is just 10:1, it can remain constant to just above 10KHz.

Note that both of the scales in this graph are logarithmic.

Calculating Amplification

So long as an op-amp is used within the boundaries of the graph, its voltage amplification can be controlled by choosing appropriate feedback and input resistors. If the op-amp is being used in noninverting mode, and R1 and R2 are placed as shown in Figure 7-7, the amplification ratio, A, is found approximately by the formula:

```
A = (approximately) 1 + (R2 / R1)
```

From this it can be seen that when R1 is very large compared with R2, the gain diminishes to near unity. If R1 becomes infinite and R2 is zero, the gain is exactly 1:1. This can be achieved by replacing R2 with a section of wire (theoretically of zero resistance) and omitting R1 entirely, as in Figure 7-9. In this configuration, the output from the op-amp should be identical with its input.

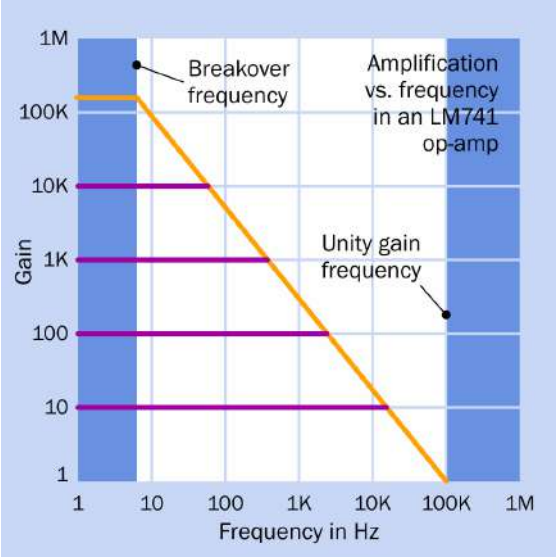

Figure 7-8. *Where each horizontal purple line meets the diagonal orange line, this is the maximum frequency that can be used without reduction in the maximum gain of an op-amp.*

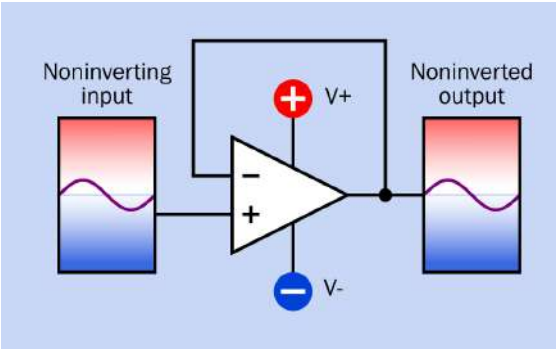

Figure 7-9. *While an op-amp is in noninverting mode, if the feedback resistor is replaced with a section of wire and the 0V ground connection is omitted entirely, the gain of the op-amp diminishes theoretically to 1:1.*

If the op-amp is being used in inverting mode, and R1 and R2 are placed as shown in Figure 7-6, then the voltage amplification ratio, A, is found approximately by the formula:

```
A = (approximately) -(R2 / R1)
```

- Note the minus sign. In inverting mode, gain is expressed as a negative number.
- In a practical circuit, at the expected frequency, the amplification factor established by choice of resistors should be no more than 20.
- An inverting circuit has a relatively low input impedance. For this reason, in most applications, a noninverting circuit is preferred.

Unintentional DC Voltage Amplification

Although the op-amp is intended primarily as an AC signal voltage amplifier, it will also amplify a DC difference between the voltages on its inputs. In the upper section of Figure 7-10, a positive DC offset is inverted and amplified to the point where the output is forced to its negative limit, and the signal is lost, because its fluctuations have been overwhelmed by the positive offset. A coupling capacitor (shown in the lower section of the figure) removes the DC voltage while passing the AC signal. The appropriate capacitor value will depend on the frequency of the signal.

Low-Pass Filter

An op-amp can facilitate a very simple low-pass audio filter, just by adding a capacitor to the basic inverting circuit previously shown in Figure 7-6. The filter schematic is shown in Figure 7-11. Capacitor C1 is chosen with a value that passes higher audio frequencies and blocks lower audio frequencies. Because the gain of the basic inverting circuit is approximately –(R2 / R1), the op-amp functions normally when the impedance of C1 is blocking the low frequencies, forcing them to pass through R2. Higher frequencies, however, are able to bypass R2 through C1, lowering the effective resistance of the feedback section of the circuit, thus reducing its gain. This way, the power of the op-amp is greatly reduced for higher frequencies compared with lower frequencies. A passive RC circuit could achieve the same effect, but would attenuate the signal, while the op-amp circuit boosts part of it.

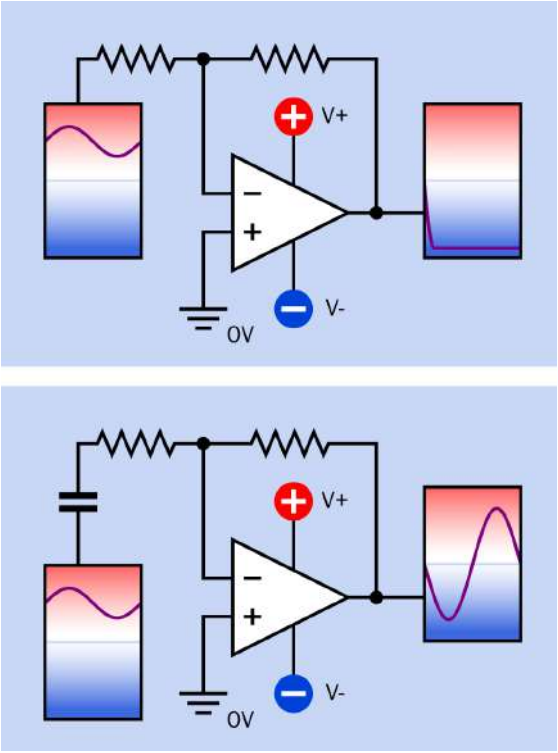

Figure 7-10. *The addition of a capacitor at the input of an op-amp is often necessary to prevent any DC voltage offset being amplified. In the upper section of this figure, a DC offset is large enough to force the inverted output to its negative limit, and the signal is completely lost.*

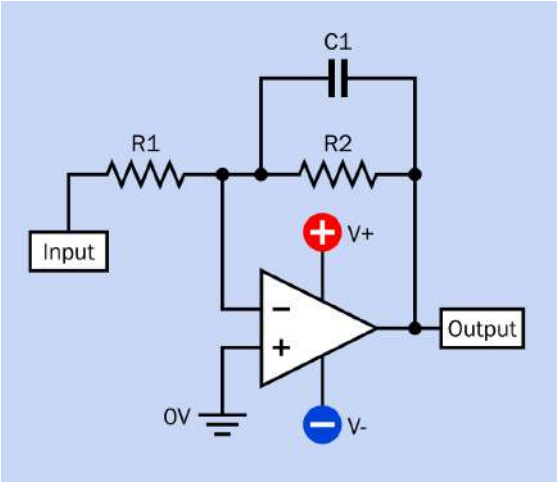

Figure 7-11. *A very basic low-pass filter, which works by allowing capacitor C1 to bypass resistor R2 at higher audio frequencies.*

High-Pass Filter

A simple high-pass filter can be created by adding a capacitor to the basic noninverting circuit previously shown in Figure 7-7. The filter schematic is shown in Figure 7-12. Once again capacitor C1 is chosen with a value that passes higher audio frequencies and blocks lower audio frequencies. Because the gain of the basic noninverting circuit is approximately 1 + (R2 / R1), the op-amp functions normally when the impedance of C1 is blocking the low frequencies, forcing them to pass through R1. Higher frequencies, however, are able to bypass R1 through C1, lowering the effective resistance of that section of the circuit, thus reducing the negative feedback and increasing the gain. This way, the power of the op-amp is increased for higher frequencies compared with lower frequencies. A passive RC circuit could achieve the same effect, but would attenuate the signal, while the op-amp circuit boosts part of it.

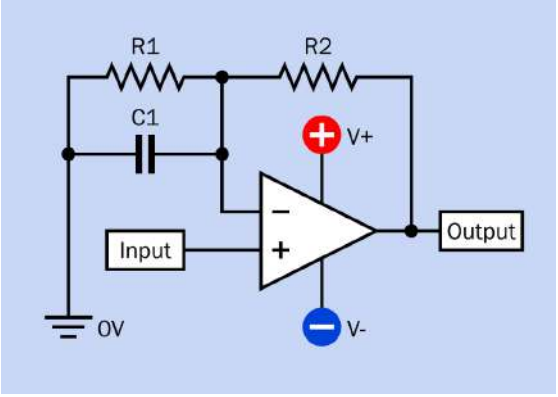

Figure 7-12. *A very basic high-pass filter, which works by allowing capacitor C1 to bypass resistor R1 at higher audio frequencies.*

Relaxation Oscillator

The schematic in Figure 7-13 is similar to the circuit shown in Figure 6-12 using a comparator. It functions as a *relaxation oscillator*, which is a form of *astable multivibrator*. The lower half of the circuit is a positive feedback loop that reinforces the output while the upper half of the circuit is charging the capacitor. Eventually the charge on the

capacitor exceeds the voltage on the noninverting input of the op-amp, creating negative feedback that exceeds the positive feedback. The capacitor discharges and the cycle repeats. The component values in the figure should generate an output that runs at around 2Hz. Reducing the value of the capacitor will increase the frequency.

Single Power Source

A few op-amps are designed to work from single voltages, but they are a relatively small minority, and will clip the output signal if the input goes negative. Power supplies are readily available that provide multiple voltages such as +15VDC, 0V, and -15VDC. They are ideal for driving an op-amp—but may not be useful for any other components in the circuit. Can an op-amp that is designed for dual voltages be made to run from a single supply, such as 30VDC?

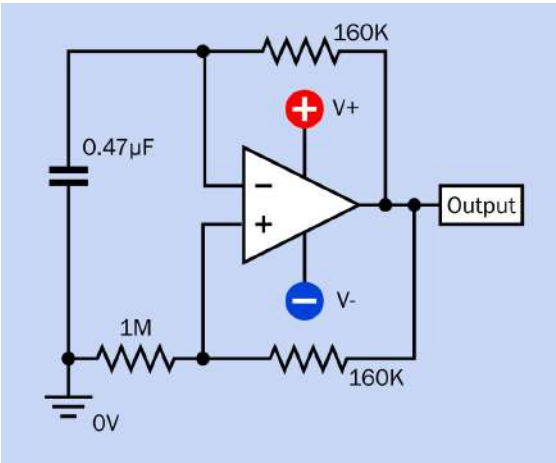

Figure 7-13. *A relaxation oscillator.*

This is relatively easy to do. The op-amp simply needs a potential difference to power its internal transistors, and 30VDC on the V+ pin with 0VDC on the V– pin will work just as well as +15VDC and -15VDC. However, referring back to Figure 7-6, if the op-amp is used in inverting mode, an intermediate voltage must be supplied to the noninverting input. Likewise, in noninverting mode, an intermediate voltage is necessary for one of the inputs, and must be half-way between the extremes of the power supply. If the supply is +15VDC and -15VDC, the midpoint is 0V. If the supply is 30VDC and 0V, the midpoint is 15VDC.

Because the inputs of an op-amp have a very high impedance and draw negligible current, the intermediate voltage can be provided with a simple voltage divider, as shown in Figure 7-14, where R3 and R4 should be no greater than 100K each. Their exact values are not important, so long as they are equal.

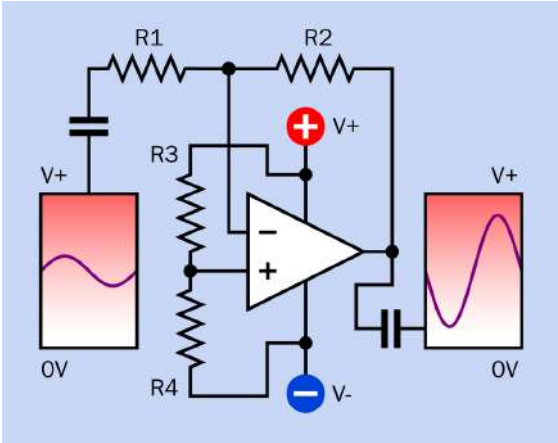

Figure 7-14. *A voltage divider, comprised of R3 and R4 in this schematic, can provide a voltage halfway between V+ and negative ground, enabling the op-amp to use just one power supply instead of two.*

A coupling capacitor should still be used on the input side, as shown, because there is no guarantee that the input signal will be centered precisely on 15V, and any offset will be amplified, potentially causing clipping of the signal. For similar reasons, a coupling capacitor is also added on the output side.

Offset Null Adjustment

Some op-amps provide two pins for *offset null adjustment*, which is a setup process to ensure that identical voltage on the two inputs will produce a null output. This is a way of compensating for any internal inconsistencies introduced during the manufacturing process.

To perform offset null adjustment, both input pins are connected directly to 0V ground, and the ends of a trimmer potentiometer (typically, 10K) are connected with the offset null pins, while the wiper of the potentiometer is centered and then connected with the negative power supply. The probes of a meter that is set to measure DC volts are placed between the output of the op-amp and 0V ground. The potentiometer is then adjusted until the meter shows a reading of 0VDC. A schematic is shown in Figure 7-15.

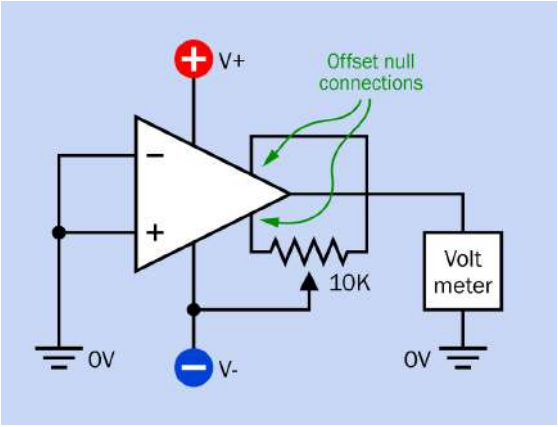

Figure 7-15. *Connections for making an offset null adjustment to an op-amp that allows this procedure.*

What Can Go Wrong

Power Supply Problems

Op-amps are especially vulnerable to reversed polarity in a power supply. If there is even a remote possibility of this occurring, a diode in series with one side of the supply can provide protection.

A more realistic concern is the destructive consequence of an input signal that exceeds the power supply voltage(s) of the op-amp. Even if the input is within the acceptable range, it can still cause permanent damage if it is applied before the op-amp powers up.

Bad Connection of Unused Sections

Multiple op-amps are often combined in a single package. If some of these "sections" remain unused, they will still receive power from the shared supply, and will attempt to function. If the inputs are left unconnected, they will pick up small stray voltages by capacitance or induction, and in the absence of negative feedback, the op-amp will create unpredictable outputs, consuming power and possibly interacting with other sections of the same chip. Figure 7-16 shows three incorrect options for addressing this problem, and one recommended option (derived from Texas Instruments Application Report SLOA067).

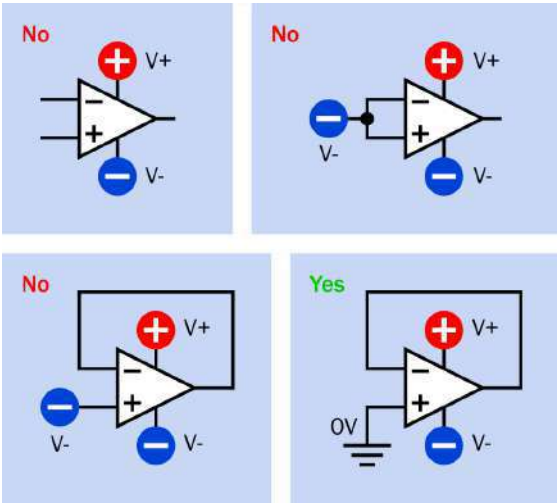

Figure 7-16. *When multiple op-amps share a chip, one that is unused will still receive power from the shared supply. Its inputs must not be allowed to float, and must be connected to minimize activity and power consumption. Three common errors are shown here, with one recommended option. Note the distinction between 0V ground (0V) and negative power (V–).*

Oscillating Output

The inputs of an op-amp are vulnerable to stray electromagnetic fields. If the conductors leading to and from the op-amp are relatively long, the output can couple capacitively with the input during voltage transitions, causing unwanted oscillations.

The commonly recommended solution to this problem is to add a 1µF bypass capacitor between the power supply and 0V ground. However, some manufacturers recommend alternatives such as introducing a very small amount of hysteresis, or reducing the value of input resistors to below 10K.

Confused Inputs

A schematic may show an op-amp with the noninverting input above the inverting input, or vice versa. The only indication of this will be the plus and minus signs inside the chip, which can be extremely small and easily overlooked. For convenience in drawing a diagram, two op-amps in the same circuit may have their inputs shown in opposite configurations. Special care must be taken to verify that the inverting and noninverting input pins on a chip are correctly assigned.

digital potentiometer

A **digital potentiometer** is also known as a *digitally adjustable potentiometer*, a *digitally controlled potentiometer*, a *digitally programmed potentiometer* (with acronym *DPP*), a *digpot*, or a *digipot*. The terms are functionally interchangeable. Because the abbreviation *pot* is often used to describe an analog potentiometer, some people refer to digital potentiometers colloquially as *digital pots*. In printed documentation, the letters in *pot* may be capitalized. Because it is an abbreviation, not an acronym, it is not capitalized here.

Because this component enables digital control of a variable voltage, it is a *mixed signal device*. It is classified here as an analog chip because it primarily emulates the function of an analog device. It may be thought of as a form of *digital-analog converter*, although this encyclopedia does not have a section devoted to that type of component or to *analog-digital converters*, as their application is relatively specialized.

OTHER RELATED COMPONENTS

- **potentiometer** (see Volume 1)

What It Does

This component is an integrated circuit chip that emulates the function of an analog **potentiometer**. It is often described as being *programmable*, meaning that its internal resistance can be changed via a control input.

Digital potentiometers are particularly suited for use in conjunction with a *microcontroller*, which can control the internal resistance of the component. Possible applications include adjustment of the pulse width of an oscillator or multistable multivibrator (e.g., using the Control pin of a 555 **timer** chip); adjustment of the gain in an **op-amp**; specification of voltage delivered by a *voltage regulator*; and adjustment of a *band-pass filter*.

A digital potentiometer in combination with a microcontroller may also be used in conjunction with a pair of external buttons or a rotational encoder, to adjust the gain of an audio amplifier and for similar applications.

Advantages

A digital potentiometer offers significant advantages over an analog potentiometer:

- Reliability. The digital component may be rated for as many as a million cycles (each storing the wiper position in an internal memory location). An analog component may be capable of just a few thousand adjustment cycles.
- Digital interface.
- Elimination of long signal paths or cable runs. The digital potentiometer can be placed close to other chips, whereas an analog potentiometer often has to be some distance away to enable control by the end user. Reduction in the length of signal paths can reduce capacitive effects, while elimina-

tion of cable runs will reduce manufacturing costs.

- Reduction in size and weight compared with a manual potentiometer.

A digital potentiometer also has some disadvantages:

- Its internal resistance is somewhat affected by temperature.
- It is not usually capable of passing significant current. Few chips can sink or source more than 20mA at the output, and 1mA is common. The output is primarily intended for connection with other solid-state components that have high impedance.
- Users may prefer the immediacy and tactile feel of a knob attached to an analog potentiometer, rather than a pair of buttons or a rotational encoder.

How It Works

A digital potentiometer changes the point at which a connection is made along a *ladder* of many fixed resistors connected in series inside the chip. Each end of the ladder, and each intersection between two adjacent resistors, is known as a *tap*. The pin that can connect with any of the taps is referred to as the *wiper*, because it emulates the function of a wiper in an analog potentiometer. In reality, a digital potentiometer does not contain a wiper or any other moving parts.

A fully featured digital potentiometer allows access to each end of the ladder through two pins that are often labeled "high" and "low," even though they are functionally interchangeable (except in the case of a component that simulates a logarithmic taper, as described later). The "low" end of the ladder is sometimes numbered 0. In this case, if there are *n* resistors, the "high" end of the ladder will be numbered *n*. Alternatively, if the "low" end of the ladder is numbered 1, and there are *n* resistors, the "high" end will be numbered *n+1*. This principle is illustrated in Figure 8-1.

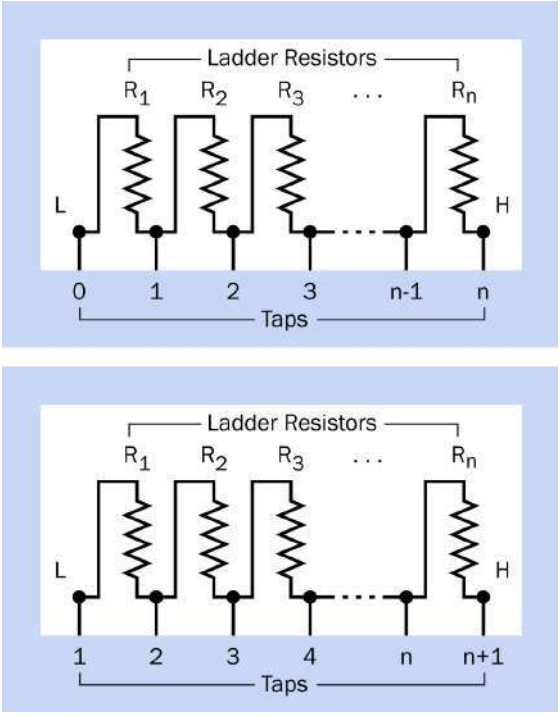

Figure 8-1. *Available wiper connections to a resistor ladder inside a digital potentiometer, showing two numbering systems that may be used.*

The "low" pin on a digital potentiometer may be identified as L, or A, or R_L, or P_A in a datasheet, while the "high" pin may be identified as H, or B, or R_H, or P_B and the pin that accesses the wiper is typically identified as W, or R_W, or P_W. Letters L, H, and W are used below. Although the L and H pins are functionally interchangeable, their labels are useful to identify which direction the W connection will move in response to an external signal.

Digital potentiometers are available with as few as 4 or as many as 1,024 taps, but common values are 32, 64, 128, or 256 taps, with 256 being the most common.

No specific schematic symbol represents a digital potentiometer. Often the component is shown as an analog potentiometer symbol inside a box that has a part number, as suggested in

Figure 8-2. Control pins and the power supply may be omitted if the schematic is just intended to show logical connections. Alternatively, if the digital potentiometer is depicted in a schematic where it is connected with other components such as a microcontroller, multiple pins and functions may be included, as shown in Figure 8-3. The pins additional to L, H, and W are explained below.

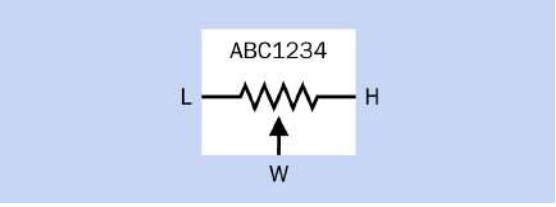

Figure 8-2. *There is no single specific symbol to represent a digital potentiometer. It may be shown using an analog potentiometer symbol in a box with a part number, as suggested here, where power connections and additional pins are omitted for clarity.*

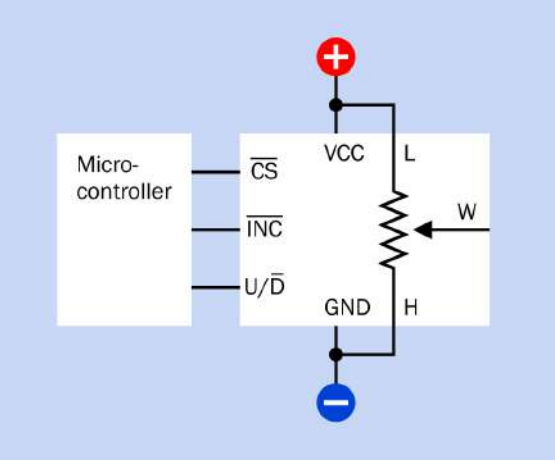

Figure 8-3. *If a digital potentiometer appears in a schematic where it is connected with other components such as a microcontroller, additional pins and functions may be indicated. This generic representation of a digital potentiometer shows some of the functions that can be included.*

Variants

A *dual* digital potentiometer contains two complete units, while a *quad* contains four. Triples exist but are relatively uncommon. A few chips contain six potentiometers. Multiple digital potentiometers in a chip can be used as the digital equivalent of *ganged* analog potentiometers, for simultaneous synchronized adjustment of multiple inputs in an audio system (two channels in a stereo amplifier, or more in a surround-sound system).

The pinouts of a sophisticated quad digital potentiometer chip are shown in Figure 8-4. Other quad chips have different pinouts and capabilities; there is no standardized format as there is with digital logic chips. In this example, the high/low states of Address 0 and Address 1 select one of the four internal resistor ladders, numbered 0 through 3. The Chip Select pin makes the whole chip either active or inactive. The Write Protect pin disables writing to the internal wiper memory. The Serial Clock pin inputs a reference pulse stream to which the serial input data must be synchronized. The Hold pin pauses the chip while data is being transmitted, allowing the data transmission to be resumed subsequently. The NC pins have no connection.

Volatile and Nonvolatile Memory

Any type of digital potentiometer requires memory to store its current wiper position, and this memory may be volatile or nonvolatile. Nonvolatile memory may be indicated in a datasheet by the term *NV*.

A digital potentiometer with volatile memory will typically reset its wiper to a center-tap position if power is disconnected and then restored. A digital potentiometer with nonvolatile memory will usually restore the most recently used wiper position, provided the chip is fully powered down and then fully powered up without glitches in the supply. If a microcontroller is being used to control the digital potentiometer, it can store the most recent resistance value in its own nonvolatile memory, in which case the type of memory in the potentiometer becomes irrelevant.

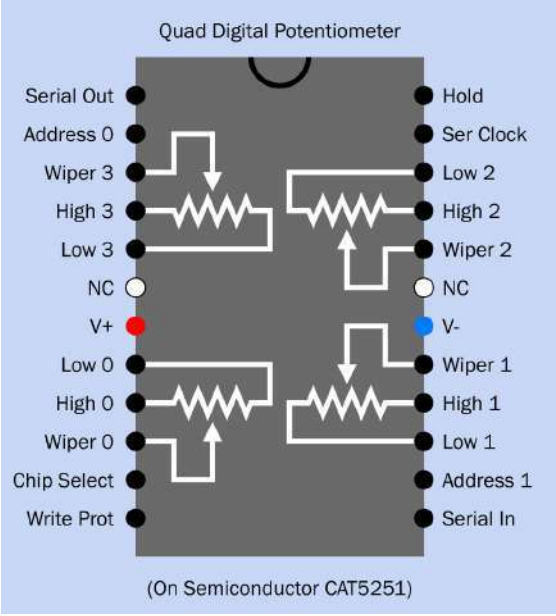

Figure 8-4. *Pinouts of a sophisticated quad digital potentiometer chip. Other chips will have different pinouts and capabilities. This example is available in surface-mount formats only. See text for details.*

Taper

Digital potentiometers are available with *linear taper* or *logarithmic taper*. In the former, each resistor in the ladder has the same value. In the latter, values are chosen so that the cumulative resistance between the wiper and the L end of the ladder increases geometrically as the wiper steps toward the H end of the ladder. This is useful in audio applications where sound intensity that increases exponentially may seem to increase linearly when perceived by the human ear.

A microcontroller can emulate logarithmic steps by skipping some taps in the ladder in a digital potentiometer, but this will result in fewer increments and lower precision.

Data Transfer

Digital potentiometers are mostly designed to use one of three serial protocols:

- *SPI*. This acronym is derived from *serial peripheral interface*, a term trademarked by Motorola but now used generically. The standard is adapted in various radically different ways among digital potentiometers.
- *I2C*. More correctly printed as *I²C* and properly pronounced "I squared C," this acronym is derived from the term *inter-integrated circuit*. Developed by Philips in the 1990s, it is a relatively slow-speed bus-communication protocol (up to 400kbps or 1Mbps in its basic form). It is built into some microcontrollers. The standard is more uniformly and rigorously defined than SPI.
- *Up/down*, also sometimes known as *push-button* or *increment/decrement* protocol.

Both SPI and I2C are supported by many microcontrollers, including the Atmel AVR at the heart of the Arduino.

These three systems for controlling a digital potentiometer are described in more detail in the following sections.

SPI

This is the most widely used protocol, but when reading datasheets, a lot of care must be taken to determine how it varies in each case.

The Microchip 4131-503, shown in Figure 8-5, uses SPI protocol. It contains 128 resistors and can be powered by 1.8VDC to 5.5VDC.

The one feature that all versions of SPI have in common is that a series of high/low pulses is interpreted by the chip as a set of bits whose value defines a tap point in the resistor ladder. In computer terminology, every tap point has an *address*. The incoming bits define the address, after which the status of an additional input pin can tell the chip to move the wiper to that location.

Typically, there will be a chip select pin, identified as CS; a serial data input pin, identified as SDA, SI, DIN, or a similar acronym; and a serial clock pin, identified as SCL, SCLK, or SCK, which must receive a stream of pulses to which the high/low data input pulses must be synchronized. In addition, the SPI protocol allows bidirectional (duplex) serial communication. Only a minority of

digital potentiometers make use of this capability, but where it exists, a serial data output pin may be labeled SDO. Alternatively, one pin may be multiplexed to enable both input and output, in which case it may be labeled SDI/SDO.

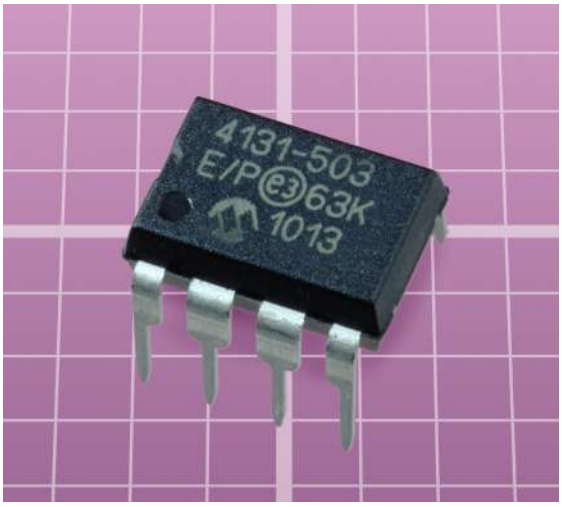

Figure 8-5. *This digital potentiometer uses SPI protocol. See text for details.*

If a pin is active-low, a bar (a horizontal line) will be printed above its acronym.

The most common type of digital potentiometer has 255 resistors and therefore 256 tap points, which have addresses numbered 0 through 255, each of which can be specified by a sequence of eight data bits constituting one byte. However, a different coding system will be applied in chips that have a different number of taps. In a 32-tap component, for instance, data is still sent in groups of eight bits, but only the first five bits define a *tap address*, while the remaining three are interpreted as commands to the chip.

Most 256-tap chips use an SPI protocol in which two eight-bit bytes are sent, the first being interpreted by the chip as a command, while the second specifies a tap address. Each manufacturer may use a different set of command codes, and these will vary among chips even from the same manufacturer.

Most commonly, three wires are used for data transmission and control (causing these chips to be described as *3-wire* programmable potentiometers).

CS is usually, but not always, pulled low to activate the digital potentiometer for input. A series of low or high states is then applied to the data-input pin. Each time the clock input changes state (usually on the rising edge of the clock pulse) the state of the data input is copied to a **shift register** inside the chip. After all the bits have been clocked in, CS can change from low to high, causing the contents of the shift register to be copied into a decoder section of the chip. The first bit received becomes the most significant bit in the decoder. The value of the eight bits is decoded, and the chip connects the W pin directly to the corresponding tap along the ladder of 255 internal resistors.

I2C Protocol

The I2C specification is controlled by NXP Semiconductors (formerly Philips), but can be used in commercial products without paying licensing fees. Only two transmission lines are required: one carrying a clock signal, the other allowing bidirectional data transfer synchronized with the clock (although many digital potentiometers use the I2C connection only to receive data). The pins are likely to be identified by the same acronyms as the pins on a chip that uses SPI protocol.

As in SPI, a command byte is followed by a data byte, although the command set differs from that of SPI and will also differ among various I2C chips. Full implementation of I2C allows multiple devices to share a single bus, but this capability may remain unused.

Up/Down Protocol

This simpler, asynchronous protocol does not require a clock input. The chip will respond to data pulses that are received at any speed (up to its maximum speed), and the pulse widths can be inconsistent.

Each pulse moves the wiper connection one step up or down the ladder. While this has the advantage of simplicity, the taps are not addressable, and consequently the wiper cannot skip to any tap without passing through intervening taps incrementally. This is not an inconvenience when the potentiometer controls audio gain, which is a primary application.

In some chips, an increment pin, usually labeled INC, receives pulses while the high or low state of a second pin, usually labeled U/D, determines whether each pulse will step the wiper up the ladder or down the ladder.

In other chips, pulses to an Up pin will step the wiper up the ladder, while pulses to a Down pin will step the wiper down the ladder.

Either of these chip designs can be referred to as a *two-wire* type. If an additional chip-select pin is included (labeled CS on datasheets), this type of digital potentiometer can be referred to as a *three-wire* type. The chip select pin is likely to be active-low, meaning that so long as it has a high state, the chip will ignore incoming signals.

The CAT5114 shown in Figure 8-6 uses an U/D pin. It contains 31 resistors, is available in 8-pin DIP or surface-mount formats, and can be powered by 2.5VDC to 6VDC. Each of its logic inputs draws only 10µA.

In six-pin chips the INC pin is omitted, one of the H, L, or W pins will be omitted, and the U/D pin will function differently. When CS is pulled low, the chip checks the state of the U/D pin. If it is high, the chip goes into increment mode; if it is low, the chip goes into decrement mode. So long as CS remains low, each transition of the U/D pin from low to high will either increment or decrement the wiper position, depending on the mode that was sensed initially. When CS goes high, further transitions on the U/D pin will be ignored until CS goes low again, at which point the procedure repeats.

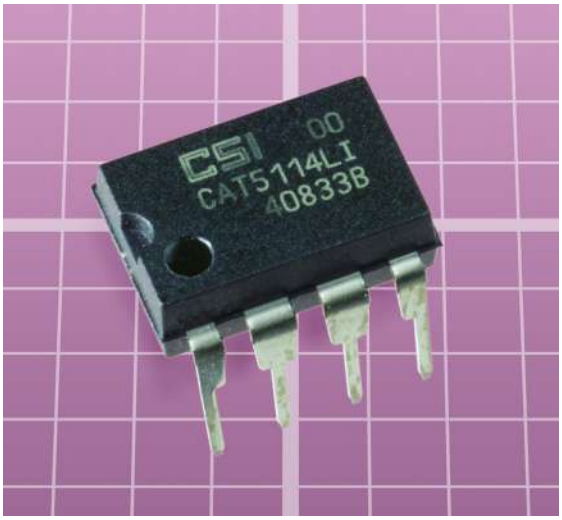

Figure 8-6. *This digital potentiometer contains 31 resistors and uses the simplest up/down protocol to step from one tap to the next.*

The chip does not provide any feedback regarding the position of its wiper, and consequently a control device such as a microcontroller cannot know the current wiper position. If the chip has nonvolatile memory (as is the case in many up/down digital potentiometers), it will resume its previous wiper location at power-up, but here again a control device will have difficulty determining what that position is. Therefore, in its basic form, an up/down chip is only appropriate for simple tasks, especially in response to up/down pushbuttons.

Other Control Systems

A few digital potentiometers use a parallel interface. Because they are relatively uncommon, they are not included here.

Connections and Modes

Some variants of digital potentiometers minimize the chip size and number of connections by limiting accessibility to the internal resistor ladder. In a chip designed to function in *rheostat mode*, the W pin is eliminated and the chip moves an internal connection point to change the resistance between the H and L pins.

In some variants, the low end of the ladder is permanently, internally connected with ground, and the L pin is omitted. In other variants, one end of the ladder is unconnected inside the chip.

A chip designed to function in *voltage divider mode* will include all three pins—H, L, and W—except in some instances where the low end of the ladder is grounded internally.

Variants are shown in Figures 8-7, 8-8, 8-9, and 8-10. Because some pins may be omitted, and there is no standardization of function among the pins that do exist, circuits and chips must be examined carefully prior to use.

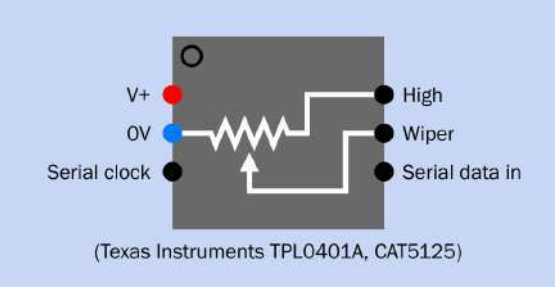

Figure 8-7. *Some digital potentiometers minimize chip size and provide specialized functionality by eliminating pins. In the variant shown here, the W pin provides a voltage between H and an internal ground connection. The chip is controlled via I2C serial protocol.*

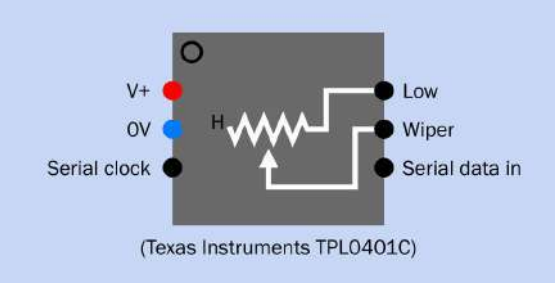

Figure 8-8. *In this variant, the H end of the internal resistor ladder is allowed to float inside the chip, and the digital potentiometer functions as a rheostat. The chip is controlled via I2C serial protocol.*

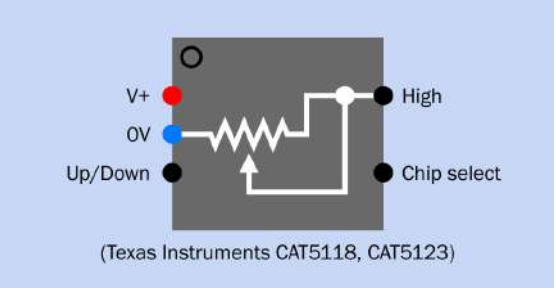

Figure 8-9. *This variant provides a variable resistance between the H pin and an internal connection with negative ground. Pin 5 is omitted. The chip is controlled by up/down pulses.*

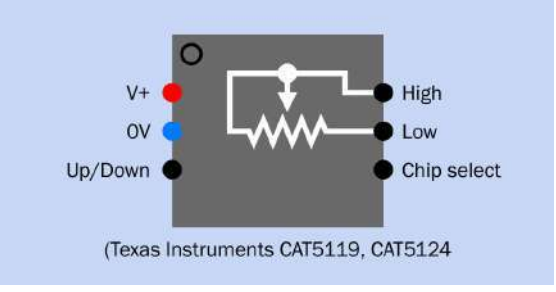

Figure 8-10. *This variant provides a variable resistance between H and L pins, without allowing either end of the resistor ladder to float. The W pin is omitted, as the wiper is tied internally to the H pin. The chips listed are controlled by up/down pulses.*

Values

A primary limitation of digital potentiometers is that they cannot withstand significant current. This may prevent them from being substituted for an analog potentiometer unless changes are made in the circuit. H, L, and W pins are usually unable to source or sink continuous, sustained current exceeding 20mA.

Wiper resistance is the resistance that is added internally by the wiper. This is nontrivial; it is often around 100Ω, and can be as high as 200Ω.

Typical end-to-end resistance of the ladder of internal resistors may range from 1K to 100K. Values of 1K, 10K, and 100K are common.

While the number of taps is likely to be a power of two in chips where the taps are addressable, up/down chips are not so constrained and may contain, for example, 100 taps.

The end-to-end resistance of a whole ladder may vary by as much as 20% from one sample of a chip to the next. Among resistor ladders in digital potentiometers sharing the same chip (i.e., in dual or quad chips) the variation will be much smaller.

Almost all digital potentiometers are designed for a supply voltage of 5V or less. The H and L pins are not sensitive to polarity, but the voltage applied to either of them must not exceed the supply voltage.

How to Use It

While most microcontrollers contain one or more analog-digital converters that change an analog *input* to an internal numeric value, a microcontroller cannot create an analog *output*. A digital potentiometer adds this functionality, although applications will be restricted by its limitation on current.

An up/down digital potentiometer can be controlled directly by a pair of **pushbuttons**, one of which will increase the resistance value while the other will reduce it. The pushbuttons must be *debounced* when used in this way. An alternative to pushbuttons is a **rotational encoder**, which emits a stream of pulses when its shaft is turned. In this case, an intermediate component (probably a microcontroller) will usually interpret the pulse stream and change it to a format that the digital potentiometer can understand.

Where a digital potentiometer is used in audio applications, it should be of the type that moves the wiper connection from one tap to another during a *zero crossing* of the audio signal (i.e., that is, at the moment when the AC input signal passes through 0V on its way from positive to negative or negative to positive). This suppresses the "click" that otherwise tends to occur during switching. Potentiometers with this feature may include phrases such as "glitch free" in their datasheets.

Digital potentiometers that are intended primarily for audio applications often have 32 taps spaced at intervals of 2dB. This will be sufficient to satisfy most listeners.

Achieving Higher Resolution

For sensitive applications where a resolution with more than 1,024 steps is required, multiple digital potentiometers with different step values can be combined. One way of doing this is shown in Figure 8-11. In this circuit, the wipers of P2 and P3 must be moved in identical steps, so that the total resistance between the positive power supply and negative ground remains constant. These two potentiometers could be contained in a dual chip, and would receive identical up/down commands. P1 is at the center of the voltage divider formed by P2 and P3, and is adjusted separately to "fine tune" the output voltage that is sensed at point A.

If all three of the potentiometers in this circuit contain 100 taps, a combined total of 10,000 resistance steps will be possible.

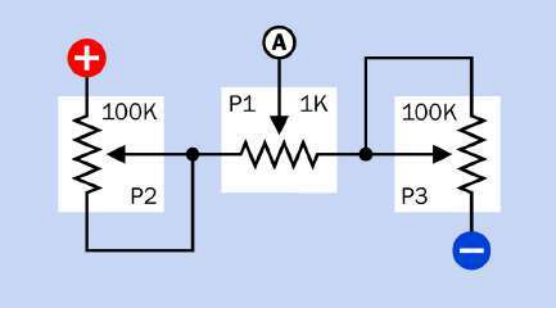

Figure 8-11. *If all three digital potentiometers in this schematic have 100 taps, and the wipers of P2 and P3 are moved in synchronization, the voltage measured at point A can have a high resolution of up to 10,000 steps.*

What Can Go Wrong

Noise and Bad Inputs

Because a digital potentiometer is capable of receiving data at speeds as high as 1MHz, it is sensitive to brief input or power fluctuations, and can misinterpret them as instructions to move the wiper—or can misinterpret them as command codes, in a component using SPI or I2C serial protocol.

To minimize noise in the power supply, some manufacturers recommend installing a 0.1µF capacitor as close as possible to the power supply pin of the component. In addition, it is obviously important to provide clean input signals. This means thorough debouncing of any electromechanical switch or pushbutton inputs.

Wrong Chip

The wide diversity of input protocols and pinouts creates many opportunities for installation error.

Up/down, SPI, and I2C protocol require totally different pulse streams. Many manufacturers offer components that are distinguished from each other by just one or two digits in their part numbers, yet have radically different functionality.

If more than one specific type of digital potentiometer may be used during circuit development, they should be stored carefully to avoid inadvertant substitutions. Using the wrong chip may be particularly confusing in that an inappropriate input protocol will still produce some results, although not those which were intended.

Controller and Chip Out of Sync

As noted in the discussion of data transmission protocols, most digital potentiometers are not capable of providing feedback to confirm the position of the internal wiper. A designer may wish to include a power-up routine which establishes the state of the digital potentiometer by resetting it to a known position, at one end of its scale or the other.

Nonlinear Effects

While the end-to-end resistance of the resistor ladder inside a digital potentiometer is not likely to be affected significantly by changes in temperature, the resistance at the wiper is more heat sensitive.

In an up/down chip, there can be differential errors between incremental and decremental modes. In other words, if a tap is reached by stepping up to it incrementally, the resistance between the W pin and H or L may not be quite the same as if the same tap is reached by stepping down to it decrementally. The difference may not be significant, but may be puzzling for those who are unfamiliar with this phenomenon.

Some differences may be found among resistors in a ladder. That is, in a supposedly linear digital potentiometer, each resistor may differ in value slightly from the next.

Data Transfer Too Fast

When using a microcontroller to send data to a digital potentiometer, a small delay may be necessary between pulses, depending on the microcontroller's clock speed. A digital potentiometer may require a minimum pulse duration of 500ns. Check the manufacturer's datasheet for details.

timer

A device that creates a single timed pulse, or a series of timed pulses with timed intervals between them, is properly known as a *multivibrator*, although the generic term **timer** has become much more common and is used here.

Three types of multivibrator exist: *astable*, *monostable*, and *bistable*. The behavior of *astable multivibrators* and *monostable multivibrators* is described in detail in this entry. A timer chip can also be made to function as a bistable multivibrator. This is described briefly below, but it is not a designed function of a timer. The primary discussion of bistable multivibrators will be found in the entry of this encyclopedia dealing with **flip-flops**.

OTHER RELATED COMPONENTS

- **flip-flop** (See Chapter 11)

What It Does

A *monostable* timer emits a single timed pulse of fixed length in response to a triggering input that is usually of shorter duration. Many monostable timers are also capable of running in *astable* mode, in which the timer spontaneously emits an ongoing stream of timed pulses with timed gaps between them. A dual-mode timer can run in either mode, determined either by external components attached to it, or (less commonly) by changing the status of a mode selection pin.

Monostable Mode

In monostable mode, the timer emits a pulse in response to a change from high to low voltage (or, less commonly, from low to high voltage) at a *trigger pin*. Most timers respond to a *voltage level* at the trigger pin, but some are insensitive to any persistent pin state and only respond to a *voltage transition*. This is known as *edge triggering*.

The pulse generated by the timer may consist of a change from low to high (or, less commonly, from high to low) at an output pin. The length of the pulse will be determined by external components, and is independent of the duration of the triggering event, although in some cases, an output pulse may be prolonged by *retriggering* the timer prematurely. This is discussed below.

At the end of the output pulse, the timer reverts to its quiescent state, and remains inactive until it is triggered again.

A monostable timer can control the duration of an event, such as the time for which a light remains on after it has been triggered by a motion sensor. Alternatively, the timer can impose a delay, such as the interval during which a paper towel dispenser refuses to respond after a towel has been dispensed. A timer can also be useful to generate a clean pulse in response to an unstable or noisy input, as from a manually operated pushbutton.

Astable Mode

In astable mode, a timer will generally trigger itself as soon as power is connected, without any need for an external stimulus. However, the output can be suppressed by applying an appropriate voltage to a *reset pin*.

External components will determine the duration of each pulse and the gap between it and the next pulse. The pulse stream can be slow enough to control the flashing of a turn signal in a 1980s automobile, or fast enough to control the bit rate in a data stream from a computer.

Modern timer circuits are often incorporated in chips that have other purposes. The flashing of a turn signal in a modern car, for instance, is now likely to be timed by a microcontroller that manages many other functions. Still, chips that are purely designed as timers remain widely used and are very commonly available in numerous through-hole and surface-mount formats.

How It Works

The duration of a single pulse in monostable mode, or the frequency of pulses in astable mode, is most commonly determined by an external *RC network* consisting of a resistor in series with a capacitor. The charging time of the capacitor is determined by its own size and by the value of the resistor. The discharge time will be determined in the same way. A **comparator** inside the timer is often used to detect when the potential on the capacitor reaches a *reference voltage* that is established by a voltage divider inside the chip.

Variants

The 555 Timer

An eight-pin integrated circuit manufactured by Signetics under part number 555 was the world's first fully functioned timer chip, introduced in 1972. It combined two comparators with a **flip-flop** (see Chapter 11) to enable great versatility while maintaining excellent stability over a wide range of supply voltages and operating temperatures. Subsequent timers have been heavily influenced by this design. A typical 555 timer chip is shown in Figure 9-1.

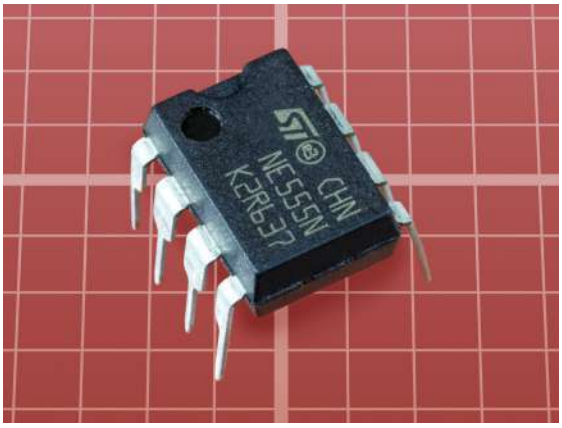

Figure 9-1. *A typical 555 timer chip. Functionally identical versions in which the "555" identifier is preceded or followed by different letter combinations are available from many different manufacturers.*

The 555 was designed by one individual, Hans Camenzind, working as an independent consultant for Signetics. According to a transcript of an interview with Camenzind maintained online at the Transistor Museum, "There was nothing like it at the time. You had to use quite a few discrete components—a comparator, a Zener diode or even two. It was not a simple circuit."

The 555 timer quickly became the most widely used chip in the world, and was still selling an annual estimated 1 billion units three decades after its introduction. It has been used in spacecraft, in intermittent windshield wiper controllers, in the early Apple II (to flash the cursor), and in children's toys. Like many chips of its era, its design was unprotected by patents, allowing it to be copied by numerous manufacturers.

The initial version was built around **bipolar transistors**, and consequently is referred to as the *bipolar version* or (more often) the *TTL version*, this being a reference to *transistor-transistor logic* protocol. Within a few years, CMOS versions based around **MOSFETs** were developed. They reduced the ability of the chip to sink or source

current at its output pin, but consumed far less power, making them better suited to battery-operated products. The CMOS versions were and still are pin-compatible with the original bipolar version, both in through-hole and surface-mount formats. Their timing parameters are usually the same.

555 Monostable Operation

The internal functionality of a 555 timer wired to run in monostable mode is illustrated in Figure 9-2 with the chip seen from above. The pins are identified in datasheets by the names shown. To assist in visualizing the behavior of the chip, this figure represents the internal flip-flop as a switch which can be moved by either of two internal comparators, or by an input from the Reset pin.

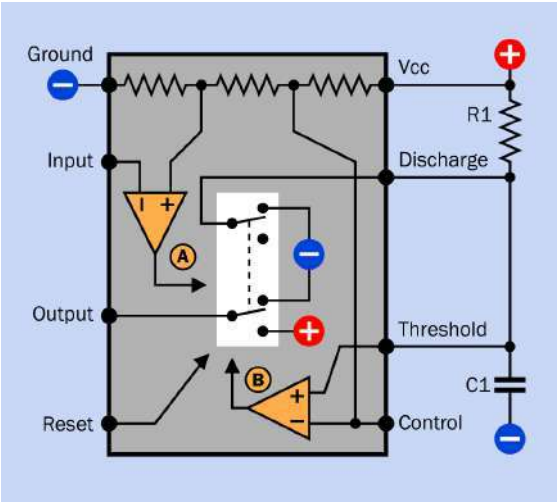

Figure 9-2. *The internal functions of a 555 chip, with its flip-flop represented as a switch that can be moved by either of two comparators, or by a low voltage on the Reset pin. An external resistor and capacitor, shown as R1 and C1, cause the timer to run in monostable (one-shot) mode, generating a single high pulse when the state of the Input pin is pulled from high to low.*

Inside the chip, three resistances of 5K each are connected between V+ (positive supply voltage) and negative ground. It has been suggested that the part number of the 555 chip was derived from these three 5K resistors, but Hans Camenzind has pointed out that Signetics was already using three-digit part numbers beginning with the number 5, and probably chose the 555 part number because the sales department had high expectations for the chip and wanted its number to be easily memorable. (A similar rationale explains the part number of the 2N2222 transistor.)

The resistances inside the timer function as a *voltage divider*, providing a reference of 1/3 of V+ to the noninverting pin of Comparator A and 2/3 of V+ to the inverting pin of Comparator B. (See Chapter 6 for an explanation of the functioning of comparators.)

When power is initially supplied to the timer, if the Input pin is at a high state, Comparator A has a low output, and the flip-flop remains in its "up" position, allowing the Output pin to remain in a low state. The flip-flop also grounds the lower end of R1, which prevents any charge from accumulating on capacitor C1.

If the state of the Input pin is pulled down externally to a voltage less than 1/3 of V+, Comparator A now creates a high output that changes the flip-flop to its "down" position, sending a high signal out through the Output pin. At the same time, C1 is no longer grounded, and begins to charge at a rate determined by its own size and by the value of R1. When the charge on the capacitor exceeds 2/3 of V+, it activates Comparator B, which forces the flip-flop into its "up" position. The Output pin goes low, C1 discharges itself into the Discharge pin, and the timer's cycle is at an end.

The low voltage on the Input pin of the timer must end before the end of the output cycle. If the voltage on the Input pin remains low, it will re-trigger the timer, prolonging the output pulse.

A pullup resistor may be used on the Input pin to avoid false triggering, especially if an external electromechanical **switch** or **pushbutton** is used to pull down the Input pin voltage.

The Reset pin should normally be held high, either by being connected directly to positive supply voltage (if the reset function will not be needed) or by using a pullup resistor. If the Reset pin is pulled low, this will always interrupt an output pulse regardless of the timer's current status.

If a voltage higher or lower than 2/3 of V+ is applied to the Control pin, this will change the reference voltage on Comparator B, which determines when the charging cycle of C1 ends and the discharge cycle begins. A lower reference voltage will shorten each output pulse by allowing a lower charge limit for C1. If the control voltage drops to 1/3 of V+ (or less), the capacitor will not charge at all, and the pulse length will diminish to zero. If the control voltage rises to become equal to V+, the capacitor will never quite reach that level, and the pulse length will become infinite. A workable range for the control voltage is therefore 40% to 90% of V+.

Because the Control pin is an input to the chip, it should be grounded through a 0.01µF ceramic capacitor if it will not be used. This is especially important in CMOS versions of the timer.

A defect of the bipolar 555 is that it creates a *voltage spike* when its Output pin changes state. If it will be sharing a circuit with sensitive components, a 0.01µF bypass capacitor should be added as closely as possible between the V+ pin and negative ground. The voltage-spike problem was largely resolved by the CMOS 555.

555 Astable Operation

In Figure 9-3, the 555 timer chip is shown with external components and connections to run it in astable mode. The pin names remain the same but have been omitted from this diagram because of limited space. The labeling of the two external resistors and capacitor as R1, R2, and C1 is universal in datasheets and manufacturers' documentation.

When the timer is powered up initially, capacitor C1 has not yet accumulated any charge. Consequently, the state of the Threshold pin is low. But the Threshold pin is connected externally with the Input pin, for astable operation. Consequently, the Input pin is low, which forces the flip-flop into its "down" state, creating a high output. This happens almost instantaneously.

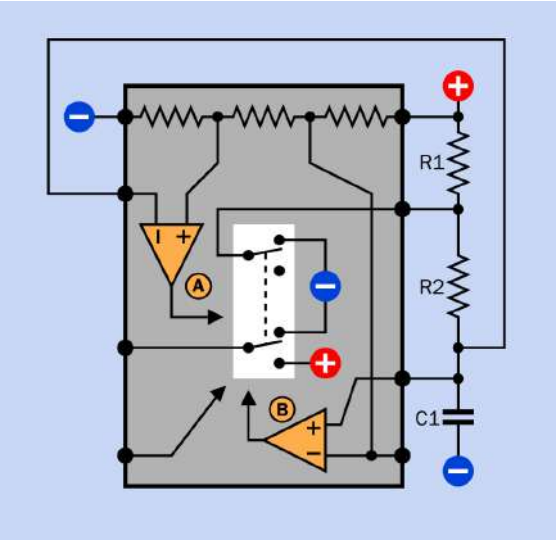

Figure 9-3. *The internal functions of a 555 chip, with two external resistors and a capacitor wired to run the timer in astable (free-running) mode.*

While the flip-flop is "down," the Discharge pin is not grounded, and current flowing through R1 and R2 begins to charge the capacitor. When the charge exceeds 2/3 of positive supply voltage, Comparator B forces the flip-flop into its "up" position. This ends the high pulse on the Output pin, and starts to drain the charge from the capacitor through R2, into the Discharge pin. However, the voltage on the capacitor is still being shared by the Input pin, and when it diminishes to 1/3 of V+, the Input pin reactivates Comparator A, starting the cycle over again.

The functions of the Reset and Control pins are the same as in monostable mode. Because voltage applied to the Control pin changes the length of each pulse and the gaps between pulses, it has the effect of adjusting the frequency of the output in astable mode.

When power is first connected to the timer, C1 must initially charge from an assumed state of zero potential to 2/3 V+. Because subsequent cycles will begin when the capacitor is at 1/3 V+, the first high output pulse from the timer will be slightly longer than subsequent output pulses. This is unimportant in most applications, especially because the rate at which a capacitor accumulates charge is greater when beginning from 0V than when it has reached 1/3 V+. Still, the longer initial pulse can be noticeable when the timer is running slowly.

Because the capacitor charges through R1 and R2 in series, but discharges only through R2, the length of each positive output pulse in astable mode is always greater than the gap between pulses. Two strategies have been used to overcome this limitation. See "Separate Control of High and Low Output Times" on page 80.

556 Timer

The 556 consists of two 555 bipolar-type timers in one package. An example of the chip is shown in Figure 9-4. The pinouts are shown in Figure 9-5. Although 556 timers have become relatively uncommon compared with the 555, they are still being manufactured in through-hole and surface-mount versions by companies such as Texas Instruments and STMicroelectronics, under part numbers such as NA556, NE556, SA556, and SE556 (with various letters or letter pairs appended). Each timer in the chip has its own set of inputs and outputs, but the timers share the same V+ and ground voltages.

558 Timer

This 16-pin chip is now uncommon, and many versions have become obsolete. It has been identified by a part number such as NE558 although different prefix letters may be used. The NTE926, shown in Figure 9-6, is actually a 558 timer.

The chip contains four 555 timers sharing a common power supply, common ground, and common control-pin input. For each internal timer, the Threshold and Discharge functions are connected internally, so that the timers can only be used in one-shot mode. However, one timer can trigger another at the end of its cycle, and the second timer can then retrigger the first, to create an astable effect.

Each timer is edge-triggered by a voltage transition (from high to low), instead of being sensitive to a voltage level, as is the case with a 555 timer. Consequently the timers in the 558 chip are insensitive to a constant (DC) voltage.

Figure 9-4. *An example of the 556 timer chip.*

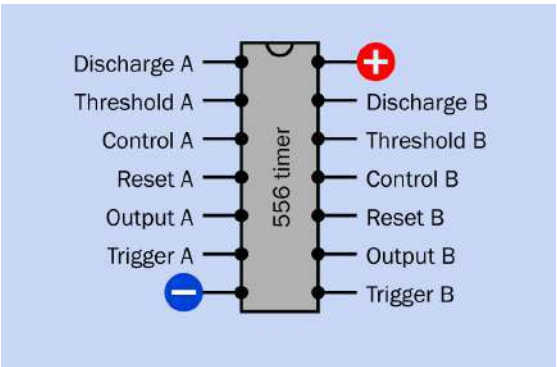

Figure 9-5. *The 556 timer contains two separate 555 timers sharing the same power supply and ground. The pin functions for timer A and timer B are shown here.*

The output from each timer is an open collector, and therefore requires an external pullup resistor. Each output is capable of sinking up to 100mA.

Figure 9-6. *The NTE926 is a 558 timer chip.*

CMOS 555 Timer

While the part numbers of many CMOS versions are significantly different from part numbers of the bipolar versions, in some instances the CMOS numbers are only distinguished by a couple of initial letters. The ST Microelectronics TS555 series and Texas Instruments TLC555 series, for example, use MOSFETs internally. The ST Microelectronics SE555 series and Texas Instruments SA555 series use bipolar transistors internally.

One way to distinguish between the two types, when searching a website maintained by a parts supplier, is to begin by looking generically for a "555 timer" and then add a search filter to show chips either with a minimum power supply of 3VDC (which will be CMOS) or with a minimum power suply of 4.5VDC (which will be bipolar).

CMOS versions of the 555 timer do not create the power spike that is characteristic of the bipolar versions during output transitions. The CMOS chips can also be powered by a lower voltage (3VDC, or 2VDC in some cases), and will draw significantly less current in their quiescent state. They also require very little current for threshold, trigger, and reset functions.

The wiring of external resistors and capacitors to the CMOS version of the chip, and the internal voltage levels as a fraction of V+, are identical to the original 555 timer. Pin functions are likewise identical. The only disadvantages of CMOS versions are their greater vulnerability to static discharge, and their lower output currents. The TLC555, for instance, will source only 15mA (although it can sink 10 times that amount). Other manufacturers have different specifications, and datasheets should be checked carefully.

5555 Timer

The 5555 contains a digital **counter** that enables it to time very long periods. Its full part number is 74HC5555 or 74HCT5555, although these numbers may be preceded or followed by letter combinations identifying the manufacturer. It is not pin-compatible with a 555 timer.

Two input pins are provided, one to trigger the timer on a rising edge, the other on a falling edge, of the input pulse. The inputs are Schmitt-triggered.

The timer is rated for 1Hz to 1MHz (using an external resistor and external capacitor). The counter section can divide the pulse frequency by values ranging from 2 to 256. For longer timed periods, different settings on the digital control pins will divide the frequency by values ranging from 2^{17} through 2^{24} (131,072 through 16,777,216). This enables the timer to achieve a theoretical pulse length lasting for more than 190 days. The timer will accept a clock input from an external oscillator to achieve better accuracy than is available with a resistor-capacitor timing circuit.

7555 Timer

This 8-pin chip is a CMOS version of the 555 timer, manufactured by companies such as Maxim Integrated Products and Advanced Linear Devices. Its characteristics are similar to those of CMOS 555 timers listed above, and the pinouts are the same.

7556 Timer

This 14-pin chip contains two 7555 timers, sharing common power supply and ground connec-

tions. Pinouts are the same as for the original 556 timer, as shown in Figure 9-5.

4047B Timer

This 14-pin CMOS chip was introduced in an effort to address some of the quirks of the 555 timer while also providing additional features. It runs in either monostable or astable mode, selectable by holding one input pin high or another input pin low. In astable mode, its duty cycle is fixed at approximately 50%, a single resistor being used for both charging and discharging the timing capacitor. An additional "oscillator" output runs twice as fast as the regular output.

In monostable mode, the 4047B can be triggered by a positive or negative transition (depending on which of two input pins is used). It ignores steady input states and will also ignore additional trigger pulses that occur during the output pulse. However, a retrigger pin is provided to extend the output pulse if desired.

Complementary output pins are provided, one being active-high while the other is active-low.

To time very long periods, the 4047B was designed to facilitate connection with an external counter.

The power supply for the 4047B can be as low as 3VDC. Its maximum source or sink output current is only 1mA when powered at 5VDC, but up to 6.8mA when powered at 15VDC.

The chip is still available from manufacturers such as Texas Instruments (which markets it as the CD4047B) in through-hole and surface-mount formats. However, despite its versatility, the 4047B is less popular than dual monostable timers, described in the next section.

Dual Monostable Timers

Various timers that run only in monostable mode are available in dual format (i.e., two timers in one chip). This format became popular partly because two monostable timers can trigger each other to create an astable output, in which the pulse width, and the gap between pulses, can be set by a separate resistor-capacitor pair on each timer. This allows greater flexibility than is available when using a 555 timer.

Most dual monostable timer chips are edge-triggered by a change in input voltage, and will ignore a steady DC voltage. Consequently, the output from one timer can be connected directly to the input of another, and no coupling capacitors are necessary.

As in the 4047B, the user has a choice of two input pins for each timer, one triggered by a transition from low to high, the other triggered by a transition from high to low. Similarly, each timer has two outputs, one shifting from low to high at the start of the output cycle, the other shifting from high to low.

The values of a single resistor and capacitor determine the pulse duration of each timer.

Dual monostable timers often have the numeric sequence 4528 or 4538 in their part numbers. Examples include the HEF4528B from NXP, the M74HC4538 from STMicroelectronics, and the MC14538B from On Semiconductor. The 74123 numeric sequence identifies chips that have a very similar specification, with chip-family identifiers such as HC or LS inserted, as in the 74HC123 and 74LS123, and additional letters added as prefix or suffix. The pinouts of almost all these chips are identical, as shown in Figure 9-7. However, Texas Instruments uses its own numbering system, and datasheets should always be consulted for verification before any connections are made.

Many chips of this type are described as "retriggerable," meaning that if an additional trigger pulse is applied to the input before an output pulse has ended, the current output pulse will be extended in duration. Check datasheets carefully to determine whether a chip is "retriggerable" or will ignore new inputs during the output pulse.

The 74HC221 dual monostable vibrator (pictured in Figure 9-8) functions very similarly to the

components cited above, but has slightly different pinouts.

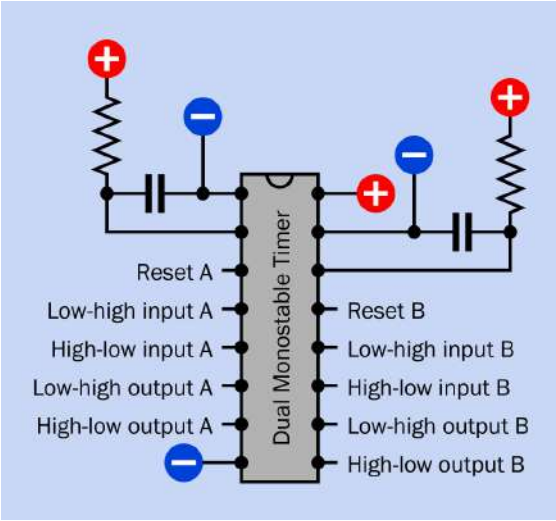

Figure 9-7. *Pin functions for most 4528, 4538, and 74123 series of dual monostable timer chips. An RC network is shown connected for each timer. Note that Texas Instruments uses different pinouts on its versions.*

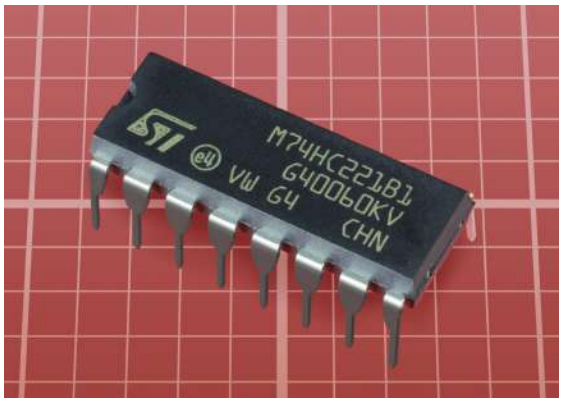

Figure 9-8. *A dual-timer chip containing two monostable multivibrators that can function in astable mode if they are connected externally to trigger each other.*

Values

555 Timer Values

The original bipolar version of the 555 timer was designed to operate using a wide range of positive supply voltages, from 4.5VDC to 16VDC. CMOS versions vary in their recommended V+ values, and datasheets must be consulted for verification.

The output of a bipolar 555 is rated to source or sink up to 200mA. In practice, the maximum current will be lower when the timer is powered at the low end of its range, around 5VDC. Attempting to source more than 50mA will pull down the voltage internally, affecting operation of the timer.

CMOS versions all impose restrictions on output current, allowing higher values for sinking than sourcing. Again, datasheets must be consulted for the values, which vary widely from one component to another.

The voltage measured on the output pin, when it is used for sourcing current, will always be lower than the power supply voltage, and a 1.7V drop is commonly specified for bipolar versions. In practice, the voltage drop that is actually measured may be less, and will vary according to the load on the output.

The voltage drop does not increase significantly with a higher supply voltage, and because it is a relatively constant value, it becomes less significant when a higher value for V+ is used.

CMOS versions of the 555 timer achieve a claimed output source voltage that is only 0.2V less than the power supply.

When choosing values for R1 and R2, a minimum for each resistor is 5K, although 10K is preferred. Lower values will increase power consumption, and may also allow overload of the internal electronics when the chip sinks current from C1. A typical maximum value for each resistor is 10M.

A high-value capacitor may cause the timer to function less accurately and predictably, because large capacitors generally allow more *leakage*. This means that the capacitor will be losing charge at the same time that it is being charged through R1 + R2. If these resistors have high values, and the capacitor has a value of 100µF or more, the rate of charge may be so low that it is

comparable with the rate of leakage. For this reason, a 555 timer is not a good choice for timing intervals much greater than a minute. If a large-value capacitor is used, tantalum is preferable to electrolytic.

The minimum practical value for a timing capacitor is around 100pF. Below this, performance may not be reliable.

Although some CMOS versions may enable fast switching, the shortest practical output pulse for a 555 timer is around 10 microseconds. On the input pin, a triggering pulse of at least 1 microsecond should be used.

Time Calculation in Monostable Mode

If R1 is measured in kilohms and C1 is measured in microfarads, the pulse duration, T, in seconds, of a 555 timer running in monostable mode can be found from this simple formula:

```
T = 0.0011 * R1 * C1
```

This relationship is the same in all versions of the 555. Figure 9-9 provides a quick and convenient way to find the pulse value using some common values for R1 and C1. Resistors can be obtained with tolerances below plus-or-minus 1%, but capacitors are often rated with an accuracy of only plus-or-minus 20%. This will limit the accuracy of the pulse values shown in the chart.

Time Calculation in Astable Mode

If R1 and R2 are measured in kilohms and C1 is measured in microfarads, the frequency of pulses, F (measured in Hz) of a 555 timer running in astable mode can be found from this simple formula:

```
F = 1440 / ( ( R1 + (2 * R2) ) * C1)
```

This relationship is found in all versions of the 555. Figure 9-10 shows the frequency for common values of R2 and C1, assuming that the value of R1 is 10K. In Figure 9-11, a value of 100K is assumed for R1.

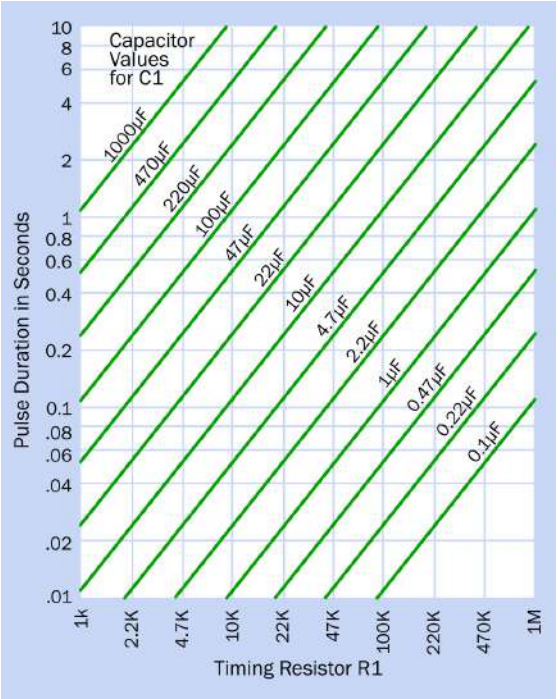

Figure 9-9. *To determine the pulse duration of a 555 timer running in monostable mode: find the value of R1 on the horizontal scale, follow its vertical grid line upward to the intersection with a green line which corresponds with the value of capacitor C1, and read across to the vertical scale providing the duration in seconds. Both axes are logarithmic.*

Dual Monostable Timers

Dual chips such as the HEF4528B from NXP, the M74HC4538 from STMicroelectronics, the MC14538B from On Semiconductor, and the 74HC123 from Texas Instruments have widely varying requirements for power supply. Some accept a limited range from 3VDC to 6VDC, while others tolerate a range of 3VDC to 20VDC. When powered with 5VDC their required input and output states are compatible with those of 5V logic chips.

Output pins of these chips source and sink no more than 25mA (much less in some instances). Because there are so many variants, they cannot be summarized here, and datasheets must be consulted for details.

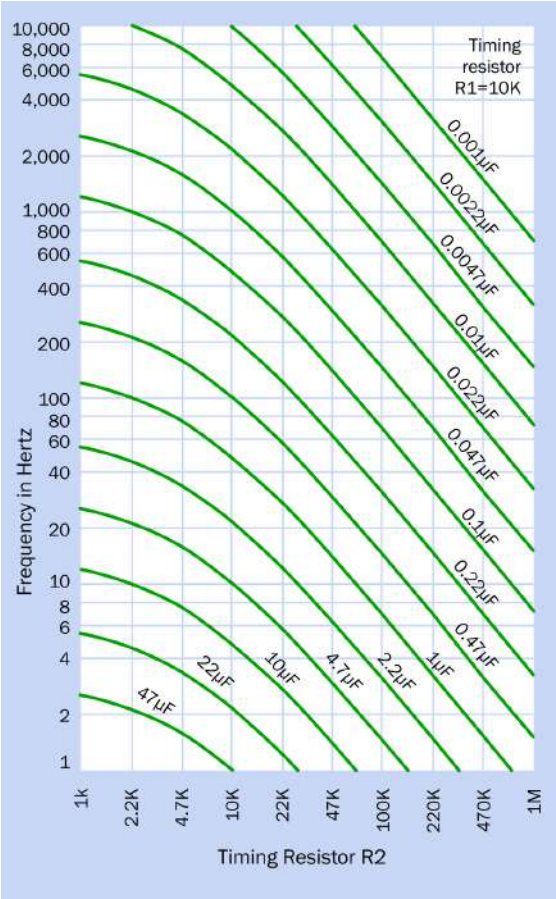

Figure 9-10. *To obtain the frequency of a 555 timer running in astable mode, when R1 has a value of 10K: find the value of R2 on the horizontal scale, follow its vertical grid line upward to the intersection with a green curve which corresponds with the value of capacitor C1, and read across to the vertical scale providing the frequency in Hertz. Both axes are logarithmic.*

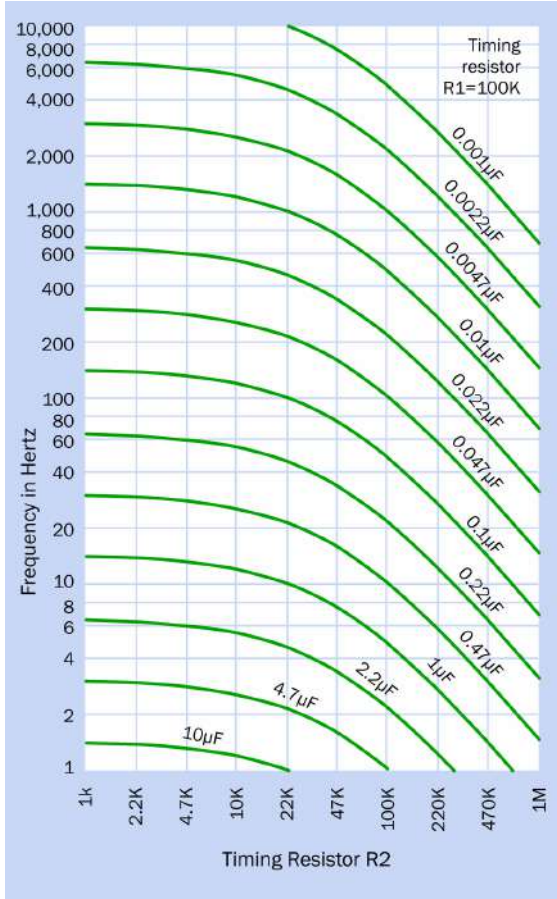

Figure 9-11. *To obtain the frequency of a 555 timer running in astable mode, when R1 has a value of 100K: find the value of R2 on the horizontal scale, follow its vertical grid line upward to the intersection with a green curve which corresponds with the value of capacitor C1, and read across to the vertical scale providing the frequency in Hertz. Both axes are logarithmic.*

As these timers are all monostable, and each timer uses just one resistor and one capacitor, the only formula required is to give the pulse time as a function of these two variables. If R is the resistor value in ohms, and F is the capacitor value in farads, and K is a constant supplied by the manufacturer, the pulse time T, in seconds, is found from the formula:

$$T = R * F * K$$

K ranges between 0.3 and 0.7 depending on the manufacturer and also on the voltage being used. Its value should be found in the manufacturer's datasheet. If R is measured in megohms and F is measured in microfarads, the formula is still valid, as the multipliers cancel each other out.

Generally speaking, these dual monostable CMOS timers are not intended for pulse duration exceeding 1 minute.

The timing capacitor should be no larger than 10µF, as it discharges directly and rapidly through the chip.

How to Use It

Where a timer is required to drive a load such as a relay coil or small motor directly, the original TTL version of the 555 timer will be the only choice. Even in this instance, a protection diode must be used across the inductive device.

For smaller loads and applications in chip-to-chip circuits, CMOS versions of the 555, including the 7555, use less power, cause less electrical interference, and are pin-compatible while using the same formulae to calculate frequency in astable mode or pulse duration in monostable mode. They are of course more vulnerable to static discharge, and care must be taken to make a connection to every pin (the capacitor that grounds the Control pin, if Control is not going to be used, is mandatory).

In dual monostable timers, unused rising-edge trigger inputs should be tied to V+ while unused falling-edge trigger inputs should be tied to ground. A Reset pin that will not be used should be tied to V+, unless that entire timer section of the chip will be unused, in which case the pin should be grounded.

To measure durations longer than a few minutes, a timer which incorporates a programmable counter to divide the clock frequency is the sensible choice. See the description of the 5555 timer that was included earlier in this entry.

The original bipolar version of the 555 remains a robust choice in hobby applications such as robotics, and its design allows some versatile variations which may even be used in logic circuits. A variety of configurations are shown in the schematics below.

555 Monostable Mode

The basic schematic for a 555 timer running in monostable mode is shown in Figure 9-12. In this particular example, a pushbutton that is liable to suffer from *switch bounce* is connected to the Input pin of the timer, which responds to the very first connection made by the pushbutton and ignores the subsequent "bounces," thus producing a "clean" output. To avoid retriggering, which results in a prolonged output pulse, the timer's output should exceed the time for which the button is likely to be pressed. The output should also exceed the duration of any possible switch bounce, which can otherwise create multiple output pulses. In the schematic, an LED is attached to the timer output for demonstration purposes.

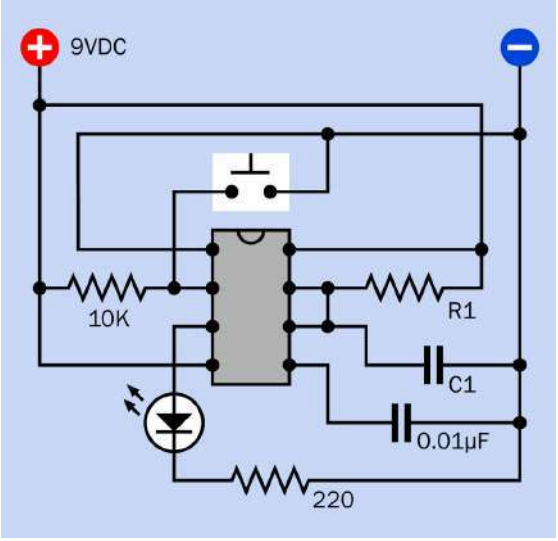

Figure 9-12. *The basic monostable configuration of a 555 timer. This particular circuit debounces an input from a pushbutton switch and converts it to a clean pulse of fixed duration, powering an LED for demonstration purposes.*

This circuit is shown on a breadboard in Figure 9-13. The red and blue wires, at the top of the photograph, supply 9VDC to the board. R1 is 1M, while C1 is 1µF, creating a pulse of just over 1 second. A tactile switch, just above the timer, provides the input.

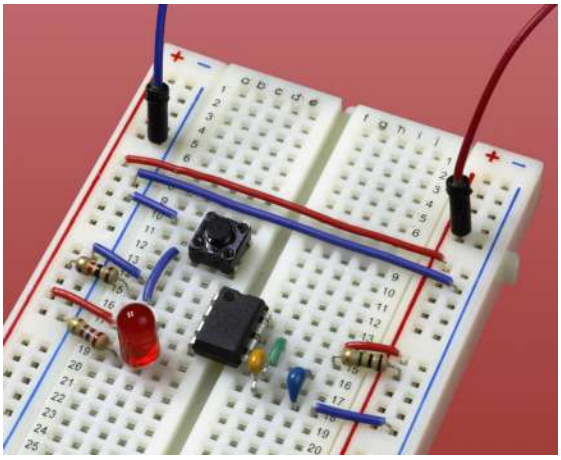

Figure 9-13. *The basic monostable configuration for a 555 timer, mounted on a breadboard.*

555 Astable Mode

A basic schematic for a 555 timer running in astable mode is shown in Figure 9-14. Once again, an LED is attached to the output for demonstration purposes. If the pulse rate exceeds the persistence of vision, a small loudspeaker can be used instead, in series with a 47Ω resistor and a 100µF capacitor.

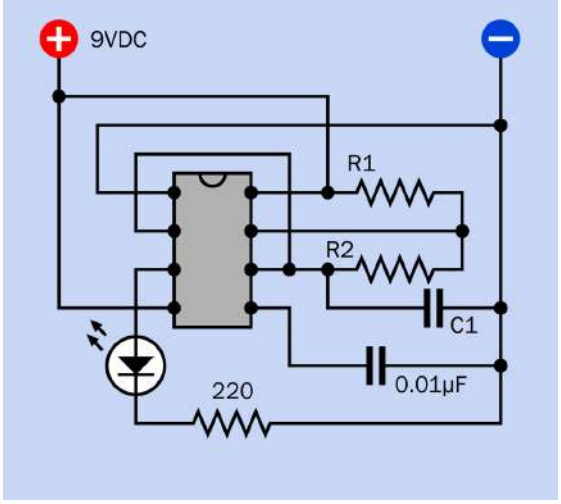

Figure 9-14. *A 555 timer with external connections and components causing it to run in astable (free-running) mode.*

Separate Control of High and Low Output Times

In Figure 9-15, a bypass diode has been added around R2. The capacitor now charges primarily through R1, as the diode has a much lower effective resistance than R2. It discharges only through R2, as the diode blocks current in that direction. Consequently, the length of the high output pulse can be adjusted with the value of R1 only, while the length of the low output pulse can be adjusted with the value of R2 only. The duration of the high output can be lower than, or equal to, the duration of the low output, which is not possible with the basic configuration of components in Figure 9-14.

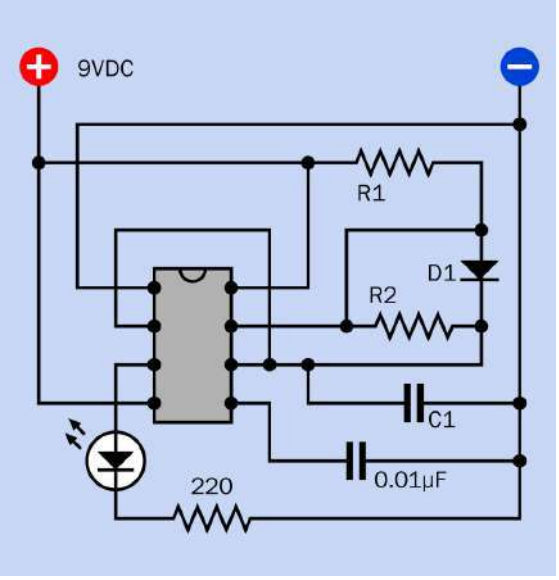

Figure 9-15. *In this circuit, a diode bypasses R2, so that the "on" time and the "off" time of the 555 timer can be set independently of each other, with R1 and R2, respectively.*

555 Fifty Percent Astable Duty Cycle: 1

In Figure 9-16, the circuit enables a fixed astable output duration of approximately 50% high and 50% low. Initially, C1 has no charge, pulling the Input of the timer low, and causing it to begin a cycle with a high pulse from the Output pin, as

usual. In this demonstration circuit, the output illuminates an LED. At the same time, resistor R1 is attached to the output and charges C1. When the voltage on C1 reaches 2/3 of V+, this is communicated to the timer Input pin, which ends the "high" cycle and initiates low status on the Output pin. This starts to sink the charge from C1, through R1. When the voltage drops to 1/3 V+, this initiates a new cycle. Because only one resistor is used to charge and discharge the capacitor, we may imagine that the charge and discharge times should be identical. However, a higher load on the output will probably pull down the output voltage to some extent, lengthening the charge time. Conversely, a load on the Output pin that has low resistance will probably sink at least some of the charge from the capacitor, shortening the discharge cycle.

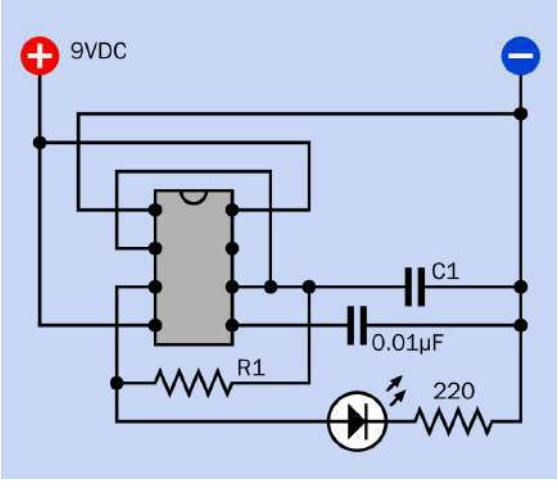

Figure 9-16. *This configuration provides an approximate 50-50 on-off duty cycle at the output pin, although the precise duration will depend on the load.*

555 Fifty Percent Astable Duty Cycle: 2

In Figure 9-17, a small modification of the basic astable circuit shown in Figure 9-14 provides another way to enable a 50% duty cycle. Compare the two schematics, and you will see that just the connection between R1 and R2 has been altered so that C1 now charges only through R1, and discharges only through R2. However, in this configuration the capacitor is discharging into a voltage divider created by the two resistors. Empirical adjustment of the resistor values may be necessary before the duty cycle is precisely 50%.

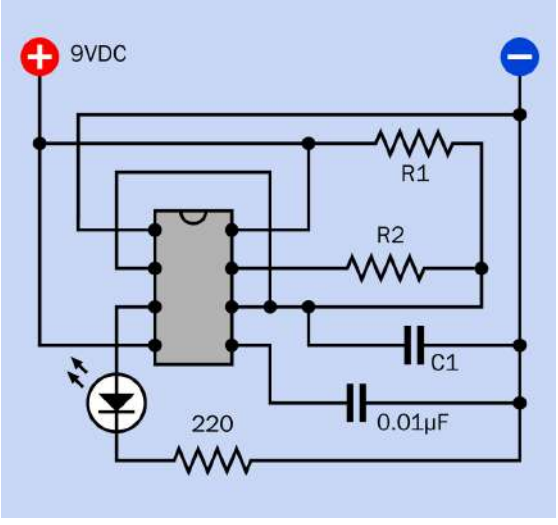

Figure 9-17. *An alternative configuration to provide an approximate 50-50 on-off duty cycle in a 555 timer.*

Use of the 555 Control Pin

In Figure 9-18, a potentiometer and two series resistors allow a varying voltage to be applied to the Control Pin. This will lengthen or reduce both the charge and the discharge times of the timing capacitor. If values for the capacitor and its associated resistors are chosen to create a frequency of approximately 700Hz, a 10K potentiometer should demonstrate more than an octave of audible tones through the loudspeaker. Other components can be substituted for a potentiometer, creating possibilities for producing pulse-width modulation. Alternatively, if a large capacitor is added between the Control pin and ground while a second 555 timer, running slowly in astable mode, applies its output to the Control pin, the charging and discharging of the capacitor will apply a smoothly rising and falling voltage. If the first 555 timer is running at an audio frequency, the output will have a "wailing siren" effect.

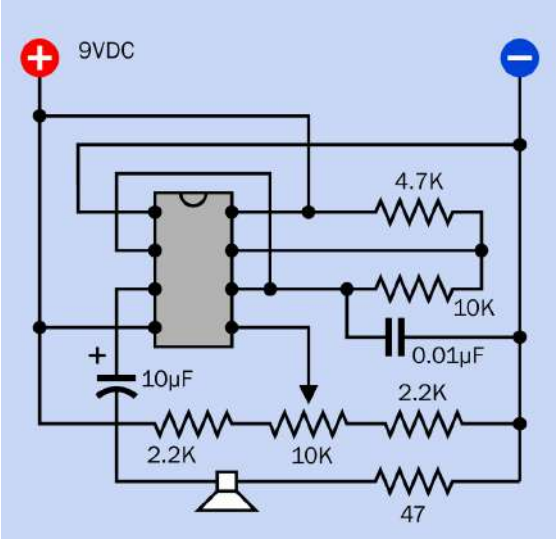

Figure 9-18. *A circuit that allows adjustment of the astable 555 frequency by increasing or lowering the voltage on the Control pin.*

Figure 9-19 shows the components specified in Figure 9-18 mounted on a breadboard.

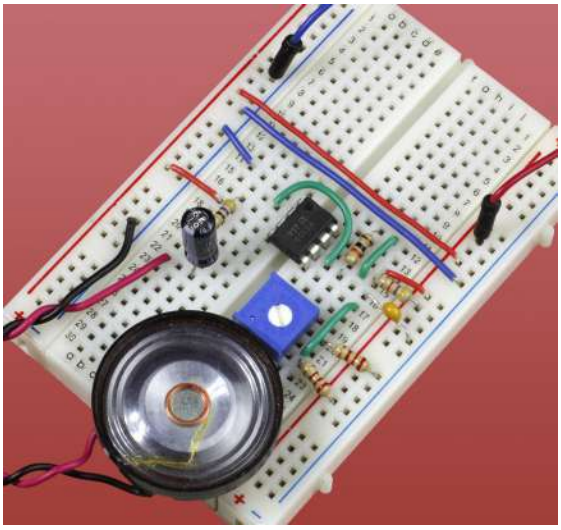

Figure 9-19. *The components in the previous schematic are shown here mounted on a breadboard. They will generate an audio output ranging between approximately 425Hz and 1,075Hz. A lower value for the timing capacitor will shift the audio range higher in frequency.*

555 Flip-Flop Emulation

The flip-flop inside a 555 timer can be accessed to control the timer's outputs. In Figure 9-20, pushbutton switch S1 applies a negative pulse to the Input pin, creating a high output from the timer, which illuminates LED D1. Normally the pulse length would be limited by the charge time of a capacitor attached to the Threshold pin, but in this circuit there is no capacitor, and the Threshold pin is hard-wired to negative ground. So, it never rises to 2/3 of positive power, and the output from the timer remains high indefinitely.

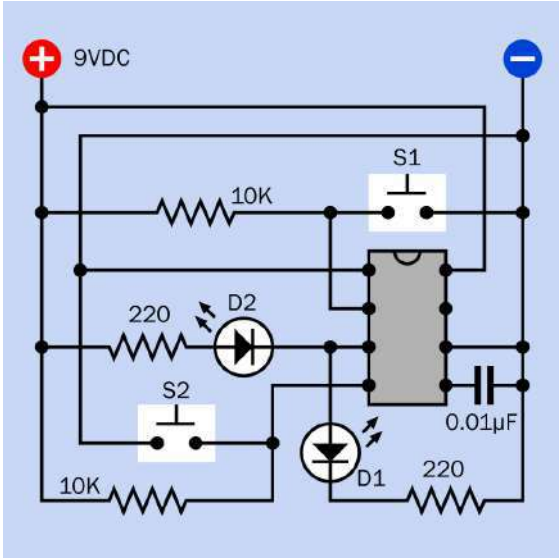

Figure 9-20. *A 555 timer can have its timing features disabled so that it functions as a flip-flop.*

However, if S2 is pressed, it grounds the Reset pin of the timer, which ends the high output and pulls the Output pin down to a low state. D1 goes out and D2 lights up, as the timer is now sinking current through it. When S2 is released, the timer output remains low and D2 remains illuminated, because the Input pin is held high by a pullup resistor. Therefore, the timer now functions in bistable mode, as a flip-flop. While this may be seen as an inappropriate use of the chip, because its full functionality is being disabled, its ability to deliver substantial current and to tolerate a wide range of supply voltages may make it more con-

venient to use than a digital flip-flop. See Chapter 11 for more information about flip-flops.

A 555 timer emulating a flip-flop is shown on a breadboard in Figure 9-21.

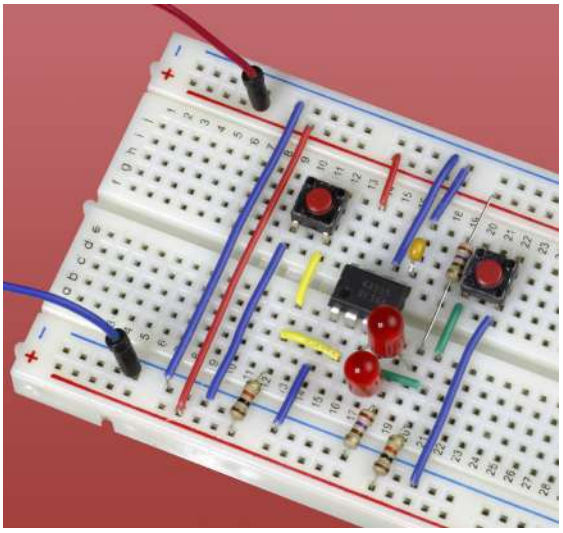

Figure 9-21. *The schematic in which a 555 timer acts as a flip-flop is shown here adapted for a breadboard.*

555 Hysteresis

The comparators inside a 555 timer enable the chip to produce hysteresis. In Figure 9-22, the Input pin and the Threshold pin are shorted together, and C1, the timing capacitor, is omitted. A 10K potentiometer, wired as a voltage divider, delivers a voltage to the Input pin ranging smoothly from V+ to negative ground. As the input dips below 1/3 V+, the Output pin goes high, lighting LED D1. Now if the input voltage gradually rises, the output remains high, even as the input rises above 1/3 V+. The output state is "sticky" because the timer does not end an output pulse until the Threshold pin tells it to, by reaching 2/3 V+. When this finally occurs, the Output pin goes low, D1 goes out, and D2 comes on, sinking current into the Output pin.

Suppose, now, the input voltage starts to go down again. Once again the output state is "sticky" because it remains low until the Input pin drops below the 1/3 level. When that happens, the output finally flips back to a high state, D2 goes out, and D1 comes on.

In the "dead zone" between 1/3 and 2/3 of supply voltage, the timer remains in its current mode, waiting for the input to stray outside of those limits. This behavior is known as *hysteresis*, and is of special importance when processing a varying signal, such as the voltage from a temperature sensor, to control an on/off device such as a thermostat. In fact the 10K potentiometer in this demo could be replaced with a thermistor or a phototransistor, wired in series with a resistor to create a voltage divider which will have an input range compatible with the 555 timer. The hysteresis can then be adjusted by varying the supply voltage that powers the timer, as this will change the values of 1/3 V+ and 2/3 V+. Alternatively, varying the voltage on the Control pin will affect the hysteresis.

A **comparator** can provide much more versatile control of hysteresis by using positive feedback (see Chapter 6 for additional details). But the 555 timer provides a quick-and-simple substitute, and its greater ability to source or sink current enables it to be connected with a wider range of other components.

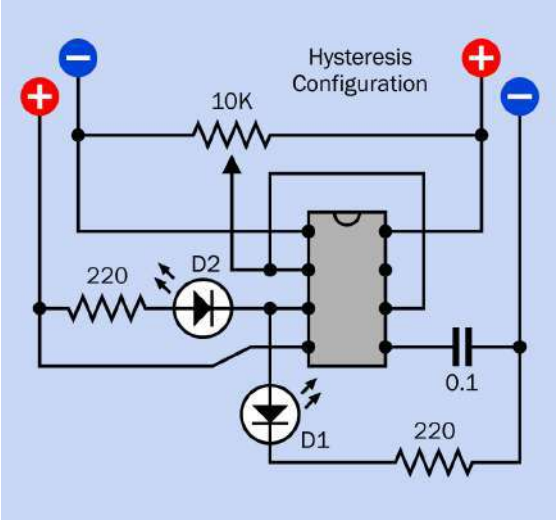

Figure 9-22. *A 555 timer wired so that it creates hysteresis, when supplied by a variable input voltage.*

555 and Coupling Capacitors

As previously noted, when a basic bipolar 555 timer (and some of its variants) is wired in monostable mode, it will retrigger itself indefinitely if its input remains low. One way to avoid this is by using a coupling capacitor. This will pass a transition from high to low, but will then block a steady subsequent voltage. In Figure 9-23, a phototransistor in series with a resistor provides a variable voltage to the noninverting input of a comparator. The reference voltage of the comparator is adjusted with a potentiometer, and resistor R3 provides positive feedback, ensuring that the output from the comparator will be quick and clean. The output from the 555 timer goes through a transistor to the relay, shown at the bottom.

It is important to see the function of the coupling capacitor, C3, with the pullup resistor, R2, which holds the Input pin of the 555 timer high by default. When the output from the comparator drops from high to low, C3 passes this transition to the Input pin of the timer, momentarily overcoming the positive potential, and triggering the timer. After the timer responds, however, C3 blocks any continuation of low voltage from the comparator. Pullup resistor R2 resumes its function of holding the input high, and prevents the timer from being retriggered.

555 Loudspeaker Connection

A small 8-ohm loudspeaker can be driven from the output of a bipolar 555 timer running in astable mode, but should be isolated from it with a 10µF to 100µF capacitor. A series resistor of 47Ω (minimum) should be used. See Figure 9-24.

Burst Mode

It is sometimes useful to create a short beep of fixed length in response to a button-press. The beep should terminate even if the button is held down. This "burst mode" can be achieved with the circuit in Figure 9-25, where the button connects power to a bipolar-type 555 timer running in astable mode, and an RC network applies a decreasing potential to a 47µF capacitor, which is wired to the Reset pin of the timer. The resistor in series with the capacitor will vary the length of the beep. When voltage to the pin drops below approximately 0.3V, output from the timer stops and cannot restart until the button is released.

A resistor of greater than 1.5K may not allow the input value at the reset pin to fall below the voltage, which is necessary to enable a reset. If a lower power supply voltage than 9VDC is used, the resistor value should be higher—for example, a 5VDC power supply works well with a 1.5K to 2K resistor.

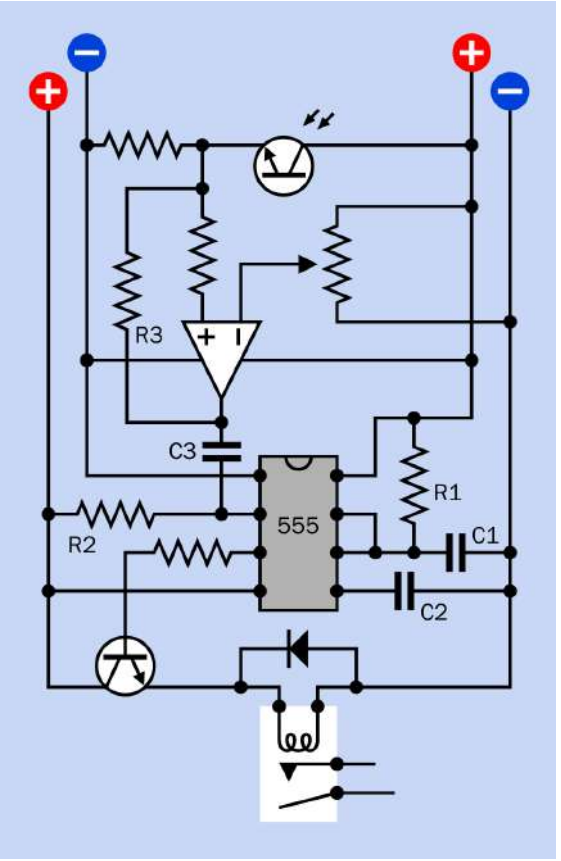

Figure 9-23. *A coupling capacitor (C3) is used in this circuit to isolate the 555 timer from a sustained low input from the comparator. The capacitor only passes a transition from high to low. The rest of the time, the pullup resistor (R3) holds the input high.*

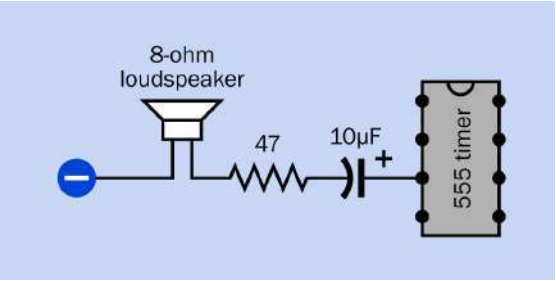

Figure 9-24. *A small 8-ohm loudspeaker can be attached through a capacitor and a resistor to the output of a bipolar 555 timer.*

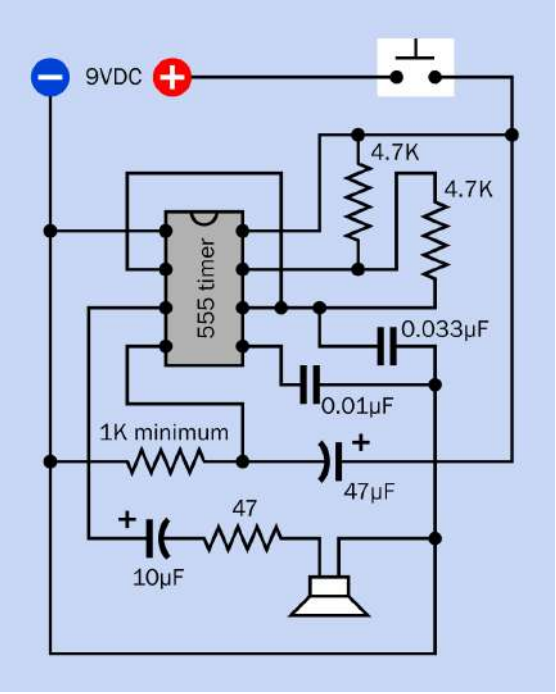

Figure 9-25. *An RC circuit, wired to apply a decreasing voltage on the Reset pin of a bipolar 555 timer, will shut off the timer shortly after it is powered up. This can be used to create a fixed-length beep in response to a button press of any duration.*

Figure 9-26 shows the components installed on a breadboard.

"You Lose" Game Sound

A timer is a simple, cheap way to create a variety of simple game sounds. The schematic in Figure 9-27 makes a groaning sound as the 100µF capacitor wired to the Control pin of a bipolar-type 555 gradually charges through the 1K resistor. Note that if a larger resistor is paired with a smaller capacitor, the effect will differ. The 150K resistor is included to discharge the capacitor reasonably quickly in time for the next cycle.

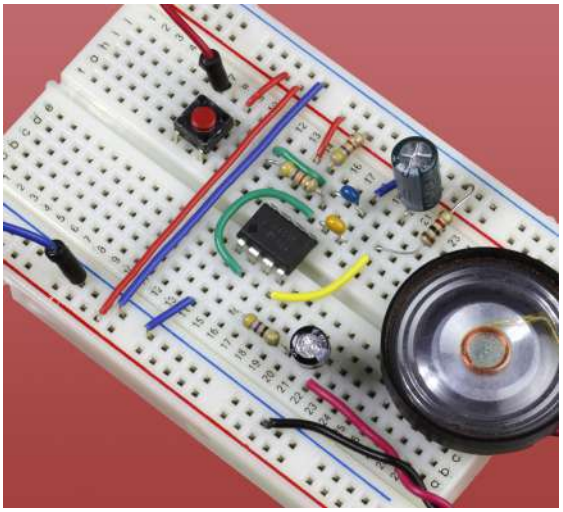

Figure 9-26. *The "burst mode" circuit installed on a breadboard with a miniature loudspeaker.*

What Can Go Wrong

Dead Timer

Like any chip, the 555 can be damaged by overvoltage, excessive source current or sinking current, static electricity, incorrectly applied polarity of power supply, and other forms of abuse. The TTL version of the timer is fairly robust, but the CMOS type much less so. Check for obvious errors such as lack of supply voltage, incorrect or ambiguous input voltages, and unusual current draw (too high, or none at all, at the V+ pin). Use the meter probes on the actual pins of the chip, in case there is a break in the wiring that feeds them. Because timer chips are cheap, a reserve supply of them should be maintained.

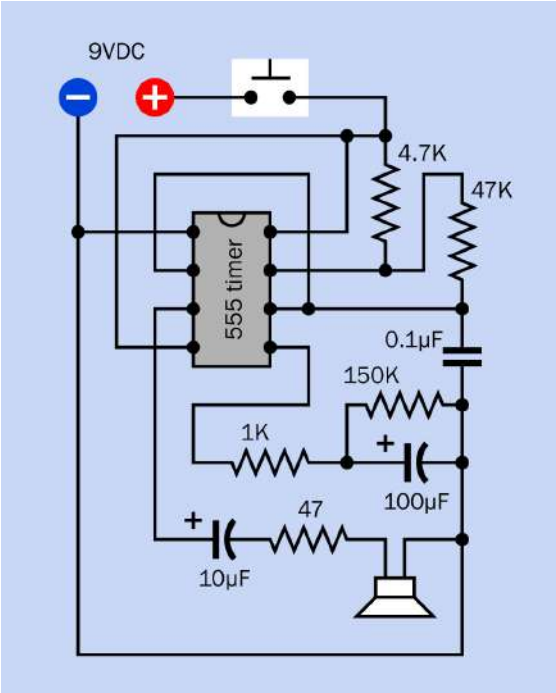

Figure 9-27. *An RC circuit, wired to apply an increasingly positive voltage to the Control pin of a bipolar timer running in astable mode, will gradually pull down the frequency at the Output pin, creating a sound that may be useful in simple game applications.*

CMOS Confused with Bipolar

The part numbers of some bipolar chips are very similar to those of some CMOS versions, and the chips look physically identical. But the CMOS version is easily overloaded, as it may source only 10mA to 20mA maximum while the TTL version is capable of 200mA. Make sure that your chips are carefully labeled when they are stored.

The Pulse that Never Ends

If a 555 timer responds correctly to a high-to-low transition on the input pin, but the output pulse continues indefinitely, check the voltage on pin 6 to see if the timing capacitor is charging above 2/3 of V+. While a 555 can run from 5VDC, a high-current device on the Output pin can pull down the voltage inside the chip to the point where the capacitor never charges sufficiently to end the cycle.

Also check that the input transition from high to low lasts for a shorter time than the pulse. A persistent low input can retrigger the timer.

Erratic Chip Behavior

Possible causes include:

- Floating pins. The Input pin, in particular, should always be connected with a defined voltage (via a 10K pullup resistor, if necessary), and must not be allowed to float at an indeterminate potential.
- Voltage spikes. A timer can be triggered by transients from other components, especially inductive loads. If the input to a monostable timer dips for even a fraction of a second, the timer will initiate a new cycle. A *protection diode* should be used in conjunction with an inductive load.
- Voltage spikes can also introduce variations in the pulse train from an astable timer.
- TTL versions of the 555 timer will tolerate a wide range of supply voltage, but if a voltage regulator is not used, fluctuations in voltage can have unpredictable consequences.

Interference with Other Components

Because the bipolar version of a 555 timer creates a voltage spike when its output changes state, it can interfere with the normal function of other components, especially CMOS chips. A 0.1µF bypass capacitor can be applied between the timer's V+ pin and ground.

Erratic Behavior of Output Devices

If a 555 timer powers an output device such as a relay, and the relay is not opening or closing in a reliable manner, first check that it is receiving sufficient voltage. If the 555 timer is powered with 5VDC, its output will be only around 4VDC.

This problem can be avoided by using the output from the timer to control the voltage on the base

of a transistor which switches a separate source of power to the relay coil.

Fatal Damage Caused by Inductive Loads

While it is possible to drive an inductive load such as a small motor or relay directly from a TTL 555 timer, two precautions should be taken. First, the motor or the coil of the relay should have a clamping diode added around it, as is standard practice. Second, because the output of the timer is capable of sinking current as well as sourcing current, it can be protected from sinking back-EMF by inserting a diode in series with the load. This is illustrated in Figure 9-28.

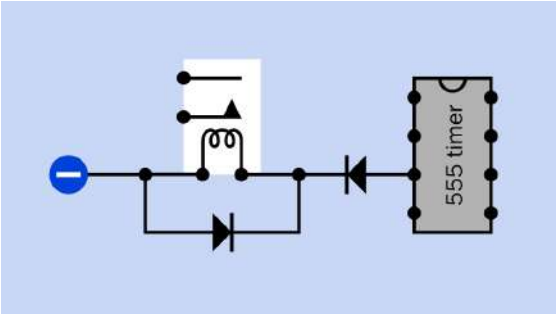

Figure 9-28. *In addition to a standard protection diode clamped around an inductive load such as a relay coil, the 555 timer can be protected from back-EMF by adding a diode in series. The series diode must of course be rated to carry sufficient current through the coil. When choosing a relay, allowance must be made for the voltage drop that will be imposed by the series diode.*

logic gate

10

Only basic **logic gates** are included in this entry—that is, components that perform a Boolean logic operation on two to eight inputs (or one input, in the case of an inverter) to create a single high or low logical output.

OTHER RELATED COMPONENTS

- **flip-flop** (see Chapter 11)

What It Does

A **logic gate** is a circuit that delivers an output, either high or low, depending on the states of its two inputs, either or both of which can be high or low.

Some gates may have more than two inputs, and an *inverter* only has one input, but the basic gates all conform with the two-input, one-output model. The components that constitute a logic gate are almost always etched into a wafer inside a silicon chip.

In a digital computer, a *high logic state* is traditionally close to 5VDC and represents a value of 1 in *binary arithmetic*, while a *low logic state* is traditionally close to 0VDC and represents a binary 0. Modern devices may use a lower voltage for the high state, but the principle is still the same.

A small network of logic gates can perform binary addition, and all other operations in a digital computer are built upon this foundation.

Origins

The concept of digital logic originated in 1894, when English mathematician George Boole announced his invention of a form of algebra (now referred to as *Boolean algebra*) to analyze combinations of two logical states that could be interpreted as "true" and "false." This concept had few practical applications until the 1930s, when Claude Shannon saw that because a basic switch has two states, Boolean algebra could enable analysis of complex networks of switches that were being used in telephone systems.

Because the state of a switch could also be used to represent the values 0 or 1 in binary arithmetic, and because a transistor could function as a switch, Boolean algebra was implemented in solid-state digital computing equipment.

How It Works

While conventional arithmetic uses *arithmetical operators* to represent procedures such as addition or multiplication, Boolean algebra uses *Boolean operators*. The operators of special interest in digital electronics are named AND, NAND, OR, NOR, XOR, and XNOR.

Although each gate actually contains multiple transistors, it is represented by a single logic symbol, as shown in Figure 10-1. The names of the Boolean operators are customarily printed all in caps. A gate requires a power supply and a connection with negative ground, separate from its inputs, but these connections are omitted from

gate schematics because they are assumed to exist.

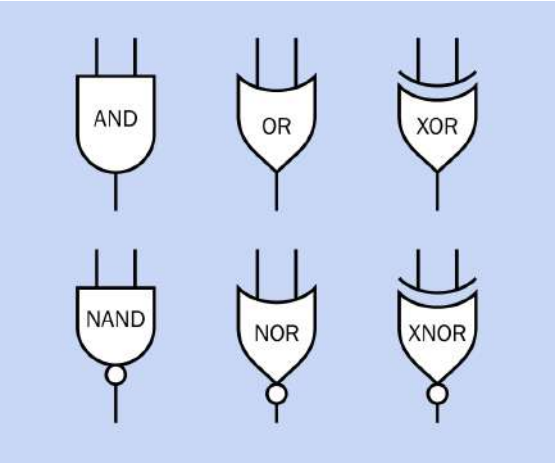

Figure 10-1. *Six types of two-input logic gates are used in digital electronics, although the XNOR gate is rare, as it has few applications. The names are customarily printed in uppercase letters.*

The functions of the gates with two inputs can be defined in electrical terms. In Figure 10-2, the four possible combinations of inputs are tabulated in the left column, with red indicating a high input and black indicating a low input. The corresponding output from each gate is shown beneath its name. This kind of tabulation is known as a *truth table*, as it is derived from Boolean algebra which originally concerned itself with "true" and "false" states.

Input states of a two-input gate		Gate Outputs					
		AND	NAND	OR	NOR	XOR	XNOR
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●

Figure 10-2. *The four possible combinations of input states in a 2-input logic gate are shown at left. The corresponding output from each gate is shown beneath its name. Red indicates a high state, while black indicates a low state.*

The truth table assumes that *positive logic* is being used. Negative logic is very uncommon, but if it were used, the red dots in the truth table would correspond with low inputs and outputs, while the black dots would correspond with high inputs and outputs.

Inversion

The small circles appended to the outputs of NAND, NOR, and XNOR gates mean that the output of each gate is inverted compared with the AND, OR, and XOR gates. This can be seen by inspection of the output states shown in Figure 10-2. The circles are known as *bubbles*.

Sometimes logic symbols are shown with a bubble applied to one input, as in Figure 10-3. In these cases, the circle indicates that an input must be inverted. More than one gate may be needed to achieve this logic function in an actual circuit. The style is often used to show the inner workings of an IC, using a minimum number of logic symbols.

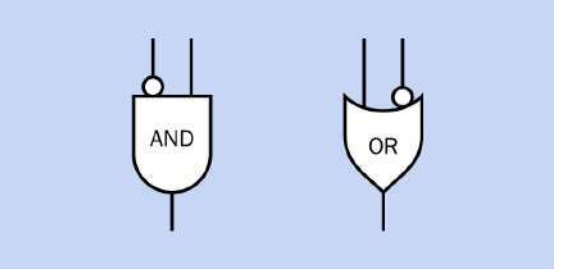

Figure 10-3. *The circle in a logic gate symbol indicates that a signal is being inverted. Circles can be inserted at gate inputs, but in a real circuit a separate inverter is likely to be needed to create this effect.*

Single-Input Gates

Two gates exist that have a single input and a single output, shown in Figure 10-4. The *buffer* should not be confused with the symbol for an **op-amp** or a **comparator**. (Those components always have two inputs.) The output state of a buffer is the same as its input state, but the component may be useful to deliver more current or to isolate one section of a circuit from another.

When a bubble is appended to a buffer, it becomes a NOT gate, more commonly known as an *inverter*. Its function is to create an output state that is opposite to its input state.

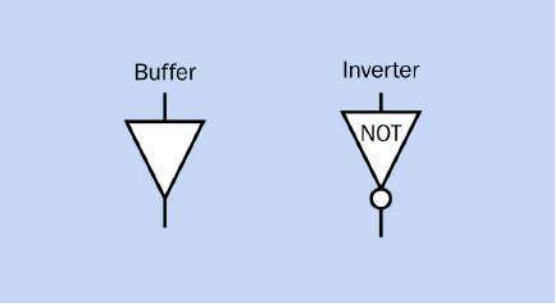

Figure 10-4. *The two logic gates that have only one input and one output. Note that in some schematics showing internal logic of ICs, the bubble on an inverter may be found on the input side instead of the output side.*

Gates with More than Two Inputs

AND, NAND, OR, and NOR gates can have any number of inputs, as suggested in Figure 10-5, although practical factors usually limit the inputs to a maximum of eight.

Input states of a gate with more than two inputs	Gate Outputs			
	AND	NAND	OR	NOR
All low	●	●	●	●
All high	●	●	●	●
At least 1 low and at least 1 high	●	●	●	●

Figure 10-5. *The previous table has been modified to show the outputs from logic gates that have more than two inputs. XOR and XNOR gates are not included in the table, because a strict interpretation of their logic requires that a unique output state exists if one input is high while the other is low.*

The rules can be summarized like this:

- Output from an AND gate: Low if any of its inputs is low, high if all of its inputs are high.
- Output from a NAND gate: High if any of its inputs is low, low if all of its inputs are high.
- Output from an OR gate: High if any of its inputs is high, low if all of its inputs are low.
- Output from a NOR gate: Low if any of its inputs is high, high if all of its inputs are low.

In the case of XOR and XNOR gates, their logic requires that a unique output state must exist if one input is high while the other input is low.

In fact, so-called three-input XOR gates do exist, an example being the 74LVC1G386 chip, in which the output is high if all three inputs are high, or if one input is high, but not if two inputs are high or no inputs are high. Further discussion of more-than-two-input XORs is outside the scope of this encyclopedia.

Boolean Notation

For reference, the original written notation for Boolean operators is shown in Figure 10-6. Unfortunately, the notation for these operators was never properly standardized, and in more than one instance, multiple symbols acquired the same meaning. The letters P and Q are often, but not always, used to represent two input states that can be true or false.

- The use of a horizontal line above a symbol, to indicate that its state has been reversed, has carried over to datasheets where this notation can show that an output state from any digital chip is inverted. The line is known as a *bar*.

Arithmetical Operations

Suppose we wish to sum two binary numbers, each containing two digits. There are four digits altogether, and depending on their values, there are 16 different possible addition sums, as shown in Figure 10-7.

If A0 and B0 represent the rightmost digits of the two numbers being added, and S0 is the sum of those two digits, inspection of the figure shows that the sum can be derived using just three rules:

1. If A0 = 0 and B0 = 0, then S = 0.
2. If A0 and B0 have opposite states, then S0 = 1.
3. If A0 = 1 and B0 = 1, then S0 = 0, and carry 1 to the next place left.

If A0 and B0 are the two inputs to an XOR logic gate, the output of the gate satisfies all three rules, except the need to carry 1 to the next place left. This last function can be satisfied with an AND gate. The function of two gates is known as a *half adder*, and is shown in the top section of Figure 10-8.

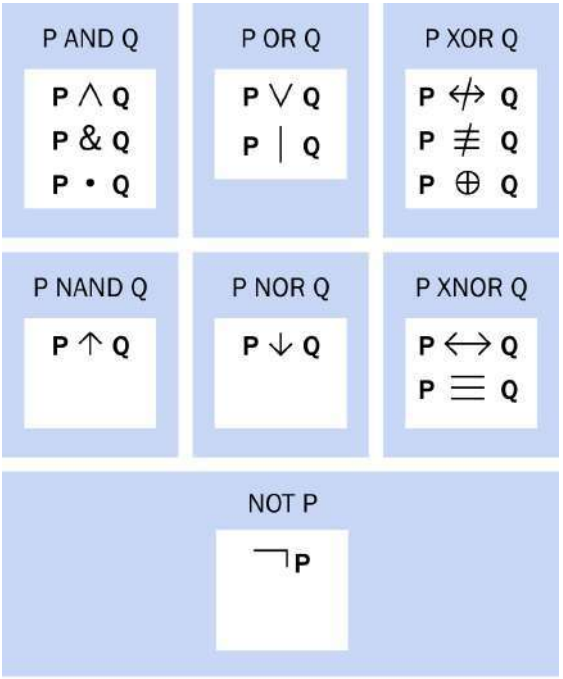

Figure 10-6. *Boolean operators as they have been expressed in written notation. Lack of standardization has resulted in more than one symbol representing some of the operators.*

When we consider the next pair of binary digits to the left, the situation now becomes more complicated, because we may be carrying 1 into this addition sum from the previous stage, and we still need to be able to to carry 1 out (if necessary) to the next stage. An assembly of five logic gates can deal with this, and their combination is known as a *full adder*. This is shown in the bottom section of Figure 10-8.

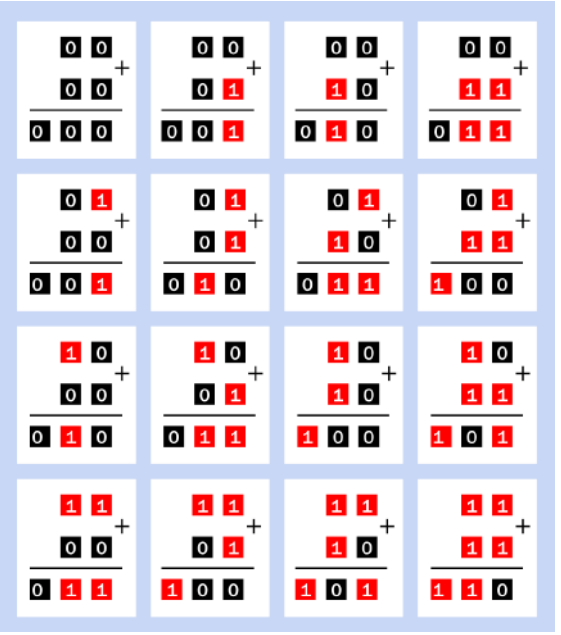

Figure 10-7. *Sixteen different addition sums are possible, when summing two binary numbers of two digits each.*

The combination of XOR and AND gates shown in Figure 10-8 is not the only one that works to add binary numbers. However, it may be the most intuitively obvious.

Other Operations

Binary arithmetic remains the most important application of logic gates, but individually packaged gates are seldom used for that purpose anymore. They were long since subsumed into large multifunction computing chips.

Single gates still have application in small systems, or to modify the inputs and outputs of microcontrollers, or to convert the output from one complex digital chip to make it compatible with the input of another. This last application is often referred to as *glue logic*.

Applications for single gates are discussed in "How to Use It" on page 103.

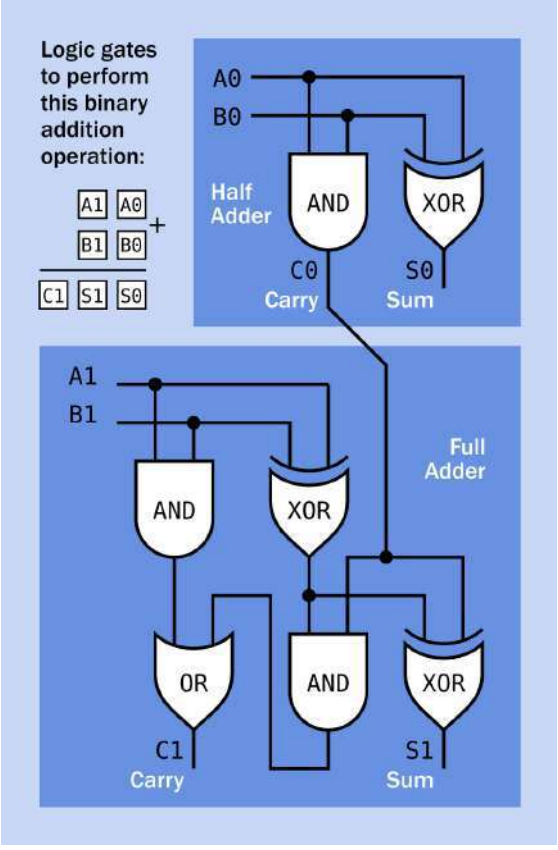

Figure 10-8. *Logic gates can be used to add binary numbers, using a high input or output to represent a binary 1 and a low input or output to represent a binary 0. This schematic shows one possible way for gates to add two two-digit binary numbers.*

Variants

Chips containing logic gates were introduced in the 1960s. The 7400 NAND chip, from Texas Instruments, was the first of a series that became so influential, the same basic part numbers (with letters added before, after, and among the digits) are still used today. An example of a currently available through-hole 7400 chip is shown in Figure 10-9.

Figure 10-9. *A modern version of a 7400 chip containing four NAND gates.*

Initially, these chips conformed with a *transistor-transistor logic* (*TTL*) standard that had been invented at TRW in 1961 and introduced in commercial products by Sylvania in 1963. It established the now-familiar standard of 5VDC for the power supply. Many logic chips now use other voltages, but the term "high" still means an input or output that is near to the supply voltage, while "low" means an input or output that is near to negative ground. The exact definition of "near" will be found in datasheets for the chips.

The *7400 series* was successful partly because it was engineered for compatibility. The output from one gate could be connected directly to the input of another gate, with a few bypass capacitors added on a circuit board to suppress voltage spikes caused by rapid switching. Earlier components had not been so easy to interface with each other. The new standard dominated the industry to the point where dozens of manufacturers started making chips that conformed with it, and a single board could mix-and-match chips from multiple vendors.

Because many logic chips acquired part numbers that began with 74, they are often referred to as the 74xx series, where other digits (sometimes more than two) can be substituted for xx. This avoids ambiguity, as the very first chip in this format was a NAND gate that had 7400 as its actual part number. In the text below, 7400 will refer to

that specific chip, whereas 74xx will refer to the whole series of chips.

RCA introduced a competing family of logic gates in 1968, using CMOS transistors. As each part number began with a 4 and contained four digits, this was referred to as the *4000 series*. The CMOS chips were slower and more expensive, but tolerated a wider range of power supply voltages (3V to 12V, initially). Their biggest advantage was that they used much less current. This was important, as TTL chips created a lot of waste heat. The lower power consumption of CMOS also enabled one chip to control the inputs of many others, which simplified circuit design. This one-to-many relationship is known as *fanout*.

Ultimately, CMOS chips transcended their early limitations. While they were reserved initially for battery-powered devices in which very low power consumption was more important than speed, CMOS is now used almost everywhere, still maintaining its advantage of low current (almost zero, in fact, while a chip is quiescent) while equalling the speed of TTL. However, CMOS logic chips are very often pin-compatible with the old TTL components, and modern CMOS part numbers are often derived from the old 74xx series.

Most CMOS logic chips in the old 4000 series are still available, and may be used in situations where a power supply greater than 5VDC is convenient.

Part Numbers

As the performance of semiconductors gradually improved, successive *families* of logic chips were introduced, identified by one-letter, two-letter, or three-letter acronyms. The acronym was inserted into the part number, so that a 7400 NAND gate in the HC (high-speed CMOS) family became a 74HC00 NAND gate.

Because these chips were available from multiple sources, the part number was also preceded with one or more letters indicating the manufacturer. And because each chip was manufactured in different versions (for example, some complied with military specifications, while others didn't), letters were also appended to the end of the part number. Today, the appended letters may indicate whether the chip is of the old through-hole format, or conforms with a more recent surface-mount format.

Summing up:

- Prefix: manufacturer ID.
- Numerals, omitting any letters in the middle: Chip functionality.
- Middle letters: Chip family.
- Suffix letters: Package format.

Thus, for example, the actual part number for a 74HC00 NAND chip could be SN74HC00N, where the SN prefix indicates that it is manufactured by Texas Instruments and the N suffix means that it is in plastic dual-inline-pin (DIP) format. (The SN prefix was introduced by Texas Instruments in the earliest days of integrated circuits as an acronym for "semiconductor network," meaning that multiple transistors were "networked" on a wafer of silicon. Other manufacturers used their own schemes for part numbering, and so SN became exclusively identified with Texas Instruments.)

The system of augmenting part numbers has been further extended by inserting 1G, 2G, or 3G immediately after the family identifier, to indicate surface-mount chips that contain one, two, or three logic gates. If the "G" identifier is missing, the chip usually has four logic gates, which was the standard used in the original 74xx series. This rule applies even in surface-mount formats, where the surface-mount pads of four-gate chips have the same functions as the pinouts of the original TTL versions (except in the case of square-format surface-mount chips, which are not discussed here).

When searching a catalog to find a chip by its part number, it helps to remember that searching for a 7400 chip may not find any hits, but searching for a 74HC00 (or any other valid number con-

taining a family identifier) is much more likely to be understood.

A key to understanding part numbers is shown in Figure 10-10. The upper part of the figure is a guide to interpreting numbers on a generic basis, while the lower part interprets the specific part number shown.

Families

As of 2013, the HC family in the 74xx series has become so widely used, it can be considered the default in the traditional DIP 14-pin format. Incremental improvements are still being made, and new families are being introduced, primarily in surface-mount formats which use lower power-supply voltages (down to around 1VDC).

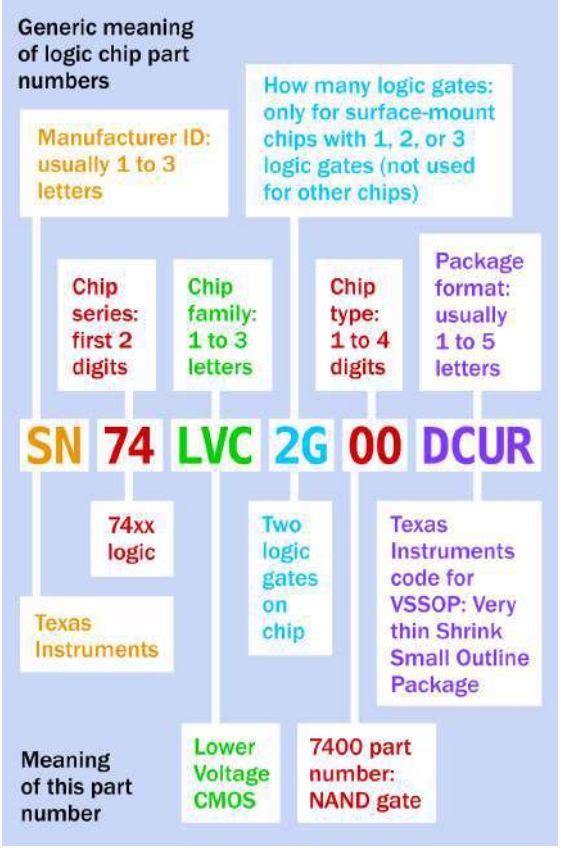

Figure 10-10. *How to interpret the segments of a logic chip part number in the 74xx family (in this case, a 7400 NAND gate).*

Here is an historical summary of the most important chip families.

- 74xx: Original series of bipolar TTL chips.
- 74Hxx: Bipolar TTL, high speed, about twice as fast as the original 74xx chips, but twice the power consumption.
- 74Lxx: Bipolar TTL, lower power consumption than the original TTL, but also much lower speed.
- 74LSxx: Bipolar TTL, lower power with Schottky input stages, faster than original TTL. Some LS chips are still being manufactured.
- 74ASxx: Bipolar TTL, Advanced Schottky, intended to supercede the 74Lxx.
- 74ALSxx: Bipolar TTL, Advanced Low Power Schottky, intended to supercede the 74LSxx.
- 74Fxx: Bipolar TTL, Faster.
- 74HCxx: CMOS high-speed emulation of 74LSxx.
- 74HCTxx: CMOS but with similar high-state input voltage threshold to bipolar TTL chips, for compatibility.
- 74ACxx: Advanced CMOS.
- 74ACTxx: Advanced CMOS emulation of TTL with similar high-state input voltage threshold to TTL, for compatibility.
- 74AHCxx: Advanced Higher-Speed CMOS, three times as fast as HC.
- 74VHCxx: Very High Speed CMOS.
- 74AUCxx, 74FCxx, 74LCXxx, 74LVCxx, 74ALVCxx, 74LVQxx, 74LVXxx: Various specifications, many using power supply voltages of 3.3V or below.

In the 4000 series, an early significant improvement was the 4000B family, which allowed a higher power supply limit (18V instead of 12V) and was much less susceptible to damage by static discharge. The 4000B family almost totally replaced the old 4000 family, and most 4000B

chips are still available, as they are useful in situations where a power supply delivers more than 5VDC.

- When it is referenced casually, the B at the end of a chip number in the 4000 series may be omitted. When the number is listed in a catalog, the B is included.

Chips with 45 as their first two digits were introduced as a new generation, but were not widely adopted. After that, the 4000 series ceased to evolve, and CMOS chips adopted 74xx part numbers, distinguishing themselves by the insertion of letter groups in the center of the number.

To add to the confusion, some 4000 series part numbers were appended to 74xx part numbers, so that, for example, the 74HCT4060 is designed to be compatible with the old 4060B chip.

Family Interoperability

One of the most important issues relating to chip families is their differing specifications for a low-state voltage and a high-state voltage in inputs and outputs.

The original 74xx TTL series, using a 5VDC power supply, used these approximate specifications:

- Output: 74xx voltage representing a low state (at most 0.4V to 0.5V)
- Input: 74xx input voltage interpreted as a low state (maximum 0.8V)
- Output: 74xx voltage representing a high state (at least 2.4V to 2.7V)
- Input: 74xx input voltage interpreted as a high state (minimum 2V)

This provided a safe margin of error of at least 0.4V when chips were communicating with each other.

In the CMOS 4000 family, however, logic chips required a minimum input of 3V to 3.5V to be interpreted as a high state. The minimum acceptable output from a TTL chip was below this level, creating problems if anyone should try to use the output from a TTL chip to communicate with an input on a CMOS chip.

One solution is to add a 4.7K pullup resistor to the TTL output, guaranteeing that it won't fall too low. But this wastes power, and the need for the resistor is easily forgotten. Another option is to use the HCT or ACT family of CMOS logic. The "T" in these family names indicates that they have been engineered to share the input standards of the old TTL chips. They still deliver the same high output as other types of CMOS, making them seem to be the best possible solution. Unfortunately, it does entail a compromise: the "T" chips are more sensitive to noise, among other factors.

- Ideally, chip families should not be intermingled.

Gates per Chip

Each of the original 74xx chips contained multiple gates within the limits of a uniform 14-pin through-hole format. The gates that were most commonly used had two inputs, and there were four of these gates per chip.

However, the desire for miniaturization, and the use of automatic chip-placement and soldering equipment, made one-gate and two-gate logic chips desirable and practical in surface-mount format. (Three-gate surface-mount chips exist, but are sufficiently unusual that they are not described in this encyclopedia.)

Two Inputs, Single Gate

Where a chip contains just one logic gate, it is almost always a surface-mount component, and the part number has 1G in the middle to indicate "one gate." Pad functions are shown in Figure 10-11. The layout is standardized for all logic gates, with the exception of XNOR gates, which are not manufactured in surface-mount format.

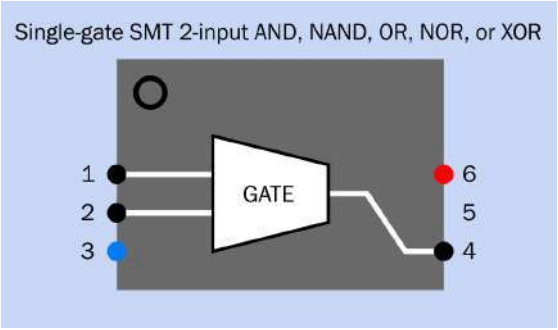

Figure 10-11. *Internal configuration and solder-pad functions for a two-input surface-mount single-gate logic chip that can contain an AND, NAND, OR, NOR, or XOR gate. XNOR gates are not manufactured in this format.*

In the figure, a gate is shown in generic form, indicating that it may be an AND, NAND, OR, NOR, or XOR gate, depending on the part number of the chip. Inputs are on the left of the gate, while its output is on the right. The chip does not have a solder pad in position 5, but the pad at top right is identified as pin 6 for consistency with the numbering pattern in other surface-mount components where six pads are common.

The generic part numbers for single-gate surface-mount two-input logic chips are shown here, with letter x indicating that letter sequences are likely to be inserted to indicate manufacturer, logic family, and chip format:

- AND gate: x74x1G08x
- OR gate: x74x1G32x
- NAND gate: x74x1G00x
- NOR gate: x74x1G02x
- XOR gate: x74x1G86x

Three Inputs, Single Gate

AND, NAND, OR, and NOR single gates are available with more than two inputs. Their output is determined by rules shown in Figure 10-5. XOR and XNOR gates are not included in the table, because a strict interpretation of their logic requires that a unique output state exists if one input is high while the other is low.

The pad functions for a surface-mount single-gate logic chip with three inputs are shown in Figure 10-12. The generic part numbers for these chips are shown below. Again, each x indicates that letter sequences are likely to be inserted to indicate manufacturer, logic family, and chip format.

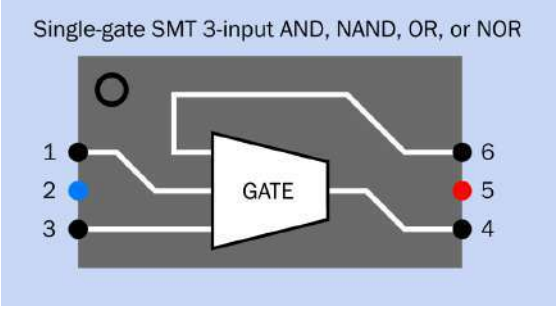

Figure 10-12. *Internal configuration and solder-pad functions for a three-input surface-mount single-gate logic chip that can contain an AND, NAND, OR, or NOR gate.*

The generic part numbers for single-gate surface-mount three-input logic chips are shown here, with each x indicating that letter sequences are likely to be inserted to indicate manufacturer, logic family, and chip format:

- AND: x74x1G11x
- NAND: x74x1G10x
- OR: x74x1G32x
- NOR: x74x1G27x

Single Gate, Selectable Function

A few surface-mount chips can emulate a variety of two-input gates, by using appropriate external connections. The internal logic of one example, with generic part number x74x1G97x (an actual example would be Texas Instruments SN74LVC1G97), is shown in Figure 10-13. Depending which pin is grounded and which other pins are used as inputs, the chip can emulate all five of the most commonly used gates. To achieve this, however, some inputs have to be inverted.

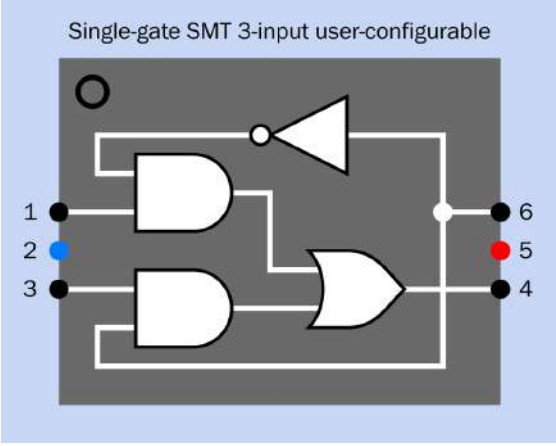

Figure 10-13. *Internal configuration for a configurable surface-mount chip that can emulate various two-input logic gates, depending which inputs are used and which are grounded. Some inputs have to be inverted to emulate some gates.*

Two Inputs, Dual Gate

Two-input surface-mount AND, NAND, OR, NOR, and XOR gates are available in dual layout (two gates per chip). The internal logic and pad functions are shown in Figure 10-14. The generic part numbers for these chips are shown here. Again, each x indicates that letter sequences are likely to be inserted to indicate manufacturer, logic family, and chip format.

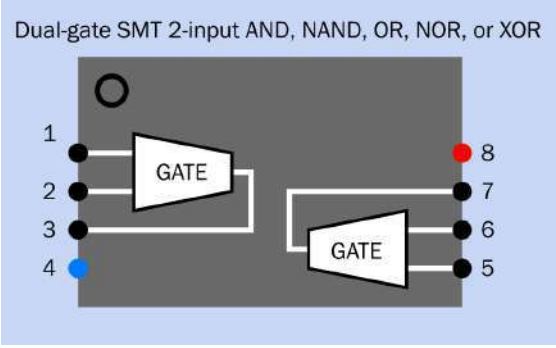

Figure 10-14. *Internal configuration and solder-pad functions for a two-input surface-mount dual-gate logic chip that can contain two AND, NAND, OR, NOR, or XOR gates. XNOR chips are not manufactured in this format.*

The generic part numbers for dual-gate surface-mount two-input logic chips are shown below, with each x indicating that letter sequences are likely to be inserted to indicate manufacturer, logic family, and chip format:

- AND: x74x2G08x
- NAND: x74x2G00x
- OR: x74x2G32x
- NOR: x74x2G02x
- XOR: x74x2G86x

Original 74xx 14-Pin Format

Each of the original 74xx TTL chips contained multiple gates within the limits of a uniform 14-pin chip format. The available options were, and still are:

- Quad 2-input: Four gates with two inputs each
- Triple 3-input: Three gates with three inputs each
- Dual 4-input: Two gates with four inputs each
- Dual 5-input: Two gates with five inputs each
- Single 8-input: One gate with eight inputs

The five-input chips have become so uncommon that they are not described in this encyclopedia.

Quad Two-Input 74xx Pinouts

14-pin DIP 74xx quad two-input logic chips are available in AND, NAND, NOR, XOR, or XNOR versions, all of which have an internal layout shown in Figure 10-15. The layout is unchanged in surface-mount format. The gates are shown in generic form, as the layout remains the same regardless of which type of gate is in the chip. All the gates in any one chip are of the same type. The four connections leading to a gate are its inputs, while the single connection from a gate is its output.

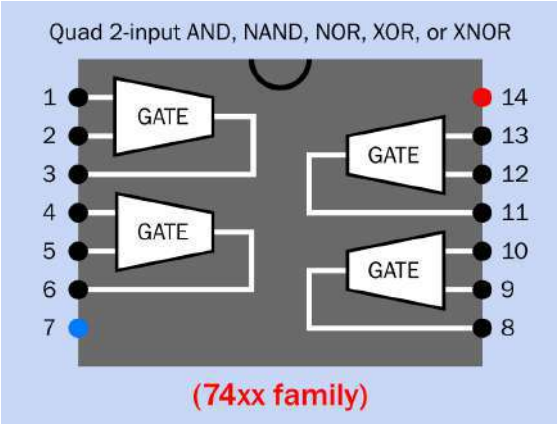

Figure 10-15. *In a 14-pin quad two-input 74xx logic chip, the AND, NAND, NOR, XOR, and XNOR versions all share this generic layout.*

- The 14-pin quad two-input OR chip has different pinouts from all the other 74xx logic chips. It is shown in Figure 10-16.

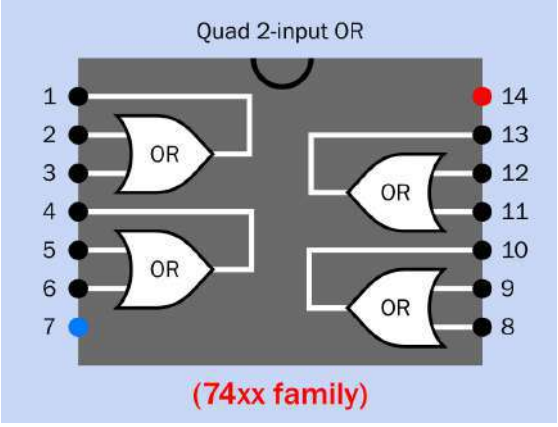

Figure 10-16. *In a quad two-input 74xx OR chip, this layout is used, which is different from that used in all the other quad two-input logic gates.*

Triple Three-Input 74xx Pinouts

The AND, NAND, and NOR versions of a 14-pin DIP 74xx triple three-input logic chip all have an internal layout shown in Figure 10-17. The layout is unchanged in surface-mount format. The gates are shown in generic form, as the layout remains the same regardless of which type of gate is in the chip. All the gates in any one chip are of the same type. Three connections leading to a gate are its inputs, while a single connection from a gate is its output.

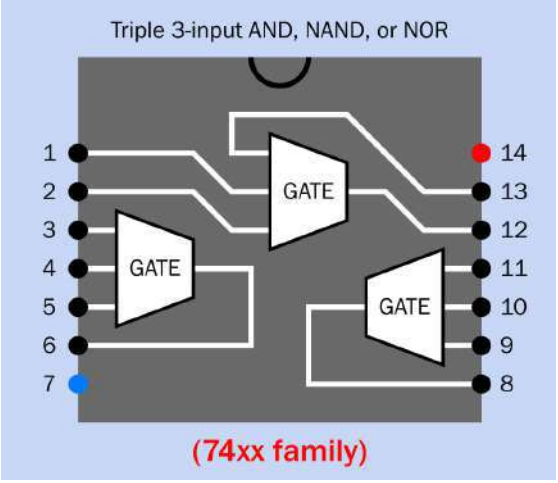

Figure 10-17. *In a 14-pin triple three-input 74xx logic chip, the AND, NAND, and NOR versions all share this generic layout.*

- The 14-pin triple three-input OR chip has different pinouts from all the other 74xx logic chips. It is shown in Figure 10-18.

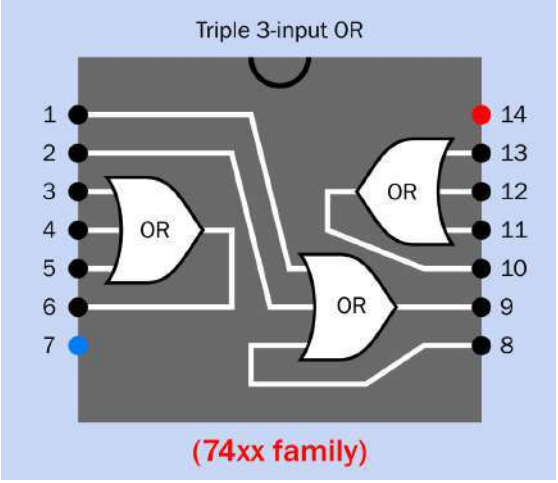

Figure 10-18. *In a triple three-input 74xx OR chip, this layout is used, which is different from that used for all the other triple three-input logic gates.*

Dual Four-Input 74xx Pinouts

A 14-pin DIP 74xx dual four-input logic chip contains two four-input gates. The AND, NAND, and NOR versions all have an internal layout shown in Figure 10-19. The layout is unchanged in surface-mount format. The gates are shown in generic form, as the layout remains the same regardless of which type of gate is in the chip. All the gates in any one chip are of the same type.

- There is no OR chip of the 14-pin dual four-input type.

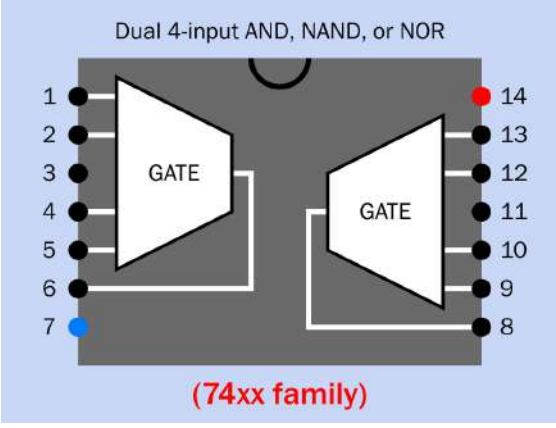

Figure 10-19. *In a 14-pin dual four-input 74xx logic chip, the AND, NAND, and NOR versions all share this generic layout. There is no 74xx OR chip with four inputs per gate.*

Single Eight-Input 74xx Pinouts

A 14-pin DIP 74xx single eight-input NAND chip contains one eight-input gate, as shown in Figure 10-20. The layout is unchanged in surface-mount format.

- There is no AND chip of the 14-pin single eight-input type.

A 14-pin eight-input logic chip in the 74xx series, able to function as both an OR and a NOR, is shown in Figure 10-21. The output from the NOR gate is connected with pin 13, but also passes through an inverter to create an OR output at pin 1. (Because a NOR gate is equivalent to an inverted-OR, when its output is inverted again, it returns to being an OR.)

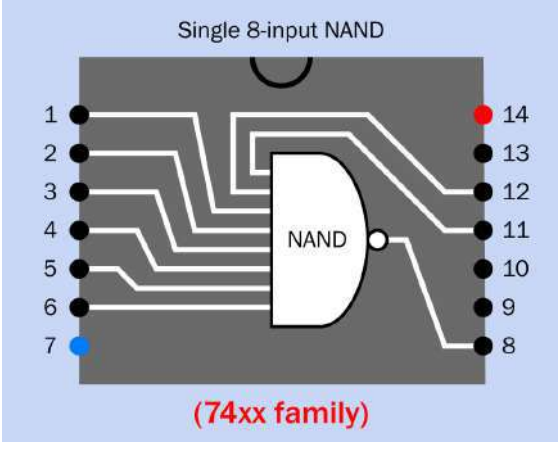

Figure 10-20. *The internal layout of single eight-input NAND chip in the 14-pin 74xx series. There is no 74xx AND chip with eight inputs per gate.*

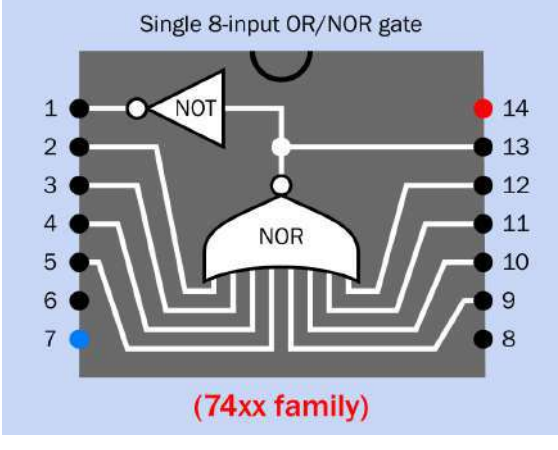

Figure 10-21. *The internal layout of single eight-input OR/NOR chip in the 14-pin 74xx series. Pin 13 has the NOR output, while pin 1 has the OR output.*

The following list shows the generic part numbers for DIP and surface-mount versions of 14-pin logic chips in the 74xx series that have two or more inputs per gate. As before, an x indicates that letter sequences are likely to be inserted to indicate manufacturer, logic family, and chip format.

- Quad 2-input AND: x74x08x
- Quad 2-input NAND: x74x00x
- Quad 2-input OR: x74x32x
- Quad 2-input NOR: x74x02x
- Quad 2-input XOR: x74x86x
- Quad 2-input XNOR: x74x266x
- Triple 3-input AND: x74x11x
- Triple 3-input NAND: x74x10x
- Triple 3-input OR: x74x4075x
- Triple 3-input NOR: x74x27x
- Dual 4-input AND: x74x21x
- Dual 4-input NAND: x74x20x
- Dual 4-input NOR: x74x4002x
- Single 8-input NAND: x74x30x
- Single 8-input OR/NOR: x74x4078x

74xx Inverters

Single, dual, and triple inverter packages in the 74xx series are available in surface-mount format only. Their internal arrangement is shown in Figures 10-22, 10-23, and 10-24.

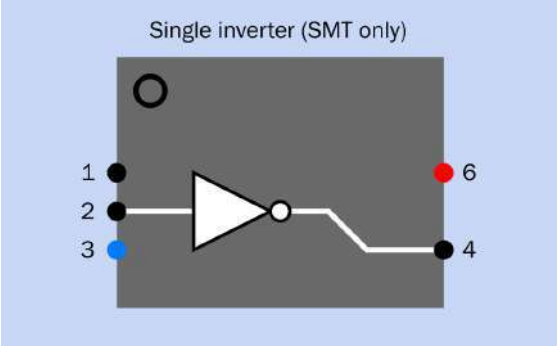

Figure 10-22. *The internal layout of a 74xx series logic chip containing one inverter. This is available in surface-mount format only. Pin 5 is absent. Pin 1 is not connected.*

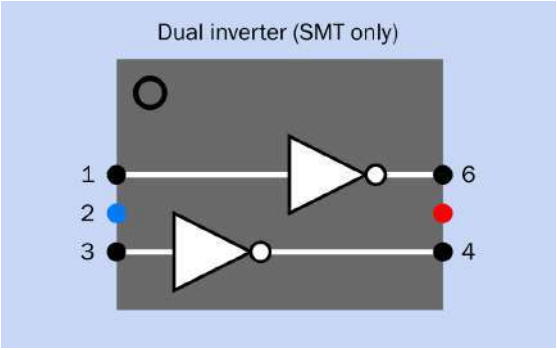

Figure 10-23. *The internal layout of a 74xx series logic chip containing two inverters. This is available in surface-mount format only.*

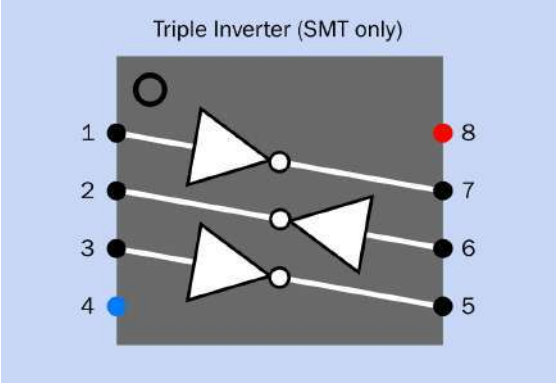

Figure 10-24. *The internal layout of a 74xx series logic chip containing three inverters. This is available in surface-mount format only.*

In the 14-pin format, a hex inverter chip (containing six inverters) is available, as shown in Figure 10-25. The layout is the same for DIP and surface-mount formats.

Generic part numbers for inverter chips are as follows:

- Single inverter: x74x1G04x
- Dual inverter: x74x2G04x
- Triple inverter: x74x3G14x
- Hex inverter: x74x04x

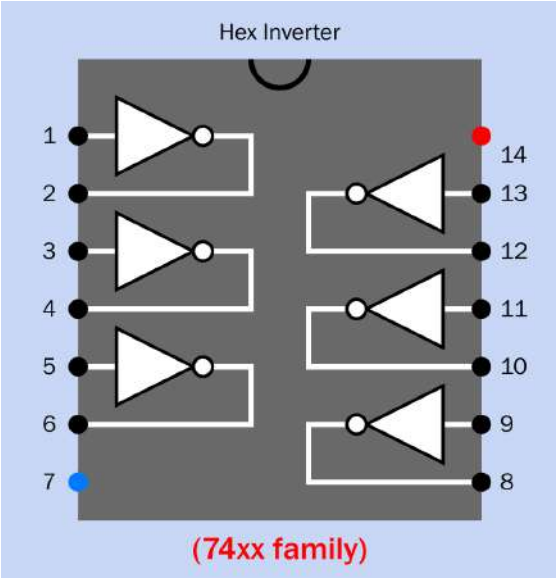

Figure 10-25. *The internal layout of a 14-pin 74xx hex inverter logic chip, containing six inverters. This layout is the same for DIP and surface-mount versions.*

Additional Variations

Some chips in the 74xx series (both DIP and surface mount versions) have variants with open drain or open collector outputs, while others have inputs that are configured as Schmitt triggers. These variants will be found as hits when searching supplier websites for logic chips by gate name and number of inputs.

Pinouts in the Original 4000 Series

Each of the original 4000 CMOS chips contained multiple gates within the limits of a uniform 14-pin chip format. The available options were, and still are:

- Quad 2-input: Four gates of two inputs each
- Triple 3-input: Three gates of three inputs each
- Dual 4-input: Two gates of four inputs each
- Single 8-input: One gate of eight inputs

In the 4000 family, 14-pin quad two-input logic chips are available in AND, OR, NAND, NOR, XOR, or XNOR versions, all of which have an internal layout shown in Figure 10-26. The gates are shown in generic form, as the layout remains the same regardless of which type of gate is in the chip. All the gates in any one chip are of the same type. The four connections leading to a gate are its inputs, while the single connection from a gate is its output.

Unlike the 74xx family, the quad two-input OR chip in the 4000 family has the same pinouts as the other types of quad two-input logic chips.

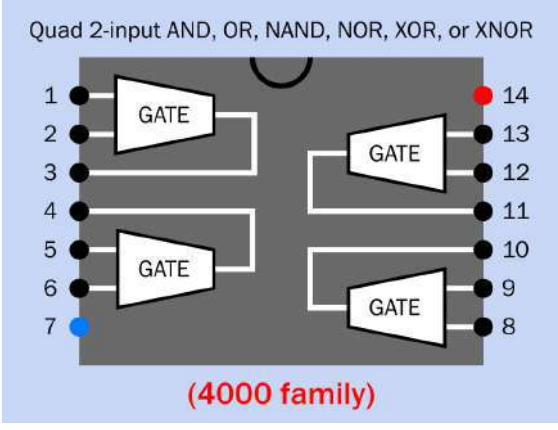

Figure 10-26. *In the 4000 family, the AND, OR, NAND, NOR, XOR, and XNOR versions of a quad two-input logic chip all share this generic layout.*

In the 4000 family, a 14-pin triple three-input logic chip contains three three-input gates. The AND, OR, NAND, and NOR versions all have an internal layout shown in Figure 10-27. The gates are shown in generic form, as the layout remains the same regardless of which type of gate is in the chip. All the gates in any one chip are of the same type. The three connections leading to a gate are its inputs, while a single connection from a gate is its output.

Unlike the 74xx family, the triple three-input OR chip in the 4000 family has the same pinouts as the other types of triple three-input logic chips.

In the 4000 family, a 14-pin dual four-input logic chip contains two four-input gates. The AND, NAND, OR, and NOR versions all have an internal

layout shown in Figure 10-28. The gates are shown in generic form, as the layout remains the same regardless of which type of gate is in the chip. All the gates in any one chip are of the same type. Each pair of connections leading to a gate are its inputs, while the single connection from a gate is its output.

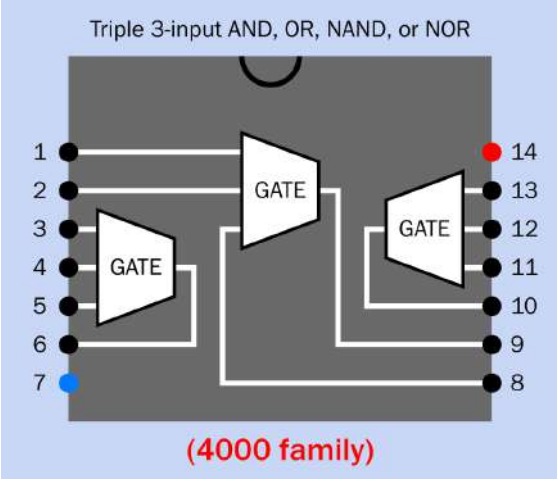

Figure 10-27. *In the 4000 family, the AND, OR, NAND, and NOR versions of a triple three-input logic chip all share this generic layout.*

Note that the 4000 family does have a dual four-input OR chip, whereas the 74xx family does not.

In the 4000 family, a 14-pin eight-input logic chip with AND and NAND outputs is available, as shown in Figure 10-29.

The following list shows the generic part numbers for 14-pin logic chips in the 4000 family that have two or more inputs per gate (in actual part numbers, letters will be substituted where an x appears):

- Quad 2-input AND: x4081x
- Quad 2-input NAND: x4011x
- Quad 2-input OR: x4071x
- Quad 2-input NOR: x4001x
- Quad 2-input XOR: x4070x
- Quad 2-input XNOR: x4077x
- Triple 3-input AND: x4073x
- Triple 3-input NAND: x4023x
- Triple 3-input OR: x4075x
- Triple 3-input NOR: x4025x
- Dual 4-input AND: x4082x
- Dual 4-input NAND: x4012x
- Dual 4-input OR: x4072x
- Dual 4-input NOR: x4002x
- Single 8-input AND/NAND: x4068x

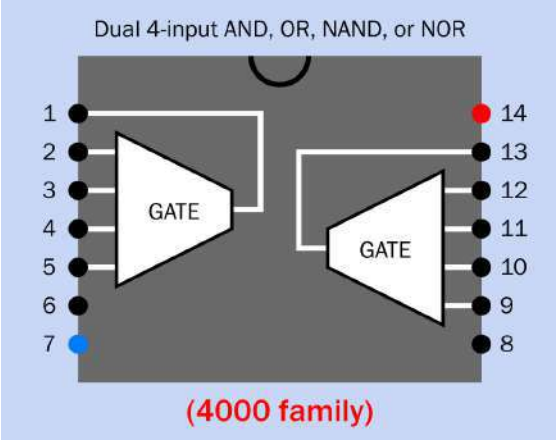

Figure 10-28. *In the 4000 family, the AND, OR, NAND, and NOR versions of a dual four-input logic chip all share this generic layout.*

4000 Series Inverters

In the 4000 family, the 4069B is a 14-pin hex inverter chip (containing six inverters), as shown in Figure 10-30. This has the same pinouts as the x74x04x chip.

How to Use It

Which Family

In DIP format, the HC family has existed for more than 30 years, and has become established as a widely used default choice.

In surface-mount formats, the choice of family will largely be determined by the choice of supply voltage.

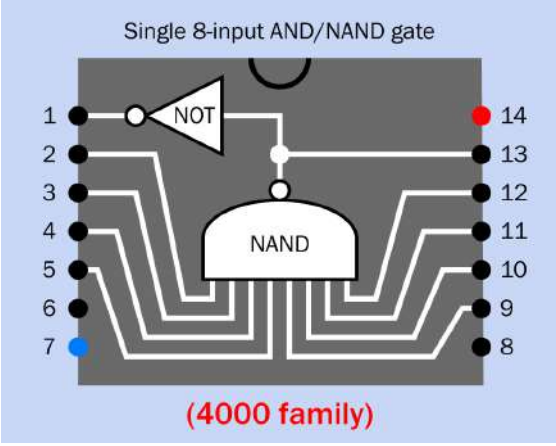

Figure 10-29. *In the 4000 family, a single eight-input AND/NAND chip has this internal layout. The inverted output from the NAND gate becomes an AND output from pin 1 of the chip.*

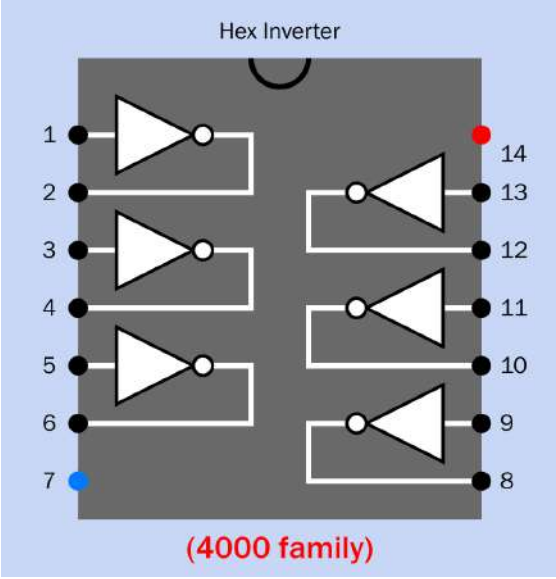

Figure 10-30. *The internal layout of a 14-pin 4069B hex inverter logic chip, containing six inverters. This layout is the same as for the x74x04x chip.*

Although the 4000 series is now more than 40 years old, it may still be useful where a 5VDC power supply is not required for other reasons in a circuit and would be added purely to power a 74xx series logic gate or other digital chip. If a circuit contains a 9VDC or 12VDC relay, for instance, a Darlington pair may be used with that voltage to drive the relay, and an old-school 4000 series logic chip could share the same supply. The relay coil would need a clamping diode to protect the logic chip from transients.

Applications

The output from a logic chip may be used as an input for a microcontroller, to enable multiple inputs to share one pin. An eight-input NAND gate, for instance, could combine the inputs from eight normally on motion sensors. If just one sensor responds to an intrusion, the gate output would change from high to low.

Logic gates may be useful in any simple device that has to respond to a single, specific combination of inputs. A digital combination lock is one example; games of chance are another. Most simple dice simulations use logic gates to convert the output from a counter to drive a dice-pattern of LEDs.

A logic gate may be used as an interface between an electromechanical **switch** and a circuit containing digital chips. A 10K pullup or pulldown resistor prevents the gate input from floating when the switch is open. A buffer can be used for this purpose, or an inverter, or any "spare" gate on a logic chip that is already in the circuit. One input of the chip can be tied to the positive power supply or negative ground, to create an appropriate input from the chip when the switch, attached to the other input, is opened or closed.

A jam-type **flip-flop** can be used to *debounce* a switch input. See Chapter 11 for details. If two NOR or two NAND gates are unused in a circuit, they can form a flip-flop.

In the original CMOS 4000 family, a positive output may be capable of driving an LED if the current does not exceed 5mA with a power supply of 5VDC or 10mA with a power supply of 10VDC. Note that the output voltage will be pulled down significantly by these loads. In the 74HCxx family, chips can source or sink as much as 20mA, but

here again the output voltage will be pulled down. Note that the total limit for all outputs from a 74HCxx chip is around 70mA.

The output from a logic chip can be passed through a buffer such as the 7407, which has an open-collector output capable of sinking as much as 200mA. This enables direct drive of modest loads, so long as they are not inductive.

Solid-state relays and **optocouplers** can be driven directly from logic chips, as they draw very little current. A solid-state relay can switch 50A or more.

What Can Go Wrong

Two problems are common when using CMOS digital chips: damage from *static electricity*, and erratic behavior caused by *floating pins*.

Static

The early 4000 series CMOS chips were especially vulnerable, but more recent CMOS designs generally include diodes at the inputs, which reduces the risk. Still, logic chips should be protected by inserting them into anti-static foam or enclosing them in conductive wrappers until they are installed in a board. While handling chips, it is good practice to be grounded, ideally using a wrist-mounted ground wire.

Floating Pins

Any pin which is unconnected in a logic chip is considered to be "floating," and can pick up signals by capacitive coupling, possibly disrupting the behavior of the chip and also causing power consumption, as the ambiguous pin state will tend to prevent that gate in the chip from entering quiescent mode.

Generally speaking, input pins in a TTL logic chip that are not being used for any purpose should be tied to the positive voltage supply, while unused CMOS pins should be tied to negative ground.

Family Incompatibilities

As previously noted, older TTL logic chips may deliver a "high" output voltage that is lower than the minimum expected by newer CMOS logic chips. The best option is not to mix families, but if chips are stored carelessly, some intermingling can occur. Part numbers should be checked if one chip appears to be ignoring output from another.

Overloaded Outputs

If a circuit calls for a logic chip with an open-collector output, and a regular chip is used by mistake, it will almost certainly be damaged.

Output Pulled Down

If the output from one logic chip is connected with the input of another logic chip, and if the output from the first chip is also connected to an **LED**, the LED may pull down the output voltage so that the second chip will not recognize it as a high state. As a general rule, a logic output can drive an LED, or can drive another logic chip, but not both. Very-low-current LEDs, which draw as little as 2mA, may be acceptable.

Incorrect Polarity and Voltages

Logic chips can be knocked out by applying incorrect polarity, or voltage to the wrong pin, or the wrong voltage. Modern logic chips tolerate a very limited voltage range, and a 74xx series chip will be irrevocably damaged if it is used where a 4000 series chip was specified for a power supply higher than 6VDC.

If a chip is inserted upside-down, it will probably be damaged when voltage is applied.

Bent Pins

Like all through-hole chips, DIP logic chips can be inserted accidentally with one or more pins bent underneath the chip. This error is very easy to miss. The bent pins will not make contact with any socket that is used, and the chip will behave unpredictably. Check for proper pin insertion with a magnifying glass if necessary.

Unclean Input

Logic chips expect a clean input without voltage spikes. A 555 timer of TTL type generates spikes in its output which can be misinterpreted as multiple pulses by the input of a logic chip. A CMOS-type 555 timer is more suitable for connection with logic chips.

If a pushbutton, rotational encoder, or electromechanical switch provides a high or low input, the input must be debounced. In hardware, this is traditionally done with a **flip-flop**. It can also be done with code in a microcontroller.

Analog Input

The input of a logic chip can be connected directly with a thermistor, phototransistor, or similar analog component, but only if there is some certainty that the voltage at the input pin will remain within the range that is acceptable to the chip. In the case of a phototransistor, for example, it should be exposed to a limited, known range of light intensity.

In general, it is best to avoid applying intermediate-voltage signals to a digital logic input, as they can create unpredictable output, or output of an intermediate voltage. A **comparator** can be placed between the analog source and the digital logic chip, or a logic chip with a Schmitt-trigger input can be used.

flip-flop

11

The term **flip-flop** is sometimes printed with a space instead of a hyphen, but the hyphenated form seems to predominate in the United States. Therefore, the hyphen is included here. The term *flipflop* (with neither a hyphen nor a space) is sometimes seen, but is unusual. The acronym *FF* is confined mostly to logic diagrams or schematics.

The term *latch* is sometimes used interchangeably with *flip-flop* but is assumed here to describe a minimal asynchronous circuit that responds immediately and transparently to an input. A flip-flop can function as a latch and also as a synchronous device which is opaque, meaning that the input does not flow directly through to the output.

OTHER RELATED COMPONENTS

- **counter** (see Chapter 13)
- **shift register** (see Chapter 12)

What It Does

Transistors enable logic gates; logic gates enable flip-flops; and flip-flops enable many mathematical, storage, and retrieval functions in digital computing. Most flip-flops today are embedded in much larger integrated circuits that have complex functions. However, they are still available as separate components in chip form, and will be discussed on that basis here.

A flip-flop is the smallest possible unit of memory. It can store a single bit of data, represented by either a high or low *logic state*. (A full explanation of logic states is included in the **logic gate** entry. See Chapter 10.) Flip-flops are especially useful in **counters**, **shift registers**, and *serial-to-parallel converters*.

A flip-flop circuit can be classified as a form of *bistable multivibrator*, as each of its outputs is stable in one of two states until an external trigger stimulates it to "flip" from one state and "flop" into the other. (For a comprehensive discussion of monostable and astable multivibrators, see the **timer** entry in Chapter 9.)

An *asynchronous* flip-flop will respond immediately to a change of input, and can be used for applications such as debouncing the signal from an electromechanical **switch** or building a *ripple* **counter**. More often, a flip-flop is *synchronous*, meaning that a change in input state will be unrecognized until it is enabled by a low-to-high or high-to-low transition in a stream of pulses from an external *clock*.

How It Works

Every flip-flop has two outputs, each of which may have a high or low state. When the flip-flop is functioning normally, the outputs will be in opposite logical states, one being high while the other is low. These outputs are typically identified as Q and NOT-Q (the latter term meaning a letter Q with bar printed above it, sometimes referred to verbally as "Q-bar"). In datasheets and other documents where a bar symbol cannot be

represented easily above a letter, the NOT-Q output may be represented as letter Q with an apostrophe after it, as in Q′.

Almost always, in a schematic diagram, a flip-flop is represented by a simple rectangle, with inputs and outputs identified by letters and other marks. Because a description of the inner workings is necessary before the different types of flip-flop can be understood, schematic symbols for various flip-flops will not be introduced until "Variants" on page 116.

The simplest flip-flop contains two logic gates whose function can be most easily understood if the inputs are controlled by a SPDT switch. It can be created from two NAND gates or two NOR gates, as described next. This type of component can be described as:

- *asynchronous*: Will accept data on an impromptu basis, as it is not synchronized with a clock.
- *jam-type*: Colloquial equivalent of *asynchronous*. The input is jammed in at any time, forcing an immediate change of output.
- *transparent*: The input state flows straight through to the output.

NAND-Based SR Flip-Flop

Figure 11-1 shows two NAND gates attached to a SPDT switch, with two pullup resistors. When either of the NANDs has a floating input from the switch, the pullup resistor attached to that input will maintain it in a high state. The data inputs for the NAND gates are labeled S and R, meaning Set and Reset, giving this component its name as an *SR* flip-flop:

- In a NAND-based SR flip-flop, a low state is considered an active logic input, as indicated by the bar placed above each letter.
- A high state is considered an inactive logic output.

The schematic style in this figure, with diagonally crossing conductors, is universally used and easily recognizable. The equivalent schematic in Figure 11-2, which might be created by circuit-drawing software, has the same functionality but would not be immediately recognizable as a flip-flop. The "classic" crossed-conductor representation is preferable.

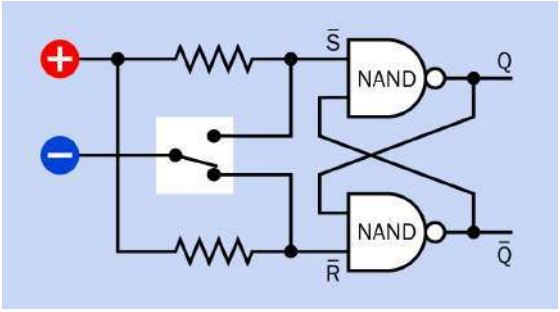

Figure 11-1. *The schematic for a simple NAND-based SR-type flip-flop, with a switch and pullup resistors added to control two inputs.*

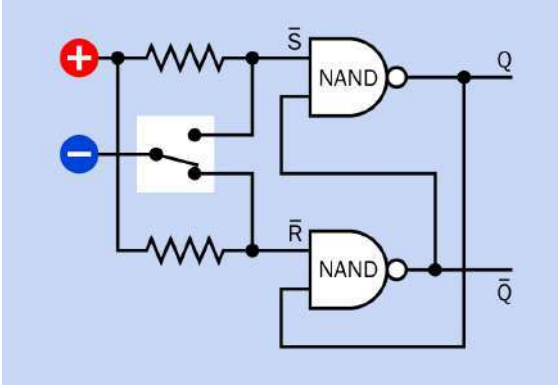

Figure 11-2. *An alternative component layout for an SR flip-flop, functionally identical to the previous schematic, but not so easily recognizable. The layout with a pair of diagonally crossing conductors has become so ubiquitous, it should be considered to be a standard.*

The first step toward understanding the behavior of flip-flops is to recall the relationship between the two inputs and the output of NAND or NOR gates. This is shown in Figure 11-3, where red indicates a high logic state and black indicates a low logic state.

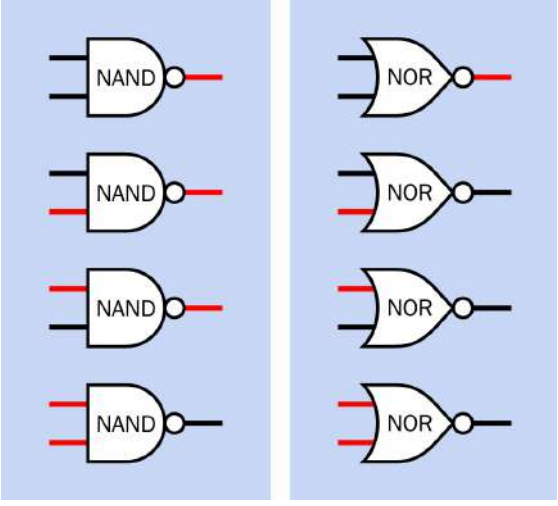

Figure 11-3. *The four possible input combinations for a NAND gate and a NOR gate, with the corresponding logical outputs. A flip-flop can be built from two NANDs or two NORs.*

The behavior of a NAND gate can be summarized:

- Both inputs high: Output low.
- Other input combinations: Output high.

Figure 11-4 shows a series of snapshots of the SR flip-flop circuit as the switch moves from one position, through an intermediate state where it makes no connection, to the other position. Remember that in this circuit, the active logical input state is low, and the active logical output state is high.

In the top panel, the pullup resistor of the lower NAND is overwhelmed by the direct connection to negative ground, which holds the R input in a low state. The other input of this gate is irrelevant, because the output from a NAND will be high if either of its inputs is low. So, the lower NAND has a high output, which feeds back to the secondary input of the upper NAND gate. The S input of this gate is high, because of the pullup resistor. Because both inputs of this gate are now high, its output is low, which feeds back to the lower gate. The lower gate doesn't change its output, because either of its low inputs is enough to keep its output high. So, the circuit is in equilibrium. A high state on the NOT-Q output is known as the *Reset* state for a NAND-based flip-flop.

The second panel shows what happens if the switch now moves up into a neutral, disconnected position. The R input of the lower NAND now becomes high, because of the pullup resistor. But this NAND still has one low input, supplied by the output of the upper gate, so its output remains high, and the circuit is still in equilibrium. This is known as the *Hold* state for the NAND circuit.

Suppose the switch bounces to and fro between the states shown in the first two panels. The output from the circuit won't change. This shows that the circuit provides a method for eliminating *switch bounce*—the very fast, momentary spikes that occur when the mechanical contacts of a switch open and close.

The third panel shows what happens if the switch now moves to its upper position. The top input of the upper NAND gate is now pulled low. Consequently, its output goes high. This feeds back to the lower gate. Its other input is high because of the pullup resistor. With both of its inputs high, its output goes low. The gate outputs have flipped and swapped values. A high state on the Q output is known as the *Set* state for a NAND-based flip-flop.

The circuit still remains in equilibrium even if the switch returns to its central, disconnected position shown in the bottom panel. Therefore, the debouncing capability of the circuit works equally well for both positions of the switch.

NOR-Based SR Flip-Flop

Figure 11-5 shows a similar circuit using two NOR gates attached to an SPDT switch. Because the NOR gates function differently, this circuit uses active-high input logic, and pulldown resistors are needed instead of pullup resistors. The output from the circuit still uses active-high logic, and is identical with the NAND-based circuit in

this respect, although the relative positions of the Q and NOT-Q outputs have been swapped.

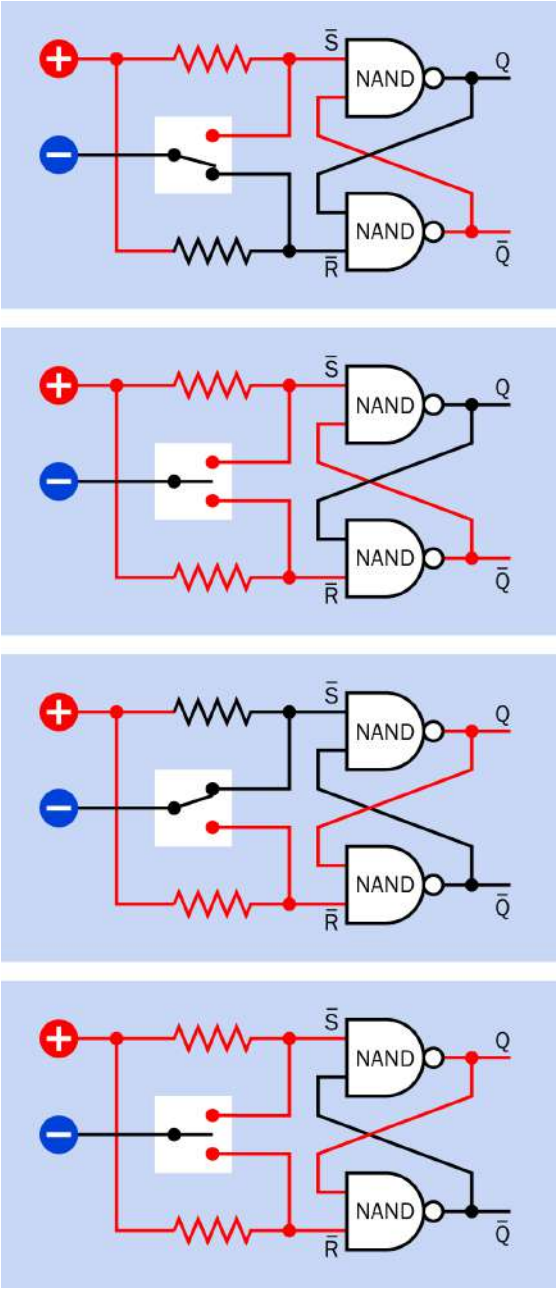

Figure 11-4. *Four snapshots of transitions in a NAND-based SR flip-flop as the switch moves down and up through an intermediate no-connection zone. See text for details.*

- In a NOR-based SR flip-flop, a high state is considered an active logic input, as indicated by the absence of a bar placed above the letters S and R.
- A high state is considered an active logic output.

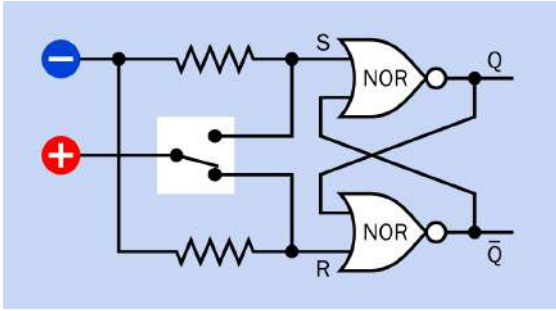

Figure 11-5. *The schematic for a simple SR flip-flop using NOR gates instead of NANDs.*

In the case of the NOR gate:

- Both inputs low: Output high.
- Other input combinations: Output low.

Figure 11-6 shows a series of snapshots as the switch moves from one position to the other, through intermediate states where it makes no connection. Remember that in this circuit, the active logical state is high at both the inputs and the outputs.

In this circuit, as in the previous circuit using NAND gates, it will ignore switch bounce, allowing the gate outputs to remain stable.

Forbidden States

Either of the circuits described so far depicts an SR flip-flop, regardless of whether it is NAND-based or NOR-based. Its input and output states are summarized in Figure 11-7. However, as this table suggests, there are some input states that create problems.

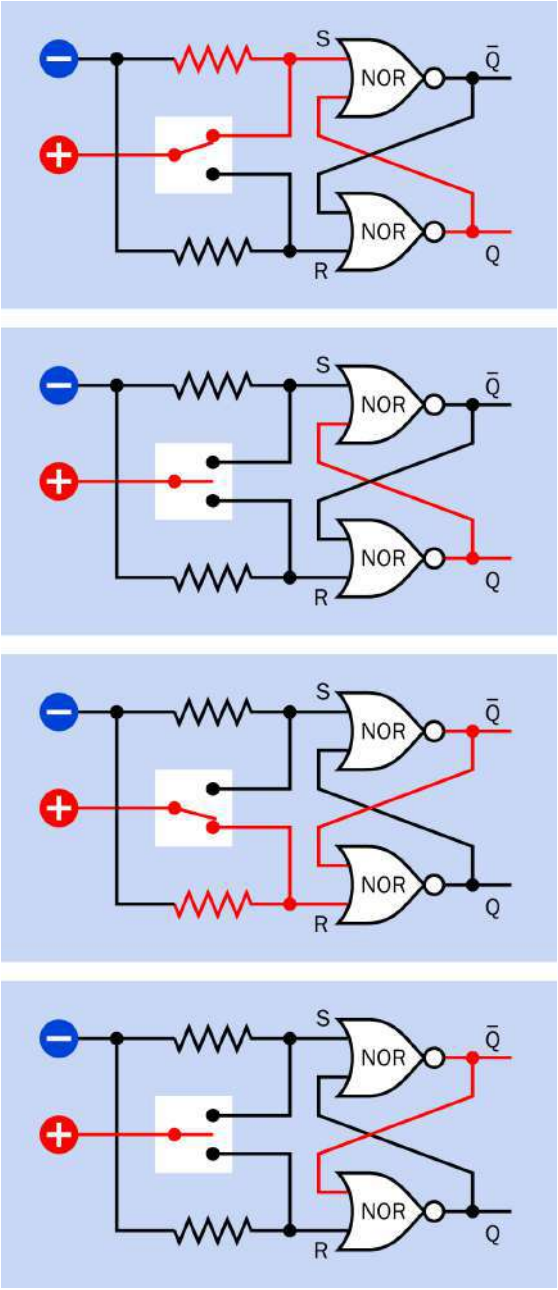

Figure 11-6. *Four snapshots of a NOR-based SR flip-flop, showing the consequence of changing switch positions, comparable with the NAND-based flip-flop.*

Flip-Flop Inputs		Flip-Flop Outputs			
		NAND-based		NOR-based	
S	R	Q	Q̄	Q	Q̄
●	●	● Problem ●		Same as Previous	
●	●	●	●	●	●
●	●	●	●	●	●
●	●	Same as Previous		● Problem ●	

Figure 11-7. *A table of input states and the consequent output states for NAND-based and NOR-based SR flip-flops.*

In either the NAND-based flip-flop or the NOR-based flip-flop, the output when the switch is in its unconnected center position will remain the same as when the switch was in its previous position. This is the usefulness of the flip-flop: it remembers the previous state. These situations are identified as "Same as Previous" in the table.

The pullup resistors (in a NAND-based flip-flop) and pulldown resistors (in a NOR-based flip-flop) are intended to guarantee that both inputs will be high (NAND) or both inputs will be low (NOR) even when the switch makes no connection. Therefore, it should be impossible for both inputs to be low (NAND) or high (NOR).

But what happens if the circuit is powered up with the switch in the unconnected position? One input of each gate is controlled by the output of the other gate. But what will those outputs be?

In the NAND-based version, the outputs from the NANDs will be low while the chips are powering up. As soon as the NAND chips are functioning, each of them will sense that it has one input high and one input low, so it will change its output to high.

But now that each chip has a high output, it will feed back to the secondary input of the other chip. Now both chips have both inputs high. This will cause them both to change their outputs to low—but this will feed back again, flipping the outputs back to high again. In fact, if the gates

are absolutely identical, the circuit will oscillate very rapidly. This is sometimes known as *ringing*.

In real life, the gates will not be absolutely identical, and eventually one of them will respond fractionally ahead of the other, tipping the circuit into the state shown either in the second panel or the fourth panel in Figure 11-4. But which chip will win? There is no way of knowing. This is known as a *race condition*, and the winner is unpredictable.

A similar but opposite situation occurs in the NOR-based flip-flop if it is powered up with the switch in the disconnected position, and the S and R outputs are both low, because of the pull-down resistors. Here again it will be a race condition.

We can address the problem by making a rule that the switch must always be in one position or the other when the flip-flop is powered up. But what if there is a faulty switch? Or what if a power interruption occurs while the switch is changing position?

Another problem occurs if the switch makes one contact a fraction before it breaks the other contact. This would result in both S and R inputs being low, in a NAND flip-flop. The same state could occur if a separate logic circuit is driving the S and R inputs, and an error causes it to make S and R both low. This is shown in Figure 11-8. Because the output from a NAND gate is always high if at least one of its inputs is low, both gates now have a high output, and the circuit is stable.

The problem is, the states of the outputs from a flip-flop should always be opposite to each other. If both of them are high, this can create logic problems in the rest of the circuit attached to the flip-flop.

- In a NAND-based SR flip-flop, if S and R are both low, this is known as a *forbidden state* or a *restricted combination*.

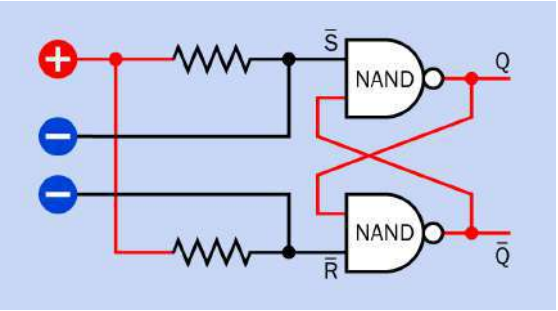

Figure 11-8. *What happens when both S and R inputs to a NAND flip-flop are low as a result of an error in a separate control circuit.*

A similar problem afflicts a NOR-based SR flip-flop, except that the forbidden state will occur when the S and R inputs are both high.

- In a NOR-based SR flip-flop, if S and R are both high, this is a *forbidden state* or a *restricted combination*.

The SR flip-flop is useful as a switch debouncer, but for computing applications, it is vulnerable to errors.

The JK Flip-Flop

Because the name of the JK flip-flop shares the initials of Jack Kilby, who won a Nobel prize for his fabrication of the world's first integrated circuit, some people speculate that this type of flip-flop was named after him. The attribution seems implausible, and may have gained currency simply because a flip-flop was the first device that Kilby happened to build when he was developing an integrated circuit.

Regardless of how it came to be named, the JK design is shown in Figure 11-9. This is commonly referred to as a JK *latch*. The electromechanical switches that were shown driving the SR flip-flop, along with pullup or pulldown resistors, are no longer included, because the inputs at positions J and K are assumed to come from other devices that have properly defined high and low states. Their behavior may be unpredictable, but neither of them will ever have a floating state.

This is a *gated* circuit, meaning that an additional input stage blocks direct access to the output stage, and it is also a *synchronous* circuit, as it uses a train of pulses at a clock input. Two three-input NAND gates are placed in front of a NAND-based SR flip-flop, and they address the problem of simultaneous identical inputs by using crossover feedback from the second stage to the first stage (via the conductors at top and bottom of the schematic).

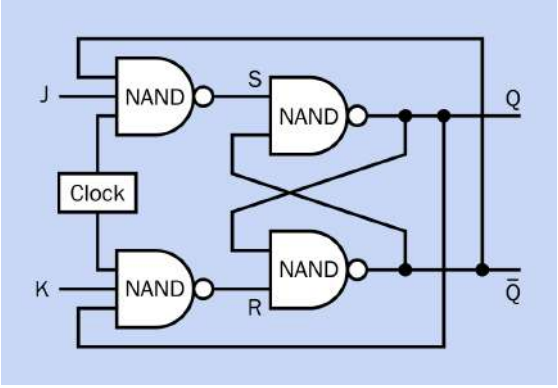

Figure 11-9. *The basic circuit for a clocked JK flip-flop, using two additional NAND gates prepended to an SR flip-flop.*

Versions of a JK flip-flop are possible using NOR gates, but are less common. Only the NAND-based version will be considered here.

In the case of a three-input NAND gate:

- All three inputs high: Output low.
- Other input combinations: Output high.

Because of the additional pair of NANDs, the circuit now recognizes a high input as logically active, instead of the low-active input in the previous SR flip-flop using NAND gates. Consequently, two simultaneous high inputs might be expected to create the type of forbidden state that was caused by two simultaneous low inputs previously. However, in Figure 11-10, the top and bottom panels show that simultaneous high inputs at J and K will support two possible valid outputs, where the state at Q is always opposite to the state at NOT-Q. In fact, when both inputs are high, a positive pulse on the clock input will *toggle* the outputs (i.e., they will switch places). In fact, the toggling will continue so long as the clock input is high. Consequently, this type of flip-flop is intended for use with short clock pulses.

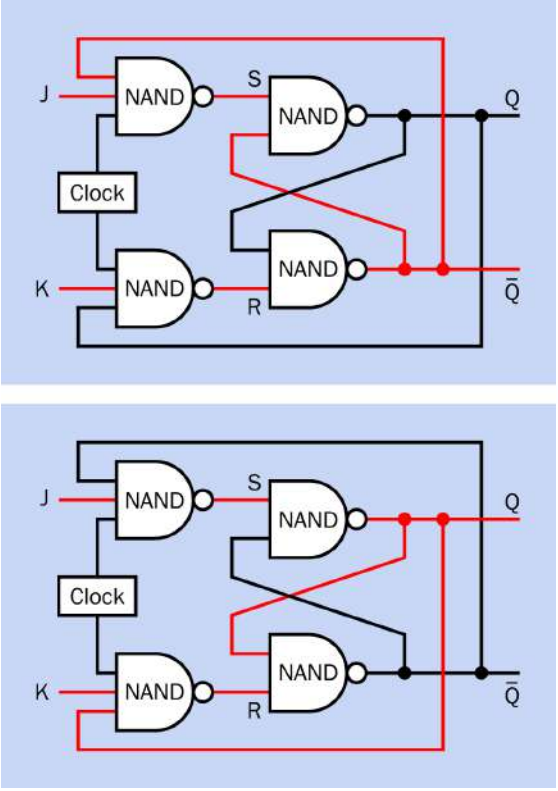

Figure 11-10. *When the J input and the K input are both high, this no longer causes a forbidden state. The combination will toggle the outputs of the flip-flop between the two states shown here.*

Master-Slave Flip-Flop

A more stable form is shown in Figure 11-11 where yet another stage has been added, this one being a "master" to the first. In fact, this configuration is known as a *master-slave* flip-flop, the slave stage being driven by the master stage but remaining inactive until a low clock input at the master stage passes through an *inverter* to become a high clock input at the slave stage. The master and slave stages thus take turns, one be-

ing activated by a high clock pulse while the other is activated by the low part of the pulse cycle. The output from the slave stage cannot feed back to the master stage while the clock pulse is still high, and thus the timing issue in the single-stage JK latch is eliminated. Because the master-slave version of the JK configuration is not *transparent*, it is correctly known as a flip-flop rather than a latch.

In addition, Preset and Clear inputs may be added to override the clock to Set or Reset the outputs. These inputs are active-low.

Figure 11-12 summarizes the behavior of a JK master-slave flip-flop that is triggered by the falling edge of each clock pulse (shown as a downward-pointing arrow in the Clock column of the table). Note that the output will be delayed while the slave stage waits for the second part of each clock cycle.

The letter X in the table indicates that the state in that cell is irrelevant.

When J and K are both low, the states of Q and NOT-Q will remain the same as in the previous cycle, and this is still referred to as a *Hold* state. When J and K are both high, the outputs toggle, meaning that their new states will be opposite to the previous states.

D-Type Flip-Flops

A D-type flip-flop places an inverter between two inputs to guarantee that they will always be in opposite states, and uses a clock signal to copy their states to a pair of logic gates.

When an inverter is added between the inputs in this way, either an SR flip-flop or a JK flip-flop can become a D-type flip-flop. Figure 11-13 shows the simplest possible D-type circuit, added to a basic SR flip-flop. Only one data input is now required (customarily labeled D), because it drives the other through the inverter.

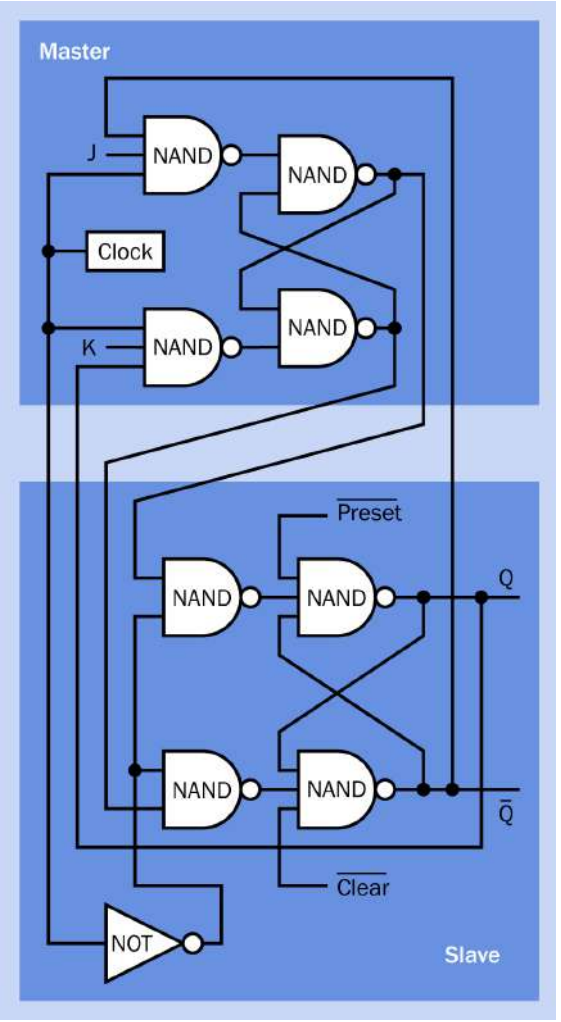

Figure 11-11. *A master-slave circuit that drives one flip-flop with another.*

Flip-Flop Inputs					Outputs	
Clock	Preset	Clear	J	K	Q	Q̄
X	●	●	X	X	●	●
X	●	●	X	X	●	●
↓	●	●	●	●	Same as Prev	
↓	●	●	●	●	●	●
↓	●	●	●	●	●	●
↓	●	●	●	●	Toggle	

Figure 11-12. *A table showing inputs and outputs for a JK master-slave flip-flop.*

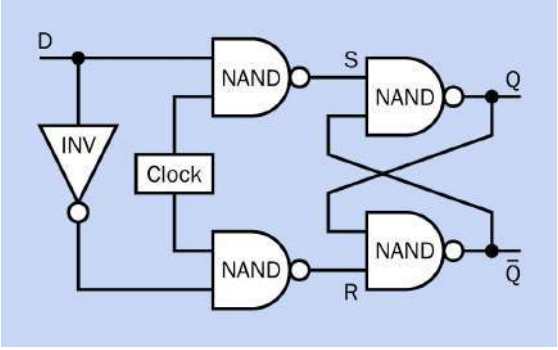

Figure 11-13. *A simple D-type flip-flop. The inverter guarantees that the state of one input will always be opposite to the state of the other.*

Figure 11-14 uses snapshots to show how the circuit responds to changing input and clock conditions. Initially, in the top panel, the data input is high, the clock input is high, and the Q output is high. In the second panel, the clock goes low, causing the output from the upper NAND gate in the input stage to change from low to high. But the upper NAND gate in the output stage still has one low input, so its state remains unchanged. In fact, the S and R inputs of the output NANDs are now both high, which creates the hold condition.

In the third panel, the D input changes from high to low, but this has no effect so long as the clock is low. The D input can fluctuate repeatedly, and nothing will happen until the clock goes high, as shown in the fourth panel. Now the clock copies the new D input state through to the output.

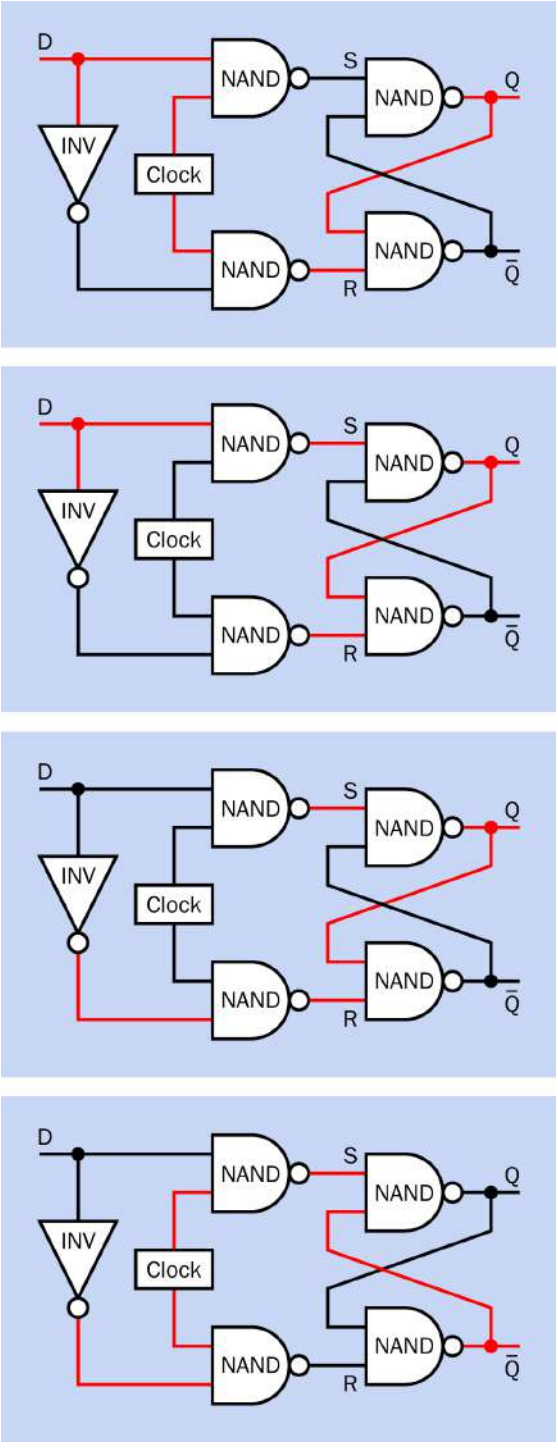

Figure 11-14. *Four snapshots showing the behavior of a D-type flip-flop.*

Summary

- An SR flip-flop can be used for switch debouncing, but in other applications it can enter an unacceptable race condition if its inputs and power supply are not carefully controlled.
- A JK flip-flop is gated, meaning that an SR circuit is preceded with an input stage and a clock input. This eliminates the race condition, adds the ability to toggle the outputs, but requires a very brief clock input. The circuit is edge-triggered.
- A master-slave flip-flop consists of two flip-flops, one driving the other. They can be JK type or SR type. The first flip-flop is activated by a positive clock state, while the second is activated by the subsequent negative clock state. Timing issues are resolved.
- A D-type flip-flop is gated with an inverter between the inputs, so that they cannot be simultaneously high or low. Consequently, only one input, labeled D, is needed. A high state on the D input causes a Set condition, while a low input causes a Reset condition, but only when the clock copies the status of the inputs through to the outputs. The status of the outputs remains stable (the flip-flop enters a hold condition) after the clock goes low.
- The JK circuit used to be widely used, because of its versatility. The D-type circuit now predominates.
- A T-type (toggling) flip-flop exists but is uncommon, and is not included in this encyclopedia.
- Many flip-flop circuits exist in addition to the ones that have been illustrated here. Only the most commonly cited circuits have been included.

A chip containing two positive-edge triggered D-type flip-flops is shown in Figure 11-15. Each flip-flop in this component has its own data, set, and reset input and complementary outputs.

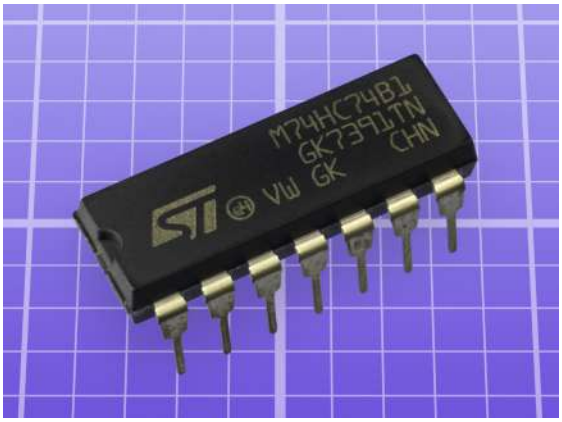

Figure 11-15. *This chip contains two positive-edge triggered D-type flip-flops.*

Variants

A selection of schematic symbols representing flip-flops is shown in Figure 11-16. Letters S, R, J, K, or D define the type of flip-flop. Q and NOT-Q are the outputs. CLK is the clock input but may alternatively be identified with letter E, meaning *Enable*. SRCK or SCLK may also identify it, the abbreviations being intended to mean "serial clock.

A triangle preceding CLK indicates that the flip-flop is positive-edge triggered. A circle, properly termed a *bubble*, preceding the triangle, indicates that the flip-flop is negative-edge triggered. In other locations, the bubble indicates that the input (or output) is inverted; it means the same thing as a bar printed above the text abbreviation, and indicates active-low logic. Synchronous inputs are shown on the left side of the flip-flop with the CLK input, while asynchronous inputs (if any) are shown above and below the flip-flop rectangle.

Using these guidelines, the examples in Figure 11-16 can be decoded:

1. An unclocked SR flip-flop with active-low inputs (probably NAND-based).
2. An unclocked SR flip-flop with active-high inputs (probably NOR-based).

3. An SR flip-flop with active-high inputs, pulse-triggered by an active-high clock input.
4. A JK flip-flop with active-high inputs, edge-triggered by a rising-edge clock input. The bubble on the lower Q output means the same thing as a letter Q with a bar printed above it.
5. A D-type flip-flop pulse-triggered by an active-low clock input.
6. A D-type flip-flop edge-triggered by a falling-edge clock input.
7. A JK flip-flop with active-high inputs, edge-triggered by a rising-edge clock input, with asynchronous active-low Preset and Clear inputs.

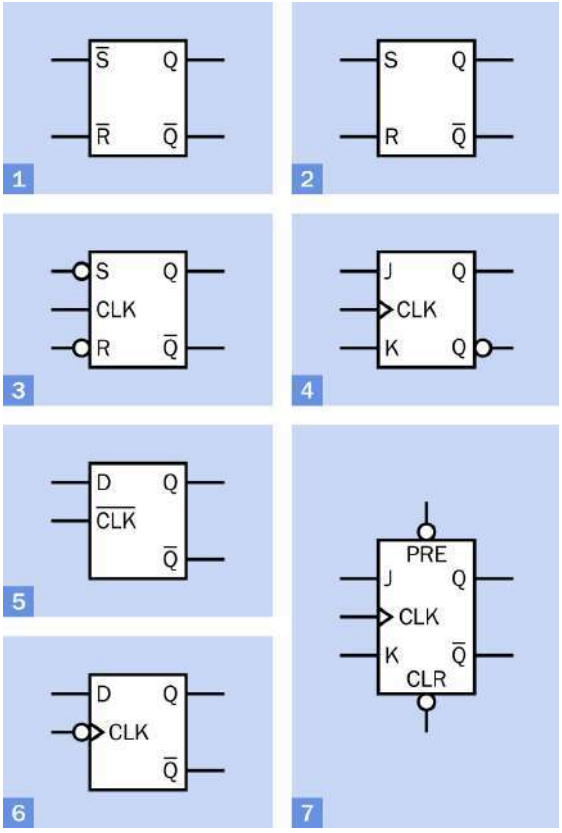

Figure 11-16. *The schematic symbol for a flip-flop is an annotated rectangle. See text for an explanation of the letters and marks.*

Packaging

Only about 10% of the flip-flops listed by a typical parts warehouse are through-hole chips. The rest are now surface-mount. Still, even if the search is narrowed further to through-hole packages in the 74xx and 4000 series, at least 100 types still exist. They provide opportunities in education and prototyping work, even though they are less often used as standalone components.

A package often contains more than one flip-flop. Dual and quad arrays are common. The flip-flops may be independently clocked, or may share a single clock input; datasheets should be checked carefully for details. Octal flip-flops, such as the D-type 74x273, are intended for use as eight-bit registers.

Many of the older flip-flops are numbered in the 74xx series of logic chips. See Chapter 10 for a detailed guide to this numbering system and the various logic families. D-type flip-flops include 74x74, 74x75, 74x174, and 74x175, where an acronym for the logic family is substituted for the x. Old-style CMOS flip-flops include the 4042B D-type latch, the 4043B quad NOR SR flip-flop, and the 4044B quad NAND SR flip-flop. The last two are synchronous, and both allow two Set inputs, labeled S1 and S2 in the datasheet.

Examples of JK flip-flops include the 74x73, 74x76, and 74x109.

Values

As is the case with other logic chips, most flip-flops in the through-hole 74xx series are intended for 5VDC power supply while the older 4000 series may tolerate up to 18VDC. Surface-mount versions may use voltages as low as 2VDC.

See "Variants" on page 93 for a discussion of acceptable high and low logic input voltages. On the output side, the 4000 series chips are able to source less than 1mA at 5VDC, but the 74HCxx series can manage around 20mA.

If a flip-flop is used for high-speed operation, the following values must be considered:

- t_S Setup time: The minimum time in nanoseconds for an input to be constant before the next clock pulse can process it.
- t_H Hold time: The minimum time in nanoseconds for an input to persist after the active edge of a clock pulse that has processed it. The interaction between a clock pulse and an input state takes a brief but measurable amount of time; errors may occur if the clock is given less than that amount of time to do its job.
- t_{CO} Clock-to-output: The elapsed time after an active clock edge, before the output changes. This is a function of the internal workings of the chip, and may be broken down into low-to-high and high-to-low output transitions, as follows.
- T_{PLH} Propagation to Low-to-High: The elapsed time after an active clock edge, before a low-to-high swing occurs at an output. This may not be identical to T_{PHL}.
- T_{PHL} Propagation to High-to-Low: The elapsed time after an active clock edge, before a high-to-low swing occurs at an output. This may not be identical to T_{PLH}.
- f_{MAX} Maximum clock frequency for reliable operation.
- $t_{W(H)}$ The minimum high clock pulse width in nanoseconds.
- $t_{W(L)}$ The minimum low clock pulse width in nanoseconds.

In a shift register or counter, where multiple flip-flops are cascaded but they share the same clock, the t_{CO} of one flip-flop must be shorter than the hold time of the next flip-flop, to allow the input of data to be complete before the window of opportunity is over.

How to Use It

The asynchronous SR flip-flop is of primary use in debouncing switches. Examples are the single MAX6816, dual MAX6817, and octal MAX6818.

D-type flip-flops are widely incorporated in frequency dividers, which are used to count pulses and display a binary output. If the NOT-Q output is wired back to the D input, the pulse stream to the clock input will have the following effect:

1. Suppose the initial D state is low and the initial state of the NOT-Q output is low.
2. The first high clock pulse propagates the low D state into the flip-flop.
3. The next low clock state forces the NOT-Q output high. This feeds back and creates a high D input.
4. The second clock pulse propagates the high D state into the flip-flop.
5. The next low clock state pulls the NOT-Q output low. This feeds back and creates a low D input.

The sequence then repeats. Only one high output is generated at NOT-Q (or at Q) for every two clock pulses; thus the circuit can become a divide-by-two **counter**. If the Q output is tapped to serve as the clock input for another flip-flop, that circuit now has a divide-by-four output. A series of many flip-flops can be chained together, so long as the propagation of signals along the chain is fast enough to occur before the next clock pulse. This is known as an *asynchronous counter*.

For more information on the use of counters, see Chapter 13.

While flip-flops have tended to be integrated with other components in digital computing, they are still used as registers where 8 or 16 bits of serial data must be assembled at a time, prior to being disseminated as parallel data.

What Can Go Wrong

Ambiguous Documentation

For reasons which are unclear, instructional texts and tutorials can be erratic when describing flip-flops:

- A truth table may fail to clarify whether the circuit uses active-high or active-low logic.
- Truth tables from different sources are often inconsistent in their representation of current and future output states, and may even fail to include the clock status in a clocked flip-flop.
- Tutorials may include logic diagrams for some types of circuit, but not others.
- NOR gates may be used, without any mention that NAND gates can also be used (and may be more common or convenient).
- The active-low or active-high status of inputs in an SR flip-flop may not be shown.

Bearing this in mind, manufacturer datasheets should be consulted whenever possible as the primary source of information.

Faulty Triggering

In many cases, a flip-flop designed for edge triggering can give erroneous results if it is level-triggered, and vice versa. Rising-edge-triggered flip-flops must be distinguished from falling-edge-triggered flip-flops. As always, it is important for similar parts that have similar functions to be stored separately.

Metastability

The behavior of flip-flops has been described in this entry under ideal conditions, where they are operating well within parameters established by the manufacturer. In reality, non-ideal scenarios may occur, especially where inputs such as data and clock, or clock and reset, are almost simultaneous. This may be difficult to avoid if a signal is received from an external source such as a sensor, with no way to control its arrival time. If the input occurs within the setup time or the hold time of a clock pulse, the flip-flop may be unable to determine whether the input precedes or follows the clock.

This may lead to *metastability*, meaning an unpredictable output and/or oscillations that take several clock cycles to settle into a stable state. If the output from a flip-flop may be used by two separate components with slightly different response times, one may interpret the oscillating output as a high state while the other interprets it as low. In a computing circuit, metastability can lead to calculation errors or a system crash. To avoid these issues, limits in datasheets should be observed. Attention should be paid to the manufacturer specifications for minimum setup time and hold time, so that the circuit has sufficient opportunity to recognize a signal and respond.

One solution to metastability is to connect multiple flip-flops in series, all sharing a common clock signal. This will tend to filter out irregularities, at the expense of requiring additional clock cycles if the flip-flops are not transparent.

Metastable-hardened flip-flops minimize metastability but cannot eliminate it completely.

Other Issues

Problems that tend to affect digital chips generally are listed in the section of the entry on logic gates (see "What Can Go Wrong" on page 105).

shift register

12

The term **shift register** is rarely hyphenated. In this encyclopedia, no hyphen is used.

A shift register can function as a *queue*, but this term is more usually applied to software. When the output from the last stage of a shift register is connected back to its input, it can function as a *ring counter*, but that application is described in the **counter** entry of this encyclopedia.

Component catalogs sometimes list shift registers as binary ripple **counters**, instead of giving them their own section. In this encyclopedia, a binary counter is considered to have binary-weighted outputs (with values 1, 2, 4, 8…. in decimal notation) and is described in the **counter** entry. A shift register has outputs that are not necessarily binary-weighted.

OTHER RELATED COMPONENTS

- **flip-flop** (see Chapter 11)
- **counter** (see Chapter 13)
- **multiplexer** (see Chapter 16)

What It Does

A *register* is a component (or a small section of computer memory) that stores information. The smallest unit of information is one *bit* (i.e., one *binary digit*) with a value 1 or 0 that can be represented by a high or low logic state. A **shift register** most commonly is designed to store eight bits, although some store four.

Each bit is memorized by the status of a **flip-flop** inside the register. For a detailed description of flip-flops, see Chapter 11. When a pulse from an external *clock* is received by the shift register, all of the bits in storage are moved along one step, from each flip-flop to the next. The high or low status of an input pin at that moment is *clocked in* to the first flip-flop, while the bit in the last flip-flop is overwritten by the bit preceding it. A diagram representing the function of a basic four-bit shift register is shown in Figure 12-1. Note that the status of the input pin is ignored until the moment when a clock pulse copies it into the first flip-flop. In the figure, when the input pin has a brief high state that ends immediately before clock pulse three, the high state is ignored.

A shift-register chip is shown in Figure 12-2.

Because the functionality of a shift register is now often incorporated in much larger logic chips, it is less widely used as a stand-alone component than it used to be. It is still useful for purposes of serial-parallel or parallel-serial conversion, and for small tasks such as scanning a matrix-encoded keyboard or keypad. It also has educational applications and can be used in conjunction with a microcontroller.

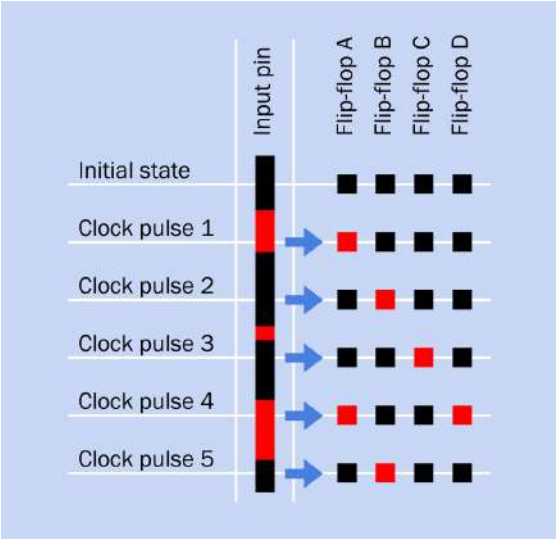

Figure 12-1. *The function of a four-bit shift register in which each flip-flop may be set to a high or a low state, represented here with red or black squares. After a high bit is clocked into the chip, it is moved one space along by each subsequent clock pulse.*

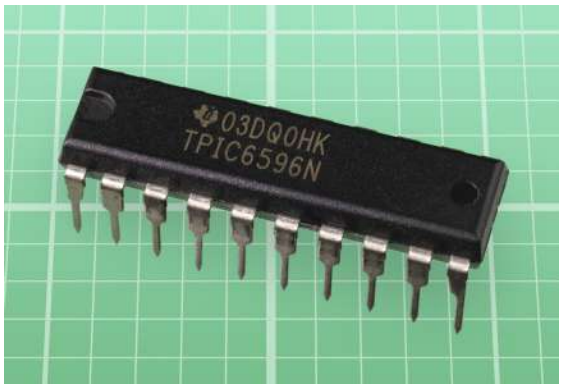

Figure 12-2. *This 8-bit shift-register chip is unusual in that it uses "power logic," in which open-drain outputs enable it to drive relatively high-current devices. It can sink up to 250mA at each of its output pins, at up to 45VDC.*

Schematic Representation

No specific symbol exists for a shift register. It is represented in a schematic by a simple rectangle, often (but not always) with control inputs on the left, data inputs arrayed along the upper edge, and data outputs along the lower edge. An example is shown in Figure 12-3, along with a diagram showing the physical chip and its pinouts. The meaning of the abbreviations identifying the inputs, outputs, and control functions will be described in "How It Works" on page 122.

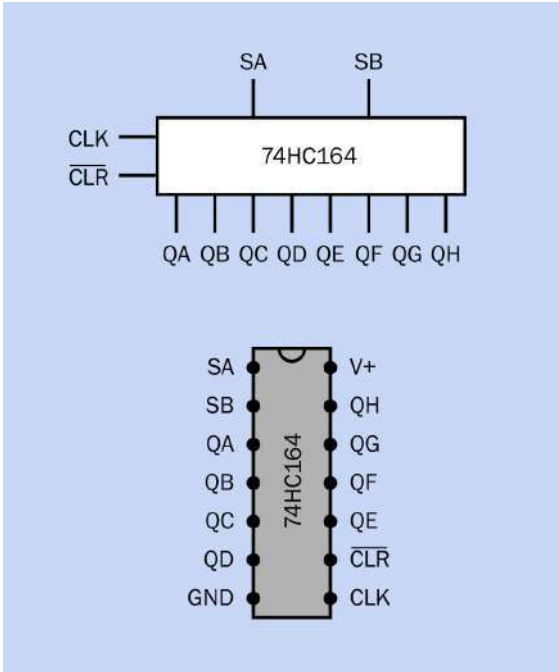

Figure 12-3. *Typical schematic representation of a shift register, compared with the pinouts of the actual component.*

The schematic symbol representing a shift register may appear superficially similar to the physical form of the chip which contains it, but the physical layout of the pins is unlikely to be the same.

How It Works

A shift register generally consists of a chain of D-type flip-flops. See the entry describing **flip-flops** in Chapter 11 for a detailed explanation of this component.

The simplest shift register functions as a *serial-in, serial-out* device, abbreviated with the acronym *SISO*. Because the first bit that enters it will be the first to leave at the opposite end, it can also be

described as a *first-in, first-out* data storage device, using the acronym *FIFO*.

The basic connections between flip-flops in a four-bit SISO shift-register are shown in Figure 12-4. The D input in each section refers to the fact that it is a D-type flip-flop. The primary output from each flip-flop is identified with letter Q.

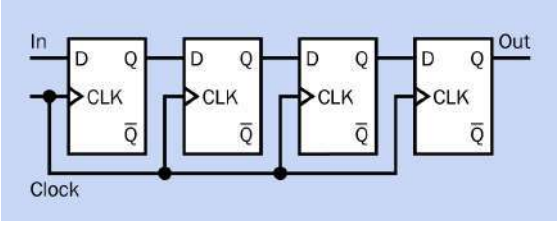

Figure 12-4. *The simplest shift register is a serial-in, serial-out (SISO) device. This example contains four D-type flip-flops.*

Each clock input is labeled CLK. When the output of each flip-flop is coupled to the input of the next flip-flop, and both share the same clock signal, the clock signal will cause the state of the third flip-flop to be sent to the fourth, the output of the second to be copied to the third, the output of the first to the second, and the input state will be copied to the first.

Abbreviations and Acronyms

The shift register will usually have an additional input that forces an immediate "clear" of all the registers, regardless of the clock state at that moment. This input is usually labeled CLR and will have a bar printed above it if it is active-low (which is the usual convention). If there is a pin labeled MR (meaning "Master Reset"), it will have the same function as CLR.

Because its effect is independent of the clock state, the clear signal is described as an *asynchronous* input.

While the abbreviation CLK is frequently used to identify the clock input, SCLK is also used (meaning "serial clock"), and occasionally the abbreviation CP may be found, meaning "clock pulse" input. If the shift register contains two stages, one to clock data in and the second to clock data out, they may be separately clocked, in which case they will be identified with different abbreviations. These are not standardized, but should be explained in the manufacturer's datasheet. No matter which abbreviation is used for a clock input, it will have a bar printed above it if the input is active-low.

Shift registers are generally *edge triggered*, meaning that the rising or falling edge of a clock pulse triggers the bit-shifting operation. If the component responds to a clock transition from low to high, it is *rising-edge triggered*. If it responds to a transition from high to low, it is *falling-edge triggered*, and this may be indicated in the schematic by a small circle, properly known as a *bubble*, preceding the triangle which indicates that this is an edge-triggered device.

Most shift registers are positive-edge triggered.

Parallel Outputs and Inputs

In many shift registers, data may be read out in parallel (from all flip-flops simultaneously), using pins provided for this purpose. In this mode, the shift register can function as a *serial-parallel converter* (*serial in, parallel out*, represented by the acronym *SIPO*). A simplified schematic of the internal connections is shown in Figure 12-5.

Where parallel outputs are provided, they are often identified as QA, QB, QC, and so on (moving from left to right) but may alternatively be described as Q1, Q2, Q3, Q4, and so on.

In a schematic, the input pin is conventionally shown as being at the left end of the component. Often two inputs are provided, connected internally as inputs to a NAND gate. The inputs are likely to be labeled A and B, but may alternatively be named SA and SB, indicating that they are serial inputs. S1 and S2 are alternative classifications. If parallel inputs exist, they may be identified as PA, PB, PC, and so on.

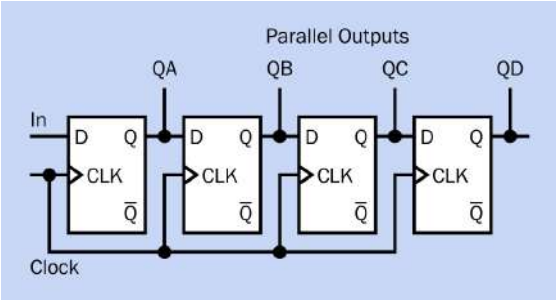

Figure 12-5. *Many shift registers have pins connected to points along the chain of flip-flops. These connections enable data to be read from the shift register in parallel.*

If serial data is supplied asynchronously, as in the illustration in Figure 12-1, it will be ignored until the shift register is triggered by the next clock pulse. The input state at that moment will then be copied into the first flip-flop, while the data that is already being stored in the shift register will be moved along the chain. In datasheets, this is customarily represented by a diagram such as the one in Figure 12-6. This diagram assumes that the shift-register is rising-edge triggered. Note that a brief fluctuation in the input which does not coincide with a clock-trigger event will be ignored.

Variants

Serial In, Serial Out

A basic SISO shift register allows only for serial input (at one end of the chain of flip-flops) and serial output (at the other end of the chain). No pins are available for parallel output of data.

This type of component usually permits 64-bit storage, where parallel output is simply impractical, as too many pins would be required. An example is the 4031B chip. This includes provision for recirculation of bits, so that it will also function as a ring counter (see Chapter 13 for a discussion of this function). As is always the case with logic chips, the part number will be preceded by letter(s) identifying the manufacturer, and a suffix will distinguish variants of the chip.

Another type of SISO shift register is programmable. It will store any number of bits from 1 through 64, determined by a binary number applied in the form of high/low states to five pins reserved for this purpose. An example is the 4557B.

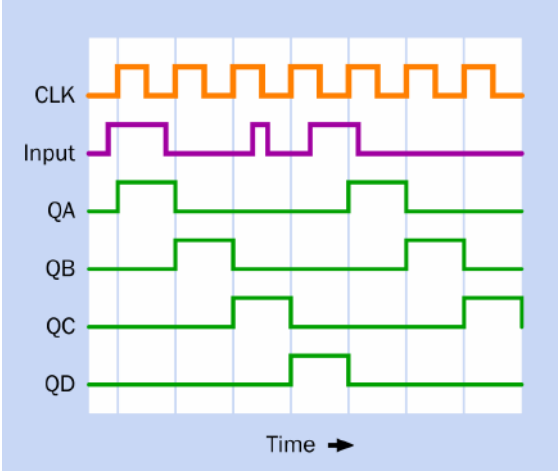

Figure 12-6. *In a rising-edge-triggered shift register, the high or low state of an asynchronous input (purple line) is copied into the first flip-flop of a shift register by each clock pulse (orange line). Brief fluctuations that do not coincide with a rising clock pulse are ignored. Existing data in the register is shifted from one flip-flop to the next.*

Serial In, Parallel Out

The majority of serial-input shift registers allow parallel output from points along the chain in addition to serial output at the end of the chain. These chips almost all are 8-bit registers. Typically two inputs are provided, one of which can be used to receive bits that recirculate from the end of the chain, back to the beginning. Widely used examples are the 4094B and the 74x164, where an acronym identifying the logic family will be substituted for the x.

Parallel In, Serial Out

A minority of shift registers are able to function as *parallel-serial converters* (*parallel in, serial out*, represented by the acronym *PISO*). Typically this type of chip allows *jam-type* parallel data input, meaning that the data is forced into the flip-flops

via a separate pin for each of them. Parallel input is enabled by the status of a serial/parallel control pin. When the control pin reverts to its opposite status, each clock pulse will now shift data along the chain of flip-flops, allowing it to be read from the final output one bit at a time. Thus, data can be entered into the chip in parallel and read out of it serially. Examples are the 4014B and 4021B. Both are 8-bit.

Parallel In, Parallel Out

Shift registers that permit parallel output in addition to parallel input are almost all of the *universal* type, described in the next section.

Universal

A *universal* shift register is capable of all four modes of operation: SISO, SIPO, PISO, and PIPO. The four modes of the component are selected by the high or low status of two *mode select* pins. In addition, this component may have the ability to shift the register states either left or right. A *bidirectional* shift register has this same capability, and may also have PISO and PIPO capability, depending on the chip. Examples are the 74x195 and 74x299, where an acronym identifying the logic family will be substituted for the x in the number.

Universal shift registers are almost all 4-bit or 8-bit. They often have relatively complicated features, such as access to internal JK flip-flops, or pins that are multiplexed to provide different functionality depending whether an enable pin is held high or low. Datasheets must be checked carefully to ensure correct use.

Dedicated shift registers of SIPO or PISO type will be easier to use.

Values

As is the case with other logic chips, most flip-flops in the through-hole 74xx series are intended for 5VDC power supply while the older 4000 series may tolerate up to 18VDC. Surface-mount versions may use voltages as low as 2VDC.

See the section on logic gates in Chapter 10 for a discussion of acceptable high and low logic-input states. On the output side, the 4000 series chips are able to source less than 1mA at 5VDC, but the 74HCxx series can usually manage around 20mA.

If a shift register is used for high-speed operation, the following values must be considered (identical notation, and similar values, are found in specifications for flip-flops):

- t_S Setup time: The input state of a shift register must exist for a very brief period before the clock trigger that processes it. This period is known as the *setup time*. In the 4000 series of chips, recommended setup may be as long as 120ns. The value will be much lower in 74xx chips.
- t_H Hold time: The minimum time in nanoseconds for an input to persist after the active edge of a clock pulse that has processed it. In many shift registers, no hold time is necessary, as the chip has already been activated by the rising edge of the clock pulse.
- t_{CO} Clock-to-output: The elapsed time after a clock trigger, before the output changes. This is a function of the internal workings of the chip, and may be broken down into low-to-high and high-to-low output transitions, as follows.
- T_{PLH} Propagation to Low-to-High: The elapsed time after an active clock trigger, before a low-to-high swing occurs at an output. This may not be identical to T_{PHL}.
- T_{PHL} Propagation to High-to-Low: The elapsed time after an active clock trigger, before a high-to-low swing occurs at an output. This may not be identical to T_{PLH}.
- f_{MAX} Maximum clock frequency for reliable operation. In the older design of 4000 series chips, 3MHz may be recommended with a power supply of 5VDC. Higher frequencies are possible with a higher voltage power

supply. Frequencies as high as 20MHz are possible in the 5VDC 74HC00 series.

- $t_{W(H)}$ The minimum high clock pulse width in nanoseconds. In the older design of 4000 series chips, 180ns may be recommended with a power supply of 5VDC. Shorter pulses are possible with higher voltage power supply. Pulses as short as 20ns are possible in the 5VDC 74HC00 series.
- $t_{W(L)}$ The minimum low clock pulse width in nanoseconds. This is likely to be the same as $t_{W(H)}$.

Power Considerations

Shift registers conform with the usual power-supply requirements for logic families. These are described in detail in the **logic gate** entry in Chapter 10. Likewise, the ability of a shift register to source or sink current is usually determined by its logic family. In a few cases, however, shift registers have an additional *open-drain* output stage for each register, capable of sinking currents as high as 250mA. The Texas Instruments TPIC6596 shown in Figure 12-2 is an example. When an open-drain output is connected with a logic device whose input cannot be allowed to float indeterminately, a *pullup resistor* must be added.

Three-State Output

A chip may have a *three-state output* (also known as *tri-state output*, a term which was trademarked but is now used generically). This means it will be capable of changing its outputs so that instead of sourcing or sinking current in a logical high or low state, they can have a high impedance. The chip then becomes "invisible" to others which may be sharing the same output bus. The high-impedance state is usually applied to all outputs from the shift register simultaneously when enabled by a separate pin, often identified as *OE*, meaning *output-enable*. Examples of three-state shift registers are the 74x595 or the 4094B chip.

The high-impedance state can be thought of as being almost equivalent to switching the outputs of the shift register out of the circuit. Consequently, if other components sharing the bus are also in high-impedance output mode, the state of the bus will "float," with uncertain results. To avoid this, a pullup resistor of 10K to 100K can be used on each bus-line.

Where the internal components of a shift register are shown in a datasheet, a three-state output is usually represented with a buffer symbol or inverter symbol that has an additional control input located on its upper edge, as shown in Figure 12-7. This should not be confused with the similar placement of a positive power supply input to an amplifier or op-amp. (Schematics showing the interior elements of a logic chip almost never include power-supply connections.)

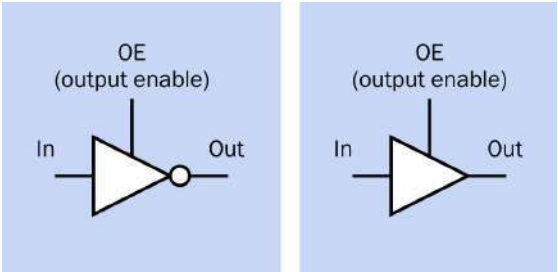

Figure 12-7. *A shift register may be capable of a three-state output, where high impedance is an option additional to the usual high or low logic state. An output enable pin allows this. It is typically shown as an additional input to an inverter (left) or buffer (right) inside the shift-register chip.*

How to Use It

The SISO application of a shift register can be used simply to delay the transmission of data by storing it and moving it from one flip-flop to the next before it is read out of the end of the chain.

The SIPO application of a shift register (serial in, parallel out) may be useful where a microcontroller has insufficient outputs to control multiple devices. Serial data can be sent from a single microcontroller output to the input of a shift register. The chip can then drive a separate device from each of its parallel output pins. If there are eight devices, the microcontroller can send a se-

quence of eight bits, each of which will control the on/off status of one device when the bits are read out of the shift register in parallel. If more devices are used, an additional shift-register can be daisy-chained to the output from the first.

Clock signals can be supplied from the microcontroller, along with a signal to the clear input of the shift register, if desired. Alternatively, the old bit states in the shift register can simply be "clocked out" and replaced with a new set of serial data. During the process of "bit banging," the parallel outputs of the shift register can remain connected directly with the output devices if the clock speed from the microcontroller is fast enough, as devices such as relays will not respond to extremely brief pulses.

For generic shift registers that do not have open-drain outputs, a buffer will be needed to provide sufficient current for any device using more current than an LED.

If a shift register is configured for PISO mode (parallel in, serial out) it can be placed on the input side of a microcontroller, polling a variety of devices and feeding their states into the microcontroller serially.

Dual Inputs

Where a shift register has two serial inputs (as is often the case), they are almost always linked as inputs to an internal NAND gate. This allows the output from the end of the chain of flip-flops to be connected back to the beginning of the chain, if the shift register is to function as a ring counter. However, if this function is not used and a single input is required, the two inputs to the shift register can be tied together. In this configuration, the input becomes active-low. The two possible configurations are shown in Figure 12-8. It is important never to leave an input *floating*, or unconnected.

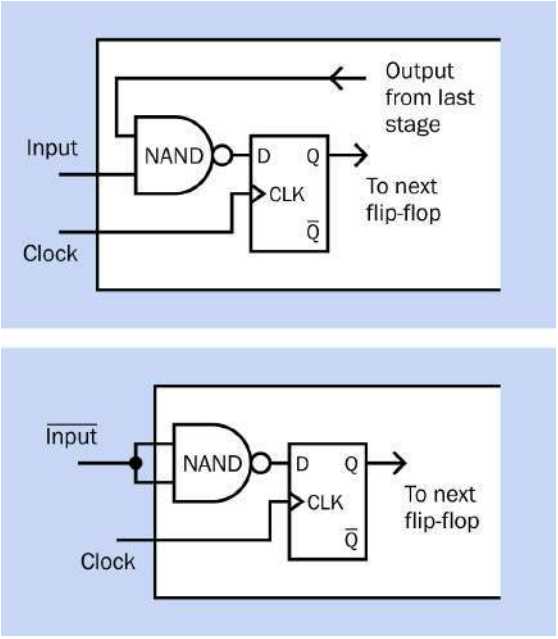

Figure 12-8. *Two possible configurations where a shift register allows two inputs linked with an internal NAND gate.*

Preloading the Shift Register

Where a shift register will be used to output a single recirculating bit (or in similar applications), the component must be preloaded with a high state in its first register. This may require a one-shot (monostable) timer which is activated only when the circuit is powered up.

Polling a Keyboard

Two shift registers can be used to scan the data lines in a matrix-encoded keyboard or keypad. This is often known as *polling* the keyboard. Provided the scan rate is sufficiently fast, the user experiences a seemingly immediate response to a key-press.

While the full schematic is too large and complex to be included here, many examples can be found online.

Arithmetical Operations

Shift registers were traditionally used to perform arithmetical operations on binary numbers. If the

number is represented by eight bits (i.e., one byte) with the most significant digit on the left, shifting the bits one space to the right will have the effect of dividing the byte value by 2. If the bits are shifted one space to the left, the byte value will be multiplied by 2 (provided an additional register is available to store the most significant bit after it has been shifted). This concept is illustrated in Figure 12-9.

Figure 12-9. *In the upper section of this diagram, a binary number represented by eight bits in a shift register is multiplied by 2 by shifting all the bits one space to the left. In the lower section, the same binary number is divided by 2 by shifting all the bits one space to the right. The binary values are shown in decimal notation to the left.*

In the upper section of the figure, the binary number 10010110 (chosen arbitrarily) is represented in the eight flip-flops of a shift register. The decimal place value of each digit is indicated. Adding up the place values of the 1s in the number, the total is 128 + 16 + 4 + 2 = 150. Below the white line, the digits have been shifted one place to the left, with the leftmost digit carried over to an additional location, while a zero is inserted in the rightmost location. Assuming that the additional place at the leftmost location has a place value of 256, the total is now 256 + 32 + 8 + 4 = 300.

In the lower section of the figure, the same binary number has been shifted one space to the right, with a 0 introduced in the leftmost location. The decimal value is now 64 + 8 + 2 + 1 = 75.

While this application for shift registers was common during development of digital computing in the 1960s and 1970s, the shift register as a separate component became less common subsequently, as its functionality was acquired by modern CPU chips.

Buffering

A shift register may also be used as a *buffer* between two circuits where the clock speeds are different. Digits are clocked in by the first circuit, then clocked out by the second. Some shift registers allow two clock inputs and can be used for this purpose.

What Can Go Wrong

Problems that tend to affect digital chips generally are listed in the entry on logic gates (see "What Can Go Wrong" on page 105).

Confusing Classification

Because of the functional similarity to a binary ripple **counter**, a shift register is sometimes listed by component suppliers as a counter. In fact, a binary counter will almost always have outputs that have place values 1, 2, 4, 8…. and upward, while the outputs from a shift register will not have place values.

When searching for a shift register, it can be found by specifying a "counting sequence" of serial to parallel, serial to serial, parallel to serial, or parallel to parallel. If the "counting sequence" is simply up or down, the component is a counter, not a shift register.

Inadequate Setup Time

Each flip-flop in a shift register must have a stable input state before the next triggering event shifts the data. If this setup time is reduced below the minimum specified in the datasheet, results will be unpredictable.

Unconnected Input

Because many shift registers have a choice of two inputs to the same chain of internal flip-flops, it is easy to leave one of them unconnected by accident. A floating input will be vulnerable to any stray electromagnetic fields, and is almost certain to create random effects.

Output Enable Issues

The output enable pin on a shift register that has three-state logic outputs is usually active-low. Consequently, if the pin is left unconnected, the logic outputs may go into high-impedance mode, or will fluctuate unpredictably. Where three-state outputs are not required, a safe course of action will be to avoid using three-state chips.

Floating Output Bus

If a pullup resistor is omitted from a bus that is shared by three-state chips, the results will be unpredictable. Even if the circuit design seems to guarantee that at least one chip will have a high or low output on the bus, a pullup resistor should still be included.

counter

13

The term **counter** is used here to mean a digital-logic chip. A counter could be built from discrete transistors, but this approach is obsolete. Counters may also be devised from parts such as multiple relays, or a solenoid advancing a ratchet wheel, but such electromechanical devices are not included in this encyclopedia.

In this encyclopedia, a counter by definition has binary-weighted outputs with values 1, 2, 4, 8…. in decimal notation. The exception to this rule is a *ring counter*, which does not have binary-weighted outputs but is included here because its name identifies it as a counter. A **shift register** may be used as a ring counter, but is more versatile and has many other functions; hence it has a separate entry.

Gray code counters, in which successive outputs differ by only one binary digit, are not described in this encyclopedia.

OTHER RELATED COMPONENTS

- **flip-flop** (see Chapter 11)
- **shift register** (see Chapter 12)

What It Does

A counter can be used to count events, or can measure time in convenient intervals if it is connected with a component such as a *quartz crystal* that operates at a precise and reliable frequency. The counter receives input pulses (usually referred to as a *clock input*) and counts a predetermined number of them before restarting from the beginning. It will repeat in this fashion so long as power is connected, and the clock pulses continue, and a reset signal is not supplied.

Almost all counters create some form of output during the count. Most commonly, the output is a pattern of high and low states expressing the number of clock pulses in binary code. Where a counter counts to a very high number before recycling, some intermediate binary digits may be omitted.

While standalone counter chips are not as widely used now as in the early days of computing, they still find application in industrial processes, small devices, and education, and can be used to control incremental devices such as stepper motors. They can be used in conjunction with microcontrollers.

Schematic Representation

No specific logic symbol exists for a counter. It is most often shown in a schematic as a rectangle with clock input(s) and clear input(s) on the left and outputs on the right. An example appears in Figure 13-1, above a representation of the physical chip and its pinouts. The meaning of the abbreviations identifying the inputs, outputs, and control functions will be found in "How It Works" on page 132. Because the two MR inputs for this particular counter are ANDed inside the chip,

the AND symbol is included with the counter symbol.

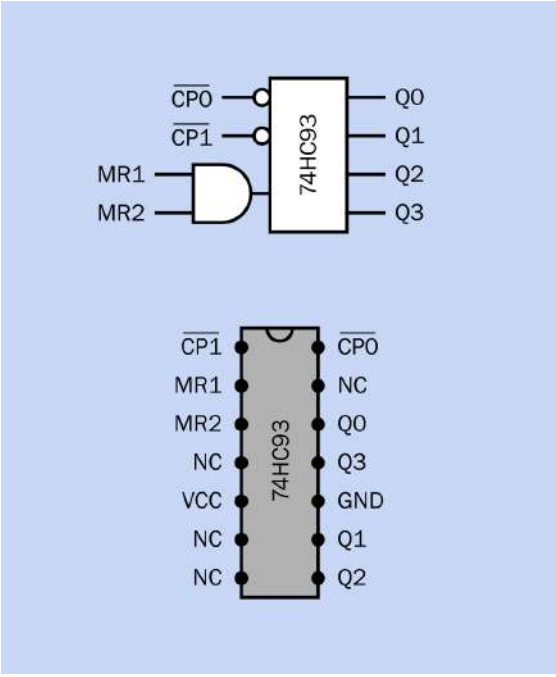

Figure 13-1. *Typical schematic representation of a counter, compared with the pinouts of the actual component.*

A counter chip is shown in Figure 13-2.

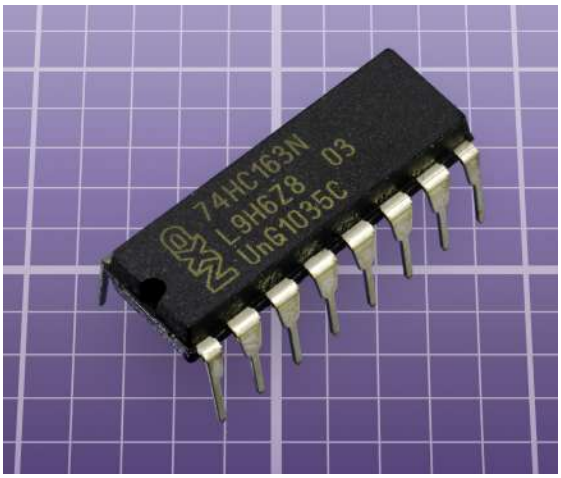

Figure 13-2. *The 74HC163 shown in this photograph is a 4-bit synchronous counter capable of being preloaded with a starting value, and able to do a synchronous reset.*

How It Works

A counter is built from a chain of **flip-flops**, with each one triggering the next. JK, T-type, or D-type flip-flops may be used. For a thorough description of a flip-flop, see Chapter 11. In Figure 13-3, a D-type flip-flop is shown, triggered by each rising clock pulse.

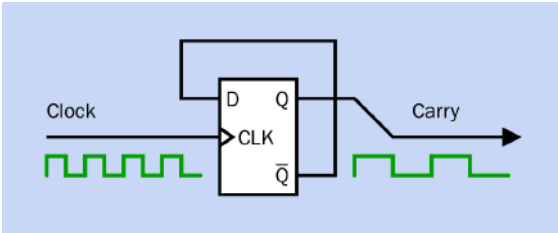

Figure 13-3. *When the complementary (NOT-Q) output from a D-type flip-flop is connected back to its input, the Q output frequency is half of the clock input frequency. See text for additional details.*

Initially the Q output of the flip-flop is low, so its NOT-Q output (identified by Q with a bar above it) is high. This feeds back to the D input, but has no effect until the rising edge of the next clock pulse copies the high D input to the Q output. The Q output is now latched high while the NOT-Q output is latched low and feeds back to the D input. The triggering event has passed, so the low D input does not have any immediate effect. The rising edge of the next clock pulse copies the low state of the D input to the output, and changes the NOT-Q output to high, causing the cycle to repeat. As a result, the output frequency of the flip-flop is one-half of the input frequency from the clock. If the output is carried to the next flip-flop to become its clock input, once again the frequency will be divided by two.

Modulus and Modulo

The *modulus* of a counter is the number it will count up to, before it repeats. This is sometimes written incorrectly as *modulo*.

In fact, *modulo* is the name of an arithmetical operation, often abbreviated as *MOD* (usually capitalized, even though it is not an acronym). This

operation consists of a division sum in which the *remainder* from the division is the result of the operation. Thus 100 modulo 5 gives a result of 0, because there is no remainder when 100 is divided by 5. But 100 modulo 7 gives a result of 2, because 2 is the remainder of the division operation.

To exacerbate the confusion, *MOD* is also used as an adjective referring to the modulus of a counter. Thus a MOD-4 counter has a modulus of 4, and a MOD-16 counter has a modulus of 16. As a general rule, when a counter is being described, *modulo* and *MOD* will mean the same thing as *modulus*. This may be confusing to people such as computer programmers who are already familiar with the correct usage of MOD as an arithmetical operator.

In a counter, to obtain a modulus that is not a power of two, logic gates inside the chip can intercept a particular value (such as 1010 binary, which is 10 decimal) and use this as a signal to restart the count at zero. External connections to the chip can achieve the same purpose.

Pin Identifiers

Abbreviations and acronyms are used in datasheets to identify pin functions. These identifiers have not been standardized, and many variants exist.

CLK is the abbreviation most commonly used for the clock input, sometimes alternatively shown as CK or CP. If it is active-low, or if its falling edge will be active, a bar will be printed above it. Where a printed font does not permit an underscore to be placed in this way, CLK' (the abbreviation followed by an apostrophe) may be used instead. Often two or more stages of a counter can be separately clocked, and the input pins will be identified with abbreviations such as CLK1 and CLK2, or 1CLK and 2CLK, or CKA and CKB, or CP1 and CP2, or similar.

Where a clock input is edge-triggered, this is indicated by a small triangle. The triangle can be seen in Figure 13-3.

CLR designates a pin which will clear the count and reset it back to zero. This signal is often active-low, indicated by a bar printed above the abbreviation.

In a schematic, a small circle, properly known as a *bubble*, may be placed at any input which is active-low. On a clock input, the circle indicates that it is falling-edge triggered. See Figure 11-16 for various implementations of symbols with flip-flop schematics.

The CLR operation may be *synchronous* (the pin state will not be recognized until the next clock pulse) or *asynchronous* (in which case the pin state overrides the clock and resets the counter immediately). MR stands for "Master Reset," and has the same function as CLR.

Where two or more counters (or multiple stages within one counter) can be reset separately, more than one clear input will be shown, and may be identified with abbreviations such as CLR1 and CLR2, or MR1 and MR2.

Output pins will almost always be identified as Q0, Q1, Q2 … or QA, QB, QC … up to the maximum necessary to express the modulus. If two or more counters are included in one chip, outputs may be prefixed with an appropriate number. Thus 2Q3 would be the third output in the second counter. Multiple counters in one chip are identified with numbers starting from 1.

Where internal flip-flops are shown, they will have identifiers such as FF1 or FF2. Each flip-flop will have its own clear function, identified as C or CD (the latter meaning "clear data"), and may have inputs labeled D1, D2, D3… in a D-type flip-flop or J and K in a JK flip-flop. See Chapter 11 for an explanation of flip-flop inputs and outputs.

The input to a counter is always imagined to begin from the left, and consequently the leftmost flip-flop shown in an internal schematic will express the least significant bit of the current value of the count, even though a binary number is written with the least significant bit in the rightmost place.

If a counter is capable of receiving parallel data as an input (explained below) it will have a pin labeled PE for parallel enable. It may also have a CE or CET pin, for count enable.

As is generally the case in logic chips, VCC or V+ are typically used to identify the positive power supply pin, while GND or V- will identify the negative-ground pin. NC means that a pin has no internal connection at all, and consequently requires no external connection.

Variants

All counter chips use binary code internally, and the number of *bits* (*binary digits*) in the counter's modulus will be the same as the number of internal flip-flops. A 4-bit counter (the usual minimum) will have a modulus of 2^4 which is 16. A 21-bit counter (the maximum typically available) will have a modulus of 2^{21} which is 2,097,152. For higher moduli, counters can be chained together, each sending a carry signal to the next. This is known as a *cascade*.

Multiple counters, with different moduli, may be chained in a single chip. For example, in a digital clock that displays hours and minutes using the 60Hz frequency of an American domestic power supply as its timebase, the initial counting stage will have a modulus of 60, to count individual seconds. The next counting stages will have moduli of 60, 10, and 6, so that they can count from 00 to 59 minutes. Additional stages in the chip will tally hours.

A counter with a *parallel input* can be preloaded with an initial value (in binary code) from which it may count up or down. A *parallel-enable* pin may put the counter into a mode where the number can be *jam loaded*, meaning that it is jammed into the counter regardless of the clock state. Other types of counter are loaded synchronously.

Ripple versus Synchronous

In a *ripple counter* each internal flip-flop triggers the clock input of the next, so that their states change in a rapid but incremental sequence from the input to the output. This is also known as an *asynchronous* counter. Because the final state will not be valid until the clock pulse has rippled all the way through the counter (and through additional counters if they are cascaded together), a ripple counter will tend to suffer from a *propagation delay* of up to a microsecond. Ripple counters may also create output spikes or momentary transient count values that are invalid. Therefore, they are more suitable for applications such as driving a numeric display than for interfacing at high speed with other logic chips.

In a *synchronous counter*, all the flip-flops are clocked simultaneously. A synchronous counter is better suited to operation at high speed.

Of the counter chips available today, about half are synchronous and half are asynchronous.

Ring, Binary, and BCD

A counter that activates output pins one at a time sequentially is said to have a *decoded output*. It is often referred to as a *ring counter*. It has the same number of output pins as its modulus. An example is the 4017B chip.

A *binary counter* is more common and has an *encoded output*, meaning that it will express the running total of the count in binary code through *weighted outputs* that typically have (decimal) values of 1, 2, 4, 8, and so on. A modulus-8 counter (often referred to as an *octal counter*) will require three outputs which represent the binary numbers 000, 001, 010, 011, 100, 101, 110, and 111 (decimal 0 through 7) before going back to 000 and repeating.

A *modulus-16* counter, also known as a *hexadecimal counter* or a *divide-by-16 counter*, will have a binary output represented by four output pins, counting from 0000 through 1111 (decimal 0 through 15). Four-digit binary counters are very common, and their outputs are compatible with other components such as a **decoder**, which converts a binary-number input into a ring-counter-style output.

A *decade counter* is a modulus-10 binary counter. It is described as having a *binary-coded decimal* output (often expressed with the acronym *BCD*), using four weighted output pins which represent the numbers 0000, 0001, 0010, 0011, 0100, 0101, 0110, 0111, 1000, and 1001 (decimal 0 through 9) before repeating. Because this counter skips binary outputs from 1010 through 1111 (decimal 10 through 15), it is said to have a *shortened modulus*.

Figure 13-4 shows a schematic diagram of JK flip-flops in a decade ripple counter. The J and K inputs are all tied to the positive power supply, as this causes the clock input to toggle the output high and low. Note that because the primary input is always shown at the left end of the component, the least significant output bit (Q0) is in the leftmost position.

To intercept binary 1010 (decimal 10), an internal NAND gate is used. Its output goes low when its two inputs, from Q1 and Q3, go high. The output from the NAND immediately activates the CLR function on all the flip-flops, so that as soon as the decade counter reaches 1010 (decimal 10), it resets itself to 0.

In this particular chip, the preload for each flip-flop is tied to the positive power supply, so that it is always inactive. In some counters, the preload feature of each flip-flop is accessible via pins outside the chip. This creates the potential hazard of preloading the counter with one of the numbers that it normally skips (for instance, 11 decimal in a decade counter). This is referred to as an *invalid number* or *disallowed state*. (This use of the term "state" refers only to the binary number stored in the counter's flip-flops. It has nothing to do with the high-state or low-state voltages used to represent binary 0 or 1.)

The counter's datasheet should include a *state diagram* showing how the counter will deal with this situation. It may reset itself to a valid value after a maximum of two steps, but this can still cause confusion, depending on the application.

The state diagram for a 74HC192 counter is shown in Figure 13-5.

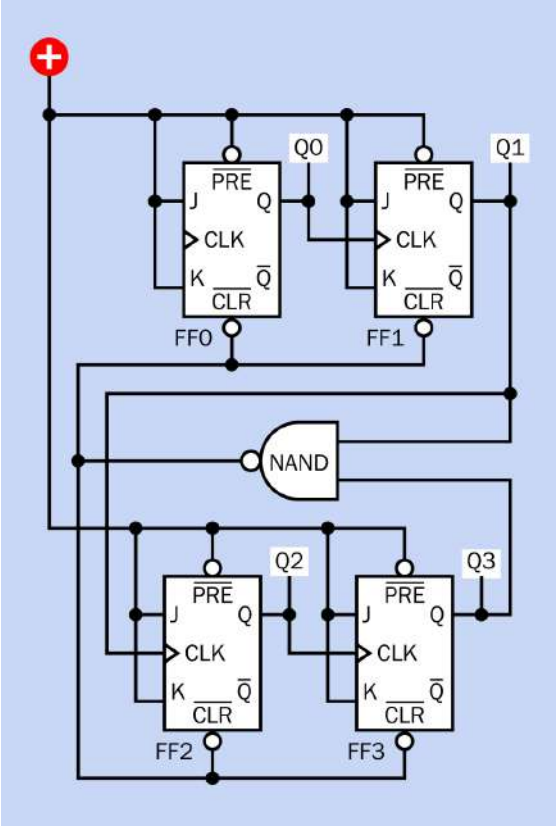

Figure 13-4. *The internal logic of a synchronous decade counter that uses JK flip-flops.*

Clock Sources

The clock input may be provided by a **timer** chip or by an *RC network*, which has the advantage of being able to run at a relatively low speed for purposes where this is desirable. It may alternatively be provided by a *quartz crystal* oscillating at a much higher frequency such as 1MHz. Successive counters may be necessary to reduce this value, depending on the application.

In some counters, the clock is built into the chip. More commonly, a resistor and capacitor may be used externally to establish a clock rate in conjunction with logic gates inside the chip. The datasheet for this type of component will include

a formula for calculating the clock frequency from the resistor and capacitor values. The 4060B chip is an example.

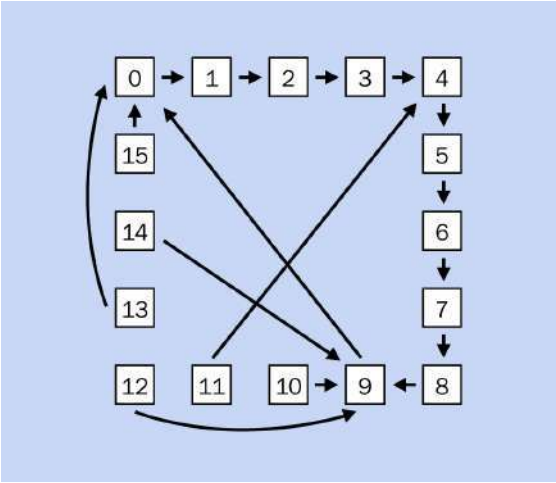

Figure 13-5. *A state diagram shows the transitions that a counter will make from each number to the next (in decimal notation), including the transitions which enable it to exit from disallowed states. This example is for a 74HC192 chip.*

Rising Edge and Falling Edge

A counter may be designed to be triggered either by the rising edge or the falling edge of the clock input, or by its high or low logic state. Generally speaking, ripple counters use the falling edge, so that the final output from one counter can become the clock input of the next. In other words, when the most significant digit of the first counter changes from a high to low logic state, this transition toggles the least significant bit of the second counter.

Synchronous counters generally use the rising edge of the clock input. If multiple synchronous counters are cascaded, they must all share the same clock signal, and will all change their flip-flop states simultaneously.

Multiple Stages

It is common for a counter chip to contain two or more *stages* with differing moduli. To take a common example, a divide-by-2 stage and a divide-by-5 stage that are both present in a single chip can be used to create a decade counter by connecting external pins. The extra stages provide a choice of moduli if they are used individually.

Single and Dual

Counter chips may contain two counters of the same modulus. This is known as a *dual* counter. Dual 4-bit counter chips are common. Each counter can be used separately, or they can be cascaded, in which case the total modulus will be found by multiplying the individual moduli together.

High-State, Low-State, and Three-State

Almost all counters use positive logic where a 1 is represented by a high state and 0 by a low state. Some counters allow an additional output state which has a high impedance and is equivalent to an open circuit. This feature is useful when two or more chips share the same output bus. It is discussed in the entry for **shift registers** in "Three-State Output" on page 126.

Descending Output

Most components only create an ascending count. The output can be converted to a descending count by passing each binary state through an inverter, but this will only work properly if the modulus is equal to the number of states. In a BCD counter, its inverted outputs will count from decimal 15 to decimal 6, not from decimal 9 to decimal 0.

A few counters are available which are designed to create a correct descending count. Other counters are available which allow the user to set the mode to ascending or descending. Examples are the 74x190 or 74x192 (where an acronym for the chip family will be substituted for the letter x).

A descending output is useful in combination with a parallel input, where a user may set an initial value from which the counter will descend

to 0. With suitable logic, this can enable a user-specified delay period.

Programmable Counters

A programmable counter can usually allow a modulus ranging from 2 to more than 10,000. The counter counts down by dividing an initial number repeatedly with a value that is preset with binary inputs. An example is the 4059B chip.

Examples

Many counter specifications date back to the 4000 family of logic chips. Versions of them subsequently became available in the 74xx series, often with the old 4000 part number preceded by 74x (where x is replaced by a designation of the logic family). For example, a version of the 4518B dual BCD chip can be obtained as the 74HC4518. As is the case with all logic chips, this part number will be preceded by letter(s) designating the particular manufacturer, with a suffix added to differentiate minor variants of the chip. The 74xx series has the advantage of higher speed and a greater ability to source or sink current at its output pins.

Most of the original CMOS chips, such as the 4518B, are still available, even in surface-mount versions. These offer the possible advantage of being able to use a higher power supply voltage.

Many counters offer multiple options such as different modulus values that can be selected by external pin connections. Some chips are tolerant of slow clock frequencies; others are not. Most are edge-triggered, but a few are level triggered. Some, such as the 4518B mentioned above, allow a choice of a rising-edge clock input and falling-edge clock input on different pins. For a specific application, it is really necessary to read a variety of datasheets to select the chip that is most suitable.

Values

As is the case with other logic chips, most counters in the through-hole 74xx series are intended for 5VDC power supply while the older 4000 series may tolerate up to 18VDC. Surface-mount 74xx versions may use voltages as low as 2VDC.

See the section on logic gates in Chapter 10 for a discussion of acceptable high and low logic-input states. On the output side, the 4000 series chips are able to source or sink less than 1mA at 5VDC, but the 74HCxx series can usually manage around 20mA.

A few counters are capable of delivering more power through additional output stages that can drive LEDs. The 4026B decade counter is still being manufactured, capable of powering modest 7-segment displays. The 4033B has the additional option of blanking any leading zeros in a multi-digit display. Other chips that were designed for direct connection to LED numerals have become obsolete as the need for this application has diminished. The 74C925, 74C926, 74C927, and 74C928 are examples. They may still be found from surplus outlets, but should not be specified in new circuit designs.

What Can Go Wrong

The entry that deals with problems affecting shift registers (see "What Can Go Wrong" on page 128), describes issues which also affect counters. The entry that deals with logic chips (see "What Can Go Wrong" on page 105), describes problems affecting all types of logic chips. In addition, the potential problems listed below are specific to counters.

Lock-Out

This is the condition which occurs if a counter with a shortened modulus is loaded with a binary state that is out of its range. Consult the datasheet and study its state diagram to determine the most likely outcome if this problem occurs.

Asynchronous Artifacts

Because the flip-flops in an asynchronous (ripple) counter do not change simultaneously, they create very brief false outputs while the ripple

process is taking place. In a 4-bit counter, the binary number 0111 (decimal 7) should be followed by 1000 (decimal 8). However, the rightmost digit (i.e., the least significant bit) will change to a 0 initially, creating 0110 as a momentary binary output (decimal 6). The carry operation will then change the next digit to a 0, creating 0100 (decimal 4). The carry operation continues, changing the next digit to a 0, creating 0000. Finally the operation completes by creating 1000 as the correct output.

These intermediate states on the output pins are often referred to as *glitches*. Because they are extremely brief, they will be indetectable when a counter is used to drive a display. They can cause significant issues, however, if the outputs of the counter are connected with other logic chips.

Another type of asynchronous problem will occur if the clock speed is sufficiently high that a new pulse is received at the first flip-flop before the ripple of changing states has passed all the way through to the final flip-flop. This will result in a different brief invalid value on the output pins.

Noise

Old TTL-type counters, such as the 74LSxx series, are especially noise-sensitive. Adding a 0.1µF or 0.047µF bypass capacitor as close to the power supply pin as possible is recommended. Breadboarding counters of this type may result in errors if a high-frequency clock is used, because conductors such as patch-cords are liable to pick up noise. Modern 74HCxx counters are preferable.

encoder

14

In this encyclopedia, an **encoder** is a digital chip that converts a decimal-valued input into a binary-coded output.

The term "encoder" may alternatively refer to a **rotational encoder** (also known as a *rotary encoder*) which has a separate entry in Volume 1 of this encyclopedia. The term may also describe a *code hopping encoder*, which is an encryption device used in keyless entry systems for automobiles.

OTHER RELATED COMPONENTS

- **decoder** (see Chapter 15)
- **multiplexer** (see Chapter 16)

What It Does

An encoder is a *logic chip* that receives an input consisting of an active logical state on one of at least four input pins, which have decimal values from 0 upward in increments of 1. The encoder converts the active pin number into a binary value represented by logic states on at least two output pins. This behavior is opposite to that of a **decoder**.

Encoders are identified in terms of their inputs and outputs. For example:

- 4-to-2 encoder (four input pins, two output pins)
- 8-to-3 encoder (eight input pins, three output pins)
- 16-to-4 encoder (sixteen input pins, four output pins)

In the early days of computing, encoders processed interrupts. This application is now rare, and relatively few encoder chips are still being manufactured. However, they are still useful in small devices—for example, if a large number of inputs must be handled by a microcontroller that has insufficient pins to receive data from each individually.

Schematic Symbol

Like other logic-based components, the encoder does not have a specific schematic symbol and can be represented by a plain rectangle as in Figure 14-1, with inputs on the left and outputs on the right. The bars printed above some of the abbreviations indicate that an input or output is active-low. In this chip, the 74LS148, all inputs and outputs are active-low.

Generally speaking, inputs labeled D0, D1, D2… are used for data input, although they may simply be numbered, with no identifying letter. The encoded outputs are typically identified as Q0, Q1, Q2… or A0, A1, A2… with Q0 or A0 designating the least significant bit in the binary number.

Pins labeled E and GS are explained in the following section.

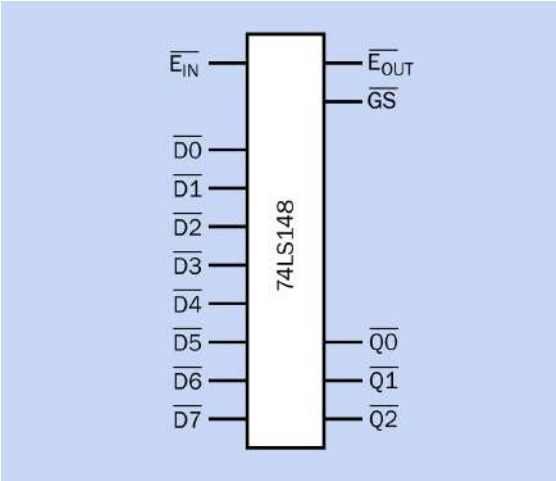

Figure 14-1. *While no specific schematic symbol exists for an encoder chip, this style is commonly used. Shown here is a 16–to–4 encoder with active-low inputs and outputs.*

Similar Devices

The similarities and differences between encoder, decoder, multiplexer, and demultiplexer can cause confusion.

- In an **encoder**, an active logic state is applied to one of four or more input pins, while the rest remain in an inactive logic state. The input pin number is converted to a binary code which is expressed as a pattern of logic states on two or more output pins.
- In a **decoder**, a binary number is applied as a pattern of logic states on two or more input pins. This value determines which one of four or more output pins will have an active logic state, while the rest remain in an inactive logic state.
- A **multiplexer** can connect a choice of multiple inputs to a single output, for data transfer. The logic state of an enable pin, or a binary number applied as a pattern of logic states to multiple control pins, chooses which input should be connected with the output pin. The alternative term *data selector* evokes the function of this device more clearly.
- An analog multiplexer may allow its inputs and outputs to be swapped, in which case it becomes a **demultiplexer**. It can connect a single input to one of multiple outputs, for data transfer. The logic state of an enable pin, or a binary number applied as a pattern of logic states to multiple control pins, chooses which output should be used. The alternative term *data distributor* evokes the function of this device more clearly.

How It Works

An encoder contains **logic gates**. The internal logic of an 8-to-3 encoder is shown in Figure 14-2, where the darker blue rectangle represents the chip. The switches in this figure are external and are included only to clarify the concept. An open switch is imagined to provide an inactive logic input, while a single closed switch provides an active logic input. (Multiple active inputs can be handled by a *priority encoder*, described below).

Each input switch has a numeric status from 1 to 7. The switch with value 0 does not make an internal connection, because the output from the OR gates is 000 by default.

The logic state of each OR output represents a binary number, weighted with decimal values 1, 2, and 4, as shown at the bottom of the figure. Thus, if switch 5 is pressed, by tracing the connections it is clear that the outputs of OR gates 4 and 1 become active, while the output from gate 2 remains inactive. The values of the active outputs thus sum to 5 decimal.

Figure 14-3 shows the outputs for all possible input states of a 4-to-2 encoder. Figure 14-4 shows the outputs for all possible input states of an 8-to-3 encoder. These diagrams assume that a high logic state is an active logic state, on input or output. This is usually the case.

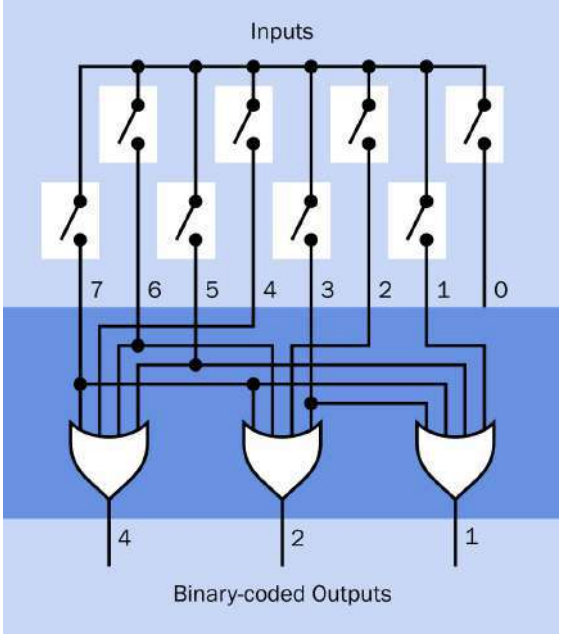

Figure 14-2. *A simplified simulation of the internal logic of an 8-to-3 encoder. The dark blue rectangle indicates the space inside the chip. The external switches are included only to clarify the concept. An encoder chip would have an Enable line to create an active output.*

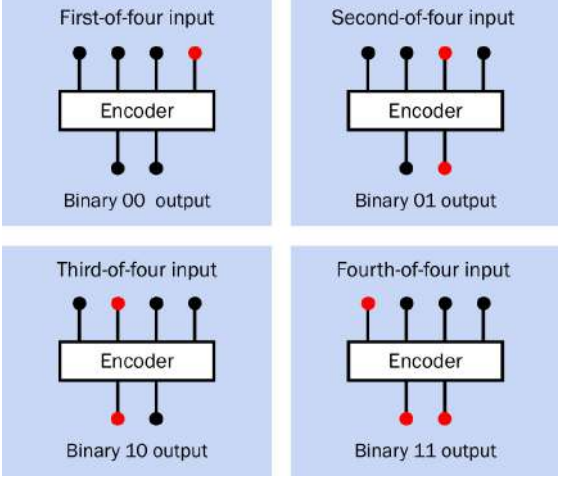

Figure 14-3. *The four possible inputs of a 4-to-2 encoder (top of each panel) and the encoded outputs (below).*

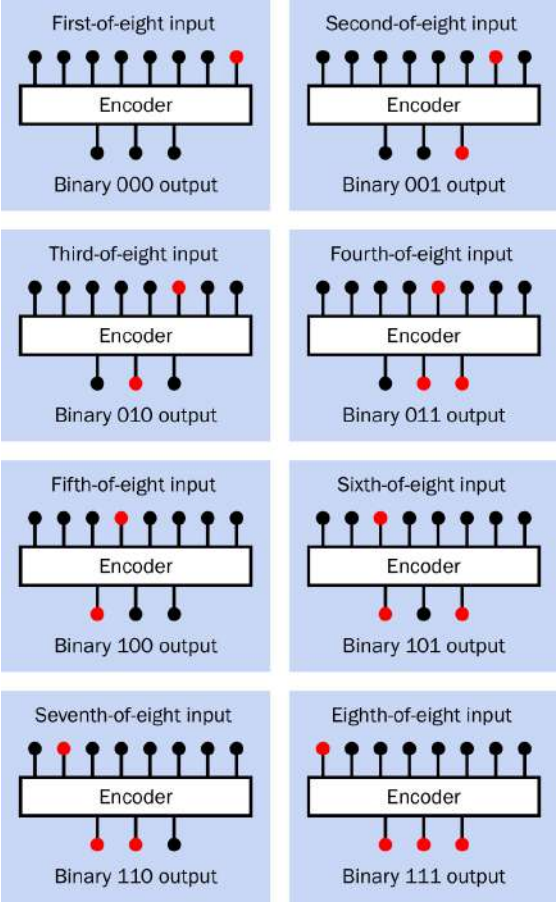

Figure 14-4. *The eight possible inputs of an 8-to-3 encoder (at the top of each panel), and the encoded outputs (below). Note that one input of an encoder must always be logic-high. All logic-low inputs are not a valid state.*

Unlike ripple counters, where propagation delays can reduce the overall response time of the component, decoders respond within two or three nanoseconds.

Variants

A *simple encoder* assumes that only one input pin can be logically active at a time. A *priority encoder* assigns priority to the highest-value input pin if more than one happens to receive an active input. It ignores any lower-value inputs. An example is the 74LS148, which is an 8-to-3 chip.

A few encoders feature *three-state* outputs (also known as *tri-state*), in which a high-impedance or "floating" output state is available in addition to the usual high and low logic states. The high-impedance state allows multiple chips to share an output bus, as those that are in high-impedance mode appear to be disconnected. This is useful if two or more encoders are cascaded to handle a larger number of inputs.

Values

As is the case with other logic chips, most encoders in the through-hole 74xx series are intended for 5VDC power supply while the older 4000 series may tolerate up to 18VDC. Surface-mount versions may use voltages as low as 2VDC.

See the section on logic gates in Chapter 10 for a discussion of acceptable high and low input states. On the output side, the 4000 series chips are able to source less than 1mA at 5VDC, but the 74HCxx series can manage around 20mA.

How to Use It

Suppose that a microcontroller should respond to an eight-position rotary switch. Because the switch cannot be turned to more than one position at a time, all of its eight contacts can be connected with the inputs on an encoder, which will deliver a 3-bit binary number to three inputs of the microcontroller. Code inside the microcontroller then interprets the pin states.

This is shown in Figure 14-5. Pulldown resistors would be needed on the input pins of the encoder, to prevent them from floating when they are not connected by the rotary switch. They have been omitted from this diagram for simplicity. Debouncing the switch would be handled by the microcontroller.

Other forms of input may be used instead of a rotary switch. For example, the outputs from eight comparators or eight phototransistors could be passed through an encoder.

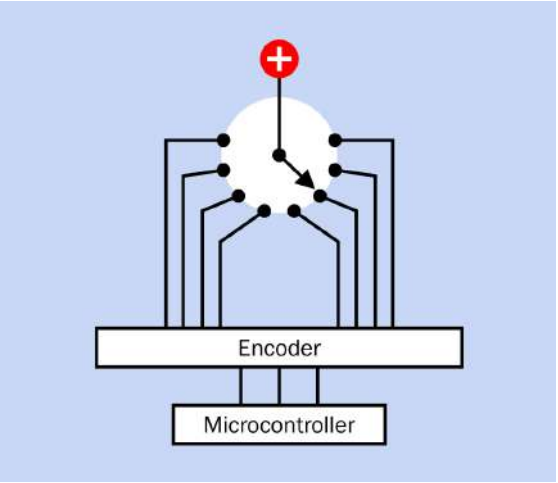

Figure 14-5. *Output from an eight-input rotary switch could be connected through an 8-to-3 encoder to provide input to a microcontroller using a reduced number of pins. Pulldown resistors have been omitted for simplicity.*

Cascaded Encoders

Encoders are often provided with features to facilitate handling additional inputs via multiple chips. Typically, a second Enable pin is provided, as an output that connects with the Enable input of the preceding chip. This preserves the priority function, so that an input on the second chip prevents any additional input to the first chip from affecting the output. In a datasheet, the enable pins may be labeled E_{IN} and E_{OUT}, or E_I and E_O.

In addition, a GS pin will be included, meaning "Group Select." It is logically active only when the encoder is enabled and at least one input is active. The GS pin of the most-significant encoder provides an additional binary digit.

The outputs from two encoders can be linked via OR gates, as shown in Figure 14-6, where the lower chip's GS output provides the most significant bit of a four-bit binary number.

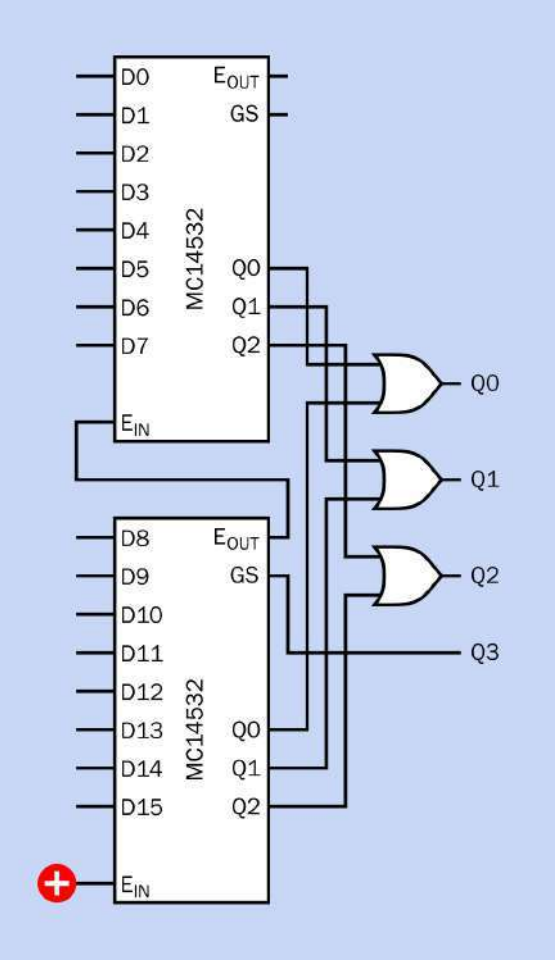

Figure 14-6. *Two eight-bit encoders can be cascaded to handle 16 separate inputs. In this example, the encoders use active-high logic.*

What Can Go Wrong

Problems that are common to all digital chips are summarized in the section on logic gates in "What Can Go Wrong" on page 105.

See "What Can Go Wrong" on page 149 in the entry describing **decoders** for a list of more specific problems that also afflict encoders.

decoder

15

In this Encyclopedia, a **decoder** is a digital chip that receives a binary-coded input and converts it to a decimal output by applying a logic state to one of a sequence of pins, each of which is assigned an integer value from 0 upward.

The term "decoder" also refers to components and devices that have other functions, such as decoding audio or video formats. These functions are not included here.

OTHER RELATED COMPONENTS

- **encoder** (see Chapter 14)
- **multiplexer** (see Chapter 16)

What it Does

A decoder receives a binary-coded number on two or more input pins. It *decodes* that number and expresses it by activating one of at least four output pins.

The behavior of a decoder with a two-bit binary input is shown in four sequential snapshots in Figure 15-1, where the least significant bit of the input is on the right in each diagram, and the output moves from right to left.

Figure 15-2 shows a similar sequence in a decoder where various values of a three-bit input are decoded to create an eight-pin output.

One sample state of a four-bit decoder is shown in Figure 15-3.

All of these figures assume that a high state represents an active input or output. In a few chips, a low state is used to represent an active output.

Decoders with 2, 3, or 4 input pins are common. To handle a binary input greater than 1111 (decimal 15), decoders can be chained together, as described below.

Manufacturers' datasheets often describe decoders in terms of their inputs and outputs. Typical examples would include:

- 2-to-4 decoder (two input pins, four output pins)
- 3-to-8 decoder (three input pins, eight output pins)
- 4-to-10 decoder (for converting *binary-coded decimal* to decimal output)
- 4-to-16 decoder (also known as a *hex decoder*).

Input Devices

The input pins of a decoder can be driven by a counter that has a binary-coded output. A decoder can also be driven by a microcontroller, which may have an insufficient number of output pins to control a variety of devices. Two, three, or four of the outputs can be used to represent a binary number which is passed through the decoder to activate the devices one at a time, perhaps with transistors or Darlington arrays introduced to handle the load. This is suggested in Figure 15-4.

A **shift register** can be used for a similar purpose, but often has only one pin for input. This pin must be supplied sequentially with a serial pattern of bits that will match the desired high/low states of the output pins. The relative advantage of this system is that a shift register can generate any pattern of output states. A one-of-many decoder can activate only one output at a time.

LED Driver

A special case is a *seven-segment decoder* designed to drive a seven-segment **LED display** numeral. A binary-coded decimal number on four input pins is converted to a pattern of outputs appropriate for lighting the segments of the display that will form a number from decimal 0 through 9.

Schematic Symbol

Like other logic-based components, the decoder does not have a specific schematic symbol and is represented by a plain rectangle as in Figure 15-5, with inputs on the left and outputs on the right. The bars printed above the E and LE abbreviations (which stand for Enable and Latch Enable, respectively) indicate that they are active-low. In this chip, the 74HC4514, all outputs are active-high, but in a related 4-to-16 decoder, the 74HC4515, all outputs are active-low. In both of these chips, the Enable pin is held low to activate the outputs. The Latch Enable pin freezes the current state of the outputs (i.e., it latches them) when it is held low.

Generally speaking, pins labeled A0, A1, A2… in a datasheet are often the binary inputs (although A, B, C… may be used), with A0 designating the least significant bit. Outputs are usually labeled Y, and are activated in sequence from Y0 when the binary input starts counting upward.

Similar Devices

The similarities and differences between encoder, decoder, multiplexer, and demultiplexer can cause confusion.

- In a **decoder**, a binary number is applied as a pattern of logic states on two or more input pins. This value determines which one of four or more output pins will have an active logic state, while the rest remain in an inactive logic state.
- A **multiplexer** can connect a choice of multiple inputs to a single output, for data transfer. The logic state of an enable pin, or a binary number applied as a pattern of logic states to multiple control pins, chooses which input should be connected with the output pin. The alternative term *data selector* evokes the function of this device more clearly.
- An analog multiplexer may allow its inputs and outputs to be reversed, in which case it becomes a **demultiplexer**. It can connect a single input to one of multiple outputs, for data transfer. The logic state of an enable pin, or a binary number applied as a pattern of logic states to multiple control pins, chooses which output should be used. The alternative term *data distributor* evokes the function of this device more clearly.

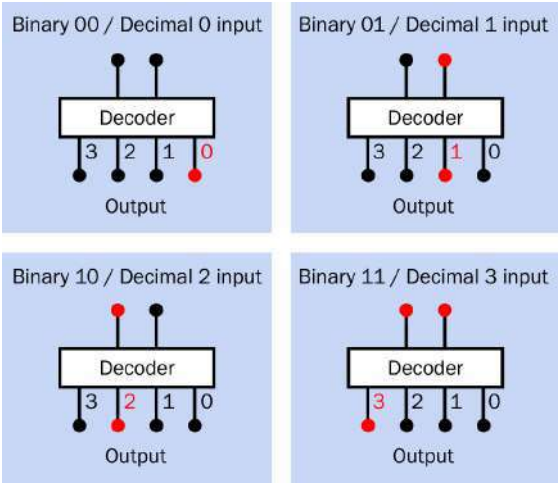

Figure 15-1. *A decoder with two input pins can interpret their binary-number representation to create an active logic state on one of four output pins.*

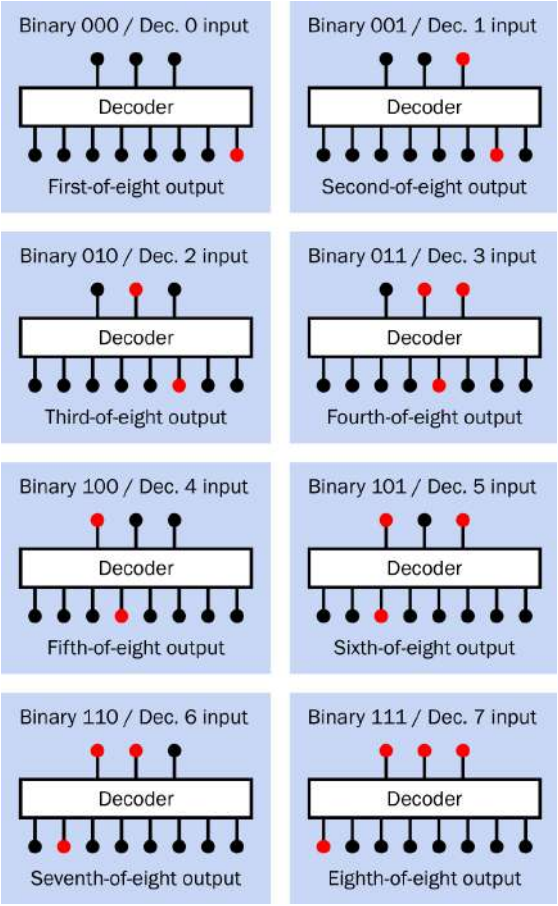

Figure 15-2. *A decoder with three input pins can interpret their binary-number representation to create a high logic state on one of eight output pins.*

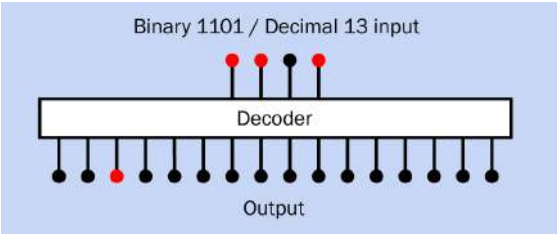

Figure 15-3. *A decoder with four input pins can interpret their binary-number representation to create a high logic state on one of 16 output pins. Only one of the 16 possible states is shown here.*

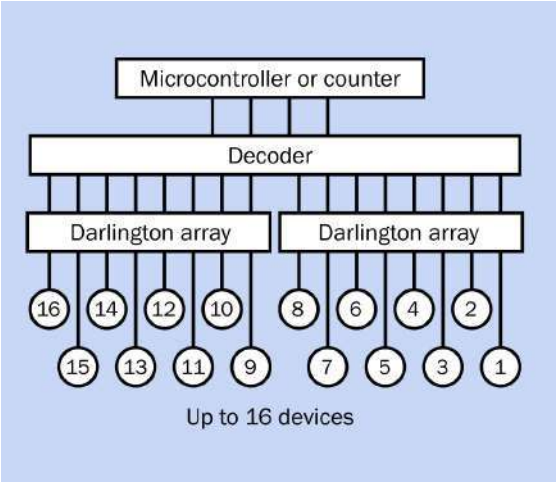

Figure 15-4. *Four outputs from a binary counter or microcontroller can be used by a decoder to activate one of up to 16 output devices.*

A photograph of a 74HC4514 decoder chip appears in Figure 15-6.

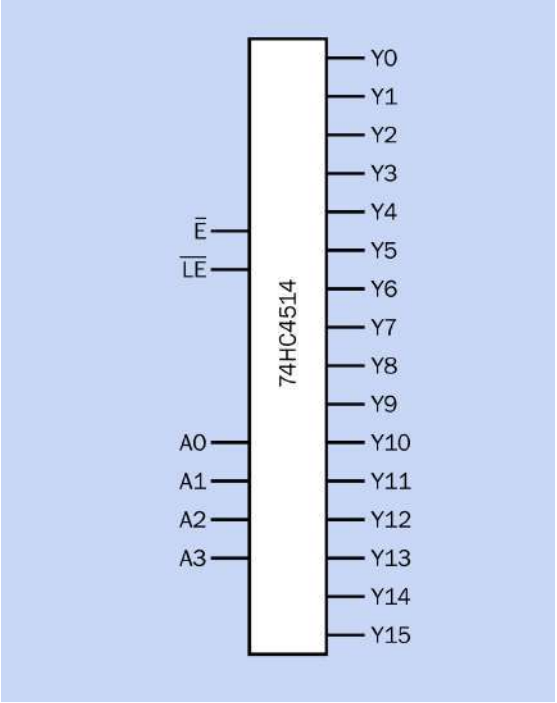

Figure 15-5. *While no specific schematic symbol exists for a decoder chip, this style is commonly used. Shown here is a 4-to-16 decoder.*

Figure 15-6. *The 24-pin 74HC4514 decoder chip processes a 4-bit input and represents it by making one of its 16 output pins active-high.*

How It Works

A decoder contains logic gates, each of which is wired to respond to a unique binary pattern of inputs. (In the case of a seven-segment decoder, the internal logic is more complicated.) Figure 15-7 shows the logic of a 2-to-4 decoder. The darker blue area contains the components inside the chip. The external switches are included only to clarify the function of the decoder. An open switch is imagined to provide a low logic input, while each closed switch provides a high logic input.

Unlike ripple counters, where propagation delays can reduce the overall response time of the component, decoders function within two or three nanoseconds.

Variants

Decoder variants have not proliferated with time, and relatively few are available. Most are 3-to-8, 4-to-16, and binary-coded-decimal types.

The 7447 and 74LS47 are seven-segment decoders that have an open-collector output capable of driving a 7-segment display directly. The 7448 is similar but also contains built-in resistors and a capability to blank out leading zeros in a display. However, some suppliers now list the 74LS48 as obsolete. It may be still available from old stock, but should not be specified in new circuits.

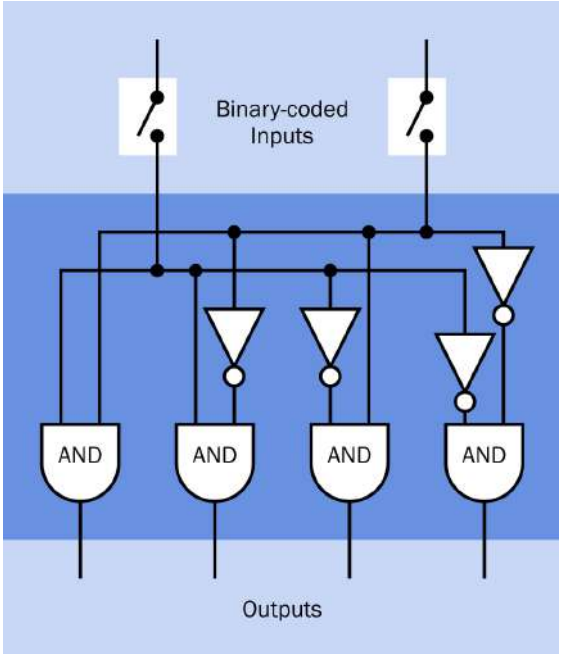

Figure 15-7. *A simplified simulation of the logic in a decoder. An actual chip would have an Enable line to activate the output. The dark blue rectangle indicates the space inside the chip.*

Although 74LS47 is still being manufactured, and is available in surface-mount as well as through-hole format, a version is not available in the widely used HC family of 74xx chips. Care must be taken to satisfy the input voltage requirements of the 74LS47 when driving it with 74HCxx chips.

Values

As is the case with other logic chips, most decoders in the through-hole 74xx series are intended for 5VDC power supply while the older 4000 series may tolerate up to 18VDC. Surface-mount versions may use voltages as low as 2VDC.

See the section on logic gates in Chapter 10 for a discussion of acceptable high and low input states. On the output side, the 4000 series chips

are able to source or sink less than 1mA at 5VDC, but the 74HCxx series can manage around 20mA.

How to Use It

The original applications for decoders in computer circuits have become uncommon, but the chips can still be useful in small appliances and gadgets where multiple outputs are controlled by a **counter** or microcontroller.

Although 16 is usually the maximum number of outputs, some chips are designed to allow expansion. The 74x138 (where a chip family identifier such as LS or HC can be substituted for the letter x) is a 3-to-8 decoder with two logic-low Enable pins and one logic-high Enable. If a value-8 binary line is applied to the low-enable of one chip and the high-enable of another, the first chip will be disabled when the line goes high to indicate that the binary number 1000 has been reached, and the second chip can continue upward from there by sharing the same three less-significant-bit inputs. As many as four chips can be chained in this way.

What Can Go Wrong

Problems that are common to all digital chips are summarized in the section on logic gates in "What Can Go Wrong" on page 105.

Glitches

Although a decoder typically functions faster than a ripple counter, it suffers the same tendency to introduce brief *glitches* in its output. These are momentary invalid states which occur while processes inside the chip that are slightly slower are catching up with other processes that reach completion slightly faster. A brief *settling time* is necessary to ensure that the output is stable and valid. This will be irrelevant when powering a device such as an **LED indicator**, which will not display such brief transients. The problem may be more important if the output from the decoder is used as an input to other logic chips.

If the input to a decoder is derived from a ripple counter, the input may also contain glitches, which can cause erroneous outputs from the decoder. It is better to use a synchronous counter on the input side of a decoder.

Unhelpful Classification

Online parts suppliers tend to list decoders under the same category heading as encoders, multiplexers, and demultiplexers, making it difficult to find what you want. Under this broad subject heading (which will include thousands of chips), if you search by selecting the number of inputs relative to the number of outputs that you have in mind, this will narrow the search considerably.

Active-Low and Active-High

Chips with identical appearance and similar part numbers may have outputs that are either active-low or active-high. Some may offer a latch-enable pin, while others have enable pins that must be pulled low or forced high to produce an output. Accidental chip substitution is a common cause of confusion.

multiplexer

16

May be abbreviated as a *mux* (this term is sometimes printed all in caps), and may be referred to alternatively as a *data selector*. Some sources maintain that a multiplexer has no more than two channels, whereas a data selector has more, but there is no consensus on this, and datasheets continue to use the term "multiplexer" predominantly.

Analog multiplexers are usually bidirectional, and thus will function equally well as *demultiplexers*. Consequently, this encyclopedia does not contain a separate entry for demultiplexers.

OTHER RELATED COMPONENTS

- **encoder** (see Chapter 14)
- **decoder** (see Chapter 15)

What It Does

A multiplexer can select one of two or more input pins, and connect it internally with an output pin. Although it is an entirely solid-state device, it behaves as if it contains a **rotary switch** in series with a SPST switch, as shown in Figure 16-1. A binary code applied to one or more Select pins chooses the input, and an Enable pin establishes the connection with the output. The Select and Enable functions are processed via an internal section referred to as a *decoder*, not to be confused with a **decoder** chip, which has its own entry in this encyclopedia.

All multiplexers are digitally controlled devices, but may be described as either *digital* or *analog* depending how they process the input signal. A digital multiplexer creates an output that is adjusted to logic-high or logic-low within the limits of its logic family. An analog multiplexer does not impose any processing on the voltage, and passes along any fluctuations. Thus, it can be used with alternating current.

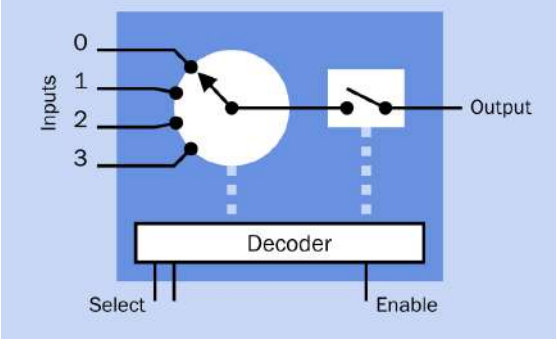

Figure 16-1. *A multiplexer functions as if it contains a rotary switch. The switch position is determined by a binary number applied to external Select pins. The internal connection is completed by applying a signal to an Enable pin.*

Because an analog multiplexer merely switches a flow of current, it can be *bidirectional*; in other words, it can function as a *demultiplexer*, in which case the input is applied to the pole of the (imaginary) internal switch and outputs are taken from the terminals.

Differential Multiplexer

A *differential* multiplexer contains multiple switches that are differentiated from one another (i.e., they are electrically isolated, although they are controlled by the same set of select pins). A differential multiplexer is conceptually similar to a rotary switch with two or more decks controlled by a single shaft. See Figure 16-2.

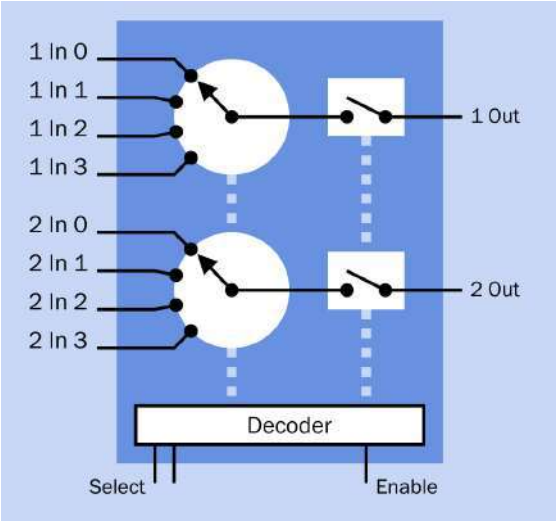

Figure 16-2. *A differential multiplexer contains two or more electronic switches that are differentiated from one another, similarly to the decks on a rotary switch. Although the channels into each switch are typically numbered from 0 upward, the switches are numbered from 1 upward.*

A bidirectional dual 4-channel differential analog multiplexer is shown in Figure 16-3.

Modern multiplexers are often found switching high-frequency data streams in audio, telecommunications, or video applications.

Similar Devices

The similarities and differences between multiplexer, demultiplexer, encoder, and decoder can cause confusion:

- A **multiplexer** can connect a choice of multiple inputs to a single output, for data transfer. The logic state of an enable pin, or a binary number applied as a pattern of logic states to multiple control pins, chooses which input should be connected with the output pin. The alternative term *data selector* evokes the function of this device more clearly.
- An *analog* multiplexer may allow its inputs and outputs to be reversed, allowing it to become a **demultiplexer**, connecting a single input to one of multiple outputs, for data transfer. The logic state of an enable pin, or a binary number applied as a pattern of logic states to multiple control pins, chooses which output should be used. The alternative term *data distributor* evokes the function of this device more clearly.

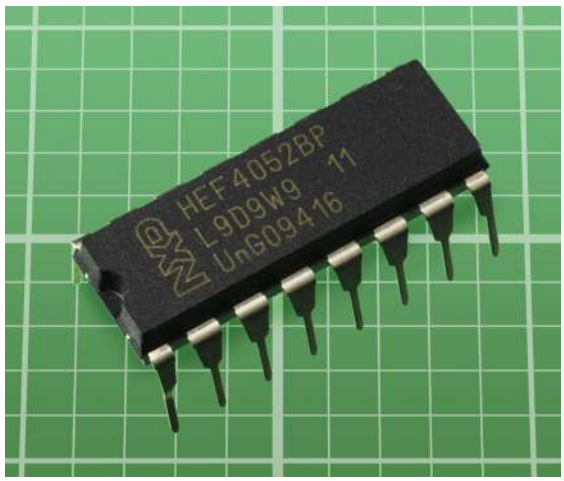

Figure 16-3. *This CMOS chip contains two four-channel differential analog multiplexers.*

- In an **encoder**, an active logic state is applied to one of four or more input pins, while the rest remain in an inactive logic state. The input pin number is converted to a binary code which is expressed as a pattern of logic states on two or more output pins.
- In a **decoder**, a binary number is applied as a pattern of logic states on two or more input pins. This value determines which one of four or more output pins will have an active logic state, while the rest remain in an inactive

logic state. A digital multiplexer does not allow reversal of its inputs and outputs, but a decoder functions as if it were a digital demultiplexer.

How It Works

The multiple inputs to a multiplexer are referred to as *channels*. Almost always, the number of channels is 1, 2, 4, 8, or 16. A 1-channel component is only capable of "on" or "off" modes and functions similarly to a SPST switch.

If there are more than two channels, a binary number will determine which channel is connected internally. The number of channels is usually the maximum that can be identified by the number of select pins, so that 2 pins will control 4 channels, 3 pins will control 8 channels, and 4 pins (the usual maximum) will control 16 channels.

In multiplexers with three or more channels, an enable pin is usually still present to activate or deactivate all the channels simultaneously. The enable feature may be described alternatively as a *strobe*, or may have an inverse function as an *inhibit* pin.

Although a rotary switch is helpful in conceptualizing the function of a multiplexer, a more common representation (sometimes in datasheets) is an array of SPST switches, each of which can be opened or closed by the decoder circuit. A typical example, depicting a dual differential multiplexer, is shown in Figure 16-4. Note that the internal decoder can only close one switch in each channel at a time.

The switch analogy is appropriate in that when an output from a multiplexer is not connected internally (i.e., its switch is "open") it is effectively an open circuit. However, some multiplexers contain *pullup resistors* to give each output a defined state. This can be an important factor in determining whether the multiplexer is suitable for a particular application.

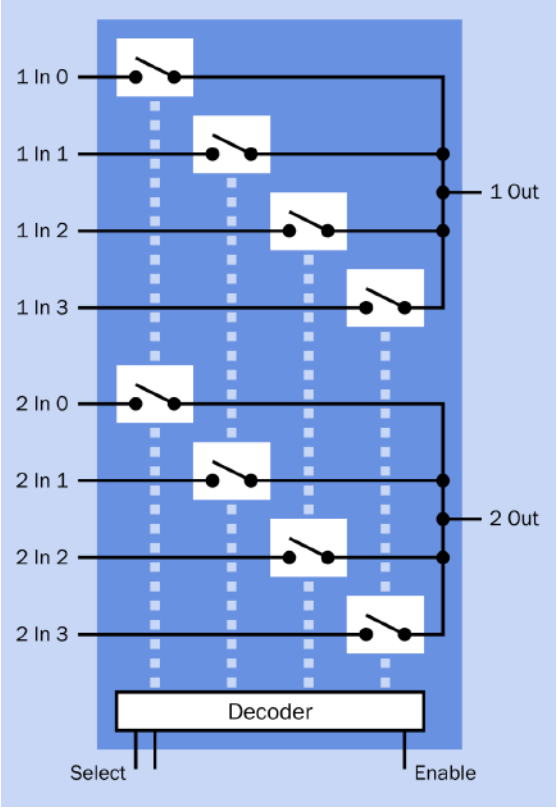

Figure 16-4. *The internal function of a dual multiplexer is commonly represented as a network of SPST switches, each of which is controlled by decoder logic.*

A digital multiplexer actually contains a network of logic gates, shown in simplified form in Figure 16-5.

A demultiplexer has internal logic shown in simplifier form in Figure 16-6.

Schematic Symbol

In a schematic, a multiplexer and demultiplexer may be represented by a trapezoid with its longer vertical side oriented toward the larger number of connections. This is shown in Figure 16-7. However, this symbol is falling into disuse.

More often, as is the case with most logic components, a multiplexer or demultiplexer is represented by a rectangle with inputs on the left and

outputs on the right, as shown in Figure 16-8. The distinction between inputs and outputs is problematic, however, in an analog multiplexer which will allow data flow to be reversed.

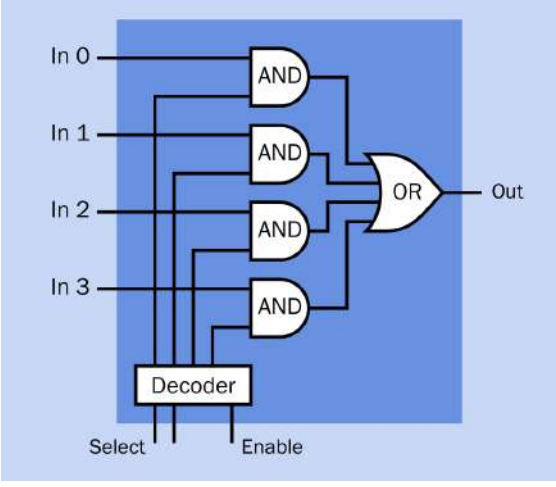

Figure 16-5. *A simplified representation of the logic gates in a digital multiplexer.*

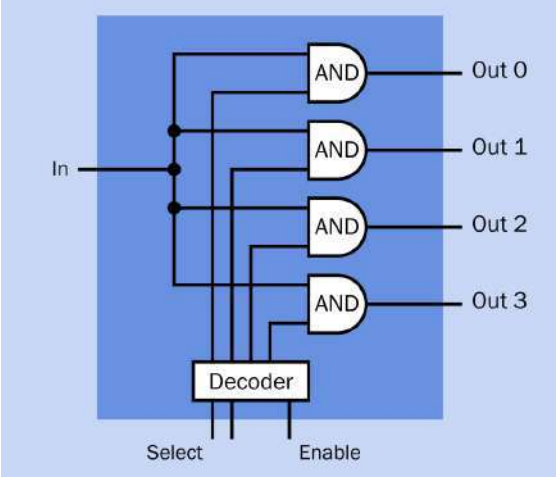

Figure 16-6. *A simplifier representation of the logic gates in a digital demultiplexer.*

Pin Identifiers

The lack of standardization in the identification of pin functions is perhaps more extreme in the case of multiplexers than for other types of logic chips.

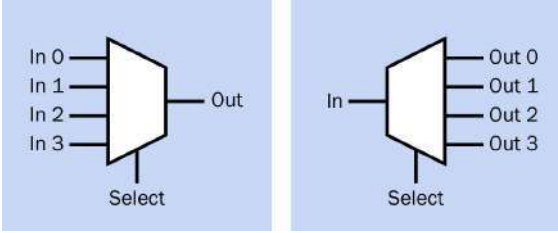

Figure 16-7. *The traditional symbol for a multiplexer (left) and demultiplexer (right). The trapezoid is oriented with its longer vertical side facing the larger number of connections. This symbol is falling into disuse.*

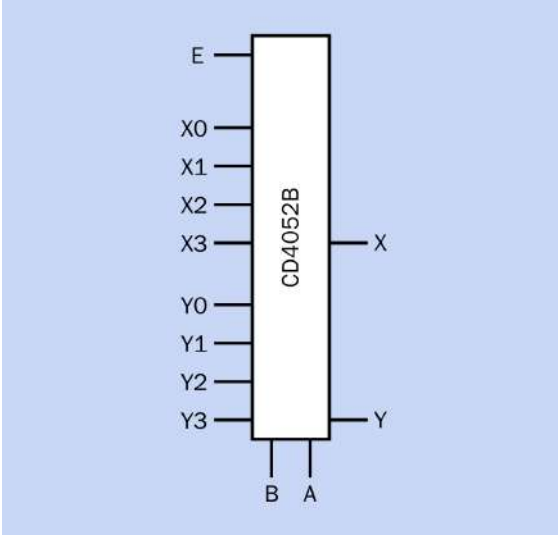

Figure 16-8. *A simple rectangle is most often used as a schematic symbol for a multiplexer, but the abbreviations assigned to pin functions are not standardized. See text for details.*

An output enable pin will be shown as E or EN, or occasionally OE. It may alternatively be described as an inhibit pin, labeled INH, or sometimes will be called a strobe. The function is the same in each case: one of its logic states will enable the internal switches, while its other logic state will prevent any internal switches from closing.

Switch inputs may be labeled S0, S1, S2… or X0, X1, X2… or may simply be numbered, almost always counting up from 0. Where two or more sets of switches coexist in one package, each set of

inputs may be distinguished from the others by preceding each identifier with a numeral or letter to designate the switch, as in 1S0, 1S1, 1S2… or 1X0, 1X1, 1X2… (Switches are generally numbered from 1 upward, even though their inputs are numbered from 0 upward.) Outputs may be identified using the same coding scheme as inputs, bearing in mind that the inputs and outputs of an analog multiplexer usually are interchangeable. Some manufacturers, however, prefer to identify each multiplexer output by preceding it with letter Y. Alternatively, Z1, Z2, Z3… may identify the outputs from switches 1, 2, 3… Fortunately, datasheets usually include some kind of key to this grab-bag of abbreviations.

Control pins are often identified as A, B, C… with letter A representing the least significant bit in the binary number that is applied to the pins.

Voltages can be confusing in multiplexers. Components intended for use with digital inputs are straightforward enough, as the supply voltage will be identified as V_{CC} and is typically 5VDC for through-hole packages (often lower for surface-mount), while negative ground is assumed to be 0VDC. However, where a multiplexer may be used with AC inputs in which the voltage varies above and below 0V, supply voltages above and below 0VDC are also possible—such as +7.5VDC and −7.5VDC, to take a random example. Three power-supply pins may be provided for this purpose. The positive supply will usually be identified as V_{DD} (the D refers to the Drain in the internal MOSFETs). A V_{EE} pin may be at 0VDC or at a negative value equal and opposite to V_{DD}. The E in this abbreviation is derived from Emitter voltage, even though the component may not contain a bipolar transistor with an emitter. Customarily, a V_{SS} pin (the S being derived from the Source in the internal MOSFETs) will be at 0VDC, and other voltages will be measured above and below this baseline. This ground pin may alternatively be labeled GND.

As is customary in logic chips, low-active control pins will have a bar printed above their identifiers, or an apostrophe will be placed after an identifier if the font does not permit printing the bar. Alternatively, low-active pins may be represented by showing a small circle, properly referred to as a *bubble*, at the input or output point of the symbol for the multiplexer. Note that analog inputs and outputs are neither high-active nor low-active; they merely pass voltages through.

Variants

Most multiplexers are "break before make" devices, where one input is disconnected before the next input is connected. However, some exceptions exist, and datasheets should be checked for this. It can be a significant issue, because make-before-break switching will briefly connect external devices with each other, through the chip.

Many multiplexers can tolerate control voltages above the usual high value in a logic circuit—as high as 15VDC in some cases. The voltage that is switched by the multiplexer may be the same as the control voltage, or may be higher.

Some analog multiplexers have *overvoltage protection* that allows them to withstand input voltages that are twice or three times the recommended maximum.

Datasheets may mention "internal address decoding," meaning that the binary number input, specifying a channel to be switched, is decoded inside the chip. In fact, virtually all multiplexers now have on-chip address decoding, and this feature should be assumed to exist, regardless of whether it is mentioned.

Values

The voltage to be switched will usually be referred to as the *input voltage*, V_{IN}.

An analog multiplexer should not be subjected to current exceeding the value that it is designed to switch. This is known as the maximum *channel current*. A typical value would be 10mA, although many modern surface-mount components are designed for currents in the microamp range.

The *on-resistance* is the resistance imposed by the analog multiplexer on the signal flowing through it. While modern, specialized analog multiplexers may have an on-resistance as low as 5Ω, these are relatively unusual. An on-resistance of 100Ω to 200Ω is more common. This value will vary within a component depending on the power supply voltage and the voltage being switched. It will increase slightly as V_{IN} deviates above (or below) 0V, will increase substantially for lower values of supply voltage, and will increase significantly with temperature.

The curves in Figure 16-9 show on-resistance of an analog multiplexer varying with input voltage, with three different power supplies: plus-and-minus 2.5VDC (described in the graph as a "spread" of 5VDC), plus-and-minus 5VDC (a "spread" of 10VDC), and plus-and-minus 7.5VDC (a "spread" of 15VDC). These curves were derived from a datasheet for the MC14067B analog multiplexer; curves for other chips will be different, although the basic principles remain the same.

Switching time is an important consideration in high-speed applications. The "on" and "off" times specified in a datasheet (often as t_{ON} and t_{OFF}) are a function of the propagation delay from the control input to the toggling of the switch, and are generally measured from the halfway point of the rising or falling edge of the control input, to the 90% point of the output signal level.

Leakage current is the small amount of current (often measured in picoamperes) that the solid-state switch will pass when it is in its "off" state. This should be insignificant except when very high-impedance loads are used.

Separate switches inside a multiplexer may have characteristics that differ slightly from one another. Differences in on-resistance between adjacent switches can be important when switching parallel analog signals. A datasheet should mention the extent to which switches have matched characteristics, and may define the maximum deviation from one another using the abbreviation R_{ON} even though this same term may be used, confusingly, to denote the on-resistance of each individual switch.

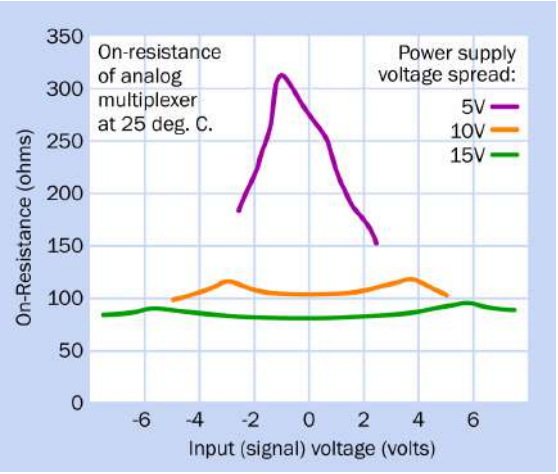

Figure 16-9. *Variations in on-resistance in an analog multiplexer. Each voltage "spread" is the difference between positive supply voltage and an equal-and-opposite negative ground voltage. Thus a "spread" of 10VDC means plus and minus voltages of 5VDC. (Curves derived from On Semiconductor datasheet for MC14067B analog multiplexer.)*

How to Use It

A multiplexer may be used as a simple switch to choose one of multiple inputs, such as a choice of input jacks on a stereo system. A dual differential multiplexer is useful in this application, as it can use a single select signal to switch two signal paths simultaneously.

A multiplexer can also be used as a digital volume control by switching an audio signal among a variety of resistances, similar to a **digital potentiometer**. In this application, the possible presence of pullup resistors inside the multiplexer must be considered.

Where a microcontroller must monitor a large number of inputs (for example, a range of temperature sensors or motion sensors), a multiplexer can reduce the number of input pins required. Its data-select pins will be cycled through all the possible binary states by the microcontroller, to select each data input in turn, while its single-

wire output will carry the analog data to a separate pin on the microcontroller which performs an analog-digital conversion.

Conversely, a demultiplexer (i.e., an analog multiplexer such as the 4067B chip which can be used in demultiplexer mode) can be used by a microcontroller to switch multiple components on and off. Four outputs from the microcontroller can connect with the control pins of a 16-channel demultiplexer, counting from binary 0000 through binary 1111 to select output pins 0 through 15. After selecting each pin, the microcontroller can send a high or low pulse through it. The process then repeats. (A **decoder** can be used in the same way.)

Other Application Notes

Multiplexers may be *cascaded* to increase the inputs-to-outputs ratio.

Modern multiplexers are found on computer boards where they choose among video output ports, or as PCI express channel switches.

A multiplexer may be used as a parallel-to-serial converter, as it samples multiple channels and converts them into a serial data stream.

In telecommunications, a multiplexer can sample voice signals from multiple separate inputs and combine them into a digital stream that can be transmitted at a faster bit rate over a single channel. However, this application goes far beyond the simple uses for multiplexers described here.

What Can Go Wrong

Problems that are common to all digital chips are summarized in the section on logic gates (see "What Can Go Wrong" on page 105).

Pullup Resistors

While they are often necessary to prevent connections from floating, pullup resistors built into a multiplexer may have unexpected consequences if the user is unaware of them.

Break Before Make

For most applications, it is desirable for each internal solid-state switch to break one connection before making a new one. This avoids the possibility of separate external components being briefly connected with each other through the multiplexer. Datasheets should be checked to verify that a multiplexer functions in break-before-make mode. If it doesn't, the enable pin can be used momentarily to disable all connections before a new connection is established.

Signal Distortion

Where a multiplexer is passing analog signals, signal distortion can result if the on-resistance of multiple internal switches varies significantly at different voltages. A datasheet for an analog multiplexer should usually include a graph showing on-resistance over the full signal range. The flatter the graph is, the less distortion the component will create. This is often described in datasheets as R_{ON} Flatness.

Limits of CMOS Switching

Although most multiplexers are built around CMOS transistors, their switching speed may be insufficient for video signals, and their on-resistance may vary enough to introduce distortion. Multiplexers are available with complementary bipolar switching for very high-speed applications. They impose some penalties in cost and power consumption.

Transients

Switch capacitance inside a multiplexer can cause transients in the output when the switch changes state. An allowance for *settling time* may be necessary. This will be additional to the switching speed claimed by the datasheet.

LCD

17

The full term *liquid-crystal display* is seldom used. Its acronym, **LCD**, is much more common. Sometimes the redundant combination **LCD display** is found. All three terms refer to the same device. In this encyclopedia, the first two words in *liquid-crystal display* are hyphenated because they are an adjectival phrase. Other sources often omit the hyphen.

The acronym **LED** (for **light-emitting diode**) is easily confused with **LCD**. While both devices display information, their mode of action is completely different.

OTHER RELATED COMPONENTS

- **LED display** (see Chapter 24)

What It Does

An LCD presents information on a small display panel or screen by using one or more segments that change their appearance in response to an AC voltage. The display may contain alphanumeric characters and/or symbols, icons, dots, or pixels in a *bitmap*.

Because of its very low power consumption, a basic monochrome LCD is often used to display numerals in battery-powered devices such as digital watches and calculators. A small liquid-crystal display of this type is shown in Figure 17-1.

Color-enabled, backlit LCDs are now frequently used in almost all forms of video displays, including those in cellular telephones, computer monitors, game-playing devices, TV screens, and aircraft cockpit displays.

How It Works

Light consists of electromagnetic waves that possess an electric field and a magnetic field. The fields are perpendicular to each other and to the direction in which the light is traveling, but the field polarities are randomly mixed in most visible radiation. This type of light is referred to as *incoherent*.

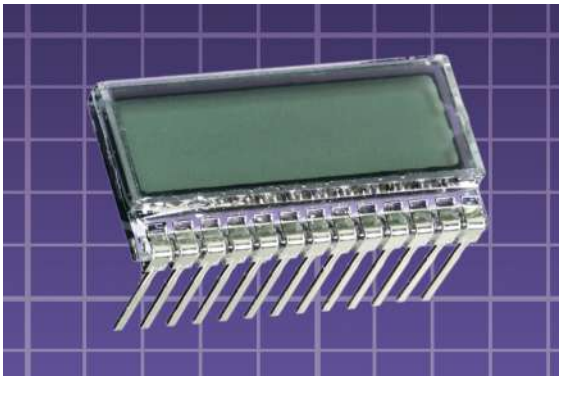

Figure 17-1. *A small, basic monochrome LCD.*

Figure 17-2 shows a simplified view of an LCD that uses a backlight. Incoherent light emerges from the backlight panel (A) and enters a vertical polarizing filter (B) that limits the electric field vector. The polarized light then enters a liquid crystal (C) which is a liquid composed of molecules organized in a regular helical structure that rotates the polarity by 90 degrees when no voltage is applied to it. The light now passes through

a horizontal polarizing filter (D) and is visible to the user.

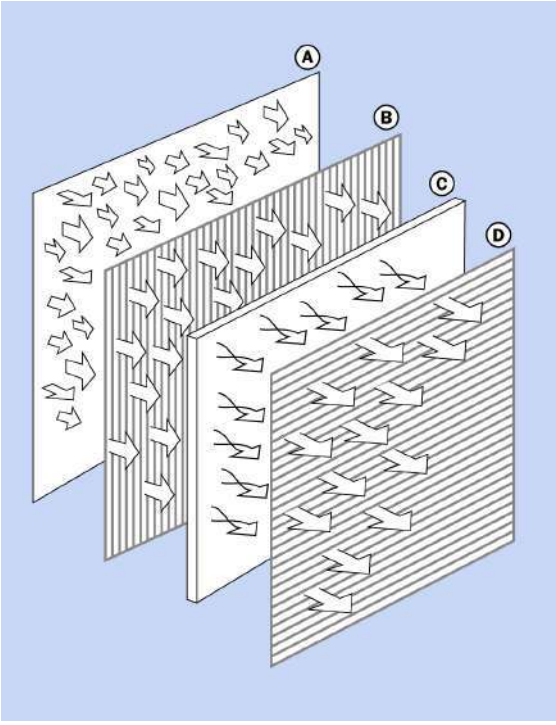

Figure 17-2. *The combination of two polarizers and a liquid crystal appears transparent when voltage is not applied. See text for details.*

- A liquid crystal itself does not emit light. It can only modify light that passes through it.

Figure 17-3 shows what happens when voltage is applied to the liquid crystal via transparent electrodes (not included in the figure). The molecules reorganize themselves in response to the electric potential and allow light to pass without changing its polarity. Consequently, the vertically polarized light is now blocked by the front, horizontally polarized filter, and the display becomes dark.

A liquid crystal contains ionic compounds that will be attracted to the electrodes if a DC voltage is applied for a significant period of time. This can degrade the display permanently. Therefore, AC voltage must be used. An AC frequency of 50Hz to 100Hz is common.

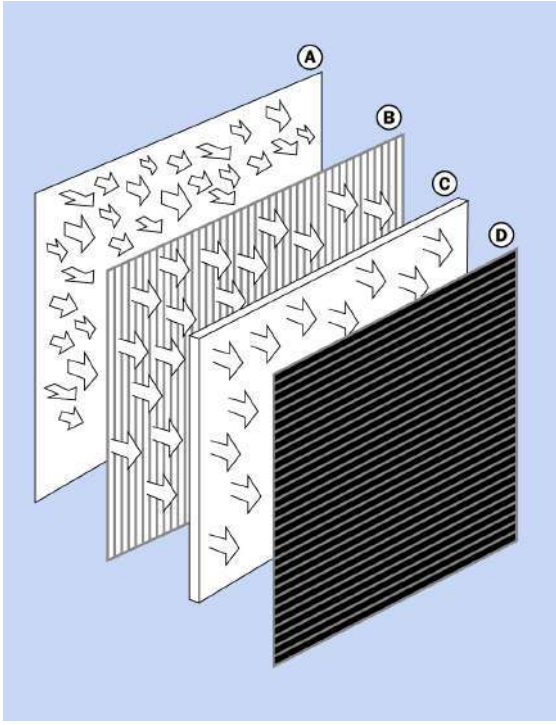

Figure 17-3. *The LCD appears dark when voltage is applied. See text for details.*

Variants

A *transmissive LCD* requires a backlight to be visible, and is the type illustrated in Figure 17-2. In its simplest form, it is a monochrome device, but is often enhanced to display full color by adding red, green, and blue filters. Alternatively, instead of a white backlight, an array of pixel-sized red, green, and blue **LEDs** may be used, in which case filters are unnecessary.

Backlit color LCDs have displaced *cathode-ray tubes*, which used to be the default system in almost all video monitors and TVs. LCDs are not only cheaper but can be fabricated in larger sizes. They do not suffer from *burn in*, where a persistent unchanging image creates a permanent scar in the phosphors on the inside of a tube. However, large LCDs may suffer from dead pixels or

stuck pixels as manufacturing defects. Different manufacturers and vendors have varying policies regarding the maximum acceptable number of pixel defects.

In a *reflective LCD*, the structure is basically the same as that shown in Figure 17-2 except that a reflective surface is substituted for the backlight. Ambient light enters from the front of the display, and is either blocked by the liquid crystal in combination with the polarizing filters, or is allowed to reach the reflective surface at the rear, from which it reflects back through the liquid crystal to the eye of the user. This type of display is very easily readable in a bright environment, but will be difficult to see in dim conditions and will be invisible in darkness. Therefore, it may be augmented with a user-activated light source mounted at the side of the display.

A *transreflective LCD* contains a translucent rear polarizer that will reflect some ambient light, and is also transparent to enable a backlight. While this type of LCD is not as bright as a reflective LCD and has less contrast, it is more versatile and can be more energy efficient, as the backlight can be switched off automatically when ambient light is bright enough to make the display visible.

Active and Passive Types

An *active matrix* LCD adds a matrix of thin-film transistors to the basic liquid-crystal array, to store the state of each segment or pixel actively while the energizing AC voltage transitions from positive to negative. This enables a brighter, sharper display as *crosstalk* between adjacent pixels is reduced. Because *thin-film transistors* are used, this is often described as a *TFT* display; but the term is interchangable with *active matrix*.

A *passive matrix* LCD is cheaper to fabricate but responds sluggishly in large displays and is not so well suited to fine gradations in intensity. This type of component is used primarily in simple monochrome displays lacking intermediate shades of gray.

Crystal Types

Twisted Nematic (TN) are the cheapest, simplest type of LCD, allowing only a small viewing angle and average contrast. The appearance is limited to black on gray. The response rate is relatively slow.

Super Twisted Nematic (STN) displays were developed in the 1980s for passive LCDs, enabling better detail, wider view angle, and a faster response. The natural appearance is dark violet or black on green, or dark blue on silver-gray.

Film-compensated Super Twisted Nematic (FSTN) uses an extra coating of film that enables a pure black on white display.

Double Super Twisted Nematic provides further enhancement of contrast and response times, and automatic contrast compensation in response to ambient temperature. The appearance is black on white. This display requires backlighting.

Color Super Twisted Nematic (CSTN) is an STN display with filters added for full color reproduction.

Seven-Segment Displays

The earliest monochrome LCDs in devices such as watches and calculators used seven segments to display each numeral from 0 through 9. This type of LCD is still used in low-cost applications. A separate control line, or electrode, connects to each segment, while a *backplane* is shared by all the segments, connecting with a *common* pin to complete the circuit.

Figure 17-4 shows a typical seven-segment display. The lowercase letters *a* through *g* that identify each segment are universally used in datasheets. The decimal point, customarily referred to as "dp," may be omitted from some displays. The array of segments is slanted forward to enable more acceptable representation of the diagonal stroke in numeral 7.

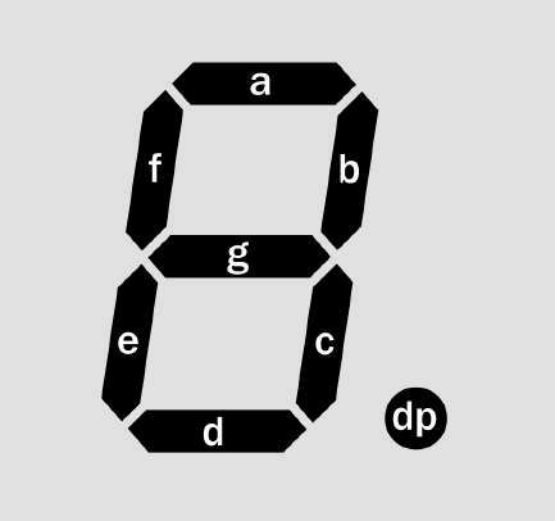

Figure 17-4. *Basic numeric display format for LCD numeric displays (the same layout is used with LEDs). To identify each segment, lowercase letters are universally used.*

Seven-segment displays are not elegant but are functional and are reasonably easy to read, as shown in Figure 17-5. Letters A, B, C, D, E, and F (displayed as A, b, c, d, E, F because of the restrictions imposed by the small number of segments) may be added to enable display of hexadecimal values.

In appliances such as microwave ovens, very basic text messages can be displayed to the user within the limitations of 7-segment displays, as suggested in Figure 17-6.

The advantage of this system is low cost, as 7-segment displays are cheap to fabricate, entail the fewest connections, and require minimal decoding to create each alphanumeric character. However, numbers 0, 1, and 5 cannot be distinguished from letters O, I, and S, while letters containing diagonal strokes, such as K, M, N, W, X, and Z, cannot be displayed at all.

Figure 17-5. *Numerals and the first six letters of the alphabet created with a 7-segment display.*

Additional Segments

Alphanumeric LCDs were developed using 14 or 16 segments to enable better representation of letters of the alphabet. Sometimes these displays were slanted forward, like the 7-segment displays, perhaps because the style had become familiar, even though the addition of diagonal segments made it unnecessary. In other cases, the 14 or 16 segments were arrayed in a rectangle. See Figure 17-7.

The same words represented in Figure 17-6 are shown in Figure 17-8, using 16-segment LCDs. Clearly, the advantage gained by enabling diagonal strokes entailed the disadvantage of larger gaps in the letters, making made them ugly and difficult to read.

Figure 17-6. *Basic text messages can be generated with 7-segment displays, although they cannot contain alphabetical letters that use diagonal strokes.*

A full character set using 16-segment LCDs is shown in Figure 17-9. This conforms partially with the ASCII coding system, in which each character has an identifying numeric code ranging from 20 hexadecimal for a letter-space to 7A hexadecimal for letter z (although this character set does not attempt to represent lowercase letters differently from uppercase). The ASCII acronym stands for *American Standard Code for Information Interchange*.

Because backlit LCDs had become common by the time 16-segment displays were introduced, the characters were often displayed in light-on-dark or "negative" format, as suggested in this figure. LEDs, of course, have always used the light-on-dark format, as an LED is a light-emitting component.

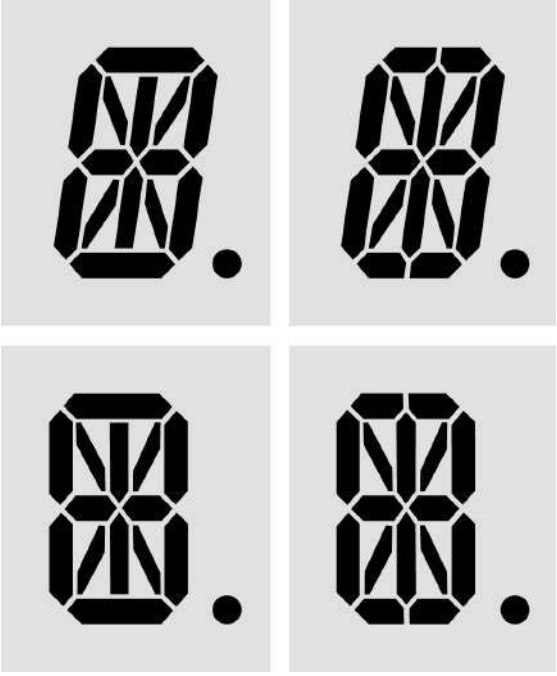

Figure 17-7. *LCDs using 14 segments (left) and 16 segments (right) were introduced to represent a full alphabet in addition to numerals. Sometimes these displays were slanted forward, like the previous 7-segment type, even though this was no longer necessary to represent the number 7.*

Dot-Matrix Displays

The 16-segment displays were never widely popular, and the declining cost of microprocessors, LCD fabrication, and ROM storage made it economic to produce displays using the more easily legible 5x7 dot-matrix alphabet that had been common among early microcomputers. Figure 17-10 shows a dot-matrix character set that is typical of many LCDs.

Because the original ASCII codes were not standardized below 20 hexadecimal or above 7A hexadecimal, manufacturers have represented a variety of foreign-language characters, Greek letters, Japanese characters, accented letters, or symbols using codes 00 through 1F and 7B through FF. The lower codes are often left blank, allowing user installation of custom symbols. Codes 00 through 0F are often reserved for control functions, such as a command to start a new

line of text. There is no standardization in this area, and the user must examine a datasheet for guidance.

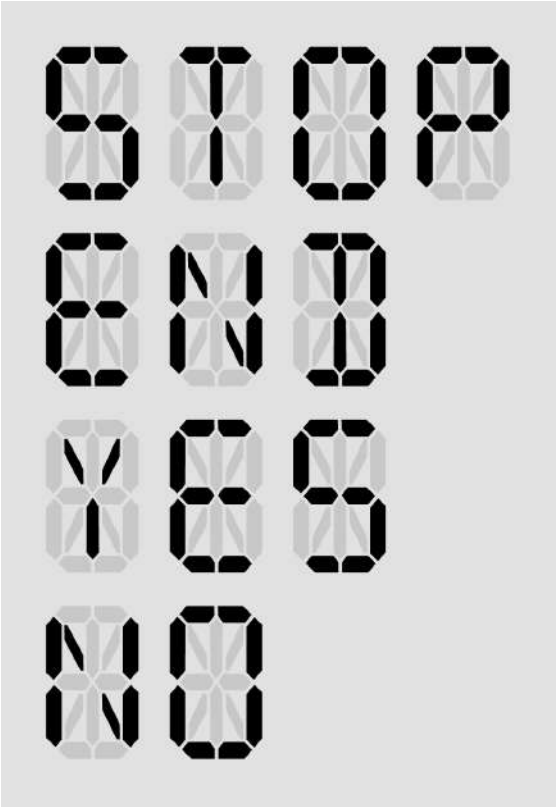

Figure 17-8. *The same text messages shown previously using 7-segment LCDs are shown here using 16-segment displays.*

Dot-matrix LCDs are usually packaged in arrays consisting of eight or more columns and two or more rows of characters. The number of columns is always stated before the number of rows, so that a typical 8 x 2 display contains eight alphanumeric characters in two horizontal rows. An array of characters is properly referred to as a *display module*, but may be described, confusingly, as a *display*, even though a single seven-segment LCD is itself a display. A 16x2 display module is shown from the front in Figure 17-11 and from the rear in Figure 17-12.

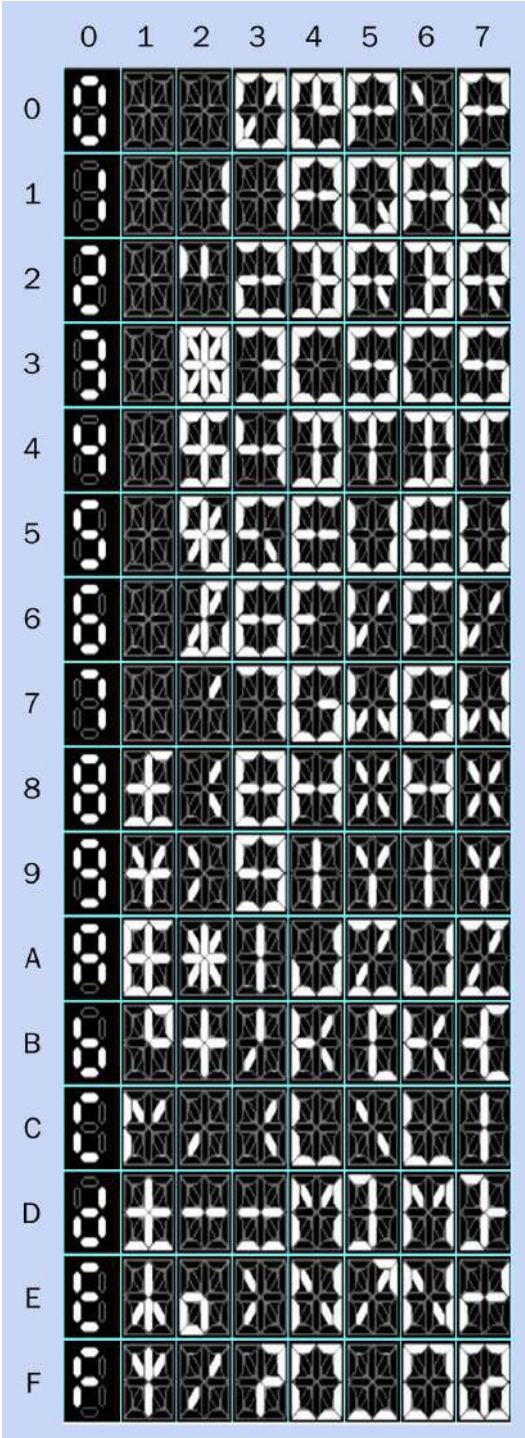

Figure 17-9. *A full character set using 16-segment LCDs.*

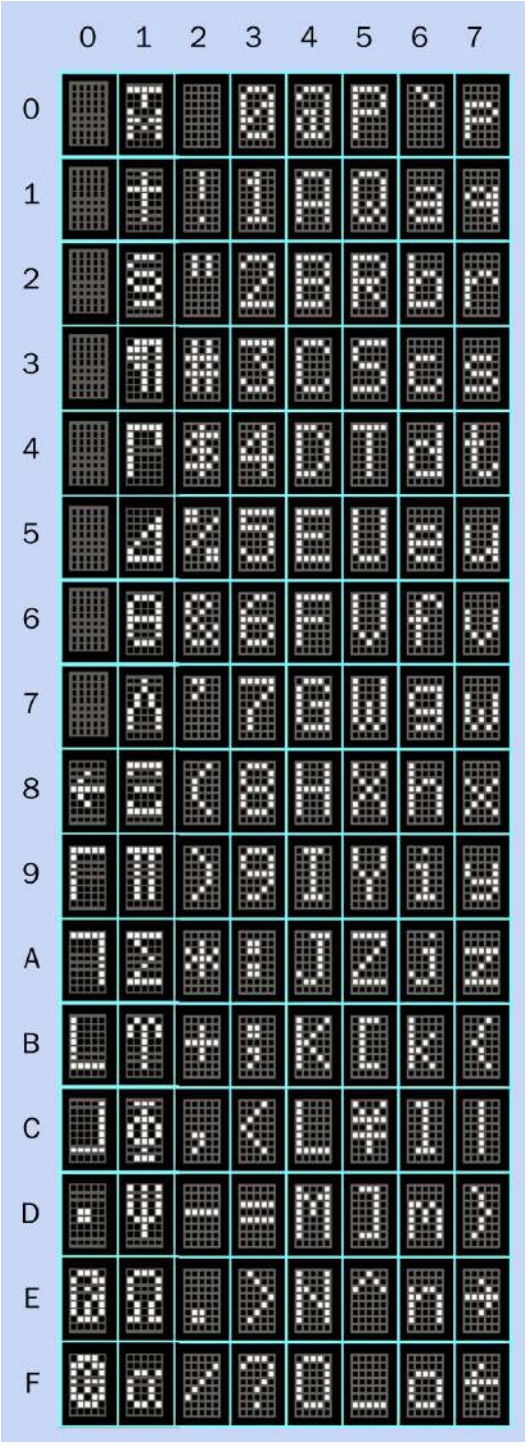

Figure 17-10. *A dot-matrix character set typical of LCDs capable of displaying a matrix of 5×7 dots.*

Figure 17-11. *A 16x2 LCD display module seen from the front.*

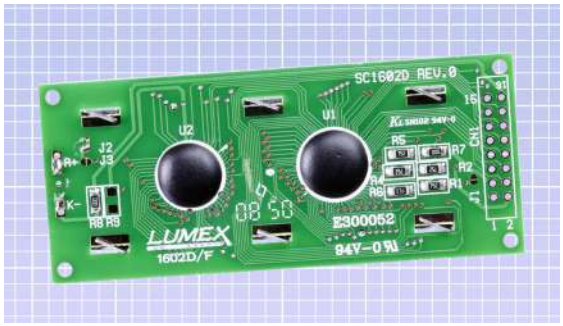

Figure 17-12. *The same 16x2 LCD display module from the previous figure, seen from the rear.*

Multiple-character display modules have been widely used in consumer electronics products such as audio components and automobiles where simple status messages and prompts are necessary—for example, to show the volume setting or broadcast frequency on a stereo receiver. Backlighting is almost always used.

Because the cost of small, full-color, high-resolution LCD screens has been driven down rapidly by the mass production of cellular phones, color displays are likely to displace monochrome dot-matrix LCD display modules in many applications. Similarly, touchscreens will tend to displace pushbuttons and tactile switches. Touchscreens are outside the scope of this encyclopedia.

Color

The addition of filters to create a full color display is shown in simplified form in Figure 17-13.

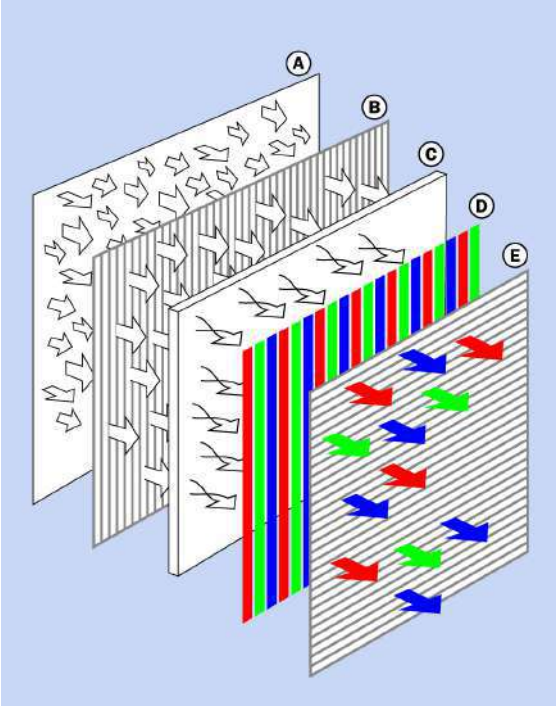

Figure 17-13. *The addition of red, green, and blue color filters, in conjunction with variable density liquid crystal pixels, enables an LCD full-color display.*

Red, green, and blue are almost always used as primary colors for transmitted light, because the combination of different intensities of these *RGB* primaries can create the appearance of many colors throughout the visible spectrum. They are said to be *additive* primaries, as they create brighter colors when they are combined. The principle is illustrated in Figure 17-14.

The use of the word "primaries" to refer to red, green, and blue can cause confusion, as full-color printed materials use a different set of *reflective* primaries, typically cyan, magenta, and yellow, often with the addition of black. In this *CMYK* system, additional layers of pigment will absorb, or subtract, more visible frequences. See Figure 17-15.

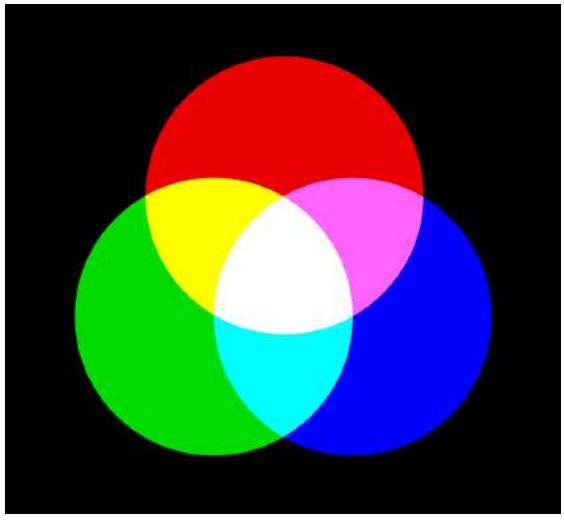

Figure 17-14. *When colors red, green, and blue are transmitted directly to the eye, pairs of these additive primaries create secondary colors cyan, magenta, and yellow. Combining all three additive primaries creates an approximation of white light. This can be verified by viewing a color monitor with a magnifying glass.*

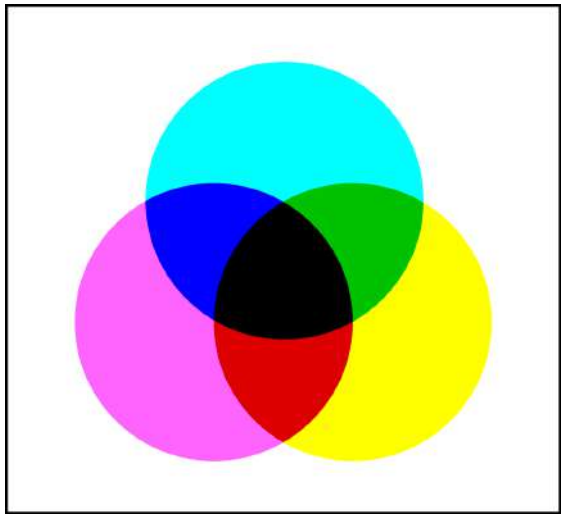

Figure 17-15. *When ink colors cyan, magenta, and yellow are superimposed on white paper and are viewed in white light, pairs of these subtractive primaries create secondary colors red, green, and blue. Overprinting all three subtractive primaries creates an approximation of black, limited by the reflective properties of available pigments. Black ink is usually added to provide additional contrast.*

The complete range of colors that can be created as a combination of primaries is known as the *gamut*. Many different RGB color standards have been developed, the two most widely used being *sRGB* (almost universal in web applications) and *Adobe 1998* (introduced by Adobe Systems for Photoshop, providing a wider gamut). None of the available systems for color reproduction comes close to creating the full gamut that can be perceived by the human eye.

Backlighting Options

For monochrome LCDs, **electroluminescent** backlighting may be used. It requires very low current, generates very little heat, and has a uniform output. However, its brightness is severely limited, and it requires an inverter that adds significantly to the current consumption.

For full-color LCDs, **fluorescent** lights were originally used. They have a long lifetime, generate little heat, and have low power consumption. However, they require a relatively high voltage, and do not work well at low temperatures. Early flat screens for laptop computers and desktop monitors used *cold-cathode fluorescent panels.*

Subsequently, white light-emitting diodes (**LED**s) were refined to the point where they generated a range of frequencies that was considered acceptable. Light from the LEDs passes through a diffuser to provide reasonably consistent illumination across the entire screen. LEDs are cheaper than fluorescent panels, and allow a thinner screen.

High-end video monitors use individual red, green, and blue LEDs instead of a white backlight. This eliminates the need for colored filters and produces a wider gamut. So-called *RGB* LCD monitors are more expensive but are preferred for professional applications in video and print media where accurate color reproduction is essential.

Zero-Power Displays

Some techniques exist to create LCDs that require power only to flip them to and fro between their transparent and opaque states. These are also known as *bistable* displays, but have not become as widely used. They are similar in concept to *e-ink* or *electronic paper* displays, but the principle of operation is different.

How to Use It

So long as an LCD consists of just one numeral, it can be driven by just one decoder chip that translates a binary-coded input into the outputs required to activate the appropriate segments of the LCD. The evolution of multi-digit displays, alphanumeric displays, dot-matrix displays, and graphical displays has complicated this situation.

Numeric Display Modules

An LCD consisting of a single digit is now a rare item, as few circuits require only one numeral for output. More commonly, two to eight numerals are mounted together in a small rectangular panel, three or four numerals being most common. A typical digital alarm clock uses a four-digit numeric display module, incorporating a colon and indicators showing AM/PM and alarm on/off. Other numeric display modules may include a minus sign.

Modules that are described as having 3.5 or 4.5 digits contain three full digits preceded by a numeral 1 composed of two segments. Thus, a 3-digit module can display numbers from 000 through 999, while a 3.5-digit display can display numbers from 000 through 1999, approximately doubling the range.

Numeric display modules of the type described here do not contain any decoder logic or drivers. An external device, such as a microcontroller, must contain a lookup table to translate a numeric value into outputs that will activate the appropriate segments in the numbers in a display, with or without decimal points and a minus sign. To avoid reinventing the wheel, a programmer may download code libraries for microcontrollers to drive commonly used numeric display modules. It is important to remember, though,

that segments in monochrome LCDs must be activated by AC, typically a square wave with a frequency of 30Hz to 90Hz.

An alternative is to use a decoder chip such as the 4543B or 4056B, which receives a binary-coded decimal input (i.e., 0000 through 1001 binary, on four input puts) and translates it into an output on seven pins suitable for connection with the seven segments of a 7-segment display. The 4543B requires a square-wave input to its "phase" pin. The square-wave must also be applied simultaneously to the backplane of the LCD, often identified as the "common" pin on datasheets. Pinouts for the 4543B are shown in Figure 17-16.

The 4543B includes provision for "display blanking," which can be used to suppress leading zeros in a multidigit number. However, the lack of outputs to control a minus sign or decimal point limits the decoder to displaying positive integers.

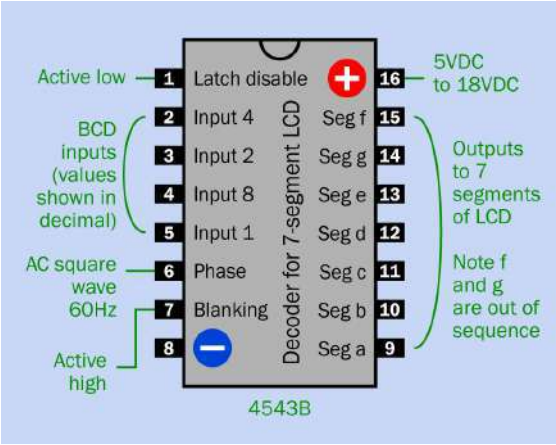

Figure 17-16. *Pinouts for the 4543B decoder chip, which is designed to drive a seven-segment numeric LCD.*

The power supply for a 4543B can range from 5VDC to 18VDC, but because the logic-high output voltage will be almost the same as that of the power supply, it must be chosen to match the power requirements of the LCD (very often 5VAC).(((

To drive a three-digit numeric display module, a separate decoder chip can be used to control each digit. The disadvantage of this system is that each decoder requires three inputs, so that a three-digit display will require nine outputs from the microcontroller.

To deal with this issue, it is common to *multiplex* a multi-digit display. This means that each output from the decoder is shared among the same segments of all the LCD numerals. Each LCD numeral is then activated in sequence by applying AC voltage to its common pin. Simultaneously, the decoder sends the data appropriate to that LCD. This process must be fast enough so that all the digits appear to be active simultaneously, and is best managed with a microcontroller. A simplified schematic is shown in Figure 17-17. It can be compared with a similar circuit to drive LED displays, shown in Figure 24-13.

Alphanumeric Display Module

Arrays of dot-matrix LCDs that can display alphabetical characters as well as numerals require preset character patterns (usually stored in ROM) and a command interpreter to process instructions that are embedded in the data stream. These capabilities are often built into the LCD module itself.

While there is no formal or de facto standard, the command set used by the Hitachi HD44780 controller is installed in many displays, and code libraries for this set are available for download from sites dedicated to the Arduino and other microcontrollers. Writing code from scratch to control all aspects of an alphanumeric display is not a trivial chore. The Hamtronix HDM08216L-3-L30S is a display that incorporates the HD44780.

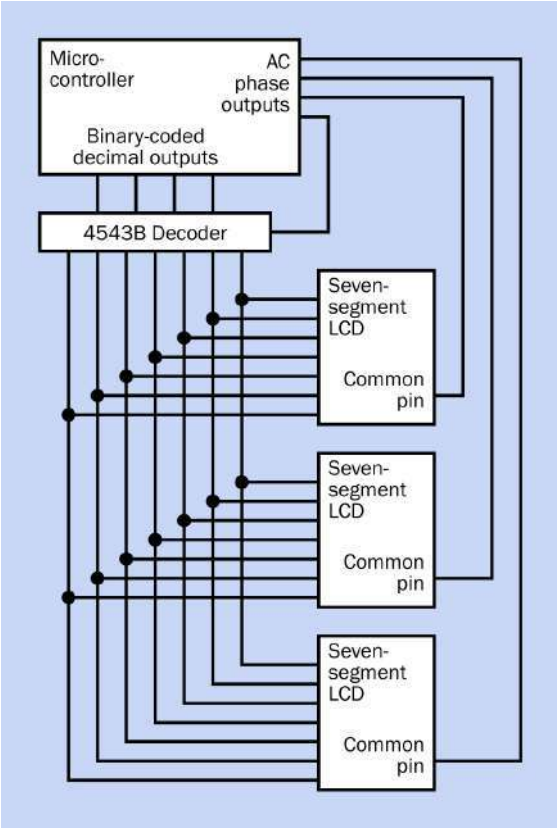

Figure 17-17. *When two or more numeric displays are multiplexed, a control device (typically, a microcontroller) activates each of them in turn via its backplane (common terminal) while sending appropriate data over a shared bus.*

Regardless of which standard is used, some features of alphanumeric display modules are almost universal:

- Register select pin. Tells the display whether the incoming data is an instruction, or a code identifying a displayable character.
- Read/write pin. Tells the display whether to receive characters from a microcontroller or send them to a microcontroller.
- Enable/disable pin.
- Character data input pins. There will be eight pins to receive the 8-bit ASCII code for each displayable character in parallel. Often there is an option to use only four of these pins, to reduce the number of microcontroller outputs necessary to drive the display. Where four pins are used, each 8-bit character is sent in two segments.
- LED backlight pin. Two may be provided, one connected to the anode(s) of the LED backlight, the other to the cathode(s).
- Reset pin.

Embedded instruction codes can be complex, including commands to reposition the cursor at a specific screen location, backspace-and-erase, scroll the display, and erase all characters on the screen. Codes may be included to adjust screen brightness and to switch the display between light-on-dark (negative) and dark-on-light (positive) characters.

Some display modules also have graphics capability, allowing the user to address any individual pixel on the screen.

Because of the lack of standardization in control codes, manufacturer's datasheets must be consulted to learn the usage of a particular alphanumeric display module. In addition to datasheets, online user forums are a valuable source of information regarding quirks and undocumented features.

What Can Go Wrong

Temperature Sensitivity

Liquid crystals vary in their tolerance for low and high temperatures, but generally speaking, a higher voltage may be necessary to create a sufficiently dense image at a low temperature. Conversely, a lower voltage may be necessary to avoid "ghosting" at a high temperature. An absolutely safe operating temperature range is likely to be 0 through 50 degrees Celsius, but check the manufacturer's datasheet for confirmation. Special-purpose LCDs are available for extreme temperatures.

Excessive Multiplexing

A twisted nematic display is likely to perform poorly if its duty cycle is greater than 1:4. In other words, more than four displays should not be multiplexed by the same controller.

DC Damage

An LCD can be damaged quickly and permanently if it is subjected to DC current. This can occur by accident if, for example, a timer chip is being used to generate the AC pulse stream, and the timer is accidentally disconnected, or has an incorrect connection in its RC network. Check timer output with a meter set to measure AC volts before allowing any connection to the common pin of an LCD.

Bad Communications Protocol

Many alphanumeric display modules do not use a formal communications protocol. Duplex serial or I2C connection may not be available. Care must be taken to allow pauses of a few milliseconds after execution of embedded commands, to give the display sufficient time to complete the instruction. This is especially likely where a command to clear all characters from the screen has to be executed. If garbage characters appear on the screen, incorrect data transfer speed or lack of pause times may be to blame.

Wiring Errors

This is often cited by manufacturers as the most common cause of failure to display characters correctly, or lack of any screen image at all.

incandescent lamp

18

The terms *incandescent light*, *incandescent bulb*, and *incandescent light bulb* are often used interchangeably with **incandescent lamp**. Because the term "lamp" seems to be most common, it is used here. A *panel-mounted indicator lamp* is considered to be an assembly containing an incandescent lamp.

A *carbon arc*, which generates light as a self-sustaining spark between two carbon electrodes, can be thought of as a form of incandescent lamp, but is now rare and is not included in this encyclopedia.

OTHER RELATED COMPONENTS

- **LED area lighting** (see Chapter 23)
- **LED indicator** (see Chapter 22)
- **neon bulb** (see Chapter 19)
- **fluorescent light** (see Chapter 20)

What It Does

The term *incandescent* describes an object that emits visible light purely as a consequence of being hot. This principle is used in an **incandescent lamp** where a wire *filament* glows as a result of electric current passing through it and raising it to a high temperature. To prevent oxidation of the filament, it is contained within a sealed bulb or tube containing an inert gas under low pressure or (less often) a vacuum.

Because incandescent lamps are relatively inefficient, they are not considered a wise environmental choice for area lighting and have been prohibited for that purpose in some areas. However, small, low-voltage, panel-mount versions are still widely available. For a summary of advantages of miniature incandescent lamps relative to **light-emitting diodes** (LEDs) see "Relative Advantages" on page 179.

Schematic symbols representing an incandescent lamp are shown in Figure 18-1. The symbols are all functionally identical except that the one at bottom right is more likely to be used to represent small panel-mounted indicators.

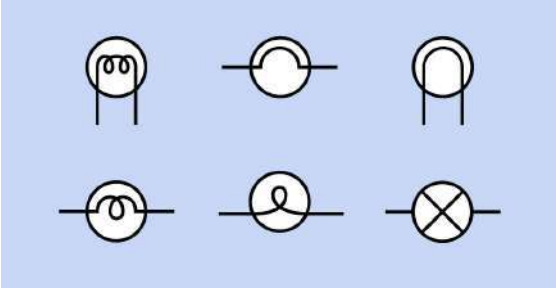

Figure 18-1. *A variety of symbols can represent an incandescent lamp. The one at bottom right may be more commonly used for small panel-mounted indicators.*

The parts of a generic incandescent light bulb are identified in Figure 18-2:

A: Glass bulb.

B: Inert gas at low pressure.

C: Tungsten filament.

D: Contact wires (connecting internally with brass base and center contact, below).

E: Wires to support the filament.

F: Internal glass stem.

G: Brass base or cap.

H: Vitreous insulation.

I: Center contact.

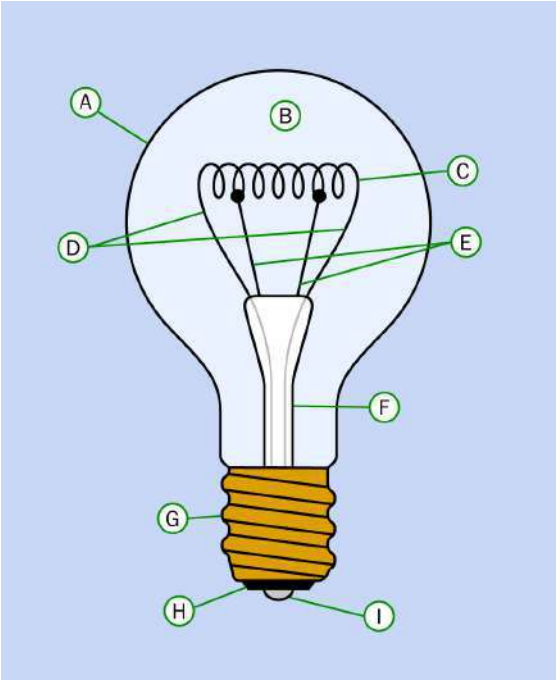

Figure 18-2. *The parts of a typical incandescent lamp (see text for details).*

History

The concept of generating light by using electricity to heat a metal originated with Englishman Humphrey Davy, who demonstrated it with a large battery and a strip of platinum in 1802. Platinum was thought to be suitable because it has a relatively high melting point. The lamp worked but was not practical, being insufficiently bright and having a short lifespan. In addition, the platinum was prohibitively expensive.

The first patent for an incandescent lamp was issued in England in 1841, but it still used platinum. Subsequently, British physicist and chemist Joseph Swan spent many years attempting to develop practical carbon filaments, and obtained a patent in 1880 for *parchmentized thread*. His house was the first in the world to be illuminated by light bulbs.

Thomas Edison began work to refine the electric lamp in 1878, and achieved a successful test with a carbonized filament in October 1879. The bulb lasted slightly more than 13 hours. Lawsuits over patent rights ensued. Carbonized filaments were used until a tungsten filament was patented in 1904 by the German/Hungarian inventor Just Sándor Frigyes and the Croatian inventor Franjo Hanaman. This type of bulb was filled with an inert gas, instead of using a vacuum.

Many other pioneers participated in the effort to develop electric light on a practical basis. Thus it is incorrect to state that "Thomas Edison invented the light bulb." The device went through a very lengthy process of gradual refinement, and one of Edison's most significant achievements was the development of a power distribution system that could run multiple lamps in parallel, using filaments that had a relatively high resistance. His error was insisting on using *direct current* (DC) while his rival Westinghouse pioneered *alternating currrent* (AC), enabling power transmission over longer distances through the use of **transformers**. The use of AC also enabled Tesla's brushless induction motor.

By the mid-1900s, most incandescent bulbs used tungsten filaments.

How It Works

All objects emit electromagnetic radiation as a function of their temperature. This is known as *black body radiation*, based on the concept of an object that absorbs all incoming light, and thus does not reflect any sources from outside itself. As its temperature increases, the intensity of the

radiation increases while the wavelength of the radiation tends to decrease.

If the temperature is high enough, the wavelength of the radiation enters the visible spectrum, between 380 and 740 nanometers. (A nanometer is one-billionth of a meter.)

The melting point of tungsten is 3,442 degrees Celsius, but a lamp filament typically operates between 2,000 and 3,000 degrees. At the higher end of this scale, evaporation of metal from the filament tends to cause deposition of a dark residue on the inside of the bulb, and erodes the filament more rapidly, to the point where it eventually breaks. At the lower end of this scale, the light will be yellow and the intensity will be reduced.

Spectrum

The color of black-body radiation is measured using the Kelvin temperature scale. The increment of 1 degree Kelvin is the same as 1 degree Celsius, but the Kelvin scale has a zero value at *absolute zero*. This is the theoretical lowest conceivable temperature, at which there is complete absence of heat. It is approximately –273 degrees Celsius.

From this it is evident that if K is a temperature in degrees Kelvin and C is a temperature in degrees Celsius:

$$K = C + 273 \text{ (approximately)}$$

Calibration of light sources in degrees Kelvin is common in photography. Many digital cameras allow the user to specify the *color temperature* of lights that are illuminating an indoor scene, and the camera will compensate so that the light source appears to be pure white with all colors in the visible spectrum being represented equally.

Some computer monitors also allow the user to specify a white value in degrees Kelvin.

Color temperature is used in astronomy, because the spectrum of many stars is comparable with that of a theoretical black body.

A color temperature of 1,000 degrees K will have a dark orange hue, while 15,000 degrees K or higher will have a blue hue comparable to that of a pale blue sky. The color temperature of the sun is approximately 5,800 K. Interior lighting is often around 3,000 K, which many people find acceptable because it creates pleasant flesh tones. An incandescent bulb described by the manufacturer as "soft white" or "warm" will have a lower color temperature than one which is sold as "pure white" or "paper white."

Graphs showing the emission of wavelengths at various color temperatures are shown in Figure 18-3. The rainbow section indicates the approximate range of visible wavelengths between ultraviolet, on the left, and infrared, on the right. For purposes of clarity, the peak intensity for each color temperature has been equalized. In reality, increasing the temperature also increases the light output.

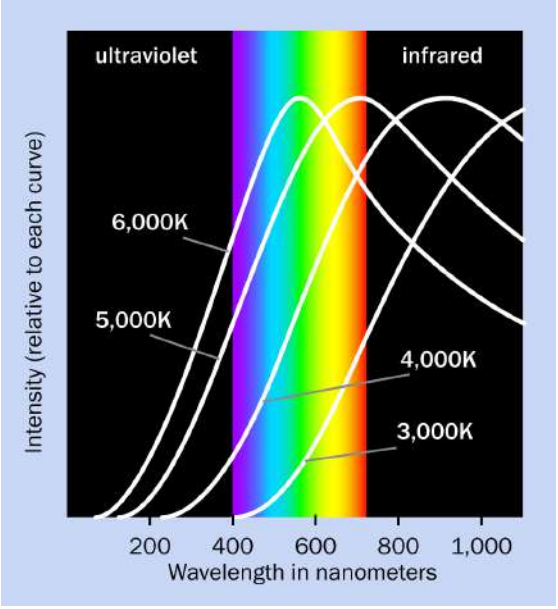

Figure 18-3. *Approximate peak wavelengths for black-body radiation at various color temperatures in degrees Kelvin. The curves have been adjusted so that their peak values are equalized. Adapted from an illustration in the reference book Light Emitting Diodes by E. Fred Schubert.*

Non-Incandescent Sources

So long as light is generated by heating a filament, plotting the intensity against wavelength will result in a smooth curve without irregularities. A higher Kelvin value will simply displace and compress the curve laterally without changing its basic shape to a significant degree.

The introduction of **fluorescent** sources and, subsequently, light-emitting diodes (**LEDs**) has complicated this scenario. Because they are *luminescent* rather than *incandescent*, they do not generate an evenly weighted, continuous range of wavelengths.

LEDs tend to emit monochromatic light, meaning that it is tightly centered around just one color. A "white" LED is really a blue LED in which a phosphor coating on the semiconductor die is excited to create light over a broader range. A fluorescent light tends to create *spectral lines* which show up as sharp peaks at a few wavelengths determined by the mercury inside the bulb. Figure 18-4 illustrates these problems.

The human eye tends to compensate for the yellow emphasis of incandescent lamps and for the irregularities in spectra emitted by other light sources. Also, the eye is often unable to distinguish between "white" light created as a mix of all the visible wavelengths, and light that appears white even though it is dominated by a few isolated wavelengths from a fluorescent source.

However, when the eye views colors that are illuminated by a source that has gaps in its spectrum, some of the colors will appear unnaturally dull or dark. This is true also if an imperfect source is used as a backlight to create colors on a video monitor. Colors rendered by different light sources are shown in Figure 23-7 and subsequent figures.

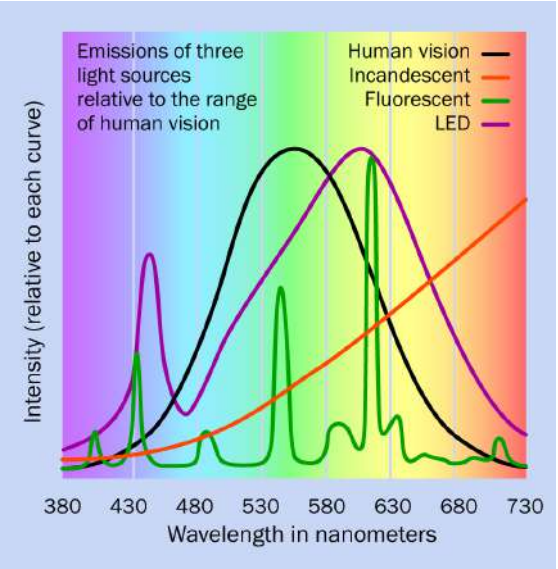

Figure 18-4. *The relative performance of three light sources compared with sensitivity of the human eye to the visible spectrum. Note that the range of wavelengths on the horizontal scale in this figure is not the same as the range in the previous figure. The color assigned to each curve is arbitrary. Adapted from VU1 Corporation.*

Photography is adversely affected by the use of LEDs or fluorescents as a light source. Reds, for example, can seem dark when lit by white LEDs, while blues can be inappropriately intense. Because the source does not have an emission curve comparable to that of an incandescent light, the auto-white balance feature of a digital camera may be unable to address this problem, and it cannot be resolved by entering a different Kelvin number manually.

The fidelity with which a light source is capable of displaying the full visible spectrum is known as the *color rendering index* (CRI), ranging from a perfect score of 100 down to 0 or even lower (sodium-vapor street lighting has a negative value). Computing the index requires standard reference color samples and has been criticized for generating scores that do not correlate well with subjective assessments.

Incandescent bulbs can have a CRI of 100, while an uncorrected "white" LED may score as low as 80.

Power Consumption

Approximately 95% of the power consumed by an incandescent lamp generates heat instead of visible light. This wastage of power in room lighting is compounded by the power consumption of air conditioning to remove the heat from enclosed spaces in hot climates. While the heat from incandescent lamps does reduce the need for space heating in cold environments, heat is delivered more efficiently by using systems designed for that purpose. Consequently, greater energy efficiency can be achieved with a light source that generates less heat, regardless of ambient air temperature.

Variants

Miniature Lamps

Prior to the development of **LED**s, all light-emitting panel-mounted indicators were either **neon bulbs** or **incandescent lamps**. The use of neon is limited by its need for a relatively high voltage.

Miniature incandescents were the traditional choice for battery-powered light sources, and at the time of writing are still used in cheap flashlights. Variants are available that are as small as a 5mm LED, with a claimed life expectancy that is comparable, although they draw more current to generate an equivalent light intensity, because much of their power is wasted in infrared wavelengths.

The photograph in Figure 18-5 is of a miniature lamp terminating in pins spaced 0.05" apart. The total height of the lamp, including its ceramic base, is less than 0.4," while its diameter is just over 0.1". It draws 60mA at 5V and is rated for 25,000 hours.

The photograph in Figure 18-6 is of a lamp of similar size and power consumption, but terminating in wire leads and rated for 100,000 hours. It emits 0.63 lumens.

Figure 18-5. *A miniature lamp less than 0.4" high, terminating in pins spaced 0.05" apart.*

Figure 18-6. *This lamp is 0.25" high and terminates in wire leads.*

The lamp pictured in Figure 18-7 is slightly larger, with a glass envelope about 0.25" diameter. It is rated for less than half the lifetime of the lamp in Figure 18-6 but emits three times as much light —a typical tradeoff. Various base styles are available.

Figure 18-7. *This lamp has a glass envelope about 0.35" high. Its screw-in base makes it easier to replace than an LED.*

In the United States, the light output from miniature incandescent lamps may be measured in lumens, but is more often rated in *mean spherical candlepower* (MSCP). An explanation of light measurement is included in "MSCP" on page 178.

Lamp lenses provide a quick and simple way to add color to a miniature incandescent lamp. Usually the lens is cylindrical with a hemispherical end cap, and is designed to push-fit or snap-fit over a small lamp. Even when the cap is translucent, it may still be referred to as a lens.

Panel-Mount Indicator Lamps

This term often refers to a tubular assembly containing a miniature lamp, ready for installation.

The enclosure is often designed to snap-fit into a hole drilled in the panel. If the incandescent bulb inside the enclosure cannot be replaced, the component is said to be "non-relampable." Figure 18-8 shows a 12-volt panel-mount indicator lamp.

Figure 18-8. *This panel-mount indicator lamp is designed to push-fit into a hole 1/2" in diameter. The bulb inside it is not replacable, causing the assembly to be classified as "non-relampable."*

Halogen or Quartz-Halogen

This is a type of incandescent lamp containing gases under pressure in which halogens such as iodine or bromine cause evaporated tungsten atoms to be redeposited on the filament. A halogen lamp can therefore operate at a higher temperature, creating a light that is less yellow and brighter than that from a comparable incandescent lamp. It also enables a smaller bulb, but requires an envelope of borosilicate-halide glass (often termed *fused quartz*) instead of regular glass. A halogen lamp will be slightly more efficient than an incandescent bulb of the same wattage, and will last longer.

Halogens are available in a variety of formats. The small bulb pictured in Figure 18-9 consumes 75W, emitting 1,500 lumens at 3,000 degrees Kelvin. The light intensity is claimed to be equivalent to that of a 100W incandescent bulb. It has a mini-candelabra base.

Oven Lamps

Oven lamps are designed to withstand the high temperature in an oven. Typically they are usable with ambient temperatures up to 300 degrees C. A common power rating is 15W.

Figure 18-9. *A halogen bulb slightly more than 2" in length, designed for 115VAC.*

Base Variants

Miniature lamps are available with a wide variety of connection options, including wire terminals, single-contact bayonet, double-contact bayonet, miniature screw base, and fuse style. Most of these options require a matching socket.

Screw-in lamps for room illumination are common in household lighting in the United States and many other countries (but not in the UK, where bayonet fittings are used). The US socket size is designated by letter E followed by a number that gives the socket diameter in millimeters. Common sizes are E10, E14 and E27.

A *bayonet base* is fitted with two small lugs protruding on opposite sides. The lamp is secured by pushing it in and twisting it to engage the lugs in slots in the socket. The advantage of a bayonet base is that the bulb is less likely to become loose as a result of vibration.

A *pin base* consists simply of a pair of pins that will push-fit into small holes in a socket.

A *flange base* has a flange that engages in a socket where flexible segments will retain it.

A *wedge base* is forced between two contacts which retain the bulb by friction.

Some indicator lamps terminate simply in long, thin leads that can be soldered.

Values

While the power consumption of full-size incandescent lamps is rated in watts, small indicator lamps are rated in milliamps at the voltage for which they are designed. Miniature lamps may require specific voltages ranging from as low as 2V to 24V. A higher voltage generally necessitates a longer filament, which may entail a larger bulb.

The light that a lamp will emit can be measured in two ways: either as the power of the lamp (not its power consumption, but its radiating power), or as the light delivered to a specific area at a specific distance. These two measurements may differ because a lamp may concentrate its light in a beam, as in the case of a reflector bulb or an LED.

Power

Flux, in watts, is a measurement of energy flow in joules per second. The total radiating power of a lamp, in all wavelengths, in all directions, is known as its *radiant flux*. Because invisible wavelengths are of little interest when assessing the brightness of a lamp, the term *luminous flux* is used to describe the apparent brightness of the lamp in the visible spectrum. The unit for luminous flux is the *lumen*.

The human eye is most responsive to yellow-green hues in the center of the spectrum. Consequently, the measurement of luminous flux is

weighted toward green at a wavelength of 555 nanometers. Red and violet are considered to have low luminous flux, while infrared and ultraviolet have a zero value.

When considering a value expressed in lumens, remember:

- Lumens are a measure of the total radiated power output of a light source, in all directions, in the visible spectrum only, weighted toward the characteristics of the human eye.
- The number of lumens of a light source does not define the direction in which the light is shining, or its uniformity.
- The abbreviation for lumen is *lm*.

A conventional incandescent lamp that consumes 100W of electricity is likely to have a light output of about 1,500 lumens. A 40W fluorescent tube can have a light output of about 2,600 lumens.

Illuminance

The *illuminance* of a light source is defined as the luminous flux per unit of area. This can be thought of as the brightness of a surface illuminated by the source.

Illuminance is measured in *lux*, where 1 lux = 1 lumen per square meter. For accurate calibration, the illuminated surface should be spherical in shape, and must be located 1 meter from the light source, with the source at the geometrical center of the sphere.

Illuminance used to be measured in *foot-candles*, where 1 foot-candle was 1 lumen per square foot.

- The number of lumens per square meter (lux) does not define the size of the illuminated area, only the brightness per unit of area.
- A lamp that has a tightly focused beam can achieve a high lux rating. When selecting a lamp for an application, the angle of dispersion of the beam must be considered in conjunction with its lux rating.

Intensity

A *candela* measures the luminous flux within an angle of dispersion. The angle is three-dimensional, and can be imagined as the sharpness of a point of a cone, where the light source is at the point and the cone represents the dispersion of light.

The three-dimensional angle of dispersion is measured in *steradians*. If a light source is at the center of a sphere that has a radius of 1 meter, and is illuminating one square meter of the surface of the sphere, the angle of dispersion is 1 steradian.

- A source of 1 lumen which projects all its light through a dispersion angle of 1 steradian is rated at 1 candela.
- The number of candelas does not define the angle of dispersion, only the intensity within that angle.
- A light source rated for 1,000 candelas could have a power of 10 lumens concentrated within an angle of 0.01 steradians, or could have a power of only 1 lumen concentrated within an angle of 0.001 steradians.
- There are 1,000 millicandelas in 1 candela. The abbreviation for candela is *cd* while the abbreviation for a millicandela is *mcd*.
- LEDs are often rated in mcd. The number describes the intensity of light within its angle of dispersion.

MSCP

Although the term *candlepower* is obsolete, it has been redefined as being equal to 1 candela. *Mean spherical candlepower* (MSCP) is a measurement of all the light emitted from a lamp in all directions. Because the light is assumed to be omnidirectional, it fills 4 * π (about 12.57) steradians. Therefore 1 MSCP = approximately 12.57

lumens. In the United States, MSCP is still the most common method of rating the total light output of a miniature lamp.

Efficacy

The *radiant luminous efficacy* (abbreviated *LER*) assesses how effective a lamp is at channeling its output within the visible spectrum, instead of wasting it in other wavelengths, especially infrared. LER is calculated by dividing the power emitted in the visible spectrum (the *luminous flux*) by the power emitted over all wavelengths.

Thus, if VP is the power emitted in the visible spectrum, and AP is the power emitted in all wavelengths:

```
LER = VP / AP
```

LER is expressed in *lumens per watt*. It can range from a low value of around 12 lm/W for a 40W incandescent bulb to 24 lm/W for a quartz halogen lamp. Fluorescent lamps may average 50 lm/W. LEDs vary, but can achieve 100 lm/W.

Efficiency

The *radiant luminous efficiency* (abbreviated *LFR*) of a lamp measures how good its radiant luminous efficacy is, compared with an imaginary ideal lamp. (Note the difference between the words "efficiency" and "efficacy.") LFR is determined by dividing the radiant luminous efficacy (LER) by the maximum theoretical LER value of 683 lm/W, and multiplying by 100 to express the result as a percentage. Thus:

```
LFR = 100 * ( LER / 683 )
```

The LFR ranges from around 2% for a 40W bulb to 3.5% for a quartz halogen lamp. LEDs may be around 15% while fluorescents are closer to 10%.

How to Use It

When first introduced, LEDs were limited by their higher price, lower maximum light output, and inability to display blue or white. The price difference has disappeared for small indicators, while gaps in the color range have been filled (although the color rendering index of LEDs is still inferior).

Brightness remains an advantage for large incandescents relative to LEDs, as they are more upwardly scalable. However, fluorescents and vapor lamps have an advantage for very high light output, as in the lighting of big-box stores or parking lots. Thus the range of applications for incandescent bulbs is diminishing, especially because common types are now illegal for domestic light fixtures in many parts of the world.

Relative Advantages

When choosing whether to use an incandescent lamp or an LED, these advantages of an incandescent lamp should be considered:

- The intensity can be adjusted with a **triac**-based dimmer. Regular fluorescents cannot be dimmed, while LEDs often require different dimmer circuitry.
- The intensity can also be adjusted with a rheostat. The output from fluorescents cannot.
- Easy white-balance correction. LEDs and fluorescents do not naturally produce a consistent output over the visible spectrum.
- Can be designed to operate directly from a wide range of voltages (down to around 2V and up to around 300V). A higher voltage entails a longer filament wire, which may require a larger bulb. LEDs require additional components and circuitry to use higher voltages.
- Incandescent bulbs are more tolerant of voltage fluctuations than LEDs. With battery operation, the incandescent will still provide some reduced light output when the voltage has diminished radically. LEDs will not perform at all at currents lower than their threshold.
- An incandescent is nonpolarized and may be socketed, which simplifies user replacement.

LEDs are polarized and are usually soldered in.

- Can be powered by AC or DC without any modification or additional circuitry. LEDs require DC, which must be provided through a transformer and rectifier, or similar electronics, if AC power is the primary source.
- Can be equally visible from a wide range of viewing angles. LEDs have restricted viewing angles.
- The heat output from an incandescent bulb may occasionally be useful (for example in a terrarium, or in incubators for poultry).
- Trouble-free switching. Fluorescents tend to hesitate and blink when power is applied, and they require a *ballast* to energize them. The lifespan of fluorescents is reduced by frequent switching.
- No low-temperature problems. Incandescent lamps are not significantly affected by low temperatures. Fluorescents may not start easily in a cold environment, and may flicker or glow dimly for 10 minutes (or more) until they are warm enough to function properly.
- Easy disposal. Fluorescent lights contain small quantities of mercury that are an environmental hazard. They should not be mixed with ordinary trash. Compact fluorescent lamps (CFLs) and LEDs used for room lighting will be packaged with electronics that should ideally be recycled, although this is not very practical. Incandescent bulbs impose the least burden on the environment when they are thrown away.

However, the incandescent lamp has some obvious disadvantages:

- Relatively inefficient.
- More susceptible to vibration.
- More fragile.
- Likely to have a shorter natural life expectancy than LEDs, fluorescents, or neon bulbs, although the lifetime of a small panel indicator can be equal to that of an LED if a low color temperature is acceptable.
- Requires a filter or tinted glass envelope to generate colored light. This further reduces the lamp's efficiency.
- Cannot be miniaturized to the same degree as an LED indicator.

Derating

The lifespan of a lamp can be greatly extended by choosing one with a higher current rating or using it at a lower voltage. The light output will be reduced, and the color temperature will be at a lower Kelvin number, but in some situations this tradeoff may be acceptable.

The graphs in Figure 18-10 suggest that if the voltage of a hypothetical miniature lamp is reduced to 80% of the manufacturer's recommended value, this can make the lamp last 20 times as long. Note, however, that this will cut the light intensity to 50% of its normal value.

Conversely, using 130% normal voltage will give 250% of the normal light output, while shortening the life of the lamp to 1/20 of its normal value. Naturally these figures are approximations that may not apply precisely to a specific lamp.

What Can Go Wrong

High Temperature Environment

If an incandescent lamp is used in an environment hotter than 100 degrees Celsius, the life of the lamp is likely to be reduced by the "water cycle." Any water molecules inside the glass envelope will break down, allowing oxygen to combine with the tungsten filament to form tungsten oxide. The tungsten is deposited on the inside of the glass while the oxygen is liberated and begins a new cycle.

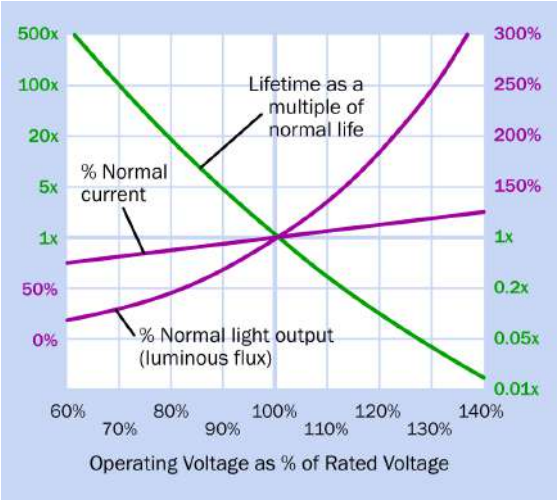

Figure 18-10. *The life expectancy of a hypothetical miniature lamp is very strongly influenced by voltage. Applying only 60% of the rated voltage can make a lamp last 500 times its normal lifespan, although it will greatly reduce light output. Note that the vertical axes apply to curves of the same color. Adapted from "Characteristics of Miniature Lamps" from Toshiba Lighting and Technology Corporation.*

Fire Risk

The partially evacuated bulb of an incandescent lamp provides some separation and protection from the heat in the filament, but if the bulb cannot disperse heat by radiation or convection, its temperature can rise to the point where it ignites flammable materials.

Halogen lamps have an elevated fire risk because they operate at a higher temperature and are smaller, providing less surface area to disperse the heat. They also contain gases under seven to eight atmospheres of pressure. Thermal stress can cause a halogen bulb to shatter, and fingerprints on the glass can increase this risk.

Current Inrush

When an incandescent lamp is first switched on, its filament has one-tenth the resistance that it will exhibit when it becomes hot. Consequently, the lamp will take a large initial surge of current, which stabilizes after about 50 milliseconds. This should be considered if one or more small lamps shares a DC power supply with components such as logic chips that may be sensitive to voltage fluctuations.

Replacement Problems

Because of the limited life of incandescent lamps, they should be installed in such a way that they are easy to replace. This can be an issue with panel indicators, where disassembly of a device may be necessary to reach the lamp.

The range of small incandescent lamps is diminishing, and may continue to diminish in the future. Future availability of replacement lamps should be considered when designing a circuit. When building equipment in small quantities, spare lamps should be purchased for future use.

neon bulb

19

The terms **neon bulb**, *neon indicator*, and *neon lamp* tend to be used interchangeably. In this encyclopedia, a neon *bulb* is defined as a glass capsule containing two electrodes in neon gas (or a combination of gases in which neon is present). A neon *lamp* is an assembly containing a neon bulb, usually using a plastic tube with a tinted transparent cap at one end. A neon *indicator* is a miniature neon lamp that is usually panel-mounted.

Large-scale neon tubes used in signage are not included in this encyclopedia.

OTHER RELATED COMPONENTS

- **incandescent lamp** (see Chapter 18)
- **fluorescent light** (see Chapter 20)
- **LED indicator** (see Chapter 22)

What It Does

When voltage is applied between two electrodes inside a neon bulb, the inert gas inside the bulb emits a soft red or orange glow. This color may be modified by using a tinted transparent plastic cap, known as a *lens*, in a *neon lamp* assembly.

A neon bulb is usually designed for a power supply of 110V or higher. It functions equally well with alternating or direct current.

The schematic symbols in Figure 19-1 are commonly used to represent either a neon bulb or a neon lamp. They are all functionally identical. The black dot that appears inside two of the symbols indicates that the component is gas filled. The position of the dot inside the circle is arbitrary. Even though all neon bulbs are gas filled, the dot is often omitted.

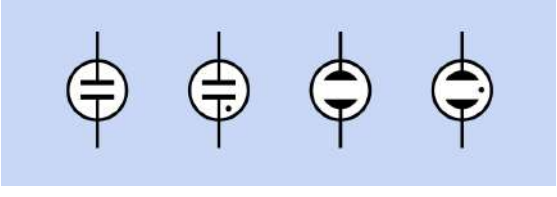

Figure 19-1. *Any of these symbols may represent a neon bulb or a neon lamp. The dot in two of the symbols indicates that the component is gas filled. All neon bulbs are gas filled, but the dot is often omitted.*

The photograph in Figure 19-2 shows a neon bulb with a series resistor preattached to one lead. Many bulbs are sold in this configuration, because a resistor must be used to limit current through the bulb. The bulb has no polarity and can be used on an AC or DC power supply. The same bulb is shown in its energized state in Figure 19-3.

Figure 19-2. *A typical neon bulb with series resistor attached to one lead.*

How It Works

Construction

The parts of a neon bulb are illustrated in Figure 19-4. When the bulb is fabricated, it begins as a glass tube. The leads are made of *dumet*, consisting of a copper sheath around a nickel iron core. This has the same coefficient of expansion as glass, so that when the glass is heated and melted around the leads, it forms a seal that should be unaffected by subsequent temperature fluctuations. This area is known as the *pinch* in the tube.

Nickel electrodes are welded onto the leads before the leads are inserted into the tube. The electrodes have an emissive coating that reduces the minimum operating voltage. The glass tube is filled with a combination of neon and argon gases, or pure neon for higher light output (which reduces the life of the component). The top end of the glass tube is heated until it melts, and is pinched off. This creates a distinctive protrusion known as the *pip*.

Figure 19-3. *The same bulb from the previous photograph, energized with 115VAC.*

Ionization

When a voltage is applied between the leads to the bulb, the gas becomes ionized, and electrons and ions are accelerated by the electric field. When they hit other atoms, these are ionized as well, maintaining the ionization level. Atoms are excited by collisions, moving their electrons to higher energy levels. When an electron returns from a higher level to a ground state, a photon is emitted.

This process begins at the *starting voltage* (also known as the *striking voltage*, the *ignition voltage*, or the *breakdown voltage*) usually between 45V and 65V for standard types of bulb, or between 70V and 95V for high-brightness types.

When the bulb is operating, it emits a soft radiance known as a *glow discharge* with a wavelength ranging from 600 to 700 nanometers.

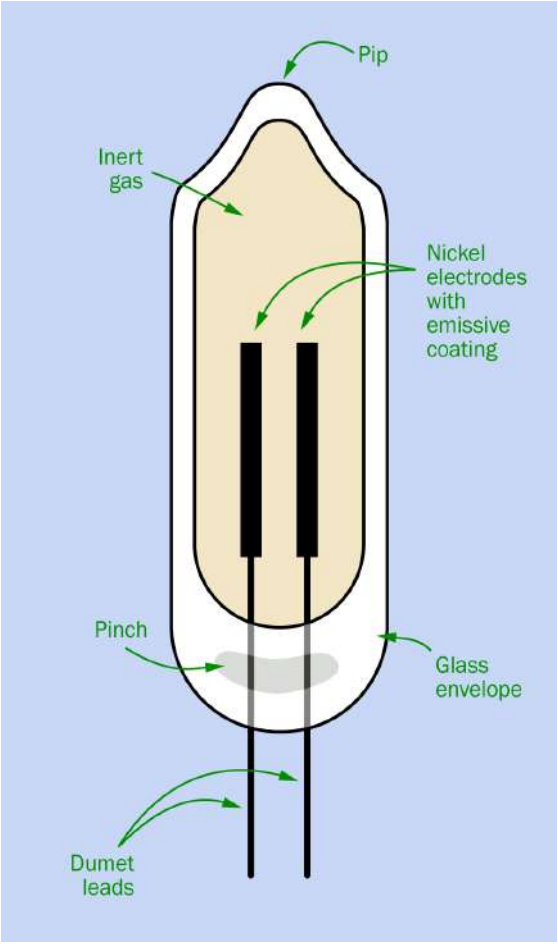

Figure 19-4. *The parts of a neon bulb. See text for details.*

The ionization of the gas allows current to flow through it. This will continue even if the power supply is reduced by 10 to 20 volts to a level known as the *maintaining voltage*.

Negative Resistance

When the glow discharge persists below the starting voltage, this is a form of *hysteresis*, meaning that the neon bulb tends to "stick" in its on state. It remains on while its power supply decreases to the maintaining voltage, but once it switches off, it will "stick" in its off state until the power supply increases again above the maintaining voltage to the starting voltage. The concept of hysteresis is discussed in the entry on **comparators**. See Figure 6-2.

A neon bulb is said to have *negative resistance*. If the current is allowed to increase without restraint, the resistance eventually decreases while the current increases further. If this runaway behavior is not controlled, the bulb will destroy itself.

This behavior is characteristic of gas-discharge tubes generally. A graph showing this appears in Figure 19-5. Note that both scales are logarithmic. Also note that the curve shows how current will be measured in response to voltage. If the voltage is reduced after it has increased, the transitional events shown by the graph will not recur in reverse order. This is especially true if arcing is allowed to begin, as it will almost certainly destroy the component.

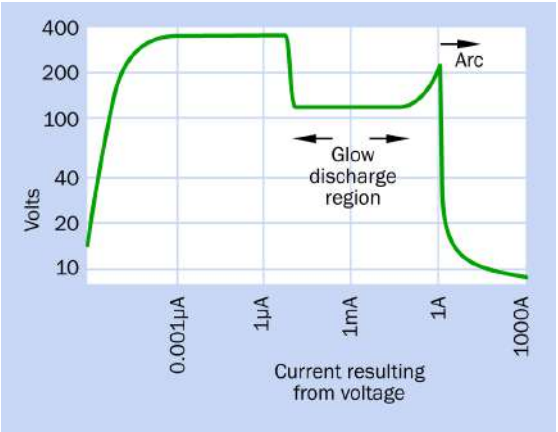

Figure 19-5. *A gas discharge tube, such as a neon bulb, is said to have a negative resistance, as current passing through it tends to increase uncontrollably after the gas is ionized and becomes conductive. (Derived from measurements made by David Knight, on a web page named after his radio ham call sign, G3YNH.)*

A neon bulb can be controlled very simply with a series resistor that maintains it in gas-discharge mode. To understand the operation of the resistor, consider the combination of the lamp and

the resistor as a voltage divider, as shown in Figure 19-6. Before the lamp begins to pass current, it has an almost infinite resistance. Therefore, the voltage on both sides of the resistor will be approximately equal, the bulb passes almost no current, and it remains dark.

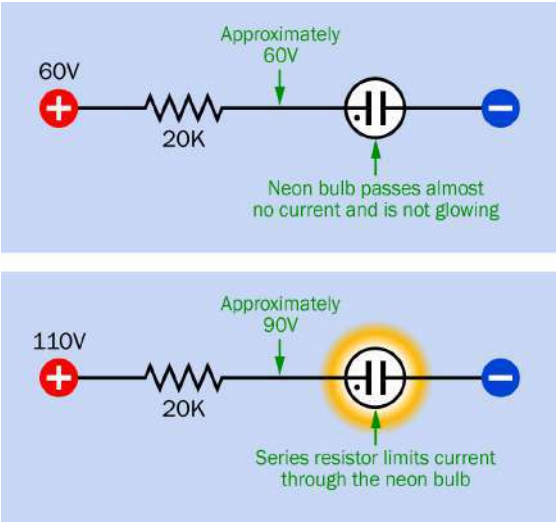

Figure 19-6. *A series resistor is essential to limit the current through a neon bulb.*

After the lamp begins to pass current, the requirement now is for the series resistor to reduce the voltage from the supply level (probably around 110V) to the maintaining level (probably around 90V). This means that the desired voltage drop is 20V, and if the manufacturer's specification tells us that the lamp should pass 1mA (i.e., 0.001 amps), R, the value of the series resistor, is given by Ohm's Law:

```
R = 20 / 0.001
```

Thus, the value for R is 20K. In fact, the value of a resistor supplied with a neon bulb may range from 10K to 220K, depending on the characteristics of the bulb and the supply voltage that will be used.

Now if the bulb's effective internal resistance falls radically, the resistor still limits the currrent. In a hypothetical worst-case scenario, if the bulb's resistance drops all the way to zero, the resistor must now impose the full voltage drop of 110V, and the current, I, will be found by Ohm's law:

```
I = 110 / 20,000
```

That is, about 5mA, or 0.005A.

Neon tubes used in signage require a more sophisticated voltage control circuit which is not included in this encyclopedia.

How to Use It

The use of a neon bulb for an indicator lamp is primarily limited to situations where domestic supply voltage (115VAC or 220VAC) is readily available. "Power on" lights are the obvious application, especially as neon indicators can accept AC. The switch shown in Figure 19-7 is illuminated by an internal neon bulb. The rectangular indicator in Figure 19-8 is designed to run on domestic supply voltage, and its internal bulb and resistor can be clearly seen through the green plastic. The assembly in Figure 19-9 is about 0.5" in diameter, which is the lower limit for neon indicators.

Figure 19-7. *This power switch is illuminated by an internal neon bulb.*

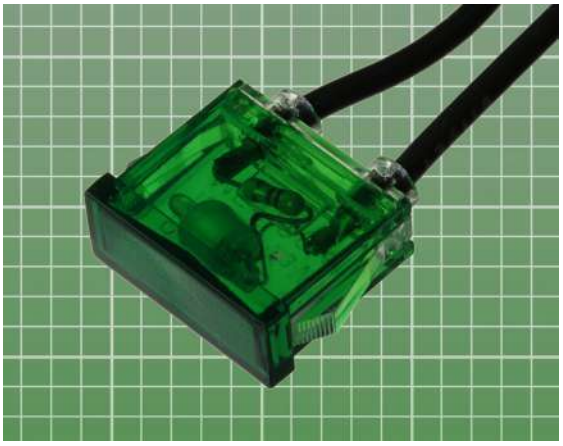

Figure 19-8. *The neon bulb and its series resistor are visible inside this indicator.*

Figure 19-9. *A relatively small neon indicator lamp, designed for insertion in a hole 0.5" diameter.*

Limited Light Output

Neon bulbs have a light output of around 0.06 lumens per milliamp of consumed power (standard brightness type) or 0.15 lumens per milliamp of consumed power (high brightness type).

Comparing this value with the intensity of **LED** indicators is difficult. Their light output is customarily measured in *millicandelas* (mcd), because LED indicators almost always include a lens that focuses the light, and the candela is a measurement of luminous flux within an angle of dispersion. Moreover, because the intensity of neon indicators is not of great interest in most applications, datasheets usually do not supply an intensity value.

One way around the problem of comparisons is to use the standard of *radiant luminous efficacy* (LER), which is defined in the entry on incandescent lamps (see "Efficacy" on page 179). A standard-brightness neon bulb has an LER of about 50 lumens per emitted watt of luminous flux. A light-emitting diode may reach an LER of 100 lm/W. However, a neon bulb operates typically around 1mA while an LED indicator may use 20mA. Therefore, a typical LED indicator may appear to be 30 to 50 times brighter than a typical neon bulb.

Consequently, neon may be an inferior choice in a location where there is a high level of ambient light. Direct sunlight may render the glow of a neon indicator completely invisible.

Efficiency

Because a neon bulb does not use a lot of power and generates negligible heat, it is a good choice where current consumption is a consideration (for example, if an indicator is likely to be on for long periods). The durability and low wattage of neon bulbs, and their convenient compatibility with domestic power-supply voltage, made them a favorite for night-lights and novelty lamps in the past. Figure 19-10 shows an antique bulb containing an ornamental electrode, while Figure 19-11 is a piece of folk art, approximately 1" in diameter, mounted on a plug-in plastic capsule containing a neon bulb.

Ruggedness

Neon bulbs are a good choice in difficult environments, as they are not affected by vibration, sudden mechanical shock, voltage transients, or frequent power cycling. Their operating temperature range is typically from -40 to +150 degrees Celsius, although temperatures above 100 degrees will reduce the life of the lamp.

Figure 19-10. *In bygone decades, ornamental neon bulbs with specially shaped electrodes were popular.*

Figure 19-11. *Neon folk art survives in this hand-painted night-light sold in a Florida tourist shop.*

Power-Supply Testing

When driven by DC current, only the negative electrode (the *cathode*) of a neon bulb will glow. When AC current passes through the bulb, both terminals will glow.

If a bulb (with series resistor) is placed between the "hot" side of a domestic AC power supply and ground, the bulb will glow. If it is placed between the neutral side of the supply and ground, it will not glow.

These features enable a neon bulb to be used for simple power-supply testing.

Life Expectancy

The metal of the electrodes gradually vaporizes during everyday use of a neon bulb. This is known as *sputtering* and can be observed as the glass capsule becomes darkened by deposition of vaporized metal. The electrodes will have a more limited life in a lamp used with DC voltage, where sputtering affects only the cathode. Using AC, the electrodes take turns functioning as the cathode, and vaporization is distributed between both of them.

Failure of a neon lamp can occur as sputtering erodes the electrodes to the point where the maintaining voltage will increase until it almost reaches the level of the power supply. At this point, the bulb will flicker erratically.

Failure can also be defined as a gradual reduction in brightness to 50% of rated light output, caused by accumulated deposition in the glass capsule. Because deposition occurs more heavily on the sides of the bulb, a longer apparent life is possible if the bulb is mounted so that it is viewed from the end.

Typically, neon bulbs are rated for 15,000 to 25,000 hours (two to three years of constant operation). However, the life can be greatly increased by a slight reduction in voltage, which may be achieved by substituting a series resistor with a slightly higher value.

The relationship between operating life and resistor value is shown below. If LA is the normal operating life, LB is the extended operating life,

RA is the normal resistor value, and RB is a higher resistor value:

$$LB = LA * (RB / RA)^{3.3}$$

For example, if a normal resistor value is 20K, and it is increased to 22K, the life of the lamp should increase by a factor of slightly more than 1.4.

Variants

A typical neon bulb terminates in leads, and a lamp assembly often has solder tabs, although it may have a base with a screw thread, flange, or bayonet pins for insertion into a compatible socket. A lamp assembly that does not use a base will either snap-fit into a hole of appropriate size and shape, or may be retained with a nut that engages with a plastic thread on the cylinder of the lamp.

Some neon bulbs or lamp assemblies terminate in pins for direct insertion into a printed circuit board.

Almost all neon bulbs operate either in the 100V to 120V range or in the 220V to 240V range.

Light intensity is expressed either as "standard" or "extra-bright," although datasheets usually do not define those terms.

Nixie Tubes

Nixie tubes, first marketed in 1955, were used to display numerals from 0 through 9 in the days before LEDs took over this capability. They are no longer being manufactured.

Each numeral was physically formed from metal and functioned as an electrode inside a tube filled with a neon-based gas mixture. The typographical elegance of the digits and their aesthetically pleasing glow made Nixies enduringly popular. With a long lifespan, vintage tubes are still usable and can be purchased cheaply from sources such as eBay. Many originate in Russia, where Nixie-type displays were manufactured into the 1980s. The Russian tubes can be identified by their use of a numeral 5 that is a numeral 2 turned upside-down.

Nixie tubes typically require 170VDC. This creates a challenge for a power supply and switching, and can be a safety hazard.

Figure 19-12 shows six Nixie-type tubes repurposed for use as a 24-hour digital clock.

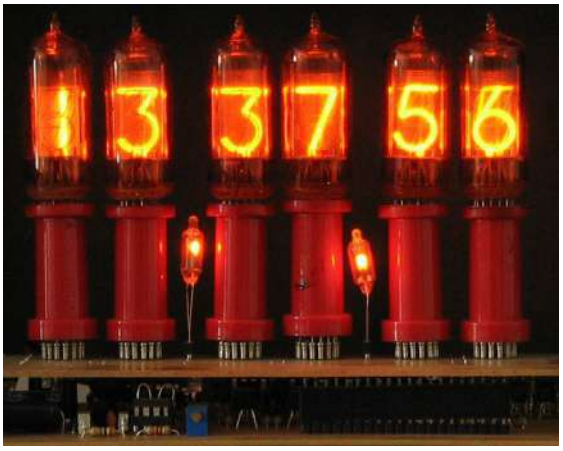

Figure 19-12. *A 24-hour clock using Nixie-type tubes. Source: Wikipedia, public domain.*

What Can Go Wrong

False Indication

Because a neon bulb requires so little power, it may be energized by induced voltages from elsewhere in a circuit, especially if inductive components such as transformers are used. To prevent this, a high-value resistor can be placed in parallel with the bulb, in addition to the series resistor that must always be used.

Failure in a Dark Environment

Because a neon bulb requires a minimal amount of light to initiate its own photon emissions, it may take time to start glowing in a very dim environment, and may not light at all in total darkness. A few bulbs include a small amount of radioactive material that enables them to self-start in complete absence of ambient light.

Premature Failure with DC

The life expectancy quoted in datasheets for neon bulbs usually assumes that they are powered by AC. Because DC results in faster vaporization of the electrodes, the expected lifetime should be reduced by 50% if DC power will be used.

Premature Failure through Voltage Fluctuations

Because the deterioration of a neon bulb accelerates rapidly with current, a sustained voltage that passes slightly more current can radically reduce the expected lifespan.

Replacement

Replacement can be an issue with panel indicators, where disassembly of a device may be necessary to reach the bulb. Bear in mind, however, that an easily removable bulb becomes vulnerable to tampering.

fluorescent light

20

This entry deals primarily with *fluorescent tubes* (infrequently but sometimes described as *fluorescent lamps*), and *compact fluorescent lamps* (CFLs) that are marketed as a substitute for **incandescent lamps**. *Cold-cathode fluorescent lamps* (CCFLs) are also mentioned.

Vacuum fluorescent devices have a separate entry in this encyclopedia. A fluorescent tube or CFL does not contain a vacuum.

Although the diode(s) in a white **LED area lighting** unit are coated with a layer of fluorescent phosphors, they are not categorized here as fluorescent lights, and have their own entry.

A **neon bulb** resembles a fluorescent light in that it is a *gas-discharge* device, but the interior of its glass envelope is usually not coated with fluorescent phosphors, and therefore it has its own entry.

OTHER RELATED COMPONENTS

- **incandescent lamp** (see Chapter 18)
- **LED area lighting** (see Chapter 23)
- **vacuum fluorescent** devices (see Chapter 25)
- **neon bulb** (see Chapter 19)

What It Does

Fluorescent tubes or *compact fluorescent lamps* (CFLs) are primarily used for area lighting. A partially disassembled CFL appears in Figure 20-1, showing the control electronics that are normally hidden inside the base.

There is no standardized schematic symbol to represent a fluorescent light. Figure 20-2 shows three commonly used symbols for a fluorescent tube on the left, and three symbols for a CFL on the right. Note that two of the symbols for a CFL are the same as those for an **incandescent lamp**, shown in Figure 18-1.

How It Works

Luminescence is the emission of light as a result of a process that does not require heat. (The opposite phenomenon is *incandescence*, in which heating causes an object to emit light; see Chapter 18 for a description of **incandescent lamps**.)

Fluorescence is a form of luminescence. It occurs when electrons in a material are energized and then make a transition back to ground level, at which point they radiate their energy as visible light. The incoming energy can consist of other light at a higher frequency. Some creatures, including species of arachnids and fish, will fluoresce when they are lit with ultraviolet light.

Figure 20-1. *A compact fluorescent lamp with its base cut away to reveal the control electronics.*

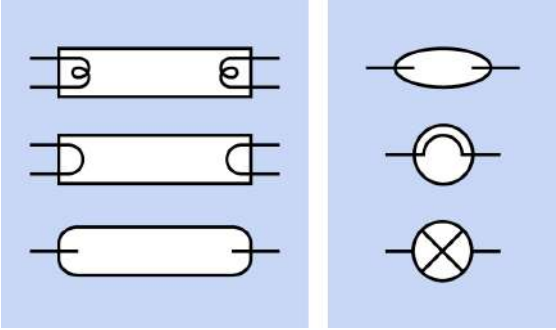

Figure 20-2. *Schematic symbols to represent fluorescent tubes and bulbs are not standardized. See text for details.*

A *fluorescent tube or lamp* contains a very small amount of mercury vapor that can be stimulated to emit ultraviolet light. This encounters a thin layer of *phosphors* coating the inner surface of the glass enclosure. The light causes the phosphors to *fluoresce*, emitting a diffuse radiance in the visible spectrum.

The tube or lamp also contains one or more inert gases such as argon, xenon, neon, or krypton at about 0.3% of normal atmospheric pressure. Two electrodes inside the glass enclosure are made primarily from tungsten, which can be preheated to initiate ionization of the gas. Confusingly, both electrodes are often referred to as *cathodes*.

The function of the gas is not to emit light, but to conduct electric current, so that free electrons may encounter mercury atoms, raising their electrons briefly to a higher energy level. When one of these electrons reverts from its unstable energized state to its previous energy level, it emits a photon at an ultraviolet wavelength.

Figure 20-3 provides a diagram showing the interior of a fluorescent tube.

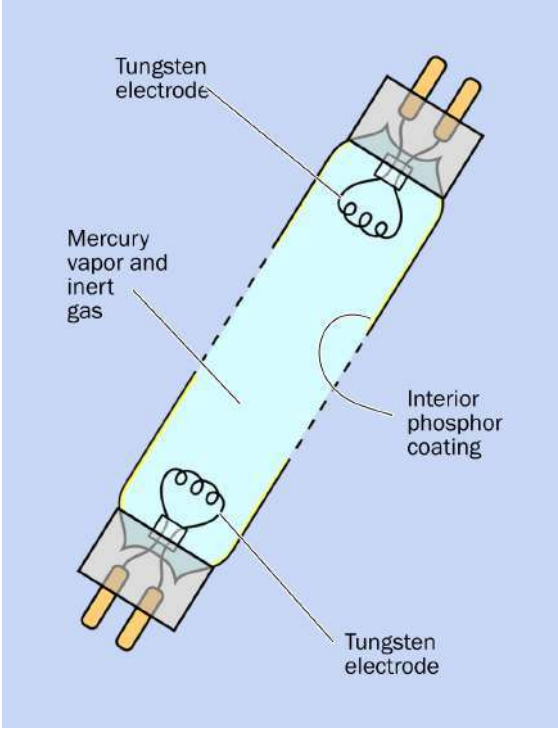

Figure 20-3. *The basic parts of a fluorescent tube.*

Ballast and Starter

Heating the tungsten electrodes is necessary but not sufficient to trigger ionization. A high-voltage pulse is also needed when the light is switched on. In a typical 48" tube, the pulse may range from 200V to 300V.

After current flow has been established, the gas, which is now a plasma, enters a phase of negative

resistance. Current passing through it will tend to increase even if the voltage decreases. This process must be controlled to prevent the formation of an *arc*, which will destroy the electrodes. (A similar process occurs in any gas discharge tube, such as a **neon bulb**, and is described in a graph in Figure 19-5.)

To heat the electrodes, ionize the gas, and then control the current, the fixture for a fluorescent tube contains components that are separate from the tube. In their simplest, traditional form, these components consist of a *starter* and a *ballast*. The starter is a neon bulb that contains a bimetallic strip serving as a normally closed switch. It allows current to flow through the electrodes in series, to heat them. The basic circuit is shown in Figure 20-4.

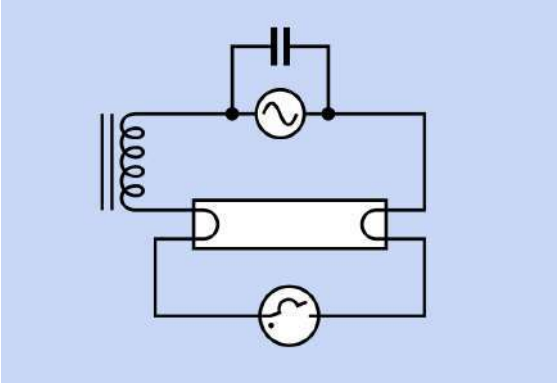

Figure 20-4. *The traditional circuit to trigger ionization of the gas in a fluorescent tube uses a starter (shown at the bottom as a neon tube containing a bimetallic strip, which serves as a switch) and ballast (an inductive load, shown at left).*

The starting process may not be immediately successful, in which case the starter may repeat several times in succession, causing the tube to flicker before its discharge becomes stable. In a cold environment, the tube will have more difficulty starting.

After the tube becomes conductive, current between the electrodes bypasses the starter. At this point, the *ballast* limits the current to prevent an arc from forming. The simplest form of ballast is a coil that functions as an **inductor**.

In a more modern system, an *electronic ballast* replaces the starter-ballast combination. It not only applies the initial surge of high current but also raises the 50Hz or 60Hz frequency of the power supply to 10KHz or more. This increases the efficiency of the tube and eliminates any visible flickering of the light.

All compact fluorescent bulbs (CFLs) contain electronic ballasts. The small components visible in Figure 20-1 are the ballast.

Flicker

When a fluorescent tube uses a conventional ballast and is illuminated with 50Hz or 60Hz AC, the glow discharge stops each time the current flow passes through the zero point in its cycle. In fact, the ionized gas in the tube cannot conduct until it is close to the maximum voltage, and stops conducting when the voltage rolls off. Consequently, the voltage across the tube fluctuates in an approximate square wave, and the light output begins and ends very abruptly. Although this occurs 100 times per second on a 50Hz supply and 120 times per second on a 60Hz supply, some people complain that the flicker is noticeable and can induce headaches.

The rapid on-off discharge is hazardous when it illuminates rotating parts in machinery, as a stroboscopic effect can make the parts seem to be stationary. To mitigate this effect, adjacent tubes in a fixture are powered by separate supplies that are out of phase. This is done either by using a three-phase power supply or by adding an LC circuit to the supply for one of the tubes.

Variants

The traditional type of ballast is also known as a *rapid-start ballast*. By preheating the electrodes, it reduces damage to them that otherwise tends to occur during the starting process. A tube designed for use with a rapid-start ballast has two

contacts at each end, and is referred to as a *bi-pin* tube.

An electronic ballast is also known as an *instant-start ballast*. It does not preheat the electrodes, and a tube designed to work with it has only one pin at each end.

CCFLs

A *cold cathode fluorescent lamp* (CCFL) may resemble a miniature fluorescent tube, typically measuring 2mm to 5mm in diameter. The tube may be straight or bent into a variety of shapes. It works on the same principle as a full-size fluorescent tube, containing mercury vapor and one or more inert gases, with an interior coating of phosphors to enable fluorescence. CCFLs are available in many colors and many shades of white.

As its name implies, the electrodes in a CCFL are not heated to establish ionization. Instead, a very high voltage (1,000VAC or more) is applied, dropping to 500VAC to 600VAC after the flow of current has been established. Because CCFLs have been often used to backlight laptop computer screens, inverter circuits are commonly available that create a high-frequency output at a high voltage from an input that can range from 3VDC to 20VDC. The inverter also includes provision to dim the CCFL by using *pulse-width modulation*.

Some CCFLs are designed for illumination of small spaces—for example, the interior of a display case. A few CCFLs look exactly like CFLs and can be used in light fixtures. Some may be compatible with the type of dimmer designed for incandescent lamps.

A CCFL usually has a limited light output compared with that of a conventional fluorescent tube, but has the advantage of working better at low temperatures. Some are designed for signage and exterior lighting in cold-weather locations.

They have a relatively long lifetime of up to 60,000 hours. A hot-cathode fluorescent lamp may fail between 3,000 and 15,000 hours.

Any tube or bulb that uses unheated electrodes to ionize a gas is technically a cold-cathode device, but will not be identified as a CCFL unless it also has an inner layer of phosphors to achieve fluorescence.

It is important to match a tube with the type of ballast installed in a fixture. This is not an issue with CFLs, as they have the appropriate ballast built in.

Sizes

Straight bi-pin tubes are sold in the United States in the following standard sizes:

- T5: 5/8″ diameter. A more modern tube, but still with tungsten electrodes that serve to heat it.
- T8: 1″ diameter. Very often 24″ or 48″ in length, consuming 18W or 36W respectively.
- T12: 1-1/2″ diameter.
- T17: 2-1/8″ diameter.

CFLs are sold in a very wide variety of configurations.

Comparisons

Fluorescent lights have significant advantages and disadvantages. On the plus side:

- After the fixture containing the ballast has been paid for, a tube is relatively cheap. A CFL or an LED light does not have this advantage, as the electronics are built in and will be discarded when the light fails.
- Fluorescent lights have a longer life than incandescent bulbs.
- Fluorescent lights are available in a wide range of shades of white.
- Fluorescent tubes create a diffuse radiance that is ideal for general lighting using ceiling-mounted fixtures. They do not cast harsh shadows.

On the minus side:

- Fluorescents were traditionally more energy-efficient than any other light source, but **LED area lighting** is now more efficient in some designs. LEDs are expected to become more efficient in the future.
- A fluorescent tube with a traditional type of ballast may cause complaints of flickering. By comparison, an LED light uses DC, and an incandescent bulb retains sufficient heat between power cycles so that it does not appear to flicker.
- Fluorescent flicker creates problems when shooting video.
- The fluorescent emission spectrum has sharp peaks that give the lighting an unnatural look.
- In applications that require a defined beam of light, a fluorescent source cannot be used.
- Conventional ballasts can create radio interference, especially in the AM band.
- Because fluorescent tubes and bulbs contain mercury, they require proper disposal, which can incur fees.
- Even an instant-on fluorescent light tends to hesitate briefly when it is switched on.
- The lifespan of a fluorescent light is greatly reduced if it is cycled on and off frequently. An incandescent bulb is less severely affected by cycling, and an LED light is not affected at all.
- Fluorescent lights have difficulty starting at low temperatures.

Values

Brightness

The intensity of a fluorescent light is measured in *lumens per watt*. Because invisible wavelengths are of little interest when assessing brightness, *luminous flux* is used to describe apparent brightness in the visible spectrum. The unit for luminous flux is the *lumen*. Additional information about light measurement is included in the entry describing incandescent lamps (see "Power" on page 177).

Spectrum

The spectrum of photons emitted from mercury vapor in a fluorescent light has wavelengths that peak at 253.7 nanometers and 185 nanometers. (A *nanometer*, customarily abbreviated as nm, is one-billionth of a meter.) These wavelengths are invisible, being in the ultraviolet range, but when the light is transposed into the visible spectrum by the layer of phosphors, "spikes" in the range of wavelengths are still present. For a comparison of output curves for incandescent, fluorescent, and LED lights, see the graph in Figure 18-4.

Various formulations for the phosphors in a tube or CFL attempt to modify the character of the light to suit the human eye, but none of them looks as "natural" as the radiance from an incandescent bulb, probably because the characteristics of incandescent light are very similar to those of sunlight.

What Can Go Wrong

Unreliable Starting

At a low temperature, the mercury inside a fluorescent tube may be slow to vaporize. At very low temperatures, vaporization may not be possible at all. Until the mercury vaporizes, fluorescence will not occur.

Terminal Flicker

As a tube ages, it may start to conduct current only in one direction, causing it to flicker visibly. As it ages more, the gas discharge becomes even less reliable, and the flicker becomes erratic. Eventually, the gas discharge fails completely. In this state, a tube may show only a dim light at each end, in proximity to the tungsten electrodes.

Cannot Dim

Neither the older style of "conventional" ballast nor a modern electronic ballast will respond appropriately to a dimmer of the type designed for incandescent bulbs. This may be an important factor when an incandescent bulb is swapped out for a CFL.

Burned Out Electrodes

Like the tungsten filament in an **incandescent lamp**, the tungsten electrodes in a fluorescent tube suffer progressive erosion. This is evident when a black tungsten deposit forms on the inside of the tube at one or both ends.

Ultraviolet Hazard

Some critics of CFLs maintain that the complex shape of a coiled or zig-zag tube tends to permit small imperfections in the internal phosphor coating, potentially allowing ultraviolet light to escape. If this occurs, and if a CFL is used in a desk fixture in close proximity to the user, ultraviolet light could elevate the risk of skin cancer.

laser

21

The term *maser* was coined in the 1950s to describe a device that used stimulated emission to amplify microwaves. When a device using similar principles amplified visible light in 1960, it was termed an *optical maser*. However, that term is now obsolete, having been replaced with **laser**. This term is always printed in lowercase letters, even though it is an acronym for Light Amplification by Stimulated Emission of Radiation.

The invented verb *to lase* is derived from *laser* and is used to describe the process of generating laser light, with the past participle *lased* and present participle *lasing* sometimes being used.

Thousands of laser variants exist. Because of space limitations, this entry will concentrate primarily on *laser diodes*, which are the smallest, most common, and most affordable type.

OTHER RELATED COMPONENTS

- **LED indicator** (see Chapter 22)

What It Does

A **laser** generally emits a thin beam of intense light, often in the visible spectrum, and usually in such a narrow range of wavelengths, it can be considered *monochromatic*. The light is also *coherent*, as explained below.

Light output from a laser has three important attributes:

- Intensity. A high-powered laser can deliver energy to a very small, well-defined area, where it may be capable of burning, cutting, welding, or drilling. Large lasers may also be used as weapons, or for power transmission.
- Collimation. This term describes a beam of light that has parallel boundaries, and therefore does not disperse significantly when passing through a transparent medium such as air, glass, or a vacuum. A laser beam can have such excellent collimation, it can be used in precision measuring devices, and has been transmitted over very long distances, even from the Earth to the Moon, where astronauts placed reflectors during the Apollo missions.
- Controllability. Because the beam can be generated with eletrical power, its intensity can be modulated rapidly with relatively simple electronic circuits, enabling applications such as burning microscopic pits in the plastic of a CD-ROM or DVD.

Laser diodes are now more common than all other forms of lasers. They are found in pointers, printers, barcode readers, scanners, computer mice, fiber-optic communications, surveying tools, weapon sights, and directional lighting sources. They are also used as a light source to trigger more powerful lasers.

No generic symbol is used for a laser, but a laser diode is often represented with the same symbol

that is used for a light-emitting diode. See Figure 22-2 in the entry for **LED indicators**.

How It Works

A laser is built around a *gain medium*, which is a material that can amplify light. The medium can be a solid, liquid, gas, or plasma, depending on the type of laser.

Initially, an input of energy provides stimulation for some atoms in the gain medium. This is known as *pumping* the laser. The energy input can come from a powerful external light source, or from an electric current.

Stimulation of an atom raises the quantum energy level of an electron associated with the atom. When the electron collapses back to its former energy state, it releases a photon. This is known as *spontaneous emission*.

If one of the photons encounters an atom that has just been excited by the external energy source, the atom may release two photons. This is known as *stimulated emission*. Beyond a threshold level, the number of released photons can increase at an exponential rate.

If two parallel reflectors are mounted at opposite ends of the gain medium, they form a *resonant cavity*. Light bounces to and fro between the reflectors, while pumping and stimulated emission amplifies the light during each pass. If one of the mirrors is partially transparent, some of the light will escape through it in the form of a laser beam. The partially transparent mirror is known as the *output coupler*.

Laser Diode

A laser diode contains an **LED**. (See "How It Works" on page 207 for a more detailed description of the function of an LED.) The p-n junction of the diode functions as the resonant cavity of the laser. Forward bias injects charges into the junction, causing spontaneous emission of photons. The photons, in turn, cause other electrons and electron-holes to combine, creating more photons in the process of stimulated emission. When this process crosses a threshold level, current passing through the diode causes it to *lase*.

The original patent for a laser diode was filed by Robert N. Hall of General Electric in 1962, and the diagram in Figure 21-1 is derived from the drawing in that patent, with color added for clarity.

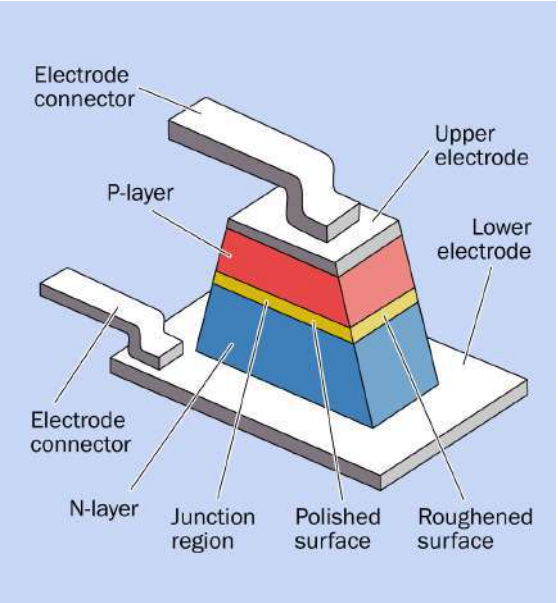

Figure 21-1. *The original design for a laser diode, from the patent filed in 1962.*

In the figure, the junction shown as a yellow layer forms the resonant cavity in which lasing occurs. It measures only 0.1 microns thick (the diagram is not drawn to scale). Its vertical front side is highly polished, and is parallel to the back side, which is also highly polished. Thus, photons reflect between these two vertical sides. The slanted face visible in the figure, and the other slanted face opposite it, are oriented and roughened to minimize internal reflection between them.

Figure 21-2 shows a simplified cross-section of the laser diode.

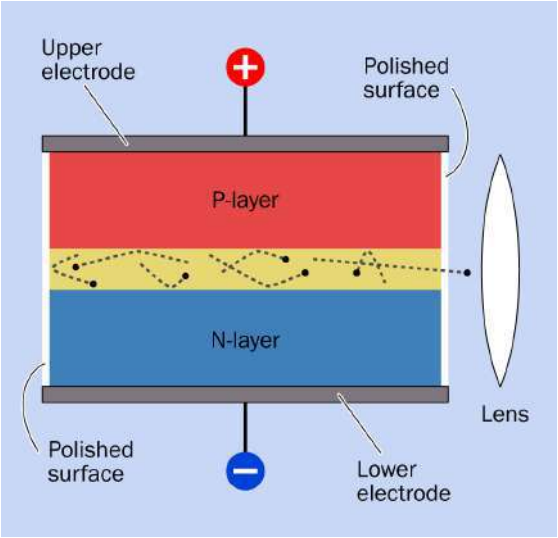

Figure 21-2. *Simplified cross-section of a laser diode.*

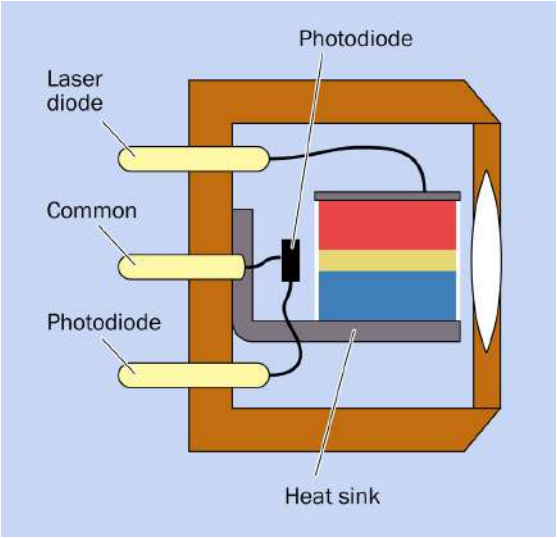

Figure 21-3. *A laser diode is typically mounted with a photodiode to provide feedback for a driver circuit, to control the current consumed by the laser.*

Figure 21-3 shows a cross-section of the diode installed in a component sold as a laser. It includes a photodiode to sense the intensity of light emerging through the polished rear end of the laser diode. External electronics are necessary to control the intensity of the laser, using feedback from the photodiode.

The component has three pins (shown pale yellow in the figure), one connecting to the photodiode, another connecting to the p-type layer of the laser diode, and the third being common to the n-type layer of the laser diode and the ground side of the photodiode.

A photograph of a laser diode is shown in Figure 21-4. Note the three pins, comparable to the pins shown in Figure 21-3, indicating that this component requires external control electronics.

In Figure 21-5, a laser is shown with a surface-mount chip adjacent to the solder pad connecting the blue wire. The presence of this chip, with only two wires, indicates that this component has its own control electronics and requires only a DC power supply.

Figure 21-4. *Lite-On 505T laser diode that emits light at 650nm. Power consumption 5mW at 2.6VDC. As indicated by the graph squares, this component is only about 0.2" in diameter.*

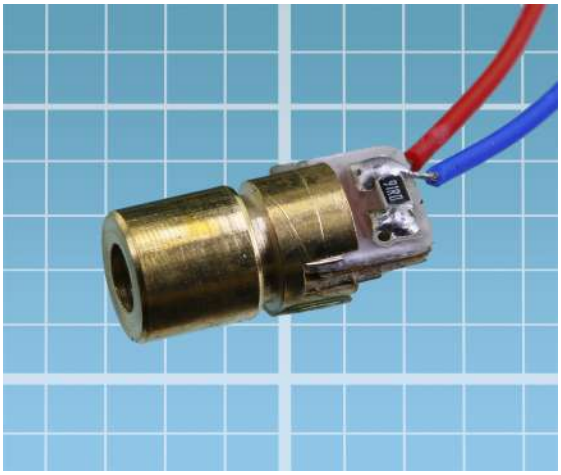

Figure 21-5. *This laser incorporates its own control electronics and requires only a 5VDC power supply. It draws 30mA and generates an output up to 5mW.*

Coherent Light

The emission of *coherent light* by a laser is often explained by suggesting that wavelengths are synchronized with each other. In fact, there are two forms of coherence that can be described approximately as *spatial coherence* and *wavelength coherence*.

If an observer looks up at a cloudy sky, the eye will perceive light radiating chaotically from many distances and directions. Thus, the light is not spatially coherent. The light also consists of many wavelengths, and thus it is not wavelength-coherent.

The filament of an incandescent lamp is a much smaller source of light, but still large enough to generate a profusion of light emissions that are spatially incoherent. The light also includes many different wavelengths.

Suppose a barrier containing a very tiny hole is placed in front of the **incandescent lamp**. If the aperture is very small, an observer on the far side will see the light as a point source. Consequently, the light that emerges from it is now spatially coherent, and will not have chaotically overlapping waves. If the light then passes through a filter, its wavelengths also will become coherent. This is suggested in Figure 21-6 where the light source is an incandescent lamp emitting a wide range of wavelengths.

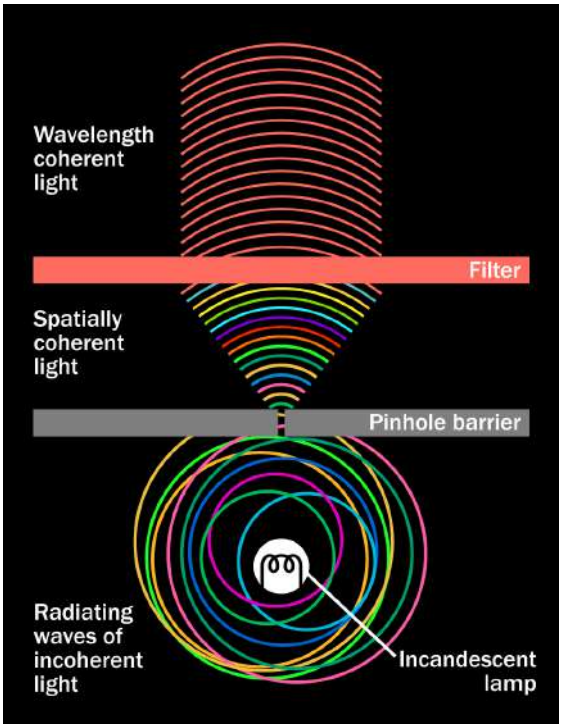

Figure 21-6. *An incandescent lamp, at the bottom of the figure, emits incoherent light at many wavelengths (exaggerated here for clarity). When it passes through a pinhole, it becomes spatially coherent. When it then passes through a colored filter, it becomes wavelength coherent.*

The small amount of light emerging through a pinhole is inevitably much dimmer than light from the original source. A laser, however, amplifies its light output, as well as tending to behave like a point source. The "hall of mirrors" effect of the parallel reflective surfaces in the resonant cavity causes much of the light to shuttle to and fro over a long distance before it emerges through the output coupler. Any light that deviates significantly from the axis of the laser will not escape at all, because the deviations will be cumulative with each reflection. Thus, the light from a laser appears to come from a point source at an almost infinite distance.

Because of the particular geometry of a light-emitting diode, the output from a laser diode is not naturally collimated, and tends to spread by an angle of around 20 degrees. A lens must be used to focus the beam.

Variants

Lasers are sold generally as fully assembled tools for a specific purpose. A very brief summary of CO2, fiber, and crystal lasers is included here.

CO2 Lasers

The gain medium is primarily carbon dioxide but also contains helium and nitrogen, with sometimes hydrogen, water vapor, and/or xenon. The laser is electrically pumped, causing a gas discharge. Nitrogen molecules are excited by the discharge and transfer their energy to the CO2 molecules when colliding with them. Helium helps to return the nitrogen to base energy state and transfer heat from the gas mixture.

CO2 lasers are infrared, and are commonly used in surgical procedures, including ophthalmology. Higher powered versions have industrial applications in cutting a very wide range of materials.

Fiber Lasers

Light is pumped via diodes and amplified in purpose-built glass fibers. The resulting beam has a very small diameter, providing a greater intensity than CO2 lasers. It can be used for metal engraving and annealing, and also for working with plastics.

Crystal Lasers

Like fiber lasers, they are pumped by diodes. These compact lasers are available in a very wide variety of wavelengths, covering the whole visible spectrum, infrared, and ultraviolet. They find applications in holography, biomedicine, interferometry, semiconductor inspection, and material processing.

Values

The output power of a laser is measured in watts (or milliwatts). This should not be confused with the power consumed by the device.

In the United States, any device sold as a laser pointer is limited to a power output of 5mW. However, laser diodes packaged similarly to laser pointers can be mail-ordered with an output of 200mW or more. The legal status of these lasers may be affected by regulations that vary state by state.

In a CD-RW drive that is capable of burning a disc, the diode may have a power of around 30mW. A laser mounted in a CD-ROM assembly is shown in Figure 21-7.

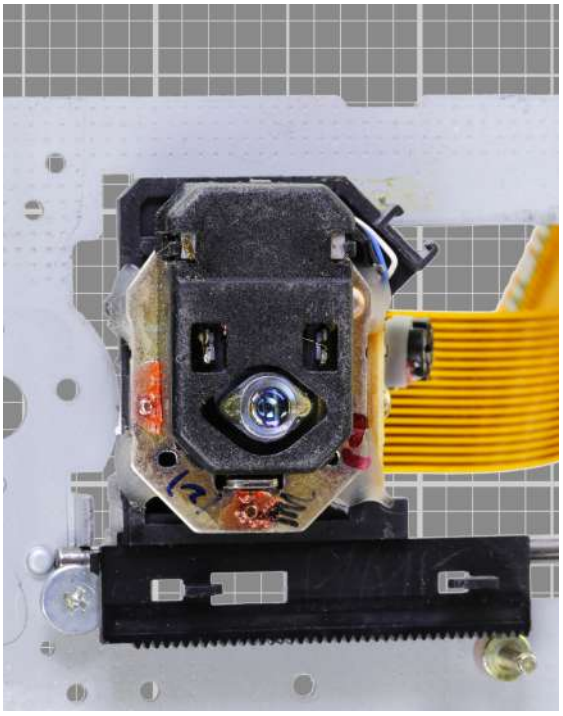

Figure 21-7. *An assembly incorporating a laser for reading a CD-ROM.*

Lasers have such a narrow range of wavelengths, they are given specific output values in nanometers. A laser in an optical mouse may have a wavelength of 848nm; in a CD drive, 785nm; in a

bar-code reader, 670nm; in a modern laser pointer, 640nm; in a Blu-ray disc player, 405nm.

How to Use It

While powerful lasers in a laboratory setting have exotic applications, a typical low-power laser diode has become so affordable (costing less than $5 in some instances, at the time of writing) it can be considered merely as a useful source of a clearly defined light beam, ideal for detecting the position of a movable mechanical component or the presence of an intruder.

Generic light-emitting diodes are made with a view angle (i.e., a dispersion angle) as low as 3 degrees, but the beam is soft-edged compared with the precise boundary of a laser beam, and cannot be used reliably in conjunction with sensors at a distance of more than a few inches.

Laser diodes that are sold as components may or may not have current-limiting control electronics built in. Applying power to the laser diode directly will result in thermal runaway and rapid destruction of the component. Drivers for laser diodes are available separately as small, preassembled circuits on breakout boards.

For many applications, it may be simpler and cheaper to buy a laser diode as an off-the-shelf product. A laser pointer provides an easy way to get a source of laser light, and if it would normally be driven by two 1.5V batteries, it can be adapted to run off a 5V supply by using a 3.3V voltage regulator.

Common Applications

In addition to being used with PowerPoint presentations and in conjunction with position sensors, laser pointers have other applications:

- Astronomy. A high-powered laser beam is visible even in clear air as a result of interaction with air molecules. This is known as *Rayleigh scattering*. The phenomenon allows one person to point out a star (or planet) for another person. Because celestial objects are so far away, parallax error is not detectable by two people viewing the beam while standing next to each other. A laser pointer may also be mounted on a telescope to assist in aiming the telescope at an object of interest. This is easier than searching for an object through an eyepiece.
- Target acquisition. Lasers are commonly used on firearms to assist in targeting, especially in low-light conditions. Infrared lasers can be used in conjunction with infrared viewing goggles.
- Survival. A small laser can be included in emergency supplies to signal search teams. A laser can also be used to repel predatory animals.

What Can Go Wrong

Risk of Injury

Lasers are potentially dangerous. Those that have an infrared or ultraviolet output are more dangerous than those with a visible beam, as there is no visual warning that the laser is active. A laser is capable of scarring the retina, although controversy exists regarding the power output that should be considered a high risk.

If a project incorporates a laser, it should be switched off while building or testing the device. It may be advisable to wear protective glasses that block laser light even when an experimenter feels confident that a laser is switched off.

Active lasers should never be pointed at people, vehicles, animals (other than dangerous animals), or oneself.

Inadequate Heat Sink

Lasers may be designed and rated for intermittent use. The burner assembly for a CD-ROM drive, for instance, will be rated for pulsed power, not continuous power. Read datasheets carefully, and provide an adequate heat sink.

Uncontrolled Power Supply

A diode laser that does not have a feedback system in place to control the flow of current can self-destruct.

Polarity

Both the light-emitting diode and the photodiode in a three-pin laser package can be damaged by incorrect polarity of applied power. Pin functions should be checked carefully against datasheets.

LED indicator

22

In this encyclopedia, an **LED indicator** is defined as a component usually 10mm or smaller in diameter, made of transparent or translucent epoxy or silicone, most often containing one *light-emitting diode*. It is purposed as a status indicator in a device, rather than as a source of illumination, and is sometimes referred to as a *standard LED*.

LED indicators that emit infrared and ultraviolet light are included in this entry. LEDs that are designed to illuminate large interior or exterior areas are discussed in a separate entry as **LED area lighting**. They are sometimes described as *high-brightness LEDs* and almost always emit white light.

The term **light-emitting diode** is becoming less common, as the acronym **LED** has become ubiquitous. The acronym does not usually include periods between the letters.

The words "light emitting" are hyphenated here, as they form an adjectival phrase, but in everyday usage the hyphen is often omitted, and no definitive rule seems to exist.

Originally, a standard LED contained only one diode, but may now include multiple diodes, either to emit additional light or to provide a range of colors. In this encyclopedia, a single epoxy or silicone capsule is still considered to be an **LED indicator** regardless of how many diodes it contains. By contrast, any component consisting of multiple separately discernible light-emitting diodes, as in a seven-segment numeral, a 14- or 16-segment alphanumeric character, a dot-matrix character, or a display of multiple characters, is listed in a separate entry as an **LED display**.

OTHER RELATED COMPONENTS

- **LED area lighting** (see Chapter 23)
- **LED display** (see Chapter 24)
- **incandescent lamp** (see Chapter 18)
- **neon bulb** (see Chapter 19)
- **laser** (see Chapter 21)

What It Does

An **LED indicator** emits light in response to a small current, typically around 20mA (but sometimes much less), at a voltage lower than 5VDC. It is usually molded from epoxy or silicone that may be colorless and transparent (often referred to as *water clear*), or colorless but translucent, or tinted and transparent, or tinted and translucent.

The color of the light is initially determined by the chemical compounds used internally, and by their dopants; therefore, a water-clear LED may emit colored light.

Ultraviolet LEDs are usually water-clear. Infrared LEDs often appear to be black, because they are opaque to the visible spectrum while being transparent to infrared.

When an LED indicator is described as being *through hole,* it has leads for insertion into holes in a circuit board. The term does not mean that the indicator itself is meant to be pushed through a hole in a panel, although this may also be done. The LED is cylindrical with a hemispherical top that acts as a lens. The leads are relatively thick, to conduct heat away from the component. A dimensioned diagram of a typical LED measuring 5mm in diameter is shown in Figure 22-1.

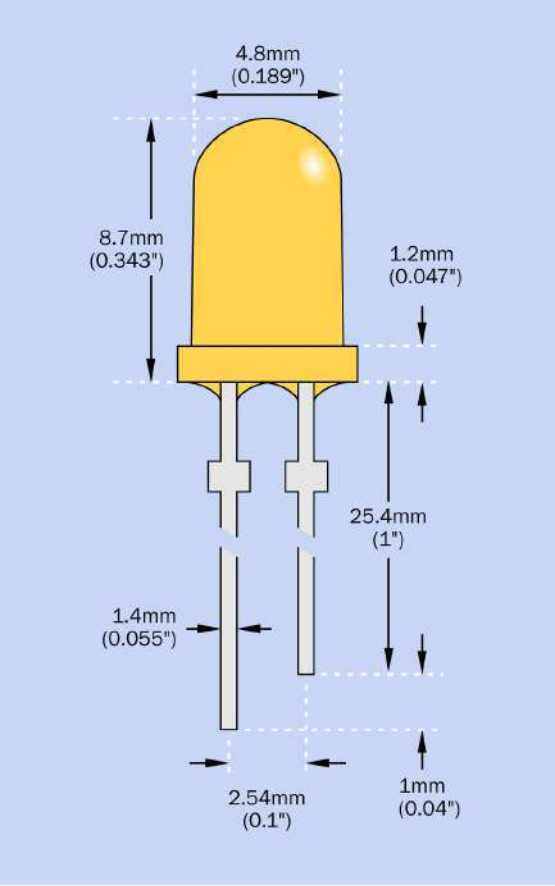

Figure 22-1. *Dimensions of a typical 5mm LED. The longer wire connects with the anode, while the shorter wire connects with the cathode. Adapted from a datasheet published by Lite-On Technology Corporation.*

An LED indicator that is not the through-hole type is usually a surface-mount component. LEDs for surface mounting are mostly rectangular and can be as small as 1mm x 0.5mm. They may require a *heat sink*.

Schematic Symbols

Figure 22-2 shows a variety of symbols that are commonly used to represent an LED. The triangle at the center of each symbol points in the direction of conventional (positive-to-negative) current flow—from the anode to the cathode. Each pair of arrows radiating away from the diode indicates emitted light. Wavy arrows are sometimes used to represent infrared (thermal) radiation. Often, however, an infrared LED is represented in exactly the same style as an LED that emits visible light. With the exception of the wavy arrows, the various styles of schematic symbol are functionally identical and do not identify different attributes of the component such as size or color.

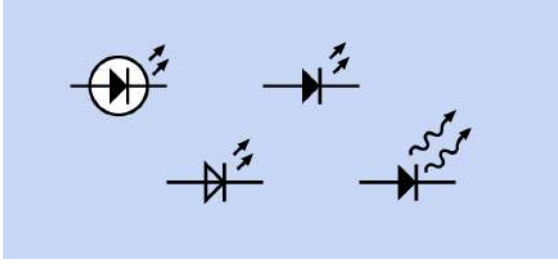

Figure 22-2. *Various symbols may be used to represent an LED. See text for details.*

Common Usage

LED indicators have mostly displaced **neon bulbs** and miniature **incandescent lamps** for the purpose of showing the status of a device. They are found in industrial control panels, home audio systems, battery chargers, washer/dryers, and many other consumer-electronics products. Higher output variants are used in flashlights, traffic signals, taillights on automobiles, and for illumination of subjects that are being photographed. LED indicators may be assembled in large numbers in attention-getting displays such as Christmas lights.

Red, orange, yellow, green, and blue are the basic standard colors. LEDs that appear to generate white light are common, but they do not emit an evenly weighted spectrum of wavelengths. See "Non-Incandescent Sources" on page 174 for a discussion of this topic.

How It Works

An LED, like any **diode**, contains a semiconductor *PN junction* that conducts current only in the forward direction (i.e., from the more-positive side of a power supply to the more-negative side). The diode becomes conductive above a *threshold voltage* sufficient to force electrons in the n-type region and holes in the p-type region to combine with each other. Each time this occurs, energy is released. The energy liberated by one electron-hole combination creates a *photon*, or one quantum of light.

The amount of energy released depends on the *band gap*, which is a property of the semiconductor material. The band gap is the smallest energy that can create an electron-hole pair. The energy determines the light's wavelength, and thus the color.

The band gap also determines the threshold voltage of the LED. For this reason, LEDs of different colors have widely different threshold voltages.

Because an LED will often be used in devices where the DC power supply exceeds the maximum forward voltage, a *series resistor* is customarily used as a simple way to restrict current through the diode.

The light emitted by a colored LED indicator tends to include only a narrow range of wavelengths. However, the addition of a phosphor coating to the diode can broaden the output. This technique is used to make the light from a blue LED appear white, as shown in Figure 22-3. Most white LEDs are actually blue LEDs with a colored phosphor layer added. See the section on **LED area lighting** in Chapter 23 for a more detailed discussion of this topic.

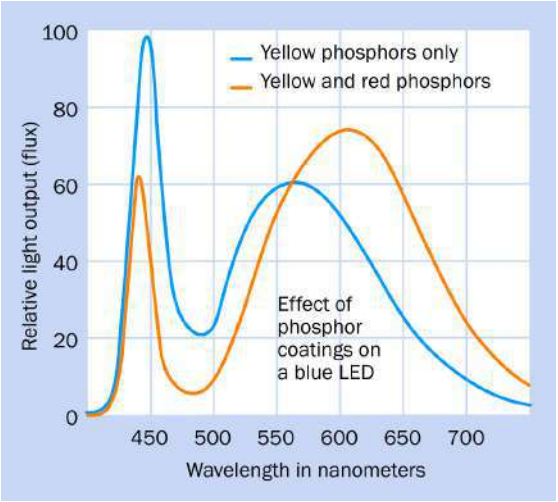

Figure 22-3. *Increasing the range of emitted wavelengths by adding phosphors to a blue LED. Source: Philips Gardco Lighting.*

Multicolor LEDs and Color Mixing

If red, green, and blue light sources are mounted extremely close together, the eye perceives them as a single source, of a color determined by their combined relative intensities. This system of additive color mixing is shown in Figure 17-14 in the entry dealing with LCDs. It is used in LED indicators that contain red, green, and blue light-emitting diodes in a single epoxy or silicone capsule.

While most video monitors use white LEDs or **fluorescent lights** to form a backlight for an **LCD** video screen, some high-end monitors use a matrix of very tiny red, green, and blue LEDs, because the combination of these separate colors generates a wider *gamut* of color wavelengths. The concept of gamut is discussed in "Color" in the **LCD** entry. The tiny LEDs in a backlight cannot be considered as indicators, but indicators are used for this purpose in billboard-sized video displays.

Variants

LED indicators vary widely in size, shape, intensity, view angle, diffusion of light, wavelength of light, minimum and maximum forward voltage, and minimum and maximum forward current.

Size and Shape

The original sizes for round LED indicators were 3mm, 5mm, or (more rarely) 10mm in diameter. Today, through-hole LEDs are sold in many intermediate sizes, although 3mm and 5mm are still most widely used.

The traditional round LED indicator is now augmented with square and rectangular shapes. In a parts catalog, a pair of dimensions such as 1mm × 5mm suggests that the LED is rectangular.

Intensity

The light intensity of an LED is usually expressed in *millicandelas*, abbreviated *mcd*. There are 1,000 mcd in a candela. For more information about units for measurement of light, see "Intensity" on page 178.

The candela measures the *luminous flux*, or visible radiant power, contained within a specified angle of dispersion, usually referred to as the *view angle*. This can be imagined as the rotated angle at the apex of a cone, where the cone defines the "spread" of the light, and the source is at the apex.

If a diode is emitting a fixed amount of luminous flux, the rating in mcd will increase with the inverse square of the view angle. This is because the light delivered to an area in front of the LED will become more intense as the angle becomes smaller. The use of mcd to rate the brightness of an LED can be misleading if it is not considered in comparison with the view angle.

For example, suppose an LED is rated at 1,000 mcd and has a view angle of 20 degrees. Now suppose the same diode is embedded in a different epoxy or silicone capsule with a lens that creates a view angle of only 10 degrees. The LED will now be rated at 4,000 mcd, even though its total power output is unchanged.

- To compare the brightness of two LED indicators meaningfully, they should share the same view angle.

Four through-hole LED indicators with a wide range of specifications are shown in Figure 22-4. From left to right: water-clear white generic, 10mm; Vishay TLCR5800 5mm (emitting red, even though the capsule is water-clear), rated for 35,000mcd with 4 degrees view angle; Everlight HLMPK150 5mm red diffused, rated for 2mcd with 60 degrees view angle; and Chicago 4302F5-5V 3mm green, rated for 8mcd at 60 degrees view angle, containing its own series resistor to allow direct connection with a 5VDC power supply.

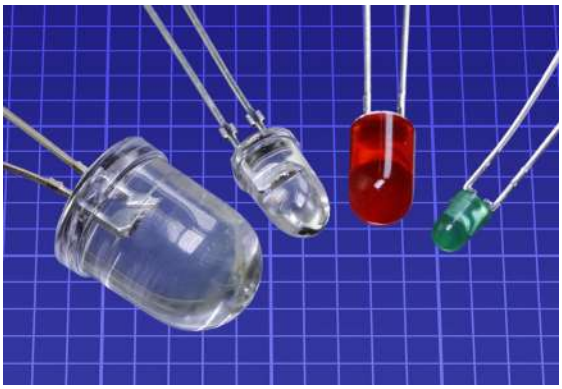

Figure 22-4. *Four assorted LED indicators with very different specifications. See text for details.*

Efficacy

The *radiant luminous efficacy* (LER) of an incandescent light source compares how effective it is at channeling its output within the visible spectrum, instead of wasting it in other wavelengths, especially infrared. Note that the word *efficacy* has a different meaning from *efficiency*. The LER acronym may help to avoid confusion.

LER is expressed in lumens per watt, and in an incandescent bulb it is calculated by dividing the power emitted in the visible spectrum (the *lumi-*

nous flux) by the power emitted over all wavelengths. This is described in detail on "Efficacy" on page 179 in the entry dealing with incandescent lamps.

In an LED indicator, almost all the radiation can be within the visible spectrum, but some power is wasted by generating heat internally. The efficacy varies depending on the type of LED; thus a red-orange indicator can have an efficacy of 98% while a blue LED will be probably below 40%.

Diffusion

Some LED indicators use epoxy or silicone that is formulated to be translucent or "cloudy" instead of transparent. They diffuse the light so that it is not projected in a defined beam, has a softer look, and has an approximately equal intensity when viewed from a wider range of angles.

"Clear" and "diffused" are options that must be taken into account when choosing LEDs from an online catalog, unless the user is willing to turn a clear LED into a diffuse LED by applying some sandpaper.

Wavelength and Color Temperature

The wavelength of light is measured in *nanometers* (abbreviated *nm*), a nanometer being 1 billionth of a meter. The visible spectrum extends from approximately 380nm to 740nm. Longer wavelengths are at the red end of the spectrum, while shorter wavelengths are at the blue end.

A typical LED emits a very narrow range of wavelengths. For example, Figure 22-5 shows the emission from a standard red LED indicator manufactured by Lite-On. Graphs of this type are typically included in manufacturers' datasheets.

Because a red LED stimulates the cones in the eye that respond to red light, it "looks red" even though the color is not comparable with the natural red that is seen, for instance, in a sunset. That natural color actually contains an additional spread of wavelengths.

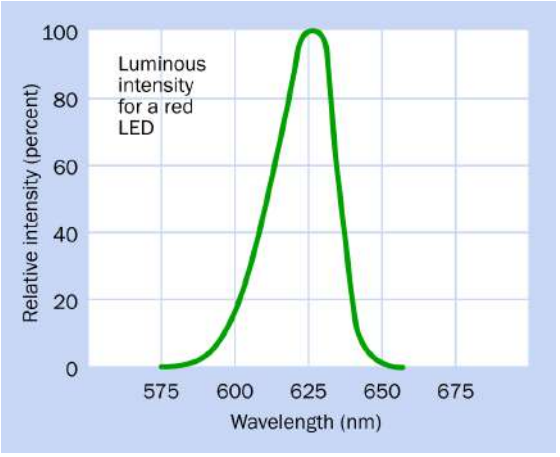

Figure 22-5. *The narrow range of wavelengths emitted by a typical red LED indicator.*

The following list shows the ranges of peak output values, in nanometers, for the most commonly available basic LED indicators (LEDs that emit other wavelengths are available, but they are less common):

- Infrared LED: 850 to 950
- Red LED: 621 to 700
- Orange LED: 605 to 620
- Amber LED: 590 to 591
- Yellow LED: 585 to 590
- Green LED: 527 to 570
- Blue LED: 470 to 475
- Ultraviolet LED: 385 to 405

Figure 22-6 shows this list graphically, omitting infrared and ultraviolet LEDs.

For almost 30 years, blue LEDs were a laboratory curiosity of little practical value, as efficiencies were stuck around 0.03%. An efficiency of more than 10% was finally achieved in 1995. Blue LEDs were marketed soon afterward.

However, when yellow phosphors are added to create the impression of white light by spreading the output over the whole visible spectrum, the wavelengths around 500nm are still not well represented, as suggested in Figure 22-3.

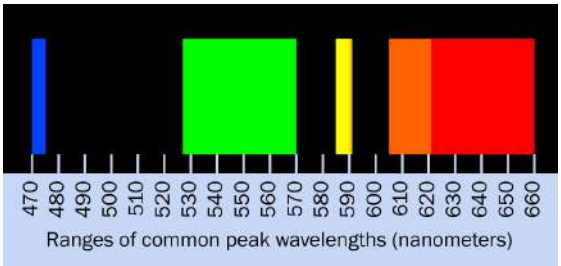

Figure 22-6. *Ranges for peak wavelengths of the most commonly used LEDs. (Source: Survey of approximately 6,000 through-hole LEDs stocked at www.mouser.com.)*

Fluorescent lights perform even more poorly than white LEDs, as can be seen in Figure 18-4 in the entry describing **incandescent lamps**.

Because white LEDs do not emit a single peak of wavelengths, their color is expressed in color temperature rather than nanometers. The concept of color temperature is explained in "Spectrum" on page 173. White LEDs are available rated from 2,800 to 9,000 degrees Kelvin, and are discussed in more detail in the **LED area lighting** entry in this encyclopedia.

Internal Resistor

To eliminate the chore of adding a series resistor to limit current through an LED, some indicators are sold with a series resistor built in. They may be rated for use with 5VDC or 12VDC, but are externally indistinguishable from each other. They are also externally indistinguishable from LEDs that do not contain series resistors. Figure 22-7 shows two 3mm LEDs, the one on the right containing its own series resistor, the one on the left being a generic LED without a series resistor.

Because of the nonlinear response of a diode, LEDs with or without internal resistors cannot be distinguished from each other reliably with a multimeter. If the meter is set to measure ohms, typically it will give an "out of range" error to all types of LED. If it is set to identify a diode, the reading will not tell you if the LED contains a resistor.

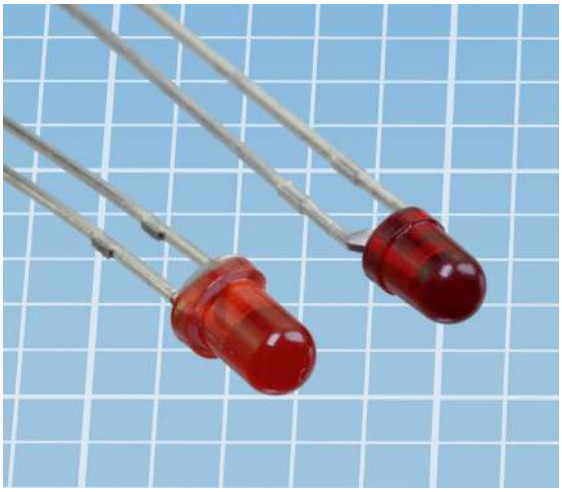

Figure 22-7. *An LED (left) that does not contain its own series resistor is usually indistinguishable from one that does (right).*

One way to determine whether an LED contains an internal series resistor would be to connect it with a variable power supply through a multimeter set to measure mA. Carefully increase the supply voltage from zero until the meter shows a current of 20mA. If the LED does not contain a series resistor, the supply voltage will be close to the recommended forward voltage for that type of LED (no lower than 1.6V for a red LED, and no higher than 3.6V for a white LED). If the LED does contain a series resistor, the supply voltage will be higher. This procedure is time consuming, but may be worthwhile to evaluate multiple LEDs that are known to be identical.

Multicolored

The leads for an LED indicator containing two or more diodes can be configured in several ways:

- Two leads, two colors. Two diodes are mounted internally in parallel, but with opposite polarity.
- Three leads, two colors. Two diodes share a common anode or common cathode.
- Four leads, three colors (RGB). Three diodes share a common anode or common cathode.

- Six leads, three colors. Three diodes, each with its own pair of leads, separate from the others.

Infrared

Most infrared emitters are LEDs that generate wavelengths longer than 800nm. They are found in handheld remotes to control consumer-electronics devices such as televisions and stereo systems, and are also used in some security systems, although *passive infrared motion detectors*, which assess infrared radiation from sources such as people or vehicles, are more commonly used for this purpose.

In conjunction with an infrared emitter, an infrared sensor is necessary, and must be sensitive to the same wavelength. To prevent false positives, the emitter modulates its output, typically with a carrier frequency between 10 and 100kHz. Remotes often use carrier frequencies of 30 to 56kHz. At the receiving end, the signal is processed with a band-pass filter matching the modulation frequency. Many different pulse-coding schemes are used, and no particular standard is dominant.

Ultraviolet

Because ultraviolet radiation can damage the eyes, LED indicators that emit ultraviolet light are potentially dangerous and should be used with caution. A yellow eyeshield can be worn to block the short wavelengths.

Ultraviolet light can be used to cure some adhesives and dental filling material. It can also kill bacteria, and can detect fluorescent print on bank notes, to check for counterfeiting. Ultraviolet flashlights are sold to detect some species of pests, such as scorpions, which fluoresce in response to ultraviolet light.

Values

The specification for an LED will include the wavelength of emitted light, luminous intensity, maximum forward voltage and current, maximum reverse voltage and current, and working values for voltage and current. All these values are important when choosing an indicator for a specific function.

White LEDs for room lighting or external use are calibrated differently. See the entry for **LED area lighting** in Chapter 23.

Forward Current

About half of all the thousands of available types of LED indicators are rated for a typical forward current of 20mA to 25mA. Absolute maximum ratings may be twice as high, but should not generally be applied.

The light intensity of a typical 5mm red LED indicator is plotted against its forward current in Figure 22-8. Note that current and light intensity have an approximately linear relationship up to the typical working current of 20mA. Even above this point, to the absolute maximum of 50mA, the light intensity rolls off only a very small amount.

Although an LED indicator can be dimmed by controlling the current passing through it, the current does not have a linear relationship with the applied voltage, and the indicator will stop functioning completely when the voltage drops below the threshold required by the diode. Consequently, LEDs are commonly dimmed by using *pulse-width modulation*.

Because of the nonlinear response of a diode, LEDs with or without internal resistors cannot be distinguished from each other reliably with a multimeter. If the meter is set to measure ohms, typically it will give an “out of range” error to all types of LED. If it is set to identify a diode, the reading will not tell you if the LED contains a resistor.

Low-Current LEDs

Indicators that require a very low forward current are convenient for direct connection to output pins of logic chips and other integrated circuits. Although a single output from an HC family chip

is capable of supplying 20mA without damaging the chip, the current will pull down the output voltage, so that it cannot be used reliably as an input to another chip while also lighting the LED.

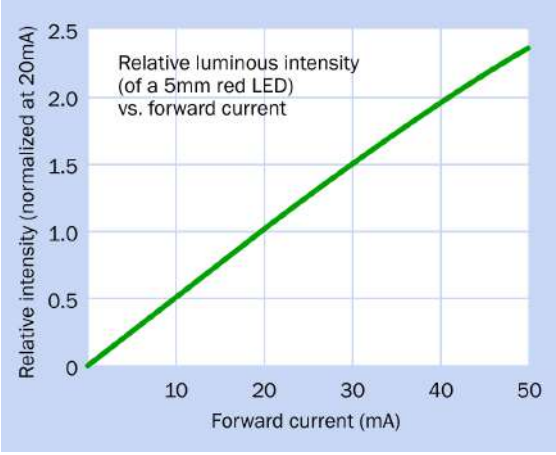

Figure 22-8. *The relationship between forward current and light intensity of a typical 5mm LED indicator is approximately linear up to the 20mA operating current, and almost linear up to the absolute maximum of 50mA.*

Various LED indicators drawing 2mA or 1mA are available, with intensities typically ranging between 1.5mcd and 2.5mcd. This low light output is still bright enough for viewing in a lab-bench environment. Low-current blue LEDs are not available. The only LEDs that draw as little as 1mA are red, as this is the most efficient type.

Using a higher value series resistor with a generic LED will of course reduce its current consumption, and some light will be visible so long as the forward voltage across the LED remains at its minimum level or above.

Forward Voltage

Red is the color that requires not only the least forward current, but the lowest forward voltage. In the range of 1.6VDC to 1.7VDC, all the LEDs are red. Typical forward voltages for various colors are shown here:

- Infrared LED: 1.6V to 2V
- Red LED: 1.6V to 2.1V
- Orange LED: 1.9V to 2.1V
- Amber LED: 2V to 2.1V
- Yellow LED: 2V to 2.4V
- Green LED: 2.4V to 3.4V
- Blue LED: 3.2V to 3.4V
- Ultraviolet LED: 3.3V to 3.7V
- White LED: 3.2V to 3.6V

Color Rendering Index

The *color rendering index* (CRI) evaluates the fidelity with which a light source is capable of displaying the full visible spectrum. It ranges from a perfect score of 100 down to 0 or even lower (sodium-vapor street lighting has a negative value). Computing the index requires standard reference color samples and has been criticized for generating scores that do not correlate well with subjective assessments.

Incandescent bulbs can have a CRI of 100, while an uncorrected white LED may score as low as 80.

Life Expectancy

Because the light output from an LED tends to decrease very gradually with time, the life expectancy is often defined as the number of hours required for the output to diminish to 70% of its output when new. Life expectancy is commonly stated on datasheets for high-brightness white LEDs, but is often omitted from datasheets for LED indicators.

Unlike incandescent lamps and fluorescent lights, LEDs do not have a shorter lifespan if they are frequently cycled on and off.

Light Output and Heat

The light intensity of an LED, measured in mcd, can vary from a few mcd to a maximum of 40,000mcd. Intensities above 30,000mcd generally are achieved by limiting the view angle to 15 degrees or less. Because the candela is weighted toward the central, green segment of the visible spectrum, green LEDs are likely to have a rela-

tively high mcd rating. LEDs rated between 20,000mcd and 30,000mcd, with a view angle of 30 degrees, are almost all green.

Datasheets may often include a *derating curve* showing the lower limit that should be placed on forward current through an LED indicator when its temperature increases. In Figure 22-9, the LED should be operated only within the boundary established by the green line.

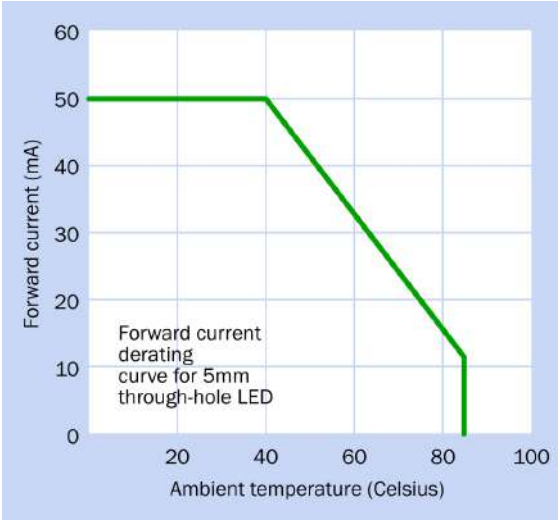

Figure 22-9. *Safe operation of an LED entails limiting the forward current if the temperature increases. The green line shows the boundary for operation of this particular component.*

View Angle

An LED formed from transparent epoxy or silicone (either water-clear or tinted) will create a well-defined beam with a view angle as narrow as 4 degrees or as wide as 160 degrees (in a few instances). The most common view angles for LED indicators are 30 degrees and 60 degrees.

Datasheets for LED indicators often include a *spatial distribution* graph showing the relative intensity of the light when viewed at various angles from the axis of the LED. The spatial distribution graph in Figure 22-10 is for an LED with a view angle defined as 40 degrees. This is the angle at which the relative luminous intensity diminishes to 50%.

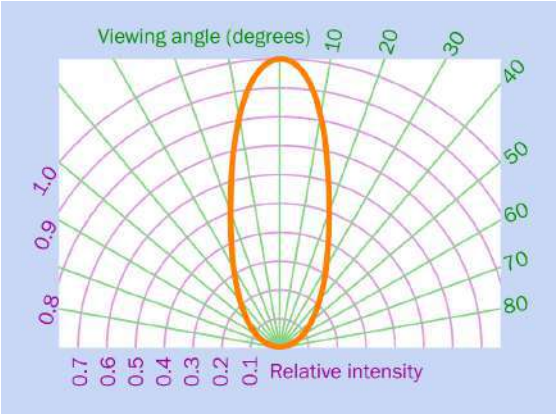

Figure 22-10. *A spatial distribution graph shows the relative intensity of light from an LED at various view angles.*

The view angle is of special concern in devices such as flashlights, where the spread of the beam affects the functionality.

How to Use It

Like all semiconductor devices, LEDs can be impaired by excess forward current and may break down irreversibly if subjected to excess reverse voltage. Their limits for reverse voltage are much lower than those of a rectifier diode. They are also vulnerable to heat, but are not particularly vulnerable to static electricity.

Polarity

A through-hole LED will have two leads of unequal length. The longer lead connects internally with the *anode* of the diode, and should be wired externally to the "more positive" side of a power source. The shorter lead connects internally with the *cathode* of the diode, and should be wired externally to the "more negative" side of a power source.

To remember the functions of the leads, consider that the plus sign would be twice as long as a minus sign if its horizontal and vertical stroke were disassembled and placed end to end.

If a round LED has a flange around its base, a flat spot in the flange will be closest to the cathode side of the component.

Series Resistor Value

Because the effective internal resistance of a diode is not a constant value at different voltages, a trial-and-error approach may be necessary to determine the ideal value for a series resistor with an LED indicator. For this purpose, a trimmer potentiometer can be used with a sample LED while measuring the current through it and the voltage drop across it. A fixed-value resistor can then be substituted. If the choice is between a resistor value that is a little too high and a value that is a little too low, the higher value resistor should be used.

An approximate value can be found using a very simple formula in which R is the resistor value, V_{CC} is the supply voltage, V_F is the forward voltage specified for the LED, and I is the desired current:

$$R = (V_{CC} - V_F) / I$$

Normally a series resistor rated at 1/4 watt will be acceptable, and 1/8 watt may be used in 5VDC circuits. However, care should be taken with a power supply of 9V or higher. Suppose an LED is rated for 1.8V forward voltage at 20mA. In a 5V circuit, the voltage drop across the series resistor will be:

$$V = 5 - 1.8 = 3.2$$

Therefore, the resistor must dissipate 3.2V * 20mA = 64mW. This is comfortably below the 125mW rating of a 1/8 watt resistor. However, with a 9V power supply, the voltage drop across the series resistor will be:

$$V = 9 - 1.8 = 7.2$$

Now the resistor must dissipate 7.2V * 20mA = 144mW. This exceeds the 125mW limit for a 1/8 watt resistor.

LEDs in Parallel

If multiple LEDs are to be driven in parallel, and none of them has to be switched individually, it is naturally tempting to save time by using a single series resistor for all of them. In these circumstances, assess the maximum current carefully and multiply by the voltage drop imposed by each of the LEDs, to determine the wattage of a series resistor.

Linking dissimilar LEDs in parallel is not recommended, because the threshold voltage decreases with increasing temperature. The hottest LED will therefore receive the largest current, and thus become even hotter. Thermal runaway can result.

LEDs containing their own series resistors can safely be wired in parallel.

Multiple Series LEDs

A series resistor wastes current by dissipating it as heat. In an application where two or more LED indicators will be illuminated simultaneously, the LEDs can be connected in series with a lower-value resistor, and three LEDs in series may eliminate the need for a resistor completely, depending on the voltage of the power supply. Here again a trimmer potentiometer should be used to determine an ideal value for any series resistor that may be necessary.

Comparisons with Other Light Emitters

Because LED indicators have largely replaced neon bulbs and miniature incandescent lamps, comparisons are of limited importance at this point. The situation regarding **LED area lighting** is different in that it is still competing actively with fluorescent lights and, in some instances, halogen. A list of advantages and disadvantages for high-intensity white LEDs is given in "Comparisons" on page 223. The advantages of incandescent lamps are listed in "Relative Advantages" on page 179.

Other Applications

LEDs are used in **optocouplers** and in **solid-state relays**. Usually an infrared LED is embedded inside a chip or a plastic module, and emits light through an interior channel to activate a phototransistor. This arrangement provides electrical isolation between the switching signal and the switched current.

Some sensors use an LED paired with a phototransistor at opposite sides of a U-shaped plastic mount. A sensor of this type can monitor industrial processes or may be found inside a photocopy machine, to detect the presence of a sheet of paper.

What Can Go Wrong

Excessive Forward Voltage

Like any diode, the LED has a *threshold voltage* in the forward direction. If this threshold is exceeded, the effective internal resistance of the LED falls very rapidly. Current rises equally rapidly, and quickly damages the component, unless it is protected by an appropriate series resistor.

Excessive Current and Heat

Exceeding the recommended value for forward current, or allowing an LED to overheat, will shorten its lifetime and cause a premature dimming of light output. LEDs generally require some current limiting or regulation (most commonly with a series resistor). They should not be connected directly to a voltage source such as a battery, even if the battery voltage matches the voltage of the diode. The exception to this rule is if the internal resistance of the battery is high enough to limit the current, as in the case of button-cell batteries.

Storage Issues

LEDs of different types are often indistinguishable from each other. They can also be indistinguishable from photodiodes and phototransistors. Careful storage is mandatory, and reusing LEDs that have been breadboarded may cause future problems if they are wrongly identified.

Polarity

If the leads on an LED indicator are trimmed, and if the indicator lacks a flange in which a flat spot will identify the cathode, the component is easily misused with reversed polarity. If it is connected with a component that has limited current sourcing capability (for instance, the output pin of a digital chip), the LED will probably survive this treatment. However, maximum reverse voltage is often as low as 5VDC. To minimize the risk of errors, the anode lead can be left slightly longer than the cathode lead when they are trimmed for insertion in a breadboard or perforated board.

Internal Resistors

As previously noted, it is difficult to distinguish an LED that contains its own series resistor from another LED that does not. The two types should be stored separately, and should be reused circumspectly.

LED area lighting

23

The term **LED area lighting** is used in this encyclopedia to describe a white LED source that is bright enough to illuminate rooms, offices, or outdoor areas. It may also be used in desk lamps or table lamps as *task lighting*. LEDs for these purposes may be categorized as *high-brightness*, *high-power*, *high-output*, or *high-intensity*. A complete fixture containing at least one light source is properly known as a *luminaire*, although the term is not uniformly applied and is sometimes written incorrectly as a *luminary*.

The full term *light-emitting diode* is not normally applied to an LED used for area lighting. For this purpose, the LED acronym has become universal. Periods are not normally placed between the letters.

While an LED area-lighting package may contain more than one diode, it is still categorized here as a single source. By contrast, any component consisting of multiple separately discernible light-emitting diodes, as in a seven-segment numeral, a 14- and 16-segment alphanumeric character, a dot-matrix character, or a display of multiple characters, is listed in a separate entry as an **LED display**.

The term *OLED* is an acronym for *Organic Light-Emitting Diode*, a thin panel in which an organic compound is contained between two flat electrodes. Despite its functionality as a form of LED, its design is similar to that of thin-film electroluminiscent light sources. Therefore it is discussed in the entry on **electroluminescence**.

OTHER RELATED COMPONENTS

- **LED indicator** (see Chapter 22)
- **incandescent lamp** (see Chapter 18)
- **fluorescent light** (see Chapter 20)
- **neon bulb** (see Chapter 19)
- **electroluminescence** (see Chapter 26)

What It Does

High-brightness white LEDs provide a plug-compatible alternative to **incandescent lamps**, *halogen lighting*, and **fluorescent lights** for work spaces and the home.

At the time of writing, products are still evolving rapidly in the field of LED area lighting. A shared goal of manufacturers is to increase efficiency while reducing retail price to the point where high-brightness LEDs will displace fluorescent tubes for most low-cost lighting applications.

A wall-mounted LED reflector-bulb that emulates a halogen fixture is shown in Figure 23-1. A small LED floodlight for exterior use is shown in Figure 23-2. An early attempt to package an LED area light in a traditional-style bulb is shown in Figure 23-3. Within a decade, as LED area lighting continues to evolve, some of these examples

may look quaint. Configurations are evolving, with final results that remain to be seen.

Figure 23-1. *A small LED reflector-light emulating a halogen fixture. Note the square of yellow phosphors mounted on the diode.*

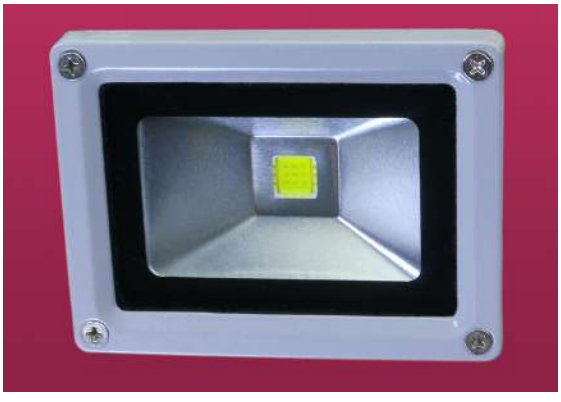

Figure 23-2. *A floodlight for exterior use. Nine LEDs are assembled behind the yellow phosphors. The steel frame measures about 4" by 3".*

Trends in Cost and Efficiency

The *luminous flux* of a source is the total power that it radiates in all directions, within the visible spectrum. The unit that measures luminous flux is the *lumen*. For a more detailed discussion of this topic, see "Power" on page 177. Since 1965, the cost per lumen of light from a given color of LED has decreased by about a factor of 10, while the maximum number of lumens emitted by an LED package has increased by a factor of 20, during each decade. This is known as Haitz's Law, named after Dr. Roland Haitz of Agilent Technologies. Figure 23-4 illustrates it graphically.

Figure 23-3. *An LED light bulb. Unlike an incandescent bulb, it focuses the illumination in one direction, like a reflector-light. Consuming only 6W, it is claimed to be equivalent to a 40W incandescent bulb.*

Schematic Symbol

Schematic symbols that are commonly used to represent an LED are shown in Figure 23-5. The symbol remains the same regardless of the size or power of the component, but architectural plans may represent any type of light using the circle-and-X symbol at bottom right.

How It Works

A high-brighteness LED functions on the same basis explained in the entry describing **LED indicators**. Photons are emitted when electrons are sufficiently energized to cross a PN junction and combine with electron-holes.

An LED that appears white, or off-white, actually emits blue light that is re-radiated over a wide range of wavelengths by adding a layer of yellow phosphors to the chip. A cutaway diagram of an

LED chip (properly known as a *die*), mounted under a silicone lens, is shown in Figure 23-6.

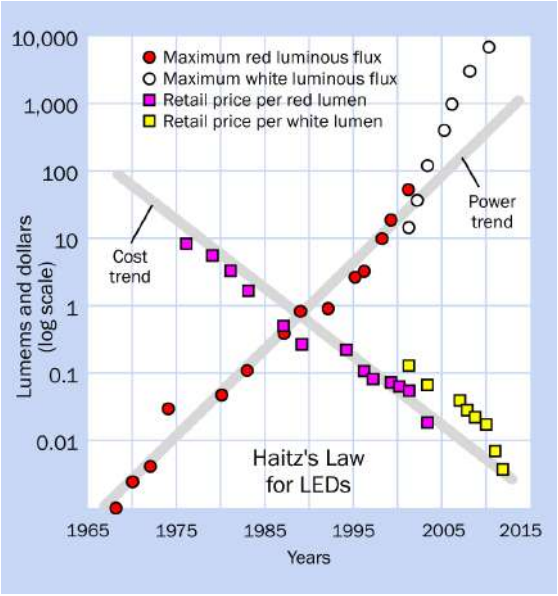

Figure 23-4. *The increase in light output (luminous flux, in lumens) of a single LED compared with the decrease in cost-per-lumen during the years since 1965. The vertical logarithmic scale measures both dollars and lumens. Source: Philips Gardco site-lighting fact sheet with additional data from a "Strategies in Light Report" published by Semiconductor Equipment and Materials International in 2013.*

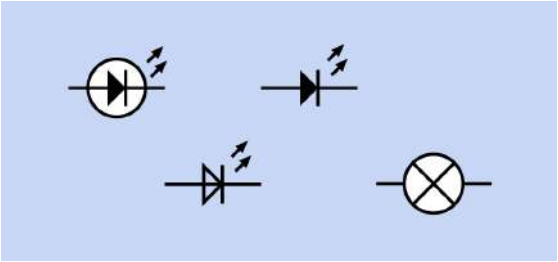

Figure 23-5. *The symbol for an LED remains the same regardless of its size and power, but architectural plans may use the circle-and-X symbol at bottom right for any type of light fixture.*

LEDs are mass-produced by etching them into crystals that are then cut into *wafers* before being subdivided into *dies*, like silicon chips. Most of the blue LEDs that form the basis of white lighting use sapphire crystals as their substrate. The crystal may range in diameter from two inches to six inches. Large sapphire wafers are also finding potential applications in camera lens covers and scratch-resistant cover plates for cellular phones.

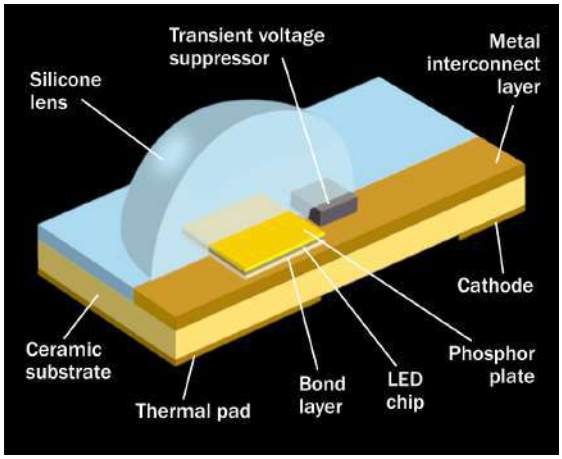

Figure 23-6. *Cutaway diagram of a high-brightness white LED. Adapted from Philips Lumileds Technical Reference document.*

While a die for an LED indicator may be 0.3mm x 0.3mm, a die in a high-brightness LED is often 1mm x 1mm. The size is limited by technical issues involving total internal reflection of the generated light.

The precise color of the light is adjusted by adding red phosphors to the yellow phosphors. This reduces the overall efficiency of the LED by around 10% but creates a "warmer" radiance. A graphical illustration of this principle is shown in Figure 22-3, in the entry on LED indicators.

The *color temperature* of white or offwhite light is measured in degrees Kelvin, typically ranging from 2,500K to 6,500K, where a lower number represents a light with more red in it and a higher number represents a light with more blue in it. This system of measurement was originally used with **incandescent bulbs** to define the temperature of the filament, which determined its color. See "Spectrum" on page 173 for a detailed explanation.

Visible Differences

The effects of different types of illumination are compared in Figure 23-7. To create this figure, first a color chart was prepared in Photoshop and printed on high-gloss photo-grade paper with a Canon Pro9000 Mark II inkjet printer, which has separate colors for red and green in addition to cyan, pale cyan, magenta, pale magenta, yellow, and black.

The color chart was then photographed twice with a Canon 5D Mark II, using a fixed white balance of 4000K. The first exposure was made with "daylight spectrum" LED lighting (claimed color temperature of 6500K) while the second was made with halogen lighting (claimed color temperature of 2900K). The photographs were adjusted in Photoshop for levels only, to fill the available range of 256 values. The two exposures show how the same chart would appear when viewed under the different lights, if the human eye did not adjust itself at all. Note the large area of the LED exposure which is rendered in shades of blue or purple. Also note the dullness of the reds. This confirms the everyday belief that "daylight spectrum" LEDs tend to have a cold, purplish cast while incandescents have a warmer, yellow look.

The same camera was then used to make two more exposures, this time with the white balance set to 6500 for LED lighting and 2900 for halogen lighting, which would be the recommended standard procedure, suggesting the kind of compensation that the human eye also tends to make for different ambient lighting. The result is shown at Figure 23-8. The LED version has improved, but the reds and yellows are still muted. The halogen version also looks better than before, but the magenta end of the spectrum has too much yellow in it. These images show the limits of white-balance correction for indoor photography.

Figure 23-7. *The same printed color chart viewed with "daylight white" LEDs (top) and halogen lighting (bottom), without any compensation to allow for the different light spectra. A fixed white balance of 4000K was used for both pictures.*

Side-by-Side Comparison

Because the human eye is much better at comparing colors when they are adjacent to each other, another color chart was prepared using just six color bars of fully saturated red, yellow, green, cyan, blue, and magenta, with paler and darker versions above and below. The bars were separated with large white gaps. The chart was photographed first with the white balance set to

6500 under "daylight white" LED lighting and then again with the white balance at 2900 for halogen lighting. In Photoshop, the bars from the halogen version were copied and pasted beside the bars from the LED version to facilitate an A-B comparison. The result is shown in Figure 23-9.

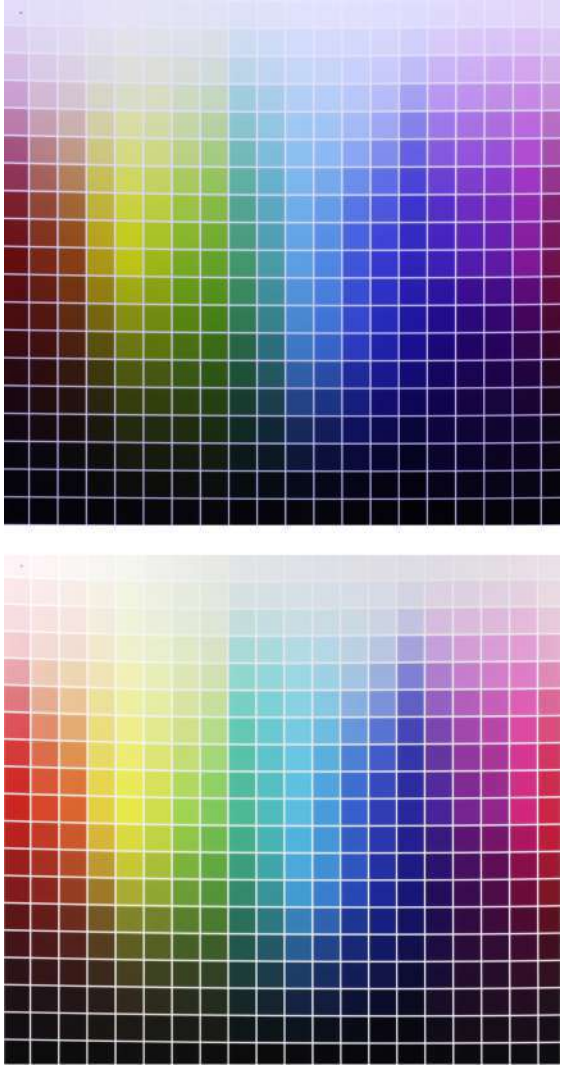

Figure 23-8. *The same color chart as before, photographed with appropriate color temperature settings of 6500K (top, using "daylight-spectrum" LEDs) and 2900K (bottom, using halogen).*

In each pair of colors, LEDs lit the one on the left, and halogen lights lit the one on the right. This figure shows the dramatic difference at the red end of the spectrum, and the poor reproduction of yellows by LED lighting. However, the LED rendering of green is better, and likewise the rendering of magenta, except where its darker version is concerned. Among the pale versions of the colors, the LED lights produce much less density (i.e., they have a brighter look) in the blues, greens, and cyans. The low densities will show up as pale highlights in a photograph of an object, and the picture will tend to have excessive contrast. This will also contribute to the "harsh" look of "daylight white" LED lighting which may be perceived by the eye.

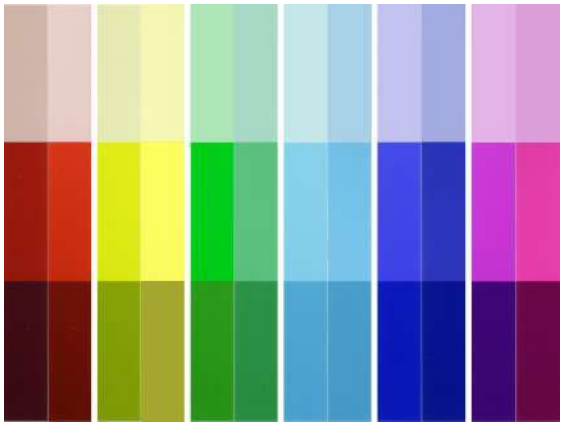

Figure 23-9. *A range of six fully saturated colors, with lighter and darker shades added above and below, photographed first with "daylight spectrum" LEDs and then with halogen lights, after which the two sets of colors were paired for easy comparison. The LED version is on the left in each pair.*

Halogen is deficient at the blue-violet end of the spectrum, even when the camera has an appropriate white-balance setting. Photographers can correct this using image-editing software. LED "daylight spectrum" lights are more difficult to correct. LEDs classified as "warm" should reproduce reds better, but may not do so well with blues.

Diffuse light from a uniformly cloudy sky may be the most ideal form of lighting for photographing objects, but this is of little help for people who work (or take photographs) under artificial lights.

LED lights that contain separate red, green, and blue emitters may perform better, but create a different problem, in that shadows will tend to have color fringes caused by the small offsets between the colored emitters.

Heat Dissipation

An LED is less than 100% efficient because not all electrons mate with electron holes. Some manage to bypass the semiconductor junction; some recombine without generating light; and some transfer their energy to other atoms. In each instance, waste heat is created. While the heat in an incandescent bulb is mostly dissipated by radiation, an LED must get rid of the heat almost entirely by conduction, typically through a *heat sink*. This complicates the design of a fixture, because the integrity of the pathway to dispose of the heat must be retained when the LED bulb or tube is replaced.

Efficacy

The *radiant luminous efficacy* (LER) of an incandescent light source measures how effective it is at channeling its output within the visible spectrum instead of wasting it in infrared radiation. LER is expressed in lumens per watt, and in an incandescent bulb, it is calculated by dividing the power emitted in the visible spectrum (the *luminous flux*) by the power emitted over all wavelengths. This is described in detail in "Efficacy" on page 179 in the entry dealing with incandescent lamps.

In an LED indicator, almost all the radiation can be contained within the visible spectrum, which suggests that its efficacy should be 100%. However, because some waste heat is still created internally, the efficacy is calculated by dividing the light output, in lumens, by the power input, in watts, at the voltage required by the LED. (Lumens can be converted directly to watts, and therefore this division makes a comparison between similar units).

In an LED lighting fixture that contains its own electronics to convert higher voltage AC to lower voltage DC, the power consumption of the fixture is measured not at the diode, but at the input side of the electronics. Therefore, the inefficiency of the electronics reduces the efficacy value of the lighting unit.

Dimming

An incandescent bulb is very sensitive to reduction in power. It becomes radically inefficient, emitting perhaps 1% of its normal light output if the power is reduced to 40%.

LEDs have an almost linear response to the supplied power. Usually a triac-based dimmer will not work well with LED area lighting, and a dimmer designed for LEDs must be substituted, using pulse-width modulation.

Ultraviolet Output

The gas plasma in a fluorescent light generates ultraviolet wavelengths that are shifted to the visible spectrum by the phosphor coating inside the glass envelope. Imperfections in the phosphor coating can potentially allow leakage of ultraviolet light, causing some researchers to claim that the use of CFLs (compact fluorescent lighting) for close-up work with desk lamps can increase the risk of developing some forms of skin cancer. (This claim remains controversial.)

LED manufacturers are quick to point out that white LEDs do not emit any ultraviolet radiation. Figure 23-10 shows spectral power distribution curves derived from measurements of three high-brightness Color Kinetics LEDs manufactured by Philips. The manufacturer states categorically that "The LED-based color and white light products made by Color Kinetics do not emit outside the visible spectrum." Infrared radiation is also negligible.

Color Variation

The *correlated color temperature* (CCT) is determined by finding the conventional incandescent color temperature which looks most similar to the light from a white LED. Unfortunately, because the CCT standard is insufficiently precise,

and because small manufacturing inaccuracies can occur, two LED sources with the same CCT number may still appear different when they are side by side. While the human eye adjusts itself to overall color temperature, it is sensitive to differences between adjacent sources. If two or more white LEDs in a lighting fixture do not have identical spectra, the difference will be noticeable.

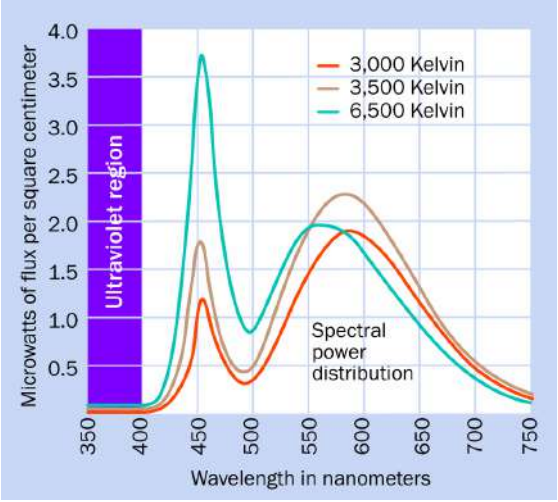

Figure 23-10. *Spectral power distribution curves for three high-brightness white LED lamps showing no ultraviolet emissions. (Adapted from a graph in a white paper published by Color Kinetics Incorporated.)*

To address the issue, manufacturers introduced the concept of "binning," in which lights are subclassified to tighter specifications and are assigned bin numbers based on their measured characteristics. The Philips Optibin system, for instance, assesses the light from various angles, as well as perpendicularly to the source. This is especially important where a large area such as a building lobby is painted white and is lit by high-brightness LEDs that must appear uniform in color temperature.

Variants

LED area lighting products are often designed to emulate the form factors of incandescent bulbs, halogen reflector bulbs, or fluorescent tubes. The standard screw-in base of an LED light bulb, the pin-base of a miniature 12V LED reflector bulb, and the pins on an LED tube enable easy migration to the newer technology.

Strip lights are unique to LED lighting systems. They are thick, flexible plastic ribbons in which are embedded a series of LEDs. For area lighting, the LEDs are white, and the strips can contain necessary control electronics for conversion of AC power. The strips can be placed behind ledges or moldings to provide soft, even illumination of the ceiling above.

Strip lights are also available for 12VDC power, to create lighting effects in customized automobiles and trucks. These strip lights are available in various colors in addition to white. Many have multicolor capability and can be controlled with a handheld remote.

Comparisons

The advantages of an **incandescent lamp** are listed in "Relative Advantages" on page 179, while advantages of **fluorescent lights** are listed in "Comparisons" on page 194. These lists can be compared with the following advantages for LED area lighting:

- While the life of an incandescent lamp for room lighting can be as little as 1,000 hours, LED area lighting typically claims up to 50,000 hours.
- The lifetime of an incandescent bulb is the average time it can emit light before catastrophic failure. The lifetime of an LED is the average time it can emit light before gradually dimming to 70% of its rated output. This is a much gentler, less inconvenient failure mode that does not require immediate replacement.
- Unlike a fluorescent light or incandescent bulb, the LED does not contain hot tungsten that fails as a result of erosion.

- Unlike a fluorescent light, an LED does not contain mercury, and therefore does not require special recycling arrangements that entail associated fees.
- While fluorescents can have difficulty starting in low temperatures, an LED is not sensitive to a cold environment.
- Bright LEDs are available in a wide range of colors that do not require filtering. Filters greatly reduce the efficiency of incandescent bulbs when they are used in applications such as traffic signals or rear lights on automobiles.
- High-brightness LEDs can be dimmable. Fluorescent lights are usually not dimmable, or perform poorly in this role.
- LEDs are inherently directional, because the die radiates light at an angle of 90 degrees to its plane. This makes it ideal for ceiling mounting, where as much light as possible should be directed downward. A fluorescent tube or incandescent bulb often requires a reflector which reduces the overall efficiency.
- LEDs are insensitive to cycling. The life expectancy of an incandescent bulb or (especially) a fluorescent tube is reduced by cycling it on and off.
- No flickering. Fluorescent tubes may start to flicker as they age.
- No electrical interference. Fluorescent tubes can interfere with AM radio reception and some audio devices.
- Safe from breakage. LED area lighting does not necessarily use any glass.

However, high-brightness LEDs still have some barriers to overcome:

- Cost. In the United States, before 60W incandescent bulbs were legislated out of existence, they could be sold profitably for less than $1 each. A T8 fluorescent tube, measuring 1″ diameter and 48″ long, currently costs between $5 and $6 (retail) but has a life expectancy in the region of 25,000 hours, and uses only 20% of the power of an incandescent bulb to generate two to three times as much light. Clearly the fluorescent tube is a more economical choice, despite the price of the electronics that must be included in the fixture to start the tube. By comparison, currently the purchase price of an LED tube is three times that of a fluorescent tube. It may last twice as long, but is not significantly more efficient, generating perhaps 100 lumens per watt while a fluorescent is typically capable of 90 lumens per watt. Prototype high-brightness LEDs have exceeded 200 lumens per watt, and should be competitive with fluorescents by 2020, but even then, migration will take time.
- Heat sensitivity. Heat reduces the light output and the lifespan of LED fixtures.
- Placement issues. Because LEDs are heat sensitive, they must be installed in locations that do not become excessively hot, their heat sinks must be correctly oriented, and they must have adequate ventilation.
- Color shift. Heat and age may cause the color temperature of an LED to shift slightly, as the color is usually derived from two types of phosphors.
- Nonuniformity. Manufacturing inconsistencies can cause LEDs of the same type to display slightly different color temperatures. Fluorescents and incandescents are more uniform.
- Lower heat output than incandescents. While this is an advantage from the point of view of efficiency, it can be a disadvantage in applications such as traffic signals or airport runway lighting where waste heat can help to keep the lights free from snow or ice.

Values

Although the output from an LED area light is directional, while the output from an incandescent bulb or a fluorescent light is omnidirectional, the intensity is measured the same way in each instance, using *lumens*. This unit expresses the total light emission, without taking directionality into account. (The intensity of **LED indicators** is calibrated in candelas, which measure the power within an angle of dispersion; but candelas are not used for area lighting.)

Typical values for incandescent bulbs are 450 lumens for a power consumption of 40 watts, 800 lumens for a consumption of 60 watts, 1,100 lumens for a consumption of 75 watts, and 1,600 lumens for a consumption of 100 watts. Because much of the output from an incandescent bulb may be wasted by using inefficient reflectors or allowing the light to shine in directions where it is not needed, a high-brightness LED rated at 1,000 lumens may actually appear brighter than a 75-watt incandescent bulb.

A T8 fluorescent tube measuring 48″ long by 1″ in diameter consumes only 32 watts but emits almost 3,000 lumens—when it is new. This output gradually diminishes by as much as 40% over the lifetime of the tube.

Incandescent bulbs deliver between 10 and 15 lumens per watt, approximately. A new fluorescent tube produces around 80 to 90 lumens per watt, and LED area lighting at the time of writing can provide 100 lumens per watt, under real-world conditions.

What Can Go Wrong

Wrong Voltage

Many high-brightness LED lighting units can be used with either 115VAC or 230VAC. There are exceptions, however. Check the specifications to make sure. Also, it is important to avoid applying domestic supply voltage to 12V LED miniature reflector-bulbs that are intended to replace 12VAC halogen bulbs of the same size.

Overheating

If a high-brightness LED fixture is equipped with a heat sink, this must be exposed to freely flowing air. Any vanes on the heat sink should be oriented vertically to encourage convection, and the fixture must not be placed in an enclosure. Overheating will radically shorten LED life.

Fluorescent Ballast Issues

A fluorescent fixture contains a *ballast* to limit the tendency of the tube to draw excessive current. The ballast is contained in a plastic box attached to the back of the frame in which the tube is mounted.

A *magnetic ballast* contains a coil, and is bypassed by an additional *starter* that applies unlimited current for one second when the power is switched on, preheating the tube to initiate plasma discharge.

An *electronic ballast* performs the same function without a separate starter.

Some LED tubes designed as substitutes for fluorescent tubes may allow a magnetic ballast to remain in the circuit, but may not tolerate an electronic ballast. Other LED tubes require any type of ballast to be unwired from the circuit. The unwiring operation will require disconnection of a couple of wires by removing wire nuts (assuming that the fixture has been designed to comply with U.S. building codes). The wires are then reconnected to apply power directly to the tube, and the wire nuts are reapplied to complete the new connection. The ballast can remain passively in the fixture.

Failing to remove the ballast and/or the starter from a fluorescent fixture before installing an LED tube that requires direct connection to the power supply can damage the tube. Connecting the power incorrectly to the LED tube may result in it failing to light up. Documentation supplied with the LED tube should provide guidance for disconnecting the ballast and connecting the tube. Note that the pin functions on LED tubes are not standardized at this time.

Misleading Color Representation

Because the spectrum of a white LED is not evenly weighted across all wavelengths, it will fail to represent some colors accurately, as shown previously. This can be important if LEDs are used to illuminate full-color printing or artwork, or if they are installed in stores selling merchandise such as clothes, furnishings, or food.

LED display

24

In this encyclopedia, a component consisting of multiple separately discernible light-emitting diodes, such as a seven-segment numeral, 14- or 16-segment alphanumeric character, a dot-matrix character, or a display module containing multiple characters, is categorized as an **LED display**. The term *light-emitting diode* is hardly ever used to describe an LED display, as the LED acronym has become ubiquitous. The acronym does not usually include periods between the letters.

An **LED indicator** is defined here as a component usually 5mm or smaller in diameter, made of transparent or translucent epoxy or silicone, most often containing one *light-emitting diode*. It is purposed as a status indicator in a device, rather than as a source of illumination, and is sometimes referred to as a *standard LED.*

LEDs that are designed to illuminate large living or working areas are discussed in a separate entry as **LED area lighting**. They are sometimes referred to as *high-brightness LEDs* and almost always emit white light.

The term *OLED* is an acronym for *Organic Light-Emitting Diode*, a thin panel in which an organic compound is contained between two flat electrodes. Despite its functionality as a form of LED, its design is similar to that of thin-film electroluminiscent light sources. Therefore it is discussed in the entry on **electroluminescence**.

OTHER RELATED COMPONENTS

- **LED indicator** (see Chapter 22)
- **LED area lighting** (see Chapter 23)
- **vacuum-fluorescent** (see Chapter 25)
- **electroluminescence** (see Chapter 26)
- **LCD** (see Chapter 17)

What It Does

An LED display presents information on a panel or screen by using multiple segments that emit light in response to a DC current, almost always at a voltage ranging between 2VDC and 5VDC. The display may contain alphanumeric characters and/or symbols; simple geometrical shapes; dots; or pixels that constitute a *bitmap*.

A *liquid-crystal display*, or **LCD**, serves the same purpose as an LED display and may appear very similar, except that a liquid crystal reflects incident light while an LED emits light. The increasing use of backlighting with LCDs has made them appear more similar to LED displays.

There is no schematic symbol to represent an LED display. Where a segmented display is used, often the segments are represented with drawn outlines.

The simplest, most basic, and probably the best-known example of an LED display is the *seven-*

segment numeral, one of which is shown in Figure 24-1. This is a Kingbright HDSP-313E with a character height of 0.4".

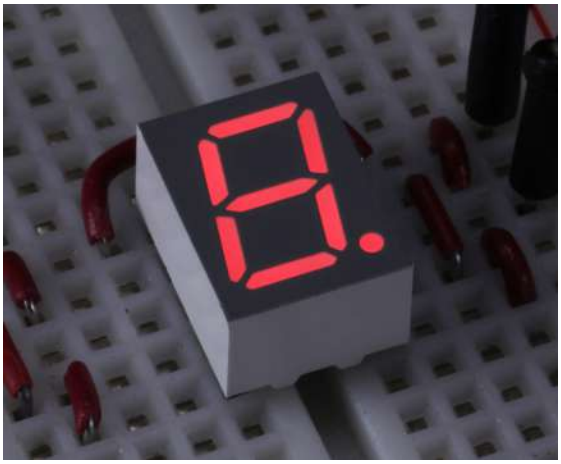

Figure 24-1. *The most basic LED display, able to create numerals from 0 through 9 using seven light-emitting segments that can be illuminated individually. An eighth segment forms the decimal point.*

How It Works

The process by which an LED generates light is explained in "How It Works" on page 207, in the entry dealing with **LED indicators**. Each light-emitting diode in an LED display is functionally the same as the diode in an LED indicator.

LEDs must be driven with DC. This is a primary distinction between an LED display and an LCD, which requires AC.

Variants

LCD comparisons

LCDs and LED displays can look very similar. This raises the obvious question: which is appropriate for a particular application?

LCDs (without backlighting) are more appropriate for applications such as digital watches and solar-powered calculators where power consumption must be minimized. They are capable of running for years from a single button cell.

LCDs are easily visible in bright ambient light, where LED displays are not. LCDs can also be designed to display complex pictographic shapes and symbols, while the segments of an LED display are more constrained to be simple in shape.

An LCD is more likely to be affected by temperature than an LED, and powering it entails some slight inconvenience, because it requires an AC source that is unlikely to be useful elsewhere in a circuit. If the LCD uses LED backlighting, it will also require a low-voltage DC power source for the backlight. An LED display is easier to use in that it can be driven directly from a microcontroller or logic chip, with only some series resistors to limit the current, and the addition of transistors to provide additional power where necessary.

Seven-Segment Displays

Early seven-segment LED displays were used in digital calculators, before LCDs became an affordable, practical alternative that greatly extended battery life. Initially, the size of the diodes was limited, sometimes requiring magnifying lenses to make them legible.

Seven-segment displays are still used in some low-cost applications, although LCDs have become more common.

Figure 24-2 shows how the segments are identified with letters *a* through *g*. This scheme is used universally in datasheets, and is also used for LCDs. The decimal point, customarily referred to as "dp," is omitted from some displays. The segments are slanted forward to enable more acceptable reproduction of the diagonal stroke in numeral 7.

Although seven-segment displays are not elegant in appearance, they are functional and are reasonably easy to read. They also enable the representation of hexadecimal numbers using letters A, B, C, D, E, and F (displayed as A, b, c, d, E, F because of the restrictions imposed by the small number of segments), as shown in Figure 24-3.

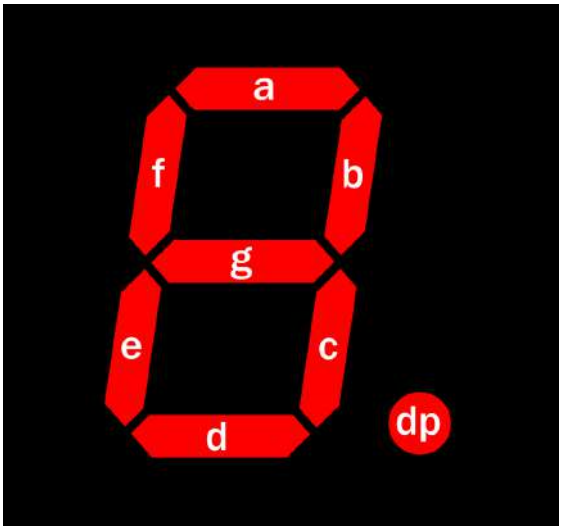

Figure 24-2. *A seven-segment LED display. The lowercase identifying letters are universally used in datasheets.*

In appliances such as microwave ovens, very basic text messages can be displayed to the user within the limitations of seven-segment displays, as suggested in Figure 24-4.

Numbers 0, 1, and 5 cannot be distinguished from letters O, I, and S, while letters containing diagonal strokes, such as K, M, N, V, W, X, and Z, cannot be displayed at all.

Multiple Numerals

Displays consisting of a single numeral are now rare, as few applications require only one digit. Displays of two, three, and four digits are more common, as shown in Figure 24-5.

Additional Segments

Displays with 14 or 16 segments were introduced in an effort to enable the representation of all the letters of the alphabet. The segment layout of these LED displays is identical to that of comparable LCDs. The differences between 14-segment and 16-segment displays are shown in Figure 24-6. Some are angled forward like seven-segment displays, even though the addition of diagonal segments makes this unnecessary for display of characters such as numeral 7.

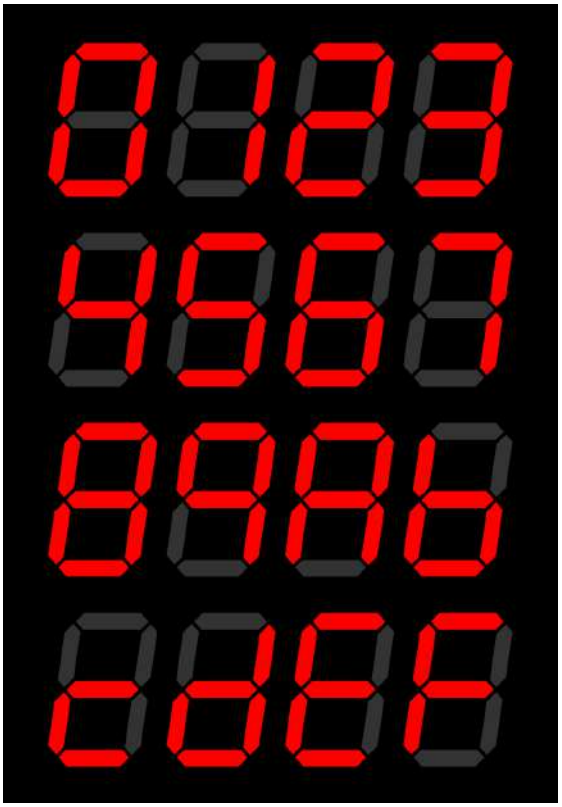

Figure 24-3. *Numerals and the first six letters of the alphabet created with seven-segment displays.*

Figure 24-7 shows the scheme for identifying the segments of a 16-segment display. This naming convention is used in all datasheets. The lowercase letters that were customary with seven-segment displays are usually abandoned in favor of uppercase, perhaps to avoid confusion with the letter L. Note that letter I is omitted from the sequence.

For a complete alphanumeric character set enabled by a 16-segment display, see Figure 17-9 in the entry discussing LCDs.

An example of a 16-segment alphanumeric LED display is shown in Figure 24-8, mounted on a breadboard and wired to show the letter N. This is a Lumex LDS-F8002RI with a character height of 0.8″. The component is still available at the time of writing, but in limited quantities.

Generally speaking, 16-segment displays were never very popular, because the gaps between adjacent segments impaired legibility. LED versions remain more readily available than LCD versions, but dot-matrix displays allow a better-looking, more easily legible alphabet, with the added possibility of simple graphics.

Dot-Matrix Displays

In the 1980s, some personal computers used a video character set in which each letter, numeral, punctuation mark, and special character was formed on a video screen from a fixed-size matrix of dots. A similar alphabet is now used in LED dot-matrix displays (and LCDs, as shown in Figure 17-10).

Figure 24-4. *Basic text messages can be generated with seven-segment displays, although they cannot represent alphabetical letters containing diagonal strokes.*

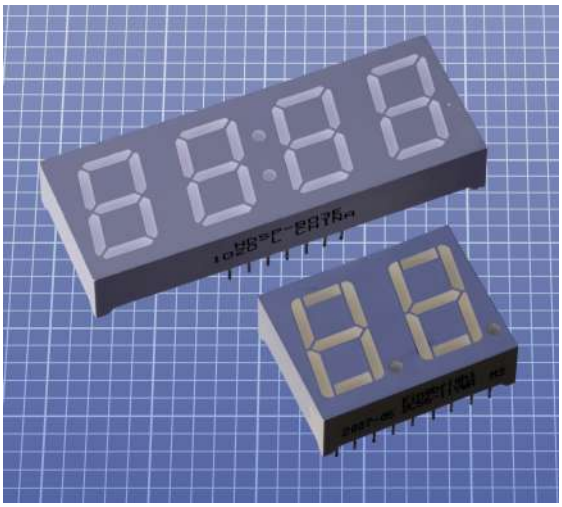

Figure 24-5. *Multiple seven-segment LED displays are often combined in a single component. Top: An Avago 2.05VDC 20mA display designed for a clock. Bottom: A Kingbright two-digit display which draws 20mA at 2.1VDC. The unlit outlines of the numerals would normally be hidden behind panels that are tinted to the same colors emitted by the LED segments when lit.*

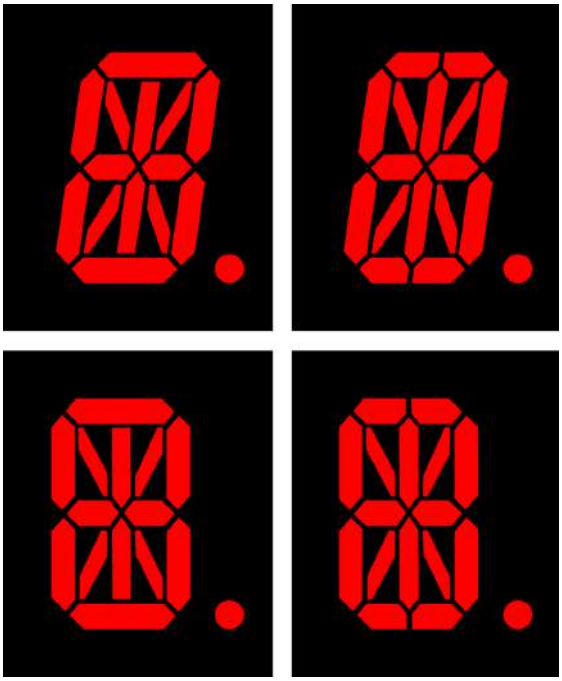

Figure 24-6. *Layouts for 14-segment and 16-segment alphanumeric LEDs are identical to those of LCDs.*

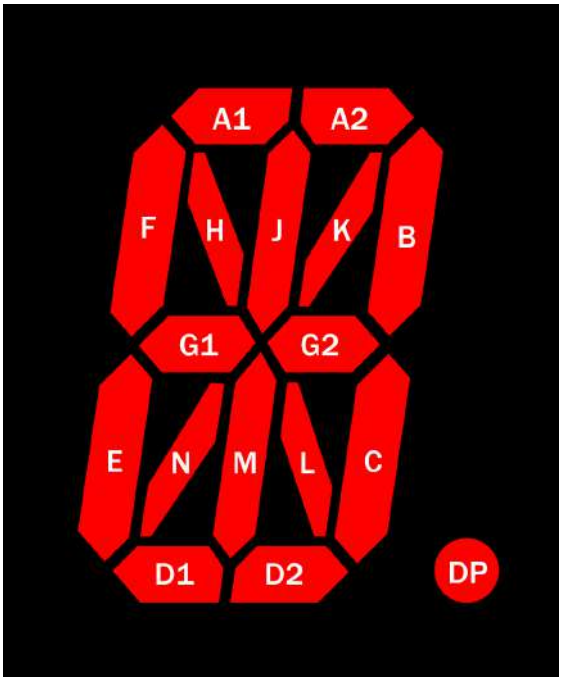

Figure 24-7. *The scheme for identification of segments in a 16-segment alphanumeric LED display.*

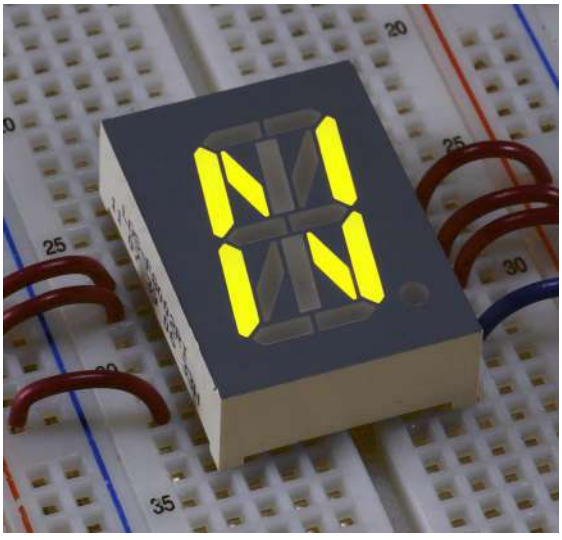

Figure 24-8. *A 16-segment alphanumeric LED display showing the letter N.*

Alphanumeric dot-matrix characters are often grouped in two or more rows with eight or more characters per row. The number of characters is always listed before the number of rows, so that an 8x2 display would contain eight alphanumeric characters in two horizontal rows. This type of component is properly described as a *display module*.

Display modules are used in consumer electronics products such as a stereo receiver where simple status messages and prompts are necessary —for example, to show the tone control settings or the frequency of a radio station. Because the cost of small, full-color, high-resolution LCD screens has been driven down rapidly by the mass production of cellular phones, and because these high-resolution screens are much more versatile, they have already displaced dot-matrix display modules in many automobiles and are likely to follow a similar path in other devices.

Pixel Arrays

The 8x8 pixel array of LED dots shown in Figure 24-9 measures 60mm square (slightly more than 2") and contains 64 LEDs, each approximately 5mm in diameter. Similar arrays are available in other sizes and with different numbers of dots. Displays of the same type may be assembled edge-to-edge to enable scrolling text or simple graphics.

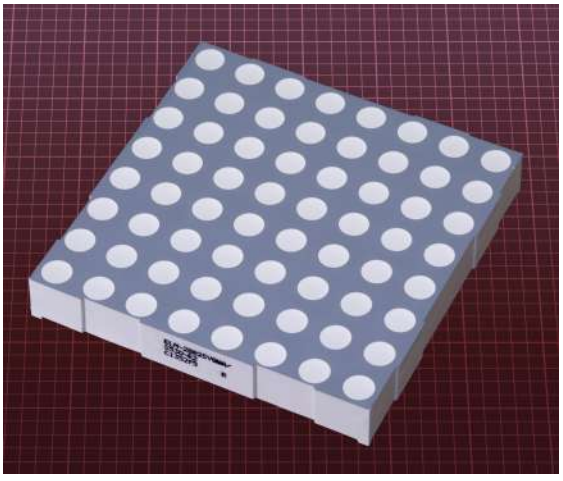

Figure 24-9. *An 8x8 matrix of LED dots measuring more than two inches square.*

Multiple Bar Display

A bar display is a row of small rectangular LEDs in a single component. It may be used for digital representation of an analog signal. The higher the voltage of the signal, the more bars will be illuminated. A typical application would be to show the signal strength of an input to an audio recorder. Ten bars are often used, as in the display shown in Figure 24-10, but multiple components can be combined end to end.

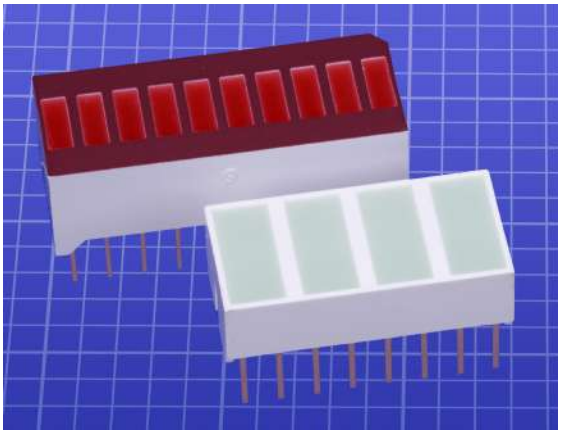

Figure 24-10. *Two LED bar displays in which segments can be lit individually.*

Single Light Bar

A light bar can be thought of as a single-source LED, as it is configured as a single square or rectangle. It is mentioned here, rather than in the entry for single-source LED indicators, because variants may be subdivided into two, three, four, or (sometimes) more discrete sections. These variants are often included in the same datasheet as the monolithic version.

A light bar contains multiple LEDs (often, four in number) behind a translucent panel that provides evenly diffused radiance.

Values

The values for most LED displays are basically the same as for LED indicators, in terms of color, brightness, current consumption, and voltage. See "Values" on page 211 for information.

Multiple-character dot-matrix LED display modules may have different requirements for forward voltage and forward current, depending on drivers that are incorporated in the module. Because there is no standardization for these modules, it will be necessary to consult the manufacturer's datasheet.

How to Use It

Seven-Segment Basics

The diodes in a seven-segment LED display share either a *common anode* or a *common cathode*, the latter being more frequently used. The two types of internal wiring are provided for convenience only. Externally, the displays function identically.

A schematic suggesting the internal wiring and pinouts of a typical ten-pin common-cathode display is shown in Figure 24-11. The pins are numbered as seen from above. Appended to each number is the identity of the segment to which it is connected. Pins 3 and 8 are connected with the cathodes of all the internal LEDs. Both of these pins should be used, to serve as heat sinks for the display.

Note that series resistors are not included inside the display and must be added externally. Their value will be determined by the power supply, to limit the forward current and forward voltage through the LEDs to the extent specified by the manufacturer.

An encapsulated *resistor array* containing either seven or eight resistors in an SIP or DIP chip can be used instead of individual resistors. A seven-segment LED display would require the type of resistor array in which both ends of each resistor are accessible.

Where two or more numerals are combined in a single component, this type of display is likely to have two horizontal lines of pins. In this case, pin 1 will be at the bottom-left corner, seen from

above. As always, the pins are numbered counterclockwise, seen from above.

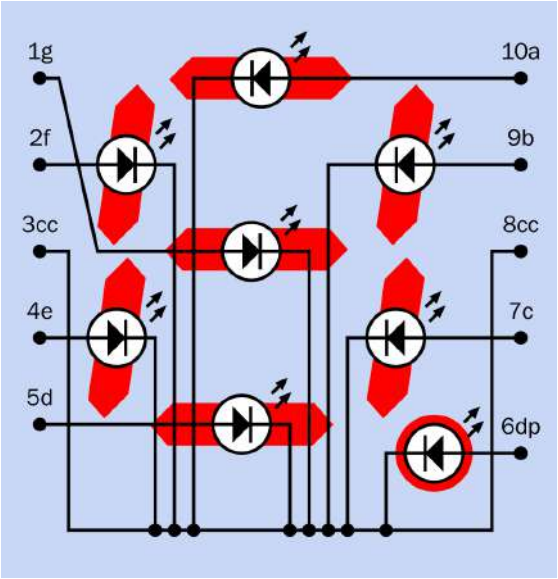

Figure 24-11. *A schematic view of internal connections and pinouts of a seven-segment common-cathode LED display. The numbers refer to the pins of the component, seen from above. The 1 pin may also have a mark beside it on the component, for identification. The orientation of the display can be deduced if there is a decimal point, as this should be at the bottom-right corner.*

Where three or more numerals are combined in a single component, the pinouts may be designed for multiplexing rather than individual access to every segment of each numeral. A four-digit clock display, for instance, may have seven pins that connect in parallel to respective segments in all of the numerals, and four additional pins that can ground each numeral in turn, so that they can be selected sequentially.

Driver Chips and Multiplexing

Illuminating the appropriate segments in a single numeral can be done directly from a microcontroller, or through a driver chip such as the well-known and widely used 4543B that converts a binary-coded decimal input into appropriate segment output patterns. The chip can source sufficient current to drive each segment through a series resistor. Its pinouts are shown at Figure 24-12.

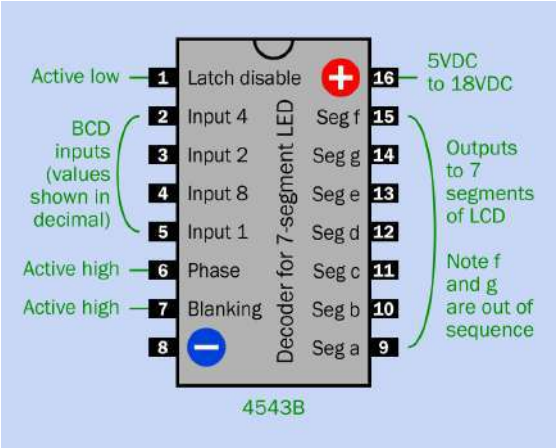

Figure 24-12. *Pinouts of the 4543B seven-segment LED driver chip.*

When used in conjunction with a microcontroller, the 4543B can drive several seven-segment displays by multiplexing them. The basic schematic to achieve this is shown in Figure 24-13, omitting optional features such as leading-zero blanking or connections for a decimal point. The microcontroller sends the binary code for the first numeral and simultaneously grounds the common cathode of that numeral through a transistor, which is needed because as many as seven segments of the numeral may be passing current in parallel. The microcontroller then sends the binary code for the second numeral, and grounds it; then sends the binary code for the third numeral, and grounds it; and the cycle repeats. So long as this process is performed at sufficient speed (at least 50Hz), persistence of vision will create the illusion that all the numerals are active simultaneously. The circuit can be compared with a similar circuit to drive LCDs, shown in Figure 17-17.

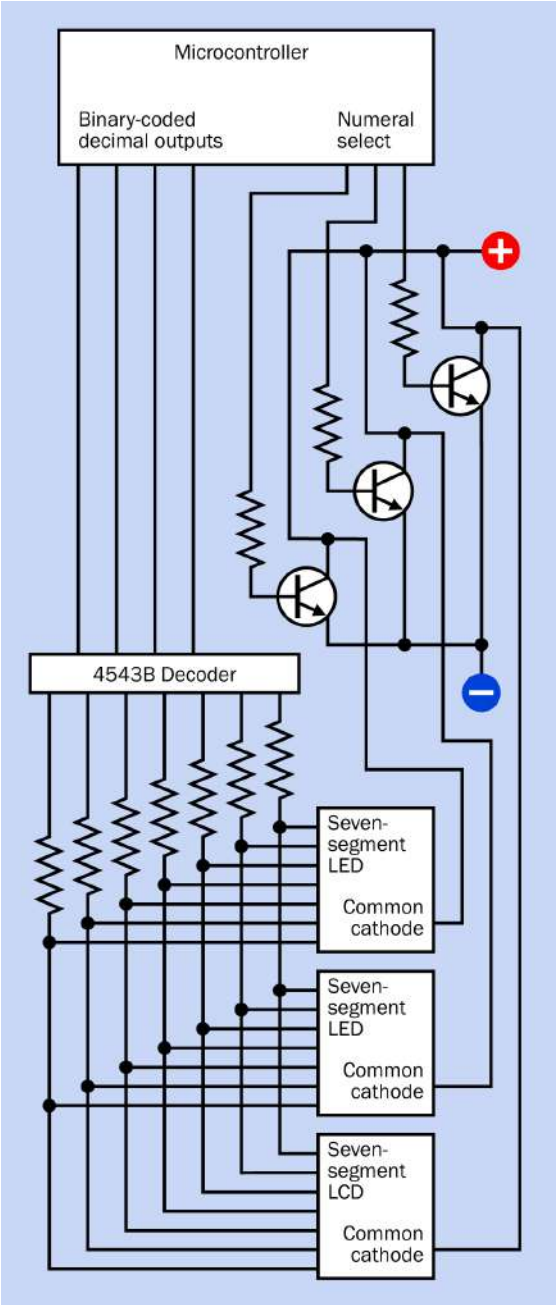

Figure 24-13. *A basic, simplified circuit for driving multiple seven-segment LED displays by multiplexing them.*

The disadvantage of this system is that the microcontroller must update the numerals constantly while performing other duties. To reduce this burden, a "smarter" driver such as the MC14489 can be used, controlling up to five 7-segment digits, or the Intersil ICM7218, which can control up to eight 7-segment digits.

The MC14489 controller receives data serially, using SPI protocol, and handles the details of addressing the LEDs. Because it contains latches to sustain the displayed data, a microcontroller only needs to communicate with the driver when the displayed information needs to be updated.

The ICM7218 is a more sophisticated chip, available in several variants, one of which can receive data on an 8-bit bus and run the seven-segment displays in hexadecimal mode.

Sixteen-Segment Driver Chip

The MAX6954 by Maxim can drive up to eight 16-segment alphanumeric LED displays using a scheme known as Charlieplexing, named after a Maxim employee named Charlie Allen who came up with the concept as a way of reducing the pin count required for multiplexing. Other Maxim controllers use this same protocol, which is transparent to the user.

A microcontroller sends data serially via I2C protocol to the MAX6954, which contains a variety of features. It can drive 14-segment and 7-segment displays as well as 16-segment displays, and contains a 104-character alphabet for each of them. Setting up a microcontroller to send the various necessary command codes to the MAX6954 is not a trivial matter, and bearing in mind the probably impending end-of-life of 16-segment displays, a better option may be to use dot-matrix LED display modules that have controller logic built in.

Dot-Matrix LED Display Modules

A dot-matrix LED display module requires data to define a character set, and a command interpreter to process instructions that will be embedded in a serial data stream. These capabilities are provided either by separate chips or (more often) are incorporated into the LED display module itself.

The SSD1306 is a monochrome graphical controller capable of I2C or SPI serial communication, or parallel communication. When this capability is built into a display module, only one of these types of communication may be activated.

The SSD1331 is a color graphical controller with similar communication capabilities.

The WS0010 is a monochrome controller, compatible with HD44780, which is designed to control LCDs.

Typical controller functions are summarized in "Alphanumeric Display Module" on page 168. Because there is no standardization in this field, precise details must be found in manufacturers' datasheets.

Pixel Arrays

The connections inside an 8x8 pixel array are shown in Figure 24-14, where the schematic symbols for LEDs have been replaced by gray circles for space reasons. To illuminate one LED, power is supplied to the intersection where it resides. In the figure, each vertical conductor (identified as A1, A2 . . . A8) can power the anodes of a column of eight LEDs, while each horizontal conductor (identified as C1, C2 . . . C8) can ground the cathodes of a row of eight LEDs. If only one vertical conductor is connected with positive power while one horizontal conductor is grounded, only one LED will light up, at the intersection of the active conductors.

A problem occurs if we wish to illuminate two LEDs. Suppose they are located at (A3,C2) and (A6,C5). Unfortunately, providing power to them will also result in activating LEDs at (A3,C5) and (A6,C2), as shown in Figure 24-15, where the yellow circles represent LEDs that have been switched on.

The answer to this problem is to rasterize the process. In other words, data is supplied on the array one line at a time, as in the process by which a TV picture is generated. If this is done quickly enough, persistence of vision will create the illusion that the LEDs are illuminated simultaneously.

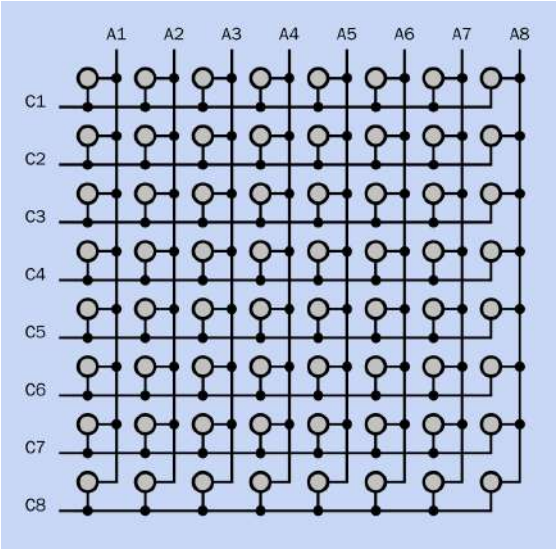

Figure 24-14. *Internal connections in the 8x8 matrix. Each gray circle represents an LED.*

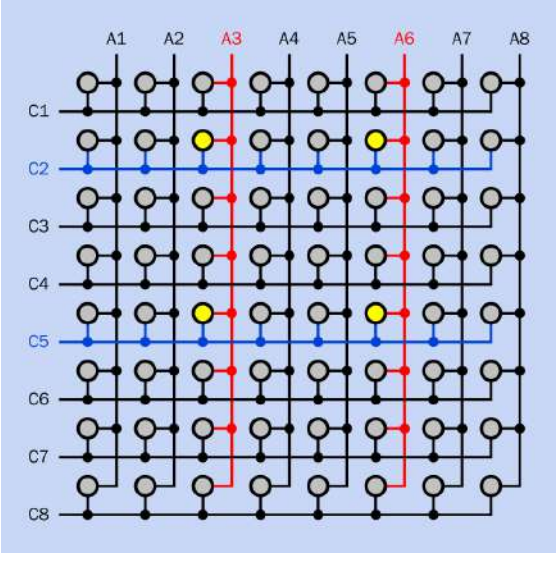

Figure 24-15. *An attempt to illuminate LEDs at (A3,C2) and (A6,C5) will also activate the LEDs at (A3,C5) and (A6,C2).*

A form of multiplexing is used to achieve this. One row of LEDs is connected to negative ground

for a brief interval. During this interval, the anodes of selected LEDs are powered momentarily. Then the next row is grounded, and selected LEDs along that row are powered momentarily. This process is repeated for all eight rows before being repeated.

If several 8x8 matrices are assembled edge to edge, their horizontal conductors can be common to all of them. A horizontally scrollable display (sometimes referred to by the archaic term, *electric newspaper*) would then be possible, although the circuit design would be nontrivial.

Multiple Bar Display Driver

The LM3914 is a driver for a bar display that compares an analog input with a reference voltage and provides power to the segments of a multiple bar display, ranging from 2mA to 30mA, adjustable to match the specification of the display that is being used. The chip can generate either a "thermometer" effect, as more outputs are activated when the analog input increases, or a "moving dot" effect, in which only one output is on at a time.

One-Digit Hexadecimal Dot Matrix

While multi-character dot-matrix LED display modules are a versatile way to display prompts and numbers, a simpler component is sometimes sufficient. The Texas Instruments TIL311 is a minimal dot-matrix LED display that receives a binary value from 0000 through 1111 on its four input pins and generates the output in hexadecimal form, using numerals 0 through 9 and letters A through F. The sixteen possible outputs in the dot-matrix display are shown in Figure 24-16. Although this component is no longer being manufactured, it is widely available from many sources, especially in Asia. It eliminates the series resistors and controller chip that are customary for a seven-segment display, and has a better-looking output.

Figure 24-16. *Sixteen possible outputs that can be displayed by the Texas Instruments TIL311 to show a hexadecimal value in response to a four-digit binary input.*

A sample of the TIL311 is shown in Figure 24-17 displaying the number 2.

If two or more of these chips are put together, they can be multiplexed to display multi-digit decimal or hexadecimal integers.

The chip features two decimal points, one to the left of the displayed numeral, and one to the right. If they are activated, they require their own series resistors to limit the current.

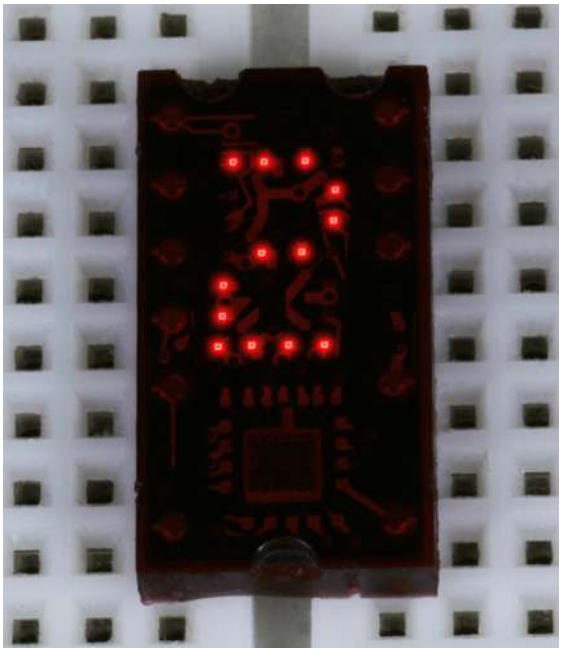

Figure 24-17. *The Texas Instruments TIL311 can be driven directly by a microcontroller or counter chip, with no series resistors necessary. It can generate a hexadecimal output.*

What Can Go Wrong

Common Anode versus Common Cathode

An LED display containing a common cathode is usually identical in appearance to a display containing a common anode, and the two versions will be distinguished by only one digit or letter in their part numbers. Because LED displays have a limited tolerance for reverse voltage, part numbers should be double-checked before applying power.

Incorrect Series Resistance

A common error is to assume that only one series resistor is necessary for a seven-segment LED display, either between the common cathode pin and ground, or, if there is a common anode, between that and the positive power supply. The problem is that if the resistor is suitable for a single LED, its value will be too high when several segments of the display are sinking current or drawing current through it. If its value is reduced, it will be too low when only two segments are using it (as when generating the number 1).

To provide equal illumination of all the segments, each must have its own series resistor.

Multiplexing Issues

When several displays are multiplexed, they naturally appear dimmer, creating a temptation to compensate by upping the current. Because current is only being applied to each display intermittently, a natural assumption is that a higher current can be safely used.

This may or may not be true. When running an LED device with pulsed current, the peak junction temperature, not the average junction temperature, determines the performance. At refresh rates below 1kHz, the peak junction temperature is higher than the average junction temperature, and the average current must therefore be reduced.

Datasheets must be checked to determine whether a device is designed with multiplexing in mind and, if so, what the recommended peak current is. Very often this value will be accompanied by a maximum duration in milliseconds, and a calculation may be necessary to determine the refresh rate, bearing in mind how many other LED displays are being multiplexed in the same circuit at the same time.

Irresponsible multiplexing will shorten the life of an LED display or burn it out.

vacuum-fluorescent display

25

The term **vacuum-fluorescent display** is seldom hyphenated, but the first two words are hyphenated here as they constitute an adjectival phrase. The acronym *VFD* is becoming increasingly popular, although it is ambiguous, being also used to identify a *variable frequency drive*. In both instances, the acronym is printed without periods between the letters.

The entry in this encyclopedia dealing with **fluorescent lights** does not include VFDs, because their purpose and design are very different. A VFD is an informational display, often showing numerals and letters, while a fluorescent light merely illuminates a room or work area. Although a VFD does use fluorescent phosphors, they are printed onto light-emitting segments of the display instead of being applied to the inside surfaces of a glass envelope.

OTHER RELATED COMPONENTS

- **LED indicator** (see Chapter 22)
- **LCD display** (see Chapter 17)
- **electroluminescence** (see Chapter 26)

What It Does

A **vacuum-fluorescent display** or *VFD* superficially resembles a backlit monochrome **LCD** or an **LED display**, as it can represent alphanumeric characters by using *segments* or a *dot matrix*, and can also display simple shapes. It is often brighter than the other information display systems, and can emit an intense green phosphorescent glow that some people find aesthetically pleasing, even though a grid of very fine wires is superimposed internally over the displayed image.

There is no specific schematic symbol to represent a vacuum-fluorescent display.

How It Works

The display is mounted inside a sealed capsule containing a high vacuum. A widely spaced series of very fine wires, primarily made of tungsten, functions as a *cathode*, moderately heated to encourage electron emission. The wires are often referred to as *filaments*.

A **fluorescent light** uses AC, and both of its electrodes are often confusingly referred to as cathodes. A VFD uses DC, and its cathode array has the function that one would expect, being connected with the negative side of the DC power supply.

Opposite the cathode, just a few millimeters away, is an anode that is subdivided into visible alphanumeric segments, symbols, or dots in a matrix. Each segment of the anode is coated with *phosphors*, and individual segments can be sep-

arately energized via a substrate. When electrons strike a positively charged anode segment, it emits visible light in a process of *fluorescence*. This behavior can be compared with that of a *cathode-ray tube*. However, the cathodes in a VFD are efficient electron emitters at a relatively low temperature, while the cathodes in a cathode-ray tube require substantial heaters.

Anode, Cathode, and Grid

A *grid* consisting of a mesh of very fine wires is mounted in the thin gap between the filaments of the cathode and the segments of the anode. A simplified view of this arrangement is shown in Figure 25-1.

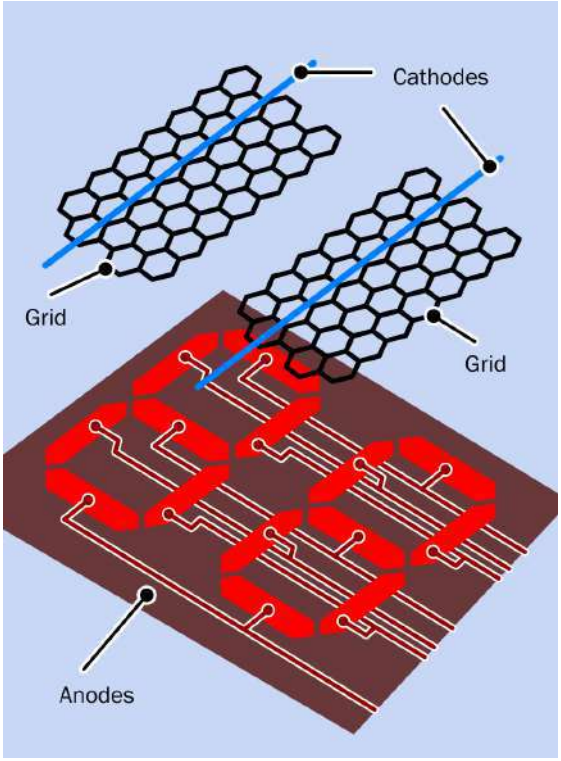

Figure 25-1. *The basic elements of a vacuum-fluorescent display.*

The polarity of the charge on the grid controls and diffuses electrons emitted by the cathode. If a grid section is negatively charged, it repels electrons and prevents them from reaching the sections of the anode beneath it. If the grid section is positively charged, it encourages electrons to reach the anode. Thus, the grid functions in the same way as the grid in a triode vacuum tube, but its conductors are so thin, they are barely visible.

How to Use It

Electronic calculators used vacuum-fluorescent displays during the 1970s, before LED displays and LCDs became more competitive. Purely numeric VFD modules are still available as strings of digits, although they are becoming uncommon and have been replaced by alphanumeric dot-matrix modules where each VFD character is mounted in its own glass module on a separate substrate.

Figure 25-2 shows the interior of a Commodore calculator from the 1970s, with its nine-digit vacuum-fluorescent display enclosed in one glass capsule.

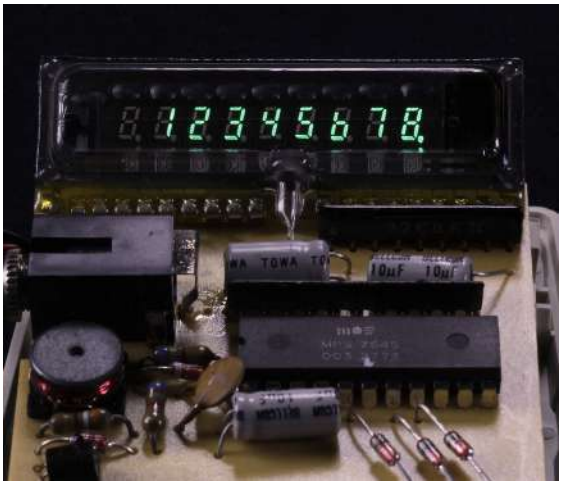

Figure 25-2. *The vacuum-fluorescent display from a 1970s Commodore calculator.*

A closeup of three digits from the previous figure appears in Figure 25-3, showing the grid superimposed above each numeral.

Figure 25-3. *Three digits from the previous figure, showing the grid that controls their illumination.*

A tinted filter of the same color as the display is usually placed in front of it, to conceal some of its workings. Thus, the Commodore calculator used a green filter in front of its green numerals. Figure 25-4 shows two seven-segment numerals from another device, with the filter removed. This reveals not only the grid but also the horizontal wires that function as the cathode. Connections between the segments of the numerals and a backplane are also visible.

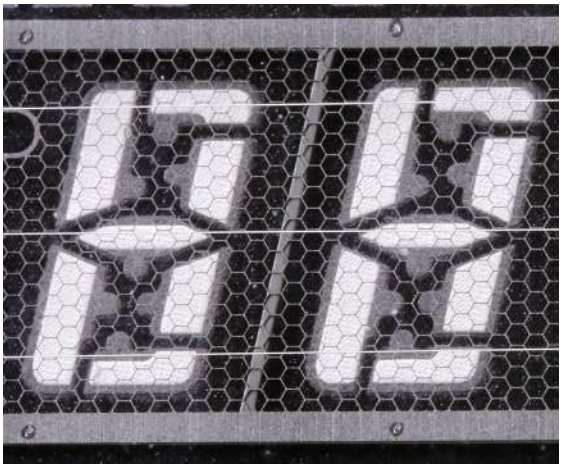

Figure 25-4. *Seven-segment numerals viewed without a colored filter, revealing the cathode (horizontal wires) and the grid (wire mesh).*

Modern Application

A modern VFD module is likely to be mated with a driver that converts 5VDC to the higher voltage (typically 50VDC to 60VDC) required for the display. Built-in logic may offer the option to receive data via an 8-bit parallel bus or with SPI serial protocol, and will contain a character set. A typical display resolution is 128 x 64 pixels.

The combination of a grid and a segmented anode enables a VFD to be controlled by *multiplexing*. For instance, in a display of four seven-segment numerals, the same equivalent segments in all four numerals can be connected in parallel while a separate grid covers each numeral. When each grid is positively energized, it selects the corresponding numeral, and the on-off segment patterns appropriate to that numeral are supplied. This procedure is repeated for each numeral in turn. Persistence of vision makes it appear that they are all active simultaneously.

Variants

Color

Although a VFD cannot provide a full-color display, selected anode segments can be coated with different phosphor colors, which can fluoresce simultaneously. Two or three individual colors are typically used, as in the display for a CD player where color helps to distinguish a variety of different functions. A closeup of a portion of the display from a CD player (with color filter removed) appears in Figure 25-5.

Figure 25-5. *The lefthand section of a vacuum-fluorescent display from a CD player.*

Character Sets and Pictorial Design

In the past, VFDs have combined seven-segment numerals in the same display as custom-shaped anodes. Solid-state gain meters in an audio amplifier, for instance, have used numerals beside a pictorial representation of gain levels resembling analog meters. The look and layout of a display of this type has been unique to a particular product.

Modern VFDs tend to use a generic dot-matrix display in which a character set in firmware dictates how patterns of dots are grouped to form numbers, letters, symbols, or icons.

The appearance of character sets generated with generic segments and dot-matrix arrays is thoroughly discussed and illustrated in the entry describing liquid-crystal displays in Chapter 17. VFD alphanumeric modules are identical in visual design to LCD modules, even though the internal electronics are different.

Comparisons

Two advantages of a VFD are that it functions well at low temperatures (unlike an LCD) and has sufficient brightness and contrast to be usable in sunlight (unlike many LED displays). It can be viewed from almost any angle.

Typical applications have included digital instrumentation in automobiles, information displays in audio and video consumer-electronics equipment, and numerical readouts in vending machines, medical devices, and some digital clocks.

Because a VFD requires a relatively high voltage, has significant power consumption, can show only a limited range of fixed colors, and is more expensive than LED displays or LCDs, its popularity has declined since the end of the 1990s.

What Can Go Wrong

Fading

VFDs gradually fade with age, as a result of reduced electron emission from the electrodes or diminishing performance of the phosphor coatings. Increasing the working voltage can prolong the life of a display.

electroluminescence

28

The field of **electroluminescent** devices is sometimes referred to as *EL*. The same acronym can also be applied as an adjective to an individual electroluminescent device, as in, for example, "an EL panel."

An *organic light-emitting diode*, more commonly known by its acronym *OLED*, is included in this entry because it is technically an electroluminescent device and its design concept is similar to that of an electroluminescent panel. Generic LEDs are also technically electroluminescent, but are not commonly described as such, and have their own entries in this encyclopedia under the subject categories **LED indicator**, **LED area lighting**, and **LED display**.

OTHER RELATED COMPONENTS

- **LED indicator** (see Chapter 22)
- **LCD display** (see Chapter 17)
- **fluorescent light** (see Chapter 20)
- **vacuum-fluorescent** display (see Chapter 25)

What It Does

An electroluminescent device configured as a *panel*, *ribbon*, or *rope-light* contains phosphors that emit light in response to a flow of electricity.

Panels can be used as backlights for LCD displays or, more often, as always-on low-power devices such as exit signs and night lights. Ribbons and rope lights (the latter being also known, more accurately, as *light wires*) are used mainly as recreational novelties. They can be battery powered through a suitable voltage converter. A battery-powered rope light can be wearable.

Thin-film OLED electroluminescent panels are used in small video screens in handheld devices. At the time of writing, OLED TV screens measuring 50" or more have been demonstrated, but are not yet economic for mass production.

No specific schematic symbol exists to represent any electroluminescent device or component.

How It Works

Luminescence is the emission of light as a result of a process that does not require heat. (The opposite phenomenon is *incandescence*, in which heating causes an object to emit light; see Chapter 18 for a description of **incandescent lamps**.)

Electroluminescence is luminescence resulting from stimulation by electricity. This very broad definition really includes devices such as **LED**s, although they are hardly ever described in those terms. Electroluminescence generally refers to panels, films, or wires where electrodes are in direct contact with light emitters such as phosphors.

The exception is an *organic LED*, usually known by its acronym *OLED*, which is frequently de-

scribed as an electroluminescent device, perhaps because its configuration as a sandwich of thin, flat layers resembles an electroluminescent panel. Two of the layers are semiconductors, and they interact as light-emitting diodes.

Phosphors

A *phosphor* is a compound such as zinc sulfide that will emit light when it receives an energy input from another light source or from electricity. Typically the compound must be mixed with an *activator* such as copper or silver.

For many decades, TV sets and video monitors were built around *cathode-ray tubes* in which the interior of the screen, at the front of the tube, was coated with phosphors. A beam of electrons that fluctuated in intensity generated a picture on the screen by drawing it as a series of lines.

Derivation

The term *phosphor* is derived from *phosphorescence*, which in turn comes from the name of the element *phosphorous*, which will glow when it oxidizes in moist air. (These terms were established before other forms of luminescence were discovered and understood. The behavior of phosphorous is really an example of *chemiluminscence*.)

For our purposes, a phosphor is a compound that is capable of fluorescence or electroluminescence.

Variants

Panels

Electroluminescent panels using phosphor powder, sometimes referred to as *thick phosphor*, are a popular choice where a constant, uniform, low light output is acceptable.

An electric potential is established between two films that act as electrodes, separated by a layer of phosphor crystals. Some manufacturers refer to this configuration as a *light-emitting capacitor* because the structure resembles a capacitor, even though that is not its purpose. The front film is transparent, allowing light to escape.

An electroluminescent panel can be powered by AC or DC but requires at least 75V. Its power consumption is self-limiting, so that no control electronics are required other than a voltage converter if battery power is used.

The phosphors generate a constant, evenly distributed luminescence over the entire area, although the output is not very intense. Applications include night-lights, exit signs, and backlighting for wristwatches.

Panelescent electroluminescent lighting by Sylvania was used for instrument panel displays in some car models such as the Chrysler Saratoga (1960 through 1963) and Dodge Charger (1966 through 1967). It is still used for night-lights. *Indiglo* electroluminiscent displays are still widely used in wristwatches.

The interior components of a disassembled electroluminescent night-light are shown in Figure 26-1. The panel emits a natural pale green glow. A separate blue or green filter passes the glow while blocking other colors of incident light that would otherwise reflect off the panel.

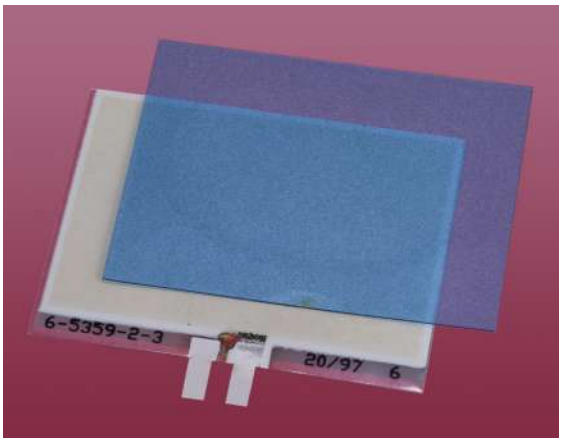

Figure 26-1. *The two interior components of an electroluminiscent night-light: the luminescent panel, and a separate translucent filter.*

Electroluminescent night-lights were popular in the 1970s and 1980s, often featuring cartoon characters to appeal to children. Figures 26-2 and 26-3 show the same night-light in its daytime off-state and its night-time on-state, respectively.

Figure 26-2. *A vintage Panelescent brand night-light, several decades old, in its off-state.*

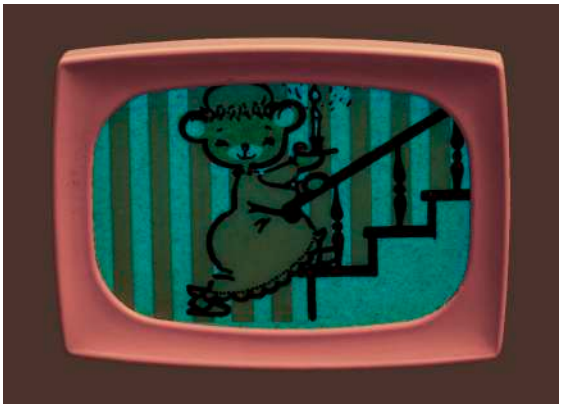

Figure 26-3. *The same night-light, with its green radiance visible under conditions of low ambient light.*

Advantages of electroluminescent panels include the following:

- Low current consumption. One US manufacturer claims that a single exit sign will use electricity costing less than 20 cents per year, while the annual cost of a night-light will be less than 3 cents per year.
- Long life, up to 50,000 hours.
- Self-regulating; no control circuitry required.
- Omnidirectional light output.
- Very wide operational temperature range, between approximately -60 and +90 degrees Celsius.
- Can be plugged directly into a wall outlet.

Disadvantages include:

- Limited light output.
- Very limited choice of colors.
- Not very efficient, 2 to 6 lumens per watt (although the low light output naturally entails low power consumption).
- Gradual reduction in phosphor performance over time.
- High voltage required: 60V to 600V. Ideal for plugging into a wall outlet, but requires a converter when used with battery-powered devices.

Flexible Ribbons

The light-emitting layers inside a night-light are somewhat flexible, and can be made more flexible by reducing their thickness. The result is an electroluminescent ribbon that has some novelty value, and may be used for customizing automobiles. Figure 26-4 shows a ribbon about 1.5" wide and 12" long, designed for 12VDC power applied through an inverter.

Rope Light

A rope light or wire light may resemble a *glowstick*. However, a glowstick generates light from chemiluminescence (chemical reactions that release photons), while a rope light uses electricity.

Figure 26-5 shows a rope light powered by two AA batteries connected through an inverter.

At the center of the rope light is a conductor that serves as one electrode. It is coated in phosphors, and the layer of phosphors is protected by a transparent sheath. One or more thin wires is wrapped around the sheath in a spiral, with large

gaps between one turn and the next. These wires serve as the second electrode. The wires are enclosed in transparent insulation that forms an outer sheath.

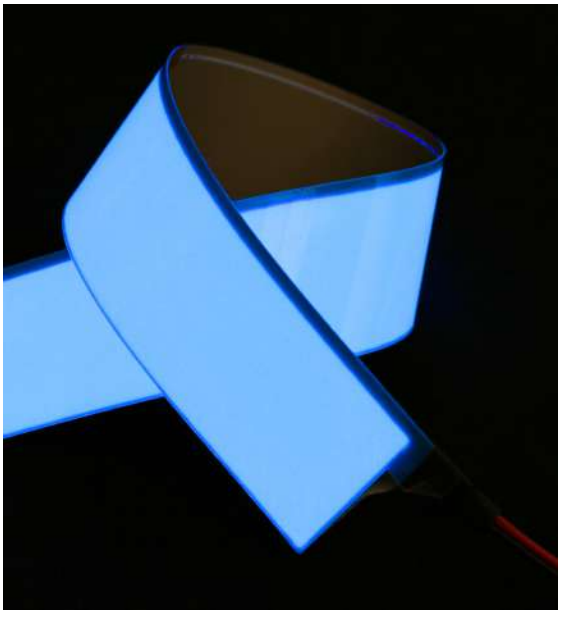

Figure 26-4. *A 12" length of electroluminescent ribbon.*

When AC is applied between the electrodes, the layer of phosphors emits light that radiates out in the gaps between the thin wires. The color of the light can be modified by using tinted outer insulation.

OLED

An OLED uses two thin, flat electrodes, somewhat like a thick-phosphor electroluminescent panel, except that it contains more layers and is capable of generating more light. The layers in an OLED are "organic" in that they consist of chemically organic molecules containing carbon and hydrogen atoms and generally do not contain heavy metals.

While an LCD video monitor or TV screen must have a separate backlight, an OLED generates its own light. This reduces the thickness of the display to a few millimeters and makes it potentially more efficient.

The semiconductor layers are subdivided into pixels, each functioning as a light-emitting diode, while additional layers carry a matrix of conductors for pixel addressing. In an AMOLED, the conductors form an active matrix, while in a PMOLED, they form a passive matrix.

Figure 26-5. *A length of glowing rope light, also known as a light wire.*

In an active matrix, each pixel is backed with a *thin-film transistor* to store its state while the energizing voltage transitions. This is often described as a *TFT* display; but the term is interchangable with "active matrix."

In a passive matrix, each pair of conductors simply supplies current to a pixel. This is cheaper and easier to fabricate but is less responsive.

The terms "active matrix" and "passive matrix" have the same meaning as when used to describe a **liquid-crystal display**.

Monochrome OLED display modules with dot-matrix characters are currently available from China for just a few dollars. Although they appear superficially similar to LCD modules, they generate pure white-on-black characters.

Small full-color OLED screens are used in smartphones and on camera backs, but at the time of writing, large OLED screens are not a mature technology, partly because of production costs. A great variety of chemicals and layer configurations have been tried, and the application of pixels to a substrate has been attempted with vacuum deposition through a shadow mask and with a system similar to inkjet printing. Pixels that emit red, green, and blue light have also been used. Filtered pixels have been used. One dominant process has not yet emerged.

Longevity and brightness have been problems. Where red, green, and blue diodes have been used, the different colors deteriorate at different rates. While the human eye tolerates an overall reduction in brightness, it does not tolerate a slight color shift caused by blue pixels, for instance, losing brightness more rapidly than red pixels.

Because OLED screens promise to be thinner, lighter, and brighter, and may eliminate the need for a fragile glass substrate, there is a strong incentive to develop this technology, which seems likely to gain dominance in the future.

OLED panels may also become a source of diffuse, shadowless room lighting or office lighting when practical problems have been solved and costs have fallen significantly.

transducer

27

The term **transducer** is used here to describe a *noise-creating device* that is driven by external electronics. By comparison, an **audio indicator** (discussed in the next entry) contains its own internal electronics and only requires a DC power supply. Either of these components is often described as a *beeper* or *buzzer*.

A **speaker**, more properly termed a *loudspeaker*, is an electromagnetic transducer but is seldom described in those terms. It has a separate entry in this encyclopedia and is defined here as a *sound reproduction device* that is larger and more powerful than a typical transducer and has a more linear frequency response.

While piezoelectric transducers formerly used crystals, only the more modern piezoelectric type that uses a ceramic wafer will be considered here.

Some transducers convert sound into electricity, but these are categorized as *sensors*, and will be discussed in Volume 3. The only transducers discussed in this entry are those that convert electricity into sound.

OTHER RELATED COMPONENTS

- **audio indicator** (see Chapter 28)
- **headphone** (see Chapter 29)
- **speaker** (see Chapter 30)

What It Does

An audio **transducer** is a device that can create an *alert*. It requires an AC signal that is supplied by external electronics, and in its simplest form may be referred to as a *buzzer* or a *beeper*.

Audio alerts are used in microwave ovens, washer/dryers, automobiles, gasoline pumps, security devices, toys, phones, and many other consumer products. They are often used in conjunction with touch pads, to provide audio confirmation that a tactile switch has been pressed.

The schematic symbols in Figure 27-1 can be used to represent any kind of audio alert, including **indicators**, which contain their own electronics to generate a simple tone or series of tones. Type A is probably the most popular symbol. Types B and C often appear with the word "buzzer" printed beside them for clarification. D and E are really symbols for a **speaker**, but are often used for an alert. F is the symbol for a *crystal*, now sometimes used to indicate a piezoelectric noise maker. G specifically represents an electromagnetic transducer, but is seldom used.

How It Works

A circular diaphragm is glued at its edges inside a cylindrical plastic enclosure, usually measuring from around 0.5" to 1.5" in diameter. The enclosure is sealed at the bottom but has an opening at the top, so that sound can emerge from the upper side of the diaphragm without being par-

tially cancelled by sound of opposite phase that is emitted from the underside of the diaphragm. The enclosure also amplifies the sound by resonating with it, in the same way that the body of a guitar or violin amplifies a note being played on the strings.

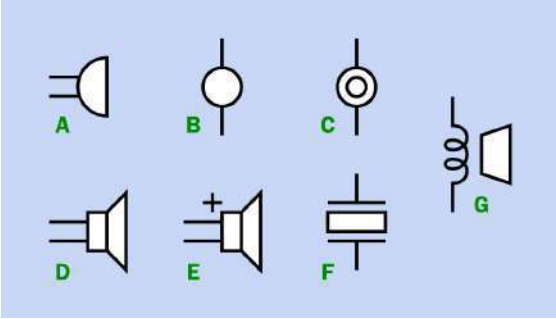

Figure 27-1. *An assortment of symbols which can represent a transducer or an indicator. See text for details.*

The diaphragm is activated either electromagnetically or piezoelectrically, as described next.

Externally, a transducer may be indistinguishable from an audio indicator such as the one pictured at Figure 28-1.

Variants

Electromagnetic

An electromagnetic transducer contains a diaphragm that is usually made of plastic. Mounted on it is a smaller *ferromagnetic disc* that responds to the fluctuating field from AC passing through a coil. When the diaphragm vibrates, it creates pressure waves that are perceived by the human ear as sound.

A car horn is a particularly loud form of electromagnetic transducer.

Piezoelectric

A piezoelectric transducer contains a diaphragm consisting of a thin brass disc on which is mounted a *ceramic wafer*. When an AC signal is applied between the piezoelectric wafer and the disc, the disc flexes at that frequency.

The term *piezo* is derived from the Greek *piezein*, which means "to squeeze or press."

Ultrasonic Transducer

The diaphragm in an *ultrasonic transducer* vibrates at a frequency above the range of human hearing. This component may be electromagnetic, piezoelectric, or crystal-based. Often it is used in conjunction with an ultrasonic receiver as a distance measuring device. The two components can be sold pre-mounted on a breakout board. An output from the board can consist of a pulse train where the pulse duration is proportional to the distance between the transducer and the nearest sound-reflecting object.

An ultrasonic transducer is pictured in Figure 27-2. Its internal components are shown in Figure 27-3.

Figure 27-2. *The exterior of an ultrasonic transducer.*

Submersible ultrasonic transducers may be used in cleaning systems, where they agitate a liquid that dislodges dirt or debris. Ultrasonic transducers are also used in echo-sounding and sonar equipment with marine applications.

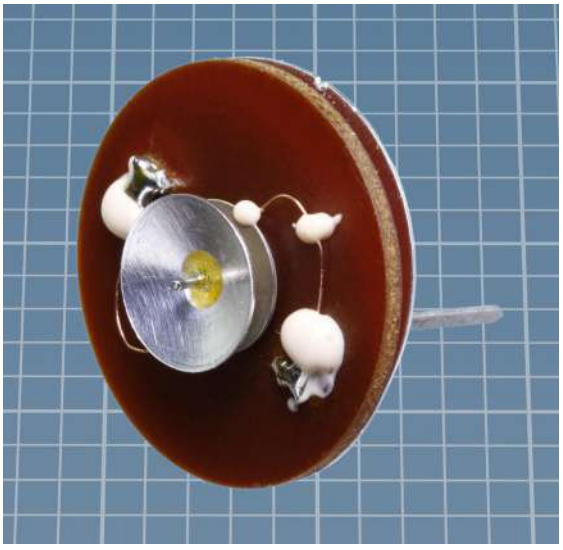

Figure 27-3. *Inside an ultrasonic transducer, a small aluminum cone is the sound radiating element. The white blobs are adhesive to secure the thin wires.*

Formats

Some transducers are available in surface-mount format, measuring about 0.5" square or less. Because the resonant frequency is related to the size of the component, surface-mount transducers usually generate a high-pitched beep.

Values

Frequency Range

Audio frequency is measured in Hertz, abbreviated Hz, named after Heinrich Rudolf Hertz, the first scientist to prove the existence of electromagnetic waves. The H in Hz is capitalized because it refers to a real name. One thousand Hertz can be written as 1 kiloHertz, almost always abbreviated as 1kHz (note that the k is lowercase).

The human ear is often described as being able to detect sounds between 20Hz and 20kHz, although the ability to hear sounds above 15kHz is relatively unusual and diminishes naturally with age. Sensitivity to all frequencies can be impaired by long-term exposure to loud noise.

The most common frequencies applied to audio transducers range between 3kHz and 3.5kHz. Piezoelectric elements are inefficient for generating sounds below 1kHz, but electromagnetic transducers are better able to generate lower frequencies. Their response curve can be approximately flat to frequencies as low as 100Hz.

Sound Pressure

Sound pressure can be measured in Newtons per square meter, often abbreviated as Pa. Newtons are units of force, while Pa is an abbreviation of Pascals.

The *sound pressure level* (SPL) of a sound is not the same as its sound pressure. SPL is a logarithmic value, to base 10, in units of decibels (dB), derived from the pressure of a sound wave relative to an arbitrary reference value, which is 20 micro-Pascals (20µPa). This is the agreed minimum threshold of human hearing, comparable to a mosquito at a distance of three meters. It is assigned the level of 0dB.

Because the decibel scale is logarithmic, a linear increase in the decibel level of a sound does not correspond with a linear increase in actual sound pressure:

- For each additional 6dB in the SPL, the actual sound pressure approximately doubles.
- For each additional 20dB in the SPL, the actual sound pressure is multipled by 10.

Bearing in mind that 0dB corresponds with the reference sound pressure of 20µPa, an SPL of 20dB represents a sound pressure of 200µPa (that is 0.0002Pa), and so on.

Many tables show an estimated decibel level for various noise sources. Unfortunately, these tables may contradict each other, or may fail to mention the distance at which a sound is measured. Figure 27-4 shows estimates derived by averaging eight similar tables. It should be viewed as an approximate guide.

Decibels	Noise Example
140	Jet engine at 50 meters
130	Threshold of pain
120	Loud rock concert
110	Automobile horn at 1 meter
100	Jackhammer at 1 meter
90	Propeller plane 300 meters above
80	Freight train at 15 meters
70	Vacuum cleaner
60	Business office
50	Conversation
40	Library
30	Quiet bedroom
20	Leaves rustling
10	Calm breathing at 1 meter
0	Auditory threshold

Figure 27-4. *Approximate decibel values for some sound sources (averaged from a selection of eight similar charts).*

Sometimes the claim is made that an increase of +10 on the decibel scale will correspond with a subjective experience that the noise is "twice as loud." Unfortunately, this statement cannot be quantified.

Weighted Sound Values

Subjective assessment of sound is complicated by the nonlinear frequency response of the human ear, which causes some frequencies to seem "louder" than others, even though their sound pressure is the same. The frequency weighting of the ear can be determined by playing a reference tone of 1kHz at 20dB and then doing an A-B comparison with a secondary tone at another frequency, asking the subject to adjust the gain of the secondary tone up or down until the two tones seem equally loud.

This procedure is performed for a range of frequencies. The test is then repeated with a louder 1kHz reference tone, at 30dB. Repetitions continue to a final reference tone of 90dB.

The resulting curves are known as *equal-loudness contours*. An averaged set, from multiple sources, has become an international standard with ISO number 226:2003. The curves shown in Figure 27-5 are derived from that standard. The curves show that the sound pressure of lower frequencies must be boosted by a significant amount to sound as loud as a 1kHz frequency, while a frequency around 3kHz must be reduced slightly, because it tends to sound louder than all others.

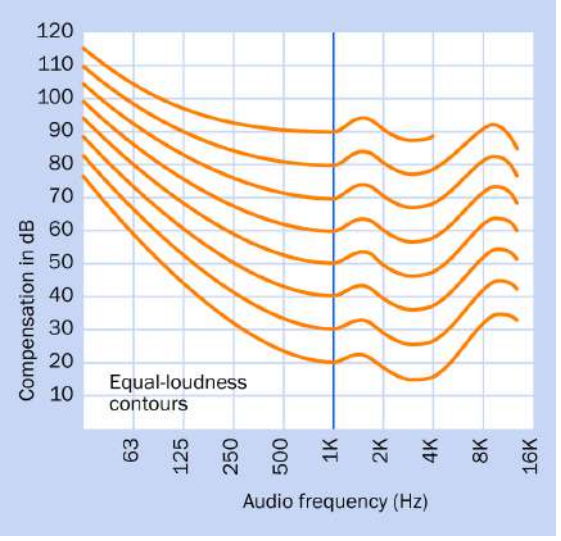

Figure 27-5. *Equal loudness contours derived from ISO 226:2003. See text for details.*

Although the accuracy of equal-loudness contours is controversial, they have been the basis of a widely used weighting system to adjust dB values to represent subjective perceptions of loudness. This *A-weighting* system remains the best-known and most widely applied audio standard in the United States, even though it has been criticized for assigning too little value to sounds that are brief in duration. If a sound level is expressed in dBA, it is A-weighted, meaning that the sounds to which the ear is least sensitive are assigned a value that is lower than their measured value. Thus, a tone of 100Hz has a dBA value about 20dB lower than its dB value, because the human ear is relatively insensitive to

low-pitched sounds. dBA values are used in regulations that limit noise in the work place and other environments.

Unweighted Values

If sound intensity is expressed in dBSPL, it is a measurement of the actual Sound Pressure Level and has not been adjusted with the A-weighting system. A graph of unadjusted dbSPL values will display low frequencies as if they are more intense than the ear will perceive. In practical terms, subjective perception of low-end rolloff will be even more severe than the graph makes it appear.

If sound intensity is expressed merely in dB, probably it is unweighted and should be considered as dBSPL.

From a practical point of view, when choosing a tone for a transducer, a 500Hz tone may sound relatively mellow and not subjectively loud. A 3.5kHz tone can be a good attention-getting signal, as the ear is most sensitive in that range.

Transducers generally have a sound pressure rating in dBSPL ranging between 65dBSPL to 95dBSPL, with just a few products that can make more or less noise.

Measurement Location

The sound pressure from an audio alert will naturally diminish if the measurement point moves farther away. Therefore, any rating in decibels should be expressed with reference to the distance at which the measurement is made.

Measurement locations may be expressed in centimeters or inches, and may vary from 10cm to 1 meter, even in datasheets for different devices from the same manufacturer. If the measurement distance doubles, the SPL diminishes by approximately 6dB.

Limitations

A piezoelectric transducer is not intended as a sound reproducer, and does not have a smooth or flat frequency response. The curve for the Mallory PT-2040PQ is not unusual, reproduced in Figure 27-6. This component measures about 3/4" in diameter, is rated for 5VDC, and uses only 1.5mA to generate 90dB (measured at a distance of 10cm). Like many piezoelectric audio devices, its response peaks around 3500kHz and diminishes above and below that value, especially toward the low end. While it is perfectly adequate as a "beeper," it will not reproduce music successfully.

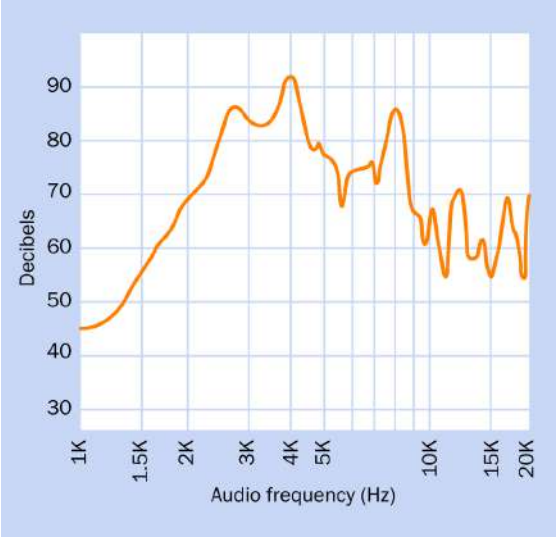

Figure 27-6. *The frequency response from a typical small piezoelectric transducer.*

An electromagnetic transducer is better able to generate low frequencies than a piezoelectric transducer. It has a low impedance that may be suitable in some circuits. However, it is slightly heavier than a comparable piezoelectric transducer, uses much more power, and as an AC device containing a coil, it can create electromagetic interference or may cause fluctuations in the circuit as an inductive load. It is also vulnerable to magnetic interference from elsewhere, while a piezoelectric transducer is not.

While an electromagnetic transducer can be used to reproduce speech or music, and will do a better job than a piezoelectric transducer, its

performance will still be dissatisfying. A miniature speaker is more appropriate for the task.

Voltage

Transducers are typically designed to work with voltages ranging from 5VAC to 24VAC. The ceramic wafer in a piezoelectric transducer usually cannot withstand voltages much above 40VAC, and its sound output will not increase significantly above 30VAC.

Current

Typical piezoelectric transducers use less than 10mA and generate negligible heat. An electromagnetic transducer may draw as much as 60mA.

How to Use It

Appropriate Sound Intensity

An alert should be chosen with reference to the environment in which it will be used. To be easily heard, it should be at least 10 dB louder than ambient background noise.

Volume Control

Sound pressure can be lowered by reducing the voltage. Because a transducer does not consume much current, a *trimmer* can serve as a volume control. Alternatively, a rotary switch with a set of fixed-value resistors can select preset sound values.

AC Supply

Although a transducer is an AC device, it is unlikely to be designed for voltage that fluctuates positively and negatively either side of a neutral value. Typically it is intended for voltage that fluctuates between 0V (ground) and the rated positive value of the power supply, and its pins, wires, or terminals are usually marked accordingly. If it has wire leads, the red lead should be connected to the more-positive side of the supply. If it has pins, the longer pin should be more positive.

The alternating signal for a transducer can be supplied by any simple oscillator or astable multivibrator circuit. For a given peak voltage, a square wave will generate a louder signal than a sinusoidal wave. A simple 555 timer circuit can be used, with a second monostable timer to limit the duration of the beep if necessary. An astable 555 can be used to test the transducer and select the audio frequency that sounds best.

Self-Drive Transducer Circuit

If a transducer has three wires or pins, it is probably a *self-drive* type. The datasheet may identify its inputs as M, G, and F, meaning Main, Ground, and Feedback. The Feedback terminal is connected with a section of the diaphragm which vibrates 180 degrees out of phase with the Main terminal. This facilitates a very simple external drive circuit, such as that in Figure 27-7, where the frequency is determined by the transducer's resonant frequency.

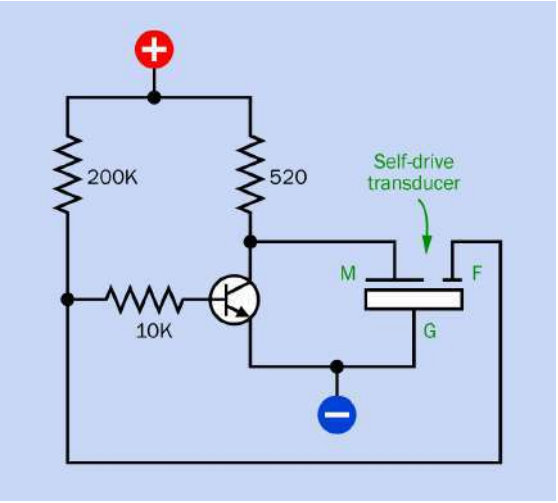

Figure 27-7. *A circuit to control a self-drive type of piezoelectric transducer.*

What Can Go Wrong

Overvoltage

Mallory Sonalerts, one of the largest producer of piezoelectric alerts, states that in the "vast ma-

jority" of returned products, the failure was caused by excessive voltage, often in the form of a transient voltage spike.

Leakage

If an alert makes a small, low-volume sound when it is supposed to be off, some current is leaking through it. Less than 1mA may be enough to cause this problem. According to one manufacturer, it can be fixed by placing a 30V Zener transient voltage suppressor diode in series with the alert, or by wiring a small **incandescent lamp** in parallel with the alert.

Note that when the alert is activated, the full supply voltage will be seen at the lamp.

Component Mounting Problems

Some alerts are packaged with mounting holes, but many are not. Those with pins can be soldered into a board, but those without must be glued in place or inserted into a cavity from which they cannot shake loose. Silicone adhesive is recommended, but care must be taken to avoid any of it dripping into the alert before it sets.

Moisture

If an alert will be used in a location where it is vulnerable to moisture, it should be of a type that is sealed against the environment. Even a sealed unit should ideally be oriented so that it faces slightly downward.

Transducer-Indicator Confusion

Externally, a transducer and an indicator often look identical, and some of them are not marked with a manufacturer's part number. Damage can be caused by applying DC to a transducer or AC to an indicator. If both types of parts are kept in inventory, they should be carefully labeled.

Connection with a Microcontroller

A piezoelectric transducer can be driven by a microcontroller, but an electromagnetic transducer is not appropriate in that role, because of its relatively higher current consumption and its behavior as an inductive load.

audio indicator

28

An **audio indicator** is defined here as a noise-creation device that generates a simple tone or series of tones. Unlike a **transducer**, which requires an external source of AC to determine its audio frequency, an indicator contains its own electronics and requires only a DC power supply. Either of these components is often described as a *beeper* or *buzzer*.

While piezoelectric alerts formerly used crystals, only the more modern piezoelectric type that uses a ceramic wafer will be considered here.

OTHER RELATED COMPONENTS

- **transducer** (see Chapter 27)
- **headphone** (see Chapter 29)
- **speaker** (see Chapter 30)

What It Does

When DC power is applied to an **audio indicator**, in its simplest form it creates a continuous or intermittent tone of a fixed frequency. This is called an *alert*.

Audio alerts are used in microwave ovens, washer/dryers, automobiles, gasoline pumps, security devices, toys, phones, and many other consumer products. They are often applied with touch pads, to provide audio confirmation that a tactile switch has been pressed.

A few indicators are programmed to create a two-tone sound, or multiple-tone sequences.

See Figure 27-1 in the previous entry for an assortment of schematic symbols that may be used to represent either an alert or a transducer.

How It Works

A circular diaphragm is glued at its edges inside a cylindrical plastic enclosure, usually measuring from around 0.5″ to 1.5″ in diameter. The enclosure is sealed at the bottom but has a small hole at the top, so that sound can emerge from the upper side of the diaphragm without being partially cancelled by sound of opposite phase that is emitted from the underside of the diaphragm. The enclosure also contains electronics to generate one or more audio tones, and amplifies the sound by resonating with it, in the same way that the body of a guitar or violin amplifies a note being played on the strings.

A PUI XL453 piezoelectric audio indicator is pictured in Figure 28-1, fully assembled on the right, and with its circuit board and diaphragm removed on the left. This indicator creates a pulsed tone at 3.5kHz with a sound pressure of 96dB. It draws 6mA at 12VDC and measures approximately 1″ in diameter.

For more information about the measurement of sound frequency and pressure, see "Frequency Range" on page 251 and "Sound Pressure" on page 251 in the previous entry.

Figure 28-1. *A typical piezoelectric audio indicator.*

Externally, an audio indicator may be indistinguishable from a transducer. However, internally, an indicator is almost always a piezoelectric device, in which a *ceramic wafer* is mounted on a thin brass diaphragm. The term *piezo* is derived from the Greek *piezein*, which means to squeeze or press.

A transducer (described in the previous entry) is a piezoelectric or electromagnetic alert that does not usually contain its own circuitry and must be driven by an external source of AC, which establishes the audio frequency.

The distinction between an indicator and a transducer is often unclear in parts catalogs, where all alerts may be identified as *buzzers*, even though they mostly beep rather than buzz.

Audio Frequency

For a discussion of audio frequency, see "Frequency Range" on page 251 in the previous entry.

History

Probably the earliest form of electrically activated alert was the door bell, in which a 6VDC battery-powered solenoid pulled a spring-loaded lever terminating in a small hammer. The hammer struck the bell, but the motion of the lever also opened a pair of contacts, cutting off power to the solenoid. The lever sprang back to its rest position, which closed the contacts and repeated the cycle so long as power was supplied through an external pushbutton.

Subsequent systems used a small loudspeaker powered by AC house current through a step-down transformer. This created a buzzing sound and may have been the origin of the term "buzzer."

Small components that made a beeping sound only became common when digital equipment required a simple, cheap way to confirm user input or attract attention to the status of a device.

Variants

Sound Patterns

Because an audio indicator contains its own electronics, the manufacturer has the freedom to create various patterns of sound output.

The default is a steady tone. Other common variants include an intermittent tone and a dual tone that fluctuates rapidly between two frequencies. This is sometimes referred to as a *siren*. A few variants can generate an output pattern consisting of several tones in sequence, or effects such as warbling or whooping sounds, which are used mainly in alarm systems.

Formats

Some audio indicators are available in surface-mount format, measuring 1/2" square or less. Because the resonant frequency is related to the size of the component, surface-mount alerts usually make a high-pitched beep.

Panel-mount and board-mount formats range from about 1/2" to 1.5" in diameter. A small audio alert designed to be mounted on a circuit board is shown in Figure 28-2, with its top removed on the right to expose the brass diaphragm glued around the edges. The same component is shown with its plastic enclosure removed completely in Figure 28-3.

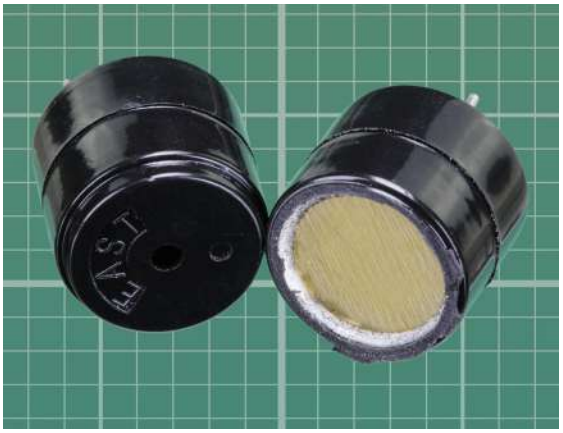

Figure 28-2. *An audio indicator approximately 0.5" in diameter, partially disassembled on the right, revealing its brass diaphragm.*

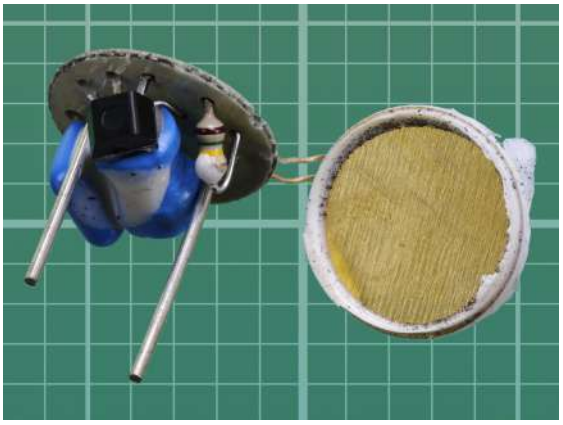

Figure 28-3. *The same indicator from the previous photograph, with its enclosure completely removed.*

Values

For an explanation and discussion of sound pressure and its measurement in decibels, see "Sound Pressure" on page 251 in the previous entry.

Audio indicators generally have a sound pressure rating in dBSPL ranging between 65dBSPL to 95dBSPL, with just a few products that make more or less noise. At 120dB and above, most products are packaged as alarm sirens ready for installation, often with a small horn attached. Their power consumption can be 200mA or more, and they are many times the price of a simple indicator designed for circuit-board mounting.

Voltage

An audio indicator containing its own electronics will almost always be rated somewhere in the range from 5VDC to 24VDC. Sirens intended for use with burglar alarms are often designed for 12VDC or 24VDC, as these are popular values for security systems with battery backup. However, in addition to a rated voltage, a datasheet may specify a wide range of acceptable operating voltages. For example, an indicator with a *rated* voltage of 12VDC may have an *operating* voltage of 3VDC to 24VDC. Naturally, the sound intensity will vary with the voltage, but not as much as one might assume. The graph at Figure 28-4 shows that the sound output from an alarm, measured in decibels, increases by only 8dB when voltage increases by almost a factor of five. Of course, the decibel scale is not linear, but human perception of sound is not linear, either.

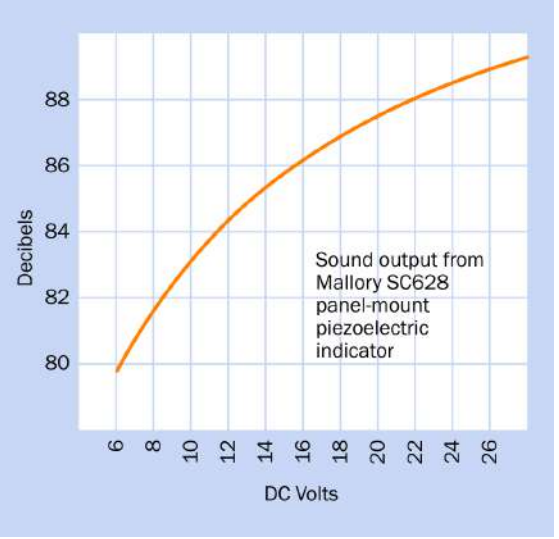

Figure 28-4. *Variation of sound output relative to voltage, in a commonly used piezoelectric indicator.*

Current

Typical piezoelectric indicators use less than 10mA (often as little as 5mA) and generate negligible heat.

Frequency

The most common frequencies for indicators range between 3kHz and 3.5kHz. Piezoelectric elements are inefficient for generating sounds below 1kHz.

Duty Cycle

Piezoelectric alerts generate very little heat and can be run on a 100% duty cycle.

If an alert will be pulsed briefly, the minimum pulse time is 50ms. A shorter duration will merely generate a clicking sound.

How to Use It

Appropriate Sound Intensity

An indicator should be chosen with reference to the environment in which it will be used. To be easily heard, it should be at least 10 dB louder than the ambient background noise.

Volume Control

Sound intensity can be reduced by reducing the voltage. Because an indicator does not consume much current, a trimmer can serve as a volume control. Alternatively, a rotary switch with a set of fixed-value resistors can select preset sound values.

However, in many indicators, variations in voltage may have relatively little effect on sound output, as shown in Figure 28-4.

Wiring

An indicator requires DC voltage. Because the indicator contains a transistor, polarity of the power supply is important. If the indicator has leads attached, the one intended for connection to the positive side of the power supply will be red. If it has pins, the longer pin will be for the positive connection.

What Can Go Wrong

The potential problems in an indicator are the same as those for a transducer. See "What Can Go Wrong" on page 254 in the previous entry.

headphone

29

The term **headphone** is used here to include almost any device that fits into or over the ear for the purpose of sound reproduction. (*Hearing aids* are not included.) Because headphones are used in pairs, the term is usually pluralized.

The term *phones* is fairly common as a colloquial diminution of *headphones* but is not used here.

An *earphone* used to be a single sound reproduction device designed for insertion into the ear, but has become rare. Pairs of *earbuds* are now common.

Because this encyclopedia assigns more emphasis to electronic components than to consumer products, this entry provides only a superficial overview of fully assembled headphones, and deals more with the drivers inside them, their principles of operation, and the general topic of sound reproduction.

OTHER RELATED COMPONENTS

- **transducer** (see Chapter 27)
- **speaker** (see Chapter 30)

What It Does

A headphone converts fluctuations of an electric signal into pressure waves that the human ear perceives as sound. It can be used for reproduction of music for entertainment purposes, or for speech in telecommunications, broadcasting, and audio recording.

Two symbols for headphones are shown in Figure 29-1. The symbol on the left shows a single headphone or earphone; when this symbol is flipped horizontally, it can represent a microphone. The pictographic symbol on the right has been used for many decades, but is still often found in schematics.

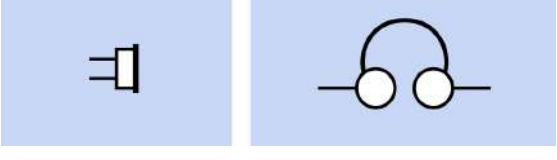

Figure 29-1. *Schematic symbols for a single earphone or headphone (left) and a pair of headphones (right).*

How It Works

Audio Basics

Sound is transmitted as pressure waves through a medium that is usually air but can be a gas, fluid, or solid. The speed of transmission will vary with the density and other attributes of the medium. Small hairs in the inner ears, known as *cilia*, vibrate in sympathy with pressure waves and transmit nerve impulses to the brain, which interprets the impulses as sound.

Three quantities describe the propagation of any type of wave, including a sound wave: its frequency (customarily represented with letter f), its speed of propagation (represented with letter v, for velocity), and its wavelength from peak-to-peak (represented by the Greek letter lambda, which appears as this λ symbol).

The relationship is defined by a very simple equation:

$$v = \lambda * f$$

Velocity is usually measured in meters per second, wavelength in meters, and frequency in Hertz, abbreviated Hz. One cycle per second is 1Hz. The H is always capitalized, as it refers to the name of Heinrich Rudolf Hertz, the first scientist to prove the existence of electromagnetic waves. One thousand Hertz can be written as 1 kilo-Hertz, almost always abbreviated as 1kHz (note that the k is lowercase).

The human ear is often described as being able to detect sounds between 20Hz and 20kHz, although the ability to hear sounds above 15kHz is relatively unusual and diminishes naturally with age. Sensitivity to all frequencies can be impaired by long-term exposure to loud noise.

Naturally occurring sounds can be converted to fluctuations in voltage by a **microphone**, which will be found listed as a *sensor* in Volume 3 of this encyclopedia. Artificial sounds can be generated as voltage fluctuations by oscillators and other electronic circuits. In either case, the output fluctuations can range between an upper limit set by a positive supply voltage and a lower limit established by electrical ground (which is assumed to be 0 volts). Alternatively, the fluctuations can range between the positive supply voltage and an equal and opposite negative supply voltage, with 0V lying midway between the two. This option can be less convenient electrically but is a more direct representation of sound, because sound waves fluctuate above and below ambient air pressure, which can be considered analogous to a ground state.

The concept of positive and negative sound waves is illustrated in Figure 29-2 (originally published in the book *Make: More Electronics*).

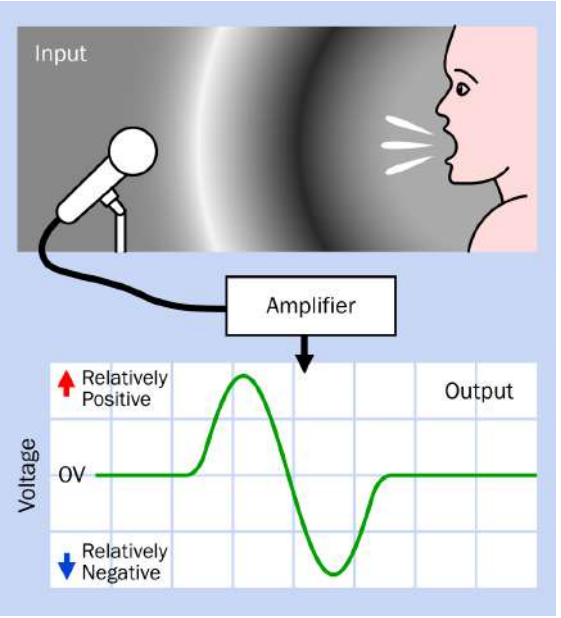

Figure 29-2. *The use of positive and negative voltages to represent a wave of high sound pressure followed by a trough of lower pressure.*

The topic of sound amplification is explored in detail in the entry on *op-amps* in Chapter 7.

A headphone inverts the function of a microphone by converting electricity back into air-pressure waves. This is done electromagnetically (moving a diaphragm in response to an electromagnet) or electrostatically (moving a membrane in response to electrostatic force between two charged electrodes).

Variants

Moving Coil

The most enduringly popular type of headphone uses a coil attached to a *diaphragm*. This is known as a *moving-coil* headphone, as the coil moves with the diaphragm. It can also be referred to as having a *dynamic driver* or *dynamic transducer*, "dynamic" referring to the movement of the coil.

The moving-coil concept is illustrated in Figure 29-3. The coil slides into a deep, narrow, circular slot in a magnet that is attached to the plastic frame of the headphone. The diaphragm is supported at its edges by a flexible rim. Variations in current passing through the coil create a fluctuating magnetic field that interacts with the field of the fixed magnet, causing the diaphragm to move in and out. A very similar configuration is used in many **loudspeakers**. Detail modifications may be made to increase efficiency, reduce production costs, or enhance sound quality, but the principle remains the same.

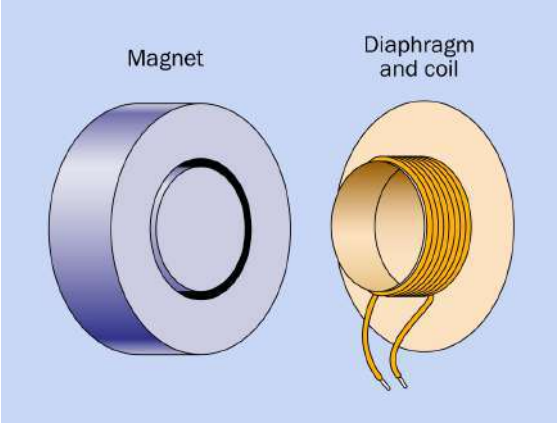

Figure 29-3. *The basic elements of a moving-coil headphone.*

The internal element of a headphone is shown in Figure 29-4. A plastic diaphragm is visible, measuring slightly less than 2″ in diameter. The magnet and coil are concealed underneath.

The element in the previous figure is normally enclosed in an assembly such as the one in Figure 29-5, which incorporates a soft padded rim to rest upon the ear.

In an effort to achieve a more balanced frequency response, some designs use two moving-coil drivers in each headphone, optimized for low frequencies and high frequencies, respectively.

Earbuds, described after the next section, often use a miniaturized version of the moving-coil design.

Figure 29-4. *The sound reproducing element removed from a headphone.*

Figure 29-5. *The sound reproducing element from the previous figure is normally packaged inside this enclosure.*

Other Types

Electrostatic headphones use a thin, flat diaphragm suspended between two grids that function as electrodes. A fluctuating potential between the grids, coupled with a reverse-phase voltage on the diaphragm, will vibrate the diaphragm, generating pressure waves. A relatively high voltage is necessary to achieve this, anywhere from 100V to 1,000V, supplied through a conversion unit between the headphones and an amplifier. Electrostatic headphones are

known for low distortion and an excellent high frequency response, at some extra cost.

Electret headphones work on a similar principle, except that the membrane is permanently charged, and a high voltage is not required. Electret headphones tend to be small, inexpensive, and not of high sound quality.

A *balanced armature* design, often referred to by the acronym *BA*, uses a pivoting magnet that is claimed to increase efficiency while reducing stress on a diaphragm. BA drivers can be extremely compact, contained within a sealed metal enclosure measuring less than 10mm x 10mm x 5mm. They are commonly used in conjunction with *in-ear* earphones, described in the next section.

Mechanical Design

Circumaural headphones use large soft pads to encircle the ear and block external noise. Their size tends to make them heavy, requiring a well-designed headband to provide comfortable support. *Supra-aural* headphones are smaller and lighter, resting on the ears instead of enclosing them. They cannot exclude ambient noise, and may have inferior bass response compared with the circumaural type.

Open-back headphones, also known as *acoustically transparent*, are favored by some audiophiles because their vented outer surfaces are thought to create a more natural sound, similar to that of a **speaker**. The open backs naturally allow ambient noise to intrude, but also allow the sound generated by the headphones to be heard by others in a room. *Closed-back* headphones contain their sound and provide more insulation against ambient noise.

Earbuds rest just within the outer folds of the ear, facing inward like a pair of tiny **speakers**. They are easily dislodged and provide very little insulation against ambient noise. Their use became common after the introduction of Apple's iPod. A pair of earbuds, one of them with its plastic cover removed, is shown in Figure 29-6.

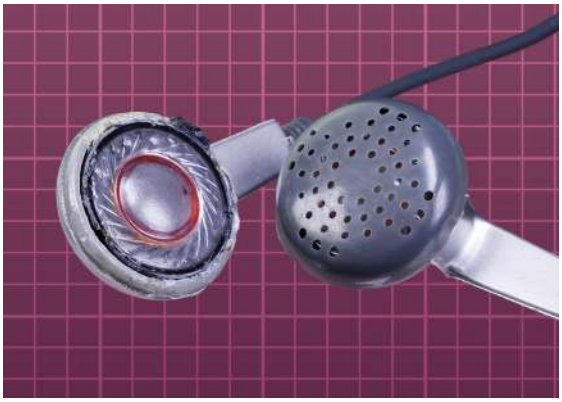

Figure 29-6. *A pair of earbuds, one with its cover removed to show the sound reproducing element, which closely resembles the diaphragm in a full-sized headphone.*

In-ear headphones are designed for insertion into the ear canal, often using a soft sheath that conforms with the ear like an earplug. This sheath is disposable for hygienic reasons, and because it may lose some of its plasticity with use. It excludes most ambient noise, and by minimizing the air gap between the driver of the headphone and the ear drum enables a high quality of sound reproduction.

In-ear headphones are also known as *in-ear monitors*, *IEMs*, *ear canal headphones*, *earphones*, and *canalphones*. A pair of in-ear headphones is shown in Figure 29-7, one of them with its foam sheath removed. The rectangular silver-colored object in the headphone on the left contains a transducer to create sound pressure.

A *headset* consists of one or two headphones plus a flexible microphone that extends to the promiximity of the mouth of the user.

Noise-cancelling headphones, popularized by Bose, monitor external noise with a built-in microphone and generate sound of opposite phase, to provide some cancellation. They are particularly effective on jet aircraft, where background noise tends to be consistent.

Figure 29-7. *A pair of in-ear headphones, supplied with disposable foam plugs that conform flexibly with the ear canal. The headphone on the left is shown with its plug removed.*

Although an *earphone* is almost obsolete, it is still obtainable from specialty suppliers. It has a high impedance, making it suitable for use with a *crystal-set radio*. An earphone is pictured in Figure 29-8.

Figure 29-8. *A vintage earphone of the type suitable for use with a crystal-set radio.*

Values

Intensity

Sound pressure is measured in decibels. For a complete explanation and discussion of weighted and unweighted decibel scales, see "Sound Pressure" on page 251 in the **transducer** entry.

Frequency Response

A plot of sound pressure as a function of frequency shows the *frequency response* of a headphone. Measuring the sound pressure meaningfully is a challenge, because the ear canal will add coloration to the sound and can amplify some frequencies while masking others. Ideally, measurement should be done at the ear drum, but this is not feasible. Consequently, high-end headphones are evaluated by making sound measurements inside simulated ear canals in a dummy human head.

A comparison between a high-quality $500 audio product and a transducer that is sold as a component for less than $1 illustrates the difference in frequency response; see Figure 29-9. The Sennheiser headphones have a smooth response that rises toward the low end, compensating for the lack of bass response that tends to be a problem in headphones, and the relative insensitivity of the human ear to low frequencies. The fluctuations at the high end are within about 5dB.

By comparison, the Kobitone emphasizes the range between 3kHz and 4kHz because its primary task is to be heard, and these are the frequencies where human hearing is most sensitive. Its low-frequency response trails off (although is still much better than that of a piezoelectric transducer, where the low response typically diminishes by 40dB to 50dB). The low-frequency output of the Kobitone is actually impressive bearing in mind that the component is only 9mm in diameter. It draws 60mA at 5VAC.

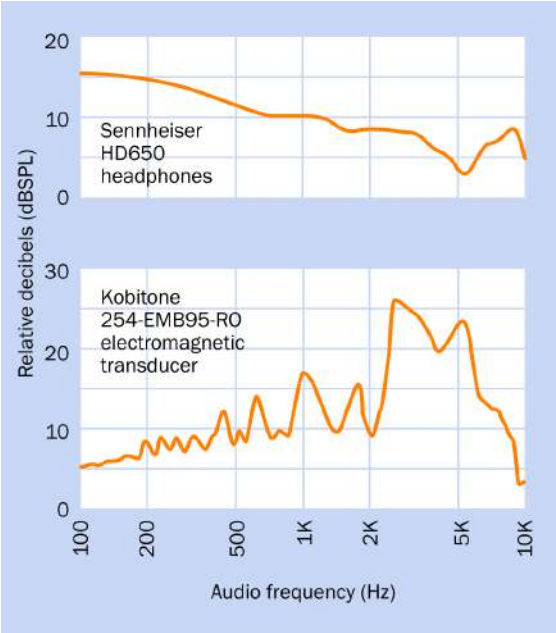

Figure 29-9. *Comparison between frequency responses of a $1 electromagnetic transducer intended as an audio alert and a $500 pair of headphones intended for sound reproduction. The upper graph is derived from a review online at headroom.com; the lower graph is from the manufacturer's datasheet.*

Some manufacturers of audio reproduction equipment prefer not to supply frequency response curves. Instead they may claim, for example, that the frequency response of a product ranges from 100Hz to 20kHz. This claim means very little unless it is accompanied by a range of sound pressure levels. If the frequency response is consistent within a range of, say, plus-or-minus 5dB, this may be acceptable. If the range is plus-or-minus 20dB, it is not acceptable. The ability to reproduce a high note or a low note is not useful if the sound is too faint to hear.

Distortion

The *total harmonic distortion* (THD) of any audio equipment measures its tendency to add spurious *harmonics* of a single frequency. If headphones are required to reproduce a pure 1kHz sinewave, they will also tend to create an additional 3kHz tone that is an artifact. This can be caused by the mechanical behavior of a vibrating diaphragm. The human ear recognizes distortion as a fuzzy or rasping sound. A square wave theoretically contains all the harmonics that are odd multiples of its fundamental frequency, and sounds extremely distorted.

THD should be less than 1% in good-quality audio devices.

Impedance

The electrical impedance of headphones is relevant in that it should match the output specification of the amplifier that drives them.

What Can Go Wrong

Overdriving

Headphones can be damaged by overdriving them. Because a low frequency requires larger excursions of a diaphragm to transmit the same energy as a high frequency, headphones are especially vulnerable to being damaged by bass at high volume.

Hearing Damage

Human hearing can be damaged by prolonged listening to headphones at a high volume. Some controversy remains regarding an acceptable limit for sound pressure.

Mismatched Impedance

If the impedance of headphones does not match the output of the amplifier driving them, distortion or a skewed frequency response can result. This is known as *mismatching*.

Incorrect Wiring

In most consumer products, a pair of headphones will share a common ground. While the connections in a typical three-layer jack plug have been standardized, hand-wired repairs or extensions should be tested carefully. Incorrect wiring will cause unpredictable results.

speaker

30

The term **speaker** is a diminution of *loudspeaker*. The full word is now so rarely used, some catalogs do not recognize it as a search term. This encyclopedia acknowledges contemporary usage by using **speaker** rather than *loudspeaker*.

A fully assembled consumer product can be referred to as a "speaker," but it also contains one or more individual components that are described as "speakers." To resolve this ambiguity, referring to the components as *drivers* is helpful, but this practice can create more ambiguity because other types of components are also called "drivers." The only real guide to the meaning of *speaker* is the context in which it is used.

For the purposes of this entry, a speaker is a *sound reproduction device*, distinguished from a typical electromagnetic **transducer** by being larger and more powerful, with a more linear frequency response. A transducer may be used as a *noise-creating device* to provide an alert, informing the user of the status of a piece of equipment. Because some speakers have been miniaturized for use in handheld products, they may be used as transducers, allowing some overlap between the two categories.

Because this encyclopedia assigns more emphasis to electronic components than to consumer products, this entry provides only a superficial overview of fully assembled speakers, and deals more with the drivers inside them, their principles of operation, and the general topic of sound reproduction.

OTHER RELATED COMPONENTS

- **headphone** (see Chapter 29)
- **transducer** (see Chapter 27)

What It Does

A speaker converts fluctuations of an electric signal into pressure waves that the human ear perceives as sound. It can be used for entertainment purposes or to provide information in the form of spoken words or distinctive sounds (as in the case of a miniature speaker in a cellular phone, playing a ring tone).

The internationally accepted schematic symbol for a speaker is shown in Figure 30-1.

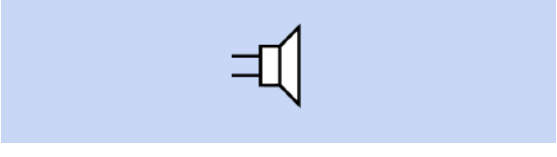

Figure 30-1. *Only one symbol exists to represent a speaker. This is it.*

How It Works

For a summary of basic concepts and terminology relating to sound and its reproduction, see "Audio Basics" on page 261 in the previous entry.

Construction

A speaker contains a *diaphragm* or *cone* with a coil attached to it. Fluctuations of current through the coil interact with a permanent magnet, causing the speaker to emit pressure waves that are proportionate with the current. The design is similar in concept to that of a headphone, shown diagrammatically in Figure 29-3. The primary difference is that a speaker of around 2″ or more will use a cone rather than a flat diaphragm. The cone shape is more rigid and creates a more directional sound.

A 2″ speaker rated for 1/4W with a 63Ω coil is shown in Figure 30-2, undamaged on the left but with its cone cut out on the right. The neck of the cone, which is normally inserted in the circular groove in the speaker magnet, is shown with the inductive coil wrapped around it.

Figure 30-2. *On the left is a 2″ speaker. On the right, its cone has been cut away to reveal the magnet, with a circular groove in it. The neck of the cone, which normally slides into the groove, is shown removed.*

A speaker with a cone 4″ in diameter is shown from the rear in Figure 30-3.

A miniature surface-mount speaker is shown from the front and from the rear in Figures 30-4 and 30-5. It measures just under 0.4″ diameter and was made for Motorola. Its power rating is 50mW.

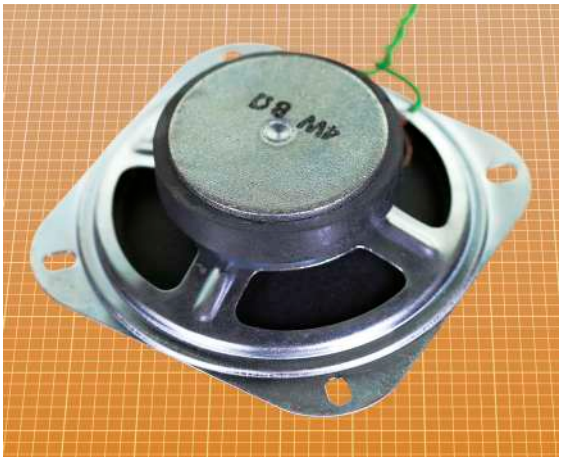

Figure 30-3. *The back side of a speaker with a cone measuring approximately 4″ in diameter. Its magnet is the large round section that is uppermost. This unit is rated for 4W and has an impedance of 8Ω.*

A speaker designed for a cellular phone is shown in Figure 30-6. Note the close resemblance in design to the driver used in an earbud, shown in Figure 29-6 in the previous entry.

In the past, speaker cones were made from tough, fibrous paper. Modern cones are more likely to be plastic, especially in small sizes.

Figure 30-4. *Front view of a surface-mount speaker measuring less than 0.4″ diameter.*

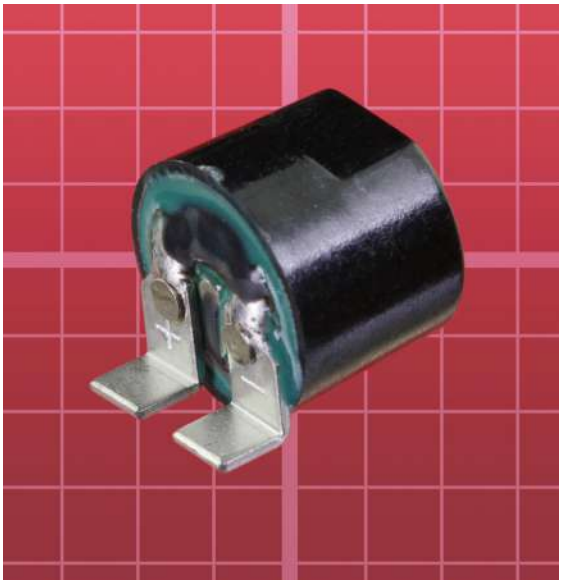

Figure 30-5. *Rear view of the speaker shown in the previous figure.*

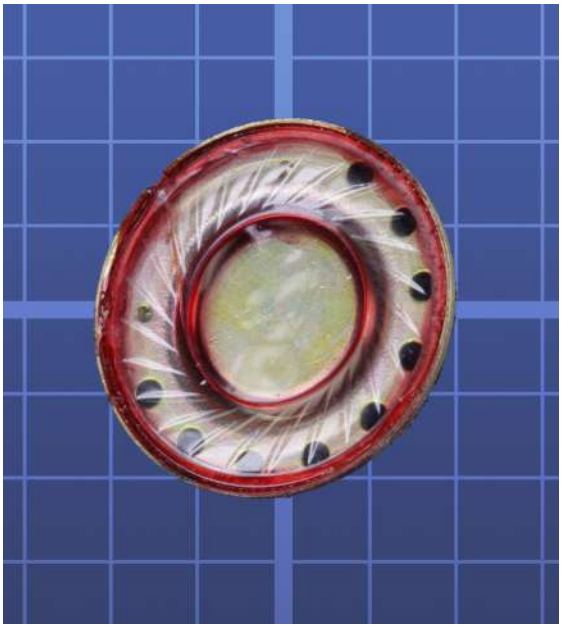

Figure 30-6. *A miniature speaker measuring slightly more than 1/2" diameter and only 0.13" thick, designed for use in a cellular phone. It has an impedance of 150Ω.*

Multiple Drivers

Generally speaking, a large-diameter speaker cone is more effective than a small cone at moving the greater volumes of air associated with reproduction of bass notes. However, the inertia of a large cone impairs its ability to vibrate at high frequencies.

To address this problem, a large speaker and a small speaker often share a single enclosure. A *crossover network* using coils and capacitors prevents low frequencies from reaching the small speaker and high frequencies from reaching the large speaker. The basic principle is shown in the simplified schematic in Figure 30-7.

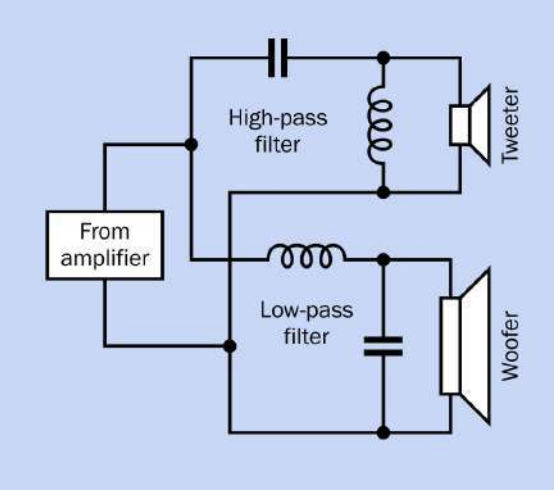

Figure 30-7. *The basic principle of a crossover network.*

Because the crossover network must be "tuned" to match the characteristics of the speakers, and because the combined sound pressure of the speakers must be relatively consistent over a wide range of frequencies, an actual network usually includes additional components.

Because the audio output from an amplifier consists of alternating current, polarized capacitors cannot be used. Polyester capacitors are common.

The small speaker in a pair is known as a *tweeter* while the large speaker is a *woofer*. Although

these appellations were whimsically coined, they have endured.

More than two speakers may be combined in an enclosure, in a wide variety of configurations.

Venting

A speaker radiates pressure waves from the back side of its cone as well as from the front, and because the waves from front and back are opposite in phase, they will tend to cancel each other out.

In a miniature speaker, this problem can be addressed simply by sealing the section of the enclosure at the rear. For larger components, a more efficient enclosure can be designed with a *vent* or *reflex port* at the front. Pressure waves from the back of the speaker are diverted over a sufficient distance inside the cabinet so that by the time they emerge through the port, they are approximately in phase with low frequencies from the front of the speaker, although the back wave will lag the front wave by one wavelength.

This design is referred to as a *bass-reflex enclosure*, and was almost universal in high-fidelity components until amplifiers became increasingly powerful during the 1960s. At that point, Acoustic Research, located in Massachusetts, marketed a product line in which speaker enclosures were sealed, the argument being that when an amplifier can deliver 100W per channel, efficiency is no longer an issue, and a sealed enclosure can eliminate compromises associated with a bass-reflex design.

Acoustic Research referred to their concept as "air suspension," as the cushion of air in the sealed cavity helped to protect the speaker by limiting its excursion. This configuration is now often referred to as a *closed-box speaker*. Some audiophiles argue that it must always be inherently superior to a bass-reflex design, partly because of the one-wavelength lag time associated with a reflex port. However, as in many aspects of sound reproduction, the debate is inconclusive.

Resonance

The enclosure for a speaker will tend to have a dominant resonant frequency. This should be lower than the lowest frequency that the speaker will reproduce; otherwise, the resonance will emphasize some frequencies relative to others, creating unwanted peaks in the response.

One reason why high-quality speakers tend to be physically heavy is to reduce their resonant frequency. A modern Thiel speaker assembly, for instance, uses a front panel of particle board that is a full 2" thick. However, heavy enclosures are expensive to transport and inconvenient to locate or relocate in the home.

To address this problem, a tweeter and a woofer can be mounted in separate boxes. The enclosure for the tweeter can be very small, lightweight, and suitable for placement on a shelf, while the heavy box for the woofer can go on the floor. Human senses have difficulty locating the source of low-frequency sound, so the woofer can be located almost anywhere in a room. In fact, its single speaker can serve both stereo channels.

This configuration has become the default for computer speakers. It is also used in home-theater systems, where the woofer has now become a subwoofer capable of very low frequency reproduction.

Miniature Speakers

If an electronics project has an audio output, and the circuit board will be sharing an enclosure with a small speaker, the size of the box and the material from which it is fabricated will affect the sound quality significantly. A box made from thin hardwood may add resonance that sounds pleasing, if the speaker is being used just for simple electronic tones. By comparison, a metal box may sound "tinny." A box fabricated from a plastic such as ABS will be relatively neutral, provided the plastic is reasonably thick (1/4" being preferable).

Variants

Electrostatic Speaker

The principle of an electrostatic speaker is the same as that of an electrostatic headphone. A charged membrane is stretched between two grids in front of it and behind it that act as electrodes. Because the membrane is so light, it responds with very little latency, and its large surface area creates a diffused sound that many audiophiles find pleasing. However, a high voltage is required to drive electrostatic speakers, and they are not cheap.

Powered Speakers

A unit containing its own driver electronics is referred to as a *powered speaker*, and is used almost universally with desktop computers, because the computer itself does not contain a power amplifier. Powered speakers may also enable a more versatile crossover network.

A subwoofer may have its own amplifier allowing control of the cutoff frequency above which the speaker will not attempt to reproduce sound. The electronics can include protection for a speaker against being overdriven.

Wireless Speakers

A wireless link between a stereo receiver and its speakers will eliminate the speaker wires that are normally necessary. However, the speakers themselves must be powered, and will have to be wired to electric outlets.

Innovative Designs

The need for small speakers in consumer products such as laptop computers has encouraged innovative designs. The speaker in Figure 30-8 is just 1″ square, and its shape is easier to accommodate in a small product than the traditional circular speaker. In Figure 30-9, the interior of the same speaker shows that inductive coils are applied to a square plastic diaphragm.

Figure 30-8. *A speaker 1″ square, suitable for use with a small electronic device.*

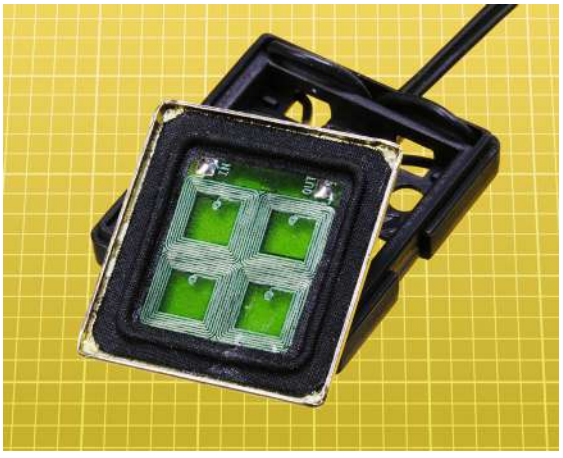

Figure 30-9. *The speaker from the previous figure, opened to show its inductive coils applied to a square plastic diaphragm.*

Values

The typical *impedance* for speakers in audio systems is 8Ω. Small speakers may have a higher impedance, which can be useful when driving them from devices that have limited power, such as a TTL-type 555 timer.

In the United States, the diameter of a circular speaker is usually expressed in inches. Speakers larger than 12″ are rare for domestic use. A 4″ speaker used to be considered minimal because

of its limited low-end frequency response, but much smaller speakers have become common in portable devices.

The low-end frequency response of a miniature loudspeaker designed to be surface-mounted on a circuit board will be very poor. The graph in Figure 30-10 was derived from data supplied by the manufacturer.

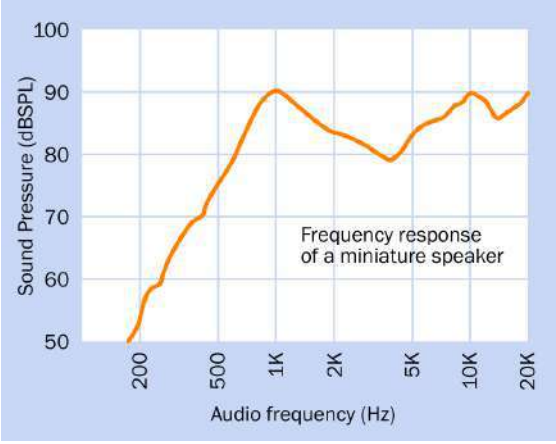

Figure 30-10. *Frequency response for a speaker measuring 15mm x 15mm x 5mm. Small dimensions and lack of an enclosure result in a negligible low-end response.*

Power rating for speakers is in watts, measured on a root-mean-square (RMS) basis.

Sensitivity is measured in decibels, at a distance of one meter, while a speaker is reproducing a single constant tone with a power input of 1W. A speaker assembly designed for undemanding home use may be rated at 85dB to 95dB.

Efficiency is a measure of sound power output divided by electrical power input. A value of 1% is typical.

What Can Go Wrong

Damage

As is the case with headphones, the most common problem affecting a speaker is damage caused by overdriving it. Because a low frequency requires larger excursions of a speaker cone to transmit an amount of energy comparable to that of a high frequency, loud bass notes can be hazardous to the cone. On the other hand, if an amplifier generates distortion (perhaps because it, too, is being overdriven), the harmonics created by the distortion can damage high-frequency speakers.

Magnetic Field

Even a small speaker (measuring 2" or less) contains a magnet that is sufficiently powerful to cause problems if it is in close proximity to other components, especially if sensors such as reed switches or Hall-effect switches are being used. Initial circuit testing should be done with the speaker as far away as possible, to eliminate it as a source of interference.

Vibration

Solder joints will be stressed if they are subjected to low-frequency vibration from a speaker. Loose parts may rattle, and parts that are bolted into place may become unbolted. The speaker itself may become loose. Thread-locker such as Loc-Tite should be applied to nuts before they are tightened.

Preface

This third and final volume of the *Encyclopedia of Electronic Components* is devoted entirely to sensors.

Two factors have caused very significant changes in the field of sensors since the 1980s. First, features such as antilock braking, airbags, and emissions controls stimulated the development of low-priced sensors for automotive applications. Many of these sensors were fabricated in silicon as MEMS (microelectromechanical) devices.

The second wave began in 2007 when MEMS sensors were installed in the iPhone. A modern phone may contain almost a dozen different types of sensors, and their size and price have been driven down to a point that would have been unimaginable 20 years previously.

Many MEMS sensors are now as cheap as basic semiconductor components such as a voltage regulator or a logic chip, and they are easy to use in conjunction with microcontrollers. In this Encyclopedia, we have allocated significant space to this segment of the market, hoping that the specific products that we have chosen will remain popular and available for at least the next decade.

In addition, we have devoted space to older components where durability has been proven.

Purpose

While much of the information in this volume can be found dispersed among datasheets, introductory texts, Internet sites, and technical briefings published by manufacturers, we believe there is a real need for a durable resource that assembles all the relevant data in one place, properly organized and verified, including details that may be hard to find elsewhere.

This volume may also serve a useful purpose by attempting to categorize and classify components in a field that is remarkably chaotic. For example, is an *object presence sensor* different from a *proximity sensor*? Some manufacturers seem to think so; others disagree. Understanding the distinctions and the underlying principles can be important if you are trying to decide which sensor to use.

Sensor terminology can also be confusing. To take another example, what is the difference between a *reflective interrupter*, a *reflective object sensor*, a *reflective optical sensor*, a *reflective photointerrupter*, and an *opt-pass sensor*? These terms are used in various datasheets to describe components that are all *retroreflective sensors*. Understanding the proliferating variety of terminology can be essential if you simply want to find something in a product index.

Organization

As in volumes 1 and 2, this volume is organized by subject. For example, if you want to measure temperature, you'll find the entries for a thermistor and a thermocouple next to each other, in an entire section devoted to the sensing of heat. This will help you to compare capabilities and choose the component that best suits your application.

The subject path leading to each sensor is shown at the top of the first page of each entry. For gas flow rate, for instance, you would follow this path:

```
fluid > gas > flow rate
```

Note that the word "fluid" is properly used to include gases as well as liquids.

Exceptions and Conflicts

Unfortunately, some sensors are not easily categorized. There are four problems in this area.

1. What Does a Sensor Really Sense?

A GPS chip is a radio receiver, picking up transmissions from satellites. Does this mean it should be categorized as a sensor of radio waves? No, its purpose is to tell you your location. Therefore, it is categorized as a location sensor. This leads to the first general rule: sensors are categorized by their primary purpose. Secondary purposes may be found in the index.

2. How Many Sensors Are in a Sensor?

Many surface-mount chips perform more than one sensing function. For example, an inertial measurement unit (often identified by its acronym, *IMU*) can contain three gyroscope sensors and three accelerometers—and may contain three magnetometers, too. How should it be categorized?

The answer is that an IMU will be mentioned in more than one entry in the Encyclopedia, because it performs more than one function; but it will not have its own separate entry, because each entry in the Encyclopedia is for a single primary sensing function.

The names of multisensor chips are, of course, included in the index.

3. How Many Stimuli Can One Sensor Sense?

A single sensing element may be used in multiple different types of sensors. The most notable example is the Hall-effect sensor, which can be found in magnetometers, object presence sensors, speed sensors, current sensors, and dozens more. Modern automobiles can contain Hall-effect sensors everywhere from the ignition system to the trunk-locking mechanism. If you are using a hard drive with rotating platters, it probably contains a Hall-effect sensor to monitor the speed of rotation. If you have a generic computer keyboard, each keypress is probably detected with a Hall-effect sensor.

Bearing this in mind, how should a Hall-effect sensor be classified? And where should you expect to find an explanation of how it works?

The answer is that where different types of components contain the same type of sensing element, the entry for each component will include a cross-reference to one location where the sensing element is explained in detail.

This location will be chosen for its relevance. Thus, Hall-effect sensors are explained in the entry for **object presence** sensors, because this is their primary function. While it is true that a Hall-effect sensor works by detecting a magnetic field, that is not its most common application.

4. Too Many Sensors!

Wikipedia lists more than 100 general types of sensors, and even that list is probably not complete. Consequently, we had to pick and choose. Some of the decisions may seem arbitrary, but all of them were made on the grounds of practicality. There were three principles for deciding what to include and what to leave out.

1. Is it a component? We are more interested in board-mounted components than in packaged products that happen to contain sensors. For instance, a thermocouple is often enclosed in a tubular steel probe, and its wire is often plugged in to a specially designed meter that displays temperature. While we do include a photograph of a probe, we are primarily interested in the welded wires of the thermocouple inside it.

2. How much does it cost? An industrial ultrasonic sensor to check items on a factory conveyor belt will be sealed into a module with a waterproof grommet around a shielded cable—which is all very nice, but will not be very affordable. This Encyclopedia is more interested in board-mountable components for one-tenth of the price.

3. How many people are likely to want it? The stock of each type of sensor was checked on component vendor sites. If a sensor wasn't in the inventory, or if only a couple of variants were stocked, we concluded that the limited demand probably didn't justify including it here. For example, a Ferraris acceleration sensor responds to eddy currents in a rotating motor shaft, as a way of measuring vibration in the shaft. This is a really interesting device, but is unlikely to be on most people's shopping lists.

Volume Contents

Having explained the organization of this book and our decisions to include or omit various components, we now present a summary of the contents of all three Encyclopedia volumes:

Volume 1

Power; electromagnetic devices; discrete semiconductors.

The *power* category includes sources of electricity and methods to distribute, store, interrupt, convert, and regulate power. The *electromagnetism* category includes devices that exert force linearly, and others that create a turning force. *Discrete semiconductors* include the primary types of diodes and transistors. See Figure P-1 for a contents listing.

Primary Category	Secondary Category	Component Type
power	source	battery
	connection	jumper
		fuse
		pushbutton
		switch
		rotary switch
		rotational encoder
	moderation	relay
		resistor
		potentiometer
		capacitor
		variable capacitor
	conversion	inductor
		AC-AC transformer
		AC-DC power supply
		DC-DC converter
		DC-AC inverter
	regulation	voltage regulator
electro-magnetism	linear output	electromagnet
		solenoid
	rotational output	DC motor
		AC motor
		servo motor
		stepper motor
discrete semi-conductor	single junction	diode
		unijunction transistor
	multi-junction	bipolar transistor
		field-effect transistor

Figure P-1 *The subject-oriented organization of categories and entries in Volume 1 of this Encyclopedia.*

Volume 2

Thyristors (SCRs, diacs, and triacs); integrated circuits; light sources, indicators, and displays; and sound sources.

Integrated circuits are divided into analog and digital components. *Light sources, indicators, and displays* are divided into reflective displays, single sources of light, and displays that emit light. *Sound sources* are divided into those that create sound, and those that reproduce sound. A contents listing for Volume 2 appears in Figure P-2.

Volume 3

All the most common types of sensing devices, including those that detect location, presence, proximity, orientation, oscillation, force, load, human input, liquid properties, gas types and concentrations, pressure, flow rate, light, heat, sound, and electricity. A contents listing for Volume 3 appears in Figure P-3.

Method

Reference Versus Tutorial

As its title suggests, this is a reference book, not a tutorial. A tutorial such as *Make: Electronics* begins with elementary concepts and builds sequentially toward concepts that are more advanced. A reference book assumes that you may dip into the text at any point, learn what you need to know, and then put the book aside. If you choose to read it straight through from beginning to end, you will find some repetition, as each entry is intended to be self-sufficient, requiring minimal reference to other entries.

Theory and Practice

This book is oriented toward practicality rather than theory. We assume that the reader mostly wants to know how to use electronic components, rather than why they work the way they do. Consequently we do not include detailed proofs of formulae or definitions rooted in electrical theory.

Primary Category	Secondary Category	Component Type
discrete semi-conductor	thyristor	SCR
		diac
		triac
integrated circuit	analog	solid-state relay
		optocoupler
		comparator
		op-amp
		digital potentiometer
		timer
	digital	logic gate
		flip-flop
		shift register
		counter
		encoder
		decoder
		multiplexer
light source, indicator or display	reflective	LCD
	single source	incandescent lamp
		neon bulb
		fluorescent light
		laser
		LED indicator
		LED area lighting
	multi-source or panel	LED display
		vacuum-fluorescent
		electroluminescence
sound source	audio alert	transducer
		audio indicator
	reproducer	headphone
		speaker

Figure P-2 *The subject-oriented organization of categories and entries in Volume 2.*

Primary Category	Attribute to be Sensed	Type of Sensor
spatial	location	GPS
		magnetometer
	presence	object presence
		passive infrared
	distance	object proximity
		linear position
	orientation	rotary position
		tilt
		gyroscope
		accelerometer
mechanical	oscillation	vibration
	force	force
	human input	single touch
		touch screen
fluid	liquid	liquid level
		liquid flow rate
	gas/liquid	pressure
	gas	gas concentration
		gas flow rate
radiation	light	photoresistor
		photodiode
		phototransistor
	heat	NTC thermistor
		PTC thermistor
		thermocouple
		RTD
		semiconductor
		infrared temperature
	sound	microphone
electricity	metering	current
		voltage

Figure P-3 *The subject-oriented organization of categories and entries in Volume 3.*

Sensor Output

In Volumes 1 and 2 of the *Encyclopedia*, each entry included hints on how to use a component. However, many sensors have identical forms of output, which are processed in a similar way. To avoid repetition, general guidance for using nine principal types of sensor outputs has been placed in Appendix A at the back of this volume.

For example, many sensors provide an analog voltage output that varies with the phenomenon that is being sensed. In Appendix A, you will find suggestions on how to adjust the range of the output, if necessary, or how to digitize it with an analog-to-digital converter.

You will also find a comparison between serial protocols such as I2C and SPI, both of which are commonly used when a microcontroller communicates with a digital sensor via a bus.

Glossary

In the world of sensors, many terms tend to recur. *Hysteresis* is one; *MEMS* is another. Rather than define these terms repeatedly, some quick definitions are gathered in a Glossary. Please remember the existence of the glossary if you encounter a term that is unfamiliar. See Glossary.

In many instances, terms that are italicized in the text are defined in the glossary.

Typographical Conventions

Within each entry, **bold type** is used for the first occurrence in each entry of the name of a component that has its own entry elsewhere. Other important electronics terms or component names may be presented in *italics*.

The names of components, and the categories to which they belong, are all set in lowercase type, except where a term is normally capitalized because it is an acronym or a trademark, or contains a proper noun. The term *Hall effect*, for instance, has an initial cap because it is named after a person named Hall. The term *GPS* is all in caps, because it is an acronym; but *psi* (meaning pounds per square inch) remains in lowercase, because even though it is an acronym, the lowercase form is more common.

The situation is different when specifying units that are named after electrical pioneers. All of these units should be lowercased when spelled out. Thus, when referring to the SI unit of force, it is "the newton." However, where a unit named after a person is abbreviated, the abbreviation is capitalized, as in N for newtons, Hz for hertz, Pa for pascals, and A for amperes.

Mathematical Syntax

In mathematical formulae, we have used the style that is common in programming languages. The * (asterisk) is used as a multiplication symbol, while the / (forward slash) is used as a division symbol. Where some terms are in parentheses, they must be dealt with first. Where parentheses are inside parentheses, the innermost ones must be dealt with first. Consider this example:

```
A = 30 / (7 + (4 * 2) )
```

You would begin by multiplying 4 times 2, to get 8; then add 7, to get 15; then divide that into 30, to get the value for A, which is 2.

Visual Conventions

Figure P-4 shows the conventions that are used in the schematics in this book. A black dot always indicates a connection, except that to minimize ambiguity, the configuration at top-right is avoided, and the configuration at top-center is used instead. Conductors that cross each other without a black dot do not make a connection. The styles at bottom right are sometimes seen elsewhere, but are not used here.

All the schematics are formatted with pale blue backgrounds. This enables components such as switches, transistors, and LEDs to be highlighted in white, drawing attention to them and clarifying the boundary of the component. The white areas have no other meaning.

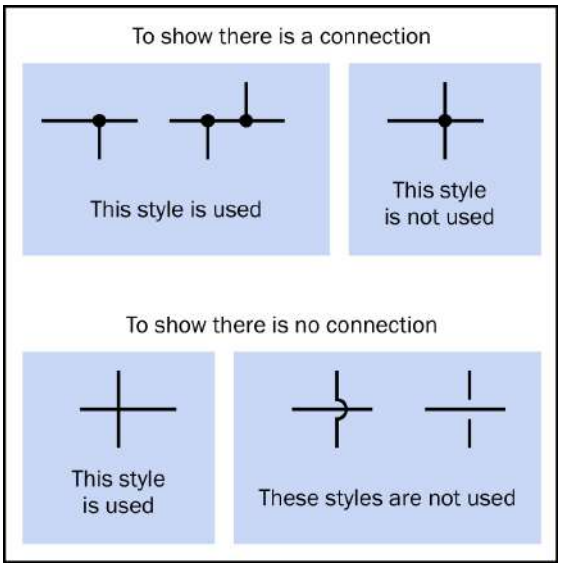

Figure P-4 *Visual conventions that are used in the schematics in this book.*

Units and Backgrounds

So long as the United States clings stubbornly to the habit of expressing dimensions in inches, there is a good argument to follow this custom in books intended for an American audience. With this in mind, Volumes 1 and 2 mostly avoided metric units of length. However, as time passed, the books were translated for use in many parts of the world where the inch is regarded as an anachronism.

Recognizing that we now have an international audience, we have used the metric system throughout this volume (with very few exceptions, such as a photograph of an American plumbing fixture that is designed to fit 3/4" pipe). For readers who are metrically impaired, here are some units of length, and their abbreviations:

- 1 nanometer (nm)
- 1 micrometer (µm) = 1,000nm
- 1 millimeter (mm) = 1,000µm
- 1 centimeter (cm) = 10mm
- 1 meter (m) = 100cm = 1,000mm

A micrometer is also known as a *micron*.

The basic conversion factor from meters to inches is 0.0254. Thus:

- 1 inch = 2.54cm = 25.4mm
- 1/1000 inch = 25.4µm

Sometimes 1/1000 inch is called a *mil*.

In many of the component photographs, a graph-paper background is included. Each square in these backgrounds is 1mm.

To avoid confusion, please remember that a few of these same component photographs appeared in books such as *Make: More Electronics*, where the background grid was in tenths of an inch. Captions to photographs in this volume will remind you that millimeters are now used.

Background colors in the photographs were chosen for contrast with the colors of the components, or for visual variety. They have no other significance.

Component Availability

The world of sensors is changing rapidly, and we have no way of knowing if a component will enjoy a long production run. We recommend checking availability at the following suppliers, which we used frequently during the preparation of the book:

- *http://www.mouser.com*
- *http://www.jameco.com*
- *http://www.sparkfun.com*
- *http://www.adafruit.com*

For obsolete parts, or those that are nearing the end of their commercial life, eBay can be very useful. Alternatively, new substitutions for old parts are often listed at *http://www.mouser.com*.

Issues and Errata

There are three situations where the reader and the writer may want to communicate with each other.

- We may want to tell you if the book contains a mistake of some significance. This is *us-informing-you* feedback.
- You may want to tell us if you think you found an error in the book. This is *you-informing-us* feedback.
- You may be having trouble making something work, and you don't know whether we made a mistake or you made a mistake. You would like some help. This is *you-asking-us* feedback.

Here's how you can deal with each of these situations.

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If you already registered your contact information in connection with *Make: Electronics* (second edition) or *Make: More Electronics*, you don't need to register again for updates relating to the Encyclopedia. If you have not already registered, here's how it works.

The only way you can be notified if there's an error in the book is if you supply your contact information. If we have your email address:

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There are dozens of forums online where you can discuss this book and mention any problems you are having, but please be aware of the power that you have as a reader, and use it fairly. A single negative review can create a bigger effect than you may realize. It can certainly outweigh half-a-dozen positive reviews.

Responses in the past have been generally positive, but in a couple of cases people have been annoyed over small issues such as being unable to find a part online. Help is available on this kind of topic, if you need it. All you have to do is send a request to *make.electronics@gmail.com*.

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You can access the errata page at *http://bit.ly/encyclopedia-electronic-components-v3*.

Make: unites, inspires, informs, and entertains a growing community of resourceful people who undertake amazing projects in their backyards, basements, and garages. Make: celebrates your right to tweak, hack, and bend any technology to your will. The Make: audience continues to be a growing culture and community that believes in bettering ourselves, our environment, our educational system—our entire

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To comment or ask technical questions about this book, send email to:

bookquestions@oreilly.com.

Acknowledgments

Datasheets and tutorials maintained by component manufacturers were considered the most trustworthy sources of information online. In addition, component retailers, college texts, crowd-sourced reference works, and hobbyist sites were used. The following books provided useful information:

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GPS

1

The acronym **GPS** properly refers to the entire Global Positioning System, including satellites and ground-based control installations. However, a *GPS sensor* consists of a surface-mount chip that processes signals from GPS satellites using a small rectangular antenna, often mounted on top of a *GPS chip*.

A *GPS module* is usually a small board on which a GPS sensor is mounted with additional components. A *GPS receiver* is a device including a data display and other features, such as memory, in addition to a GPS module. In casual colloquial usage, someone who refers to "a GPS" usually means a GPS receiver.

GPS is almost always capitalized without periods.

OTHER RELATED COMPONENTS

- **magnetometer** (see Chapter 2)

What It Does

The Global Positioning System is a navigational aid jointly funded by the U.S. Department of Defense and the U.S. Department of Transportation, while being maintained by the U.S. Air Force. Signals from GPS satellites can be received and processed by modules in a wide variety of equipment ranging from aircraft to wristwatches. The signals provide location data, and may also be used as an accurate time reference.

Schematic Symbol

There is no specific schematic symbol for a GPS chip. It is likely to be shown as a box containing abbreviations that define pin functions, similar to any integrated circuit chip.

GPS Segments

The Global Positioning System consists of three segments:

The space segment

This originally required 24 communications satellites, but was revised in 2011 to require 27, to provide better global coverage. As of August 2015, there were actually 31 satellites in service, with additional "spares" that can be activated if necessary. The satellites occupy orbits 12,500 miles above the Earth, allowing each of them to circle the planet twice in 24 hours. Specifications are maintained online.

The control segment

This includes a master ground-based control station, an alternate master control station, 12 command and control antennas, and 16 monitoring sites, all maintained by the U.S. Air Force.

The user segment

This consists of receiving devices, including those that are government-owned and those that are privately owned.

How It Works

Each satellite carries multiple atomic clocks that maintain precise time, and a pseudo-random number generator in the form of a linear-feedback **shift register** (see Volume 2).

A GPS receiver can distinguish the signals from at least four satellites by comparing their received pseudo-random bit sequences, and can compute the receiver's distance to each satellite by comparing the arrival times of satellite signals.

When a satellite appears above the horizon, it approaches a receiver. After passing overhead, it moves away. This relative motion causes a *Doppler shift* in the received frequency, which the receiver circuit must take into account.

GPS satellites transmit on several frequencies simultaneously. The one for civilian use is 1575.42 MHz, called L1. Another one, 1227.6 MHz, called L2, is reserved for military use.

Variants

A GPS chip generally processes input from an antenna and provides output through solder pads. The antenna is often integrated as a ceramic square or rectangle mounted above the chip, but many chips can also process input from an external antenna. Figure 1-1 shows a GPS chip with a metal shield that is easily mistaken for an antenna. In Figure 1-2, the GPS sensor does incorporate a ceramic antenna.

Some GPS chips contain flash memory for internal data logging, although this is not a standard feature.

Suppliers such as Adafruit and Sparkfun offer GPS modules mounted on breakout boards for easier connection with other components, as shown in Figure 1-2. Some breakout boards also include provision for battery backup with a button cell.

Figure 1-1 *A GPS sensor. This surface-mount chip is hidden beneath a metal shield.*

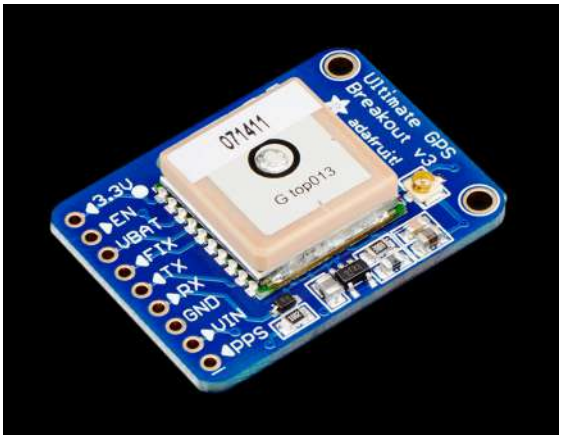

Figure 1-2 *A breakout board offered by Adafruit, incorporating a GPS sensor.*

GPS capability is almost always included in modern smartphones and tablets. It is used in handheld devices for navigation on foot, and in devices designed to be mounted in motor vehicles. Cars offer GPS capability as an option accessed via a built-in screen.

A *GPS tracker* is a device that may lack a display and simply logs its position to internal memory, from which data can be downloaded to a com-

puter later. Many (older) handheld GPS receivers have a connector giving access to a serial or USB port, and provide data in the same NMEA format as the GPS modules described below.

After the Global Positioning System became widely used, other competing systems were introduced. These include the European Galileo, the Russian GLONASS (an acronym for Global Navigation Satellite System), and the Chinese Beidou. As of 2015, GLONASS had become fully operational. Some receivers, including those in cellular phones, compare signals from GPS and GLONASS satellites to achieve higher accuracy.

Values

Sensitivity is expressed usually in dBm, meaning the power ratio in decibels (dB) of the measured power referenced to one milliwatt (mW).

Time to First Fix (TTFF) is the time required to obtain an initial fix from a satellite.

Number of channels is the number of satellites that a GPS receiver can track simultaneously. Early GPS receivers could sense only four channels. Modern units may be able to deal with 22.

Power consumption may be measured in milliwatts. For example, the FGPMMOPA6H GPS standalone module by G.top claims power consumption of 82mW during acquisition of satellite signals and 66mW while tracking subsequently. At a typical voltage of 4VDC, the chipset consumes about 20mA and approximately 17mA, respectively.

Form factor. This is the size of a chip, often determined by the dimensions of the ceramic antenna on top of it. Dimensions may be 15mm x 15mm or larger.

Update rate. The number of position measurements per second. While 1 update per second is often sufficient, some chips generate updates more rapidly. The frequency of updates is expressed in hertz.

Output type. This is often TTL-level serial providing NMEA data. The baud rate can vary and is often selectable.

Supply voltage. Often below 5VDC.

Current consumption. Higher during satellite acquisition.

How to Use It

A GPS module requires only a DC power supply, and will start outputting data as soon as it has identified satellites that are currently within range.

Data provided by a GPS module uses a rather slow and primitive plain-ASCII protocol known as NMEA, developed by the National Marine Electronics Association. Each block of data is known as a *sentence*, and can be parsed independently of previous and subsequent sentences. The default transmission rate is 4,800 bits per second, using 8 bits to identify an ASCII character, no parity, and 1 stop bit. However, some GPS modules use a serial rate of 9,600 bps or faster.

A sentence begins with a two-letter abbreviation defining the type of device employing the sentence. For a GPS device, the abbreviation is GP. The sentence continues with another abbreviation of three characters or more, describing the type of data being transmitted, so that numeric values in the sentence can be interpreted correctly.

The remainder of a sentence consists of letters and numerals in plain ASCII, with values separated by commas. A sentence cannot contain more than 80 characters. A sentence will specify the latitude, longitude, and altitude of the GPS, and a value defining the time when the readings were derived from satellite signals. Some sentence data structures are proprietary, established by the device manufacturer, and will begin with the letter P.

A GPS device may send a variety of different sentence types in succession, to overcome the 80-character sentence length limit. Each sentence will be preceded with an identifier. Sentence types and data contents will be defined in a manufacturer's datasheet.

Output from GPS chips may be compatible with a microcontroller. Output from a GPS breakout board will almost certainly be compatible, and the board is likely to have its own voltage regulator. The microcontroller can receive serial data from the GPS chip, can stop the GPS chip via its enable pin, and can start and stop internal logging of data in flash memory on the GPS chip if this feature is available.

Code libraries are available online for a microcontroller, to enable it to receive and interpret serial data from a GPS device.

Pulse per Second Output

As the GPS positioning depends on calculating distances from the time it takes for a radio signal to travel, accurate timekeeping is needed. When a GPS receiver obtains a fix for its position, it will get a value for the current time as well. This makes GPS receivers usable to supply time and frequency standards. Most receiver modules report the time together with the position. Many also provide a special PPS output, which produces one pulse per second, precisely synchronized with the satellites in view.

The accurate time provided by the GPS receiver can be used to *discipline* a crystal oscillator. This means measuring the crystal oscillator frequency relative to a GPS-provided reference, and continuously adjusting the crystal frequency to keep it stable.

What Can Go Wrong

Problems generally affect chips and modules rather than devices.

Electrostatic Discharge

The patch antenna on a GPS chip connects with the chip via an RF input. If the antenna is subjected to an electrostatic discharge, the chip can be permanently damaged. Likewise, damage will result if a discharge is applied to the RF input, for example through a soldering iron. The chip must be grounded before any work is done involving the RF input.

Failure to Ground Properly

The ground solder pad on a chip, or the ground pin on a breakout board, must make contact before voltage is applied to other pads or pins.

Cold Joints

The patch antenna on a GPS chip can function as a heat sink, increasing the risk of cold solder joints when the chip is being mounted on a board.

Restricted Availability

U.S. regulations limit the export of some GPS devices capable of rapid positional updates that could be usable in military aircraft or missiles. Other restrictions also apply. Suppliers may be inconsistent in their refusal to allow purchase of restricted items outside of the United States.

Inability to Detect Satellites

Any GPS device may fail to detect satellite signals if its view of the sky is obstructed. Reception is usually possible through window glass, but may not be available through walls, a roof, heavy tree cover, and other natural obstructions.

Exceeding Maximum Velocity or Altitude

Security regulations limit the capability of GPS devices to function above 60,000 feet or at greater than 1,200 miles per hour. Outside of these limits, the GPS device will not provide data. This may affect applications in amateur rocketry or high-altitude balloons.

magnetometer

2

This entry deals only with magnetic sensors that respond to the Earth's magnetic field. Small magnetic sensors such as the ubiquitous *Hall sensor* may be used for many other purposes, such as determining the position or rotational speed of mechanical components. These applications involve **object presence** sensing; see Chapter 3. In that entry, Hall sensors are discussed at "Hall-Effect Sensor".

In the past, a **magnetometer** was a bulky measurement device incorporating knobs or other controls and some form of display. While that use of the word is still common, this entry deals only with chip-based magnetic sensors.

OTHER RELATED COMPONENTS

- **accelerometer** (see Chapter 10)
- **gyroscope** (see Chapter 9)
- **GPS** (see Chapter 1)

What It Does

A traditional compass consists of a thin magnetized strip of metal balanced on a pivot. It aligns itself with the Earth's magnetic field.

A *scalar magnetometer* measures the total strength of a magnetic field. A *vector magnetometer* can measure the strength in a specified direction. In particular, it can provide a numeric output describing the angle between the orientation of the measuring device and the Earth's magnetic poles.

Chip-based magnetometers are usually vector-type, containing three sensors mounted orthogonally—that is, each of them at 90 degrees to the other two. Suitable software can interpret the analog readings from the sensors to calculate magnetic north or south regardless of the angle at which the instrument is being held, relative to the ground.

Schematic Symbol

There is no specific schematic symbol for a magnetometer.

IMU

A **gyroscope** measures the rate of rotation of the enclosure in which it is mounted. This is properly known as the *angular velocity*. A gyroscope will also respond to changes in the rate of rotation. It does not measure linear motion or a static angle of orientation.

An **accelerometer** measures variations in linear motion and will also measure its own static orientation relative to the force of gravity. If an accelerometer rotates around its own axis, it will not measure angular velocity.

When an accelerometer and a gyroscope are contained in the same package, optionally with a magnetometer, they may be described as an *IMU* (inertial measurement unit), which can pro-

vide necessary data to maneuver aircraft, spacecraft, and watercraft, especially when **GPS** signals are unavailable.

Applications

Magnetometers are found in handheld equipment such as digital compasses, cameras, and cellular phones. They are usually surface-mount chips that are manufactured in large quantities and may be used in conjunction with microcontrollers. For the hobby-electronics community, or for experimental product development, a magnetometer may be mounted on a breakout board for ease of use. A board using a Honeywell HMC5883L is shown in Figure 2-1.

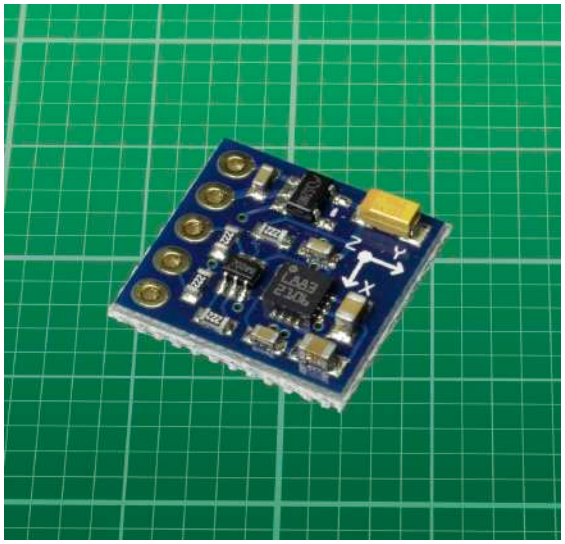

Figure 2-1 *The Honeywell HMC5883L 3-axis magnetometer mounted on a breakout board. The background grid is in millimeters.*

How It Works

An explanation of magnetometers requires an understanding of the fundamentals of magnetism.

Magnetic Fields

A magnetic field is often represented by *field lines* that show the strength and vector of the field. Field lines associated with a simple permanent magnet are shown in Figure 2-2, where the strength, or *flux density*, at any point, is indicated by the spacing the lines, while the angle tangential to a line indicates its vector. (For an extended discussion of magnetism, see **electromagnet** in Volume 1.)

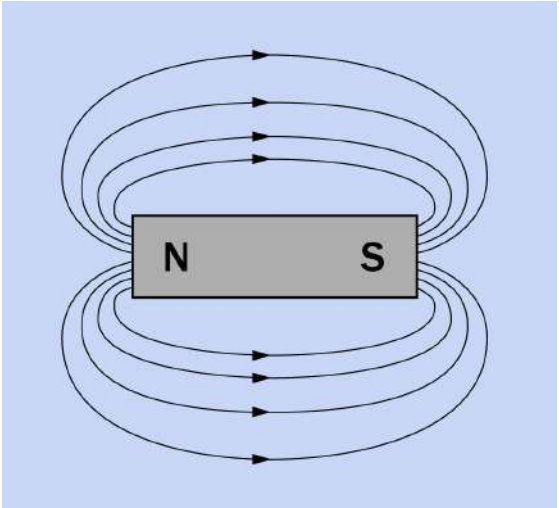

Figure 2-2 *Field lines representing magnetic flux created by a bar magnet. Space between the field lines is inversely proportional to flux density. In reality this is a three-dimensional effect, and a more accurate representation would show the magnet and field lines revolved around the axis of the magnet.*

The flux density of a magnetic field is usually represented by the letter B, and is measured in *newton-meters per ampere*, more commonly referred to as *teslas* (T). An older unit of measurement was gauss (G), 1 tesla being equivalent to 10,000 gauss. Some datasheets still refer to gauss.

The Earth's magnetic field is believed to result from convection currents in the outer liquid of the Earth's core. The strength of this field varies from 25 to 65 microteslas (0.25 to 0.65 gauss) depending on the location where it is measured. To a very rough approximation, the Earth behaves as if a giant bar magnet connects the magnetic north pole and the magnetic south pole. See Figure 2-3.

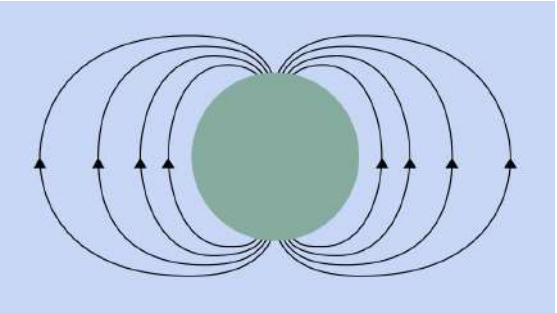

Figure 2-3 *The magnetic field of the Earth approximately resembles the field around a bar magnet.*

Note that in northern and southern latitudes, the field lines angle steeply down toward the surface, while the lines are approximately parallel with the surface near the equator. Consequently a magnetometer held tangentially to the surface of the Earth will tend to measure a stronger horizontal field near the equator than near the poles.

The varying angle of the field lines tangential to the Earth is known as their *inclination*. Variations in field strength can be used to determine an approximate location, although the **GPS** (Global Positioning System, using satellites) enables this much more accurately.

Confusion results from the fact that the nothern magnetic pole of the Earth actually behaves as a south pole, while the southern magnetic pole behaves as a north pole. That is, when a permanent magnet is free to rotate, its north pole will orient itself toward the so-called northern magnetic pole of the Earth, even though opposite poles attract. The northern pole of the Earth should therefore be thought of as the pole that attracts the north end of a compass.

Earth's Axes

Planet Earth revolves around an imaginary line referred to as the *axis of rotation*. This line is close to, but not quite coincident with, the *magnetic axis* connecting the magnetic north pole and magnetic south pole, as shown in Figure 2-4.

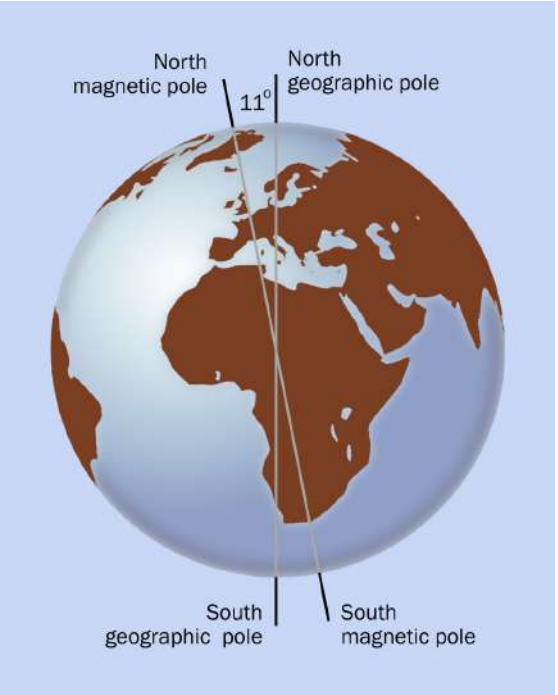

Figure 2-4 *The angle between the magnetic axis and the rotational axis of the Earth is approximately 11 degrees.*

Magnetic declination is the angle between the magnetic north pole and the geographical north pole, as perceived by an observer. This angle will vary depending on the observer's location on the surface.

Because of declination, the direction of magnetic force at points on the surface of the planet will vary with latitude and longitude, as shown in Figure 2-5. In this figure, the *magnetic meridians* are shown in red, superimposed on the *geographical meridians* shown in green. Magnetic meridians show the direction of magnetic force, while geographic meridians are drawn between the ends of the axis of rotation of the Earth. While there is an approximate correlation between the two, in some areas, especially near the north and south poles, the discrepancy can be more than 40 degrees.

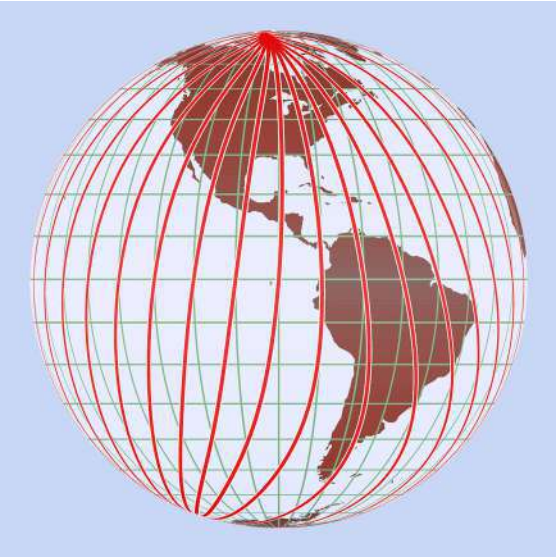

Figure 2-5 *The red lines indicate the direction in which a compass would be likely to point to magnetic north. The green lines connect the geographical poles of the planet. (From Wikimedia Commons.)*

Standard declination tables for locations on the Earth are available, and these values must be added to, or subtracted from, the reading from a compass or magnetometer to determine the direction of geographical north. Navigational systems customarily express the heading of a vehicle or vessel relative to geographical north, as shown in Figure 2-6.

Coil Magnetometer

Current flowing through a wire creates a magnetic field with flux density that is directly proportional to the current in amperes. Conversely, a changing magnetic field will induce current in a wire. This principle is used in a *coil magnetometer*, which can detect buried objects when the coil moves above them. A *rotating coil magnetometer* can determine magnetic field strength while remaining in a stationary position. However, the coil in a coil magnetometer must be relatively large.

Hall Effect and Magnetoresistance

In modern handheld devices, a magnetometer will generally use either the *Hall effect* (see "Hall-Effect Sensor") or *magnetoresistance*, described here.

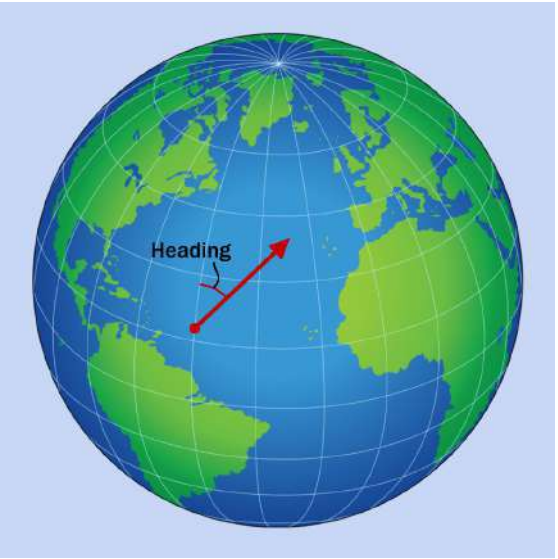

Figure 2-6 *Heading is an angle usually calculated relative to geographical north, sometimes referred to as "true north."*

Magnetoresistance is a phenomenon where the resistance of a material changes fractionally when it is exposed to a magnetic field. This is capable of yielding greater accuracy than Hall-effect sensors, but has tended to be more expensive.

Orthogonally oriented sensors contained in a surface-mount chip are aligned with axes identified with letters X, Y, and Z. These sensors are analog devices whose values are converted to digital values by an onboard *analog-to-digital converter* (ADC). The values are stored in *registers* that are available to other devices, often via the *I2C* protocol, which is widely used by microcontrollers.

Typically there will be two eight-bit registers for each axis, one defining the high byte and the other defining the low byte for the digital value. In reality the ADC is likely to use 10 to 13 bits, with the remaining 6 to 3 bits being unused.

Variants

The Freescale Semiconductor FXMS3110 is a typical low-cost chip containing a 3-axis magnetometer sensor. Many chips now additionally include a 3-axis accelerometer sensor. An example is the LSM303 by STMicroelectronics, which is sold on a breakout board by Adafruit. See Figure 2-7.

Figure 2-7 *The LSM303 is a chip manufactured by STMicroelectronics. It is shown here on a breakout board from Adafruit.*

See Chapter 10 for an explanation of the function of accelerometers.

The InvenSense MPU-9250 is a highly sophisticated IMU, including a 3-axis **gyroscope** in addition to a 3-axis magnetometer and 3-axis accelerometer.

A processing unit in the MPU-9250 reconciles the nine variables, and the digital output can be accessed via I2C or SPI protocol at speeds up to 1MHz. All functions of the chip are contained within a package measuring less than 3mm square.

See Chapter 9 for additional details about the functioning of a gyroscope.

How to Use It

A basic 3-axis magnetometer sensor such as the HMC5883L can be tested with a microcontroller that can receive data from its registers via I2C protocol. This is relatively easy with an Arduino, which was designed to be I2C-capable.

Several breakout boards are available with the HMC5883L mounted on them. Many of these boards contain a voltage regulator, allowing a 5VDC power supply to be used even though the chip is designed for a typical supply of 2.5VDC.

In addition to the power supply, the breakout board only requires two connections for I2C communication, to its SCL pin (serial clock input) and SDA pin (serial data input/output). If basic I2C software is installed on the microcontroller, it will read digital values from the magnetometer registers. If additional software is used, it will convert the values to magnetic flux densities in microteslas for the X, Y, and Z axes. Code libraries to achieve these goals are widely available online.

A more sophisticated chip such as the InvenSense MPU-9250 can be used similarly, but yields additional data for conversion. Here again, code libraries can be found online. The slightly older MPU-9150 is sold on a breakout board with downloadable code from Sparkfun.

What Can Go Wrong

Bias

Magnetometers are sensitive to their environment, which can induce *magnetometer bias* of two types.

Hard-iron bias is primarily caused by magnetized material inside the device containing the magnetometer. Because this effect is usually unvarying, compensating for it is relatively easy. *Soft-iron bias* is caused by interaction between variations in the Earth's magnetic field and

materials inside a magnetometer that can be magnetized.

A common example of soft-iron bias would be power lines, generating a magnetic field that can affect model aircraft and drones using magnetometers for navigation.

Mounting Errors

Placement of a chip-based magnetometer on a circuit board is critical. The field effects of transformers or relays must be taken into account, and even the low voltage and low current in a circuit trace can create a magnetic field sufficient to disturb a chip. No traces on any layer of the board should pass across the footprint of the chip. A magnetometer should not be mounted within a ferromagnetic case.

object presence sensor

3

An **object presence** sensor may also be described as an *object detector* or *detection sensor*.

The term **proximity** sensor may be applied to this component. However, in this Encyclopedia a proximity sensor has the capability of estimating the distance to a target. See Chapter 5. An object presence sensor merely detects whether an object is within a preset range, and does not provide additional information.

Optical and *magnetic* object-presence sensors are described and compared in this entry. *Ultrasonic sensors* are described in the entry dealing with proximity sensors, because they tend to be used for distance measurement rather than just for detection. Other methods of object presence sensing, including *capacitive*, *doppler*, *inductive*, *radar*, and *sonar*, are not included in this Encyclopedia.

A sensor that detects an object by receiving light reflected from it is categorized as a *reflective* sensor, and is included in this entry. (If a module includes a light source as well as a light sensor, it is properly categorized as *retroreflective*, although that term is not always used.)

A sensor that detects an object when it interrupts a beam of light is a *transmissive* sensor, and is included in this entry. It may also be described as a *through-beam* sensor or as an *optical switch*.

A sensor that responds to the motion of an object that emits infrared radiation is a **passive infrared** motion sensor, also described by its acronym, PIR, and often referred to simply as a *motion sensor*. It has its own separate entry. See Chapter 4.

Phototransistors and **photodiodes** may be used as sensing elements in presence sensors. These components have their own entries as light sensors. See Chapter 22 and Chapter 21.

OTHER RELATED COMPONENTS

- **proximity** sensor (see Chapter 5)
- **passive infrared** sensor (see Chapter 4)

What It Does

An **object presence** sensor verifies the presence or absence of an object within a predetermined range, without necessarily measuring how far away it is or how fast it is moving. The object may be described as a *target*.

Object presence sensing is often used to verify the correct function of an automated system—for example, the placement of objects on a conveyor belt. It can also be used to count objects as they pass a sensor.

Some types of security systems use presence sensors to sound an alarm if an intruder interrupts a beam of light. They can verify that a door or window is closed. They may also function as a limit switch to control the operation of a motor.

Schematic Symbol

In schematics, an optical presence sensor may be indicated with the symbol for an LED, plus the symbol for a **phototransistor**, with one or two arrows connecting them, as shown at top-left in Figure 3-1. Wavy-line arrows may indicate an infrared connection.

A **photodiode** may be substituted for a phototransistor, as shown at top-right in the figure.

A magnetic sensor may be shown with the symbol for a *Hall-effect sensor*, as in the lower half of Figure 3-1.

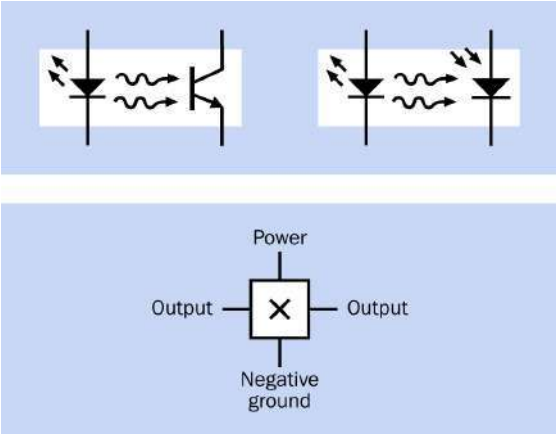

Figure 3-1 *Top: two possible schematic symbols for an optical presence sensor, using a phototransistor (left) or photodiode (right). Other variants are possible. Bottom: the schematic symbol for a Hall-effect sensor, commonly used in a magnetic sensor.*

Variants

To assist the reader in comparing different options for detecting the presence of an object, this entry includes two primary variants: *optical* and *magnetic*.

The optical sensors are divided into *transmissive* and *reflective* (including *retroreflective*). The magnetic sensors are *reed switches* and *Hall-effect sensors*. A chart showing the categories and subcategories is shown in Figure 3-2.

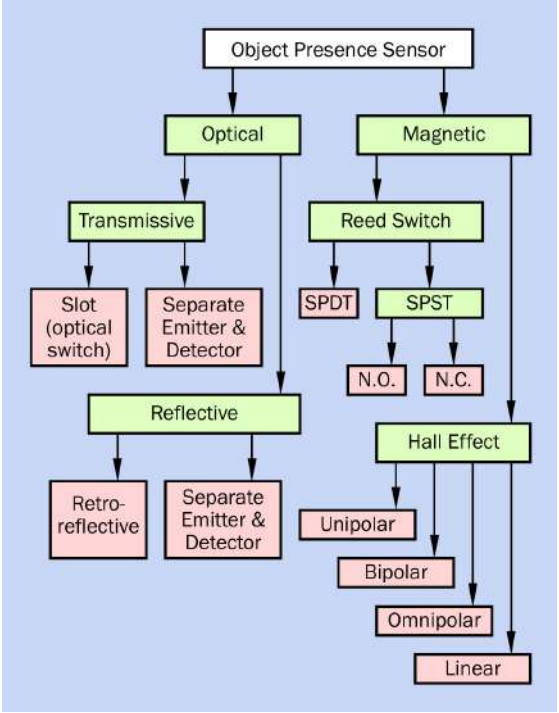

Figure 3-2 *Categories of object presence sensors discussed in this entry. Other types of object presence sensors exist, but are less common, and are not included here.*

Optical Detection

A *transmissive optical sensor*, also known as a *through-beam sensor*, is really a pair of components, one emitting light and the other receiving it. The sensor is triggered if an object

interrupts or reflects the light beam, as shown in Figure 3-3.

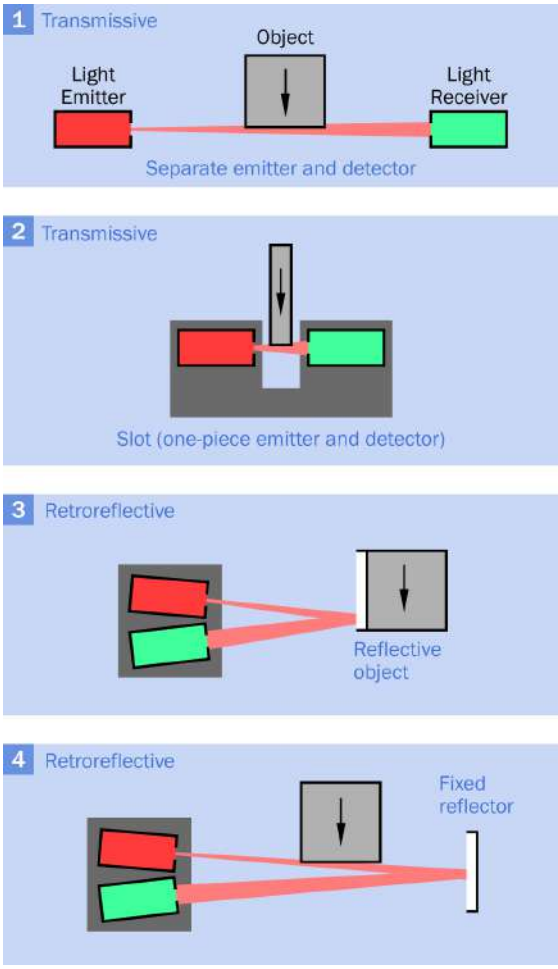

Figure 3-3 *Various configurations of optically activated object presence sensors. See text for details.*

If the light emitter and the light detector face each other across a small gap, they may be contained in a single module (usually with a slot in it) as shown in section 2 of Figure 3-3. This is often referred to as an *optical switch* (not to be confused with the solid-state switching devices used in telecommunications). It is sometimes described as a *photointerruptor* or *photointerrupter*.

A *reflective optical sensor* also consists of a light emitter and a light detector, but they are placed adjacent to each other, facing in the same general direction. When they are mounted in one module, as is often the case, the arrangement is properly known as a *retroreflective sensor*. Either way, the combination may be triggered in one of two ways:

- An object passing in front of the light beam reflects it back to the detector. The object must be naturally reflective (for example, glass containers or white boxes on a conveyor), or must have a reflective patch applied to it, or the light source must be bright enough to reflect from an object that is not highly reflective. This configuration is shown in section 3 of Figure 3-3.
- A stationary reflector can be mounted opposite the light emitter, in which case a detector beside the light emitter is triggered when an object interrupts the reflected light beam. This configuration is shown in section 4 of Figure 3-3.

Transmissive Optical Sensors

A light source and light detector may be sold as separate components in a matched pair. An example is the Vishay TCZT8020, shown in Figure 3-4. These components are small, each measuring no more than 5mm x 3mm. They are designed to be placed just a few millimeters apart. The light source is an infrared LED, while the detector is a **phototransistor** (see Chapter 22 for information about phototransistors).

The source and detector are both designed to use 5VDC. Output from the phototransistor is an open collector. Current through the collector must not exceed 50mA, and must be limited by a pullup resistor of 100 ohms or more. Current through the source must not exceed 60mA, and must be limited by an appropriate series resistor.

Details on using an open-collector output will be found in the Appendix. See Figure A-4.

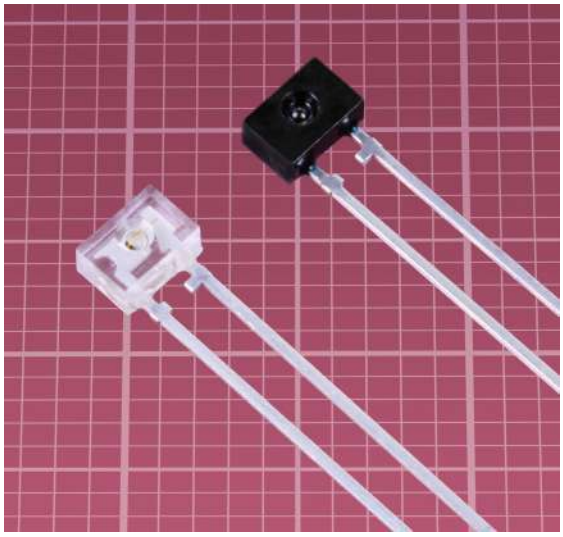

Figure 3-4 *A matched light source and light detector, for use as a transmissive optical sensor. The background grid is in millimeters.*

The Omron EE-SX range includes a variety of configurations of light source and detector separated by a 5mm slot in one module. The source is an infrared LED, and the detector is a phototransistor.

The Omron components tolerate a wide range of supply voltages, from 5VDC to 24VDC, with no series resistor necessary for the LED. Open-collector output from the phototransistor can tolerate 50mA to 100mA, depending on the particular version of the sensor. A red indicator LED is illuminated when an object blocks the slot in the sensor. Some versions have a high output when the slot is open, while others have a high output when the slot is closed. Because of their various features, these sensors are relatively expensive.

A much cheaper optical switch is the Everlight ITR9606 (described by the manufacturer as an "opto interrupter"). It is pictured in Figure 3-5. This is intended as a 5V device and has an open-collector output. It requires a series resistor for the LED and a pullup resistor for the open-collector output. Many similar detectors are available.

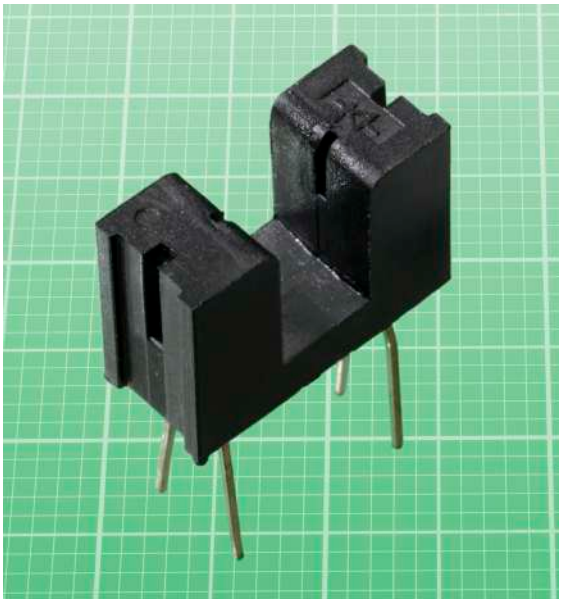

Figure 3-5 *A low-cost transmissive sensor, more commonly known as an optical switch. The background grid is in millimeters. The slot in the sensor is about 5mm wide.*

For longer-distance detection, an infrared receiver can be mounted separately from an infrared LED. The TSSP77038 from Vishay detects infrared light from as far away as 50cm, and pulls its open collector output low in response. The light must be modulated at 38kHz.

Polulo Robotics and Electronics sells a very affordable breakout board containing a TSSP77038 receiver paired with an infrared LED modulated by a 555 timer. It is shown in Figure 3-6. Because this board contains a light source as well as a light detector, it is really a retroreflective sensor.

Where distances exceeding 1 meter are involved, a laser coupled with a phototransistor that is shielded from ambient light may be necessary.

Figure 3-6 *The Vishay TSSP77038 installed with an appropriate light source on a breakout board from Polulo Robotics and Electronics.*

Retroreflective Optical Sensors

As is the case with a transmissive object detector, the retroreflective type may be listed by vendors as an *optical switch*. Other terms used in datasheets include *reflective interrupter*, *reflective object sensor*, *reflective optical sensor*, *reflective photointerrupter*, *opt-pass sensor*, and *photomicrosensor (reflective)*. The remarkable lack of standardization in terminology creates a problem when searching online for these devices. Why so many different names evolved for the exact same component is unclear.

Many retroreflective object-detection sensors are available in packages ranging from 5mm x 5mm to 10mm x 10mm in size. Almost all of these modules are analog devices using an infrared LED as the light source and a phototransistor as the sensor, with an open-collector output. (For more information about phototransistors, see Chapter 22.)

With a suitable pullup resistor, the output voltage will be proportional with the inverse of the distance. If V is the voltage, d is the distance, and k is a conversion factor:

```
V = k * ( 1 / d)
```

While many of the smaller modules are surface-mount, some have leads, as shown in Figure 3-7. A major limitation of these small components is that they have a very limited range, typically less than 5mm. They can only be used in applications such as process control where the position of a target is controlled and predictable.

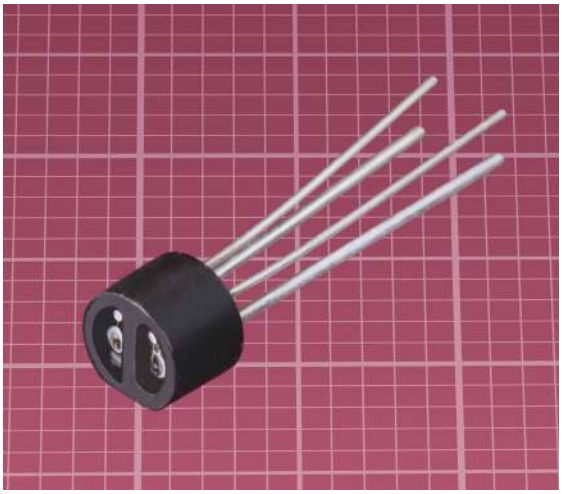

Figure 3-7 *The Rodan RT-530 is a small object-presence sensor with a limited range typical of this type of retroreflective component. The background grid is in millimeters.*

Another example of a retroreflective sensor in a small package is the Optek OPB606A shown in Figure 3-8. The background grid is in millimeters.

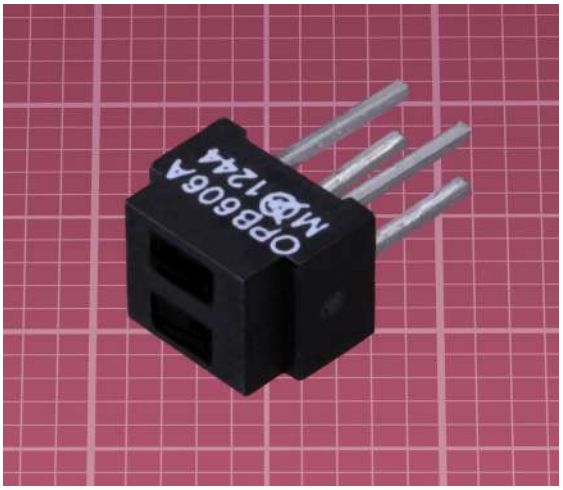

Figure 3-8 *The Optek OPB606A. The background scale is in millimeters.*

A retroreflective module, with a lensed LED and lensed phototransistor to focus the outgoing and reflected beams, is the Vishay TCRT5000 shown in Figure 3-9.

Figure 3-9 *The Vishay TCRT5000 retroreflective sensor. The background grid is in millimeters.*

Retroreflective modules that have a greater range tend to be physically larger, less common, and more expensive. Sharp makes a popular series. Some part numbers and distance sensing limits are: GP2Y0D805Z0F (5mm to 5cm), GP2Y0D810Z0F (2cm to 10cm), and GP2Y0D815Z0F (5mm to 15cm). Figure 3-10 shows the GP2Y0D810Z0F mounted on a small breakout board from Polulo Robotics and Electronics. The board is useful, as the pins on the sensor are spaced only 1.5mm apart. The size of the board is approximately 8mm x 20mm.

Figure 3-10 *The Sharp GP2Y0D810Z0F detection sensor mounted on a board from Polulo Robotics and Electronics. From a photograph by Adafruit Industries.*

Each of the detection sensors in this series is described in Sharp datasheets as a "Distance Measuring Sensor Unit," but in fact they do not measure distance. A single output is normally logic-high and drops to logic-low when a target is within range. Sharp refers to this as a "digital" output, but in fact it is binary, and should not be confused with the digital buffer on a more sophisticated proximity sensor that contains an analog-to-digital converter and provides a numeric output.

It is important to distinguish the Sharp object-presence sensors listed above from the range of Sharp **proximity** sensors described in the entry in Chapter 5. The proximity sensors are physically larger, and most have an analog output that varies with the distance of a target.

Magnetic Sensors

Prepackaged magnetic sensing units are sold in many configurations for industrial and military applications. Although they may be referred to as "magnetic sensors," they are outside the scope of this Encyclopedia. Here we discuss board-mounted components. Almost always, they use a *reed switch* or a *Hall-effect* sensor as their sensing elements.

Reed Switch

A reed switch is a magnetically activated mechanical switch. It consists of two metallic contacts in a small enclosure that is usually a glass capsule. The contacts are magnetic, and move in response to a magnetic field. A permanent magnet is used to activate the switch. Two reed switches are shown in Figure 3-11.

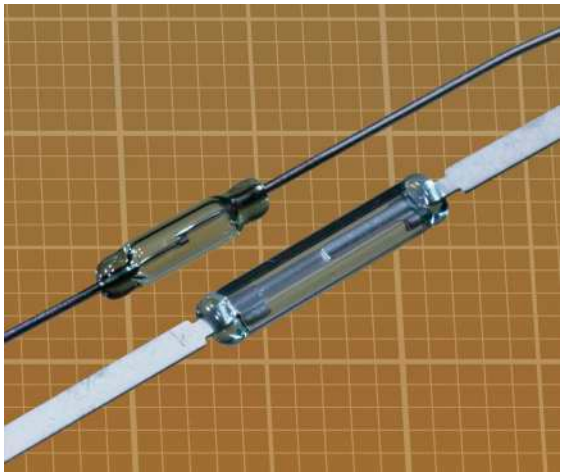

Figure 3-11 *Two SPST reed switches. Although the contacts may seem to be touching, in fact they are separated by a tiny gap, and these switches are the normally open type. The background grid is in millimeters.*

A reed switch exhibits a small amount of *hysteresis*, because the magnetic field strength required to overcome the mechanical resistance of the springy contacts is greater than the field strength required to keep them closed.

Very small electromagnetic relays that only switch a very low current may use a coil-activated reed switch. For purposes of this Encyclopedia, such a component is considered to be a relay, not a sensor. For more information about **relays**, see the entry in Volume 1.

The most common everyday application for a reed switch is in an alarm system that is triggered by an intruder entering a building. A magnet in a sealed plastic enclosure is attached to a door or window, while a reed switch, in another sealed plastic enclosure, is attached to the frame, very close to the magnet. Typical components of this type are shown in Figure 3-12. A diagram illustrating the mode of operation appears in Figure 3-13.

Figure 3-12 *A typical alarm sensor to detect the opening of a door or window. The nearer module contains a magnet, while the module behind it contains a reed switch.*

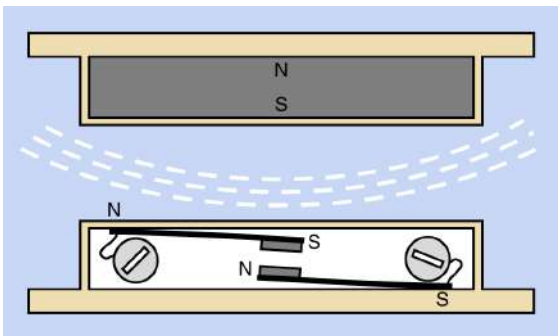

Figure 3-13 *The dashed white lines suggest the magnetic field that closes the contacts of a reed switch.*

So long as the alarmed door or window remains closed, the magnet activates the reed switch. If the door or window is opened, the magnet moves away from the reed switch, and its contacts relax. Usually in this application the reed switch is the normally open type, and is held in its closed state by the magnet. This allows multiple switches to be wired in series, completing a circuit. If a single switch opens, the circuit is broken, and an alarm is triggered.

Reed Switch Variants

Most reed switches are SPST, either normally open or normally closed, although normally

open variants are more common. Some switches are SPDT, although this variant is relatively rare. An example of a SPDT reed switch is shown in Figure 3-14.

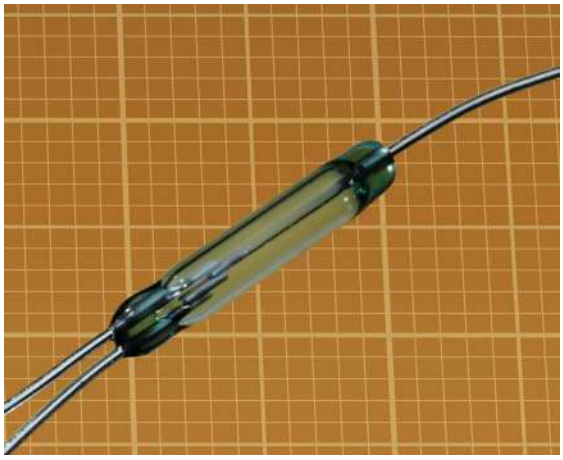

Figure 3-14 *A SPDT reed switch. The background grid is in millimeters.*

The physical size of a reed switch tends to vary roughly in proportion with its current-switching capability.

Reed switches are most commonly supplied with axial leads. A minority are available for surface-mount applications.

Some reed switches are packaged in a plastic pod to provide physical protection for the glass capsule.

Reed Switch Values

The datasheet for a reed switch is likely to contain the following values:

Pull-in: The minimum magnetic field strength required to activate the switch, often measured in ampere-turns.

Drop-out: The maximum magnetic field strength that allows the contacts of the switch to relax, often measured in ampere-turns. Pull-in will be a higher value than drop-out.

Maximum switching current: While a few industrial reed switches can switch as much as 100A, they are uncommon and expensive. A common value for a reed switch about 15mm long is 500mA.

Maximum carry current: If specified, it will be higher than the switching current.

Maximum switched power: Because a reed switch can be used with alternating current, its switching capability may be expressed in watts, or as VA (volts multiplied by amps). 10VA is a common value.

Maximum voltage: While reed switches are most often used with low voltages, some are rated to switch up to 200V.

How to Use a Reed Switch

While an optical object presence sensor may be supplied in a single package containing a light emitter and a light detector, a reed switch always requires an activating magnet that is mounted separately. For reliable operation, the maximum distance between the switch and the magnet is usually restricted to a few millimeters.

The orientation of a magnet that activates a reed switch is not crucial, but will affect the sensitivity of the switch. A manufacturer's datasheet should be consulted for information about optimal magnetic polarity.

As in other mechanical switches, the contacts in reed switches vibrate very briefly when opening or closing. This is known as *contact bounce*, and can be misintepreted as a series of separate signals by digital logic or a microcontroller. *Debouncing* with hardware designed for that purpose, or software (in a microcontroller), may be necessary. See the entry on **switches** in Volume 1.

Hall-Effect Sensor

A Hall-effect sensor responds to a magnetic field by generating a small voltage, usually amplified by a transistor included in the package with the sensor.

When a Hall sensor is in its "off" state (i.e., not triggered by a magnetic field), the sensor creates high resistance between the collector of an internal NPN transistor and negative ground. Consequently, if voltage through a pullup resistor is applied to the collector, the voltage on the collector will be high.

When the sensor is in its "on" state, the resistance drops, the voltage supplied to the collector from the pullup resistor is shunted to ground, and the output voltage appears to go low. As a general rule:

- Activated Hall sensors appear to have a low output.
- Inactive Hall sensors appear to have a high output.

Information about using open-collector outputs is contained in the Appendix. See Figure A-4.

The clean output, reliability, small size, and cheapness of Hall sensors have encouraged their use in devices as different such as hard drives, cameras, keyboards, and automobiles. They are useful in almost any situation where a sensor must detect a mechanical operation at close range. Three through-hole Hall sensors are shown in Figure 3-15. Surface-mount versions are much smaller.

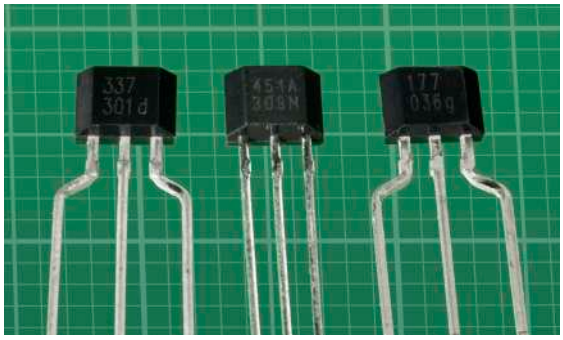

Figure 3-15 *Three through-hole Hall-effect sensors. The background grid is in millimeters.*

How a Hall-Effect Sensor Works

When current is flowing through the length of a conductor, and a magnetic field is applied across the width of the conductor, the field generates a force causing electrons and electron holes to accumulate asymmetrically on opposite sides. This is known as the *Hall effect*.

The voltage difference between the electron-rich and electron-depleted zones is known as the *Hall voltage*. It is proportional to the magnetic field, and inversely proportional to the density of free electrons in the material. For this reason, the Hall effect is easiest to observe in semiconductors, where the density of electrons or electron holes is low.

Hall sensor components contain amplifier circuitry in addition to the sensing element itself. Typically there is an open-collector output, and a comparator or Schmitt trigger to provide some hysteresis.

Hall-Effect Sensor Variants

Four primary variants of Hall sensors are widely used.

Unipolar Hall Sensor

This is activated when an external magnetic field exceeds a threshold value. When the field diminishes, the sensor switches off. Unipolar sensors are available in versions activated by the north magnetic pole or south magnetic pole.

Bipolar Hall Sensor

Proximity to one magnetic pole will switch it on. Proximity to the opposite magnetic pole will switch it off. The sensor remains in its current state (on or off) in the absence of a magnetic field.

Omnipolar Hall Sensor

Proximity to a strong magnetic field of either polarity will switch it on. Removal of the magnetic field will switch it off. An omnipolar sensor can be thought of as a pair of unipolar sensors mounted in opposite directions and

with their (open-collector) outputs wired together. This component functions similarly to a reed switch, although of course it still requires a power supply.

Linear Hall Sensor

Also known as an *analog* Hall sensor, its output voltage varies in proportion to an external magnetic field instead of switching cleanly between high and low states. When no magnetic field is detected, the output is half of the sensor's supply voltage. In response to one magnetic polarity, the output can drop almost to zero. The opposite polarity can increase the output almost to supply voltage.

The output from a linear sensor usually is supplied from the emitter of an internal NPN transistor, not the collector. A minimum 2.2K resistor should be connected between output and ground.

The variable output can be interpreted as a measurement of distance between the sensor and a magnet. In this mode, a Hall sensor functions as a **proximity** sensor. However, it is not usually capable of measuring a distance of more than 10mm.

Other Applications

Hall sensors are incorporated in other types of components. A **magnetometer**, for example, may contain Hall sensors.

Additional discussion of Hall-effect sensors, with test circuits, will be found in the book *Make: More Electronics*, from which some of the figures here have been excerpted.

Values

Magnetic field at operating point is the minimum field necessary for the output to switch on. It is measured in tesla or gauss, and the abbreviation B_{OP} is used.

Magnetic field at release point is the maximum field that allows the output to switch off. It is measured in tesla or gauss, and the abbreviation B_{RP} is used.

Magnetic field range may be specified for linear (analog) Hall sensors.

Supply voltage may range as widely as 3VDC to 20VDC, or may be restricted between 3VDC to 5.5VDC. Check datasheets carefully.

Sourcing or sinking capability for the open-collector output is typically 20mA.

How to Use a Hall-Effect Sensor

Hall sensors are often made in 3-pin packages. Through-hole variants are usually made of black plastic and look like TO-92 transistors, but are slightly smaller.

Surface-mounted variants are common.

A typical through-hole Hall sensor has one bevelled face and a flat face on the opposite side. The bevelled face may be referred to as the "front" of the component in a datasheet. The sensor responds when an appropriate magnetic pole is brought close to the front face of the sensor.

The part number printed on the front of the sensor may be abbreviated as three digits. The code below this usually refers to the date of manufacture.

A simple circuit for a Hall sensor resembles a typical circuit for a phototransistor. Positive supply voltage and negative ground are applied to two of the three leads. Positive voltage is also applied, through a pullup resistor, to the third lead, which is the open-collector output (except in the case of a linear Hall sensor, described previously). The output pin is then tapped as the output from the sensor, to be applied to a component that will not draw more than 20mA.

Configuration of Object Presence Sensors

While most of the following suggestions relate specifically to Hall-effect sensors, some general principles may be applied to optical sensors.

Linear Motion

A presence sensor can be activated when the triggering source (such as light or a magnet) approaches it directly. This is sometimes referred to as *head-on mode*. Alternatively, triggering can be arranged when the source moves past the sensor. This is sometimes referred to as *slide-by mode*. The two modes are illustrated in sections 1 and 2 of Figure 3-16.

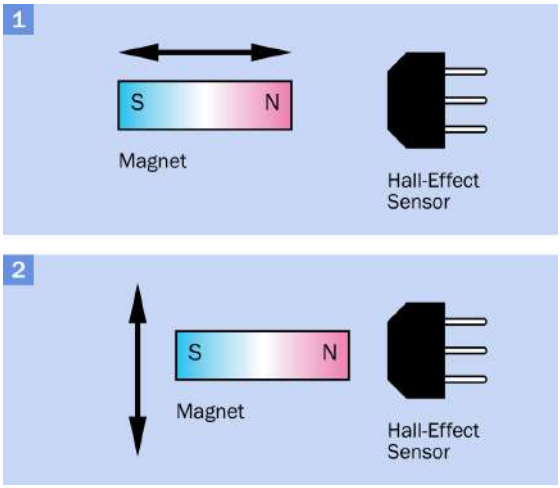

Figure 3-16 *Section 1 of this figure illustrates a presence sensor being used in head-on mode, while section 2 illustrates slide-by mode.*

Slide-by mode may be preferred because it eliminates the risk of damage to the sensor if overshoot occurs in head-on mode.

In slide-by mode, using a bipolar Hall-effect sensor, two magnets can be placed together with opposite polarity, creating a very steep transition in the overall magnetic field. This minimizes the risk of imprecise triggering. Using neodymium magnets, the triggering point can be adjusted with a precision of 0.01mm or better. See Figure 3-17.

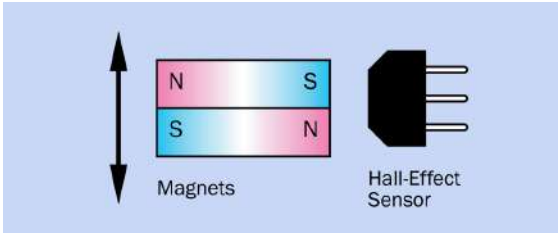

Figure 3-17 *In slide-by mode, two magnets with opposite polarity can be put together to create a very precise transition in a bipolar Hall-effect sensor.*

Sensing by Interruption

An *optointerrupter* is sensitive to an object passing between the light source and the light sensor. A comparable arrangement can be used with a Hall-effect sensor or a reed switch, but only if the interrupting object is thin and ferrous. This configuration is known as a *ferrous vane interruptor*.

Note that the magnet will exert significant force on the ferrous vane. This becomes an issue in sensors where the mechanical force is limited—for example, in paper-path sensors in a photocopy machine.

Additional information about the detection and measurement of moving objects will be found in the entry describing **linear position** sensors. See Chapter 6.

Angular Motion

One or more magnets can be used with a Hall-effect sensor to detect the angular motion, relative angular position, or absolute angular position of a rotating part. This data can be used to determine its speed of rotation. Some techniques to achieve this are described in the entry describing **rotary position** sensors. See Chapter 7.

Sensor Comparisons

Advantages of Optical Presence Sensors

- Not affected significantly by magnetic fields that can interfere with operation of a Hall-effect sensor or a reed switch.
- May be contained in a small, all-in-one package.
- Some optical sensors can operate over a distance of 50cm.
- Very well suited to sensing an object that blocks the light source (the *optointerrupter* configuration).

Disadvantages of Optical Presence Sensors

- Must have clear line-of-sight with the object and/or a reflector.
- Performance will be degraded by accumulation of dust or dirt.
- Limited lifetime of LED light source, if used continuously.
- May be accidentally triggered or impaired by some types of ambient light.
- Often requires a load resistor for the LED as well as a pullup resistor for the open-collector output.
- Range of acceptable voltage is usually narrow.

Advantages of a Reed Switch

- No polarity.
- No additional components required, other than a magnet.
- Able to switch AC or DC.
- Able to switch to voltages as high as 200V in some cases.
- Can be maintained by a magnet in open or closed state indefinitely without any power consumption.
- Many variants are capable of switching 500mA, and higher-current types are available.
- Can be activated through nonmagnetic materials (plastic, paper).
- Not significantly affected by dust or dirt that can degrade performance of an optical switch.

Disadvantages of a Reed Switch

- Requires a separate magnet (which must be placed carefully to avoid affecting other components).
- Cannot be miniaturized to the same extent as a surface-mount chip.
- Glass envelope is easily damaged.
- Arcing may occur between contacts.
- Will not work reliably when the activating magnet is more than a few millimeters from the switch.
- Can be activated accidentally by other magnetic fields.
- When sensing an object that comes between the switch and a magnet, only a ferrous object can be used.
- Must be debounced when connected with a logic chip or controller.

Advantages of a Hall Effect Sensor

- Robust solid-state component.
- Can be miniaturized for surface-mount applications.
- Very low cost.
- Fast response.
- No contact bounce.

- Extremely durable, with an almost unlimited lifetime.
- Not significantly affected by dust or dirt that can degrade performance of an optical switch.
- Low cost.

Disadvantages of a Hall Effect Sensor

- Requires a separate magnet (which must be placed carefully to avoid affecting other components).
- Open-collector output typically limited to 20mA or less.
- May be vulnerable to magnetic fields.
- When sensing an object that comes between the switch and a magnet, only a ferrous object can be used.

What Can Go Wrong

Optical Sensor Issues

Deterioration of LEDs

Most object presence sensors depend on infrared LEDs as a light source. An LED has many virtues (discussed in Volume 2), but does tend to suffer from gradual reduction in light output over a period of years. In a device such as a photocopy machine, which is used intermittently and may have an "economy" or "sleep" mode in which most of its components are powered down, LED-based detectors should last almost indefinitely. In other applications where an LED is powered continuously, its light output will diminish signicantly in 3 to 5 years. Bearing this in mind, an optical sensor should be chosen to operate well below its light-detection limits.

Object Too Close

Some optical and ultrasonic detectors triangulate on an object; that is, the light emitter and light sensor are angled slightly toward each other (as shown in sections 3 and 4 of Figure 3-3). The signal output from the sensor will peak at the distance where the emitter and sensor focus at a point. Consequently the output voltage will diminish when the object comes closer, which may create the misleading impression that the object is moving further away. To avoid spurious readings, detectors should not be used with objects that are closer than the minimum distance specified by the manufacturer.

Reed Switch Issues

Mechanical Damage

Bending the axial leads on a reed switch can easily fracture the glass envelope. Reed switches must be handled with care.

Contact Bounce

If the switch is wired to the input of a logic chip or microcontroller, contact bounce when the switch opens or closes is likely to be misinterpreted as multiple switching events. Debouncing will be necessary, either by additional components or by insertion of a momentary delay in the code embedded in a microcontroller.

Arcing

When switching high voltages or currents, an arc may be created briefly between the switch contacts, most often when they are moving from the closed to the open state. The arc erodes the contacts of the switch. Inductive loads make the arcing problem worse. If the switched voltage is kept below 5V arcing generally does not occur, extending the life of the switch.

passive infrared sensor

4

In coloquial speech, the term *motion sensor* is usually understood to mean a **passive infrared** motion sensor.

The acronym *PIR* is often used for a passive infrared sensor. It is always capitalized, without periods.

Object presence sensors and **proximity** sensors require an active source of a magnetic field, ultrasound, or infrared radiation. A passive infrared sensor does not require any such source, and responds passively to heat radiated from the object that is being detected.

OTHER RELATED COMPONENTS

- **object presence** sensor (see Chapter 3)
- **proximity** sensor (see Chapter 5)

What It Does

A **passive infrared** motion sensor, often described as a *PIR*, detects *black-body radiation*, which all objects emit as a function of their temperature relative to absolute zero. The sensor responds to infrared radiation centered around a wavelength of 10µm (10 microns, or 10,000nm). This is the approximate body temperature of people and animals.

The word "passive" in the term "passive infrared" refers to the behavior of the detector, which receives infrared radiation passively. **Proximity** sensors must generate their own infrared radiation actively, which is interrupted or reflected by nearby objects. See Chapter 5.

Schematic Symbols

Schematic symbols that are sometimes used to represent a passive infrared motion sensor are shown in Figure 4-1.

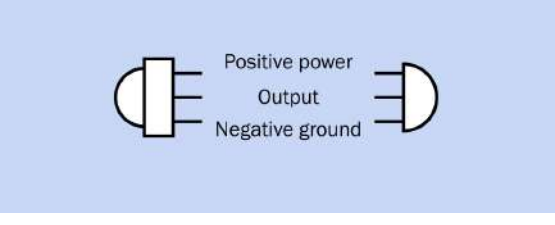

Figure 4-1 *Schematic symbols that may represent a passive infrared motion sensor. The orientation (pointing left or right) is arbitary. The pin sequence may vary.*

Applications

Motion-sensitive outdoor lighting almost always is based around a PIR. Similarly, a security system may sound an alarm or activate a video camera when a PIR indicates human activity.

Wildlife monitoring systems use PIRs to start a video camera that can then run for a preset interval.

Warning systems for automobiles have been developed that use a rear-facing PIR to detect pedestrians.

Industrial indoor lighting may use PIRs that switch the lights on automatically when people enter a room, and then switch the lights off (after a timed delay) when people are no longer detected in the room. The goal is to prevent wastage of energy as a result of employees forgetting to switch the lights off.

How It Works

A PIR module contains multiple components. Most visible is an array of at least 15 small lenses that focus infrared light from zones in the environment onto a *pyroelectric detector*, also known as a *pyroelectric sensor*. The response of the detector is processed by an amplifier, so that the signal can trigger an electromechanical **relay** or **solid-state relay** (see Volume 2). The relay operates an external device such as a light or an alarm.

Additional circuitry may allow the user to control the sensitivity of the PIR module and the length of time that the relay remains closed. The user may also be able to set the time of day when the PIR is active, or an additional **phototransistor** can shut down the PIR during daylight hours. If a phototransistor is included, its sensitivity is adjustable. For more information about phototransistors, see Chapter 22.

Pyroelectric Detector

The pyroelectric detector is actually a type of *piezoelectric* device. It is based around a wafer of lithium tantalate, which generates a small voltage in response to incident thermal radiation. However, like other piezoelectric components, it does not respond to a steady-state input, and must be activated by a transition. This distinguishes it from other types of light sensors, such as an infrared **photodiode**, in which the response is consistently related to a temperature input.

The response of a pyroelectric detector is suggested by the graphs in Figure 4-2.

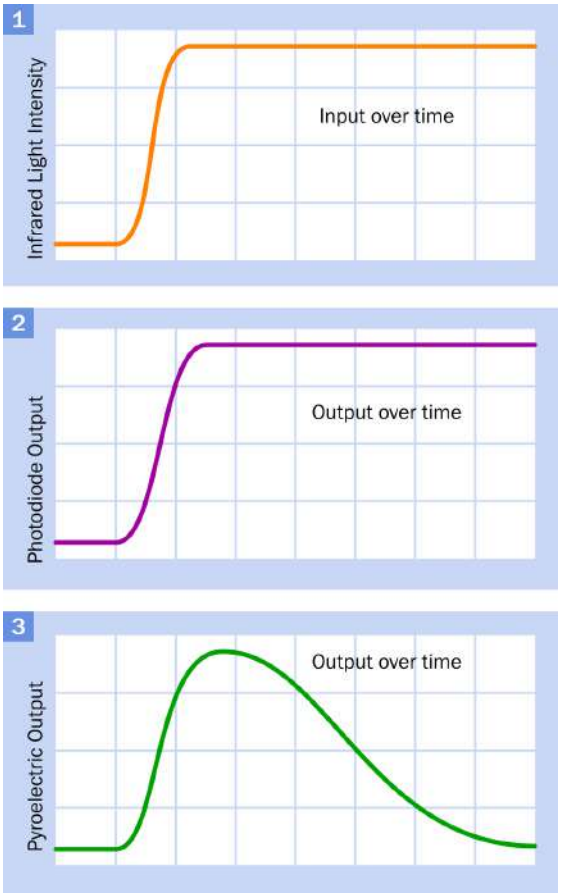

Figure 4-2 *Top: incident infrared light intensity. Center: the voltage output from a hypothetical photodiode. Bottom: the voltage output from a hypothetical pyroelectric detector.*

A pyroelectric detector in a PIR module is mounted in a sealed metallic container, as shown in Figure 4-3. The rectangular window in the detector is usually made of silicon, which is opaque to visible wavelengths but transparent to long-wave infrared radiation.

Elements

The pyroelectric detector used in a PIR contains at least two *elements* with opposite polarities, connected in series. If a sudden change in temperature affects both elements equally, their

responses will cancel each other out. Thus, the detector ignores changes in ambient temperature. However, if a source of infrared radiation in the appropriate waveband affects one element before the other, the detector will emit two pulses of opposite polarity. See Figure 4-4.

Figure 4-3 *A pyroelectric detector mounted on a small circuit board in a passive infrared radiation sensor.*

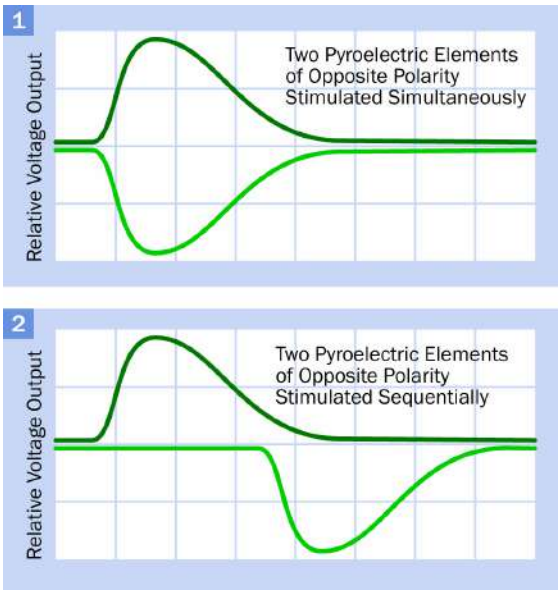

Figure 4-4 *Top: in a pyroelectric detector, if a change in temperature affects two elements of opposite polarity simultaneously, their voltages cancel each other out. Bottom: if one element is triggered before the other, the detector emits a signal.*

Lenses

Lenses are used to trigger the elements sequentially. Each lens faces toward one visible zone in the target area. When a source of infrared radiation moves from one zone to the next, it energizes the elements alternately, creating an output.

In some PIRs, four pyroelectric elements are used instead of two, to provide better coverage. The pairs of sensors may be wired in series or in parallel, but the principle remains the same.

The lenses are molded into a polyethylene dome that is often white and covers the pyroelectric detector. The dome appears smooth on the outside, but fine patterns of concentric ridges are molded on the inside. These are *fresnel lenses*, which are much cheaper, smaller, lighter, and easier to fabricate than conventional optical lenses. A fresnel lens introduces some distortion and aberration, but these defects are unimportant in a PIR.

Figure 4-5 illustrates the principle of a simple fresnel lens. The first section of this figure shows a conventional optical lens with one flat side and one curved side. A distant object emits almost-parallel beams of infrared light that are focused by the lens. Section 2 shows the same lens divided into segments that are stacked with no space between them. They behave in exactly the same way as the original lens. In section 3, each segment has been reduced in width, but because the optical faces still have the same geometry, they will still have the same function, although a small amount of distortion will be added by the reduction in width. This is a fresnel lens, which found an early application in lighthouses, where it greatly reduced the weight of very large glass lenses that focused the beam.

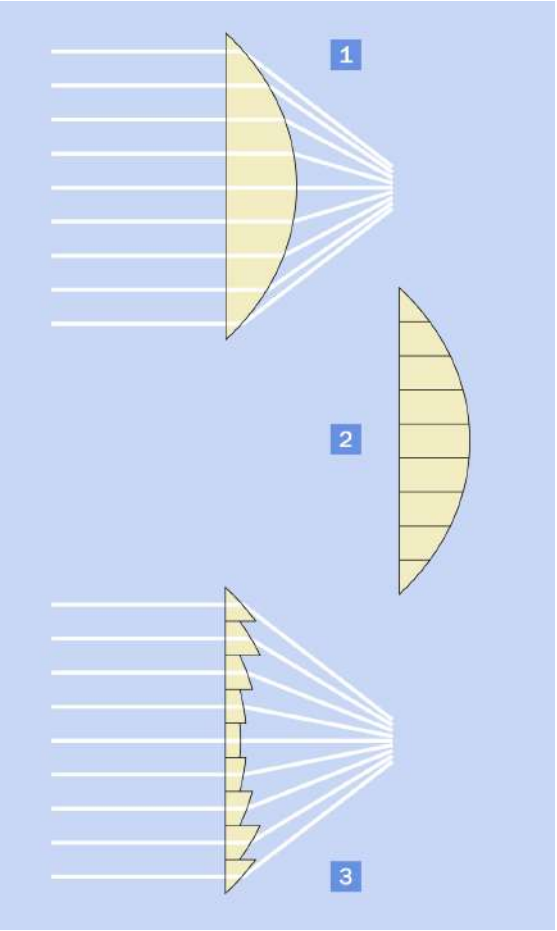

Figure 4-5 *Principle of a fresnel lens. See text for details.*

The same principle can be applied to a lens in which both surfaces are curved, as shown in Figure 4-6. In practice this will introduce more imperfections in the image, although some compensation is possible by adjusting the exact shape of the lens.

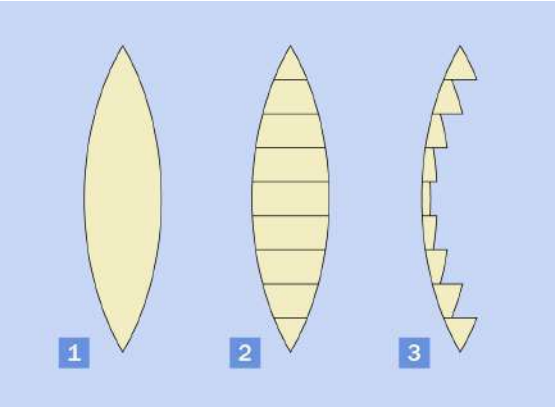

Figure 4-6 *The principle of a fresnel lens applied to a conventional lens in which both surfaces are curved.*

Figure 4-7 shows three curved fresnel lenses placed edge-to-edge, seen from above. In section 1 of this figure, infrared rays from a distant source are focused by the first lens onto the right-hand element of a pyroelectric sensor. In section 2, the external source has moved laterally, and the rays now focus on the left-hand element. In section 3, the source has moved into the zone covered by the centrally located fresnel lens, which focuses on the right-hand element again. The fluctuating inputs will trigger the sensor.

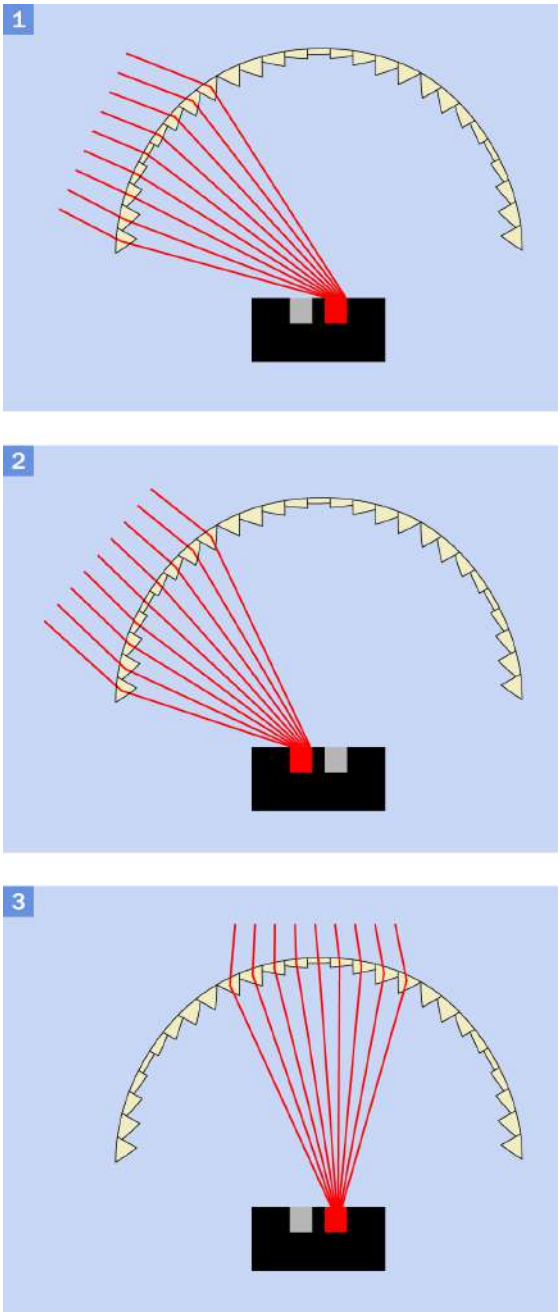

Figure 4-7 *Sections 1, 2, and 3 show fresnel lenses focusing an external source of infrared radiation on individual elements of a pyroelectric sensor.*

PIRs may combine fresnel lenses in a variety of patterns. Figure 4-8 shows an evenly weighted mosaic that would be suitable for a motion detector mounted on a ceiling, facing directly downward. Figure 4-9 shows a pattern weighted toward lateral motion, providing less sensitivity for motion above and below the primary band.

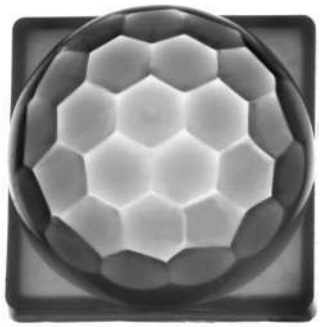

Figure 4-8 *An evenly weighted mosaic of fresnel lenses.*

Figure 4-9 *A mosaic weighted more toward sensing lateral motion. The grooves of the fresnel lenses are visible.*

Variants

PIR sensor modules are available mounted on a small board such as the one shown in Figure 4-10 from Parallax, Inc. The detection range is 5 to 10 meters, selected by a jumper on the board. The three pins visible in the photograph are for power supply (3VDC to 6VDC), ground, and output. The output can source up to 23mA with a 5VDC power supply. Power consumption of the module is only 130µA when it is idle, or 3mA when it is active but has no load.

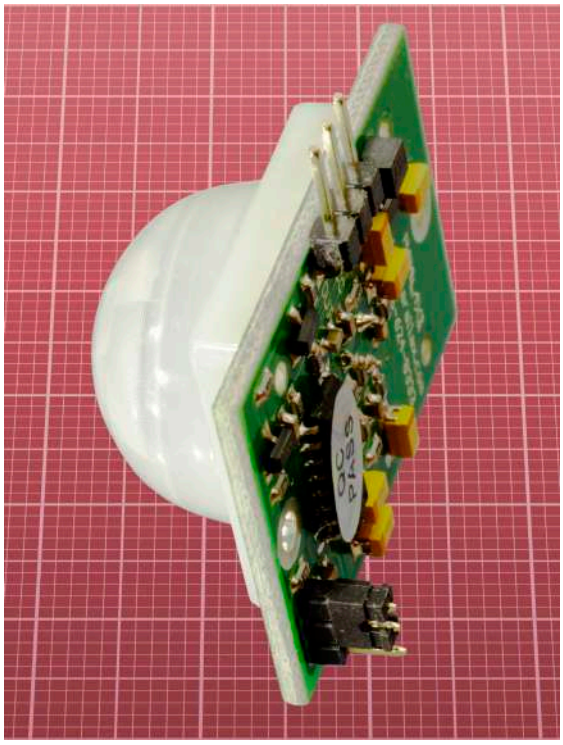

Figure 4-10 *A passive infrared detector mounted with basic necessary components on a small board.*

A board of this type still requires additional components to set the "on" time for a light or alarm, and to deactivate the PIR during daylight hours.

Various lens patterns are available, sold separately.

A PIR can be bought as a single component containing two elements and FET transistors to amplify the signal. Surface-mount and through-hole versions are available, requiring a typical power supply of 3VDC to 15VDC.

However, a PIR bought as a "bare" component requires significant external circuitry, using comparators or op-amps. Circuit design is non-trivial, entailing practical problems such as op-amps being sensitive to voltage spikes caused by activating a relay that shares the same power supply.

An easier alternative is an all-in-one detector, lens, and control circuit such as the Panasonic AMN31111, which is ready for board mounting. Its small output current of 100µA would be capable of activating a solid-state relay. Similar Panasonic PIRs offer a variety of ranges, sensitivities, and supply voltages.

The AMN31111 is in Panasonic's AMN series. There are many type numbers for combinations of analog or digital output, lens shape, and black or white lens. A selection of lens shapes, derived from the manufacturer's datasheet, is shown in Figure 4-11.

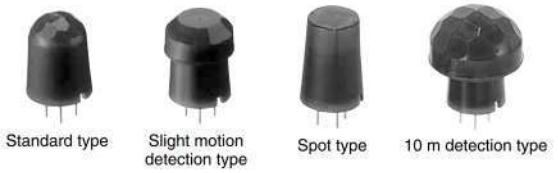

Figure 4-11 *Four lenses from the Panasonic AMN series of passive infrared sensors.*

What Can Go Wrong

Temperature Sensitivity

In warmer weather, objects in the field of view of a PIR will tend to be warmer, and the temperature difference between them and human skin will diminish. This can degrade the performance of a PIR.

Detector Window Vulnerability

The silicon window on a detector is vulnerable to dirt or grease. Avoid touching the component if it is not protected by lenses.

Moisture Vulnerability

Water absorbs far-infrared light. Consequently, condensation on the lens or detector can degrade performance, and a PIR may not function in heavy rain or snow.

proximity sensor

5

Proximity sensors that use infrared, ultrasound, and capacitance are described here. This Encyclopedia does not include proximity sensors that use magnetism, inductance, or other methods of determining distance.

Sometimes proximity sensors are referred to as *distance sensors*. An ultrasonic proximity sensor may be described as a *range finder* or a *ranger*.

High-end ultrasound proximity sensors sold as large, sealed modules with cabling can monitor the status of industrial processes. These commercial units are outside the scope of the Encyclopedia.

A sensor that detects whether an object is present, but does not measure the distance to it, is considered to be an **object presence** sensor and has its own separate entry. See Chapter 3. Many devices that are sold as proximity sensors or distance sensors actually do not provide meaningful distance data, and therefore in this Encyclopedia they are included with presence sensors.

Phototransistors and **photodiodes** may be used as sensing elements in proximity sensors. These components have their own entries as light sensors. See Chapter 22 and Chapter 21.

OTHER RELATED COMPONENTS

- **object presence** sensor (see Chapter 3)
- **passive infrared** sensor (see Chapter 4)

What It Does

A proximity sensor measures the distance between itself and a physical object that is often described as the *target*. The output from the sensor may be analog (voltage), serial data, or pulse-width modulation. It may be transmitted via a serial protocol such as SPI, TTL, or I2C, and may be stored as digital data in a register that is accessed by a microcontroller, using I2C. For additional details about protocol, see Appendix A.

Schematic Symbols

Either of the schematic symbols in Figure 5-1 may represent a proximity sensor, but are not used consistently. The sensor may also be represented as a rectangle containing text describing its function.

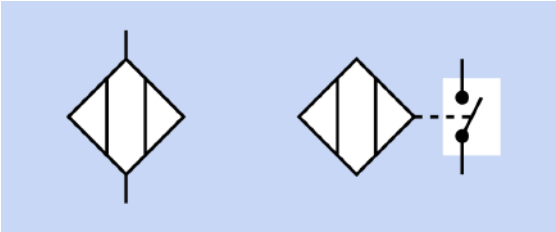

Figure 5-1 *Two ways to represent a proximity sensor in a schematic.*

Applications

In robotics, a proximity sensor can prevent a collision between a robot and an object or barrier in front of it. Some sophisticated proximity sensors can provide sufficient data for software to map the entire environment, but are outside the scope of this entry.

Proximity sensors can also be used in alarm systems, or for liquid-level sensing in storage tanks, or in automobiles to sound a warning if the driver is backing into an obstacle (although these devices are being augmented with rear-view video monitors).

In handheld devices, proximity sensors are used to sense the presence of the user's hand or face —for example, to shut down the display when a person raises a phone to talk into it.

Variants

This entry is subdivided to describe proximity sensors that use ultrasound, infrared light, and capacitance.

Ultrasound

An ultrasonic proximity sensor functions by emitting a short burst of sound and then listening for echoes from objects in front of it.

The sound is created by a **piezoelectric transducer** (see Volume 2) at a frequency between 30kHz and 50kHz, well above the range that can be detected by the human ear. The transducer may do dual duty as a microphone, sending and receiving sound on an alternating basis; or a second transducer, serving as a microphone, may be mounted beside the emitter on a small circuit board. The economically priced HC-SR04 is an ultrasound proximity detector popular in the robotics community, working reliably in the range of 2cm to 5m.

A board on which the sensor is mounted may include a microcontroller to measure the delay between propagation of a pulse and reception of the echo. Distance to the reflecting object is then calculated using the speed of sound in air at sea level, which is approximately 340 meters per second.

Infrared

An infrared proximity sensor requires a beam of infrared light from an LED that may be incorporated in the sensing module or mounted separately. Light reflects from the target and is detected by a **phototransistor** or **photodiode**. From the angle of the reflected light, onboard electronics can calculate the distance to the target by a process known as *triangulation*. See Figure 5-2. (This diagram is simplified. An actual sensor may use a linear array of photodiodes to assess the angle of the returning light beam.)

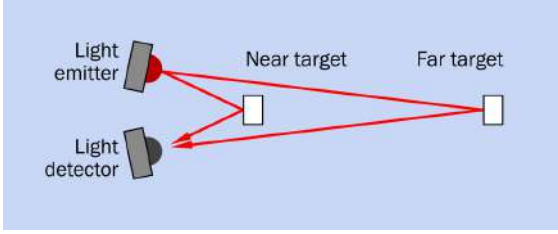

Figure 5-2 *An infrared proximity sensor determines the distance to an object by assessing the angle of reflected light.*

To reduce the risk of false positives, light from the LED contains only a narrow range of infrared wavelengths. Also, it is modulated at a frequency recognized by sensing circuitry in the module.

Relative Advantages

Ultrasound Devices

- Generally more suitable for detecting objects that are more than 1 meter away.
- Unaffected by direct sunlight, fluorescent tubes, and other light sources that can interfere with infrared devices.
- More accurate, often capable of placing objects within 5mm.
- Able to measure the distance to liquids and transparent objects, which may not be easily detected with infrared.

Infrared Devices

- Physically smaller—especially surface-mount versions.
- Able to measure the distance to soft objects, which may not be easily detected by ultrasound.
- More appropriate for targets that are closer than 10mm.
- More affordable.

Ultrasonic Examples

The proximity sensor in Figure 5-3 is a low-priced model, popular in the robotics community. Manufactured by MaxSonar, it uses a single element to send and receive. The manufacturer claims that it can detect a 6mm (quarter-inch) dowel 1.8 meters directly in front of it, and a 9cm dowel at 3.3 meters. This performance is beyond the capability of almost all infrared sensors.

MaxSonar offers a variety of sensors that appear physically very similar but have different range capabilities. Each has three outputs that can be accessed simultaneously: serial data at 9,600bps, analog voltage, and pulse-width modulation.

Figure 5-3 *The MaxSonar MB1003 can detect large solid objects as far away as 5 meters. Photo derived from an image by Adafruit.*

The serial output uses the RS232 protocol and consists of the letter R followed by four ASCII-coded numerals representing the measured range in millimeters. Thus, R1000 would indicate an object at 1 meter distance.

The analog voltage ranges linearly from 293mV when sensing an object at 300mm to 4,885mV for an object at 5,000mm.

The pulse-width output sends pulses ranging from 300µs indicating an object 300mm away to 5,000µs indicating an object 5 meters away.

The unit incorporates a temperature sensor that compensates for the lower density of air when its temperature increases. Weatherproofed versions are available. The power supply is 5VDC and must be smoothed.

Imports

Some international sources offer minimal paired ultrasound components at a very low price, such as the HC-SR04 from Cytron Technologies in Malaysia. See Figure 5-4.

Sound dispersion of the transducer is claimed to be plus-or-minus 15 degrees, and the claimed range is up to 4 meters. The module requires a triggering input pulse that must last at least 10µs. This prompts it to emit eight rapid

ultrasound signals at 40kHz. The module measures the response time and applies a high state to its echo pin for a duration that is proportional with the distance measured. An external microcontroller must time the duration, then divide by a factor of 58 to obtain distance in centimeters.

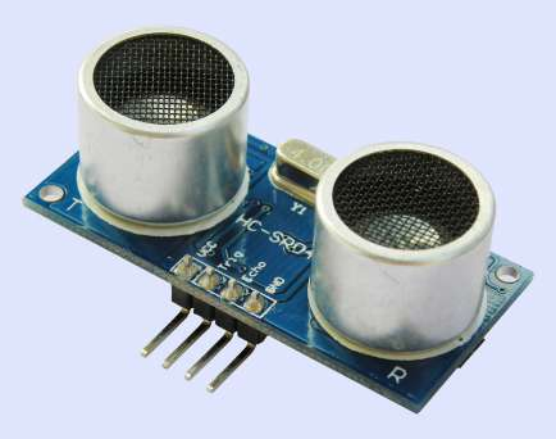

Figure 5-4 *The HC-SR04 is a very low-cost import that can provide acceptable performance when used with an external microcontroller.*

Many online sources offer simple code libraries for Arduino or PICAXE microcontrollers for use in conjunction with the HC-SR04.

Individual Elements

Individual ultrasonic components such as those shown in Figure 5-5 are available from many vendors. The user must add circuitry to generate a high frequency for a short duration, amplify the microphone signal, measure the time difference, and calculate distance.

Figure 5-5 *These components, listed as the "40TR12B-R ultrasonic sensor kit" by the online supplier Jameco, could form the basis of a DIY ultrasonic proximity sensor.*

Infrared Examples

Sharp manufactures four infrared proximity sensors that are widely regarded as accurate and easy to use. They are popular in the robotics community. Their part numbers and ranges are:

- GP2Y0A51SK0F (20mm to 150mm)
- GP2Y0A21YK0F (10cm to 80cm)
- GP2Y0A02YK0F (20cm to 150cm)
- GP2Y0A60SZLF (10cm to 150cm).

The GP2Y0A60SZLF is the most recent product, with the most impressive specification. The GP2Y0A21YK0F is shown in Figure 5-6.

Figure 5-6 *The Sharp GP2Y0A21YK0F infrared proximity sensor. The background grid is in millimeters.*

Sharp describes these sensors as having an *analog output*. The voltage on an output pin varies in inverse proportion with the distance being measured. The relationship is illustrated by the graph in Figure 5-7, derived from the manufacturer's datasheet for model GP2Y0A02YK0F.

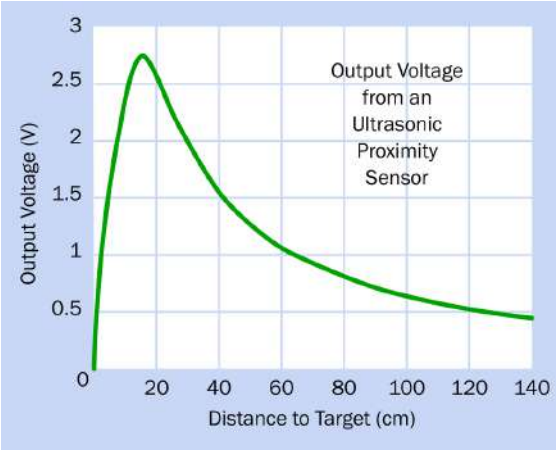

Figure 5-7 *Relationship between output voltage and target distance for a Sharp infrared proximity sensor, derived from the manufacturer's datasheet.*

The Sharp sensors can work with 5VDC. They consume around 30mA, except for the GP2Y0A60SZLF, which uses less current. Because the infrared LED functions in bursts, the manufacturer recommends protecting other components sharing the power supply by placing a 10µF capacitor across the sensor supply pins.

Trends in Infrared Proximity Sensing

Like many other types of sensors, proximity sensors have been affected by the huge market for handheld devices.

Handheld applications have had four consequences:

Miniaturization

Infrared proximity sensors are now commonly found in surface-mount chips measuring 5mm × 3mm or smaller.

Onboard processing

The status of a photodiode can be processed by a microcontroller on the same chip, to determine what the sensor is really "seeing." Input from an included ambient light sensor is factored into the evaluation.

Cost reduction

While chip-based proximity sensors have become increasingly sophisticated, their unit cost has plummeted, so that they are now actually much cheaper than simpler devices such as the Sharp analog sensors described above.

Complexity

Modern sensors must be programmed with a complex variety of instructions, and their coded output must be interpreted with a separate microcontroller running its own program. Whether this compensates for the low price and added functionality is something for the individual developer or experimenter to decide.

The Silicon Labs Si1145/46/47 series are chips with the kind of sophisticated capabilities required for handheld devices. An external microcontroller communicates with the sensor via an I2C connection, and can instruct it to adjust its distance range (from 1cm to more than 50cm), its analog-to-digital conversion sensitivity, and its current-sinking capability for up to 3 external LEDs. The chip incorporates ultraviolet sensing and ambient-light sensing capability. Its I2C connection can run at up to 3.4Mbps. Because its light output is pulsed for only 25.6µs every 800ms at 180mA, the average power consumption is only 9µA, assuming a supply voltage of 3.3VDC.

For additional details about protocols such as I2C, see Appendix A.

In addition to its use in handheld devices, the manufacturer suggests applications including heart-rate monitoring, pulse oximetry, and display backlighting control. These applications

require only a subset of the features built into the sensor, but its price is so low, it may be cost-effective even when many of its capabilities are unused.

Proximity sensors with comparable specifications are available from many manufacturers. Examples are the Vishay VCNL4040 and the Avago HSDL-9100. Figure 5-8 shows the Silicon Labs SI1145 on the left, and the Avago HSDL-9100 on the right.

Figure 5-8 *Two sophisticated surface-mount proximity sensors with digital output. Left: Silicon Labs SI1145. Right: Avago HSDL-9100. The background grid is in millimeters.*

Several guidelines must be observed when using this kind of sensor. First and most obviously, if an external LED is used, it must have a peak wavelength compatible with the photodiode in the sensor. The LED must be placed as near as possible to the photodiode, as reducing the separation increases the sensitivity; but crosstalk between the photodiode and LED must be minimized, usually by placing a thin barrier between them that is barely taller than the higher component.

If the light emitter and/or light sensor are protected behind a transparent glass or plastic panel, it must have minimal resistance to infrared wavelengths, and its thickness must be chosen in compliance with guidelines in the sensor datasheet. To prevent light from reaching the sensor by reflection from the rear of the panel, a thin, opaque tube can be installed between the LED and the panel.

A sensor of this type may be configurable with a "detection scheme," meaning high and low sensing threshold levels appropriate to the object that is likely to be detected. Determining this may be a process of trial and error.

Capacitive Displacement Sensor

This is also known as a *capacitive linear displacement sensor*. It should not be confused with a capacitive **single touch** sensor, a human-input device that has its own entry. See Chapter 13.

A **capacitive displacement** sensor measures the distance between itself and a target that must be electrically conductive. Unlike optical or ultrasound position sensors, no additional source of light, sound, or other radiation is required. Unlike a magnetic position sensor, it does not require a separate permanent magnet. It simply measures its electrical capacitance with the target.

High-precision capacitive displacement sensors are used mainly for industrial process management. Lower-precision variants are much less expensive and can be used as **object presence** sensors to determine if an object is anywhere within a specified range.

A typical maximum range would be 10mm. For larger distances, optical and ultrasound sensors are more appropriate.

A selection of cylindrical sensor probes is shown in Figure 5-9.

Figure 5-9 *Some high-precision capacitive displacement sensors from Lion, which builds them into cylindrical probes ranging from 3mm to 18mm in diameter.*

Applications

The high-precision variant of this type of sensor is commonly used during the production of small devices, such as disk drives. It can also measure vibration of a rotating metal part, such as a motor shaft, and may maintain automatic focus of a microscope.

Lower-precision variants can be used for applications such as counting objects on a conveyor.

When used to measure materials thickness, the sensor finds applications in checking automobile brake rotor fabrication and the thickness of silicon wafers.

How It Works

When two plates of electrically conductive material are placed opposite each other, they possess capacitance. This means that they have an electrical storage capacity enabled by accumulation of opposite charges on each plate.

The capacity is directly proportional to the plate area, inversely proportional to the distance between the plates, and is affected by the medium separating the plates, known as the *dielectric*.

If the plate area and dielectric remain constant, the distance between the plates will be the only factor affecting the capacitance. Therefore, the distance between the plates can be calculated by measuring the capacitance.

Measurement can be performed by evaluating the *displacement current* that passes through the dielectric from one plate to another when a pulse of voltage is applied. (Hence the term "capacitive displacement" in the name of this type of sensor.)

A detailed explanation of displacement current is included in the second edition of *Make: Electronics*.

The sensor itself functions as one plate of the capacitor while the target functions as the opposite plate. Alternating current is applied as a rapid series of pulses, and the current that passes between the plates is proportional to the distance between them.

Ideally, the target should be grounded to the current source. However, since AC is being used, capacitive coupling of the target to the current source is also possible, so long as the additional capacitor has a value of 0.1µF or higher.

Sources of Error

To obtain a meaningful measurement, the electric field from the sensor is focused on the target. Some dispersion will still occur, and the combination of sensor and target must be compatible. A target typically should be flat and should have a larger surface area than the sensor.

Humidity can affect sensor performance, as it changes the value of the dielectric. Temperature can affect performance, partly because it causes small dimensional variations in the sensor and the target.

The surface of the sensor and the surface of the target should be precisely parallel, because the spot where the field hits the target will be elongated if the target is tilted relative to the sensor. Elongation increases the capacitive area and affects the accuracy of measurement.

This type of sensor can also measure the thickness of a nonconductive material, if the material is a thin sheet that can be interposed between two sensors. In this mode the material functions as a dielectric, and its thickness will affect the AC current passing through it.

While lower-precision capacitive displacement sensors are relatively unusual, they can potentially serve as a relatively affordable and simple **object presence** sensor, so long as the target is conductive and will not be damaged by passing a small alternating current at a relatively low voltage.

Values

A high-precision capacitive displacement sensor can measure distances usually ranging from 0.25mm to 10mm with an accuracy that can be better than 0.05mm. High voltages are not required, with a supply of plus-or-minus 15V being common.

The sensing element, often referred to as a *probe*, is usually plugged into a custom-designed control unit that converts the capacitance measurement into a variable output voltage. The performance is then expressed in millimeters per volt. Thus if the voltage varies by 5V over a distance of 1mm, the sensor is rated as providing 0.2mm per volt.

What Can Go Wrong with Optical and Ultrasound Proximity Sensors

Object Too Close

Because both types of proximity sensors (ultrasonic and infrared) may include emitters that are angled toward the distance range for which they are designed, they may fail to "see" an object that is closer. Consequently the sensor will provide no response, or may detect a different object that is further away. In either case, if the sensor is being used on a moving device, the device may collide with the undetected near object.

Multiple Signals

If two or more sensors and emitters are used concurrently, their combined signals can interfere with each other and create inaccurate readings.

Inappropriate Surfaces

Ultrasonic proximity sensors are intended to identify a single object that is closer to the sensor than other objects, within a narrow beam dispersion angle. Multiple objects, complex surfaces, soft surfaces such as clothing or furnishings, or an unusual configuration of interior walls can create inaccurate readings.

Infrared sensors may be unable to "see" liquids or transparent objects, and may give different assessments of distance depending on the properties of a surface. Human skin, for example, is a poor reflector, as it absorbs some infrared radiation.

Environmental Factors

An ultrasonic transducer uses a very small moving diaphragm to generate sound. Like any system containing moving parts, it will be vulnerable to moisture or excessive humidity, and may need to be protected.

After a device is built and tested indoors, in a controlled environment, it is likely to behave differently if it is moved outside where the temperature is significantly higher or lower.

Deterioration of LEDs

As noted in the section on presence sensors (see Chapter 3), LEDs tend to suffer from gradual reduction in light output over time. The performance of an infrared proximity sensor may deteriorate over a period of years, depending on how intensively it is used.

linear position sensor

A **linear position** sensor may also be described as a *linear displacement sensor* or a *linear position transducer*. It is sometimes categorized as a type of **proximity** sensor, but in this Encyclopedia a proximity sensor emits a signal and receives an echo to measure the distance from itself to an object. By comparison, a linear position sensor measures the position of a sliding object within a stationary enclosure.

An **object presence** sensor can be considered as a form of linear position sensor, but it only responds to the presence of an object, without measuring its position.

OTHER RELATED COMPONENTS

- **proximity** sensor (see Chapter 5)
- **object presence** sensor (see Chapter 3)
- **rotary position** sensor (see Chapter 7)

What It Does

Control of a mechanical device may require accurate and timely information about the position of a movable part in the device. A **linear position** sensor can be used for this purpose.

Three attributes are likely to be of interest:

- Position
- Direction of motion
- Speed of motion

Typically a linear position sensor measures only the first attribute. Additional electronics may calculate the second and third attributes by taking multiple position readings. Thus a *speed sensor* is very likely to be built around a position sensor, and therefore this Encyclopedia does not have a separate entry for speed sensors.

Applications

Robotic arm positioning, wing flap and rudder positions on an aircraft, computer-controlled machine tools, 3D printers, and automobile seat position sensors are some of the many applications.

Schematic Symbol

In a schematic, a linear position sensor may be represented by symbols for the sensing elements that are inside it (potentiometer, LED, phototransistor, or others).

How It Works

Linear potentiometers, *magnetic linear encoders*, *optical linear encoders*, and *linear variable differential transformers (LVDTs)* are described here. Other options are available, but they tend to be more specialized, and are not included.

Linear Potentiometer

For a full description of **potentiometers**, see Volume 1.

A linear potentiometer, often referred to as a *slider potentiometer*, contains an electrical resistance in the form of a straight section of *track*. The track may be a strip of *resistive polymer* or (less often) may consist of an insulator with a coil of nichrome wire wrapped around it.

For sensing purposes, the potentiometer is wired as a voltage divider, and a fixed potential is applied across its full length, as shown in Figure 6-1. A *wiper* slides along the track, sensing a voltage that varies linearly with the wiper's position. Output from the wiper can be used directly to control an analog indicator such as a meter, or can be processed by an analog-to-digital converter.

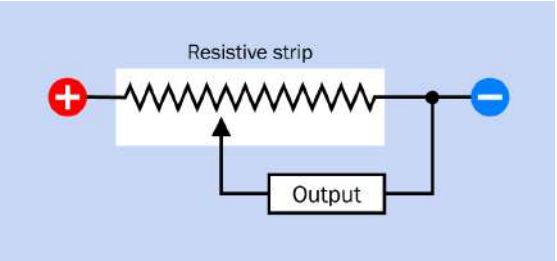

Figure 6-1 *A linear potentiometer can consist of a fixed track with a known voltage applied at each end, and a movable wiper.*

For audio applications, a slider potentiometer may have resistance that varies logarithmically with the position of the wiper. However, this type of component is not generally used as a position sensor.

For sensing purposes, the potentiometer is usually protected by a long, narrow box or tube through which a rod slides on sealed bearings. An example is shown in Figure 6-2.

Figure 6-2 *A linear potentiometer contained in a tube with sealed bearings.*

Small linear potentiometers for position sensing are available from companies such as Bourns. The one shown in Figure 6-3 is about 20mm long, and the rod that slides through it has a travel of approximately 10mm. The component is available with resistance values ranging from 1K to 50K, and its power rating is 1/8 watt. The manufacturer claims a life expectancy of 500,000 cycles.

Figure 6-3 *A miniature linear potentiometer. The body is about 20mm long.*

A linear potentiometer is simple, inexpensive, compact, and requires few additional components. The track contains a lubricant, but inevitably some wear occurs as a result of motion of the wiper. Life expectancy will be reduced by vibration or by contamination with dirt or moisture.

A linear potentiometer may rarely be described as a *linear potentiometric sensor*.

Magnetic Linear Encoders

A ferrous rod or strip can be magnetized with alternating north and south poles. When it slides past a single bipolar Hall-effect sensor, it generates a pulse train from the sensor that can be interpreted to provide positional information. The principle of the component is shown in Figure 6-4. (Magnetic rotary encoders also exist; see "Rotary Encoders".)

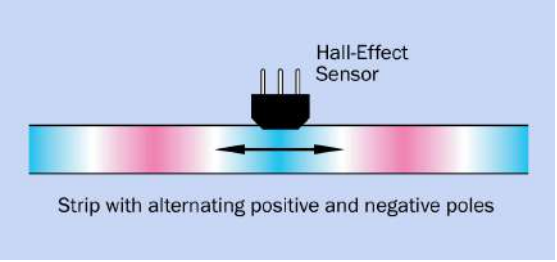

Figure 6-4 *When a strip magnetized with alternating north and south poles slides past a sensor, the pulse train from the sensor can be decoded to indicate the relative position of the strip.*

The sensing element may be described as a *read head*. If two are used, with a spacing equal to half the interval between the north and south poles on the strip, the phase difference between the pulse trains from the sensors will indicate the direction in which the magnetized strip is moving. This is shown in Figure 6-5.

The combination of pulse trains is known as *quadrature*, because there are four possible combinations: A and B both high, A and B both low, A high and B low, or A low and B high. The same principle is used in an optical rotary position sensor; see Figure 7-6.

This type of linear position sensor is often described as a *magnetic encoder*, meaning that the position of the sliding part is encoded in a series of pulses. Relatively high resolution is possible, as the north and south poles on a strip of ferrous material can be as close as 2mm. Optical encoders may use the same principle; see "Optical Linear Encoders".

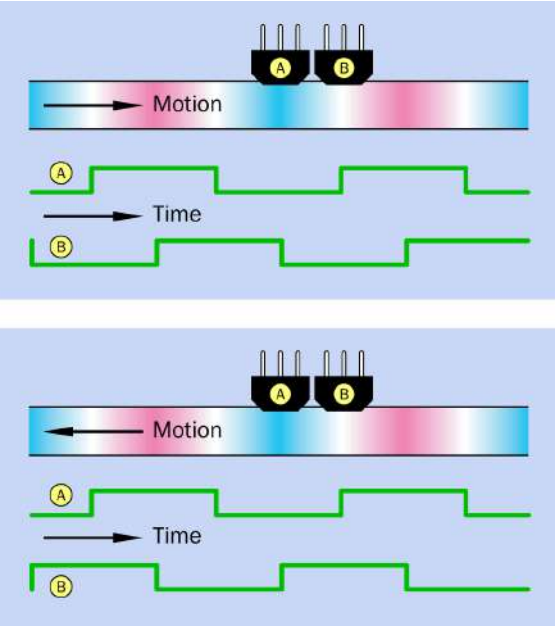

Figure 6-5 *Pulse trains from Hall-effect sensors A and B are shown in green. The phase difference between them can be interpreted to show the direction in which the magnetized strip is moving.*

The sensor can be built into a module containing an analog-to-digital converter that provides numeric output defining the position of the read head.

In an *absolute* magnetic encoder, nonvolatile memory can store the digitized position when the device is switched off. An *incremental* magnetic encoder does not store this information, and will require at least one additional *home sensor* to detect when the encoder is at either end of its travel. At power-up, an initialization routine moves the magnetized strip until the home sensor is triggered.

For details of Hall-effect sensors see "Hall-Effect Sensor".

Optical Linear Encoders

The operation of an optical linear encoder is identical to that of the magnetic linear encoder described immediately above, except that a sliding *optical grating* is used in conjunction with a light source and a detection device such

as a **phototransistor** or **photodiode** that functions as the read head. The principle is shown in Figure 6-6. The grating may be described as a *codestrip*.

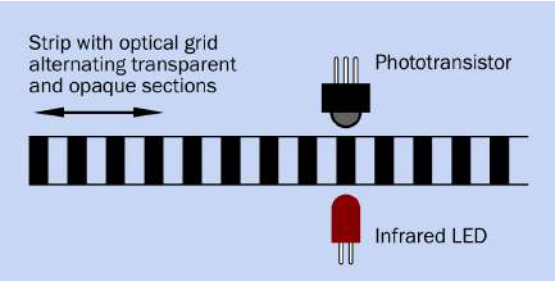

Figure 6-6 *An optical linear encoder uses the same general principle as a magnetic linear encoder.*

For details of phototransistors, see Chapter 22. For details of photodiodes, see Chapter 21.

An example of a low-cost optical linear encoder is the Avago HEDS-9 series, which consists of a horseshoe-shaped module with an LED in one arm and an array of photodiodes in the opposite arm. When a codestrip passes between the arms, the module emits two pulse trains from internal comparators. The pulse trains are 90 degrees out of phase, and can be interpreted to show which way the codestrip is moving.

These sensors have a body measuring approximately 10mm wide and are designed to read opaque/transparent intervals ranging from 1.5 to 7.87 cycles per millimeter. The output rate can be as high as 20kHz. No pullup resistor is required on the output, as a 2.5K resistor is integrated.

A *codewheel* may be used, in which case the module senses rotation instead of linear motion. This is described in detail in the entry on **rotary position** sensors. See Chapter 7.

Linear Encoder Applications

Optical or magnetic linear encoders are found in some laboratory equipment, machine tools, and industrial robots. The mean time between failures can range from 100,000 to 1,000,000 hours. Optical encoders must be sealed to provide good protection from dust and dirt.

Linear Variable Differential Transformers

This type of sensor, often referred to by the acronym LVDT, tends to be used in industrial environments where great reliability is required under severe conditions. Examples are high-temperature steam valves and nuclear reactor control mechanisms. However, the robust, frictionless design suggests other possible applications, and custom fabrication is a possibility.

Figure 6-7 illustrates the general principle. Three coils are wound sequentially around a (nonmagnetic) stainless-steel tube, enclosed in a second tube also made of stainless steel. The coils act as transformers with the variable voltage ratio determined by the position of a solid iron armature that slides through them.

The center coil is the primary winding, to which AC is applied between 2kHz to 50kHz, depending on the application. (The frequency must be at least ten times the maximum rate of motion of the armature.) The iron armature is attached to a nonmagnetic rod. The voltages on the secondary windings provide the output from the sensor.

While more than one wiring arrangement is possible, the most common schematic is shown in Figure 6-8. The secondary coils are in series, with one of them reversed, so that the phase of the output is inverted as the armature moves from one end of its travel to the other. The phase detector responds to the phase difference by creating a DC output that varies with movement of the armature. All the functions shown in the schematic are available on a single integrated circuit chip.

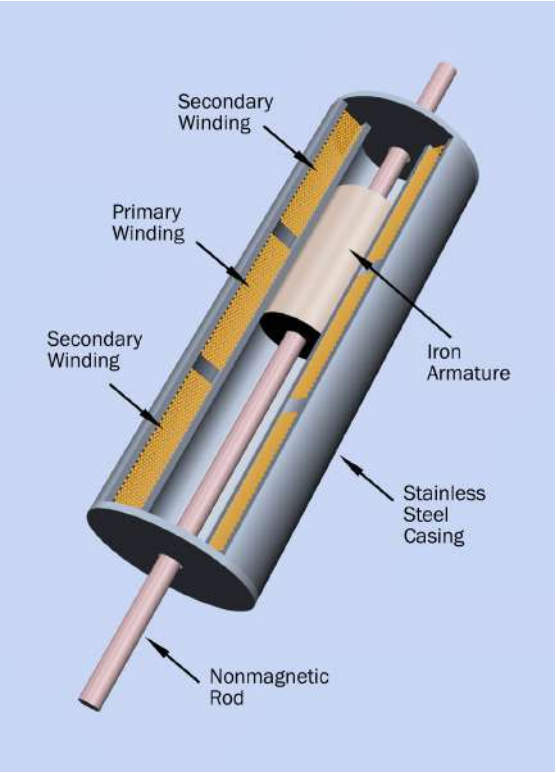

Figure 6-7 *Cutaway drawing showing the internal design of a linear variable differential transformer, in which the position of a sliding iron armature determines the voltage induced in the secondary windings.*

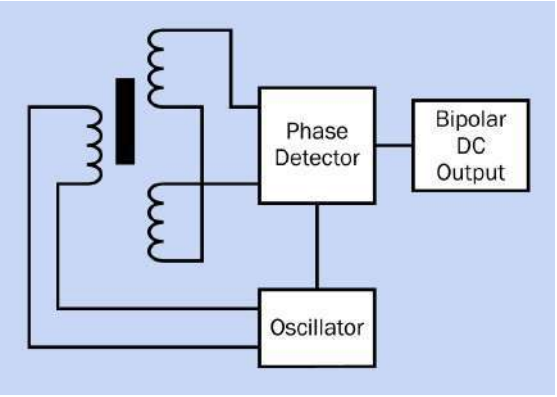

Figure 6-8 *Typical schematic for using a linear variable differential transformer.*

An example of a linear variable differential transformer is shown in Figure 6-9.

Figure 6-9 *External view of a linear variable differential transformer.*

What Can Go Wrong

Mechanical Issues

Any sliding mechanism will involve friction, and will be vulnerable to wear and tear, resulting in looseness that will degrade its accuracy. In addition, optical systems are vulnerable to dust and dirt.

LED Longevity

Light output of an LED diminishes over a period of years if the LED is "always on." This will limit the life of the sensor.

rotary position sensor

7

Alternative terms for **rotary position** sensor are *rotary sensor*, *rotational position sensor*, *angular position sensor*, and *angle sensor*.

The terms *rotary* and *rotational* are used interchangeably. In this entry, an attempt has been made to use the term that is most common for each specific application. For example, "rotary position sensor" versus "rotational encoder."

A few sensors are available that specifically measure *rotary speed*, but generally a rotary speed sensor uses information from a rotary position sensor. Therefore, this Encyclopedia does not include a separate entry for rotary speed sensing.

A **rotational encoder** can be used as a rotary position sensor. It is mentioned briefly here but is described in more detail in Volume 1 of this Encyclopedia in the entry describing **switches**.

OTHER RELATED COMPONENTS

- **linear position** sensor (see Chapter 6)

What It Does

Control of a mechanical device may require accurate and timely information about the orientation of a rotating part in the device. A **rotary position** sensor can be used for this purpose.

A sensor may be capable of measuring three attributes:

- Angular orientation
- Direction of rotation
- Speed of rotation

Typically a rotary position sensor measures only the first attribute. Additional electronics are required to calculate the second and third attributes by taking multiple position readings. Thus a *speed sensor* is very likely to be built around a position sensor, and therefore, this Encyclopedia does not have a separate entry for speed sensors.

Applications

In robotics, a rotary position sensor is commonly used to show the orientation of a pivoting arm or strut. It can also be used as a limit switch on a motor.

Specific applications include solar array positioning, remotely piloted vehicles, guidance and navigation, antenna positioning, and wind turbine pitch control.

Pulses from a rotary position sensor are used to measure speed of rotation in vehicles, industrial processes, and aviation. Small rotary speed sensors are built into devices such as cooling fans and computer hard drives.

Schematic Symbol

In a schematic, a rotary position sensor may be represented by symbols for the sensing elements that are inside it (potentiometer, LED, phototransistor, and others).

Potentiometers

Single-turn and multiturn potentiometers may be used as rotary position sensors. For basic information about **potentiometers**, see the entry describing this component in Volume 1.

Arc-Segment Rotary Potentiometer

An *arc-segment rotary potentiometer* is often referred to simply as a "potentiometer," as this type is more common than the multiturn type or the linear type. When used as a sensor, it can measure a turn angle that is less than 360 degrees.

This component contains a resistor in the shape of an arc, referred to as the *track.* It may be a strip of *resistive polymer* or (less often) may consist of an insulator with a coil of nichrome wire wrapped around it.

For sensing purposes, the potentiometer is wired as a voltage divider, and a fixed potential is applied along the full length of the track, as shown in Figure 7-1. A *wiper* slides along the track, sensing a voltage that varies linearly with the wiper's angular position. Output from the wiper can be used directly to control an analog indicator such as a meter, or can be processed by an analog-to-digital converter.

For audio applications, an arc-segment potentiometer may have resistance that varies logarithmically with the position of the wiper. However, this type of component is not generally used as a position sensor.

Low-cost potentiometers were traditionally used as volume or tone controls in stereo systems. When a potentiometer is designed for use as a sensor, it tends to be more ruggedly built and better protected against dust, dirt, and moisture. Its advantages are that it is simple, inexpensive, compact, and requires few additional components.

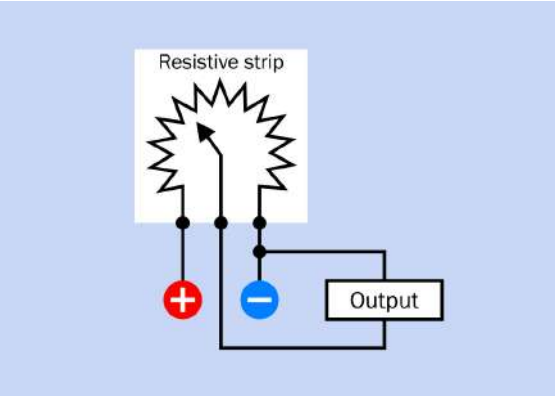

Figure 7-1 *An arc-segment potentiometer consists of a fixed track in the shape of an arc with a known voltage applied at each end, and a movable wiper.*

The major disadvantage is that although the track contains a lubricant, some wear will gradually result from friction with the wiper. Life expectancy will be further reduced if there is vibration or contamination with dirt or moisture.

End Stops

An arc-segment potentiometer usually has *end stops* to prevent the wiper from running off either end of the track. Typically, these stops limit rotation to around 300 degrees.

A few arc-segment potentiometers allow unrestricted rotation. The Bourns 6639 series is an example, although the wiper still passes through a "dead zone" of 20 degrees between the start and end of its track. An application for this type of potentiometer could be as a direction sensor for a weather vane.

Multiturn Rotary Potentiometer

A spiral track, which resembles a coil spring, enables a rotary potentiometer to make multiple turns. The wiper rotates inside the track and follows its contour. A potentiometer of this type

will still be calibrated in degrees; thus, a 10-turn component may be listed as allowing an *electrical travel* of approximately 3,600 degrees.

The exterior of a multiturn rotary potentiometer is shown in Figure 7-2.

Figure 7-2 *A multiturn rotary potentiometer. Each pair of solder tags is attached internally to one end of the internal coiled track. The smaller tag at the far end connects with the wiper.*

A simpler type of multiturn potentiometer is intended for use as a trimmer—a small potentiometer that can be mounted on a circuit board to allow adjustment or calibration, often during the manufacturing process. This type of trimmer contains a worm gear that engages with a spur gear internally. The wiper is mounted on the spur gear. It has no applications as a sensor, but is mentioned here to avoid ambiguity, as it is probably the component that is most commonly referred to as a "multiturn potentiometer."

Magnetic Rotary Position Sensor

Externally, a modern magnetic rotary position sensor may look very much like an arc-segment rotary potentiometer. Internally, a permanent magnet is attached to the base of the shaft, and one or more **Hall-effect** sensors are mounted on a small circuit board immediately below the magnet, in the bottom of the enclosure. A simplified diagram appears in Figure 7-3.

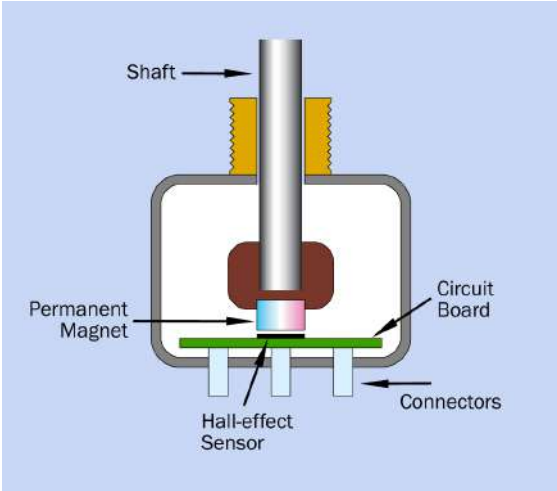

Figure 7-3 *Simplified interior view of a magnetic rotary position sensor.*

For more information about Hall-effect sensors, see "Hall-Effect Sensor".

A magnetic rotary position sensor may be described as a *noncontacting* sensor. Two views of an example are shown in Figure 7-4.

Figure 7-4 *Two views of a Bourns AMS22 magnetic rotary position sensor.*

The AMS22 sensor shown in Figure 7-4 has an analog output ranging from 0.1VDC to 4.9VDC when powered with 5VDC. A noncontacting sensor of this type will cost three to four times as much as a conventional potentiometer, but has the great advantage of extreme durability, with the manufacturer claiming a life of 50 mil-

lion shaft rotations. A disadvantage is its low-current output, limited to 10mA. The maximum rotation speed of its shaft is 120rpm.

Rotary Position Sensing Chips

Chips of the type used in a magnetic rotary position sensor are available as individual components, many of which have advanced features. For example, the AM8192B angular magnetic encoder by RLS is a 44-pin surface-mount chip containing Hall sensors that detect the orientation of a permanent magnet above or below the chip. Various outputs provide information such as sine or cosine of the turn angle, incremental pulses, and digitized output via an SPI interface.

Rotary Encoders

Many rotating position sensors communicate their angle of rotation with an output that consists of a pulse train or some other coded signal. This type of rotary sensor is known as a *rotary encoder* or *rotational encoder*. (Linear encoders also exist; see "Magnetic Linear Encoders".)

The simplest version of this component is a *mechanical encoder* containing two small electromechanical switches that are activated, out of phase, by a toothed wheel attached to the rotating shaft. This component is described in detail in Volume 1 of the Encyclopedia, where it is categorized as being a form of **switch**. Its low cost and simplicity has made it popular for rotary controls on car radios and small stereo systems, but its switches have a limited life expectancy and create a "noisy" output that must be *debounced* if connected with a logic chip or microcontroller. Typically the microcontroller will include a pause of up to 50ms in its program code to allow time for the switch contacts to settle (although some manufacturers claim only 5ms).

Confusingly, a mechanical encoder is often identified only as a "rotational encoder," even though optical and magnetic rotational encoders also exist, as described immediately below. As a general rule, if a component is described simply as a rotational encoder, it probably contains electromechanical switches.

Optical Rotary Encoders

This type of component works on the same principle as an *optical linear encoder* of the type described in "Optical Linear Encoders". The difference is that a *codewheel* is used instead of a *codestrip*. Typically the codewheel is supplied by the manufacturer of the component that is designed to read it.

A *transmissive* codewheel is shown in Figure 7-5. The distance between the light emitter and the light detector has been exaggerated in this diagram for clarity.

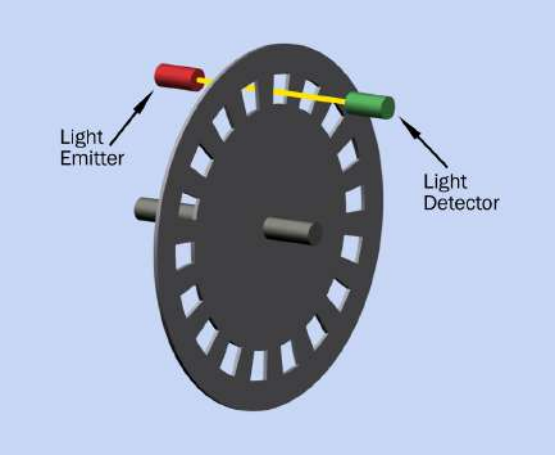

Figure 7-5 *A light-transmissive codewheel for use in an optical rotary encoder.*

Some optical rotary encoders use a *reflective* codewheel, in which case alternating sections of the wheel are light-absorptive and light-reflective, and the emitter and detector are both on the same side of the wheel.

If only one light emitter and light detector are used, the pulse train from the sensor reveals how many increments the wheel has turned relative to its previous position.

A single sensor cannot indicate the direction of rotation, but if a second emitter-sensor pair is added, 90 degrees out of phase with the first, a microcontroller can assess the phase difference between pulse streams to determine which way the wheel is turning. This principle is illustrated in Figure 7-6 where one transmitter-detector pair is located in position A and another is in position B. The resulting pulse trains, for clockwise and counterclockwise rotation of the wheel, are shown in green. The combination of pulse trains is known as *quadrature*, because there are four possible combinations: A and B both high, A and B both low, A high and B low, or A low and B high.

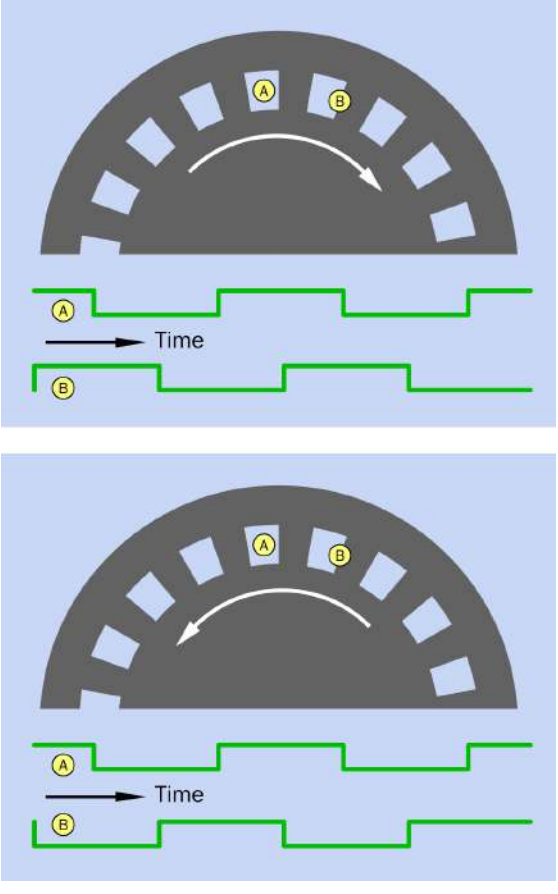

Figure 7-6 *With transmitter-detector pairs mounted at positions A and B, the phase difference between their pulse trains can show the direction of rotation of the wheel.*

This is the same principle as illustrated for a magnetic linear position sensor in Figure 6-5.

An alternative system of quadrature for an optical rotary encoder uses two separate tracks on the disc, each having an equal number of opaque and transparent sections, but half an interval out of phase.

Any system that reveals the relative motion of the wheel, but cannot determine its absolute angular position, is an *incremental sensor*.

Optical Products

High-end optical rotary encoders may use discs with as many as 600 sequential opaque and transparent segments to provide extremely high resolution. They are outside the scope of this Encyclopedia.

Moderately priced optical encoders are available as shaft-driven assemblies very similar in external appearance to potentiometers. Typically they have four terminals, one pair for power and ground connections and another pair for quadrature output from the two internal sensors, usually identified as A and B in datasheets. Some encoders also contain an on-off switch that is activated by pressing the shaft, in which case two additional terminals will be provided.

Bourns is a leading manufacturer of this type of encoder, an example being the EM14, which is mounted in a box-shaped body measuring 14mm square. It uses a 5VDC power supply and provides pulses of 4VDC minimum with intervals of 0.8VDC maximum. Variants are available with 8 to 64 pulses per revolution. Intended for audio applications, this type of encoder has a maximum rotation speed of 120rpm.

An example of an optical rotary encoder from a German manufacturer is shown in Figure 7-7. Its resolution is 25 pulses per rotation. The rectangular package measures approximately 19mm × 25mm. The power supply can be 3.3VDC or 5VDC.

Optical rotary encoders of this type cost about five times as much as mechanical rotary encoders at the time of writing, but their longevity and their clean output signals make them an attractive alternative, and the price difference may diminish over time.

Figure 7-7 *A compact incremental optical rotary encoder in the MRB25 series from Megatron Elektronik AG & Co.*

Encoders such as the Avago HEDS-9 series are not protectively enclosed, and require assembly with a codewheel supplied by the manufacturer. See Figure 6-6 for additional information.

A more basic optical rotary encoder, shown in Figure 7-8, is sold by Cytron Technologies as an *optical switch* mounted on a small board, with a separate codewheel consisting of a slotted disc. This low-cost kit is intended for use in DIY robotics. More information about optical switches will be found in the entry dealing with **optical presence** sensors. See Figure 3-3.

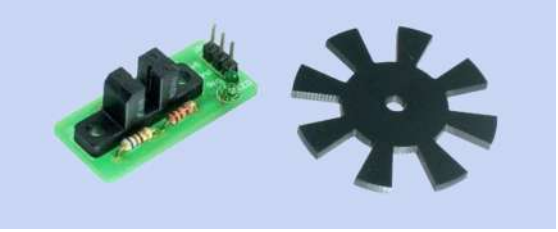

Figure 7-8 *A bare-bones optical encoder for DIY robotics.*

Computer Mouse Principles

The original design of a computer mouse, with a hard rubber ball, contained two optical rotary encoders oriented at right angles to each other. Each of them used a transmissive codewheel. The rolling ball turned the codewheels as the mouse was moved across a desktop, and electronics in the mouse converted the outputs from the encoders into a pulse train that could be interpreted by a computer. Figure 7-9 shows the primary components.

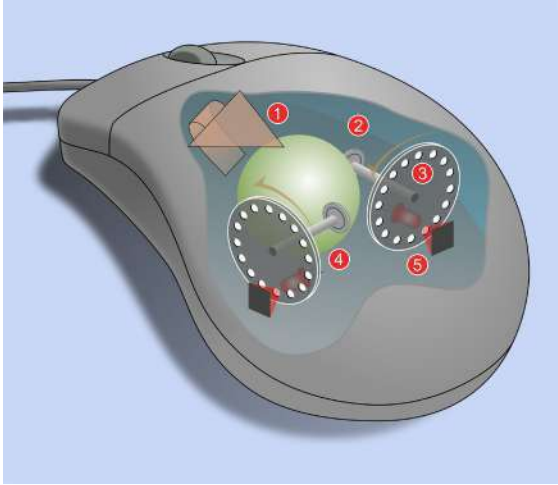

Figure 7-9 *From Wikimedia Commons, this rendering by Jeremy Kemp shows (1) rotation of the ball, (2) a roller touching the ball, (3) a transmissive optical codewheel, (4) an infrared LED that shines through a second codewheel, and (5) a sensor detecting the pulses of light.*

An *optical mouse* works on a different principle, maintaining a monochrome image of the desk surface on an optical array that functions like a very low-resolution camera sensor. Electronics in the mouse detect displacement of the image as the mouse is moved.

Rotational Speed

Incremental rotary encoders, which only supply relative data, are adequate in many applications, especially speed measurement, where a microcontroller can compare a pulse stream from a sensor with a target frequency, and can also provide feedback to control motor speed

appropriately. This is convenient when a stepper motor is being used, or a DC motor that is controlled with pulse-width modulation. (See the entry on **motors** in Volume 1.)

Toothed wheels or magnetized wheels are commonly used to measure speed of rotation in applications ranging from automobile transmissions to computer disk drives.

While a second sensor can be added to determine the direction of rotation, this still does not provide information about the absolute orientation of a part.

Absolute Position

If associated electronics are equipped with nonvolatile memory, it may be used to store a sensor-wheel position from one session to the next. This may be sufficient in noncritical applications such as volume control in a car radio or stereo system.

Alternatively, an additional single window in an optical wheel can activate a *home sensor*. When the device is powered up, the wheel is turned until the home sensor is triggered, at which point the orientation of the wheel is known, and subsequent pulses from rotation sensor(s) will add or subtract angular information.

The pulse generated by a home sensor may be described in datasheets as a *reference signal* or *index signal*. In the early days of desktop computers, each 5.25-inch floppy diskette was perforated with an index hole for this purpose.

The Gray Code

For greater reliability in determining absolute position, an optical wheel can be divided into several concentric tracks, each of which contains a different coded sequence and is assigned its own light emitter and light sensor. The sensors are arranged in a radial line to scan the disc as it rotates. Since each detector will provide either a signal or no signal, output from the set of sensors can be combined to create a binary number.

Figure 7-10 shows binary codes from 0000 through 1111, corresponding with decimal numbers 0 through 15, where a white square is equivalent to a numeral 1 and a black square is equivalent to a numeral 0.

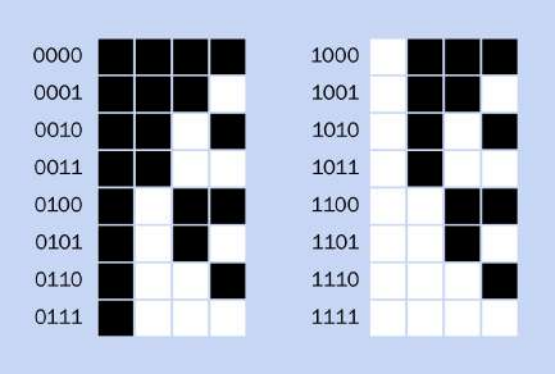

Figure 7-10 *Binary codes from 0000 through 1111, using white to represent 1 and black to represent 0.*

Figure 7-11 shows this system mapped onto a codewheel. The red circles indicate the locations of four stationary light detectors, which begin by providing a reading of 0000, since they coincide with four opaque areas of the wheel. Now if the wheel makes 1/16th of a full rotation in the direction of the arrow, the detectors will register 0001. If the wheel continues to rotate, the detectors will count in binary up to 1111 before the sequence repeats.

The problem with this design is that small manufacturing inaccuracies and other imperfections will result in some light detectors responding fractionally more quickly than others as the wheel rotates. This will occur in transitions where two or more adjacent segments of the wheel change between transparency and opacity. For instance, where 0011 is followed by 0100, transient values of 0010, 0001, 0111, 0110, or 0101 are possible. Although they will be brief, these values may trigger associated electronics.

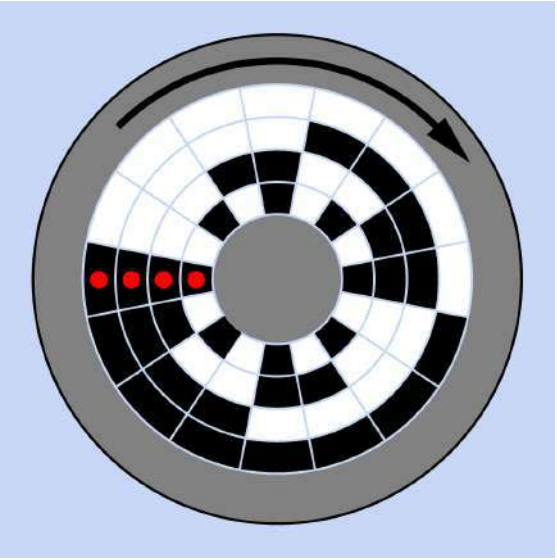

Figure 7-11 *The binary sequence mapped onto a code-wheel as areas of opacity and transparency. Red circles indicate light detectors.*

To eliminate this problem, a different code sequence can be used in which only one of the four sensors is allowed to make a transition from each value to the next. This is called a *Gray code*, and eliminates the issue of simultaneous transitions. A commonly used Gray code is shown in Figure 7-12.

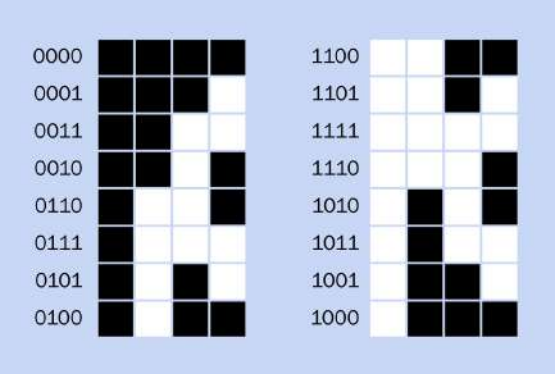

Figure 7-12 *A Gray code that allows only one binary digit to change in each transition from one value to the next.*

Magnetic Rotary Encoders

If a ferrous wheel is magnetically polarized in multiple domains, its rotation can be detected by a Hall-effect sensor in much the same way that a wheel divided into transparent and opaque sections can be assessed by light detectors and emitters. This is illustrated in Figure 7-13, where magenta and cyan bands indicate north and south magnetic poles.

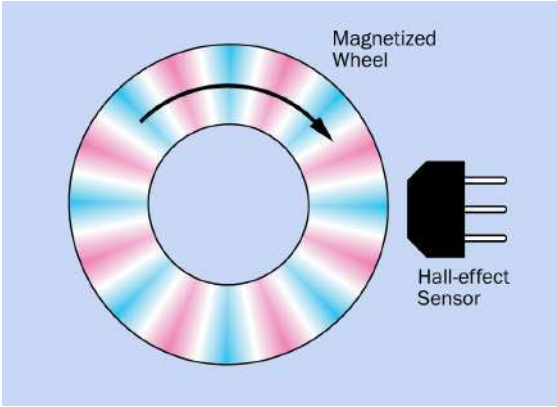

Figure 7-13 *A Hall-effect sensor can detect the rotation of a wheel that is divided into multiple north and south magnetic poles.*

See "Hall-Effect Sensor" for information about Hall-effect sensors.

An additional Hall sensor can be added, offset from the first, as in Figure 7-14. Once again the phase difference between the pulse trains can be used to determine the direction of rotation.

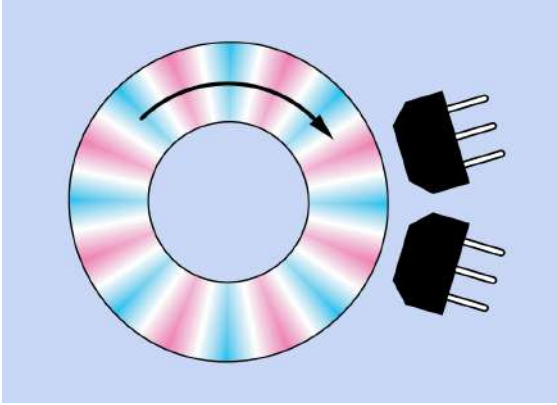

Figure 7-14 *Direction of rotation of the wheel can be deduced from the phase difference between the pulse trains from two sensors.*

Alternatively, a toothed wheel can be used, as suggested in Figure 7-15.

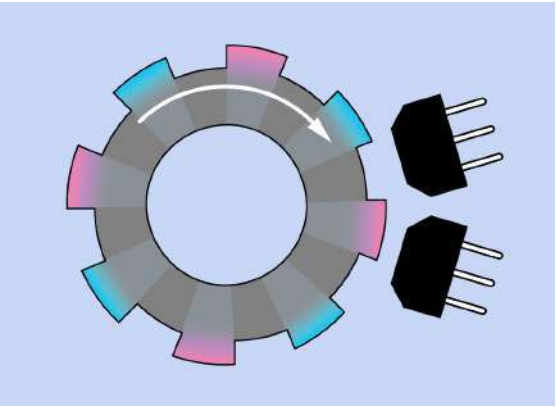

Figure 7-15 *A toothed wheel can trigger a Hall sensor if the teeth are magnetized.*

Another option is to mount a pair of magnets on a nonmagnetic wheel, with a Hall-effect sensor in the center. If it is a sensor with an analog output, the voltage will fluctuate smoothly between positive and negative, relative to the power supply for the sensor. Alternatively, a bipolar Hall-effect sensor can be used to provide a binary output. The concept is illustrated in Figure 7-16. An advantage of this configuration is that it provides approximate information about the absolute position of the wheel.

The two magnets will provide usable linear sensor outputs over a span of plus-or-minus 30 degrees of rotation, approximately. Additional magnets or sensors can produce a more complex output that would be decoded by a microcontroller.

How to Use It

An optical or rotary encoder is well suited for use with a microcontroller program that can count pulses, compare pulse trains, or interpret a Gray code. The microcontroller then takes appropriate action. For example, if a rotational encoder is used to control the gain of an audio amplifier, the microcontroller determines the direction and angle through which the encoder turns, and can respond by changing the value of a **digital potentiometer** (see Volume 1).

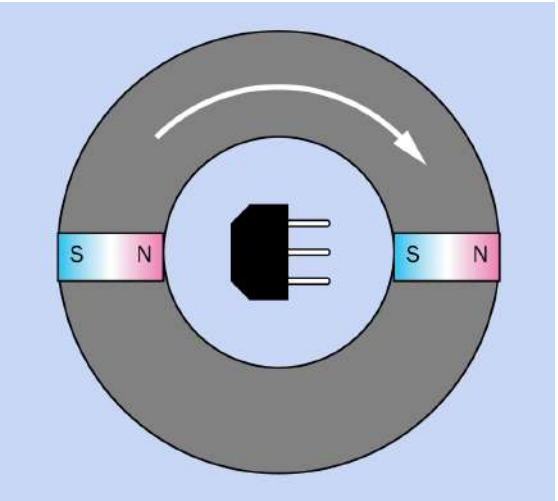

Figure 7-16 *A Hall-effect sensor can detect the angle of rotation of a ring on which two magnets are mounted as shown.*

Integrated circuit chips are available to convert a sequence of quadrature signals into an up-pulse or a down-pulse, thus eliminating the chore of achieving this with a microcontroller program. The LS7183 by LSI Computer Systems is an example.

What Can Go Wrong

Wiring Errors

If two sensors are used to detect the direction of rotation of a rotary encoder, and outputs from the sensors are accidentially swapped, the component will seem to work normally except that the indicated direction will be inverted.

Coding Errors

Microcontroller code that interprets quadrature signals must be fast enough to keep up with the pulse streams. If a microcontroller is performing other tasks, an interrupt may be necessary for processing the rotational data. This should not be a significant problem when interpreting human input from a knob or dial, but

for a motor-driven encoder, pulse counting in hardware may be a better alternative.

Ambiguous Terminology

Rotational encoders are often referred to simply as "encoders," because they are more common than linear encoders. When searching for an encoder, check each datasheet carefully to determine which type you are dealing with.

tilt sensor

A *tilt switch* is defined here as an electromechanical switch, while a *tilt sensor* uses electronics. Both types are included in this entry.

A *tipover switch* is very similar to a tilt switch and uses the same principles. Therefore, it is included in this entry.

Some manufacturers' datasheets refer to tilt sensors as *tip sensors*. Some Asian supply catalogues refer to tilt switches as *breakover switches*.

An **accelerometer** can measure the angle at which it is held relative to the downward force of gravity, but it has additional capabilities. Therefore, it has its own separate entry in this Encyclopedia.

An *inclinometer* measures the incline, or positive slope, from an observation point to the top of an object such as a building or tree. The height of the object can be calculated from the angle. A *clinometer* can additionally measure a decline, or negative slope. These measurement devices are fully featured products as opposed to sensors, and are not included in this Encyclopedia.

OTHER RELATED COMPONENTS

- **accelerometer** (see Chapter 10)
- **vibration** sensor (see Chapter 11)

What It Does

Three principal types of tilt sensor exist.

1. Single axis, single output. The sensor responds to being tilted around one horizontal axis, relative to the downward force of gravity.
2. Dual axis, dual output. The sensor contains two sensing elements at 90 degrees to each other. Each has an output determined by its angle of tilt from vertical around one axis.
3. Dual axis, single output. A single sensor responds to an angle of tilt from vertical around any horizontal axis.

A *tilt switch* is usually of the third type, and is defined here as containing an electromechanical or electronic switch that opens or closes a connection. Most tilt switches are SPST (normally open) or SPST (normally closed). A minority are DPDT.

A *tipover switch* is a type of high-current tilt switch that cuts power to a device such as an electric heater when it is tipped over.

This Enclopedia defines a *tilt sensor* as being an electronic component, as opposed to an electromechanical component. The distinction is often observed in datasheets, but not always.

Schematic Symbol

No specific schematic symbol is generally used for any variant of a tilt sensor. It can be represented with an annotated switch symbol.

How It Works

Because a tilt switch is a simpler device than a tilt sensor, it will be described first.

The most common type of tilt switch consists of a cylindrical metal or plastic enclosure, often measuring about 5mm by 15mm, containing two spherical steel balls that may be nickel-plated or gold-plated. When the switch is tilted, the balls eventually run downhill, and the lower ball completes an electrical connection between two contacts or between a single contact and the metal enclosure of the switch. The second ball is included to add weight and suppress vibration in the first.

Figure 8-1 shows a switch manufactured by Comus Global, rated for 0.25A at 60VAC or 60VDC, maximum. The body of the switch measures approximately 10mm x 5mm, and the switch is activated when tilting -10 degrees from horizontal. It is deactivated when tilting +10 degrees. A scale drawing of the interior is shown in Figure 8-2.

Figure 8-1 *The CW1300 tilt switch manufactured by Comus Global.*

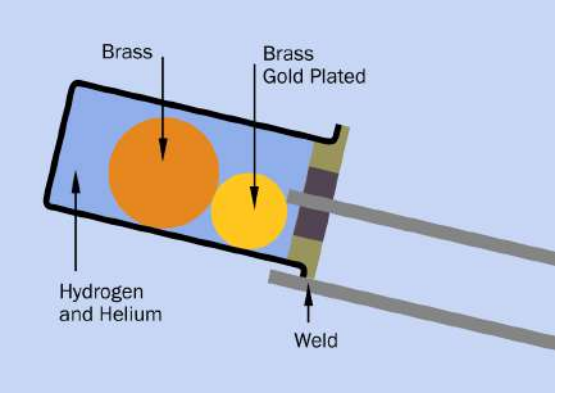

Figure 8-2 *Interior of the CW1300 tilt switch, from a scale drawing supplied by the manufacturer. The lower lead is welded to the shell of the sensor. The leads may be inserted in a circuit board.*

Figure 8-3 shows three common internal configurations of a generic tilt switch. The top version has axial leads and uses the metal shell of the switch to complete the circuit. The center version has radial leads, with a plastic shell. The bottom version has radial leads, one of which is attached to the metal shell to complete the circuit.

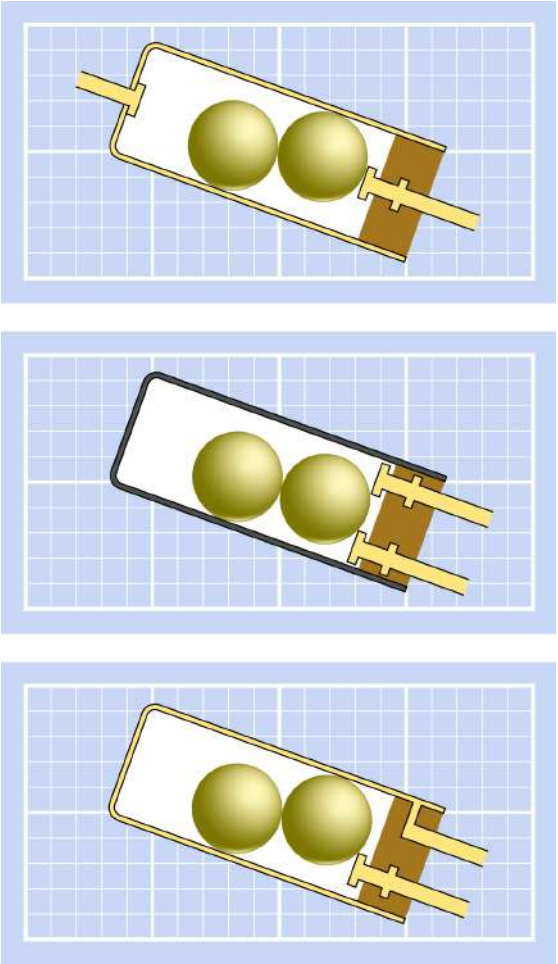

Figure 8-3 *Three variants of a generic ball-operated tilt switch. The graph-paper scale is in millimeters.*

Figure 8-4 shows the parts of a disassembled tilt switch.

Simplified Version

Where size is not a significant consideration, a tilt switch can be created by attaching a pivoting, weighted arm to a small snap-action switch.

Applications

An old-style (nonelectronic) thermostat may contain a tilt switch attached to the end of a bimetallic strip coiled into a spiral. When the strip bends in response to a drop in temperature, the switch closes its contacts, activating a relay that starts a heating unit. If the temperature rises, an additional set of contacts in the same relay may activate an air-conditioning unit. In old thermostats, the tilt switch may contain mercury in a glass tube, which should be handled with caution.

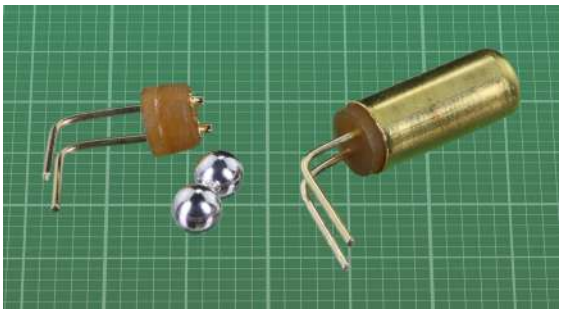

Figure 8-4 *At right, a tilt switch. At left, the cap removed, and the two balls that make internal contact. The background grid is in millimeters.*

A tilt switch may detect the opening of a door or window in a simple alarm system.

Tilt switches have been used in automobiles to switch on the interior light in the trunk when its lid is opened.

A normally closed tilt switch is often used to stop the inflow of granular material to a bin when it is almost full. This is colloquially known as a *bin switch*. In industrial applications of this kind, the switch is activated by a long lever that has a ball mounted at the end. The switch assembly is physically large. See Figure 8-5.

A normally open tilt switch may operate a valve or start a pump when the liquid in a tank drops below a certain point. If the switch uses a float to sense the level of the liquid, it is often known as a *float switch*. This is described in the entry on liquid level sensors. See Chapter 15.

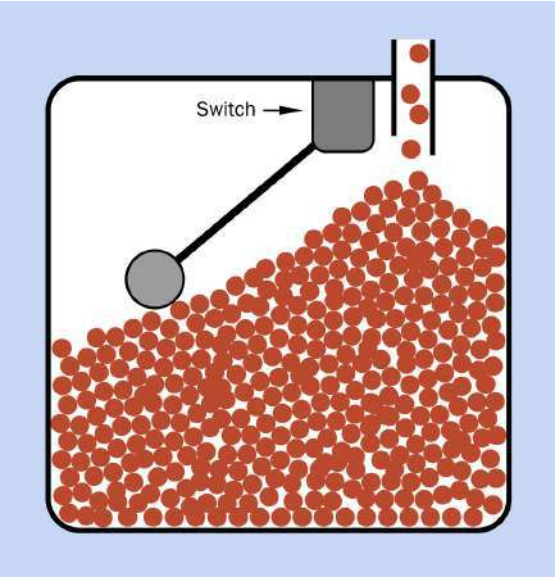

Figure 8-5 *The flow of granular material into a bin can be sensed and stopped by a tilt switch of this type, often known as a bin switch.*

A *tipover switch* may use the simplified system of a weighted arm that activates a snap-action switch. When used in conjunction with a room heater, the switch must handle substantial current.

A motorcycle may contain a tipover switch to stop the electric fuel pump if the motorcycle falls on its side.

Four tilt switches placed in a cross-shaped pattern on a flexible mount can be used as the basis of a very simple game controller, with a joystick mounted in the center.

Variants

The three configurations of ball-type tilt switches shown in Figure 8-3 are functionally interchangeable and can be chosen for convenience of their leads in fitting the circuit.

Mercury Switches

Early tilt switches contained a blob of mercury in a glass bulb. When the bulb was tilted, the mercury rolled to the end and made an electric connection between two metal contacts that penetrated the bulb.

A small mercury switch is shown in Figure 8-6. This type of sensor became less common after many countries classified mercury as an environmental hazard and established regulations restricting its use.

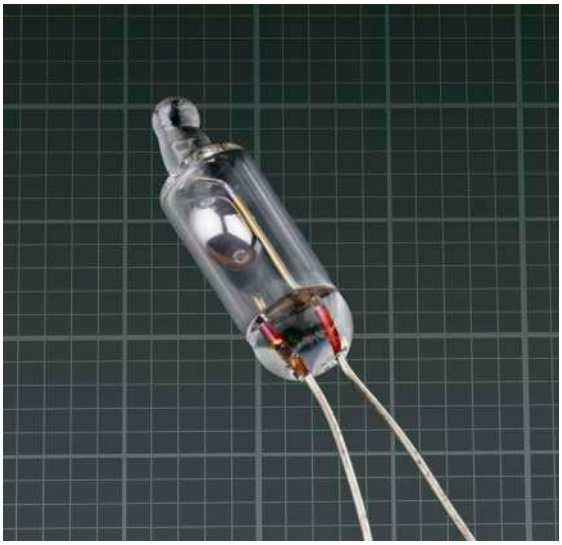

Figure 8-6 *Small mercury switch rated for 0.3A at 24VDC or 24VAC. Larger mercury switches can switch more power; 1A at 230V is common. The background grid is in millimeters.*

Mercury is an excellent electrical conductor. It remains in a liquid state between about -38 degrees Celsius and +356 degrees Celsius, and has very high surface tension, encouraging it to form a single blob instead of breaking up into small droplets. Because free space in the bulb is filled with an inert gas to prevent oxidation of the electrodes, a mercury switch can have a very long operating life. In the United States in the 1970s, some light switches were sold containing mercury switches with a claimed life expectancy of 100 years.

Pendulum Switch

This type of switch, now relatively rare, was found in vintage pinball machines. It consists of a pendulum about 5cm long, suspended inside

a steel ring about 1cm in internal diameter. If the machine was rocked sufficiently to bring the pendulum in contact with the ring, the game was cancelled and the word "Tilt" appeared on the display. Consequently this was referred to as a tilt switch, although really it was a form of **vibration** sensor with a long period of oscillation.

Magnetization

Some tilt switches use a steel ball that is weakly magnetized, so that it will seat itself more firmly when it rolls into a circular depression or ring. This type of switch must be tilted back through a larger angle to dislodge the ball. Therefore it will exhibit greater *hysteresis*.

Tilt Sensors

Unlike a tilt switch, a tilt sensor is not built around an electromechanical switch.

The principle of a rolling ball has been miniaturized and encapsulated in a small enclosure (10mm square or smaller), in which the ball rolls to interrupt a beam from an internal LED shining on a phototransistor. Examples are found in the Panasonic AHF series. Internal circuitry ensures a clean on-off signal, free from the switch bounce that is a problem in basic ball-type tilt switches. However, the switch requires a power supply, and the open-collector output must be used with a pullup resistor. By comparison, a simple electromechanical tilt switch can be wired directly to the device that it controls.

Diagrams from the Panasonic datasheet show the three types of AHF sensor available for vertical, horizontal, and reverse mounting. In each case, the ball (dotted circle) rests in a shallow cup (dotted curve) where it obstructs the beam from an internal LED (not shown). See Figure 8-7. An exterior view of the AHF22 is shown in Figure 8-8.

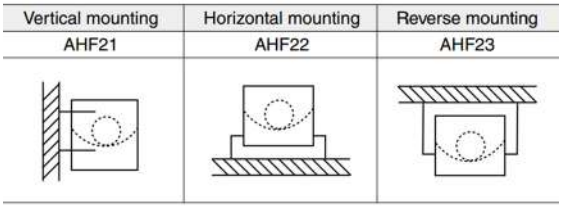

Figure 8-7 *Three types of Panasonic tilt sensor, from the manufacturer's datasheet. See text for details.*

Figure 8-8 *Exterior view of the Panasonic AHF22 tilt sensor. The background grid is in millimeters.*

Two-Axis Tilt Sensors

The Rohm RPI-1035 is a surface-mount tilt sensor about 4mm square, with two phototransistor outputs that indicate which axis the sensor is tilting around. The outputs can be interpreted as a 2-bit binary number, with its four possible states indicating the rotation of the switch around two axes at 90 degrees to each other. Switches of this type were developed to indicate the orientation of consumer-electronic devices such as digital cameras, but more sophisticated sensors containing accelerometers are becoming price-competitive.

Surface-mount 2-axis tilt sensors have been made available on small breakout boards that are easy to use experimentally. An example is the Parallax 28036 shown in Figure 8-9.

Figure 8-9 *A 2-axis tilt sensor mounted on a breakout board available from Parallax.*

The behavior of the rolling-ball sensor at the heart of this board is shown in Figure 8-10. The sensor contains a square cavity in which the ball is depicted as a blue circle. At one corner of the cavity is a red LED, while two phototransistors, labeled A and B, are at the corners on the left and right. When the sensor is held as in section 1 of the figure, with the LED at the top and the ball resting at the bottom, both phototransistors have a high output as they receive light from the LED.

In section 2 of Figure 8-10, the sensor has been turned through 90 degrees. The ball now prevents light from reaching sensor B, while phototransistor A is still active. In section 3 of the figure, the sensor has been turned through another 90 degrees, so that the ball prevents light from escaping from the LED, and both phototransistors are now dark. In section 4, the ball obstructs phototransistor A but not phototransistor B.

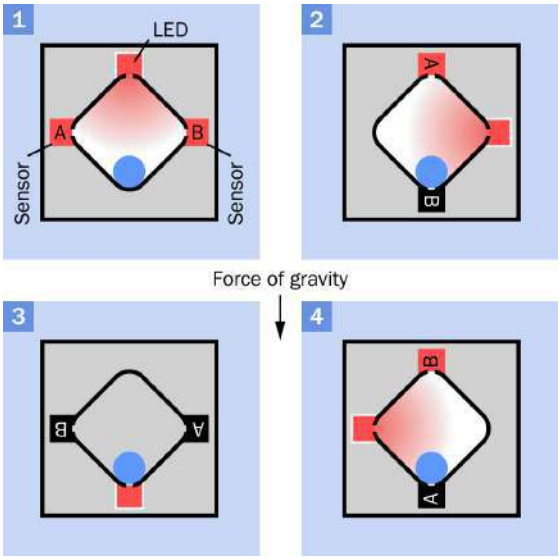

Figure 8-10 *The rolling-ball sensor inside the Parallax 28036. See text for details.*

Suppose that the sensor is placed flat on a horizontal surface. The sensor will now respond to being tipped either way around two horizontal axes. This justifies its description as a 4-directional tilt sensor, although its design suggests that it may have been intended for use as described above, rotating through four positions around one horizontal axis.

Values

A heavy-duty tilt switch can be rated as highly as 10A at 240VAC. More commonly, a tilt switch about 15mm long can be expected to switch about 0.3A at 24VAC or 24VDC.

The *operating angle* is the angle through which the switch must be turned to activate it, relative to its normal rest position.

The *return angle* is the angle to which the switch must be returned to deactivate it. Hysteresis results from the return angle being smaller than the angle that activates the sensor.

Tilt sensors with an open-collector output will specify maximum forward current for the internally mounted LED (usually no greater than

50mA), the maximum collector-emitter voltage at the output (typically 30V), and the maximum collector current (often 30mA). An explanation of open-collector outputs is given in Appendix A (see "3. Analog: Open Collector").

How to Use It

An electromechanical tilt switch can be connected directly between a power supply and a device, so long as the device does not draw more current than the switch is rated to handle. Note that inductive loads such as motors draw an initial surge that can be at least twice the operational rating, while relays may be more likely to create a voltage spike when disconnecting. Switches should be chosen accordingly. For more discussion of this topic, see **switch** in Volume 1.

A small tilt switch can be used in conjunction with a relay or transistor to amplify its signal sufficiently to drive a larger load.

If an electromechanical tilt switch is connected to an electronic device such as a microcontroller or logic chip, output from the switch will have to be *debounced* to prevent a series of brief voltage spikes that can cause false triggering when the switch turns on or off. A debouncing logic circuit or chip can be used, or the program code in a microcontroller can introduce a wait period of up to 50 milliseconds to allow the contacts to settle.

Mercury switches are much less likely to create a noisy output than rolling-ball switches, and may require little or no debouncing.

For an application that must sense rotation around two or three axes, multiple single-axis tilt switches can be combined. A microcontroller or logic gates will be necessary to evaluate signals from the switches, to determine the orientation.

What Can Go Wrong

Contact Erosion

If a ball-type tilt switch is subjected to current that exceeds its specification, arcing may erode its contacts, and they will become less reliable, especially if the contacts are plated with a thin metallic film that is eroded. For additional information on arcing in switches, see the **switch** entry in Volume 1.

Random Signals

During the brief time when a ball-type tilt switch is turning from one position to the other, vibration of the ball(s) inside it is likely to create erratic, random signals. If the output from the switch is being evaluated by a microcontroller, a debouncing routine may be insufficient to prevent the random signals from being sensed, and some programming will be necessary to ignore the signals during this transitional phase. If the switch is connected directly to a relay, the intermittent signals may occur sufficiently rapidly that the relay will ignore them.

Environmental Hazard

A device that incorporates a mercury switch may have to be re-engineered in the future if the availability of mercury switches becomes unreliable as a result of tighter environmental regulations. For the same reason, the end user may have difficulty replacing a mercury switch if it fails. Therefore, a ball-type tilt switch should be used instead of a mercury switch in any newly designed device.

Requirement for Gravity

Because a tilt switch depends on gravity to roll a ball or move a blob of mercury, it will not work in low-gravity, reversed-gravity, or zero-gravity conditions—for example, in a rocket during the unpowered phase of ascent and descent, or in an aircraft that performs aerobatic maneuvers. Performance of a tilt switch in a vehicle that accelerates or decelerates sud-

denly may also be unreliable. Likewise, it cannot be used on a small boat.

Requirement for Stability

A tilt switch will tend to give erroneous results in a location where there is significant vibration or where the object containing the switch may be turned or repositioned unpredictably by the user.

gyroscope

Historically, a **gyroscope** always contained a spinning disc. Some devices for navigation still depend on rotating elements, but they are outside the scope of this Encyclopedia. This entry deals primarily with *vibrating gyroscopes*, also known as *resonator gyroscopes*, that are MEMS devices contained within silicon chips.

OTHER RELATED COMPONENTS

- **accelerometer** (see Chapter 10)
- **GPS** (see Chapter 1)
- **magnetometer** (see Chapter 2)

What It Does

A **gyroscope** resists rotation around any axis at right angles to its own axis of rotation or vibration. Consequently, if the gyroscope is allowed to move freely on gimbals in a sealed enclosure, the gyroscope will tend to maintain its orientation while the enclosure can rotate freely around it.

Taking this concept a step further, if the enclosure is mounted in an aircraft, the aircraft's rotation around two axes can be determined by referring to the gyroscope. If additional gyroscopes are added orthogonally to the first, the aircraft's rotation around all three axes can be determined.

A gyroscope does not measure linear motion in any direction, or any static angle of orientation.

Schematic Symbol

A chip-based gyroscope, magnetomer, or accelerometer may be represented in a schematic as a rectangular box containing abbreviations to identify pin functions (as in any integrated circuit chip).

IMU

An **accelerometer** measures variations in linear motion and will also measure its own static orientation relative to the force of gravity. If an accelerometer rotates around its own axis, it will not measure angular velocity.

A **magnetometer** measures the magnetic field surrounding it, and may be sufficiently sensitive to determine its orientation relative to the Earth's magnetic field.

When an accelerometer and a gyroscope are contained in the same package, optionally with a magnetometer, they may be described as an *IMU* (inertial measurement unit), which can provide necessary data to maneuver aircraft, spacecraft, and watercraft, especially when **GPS** signals are unavailable.

Applications

The first chip-based gyroscope was used in automobiles in 1998 as a yaw sensor in a skid-

control system. Subsequent automotive applications include active suspension control, air bag sensors, rollover detection and prevention, and navigation systems.

Gyroscopes may be installed in military ordnance to provide backup in case an onboard **GPS** system fails, possibly as a result of radio jamming.

Handheld 3D game controllers and headsets may use gyroscopes to control images displayed to the viewer. A digital camera may employ a gyroscope to provide image stabilization. Gyroscopes are usually found in quadcopters or drones, are used to stabilize two-wheeled vehicles such as the Segway, and are used in robotics.

How It Works

The traditional form of gyroscope is a rotating wheel, which will resist turning forces perpendicular to its own axis of rotation. In Figure 9-1, three directions at right angles to each other are defined in the bottom-right corner of the diagram as X, Y, and Z. The wheel is rotating around the X axis, as shown by the green arrow. It will resist any turning force around the Y axis (red arrows) or the Z axis (yellow arrows).

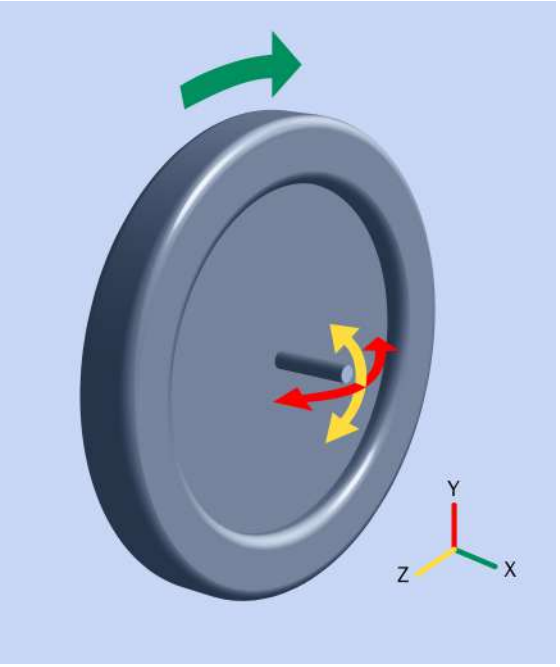

Figure 9-1 *In a traditional gyroscope, a wheel that is rotating (shown by the green arrow) will resist a turning force on either of the axes (shown by red and yellow arrows) perpendicular to its axis of rotation.*

Vibrating Gyroscope

A vibrating fork can be substituted for a wheel. In Figure 9-2 a fork is secured at its base while its tines are induced to vibrate toward each other and away from each other, as suggested by the double-ended arrow. In a chip-based gyroscope, this vibration is induced piezoelectrically or by static electricity.

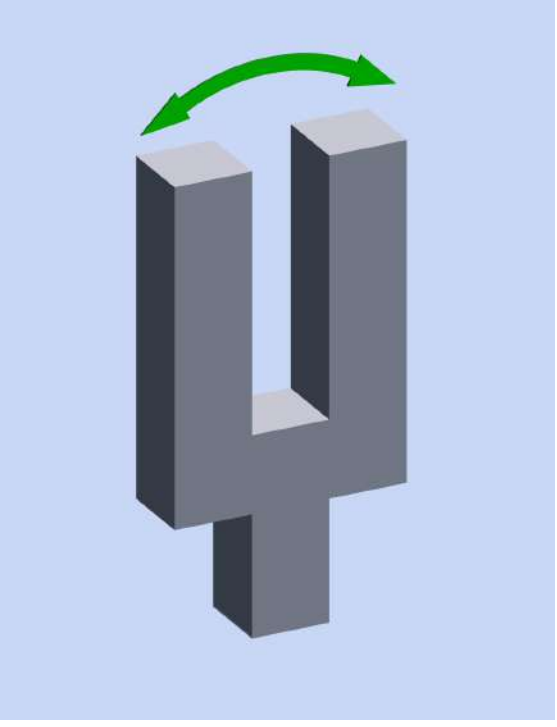

Figure 9-2 *A vibrating fork (green arrows) can be substituted for a rotating wheel in a gyroscope.*

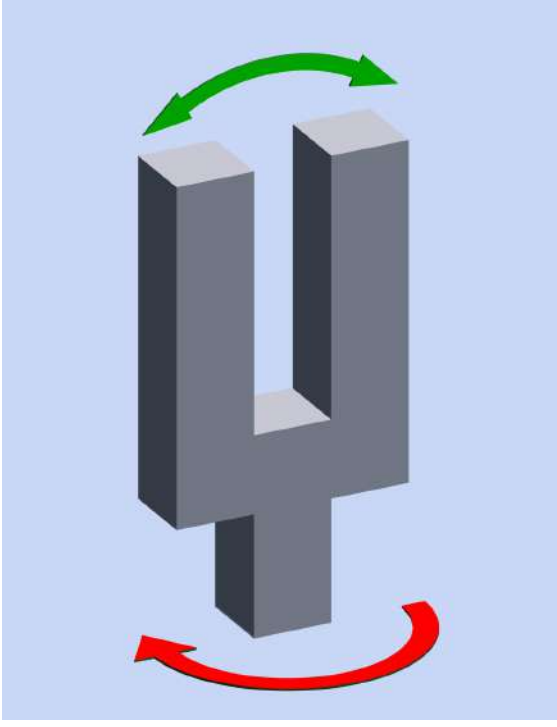

Figure 9-3 *A turning force is applied to the base of the fork around a vertical axis, as shown by the lower arrow.*

Now suppose a turning force is applied around the vertical axis at the base of the fork, as suggested by the lower arrow in Figure 9-3.

The angular momentum of the vibrating tines causes them to resist this turning force, and consequently they will tend to bend, as shown by the yellow arrows in Figure 9-4. The amount of their deflection can be measured capacitively. This system is used in many chip-based gyroscope systems, and may be referred to as a *vibrating gyroscope* or a *resonator gyroscope*.

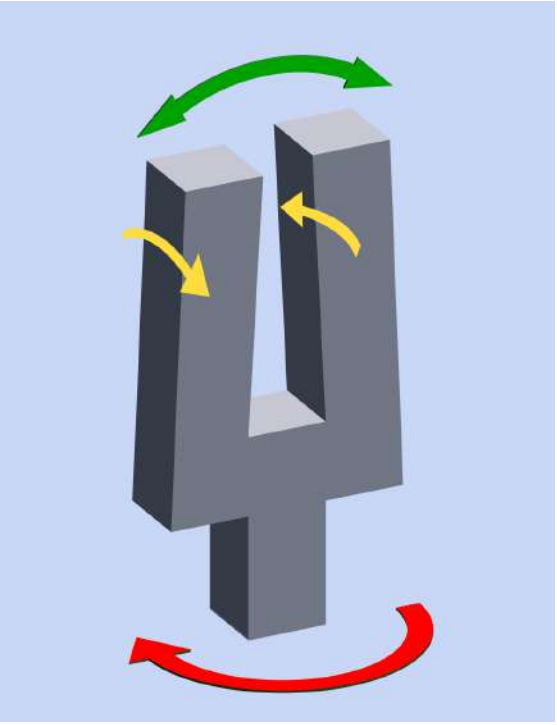

Figure 9-4 *The angular velocity of the rotating fork causes deflection of its vibrating tines, shown by the yellow arrows.*

An assembly of microscopic forks can be etched into a silicon chip. In Figure 9-5, an electron micrograph shows the interior of this type of chip. It contains three rotational sensors, responding to the X, Y, and Z axes of motion. These sensors respond to *pitch* (rotation around the X axis), *roll* (rotation around the Y axis), and *yaw* (rotation around the Z axis).

Fork-based sensors are analog devices whose values are converted to digital values by an onboard *analog-to-digital converter* (ADC). The values are stored in registers that are available to other devices, often via the I2C protocol, which is widely used by microcontrollers.

For additional details about I2C, see Appendix A.

Typically there will be two 8-bit registers for each axis. Each register stores the binary equivalent of a signed integer, where the positive or negative value represents the direction and magnitude of deflection, usually in degrees per second (dps).

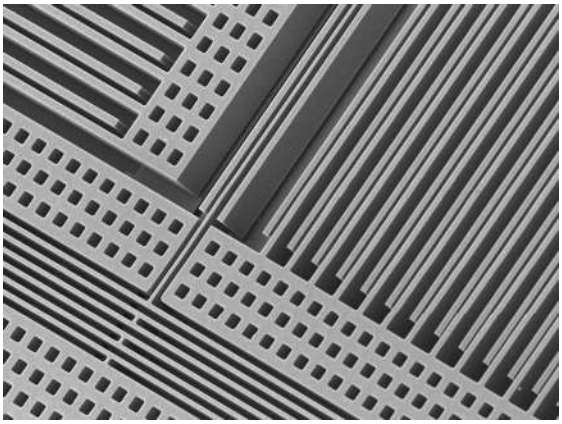

Figure 9-5 *Electron micrograph of the STMicroelectronics LIS331DLH vibrating gyroscope installed in the Apple iPhone 4. The parallel plates at bottom-left function as a spring, while the elements at top-left and at right measure capacitance as their orientation varies according to rotational velocity. Photo courtesy of MEMS Journal published by Chipworks*

Variants

The L3G420D by STMicroelectronics is a 3-axis gyroscope-only chip. It communicates via the SPI or I2C protocol, is approximately 4mm square, and can measure rotational rates up to plus-or-minus 2,000 degrees per second.

The Freescale FXAS21002C has a similar specification. Gyroscope-only chips of this type have fallen in price to the point where they are comparable to the retail cost of everyday components such as a small-signal relay or an audio amplifier on a chip.

IMUs

Chips that only contain gyroscopes are becoming less common as the cost of adding accelerometers decreases.

Gyroscopes and accelerometers are complementary, as gyroscopes are insensitive to linear motion or the Earth's gravity, but accelerome-

ters can measure the rate of change of linear motion and orientation of the chip relative to the Earth. Software can combine this data to calculate the shape of the path being described by a device containing the chip, in addition to the changing velocity of the chip along that path.

The InvenSense MPU-6050 is a common 3-gyroscope, 3-accelerometer chip. It also includes an interface for connecting an external 3-axis magnetometer. The SPI and I2C communications protocols are supported. The MPU-6050 has been a popular choice in the hobby-electronics community, so that Arduino-compatible code to interpret its data is available from many sources. Breakout boards are available with the MPU-6050 installed. An example is the Sparkfun SEN-11028 shown in Figure 9-6.

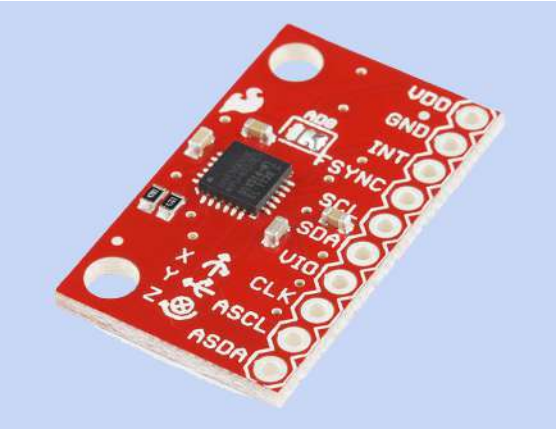

Figure 9-6 *A breakout board from Sparkfun, providing easy access to the InvenSense MPU-6050 chip combining three gyroscopes and three accelerometers.*

Values

The *rotational velocity* of a gyroscope element is usually expressed in degrees of rotation per second (dps), and sometimes in rotations per minute (RPM).

A datasheet will specify the number of sensor axes (usually 3), supply voltage (3.3VDC is common), maximum digital-low and minimum digital-high output voltages, and power consumption in normal mode and sleep mode. Power consumption is usually less than 10mA.

The *dynamic range* is the maximum forward and reverse rotational velocity, which usually will not exceed plus-or-minus 2,000 degrees per second. Lower ranges may be user-selectable. The advantage of selecting a lower maximum rate of change is that it can be converted to a digital value with higher precision.

The *sensor resonant frequency* will be several kilohertz, and must be higher than the frequency of any vibration that is applied to the sensor during use.

The *communications protocol* is usually I2C and SPI may be offered as an option, with a selectable digital output data rate.

Bias temperature coefficient describes the effect of temperature on the gyroscope.

The *resolution* of the gyroscope relates to the number of bits used in the digital output from the onboard ADC. A 16-bit resolution is common.

How to Use It

Using a smart chip such as the MPU-6050, the circuit designer can take advantage of its onboard digital motion processor (DMP). Still, obtaining orientation information from the contents of registers on the MPU-6050 is non-trivial. Online sources and code libraries are necessary. The book *Make: Sensors* contains code listings for the Raspberry Pi as well as the Arduino.

What Can Go Wrong

Temperature Drift

Vibrating materials at the heart of a chip-based gyroscope are likely to change their behavior with temperature. Typically the chip will con-

tain a temperature sensor, the value of which can be used to adjust the output value of the gyroscope.

Mechanical Stress

Stress can be induced when a surface-mount chip is soldered to a board. The vibrating parts of a chip-based gyroscope may be adversely affected. Datasheets will supply information regarding maximum acceptable temperature during the soldering process.

Vibration

Because a chip-based gyroscope depends on the consistent behavior of internal vibrating parts, external vibration can degrade its accuracy. Sensor design can minimize the effects of vibration, but the datasheet should be consulted for details.

Placement

A gyroscope should be placed on a circuit board near a hard mounting point where deflection of the board will be minimized.

accelerometer

10

OTHER RELATED COMPONENTS

- **GPS** (see Chapter 1)
- **gyroscope** (see Chapter 9)
- **tilt** sensor (see Chapter 8)
- **vibration** sensor (see Chapter 11)

What It Does

Acceleration is the rate at which velocity changes over time. If a car takes 10 seconds to increase its speed from 30kph to 40kph relative to the road on which it is traveling, it is accelerating at an average of 1kph each second. If it then reduces its speed back to 30kph during another 10-second interval, it is decelerating at the same rate—although deceleration is really just negative acceleration.

While a car is accelerating, passengers will feel a lateral force exerted on them. Similarly, astronauts in a rocket that blasts off will feel a downward force. According to Einstein's theory of equivalence, forces resulting from acceleration are indistinguishable from the force of gravity.

Consequently, a sensor that measures acceleration can also measure gravity. This sensor is an **accelerometer**. Its output may be measured in *gravities*, abbreviated with the letter g (not to be confused with the usage of G to measure the strength of a magnetic field in gauss).

If three accelerometers are mounted orthogonally (at 90 degrees to each other), their readings can reveal:

- The direction of acceleration of a moving object.
- If an object has been dropped and is falling freely.
- Which way up it is being held in a stationary position.
- The severity of an impact when a moving object collides with some other object.

IMU

A **gyroscope** measures the rate of rotation of the enclosure in which it is mounted. This is properly known as the *angular velocity*. A gyroscope will also respond to changes in the rate of rotation. It does not measure linear motion or a static angle of orientation.

A **magnetometer** measures the magnetic field surrounding it, and may be sufficiently sensitive to determine its orientation relative to the Earth's magnetic field.

When an accelerometer and a gyroscope are contained in the same package, optionally with a magnetometer, they may be described as an *IMU* (inertial measurement unit), which can pro-

vide necessary data to maneuver aircraft, spacecraft, and watercraft, especially when **GPS** signals are unavailable.

Schematic Symbols

A chip-based accelerometer may be represented in a schematic as a rectangular box containing abbreviations to identify pin functions, as in any integrated circuit chip. No specific symbol is used for any of these components.

Applications

In the past, accelerometers were laboratory devices that calibrated the performance of cars, airplanes, and other types of vehicles. Measuring the ability of car tires to withstand cornering forces was an application where an accelerometer was used.

Miniaturization of accelerometer elements, coupled with a radical reduction in their cost, has enabled them to be installed in small electronic devices ranging from smartphones to hard drives.

In a phone or a camera, accelerometers can determine which way up the user is holding the device. The camera can rotate the picture appropriately, and the orientation of the picture can be saved with its image data.

In an external hard drive containing rotating platters, accelerometers can protect the read-write heads by rapidly parking them during the fraction of the second that elapses between someone dropping the hard drive and its impact with the floor.

Accelerometers can be installed in a 3D mouse or virtual-reality headset to determine its orientation and motion. This enables a video image to be updated appropriately. For example, the Nintendo Wii Remote has been marketed with an ADXL330 accelerometer.

In an automobile, an accelerometer can trigger the deployment of an air bag when the deceleration caused by an impact exceeds a threshold level.

How It Works

The simplest conceptual model of an accelerometer consists of a mass attached to one end of a coiled compression spring. The other end of the spring is anchored in an object whose acceleration is being measured. The mass can only move along the same axis as the spring.

Figure 10-1 shows three views of a simplified accelerometer, which is a sealed tube shown in dark red. In the center image, the accelerometer is in its rest state. The top image shows the mass (a dark blue square) responding when the tube accelerates from left to right. The third image shows it decelerating (that is, undergoing negative acceleration, or acceleration from right to left). Using an ideal spring, the displacement of the mass will be proportional to the rate of acceleration, within reasonable limits. The displacement can be measured optically or capacitively.

Note that the rest state will resume when the acceleration stops, regardless of constant motion in any direction. An accelerometer only measures a *change* in velocity. It does not measure a constant velocity.

An accelerometer cannot measure rotation around its own axis of movement. Therefore, it may be used in conjunction with a **gyroscope**, which measures angular velocity.

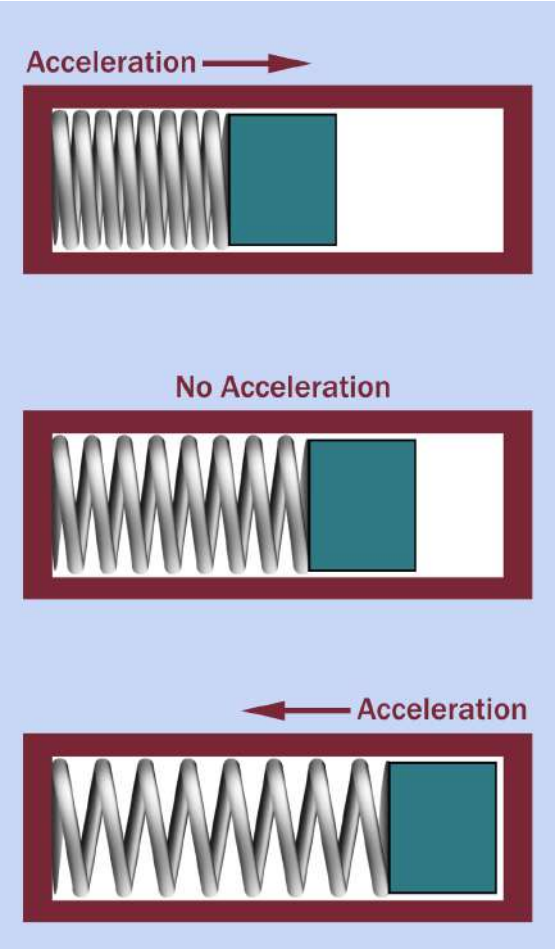

Figure 10-1 *Simplified view of an accelerometer consisting of a sealed tube (dark red outline) with a spring anchored to it at left. A small mass (dark blue) is attached to the right end of the spring. The mass responds to acceleration of the tube.*

Gravity and Free Fall

If a device containing the simplified accelerometer described previously rests on the ground, and is mounted vertically as in the left section of Figure 10-2, gravity acting on the mass will apply a force to one end of the spring, while the other end is restrained. The accelerometer will now measure 1g as a downward force.

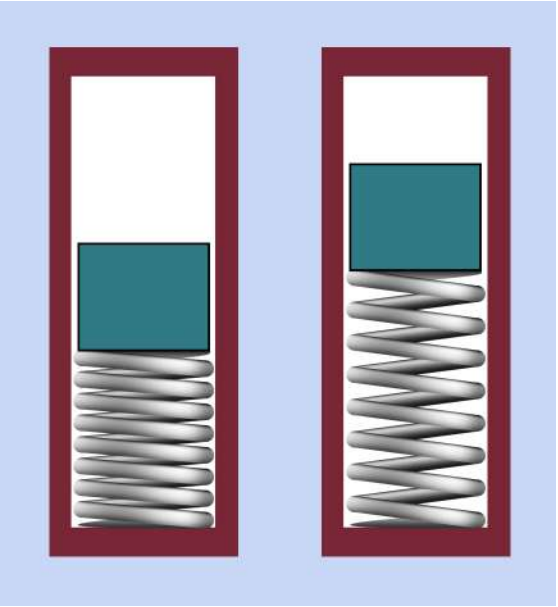

Figure 10-2 *Left: an accelerometer resting on the ground measures 1g, as the force of gravity pulls the mass downward. Right: in free fall, the accelerometer measures 0g.*

If the device is dropped so that it falls freely under the influence of gravity, it is in *free fall* and will accelerate at approximately 9.8 meters per second each second. This is usually written as 9.8m/sec^2, or can be described as 1 gravity, often expressed as 1g.

An accelerometer in free fall will measure 0g, as shown on the right in Figure 10-2, because all parts of the accelerometer are now accelerating equally under the force of gravity.

If three accelerometers are assembled orthogonally, and if one accelerometer is vertical, and the device is held motionless relative to the Earth, the vertical sensor will show 1g while the other two accelerometers will show 0g. If the device is dropped, all sensors will show 0g.

Rotation

If a device containing three accelerometers is turned over, and is not in free fall, accelerometers mounted orthogonally will show values that vary depending on their alignment with the force of gravity.

Calculation

The force acting upon an object will cause a rate of acceleration that can be calculated by Newton's Second Law of Motion, provided that the object can move freely and is not being subjected to any additional forces, such as the force of gravity. If F is the force, m is the mass of the object, and a is the acceleration:

```
F = m * a
```

And therefore:

```
a = F / m
```

If the mass is restrained by a spring whose compression or extension has an approximately linear relationship to the force applied to it, acceleration can be calculated as a function of the linear displacement of the mass.

These statements ignore relativistic effects that are insignificant unless ultra precise time and motion measurement may be involved.

In a real-world accelerometer, movement of the mass will require some form of damping to prevent it from oscillating.

Variants

Accelerometer prices dropped radically after 2010. In an effort to maintain profitability, manufacturers have loaded more features onto chips. While a 2-axis accelerometer such as the Memsic 2125 seemed a good option when first introduced, it is now facing obsolescence as 3-axis accelerometer chips that also contain 3-axis gyroscopes have become ubiquitous—and no more expensive.

Early chip-based accelerometers provided analog outputs where voltage was proportional with acceleration and could be processed by a comparator. On some breakout boards, such as the Dimension Engineering DE-ACCM6G, which used the STMicroelectronics LIS244ALH chip, a comparator was included (see Figure 10-3).

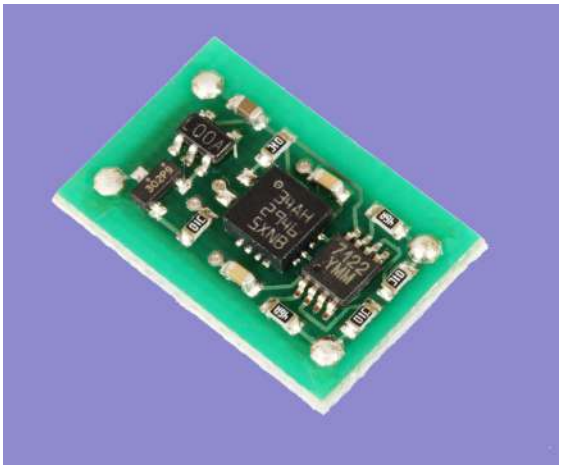

Figure 10-3 *A relatively early, relatively expensive breakout board using the 2-axis accelerometer LIS244ALH chip by STMicroelectronics. It has been superceded by chips that combine accelerometers, gyroscopes, and processors to provide a digital output.*

Because this board allowed a maximum output of only 0.83mA, it was only suitable for high-impedance logic chips or a microcontroller. However, because the output was analog, it could be passed through another comparator for direct connection to a piezo beeper to create a device that would sound an alarm when tilted. This is shown in Figure 10-4.

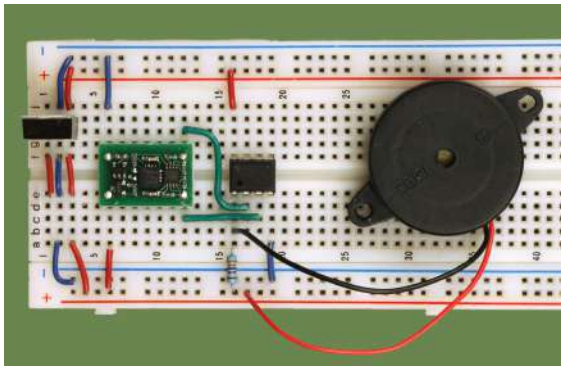

Figure 10-4 *Connecting the analog output from the DE-ACCM6G 2-axis comparator breakout board through a comparator to a piezo beeper.*

Many chips now contain gyroscopes as well as accelerometers. The electron micrograph in Figure 10-5 shows the interior of a chip of this

kind, where the zig-zag shapes are "springs" etched into the die, the large areas patterned with dots are masses that can respond to various forms of motion, and the parallel plates are capacitive sensors.

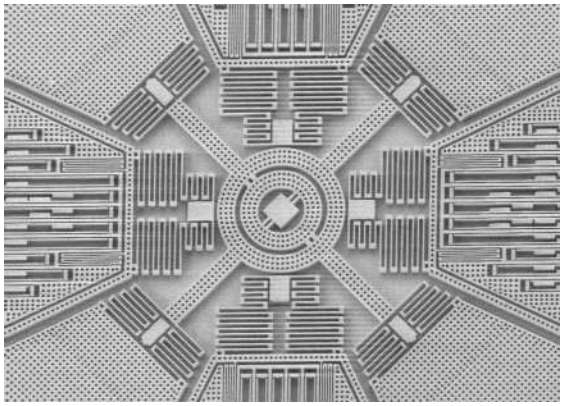

Figure 10-5 *Interior of a chip combining gyroscopes with accelerometers.*

The complexity of a chip combining two types of sensors creates a need for more complicated code to process the six outputs. Consequently most accelerometer chips now have their own onboard ADCs, and digital registers for communication with microcontrollers via the I2C communication protocol. Some chips also have onboard processing to interpret the mix of data. However, microcontrollers still need code to make sense of the data.

The hobby-electronics community has responded. A breakout board such as the LSM9DS0 from Adafruit, using a chip from STMicroelectronics that shares that same part number, tries to make this extremely complex chip accessible to experimenters. Shown in Figure 10-6, the LSM9DS0 contains a 3-axis magnetometer in addition to a 3-axis gyroscope and a 3-axis accelerometer.

The datasheet for the LSM9DS0 runs to more than 70 pages. At the time of writing, Adafruit is still refining code for the Arduino to make the features of this chip accessible.

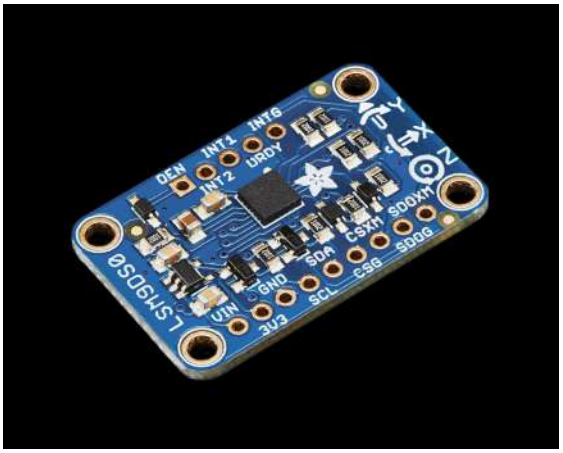

Figure 10-6 *This breakout board from Adafruit is built around an LSM9DS0 chip that combines accelerometers with gyroscopes and magnetometers.*

Despite the complexity of the LSM9DS0 chip, the breakout board sells for approximately the same price, at the time of writing, as the DE-ACCM6G 2-axis analog-output magnetometer four years ago. In the future we may expect IMU prices to fall still further, so that this type of multifunction chip becomes the default, and users simply ignore the functions that they don't need.

Values

Current consumption will vary depending on the activity of the chip, and may be broken down for different types of sensors on multi-sensor chips. A modern accelerometer may typically draw less than 1mA. Gyroscope power consumption will be greater, as a segment of the chip will be maintained in a state of vibration.

Linear acceleration measurable by an accelerometer is customarily expressed in gravities, abbreviated g. Current generations of chips may be able to measure as much as plus-or-minus 16g, but because the value is converted internally to a digital quantity, smaller accelerations will not be expressed so accurately. Therefore the measurement range for acceleration is

usually user-selectable by sending an appropriate code to the chip. Ranges may include plus-or-minus 2g, 4g, 6g, 8g, and 16g.

Sensitivity defines the smallest increment of acceleration measurable by the least significant bit (LSB) in an output register, for each of the acceleration ranges. In a range of plus-or-minus 2g, the internal 16-bit ADC may be capable of measuring 0.06 milligravities. When the range is reset to plus-or-minus 16g, the smallest increment may be around 0.7 milligravities.

The measurable range of gravities should not be confused with the maximum acceleration that the chip can tolerate without suffering internal mechanical damage, either while it is powered or unpowered. This will be more than 1,000g provided the duration is brief, and would only be experienced during an impact.

Linear acceleration sensitivity change versus temperature is usually expressed as a percentage, such as plus-or-minus 1.5%.

Output type will be analog or digital. If digital, the data protocol will be I2C or SPI. If I2C, the address of the device should be configurable. The data transfer rate is typically at least 100kHz, and this also may be configurable to different rates.

For additional details about protocols such as I2C, see Appendix A.

What Can Go Wrong

Mechanical Stress

Stress can be induced when a surface-mount chip is soldered to a board. The moving parts in a chip-based accelerometer may be adversely affected. Datasheets will supply information regarding maximum acceptable temperature during the soldering process.

Other Problems

If the accelerometer function is combined with other sensing functions such as magnetometer or gyroscope, see Chapter 2 or Chapter 9 for additional cautions about potential problems affecting these kinds of sensors.

vibration sensor

11

An **accelerometer** can measure some aspects of vibration. However, this entry deals primarily with mechanical devices (often described as *vibration switches*) and piezoelectric devices (often described as *vibration sensors*) that are solely intended to measure vibration.

A *vibrometer* measures vibration using a laser beam aimed at a reflective spot applied to a surface. It is usually a laboratory instrument, beyond the scope of this Encyclopedia.

OTHER RELATED COMPONENTS

- **accelerometer** (see Chapter 10)
- **tilt** sensor (see Chapter 8)
- **force** sensor (see Chapter 12)

What It Does

A vibration sensor responds to repetitive mechanical motion. Most versions contain two switch contacts that are normally open and will close if the sensor vibrates in its designed frequency range. In some sensors, the frequency range and sensitivity are manually adjustable.

Large sensors are used as automatic shutdown switches responding to excessive vibration in machinery, and may be capable of switching substantial currents (10A or higher). Smaller versions can shut down domestic appliances such as a washing machine that is seriously out of balance during a spin cycle.

A vibration sensor can be used as a simple user-input device in toys and games.

A shock sensor can detect abuse of a sensitive device, for example, by including the sensor and a data logger when the device is transported.

Schematic Symbols

Either of the symbols in Figure 11-1 may represent a piezoelectric or piezoresistive vibration sensor, but they also represent other piezo-based devices.

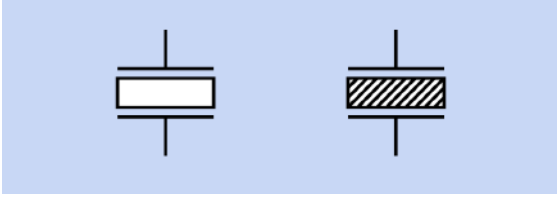

Figure 11-1 *Either of these symbols may represent a piezoelectric or piezoresistive device, including (but not limited to) vibration sensors that operate on this principle. The symbol on the left is more common.*

Variants

Vibration sensors use a wide variety of detection methods.

Pin-and-Spring

Probably the simplest type of sensor consists of a small, thin pin in the center of a miniature coil spring. The spring is anchored at its base, but its other end is free to vibrate. If the vibration reaches a sufficient amplitude, the spring touches the pin, completing a circuit between the two leads of the device.

An example is shown in Figure 11-2, where two identical sensors are shown, one of them cut open to reveal the gold-plated rod and spring inside. This sensor is rated for 10mA at up to 12VDC.

Figure 11-2 *When the spring in this sensor vibrates, it touches the pin that is centered in it. The background grid is in millimeters.*

Advantages of this system are low cost, ability to respond along two out of three axes, no power supply requirement, and ability to switch AC or DC. However, because the internal contact is extremely brief, it must be connected with a latching component of some type. A flip-flop could be used, or a 555 timer. The switch may also be connected with an input pin on a microcontroller, provided a pullup or pulldown resistor is used to prevent the input from floating when the switch is open.

Externally, the packaging of a pin-and-spring vibration sensor is almost indistinguishable from a small **tilt** sensor that contains one or two spherical metal balls. The tilt sensor may respond to vibration, but only of a large amplitude and low frequency.

A miniature board containing a pin-and-spring vibration sensor, comparator, and trimmer potentiometer for sensitivity control is sold cheaply by the Chinese supplier Elecrow as their product SW-18015P, shown in Figure 11-3. Elecrow also offers a wide range of other low-cost sensors.

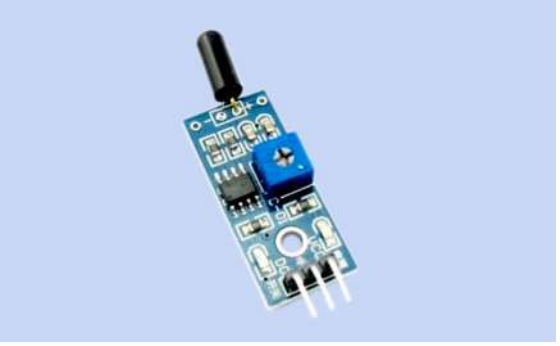

Figure 11-3 *A pin-and-spring vibration sensor mounted on a board with sensitivity control.*

Piezoelectric Strip

The LDT0-028K by Measurement Specialties is a section of piezoelectric polymer film laminated to a polyester substrate. The film is designed to be anchored at one end, allowing the other end to vibrate. An unweighted version and a weighted version are shown in Figure 11-4, each measuring about 13mm x 25mm. Addition of the weight alters the resonant frequency of the sensor.

Deflection of about 2mm is sufficient to generate a surprising 7VDC between the two leads. Larger deflections will generate higher voltages. The manufacturer suggests that direct connection to a CMOS component is possible. An op-amp may be used for signal conditioning.

A piezoelectric device of this type only generates voltage during the process of deflection. If

the strip is held in a curved position, its output diminishes to zero.

This sensor has a resonant frequency around 170Hz when there is no weight attached to its free end.

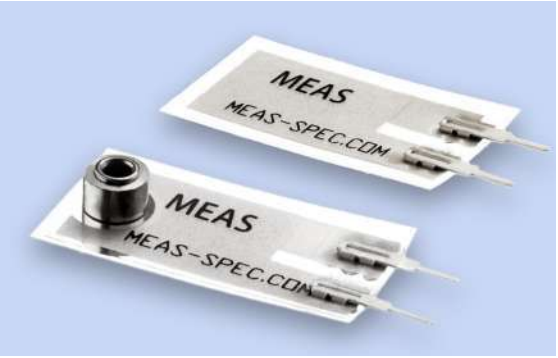

Figure 11-4 *Two versions of the LDT0-028K vibration sensor from Measurement Specialties, one with an added weight to lower its resonant frequency.*

Chip-Based Piezoelectric

The Murata PKGS series is an example of a surface-mount piezoelectric shock sensor. Measuring only about 1mm x 2mm x 4mm it has an analog output designed for connection through an op-amp. The manufacturer suggests application in a hard-disk drive to block read-write operations when vibration occurs. Similarly, these shock sensors may be used in CD-ROM or DVD drives. They may also be installed in cash dispensing machines to sound an alarm if vandalism occurs.

Toshiba's TB6078FUG is a similar product. Note that because these devices contain electronic components, they require a power supply (usually 3.3VDC to 5VDC) for operation.

"Mousetrap" Type

Some vibration switches rely on a simple system of leverage that is comparable to a mousetrap, in that a relatively small stimulus releases a strong spring. In Figure 11-5 the upper part of the figure shows the switch at rest, held in its position by a powerful spring and by the weight of a mass attached to a pivoted arm. In the lower part of the figure, severe vertical vibration has caused the assembly to move up and down with sufficient energy to overcome the tension in the spring while the inertia of the mass has resisted the motion. Consequently the arm has moved past the position where the spring is aligned with the pivot, and the spring now acts to hold the arm against a snap-action switch. A system of this type is used in sensors on some power-station cooling towers, where the loss of a large fan blade can result in major vibration.

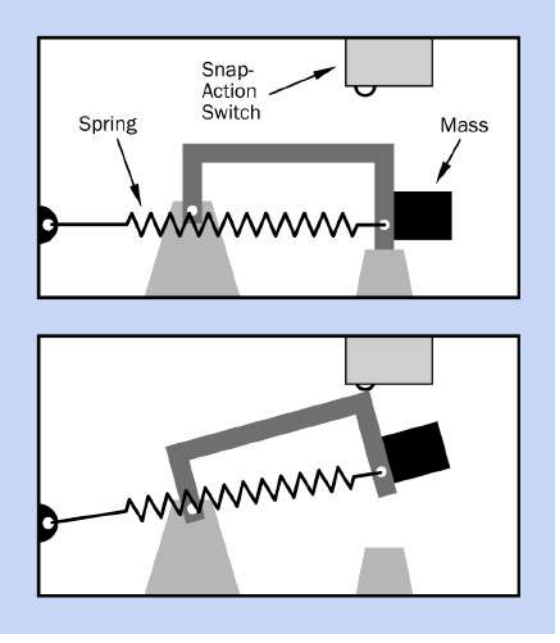

Figure 11-5 *A spring-loaded vibration sensor.*

Magnetic

Typically this method is used to detect excessive vibration in machines or other devices containing heavy rotating mechanical components. The sensor may be physically large, moving switch contacts that are designed to handle currents of 1A or significantly more.

In one system, a steel ball is retained by a permanent magnet that is barely powerful enough to prevent the ball from falling. Excessive low-frequency vibration will dislodge the ball, which falls and completes a circuit between

two contacts. This activates a relay that powers down the piece of machinery that is vibrating.

The ball may be spaced a small distance from the magnet by a beveled nonmagnetic seat, and the seat may be movable with an external screw. This will adjust the sensitivity of the switch. After the switch has been triggered, it must be reset, which may entail using an external lever to raise the ball back to its location near the magnet.

Another magnetic system is shown in Figure 11-6, where a magnet on a vertical arm can be displaced by horizontal vibration, and an inertial mass on a spring-loaded horizontal rod can also dislodge the magnet in response to vibration along the other two axes.

Figure 11-6 *A magnetic vibration switch. See text for details.*

Mercury

A small *mercury switch* may be used as a vibration sensor, although this application is uncommon. See Chapter 8 for more information about mercury switches.

Values

Measurement of vibration is a complex science of special interest in mechanical design, especially in areas such as the powertrain and suspension geometry in an automobile. Only a few fundamentals will be summarized here.

Primary Variables

The four primary variables in vibration are frequency, displacement, velocity, and acceleration. Frequency describes how rapidly the vibration occurs; displacement describes how far the vibrating object moves in each direction; velocity describes how fast it moves during each cycle; and acceleration describes how rapidly the velocity changes during each cycle. Different types of sensors can be chosen for their responsiveness to each attribute.

Figure 11-7 shows the theoretical relationships between displacement, velocity, and acceleration plotted against the frequency of vibration. The y axis of this graph (the vertical axis) is often labeled "amplitude," but in reality it is being used to measure three different units, as shown. The curves indicate that if the velocity of vibration remains constant while frequency increases, acceleration must increase as a function of the frequency while displacement decreases. The acronym "rms" denotes that the values are measured as the "root mean square" of their fluctuations.

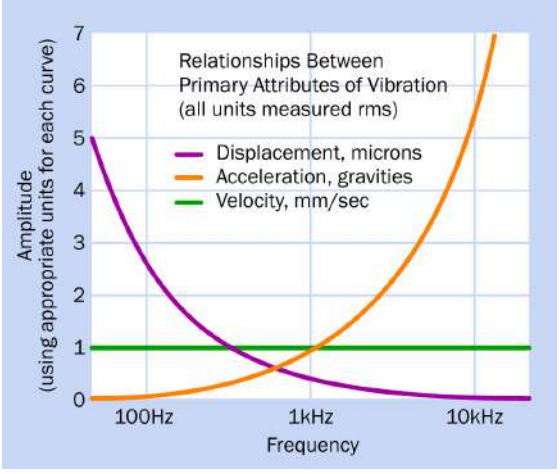

Figure 11-7 *Theoretical relationships among the primary attributes of vibration.*

Mechanical sensors or switches that respond to displacement are best suited to low frequencies, while piezoelectric sensors that are sensitive to acceleration are best suited to higher

frequencies. Serious mechanical problems tend to result in low-frequency vibrations, while wear on bearings and in gear trains will be more likely to create high-frequency vibration.

Dynamic Attributes

Datasheets for small piezoelectric sensors may only show basic values such as the voltage range that is likely to be created.

Small mechanical sensors of the pin-and-spring type will be rated for maximum voltage and switching current. Typical values may be around 12V (AC or DC) and 10mA, indicating that the output from this type of sensor should be used with an op-amp, microcontroller, logic chip, solid-state relay, or other semiconductor with a high-impedance input.

Sensors that are manufactured for industrial applications will be rated for attributes such as measurable acceleration range (in gravities), temperature sensitivity, frequency response, resonant frequency, capacitance, and power requirement.

The sensitivity of piezoelectric sensors is usually expressed in mV/g. This type of sensor will require a comparator to process the tiny amount of current that it creates.

How to Use It

If a vibration sensor has an analog output requiring a comparator, the output from the comparator is likely to be of the open-collector type. This will require a pullup resistor of a value that provides an appropriate voltage for the next stage in the circuit. For more information about comparators, see Volume 2. For more information about the use of an open-collector output, see "3. Analog: Open Collector".

A *coupling capacitor* can remove the DC component from the comparator output, allowing only the frequency of vibration to pass through. The choice of capacitor value will depend on the frequency.

When using a piezoelectric sensor with analog output, a 10M resistor may be installed across its two terminals to reduce voltage drift.

The primary challenge in getting a vibration sensor to work successfully will be matching it to the source of vibration. Manufacturers' datasheets for chip-sized sensors often provide very little information about the optimal values for their products. Peak performance will occur when the natural resonant frequency of a sensor is close to the frequency of vibration that it must detect. Trial and error may be necessary.

A sensor must be mounted appropriately. Most sensors are directional, at least to some extent, and many will not respond significantly to vibration at 90 degrees to their primary axis of sensitivity. Their performance will also diminish if they are placed too far from the vibration source, or if they are mounted on a flexible or yielding surface that will tend to absorb vibration.

While industrial vibration switches may be adjusted manually, the response of small devices designed for circuit-board mounting can only be tweaked using external components to filter out unwanted signals from the sensor.

What Can Go Wrong

Long Cable Runs

The output from a piezoelectric vibration sensor is primarily an AC signal, fluctuating at the frequency of the vibration. Long cabling, or inadequately shielded cabling, can potentially introduce capacitive effects that can degrade the sensor signal. This issue will only affect higher frequencies.

Interference

Sensor signals can also be affected by electromagnetic interference from power lines, transformers, and large motors. This is a significant

issue, as a primary application for industrial vibration sensors is to measure vibration created by motors.

Correct Grounding

For large sensing equipment, grounding may be important to shield cables that transmit data. In an industrial environment, however, grounding is primarily motivated by safety considerations, and an electrical ground can carry unwanted interference. Ground loops may be created if there are multiple ground points. Ideally, a "ground tree" should be used, where there is only one primary grounding point, and grounds to equipment branch out from it.

Fatigue Failure

In installations where some vibration normally exists, cables should be anchored properly to minimize the risk of fatigue failures.

force sensor

12

A *load cell* or *load sensor* is generally intended to measure a static load, while a *force sensor* can respond dynamically. However, this semantic distinction is not always observed. This entry differentiates between load cells and force sensors but includes them both.

Traditional types of *hydraulic* and *pneumatic* load sensors are not electronic devices. They are outside the scope of this Encyclopedia.

Capacitive, *ultrasonic*, *magnetic*, *optical*, and *electrochemical* force sensors are relatively unusual, and are not included in this Encyclopedia.

A force sensor is occasionally described as a **pressure** sensor, but that term is ambiguous, as it is more often used in conjunction with fluids. This Encyclopedia assumes that a pressure sensor only measures gas or liquid pressure. See Chapter 17.

A **vibration** sensor reacts to rapidly changing forces, but usually cannot measure them accurately, and is simply triggered when vibration exceeds a threshold. See Chapter 11.

Impact sensors that measure the force of a collision are outside the scope of this Encyclopedia.

A sensor designed to respond to a single touch from a fingertip is considered a human-input device and is discussed in the **single touch** sensor entry. See Chapter 13.

OTHER RELATED COMPONENTS

- **vibration** sensor (see Chapter 11)
- **single touch** sensor (see Chapter 13)

What It Does

A **force** sensor measures physical force that is applied to it, either by a person or by an object. Many force sensors respond rapidly and can measure fluctuating forces.

A *load cell* or *load sensor* is usually intended to measure the static weight of an object.

Applications

In robots, force sensors can provide feedback to limit the grip of a mechanical hand. They can also provide haptic feedback for a surgeon performing robotic surgery. In the future, force sensors may find increasing application in agriculture, as mechanized handling of fruit and other foods requires a carefully controlled gripping force.

In medicine, the use of force sensors to evaluate muscle strength in hands or limbs can be important as an indicator of neurological problems or to monitor progress in occupational therapy. Thin force sensors can be installed in shoes to check the weight distribution of each foot. They can also be used for entertainment purposes, to light LEDs in sneakers.

A force sensor may respond to a single-touch user input. See Chapter 13 for more information about **single touch** sensors. Some video game controllers use resistive force sensors to measure the amount of pressure applied to a button. The PlayStation is an example. (Old PlayStation DualShock 2 controllers are a salvageable source of pressure-sensitive buttons.)

Load sensors are used to weigh industrial products, and are also used domestically in kitchen and bathroom scales.

A load sensor can also detect human presence—for example, in the passenger seat of an automobile, where an air bag must not deploy if a young child is present, or in a hospital, to monitor the number of times the patient gets out of bed.

Schematic Symbol

No specific schematic symbol is used for either a force sensor or a load sensor. If a force sensor uses a piezoelectric or piezoresistive element, it may be represented by the symbol shown in Figure 11-1, which is used for many piezo devices.

How It Works

Two methods of force measurement are commonly used: resistive and piezoelectric.

A *piezoelectric* force sensor uses a piezoelectric element, often consisting of a quartz crystal, to convert force to a small voltage that can be amplified. However, this type of sensor only responds to changes in force. If a constant load is applied, the output peaks quickly and then gradually diminishes to zero.

Resistive force sensors change their electrical resistance when force is applied. They include *metallic strain gauges* and *plastic-film* sensors in which two layers of conductive ink are pressed together.

In SI (standard international) units, the force needed to activate a sensor is measured in newtons, abbreviated with a capital letter N. A newton is defined as the force that would accelerate a mass of 1 kilogram at 1 meter per second each second. More practically, in the gravitational field at the surface of the Earth, 1N = about 100 grams of weight. There are about 28 grams in an ounce; thus 1N is slightly less than 4 ounces.

Strain Gauge

A strain gauge is often made from metallic foil applied to an insulating flexible backing. The backing is glued to a shaped piece of metal, usually steel or aluminum, which is designed to flex slightly under pressure and may be referred to as a *spring*, even though it is often one solid object. Its deflection will be related to the force imposed on it.

The maximum deformation of the spring under a strain gauge is usually 500 to 2,000 parts per million (ppm) when subjected to the maximum force that it is designed to measure. A change of 1ppm is referred to as a *microstrain* (abbreviated μe).

The strain gauge has no polarity, and functions like a force-controlled **potentiometer** (see Volume 1). The ratio of the change in its resistance to the change in the strain that it experiences is called the *gauge factor*. For metal foil gauges, the gauge factor is usually around 2.0. This is an approximately linear relationship.

The most common type of foil pattern is shown in Figure 12-1. In the figure, if a stretching force is applied horizontally, the multiple thin sections of foil are slightly elongated, and their

resistance increases within the limits of elasticity of the foil. This effect is multiplied by the number of sections. If the stretching force is applied vertically, the sections are merely separated slightly, and the result is negligible.

Wheatstone Bridge Circuits

The very small changes in resistance in a strain gauge must be amplified to be usable, and the first step is to use a Wheatstone bridge circuit. The simplest form of this circuit is shown in Figure 12-2.

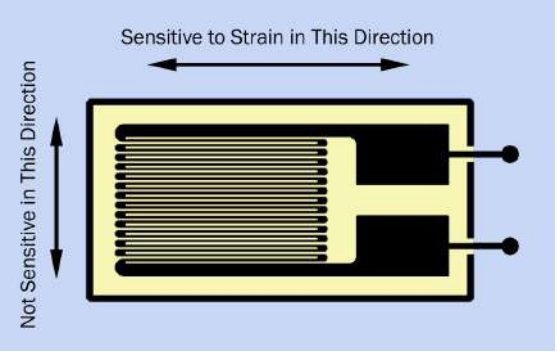

Figure 12-1 *The pattern of metallic foil used in a typical strain gauge.*

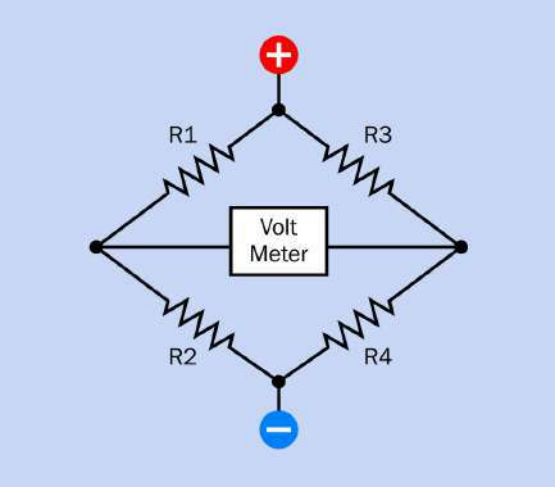

Figure 12-2 *A demonstration version of the basic Wheatstone bridge circuit that is often used to detect small changes in a resistance.*

Each pair of resistors (R1 + R2, and R3 + R4) functions as a voltage divider. If all the resistors have an exactly equal value, the voltage at the midpoint of each pair will be identical, and the volt meter at the center will have a zero reading. However, if the value of one resistor changes slightly, the meter will register the imbalance. This circuit is commonly used because of its sensitivity to small variations.

In Figure 12-3 two strain gauges have been substituted for resistors R3 and R4. The upper strain gauge has been mounted so that it experiences an increase in force at the same time that the lower strain gauge experiences a decrease, usually because one gauge is mounted on the top side of a flexing element while the other gauge is mounted on the underside.

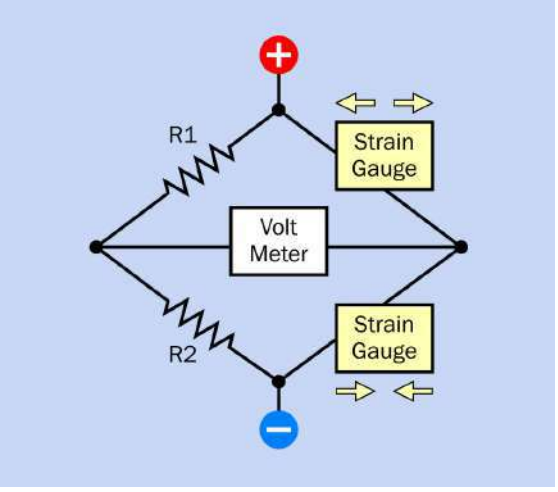

Figure 12-3 *Two strain gauges, oppositely oriented, can be used as resistances in the Wheatstone bridge circuit.*

Using two strain gauges in this way doubles the sensitivity of the Wheatstone bridge circuit. The configuration is known as a "half Wheatstone" force sensor, and will have three connecting wires. One will be black, one will be red, and the third will be a different color. The red and black wires are for connection to the power supply, as shown in the schematic, while the third wire is common and should be considered as an output.

If an additional two strain gauges are inserted in the Wheatstone bridge circuit, this is now a "full Wheatstone" force sensor (see Figure 12-4). Note, however, the diagonally symmetrical orientations of the strain gauges, necessary to multiply their effect.

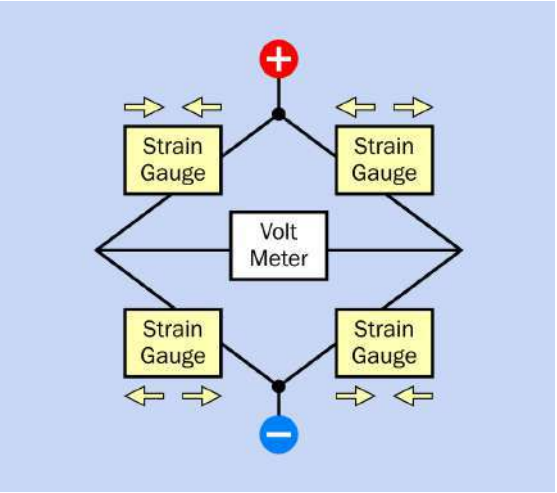

Figure 12-4 *Two additional strain gauges create a "full Wheatstone" circuit.*

A typical digital bathroom scale contains two half-Wheatstone force sensors, wired to create a full-Wheatstone configuration.

The force sensors shown in Figure 12-5 are rated for up to 50kg each, and can thus weigh up to 100kg if they are combined in a scale. In this figure, one sensor has been turned over to show its underside. The strain gauges are hidden in each sensor where the steel sections overlap.

Wheatstone Bridge Errors

Where more than one strain gauge is used in a Wheatstone bridge, they should ideally have identical performance. Since this is impossible as a result of manufacturing tolerances, some error correction is built into devices using multiple strain gauges.

Figure 12-5 *Two force sensors suitable for a bathroom scale, each containing a pair of strain gauges that will flex oppositely under load.*

Strain-Gauge Amplification

The voltage output from a Wheatstone bridge circuit is given by the following formula, where V_{IN} is the supply voltage, V_{OUT} is the output, and R1 through R4 are the resistance values that were used in Figure 12-2.

$$V_{OUT} = [(R3/(R3+R4)) - (R2/(R1+R2))] * V_{IN}$$

The good news is that the output when a strain gauge is used will vary linearly with the load applied. The bad news is that it will be very small.

To amplify it, an op-amp such as the AD620 is often recommended. Using external resistors, its amplification factor can be adjusted from 1:1 to 10,000:1. Alternatively a chip such as the HX711 by Avia Semiconductor contains a 10-bit analog-to-digital converter and is specifically designed for use in weighing scales. Its digital output uses a very simple serial format. Sparkfun sells a breakout board incorporating this chip. See Figure 12-6.

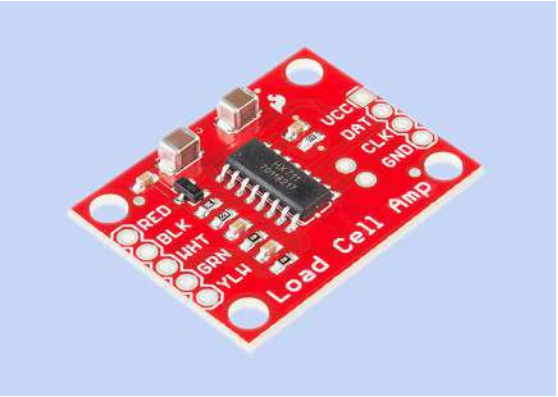

Figure 12-6 *Sparkfun HX711 breakout board for the HX711 amplifier chip, specifically designed for a full-Wheatstone array of strain gauges in a force sensor.*

Other Strain-Gauge Modules

Strain gauges are built into a variety of sensor modules. Figure 12-7 shows a selection, all of which are available from Sparkfun. Many more can be found online.

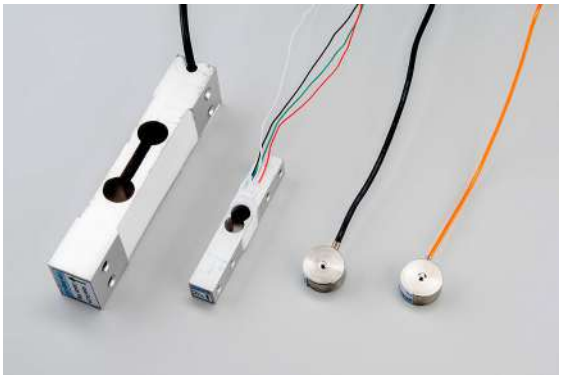

Figure 12-7 *A selection of load cells containing strain gauges, available from Sparkfun.*

Plastic-Film Force Sensors

Plastic-film resistive sensors contain two layers of conductive ink, sealed between two layers of thin, transparent plastic film. The resistance between the ink layers diminishes when they are pressed together. It may vary from as little as 30K when fully loaded to more than 1M when unloaded.

Like a strain gauge, this sensor has no polarity and requires no power supply.

Examples of this type of sensor are shown in Figures 12-8 and 12-9. Other shapes and sizes are available. Manufacturers include Tekscan, whose product is named FlexiForce; Alpha Electronic, in Taiwan; and Interlink Electronics.

Figure 12-8 *A FlexiForce A401 resistive film sensor made by Tekscan, Inc. Its sensing area is 25.4mm in diameter (1 inch) and is rated to measure up to 111N (25lbs).*

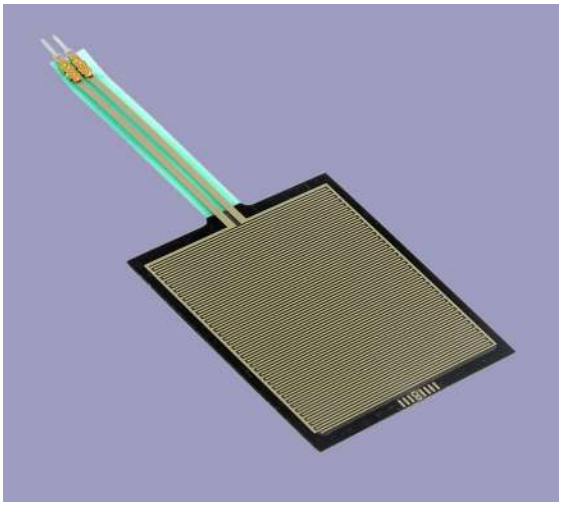

Figure 12-9 *An Interlink FSR406 resistive film sensor. Its sensing area is slightly less than 40mm square, and is rated to measure up to 20N (4.5lbs).*

Plastic-film sensors should not be confused with film-based piezoelectric vibration sensors, which are described in the **vibration** entry (see "Piezoelectric Strip"). Those sensors provide a transient output when they flex rapidly. The

resistive sensors provide a stable output in response to a steady load.

Deformative Force Sensors

A sheet of natural or silicone-based rubber can be impregnated with conductive particles. The conductivity of the sheet may not change significantly when it is compressed, but if it is separated from a metal plate by a mesh of thin nylon fibers, compression will result in greater conductivity by pushing the rubber into the gaps between the fibers. See Figure 12-10.

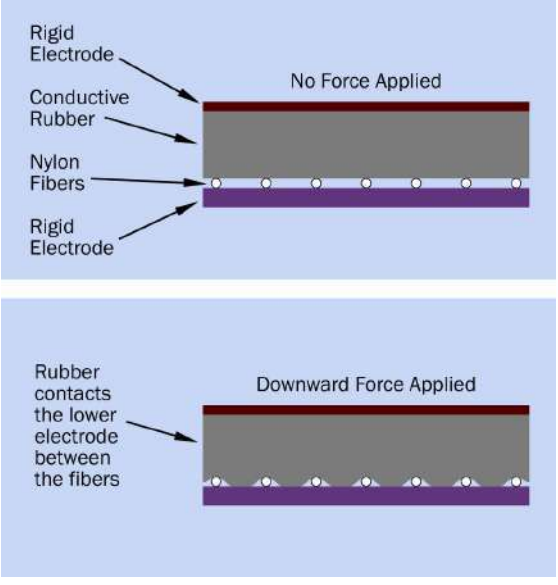

Figure 12-10 *In the top image, a flexible conductive layer is separated from an underlying rigid electrode by nylon mesh. In the lower image, a load applied to the flexible layer has forced more of it into contact with the electrode, reducing the resistance between them.*

Improvised Resistive Sensors

Polyethylene film impregnated with carbon particles is available under the brand name Velostat, owned by 3M. Although it was developed as an antistatic packaging material for semiconductors, it can be used to make a DIY force sensor. When the material is stretched, the embedded particles are more dispersed, and electrical resistance increases. When the material is compressed, its resistance is reduced.

Antistatic foam of the type used to package CMOS components can be used in the same way, although some types behave like memory foam, being slow to recover from pressure. The foam can be sandwiched between a pair of copper-plated circuit boards as electrodes.

How to Use It

Plastic-Film Resistive Force Sensors

The conductivity of a plastic-film sensor has an almost linear relationship with the force applied. In other words, if F is the force and I is the current:

```
I = k * F
```

where k is a constant determined by the characteristics of the materials used.

By Ohm's Law, R = V / I where V is the voltage drop across a resistance of value R. By substitution, using k * F instead of I:

```
R = V / (k * F)
```

Therefore, if a constant voltage is applied across the force sensor, the resistance of the sensor will be proportional to the reciprocal of the force (i.e., 1 / F). These relationships are shown in Figure 12-11.

For convenient measurement, it will be helpful if the resistance of the sensor can be converted to a voltage output that varies linearly with the force applied. To achieve this, a resistive force sensor of this type is customary amplified with an **op-amp** (see Volume 2). Using the schematic shown in Figure 12-12, the amplification ratio, A, is found from this formula:

```
A = 1 + (R2 / R1)
```

where R2 if the potentiometer, and R1 is the resistive force sensor. Therefore, the output from the op-amp should have an approximately linear relationship with the force applied to the sensor.

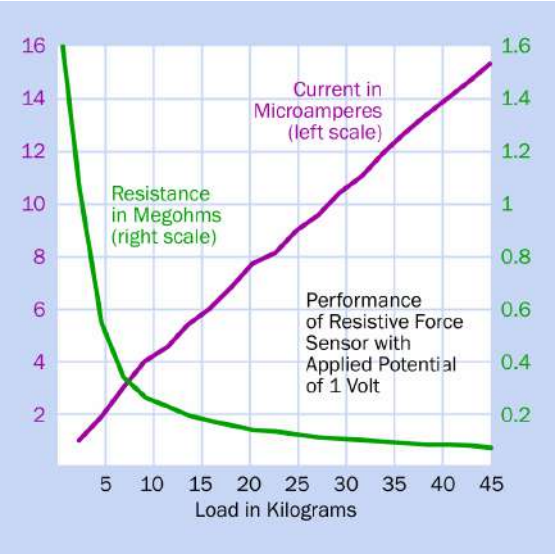

Figure 12-11 *The relationship between force, current, and resistance in a flexible resistive sensor, assuming a constant voltage of 1V is applied across it (derived from FlexiForce Sensors User Manual).*

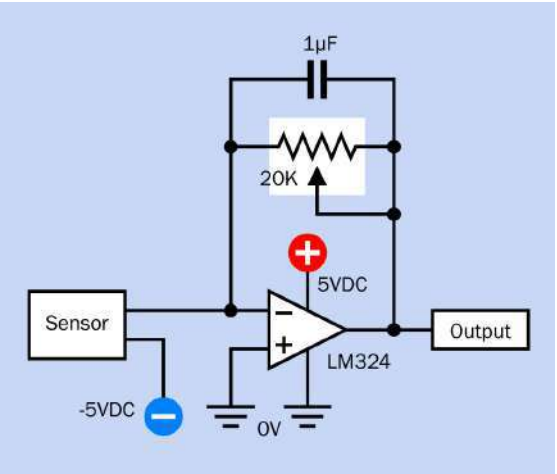

Figure 12-12 *An amplification circuit with an output that is approximately linear with force applied to a resistive film sensor.*

The capacitor in this circuit is added to suppress noise that the circuit might otherwise pick up.

An alternative is to wire a resistive sensor in series with a capacitor, and connect the other side of the capacitor to a comparator that has adjustable feedback. The resistance of the sensor will determine how quickly the capacitor charges. However, because of the mathematics describing the charge rate, the output from the comparator would not be linear with the force on the sensor. Also, provision would be necessary to discharge the capacitor intermittently.

Values

Film-Based Force Sensors for User Input

A very light pressure with a fingertip could be around 50g. A more defined finger-press would be 250g, and a heavy push with a finger would be around 1kg.

The Interlink range of flexible force sensors requires a minimum pressure of 0.2N, or about 20g. Similarly, Alpha products range from a minimum of 10g to 30g.

These specifications suggest that film-based force sensors may be used for one-touch user input, but the no-load resistance will be at least 1M, and more than 10M in some instances. A small amount of pressure is unlikely to reduce this electrical resistance much below 500K. Using an op-amp or comparator to detect that difference and convert it into a reliable on-off output may be vulnerable to noise and power-supply disturbance.

Another consideration is that film-based sensors provide no tactile feedback. For these reasons, and because film-based products are described by their manufacturers as "force sensors" rather than as "touch sensors," they are included in this entry rather than in Chapter 13. That said, they may be considered as an option for one-touch user input where they are appropriate—for instance, in games where players are likely to slap or hit a sensor vigorously.

Specifications for Film-Based Force Sensors

Durability of film-based sensors is excellent, with manufacturers claiming that performance

is not degraded after 1 million applications of a 20kg load. Sensors have no polarity, will function using voltages from 1V to 15V in most cases, and have a response time of less than 5ms. They do not generate, and are not vulnerable to, electromagnetic interference.

Important attributes when evaluating film-type sensors are their limits of tolerance for applied force, and resistance values at each end of the range. Unfortunately these values are poorly documented for many sensors, or may be unspecified.

Maximum force may range from 20N to 440N, depending on the brand and model of sensor.

Electrical resistance is at least 1M when unloaded, and may be as high as 20M.

Accuracy ranges from plus-or-minus 2% to plus-or-minus 5% from one application of force to the next, depending on the model of sensor and the manufacturer. If force is not applied each time in exactly the same area of the sensor, results will vary. If a sensor is swapped with another sensor of the same type, sensor-to-sensor consistency will be uncertain. Therefore, film-based force sensors are not a good choice for applications where accuracy is important.

Sensors may be rated for 5% to 10% hysteresis.

The area of active detection may range from about 4mm wide (FlexiForce sensors) to more than 40mm wide (Interlink FSR-406).

Strain Gauges

Strain gauges are not sold as individual components by most electronics suppliers. They are sometimes available as surplus parts or from sites such as eBay, where specifications range from 100 ohms to 1K as the resistance when no load is applied.

A load sensor on which a strain gauge has been preinstalled is much easier to use, and will be plug-compatible with an appropriate amplifier chip as previously described.

What Can Go Wrong

Soldering Damage

The pins on plastic-film resistive sensors are embedded in thin plastic. Heat from a soldering iron can easily damage this plastic. Heat-sink alligator clips should be used while soldering, or the pins can be socketed instead of soldered.

Bad Load Distribution

Film-based sensors will not provide accurate readings if a load is imposed unevenly or inconsistently, or extends outside the detection area. A *puck* consisting of a small, rigid disc may be interposed between the source of the force and the sensor, to distribute the load within the maximum area. A puck may also be referred to as a *shim*.

Similarly, the sensor must be mounted on a flat, smooth surface, and if this is not available, a rigid plate should be interposed.

Water Damage

Although film-based sensors are enclosed in plastic, they are not waterproof. Immersion may cause the layers to delaminate.

Temperature Sensitivity

Because electrical resistance tends to vary with temperature, readings from resistive force sensors will vary with temperature.

Ambient temperatures of 70 degrees Celsius and above may damage a film-based sensor.

Leads Too Long

Although film-based sensors are supplied with a variety of lead lengths enclosed in the laminated layers of flexible plastic, the leads may be too long for a particular application. If they are trimmed, wires cannot be attached with solder, as it will melt the plastic. Conductive epoxy should be used.

single touch sensor

13

This entry only describes *capacitive* touch sensors. A *conductive* sensor, which uses the fingertip to complete a circuit between two exposed contacts, is not very common, and is not included here.

The type of touch sensor described in this entry requires no physical pressure for activation. It should not be confused with a resistive or piezoelectric **force** sensor that requires pressure. See Chapter 12.

An integrated circuit chip that processes a signal from a *touch pad* is often described as a *touch sensor*, even though it does not contain a sensing element. This entry describes it as a "touch sensor chip" to eliminate ambiguity, and refers to touch input elements as "touch pads."

Touch pads that contain *tactile switches* or *membrane switches* are described in the entry discussing **switches** in Volume 1. All types of switches are described in that volume, with the exception of a *reed switch*, which is magnetically activated and is therefore categorized as a sensor.

Capacitive touch sensors are sometimes referred to as *capacitive proximity sensors*, because they sense the proximity of a human fingertip. In this Encyclopedia, and in most other sources, a **proximity** sensor measures distance, not touch. See Chapter 5.

A *capacitive displacement sensor* employs the same principle as a capacitive touch sensor, but is used to detect the position of an object, not for human input.

OTHER RELATED COMPONENTS

- **force** sensor (see Chapter 12)
- **touch screen** (see Chapter 14)

What It Does

A *touch pad* detects the presence of a human fingertip (or other part of the body) and signals an integrated circuit chip, which is very often termed a *touch sensor*, even though it does not contain a sensing element itself. The chip creates an output to signify that human touch has been recognized.

A keypad of the type found on microwave ovens may appear similar to an array of touch pads, but is more likely to contain *membrane switches* or *tactile switches*, which are described with other forms of switches in Volume 1. The type of touch pad described in this entry requires no physical force and contains no parts that move or flex when pressed.

A modern **touch screen** is usually a capacitive device and can be thought of as an array of touch pads. See Chapter 14.

Applications

Capacitive touch sensors have become common as their cost has fallen relative to simpler components that respond to being pressed.

A touch sensor can be used to start or stop a process, or to power up or power down a device. Multiple sensors may be found wherever user input of a few alphanumeric characters is required. Because touch pads can be completely sealed, they are useful where hygiene is important.

Specific applications include the activation of a backlight in a handheld device, wake-up from standby, ear detection in a cellular telephone, control of medical devices, and activation of interior lighting in some automobiles.

The absence of moving parts or electrical contacts means that a touch pad is more reliable than any type of electromechanical switch. A disadvantage is that it provides no tactile feedback, and therefore will require a visual or audible confirmation when it responds to input. Lack of tactile feedback makes touch pads unsuitable for computer keyboards and other key-entry devices where rapid typing is required.

When the capacitive elements of a touch pad are transparent, it can be mounted in front of a screen.

Schematic Symbols

Either of the schematic symbols in Figure 13-1 may sometimes be used to represent a touch sensor, but not on a consistent basis.

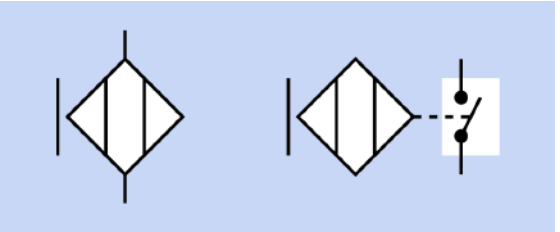

Figure 13-1 *Two possible schematic symbols that may represent a touch sensor.*

How It Works

The two plates in a capacitor are separated by an insulator known as the *dielectric*. Paper, plastic, glass, air, and other insulators can serve this purpose. Although no electrical connection exists between the plates, AC passes through the dielectric as a field effect.

Electrical capacitance exists between any pair of electrical conductors. The human body has high electrical resistance but still is electrically conductive, and therefore has capacitance with other conductive objects.

A touch pad can function as one side of a capacitor, with a fingertip functioning as the other side. In this mode, AC can pass from the touch pad and through the human body to ground. The current is very small, but fluctuations can be detected by an appropriately designed integrated circuit chip, or by a microcontroller.

The precise characteristics of a dielectric will affect the performance of a capacitor to some extent, but will not prevent it from working. Therefore a touch pad can function even when it is shielded behind a protective layer of glass or plastic, as is often the case.

A touch sensor chip generates pulses of low-voltage AC and sends them to a touch pad. The chip detects any variation in the current through the touch pad, indicating the presence of a fingertip. Where an input occurs, the chip changes its output, which usually requires a microcontroller for processing.

How to Use It

Touch sensor chips are available in as many as 40 different formats and configurations. All of them are surface-mount. For breadboarding, an experimenter can use breakout boards that have sensor chips installed. Figure 13-2 shows a product from Adafruit that is capable of addressing 12 touch pads. Its output is accessible from a microcontroller via the I2C protocol. For additional details about protocols such as I2C, see Appendix A.

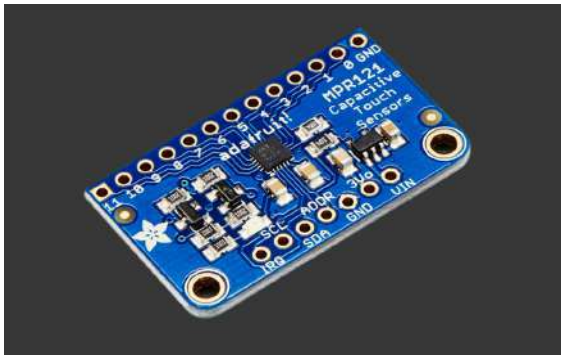

Figure 13-2 *A capacitive touch sensor chip on a breakout board from Adafruit.*

Similar breakout boards are available from Sparkfun, and from large online vendors such as *http://www.mouser.com* (where they are categorized as *development tools*).

While most touch sensor chips require a microcontroller, a few are available with the same number of output pins as touch-pad input pins, and each output pin will transition between logic-high and logic-low when an input on the corresponding pin is detected. Another breakout board from Adafruit, the AT42QT1070, uses this simple system.

A library exists for Arduino that enables two pins to sense touch on a piece of aluminum foil.

It can also work with conductive ink or paint.

Obtaining Touch Pads

Sensor chips are widely available as components, and are very inexpensive. On the other hand, touch pads are not common as components, probably because a touch pad is usually created as a pattern of copper traces etched onto a circuit board by a device manufacturer.

Touch pads from hobby-electronics sources usually include touch sensor chips. Sparkfun offers a 12-key keypad on this basis, and also a 9-key keypad designed as a "touch shield" for use with the Arduino. Both of the Sparkfun products are shown in Figure 13-3. They include the same MPR121 touch sensor chip as the breakout board from Adafruit shown in Figure 13-2, and require an I2C connection with a microcontroller.

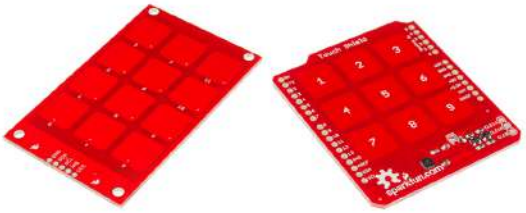

Figure 13-3 *Two capacitive keypads from Sparkfun, the one on the right designed as an Arduino shield.*

Because a capacitive touch pad is usually mounted inside an enclosure, the appearance of the bare touch pad as a component is unimportant. The outside of the enclosure can be printed with a design showing key outlines.

Individual Touch Pad

Adafruit sells the AT42QT1010 touch pad that emulates a momentary switch. Its output transitions from logic-low to logic-high when a finger presence is detected, and transitions back to logic-low when the finger is removed.

An alternative, shown in Figure 13-4, toggles between a logic-high and logic-low output and latches in each state with each single key press.

Both of these keypads contain sensor chips to generate the output.

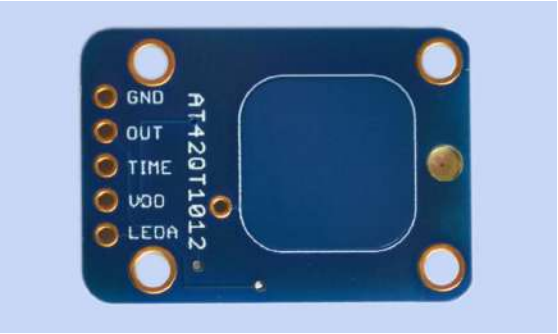

Figure 13-4 *The output from the AT42QT1012 sensor chip on this touch pad from Adafruit toggles between logic-high and logic-low each time the pad is touched.*

Wheels and Strips

A touch wheel uses a circular pattern of conductive traces, often referred to as *electrodes*, to receive finger input. A simple configuration is shown in Figure 13-5. The traces interlock without making contact with each other, so that moving the finger in a circular motion creates a capacitive input that rises and falls sequentially on each element. In the figure, three sections are used, each colored differently here for purposes of clarity. Other touch wheels may contain more sections.

Firmware that is designed to interact with wheel-shaped touch pads will generally assume that two electrodes are receiving input at one time. The firmware attempts to calculate the position and motion of the finger by assessing the relative capacitance of adjacent segments. Ideally the capacitance values should vary linearly and complementarily; that is, from a 50-50 value at a midpoint between two segments, the progression should change to 60-40, 70-30, and so on, as the finger moves around the wheel.

A *touch potentiometer* consists of multiple touch pads, usually arrayed in a straight line. This may be described as a *touch strip*. An example is made by GHI Electronics and sold by Robot Shop as their L12 Capacitive Touch Module, shown in Figure 13-6.

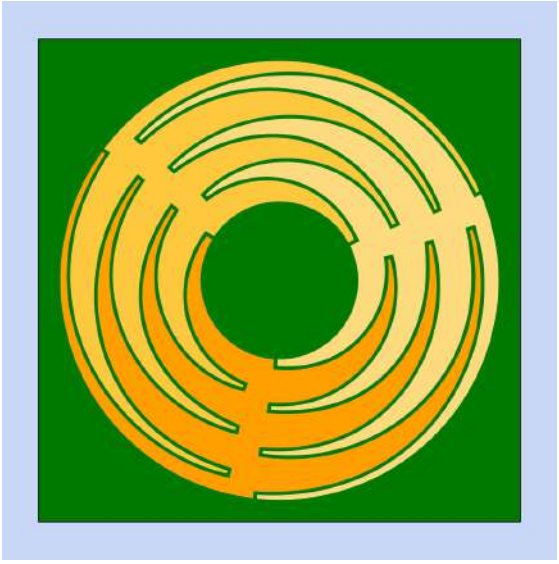

Figure 13-5 *A touch wheel created by copper traces on a circuit board (green). Each section is colored differently, for purposes of clarity.*

Figure 13-6 *Multiple capacitive touch pads arrayed as a strip, made by GHI Electronics.*

Design Considerations

A simple touch pad is often surrounded by additional copper that is grounded and may be described as a *shield* or a *guard*. The capacitance of a fingertip (spaced above the electrode by a layer of plastic or glass that functions as the dielectric) interferes with the field between the electrode and the shield.

The underside of the circuit board is often plated and grounded to protect the touch pad from electromagnetic interference. This, too, can be referred to as a shield or a guard. The ground plating can be in a hatched pattern to reduce its capacitance with the electrode above.

Layout of a circuit involving a single touch sensor chip can affect its performance significantly. A touch sensing device may have to be "tuned" to detect finger presence reliably.

A long trace between the touch sensor and an electrode will tend to pick up noise and will increase capacitance.

The distance between adjacent traces from multiple touch pads must be maximized to reduce capacitance between them. If output from a sensor chip uses the I2C or SPI digital protocol, any trace carrying that digital signal should be at least 4mm from input traces. If they cross, they should be at 90 degrees to each other.

Electrodes should not be shaped to resemble numbers or other characters printed above them. A single basic electrode should be circular.

What Can Go Wrong

Insensitive to Gloves

Gloves are a challenge for touch-sensor design, as they alter the dielectric and the distance between the electrode and the finger. Capacitive touch sensors may not work at all with some types of gloves. However, special gloves containing metallic threads are available.

Stylus Issues

A nonconductive stylus cannot activate a touch pad.

Conductive Ink

Ink that prints the shapes of touch pads on the exterior of a device should be nonconductive.

touch screen

14

The term **touch screen** is written as two words in this Encyclopedia. In many sources, the words are concatenated as "touchscreen."

The two words are hyphenated here when they function as an adjective, but not otherwise. In manufacturers' datasheets where the two words are used, they are not usually hyphenated.

OTHER RELATED COMPONENTS

- **single touch** sensor (see Chapter 13)
- **force** sensor (see Chapter 12)

What It Does

A touch screen is a video display with embedded touch sensing. The screen reports the position of the touch, and is used as a pointing device as an alternative to a mouse or trackpad. Some touch screens report pressure as well as position.

Touch screens are widely used in smartphones and tablets, and also in some laptop computers. Smaller, simpler touch screens may be found in office equipment such as photocopiers.

Schematic Symbol

No specific schematic symbol is used to represent a touch screen.

Variants

Early designs used infrared LEDs recessed into the edges of a frame around a screen. A matching photodiode picked up the focused beam from each LED. The presence of a fingertip was detected when it interrupted one or more of the beams. This system was not capable of high resolution, but was adequate for detecting user input at predefined locations.

Most touch screens currently are either resistive or capacitive.

Resistive Sensing

A resistive touch screen consists of two transparent layers that can be installed over a separate video display.

Each of the layers has uniform electrical resistance. Pressure from a fingertip on the outer layer (which we can refer to as layer 1) forces it to make contact at a point with the inner layer (referred to here as layer 2).

Two vertical electrodes connect with layer 1 along its left and right edges. Two horizontal electrodes connect with layer 2 along its top and bottom edges. When voltage is applied between the vertical electrodes on layer 1, the layer acts as a horizontal voltage divider. The voltage at the point where the layer is being pressed is applied to layer 2, and can be read from either of the electrodes on layer 2, so long

as the metering has a much higher impedance than that of the layer. The voltage is decoded as a value for the horizontal position on layer 1.

An external switching device now repeats the procedure, except that it applies voltage to layer 2, and reads it from layer 1 to supply a value for the vertical position on layer 2. The sequence is illustrated by the top and bottom sections of Figure 14-1.

Because only four connections are necessary, this is referred to as a *four-wire* resistive touch screen. Five-wire variants exist, but are less common, and are not included in this entry.

Advantages of a resistive screen include:

- Simplicity. Only four connections are necessary, and the layers of the screen do not have to be subdivided into separate conductors.
- Low cost, relative to capacitive touch screens.
- Will respond equally well if a user wears gloves or uses a stylus.

Disadvantages of a resistive screen include:

- Some resistive versions require a stylus input instead of finger pressure.
- Resistive screens only respond to a one-location input. Two-finger gestures are not supported.
- Contact bounce occurs when the flexible layer is pressed against the underlying layer, and voltage spikes may be associated with switching power to the screen. To address this issue, firmware in a microcontroller may have to take a median value from several rapid readings.
- The flexible membrane is vulnerable to damage from sharp objects.

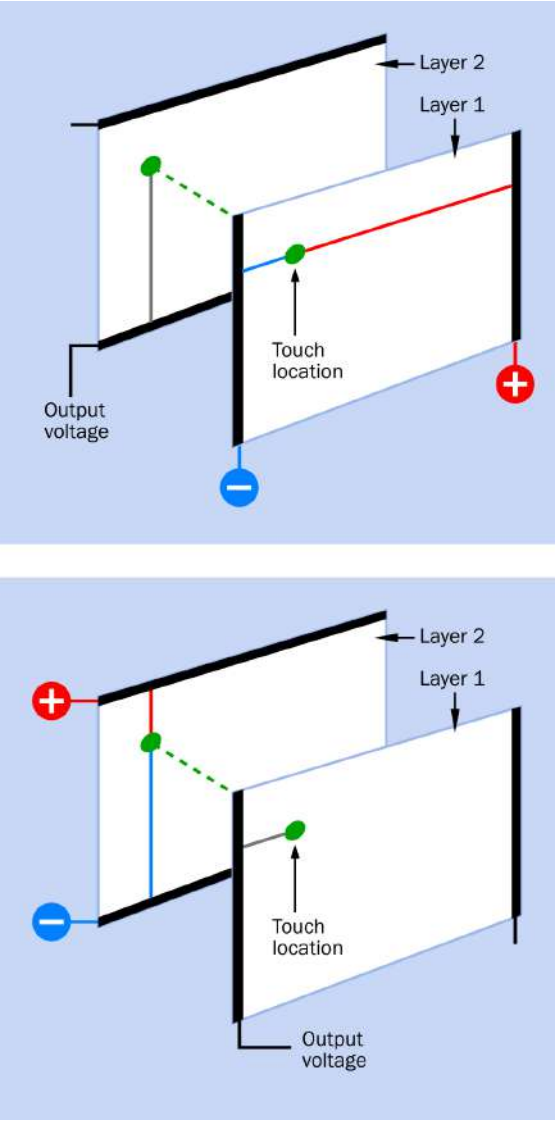

Figure 14-1 *Sections of a resistive touch screen are shown displaced for clarity. In reality they would be separated by a very small gap, allowing one section to make contact with the other in response to finger pressure.*

Capacitive Sensing

A capacitive touch screen can consist of an array of **single touch** sensors printed onto a glass panel as vertical and horizontal lines of transparent conductive ink.

Alternatively, a small capacitive screen can measure the tiny amount of current drained by

a fingertip from four sources located at corners of the screen.

For more information about capacitive touch sensing, see the entry on touch sensors in Chapter 13.

Screens Available as Components

A wide variety of screens can be found in diagonal sizes ranging from 2 inches upward. Onboard electronics can be suitable for connection with a microcontroller using the I2C and SPI protocols, or USB. Different screen resolutions are available.

An example of a 3.5-inch touch screen with 320x200 resolution, mounted on a breakout board that can be used with a breadboard and an Arduino, is shown in Figure 14-2.

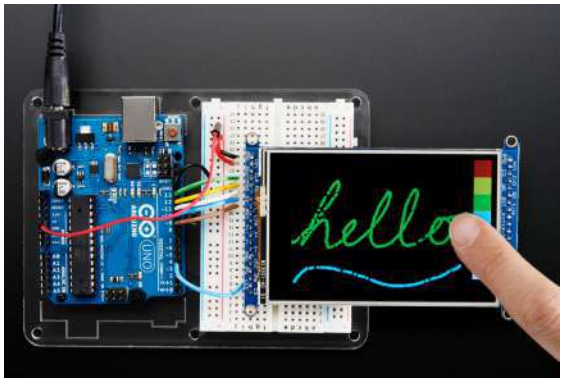

Figure 14-2 *An Arduino-compatible touch screen mounted on a breakout board, available from Adafruit.*

A 7-inch resistive touch screen that can be mounted on a separate video display is shown in Figure 14-3. It can be used with the STMPE610 controller chip, which converts resistive screen values into digital coordinates and can be accessed by a microcontroller over both SPI and I2C. This surface-mount chip is available on a breakout board.

Figure 14-3 *This resistive touch screen is intended for use as a layer applied to a 7-inch video display. The screen is available from Adafruit.*

When choosing a touch screen as a component for a DIY project, the availability of microcontroller code libraries for reading and refreshing the display is an important consideration.

liquid level sensor

15

Level indicators that contain no electronic components are not included in this entry.

Specialized industrial level-sensing equipment is generally outside the scope of this Encyclopedia. This entry discusses small-scale, lower-cost sensors.

Liquid volume can be assessed by measuring liquid pressure at the bottom of a reservoir. Sensors for this purpose are discussed in the entry describing **gas/liquid pressure** sensors. See Chapter 17.

OTHER RELATED COMPONENTS

- **liquid flow rate** sensor (see Chapter 16)
- **gas/liquid pressure** sensor (see Chapter 17)

What It Does

Measuring the volume of liquid in a storage vessel or reservoir is such a fundamental task, countless methods have been devised, of which only the simplest and most common will be discussed here.

A liquid level sensor can have a binary output, meaning that it signals when the volume rises above or falls below a level that can be preset or reset. Often the sensor will be connected to a pump or valve that maintains a relatively constant volume in a container.

Alternatively a sensor can indicate the actual stored volume, either with an analog output or in digital increments.

Schematic Symbols

Three variants of a schematic symbol for a simple liquid level sensor are shown in Figure 15-1. They are not always used, however, and a sensor may be shown simply as an annotated switch.

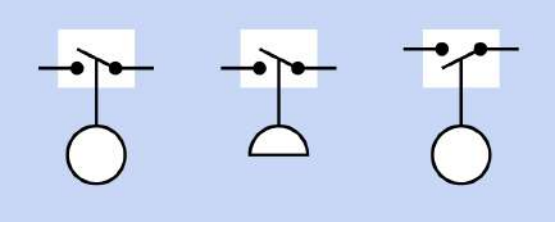

Figure 15-1 *Three variants of a schematic symbol to represent a liquid level sensor. The rightmost symbol indicates that a rising level closes, rather than opens, a switch.*

Applications

The fuel gauge in a vehicle is one of the most commonly encountered applications of a liquid level sensor. The water tank in a recreational vehicle or boat may use similar electronics. In industry, the choice of a sensor will be influenced by the type of liquid that is being stored, the desired accuracy, the temperature range, and whether the storage tank is sealed or open to atmospheric pressure.

How It Works

Desirable attributes of any liquid-level sensor include resistance to vibration, some damping to average out fluctuations caused by turbulence or sloshing in the liquid, resistance to chemical reactions with the liquid, and few moving parts that may require maintenance if the sensor is inside a sealed tank. Desirable attributes of an analog float sensor include a linear response, and some hysteresis if the application requires it.

This entry compares a variety of sensing strategies.

Binary-Output Float Sensor

The term "binary output" is used here to describe an output that only has two states (on and off, or logic-high and logic-low). The simplest type of liquid-level sensor with a binary output consists of a donut-shaped float that contains a permanent magnet and is free to slide vertically up and down a sealed tube containing a reed switch. The tube is supported on a bracket that can be mounted on the wall or the lid of the vessel containing the liquid.

The tube and float must be nonmagnetic, and the float must have a significantly lower specific gravity than the liquid that is being used ("significantly" because the float requires sufficient buoyancy to carry the weight of the magnet and overcome any friction between itself and the tube). A diagram illustrating this configuration is shown in Figure 15-2.

To change the level setting of the sensor, the bracket may be mounted on a screw thread to adjust its vertical position.

The reed switch can be normally open or normally closed, as needed to respond to a rising or falling liquid level. For basic information about reed switches, see "Reed Switch". Additional, detailed information about reed switches is included in the book *Make: More Electronics*.

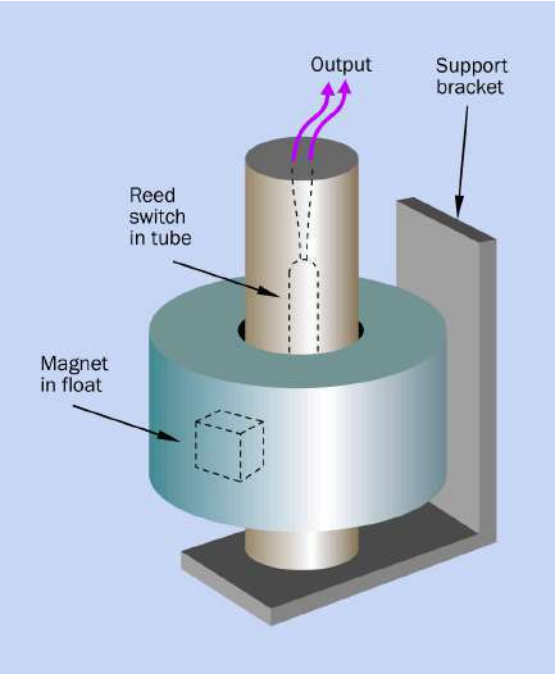

Figure 15-2 *The principal parts of a basic binary-output float sensor.*

For increased reliability, a Hall-effect sensor could be substituted for a reed switch. See "Hall-Effect Sensor" for general information about Hall-effect sensors.

Another binary-output float sensor is shown in Figure 15-3. This is a sealed plastic capsule containing a snap-action switch and a steel ball. The cable is attached to the underside of the top of a tank, and the capsule dangles into liquid in the tank. A separate weight (not shown) has a hole in the middle, and is threaded over the wire. The weight keeps the wire approximately in a vertical position as it dangles into the tank.

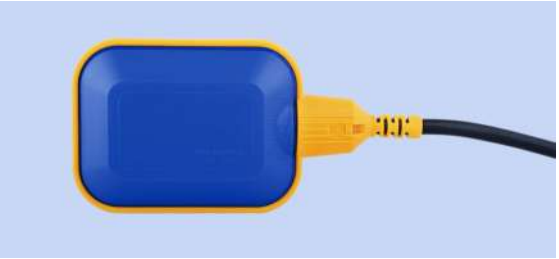

Figure 15-3 *An air-filled float that switches external power depending on its orientation.*

Figure 15-4 shows the components inside the float. When the liquid level in the tank falls, the float adopts the position shown on the left in the figure. The ball drops against a lever that closes a snap-action switch, which starts an external pump to replenish the tank. As the liquid level rises, the buoyancy of the air-filled float changes its orientation to that shown on the right in Figure 15-4. The ball drops and the switch opens, stopping the pump.

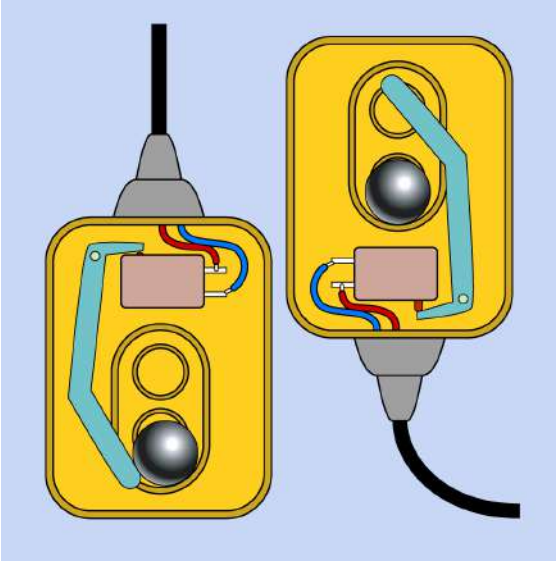

Figure 15-4 *Internal components of the float shown in the previous figure.*

Two circular indents on the inner surface of the plastic capsule prevent the ball from rolling erratically if there is turbulence in the liquid. They also provide some hysteresis.

Analog-Output Float Sensor

The simplest type of liquid-level sensor with an analog output consists of a float on an arm attached to a potentiometer, as shown in Figure 15-5. This very basic design was used in fuel tanks in vehicles for many decades. Disadvantages include a nonlinear response and the limited life expectancy characteristic of potentiometers. Some compensation for the nonlinear response can be made by using an analog fuel gauge with a nonlinear scale.

For more information about potentiometers, see "Arc-Segment Rotary Potentiometer".

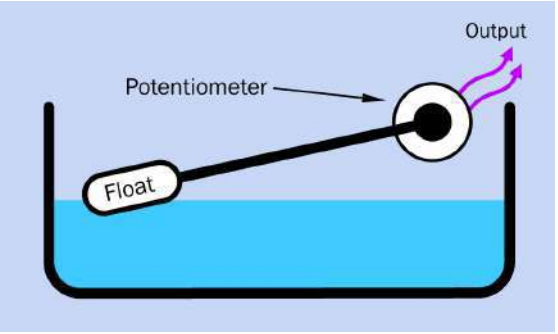

Figure 15-5 *A basic float sensor with an analog output.*

Incremental-Output Float Sensor

A schematic diagram for a simple float sensor with incremental output is shown in Figure 15-6. A magnet embedded in a donut-shaped float, similar to that shown in Figure 15-2, interacts with a sequence of reed switches installed in the central tube. The switches are spaced at equal intervals and apply power between resistors of equal value wired in series. This system has been used in motorcycle and automobile fuel tanks, where the switches may be enclosed in a (nonmagnetic) stainless-steel tube. The accuracy is limited by the number of reed switches.

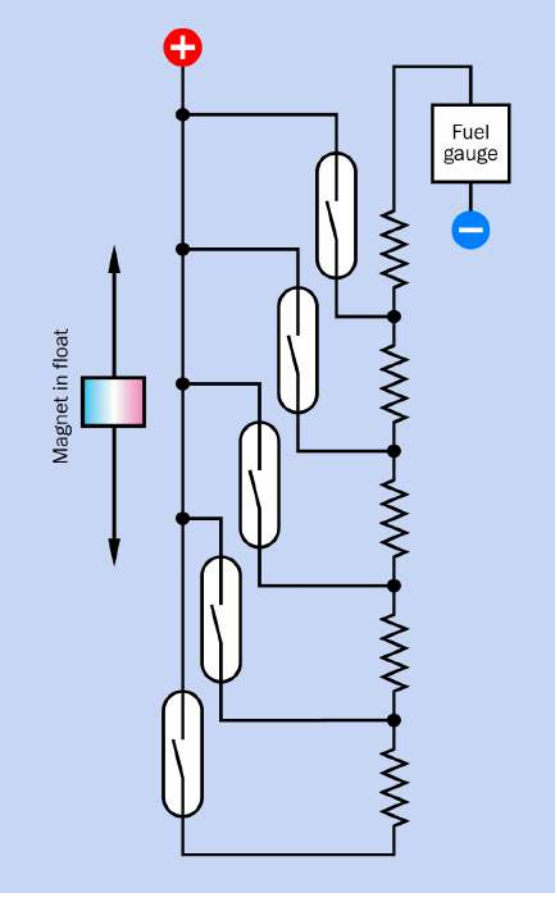

Figure 15-6 *A float sensor with incremental output.*

Displacement Level Sensors

If a heavy object, described as the *displacer*, is suspended in liquid, the effective weight of the object diminishes as the liquid rises up around it. This occurs because according to Archimedes' Principle, the upward buoyant force is equal to the weight of liquid that the object displaces. The displacer is suspended from a load sensor that measures its weight. Analog output from the sensor will be approximately linear with liquid level.

For a simplified diagram showing a displacement level sensor using this concept, see Figure 15-7.

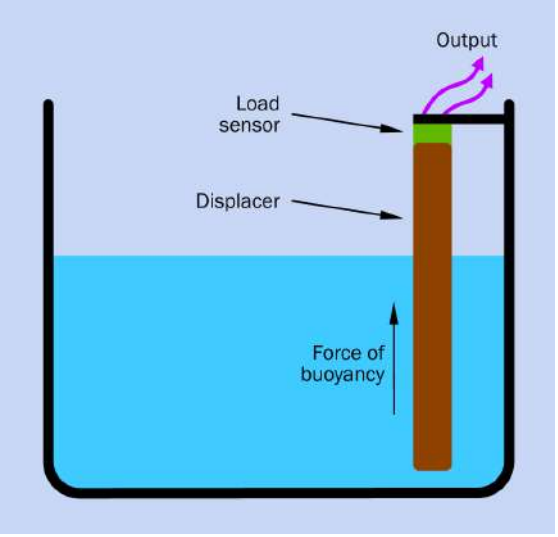

Figure 15-7 *A displacement sensor. The displacer is heavier than the liquid around it, but its effective weight diminishes as the liquid rises.*

For more information on load sensors, see Chapter 12.

Ultrasonic Level Sensors

An ultrasonic sensor can be used to measure the level of liquid in a reservoir, as shown in Figure 15-8. For more information about this type of sensor, see the entry discussing proximity sensors in Chapter 5. A disadvantage of using ultrasound for liquid level sensing is that the speed of sound will be affected by any vapor given off by a volatile liquid.

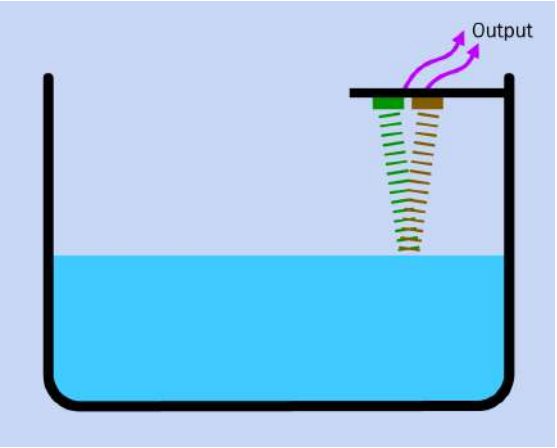

Figure 15-8 *An ultrasonic proximity sensor can measure the level of liquid in a reservoir.*

Reservoir Weight

The weight of a reservoir can be measured to assess the volume of liquid in it. This can be done by mounting the reservoir on load sensors. However, pipes leading to and from the reservoir must be designed so that they do not add or subtract any significant weight. Figure 15-9 suggests an arrangement, although the outflow will still change the weight to some extent depending on the amount of suction that is applied. For more information on load sensors, see Chapter 12.

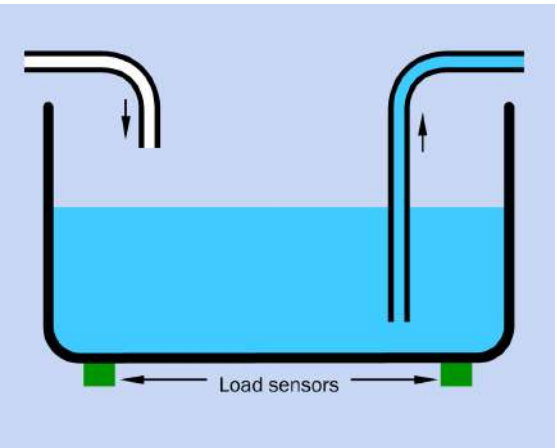

Figure 15-9 *Using load sensors to assess the weight of liquid in a reservoir requires that the weight of plumbing should not be imposed on the structure of the reservoir.*

Pressure Sensing

A differential pressure sensor can be added to a pipe near the bottom of a reservoir. The sensor measures the difference between the liquid pressure and ambient air pressure. See Figure 15-10.

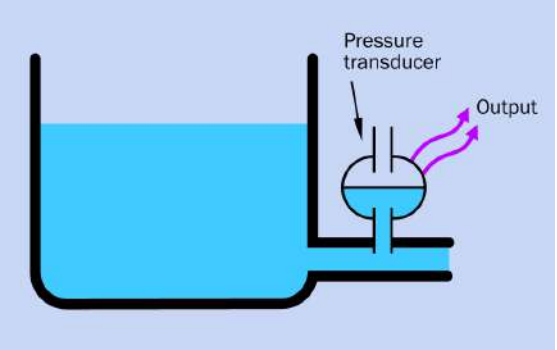

Figure 15-10 *A pressure sensor can assess the volume of liquid in a reservoir.*

This arrangement assumes that the reservoir is vented so that air pressure above the liquid level is equal to air pressure at the sensor. If the reservoir is not vented, a pipe must connect the reference port on the sensor with the space above the liquid.

The reservoir must have straight, vertical sides for the pressure to be directly proportional to the liquid volume.

Liquid volume can also be assessed by measuring the pressure inside a container, near the bottom. A submersible pressure sensor can be used, typically consisting of a watertight capsule fitted with a diaphragm that connects with an internal strain gauge. The sensor is lowered on a cable that also contains an air line. Because pressure in a liquid is affected by atmospheric pressure above the surface of the liquid, the sensor requires an air line so that its measurements are relative to the outside air.

Submersible pressure sensors are useful where access is limited—for example, when measuring fluctuations in an open-air municipal water reservoir.

What Can Go Wrong

Turbulence

Surface turbulence consisting of ripples, waves, or sloshing of liquid will tend to occur when a reservoir is refilled rapidly or is subjected to lateral movements as a result of being mounted in a moving vehicle. To minimize output fluctuations, some *damping* is desirable.

Baffles consisting of perforated plates inside the reservoir are a common strategy, as shown in Figure 15-11. In the upper section of the figure, lateral acceleration causes submersion of a float sensor in the reservoir. In the lower section, perforated baffles minimize the problem.

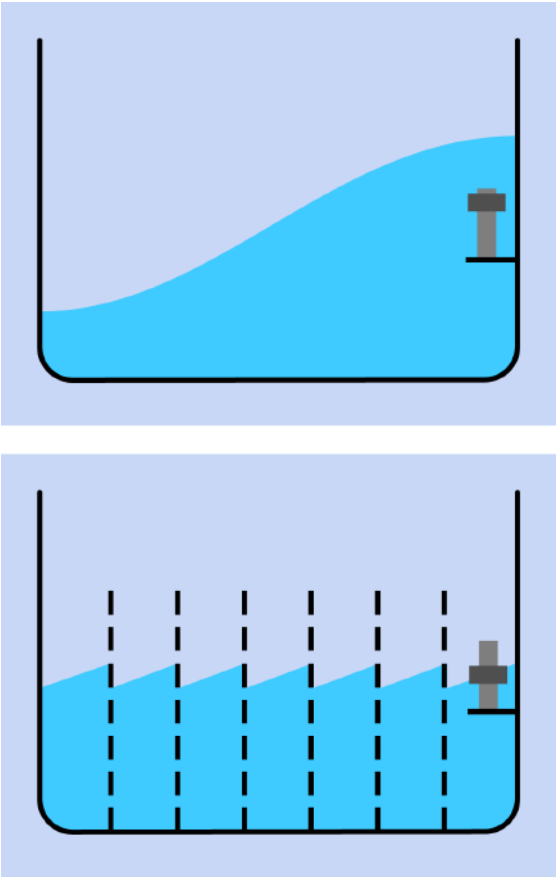

Figure 15-11 *Insertion of perforated baffles in a reservoir minimizes the sloshing that otherwise tends to occur when the reservoir is subject to lateral motion.*

Sensors that measure the weight or pressure of a liquid are less susceptible to turbulence. In a displacement sensor, the weight of the displacer provides a damping effect.

Tilting

All level sensors will tend to give inaccurate readings when a reservoir is tilted. A float sensor will be affected less if it is mounted centrally in a reservoir, because the reservoir will tilt around the sensor, as shown in Figure 15-12.

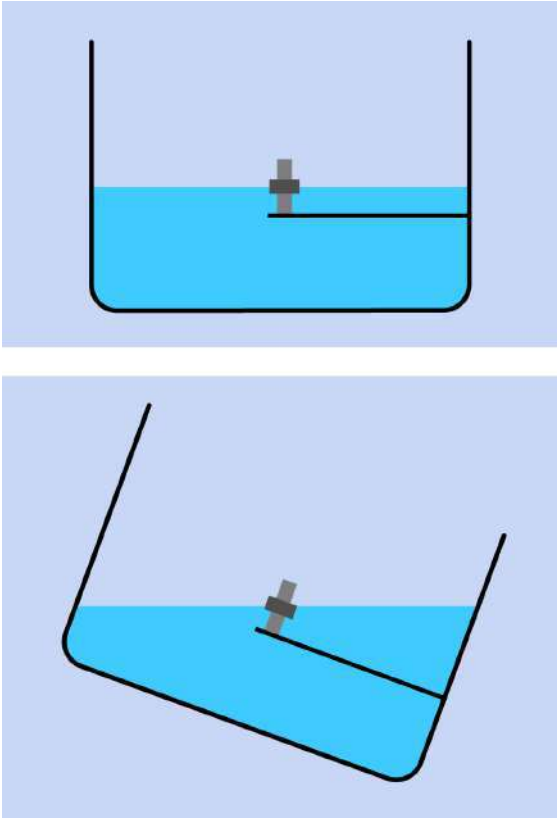

Figure 15-12 *If a float sensor is mounted centrally in a reservoir, it will be significantly less affected if the reservoir tilts.*

liquid flow rate sensor

16

Flow rate sensors that contain no electronic components are not included in this entry.

Some methods of liquid flow sensing can also be applied to gases, but sensors are usually designed for one application or the other. Therefore, gas flow sensors have their own entry. See Chapter 19.

Many liquid flow rate sensors are large devices designed for industrial applications. This entry focuses on lower-cost solid-state sensors.

OTHER RELATED COMPONENTS

- **liquid level** sensor (see Chapter 15)
- **gas/liquid pressure** sensor (see Chapter 17)
- **gas flow rate** sensor (see Chapter 19)

What It Does

A liquid flow rate sensor measures the rate at which liquid flows past or through the device. A water meter is an example of a flow rate sensor.

A sensor may have a binary output, meaning that it signals when flow stops or starts, or if its rate rises above or falls below a level that can be preset or reset. However, most flow meters have an analog output that varies with the volume per unit of time.

Measuring the flow rate of a liquid can be challenging if the viscosity is very high, the liquid is chemically reactive, or the rate is very low. Such factors may require specialized equipment that is outside the scope of this Encyclopedia.

This entry compares the most popular sensing strategies.

Schematic Symbols

Many specialized symbols are used in flow diagrams to represent pumps, valves, and sensors. Typically they involve a single letter or an X in a circle. These symbols are not generally found in electronic schematics, and therefore they are not included here.

Paddlewheel Liquid Flow Rate Sensors

The simplest and most common liquid flow rate sensor uses a *paddlewheel*, also referred to as a *rotor*, that is mounted with its axis of rotation at 90 degrees to the direction of liquid flow. An example is the Koolance INS-FM16 shown in Figure 16-1. This sensor is intended for use in an aftermarket cooling system for the CPU in an overclocked desktop computer, but can be used in any system where the rate of flow ranges from 0.5 to 15 liters per minute. The paddlewheel has a pair of magnets mounted in

it, activating a *reed switch* that is mounted in a sealed enclosure beneath the wheel. (For more information regarding reed switches, see "Reed Switch" in the entry describing **object presence** sensors.)

Figure 16-1 *A low-cost, simple paddlewheel sensor designed for rates of 0.5 to 15 liters per minute. The background grid is in millimeters.*

While the reed switch in the Koolance flow sensor inevitably suffers from contact bounce, it has the advantage of simplicity and can be used in conjunction with appropriate hardware or microcontroller code to debounce the pulse stream.

As in any device with a rotating part, friction and wear will afflict a paddlewheel sensor, especially because the bearings are often in the chamber through which the liquid passes. This eliminates the possibility for roller bearings. Typically a plain bearing is used, consisting of a pin that engages in a hole in the casing. Friction wears the bearing surface, creating a larger gap, which allows the rotor to vibrate or bounce instead of spinning smoothly. Flow resistance increases and accuracy is degraded.

In modern designs, the mass of the rotor is minimized to reduce the friction. Also, if the shaft is horizontal (but still at 90 degrees to the direction of the flow), buoyancy of the rotor in the liquid can reduce friction still further, as suggested in Figure 16-2. Ideally, the density of the rotor and the density of the liquid will be the same.

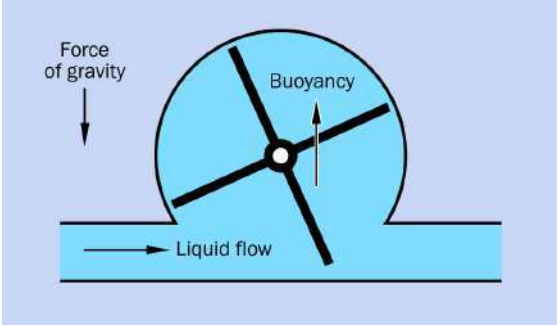

Figure 16-2 *In this configuration, friction on the rotor bearings is mitigated by taking advantage of the buoyancy of a low-density rotor in the liquid that passes through.*

The U-shaped flow path in the Koolance sensor in Figure 16-1 maximizes the responsiveness of the rotor, but an inline path is more common. An example is shown in Figure 16-3.

Figure 16-3 *An inline flow sensor rated for 3 to 6 liters per minute.*

Turbine Flow Rate Sensors

In a turbine-type sensor, two or more spiral blades are attached to a hub that rotates around an axis in line with the liquid flow, as shown in Figure 16-4. A magnet in each spiral blade triggers a reed switch or Hall-effect sensor mounted in a bracket that suspends the turbine from the interior walls of the tube.

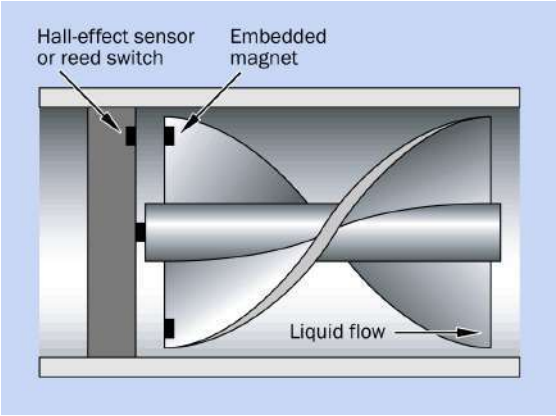

Figure 16-4 *Simplified view of a turbine flow rate sensor mounted inside a tube.*

The support bracket often consists of four struts, which impose resistance to liquid flow. The bearings suffer from the same kinds of problems as the bearings in a paddlewheel sensor, and must withstand additional load resulting from the inline force exerted by flow. Overall, while the turbine type of sensor is popular in laboratory equipment, it has disadvantages that are not shared by the bulkier paddlewheel type.

Limitations of Paddlewheels and Turbines

Both the paddlewheel and turbine types of sensors require a minimum flow to overcome the friction in their bearings. Below this minimum, liquid will find its way around the rotor without turning it. Even when the flow exceeds the minimum, response of the rotor is likely to be nonlinear as a result of turbulence and other factors.

Above a limit stated by the manufacturer, turbulence increases to the point where output from the sensor is no longer meaningful. Wear on the bearing will also increase with flow rate.

A significant problem for these types of sensors is that they do not respond well to sudden variations in flow. The paddlewheel, in particular, has inertia as a function of the diameter of the rotor, and will take some time to spin up in response to an increase in flow. Conversely, when the flow diminishes, the paddlewheel will tend to overrun.

The viscosity of the liquid passing through a paddlewheel or turbine sensor will have a very significant effect on its performance.

Thermal Mass Liquid Flow Rate Sensor

The thermal-mass system is commonly used when volumes are extremely low. The system is illustrated in Figure 16-5. A tube containing liquid is fabricated from a heat-conductive metal such as aluminum. It is enclosed in a larger tube, and the gap between them is filled with thermal insulation. A temperature sensor such as a thermistor measures the temperature of liquid entering the system. A second sensor, combined with a small resistive heater in the form of a coil around the tube, is placed downstream. Liquid passing through the tube will tend to remove heat more effectively at higher flow rates, and the difference in temperature between the two sensors is a logarithmic function of the flow rate.

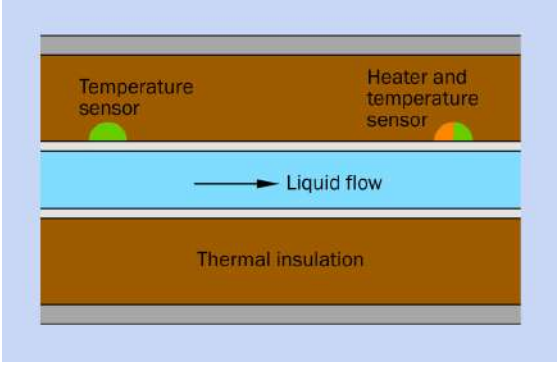

Figure 16-5 *In this type of low-flow sensor, the temperature differential between the two sensors is a logarithmic function of the flow rate.*

Variants of this system use slightly different tube configurations and sensor placement, but the principle is the same. Its advantages include the lack of any moving parts, and the

avoidance of any probes intruding into the liquid, which is desirable in biochemical and medical applications.

The same principle is applied in many **gas flow rate** sensors. See "Mass Flow Rate Sensing".

Sliding Sleeve Liquid Flow Switch

This sensor is used in some domestic systems, where flow-activated water heating is required. A vertical section of brass (nonmagnetic) water pipe contains a sliding inner sleeve that incorporates a magnet. An external reed switch is activated when the sleeve is moved by water flowing through it. When the flow stops, the sleeve is returned to its rest position by the force of gravity.

Sliding Plunger Liquid Flow Switch

Figure 16-6 shows an exploded view of a similar device, using a plastic plunger that slides inside a nylon plumbing fixture designed for 3/4-inch pipe. The plunger contains a magnet and is restrained by a compression spring and a circular perforated plate. When water flow is sufficient to overcome the resistance of the spring, the plunger slides far enough for the magnet to activate a reed switch sealed into the external housing.

Ultrasonic Liquid Flow Rate Sensor

This type of sensor passes ultrasound through a liquid in a pipe. The speed of sound through the liquid is affected by the flow rate, and external electronics translate this lag time into a value for volume-per-minute. The system adjusts for variations in temperature that also affect the speed of sound.

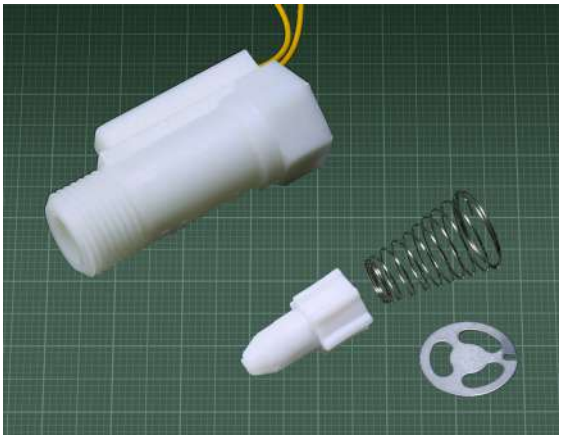

Figure 16-6 *Parts of a flow switch. The small plunger is inserted into the pipe and retained with the perforated plate and compression spring.*

Various configurations are available, some allowing ultrasound sources and detectors to be clamped to the outside of a pipe, as shown in Figure 16-7. To eliminate other variables, one ultrasound pulse is transmitted in the same direction as the flow, followed by another pulse contrary to the flow, and the difference between the two transmission times is used as an indicator of the flow rate.

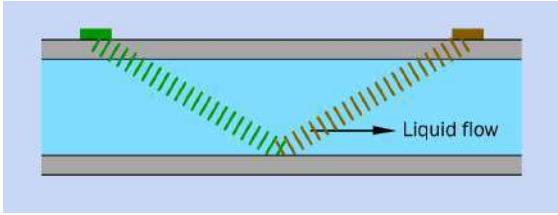

Figure 16-7 *Some ultrasound flow sensors are designed to be clamped externally to a pipe.*

Magnetic Liquid Flow Sensor

A magnetic field is induced in a metal pipe by a coil generating its field perpendicular to flow. The inside of the pipe is lined with nonconductive material in which two electrodes are mounted. Because water containing ions is conductive, the flow of water through the magnetic field induces a small potential difference

between the electrodes. This voltage can be used as an indication of the flow rate.

To eliminate external factors that would also affect the potential difference, the polarity of current through the coil around the pipe alternates rapidly. The induced field remains the same regardless of the direction of the current.

A magnetic flow sensor should not be confused with a magnetic flow *switch.* Various types of switches are made, including large, heavy-duty devices where flow moves a magnet that triggers a shutoff valve. This type of industrial device is outside the scope of the Encyclopedia.

Differential Pressure Liquid Flow Meter

In this system, a pipe contains a perforated plate or some similar constrictor that partially obstructs the flow of liquid. Pressure is measured by a pair of pressure transducers placed before and after the constrictor. The pressure difference is an indicator of flow, because it increases as the flow rate increases.

This system was developed originally for large industrial applications but has been miniaturized and etched into silicon to measure very small flow rates. The Omron D6F-PH is an example, measuring less than 3cm square. It contains digital correction to enable a close-to-linear output. Because of its small size, it can be used only for slow flow rates, or as a bypass sensor. The general concept of a bypass sensor is illustrated in Figure 19-7, in the entry discussing gas flow sensors.

What Can Go Wrong

Vulnerability to Dirt and Corrosive Materials

MEMS liquid flow rate sensors containing very delicate, very small sensing elements are very vulnerable to contamination with dirt. Liquids should be filtered to minimize this risk. A manufacturer's datasheet should provide information about the use of corrosive or chemically active liquids.

gas/liquid pressure sensor

17

Pressure measurement devices that do not contain any electronics, such as a nondigital tire-pressure gauge or a mercury manometer, are outside the scope of this Encyclopedia.

Many pressure sensing methods can be used with both gases and liquids. To avoid duplication, gas pressure sensors and liquid pressure sensors do not have separate entries. Both types are described here.

This entry deals almost exclusively with MEMS components. It does not include pressure measurement devices sold as industrial products.

Some manufacturers and vendors use the term *pressure sensor* to describe a component that measures mechanical load or force. In this Encyclopedia, the term only describes components that measure liquid or gas pressure. Mechanical load cells and force sensors will be found in the section on **force** sensors. See Chapter 12.

OTHER RELATED COMPONENTS

- **liquid level** sensor (see Chapter 15)
- **liquid flow rate** sensor (see Chapter 16)
- **gas flow rate** sensor (see Chapter 19)

What It Does

A pressure sensor measures the force exerted by a gas or liquid, often in a container or pipe.

Static pressure is measured under conditions that change slowly or not at all. *Dynamic pressure* is subject to fluctuations. Pressure sensors tend to be designed for one condition or the other.

Schematic Symbols

Many specialized symbols are used in flow diagrams to represent pumps, valves, and sensors, including pressure sensors. Typically they involve a single letter or an X in a circle. These symbols are not generally found in electronic schematics, and therefore they are not included here.

Applications

Barometric sensors are found in barometers and weather stations. Altimeters are really a specialized form of barometric sensor, used in airborne vehicles. Gas pressure sensors have many industrial applications, and are used to monitor tire inflation in vehicles and the output from air compressors. They may also measure liquid pressure indirectly, as in a blood-pressure cuff.

Liquid pressure sensors are widely used to measure oil pressure in automobile engines and hydraulic braking systems. They have med-

ical applications, and monitor water pressure in municipal systems and pumped supplies.

Design Considerations

As a result of random molecular movement, gases will tend to disperse to fill a container. After a gas reaches equilibrium, the pressure will be almost equal in all directions, affected only slightly by gravity. Where a gas is in a sealed, rigid container, pressure will vary linearly with temperature.

A liquid will tend to accumulate at the bottom of any container under the force of gravity. Liquid pressure in a container will be highest at the bottom, because of the weight of liquid above it. However, because almost all liquids are not easily compressible, they transmit force from any point in a container to any other point, including the sides of a container.

Units

Pressure is measured as force per unit area, which can be expressed in a confusing variety of units.

In the United States, gas and liquid pressure are still often expressed in pounds per square inch, abbreviated as PSI, or more often as psi, or sometimes as lb/in^2.

In standard international (SI) units, 1 bar of pressure is approximately equal to atmospheric pressure at sea level. Millibars are popular among meteorologists, 1 millibar being 1/1000 of a bar, equivalent to 100 pascals, where 1 pascal = 1 newton per square meter.

A bar is equivalent to 14.504 psi.

Blood pressure is measured in millimeters of mercury, because mercury manometers were used for this purpose originally. Atmospheric pressure may also be measured in millimeters of mercury, because the earliest barometers used a tube containing mercury. In the United States, some sources still refer to inches of mercury.

How It Works

Pressure sensing usually entails three stages.

1. A *sensing element* translates pressure into the mechanical displacement of a flexible part.
2. A *transducer* converts mechanical displacement into an electrical effect, either modifying resistance or creating a small voltage or current.
3. Electronics are used for *signal conditioning*. This may entail modifying a nonlinear signal, or may convert an analog output to a digital output.

As pressure sensors are increasingly taking the form of MEMS devices, all three stages may be combined in one silicon chip.

Basic Sensing Elements

Figure 17-1 shows four types of sensing elements that are used, or have been used, to convert pressure into mechanical motion. In each case, a green arrow shows where gas or liquid is introduced under pressure. 1: A Bourdon tube flexes under pressure, increasing its radius. The tube is hollow, open at one end and sealed at the other. 2: A coiled Bourdon tube uncoils partially under pressure, causing the top end to rotate. 3: A simple flat diaphragm. 4: A ribbed diaphragm.

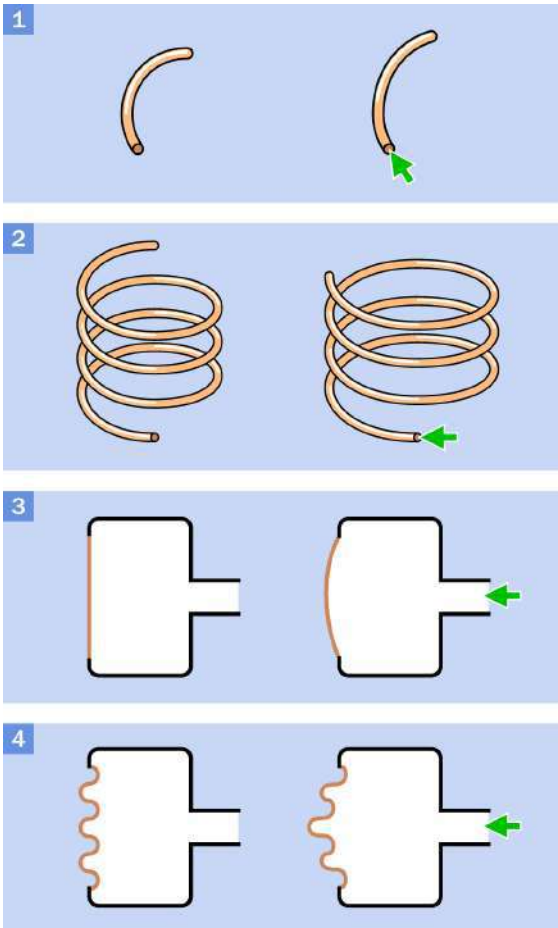

Figure 17-1 *Sensing elements. See text for details.*

The sensing elements numbered 1 and 2 are less likely to be used in modern systems, although a coiled Bourdon tube may be used to turn a potentiometer in low-cost oil-pressure sensing designs. Number 3 is well suited to MEMS devices, as it can be etched into silicon using the principle illustrated in Figure 17-2.

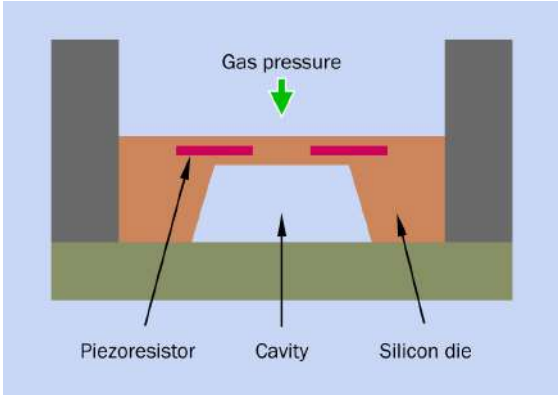

Figure 17-2 *A section of a flat-diaphragm pressure sensor, viewed from the side. An aperture in the top face of the chip allows air to enter. The sensor is etched into silicon, and the deflection of the wafer is measured using embedded piezoresistors.*

Relative Measurement

Pressure is a relative measurement. It is expressed relative to a *reference pressure* of some kind. Three types of measurement are commonly used:

1. *Absolute pressure*, relative to the zero value of a vacuum.
2. *Gauge pressure*, relative to ambient pressure (that is, pressure in the environment around the sensor). Air pressure is the reference source for gauge pressure, and a *vent* is incorporated into the sensing system.
3. *Differential pressure*. In this case, the pressure being measured is relative to some other pressure—for example, the pressure differential between two sealed tanks.

Figure 17-3 illustrates these three measurement types.

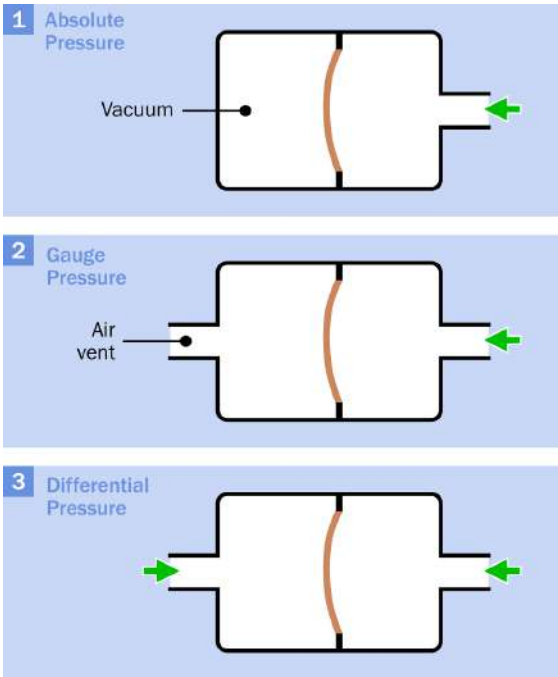

Figure 17-3 *Three ways in which pressure is measured.*

Variants

Ambient Air Pressure

A *barometric* sensor measures the pressure of air around it. This is an absolute value, relative to a vacuum.

The earliest barometers consisted of a tube sealed at one end, containing mercury. No air was allowed to enter the tube. It was inverted so that its open end was immersed in a small reservoir that was open to the air, the pressure of which supported the column of mercury in the tube. Thus, the height of the column was ratiometrically equivalent to atmospheric pressure. Because low air pressure is often an indicator of inclement weather, a barometer was a very simple tool for weather forecasting.

A modern barometric sensor consists of a chip with a vent hole in its upper surface, allowing ambient air pressure to reach a sensor inside the chip. A popular example has been the Bosch BMP085, shown soldered onto a breakout board in Figure 17-4. The BMP180 has a very similar specification, the primary difference being that it is designed for a SPI bus instead of I2C. For additional details about protocols such as SPI and I2C, see Appendix A.

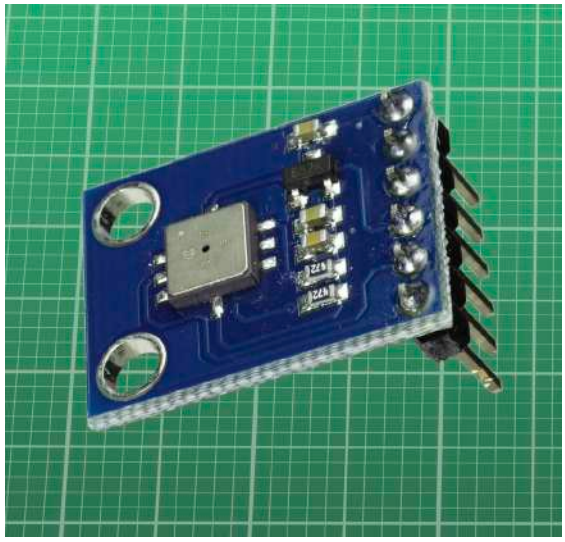

Figure 17-4 *A Bosch barometric sensor on a breakout board. The background grid is in millimeters.*

This sensor uses a supply voltage ranging from approximately 2VDC to 3.5VDC, but a breakout board includes a voltage regulator that tolerates a 5VDC supply. The output is digitized for access by a microcontroller, but the format is quite complex and consists of raw data that must be converted to air pressure by applying a formula. The manufacturer offers free code in the C language for this purpose. A thermometer that is built into the chip enables temperature compensation.

Subsequent products from Bosch include the BME280, which adds a humidity sensor. Breakout boards using this and other barometric chips are available from sources such as Sparkfun and Adafruit, where Arduino code libraries to interpret the data are available for download.

Altitude

A barometric sensor can be used to determine altitude. At sea level, air pressure is approxi-

mately 101kPa (kilopascals), or 760 millimeters of mercury. At 5,000 meters altitude, air pressure drops to 56kPa. The transition is nonlinear, changing most rapidly at lower altitudes.

Air pressure will be affected by temperature and weather conditions. Weather is unlikely to affect the value by more than plus-or-minus 1%, and temperature has a smaller effect; but the barometric sensor can be reset to a zero point based on current temperature and weather data.

Gas Pressure

Thousands of board-mountable gas pressure sensors are available from retail component suppliers. The need to make connections via tubing imposes a minimum size limit on these parts. Many have a through-hole format, but even the surface-mount variants can be relatively large (e.g., 10mm × 10mm). Most tend to have barbed tubing ports, the "barbs" being ridges to retain push-on flexible tubing. Output may be analog or digital, the digital protocol being designed for I2C, SPI, or plain TTL serial buses.

These components are designed for pressures ranging up to 500kPa (kilopascals). Some manufacturers use psi in their specifications, while others use bars and millibars, and a few state gas pressures equivalent to inches of water.

Dual-ported gas sensors for differential pressure measurement can be used for gauge measurement (i.e., relative to ambient air) if one port is left open. Absolute pressure sensors have only one port, as they measure pressure relative to a vacuum maintained inside the chip, behind the diaphragm.

- Some gas pressure sensors can do dual duty as liquid pressure sensors, but others cannot, and datasheets must be consulted carefully, as online vendors may not include this information prominently.

The sensor in Figure 17-5 by All Sensors Corporation is designed for flexible tubing with 1/16" internal diameter (1.6mm). Its pin spacing is 0.1" (2.54mm), making it breadboardable. This sensor is intended for gases only, but has a "10-inch" water-equivalent rating, meaning that it can tolerate a maximum pressure equivalent to that of a 10-inch (25.4cm) column of water.

When supplied with up to 16VDC, an internal Wheatstone bridge circuit provides an analog output that varies ratiometrically by a few millivolts over the full range of measurable pressures (the exact specification depending on the power supply). The output may be amplified with an external op-amp. Although this is a differential sensor, it can provide gauge pressure if one of the ports is left open.

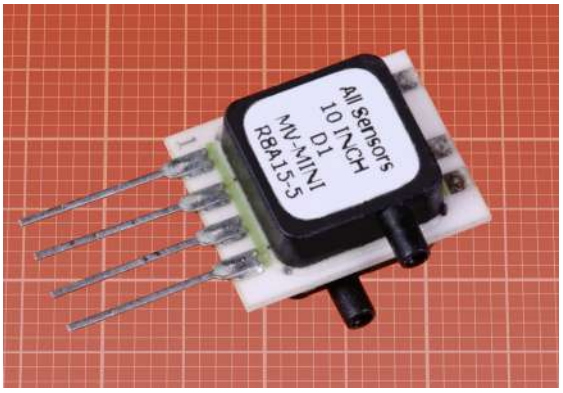

Figure 17-5 *A gas pressure sensor for use with 1/16" (1.6mm) internal diameter flexible tubing. The background grid is in millimeters.*

The larger sensor in Figure 17-6 is in the ADCA range from All Sensors Corporation, designed for flexible tubing with 1/8" internal diameter (3.2mm). This is intended for gases only, and has a "5-inch" water-equivalent rating. It requires a 5VDC power supply and has an internal op-amp that provides an output that varies ratiometrically by 0.2VDC (centered on 4VDC) over the range of measurable differential pressures. Like its smaller cousin, it can provide gauge pressure if one of the ports is left open.

Figure 17-6 *A gas pressure sensor for use with 1/8" (3.2mm) internal diameter flexible tubing. The background grid is in millimeters.*

What Can Go Wrong

Vulnerability to Dirt, Moisture, and Corrosive Materials

MEMS pressure sensors containing very delicate, very small sensing elements must inevitably come into direct contact with gases and, in some cases, liquids. Datasheets will provide warnings regarding humidity and corrosive fluids, but the risk of contamination with dirt remains. Liquids should be filtered to minimize this risk.

Barometric sensors have a hole in the package, exposing the sensor element to the ambient air. This vent must be protected from direct contact with the environment.

Light Sensitivity

If light is allowed into the vent hole in a barometric sensor, it can create photocurrents in the chip. This will affect accuracy.

gas concentration sensor

18

Humidity sensors and *vapor sensors* are included in this entry, as they measure concentrations of a liquid while it is in its gas phase.

Sophisticated *industrial sensors* are available for accurate gas sensing, but this entry deals almost entirely with lower-cost solid-state sensors that are often classified as *board-mount* components.

OTHER RELATED COMPONENTS

- **gas/liquid pressure** sensor (see Chapter 17)

What It Does

Small semiconductor-based gas sensors provide a low-cost method for detecting specific gases in ambient air. The sensors vary their electrical resistance or capacitance in response to the concentration of the gas. They may be used in conjunction with an alarm system that will sound if gases such as *propane* or *carbon monoxide* exceed a preset level, or if the concentration of *oxygen* drops below a preset level.

Because vapor consists of a liquid in its gas phase, gas sensors can respond to vapor, as in the case of *alcohol sensors*.

A *humidity sensor* measures the amount of water vapor in the air, which can be important in refrigeration, HVAC (heating, venting, and air conditioning), medical equipment, meteorology, and storage rooms where art objects, antiques, or paper archives must be preserved in an environment that is neither too dry nor too moist, and is held at a constant temperature. Humidity control can be important also in climates where growth of mold is a concern. Humidity sensors are also used in automobile climate control and windshield defogging, and in the storage of food, fabrics, wood products, and medications.

High humidity coupled with high temperature contributes to the decomposition of many substances, while low humidity can cause desiccation. High humidity can also create damage if it causes materials to expand as a result of taking up moisture.

Many methods have been devised to detect individual gases, but semiconductor sensors are now dominant in applications where accuracy and gas-specificity are not crucial.

Schematic Symbol

No specific schematic symbol exists to represent a semiconductor gas sensor.

Semiconductor Gas Sensors

During the development of transistors in the 1950s, engineers noticed that semiconductor p-n junctions were sensitive to the presence of some gases in the atmosphere. This was regarded as a problem, which was solved by encapsulating transistors to prevent their exposure.

During the 1980s, Japanese law required installation of sensors in every home to detect hazardous concentrations of propane gas. This encouraged the development of cheap, long-lasting components that took advantage of semiconductor sensitivity.

Tin oxide is widely used in a variety of solid-state gas sensors. A sintered layer of the compound is deposited on a ceramic substrate in combination with other compounds such as antimony oxide. The granular layer functions as an n-type semiconductor in which electron transfer increases when certain gases are adsorbed among the grains. When the gas concentration diminishes, oxygen atoms displace the gas molecules, and the sensor returns to its original state. It is unimpaired by being activated, and has a life expectancy of at least 5 years during active (powered) use.

Each sensor includes a tiny resistive heater that is necessary for the chemical reaction to occur. Voltage must be applied to two pins that are connected with the heater. Two other pins connect internally with the sensing element. The resistance between these pins will vary with presence of the target gas; thus, this type of component has a resistive output.

It is a feature of semiconductor gas sensors that they tend to suffer from *cross-sensitivity*. That is, one sensor may respond to more than one gas. Manufacturers control this problem to some extent by adding filtering material around the semiconductor element, or by adjusting the proportions of dopants used in the semiconductor. Datasheets should be consulted carefully to see if a sensor may give false positives as a result of other gases that are likely to be present in the area where it will be used.

Figure 18-1 shows an MQ-5 propane sensor from Hanwei Electronics. The component also responds to methane, hydrogen, alcohol, and carbon monoxide, but with much less sensitivity. The manufacturer recommends calibrating the sensor by using a resistor ranging from 10K to 47K in series with the output resistance.

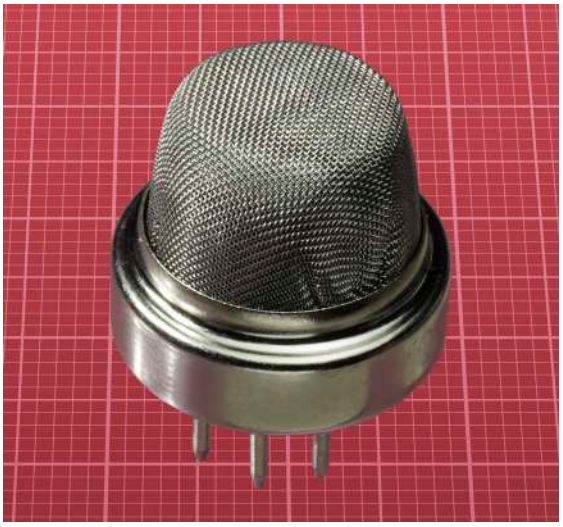

Figure 18-1 *A propane gas sensor. The background grid is in millimeters.*

Figure 18-2 shows an MQ-3 alcohol sensor, also manufactured by Hanwei. It has some sensitivity to benzene, but this is unlikely to be a problem, as benzene is seldom present in significant concentrations in ambient air. However, the response of the sensor to alcohol varies with temperature and humidity. Consequently this component can only be used as a "breathalyzer" if the user can be satisfied with an approximate response.

Semiconductor gas sensors are also available for detecting methane, carbon monoxide, hydrogen, ozone, and other gases.

These components are not low-current devices. Typically the internal heater in the Hanwei range has a resistance of slightly more than 30 ohms, and will draw 150mA to 160mA at 5V (i.e., slightly less than 1W). Because the heater is a simple resistive device, it can be used with AC or DC. The output resistance of the sensor can also be assessed with an AC or DC signal.

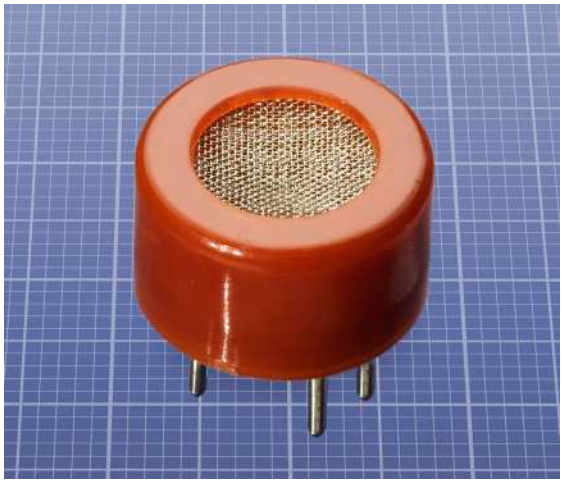

Figure 18-2 *An alcohol sensor. The background grid is in millimeters.*

A breakout board from Parallax simplifies the use of Hanwei gas sensors. The board is shown in Figure 18-3. It is compatible with carbon monoxide, propane, methane, and alcohol sensors, each of which can be plugged into a socket on the board. Two trimmers establish the sensitivity and the trip point for the sensing element, and the TTL output is then logic-high when a gas is detected, and logic-low otherwise.

Figure 18-3 *A Parallax breakout board to simplify the use of Hanwei gas sensors.*

Oxygen Sensors

Oxygen sensors are often built using a membrane made of zirconium dioxide. This material has the property that it can transport oxygen ions when heated. One setup is to have a zirconium membrane separating the gas to be measured from ambient air. This is a type of fuel cell, called a concentration cell or Nernst cell. If the oxygen concentration differs between the two sides of the membrane, oxygen ions will flow through it. Only oxygen ions can move—not neutral oxygen atoms or molecules. The ions are negatively charged, so the transport will lead to a potential difference over the cell, which can be measured with platinum electrodes.

To comply with emissions regulations, automobiles sense the oxygen level of exhaust gases. This data controls the fuel-air ratio in the fuel injection system. Too much air results in the formation of nitrogen oxides, while too little air results in excessive carbon monoxide.

Humidity Sensors

Moisture content of the air is expressed in three different ways:

Absolute humidity
: This is the weight of water vapor in a fixed volume of air. It is measured in grams per cubic meter in the metric system. An absolute humidity sensor is properly called a *hygrometer*.

Dew point
: If a sample of air is cooled without a change of pressure, the dew point is the temperature at which moisture will start to condense. The dew point is a way of describing how humid the ambient air is currently, as water will condense more readily in humid conditions.

Relative humidity
: This is often referred to by its acronym, RH. If temperature, pressure, and volume of a sample of air remain constant, relative humidity is the ratio between the current value of absolute humidity and the hypothetical level where the addition of

water vapor would result in condensation. The ratio is expressed as a percentage. Thus, if moisture is already condensing in an air sample, relative humidity is 100%. If an air sample contains half the weight of moisture required for condensation to begin, relative humidity is 50%. If there is no moisture at all in the air, relative humidity is 0%.

Colloquial usage of the term "humidity" usually means relative humidity, and sensor output is usually convertible to this value. However, some absolute humidity sensors do exist.

Dew-Point Sensor

Historically, meteorologists used a *chilled mirror hygrometer*, in which a metal mirror was exposed to the atmosphere and cooled until the surface was seen to become misty with condensation. The temperature where this occurred was the dew point.

This system is still used in conjunction with an LED and a **phototransistor**. The LED is positioned so that its light reflects from a mirror, directly onto the phototransistor. The mirror is cooled until mist starts to form, which diffuses the reflected light and causes a well-defined change in output from the phototransistor.

Although the formula linking dew point with relative humidity is complex, a simplified approximation is available that is reasonably accurate so long as the relative humidity is 50% or greater. If RH is the relative humidity, t is the current temperature, and t_D is the dew-point temperature at which mist forms:

$$RH = 100 - (5 * (t - t_D)) \text{ approx.}$$

Although a chilled-mirror dew-point sensor has a reputation for being accurate, it is heavy, expensive, and impractical for most applications outside of meteorology.

Absolute Humidity Sensors

An absolute humidity sensor may use two NTC (negative temperature coefficient) **thermistors** in a Wheatstone bridge circuit. One thermistor is sealed in a compartment containing dry nitrogen, with zero humidity. The other is exposed to the atmosphere. Current passing through the thermistors raises their temperature to at least 200 degrees Celsius. Because heat radiates less efficiently when there is moisture in the air, the exposed thermistor will run hotter, and its resistance will be higher, at higher levels of humidity. This type of sensor is used in clothes dryers and wood kilns, among other applications.

See Chapters 23 and 24 for more information about thermistors.

Relative Humidity Sensors

Two main types of sensing elements are used to measure relative humidity: resistive and capacitive.

In a *resistive* sensing element, a thin layer of polymer, salt, or other hygroscopic substance is deposited on a substrate consisting of ceramic or other unreactive material. When the substance absorbs water, its electrical conductivity increases. Voltage is applied to the sensing element, and AC is used to avoid polarizing it. The current flow is processed externally, with conversion to DC followed by linearization, meaning that the current is processed to establish an almost linear relationship with gas concentration, with temperature compensation factored in. Alternatively, these functions can be performed by hardware built into the sensor, and a digital value for relative humidity can be accessed by an external microcontroller.

In a *capacitive sensor*, once again a thin film of polymer or metal oxide is deposited on a ceramic or glass substrate, but the film functions as a *dielectric* between two metal electrodes that serve as the plates of a capacitor. The dielectric value changes as the film absorbs moisture, and this causes the capacitance to

vary, typically by 0.2pF to 0.5pF for each 1% change in relative humidity. This is almost a linear relationship extending over the entire range from 0% to 100% relative humidity.

The actual capacitance value at 50% relative humidity is likely to be between 100pF and 500pF. The sensor may be excited with AC from an external source, or can be incorporated in a chip that derives AC from a DC power supply and provides a digital output.

To determine the dew point or absolute humidity from a value for relative humidity, ambient temperature must also be measured. A chip such as the Si7005 from Silicon Labs includes a temperature sensor with a relative-humidity sensor based around a capacitor in which polyimide film forms the dielectric. If condensation forms, an on-chip heater will cause it to evaporate so that normal operation can resume. Data from the chip is supplied via an I2C interface.

Humidity Sensor Output

When the output is analog, resistance or capacitance of the internal sensing element is available via two pins or solder pads on the sensor. The analog value must be converted to a value for relative humidity by performing a calculation that takes the current temperature into account. The component may or may not include a temperature sensor.

With a digital output, an internal analog-to-digital converter can be accessed by a microcontroller via serial, I2C, or SPI interface. Alternatively, the sensor may communicate values using pulse-width modulation. Either way, the output is a value for relative humidity, calculated on the chip with reference to an onboard temperature sensor.

Analog Humidity Sensor

The Humirel HS1101 is a low-cost analog-output humidity sensor that varies its internal capacitance between approximately 160pF and 200pF as relative humidity increases from 0% to 100%. The response is almost linear, with the curve steepening slightly when humidity exceeds 80%. The component is shown in Figure 18-4.

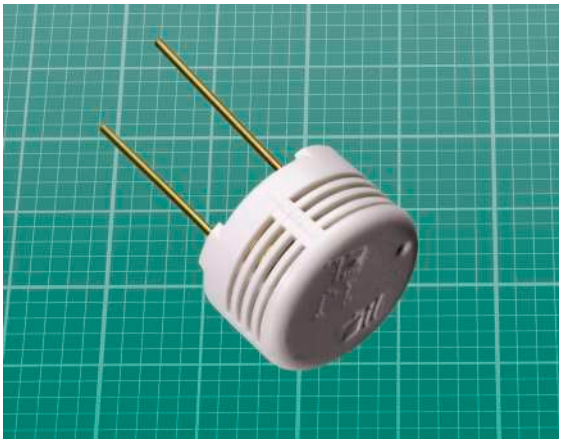

Figure 18-4 *A Humirel HS1101 humidity sensor. The background grid is in millimeters.*

The manufacturer claims a recovery time of 10 seconds after 150 hours of condensation. In other words, the performance of the sensor should be restored to its original specification.

A microcontroller can evaluate the output by measuring the charge time of the internal capacitor in the sensor. If the sensing element is wired in parallel with a 10M resistor, this will allow the capacitor to discharge before the microcontroller charges it again. A 220-ohm series resistor should be used between the microcontroller and the sensor, to limit the charge current. This circuit is illustrated in Figure 18-5.

Alternatively, the sensor manufacturer suggests using the capacitance value to control the output frequency of a 555 timer. A counter or microcontroller may be used to count the number of pulses per unit of time.

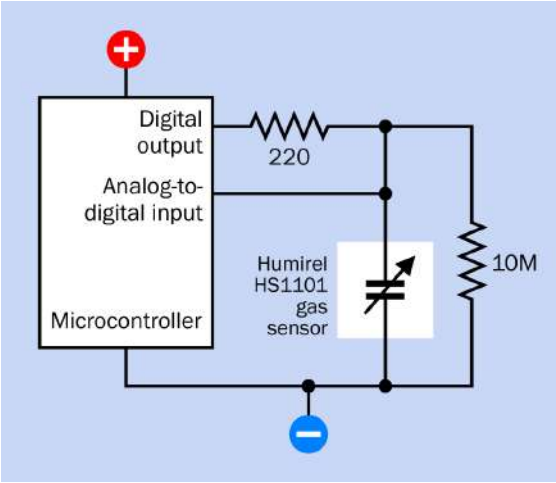

Figure 18-5 *Using a microcontroller to measure the charge time of a gas sensor with capacitive output.*

The Honeywell HIH4030 is a surface-mount humidity sensor with a more convenient analog voltage output that increases almost linearly from approximately 0.8VDC at 0% humidity to 3.8VDC at 100% humidity, assuming a 5VDC power supply. The sensor is available on a miniature breakout board from Sparkfun, shown in Figure 18-6.

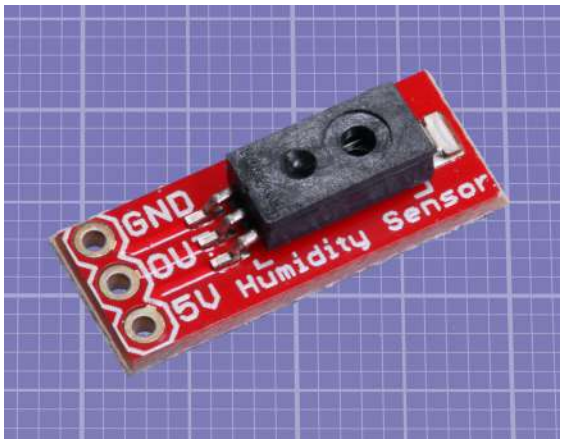

Figure 18-6 *The Honeywell HIH4030 on a breakout board from Sparkfun.*

Design Considerations

As relative humidity is temperature-dependent, a relative-humidity sensor must have the same temperature as the air it measures. Many datasheets recommend that when a sensor is mounted on a printed circuit board, slots should be milled around it to minimize heat transfer to it. The sensor should also be mounted as far away as possible from heat-generating components.

Where a capacitive humidity sensor with an analog output is located some distance from the electronics that will process its output, shielded cables or twisted pair cables should be used to minimize capacitance in the wiring. A decoupling capacitor between the supply voltage and ground close to the sensor can help to keep the supply voltage stable.

Digital Humidity Sensor

The AM2302, available from Adafruit, is a capacitive humidity sensor with a digital output accessible by a microcontroller via the I2C protocol. Onboard electronics calculate relative humidity with reference to an included temperature sensor. This component is pictured in Figure 18-7.

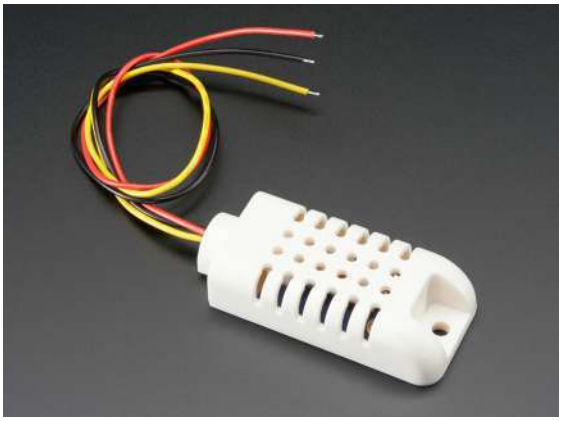

Figure 18-7 *A low-cost humidity sensor with temperature-compensated digital output. From a photograph by Adafruit.*

What Can Go Wrong

Contamination

A semiconductor gas sensor can be damaged by exposure to volatile chemical vapors. This

would be unusual in a domestic environment, but is still an important consideration, as there will be no obvious indication that damage has occurred.

Recalibration

If a humidity sensor is exposed to very high humidity where condensation occurs, some datasheets advise a baking procedure, where the sensor is placed in warm, dry air for several hours and then allowed to rehumidify.

Soldering

Semiconductor gas sensors should be soldered quickly and at a controlled temperature, to minimize heat transfer.

gas flow rate sensor

19

Sensors that contain no electronic components are not included in this entry.

A **gas flow rate** sensor may often be described as a *mass flow* sensor or *mass flow rate* sensor. Although it measures volume rather than mass, the mass of gas can be calculated so long as its temperature and pressure are controlled.

Some methods of gas flow sensing can also be applied to liquids, but sensors are usually designed for one application or the other. Therefore, **liquid flow rate** sensors have their own entry. See Chapter 16.

An *anemometer* is a gas flow rate sensor that measures air speed. It is included in this entry.

Many gas flow rate sensors are large devices designed for industrial applications. This entry focuses mostly on lower-cost solid-state sensors that are often classified as *board-mount* components.

OTHER RELATED COMPONENTS

- **liquid flow rate** sensor (see Chapter 16)

What It Does

A **gas flow rate** sensor measures the volume of gas flowing past or through the device, usually inside a pipe. In most applications, users wish to know the mass of the gas that is passing per unit of time. Consequently a gas flow rate sensor is very often identified as a *mass flow rate* sensor. If it functions by heating the gas and measuring the heat dissipation, it is a *thermal mass flow rate sensor*.

A sensor that measures the flow of open air is often described as an *anemometer*. Its output will be expressed as a velocity, not as a volume or mass.

Applications

Mass flow rate sensors are used frequently for laboratory and medical applications, although the reliability and affordability of thermal mass flow rate sensors is now making them attractive for metering municipal gas supplies.

Anemometers are used mostly in meteorology, aviation, and on boats.

Schematic Symbol

Many specialized symbols are used in flow diagrams to represent pumps, valves, and sensors, but they are not schematic symbols of the type generally found in electronic circuit diagrams, and are not included here.

How It Works

Because an anemometer functions so differently from a gas flow rate sensor that is enclosed in a pipe, the two types of sensors will be discussed separately.

Anemometer

The name of this device is derived from the Greek word *anemos*, meaning "wind." The *cup anemometer* was invented in 1846, using four hemispherical cups attached to horizontal arms rotating on a vertical shaft. The rate of rotation was proportional to wind speed over a substantial range, but the conversion factor between wind speed and RPM varied depending on the size of the cups and their distance from the shaft.

Anemometer design was simplified to three cups in 1926 and was modified in 1991 by adding a tag to one cup. This causes the speed of rotation to fluctuate as the tag rotates through the wind stream, and the direction of the wind can be calculated from the speed fluctuations. Not all anemometers rely on this principle, however, and a separate wind vane can be used to determine wind direction.

The basic design of a modern anemometer is illustrated in Figure 19-1.

Figure 19-1 *The basic design of a metereological cup anemometer.*

Anemometers traditionally used a mechanical counter to log the number of rotations, which were checked at fixed intervals to derive the wind speed. The output of a modern anemometer may be achieved by generating AC or DC power, or from *Hall-effect sensors* (see "Hall-Effect Sensor" for a full discussion of Hall-effect sensors).

Handheld Anemometer

A digital handheld anemometer for personal use is shown in Figure 19-2. A cup anemometer made by Vaavud for use with a mobile phone (with appropriate software) is shown in Figure 19-3.

Figure 19-2 *A handheld digital anemometer.*

Figure 19-3 *A cup anemometer sold as an accessory for smartphones.*

Ultrasound Anemometer

The movement of air affects the speed of sound, enabling calculation of both wind direction and wind velocity by using an array of

ultrasound emitters and receivers. The lack of rotating parts promises greater reliability, and in Figure 19-4 an ultrasound anemometer manufactured by Biral Metereological Sensors also includes heaters so that it will be immune to snow or ice accumulation during freezing conditions.

Figure 19-4 *Made by Biral Metereological Sensors, this anemometer uses ultrasound to determine wind speed and direction.*

Ultrasound anemometers have been built on a DIY basis by hobbyists, typically using off-the-shelf ultrasound emitters and an Arduino to decode the signals. Several of these projects are documented online.

Hot Wire Anemometer

A hot wire anemometer measures the cooling effect of the air. It heats a thin wire by passing current through it, and measures the heating power needed to keep the temperature constant.

It is also possible to keep either the voltage over the wire or the current constant, and to assess the wire temperature. The temperature can be measured directly or calculated from the wire's resistance, which increases as the wire gets hotter.

Mass Flow Rate Sensing

A mass flow rate sensor measures the flow speed of a gas. When this is multiplied by the density, the mass flow rate can be calculated.

Most sensors of this type heat the gas and are categorized as *thermal mass flow rate* sensors. The gas passes over a *thermopile* (consisting of several thermocouples wired in series), then a heater, and then another thermopile. These components are miniaturized and can be etched into a chip measuring 2mm square or less.

The temperature difference between the two thermopiles increases as the flow of gas becomes faster and transports more heat to the second thermopile. This is known as the *heat transfer principle*, illustrated in Figure 19-5.

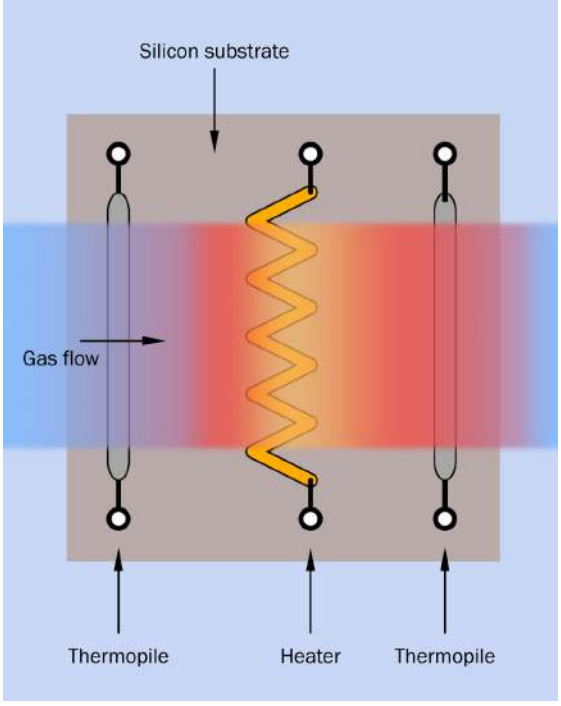

Figure 19-5 *In a thermal mass flow sensor, the flow of gas heats the thermopiles disproportionately, and the temperature difference can be used to evaluate the rate of flow.*

This principle is used also in a liquid thermal mass flow rate sensor, described in "Thermal Mass Liquid Flow Rate Sensor".

An example of a thermal mass flow rate sensor is shown in Figure 19-6.

Figure 19-6 *A thermal mass flow rate sensor made by the Chinese manufacturer Zhengzhou Winsen Electronic Technology Co. Ltd.*

Applications

In medicine, mass flow rate sensors are used in anesthesia delivery, respiratory monitoring, sleep apnea machines, ventilators, and other devices. Industrial uses include air-to-fuel ratio measurement, gas leak detection, and gas metering.

While the metering of municipal gas supplies was traditionally done with all-mechanical devices, MEMS-based meters are replacing many of the 400 million mechanical gas meters estimated to exist worldwide.

Units

Mass flow rate sensors are often rated in SLM, meaning standard liters per minute. A "standard liter" has a temperature of 0 degrees Celsius and a pressure of 101.325 kPa (kilopascals). This pressure is equivalent to that of air at sea level. Because temperature and pressure are specified, the mass of a gas in a standard liter can be calculated by knowing the density of the gas. Thus SLM is a way of measuring mass flow, even though it is a measurement of volume.

The acronym SLPM is also used, but it means the same thing as SLM. SLs and SLPs are measurements of standard liters per second, while SCCM refers to standard cubic centimeters per minute.

Measuring Higher Volumes

MEMS sensors are typically equipped with inflow and outflow nozzles suitable for flexible tubing of 3mm or 5mm internal diameter. The nozzles are "barbed," meaning that they have ridges to retain the tubing.

Small tubing can only deal with low flow rates. A few sensors are threaded for standard plumbing pipes, and can accept volumes of up to 10 liters per minute. They are a minority. A low-rate sensor can still be used to measure higher volumes if it is supplied with just a percentage of the primary flow. This principle is illustrated in Figure 19-7, where an adjustable vane in the main pipe creates a pressure differential. A narrower, constricting section of pipe could have a similar effect, but it would not be adjustable.

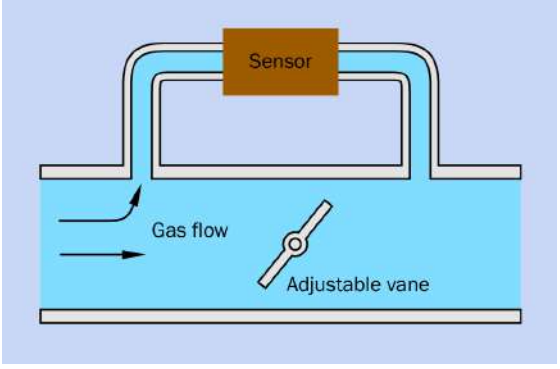

Figure 19-7 *A vane in a primary pipe can divert a percentage of the flow to a sensor.*

Output

Many mass flow sensors have an analog output consisting of a voltage that varies ratiometrically with gas flow. With a typical 5VDC power supply, output voltage may vary from around 1VDC to 4VDC.

Some sensors now incorporate analog-to-digital converters and data processing to provide SLM digital values, accessible from a microcontroller via an I2C interface.

What Can Go Wrong

The primary risk for gas flow rate sensors is damage caused by particles and contaminants in the gas stream. A 5-micron filter is recommended. A *dust segregation system* can also be used, consisting of a small compartment containing semicircular centrifugal chambers. Dust tends to follow the outer edge of the flow path, while the flow sensor is placed on the inner side of the path.

photoresistor

20

A **photoresistor** has a function similar to that of a **phototransistor**, but as its name implies, it is a purely passive component that varies its resistance in response to light.

The term *photocell* was used formerly, but has been displaced by the term **photoresistor**, which describes its function more accurately. The term *photoconductive cell* is sometimes used, or *light-dependent resistor* (or its acronym, *LDR*).

OTHER RELATED COMPONENTS

- **resistor** (see Volume 1)
- **photodiode** (see Chapter 21)
- **phototransistor** (see Chapter 22)

What It Does

Formerly known as a *photocell*, a **photoresistor** is a disc-shaped component with two leads. When light falls on the surface of the disc, resistance between the leads will diminish. Some photoresistors have a resistance in darkness as high as 10 megohms. A few have a resistance in bright light as low as 500 ohms, although several kilohms would be more common.

A photoresistor is less sensitive to light than a **phototransistor** or **photodiode**, and unlike them it is a passive component with no polarity. It presents equal resistance to current in either direction, and may be used with DC or AC.

Because cadmium sulfide is commonly used in this component and is regarded as hazardous to the environment, photoresistors are now unavailable in some regions (notably, Europe). However, at the time of writing, they are still available from many Asian sources, and from some importers in the United States.

Schematic Symbol

Six schematic symbols for a photoresistor are shown in Figure 20-1. They are functionally identical, regardless of whether the single slanting arrow across the resistor symbol is omitted.

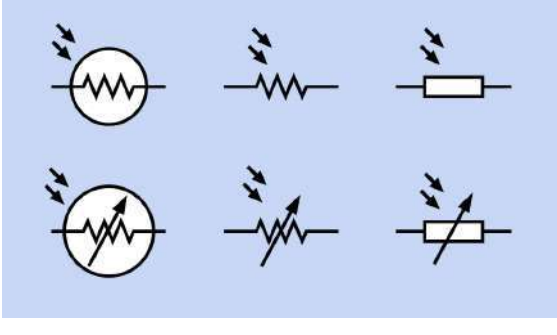

Figure 20-1 *All six symbols for a photoresistor are functionally identical.*

How It Works

Cadmium sulfide is a semiconductor. When exposed to light, more charge carriers are excited into states where they are mobile and can participate in conduction. As a result, electrical resistance decreases.

Construction

A closeup of a photoresistor appears in Figure 20-2. The brown material is a layer of cadmium sulfide deposited onto a ceramic base. The silver material is a conductive compound evaporated onto the cadmium sulfide to form two interlocking electrodes, in a pattern that maximizes the length of the boundary between each of them and the semiconductor. The electrodes connect with leads projecting from the back of the component.

Figure 20-2 *Closeup of a photoresistor. Two interlocking electrodes are mounted on a brown semiconductor layer.*

Variants

Figure 20-3 shows a variety of photoresistors, illustrating the range of sizes available. Small photoresistors may be less than 5mm in diameter; large ones may be 25mm in diameter. The size generally suggests the ability of the component to pass current.

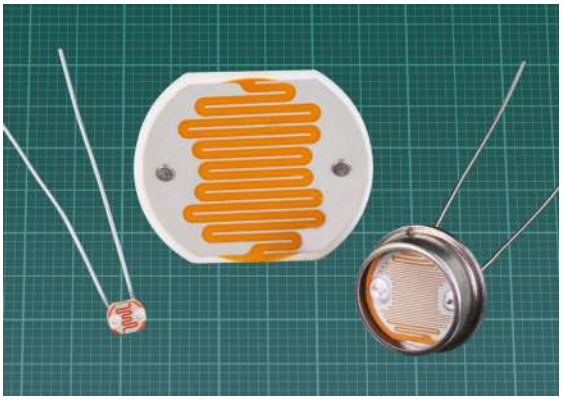

Figure 20-3 *Photoresistors are available in a wide range of sizes. The component in the center is shown at the same scale as the others. Generally speaking, larger components are able to conduct higher currents. The background grid is in millimeters.*

Photoresistors in Optical Isolators

An *optical isolator*, popularly known as an *optocoupler*, contains an LED opposite to a photoresistor, in a sealed package. This is discussed in Volume 2. A *Vactrol* is a similar component, except that the LED is placed opposite to a photoresistor. An example is shown in Figure 20-4.

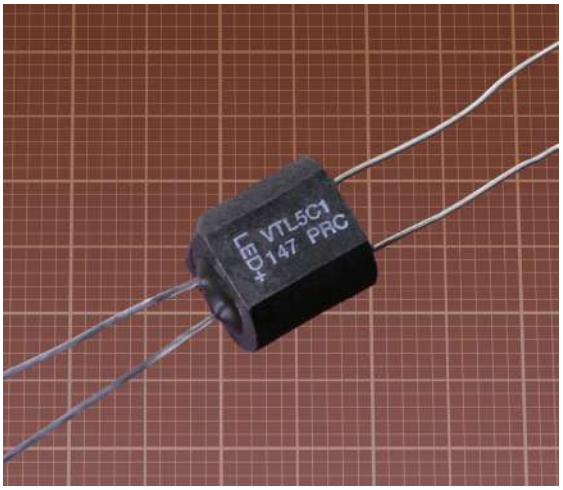

Figure 20-4 *A Vactrol, containing an LED opposite to a photoresistor. The background grid is in millimeters.*

Vactrol is a brand name owned by its initial manufacturer, Vactec. It was developed to con-

trol a vacuum tube, hence its name. In the 1950s, Vactrols were used in guitar amplifiers to control tremolo.

Because of the relatively slow response time of a photoresistor, and its sensitivity to temperature, optical isolators based on photoresistors are not used in digital devices. They still retain some utility in audio components and music equipment, where the ability of the photoresistor to pass AC is an advantage and its response time is adequate.

Values

Datasheets for a few photoresistors can still be found from some suppliers, such as Digi-Key, but are mostly unobtainable, as major semiconductor companies have stopped making these components. Vendors may quote basic values, but in the absence of part numbers or a manufacturer name, a buyer cannot verify the information.

The resistance range can be determined by testing a sample component. A typical range would be from 50K in a light intensity of 10 lux, up to 1M in darkness. Maximum power dissipation is likely to range from 100mW for a small photoresistor to 500mW for a large one.

Maximum voltage may be as high as 200V, but photoresistors will work just as well at low voltages.

Comparisons with a Phototransistor

Slower response
: A photoresistor typically takes several milliseconds to respond to bright light, and can require more than 1 second to regain its dark resistance. A phototransistor is much more responsive, and a photodiode is faster still.

Narrower range of resistance
: The maximum resistance of a photoresistor is almost always significantly lower than the effective maximum resistance of a phototransistor in darkness, and the minimum resistance is likely to be significantly higher than that of a phototransistor in bright light.

Greater current-carrying capacity
: Often a photoresistor is rated for twice as much current as the output from a phototransistor.

Not directional
: Because a photoresistor is not packaged with a lens, it is sensitive to incident light from anywhere in front of it. If an application requires that light sensitivity should be confined within a narrow angle while the component is insensitive to incident light from other directions, a phototransistor or photodiode should be used.

Temperature dependent
: The resistance of a photoresistor varies more with temperature than the effective resistance of a phototransistor.

Cost
: At this time, photoresistors are likely to be more expensive than phototransistors.

Lack of information
: Photoresistors are often sold without means of checking their specification in a datasheet.

How to Use It

While the effective resistance of phototransistors and photodiodes varies with the applied voltage, photoresistors present the same resistance for a particular light intensity regardless of the voltage applied. This property has made them suitable for use in “stomp box” guitar-effects pedals.

Because the minimum resistance of a photoresistor in bright light tends to be relatively high, and because its response time is quite slow, it is

suitable primarily as an analog component rather than as a switch.

In principle, any resistor in a circuit can be replaced by a photoresistor, and its smooth response to light variations would make it suitable, for example, as the resistance in an RC oscillator circuit, where it would determine the charge time of a capacitor. The frequency of the circuit would thus become light-dependent.

Cadmium sulfide photoresistors respond most actively to wavelengths of light ranging from 400nm to 800nm. This is especially important where an **LED indicator** is used as a light source, as LEDs often emit an extremely narrow range of wavelengths. (See the entry for LED indicators in Volume 2.)

Choosing a Series Resistor

To convert light intensity into a voltage, a photoresistor can be connected in series with a regular resistor, to form a voltage divider. There are two ways to do this, as shown in Figure 20-5. On the left side of this figure, light falling on the photoresistor will cause the output voltage to rise. On the right side, light will cause the output to drop.

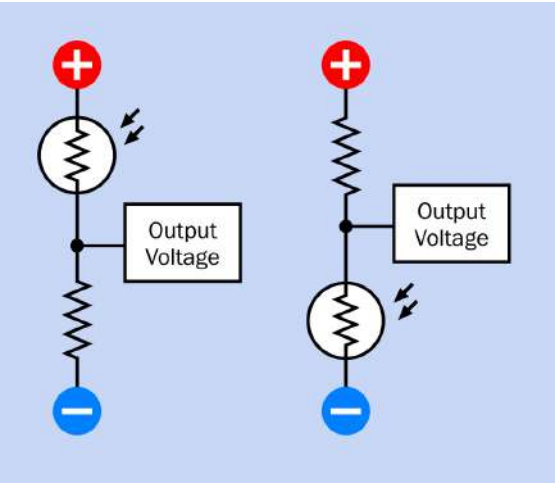

Figure 20-5 *Using a photoresistor to create a variable voltage. See text for details.*

If R_{MIN} is the minimum photoresistor value in the brightest light that will be used, and R_{MAX} is the maximum value in the dimmest light that will be used, a simple formula can be used to find R_S, the optimum value for a series resistor, which will provide the widest range of voltage values at the center of the voltage divider:

$$R_s = \sqrt{R_{min} * R_{max}}$$

What Can Go Wrong

Overload

Because a datasheet may be unavailable, a photoresistor may have to be used on a trial-and-error basis. A test-to-destruction approach may be necessary to determine the limits of the component.

Excessive Voltage

Exceeding the maximum rated voltage for a photoresistor, even for a short time, can cause irreversible damage. Depending on the component, overvoltage can range from 100V to 300V.

Confusion Among Components

Because photoresistors often have no part numbers printed on them and may be sold in miscellaneous assortments, one component may be easily confused with another that has different characteristics. Where two or more photoresistors are used in one device, their characteristics should be measured to determine whether they are functionally identical.

photodiode

21

OTHER RELATED COMPONENTS

- **diode** (see Volume 1)
- **photoresistor** (see Chapter 20)
- **phototransistor** (see Chapter 22)

What It Does

Light falling on a **photodiode** causes it to generate a very small current. This is often called the *photovoltaic effect*. The component functions like a solar panel; in fact, a solar panel can be thought of as being an array of very large photodiodes.

Often, a DC power source is used to apply *reverse bias* to a photodiode. This enables the component to deliver more current. It is now operating in *photoconductive* mode.

Schematic Symbols

Schematic symbols for a photodiode are shown in Figure 21-1. Wavy arrows are often (but not always) used to indicate infrared light.

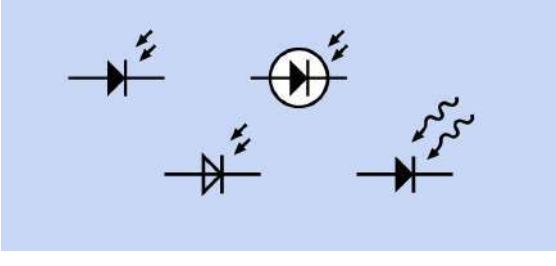

Figure 21-1 *Symbols representing a photodiode.*

Applications

The rapid response of photodiodes makes them suitable for use in optical disc drives, telecommunications, infrared data transfer, digital cameras, and optical switches. Many sensors in this Encyclopedia use a photodiode. **Proximity** sensors, optical encoders, and light meters are examples.

How It Works

When light falls on a semiconductor, it can excite an electron to a higher energy state. The electron then becomes mobile, and leaves behind an *electron hole* (See the entry discussing **diodes** in Volume 1.)

In photovoltaic mode, incident light creates pairs of electrons and electron holes in the semiconductor material. The electrons move to the cathode of the diode while the holes move to the anode, creating voltage between the two. Note that this happens to some extent even in the absence of visible light, as the photodiode may respond to infrared radiation. The tiny amount of current created without visible light is called *dark current*.

In photoconductive mode, light falling on the photodiode creates pairs of electrons and elec-

tron holes in the semiconductor material. These will move in opposite directions due to the bias voltage, which means a small current flows through the diode.

Photoconductive mode enables a faster response than photovoltaic mode, because reverse-bias voltage makes the depletion layer wider, which in turn decreases the capacitance. (The same effect is used in *capacitance diodes*.)

Simplified circuits showing the component in photovoltaic mode and photoconductive mode appear in Figure 21-2.

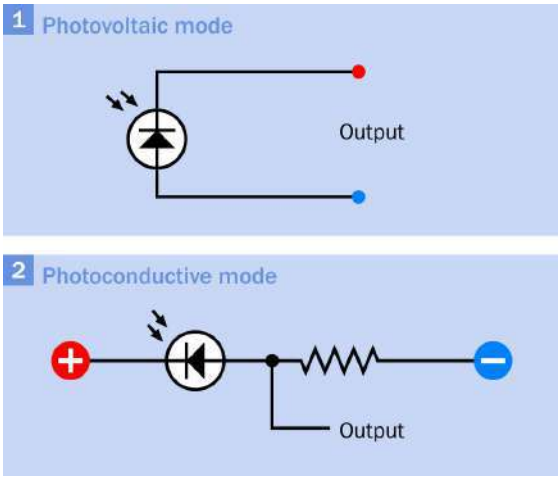

Figure 21-2 *Two modes in which a photodiode may be used. In photovoltaic mode, voltage between the two pins must be measured.*

Variants

PIN Photodiodes

Like *PIN diodes*, PIN photodiodes incorporate an undoped (intrinsic) semiconductor layer between the p- and n-doped layers. They are more sensitive and have faster responses than regular PN photodiodes. Many of the photodiodes available are of the PIN type.

Avalanche Diodes

When light enters the undoped region of the avalanche photodiode, it triggers the creation of electron-hole pairs. When electrons migrate toward the *avalanche region* of the diode, the cumulative field strength increases their velocity to the point where collisions with the crystal lattice create further electron-hole pairs.

This behavior causes the avalanche diode to be more sensitive than a PIN photodiode. However, the sensitivity also makes it vulnerable to electrical noise, and it is significantly affected by heat. A guard ring is added around the p-n junction, and a heat sink is often used.

Packages

Many surface-mount and through-hole versions are available. A selection is shown in Figure 21-3 and Figure 21-4. While a through-hole photodiode may look indistinguishable from a through-hole 3mm or 5mm LED, versions are available without lenses, and some are sensitive to incident light coming from the side (they are referred to as *side-looking* or *side-view* variants).

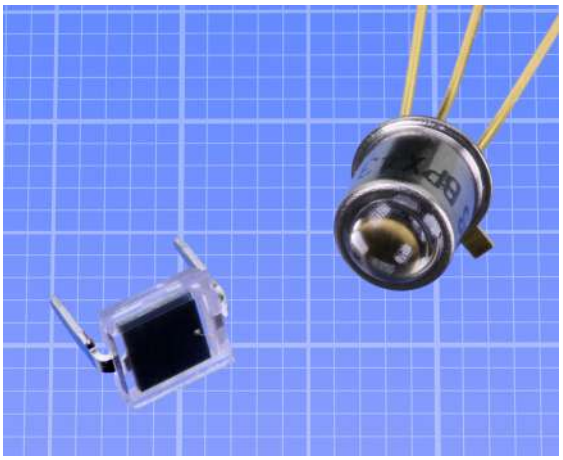

Figure 21-3 *Two sample photodiodes. Left: top-view unfiltered Vishay BPW34. Right: Osram BPX43 in metal can suitable for temperatures up to 125 degrees Celsius.*

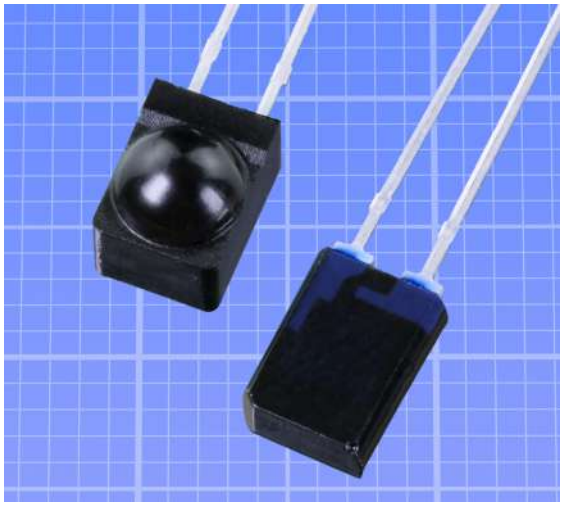

Figure 21-4 *Two side-looking photodiodes. Left: Vishay BPV22NF with lens. Right: Vishay BPW83 without a lens. Both have daylight-blocking filters.*

Wavelength Range

In order for a photon to be detected by the photodiode, it must carry enough energy to be able to create an electron-hole pair. This energy is a property specific to the semiconduct material, and is known as its *band gap*. Additionally, the epoxy packaging of the photodiode may be designed to block some wavelengths of light. Often, an application will require that the component should only respond to infrared light, not visible light.

Photodiode Arrays

A *photodiode array* has several photodiodes mounted in a row or in a grid, for imaging or measurement applications. A row of photodiodes may be used in a flatbed scanner, where it is moved relative to the reflective object being scanned.

In some arrays, photodiodes are available with color filters preinstalled, to facilitate full-color scanning using the transmitted primary colors.

Output Options

Because the output from a photodiode must be processed to be usable, options exist to convert it to a more convenient form, such as a wider range of voltages, a square wave signal where the frequency is proportional with light input, or a binary value accessible by a microcontroller via a serial bus such as I2C. For a discussion of sensor outputs see Appendix A.

Specific Variants

Light to Frequency

The Taos TSL235R is a 3-pin, through-hole chip. It combines a photodiode with logic that creates a square-wave pulse train in which frequency is proportional to the light intensity.

Logarithmic Light Meter

The Sharp GA1A1S202WP light sensor has an output voltage that changes logarithmically with the light level. This gives the sensor a large dynamic range, from 3 lux to 55,000 lux, without requiring a high-resolution analog-to-digital converter. (Human perception of light and sound levels is approximately logarithmic.) This is a surface-mount chip, but is available on a breakout board from Adafruit.

Ultraviolet to Analog

The ML8511 from Lapis Semiconductor combines an ultraviolet-sensitive photodiode with an op-amp that provides an output voltage from approximately 1V to 3V, varying with ultraviolet intensity. A breakout board containing this surface-mount chip is available from Sparkfun and many other sources.

Ultraviolet to Digital

The SI1145 from SiLabs combines ultraviolet sensing with data processing to create a UV index, readable from a microcontroller with I2C. Adafruit offers it on a breakout board.

Color to Digital

The Taos TCS3414FN module contains photodiodes sensitive to red, green, blue, and clear (no filtering). Four 16-bit analog-to-digital converters, one for each

channel, provide a digital output accessible over an I2C bus. This module can be used to determine the color of ambient light with some accuracy.

Color to Analog

The Taos TCS3200 also uses red, green, blue, and clear photodiodes but encodes the output from each as a square wave in which the frequency corresponds with the light intensity. The surface-mount chip is available on a breakout board from Robot Shop, shown in Figure 21-5.

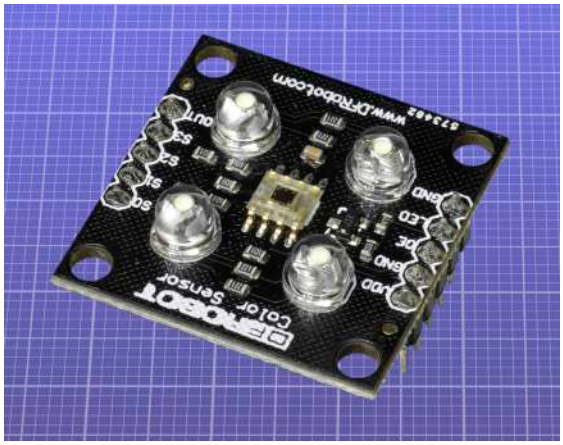

Figure 21-5 *This breakout board from Robot Shop uses the Taos TCS3200 chip to analyze the color of incident light.*

Values

Abbreviations found in datasheets are included in the list below, with values in parentheses for an Osram SFH229FA infrared photodiode, which resembles a 3mm through-hole LED. It has a peak sensitivity of 880nm and appears black to the human eye, being opaque to wavelengths of light shorter than 700nm, the red end of the visible spectrum.

In Figure 21-6 the SFH229FA is shown beside the SFH229, which has the same peak sensitivity of 880nm but is encapsulated in an untinted module, allowing a sensitivity that tapers gradually to below 400nm, in the green part of the visible spectrum. With the exception of their spectral range, the two photodiodes have identical specifications.

Figure 21-6 *Osram infrared photodiodes SFH229 (left) and SFH229FA (right). The background grid is in millimeters.*

- Typical forward voltage: V_F (1.3V)
- Typical photocurrent: I_P (20µA)
- Maximum power dissipation: P_{TOT} (150mW)
- The *half angle* is measured from the axis of the photodiode to the angle at which the sensitivity has dropped by 50% (plus or minus 17 degrees)
- Dark current: I_R (50pA)
- Wavelength of maximum sensitivity: $\lambda_{S\ MAX}$ (880nm)
- Response speed is the rise and fall time of photocurrent: t_r and t_f (10ns)

Infrared photodiodes exist with a variety of peak wavelengths. They are designed to function in conjunction with an LED that has a matching wavelength.

The angle of sensitivity depends on the geometry of the package.

Rise and fall speeds are important for high-speed measurement, signaling, or data transfer. The rise and fall time of a typical photodiode can be 1,000 times faster than that of a phototransistor. See "Values" in Chapter 22 for a comparison. Note also that the dark current of a photodiode is much lower than that for a phototransistor.

How to Use It

In photoconductive mode, the photodiode can be connected in series with a suitable resistor so that a voltage divider is formed, as shown in Figure 21-2. The voltage at the output will then vary almost linearly with the intensity of the light.

In the photoconductive mode of operation, the output signal is generally measured in millivolts and microamperes. This signal needs to be amplified, usually with an **op-amp** (described in Volume 2).

Figure 21-7 shows simplified schematics for a standard voltage amplifier, in section 1, and a transimpedance amplifier, in section 2.

A transimpedance amplifier measures the current through the photodiode and converts it into a voltage, without the need for a voltage divider. Advantages include less noise, and no need to determine the value of a voltage-divider resistor.

The output voltage of this amplifier is calculated by using this simple formula:

$$V = R * I_P$$

R is the value of the feedback resistor, which determines the gain of the amplifier.

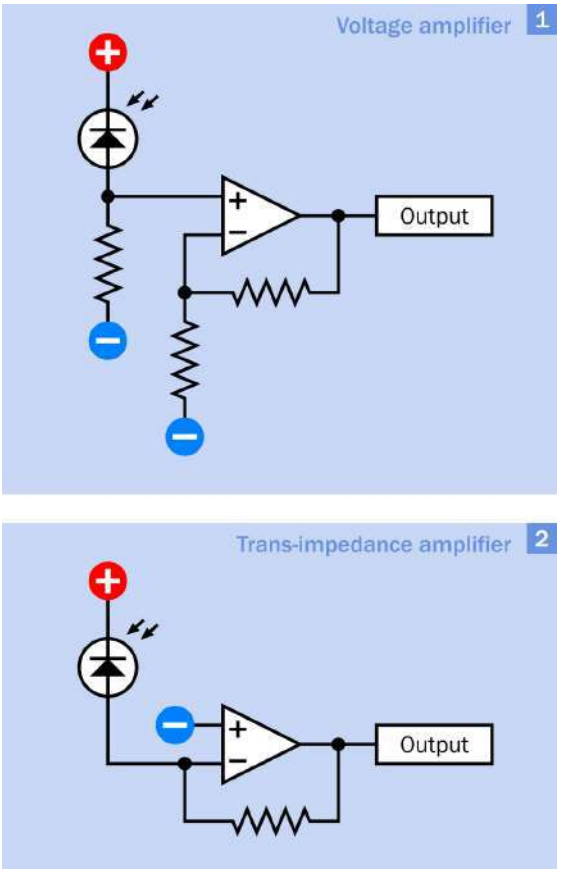

Figure 21-7 *Simplified op-amp circuits for use with photodiodes.*

What Can Go Wrong

Photodiodes can be hard to distinguish from phototransistors and LEDs, in particular infrared ones. They are typically not marked with type numbers. Using a meter may not be helpful, as regular LEDs behave similarly to photodiodes.

Decision procedure:

1. Does the component conduct in either direction while shielded from light? If so, it is a diode and not a phototransistor or photodiode.
2. Pass a weak current (e.g., 4mA) in the forward direction. If it emits visible or infrared light, it's an LED. (Infrared light may be visible when using a digital camera, or can be detected with a known phototransistor or photodiode.) If the package is clear but cloudy so that the die cannot be seen, it is probably a white LED in which the cloudiness is the fluorescent pigment converting blue light into white.

phototransistor

22

OTHER RELATED COMPONENTS

- **photodiode** (see Chapter 21)
- **photoresistor** (see Chapter 20)
- **passive infrared** sensor (see Chapter 4)
- **transistor** (see Volume 1)

What It Does

A **phototransistor** is a transistor controlled by exposure to light. (**Transistors** are described in Volume 1.) It can be either a bipolar transistor or field-effect transistor (FET), and its body is often superficially similar in appearance to a 3mm or 5mm **photodiode** or **LED indicator** encased in resin or plastic. (LED indicators are described in Volume 2.) However, some phototransistors are encased in a metal shell with a window in it.

The window or the plastic body is either transparent to visible light, or may appear black if the component is intended for use only with infrared while blocking visible wavelengths. A selection of phototransistors is shown in Figure 22-1 (left: Optek/TT Electronics OP506A with a broad spectral response centered around 850nm; center: Vishay TEKT5400S with a side-view lens; right: Vishay BPW17N).

Typically a phototransistor has two leads that connect internally with its collector and emitter (or source and drain, in the case of an FET). The base of the transistor (or the gate of an FET) responds to light and controls the flow of current between the leads.

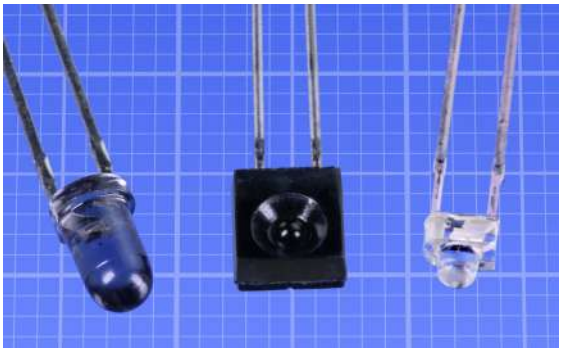

Figure 22-1 *A variety of phototransistors. The background grid is in millimeters. See text for details.*

In the absence of light, a bipolar phototransistor permits leakage between collector and emitter of 100nA or less. When exposed to light, it conducts up to 50mA. This alone differentiates it from a photodiode, which cannot pass much current.

Schematic Symbols

Symbols for a phototransistor are shown in Figure 22-2. They are functionally identical, with the exception of type C, where an additional connection to the base is included. Often (but not always), wavy arrows indicate infrared light.

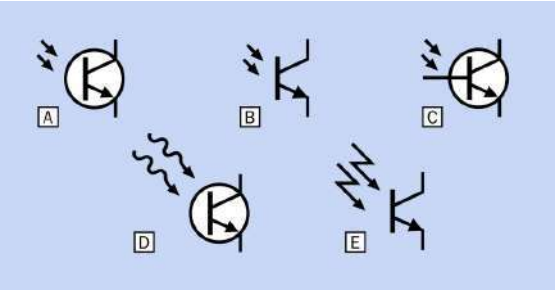

Figure 22-2 *Schematic symbols for a phototransistor.*

Applications

A phototransistor may be used for light measurement or as a light-sensitive switch.

Often the output from a phototransistor is used in conjunction with a *microcontroller* containing an analog-to-digital converter.

Where a clean on-or-off signal is required, a phototransistor can drive the input of a logic chip that contains a *Schmitt trigger*, or it can be processed by a **comparator**.

An *optocoupler* or **solid-state relay** (described in Volume 1) usually contains a phototransistor that is activated by an internal LED. Its purpose is to switch current while electrically isolating one section of a circuit from another.

How It Works

Like a photodiode, the phototransistor responds to light when the light generates electron-hole pairs in the semiconductor material. For a bipolar NPN phototransistor (the most common variant), the important region for pair generation is the reverse-biased collector-base interface. Photocurrent generated here acts as current injected into the base of an ordinary transistor, and permits a larger current to pass from the collector to the emitter.

The behavior of a phototransistor can be visualized as being similar to a photodiode controlling an ordinary bipolar transistor, as shown in Figure 22-3.

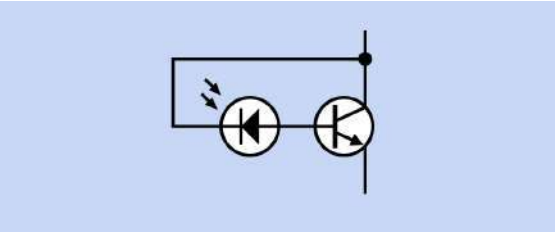

Figure 22-3 *A phototransistor is functionally similar to a photodiode controlling an ordinary transistor.*

Variants

While surface-mount variants are very widely available, through-hole packaging also remains common. When encapsulated like an LED indicator, a phototransistor gathers light from a relatively narrow angle. Variants with a flat surface are sensitive to light from almost any direction in front of the component.

Optional Base Connection

The base of a phototransistor is usually not accessible. However, some variants provide a base connection (or gate connection, in an FET) in addition to the collector and emitter (or the source and drain, in an FET). This third connection allows the application of a bias current, which can prevent low light levels from triggering the transistor.

Photodarlington

A photodarlington is a pair of bipolar transistors, the first being sensitive to light while the second acts as an amplifier for the first. This configuration is very similar to that of a *Darlington transistor* (described in Volume 1). The two-stage design makes it more sensitive to light than a regular phototransistor, but makes the response slower and less linear.

PhotoFET

A field-effect phototransistor is sometimes identified as a *photoFET*. They are relatively uncommon as separate components, but are used in optocouplers, because they have some interesting properties:

- Provided the applied voltage is low enough (less than 0.1V) the photoFET works as a controllable resistance—in contrast to bipolar transistors, where the current is controlled, and is relatively independent of the applied voltage.
- The FET transistor is symmetrical, functioning similarly for signals of either polarity. This makes an FET optocoupler suitable for AC signals.

Values

Abbreviations found in datasheets are included in the list below, with values in parentheses for an Osram SFH300FA infrared photodiode, which resembles a 5mm through-hole LED. It has a peak sensitivity of 880nm and appears black to the human eye, being opaque to wavelengths of light shorter than 700nm, the red end of the visible spectrum.

In Figure 22-4 the SFH300FA is shown beside the SFH300, which has the same peak sensitivity of 880nm but is encapsulated in an untinted module, allowing a sensitivity that tapers gradually to 450nm, in the green part of the visible spectrum. With the exception of their spectral range, the two phototransistors have identical specifications.

Figure 22-4 *Osram infrared phototransistors SFH300 (left) and SFH300FA (right). The background grid is in millimeters.*

- Maximum collector-emitter voltage: V_{CE} (35V)
- Maximum collector current: I_C (50mA)
- Maximum power dissipation: P_{TOT} (200mW)
- The *half angle* is measured from the axis of the photodiode to the angle at which sensitivity has dropped by 50% (plus or minus 25 degrees)

The angle of sensitivity depends on the geometry of the package. For phototransistors that resemble an LED indicator, with a rounded end that acts as a lens, typical values are plus-or-minus 20 degrees.

- Dark current (when the phototransistor receives no incident light): I_{CE0} (1nA)
- Wavelength of maximum sensitivity: $\lambda_{S\ MAX}$ (880nm)

Infrared phototransistors exist with a variety of peak wavelengths. They are designed to function in conjunction with an LED that has a matching wavelength.

- Response speed is the rise and fall time of photocurrent: t_r and t_f (10 µs)

Behavior Compared to Other Light Sensors

An extended list of comparisons between a photoresistor and a phototransistor will be found in the entry on **photoresistors**. See "Comparisons with a Phototransistor".

A photodiode has a close-to-linear electrical response over a much wider range of intensities of light than a phototransistor. Consequently, photodiodes tend to be the component of choice in applications where measurement of light must be wide-ranging and precise.

Photodiodes can pass less current than a phototransistor, but also tend to draw less current,

making them appropriate in battery-powered devices that must draw as little current as possible.

Rise and fall speeds are important for high-speed measurement, signaling, or data transfer. The rise and fall time of a typical phototransistor can be 1,000 times slower than that of a photodiode. See "Values" in Chapter 21 for a comparison. Note also that the dark current of a phototransistor is much higher than that for a photodiode.

The ability of a phototransistor to sink 20mA to 50mA at its output is useful where it will be connected to a component that has relatively low impedance. For instance, a phototransistor can drive a piezoelectric audio transducer directly, or an LED indicator.

Unlike a photodiode, a phototransistor is a solid-state switch. Its saturation voltage (listed in datasheets as $V_{SE(SAT)}$ as described above) is the voltage drop between collector and emitter, and seldom exceeds 0.5V.

Binning

Small variations that occur during the fabrication process can cause inconsistency in the performance of phototransistors that share the same part number. To provide a more consistent response, manufacturers use *binning*, meaning that units sharing the same bin number are likely to share a tighter tolerance. (The same concept is used to minimize variations in **LED area lighting**, described in Volume 1.)

Datasheets will provide information on the availability and meaning of bin numbers, if available.

Bins with higher photocurrents typically have longer response times.

How to Use It

Most phototransistors are bipolar devices with an *open collector output*. That is, the collector of the transistor is accessible from one of the two leads, making it "open" to being used. See Figure A-4 for general instructions on using an open-collector output. A summary relating to phototransistors is included here.

The schematic in Figure 22-5 shows the basic concept. The resistor is referred to as a *pullup resistor*. When the phototransistor is receiving very little light, its effective resistance is high. Consequently almost all the current flowing through the pullup resistor will go to any device attached to the output, and the output voltage will seem to be "high."

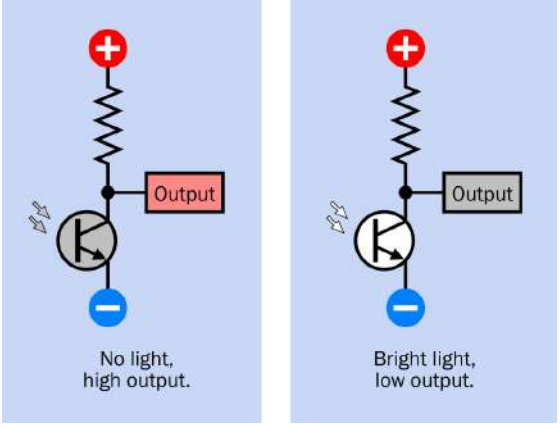

Figure 22-5 *How an open-collector output works.*

If the phototransistor is exposed to a significant light source, the effective resistance between the collector and emitter drops dramatically, and the phototransistor will sink current to ground. Consequently, the output will seem to be "low."

The pullup resistor is necessary between the power source and the collector pin to protect the phototransistor from sinking excessive current when it is exposed to light. The ideal value of the resistor will depend partly on the impedance of any device attached to the output.

In this scenario, exposure to light causes low output whereas darkness causes high output. What if we wish to have it the other way around?

The protective resistor can be moved to the emitter pin, where it becomes a pulldown resistor. It will still protect the phototransistor from passing excessive current, so long as the output is connected to a high impedance. The output is taken from the emitter pin, and will transition from low to high when the component is exposed to light. This is illustrated in Figure 22-6.

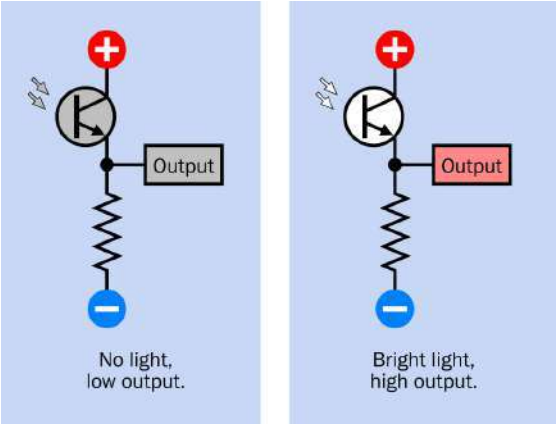

Figure 22-6 *Moving the resistor and taking an output from the emitter pin inverts the behavior of a phototransistor. Any device attached to the output must have a relatively high impedance to protect the phototransistor from excessive current.*

Output Calculation

Using an open-collector output, the photocurrent is almost independent of the applied voltage V_{CE}, provided that the voltage is higher than the saturation voltage $V_{CE(SAT)}$, which is typically between 0.4V and 0.5V.

If the pullup resistor has value R, the voltage across it is

$$U = R * I_P$$

where I_P is the photocurrent passed by the phototransistor.

When choosing R, one should consider the range of currents expected in the light conditions that will be measured, and the voltage range suitable for the next stage of the circuit. 10K is a reasonable starting point (e.g., when measuring light intensity with a microcontroller's analog input). The resistor value can be reduced from there, if necessary.

The value of the pullup resistor must also be chosen to restrict current within the limits specified by the phototransistor datasheet. A value for the resistor guaranteed to be safe is

$$R = V / I_{MAX}$$

where V is the supply voltage and I_{MAX} is the maximum allowed current. With this value, the resistor limits the current to the highest allowed value, even if the phototransistor is brightly illuminated and assumed to conduct perfectly.

When V = 5V and I_{MAX} = 15mA, R should be at least 330 ohms.

What Can Go Wrong

Visual Classification Errors

Phototransistors can be visually similar to LEDs and photodiodes. They are easily confused, as neither type of component is usually marked with any identification number. The entry for **photodiodes** describes a system for distinguishing the three types of components. See "What Can Go Wrong" in Chapter 21.

Output Out of Range

The output voltage from a phototransistor will depend on the intensity of incident light, the value of any pullup resistor that is used, and the supply voltage. While a circuit is being developed, the light range may seem predictable, but in actual use the output range may not fall within expectations.

NTC thermistor

23

PTC thermistors, in which the resistance increases as the temperature increases, have a separate entry. See Chapter 24.

A *resistance temperature detector* or **RTD** has a resistance that increases as its temperature increases, but it is not usually classified as a thermistor, because its sensing element is fabricated differently. Its entry will be found at Chapter 26.

Semiconductor temperature sensors and **thermocouples** each have their own entries.

Infrared temperature sensors and **passive infrared** motion sensors have their own entries. They are *noncontact* temperature sensors that respond to infrared radiation.

OTHER RELATED COMPONENTS

- **PTC thermistor** (see Chapter 24)
- **infrared temperature** sensor (see Chapter 28)
- **passive infrared** motion sensor (see Chapter 4)
- **semiconductor** temperature sensor (see Chapter 27)
- **thermocouple** (see Chapter 25)
- **RTD** (resistance temperature detector) (see Chapter 26)

What It Does

An NTC thermistor is the most common type of discrete-component temperature sensor, and is usually the most affordable. Its resistance diminishes as its temperature increases. This behavior is referred to as a *negative temperature coefficient*, which is the source of the acronym NTC.

This is a simple, passive component that is not polarized. It requires no separate power supply, but an external device must pass a small AC or DC current through it to determine its resistance. This is known as an *excitation current*.

Schematic Symbols

Schematic symbols for a thermistor are shown in Figure 23-1. Those in the top row may still be found in the United States, but are being replaced by the European variants in the second row. The addition of -t° to the symbol indicates an NTC type of thermistor, while +t° indicates that it is the PTC type, with a positive coefficient (see Chapter 24). If no indication is shown, the thermistor is likely to be the NTC type.

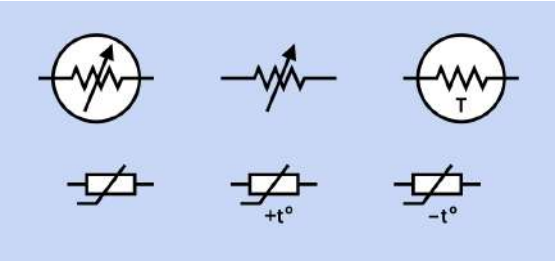

Figure 23-1 *Schematic symbols representing a thermistor. Letter t preceded by a plus or minus sign indicates whether the thermistor is the PTC or NTC type, respectively.*

Applications

Thermistors monitor temperature in air-conditioning systems, clothes washers, refrigerators, pool and spa controls, dishwashers, toasters, and other domestic devices. They are used in laser printers, 3D printers, industrial process controls, and medical equipment.

As many as 20 thermistors may be found in a modern automobile, measuring temperature in locations ranging from the transmission to the ambient air in the passenger compartment.

Comparison of Temperature Sensors

In this Encyclopedia, contact temperature sensors, which measure temperature by making contact with the source, are divided into five main categories, each of which has a separate entry. For convenience, these categories are listed in a comparative summary at the end of this entry. See "Addendum: Comparison of Temperature Sensors".

How an NTC Thermistor Works

Although the term *thermistor* suggests that it is a thermally sensitive resistor, in fact an NTC thermistor is a semiconductor.

Some metal oxides, such as ferric oxide or nickel oxide, become n-type semiconductors when they are treated with dopants. The exact mix is a proprietary secret of each manufacturer. Raising the temperature of this kind of material increases the number of charge carriers in it, promoting electron mobility and thus lowering its effective resistance.

To create a thermistor, the metal oxide mix is heated until it melts and turns into a ceramic. Typically a thin sheet is cut into small pieces for individual sensors. After two leads are connected, the assembly is dipped into epoxy or encapsulated in glass. The most common packages consist of a glass bead, surface-mount chip, or ceramic disc.

Figure 23-2 shows three NTC thermistors. At left is a Murata NXFT15XH103FA2B100 approximately 1mm in diameter, with a reference resistance of 10K and a tolerance of plus-or-minus 1%. At center is a Vishay NTCALUG03A103GC rated 10K at 2%, fitted with a mini-lug. At right is a TDK B57164K153K rated 15K and 3%.

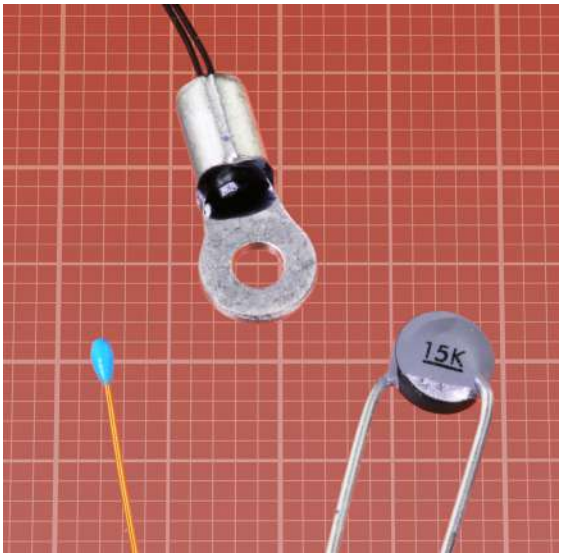

Figure 23-2 *Sample NTC thermistors. See text for details. The background grid is in millimeters.*

Output Conversion for Temperature Sensing

Ideally, the electrical behavior of a temperature sensor should be a linear function of temperature. Thermistors fail in this respect, as their resistance is an approximately inverse exponential function. This is illustrated in Figure 23-3, where the measured resistance of a thermistor rated for 5K at 25 degrees is plotted against temperatures from 0 degrees to 120 degrees Celsius.

- In many datasheets, graphs of this kind may appear flatter because they are customarily plotted against a vertical logarithmic scale.

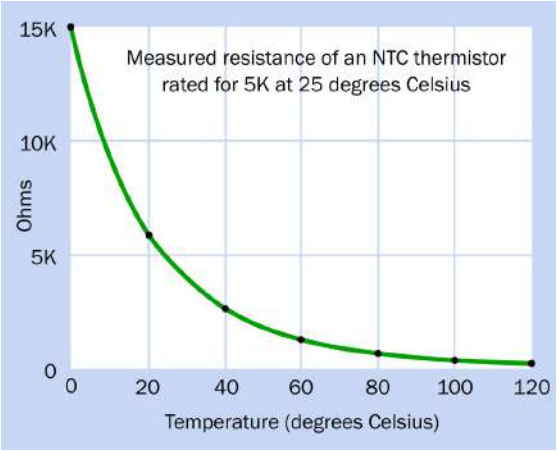

Figure 23-3 *Resistance of a thermistor from 0 to 120 degrees Celsius.*

To monitor the resistance of a thermistor, it can be placed in a simple voltage divider as shown in Figure 23-4, where the fluctuating resistance of the component creates a fluctuating voltage at point A.

- The voltage can be used as an input to a microcontroller that contains an analog-to-digital converter. Alternatively it can be connected directly to a solid-state relay, or amplified with an op-amp, or can be passed through a comparator to create an adjustable switching threshold.

Although this circuit is a voltage divider, it is also known as a *half bridge*, as it is half of a Wheatstone bridge.

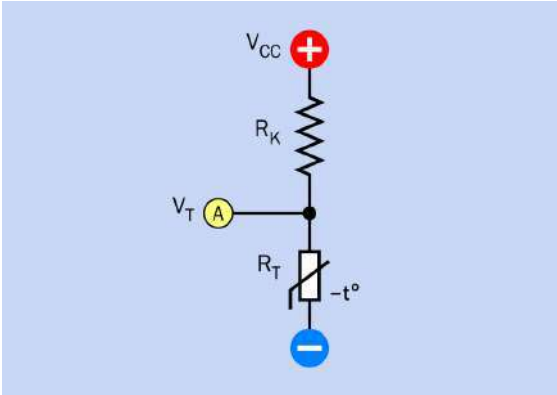

Figure 23-4 *A half-bridge circuit for determining the resistance of a thermistor.*

If V_{CC} is the supply voltage, V_T is the measured voltage at point A, R_T is the resistance of the thermistor, and R_K is the constant value of the series resistor, the basic formula for a voltage divider looks like this:

$$V_T = V_{CC} * (R_T / (R_T + R_K))$$

By transposing terms, a formula can be derived to obtain a value for R_T from the measured voltage and the value of R_K:

$$R_T = (R_K * V_T) / (V_{CC} - V_T)$$

Choosing a Series Resistor

The value for R_K in the formula should be chosen to provide a reasonably wide response over the range of temperatures for which the thermistor is likely to be used. To calculate R_K, another formula must be applied. If R_{MIN} is the resistance of the thermistor at the lowest likely temperature, and R_{MAX} is its resistance at the highest likely temperature:

$$R_k = \sqrt{R_{min} * R_{max}}$$

(This is the same formula as suggested in Figure 20-5 to find the value of a series resistor for use with a photoresistor.)

Wheatstone Bridge Circuit

The half-bridge circuit has the disadvantage that it does not compensate for nonlinearity of a thermistor. Voltage values will change rapidly at the low end of the temperature range, but will change more slowly at the high end, requiring an analog-to-digital converter with a high degree of accuracy to distinguish one voltage value from the next.

A full Wheatstone bridge circuit has a nonlinear output that compensates, somewhat, for the inverse nonlinearity of the thermistor. Referring to the circuit shown in Figure 23-5, the three resistors R_K are chosen using the formula above.

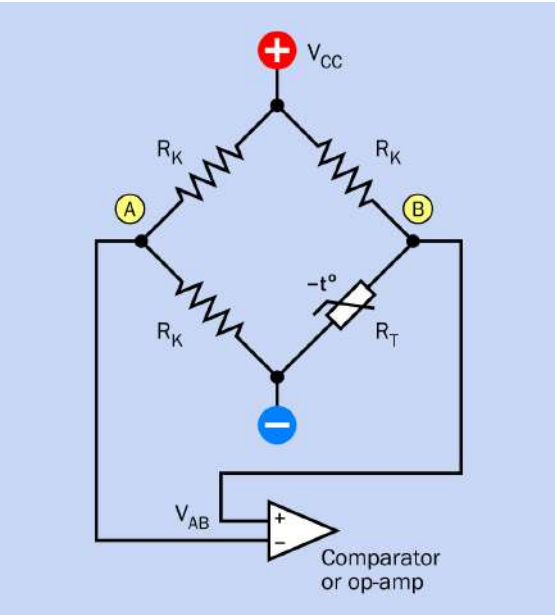

Figure 23-5 *A thermistor may be placed in a full Wheatstone bridge circuit. Outputs A and B are often connected with the two inputs of an op-amp or comparator.*

A standard formula provides the relationship between R_T, the resistance of the thermocouple; V_{CC}, the supply voltage; R_K, the fixed resistances; and V_{AB}, the output voltage measured between points A and B:

$$V_{AB} = (V_{CC} / 2) * (R_T - R_K) / (R_T + R_K)$$

From this formula, a version can be derived to calculate R_T by measuring the output voltage, V_A:

$$R_T = R_K * (V_{CC} + (2*V_{AB})) / (V_{CC} - (2*V_{AB}))$$

- The polarity of V_{AB} is reversible, depending on whether R_T is greater or less than R_K. To accommodate this, A and B can be connected to the two inputs of a comparator or op-amp.

Deriving the Temperature Value

After the resistance of the thermistor has been calculated, it can be converted to a temperature value. The datasheet for a thermistor will usually provide a table showing temperature values tabulated against resistance values, so that a lookup table can be created in a microcontroller program.

Alternatively, a datasheet usually includes constants that can be inserted in a resistance-to-temperature conversion equation, but this is nontrivial and requires natural logarithms, which may not be available in a language implemented on a particular microcontroller.

Inrush Current Limiter

NTC thermistors with appropriate characteristics can be used to limit the inrush of current that tends to occur when a circuit is switched on and large capacitors in the power supply charge very quickly.

An *inrush current limiter* is also known as a *surge limiter*, or may be referred to by its acronym, *ICL*. It is an NTC thermistor whose initial resistance diminishes rapidly as its temperature increases.

While NTC thermistors are the type most often used for inrush limiting, PTC thermistors can

serve this purpose if wired differently. See "PTC Inrush Current Limiting". The remainder of this discussion refers only to NTC current limiters.

A suitable NTC thermistor can be placed as shown in the simplified schematic in Figure 23-6, where a rectified AC source is connected with a DC-to-DC converter, and a large smoothing capacitor is used. Initially the thermistor has resistance that is sufficient to limit current and generate heat. But the rise in temperature causes the resistance of the thermistor to fall. Eventually it reaches a steady state where it remains sufficiently warm to maintain a low resistance that imposes a negligible load on the circuit.

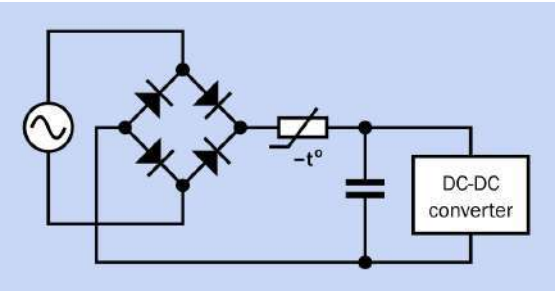

Figure 23-6 *Placement of an NTC thermistor that is designed for inrush current limiting.*

In thermistors that are used for temperature measurement, self-heating is an undesirable attribute. By contrast, an inrush current limiter depends on self-heating to perform its function.

The TDK B57237S509M inrush limiter, shown in Figure 23-7, is rated for 5A and has an initial resistance of 5 ohms at 25 degrees Celsius while not passing current. When tested with a 2,800µF capacitor at 110VAC, its resistance drops to a minimum of 0.125 ohms at 5A. The relationship between current and resistance is shown in Figure 23-8.

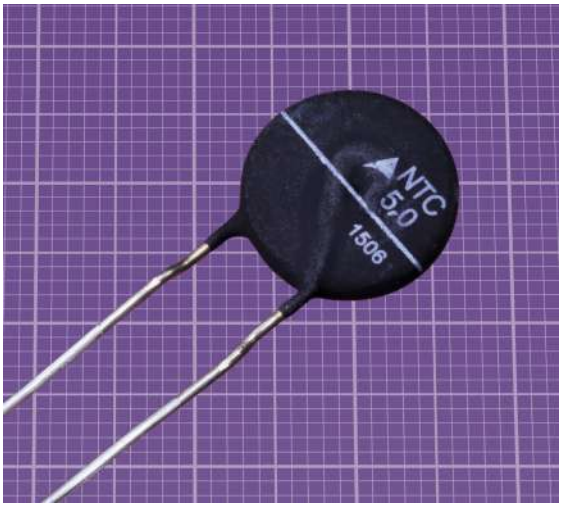

Figure 23-7 *A TDK B57237S509M NTC thermistor designed as an inrush current limiter, rated 5 ohms at 5 amps. The background grid is in millimeters.*

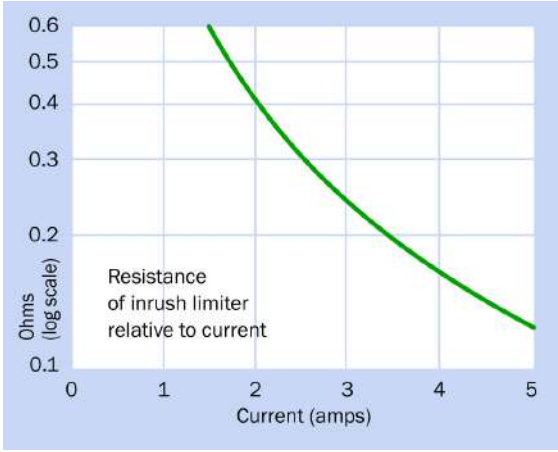

Figure 23-8 *This graph shows the relationship between resistance and current in a TDK B57237S509M inrush limiter.*

Restart

If a protected device is switched off momentarily and is then switched on again, the thermistor cannot provide protection, as it has not had time to cool down and regain its resistance. However, during the 30 seconds to 2 minutes required for heat in the thermistor to dissipate, smoothing capacitors are unlikely to lose much of their charge. Therefore, if the device is restarted, an inrush of current should not occur.

Thermistor Values

Datasheets for thermistors may be more complex and cryptic than for many components.

When examining a datasheet, first check to see if the thermistor is described as being suitable for temperature measurement or inrush current limiting. A component designed for temperature measurement will not survive inrush current, while one designed for inrush current limiting will have a very low resistance making it unsuitable for temperature measurement.

Time and Temperature

In most datasheets, lowercase letter t is used for values relating to time, whereas an uppercase T is used for values relating to temperature. Unfortunately, T may also be used as an abbreviation for "thermistor."

Resistance and Response

Letter R often means resistance, but may indicate response time, depending on the context in which it is used. For example, R_T is the resistance of a thermistor, and t_R is a response time.

Kilohms and Kelvin

Letter K may be used to represent temperature in degrees Kelvin, 0 degrees on the Celsius scale being approximately 273 degrees Kelvin. However, letter K is also used to represent thousands of ohms, sometimes in the same datasheet. In both instances, K is capitalized.

Reference Temperature

This is the temperature at which many attributes of the component are measured, such as its temperature coefficient and resistance. Usually the reference temperature is 25 degrees Celsius, but in some cases it may be 0 degrees, and other values are occasionally used. The term is abbreviated T_{REF}.

Reference Resistance

The reference resistance for a thermistor (sometimes described as its nominal resistance) may be referred to as R_R, and is the resistance at the reference temperature. It may be referred to as the "R value," but in thumbnail product descriptions it can be cited simply as "Resistance."

In datasheets, R25 or R_{25} is the resistance at 25 degrees Celsius. If this is the reference temperature, R_R and R_{25} will be the same.

Dissipation Constant

DC is the *power dissipation constant*, a ratio normally expressed as milliwatts per degree Celsius (written as mW/°C). This is a measurement of how much thermal power the thermistor can transfer to the environment for a 1 degree increase in temperature.

Temperature Coefficient

TC may be used as an acronym for the *temperature coefficient*, which represents the sensitivity of the thermistor. (Sometimes TCR is used instead of TC, the letter R denoting resistance. The two acronyms both mean the same thing.) The value is the percentage change in resistance for each change in temperature of 1 degree Celsius. Thus, if the resistance of a thermistor drops from 800 ohms to 768 ohms when the temperature increases from 28 to 29 degrees Celsius, TC = -4%. For NTC thermistors, which have a resistance that decreases when temperature increases, the temperature coefficient is negative. However, the minus sign may be omitted.

The coefficient may be expressed in parts per million (abbreviated ppm) instead of as a percentage. To convert parts per million to a percentage, divide by 10,000. Thus, a figure of 50,000ppm is equivalent to 5%.

Thermal Time Constant

Unfortunately TC is also used to represent the thermal *time constant*. If T_D is the temperature difference between the thermistor's initial temperature and a new, higher ambient temperature in which it finds itself, TC is the time it takes for the thermistor to add 63.2% of T_D to its cur-

rent temperature. TC is expressed in seconds, and is defined without power being applied to the thermistor. A low thermal time constant is characteristic of a physically small thermistor that acquires heat rapidly. (TC is very similar to the concept of a time constant for a capacitor acquiring charge. See the entry on **capacitors** in Volume 1.)

Tolerance

The *tolerance* of a thermistor is a measure of its accuracy, usually at 25 degrees Celsius, unless a range of temperatures is stated. A thermistor rated for 5K, with a tolerance of plus-or-minus 1% at 25 degrees, may be found to have an actual resistance ranging from 4,950 to 5,050 ohms at that temperature. Some thermistors have a tolerance of plus-or-minus 20%. A tolerance better than plus-or-minus 1% is relatively rare.

Temperature Range

The *working temperature range* of any thermistor that uses silicon dioxide is usually between about -50 and +150 degrees Celsius (slightly wider for versions encapsulated in glass, and slightly narrower if accuracy is important).

Switching Current

For a thermistor with a nonlinear response, the switching current is the approximate current that forces a sharp transition in resistance. It is represented by I_S.

Power Limitations

Operating current is the maximum current recommended to avoid self-heating. The *power rating* is the maximum allowed power (usually 100mW to 200mW).

Interchangeability

To measure temperature reliably, two thermistors of the same type, from the same manufacturer, should display the same characteristics. This is known as *interchangeability*. A value of plus-or-minus 0.2 degrees Celsius is common for a modern thermistor, but is not often mentioned in a datasheet.

What Can Go Wrong

Self-Heating

Self-heating can affect the accuracy of an NTC thermistor that is used for temperature measurement. To get accurate temperature readings, keep the current as small as possible. When the resistance of a thermistor is at the high end of its range, brief pulses of current can be used.

Heat Dissipation

Where a thermistor is used for inrush current limiting, it will create some heat during the whole time that a device is switched on. If insufficient air space is allowed between the thermistor and other components, they may be affected.

Lack of Heat

An NTC thermistor will sometimes fail as an inrush current limiter. In very cold climates, it may never become warm enough for its resistance to drop to an acceptable level. Conversely, in a very hot location (such as close proximity to a hot-water pump) it may not get cool enough to provide adequate initial protection.

Addendum: Comparison of Temperature Sensors

A chart illustrating the five main types of contact sensors, and their variants, is shown in Figure 23-9.

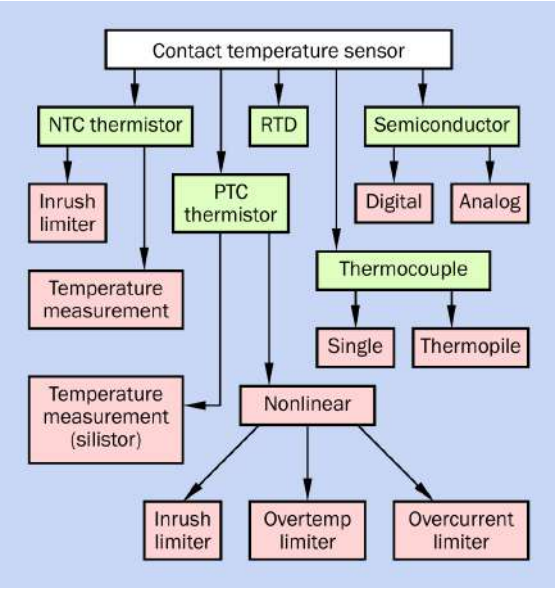

Figure 23-9 *Five types of contact temperature sensors (green boxes) and the variants (red).*

NTC Thermistor

The electrical resistance of an **NTC thermistor** diminishes as its temperature increases. Thus, it has a *negative temperature coefficient*, which is the source of the acronym NTC.

An NTC thermistor is traditionally used where low cost and simplicity are desirable and a relatively limited temperature range is acceptable (often -50 to +150 degrees Celsius). It has the advantage of familiarity, having existed in its present form for many decades. It remains the lowest-cost option among the various types of temperature sensors, and can be connected directly with an external device such as a solid-state relay, in which case no microcontroller is necessary.

PTC Thermistor

The sensing element for a positive-coefficient thermistor is a polycrystalline compound that increases in resistance very rapidly above a threshold temperature. This makes it suitable for blocking a high current to prevent circuit overload.

A *silicon temperature sensor*, sometimes called a *silistor*, can be considered as a PTC thermistor, in that it is a resistive component with a positive temperature coefficient. Its sensing element is etched into silicon.

PTC thermistors are passive, nonpolarized components with two leads or solder pads. For more information about them, see Chapter 24.

Thermocouple

This sensor consists of two wires made from different metals, joined at one end. The differing thermoelectric properties of the wires creates a very small voltage between their free ends. Thermocouples have the widest range of any contact sensor. They are simple, robust, and free from self-heating effects, as they consume no power. Their response is rapid, but very nonlinear, and their sensitivity is limited. They are used in industry and in laboratories, often plugged into a panel meter that combines a digital temperature display with hardware to decode the signal from the type of thermocouple being used.

For more information about thermocuples, see Chapter 25.

Resistance Temperature Detector

Often known by its acronym **RTD**, and sometimes referred to as a *Resistive Temperature Device*, it commonly uses a sensing element fabricated from pure platinum, nickel, or copper. The element may consist of wire wound around a core, or a very thin film deposited on an insulating substrate.

An RTD has a positive temperature coefficient, as its resistance increases while its temperature increases. It is very accurate and stable, providing an almost linear output, especially near the center of its range. However, its sensitivity is often one-tenth of that of an NTC thermistor.

Like a thermistor or a thermocouple, an RTD is a passive device, able to operate at a wide range

of voltages and requiring no power supply. It is nonpolarized, with two leads or solder pads.

For more information about resistance temperature detectors, see Chapter 26.

Semiconductor Temperature Sensor

This is a chip-based sensor that requires no additional components to linearize its output, as linearization is performed in the chip.

The temperature range is similar to that of an NTC thermistor, but the output is a variable voltage with a positive temperature coefficient of about 20mV per degree Celsius, supplied by a built-in op-amp. Response time is 4 to 60 seconds.

This type of sensor requires a power supply, typically of 5VDC or less. It does not have to be calibrated before use, as it is trimmed during the production process to achieve accuracy that can be better than that of a thermistor. Manufacturers may claim plus-or-minus 0.15 degrees over the whole temperature range, which is usually -50 degrees Celsius to +150 degrees, but may be less for variants in which accuracy is more important.

The linear analog output is very convenient for use with a microntroller that has an analog-to-digital converter, and the relatively low cost makes this type of sensor increasingly competitive with thermistors.

An analog-to-digital converter may be included on the sensor chip, in which case it is often described as a *digital temperature sensor* or *digital thermometer*, with an output in degrees Celsius (or, sometimes, Fahrenheit) accessible via I2C or SPI bus. For additional details about protocols such as I2C and SPI, see Appendix A.

A *digital thermostat* or *thermostatic switch* is a semiconductor temperature sensor with a binary output that transitions from logic-high to logic-low (or vice-versa) if the temperature goes above a maximum or below a minimum level. The level can be programmed into the chip.

Semiconductor temperature sensors are identified with a variety of other names. For more information, see Chapter 27.

PTC thermistor

24

A *silistor*, or *silicon-based thermistor*, is included in this entry as a form of **PTC thermistor**.

A *resettable fuse* is not quite the same as a PTC thermistor. For more information, see the entry on **fuses** in Volume 1.

NTC thermistors, in which the resistance decreases as the temperature increases, have a separate entry. See Chapter 23.

A *resistance temperature detector* or **RTD** has a resistance that increases as its temperature increases, but it is not usually classified as a thermistor, because its sensing element is fabricated differently. Its entry will be found at Chapter 26.

Infrared temperature sensors, **semiconductor temperature** sensors, and **thermocouples** each have their own entries.

OTHER RELATED COMPONENTS

- **infrared temperature** sensor (see Chapter 28)
- **semiconductor** temperature sensor (see Chapter 27)
- **thermocouple** (see Chapter 25)
- **NTC thermistor** (see Chapter 23)
- **RTD** (resistance temperature detector) (see Chapter 26)

What It Does

The electrical resistance of a PTC thermistor increases as its temperature increases. Variants can measure temperature or can protect circuits by detecting excessive heat or current.

Because a PTC thermistor is a resistive sensor, it has no polarity. Current may flow through it in either direction, or AC may be used.

Schematic Symbols

The schematic symbol for a PTC thermistor is very similar to the symbol for an NTC thermistor. See Figure 23-1.

Comparison of Temperature Sensors

In this Encyclopedia, contact temperature sensors are divided into five main categories, each of which has a separate entry. For convenience, a comparative summary is included in the entry for

NTC thermistors. See "Addendum: Comparison of Temperature Sensors". Also see Figure 23-9.

PTC Overview

PTC thermistors can be subdivided into two groups:

- *Linear*, with a chip-sized silicon-based sensing element. They are sometimes referred to as *silistors*. The component has a very linear response and is used for temperature measurement. It may be connected directly to a microcontroller.

- *Nonlinear*, mostly using a sensing element containing barium titanate in a polycrystalline compound that increases in resistance very sharply above a threshold temperature. This type of sensor may be described as a *switching thermistor*, because its nonlinear output can activate a switching device.

The sensing elements in positive-coefficient thermistors are different in principle from the element in an NTC thermistor.

Nonlinear thermistors are used in two different ways:

Externally heated
: The thermistor responds to ambient heat or to the temperature of a device to which it is attached. It can be used to protect a circuit or a motor from overheating. Current through the thermistor is minimized to avoid self-heating.

Internally heated
: The thermistor responds to its own temperature caused by current passing through it. It can activate a warning signal or shut down equipment in the event of a short circuit. It can also control current for starting a motor or a fluorescent tube, and is sometimes used as a source to create localized heat.

Silistor for Temperature Measurement

A silicon-based PTC thermistor, sometimes known as a *silistor*, provides a highly desirable, almost linear relationship between temperature and resistance. A popular example is the KTY81 series from NXP, a sample of which is shown in Figure 24-1.

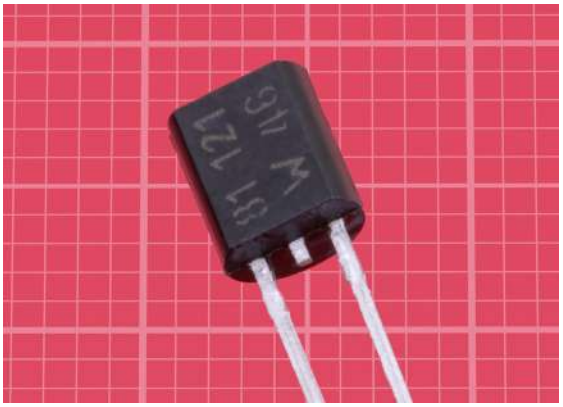

Figure 24-1 *A KTY81 thermistor from NXP. The background grid is in millimeters. Note the amputated center lead.*

The response of this thermistor is shown in Figure 24-2.

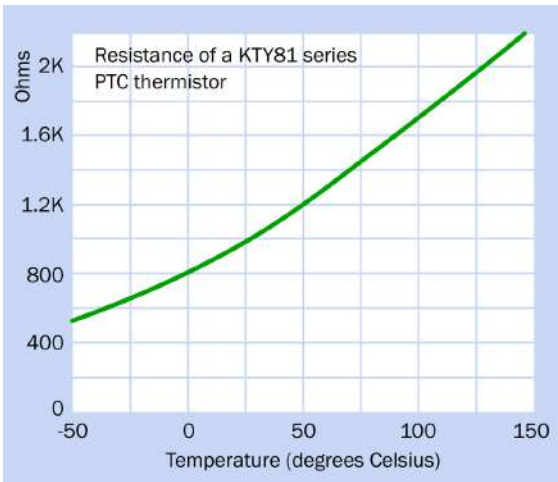

Figure 24-2 *Resistance of the KTY81 thermistor in response to temperature.*

Note that this graph is plotted with a linear vertical scale, unlike the performance curves for many thermistors that are plotted with a log scale. The log scale tends to make a response curve look flatter.

The sensor is a silicon chip designed on the "spreading resistance principle," in which current fans out from a metal contact through a thin layer of silicon to a metallized bottom plane. This effect progresses less actively as the temperature increases. Although the result is partly dependent on polarity, a second metal contact is biased in the opposite direction, and when the two active regions of the chip are wired in series, the result is a component that has no polarity.

- The almost-linear output of this type of sensor makes it easy to use with a microcontroller that has a built in analog-to-digital converter.

Tolerance ranges from plus-or-minus 1% to 5%, depending on the temperature. Variants have a typical reference resistance of 1K or 2K. The temperature coefficient is commonly about 1%, which is considerably lower than that of a typical NTC thermistor, where 4% is common.

- Guidance on reading thermistor datasheets will be found in the entry describing NTC thermistors. See "Thermistor Values".

For correct operation, a typical silistor requires a current ranging from around 0.1mA to 1mA.

- The lower sensitivity and slightly higher price of a PTC temperature-measurement thermistor, compared with an NTC thermistor, may explain why the NTC type seems to remain more popular, with many more variants available. In addition, the NTC type is much more tolerant of variations in current.
- Silistors continue to find some automotive applications, measuring oil temperature, transmission temperature, and climate control, among other parameters.

As a simple strategy to determine its resistance, a series resistor can be used with a PTC sensor to create a voltage divider. The circuit is identical to that used for NTC thermistors. See "Output Conversion for Temperature Sensing".

RTDs

A *resistance temperature detector* or **RTD** is sometimes classified as a PTC thermistor. However, it has a different type of pure-metal sensing element, much lower sensitivity, and is discussed in a separate section of this Encyclopedia. See Chapter 26.

Nonlinear PTC Thermistors

Over-Temperature Protection

This type of nonlinear thermistor is externally heated, but has a switching function. If it is incorporated among other components on a circuit board, its output can be used to activate a warning signal, or can trigger a relay to shut down the circuit until the temperature subsides. This is of special interest for battery chargers where excessive heat can often be a problem, but is also useful in electronic devices generally.

To avoid the possibility of self-heating, current passing through the thermistor must be minimized to a few milliamps.

Some thermistors in the Vishay PTCSL series will make a transition at a temperature as low as 70 degrees Celsius. Others will be triggered by temperatures above 100 degrees. A typical response curve is shown in Figure 24-3, where resistance rises from 100 ohms at 25 degrees to around 1K at the transitional reference temperature of 90 degrees, and reaches at least 4K at 105 degrees.

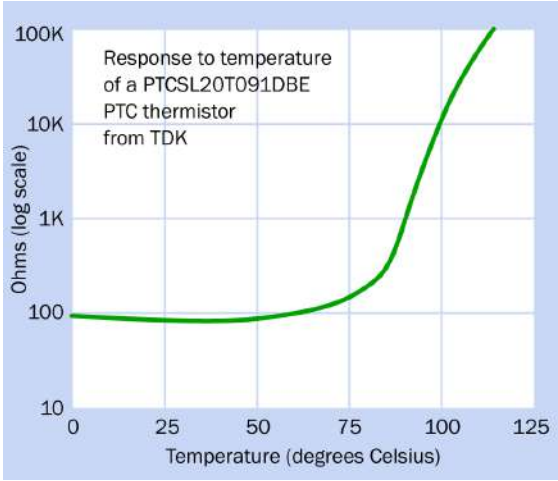

Figure 24-3 *The relationship of resistance to heat in an over-temperature protection thermistor.*

To respond to this transition, the manufacturer recommends a Wheatstone bridge circuit with its outputs connected to a comparator, as suggested for an NTC thermistor in Figure 23-5. The comparator can then activate a signal or a relay.

A picture of the PTCSL20T091DBE thermistor appears in Figure 24-4.

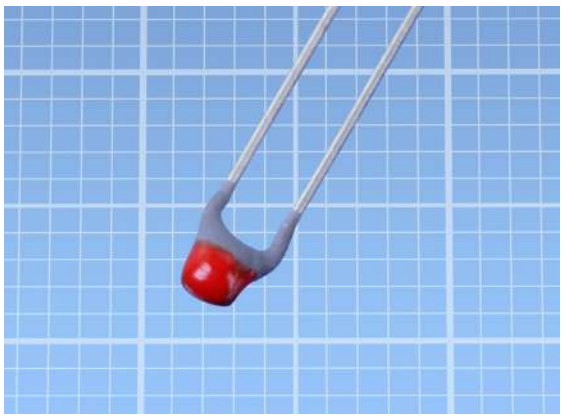

Figure 24-4 *A thermistor in the PTCSL range from TDK. It is color coded using a proprietary scheme by the manufacturer to indicate a reference temperature of 90 degrees Celsius. The background grid is in millimeters.*

This type of thermistor can tolerate a maximum of 30V (AC or DC).

Over-Current Protection

This type of nonlinear thermistor is a substitute for a fuse, as it responds to internal heat created by current passing through it. If the flow of current is excessive, the resistance of the thermistor increases, throttling the flow. When the over-current problem is resolved, the thermistor returns to its normal state. Whereas a fuse must be placed in a location allowing replacement, the thermistor is unharmed by its transition and does not have to be replaced.

Over-current may occur as a result of failure of other components, such as a rectifier diode or a capacitor, or can occur in situations such as a DC motor locking up.

The B598 series from TDK can tolerate voltages over 240V, AC or DC. They typically respond when currents exceed 100mA to 1A, depending on the specific component (a few fall outside that range), and many can withstand 1A to 7A. The B59810C0130A070 pictured in Figure 24-5 is switched by 980mA, can tolerate as much as 7A, and has a reference resistance of 3.5 ohms, rising above 10K when excessive current causes sufficient heat.

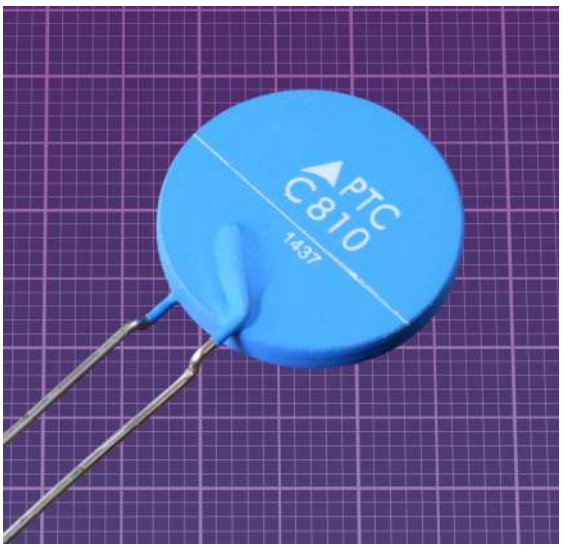

Figure 24-5 *A large over-current protection PTC thermistor. The background grid is in millimeters.*

An over-current thermistor of this type remains wired into the power supply for a device on a permanent basis. Its reference resistance will generate some heat, which is why this type of component is usually restricted to applications where the triggering current is below 1A.

The Murata PTGL07BD220N3B51B0 pictured in Figure 24-6 provides over-current protection with a reference resistance of 22 ohms, has a trip current of 200mA, and tolerates a maximum of 1.5A.

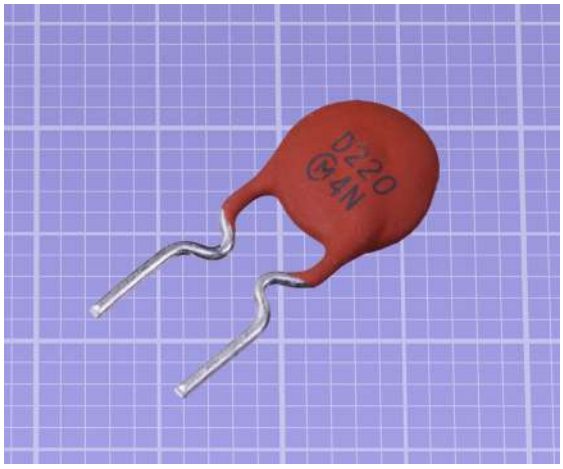

Figure 24-6 *An over-current protection PTC thermistor with a trip current of 200mA. The background grid is in millimeters.*

PTC Inrush Current Limiting

This nonlinear thermistor responds to internal heat caused by an inrush of current when power to a device is switched on. The inrush occurs when current flows rapidly into smoothing capacitors, charging them very rapidly. This can overload a power supply and shorten its life expectancy.

NTC thermistors are traditionally used as inrush limiters. The initially high resistance of this type of component blocks the surge in current, but as heating occurs, the resistance of the NTC thermistor drops rapidly. It remains in the circuit, imposing a relatively small load while the device functions normally. For more details of this application, see "Inrush Current Limiter" in the entry discussing NTC thermistors.

However, an NTC thermistor used in this way will waste some power. Suppose a supply of 120VAC is being used. If the power consumption of a device is 1,000W, the current will be approximately 8A. An NTC thermistor that has a resistance of 0.2 ohms while running warm will introduce a voltage drop of approximately 1.6V, consuming about 13W. This power loss will be greater in applications where the current is even higher—for example, in an electric vehicle recharging station.

To eliminate the loss, a timed bypass relay can be added around the thermistor. The relay closes automatically after a short interval, eliminating the power loss. This is known as *active inrush current limiting*.

However, in this arrangement, an ordinary resistor could be used instead. But in that case, why not use a PTC thermistor that has a reference (cold) resistance of 50 ohms or more? This not only limits the inrush current, but provides additional protection. If a smoothing capacitor in the circuit suffers a short circuit, or if the bypass relay fails to close, excess current passing through the PTC thermistor quickly raises its resistance, protecting the rest of the circuit.

The B5910 series of PTC thermistors from TDK is designed for inrush current limiting. They are packaged in a flame-retardant phenolic resin plastic case, as shown in Figure 24-7. The B59105J0130A020 has a reference resistance of 22 ohms that rises quickly beyond 10K when the temperature exceeds 120 degrees Celsius, as shown in Figure 24-8. This type of component is robust enough to withstand a complete short circuit across a 220-volt supply.

Figure 24-7 *This inrush current-limiting PTC thermistor by TDK is packaged in a flame-retardant case. The background grid is in millimeters.*

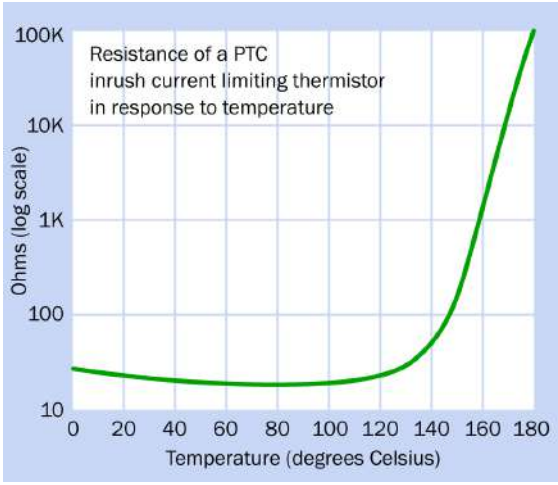

Figure 24-8 *Relationship of resistance to temperature in a PTC inrush current limiting thermistor. Note that the vertical axis has a logarithmic scale.*

PTC Thermistor for Starting Current

In some applications an initial inrush of current is actually necessary and desirable. An air conditioning compressor, for example, requires a surge of high current for "torque assist" when it is starting from a rest state.

High-current PTC thermistors may be used in this kind of situation. The Vishay PTC305C series is an example. These are heavy-duty components that have a switching time of about half a second, a maximum voltage rating of 410VAC or more, and a current rating from 6 to 36 amps.

The PTC thermistor has a relatively high temperature while the motor is running, and must be allowed time to cool before a restart is possible after shutdown. A waiting time of 3 to 5 minutes is imposed by a thermostat or separate time-delay relay.

PTC Thermistor for Lighting Ballast

The starting sequence for a fluorescent lamp requires that current should flow through the cathode heater initially. The thermistor allows this by bypassing a capacitor. Within less than a second, the resistance of the thermistor rises to block current. By this time, the heater has done its job and the lamp runs from high-frequency AC.

PTC Thermistor as a Heating Element

For small applications, a heating element can be made from a PTC thermistor, using its internal resistance to create heat. It has the advantage of being self-limiting, as its resistance rises with temperature. The TDK 5906 series is an example, shown in Figure 24-9. The component is approximately 12mm in diameter, and is designed to be clamped in place, not soldered. It has automotive applications for diesel fuel preheating and spray nozzle defrosting. Residential applications include vaporizers for air fresheners.

The initial resistance is as low as 3 or 4 ohms, rising very quickly at a transition temperature ranging from 70 to 200 degrees Celsius, depending on the specific component.

Figure 24-9 *This TDK B59060A0060A010 heating element is a PTC thermistor whose resistance rises rapidly around 80 degrees Celsius. Rated for 12VDC, it is intended for automotive applications. The background grid is in millimeters.*

What Can Go Wrong

Self-Heating

Self-heating may affect the accuracy of a temperature sensor. To get accurate readings, keep the current small. When the resistance of a thermistor is at the high end of its range, brief pulses of current can be used.

Heating Other Components

In cases where the self-heating of thermistors serves a useful purpose, as in surge protectors and when used for delays, the heat can damage nearby components or materials.

thermocouple

25

Because a *thermopile* is an assembly of thermocouples, it is included at the end of this entry. Other types of temperature sensors have their own entries.

OTHER RELATED COMPONENTS

- **NTC thermistor** (see Chapter 23)
- **PTC thermistor** (see Chapter 24)
- **semiconductor** temperature sensor (see Chapter 27)
- **RTD** (resistance temperature detector) (see Chapter 26)
- **infrared temperature** sensor (see Chapter 28)

What It Does

A **thermocouple** measures temperature by using a pair of wires made from dissimilar metals. At one end of each wire, they are joined together, often by welding them. The differing thermoelectric characteristics of the wires generates a very small voltage between their free ends, from which the temperature of the joined ends can be derived.

No power supply is needed for a thermocouple, but the voltage that it generates is extremely small (measured not just in millivolts, but microvolts) and very nonlinear, requiring hardware and/or software to convert it to a temperature value. Laboratory equipment or integrated circuit chips are available for this purpose.

Different types of thermocouples are available to measure different temperature ranges, and each type has its own characteristics, requiring appropriate conversion.

A "raw" thermocouple looks very unimpressive, as it merely consists of two wires welded together at one end. This is illustrated in Figure 25-1. The full length of the photocouple is shown in Figure 25-2.

Figure 25-1 *Closeup of the welded wires in a K-type thermocouple. The background grid is in millimeters.*

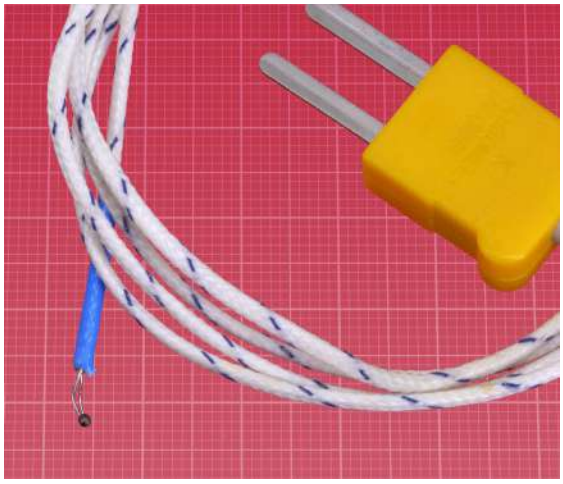

Figure 25-2 *Overview of the thermocouple in the previous photograph.*

A thermocouple sold as a commercial product is likely to be enclosed in a probe, as shown in Figure 25-3.

Figure 25-3 *A probe that contains a thermocouple.*

Schematic Symbol

A schematic symbol that is often used to represent a thermocouple is shown in Figure 25-4. Because this component does not consume current, the plus and minus signs do not mean that power should be applied to the wires. The positive sign indicates which wire will generate a higher voltage than the wire with the negative sign.

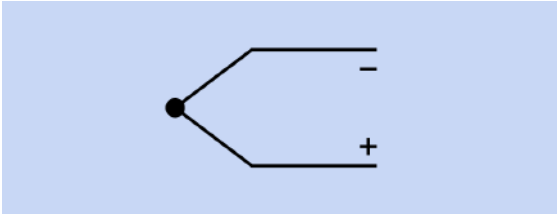

Figure 25-4 *A symbol that is often used for a thermocouple.*

Comparison of Temperature Sensors

In this Encyclopedia, temperature sensors are divided into five main categories, each of which has a separate entry. For convenience, a comparative summary is included in the entry for **NTC thermistors**. See "Addendum: Comparison of Temperature Sensors" for an overview. Also see Figure 23-9.

Thermocouple Applications

Thermocouples have a wider range than any other form of contact temperature sensor, some types being capable of measuring up to 1,800 degrees Celsius. The main limitation is the ability of the joint between the wires to withstand the heat. Appropriate insulation must be used, but segments of ceramic tube are marketed to serve this purpose if necessary.

The very small thermal mass of a thermocouple enables a rapid response to temperature fluctuations. No self-heating occurs, because the thermocouple consumes no power. It is simple and robust. However, its response is very nonlinear, and the tiny voltages involved are vulnerable to corruption by electrical noise. Accuracy is usually not better than plus-or-minus 0.5 degrees Celsius, and may be less at low temperatures.

Thermocouples are commonly found in laboratories and in some industrial applications, such as monitoring the temperature in a blast furnace or inside an internal combustion engine.

They may also measure temperatures as low as -200 degrees, but at temperatures below -100 degrees the temperature coefficient diminishes to the point where voltage increments are less than 30µV per degree Celsius.

How a Thermocouple Works

When one end of a piece of wire is maintained at a temperature that is different from the other end, the temperature gradient along the wire creates a small electromotive force that manifests itself as a difference in electrical potential between one end of the wire and the other. This is known as the *Seebeck effect*, named after the man who discovered it. The magnitude of the potential will depend on two factors: the temperature difference between the ends of the wire, and the type of wire that is used.

Figure 25-5 illustrates the concept. Part 1 of this figure shows two wires, named A and B. The left ends of the wires are heated to the same temperature, T_X, while the right ends remain at a cooler temperature, T_Y. Because the wires are composed of different metals, the voltage drop across each wire will be different.

To make this model useful, some factors must be eliminated. In part 2 of Figure 25-5, the hot ends of the wires have been welded together. This now guarantees that they share the same temperature and the same voltage, V_X. We do not yet know what these X values are.

In part 3 of the figure, the cold ends of the wires are clamped in an isothermal block, which keeps them at an equal temperature, still represented as T_Y. The block is not electrically conductive, so the cold ends of the wires still have different voltages, V_A and V_B. We cannot measure these voltages directly, because they are relative to V_X, which is unknown. However, a volt meter can measure V_A and V_B relative to each other.

The volt meter will have its own voltage gradient on its wires, and possibly a temperature gradient too, but both of these wires are made of the same metal (probably copper) and share the same temperature gradient. Therefore, their effects will be equal.

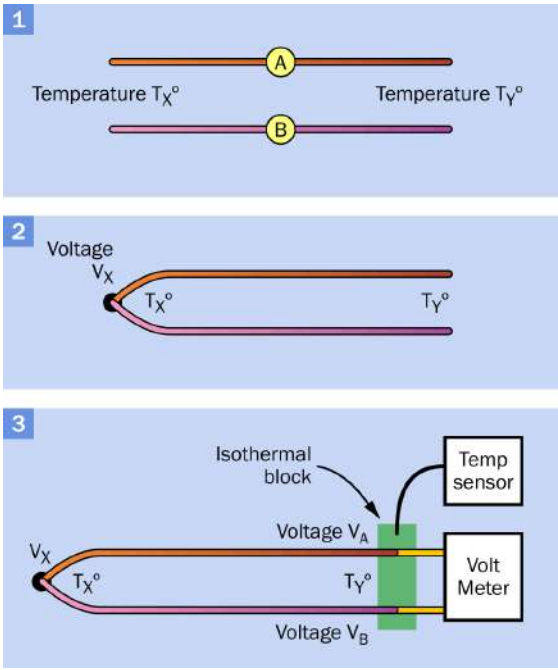

Figure 25-5 *Basic principles of a thermocouple. See text for details.*

A mathematical relationship exists between the temperature gradient and the voltage difference in each thermocouple wire. Suppose K_A is a constant or function that enables the voltage difference in wire A to be determined from its temperature gradient, and K_B serves the same function for wire B. Suppose T_{DIF} is the difference in temperature between T_X and T_Y. We may state:

$$K_A * (T_{DIF}) = V_X - V_A$$

$$K_B * (T_{DIF}) = V_X - V_B$$

By subtracting the second equation from the first and rearranging the terms, we get:

$$T_{DIF} * (K_A - K_B) = V_X - V_A - V_X + V_B$$

The two V_X terms cancel out, leaving $V_B - V_A$ on the right. We can recognize $V_B - V_A$ as the volt-

age difference measured by the meter. Call it V_M. So:

$$T_{DIF} = V_M / (K_A - K_B)$$

This enables calculation of the temperature difference between the ends of the wires, based on the meter reading and the conversion factor for each wire, which can be found experimentally. Because T_Y is being held at a known, constant value, we can determine the value of T_X:

$$T_X = T_Y + T_{DIF}$$

Thermocouple Details

When the thermocouple was first invented, the cold ends of the wires were placed in a bath of ice and water, forcing them to acquire and maintain a known temperature of 0 degrees Celsius.

The advent of accurately calibrated thermistors made it possible simply to measure the temperature of the cold ends. In this way, a thermistor enables a thermocouple to work. This prompts the question: why not just use the thermistor to measure T_X, and throw away the thermocouple? The reason is that a thermistor has a more limited range, seldom being used for temperatures above 150 degrees Celsius.

Note that the "hot end" of the thermocouple wires does not actually have to be hotter than the "cold end," even though those terms are commonly used. The equation to find T_X works just as well if T_Y is higher than T_X. The temperature difference will simply have a negative value instead of a positive value.

Because "hot" and "cold" are misleading terms, modern documents generally refer to the "measurement junction" and the "reference junction" of the wires. Note, however, that the wires are not actually joined with each other at the reference junction.

A common misconception is that voltage is generated where the wires are joined at the measurement junction. This is not correct. The voltage is a function of the temperature gradient between the measurement junction and the reference junction in each wire. Therefore, the way in which the wires are joined is irrelevant, provided there is an electrical connection between them. They can be welded, soldered, brazed, or crimped together.

How to Use It

Where a thermocouple is used in a laboratory, typically each wire is insulated, and they terminate in a plug that is inserted in a meter. The reference junction is hidden inside the meter, along with some electronics to decode the temperature data. The meter must have a setting that is appropriate to the specific type of thermocouple being used, so that the conversion factors are correct.

Because the type of metal in each wire must be consistent all the way from the measurement junction to the reference junction, other types of wires cannot be used to extend the reach of a thermocouple. Any extension must use wires made from the same metals. Connectors, also, must have pins and sockets that match the types of metals in the wires.

An extension wire for a thermocouple is shown in Figure 25-6.

Figure 25-6 *Extension wire for a type K thermocouple. Note the polarized plug.*

Types of Thermocouples

Thermocouples are identified by ANSI standard codes consisting of single letters of the alphabet, shown below. Temperature ranges are approximate, in Celsius, with minimums rounded up and maximums rounded down to the nearest 50 degrees. Some data sources recommend narrower temperature ranges for practical use.

K type
: -250 to +1,350 degrees. Most popular type of thermocouple. Positive wire is a nickel-chromium alloy, negative wire is a nickel-aluminum alloy. Commonly used in 3D printers.

J type
: -200 to +1,200 degrees. Positive wire is iron, negative wire is a copper-nickel alloy. The iron wire is magnetic and vulnerable to corrosion. This thermocouple is not recommended for low temperatures, even though it is theoretically capable of measuring them.

T type
: -250 to +400 degrees. Recommended for cryogenic applications. Positive wire is copper, negative wire is a copper-nickel alloy.

E type
: -250 to +1,000 degrees. Most sensitive type, with the highest temperature coefficient. Positive wire is a nickel-chromium alloy, negative wire is a copper-nickel alloy.

N type
: -250 to +1,300 degrees. An alternative to the K type, more stable at higher temperatures. Positive wire is a nickel-chromium-silicon alloy, negative wire is a nickel-silicon-magnesium alloy.

R type
: -50 to +1,750 degrees. For high-temperature applications. Positive wire is a platinum-rhodium alloy, negative wire is platinum. Very low temperature coefficient.

S type
: -50 to +1,750 degrees. For high-temperature applications. Positive wire is a platinum-rhodium alloy, negative wire is platinum. Very low temperature coefficient.

Seebeck Coefficients

Datasheets for thermocouples list the Seebeck coefficient, which is the temperature coefficient caused by the Seebeck effect, measured in microvolts per degree. In other words, the value provided by a Seebeck coefficient is the number of additional microvolts that a thermocouple will generate for an increase in 1 degree Celsius.

Each type of thermocouple has a different coefficient, and because thermocouples tend to have a very nonlinear response, the coefficients will vary with temperature. Figure 25-7 shows the variations for six types of thermocouples, over a range from -400 to +1,400 degrees Celsius. It is important to understand that the vertical scale shows the coefficient for each type of thermocouple—that is, the *change* in voltage, not the *actual* voltage, at temperature values along the horizontal axis.

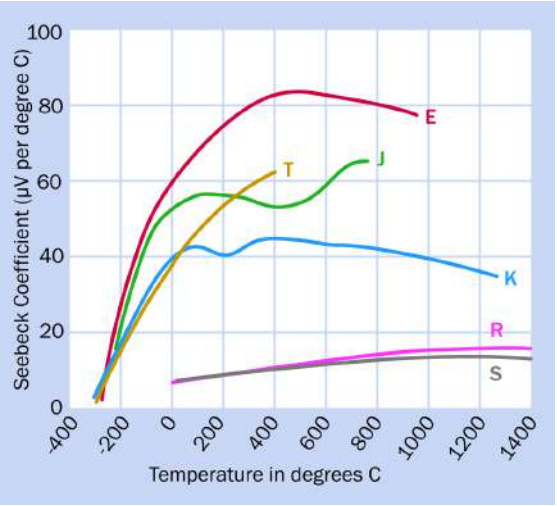

Figure 25-7 *The Seebeck (temperature) coefficient for six types of thermocouples. Partially derived from a datasheet published by Analog Devices.*

R and S type thermocouples have a relatively consistent response, but cannot achieve great accuracy, because the voltage increment is so small for each change in temperature. The K type thermocouple does relatively well between 0 and 1,200 degrees, but the J type only performs adequately between 0 and 800 degrees, while the T and E types are quite inconsistent.

For lower voltage readings, electrical noise becomes an issue. Thermocouple wires are often twisted together, and may also be shielded, to reduce sensitivity to noise. The electronics that decode the thermocouple voltage should include a filter to reject 50Hz or 60Hz interference from wiring in the vicinity.

Chips for Output Conversion

Meters that are designed to interpret the output from a thermocouple and display a temperature tend to be expensive, and may not be convenient for a custom-built application. Fortunately integrated circuit chips are now available to amplify the thermocouple output and apply signal conditioning to create an almost linear response.

The AD8494 and AD8496 from Analog Devices are precalibrated by laser wafer trimming to match the characteristics of J type thermocouples, while the AD8495 and AD8497 match the characteristics of K type. The chips require a power supply of at least 3VDC and have an analog output of 5mV per degree Celsius, enabling measurement over a range of almost 1,000 degrees. They require a very low supply current of 180µA. The manufacturer claims an accuracy of plus-or-minus 2 degrees Celsius.

The chip contains a temperature sensor which should be at the same temperature as the reference junction of the thermocouple. This means that the reference junction (typically, at the socket where a thermocouple plug is inserted) should be as close to the chip as possible, and the chip should be protected from heat created by other components. Any difference in temperature between the reference junction and the chip will create a temperature measurement error.

The MAX31855K chip from Maxim Integrated Products is another thermocouple-to-digital converter. It linearizes the output from the thermocouple and digitizes it as a temperature that is accessible by a microcontroller via a serial SPI bus. Breakout boards with this chip are available. The last letter of the chip number specifies the thermocouple type. Variants for J, K, N, T, S, and R are available.

The AD8495 is mounted on a breakout board from Adafruit, and the MAX31855K is mounted on a breakout board from Sparkfun. These boards are pictured in Figure 25-8.

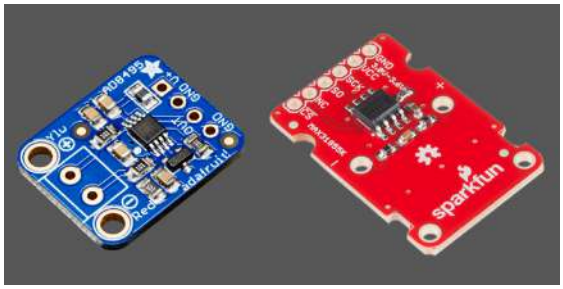

Figure 25-8 *Thermocouple amplifier/conversion chips from Adafruit (left) and Sparkfun (right).*

Thermopile

A thermopile is an assembly of thermocouples connected in series, as suggested in Figure 25-9, where a hot area is shown on the left and a cooler area is shown on the right. The figure assumes that the orange-colored wires have a voltage difference of 5mV from left to right, as a result of the temperature difference, while the purple-colored wires only have a voltage difference of 1mV from left to right. Therefore, the voltage difference between each reference junction and the next is 4mV, as shown on the right side of the figure. So long as the temperature difference exists, the voltage differences will be cumulative, totaling 16mV between top and bottom in this example.

Note that the multiple thermocouple junctions are not electrically connected with each other in each temperature zone.

In reality, more thermocouples than this will be added, and the voltage differences may be lower.

Generally a thermopile is not sold as a separate component from retail suppliers, but is built into other devices. It may be used to generate small amounts of current from a heat difference, as in an infrared thermometer. It can also be used as a safety device to shut down a gas supply if a burner is not lit. See Chapter 28.

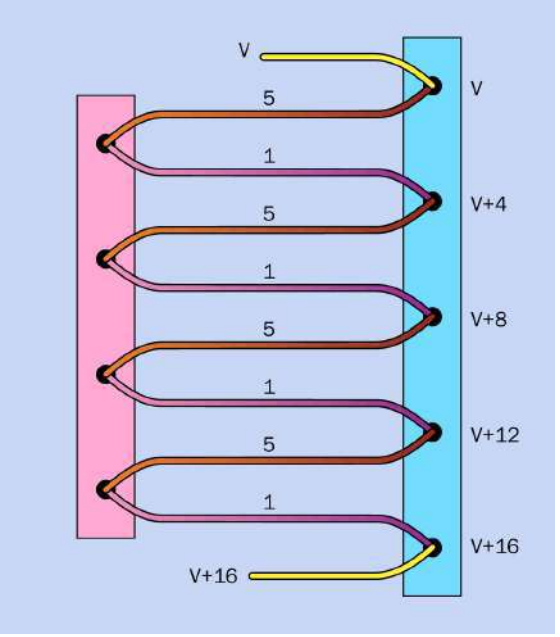

Figure 25-9 *The operating principle of a thermopile. The numbers represent mV, but are chosen arbitrarily as an example.*

What Can Go Wrong

Polarity

The output from a thermocouple has polarity. If this is not observed, an error will result.

Electrical Interference

Thermocouple wires are vulnerable to electrical interference, and should be a twisted pair or, ideally, shielded.

Metal Fatigue and Oxidation

The wire used in some thermocouples tends to be relatively brittle, and cannot withstand much flexing. Also, some metals or alloys are vulnerable to oxidation.

Using the Wrong Type

Different types of thermocouples have totally different characteristics. The electronics to decode the signal from a thermocouple must be matched to the type of thermocouple being used. The plugs on the ends of the thermocou-

ple wires are often retained with screws. A detached plug should be replaced immediately, to avoid the error of attaching it to the wrong type of thermocouple.

Heat Damage from Creating a Thermocouple

If a thermocouple is made from two wires on a DIY basis by welding the tips of the wires together, minimal heat must be used to avoid degrading the alloys in the wires.

RTD (resistance temperature detector)

28

RTD is an acronym, either for *resistance temperature detector* or *resistive temperature device*. No definitive information seems to exist regarding which term is correct, but *resistance temperature detector* is more common.

Occasionally an RTD may be described as a *PTC thermistor*, but its sensing element is different, consisting of pure metal wire or film.

OTHER RELATED COMPONENTS

- **thermocouple** (see Chapter 25)
- **NTC thermistor** (see Chapter 23)
- **PTC thermistor** (see Chapter 24)
- **semiconductor** temperature sensor (see Chapter 27)
- **infrared temperature** sensor (see Chapter 28)

What It Does

A *resistance temperature detector*, also known as a *resistive temperature device*, is usually referred to as an **RTD**. It has a positive temperature coefficient (that is, its resistance increases as its temperature increases) but differs from a **PTC thermistor** in that its sensing element is pure metal instead of a semiconductor.

Comparison of Temperature Sensors

In this Encyclopedia, temperature sensors are divided into five main categories, each of which has a separate entry. For convenience, a comparative summary is included in the entry for **NTC thermistors**. See "Addendum: Comparison of Temperature Sensors" for an overview. Also see Figure 23-9.

RTD Attributes

Positive attributes of RTDs include:

- Accuracy, often plus-or-minus 0.01 degrees Celsius. This very small tolerance allows excellent interchangeability.
- Stability, with a response that drifts by as little as 0.01 degree per year.
- The output is an almost linear function of temperature, making them easily used with a microcontroller.
- Immunity to electrical noise.
- Reasonably rapid response to temperature changes (about 1 to 10 seconds).

Undesirable attributes include:

- Temperature coefficient about one-tenth of that of an NTC thermistor.
- To measure the resistance, some current must pass through the sensor, raising the possibility of self-heating (as in the case of other temperature sensors, with the exception of a thermocouple).
- Relatively high cost, especially of the wire-wound type.

The resistance curves for three generic NTC thermistors are shown in Figure 26-1, plotted against the resistance for a generic platinum RTD that has a reference resistance of 100 ohms at 0 degrees Celsius. Note that this graph is unlike many that illustrate the response of NTC thermistors, in that its vertical scale is not logarithmic.

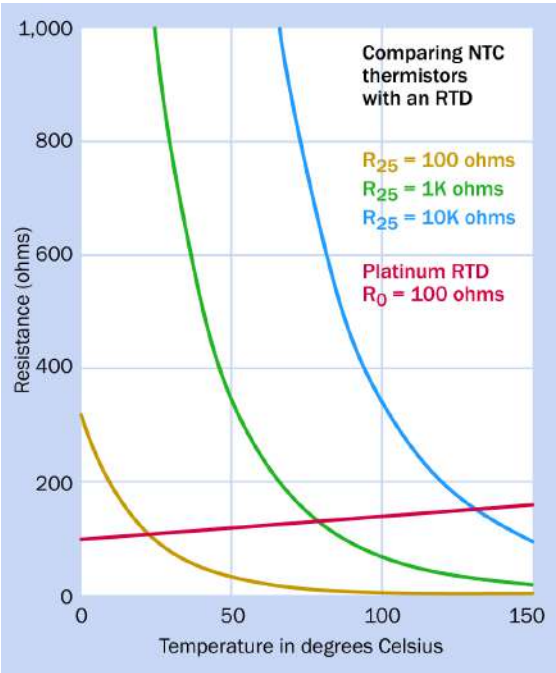

Figure 26-1 *The brown, green, and blue curves show the resistance of three generic NTC thermistors varying with temperature. The red line shows the resistance of a platinum RTD. Derived from a diagram created by Texas Instruments.*

Schematic Symbol

There is no specific schematic symbol for an RTD. Often the symbol for a thermistor may be used. See Figure 23-1.

Applications

Because of its high accuracy, an RTD may be used where precision is important. It can calibrate other temperature sensors, and may measure the temperature of a reference junction of a thermistor. However, it requires sensitive electronics for signal conditioning, because of its low temperature coefficient.

How It Works

An RTD exploits the fractional increase in electrical resistance of a metal film, metal filament, or (in some cases) a carbon film, when the temperature of the metal rises. In its simplest form, an RTD is a 2-wire device with no polarity.

The sensing element is often made from platinum, as this has a linear response to temperature over a wide range. High-quality RTD sensors with a wide temperature range usually consist of platinum wire that is wound around a glass or ceramic core. Smaller sensors may be fabricated from a thin layer of platinum evaporated onto an insulating substrate. Nickel may be substituted for platinum, and has a more sensitive but less linear response.

The wire-wound type is usable at temperatures as high as 500 Celsius (up to 1,000 degrees for some platinum-element types). Some variants are able to measure temperatures as low as -250 degrees.

DIN 60751 is an international standard defining the performance of platinum RTDs. It specifies a reference resistance of 100.00 degrees at 0 degrees, and a temperature coefficient between 0 degrees and 100 degrees. Outside of this range, a formula defines the response.

The response is almost precisely linear, ranging from 100 ohms at 0 degrees to approximately

138 ohms at 100 degrees. The temperature deviation from a straight line, between 0 and 100 degrees, is no more than plus-or-minus 0.8 degrees.

However, current through the RTD must be restricted to avoid self-heating. A range of 0.5mA to 1mA is recommended.

Variants

Some RTDs are potted in glass or resin, as shown in Figure 26-2. This shows an RTD in the TFPTL range from Vishay, containing a nickel thin-film sensing element with a temperature coefficient of about 0.4% and a tolerance of 0.01%. It is available with a very wide range of reference resistances, from 100 ohms to 5K (measured at 25 degrees Celsius). The temperature range is -55 to +70 or -55 to +150 degrees, and the maximum voltage is 30V to 40V, depending on the specific component.

Figure 26-2 *An RTD in the TFPTL series from Vishay. The background grid is in millimeters.*

The flat package shown in Figure 26-3 may be encased in a protective sheath of plastic or silicone rubber, and can be used for surface temperature sensing where the component is glued to the exterior of a flat-sided container. This figure shows an RTD in the L420 range from Heraeus Sensor Technology, containing a platinum thin-film sensing element with a temperature coefficient of 0.385%. It is available in reference resistances of 100, 500, and 1,000 ohms (measured at 25 degrees Celsius). The temperature range is -50 degrees to +400 degrees.

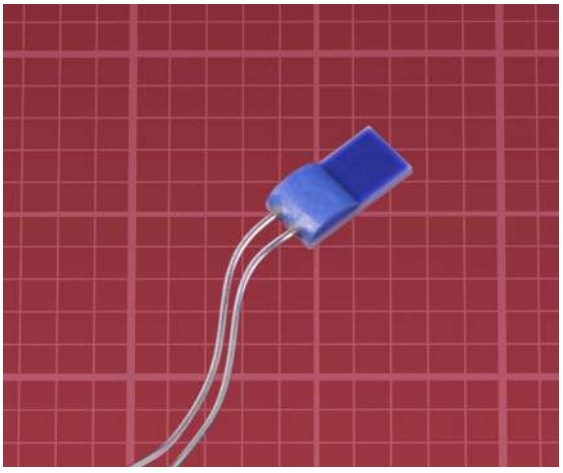

Figure 26-3 *An RTD in the L420 series from Heraeus. The background grid is in millimeters.*

Wiring

The leads to an RTD can be a source of error. If a simple 2-wire configuration is used, the leads will have an unknown resistance that will be affected by temperature, just as the element inside the RTD will have a temperature-sensitive resistance.

To enable temperature compensation, a three-wire design can be used. Figure 26-4 illustrates the principle. In the first section of this figure, resistances R_A and R_B remain unknown. In the second section, the resistances of R_B and R_C can be found by passing a test current through one wire and back through the other, bypassing the component. Assuming that all of the leads are identical in length and composition, the resistance of $R_A + R_B$ will be equal to that of $R_B + R_C$.

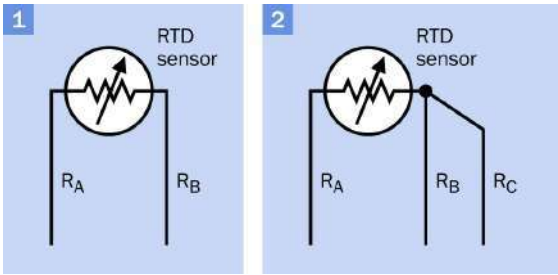

Figure 26-4 *A three-wire configuration enables temperature compensation for the leads to an RTD. See text for details.*

RTD Probe

For practical applications, an RTD sensor is often packaged inside a probe that can be indistinguishable from the type of probe used with a **thermocouple**. However, a thermocouple always uses two wires, as the wires themselves create the voltage. An RTD often uses three wires, as shown in Figure 26-5. This particular sensor is sold for use in a "Brew-Magic" system for brewing craft beer on a commercial basis.

Figure 26-5 *A three-wire RTD is packaged inside this steel probe.*

Signal Conditioning

To process the signal of an RTD, a chip such as the LM75 from National Semiconductor can be used. This is calibrated for connection with a platinum RTD. Internally it converts the resistance of an RTD to a value of 5mV per degree Celsius. This then passes through an analog-to-digital converter on the chip, creating a digital value that can be read via an I2C bus.

What Can Go Wrong

Self-Heating

Self-heating is an issue for RTDs, just as it is for thermistors. Current through an RTD should be limited to 1mA, especially when measuring low temperatures.

Insulation Affected by Heat

The resistance of insulation on the wires leading to a sensor can change with temperature, leading to incorrect resistance readings. This is a more likely source of problems for RTDs than for thermistors, as RTDs are often used at higher temperatures and have a lower temperature coefficient.

Incompatible Sensing Element

If signal conditioning is applied to an RTD that has an incompatible sensing element, temperature readings will be incorrect. For example, an RTD with a nickel element should not be used with signal conditioning designed for a platinum element.

semiconductor temperature sensor

27

This type of sensor may also be referred to as a *bandgap temperature sensor*, a *diode temperature sensor*, a *chip-based temperature sensor*, or an *IC temperature sensor*.

The unfortunate term *integrated silicon-based sensor* is sometimes used, which can be confused with *silicon temperature sensor* (also known as a *silistor*), which is a type of **PTC thermistor**. See Chapter 24.

Some vendors do not divide temperature sensors into clear categories. Semiconductor temperature sensors may be classified as *board-mount* temperature sensors, even though many of them have leads and are not specifically designed to be mounted on circuit boards.

A semiconductor temperature sensor with a digital output is sometimes described as a *digital temperature sensor* or *digital thermometer*. This can be misleading, as the outputs from other types of temperature sensors may be digitized with appropriate components.

OTHER RELATED COMPONENTS

- **thermocouple** (see Chapter 25)
- **NTC thermistor** (see Chapter 23)
- **PTC thermistor** (see Chapter 24)
- **infrared temperature** sensor (see Chapter 28)
- **RTD** (resistance temperature detector) (see Chapter 26)

What It Does

A **semiconductor** temperature sensor is an integrated circuit chip incorporating a sensing element composed of transistor junctions. It has an approximately linear response and is easy to use, in some cases being designed for direct connection with a microcontroller, requiring no additional components.

In analog variants, the output consists either of voltage or current that varies with temperature. These components have a positive temperature coefficient, except for a few CMOS variants where a voltage output diminishes as temperature increases.

Digital variants are becoming more common, creating a numeric output accessible by a microcontroller.

In almost all semiconductor temperature sensors, the characteristics of silicon dioxide limit the temperature range to approximately -50 to +150 degrees Celsius (sometimes less).

This type of component is not (yet) as low in cost as a thermistor, but can include its own amplification, signal processing, and (optionally) analog-to-digital conversion on one chip.

Comparison of Temperature Sensors

In this Encyclopedia, temperature sensors are divided into five main categories, each of which has a separate entry. For convenience, a comparative summary is included in the entry for **NTC thermistors**. See "Addendum: Comparison of Temperature Sensors" for an overview. Also see Figure 23-9.

Semiconductor Temperature Sensor Applications

When a semiconductor temperature sensor is used in surface-mount format, it can measure the temperature of the board on which it is mounted. This enables protection from overheating, often in power supplies.

Because the sensing elements and signal processing circuits are all chip-based, they can be transplanted into other types of sensors. For example, a gas pressure sensor or a proximity sensor can have onboard compensation using a semiconductor temperature sensor. They have also been built into computer CPUs such as the Pentium series from Intel.

Some variants are manufactured in a three-lead TO-92 package, appearing superficially similar to bipolar transistors. They are suitable for remote temperature sensing, and have automotive applications such as measuring the temperature of the transmission, engine oil, or cabin interior. They may also be found in some heating and air-conditioning systems, and some kitchen equipment.

Schematic Symbol

No unique schematic symbol has been developed for a semiconductor temperature sensor. It may be represented by a rectangle containing text abbreviations to represent pin functions, similar to other types of integrated circuit chips.

In the case of a sensor with an output consisting of current that varies with temperature, the sensor may be shown as a *current source*, using the symbol in Figure 27-1. However, this symbol is not specific to temperature sensors; it is used for any component that is a current source.

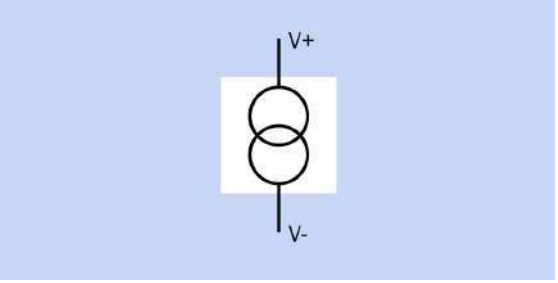

Figure 27-1 *A temperature sensor whose output consists of current varying with temperature may be shown in a schematic as a current source, using this symbol.*

Attributes

Desirable attributes of a semiconductor temperature sensor include:

- Easy to use. Few or no external components may be required, and little or no signal processing.
- Factory-calibrated, with an almost linear response.
- Versions with a digital output are easy to add to any system that already has an I2C bus. For additional details about protocols such as I2C, see Appendix A.

Undesirable attributes of semiconductor temperature sensors include:

- Limited temperature range, the same as thermistors.
- Self-heating issues, especially in versions where signal-processing functions are built into the same chip.

- Not as rugged as some types of temperature sensors.

For an explanation of terminology used for temperature sensors in datasheets, see "Thermistor Values".

How It Works

When a constant current is flowing through a p-n junction in a diode, the voltage across the diode will change by about 2mV for each change in temperature of 1 degree Celsius. This can be demonstrated by the simple circuit shown in section 1 of Figure 27-2.

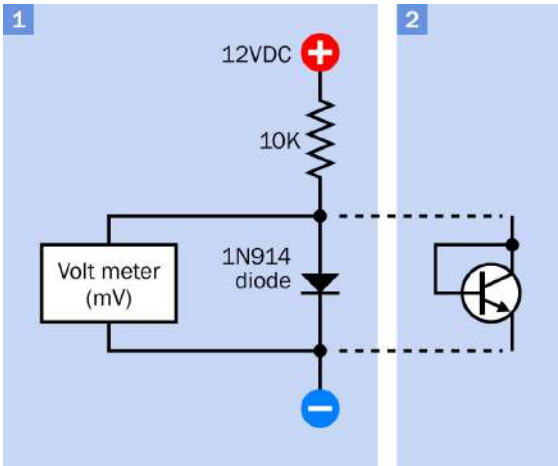

Figure 27-2 *Left, a basic circuit for demonstrating the temperature sensitivity of a diode. Right, an NPN transistor can be substituted to emulate the diode.*

Similarly, the voltage across the p-n junction in an NPN transistor varies with temperature, if the current is constant. A transistor can be substituted for a diode as suggested in section 2 of Figure 27-2. Integrated circuit chips that contain transistors can measure temperature by exploiting this phenomenon.

CMOS Sensors

Some semiconductor temperature sensors use CMOS instead of bipolar transistors. The general concept is similar, but they are described separately, below. See "CMOS Semiconductor Temperature Sensors".

Multiple Transistors

The heat sensitivity of a bipolar transistor can be defined with an equation. If the base-emitter voltage is V_{BE}, q is the charge of an electron, k is a constant (known as Boltzmann's constant), T is the temperature in degrees Kelvin (relative to absolute zero), I_C is the collector current, and I_S is the saturation current (which is less than I_C):

$$V_{BE} = ((k*T) / q) * \log_e (I_C / I_S)$$

The term $\log_e$ means, "the logarithm to base e of the expression in parentheses."

Because k and q have known values, the base-emitter voltage turns out to be proportional to the logarithm of the collector current divided by the saturation current. However, the saturation current depends on the geometry of a transistor, and varies with temperature in a nonlinear way.

To eliminate the factor of saturation current, one transistor can be compared with another transistor that has a larger emitter area. This enables the derivation of a new equation that specifies temperature while getting rid of the troublesome saturation currents, with their nonlinear behavior.

However, it may not be easy to fabricate two transistors, in the same silicon chip, that have the same characteristics except that the emitter area of one is bigger than that of the other. It is much easier to add multiple transistors in parallel, each of them identical to the first. The total emitter area will then be equal to the area in one transistor multiplied by the number of transistors.

In Figure 27-3, assuming all the transistors are at the same temperature in addition to being of identical specification, we can now write two equations. The figure allows room to show only three transistors, but suppose there are N of

them. If V_{BE0} is the base-emitter voltage of transistor Q0, on the left, and V_{BEN} is the aggregate base-emitter voltage of the N transistors on the right:

$$V_{BE0} = ((k*T) / q) * \log_e (I_C / I_S)$$

$$V_{BEN} = ((k*T) / q) * \log_e (I_C / N*I_S)$$

From these, an equation can be derived that gets rid of I_C and I_S:

$$V_{BE0} - V_{BEN} = ((k*T) / q) * \log_e (N)$$

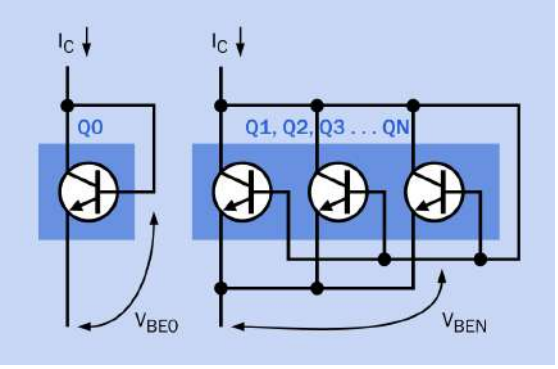

Figure 27-3 *Comparing the base-emitter voltage of one transistor with a set of identical transistors can enable measurement of temperature regardless of the collector current and saturation currents, so long as all the transistors are at the same temperature. See text for details.*

PTAT and the Brokaw Cell

Now if a comparator is added to control the current, a circuit known as the Brokaw Cell is created, shown in Figure 27-4. This is also known generically as a *bandgap temperature sensor*. (A couple of resistors have been omitted for the sake of simplicity.)

Typically, N = 8. That is, there is a set of eight transistors in addition to Q0 (only three being shown here). The voltage difference in the previous equation, V_{BE0} - V_{BEN}, now appears across R2 in the figure, and the voltage across R1 is *proportional to absolute temperature*, often referred to by its acronym, *PTAT*. This voltage can be found from this equation:

$$V_{PTAT} = ((k*T)/q) * \log_e(N) * (2*R1/R2)$$

The Brokaw Cell was the basis of the AD580 chip introduced in 1974 by Analog Devices, and the principle is now used very widely in semiconductor temperature sensors.

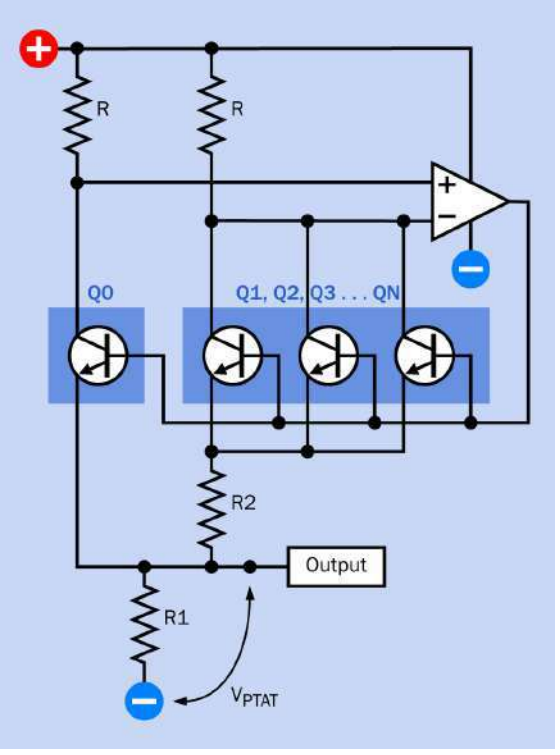

Figure 27-4 *The Brokaw Cell. See text for details.*

Variants

Three output types are used:

- Analog voltage output (voltage varies with temperature).
- Analog current output (current varies with temperature).
- Digital output.

A fourth type creates an output in the form of a square wave, either with a frequency or wavelength proportional to temperature. The Maxim MAX6576 and MAX6577 are examples. How-

ever, this type of output is so rare, it is not described in detail here.

Some semiconductor temperature sensors are CMOS-based, and have a voltage output with a negative temperature coefficient. They are described separately. See "CMOS Semiconductor Temperature Sensors".

Analog Voltage Output

LM35 Series

The LM35 is a typical, widely used semiconductor temperature sensor, available from Analog Devices, Texas Instruments, and other manufacturers. Its output voltage changes by 10mV per degree Celsius over a range of approximately -50 degrees to +150 degrees. Accuracy is stated to be plus-or-minus 0.25 degrees at room temperature and plus-or-minus 0.75 degrees over the whole range.

The sensor can be obtained packaged like a transistor, in a TO-92 plastic capsule or metal can. It is also available as a surface-mount component, or in a TO-220 package, like a 5V voltage regulator, as shown in Figure 27-5.

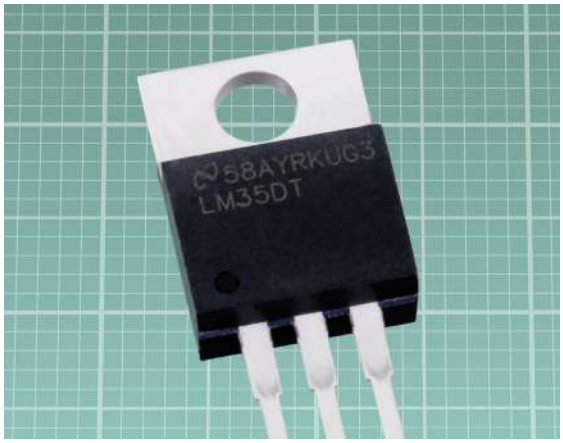

Figure 27-5 *This version of the LM35 can be used to measure surface temperature when secured with a bolt. The background grid is in millimeters.*

This is a three-wire component, two pins or solder pads being used for the power supply while the third serves as the sensor output. The supply voltage typically ranges from 4V to 30V. Necessary current consumption is only 60µA, which minimizes self-heating.

Because this device is specifically designed for the Celsius temperature range, its output is scaled to 0mV at 0 degrees. A pulldown resistor can be added to measure temperatures below zero.

A bypass resistor of 200 ohms between the output and ground is recommended as a precaution against capacitive effects in the cable run.

The LM34 is almost identical to the LM35, except that its output changes by 10mV per degree Fahrenheit instead of 10mV per degree Celsius.

LM135 Series

Although this sensor contains multiple NPN junctions, the manufacturer describes it as behaving like a zener diode in which the breakdown voltage is directly proportional to absolute temperature. The output increases by 10mV per degree over a range from -55 to +150 degrees Celsius.

For the LM135, the manufacturer claims an error of less than plus-or-minus 1 degree Celsius between 0 and 100 degrees. For the LM235 and LM335, in the same product series, the temperature range is narrower, the accuracy is lower, and the price, also, is lower. An LM335 sensor is shown in Figure 27-6.

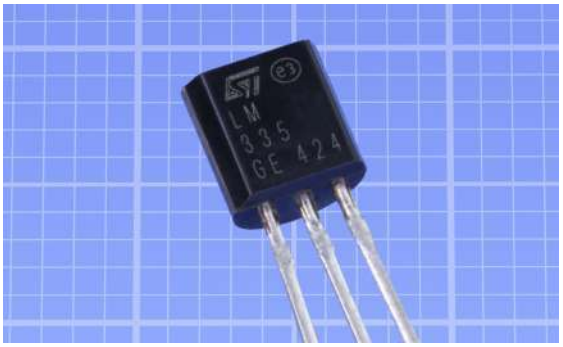

Figure 27-6 *A sample of the LM335 temperature sensor in a TO-92 package. The background grid is in millimeters.*

The sensor is available in a TO-92 package (plastic, like a transistor) or a TO-46 (metal can). It is also manufactured in a surface-mount format. The negative terminal is connected directly to ground, while the positive terminal is connected through a series resistor to the positive side of a power supply that can range from 5V to 40V. The third terminal, labeled "ADJ" on datasheets, allows for the output to be adjusted. Figure 27-7 shows the basic circuit. The value of R1 can be chosen to establish an optimal current of 1mA through the sensor, although a range of 400µA to 5mA is tolerable.

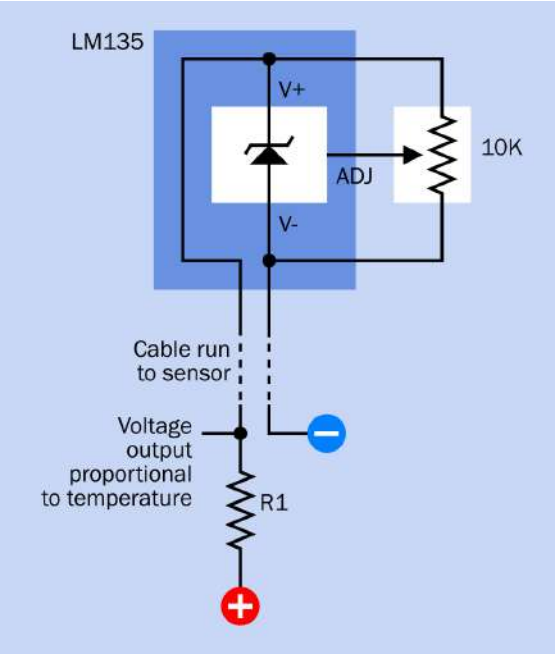

Figure 27-7 *Basic schematic for using an LM135, including output adjustment. Because the sensing element behaves like a zener diode, it is represented with the zener symbol.*

Analog Current Output

Fewer components exist using output current to measure temperature. The output is applied to a grounded resistor, and the voltage across the resistor then changes with current from the sensor.

The useful aspect of a current output is that its accuracy is unaffected by a cable run as long as 200 or 300 feet. Therefore, this type of component is appropriate as a remote sensor.

LM234-3 Series

This is a three-wire sensor, two wires being used for bias power supply and ground (labeled V+ and V- on the datasheet) and a third (labeled R) that delivers current proportional to temperature. The current from pin R passes through an external resistor to ground, and the voltage across this resistor varies by 214µV per degree Kelvin. A bias voltage ranging from 1V to 40V is required.

A sample of the LM234 is shown in Figure 27-8.

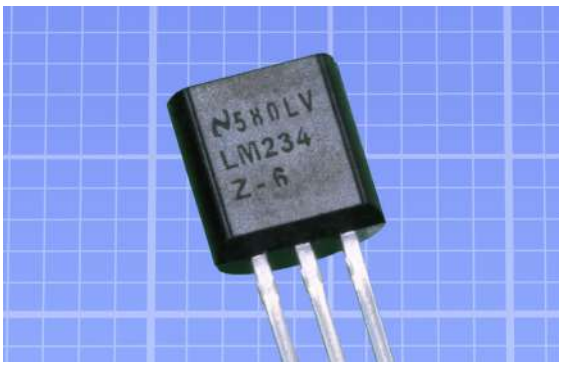

Figure 27-8 *The LM234Z temperature sensor in a TO-92 package. The background grid is in millimeters.*

If the component is used for remote sensing, the resistor should be 230 ohms and can be connected directly between pin R and pin V- of the sensor at the far end of a wire run. At the "home" end of the wire run, temperature output is taken from above a 10K resistor that is placed between the return wire and ground, as shown in Figure 27-9. With these component values, the output voltage will change by 10mV per degree Kelvin.

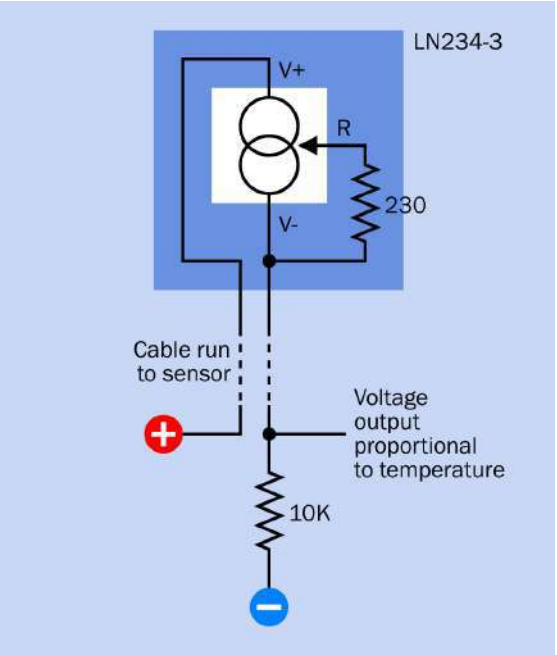

Figure 27-9 *Using an LM243-3 sensor with a current output that varies with temperature.*

The LM234-3 can be encapsulated in a plastic TO-92 package or a TO-46 metal can. A surface-mount version is also available.

The claimed accuracy is plus-or-minus 3 degrees. The temperature range is -25 degrees to +100 degrees.

AD590 Series

The Analog Devices AD590 (successor to the original AD580) is a current-output sensor that uses only two wires. Like the LN234-3 it is available in a TO-46 metal can, but with one lead making no internal connection. It also can be bought in a two-wire "flatpack," or as a surface-mount chip (with eight solder pads, only two of which are connected).

Using a supply voltage of 4V to 30V, the sensor's high-impedance output changes by 1µA per degree Kelvin. Voltage supply variations produce very small errors in the output current; substituting 10V for 5V creates a deviation of only 1µA.

Figure 27-10 shows an application for the AD590 using a resistor and a trimmer to adjust the scale factor. When properly set up, this circuit provides an output that changes by 1mV per degree Kelvin.

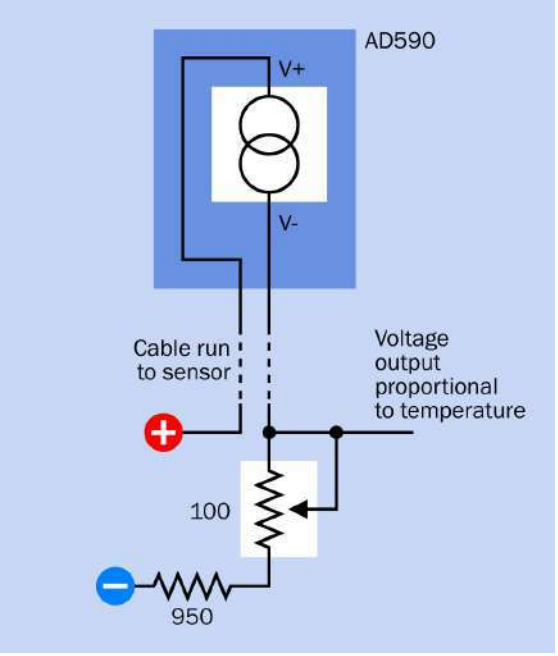

Figure 27-10 *The simplest circuit allowing fine adjustment for use with an AD590 sensor.*

Digital Output

Some of the most popular examples of semiconductor temperature sensors with digital output include the TMP102 series from Texas Instruments, MCP9808 series from Microchip, LM73 series from Texas Instruments and National Semiconductor, and DS18B20 series from Maxim. All of these components can measure a range typical of semiconductor temperature sensors, from approximately -50 to +150 degrees Celsius. Most of them claim an accuracy in the region of plus-or-minus 1 degree over the full range or 0.5 degree in the 0 to 100 range. With the exception of the Maxim DS18B20, which uses its own unique protocol, the components communicate via either the I2C or SMBus protocol.

TMP102 Series

This is available only in a surface-mount format. It has fewer features than the other sensors listed here, and is less accurate, claiming plus-or-minus 3 degrees Celsius over its maximum range of -40 to +125 degrees Celsius. However, it is less expensive. (For greater accuracy, the TMP112 is available.) This is a low-voltage chip requiring 1.4V to 3.6V as its power supply, drawing a quiescent current of 10µA. Temperatures are stored in a 12-bit or 13-bit format that requires some conversion, as a single bit represents 0.0625 degrees Celsius. An alert pin is activated when the measured temperature deviates above or below limits that are preset by the user. No hysteresis adjustment is available for the alerts. The TMP102 is available on a breakout board from Sparkfun, as shown in Figure 27-11.

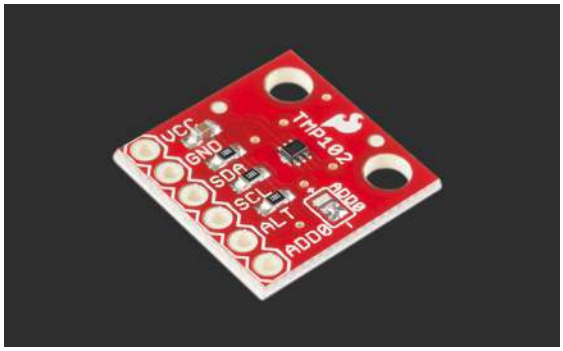

Figure 27-11 *The Texas Instruments TMP102 on a breakout board from Sparkfun.*

MCP9808 Series

This multifunction sensor is available either as a regular surface-mount component, or as a surface-mount with an exposed "thermal pad." It conforms with the I2C bus standard at up to 400kHz, allowing up to 16 sensors to share the same bus. The chip has a variety of temperature alert features, including high and low limits that can activate a dedicated "alert" pin, and a hysteresis value that can be set for the limits, to ignore brief temperature excursions. The chip can be put into "comparator mode," where it simply provides logic-high or logic-low output if the temperature is above or below a user-specified value. This feature makes the chip operate as a thermostat. Temperature resolution is user-selectable. The temperature storage format requires some conversion to obtain a Celsius value, to deal with negative values and fractional values. However the chip is available on a breakout board from Adafruit, as shown in Figure 27-12, and an Arduino code library is available.

Figure 27-12 *The Microchip MCP9808 on a breakout board from Adafruit.*

LM73 Series

This sensor is only available in surface-mount format. It conforms with the I2C bus standard at up to 400kHz. Its temperature resolution can be set to 11, 12, 13, or 14 bits. An "alert" pin becomes active if the temperature exceeds a preprogrammed limit. An "address" pin can select one of three device addresses by being held in logic-high, ground, or disconnected status. The chip can be put into shutdown mode when power conservation is necessary.

DS18B20 Series

Unlike most digital sensors, this is a three-wire component, because it uses Maxim's proprietary "1-wire bus" with a unique protocol. The bus allows access to a 2-byte register storing digital output from the temperature sensor, but also allows the user to perform other functions, such as setting the resolution of an onboard analog-to-digital converter (which has a maximum resolution of 12 bits), setting a high-temperature and low-temperature alarm, and

allowing the sensor to be identified, as each component has a unique 48-bit serial number in ROM.

The chip can draw sufficient power from the data bus to operate, so long as the bus is held high by a 4.7K pullup resistor. (Maxim describes this as "parasite power.") An internal capacitor sustains the chip briefly while the bus is used for its normal purpose of transferring data, but if the bus has low voltage for more than 480µs the chip will reset itself. The "parasite power" feature also will not work above 100 degrees Celsius. Perhaps recognizing that this system may create more problems than it solves, Maxim has also given the component a normal power input pin.

The DS18B20 is available in the TO-92 package and two sizes of surface-mount chip. Its lack of a standard I2C bus, and its use of complicated proprietary codes, create a steep learning curve. Still, it remains a popular sensor, and an Arduino code library for it is available online.

CMOS Semiconductor Temperature Sensors

CMOS variants of semiconductor temperature sensors have appeared relatively recently compared with the bipolar variants. They draw a very low quiescent current (typically, a few microamps) and can work with a power supply from 5.5VDC down to 2.2VDC, making them suitable for handheld battery-powered devices. An analog output is common. Popular examples are the LM20 and the LMT86 series.

Like bipolar sensors, the LMT86 sensors have a limited temperature range, between approximately -50 and +150 degrees Celsius. Again, like the bipolar sensors, they are available optionally in TO-92 and surface-mount packages. A significant difference is that the output has a negative temperature coefficient, diminishing by 10mV per degree Kelvin, because of the characteristics of CMOS semiconductors. The claimed accuracy is plus-or-minus 0.25 degrees Celsius. The output voltage covers a range of about 2V, diminishing from 0.5V below the supply voltage at -50 degrees Celsius.

A sample of the LMT86 is shown in Figure 27-13.

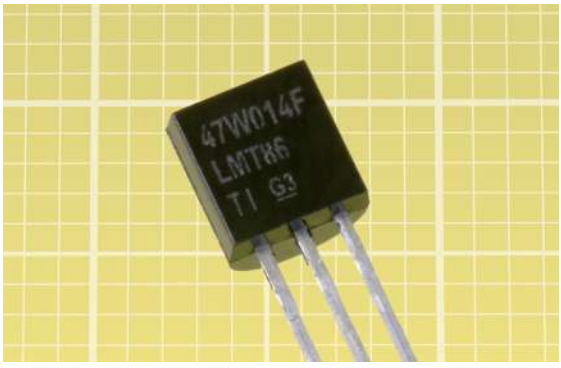

Figure 27-13 *A sample of the LMT86 CMOS temperature sensor. The background grid is in millimeters.*

What Can Go Wrong

Different Temperature Scales

Some voltage-output sensors create an output convertible to degrees Kelvin, while others use degrees Celsius. While the temperature degrees are the same in each scale, a component with an output in millivolts may assign 0mV either to 0 degrees Celsius or 0 degrees Kelvin (equivalent to -273.15 degrees Celsius). The advantage of using a Kelvin scale is that it avoids the problem of negative temperature values.

Rarely, a sensor may use degrees Fahrenheit.

Interference in Cable Runs

Sensors with a voltage output are susceptible to electrical interference. Twisted-pair or shielded cable runs are recommended when sensors are placed remotely.

For the Maxim DS18B20, which uses a 1-wire bus, multiple sensors should be connected along one run of wire (linear topology) instead of each sensor being connected to a central point (star topology). If the cable lengths are

longer than a few meters, the topology starts to matter.

Latency

The packaging of semiconductor temperature sensors can create latency in their response time. While a thermocouple consists only of a pair of wires joined by a small dot of melted metal, a TO-92 semiconductor package adds thermal mass that will slow the response considerably. Moreover, copper leads will conduct heat from a circuit board if the board is warmer than its environment.

Surface-mount chips have a very low mass, but must be soldered to some kind of board, even if it is a very small one.

Generally, other types of sensors may be appropriate where rapid response is necessary.

Processing Time

In a sensor with a digital output, the onboard analog-to-digital converter will add a small delay before the data becomes available, and during that delay, the component cannot respond to a new temperature. The output from an analog device may be more suitable for rapid detection of temperature variations.

infrared temperature sensor

28

An **infrared temperature** sensor is sometimes described as a *thermopile*. In reality the sensor module *contains* a thermopile. In this Encyclopedia, a thermopile is considered to be a separate component, described in the entry discussing **thermocouples**. See "Thermopile" in Chapter 25.

Other terms that are sometimes used for an infrared temperature sensor are *contactless thermometer* or *infrared thermometer*. This Encyclopedia classifies a thermometer as a commercially marketed product, not a component.

Devices such as a *radiation pyrometer*, *IR pyrometer*, *optical pyrometer*, or *thermal imager* provide ways of measuring infrared radiation, but are outside the scope of this Encyclopedia.

A **passive infrared** motion sensor (PIR) can detect infrared radiation, but only responds to fluctuations in intensity. An infrared temperature sensor measures the steady-state value of incident radiation.

OTHER RELATED COMPONENTS

- **passive infrared** motion sensor (see Chapter 4)
- **thermocouple** (see Chapter 25)

What It Does

Most temperature sensors discussed in other entries in this Encyclopedia are *contact sensors*, meaning that to measure the temperature of an object, liquid, or gas, they must make contact with it. In situations where contact is not possible or desirable, an **infrared temperature** sensor can be used. It responds to the *black-body radiation* (sometimes known as *characteristic radiation*) that is emitted by all materials above absolute zero (0 degrees Kelvin). This varies with temperature as a result of the movements of molecules.

Situations where noncontact sensors may be preferable to contact sensors include:

- An object is inconveniently located or too far away.
- The temperature of a large area must be measured.
- Contact with a small object would change the temperature of the object. The act of measurement would change the value being measured.
- The object is corrosive, abrasive, or otherwise liable to damage a sensor.
- The object is moving or vibrating.
- The surface of the object must not be contaminated (for example, unprotected foods).

- The temperature of the object is lower than around -50 degrees Celsius or higher than 1,300 degrees Celsius.

However, noncontact sensors have some limitations:

- Normally, only the surface temperature of a target can be measured.
- The optics of the sensor must be protected from dust, dirt, and liquid.
- The target must be clearly visible, in line-of-sight.
- Air pollution will degrade the temperature measurement. Some gases, such as carbon dioxide, will tend to absorb infrared radiation.
- The sensor will be affected by other sources, including reflected, transmitted, and convective heat.
- While an infrared sensor can theoretically respond to a very wide range of temperatures, in practice separate sensors of differing sensitivity are needed to cover a full range.
- Different types of materials emit differing intensities of black-body radiation, even if they are at the same temperature. Some compensation is necessary, or the surface of the object may have to be painted.

Applications

Handheld contactless thermometers were an early application for noncontact sensors.

In astronomy, the thermal radiation from the Sun and other stars is of interest to astronomers.

More recently, the declining cost of an infrared temperature sensor, and the ease of deploying it, have made it appropriate in consumer products. A significant area of adoption is in notebook computers and handheld devices, where processor performance must be balanced against the need to prevent the case from becoming too hot to hold comfortably. In this kind of application, gluing a sensor to the interior of the case would be a manual operation during the production process and would require a wired connection. An infrared temperature sensor mounted on the circuit board, viewing the underside of the case, can achieve the same objective more simply.

A contactless sensor is also very useful for measuring the temperature of rotating objects, such as heating rollers in a laser printer.

Schematic Symbol

No specific schematic symbol exists for an infrared temperature sensor.

How It Works

While nanometers (abbreviated nm) are generally used to measure visible wavelengths, the longer wavelengths of far-infrared are often measured in micrometers (abbreviated µm). The measurable infrared values are defined as ranging from 0.7µm to 14µm, corresponding to peak emissions from a black body ranging in temperature from 200 degrees Kelvin to 6,000 degrees Kelvin (about -70 to +5,700 Celsius).

Unfortunately an object does not emit just one wavelength of black-body radiation for each temperature value. It emits a spread of wavelengths that becomes wider as the temperature increases. However, the peak intensity also increases with temperature, when measured as *spectral radiance*, which is defined as watts per steradian, per micrometer of wavelength. (A steradian is the solid angle at the top of a cone, in this case the cone being of emitted radiation.) Because the intensity increases, it can be used to calculate the temperature.

Figure 28-1 illustrates this concept. Note that both of the axes have logarithmic scales.

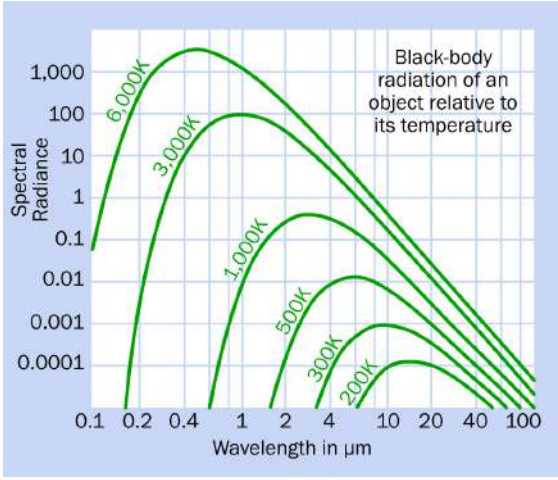

Figure 28-1 *The increase in intensity, and the widening spread of wavelengths, of black-body radiation emitted by one object at six different temperatures (in degrees Kelvin).*

All the curves are for one object. Each curve is specific to one temperature in degrees Kelvin, showing how the intensity of emitted radiation varies with wavelength. Note that radiation at wavelengths shorter than 0.7µm is within the visible spectrum; thus, objects at 1,000 degrees Kelvin, or hotter, may be seen to glow visibly.

Because of the wide variety of intensities and temperatures, an infrared sensor that is ideal for measuring a temperature of 1,000 degrees Kelvin will not provide an accurate result at 200 degrees Kelvin. The peak spectral radiance at 1,000 degrees is more than 10,000 times the peak at 200 degrees. Also, the curves in the figure are for an "ideal" object emitting pure black-body radiation. In reality, glass, plastic, and many other materials have a much lower *emissivity*, meaning that they emit less radiation, and are classified as *gray bodies*. A metallic object with a polished surface may emit one-tenth of true black-body radiation.

These issues cannot be ignored, but may be dealt with by relatively simple strategies. Infrared sensors will be rated according to their suitability for different temperature ranges, and the emissivity of the object being measured can be determined by consulting standard tables. Alternatively, the object can be spray-painted with special black paint (such as "Senotherm" or "3-M Black") that has a known emissivity of about 0.95 of pure black-body radiation. Alternatively, a specially formulated black sticker may be applied to the object that is being measured, so long as its temperature is within reasonable limits.

However, a basic infrared temperature sensor will not function reliably if it is pointed randomly at a variety of objects that vary widely in temperature. Specialized, expensive industrial devices incorporate compensation to deal with these issues, but they are outside the scope of this Encyclopedia.

Thermopile

A typical low-cost, chip-based infrared temperature sensor contains a *thermopile* consisting of multiple thermocouples etched into silicon and connected in series. The concept of a thermopile is illustrated in Figure 25-9, where a brief explanation is included.

The configuration of the thermopile is arranged so that the hot junctions of its thermocouples are all clustered in a small central area, where they receive incoming radiation through a window (often made of silicon) that is transparent to infrared wavelengths. The cold junctions are dispersed around the periphery, where they are shielded from incoming radiation. One way to visualize this is shown in Figure 28-2, although this is not a literal depiction of an actual sensor.

Instead of using alternating types of wire, as in a **thermocouple**, a chip-based thermopile often uses alternating segments of n-type and p-type silicon. The hot junctions are mounted on a thin film that has very little heat capacity, while the cold junctions are mounted on a thicker substrate that acts as a heat sink.

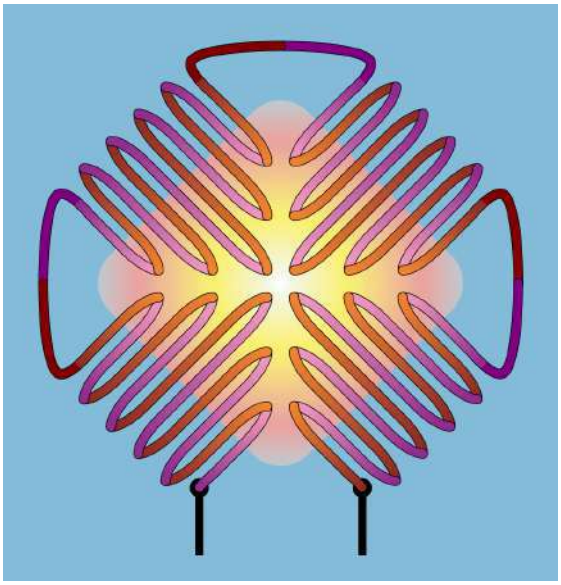

Figure 28-2 *Simplified diagram of the thermopile configuration inside an infrared sensor chip. Radiation arriving through a window in the chip affects the thermocouple junctions in the central region, while junctions around the edges remain at a lower temperature.*

Temperature Measurement

The voltage generated by the thermopile is related to the difference in temperature between the hot and cold thermocouple junctions. Thus there are three interrelated variables: hot temperature, cold temperature, and voltage. To calculate one variable, we must know the other two.

The hot temperature is what we wish to know. Therefore we must establish the voltage (which can easily be measured) and the cold temperature. The cold temperature can be determined by adding a thermistor inside the chip.

Typically an infrared temperature sensor with an analog output will have two pins that provide access to the internal thermistor, so that its temperature can be calculated from its resistance. Another two pins provide the voltage between the ends of the thermopile.

Interpreting and reconciling these values is not a trivial matter, especially bearing in mind that the thermistor has a negative temperature coefficient and a nonlinear output, and the thermopile will also have some nonlinearity. To simplify this situation, some infrared temperature sensors incorporate electronics to perform the necessary calculations and provide a digital output. This output can be converted to degrees of temperature by some fairly simple mathematical operations in an external microprocessor.

Variants

Two types of sensors are popular. One is surface-mounted, such as the TMP006, shown in Figure 28-3. This type generally has a digital output. The other type is a discrete component with four leads, such as the Amphenol ZTP135, shown in Figure 28-4. Discrete components may have either an analog or a digital output.

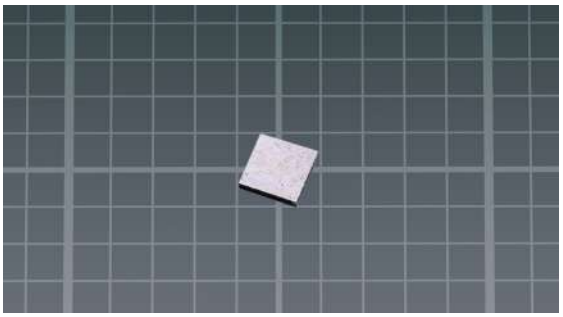

Figure 28-3 *A surface-mount infrared temperature sensor with digital output. Eight tiny solder pads are located on the underside. The background grid is in millimeters.*

Both types of sensors allow infrared light to enter through an area that is opaque to the visible spectrum but transparent to the appropriate range of wavelengths.

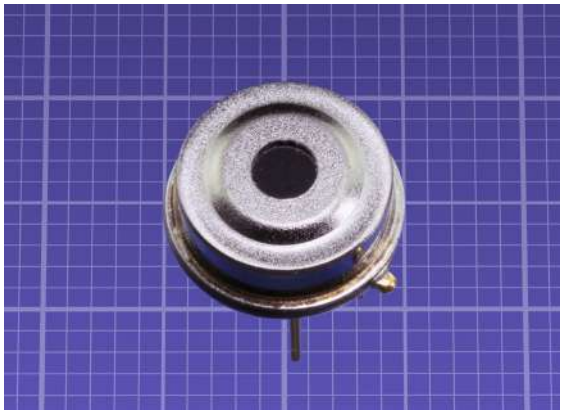

Figure 28-4 *A through-hole infrared temperature sensor with analog output. The background grid is in millimeters.*

The ZTP135 has an analog output shown in Figure 28-5.

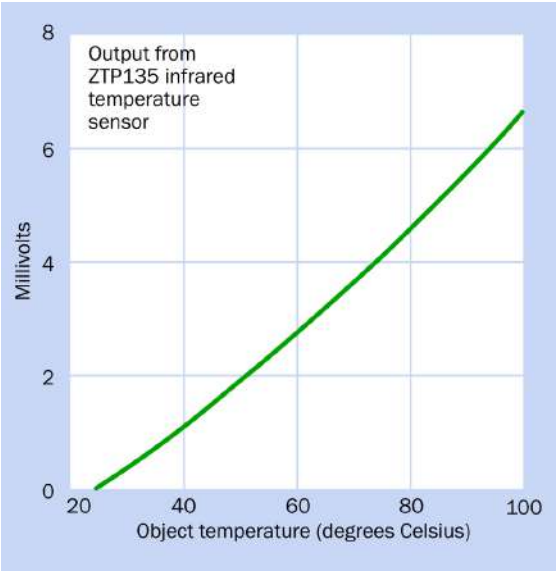

Figure 28-5 *Analog output from an infrared temperature sensor.*

The TMP006 is only about 1.5mm square, but is available on a breakout board from Sparkfun. Its successor, the TMP007, is available on a breakout board from Adafruit, shown in Figure 28-6.

Figure 28-6 *The TMP007 sensor mounted on a breakout board from Adafruit.*

Surface-Mount Specifications

The TMP006 and TMP007 require a supply voltage that can range from 3.3V to 5V. These chips support the SMBus and I2C bus protocols, using a bus address that can be user-selected. An internal analog-to-digital converter uses 1 least-significant bit to represent 1/32nd of a degree Celsius, and data is saved as a 14-bit signed integer. Up to 16 temperature samples can be averaged internally.

Measurable temperature range is -40 to +125 degrees Celsius. Some hysteresis is built in. The TMP007 supports an alert mode if temperature falls above or below a user-specified threshold.

Sensor Arrays

Using multiple thermopile sensors arrayed in a line or a grid, with an array of lenses, it is possible to capture an image of temperature variations over a surface or a scene. This is known as *thermal imaging*. It can detect heat leakage from buildings, indicating poor insulation, or can locate hot spots in electronic circuits. Heimann Sensor has pioneered the miniaturization of a 31 x 31 grid of thermopile sensors in a single TO-8 or TO-39 package.

Values

Temperature Range

Chip-based infrared temperature sensors are typically designed for a range from about -20

degrees Celsius to about +125 degrees Celsius. Their peak sensitivity is to wavelengths between 4µ and 16µm.

Other types of infrared temperature sensors can have a much wider temperature range, but are more costly.

Field of View

Often referred to by its acronym, *FOV*, the field of view is the angle at the apex of an imaginary cone extending outward from the sensor, defining a boundary where the sensitivity diminishes below 50% of the value directly in front of the sensor. Greek letter ϕ may be used to represent the angle between the surface of the cone and the center line, while θ represents the angle between the opposite surfaces of the cone (i.e., 2 * ϕ). This is shown in Figure 28-7. θ is usually the angle defined as field of view.

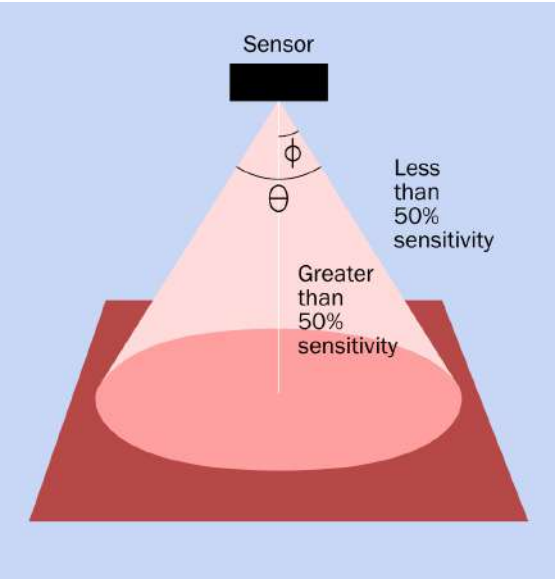

Figure 28-7 *Measurement of the field of view from a sensor, defined as the boundary of an imaginary cone where sensitivity drops below 50%.*

Because most infrared temperature sensing components do not have a lens, they are sensitive over a wide angle. The field of view is typically 90 degrees.

What Can Go Wrong

Inappropriate Field of View

The object being evaluated must fill the field of view of the sensor, to avoid measuring other objects around it.

Reflective Objects

A reflective object has lower infrared emissivity, and also may provide misleading output if the sensor is actually measuring thermal radiation reflected in the surface of the object in front of it. In a permanent installation, such as inside a device, the surface to be measured may have to be painted to reduce its reflectivity.

Glass Obstruction

Because glass is opaque to the spectrum of infrared that is of interest, temperature cannot be measured through a glass window. Silicon is opaque to visible wavelengths but is transparent to wavelengths longer than 2µm.

Multiple Heat Sources

Heat is transferred by convection, conduction, and radiation. While an infrared temperature sensor is designed to be sensitive to radiation, it will also respond to other heat sources. Warm or cold air currents will affect its response, and so will heat conducted through the material on which it is mounted. Careful placement of the sensor is important. A shield around the sensor, with a small hole in the center, can prevent convection, while correct location on a circuit board can minimize conduction.

Thermal Gradients

An infrared temperature sensor should be mounted in a stable environment where it will not be exposed to thermal gradients (one side being hotter than another). This asymmetry can cause inaccurate readings.

microphone

29

OTHER RELATED COMPONENTS

- **speaker** (see Volume 2)
- **headphone** (see Volume 2)

What It Does

The sensation of sound is created by rapid waves of air pressure impinging upon the eardrum. A microphone can convert these pressure waves into an alternating electrical signal that can be amplified, recorded, broadcast, transmitted through wires, and reproduced as sound by a headphone or speaker. The principle is illustrated in Figure 29-1. (For more information about sound reproduction, see the entries on **headphone** and **speaker** in Vol. 2.)

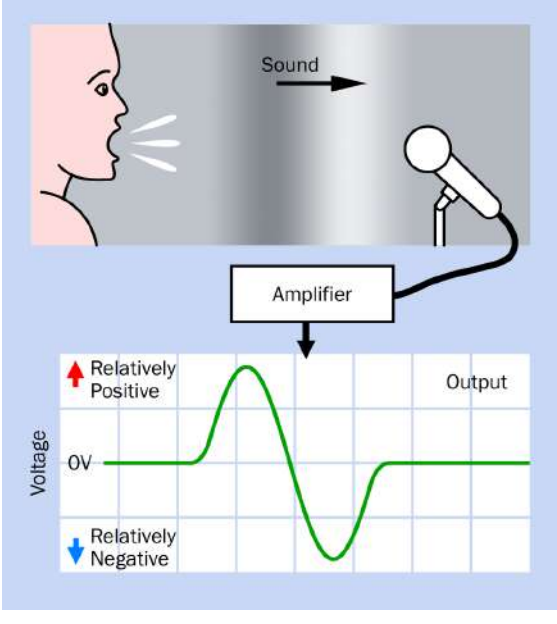

Figure 29-1 *The principle of converting pressure waves into an alternating electrical signal (adapted from an illustration in Make: More Electronics).*

Schematic Symbol

Various schematic symbols for a microphone have been used during the decades since its invention. A selection is shown in Figure 29-2. Each symbol assumes that sound is traveling from left to right. This is important when interpreting the symbol at top right, which can represent an earphone when it points in the opposite direction. Unfortunately, some schematics do not conform with this rule.

The two symbols at the bottom, showing a capacitor inside the microphone, should be reserved for condenser or electret microphones.

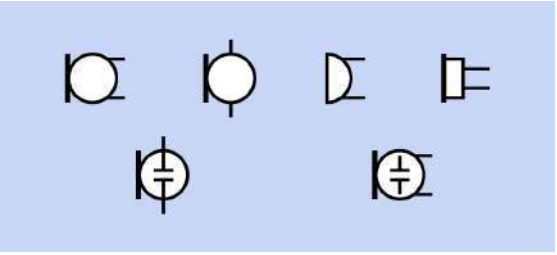

Figure 29-2 *A selection of schematic symbols that represent a microphone.*

How It Works

Some types of microphones generate a small voltage, while others have a fluctuating resistance that modulates a DC current.

Carbon Microphone

This was a very early attempt to reproduce sound. It contained carbon granules whose packing density increased and decreased in response to air pressure waves. When the density increased, the resistance between the granules diminished, and vice-versa. The principle is illustrated in Figure 29-3, and was patented by Thomas Edison in 1877 for use in telephones. As late as the 1950s (and even later in some countries), wired telephone handsets contained carbon microphones. Their bandwidth was extremely limited.

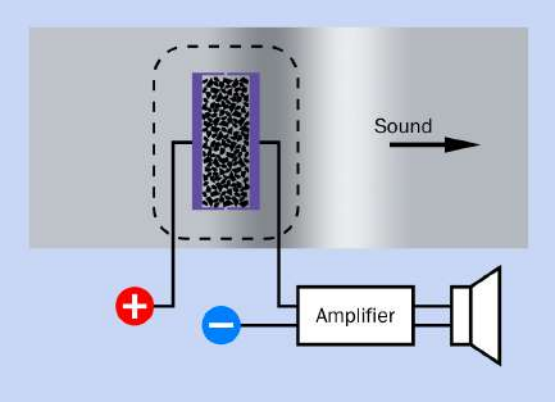

Figure 29-3 *The principle of a carbon microphone.*

Moving-Coil Microphone

Also known as a *dynamic* microphone, this consists of a very small, light coil of thin wire on a cylindrical tube that can vibrate along the axis of a permanent magnet. This principle is illustrated in Figure 29-4. A diaphragm is attached to the front of the tube, and responds to air pressure waves that penetrate the perforated enclosure of the microphone. Movements of the coil around the magnet create small alternating currents in the wire. The inertia of the coil, tube, and diaphragm, and the force needed to overcome the interaction between the coil and the magnet, impose a limit on the high-frequency response of this design.

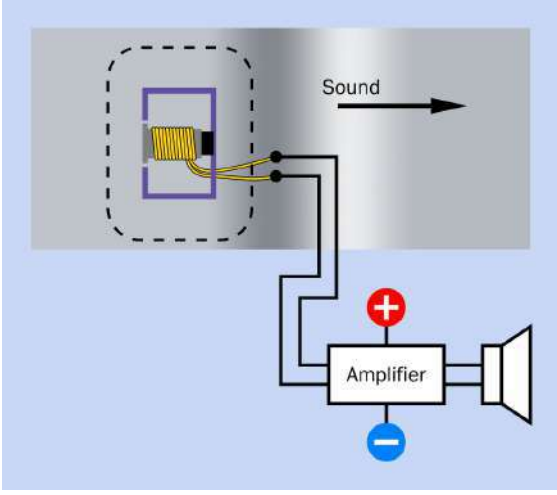

Figure 29-4 *The principle of a moving-coil microphone.*

Condenser Microphone

This type of microphone contains two thin discs or plates that form a capacitor. (In the early days of electricity, a capacitor used to be known as a condenser. The terminology has persisted for microphones.) An equal and opposite charge is applied to the plates. One plate is flexible, and as it responds to pressure waves, the capacitance between it and the other, rigid plate fluctuates. If the charge on the plates is kept approximately constant while the capacitance fluctuates, the voltage across the

capacitor fluctuates also. These fluctuations can be amplified, as suggested in Figure 29-5.

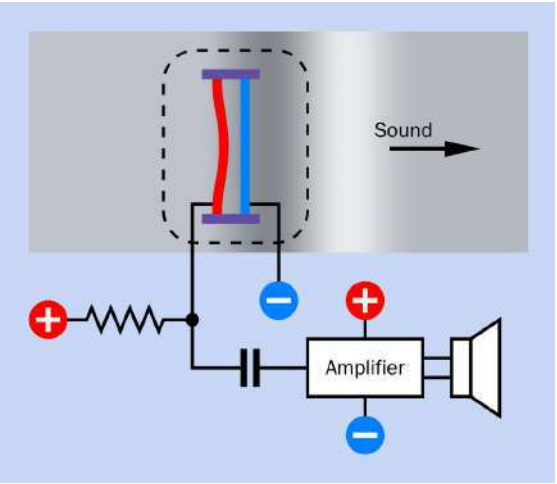

Figure 29-5 *The principle of a condenser microphone.*

Electret Microphone

This works on the same principle as a condenser microphone, except that its plates are made from a ferroelectric material that retains an electrical charge, just as iron will retain a magnetic polarization. The name of the microphone is derived from "electrostatic" and "magnet." While early electret microphones were of poor quality, they have evolved to rival condenser microphones, and are extremely affordable. Because the electret creates very small currents, it usually includes a transistor or op-amp in its package to boost the signal, and has an open-collector output. The basic circuit for an electret is shown in Figure 29-6. For more information about using an open-collector output, see Figure A-4.

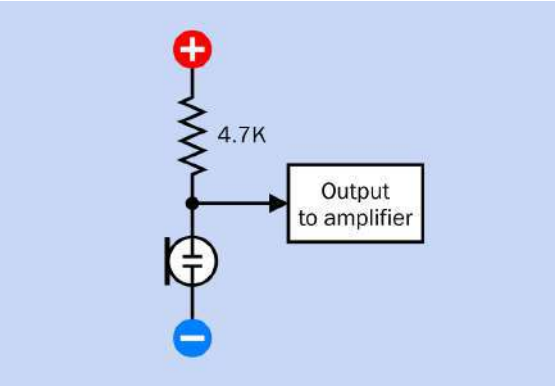

Figure 29-6 *The basic circuit for using an electret microphone.*

An example of a low-cost electret microphone is shown in Figure 29-7. This type of component is sold either with leads attached, or with solder pads.

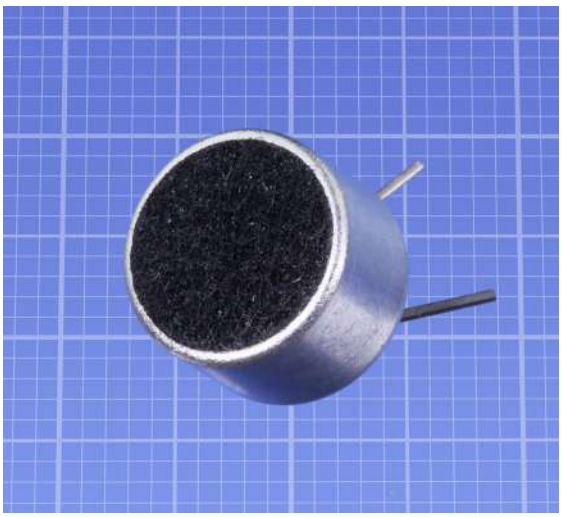

Figure 29-7 *A generic electret microphone. The background grid is in millimeters.*

MEMS Microphone

This type, often used in mobile phones, is a capacitive device that works on the same principle as a condenser microphone, although the component is etched in silicon and has a diaphragm that measures only about 1mm square. Many MEMS microphones have an analog output that is amplified in the same chip. Others have a digital output, using *PDM encoding*. This

reduces the analog signal to a very fast bit stream, in which the density of the bits represents the amplitude of each fluctuation in a sound wave. PDM is an acronym for *pulse density modulation*. It requires an external clock signal to time the bit stream.

A breakout board from Sparkfun, on which is mounted an Analog Devices ADMP401 MEMS microphone with a preamplifier, is shown in Figure 29-8.

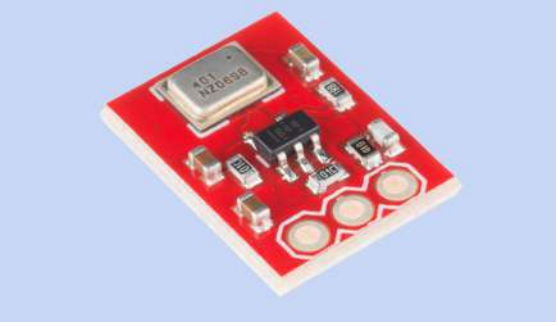

Figure 29-8 *A breakout board for a MEMS microphone (the metal-clad rectangular component at the far end).*

Piezoelectric Microphone

This has also been known as a *crystal* microphone. It contains a diaphragm that functions as a transducer. When it flexes in response to pressure waves, the mechanical energy is transformed into a small amount of electrical energy. Piezoelectric microphones were replaced by the moving-coil type in domestic audio devices when vacuum tubes were replaced with transistors, but may still be used as contact microphones to amplify acoustic musical instruments, or to trigger the playback of digitally sampled musical sounds.

Other variants include *ribbon* microphones (which were common in recording studios in the 1950s and 1960s, but have become rare), *laser* microphones, and *fiber-optic* microphones. They are not sufficiently common to be included in this entry.

Values

Sensitivity

Sound pressure is a complicated topic, explored in detail in the **transducer** entry in Volume 2. It can be measured in pascals, where 1 pascal = 1 newton per square meter.

The *sound pressure level* is a different concept. It measures the *relative* intensity of a sound, in a logarithmic scale calibrated in *decibels* (abbreviated dB). The reference value for this relative scale is 20 micropascals, considered to be the threshold of human hearing, comparable to a mosquito three meters away. This is assigned the value of 0dB.

From this point upward, the actual sound pressure doubles for each additional 6dB. A table of noise sources and their approximate decibel values is shown in Figure 29-9. This is derived from averaging eight similar tables, which are not always consistent in their estimates. It is an approximate guide only.

Decibels	Noise Example
140	Jet engine at 50 meters
130	Threshold of pain
120	Loud rock concert
110	Automobile horn at 1 meter
100	Jackhammer at 1 meter
90	Propeller plane 300 meters above
80	Freight train at 15 meters
70	Vacuum cleaner
60	Business office
50	Conversation
40	Library
30	Quiet bedroom
20	Leaves rustling
10	Calm breathing at 1 meter
0	Auditory threshold

Figure 29-9 *Decibel values for some common sound sources. Reproduced from Volume 2 of this Encyclopedia.*

The decibel unit is important when understanding the specifications of microphones, because it is used to measure their response. Microphone sensitivity is established with a standard input sine wave of 1kHz in frequency and 94dB in intensity (equivalent to 1 pascal in actual sound pressure), measured at the microphone. The sensitivity of an analog microphone is then defined as the number of decibels in an output signal of 1V. Because the output is an AC signal, voltage is measured as a root-mean-square (RMS) value.

For digital microphones, sensitivity is measured as the decibels that can be reproduced by a full-scale digital output. This value is abbreviated as dBFS.

Directionality

A microphone that has a directional response is desirable in many situations. Often, for example, sounds in front of the microphone are more important than sounds from behind the microphone. The directionality of a microphone (sometimes referred to as its *directivity*) is usually represented with a *polar graph* in which the microphone is seen from above, and its sensitivity to sounds from various directions is shown with a curve such as those in Figure 29-10. The circles are drawn at intervals of 5dB, with 0dB at the periphery and -30dB at the center. The precise response for an individual microphone should be shown in its documentation.

Frequency Response

Every microphone tends to be more sensitive to some sound frequencies than others. A manufacturer will provide a graph showing this sensitivity, in decibels, plotted against sound frequency on a logarithmic horizontal axis. Theoretically, human hearing extends from around 20Hz to 20kHz, but few people are actually capable of hearing the high end of that range, and 15kHz may be a more realistic limit for a young person, diminishing to 10kHz with middle age.

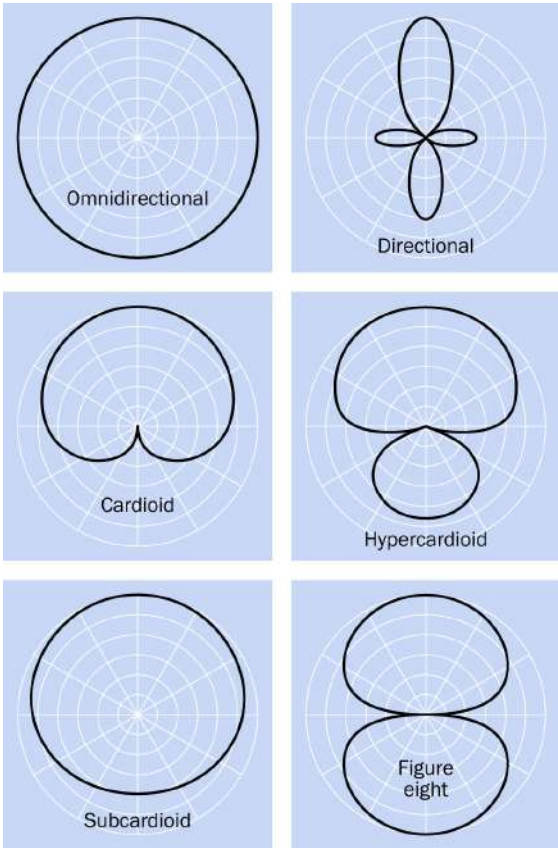

Figure 29-10 *Six generic sensitivity patterns. Individual microphones will deviate somewhat from these generic curves.*

An ideal flat response would show that a microphone is equally sensitive to all frequencies. In reality, *rolloff* usually occurs at low frequencies, and will eventually occur at high frequencies, although it may be preceded by a rise in response. If the central section of a curve is flat within plus-or-minus 1dB, this is a level of performance that was attained only by expensive studio microphones in the past. Electrets and MEMS microphones can now provide equivalent frequency response for $1 or $2 apiece, as opposed to the hundreds or even thousands of dollars that used to be necessary for professional equipment.

The response curve shown in Figure 29-11 is for the eMerging i436, an electret microphone sold in a module as an accessory to enable high-

quality recordings on handheld devices. The rise around 15kHz may have been introduced deliberately by the manufacturer to compensate for reduced sensitivity of the human ear in that range.

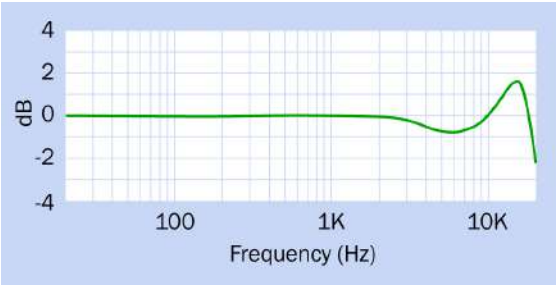

Figure 29-11 *Frequency response for an electret microphone.*

Impedance

The impedance value for a microphone is a function of its resistance, capacitance, and inductance. An amplifier input will also have an impedance rating, and for ideal power transfer between microphone and amplifier, the impedance values should be identical. However, a more important consideration in audio equipment is to avoid voltage loss between the output device (in this case, the microphone) and the input device (the amplifier). To achieve this, the output device should have a low impedance, while the input device should have a high impedance. Most microphones are rated at 150 to 200 ohms, while an amplifier may be rated at 1.5K to 3K.

Total Harmonic Distortion

When an audible sine wave is converted to an electrical output by a microphone (and by its preamplifier, if one is included in the module), the output may become corrupted by some multiples of the basic frequency. These are known as *harmonics*, and they are considered as a distortion of the signal. Total harmonic distortion, measured by a spectrum analyzer over the entire frequency range, should ideally be less than 0.01%.

Signal-to-Noise Ratio

Often abbreviated as S/N or SNR, the signal-to-noise ratio in a microphone is measured in decibels, and should be 60dB or higher.

What Can Go Wrong

Cable Sensitivity

Audio amplification is always vulnerable to electrical noise, which tends to be amplified along with the signal. Small signals from microphones require the use of shielded cables to reduce hum and other types of interference.

Noisy Power Supply

For similar reasons, power supplies must be as free as possible from voltage spikes and other fluctuations.

current sensor

30

The entry describes components that can be installed to monitor current on an indefinite basis. It does not include test equipment, such as test meters or multimeters.

A *current transformer* may be used to measure current, but is not included in this Encyclopedia.

OTHER RELATED COMPONENTS

- **voltage** sensor (see Chapter 31)

What It Does

A current sensor measures the flow of electricity through a wire or a device, and supplies an output that can be interpreted either visually or by a microcontroller to provide a reading in amperes or fractions of an ampere.

Applications

Current sensing is important in industrial applications such as the control of high-powered motors. It can be used to monitor the performance of an inverter, or for everyday purposes such as monitoring the long-term power consumption of an appliance. During product development, a current sensor can indicate the power consumption of a circuit as it changes with modifications.

This entry describes three methods to measure current: an ammeter, series resistor, and Hall sensor. While other methods exist, they are outside the scope of this Encyclopedia.

Ammeter

An ammeter that is sold as a standalone device with leads for circuit testing is often described as a *test meter*. Its functionality is usually built into a *multimeter*. Test meters and multimeters are outside the scope of this Encyclopedia.

An ammeter designed for permanent installation in a device or prototype is a type of *panel meter*, such as the one shown in Figure 30-1. This traditional-style analog meter may be less expensive than the many digital types that are available. It uses a magnetic field created by current flowing through a coil to pull a needle across a scale, against the force of a spring.

Figure 30-1 *A traditional-style analog ammeter.*

A digital ammeter allows a wider range of values to be viewed more easily. The meter from Adafruit in Figure 30-2 has a range of 0A to 9.99A, at voltages from 4.5VDC to 30VDC. The meter can be powered parasitically from the currents that it is measuring, or can use a separate isolated 5VDC supply.

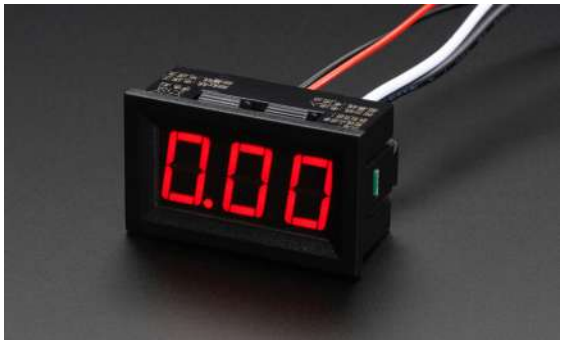

Figure 30-2 *A panel-mount digital ammeter that can measure up to 9.99A.*

Schematic Symbol

An ammeter may be represented in a schematic with the letter A inside a circle, as shown in Figure 30-3.

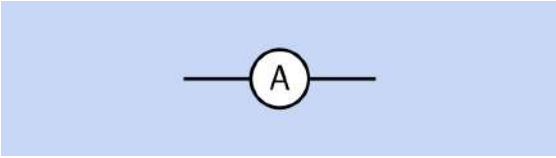

Figure 30-3 *An ammeter may be represented like this in a schematic.*

Ammeter Wiring

Two ways to use an ammeter in a circuit are illustrated in Figure 30-4, where the load may be any equipment, device, or component that provides some electrical resistance. Because current is the same at all points in a simple circuit, the current that the meter measures flowing through itself will be the same as the current flowing through the load, and the sequence of components is immaterial.

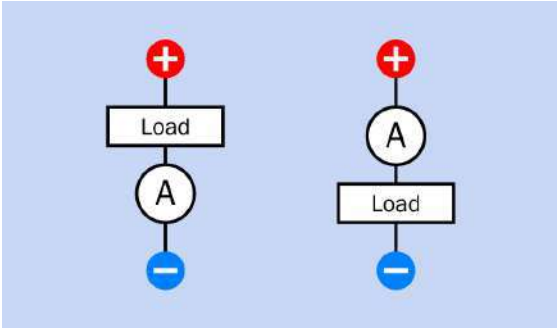

Figure 30-4 *Two options for placement of an ammeter in a circuit.*

However, regardless of the placement of the meter, the process of measuring current will inevitably change the value of the current being measured. This is because the ammeter imposes some internal resistance of its own. The resistance is extremely low, and may be considered negligible for loads of more than a few ohms.

- The low internal resistance of an ammeter means that it must never be connected in parallel with a load, or directly across a power source.

A disadvantage shared by analog and digital meters is that they are not usually interchangeable between AC and DC.

Series Resistor

The current flowing through a load can be calculated by measuring the voltage across a series resistor that is inserted between the load and its ground connection. The concept is illustrated in Figure 30-5.

Using Ohm's law, if U is the voltage drop, I is the current, and R is the value of the resistor:

```
I = U / R
```

This tells us that for a fixed value of R, current is proportional to voltage. Therefore, measuring the voltage enables calculation of the current, so long as the value of R is known.

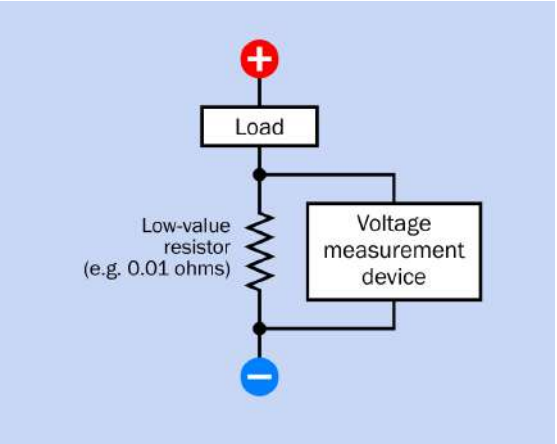

Figure 30-5 *A basic circuit for measuring current as a function of the voltage drop across a small-value resistor. The load in this figure is any circuit or device with a relatively higher resistance. The voltage measurement device could be a microcontroller or analog-to-digital converter.*

Suppose that R has a very small value, which is trivial compared with the resistance of the load. Consequently, the current in Figure 30-5 will be mainly determined by the load, and we may consider the value of the current to be almost the same with or without the addition of R. In that case, the voltage drop across the resistor will be smaller if R is smaller. A smaller voltage drop will not be as easy to measure, but a lower resistance will result in less wastage of power.

If P is the power:

$$P = R * I^2$$

An example may help to make this clear. Suppose the resistor has a value of 0.5 ohms, and the voltage drop across it is measured to be 1V. Ohm's law shows that current flow is 1 / 0.5 = 2A. The power formula shows that P = 0.5 * 4 = 2W.

To waste less power, the value of the resistor should be reduced further. Suppose a resistor of 0.01 ohms is used, and the voltage drop across it is measured as 0.02 volts. The current is 0.02 / 0.01 = 2A, as in the preceding example, but the power dissipation is now only 0.01 * 4 = 0.04W, which is negligible.

But are resistors available that have values measured in fractions of an ohm?

Current-Sense Resistors

In fact, many *current sense* resistors are available, with values of 0.1 ohms, 0.001 ohms, 0.0001 ohms, and many in between. Some resistors have values measured in micro-ohms. Examples are shown in Figures 30-6, 30-7, and 30-8.

Measuring a small voltage drop is easily done by using a microcontroller. However, the connection to the microcontroller must be made as near to the resistor as possible, to eliminate the additional resistance of wires or circuit-board traces. For this reason, precision current-sense resistors may be equipped with four terminals. Two are wider, and are meant for connection to the flow of current. The other two are narrow, for measuring the voltage over the resistor. With this *4-point* configuration, voltage drop over the resistor can be measured as close to it as possible. The 0.001-ohm surface-mount resistor in Figure 30-8 is designed for 4-point measurement.

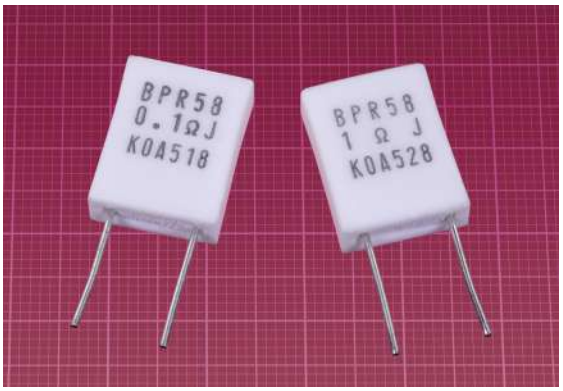

Figure 30-6 *Two current resistors manufactured by KOA Speer. Left: 0.1 ohms, 5W, 5%. Right: 1 ohm, 5W, 5%. The background grid is in millimeters.*

Figure 30-7 *Two styles of current resistors rated for 0.01 ohms. Bottom left: A plug-in version from TT Electronics, rated 1W and 5%. Top right: Ohmite, 4W, 1%. The background grid is in millimeters.*

Resistors that have the lowest values and are intended to tolerate high current may consist of just a metallic strip welded to solderable pins. This type of component is sometimes called an *open-air resistor*. It is commonly used in multimeters, for measuring currents up to 10A or above.

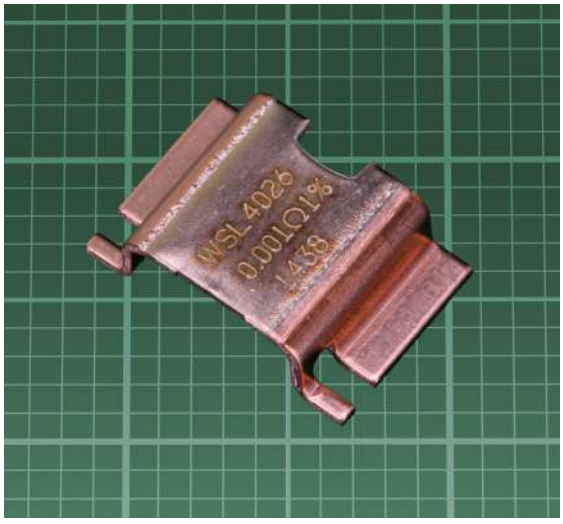

Figure 30-8 *This Vishay 4-terminal surface-mount current resistor is rated for 0.001 ohms, 3W, 1%. The background grid is in millimeters.*

Voltage Measurement

Some chips are designed for amplifying the voltage drop across a current-sensing resistor. An example is the Texas Instruments INA169.

A few chips contain an analog-to-digital converter in addition to the amplifier. The INA219 by Texas Instruments is designed to measure voltage as well as current, on the "high side" of a circuit—that is, between the positive power supply and the power input of the circuit. It makes its digital data available over an I2C bus.

For additional details about protocols such as I2C, see Appendix A.

Measuring current from the voltage drop across a series resistor offers the advantages of simplicity, ability to work with AC or DC, and low cost (although some resistors of extremely low value can be relatively expensive). A possible disadvantage is that the measurement circuit is not isolated from the circuit whose current is being measured.

Hall-Effect Current Sensing

The principle of a Hall-effect sensor is explained in the entry for **object presence** sensors. See "Hall-Effect Sensor". Normally this type of sensor is activated by an external permanent magnet, but it can also react to the magnetic field generated by current flowing through a wire.

Because the field generated around a wire is proportional with the current, the analog output voltage generated by a linear Hall-effect sensor can also be proportional with the current.

Hall-effect sensors for this specific purpose are available in 8-pad surface-mount packaging. The current to be measured passes through a copper conductor that is embedded in the chip. An example is Allegro's ACS712, for AC or DC currents up to 30A. The internal resistance of the current path through this chip is stated

as 1.2 milliohms, and the path is isolated from the sensing circuitry.

Three variants of the chip are available, for currents of plus-or-minus 5A, 20A, and 30A. Depending on which variant is used, the output will range from 66mV to 185mV for each increase of 1A in the current path. Because the current path is isolated, the chip requires a separate power supply of 5VDC.

The 5A version of the AVS712 can be bought on breakout boards from Sparkfun. In Figure 30-9, the board at top-left contains only the ACS712, while the board at lower-right adds an op-amp with sensitivity control, to amplify the voltage output when measuring small currents.

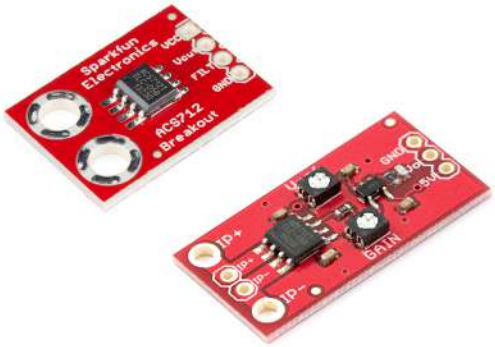

Figure 30-9 *Breakout boards using the AVS712 Hall-effect current sensor. The one at lower-right includes an op-amp to amplify small signals.*

What Can Go Wrong

Confusing AC with DC

A panel meter that is designed only to measure DC should not be used with AC, and vice-versa. Erroneous readings or damage to the meter may result.

Magnetic Interference

A disadvantage of Hall-effect current sensing is that the sensor can be affected by stray magnetic fields. Because a Hall-effect chip is responding to very small magnetic effects, it is vulnerable to interference. Consult the manufacturer's datasheet carefully regarding correct placement of a chip on a circuit board.

Incorrect Meter Wiring

The correct wiring of an ammeter is in series with a load, not in parallel with a load. This may seem an elementary error, but is easy to make if an ammeter and a volt meter are both being used, and they look similar.

Because some panel meters are not fused, applying an ammeter directly across a power supply, without any series resistance, may result in immediate and hazardous destruction of the meter.

Incorrect wiring can also occur when using a digital meter that has four wires emerging from it: two for current testing and two for a separate power supply. This issue is especially important when measuring substantial currents (above 1A).

Current Out of Range

Attempting to measure a current that exceeds the range of an ammeter may damage the meter or blow its internal fuse, if it has one.

voltage sensor

31

The entry describes the type of component that can be installed to monitor voltage on an indefinite basis. It does not include test equipment, such as test meters or multimeters.

OTHER RELATED COMPONENTS

- **current** sensor (see Chapter 30)

What It Does

A voltage sensor measures the electrical potential between any two points in a circuit, or the voltage supplied by a power source, and provides data in volts or fractions of a volt. It should not be confused with an *analog-to-digital converter*, which is not a sensor in itself, but can process the voltage output from a sensor by digitizing it. More information about analog-to-digital conversion is in the Appendix. See Appendix A.

Applications

Voltage measurement is important in conjunction with all types of power supplies, to verify their performance. A volt meter may also be used to show the output from various types of analog sensors that have voltage output.

A graphical display may be used in audio equipment to indicate signal level, which can be proportional with voltage.

Volt Meter

A volt meter that is sold as a standalone device with leads for circuit testing is often described as a *test meter*. Its functionality is usually built into a *multimeter*. Test meters and multimeters are outside the scope of this Encyclopedia.

A volt meter designed for permanent installation in a device or prototype is a type of *panel meter*, which is described here.

An antique analog panel meter is shown in Figure 31-1.

Figure 31-1 *An antique analog volt meter.*

The four scales on the dial correspond with separate input terminals at the rear of the unit. The

unequally divided scales are a simple way to compensate for the nonlinear response of the mechanical movement inside the meter.

Modern analog volt meters are still manufactured, and may be cheaper than their digital equivalents. However, a digital volt meter allows a wider range of values to be viewed more easily. The meter in Figure 31-2, sold as a low-cost battery tester, measures voltages from 4VDC to 13VDC to an accuracy of two decimal places. It needs no separate power supply.

Figure 31-2 *A panel-mount digital volt meter.*

Sometimes the number of digits in a volt meter is specified as ending with one-half, as in 3.5 or 3-1/2 digits. This means that the most significant (leftmost) digit can only be a 1 or a blank. The extra "half digit" may seem inconsequential but doubles the range of displayable values. For example, a 2-digit display can only show 100 values, from 0 to 99. A 2-1/2-digit display can show 200 values, from 0 to 199.

Schematic Symbol

A volt meter may be represented in a schematic with the letter V inside a circle, as shown in Figure 31-3.

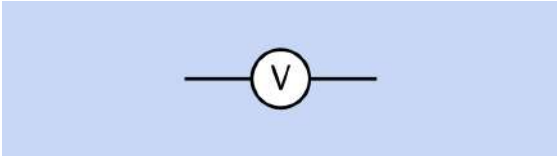

Figure 31-3 *A volt meter may be represented like this in a schematic.*

Volt Meter Wiring

Two ways to use a volt meter in a circuit are illustrated in Figure 31-4, where the load may be any equipment, device, or component that provides some electrical resistance.

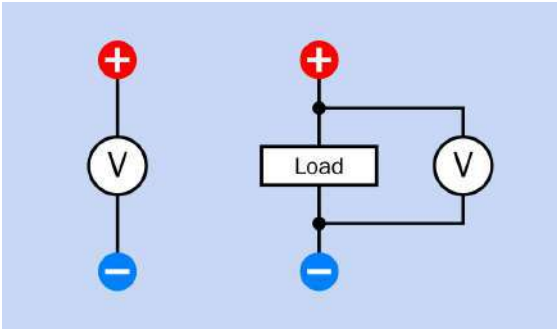

Figure 31-4 *Two options for placement of a volt meter.*

On the left side of the figure, a volt meter may be connected directly across a power source, because the internal resistance of the meter is so high, it will draw very little current. In this configuration, the meter measures the voltage of a source when the source is virtually unloaded.

On the right, the meter can measure the voltage drop across a load, or can measure the voltage across any component, or group of components, that are a subset of the load.

A disadvantage shared by dedicated analog and digital volt meters is that they are not usually interchangeable between AC and DC.

How It Works

An analog volt meter usually contains a built-in, high-value fixed resistance, and an ammeter

measuring the current passing through it. The current sensed by the ammeter is then converted to a reading in volts.

Suppose that R represents the fixed resistance, U is the voltage drop across the resistance, and I is the current flowing through it. Ohm's Law tells us:

```
U = I * R
```

The formula shows that if the resistance is fixed, the voltage will vary in proportion with the current, and therefore can be calculated from it.

Load-Related Inaccuracy

When the meter is measuring the voltage drop created by a load that has high resistance comparable to the internal resistance of the meter itself, the meter will not give an accurate reading. Figure 31-5 illustrates this problem.

On the left side of the figure, two resistors 10M each are wired in series between a 9VDC power source and negative ground. Because the resistors are equal, each of them imposes an equal voltage drop of 4.5V.

On the right side of the figure, an additional 10M resistance has been added in parallel with the lower resistor. When two resistors of values R1 and R2 are wired in parallel, their total resistance, R, is given by this formula:

```
1 / R = ( 1 / R1 ) + ( 1 / R2 )
```

Therefore, the total resistance in the bottom half of the circuit is now 5M instead of 10M, and the voltage drop across the upper resistor becomes twice the voltage drop across the two lower resistors.

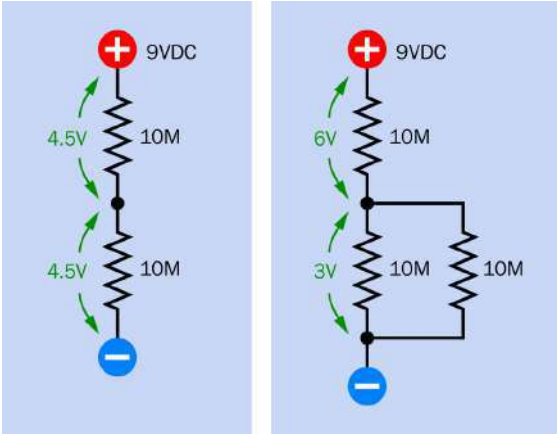

Figure 31-5 *If a meter measuring the voltage drop across a load has an internal resistance comparable to that of a load, the meter will not give an accurate reading. See text for details.*

Now suppose that the additional 10M resistor is actually the fixed resistance inside a volt meter. In fact, many volt meters do have an internal resistance of around 10M. Because the meter has reduced the resistance in the bottom half of the circuit by a factor of 2, it measures the voltage drop as 3V. If the meter had an ideal, infinite resistance, it would give the correct value of 4.5V. In the real world, that is impossible.

Bar Graph

Sometimes it is useful to represent voltage with a graphical display. A *bar graph* component makes this possible, and is often used in audio equipment.

The bar graph can consist of a row of *LEDs*. In a component designed for this purpose, there are usually 10 or more. To represent 0 volts, all the LEDs remain dark. More LEDs are illuminated as the voltage increases.

Because the bar graph itself only contains LEDs, a driver is necessary to convert voltage into the "rising thermometer" effect. Examples are the LM3914 (linear), the LM3915 (logarithmic, 3 dB per step), and the LM3916 (using VU or Volume Units, for audio). Each of these components has 10 LED outputs, and is fabricated using a chain

of resistors as a multitap voltage divider, with 10 comparators.

A driver can be set to show only one LED corresponding with the current voltage level, or (more commonly) a cumulative string of LEDs from zero upward. Some bar graphs also contain different colored LEDs, such as green for the first 7, yellow for the next 2, and red for the final one.

A microcontroller containing an analog-to-digital converter can be used to illuminate a bar graph, instead of a driver chip.

An example of a bar graph is the Avago HDSP-4830, shown in Figure 31-6.

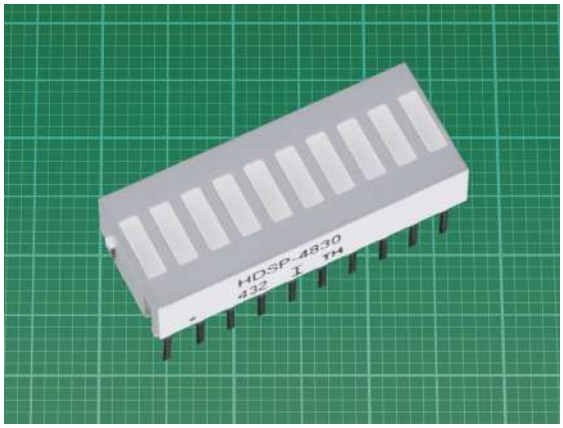

Figure 31-6 *A bar graph LED display, which can be used to represent voltage. The background grid is in millimeters.*

What Can Go Wrong

Confusing AC with DC

A panel meter that is designed only to measure DC should not be used with AC, and vice-versa. Erroneous readings or damage to the meter may result.

High Circuit Impedance

When a meter is measuring the voltage drop across a high-value resistance, it will give an inaccurate reading, as it is diverting a significant proportion of the current.

Voltage Out of Range

Attempting to measure a voltage that exceeds the limited range of a meter can damage the meter or blow its internal fuse, if it has one. Attempting to measure a voltage that is at the very low end of a meter's range will result in an inaccurate value.

Voltage Relative to Ground

If one input to a digital meter is connected with ground, the meter will only be able to measure voltage in a circuit relative to ground.

Sensor Output

A

This appendix provides some basic information about nine forms of sensor outputs, and the ways in which they can be processed. Other types of encoded output exist, but those examined here are the ones most likely to be found.

Figure A-1 provides an overview. Every sensor initially creates an analog output, which is sometimes connected directly to an output pin. In thermistors and photoresistors, for example, the internal resistance of the component constitutes its output. In many sensors, however, the behavior of the sensing element is processed internally to create voltage, open collector, encoded pulse stream, or current output.

If the sensor is chip-based, it may process the analog sensor response internally to create a binary output or a digital output.

In this Encyclopedia, the term "binary output" means "an output that has two states," usually logic-low or logic-high. The states may be accessible via an output pin, or may be processed internally to create a pulse stream. In that case the stream fluctuates between the two states as a way of encoding an analog value with pulse-width modulation (PWM) or frequency. Other types of encoding are also possible, but are unusual.

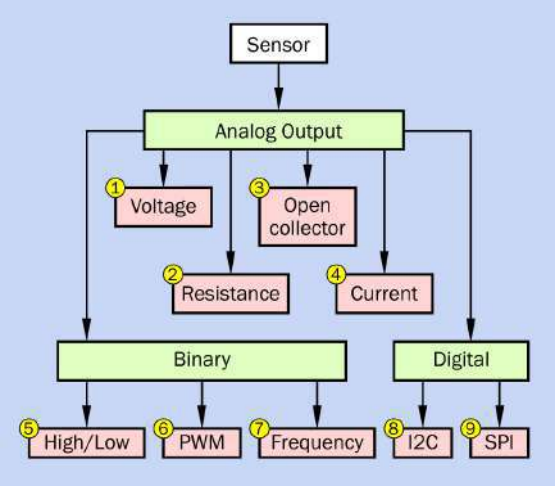

Figure A-1 *Nine possible types of output from sensors. The primary categories are highlighted in green.*

The term *digital output* is used here to mean one or two bytes of data that are stored in a register (memory location) in the sensor chip. While other forms of output are "always on" and can be accessed at any time from an output pin, a digital output is usually not available until an external device, such as a microcontroller, sends an instruction to the sensor chip, telling it to return the data. This two-way communication usually is handled by the I2C or SPI protocols (other protocols exist, but are less common).

Analog Outputs

Voltage is by far the most common form of analog output. Other forms of analog output can easily be converted to a voltage value, using the simple techniques described here.

1. Analog: Voltage

Direct Connection: Analog-to-Analog

An analog voltage output can be connected directly to an analog input, so long as the range is compatible and the sensor can provide sufficient current. Examples of external analog devices would be an analog volt meter, a light source or sound source that changes intensity, or a transistor or op-amp that will amplify the output for other audio/visual purposes.

If the voltage output from the sensor rises above a usable range, it can be converted to a lower value by applying it across two resistors connected in series to form a voltage divider. This is shown in Figure A-2.

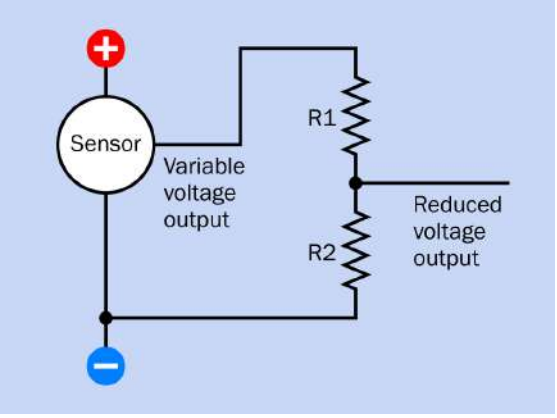

Figure A-2 *Using a voltage divider to reduce the range from a sensor.*

The values of R1 and R2 can be derived from this basic formula, where V_{SEN} is the voltage from the sensor and V_{OUT} is the output from the voltage divider:

Example A-1

$$V_{OUT} = V_{SEN} * (R2 / (R1 + R2))$$

The impedance of the device used for voltage sensing must be high relative to the values of R1 and R2. Note also that if the analog voltage out from the sensor varies linearly with the phenomenon being sensed, this relationship is likely to be disturbed by the voltage divider.

Analog-to-Binary Conversion

The term "binary" is used here to mean an output that can be in one of two states, such as logic-high and logic-low.

A varying analog voltage output can be simplified by passing it through a component that transforms the signal into binary form. This may be done by using a logic chip with a *Schmitt trigger* input, a *zener diode*, or a **comparator**. (For a description of comparators, see the entry in Volume 2.) A comparator provides desirable features such as adjustable positive feedback to create hysteresis. It may be used, for example, to convert a slowly changing signal from a phototransistor while the sun is setting, to a high/low output that can activate a relay to switch on a light.

Analog-to-Digital Conversion

The analog voltage output from a sensor can be digitized by an external analog-to-digital converter (ADC), either inside a microcontroller or by a separate ADC chip.

If a microcontroller is used, a sensor may often be wired directly to an input pin that connects internally with an ADC. A program in the microcontroller can then assess the integer output from the ADC and either execute a conditional statement or convert the value to a format appropriate for another device, such as a digital display.

If an ADC chip is used, there are thousands to choose from. A few basics:

- A *flash* converter contains a row of comparators with different reference voltages generated with a chain of equal resistors. The comparator outputs are fed into a priority **encoder**

that outputs a binary number. This system is very fast but has limited resolution.

- A *successive approximation* converter uses a single comparator, comparing the input voltage with the output from a DAC. The binary number that is supplied to the DAC is determined one bit at a time, from the most significant to the least significant bit, using the comparator's result to determine if the bit should be 0 or 1. These bits are stored in a register, called a successive approximation register (SAR). When the process finishes, the SAR contains a binary representation of the input voltage. This type of ADC can achieve high resolution (many bits) at the cost of lower conversion speed.
- In a *dual slope* converter, a capacitor is charged for a fixed time, with a rate proportional to the input voltage, then discharged at a known rate while measuring time by counting clock pulses. The resulting count is the ADC output.

  The name of the converter is derived from the voltage on the capacitor.
- A *voltage-to-frequency* converter uses a voltage-controlled oscillator to produce pulses with a frequency proportional to the input voltage. If the pulses are counted over a fixed time interval, the count is proportional to the signal level.

The number of the bits in the output from an ADC must be sufficient to digitize the input voltage range with desired accuracy. Because the voltage range may contain unexpected peaks, a cautious strategy is to use many more bits than are necessary. However, this means that for most of the time, only a few bits will be used to represent the low end of the voltage range, and accuracy will suffer.

For example, suppose a voltage input normally ranges from 0V to 2V, with occasional brief excursions to 8V. An 8-bit ADC can provide 256 digital values to represent input voltages. If the values are spread uniformly over the full 8V input range, the least significant bit can measure 1/32nd of a volt, or about 31mV. Smaller voltage fluctuations will be ignored. On the other hand, if the 256 values are used to measure a range of just 2 volts, the least significant bit can measure 1/128th of a volt, or slightly less than 8mV—but voltages higher than 2V will be clipped.

An ADC will typically require a reference voltage, and will digitize the range from 0V to that voltage. The reference voltage must be chosen with the issues of accuracy and range in mind.

A microcontroller may provide a feature in its language to perform automatic scaling of an analog input within limits set by a variable in program code. This is done by comparing the input with a selectable voltage level, such as the voltage of the power supply, an externally supplied voltage, or a fixed built in reference. While the ADC in the microcontroller normally digitizes values from 0V to the supply voltage for the chip, the conversion routine can instruct the microcontroller to use its full number of bits (often, 10) to digitize an input range from 0V to 1V.

For a higher sample rate, an ADC chip may be connected with the microcontroller over an I2C or SPI bus.

2. Analog: Resistance

Resistance-to-Voltage Conversion

A sensor that changes its resistance as it responds to its environment can be placed in a *voltage divider* to provide an analog voltage output. This is illustrated in Figure A-3.

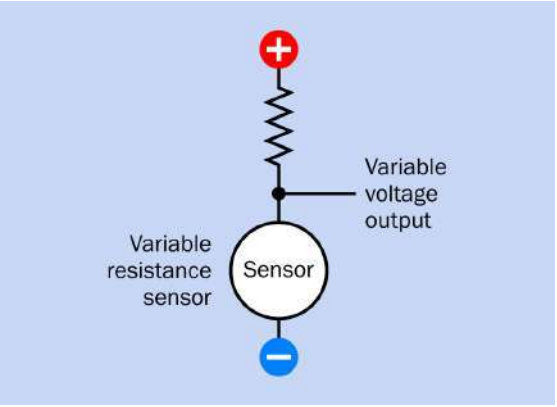

Figure A-3 *The basic principle of putting a variable-resistance sensor in series with a fixed resistance, to create a voltage divider.*

To choose the value for the series resistor, if R_{MIN} and R_{MAX} are the minimum and maximum resistance values for the sensor, the optimum value R_S for the series resistor, to produce the widest variation in voltages, will be found from this formula:

$$R_s = \sqrt{(R_{min} * R_{max})}$$

When the sensor has been set up in this way, the output can now be processed in the same way as any analog voltage output from a sensor.

The datasheet of the sensor should be consulted to make sure that a series resistor value does not allow any chance of the sensor being damaged by excessive current.

3. Analog: Open Collector

Many sensor packages or modules include a bipolar transistor that has an *open-collector* output (or *open drain*, if a CMOS transistor is used). The transistor may or may not be incorporated in an internal **op-amp** (described in Volume 2). Either way, the principle is the same.

Figure A-4 shows a sensor, in darker blue, that has one connection for positive power, another connection for negative ground, and a third connection to the collector of the internal transistor.

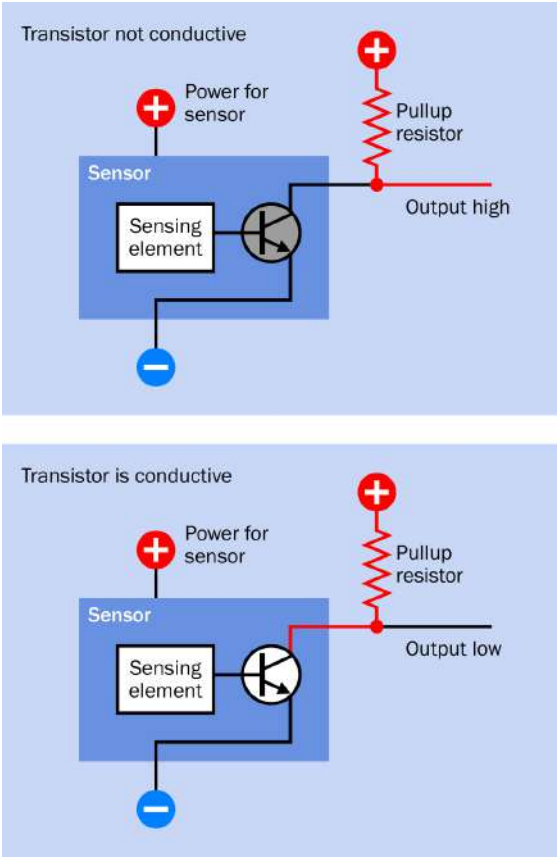

Figure A-4 *How to use an open-collector output from an internal transistor.*

In the upper section of the figure, the sensing element is not applying voltage to the base of the internal transistor, and the transistor only conducts a tiny amount of leakage current. Power applied to it through an external *pullup resistor* cannot reach negative ground in any significant quantity, and therefore it can provide a voltage input to a high-impedance device such as a microcontroller, or can power a component such as an LED, which draws relatively little current (20mA or less).

In the lower section of the figure, the sensing element is now applying voltage to the base of the transistor, drastically lowering its effective

resistance. The transistor diverts current from the pullup resistor to ground, and the output appears to go low.

The type of sensing element will determine whether the transistor becomes conductive or nonconductive when the element detects a stimulus.

The value that should be chosen for the pullup resistor will depend on the impedance of any device attached to the open-collector output. A 10K resistor may be appropriate for use with a device such as a microcontroller, which has very high impedance. At the other extreme, if the device is an LED, a 330-ohm resistor may be necessary. The value of the pullup resistor must be sufficiently low to enable reliable operation, but sufficiently high to prevent excessive current from passing through the internal transistor when it becomes conductive (20mA is a common maximum value).

The voltage from the open collector can be processed in the same way as any analog voltage output from a sensor.

An open-collector output may be used when the outputs from multiple devices share the same bus. One device can drive the bus without the problem of other devices attempting to hold the bus voltage high.

4. Analog: Current

Relatively few sensors provide an output consisting of variations in current. Some semiconductor temperature sensors function in this way. The output current can be converted to a voltage output simply by placing a fixed series resistor, as shown in Figure A-5.

The voltage at the point shown, relative to negative ground, will vary linearly with the current. The value of the resistor should be defined in a datasheet for the sensor.

The voltage can now be processed in the same way as any analog voltage output from a sensor.

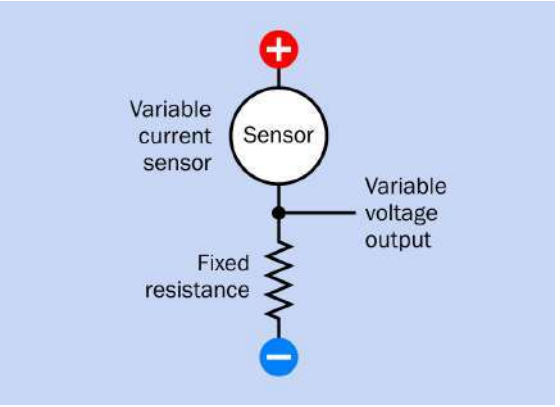

Figure A-5 *How to convert the output from a variable-current sensor.*

5. Binary: High/Low

A sensor that provides a binary output (that is, an output that is either logic-high or logic-low) can be connected directly with a microcontroller, if the voltage range is compatible. Program code in the microcontroller can then test the pin to establish its state. Note that some microcontrollers require a 3.3VDC power supply, while sensor chips may use 5VDC.

A binary output can also be used to control a solid-state relay, or an electromagnetic relay if transistor amplification is used. The output may be sufficient to power an LED indicator.

6. Binary: PWM

PWM is an abbreviation for *pulse-width modulation*. The sensor emits a stream of square-wave pulses with a fixed frequency, but the width of each pulse varies with the stimulus to which the sensor is responding. The width of each high pulse, relative to the wavelength between the start of one pulse and the start of the next, is called the *duty cycle*. A duty cycle of 0% means that there are no pulses at all. With a duty cycle of 100%, there are no gaps between pulses, so the output is high all the time. With a duty cycle of 50%, the duration of each high pulse is the same as the duration of the gap between pulses.

Various microcontrollers offer different ways to decode a PWM pulse stream. The most basic way is for a program to check an input pin repeatedly, as fast as possible, until a high state is detected. The microcontroller copies the value of its internal clock into a variable, then continues to check the input repeatedly until the pulse ends. The pulse duration that has been measured can be converted to a sensor value with a formula or lookup table.

This system is not recommended, as the microcontroller may miss the next pulse while it is converting the value of the previous pulse. To address this problem, a microcontroller language may offer a function that blocks execution of code while waiting for a pulse. The pulseIn() function on the Arduino is an example of this feature. However, the microprocessor must now spend most of its time waiting for a pulse instead of doing useful work.

A better solution is to write a program that is interrupt-driven.

Another option for decoding PWM is to use a low-pass filter that converts the pulse stream into an analog voltage, although some ripples will tend to remain.

Finally PWM can be used directly to power an LED or a DC motor, with transistor amplification as required. The speed of the motor or the brightness of the LED will vary with the duty cycle.

7. Binary: Frequency

Here again, the pulseIn() function on the Arduino may be used, so long as the frequency is a square wave with a known duty cycle.

8. Digital: I2C

In digital electronics, a *bus* is a communal pathway for sharing data among components or devices. The *I2C bus* is an abbreviation for *inter-integrated circuit* bus, developed originally by Philips in 1982. (Philips has since been subsumed into NXP Semiconductors.) The correct notation for I2C is I^2C, and it is spoken as "I-squared-C." However, the term is very commonly written as I2C.

The I2C standard defines a data sharing protocol that is limited to 400kHz (with some exceptions) and designed to work on a small scale, almost always within one device, and usually on one circuit board. It is a low-cost, simple design. Data is transmitted serially over two wires, and the devices sharing the bus are connected in parallel.

Typically there is one *master* device on the bus, and a number of *slave* devices. Masters and slaves can both transmit information, but the master normally initiates communication. It also emits a clock signal for synchronization of data.

A sensor is a slave device that can be interrogated by a microcontroller in its role as the master device. Because multiple slave devices can share a bus, the microcontroller needs a way to identify the slave that it wishes to talk to, and each slave is assigned a unique address for this purpose. Often a slave will allow the user to modify the last two bits of the address, so that up to four identical devices can share a bus.

Code libraries to support the I2C protocol are available for most microcontrollers, and communication with a sensor that uses I2C should simply require knowledge of the sensor's I2C address. However, the data registers in a sensor can be quite elaborate, requiring careful study of the manufacturer's datasheet. Multiple procedures may be required to set functions on a device (such as the sensitivity range of an accelerometer, or the threshold for a temperature alarm). Multiple procedures may also be required to read data out of a sensor (such as two bytes to define a temperature, and several bytes to obtain time as well as location readings from a GPS module).

9. Digital: SPI

SPI is an acronym for serial peripherals interface, a standard introduced by Motorola that serves a similar function to the I2C bus, described immediately above. The SPI standard is slightly more sophisticated, enabling duplex communication and higher data transfer speeds. However, SPI requires a minimum of three wires shared by all devices on the bus, and an additional device-selection line for each slave device. The benefit of the extra device lines is that devices are easier to select and address than on an I2C bus, where more program statements are required. As is the case for I2C, code libraries for microcontrollers are widely available to support SPI. However, the requirement for SPI to use three pins on a microcontroller, plus an additional pin for each slave device, is a disadvantage.

More sensors have I2C capability than SPI capability. The SPI protocol is potentially much faster than I2C.

A sensor that is SPI-enabled will almost certainly be available in a similar version that uses I2C. An increasing number of chip-based sensors support both protocols.

Glossary

This glossary is not comprehensive. It contains only the technical terms that have been used most frequently in this book in conjunction with sensor attributes.

ADC Analog-to-digital converter, which accepts a varying signal (usually, a voltage) as an input, and converts it to a digital value in the form of a binary number. This number is likely to have a high limit ranging from 255 decimal to 65535 decimal. Many microcontrollers contain their own ADC, which is multiplexed to assess the inputs on several pins. On an Arduino Uno, the ADC creates a digital value ranging from 0 through 1,023.

analog output When a sensor creates a voltage or varies its resistance without steps or increments, as a function of the phenomenon that it is measuring, this is an analog output.

binary output In this Encyclopedia, the term "binary output" describes a sensor output that only has two states: logic-high and logic-low, or on and off. The term is used in some datasheets, but more often a binary output is described, misleadingly, as an analog output.

breakout board A small printed-circuit board containing one or more integrated circuit chips, usually surface-mounted. The board makes the features of the chips easier to access, because it has pins or connectors with 2.54mm (0.1") spacing for convenient experimental use with a breadboard. Additional features may be included, such as a voltage regulator.

chip-based sensor This term is used in the Encyclopedia to describe a sensor that is etched into a silicon chip and usually has signal conditioning components and circuitry built in.

contact bounce The tiny and rapid vibrations of mechanical switch contacts, when the switch opens or closes. If the switch is connected with a digital device such as a logic chip, debouncing hardware may be necessary, to allow the contacts time to settle. If the switch is connected with a microcontroller, a delay from 5ms to 50ms may be written into program code. Different switches have widely different settling times.

decibel A unit that expresses relative power or intensity, often (but not exclusively) applied to audible sound. The decibel is one-tenth of a bel, and is abbreviated dB, with the B capitalized because it is derived from the name of Alexander Graham Bell. Because dB is a logarithmic unit, the scale has no zero origin. However, 0dB may be assigned arbitrarily to any intensity, in which case lower intensities will have a negative value. An increase of 3dB corresponds to a doubling of sound intensity (acoustic energy). However, when a sound is sensed

by the human ear and evaluated by the brain, its subjective loudness doubles when the intensity increases by 10dB.

dielectric The insulating layer separating two plates in a capacitor.

hysteresis The difference between thresholds for switching an output on and off. When a sensor exhibits hysteresis, it may be unresponsive to a stimulus slightly above or below its equivalent current value. This may be useful to eliminate numerous responses to very small stimuli —for example, in a room thermostat.

I2C Interintegrated circuit bus. Sometimes written as I^2C, and often referred to verbally as "I-squared-C." A communications protocol that is often used between a microcontroller and other components on a circuit board. For a description, see "8. Digital: I2C" in the Appendix.

IMU Inertial measurement unit, consisting of three accelerometers and three gyroscopes, sometimes with the addition of three magnetometers. It can be used as a navigational aid. It may also be used in handheld user input devices, such as game controllers.

Kelvin A temperature scale, often abbreviated with the letter K, in which each degree is equivalent to a Celsius degree, but 0 degrees is at absolute zero—the temperature at which materials have no heat energy at all. 273 degrees K is approximately equal to 0 degrees C.

MEMS Microelectromechanical system, i.e., an integrated circuit chip that also contains tiny moving parts. For example, a MEMS accelerometer is built around microscopic springs that respond to accelerative forces.

newton A unit of force named after Isaac Newton, abbreviated with the capital letter N. A force of 1N will accelerate a mass of 1kg at a rate of 1 meter per second each second.

open collector output Many sensors have an open collector output, or contain an op-amp that has an open collector output. The output pin is attached to the collector of an internal transistor, with its emitter connected to negative ground. Positive voltage applied through a pullup resistor to the open collector will be grounded when the internal transistor is conducting current, but will be available for other devices when the transistor is off. See "3. Analog: Open Collector".

orthogonal Angled at 90 degrees. Three orthogonal elements in a sensor will all be angled at 90 degrees to each other.

pascal A unit of pressure equivalent to 1 newton of force per square meter.

PIR Passive infrared sensor. See Chapter 4.

pullup resistor A resistor that pulls up an output or input voltage in the absence of a signal. May be used in conjunction with an **open collector output**.

quadrature An encoding system for output from a pair of sensors. If the sensors are identified as A and B, four output combinations are possible: A high and B low; A high and B high; A low and B high; A low and B low. A common application is to show the direction of movement of a magnetic or optical pattern past the sensor pair.

reference temperature The temperature at which the output signal of a temperature sensor is measured. This is often listed in a datasheet.

register A section of memory that stores a digital value (usually 1 or 2 bytes in a sensor).

target Any object that is being detected by a motion sensor, proximity sensor, or presence sensor.

temperature coefficient The percentage increase or decrease in the value of a sensor as a result of unit change in temperature (usually 1 degree Celsius). Often abbreviated as TC. The

value may be resistance, voltage, or current, depending on the sensor. The temperature coefficient should be negative if the value of the sensor diminishes when its temperature increases. If it is expressed in parts per million, abbreviated ppm, it can be converted to a percentage by dividing by 10,000.

Wheatstone bridge A network of four resistors. At least one of the resistors has an unknown value, while the others have precisely known reference values. The network enables calculation of the unknown value. See Figure 12-2.

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Colophon

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(54) MAGNETIC VORTEX WORMHOLE GENERATOR

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(57) **ABSTRACT**

This invention relates to a magnetic vortex generator which has the ability to generate negative mass and a negative spring constant which, according to Einstein's General Theory of Relativity, is required in order to create a stable wormhole between our space and hyperspace. Two separate, but electrically connected, toroidal coils of differing radii, carry magnetic flux in opposite directions about their common centerline. According to Maxwell's equation, this produces bucking electric fields along said centerline. Because the two solenoids have different radii, the parallel spring constant of both coils is negative. The negative mass together with the negative spring constant produce a real resonant frequency which can distort the spacetime curvature due to the creation of powerful spikes of negative mass. This phenomenon, similar to the common electrical thunderstorm, opens up a wormhole into hyperspace through which low-density hyperspace energy can enter into our dimension. This energy finds many application in new types of power supplies, inertia-less and mass-less spacecraft, vehicles that can travel light-years by moving out of dimension through hyperspace, surgery-less medical tables, cranes for lifting heavy objects, cold-welded crystals for crystal rotors, folding space waveguides, and electromagnetic field propulsion vehicles using highly relativistic fields.

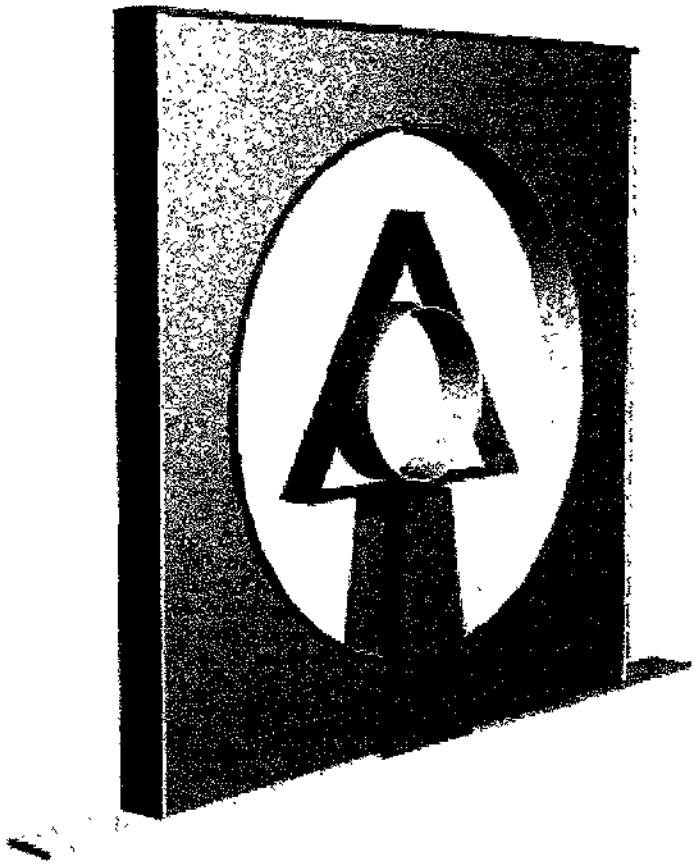

Figure 1

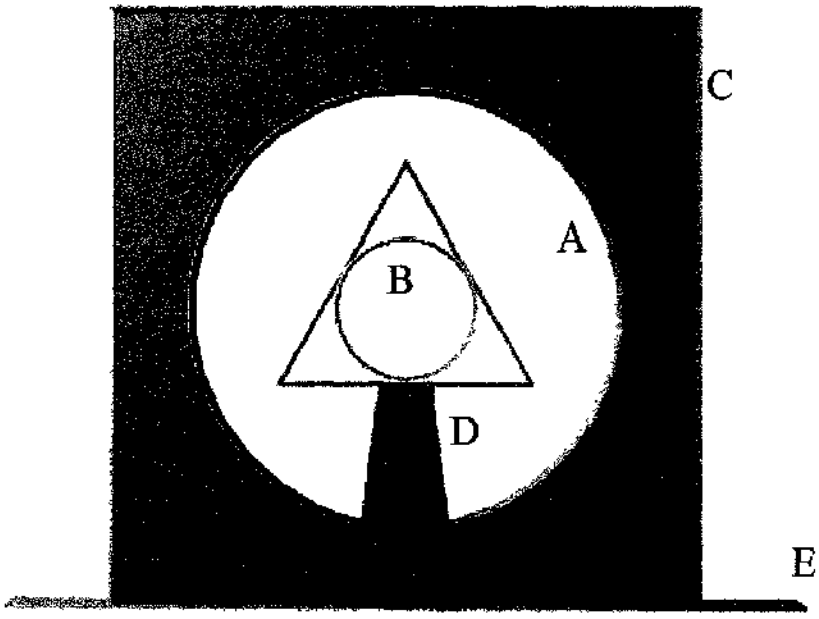

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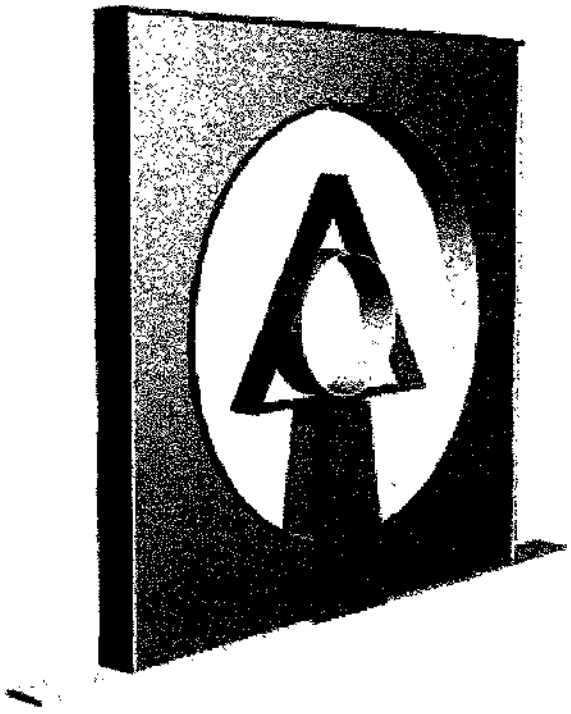

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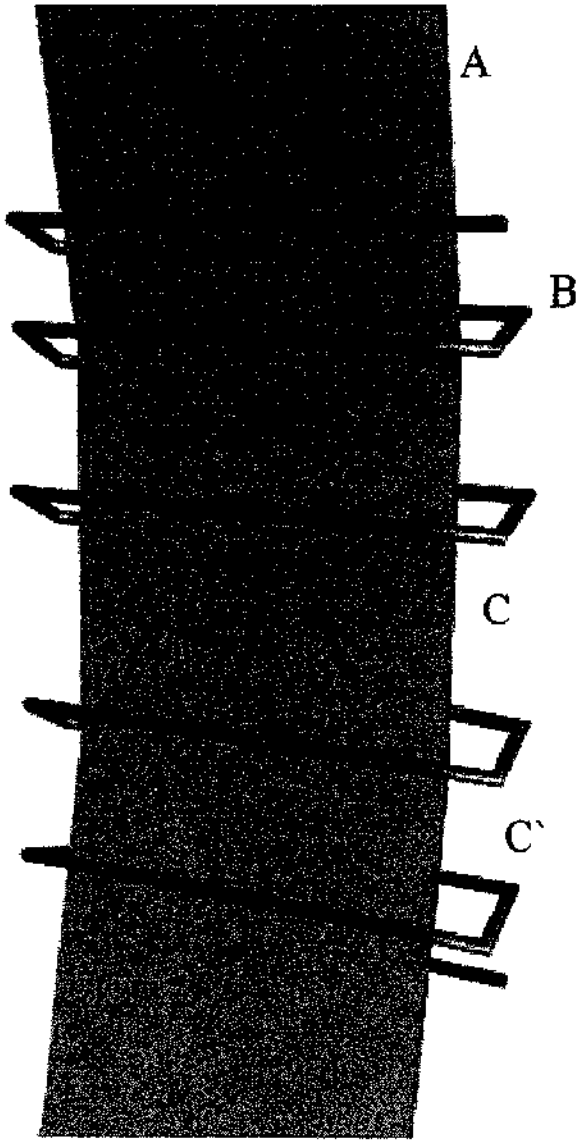

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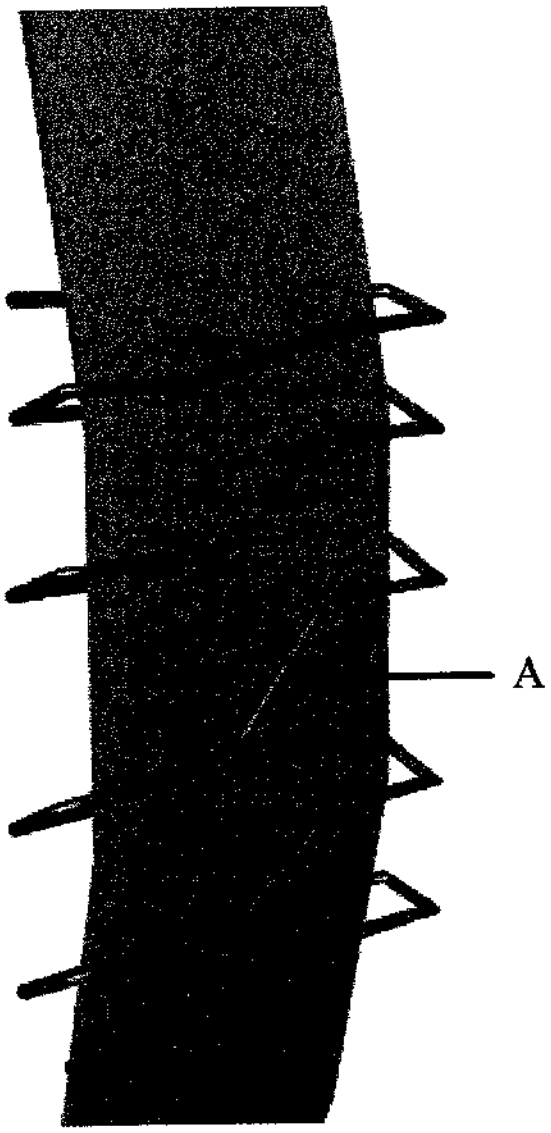

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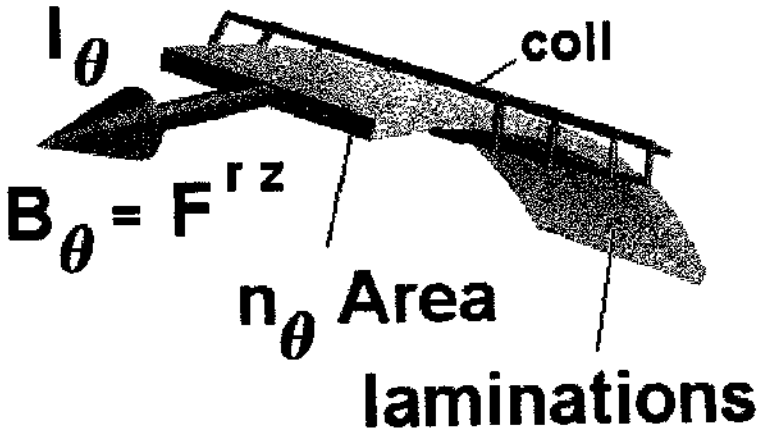

Figure 6

$$F^{\mu\nu} = \begin{array}{c|cccc|} & t & r & \theta & z \\ \hline t & 0 & 0 & 0 & 0 \\ r & 0 & 0 & 0 & B_\theta \\ \theta & 0 & 0 & 0 & 0 \\ z & 0 & -B_\theta & 0 & 0 \end{array}$$

Figure 7

$$k^z = \frac{\text{coul}}{\text{sec}} \cdot m^2 \cdot \frac{1}{m^2} \cdot \frac{\text{kg}}{\text{sec} \cdot \text{coul}} = \frac{\text{newton}}{m} = \frac{\text{force}}{m}$$

Figure 8

$$k^z = \frac{1}{(r+a)^2} - \frac{1}{r^2} = -a\left[\frac{(2 \cdot r + a)}{(r+a)^2 \cdot r^2}\right]$$

Figure 9

$$g_{\alpha\beta} = \begin{array}{c|cccc|} & t & r & \theta & z \\ t & -1 & & B(\cos\theta - \sin\theta) & 0 \\ r & 0 & 1 & 0 & 0 \\ \theta & B(\cos\theta - \sin\theta) & 0 & r^2 & 0 \\ z & 0 & 0 & 0 & 1 \end{array}$$

Figure 10

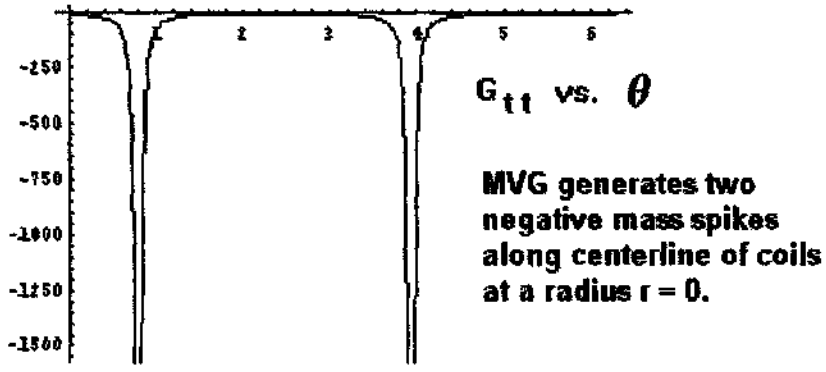

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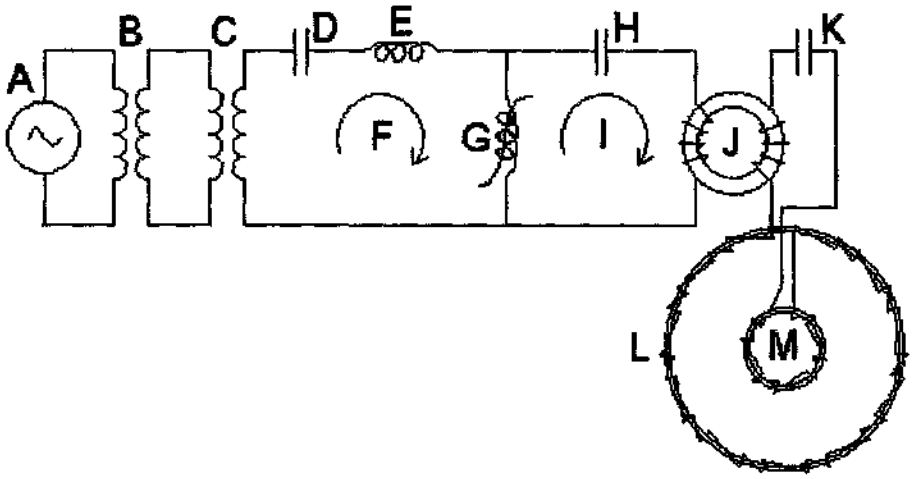

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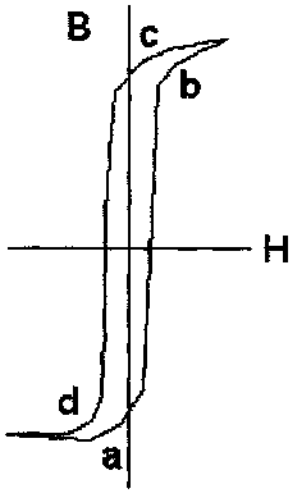

MAGNETIC VORTEX WORMHOLE GENERATOR

BRIEF SUMMARY OF THE INVENTION

[0001] This invention, which is the subject of my present application, is comprised of two solenoids wound with a common wire in opposite directions on two separate toroidal curved-sheet transformer laminates of differing radii. The smaller solenoid is mounted along the centerline of the larger solenoid. This circular magnetic geometry creates linear bucking electric fields along the centerline of the coils. Because the magnetic flux in the laminates travels in opposite directions along arcs of differing radii in the two coils, a negative mass and a negative spring constant are generated by the system. From the theory of gravitational physics, a negative mass is prerequisite to producing a wormhole because it allows the throat of the wormhole to remain open and stable. The creation of the wormhole is facilitated by the appearance of a negative spring constant which allows the spacetime curvature to resonate to such a degree that said wormhole develops between our dimension and another co-dimension of hyperspace. Because the physics constants of hyperspace are different from ours, the wormhole allows hyperspace energy having a low speed of light to enter our dimension. Because electromagnetic fields obey the Lorentz transformation, it is now possible with this lower velocity of light to create huge relativistic fields which can drive the new electromagnetic field propulsion vehicles.

BACKGROUND OF THE INVENTION

[0002] The idea for this coil configuration comes from the observation of powerful thunderstorms, as described by physicist Dr. Richard Feynman in his *Lectures on Physics,* a copy of which is enclosed as a reference. Upon reading his explanation, I realized that the thunderstorm is actually a hyperspace physics phenomenon.

[0003] After the passage of a large lightning storm, people have observed that a car tire rim has merged with the trunk of a tree growing in the ground. Due to the large branches of the tree, there is no possible way that it could slide down the branches and around the trunk. It was observed also that a straw of wheat became embedded in the hard wood of a telephone pole. It turns out that the thunderstorm offers an explanation as to how this can occur.

[0004] After reading Feynman's explanation, it can be seen that the key to this phenomenon is that there is a downward and an upward lightning bolt, sometimes occurring together if the leader branches into two paths. Bolts of lightning also like to strike tall objects such as telephone poles or trees. Now an electrical current moving downward produces a clockwise magnetic B field, as seen from above. On the return stroke, the current is moving upward which produces a counterclockwise magnetic B field. Thus the thunderstorm produces two huge bucking magnetic B fields which is the magnetic geometry of this magnetic vortex generator. Using my tetrahedron diagram, I will then show that the low density hyperspace energy with its low speed of light is able to pull the rim out of dimension so that it can merge with the tree at the moment the lightning strikes.

SUMMARY OF THE INVENTION

[0005] It is the object of this invention to produce two toroidal oppositely-directed magnetic flux fields in two separate yet electrically connected solenoids of differing radii. Because the lines of flux are traveling in toroidal, curved-sheet transformer laminates along arcs of different curvature, the fields produce what is known in gravitational physics as negative mass. Negative mass has the property that if you project it onto a hot surface, the surface will cool rather than heat up. The negative mass, together with the resonance of the spacetime curvature involving a negative spring constant, create a wormhole into hyperspace. This interdimensional connection allows low speed of light hyperspace energy into our dimension which can be used to decrease the weight of an object, or produce huge relativistic electromagnetic fields that can be used to drive the new electromagnetic field propulsion spacecraft.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0006] Not Applicable.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0007] **FIG. 1**. Front view of magnetic vortex generator.

[0008] **FIG. 2**. Perspective view of the magnetic vortex generator.

[0009] **FIG. 3**. The non-linear coil winding on the interior face of the laminations.

[0010] **FIG. 4**. The non-linear coil winding on the exterior face of the laminations showing that there is an electrical current component in the theta direction.

[0011] **FIG. 5**. The coil variables for the tensor calculation of the negative spring constant.

[0012] **FIG. 6**. The Faraday electromagnetic tensor showing the position of the magnetic field in the {r,z} slots.

[0013] **FIG. 7**. The units of the spring constant.

[0014] **FIG. 8**. The parallel spacetime spring constant.

[0015] **FIG. 9**. The cylindrical g metric tensor including the magnetic fields.

[0016] **FIG. 10**. A plot of the mass term G_n for Einstein's G curvature tensor showing that two negative mass spikes are created along the centerline of the generator. Negative mass is required to keep open the throat of the wormhole.

[0017] **FIG. 11**. Circuit diagram for the magnetic vortex generator.

[0018] **FIG. 12**. BH curve for non-linear SuperMalloy toroidal core. From the equation, $B=\mu H$, the slope of the line is equal to the permeability $\partial B/\partial H=\mu$.

DETAILED DESCRIPTION OF THE INVENTION

[0019] 1. The fact that negative mass is required to keep the throat of a wormhole open has been shown to be valid by physicist Dr. Kip Thorne in the enclosed reference physics paper. The key point of this invention is that if you have a negative mass, you also require a negative spring constant in order to get a real frequency and vice versa. The angular frequency of vibration is equal to the square root of the spring constant K divided by the mass M, or $\omega=\sqrt{K/M}$. If the mass is negative, and the spring constant is positive,

the frequency is imaginary. Therefore, in order to get a real frequency, the spring constant has to be negative also.

[0020] 2. Referring to **FIG. 1**, the magnetic vortex generator consists of a large toroidal solenoid (A) and its support structure (C), a smaller toroidal coil (B) with its support structure (D) which holds the coil along the centerline of the larger coil. The entire structure sits on a base (E).

[0021] 3. The two solenoids are wound with a common wire in opposite directions on two separate toroidal curved-sheet transformer laminations of differing radii. From the right hand rule, a changing circular magnetic field in the direction of the fingers produces a linear electric field in the direction of the thumb. Because there are two coils producing two magnetic fields in opposite directions, there are two bucking electric fields down the centerline of the coils. This duplicates the thunderstorm conditions. A perspective view of the generator is shown in **FIG. 2**.

[0022] 4. A enlarged view of the non-linear coil winding is shown in **FIG. 3**. The wire (B) is wound around the thin transformer laminations (A) with a non-linear coil spacing as shown by the difference in spacing between length (C) and (C'). On this inner side of the coil, the wire is wound straight across where it can be seen that the wire is normal to the edge of the laminations. Not shown are two strips of Velcro which keep the wire aligned and offset from the tape-covered metal laminations.

[0023] 5. Since the wire is straight across on this side, the opposite side has to have the wire run in a diagonal manner as seen in **FIG. 4A**. In terms of cylindrical coordinates, the components of the electrical current in the coil flow in the z-direction across the breadth of the lamination and in the O-direction around the lamination.

[0024] 6. The reason for the non-linear spacing is to preserve the vector potential of the coil. The vector potential is a more important field than the magnetic field because it can extend out past the windings of a long solenoid. If you look at the units, it is the field momentum per charge or kilogram meter per second coulomb. Notice that the derivative of the vector potential with respect to time is an electric field, while a derivative with respect to length is the magnetic field. The inductance of the coil times the current density is equal to the vector potential. Thus the inductance gradient of the coil times the current per meter is the magnetic field. So the non-linear coil picks up an additional magnetic field around the coil besides the one created in the laminations by the winding itself

[0025] 7. Taking a closer look at the coil in **FIG. 5**, it is constructed of thin laminations taped together to form a cylindrical shape with a wire coil wrapped around it. This creates a magnetic field in the theta θ direction within the laminations. Because the coil is wrapped as a helix, there is a current component I_θ in the theta direction. The cross-sectional area Area through which the magnetic flux flows times a normal vector n in the theta direction is the tensor area n_θ Area. If the radius of the coil is r, then the curvature K is $1/r^2$ pointing in the radial direction. Because there are two coils with differing radii, the generator has two curvatures associated with it.

[0026] 8. In the geometry of electromagnetism, the magnetic field is part of the electromagnetic Faraday tensor $F^{\mu\nu}$ which is a 4 by 4 spacetime matrix having rows and columns of time t, radius r, angle θ and height z in cylindrical coordinates. The first index μ refers to the row, and the second index v refers to the column. The diagonal of the matrix is zero. The first row and column belong to the electric field. All the other slots are filled by the components of the magnetic field. The B_θ component is located in the complementary slots of r and z as shown in **FIG. 6**. Now a tensor product can be written with the available variables I^θ no Area $K_r F^{rz}=k^z$. This says that the current around the loop in the theta direction times the lamination area vector in the theta direction times the curvature K of the coil in the radial direction times the magnetic field in the theta direction is equal to a spring constant in the z-direction, or normal to the plane of the coil. All the tensor components cancel out except for the z-direction. That is, the coil produces a spacetime spring constant through the center of the coil where there are resonant bucking electric fields. So the coil is creating a magnetic spring. The units of the spring constant are shown in **FIG. 7** as force per meter.

[0027] 9. Because there are two coils operating in opposite directions in regions of differing curvature, there are two parallel spring constants generated along the centerline. Two springs in parallel sum, but the inner coil is negative due to the triple product of negative signs of current, field and area. Looking at the front view of the coils, the right hand rule shows the field going counterclockwise with the thumb pointing along the electric field in the positive z-direction. The inner coil with the field going in the clockwise direction has the electric field in the negative z-direction. Therefore the outer coil's positive spring constant sums with the inner coil's negative spring constant to produce an overall negative spring constant as shown in **FIG. 8**. The inner coil has a radius r, and the spacing between the outer and inner coil is a. In this design, the inner radius is 1, and the outer radius is 3 which is the magic ratio in physics of 1/3. That makes length a equal to 2. Substituting r=1 and a=2 into the spring constant equation shows that the ratio is negative 8/9. That is, the spring constant is negative as previously asserted. If the spring constant is negative, it must produce negative mass in order to have a real frequency of resonance. Since it produces negative mass, then it can produce a wormhole as shown by Dr. Kip Thorne.

[0028] 10. The geometry of hyperspace physics is based on the geometry of the tetrahedron which is circumscribed by the sphere. The corners of the tetrahedron touch the sphere at a latitude of 19.47122063° which turns out to be, in terms of planet cosmology, the location where all the large volcanoes and vortices occur on Earth, Mars, Jupiter, Uranus and Neptune. Furthermore, the cosine squared of this angle is 8/9, which is the spring constant ratio for the magnetic vortex generator. That is, the coil is interacting with the geometry of spacetime which is why it is such an effective wormhole generator. As will be demonstrated later, the tetrahedral geometry of hyperspace shows that the electron and proton are one and the same particle. This is a new discovery in science coming out of this research. The diagram also shows that when the speed of light is reduced, due to the low density of energy coming into our dimension through the wormhole, Planck's constant divided by the speed of light puts the electron at the boundary between space and hyperspace. That is, the electron and the proton go out of dimension which is the reason that the car tire rim can become merged with the tree. The ramifications of this magnetic vortex generator are enormous. It means develop-

ing new types of crystals through interdimensional merging which will be needed in the development of these spacecraft and their crystal rotors. It means the possibility of teleporting spacecraft through hyperspace over distances of light years using the new folding space waveguides. It means light-weight or inertia-less spacecraft which can be accelerated at hundreds of thousands of g's. It means the ability to lift extraordinary loads in construction work. It means surgery-less medical tables where tumors can be pulled directly out of the patient's body.

[**0029**] 11. Because we have a magnetic spring, then there is some resonant frequency at which the coil can be operated in order to create a large spacetime distortion. It is this distortion that creates the wormhole into hyperspace. From this it follows that the wormhole attaches to a low pressure region with a magnetic monopole. Because pressure is linear mass times the speed of light squared divided by area, a low pressure signifies a low speed of light and less dense matter. What this means is that opposite polarity spacetime curvature at two ends of an electrode will produce a voltage along the electrode, effectively creating a power supply. The reason for this is that spacetime curvature, as shown by Einstein's General Theory of Relativity equation $G_{\alpha\beta}=8\pi T_{\alpha\beta}$, is equal to the square of the electromagnetic fields in the stress-energy tensor T. So the curvature on the ends of the electrode appear as voltages and the system acts as a battery supply to power the spacecraft.

[**0030**] 12. The other characteristic of the magnetic vortex generator is that it can pull objects out of dimension allowing the object to apparently move through solid walls. The object doesn't actually move through the wall because the object is not in the same dimension as the wall; it just appears that way. Moving out of dimension and then back again on the other side of the wall would effectively move the object through the wall for all intents and purposes.

[**0031**] 13. The tetrahedron diagram is a physics diagram which plots the natural logarithm of mass to the natural logarithm of wavelength. The product of mass times wavelength is equal to Planck's constant divided by the speed of light. So the product of the electron mass times its wavelength is equal to the proton mass times its wavelength is equal to the Planck mass times the Planck wavelength. The Planck wavelength is the bottom dimensional limit of the universe. We live in the Planck box which is bounded by the Planck wavelength and Planck mass. Outside this box is hyperspace.

[**0032**] 14. Because logarithms sum, the sum of the log of the mass plus the log of the wavelength is a constant sum. Thus the electron and proton and Planck mass slide on a 45° line known as the base constant which is equal at the axes to the log of Planck's constant divided by the speed of light. Planck's constant is measured in joule-sec so that multiplying it by the frequency 1/second of light gives the energy of the photon particle.

[**0033**] 15. Planck's constant is equal to the Planck wavelength times the Planck mass times the speed of light. The 45° base constant is Planck's constant divided by the speed of light, which means that the speed of light cancels out top and bottom, leaving the area of the Planck box as the value of the base constant. Hyperspace has a low linear mass compared to our dimension. Therefore, Planck's constant is reduced when this energy enters our dimension through the wormhole created by the generator. And the base constant is also so reduced. In terms of logs, this means that the 45° base line becomes more negative and moves to the right on the diagram. As it does so, the base line intersects the electron at the Planck wavelength which is the separation point between space and hyperspace. That is, the electron moves out of dimension. Because the electron and proton are one and the same particle, as shown in reference tetrahedron diagram tet0565, the proton and hence the entire atom is taken out of dimension as well.

[**0034**] 16. All of this can be seen more easily graphically on the tetrahedron diagram itself, referring to reference tetrahedron diagram tet3025. The 45° line which intersects the electron at point (b) is the base constant for our dimension. As you can see, this base line intersects the horizontal axis at a value of −95.91546344 which is the log of Planck's constant h divided by the speed of light. Because Planck's constant is proportional to the linear mass, it is reduced in value by the low density hyperspace energy and, in terms of logs, becomes more negative. This moves the base line to the right at a value of around minus **105**. The new base line intersects the electron at point (a) which is located on the Planck wavelength that is the boundary between space and hyperspace. Thus the electron at point (a) goes out of dimension.

[**0035**] 17. It was inferred previously that a negative spring constant meant a negative mass was produced by the wormhole generator. This can actually be calculated using Einstein's General Theory of Relativity. The calculation starts with the g metric tensor which is a spacetime measurement of distance in terms of time t, radius r, horizontal angle θ and length z. This 4 by 4 matrix is shown in **FIG. 9** where the diagonal line has a signature in cylindrical coordinates of values equal to $\{-1, 1, r^2, 1\}$. All the other terms of the matrix are zero except for the magnetic fields in the two coils. Because the field is changing sinusoidally with time in the theta direction, the field has to go into the $\{t, \theta\}$ and $\{\theta, t\}$ slots of the matrix. Because the field in the inner coil is in the negative direction compared to the outer coil, and including a 90° phase shift between the two fields, a suitable magnetic field function would be $B(\cos(\theta)-\sin(\theta))$.

[**0036**] 18. Using a general relativity software package, Einstein's G curvature tensor can be calculated for this particular metric. The first term G t in the upper left hand slot in the corner is the mass term for the tensor. All the other terms are either electromagnetic fluxes or pressure terms involving the squares of the fields.

[**0037**] 19. Referring to **FIG. 10, a** plot of the mass as a function around a small circle shows that two negative mass spikes occur around the circumference of the circle. Because the radius is almost zero, the two spikes are actually coincident.

[**0038**] 20. This next section shows the electrical system used to drive the magnetic vortex generator. Referring to **FIG. 11**, the system is driven by a sinusoidal voltage source (A) into a 1:1 turns isolation transformer (B). The voltage is stepped up into the range of thousands of volts using a step-up hi-pot transformer (C). The first loop consists of a direct current blocking capacitor (D), a transformer choke (E), a variable inductance (G) and the current in the loop (F). The variable inductance is a coil winding on a toroidal core

wound with thousandth-inch thick SuperMalloy tape. This coil acts as a magnetic switch due to its variable permeability.

[0039] 21. Referring to the accompanying drawing in **FIG. 12**, the slope of the BH curve is actually the permeability of the core. At point (a) on the curve, the slope is very low and therefore the permeability is very small. The resistance of the coil is the frequency of the current times the inductance of the coil. If the permeability is small, then the inductance is low, which means that the coil resistance is low initially. With a low resistance in the coil, current (F) flows through the winding rather easily. Then the coil goes from point (a) to point (b) where the permeability and resistance increase. This change in resistance from a low to a high value dumps the magnetic energy into capacitor (H). Then the non-linear coil saturates between points (b) and (c) where again the coil has a small slope and the coil resistance switches to a low value. Capacitor (D) then dumps its charge (I) through coil (G) producing a large voltage spike in the input and output winding of transformer toroidal coil (J). The magnetic flux in coil (J) then produces a voltage spike in coils (L) and (M) of the magnetic vortex generator. The frequency of oscillation of the generator is determined by capacitor (K) and the overall inductance of the two coils. The diagram shows that the winding is non-linear and in opposite directions going from outer coil to the inner coil.

[0040] 22. Frequency of oscillation has to be kept under 20 MHz in order to create a soft wormhole that connects to low pressure regions of hyperspace. The pressure regions of hyperspace are similar to the pressure produced by a dam holding water. The upper surface of the water, where there is no water pressure, is analogous to the black void into which our universe is expanding. In the middle of the dam, there is a region just above us having a lower water pressure which corresponds to the low density hyperspace energy. This analogy is not perfect because the many frequencies of hyperspace are quantized, as we know from quantum physics, rather than being a continuous spectrum of lower and lower frequencies down to the zero frequency of the black void.

What I claim as my invention is

1. A magnetic vortex generator which can generate negative mass according to Einstein's General Theory of Relativity, which is a tested and proven theory. As a result of this theory, it can be shown that negative mass is required to create a stable wormhole between space and hyperspace. Without the negative mass, the throat would close.

2. The generator consists of two solenoids wound with a common wire in opposite directions on two separate toroidal curved-sheet transformer laminates of differing radii. The smaller solenoid is mounted along the centerline of the larger solenoid.

3. According to Maxwell's equations, said geometrical and magnetic arrangement produces linear bucking electric fields along the centerline of said coils. Since curvature and the square of the electromagnetic fields are one and the same phenomenon according to Einstein's spacetime curvature tensor $G=8\pi T$, this resonance of the electric fields causes a resonance of the spacetime curvature and the opening of the wormhole.

4. Due to the fact that the magnetic flux travels within the laminations at a curvature equal to the inverse of the radius squared, each coil produces a spring constant which depends on the current, lamination area, magnetic field strength and the individual curvature of each coil.

5. Due to the fact that the flux travels in opposite directions in each solenoid, the spring constant of the outer coil is positive, and the spring constant of the inner coil is negative. These two spring constants, one positive and one negative, add in parallel to create a negative spring constant for the generator. Because the frequency of resonance is equal to the square root of the negative spring constant divided by the negative mass, the resonant frequency is positive real.

6. This process of creating and keeping open the wormhole allows low density hyperspace energy to enter our dimension. Because the linear mass is lower, Planck's constant, equal to the Planck mass times the Planck wavelength times the speed of light, is reduced to such an extent that the electron is moved out of dimension. Because the electron and proton are one and the same particle, when considering a path through space and hyperspace, the proton is also moved out of dimension. Thus this process of moving the atom in and out of dimension using the magnetic vortex generator has the ability to create cold-welded crystals, new types of materials and new ways to cold solder one disparate material to another.

7. As a consequence of said process, highly relativistic electromagnetic fields can be created because the velocity of light has been reduced considerably. These fields than can be used to produce life in the new class of electromagnetic propulsion vehicles.

8. As a consequence of said process, refrigeration systems can be created because negative energy cools rather than heats.

9. As a consequence of said process, power supplies can be made such that a differential spacetime curvature on the ends of a carbon electrode can create a differential voltage similar to a regular chemical battery.

10. As a consequence of this process, surgery-less medical tables can be fabricated whereby tumors can be pulled directly from the patient's body.

11. As a consequence of this process, the negative mass produced by the generator can offset the mass of a spacecraft to create a mass-less, inertia-less vehicle which can accelerate at hundreds of thousands of g's.

12. As a consequence of this process, the folding space waveguide becomes a reality whereby hyperspace energy, which has a low spring constant, can be easily folded and curved using powerful, relativistic electromagnetic fields. Spacecraft will be able to teleport themselves out-of-dimension over huge distances measured in terms of light-years.

13. Because the wormhole opens up an interdimensional connection to hyperspace having a magnetic monopole, a radial magnetic field is created. As a consequence of this process, a changing magnetic monopole field crossed with a changing electric field can produce a toroidal electromagnetic flux around the circular hull of the spacecraft. As a consequence of the merger of these two fields, a spacetime curvature G_{zz} is produced over the hull of the spacecraft which creates a tension or lift force which enables the spacecraft to ascend, hover or descend.

14. An electrical system, comprised of a variable frequency generator and amplifier, an isolation transformer and voltage step-up transformer, drives a non-linear inductance which switches on and off the current in the output circuit in such a manner as to produce large voltage spikes through

magnetic vortex generator. The generator responds by producing two large negative mass spikes close to the centerline of the two coils.

15. The winding on each coil of the generator has a non-linear spacing to enhance the magnetic field and to reduce the interwinding coil capacitance.

16. The ratio of the radius of the small coil to that of the larger coil is 1/3, which is the magic ratio in physics. This creates a spring constant that is proportional to 8/9. The square of the cosine of the tetrahedral angle of 19.47° is equal to this ratio. Also the ratio of the area-to-volume ratio of the circumscribing sphere of a tetrahedron to the area-to-volume ratio of the tetrahedron is also 1/3. And the corners of the tetrahedron touch the circumscribing sphere at 19.47°. All the large volcanoes and vortices on Earth, Mars, Jupiter, Uranus and Neptune are located at this latitude. Thus this invention is more effective in developing a wormhole because it is tuned geometrically to the tetrahedral geometry of space.

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(54) FULL BODY TELEPORTATION SYSTEM

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(57) ABSTRACT

A pulsed gravitational wave wormhole generator system that teleports a human being through hyperspace from one location to another.

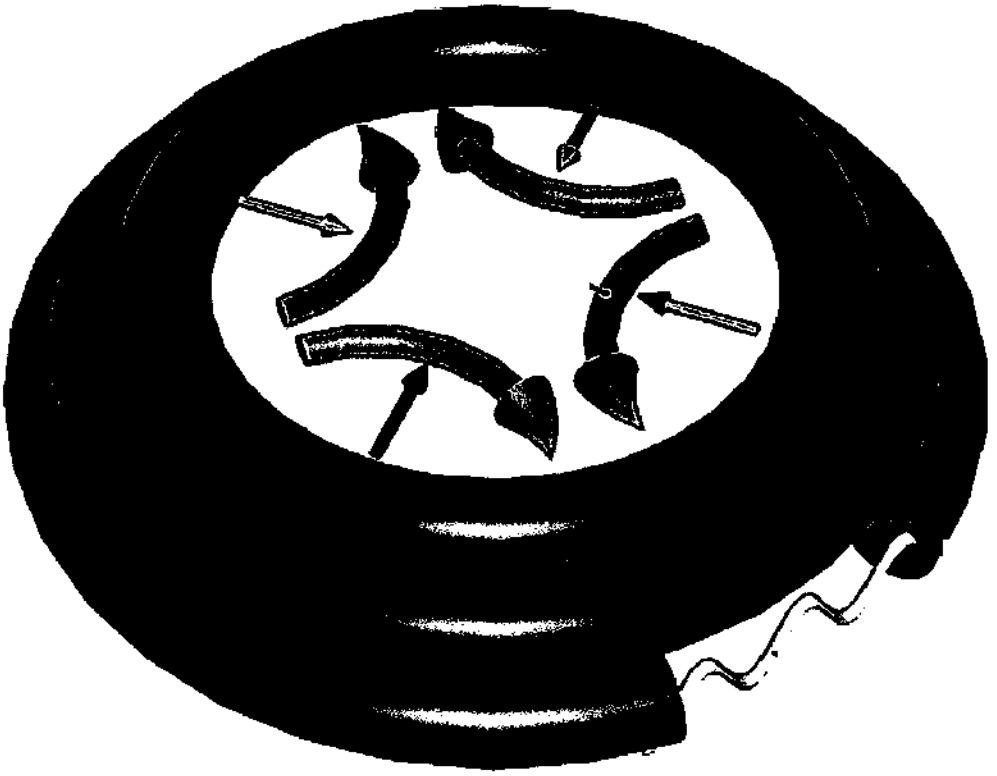

Figure 1

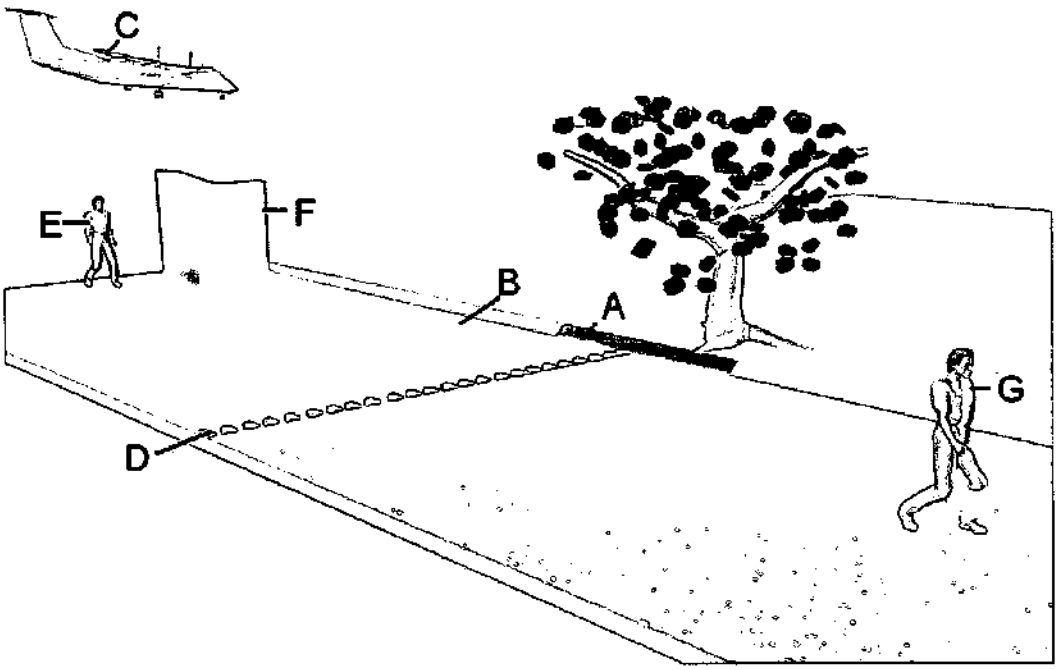

Figure 2

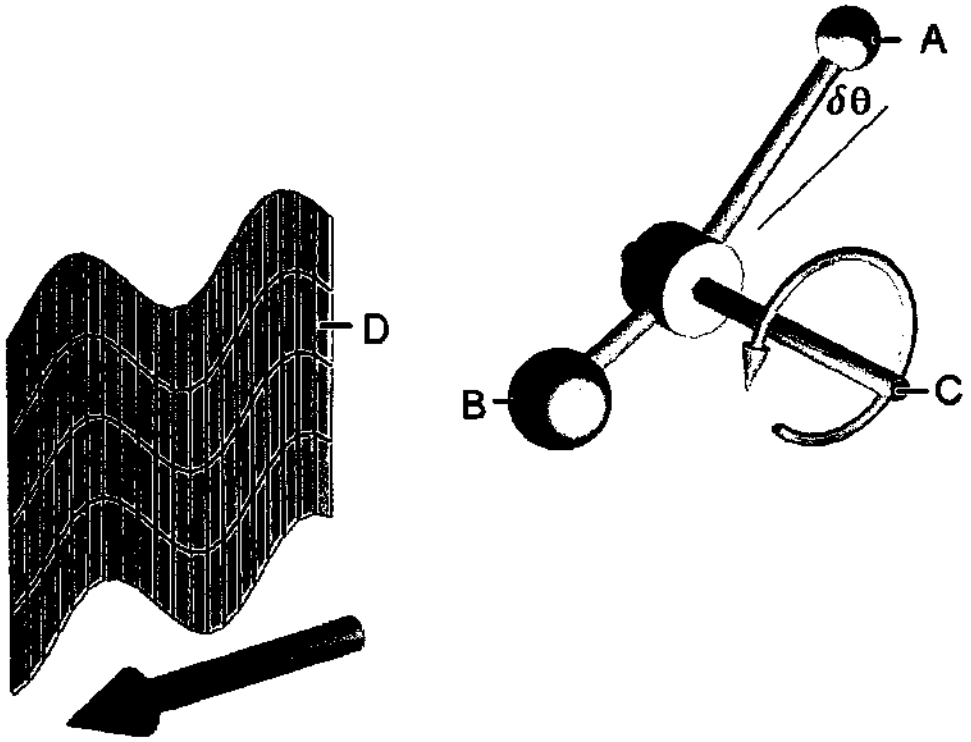

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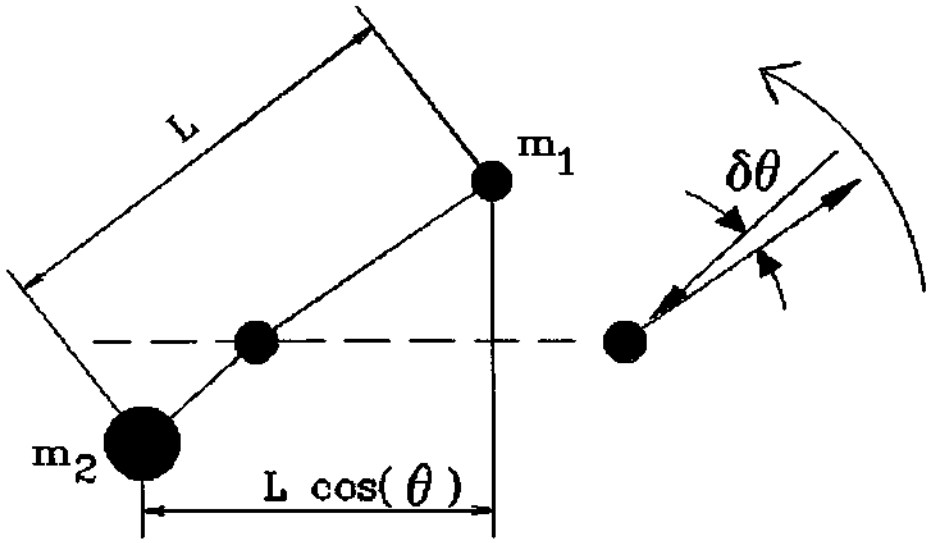

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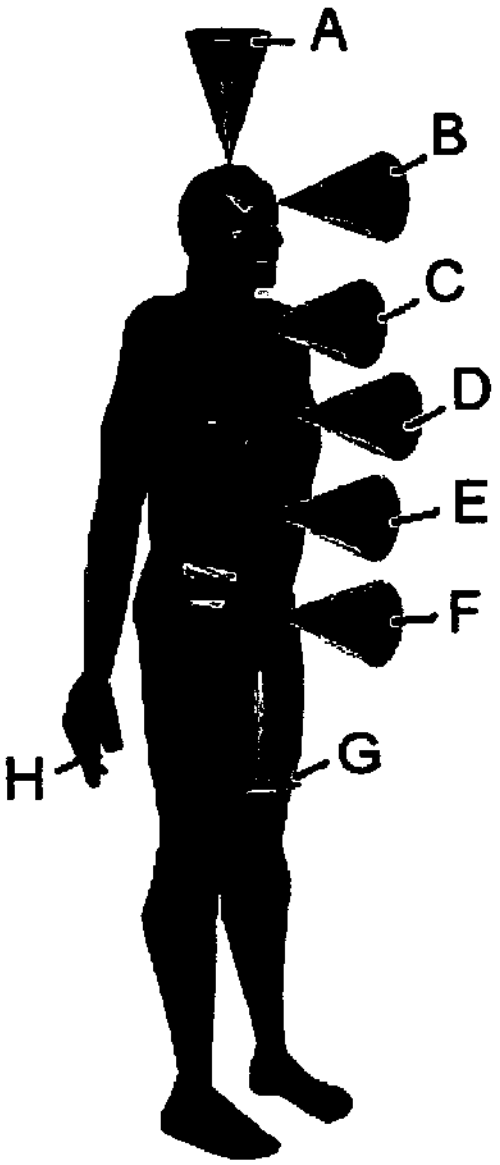

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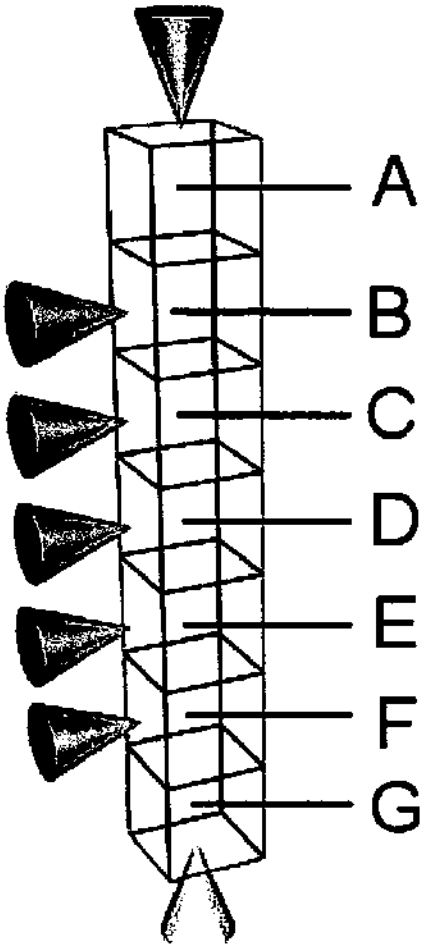

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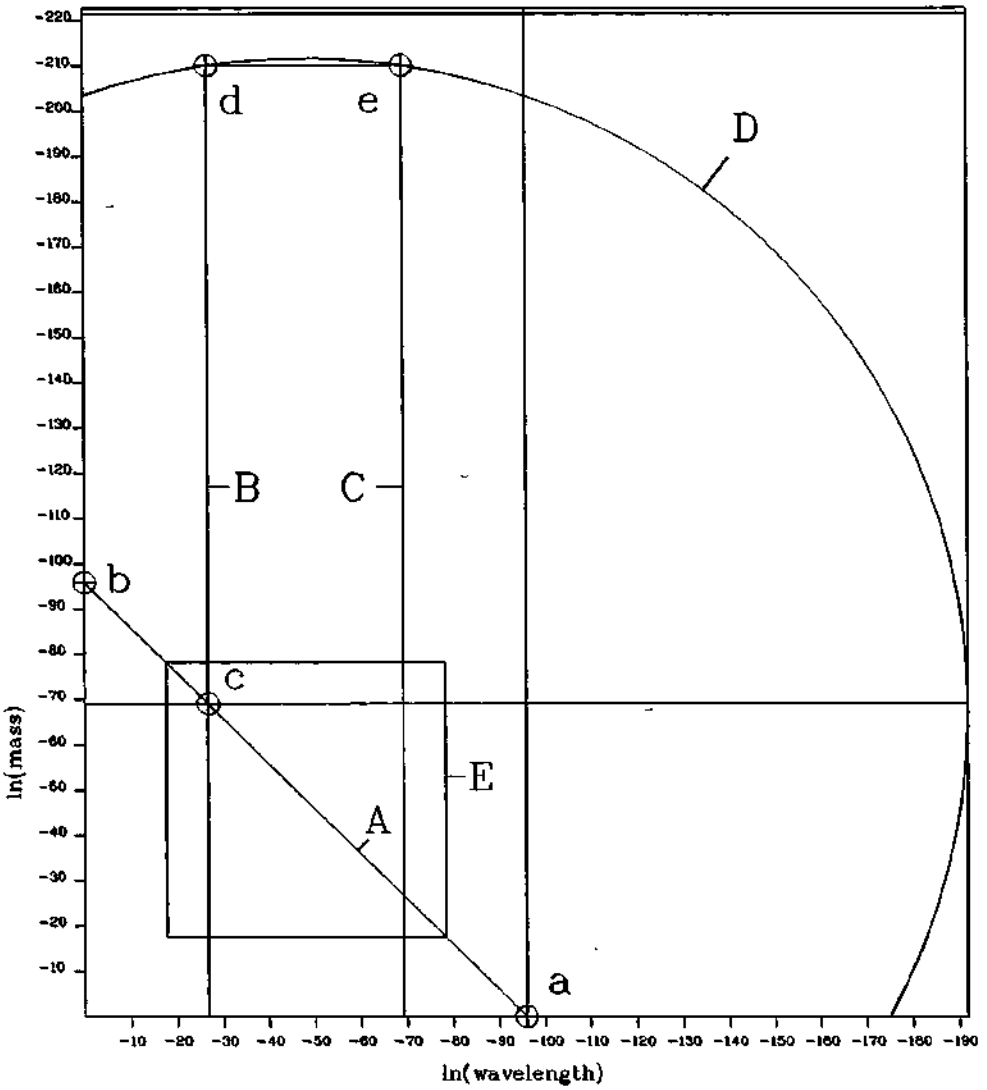

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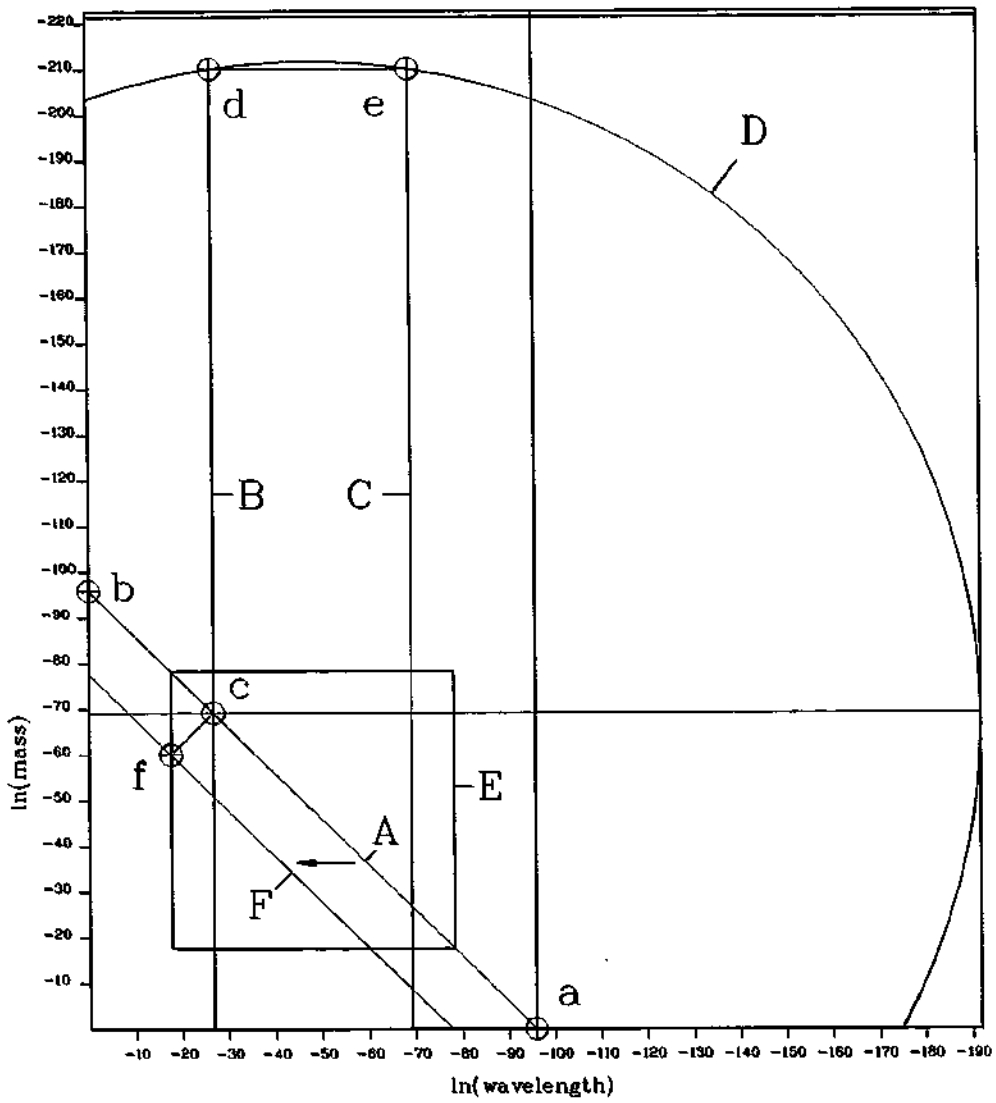

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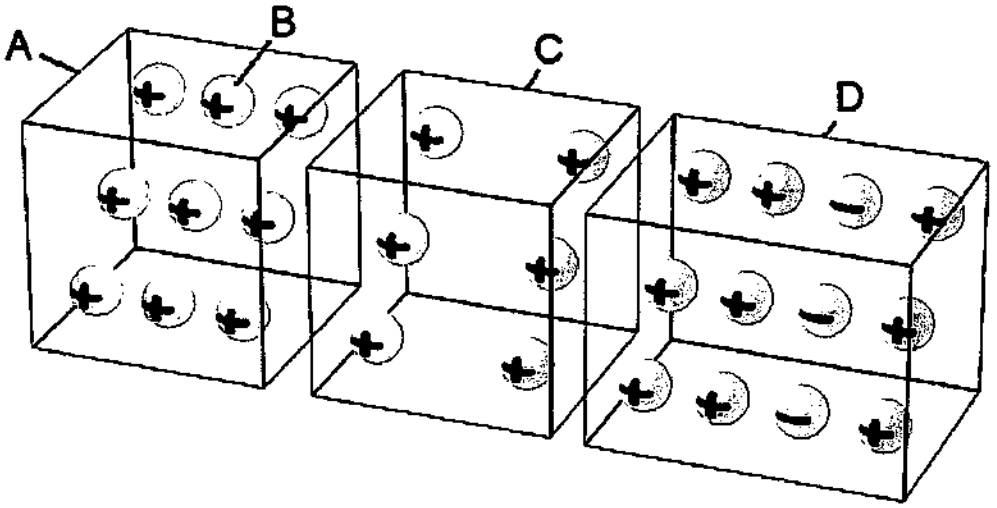

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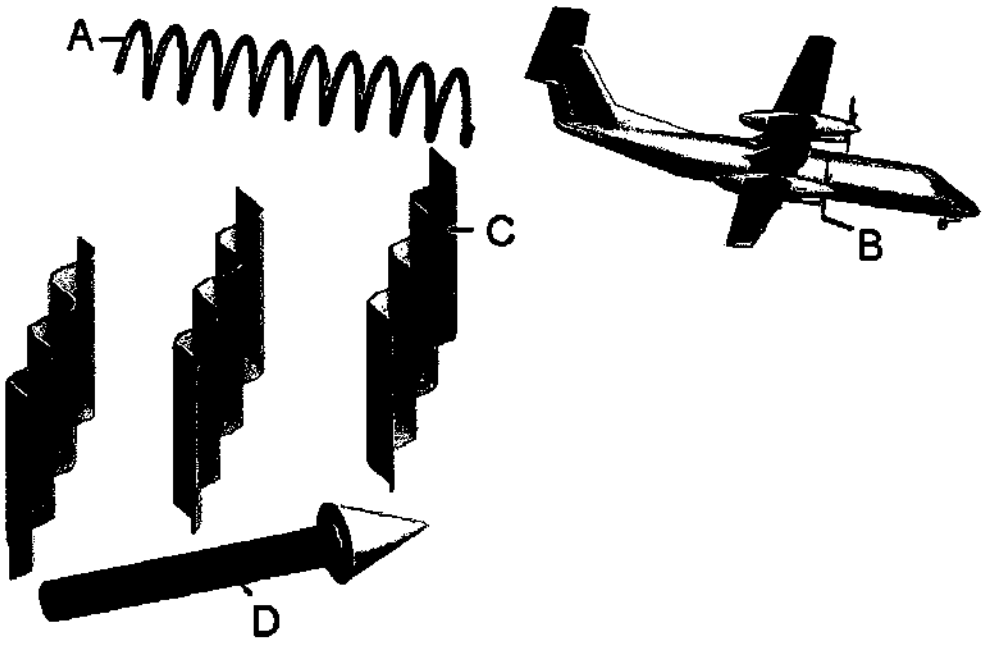

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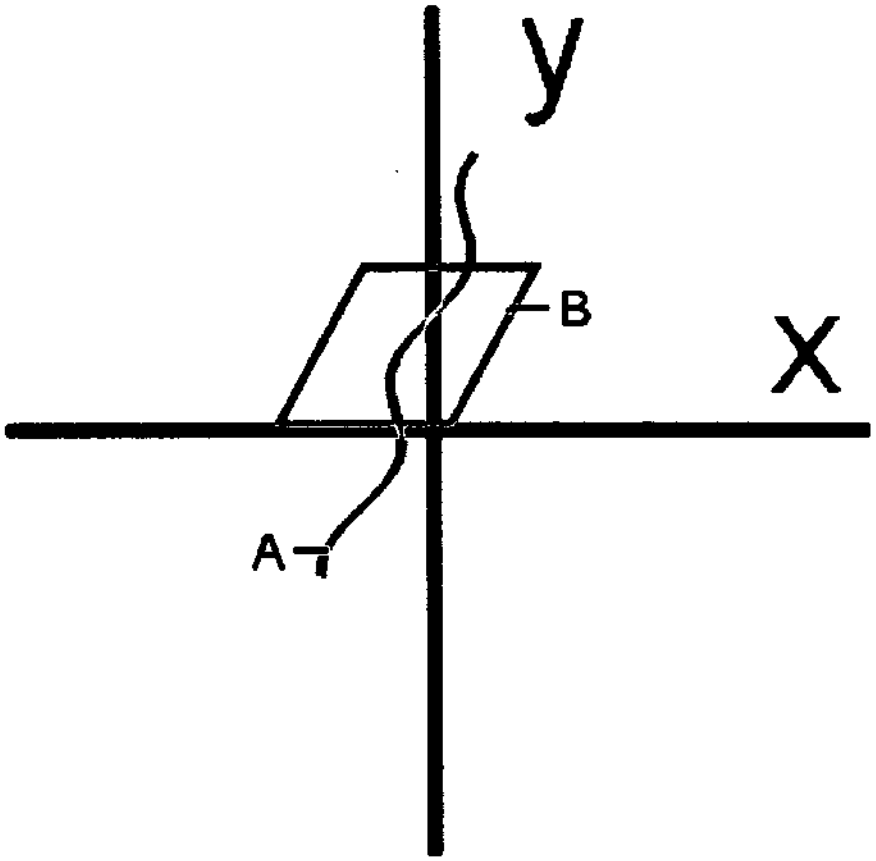

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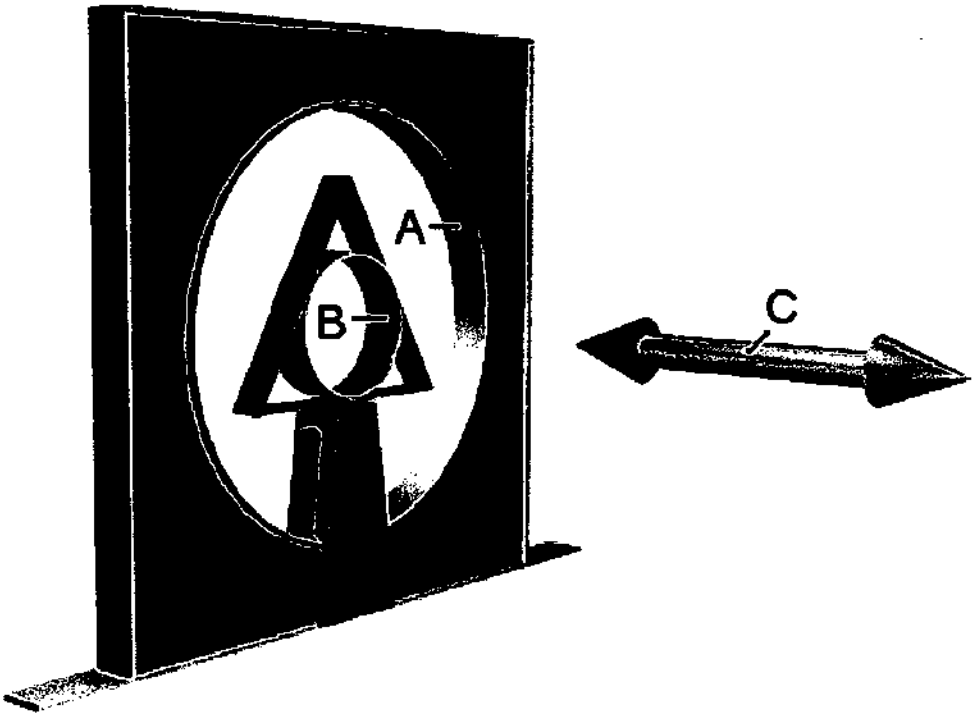

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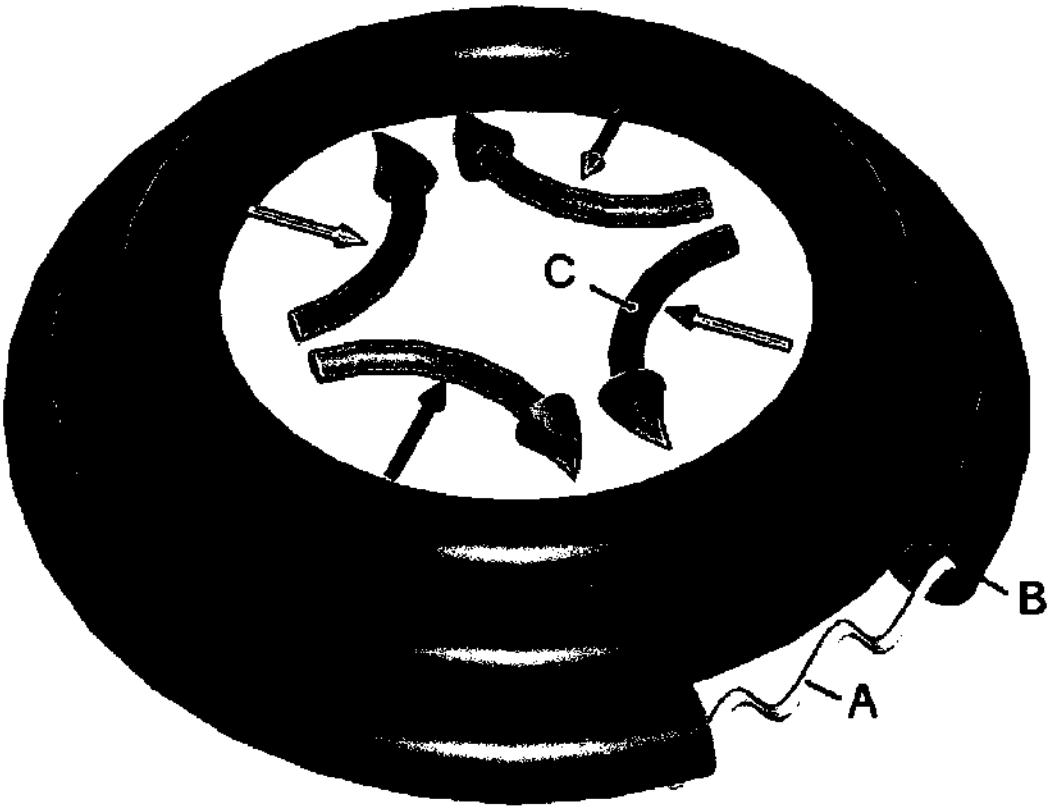

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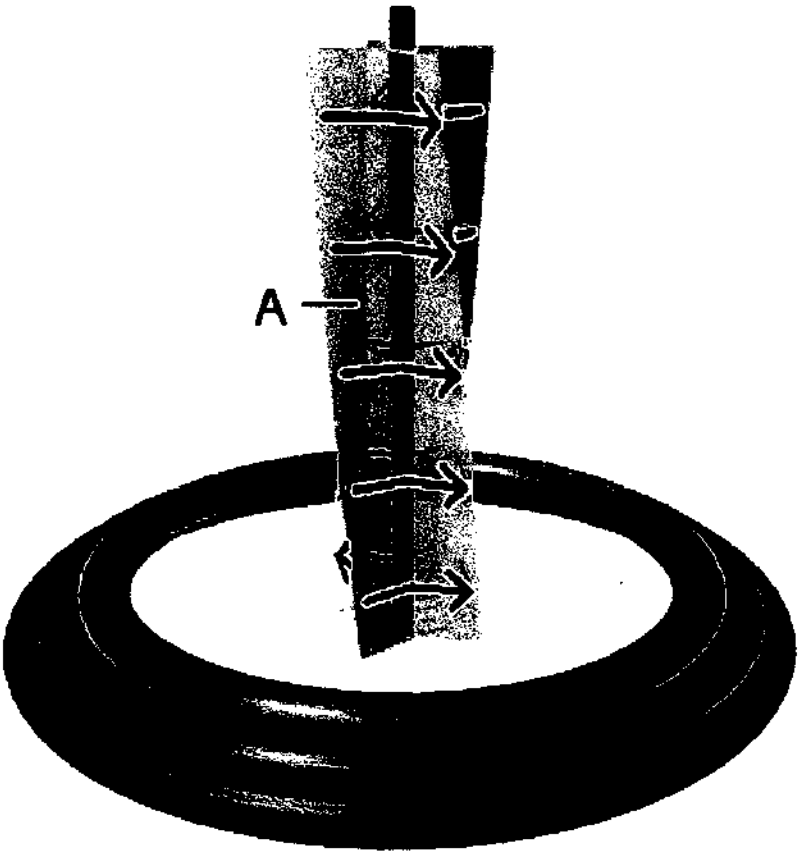

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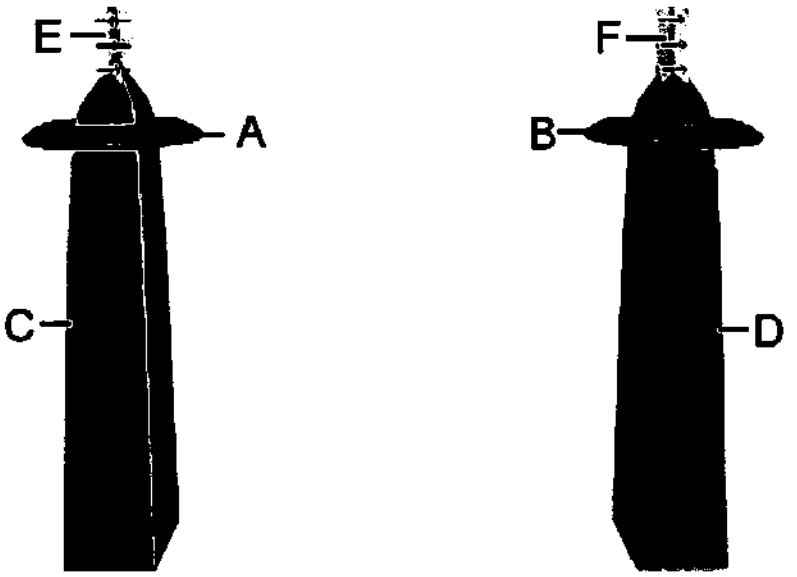

Figure 15

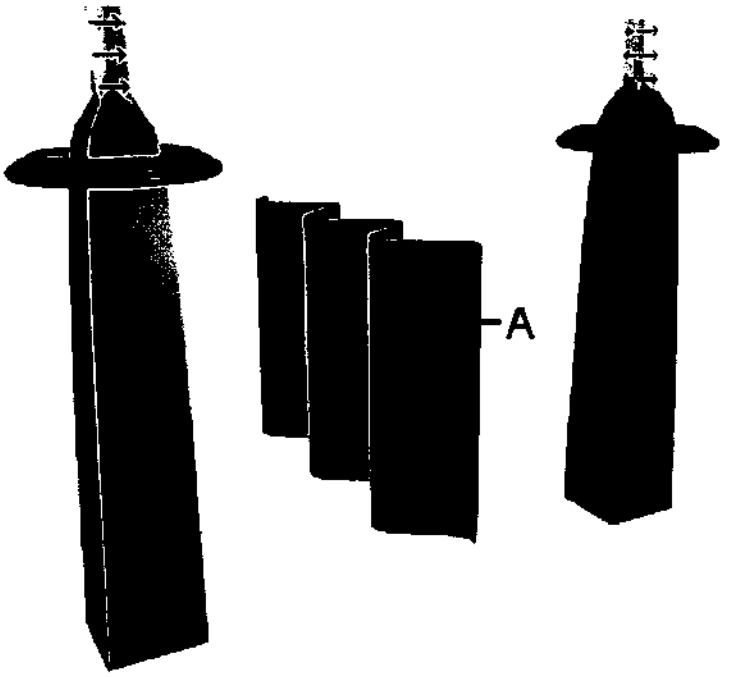

Figure 16

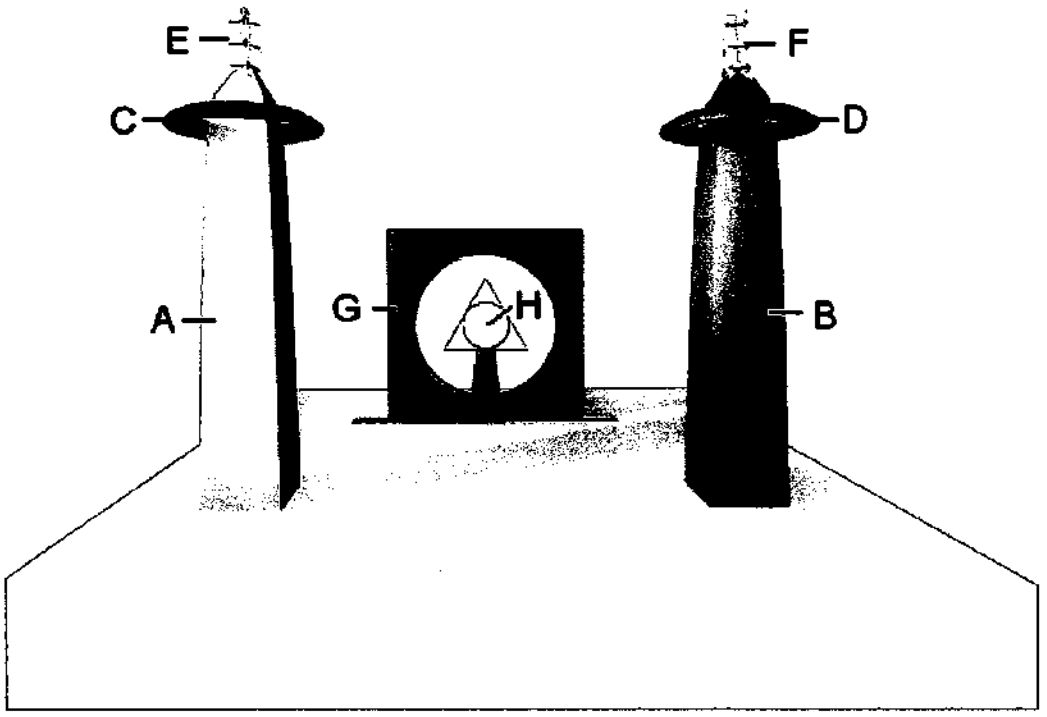

FULL BODY TELEPORTATION SYSTEM

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a system that teleports a human being through hyperspace from one location to another using a pulsed gravitational wave traveling through hyperspace.

BACKGROUND OF THE INVENTION

[0002] The basis for this invention is an event, referring to **FIG. 1**, occurring on May 2, 2004, in which the inventor ("he") personally experienced a full-body teleportation while walking to the bus stop (A) along a road (B) that runs perpendicular to the nearby commercial airport runways where planes are landing. There is a wide iron grating (D) for water drainage that crosses the road at the center of the bus stop. The grating width is such that one has to make a concerted effort to jump across it in order to get from one side to the other. Approximately 50 meters from the iron grating, he (E) felt a vertical wave (F), similar to a flag waving in the breeze, traveling down the street toward the bus stop. The wave velocity was about 1 meter per second, which was slightly faster than his walking speed. In the next instance, he (G) found himself down the street near the corner of the next block. Realizing that he had passed the bus stop, he turned around to see the iron grating approximately 50 meters up the street in back of him. Because there was no recollection of having jumped across the iron grating nor of having passed the bus stop's yellow marker line, he realized that he had been teleported a distance of 100 meters while moving along with the traveling wave. It was obvious that the wave was pulsed because the front edge overtook the inventor, moved with him momentarily, and then the back edge of wave left him as it moved on down the street. While contemplating this sequence of events, he then looked up and saw in a span of a few seconds a twin-turboprop airplane (C) in the distance crossing above the road while making a shallow descent in order to land at the airport.

[0003] It took a number of days in order to understand this sequence of events. The explanation involves knowledge of a wide range of subjects such as gravitation physics, hyperspace physics, wormhole electromagnetic theory and experimentation, quantum physics, and the nature of the human energy field.

[0004] It is obvious from the above scenario that the airplane momentarily crossing perpendicular to the road generates the aforementioned pulse. Because the airplane has an engine on each wing, there are two propellers which conceivably are rotating out-of-phase with each other. That is, the blade of one propeller could be pointing up and the equivalent blade on the other engine could be pointing in a slightly different direction. Notice that the tip of the blade traces out a helix as the plane is landing.

[0005] In gravitation physics, referring to **FIG. 2**, it is known that two masses of mass **m1** and **m2** (A,B) attached by lever arms slightly offset by an angle $\delta\theta$ along the radial direction to the rotating shaft (C), will produce a gravitational wave (D) traveling perpendicular to the shaft. The mass and wave are referred to as the source and receptor respectively. Referring to a side view looking along the shaft **FIG. 3**, the product of the mass m times the angular acceleration a is a constant such that $m1a1$ is equal to $m2a2$. The distance between the masses is length L, which makes an angle θ with the horizontal axis. The difference in time of travel to the receptor gives rise to a difference in phase $\delta\theta$ equal to the angular velocity ω of the rotating shaft times the length L times the cosine of the angle θ

$$\delta\theta=\omega L\cos(\theta)$$

[0006] At the receptor, the amplitude of the wave is equal to the mass times the acceleration times the phase difference divided by the radius r to the receptor

$$A=\frac{m_1a_1}{r}\delta\theta\approx\left(\frac{m\omega L\sin(\theta)}{r}\right)(\omega L\cos(\theta))=\frac{m\omega^2L^2\sin(2\theta)}{r}$$

Even though the turboprop airplane engines have a high rotational speed and a large separation distance between masses, the gravitational wave which is produced is small and not noticed. The problem is that the gravitational constant G in this dimension has such a small value equal to the speed of light c squared divided by the linear mass Ω of the universe

$$G=\frac{c^2}{\Omega}=\frac{(299792458\ \text{m/s})^2}{1.346812891\cdot10^{27}\ \text{kg/m}}=6.673200002\cdot10^{-11}\ \frac{\text{m}^3}{\text{kgs}^2}$$

[0007] On the other hand, a gravitational wave traveling in hyperspace would be magnified enormously due to the face that the linear mass is so small. The magnitude of the gravitational constant in hyperspace can be estimated in the following manner. At the beginning of the 20th century, a man's parents were dying of tuberculosis. With their permission, he placed them and their beds on weighing scales. When each one passed away, each scale registered a drop in mass equal to 0.071 kilograms. This is the mass of the hyperspace energy being which resides in the physical body. Because hyperspace is co-dimensional with our dimension, the energy being interpenetrates the body and controls its movement.

[0008] Referring to **FIG. 4**, a human being has seven vortices (A through G) which are aligned along the centerline of the body. Each vortex is actually a co-gravitational field K which causes a pendulum placed in the field to spin in circles. For this reason, the K field has units of inverse seconds similar to an angular velocity. The vortex transports energy from our dimension to the energy being located in hyperspace. The gravitational field g and the co-gravitational field K are equivalent gravitationally to the electric E field and the magnetic B field found in electromagnetism. The equivalent gravitational solution to an electromagnetic problem can be obtained by substituting the following gravitational constants for the electromagnetic constants

Electromagnetic	Gravitational
q (charge)	m (mass)
ρ (volume charge density)	ρ (volume mass density)
σ (surface charge density)	σ (surface mass density)
λ (line charge density)	λ (line mass density)
J (convection current density)	J (mass current density)

-continued

Electromagnetic	Gravitational
E (electric field)	g (gravitational field)
B (magnetic field)	K (co-gravitational field)
ϵ_0 (permittivity of space)	$-1/4\pi G$
μ_0 (permeability of space)	$-4\pi G/c^2$
$-1/4\pi\epsilon_0$ or $-\mu_0 c^2/4\pi$	G (gravitational constant)

[0009] Referring to **FIG. 5**, each vortex is connected through the pineal gland by light cords to a separate hyperspace quantum well having its own frequency and dimension. The reason for this separation is that the conical spiritual eye, attached to vortex B, has to have its own energy structure which is different from vortex (A) which is connected to the quantum energy field in which the mental processes are developed. Due to the high speed of light in our dimension, the quantum wells are the size appropriate to molecules and atoms. In hyperspace, where the speed of light is one meter per second, the quantum wells are huge and can be manipulated. This manipulation has shown that the quantum wells are in the shape of a cube about a meter on a side. This makes the whole structure about seven meters tall for a volume of seven cubic meters. Thus the mass density ρ of hyperspace is about

$$\rho_h = \frac{.071\ \text{kg}}{7\ \text{m}^3} = .01\ \frac{\text{kg}}{\text{m}^3}$$

which per unit area is the same value. Therefore the hyperspace gravitational constant is equal to

$$G_h = \frac{c^2}{\Omega_h} = \frac{\left(1\ \frac{\text{m}}{\text{s}}\right)^2}{.01\ \text{kg/m}} = 100\ \frac{\text{m}^3}{\text{kgs}^2}$$

The enormous magnification of the gravitational constant is therefore of the order of

$$\frac{G_h}{G} = \frac{100}{6.6732 \cdot 10^{-11}} \approx 1.5 \cdot 10^{12}$$

The question is how does this amplified gravitational wave created by the rotating propellers and turbines get into hyperspace from our dimension?

[0010] The answer comes from experiments done using the ancient Chinese form of breathing known as Chi Kung. Using this breathing technique, we have been able to levitate the human body over six feet in the air. The internal temperature of the stomach is around 200 degrees Fahrenheit. By simultaneously squeezing the diaphragm to bring hot air up through the lungs, and breathing through the nose to bring cold air down, rotating vortices are generated in the lung passages when these two air masses meet and twist around each other as depicted in the famous Yin-Yang diagram. Because the lung has variable diameter passages from the large diameter at the throat to the final small air sacs, there is a spectrum of rotating frequencies.

[0011] From quantum physics it is known that if there is a temperature fluctuation occurring among a group of harmonic oscillators in the environment, then Planck's reduced constant $\hbar$ is increased by the cotangent of the constant times the frequency ω of the oscillator divided by twice Boltzmann's constant k times the temperature T

$$\hbar = \hbar\coth\left(\frac{\hbar\omega_n}{2kT}\right)$$

[0012] The effect of increasing Planck's constant, referring to **FIG. 6**, can be seen in the tetrahedron diagram. This diagram, of which there are now over 4000, plots the natural logarithm of mass on the vertical axis versus the natural logarithm of wavelength on the horizontal axis. In terms of mathematics, it is a subspace logarithmic manifold which projects geometrically the physics constants into our 4D spacetime dimension. That is, it is the geometry of the tetrahedron circumscribed by the sphere that determines the mass of the proton and electron. The mass of the electron times its wavelength is equal to the mass of the proton times its wavelength which in turn is equal to Planck's constant h divided by the speed of light c

$$m_e\lambda_e = m_p\lambda_p = \frac{h}{c}$$

Taking the natural logarithm of the above equation shows that the mass plus the wavelength is equal to what is termed the base constant

$$\ln(m_e) + \ln(\lambda_e) = \ln\left(\frac{h}{c}\right) = -95.91546344$$

which is represented in **FIG. 6** by the 45 degree line (A) from point (a) on the horizontal axis to the vertical axis at point (b). The electron is located at point (c) which is the intersection of the electron wavelength (B) with line (A). The electron wavelength (B) reflects off the sphere (D) at points (d) and (e) and returns along line (C) as the electron mass. As shown in tetrahedron diagram tet0565, stored in the Library of Congress, the clockwise path of the electron transitions into the counter-clockwise path of the proton showing that the electron and proton are one and the same particle. Because the electron and proton travel in opposite directions along the path, they have the same charge but of opposite sign.

[0013] Our dimension is represented by Planck box (E) which is bounded by the Planck mass and the Planck wavelength. The Planck mass is equal to the linear mass of the universe times the Planck length which is the bottom limit of our dimension. The Planck wavelength is 2π times the Planck length. Notice that the electron is located within the Planck box.

[0014] Referring to **FIG. 7**, if there is an increase in Planck's constant due to the temperature fluctuations among the harmonic oscillators, the 45 degree base line (A) moves to the left on the tetrahedron diagram as shown by line (F).

Because of the increase in the base constant, there is a corresponding increase in the electron mass and wavelength. The electron moves from point (c) to point (f) which places it at the edge of the Planck box (F) which is the boundary between space and hyperspace. At point (f), the electron is essentially no longer in our dimension.

[0015] Referring to **FIG. 8**, imagine a box (A) filled with nine electron oscillators (B). If Planck's constant is increased near the three oscillators in the middle, these electrons will leave this dimension. This leaves six oscillators as shown in the box (C). However, box (C) is the equivalent of box (D) in which there are still nine positive mass oscillators together with 3 negative mass oscillators. Thus there is an accumulation of negative energy ($-\rho$) when information is lost from the environment to another dimension.

[0016] Dr. Kip Thorne, who co-authored the book *Gravitation* with Dr. Archibald Wheeler of Princeton University, has shown in a General Relativity spacetime curvature calculation that negative energy is required to open and stabilize the throat of a wormhole between space and hyperspace. The accumulation of negative energy in the aforementioned example generates wormholes between into hyperspace. Hyperspace has a low energy density because of the reduced speed of light in that dimension. Ordinarily, energy would not flow from hyperspace to space because space has a higher potential than the potential of hyperspace. This, of course, is the reason that the body vortices can flow energy into the energy field of the human being who is located in hyperspace. By creating negative energy, the potential becomes reversed such that low density hyperspace energy flows into our dimension as seen by the positive head

$$PE=\rho_{hyperspace}-(-\rho_{space})=+2\rho$$

The low-density energy fills the body which allows a human being to float upwards like a helium balloon as verified by Chi Kung breathing as well as spinning on a motorized platform known as the Chakra Vortex Accelerator. The latter device resulted in the first mechanical means to produce anti-gravity.

[0017] The process of creating spinning thermal fluctuations is the same as found in the hot air vortices created by the jet airplanes landing at the airport near the road where the full-body teleportation occurred. Large vortices are created over the wing of the airplane at the same time that the turbine engines are spinning hot vortices into relatively cold air. These conditions produce wormholes between space and hyperspace. It takes a twin turboprop airplane landing behind the jet to generate the gravitational wave in the region where the wormholes have formed. The gravitational wave then traverses the wormholes into hyperspace, becoming highly amplified due to the change in linear mass and speed of light. Because the propeller blades are co-linear with the road, the gravitational wave travels in the direction along the road where it was encountered by the inventor.

[0018] From experiments with cavitating bubbles (see patent application Cavitating Oil Hyperspace Energy Generator), it was found that it is possible to produce a wormhole if the surfaces of the bubble collapse asymmetrically. A symmetric collapse of a spherical bubble produces enormous spacetime curvature distortions. An asymmetric collapse, using a magnetic field to distort the collapse, produces, in addition to the same severe spacetime distortions, negative energy as the bubble collapses. Due to some General Relativity considerations, the wormhole that is created starts rotating in a manner similar to the beacon light produced by a lighthouse.

[0019] Referring to **FIG. 9**, due to the forward helical motion (A) of the propellers (B) as the airplane crosses the road, the pulsed gravitational wave (C) is skewed backward at an angle (D). Due to the wormholes created by the presence of thermal vorticity fluctuations generated by the wing and turbines of the airplane, this skewed wave moves into hyperspace where it is highly magnified and detected by the inventor.

[0020] Referring to top view **FIG. 10**, the gravitational wave (A) causes a skewed compression and expansion of the hyperspace quantum wells (B) which constitute the human energy being. Due to this asymmetric distortion in the xy-plane, the quantum wells take the physical body out of dimension as long as the wave pulse is traveling with the human energy field. Once the back edge of the gravitational wave moves on past the quantum wells, the body is then brought back into dimension.

SUMMARY OF THE INVENTION

[0021] It is the object of this invention to teleport a human being from one location to another by creating a pulsed gravitational wave traveling through hyperspace that asymmetrically compresses and expands the quantum wells of the human energy being. This spacetime curvature distortion of the hyperspace quantum wells pulls the physical body out of dimension such that the human being is teleported along with the wave. As the pulsed wave moves on past the quantum wells, the human is brought back into dimension at some distant location. The invention requires (1) a device that will generate a wormhole between space and hyperspace, and (2) a device that will generate a gravitational wave which can be inserted through the wormhole.

[0022] Referring to **FIG. 11**, a magnetic vortex wormhole generator has already been developed which generates a wormhole between space and hyperspace as described in a previous patent application entitled Magnetic Vortex Wormhole Generator. Using this generator, it was found that smoke blown through one side of the coil does not appear on the other side of cylindrical coil. The smoke flows through the wormhole and appears in a hyperspace co-dimension. It was this experiment that resulted in making first contact with the androids of the Grey aliens who told me, in a remote viewing session, that "We saw you blowing smoke into hyperspace."

[0023] The wormhole generator consists of two concentric cylindrical coils (A,B), one of larger radius than the other, made of thin transformer iron laminate wrapped in opposite directions with one continuous wire driven by a sinusoidal current. The solenoidal coil generates a magnetic field through the laminate. Because the electrical current flows in opposite directions at different radii through the two windings, bucking electric fields (C) are created along the centerline of the generator. These radially-offset magnetic fields and bucking electric fields, as shown by a calculation using Einstein's General Theory of Relativity, generate both an enormous spiking spacetime curvature and negative energy

at small radius along the centerline where the wormhole is formed. The gravitational wave generator is then coupled to this wormhole generator.

[0024] Referring to **FIG. 12**, it is known from gravitation physics that injecting an electromagnetic wave (A) into a hollow toroidal waveguide (B) produces a hyperbolic spacetime curvature stress (C) in the plane of the waveguide. The tips of the arrows indicate compression and the tail of the arrows indicate expansion or stretching of spacetime. The reason for this spacetime curvature is because the waveguide forces the electromagnetic wave to curve around and travel in a circle. Spacetime has to compensate for this toroidal-generated stress by creating hyperbolic lines of stress in the inner plane of the toroid so that the overall spacetime curvature is zero. For a greater gravitational effect, three toroidal waveguides, phased 120 degrees apart, are used to seal off the curvature.

[0025] Referring to **FIG. 13**, the three toroids create a rotating, twisting, vertical propagating gravitational field (A) through the centerline of the toroids provided that the period of the electromagnetic wave is twice the period of the gravitational wave. This phase relationship is adjusted by selecting the correct radius for the frequency of the monochromatic wave.

[0026] In order to effectively use this gravitational wave, referring to **FIG. 14**, three phased toroidal waveguides (A,B) are mounted at the top of each of two identical square granite obelisks (C,D). The two obelisks are offset by a short distance between them. As the vertical gravitational wave rotates around along the vertical axis inside the obelisk, the edges of the square obelisks are compressed and expanded such as to create two cylindrical asymmetric gravitational waves traveling radially outward.

[0027] Referring to **FIG. 15**, these waves meet to form a plane gravitational wave (A) which travels down the centerline between the two obelisks.

[0028] Referring to **FIG. 16**, the full body teleportation system consists of the twin granite obelisks (A,B) on which are mounted near the top of each the toroidal waveguides (C,D) which produce the pulsed gravitational waves (E,F) that run the length of the obelisks. Because the gravitational wave is rotating inside the obelisk, the granite stone undergoes a very small asymmetrical compression and expansion. A cylindrical gravitational wave propagates out from each obelisk such that along the centerline between the two there is generated a plane gravitational wave. This wave enters the wormhole (H) created by the magnetic vortex generator which is located a short distance from and parallel to the obelisks. The wave is amplified by a factor of almost 10^{13} when it enters the hyperspace co-dimension.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0029] **FIG. 1**. Perspective view of site where full-body teleportation occurred.

[0030] **FIG. 2**. Perspective view of gravitational wave generator.

[0031] **FIG. 3**. Planar view of gravitational wave generator.

[0032] **FIG. 4**. Perspective view of seven vortices of human energy being.

[0033] **FIG. 5**. Perspective view of seven large quantum wells of human energy being.

[0034] **FIG. 6**. Tetrahedron diagram showing Planck's constant and electron.

[0035] **FIG. 7**. Tetrahedron diagram showing electron moving out of dimension.

[0036] **FIG. 8**. Perspective view showing production of negative energy.

[0037] **FIG. 9**. Perspective view of skewed gravitational wave produced by propellers.

[0038] **FIG. 10**. Planar view of skewed quantum wells deformed by gravitational wave.

[0039] **FIG. 11**. Perspective view of magnetic vortex wormhole generator.

[0040] **FIG. 12**. Perspective view of hyperbolic lines of stress generated by toroidal waveguide.

[0041] **FIG. 13**. Perspective view of rotating, twisting, propagating gravitational wave generated by toroidal waveguides.

[0042] **FIG. 14**. Perspective view of toroidal waveguides attached to obelisks.

[0043] **FIG. 15**. Perspective view of gravitational wave generated by obelisks.

[0044] **FIG. 16**. Perspective view of magnetic vortex wormhole generator and obelisk gravitational wave generator.

DETAILED DESCRIPTION OF THE INVENTION

[0045] 1. The obelisks are quarried out of granite stone and cut with a large-diameter diamond saw that is used in highway construction. The beveled piece at the top is cut separately and cemented in place. A tapered aluminum bracket holds the toroids in place.

[0046] 2. The electronics for the magnetic vortex generator are similar to that used in the patent application Magnetic Vortex Wormhole Generator.

[0047] 3. The electronics for the toroidal waveguides is the familiar stub and coaxial cable driven by an amplifier and pulsed variable-frequency generator.

I claim:

1. A full body teleportation system consisting of:

generating a pulsed gravitational wave which propagates through a magnetic vortex wormhole generator; and

generating a wormhole with the magnetic vortex generator whereby the pulsed gravitational wave traverses through the wormhole and enters into hyperspace where the wave is enormously magnified due to the lower speed of light in that dimension.

2. The method of claim 1, wherein the step of generating the pulsed gravitational wave comprises:

using two granite stone obelisks;

mounting monochromatic-wave toroidal waveguides on top of each obelisk to create a rotating, twisting, propagating gravitational wave through the vertical axis of each obelisk; and

creating a cylindrical compression and expansion in each obelisk to produce a plane gravitational wave traveling down the centerline between the two obelisks.

3. The method of claim 1, wherein the step of generating a wormhole into hyperspace comprises:

using two concentric cylindrical solenoidal coils of different radii connected by a single wire wrapped in opposite directions on thin iron transformer laminate;

generating bucking electric fields down the centerline of the vortex generator which creates a spacetime curvature distortion with negative energy in accordance with Einstein's General Theory of Relativity.

4. A teleportation system comprising:

generating a gravitational wave traveling through hyperspace which interacts with the human energy being; and

pulling the human energy being and physical body out of dimension when interacting with the pulsed gravitational wave such that the person is teleported from one location to another through hyperspace and back again into our 4D spacetime dimension.

* * * * *

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(54) TRIANGULAR SPACECRAFT

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(52) **U.S. Cl.** **244/171.5**

(57) **ABSTRACT**

A spacecraft having a triangular hull with vertical electrostatic line charges on each corner that produce a horizontal electric field parallel to the sides of the hull. This field, interacting with a plane wave emitted by antennas on the side of the hull, generates a force per volume combining both lift and propulsion.

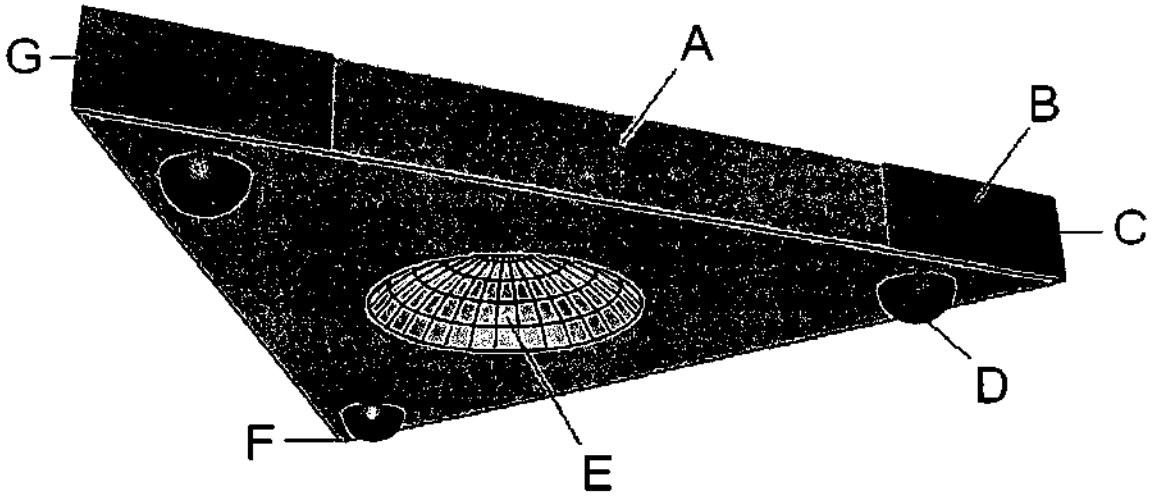

Figure 1

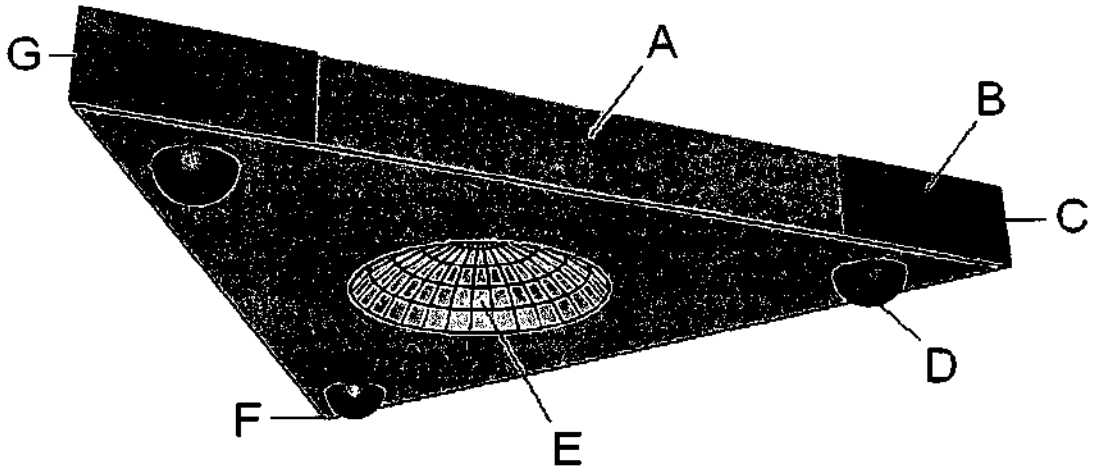

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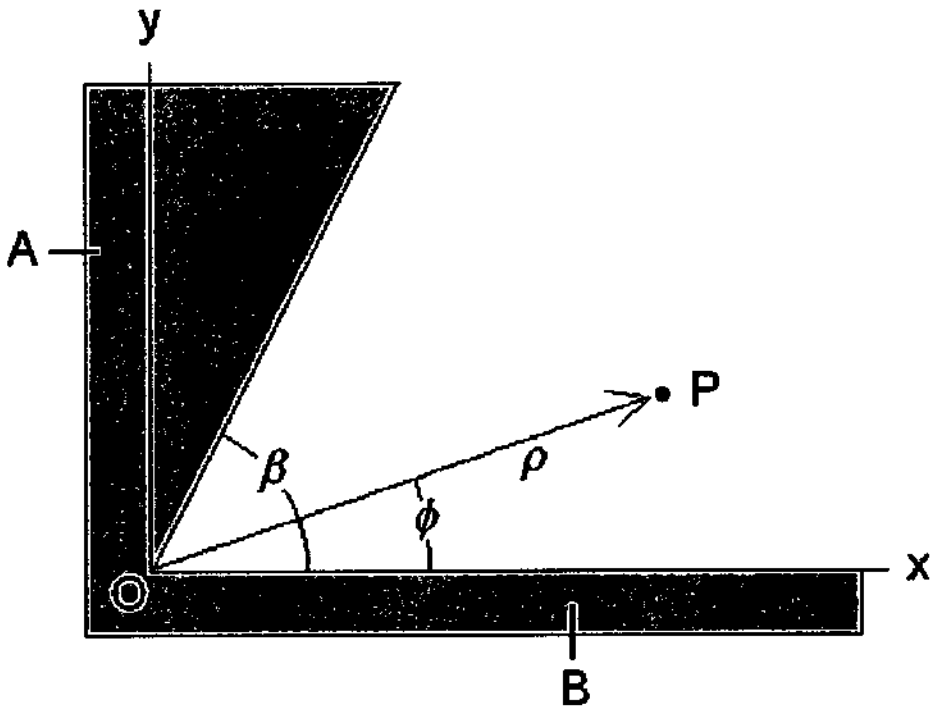

Figure 3

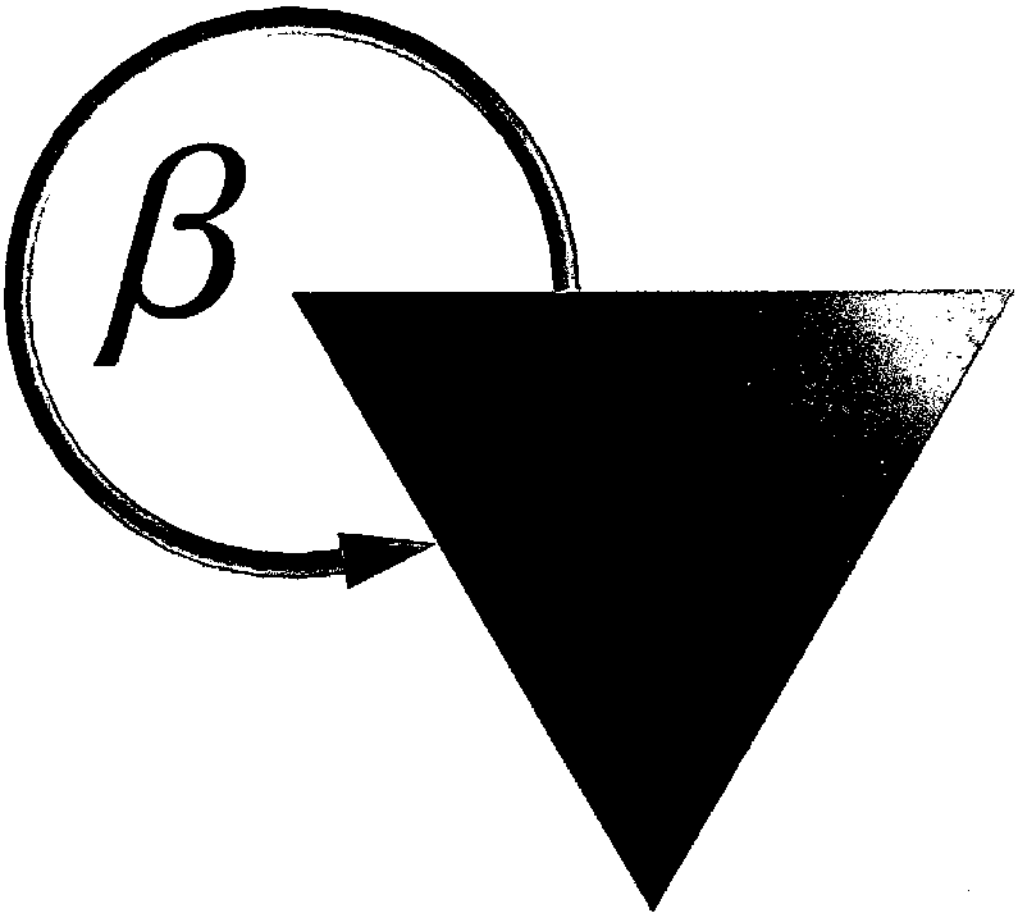

Figure 4

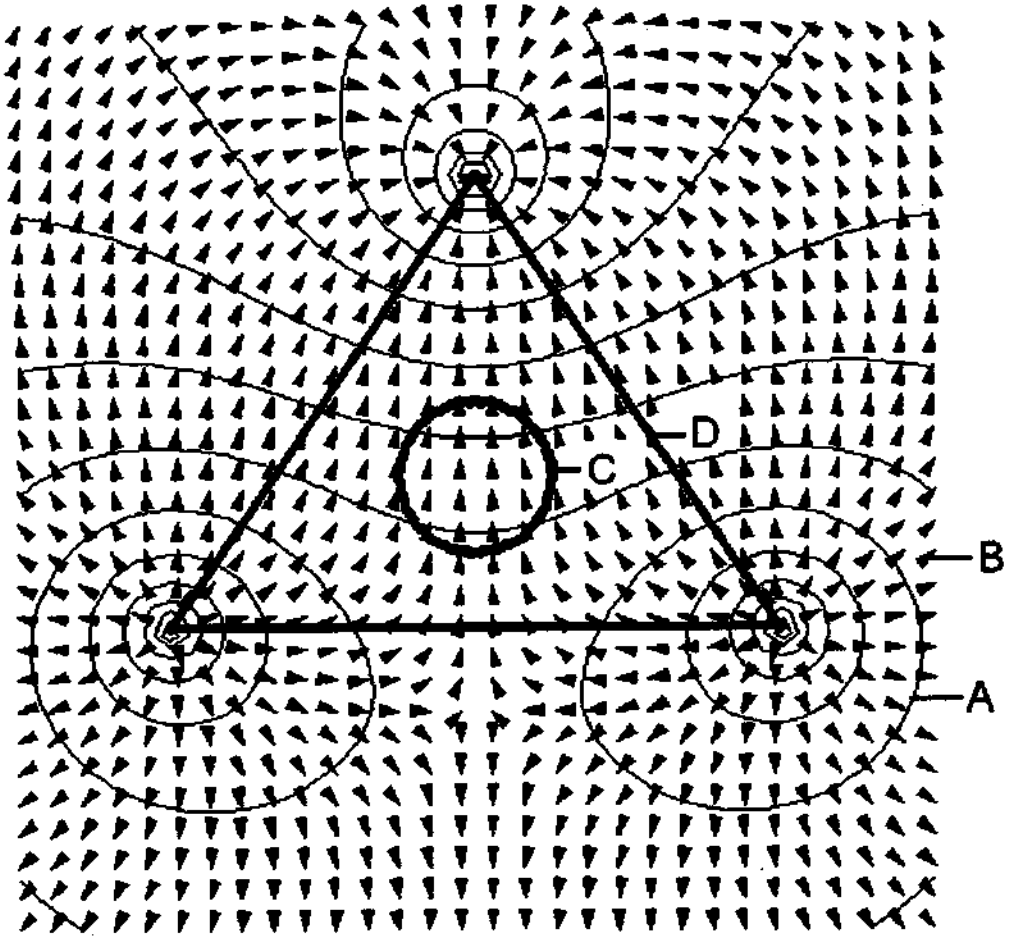

Figure 5

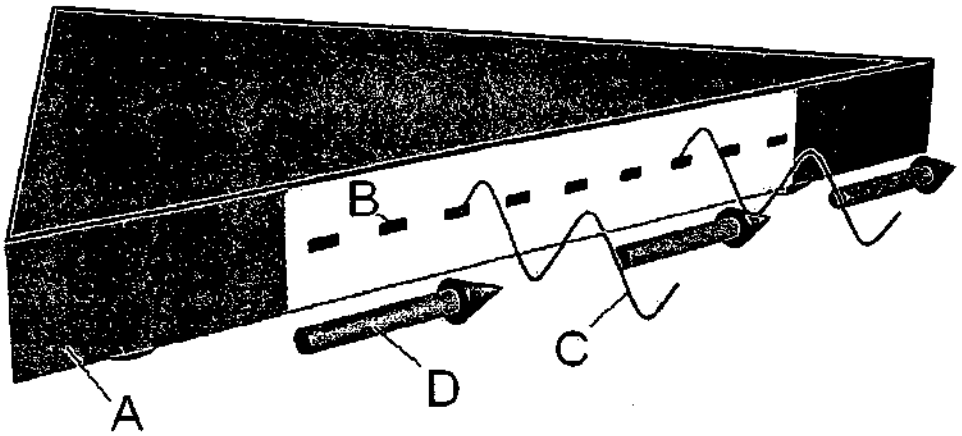

Figure 6

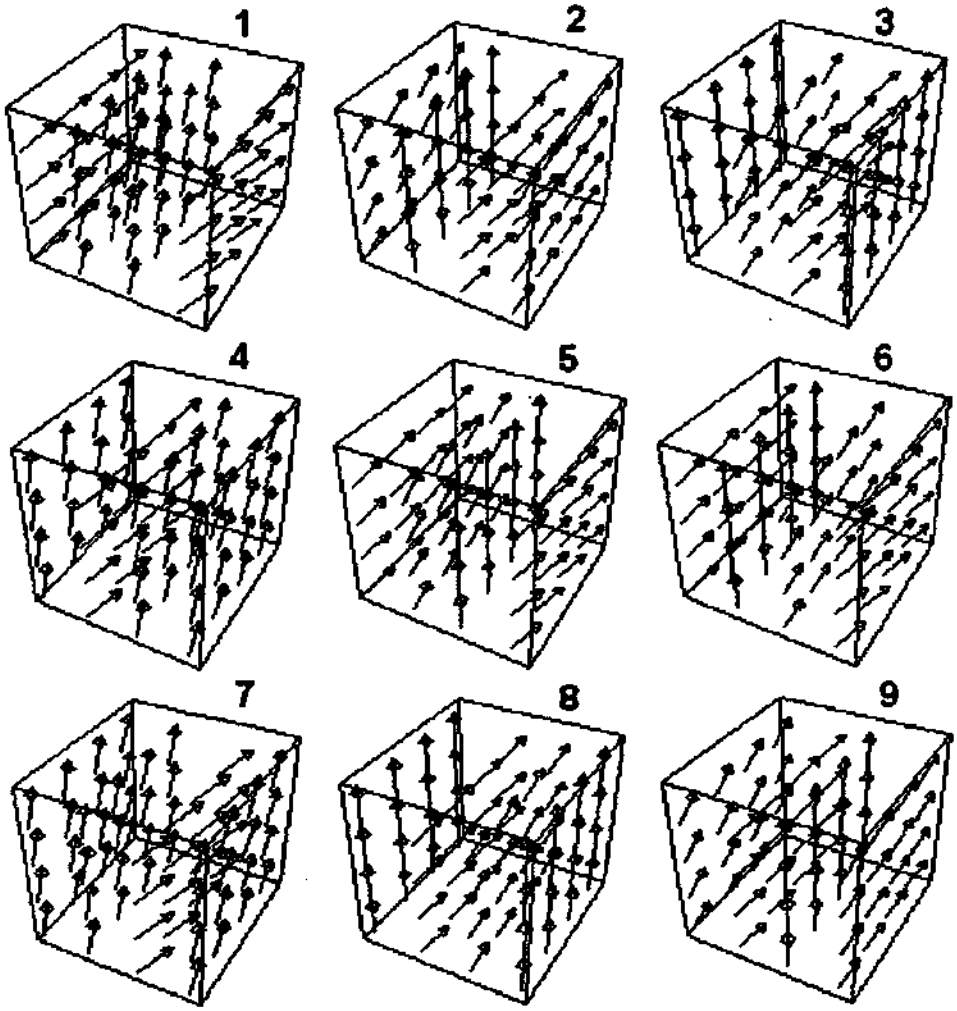

Figure 7

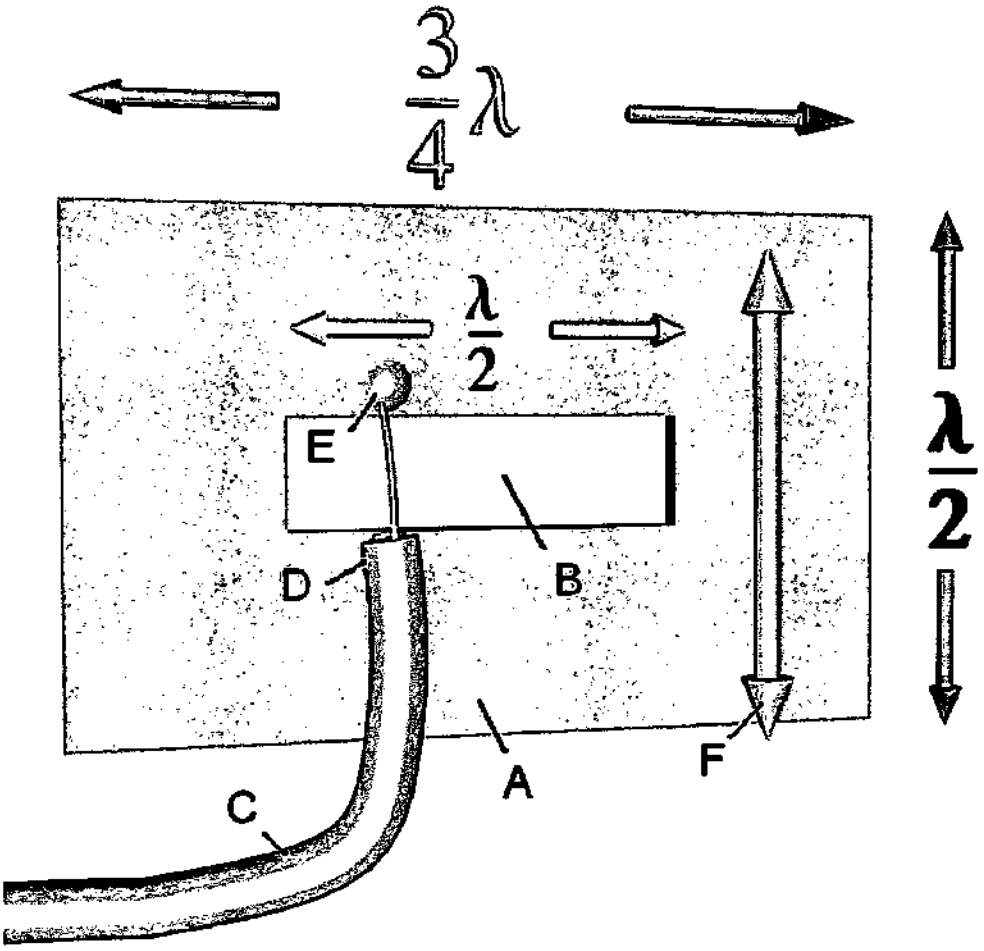

TRIANGULAR SPACECRAFT

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a spacecraft having a triangular hull with vertical electrostatic line charges on each corner. The line charges create a horizontal electric field that, together with a plane wave emitted by antennas on the side of the hull, generates a force per volume providing a unique combination of both lift and propulsion.

BACKGROUND OF THE INVENTION

[0002] Referring to **FIG. 1**, the spacecraft has a hull in the shape of an equilateral triangle. A parabolic antenna (E) is centrally located in the bottom of the hull. An array of horizontal slot antennas is located along the side of the hull (A). Each back corner (F,G) has a corner conducting plate which is charged to a positive voltage +V. The forward corner (C) has a conducting plate charged to a negative voltage −V. A motion control hemisphere (D) is located on the bottom surface in each of the three corners.

[0003] Referring to **FIG. 2**, two planes (A,B) intersect at the origin O at an opening angle β. Each plane (x,y) is charged to a voltage V. The potential at point P is determined in polar coordinates {ρφ}. The Laplace equation for the potential Φ in polar coordinates is given by:

$$\frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial\Phi}{\partial\rho}\right)+\frac{1}{\rho^2}\frac{\partial^2\Phi}{\partial\phi^2}=0$$

Using a separation of variables solution, the potential is given as the product of two functions:

$$\Phi(\rho,\phi)=R(\rho)\Psi(\phi)$$

which when substituted into the Laplace equation becomes:

$$\frac{\rho}{R}\frac{d}{d\rho}\left(\rho\frac{dR}{d\rho}\right)+\frac{1}{\Psi}\frac{d^2\Psi}{d\phi^2}=0$$

Since the two terns are separately functions of ρ and φ respectively, each one has to be constant with the sum of the constants equal to zero:

$$\frac{\rho}{R}\frac{d}{d\rho}\left(\rho\frac{dR}{d\rho}\right)=\nu^2 \quad \frac{1}{\Psi}\frac{d^2\Psi}{d\phi^2}=-\nu^2$$

These two equations have solutions:

$$R(\rho)=a\rho^{\nu+b\rho-\nu}$$

$$\psi(\phi)=A\cos(\nu\phi)+B\sin(\nu\phi)$$

The azimuthal angle φ is restricted to a value in the range $0\leqq\phi\leqq\beta$. The boundary condition is that the potential Φ is equal to V for any radius ρ when φ=0 and φ=β. This means that v has to be an integer value of π so that the sine function is zero:

$$\sin(\nu\beta)=\sin\left(\frac{m\pi}{\beta}\beta\right)=\sin(m\pi)=0 \quad m=1,2\ldots$$

which in turn means that the coefficient A of the cosine term has to be zero in the solution above. Choosing b=0 makes the general solution for the potential equal to:

$$\Phi(\rho,\phi)=V+\sum_{m=1}^{\infty}a_m\rho^{m\pi/\beta}\sin(m\pi\phi/\beta)$$

which shows that when the angle is zero, the sine is zero and the potential is V. If the angle is β, then there is a multiple of π such that the sine is zero again.

[0004] Because the series involves positive powers of the radius, for small enough ρ, only the first term $m=1$ in the series is important. Thus around ρ=0, the potential is approximately

$$\phi(\rho,\phi)=V+a_1\rho^{\pi/\beta}\sin(\pi\phi/\beta)$$

[0005] The electric field component is the negative gradient of the potential:

$$E_\phi(\rho,\phi)=-\frac{1}{\rho}\frac{\partial\Phi}{\partial\phi}=-\frac{\pi a_1}{\beta}\rho^{(\pi/\beta)-1}\cos(\pi\phi/\beta)$$

The surface charge distribution σ at φ=0 and φ=β is equal to the electric field perpendicular to the surface times the permittivity of space ϵ_0:

$$\sigma(\rho)=\varepsilon_0E_\phi(\rho,0)=-\frac{\varepsilon_0\pi a_1}{\beta}\rho^{\frac{\pi}{\beta}-1}$$

Notice that if angle of intersection β is less than π, then the equation says that there is a very small radius to a positive power which means little charge density accumulation.

[0006] Referring to **FIG. 3**, the value of β, in the case of the triangular hull, is equal to 360° less 60° for a total of 300° or:

$$\beta=\frac{300}{180}\pi=\frac{5}{3}\pi$$

$$\rho^{\frac{\pi}{\frac{5}{3}\pi}-1}=\frac{1}{\rho^{\frac{2}{5}}}$$

which says that there is a charge density singularity to the two fifths power for small radius. Thus, the corner plates on the hull create a huge line charge density along the sharp vertical corner edge. The equation for the potential of a line charge density is given as:

$$\Phi(x,y)=-\frac{\lambda}{2\pi\varepsilon_0}\mathrm{Ln}((x-x_0)^2+(y-y_0)^2)$$

where λ is the charge per unit length in the vertical z-direction, and x_0 and y_0 are the location of the line charge in the xy-plane.

[0007] Referring to **FIG. 4**, the triangular hull (D) is plotted together with the potential contours (A) and the electric field arrows (B) created by the three corner line charges. The line charges are perpendicular to the paper. Notice that the electric field arrows are parallel crossing the center parabolic antenna (C). The electric field is also parallel to the sides (D) of the triangle.

[0008] Referring to **FIG. 5**, along the side of the triangle (A), an array (B) of horizontal slot antennas emit electromagnetic waves that have a vertically polarized electric E field (C). These traveling waves interact with the electric field (D) produced by the line charges on the corners of the triangle.

[0009] Using differential forms mathematics, this combination of fields is represented by the Hodge star of the differential of the wedge product of the two fields. The antenna electromagnetic field is a combination of a traveling magnetic field B_w, and electric field E_w. The stationary field E created by the line charges is perpendicular to the traveling wave.

$$*d(E \wedge (B_w + E_w \wedge dt))\frac{\varepsilon}{c} = \frac{\text{force}}{\text{volume}}$$

where ϵ is the linear capacitance of space and c is the speed of light. Thus there is a force per volume around the hull.

[0010] This combination of fields produces a spacetime curvature as determined by Einstein's General Theory of Relativity. The traveling electric field has an amplitude in the vertical z-direction and travels in the x-direction

$$E_{w=Ez}\cos(x-t)$$

The Faraday electromagnetic tensor contains all the electric and magnetic fields in all the {x,y,z} directions. The first row and first column contain the two electric fields

$$F^{\alpha}_{\beta} = \begin{array}{c|cccc|} t & 0 & E_x & 0 & E_z\cos(x-t) \\ x & E_x & 0 & 0 & 0 \\ y & 0 & 0 & 0 & 0 \\ z & E_z\cos(x-t) & 0 & 0 & 0 \end{array}$$

The stress exerted on spacetime occurs in the xx, yy and zz-direction as calculated from the stress-energy tensor T of gravitational physics

$$4\pi T^{\mu\nu} = F^{\mu\alpha}F^{\mu}_{\alpha} - \frac{1}{4}g^{\mu\nu}F_{\alpha\beta}F^{\alpha\beta}$$

where g is the metric tensor for Cartesian space

$$g_{\alpha\beta} = \begin{array}{c|cccc|} t & -1 & 0 & 0 & 0 \\ x & 0 & 1 & 0 & 0 \\ y & 0 & 0 & 1 & 0 \\ z & 0 & 0 & 0 & 1 \end{array}$$

where the diagonal components are the coefficients of the elementary spacetime length ds squared

$$(ds)^2 = -(dt)^2 + (dx)^2 + (dy)^2 + (dz)^2$$

The calculation produces three stresses T^{xx}, T^{yy} and T^{zz} in their respective {x,y,z} directions.

[0011] Referring to **FIG. 6**, these three stresses are plotted together as a 3D vector field animated over time in nine frames. The graphs show that there is a lift force as depicted by the vertical arrows as well as a force of propulsion as shown by the interspersed horizontal arrows. With the passage of time, these vectors exchange places with each other so that the lift becomes the propulsion and vice versa, creating a wavy stress-energy field around the hull.

SUMMARY OF THE INVENTION

[0012] This invention is a spacecraft with a triangular hull having charged flat plates on the vertical corners of the three sides. The two rear corners are charged to a potential V. The forward corner is charged to a potential −V. The 60° angle on the corner creates a line charge density singularity that produces a huge horizontal electric field pointing from the back to the front of the craft which is also parallel to the sides of the triangle. An array of horizontal slot antennas located on the sides of the triangular hull produce an electromagnetic wave with the electric field polarized in the vertical direction. This combination of fields produces a spacetime force in both the vertical and horizontal directions such that the spacecraft receives a lift force and a force of propulsion.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIG. 1**. Perspective view of triangular spacecraft.

[0014] **FIG. 2**. Drawing of the intersection of two charged plates in order to calculate the charge density in the corner.

[0015] **FIG. 3**. Perspective view of the corner angle β for the equilateral triangle.

[0016] **FIG. 4**. Planar 2D graph showing the electric field produced by three line charges on the corners of the triangular hull.

[0017] **FIG. 5**. Perspective view of electric field produced by the linear charge interacting with the traveling electromagnetic wave produced by the slot antenna.

[0018] **FIG. 6**. 3D vector animation of the lift and thrust force generated by the fields.

[0019] **FIG. 7**. Perspective view of slot antenna.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Referring to **FIG. 7**, the antenna (A) is made out of sheet copper in which a rectangular horizontal slot (B) has been notched out using a die press and sheet metal fixture. A coaxial cable from the amplifier and frequency generator is attached across the slot by soldering the outer cable (D) to one side of the slot and the inner cable (E) to the other side of the slot. This creates the positive and negative charges across the gap which forms the vertical electric field (F) which radiates out perpendicularly to the copper sheet.

[0021] Although the invention has been described with reference to specific embodiments, such as a particular antenna system, those skilled in the art will appreciate that many modifications and variations are possible without departing from the teachings of the invention. All such modifications and variations are intended to be encompassed within the scope of the following claims.

1. A spacecraft comprised of the following components:

(a) a triangular hull in the form of an equilateral triangle;

(b) two copper plates attached on opposite vertical sides at each of the three corners of the hull (**1***a*) such that a sharp vertical edge is formed where they come together;

(c) an electrostatic generator used to charge the back two copper-cladded corners (**1***b*) to a high positive voltage, and the third forward copper-cladded corner to a high negative voltage;

(d) a horizontal slot antenna array mounted-on the sides of the hull; and

(e) a frequency generator, antenna and coaxial cables to drive the antenna array (**1***d*).

2. To create, by claims (**1***a*, **1***b*, **1***c*), an intense vertical line charge at the corners (**1***b*) and a horizontal electric field that that is parallel to the sides of the hull (**1***a*);

3. To create, by claims (**1***d*,**1***e*), an electromagnetic wave with a vertically polarized electric field traveling outward from the side of the hull (**1***a*); and

4. To create, by claims (**2**,**3**), an interaction of the electrostatic field (**2**) with the electromagnetic wave (**3**) such that a combined spacetime curvature pressure is generated on the hull in the upward and forward direction to produce lift and propulsion respectively.

* * * * *

March 25, 1969 W. C. BROWN ET AL 3,434,678

MICROWAVE TO DC CONVERTER

Filed May 5, 1965

Sheet 1 of 3

FIG. 1

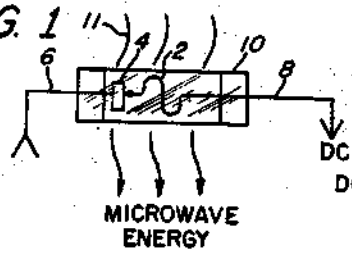

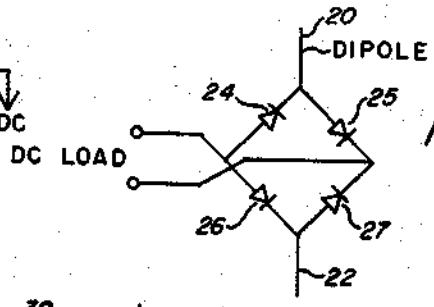

FIG. 2

FIG. 3

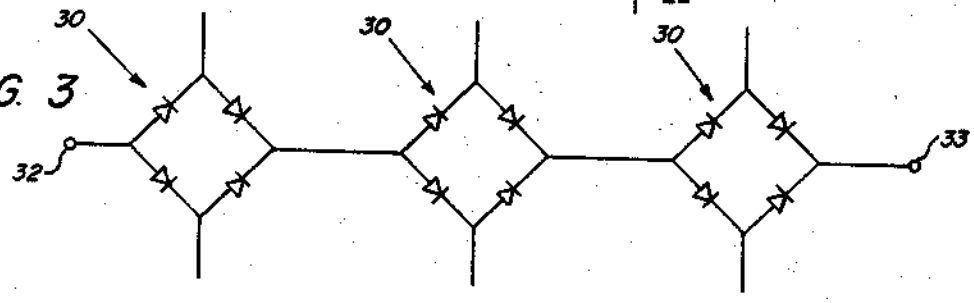

FIG. 4

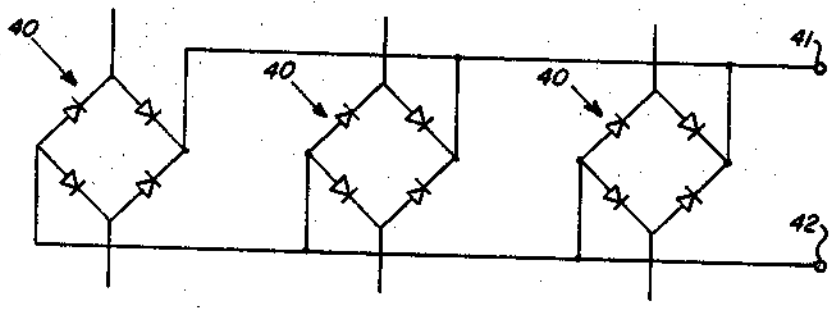

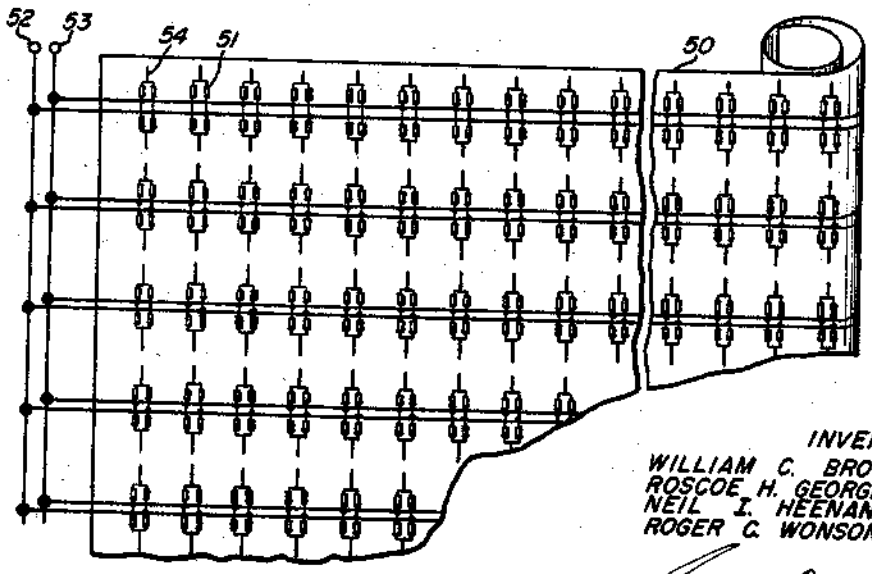

FIG. 5

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FIG. 7

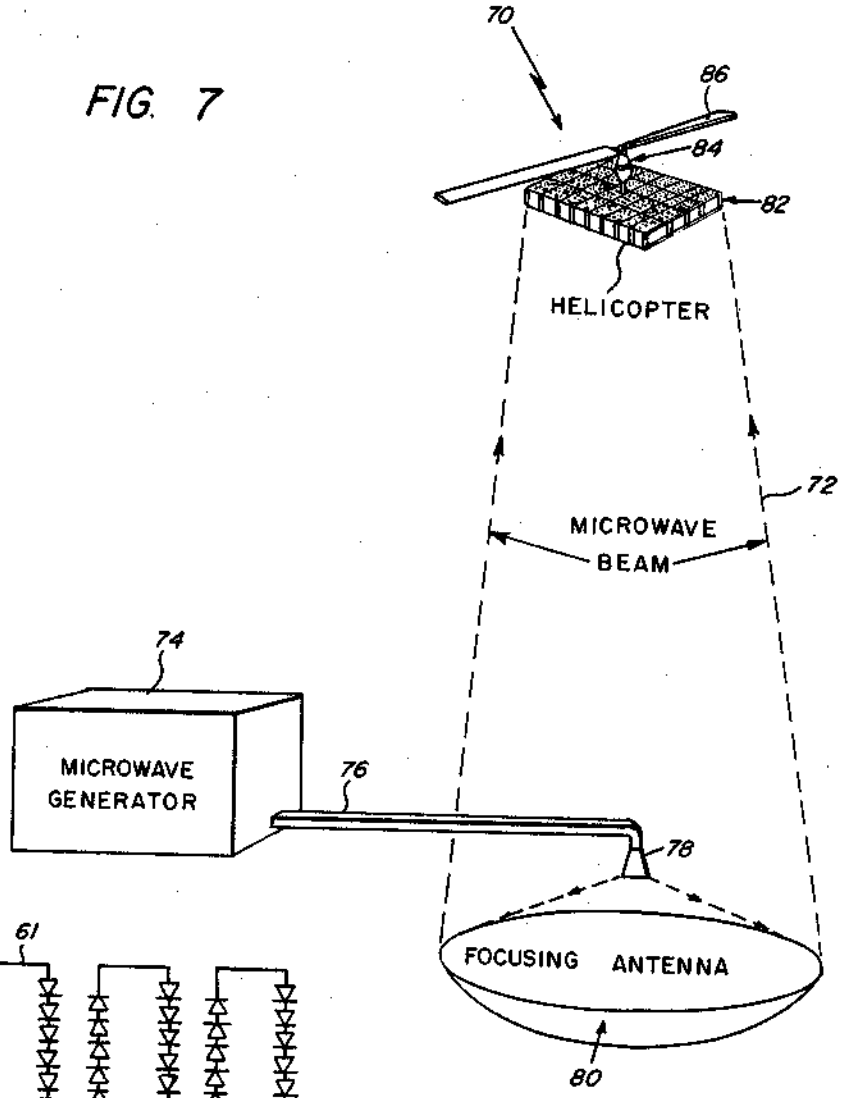

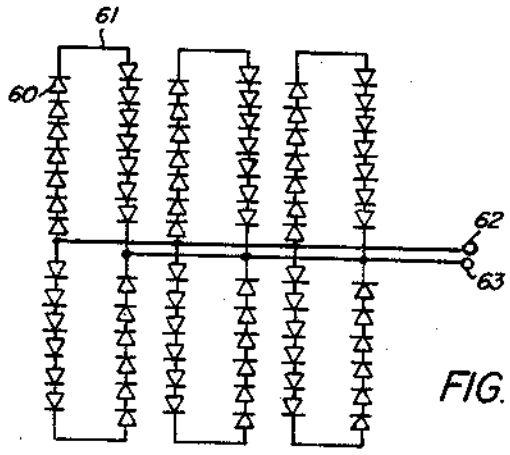

FIG. 6

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MICROWAVE TO DC CONVERTER

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Sheet 3 of 3

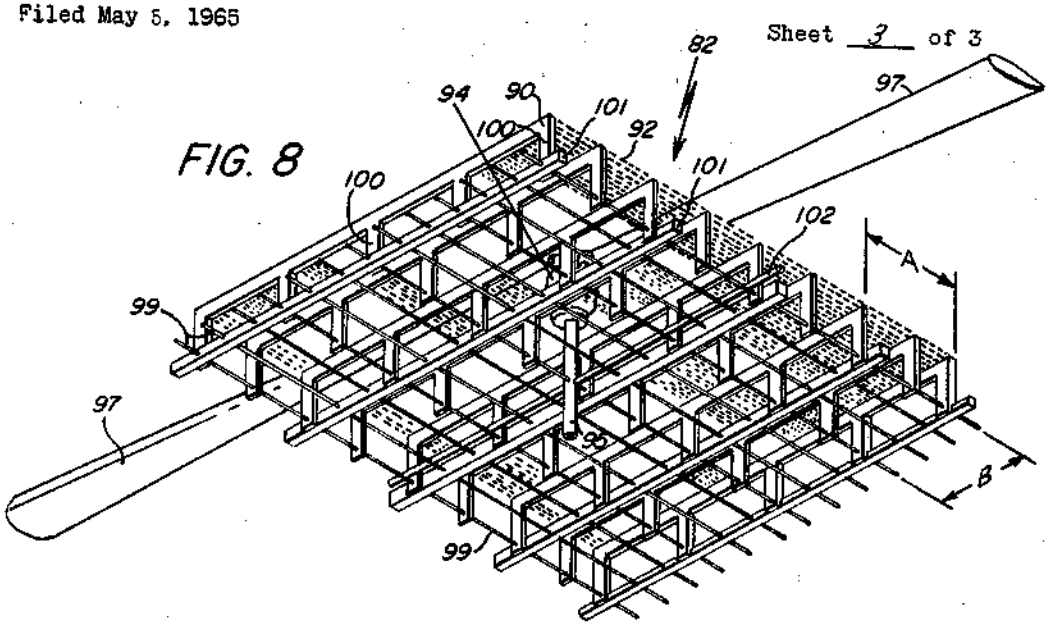

FIG. 8

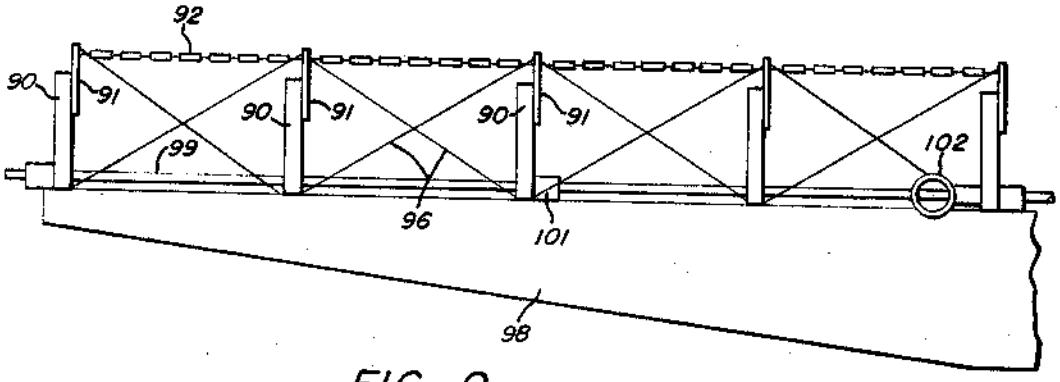

FIG. 9

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MICROWAVE TO DC CONVERTER

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Filed May 5, 1965, Ser. No. 453,415
Int. Cl. B64g 1/00
U.S. Cl. 244—1 3 Claims

ABSTRACT OF THE DISCLOSURE

A combined antenna and conversion mechanism for reception of beamed high frequency electromagnetic energy in space including a large array of unidirectional current semiconductor rectifier devices. A self-supporting space vehicle utilizing the rectified DC electrical energy for propulsion is disclosed in an illustrative embodiment.

The present invention relates in general to the transfer of energy by means of an electromagnetic wave beam and more particularly to interception and rectification of such energy into low frequency electrical DC energy with a high degree of efficiency.

Improved technology in the field of microwave energy generation at superpower levels has resulted in the realization of electrical energy transmission over considerable distances for remote energization of devices or vehicles without the aid of wires. The transmission of microwave electromagnetic energy into space has been commonly employed in the radar pulse echo systems for the detection and orientation of desired objects within a predetermined scanning range of a transmitting antenna. Beams of a similar nature may now be employed for other useful purposes and the advantages attendant the utilization of electromagnetic energy in the microwave region in contrast with other wavelengths may now be enumerated.

Microwaves have been generally defined as high frequency radio waves whose wavelength is less than 30 centimeters, with a lower wavelength limit on the order of 1 millimeter sometimes being applied to what is commonly referred to as the "microwave region." The superiority of high frequency microwaves is due in part to the fact that it is generally desirable to focus the transmitted energy so as to achieve a high power density at a remote point or area with respect to a given power source. In accordance with the laws of optics, the sharpness of the microwave beam produced by a transmitting antenna varies as the ratio of antenna dimensions to the wavelength of the transmitted energy. Therefore, for a given or desired power density or beam sharpness, a decrease in the wavelength of the transmitted energy permits a corresponding decrease in the dimensions of the antenna. From the standpoint of mechanical considerations, it is desirable to employ small antennas and other components, and it is therefore advantageous to employ high frequency energy of very short wavelength. In addition, the difficulties encountered in long wave transmission as a result of natural and man-made interference or noise do not occur with any appreciable significance at microwave frequencies. Further, in aerospace applications with considerable distances separating the transmitter at an earth or mother planet location and the employment of shorter wavelength beamed energy is preferred since longer wave signals will generallly be reflected at certain altitudes by reflecting layers in the atmosphere.

In view of certain losses due to absorption which may occur in the atmosphere, microwaves in the region having the approximate bounds of 2 and 30 centimeters are

2

readily adaptable to the convenient radiation of power to remote points without the utilization of wires. The preferred wavelengths are of the order of 5 or 10 centimeters to provide efficient focusing with existing transmitting antenna systems which may be maintained at a reasonable size. An illustrative device of the superpower high frequency microwave generators operative in the desired band is the so-called Amplitron which is an amplifier having a broad bandwidth and excellent performance characteristics for the focusing of the beam. Such devices are capable of producing 15 or 20 kilowatts of average continuous wave power in the neighborhood of 10 centimeters in wavelength with capabilities expected in the region of 500 kilowatts or more average power with 50 megawatts peak power. A complete description of such devices may be had by referring to Patent No. 2,933,723 issued Apr. 19, 1960 to William C. Brown and assigned to the assignee of the present invention.

With microwave energy capable of being generated and directed over longer distances conversion of such high frequency electromagnetic energy is of paramount concern. One conversion mechanism in the prior art involves direct conversion of such energy into heat which may then be utilized directly or indirectly for propulsion or generation of flight-producing forces. Examples of such devices for heat energy exchange as well as space vehicles utilizing such energy may be noted in Patent No. 3,174,-705, issued Mar. 23, 1965, to D. Schiff et al., as well as U.S. Letters Patent No. 3,083,528, issued Apr. 2, 1963 and No. 3,114,517, issued Dec. 17, 1963, to William C. Brown. The heat exchanger method of conversion of electromagnetic energy into useful power is limited by the overall efficiencies of approximately 25 percent in the conversion of heat into mechanical or electrical work. Desirable, therefore, would be the direct rectification of the high frequency electromagnetic energy into low frequency electrical energy for the operation of many useful aerospace devices as well as systems.

The present invention has for its primary object the conversion of high frequency electromagnetic energy in the microwave region directly into low frequency electrical energy.

A further object of the present invention is the provision of a combined nondirectional receiving antenna and microwave electromagnetic energy to low frequency electrical energy conversion means in a unitary structure.

A still further object of the present invention is a provision of a new and novel combined nondirectional receiving antenna and microwave to DC energy converter for aerospace applications.

Another object of the present invention is the provision of a new and novel nondirectional receiving antenna and microwave to DC energy converter having a high degree of efficiency.

Still another object of the present invention is the provision of a new and novel aerospace vehicle with nondirectional receiving antenna and microwave to DC energy converter means with said vehicle being capable of being supported by its own energy generation means at a distance spaced apart from the power generation means.

In accordance with the teachings of the present invention, the above and other objects are achieved by the employment of efficient unidirectional microwave power rectifiers and dipole antenna means. Such rectifying devices, while being individually limited in power-handling capabilities, normally in the order of fractions of watts, have been found to be highly efficient means for the rectification of microwave power when assembled in large numbers in various arrays. It is interesting to note that the observed collective efficiency was on the order of 40 to 70 percent. In an illustrative embodiment, point-

contact semiconductor diodes were arranged in four arm bridge connected networks with the networks interconnected in various configurations such as series, parallel and series-parallel.

In discussing aerospace applications, an additional problem is encountered in the beaming of microwave energy to a remote point and the interception and utilization of such electrical energy. In such applications the advantages of a vehicle which may be maintained in space for indeterminate periods of time without employing a local fuel source are readily apparent. Such devices could readily provide communication networks, surveillance functions using radar techniques along with numerous other functions. The acapture of the beamed high frequency electromagnetic energy raises the need for an efficient antenna means capable of intersecting the beam at high altitudes. Conventional techniques employed in microwave radar usage such as receiving antenna horns are capable of intersecting only a small portion of the beam energy and add considerable weight in applications involving heavier-than-air vehicles. In an exemplary embodiment of the invention a space vehicle, namely a helicopter, is disclosed for either moving flight or a stationary location with self-supporting electrically operative propulsion means. The semi-conductor diode rectifier arrays have been demonstrated to fulfill the receiving antenna functions as well as the electrical energy rectification means in a highly efficient manner. Such combined antenna and rectifier means has also assisted in reduction of the weight problem in airborne devices. Further, it has provided a nondirectional means for the interception of the microwave energy to thereby reduce the problems of focusing inherent in prior art directional horn type receiving antennas.

With the above features, advantages and objects in mind the invention will now be described by reference to the following detailed description together with the accompanying drawings in which:

FIG. 1 is a perspective view of an illustrative diode rectifier;

FIG. 2 is a schematic circuit diagram of a bridge connected diode network with dipole antenna means;

FIG. 3 is a schematic circuit diagram of a plurality of bridge connected networks arranged in series;

FIG. 4 is a schematic circuit diagram of a parallel bridge connected network array;

FIG. 5 is a perspective view of an illustrative embodiment of a combined antenna and rectifier array in a folded or rolled up configuration;

FIG. 6 is a schematic circuit diagram illustrating the bridge connected diode array incorporated in the aerospace vehicle shown in FIG. 7;

FIG. 7 is a schematic representation in elevation illustrative of a heavier-than-air aerospace vehicle incorparating the structure of the present invention;

FIG. 8 is a perspective view of the aerospace vehicle embodiment as viewed from the under portion thereof; and

FIG. 9 is an enlarged partial view in elevation of a portion of the illustrative embodiment shown in FIG. 8.

FIG. 1 illustrates a point-contact semiconductor diode rectifier of the type employed in radar microwave receiver apparatus to rectify returned radar pulses. Any of the high burnout semiconductor diodes having high rectification characteristics are preferred and are commercially available, such as the 1N82 or 1N830. The rectifying junction is formed by whisker element **2** contacting the semiconductor element **4** respectively connected to leads **6** and **8**. Silicon is preferred over germanium for element **4** because of its ability to operate at higher temperatures and thereby handle higher powers. Envelope **10** houses the rectifying elements and may be of a hermetically sealed dielectric material or combination metal and ceramic composition. The inherent characteristic of such diode rectifiers is that the microwave energy is intercepted and rectified in a unidirectional manner and the line **11** indicate pictorially the rays of the beamed electromagnetic microwave energy in a plane normal to the envelope. In FIG. 2 a full-wave bridge connected diode network is illustrated with the forward direction of the rectified DC electric current indicated by the direction of the arrow symbols. The network shown consists of half-wave dipoles **20** and **22** each terminated with a diode rectifier element **24** to **27** in an arm of the bridge connected network. The dipole elements **20** and **22** are of the half-wave configuration and may be spaced apart from each other a one-half wavelength at the frequency of the beamed electromagnetic energy.

Referring now to FIG. 3, an array of bridge connected diode networks each with the half-wave dipoles are shown connected in series. Each network is referred to by the numeral **30** and is similar in the bridge connections to the single element network shown in FIG. 2. The DC output of the collective rectified energy is coupled by means of terminals **32** and **33**. In FIG. 4, a similar number of individual bridge connected diode-dipole networks are shown connected in a parallel array. Each network is indicated by the numeral **40**, and the output terminals are indicated as **41** and **42**.

Any number of diode-dipole networks may be provided and in FIG. 5 such a multi-element array is illustrated by mounting on a flexible material **50** which may be rolled or folded into any desired package or enclosed within a capsule to be launched and released at a predetermined point in space. Any flexible material which is pervious to electromagnetic energy is preferred. The total power desired would be the determining factor in a number of individual diode-dipole elements required. In this embodiment, the bridge connected networks **51** are connected in parallel to the output load indicated by terminals **52** and **53**, and representative measurements of electrical characteristics have shown that approximately five watts of DC electrical energy is realizable for each square foot of area of the combined antenna-rectifier. While the dipole elements **54** have been indicated in a particular array, it is within the scope of the invention to stagger the placement of such dipoles to increase the overall efficiency of the antenna-rectifier.

To further increase the DC powder output, the full-wave bridge connected networks are preferably arranged with a plurality of diodes in series in each arm of the bridge. An illustrative schematic circuit diagram of such a configuration is shown in FIG. 6 wherein seven diodes **60** are shown in each arm of the bridge circuit and are connected in series for a total of twenty-eight diodes in each bridge network. The dipole members will then be the substantially U-shaped end portions **61** at the ends of each brace of seven diodes. In the illustration three such twenty-eight diode bridge networks are shown connected in parallel to terminals **62** and **63**. This closer spacing and compact arrangement has been shown to be a source of improved power output and is capable of a high degree of reliability through the redundant nature of the parallel series connections within each bridge network. If one of the diode rectifiers fails to function the over-all voltage drop across this element would be divided among the six remaining diode rectifiers. If any of the connecting wires between the diode elements should break, the adjacent arms of the other bridge assemblies would take the additional load due to the close proximity of the respective arms to each other. In addition, it is possible to have a number of open connections or inoperative diodes dispersed throughout the array without any serious impairment in performance.

In relation to the array concept to be hereinafter described it may be stated that within a six inch square area ten such individual bridge networks each containing twenty-eight diode rectifiers for a total of 280 diode rectifiers may be deployed in such a manner as to provide

maximum exposed area for each diode as well as the connecting leads. Such an arrangement will be hereinafter referred to as a "module" and a DC output in excess of fourteen watts has been measured for such a module. Any number of such modules could be connected provided for a desired power yield and this module concept readily lends itself to use in certain aerospace applications now to be described.

In FIG. 7 a propelled type of space vehicle **70** is shown wholly supported by means of the transfer and rectification of continuous wave electromagnetic energy via a microwave beam **72**. The source of the microwave energy which may be of the Amplitron type device as described in the aforementioned issued Patent No. 2,933,723 is indicated as **74**. This energy is fed by waveguide means **76** to a transmitting horn **78** to illuminate an ellipsoidal beam forming focusing antenna **80** for the transmission of the microwave beam **72**. It will be appreciated by those skilled in the art that the representations of the microwave generation and transmitting antenna means are pictorial representations to illustrate the usage of the invention in diagrammatic form and the present invention is not limited to any particular source of microwave energy or transmitting antenna assembly. It may be stated the reflector of the antenna assembly is considerably larger than most of the reflectors of the prior art in order to focus a large amount of the microwave power at high altitudes for use in the transfer of energy to space vehicles. Such antenna assemblies may be partially supported in a large hollowed area on the earth's surface or other convenient means of support.

The space vehicle or helicopter **70** can be described as a main body member supporting antenna-rectifier means **82** including a large number of the so-called modules connected together and rigidly supported in a planar parallel array. A motor **84** is supported by the combined body member and the receiving antenna-rectifier means and actuates the rotor **86** of conventional design employed in such self-propelled hovering vehicles. The disclosed vehicle provides for the illumination of the planar array of the semiconductor diode dipole elements by the microwave beam and the direct conversion of the microwave power transmitted by the beam into usable electrical energy for the self-propulsion of the device without any local fuel supply being required.

FIGS. 8 and 9 illustrate a space vehicle **82** comprising a plurality of the combined receiving antenna-rectifier module means for interception and rectification of the electromagnetic microwave energy beam emanating from an earth or mother planet source. A planar array of the antenna-rectifier modules is mechanically supported by means of structural members **90** of any lightweight wood or metal. Insulators **91** positioned coextensive with the members **90** support the diode rectifier array and avoid interference with the receiving and electrical performance characteristics by the structural support members. Carrying forward the module concept of 280 diode rectifiers to provide an approximate power output of 14 watts, it was noted that any number of such modules may be coupled together since the individual module outputs are relatively insensitive to a wide range of load resistances connected to the common output terminals. To achieve the desired electrical output of approximately 120 volts and 250 watts of power, subgroups of four modules each were assembled and parallel connected with an approximate 30 volts available for each subgroup. Four such subgroups were series-connected to result in a total of 4,480 diode rectifiers or 16 modules assembled in a two foot square self-supporting planar parallel array structure. The individual diode rectifiers connected in each arm of the bridge network are indicated by the numeral **92**. An exemplary module configuration would extend within the area delineated by the dotted lines and reference letter A on one side and similar dotted lines and reference letter B on the other side.

A motor **94** is connected to the DC side of the overall array and may be additionally supported by tubular member **95**. A shaft and propulsion means consisting of rotor blades **97** provide for the upward lift of the overall vehicle for the self-supporting of same in space applications. Additional structural support such as interlaced rigging **96** of a high tensile strength material such as nylon or steel wire, as well as bracing member **98**, may be employed for strengthening of the body means to withstand the vibrational forces and downwash from the propulsion means.

In accordance with the well known technology of microwave transmission the combined array of diode rectifiers and propulsion means presents a specific load impedance which must be suitably matched to the transmitted microwave energy beam to result in maximum efficiency. In aerospace applications a mismatch of approximately ten to one may be evident. Matching of the load impedance to a value of approximately 377 ohms as the free space value will be provided by a plurality of coplanar parallel metallic rod members **99** disposed in a grating array in front of the diode rectifiers a predetermined distance. Rod members **99** are linearly disposed and extend in a similar direction as the assembled diode rectifiers. A selected frontal spacing of one-quarter of the wavelength of the microwave frequency being transmitted has been experimentally determined to be suitable for impedance matching purposes. An approximate spacing of two inches between the respective members was preferred for a selected microwave frequency of 2,450 megacycles. Each of the members **90** are provided with lateral sections **100** to support the elongated bar members **101** which in turn maintain the rod members **99** in the desired position. A tubular member **102** of a lightweight metal may also be provided to combine with the motor support member **95** for structural support.

The combined antenna-rectifier array provides a source of electrical energy to render any space vehicle self-supporting. The diode rectifier elements when assembled in the antenna array have been found to be nondirectional with respect to interception of the beamed microwave energy. This represents a large step forward in the utilization of high power microwave energy over the prior art horn-type receiving antennas which must be accurately focused and pointed in a particular direction for the reception of any energy. The connections between the respective members of the diode rectifier array and deployment in the parallel configuration serves to provide maximum exposed area. Such connections and in particular the end loop portions adjacent the terminus of each arm of the bridge networks serves as an efficient dipole for the interception of the microwave energy.

Although it is not intended as a full explanation of the high degree of efficiency attained with the disclosed antenna-rectifier array, it is believed that the whisker elements within the semiconductor diodes themselves are a contributing factor and may function as additional dipole elements. The disclosed embodiment functioned efficiently when illuminated by microwave energy generating a vertically polarized beam. Hence, an efficient and light weight energy conversion apparatus is disclosed which may be self-supporting without the requirement of a large local fuel supply payload.

It may be within the purview of the invention to use the available rectified electrical energy for performing many functions in addition to the actuation of the propulsion means. Hence, communications' payloads may be maintained at predetermined positions in space in a hovering attitude utilizing a portion of the electrical energy available. Relay signals to other such vehicles or return signals to ground stations would then be within the realm of possibility. Such available energy may also be employed for servomechanisms, stabilizing and countertorque systems for the navigation of such vehicles.

The electrical efficiencies realized with the combined

receiving antenna and rectifier means have also provided certain weight advantages over other energy converters in aerospace applications. Examples of such converters would be heat exchangers or solar cells. In comparison to the present invention where five to eight pounds per kilowatt of energy realized is a normal characteristic, other energy conversion means weigh in the vicinity of 150 pounds per kilowatt of realizable energy. The inherent advantages of the present invention are therefore apparent. While the technology in the diode rectifier art is being continually advanced, new diode power rectifiers as well as integrated circuit techniques are readily available to future configurations of the present invention. The so-called Schottky barrier diodes could be employed to produce combined antenna-rectifier means weighing even less than two pounds per kilowatt of available energy.

Although the foregoing detailed description has referred to DC power rectification it will be evident that with suitable circuit components low frequency AC energy may also be made available. In addition, other propulsion means may be readily substituted using electrical energy. The embodiments disclosed herein are illustrative only and other modifications or alterations will be apparent to those skilled in the art which do not depart from the scope of the broadest aspects of the present invention as defined in the appended claims.

What is claimed is:

1. A space vehicle comprising:

body means;

said body means including spaced structural support members;

combined antenna and DC electrical energy rectification means for the interception and rectification of incident high frequency electromagnetic microwave energy carried by said support members in a planar parallel array;

said rectification means comprising a plurality of four arm full-wave bridge connected rectifier circuit networks each having a plurality of unidirectional semiconductors in each arm;

said networks being electrically interconnected to common output terminals;

electrically operable propulsion means comprising a motor and rotor members carried by said body means and connected to said terminals for the utilization of said rectified DC energy; and

means for matching the load impedance of said combined antenna and electrical energy rectification means to the incident microwave energy.

2. A space vehicle according to claim 1 wherein said load impedance matching means are arranged in a coplanar array coextensive with said antenna and energy rectification means array, and spaced therefrom a distance of approximately one-quarter of a wavelength at the frequency of the microwave energy.

3. A space vehicle according to claim 2 wherein said load impedance matching means comprise a plurality of parallel disposed elongated metallic members.

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307—151; 318—16; 321—27; 325—494; 343—100

Teleportation of Entangled Coherent States through Visual Pathways in the Human Brain

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Abstract:
In this paper we have proposed a new model for visual consciousness based on the premise there exists a quantum teleportation mechanism between the eye and the brain. In our model, some open questions will be answered.

1) Introduction:

Schrödinger's book "What is life?" has had an enormous influence on the development of molecular biology [1]. His insight has since then inspired many researchers to investigate the molecular basis of a living organism [2,3,4]. Several researchers have noticed the sweeping consequences that would follow from the discovery that living organisms might process information quantum mechanically, either at the bio-molecular level, or the cellular/neuronal level [5,6,7,8,9]. Computational models of the behavior of networks of neurons are still mainly based on the integrate-and-fire model of neural function. Mainstream cognitive neuroscience typically ignores the role of quantum physical effects in the neural processes underlying cognition and consciousness. However, many unsolved problems remain, suggesting the need to consider new approaches. Recent contributions to the investigations of quantum effects in the human brain are due to Jibu and Yasue, Pribram, Lockwood, Mavromatos and Nanopoulous, Hameroff and Penrose, and Stapp [10]. These authors have proposed models in which the operation of consciousness is associated with some sort of explicit wave function collapse. There have been numerous suggestions that consciousness is a macroscopic quantum effect possibly involving superconductivity, superfluidity, electromagnetic fields, Bose-Einstein condensation or some other physical mechanism. Perhaps the most specific model developed thus far is that of Penrose and Hameroff and it asserts that quantum information processing takes place in microtubules (MTs). It has been argued that MTs can process information similarly to a cellular automaton, and hence Hameroff and Penrose suggest that neuronal MTs may operate as a quantum computer.
In this paper, we investigate visual information transfer from a quantum information point of view. Theoretically we consider the conscious observer looking at a quantum system and propose that the state of this system is reported via superposed photons. We address the question whether the observer can receive the exact same state of this system quantum mechanically in his/her brain or this quantum state collapses before reaching the brain. Below we investigate the problem in detail.

2) Evolution of Information from the Eye to the Brain

We assume that a conscious observer directs his/her attention to a quantum system. For simplicity we consider this system to be a manifestation of the celebrated *Schrödinger's cat*. This system can exist in two states: Live$|L\rangle$, or Dead$|D\rangle$.

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$$\psi_{sys} = \frac{1}{\sqrt{2}}(|L\rangle + |D\rangle) \qquad (2\text{-}1)$$

The state of this system is then reported via superposed photons. 4% of these photons are reflected from the cornea. 50% of remaining photons are dissipated through ocular media absorption. Other photons enter the 200-250 µm thick retina. There, photons interact with the photoreceptors in the rods and cons layer after 80% loss due to retinal transmission [11],[12]. In this case, we consider just a few remaining photons which are in a superposed quantum state. The key question here is whether this quantum state of photons can be reported to the brain.

When this state interacts with the last layer of retina, according to Thaheld, this superposed photon undergoes a wavefunction collapse. On the other hand, photons can be absorbed and then transformed into classical signals. Here, we use the symbols introduced by Tegmark [13] for the observer. The symbol $|\ddot{_}\rangle$ denotes the state for which the information on photons is not received by the brain and thus the observer is amphoteric. The symbol $|\ddot{\smile}\rangle$ stands for the state in which the information received in the brain reports that the cat is alive (and the observer is happy). Finally, the symbol $|\ddot{\frown}\rangle$ corresponds to the state in which the information received in the brain indicates that the cat is dead (and the observer will be sad). It means that:

$$U|\ddot{_}D\rangle = |\ddot{\frown}D\rangle \qquad (2\text{-}2\text{-a})$$

$$U|\ddot{_}L\rangle = |\ddot{\smile}L\rangle \qquad (2\text{-}2\text{-b})$$

Where $U = \exp\left[-\frac{i}{\hbar}\int H_{photon-brain}\, dt\right]$.

Now, we consider another state in which the brain interacts with itself. Penrose and Hameroff have proposed a model of consciousness involving quantum computation with objective reduction in *microtubules* (or MTs) within the brain's neurons (see Figure 1) [14],[15],[16],[17]. MTs are cylindrical polymers comprised of the protein tubulin which organize numerous cellular activities including neuronal motor transport. According to Hameroff and Penrose, switching of tubulin conformational states is governed by quantum mechanical forces within each tubulin interior, and an essential feature of the Orch OR model is that tubulins may exist in quantum superpositions of two or more conformations. Therefore, these states could function as quantum bits, or "qubits" by interacting non-locally (through their entanglement) with other tubulin qubits so that MTs may act as quantum computers. When sufficiently many entangled tubulins are superposed for long enough to reach Penrose's OR threshold given by E=h/T, an objective reduction (OR) "conscious event" occurs as stated in the Orch-OR model.

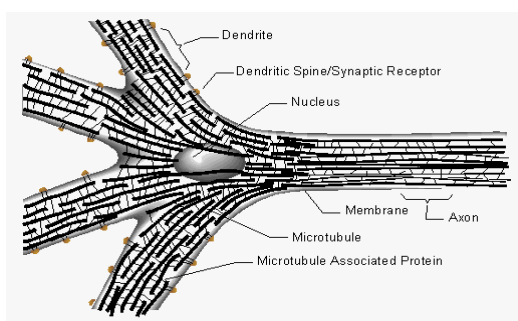

Figure 1 Representation of MTs inter a brain neuron. The Orch OR model suggests that the main information processing is implemented in these structures.

If previous evolution is described by Penrose's self-collapse in the brain (i.e. Orch-OR), MTs in the neurons of the brain collectively evolve and then collapse (i.e. conscious event) to one of the happy or sad states. It mathematically means that:

$$U|\ddot{\smile}\rangle = \frac{1}{\sqrt{2}}(|\ddot{\smile}\rangle + |\ddot{\frown}\rangle \qquad (2\text{-}3)$$

where $U = \exp[-\frac{i}{\hbar}\int H_{brain}\, dt]$.

If we compare this state (2-3) and the state which has the information about the photon (2-2), we can say that there's a great amount of correlation between the retina and the visual cortex, because their result should be identical. We know that in accordance with the Einstein-Podolsky-Rosen (EPR) pair, when two entities originate from a common source they can be entangled with each other. Retina has a similar layered structure as the gray-matter top layers of the cerebral cortex of the brain. In fact, retina is an extension of the central nervous system (the brain and spinal cord) that forms during embryonic development. One reason why scientists are interested in retinal processing is that retina is an accessible part of the brain that can be easily stimulated with light [18]. Thus, we can say that retina and visual cortex are entangled with each other. The other argument for this entanglement is that the image of a system is inverted on the retina but it is perceived in the brain directly. As we know, in two entangled entities when one has a property in some direction the other exhibits that property but in the opposite direction. Thus retina receives an inverted image, while it is received in the visual cortex upright. This property is special to entanglement.

The human body is made up of many organs, which themselves are made up of many millions of cells. How can such a system, with millions, or even billions, of parts function effectively and coherently? This is a no small feat as even small-size human societies often undergo periods of turbulence and trouble due to conflict and poor organization. Now some scientists think that quantum coherence in MTs is a major factor responsible for our bodies, and especially our brains, being so efficiency. Here, we intend to describe visual processing on the basis of quantum information theory.

3) Generation of Entangled Coherent States

Centrioles and cilia, which are microtubular structures, are involved in photoreceptor functions in single cell organisms and primitive visual systems. Cilia are also found in all retinal rod and cone cells. The dimensions of centrioles and cilia are comparable to the wavelengths of visible and infrared light (see Figure 2) [50]. Moreover, cytoskeletons are found mostly among the retina and the visual cortex in the cells of the optic nerve. Cytoskeletal structures of the centrioles can be expected to vibrate like a harmonic oscillator in its ground state. Vibrational dynamics of MT's has been the subject of a recent paper where typical frequency ranges have been discussed [19].

When a photon interacts with a centriole, its electric field can displace the potential of the harmonic oscillator and then releases it, thus generating coherent states [20]. It means that:

$$D(\alpha)|0\rangle = |\alpha\rangle \qquad (3\text{-}1)$$

Where $D(\alpha)$ is the displacement operator; $D(\alpha) = e^{\alpha a^{\dagger} - \alpha^{*} a}$, and $|0\rangle$ is the ground state of harmonic oscillator, and $|\alpha\rangle$ is the coherent state: $|\alpha\rangle = e^{-\frac{|\alpha|^2}{2}} \sum_{n=0}^{\infty} \frac{\alpha^n}{\sqrt{n!}} |n\rangle$.

Hameroff [21] and Penrose [22] have suggested that MTs inside cells permit long-range quantum coherence, enabling quantum information processing to take place at the sub-cellular level. They use this hypothesis to develop their theory of consciousness. Cells interconnected by gap junctions form networks

which fire synchronously, behaving like one giant neuron [23], and possibly accounting for synchronized neural activity such as coherent 40 Hz waves [24]. Marshall [25] suggested that coherent quantum states known as Bose-Einstein condensation occurred among neural proteins [26], [27], [28]. Other issues, such as preconscious-to-conscious transitions were identified by Stapp [29] with the collapse of a quantum wave function in presynaptic axon terminals [7]. The other reason for coherence of these structures is that light is an electromagnetic wave and thus is vibrational, and according to Froehlich's theory [44],[45],[46] it can take these cytoskeletal structures (i.e. nonlinear structures composed of electric dipoles) into one mode of frequency and coherence.

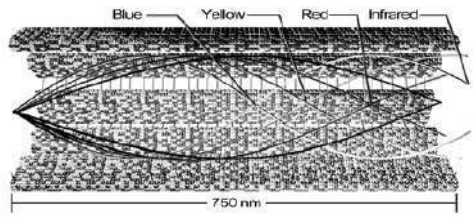

Figure 2 Representation of one centriole, the dimensions of centrioles are comparable to wavelengths of visible and infrared light.

Centrioles are two cylinders composed of MTs which are perpendicular to each other and in accordance with the Hameroff theory of the origin of cancer [30], centrioles are entangled with each other. Because of this entanglement, when a coherent state $|\alpha\rangle$ is generated in one centriole, in the other it will generate state $|-\alpha\rangle$. Now, we can say that after interaction of photons with centrioles, they generate "entangled coherent states" in these structures in the retina, i.e.:

$$|\varphi\rangle_{12} = (A|\alpha\rangle_1|\alpha\rangle_2 - B|-\alpha\rangle_1|-\alpha\rangle_2\ ) \qquad (3\text{-}2)$$

where $|\varphi\rangle_{12}$ is an entangled coherent state in centrioles with two modes 1 and 2. QED-cavity model of MTs [31] describes that coherent modes of electromagnetic radiation can be sustained in the interior of the MTs. These modes are provided by the interaction of the electric dipole moments of the ordered-water molecules in the interior of MTs with quantized electromagnetic radiation [32],[33]. Jibu, et. al.[49], have proposed that the quantum dynamical system of water molecules and the quantized electromagnetic field confined inside the hollow MT core can manifest a specific collective dynamical effect called superradiance [34] by which the MT can transform any incoherent, thermal and disordered molecular, atomic or electromagnetic energy into coherent photons inside the MT. Furthermore, they have also shown [49] that such coherent photons created by superradiance penetrate perfectly along the internal hollow core of the MT as if the optical medium inside it were made "transparent" by the propagating photons themselves. This is referred to as the quantum phenomenon of self-induced transparency [35]. Superradiance and self-induced transparency in cytoskeletal MTs can lead to "optical" neural holography [36]. Neurons (and maybe also other cells) may contain microscopic coherent optical supercomputers with enormous capacity. Thus Jibu, et. al.[49], suggest that MTs can behave as optical waveguides which result in coherent photons. They estimate that this quantum coherence is capable of superposition of states among MT spatially distributed over hundreds of microns. These in turn are in superposition with other MTs hundreds of microns away in other directions and so on. With the above conclusions $|\varphi\rangle_{12}$ can produce those photons which produced itself, thus if the state $|\varphi\rangle_{12}$ can be restored in the brain, it will reproduce the photons which were absorbed in the retina.

Additional arguments in favor of the feasibility of production of photons in the brain can be found in the conclusions of the paper [37], which also asserts that there exists a neural activity-dependent ultra-weak photon (biophoton) emission in the brain. Thus there is the possibility to restore the initial state of the photon in the brain after absorption in the eye. This process can be implemented through teleportation mechanism between retina and the visual cortex as will be discussed in the following sections.

4) The Decoherence Problem

The important question about the quantum processing in the living systems is: how is it possible for MTs to process information quantum mechanically while the environment surrounding them is relatively hot, wet and noisy?

According to the Orch-OR model, microtubular structures in the neurons of the brain process information quantum mechanically and to avoid decoherence, like lasers maintain quantum coherence against thermal noise. Water within cells is itself not truly liquid, but has been shown to be, to a large extent, ordered [38]. Most of the ordered water in the cell in fact surrounds the cytoskeleton [39]. MTs and other cytoskeletal components are embedded in cytoplasm which exists in alternating phases of (1) "sol" (solution, liquid); and (2) "gel" (gelatinous, solid). Among the most primitive of biological activities, "sol-gel transformations" within neurons and other living cells are caused by assembly and disassembly of cytoskeletal actin (e.g. regulated by calcium ions through the protein calmodulin, in turn regulated by MTs). Sol-gel transformations are essential in basic cellular activities such as ("amoeboid") movement, growth and synaptic formation and neurotransmitter vesicle release [40], [41]. Transitions can occur rapidly (e.g. 40 sol-gel cycles per second), and some actin gels can be quite solid, and withstand deformation without transmitted response [42]. Cyclical encasement of MTs by actin gels may thus be an ideal quantum isolation mechanism. In the gel phase of cytoplasm, the water ordering surfaces of a MT are within a few nanometers of actin surfaces which also order water. Thus bundles of MTs encased in actin gel may be effectively isolated extending over the radius of the bundle, on the order of hundreds of nanometers. There are many mechanisms which can protect these structures against decohering factors. In general, Quantum states of tubulin/MTs are protected from environmental decoherence by biological mechanisms which include phases of actin gelatin, plasma-like Debye layering, coherent pumping and topological quantum error correction [54]. Moreover, quantum spin transfer between quantum dots connected by benzene rings (the same structures found in aromatic hydrophobic amino acids) is more efficient at warm temperature than absolute zero[43]. It is conjectured that the "flexibility" of the resonant benzene electrons is advantageous to quantum processes by harnessing ambient thermal energy. MTs may possibly utilize nonspecific thermal energy for "laser-like" coherent pumping, for example in the GHz range by a mechanism of "pumped phonons" suggested by Froehlich [44,45,46].

5) What is the mechanism of Teleportation?

According to the definition of teleportation as stated in [47], in the process of quantum teleportation, one can construct an exact replica of the original unknown quantum state at a cost of destroying the original state. Therefore, to call a quantum state transfer operation- quantum teleportation, the process should not only generate output states with better qualities than what can be done classically but also obey the no-cloning theorem [48].The quantum state of a system can be transmitted from a location to a distant one using only classical information provided that a quantum channel exists between the sender and the receiver. Sharing entangled states between the two parties opens the necessary quantum channel. Research in quantum state transfer, especially the quantum teleportation, has emerged as one of the major research areas of theoretical and experimental quantum mechanics. Assume that Alice wants to send Bob an unknown quantum state but when she receives this state she does not know anything about that unless she affects it and collapses it to classical state, or in other hand she destroys that quantum state. She just can send classical signals to Bob through classical channel, but if there is a shared entangled channel between Alice and Bob, Bob can construct initial quantum state with the help of classical signal which is sent by Alice and quantum channel between them. This operation is implemented by operating special unitary operators. For more details see [47]. Here, we want to simulate visual information transfer with teleportation mechanism. We know that when photon penetrates the retina, it changes to action potentials or electrical signals and these classical signals are sent to the brain for interpretation. It means that *retina* (Alice) wants to send the *brain* (Bob) a *photon state* (unknown quantum state), but *retina* (Alice) absorbs

it (collapses the quantum state) and changes it to *action potential* (classical state) and send it through *membranes of axons of the brain neurons* (classical channel). *Brain* (Bob) can reconstruct the initial *state of photon* (unknown quantum state) to process it to emerge consciousness. Our arguments for this simulation are below conclusions:

Orch OR [14], [15]: There is quantum processing in the neurons of the brain (there is a quantum channel between retina and brain)

Tegmark [13]: Displacement of ions through membranes of brain neurons is a classical phenomenon (action potentials are classical signals and membranes of neurons are classical channels).

Thaheld [11],[12]: Superposed photons do collapse in the retina (the quantum state is collapsed by the sender [Alice]).

We assert that they describe different aspects of the teleportation mechanism. We simulate visual consciousness with the teleportation mechanism as shown in Table 5-1.

Table 5- 1 Simulation of the transferring visual information from the eye to the brain to the Teleportation mechanism.

Human Brain	***Quantum Teleportation Mechanism***
Retina	Alice
Membrane of axons in neurons	Classical channel
Cytoskeletal structures	Entangled channel (quantum channel)
Visual cortex	Bob
Action potentials	Classical signals

Now we want to investigate this teleportation mechanism via teleporting of entangled coherent states through visual pathways in more details. We will show how photon states are constructed in the visual cortex.

6) Teleportation of Entangled Coherent States through Visual Pathways

Super radiance and self induced transparency [49] besides Froehlich oscillations can cause the coupling of MT dynamics over wide areas and take them into a superposition and a coherent state. While in superposition, tubulins communicate with entangled tubulins in the same manner, and in MTs in neighboring neurons, and through macroscopic regions of the brain via tunneling through gap junctions and possibly tunneling nanotubes [50]. As we have already said, retina and the visual cortex are entangled with each other. Thus there is a quantum channel between retina and the visual cortex which is composed of microtubular structures. MTs interact with membrane structures mechanically by linking proteins, chemically by ions and second messenger signals, and electrically by voltage fields. The transduction of light into electrical signals takes place in the photoreceptors. Except for the ganglion cells, none of the retinal cells display action potentials [51].

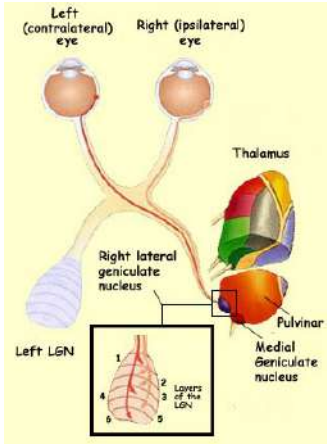

Figure 3 The LGN is a laminated structure, having 6 layers. Contralateral fibers and ipsilateral fibers couple in the LGN. The ipsilateral fibers of the optic nerve terminate in laminae 2,3 and 5 of LGN, while the contralateral fibers terminate in laminae 1, 4 and 6.[52]

Axons leaving the temporal half of the retina traverse the optic nerve to the optic chiasm, where they join the optic tract and project to ipsilateral structures. Axons leaving the nasal half of the retina cross the midline at the chiasm and terminate in contralateral structures. This arrangement means that all the axons in the optic tract carry information about the contralateral visual field. Axons of the optic tract terminate in three areas of the central nervous system, the lateral geniculate nucleus (i.e. LGN), the superior colliculus and the pretectal area. The trajectory through the LGN is the largest most direct and clinically most important pathway by which visual information reaches the cerebral cortex. About 80% of the optic tract axons synapse in the LGN. The LGN is a laminated structure, having 6 layers. Contralateral fibers and ipsilateral fibers couple in the LGN. The ipsilateral fibers of the optic nerve terminate in laminae 2,3 and 5 of LGN, while the contralateral fibers terminate in laminae 1, 4 and 6 of LGN (see Figure 3). There are about 10^6 neurons in each LGN, all of which project to the ipsilateral occipital cortex (area 17) as the optic radiations. The portion of the cerebral cortex that receives LGN axons is called the striate cortex and is usually labeled V1 to designate it as the primary visual cortical area (Figure 3). Virtually all information in the visual system is recognized as being processed by V1 first, and then passed out to higher order systems [53]. The upper visual cortex receives signals from the lower visual field and similarly, lower visual cortex process information from the upper visual field. The right visual cortex processes the left field of view and vice versa (see figure 4).

Now, we investigate the information transfer through visual pathways. The important model among quantum models about the processing in the human brain is the Orch-OR model which is based on the structure of the cytoskeleton. As already said this model asserts that the main processing in the neurons of the brain is performed in the MTs and the nature of the processing is mainly quantum mechanical. The processing unit in this model is *tubulin* which can be in a superposed state. Tubulins act like qubits in quantum computers. *Max Tegmark* believes that there is no quantum processing in the human brain. He has calculated decoherence times for every superposition state which can be possible in the neurons of the brain [13]. In his opinion, superposition states include ions such as Na^+ which are "in" and "out" of the membrane of axon. On the other hand, Na^+ ions are in the superposition of "in" and "out" with a separation distance comparable to the membrane thickness. He has considered three factors which can destroy this superposition state in neurons. *Collisions with the neighboring ions, Collisions with the water molecules* and *Interaction with distant ions* are the factors which Tegmark investigated for decoherence. He has estimated 10^{-19} s and 10^{-20} s for decoherence times. It is clear that above times are very small for the brain processes such as seeing, thinking, speaking and the other cognitive processes. Typically, dynamical timescales for neuron firing and cognitive processes are in the range of 10^{-4} to 1 seconds, whereas decoherence timescales are many orders of magnitude shorter. Thus, action potentials should be

regarded as classical signals or the displacement of ions through the membrane of axons should be investigated classically. It is remarkable that Tegmark has also calculated decoherence time for MTs, but he has used wrong assumptions about these structures (for more details see [54]) and we just accept his calculations about action potentials. Thaheld [11], [12] believes that the wave function of any superposed photon state or states is always objectively changed within the complex architecture of the eye, and any incident photons have to run a very daunting gauntlet before they are even converted or transduced to retinal ganglion cell spike trains (To learn more about Thaheld arguments, the reader is referred to refs. [55,56,57]). According to Thaheld, the quantum state of photons does collapse in the retina and it does not reach the brain.

Is Thaheld right? Is not there any mechanism to rebuild the quantum state of photons in the brain? Here we accept that the states of photons collapse in the retina but we believe that they can be restored in the visual cortex via the teleportation mechanism.

Now, the question is how can it be possible to restore the exact state of photons in the brain while its state is collapsed in the retina. The other question which one may ask is: if this state is reported through action potentials how is this information reported to the brain and how can it interpret action potentials to obtain the exact state of the photons? Our solution to the above problems involves the teleportation of entangled coherent states through visual pathways. The state of the photon is teleported from the eye to the brain. On the other hand, the state of the photon is transferred via some "cut-and-paste" mechanism from the eye to the brain. But how is it possible?

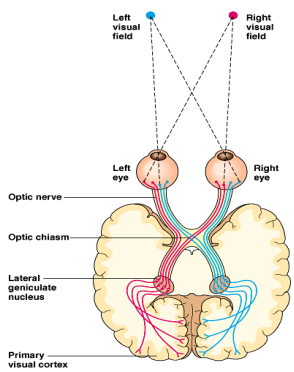

Figure 4 Visual pathways from the eye to the brain. See crossing of pathways.

We concluded before that retina and the visual cortex are entangled. Also we explained how the entangled coherent state is generated in the retina. Now, we want to formulate the process of information transfer from the retina to V1. The state (3-2) with two modes 1 and 2 should be teleported to V1. After the interaction of light with retina, modes 3, 4 and 5, 6 are generated through microtubular structures between retina and V1, and thus they produce entangled coherent channels between retina and V1. It means that the channels are:

$$|\psi\rangle_{35} = \frac{1}{\sqrt{N_\alpha}}(|\alpha\rangle_3|\alpha\rangle_5 - |-\alpha\rangle_3|-\alpha\rangle_5) \qquad (6\text{-}1)$$

$$|\phi\rangle_{46} = \frac{1}{\sqrt{N_\alpha}}(|\alpha\rangle_4|\alpha\rangle_6 - |-\alpha\rangle_4|-\alpha\rangle_6) \qquad (6\text{-}2)$$

Where N_α is the number of tubulins in each channel. Each mode is reported via a special fiber through visual pathways. All of the neurons which are collected in the LGN are divided into two major pathways: ipsilateral fibers and contralateral fibers. Information transfer in the contralateral fibers takes longer than information transfer in ipsilateral fibers because contralateral fibers have crossing relative to ipsilateral

fibers and then they have longer lengths than ipsilateral fibers. On the other hand, contralateral fibers have a retarded phase relative to ipsilateral fibers. Now we want to answer the following questions. What is this phase difference? What is the role of this crossing? And how does crossing restore the initial state in the retina?

7) The Role of Phase Shift to Restore Information in LGN

When the information is collapsed in the retina, action potentials are produced. The shape of action potentials is the same for each neuron, but the main problem is which neurons are fired, or in other words which neurons carry action potentials and information. Consider two fibers selected from ipsilateral fibers and two fibers selected from contralateral fibers. The two ipsilateral fibers are called 1 and 2, and the two contralateral fibers are called 3 and 4 while the two fibers from the LGN to V1 are called 5 and 6 which are selected from the group of magnocellular and parvocellular fibers. Now, we start from the retina. The state of centrioles and channels is:

$$|\psi'\rangle = |\varphi\rangle_{12} \otimes |\psi\rangle_{35} \otimes |\phi\rangle_{46}$$

$$= \frac{1}{N_\propto'}(A|\alpha\rangle_1|\alpha\rangle_2|\alpha\rangle_3|\alpha\rangle_4|\alpha\rangle_5|\alpha\rangle_6$$

$$-A|\alpha\rangle_1|\alpha\rangle_2|\alpha\rangle_3|-\alpha\rangle_4|\alpha\rangle_5|-\alpha\rangle_6$$

$$-A|\alpha\rangle_1|\alpha\rangle_2|-\alpha\rangle_3|\alpha\rangle_4|-\alpha\rangle_5|\alpha\rangle_6$$

$$+A|\alpha\rangle_1|\alpha\rangle_2|-\alpha\rangle_3|-\alpha\rangle_4|-\alpha\rangle_5|-\alpha\rangle_6$$

$$-B|-\alpha\rangle_1|-\alpha\rangle_2|\alpha\rangle_3|\alpha\rangle_4|\alpha\rangle_5|\alpha\rangle_6$$

$$+B|-\alpha\rangle_1|-\alpha\rangle_2|\alpha\rangle_3|-\alpha\rangle_4|\alpha\rangle_5|-\alpha\rangle_6$$

$$+B|-\alpha\rangle_1|-\alpha\rangle_2|-\alpha\rangle_3|\alpha\rangle_4|-\alpha\rangle_5|\alpha\rangle_6$$

$$-B|-\alpha\rangle_1|-\alpha\rangle_2|-\alpha\rangle_3|-\alpha\rangle_4|-\alpha\rangle_5|-\alpha\rangle_6) \qquad (7\text{-}1)$$

All of the above states are collected in the LGN. But here the role of action potentials is very important. They determine which fibers are fired. If fibers 1 and 2 carry action potentials, then it shows that information passes through ipsilateral fibers. Thus to select information from the LGN to send it via fibers 5 and 6 to V1 there is no need for phase difference (or to apply the phase shift operator on the states) and thus the state of (3-2) can be transferred like its first state through fibers 5 and 6. In the formulation (7-1) we see that if fibers *x* and *y* are fired, the expression with $|\alpha\rangle_x|\alpha\rangle_y$ should be selected from the terms with coefficients +A besides the expression $|-\alpha\rangle_x|-\alpha\rangle_y$ from the terms with coefficients $-B$. Hence,

$$1,2\ firing \quad \xrightarrow{yields} \quad |\phi'\rangle_{56} = A|\alpha\rangle_5|\alpha\rangle_6 - B|-\alpha\rangle_5|-\alpha\rangle_6 \qquad (7\text{-}2)$$

In another state, if fibers 1 and 4 are fired it means that one fiber is selected from ipsilateral fibers and the other is from contralateral fibers, thus they have phase difference with respect to each other. Hence,

$$1,4\ firing \quad \xrightarrow{yields} \quad |\phi'\rangle_{56} = A|\alpha\rangle_5|-\alpha\rangle_6 - B|-\alpha\rangle_5|\alpha\rangle_6 \qquad (7\text{-}3)$$

To restore initial information, the operator

$$R(\varphi) = e^{-i\pi a^{\dagger}{}_6 a_6}$$

should operate on the state in LGN in which fibers 1 and 4 have conveyed action potentials. This operator changes the ket $|\alpha\rangle_6$ to $|-\alpha\rangle_6$ and vice versa. It means that fiber 4 has a π radian phase difference with respect to fiber 1, and this phase difference can restore the exact state of the photon. If fibers 2 and 3 are fired, this yields:

$$2,3\ \ firing \quad \xrightarrow{yields} \quad |\phi'\rangle_{56} = A|-\alpha\rangle_5|\alpha\rangle_6 - B|\alpha\rangle_5|-\alpha\rangle_6 \qquad (7\text{-}4)$$

In this case the operator

$$R(\varphi) = e^{-i\pi a^{\dagger}{}_5 a_5}$$

should be involved. For the case of 3 and 4 firing, this yields,

$$3,4\ \ firing \quad \xrightarrow{yields} \quad |\phi'\rangle_{56} = A|-\alpha\rangle_5|-\alpha\rangle_6 - B|\alpha\rangle_5|\alpha\rangle_6 \qquad (7\text{-}5)$$

in which case the operator

$$R(\varphi) = e^{-i\pi(a^{\dagger}{}_5 a_5 + a^{\dagger}{}_6 a_6)}$$

should be involved. In this case we see that the main path is that of ipsilateral fibers which are direct to each eye and fibers 3 and 4 both have a π radian phase difference with it. We also know that there are two LGNs and the left and right V1. Now, another question emerges. How do these two left and right parts in V1 can instantaneously receive information? To answer this question, we can say that the synaptic β-neurexin/neuroligin-1 adhesive protein complex is claimed to be a device mediating entanglement between the cytoskeletons of the cortical neurons. Thus the macroscopic coherent quantum state can extend through large brain cortical areas [58].

We see that crossing or rotation of neurons in the visual pathways has an important role in restoring information in the brain. Maybe rotations or crossings of neurons throughout the body are there for this very reason.

8) Discussion

In general, we can briefly summarize our approach by listing the following properties:

1- It can combine the Orch-OR model with Tegmark's approaches and the Thaheld conclusion in a compact physical model which is called Teleportation.
2- It investigates visual pathways from atomic scales to macroscopic scales. This approach includes classical descriptions as well as new answers to open questions.
3- It explains why the shape of action potentials stays the same. Classical models state that "sensations" are action potentials that reach the brain via sensory neurons, and "perception" is the awareness and interpretation of the sensation. It is reasonable to assume that the constant shape of action potentials cannot result in different profiles of information. Thus the shape of information should be due to neurons. In this approach MTs are the representatives of information carriers. In our approach action potentials just determine which neurons fire and which do not.
4- It describes why neurons cross at some point. This crossing causes a phase shift relative to a special pathway. In teleportation of entangled coherent states the phase shift operators can rebuild initial information.

5- It explains that how the inverted image on the retina is perceived in the brain as upright.
6- It can describe how different information can be simultaneously perceived as a binding nature of conscious experience. This can be done via quantum parallel processing.
7- It explains how the brain of the observer can receive quantum information from the environment. We can see that there still exists this possibility that the mind can play the main role in the measurement problem, and this is in accord with what London, Bauer, von Neumann and Wigner (initially) asserted.

9) Conclusions

In this paper we have theoretically demonstrated the plausibility of a quantum teleportation mechanism between the eye and the brain which can describe different aspects of visual processing through visual pathways. Our model covers both quantum and classical aspects of neuroscience. This mechanism can combine some features of the Orch-OR model with Tegmark's conclusions and Thaheld's belief in one general model.

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Teleportation Physics Study

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Special Report

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

This study was tasked with the purpose of collecting information describing the teleportation of material objects, providing a description of teleportation as it occurs in physics, its theoretical and experimental status, and a projection of potential applications. The study also consisted of a search for teleportation phenomena occurring naturally or under laboratory conditions that can be assembled into a model describing the conditions required to accomplish the transfer of objects. This included a review and documentation of quantum teleportation, its theoretical basis, technological development, and its potential applications. The characteristics of teleportation were defined and physical theories were evaluated in terms of their ability to completely describe the phenomena. Contemporary physics, as well as theories that presently challenge the current physics paradigm were investigated. The author identified and proposed two unique physics models for teleportation that are based on the manipulation of either the general relativistic spacetime metric or the spacetime vacuum electromagnetic (zero-point fluctuations) parameters. Naturally occurring anomalous teleportation phenomena that were previously studied by the United States and foreign governments were also documented in the study and are reviewed in the report. The author proposes an additional model for teleportation that is based on a combination of the experimental results from the previous government studies and advanced physics concepts. Numerous recommendations outlining proposals for further theoretical and experimental studies are given in the report. The report also includes an extensive teleportation bibliography.

15. SUBJECT TERMS

teleportation; physics, quantum teleportation; teleportation phenomena; anomalous teleportation; teleportation theories; teleportation experiments; teleportation bibliography

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FOREWORD

This Special Technical Report presents the results of a subcontracted study performed by Warp Drive Metrics, Las Vegas, NV, under Contract No. F04611-99-C-0025, for the Air Force Research Laboratory (AFRL)/Space and Missile Propulsion Division, Propellant Branch (PRSP), Edwards AFB, CA. The Project Manager for AFRL/PRSP was Dr. Franklin B. Mead, Jr.

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Glossary

AEC	Average Energy Condition
AFRL	Air Force Research Laboratory
AU	Astronomical Unit
BBO	Beta (β)-Barium Borate
CGS	Centimeter-Gram-Second
CIA	Central Intelligence Agency
DARPA	Defense Advanced Research Projects Agency
DEC	Dominant Energy Condition
DIA	Defense Intelligence Agency
DNA	Deoxyribo Nucleic Acid
DoD	Department of Defense
EPR	Einstein, Podolsky and Rosen
ESP	Extrasensory Perception
eV	Electron Volt
FRW	Friedmann-Robertson-Walker
FTL	Faster-Than-Light
IBM	International Business Machines
INSCOM	Intelligence and Security Command
IR	Infrared
MeV	Mega-Electron Volt
MKS	Meter-Kilogram-Second
NEC	Null Energy Condition
NLP	Neuro-Linguistic Programming
NMR	Nuclear Magnetic Resonance
NSA	National Security Agency
PK	Psychokinesis
PPN	Parameterized Post-Newtonian
PRC	Peoples Republic of China
PV-GR	Polarizable-Vacuum Representation of General Relativity
QED	Quantum Electrodynamics
QISP	Quantum Information Science Program
R&D	Research and Development
SAIC	Science Applications International Corporation
SEC	Strong Energy Condition
SRI	Stanford Research Institute
USSR	Union of Soviet Socialist Republics
UV	Ultraviolet
WEC	Weak Energy Condition
ZPE	Zero-Point Energy
ZPF	Zero-Point Fluctuations

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There are two colleagues who provided important contributions to this study that I wish to acknowledge. First, I would like to express my sincere thanks and deepest appreciation to my first longtime mentor and role model, the late Dr. Robert L. Forward. Bob Forward was the first to influence my interests in interstellar flight and advanced breakthrough physics concepts (i.e., "Future Magic") when I first met him at an AIAA Joint Propulsion Conference in Las Vegas while I was in high school (ca. 1978). The direction I took in life from that point forward followed the trail of exploration and discovery that was blazed by Bob. I will miss him, but I will never forget him. Second, I would like to express my sincere thanks and appreciation to my longtime friend, colleague and present mentor, Dr. Hal Puthoff, Institute for Advanced Studies-Austin, for our many discussions on applying his Polarizable Vacuum-General Relativity model to a quasi-classical teleportation concept. Hal taught me to expand my mind, and he encourages me to think outside the box. He also gave me a great deal of valuable insight and personal knowledge about the Remote Viewing Program. Last, I would like to offer my debt of gratitude and thanks to my business manager (and spouse), Lindsay K. Davis, for all the hard work she does to make the business end of Warp Drive Metrics run smoothly.

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Preface

The Teleportation Physics Study is divided into four phases. Phase I is a review and documentation of quantum teleportation, its theoretical basis, technological development, and its potential application. Phase II developed a textbook description of teleportation as it occurs in classical physics, explored its theoretical and experimental status, and projected its potential applications. Phase III consisted of a search for teleportation phenomena occurring naturally or under laboratory conditions that can be assembled into a model describing the conditions required to accomplish the disembodied conveyance of objects. The characteristics of teleportation were defined, and physical theories were evaluated in terms of their ability to completely describe the phenomenon. Presently accepted physics theories, as well as theories that challenge the current physics paradigm were investigated for completeness. The theories that provide the best chance of explaining teleportation were selected, and experiments with a high chance of accomplishing teleportation were identified. Phase IV is the final report.

The report contains five chapters. Chapter 1 is an overview of the textbook descriptions for the various teleportation phenomena that are found in nature, in theoretical physics concepts, and in experimental laboratory work. Chapter 2 proposes two quasi-classical physics concepts for teleportation: the first is based on engineering the spacetime metric to induce a traversable wormhole; the second is based on the polarizable-vacuum-general relativity approach that treats spacetime metric changes in terms of equivalent changes in the vacuum permittivity and permeability constants. These concepts are theoretically developed and presented. Promising laboratory experiments were identified and recommended for further research. Chapter 3 presents the current state-of-art of quantum teleportation physics, its theoretical basis, technological development, and its applications. Key theoretical, experimental, and applications breakthroughs were identified, and a series of theoretical and experimental research programs are proposed to solve technical problems and advance quantum teleportation physics. Chapter 4 gives an overview of alternative teleportation concepts that challenge the present physics paradigm. These concepts are based on the existence of parallel universes/spaces and/or extra space dimensions. The theoretical and experimental work that has been done to develop these concepts is reviewed, and a recommendation for further research is made. Last, Chapter 5 gives an in-depth overview of unusual teleportation phenomena that occur naturally and under laboratory conditions. The teleportation phenomenon discussed in the chapter is based on psychokinesis (PK), which is a category of psychotronics. The U.S. military-intelligence literature is reviewed, which relates the historical scientific research performed on PK-teleportation in the U.S., China and the former Soviet Union. The material discussed in the chapter largely challenges the current physics paradigm; however, extensive controlled and repeatable laboratory data exists to suggest that PK-teleportation is quite real and that it is controllable. The report ends with a combined list of references.

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1.0 INTRODUCTION

1.1 Introduction

The concept of teleportation was originally developed during the Golden Age of 20th century science fiction literature by writers in need of a form of instantaneous disembodied transportation technology to support the plots of their stories. Teleportation has appeared in such SciFi literature classics as Algis Budry's *Rogue Moon* (Gold Medal Books, 1960), A. E. van Vogt's *World of Null-A* (Astounding Science Fiction, August 1945), and George Langelaan's *The Fly* (Playboy Magazine, June 1957). The Playboy Magazine short story led to a cottage industry of popular films decrying the horrors of scientific technology that exceeded mankind's wisdom: *The Fly* (1958), *Return of the Fly* (1959), *Curse of the Fly* (1965), *The Fly* (a 1986 remake), and *The Fly II* (1989). The teleportation concept has also appeared in episodes of popular television SciFi anthology series such as *The Twilight Zone* and *The Outer Limits*. But the most widely recognized pop-culture awareness of the teleportation concept began with the numerous *Star Trek* television and theatrical movie series of the past 39 years (beginning in 1964 with the first TV series pilot episode, *The Cage*), which are now an international entertainment and product franchise that was originally spawned by the late genius television writer-producer Gene Roddenberry. Because of *Star Trek* everyone in the world is familiar with the "transporter" device, which is used to teleport personnel and material from starship to starship or from ship to planet and vice versa at the speed of light. People or inanimate objects would be positioned on the transporter pad and become completely disintegrated by a beam with their atoms being patterned in a computer buffer and later converted into a beam that is directed toward the destination, and then reintegrated back into their original form (all without error!). "*Beam me up, Scotty*" is a familiar automobile bumper sticker or cry of exasperation that were popularly adopted from the series.

However, the late Dr. Robert L. Forward (2001) stated that modern hard-core SciFi literature, with the exception of the ongoing *Star Trek* franchise, has abandoned using the teleportation concept because writers believe that it has more to do with the realms of parapsychology/paranormal (a.k.a. psychic) and imaginative fantasy than with any realm of science. Beginning in the 1980s developments in quantum theory and general relativity physics have succeeded in pushing the envelope in exploring the reality of teleportation. A crescendo of scientific and popular literature appearing in the 1990s and as recently as 2003 has raised public awareness of the new technological possibilities offered by teleportation. As for the psychic aspect of teleportation, it became known to Dr. Forward and myself, along with several colleagues both inside and outside of government, that anomalous teleportation has been scientifically investigated and separately documented by the Department of Defense.

It has been recognized that extending the present research in quantum teleportation and developing alternative forms of teleportation physics would have a high payoff impact on communications and transportation technologies in the civilian and military sectors. It is the purpose of this study to explore the physics of teleportation and delineate its characteristics and performances, and to make recommendations for further studies in support of Air Force Advanced Concepts programs.

1.2 The Definitions of Teleportation

Before proceeding, it is necessary to give a definition for each of the teleportation concepts I have identified during the course of this study:

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- *Teleportation* – SciFi: the disembodied transport of persons or inanimate objects across space by advanced (futuristic) technological means (adapted from Vaidman, 2001). We will call this *sf-Teleportation*, which will not be considered further in this study.

- *Teleportation* – psychic: the conveyance of persons or inanimate objects by psychic means. We will call this *p-Teleportation*.

- *Teleportation* – engineering the vacuum or spacetime metric: the conveyance of persons or inanimate objects across space by altering the properties of the spacetime vacuum, or by altering the spacetime metric (geometry). We will call this *vm-Teleportation*.

- *Teleportation* – quantum entanglement: the disembodied transport of the quantum state of a system and its correlations across space to another system, where *system* refers to any single or collective particles of matter or energy such as baryons (protons, neutrons, etc.), leptons (electrons, etc.), photons, atoms, ions, etc. We will call this *q-Teleportation*.

- *Teleportation* – exotic: the conveyance of persons or inanimate objects by transport through extra space dimensions or parallel universes. We will call this *e-Teleportation*.

We will examine each of these in detail in the following chapters and determine whether any of the above teleportation concepts encompass the instantaneous and or disembodied conveyance of objects through space.

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2.0 vm-TELEPORTATION

2.1 Engineering the Spacetime Metric

A comprehensive literature search for vm-Teleportation within the genre of spacetime metric engineering yielded no results. No one in the general relativity community has thought to apply the Einstein field equation to determine whether there are solutions compatible with the concept of teleportation. Therefore, I will offer two solutions that I believe will satisfy the definition of vm-Teleportation. The first solution can be found from the class of traversable wormholes giving rise to what I call a true "stargate." A stargate is essentially a wormhole with a flat-face shape for the throat as opposed to the spherical-shaped throat of the Morris and Thorne (1988) traversable wormhole, which was derived from a spherically symmetric Lorentzian spacetime metric that prescribes the wormhole geometry (see also, Visser, 1995 for a complete review of traversable Lorentzian wormholes):

$$ds^2 = -e^{2\phi(r)}c^2dt^2 + [1-b(r)/r]^{-1}dr^2 + r^2d\Omega^2 \qquad (2.1),$$

where by inspection we can write the traversable wormhole metric tensor in the form

$$g_{\alpha\beta} = \begin{pmatrix} -e^{2\phi(r)} & 0 & 0 & 0 \\ 0 & [1-b(r)/r]^{-1} & 0 & 0 \\ 0 & 0 & r^2 & 0 \\ 0 & 0 & 0 & r^2\sin^2\theta \end{pmatrix} \qquad (2.2)$$

using standard spherical coordinates, where c is the speed of light, $\alpha,\beta \equiv (0 = t,\ 1 = r,\ 2 = \theta,\ 3 = \varphi)$ are the time and space coordinate indices ($-\infty < t < \infty$; r: $2\pi r$ = circumference; $0 \le \theta \le \pi$; $0 \le \varphi \le 2\pi$), $d\Omega^2 = d\theta^2 + sin^2\theta d\varphi^2$, $\phi(r)$ is the freely specifiable redshift function that defines the proper time lapse through the wormhole throat, and $b(r)$ is the freely specifiable shape function that defines the wormhole throat's spatial (hypersurface) geometry. Such spacetimes are asymptotically flat. The Einstein field equation requires that a localized source of matter-energy be specified in order to determine the geometry that the source induces on the local spacetime. We can also work the Einstein equation backwards by specifying the local geometry in advance and then calculate the matter-energy source required to induce the desired geometry. The Einstein field equation thus relates the spacetime geometry terms comprised of the components of the metric tensor and their derivatives (a.k.a. the Einstein tensor) to the local matter-energy source terms comprised of the energy and stress-tension densities (a.k.a. the stress-energy tensor). The flat-face wormhole or stargate is derived in the following section.

2.1.1 Wormhole Thin Shell Formalism

The flat-face traversable wormhole solution is derived from the thin shell (a.k.a. junction condition or surface layer) formalism of the Einstein equations (Visser, 1989; see also, Misner, Thorne and Wheeler, 1973). We adapt Visser's (1989) development in the following discussion. The procedure is to take two copies of flat Minkowski space and remove from each identical regions of the form $\Omega \times \Re$, where Ω is a three-dimensional compact spacelike hypersurface and $\Re$ is a timelike straight line (time axis). Then identify these two incomplete spacetimes along the timelike boundaries $\partial\Omega \times \Re$. The resulting spacetime

is geodesically complete and possesses two asymptotically flat regions connected by a wormhole. The throat of the wormhole is just the junction $\partial\Omega$ (a two-dimensional space-like hypersurface) at which the two original Minkowski spaces are identified (see Figures 1 and 2).

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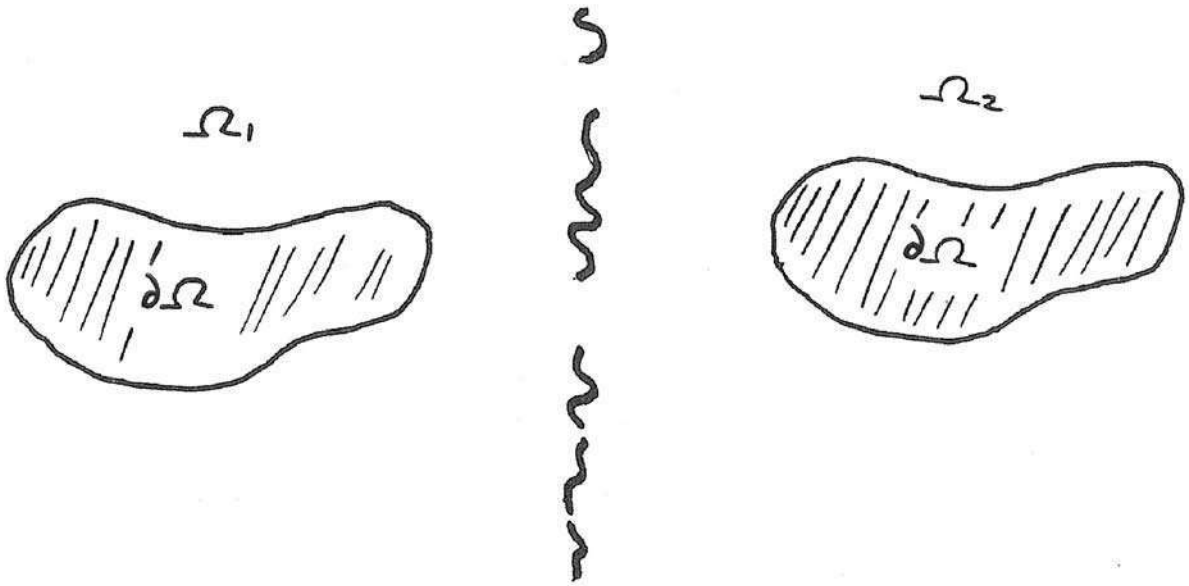

Figure 1. Diagram of a Simultaneous View of Two Remote Compact Regions (Ω_1 and Ω_2) of Minkowski Space Used to Create the Wormhole Throat $\partial\Omega$, Where Time is Suppressed in This Representation (adapted from Bennett et al., 1995)

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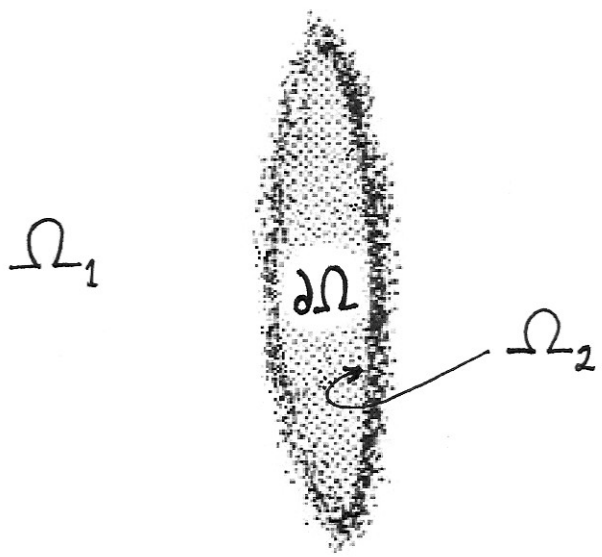

Figure 2. The Same Diagram as in Figure 1 Except as Viewed by an Observer Sitting in Region Ω_1 Who Looks Through the Wormhole Throat $\partial\Omega$ and Sees Remote Region Ω_2 (Dotted Area Inside the Circle) on the Other Side

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The resulting spacetime is everywhere Riemann-flat except possibly at the throat. Also, the stress-energy tensor in this spacetime is concentrated at the throat with a δ-function singularity there. This is a consequence of the fact that the spacetime metric at the throat is continuous but not differentiable, while the connection is discontinuous; thus causing the Riemann curvature to possess a δ-function singularity (causing undesirable gravitational tidal forces) there. The magnitude of this δ-function singularity can be calculated in terms of the second fundamental form on both sides of the throat, which we presume to be generated by a localized thin shell of matter-energy. The second fundamental form represents the extrinsic curvature of the $\partial\Omega$ hypersurface (i.e., the wormhole throat), telling how it is curved with respect to the enveloping four-dimensional spacetime. The form of the geometry is simple, so the second fundamental form at the throat is calculated to be (McConnell, 1957):

$$\begin{aligned} K^{i}{}_{j}{}^{\pm} &= \pm\begin{pmatrix} \kappa_0 & 0 & 0 \\ 0 & \kappa_1 & 0 \\ 0 & 0 & \kappa_2 \end{pmatrix} \\ &= \pm\begin{pmatrix} 0 & 0 & 0 \\ 0 & 1/\rho_1 & 0 \\ 0 & 0 & 1/\rho_2 \end{pmatrix} \end{aligned} \qquad (2.3),$$

where $i,j = 0,1,2$ and $K^{i\pm}_{j}$ is the second fundamental form. The full 4×4 matrix $K^{\alpha}{}_{\beta}$ has been reduced to 3×3 form, as above, for computational convenience because the thin shell (or hypersurface) is essentially a two-surface embedded in three-space. The overall ± sign in equation (2.3) comes from the fact that a unit normal points outward from one side of the surface and points inward on the other side. We hereafter drop the ± sign for the sake of brevity in notation. The quantities κ_0, κ_1, and κ_2 measure the extrinsic curvature of the thin shell of local matter-energy (i.e., the stuff that induces the wormhole throat geometry). Since the wormhole throat is a space-like hypersurface, we can exclude time-like hypersurfaces and their components in the calculations. Therefore we set $\kappa_0 = 0$ in equation (2.3) because it is the time-like extrinsic curvature for the time-like hypersurface of the thin shell of matter-energy. As seen in equation (2.3) κ_1 and κ_2 are simply related to the two principal radii of curvature ρ_1 and ρ_2 (defined to be the eigenvalues of K^{i}_{j}) of the two-dimensional spacelike hypersurface $\partial\Omega$ (see Figure 3). It should be noted that a convex surface has positive radii of curvature, while a concave surface has negative radii of curvature.

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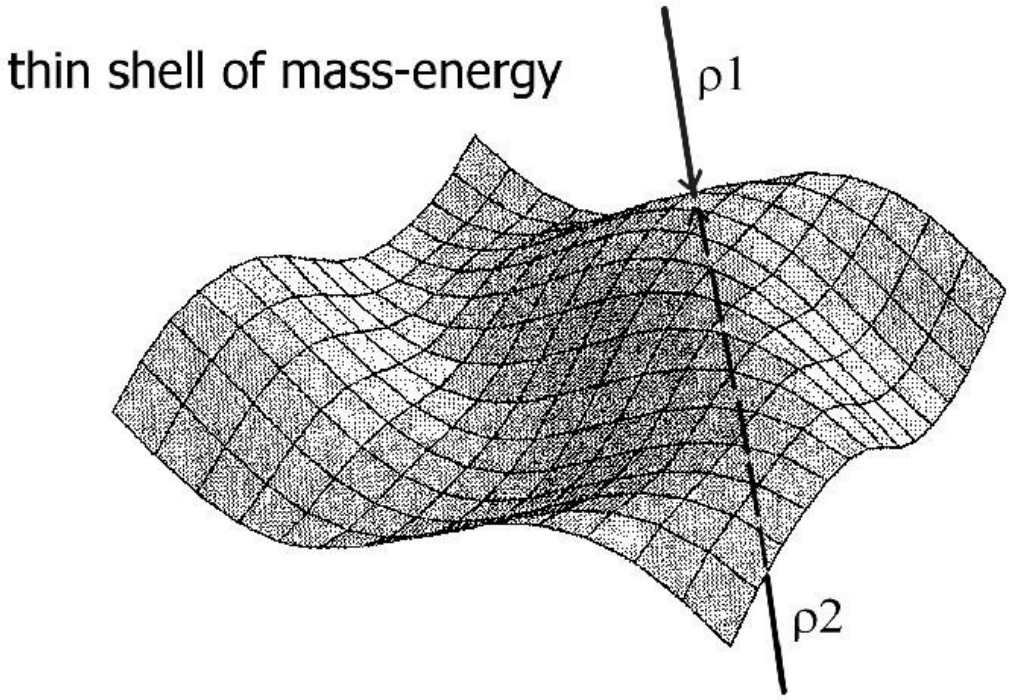

Figure 3. A Thin Shell of (Localized) Matter-Energy, or Rather the Two-Dimensional Spacelike Hypersurface $\partial\Omega$ (via (2.3)), Possessing the Two Principal Radii of Curvature ρ_1 and ρ_2

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It is a standard result of the thin shell or junction condition formalism that the Einstein field equation may be cast in terms of the surface stress-energy tensor S^i_j of the thin matter-energy shell localized in $\partial\Omega$ (note: we are exploiting the symmetry of the wormhole with respect to interchange of the two flat regions Ω_1 and Ω_2):

$$S^i{}_j = -\frac{c^4}{4\pi G}\left(K^i{}_j - \delta^i{}_j K^k{}_k\right) \quad (2.4),$$

where G is Newton's gravitational constant and δ^i_j is the (three-dimensional) unit matrix. K^k_k is the trace of equation (2.3):

$$\begin{aligned} K^k{}_k &= Tr\, K^i{}_j \\ &= \frac{1}{\rho_1} + \frac{1}{\rho_2} \end{aligned} \qquad (2.5)$$

and

$$\delta^i{}_j K^k{}_k = \begin{pmatrix} \frac{1}{\rho_1} + \frac{1}{\rho_2} & 0 & 0 \\ 0 & \frac{1}{\rho_1} + \frac{1}{\rho_2} & 0 \\ 0 & 0 & \frac{1}{\rho_1} + \frac{1}{\rho_2} \end{pmatrix} \qquad (2.6).$$

Substituting (2.3) and (2.6) into (2.4) gives (after simplification):

$$S^i{}_j = \frac{c^4}{4\pi G}\begin{pmatrix} \frac{1}{\rho_1} + \frac{1}{\rho_2} & 0 & 0 \\ 0 & 1/\rho_2 & 0 \\ 0 & 0 & 1/\rho_1 \end{pmatrix} \qquad (2.7).$$

The thin matter-energy shell's surface stress-energy tensor may be interpreted in terms of the surface energy density σ and principal surface tensions ϑ_1 and ϑ_2:

$$S^i{}_j = \begin{pmatrix} -\sigma & 0 & 0 \\ 0 & -\vartheta_1 & 0 \\ 0 & 0 & -\vartheta_2 \end{pmatrix} \qquad (2.8).$$

Thus we arrive at the Einstein field equation by equating (2.8) and (2.7) and multiplying both sides by –1:

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$$\begin{pmatrix} \sigma & 0 & 0 \\ 0 & \vartheta_1 & 0 \\ 0 & 0 & \vartheta_2 \end{pmatrix} = -\frac{c^4}{4\pi G}\begin{pmatrix} \frac{1}{\rho_1}+\frac{1}{\rho_2} & 0 & 0 \\ 0 & 1/\rho_2 & 0 \\ 0 & 0 & 1/\rho_1 \end{pmatrix} \qquad (2.9),$$

which gives the final result

$$\sigma = -\frac{c^4}{4\pi G}\left(\frac{1}{\rho_1}+\frac{1}{\rho_2}\right) \qquad (2.10a)$$

$$\vartheta_1 = -\frac{c^4}{4\pi G}\frac{1}{\rho_2} \qquad (2.10b)$$

$$\vartheta_2 = -\frac{c^4}{4\pi G}\frac{1}{\rho_1} \qquad (2.10c).$$

These are the Einstein equations. Equations (2.10a-c) imply that (for $\partial\Omega$ convex) we are dealing with ***negative*** surface energy density and ***negative*** surface tensions. This result is in fact the primary matter-energy requirement for traversable wormholes, as was proved by Morris and Thorne (1988), and later by Visser (1995), within the paradigm of classical Einstein general relativity. The negative surface tension (= *positive outward pressure*, a.k.a. gravitational repulsion or antigravity) is needed to keep the throat open and stable against collapse. The reader should **not** be alarmed at this result. Negative energies and negative stress-tensions are an acceptable result both mathematically and physically, and they manifest gravitational repulsion (antigravity!) in and around the wormhole throat. One only needs to understand what it means for stress-energy to be negative within the proper context. In general relativity the term "*exotic*" is used in place of "*negative*." The effects of negative energy have been produced in the laboratory (the Casimir Effect is one example). In short, negative energy arises from Heisenberg's quantum uncertainty principle, which requires that the energy density of any electromagnetic, magnetic, electric or other fields must fluctuate randomly. Even in a vacuum, where the average energy density is zero, the energy density fluctuates. This means that the quantum vacuum can never remain truly empty in the classical sense of the term. The quantum picture of the vacuum is that of a turbulent plenum of virtual (i.e., energy non-conserving) particle pairs that spontaneously pop in and out of existence. The notion of "zero energy" in quantum theory corresponds to the vacuum being filled with such fluctuations going on. This issue is further elaborated on and clarified in greater detail in Appendix A. We will also revisit this in Section 2.2. Finally, it should be noted that for the analysis in this section we assumed an ultrastatic wormhole [i.e., $g_{00} \equiv 1 \Rightarrow \phi(r) = 0$ in equation (2.1)] with the "exotic" matter-energy confined to a thin layer, and we dispensed with the assumption of spherical symmetry.

We can now build a wormhole-stargate and affect *vm-Teleportation* such that a traveler stepping into the throat encounters **no** exotic matter-energy there. This will require that our wormhole be flat shaped. To make the wormhole flat requires that we choose the throat $\partial\Omega$ to have at least one flat face (picture the thin shell in Figure 3 becoming a flat shell). On that face the two principal radii of curvature become $\rho_1 = \rho_2 = \infty$ as required by standard geometry. Substituting this into equations (2.10a-c) gives

$$\sigma = \vartheta_1 = \vartheta_2 = 0 \qquad (2.11),$$

which is a remarkable result. A further consequence of this is that now $K^i_j = 0$, thus making the Riemann curvature and stress-energy tensors (Riemann: $R^\alpha{}_\beta \sim K^\alpha{}_\beta$; stress-energy: $T^\alpha{}_\beta \sim K^\alpha{}_\beta$) at the throat become zero such that the associated δ-function singularities disappear there. This means that a traveler encountering and going through such a wormhole will feel no tidal gravitational forces and see no exotic matter-energy (that threads the throat). A traveler stepping through the throat will simply be <u>*teleported*</u> into the other remote spacetime region or another universe (note: the Einstein equation does not fix the spacetime topology, so it is possible that wormholes are inter-universe as well as intra-universe tunnels). We construct such a *teleportation* stargate by generating a thin shell or surface layer of "exotic" matter-energy much like a thin film of soap stretched across a loop of wire.

2.1.2 "Exotic" Matter-Energy Requirements

Now we have to estimate the amount of negative (or exotic) mass-energy that will be needed to generate and hold open a *vm-Teleportation* wormhole. A simple formula originally due to Visser (1995) for short-throat wormholes using the thin shell formalism gives:

$$\begin{aligned} M_{wh} &= -\frac{r_{throat}c^2}{G} \\ &= -(1.3469\,x10^{27}\,kg)\frac{r_{throat}}{1\,meter} \qquad (2.12), \\ &= -(0.709\,M_{Jupiter})\frac{r_{throat}}{1\,meter} \end{aligned}$$

where M_{wh} is the mass required to build the wormhole, r_{throat} is a suitable measure of the linear dimension (radius) of the throat, and $M_{Jupiter}$ is the mass of the planet Jupiter (1.90×10^{27} kg). Equation (2.12) demonstrates that a mass of $-0.709\ M_{Jupiter}$ (or -1.3469×10^{27} kg) will be required to build a wormhole 1 meter in size. As the wormhole size increases the mass requirement grows negative-large, and vice versa as the wormhole size decreases. After being alarmed by the magnitude of this, one should note that M_{wh} is **<u>not</u>** the total mass of the wormhole as seen by observers at remote distances. The non-linearity of the Einstein field equations dictates that the total mass is zero (actually, the total net mass being positive, negative or zero in the Newtonian approximation depending on the details of the negative energy configuration constituting the wormhole system). And finally, Visser et al. (2003) have demonstrated the existence of spacetime geometries containing traversable wormholes that are supported by ***<u>arbitrarily small quantities</u>*** of exotic matter-energy, and they proved that this was a general result. In Section 2.3 we will discuss how or whether we can create such a wormhole in the laboratory.

2.2 Engineering the Vacuum

Engineering the spacetime vacuum provides a second solution that also satisfies the definition of vm-Teleportation. The concept of "*engineering the vacuum*" was first introduced to the physics community by Lee (1988). Lee stated:

"*The experimental method to alter the properties of the vacuum may be called vacuum engineering…If indeed we are able to alter the vacuum, then we may encounter some new phenomena, totally unexpected*."

This new concept is based on the now-accepted fact that the vacuum is characterized by physical parameters and structure that constitutes an energetic medium which pervades the entire extent of the

universe. We note here the two most important defining properties of the vacuum in this regard (Puthoff et al., 2002):

- Within the context of quantum field theory the vacuum is the seat of all energetic particle and field fluctuations.

- Within the context of general relativity theory the vacuum is the seat of a spacetime structure (or metric) that encodes the distribution of matter and energy.

We begin our look into this concept by examining the propagation of light through space. We know from quantum field theory that light propagating through space interacts with the vacuum quantum fields (a.k.a. vacuum quantum field fluctuations). The observable properties of light, including the speed of light, are determined by these interactions. Vacuum quantum interactions with light lead to an effect on the speed of light that is due to the absorption of photons (by the vacuum) to form virtual electron-positron pairs followed by the quick re-emission (from the vacuum) of the photon (see Figure 4). The virtual particle pairs are very short lived because of the large mismatch between the energy of a photon and the rest mass-energy of the particle pair. A key point is that this process makes a contribution to the observed vacuum permittivity ε_0 (and permeability μ_0) constant and, therefore, to the speed of light c [$c = (\varepsilon_0\mu_0)^{-1/2}$].

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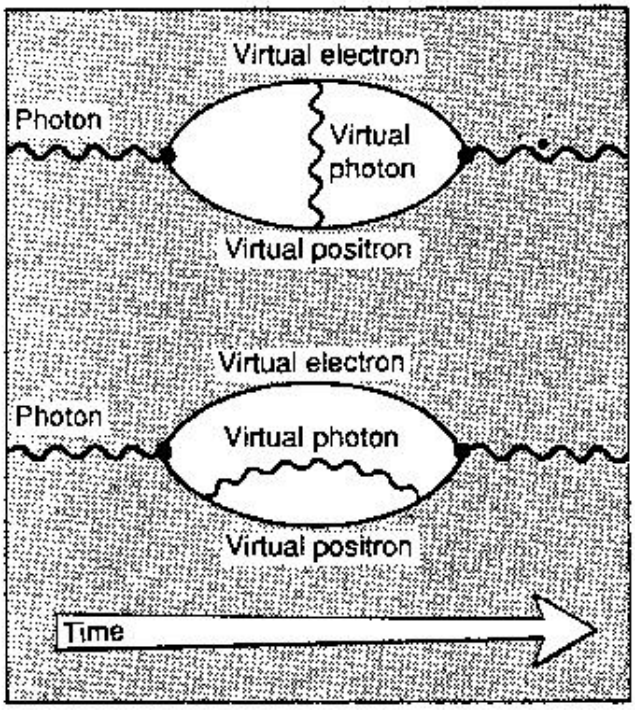

Photons can change into a variety of short-lived, or "virtual", particles as they fly through the vacuum. The processes above, represented by Feynman diagrams, are "two-loop"' processes. They affect light's speed

Figure 4. A Schematic of Vacuum Quantum Field Fluctuations (a.k.a. Vacuum Zero Point Field Fluctuations) Involved in the "Light-by-Light" Scattering Process That Affects the Speed of Light (from Chown, 1990)

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The role of virtual particle pairs in determining the ε_0 (μ_0) of the vacuum is analogous to that of atoms/molecules in determining the relative permittivity ε (and μ) of a dielectric material. We know that the absorption/re-emission of photons by atoms/molecules in a transparent medium (note: there are no strongly absorbing resonances, so the atoms/molecules remain in their excited states for a very short time before re-emitting photons) is responsible for the refractive index of the medium, which results in the reduction of the speed of light for photons propagating through the medium. This absorption/re-emission process is also known in physics as a scattering process. We know from experiment that a change in the medium leads to a change in ε (μ), thus resulting in a change of the refractive index. The key point arising from this analogy is that a modification of the vacuum produces a change in ε_0 (μ_0) resulting in a subsequent change in c, and hence, a corresponding change in the vacuum refraction index.

Scharnhorst (1990) and Latorre et al. (1995) have since proved that the suppression of light scattering by virtual particle pairs (a.k.a. coherent light-by-light scattering) in the vacuum causes an ***increase*** in the speed of light accompanied by a decrease in the vacuum refraction index. This very unique effect is accomplished in a Casimir Effect capacitor cavity (or waveguide) whereby the vacuum quantum field fluctuations (a.k.a. zero-point fluctuations or ZPF) inside have been modified (becoming anisotropic and non-translational invariant) to satisfy the electromagnetic boundary conditions imposed by the presence of the capacitor plates (or waveguide walls). The principal result of this modification is the removal of the electromagnetic zero-point energy (ZPE) due to the suppression of vacuum ZPE modes with wavelengths longer than the cavity/waveguide cutoff ($\lambda_0 = 2d$, where d = plate separation; see Figure 5). This removal of free space vacuum ZPE modes suppresses the scattering of light by virtual particle pairs, thus producing the speed of light increase (and corresponding decrease in the vacuum refraction index). We know from standard optical physics and quantum electrodynamics (QED) that the optical phase and group velocities can exceed c under certain physical conditions, but dispersion always ensures that the signal velocity is $\leq c$. But recent QED calculations (see, Scharnhorst, 1990 and Latorre et al., 1995) have proved that in the Casimir Effect system, the dispersive effects are *much weaker* still than those associated with the increase in c so that the phase, group and signal velocities will therefore *all increase* by the same amount. Note that, in general, no dispersion shows up in all of the modified vacuum effects examined by investigators.

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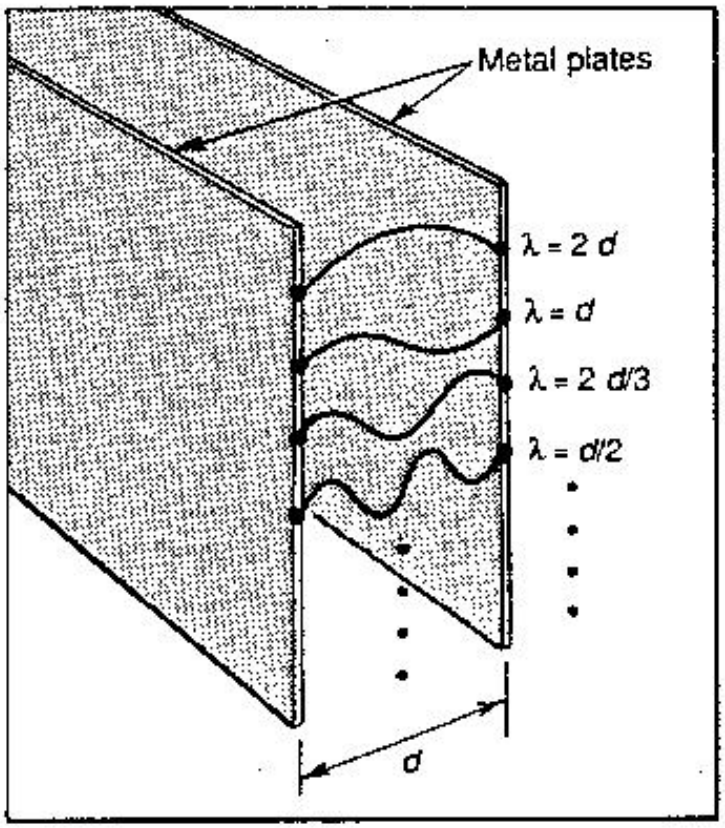

Casimir effect: the vacuum is full of virtual photons, but photons with wavelengths (λ), more than twice the separation of the plates, are excluded from the space between them. The imbalance pushes the plates together

Figure 5. A Schematic of the Casimir Effect Cavity/Waveguide (from Chown, 1990)

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Examples demonstrating the increase in light speed (decrease in vacuum refraction index) via the Casimir Effect vacuum and other modified vacuum effects, as well as those effects producing a decrease in light speed (increase in vacuum refraction index), are described as follows. The vacuum modification effect on the speed of light described in the previous paragraph is (Scharnhorst, 1990):

$$\begin{aligned}\frac{c_\perp^{\ *}}{c_0} &= \left(1+\frac{11}{2^6\bullet(45)^2}\frac{e^4}{(m_e a)^4}\right) \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1) \\ &= \left(1+\frac{11\pi^2}{8100}\alpha^2\frac{1}{(m_e a)^4}\right) > 1\end{aligned} \qquad (2.13),$$

where $c_\perp^{\ *}$ is the (modified) speed of light propagation perpendicular to the Casimir Effect capacitor plates, c_0 is the speed of light in free space (3×10^8 m/s in MKS units), m_e is the electron mass, α is the fine structure constant ($\approx 1/137$), e is the electron charge ($e^2 = 4\pi\alpha$ in quantum field theory natural units), a is the plate separation, $\hbar$ is Planck's reduced constant, and ε_0 is the vacuum permittivity constant. The condition $\hbar = c_0 = \varepsilon_0 = \mu_0 = 1$ stresses that (2.13), and all the equations that follow, are in quantum field theory natural units. The speed of light and vacuum refraction index measured parallel to the plates is unchanged from their free space values ($c_\parallel = c_0$, $n_\parallel = n_0 = 1$). The modified vacuum refraction index measured perpendicular to the plates is (Scharnhorst, 1990):

$$n_\perp = \left(1-\frac{11}{2^6\bullet(45)^2}\frac{e^4}{(m_e a)^4}\right) < 1 \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1) \qquad (2.14).$$

Equations (2.13) and (2.14) show that in general $n_\perp < 1$ and $c_\perp^{\ *} > c_0$. But $c_\perp^{\ *} \to c_0$ and $n_\perp \to 1$ when $a \to \infty$ as expected, since we are now allowing all of the vacuum ZPE modes to re-enter the Casimir cavity in this case.

We now survey the additional examples of modified vacuums which increase/decrease light speed (from Latorre et al., 1995):

- For light (photons) propagating in a Friedmann-Robertson-Walker (FRW) vacuum (i.e., a homogeneous and isotropic Robertson-Walker gravitational background with Friedmann cosmology):

$$\frac{c^*}{c_0} = \left(1+\frac{11}{45}\alpha G\frac{\rho_r + p}{m_e^{\ 2}}\right) > 1 \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1) \qquad (2.15),$$

where c^* is the modified vacuum speed of light, G is Newton's constant, ρ_r is the energy density and p is the pressure of a radiation-dominated universe ($p = \rho_r/3$). Here the speed of light is increased.

- For light (photons) propagating in a homogeneous and isotropic thermal vacuum:

$$\frac{c^*}{c_0} = \left(1-\frac{44\pi^2}{2025}\alpha^2\frac{T^4}{m_e^{\ 4}}\right) < 1 \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = k_B = 1) \qquad (2.16),$$

where T is the temperature of the vacuum and k_B is the Boltzmann constant. Here the speed of light is decreased.

- For light (photons) propagating in an anisotropic vacuum given by an external constant uniform magnetic field $\boldsymbol{B}$:

$$\frac{c_{\parallel}^{*}}{c_0} = \left(1 - \frac{8}{45}\alpha^2 \frac{\mathbf{B}^2}{m_e^{\,4}} \sin^2\theta\right) < 1 \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1)$$
$$\frac{c_{\perp}^{*}}{c_0} = \left(1 - \frac{14}{45}\alpha^2 \frac{\mathbf{B}^2}{m_e^{\,4}} \sin^2\theta\right) < 1 \qquad (2.17),$$

where the speed of light is decreased in this vacuum for polarizations coplanar (||) with and perpendicular (⊥) to the plane defined by $\boldsymbol{B}$ and the direction of propagation, and θ is the angle between $\boldsymbol{B}$ and the direction of propagation. Latorre et al. (1995) calculated the polarization-average of (2.17) to give the averaged (modified) speed of light in the B-field:

$$\frac{c^*}{c_0} = \left(1 - \frac{22}{135}\alpha^2 \frac{\mathbf{B}^2}{m_e^{\,4}}\right) < 1 \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1) \quad (2.18).$$

- For light (photons) propagating in an anisotropic vacuum given by an external constant uniform electric field $\boldsymbol{E}$, the polarization-averaged modified speed of light is:

$$\frac{c^*}{c_0} = \left(1 - \frac{22}{135}\alpha^2 \frac{\mathbf{E}^2}{m_e^{\,4}}\right) < 1 \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1) \qquad (2.19).$$

Here the speed of light is decreased.

Equations (2.16) – (2.19) are the result of vacuum modifications that populate the vacuum with virtual or real particles that induce coherent (light-by-light) scattering, which reduces the speed of massless particles. By examining the form of equations (2.13) and (2.15) – (2.19) Latorre et al. (1995) discovered that the low energy modification of the speed of light is proportional to the ratio of the modified vacuum energy density (as compared to the standard vacuum energy density, $\rho_{vac} = 0$) over m_e^4, with a universal numerical coefficient and the corresponding coupling constants. And a general rule became apparent from their analysis that is applicable to modified vacua for massive and massless quantum field theories, for low energy:

$c^* > c_0$ (vacuum refraction index < 1) when the modified vacuum has a lower energy density
$c^* < c_0$ (vacuum refraction index > 1) when the modified vacuum has a higher energy density
$c^* = c_0$ (vacuum refraction index = 1) when the vacuum is free (or un-modified) with $\rho_{vac} = 0$

The first two rules explain the sign of the change of the speed of light. From this rule and the mathematical commonality between the form of (2.13) and (2.15) – (2.19) Latorre et al. (1995) found a single unifying expression to replace these equations:

$$\frac{c^*}{c_0} = 1 - \frac{44}{135}\alpha^2 \frac{\rho}{m_e^{\,4}} \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1) \qquad (2.20),$$

where ρ is the energy density of the modified vacua under consideration such that $\rho \to \rho_E \sim \boldsymbol{E}^2$ for the electric field vacuum, $\rho \to \rho_B \sim \boldsymbol{B}^2$ for the magnetic field vacuum, and $\rho \to \rho_T \sim \pi^2 T^4$ for the thermal vacuum. If the vacuum is a FRW gravitational vacuum, then one has to substitute one factor of α in (2.20) by $-m_e^2 G$ and $\rho \to \rho_r$. Equation (2.13) for the Casimir Effect vacuum studied earlier is recovered when $\rho \to \rho_{Casimir} = -(\pi^2/240)a^{-4}$.

Let us recast (2.20) into a more useful form. We subtract one from both sides of (2.20), do some algebra, and thus define the ratio of the change in the speed of light Δc in a modified vacuum to the speed of light in free space c_0:

$$\frac{c^*}{c_0} - 1 = \frac{c^* - c_0}{c_0} \equiv \frac{\Delta c}{c_0}$$

$$\frac{\Delta c}{c_0} = -\frac{44}{135}\alpha^2 \frac{\rho}{m_e^{\,4}} \qquad (\hbar = c_0 = \varepsilon_0 = \mu_0 = 1) \quad (2.21).$$

Equations (2.20) and (2.21) are in quantum field theory natural units, which is completely undesirable for estimating physically measurable values of $\Delta c/c_0$. We thus transform or "unwrap" (2.20) and (2.21) back into MKS or CGS units by making the following substitutions (Puthoff, 2003)

$$\rho \text{ (natural units)} \to \frac{\rho}{\hbar c} \text{ (MKS or CGS units)}$$

$$m_e \text{ (natural units)} \to \frac{m_e c}{\hbar} \text{ (MKS or CGS units)},$$

and after some algebra and rearranging we arrive at the final result:

$$\frac{c^*}{c_0} = 1 - \frac{44}{135}\alpha^2 \frac{\rho}{m_e c_0^{\,2}} \left(\frac{\hbar}{m_e c_0} \right)^3 \qquad (2.22)$$

and

$$\frac{\Delta c}{c_0} = -\frac{44}{135}\alpha^2 \frac{\rho}{m_e c_0^{\,2}} \left(\frac{\hbar}{m_e c_0} \right)^3 \qquad (2.23),$$

where all quantities are now in MKS or CGS units. We chose the former units so that $c_0 = 3\times10^8$ m/s, $\hbar = 1.055\times10^{-34}$ J-s, $m_e = 9.11\times10^{-31}$ kg, and $\alpha = 1/137$. Note that the ratio of the modified vacuum energy density to the electron rest-mass energy has the dimension of (*volume*)$^{-1}$ while the quantity in the bracket is the cubed Compton wavelength of the electron having the dimension of (*volume*), and the product of these is dimensionless.

An excellent example for estimating the magnitude of the change in the speed of light (in a modified vacuum) is the Casimir Effect vacuum, since Casimir Effect experiments are common and widespread such that this would be ideal to experimentally test (2.23). We substitute the Casimir vacuum energy density $\rho_{Casimir} = -(\pi^2 \hbar c_0/240)a^{-4}$ (in MKS units) into (2.23), do the algebra, insert the MKS values for the physical constants, and make further simplifications to get:

$$\frac{\Delta c}{c_0} = -\frac{44}{135}\alpha^2\left(-\frac{\pi^2}{240}\frac{\hbar c_0}{a^4}\right)\frac{1}{m_e c_0^{\,2}}\left(\frac{\hbar}{m_e c_0}\right)^3$$
$$= \frac{11}{8100}\alpha^2\pi^2\left(\frac{\hbar}{m_e c_0 a}\right)^4 \qquad (2.24),$$
$$\approx \left(1.59\times 10^{-56}\right)a^{-4}$$

where a (the plate separation) is in meters. Another useful equation is:

$$c^* = \left(1+\frac{\Delta c}{c_0}\right)c_0 \qquad (2.25),$$

where we make the substitution $c^* \rightarrow c_\perp^*$ for the present case. H. E. Puthoff and the author (Puthoff, 2003) compared the third line in (2.24) with equation (26) in Scharnhorst (1990) and discovered that the result cited there is in error, because the numerical coefficient is four orders of magnitude too small (Scharnhorst originally pointed out this error to Forward, 1996).

We now set $a = 10^{-6}$ m (1 μm) and we get $\Delta c/c_0 \approx 10^{-32}$ and $c_\perp^* \approx c_0$, which is a horrifically small 1 part in 10^{32} change that we cannot hope to measure at present. But for $a = 10^{-10}$ m (1 Å) we get $\Delta c/c_0 \approx 10^{-16}$ and $c_\perp^* \approx c_0$, which is a 1 part in 10^{16} change that could be measurable at present or in the very near future using high precision laser technology. Last, for $a = 1.1229\times 10^{-14}$ m (11.229 fm or ≈ 11 times the nuclear diameter; 1 fm = 10^{-15} m) we find that $\Delta c/c_0 \approx 1$ and $c_\perp^* \approx 2c_0$. We are not able to do technical work at nuclear distances at this time; however, that could change as ultrahigh precision measurement technology continues to evolve. The threshold for the onset of significant changes in light speed occurs when $a < 10^{-12}$ m. This result is generally true for the other modified vacua surveyed in (2.15) – (2.19), since accessible (everyday) values for electric and magnetic field strengths, thermal temperatures and radiation densities are not large enough to overcome the size of the electron mass to create a measurable effect. However, there is a class of ultrahigh intensity tabletop lasers that have achieved such extreme electric and magnetic field strengths and temperatures that it may now be possible to consider using them to explore vacuum modification effects in the lab. We will return to this theme in a later section.

•**Key Point**: As disappointing as the Casimir Effect vacuum (and other modified vacua) results are, it should be strongly pointed out that special relativity theory says that if in one inertial reference frame an object travels only one part in 10^{16} (or even one part in 10^{32}) times faster than c_0, then one can find another reference frame where departure and arrival times of the object are simultaneous, and thus the velocity is ***infinite***. This is what motivates us to look at a teleportation mechanism based on engineering of the vacuum.

•**Technical Notes**:

- Equation (2.15) is interpreted as an increase in the speed of light due to a decrease in the number of vacuum ZPE modes. However, this effect is totally unrelated to light-by-light scattering in the vacuum because the gravitational background "squeezes" (as in squeezed quantum optics states; see Davis, 1999a) the ZPE modes, therefore reducing the vacuum energy density. We further note that the coefficient of 11 is the same for the gravitational vacuum as for the other modified vacua examples based on QED. This factor also appears in the coefficient of the Euler-Poincare characteristic spin-½ contribution to the gravitational trace anomaly (Birrell and Davies, 1982). It is beyond the scope of this study to consider the deep connections between quantum field theory and gravitation.

- We have excluded from our survey the Latorre et al. (1995) results pertaining to all other (high or low energy) modifications of the speed of massless particles. That is because the other examples invoked different QED theories possessing massless ($m_e = 0$), massive and intrinsic mass scales that introduced complex correction terms (beyond the leading low energy terms surveyed above) which are mass-related or running mass-related, and they introduced no new speed modification effects (beyond the low energy electron-positron virtual pair contributions); or no genuine speed modification was possible (especially for the massless Quantum Chromodynamic sector involving pseudo-Goldstone particles).

- There is ongoing (very noisy) controversy within the physics community over the effects of $c^* > c_0$ on causality. As this topic is beyond the scope of this study, I will make three points in this regard: 1) There are no grounds for microcausality violations in accordance with Drummond and Hathrell (1980). 2) A new definition of causality is in order for FTL (faster-than-light) phenomena. 3) Investigators have found that time machines (a.k.a. closed timelike curves) do not affect Gauss's theorem, and thus do not affect the derivation of global conservation laws from differential ones (Friedman et al., 1990). The standard conservation laws remain globally valid while retaining a natural quasi-local interpretation for spacetimes possessing time machines (for example, asymptotically flat wormhole spacetimes). Thorne (1993) states that it may turn out that causality is violated at the macroscopic scale. Even if causality is obeyed macroscopically, then quantum gravity might offer finite probability amplitudes for microscopic spacetime histories possessing time machines. Li and Gott (1998) found a self-consistent vacuum for quantum fields in Misner space (a simple flat space with closed timelike curves), for which the renormalized stress-energy tensor is regular (in fact zero) everywhere. This implies that closed timelike curves could exist at least at the level of semi-classical quantum gravity theory. Therefore, FTL causality paradoxes are just a reflection of our ignorance or inadequate comprehension of the physics of chronology and causality.

In this section we have shown how "vacuum engineering" can modify the speed of light, and how this can, in principle, lead to vm-Teleportation. The vacuum modification concepts summarized above lead us to a formal theory that implements the concept of vacuum engineering within a framework that parallels general relativity theory. This theory is called the Polarizable-Vacuum Representation of General Relativity. In the next section we will introduce and summarize this theory.

2.2.1 The Polarizable-Vacuum Representation of General Relativity

The polarizable-vacuum representation of general relativity (a.k.a. PV-GR) treats the vacuum as a polarizable medium of variable refractive index (Puthoff, 1999a, 2002a, b; Puthoff et al., 2002) exemplifying the concept of the vacuum modification (or vacuum engineering) effects surveyed and discussed in the previous section. The PV-GR approach treats spacetime metric changes in terms of equivalent changes in the vacuum permittivity and permeability constants (ε_0 and μ_0), essentially along the lines of the "*TH*εμ" methodology (see Appendix B for a brief description of this) used in comparative studies of alternative metric theories of gravity (Lightman and Lee, 1973; Will, 1974, 1989, 1993; Haugan and Will, 1977). Such an approach, relying as it does on parameters familiar to engineers, can be considered a "metric engineering" approach. Maxwell's equations in curved space are treated in the isomorphism of a polarizable medium of variable refractive index in flat space (Volkov et al., 1971); the bending of a light ray near a massive body is modeled as due to an induced spatial variation in the refractive index of the vacuum near the body; the reduction in the velocity of light in a gravitational potential is represented by an effective increase in the refractive index of the vacuum, and so forth. This optical-engineering approach has been shown to be quite general (de Felice, 1971; Evans et al., 1996a, b).

As recently elaborated by Puthoff (1999a, 2002a, b; Puthoff et al., 2002) the PV-GR approach, which was first introduced by Wilson (1921) and then developed by Dicke (1957, 1961), can be carried out in a self-consistent way so as to reproduce to appropriate order both the equations of general relativity and the match to the standard astrophysics weak-field experimental (PPN parameters and other) tests of those equations while posing testable modifications for strong-field conditions. It is in application that the PV-GR approach demonstrates its intuitive appeal and provides additional insight into what is meant by a curved spacetime metric.

Specifically, the PV-GR approach treats such measures as the speed of light, the length of rulers (atomic bond lengths), the frequency of clocks, particle masses, and so forth, in terms of a variable vacuum dielectric constant K in which the vacuum permittivity ε_0 transforms as $\varepsilon_0 \rightarrow K\varepsilon_0$ and the vacuum permeability transforms as $\mu_0 \rightarrow K\mu_0$ (see also, Rucker, 1977). In a planetary or solar gravitational potential $K = exp(2GM/rc_0^2) > 1$ (M is a local mass distribution, r is the radial distance from the center of M) while $K = 1$ in "empty" or free asymptotic space (Puthoff, 1999a, 2002a, b; Puthoff et al., 2002). In the former case, the speed of light is reduced, light emitted from an atom is redshifted as compared with a remote static atom (where $K = 1$), clocks run slower, objects/rulers shrink, etc. See Table 1.

Table 1. Metric Effects in the PV-GR Model When $K > 1$ (Compared With Reference Frames at Asymptotic Infinity Where $K = 1$; adapted from Puthoff et al., 2002**)**

Variable	**Determining Equation** (subscript 0 is asymptotic value where $K = 1$)	$K > 1$ *(typical mass distribution, M)*
modified speed of light $c^*(K)$	$c^* = c_0/K$	speed of light $< c_0$
Modified mass $m(K)$	$m = m_0K^{3/2}$	effective mass increases
modified frequency $\omega(K)$	$\omega = \omega_0K^{-1/2}$	redshift toward lower frequencies
modified time interval $\Delta t(K)$	$\Delta t = \Delta t_0K^{1/2}$	clocks run slower
modified energy $E(K)$	$E = E_0K^{-1/2}$	lower energy states
Modified length $L(K)$	$L = L_0K^{-1/2}$	objects/rulers shrink
dielectric-vacuum "gravitational" forces $F(K)$	$F(K) \propto \nabla K$	attractive gravitational force

When $K = 1$ we have the condition that $c^* = c_0$ (vacuum refraction index = 1), because the vacuum is free (or un-modified, and $\rho_{vac} = 0$) in this case. When $K > 1$, as occurs in a region of space possessing a gravitational potential, then we have the condition that $c^* < c_0$ (vacuum refraction index > 1), because the modified vacuum has a higher energy density in the presence of the local mass distribution that generates the local gravitational field. This fact allows us to make a direct correspondence between the speed of light modification physics discussion in Section 2.2 and the underlying basis for the physics of the PV-GR model. Under certain conditions the spacetime metric can in principle be modified to reduce the value of K to below unity, thus allowing for faster-than-light (FTL) motion to be physically realized. In this case, the local speed of light (as measured by remote static observers) is increased, light emitted from an atom is blueshifted as compared with a remote static atom, objects/rulers expand, clocks run faster, etc. See Table 2. We therefore have the condition that $c^* > c_0$ (vacuum refraction index < 1) because the modified vacuum has a lower energy density. In fact, Puthoff (1999a, 2002a) has analyzed certain special

black hole metrics and found $K < 1$ from the model. We will return to this theme later. In what follows we briefly review and summarize the key points and equations from the development of the PV-GR model, and we refer the reader to Puthoff (1999a, 2002a, b) for more extensive discussion and derivations.

Table 2. Metric Effects in the PV-GR Model When $K < 1$ (Compared With Reference Frames at Asymptotic Infinity Where $K = 1$; adapted from Puthoff et al., 2002**)**

Variable	**Determining Equation** (subscript 0 is asymptotic value where $K = 1$)	$K < 1$ *(typical mass distribution, M)*
modified speed of light $c^*(K)$	$c^* = c_0/K$	speed of light > c_0
modified mass $m(K)$	$m = m_0 K^{3/2}$	effective mass decreases
modified frequency $\omega(K)$	$\omega = \omega_0 K^{-1/2}$	blueshift toward higher frequencies
modified time interval $\Delta t(K)$	$\Delta t = \Delta t_0 K^{1/2}$	clocks run faster
modified energy $E(K)$	$E = E_0 K^{-1/2}$	higher energy states
modified length $L(K)$	$L = L_0 K^{-1/2}$	objects/rulers expand
dielectric-vacuum "gravitational" forces $F(K)$	$F(K) \propto \nabla K$	repulsive gravitational force

We begin by recalling that in flat space electrodynamics, the electric flux vector ***D*** in a linear, homogeneous medium can be written

$$\begin{aligned} \mathbf{D} &= \varepsilon \mathbf{E} \\ &= \varepsilon_0 \mathbf{E} + \mathbf{P} \\ &= \varepsilon_0 \mathbf{E} + \alpha_V \mathbf{E} \end{aligned} \qquad (2.26),$$

where ε is the permittivity of the medium, the polarization ***P*** corresponds to the induced dipole moment per unit volume in the medium whose polarizability per unit volume is α_V, and ***E*** is the electric field. The identical form of the last two terms naturally leads to the interpretation of ε_0 as the polarizability per unit volume of the vacuum. The quantum picture of the vacuum, where it has been shown that the vacuum acts as a polarizable medium by virtue of induced dipole moments resulting from the excitation of virtual electron-positron particle pairs (Heitler, 1954), completely justifies the interpretation that the vacuum is a medium. Note that there are other virtual particle pairs in the vacuum that also contribute to this picture; however, it is the electron-positron pairs that dominate the others, as shown in Section 2.2. The basic postulate of the PV-GR model for curved space conditions is that the polarizability of the vacuum in the vicinity of localized mass-energy distributions differs from its asymptotic free space value by virtue of vacuum polarization effects induced by the presence of the local mass-energy. Thus the postulate for the vacuum itself is

$$\begin{aligned} \mathbf{D} &= \varepsilon \mathbf{E} \\ &\equiv K \varepsilon_0 \mathbf{E} \end{aligned} \qquad (2.27),$$

where K (a function of position) is the modified dielectric constant of the vacuum due to the induced vacuum polarizability changes under consideration. Equation (2.27) defines the transformation $\varepsilon = K\varepsilon_0$.

Table 1 shows the various quantitative effects a polarizable vacuum (in the presence of positive mass-energy distributions) has on the various measurement processes important to general relativity. The effects demonstrated in the middle and right columns demonstrate the basis of the polarizable vacuum approach to general relativity. Table 2 shows what effects are manifested when negative mass-energy distributions induce vacuum polarizability changes that lead to FTL phenomenon. Experimental observations impose constraints on the model causing key physical constants to remain constant even with variable polarizability present in the local space. Puthoff (1999a, 2002a, b) has shown that the fine structure constant is constrained by observational data to remain constant within a variable polarizable vacuum, and this constraint actually defines the transformation $\mu = K\mu_0$. The elementary particle charge e is also taken to be constant in a variable polarizable vacuum because of charge conservation. And $\hbar$ remains a constant by conservation of angular momentum for circularly polarized photons propagating through the (variable polarizability) vacuum. The remaining constant of nature is the speed of light, and although the tables showed how this was modified in variable polarizability vacuums, it is interesting to see how this modification comes about. In a modified (variable polarizability) vacuum the speed of light is defined, as it is in standard electrodynamics, in terms of the permittivity and permeability by:

$$\begin{aligned} c^* &\equiv (\varepsilon\mu)^{-1/2} \\ &= (K\varepsilon_0 \bullet K\mu_0)^{-1/2} \\ &= (K^2\varepsilon_0\mu_0)^{-1/2} \qquad (2.28), \\ &= \frac{1}{K}(\varepsilon_0\mu_0)^{-1/2} \\ &= \frac{c_0}{K} \end{aligned}$$

where the permittivity/permeability transformations and the free space (un-modified vacuum) definition for c_0 were inserted. Note that (2.28) can be re-written as $c^*/c_0 = 1/K$, and this is to be compared with (2.22). Thus we see from (2.28), and by comparison with (2.22), that K plays the role of a variable refractive index under conditions in which the vacuum polarizability is assumed to change in response to general relativistic-type influences. One further note of interest is that the permittivity/permeability transformations also maintains constant the ratio

$$\sqrt{\frac{\mu}{\varepsilon}} = \sqrt{\frac{\mu_0}{\varepsilon_0}},$$

which is the impedance of free space. This constant ratio is required to keep electric-to-magnetic energy ratios constant during adiabatic movement of atoms from one position in space to another of differing vacuum polarizability (Dicke, 1957, 1961). And this constant ratio is also a necessary condition in the $TH\varepsilon\mu$ formalism for an electromagnetic test particle to fall in a gravitational field with a composition-independent acceleration (Lightman and Lee, 1973; Will, 1974, 1989, 1993; Haugan and Will, 1977).

Now we make the "crossover connection" to the standard spacetime metric tensor concept that characterizes conventional general relativity theory, as originally shown by Puthoff (1999a, 2002a, b). In flat (un-modified or free) space the standard four-dimensional infinitesimal spacetime interval ds^2 is given (in Cartesian coordinates with subscript 0) by

$$ds^2 = -c_0{}^2 dt_0{}^2 + \sum_{i=1}^{3} dx_{i0}{}^2 \qquad (2.29),$$

where $i \equiv (1 = x,\ 2 = y,\ 3 = z)$. This metric means that measuring rods and clocks are non-varying wherever one goes in spacetime to make measurements. However, this has been shown to be incorrect in general relativity theory, so the length and time transformations (between proper and coordinate values) given in the tables (middle columns) indicate that measuring rods and clocks do vary when placed in regions where $K \neq 1$. Therefore, we replace the time and space differentials in (2.29) with the length and time transformations in the tables into (2.29), and derive the general relativistic spacetime interval

$$ds^2 = -\frac{1}{K} c_0{}^2 dt^2 + K\left(\sum_{i=1}^{3} dx_i{}^2\right) \qquad (2.30).$$

Note that observers within a $K \neq 1$ region will always measure the speed of light to be c_0. Equation (2.30) defines an isotropic coordinate system, which is a common and useful way to represent spacetime metrics in general relativity studies. By inspection the metric tensor is written

$$g_{\alpha\beta} = \begin{pmatrix} -1/K & 0 & 0 & 0 \\ 0 & K & 0 & 0 \\ 0 & 0 & K & 0 \\ 0 & 0 & 0 & K \end{pmatrix} \qquad (2.31).$$

The Lagrangian density for matter-field interactions in a vacuum of variable K is given by Puthoff (1999a, 2002a, b) as

$$\begin{aligned} L_d = &-\left[\frac{m_0 c_0{}^2}{\sqrt{K}}\sqrt{1-\left(\frac{v}{c_0/K}\right)^2} + q\Phi - qA_i v^i\right]\delta^3(\mathbf{r}-\mathbf{r}_0) \\ &-\frac{1}{2}\left(\frac{\mathbf{B}^2}{K\mu_0} - K\varepsilon_0\mathbf{E}^2\right) - \frac{c_0{}^4}{32\pi G}\frac{1}{K^2}\left[(\nabla K)^2 - \frac{1}{(c_0/K)^2}\left(\frac{\partial K}{\partial t}\right)^2\right] \end{aligned} \qquad (2.32),$$

where the first term is the Lagrangian density for a free particle of mass m_0, charge q and 3-vector velocity $\boldsymbol{v}$ ($v = |\boldsymbol{v}|$, 3-vector components are labeled by i) interacting with electromagnetic fields via the electromagnetic field 4-vector potential $\boldsymbol{A}_\mu = (\Phi, A_i)$ (note that $\delta^3(\mathbf{r} - \mathbf{r}_0)$ is the delta function that locates the point particle at position $\mathbf{r} = \mathbf{r}_0$); the second term is the Lagrangian density for the electromagnetic fields themselves, and the last term is the Lagrangian density for K (treated here as a scalar variable). This last term emulates the Lagrangian density for the gravitational field. Equation (2.32) does not include any quantum gauge field interaction terms because it is beyond the scope of the present incarnation of the PV-GR approach to include them. We can obtain the equations of particle motion in a variable dielectric vacuum by performing the standard variations of the Lagrangian density $\delta(\int L_d\, dx\, dy\, dz\, dt)$ with respect to the particle variables. However, we are more interested in obtaining the "master equation" for K by varying the Lagrangian density with respect to K, and Puthoff (1999a, 2002a, b) gives the result:

$$\nabla^2\sqrt{K}-\frac{1}{\left(c_0/K\right)^2}\frac{\partial^2\sqrt{K}}{\partial t^2}$$

$$=-\frac{8\pi G}{c_0^{\,4}}\sqrt{K}\left\{\frac{\left(m_0c_0^{\,2}/\sqrt{K}\right)}{\sqrt{1-\left(\frac{v}{c_0/K}\right)^2}}\frac{1}{2}\left[1+\left(\frac{v}{c_0/K}\right)^2\right]\delta^3(\mathbf{r}-\mathbf{r}_0)\right. \qquad (2.33).$$

$$\left.+\frac{1}{2}\left(\frac{\mathbf{B}^2}{K\mu_0}+K\varepsilon_0\mathbf{E}^2\right)-\frac{c_0^{\,4}}{32\pi G}\frac{1}{K^2}\left[(\nabla K)^2+\frac{1}{\left(c_0/K\right)^2}\left(\frac{\partial K}{\partial t}\right)^2\right]\right\}$$

This equation describes the generation of general relativistic vacuum polarization effects due to the presence of matter and fields. By inspecting the right-hand side of the equation, we observe that changes in K are driven by the mass density (1st term), electromagnetic energy density (2nd term), and the vacuum polarization energy density itself (3rd term). In fact, the 3rd term emulates the gravitational field self-energy density. Note that the 2nd and 3rd terms in (2.33) appear with opposite signs with the result that electromagnetic field effects can counteract the gravitational field effects. Puthoff found that (2.33) gives the solution $K = exp(2GM/rc_0^2)$ in the vicinity of a static spherically symmetric (uncharged) mass M (in the low velocity limit $v << c_0$, $\partial K/\partial t = 0$, $\boldsymbol{E} = \boldsymbol{B} = 0$, $q = 0$), which reproduces to appropriate order the standard general relativistic Schwarzschild spacetime metric for the weak gravitational field conditions prevailing in the solar system. This solution guarantees that $K > 1$ near mass concentrations.

Of major importance to the present study are solutions giving $K < 1$ so that teleportation can be realized. Puthoff has found one such solution by studying the case of a static spherically symmetric mass M with charge Q familiar from the study of the Reissner-Nordstrφm spacetime metric. In this case Puthoff found the result

$$K=\left[\cos\left(\frac{\sqrt{b^2-a^2}}{r}\right)+\frac{a}{\sqrt{b^2-a^2}}\sin\left(\frac{\sqrt{b^2-a^2}}{r}\right)\right]^2 \qquad \left(b^2>a^2\right) \qquad (2.34),$$

where $a^2 = (GM/c_0^2)^2$, $b^2 = Q^2G/4\pi\varepsilon_0c_0^4$, and r is the radial distance from the center of M. And in this case (2.34) gives $K < 1$, which shows that FTL solutions are available in the PV-GR approach (as they are also in the Einstein theory). (For $a^2 > b^2$ the solution is hyperbolic-trigonometric and describes the standard Reissner-Nordstrφm metric where $K > 1$.)

Generally speaking, in Einstein general relativity the Reissner-Nordstrφm metric can be manipulated along with two shells of electrically charged matter to form a traversable wormhole (Schein and Aichelburg, 1996). But there are two drawbacks to this. The first is that the scheme involves dealing with the collapsed state of the stellar matter that generates the metric (a.k.a. Reissner-Nordstrφm black hole) along with the unpleasant side effects that are encountered, such as the crushing singularities and multiple (unstable) event horizons. Second, the traversable wormhole is an eternal time machine connecting remote regions of the same universe together. Now there are no black hole solutions found in the PV-GR model because in that approach stellar matter collapses smoothly to an ultra-dense state and without the creation of singularities and event horizons (Puthoff, 1999b).

In either case, the Reissner-Nordstrφm metric does not offer a viable mechanism for vm-Teleportation. We are more interested in examining other PV-GR cases (where $K < 1$ or even $K << 1$)

that emulate the effects of traversable wormhole metrics that do obey the vm-Teleportation definition, such as the example presented in Section 2.1. Equation (2.33) suggests that we search for a vacuum engineering concept that exploits electromagnetic fields to alter the vacuum dielectric constant K to induce the desired vm-Teleportation effect in the modified vacuum. (However, we can insert other source terms that will lead to the desired result.) We envision this particular teleportation concept to resemble Figure 2. [Note: Before this report went to press H. E. Puthoff, C. Maccone and the author discovered a number of $K < 1$ solutions to equation (2.33) that uniquely meet the definition of vm-Teleportation and FTL motion. We discovered that the generic energy density required to generate $K < 1$ solutions must be negative, and that the total energy density of the system as seen by remote observes is approximately zero. This unique result compares very well with the traversable wormhole mass-energy density requirements discussed in Section 2.1.2. This discovery will be the subject of a forthcoming paper.]

2.3 Conclusion and Recommendations

The concept we envision for vm-Teleportation is that animate or inanimate objects would be placed inside an environmentally enclosed vessel that would simply be moved into the teleportation device. The "teleporter" would be activated, and the vessel would almost immediately disappear and then reappear at the remote destination as if it were briefly moving through a portal or "stargate." The teleportation device might be required to operate in the vacuum of space outside of the Earth's atmosphere. We have shown two practically equivalent ways to implement vm-Teleportation. There is the manipulation of spacetime geometry via exploiting negative (i.e., quantum vacuum zero point) energy as shown by Einstein's general relativity theory, and there is the modification of the vacuum dielectric constant as shown by the PV-GR model. Both have a great deal of theoretical foundation to begin exploring experimentally. The PV-GR model needs additional theoretical work for the present application, but it is now mature enough for experimental exploration.

There already is extensive theoretical, and more importantly, experimental research proving that the vacuum can be engineered (or physically modified) so that the vacuum ZPE can be exploited (via the Casimir Effect, for example) to extract electrical energy or actuate microelectromechanical devices (see for example, Ambjφrn and Wolfram, 1983; Forward, 1984, 1996, 1998; Puthoff, 1990, 1993; Cole and Puthoff, 1993; Milonni, 1994; Mead and Nachamkin, 1996; Lamoreaux, 1997; Chan et al., 2001, and the references cited therein). But most of this research involves very low energy density regimes, which are much too low for our purposes. The Mead and Nachamkin (1996) device is actually designed to extract electrical energy from the higher frequency/higher energy density ZPE modes. However, new ultrahigh-intensity lasers became available in the 1990s that have achieved extreme physical conditions in the lab that are comparable to the extreme astrophysical conditions expected to be found in stellar cores and on black hole event horizons (Perry, 1996; Mourou et al., 1998; Perry, 2000). The power intensity of these lasers has reached the point to where they actually probe QED vacuum physics and general relativistic physics, and they have even modified the vacuum itself. The lasers were originally called petaWatt lasers (operating range of $10^{14} - 10^{18}$ Watts/cm^2 at femtosecond pulses), but they have now reached power intensity levels in the $10^{25} - 10^{30}$ Watts/cm^2 range. The lasers were made possible by a novel breakthrough called "chirped pulse amplification" whereby the initial low energy/low power intensity laser beam is stretched, amplified and then compressed without experiencing any beam distortions or amplifier damage. This laser system was initially designed as a large-optics beam-line power booster for the NOVA laser fusion experiment at Lawrence Livermore National Laboratory. But researchers found a way to shrink the optics down to tabletop scale, and one can now own and operate a tabletop ultrahigh-intensity laser for ≈ $500,000. The dimensions of the optical bench used by the University of California-San Diego is ≈ 5 m × 12 m (or ≈ 60 m^2; see Mourou et al., 1998). In tabletop lab experiments ultrahigh-intensity lasers have generated >> gigagauss magnetic fields, ≥ 10^{16} Volt/cm electric field strengths, >> terabar light pressures and >> 10^{22} m/sec^2 subatomic particle accelerations. These ultrahigh-intensity

tabletop lasers are thus the ideal instrument with which to explore the fundamental physics underlying the two possible concepts for vm-Teleportation.

There are several ideas on how to generate negative energy in the lab that could potentially be extracted and concentrated in the proper fashion to induce the traversable flat-face wormhole outlined in Section 2.1.1 or induce the $K < 1$ condition (in the PV-GR model) outlined in Section 2.2.1. The schemes for generating negative energy are:

- Casimir Effect (described in Section 2.2): This is the easiest and most well known way to generate negative energy in the lab. The energy density $\rho_{\text{Casimir}} = -(\pi^2\hbar c_0/240)a^{-4}$ within a Casimir capacitor cavity is negative and manifests itself by producing a force of attraction between the capacitor plates. This has been measured in the lab (see above references). Forward (1998) proposes a mechanism for the endless extraction of energy from the vacuum in a Casimir cavity by cyclic manipulation of the cavity dimensions.

- Moving Mirror: Negative quantum vacuum energy can be created by a single moving reflecting surface (a moving mirror). If a mirror moves with increasing acceleration, then a flux of negative energy emanates from its surface and flows out into the space ahead of the mirror (Birrell and Davies, 1982). However, this effect is known to be exceedingly small, and it is not the most effective way to generate negative energy.

- Optically Squeezed Laser Light: Negative quantum vacuum energy can also be generated by an array of ultrahigh intensity lasers with an ultrafast rotating mirror system. In this scheme a laser beam is passed through an optical cavity resonator made of lithium niobate crystal that is shaped like a cylinder with rounded silvered ends to reflect light. The resonator will act to produce a secondary lower frequency light beam in which the pattern of photons is rearranged into pairs. This is the quantum optical "squeezing" of light effect. (See Section A.2 in Appendix A for a complete definition and description of squeezed quantum states.) Therefore, the squeezed light beam emerging from the resonator will contain pulses of negative energy interspersed with pulses of positive energy. Another way to squeeze light would be to manufacture extremely reliable light pulses containing precisely one, two, three, etc. photons apiece and combine them together to create squeezed states to order. Superimposing many such states could theoretically produce bursts of intense negative energy. For the laser beam resonator example we find that both negative and positive energy pulses are of $\approx 10^{-15}$ second duration. We could arrange a set of rapidly rotating mirrors to separate the positive and negative energy pulses from each other. The light beam is to strike each mirror surface at a very shallow angle while the rotation ensures that the negative energy pulses are reflected at a slightly different angle from the positive energy pulses. A small spatial separation of the two different energy pulses will occur at some distance from the rotating mirror. Another system of mirrors will be needed to redirect the negative energy pulses to an isolated location and concentrate them there.

- Gravitationally Squeezed Vacuum Energy: A natural source of negative quantum vacuum energy comes from the effect that gravitational fields (of astronomical bodies) in space have upon the surrounding vacuum. For example, the gravitational field of the Earth produces a zone of negative energy around it by dragging some of the virtual particle pairs (a.k.a. virtual photons or vacuum ZPF) downward. This concept was initially developed in the 1970s as a byproduct of studies on quantum field theory in curved space (Birrell and Davies, 1982). However, Hochberg and Kephart (1991) derived an important application of this concept to the problem of creating and stabilizing traversable wormholes, and their work was corrected and extended by Davis (1999a). They proved that one can utilize the negative vacuum energy densities, which arise from *distortion of the electromagnetic zero point fluctuations* due to the interaction with a prescribed gravitational background, for providing a violation of the energy conditions (see

Section A.1 in Appendix A). Hochberg and Kephart (1991) showed that the squeezed quantum states of quantum optics provide a natural form of matter having negative energy density. And since the vacuum is defined to have vanishing energy density, anything possessing less energy density than the vacuum must have a negative energy density. The analysis, via quantum optics, shows that gravitation itself provides the mechanism for generating the squeezed vacuum states needed to support stable traversable wormholes. The production of negative energy densities via a squeezed vacuum is a necessary and unavoidable consequence of the interaction or coupling between ordinary matter and gravity, and this defines what is meant by gravitationally squeezed vacuum states. The magnitude of the gravitational squeezing of the vacuum can be estimated from the squeezing condition, which simply states that substantial gravitational squeezing of the vacuum occurs for those quantum electromagnetic field modes with *wavelength* (λ in meters) > *Schwarzschild radius* (r_S in meters) of the mass in question (whose gravitational field is squeezing the vacuum). The Schwarzschild radius is the critical radius, according to general relativity theory, at which a spherically symmetric massive body becomes a black hole; i.e., at which light is unable to escape from the body's surface. We can actually choose any radial distance from the mass in question to perform this analysis, but using the Schwarzschild radius makes equations simpler in form. The general result of the gravitational squeezing effect is that as the gravitational field strength increases the negative energy zone (surrounding the mass) also increases in strength. Table 3 shows when gravitational squeezing becomes important for example masses. The table shows that in the case of the Earth, Jupiter and the Sun, this squeeze effect is extremely feeble because only ZPF mode wavelengths above 0.2 m – 78 km are affected. For a solar mass black hole (radius of 2.95 km), the effect is still feeble because only ZPF mode wavelengths above 78 km are affected. But note from the table that quantum black holes with Planck mass will have enormously strong negative energy surrounding them because all ZPF mode wavelengths above 8.50×10^{-34} meter will be squeezed; in other words, all wavelengths of interest for vacuum fluctuations. Black holes with proton mass will have the strongest negative energy zone in comparison because the squeezing effect includes all ZPF mode wavelengths above 6.50×10^{-53} meter. Furthermore, a black hole smaller than a nuclear diameter ($\approx 10^{-16}$ m) and containing the mass of a mountain ($\approx 10^{11}$ kg) would possess a fairly strong negative energy zone because all ZPF mode wavelengths above 10^{-15} meter will be squeezed.

Table 3. Substantial Gravitational Squeezing Occurs When $\lambda \geq 8\pi r_S$ (For Electromagnetic ZPF; adapted from Davis, 1999a**)**

Mass of body	Schwarzschild radius of body, r_S	ZPF mode wavelength, λ
Sun = 2.0×10^{30} kg	2.95 km	$\geq$ 78 km
Jupiter = 1.9×10^{27} kg	2.82 m	$\geq$ 74 m
Earth = 5.976×10^{24} kg	8.87×10^{-3} m	$\geq$ 0.23 m
Typical mountain $\approx 10^{11}$ kg	$\approx 10^{-16}$ m	$\geq 10^{-15}$ m
Planck mass = 2.18×10^{-8} kg	3.23×10^{-35} m	$\geq 8.50 \times 10^{-34}$ m
Proton = 1.673×10^{-27} kg	2.48×10^{-54} m	$\geq 6.50 \times 10^{-53}$ m

•**<u>Recommendations</u>**:

- <u>Theoretical Program 1</u>: A one to two year theoretical study (cost ≈ $80,000) should be initiated to explore the recently discovered $K < 1$ (FTL) solutions to equation (2.33) in order to define,

characterize and model the negative energy density source(s) that induce the FTL vacuum modification. The study should also identify potential lab experiments designed to test theoretical predictions.

- Theoretical Program 2: A one to two year study (cost ≈ $80,000) should be initiated to conduct a detailed review of the negative energy generation schemes summarized above to define their characteristics, performances and requirements. The study should develop technical parameters for each of the schemes in order to identify potential lab experiments.

- Experimental Program 1: An experimental study should be conducted to test Forward's (1998) Casimir energy extraction proposal. An experiment definition study will be required to estimate the experimental method, procedure, equipment needs and costs.

- Experimental Program 2: An experimental study using ultrahigh-intensity lasers should be conducted to test the Optically Squeezed Laser Light proposal. An experiment definition study will be required to estimate the experimental method, procedure, equipment needs and costs.

- Experimental Program 3: An experimental study using ultrahigh-intensity lasers should be conducted to probe QED vacuum physics and vacuum modification as well as test elements of the PV-GR model. A starting point for this program would be to use such lasers to perform the Ding and Kaplan (1989, 1992, 2000; see also, Forward, 1996) experiment. This is an important fundamental physics experiment to do, because it can distinguish between the rival quantum vacuum electromagnetic ZPE fluctuation and fluctuating charged particle source field theory models, which would settle the acrimonious debate over whether the vacuum really fluctuates or not. R. L. Forward (1999) told the author that a Nobel Prize rides on performing this experiment and settling the issue once and for all. The Ding and Kaplan proposal is already designed to probe QED vacuum physics and vacuum modification. [The essence of the Ding and Kaplan proposal is to demonstrate that a form of photon-photon scattering predicted by QED gives rise to 2nd-harmonic generation of intense laser radiation in a DC magnetic field due to the broken symmetry of interaction (in the Feynman "box" diagram approximation). This effect is possible only when the field system (optical wave + DC field) is inhomogeneous, in particular when a Gaussian laser beam propagates in either a homogeneous or inhomogeneous DC magnetic field. In other words, a vacuum region is filled with a DC magnetic field that polarizes the virtual particle pairs (a.k.a. virtual photons) in the vacuum. This polarized vacuum then scatters incident ultrahigh-intensity laser photons of frequency ν (energy E), thereby generating outgoing photons of frequency 2ν (energy $2E$).] An experiment definition study will be required to estimate the experimental method, procedure, equipment needs and costs.

- Experimental Program 4: An experimental study using ultrahigh-intensity lasers should be conducted to establish the extreme physical conditions necessary to test the strong-field limit of general relativity with an emphasis on generating spacetime curvature and negative energy in order to induce a putative micro-wormhole. (Experimental Programs 3 and 4 could be done together to determine whether Puthoff's PV-GR theory or Einstein's general relativity theory is the correct model for nature.) A Nobel Prize is in the offing if this question were to be addressed and settled. An experiment definition study will be required to estimate the experimental method, procedure, equipment needs and costs.

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3.0 q-TELEPORTATION

3.1 Teleportation Scenario

Future space explorers and their equipment will need to easily and quickly travel from an orbiting spacecraft to the surface of some remote planet in order to get their work done, or military personnel in the United States need to easily and quickly travel from their military base to another remote location on Earth in order to participate in a military operation, or space colonists will need quick transport to get from Earth to their new home planet. Instead of using conventional transportation to expedite travel the space explorer, military personnel or space colonist and/or their equipment go into the "Teleporter" (a.k.a. "Transporter" in Star Trek lingo) and are "beamed down" or "beamed over" to their destinations at light speed. The mechanism for this teleportation process is hypothetically envisioned to be the following:

1. Animate/inanimate objects placed inside the teleporter are scanned by a computer-generated and -controlled beam.

2. The scan beam encodes the entire quantum information contained within the animate/inanimate object(s) into organized bits of information, thus forming a digital pattern of the object(s).

3. The scan beam then dematerializes the object(s) and stores its pattern in a pattern buffer, thus transforming the atomic constituents of the dematerialized object(s) into a matter stream. Alternative 1: The dematerialization process converts the atoms into a beam of pure energy. Alternative 2: The scan beam does not dematerialize the object(s).

4. The teleporter then transmits the matter/pure energy stream and quantum information signal in the form of an annular confinement beam to its destination. Alternative: Only the quantum information signal is transmitted.

5. At the receiving teleporter the matter/pure energy stream is sent into a pattern buffer whereby it is recombined with its quantum information, and the object(s) is rematerialized back into its original form. Alternative 1: The receiving teleporter recombines the transmitted quantum information with atoms stored inside a reservoir to form a copy of the original. Alternative 2: The quantum information is reorganized in such a way as to display the object on some three-dimensional (holographic) visual display system.

Problem: This generic scenario is modeled after teleportation schemes found in SciFi. There are a lot of important little details that were left out of the teleportation process because we simply do not know what they are. This technology does not yet exist. And we are left with the question of which one of the alternative processes identified in items 3 – 5 one wants to choose from. The above scenario is only an outline, and it is by no means complete since it merely serves to show what speculation exists on the subject. The above scenario describes a speculative form of what we call *q-Teleportation*.

There are questions to be addressed in the above scenario. Does the teleporter transmit the atoms and the quantum bit information signal that comprises the animate/inanimate object or just the quantum bit information signal? There are $\approx 10^{28}$ atoms of matter combined together in a complex pattern to form a human being. How does one transmit this much information and how do we disassemble that many atoms? Computer information gurus would insist that it is not the atoms that matter but only the bits of

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information representing them when considering the transmission of large "bodies" of information. But are humans simply the sum of all the atoms (and the related excited atom quantum states) that comprise them? We could possibly learn to reconstitute a beam of atoms into a chemically accurate human being. However, would this also include the reconstruction of a person's consciousness (personality, memories, hopes, dreams, etc.) and soul or spirit? This question is beyond the scope of this study to address, but it is nevertheless one of the most important concepts awaiting a complete scientific understanding.

For the teleporter to process and transmit the quantum bit information signal that encodes the animate/inanimate object's pattern will require stupendous digital computer power. For each atom comprising the object we must encode its location in space (three position coordinates), its linear and angular momentum (three vector components for each quantity), and its internal quantum state (electron orbital-energy levels and their excitation/de-excitation and ionization states, binding to other atoms to form molecules, molecular vibrational/rotational states, bound nuclei states, spin states for electrons and nuclei, etc.), etc. If we assume that we can digitally encode all of this information for a single atom with a minimum of one kilobyte (1 byte = 8 bits, 1 bit ≡ 0 or 1) of data, then we will require a minimum of 10^{28} kilobytes to encode and store an entire human being (in three-dimensions). To digitally store and access this much information at present (and for the foreseeable future) is nontrivial. It will take more than 2,400 times the present age of the universe (≈ 13 billion years) to access this amount of data using commercially available computers (operating at ≈ 10 gigabyte/sec). Top-of-the-line supercomputers will not reduce this time significantly. The computer technology needed to handle such a large data storage requirement simply does not exist. The largest commercially available computers can store ≈ 40 gigabytes on a single hard drive. We will need ≈ 10^{20} of these hard drives to store the encoded information of just one human being. Also, wire and coaxial/fiber optic cables do not have the physical capacity to transmit this amount of data between devices. These numbers will not be significantly different for macroscopic inanimate objects. The information processing and transfer technology required for the teleportation system may become possible in 200 – 300 years if improvements in computer storage and speed maintains a factor of 10 – 100 increase for every decade. There is speculation that emergent molecular, bio-molecular (DNA-based systems) and quantum computer technology may achieve the performances required for a teleportation system. In the former case molecular dynamics mimics computer logic processes and the ≈ 10^{25} particles in a macroscopic sample will all act simultaneously, making for far greater digital information processing and transfer speeds. Researchers have given no formal performance estimates for this emergent technology. In the latter case quantum computing would take advantage of entangled quantum states of subatomic matter or photons, whereby digital logic processes would occur at light speed. This technology is in its infancy, and there has been no clear direction on what performance levels will be possible in the future. This topic will be discussed further in Section 3.2.3.

In the above teleportation scenario we might consider dematerializing animate/inanimate objects into a matter stream consisting of only the object's constituent atoms or atomic subcomponents (protons, neutrons and electrons) and transmitting them at the speed of light (or close to it). To push atoms or subatomic particles to near the speed of light will require imparting to them an energy comparable to their rest-mass energy, which will be at a minimum of one order of magnitude larger than the amount of energy required to break protons up into free quarks. The energy required to completely dematerialize (or dissolve) matter into its basic quantum constituents or into pure energy is alone stupendous. At first one will have to impart to every molecule within the object an energy that is equivalent to the binding energy between atoms (atomic binding energy ~ chemical energy ~ *several* eV) in order to break apart the molecules comprising the object's macro-structure. After this an energy equivalent to nuclear binding energies (≈ *several* × 10^6 times atomic binding energy, or ≈ *several* MeV) must be imparted to every free atomic nucleus inside the object in order to break apart the protons and neutrons residing within each nucleus. And last, an energy equivalent to the binding energy that holds together the three quarks residing within each proton and neutron must be imparted to each of the free protons and neutrons within the object. According to the Standard Model and experimental data, the quark binding energy is

practically infinite. But all is not lost, because the Standard Model also predicts that if we could heat up the nuclei to ≈ 10^{13} °C (≈ 10^6 times hotter than the core temperature of the Sun, or ≈ 10^3 MeV), then the quarks inside would suddenly lose their binding energies and become massless (along with other elementary matter). This heat is also equivalent to the rest-mass energy of protons and neutrons. Therefore, to heat up and dematerialize one human being would require the annihilation of the rest mass-energy of all 10^{28} protons-neutrons or the energy equivalent of 330 1-megaton thermonuclear bombs. Compare this stupendous explosive energy with the explosive yield of the largest thermonuclear bomb ever detonated on Earth, which was a 50-megaton bomb that was built by Andrei Sakharov in the USSR and detonated on October 30, 1961; it was called "Tzar Bomba." Its first incarnation (ca. early October 1961) comprised a uranium fusion tamper, which gave an estimated explosive yield of ≈ 100 megatons. But the weapon was too heavy (27 metric tons) for a bomber to carry, so the tamper was replaced by one made of lead, which reduced both the weight and the yield. In the end we see that it is not a trivial problem to simply heat up and dematerialize any human or inanimate objects. The technology to do so does not exist unless we invoke new physics to get around the energy requirement.

Finally, we must consider the resolution and aperture of the optics required to scan and transmit the animate/inanimate object's matter (or energy) stream. The Heisenberg quantum uncertainty principle fundamentally constrains the measurement resolution of conjugate observable quantities, such as position and momentum or energy and time. The measurement of any combination of (conjugate) observables with arbitrarily high precision is not possible, because a high precision measurement of one observable leads to imprecise knowledge of the value of the conjugate observable. The quantum uncertainty principle makes it impossible to measure the exact, total quantum state of any object with certainty. The scan resolution of a teleportation system is defined by the wavelength of light used to illuminate the object's atomic/subatomic constituents and record their configurations. To resolve matter at atomic/subatomic distance scales requires that the energy of the scanner light (photons) be extremely large (according to the uncertainty principle); and during the scan this large light energy will be conveyed to the constituents, causing them to drastically change their speed and direction of motion. This means that it is physically impossible to resolve an object's atomic/subatomic particle components and their configurations with the precision necessary to accurately encode and later recreate the object being teleported. To resolve atomic/subatomic particles requires wavelengths smaller than the size of these constituents, which will typically be 1 Å – 1 fm. Such wavelengths are in the gamma ray part of the spectrum, and this becomes a major technical problem for us because at present there is no gamma ray electro-optics with which to work with. Now consider the example of teleporting an object from the surface of a planet back to its spacecraft in orbit some *several* × 10^2 – 10^3 km away. The optical aperture required to illuminate and scan an object with ≈ 1 Å – 1 fm resolution from orbit will be >> *several* × 10^2 – 10^3 km. If we are to consider teleporting an object from planet to planet or from star to star then the aperture required will be >> *several* × 10^8 – 10^{13} km. These technical problems are truly insurmountable unless totally new physics becomes available.

3.2 Quantum Teleportation

It turns out that there does in fact exist a form of teleportation that occurs in nature despite the numerous technical roadblocks described in the previous section. It is called *quantum teleportation*, which is based on the well-known concept of quantum entanglement. Erwin Schrödinger coined the word "entanglement" in 1935 in a three-part paper (Schrödinger, 1935a, b, c, 1980). These papers were prompted by the Einstein, Podolsky and Rosen (1935; denoted hereafter as EPR) paper that raised fundamental questions about quantum mechanics, whereby Einstein had loudly complained that quantum mechanics allowed physical processes resembling "spooky action at a distance" to occur. EPR recognized that quantum theory allows certain correlations to exist between two physically distant parts of a quantum system. Such correlations make it possible to predict the result of a measurement on one part of a system by looking at the distant part. On this basis, EPR argued that the distant predicted quantity

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should have a definite value even before being measured, if quantum theory is complete and respects locality (a.k.a. causality). EPR concluded that, from a classical perspective, quantum theory must be incomplete because it disallows such definite values prior to measurement. Schrödinger's perspective on this argument gives the modern view of quantum mechanics, which is to say that the wavefunction (a.k.a. quantum state vector) provides all the information there is about a quantum system. In regards to the nature of entangled quantum states, Schrödinger (1935a, b, c, 1980) stated that, "The whole is in a definite state, the parts taken individually are not." This statement defines the essence of pure-state entanglement. Schrödinger went on to give a description of quantum entanglement by introducing his famous cat experiment.

To better understand the concept of quantum entanglement/teleportation we will focus on the quantum wavefunction (a.k.a. quantum state function). Any quantum system such as a particle that possesses a position in space, energy, angular and linear momentum, and spin is completely described by a wavefunction. This is usually symbolized in a variety of ways, and we choose to represent a generic wavefunction using the traditional "bra-ket" notation of quantum mechanics: $|\varphi\rangle$. Anything that we want to know about the particle is mathematically encoded within $|\varphi\rangle$. As we discussed in the previous section the wavefunction can never be completely known because there is no measurement that can determine it completely. The only exception to this is in the special case that the wavefunction has been prepared in some particular state or some member of a known basis group of states in advance. By measuring one of the properties of a quantum system, we can get a glimpse of the overall quantum state that is encoded within $|\varphi\rangle$. According to the quantum uncertainty principle the act of doing such a measurement will destroy any ability to subsequently determine the other properties of the quantum system. So the act of measuring a particle actually destroys some of the information about its pristine state. This makes it impossible to copy particles and reproduce them elsewhere via quantum teleportation. However, it turns out that one can recreate an unmeasured quantum state in another particle as long as one is prepared to sacrifice the original particle. The trick is to exploit the EPR process to circumvent the quantum uncertainty principle.

As discussed previously, EPR discovered that a pair of spatially separated quantum sub-systems that are parts of an overall quantum system can be "entangled" in a non-local (i.e., non-causal) way. When two particles come into contact with one another, they can become "entangled." In an entangled state, both particles remain part of the same quantum system so that whatever you do to one of them affects the other one in a predictable fashion. More precisely, a measurement on one of the entangled sub-systems puts it into a particular quantum state, while instantaneously putting the sub-system with which it is entangled into a corresponding quantum state, while the two sub-systems are separated by arbitrarily large distances in spacetime (even backwards in time!). A simple example of this phenomenon is to prepare a pair of photons in the same quantum state such that they are entangled, and then allow them to fly apart to remote locations without any form of communication occurring between them along their journey. Measuring the polarization of one of the pair of entangled photons induces the other photon, which may be light-years away, into the same state of polarization as that which was measured for its entangled twin. The basic operation of quantum teleportation can be described as determining the total quantum state of some large quantum system, transmitting this state information from one place to another, and making a perfect reconstruction of the system at the new location. In principle, entangled particles can serve as "transporters" of sorts. By introducing a third "message" particle to one of the entangled particles, one could transfer its properties to the other one, without ever measuring those properties.

Historically, quantum entanglement was never reconciled with the quantum uncertainty principle and the requirement of locality (or causality) in observed physical phenomena, thus it became a paradox in quantum theory. A three-decade debate began following the appearance of the EPR paper over whether quantum entanglement (a.k.a. "spooky action at a distance") was a real quantum phenomenon or not, and this debate came to be called the "EPR dilemma." Einstein's only solution to the dilemma was to suggest that quantum mechanics was incomplete and needed a reformulation to incorporate local hidden-variables that can account for observed physical phenomena without violating causality. Bell (1964) later solved the EPR dilemma by deriving correlation inequalities that can be violated in quantum mechanics but have

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to be satisfied within every model that is local and complete. Such models are called "local hidden-variable models." Bell showed that a pair of entangled particles, which were once in contact but later moved too far apart to interact directly (i.e., causally), can exhibit individually random behavior that is too strongly correlated to be explained by classical statistics. Bell's inequalities make it possible to test whether local hidden-variable models can account for observed physical phenomena in lab experiments. Groundbreaking experimental work by Aspect et al. (1982a, b) along with further theoretical and experimental work done by others (Freedman and Clauser, 1972; Aspect, 1983; Aspect and Grangier, 1985; Hong and Mandel, 1985; Bennett and Wiesner, 1992; Tittel et al., 1998a, b; Tittel and Weihs, 2001) demonstrated violations of the Bell inequalities, which therefore invalidated the local hidden-variable models. The key result of recent theoretical and experimental work is that an observed violation of a Bell inequality demonstrates the presence of entanglement in a quantum system.

3.2.1 Description of the q-Teleportation Process

The experimental work of Bennett et al. (1993) followed by the theoretical and experimental work of others (Vaidman, 1994; Kwiat et al., 1995; Braunstein, 1996; Braunstein and Kimble, 1998; Pan et al., 1998; Stenholm and Bardroff, 1998; Zubairy, 1998; Vaidman and Yoran, 1999; Kwiat et al., 1999) made the breakthrough that was necessary to demonstrate the principle of quantum teleportation in practice. It was a remarkable technical breakthrough that settled, once and for all, the nagging question of whether quantum entanglement could be used to implement a teleportation process to transfer information between remotely distant quantum systems non-causally (i.e., at FTL speed). It is easy to describe how quantum teleportation works in greater detail. Figure 6 compares conventional facsimile transmission with the quantum teleportation process seen in Figure 7. In a conventional facsimile transmission the original document is scanned, extracting partial information about it, but it remains more or less intact after the scanning process. The scanned information is then sent to the receiving station, where it is imprinted on new paper to produce an approximate copy of the original. In quantum teleportation (Figure 7) one scans out part of the information from object A (the original), which one wants to teleport, while causing the remaining, unscanned, part of the information in A to pass, via EPR entanglement, into another object C which has never been in contact with A. Two objects B and C are prepared and brought into contact (i.e., entangled), and then separated. Object B is taken to the sending station, while object C is taken to the receiving station. At the sending station object B is scanned together with the original object A, yielding some information and totally disrupting the states of A and B. This scanned information is sent to the receiving station, where it is used to select one of several treatments to be applied to object C, thereby putting C into an exact replica of the former state of A. Object A itself is no longer in its original initial state, having been completely disrupted by the scanning process. The process just described is teleportation and not replication, and one should not confuse the two. There is a subtle, unscannable kind of information that, unlike ordinary information or material, can be delivered via EPR correlations/entanglement, such that it cannot by itself deliver a meaningful and controllable message. But quantum teleportation delivers exactly that part of the information in an object that is too delicate to be scanned out and delivered by conventional methods.

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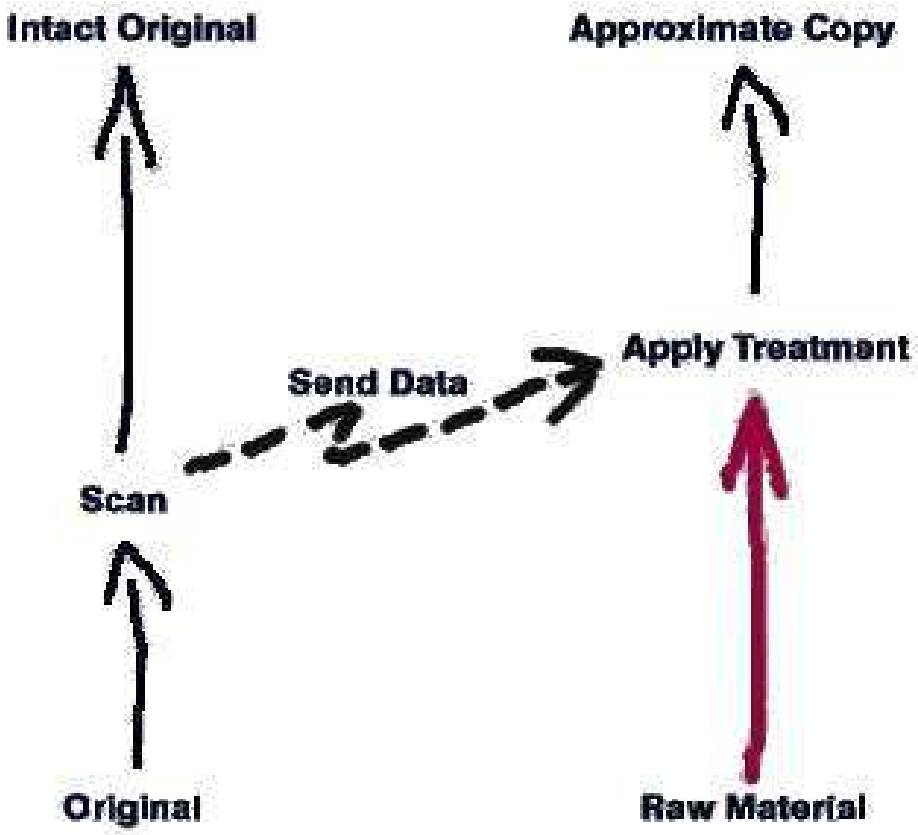

Figure 6. Classical Facsimile Transmission (Modified IBM Press Image)

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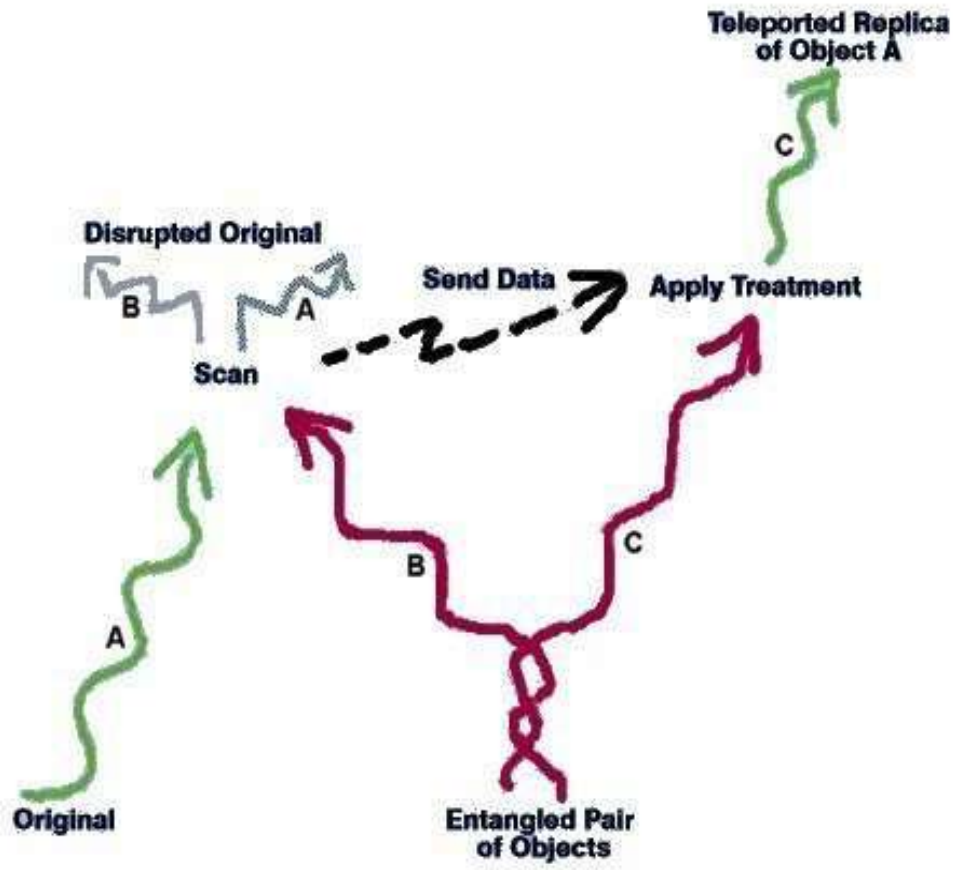

Figure 7. Quantum Teleportation (Modified IBM Press Image)

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We now go one more final step to give a simplified outline of the actual teleportation process according to Bennett et al. (1993). They propose a multistep procedure by which any quantum state $|\chi\rangle$ of a particle or a photon (that correspond to an N-state system) is to be teleported from one location to another. For example, $|\chi\rangle$ might be a two-level system that could refer to the polarization of a single photon, the nuclear magnetic spin of a hydrogen atom, or the electronic excitation of an effective two-level atom. The following scenario outlines the q-Teleportation process in a very simplified way:

1. Prepare a pair of quantum subsystems $|\varphi\rangle$ and $|\psi\rangle$ in an EPR entangled state so that they are linked together. $|\varphi\rangle$ and $|\psi\rangle$ are maximally entangled and together constitute a definite pure state superposition even though each of them is maximally undetermined or mixed when considered separately.

2. Transport $|\varphi\rangle$ to the location of the teleportation transmitter and transport $|\psi\rangle$ to the location of the teleportation receiver. (In the technical literature the transmitter is called "Alice" and the receiver is called "Bob.") The transmitter and receiver can be many light years apart in space. Note that the two subsystems are non-causally correlated via entanglement, but they contain no information about $|\chi\rangle$ at this point. The two subsystems represent an open quantum channel that is ready to transmit information.

3. Now Alice brings the teleported state $|\chi\rangle$ into contact with the entangled state $|\varphi\rangle$ and performs a quantum measurement on the combined system $|\chi\rangle|\varphi\rangle$. Bob and Alice have previously agreed upon the details of the quantum measurement.

4. Using a conventional classical communication channel, Alice transmits to Bob a complete description of the outcome of the quantum measurement she performed on $|\chi\rangle|\varphi\rangle$.

5. Bob then subjects $|\psi\rangle$ to a set of linear transformations (i.e., suitable unitary rotations) that are dictated by the outcome of Alice's quantum measurement. The quantum subsystem Bob originally first received is no longer in state $|\psi\rangle$ after the linear transformations because it is now in a state identical to the original state $|\chi\rangle$. Therefore, $|\chi\rangle$ has in effect been teleported from Alice to Bob.

Bennett et al. (1993) showed in their experimental work that this scheme requires both a conventional communication channel and a non-causal EPR channel to send the state $|\chi\rangle$ from one location to another. In addition to this, a considerable pre-arrangement of entangled states and quantum measurement procedures is required to make the process work. Bennett et al. (1993) analyzed the information flow implicit in the process and showed that Alice's measurement does not provide any information about the quantum state $|\chi\rangle$. All of the quantum state information is passed by the EPR link between the entangled particle states $|\varphi\rangle$ and $|\psi\rangle$. We can think of the measurement results as providing the "code key" that permits the EPR information to be decoded properly at Bob's end. And because the measurement information must travel on a conventional communications channel, the decoding cannot take place until the code key arrives, insuring that no FTL teleportation is possible.

The q-Teleportation scheme teleports the state of a quantum system without having to completely measure its initial state. The outcome of the process is that the initial quantum state $|\chi\rangle$ is destroyed at Alice's location and recreated at Bob's location. It is very important for the reader to understand that it is the *quantum states* of the particles/photons that are destroyed and recreated in the teleportation process, and not the particles/photons themselves. The quantum state or wavefunction contains the information on the state of a particle, but is not a directly observable physical quantity like mass-energy. The quantum information contained within a state is available in the form of probabilities or expectation values.

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Therefore, q-Teleportation *cannot* teleport animate or inanimate matter (or energy) in its physical entirety. However, some experts argue that because a particle's or a photon's quantum state is its defining characteristic, teleporting its quantum state is completely *equivalent* to teleporting the particle/photon even though the original particle's/photon's quantum state (and defining characteristic) was completely destroyed in the process (more on this in Section 3.3). Therefore, no quantum cloning is possible and we are left with a (near-perfect) copy of the now-destroyed original after teleportation (Wootters and Zurek, 1982; Barnum et al., 1996). And finally, classical information itself *cannot* be teleported faster than the speed of light via the non-causal EPR channel; however, quantum information can (more on this in Section 3.2.3).

3.2.2 Decoherence Fundamentally Limits q-Teleportation

Finally, the reader must understand that the q-Teleportation scenario described in the previous section was simplified because we unrealistically assumed that Alice and Bob shared an EPR entangled pair that was free of noise or decoherence. Decoherence is the process, whereby an object's quantum states degrade when information leaks to or from the environment (i.e., environmental noise) through stray interactions with the object. In reality, Alice and Bob have quantum systems that interact directly or through another mediating quantum system like two ions in an ion trap that interact through phonon modes of the trap, or Rydberg atoms in a laser cavity that interact via photons (Sackett, 2001; Raimond et al., 2001). Decoherence degrades the fidelity of the quantum link (i.e., the set of pure EPR entangled pairs) between two quantum systems, thus introducing a certain level of error in the exchange of quantum information between the systems.

In a real-world example of an application of q-Teleportation to quantum computation (discussed in the next section), we can devise an array of interconnected ion traps with each trap holding a small number of ions that are coupled by ions that are moved between the traps or by traveling photons (Wineland et al., 2002). The quantum link (or EPR interaction) between a pair of systems is subject to noise or decoherence through photon loss or heating of the phonons. At present, decoherence imposes a fundamental limit on our ability to perform quantum information processing. Research is continuing on whether decoherence can be reduced, circumvented, or otherwise be (partially or totally) eliminated. Dür and Briegel (2003) have taken the first step towards this goal at rudimentary level by showing that fault-tolerant quantum computation can be achieved in the presence of very high noise levels occurring in the interaction link between small quantum systems, if one assumes that local quantum processing on each end is nearly error free. They showed that the interaction link can have an error rate of two-thirds.

3.2.3 Recent Developments in Entanglement and q-Teleportation Physics

Quantum teleportation physics is still in its infancy. Both theoretical and experimental developments are advancing in many different directions, but are far from maturity at this point in time because the field is still evolving at present. Technical applications of entanglement and q-Teleportation are just becoming conceptualized for the first time, while a small number of basic physics breakthroughs and their related applications are in experimental progress at present. The research community is still in the process of discovering the full nature of entanglement and q-Teleportation, its rules, and what roadblocks nature has in store for its applications and further progression. The literature cited in this study is by no means complete, and only represents a subset of the entire field, because the research is still evolving.

An important application of quantum entanglement and q-Teleportation was the discovery made by Shor (1994, 1997) that computation with quantum states instead of classical bits can result in large savings in computation time. For example, the best algorithms take exponentially more resources to factor ever-larger numbers on a classical computer. A 500-digit number needs 10^8 times as many computational steps to factor as a 250-digit number. The latter classically requires $\approx 5\times10^{24}$ computational steps, or about 150,000 years computing time at terahertz speed, to factor. Shor found a polynomial-time quantum algorithm that solves the problem of finding prime factors of a large integer.

He showed that his algorithm rises only polynomially so that a 500-digit number takes only eight times as many computational steps to factor as a 250-digit number. And by using the quantum factoring algorithm, a 250-digit number requires only $\approx 5\times10^{10}$ steps or < 1 second to factor at terahertz speed, so that a 500-digit number will take ≤ 1 second to factor. No classical polynomial-time algorithm for this problem exists at present. This breakthrough generated a cottage industry of research into quantum computing and quantum information theory.

IBM (2001) constructed a prototype quantum computer that uses the nuclear spins of seven atoms that are part of a large molecule with the iron-based chemical composition $H_5C_{11}O_2F_5Fe$. The computer uses entangled nuclear spins for storage and has a capacity of seven qubits (qubits are defined in the bulleted list in the next two paragraphs below). All of the Fluorine atoms in the large molecule are Fluorine isotope 19 and two of the Carbon atoms are Carbon isotope 13. All the other non-hydrogen atoms have even isotope numbers and no nuclear spins. The objective of the prototype quantum computer was to factor the number 15 into its two prime factors 3 and 5 by using Shor's quantum factoring algorithm. The quantum computation required that a sample of $\approx 10^{18}$ of the large molecules be placed in a magnetic field and manipulated by nuclear magnetic resonance (NMR) techniques. This mechanism allows the spins to function as qubits, whereby Schor's algorithm can be performed via manipulation of the NMR fields. NMR was used to implement quantum computing in this prototype, because the nuclear spins are well isolated from decoherence as a result of the very long decoherence time (the time after which quantum coherence is lost due to environmental noise) in the system.

To factor larger numbers will require a system that uses more than seven qubits. It is estimated that a quantum computer using ≈ 36 qubits could very quickly perform computations that would require a conventional computer ≈ 13 billion years to perform. And such a computer could solve one of the technical problems of human teleportation discussed in Section 3.1. However, a scale-up in the number of qubits is difficult because the IBM prototype has reached the technology limit of NMR quantum computing. The prototype's operation requires that all of the qubits must be in the same molecule. And molecules with more than seven spins that can be used as qubits are not feasible at present. However, there are alternative technologies for quantum computing that show promise for scaling up the number of qubits. The technologies of nuclear spin orientation of single atom impurities in semiconductors, electron spin orientation in quantum dots, and the manipulation of magnetic flux quanta in superconductors all show promise of providing a basis for scalable quantum computers. Finally, the primary technical problem in quantum computing at the present time is decoherence, and this must be eliminated or otherwise mitigated before new quantum technology can become competitive with conventional computer technology.

A byproduct of the recent quantum computing and information research is that a modern theory of entanglement has emerged. Researchers now treat entanglement as a quantifiable physical resource that enables quantum information processing and computation. Entanglement is no longer treated as a paradox of quantum theory. It has been recently discovered that (Nielsen and Chuang, 2000; Nielsen, 2003; Terhal et al., 2003):

- various kinds of pure and mixed entangled states may be prepared in addition to the simple pure-state superpositions that was described in the previous section

- the members of an entangled group of objects do not have their own individual quantum states, only the group as a whole has a well-defined state (i.e., "the whole is greater than the sum of its parts")

- entangled objects behave as if they were physically connected together no matter how far apart they actually are, distance does not attenuate entanglement in the slightest – it has been demonstrated that information can be teleported over 40 km using existing technology (H. Everitt, Army Research Office, 2000)

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- if something is entangled with other objects, then a measurement of it simultaneously provides information about its partners

- some quantum systems can have a little entanglement while others will have a lot

- the more entanglement available, the better suited a system is to quantum information processing

- decoherence degrades the fidelity of the quantum link (i.e., the set of pure EPR entangled pairs) between two quantum systems, thus introducing a certain level of error in the exchange of quantum information between the systems; thus limiting our ability to perform quantum information processing (see more on this issue in the next paragraph below)

- mixed entangled states may be measured, distilled, concentrated, diluted, and manipulated

- the basic resource of classical information is the bit (i.e., the two values 0 and 1), while quantum information comes in quantum bits (i.e., qubits) that are described by their quantum state; qubits can exist in superpositions that simultaneously involve 0 and 1, thus giving them an infinite range of values; groups of qubits can be entangled; qubits must be insulated against decoherence, so that the coherent state of the quantum system in a quantum computer is preserved for a time that is long enough to set up a calculation, perform it, and read out the results

- quantum computers processing qubits or entangled qubits can outperform classical computers; functional requirements of quantum computers:

    - ❖ they must have the ability to initialize any qubit in a specified state, and to measure the state of a specific qubit
    - ❖ they must have universal quantum gates, which are logical elements capable of arranging any desired logical relationship between the states of qubits
    - ❖ they must also have a processor capable of interlinking quantum gates to establish rules and boundary conditions for their inter-relationships – in a quantum computation, the arrangement of quantum gates connects the qubits in a logical pattern, according to a program or algorithm, and after an interval the qubits assigned to the result are read out

- quantum error correction codes exist, whereby qubits are passed through a circuit (the quantum analogue of logic gates) that will successfully fix an error in any one of the qubits without actually reading what all the individual qubit states are; no qubit cloning is required

- a completely secure quantum key can be generated and distributed (for communication and decoding of encrypted messages) using entangled photons has been demonstrated (Tittel et al., 2000; Jennewein et al., 2000; Naik et al., 2000); any eavesdropper's attempt to intercept the quantum key will alter the contents in a detectable way, enabling users to discard the compromised parts of the data

- in an experiment which verified that EPR entanglement obeys Special Relativity (Seife, 2000; Scarani et al., 2000; Gisin et al., 2000; Zbinden et al., 2000a, b), and involving a photon detector moving at relativistic speeds (for example, Bob moves away from Alice at close to the speed of light), investigators determined that quantum information via EPR photon pair entanglement must travel > 10^7 times light speed (the photon detectors were 10.6 km apart)

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- investigators are still developing quantitative laws of entanglement to provide a set of principles for understanding the behavior of entanglement and how it is used to do information processing

- investigators are working to develop an understanding of the general principles that govern complex quantum systems such as quantum computers

Other developments are equally as interesting or compelling. For example, the quantum state of the object we wish to teleport does not have to describe single microscopic systems like photons, ions, atoms or electrons. Quantum states can describe large collections of atoms like chemical compounds, humans, planets, stars, and galaxies. Hartle and Hawking (1983) even derived the quantum wavefunction of the Universe in closed form, although, it was extremely simplified and excluded the presence of quantum matter-energy. So it has become possible to consider teleporting large quantum systems. We summarize the more recent spectacular developments in the following:

- Generation of entanglement and teleportation by Parametric Down-Conversion (Bouwmeester et al., 1997; Zeilinger, 2003): EPR entangled photon pairs are created when a laser beam passes through a nonlinear β-barium borate or BBO crystal. Inside the crystal (BBO, for example) an ultraviolet photon (λ = 490 nm) may spontaneously split into two lower energy infrared photons (λ = 780 nm), which is called parametric down-conversion. The two "down-conversion" photons emerge as independent beams with orthogonal polarizations (horizontal or vertical). (The orthogonal polarization states represent a classic example of the discrete quantum state variables that can be teleported. Other examples of discrete quantum variables that have been teleported using other schemes include the nuclear magnetic spin of a hydrogen atom, electronic excitations of an effective two-level atom, elementary particle spins, etc.) In the two beams along the intersections of their emission cones, we observe a polarization-entangled two-photon state. For the experimental realization of quantum teleportation, it is necessary to use pulsed down-conversion. Only if the pulse width of the UV light, and thus the time of generating photon pairs is shorter than the coherence time of the down-converted photons, then interferometric Bell-state analysis can be performed. In this type of experiment, the pulses from a mode-locked Ti:Saphire laser have been frequency doubled to give pulses of ≈ 200 fs duration (1 fs = 10^{-15} second). The interfering light is observed after passage through IR filters of 4 nm bandwidth giving a coherence time of ≈ 520 fs. After retroflection during its second passage through the crystal, the UV pulse creates another pair of photons. One of these will be the teleported photon, which can be prepared to have any polarization. Beam splitters and photon detectors are used to perform the Bell-state analysis during the standard teleportation process that ensues. See Figure 8 for a schematic showing the layout of a standard parametric down-conversion entanglement-teleportation experiment.

- Teleportation of squeezed states of light and continuous quantum state variables (Furusawa et al., 1998; Sørensen, 1998; Braunstein and Kimble, 1998; Opatrný et al., 2000; Braunstein et al., 2001; Zhang et al., 2002; Bowen et al., 2002; Bowen et al., 2003; Zeilinger, 2003): Squeezed light (see Section A.2 in Appendix A) is used to generate the EPR entangled beams, which are sent to Alice and Bob. A third beam, the input, is a coherent state of unknown complex amplitude. This state is teleported to Bob with a high fidelity only achievable via the use of quantum entanglement. Entangled EPR beams are generated by combining two beams of squeezed light at a 50/50 beam splitter. EPR beam 1 propagates to Alice's sending station, where it is combined at a 50/50 beam splitter with the unknown input state, in this case a coherent state of unknown complex amplitude. Alice uses two sets of balanced homodyne detectors to make a Bell-state measurement on the amplitudes of the combined state. Because of the entanglement between the EPR beams, Alice's detection collapses Bob's field (EPR beam 2) into a state

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conditioned on Alice's measurement outcome. After receiving the classical result from Alice, Bob is able to construct the teleported state via a simple phase-space displacement of the EPR field 2. Quantum teleportation in this scheme is theoretically perfect, yielding an output state which equals the input with a fidelity $F = 1$. In practice, fidelities less than one are realized due to imperfections in the EPR pair, Alice's Bell measurement, and Bob's unitary transformation. By contrast, a sender and receiver who share only a classical communication channel cannot hope to transfer an arbitrary quantum state with a fidelity of one. For coherent states, the classical teleportation limit is $F = 0.5$, while for light polarization states it is $F = 0.67$. The quantum nature of the teleportation achieved in this case is demonstrated by the experimentally determined fidelity of $F = 0.58$, greater than the classical limit of 0.5 for coherent states. The fidelity is an average over all input states and so measures the ability to transfer an arbitrary, unknown superposition from Alice to Bob. This technique achieves the teleportation of continuous quantum state variables, as opposed to the discrete quantum state variables used in the Bennett et al. (1993) teleportation protocol and its variants. The teleportation of a squeezed state of light from one beam of light to another demonstrates the teleportation of a continuous feature (of light) that comes from the superpositions of an infinite number of basic states of the electromagnetic field, such as those found in squeezed states. This line of research also involves the experimental demonstration of the mapping of quantum states from photonic to atomic media via entanglement and teleportation. Hald et al. (1999) reported on the experimental observation of a spin-squeezed macroscopic ensemble of 10^7 cold atoms, whereby the ensemble is generated via quantum state entanglement/teleportation from non-classical light to atoms.

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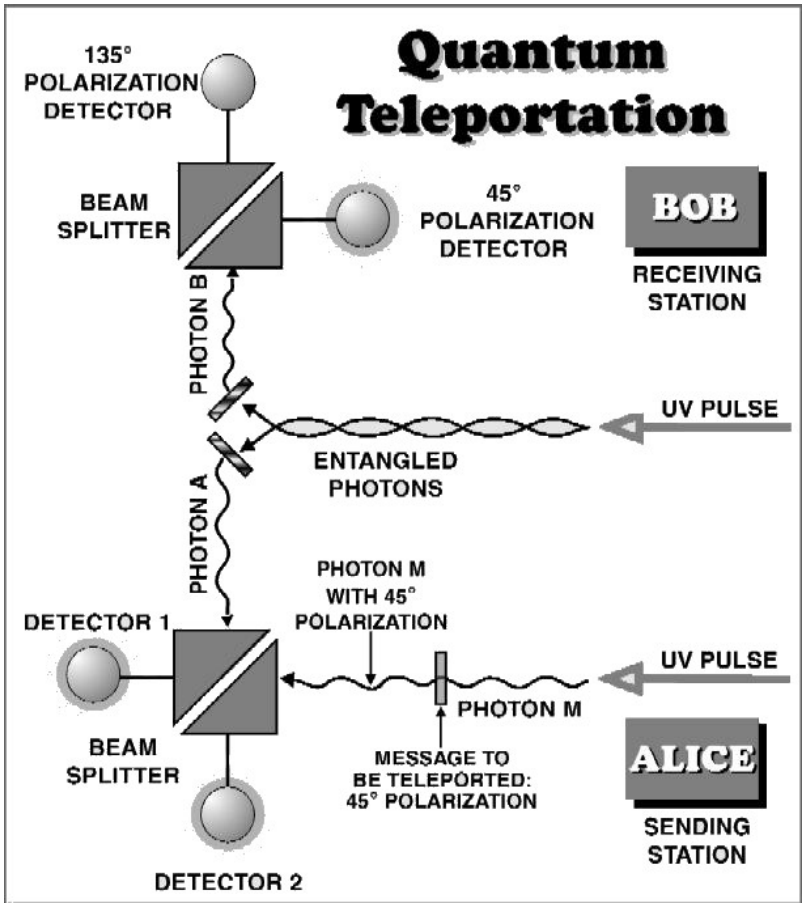

Figure 8. Quantum Teleportation (From www.aip.org)

At the sending station of the quantum teleporter, Alice encodes a "messenger" photon (M) with a specific state: 45 degrees polarization. This travels towards a beam splitter. Meanwhile, two additional entangled photons (A and B) are created. The polarization of each photon is in a fuzzy, undetermined state, yet the two photons have a precisely defined interrelationship. Specifically, they must have complementary polarizations. For example, if photon A is later measured to have horizontal (0 degrees) polarization, then the other photon must collapse into the complementary state of vertical (90 degrees) polarization. Entangled photon A arrives at the beam splitter at the same time as the message photon M. The beam splitter causes each photon to either continue toward detector 1 or change course and travel to detector 2. In 25% of all cases, in which the two photons go off into different detectors, Alice does not know which photon went to which detector. This inability for Alice to distinguish between the two photons causes quantum weirdness to kick in. Just by the very fact that the two photons are now indistinguishable, the M photon loses its original identity and becomes entangled with A. The polarization value for each photon is now indeterminate, but since they travel toward different detectors Alice knows that the two photons must have complementary polarizations. Since message photon M must have complementary polarization to photon A, then the other entangled photon (B) must now attain the same polarization value as M. Therefore, teleportation is successful. Indeed, Bob sees that the polarization value of photon B is 45 degrees: the initial value of the message photon.

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- Entanglement of Atoms (Hagley et al., 1997; Sackett et al., 2000): EPR entanglement at the level of atoms has been experimentally demonstrated using rubidium atoms prepared in circular Rydberg states (i.e., the outer electrons of the atom have been excited to very high energy states and are far from the nucleus in circular orbits). The experimental apparatus produces two entangled atoms, one atom in a ground state and the other atom in an excited state, physically separated so that the entanglement is non-local. And when a measurement is made on one atom, let us say the atom in a ground state, then the other atom instantaneously presents itself in the excited state – the result of the second atom wave function collapse, thus determined by the result of the first atom wave function collapse. This work is now evolving towards the demonstration of entanglement for molecules and larger entities followed by teleportation of their states. Bose and Home (2002) have improved on this concept by proposing a single, simple generic method by which any atoms, ions and macroscopic objects can be entangled and teleported.

- Teleportation of an Atomic State via Cavity Decay (Bose et al., 1999; Sackett et al., 2000): It has been shown how the state of an atom trapped in a cavity can be teleported to a second atom trapped in a distant cavity simply by detecting photon decays from the cavities.

- Biological Quantum Teleportation (Mavromatos et al., 2002): There are several obstacles to teleporting large complicated objects, especially biological entities. Decoherence is the primary obstacle. That is because observable quantum effects in biological matter is thought to be strongly suppressed due to the macroscopic nature of most biological entities and the fact that such systems live at near room temperature, and there is always contact between biological entities and the environment (the source of decoherence). These conditions result in very fast collapse of pertinent quantum wavefunctions to one of the allowed classical states of the biological entity. Mavromatos et al. (2002) propose a daring model that predicts dissipationless energy transfer along shielded macromolecules at near room temperatures as well as quantum teleportation of states across microtubules and perhaps neurons. It is proposed that under certain circumstances it is in principle possible to obtain the necessary isolation against environmental decoherence, so that meso/macroscopic quantum coherence, and entanglement extending over scales that are larger than the atomic scale, may be achieved and maintained for times comparable to the characteristic times for biological and cellular processes. Microtubules are comprised of tubulin that is a common polar protein found in the cytoskeleton of eukariotic cells, which is especially enriched in brain tissue. The model treats microtubules as quantum mechanically isolated high-Q QED cavities, exhibiting properties analogous to those of electromagnetic cavities routinely used in quantum optics. The model builds a microtubule network that achieves quantum teleportation of coherent quantum states, leading to decoherence-resistant bulk quantum information processing and computing within the biological matter. It is speculated that the model can explain how consciousness works, and how the brain processes and computes information.

- Teleportation of a laser beam with embedded radio signal (Bowen et al., 2003): The teleportation of a laser beam from one part of a lab to another has been demonstrated. Investigators embedded a radio signal into a laser beam, then disintegrated the beam and reassembled it a meter away, virtually instantaneously. The laser beam was destroyed in the teleportation process, but the radio signal survived. The laser light at one end of an optical communications system was disassembled and its replica was recreated elsewhere in the lab. Even though the laser beam did not survive teleportation, its encoded message did. This system could be used to transport secure data, such that it could become possible to construct a perfect cryptography system. When two

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parties want to communicate with one another, one can enable the secrecy of the communication to be absolutely perfect.

- Entanglement and Teleportation of a Macroscopic Ensemble of Atoms (Julsgaard et al., 2001): Expanding upon the earlier work of Hald et al. (1999) and Sackett et al. (2000), investigators experimentally demonstrated the entanglement of two macroscopic objects, each consisting of a cesium gas sample containing $\approx 10^{12}$ atoms. Entanglement is generated via interaction of the samples with a pulse of light, which performs a non-local Bell measurement on the collective spins of the samples. The entangled spin-state can be maintained for 0.5 milliseconds. The teleportation of macro-ensemble atom quantum states is expected to follow this experiment. This work is evolving towards the experimental demonstration of the Bose and Home (2002) proposal, which proved that there is a single generic process that can entangle and teleport any atoms, ions and macroscopic objects.

- Entanglement/teleportation of internal state and external motion information of atoms (Opatrný and Kurizki, 2001): Investigators propose an experiment for transmitting an atom's full information, including its "external" states, such as its energy of motion. This procedure replicates the quantum features of the external motion of a particle. For example, if particle-to-be-teleported C yielded a diffraction pattern after passing through two slits, then the same pattern would be produced by particle B, which receives the teleported information. The researchers propose the following idea: Dissociate a very cold molecule with a laser pulse into two atoms (called A and B). Then manipulate the two atoms so that they become entangled: each one is in a fuzzy state individually, but has a precisely defined relationship with its partner. Then let one of the entangled particles (such as A) collide with particle C, whose unknown state should be teleported. After their collision, the momentum values of the collision partners A and C are measured. With that information, the researchers know how to "kick" and deflect atom B, so that the motion of B precisely emulates that of particle C. The investigators say that state-of-the-art equipment for studying atomic collisions and quantum effects makes this experiment difficult, but feasible, to do. If this proposal proves to be correct, then the implication is that it will become possible to experimentally expand this concept to the teleportation of a large ensemble of atoms, such that the entire physical motion and quantum states of the ensemble can be teleported. This could lead to the future development of a teleportation process similar to what was discussed in Section 3.1.

- Laser-like Amplification of Entangled Particles and Entangled-Photon Lasers (Lamas-Linares et al., 2001): Entangled particles are notoriously difficult to create in bulk. To create entangled photons, for example, researchers use the parametric down-conversion technique to send laser light through a barium borate crystal. Passing through the crystal, a photon sometimes splits into two entangled photons (each with half the energy of the initial photon). However, this only occurs for one in every ten billion incoming photons. To increase the yield, researchers added a step: they put mirrors beyond the crystal so that the laser pulse and entangled pair could reflect, and have the chance to interact. The entangled pair and reflected laser pulse interfere constructively to generate fourfold more two-photon pairs or interfere destructively to create zero pairs. Following these steps, the researchers increased production of two-photon entangled pairs, and also of more rare states such as four-photon entangled quartets. This achievement could represent a step towards an entangled-photon laser, which would repeatedly amplify entangled particles to create greater yields than previously possible, and also towards the creation of new and more complex kinds of entangled states.

This list is by no means complete as new developments in this field continue to arise.

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3.3 Conclusion and Recommendations

Given the incredible advancements that have been made in the entanglement and teleportation of macroscopic objects the size of 10^{12} atoms, we are still very far away from being able to entangle and teleport human beings (and even simpler biological entities such as cells, etc.) and bulk inanimate objects (tools, technical equipment, pencils and pens, weapons platforms, communications devices, personal hygiene supplies, etc.). There still remain four essential problems:

- One needs an entangled pair of such bulk objects.
- The bulk objects to be entangled and teleported must be in a pure quantum state (as in a Bose-Einstein condensate, for example). And pure quantum states are very fragile.
- The bulk objects to be entangled and teleported must be extremely isolated from the environment to prevent the onset of decoherence.
- The Bell-state measurement of animate or inanimate objects during entanglement/teleportation will require extracting an amount of information (in bits) that equals or exceeds the number of atoms contained within the object. This infers that the computer storage and processing requirements to entangle and teleport a complete bulk object will be astronomically huge (recall the discussion in Section 3.1).

It is difficult to imagine how we can achieve an extreme level of environmental isolation for an object, let alone a living being that breathes air and radiates heat. Experiments with atoms and larger objects must be done in a high vacuum to avoid collisions with molecules. Thermal radiation from the walls of a teleportation apparatus would easily disturb a tiny amount of matter. At present, decoherence imposes a fundamental limit on quantum entanglement and teleportation. Decoherence is the primary reason why we do not routinely see any quantum effects in our everyday world. Research is continuing on whether decoherence can be reduced, circumvented, or otherwise be eliminated. And some minor progress has been made in that direction.

In q-Teleportation it is the *quantum states* of the objects that are destroyed and recreated, and not the objects themselves. Therefore, q-Teleportation *cannot* teleport animate or inanimate matter (or energy) in its physical entirety. However, some experts argue that because an object's quantum state is its defining characteristic, teleporting its quantum state is completely *equivalent* to teleporting the object, even though the original object's quantum state (and defining characteristic) was completely destroyed in the process. This goes to the heart of what is meant by identity. When an object has all the right properties and features, it will be the same object that one observes whether it was observed now or 24 hours ago. Quantum physics reinforces the point that objects of the same type in the same quantum state are indistinguishable from each other. One should, according to this quantum principle, be able to swap all the atoms in a particular object with the same atoms from a mound of raw materials, and reproduce the original object's quantum states exactly with the end result that the new object is identical to the original. Last, we do not know how to put a human being into a pure quantum state or what doing so would mean for biological functioning (including brain function), but we do know how to put $\leq 10^{12}$ gas atoms/ions and a beam of photons into a pure state in practice. Further research will be required to ascertain whether microbiological and higher-level biological systems, in addition to bulk inanimate matter, can be put into pure quantum states and entangled/teleported.

To perform a Bell-state measurement on (bulk) animate or inanimate objects, during the entanglement/teleportation process, to extract and encode its information will require extracting an amount of information (in bits) that equals or exceeds the number of atoms contained within the object. An object containing a few grams of matter will require the extraction of $> 10^{28}$ bits of data. A simple virus of $\approx 10^{7}$ atoms would require the extraction of $\geq 10^{8}$ bits of information during the

entanglement/teleportation process, whereas the extraction of a minimum of 10^{28} kilobytes will be required to encode and store an entire human being. This is beyond the capability of present digital electronic computer technology to store and process. It is difficult to see how far computer technology will advance towards meeting this requirement.

It is difficult to fathom what will be in store for the teleportation of human beings given some possible future technology. What about the effects of the q-Teleportation process on the human consciousness, memories and dreams, and the spirit or soul? We know from quantum physics that "the whole is greater than the sum of its parts." So what happens to the fundamental characteristics of a human being when he/she steps into the teleporter-transmitter, where their quantum states (i.e., their complete identity) are destroyed during the quantum entanglement/teleportation process, and then their copy is created at the teleporter-receiver an instant later? What will things be like during the entanglement process? Will a teleported individual's consciousness, memories and dreams, and spirit/soul be successfully and accurately teleported or not? This is a major ethical and technical question that will have to be addressed by future research.

•**Recommendations**:

- Broad-spectrum Quantum Computing Technology Development Program: At present, the Quantum Information Science Program (QISP) is coordinated by the U.S. Army Research Office with funding and support from the Army, the National Security Agency, DARPA, and the Office of the Deputy Director of Defense for Research and Engineering. The Naval Research Lab and the CIA are both involved in their own programs. The CIA vets new commercial development of computer technology and computer information processing via its In-Q-Tel company (reference 44). This includes R&D on quantum entanglement and teleportation for computer, information processing and secure communications. QISP was funded for $19 million in 1999. The program involves 34 projects by researchers at 21 universities, three government laboratories and two corporate laboratories. QISP goals include building a quantum computer, developing quantum information processing, and further advances in quantum teleportation. The AFRL should join QISP and provide partnership funding on the order of $1 million per year. An alternative to this would be for AFRL to collaborate with In-Q-Tel and participate in its technology R&D venture capital programs. This R&D investment would allow the Air Force to acquire very advanced quantum physics and related technological applications that can support its mission. The R&D investment benefits would include the development and implementation of quantum computing/information processing and secured quantum communications technology, which can significantly enhance the performance and security of Air Force computing and communication systems infrastructure, and aerospace weapons systems.

- Quantum Cryptography: A dedicated research program should be implemented to develop a mature quantum cryptography technology. Theoretical and experimental work is in progress among a small number of select groups (QISP, In-Q-Tel, universities, etc.), but this field is not advancing fast enough for practical applications to become available to meet increasing adversarial threats against secured military and intelligence communications. The goal of proposed quantum cryptography research is to bring the theoretical and experimental foundation of quantum cryptography and secure quantum information processing to maturity, and to fully develop and implement quantum entanglement/teleportation-based cryptography technology. Recent experimental work has demonstrated that a completely secure quantum key can be generated and distributed for the communication and decoding of encrypted messages using entangled photons. Any eavesdropper's attempt to intercept the quantum key will alter the contents in a detectable way, enabling users to discard the compromised parts of the data. There is much more work that needs to be done in this area. I recommend that the AFRL implement a

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$1 million/year program for five years in order to advance the state-of-art in quantum cryptography technology.

- Quantum Decoherence: Decoherence is the primary reason why we do not routinely see any quantum effects in our everyday world. And it imposes a fundamental limit on quantum entanglement and teleportation via the interaction between entangled/teleported quantum systems and their local environment. In order to advance quantum entanglement/teleportation physics and develop applied technologies, it is necessary that a research program be implemented by the AFRL to explore whether decoherence can be significantly reduced, circumvented, or otherwise be eliminated. An insufficient number of small university groups have slowly made minor progress in this direction. I recommend that a $500,000 - 750,000 per year R&D program be conducted for five years to overcome this technical challenge.

- Pure Quantum States: In order to entangle and teleport quantum particles and bulk objects, they both must be prepared in a pure quantum state. And pure quantum states are very fragile to decoherence. A technical challenge for entanglement/teleportation physics is whether the requirement for pure quantum states can be relaxed and how much decoherence will play a role in this situation, what technical challenges will arise when increasing the size of entangled/teleported matter to larger macroscopic scale ($>> 10^{12}$ atoms), and whether matter of mixed composition (such as a gas or Bose-Einstein condensate of mixed atomic elements) can be entangled/teleported in both pure and mixed quantum states. I recommend that a $250,000 – 500,000 per year research program be conducted for five years to study this problem.

- Entangling Bulk Matter and Bell-State Measurement to Extract Information: Recent experiments demonstrated the entanglement of two macroscopic objects, each consisting of a cesium gas sample containing $\approx 10^{12}$ atoms. Entanglement was generated via interaction of the samples with a pulse of light, which performs a non-local Bell measurement on the collective spins of the samples. In order to push the envelope on this development and take it to higher practical levels, it will be necessary to ascertain the limit on the size and composition of bulk matter entanglement (given the decoherence and pure-state constraints); and to determine what other quantum states can be used for entanglement, what other Bell-state measurement techniques can be used, and whether multiple quantum states can be entangled. The chief technical challenge is the computer technology that will be required to facilitate the huge amount of data that must be extracted, processed and stored from bulk matter quantum states during the Bell-state measurement process. I recommend that a $500,000 – 1 million per year research program be implemented for five years in order to explore these questions and ascertain what solutions may be technically available, and to develop such solutions.

- Biological Quantum Teleportation: The Mavromatos et al. (2002) theoretical model for biological entanglement and teleportation is a remarkable concept that could result in the development of a workable physics theory of consciousness. The model has potential applications to advanced quantum computing/information processing physics and the physics of psi phenomena (see Chapter 5). A research program should be implemented to continue the Mavromatos et al. (2002) work and bring their model to theoretical maturity. It is recommended that this program be funded at $500,000 – 800,000 per year for five years. A parallel or follow-up program should be implemented to experimentally test this model and ascertain any useful technological applications. One application that should be explored in the proposed research program is advanced, ultra-fast, ultra-high-capacity quantum computing and information processing using natural and/or artificial biological systems. The parallel or follow-up experimental research program should be funded at $800,000 – 1.5 million per year for five years.

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- FTL Communication: Experiments verifying that EPR entanglement obeys Special Relativity (Seife, 2000; Scarani et al., 2000; Gisin et al., 2000; Zbinden et al., 2000a, b) determined that quantum information via EPR photon pair entanglement must travel > 10^7 times light speed. Can this mechanism be exploited to achieve FTL communication? If so, then the potential military and commercial applications will be revolutionary, and the science and industry of communications will be forever transformed. A comprehensive theoretical and experimental research program should be implemented to answer this question. It is recommended that this program be funded at $700,000 – 1 million per year for five years. A modest experiment definition study should be funded at $80,000 for one year to delineate the most promising experimental approaches to be used for the larger research program. [There is much controversy and debate over FTL (a.k.a. superluminal) signals/communication, and the reader should see the selected superluminal references in the Teleportation References section of this study.]

- New Entanglement/Teleportation Breakthroughs: The most exciting developments in quantum teleportation physics has included the teleportation of a laser beam with an embedded radio signal, the teleportation of squeezed states of light (and hence, continuous quantum state variables), the teleportation of photon states to atoms/ions (from light to matter!), the entanglement of two similar/dissimilar quantum particles that are created by two (independently) different particle sources, the laser-like amplification of entangled particle/photon pairs, parametric down-conversion entanglement and teleportation (of discrete quantum state variables), quantum cryptography with unbreakable keys, the teleportation of quantum information at speeds > 10^7 times light speed, the entanglement and teleportation of macroscopic (10^{12} atoms) matter quantum states, etc. There is also the yet-untested proposal to entangle/teleport the external physical motion and internal quantum state information of atoms. This shows that quantum physics sets no apparent limit on what it is that can be teleported/entangled and how it is to be teleported/entangled, or where it is to be teleported/entangled. At present teleportation technology requires fiber optic and coaxial cables to teleport quantum state information from one location to another. Can we avoid the use of cables and teleport through free space? [Note: Before this report went to press, Aspelmeyer et al. (2003) reported their outdoor experiment that demonstrated the distribution of quantum entanglement (of laser photons) via optical free-space links to independent receivers separated by 600 m across the Danube River (during inclement nighttime weather), with no line of sight between them. This experiment is revolutionary and begins the step toward conducting satellite-based distributed quantum entanglement.] We have not discovered all the possibilities that nature has in store for us. The present breakthrough discoveries will likely introduce novel military and intelligence technology applications in the near and far future. But further R&D must be conducted in order to discover new applications for these recent breakthroughs, to make additional breakthroughs and discoveries, and to advance the state-of-art in quantum teleportation physics to meet future challenges to the Air Force mission. I recommend that a two-track R&D program be implemented over five years. The first track should be funded at $250,000 – 750,000 per year for the purpose of developing new entanglement/teleportation breakthroughs in quantum teleportation physics. The second track should be funded at $750,000 – 1.5 million per year for the purpose of developing applications for any new breakthroughs with the proviso that such applications benefit the Air Force mission and have commercial dual-use capability to leverage advance technology in the private sector.

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4.0 e-TELEPORTATION

4.1 Extra Space Dimensions and Parallel Universes/Spaces

A literature search for proposed e-Teleportation concepts based on the conveyance of objects through extra space dimensions and/or parallel universes/spaces has yielded only one result (see Section 4.2). The present state-of-art in research on parallel universes/spaces and extra space dimensions has been strictly limited to the work on developing a grand unified quantum field theory and a quantum theory of gravity, whereby the former necessarily includes the latter. Quantum gravity/unified field theory research has been evolving since the 1920s when Kaluza and Klein published the first papers to describe a model for the unification of gravity with electrodynamics. Many of the more prominent theories today invoke extra spatial dimensions, the existence of parallel universes/spaces, or both in order to quantise gravity and/or to unify gravity with the other forces of nature. It is beyond the scope of this study to provide an in-depth review of all of the research that has been done in this area, so we list below a select few of the historically prominent models that have largely gained a secure foothold in present-day research:

- Kaluza-Klein Electromagnetic-Gravity Unification Theory/Modern Kaluza-Klein Gravity Theories (Kaluza, 1921; Klein, 1926; de Sabbata and Schmutzer, 1983; Lee, 1984; Appelquist et al., 1987; Kaku, 1993, 1994; Overduin and Wesson, 1998): It was originally suggested that Maxwellian electrodynamics and Einstein gravitation could be unified in a theory of five-dimensional Riemannian geometry, where the gravitational and electromagnetic potentials together would determine the structure of spacetime. The fifth space dimension is curled up into a ball of space with a radius slightly larger than 10^{-35} m, and it was originally regarded as having no physical significance because it was simply a mathematical tool used to catalyze unification. At present, the generic name of Kaluza-Klein stands for a wide variety of approaches to quantising and unifying gravitation with other quantum fields using any number of dimensions greater than four.

- Superstring Theories (Green, 1985; Kaku, 1988, 1993, 1994): These theories come in a wide variety of interrelated concepts, and they are a highly evolved form of Kaluza-Klein theories. They are based on the dynamics of string-like fundamental quanta, whereby the observed fundamental particles are manifested by the vibrational ground or excitation states of a quantum string (open or closed loop). The superstrings are $\approx 10^{-35}$ m (i.e., the Planck length) in size. There are different versions of these theories that require ten, eleven or twenty-six extra space dimensions to unify and quantise gravity, whereby the extra dimensions are curled up (i.e., compactified) into balls of space with a radius $< 10^{-35}$ m. These theories later evolved into versions that are now called F- and M-theory. The mathematics behind this class of theories is very ugly, and it is difficult for even the best superstring theorists to make simple or sophisticated calculations and predictions. And so far, this class of quantum gravity theories has escaped experimental verification.

- D-Brane and 3-Brane Theories/Parallel Spaces (Rubakov and Shaposhnikov, 1983a, b; Polchinski, 1995; Antoniadis et al., 1998; Randall and Sundrum, 1999a, b; Weiss, 2000; Pease, 2001; Arkani-Hamed et al., 1998, 2000, 2002): D-brane theory is a recent incarnation of the original superstring theories in which open strings, corresponding to the fundamental particles of the standard model (quarks, leptons, gauge bosons), have their free ends stuck on a (hypersurface)

membrane called a D-brane (D = Dirichlet boundary conditions). But the graviton, which corresponds to a closed loop of string, can propagate in all the dimensions. It provides both unification and quantization of gravity by assuming that there are n new spatial dimensions in addition to the three infinite spatial dimensions we know about. And the extra space dimensions are $\approx 10^{-35}$ m in extent. A very recent alternative version of this model is called "3-brane" theory. In this theory, each of the n extra space dimensions is of finite extent $R \approx 2\times10^{(32/n)-17}$ centimeters. The space spanned by the new dimensions is called "the bulk." In this theory, the particles of the standard model live within our familiar realm of three spatial dimensions, which forms a three-dimensional (hypersurface) membrane or "3-brane" within the bulk. The propagation of electroweak and strong nuclear forces is then confined to our 3-brane. However, at distances (r) less than R, gravity (via gravitons) propagates in the full $(3 + n)$-dimensional space, whereby its strength falls as $r^{-(2+n)}$ with increasing separation r. When $r > R$, the gravitational force reverts to its normal Newtonian r^{-2} falloff because there is no longer any extra-dimensional space for it to spread into. If $n = 1$, then the size of the extra-dimension would have to be $R \approx 2\times10^{15}$ cm (or 2×10^{10} km = 133.3 AU; 1 AU = 1.5×10^{8} km is the mean Earth-Sun distance) in order to account for the weakness of gravity, but an extra space dimension this large would have already made itself obvious in the observed dynamics of the solar system. For this reason, investigators have discounted the possibility that $n = 1$. If $n = 2$, then the size of both extra space dimensions would have to be $R \approx 0.2$ cm (or 2 mm). In any case, inconspicuous neighboring 3-branes may be separated from the 3-brane we live on by only a fraction of a millimeter, or even much smaller distances, across the higher-dimensional bulk. Such neighboring 3-branes may be distant folds of our own 3-brane, with the same physics, but able to influence us across shortcuts through the bulk. Or they may be completely separate 3-branes possessing their own fundamental laws and parameters of nature that are completely different from our own. Several tabletop Cavendish-type experiments are now looking for sub-millimeter deviations from Newtonian gravitation as a first step towards verifying 3-brane theory, and other experiments are now being planned or are already underway (Pease, 2001). At present the preliminary experimental results have been negative for the existence of extra space dimensions, and the experimental data suggests that two extra space dimensions are now constrained to length scales << 0.2 – 0.3 millimeters while seven extra space dimensions can be no larger than 2 femtometers (Pease, 2001).

- Parallel Universes/Parallel Spaces (Everett, 1957; Wheeler, 1957, 1962; DeWitt, 1970; DeWitt and Graham, 1973; Jammer, 1974; Davies, 1980; Wolf, 1988; Kaku, 1994; Visser, 1995 and Section 2.1): There are only two other research tracts that are concerned with parallel universes besides 3-brane theory. The first tract is the traversable wormhole research that was discussed in Section 2.1. Traversable wormholes can connect many different universes in the "multiverse" (i.e., a conglomeration of many universes), and these are called inter-universe wormholes. However, traversable wormhole physics (a.k.a. Einstein's General Relativity Theory) does not provide a physical prescription for the existence and nature (i.e., fundamental parameters and physical laws) of other putative universes. The difference between inter-universe and intra-universe (i.e., two distant regions of one universe are connected with each other) wormholes arises only at the level of global geometry and global topology. Local physics near the throat of a traversable wormhole is insensitive to issues of intra-universal or inter-universal travel. An observer in the vicinity of the throat, while making local measurements, would not be able to tell whether he was traveling to another universe or to a remote part of our own universe. And one cannot rely on the topological (as opposed to geometrical) information to determine which is the case, because topological information is not enough to uniquely characterize an inter-universe connection. And General Relativity Theory does not fix the topology of spacetime, so we cannot ascertain the existence of other universes. [Note: Traversable wormholes are also geometrically possible for higher dimensional spaces.] The second tract is the "Many Worlds" interpretation of

quantum theory. This version of quantum theory requires the simultaneous existence of an infinite number of equally real worlds, all of which are more-or-less causally disjoint, in order to interpret consistently the relationship between observed phenomena and observers. The theory was proposed in an attempt to overcome a number of deep paradoxes inherent in the interpretation of the theory of measurement and quantum theory. The Many Worlds theory argues that quantum theory requires the existence of a "superspace" of worlds spanning the range of all possible quantum observations (or quantum measurements). Through our acts of measurement we are imagined to trace a path through the mesh of possible outcomes. All the "worlds" are causally disjoint, and the uncertainty of quantum observation can be interpreted as an artifact of our access to such a limited portion of the superspace of possible worlds. The evolution in the superspace as a whole is entirely deterministic.

At present, none of the theoretical concepts outlined above have been brought to a level of technical maturity, where it becomes meaningful to ascertain whether any form of e-Teleportation is theoretically possible between extra space dimensions and different or parallel universes/spaces. However, as mentioned in the item on parallel universes/parallel spaces, there is the exception that traversable wormholes (three- and higher-dimensional) provide a solid physics principle for the implementation of teleportation between parallel universes/spaces. And traversable wormholes can be devised to connect 3-branes together. See Section 2.1 for the discussion on teleportation via traversable wormholes. Also, Kaluza-Klein theories, superstring theories and D-brane theory all have the common feature that their extra space dimensions are $\leq 10^{-35}$ m in extent, which makes it impossible for any useful form of macroscopic-level teleportation to occur between space dimensions. Last, it is not yet possible to do theoretical calculations or even experimentally verify most of these theories. Three-brane theory is the best parallel space theory there is, with the possibility that macroscopic-level teleportation is possible between space dimensions (only if the extra space dimension(s) has length scale(s) >> millimeters). But this theory is still in the stage of maturing theoretically and achieving experimental verification (or falsification). Therefore, we can go no further in this section.

4.2 Vacuum Hole Teleportation

An unusual teleportation concept has been proposed by Leshan (1999, 2002), which describes the teleportation of objects throughout our universe by using the geometrical properties of spacetime. The proposal posits that there is a "zero-space" that exists outside the boundary of our universe, whereby this zero-space is a "point form" space, where the distance between any two points is always equal to zero. Leshan also calls this space a "hole." Further requirements and assumptions of the model are:

- time does not exist as a property in zero-space
- the cosmological principle (i.e., there are no privileged frames relative to another place or point in the universe) requires that the boundary or border of the universe must pass through every point of space
- virtual holes (or zero-space) in spacetime must exist at every point of the universe, which are also called "vacuum holes"
- vacuum holes exist as virtual particles

The last item is interesting because it implicitly says that vacuum holes (a.k.a. zero-space) must also be virtual particles, and in Section 2.2 we showed that virtual particles are a representation of the vacuum ZPF. Therefore, this infers that vacuum holes can be considered to be vacuum zero-point fluctuations in

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Leshan's model. Thus, a teleportation mechanism can arise in this model because distances between zero-space and any other point in the universe are zero, so that the vacuum holes can potentially exist at every point in the universe simultaneously. Therefore, if an object is sent "out of the universe" and into a vacuum hole (a.k.a. zero-space), then the object can appear at random at any spacetime point in the universe.

The mechanism for teleportation in this model is:

- to send an object outside of the universe by creating a closed surface (i.e., "hole sphere"), which consists of vacuum holes, around the object;
- while inside the hole sphere, the object then ceases to exist because objects cannot really exist outside of the universe;
- however, the object simultaneously exists at any other remote location in the universe (via the cosmological principle) at the instant it became enclosed by the hole sphere;
- therefore, it has been teleported to some remote location in the universe

Leshan points out that the teleportation device must curve spacetime so that the starting and destination points in the universe coincide, and the curved geometry must be similar to that of a black hole for an instant, so that a channel between the two points can be formed. (This sounds suspiciously like creating a traversable wormhole via an Einstein-Rosen bridge, which can be made traversable by perturbing the Schwarzschild spacetime metric an infinitesimal amount.) There is no space to traverse, so therefore there will be no passage of time during teleportation. The only expenditure of energy in this teleportation scheme is the energy that will be needed to curve spacetime.

This teleportation concept is very convoluted. Leshan does not offer any further explanations that are useful nor does he offer any precise technical description for the vacuum holes, and how they are to be produced and manipulated. There is also no mathematical physics derivation published by Leshan to support this concept. I am totally unable to evaluate this concept in the absence of a rigorous theoretical framework. This concept is too sketchy and full of technical "holes" to seriously consider it any further for this study. The reader should note that it has already been demonstrated that traversable wormholes are the best physical principle available to implement teleportation between universes and extra space dimensions.

4.3 Conclusion and Recommendations

At present, none of the theoretical concepts explored in this chapter have been brought to a level of technical maturity, where it becomes meaningful to ascertain whether any form of e-Teleportation is theoretically possible between extra space dimensions and different or parallel universes/spaces. However, there is the exception that traversable wormholes (three- and higher-dimensional) provide a solid physics principle for the implementation of teleportation between parallel universes/spaces. And traversable wormholes can be devised to connect 3-branes together. Kaluza-Klein, superstring and D-brane theories do not allow for any useful form of macroscopic-level teleportation to occur between space dimensions, because these theories require that the extra space dimensions be $\leq 10^{-35}$ m in extent. Last, it is not yet possible to do theoretical calculations to make predictions or even to experimentally verify most of these theories. Three-brane theory is the best parallel space theory there is with the possibility that macroscopic-level teleportation is possible between space dimensions. But this theory is still in the stage of maturing theoretically and getting experimental verification.

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•**Recommendations**:

- The recommendations outlined in Section 2.3 are relevant to the investigation of the possibility for e-Teleportation.

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5.0 p-TELEPORTATION

5.1 PK Phenomenon

P-Teleportation is a form of psychokinesis (or PK) similar to telekinesis but generally used to designate the movement of objects (called apports) through other physical objects or over great distances. Telekinesis is a form of PK, which describes the movement of stationary objects without the use of any known physical force. And PK is essentially the direct influence of mind on matter without any known intermediate physical energy or instrumentation. Rigorously controlled modern scientific laboratory PK, and related psychic (a.k.a. "psi", "paranormal" or parapsychology), research has been performed and/or documented by Rhine (1970), Schmidt (1974), Mitchell (1974a, b, see also the references cited therein), Swann (1974), Puthoff and Targ (1974, 1975), Hasted et al. (1975), Targ and Puthoff (1977), Nash (1978, see also the references cited therein), Shigemi et al. (1978), Hasted (1979), Houck (1984a), Wolman et al. (1986, see also the references cited therein), Schmidt (1987), Alexander et al. (1990), Giroldini (1991), Gissurarson (1992), Radin (1997, see also the references cited therein), Tart et al. (2002), Shoup (2002), and Alexander (2003).

A well-known theoretical/experimental/operational program directed by H. E. Puthoff, R. Targ, E. May and I. Swann was conducted at SRI International and the NSA, and sponsored at various times by the Central Intelligence Agency (CIA), the Defense Intelligence Agency (DIA), and the Army Intelligence and Security Command (INSCOM) over more than two decades; and the program was later carried on by E. May at SAIC (Alexander, 1980; Puthoff, 1996; Targ, 1996; Schnabel, 1997; Tart et al., 2002). This was called the Remote Viewing program, and it was a compartmentalized special access program possessing a variety of codenames during its 22 years of operation. Remote viewing involves precognition and clairvoyance, and it allows a practitioner to acquire information irrespective of intervening distance or time. The Remote Viewing program ended in 1994 and President W. J. Clinton officially declassified it in 1995. The reader should note that the very first U. S. military-intelligence R&D programs on psi, PK and mind control were conducted by H. K. (Andrija) Puharich, M.D., L.L.D during his military service at the Army Chemical and Biological Warfare Center at Fort Detrick, Maryland in the 1940s-50s. Puharich had an interest in clairvoyance and PK, and dabbled in theories for electronically and pharmaceutically enhancing and synthesizing psychic abilities. While in the Army, Puharich took part in a variety of parapsychology experiments, and he lectured Army, Air Force and Navy groups on possibilities for mind warfare. He was a recognized expert in hypnotism and microelectronics.

PK phenomenon was also explored in the Remote Viewing program. Col. J. B. Alexander (USA ret.) credits professional aerospace engineer Jack Houck for "capturing PK phenomenon and transitioning it into an observable form" (Houck, 1982, 1984a, b; Alexander et al., 1990; Alexander, 2003). During the past three decades, Houck (along with Alexander) held a number of PK sessions, whereby attendees are taught the PK induction process, and initiate their own PK events using various metal specimens (forks, spoons, etc.). Individuals were able to completely bend or contort their metal specimens with no physical force being applied whatsoever. Numerous government science advisors and senior military officials took part in and/or witnessed these events, which took place at the Pentagon, at officers' or scientists' homes, and at one quarterly INSCOM retreat attended by the commanding general and a group of colonels and generals commanding INSCOM units around the globe. Spontaneous deformation of the metal specimens was observed at the PK session conducted during the INSCOM retreat, causing a great deal of excitement among those present. Other notable trained observers were also present at this session, and they critically reviewed the events. Psychic Uri Geller (1975) is the original model for demonstrating

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PK metal bending. During a talk that he gave at the U.S. Capitol building, Uri caused a spoon to curve upward with no force applied, and then the spoon continued to bend after he put it back down and continued with his talk (Alexander, 1996). Jack Houck continues doing extensive experimental work and data collection on micro- and macro-PK phenomena. Scientifically controlled PK experiments at the Princeton University Engineering Anomalies Research Laboratory were conducted by Robert Jahn (Dean Emeritus of the School of Engineering), who reported that repeatedly consistent results in mentally affecting material substances has been demonstrated in the lab (Jahn and Dunne, 1987). In the 1980s, Jahn attended a meeting on the PK topic at the Naval Research Laboratory, and warned that foreign adversaries could exploit micro- or macro-PK to induce U.S. military fighter pilots to lose control of their aircraft and crash.

Very early investigations of, and experiments on, p-Teleportation occurred during the 19th and early 20th centuries. Many cases that were studied, and the experiments that were performed, were undoubtedly due to fraud, and few experiments have occurred under controlled conditions during that period. However, most of the credible, scientific reports of p-Teleportation phenomenon and related (controlled) experiments occurred in the late 20th century (see for example, Alexander et al., 1990; Radin, 1997). Some of that scientific work involved the investigation of Uri Geller and a variety of other recurrent spontaneous PK phenomena (Hasted et al., 1975; Puthoff and Targ, 1975; Targ and Puthoff, 1977; Nash, 1978; Wolman et al., 1986). Psychics Uri Geller (1975) and Ray Stanford (1974) claimed to have been teleported on several occasions. Most claimed instances of human teleportation of the body from one place to another have been unwitnessed. There are also a small number of credible reports of individuals who reported being teleported to/from UFOs during a UFO close encounter, which were scientifically investigated (Vallee, 1988, 1990, 1997). But there are a larger number of such reports that are anecdotal, whereby the witness data tends to be unreliable. However, we will confine our discussion to the controlled laboratory experiments that have been performed and reported.

One of the more interesting examples of controlled experiments with Uri Geller was one in which he was able to cause a part of a vanadium carbide crystal to vanish (Hasted et al., 1975). The crystal was encapsulated so it could not be touched, and it was placed in such a way that it could not be switched with another crystal by sleight of hand. A more spectacular series of rigorously controlled (and repeatable!) laboratory experiments occurred in the Peoples Republic of China (PRC). In September 1981, an extraordinary paper was published in the PRC in the journal Ziran Zazhi (transl.: Nature Journal), and this paper was entitled, "Some Experiments on the Transfer of Objects Performed by Unusual Abilities of the Human Body" (Shuhuang et al., 1981). The paper reported that gifted children were able to cause the apparent teleportation of small objects (radio micro-transmitters, photosensitive paper, mechanical watches, horseflies, other insects, etc.) from one location to another (that was meters away) without them ever touching the objects beforehand. The experiments were operated under exceptionally well-controlled conditions (both blind and double-blind). The researchers involved included not only observers from various PRC colleges and medical research institutes, but also representatives from the PRC National Defense Science Commission. Because of the involvement of the latter, it was deemed necessary that an unclassified Intelligence Information Report be prepared by the DIA (see Shuhuang et al., 1981), which included a detailed English translation of the article.

Additional research carried out by the Aerospace Medicine Engineering Institute in Beijing was reported in the July 1990 issue of the Chinese Journal of Somatic Science (Kongzhi et al., 1990; Jinggen et al., 1990; Banghui, 1990), which was also translated into English by the DIA. Reported in several articles are experiments involving the videotaping and high-speed photography of the transfer of test specimens (nuts, bundles of matches, pills, nails, thread, photosensitive paper, chemically treated paper, sponges dipped in $FeCl_3$, etc.) through the walls of sealed paper envelopes, double layered KCNS type paper bags, sealed glass bottles and tubes with sealed caps, and sealed plastic film canisters without the walls of any of these containers being breached. All of the Chinese experiments reported using gifted children and young adults, who possessed well-known extraordinary PK ability, to cause the teleportation of the various test specimens. In all the experimental cases that were reported, the test specimens that were teleported were completely unaltered or unchanged from their initial state, even the insects were

unaffected by being teleported. The experiments were well controlled, scientifically recorded, and the experimental results were always repeatable.

The Chinese papers are all extremely interesting and very well written, and they show photographs and schematic diagrams of the various experimental setups. The experimental protocols were explained in lengthy detail, and thorough data and statistical analysis were presented in the results. The combined results from the several Chinese experiments showed that:

- different research groups designed different experimental protocols, used different gifted psychics, used different sealed containers, and used different test specimens (live insects, bulk inanimate objects, and even radio micro-transmitters were used to track the location of the specimens) that were to be teleported;

- the time required for the teleportation of test specimens through various barriers was anywhere from a fraction of a second to several minutes, and this was not dependent on the test specimen that was used, the sealed container that was used (or its barrier thickness), which experimental protocol was used, or which psychic was being used

- the high-speed photography/videotaping recorded in one series of experiments that test specimens would physically "meld" or blend with the walls of sealed containers; and recorded in a different series of experiments that test specimens would simply disappear from inside the container only to reappear at another location (after seconds to several minutes of time transpired), such that the test specimen did not actually undergo total material disintegration/reintegration during teleportation – this data is important, because without the aid of electronic monitoring instruments, the average person's sensory organs and usual methods of detection are temporarily unable to perceive the test specimen's (ambiguous) existence during the teleportation process;

- the radio micro-transmitter used as a test specimen in one series of experiments (Shuhuang et al., 1981) transmitted a radio signal to several stationary electronic instruments/receivers, so that the specimen could be tracked and monitored (via signal amplitude and frequency measurements) during the teleportation process; the experimenters discovered that there was large fluctuations in the intensity (in both amplitude and frequency) of the monitored signal to the effect that it would either completely disappear or become extremely weak (to the extent that the monitoring instruments could scarcely detect it) – it was discovered that there was a definite correlation between the change in strength (i.e., radical frequency shifts were observed) of the monitored radio signal and the teleportation of the test specimen, such that the weak or absent signal indicated that the specimen was "nonexistent" (or in an altered physical state) during teleportation (note: the monitored signal amplitude and frequency of the micro-transmitter specimen were stable before and after teleportation);

- before and after "passing through the container wall/barrier", the test specimen and the container's wall/barrier are both complete solid objects;

- the gifted psychics were never allowed to see (they were blindfolded in many experiments) or touch each of the test specimens or the sealed containers before and after experiments were conducted, and only the experimenters touched the specimens and containers (using both blind and double-blind protocols);

- the experimental results were all repeatable

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- the conditions for fraud and sleight of hand were totally eliminated, and multiple independent outside witnesses (technical and military-intelligence experts) were present at all times to ensure total fidelity of the experiments

The experimental radio micro-transmitter and high-speed photography/videotaping data offer an important clue on what the teleportation mechanism is, and this will be discussed further in Section 5.1.1. The Chinese were unable to offer any significant physics hypothesis that could explain their results. Some researchers stated that it is necessary to invoke a new physics, which somehow unifies the human consciousness (i.e., physics of consciousness) with quantum and spacetime physics, in order to understand p-Teleportation and related PK phenomena. The researchers were amazed by their repeated results, and were barely able to fathom the altered "state of being" that test specimens underwent during teleportation.

It is also important to point out that during the Cold War the DIA produced three (now declassified) reports on the parapsychology research of the Soviet Union and its Warsaw Pack allies (LaMothe, 1972; Maire and LaMothe, 1975; DIA Report, 1978; other related studies were reported by Groller, 1986, 1987). The purpose of the reports was to collate and summarize collected intelligence, describe in great detail, and assess the Soviet Union and Warsaw Pact R&D on parapsychology and paraphysics. The reports outlined the history of pre-revolutionary (Czarist) Russian, and WWII and post-WWII era Soviet R&D on psychotronics, human mind/behavior control, and the entire spectrum of parapsychology. The Soviet information also mentions the psychotronic/parapsychology R&D materials that Soviet military forces took from various Nazi research centers in and around Germany at the end of WWII. The entire spectrum of parapsychology phenomena was explored by the Soviets, which resulted in the generation of a wealth of experimental data and related scientific research literature. One DIA report noted that there was an East versus West science debate in the Soviet literature over whether paranormal phenomenon and related experimental data was real or even scientifically sound in comparison to western scientific practice and philosophy. Another DIA report lists the names and affiliations of all the researchers, as well as the names of the various Soviet and Warsaw Pact research centers, that were involved. Also, Pratt (1986) reviews and summarizes the history of Soviet psychotronics research.

The U.S. military-intelligence establishment was concerned with the possibility that the Soviets and their Warsaw Pact allies were conducting psychotronics and mind control R&D in order to discover how to exploit and control powerful phenomena that could be used against the U.S. and its allies. LaMothe (1972) chronicled how the Soviets had been researching methods of influencing human behavior for over sixty years. The Soviets and their allies extensively explored an influence technology that they called "controlled offensive behavior", which is defined as "research on human vulnerability as it applies to methods of influencing or altering human behavior" (LaMothe, 1972). Also, LaMothe (1972) describes the revolutionary techniques the Soviets studied to influence human behavior, which included: sound, light, color, odors, sensory deprivation, sleep, electromagnetic fields, biochemicals, autosuggestion, hypnosis, and parapsychology phenomena (such as psychokinesis, telekinesis, extrasensory perception-ESP, astral projection, clairvoyance, precognition, and dream state, etc.). The LaMothe (1972) report became an aid in the development of countermeasures for the protection of U.S. and/or allied personnel.

Psychotronics is the general term that was used in the former Soviet Union/Warsaw Pact countries to categorize many psychic phenomena undergoing scientific research. The conclusions that were reached in the DIA reports are that within the category of psychotronics, the Soviets identified two discrete skills (LaMothe, 1972):

- <u>bioenergetics</u>: those phenomena associated with the production of objectively detectable effects such as psychokinesis, telekinesis, levitation effects, transformations of energy, i.e. the altering or affecting of matter

- <u>bioinformation</u>: those phenomena associated with the obtaining of information through means other than the normal sensory channels (i.e., ESP), such as telepathy, precognition, and

clairvoyance, i.e., using the mind to tap into the thoughts of others or to acquire present or future information about objective events in the world

These phenomena involve using the mind and/or some "field" of the body to affect other minds and inanimate objects irrespective of intervening distance or elapsed time, and without engaging any conventional tools. Bioenergetics and bioinformation are two classifications that form a single branch of science the Soviets preferred to call biocommunications. Soviet biocommunications research is primarily concerned with exploring the existence of a definite group of natural phenomena controlled by laws that are not based on any known (energetic) influence. The types of biocommunication (a.k.a. psychotronics) phenomena includes special sensory biophysical activities, brain and mind control, telepathic communications or bioinformation transceiving, bioluminescent and bioenergetic emissions, and the effects of altered states of consciousness on the human psyche. Psychotronics and remote viewing provide capabilities that have obvious intelligence applications. The Soviets and their Warsaw Pact allies invested millions of dollars in psychotronics R&D because they understood this, and saw the potential payoff for military and intelligence applications.

The U.S. response to Soviet psychotronics R&D programs was the Remote Viewing program. In addition, the U.S. Army began the JEDI Project in 1983, which sought to increase human potential using teachable models of behavioral/physical excellent by unconventional means (Alexander et al., 1990). The JEDI Project was essentially a human-performance modeling experiment based on neuro-linguistic programming (NLP) skills, whereby advanced influence technologies to model excellence in human performance was used. The program ran under the auspices of the Army INSCOM and the Organizational Effectiveness School, and was sponsored by a U.S. government interagency task force. Finally, it should be pointed out that the program had successfully trained several hundred people, including members of Congress (such as Al Gore, Jr. and Tom Downey), before being terminated.

There is a wealth of factual scientific research data from around the world attesting to the physical reality of p-Teleportation and related anomalous psi phenomena (Mitchell, 1974b; Targ and Puthoff, 1977; Nash, 1978; Radin, 1997; Tart et al., 2002). The skeptical reader should not be so quick to dismiss the subject matter in this chapter, because one must remain open-minded about this subject and consider p-Teleportation as worthy of further scientific exploration. The psychotronics topic is controversial within the western scientific community. The debate among scientists and scientific philosophers is highly charged at times, and becomes acrimonious to the point where reputable skeptical scientists cease being impartial by refusing to examine the experimental data or theories, and they prefer to bypass rational discourse by engaging in ad hominem attacks and irrational "armchair" arguments.

P-Teleportation and related phenomena are truly anomalous, and they challenge accepted modern scientific paradigm. Lightman and Gingerich (1991) wrote, "Scientists are reluctant to change paradigms for the purely psychological reasons that the familiar is often more comfortable than the unfamiliar and that inconsistencies in belief are uncomfortable." And theories change over time when anomalies enter the picture. Anomalies are particularly helpful for they point to the inadequacies of an old model and point the way to a new one. Anomalous scientific facts are unexpected and difficult to explain within an existing conceptual framework. Kuhn (1970) describes scientific discovery as a complex process, in which an anomalous fact of nature is recognized, and then followed by a change in conceptual framework (i.e., paradigm) that makes the new fact no longer an anomaly. Kuhn stated that, "Discovery commences with the awareness of anomaly, that is, with the recognition that nature has somehow violated the pre-induced expectations that govern normal science." This statement neatly describes exactly what transpired during the historical revolution that took place in physics between the classical mechanics/electrodynamics age in the 19th century and the quantum/atomic/nuclear/relativistic age in the 20th century. And this isn't the only time in human history that scientific paradigms have dramatically changed. The discovery of p-Teleportation already commenced in the 20th century, so let us continue the discovery and create a new physics paradigm for the 21st century.

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5.1.1 Hypothesis Based on Mathematical Geometry

The Chinese researchers reported in their teleportation experiments that high-speed photography/videotaping recorded test specimens physically "melding" or blending with the walls of sealed containers, and in a different series of experiments the test specimens would simply disappear from inside the container only to reappear at another location (after seconds to several minutes of time transpired). They also reported in the series of radio micro-transmitter experiments that there were large fluctuations in the intensity (in both amplitude and frequency) of the monitored signal to the effect that it would either completely disappear or become extremely weak (to the extent that the monitoring instruments could scarcely detect it); and they discovered that there was a definite correlation between the change in strength (i.e., radical frequency shifts were observed) of the monitored radio signal and the teleportation of the radio micro-transmitter, such that the weak or absent signal indicated that the specimen was "nonexistent" (or in an altered physical state) during teleportation. This data is important because without the aid of electronic monitoring instruments, the average person's sensory organs and usual methods of detection are temporarily unable to perceive the test specimen's (ambiguous) existence during the teleportation process. This data offers an important clue on what the teleportation mechanism is.

It is beyond the scope of this study to propose a complete self-consistent physics theory of consciousness/mind, which explains how the mind can activate p-Teleportation and related psychotronics phenomena. This topic has been under study in recent decades by a legion of medical science, bio- and neuro-physiology, psychology, mathematics, philosophy, and physics experts. Many different theories with varying degree of theoretical maturity and self-consistency have been proposed over the years, and most of them have not yet been experimentally tested for various reasons. However, some first-order experimental work has been done (Mitchell, 1974b; Targ and Puthoff, 1977; Wolman et al., 1986; Radin, 1997; Tart et al., 2002). Ironically, quantum mechanics theory, and the related physics of quantum entanglement and teleportation, has become the primary focus of all of the physics theories of consciousness/psychotronics that have been recently proposed (see for example, Shan, 2003). Wolman et al. (1986) and Radin (1997) provide a review and discussion on recent theories and experiments that are based on quantum physics theory (see also, Walker, 1974; Targ and Puthoff, 1977; Mitchell, 1999, and the references cited therein; Tart et al., 2002). It appears that the physics of q-Teleportation (Chapter 3) has tremendous relevance to the physics of p-Teleportation and psychotronics.

In the following I propose a parsimonious first-order hypothesis that can explain the gross features of both the Chinese p-Teleportation data and the other reported p-Teleportation phenomena. But I will refrain from including any role that might be played by quantum phenomena since the scientific community has not yet settled that particular issue. (However, it is apparent that quantum theory and quantum phenomena will likely play a key role in a formal physics theory of PK and psychotronics.)

First-Order Hypothesis:

- Fact 1: The mature discipline of mathematical geometry developed the properties of higher dimensional spaces (Reichenbach, 1957; Manning, 1977; Rucker, 1977). An example of one such property that is of relevance to the hypothesis: One can visualize a four-dimensional world by using color as the 4th dimension. We can think of a three-dimensional world, whereby objects pass through one another if their colors (i.e., four-dimensional locations) are different (Reichenbach, 1957). For example, color can be used as a 4th dimension to see how a knot in three-dimensions can be untied in a 4th spatial dimension without moving the ends of the cord. That is because a cord cannot stay knotted in four-dimensional space, because the extra degree of freedom will cause any knot to slip through itself. Two other interesting and relevant examples are that the links of a chain may be separated unbroken in the 4th dimension, and a flexible sphere may be turned inside out without tearing in the 4th dimension (Manning, 1977; Rucker, 1977).

- Proposition 1 and Fact 2: It has been proposed that our space actually possesses a slight four-dimensional hyperthickness, so that the ultimate components of our nervous system are actually higher dimensional, thus enabling the human mind/brain to imagine four-dimensional space (Hinton, 1888, 1904; Rucker, 1977). If this is the case, then the three-dimensional nets of neurons that code thoughts in our brain may form four-dimensional patterns to achieve four-dimensional thought. The "bulk" space in 3-brane theory (see Section 4.1), and experimental data from the Remote Viewing program (see Section 5.1), provide support for this concept. Can we see into the 4th dimension and have four-dimensional thoughts? Yes, we can. Proof (see, Rucker, 1977, 1984): If you look at a Necker cube for a while, it spontaneously turns into its mirror image and back again. If you watch it do this often enough, the twinkling sort of motion from one state to the other begins to seem like a continuous motion. But this motion can only be continuous if it is a rotation in four-dimensional space. The mathematician August F. Möbius discovered in 1827 that it is in fact possible to turn a three-dimensional solid object into its mirror image by an appropriate rotation through four-dimensional space (a.k.a. hyperspace rotation). Thus, it is actually possible for our minds to perform such a rotation. Therefore, we can actually produce four-dimensional phenomenon in our minds, so our consciousness is four-dimensional. Rucker (1984) shows another dramatic example of being able to see into the 4th dimension via a "Neck-A-Cube."

- Fact 3: Another property of higher dimensional geometry (Reichenbach, 1957; Rucker, 1977, 1984) is that one can move through solid three-dimensional obstacles without penetrating them by passing in the direction of the 4th (spatial) dimension. The 4th dimension is perpendicular to all of our normal three-dimensional space directions, and so our three-dimensional enclosures have no walls against this direction.

- Conclusion and Hypothesis: Therefore, the results of the Chinese p-Teleportation experiments can simply be explained as a human consciousness phenomenon that somehow acts to move or rotate test specimens through a 4th spatial dimension, so that the specimens are able to penetrate the solid walls/barriers of their containers without physically breaching them. No real dematerialization/rematerialization of the specimens takes place. The intensity fluctuations of the radio micro-transmitter specimen's electromagnetic signal, and the apparent blending of the other specimens with the walls of their containers, represent the passage of the specimens through a 4th spatial dimension. During teleportation the radio signals emitted by the micro-transmitter became weak/non-existent and fluctuated, because they were spreading out into the 4th dimension and became undetectable in our three-dimensional space. The weak signals that were ("barely") detected represent the leakage of a portion of the radio signal back into our three-dimensional space from the 4th dimension during teleportation. The observed blending of the other specimens with the walls of their containers is how the movement/rotation of the specimens through the 4th dimension was visually interpreted by the mind (along the lines of the Necker cube or Neck-A-Cube examples).

5.2 Conclusion and Recommendations

We will need a physics theory of consciousness and psychotronics, along with more experimental data, in order to test the hypothesis in Section 5.1.1 and discover the physical mechanisms that lay behind the psychotronic manipulation of matter. P-Teleportation, if verified, would represent a phenomenon that could offer potential high-payoff military, intelligence and commercial applications. This phenomenon could generate a dramatic revolution in technology, which would result from a dramatic paradigm shift in science. Anomalies are the key to all paradigm shifts!

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•**Recommendations**:

- There are numerous supporters within the U.S. military establishment who comprehend the significance of remote viewing and PK phenomenon, and believe that they could have strategic implications. Bremseth (2001), a U.S. Navy SEAL, attended the Marine War College and studied the Remote Viewing program, and interviewed many of the former program participants. Bremseth then wrote his thesis on the topic, and concluded that the evidence supported continued research and applications of remote viewing. A research program improving on and expanding, or implementing novel variations of, the Chinese and Uri Geller-type experiments should be conducted in order to generate p-Teleportation phenomenon in the lab. The performances and characteristics of p-Teleportation need to be delineated in order to develop a refined hypothesis. Such a program should be designed so that an operational model for p-Teleportation can be developed and implemented as a prototype. An experimental program similar in fashion to the Remote Viewing program should be funded at $900,000 – 1,000,000 per year in parallel with a theoretical program funded at $500,000 per year for an initial five-year duration. The role of quantum physics theory and related quantum phenomena (i.e., entanglement and teleportation) in p-Teleportation and psychotronics should be explored in this program (see for example, the Biological Quantum Teleportation recommendation in Section 3.3). An experiment definition study should be conducted first to identify and propose the best experiments for this program, which should be funded at $80,000 for one year.

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APPENDIX A – A Few Words About Negative Energy

A.1 A General Relativistic Definition of Negative or Exotic Energy

We saw in equations (2.10a-c) that the surface energy and stress-tension densities of the material required to create and thread a traversable wormhole must be "negative." For surface stress-energy, and volume stress-energy in general, this is "negative" in the sense that the material we must deploy to generate and thread the traversable wormhole must have an energy density (ρc^2, ρ = mass density) that is less than the stress-energy density (τ), or we can write this condition as: *mass-energy* $\rho c^2 \leq$ *stress-energy* τ. On the basis of this condition, we call this material property "exotic." Therefore, the term "negative" is just a misnomer in this context. The condition for ordinary, non-exotic forms of matter that we are all familiar with is *mass-energy* $\rho c^2 >$ *stress-energy* τ. This condition represents one version of what is variously called the weak (WEC), null (NEC), average (AEC), dominant (DEC), strong (SEC) or "standard" energy conditions (that are mere hypotheses!), which allegedly forbid negative mass-energy density and gravitational repulsion (antigravity) between material objects to occur in nature. Hawking and Ellis (1973) formulated these energy conditions in order to establish a series of mathematical proofs in their study of the application of general relativity theory to cosmology and black hole physics.

However, there are general theorems of differential geometry that guarantee that there must be NEC violations (meaning exotic matter-energy is present) at a wormhole throat (Visser, 1997). In view of this, it is known that static radial electric or magnetic fields are borderline exotic when threading a wormhole, if their tension were infinitesimally larger, for a given energy density (Herrmann, 1989; Hawking and Ellis, 1973). Other exotic (energy condition violating) matter-energy fields are known to be squeezed quantum states of the electromagnetic field and other squeezed quantum fields (see Section A.2 for the discussion on squeezed quantum states), gravitationally squeezed vacuum electromagnetic zero-point energy (see Section 2.3 for the discussion on Gravitationally Squeezed Vacuum Energy), Casimir (electromagnetic zero-point) energy and other quantum fields/states/effects. These examples represent forms of matter-energy that possess negative energy density. Since the vacuum is defined to have vanishing energy density, anything possessing less energy density than the vacuum must have a negative energy density. With respect to creating wormholes, these have the unfortunate reputation of alarming physicists. This is unfounded since all the energy condition hypotheses have been experimentally tested in the laboratory and experimentally shown to be false - 25 years before their formulation (Visser, 1990 and references cited therein). Further investigation into this technical issue showed that violations of the energy conditions are widespread for all forms of both classical and quantum matter-energy such as planets, stars, black holes, neutron stars, people, space dust clouds, etc. (Davis, 1999b; Barcelo and Visser, 2002). In addition, Visser (1995) showed that all (generic) spacetime geometries violate all the energy conditions. Violating the energy conditions commits no offense against nature.

A.2 Squeezed Quantum States and Negative Energy

In quantum mechanics the energy (E) and frequency (ν) of a quantum oscillator system, such as electromagnetic radiation (or light), are interchangeable via the Planck relation $E = h\nu$ ($h = 2\pi\hbar$). And from the Heisenberg quantum uncertainty principle, we know that the conjugate variable to the frequency is the oscillator phase (φ), such that $\Delta\nu\Delta\varphi \geq \hbar$ is obeyed. Phase is difficult to measure and is ignored in characterizing complex quantum systems.

Recent theoretical and experimental work has shown that in many quantum systems the limits to measurement precision imposed by the quantum vacuum zero-point fluctuations (ZPF) can be breached

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by decreasing the frequency noise at the expense of increasing the phase noise (thus maintaining $\Delta\nu\Delta\varphi \geq \hbar$), while at the same time the variations in frequency, and therefore the energy, are reduced below the ZPF such that the energy becomes "negative." "Squeezing" is thus the control of quantum fluctuations and corresponding uncertainties, whereby one can squeeze the variance of one (physically important) observable quantity provided the variance in the (physically unimportant) conjugate variable is stretched/increased. The squeezed quantity possesses an unusually low variance, meaning less variance than would be expected on the basis of the equipartition theorem. We can exploit quantum squeezing to extract energy from one place in the ordinary vacuum at the expense of piling up excess energy elsewhere (Morris and Thorne, 1988).

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Appendix B – *TH*εμ Methodology

In the formalism of the *TH*εμ methodology, the functions T and H are introduced by requiring that the Lagrangian for the motion of particles (with charge e_a and mass m_{0a} for the ath particle), under the joint action of gravity and the electromagnetic field A_α ($\alpha \equiv$ spacetime vector components), be expressed in the canonical form

$$L = \sum_a \int \left(-m_{0a} \sqrt{T - H v_a^{\ 2}} + e_a A_\alpha v_a^{\ \alpha} \right) dt + \left(8\pi\right)^{-1} \int \left(\varepsilon \mathbf{E}^2 + \mu^{-1} \mathbf{B}^2 \right) d^3x\, dt \qquad \text{(B.1);}$$

where the arbitrary functions T, H, ε, and μ are functions of the metric (a.k.a. gravitation field), $v_a^{\ \alpha}$ is the ath particle four-vector velocity, and A_α is the electromagnetic field four-vector potential, $\boldsymbol{E}$ and $\boldsymbol{B}$ are the electric and magnetic field strengths, and (B.1) is in geometrodynamic natural units ($\hbar = c_0 = G = \varepsilon_0 = \mu_0 = 1$). The Lagrangian characterizes the motion of charged particles in an external gravitational field by the two functions T and H, and characterizes the response of the electromagnetic fields to the external gravitational field by the two functions ε and μ. For all standard (metric) theories of gravity, the four functions are related by

$$\varepsilon = \mu = \sqrt{\frac{H}{T}} \qquad \text{(B.2);}$$

and ***every*** metric theory of gravity satisfies this relation, such that the Einstein Equivalence Principle is satisfied.

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In this paper I discuss the theory and actuality of the effects of Time Dilation, as predicted by Einstein's Special Relativity. Alongside this the research investigates the visible, experiential effects of most personal form of Time Travel from a personal, phenomenological perspective, illustrated through digital media.

The body of work, this paper and an accompanying book of modified digital images, recalls the Hafele-Keating experiment of October 1971 and parallels the Quantified Self experiments of diary photography and personal analytics in a holistic, interconnected way.

The work tracks 12 months of air travel and illustrates with practical data the physics and mathematics behind the theory and actuality of Time Dilation. The research combines the interdisciplinary worlds of Computer Arts with Data and Scientific Visualisation to create a tangible collision between the visualisation of the personal and illustration of theory

The observations are documented in ethnographic, photo essay illustrations as an investigation into the mathematics and physics of personal and interpersonal time. Using situated imaging presented as a practice-based body of work to communicate the abstract world of very small time periods and the direct relevance of Einstein's work on the personal and perceptual world we inhabit. Contrasting Newtonian mechanics and Einsteinian space-time the work seeks to illustrate the personal nature of how the reality of time travel influences every aspect of the interpersonal

Time dilation. Time travel. General relativity. Special relativity. Visual thinking. Photography. Visualisation. Practice-based research. Art.

1. INTRODUCTION

In 1971 two American researchers, J.C. Hafele and R. E. Keating, conducted an experiment.

They placed two caesium atomic clocks on passenger airplanes and flew them in opposite directions around the globe to test a hypothesis first posited in Einstein's theory of special relativity.

Their aim was to measure the effects of relativity on these highly accurate devices - the predictions indicated that the eastward flying clock would lose 40ns and the westward gain 275ns. A nanosecond is equal to one billionth of a second (10^{-9} or $^{1}/_{1,000,000,000}$ s). To compare, one nanosecond is to one second as one second is to 31.7 years.

> During October, 1971, four cesium atomic beam clocks were flown on regularly scheduled commercial jet flights around the world twice, once eastward and once westward, to test Einstein's theory of relativity with macroscopic clocks. From the actual flight paths of each trip, the theory predicted that the flying clocks, compared with reference clocks at the U.S. Naval Observatory, should have lost 40+/-23 nanoseconds during the eastward trip and should have gained 275+/-21 nanoseconds during the westward trip ... Relative to the atomic time scale of the U.S. Naval Observatory, the flying clocks lost 59+/-10 nanoseconds during the eastward trip and gained 273+/-7 nanosecond during the westward trip, where the errors are the corresponding standard deviations. These results provide an unambiguous empirical resolution of the famous clock 'paradox' with macroscopic clocks. (Hafele & Keating 1972)

The results showed that compared to stationary clocks in the laboratory the eastward clock lost 59ns and the westward gained 273ns. Whilst there has been discussion of the accuracy and therefore reliability of the measurements the experiment is commonly held up as one of the first to give practical evidence of the physical effects of time dilation.

2. SPECIAL RELATIVITY AND TIME DILATION

In special relativity Einstein States that the duration of time will pass at different rates when comparing an object at rest versus an object in motion. The greater the velocity of the object in motion, the closer to the speed of light, c, the greater the effect of what is known as 'time dilation'

The effect of this phenomenon is significant at speeds close to the constant of light speed but becomes exponentially less as the object in question approaches rest.

$$t' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Figure 1: *The mathematical relationship of time, velocity and the speed of light describing Time Dilation*

Unless our velocity is a substantial fraction of the constant speed of light the dilation effect (γ) is approximately 1. This, combined with our extremely limited lifespan is why we don't immediately notice time dilation at ordinary speeds. The fastest speed most humans will achieve, an airplane travelling near the speed of sound, gives a time dilation where γ = 1.0000000000005.

In other words, 1 second for a passenger on the plane would pass as 1.0000000000005 seconds for a stationary observer.

Time effectively passes more slowly for the traveller relative to the observer.

3. THE REALITY OF THE EFFECT

Whilst there is discussion of the validity of the results of the 1971 Hafele & Keating experiment, particularly around the 'corrections' made to their data at publication, their initial observations are clearly aligned with the predicted results to be expected from the mathematics for time dilation.

As Reinhardt *et al* (2007) note:

> Time dilation is one of the most fascinating aspects of special relativity as it abolishes the notion of absolute time

In their 2007 paper they investigate the effects of time dilation with even more accurate atomic clocks, adding more experimental evidence consistent with special relativity. There are also numerous other experiments, such as those into muon decay, that provide additional practical evidence that the effect described is real and measurable.

Figure 2: *Over Dorset: Duration 55 minutes*

4. IMPLICATIONS FOR EVERYDAY LIFE

The practical implications for everyday life at first appear intangible when one considers the seemingly miniscule time periods being discussed. Even taking some of the most extreme examples one can imagine being feasible, such as that of a cosmonaut living in a fast low earth orbit, circumnavigating the earth every 90 minutes gives γ of approximately 1.0000000003.

If one considers our astronaut in orbit for two years, the Time Dilation due to special relativity would give an increase in lifespan of approximately 20 milliseconds. A millisecond is a thousandth (10^{-3} or $^{1}/_{1,000}$) of a second.

This gap of 20 milliseconds, or two hundredths of a second, are suddenly well within human scale perception and understanding. This is a common measured gap in motor racing and fast sports like downhill skiing. Even the record for the 100m sprint is now is 9.58 seconds, run by Usain Bolt at the World Athletics championships in Berlin in 2009.

Scales in milliseconds are spaces and durations that even humans with our modest lifespans can perceive and understand.

As Ed Lu, Science Officer on the International Space Station writes, from orbit, in his blog post on experiments in 'Relativity':

> After our 6 months in space, we will have actually aged slightly less than everyone else on the ground because of an effect called time dilation. It isn't by much (about 0.007 seconds), but it is one side benefit of flying in space!

Though the effects of time dilation at human scale speeds are often imperceptibly small they are nonetheless real. Seeing the implications of this reflected in everyday life reveals the truly personal nature of the time travel that we undertake in everything we do.

The realisation that time dilation is a tangible and observable phenomena that affects ourselves and everything around us was given heightened

poignancy by spending large amounts of time flying at altitude and high speed. Observing the curvature of our planet and seeing the dark sky at the edge of space overhead, watching the mountains and deserts as they slid effortlessly under the wings of successive aeroplanes. Being able to observe the size of the individual against the backdrop of a macro-cosmic scale all the while reflecting on the fact that to a subatomic particle travelling near the speed of light, the universe is about four weeks old and it can be crossed in a matter of months.

> Nature can produce even larger particle energies. Some particles striking the Earth's upper atmosphere have energies that exceed 2*1020 eV. If such particles are protons (with mass of about 1 GeV), their speeds would be 0.999 999 999 999 999 999 999 995 c. For them, γ is 1011. Now the age of the universe is about 13 billion years for us, but for such particles, the age of the universe would be about (13 billion years/1011), ie about a month. Such a particle could cross the visible universe in a matter of months (their time).

This twist of perspective, the deliberate 'making strange' that Shlovsky (1917) describes occurs when translating the abstract of the macrocosmic to the intimacy of the personal. The act of comparing and contrasting macro-scale physics and mathematics with recordings of human scale observations evidence reveals useful and potentially significant insights into the nature of the world we actually inhabit.

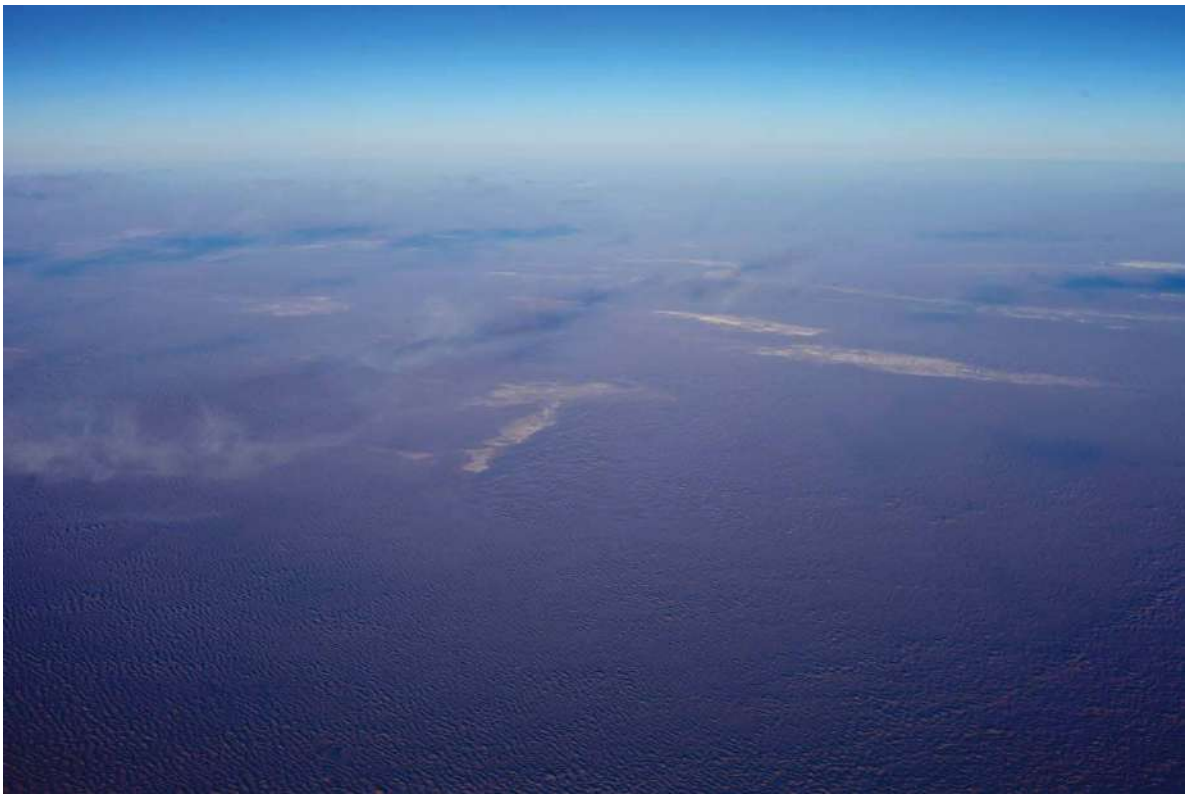

Figure 3: *Sunset over Northern China. Duration: 10 hours 50 minutes*

5. THE PICTORIAL AS PRACTICE-BASED RESEARCH

As Blevis (2011) so eloquently puts it, as an introduction to the extensive list of uses of digital imagery in design thinking.

> **Visual thinking** is the use of imagery and other visual forms to make sense of the world and to create meaningful content. Digital imagery is a special form of visual thinking, one that is particularly salient for HCI and interaction design

Alongside the descriptions of digital imagery as a *'form of information'* and a '*shared and externalised memory and cognition'* (Blevis 2012) I would argue that practice-based research, when used as an investigative tool, can assist in revealing and documenting subtle but important non-verbal evidence and also provide compelling and persuasive arguments within presentation of research findings and conclusions. The research approach taken in this area is explicitly practice-based, rooted within contemporary lens based digital media and video art. The investigative material presented as the counterpart to this research paper was collated from hundreds of

minutes of digital video and several hundreds of digital still images taken while airborne on commercial passenger aircraft during January - December 2013. Taken over the course of 44 flights, totalling over 80 hours airborne the visual material is published as a 42 page visual essay, also containing text elements and descriptions taken from this academic paper.

Figure 4*: Sunset over London. Duration: 55 minutes*

6. REALISATION OF EFFECT ON THE PERSONAL

Having recorded the number of flights, durations and distances the calculations based upon the mathematics of special relativity, as discussed earlier show that.

Given 44 flights totalling 85 hours and 20 minutes or approximately 5120 minutes flying time. gives 307,200 seconds of travel per year.

If γ = 1.0000000000005 when travelling at or near the speed of sound, gives a dilation of 0.0000001536 seconds.

To slip one second from base reference, such as the clock sat on my kitchen table I need to travel at my present annual rate for 6,510,416 Years.

Or to put it a different way, travel for a little over 260,000 years to slip one frame out of sync on a standard rate video camera.

7. CONSIDERING PHOTOGRAPHY IN EVIDENCE

When collating the increasing amounts of video and photographic material recorded whilst airborne, travelling at or near the speed of sound, the overwhelming sensation of velocity, of speed, of travel is ever-present. Viewed at a macro scale the visual material illustrates this distancing, sliding nature of objects moving in a larger framework. It supports the realisation that the terra firma so often taken as a baseline for observation is in itself only a small part of a larger perspective. The perspective that the proprioceptive nature of our observations of time, informed by the physicality of the form we have evolved and the life span perspective we consider as a norm and useful context are challenged by the linking of these measurable effects. The effects of the micro-scale variations in time seen in contrast to the macro-scale movement around the curve of the earth.

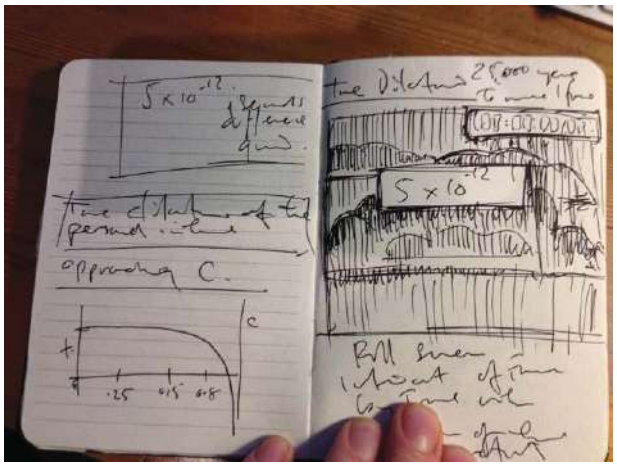

Figure 5: *An airplane travelling near the speed of sound gives a time dilation where γ = 1.0000000000005*

The visual material, when presented as an adjunct to the evidence of the universal but intimately personal nature of the effects of time dilation help communicate the simple fact that we are all time travelling. Pursuing our own clearly delineated paths and durations relative to each other. Rather than there being one universal time that exists everywhere, for everyone, all at the same moment the personal implication that there is real evidence to prove that this is an illusion is both moving and compelling.

Sitting in an airline seat riding at the edge of space, looking down on the oceans, seas, cities, forests and deserts, seeing terra firma for the illusion that it is. Not a constant underlying grid of space and time - the universal yard stick and the universal clock, such as Newtonian physics promised as it replaced the Aristotelian events-make-time view of the world that had reigned before in popular consciousness.

Realising that the H&K caesium clock from 1971 could be sat beside me, ticking away in its own little timetrack, ticking to a completely separate rhythm than its counterpart clock sat on my kitchen table at home. Realising that the slipping and sliding of our lives against each other is our own intimate version of time travel, we all move forward as future becomes present becomes past but the durations we experience, and that actually occur, and when ***now*** happens is subtly different for everyone. The

time we each experience actually does expand and contract as we move in space.

Figure 6: *Frost over Mongolia. Duration: 10 hours 55 minutes*

The illusion of the Newtonian ideal of a universal timescale, the idea of a 'universal now' is disappearing and being replaced by the ideas of general relativity. Of a universe full of individual 'nows' all unique and all moving independently. This change is akin to seeing the universe of unique, individual 'nows' at a human, personal scale and seeing a life travelling, sliding, back and forth in time against the 'nows' of those around one.

The important element this body of work seeks to describe is not physics or even a discussion of physics but an explanation of physics and the revelatory moment of seeing it in 'real' experienced life. This work seeks to relate that revelatory moment and articulate it with the artefacts, the book and the paper, telling the story of seeing how each and every one of us is travelling in time, independently, uniquely, every day.

> To see a World in a Grain of Sand
> And a Heaven in a Wild Flower,
> Hold Infinity in the palm of your hand
> And Eternity in an hour. (William Blake)

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St. Clair (43) Pub. Date: Dec. 18, 2003

(54) ROTOR INDUCTANCE PROPULSION SYSTEM

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(52) **U.S. Cl.** **244/172**

(57) **ABSTRACT**

The invention is a spacecraft having a circular, domed hull around which dual electrically-charged rotors one above the other are counter-rotating on the edge of the hull. Embedded in the hull are three solenoids which create a positive vector potential at the rotors. The surface charge density times the radius times the vector potential times the area of the rotors creates an angular momentum in the vertical direction. This angular momentum produces a positive spacetime curvature over the dome of the hull and a negative spiking spacetime compression over the rotors. By machining circumferential grooves of decreasing height along the radius of the rotor, a negative surface inductance is generated. This negative inductance gradient times the negative spacetime compression time the rotor current density squared times the rotor area squared is a positive lift force on the spacecraft.

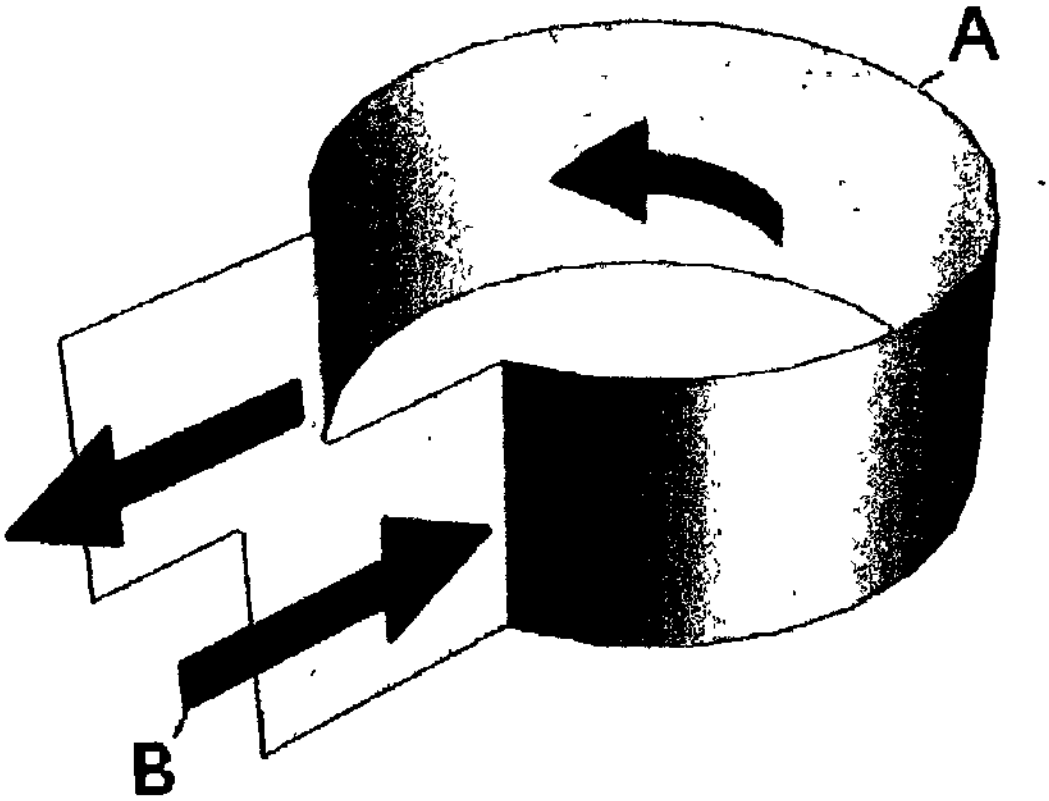

Figure 1

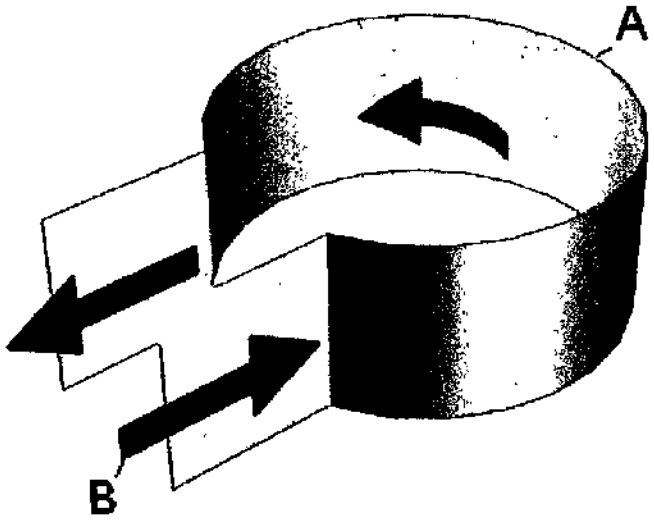

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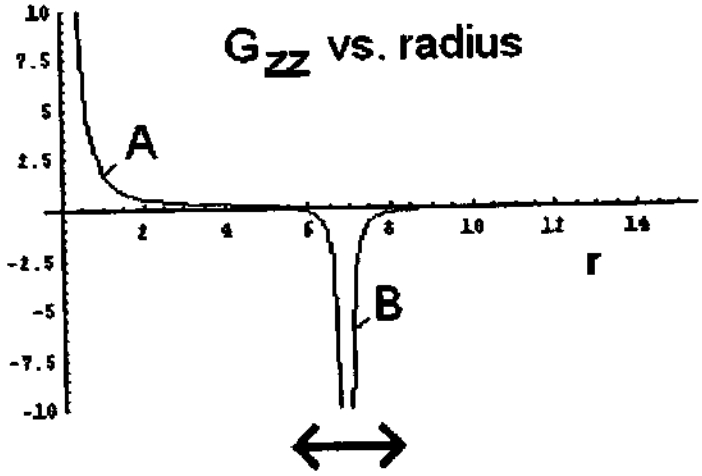

Figure 3

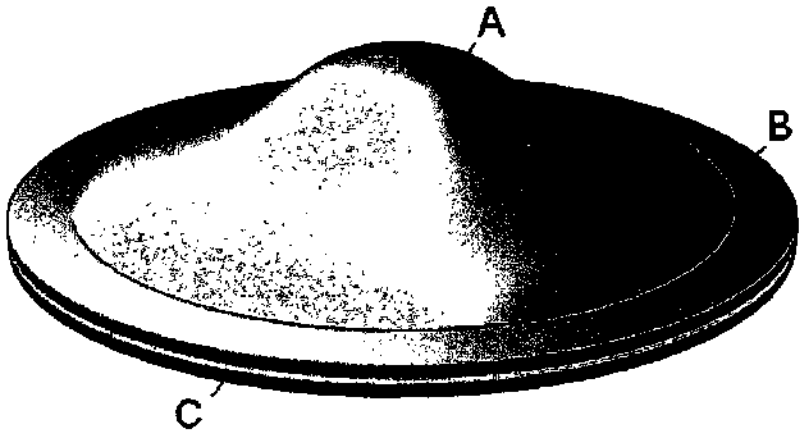

Figure 4

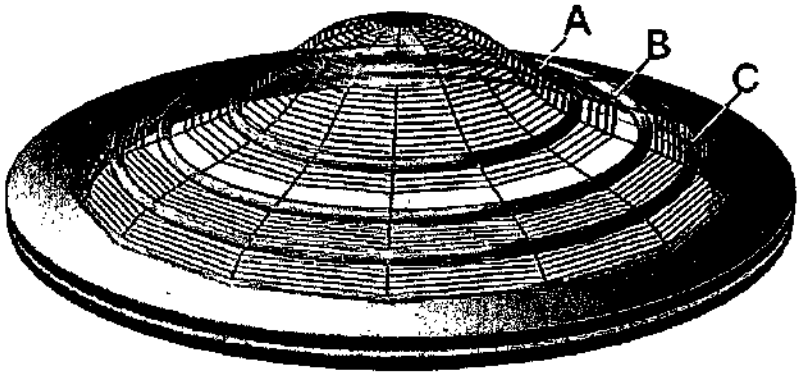

Figure 5

$$A = \frac{n I a^2}{2\varepsilon_0 c^2} \frac{1}{r'}$$

Figure 6

$$A \equiv \frac{1}{m} \frac{coul}{sec} m^2 \frac{m^2 kg\, m}{coul^2 sec^2} \frac{sec^2}{m^2} \frac{1}{m} = \frac{kg\, m}{sec\, coul}$$

Figure 7

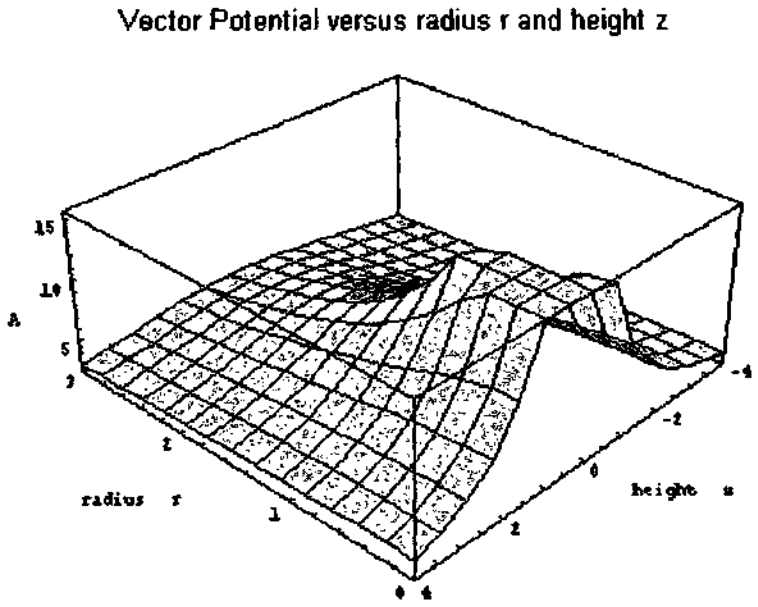

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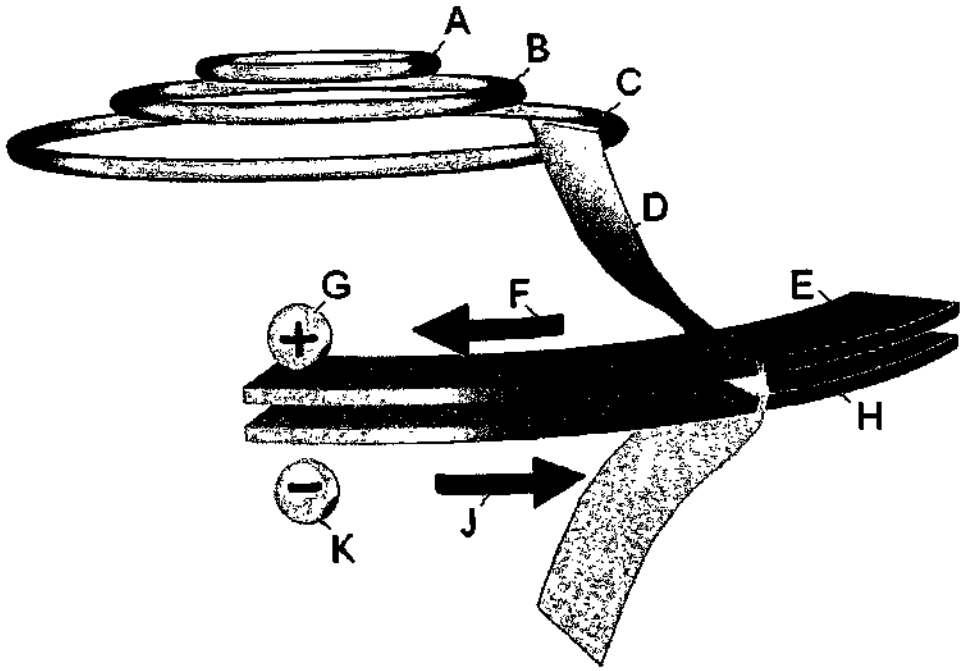

Figure 9

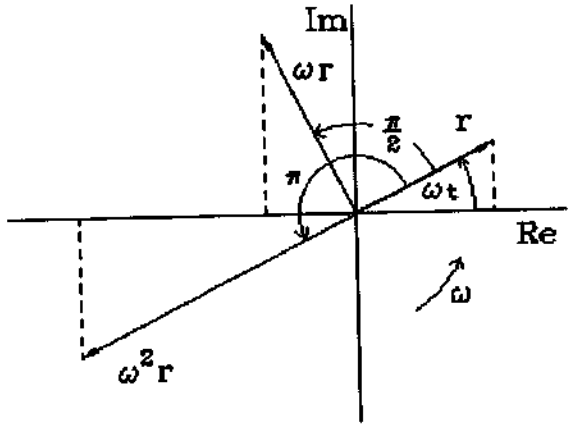

Figure 10

$$S_k = \left[-\sigma r e^{i\omega t} + \sigma r e^{-i\omega t}\right]\frac{n I a^2}{2\varepsilon_0 c^2}\frac{n_z \text{area}}{r'}$$

$$= -\left[e^{i\omega t} - e^{-i\omega t}\right]\left[\sigma r \frac{n I a^2}{2\varepsilon_0 c^2}\frac{n_z \text{area}}{r'}\right]$$

$$= -\left[e^{i\omega t} - e^{-i\omega t}\right]K$$

Figure 11

$$S \equiv \frac{\text{coul}}{m^2} m \frac{1}{m}\frac{\text{coul}}{\text{sec}} m^2 \frac{m^2}{\text{coul}^2}\frac{\text{kg}\,m}{\text{sec}^2}\frac{\text{sec}^2}{m^2}\frac{m^2}{m} = \frac{\text{kg}\,m^2}{\text{sec}}$$

Figure 12

$$e^{i\omega t} - e^{-i\omega t} = 2i\,\text{Sin}[\omega t]$$

Figure 13

$$S_k = -2iK\,\text{Sin}[\omega t]$$

Figure 14

$$ds^2 = \ldots - 4\frac{S}{r}dtd\theta = \ldots 8\frac{iK\,\mathrm{Sin}[\omega t]}{r}dtd\theta$$

Figure 15

$$g_{\mu\nu} = \begin{array}{c} \\ t \\ r \\ \theta \\ z \end{array} \begin{array}{c} \begin{array}{cccc} t & r & \theta & z \end{array} \\ \begin{vmatrix} -1 & 0 & 4\frac{iK\,\mathrm{Sin}[\omega t]}{r} & 0 \\ 0 & 1 & 0 & 0 \\ 4\frac{iK\,\mathrm{Sin}[\omega t]}{r} & 0 & r^2 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \end{array}$$

Figure 16

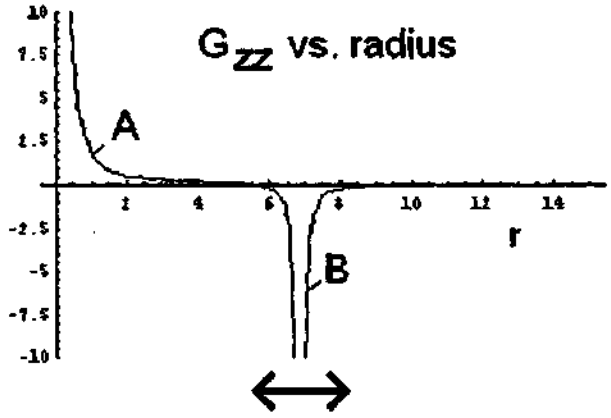

Figure 17

$$\text{Magnetic Energy} = -L\,K\,J^2\,A^2$$

Figure 18

$$\text{Magnetic Energy} \equiv -\frac{\text{kg}\,\text{m}^2}{\text{coul}^2}\frac{1}{\text{m}^2}\frac{\text{coul}^2}{\text{sec}^2\,\text{m}^2}\text{m}^4 = -\frac{\text{kg}\,\text{m}^2}{\text{sec}^2} = -\text{joule}$$

Figure 19

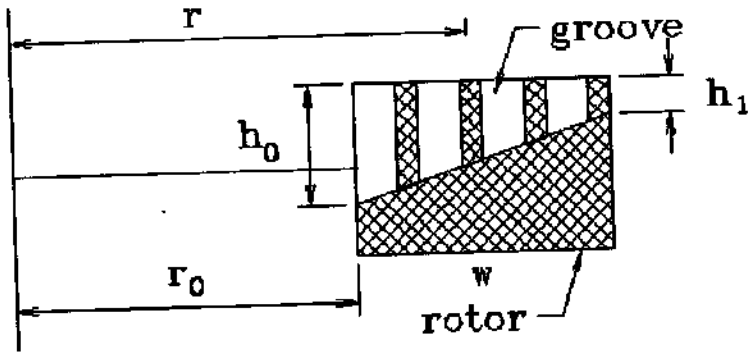

Figure 20

$$h = h_0 - (r - r_0)\left(\frac{h_0 - h_1}{W}\right)$$

Figure 21

$$\frac{dL}{dr} = \mu n^2 2\pi w \frac{\partial}{\partial r}\left(r\left(h_0 - (r - r_0)\left(\frac{h_0 - h_1}{w}\right)\right)\right)$$

$$\frac{dL}{dr} = \mu n^2 2\pi w\left(h_0 - \frac{(h_0 - h_1)(2r - r_0)}{w}\right)$$

Figure 22

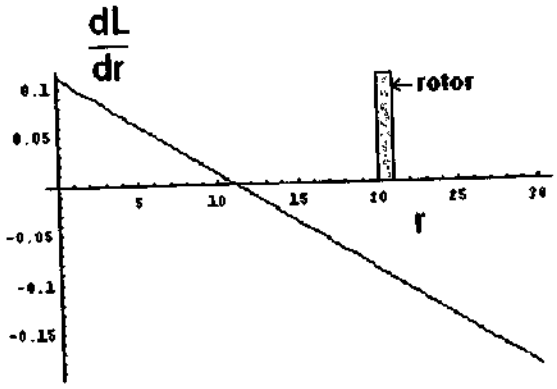

Figure 23

$$F = \frac{dL}{dr} K_c J^2 A^2 = \frac{kg\,m}{coul^2}\frac{1}{m^2}\frac{coul^2}{sec^2\,m^2} m^4 = \frac{kg\,m}{sec^2} = newton$$

ROTOR INDUCTANCE PROPULSION SYSTEM

BRIEF SUMMARY OF THE INVENTION

[0001] The invention, which is the object of my present application, is a spacecraft with a circular, domed hull around which are located dual electrically-charged counter-rotating rotors. The top surface of the upper rotor is etched with circular metallic grooves which give the rotor a surface inductance. The groove height decreases from the inside radius to the outside radius of the rotor giving it a radial inductance gradient. The surface charge density times the angular velocity produces a current density. The counter-rotating rotors produce a negative spacetime curvature over the rotors. The negative surface inductance gradient times the negative spiking spacetime curvature times the current density squared times the area squared is the positive lift force on the rotor.

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BACKGROUND OF THE INVENTION

[0007] I was reading several articles about the development of the magnetron during World War II in the Bell System Technical Journal. I was trying to understand why the device resonates because it must contain a spring constant which would arise from an inductance and capacitance due to the geometry of the cavity. As given by Feynman, inductance of a solenoid is the permeability of space times the turns per length squared times the volume of the solenoid. Referring to **FIG. 1**, the magnetron cavity (A) has a circular region connected to a planar region. The electrical current flows on the sides of the cavity shown by the arrows (B). In this case, there is only one turn per height of the cavity times the volume of the cavity times the permeability which produces the inductance. The two planar regions produce a capacitance across the ends which creates the resonant frequency.

[0008] From my previous patent application Dual Rotor Propulsion System I know that the two rotors produce a current density in the angular direction along the rotor. If I spread out the magnetron cavity into a circular groove around a rotor, then the current would flow on the side walls enclosing the groove volume. The rotors also produce a spacetime curvature profile as shown in **FIG. 2**. Curve (A) is a positive spacetime curvature tension over the dome. Curve (B) is a negative spiking spacetime curvature over the rotors. The curvature is measured in inverse meter squared. So the surface inductance times the negative curvature times the current density squared times the rotor area squared is magnetic energy. The differential of the magnetic energy would be a force. So there has to be a gradient of the surface inductance. The volume element of a groove is equal to the circumferential length times the height times the width of the groove. The easiest is to vary the height with radius. Since the curvature is negative, the gradient has to be negative as well in order to get a positive lift force. Thus the height goes from large to small from the inside to the outside radius.

SUMMARY OF THE INVENTION

[0009] The invention relates to a spacecraft with a domed, circular hull of elliptical cross-section having dual electrically-charged counter-rotating rotors located one above the other on the edge of the hull. The upper rotor is positively charged and rotates clockwise with a negative angular velocity per the right-hand rule. The lower rotor is negatively charged and rotates with a positive angular velocity. The current density is the surface charge density times the velocity of the rotor. This particular combination of velocity and charge produces an angular momentum which creates a negative spiking spacetime curvature over the rotors.

[0010] The top surface of the rotor is etched or machined with circular grooves around the rotor. This creates a surface inductance which is equal to the permeability of space times the turns per length squared times the volume of the groove. In this case, there is only one turn per height of the groove. If the height of the groove decreases from one groove to the next, then there is a negative surface inductance gradient in the radial direction. So the lift force on the rotors would be the negative surface inductance gradient times the negative spacetime curvature times the current density squared times the rotor area squared.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0011] Not Applicable.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **FIG. 1**. Perspective of magnetron cavity.

[0013] **FIG. 2**. Spacetime curvature G_{zz} over hull and rotor.

[0014] **FIG. 3**. Perspective view of spacecraft with dual rotors.

[0015] **FIG. 4**. Wire frame view of three solenoids.

[0016] **FIG. 5**. Vector potential equation for solenoid.

[0017] **FIG. 6**. Units of vector potential.

[0018] **FIG. 7**. 3D graph of vector potential using three solenoids.

[0019] **FIG. 8**. Perspective of vector potential along rotors.

[0020] **FIG. 9**. Rotor mechanics diagram using exponential representation.

[0021] **FIG. 10**. Angular momentum equation due to vector potential and rotating charged rotors.

[0022] **FIG. 11**. Units of angular momentum.

[0023] **FIG. 12**. Exponential equation for twice imaginary sine of the angle.

[0024] **FIG. 13**. Angular momentum equation for g metric tensor.

[0025] **FIG. 14**. Angular momentum term for elemental line length ds^2.

[0026] **FIG. 15**. The g metric tensor containing the angular momentum.

[0027] **FIG. 16**. The spacetime curvature tension G_{zz} versus radius due to angular momentum.

[0028] **FIG. 17**. Magnetic energy equation.

[0029] **FIG. 18**. Units of magnetic energy.

[0030] **FIG. 19**. Cross-section of rotor showing groove height gradient.

[0031] **FIG. 20**. Equation for the height h of the rotor groove as a function of radius.

[0032] **FIG. 21**. Equation for the groove inductance gradient.

[0033] **FIG. 22**. Plot of the groove inductance gradient as a function of radius showing that it is negative at the rotor.

[0034] **FIG. 23**. Lift force on rotors due to inductance gradient, compression curvature, rotor current density and area.

DETAILED DESCRIPTION OF THE INVENTION

[0035] 1. Referring to **FIG. 3**, the spacecraft has a circular, domed hull of elliptical cross-section with dual electrically-charged counter-rotating rotors one above the other on the edge of the hull.

[0036] 2. Referring to **FIG. 4**, embedded within the hull are three solenoids or current loops carrying a constant electrical current in the positive sense per the right-hand rule.

[0037] 3. Referring to **FIG. 5**, Feynman has shown that the vector potential {A} of a solenoid is equal to the number of turns per length {n} times the current {I} times the radius of the solenoid {a} squared divided by half the permittivity of space $\{\epsilon_0\}$ times the speed of light {c} squared times the radius {r'} prime from the center of the coil to some location in space such as the rotors. It has been found by physicists Bohm and Aharanov that the vector potential field is not confined to an infinitely long solenoid as is the magnetic B field. The vector potential has units of kilogram-meter per second-coulomb as seen in **FIG. 6**.

[0038] 4. Referring to **FIG. 7**, the three solenoids of varying radius and area produce a positive vector potential at the centerline of the rotors as seen in the graph.

[0039] 5. This graph is then rotated ninety degrees so that it can be located in relation to the rotors as seen in **FIG. 8**. The vector potential (D), which is created by solenoids (A,B,C), passes through rotors (E) and (H). Rotor (E), which has a positive charge (G), is rotating clockwise (F), and rotor (H), which has a negative charge (K), is rotating counter-clockwise (J).

[0040] 6. Referring to **FIG. 9**, rotor mechanics uses the exponential function for the harmonic motion of the rotor. The radius is $\{r\ e^{i\omega t}\}$ which when differentiated with respect to time becomes a velocity $\{i\ \omega\ r\ e^{i\omega t}\}$ where the imaginary {i} is a 90° phase lead which makes the velocity tangential to the rotor.

[0041] 7. The rotor surface charge {σ sigma} is rotating around at some radius {r}. For the upper rotor the surface charge density is positive {+σ} but the rotor has a negative angular velocity {−ω}. For the lower rotor, the surface charge density is negative {−σ} but the rotor has a positive angular velocity {+ω}. So the combined surface charge rotation is $\{-\sigma\ r\ e^{i\omega t}+\sigma\ r\ e^{-i\omega t}\}$. This charge rotation times the positive vector potential due to the solenoids times the rotor surface area is equal to angular momentum S as shown in **FIG. 10**. The units are given in **FIG. 11**. The angular momentum is equal to the negative of the difference of the exponentials times a constant. I then recalled that this difference is equal to twice imaginary sine of the angle as shown in **FIG. 12**.

[0042] 8. Referring to **FIG. 13**, the angular momentum is equal to minus two times the imaginary number times a constant times the sine of the rotational angle. In most of my spacecraft designs, the electromagnetic fields determine the flow rate of angular momentum. When the flow rate is integrated with respect to time, the angular momentum becomes imaginary. In this invention, the angular momentum is imaginary due directly to the rotors. The importance of being imaginary is that the radius resonates with the angular momentum. In some spacetime curvature equations, the denominator has a term equal to the radius to the fourth power plus twice the square of the angular momentum. In spacetime units, angular momentum is viewed as meter squared. So the square of imaginary angular momentum is negative angular momentum equal to negative meters to the fourth power. So at some radius, these two terms are equal, the denominator goes to zero, and the spacetime curvature becomes infinitely-large, creating a huge spike.

[0043] 9. This next section calculates the spacetime curvature from the equation for the angular momentum.

[0044] 10. Referring to **FIG. 14**, the elemental length ds^2 is curved by the presence of the angular momentum which is one of the energies, such as mass, charge, and electromagnetic fields, that Einstein showed can curve spacetime. Because the angular momentum is pointing in the vertical z-direction, due to the direction of the unit normal vector to the surface of the rotor, it rotates around in the angular direction {dtdθ} as found in cylindrical coordinates {t,r,θ,z}.

[0045] 11. In gravitational physics there is a g metric tensor which is a measure of length in spacetime coordinates. It is a 4 by 4 matrix with rows and columns equal to the cylindrical coordinates. Referring to **FIG. 15**, the diagonal of the matrix is $\{-1,1,r^2,1\}$ where the minus one corresponds to time which is Einstein's convention. Half the angular momentum goes in the {tθ} slot of the g metric tensor, and the other half goes in the {θt} slot.

[0046] 12. From this g metric tensor, Einstein's G curvature tensor can be calculated in the various direc-

tions. In Einstein's General Theory of Relativity, his equation is $G=8\pi T$ where G is the spacetime curvature measured in inverse meter squared, and the T tensor is the stress-energy-momentum matrix containing all the electromagnetic pressures, mass and momentum components that curve spacetime. The spacetime curvature tension G_{zz} in the vertical direction, as a function of radius, is shown in **FIG. 16**. A positive curvature indicates that there is a spacetime tension over the hull which produces lift. The curvature has a large positive spike over the dome of the hull (A) which means that there is a large lift force over the center of the hull. The curvature then falls off and spikes with a negative spacetime curvature compression over the rotors (B). This curvature also oscillates back and forth a short distance due to the sinusoidal term. The problem is to convert this compression into a lift force which this invention solves.

[0047] 13. This next section shows how the spacetime compression over the rotors generates lift.

[0048] 14. As I mentioned, I have been reading some of the World War II magnetron scientific papers of the Bell System Technical Journal. It turns out that inductance of a solenoid is equal to the permeability of space times the number of wire turns per length squared times the volume of the solenoid. Imagine having a copper strip in the shape of the magnetron cavity in **FIG. 1**. The electrical current (B) flows around the height of the strip (A), so there is only one turn per the height. Then that is multiplied by the volume of the cavity and permeability to get the inductance. The inductor is storing magnetic energy equal to half the inductance times the current squared. In this invention, current density J in amp per meter is used rather than current. So taking a hint from this information, the magnetic energy would have to be related to the inductance times the square of the current density times the area squared of the rotor and times the negative spacetime curvature. The curvature is measured in inverse meter squared. That product produces a negative magnetic energy when in fact I want a positive force. This means that there has to be an inductance gradient in the equation instead of pure inductance and, furthermore, the gradient has to be negative in order to cancel out the negative sign of the compression curvature.

[0049] 15. The equation for the magnetic energy in terms of the inductance $\{\mathcal{L}\}$, curvature $\{K\}$, current density $\{J\}$ and area $\{A\}$ is shown in **FIG. 17** with the units in **FIG. 18**. The inductance in the equation is proportional to the volume of the circular groove in the top surface of the rotor. That volume is equal to $\{2\pi\ r\ h\ w\}$ where $\{h\}$ is the height of groove (depth) and $\{w\}$ is the width located at some radius $\{r\}$. In terms of machining, it would be more difficult to machine a variable width groove rather than a deeper groove of a constant width. So I am going to say the gradient is in the radial direction with the height of the groove decreasing going from the inside radius to the outside radius as depicted in **FIG. 19**.

[0050] 16. **FIG. 20** gives the equation for the height of the groove along the radius of the rotor.

[0051] 17. **FIG. 21** gives the inductance gradient by differentiating the inductance with respect to the radius. The initial groove height ho is not very large, and the inductance gradient becomes negative at the rotor as seen in the graph of **FIG. 22**.

[0052] 18. Referring to **FIG. 23**, the lift force on the rotor is now positive due to the combined negative inductance gradient times the negative spacetime compression. The square of the negative current density is positive also. This means that that the top surface of the lower rotor can also have a surface inductance gradient which would double the lift force.

What I claim as my invention is:

1. A spacecraft having a circular, domed hull with dual electrically-charged counter-rotating rotors one above the other located on the edge of hull.

2. Said hull having embedded within it three or more solenoids which generate a positive vector potential at the rotors.

3. Said upper rotor having a positive surface charge density, and rotating clockwise in the negative direction per the right-hand rule.

4. Said lower rotor having a negative surface charge density, and rotating counterclockwise in the positive direction per the right-hand rule.

5. Said rotor surface charge density and velocity creating a negative current density on both rotors.

6. Said vector potential and rotating surface charge density on rotors generating an angular momentum in the vertical direction.

7. Said angular momentum, generating a spacetime curvature tension over the dome of the hull, and a negative oscillating spacetime curvature compression over the rotors.

8. Said rotors having circumferential grooves of decreasing height machined into the top surface of the rotors in order to create a negative surface inductance gradient.

9. Said negative surface inductance gradient times the negative spacetime curvature compression times the rotor current density squared times the rotor area squared generating a positive lift force on the spacecraft.

* * * * *

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(54) WALKING THROUGH WALLS TRAINING SYSTEM

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G09B 19/00 (2006.01)

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(57) ABSTRACT

This invention is a training system which enables a human being to acquire sufficient hyperspace energy in order to pull the body out of dimension so that the person can walk through solid objects such as wooden doors.

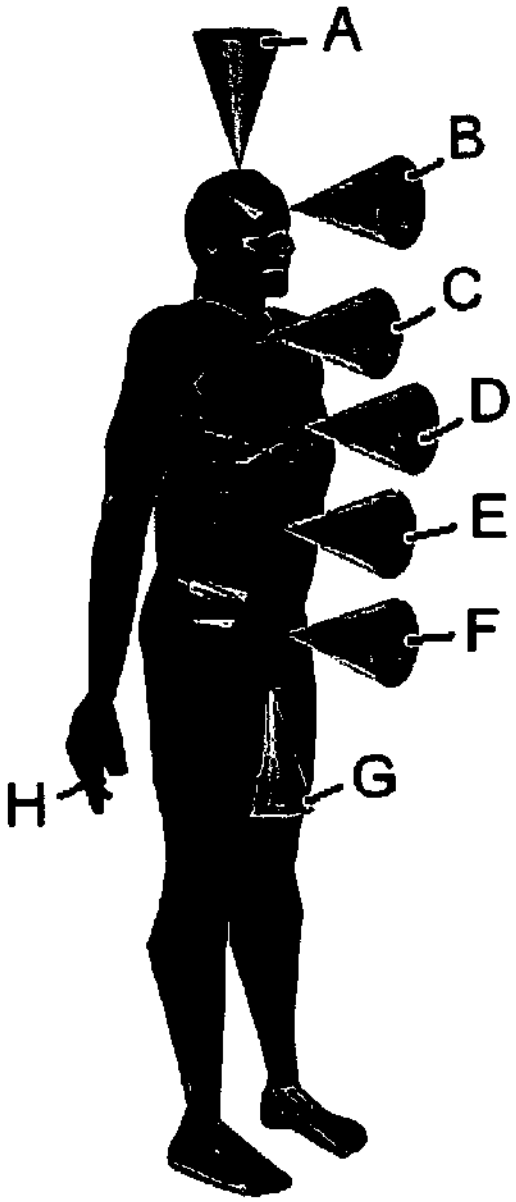

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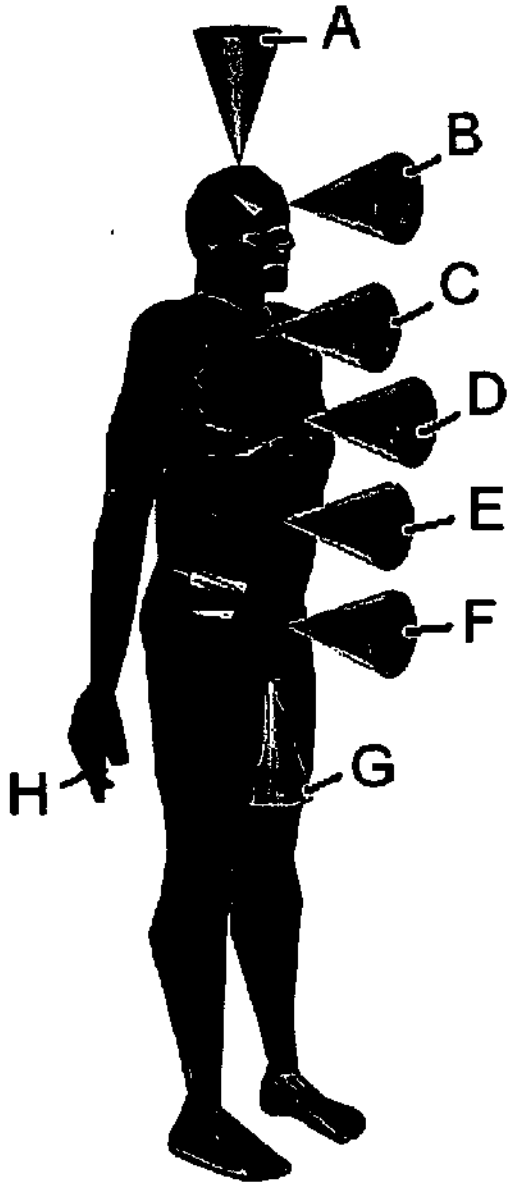

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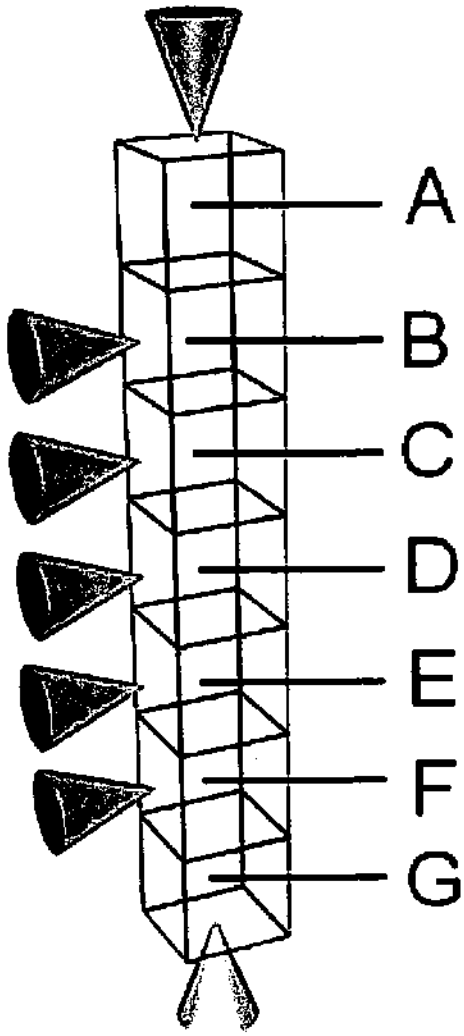

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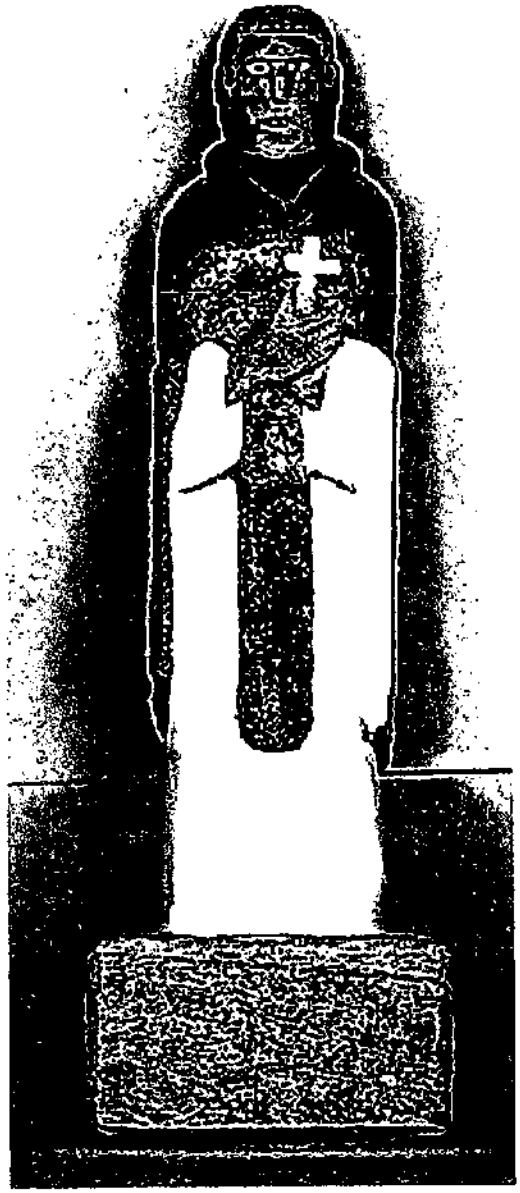

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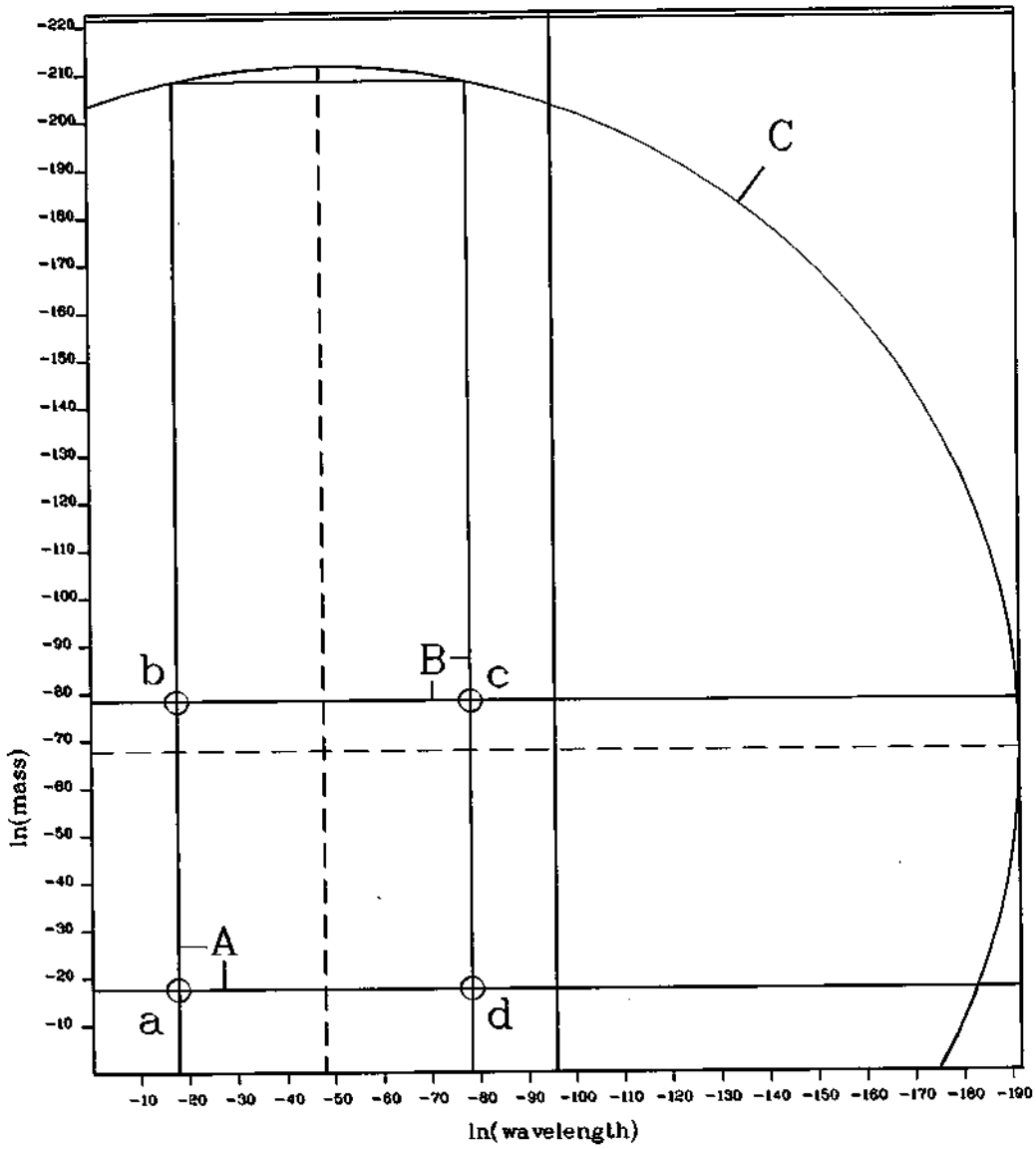
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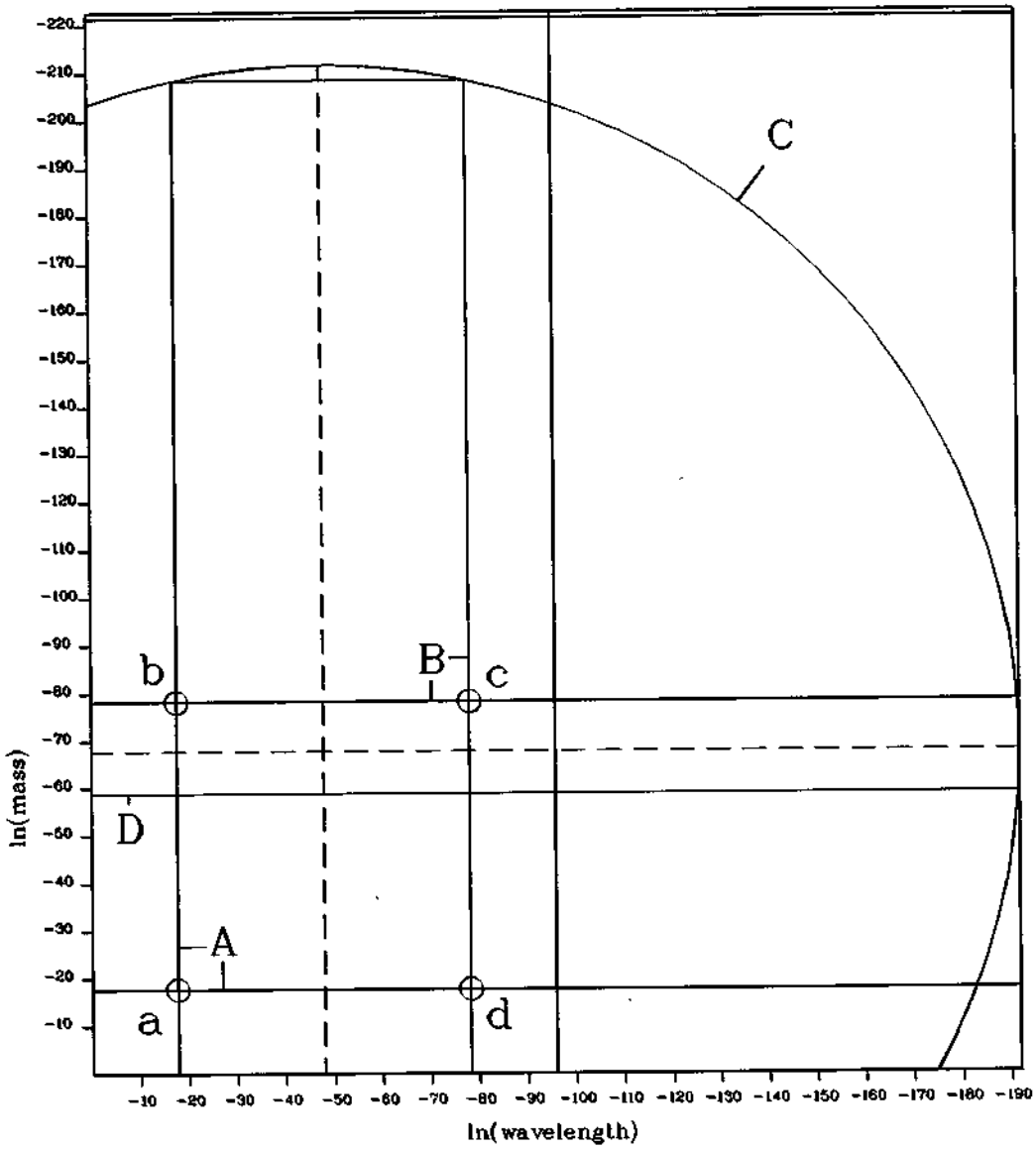
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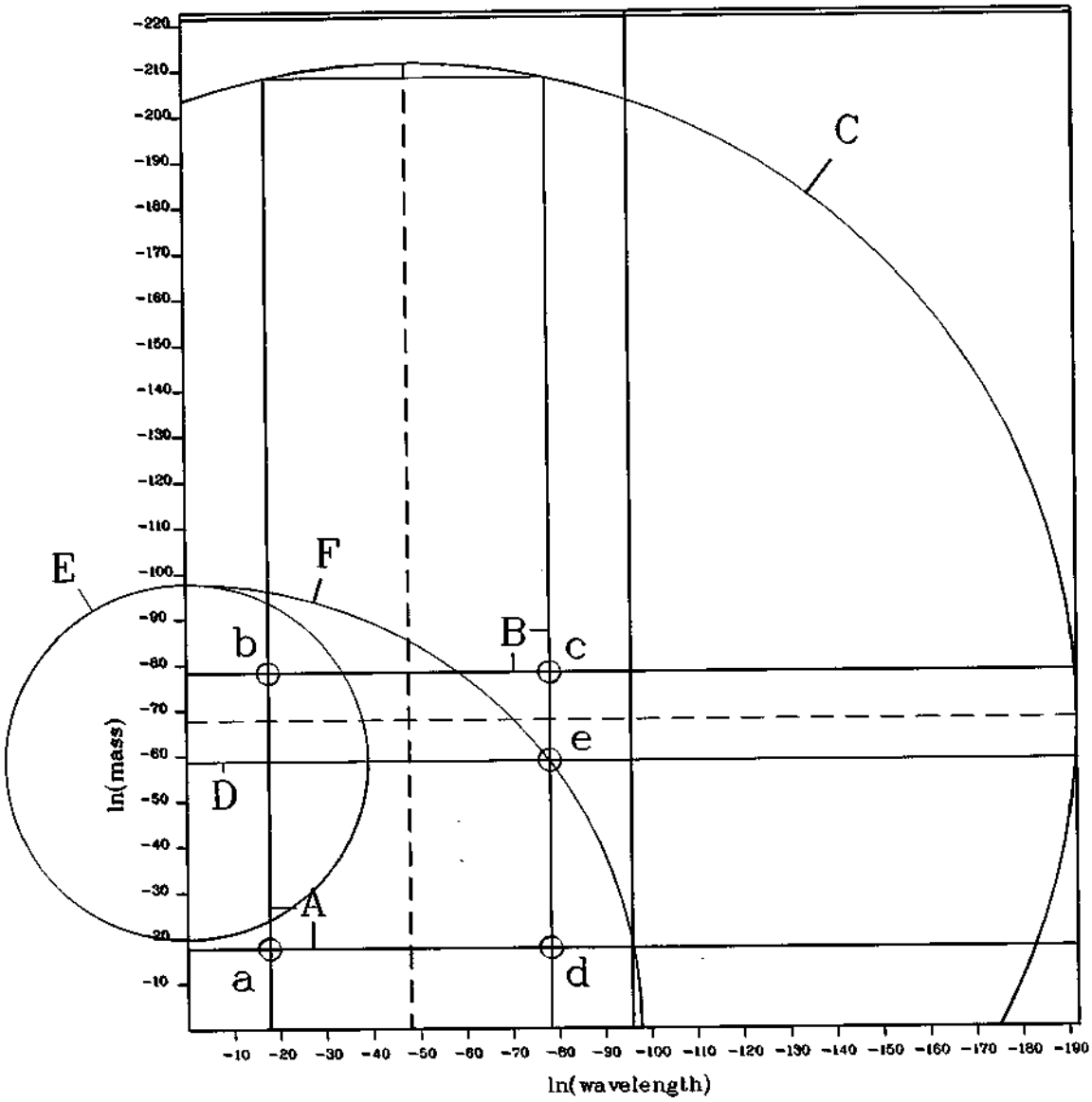
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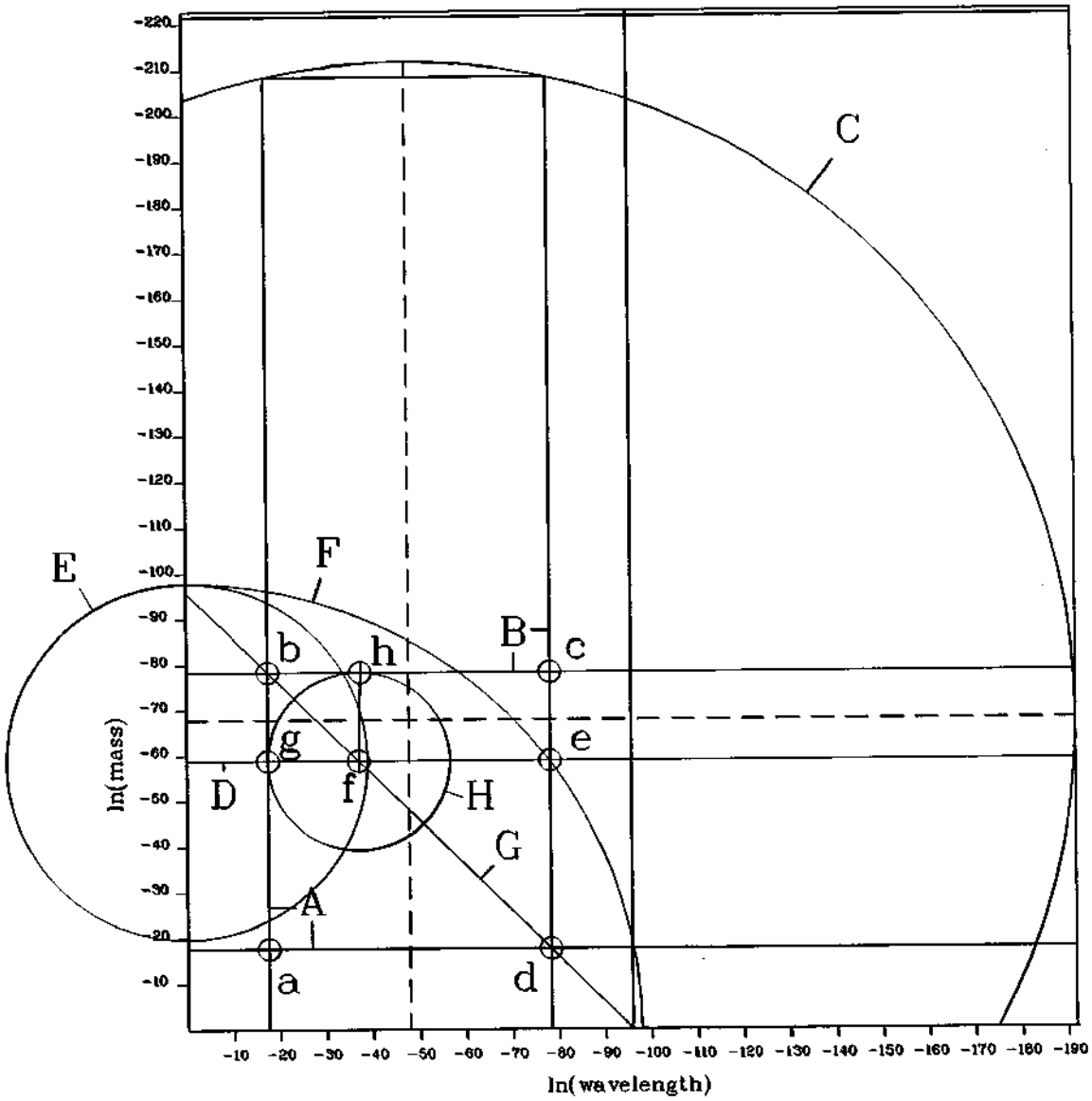
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Figure 8

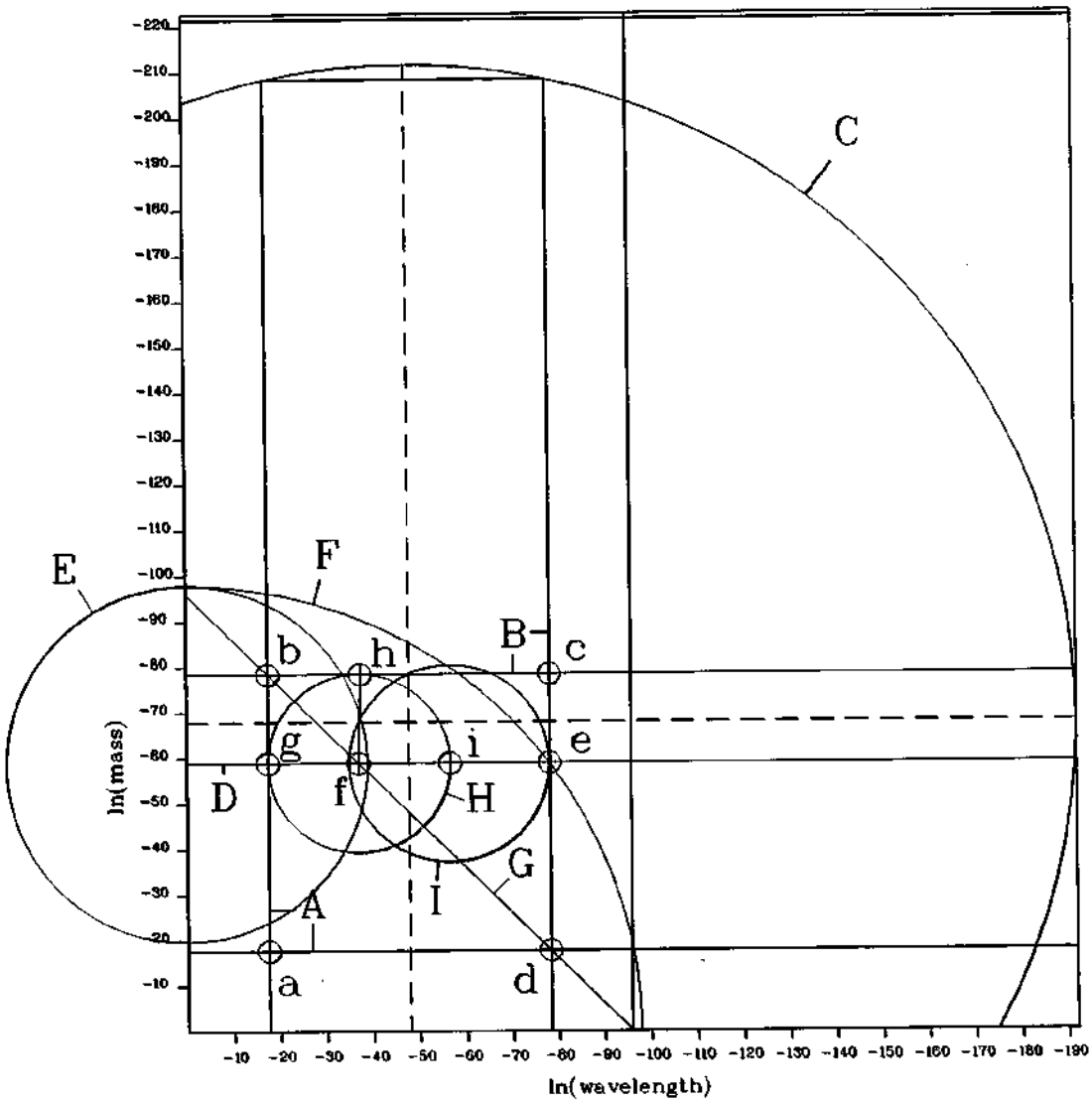
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Figure 9

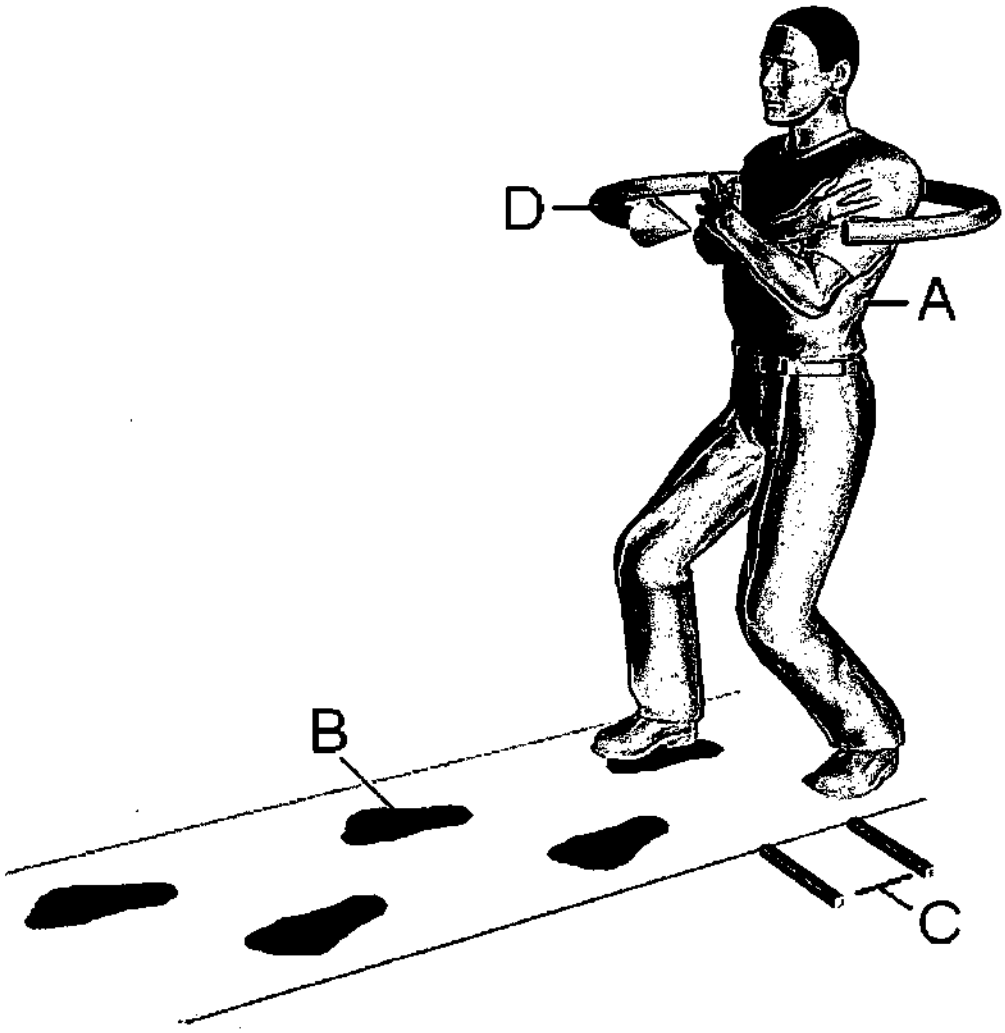

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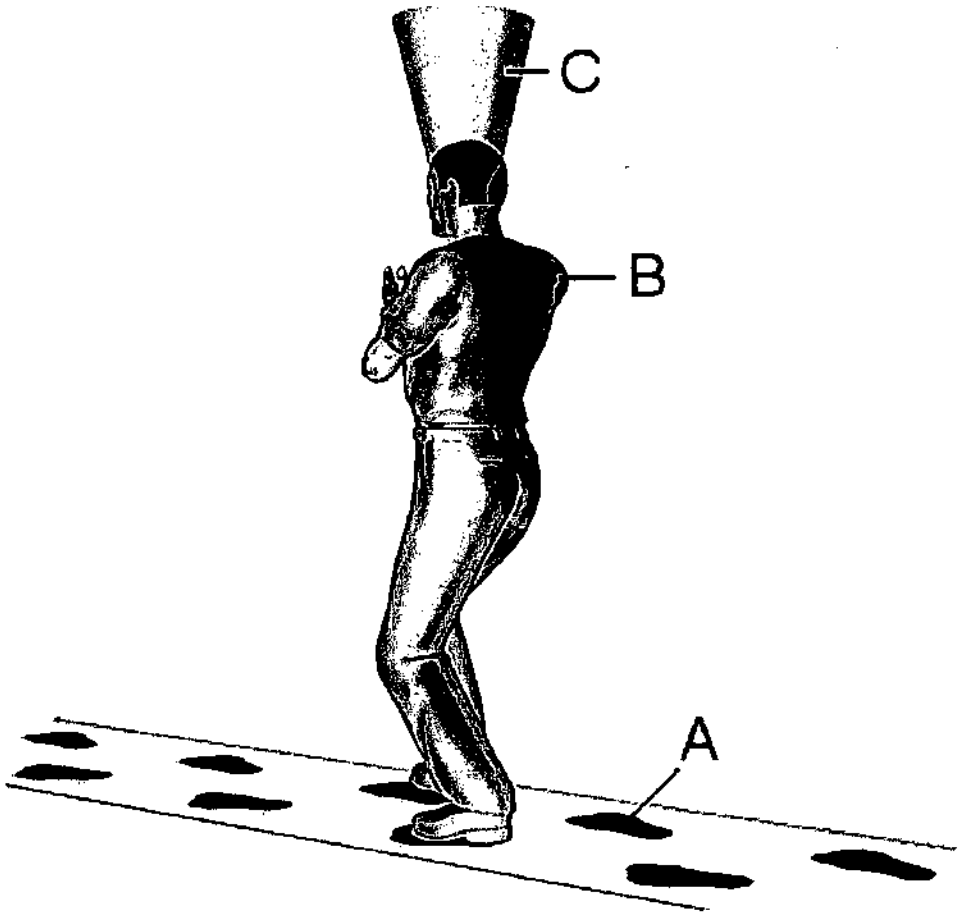

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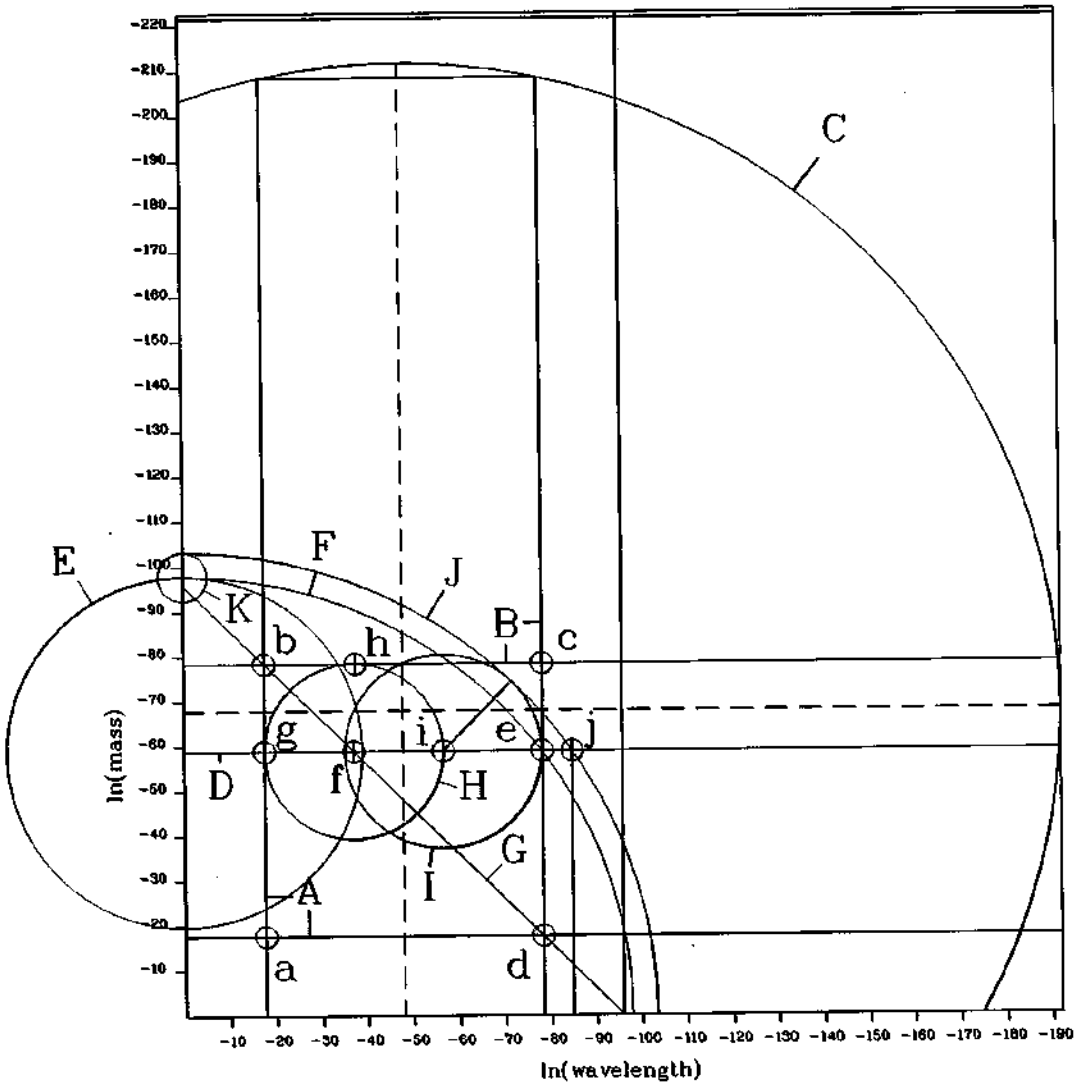

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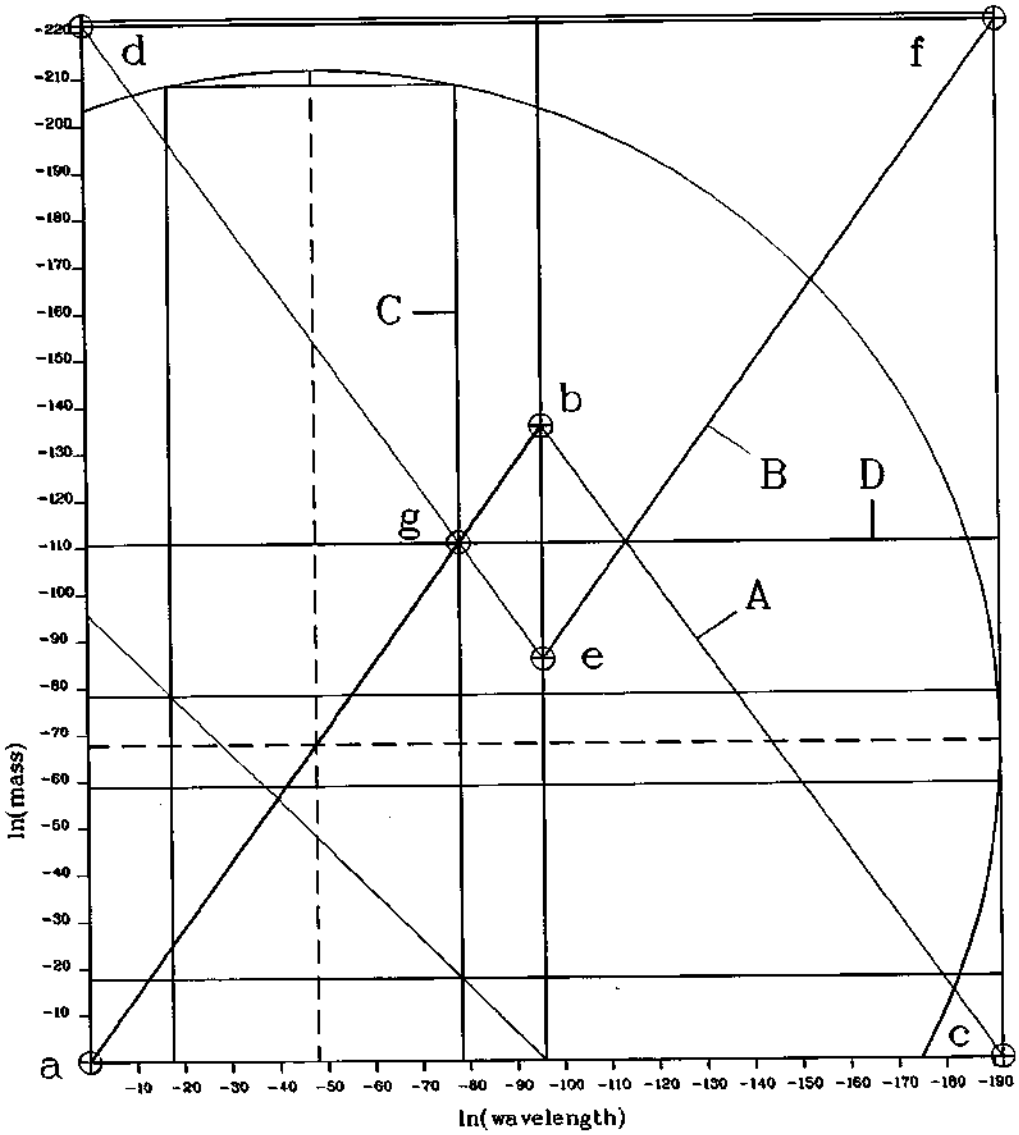
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Figure 13

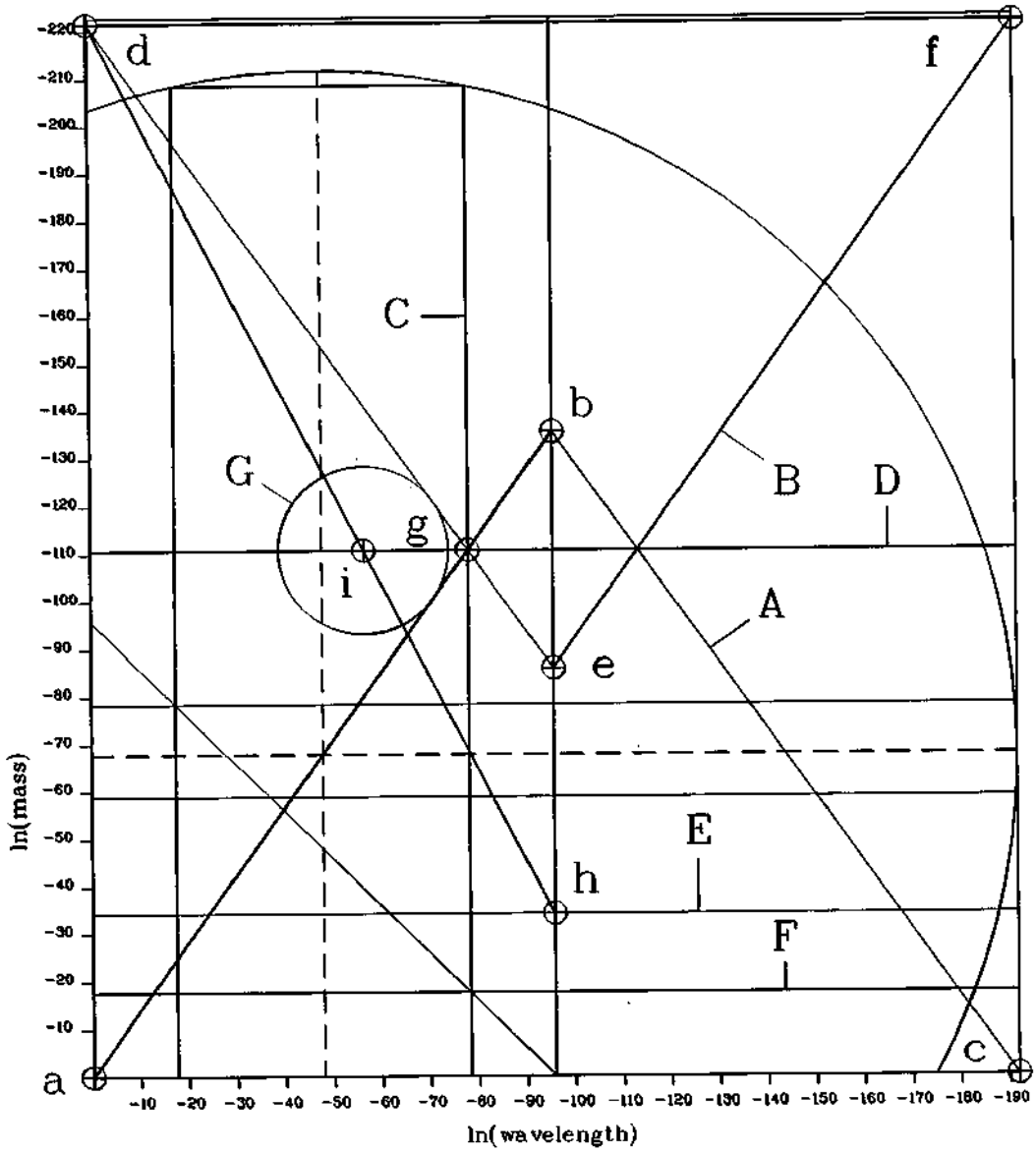
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Figure 14

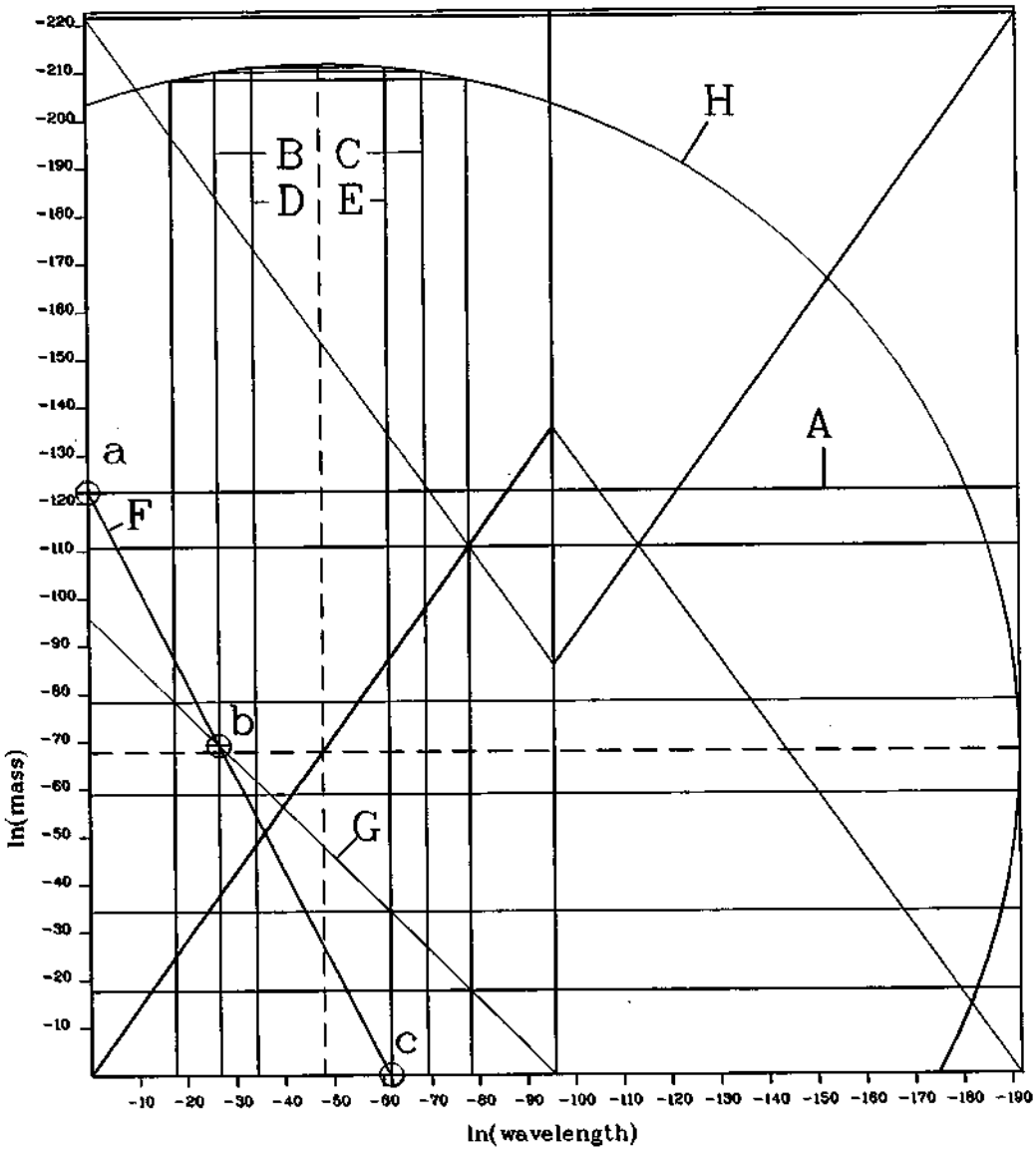
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Figure 15

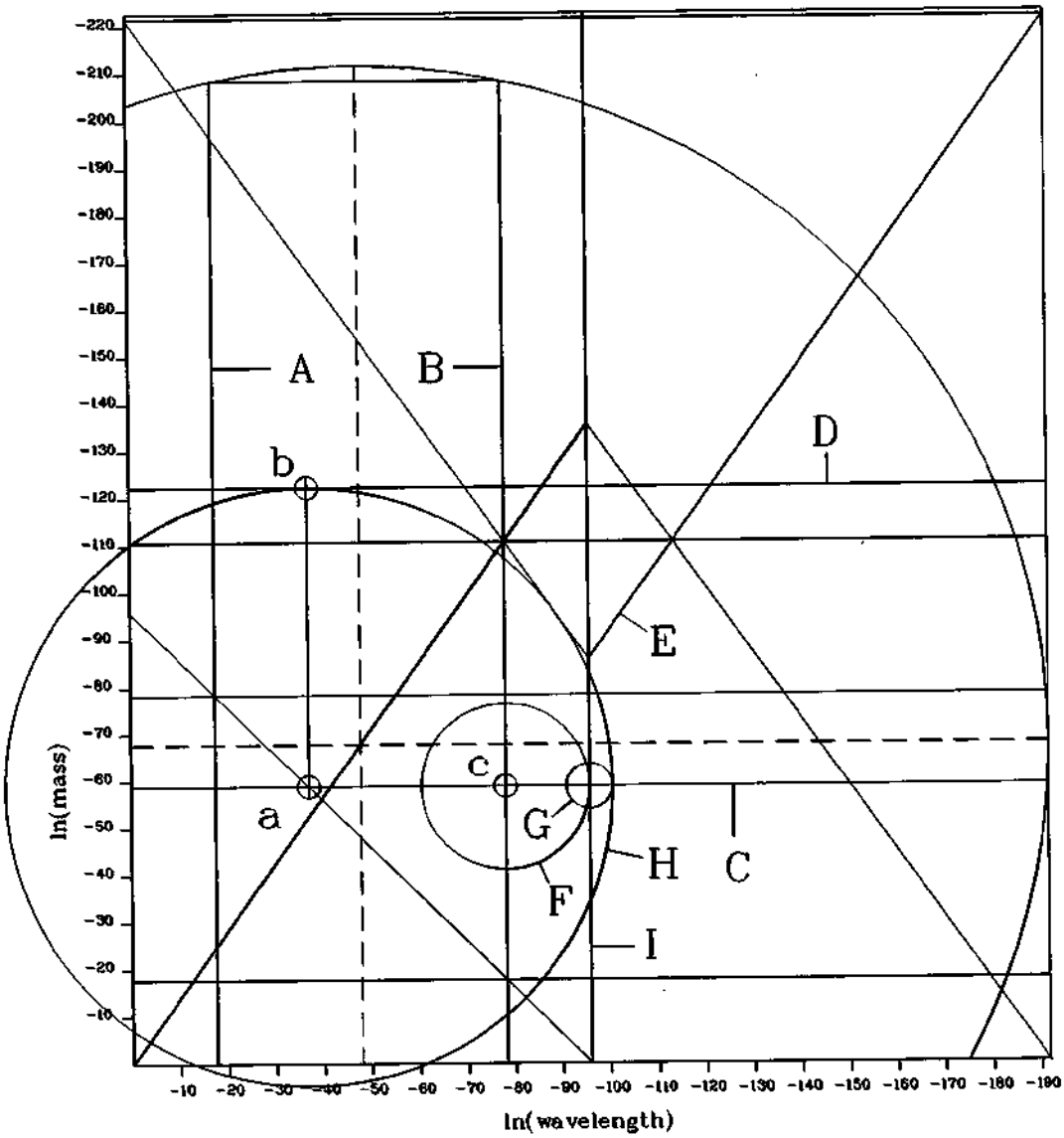
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Figure 16

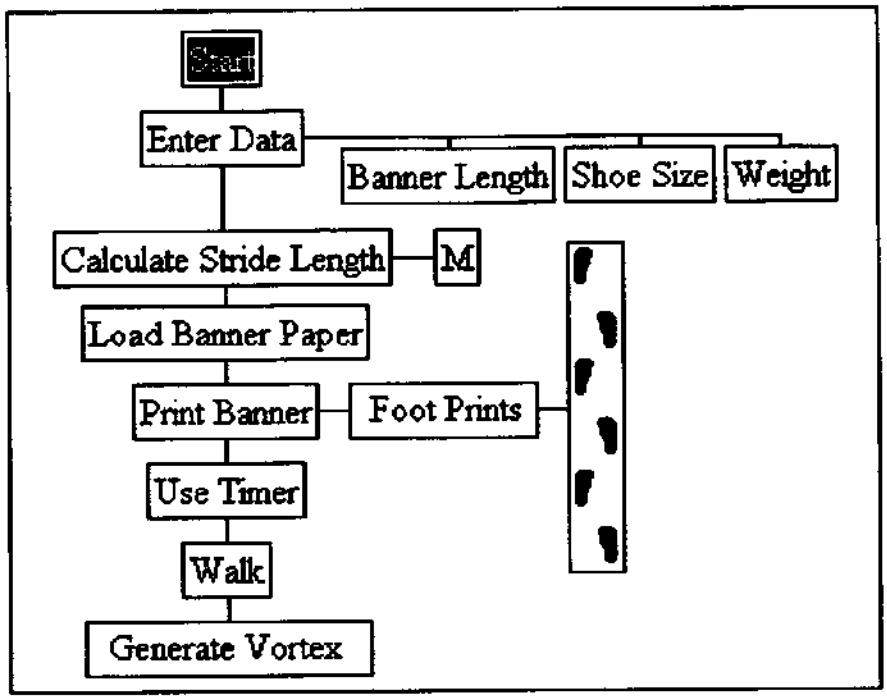
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Walk
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Figure 17

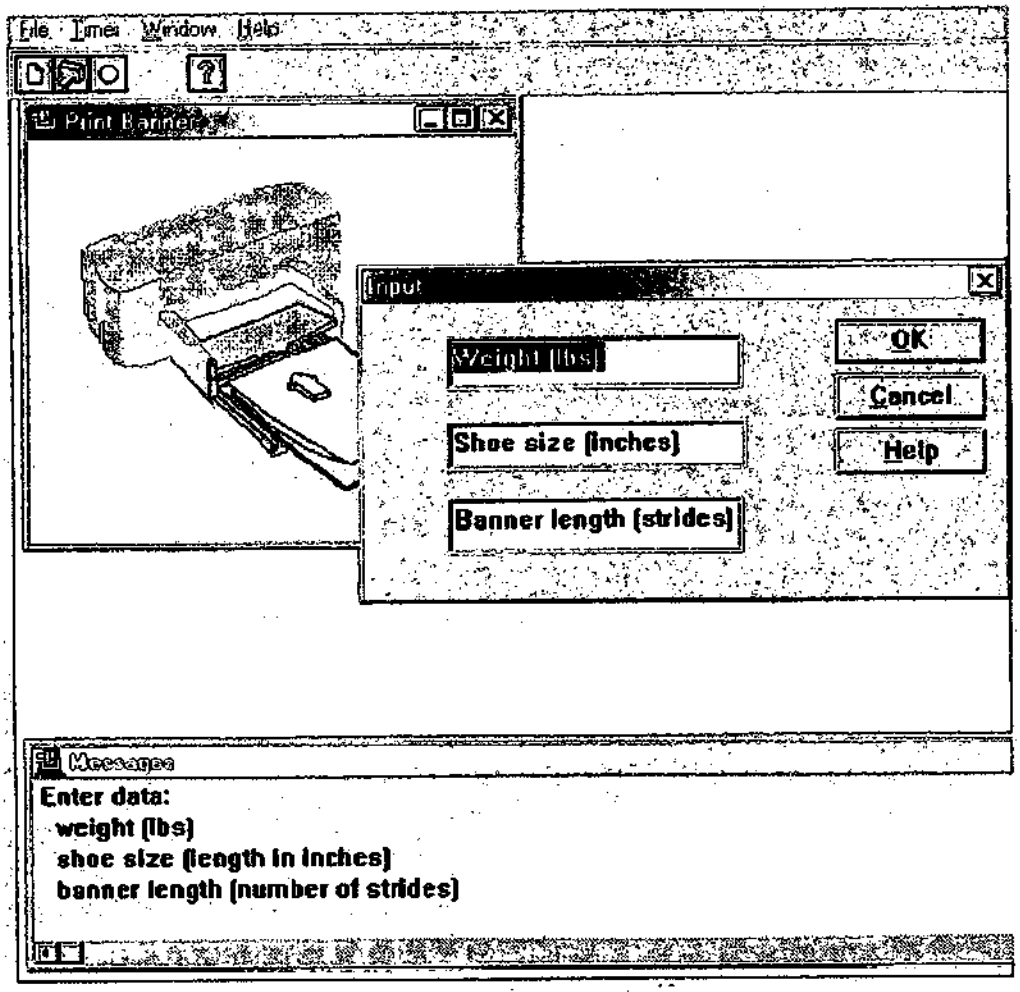
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Figure 18

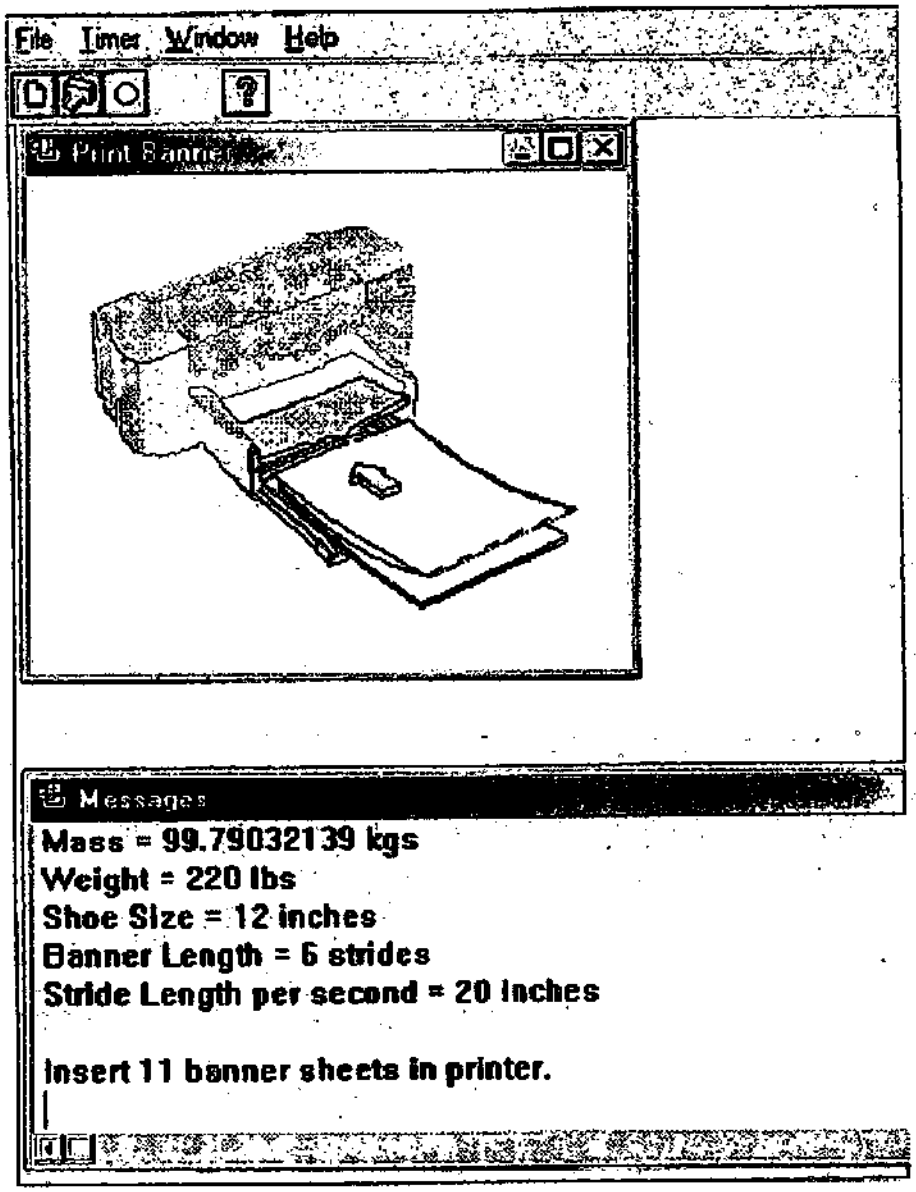
File Timer Window Help
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Banner Length = 6 strides
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Figure 19

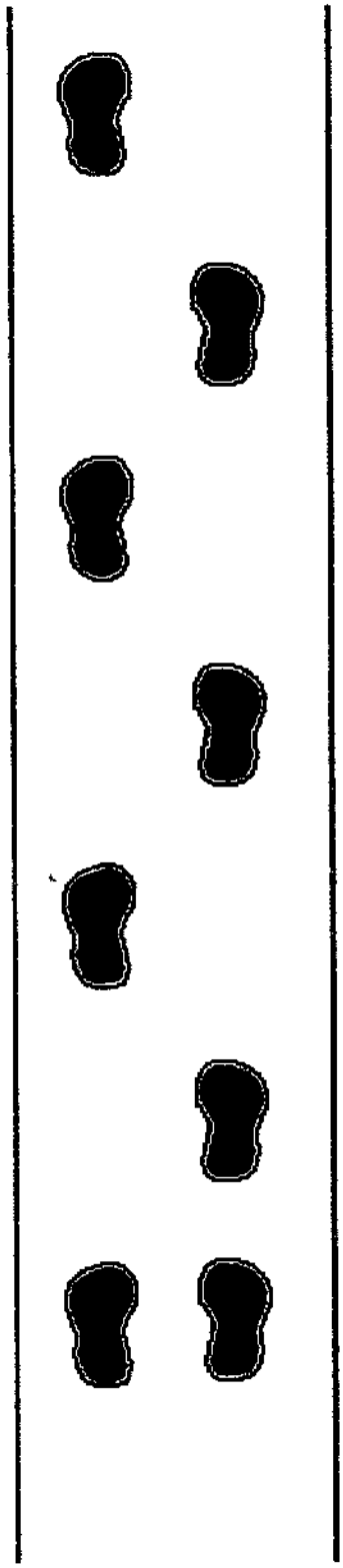

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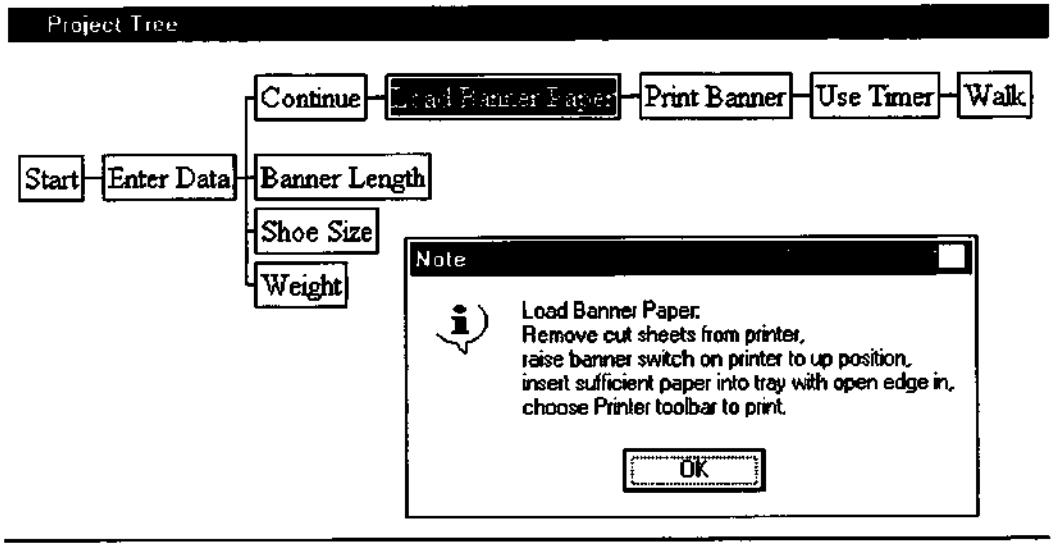
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raise banner switch on printer to up position,
insert sufficient paper into tray with open edge in,
choose Printer toolbar to print.
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WALKING THROUGH WALLS TRAINING SYSTEM

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a training system that enables a human being to acquire sufficient hyperspace energy in order to pull the body out of dimension so that the person can walk through solid objects such as wooden doors.

BACKGROUND OF THE INVENTION

[0002] A human being is a hyperspace energy being living in a physical container or body that is comprised of 67% water. This high percentage of water makes this invention possible. Referring to **FIG. 1**, the hyperspace energy being receives energy from our dimension through seven vortices that run the length of the body. Each vortex connects to a separate hyperspace dimension having its own particular frequency. This arrangement allows for the development of seven modular energy components corresponding to the mind, spiritual eye, voice, body, abdomen, plasma energy ball (battery), and ground connection.

[0003] Vortex (A), known as the top vortex, supplies energy to the mind and provides a channel of communication to other entities in the universe. This channel has been tested up to 100,000 light years which is the diameter of the galaxy.

[0004] Vortex (B), known as the spiritual eye, has a hollow cone-like appearance surrounded by white, misty, low-density hyperspace energy. Because the eye is modular, the mind can project it to vast distances, a process known as remote viewing.

[0005] Vortex (C), known as the voice and hearing module, can also be projected to enormous distances in order to communicate verbally with other entities. Using the proper remote viewing instruments, it is possible to project both the eye and verbal modules to see and talk at the same time.

[0006] Vortex (D), known as the heart vortex, provides protective energy to the upper internal organs, arms and hands.

[0007] Vortex (E) provides protective energy for the lower organs such as the intestines, liver and kidneys.

[0008] Vortex (F), known as the battery of the body, consists of an orange-colored plasma energy ball about one to two inches in diameter. The body becomes paralyzed if this ball is removed from the body. When the hyperspace energy being leaves the body, the vortices close and the battery takes over in order to keep the body functioning. This vortex also plays a role in the creation of the astral energy baby that attaches to the fertilized egg.

[0009] Vortex (G) is the ground vortex which rotates in the counter-clockwise direction in order to provide an energy ground for the electrical circuit. All the other vortices rotate in the clockwise direction as seen from the front such that energy flows into the vortex according to the right-hand rule of physics.

[0010] Vortex (H) is the hand vortex which rotates counterclockwise on the right hand and clockwise on the left hand as seen looking at the palm. Thus there is a rotating flow of hyperspace energy between the two hands when the palms are facing each other.

[0011] Referring to **FIG. 2**, each vortex feeds energy into its own hyperspace module shown by the lettered box. In terms of quantum mechanics, each box is actually a potential energy well in which each module develops separately. At the time of death of the body, these modules are joined together as a single energy being. The process is powered by the plasma energy ball battery which also contains the logical instructions for assembly.

[0012] Different people, as tested by the pendulum on the hand vortex, have different vortex sizes. Three people were tested. The first person had almost no rotational movement showing very little energy. The second person had a vortex radius of one inch. Another had a vortex radius of four inches which covered his entire hand. The latter also has the ability to lift another human being, lying prone on a table, off the table by flowing low-density hyperspace energy into the person through the hand vortices. He has also experienced walking through a solid wooden door with a dog at his side. What this means is that there is a way, as described in this invention, of creating large energy vortices which will enable a person to acquire sufficient energy to walk out of dimension through solid objects such as wooden doors.

[0013] Researching the historical records, referring to the statue in **FIG. 3**, a humble black Catholic Dominican friar of the Santo Rosario Convent, by the name of San Martin de Porres, living in Peru in the 1500's, also developed this ability to walk through doors. For his beatification, many witnesses came forward to recount his extraordinary abilities. For example, a witness, who worked in the Convent, went to the cell of San Martin to ask for something to eat. When he reached the cell, he saw San Martin leaving with some medications apparently to heal someone sick. The witness waited by the open door of the cell for his return. After having waited awhile without being distracted by anything else, he saw said venerable brother fray Martin come out from his cell from the inside and call him by name. The witness was terrified, not understanding how this was possible.

[0014] The woman who gave me the statue told me that he would walk miles and miles each day to visit the poor. The task of walking means that there is a velocity involved. Because the body has mass, then there is a mass times a velocity, or momentum, involved in this ability. Notice also that the statue shows him walking with his right arm crossed over his left arm in the form of an X.

[0015] What this walking momentum means in terms of physics is given in the following analysis. The human body consists of 67% water. A water molecule consists of two hydrogen atoms and one oxygen atom having the atomic formula H_2O. The atomic weight of one atom of hydrogen is 1.008 awu. The atomic weight of one atom of oxygen is 16.000 awu. The molecular weight of one atom of water is therefore:

Weight of two atoms of hydrogen 2 × 1.008 awu =	2.016 awu
Weight of one atom of oxygen 1 × 16.000 awu =	16.000 awu
	18.016 awu

The formula weight is just the atomic weight expressed in grams. Thus the formula weight of water would be 18.016

grams or 0.018016 kilograms. According to Avogadro's law, the formula weight contains $N=6.02\times10^{23}$ molecules. Thus the mass of one water molecule is the formula weight divided by the number of molecules:

$$\text{mass} = \frac{.018016\ \text{kg}}{N} = 2.99269103\cdot10^{-26}\ \text{kg}$$

$$\ln\left(\frac{\text{mass}}{1\ \text{kg}}\right) = -58.77103943$$

[0016] According to Einstein's Special Theory of Relativity, energy is equal to the mass times the speed of light squared. The energy of a photon is equal to Planck's constant h times the frequency f of the photon. Equating these two energies shows that

$$E = mc^2 = hf = h\frac{c}{\lambda} = \frac{h}{c}\frac{c^2}{\lambda}$$

$$\Rightarrow m\lambda = \frac{h}{c}$$

$$\Rightarrow \ln(m) + \ln(\lambda) = \ln\left(\frac{h}{c}\right) = \text{base} = -95.91546344$$

which says that the natural logarithm of the mass plus the natural logarithm of the wavelength is equal to the natural logarithm of Planck's constant divided by the speed of light c, known as the base constant in the tetrahedron diagram. This diagram plots the mass versus wavelength in natural logarithms. Notice that the left hand side of the equation is the sum of mass and wavelength, so the right hand side must also be the same.

$$\ln\left(\frac{h}{c}\right) = \ln\left(\frac{\Omega\Lambda\ 2\pi\Lambda\ c}{c}\right) = \ln(\Omega\Lambda) + \ln(2\pi\Lambda)$$

where $\Omega\Lambda$, known as the Planck mass, is the linear mass Ω of the universe times the bottom dimensional limit of the universe Λ, and $2\pi\Lambda$ is the bottom dimensional wavelength, known as the Planck wavelength. That is, our dimension is bounded by the Planck box having sides Planck mass and Planck wavelength. These boundaries have values:

$$\ln(\Omega\Lambda) = -17.64290101$$

$$\ln(2\pi\Lambda) = -78.27256243$$

[0017] Referring to **FIG. 4**, these two lines are plotted on the tetrahedron diagram. The Planck mass line (A) reflects off the sphere (C) and returns as the Planck wavelength (B) which shows the dual nature of quantum physics. This creates the Planck box (a,b,c,d) which is the boundary of our dimension.

[0018] Referring to **FIG. 5**, the mass of the water molecule is plotted as horizontal line (D) on the diagram. The energy of the water molecule is the mass times the speed of light squared.

$$E = mc^2$$

$$\ln(c) = 19.51860099$$

$$\ln(mc^2) = \ln(m) + 2\ \ln(c)$$

[0019] Referring to **FIG. 6**, a circle (E), having a radius equal to the speed of light squared, centered on the mass of the water molecule at the vertical axis, generates a circle (F), centered at the origin, that intersects (e) the mass of the water molecule at the Planck wavelength. That is, this intersection point sits right on the Planck box boundary between space and hyperspace. The radius of circle (F) is actually the mass of the water molecule divided by the speed of light squared.

$$E = \frac{m}{c^2} = m$$

$$\Rightarrow \frac{1}{c^2} = 1$$

$$\Rightarrow c = 1\frac{\text{meter}}{\text{sec}}$$

$$\ln(c) = 0$$

Taking the positive square root, the speed of light is one meter per second at the Planck boundary. The experiments with brain hemisphere resonance show that the resonant frequency of the human energy field is between 1 Hz to 5 Hz which is well below the hearing threshold of 20 Hz. Because the traveling wave has a wavelength of 0.3048 m and the speed of light is unity at the boundary, the frequency should be

$$f = \frac{c}{\lambda} = \frac{1\frac{m}{\text{sec}}}{.3048\ m} = 3.28\ \text{Hz}$$

which is within the middle of the experimental male range. At this resonant frequency, the human energy being pops out of the body. This represents only a first stage in the development of the energy being. But what is really wanted is to have both the physical body and the energy field move out of dimension together as San Martin did.

[0020] Referring to **FIG. 7**, the 45° base line (G) is added to the diagram. Notice that the Planck mass intersects (b,d) the Planck wavelength on this line because they sum to the base constant. The mass of the water molecule crosses this line at point (f). A circle, centered (f), with a radius equal to the speed of light, is tangent to the Planck wavelength (h) and the Planck mass (g). Since mass times velocity is momentum, the diagram says that the momentum of the water molecule is tangent to the boundaries of the Planck box which separates space from hyperspace. In order to get to point (e) from the momentum of the water molecule, a second circle is added to the momentum.

[0021] Referring to **FIG. 8**, a circle (I), centered on the water molecule mass at the speed of light circle (i), is made tangent to the Planck wavelength at point (e). The momentum M of space is equal to the Planck mass times the Planck scale times the speed of light. At point (e), the speed of light

is unity, so that the momentum is just the Planck mass in momentum units:

$$M = \Omega \Lambda c = 2.176634194 \cdot 10^{-8}\ \mathrm{kg}\frac{m}{s}$$

Circle (I) has a radius equal to

$$\text{ratio} = e^{21.572952} = 2338912700$$

Therefore the walking momentum in order to get to point (e) is the momentum of space M times this ratio

$$M_w = M \cdot \text{ratio} = 50.909573606\ \mathrm{kg}\frac{m}{\mathrm{sec}}$$

The stride length L per second that a person of mass W has to walk is the walking momentum divided by the mass W times a period T of one second

$$L = \frac{M_w}{W} T$$

For a person with a mass W of 99.79 kg (220 pounds), then the stride length L is 20.08 inches or one foot and eight inches. The person has to walk this length in one second on each foot.

[0022] Looking at the statue of San Martin, his arms are crossed over each other. The vortex of the right hand points backward, and the left hand vortex points forward due to the reversed rotation. Referring to **FIG. 9**, this creates a rotational energy channel (D) around his body (A). The stride length (C) is calculated according to the body mass, and then a banner printout is made showing where the footprints (B) are to be placed each second. The question is: "What happens when one walks the walk?".

[0023] On the very first experiment, referring to **FIG. 10**, what happens is that, after taking only six strides on the banner printout (A), a huge spinning vortex (C) develops over the top of the head and the vertex locks onto the heart vortex in the center of the chest (B). In everyday life, this vortex is not created because normal walking is much faster and the hands are held at the side of the body. The energy rush through the pineal gland is so intense that one feels immediately sleepy and starts yawning excessively due to the increased flow of melatonin.

[0024] After practicing with the banner printout, long walks were made through the park. In this case, a vertical white line rotated around a vertical axis located about six feet perpendicular to the path on the right side of the body. When the walking speed was correct, this white line would lock onto the centerline of the body. Speeding up or down caused the white line to lose synchronization and rotate away. This white line is related to the ability to levitate the body. San Martin had so much energy that, according to witness testimony, he could float horizontally in the air with his head resting against the bowed head of Christ on a carved wooden cross. Thus San Martin's energy sources were channeling energy from Christ, collective broom energy as described in a separate patent application, and the walking momentum vortex energy.

[0025] During the early part of the 20th century, a man's parents were lying in bed dying of tuberculosis. With their permission, he placed a weighing scale under each of their beds. When they passed away, he found that each scale registered a loss in weight of 2.5 ounces. This is equivalent to 0.071 kg, which is the mass of the human energy being.

[0026] After conducting a number of experiments with water vortices draining from a cylindrical tank, it can be stated from Bernoulli's theorem that the potential energy plus the kinetic energy is a constant

$$gz + \frac{1}{2}mv^2 = const$$

The shape of the inner surface of the water circulation has a velocity proportional to the inverse of the radius, so the shape of the surface is

$$(z - z_0) = \frac{k}{r^2}$$

which says that the height of the vortex is proportional to the inverse of the square of the radius.

[0027] The hand vortex area ratio between the second test subject and the third test subject is equal to the square of their radii:

$$\text{ratio} = \frac{(1\ \mathrm{in})^2}{(4\ \mathrm{in})^2} = \frac{1}{16}$$

Because the speed of light at the boundary was determined to be one meter per second, the energy of the third test subject is

$$E = \left(\frac{.071\ \mathrm{kg}}{16}\right)\left(\frac{1\ \mathrm{m}}{\mathrm{sec}}\right)^2 = 4.4375 \cdot 10^{-3}\ \mathrm{joule}$$

$$\ln(E) = -5.417664124$$

[0028] Referring to **FIG. 11**, a circle (K), having this radius, is added to the energy of the water molecule (E), to produce augmented energy circle (J). This circle (J) intersects the mass of the water molecule outside the Planck box at point (j). This means that the increased hyperspace energy moves the water molecule, and hence the body, out of dimension. Furthermore, circle (J) is tangent to the walking momentum ratio circle (I) which keeps the geometry locked together.

SUMMARY OF THE INVENTION

[0029] It is the object of this invention to create a training system that allows a person to develop the ability to walk

around out of dimension, passing through solid objects. This invention is based on one of the most remarkable relationships between the water molecule and the boundary between space and hyperspace. The mass of the water molecule is equal to the energy of the water molecule at this boundary. Because the body is composed of 67% water, the body sits on the boundary such that any additional increase in energy would move the body out of dimension into hyperspace. Because human beings are actually hyperspace energy beings living in physical bodies, the additional energy required to move the body out of dimension comes from increasing the energy of the hyperspace being. One source of this energy comes from walking cross-handed at the proper velocity in order to generate a large hyperspace energy vortex that flows energy into the potential wells of the hyperspace being. This increased hyperspace energy will then allow the person to walk around out of dimension through solid wooden doors. Because the door and the person are in two slightly different dimensions at the same moment, it appears that the person is walking through the door. After passing through the closed door, the person then returns to our dimension and emerges in the interior of the closed-door room.

[0030] This technique can be used in reverse to heal an infected hand instantaneously. A salve made from the St.Mary's herb is applied to the skin of the infected hand. The hyperspace energy then flows through the right-hand vortex such that the infected hand and the salve are taken slightly out of dimension. What happens is similar to when a short piece of straw is embedded in a hard wooden telephone pole as a tornado passes over the pole. The straw and pole are taken out of dimension such that they briefly merge together. As the tornado moves on, both objects come back to dimension merged together. Thus the salve (straw) is merged with the bacteria (pole) in hyperspace such that the bacteria is killed instantly. Removing the hand vortex brings the infected hand back into dimension cured.

[0031] Based on this information and the results of many experiments, this invention creates a large vortex by walking at a certain velocity with the hands crossed over the chest. The proper walking momentum is created by a computer program that inputs the person's weight, shoe length, and the number of strides to be taken. The program then prints out a banner showing the footprints where the person has to step each second. When a person obtains sufficient energy from these methods, the person is then tuned to the subspace geometry of the universe as will be shown using the tetrahedron physics diagram.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0032] **FIG. 1**. Energy vortices of the human body.

[0033] **FIG. 2**. Seven potential wells fed by the energy vortices of the body.

[0034] **FIG. 3**. Carved wooden statue of San Martin de Porres who could walk through solid wooden doors.

[0035] **FIG. 4**. Tetrahedron diagram showing boundaries of the Planck box of dimension.

[0036] **FIG. 5**. Tetrahedron diagram showing mass of water molecule.

[0037] **FIG. 6**. Tetrahedron diagram showing water molecule energy and mass are equal at the Planck box boundary.

[0038] **FIG. 7**. Tetrahedron diagram showing that water molecule momentum is tangent to the boundaries of the Planck box.

[0039] **FIG. 8**. Tetrahedron diagram showing the momentum ratio required to reach the Planck wavelength boundary from the water momentum.

[0040] **FIG. 9**. Perspective view of crossed-hand momentum walking using banner printout.

[0041] **FIG. 10**. Perspective view of vortex generated by momentum walking.

[0042] **FIG. 11**. Tetrahedron diagram showing how additional hyperspace energy supplied to the potential wells of the hyperspace energy being enables the human body to be pulled out of dimension.

[0043] **FIG. 12**. Tetrahedron diagram showing the inverted tetrahedrons whose crossing represents the merging of two worlds between space and hyperspace.

[0044] **FIG. 13**. Tetrahedron diagram showing that the proton wavelength is determined by the Planck mass tangent to the inverted tetrahedrons.

[0045] **FIG. 14**. Tetrahedron diagram showing that the mass of the universe determines the electron and proton elementary particles.

[0046] **FIG. 15**. Tetrahedron diagram showing that momentum walking together with the increased energy of the hyperspace energy being is tangent to the mass of the universe.

[0047] **FIG. 16**. Computer program block diagram for printing banner footprints.

[0048] **FIG. 17**. Computer program input dialog window.

[0049] **FIG. 18**. Computer program calculation of stride length per second.

[0050] **FIG. 19**. Six-stride screen banner printout for 220 lb. person.

[0051] **FIG. 20**. Project tree showing help information by double clicking on node.

DETAILED DESCRIPTION OF THE INVENTION

[0052] 1. Referring to **FIG. 12**, a tetrahedron (A, path abc) is added to the diagram. The tip of the tetrahedron (e) falls on the base constant which is equal to Planck's constant divided by the speed of light. A second tetrahedron (B, path def) is inverted around horizontal line (D) which has a geometrical relationship to the base constant. The line is located at

$$\text{centerline} = \frac{2}{\sqrt{3}}\ln\left(\frac{h}{c}\right) = -110.7536373$$

Notice that the intersection of the two inverted tetrahedrons (g) occurs at the Planck wavelength which is the boundary between space and hyperspace. Line (D) is referred to as the merging of two worlds or the connecting of two worlds, a phrase obtained by means of remote viewing. That is, it is

the dividing line between space and hyperspace. This is the reason that the two boundaries intersect at this point.

[0053] Referring to **FIG. 13**, the proton wavelength (E) is added to the diagram. The proton wavelength has a value of the electron wavelength divided by 1836.1527

$$\ln(\lambda_p) = \ln\left(\frac{\lambda_e}{1836.1527}\right) = -34.26005901$$

A line (hd), from the base constant at the proton wavelength (h), to the corner of the inverted tetrahedron (d), intersects the merging of two worlds line at point (i). A circle, with a radius equal to the Planck mass (G), centered (i), is tangent to the inverted tetrahedrons. Thus the proton is defined by the base constant and the geometry of subspace. The reason that the proton is tangent to both tetrahedrons is because the electron and proton follow one single path between space and hyperspace. Thus there is only one single particle in nature. Because the particle enters our space at two different locations, we see the one particle as two distinct elementary particles. This relationship can be seen in Library of Congress tetrahedron diagram tet0565.

[0054] Referring to **FIG. 14**, the mass of the universe MU is equal to the linear mass Q of the universe times the radius R of the universe which is 10^{26} meters

$$\ln(MU)=\ln(\Omega R)=122.3347509$$

as shown on the diagram as line (A). The electron wavelength (B) reflects off the circumscribing sphere (H) and returns as the electron mass (C). The distance between reflection points is the hyperspace charge which is equal to the charge of space less the electron charge. So the electron goes from wavelength to electric charge to mass. The proton wavelength (D) reflects off the sphere and returns as the proton mass (E) which intersects the horizontal axis at point (c). A line (abc) from the mass of the universe at the vertical axis (a) to the proton at the horizontal axis (c) intersects the electron (b) which determines the electron's mass and wavelength since this point is on the 45° base line. What this means is that cosmology determines the values of the elementary particles.

[0055] Referring to **FIG. 15**, the mass of the water molecule (C) intersects the 45° base line at point (a). A circle (F), with a radius equal to the Planck mass is centered on point (c) at the Planck wavelength boundary (B) where the mass of the water molecule numerically equals the energy of the water molecule and where the speed of light is unity. The Planck mass is tangent to the base constant which is the vertical centerline (I) of the diagram. The large circle (H), centered (a) on the water molecule, is tangent to the mass of the universe (b) and tangent to the inverted tetrahedron (E). The difference between this circle (H) and the base constant (I) is the energy the hyperspace being has to acquire in order to be tuned to the mass and geometry of subspace. This difference, shown as circle (G), has a mass

$$m=e^{-4.792671}\ \text{kg}=8.29\cdot10^{-3}\ \text{kg}$$

Thus the hand vortex radius ratio has to be the square root of the mass of the hyperspace energy being divided by this tangent mass, or:

$$r=\sqrt{\frac{.071\ \text{kg}\cdot 1\ \text{in}^2}{e^{-4.792671}\ \text{kg}}}\approx 3\ \text{inches}$$

which is a vortex radius that is three times larger than that of a normal person, but one inch smaller than the third test subject who had a hand vortex radius of 4 inches. This is the reason that the third test subject was able to walk through walls and teleport to other locations because his energy was sufficiently large enough to cross over the inverted tetrahedron into a co-dimension of hyperspace. Notice also that dotted circle (J) with a radius equal to the mass of the water molecule, centered (c) on the boundary, is tangent to the tetrahedron (K). This makes the combined geometry tangent to the inverted tetrahedrons and the mass of the universe.

[0056] 2. Referring to **FIG. 16**, a computer program generates a banner printout with footprints spaced for walking according to the weight, shoe size and length of banner desired. Some banners could fit in a small room, or be placed on the floor of a long corridor. As shown in the block diagram the program inputs these three variables with error checking. Then the program calculates the stride length L per second from the equation

$$L=\frac{M}{W}T$$

[0057] 3. In the above equation, the value of the momentum M, as determined by the tetrahedron diagram, is preferably 50.9095736 kg m/s. The weight of the person is converted to mass W in kilograms. The stride period is preferably 1 second. Referring to **FIG. 17**, the data is entered in the dialog input window.

[0058] 4. Once the stride length has been calculated, the program displays the stride length and the required number of banner sheets in the message window, as seen in **FIG. 18**.

[0059] 5. The print banner menu is selected and the foot prints are printed on continuous banner paper. A six-stride scaled screen version of the banner is shown in **FIG. 19**. The banner paper is then placed on the floor, and a one-second beeping timer is activated from the toolbar or menu. The person then walks beside the printed foot prints, taking one stride per beep, which produces the correct walking momentum to generate the hyperspace vortex. The vortex, which forms in only six strides, brings additional hyperspace energy into the quantum potential wells of the hyperspace energy being.

[0060] 6. A help system consists of a project tree which explains the various steps in using the program. Double mouse clicking on a project tree node displays the help instructions in a dialog window as shown in **FIG. 20**.

[0061] 7. In summary, the purpose of the training system is to substantially increase the energy of a human being who will then have the capability of walking through walls, body levitation, instantaneous healing of infections, full-body teleportation to another location, remote viewing at vast distances in terms of light-years, and looking into hyper-

space co-dimensions. The third test subject and I have been able to experience all the above phenomena. He did it through augmenting his energy, and I have done it through the application of electromagnetic fields, by spinning on my vortex accelerator machine and using this invention.

I claim:

1. A training method comprising the steps of:

generating a banner having a plurality of footprints spaced at regular intervals wherein the banner is placed on the ground;

generating a periodic audible signal, whereby the audible signal repeats at a regular interval of time equal to the period; and

walking on the banner by tracing the footprints spaced at regular intervals, wherein one step is made with each audible signal.

2. The method of claim 1, wherein the step of generating the banner further comprises:

providing a person's actual mass in kilograms; and

determining the stride length based upon the following equation:

$$L=(M/W)*T$$

where L is the stride length in meters, M is a constant of approximately 50.91, W is the mass of the person in kilograms, and T is the period of the audible signal in seconds, and

wherein the footprints on the banner are spaced at the stride length.

3. The method of claim 2, wherein the audible signal is a beep and the period of the audible signal is one second.

4. A training method for a person comprising the steps of:

generating an audible signal having a fixed period;

generating a banner having regularly spaced indicia for identifying preferred step locations, wherein the distance between adjacent indicia is determined by the following formula:

$$L=(M/W)*T$$

where the distance between adjacent indicia in meters is L, a constant of 50.9095736 is equal to M, the person's mass in kilograms is W, and the fixed period in seconds is T; and

walking on the marked path by stepping upon each of the regularly spaced indicia wherein one step is made with each period of the audible signal.

5. The training method of claim 4 wherein the fixed period is one second.

6. The training method of claim 5, wherein the regularly spaced indicia are footprints.

* * * * *

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(54) BOBBIN ELECTROMAGNETIC FIELD PROPULSION VEHICLE

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(57) ABSTRACT

This invention relates to a spacecraft which generates its own magnetic moment and magnetic field gradient in order to produce lift on the hull. The magnetic moment is generated by a large area solenoid located in the hull. A toroidal core wrapped with electrical bobbins at intervals along said core produces a traveling magnetic wave along its surface. This magnetic wave creates a spacetime curvature, similar to a tilted plate, which causes the formation of a magnetic field gradient. Power is not critical because the system uses a magnetic vortex wormhole generator to lower the speed of light in order to efficiently create highly relativistic fields due to Lorentz transformation.

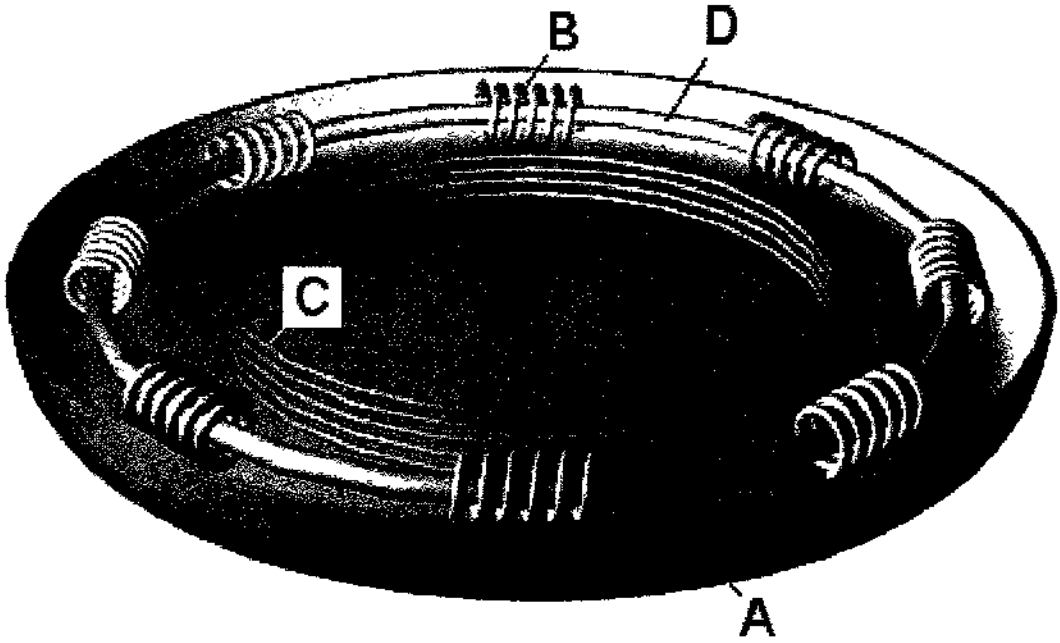

Figure 1

$$\text{Force} = \mu \cdot \frac{\partial B_z}{\partial z} = \text{amp} \cdot \text{m}^2 \frac{\text{kg}}{\text{sec} \cdot \text{coul} \cdot \text{m}} = \frac{\text{coul}}{\text{sec}} \cdot \text{m}^2 \cdot \frac{\text{kg}}{\text{sec} \cdot \text{coul} \cdot \text{m}} = \frac{\text{kg} \cdot \text{m}}{\text{sec}^2} = \text{newton}$$

Figure 2

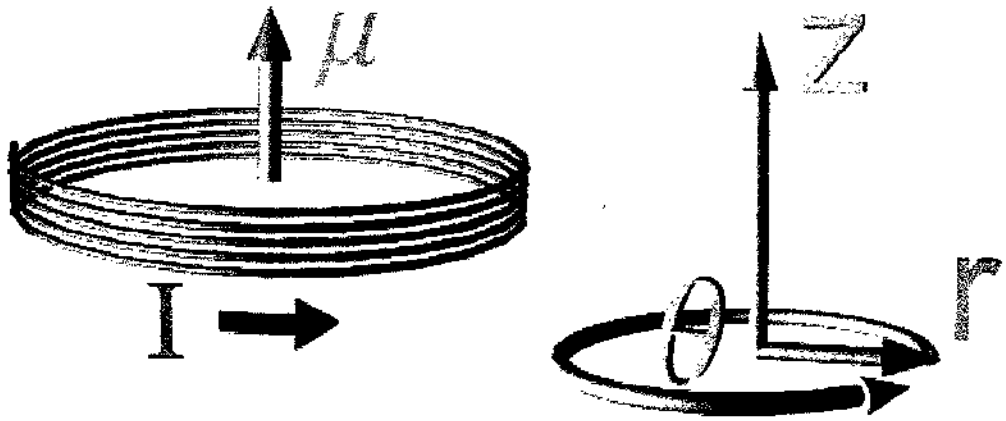

Figure 3

$$B_Z = \mu n I$$

Figure 4

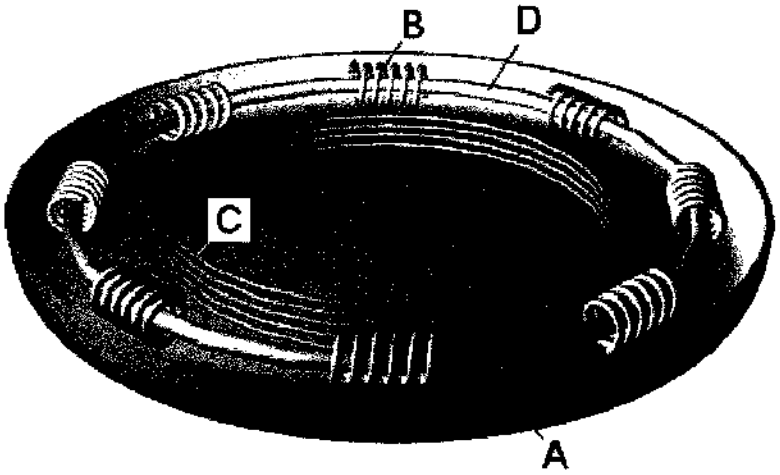

Figure 5

$$v = \sqrt{\frac{\omega}{\sigma\mu}}$$

Figure 6

$$g_{\alpha\phi} = \begin{array}{c} \\ t \\ r \\ \theta \\ z \end{array} \begin{array}{c} \begin{array}{cccc} t & r & \theta & z \end{array} \\ \begin{vmatrix} -1 & 0 & \mathrm{Sin}[\theta - t] & 0 \\ 00 & 1 & 0 & 0 \\ \mathrm{Sin}[\theta - t] & 0 & r^2 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \end{array}$$

Figure 7

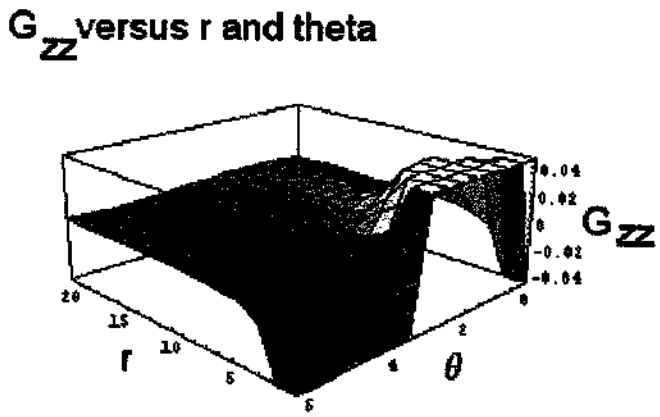

Figure 8

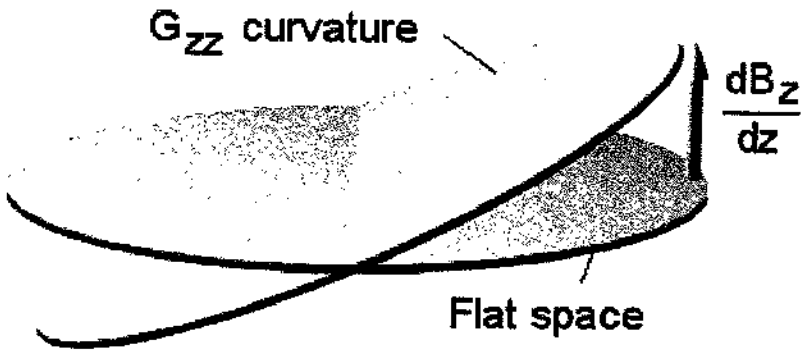

BOBBIN ELECTROMAGNETIC FIELD PROPULSION VEHICLE

BRIEF SUMMARY OF THE INVENTION

[0001] This invention, which is the subject of my present application, is comprised of a toroidal core around which are wound a plurality of electromagnetic bobbins. The bobbins are pulsed electrically to create an amplified magnetic wave that travels around the core. At the same time, a circular electrical conductor carrying direct current creates a magnetic field around its area which results in the formation of a magnetic moment. This magnetic moment, together with the spacetime curvature distortion created by the traveling magnetic wave, produces a lift force on the vehicle.

REFERENCE PAPERS

[0002] Levitron, Hones, U.S. Pat. No. 5,404,062.

[0003] *Geometry of Electromagnetic Systems,* Paul Hammond, page 179.

BACKGROUND OF THE INVENTION

[0004] The idea for this invention comes from experiments I have done using thin transformer laminations wound in intervals with bobbins of wire connected to a frequency generator. Pulsing the bobbins electrically creates a slow traveling magnetic wave along the surface of the lamination. The velocity of the wave, as shown by Hammond in the reference paper, is the square root of the frequency divided by the conductivity and permeability of the material. From Einstein's General Theory of Relativity, this type of wave around the circumference creates a spacetime curvature distortion in the vertical direction that looks like a tilted plate. The magnetic field traveling around the circumference has to follow this curvature. This creates a magnetic gradient in the z-direction which together with the magnetic moment developed by a solenoid produces lift on the vehicle.

SUMMARY OF THE INVENTION

[0005] It is the object of this invention to create a magnetic field gradient and magnetic moment in order to produce a lift force on the hull of a vehicle. The magnetic field gradient is produced by a traveling magnetic wave which produces a tilting-plate spacetime curvature around the hull. The magnetic moment is created by a simple circular wire carrying direct current around its area.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0006] Not Applicable.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0007] **FIG. 1**. The lift force on the vehicle is equal to a magnetic moment times the magnetic field gradient.

[0008] **FIG. 2**. Magnetic moment μ created by direct current I flowing counterclockwise around the wire coil. Cylindrical coordinates are shown to the right.

[0009] **FIG. 3**. The wire coil solenoid creates a magnetic field in the z-direction equal to the permeability of space times the number of turns per length of the solenoid times the current in the windings.

[0010] **FIG. 4**. Perspective view of bobbin spacecraft.

[0011] **FIG. 5**. Magnetic wave velocity along core.

[0012] **FIG. 6**. The g metric tensor in cylindrical coordinates with the sinusoidal wave function in the $\{t,\theta\}$ slots.

[0013] **FIG. 7**. The spacetime curvature G_{zz} in the vertical direction created by the magnetic wave traveling around the core.

[0014] **FIG. 8**. Tilted plate spacetime curvature showing magnetic gradient.

DETAILED DESCRIPTION OF THE INVENTION

[0015] 1. Referring to the equation in **FIG. 1**, the lift force on the bobbin spacecraft is equal to its magnetic moment times its magnetic field gradient. The magnetic moment has units of electrical current, measured in amps, times the area enclosed by the current. Thus the units of the magnetic moment are amp–m^2. The magnetic moment can be created by a large, circular coil of wire carrying direct current **I** as shown in **FIG. 2**. The spacetime cylindrical coordinates $\{t, r, \theta, z\}$ are shown to the right of the drawing where t is time, r the radius, the horizontal angle θ, and the vertical height z.

[0016] 2. The wire coil solenoid also produces a magnetic field in the vertical z-direction equal to the permeability of space μ times the number of turns per unit length of the solenoid n, times the current I in the winding. The equation is shown in **FIG. 3** which can be developed from Ampere's law that the magnetic field around a loop is equal to the current passing through the loop.

[0017] 3. Referring to **FIG. 4**, the bobbin spacecraft consists of a large, horizontal, highpermeability toroidal core (D) wrapped at intervals with electrical bobbins (B) which can be pulsed electrically to create a traveling magnetic wave around the core. Interior to this core is a large direct current solenoid (C) which produces said magnetic field in the z-direction. These devices are enclosed in a circular hull (A) containing the coils on the outer rim and a cabin area in the center.

[0018] 4. Referring to **FIG. 5**, the velocity of the magnetic wave on the surface of the core is equal to the square root of the wave frequency ω divided by the conductivity a times the permeability μ of the core material. When the first bobbin is pulsed, a wave starts to propagate along the surface of the core. As the wave passes the second bobbin in sequence, another electrical pulse is generated to amplify the wave. After many cycles, the wave traveling around the core becomes larger and larger in amplitude.

[0019] 5. A traveling wave has a wave function equal to a sinusoidal function with an argument of the angle θ around the periphery less the time t, or $\mathrm{Sin}[\theta-\omega t]$.

[0020] 6. In gravitational physics, there is a g metric tensor which is a measure of length in spacetime coordinates. When mass or electromagnetic fields are involved in a certain region of space, a curvature of space is created. The curvature of space can then be calculated directly from this metric tensor. The result is Einstein's G curvature tensor which shows the spacetime distortion. The g metric tensor is a 4 by 4 matrix having rows and columns equal to time t,

radius r, angle theta, and vertical height z. The diagonal from top left to bottom right has a signature equal to $\{-1, 1, r^2, 1\}$.

[0021] 7. Because the magnetic wave traveling around the core is varying with time t in the theta direction, the wave function has to go into the $\{t,\theta\}$ and $\{\theta,t\}$ slots of the metric tensor, as shown in **FIG. 6**.

[0022] 8. From this metric tensor, Einstein's G curvature tensor is calculated using a general relativity software program. The spacetime curvature in the vertical z-direction is contained in the G_{zz} component. A 3D plot of this curvature with respect to radius and theta is shown in **FIG. 7**. The axis on the right side is the angle around the periphery, and the axis on the left is the radius which goes from 0 to 20 meters. The vertical axis of the graph is the spacetime curvature in the vertical z-direction. The center of the vertical axis is zero. At a small radius, there is a sinusoidal curvature which is positive from 0 to π and which is negative from π to 2π. What this looks like is a tilted plate as depicted in **FIG. 8**.

[0023] 9. In flat spacetime with no electromagnetic fields or mass, the curvature would be the horizontal plate as seen **FIG. 8**. Due to the traveling magnetic wave, the spacetime curvature looks like the tilted plate. The flat-space magnetic field was pointing up in the vertical direction, having no divergence and no gradient. In curved spacetime, however, the magnetic field becomes tilted just like the plate and a magnetic gradient dB_z/dz is created. This spacetime curvature gradient of the magnetic field times the magnetic moment of the second coil produces a lift force on the hull which is anchored to these coils.

What I claim as my invention is:

1. A spacecraft that generates a magnetic moment and a magnetic field gradient in the vertical direction in order to create a lift force on the hull.

2. A toroidal core wrapped with electrical bobbins at intervals around the core whose purpose is to create and amplify a magnetic wave that travels along the surface of the core.

3. A circular, direct-current carrying solenoid, located radially inside the toroidal core, to create the magnetic moment.

4. Said magnetic surface wave creates a spacetime curvature, similar to a tilted plate, which produces a magnetic field gradient in the vertical direction.

5. A circular hull, with interior cabin, electrical power supply to drive the coils, and a computer to calculate and sequence the activation of the electrical bobbins.

6. Magnetic sensors, in the form of small coils, located on the toroidal core which can detect the velocity and position of the traveling magnetic wave as feedback to the computer control system.

7. A magnetic vortex generator, either rotating magnet or dual coil, to produce a wormhole through which low linear mass and low speed of light hyperspace energy can enter the hull in order to create highly relativistic electromagnetic fields.

8. A variable current generator to modulate the direct current in the coil so as to produce a variable magnetic moment that can control lift, hover and descent.

9. An electrical power supply using mechanical flywheel stored energy together with a large area capacitor, resupplied with energy by solar cells located on the outer surface of the hull.

* * * * *

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St. Clair (43) Pub. Date: Aug. 26, 2004

(54) HYPERSPACE ENERGY GENERATOR

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(52) U.S. Cl. 333/243

(57) ABSTRACT

This invention is a braided gold wire coaxial cable of micron size which generates hyperspace energy by coupling to the tetrahedral geometry of subspace, dimension and the Planck mass.

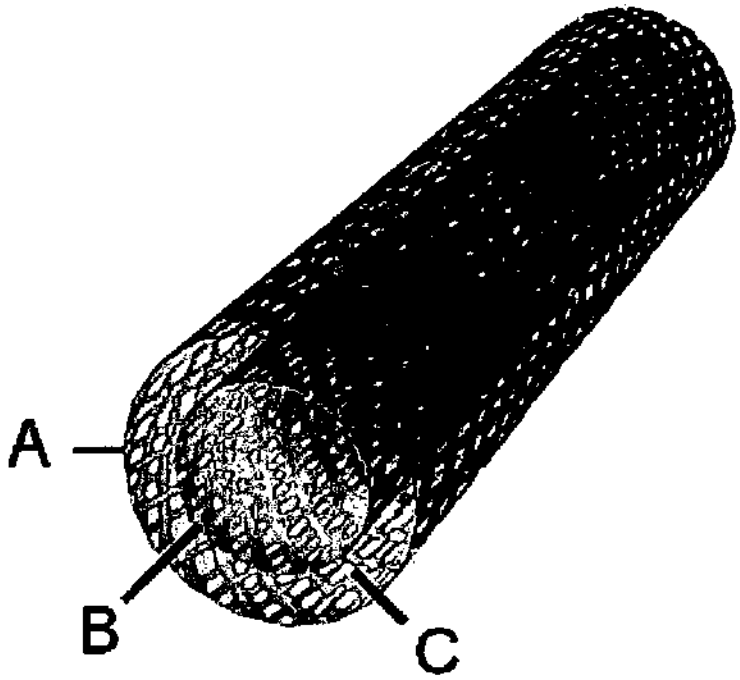

Figure 1

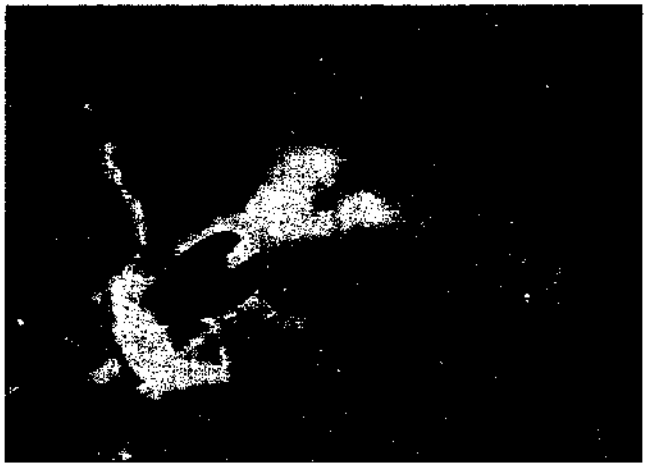

Figure 2

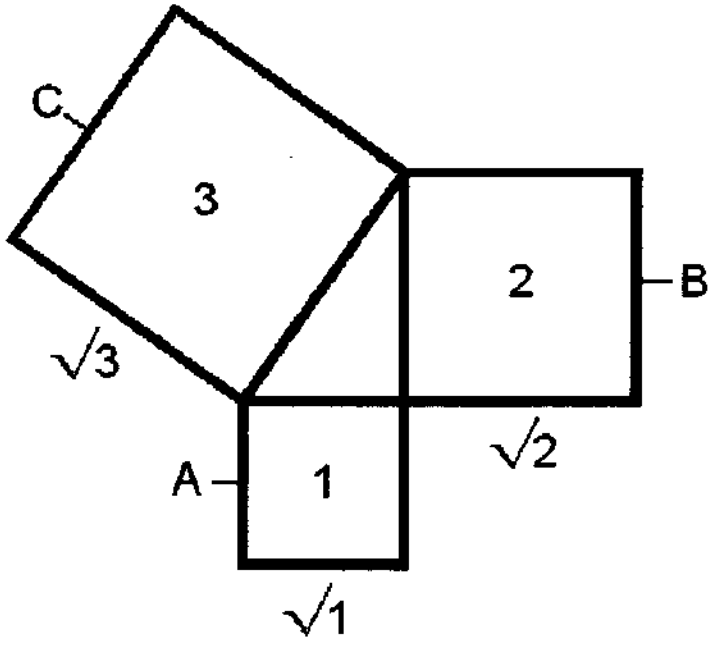

Figure 3

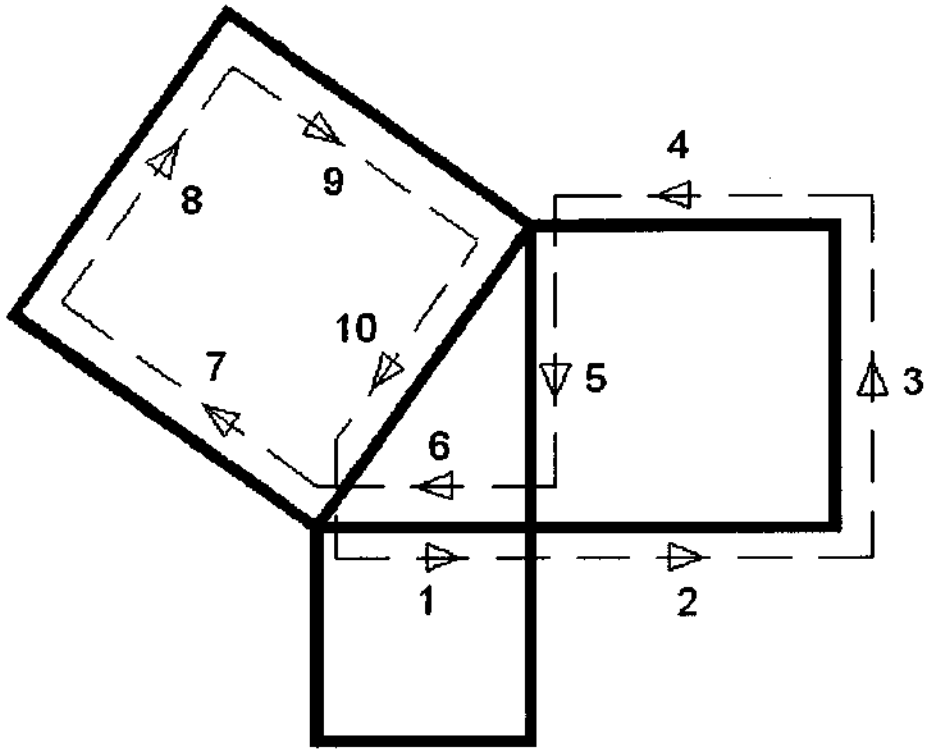

Figure 4

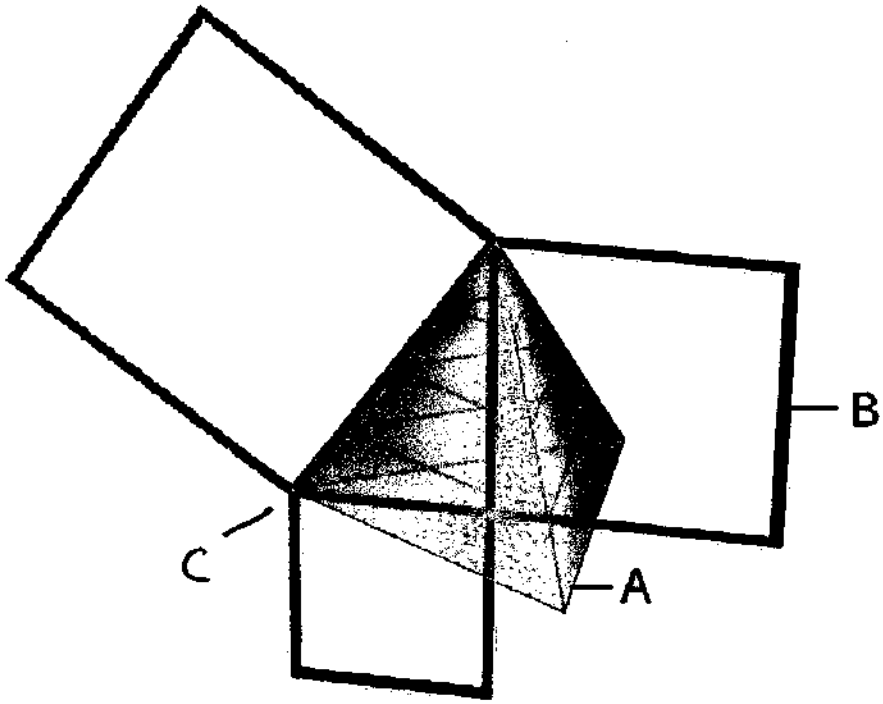

Figure 5

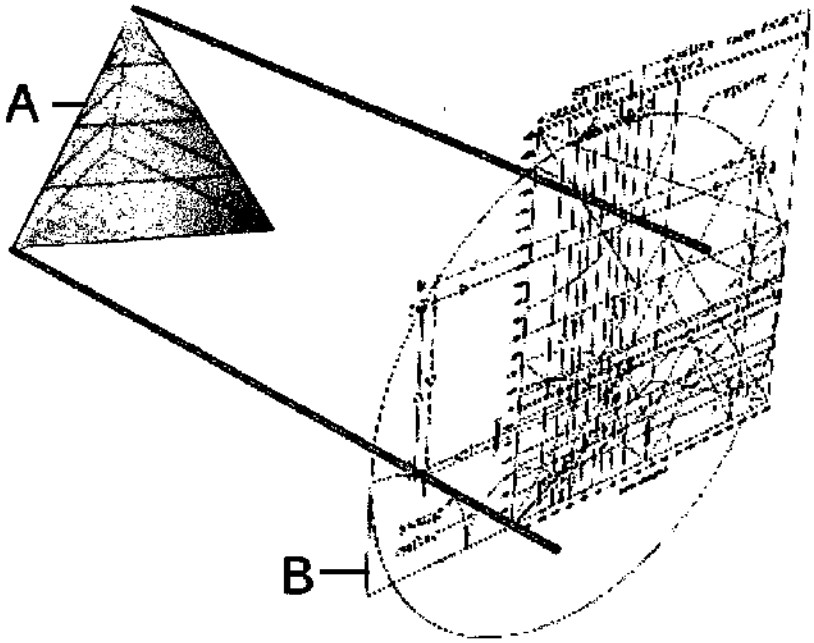

Figure 6

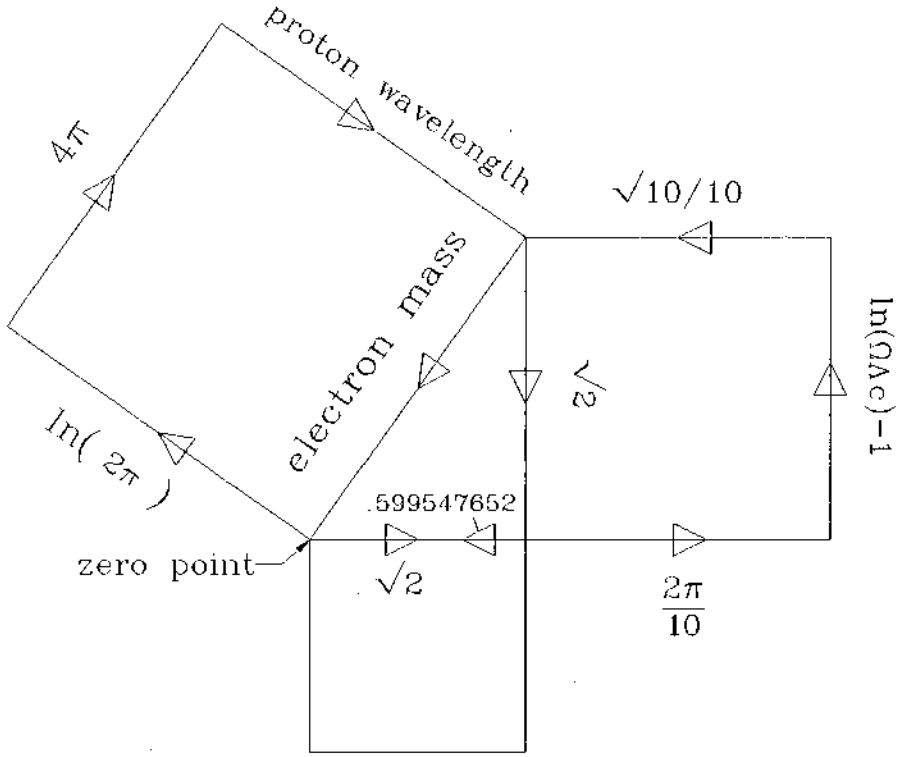
ln(ΩΛc)−1
2π/10
√10/10
√2
.599547652
√2
proton wavelength
zero point
electron mass
4π
ln(2π)

Figure 7

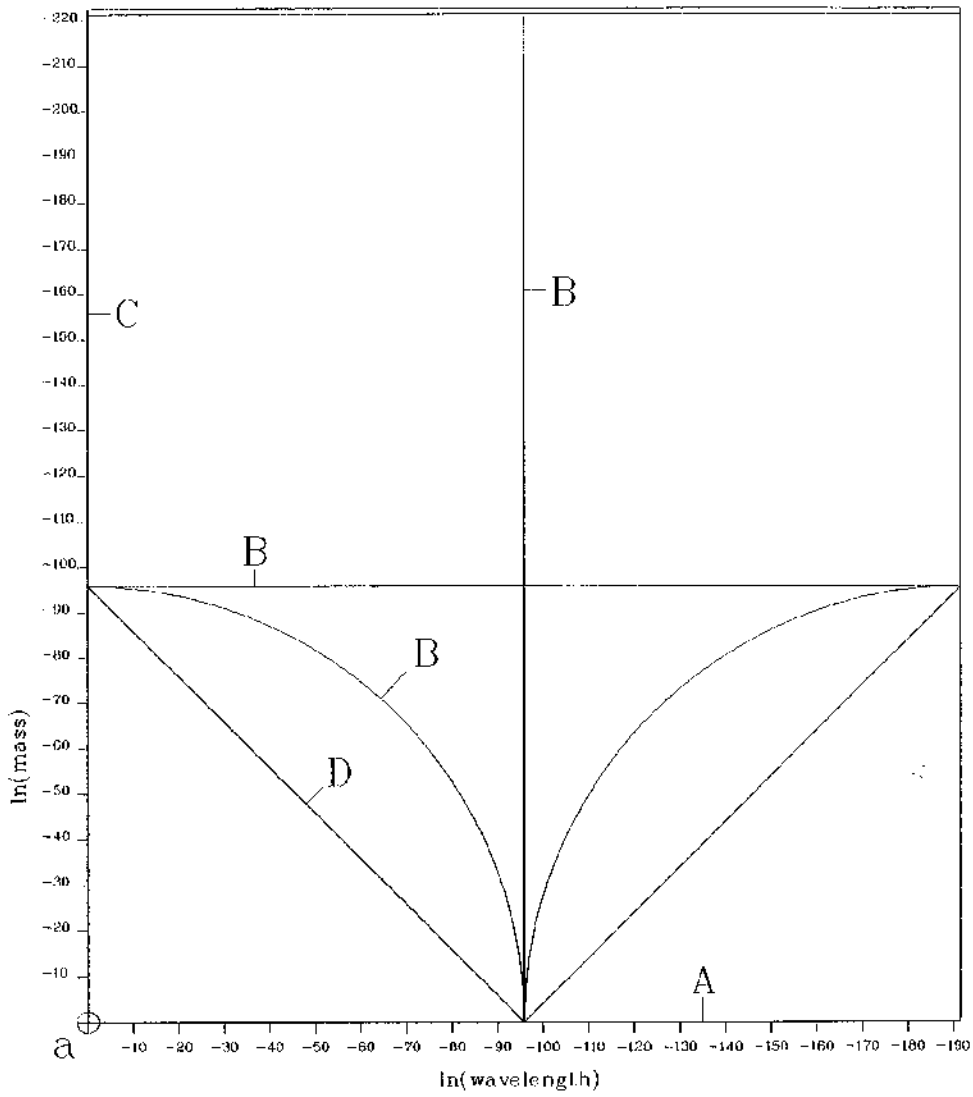

Figure 8

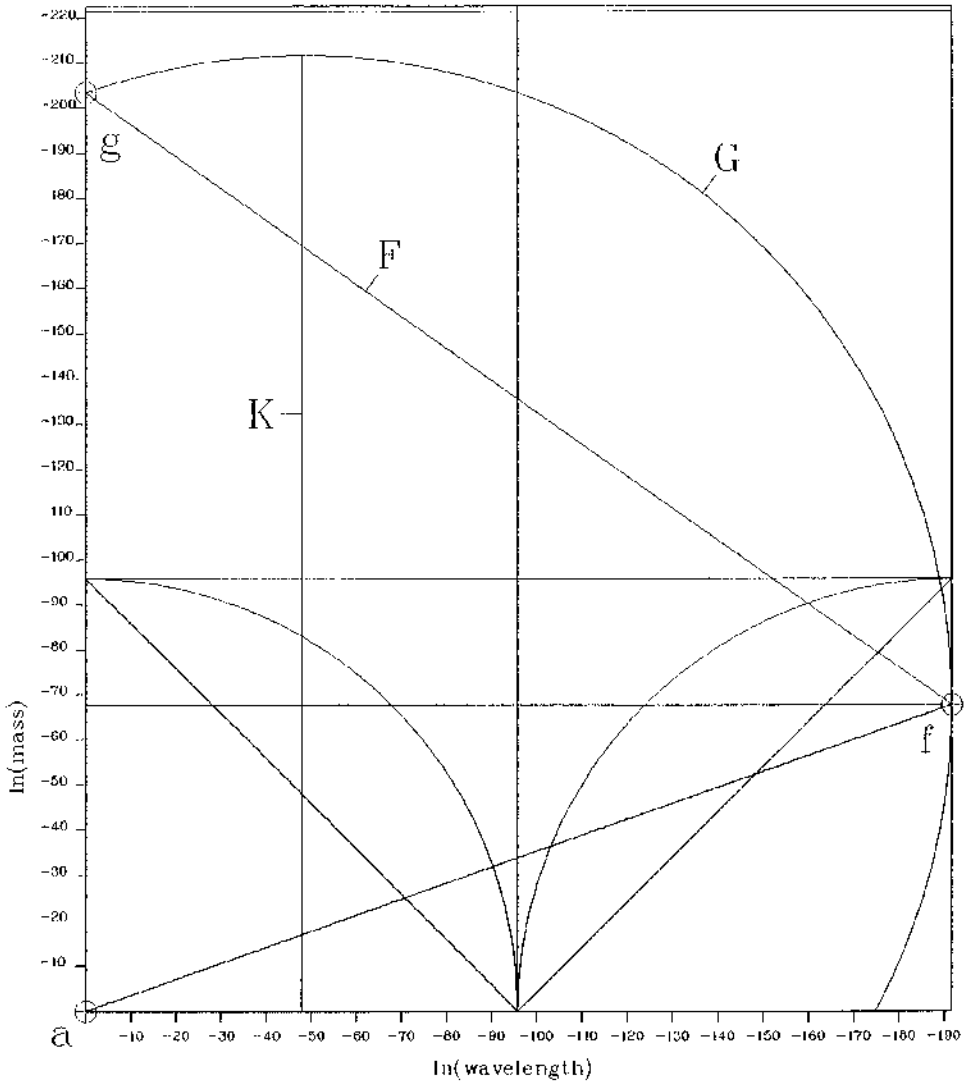

Figure 9

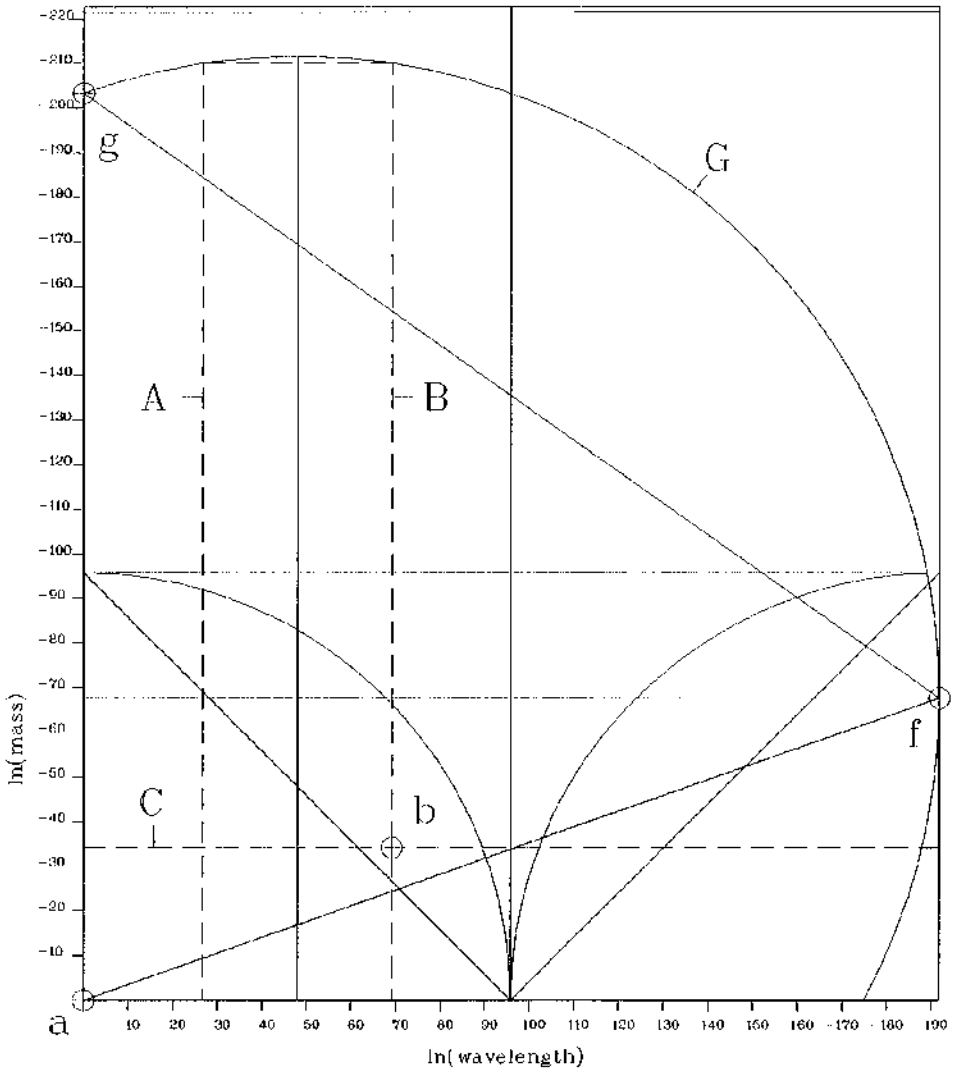

Figure 10

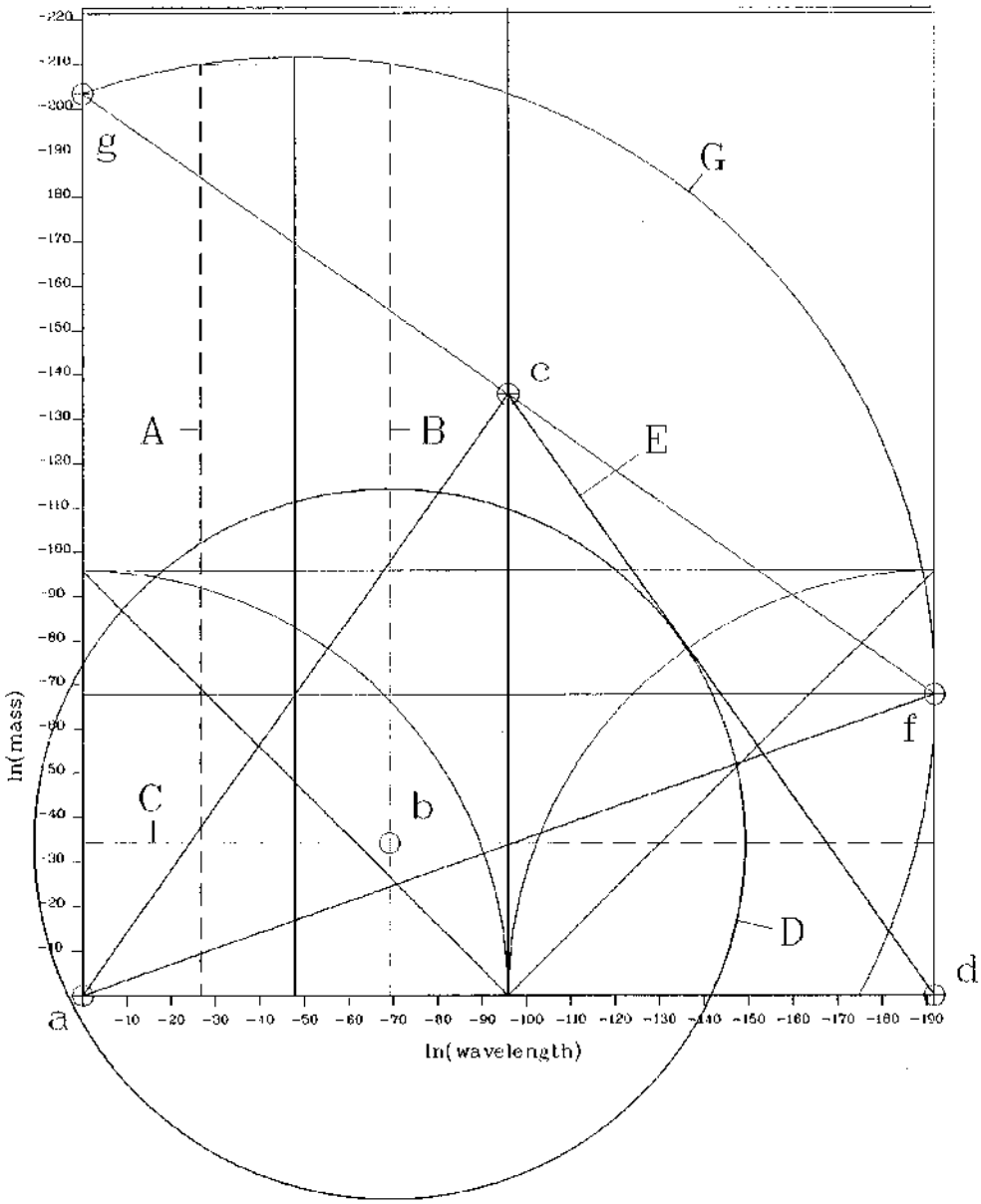

Figure 11

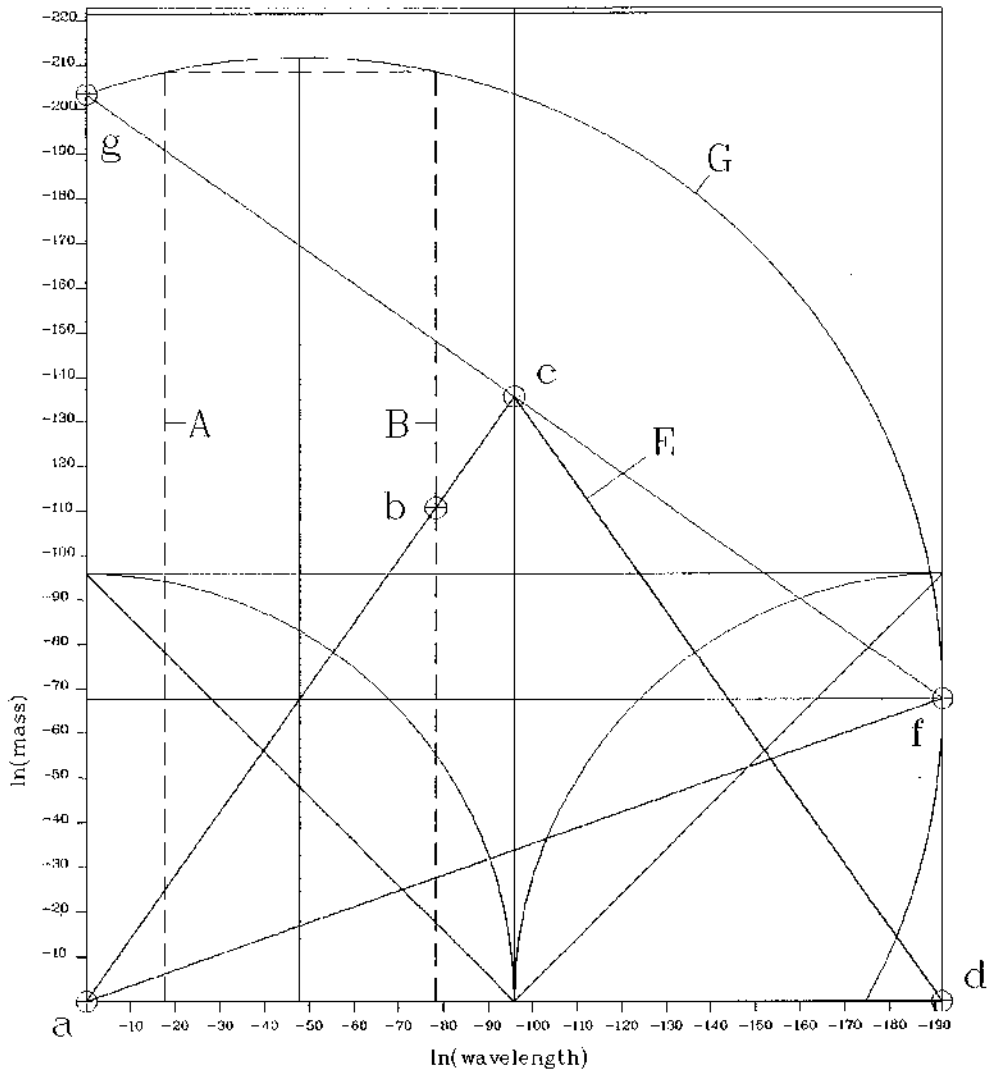

Figure 12

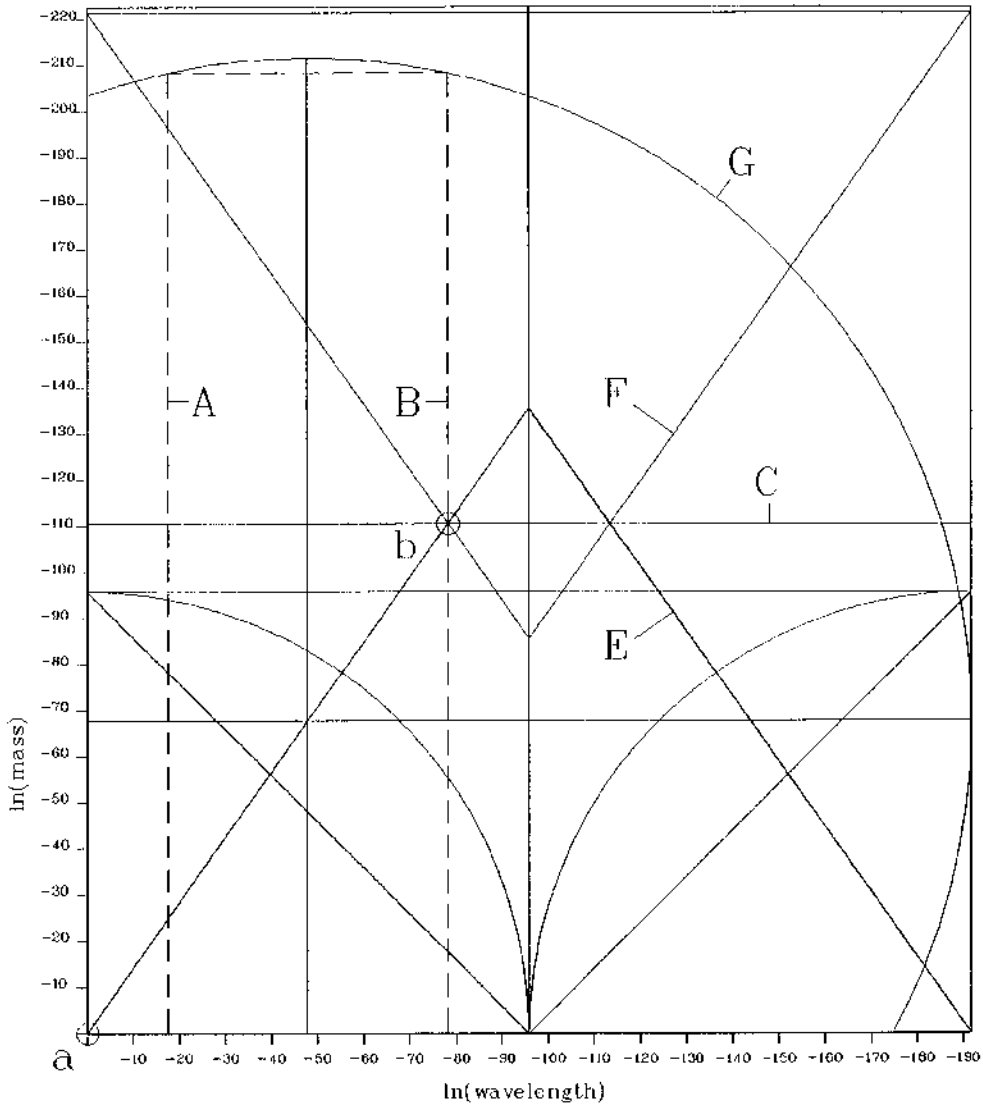

Figure 13

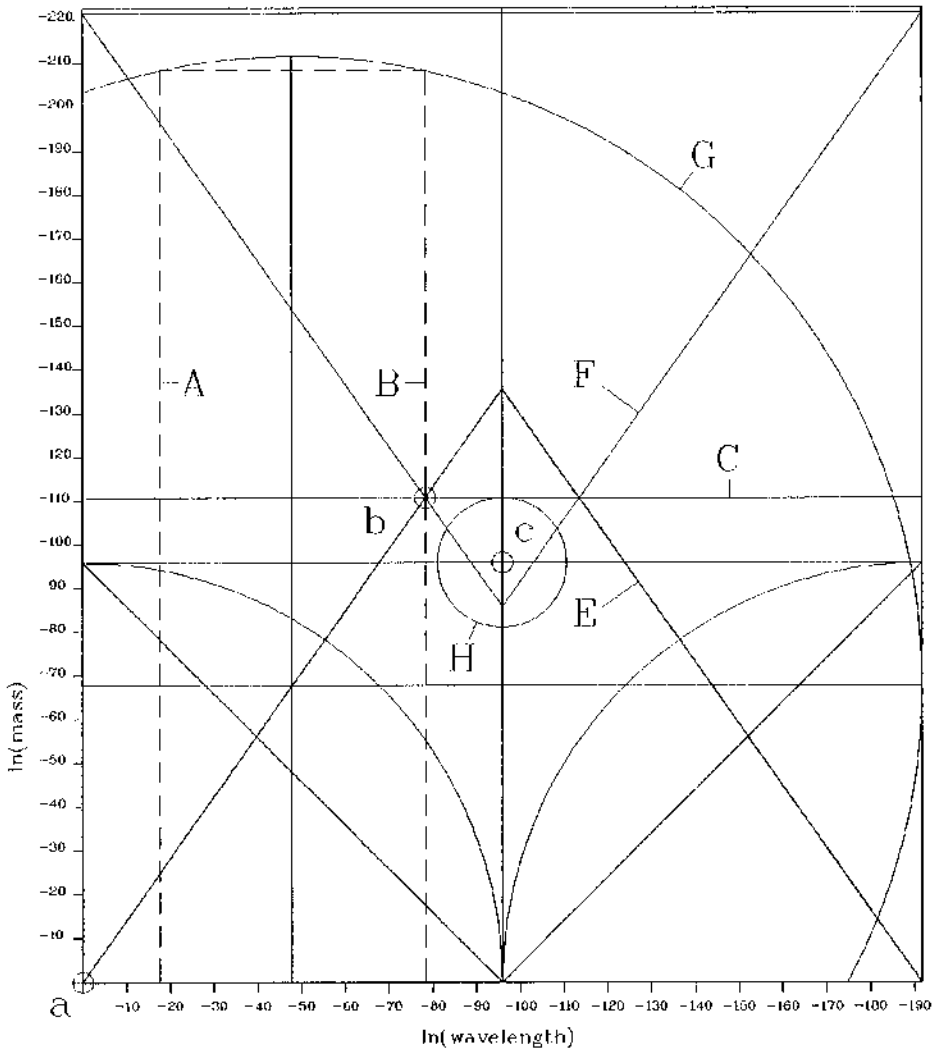

Figure 14

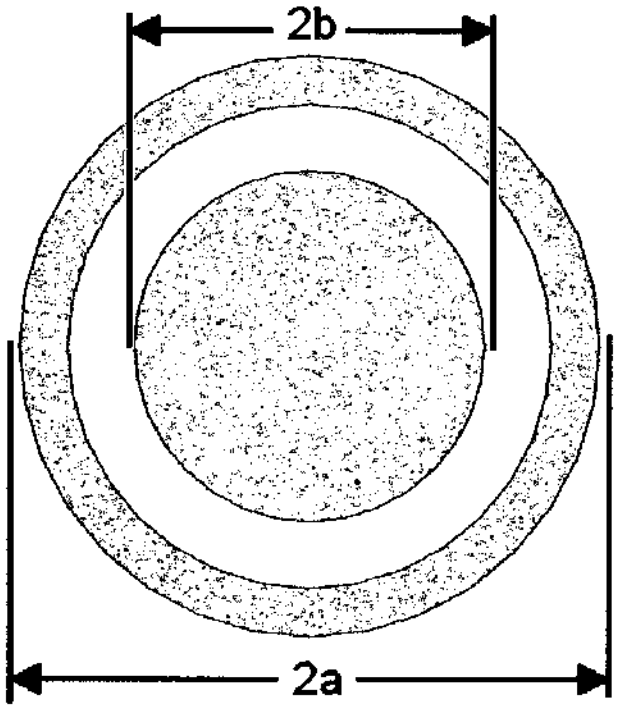

Figure 15

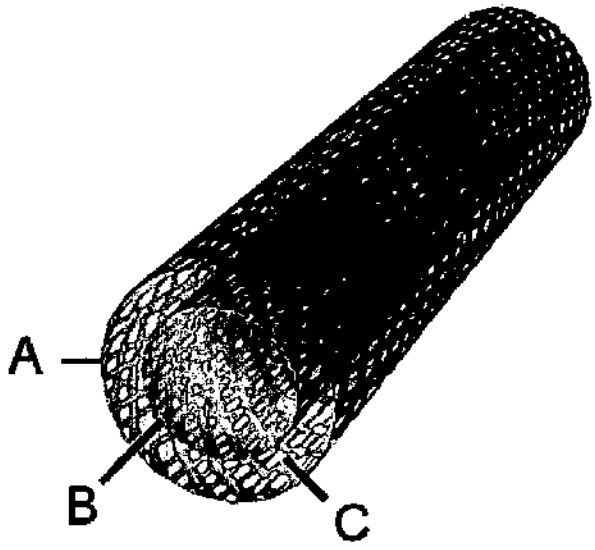

HYPERSPACE ENERGY GENERATOR

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a braided gold wire coaxial cable of micron size which generates hyperspace energy.

BACKGROUND OF THE INVENTION

[0002] Electrical experiments with micron-sized braided gold wire coaxial cable show that it is capable of generating substantial amounts of hyperspace energy. Referring to the electron microscope photograph shown in **FIG. 1**, the white mist emanating from the cable is low-density hyperspace energy that is flowing in from a co-dimension of our universe. The dimensions of the cable are of such a particular size as to couple the cable to the tetrahedral geometry of subspace, the dimension of space, the Planck mass and the linear inductance of the universe.

[0003] According to physicist Dr. Edward Witten of Princeton University, space has twenty-four dimensions, of which ten dimensions are non-redundant. Imagine taking a path around the Pythagorean triangle, as known as the planar tetrahedron, with sides equal to $\{\sqrt{1}, \sqrt{2}, \sqrt{3}\}$ as shown in **FIG. 2**. There are three squares denoted the one-square (A), the two-square (B) and the three-square (C). Each square has four sides. The edge of each square can be traversed in two directions. Thus the total number of dimensions is

$$dim_{total}=2\cdot(4+4+4)=24$$

[0004] Referring to **FIG. 3**, there is a path starting at the corner of the triangle, along the one-square **(1)**, around the two-square **(2,3,4,5)**, back along the one-square **(6)**, around the three-square **(7,8,9,10)** and back to the corner of the triangle. The numbering of the edges shows that there are ten edges. Because the path is traversed in only one direction, the number of reduced dimensions is

$$dim_{reduced}=1\cdot(10)=10$$

[0005] Referring to **FIG. 4**, the planar tetrahedron (B) forms one edge of the three-dimensional tetrahedron (A). Rotating the planar tetrahedron ±120° produces the other two edges. The tetrahedron has four faces which are equilateral triangles. The ten dimensional path starts and ends at (C), the corner of the tetrahedron known as the zero point.

[0006] Referring to **FIG. 5**, the projection of the 3D tetrahedron (A) onto a plane is called the tetrahedron diagram (B) which is the main diagram of the new geometrical physics known as Δphysics. All the constants of physics can be derived geometrically from the tetrahedron diagram and its associated planar tetrahedron. An example of this is shown in **FIG. 6** where the edges are given specific constants related to tetrahedral geometry, dimension, curvature, and the mass and wavelength of the elementary particles such as the electron and proton. The ten dimensional path includes the following constants

[0007] a. electron wavelength

[0008] b. proton wavelength

[0009] c. 47π The solid angle of the sphere. The tetrahedron is circumscribed by a sphere.

[0010] d. ln(2π) The natural log of the curvature. The subspace geometry is a logarithmic manifold. The tetrahedron diagram plots the logarithm of mass versus the logarithm of wavelength.

[0011] e. 0.599547652 A constant related to fractal dimension and the speed of light factor 2.99792458.

[0012] f. $\sqrt{2}$ The edge of the two-square.

[0013] g. $\sqrt{10}/10$ The square root of ten dimensions per 10 dimensions.

[0014] h. ln(ΩΛc)−1 The natural log of the momentum of space less one.

[0015] i.

$$\frac{2\pi}{10}$$

[0016] The curvature of space per 10 dimensions.

[0017] j. $\sqrt{2}$ The edge of the two-square.

[0018] The length of each edge is multiplied by the constant assigned to that edge. The ten edges have the order of $\{\sqrt{1}, \sqrt{2}, \sqrt{2}, \sqrt{2}, \sqrt{1}, \sqrt{3}, \sqrt{3}, \sqrt{3}, \sqrt{3}\}$. What subspace geometry does is to multiply the edge length, such as $\sqrt{1}$, times the square root of two $\sqrt{2}$. Then it takes the square root of that number and multiplies it by the next edge, which is $\sqrt{2}$, times the curvature per 10 dimensions

$$\frac{2\pi}{10}.$$

[0019] It then takes the square root of that number and so on. In equation form, this looks like the following calculation

$$\sqrt{3a\sqrt{3b\sqrt{3c\sqrt{3d\sqrt{1e\sqrt{2f\sqrt{2g\sqrt{2h\sqrt{2i\sqrt{1j}}}}}}}}}}} = 80.1104395$$

[0020] where the letters correspond to those in the list of constants. The square root sum total is equal to the Planck scale Λwhich is the bottom dimensional limit of the universe. The sum of the ten constants per a speed of light circumference is equal to unity

$$\frac{\sum_{n=10} s_n}{2\pi\ln(c)} = 1.000000000$$

[0021] where the log of the speed of light is

$$\ln(c)=\ln(299792458)=19.51860099$$

[0022] and multiplying by 2π is the circumference of a circle with a radius equal to the speed of light.

[0023] Referring to **FIG. 7**, the tetrahedron diagram plots the natural logarithm of mass on the vertical axis (C) versus the natural logarithm of wavelength on the horizontal axis (A). The reason for this is that the mass of the electron times its wavelength is equal to the mass of the proton times its wavelength which in turn is equal to Planck's constant h divided by the speed of light, known as the base constant (B). If two numbers multiply, they sum in logarithms. In subspace geometry, the sum of the logarithm of the mass of the electron plus the logarithm of the wavelength is equal to the logarithm of the base constant which has a value of −95.91546344.

$$\ln(m_{electron}) + \ln(\lambda_{electron}) = \ln\left(\frac{h}{c}\right) = -95.91546344$$

[0024] What this means is that the mass and wavelength slide on a 45° base line (D) which has end points on the vertical and horizontal axes equal to the base constant.

[0025] Referring to **FIG. 8, a** line (af) drawn from the origin at the tetrahedral angle of 19.47122063, equal to the asin(⅓), creates a tetrahedron (F) along path (afg). This tetrahedron is circumscribed by a sphere (G) with sphere diameter (K).

[0026] The Planck scale path calculation showed that the electron mass and the proton wavelength were the last two edges. The electron mass has a value of

$$\ln(m_e) = -69.17083217$$

[0027] and the electron wavelength has a value of

$$\ln(\lambda_E) = -26.74463127$$

[0028] Referring to **FIG. 9**, the electron wavelength (A) is plotted as a vertical line on the tetrahedron diagram. The wavelength reflects off the circumscribing sphere (G), and returns as the electron mass (B). So the diagram incorporates the concepts of both classical physics (point mass particles) and quantum mechanics (wave particles).

[0029] The proton wavelength has a value of

$$\ln(\lambda_p) = -34.26005901$$

[0030] The proton wavelength (C) is plotted as a horizontal line in order to get the intersection (b) with the electron mass.

[0031] Referring to **FIG. 10, a** circle (D) with a radius equal to the Planck scale is drawn centered (b) on the intersection of the electron mass with the proton wavelength, which are the last two edges of the Planck scale calculation. A line (ac) from the origin to the intersection of the base constant with the rotated tetrahedron creates the vertical tetrahedron (acd). As can be seen, the Planck scale is tangent to the tetrahedron on side (cd). This tetrahedron is the projection of the 3D tetrahedron shown before in **FIG. 5**. What this means is that the tetrahedral geometry of subspace determines the bottom limit of our universe. And this bottom limit, called the Planck scale, contains within itself the mass and wavelength of the elementary particles, curvature, dimension and planar tetrahedral geometry. Tetrahedron diagram tet0565 shows that the electron and proton are one and the same particle because the electron path rotates counterclockwise around the curvature and then returns clockwise as the proton path. This path occurs moving through space and hyperspace. Because the single particle enters our universe from hyperspace at two different positions, we see it as two distinct particles. Thus the tetrahedron diagram shows that hyperspace exists.

[0032] The speed of light is equal to the inverse of the square root of the permeability μ of space times the permittivity ϵ of space

$$c = \sqrt{\frac{1}{\mu\epsilon}}$$

[0033] The permeability is linear inductance or inductance per length which you would find in a solenoid for example. The permittivity is linear capacitance or capacitance per length which you find in a capacitor. In an electrical circuit, the inductance and capacitance form a resonant circuit. The resonance frequency can be changed by changing the inductor or capacitor. In a similar manner, the speed of light is not constant, but can be lowered by increasing the permittivity. Hyperspace energy has a high permittivity and therefore a low speed of light. This low speed of light gives hyperspace energy a luminescent quality which is seen as a white mist **(FIG. 1)**.

[0034] From Einstein's General Theory of Relativity, the stress pressure T on spacetime is proportion to the square of the ratio of the electric field E to the speed of light c.

$$T = \left(\frac{E}{c}\right)^2$$

[0035] Thus substantially lowering the speed of light creates an enormous spacetime pressure which can be used to generate the lift force on electromagnetic field propulsion vehicles. Furthermore, the electric field is subject to the Lorentz transformation

$$E = \frac{E_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

[0036] The electric field E_0 moving in a frame velocity of v, can quickly attain relativistic proportions because the speed of light could be 1 meter per second, rather than the enormous value in our universe of 299792458 meters per second. Thus one would like to permeate the hull of the electromagnetic field propulsion vehicle with this hyperspace energy in order to increase the electric field and hence the spacetime curvature around the hull which produces the enormous lift force on the vehicle. The method of bringing in this hyperspace energy is to use braided gold wire coaxial cable which is coupled to the geometry of subspace. The subspace geometry is contained in the Δphysics tetrahedron diagram.

[0037] Just as space has a linear inductance and linear capacitance, it also has a linear mass Ω or mass per meter.

Physicist Dr. John A. Wheeler of Princeton likes to invert this and call it "mom" for meter of mass. The Planck mass is equal to the Planck scale Λtimes the linear mass Ω

$$\ln(m_{Planck})=\ln(\Omega\Lambda)=-17.64290101$$

[0038] Planck's constant h is equal to 2π times the Planck scale squared times the linear mass Ω times the speed of light c.

$$h=2\pi\Lambda^2\,\Omega c=2\pi\Lambda(\Omega\Lambda)c$$

[0039] which shows that Planck's constant is actually the circumference of a circle of radius Planck scale times the Planck mass times the speed of light. The base constant is therefore

$$\text{base}=\frac{h}{c}=\frac{2\pi\Lambda(\Omega\Lambda)c}{c}=(2\pi\Lambda)(\Omega\Lambda)=-95.91546344$$

[0040] which is an area, known as the Planck box, bounded by the Planck wavelength (2πΛ) and the Planck mass. Everything outside the Planck box is hyperspace. Everything inside the Planck box is our universe. Thus the boundary between space and hyperspace is the Planck wavelength and the Planck mass. In logarithms, notice that the Planck mass and Planck wavelength, just like the electron and proton, sum to the base constant.

[0041] Referring to **FIG. 11**, the Planck mass (A) and the Planck wavelength (B) are plotted on the diagram and reflected off the sphere. The Planck wavelength intersects the tetrahedron at (b) which is the boundary between space and hyperspace known as the centerline of the diagram. The centerline has a value equal to the base times the square root of ⅔.

$$centerline=\sqrt{\frac{4}{3}}\,base=-110.7536373$$

[0042] Referring to **FIG. 12**, the centerline (C) is drawn on the diagram and the tetrahedron (E) is mirrored (F) across the centerline to indicate the co-dimensions of hyperspace.

[0043] Referring to **FIG. 13, a** circle (H), centered at the base at the base (c), tangent to the centerline (C), has a radius equal to base times the square root of 4/3 less one

$$R=\left(\sqrt{\frac{4}{3}}-1\right)base=14.83817383$$

[0044] This is the length that has to traversed in order to cross over the centerline from the base constant of our universe to the co-dimension of hyperspace. Furthermore, the Planck mass, which is the other boundary, has to be crossed in order to get to either axis as seen by the length between the vertical axis and line (A). It can be looked at also as the length needed to go from the Planck wavelength (B) to the tangent point of circle (H) in order to reach the center of the mirror tetrahedrons.

SUMMARY OF THE INVENTION

[0045] This invention is a braided gold wire coaxial cable of micron size that is coupled to the subspace geometry of the universe for the purpose of bringing in low-density hyperspace energy into our universe from the co-dimensions of hyperspace. The dimensions of the coaxial cable are of such particular size as to enable it to couple to the ten dimensions of space, the 3:1 geometrical ratio of the tetrahedron, the coaxial wave function based on the logarithm of the ratio of the outer radius to the inner radius of the cable, the length between the base constant of our universe and the centerline between mirror tetrahedrons, and the geometrical relationship between the Planck mass and the linear inductance of the cable.

[0046] Referring to **FIG. 14**, the coaxial guide has an outer braided conductor (A) and an inner braided conductor (B) in which the outer and inner conductors are at radii a and b respectively. The linear inductance L of the cable is equal to the natural logarithm of the ratio of the radii times the permeability μ of space divided by the curvature 2π

$$L=\ln\left(\frac{a}{b}\right)\frac{\mu}{2\pi}$$

[0047] It can be shown that the ratio of the area-to-volume ratio of the tetrahedron to the area-to-volume ratio of its circumscribing sphere is 3:1. It is also the ratio of the area of the three-square to the area of the one-square on the planar tetrahedron. It is also the tetrahedral angle asin(⅓) equal to 19.47122063°. It is also a maximum work condition between the velocity ratio of a fluid stream and a moving vane such as in turbomachinery. So the first constraint on the radii is

$$\exp\left(\ln\left(\frac{a}{b}\right)+1\right)\equiv 3$$

[0048] The second constraint is that the radius c of the circle, equal to the difference between the base constant and the centerline, is related to ten dimensions. The value of the radius projected into our universe is

$$c=\left(\sqrt{\frac{4}{3}}-1\right)\text{base}=.3596358547\cdot\text{microns}$$

[0049] and the dimensional constraint is

$$\left[\ln(c)+\ln\left(\frac{1}{a}\right)\right]^2=10$$

[0050] The coaxial wave function constraint is

$$\frac{\ln(a)^2}{2\pi\ln\left(\frac{a}{b}\right)} = \ln(c)^2$$

[0051] The linear inductance of the coaxial cable has to be such that it gets geometrically across the Planck mass which is the second boundary of our Planck box

$$\exp\left(\ln(\Omega\Lambda) - \ln\left(\frac{\ln\left(\frac{a}{b}\right)}{2\pi}\mu\right) + 1\right) = 3$$

[0052] With these four subspace constraints, the outer radius a and inner radius b of the cable are

[0053] a=8.342461828 microns

[0054] b=7.559058141 microns

[0055] so the cable has an outside diameter of roughly 16 to 17 microns.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0056] Not Applicable.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0057] **FIG. 1**. Electron microscope photograph of the coaxial cable and hyperspace mist.

[0058] **FIG. 2**. The planar tetrahedron.

[0059] **FIG. 3**. The ten dimensional path around the planar tetrahedron.

[0060] **FIG. 4**. The relationship between the planar tetrahedron and the 3D tetrahedron.

[0061] **FIG. 5**. Projection of the 3D tetrahedron onto a plane to create the tetrahedron diagram.

[0062] **FIG. 6**. Dimension, geometry, curvature and elementary particles that make up the ten dimensional Planck scale path.

[0063] **FIG. 7**. Tetrahedron diagram showing base constant.

[0064] **FIG. 8**. Tetrahedron diagram showing rotated tetrahedron and circumscribing sphere with electron mass and wavelength reflecting off sphere.

[0065] **FIG. 9**. Tetrahedron diagram showing intersection of electron mass with proton wavelength which are components of the Planck scale path.

[0066] **FIG. 10**. Tetrahedron diagram showing Planck scale tangent to tetrahedron.

[0067] **FIG. 11**. Tetrahedron diagram showing Planck mass and Planck wavelength intersecting tetrahedron.

[0068] **FIG. 12**. Tetrahedron diagram showing mirror tetrahedrons across centerline, the boundary between space and hyperspace.

[0069] **FIG. 13**. Tetrahedron diagram showing distance between the base constant and the centerline used to calculate the dimensions of the coaxial cable.

[0070] **FIG. 14**. End view of coaxial cable showing radii a and b used in the subspace geometry constraints in order to couple to hyperspace.

[0071] **FIG. 15**. Perspective view of braided gold wire coaxial cable.

DETAILED DESCRIPTION OF THE INVENTION

[0072] 1. Referring to **FIG. 15**, the coaxial cable has a braided gold wire outer conductor (A) and a braided gold wire inner conductor (B) separated by a dielectric (C). The open braiding promotes the conduction of the electromagnetic wave while allowing the hyperspace mist to seep out of the braid and permeate the surrounding material in which it is embedded.

[0073] 2. The radius of the outer conductor a and the radius of the inner conductor b have the following values in order to couple the cable to the tetrahedral geometry of subspace.

[0074] a=8.342461828 microns

[0075] b=7.559058141 microns

[0076] 3. Even though the wire size is very small, the cable can be made in limited lengths using the new nanotechnology and silicon micromotors.

I claim:

1. A coaxial cable which has:

a) a braided gold wire outer conductor of radius 8.34 microns;

b) a braided gold wire inner conductor of radius 7.56 microns;

c) a thin dielectric separator between the two conductors; and

d) an open weave to allow the hyperspace mist to seep out of the cable and permeate the surrounding material in which the cable is embedded;

2. A specific relationship between the physical dimensions of the coaxial cable, given in items (**1***a*) and (**1***b*), to the following tetrahedral subspace couplings:

a) the ratio of the area-to-volume ratio of the tetrahedron to the area-to-volume ratio of its circumscribing sphere, equal to 3:1, with a coupling to the natural logarithm of the ratio of the radii of the conductors;

b) the ratio of the area of the three-square of the planar tetrahedron to the area of the one-square, equal to 3:1, with a coupling to the Planck mass and the linear inductance of the cable;

b) the distance between the base constant and $\sqrt{4/3}$ times the base constant, equal to −14.83817383 in natural logarithms, with a coupling to the outer radius of the

conductor, the ten dimensions of space, and the co-dimensions of hyperspace; and

c) the wave function of the coaxial guide given in terms of item (**2***c*), the natural logarithm of the ratio of the radius of the outer conductor to the radius of the inner conductor, and the curvature 2π.

* * * * *

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(54) ELECTRIC DIPOLE MOMENT PROPULSION SYSTEM

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(52) U.S. Cl. 60/203.1

(57) ABSTRACT

A spacecraft propulsion system utilizing a rotating octagon of trapezoidal electrically charged flat panels to create an electric dipole moment that generates lift on the hull.

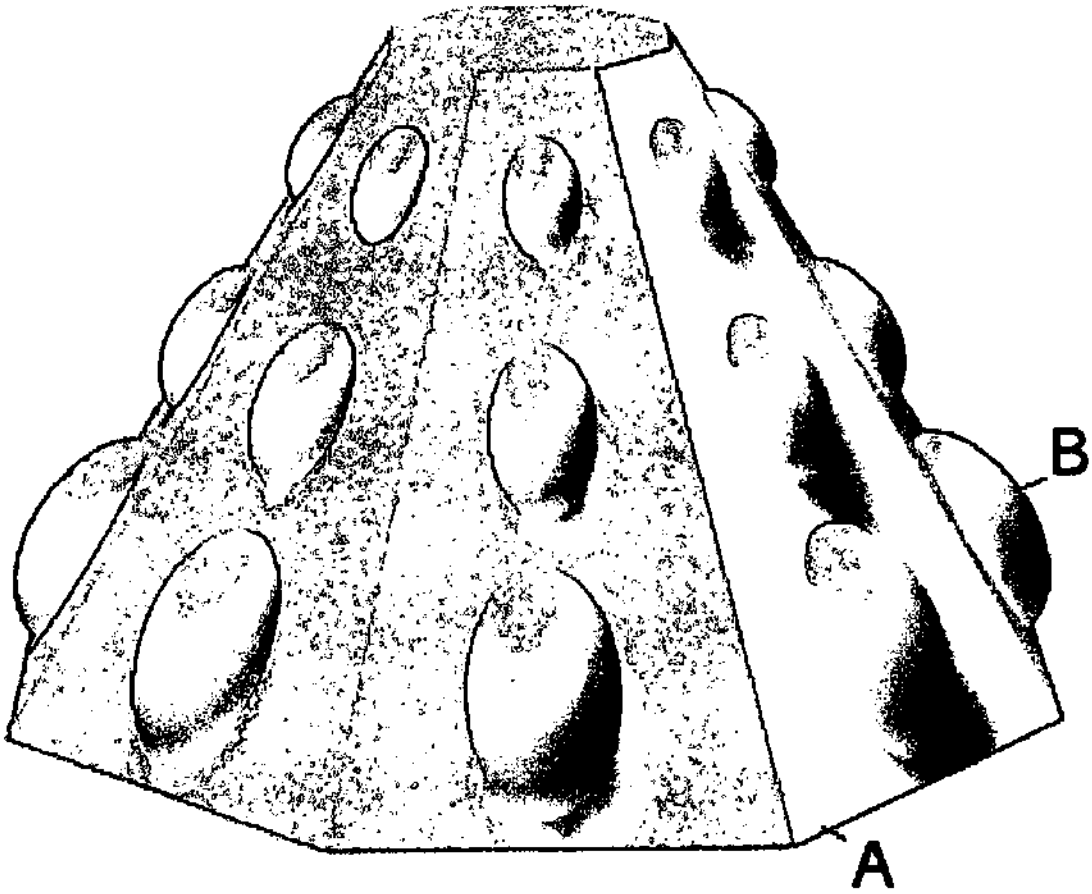

Figure 1

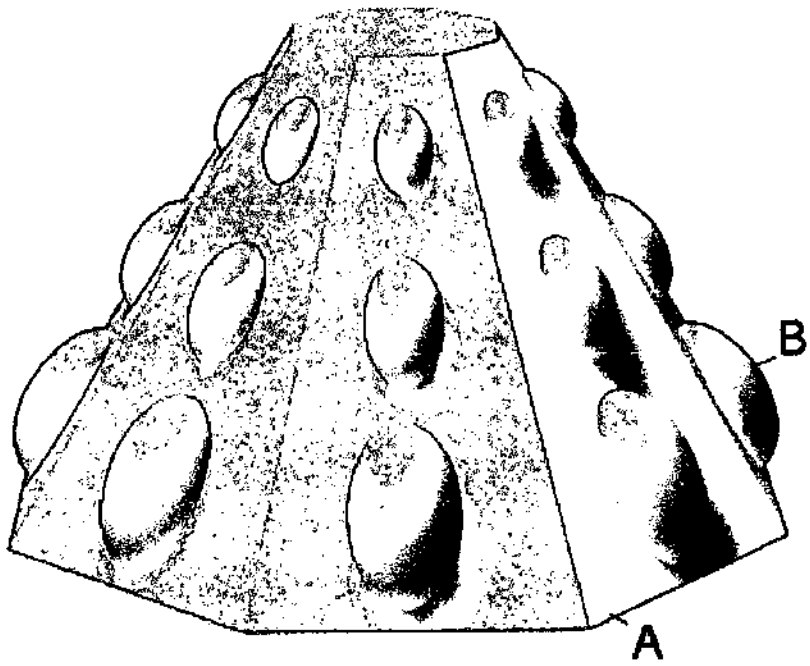

Figure 2

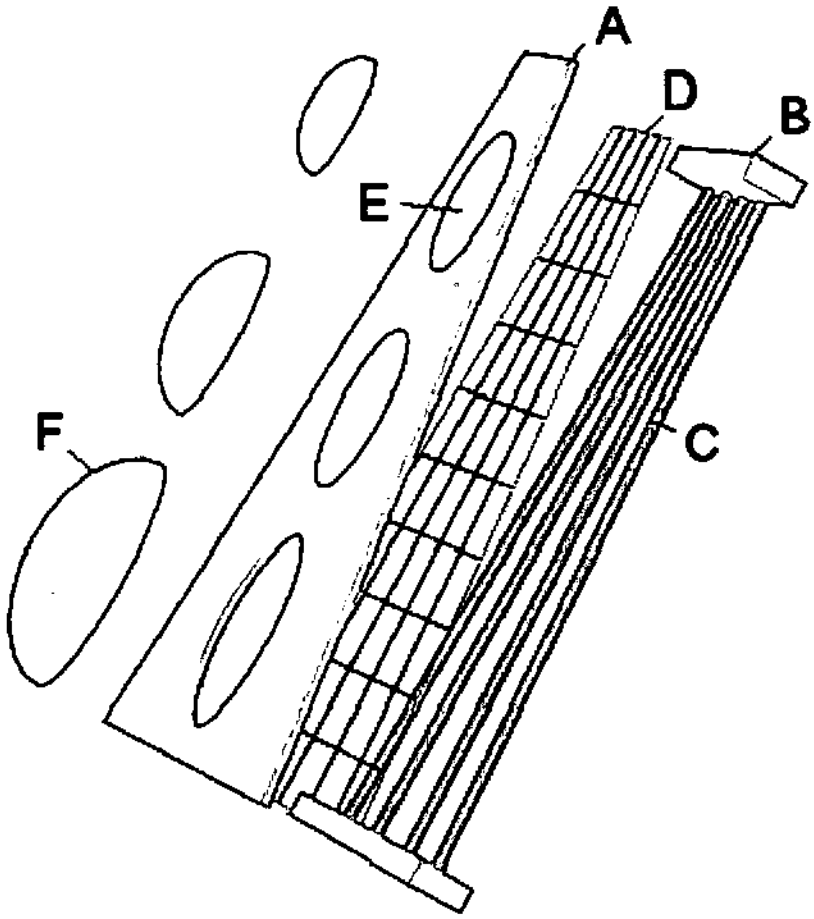

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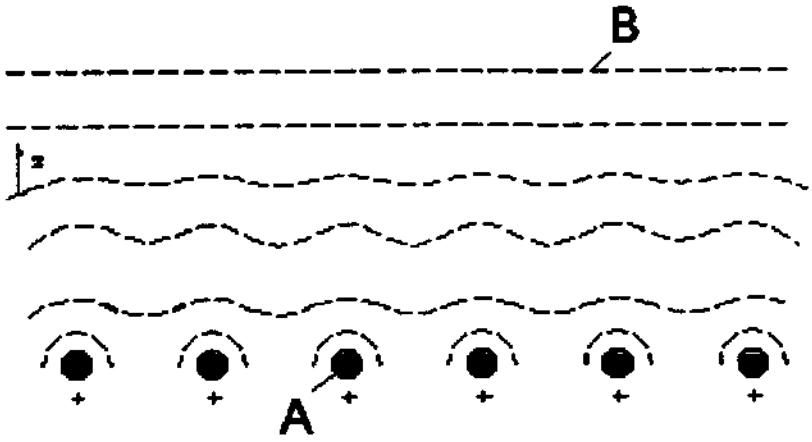

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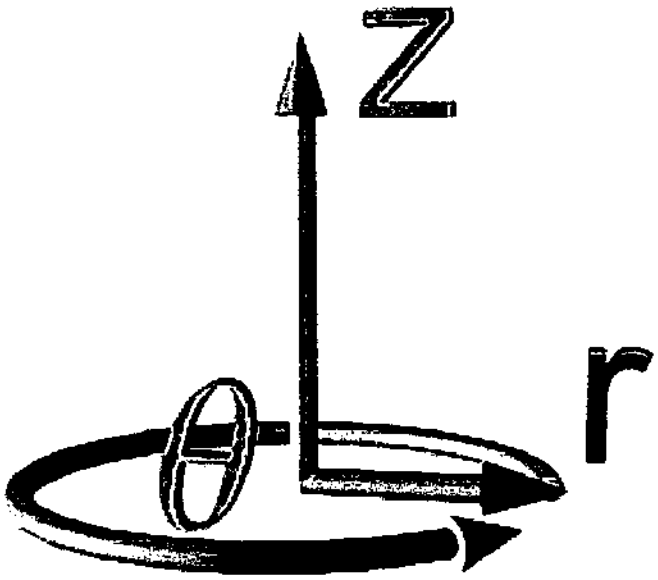

Figure 5

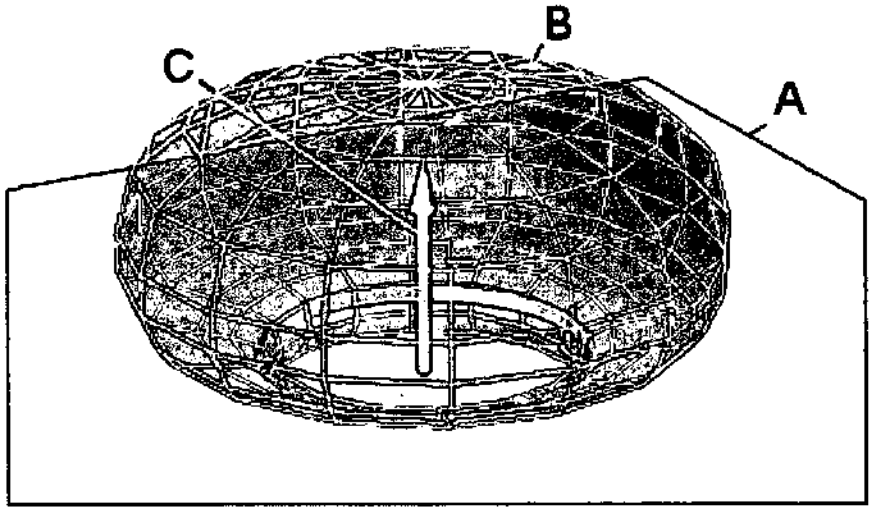

Figure 6

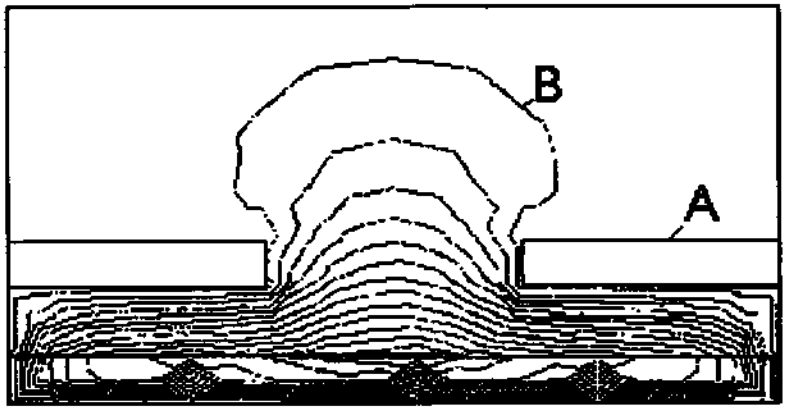

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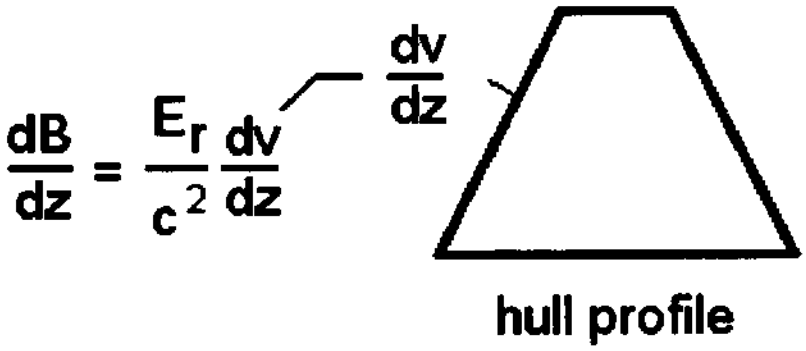

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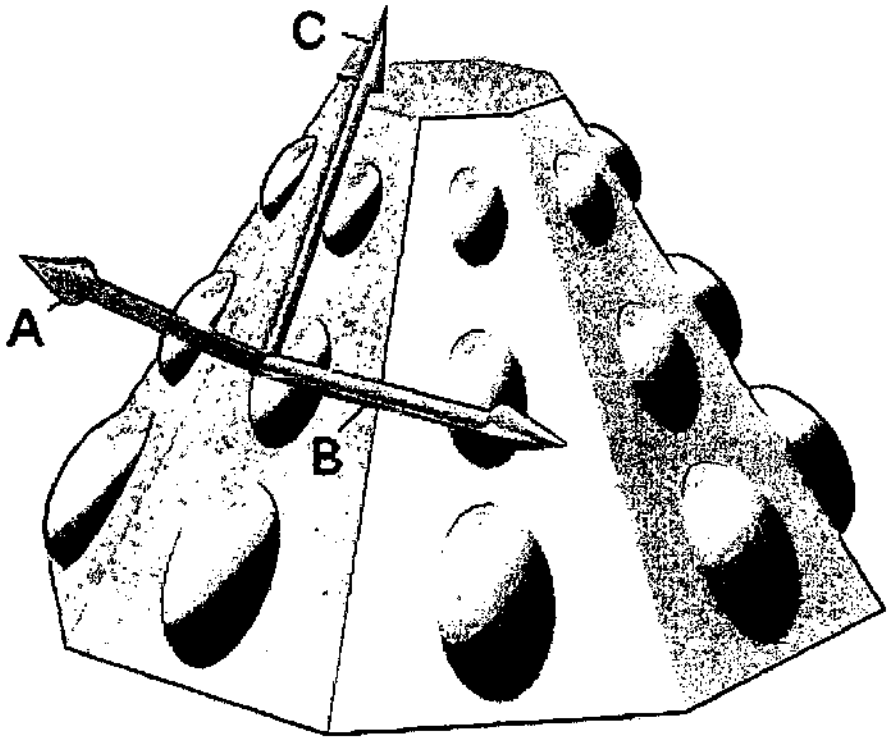

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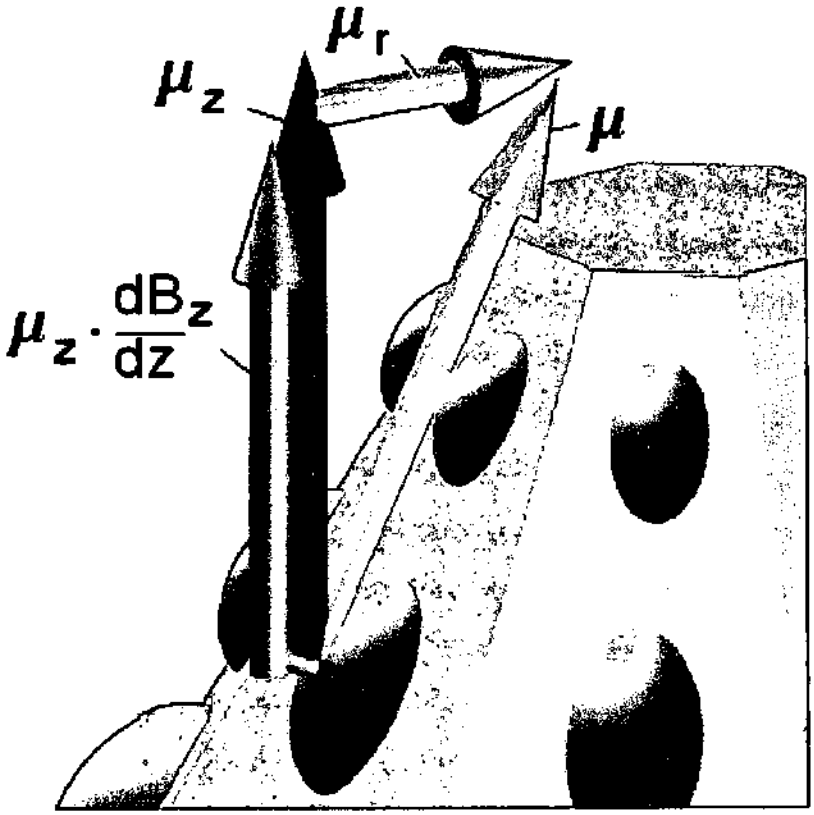

Figure 10

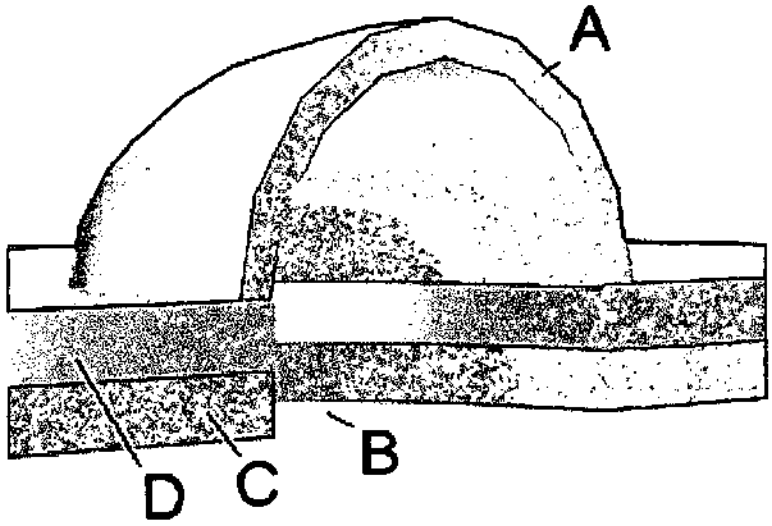

Figure 11

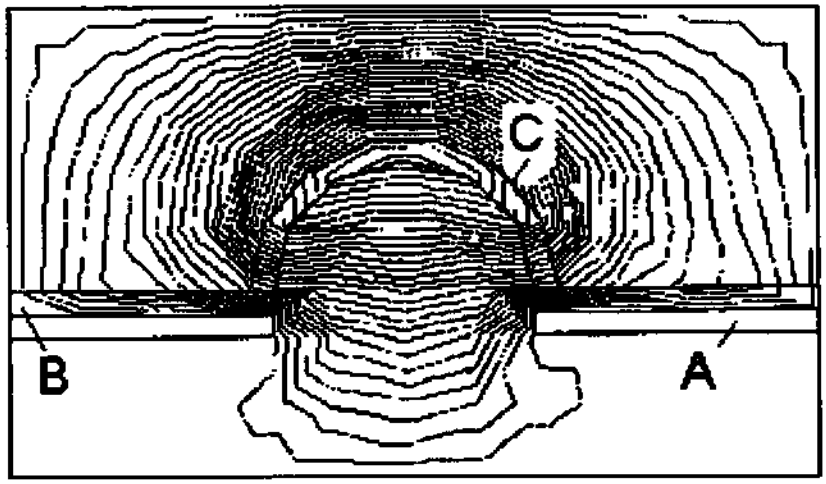

ELECTRIC DIPOLE MOMENT PROPULSION SYSTEM

BRIEF SUMMARY OF THE INVENTION

[0001] The invention is a spacecraft utilizing trapezoidal electrostatically charged flat plate panels which form a pyramidal hull. A panel contains three holes each of which produces a potential energy ellipsoidal bubble that creates an electric dipole moment. The rotation of the hull generates a magnetic moment and a magnetic field gradient in the vertical direction that produces a lift force on the spacecraft.

BACKGROUND OF THE INVENTION

[0002] It is known from electrodynamics that a hole in a conducting plane forms a potential energy bubble. This bubble creates an electric dipole moment from which it is possible to develop a magnetic moment. A rotating tilted hull produces a velocity gradient that generates a magnetic field gradient in the vertical direction. This combination produces a lift force on the spacecraft. A very large potential energy bubble is produced provided that the hole protrudes out of the plate in an ellipsoidal shape. Furthermore, a double cladding, in which each layer around the hole has a different permittivity, confines the field to the outside of the hull for even better results.

[0003] The planar potential energy is created by a grid of electrically charged wires or rods running the length of each panel. A circular potential energy from each rod very quickly sums to form a flat sheet of energy which emerges from the hole to form the potential energy bubble.

SUMMARY OF THE INVENTION

[0004] The invention relates to a spacecraft utilizing a rotating octagon of trapezoidal electrically charged flat plate panels to form a hull in the shape of a pyramid. Each panel has three protruding ellipsoidal bubbles that produce an electric dipole moment from a planar potential energy field created by a group of charged rods parallel to the panel. Because the panels are tilted and the hull is rotating, there is a tangential velocity gradient in the vertical direction. This creates the magnetic moment. Because the hull rotates, the radial electric field produces a magnetic field gradient in the vertical direction. This combination of magnetic moment and magnetic field gradient produces a lift force on the hull of the spacecraft.

[0005] On the underside of each panel is a group of high voltage electrically charged rods which run parallel to the panel. These wires or rods produce a planar electrical potential field underneath the holes in the panel. This potential energy field then bubbles out of the holes in the panel to create a large ellipsoidal potential energy field above the hull. The potential energy bubble carries an electric dipole moment which when rotated with the hull generates a magnetic moment in the vertical direction.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0006] **FIG. 1**. Perspective view of electric dipole moment spacecraft.

[0007] **FIG. 2**. Perspective exploded view of one panel with the ellipsoidal domes, flat hull panel with three holes, the charged rod grid and the planar potential energy field.

[0008] **FIG. 3**. Planar view of flat potential energy field produced by electrically charge wire rods.

[0009] **FIG. 4**. Perspective view of cylindrical coordinates $\{r, \theta, z\}$.

[0010] **FIG. 5**. Perspective view of ellipsoidal potential energy field emerging from hole in plate which produces an electric dipole moment.

[0011] **FIG. 6**. Planar view of field lines of potential energy bubble emerging from plate hole.

[0012] **FIG. 7**. Planar view of sloping hull profile needed to get a velocity gradient.

[0013] **FIG. 8**. Perspective view of hull showing electric dipole moment, the tangential velocity of the hull, and the magnetic moment.

[0014] **FIG. 9**. Perspective view of the magnetic moment components in the radial and vertical direction whereby the lift force is generated by the dot product of the vertical magnetic moment with the magnetic field gradient.

[0015] **FIG. 10**. Perspective view of cross section of dome showing two layer cladding with different permittivities to enhance potential energy field.

[0016] **FIG. 11**. Planar view of enhanced potential energy field with two layer cladding.

DETAILED DESCRIPTION OF THE INVENTION

[0017] 1. Referring to **FIG. 1**, the spacecraft is a rotating octagon of trapezoidal electrostatically charged flat panels which form a closed hull (A). Each panel has three ellipsoidal domes (B) of varying size centrally located along the major length of the panel. The purpose of the dome is to create a large ellipsoidal potential energy bubble over the hull which develops an electrical dipole moment. Because the hull is rotating, a magnetic moment is created in the vertical direction. A magnetic field gradient created by the rotating electric field on the hull in combination with the magnetic moment produces a lift force on the hull.

[0018] 2. Referring to **FIG. 2**, the trapezoidal hull panel (A) contains three ellipsoidal holes (E). A group of wires or rods (C) running parallel to and just underneath the panel are electrically charged to a high voltage at the end terminals (B). The rods produce a planar potential energy field (D) just under the holes in the panel. The field emerges from the holes in the shape of an ellipsoidal bubble and is amplified by an ellipsoidal dome (F) on the outside of the hull.

[0019] 3. Referring to **FIG. 3**, the group of parallel rods (A) are given a linear charge λ in units of charge per meter. The electric field E developed by the rod is the linear charge divided by the circumference of a circle of radius r around the wire times the permittivity ϵ of space. The analysis of this arrangement shows that within a few grid width spacings, the potential energy field ϕ due to the electric field E_0 has become planar (B) in the z-direction given by the equation

$$\phi = -E_0 z$$

[0020] 4. Referring to **FIG. 4**, the following analysis is done in cylindrical coordinates {r,θ,z}.

[0021] 5. Referring to **FIG. 5**, the ellipsoidal potential energy (B) emerges through the hole in the panel plate (A). In doing so it creates an electrical dipole moment (C) shown by the arrow normal to the hole area.

[0022] 6. Referring to **FIG. 6**, the bubble (B) emerges through plate (A).

[0023] 7. Because the bubble has the shape of an ellipse, the centroid y of the bubble would be four thirds the radius a divided by π as given by

$$\bar{y}_{ellipse} = \frac{4}{3}\frac{a}{\pi}$$

[0024] The electric dipole moment is then given as the charge q times the centroid y. The charge of the hole is equal to the permittivity E times the electric field E emerging from the hole times the area of the hole of radius a

$$q = \varepsilon_0 E\pi a^2 \frac{\text{coul}^2}{\text{m}^2\ \text{newton}}\frac{\text{newton}}{\text{coul}}\ \text{m}^2 = \text{coul} = \text{charge}$$

[0025] 8. The electric dipole moment p is the centroid y times the charge q

$$p = qy = \varepsilon_0 E\pi a^2 \frac{4}{3}\frac{a}{\pi} = \frac{4}{3}\varepsilon_0 E a^2\ \text{coul}\cdot\text{meter}$$

[0026] The electric dipole moment p times the hull velocity v is equal to a magnetic moment μ which is what creates the lift force on the hull

$$\mu = pv\ \text{amp}\cdot m^2$$

[0027] 9. The rotating hull creates the electric dipole moment velocity so that the entire hull develops a magnetic moment. In tensor notation, the magnetic moment μ is in the vertical z-direction because there is a radial component of the electric dipole moment times the velocity. The velocity is the radius r in the radial direction times the angular velocity ω in the z-direction

$$\mu^z = p_r x^r \omega^z$$

[0028] 10. The force F on the hull is the gradient of the dot product of the magnetic moment μ with the magnetic B field

$$F = \nabla(\mu\cdot B)$$

[0029] 11. By electrically charging the hull of the vehicle, a radial electric field is produced. By rotating the hull, the radial electric field changes with time. Thus Maxwell's equations will involve the curl of the magnetic field in the radial direction because the radial electric field is varying with time

$$(\nabla \times B)_r = \frac{1}{c^2}\frac{\partial E_r}{\partial t}$$

[0030] 12. The cross product involves the magnetic field in the theta direction which is zero

$$\frac{1}{r}\frac{\partial B_z}{\partial \theta} - \frac{\partial B_\theta}{\partial z} = \frac{1}{c^2}\frac{\partial E_r}{\partial t} = \frac{1}{r}\frac{\partial B_z}{\partial \theta}$$

[0031] Substituting the derivative of the electric field E

$$E_r = E_0 e^{i\omega t}$$

[0032] and integrating with respect to angle theta gives the vertical magnetic field B as the tangential velocity v times the radial electric field E divided by the speed of light c squared

$$B_z = \frac{v}{c^2}E_r$$

[0033] 13. The force on the hull is the gradient of the magnetic moment μ times the magnetic field B. In the equation for the magnetic field, the only available variable to work with in order to get a gradient of the magnetic field comes from the velocity.

$$\frac{dB_z}{dz} = \frac{E_r}{c^2}\frac{dv}{dz}$$

[0034] 14. Referring to **FIG. 7**, because the hull is in the shape of a pyramid, the velocity is a function of the height z of the hull. Using eight flat sides keeps the radial electric field pointing in the same direction in each panel. Each panel has three domes to produce the magnetic moment for a total of 24 magnetic moment generators.

[0035] 15. Referring to **FIG. 8**, the electric dipole moment (A) points in the radial direction, the rotating hull produces a tangential velocity (B), and the result is a magnetic moment (C) along the panel.

[0036] 16. Referring to **FIG. 9**, because the magnetic moment is parallel to the panel, there are vertical and radial components of the magnetic moment. The vertical magnetic moment creates the dot product with the magnetic field gradient, which is equal to the lift force.

[0037] 17. **FIG. 10** shows a cross-section of the dome (A) and the plate hole (B) with double cladding to enhance the field. The upper cladding (D) has a low relative permittivity in the range of 2 to 40, and the lower layer has a high relative permittivity in the range of 1200 to 4000.

[0038] 18. Comparing **FIG. 11** to **FIG. 7**, this dome and cladding configuration creates a much larger electric dipole moment compared to a hole in the plate. The wavy

lines are the equi-potential energy lines from the dome (C) and the upper layer (B) and the lower level (A).

I claim:

1. A spacecraft propulsion system comprising:

a rotating octagon of trapezoidal electrostatically charged flat panels which form a closed sloping hull in the shape of a pyramid;

panels each having three holes covered by three ellipsoidal domes of varying size centrally located along the major length and axis of each panel; and

a grid of high voltage electrostatically charged rods located on the interior side of each panel such that a planar potential field is produced parallel to and under each panel hole.

2. The domes, holes and rotating charged hull of method 1 producing:

an ellipsoidal potential energy field emerging from the holes and generating an electric dipole moment on the outside of the hull;

a magnetic moment in the vertical direction due to the rotating electric dipole moment; and

a rotating electric field in the radial direction which generates a corresponding magnetic field gradient in the vertical direction proportional to the velocity gradient of the sloping panels of the hull.

3. A lift force on the spacecraft hull generated by:

the magnetic moment times the gradient of the magnetic field in the vertical direction; and

a dual surface layer hull cladding having different permittivities which enhance the electric dipole moment whereby the upper cladding has a low relative permittivity in the range of 2 to 40, and the lower layer has a high relative permittivity in the range of 1200 to 4000.

* * * * *

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St. Clair (43) Pub. Date: Feb. 23, 2006

(54) ELECTRIC DIPOLE SPACECRAFT

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B64G 1/40 (2006.01)

(52) U.S. Cl. 244/171.5

(57) ABSTRACT

This invention is a rotating spacecraft that produces an electric dipole on four rotating spherical conducting domes perturbing a uniform spherical electric field to create a magnetic moment interacting with the gradient of a magnetic field that generates a lift force on the hull.

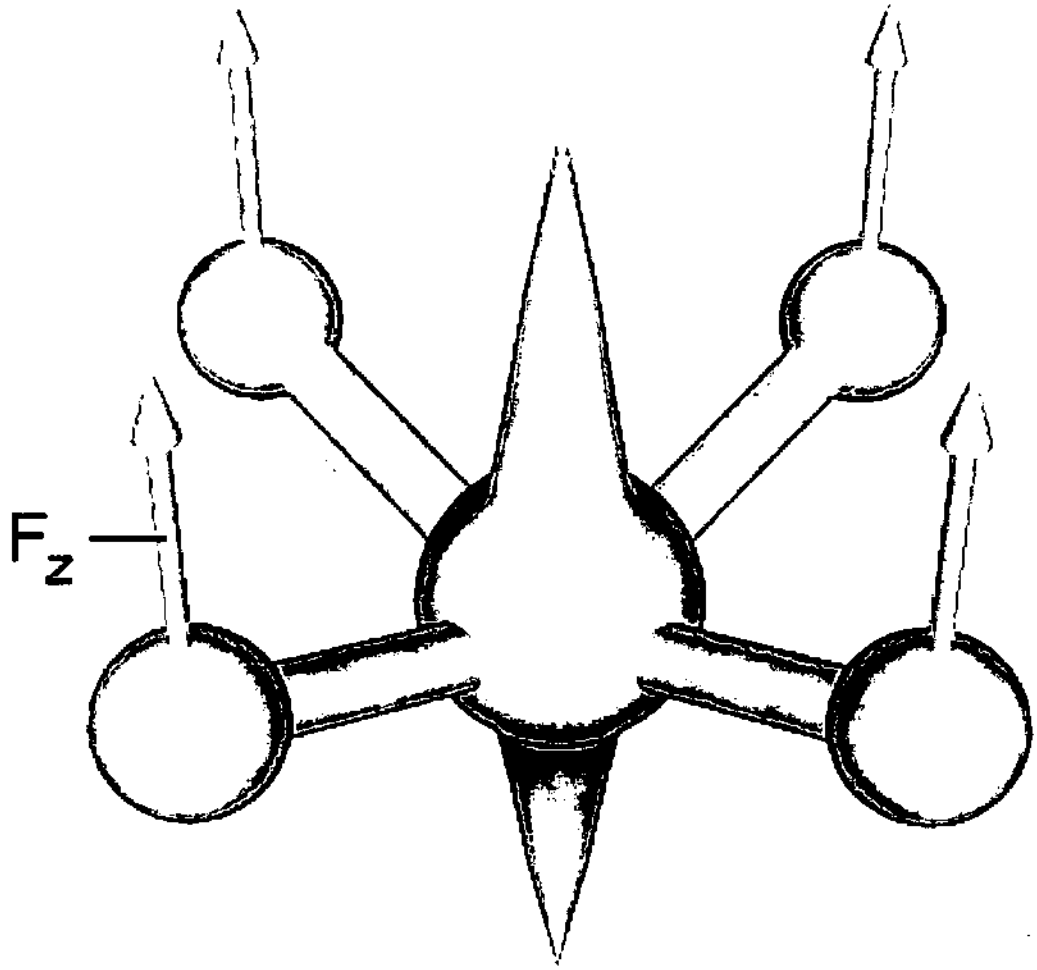

Figure 1

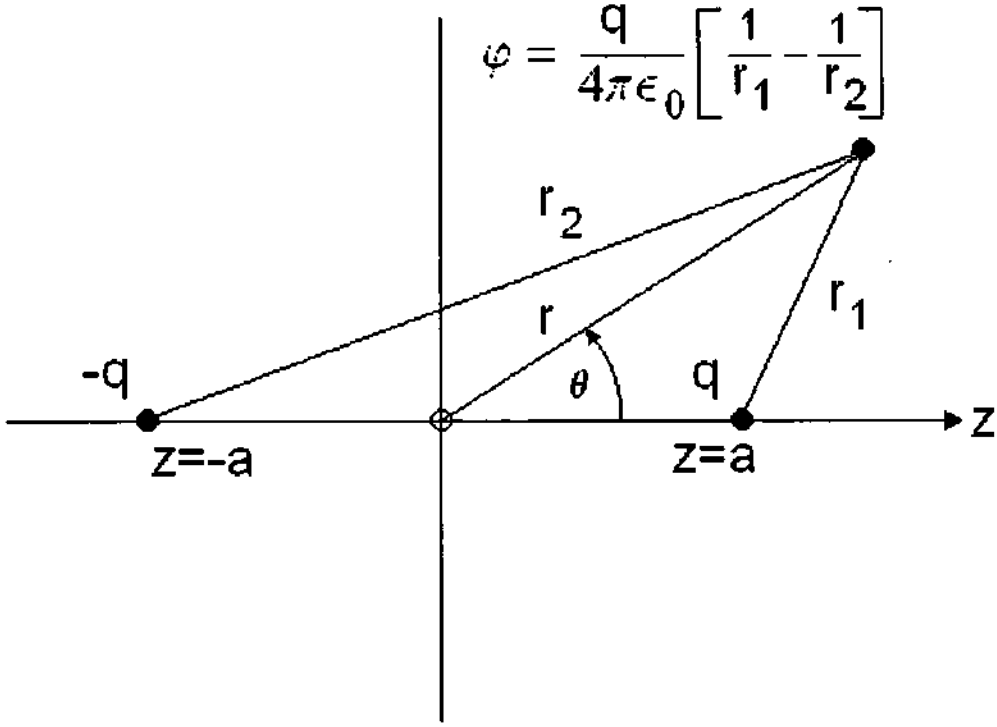
$\varphi = \frac{q}{4\pi\epsilon_0}\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$
r_2
r_1
r
θ
-q
q
z
z=-a
z=a

Figure 2

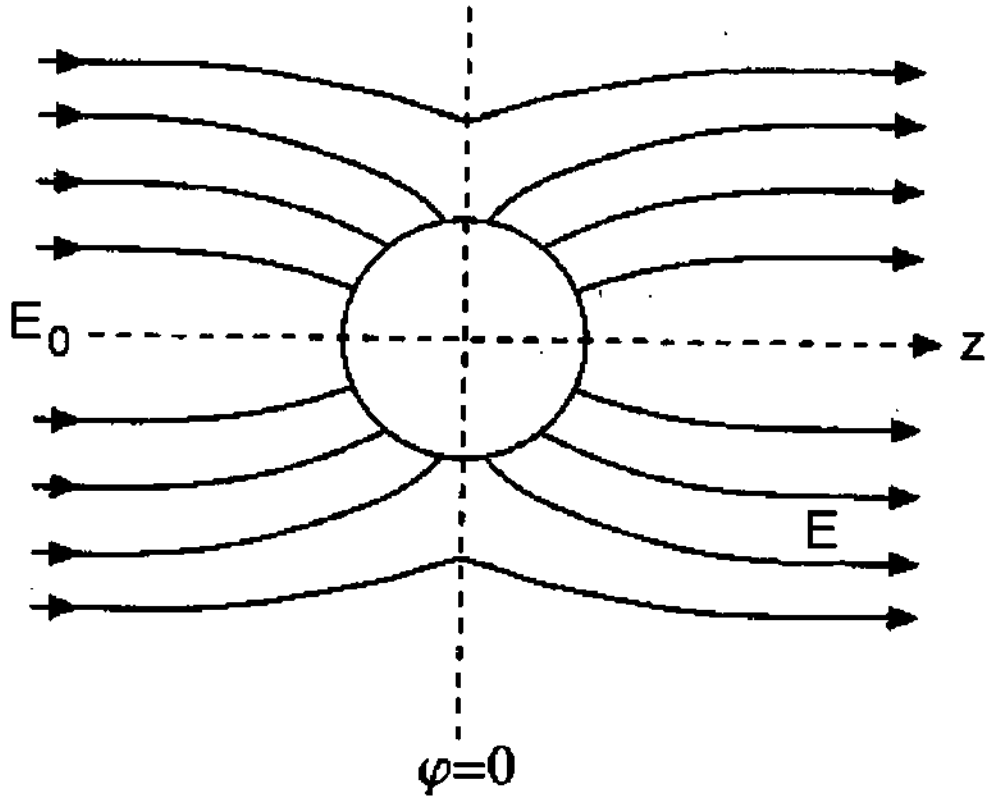

Figure 3

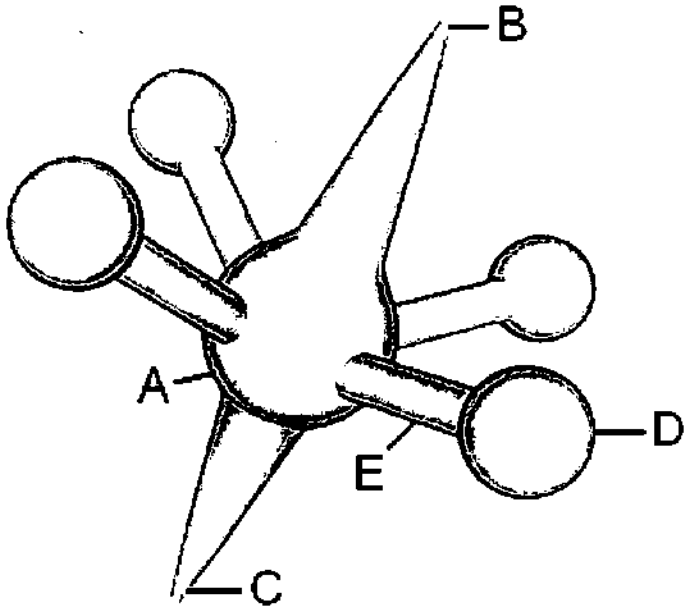

Figure 4

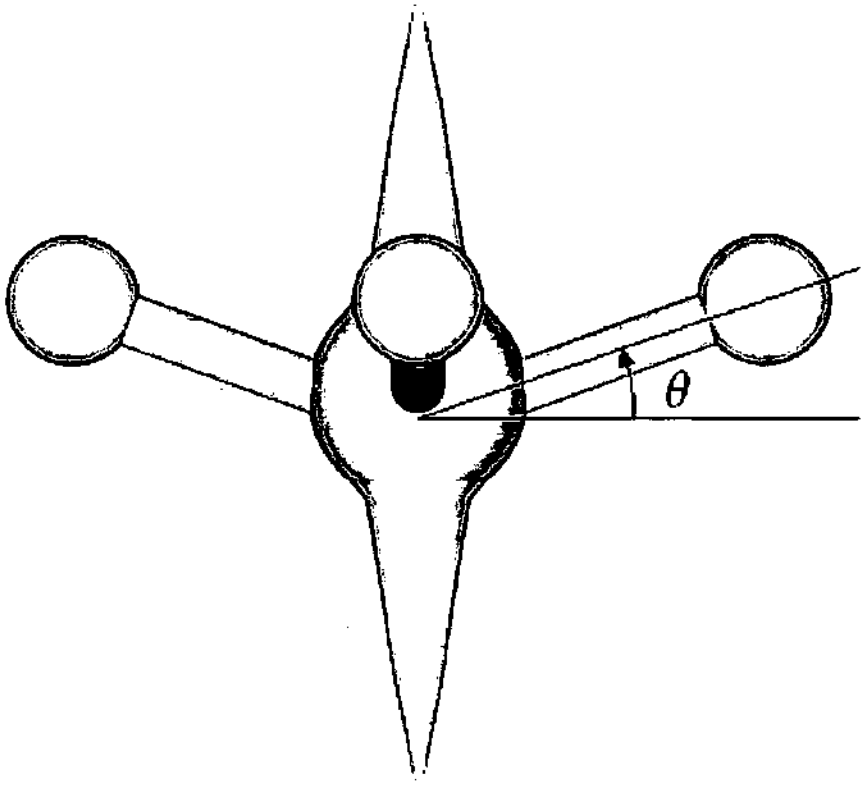

Figure 5

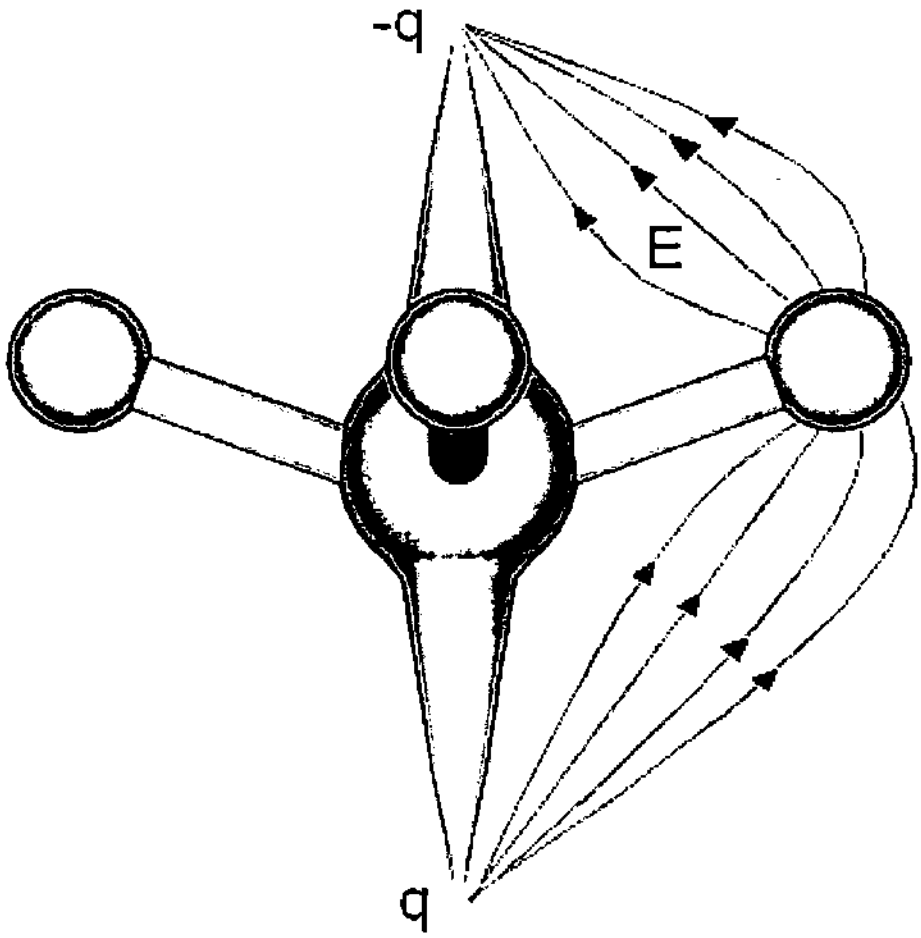

Figure 6

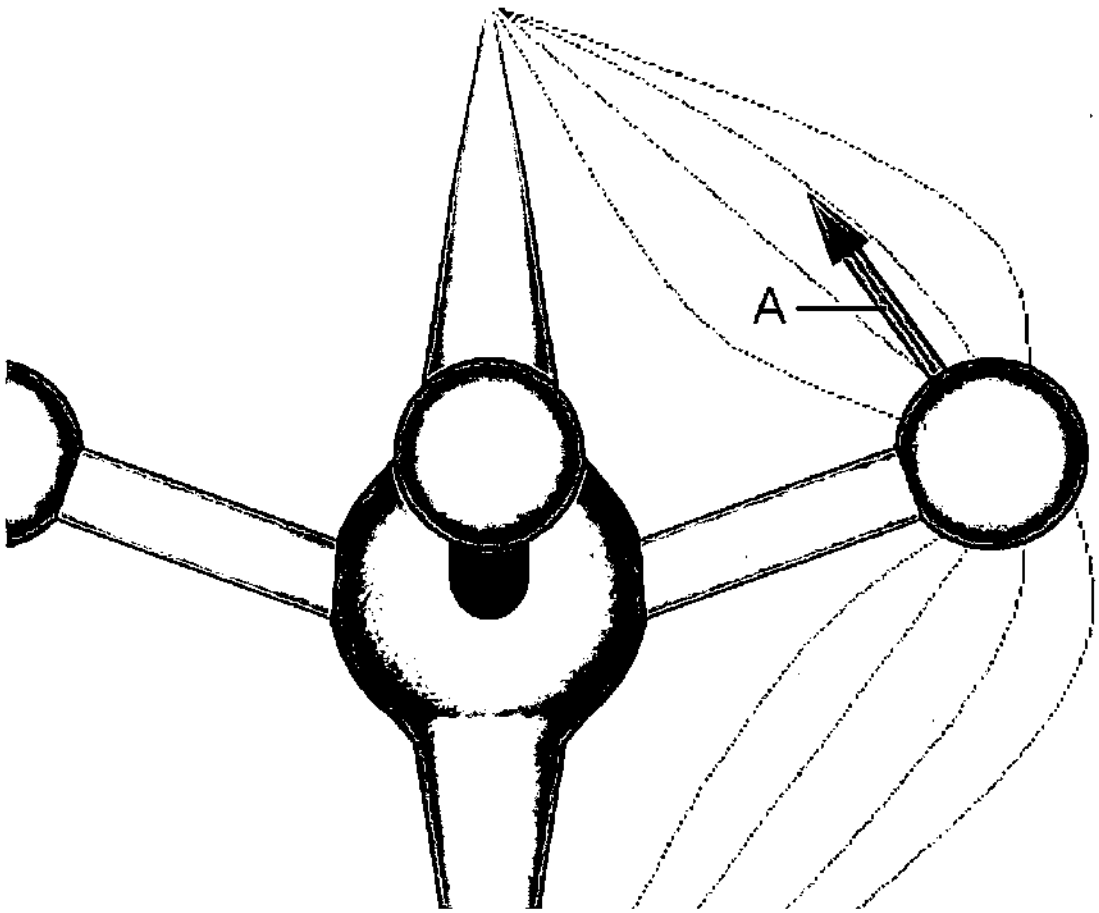

Figure 7

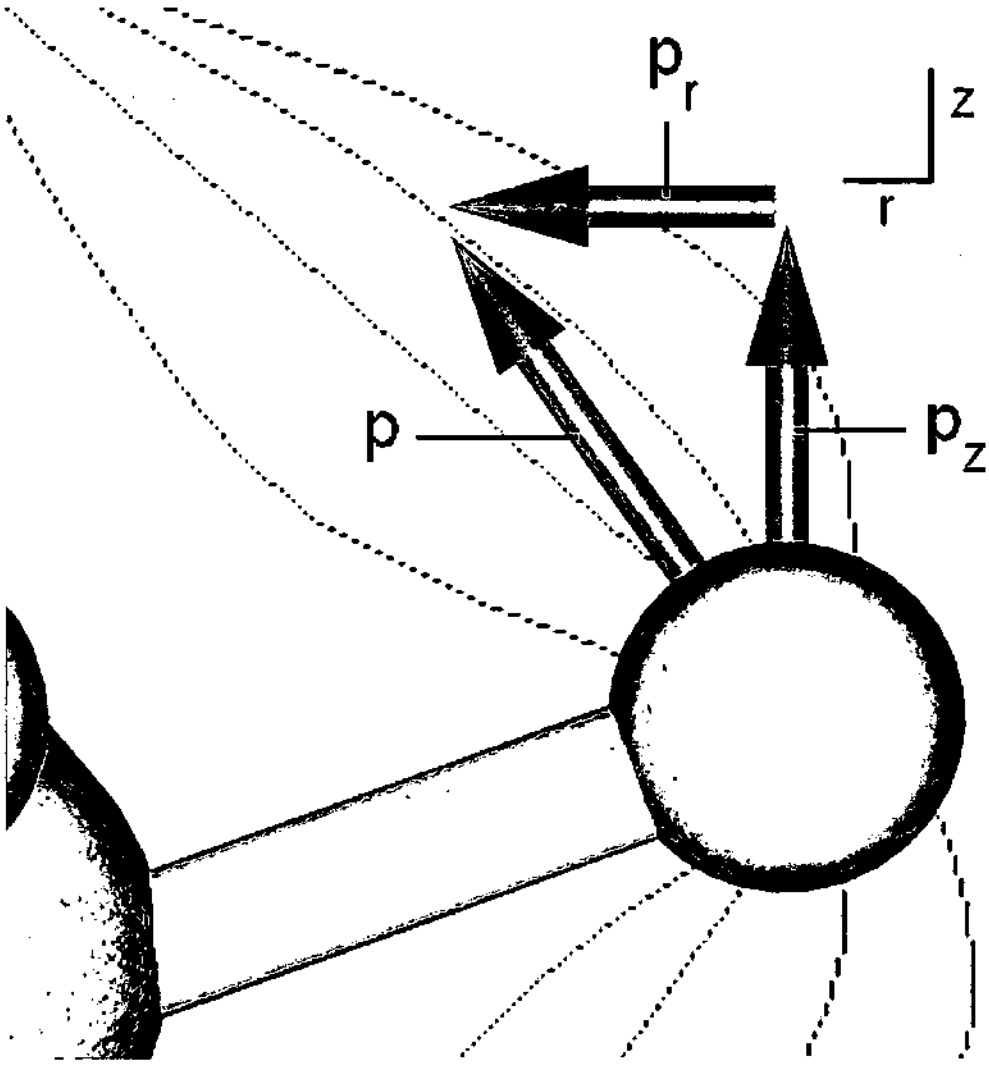

Figure 8

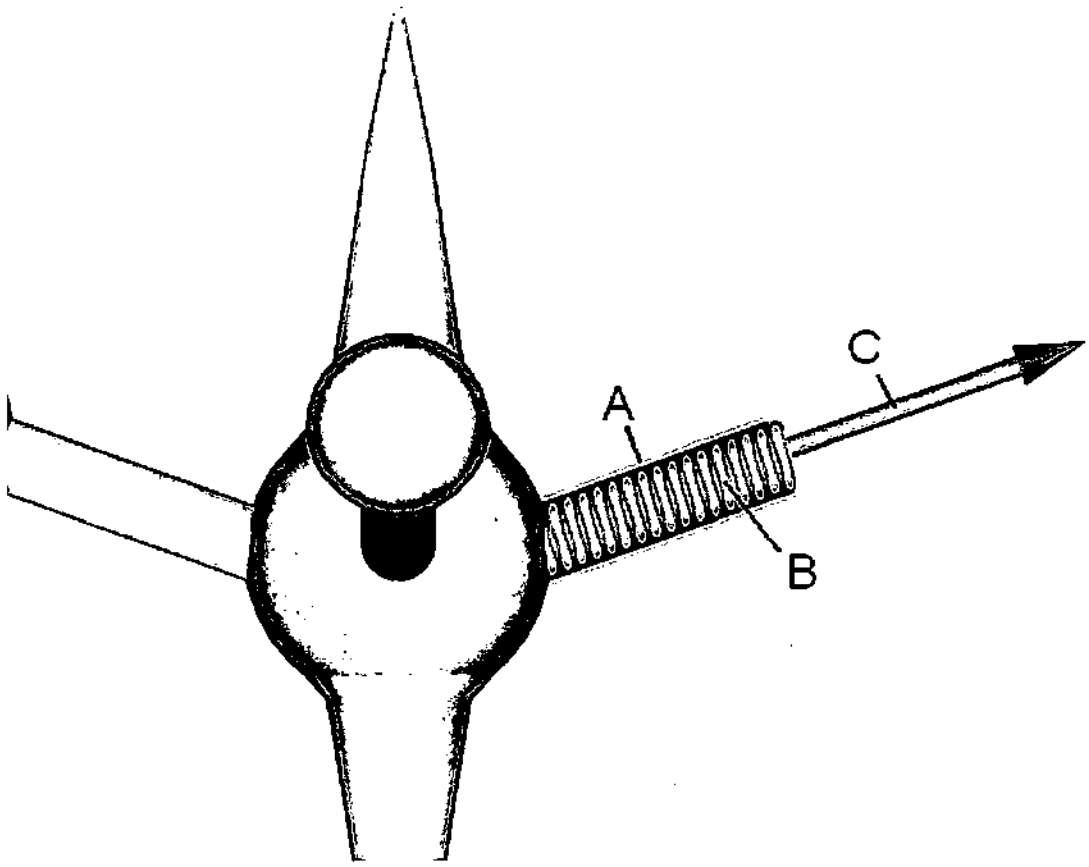

Figure 9

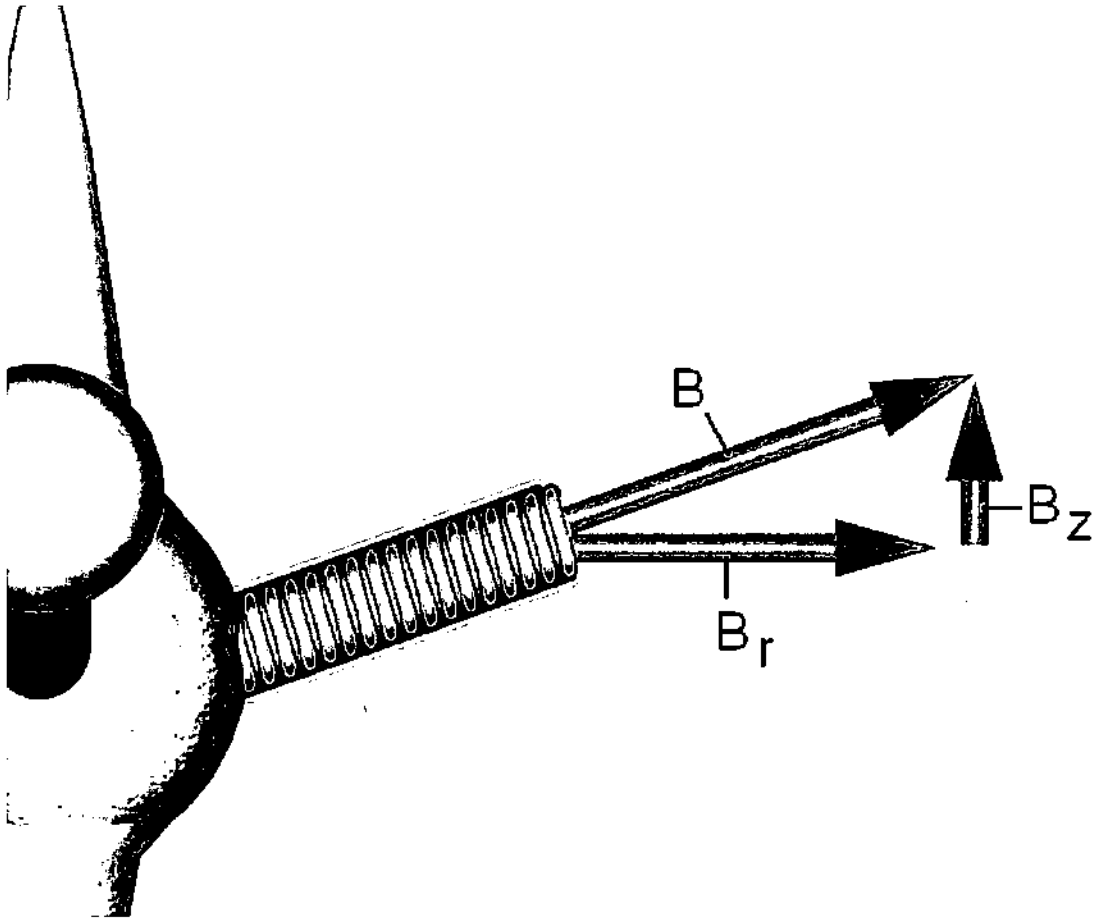

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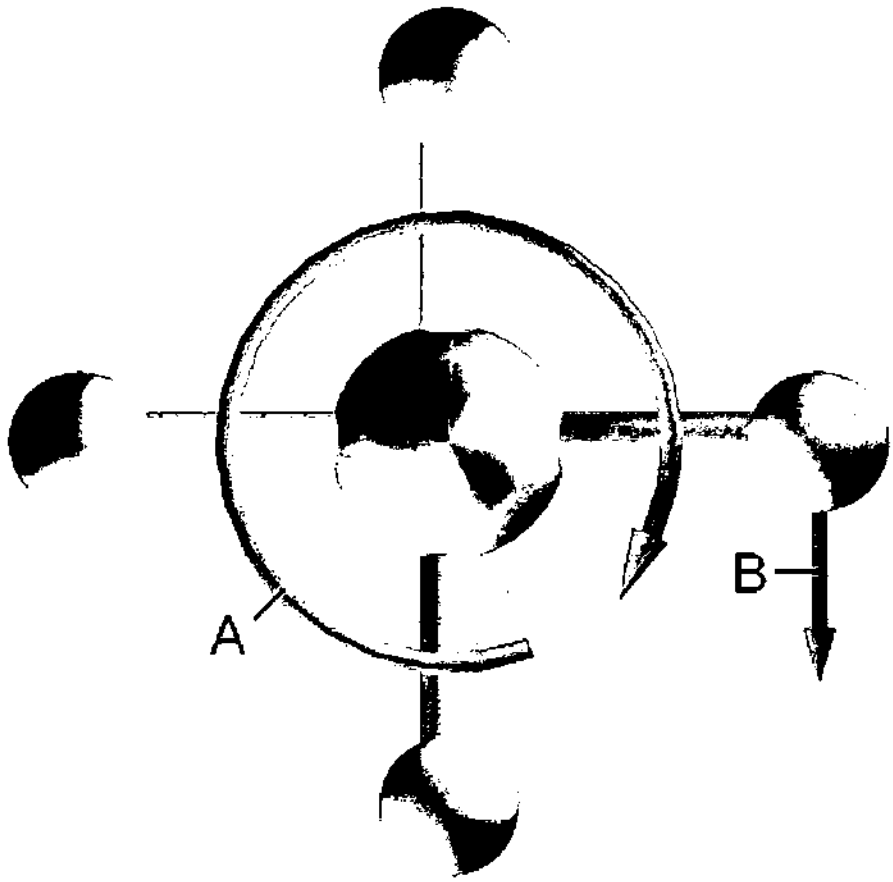

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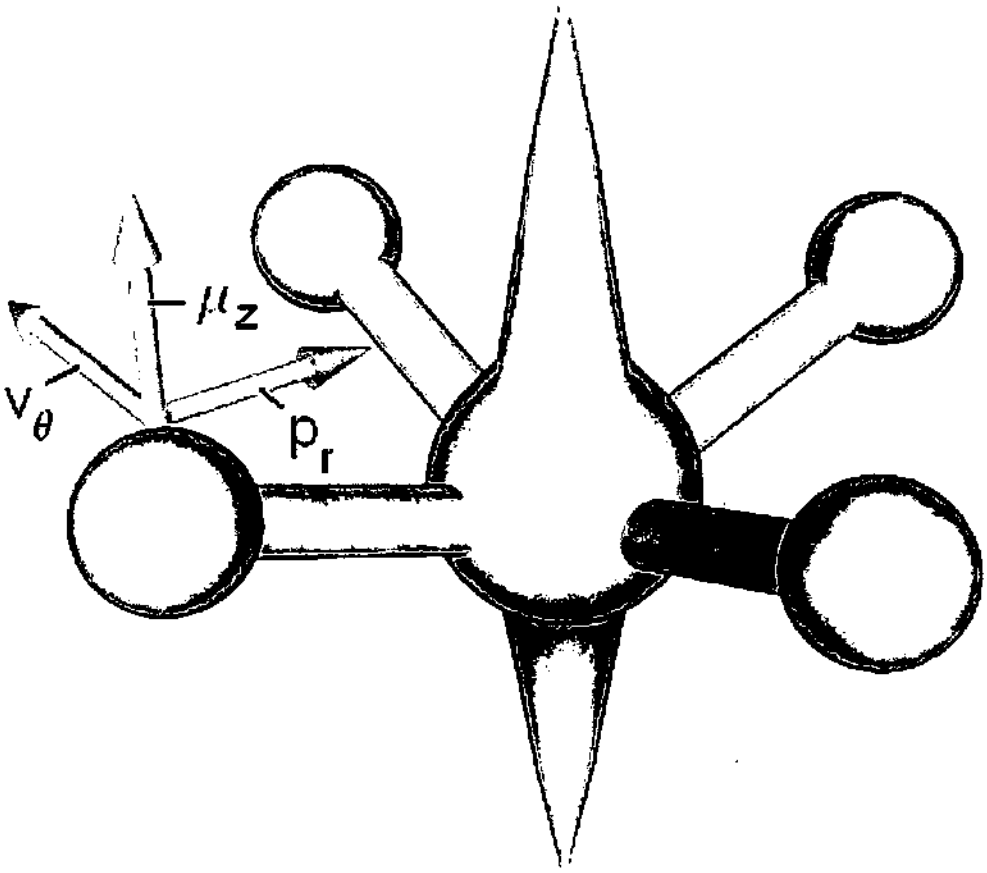

Figure 12

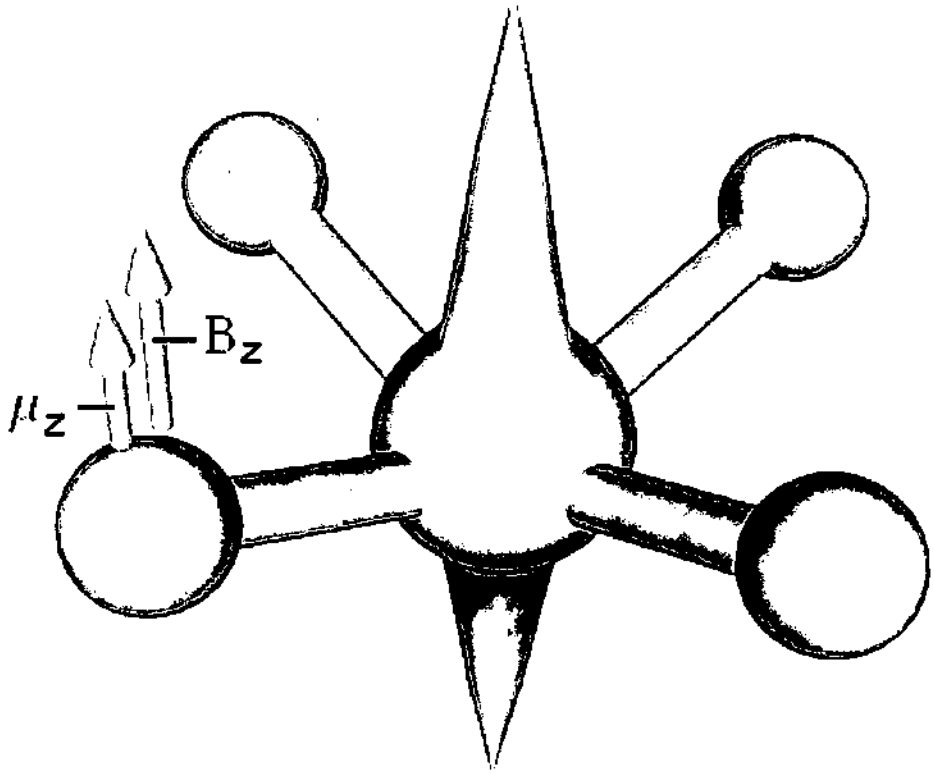

Figure 13

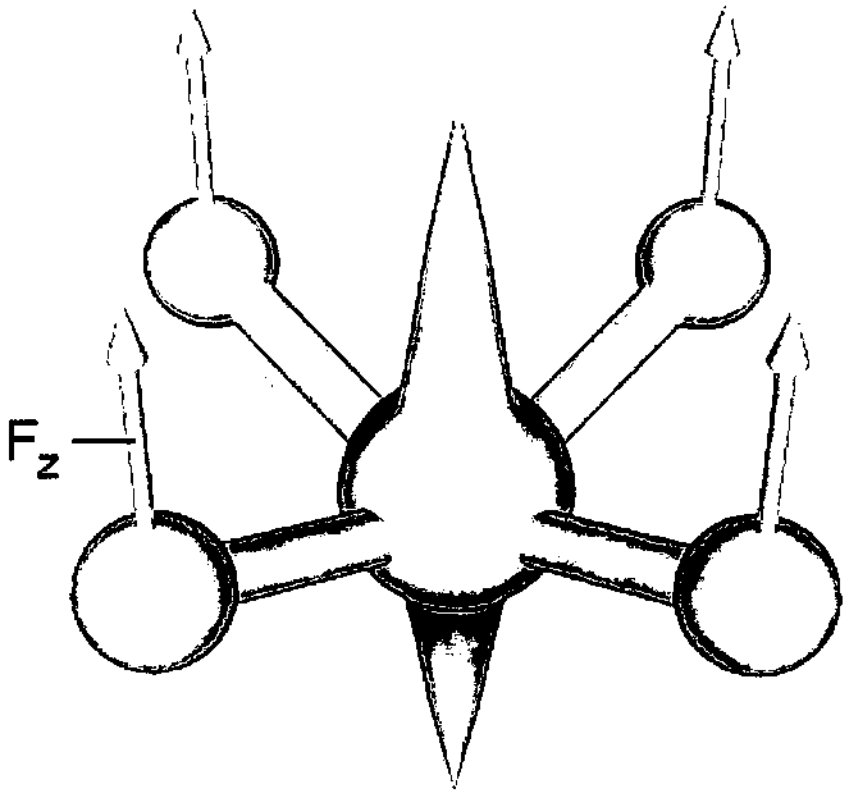

Figure 14

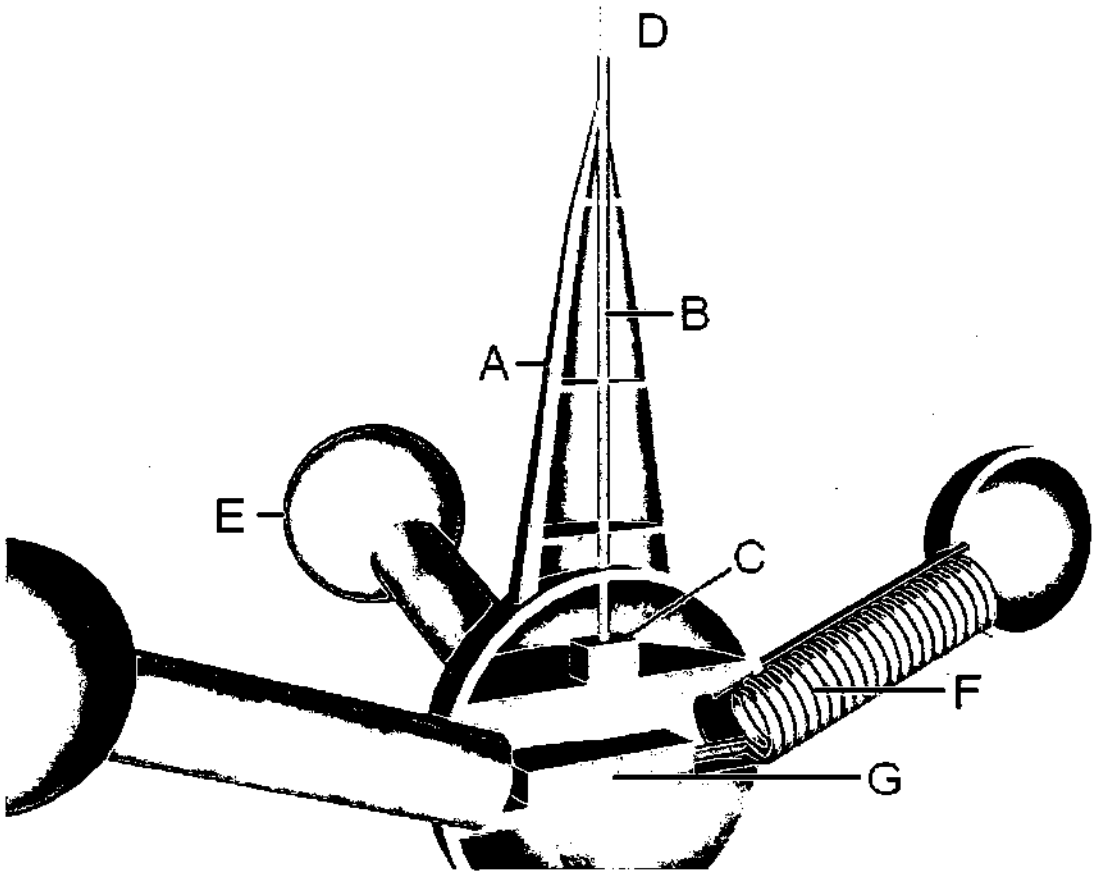

ELECTRIC DIPOLE SPACECRAFT

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a rotating spacecraft that utilizes four spherical conducting domes perturbing a uniform electric field in order to create a lift force by means of a magnetic moment times the gradient of a magnetic field.

BACKGROUND OF THE INVENTION

[0002] An electric dipole p is two electrical charges of opposite sign {q, −q} separated by a distance a.

$$p=qa=\text{coulomb}\cdot\text{meter}$$

[0003] If this dipole is moving with a velocity v, it produces a magnetic moment μ.

$$\mu = pv = qav = \text{coulomb meter}\frac{\text{meter}}{\text{sec}} = \frac{\text{coulomb}}{\text{sec}}\text{meter}^2 = IArea$$

[0004] The magnetic moment is equal to a current **I** circulating around an area. The magnetic field B has units of kilogram per second per charge coulomb.

$$B = \frac{\text{kg}}{\text{sec } coul}$$

[0005] The gradient of the magnetic field in the vertical direction z has units of

$$\frac{\text{dB}}{dz} = \frac{\text{kg}}{\text{sec } coul \text{ meter}}$$

[0006] This gradient interacting with a magnetic moment creates a force F measured in newtons.

$$F_z = \mu\frac{\text{dB}}{dz} = \frac{coul\ \text{m}^2}{\text{sec}}\frac{\text{kg}}{\text{sec } coul\ m} = \frac{\text{kg } m}{\text{sec}^2} = \text{newton}$$

[0007] In terms of vectors, the force is equal to

$$F=\nabla(\mu\cdot B)$$

which is the gradient ∇ of the dot product (·) of the magnetic moment with the magnetic field. This means that the magnetic moment has to be aligned with the field. The lift force on the spacecraft would then be the magnetic moment in the vertical z-direction μ_z times the magnetic field in the z-direction B_z. For constant magnetic moment, the gradient affects the magnetic field only, resulting in the same force equation

$$F_z=\nabla(\mu_z\cdot B_z)=\mu_z\nabla B_z$$

[0008] Referring to **FIG. 1**, the electric dipole has a positive charge q located on the z-axis at a distance a from the origin of the graph. A second negative charge −q is located at a distance −a from the origin. The positive charge produces an electrostatic potential ϕ_1 at a radius r_1 equal to the charge q divided by 4π times the permittivity of space ϵ_0

$$\varphi_1 = \frac{q}{4\pi\varepsilon_0}\frac{1}{r_1}$$

where the permittivity is linear capacitance, measured in farads per meter. The electrostatic potential has units of volts

$$\varphi = \frac{coul}{\left(\frac{\text{farad}}{\text{meter}}\right)}\frac{1}{\text{meter}} = \frac{coul}{\text{farad}} = \text{volt}$$

because the charge in coulombs held by a capacitor is equal to the capacitance, measured in farads, times the capacitor voltage. Because the second charge has the opposite sign, the potential ϕ_2 at a radius r_2 to the same point in space is

$$\varphi_2 = \frac{-q}{4\pi\varepsilon_0}\frac{1}{r_2}$$

[0009] The total potential ϕ at some point in space is equal to the sum of the two potentials, or

$$\varphi = \varphi_1 + \varphi_2 = \frac{q}{4\pi\varepsilon_0 r_1} - \frac{q}{4\pi\varepsilon_0 r_2} = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$$

[0010] As seen in the diagram, the point of space is a distance r from the origin. Using the law of cosines, radius r_1 can be written as

$$r_1 = (r^2 + a^2 - 2ar\cos(\theta))^{\frac{1}{2}} = r\left(1 + \left(\frac{a}{r}\right)^2 - 2\left(\frac{a}{r}\right)\cos(\theta)\right)^{\frac{1}{2}} = r(1 - 2xt + t^2)^{\frac{1}{2}}$$

where t is the ratio of the charge location over the radius, and x is cos(θ). The potential for positive charge q_1 can be written

$$\varphi_1 = \frac{q}{4\pi\varepsilon_0}\frac{1}{r_1} = \frac{q}{4\pi\varepsilon_0}\frac{1}{r}(1 - 2xt + t^2)^{-1/2}$$

[0011] Dropping the factor $q/4\pi\epsilon_0 r$, the square root can be expressed in terms of the Legendre polynomial $P_n \cos(\theta)$ of the nth power

$$g(t, x) = (1 - 2xt + t^2)^{-1/2} = \sum_{n=0}^{\infty} P_n(x)t^n$$

where the absolute value of t is less than one. The polynomial coefficients of t^n can be obtained by using the binomial theorem to expand the generating function g(t,x) as

$$(1-2xt+t^2)^{-1/2}=\sum_{n=0}^{\infty}\frac{(2n)!}{2^{2n}(n!)^2}(2xt-t^2)^n$$

which evaluates to

$$\frac{0!}{2^0(0!)^2}(2xt-t^2)^0+\frac{2!}{2^2(1!)^2}(2xt-t^2)^1+\frac{4!}{2^4(2!)^2}(2xt-t^2)^2$$
$$1t^0+xt^1+\left(\frac{3}{2}x^2-\frac{1}{2}\right)t^2+\text{order}(t^3)$$

[0012] The first three Legendre polynomials are therefore

$$P_0=1$$
$$P_1=x$$
$$P_2=\frac{1}{2}(3x^2-1)$$

[0013] The electrostatic potential for both charges of the electric dipole is

$$\varphi=\frac{q}{4\pi\varepsilon_0}\frac{1}{r}\left\{\left(1-2\left(\frac{a}{r}\right)\cos(\theta)+\left(\frac{a}{r}\right)^2\right)^{-1/2}-\left(1+2\left(\frac{a}{r}\right)\cos(\theta)+\left(\frac{a}{r}\right)^2\right)^{-1/2}\right\}$$

[0014] The potential can be evaluated in terms of the Legendre polynomials as

$$\varphi=\frac{q}{4\pi\varepsilon_0 r}\left[\sum_{n=0}^{\infty}P_n(\cos(\theta))\left(\frac{a}{r}\right)^n-\sum_{n=0}^{\infty}P_n(\cos(\theta))(-1)^n\left(\frac{a}{r}\right)^n\right]$$
$$=\frac{2q}{4\pi\varepsilon_0 r}\left[P_1(\cos(\theta))\left(\frac{a}{r}\right)+P_3(\cos(\theta))\left(\frac{a}{r}\right)^3+\ldots\right]$$

[0015] The first and most dominant term when the radius is much greater than location a is equal to

$$\varphi=\frac{2aq}{4\pi\varepsilon_0}\frac{P_1(\cos(\theta)0}{r^2}$$

which is the electric dipole potential and 2aq is the dipole moment

$$p=2aq$$

[0016] Now imagine a constant electric field E_0 which is perturbed by a conducting sphere of radius a. The unperturbed electrostatic potential outside the sphere would the negative of the electric field times the radius times the Legendre polynomial, or

$$\phi_1=-E_0rP_1$$

[0017] The electrostatic potential perturbed by the charges is the voltage E_0a times the radius a times the a of the dipole moment times the Legendre polynomial divided by the radius squared

$$\varphi_2=E_0aaa\frac{P_1}{r^2}=E_0a^3\frac{P_1}{r^2}$$

[0018] The total potential outside the sphere is the sum of the two potentials equal to

$$\varphi=-E_0rP_1+E_0a^3\frac{P_1}{r^2}=-E_0P_1\left(r-\frac{a^3}{r^2}\right)=-E_0rP_1\left(1-\left(\frac{a}{r}\right)^3\right)$$

[0019] Referring to **FIG. 2**, the previously uniform electric field is shown perturbed by the neutral conducting sphere. The center of the sphere is taken as the origin and the z-axis is oriented parallel to the original uniform field.

[0020] The electric field induces a surface charge density σ on the sphere equal to the negative of the permittivity of space times the gradient of the electrostatic potential

$$\sigma=-\varepsilon_0\frac{\partial\varphi}{\partial r}\Big|_{r=a}=3\varepsilon_0E_0\cos(\theta)$$

[0021] The electric field also induces an electric dipole moment on the sphere equal to the

$$p=\frac{qa}{r}\cdot\frac{2a^2}{r}=4\pi\varepsilon_0E_0a^3$$

with units of coulomb-meter. If this sphere is rotating around a central axis at a velocity v, it will create a magnetic moment μ equal to the dipole moment times the velocity.

$$\mu=pv$$

with units of ampere-meter^2.

SUMMARY OF THE INVENTION

[0022] As shown in the preceding background section, a neutral conducting sphere placed in a uniform electric field will generate a magnetic moment when rotated around a central axis. The electric field can be created by two points charges of opposite sign separated by a distance between them.

[0023] Referring to **FIG. 3**, the spacecraft has a spherical cabin **(A)** to which are attached cone-shaped electrostatic towers **(B,C)** above and below the cabin along the direction of travel in the z-direction. Because the electric field goes from the positive charge to the negative charge, the tip of the lower tower has a positively charged electrode, and the upper tower has a negatively charged electrode. Four equally-spaced neutral conducting spheres **(D)** are connected to the cabin by non-conducting tubes **(E)**. The tubes make an angle with the cabin such that the distance (CD) is greater than distance (DB). The angle θ of the tube with respect to the cabin can be seen in side view **FIG. 4**.

[0024] Referring to **FIG. 5**, the charges create a uniform spherical field between the towers. The conducting spheres perturb this field such that the electric field **(E)** points toward the upper tower in a manner similar to that shown previously in **FIG. 2**.

[0025] Referring to **FIG. 6**, the conducting sphere produces an electric dipole moment (A) pointing at an angle toward the upper tower.

[0026] Referring to **FIG. 7**, by the law of addition of vectors, the electric dipole $\vec{p}$ can be represented by two orthogonal vectors pointing in the vertical z-direction p_z and in the inward radial direction p_r.

[0027] Referring to **FIG. 8**, the hollow tube (A) connecting the cabin with the conducting sphere contains a spiral-wound electrical solenoid (B) which produces a magnetic field (C). This magnetic field B can be decomposed into two orthogonal vectors pointing in the vertical z-direction B_z and in the outward radial direction B_r as shown in **FIG. 9**.

[0028] Referring to top-view **FIG. 10**, the spacecraft has a clockwise angular velocity ω (A) which gives the conducting sphere a velocity v as shown by the vector (B). By the right-hand rule of physics, the angular velocity vector points in the negative z-direction. The angular velocity in the z-direction crossed with the radius r in the radial direction produces a velocity v in the clockwise θ-direction using cylindrical coordinates {r,θ,z}.

$$v_\theta = w_z \times r_r = -\omega r$$

[0029] Referring to **FIG. 11**, the negative radial dipole moment p_r crossed with the negative velocity v_θ of the sphere produces a positive magnetic moment μ_z in the z-direction.

$$\mu_z = p_r \times v_\theta = (-p_r)(-v_\theta) = pv$$

[0030] Referring to **FIG. 12**, the magnetic field B_z in the vertical z-direction is dotted with the magnetic moment μ_z in the z-direction to produce a force F_z in the vertical z-direction on each conducting sphere **(FIG. 13)**.

$$F_z = \nabla(\mu_z \cdot B_z) = \mu_z \nabla B_z$$

[0031] The magnetic field that is produced by the solenoid actually curves away and around. Thus there is a gradient of the field in the z-direction.

[0032] The force can also be expressed in tensor notation. The magnetic B field in the vertical direction is part of an electromagnetic 4×4 matrix Faraday tensor F

$$F^\alpha_\beta = \begin{array}{c|cccc} & \beta = t & r & \theta & z \\ \hline \alpha = t & 0 & 0 & 0 & 0 \\ \alpha = r & 0 & 0 & B_z & 0 \\ \alpha = \theta & 0 & -B_z & 0 & 0 \\ \alpha = z & 0 & 0 & 0 & 0 \end{array}$$

which shows that the magnetic field is located in slot $F^r{}_\theta$ of the Faraday tensor. In tensor notation the subscripts and superscripts have to match up on both sides of the equation. Matching subscripts and superscripts on the same side of the equation cancel. In this case, the electric dipole moment is in the radial direction p_r. The velocity can be represented as a time derivative of the θ-coordinate x^θ or

$$v^\theta = \frac{\partial x\theta}{\partial t}$$

[0033] Thus the force component in the z-direction becomes

$$F_z = p_r v^\theta F^r_{\theta,z} = (-p)(-v)\frac{\partial B_z}{\partial z} = pv\frac{\partial B_z}{\partial z}$$

where the angular and radial tensor components cancel and comma-z (, z) represents differentiation of the magnetic field in the z-direction.

[0034] The spacecraft design also has an inherent motion control system for moving in various directions. If the magnetic field of one solenoid arm is increased or decreased, the force on that sphere will be increased or decreased. Thus the spacecraft can turn in a particular direction.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0035] **FIG. 1**. Electric dipole.

[0036] **FIG. 2**. Uniform electric field perturbed by electric dipole.

[0037] **FIG. 3**. Perspective view of spacecraft.

[0038] **FIG. 4**. Angle of solenoid tube.

[0039] **FIG. 5**. Electric field perturbed by conducting sphere.

[0040] **FIG. 6**. Electric dipole generated by conducting sphere.

[0041] **FIG. 7**. Orthogonal vector components of electric dipole.

[0042] **FIG. 8**. Magnetic field produced by tube arm solenoid.

[0043] **FIG. 9**. Orthogonal vector components of magnetic field.

[0044] **FIG. 10**. Angular velocity of hull.

[0045] **FIG. 11**. Magnetic moment produced by radial electric dipole and sphere velocity.

[0046] **FIG. 12**. Dot product of the magnetic moment with the magnetic field.

[0047] **FIG. 13**. Vertical lift force on all four conducting spheres.

[0048] **FIG. 14**. Perpective view of spacecraft interior.

DETAILED DESCRIPTION OF THE INVENTION

[0049] 1. Referring to the cut-away view **FIG. 14**, the construction of the spacecraft is a thin-wall insulating thermoplastic having a dielectric constant in the range of 20 kilovolts per millimeter (A). An insulated electrode (B) runs from the cabin power supply and high-voltage transformer

(C) to the tip of each tower (D). The four spheres (E) are silver plated to make them conducting. The tube solenoids (F) are driven by a direct current power supply (G).

[0050] 2. The present model uses 3D computer design software and stereolithography fabrication techniques to create the thin-wall, low-weight, hollow structure of the hull. The computer model is sliced into many thin horizontal slices. A laser, mounted on an x-y table, draws out the slice on a table immersed in a bath of liquid polymer. Due to its sensitivity to the light, the liquid polymerizes. The table is then lowered a few thousandths of an inch more and the process is repeated. Thus making hollow spherical and conical shapes is extremely easy to do. Parts can be designed and stored in *.STL stereolithography files for transmission by Internet e-mail to the service bureau machine shop which sends the finished parts back the next day by express mail.

I claim:

1. A spacecraft comprising:

a. a spherical cabin;

b. an electrostatic conical tower mounted on top of item (**1***a*), supporting a vertically-mounted negatively-charged insulated electrode at the tip of the tower;

c. an electrostatic conical tower mounted on the bottom of item (**1***a*), supporting a vertically-mounted positively-charged insulated electrode at the tip of the tower;

d. a vertical electric dipole created by items (**1***b*) and (**1***c*);

e. a high-voltage transformer to drive item (**1***d*), mounted in item (**1***a*);

f. four tubular arms, mounted at 90° around and extending at an angle from item (**1***a*);

g. four solenoids, each of which is mounted axially inside item (**1***f*);

h. a direct current power supply to drive item (**1***g*);

i. four silver-plated conducting spheres, each of which is mounted on the end of item (**1***f*);

2. an electrostatic lift system that:

a. produces a uniform spherical electric field by means of item (**1***d*) which envelopes item (**1***i*);

b. produces a perturbed electric field due to the presence of item (**1***i*);

c. produces an electric dipole moment in the direction of item (**1***b*) due to items (**2***a*) and (**2***b*);

d. produces a vertical magnetic moment due to the clockwise angular velocity of item (**1***a*) combined with item (**2***c*);

e. produces a vertical lift force on item (**1***i*) due to item (**2***d*) combined with the magnetic field gradient in the vertical direction produced by item (**1***g*); and

f. creates a motion control system by varying the current to item (**1***g*) in order to increase or decrease the effect of item (**2***e*) on a particular item (**1***i*).

* * * * *

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(54) **PHOTON SPACECRAFT**

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(52) **U.S. Cl.** **60/203.1**; 60/204

(57) **ABSTRACT**

A spacecraft propulsion system utilizing photon particles to create negative energy over the hull in order to generate a lift force on the hull.

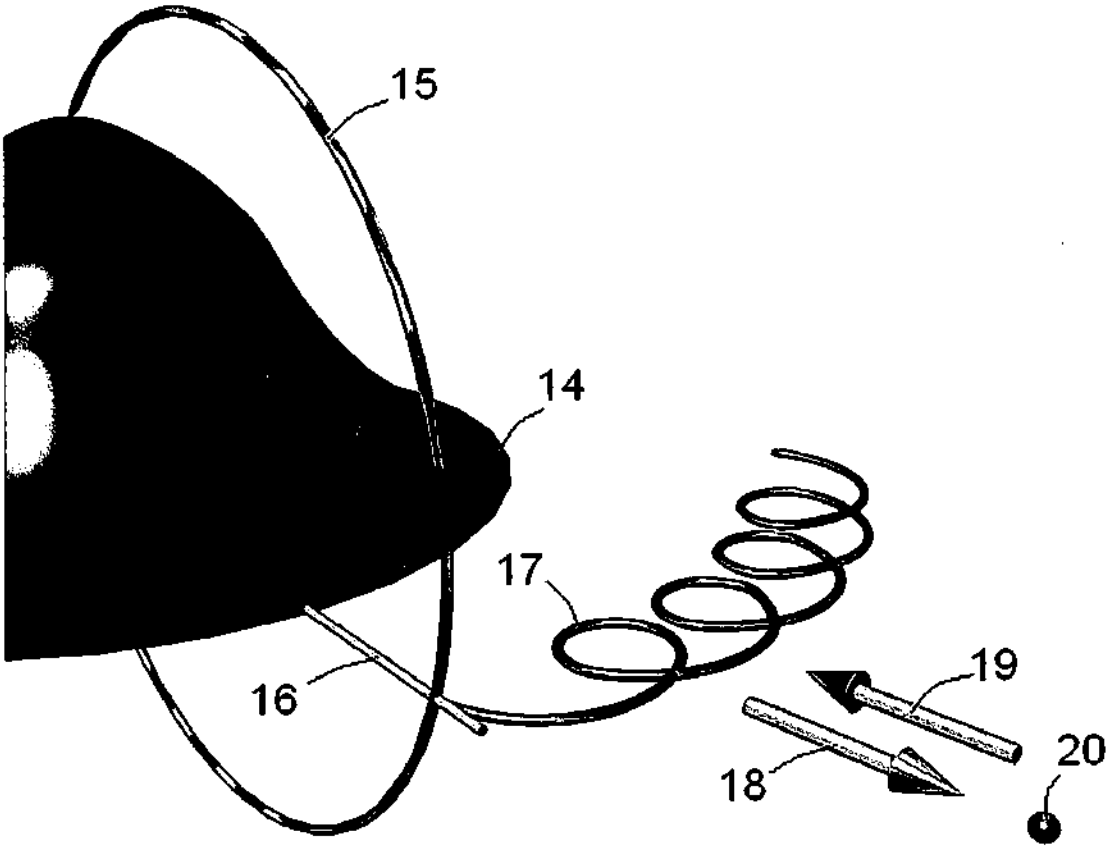

Figure 1

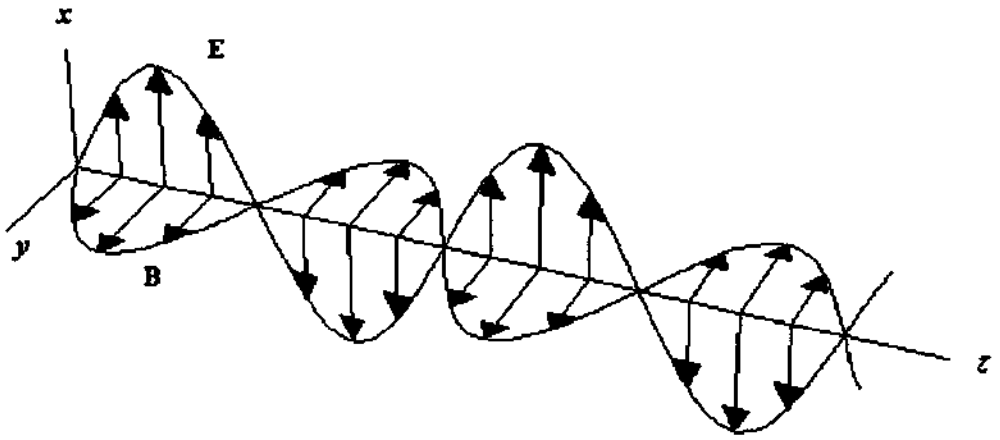

Figure 2

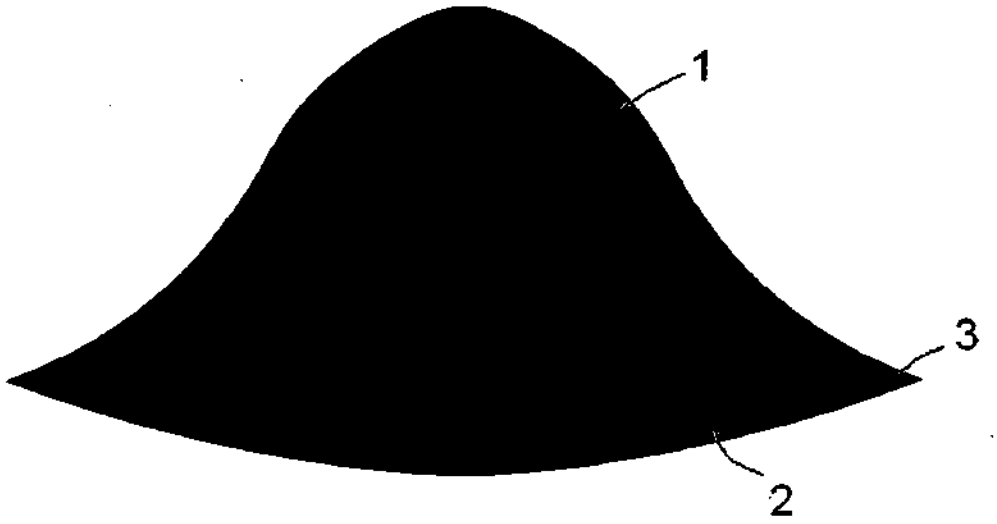

Figure 3

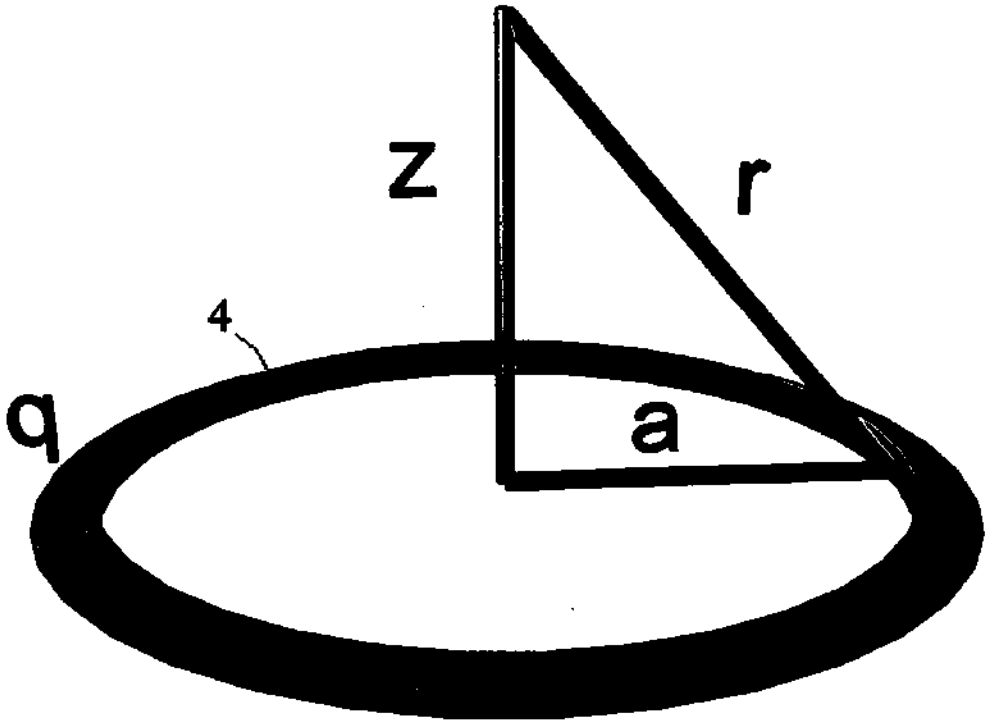

Figure 4

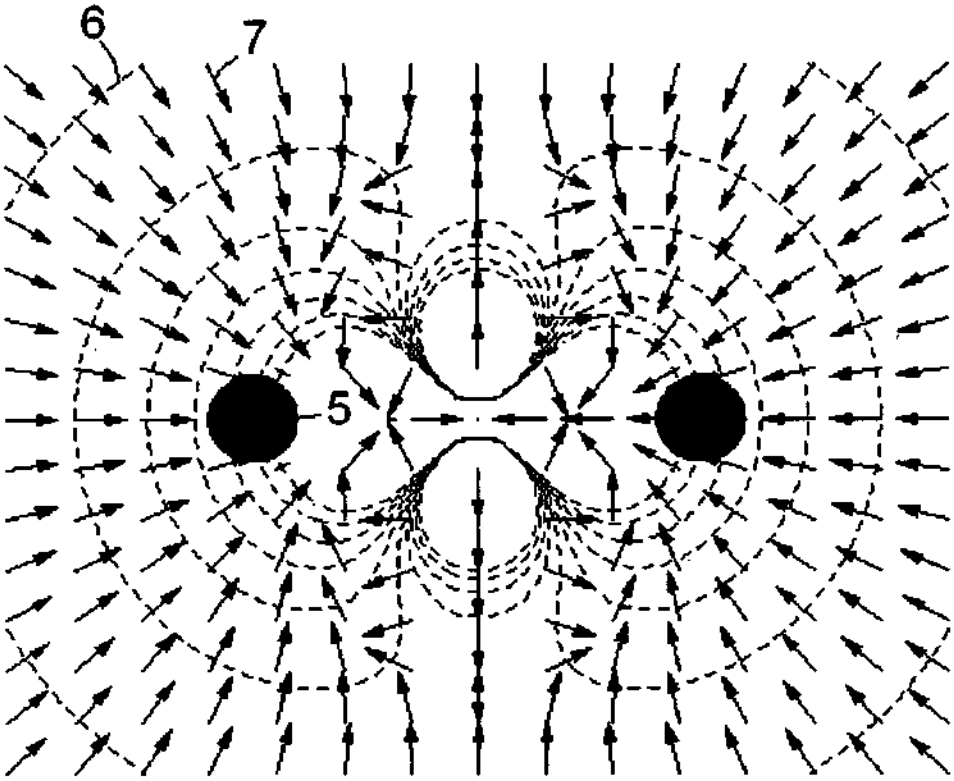

Figure 5

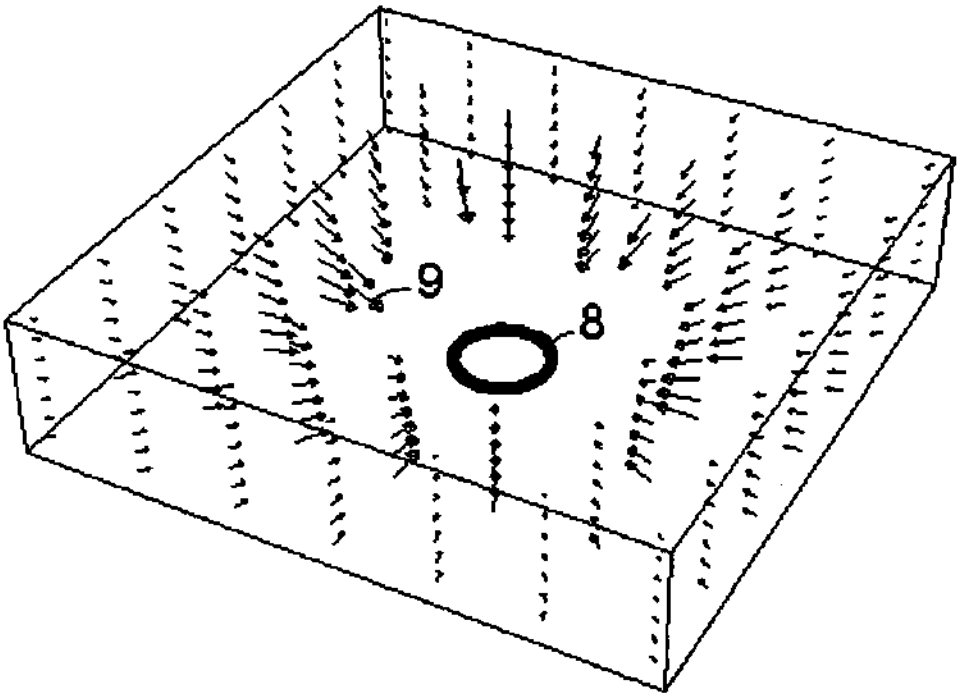

Figure 6

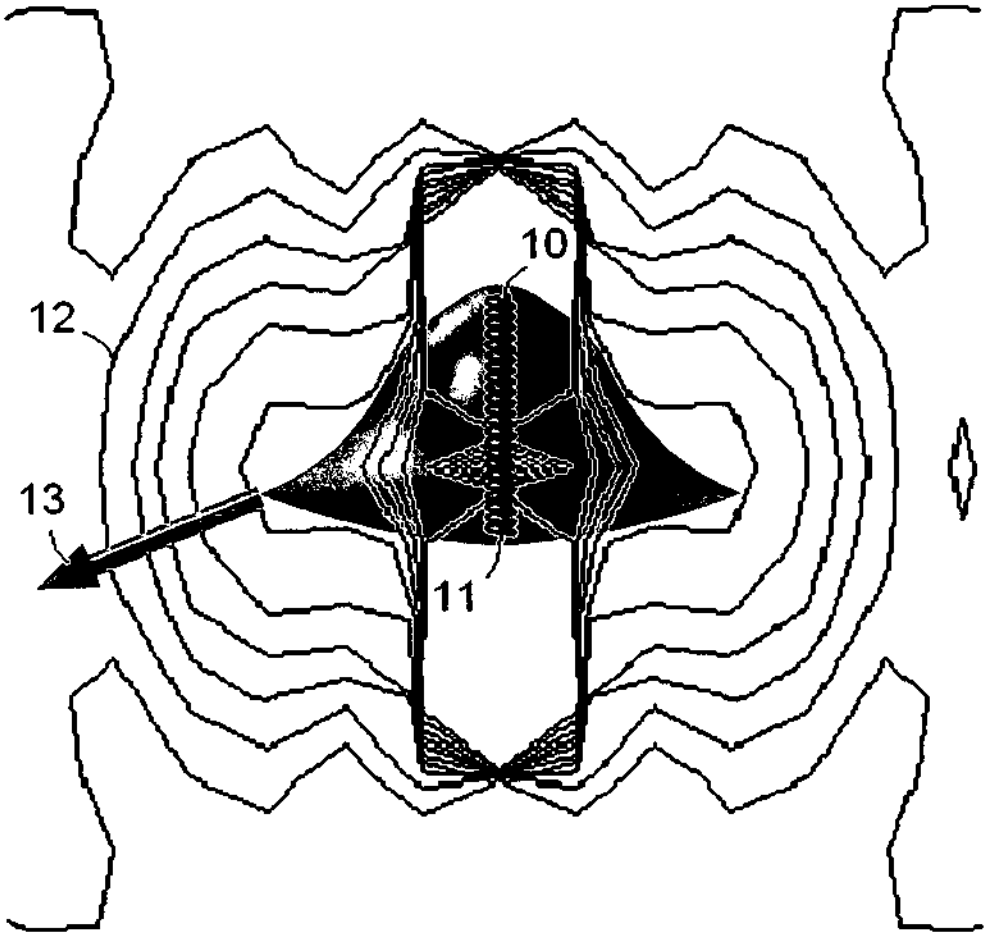

Figure 7

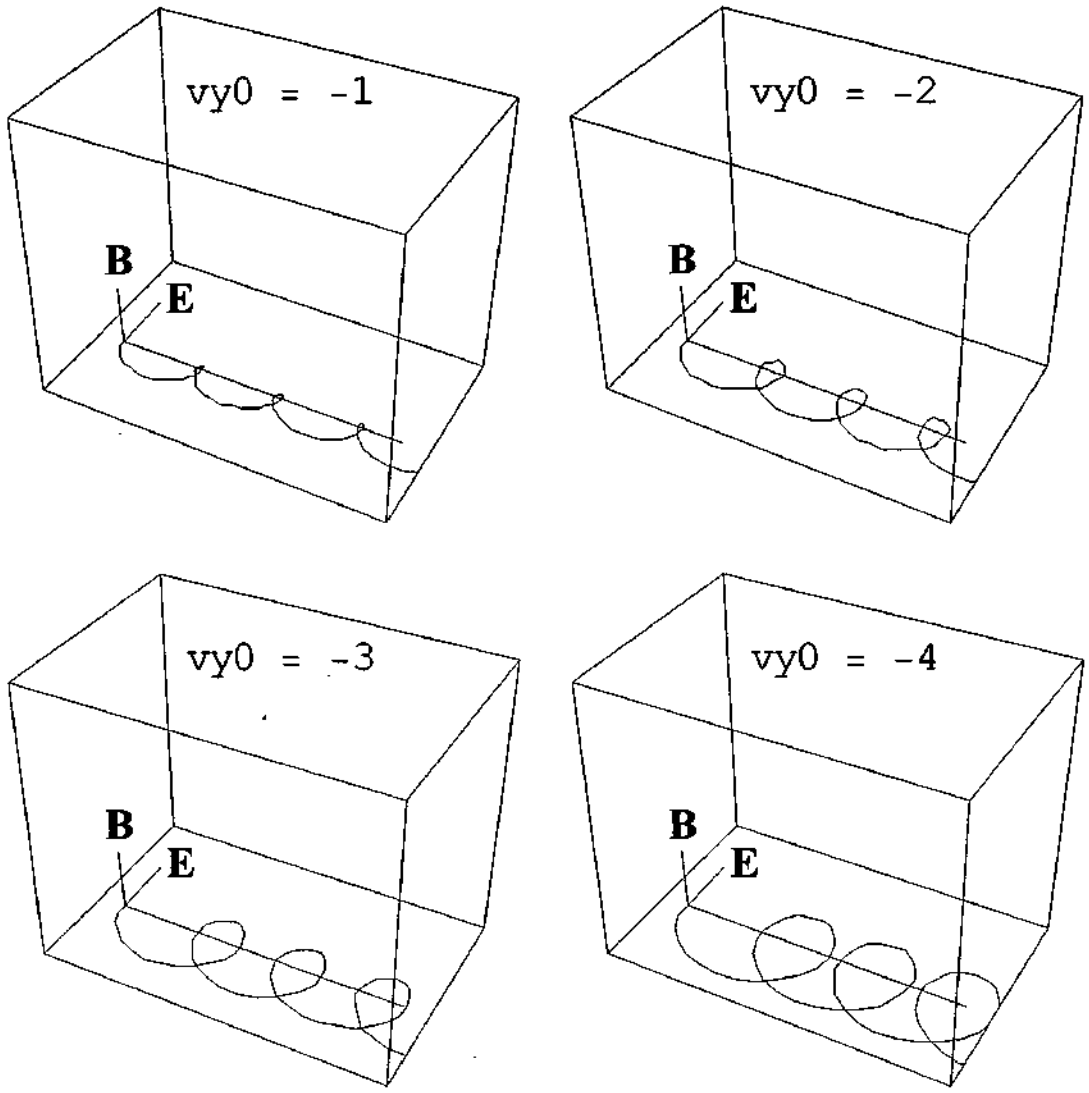

Figure 8

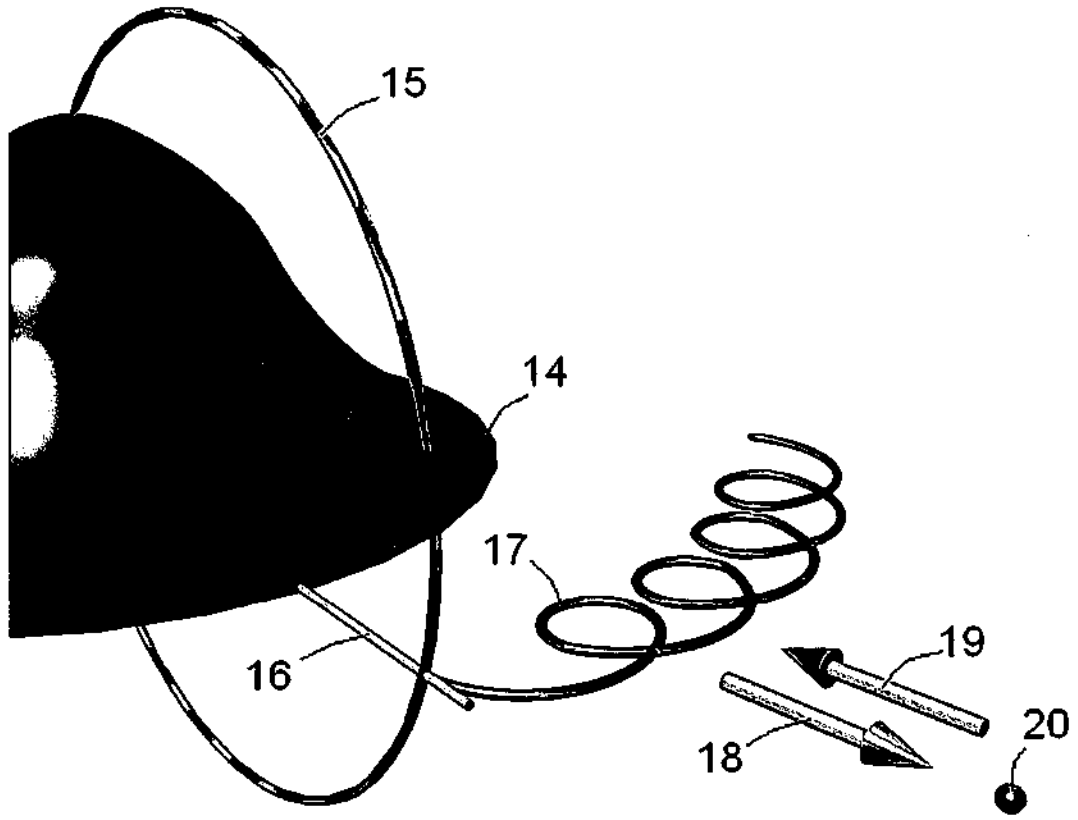

Figure 9

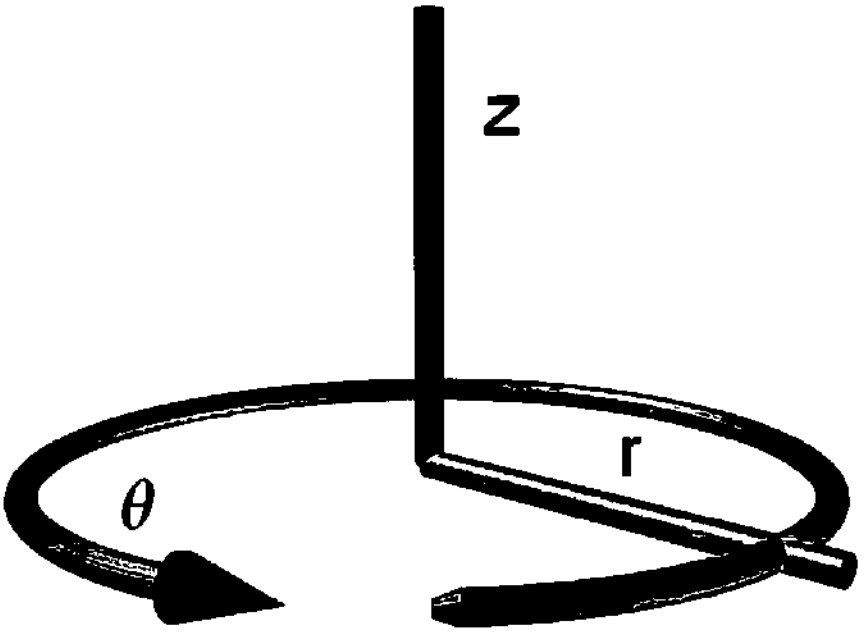

PHOTON SPACECRAFT

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a spacecraft propulsion system that employs photon particles to generate a field of negative energy in order to produce lift on the hull.

BACKGROUND OF THE INVENTION

[0002] Referring to **FIG. 1**, an electromagnetic wave traveling in the z-direction consists of an electric E field vibrating in the x-direction and a magnetic flux density B field vibrating at right angles in the horizontal y-direction. The energy-stress-momentum of this photon can be analyzed using Einstein's General Theory of Relativity and the Faraday F tensor. The Faraday tensor is a 4×4 matrix containing the electromagnetic wave components as shown here in general where c is the speed of light

$$F^{\alpha}_{\beta} = \begin{array}{c|cccc|} & & & & \\ t & 0 & \frac{E_x}{c} & \frac{E_y}{c} & \frac{E_z}{c} \\ x & \frac{E_x}{c} & 0 & B_z & -B_y \\ y & \frac{E_y}{c} & -B_z & 0 & B_x \\ z & \frac{E_z}{c} & B_y & -B_x & 0 \end{array}$$

For this particular photon, this tensor is

$$F^{\alpha}_{\beta} = \begin{array}{c|cccc|} & & & & \\ t & 0 & \frac{E_x}{c} & 0 & 0 \\ x & \frac{E_x}{c} & 0 & 0 & -B_y \\ y & 0 & 0 & 0 & 0 \\ z & 0 & B_y & 0 & 0 \end{array}$$

[0003] The elemental spacetime length ds squared is equal to sum of the squares of the Cartesian elemental lengths

$$(ds)^2 = -(dt)^2 + (dx)^2 + (dy)^2 + (dz)^2$$

The coefficients of this equation, $\{-1,1,1,1\}$ are the diagonal components of the g metric tensor

$$g_{\alpha\beta} = \begin{array}{c|cccc|} t & -1 & 0 & 0 & 0 \\ x & 0 & 1 & 0 & 0 \\ y & 0 & 0 & 1 & 0 \\ z & 0 & 0 & 0 & 1 \end{array}$$

The stress-energy-momentum tensor T can then be calculated for the photon using the Faraday tensor and the g metric tensor in the following equation from gravitation physics

$$4\pi T^{\mu\nu} = F^{\mu\alpha} F^{\nu}_{\alpha} - \frac{1}{4} g^{\mu\nu} F_{\alpha\beta} F^{\alpha\beta}$$

The stress-energy-momentum tensor indicates the curvature of space due to the application of electromagnetic fields, mass, angular momentum and charge. The mass of the Earth, for example, generates a negative curvature of spacetime such that objects fall toward the mass. The T tensor, which is also a 4×4 matrix, contains the momentum or flux terms in the first row and first column. The normal pressure stress is located along the diagonal. The shearing stresses are located off the diagonal. The energy term is in the upper left corner as depicted here,

$$T^{\mu\nu} = \begin{array}{c|cccc|} t & \text{energy} & flux_x & flux_y & flux_z \\ x & -flux_x & pressure_x & shear_{xy} & shear_{xz} \\ y & -flux_y & shear_{yx} & pressure_y & shear_{yz} \\ z & -flux_z & shear_{zx} & shear_{zy} & pressure_z \end{array}$$

[0004] Since $B^2 = E^2/c^2$, the stress-energy-momentum tensor for the photon is therefore

$$T^{\mu}_{\nu} = \begin{array}{c|cccc|} t & \frac{-E^2}{c^2} & 0 & 0 & \frac{+E^2}{c^2} \\ x & 0 & 0 & 0 & 0 \\ y & 0 & 0 & 0 & 0 \\ z & \frac{-E^2}{c^2} & 0 & 0 & \frac{+E^2}{c^2} \end{array}$$

This remarkable result shows that the photon is actually a negative energy particle (top left corner) which is pushed along by a positive pressure wave (lower right corner). The particle has a positive flux (upper right corner) in the z-direction, as well as a balancing negative flux in the lower left corner so that the overall momentum of the universe remains the same. All four components cancel and we see the photon as a massless particle moving at the speed of light.

[0005] Thus the key idea behind this invention is that it is possible to cancel out the pressure term and leave a stationary vibrating electromagnetic field of negative energy over the hull of the spacecraft. The importance of negative energy is that it is a prerequisite to generating wormholes between space and hyperspace.

[0006] Hyperspace consists of the those co-dimensions which have different physics constants such as a low speed of light. The existence of hyperspace, which has a white misty look, is not a well-known scientific concept. Experiments with our magnetic vortex wormhole generators, hyperspace torque generator, full body levitation using Chi Kung breathing, arm levitation by spinning the co-gravitational K field, full body teleportation through hyperspace a distance of 100 meters using a pulsed gravitational wave, jumping into hyperspace, having a plate of toast enfold off the breakfast table and disappear into thin air, walking through walls and doors out-of-dimension, looking into other dimensions, remote viewing through subspace to distances of 100,000 light years, and other electromagnetic experiments carried out by co-researchers, have shown us the reality and existence of hyperspace.

[0007] Referring to **FIG. 2**, the spacecraft consists of an upper (**1**) and lower (**2**) hull attached by ceramic insulators

to a circular ring (**3**). The ring provides support and is attached to an outer sharp-edged rim which is electrostatically charged to a potential −V. The purpose of the charged rim is to generate a radial electric E field around the vehicle.

[0008] Referring to **FIG. 3**, the radius of the ring (**4**) is equal to a. The distance from a point on the ring to the z-axis is r. The potential on the z-axis is therefore the charge divided by the distance,

$$potZ = \frac{q}{\sqrt{a^2 + r^2}}$$

This potential is expanded as a series in terms of inverse radius r

$$potZout = \frac{35qa^8}{128r^9} - \frac{5qa^6}{16r^7} + \frac{3qa^4}{8r^5} - \frac{qa^2}{2r^3} + \frac{q}{r}$$

The potential outside the ring can be written in terms of the Legendre polynomials P

$$Vout = \sum_{n=0}^{s} \left(\frac{a}{r}\right)^{n+1} A[n]\,LegendreP[n, \mathrm{Cos}(\theta)]$$

where s is the number of terms in the expansion. By equating the known particular solution potZout on the z-axis with the general Vout solution, the coefficients A[n] are found to be

$$A(0) = \frac{q}{a}$$
$$A(1) = 0$$
$$A(2) = \frac{-q}{2a}$$
$$A(3) = 0$$

which are substituted back into the Vout equation to get the potential outside the ring.

[0009] Referring to **FIG. 4**, the potential (dotted lines **6**) looking at a slice through the ring (**5**) is shown together with the electric E field. The negative gradient of the potential is the electric field (**7**) shown by the direction of the arrows. The importance of this diagram is that the electric field points in the radial direction toward the negatively charged ring. The force on an electron is the electron charge times the electric field

$$F = q_e E_r = -|q_e|(-|E_r|) = +F$$

Because the electron charge is negative and the radial field points in the negative direction toward the ring, the force on the electron is positive. Thus the electron moves away from the ring in the positive radial direction. A 3-dimensional plot of the ring (**8**) and the electric field (**9**) is shown in **FIG. 5**.

[0010] The stress-energy-momentum generated by a radial electric field is calculated using the Faraday F tensor

$$F_a^b = \begin{vmatrix} 0 & E_r & 0 & 0 \\ E_r & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{vmatrix}$$

The g metric tensor has to be given in spherical coordinates {r,θ,ϕ}

$$g_{\alpha\beta} = \begin{vmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & r^2 & 0 \\ 0 & 0 & 0 & r^2\sin(\theta)^2 \end{vmatrix}$$

where θ is the angle from the vertical to the radius r. The stress tensor T^{rr} along the radial direction is

$$T^{rr} = \frac{E_r^2}{8\pi c^2}$$

which shows that the pressure is negative along the radial line equal to the square of the radial electric field divided by the square of the speed of light. Because the field is squared, it doesn't matter that the electric field points in the negative direction. The square makes it positive, but the overall curvature pressure is negative. Thus this negative pressure cancels out the positive pressure propelling the photon along. The second key idea of the invention is how to generate this photon moving in the radial direction.

[0011] It has been known for a long time in physics that an electron moving in a circular path will emit photons in a process known by the German word Bremsstrahlung which is translated as "breaking radiation." There are several types of radiation such as classical Bremsstrahlung involving a charged particle making a collision with another charged or uncharged particle in which photons are emitted. The quantum mechanical Bremsstrahlung involves the sudden appearance or disappearance of a charged particle which also emits radiation. In space, having a field of wormholes in which the electrons are spiraling down into hyperspace would result in the emission of photons by the quantum mechanical method. Also, in the atmosphere, having collisions with air molecules results in emission of photons in the classical way.

[0012] In order to get the electrons to spiral around and emit photons, a crossed electromagnetic field is used as shown by the following equation

$$F = q(E_r + v_r \times B_\theta)$$

where the velocity v is in the positive radial direction due to the force of the electric field. The velocity crossed with a magnetic flux density B field in the θ-direction makes the electron move sideways back and forth in a wiggling motion.

[0013] Referring to **FIG. 6**, a direct current solenoid (**10**), represented by multiple current loops, running vertically

through the center of the hull, generates a magnetic field that curves around the outside of the hull, as shown by contour lines (**12**). The north pole (**11**) is at the bottom of the hull. A radial arrow (**13**) from the electrostatically-charged rim is perpendicular to the magnetic field lines. The cross product in the force equation becomes the electron radial velocity times the magnetic field $v_r B_\theta$.

[0014] Referring to **FIG. 7**, the electric field is in the y-direction and the magnetic field is in the z-direction. The flat looping path in the x-direction is the motion of the electron. The electron, which has a negative charge, starts to move in the direction opposite to that of the electric field. In this particular diagram, the electron acquires a velocity in the negative y-direction. Then a sideways force in the x-direction is produced due to the cross product of the velocity with the magnetic field times the negative charge

$$-q(-v_y \times B_z) = +F_x$$

Depending on the magnitude of the velocity, various size loops can be produced.

[0015] In terms of the hull coordinates, because the flat loop is in the plane of the electric field which points in the radial direction, the electron emits light in the radial direction. This condition means that the negative radial pressure created by the electric field cancels the radial pressure of the photon. Thus the photon becomes a stationary vibrating quantum of negative energy. This has the appearance of a luminescent light source. The stress tensor for this condition is therefore

$$T_\mu^\nu = \begin{vmatrix} -\frac{E^2}{c^2} & 0 & 0 & \frac{E^2}{c^2} \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ -\frac{E^2}{c^2} & 0 & 0 & 0 \end{vmatrix} = -\frac{E^2}{c^2} \text{residual negative energy}$$

[0016] residual negative energy

which leaves a residual negative energy per photon.

[0017] Referring to **FIG. 8**, the negatively charged rim (**14**) produces a radial electric field (**16**) that crosses the magnetic B field (**15**) of the solenoid. Electrons emitted by the charged rim then encounter this crossed field which makes them spiral (**17**) around the hull. Because of the tight loop, the electron emits Bremsstahlung radiation in the radial direction (**18**). The positive pressure field of the photon, which is directed in the radial direction, is canceled by the negative pressure field (**19**) created by the electric field. Because the photon energy is negative, a stationary vibrating electromagnetic quantum of negative energy (**20**) surrounds the hull.

[0018] This negative energy and the pressure stress created by the electromagnetic fields open up wormholes between space and hyperspace. The potential head is positive from hyperspace into space because the energy of hyperspace is more positive than the negative energy field. The low-density hyperspace energy fills the hull and its surrounding space with a white misty hyperspace energy which makes the spacecraft lighter in mass, and therefore lighter in weight within a gravitational field. The actual physics is more complicated still because the electrons find that the resistance of hyperspace is lower than the resistance of space. Thus they spiral down the wormholes which results in a sudden disappearance of charge. The quantum mechanical effect of this is to radiate even more photons which in turn produce even more negative energy.

[0019] The lift on the hull is generated by the radial electric field. In cylindrical coordinates, the g metric tensor is

$$g_{\alpha\beta} = \begin{vmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & r^2 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

Using this metric tensor, the pressure stress in the vertical direction T^{zz} is

$$T^{zz} = \frac{E^2}{8\pi c^2}$$

which is a positive curvature over the hull. The mass of Earth produces a negative curvature in which objects fall toward the mass. By counteracting this negative curvature with a more than positive curvature, lift is developed on the spacecraft. Because the negative energy lowers the effective mass of the vehicle, the acceleration is large with a modest electric field. Moreover, in our dimension, the speed of light is 299792458 meters per second. Hyperspace energy has a speed of light equal to one meter per second. Thus the stress is amplified by a factor of

$$A = \left(\frac{299792458\, m/s}{1\, m/s}\right)^2 \approx 9 \cdot 10^{16}$$

Because electromagnetic fields are relativistic, motion in a low-velocity-of-light energy field amplifies their strength.

SUMMARY OF THE INVENTION

[0020] It is the object of this invention to create a spacecraft propulsion system that produces wormholes between space and hyperspace using negative energy in order to generate lift on the hull. It was discovered in the Riemannian curvature calculations of gravitation physics that negative energy is required to keep open the throat of the wormhole. From experiments with the magnetic vortex wormhole generator, it is known that the proper combination of electromagnetic fields, together with this negative energy, can create a wormhole through which smoke can be blown into hyperspace.

[0021] Referring to **FIG. 9**, the directions of force, velocity, and electromagnetic fields are referred to in the cylindrical coordinate system {r,θ,z}. An electrostatically charged sharp-edged ring in the θ-direction around the hull of the spacecraft produces a radial electric field. A vertical solenoid in the z-direction through the center of the hull

produces a magnetic field which is perpendicular at the rim to the electric field. With the current in the solenoid flowing in the clockwise (−θ) direction, using the right-hand rule, the magnetic field points in the upward z-direction outside the rim. Because the rim is charged to a negative voltage, the electric field points toward the hull in the negative radial (−r) direction. Electrons emitted by the rim travel outward (+v) because the charge on the electron is negative which, together with the negative electric field, produces a positive radial force. The radial force on the electron causes it to acquire a velocity which interacts with the magnetic field. The cross product of the velocity (+v) with the positive (+B) magnetic field produces a sideways force on the electron in the negative θ-direction. However, because the charge on the electron is negative, the force is

$$F=-q\{v_r,0,0\}\times\{0,0,B_z\}=\{0,qB_zv_r,0\}$$

which is positive in the θ-direction. It is this sideways force that produces a flat spiraling or looping motion whereby the electron emits photons, known in German as Bremsstahlung radiation, in the radial direction. The photon, which is actually a quantum of negative energy, has a positive radial pressure which propels it along. Because the radial electric field produces a negative pressure in the radial direction, the two opposite fields cancel in the radial direction to form a residual stationary vibrating negative energy. Thus the hull becomes surrounded by negative energy which, together with the pressure stresses created by the electric field, generates wormholes between space and hyperspace.

[0022] The gravitational potential between hyperspace and space is positive because the hyperspace energy is more positive than the negative energy around the hull. Thus the low-density, low-speed-of-light hyperspace energy flows through the wormhole and fills the hull. This has the effect of reducing the effective mass of the hull. Because the electric field generates a positive pressure over the hull in the vertical z-direction, there is an upward force on the vehicle due to the pressure times the hull area. Since the vehicle has a low mass, there is a modest upward acceleration on the spacecraft equal to the force divided by mass.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0023] **FIG. 1**. Perspective view of an electromagnetic wave.

[0024] **FIG. 2**. Perspective view of spacecraft.

[0025] **FIG. 3**. Perspective view of charged ring.

[0026] **FIG. 4**. Planar plot of the radial electric field produced by charged ring.

[0027] **FIG. 5**. Perspective view of radial electric field around ring.

[0028] **FIG. 6**. Planar view of magnetic flux density field contour lines.

[0029] **FIG. 7**. Perspective view of electron motion in crossed electric and magnetic fields.

[0030] **FIG. 8**. Perspective view of production of negative energy around hull.

[0031] **FIG. 9**. Perspective view of cylindrical coordinate system {r,θ,z}.

DETAILED DESCRIPTION OF THE INVENTION

[0032] 1. The hull is made from a single sheet of aluminum which has been stretched to its yield point by hydraulic cylinders. An upper and lower die is CNC machined to the profile of the hull. The soft sheet is then clamped in the die where it takes on the smooth shape of the hull without any wrinkles. The hull is extremely rigid after forming and does not require any structural reinforcements.

[0033] 2. A section of the aluminum ring is made in a 3D computer graphics program. The model is stored as a stereolithography file (*.stl). The computer model is then sent via Internet e-mail to the stl server who prints the part in an ultraviolet light-cured polymer. The part is returned the next day by Express Mail. Using a rubber blanket mold to create several ring sections, the entire ring is assembled together in another wooden mold box having thin circular laminate-coated particulate wall boards on either side of the ring. Then a liquid rubber mold is poured on top of the ring and allowed to harden overnight at room temperature. Since the rubber mold is flexible, the ring can be extracted fairly easily. This ring model is then sent to the foundry where it is cast in aluminum using the lost wax process in which a wax mold evaporates out of the sand casting. We are also experimenting with non-magnetic copper casting metals containing beryllium having good conductivity.

[0034] 3. A 11.5 cm plastic pipe is mounted on a rotating fixture driven slowly by a microcontoller, stepper motor, and power electronics board. Using a large diameter insulated wire, such as a 17 AWG with a wire diameter of 0.127 cm, the wire is wound slowly on the pipe and expoxied so that the windings don't come loose. The solenoid is then mounted vertically in the hull supported by the support ring and driven by a current generator located nearby on the test rig.

[0035] 4. The ring is driven by a high voltage electrostatic generator similar to the night vision scope high voltage power supplies. The ring charge is isolated from the hull by ceramic insulators.

I claim:

1. A spacecraft propulsion system comprising the components:

an aluminum horizontal circular structural support ring;

an aluminum hull in the shape of a high dome on top and shallow dome on the bottom attached to the circular support ring using ceramic insulators;

an electrostatically negatively-charged sharp-edged circular ring, preferably of non-magnetic aluminum or copper, attached with ceramic insulators to the outside of the support ring;

a solenoid mounted through the center of the hull in the vertical direction and attached to the center of the support ring;

an electrostatic high-voltage generator to drive the outer electrostatic ring; and

a direct high-current generator to drive the solenoid.

2. The method of claim 1, wherein a negative radial electric field is generated around the hull by placing a negative potential on the sharp-edged electrostatic ring using the electrostatic generator.

3. The method of claim 1, wherein the current-driven solenoid generates a vertical magnetic field around the hull with the north pole of the solenoid facing down through the bottom of the hull which causes the magnetic flux density field to point up outside the rim.

4. The method of claim 1, wherein electrons are emitted radially by the sharp edge of the charged ring.

5. The methods of claims **2**, **3** and **4**, wherein the crossed electromagnetic fields cause the electrons to spiral around in flat loops during which photons are emitted in the radial direction.

6. The methods of claims **2** and **5**, wherein the negative radial pressure created by the electric field cancels the positive radial pressure of the photon to leave a residual quantum of negative energy per photon around the hull.

7. The methods of claims **2** and **6**, wherein the pressure stress created by the electric field, and the negative energy combine to form wormholes between space and hyperspace.

8. The method of claim 7, wherein low-density hyperspace energy of a higher gravitational potential flows through the wormholes to fill the hull and surrounding space around the hull with the effect of reducing the effective mass of the spacecraft.

9. The method of claim 2, wherein the electric field generates a positive pressure in the vertical direction over the hull which together with the hull surface area, generates an upward lift force on the hull.

10. The method of claim 6, wherein the negative energy, having a low light speed, amplifies the strength of the electromagnetic fields and pressure stress fields.

11. The methods of claims **4** and **7**, wherein the electrons spiral down the low resistance wormholes into hyperspace such as to create a sudden disappearance of electrical charge which quantum mechanically causes a large emission of additional photons.

* * * * *

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(54) CAVITATING OIL HYPERSPACE ENERGY GENERATOR

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Publication Classification

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(57) **ABSTRACT**

A hyperspace energy generator that uses cavitating oil bubbles within a magnetic field in order to create wormholes between space and hyperspace for the purpose of permeating the hull of a spacecraft with low-density hyperspace energy.

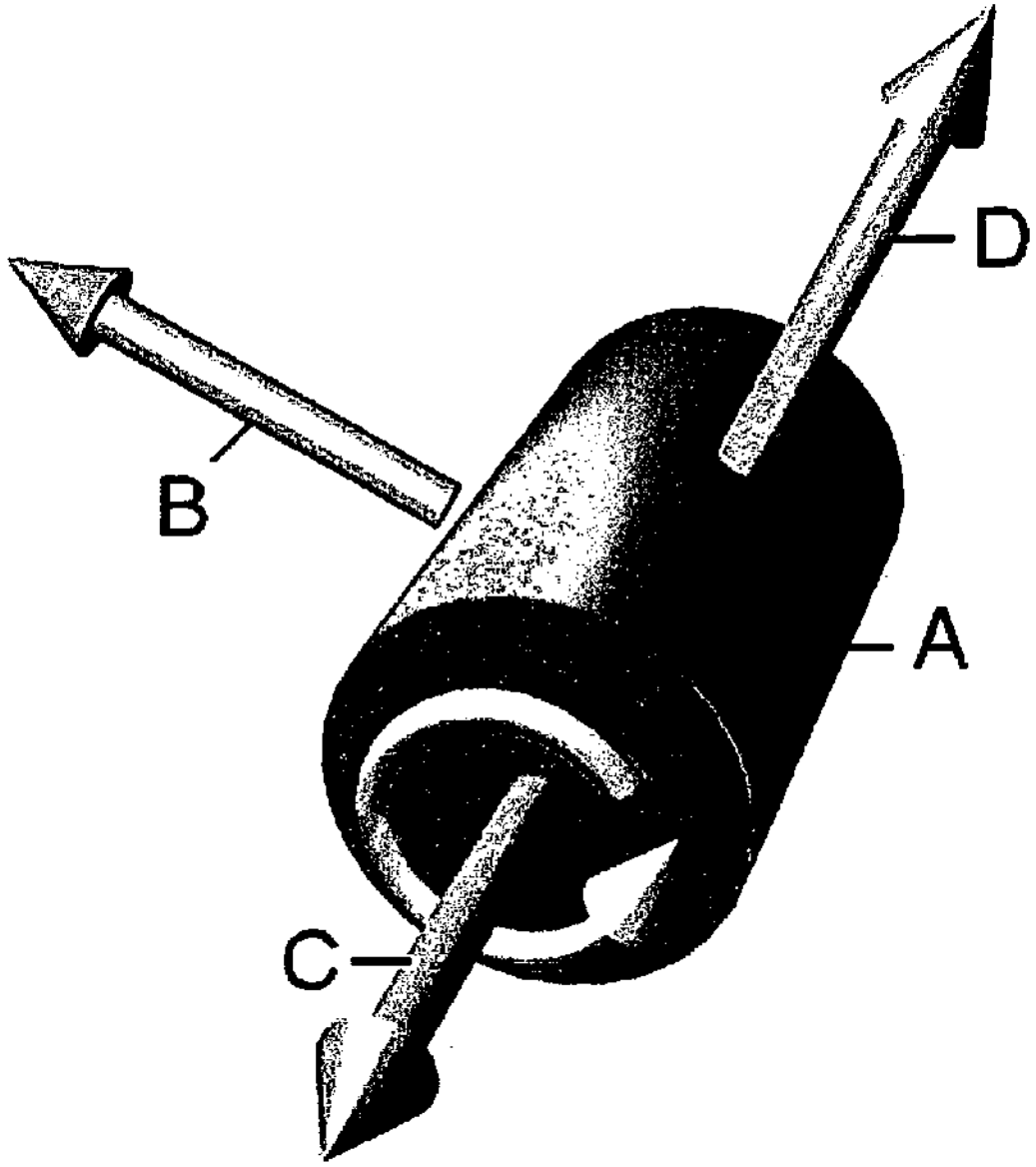

Figure 1

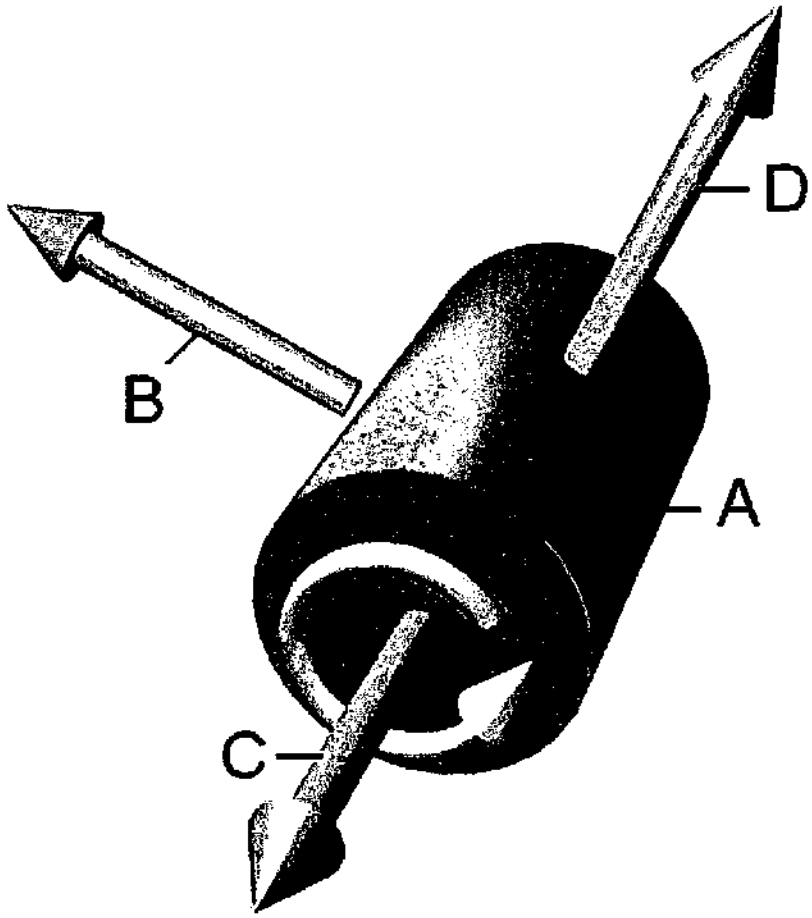

Figure 2

Figure 3

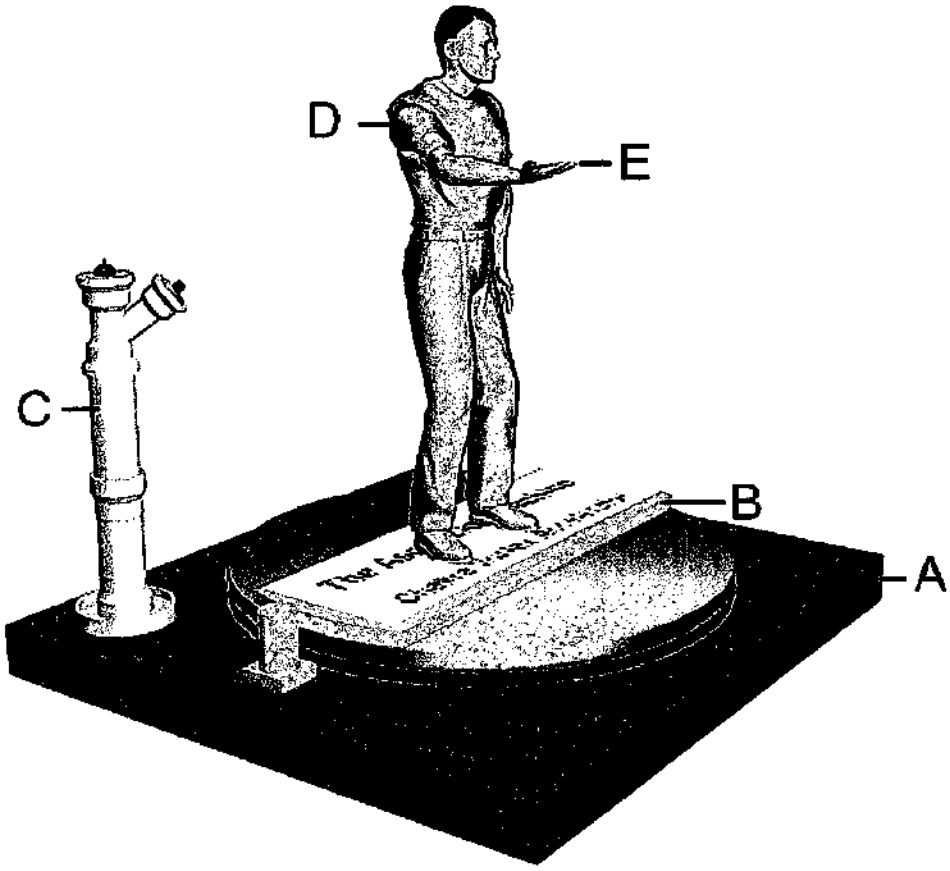

Figure 4

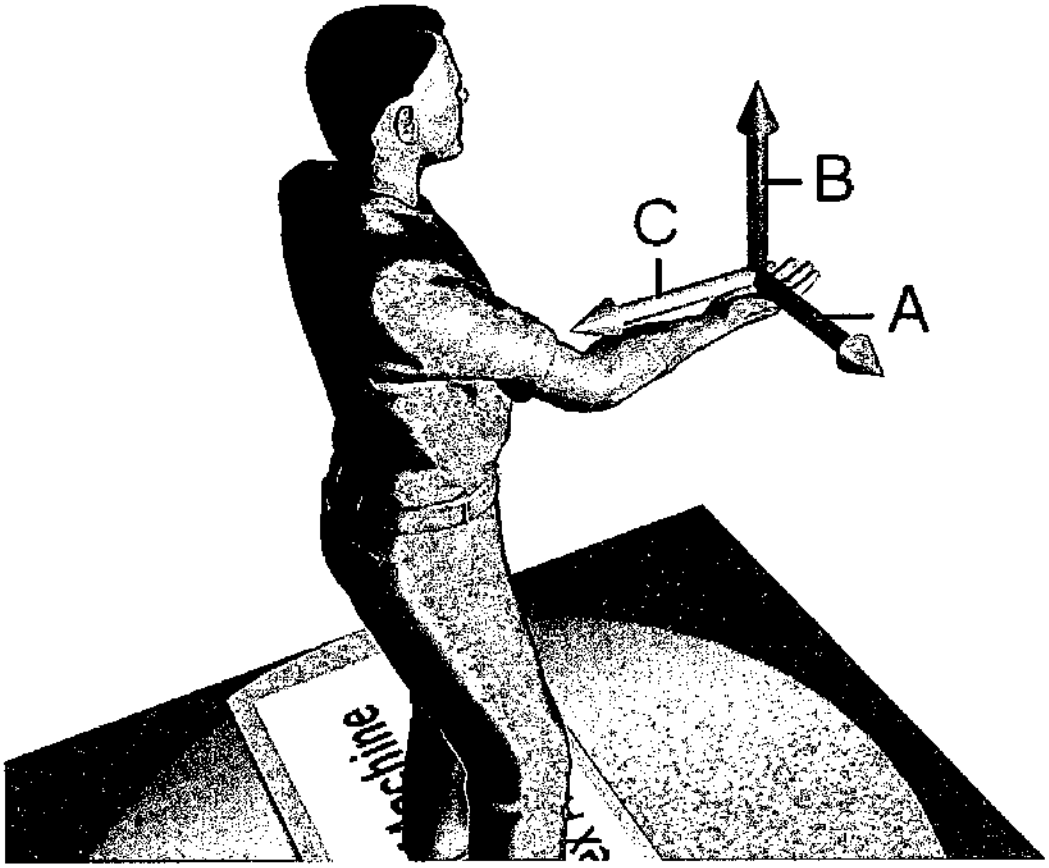

Figure 5

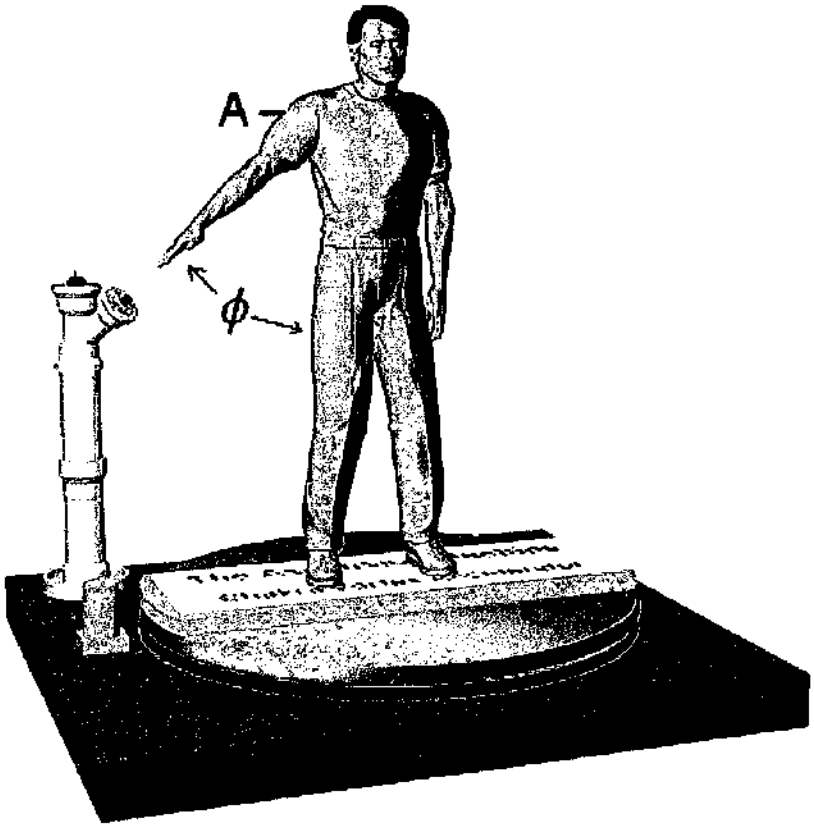

Figure 6

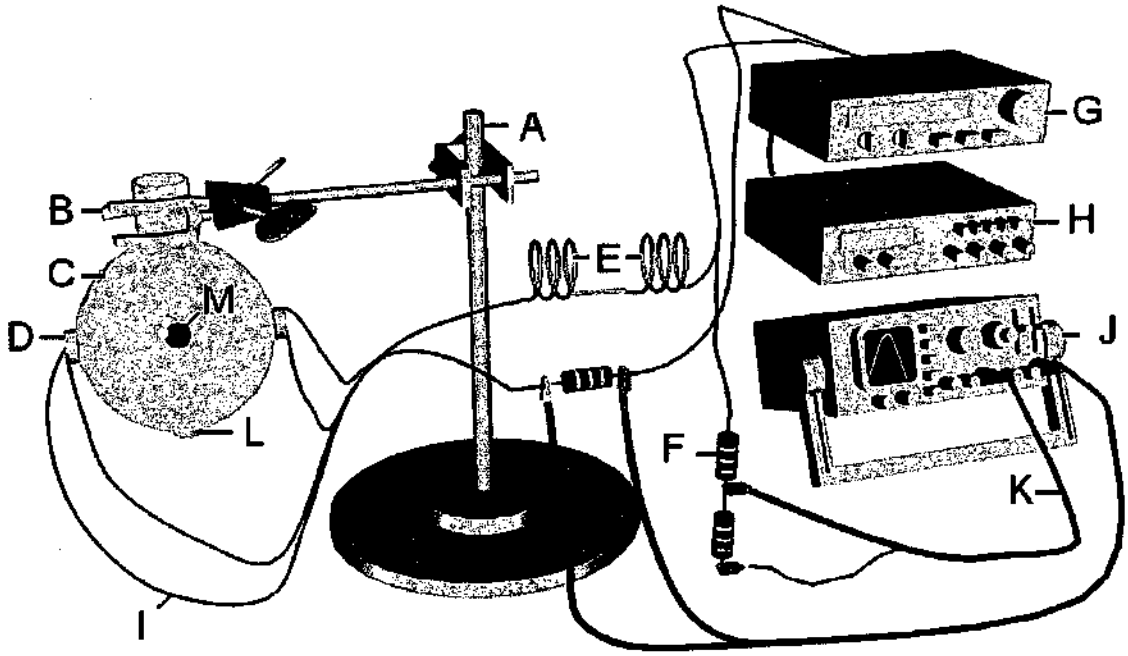

Figure 7

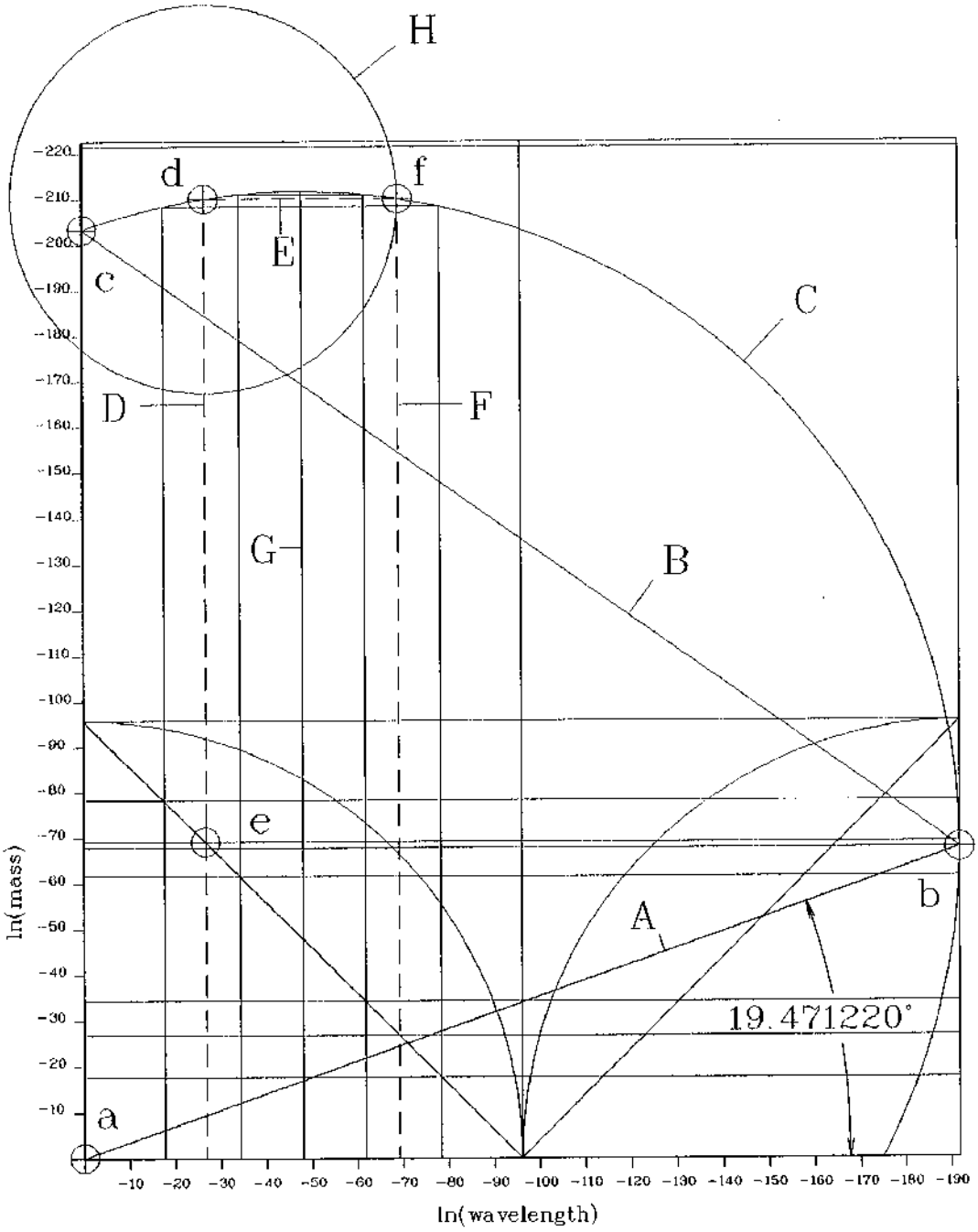
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Figure 8

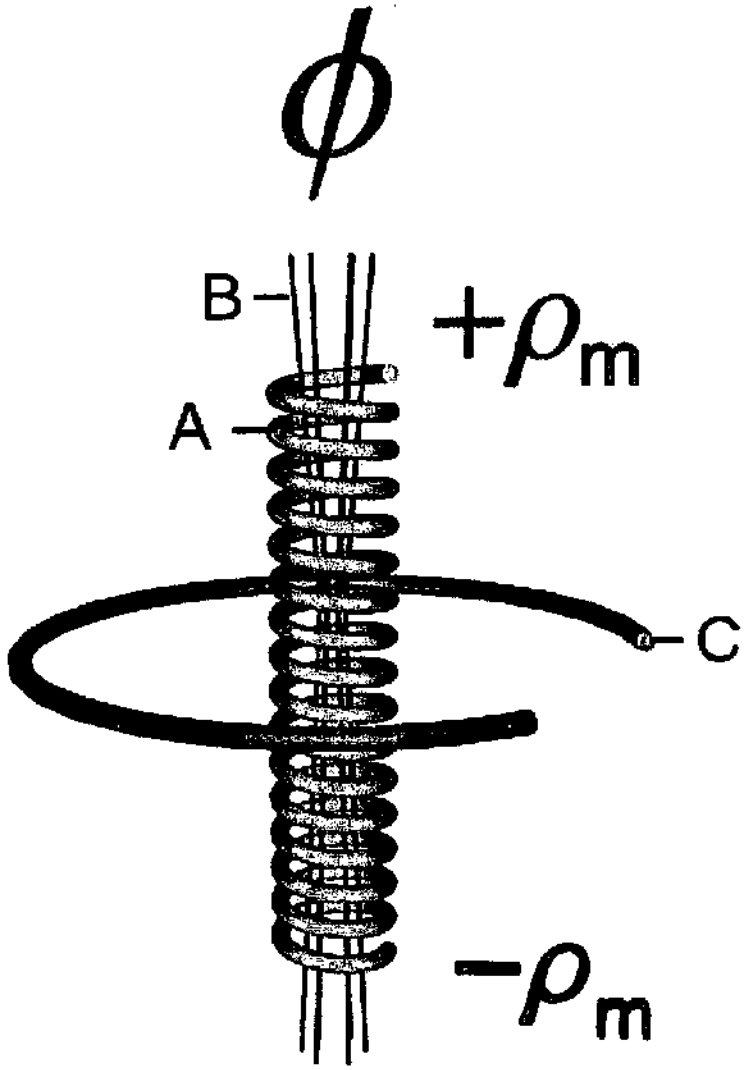

Figure 9

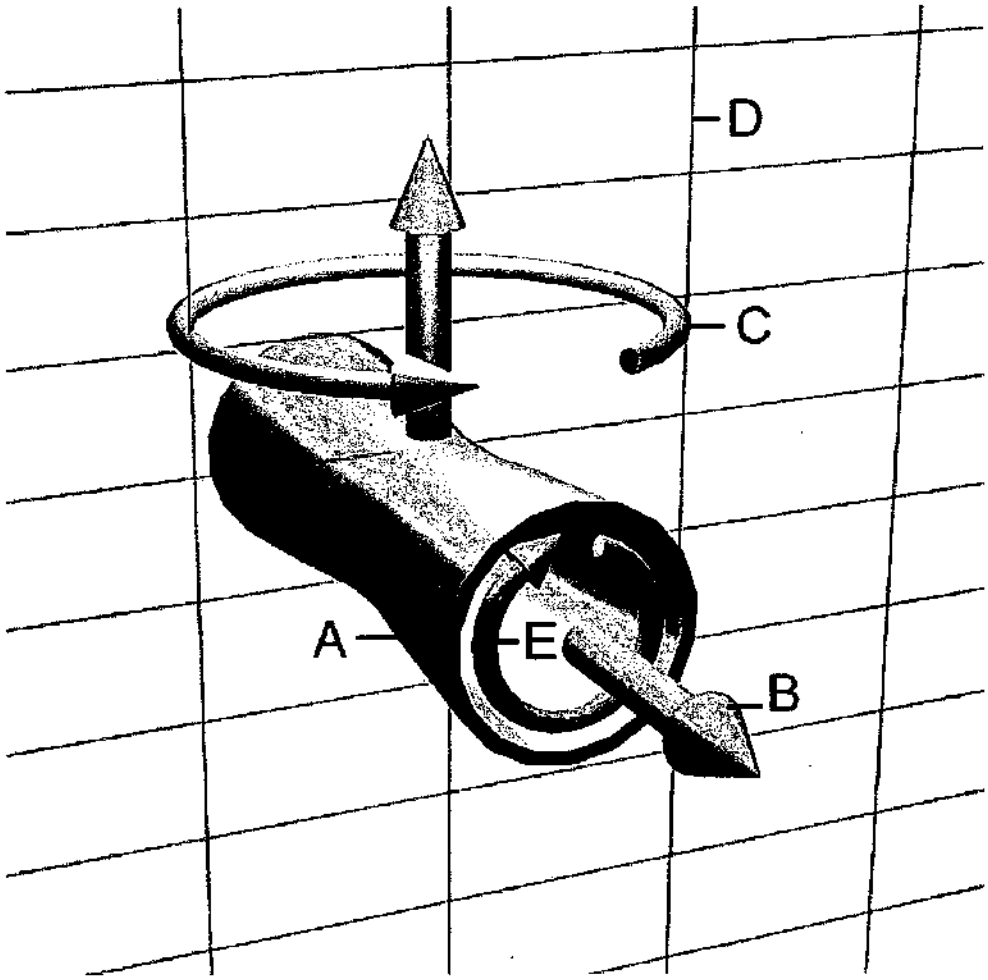

Figure 10

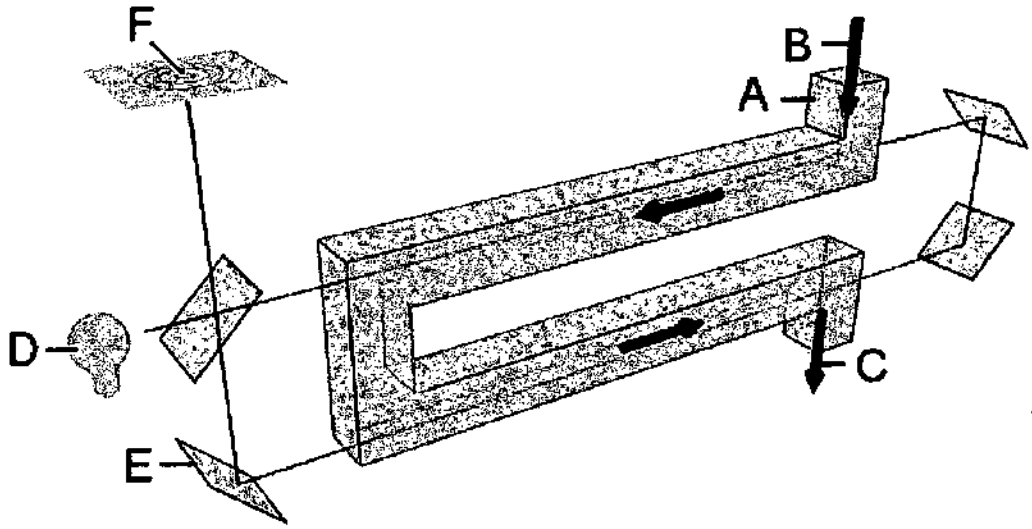

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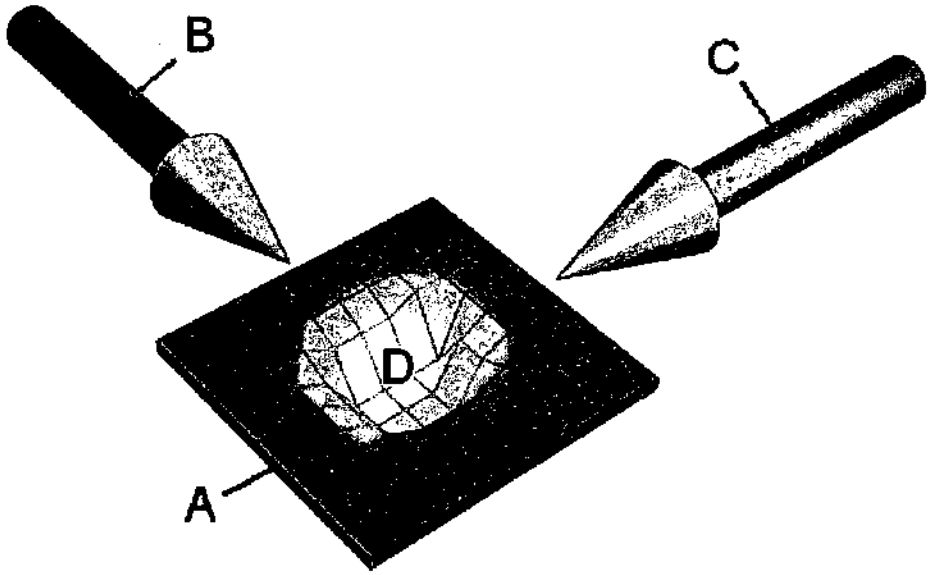

Figure 12

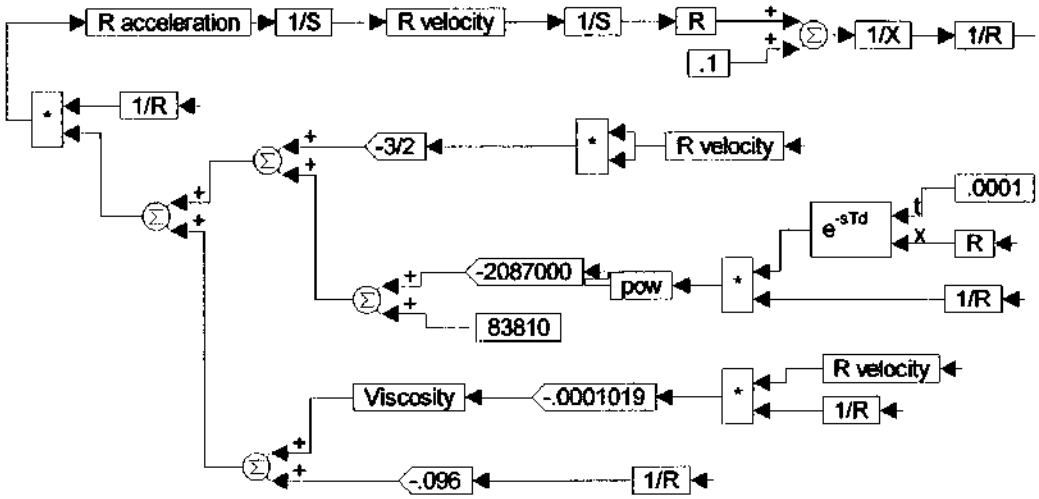
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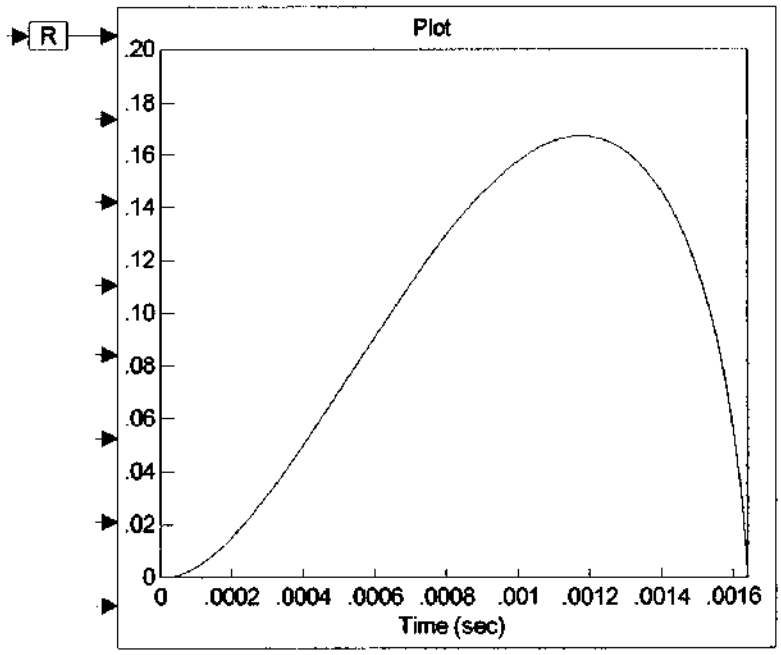
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Figure 13

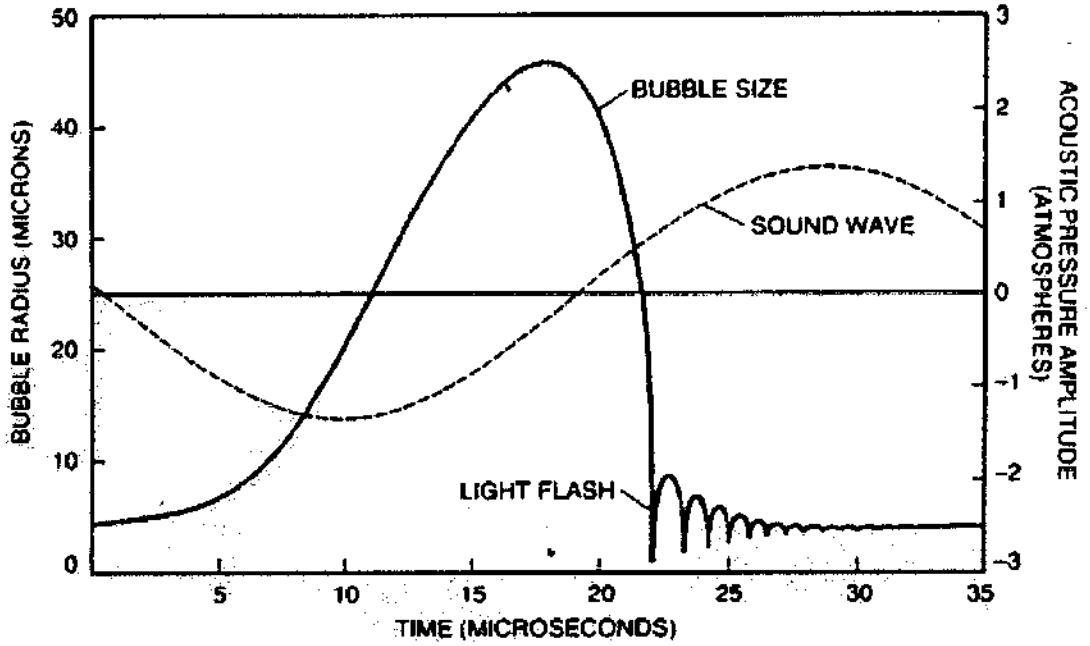
BUBBLE SIZE
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Figure 14

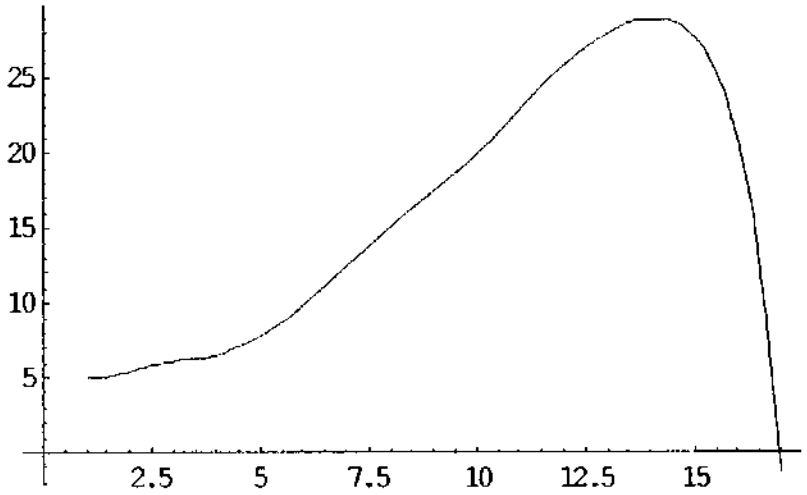

Figure 15

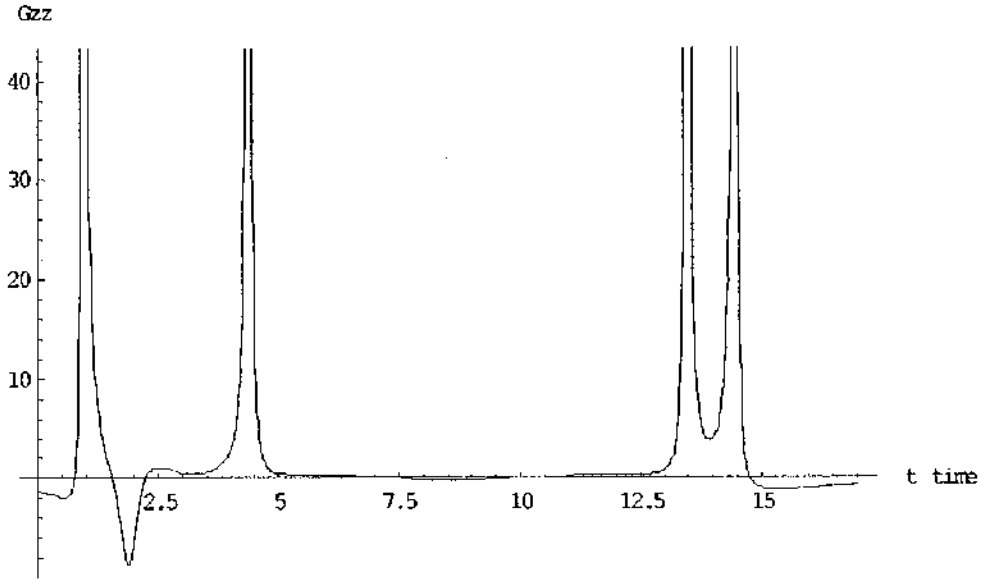

Figure 16

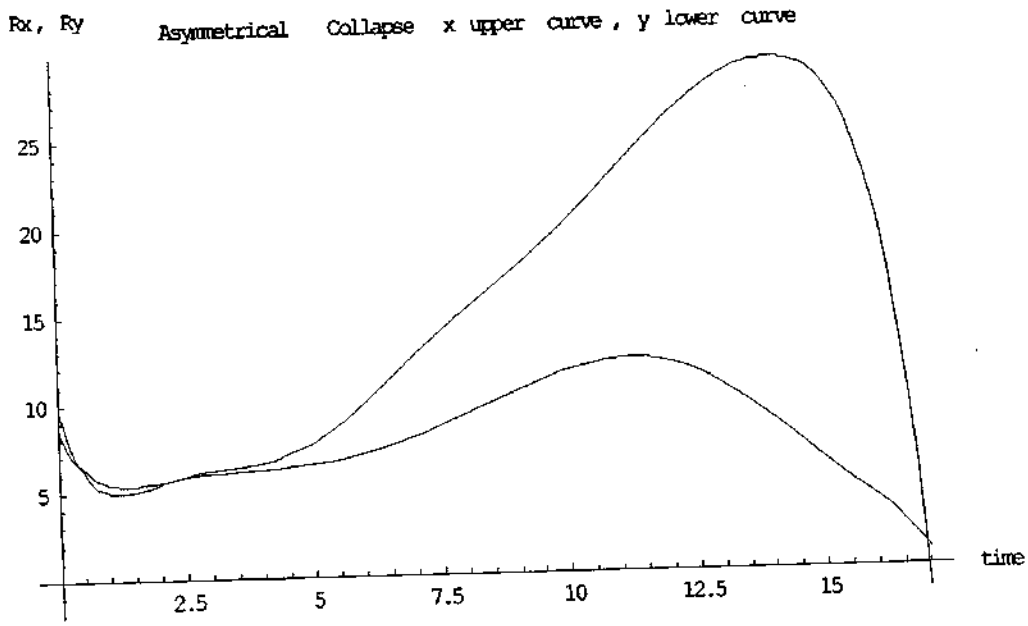
Rx, Ry
Asymmetrical Collapse x upper curve , y lower curve
25
20
15
10
5
2.5
5
7.5
10
12.5
15
time

Figure 17

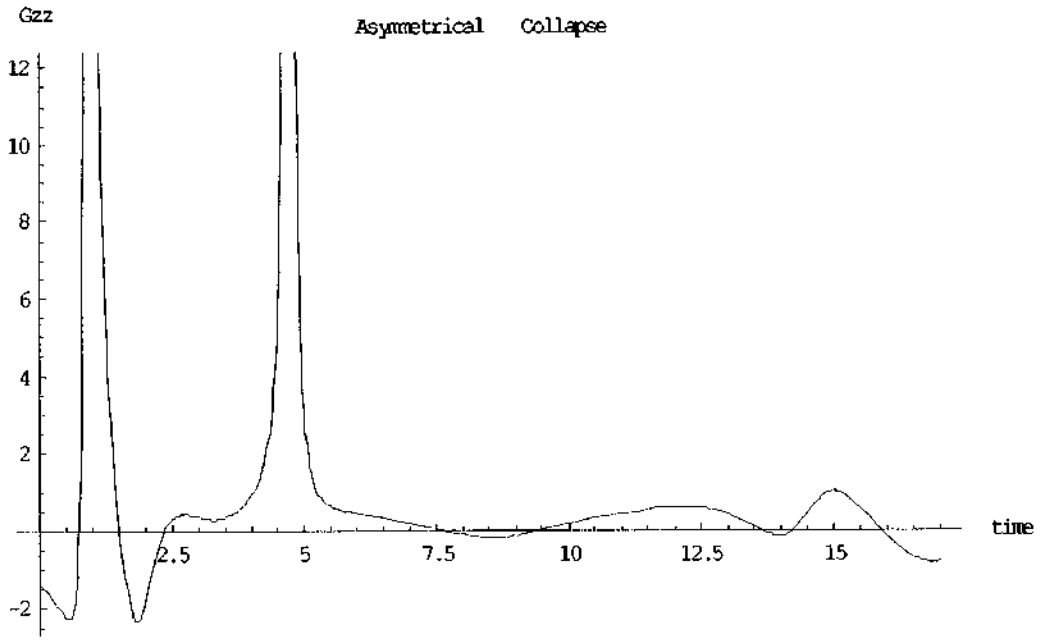

Figure 18

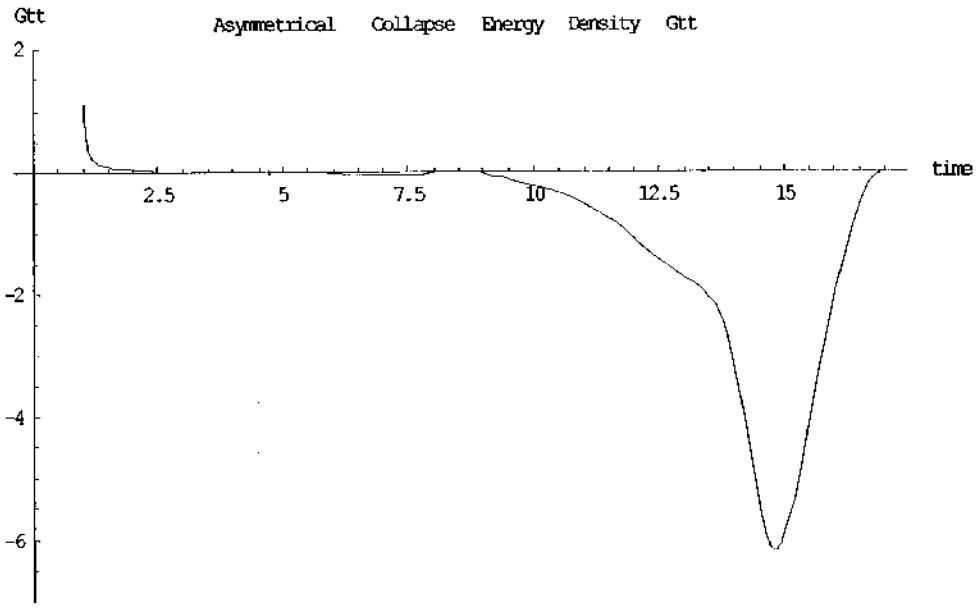
Gtt
Asymmetrical Collapse Energy Density Gtt
2
-2
-4
-6
2.5
5
7.5
10
12.5
15
time

Figure 19

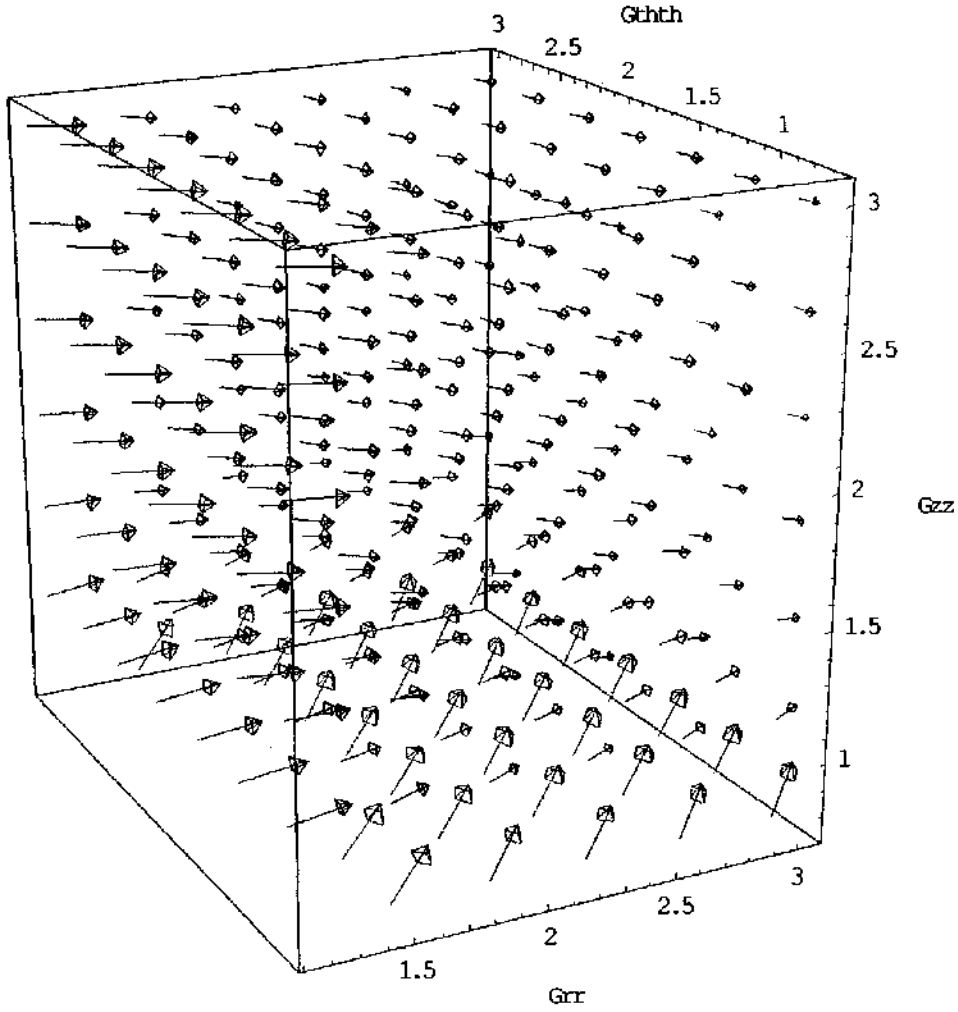

Figure 20

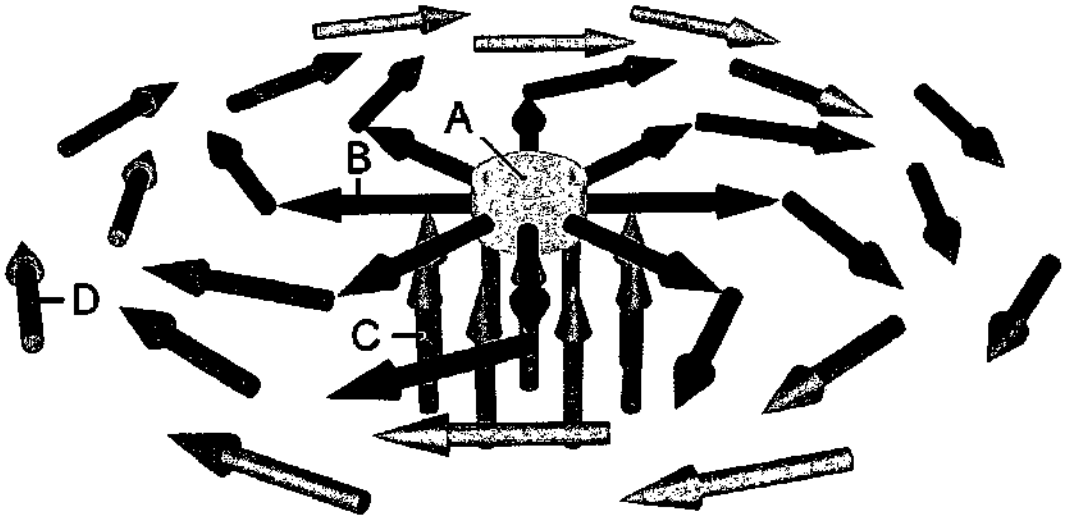

Figure 21

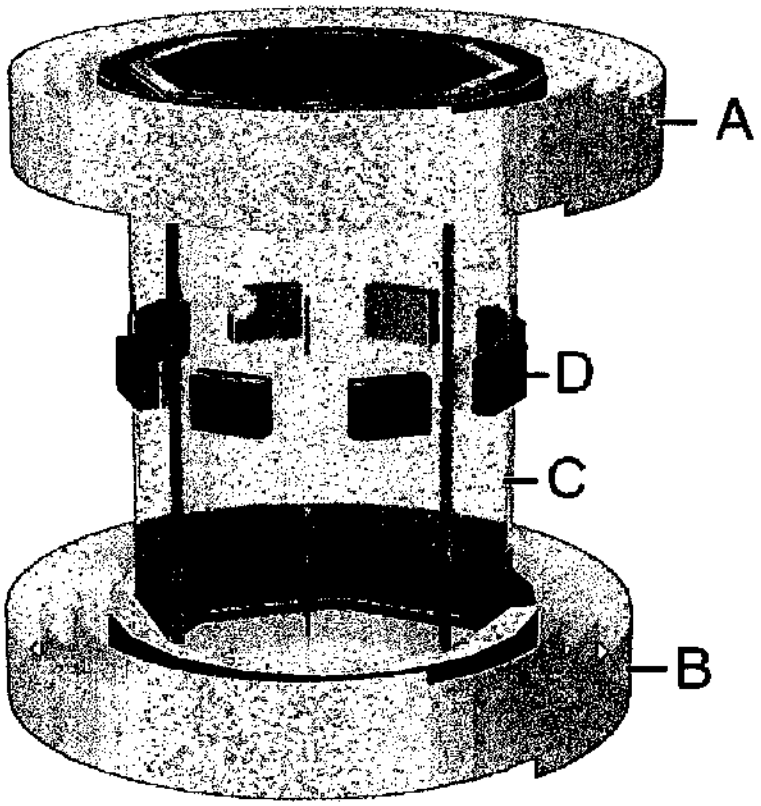

Figure 22

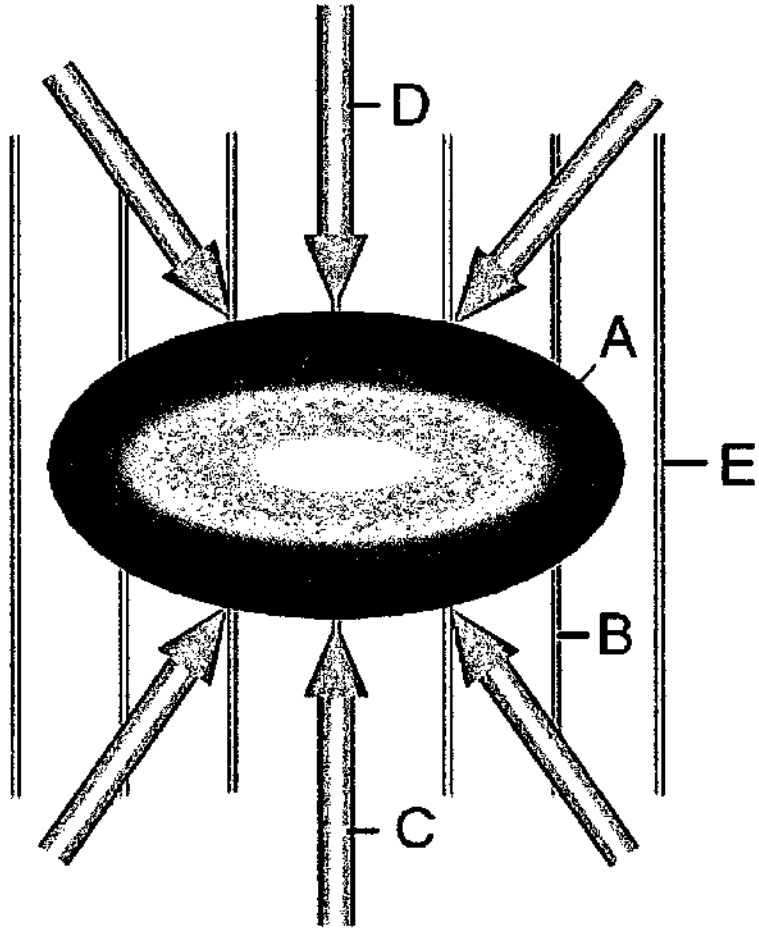

Figure 23

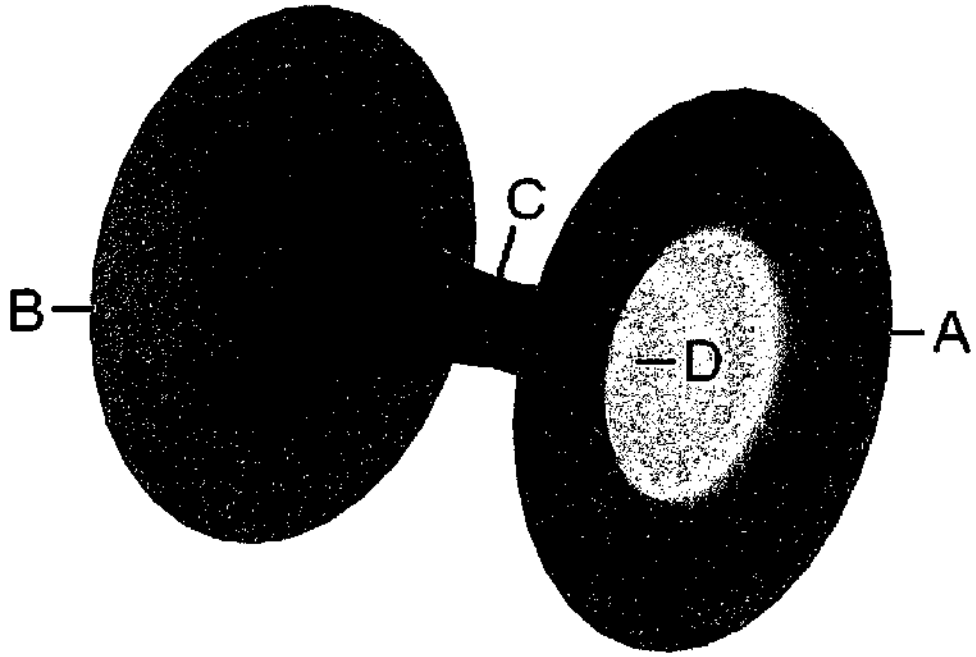

Figure 24

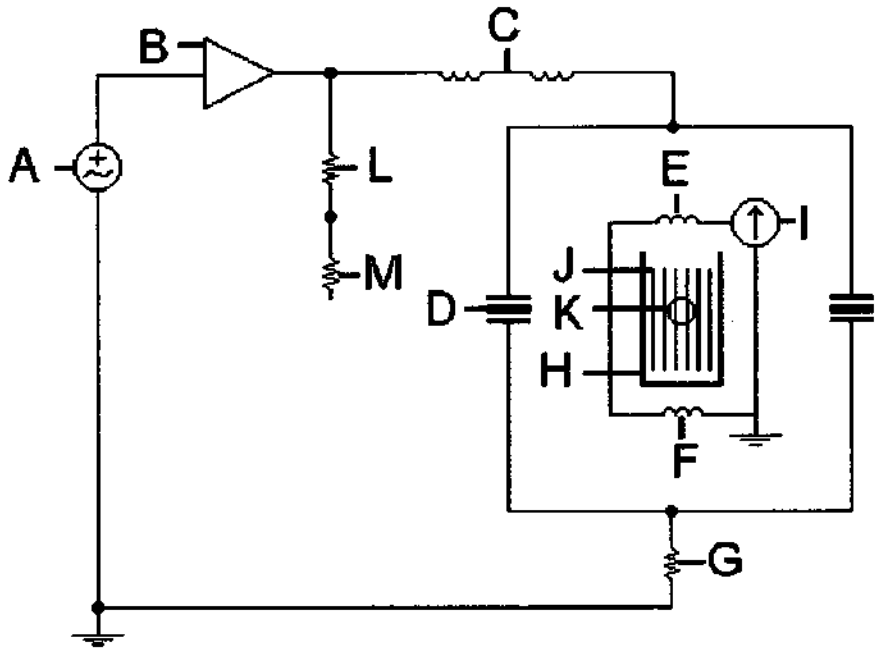

CAVITATING OIL HYPERSPACE ENERGY GENERATOR

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a hyperspace energy generator that uses cavitating oil bubbles within a magnetic field in order to create wormholes between space and hyperspace for the purpose of permeating the hull of a spacecraft with low-density, low-speed-of-light hyperspace energy.

BACKGROUND OF THE INVENTION

[0002] As shown by physicist Dr. John Archibald Wheeler of Princeton University, there is a second term in Newton's gravitational equation which includes an additional force depending on whether or not the body is spinning.

$$F=mg+m(v\times\Omega)$$

[0003] where F is the force, m the mass, g the acceleration of gravity, v the forward velocity of the body, and Ω the angular velocity of the body. Referring to **FIG. 1**, a rotating cylinder (A) is moving with a velocity (B) while spinning counterclockwise as shown by the angular velocity vector (C). The velocity crossed with the angular velocity vector produces a force in the upward direction (D).

[0004] Referring to **FIG. 2**, a pendulum (A) held in the left hand over the right hand will spin in the counterclockwise direction due to the hyperspace energy vortex (B) emanating from the palm of the right hand. This vortex arises because human beings are hyperspace energy beings that live in physical containers located in this universe. The vortex might be considered a wormhole between space and hyperspace. Notice that the angular momentum vector of the vortex points up out of the palm of the hand. If the hand were spinning from left to right, then there would be a force exerted, as shown by the above equation, that would bring hyperspace energy into the right arm.

[0005] Referring to **FIG. 3**, in order to test this hypothesis, a Chakra Vortex Accelerator was built for the purpose of spinning this hand vortex. The motor-driven machine has a base (A) on which is mounted a warehouse palletizing ring and platform (B). A control column (C) has a speed control and on/off switch. A person (D) stands on the platform with his right arm outstretched and palm facing upward (E). The platform spins from left to right.

[0006] Referring to **FIG. 4**, the velocity vector (A) points to the right. The angular momentum vector of the rotating chakra energy vortex points up. The cross product A×B=C produces a force that brings in high permeability hyperspace energy into the arm.

[0007] Referring to **FIG. 5**, after spinning 99 times per day for a few months, it was noticed that the right arm (A) would remain out at an angle ϕ from the body without making any exertion to do so. The left arm, which was not receiving the energy, remained at the side of the body. That is, the low-density hyperspace energy in the right arm was making the arm lighter and producing a subsequent anti-gravitational effect. The conclusion was that it might be possible to invent some device which would produce large amounts of hyperspace energy. This would make possible relativistic electromagnetic fields which can be used to produce the lift force for electromagnetic field propulsion vehicles.

[0008] Then in the February 1995 issue of *Scientific American*, an article appeared entitled *Producing Light from a Bubble of Air* which gave the details for producing sonoluminescence from a cavitating bubble using a kit for sale containing the piezoelectric transducers. Referring to **FIG. 6**, the experimental setup includes a ring stand (A) with a three-finger clamp (B) holding a 100 milliliter flask containing degassed water produced by a Walsh vacuum/pressure pump. Piezoelectric drive transducers (D) are mounted on the sides of the flask in order to create sound pressure waves which create the cavitation bubble (M) in the center of the flask. The transducers are connected by insulated wire (I) to a pair of inductors (E) having a mutual inductance between them. These inductors are driven by a frequency generator (H) connected to an audio amplifier (G). The oscillation signals are picked up by the oscilloscope (J) which is connected to the resistors (F) using the probes (K). The piezoelectric drive transducers act electrically as capacitors. The inductors are wired in series with the capacitance such that the combination resonates at the frequency at which acoustic resonance occurs. Bubbles introduced into the flask tend to coalesce in the center of the flask Above a certain sound intensity, the bubble will collapse and emit a dim light visible to the unaided eye in a darkened room, a process called sonoluminescence.

[0009] Further research showed that there were some earlier doctoral theses available. One of them by Dr. Steven DeWitt Horsburgh entitled *Radial Instabilities of a pulsating air bubble in water* mentioned a most interesting observed phenomenon of the surface oscillations called a "beaconing effect." When a bubble exhibited a stable or long-lived shape oscillation lasting more than two minutes, the bubble had a tendency to slowly precess. The precession rate was on the order of a few hertz which can be taken to mean around 3 Hz. Visually, the beacon looked like a light house beacon. It was a very obvious effect and when the beacon crossed the photodiode, the output voltage increased by at least an order of magnitude.

[0010] Upon reading this, it became apparent that sonoluminescence is involved with gravitational hyperspace physics. Einstein's theory says that inertia is a manifestation of the geometry of spacetime. It also says that geometry is affected by the presence of matter to an extent proportional to the factor G/c^2 where G is the gravitational constant and c is the speed of light. The inverse of this factor is the linear mass Ω of the universe. A spherical shell of mass m with a radius R will create a drag angular velocity on a pendulum equal to

$$\omega_{drag}=\frac{4}{3}\frac{G}{c^2}\frac{m_{shell}}{R_{shell}}\omega_{shell}=\frac{4}{3}\frac{\frac{m_{shell}}{\Omega}}{R_{shell}}\omega_{shell}$$

[0011] The mass of the shell divided by the linear mass (mass per length) converts the mass into a length which is then divided by the radius of the shell which is also a length. The numerical factor 4/3 is found only by a detailed calculation. The calculation, starting from a flat background spacetime manifold, showed the effect of the moving current of mass on the metric. Expressed in polar coordinates, the metric acquires a non-zero coefficient $g_{\phi t}$. Inserted into the equation for geodesic motion, this off-diagonal metric coef-

ficient gives rise to a precession according to the above equation. The numerical factor corresponds to a pendulum located anywhere inside the rotating shell of mass.

[0012] In other doctoral theses, books and physics articles on cavitation, light is emitted after the bubble starts to collapse. A very sharp peak of light is produced which lasts in terms of picoseconds. Thus this type of sonoluminescence is very different than the beaconing effect where the bubble remains stable for long periods of time. The beaconing effect is actually a rotating wormhole between space and hyperspace.

[0013] Briefly what happens is that there is ionized gas in the bubble which releases electrons. As the electrons spiral down through the wormhole from space into hyperspace, they give off light. This situation puts the electrons in contact with the charge of hyperspace. Space has a charge which is equal to the sum of the electron charge q_e and the hyperspace charge q_h. The charge of space q is equal to the Planck mass times a conversion factor between mass and charge. The Planck mass is equal to the linear mass Ω of the universe times the bottom dimensional limit of the universe known as the Planck scale Λ. The conversion factor is the square root of the gravitational constant G times the permittivity of space ε. The permittivity is linear capacitance or capacitance per unit length. Thus the charge of space is

$$q=\Lambda\Omega\sqrt{G\epsilon}=q_e+q_h$$

[0014] Because the electron comes in contact with the hyperspace charge, the drag angular velocity in the above equation has to be modified. Notice that if the angular velocity of the shell is modified by the electron fine structure constant α, and the mass involved is the mass of the electron, moving through a radius into hyperspace of the Planck scale Λ, then the drag angular velocity would be

$$\omega_{drag}=\frac{4}{3}\frac{\frac{m_{electron}}{\Omega}}{\Lambda}\omega_{shell}\frac{1}{\alpha}$$

[0015] The angular frequency of the shell is 2π times the electron frequency f_e.

$$\omega_{shell}=\omega_{electron}=2\pi f_e$$

[0016] The inverse of the electron fine structure constant α is equal to Planck's reduced constant ħ times the speed of light c times the factor 4π times the permittivity of space ε divided by the square of the charge of the electron q_e.

$$\frac{1}{\alpha}=\frac{\hbar c 4\pi\varepsilon}{q_e^2}n=137.037916527$$

[0017] Planck's constant is equal to the Planck scale Λ squared times the linear mass Ω times the speed of light.

$$\hbar=\Lambda^2\Omega c$$

[0018] Notice that the fine structure constant has a square in it and Planck's constant also has a square. If the electron charge were traveling through the Planck scale into hyperspace, then there would be a linear charge equal to the electron charge divided by the Planck scale

$$\frac{1}{\alpha}=\frac{\hbar c 4\pi\varepsilon}{q_e^2}n=\frac{\Lambda^2\Omega c c 4\pi\varepsilon}{q_e^2}n=\frac{4\pi\Omega\varepsilon c^2}{\left(\frac{q_e}{\Lambda}\right)^2}n$$

[0019] The constant equal to the linear mass Ω times the permittivity times the square of the speed of light is actually the square of the linear charge χ of space. So the fine structure constant can be written

$$\frac{1}{\alpha}=4\pi n\frac{(\chi)^2}{\left(\frac{q_e}{\Lambda}\right)^2}=4\pi n\frac{\left(\frac{q}{\Lambda}\right)^2}{\left(\frac{q_e}{\Lambda}\right)^2}=4\pi n\left(\frac{q}{q_e}\right)^2=4\pi n\left(\frac{q_h+q_e}{q_e}\right)^2=$$
$$4\pi n\left(\frac{q_h}{q_e}+1\right)$$

[0020] So the electron fine structure constant is related to the ratio of the charge of hyperspace to the charge of the electron, which is the reason that the equation had to be modified. The electron moving across the Planck scale wormhole is modified by the hyperspace charge it is seeing in a hyperspace co-dimension. This confirms that the beaconing effect is a rotating wormhole into hyperspace.

[0021] The electron fine structure constant is actually the fastest velocity in the Bohr atom. The fine structure constant is the ratio of the electron orbital velocity to the speed of light.

$$\alpha=\frac{v_n}{c}$$

[0022] where the permitted quantized n orbital speeds are v_n/n or v/1, v/2, v/3 and so on. Using a value of v/3, the fine structure constant would be

$$\frac{1}{\alpha}=\frac{3c}{v}=4\pi n\left(\frac{q_h}{q_e}+1\right)=12\pi\left(\frac{q_h}{q_e}+1\right)$$

[0023] which when substituted into the drag angular frequency equation

$$\omega_{drag}=\frac{4}{3}\frac{\frac{m_e}{\Omega}}{\Lambda}2\pi f_e 12\pi\left(\frac{q_h}{q_e}+1\right)=17.809\ \frac{\text{radians}}{\text{sec}}$$

[0024] The frequency of precession is

$$f_{drag}=\frac{\omega_{drag}}{2\pi}=2.83\ \text{Hz}$$

[0025] which is close to the 3 Hz observed in the experiment. The ionized electrons are moving at a slower velocity

in the bubble. The 1/3 ratio could also come from the subspace tetrahedron geometry where the tetrahedral angle is determined by this ratio

$$\theta = \operatorname{asin}(1/3) = 19.47122063^\circ$$

[0026] This is an alternative possibility because this angle determines the charge of hyperspace according to the tetrahedron diagram of Δphysics. In geometrical physics, all the constants of physics are determined geometrically by the tetrahedron. The tetrahedron diagram plots the natural logarithm of mass versus the natural logarithm of wavelength. The tetrahedron is circumscribed by a sphere which reflects the electron wavelength into the electron mass. Thus the diagram combines the dual reality of classical physics, involving point mass particles, and quantum physics, involving wave-like particles. The scientific discovery that the electron and the proton are one and the same particle was made using this diagram. It also shows that hyperspace exists.

[0027] Referring to the tetrahedron diagram in **FIG. 7**, a line drawn at the tetrahedral angle produces the tetrahedral lines (A,B) along path (abc). This tetrahedron is circumscribed by sphere (C) with diameter (G). The electron wavelength (vertical dotted line D) reflects off the sphere (d,f) and returns as the electron mass (F). The distance (df) between reflection points is equal to the natural logarithm of the hyperspace charge. It can be shown that the electron charge is related to the geometry around the top of the sphere. Part of the geometry is outside the sphere which makes the charge immune to relativistic velocities.

[0028] Referring to **FIG. 8**, a current-carrying solenoid (A) produces a magnetic flux (B) through the center of the coil. The end of the solenoid behaves like a magnetic monopole. One end has a positive magnetic charge density $+\rho_m$ and the other has a negative magnetic charge density $-\rho_m$. One of Maxwell's electromagnetic equations states that the divergence of the magnetic field is equal to the magnetic charge density.

$$\nabla \cdot B = \rho_m = +\rho_m - \rho_m = 0$$

[0029] Because the magnetic field is solenoidal, the sum of the charges in our spacetime is equal to zero, which is the usual Maxwell equation. In the case of the wormhole, one pole of the magnetic flux is in our spacetime and the other pole is in a co-dimension of hyperspace. In our universe, there is a net magnetic charge density, and Maxwell's equation becomes

$$\nabla \cdot B = \rho_m$$

[0030] When working with bar magnets, bringing two north poles together shows that there is a spring constant involved. The electrons on the surface of the pole spin in the same direction which creates an electrical current around the surface. The magnetic pole strength g is therefore a spring constant K divided by the current per area J.

$$g = \frac{K}{J} = \frac{kg\,m}{s^2}\frac{1}{m}\frac{s\,m^2}{q} = \frac{kg\,m^2}{s\,q}$$

[0031] The magnetic charge density is then the pole strength per volume V or

$$\rho_m = \frac{g}{V} = \frac{kg\,m^2}{s\,q}\frac{1}{m^3} = \frac{kg}{m\,s\,q}$$

[0032] The divergence of the magnetic field has units of

$$\nabla \cdot B = \frac{1}{m}\frac{kg}{s\,q}$$

[0033] which are the units of the magnetic charge density. Notice that the units can also be formatted as a pressure per electrical current in the wire.

$$\rho_m = \frac{kg}{s\,q\,m} = \frac{kg\,m}{s^2\frac{q}{s}m^2} = \frac{\text{force}}{\text{area}}\frac{1}{I} = \frac{\text{pressure}}{\text{current}}$$

[0034] The current flowing through the coils of the solenoid, or around the pole face of the bar magnetic creates a pressure on spacetime. And it is this pressure that can punch through spacetime into hyperspace. Referring again to **FIG. 8**, an electrical charge winding n times around the end of the spacetime solenoid, as seen by path (C), is equal to the charge divided by Planck's constant times the pole flux

$$2\pi n = \frac{q}{h}\int_{Surface} B = \frac{q}{h}\Phi$$

[0035] which shows that the flux Φ is quantized by the winding number n

$$\Phi = n\frac{2\pi h}{q} = n\frac{h}{q}$$

[0036] where the flux is equal to the winding number n times Planck's constant h divided by the charge. Since the flux is the pole strength in webers, the pole strength g has a value of

$$g = n\frac{h}{q}$$

[0037] The magnetic charge density is the pole strength divided by the Planck volume or

$$\rho_m = \frac{g}{\Lambda^3} = n\frac{h}{q}\frac{1}{\Lambda^3} = n\frac{2\pi\Lambda^2\Omega c}{q\Lambda^3} = \frac{2\pi n}{\Lambda}\frac{\Omega c}{q} = 2\pi n\frac{B}{\Lambda}$$

[0038] The magnetic B field of space divided by the Planck length of the wormhole, acting as a linear magnetic field, times the winding number is equal to the magnetic charge density.

[0039] Referring to **FIG. 9**, the wormhole (A), connecting space and hyperspace (D), is precessing (C) in the counterclockwise direction with the angular velocity vector in the vertical z-direction. The magnetic flux (B) through the wormhole is in the radial direction. The mouth of the wormhole is an area with a normal vector in the radial direction also. This arrangement creates an electric field which circulates around the interior periphery of the wormhole. Maxwell's equation says that the curl of the electric field E is equal to the negative time rate of change of the magnetic B field.

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

[0040] This equation is difficult to manage in differential form. As both Maxwell and Feynman have said, it is better to use the integral form involving Stokes' theorem where the area da is converted into a line integral ds which goes well with Maxwell's idea of flux linkage.

$$\int_{surface} (\nabla \times E)\cdot n\, da = \oint E\cdot ds = -\frac{\partial}{\partial t}\int_{surface} B\cdot n\, da = -\frac{\partial}{\partial t}\Phi = -\Phi\,\omega_{drag}$$

[0041] The flux Φ, which is precessing around at the drag angular velocity calculated previously, is equal to the negative of the electric field around the interior perimeter (E) of the wormhole. This is the reason that the beaconing effect lasts for such a long length of time. The force on the electron is equal to the charge of the electron times the electric field. Because the charge is negative, the electron rotates counterclockwise in the opposite direction to that of the electric field. The electrons continuously circulate around the inside periphery of the wormhole. Quantum theory predicts that any radiated electromagnetic energy from an accelerated electron will give off one or more discrete quanta, or photons. The electron is accelerating because it is moving in a circular path. Because the water vapor is ionized in the cavitating bubble due to shock waves, surface oscillations and high temperatures, there are huge numbers of electrons available for producing an intense light which, as registered by the photodiode, increased by an order of magnitude when the beacon rotated by the photodiode.

[0042] From gravitational physics it is known that negative energy has to be produced in order to create a wormhole. Most experimenters are using collapsing spherical bubbles that do not produce negative energy and therefore do not produce the beaconing effect. This next background section shows that if the bubble collapses asymmetrically, then negative energy is produced.

[0043] Referring to an experiment carried out by Fizeau, **FIG. 10**, water flows (B,C) in opposite directions in two tubes of water (A). A light beam from a lamp (D) is projected through both tubes using half-silvered mirrors (E). Fizeau measured an interference (F) between light propagating with the flow and light swimming against the current, indicating that the flow of the medium does affect light propagation. A moving medium turns out to drag light to an extent quantified by a dragging coefficient

$$\alpha = 1 - \frac{1}{n^2}$$

[0044] where n is the index of refraction of the medium. Einstein's addition theorem of velocities states

$$v = \frac{v' + u}{1 + \frac{v'u}{c^2}} = \frac{\frac{c}{n} + u}{1 + \frac{cu}{nc^2}} = \frac{\frac{c}{n} + u}{1 + \frac{u}{nc}}$$

[0045] In the limit of slow flows compared with the speed of light in a vacuum, the effective velocity of light v in the medium flowing at a velocity u is

$$v \approx \left(\frac{c}{n} + u\right)\left(1 - \frac{u}{nc}\right) \approx \frac{c}{n} + \alpha u$$

[0046] The relationship between cavitating bubbles and light dragging is that when the bubble collapses, the surface has a tremendous acceleration and velocity which creates internal shockwaves that bounce back and forth within the medium. At the same time, the water vapor and air are ionized which creates short bursts of light. Thus there is light that is being dragged along by the collapsing surface of the bubble. This moving medium appears to light as a change in the metric of spacetime resembling, it turns out, a gravitational field. The velocity of the medium affects the elemental length ds^2 of spacetime as given by the metric for light dragging

$$ds^2 = c^2dt^2 - dx^2 + k(c^2dt^2 - u\cdot dx)^2$$

[0047] where k is equal to

$$k = \frac{\alpha}{c^2 - u^2}$$

[0048] and dx is the elemental length in the {dx,dy,dz} directions. The velocity u in the dot product is equal to the velocities {ux,uy,uz} in the x, y and z-directions. Expanding the equation produces the following metric

$$ds^2 = (1+k)dt^2 + (ku_x^2 - 1)dx^2 + (ku_y^2 - 1)dy^2 - dz^2 - 2ku_x dx dt - 2ku_y dy dt + 2ku_x u_y dx dy$$

[0049] where velocity uz is zero and the speed of light is equal to one.

[0050] The dt^2 energy density term is modified by one plus the k factor. Thus the index of refraction of the medium, the speed of light and the overall light dragging velocity u affects the energy density. It can be shown that the speed of light in hyperspace is much lower. The difference of the squares of the velocities in the denominator creates the possibility for amplification of this term.

[0051] The factors of the elemental lengths are then inserted into the g metric tensor which is then used to calculate the spacetime distortion generated by the collaps-

ing bubble. The g metric tensor is a 4×4 matrix having rows and columns that correspond to the elemental lengths {t, x, y, z}.

$$g_{\alpha\beta} = \begin{array}{c} \\ \alpha = t \\ \alpha = x \\ \alpha = y \\ \alpha = z \end{array} \begin{array}{c} \begin{array}{cccc} \beta = t & \beta = x & \beta = y & \beta = z \end{array} \\ \begin{Vmatrix} 1+k & -ku_x & -ku_y & 0 \\ -ku_x & ku_x^2 - 1 & ku_xu_y & 0 \\ -ku_y & ku_xu_y & ku_z^2 - 1 & 0 \\ 0 & 0 & 0 & -1 \end{Vmatrix} \end{array}$$

[0052] In Einstein's General Theory of Relativity, the G curvature tensor, which is a 4×4 matrix having units of inverse meter squared, is equal to a stress-energy-momentum T tensor that is calculated from the electromagnetic fields. The stress tensor T combines energy density, electromagnetic flux, and pressure terms in one matrix.

$$G=8\pi T$$

[0053] Most of the physics constants are linear constants such as linear mass which is mass per unit length. The permittivity of space ϵ is linear capacitance or capacitance per meter. The permeability of space μ is linear inductance or inductance per meter. The speed of light converts time into meters. What this means is that energy, pressure and momentum can all be converted into meters using these linear constants. The inverse squared of the length in meters is the curvature which is measured in units of m^{-2}.

[0054] Referring to **FIG. 11**, a square bubble (A) in the xy plane collapses with a velocity in the x-direction (C), and a velocity in the y-direction (B). This produces a curvature in the vertical z-direction (D). The curvature in the z-direction is the curvature tensor component G_{zz}, which can be computed directly from the g light dragging metric tensor. The result of the calculation is an equation in terms of the velocity, acceleration and the time rate of change of the acceleration, known as jerk.

[0055] Because the profile of the bubble radius expanding and collapsing with time has been published by those researching cavitation, it is possible to differentiate the profile to get the velocity, acceleration and jerk. These equations can then be inserted into the equation for the G curvature tensor.

[0056] The radius R of the bubble depends on the air density inside the bubble ρ, the viscosity of the water μ, the pressure of the P of the environment, the surface tension σ of the water, the ratio of specific heats γ, and the velocity $\dot{R}$ and acceleration $\ddot{R}$ of the bubble radius.

$$R\ddot{R} + \frac{3}{2}\dot{R} + \frac{4\mu}{\rho}\frac{\dot{R}}{R} + \frac{2\sigma}{\rho R} + \frac{P_0}{\rho} - \left(P_0 + \frac{2\sigma}{R_0}\right)\left(\frac{R_0}{R}\right)^{3\gamma} = 0$$

[0057] Referring to **FIG. 12**, the above equation for the bubble radius is shown in the feedback simulation program. The diagram starts by solving the equation for the acceleration which is then integrated twice (1/S) to get the velocity and position. These variables are then fed back to the input through the various constants involving the viscosity, surface tension, pressure and air density. The graph at the bottom of the simulation shows the bubble radius with time.

[0058] Referring to **FIG. 13**, the bubble profile with time is reproduced from the *Scientific American* article mentioned previously. This profile was then fitted with a polynomial equation which is plotted in **FIG. 14**. By differentiating the equation, the velocity, acceleration and jerk are obtained which can then be inserted into Einstein's G curvature tensor.

[0059] Referring to **FIG. 15**, the curvature component in the vertical direction G_{zz} is plotted with respect to time. In the *Scientific American* plot, the light flash occurs at the end of the collapse marked "LIGHT FLASH" around 22 microseconds (**FIG. 13**). This corresponds to the two intense positive curvature G_{zz} spikes at the end of the collapse. This represents a symmetrical spherical bubble collapse where the velocities are the same in the x and y directions.

[0060] The energy density component G_{tt} for this symmetrical collapse is given by

$$G_{tt} = \frac{-2u_y^2a_x^2 + 4u_xu_ya_xa_y - 2u_x^2a_y^2}{4(u_x^2 + u_y^2 - 2)}$$

[0061] Looking at this carefully, notice that if the velocity in the x-direction u_x is equal to the velocity in the y-direction u_y, and the acceleration in the x-direction a_x is equal to the acceleration in the y-direction, then the equation reduces to zero.

$$G_{tt} = \frac{-2u^2a^2 + 4u^2a^2 - 2u^2a^2}{8(u^2 - 1)} = 0$$

[0062] which means that the symmetrical collapse with equal velocities does not produce any negative energy with which to create the wormhole. Only sharp pulses of light are emitted at the end of the bubble collapse where the intense positive curvature spikes are encountered. In order to get the rotating wormhole beaconing effect, the velocities have to be different.

[0063] Referring to **FIG. 16**, the bubble is given an asymmetrical profile as shown by the two curves. The upper curve is in the x-direction, and the lower curve is in the y-direction. The collapse in the y-direction is not as severe.

[0064] Referring to **FIG. 17**, the asymmetrical collapse has the curvature spikes at the beginning similar to the symmetrical case of **FIG. 15**. Notice that there are no spikes at the end of the collapse. However, the energy density is much different.

[0065] Referring to **FIG. 18**, the energy density G_{tt} is plotted as a function of time. Rather than being zero as in the symmetrical case, there is a large region of negative energy density as the bubble collapses. This negative energy is what creates the wormhole. Because there are no large curvature spikes at the end of the collapse, the wormhole bubble is stable and precesses for a few minutes.

[0066] Experiments with the pendulum show that some people have much larger auras than others. The pendulum swings over the entire hand. One particular person who has enormous vortices was working in a television repair shop. When a television set is brought in to the shop, the large capacitor has to be discharged first. The repairman with the large chakra vortices was standing behind a second repairman who was approaching the television set. As the second repairman got closer to the set, an enormous streaming blue spark sailed over his head and zapped the first technician. Hyperspace has a much higher permittivity than our spacetime. The resistance of space R is equal to the square root of the permeability μ over the permittivity ϵ.

$$R = \sqrt{\frac{\mu}{\varepsilon}}$$

[0067] Since the technician with the large chakra vortices was producing large quantities of hyperspace energy, his resistance was very much lower due to his larger permittivity. The spark grounded on his body. The free electrons, which are created by ionization of the hydrogen atoms of the water vapor, see a very low path of resistance and flow toward the wormhole. There they are trapped in accelerated motion due to the presence of the circular electric field and give off substantial numbers of photons which produces the beaconing lighthouse effect.

[0068] The elemental length ds^2 in cylindrical coordinates {t, r, θ, z} for a mass M is given by

$$ds^2 = -\frac{dt^2}{1-\frac{M}{r}} + \left(1-\frac{M}{r}\right)dr^2 + r^2 d\theta^2 + dz^2$$

[0069] The mass M distorts the radius r of the elemental length which is what gives the mass a curvature or gravitational field. Negative energy, which is produced at the end of the bubble collapse, is equal to a negative mass times the speed of light squared. Thus mass M in the equation goes to negative mass, or M→−M. Furthermore, negative energy inverts the mass factor so that the metric becomes

$$ds^2 = -\left(1+\frac{M}{r}\right)dt^2 + \frac{dr^2}{1+\frac{M}{r}} + r^2 d\theta^2 + dz^2$$

[0070] The g metric tensor contains the factors of the elemental lengths along the matrix diagonal

$$g_{\alpha\beta} = \begin{Vmatrix} -\left(1+\frac{M}{r}\right) & 0 & 0 & 0 \\ 0 & \frac{1}{1+\frac{M}{r}} & 0 & 0 \\ 0 & 0 & r^2 & 0 \\ 0 & 0 & 0 & 1 \end{Vmatrix}$$

[0071] As before, Einstein's G curvature tensor in the radial G_{rr}, angular $G_{\theta\theta}$, and vertical z-direction G_{zz} is calculated from this negative energy g metric tensor.

[0072] Referring to the 3D G curvature plot in **FIG. 19**, the strength of the curvature is given by the length of the arrow, and the direction of the curvature is given by the arrow. The curvature in the radial direction G_{rr} is along the bottom axis from the box corner origin to the right. The curvature in the angular direction $G_{\theta\theta}$ is the bottom axis from the origin to the left. The height of the box is the curvature in the vertical direction G_{zz}. Notice in general that the curvature is perpendicular to the left face (θz-plane) and then starts to curve to the right and begins to point toward the right face (rz-plane). On the bottom face (rθ-plane) there is an upward vertical curvature.

[0073] In cylindrical coordinates, the θz-plane is actually a vertical tube of radius r. So at small r, the curvature is perpendicular to the tube. At larger radius, the curvature starts to point in the θ-direction, wrapping around the tube. At small radius, there is also a vertical curvature parallel to the sides of the tube.

[0074] Referring to **FIG. 20**, the curvature in cylindrical coordinates is seen to be the structure of the wormhole. The wormhole (A) is formed due to the radial pressure (B) which pulls open the wormhole. One end of the tube connects to hyperspace, and the other end connects to our spacetime. There is also a shearing pressure (D) along the sides of the tube which slices spacetime open and helps shape the tube. Moving outward along the radius, the curvature turns sideways and produces a shearing pressure (D) in the θ-direction which gives the wormhole a vortex appearance. These wormholes can also be very large, enabling one to peer into a co-dimension as attested to by the inventor.

SUMMARY OF THE INVENTION

[0075] As described in the previous section, the cavitating bubble has to collapse asymmetrically in order to generate the negative energy which creates the wormhole. In order to collapse asymmetrically, the forces on the bubble surface have to be unequal. The force on the bubble is given in terms of the a dragging coefficient, the bubble radius R, the surface charge density D_r, the magnetic B field in spherical coordinates $\{B_r, B_\theta, B_\phi\}$. The fields are integrated over the entire solid angle Ω of the bubble to determine the force F.

$$F_r = -\left(1-\frac{1}{n^2}\right)\frac{R^2}{2}\oint d\Omega\left[\left(1+\frac{1}{n^2}\right)(D_r^2 + B_r^2 - B_\theta^2 - B_\phi^2)\right]$$

[0076] The integration of the tangential components of the magnetic field such as $\{B_\theta, B_\phi\}$ over the solid angle of the bubble will sum to zero. The surface charge density D_r and the radial magnetic field B_r are the only fields which can be used to create an unbalanced force. If there is no surface charge density, then the force equation reduces to

$$F_r = -\alpha \frac{R^2}{2} \oint d\Omega \left[(2-\alpha) \left(\frac{\chi^2}{\Omega_m} B_r^2 \right) \right]$$

[0077] where the conversion constant is the linear charge squared divided by the linear mass of the universe χ^2/Ω_m.

[0078] In this invention, referring to **FIG. 21**, the magnetic field is created by two cylindrical solenoids (A,B) which are wrapped around the top and bottom of the glass container (C). The container has flat sides in the shape of an octagon. Each solenoid consists of a continuous roll of very thin sheet copper which are separated by beaded mylar line. The mylar beads separate the sheets electrically and provide air cooling to the coil which can get rather hot. This makes it easy to assemble the coil because the copper roll and mylar line are wound together as the solenoid is formed. The lines of magnetic flux flow vertically through the container yet do not interfere with the transducers (D) which are mounted on the flat sides of the container.

[0079] Referring to **FIG. 22**, the cavitating bubble which forms in the liquid in the container experiences a vertical magnetic field (B) due to the two solenoids. These flux lines create a radial force on the top and bottom of the bubble (D,C). The flux lines on the outside (E) do not create any radial force because they are tangential to the surface. The spherical bubble flattens into an asymmetrical ellipsoidal shape (A) which enables the creation of the wormhole and lighthouse beaconing effect.

[0080] Referring to **FIG. 23**, the spacetime curvature of the wormhole (D) creates a tunnel (C), known as the throat of the wormhole, between flat space in our universe (A) and flat hyperspace (B) which exists in a co-dimension of our universe. In general, the co-dimensions have different physics constants. Going back to the chakra vortices of the human energy field, the vortices remove energy from space and deliver it to several hyperspace co-dimensions. This energy builds up human aura modules at different frequencies in astral space. Astral space has a very low speed of light and small linear mass. This is the reason that human beings can leave their bodies and pass through solid concrete walls, or project their spiritual eye to remote locations for viewing. On the other hand, the linear mass and speed of light of space is very much greater than hyperspace. Therefore, the pressure of the space is much greater than the pressure in hyperspace. In terms of the wormhole with a throat area A, the pressure would be the linear mass times the speed of light squared over the area

$$P_{space} = \frac{\Omega_s c_s^2}{A}$$

[0081] The pressure of hyperspace on the other side of the wormhole is

$$P_{hyperspace} = \frac{\Omega_h c_h^2}{A}$$

[0082] Because the linear mass and the speed of light of hyperspace are lower than that of space, there is a positive net pressure going into hyperspace.

$$P_{net} = P_{space} - P_{hyperspace}$$

[0083] This is the reason that the human vortices can obtain energy from this universe. Because the cavitating bubble produces negative energy, the linear mass is negative on the side of space. The pressure equation is then given by

$$P_{net} = -\frac{P_s}{A} - \frac{P_h}{A} = -\frac{P_s + P_h}{A}$$

[0084] which shows that there is a reverse pressure going from hyperspace into our space. The asymmetrical cavitating bubble generates hyperspace energy. The hyperspace energy flowing into our universe also gives the light generated by the wormhole a soft white misty look.

[0085] There are many reasons for generating this hyperspace energy. Electromagnetic fields are subject to the Lorentz transformation which involves comparing the frame velocity with that of the velocity of light.

$$E' = \frac{E}{\sqrt{1 - \frac{v^2}{c^2}}}$$

[0086] If the ratio of the velocity v to the velocity of light c is close to unity, then huge relativistic fields can be produced. These fields can curve spacetime to such an extent that a large lift force can be produced on the hull of an electromagnetic field propulsion vehicle.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0087] Not Applicable.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0088] **FIG. 1**. Rotating cylinder demonstrating additional lift force.

[0089] **FIG. 2**. Use of the pendulum.

[0090] **FIG. 3**. The Ascension Machine, Chakra Vortex Accelerator.

[0091] **FIG. 4**. Hyperspace energy brought into body by rotation of hand chakra.

[0092] **FIG. 5**. Antigravitational effect using low density hyperspace energy.

[0093] **FIG. 6**. Sonoluminescence experiment.

[0094] **FIG. 7**. Tetrahedron diagram showing hyperspace charge.

[0095] **FIG. 8**. Magnetic monopole.

[0096] **FIG. 9**. Precessing wormhole.

[0097] **FIG. 10**. Fizeau light dragging experiment.

[0098] **FIG. 11**. Asymmetrical velocity collapse of bubble radius generates wormhole.

[0099] **FIG. 12**. VisSim feedback simulation of the collapsing bubble.

[0100] **FIG. 13**. Cavitating bubble radius as a function of time.

[0101] **FIG. 14**. Digitized bubble radius of **FIG. 13**.

[0102] **FIG. 15**. Spiking spacetime curvature of collapsing bubble.

[0103] **FIG. 16**. Dual velocity profile required to produce negative energy.

[0104] **FIG. 17**. Spacetime curvature for dual velocity collapse.

[0105] **FIG. 18**. Negative energy generated from asymmetrical collapse of bubble.

[0106] **FIG. 19**. 3D plot of spacetime curvature using negative energy.

[0107] **FIG. 20**. Wormhole vortex.

[0108] **FIG. 21**. Perspective of cavitation tank equipped with magnetic coils.

[0109] **FIG. 22**. Flattening of bubble by magnetic field.

[0110] **FIG. 23**. Hyperspace energy generated by reverse pressure gradient of wormhole.

[0111] **FIG. 24**. Solenoid and transducer driving circuits.

DETAILED DESCRIPTION OF THE INVENTION

[0112] 1. Referring to **FIG. 24**, the transducer driving circuit uses a frequency generator (A) driving a linear amplifier (B) into a pair of variable inductors (C) which resonate with the capacitance of the transducers (D) attached to the sides of the octagonally-shaped glass container (H). Resistors (L,M,G) provides voltage measuring points for the oscilloscope.

[0113] A DC current source (I) drives the two solenoids (E,F) which produce a vertical magnetic field (J) through the container. The magnetic field produces an asynmetrical force on the bubble surface (K) such that the collapsing bubble produces negative energy. The spacetime curvature produced by the light dragging of the collapsing bubble surface, together with the negative energy, create a wormhole between space and hyperspace. The negative spacetime energy produces a negative pressure which brings low-density hyperspace energy into our dimension.

I claim:

1. A hyperspace energy generator having:

a) a glass container in the shape of an octagon acting as the resonating chamber;

b) two piezoelectric transducers, mounted and operating acoustically as a pair on opposite sides of item (1a);

c) an opaque oil-like liquid with a high index of refraction filling item (1a) acting as the resonating liquid in which the cavitating bubbles are formed;

d) two thin sheet copper solenoids, located on top and bottom of item (1a), that produce a vertical magnetic field through items (1a) and (1c);

e) two variable inductance coils for creating a resonant frequency with item (1b);

f) a linear amplifier driving items (1b) and (1e);

g) a variable frequency generator driving item (1e);

h) a direct current electrical generator driving item (1d);

2. a cavitation system which:

a) produces one or more cavitating bubbles that collapse asymmetrically due to the differential force exerted on the bubble surface by the presence of a vertical magnetic field generated by item (1d) referred to above;

b) generates negative energy due to light dragging of the collapsing bubble surface;

c) creates wormholes between space and hyperspace due to the presence of item (1b);

d) generates a negative pressure between space and hyperspace that forces low-density hyperspace energy into our dimension; and

3. optional dual electrically-charged plates that:

a) are mounted on the sides of item (1a);

b) create a differential electric charge density across the bubble surface for the purpose of creating an additional method of asymmetrical bubble surface collapse.

* * * * *

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(54) ROTATING ELECTROSTATIC PROPULSION SYSTEM

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(52) **U.S. Cl.** **244/172**

(57) **ABSTRACT**

This invention relates to a spacecraft propulsion system utilizing thrusters comprised of a motor-driven electrostatically charged cylinder rotating within an electrostatically charged annular ring for the purpose of creating a spacetime curvature stress-energy tension in the horizontal direction. The thrusters are augmented by magnetic vortex generators, either embedded in the cylinders or located above each thruster, for the purpose of increasing the permittivity of space by permeating each thruster with low density hyperspace energy generated by a wormhole created between our space and hyperspace. A combination of three thrusters mounted on the underside of the hull of the spacecraft provide thrust and yaw motion control.

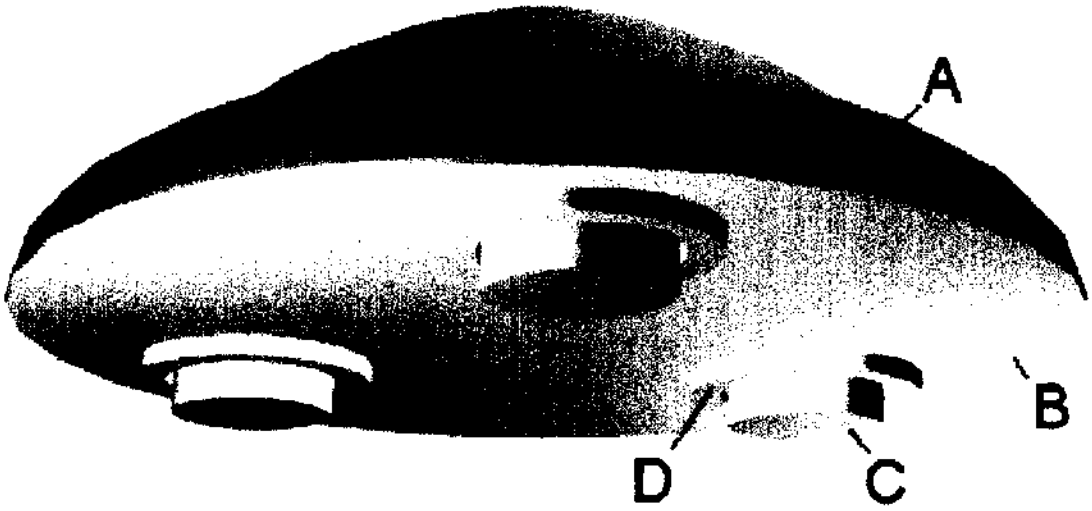

Figure 1

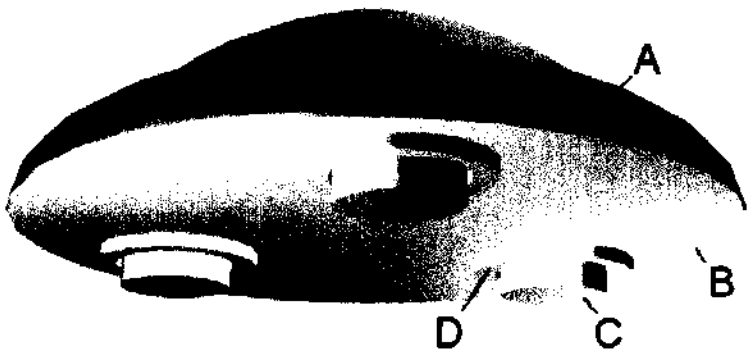

Figure 2

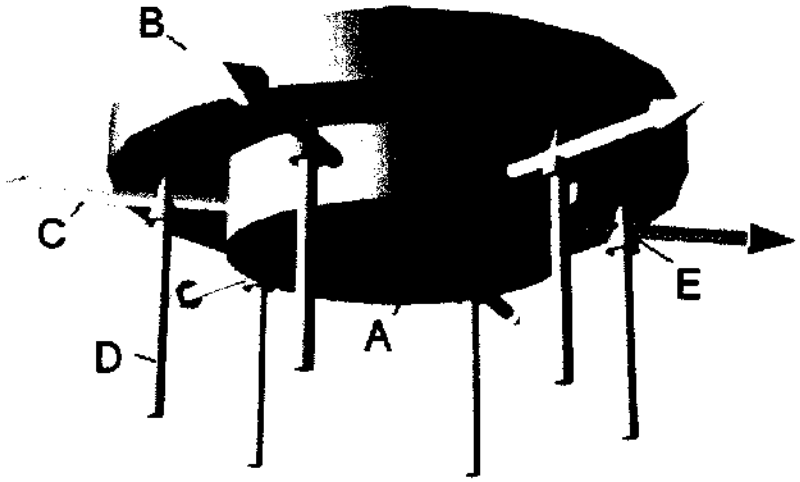

Figure 3

$$T^{zr} = -\frac{\varepsilon_0}{\Omega c^2}\frac{E_z E_r}{4\pi} = \frac{\text{coul}^2}{\text{m}^2\text{n}}\frac{\text{n}}{\text{coul}}\frac{\text{n}}{\text{coul}}\frac{\text{m}}{\text{kg}}\frac{\text{s}^2}{\text{m}^2} = -\frac{\text{kg m}}{\text{s}^2}\frac{\text{s}^2}{\text{kg m}^3} = \frac{-1}{\text{m}^2}$$

Figure 4

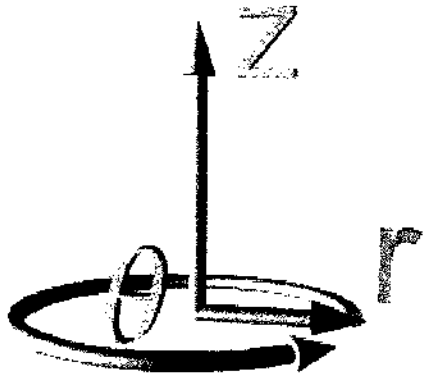

Figure 5

$$F^{\alpha}{}_{\beta} = \begin{array}{c} t \\ r \\ \theta \\ z \end{array} \begin{vmatrix} 0 & E_r & 0 & E_z \\ E_r & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ E_z & 0 & 0 & 0 \end{vmatrix}$$

Figure 6

$$T^{zr} = -\frac{E_r E_z}{4\pi}$$

Figure 7

$$\frac{d}{dt} S_r = \varepsilon_0 \, \varepsilon_{r\,t\,z} x^t T^{zr} n_r \mathrm{Area} = \varepsilon_0 \, t \frac{E_r E_z}{4\pi} n_r \mathrm{Area}$$

Figure 8

$$\frac{\mathrm{coul}^2}{\mathrm{m}^2\,\mathrm{n}} \sec \frac{\mathrm{n}}{\mathrm{coul}} \frac{\mathrm{n}}{\mathrm{coul}} \mathrm{m}^2 = \mathrm{kg} \frac{\mathrm{m}}{\sec^2} \sec = \mathrm{kg} \frac{\mathrm{m}}{\sec}$$

Figure 9

$$\frac{d}{dt} S_{r,t} = \frac{\varepsilon_0}{4\pi} e^{i\omega t} E_r E_z \,\mathrm{area} + \frac{i\varepsilon_0}{4\pi} e^{i\omega t} E_r E_z t \omega \,\mathrm{area}$$

Figure 10

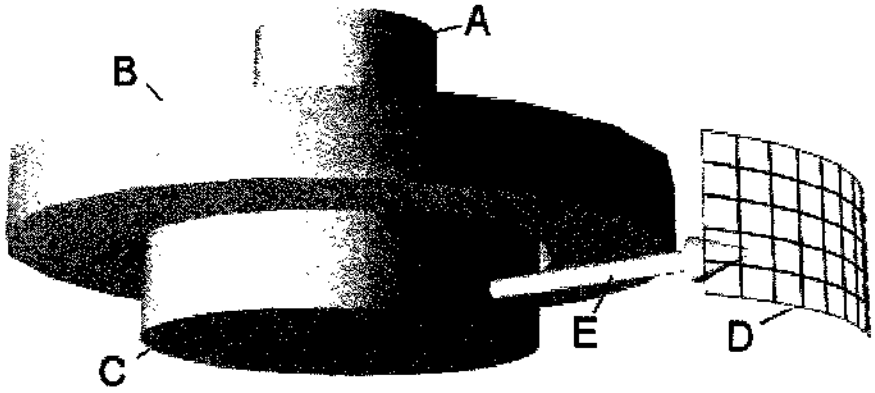

Figure 11

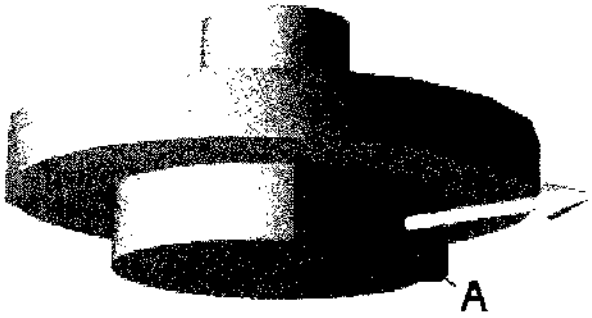

Figure 12

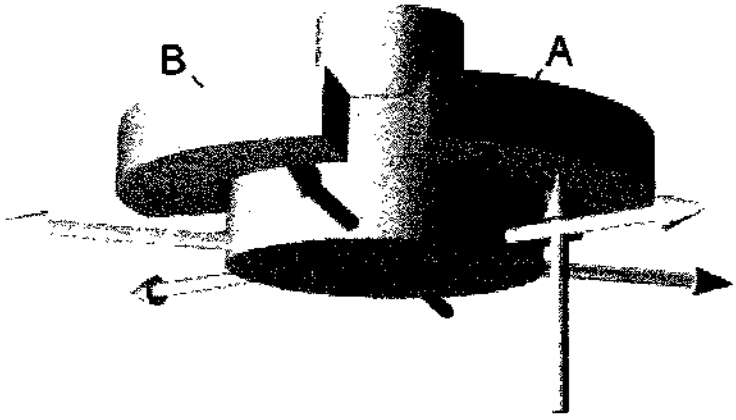

ROTATING ELECTROSTATIC PROPULSION SYSTEM

BRIEF SUMMARY OF THE INVENTION

[0001] The invention, which is the object of my present application, is a spacecraft propulsion system which develops a spacetime curvature tension utilizing a combination of a rotating radial electrostatic field and a fixed vertical electrostatic field. The two fields create a stress-energy T^{zr} gradient in the radially direction which is equal to force. The radial field is created on the side of a charged rotating cylinder on the underside of the hull. The vertical field is created by an annular charged ring concentric with the cylinder. Three rotating cylinders are located in a triangle on the bottom of the hull in order to produce a force in any direction in the horizontal plane.

REFERENCE PAPERS

[0002] *Gravitation*, Wheeler, page 80.

BACKGROUND OF THE INVENTION

[0003] When working with Maxwell's equations in tensor notation, it became apparent that a tensor can change identity depending on what permutation of variables is involved. For example, one single equation can involve both charge density and current density. And all of Maxwell's equations can be reduced to just two equations.

[0004] In the tensor equation for momentum, if the lever arm is length then the equation is equal to the flow rate of angular momentum. If the lever arm is time, then you get linear momentum. And if the field rotates with time, then the time rate of change of linear momentum is a force which is the basis for this invention.

[0005] Einstein said that mass curves space and space tells mass how to move. In this sense, generalized mass can be mass, electromagnetic fields, charge or angular momentum which create a spacetime curvature that produces a force on the spacecraft.

SUMMARY OF THE INVENTION

[0006] The invention relates to a spacecraft utilizing a rotating electrostatically charged cylinder and a concentric annular charged ring to create a stress-energy spacetime curvature in the horizontal plane on the spacecraft's underside hull. A motor drives the rotating cylinder which extends below the hull. A charged surface produces an electric field in the direction normal to the surface. The vertical and rotating electric fields combine to create a rate of change of linear momentum which creates a horizontal propulsive force on the hull.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0007] Not Applicable.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1**. Perspective view of spacecraft hull (A) with the three electrostatically charged rotating cylinders (C) surrounded by their annular charge rings (D) extending down on the underside of the hull (B).

[0009] **FIG. 2**. Perspective view of individual thruster showing rotating cylinder and ring.

[0010] **FIG. 3**. Stress-energy tension created by two electric fields and having units of curvature.

[0011] **FIG. 4**. Cylindrical spacetime coordinates {t, r, θ, Z}.

[0012] **FIG. 5**. Faraday electromagnetic F tensor containing electric fields in the radial and vertical directions.

[0013] **FIG. 6**. Stress-energy tensor **T** showing it is equal to the product of the two electric fields divided by 4π.

[0014] **FIG. 7**. The tensor equation for flow rate of angular momentum S.

[0015] **FIG. 8**. The units are linear momentum due to the time lever arm.

[0016] **FIG. 9**. The rate of change of linear momentum is the horizontal force produced by the two electric fields.

[0017] **FIG. 10**. The angular momentum flows through an area whose normal vector is in the radial direction.

[0018] **FIG. 11**. Cylinder with only one electrostatically charged segment.

[0019] **FIG. 12**. Annular ring with three individual segments which can be charged separately to create a force in a particular direction.

DETAILED DESCRIPTION OF THE INVENTION

[0020] 1. Referring to **FIG. 1**, the spacecraft comprises an upper hull (A) with three rotating electrostatically charged cylinders (C) with their concentric annular electrostatically charged rings (D) located on the spacecraft's bottom hull (B).

[0021] 2. In a closer view of one of the cylinders seen in **FIG. 2**, motor-driven rotating cylinder (A) has an electrostatically charged surface which produces an electric field (C) normal to said surface. The fixed, electrostatically charged annular ring (B), which is concentric with the cylinder, produces a vertical electric field (D) normal to its surface. This crossed field (E) creates a negative spacetime curvature tension which is the product of the two fields divided by 4π as seen in the equation, **FIG. 3**.

[0022] 3. Notice that the equation involves the permittivity of space ϵ_0 divided by the linear mass of the universe Ω and the speed of light. This produces units of inverse meter squared which is the spacetime curvature. In Einstein's General Theory of Relativity, the spacetime curvature tensor is equal to the stress-energy tensor or $G=8\pi T$ where G is the curvature, and T is the product of the electromagnetic fields. The problem with this equation, which has been resolved with this invention, is that the linear mass Ω times the speed of light c is an enormous number. Even with the square of enormous electric fields, the curvature would be too small even to notice, and little force would be generated.

[0023] 4. In another patent application of mine entitled Magnetic Vortex Generator, it was shown that a rotating

cylinder containing embedded and stacked bar magnets produces a negative mass and negative spacetime spring constant. It can be shown that this combination produces a small wormhole or interdimensional connection between our space and hyperspace along the centerline of the rotating cylinder. Co-dimensions of hyperspace have different physics constants. A low pressure region of hyperspace has a very low mass density and a very low speed of light. The wormhole allows this low density hyperspace energy to enter into our space and permeate the cylinder and annular ring. The permittivity is proportional to the inverse of the speed of light squared. The hyperspace speed of light, obtained from my tetrahedron physics diagram, is 8971 meters per second. The speed of light in our dimension is 299792458 meters per second. As shown by the enclosed reference calculation, the hyperspace permittivity is about a trillion times larger. Because the force is equal to this new permittivity times the electric fields squared times the area around cylinder, the force is greatly amplified by this increase in the permittivity of space.

[0024] 5. It is pertinent to this invention how the stress-energy is created due to the two electric fields in the vertical and radial direction. In gravitational physics, there is a Faraday F tensor which contains all the components of the electromagnetic fields. It is a 4 by 4 matrix whose rows and columns correspond to the coordinates of spacetime which in cylindrical coordinates are {t, r, θ, z} where t is time, r the radius, theta the horizontal angle and z the vertical height. These coordinates are shown in **FIG. 4**.

[0025] 6. The radial electric E_r field and the vertical electric E_z field can be inserted into the Faraday tensor seen in **FIG. 5**. The sign of the vertical field is positive because it points in the positive z-direction due to the fact that the annular ring has a negative charge. The cylinder has a positive charge. This produces the negative stress-energy tensor T^{zr} as drawn in **FIG. 6**.

[0026] 7. In order to calculate the force on the cylinder, it is necessary to calculate the flow rate of angular momentum. Momentum is mass times velocity or mass meter per second. If the mass is moving in a circle, then there is a lever arm times the momentum which makes it mass meter squared per second. If this is differentiated with respect to time, then a flow rate of angular momentum is produced with units of mass meter squared per second squared. As mentioned previously, tensors have this dual nature where depending on the permutation of the variables, it means one thing or another. In this case, the lever arm will be time, rather than length which converts the flow rate of angular momentum into just linear momentum. If you change linear momentum with respect to time, then you get a force.

[0027] 8. The flow rate of angular momentum S is shown in **FIG. 7**. The force has to be against the area whose normal vector is in the radial direction which is also the direction of the momentum. So S has an r subscript indicating that it flows in the radial direction. The permutation tensor ϵ has three subscripts which keeps track of the tensor notation. The first subscript is the same as the momentum subscript. Permutations of the coordinate variables which are in order have a plus one sign. Permutations which are in reverse order have a minus one sign. Permutations in which the variable are repeated are zero. For example, $\epsilon_{tr\theta z}=-\epsilon_{rt\theta z}$ because the r and t are in reverse order in cylindrical coordinates. Because the permutation tensor starts with r, then we can have permutations such as {r,t,z} which is a reverse order negative permutation. This negative sign cancels the negative sign of the stress tensor. The reason this permutation is chosen is because the first subscript on the stress-energy tensor is now z. Because the normal to the area is in the radial direction, then the stress-tensor matches the electric fields that we have available, which are also in the zr-direction.

[0028] 9. In this case, the second subscript of the permutation tensor is time, rather than length. So the units become, as shown in **FIG. 8**, those of linear momentum. To me, this was very surprising. Then I realized that the radial electric field rotates with time which means the differential of the linear momentum produces a force on the hull. In exponential notation, the radial electric field rotates with Exp[iωt]. This is multiplied by the time lever arm, so the term that has to be differentiated is $t\,e^{i\omega t}$. The time lever arm saves the differentiation by making one term real so that the force is real. This is shown in **FIG. 9**. The units of the first term are real newtons. In the second term, the time t multiplied by the frequency cancels out in terms of units, so the units are still force, but imaginary

[0029] 10. There is an area involved in the force equation which is depicted in **FIG. 10**. The charged rotating cylinder (C) located inside the charged annular ring (B) is driven by motor (A). The radial electric field (E) is normal to the area (D) whose normal vector is also in the radial direction. The angular momentum flows through this area which surrounds the cylinder. In doing so, it curves spacetime which produces the force.

[0030] 11. If the radial electric field is continuous around the cylinder, then the net force is zero. Referring to **FIG. 11**, one section (A) of the rotating cylinder is charged, which means that there is a force once per cycle in a selected direction depending on when the annular ring is charged. The other option, referring to **FIG. 12**, is that the annular ring is divided up into two or three sections with the feature that the charge can be turned on (A) or off (B) on a particular segment. As the rotating electric field goes around, one of the annular ring sections will have an electric field in order create a force on that side.

[0031] 12. Since there are three force cylinders, this allows for yaw motion control so that the hull of the spacecraft can pivot to change direction. After the directional change, the two back cylinders can be synchronized to produce thrust in the forward direction.

[0032] 13. There could also be a polarity change for the vertical electric field such that a positive stress-energy is produced which would reverse the direction of the thrust.

What I claim as my invention is:

1. A spacecraft propulsion system utilizing three electrostatically charged motor-driven cylinders each one of which rotates within a charged annular ring to produce a spacetime stress curvature tension in the horizontal plane on the underside of the hull.

2. Said rotating cylinder comprised of bar magnets embedded in the cylinder and stacked in groups at intervals around the periphery of the cylinder with the purpose of increasing the permittivity of space by permeating the cylinder and ring with low linear mass, low speed of light hyperspace energy by means of a wormhole between our space and hyperspace. The larger permittivity is to increase the force. Said technique is contained in my patent applications Magnetic Vortex Wormhole Generator and Magnetic Vortex Generator.

3. Said rotating cylinder and annular ring having a suitable metal surface for forming and maintaining the electrostatic charge.

4. Said rotating cylinder having one or more segments which can be electrostatically charged individually or together to produce a force in a particular direction.

5. Said annular ring having one or more segments which can be electrostatically charged individually or together to produce a force in a particular direction.

6. A combination of three such thrusters providing a force in any particular direction or for yaw motion control.

7. Electric polarity switching of the fields in order to reverse the spacetime curvature and therefore change the direction of thrust.

8. The use of a magnetic vortex generator located above each thruster in order to permeate the cylinders and rings with low density hyperspace energy which would substitute for the embedded magnets in each cylinder.

* * * * *

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St. Clair

(54) REMOTE VIEWING AMPLIFIER

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(52) **U.S. Cl.** **359/896**; 359/894

(57) **ABSTRACT**

An apparatus which enhances the ability of a person to perform remote viewing by connecting the human spiritual eye to the tetrahedral geometry of subspace.

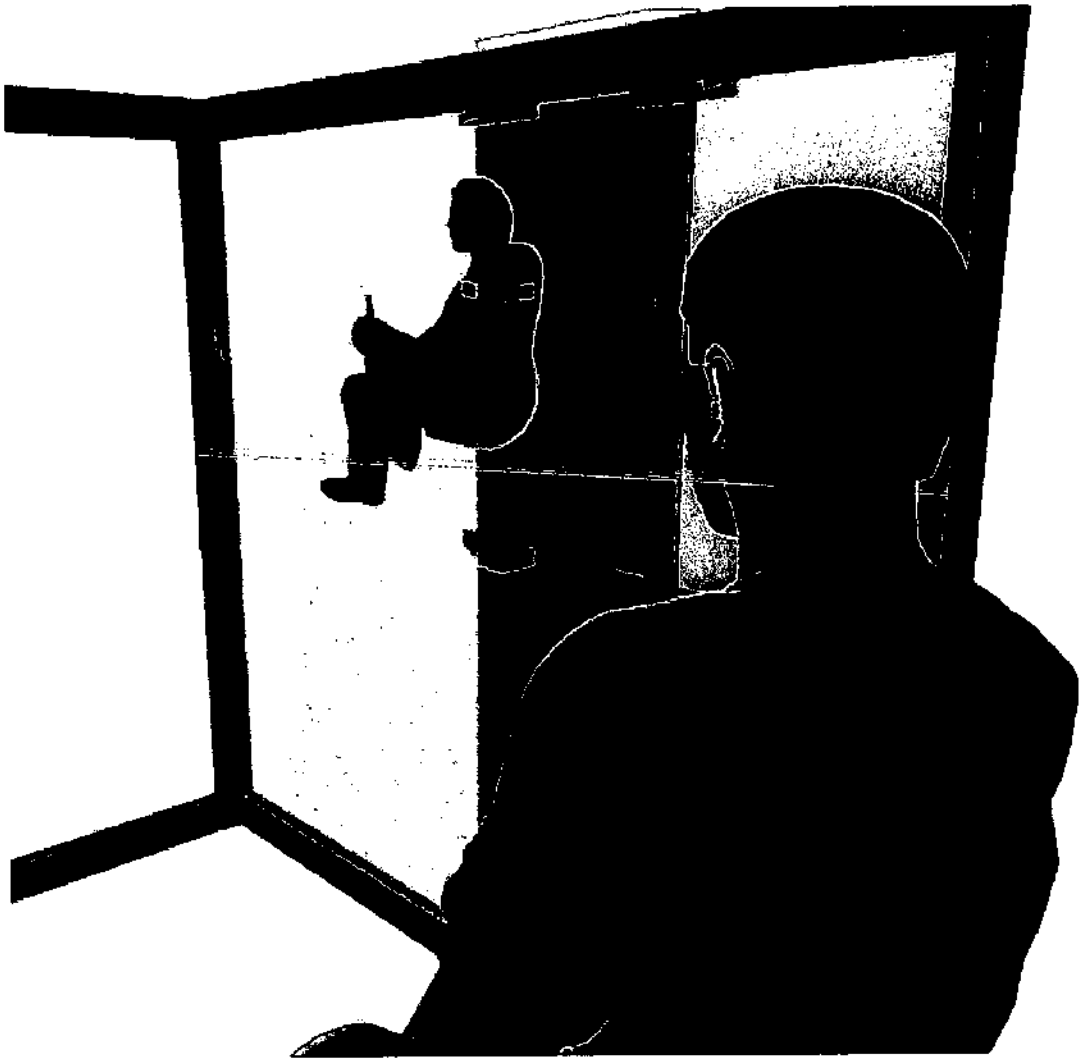

Figure 1

Figure 2

Figure 3

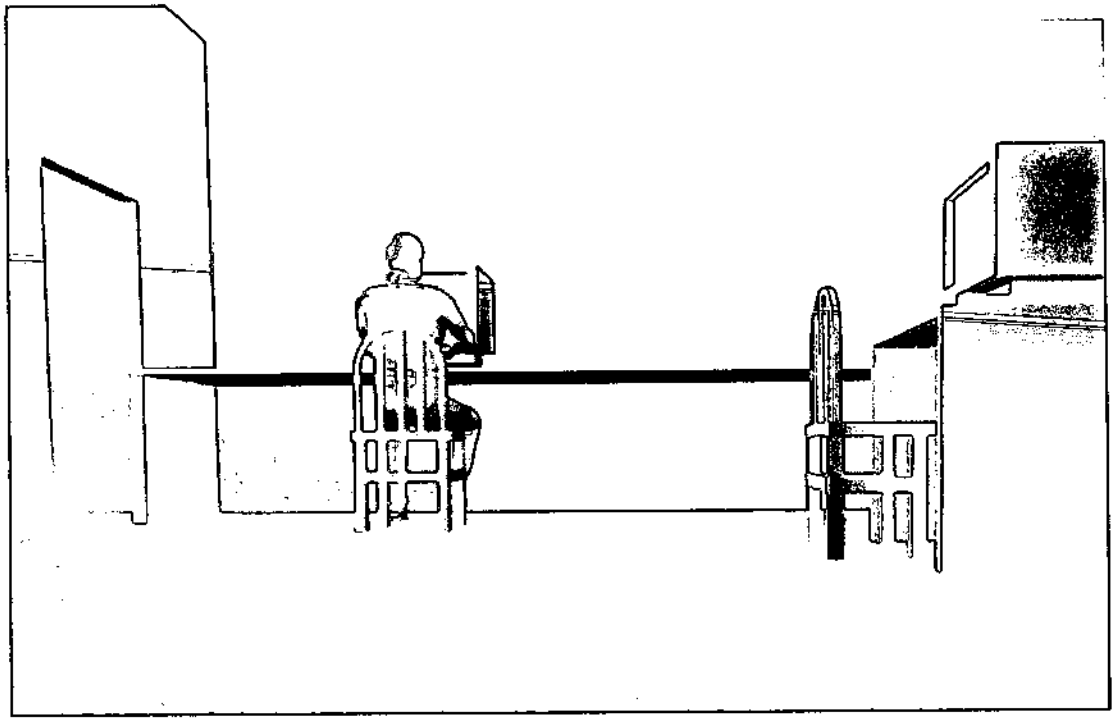

Figure 4

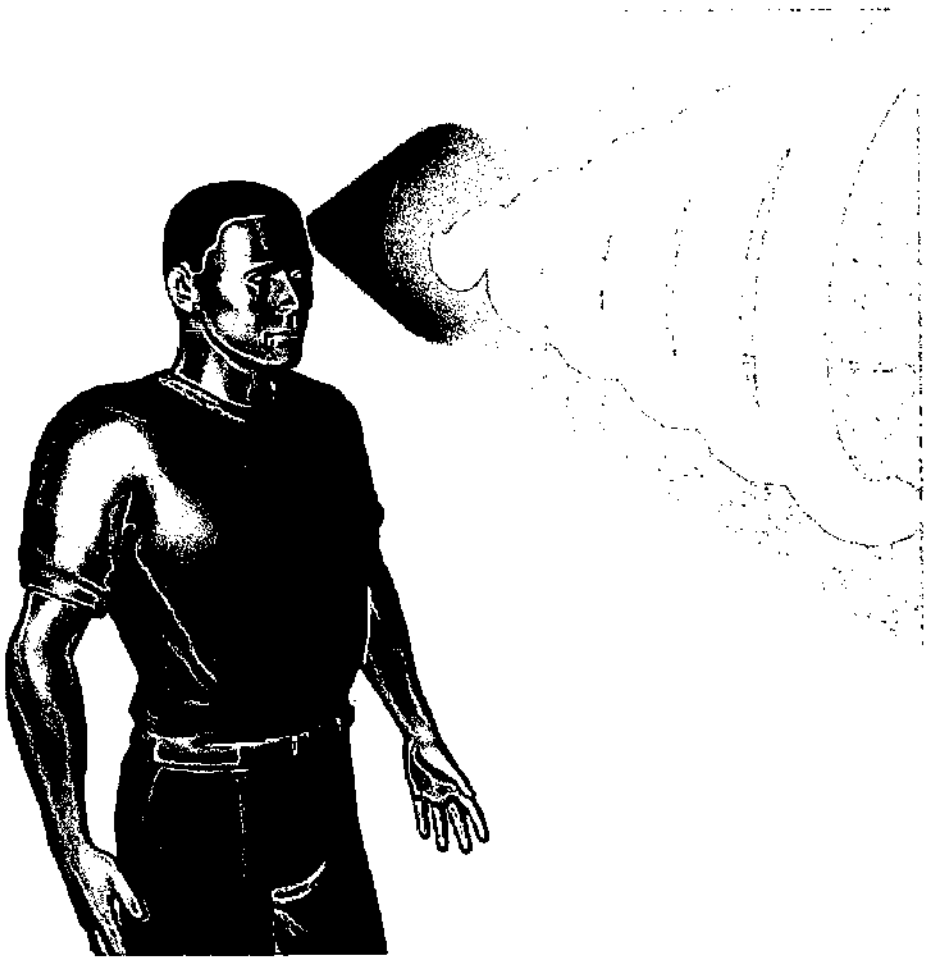

Figure 5

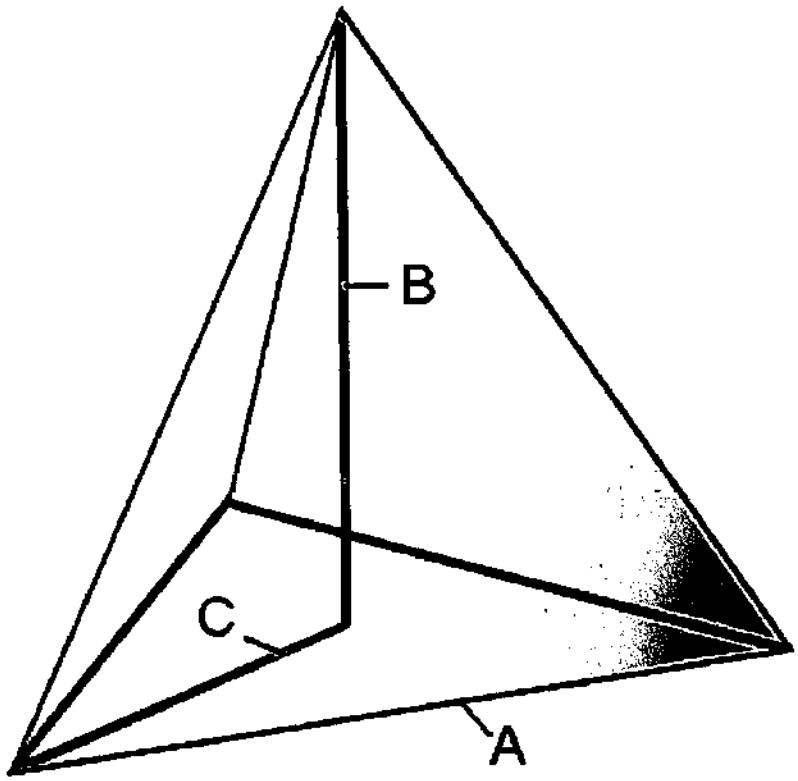

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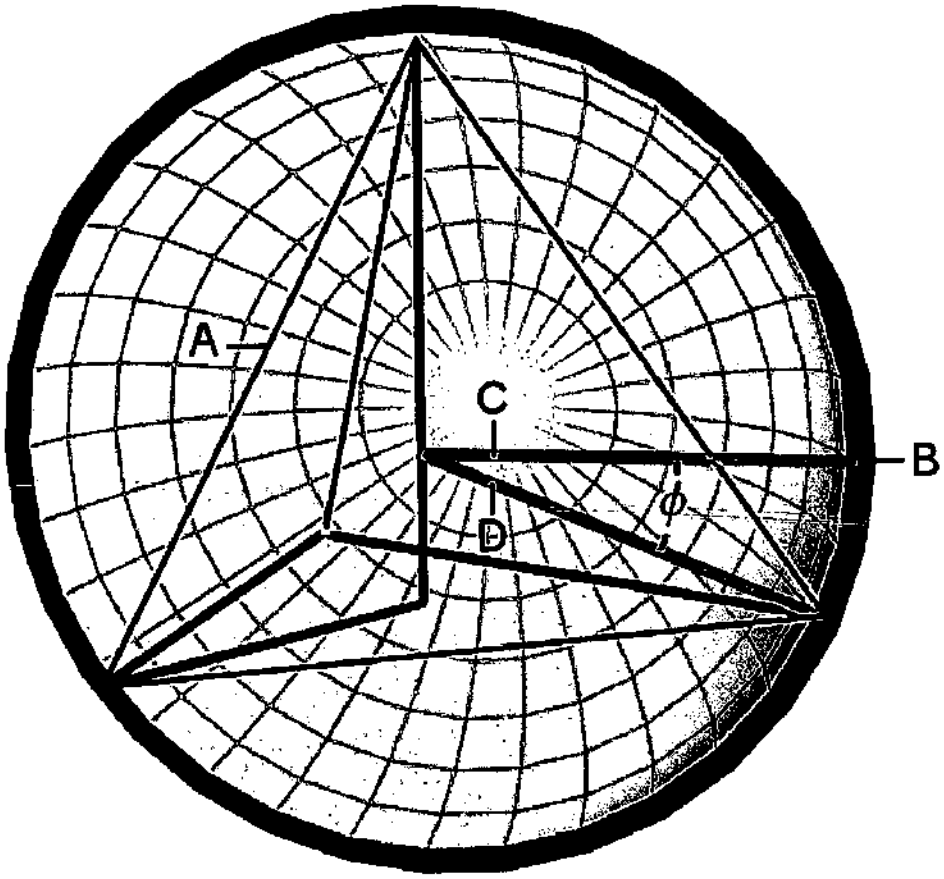

Figure 7

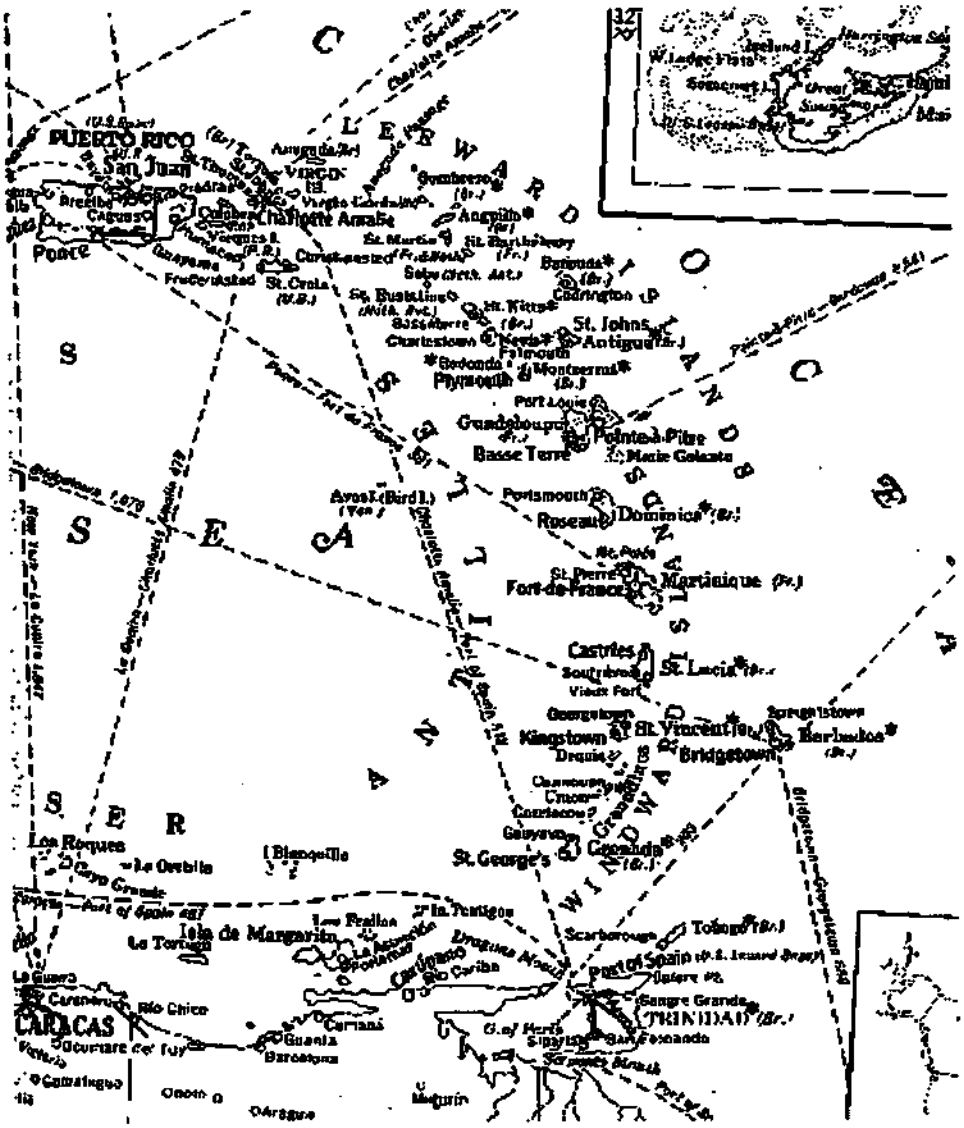
PUERTO RICO
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Quito
Guayaquil
Manta
Esmeraldas
Machala
Loja
Cuenca
Ambato
Riobamba
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Ibarra
Tulcán
Puerto Bolívar
Puerto Ayacucho
Puerto Cabello
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Figure 8

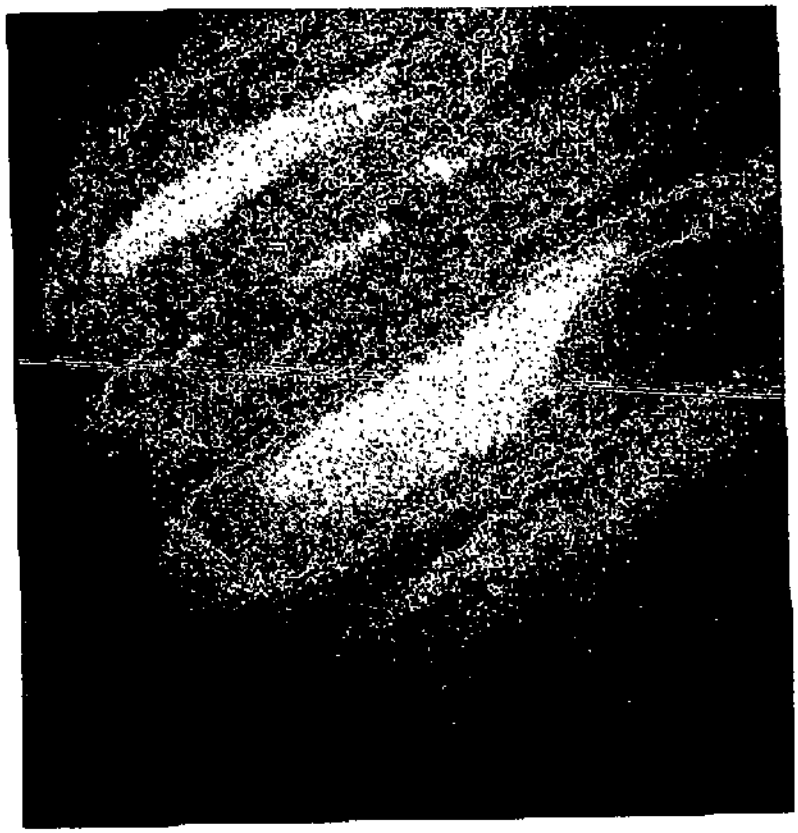

Figure 9

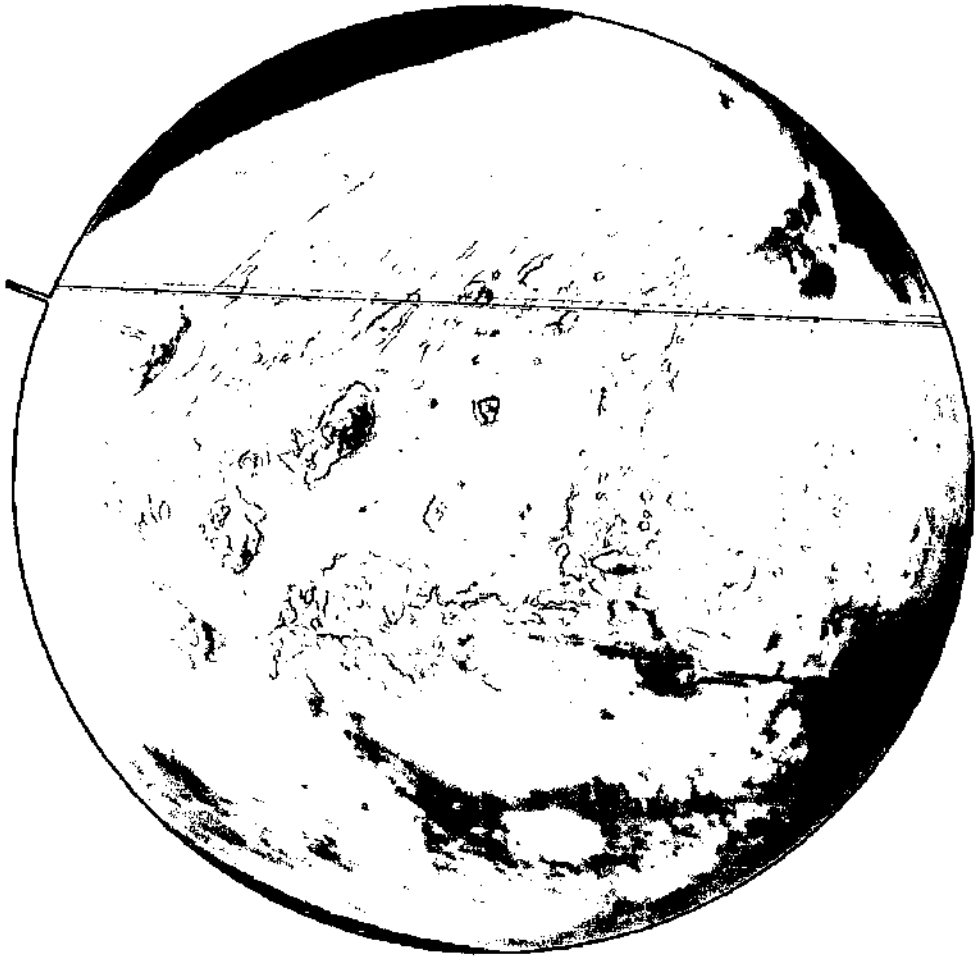

Figure 10

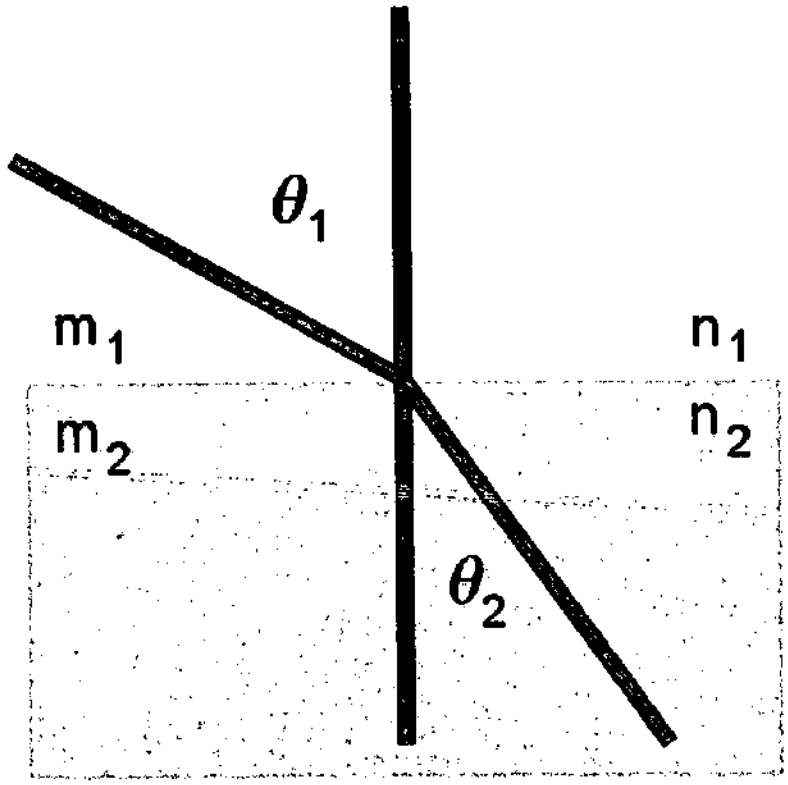

Figure 11

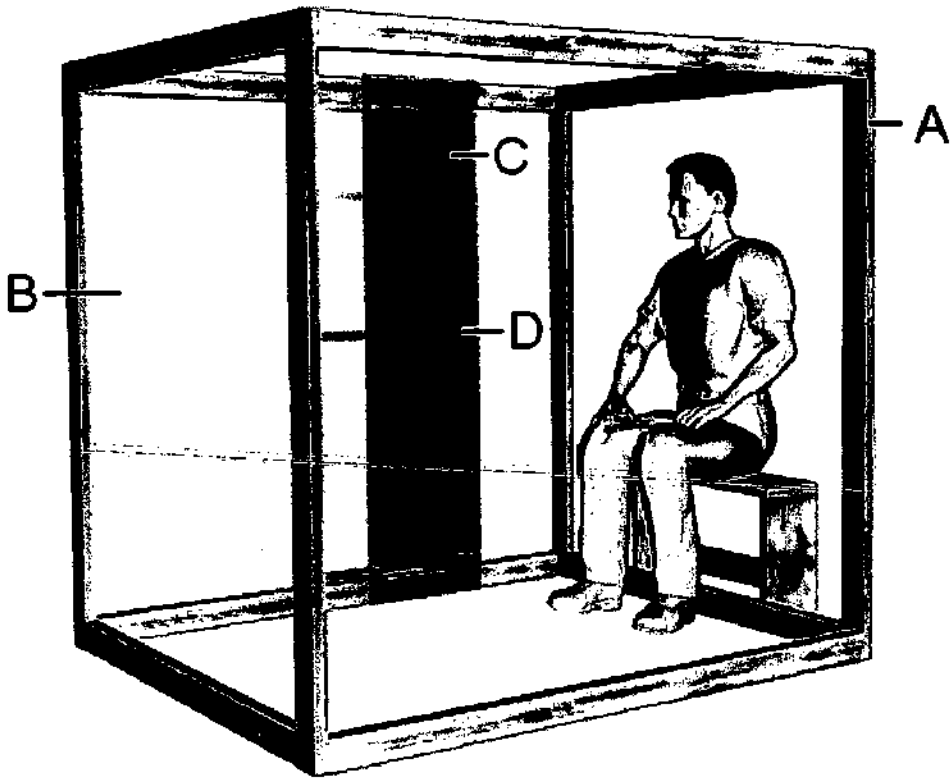

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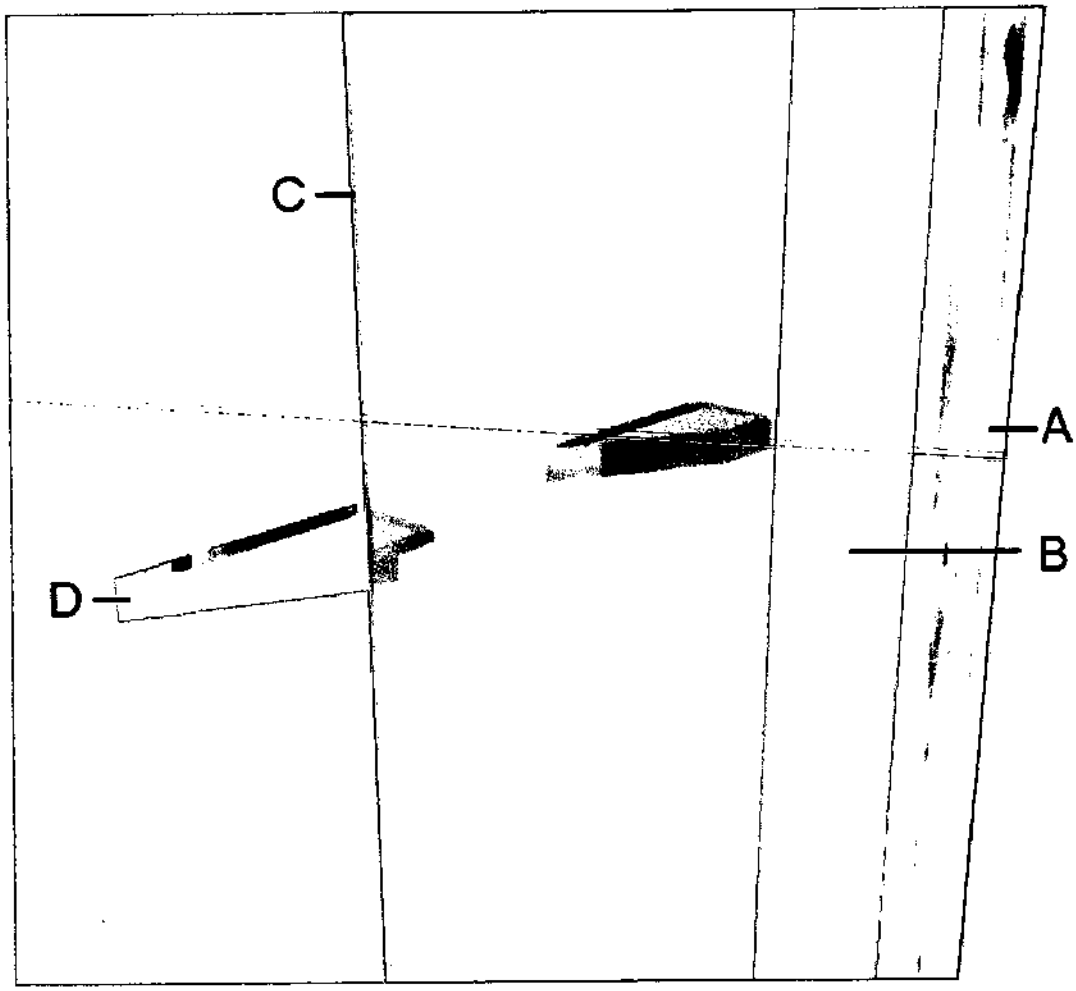

Figure 13

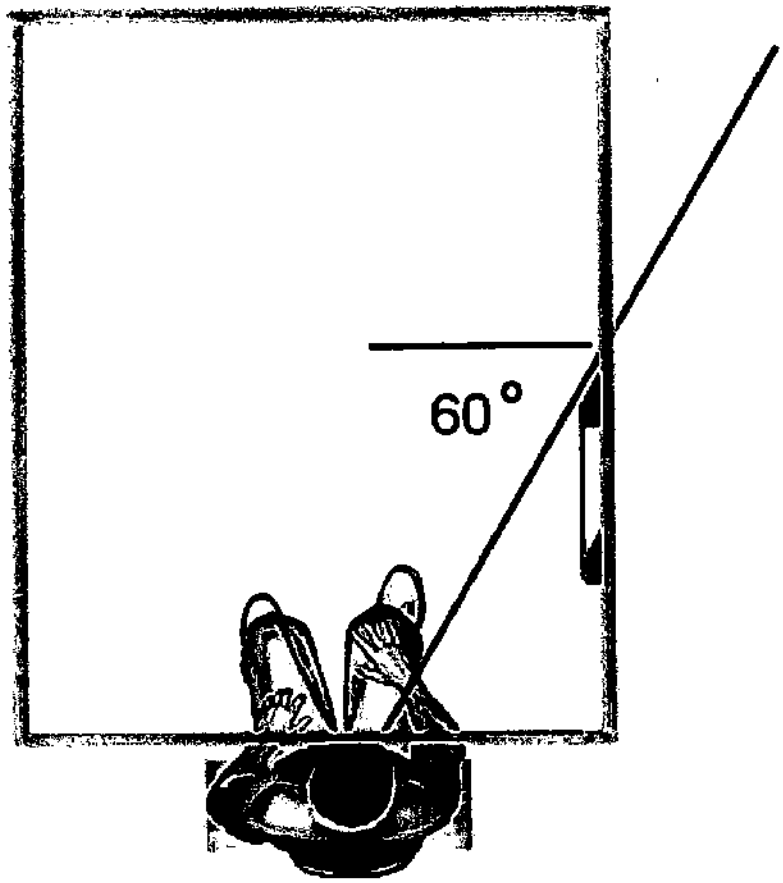

Figure 14

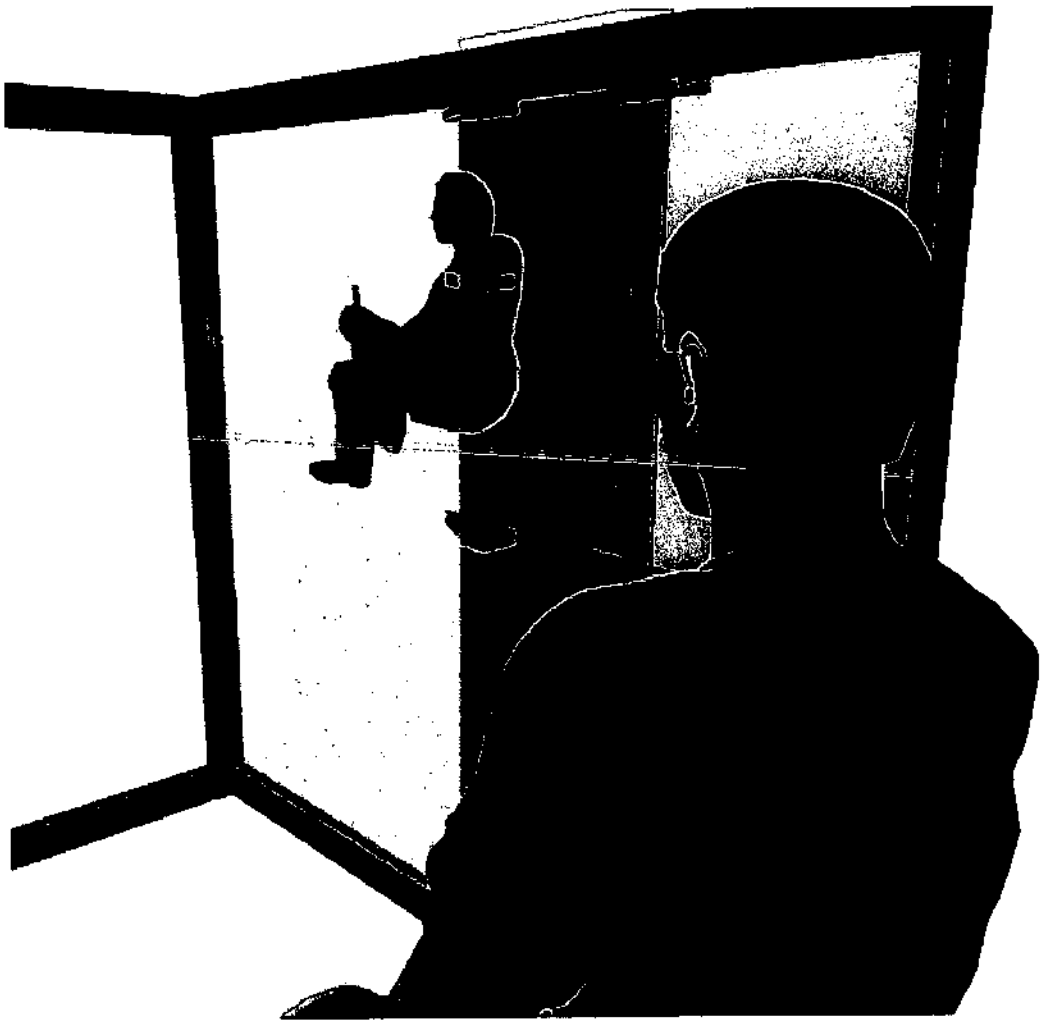

REMOTE VIEWING AMPLIFIER

BRIEF SUMMARY OF THE INVENTION

[0001] This invention enhances the ability of a person to perform remote viewing by connecting the spiritual eye to the tetrahedral geometry of subspace.

BACKGROUND OF THE INVENTION

[0002] Remote viewing is the projection of spiritual modules of the human energy field to distant locations in order to see, communicate and interact with other entities who live in subspace, space and hyperspace co-dimensions of the universe.

[0003] One of my first remote viewings was made at night to a distance of 10,000 miles on the sunlit side of the earth. My spiritual eye and body projected together while my mental facilities remained in my physical body. I found myself looking down on a palm tree from a height of about one hundred feet. The palm tree had several coconuts in it as seen in **FIG. 1**. I then gave the command to lower myself to the ground. At that moment I went sailing down past the coconuts, barely missing the tree! Finding myself on a pathway through the tropical forest, I then came to an extremely long wooden bridge which crossed over a river gorge. On the other side of the bridge I could see three soldiers running toward me as shown in **FIG. 2**. The two soldiers in front were carrying rifles and wearing light blue berets. The man running behind them was wearing an officer's cap with a red band. My first reaction was that I was going to be shot. I edged over on the right side of the wooden railing. They ran right past without seeing me. I then asked to see the building that these soldiers were guarding. Everything went dark, and then I found my spiritual eye peeking out of the floor of a computer room as seen in **FIG. 3**. There was one man using a computer on the opposite side of the room near an open door. He got up from his chair and came over to sit in front of a second computer located a few feet from where I was located. From the glare of the computer monitor, I could clearly see his face. Everything went dark as my spiritual eye and body projected back to my physical body.

[0004] Another time my spiritual eye, spiritual body and mind were standing outside the closed front door of my condominium. Upon patting my legs with my hands, I couldn't find the keys in my trousers. When I looked down, I realized I wasn't in my physical body. I then shot through two solid walls of concrete and returned to my awakening body.

[0005] What these two examples show is that the human spiritual energy system is modular. The reason it is modular is because there are seven hyperspace co-dimensions, each vibrating at a slightly different frequency, which receive energy from space through seven vortices located along the physical body. Over a lifetime, these vortices build up the human aura. Because all energy systems have to be grounded, the remaining six modules are the legs, body, arms/hands, voice, eye and mind. When the entire group is out-of-body as a single entity, then the soul energy powers the body in a manner similar to a battery. The soul looks like a two-inch diameter orange ball of plasma. If the soul is removed from the body, then the body becomes paralyzed except for a small movement of the eyelids. Upon death, all these separate modules are assembled into a single energy being. A light cord from the soul provides the battery power and information required to join these modules together. A second light cord from the pituitary gland transfers the modules into the energy being for assembly. This energy information transfer is the reason that people in a near-death situation say they saw their entire life flash before them.

[0006] Moving to a larger picture of things that are happening in the galaxy, I was able to make contact with the Pleiadian Federation which is located about 400 light years from earth. The Federation is a group of over one hundred intelligent beings that were brought to the Pleiades from around the galaxy. One member of the Federation calls itself the Intelligent Insect Beings. They are the ones who fly the black triangles over Belgium and France for the purpose of evacuating human beings back to the Pleiades for relocation on a planet called Earth II. The reason for this evacuation was that it was not known if it would be possible to win the battle of Revelations, which would take place about two years later here on earth.

[0007] As could be expected, the humans were angry and hysterical at being abducted. So the Intelligent Insect Beings asked me if I could calm them down. I was in telepathic communication with them, and they were in telepathic communication with their computer system, which meant that I could have my thoughts displayed to the humans on the computer monitor. It turned out that one woman was from Central America and only spoke Spanish. The Intelligent Insect Beings didn't speak Spanish so they thought there would be no way I could communicate with her. So I told them that I would spell the Spanish words letter-by-letter and she could then read my message. Since most Spanish people are Catholics, I thought a religious message would be of importance to her. I spelled out the phrase, "Que Dios te bendiga," which means, "May God bless you." I also asked the two beings to put their hands together in a form of prayer, and the woman followed suit. At that moment the Intelligent Insect Beings were reading her mind to understand her emotional state. They said, "She is crying tears . . . " After a slight but tense pause, they continued, "of joy!" They said the woman had a big smile on her face and was successfully transitioned into her new life.

[0008] One year later, the Blond Aliens of the hundred member council of the Pleiadian Federation remote viewed me so that I could celebrate with them the success of their mission to earth. The Blond Aliens, which is not their real name, fly the Beamship spacecraft. This hyperspace vehicle can teleport itself to any location in the galaxy. It dematerializes into the black void for an instance and then rematerialize anywhere in the galaxy. This ship can be seen in Billy Meier's video from Switzerland along with a picture of their envoy, Semjase.

[0009] Just recently I had a demonstration of the Beamship's ability. I heard an emergency distress call by a commander of a spacecraft who said that they had a fire onboard their spacecraft. I immediately remote viewed a Federation maintenance mothership, they got the frequency and location of the ship, and dispatched the Beamship in time to rescue the commander. The burned-out cables, which had caused the fire, were repaired by the Federation and the commander arrived home safely on his planet in his own spacecraft.

[0010] The Federation then received a message from the commander saying that he wanted his planet to join the Federation now that there was this type of communication available. So the Federation visited his planet for the signing ceremony, and I was invited to attend the proceedings by remote view. Word got around about this, and within three weeks another 20 planets joined the Federation for the same reason.

[0011] At one ceremony, which was attended by Admiral Third Class of the Pleiadian Defense Department, His Highness of the planet was signing the document of incorporation. At that moment, I could see him signing, so I exclaimed, "He is signing with his left hand." The Admiral was almost apoplectic at hearing this. After giving her the signed document, His Highness held up his hand and asked me how many fingers he was holding up. He had a fist so I said none. Then he put his index finger out and I said one. He then made a fist again and I said none. Then he held out all fingers and I said five. The Admiral said that he had a big smile on his face as he went to announce the agreement because he knew, even though his planet was located **90,000** light years away on the other side of the galaxy, he could instantly communicate any problems to the Federation. So this is the importance of developing inventions that can enhance our remote viewing ability because one day it will mean that we can become a vital part of the Pleiadian Federation.

SUMMARY OF THE INVENTION

[0012] Referring to **FIG. 4**, the spiritual eye of the human energy system is located at the pituitary gland in the forehead. It has the shape of a hollow cone which is composed of the misty white energy of hyperspace. Light coming into this vortex is then transferred by a light cord to a visual energy module which is located in a co-dimension of hyperspace. Because these modules are interconnected by light cords, the mind module is able to interpret the visual pattern the eye is seeing. More importantly, the mind can give logical instructions to this spiritual eye module for it to rotate around or move in a particular direction.

[0013] The reason that hyperspace has a white misty look to it is that the speed of light is very much less than the speed of light in our spacetime. The Lorentz transformation says that the distance L is shortened relativistically to a distance L' in a way related to the ratio of the velocity v of the object to the velocity of light c.

$$L' = L\sqrt{1 - \frac{v^2}{c^2}}$$

If the velocity of light is very low, then a small velocity creates an enormous contraction in length. By moving through hyperspace, therefore, enormous distances can be traversed. And this is the reason that it is possible to project the spiritual eye, voice and hearing to remote locations in the galaxy.

[0014] The universe is composed of subspace, space and hyperspace which are co-dimensions of each other. Subspace is defined by the geometry of the tetrahedron which is a four-sided solid whose faces are equilateral triangles having three 60° angles. Referring to **FIG. 5**, a tetrahedron whose sides are the square root of three (A), has a height of the square root of two (B), and base length equal to the square root of one (C). This forms the basic number set $\{\sqrt{1}, \sqrt{2}, \sqrt{3}\}$.

[0015] Referring to **FIG. 6**, the tetrahedron (A) is circumscribed by the sphere (B). Rod (C) is the sphere radius. A second rod (D), of equal length to rod (C), from the center of the sphere to the corner of the tetrahedron makes an angle ϕ of

$$\phi = \text{ArcSin}\left(\frac{1}{3}\right) = 19.47122063'$$

So the four corners of the tetrahedron touch the sphere.

[0016] This tetrahedral geometry can be seen throughout the planets of the solar system Referring to **FIG. 7**, the islands of the Caribbean curve down from Puerto Rico to Venezuela forming an island vortex. The low density hyperspace energy releasing from the corner of the tetrahedron softens the rock mantle. The hot magma then rises through the rock with the least resistance. This creates a circular arc of volcanic islands along the edge of the vortex.

[0017] Referring to **FIG. 8**, the Giant Red Spot of Jupiter is located at a southern latitude of 19.5°. This vortex is so large that the entire earth can fit in it.

[0018] Referring to **FIG. 9**, the Olympus Mons volcano is located at a northern latitude of 19.5° as shown by the marker. This volcano is the size of France. Notice the fallen plume of volcanic debris toward the north east.

[0019] The double harmonic of the tetrahedral angle is twice 19.5° or 39° which is the location of the Silver Bridge in Point Pleasant, West Va. A large wormhole opened up around the bridge during Christmas rush hour when the bridge was full of cars. Due to the low density hyperspace energy, the rivets holding the cables down popped loose and all the cars were dumped into the river. A computer simulation using Schrodinger's quantum mechanics equation for a particle in a potential well shows that as the energy becomes less dense, the particle is no longer contained in the potential well. The electron jumps out. Thus the atomic bonds are broken which softens the rivets. This is the first time that there has been an understanding of the failure mechanism of this bridge.

[0020] After downloading from the Internet several pages of the index of refraction of a wide range of materials, I noticed that the index of refraction for Plexiglas was 1.50. Another source said it was 1.51. One of the Internet sites had a movable flashlight which showed the incident ray and the refracted ray. For Plexiglas, surprisingly enough, the incident ray was coming in at an angle of 60° to the normal, and the light was refracted at 35.26°, both of which are tetrahedral angles. The angle of the equilateral face of the tetrahedron is of course 60°. The angle at the top of tetrahedron is the arc-cosine of the ratio of the height over the edge length.

$$\theta = \mathrm{ArcCos}\left(\frac{\sqrt{2}}{\sqrt{3}}\right) = 35.26'$$

According to Snell's law, the index of refraction n, times the sine of the angle $\sin(\theta_1)$ of the ray leaving material m_1, is equal to the index of refraction n_2 times the sine of the angle of refraction $\sin(\theta_2)$ of the ray entering material m_2. Referring to **FIG. 10**, the equation is

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$$

The index of air n_1 is equal to one. The index n_2 of Plexiglas is 1.50. If the incident ray is at $\theta_1 = 60°$ to the normal, then the output angle is

$$\theta_2 = \mathrm{ArcSin}\left[\frac{n_1}{n_2}\mathrm{Sin}(\theta_1)\right] = \mathrm{ArcSin}\left[\frac{2}{3}\frac{\sqrt{3}}{2}\right] = 35.26°$$

which is equal to the angle of the tetrahedron.

[0021] Then I recalled several months earlier that I had gone to the Subway restaurant to get a sandwich. I was sitting by the Plexiglas window communicating with the Admiral whose mothership was in earth orbit. She mentioned that they were bringing two people aboard. At that moment I looked out through the window and I could see both of them clearly and easily through my spiritual eye. To my amazement, I saw both of the captives start to pull out guns from behind their backs. I then projected by spiritual hands which resulted in preventing the attack on the security guards. To say the least, the Admiral was rather surprised at these events. She then asked me to look at the design of the window because she thought it had something to do with my enhanced remote viewing capabilities. Looking at the Plexiglas, I noticed that on the edge of the large window pane there was a shorter piece of Plexiglas which was mounted parallel to the window pane. This smaller panel acted to protect the yellow neon fluorescent tube. I took the measurements of the design using a piece of paper that I found near the table.

[0022] I then went home and designed up a mounting bracket with my 3D computer software. I had already installed the stereolithography software that converts the design to the *.STL file format. How stereolithography works is that it slices the design into many thin horizontal sections. The machine has a platform which is mounted in a bath of liquid polymer. An ultraviolet laser, mounted on an xy-table, then traces out the slice. Because the liquid polymer is light sensitive, it polymerizes immediately into solid plastic. Then the platform is lowered a few thousandths of an inch and the second slice is added. This process eventually builds up the complete 3D part. Using the Internet, the *.STL file is sent by e-mail to the stereolithography service provider who returns the part overnight. So the next day I had the piece from which I made a plastic mold and several additional pieces for mounting the Plexiglas bracket on a full sheet of Plexiglas that I ordered locally. It never occurred to me to measure the angles, so after I got the index of refraction for Plexiglas, I measured the incident angle and it turned out to be 61°. So then I realized that the spiritual eye was being diffracted across these two Plexiglas plates which connected it to the tetrahedral geometry of subspace. Because subspace is the foundation of space, this created a much more efficient route for remote viewing. The result is that this invention has allowed me to make contact with 430 alien civilizations. Since then I have been awarded the Aphysics prize for my work in the invention and elaboration of the tetrahedron diagram of which there are now over 4000 graphs. The scientific discoveries contained in the diagram are (1) the electron and proton are one and same particle, (2) the existence of hyperspace, (3) how mass can be taken out of dimension, (4) cosmology determines the elementary particles, (4) all the physics constants and the tetrahedral geometry are contained in the two 360° circles of the infinity symbol and (5) all the physics constants are determined geometrically and projected from a subspace manifold into our dimension. For my work in Revelations, I was awarded four beautiful galloping riderless white horses of the Apocalypse.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0023] **FIG. 1**. Remote viewing the top of a palm tree containing several coconuts.

[0024] **FIG. 2**. Remote viewing three soldiers running across a wooden bridge.

[0025] **FIG. 3**. Remote viewing computer building that soldiers were guarding.

[0026] **FIG. 4**. Spiritual eye of human aura.

[0027] **FIG. 5**. Tetrahedron.

[0028] **FIG. 6**. Tetrahedron circumscribed by sphere.

[0029] **FIG. 7**. Caribbean volcanic island vortex.

[0030] **FIG. 8**. Giant Red Spot on Jupiter.

[0031] **FIG. 9**. Olympus Mons volcano on Mars.

[0032] **FIG. 10**. Snell's Law of Refraction.

[0033] **FIG. 11**. Perspective view of remote viewing station.

[0034] **FIG. 12**. Wedge-shaped spacers for diffraction panel.

[0035] **FIG. 13**. Remote viewing angle.

[0036] **FIG. 14**. A remote viewing session taking place on a planet located 90,000 light years from earth on the other side of the galaxy showing His Highness signing with his left hand the document that allows his planet to become a member of the Pleiadian Federation.

DETAILED DESCRIPTION OF THE INVENTION

[0037] 1. Referring to **FIG. 11**, the remote viewing station is a rectangular box wooden frame (A) on which is mounted on one side a large sheet of Plexiglas (B). The diffraction panel (C), made of a shorter length of Plexiglas, is mounted with acrylic glue on the Plexiglas sheet using clear polyoptic molded plastic spacers (D).

[0038] Referring to **FIG. 12**, the wedge-shaped spacers (D) hold the diffraction panel (C) to the sheet of Plexiglas (B). The angle of the wedge is 30° which makes the incident angle 60° to the normal.

[0039] Referring to the top view perspective **FIG. 13**, sitting on the wide bench, the remote viewer can adjust his sight along the wedge for proper alignment at an angle of 60°. Due to the 1.50 index of refraction of Plexiglas, the spiritual eye is diffracted across the edge of the first panel and then refracted across the second panel at the tetrahedral angle of 35.26°.

[0040] Referring to **FIG. 14**, the remote viewing image is seen superimposed on the large sheet of Plexiglas which acts as the viewing screen.

I claim:

1. A remote viewing station comprising:

(a) a rectangular box frame made of wood having a length of six feet, a width of four feet and a height of six feet;

(b) a large sheet of quarter inch Plexiglas, having an index of refraction of 1.50, mounted on the right side of item (1a);

(c) several wedge-shaped clear plastic spacers, three inches in width and eight and a half inches in length, having a wedge angle of 30° that are mounted on the interior right side of item (1b);

(d) a shorter sheet of quarter inch Plexiglas, having a length of one and a half feet, mounted on item (1c) parallel to item (1b);

(e) a wide bench on which the remote viewer sits so that the remote viewer can align his sight along the wedge angle of item (1c);

2. A remote viewing amplifier that:

(a) diffracts the spiritual eye of the remote viewer across the edge of item (1d) at an incident angle of 60° to the normal;

(b) refracts the spiritual eye at 35.26° to the normal due to the refractive index of item (1a) according to Snell's Law of Refraction; and

(c) aligns the spiritual eye with the tetrahedral geometry of subspace due to the diffraction/refraction combination of item (2a) and (2b).

* * * * *

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St. Clair

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(54) TRIANGULAR SPACECRAFT

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(57) **ABSTRACT**

A spacecraft having a triangular hull with vertical electrostatic line charges on each corner that produce a horizontal electric field parallel to the sides of the hull. This field, interacting with a plane wave emitted by antennas on the side of the hull, generates a force per volume combining both lift and propulsion.

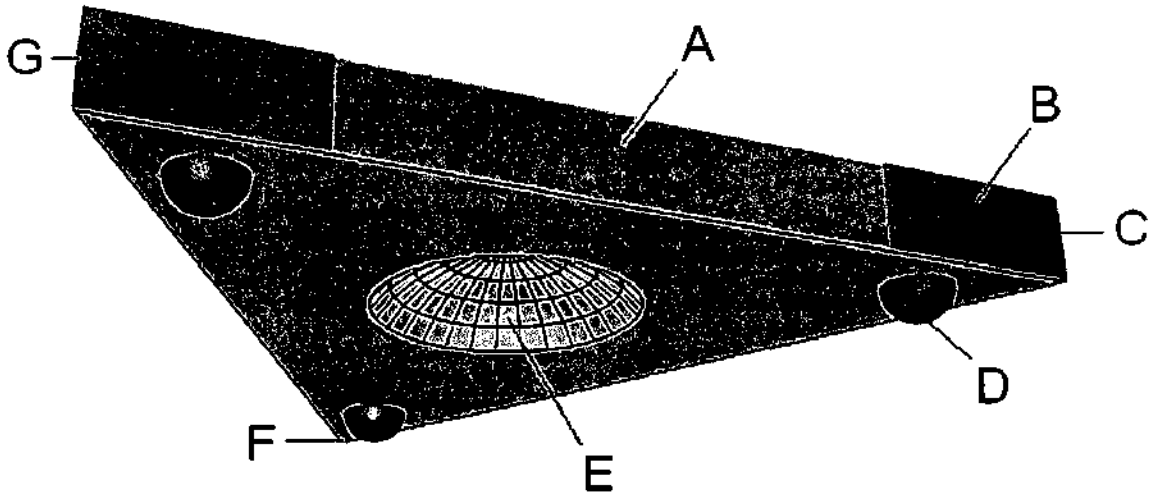

Figure 1

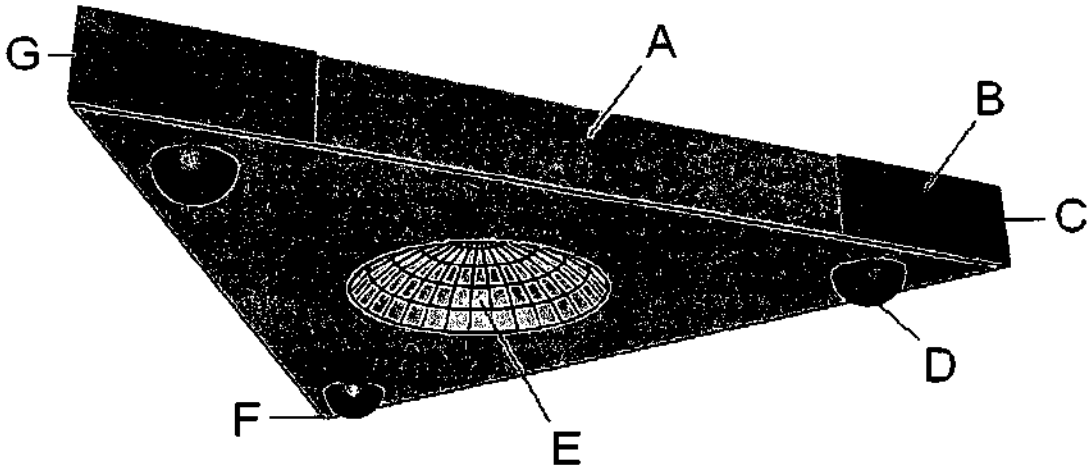

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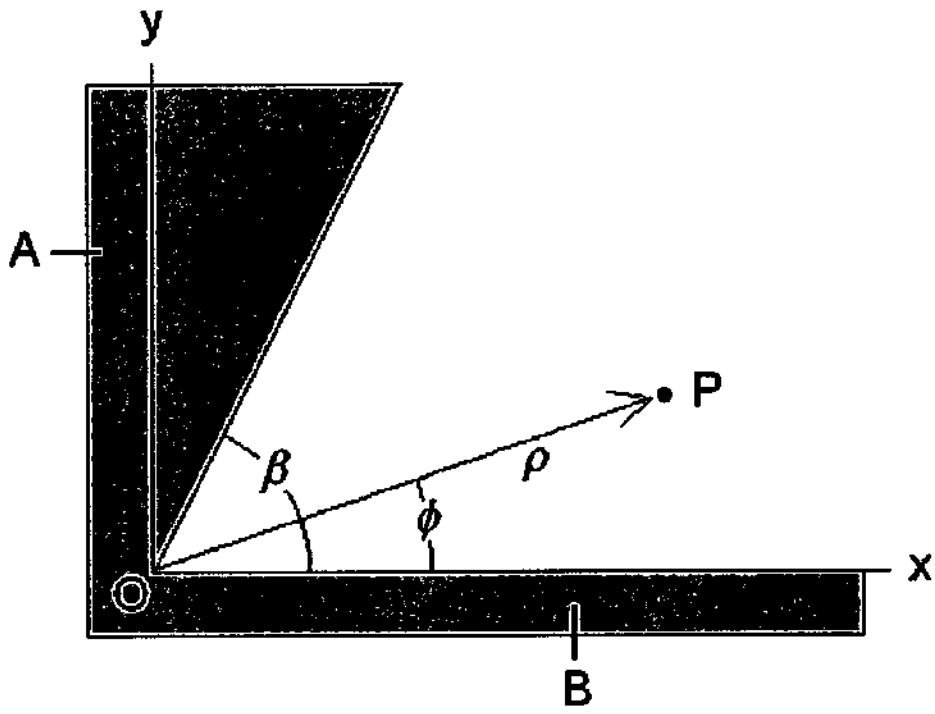

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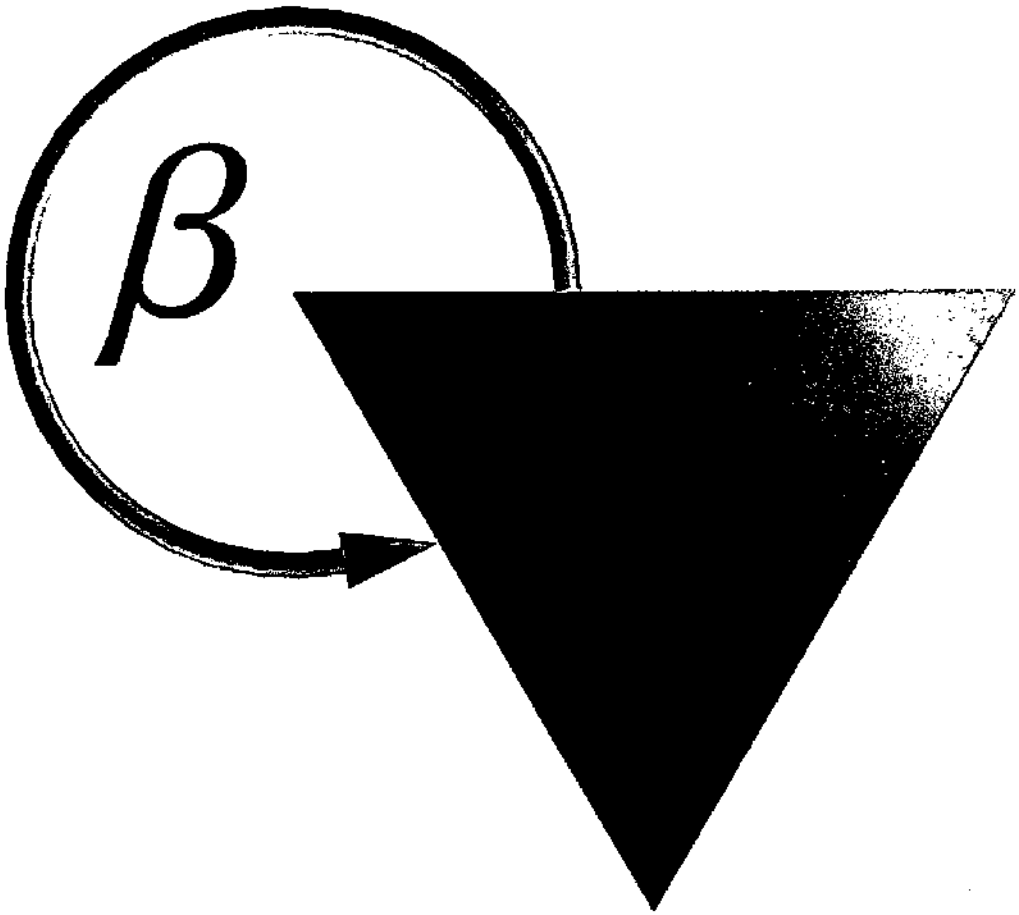

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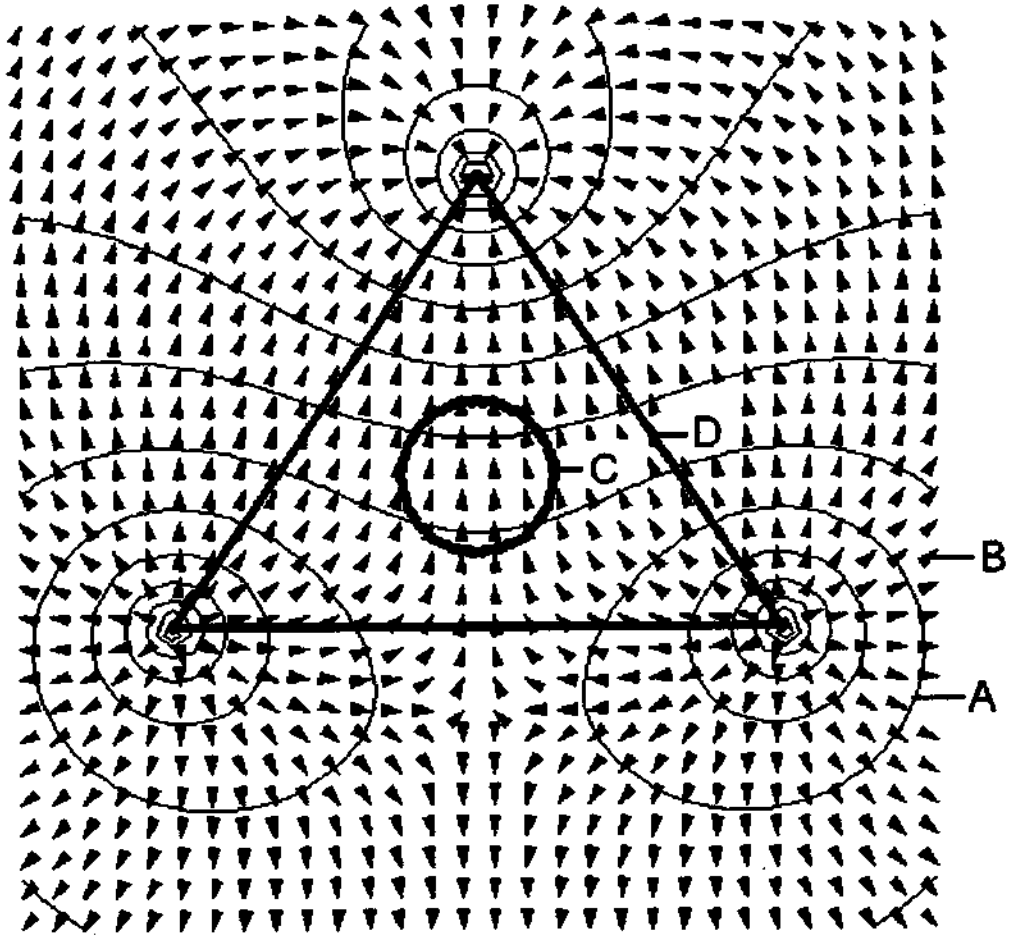

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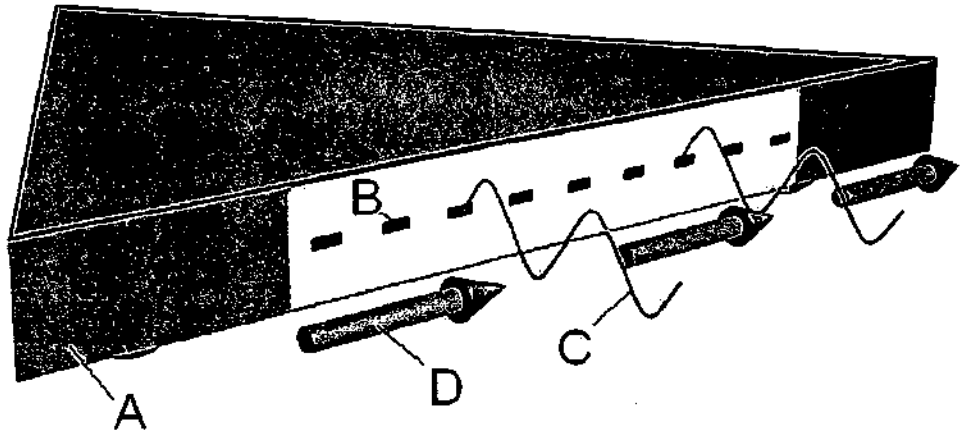

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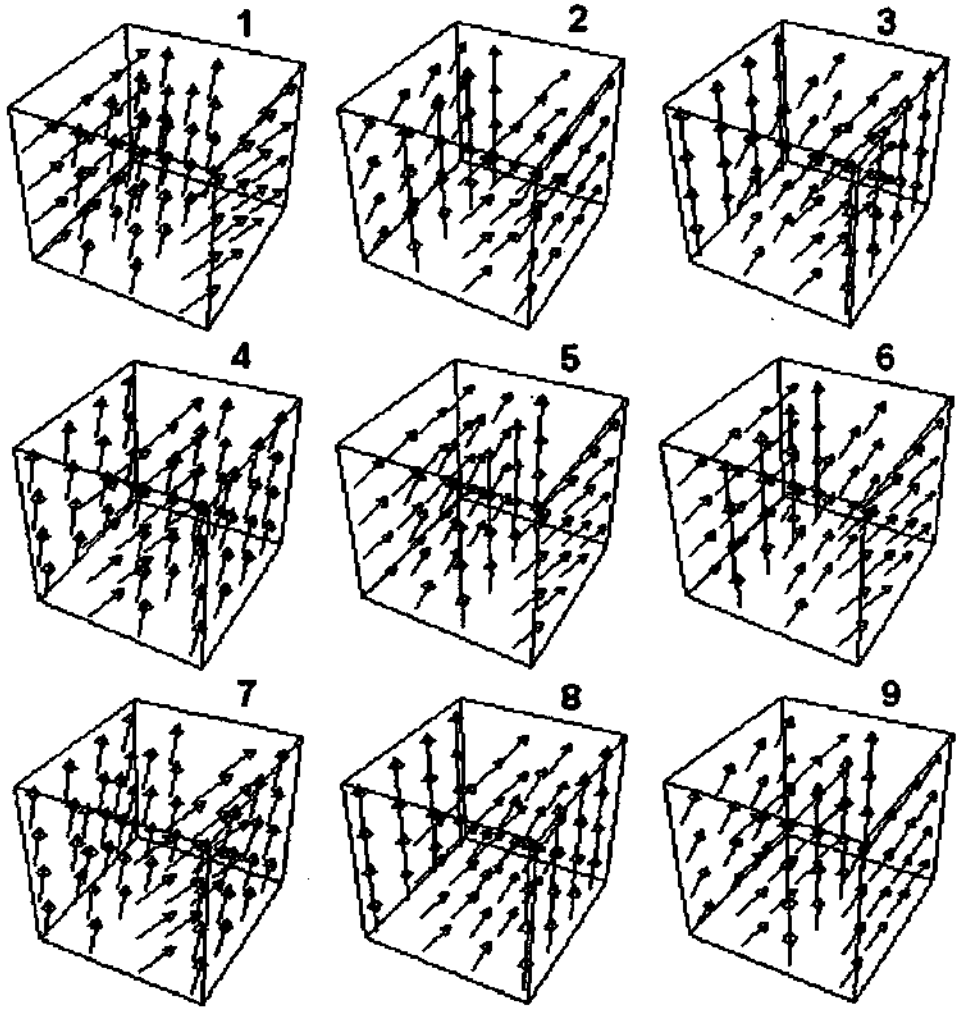

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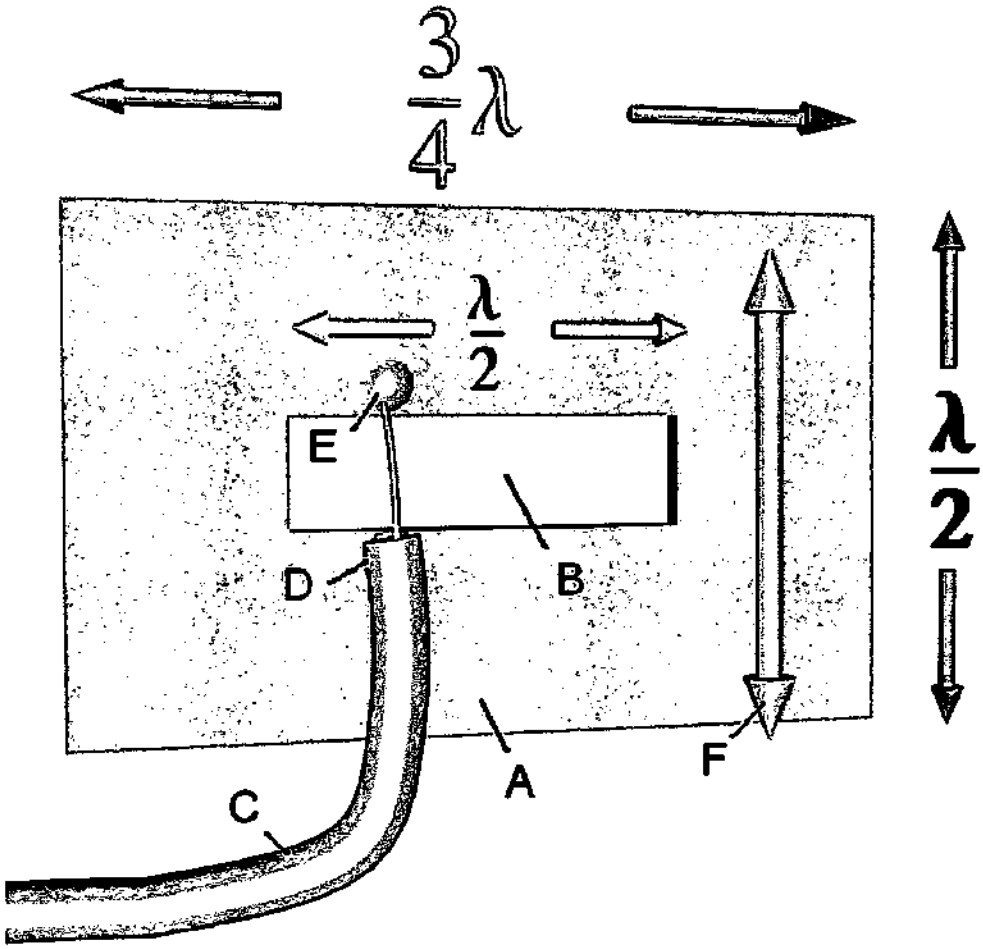

TRIANGULAR SPACECRAFT

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a spacecraft having a triangular hull with vertical electrostatic line charges on each corner. The line charges create a horizontal electric field that, together with a plane wave emitted by antennas on the side of the hull, generates a force per volume providing a unique combination of both lift and propulsion.

BACKGROUND OF THE INVENTION

[0002] Referring to **FIG. 1**, the spacecraft has a hull in the shape of an equilateral triangle. A parabolic antenna (E) is centrally located in the bottom of the hull. An array of horizontal slot antennas is located along the side of the hull (A). Each back corner (F,G) has a corner conducting plate which is charged to a positive voltage +V. The forward corner (C) has a conducting plate charged to a negative voltage −V. A motion control hemisphere (D) is located on the bottom surface in each of the three corners.

[0003] Referring to **FIG. 2**, two planes (A,B) intersect at the origin O at an opening angle β. Each plane (x,y) is charged to a voltage V. The potential at point P is determined in polar coordinates {ρφ}. The Laplace equation for the potential Φ in polar coordinates is given by:

$$\frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial\Phi}{\partial\rho}\right)+\frac{1}{\rho^2}\frac{\partial^2\Phi}{\partial\phi^2}=0$$

Using a separation of variables solution, the potential is given as the product of two functions:

$$\Phi(\rho,\phi)=R(\rho)\Psi(\phi)$$

which when substituted into the Laplace equation becomes:

$$\frac{\rho}{R}\frac{d}{d\rho}\left(\rho\frac{dR}{d\rho}\right)+\frac{1}{\Psi}\frac{d^2\Psi}{d\phi^2}=0$$

Since the two terns are separately functions of ρ and φ respectively, each one has to be constant with the sum of the constants equal to zero:

$$\frac{\rho}{R}\frac{d}{d\rho}\left(\rho\frac{dR}{d\rho}\right)=\nu^2 \quad \frac{1}{\Psi}\frac{d^2\Psi}{d\phi^2}=-\nu^2$$

These two equations have solutions:

$$R(\rho)=a\rho^{\nu+b\rho-\nu}$$

$$\psi(\phi)=A\cos(\nu\phi)+B\sin(\nu\phi)$$

The azimuthal angle φ is restricted to a value in the range $0\leqq\phi\leqq\beta$. The boundary condition is that the potential Φ is equal to V for any radius ρ when φ=0 and φ=β. This means that ν has to be an integer value of π so that the sine function is zero:

$$\sin(\nu\beta)=\sin\left(\frac{m\pi}{\beta}\beta\right)=\sin(m\pi)=0 \quad m=1,2\ldots$$

which in turn means that the coefficient A of the cosine term has to be zero in the solution above. Choosing b=0 makes the general solution for the potential equal to:

$$\Phi(\rho,\phi)=V+\sum_{m=1}^{\infty}a_m\rho^{m\pi/\beta}\sin(m\pi\phi/\beta)$$

which shows that when the angle is zero, the sine is zero and the potential is V. If the angle is β, then there is a multiple of π such that the sine is zero again.

[0004] Because the series involves positive powers of the radius, for small enough ρ, only the first term $m=1$ in the series is important. Thus around ρ=0, the potential is approximately

$$\phi(\rho,\phi)=V+a_1\rho^{\pi/\beta}\sin(\pi\phi/\beta)$$

[0005] The electric field component is the negative gradient of the potential:

$$E_\phi(\rho,\phi)=-\frac{1}{\rho}\frac{\partial\Phi}{\partial\phi}=-\frac{\pi a_1}{\beta}\rho^{(\pi/\beta)-1}\cos(\pi\phi/\beta)$$

The surface charge distribution σ at φ=0 and φ=β is equal to the electric field perpendicular to the surface times the permittivity of space ϵ_0:

$$\sigma(\rho)=\varepsilon_0E_\phi(\rho,0)=-\frac{\varepsilon_0\pi a_1}{\beta}\rho^{\frac{\pi}{\beta}-1}$$

Notice that if angle of intersection β is less than π, then the equation says that there is a very small radius to a positive power which means little charge density accumulation.

[0006] Referring to **FIG. 3**, the value of β, in the case of the triangular hull, is equal to 360° less 60° for a total of 300° or:

$$\beta=\frac{300}{180}\pi=\frac{5}{3}\pi$$

$$\rho^{\frac{\pi}{\frac{5}{3}\pi}-1}=\frac{1}{\rho^{\frac{2}{5}}}$$

which says that there is a charge density singularity to the two fifths power for small radius. Thus, the corner plates on the hull create a huge line charge density along the sharp vertical corner edge. The equation for the potential of a line charge density is given as:

$$\Phi(x,y)=-\frac{\lambda}{2\pi\varepsilon_0}\mathrm{Ln}((x-x_0)^2+(y-y_0)^2)$$

where λ is the charge per unit length in the vertical z-direction, and x_0 and y_0 are the location of the line charge in the xy-plane.

[0007] Referring to **FIG. 4**, the triangular hull (D) is plotted together with the potential contours (A) and the electric field arrows (B) created by the three corner line charges. The line charges are perpendicular to the paper. Notice that the electric field arrows are parallel crossing the center parabolic antenna (C). The electric field is also parallel to the sides (D) of the triangle.

[0008] Referring to **FIG. 5**, along the side of the triangle (A), an array (B) of horizontal slot antennas emit electromagnetic waves that have a vertically polarized electric E field (C). These traveling waves interact with the electric field (D) produced by the line charges on the corners of the triangle.

[0009] Using differential forms mathematics, this combination of fields is represented by the Hodge star of the differential of the wedge product of the two fields. The antenna electromagnetic field is a combination of a traveling magnetic field B_w, and electric field E_w. The stationary field E created by the line charges is perpendicular to the traveling wave.

$$*d(E \wedge (B_w + E_w \wedge dt))\frac{\varepsilon}{c} = \frac{\text{force}}{\text{volume}}$$

where ϵ is the linear capacitance of space and c is the speed of light. Thus there is a force per volume around the hull.

[0010] This combination of fields produces a spacetime curvature as determined by Einstein's General Theory of Relativity. The traveling electric field has an amplitude in the vertical z-direction and travels in the x-direction

$$E_{w=Ez}\cos(x-t)$$

The Faraday electromagnetic tensor contains all the electric and magnetic fields in all the {x,y,z} directions. The first row and first column contain the two electric fields

$$F^{\alpha}_{\beta} = \begin{array}{c|cccc|} t & 0 & E_x & 0 & E_z\cos(x-t) \\ x & E_x & 0 & 0 & 0 \\ y & 0 & 0 & 0 & 0 \\ z & E_z\cos(x-t) & 0 & 0 & 0 \end{array}$$

The stress exerted on spacetime occurs in the xx, yy and zz-direction as calculated from the stress-energy tensor T of gravitational physics

$$4\pi T^{\mu\nu} = F^{\mu\alpha}F^{\mu}_{\alpha} - \frac{1}{4}g^{\mu\nu}F_{\alpha\beta}F^{\alpha\beta}$$

where g is the metric tensor for Cartesian space

$$g_{\alpha\beta} = \begin{array}{c|cccc|} t & -1 & 0 & 0 & 0 \\ x & 0 & 1 & 0 & 0 \\ y & 0 & 0 & 1 & 0 \\ z & 0 & 0 & 0 & 1 \end{array}$$

where the diagonal components are the coefficients of the elementary spacetime length ds squared

$$(ds)^2 = -(dt)^2 + (dx)^2 + (dy)^2 + (dz)^2$$

The calculation produces three stresses T^{xx},T^{yy} and T^{zz} in their respective {x,y,z} directions.

[0011] Referring to **FIG. 6**, these three stresses are plotted together as a 3D vector field animated over time in nine frames. The graphs show that there is a lift force as depicted by the vertical arrows as well as a force of propulsion as shown by the interspersed horizontal arrows. With the passage of time, these vectors exchange places with each other so that the lift becomes the propulsion and vice versa, creating a wavy stress-energy field around the hull.

SUMMARY OF THE INVENTION

[0012] This invention is a spacecraft with a triangular hull having charged flat plates on the vertical corners of the three sides. The two rear corners are charged to a potential V. The forward corner is charged to a potential −V. The 60° angle on the corner creates a line charge density singularity that produces a huge horizontal electric field pointing from the back to the front of the craft which is also parallel to the sides of the triangle. An array of horizontal slot antennas located on the sides of the triangular hull produce an electromagnetic wave with the electric field polarized in the vertical direction. This combination of fields produces a spacetime force in both the vertical and horizontal directions such that the spacecraft receives a lift force and a force of propulsion.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIG. 1**. Perspective view of triangular spacecraft.

[0014] **FIG. 2**. Drawing of the intersection of two charged plates in order to calculate the charge density in the corner.

[0015] **FIG. 3**. Perspective view of the corner angle β for the equilateral triangle.

[0016] **FIG. 4**. Planar 2D graph showing the electric field produced by three line charges on the corners of the triangular hull.

[0017] **FIG. 5**. Perspective view of electric field produced by the linear charge interacting with the traveling electromagnetic wave produced by the slot antenna.

[0018] **FIG. 6**. 3D vector animation of the lift and thrust force generated by the fields.

[0019] **FIG. 7**. Perspective view of slot antenna.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Referring to **FIG. 7**, the antenna (A) is made out of sheet copper in which a rectangular horizontal slot (B) has been notched out using a die press and sheet metal fixture. A coaxial cable from the amplifier and frequency generator is attached across the slot by soldering the outer cable (D) to one side of the slot and the inner cable (E) to the other side of the slot. This creates the positive and negative charges across the gap which forms the vertical electric field (F) which radiates out perpendicularly to the copper sheet.

[0021] Although the invention has been described with reference to specific embodiments, such as a particular antenna system, those skilled in the art will appreciate that many modifications and variations are possible without departing from the teachings of the invention. All such modifications and variations are intended to be encompassed within the scope of the following claims.

1. A spacecraft comprised of the following components:

(a) a triangular hull in the form of an equilateral triangle;

(b) two copper plates attached on opposite vertical sides at each of the three corners of the hull (**1***a*) such that a sharp vertical edge is formed where they come together;

(c) an electrostatic generator used to charge the back two copper-cladded corners (**1***b*) to a high positive voltage, and the third forward copper-cladded corner to a high negative voltage;

(d) a horizontal slot antenna array mounted-on the sides of the hull; and

(e) a frequency generator, antenna and coaxial cables to drive the antenna array (**1***d*).

2. To create, by claims (**1***a*, **1***b*, **1***c*), an intense vertical line charge at the corners (**1***b*) and a horizontal electric field that that is parallel to the sides of the hull (**1***a*);

3. To create, by claims (**1***d*,**1***e*), an electromagnetic wave with a vertically polarized electric field traveling outward from the side of the hull (**1***a*); and

4. To create, by claims (**2**,**3**), an interaction of the electrostatic field (**2**) with the electromagnetic wave (**3**) such that a combined spacetime curvature pressure is generated on the hull in the upward and forward direction to produce lift and propulsion respectively.

* * * * *

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(54) PERMANENT MAGNET PROPULSION SYSTEM

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(57) ABSTRACT

This invention is a propulsion system for a train that uses permanent magnets mounted on a rotating iron cylindrical plate carrying a radial current in order to create a spacetime curvature distortion which pulls the locomotive along the track.

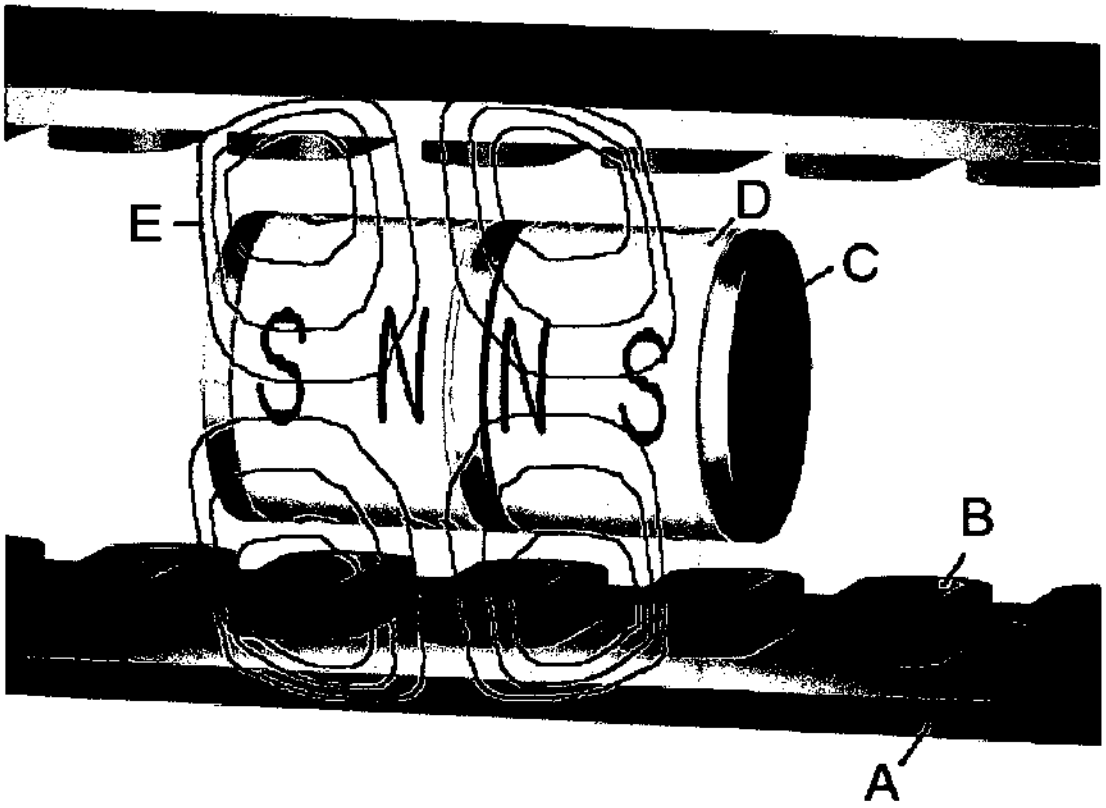

Figure 1

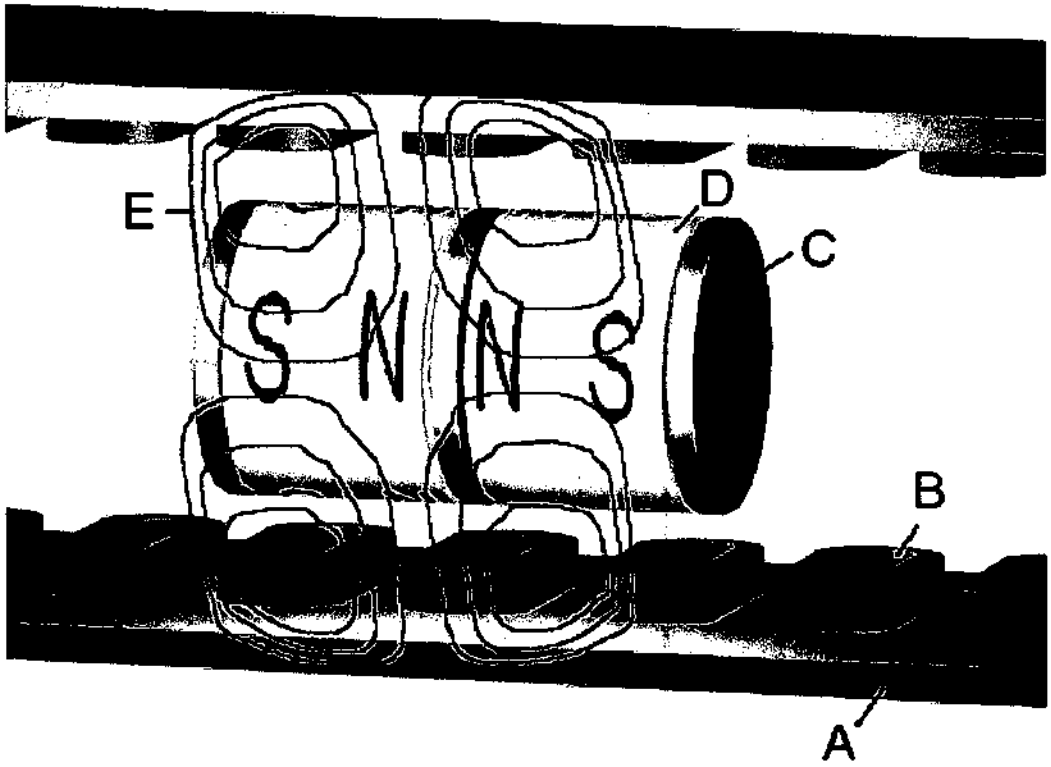

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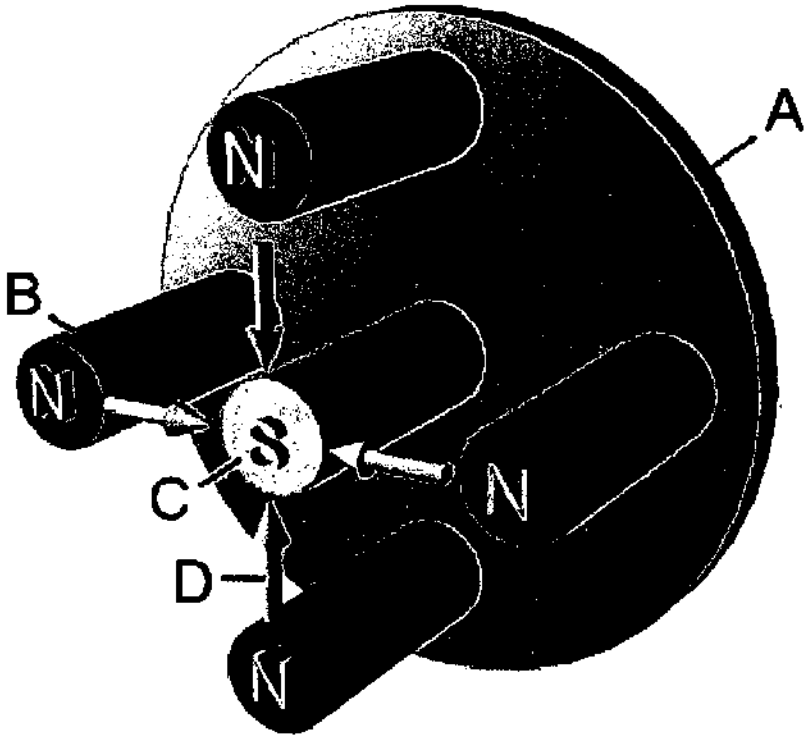

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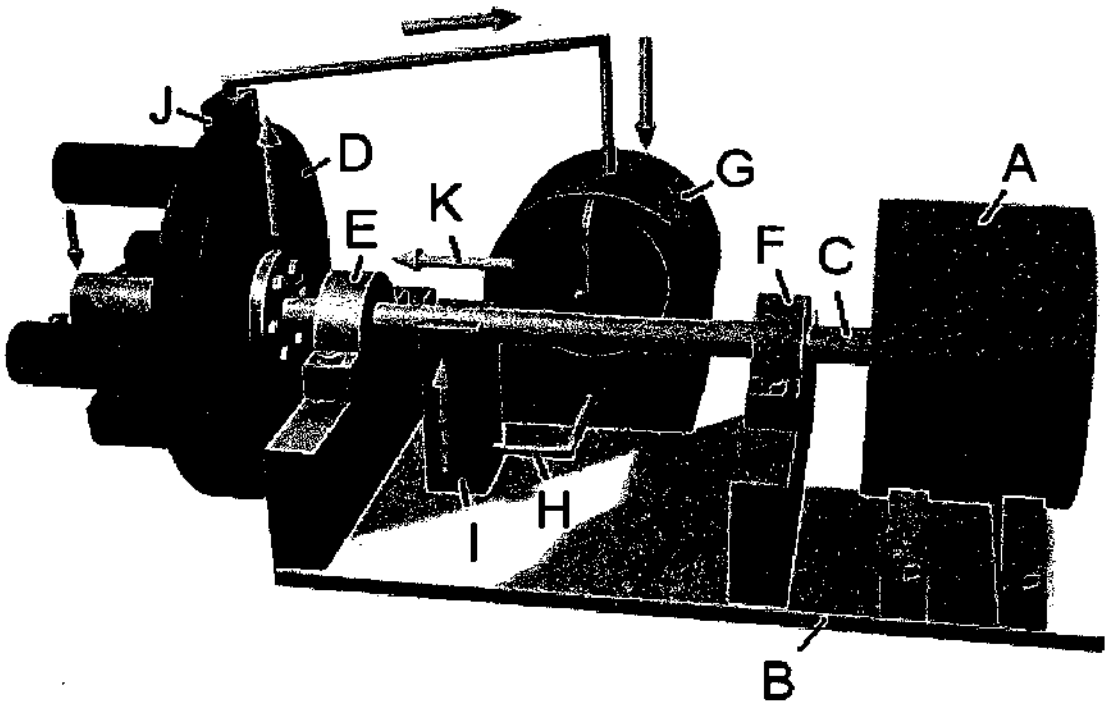

Figure 4

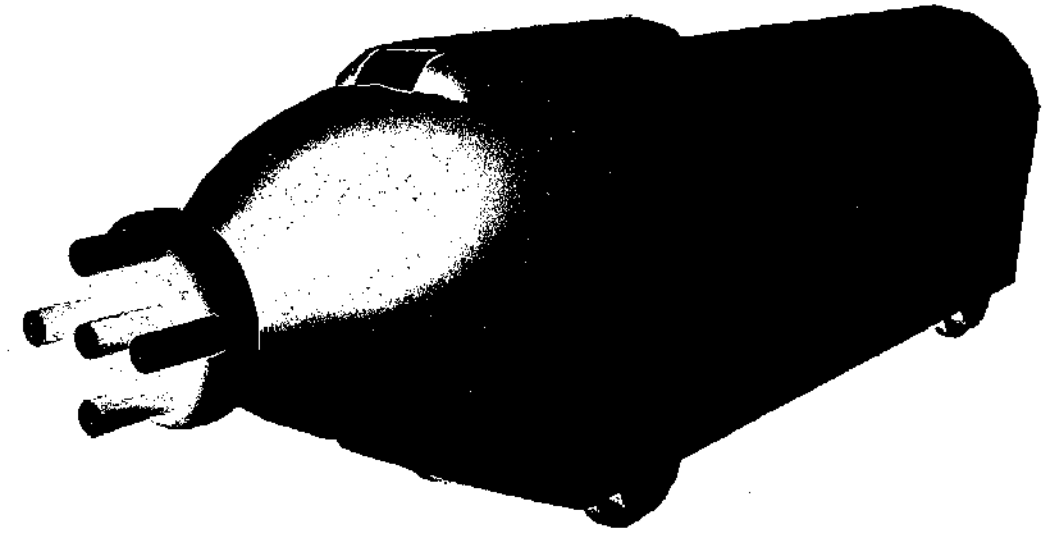

PERMANENT MAGNET PROPULSION SYSTEM

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a propulsion system for a train that utilizes spinning cylindrical magnets in order to create a spacetime pressure distortion ahead of the vehicle that pulls the locomotive along the track.

BACKGROUND OF THE INVENTION

[0002] At the present time, referring to **FIG. 1**, proposed permanent magnet propulsion systems use a dual railway track (A) supporting a series of coil windings (B) located along the track. The vehicle is attached to two permanent magnets (D) between steel pole pieces (C). The north pole of each magnet faces the interior pole piece such that the magnetic flux path (E) follows the center pole piece up through the railway bed and then back to the south pole of the magnet. As the magnets move along the track, the coil windings are activated at the correct time by Hall sensors. With the coil energized as a north pole, the permanent magnet north pole is repelled which drives the vehicle along the track The problem with this design, and other similar designs, is that it is not practical to wind huge numbers of sensor-activated electrical coils along a steel track.

[0003] From Einstein's General Theory of Relativity, it is known that a spacetime curvature pressure develops perpendicular to direction of vibration of the electric and magnetic field. As an example, the photon has an electric field vibrating in the vertical y-direction and a magnetic field vibrating in the horizontal x-direction. The spacetime curvature pressure is therefore along the z-axis of radiation which pushes the negative mass of the photon along. Thus in order to create a spacetime curvature pressure in the z-direction along the track which would pull the train forward, a magnetic flux density field is required in the radial direction.

[0004] Referring to **FIG. 2**, four equally-spaced north permanent magnets (B) surrounding a centrally-located south permanent magnet (C) are mounted on an iron cylinder which acts as the radial flux return path. The magnetic flux density field (D) is in the radial direction from the north pole to the south pole. In order to provide strength, the magnets are molded onto a steel shaft and coated with epoxy so that they don't rust. During the molding process, a capacitor-discharge magnetizer is used to create the magnetic field of the magnet.

[0005] In Cartesian coordinates {−ct,x,y,z}, the elemental spacetime length ds squared is the sum of the squares of the incremental lengths {cdt,dx,dy,dz}

$$(ds)^2=-(dt)^2+(dx)^2+(dy)^2+(dz)^2$$

where the speed of light c is unity. The coefficients (−1,1,1,1) of this equation make up the g metric 4×4 tensor

$$g_{\alpha\beta} = \begin{array}{c|cccc|} & t & x & y & z \\ \hline t & -1 & 0 & 0 & 0 \\ x & 0 & 1 & 0 & 0 \\ y & 0 & 0 & 1 & 0 \\ z & 0 & 0 & 0 & 1 \end{array}$$

[0006] The Faraday electromagnetic tensor contains the magnetic fields which determine how the spacetime length ds is curved. For a magnetic flux density field in the x-direction, Bx, and a magnetic flux density field in the y-direction, By, the Faraday tensor is

$$F^{\alpha}_{\beta} = \begin{array}{c|cccc|} & t & x & y & z \\ \hline t & 0 & 0 & 0 & 0 \\ x & 0 & 0 & 0 & -By \\ y & 0 & 0 & 0 & Bx \\ z & 0 & By & -Bx & 0 \end{array}$$

The stress-energy-momentum tensor T, which determines how space is curved, is calculated from the following equation

$$4\pi T^{\mu\nu} = F^{\mu\alpha}F^{\nu}_{\alpha} - \frac{1}{4}g^{\mu\nu}F_{\alpha\beta}F^{\alpha\beta}$$

The stress-energy in the z-direction ahead of the locomotive is

$$T^{zz} = \frac{B_x^2 + B_y^2}{8\pi} = \frac{B_r^2}{8\pi}$$

where the sum of the squares of the fields in the x and y directions is the radial B field. In Einstein's General Relativity Theory, the curvature G tensor is equal to the stress-energy tensor divided by 8π. The G tensor is the curvature of space having units of inverse radius squared.

$$G = \frac{T}{8\pi}$$

Therefore the curvature G_{zz} generated along the z-direction ahead of the train is proportional to the square of the magnetic flux density field

$$G_{zz} = \frac{1}{r^2} = \frac{G\varepsilon}{c^2}\frac{B_r^2}{8\pi} = \frac{1}{meter^2}$$

where G is Newton's gravitational constant (not to be confused with the curvature tensor), ε is the linear capacitance of space, and c is the speed of light. The linear mass of space Ω is the speed of light c squared divided by the gravitational constant G, so that the equation can be written as

$$\frac{G\varepsilon}{c^2}\frac{B_r^2}{8\pi} = \frac{\varepsilon}{\Omega}\frac{B_r^2}{8\pi} = \frac{1}{\frac{\Omega}{\varepsilon}}\frac{B_r^2}{8\pi}$$

where the conversion factor is the square of the magnetic vector potential A

$$\sqrt{\frac{\Omega}{\varepsilon}} = \frac{\text{kgm}}{seccoul} = A$$

which is actually the momentum per charge. Therefore the curvature equation can be written as

$$\frac{1}{r^2} = \frac{1}{8\pi}\left(\frac{B_r}{A}\right)^2$$

This equation shows that it is necessary to create a magnetic vector potential together with the radial magnetic flux density field in order to create a curvature of space. Looking at the units of A shows that it is a mass momentum per charge

$$A = \frac{\text{kg}}{sec}\frac{m}{coul} = \frac{m\omega^2 r}{I}$$

or a mass m rotating with angular velocity c) per current along the radius. In terms of the invention, what this means is that the mass of the iron cylinder has to be rotating and there has to be a radial electrical current I in order to produce the linear charge along the radius. The differential mass dm depends on the circumference times the differential radius dr, the mass density p, and the length L of the cylinder

$$dm = \rho 2\pi r L dr$$

so that the magnetic vector potential becomes

$$A = \int_0^R \frac{\rho 2\pi r L\omega^2 r}{I} dr = \frac{2}{3}R^3\rho\pi L\frac{\omega^2}{I}$$

The value of A for the iron cylinder is

$$L = .2m$$

$$\rho = 7866\frac{kg}{m^3}$$

$$R = 1m$$

$$\omega = 2\pi f = 6.28\ \text{sec}^{-1}$$

$$I = 3000000\ \text{amp}$$

$$A = .04335\frac{kgm}{\text{sec}coul}$$

$$Br = 1.2tesla$$

$$\frac{1}{8\pi}\left(\frac{Br}{A}\right)^2 = 30.47m^2$$

$$r_{curvature} = \sqrt{8\pi}\left(\frac{A}{Br}\right) = .181m$$

What makes this possible is that the new N-machines can easily generate a minimum of 6 million amps which is twice the value of the electrical current above.

[0007] Referring to **FIG. 3**, the assembly consists of a large induction motor (A) mounted on the train's base plate (B) driving a motor shaft (C) attached to the iron cylinder (D). The shaft is held in place by two thrust bearings mounted in two pillow blocks (E,F). The current-generating N-machine (G) is electrically connected by a copper bus (H) to a copper-beryllium brush (I) on the motor shaft with a similar return brush (J) on the edge of the iron cylinder. The current (K) flows through the motor shaft to the center of the rotating cylinder and then radially outward to the edge. The magnetic flux density flows from the north poles of the outer permanent magnets to the central south pole, along the central magnet to the center of the rotating cylinder and then radially outward to the south poles of the outer magnets.

[0008] The thrust F developed is the radius of curvature of spacetime r_c calculated above times the magnet flux density field times the current I

$$F = \frac{r_c B_r I}{\sqrt{8\pi}} \approx 30000lbf$$

Using conservation of tensor coordinates, the radius of curvature is in the z-direction, the magnetic flux density field is in the radial direction and the current is in the radial direction

$$F^z = x^z B_r I^r$$

where the radial indices cancel, leaving the z-index as the direction of the force.

SUMMARY OF THE INVENTION

[0009] It is the object of this invention to create a spacetime curvature in front of a train locomotive in order to pull the vehicle along the track It is known from gravitational physics that a spacetime curvature is generated perpendicular to the direction of vibration of the electric and magnetic field. A radial magnetic field, which can be produced by permanent magnets attached to the flat faces near the rim of a iron cylinder rotating about the z-axis, will create a curvature in the z-direction. Four cylindrical north-pole-oriented magnets produce a radial magnetic flux density with is channeled into a central cylindrical south-pole-oriented magnet. The flux lines then flow radially outward through the steel rotating cylinder and reconnect with the south poles of the four outer magnets. The rotating iron cylinder generates the equivalent of a magnetic vector potential when an electrical current flows from the center of the cylinder to the edge. This current is generated by an N-machine current generator. The square of the magnetic flux density divided by the magnetic vector potential is equal to the spacetime curvature. The square root of the inverse of the spacetime curvature is the radius of curvature. The thrust developed is this radius of curvature times the magnetic flux density field times the current.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1**. Perspective view of proposed permanent magnetic propulsion system using coil windings on the steel track.

[0011] **FIG. 2**. Perspective view of permanent magnet rotor assembly.

[0012] **FIG. 3**. Perspective view of system showing motor drive, N-machine and permanent magnet rotor.

[0013] **FIG. 4**. Perspective view of locomotive and rotor/magnet assembly.

DETAILED DESCRIPTION OF THE INVENTION

[0014] 1. The permanent magnets are made of neodymium-iron-boron material which is heated to its melt temperature and injection molded around a steel shaft threaded at one end while at the same time a pulsed magnetic field is applied to the material using a charge-discharge magnetizer. Because of the iron in the material, a coat of epoxy is applied to the magnet in order to protect it from the environment. Holes are drilled into the iron plate 90° apart near the rim, threaded, and then the steel shaft with the magnet is then inserted. Another hole is drilled and tapped in the center of the circular plate for attaching the south pole magnet which is used as the return path for the magnetic flux.

[0015] 2. Another easier way to make the magnets is to purchase short lengths of tubular NdFeB magnets and then stack them on the steel shaft with a cylindrical iron pole piece on the end of the shaft. The pole piece then holds the magnets down in place when the shaft is threaded into the plate.

[0016] 3. Referring to **FIG. 4**, the propulsion system is mounted inside the train cabin such that the rotor/magnet assembly extends out in front of the locomotive where the spacetime curvature is generated.

I claim:

1. A train propulsion system consisting of the following components:

a. a rotating iron cylindrical plate rotor of high relative permeability driven by an induction motor and horizontal steel motor shaft mounted in pillow block thrust bearings;

b. four cylindrical magnets, each molded to a steel support shaft threaded into the iron plate at 90° intervals around the rim of the plate with their north poles facing away from the plate;

c. a fifth cylindrical magnet molded to a steel support shaft which is threaded into the center of the iron plate with the south pole facing away from the plate;

d. an N-machine current generator supplying a radial electrical current from the center of the rotating plate by means of a copper-beryllium brush on the motor shaft (**1***a*) and another similar brush on the outside edge of the rotor.

e. a locomotive train on which the components are mounted such that the rotor/magnet assembly extends out in front of the locomotive with the rotor's angular velocity vector pointing along the track.

2. a closed magnetic flux path along a radial path in air from the north poles of the four outer magnets (**1***b*) to the south pole of the central magnet (**1***c*), through the center magnet and then radially outward through the rotor (**1***a*), returning back through the four outer magnets, such that the flux and electrical current (**1***d*) flow in the same outward radial direction through the rotor.

3. the creation of a spacetime curvature due to claims (**1***a* through **2**) that produces a large force on the locomotive equal to the radius of the spacetime curvature times the flux times the current.

* * * * *

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(54) WATER ENERGY GENERATOR

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(57) ABSTRACT

A water energy generator that generates electricity using a magnetic vortex wormhole generator and a water injector/vacuum chamber to produce low density hyperspace energy that causes the hydrogen atoms of water molecules to decay into electron pairs.

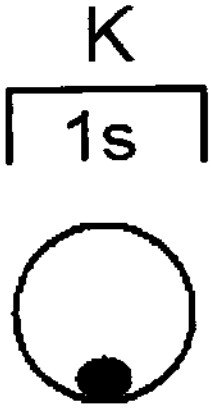

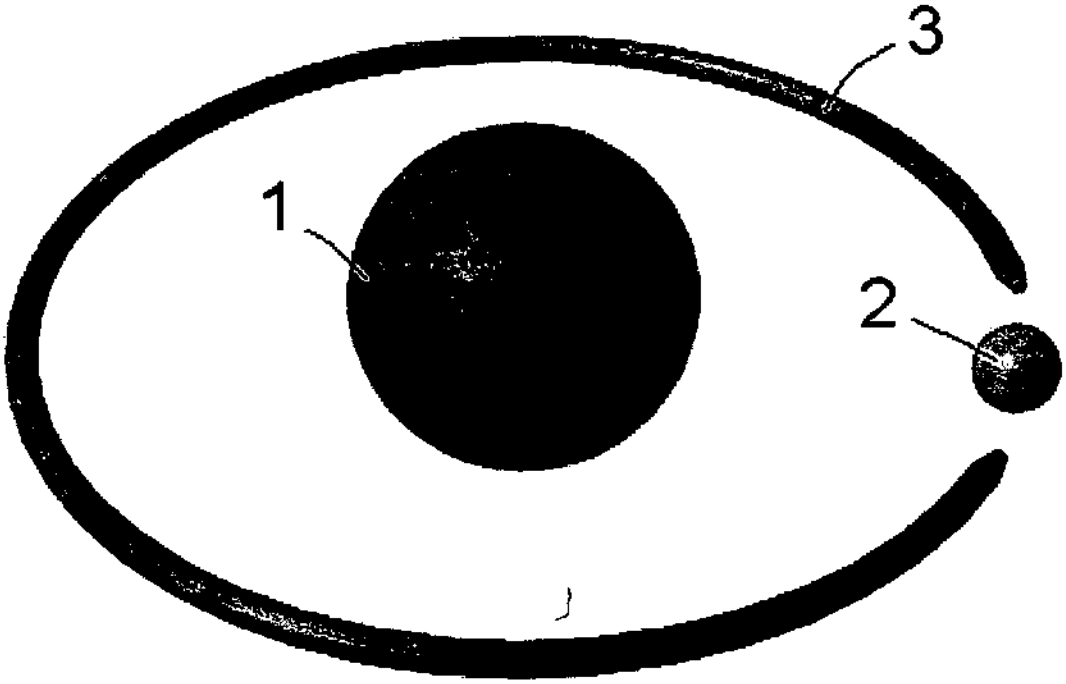

Figure 1

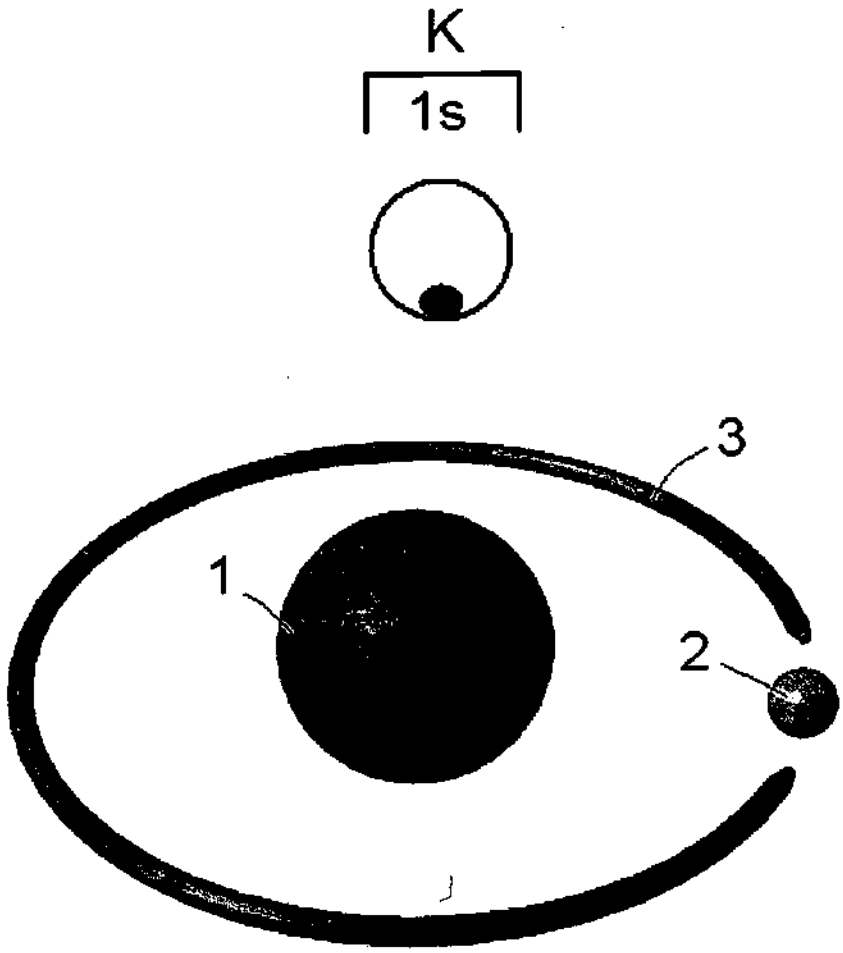

Figure 2

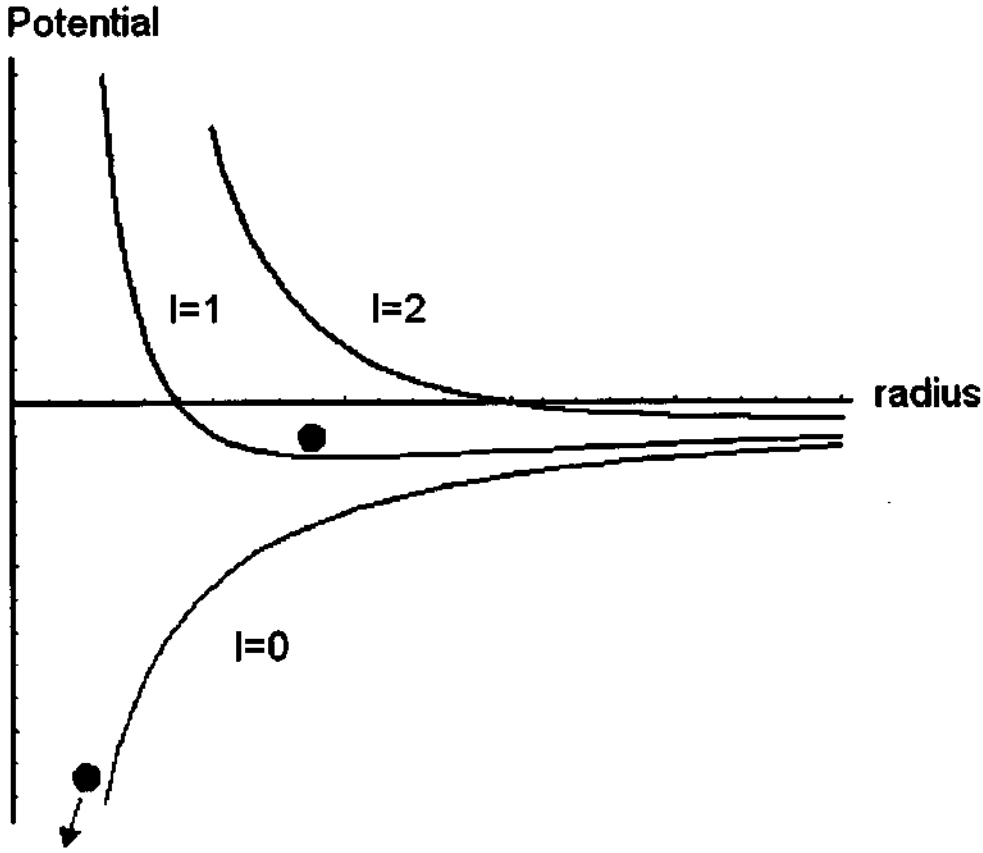

Figure 3

Figure 4

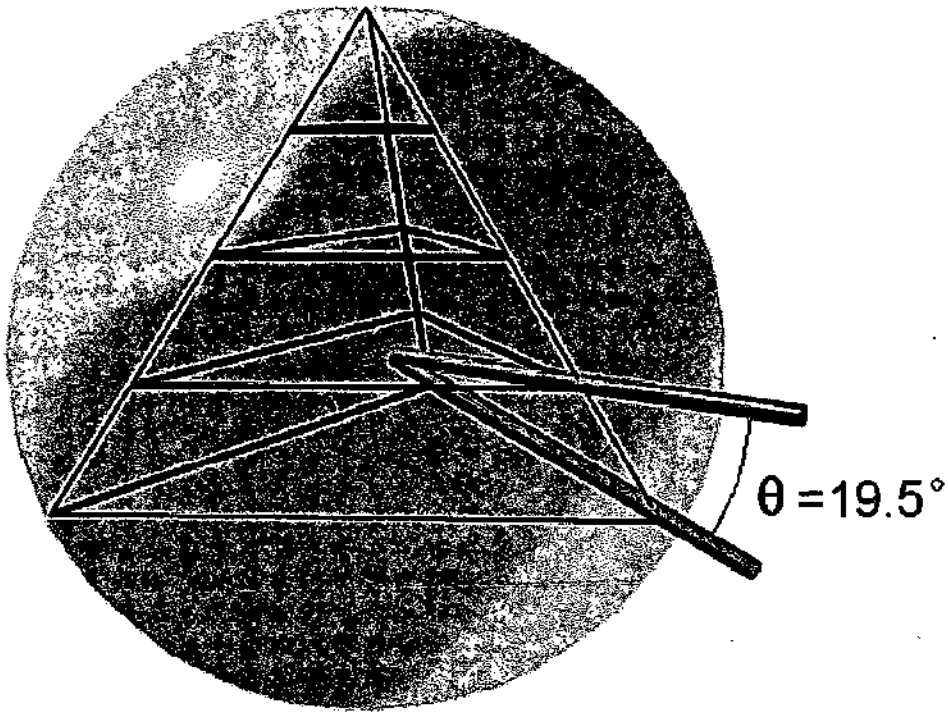

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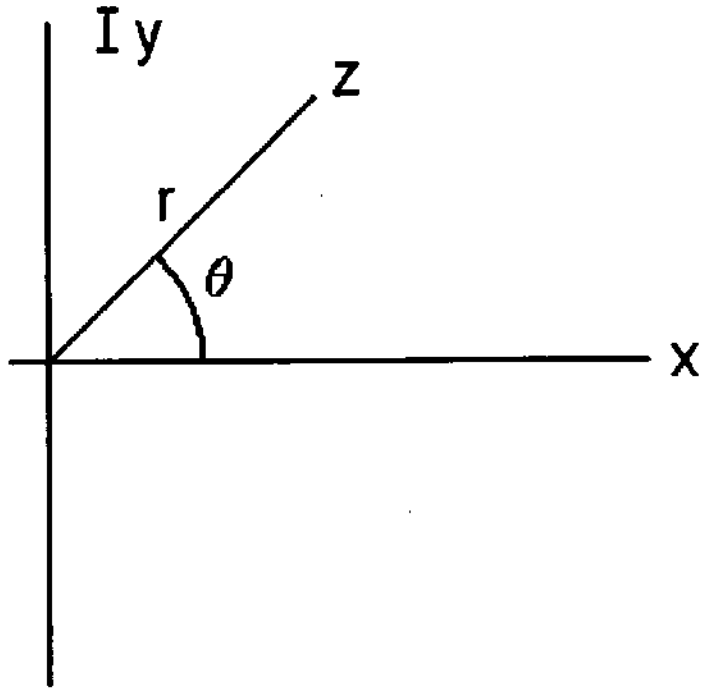

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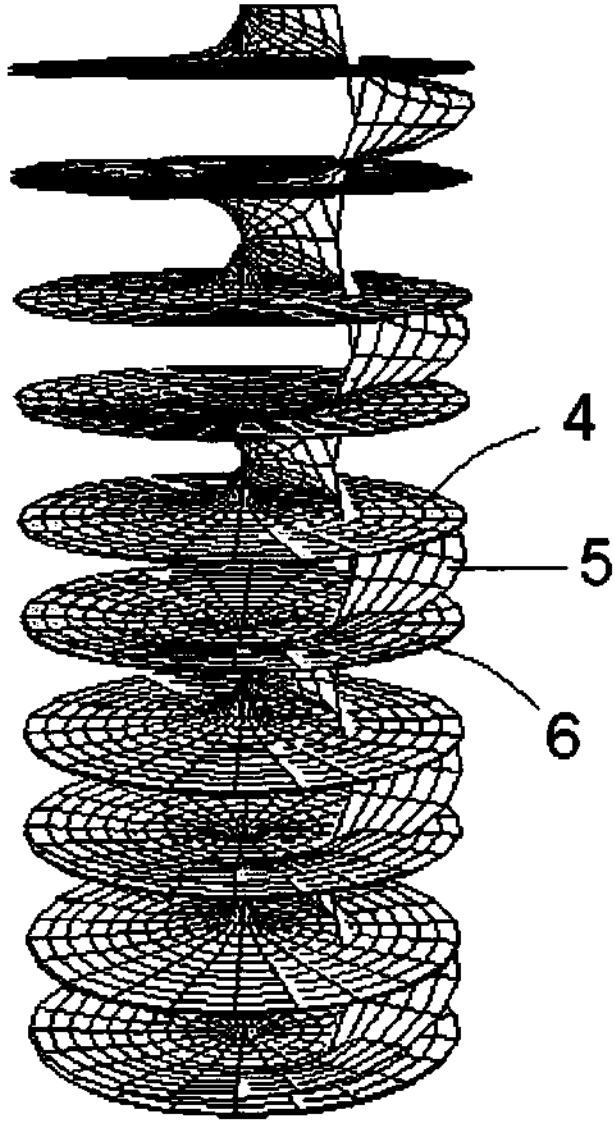

Figure 7

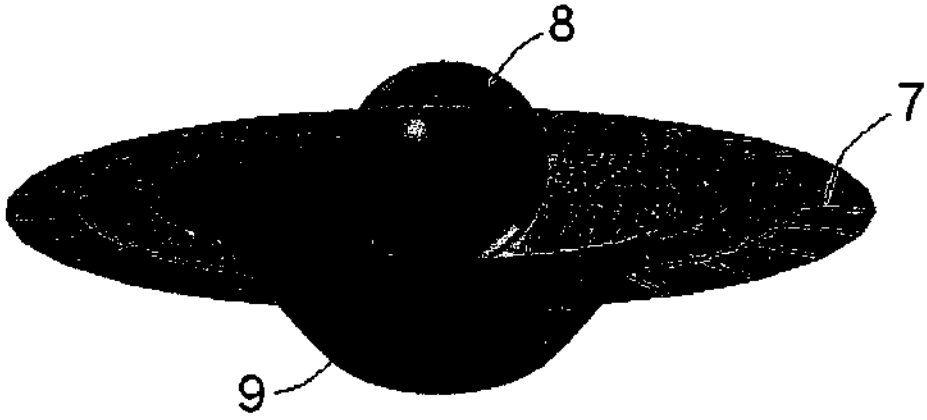

Figure 8

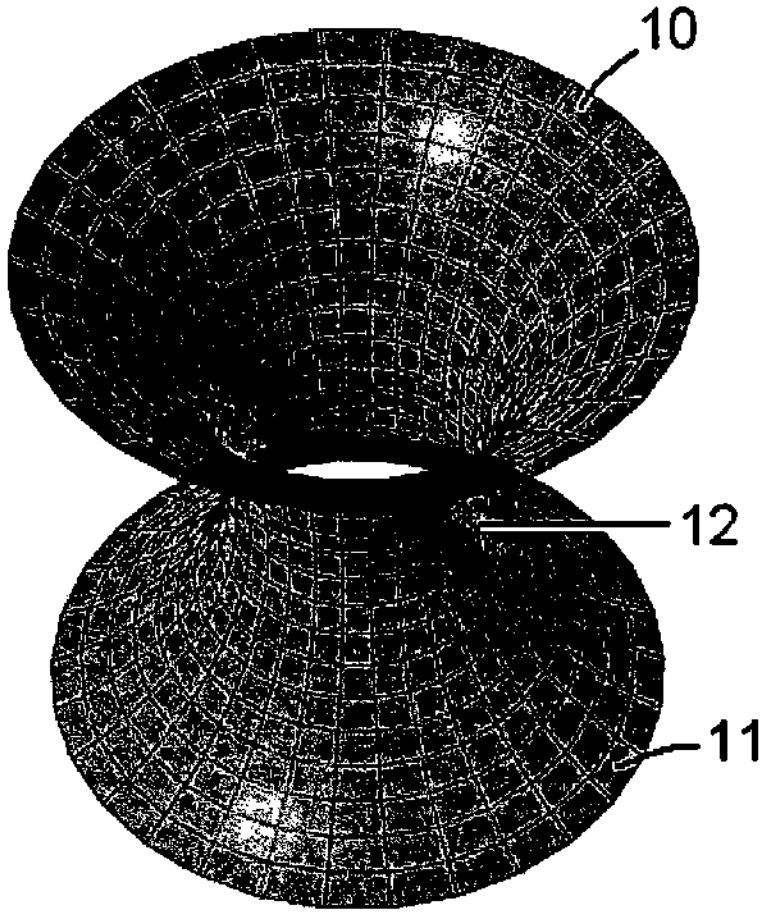

Figure 9

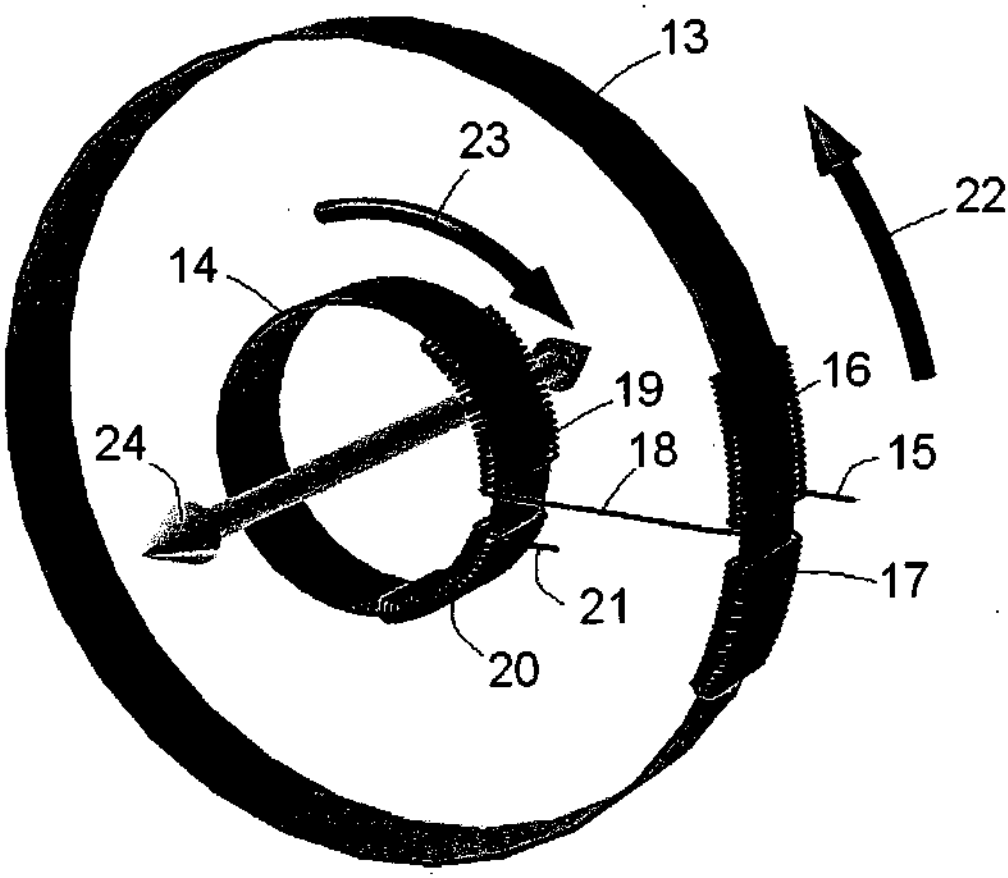

Figure 10

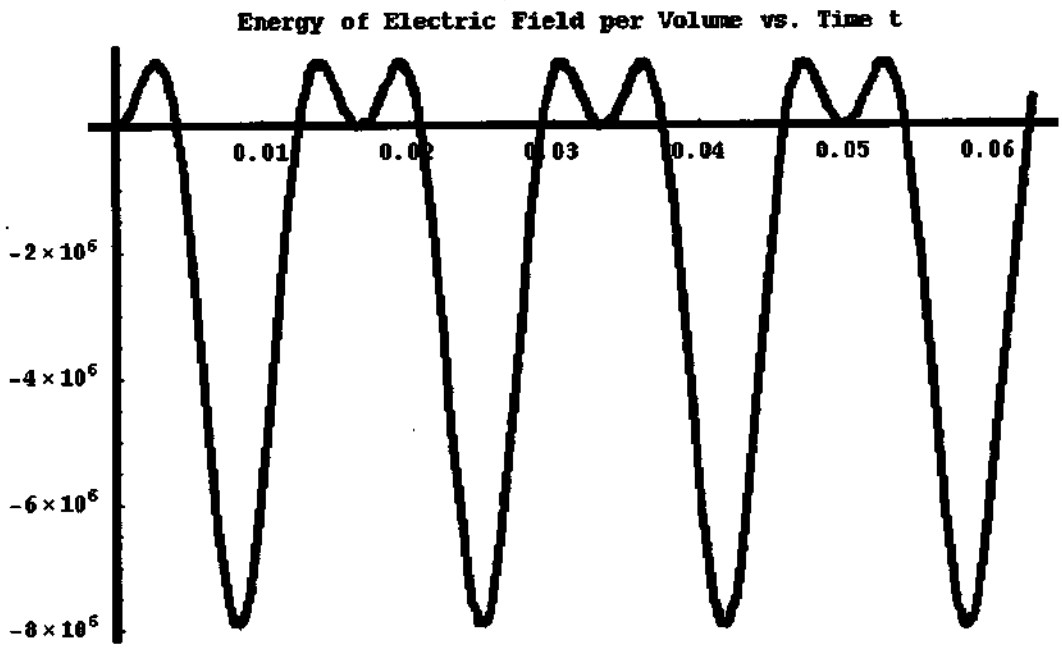
Energy of Electric Field per Volume vs. Time t
0.01
0.02
0.03
0.04
0.05
0.06
-2 × 10^6
-4 × 10^6
-6 × 10^6
-8 × 10^6

Figure 11

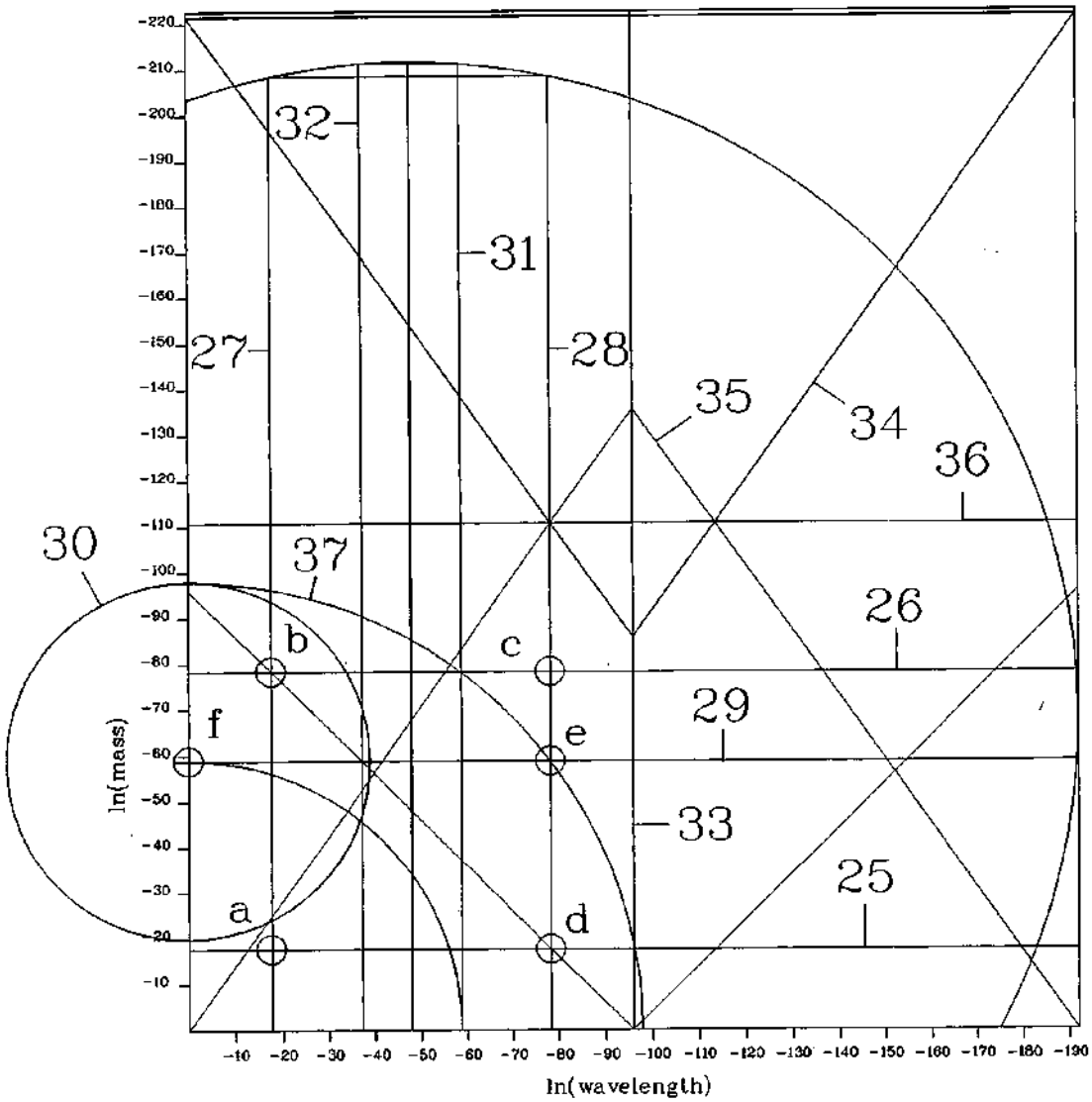
32
31
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28
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b
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f
e
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25
a
d
ln(mass)
ln(wavelength)

Figure 12

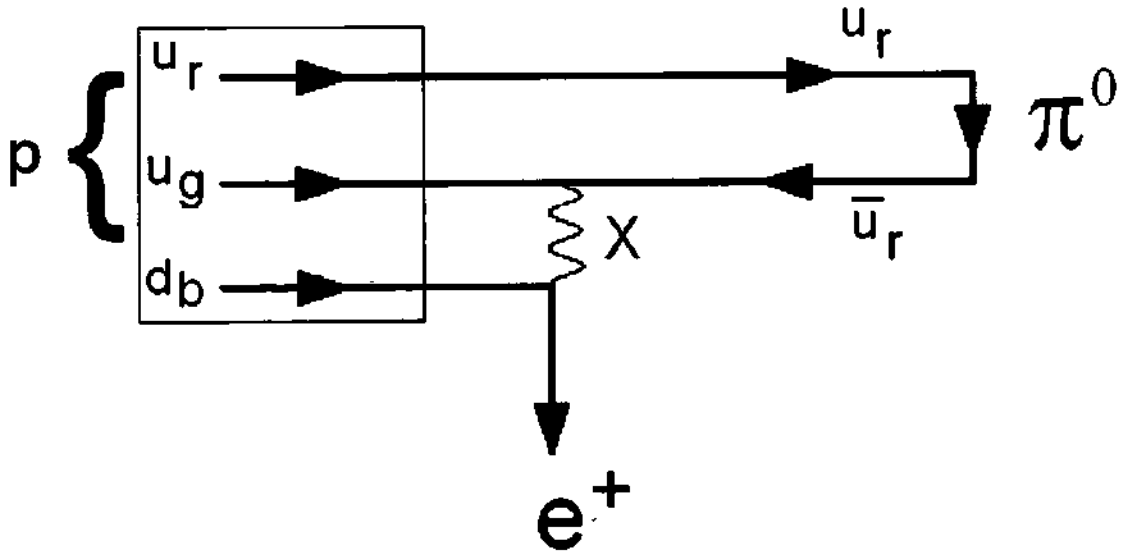

Figure 13

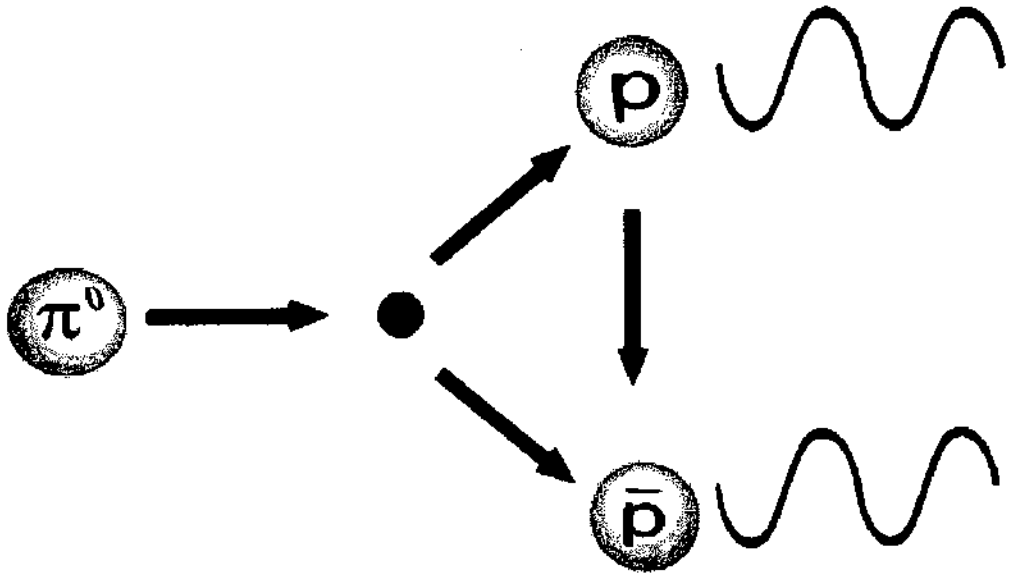

Figure 14

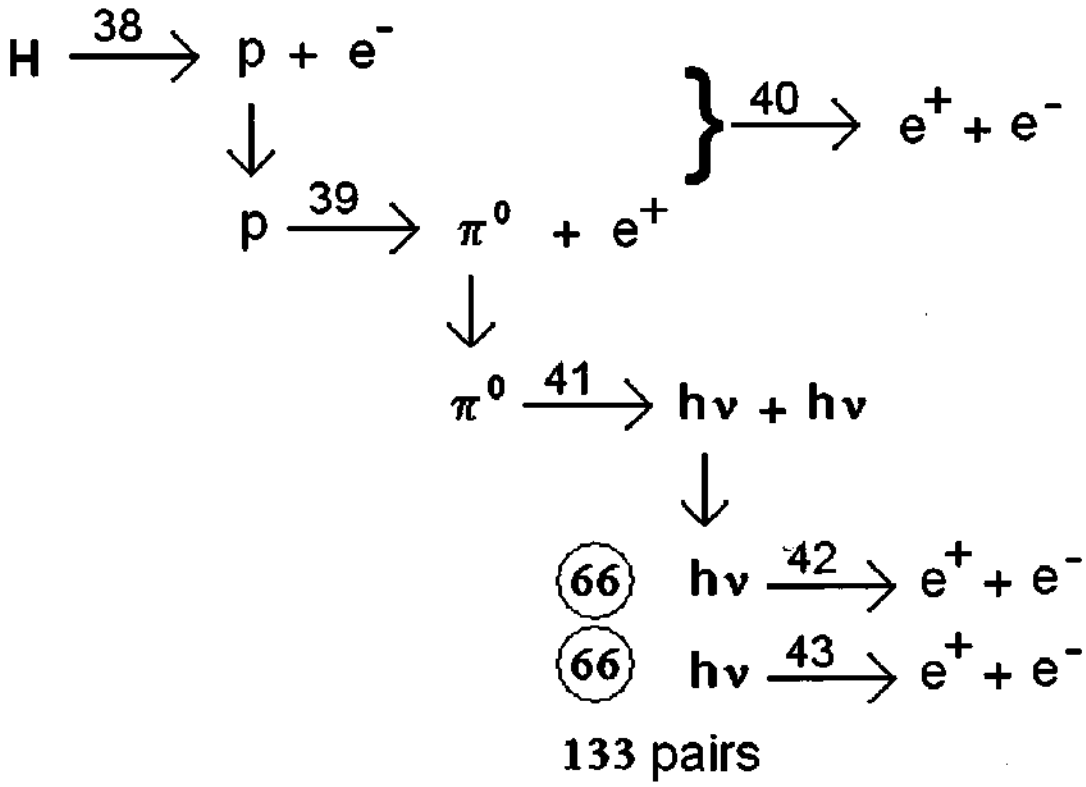

Figure 15

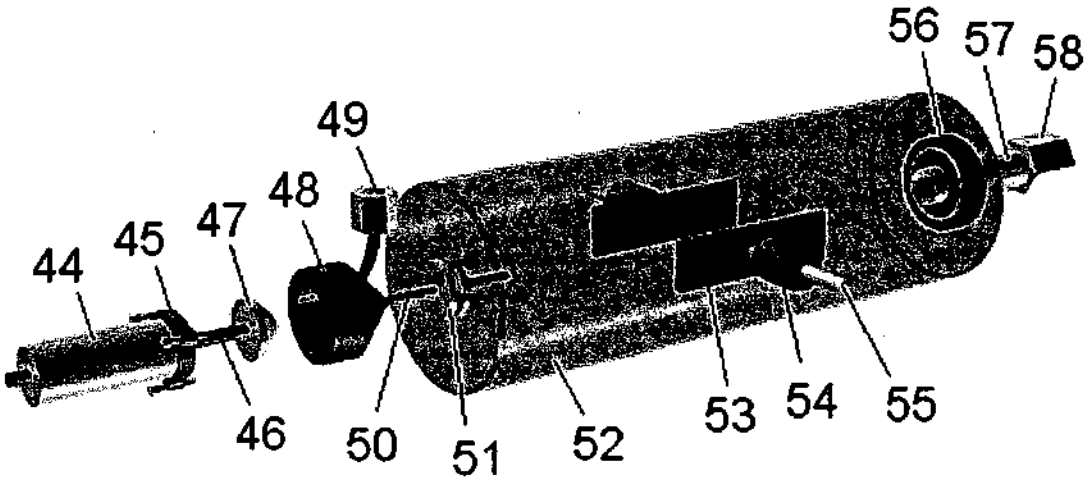

Figure 16

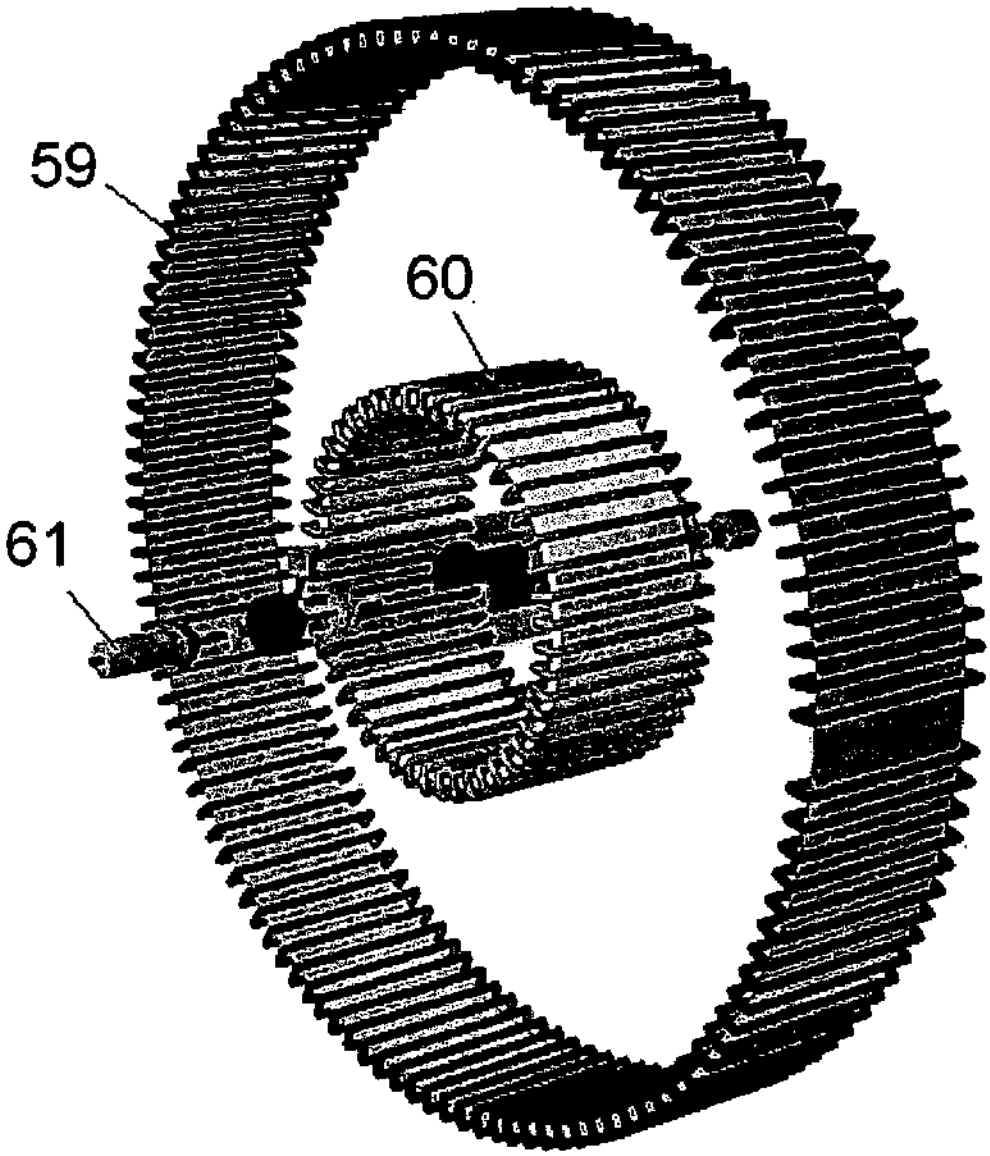

Figure 17

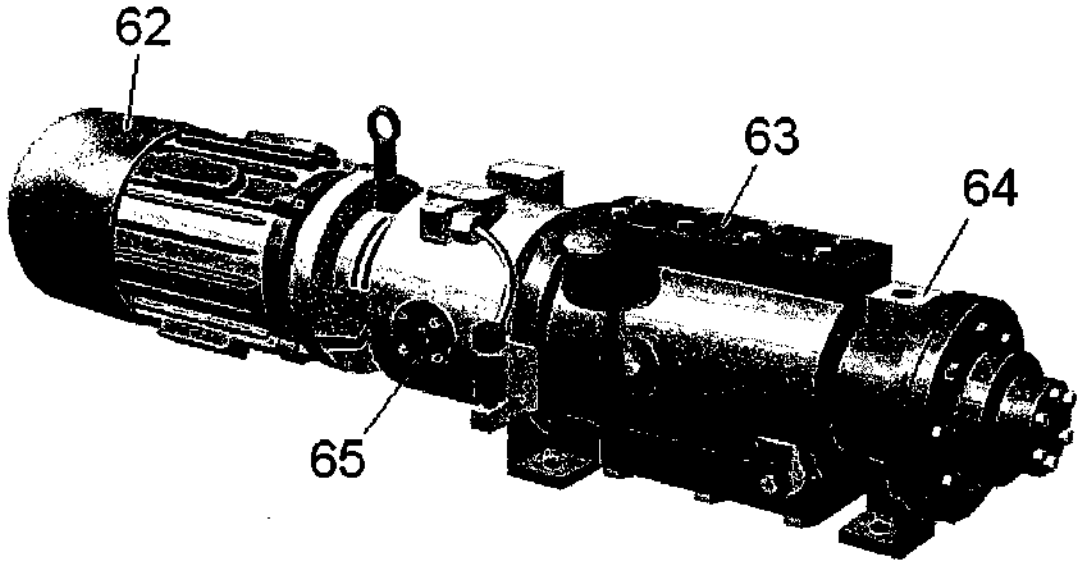

WATER ENERGY GENERATOR

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is an energy generator that uses the transition through wormholes of the hydrogen atoms of water molecules to break the bonds of the atoms and convert the protons into photons and electrons which can be collected for energy.

BACKGROUND OF THE INVENTION

[0002] A molecule of water consists of two hydrogen H atoms and one atom of oxygen O which has the chemical formula

H_2O

The hydrogen atoms can be separated from the oxygen atom by electrolysis. In this process, a direct current of electricity, such as from a battery, is passed through water decomposing it into hydrogen and oxygen. Pure water, however, is a poor conductor of electricity. It is therefore necessary to add some substance to form a solution that will conduct an electric current. Such a solution that will conduct electric current is called an electrolytic solution. A small amount of sulfuric acid or sodium hydroxide is added to the water to form an electrolytic solution. Water electrolyzed yields hydrogen plus oxygen

Water->hydrogen+oxygen

$2H_2O \rightarrow 2H_2+O_2$

Because this invention is to be used on spacecraft, the oxygen can be used for breathing and the hydrogen can be used to produce energy that will be used to create the electromagnetic fields which provide lift and propulsion.

[0003] Referring to **FIG. 1**, a single hydrogen atom consists of one proton (1) in the nucleus and one electron (2) moving in an orbital (3) around the nucleus. In quantum physics notation, there is only one main K shell and one orbital containing a single electron in the 1 s subshell. An orbital is an energy level containing one or two electrons in a subshell of an atom. Only a total of two electrons may be placed in one orbital with the added constraint that the electrons spin in opposite directions. Looking at the 1 s orbital, it can be seen that only half of it is occupied. What this means is that it is possible to add another hydrogen atom in which its electron occupies the other position in the orbital to from the hydrogen molecule H_2.

[0004] In 1925, a physicist by the name of Edwin Schrodinger developed a wave equation, which bears his name, that models the hydrogen atom. Even though the classical picture of **FIG. 1** showing a distinct electron orbiting the proton is easy to visualize, in reality the electron is a wavefunction Ψ whose square indicates the probability of finding the electron at a particular point. This then was the start of quantum physics where it was found that the electron energy can only take on certain discrete values.

[0005] A traveling wave moving in the positive x-direction can be represented by the function $\Psi_1=\Psi_1(x,t)$ of the form

$$\Psi_1=A_1 \cos(2\pi(x/\lambda-v\,t))$$

where x is the distance along the x-axis, A the wave amplitude, λ the monochromatic wavelength, v the velocity of the wave and t time.

[0006] A similar monochromatic wave moving to the left can be represented by

$$\Psi_2=A_2 \cos(2\pi(x/\lambda+v\,t))$$

where the sign of the velocity is reversed. The superposition of these traveling waves results in a standing wave, or stationary waves, of the form

$$\Psi=\Psi_1+\Psi_2=A \cos(2\pi x/\lambda) \cos(2\pi v\,t)$$

which is now a product of a spatial-dependent term A $\cos(2\pi x/\lambda)$, and a time-dependent term $\cos(2\pi v\,t)$. Taking the partial derivative of Ψ twice with respect to x

$$\frac{\partial^2\Psi}{\partial x^2}=-\left(\frac{2\pi}{\lambda}\right)^2\Psi$$

The momentum p of a particle is equal to Planck's constant h divided by the mass m of the particle

$$p=h/\lambda=\frac{2\pi h}{\lambda}$$

where h bar is the reduced Planck constant. Thus Schrodinger's equation can be written as

$$\frac{\partial^2\Psi}{\partial x^2}=-\frac{p^2}{\hbar^2}\Psi$$

For a particle whose potential energy is V(x), the total energy is the kinetic energy K plus the potential energy

$$E=K+V=(p^2/2m)+V$$

Therefore,

$$p^2=2\,m\,(E-V)$$

and Schrodinger's equation becomes

$$\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2}+(E-V)\Psi=0$$

The potential V is just the Coulomb potential of the product of two charges e divided by the radius r between them

$$V=\frac{e^2}{4\pi\epsilon r}$$

where ϵ is the linear capacitance of space. A general wavefunction can be separated into a radial R part and a spherical harmonics part Y

$$\Psi=R_{n,l}Y_{l,m}(\theta,\phi)$$

where the first term is called a radial wavefunction which describes the "in-out" motion of the electron. When Schrodinger's equation is separated, it is found that the radial part of the wavefunction, R, must be a solution of the quantized differential equation

$$\frac{\hbar^2}{2mr}\frac{d^2(rR)}{dr^2}+\left(E-\frac{l(l+1)\hbar^2}{2mr^2}+\frac{e^2}{4\pi\varepsilon r}\right)R=0$$

This can be expressed in a simpler form by defining the function

$$f=rR$$

which is then found to satisfy the equation

$$\frac{\hbar^2}{2m}\frac{d^2f}{dr^2}+(E-V_{eff})f=0$$

where the effective potential is given by

$$V_{eff}=\frac{l(l+1)\hbar^2}{2mr^2}-\frac{e^2}{4\pi\varepsilon r}$$

where the l's are the quantum orbital numbers. For s orbitals equal to l=0, the effective potential is just the electrostatic potential of the nucleus. For l greater than zero, the first term is equal to the kinetic energy owing to the angular motion of the electron at a distance r and with angular momentum √l(l+1)h.

[0007] Referring to **FIG. 2**, the effective potential is graphed as a function of radius r and the orbital numbers. For orbital number l=0, which is the lower of the three curves, the potential does not provide a stable position for the electron (black disk) and the negatively-charged electron just crashes into the positively-charged proton nucleus as shown by the arrow. For orbital l=1, the first term is called the centrifugal repulsion which together with the electrostatic potential provides for a stable position for the electron as seen in the middle curve. The potential energy is negative which creates a slight valley in which the electron obtains a stable orbit. Higher orbital numbers l=2 produce a similar valley potential further out on the radius. The l=1 orbital does not allow the electron to come near the proton which provides for a stable hydrogen atom. So the key to this invention is how to destabilize this hydrogen atom energy system and produce usable energy which can propel the electromagnetic spacecraft and run other hyperspace inventions. Refer to my patent applications such as Dipole Moment Spacecraft, Dual Potential Hull Spacecraft, Photon Spacecraft, Electromagnetic Field Propulsion System, Full Body Teleportation, Magnetic Vortex Wormhole Generator, Electric Vortex Wormhole Generator, Sulfur S8 Wormhole Generator, Cavitating Oil Hyperspace Energy Generator, Rotor Inductance Propulsion System and Triangular Spacecraft.

[0008] Many of these patent applications involve wormholes and hyperspace which are not well-known concepts in the scientific community. Hyperspace consists of those dimensions which are co-dimensional with our spacetime. The reason I know about hyperspace is because (1) I have been in hyperspace on a number of occasions and have experienced Einstein's time dilation according to his General Theory of Relativity, (2) I have experienced more than one full-body hyperspace teleportation over a distance of 100 meters, (3) we have been able to create a wormhole between space and hyperspace with the magnetic vortex wormhole generator in which smoke was blown through one side of the coil into hyperspace, a first contact verified by the Grey Aliens, (4) I have seen the green mist associated with moving out of dimension and crossing over into hyperspace, (5) I have looked into another dimension and have seen another building, a car and a man who waving at me in the presence of an artificially-intelligent Cyborg with the "high-tech look" from the Pleiadian Defense Department, (6) I can remote view through hyperspace subgeometry to distances of 100,000 light years to the edge of the galaxy and have made first contact with around 500 extraterrestrial civilizations involving the use of patent applications such as Remote Viewing Amplifier, Quantum Dot Energy Cylinder and Walking Through Walls Training System, (7) I am the only person on Earth who has communicated with the designers of the crop circles found in England and explained their design to them in terms of subspace geometry, (8) I can walk through walls as a hyperspace energy being, and (9) I have discovered how anti-gravity is possible using low density hyperspace energy, not to mention all the other research work on these electromagnetic field propulsion vehicles. For my work in developing the geometry of the subspace manifold known as the tetrahedron diagram, I was given the Aphysics award by the Admiral, who is third in line to the Admiralty of the Pleiadian Defense Department. For my work in Revelations, she awarded me four beautiful galloping white riderless horses of the Apocalypse. The reason that the Pleiadian Defense Department was involved was that the Admiral had the task of creating the energy being that would protect the subspace manifold during the battle of Revelations which took place in the year 2001. So these are some of my personal experiences in the field of hyperspace physics.

[0009] As to the scientific aspect of hyperspace physics, observations of the solar system have noted that large vortices occur on the planets at a latitude of ±19.5°. On the planet Jupiter, for example, the Giant Red Spot vortex, which is the size of two planets like Earth, is located at −19.5° latitude.

[0010] Referring to **FIG. 3**, the Olympus Mons volcano, which is the size of France, occurs in the northern hemisphere at 19.5°. The plume of volcanic ash can be seen being blown to the upper right.

[0011] Here on Earth, just north of me at +19.5° in the Caribbean, there is a slow moving rock mantle vortex that curves the islands down toward Venezuela. Since the tetrahedron has three corners, another corner occurs at 120° to the west where the Marshall Islands are located. The reason that the volcanic islands form is that low density hyperspace energy softens the atoms and molecules to such an extent that the atomic bonds are broken. The hot magma from the core has an easier path to the surface through the soft rock compared to the hard rock of surrounding areas. As the vortex rotates, the rising hot magma creates volcanoes which form the chain of islands.

[0012] As another example of this, the Silver bridge, which is located at a double harmonic of 39° between Ohio and West Virginia, collapsed because a large wormhole

opened up and flooded the bridge with low density hyperspace energy. The metal rivets softened and pulled out of the plates holding down the suspension cables. Thus the roadway tilted to one side and all the cars fell into the river.

[0013] If you look at the quarried granite polygonal megalithic stone blocks that were used to build Machu Picchu, the blocks are put together as though they were soft putty. They fit together perfectly. Machu Picchu, or Great Picchu, is the Quichua name for a sharp peak which rises ten thousand feet above the sea. How this was achieved is described in my patent application *Rotating Magnetic Vortex Generator* which shows that rotating permanent magnets can create a wormhole between space and hyperspace. The low density hyperspace energy then floods the block as to make it weightless. The block is then floated up from the quarry which is 2500 feet below Machu Picchu. The huge 1000-ton blocks found in the platform at Baalbek in the Cedar Mountains of Lebanon were also lifted into position in this manner.

[0014] Using a technique called Chi Kung breathing, not necessarily known to the Chinese, one of our researchers has been able to levitate himself to a height of six feet. He might have gone higher but he lost his balance and his arm touched a nearby metal pipe. He then floated back to the ground. Contracting the abdominal muscles causes hot air to rise in the lungs while at the same time cold air is inhaled through the nose. This combination of hot and cold air mixing together creates environmental oscillators having a temperature fluctuation. This changes Planck's constant such that the body goes out of dimension and low density hyperspace energy fills the body.

[0015] The final example comes from Biblical times. Jesus and his father Joseph were both carpenters. A chair that Joseph had made for a client was found to be too small. So Jesus placed his hands on either side of the chair and stretched the chair to fit. The phrase in Spanish is "mas silla" which means that Jesus made more chair. In the dictionary, the Spanish word for putty is "masilla." The reason that Jesus could do this is that he passed hyperspace energy through his hand vortices which softened the wood. See my patent application called *Hyperspace Torque Generator* which shows this in more detail. The hand vortex is actually a planar co-gravitational K field that can rotate a pendulum around in circles. This solenoidal field corresponds to the magnetic H field. The electric field corresponds to the linear gravitational g field. The equations are identical for both sets of fields. I learned that Jesus actually reincarnated here on Earth in order to identify the planet on which the battle of Revelations would take place.

[0016] In summary, these are some examples as to how low density hyperspace energy can soften and break the bonds of atoms and molecules.

[0017] As mentioned previously, the astronomical observations suggest that the structure of the universe is related to the tetrahedron. Referring to **FIG. 4**, the corners of a tetrahedron circumscribed by a sphere, touch the sphere at an angle of 19.47122063°. The ratio of the area-to-volume ratio of the sphere to the area-to-volume ratio of the tetrahedron is ⅓ which is the magic ratio in physics. The arcsin(⅓) is 19.47°.

[0018] In order for all the physics constants to be projected into our universe and the co-dimensional hyperspace dimensions, there has to be a tetrahedral subspace manifold. The only mathematical function which allows multiple rotations of the complex plane is the logarithmic function Log[z].

[0019] Referring to **FIG. 5**, the complex number z in the complex plane is equal to x+I y where x and y are real constants and $I^2=-1$. The complex number z can also be written in terms of a radius and an angle

$$z=r\,\mathrm{Exp}[I\,\theta]$$

Because the angle can rotate more than once in 2π m multiples, the complex number z is actually

$$z=r\,\mathrm{Exp}[I(\theta+2\pi\,m)]$$

Taking the logarithm of z

$$\mathrm{Log}[z]=\mathrm{Log}[r]+I(\theta+2\pi m)$$

[0020] Referring to **FIG. 6**, it can be seen that it is not possible to go around multiple times on the same surface due to a branch cut along the origin where Log[0] is undefined. What happens is that as you rotate around on surface (4) and get to the origin, you go down along the branch (5) to the next hyperspace plane (6). Thus the universe is composed of many hyperspace co-dimensions. From personal experience, I estimate that the distance separating the two dimensions is about 3 meters when I was looking into another dimension at the man waving at me. The physics is even more complicated because there is a Lorentz dimensional transformation in which higher dimensions appear smaller and lower dimensions appear larger. In one case I was looking at a huge mothership at a much higher dimension and it looked like a tiny toy model spacecraft. They fired a laser cannon at me, and I then curved space which made the beam change course. You can see why I was awarded the four horses.

[0021] The antilog of Log[z] is

$$e^{\mathrm{Log}[z]}=z=re^{I\,\omega t}$$

where the angle is the angular frequency ω times the time t. The subspace geometry remains stationary or fixed, but the projection of the antilog into our dimension generates a system which is frequency dependent. This is why we get oscillating fields.

[0022] From Einstein's General Theory of Relativity, it is known that various kinds of energy can curve spacetime such as mass, electromagnetic fields, angular momentum and electrical charge. The elemental spacetime length ds in cylindrical coordinates {t,r,θ,z}, known as the Schwarzschild metric, shows that spacetime can be curved using mass M and charge Q

$$(ds)^2=-(dt)^2\left(1-\frac{2M}{r}+\frac{Q^2}{r^2}\right)+\frac{dr^2}{\left(1-\frac{2M}{r}+\frac{Q^2}{r^2}\right)}+(rd\theta)^2+(dz)^2$$

where you can see that the elemental time dt is dilated by the mass M and the elementary radius dr is reduced. I have actually experienced this time dilation in which, as I was jumping into hyperspace, I was hit by a car which broke my shoulder. When I came back into dimension which appeared to be a few seconds later, I found that I had an 8-inch blood ring down the right side of my chest. My shoulder blade, which sticks up about two inches, is still broken to this day.

[0023] Referring to **FIG. 7**, flat space (**7**) can be curved (**9**) by a massive body (**8**) such as a planet. For example, the mass of the Earth gives space a negative curvature such that objects tend to fall toward the center of the mass (bowl). On the other hand, using electromagnetic fields, it is possible to produce a positive curvature such that a spacecraft rises by falling upward.

[0024] Referring to **FIG. 8**, if the fields are intense enough, then a wormhole (**12**) forms between space (**10**) and hyperspace (**11**). This depiction is called an embedding diagram because there is no open space going through the wormhole. An object traversing the wormhole moves along the surface from one dimension to another. In order to open the throat (**12**) of the wormhole, negative energy is required. Referring to my patent application Dual Potential Hull Spacecraft, negative energy is produced by the interaction of a microwave beam with an oscillating magnetic H field. In terms of differential forms mathematics, this is given as the Hodge Star * of the differential d of the wedge ^ product of the magnetic H field with the electromagnetic wave {B,E}

$$*d(H\wedge(B+E\wedge dt)) = \frac{\partial(-\rho)}{\partial t}$$

which says that there is an increasing rate of change of negative energy (−ρ). Due the presence of negative energy together with the spacetime curvature pressure produced by the electromagnetic fields, wormholes open up between space and hyperspace. There is a positive gravitational potential between hyperspace and space because the low density hyperspace energy is more dense than the negative energy in this dimension. Thus the hyperspace energy flows into our dimension which reduces the mass of the spacecraft. The upward spacetime pressure stress over the hull due to the electromagnetic fields creates a lift force on the nearly massless vehicle. Because the hyperspace energy has a speed of light equal to one meter per second, the electromagnetic fields become relativistically strong since they obey the Lorentz transformation. Due to the low mass, high spacetime lift pressure and strong EM fields, the vehicle can attain very high rates of acceleration.

[0025] Another method to produce a wormhole is to use bucking magnetic fields which is described in my patent application *Magnetic Vortex Wormhole Generator*. In gravitation physics, the Faraday F tensor, which is a 4×4 spacetime metric {t,x,y,z}, contains all the components of the electromagnetic fields in the various spatial directions {x,y, z}

$$F^{\alpha}_{\beta} = \begin{array}{c} t \\ x \\ y \\ z \end{array}\begin{vmatrix} 0 & E_x & E_y & E_z \\ E_x & 0 & B_z & -B_y \\ E_y & -B_z & 0 & B_x \\ E_z & B_y & -B_x & 0 \end{vmatrix}$$

where contravariant index a refers to the rows, and the covariant index β refers to the columns. For example, the component $F^{t}_{x}=E_x$ is the electric field in the x-direction. If there were two magnetic bucking fields in the x-direction the Faraday tensor would be

$$F^{\alpha}_{\beta} = \begin{array}{c} t \\ x \\ y \\ z \end{array}\begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & B_x - B_x \\ 0 & 0 & -(B_x - B_x) & 0 \end{vmatrix} = \begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{vmatrix}$$

which says that the Faraday tensor is zero. Thus no spacetime curvature is generated from two bucking magnetic fields at the same position. On the other hand, if the two bucking magnetic fields are concentric at different radii, then the Faraday tensor becomes

$$F^{\alpha}_{\beta} = \begin{array}{c} t \\ x \\ y \\ z \end{array}\begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & B_x\delta(x_1) - B_x\delta(x_2) \\ 0 & 0 & -(B_x\delta(x_1) - B_x\delta(x_2)) & 0 \end{vmatrix}$$

which is not zero due to the presence of the Kronecker δ delta function which locates the fields at different positions. The spacetime stress-energy-momentum tensor T is then computed from the following equation

$$4\pi T^{\mu\nu} = F^{\mu\alpha}F^{\nu}_{\alpha} - \frac{1}{4}g^{\mu\nu}F_{\alpha\beta}F^{\alpha\beta}$$

where g is the metric tensor containing the coefficients of the elemental spacetime length ds. With the mass M and charge Q term equal to zero, there being just electromagnetic fields involved, the g metric tensor in cylindrical coordinates becomes

$$g_{\alpha\beta} = \begin{array}{c} t \\ r \\ \theta \\ z \end{array}\begin{vmatrix} -\left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right) & 0 & 0 & 0 \\ 0 & \left(1 - \frac{2M}{r} + \frac{Q^2}{r^2}\right)^{-1} & 0 & 0 \\ 0 & 0 & r^2 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} = \begin{vmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & r^2 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

[0026] Referring to **FIG. 9**, the magnetic vortex generator has two concentric, thin, flat cylindrical silicon-iron cores (**13**,**14**), each consisting of a stack of three 0.020 inch thick transformer laminations wrapped with insulating tape. Using insulated magnetic wire, a flat helical coil (**16**) is wrapped counter-clockwise around the outer laminations. The coil receives power through connection (**15**). The winding then continues around the core until coil (**17**) where the wire (**18**) is extended to the inner core and the wrapping of coil (**19**) proceeds in the clockwise direction. The inner core wrapping terminates on coil (**20**) with the extension of the second power connection (**21**). Because the coils are wound in

opposite directions, the generator produces two bucking magnetic fields at different radii (**22**,**23**).

[0027] According to Maxwell's electromagnetic equations, the curl of the magnetic flux density B field times the square of the speed of light squared is equal to the rate of change of the electric E field

$$c^2\nabla xB = \frac{\partial E}{\partial t}$$

Multiplying both sides by the elemental area of the core and integrating over the area

$$c^2\int_0^{r_0}\nabla xBdA = \frac{\partial}{\partial t}\int_0^{r_0}E\cdot ndA = \frac{\partial}{\partial t}\int_0^{r_0}E\cdot n2\pi rdr$$

The curl of the field can be converted into a line integral around the core contour using Stokes' Theorem

$$c^2\int_0^{r_0}\nabla xBdA = c^2\oint_{r_0}B\cdot ds = c^2\int_0^{2\pi}Br_0d\theta$$

[0028] The magnetic flux density B field oscillates with angular frequency ω

$$B=B_0e^{i\omega t}$$

Substituting this into the equation and integrating over time for the inner core field

$$-c^2\int_0^{t}\int_0^{2\pi}B_0e^{i\omega t}r_0d\theta = \int_0^{r_0}E2\pi rdr = E\pi r_0^2$$

This can be solved for the electric E field that is produced by the oscillating magnetic flux density B field

$$E_0 = \frac{2iB_0c^2(-1+e^{i\omega t})}{r_0\omega}$$

The electric field for the outer core is the same equation except that the opposite sign of the magnetic flux density B field and the radius r**1**

$$E_1 = \frac{-2iB_0c^2(-1+e^{i\omega t})}{r_1\omega}$$

Adding these two fields together is the total electric field E

$$E = E_0 + E_1 = \frac{-2B_0c^2(-1+\mathrm{Exp}(i\omega t))(r_0-r_1)}{r_0r_1\omega}$$

The electrostatic energy of the field is equal to half the linear capacitance of space times the summation over the volume of the dot product of the electric field with itself

$$U = \frac{\varepsilon}{2}\int E\cdot EdV$$

Because the electric field points in the z-direction out of the coil, the dot product is actually the square of the electric field.

[0029] Referring to **FIG. 10**, the energy U per volume is plotted as a function of time with a radius ratio r_1/r_0 of 3/1. As the graph shows, the magnetic vortex wormhole generator produces mostly negative energy which is required in order to create the wormholes. Because the stress-energy-momentum T tensor is also the square of the electric field, this graph gives the spacetime curvature pressure. Thus the electric field produces both the pressure and negative energy required to open up wormholes between space and hyperspace.

[0030] Going back to the effective potential equation,

$$V_{eff} = \frac{l(l+1)\hbar^2}{2mr^2} - \frac{e^2}{4\pi\varepsilon r}$$

it can be seen that the first term is divided by the mass of the particle. In current gravitation physics, the mass of the particle is invariant with velocity. It does not obey the Lorentz transformation. The mass is related to the energy E of the particle and its momentum p by

$$m^2=E^2-p^2$$

In different inertial frames moving with a relative velocity v, the energy and the momentum obey the Lorentz transformation, but no matter what the relative motion, the mass of the particle is constant. In the first term of the effective potential, the mass is constant which leaves just Planck's constant.

[0031] Having worked for over ten years on the subspace manifold, known as the tetrahedron diagram, I found a most incredible intersection on the diagram when working with the water molecule. The water molecule has two hydrogen atoms and one oxygen atom as mentioned previously. The atomic weight of one atom of hydrogen is 1.008 atomic weight units (awu). The atomic weight of oxygen is 16.000 awu. Therefore the molecular weight of water is

$$\text{Weight of two atoms of hydrogen } 2\times1.008\ awu = 2.016\ awu$$

$$\text{Weight of one atom of oxygen } 1\times16.000\ awu = \frac{16.000\ awu}{18.016\ awu}$$

The gram molecular weight is the atomic weight expressed in grams, so there are 18.016 grams in Avogadro's number of molecules. So the mass per molecule in logs is

$$\mathrm{Log}\left[\frac{18.016\ \mathrm{gram-mol}\Big/\left(1000\ \frac{\mathrm{gm}}{\mathrm{kg}}\right)}{6.02\times10^{23}\ \mathrm{mol}}\right]=-58.77103943$$

[0032] Referring to **FIG. 11**, the tetrahedron diagram plots the natural logarithm of mass versus the natural logarithm of wavelength. The reason for this is that mass times wavelength is equal to Planck's constant divided by the speed of light c, known on the diagram as the base constant. At the present time there are over 4000 diagrams which are copyrighted in the Library of Congress. In logarithms, the product of two numbers is the sum of the two numbers. This means that the sum of the mass and the wavelength are equal to the base constant which has a value of

$$\ln[m]+\ln[\lambda]=\ln[h/c]=-95.91546344=\text{base constant}$$

Our dimension has a lower limit on mass and length known respectively as the Planck mass and the Planck wavelength. The Planck mass is the linear mass Ω of the universe times the Planck scale Λ. The Planck wavelength is circumference of a circle of radius Planck scale. In terms of logs, the Planck mass and Planck wavelength are

$$\text{Planck mass}=\ln(\Omega\Lambda)=-17.64290101$$

$$\text{Planck wavelength}=\ln(2\pi\Lambda)=-78.27256243$$

[0033] When these values are plotted on the tetrahedron diagram shown in **FIG. 11**, the Planck box (abcd) is formed which are the boundaries of our dimension in subspace. The line numbering is as follows

Planck mass	25, 27
Planck wavelength	26, 28
mass of water molecule	29, 31
speed of light squared circle	30
base constant	33
inverted tetrahedrons	34, 35
centerline	36

The energy of the water molecule, circle (**37**), is equal to the sum of the water molecule mass (**29**) plus the speed of light squared circle (**30**). The energy circle (**37**) intersects the mass of the water molecule (**29**) at the Planck wavelength (**28**, point e), which is the boundary between space and hyperspace. What this means is that the mass is equal to the energy at the Planck box boundary. The only way that this is possible is if the speed of light c is equal to one meter per second

$$E=m\ c^2=m\ c=1\ \text{meter/second}$$

A water molecule traversing a wormhole into hyperspace undergoes a change in the speed of light from 299792458 m/s to 1 m/s.

[0034] Planck's constant h is equal to the Planck mass ΩΛ times the Planck scale Λ times the speed of light c.

$$h=\Omega\Lambda\Lambda c$$

By having the speed of light go to 1 m/s, the orbital term in the effective potential V_{eff} is reduced by a factor of the speed of light squared equal to 9×10^{16}. This unbalances the equation to such an extent that only the Coulomb potential term remains.

$$\frac{l(l+1)\hbar^2}{2mr^2}\ll\text{coulomb term}$$

The electron is attracted to the proton nucleus because the centrifugal term no longer provides a stable orbit for the electron. Thus the atomic binding is destroyed and the water molecule becomes soft as putty.

[0035] Referring to **FIG. 12**, the collision of the electron with the proton together with the enormous change in the proton's energy causes the proton p to become unstable and decay. According to the Standard Model of particle physics, the elementary particles are composed of smaller particles known as quarks. The six quarks have been named up u, down d, strange s, charm c, top t, and bottom b. The subscript on the quark indicates one of three colors {red r, blue b, green g). As shown in the diagram, the proton is composed of three quarks $\{u_r, u_g, d_b\}$, two of which are up quarks of which one is red and the other green, and a third blue down quark. The proton p decays into a positron e^+ which is an electron with a positive charge, and a neutrally-charged pion π^0 particle through the exchange of an X boson particle. The pion has a mass between the electron and the proton.

$$p\rightarrow\pi^0+e^+$$

[0036] Referring to **FIG. 13**, the pion π^0 then decays into a proton p and antiproton $\bar{p}$ which annihilate each other to produce two photons shown on the right by the traveling waves. So the overall energy exchange is

$$p\rightarrow\frac{2h\nu}{c^2}+e^+$$

where hν is the energy per gamma photon with frequency ν. The electron of the hydrogen atom would then annihilate the positron for additional photon energy.

[0037] Referring to **FIG. 14**, the hydrogen H atom is composed (**38**) of the proton and electron as seen in the upper left corner. The proton decays (**39**) into the neutral pion and a positron. The electron from the hydrogen atom and this positron form one electron pair (**40**). The pion then decays (**41**) into two gamma photons which produce an electron pair production energy cascade into 132 pairs (**42,43**) for a total of 133 electron pairs. These electrons can then be captured electrostatically and used for the production of electricity.

[0038] Referring to **FIG. 15**, the electrons are captured with the water droplet injector . The plunger (**46**) of a spring-loaded cylindrical solenoid (**44**) is attached to a tapered piston (**47**). By means of ring collar and bolts (**45**), the solenoid is bolted to the injector (**48**). A supply of purified water is attached to the water inlet connection (**49**). When the solenoid is activated, it pulls back slightly so that water can enter the valve. When the solenoid is deactivated, the piston forces the water droplet out through the nozzle (**50**) into a cylindrical glass vacuum chamber (**52**). Two cylindrical glass disks (**51**) hold the nozzle in place. On the other end of the vacuum chamber is the sealed-tube con-

nection (**56**,**57**,**58**) to the vacuum pump. In the middle of the vacuum chamber, two metal plates (**53**) are attached through sealed glass collars (**54**) to electrical pins (**55**). The plates are electrostatically-charged with opposite charges so as to form a capacitor. This creates an electrical field between the plates which attracts the electrons to the positively-charged plate.

[**0039**] Referring to **FIG. 16**, the vacuum tube and water injector (**61**) are mounted along the centerline of the inner (**60**) and outer (**59**) magnetic vortex wormhole generator coils. The low density hyperspace energy traversing the wormhole along the centerline of the coils causes the injected water molecules to soften and decay into a cascade of electrons. The oscillating electric field along the centerline causes the electrons to vibrate back and forth. The crossed electric field between the charged capacitor plates causes the electrons to flow toward the positively-charge plate in order to produce electricity.

[**0040**] Referring to **FIG. 17**, the vacuum tube is connected to the vacuum pump through a hose connection to the pump air inlet (**64**). A 5 Hp electric motor (**62**) drives dual rotating flights of screws which trap the air and move it toward the exhaust outlet (**65**) shown with no muffler. On a spacecraft operating in the vacuum of outer space, this component would not be needed.

SUMMARY OF THE INVENTION

[**0041**] It is the object of this invention to generate electricity by using low density hyperspace energy to soften water molecules such that the atomic binding is broken which causes the hydrogen nucleus to decay into a cascade of electron pairs. These electrons are then collected on a positively-charged plate in order to produce electricity. The water molecules are softened by flooding them with low density hyperspace energy that is produced by a magnetic vortex wormhole generator. The generator creates negative energy and a spacetime curvature along the centerline of two concentric coils. This combination opens up wormholes along the centerline. Because the gravitational potential of low density hyperspace energy is greater than the negative energy, the hyperspace energy flows through the wormhole from hyperspace into our dimension. The hyperspace energy has a speed of light equal to one meter/second. This causes a change in Planck's constant h such that the proton orbitals of the hydrogen atom are unable to produce a centrifugal repulsion which keeps the electron in orbit. The Coulomb potential term dominates and the electron is attracted to the proton. Due to the vast change in the speed of light, and the collision of the electron with the proton, the proton becomes unstable and decays into a neutral pion and a positron. The pion then decays into two gamma photons which produce a large cascade of electron pairs.

[**0042**] A water injector, consisting of a solenoid-activated valve and nozzle, injects water droplets into a vacuum chamber which is positioned along the centerline of the two concentric coils where the wormholes form. Due to the low density hyperspace energy passing through the wormholes into our dimension, the water molecules soften and decay into electrons which are collected on an electrostatically-charged capacitor plate having a positive charge located in the glass vacuum chamber.

A BRIEF DESCRIPTION OF THE DRAWINGS

[**0043**] **FIG. 1**. Perspective view of hydrogen atom K shell.

[**0044**] **FIG. 2**. Graph showing potential binding energy of hydrogen atom.

[**0045**] **FIG. 3**. Perceptive view of Olympus Mons volcano at +19.5° Mars latitude.

[**0046**] **FIG. 4**. Perspective view of tetrahedron inscribed in sphere.

[**0047**] **FIG. 5**. Graph showing complex plane.

[**0048**] **FIG. 6**. Perspective view of hyperspace co-dimensions of logarithmic manifold.

[**0049**] **FIG. 7**. Perspective view of embedding diagram showing curvature of space caused by a mass.

[**0050**] **FIG. 8**. Perspective view of wormhole embedding diagram.

[**0051**] **FIG. 9**. Perspective view of coils of magnetic vortex wormhole generator.

[**0052**] **FIG. 10**. Graph showing that generator produces negative energy.

[**0053**] **FIG. 11**. Tetrahedron diagram showing that the speed of light at the Planck box boundary at the water molecule is one meter/second.

[**0054**] **FIG. 12**. Perspective view of proton decay into neutral pion and positron.

[**0055**] **FIG. 13**. Perspective view of pion decaying into two gamma photons.

[**0056**] **FIG. 14**. Diagram showing decay of the hydrogen atom into electrons.

[**0057**] **FIG. 15**. Perspective view of water injector and vacuum chamber.

[**0058**] **FIG. 16**. Perspective view of vacuum chamber mounted along centerline of magnetic vortex wormhole generator.

[**0059**] **FIG. 17**. Perspective view of vacuum pump used to evacuate vacuum chamber.

DETAILED DESCRIPTION OF THE INVENTION

[**0060**] 1. The coils of the magnetic vortex wormhole generator are made of three stacks of 0.020 inch silicon-iron transformer laminates. These are washed to remove the oil, and then wrapped with insulating tape in order to keep the laminations together. Using a very long bench made of wooden planks and 2×4 sawhorses, the outer coil is wrapped counter-clockwise right to left using a large spool of 14 AWG magnetic wire. A thin spacer is used between windings in order to reduce the winding capacitance. Once the outer coil is wound, the wire is continued to the second inner coil which is wrapped clockwise, leaving enough wire between coils such that when the coils are mounted in the wooden frame, the coil is one continuous winding having an input and output connection. Using an inductance meter, the inductance of the coil is measured. Using a standard frequency of 60 Hz, the capacitance of a sheet metal capacitor is calculated such that the generator is electromagnetically resonant at this frequency. The generator is connected to the line voltage by a 1:1 isolation transformer which is connected to a small primary coil wrapped on a toroidal core

whose similar secondary coil is connected to the sheet metal capacitor and inductance coil. Resonance is achieved by adjusting the spacing and overlap of the sheet metal.

[0061] 2. The vacuum chamber is made of a glass tube with sufficient wall thickness to withstand the vacuum pressure. A number of glass blowing techniques are used to make the glass-electrode connection for the capacitor plates. Then circular pieces of glass plate are cut out and ground to the inside diameter of the tube, fitted with the nozzle and vacuum connection, and then heat sealed to the chamber. The chamber and water injector are then attached to a wooden bracket mounting which is doweled and glued to the wooden frame of the generator.

I claim:

1. A water energy generator system comprising the components:

a magnetic vortex wormhole generator and driving resonant electrical circuit;

a water droplet injector;

a vacuum chamber and vacuum pump; and

an electrostatic electron capture system.

2. By means of claim (**1**), a magnetic vortex wormhole generator comprising two concentric cylindrical coils of different radii wound in opposite directions, made of thin sheet silicon-iron transformer laminations wound with one continuous length of magnetic wire providing a single input and single output connection to the driving electrical circuit.

3. By means of claim (**2**), a coil winding method and oscillating driving circuit producing bucking electric fields along the centerline of the generator normal to the coils which create a spacetime curvature pressure and negative energy.

4. By means of claim (**3**), the generation of wormholes between space and hyperspace along the centerline of the generator such that low density, low speed of light hyperspace energy flows through a positive gravitational gradient from hyperspace to space.

5. By means of claim (**1**), a water injector comprising a solenoid-activated water valve, water supply connection, seal and nozzle for injecting water droplets into the vacuum chamber.

6. By means of claims (**5**) and (**4**), the softening and particle decay of the water molecules by the hyperspace energy into neutral pions, positrons, gamma photons and finally a cascade of electron pairs.

7. By means of claims (**6**) and (**1**), the capture of the electrons on electrostatically charged capacitor plates located in the vacuum chamber for the purpose of producing electrical energy.

8. By means of claims (**1**) and (**2**), a resonant electrical driving circuit comprising a line isolation transformer connected to a primary coil wound on a toroidal coil whose secondary output coil is connected to a capacitor and the inductance coil of the generator such that the capacitance of the capacitor and the inductance of the coil form a highly resonant electrical circuit.

* * * * *

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(54) MAGNETIC MONOPOLE SPACECRAFT

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(52) **U.S. Cl.** **60/203.1**

(57) **ABSTRACT**

A spacecraft propulsion system that utilizes a dual method of providing lift on the hull by means of magnetic monopoles and electromagnetic spacetime curvature pressure.

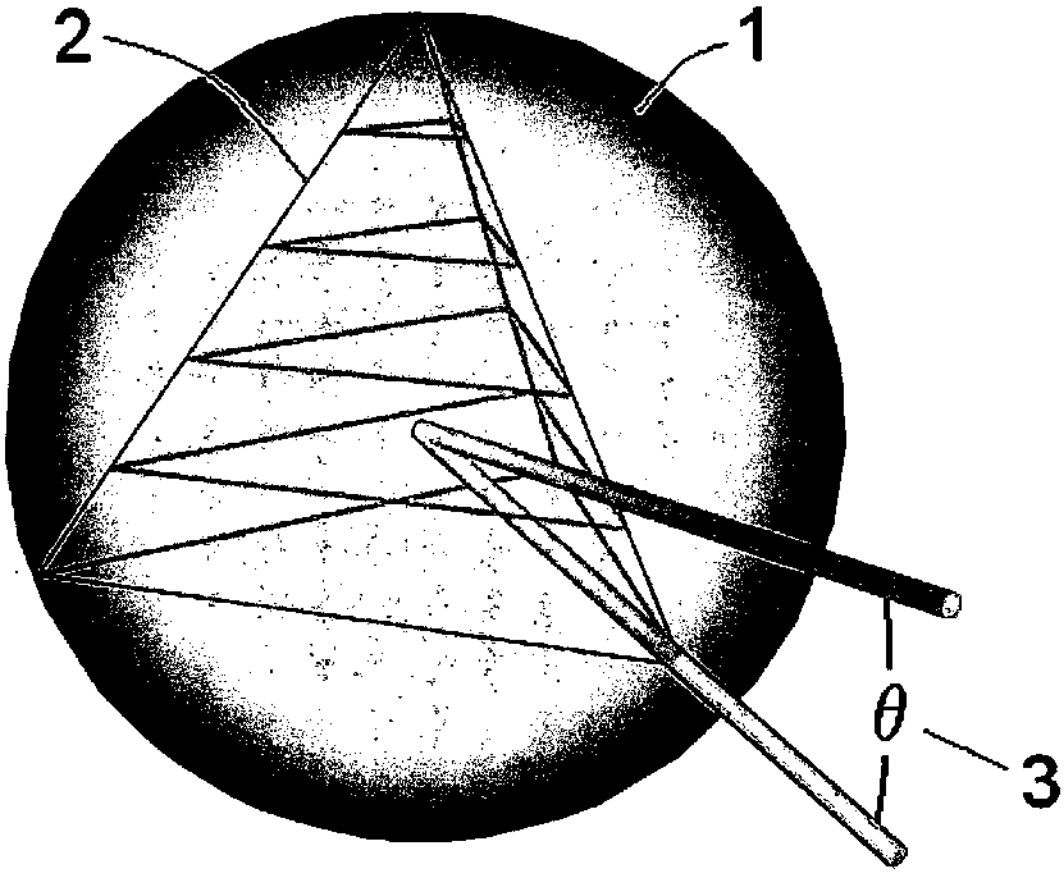

Figure 1

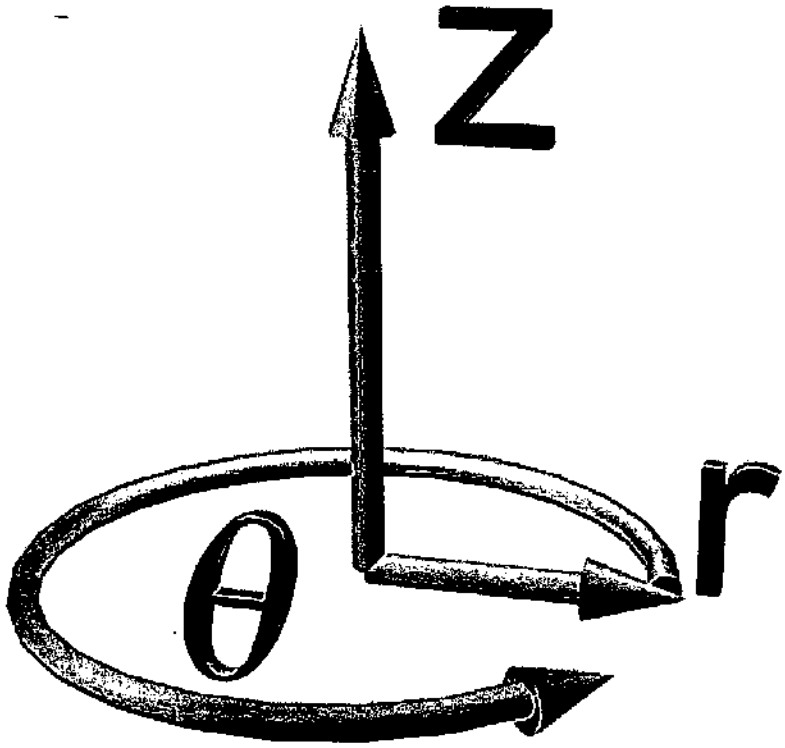

Figure 2

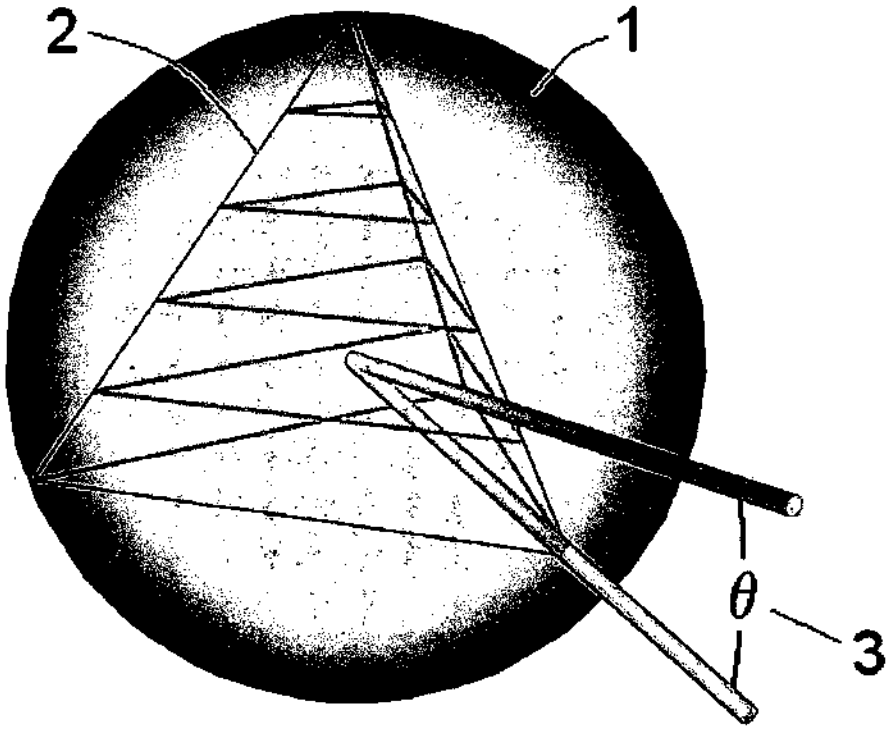

Figure 3

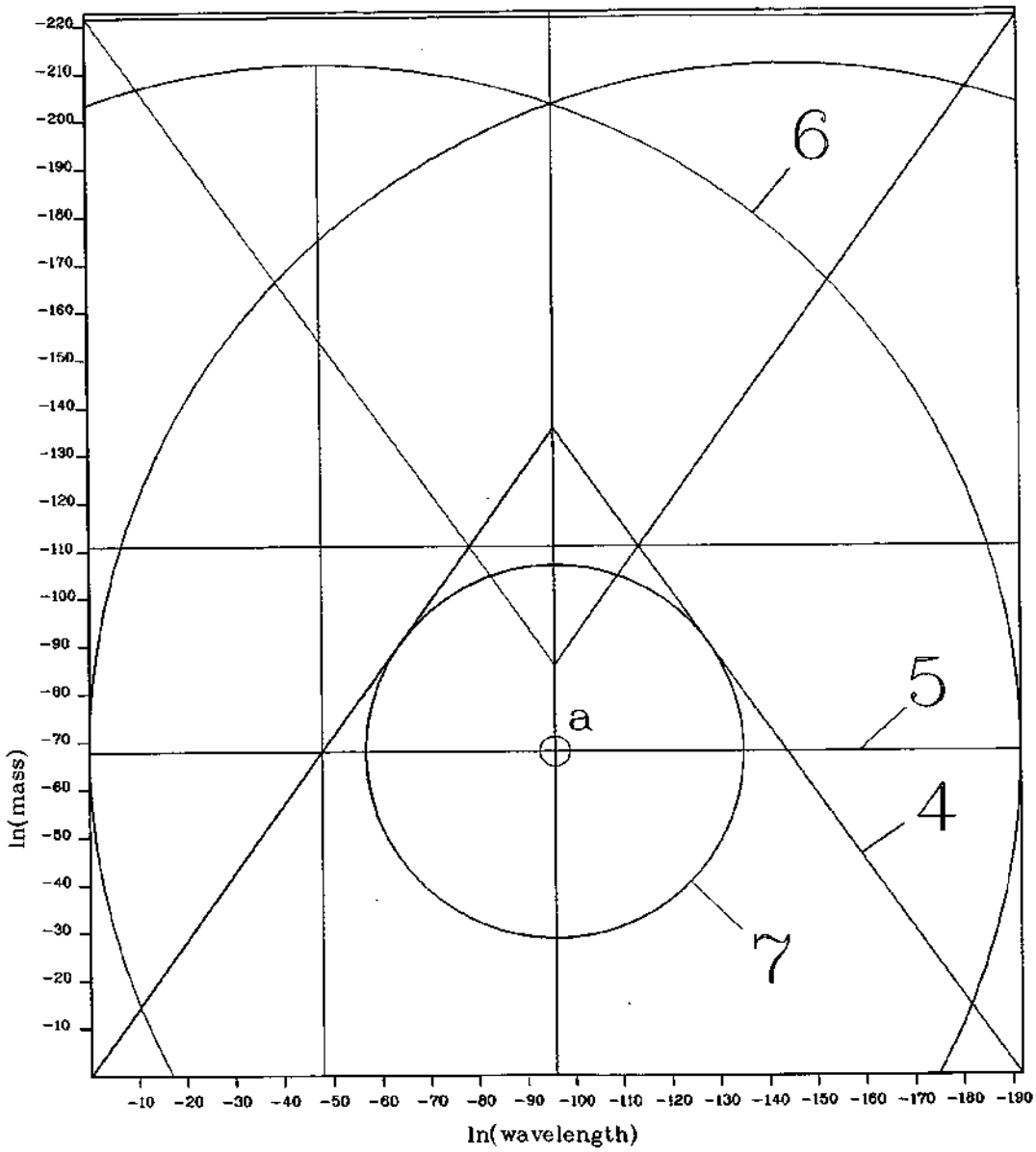
6
5
4
7
a
ln(mass)
ln(wavelength)
-220
-210
-200
-190
-180
-170
-160
-150
-140
-130
-120
-110
-100
-90
-80
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-40
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-10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190

Figure 4

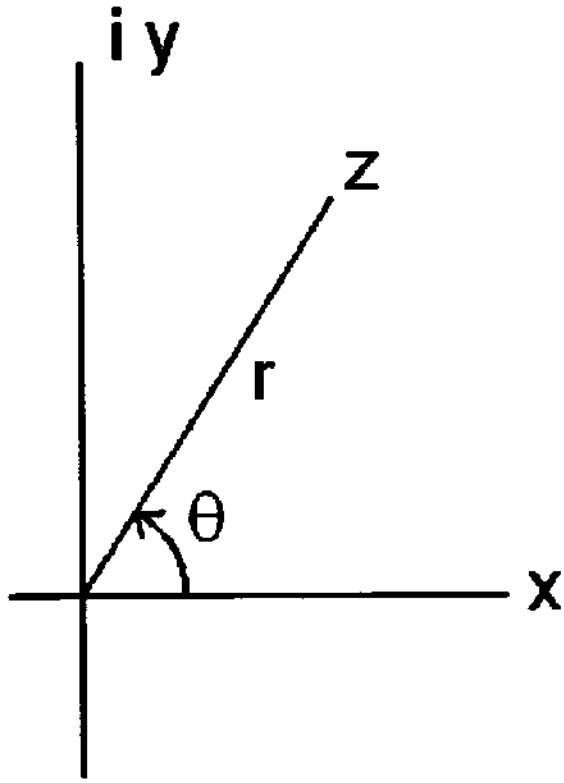

Figure 5

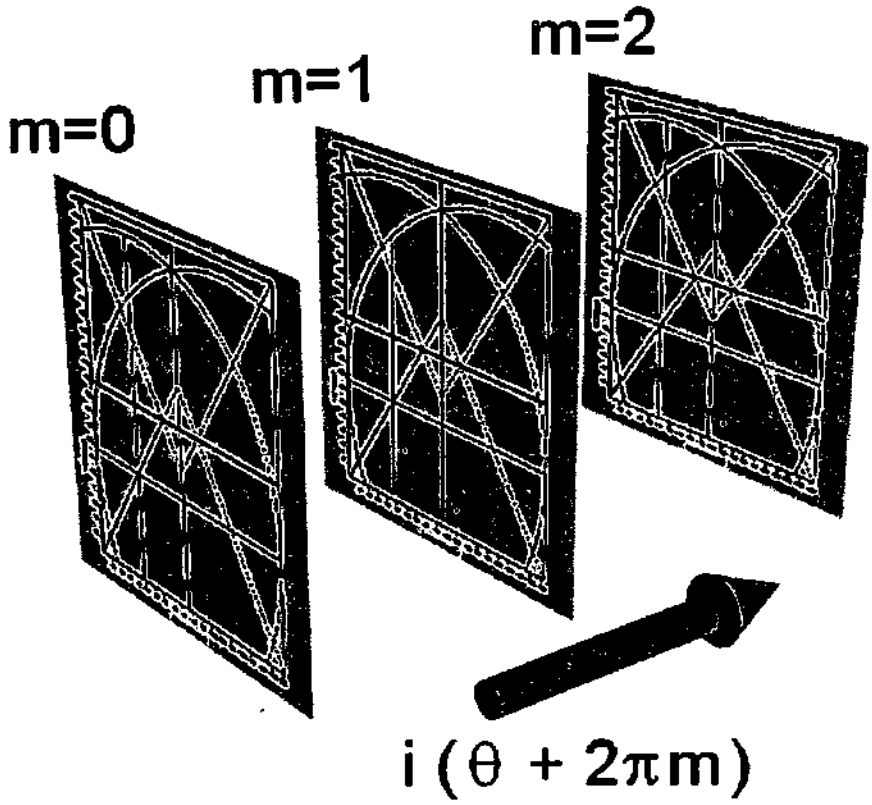

Figure 6

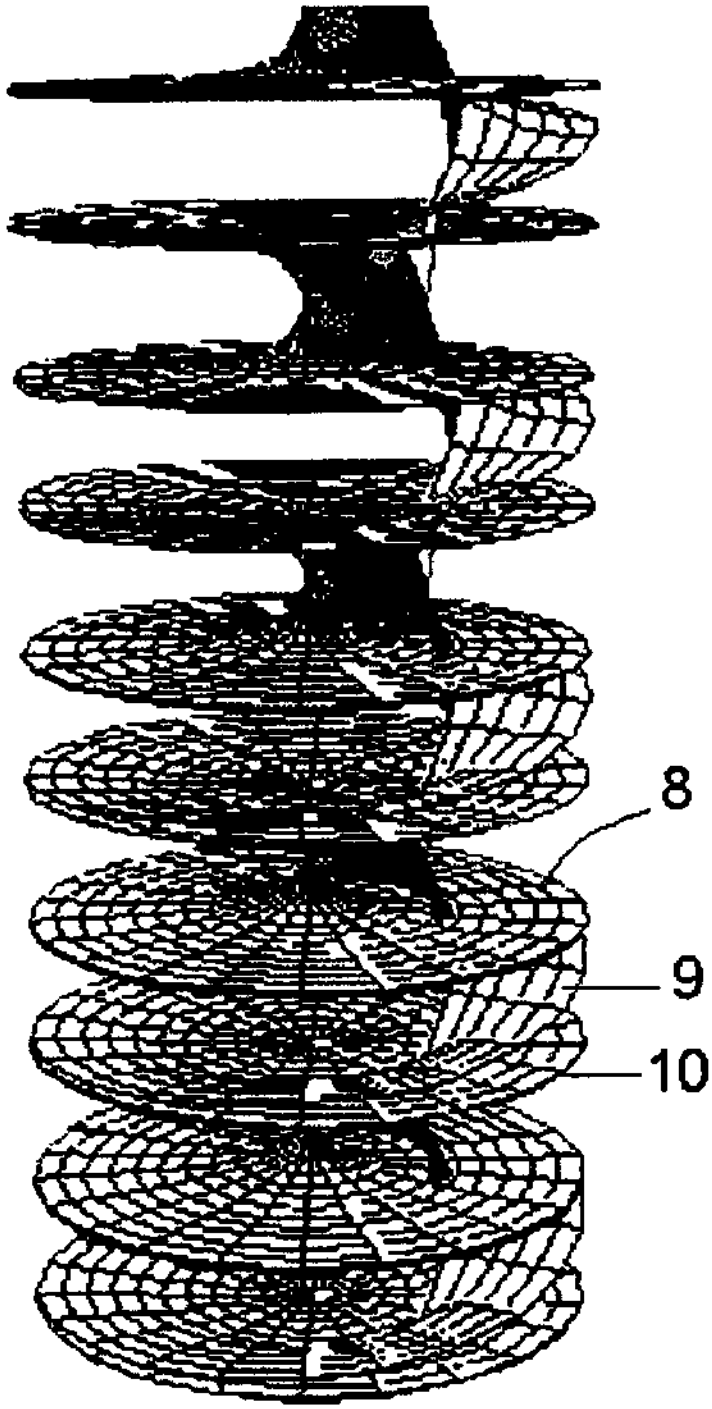

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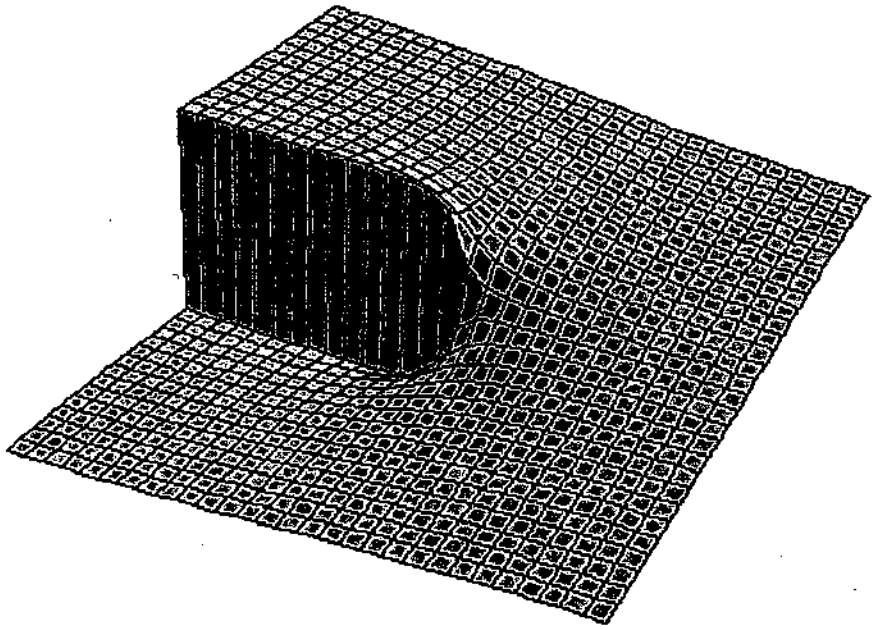

Figure 8

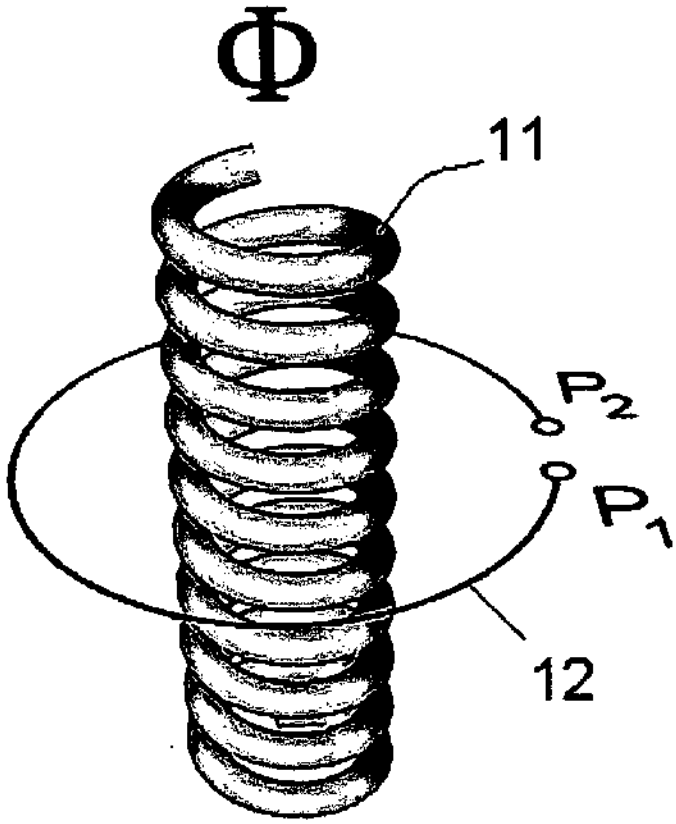

Figure 9

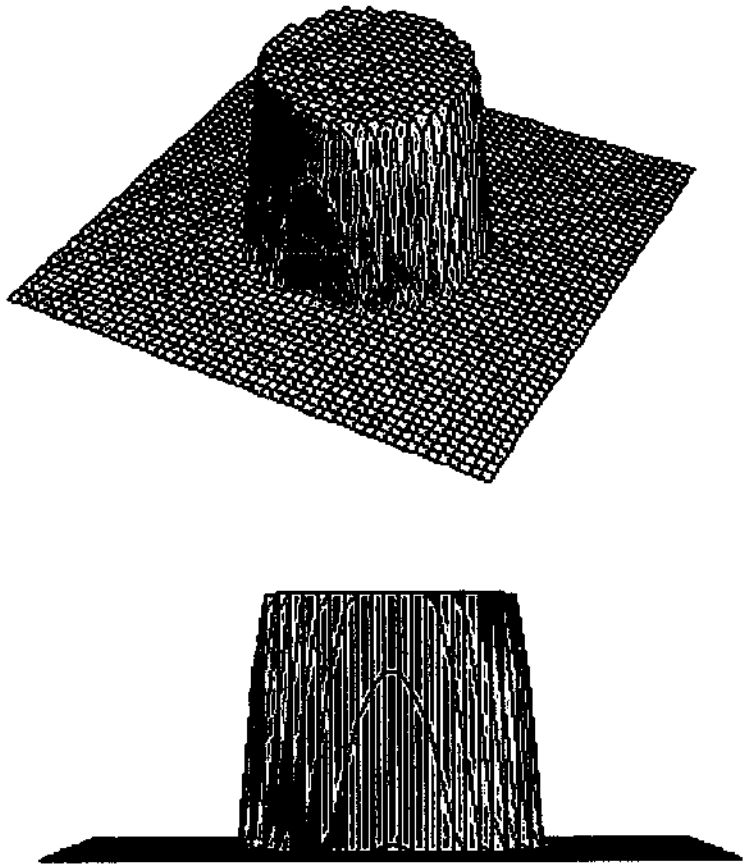

Figure 10

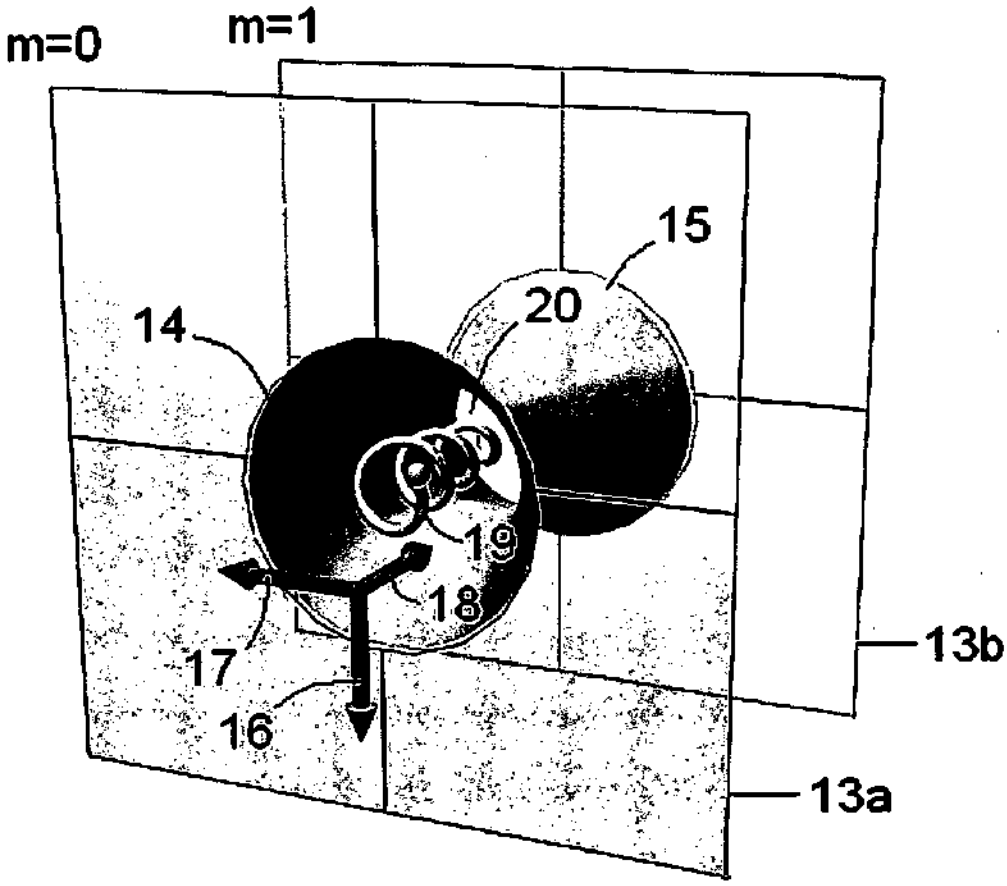

Figure 11

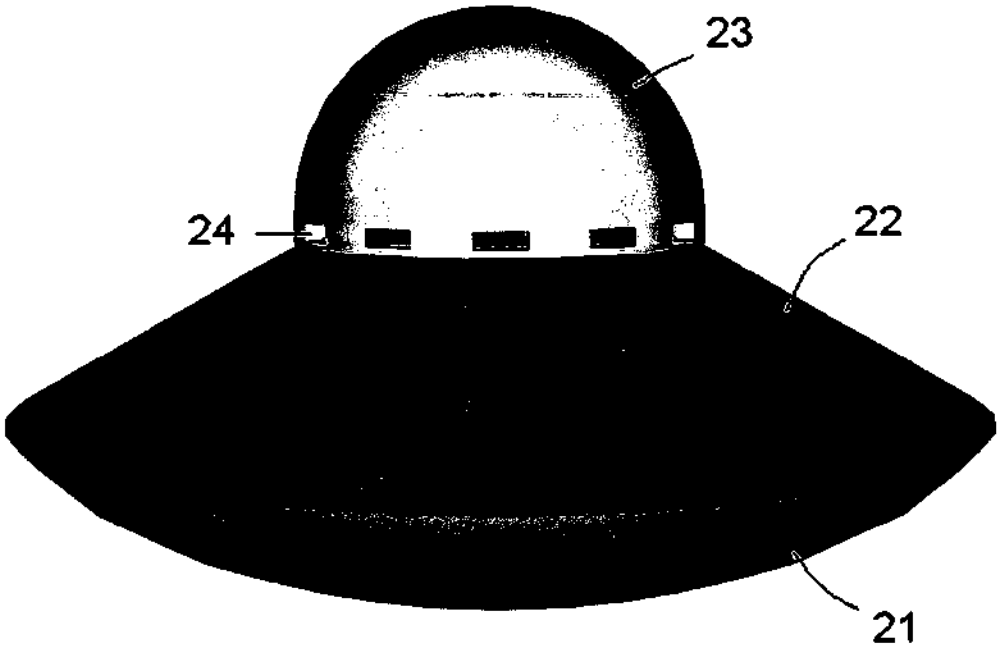

Figure 12

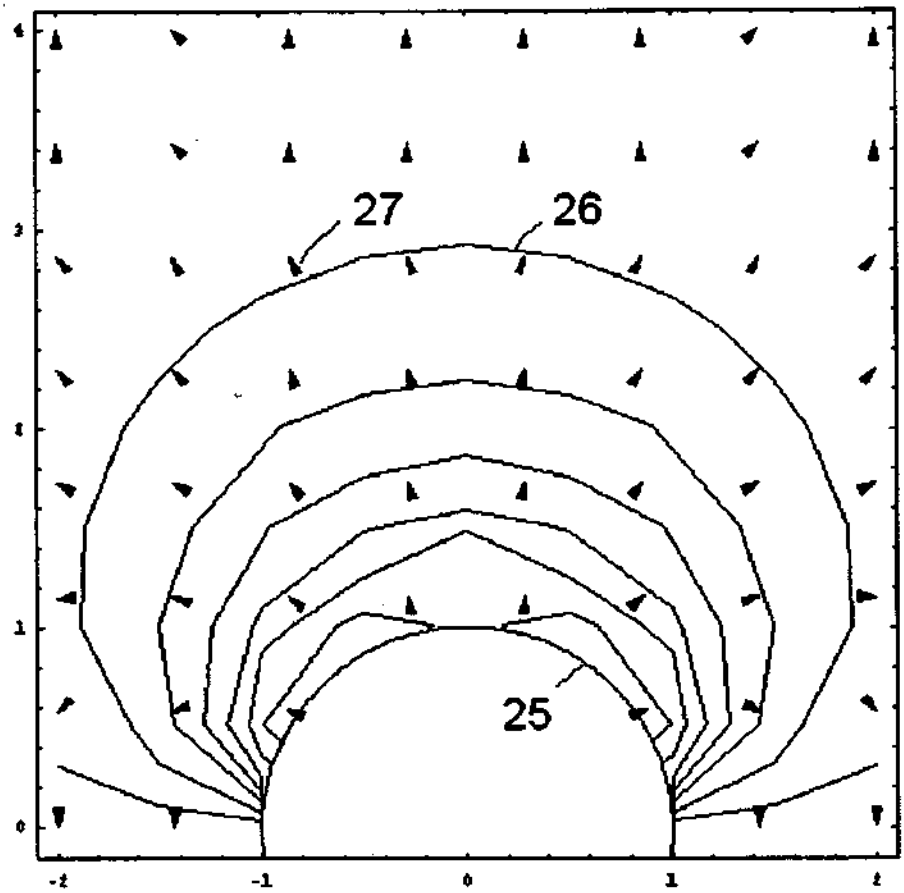

Figure 13

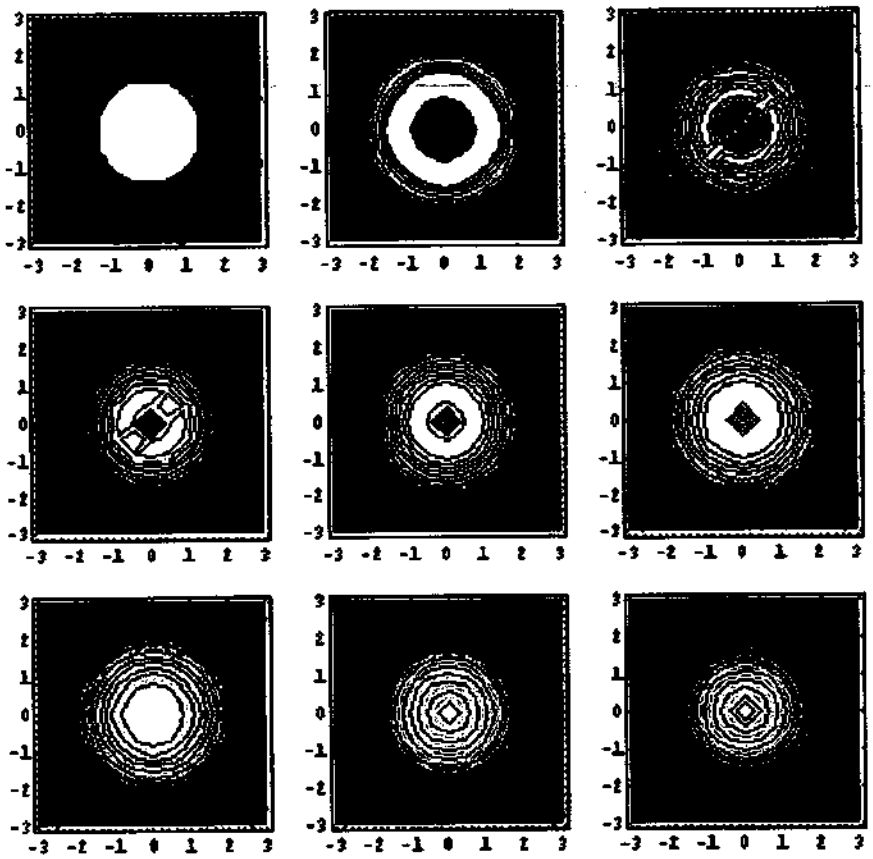

Figure 14

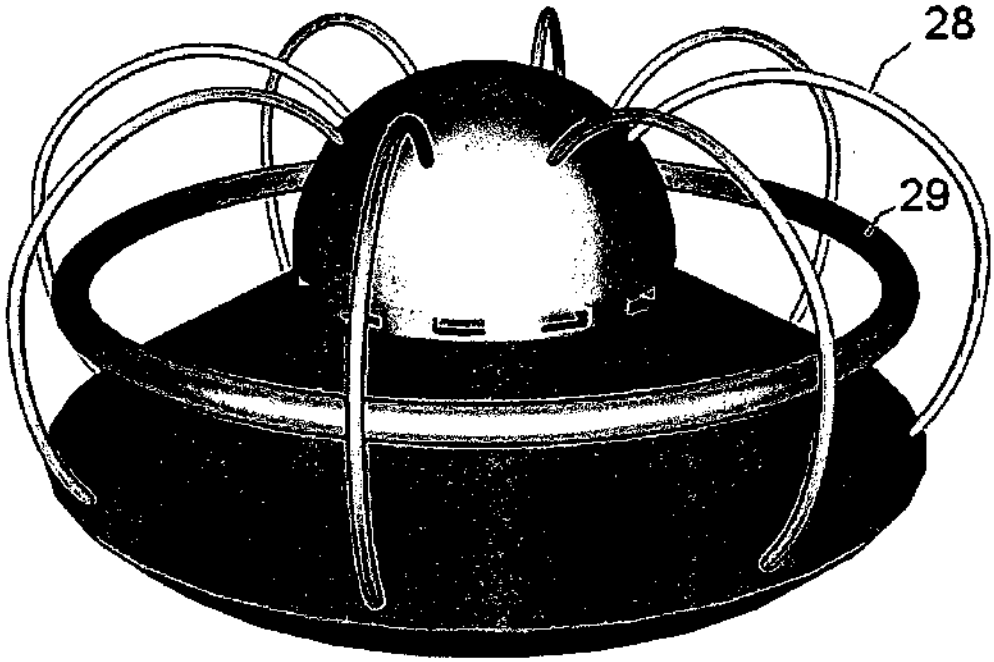

Figure 15

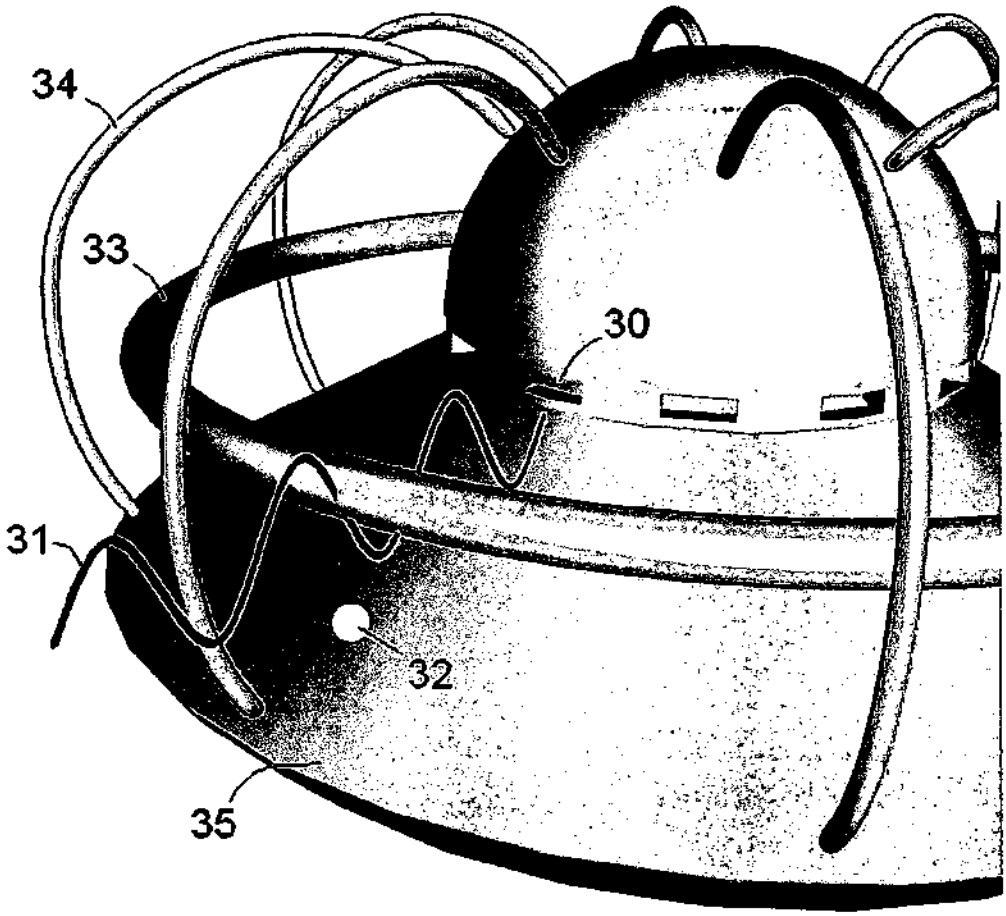

Figure 16

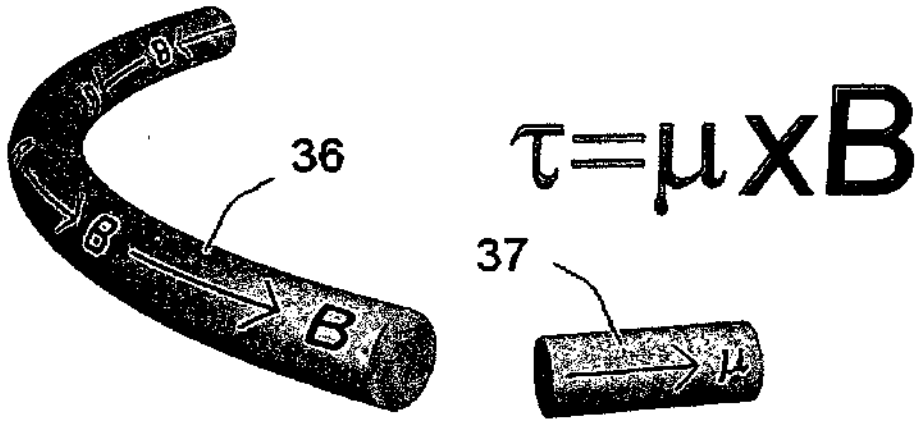

Figure 17

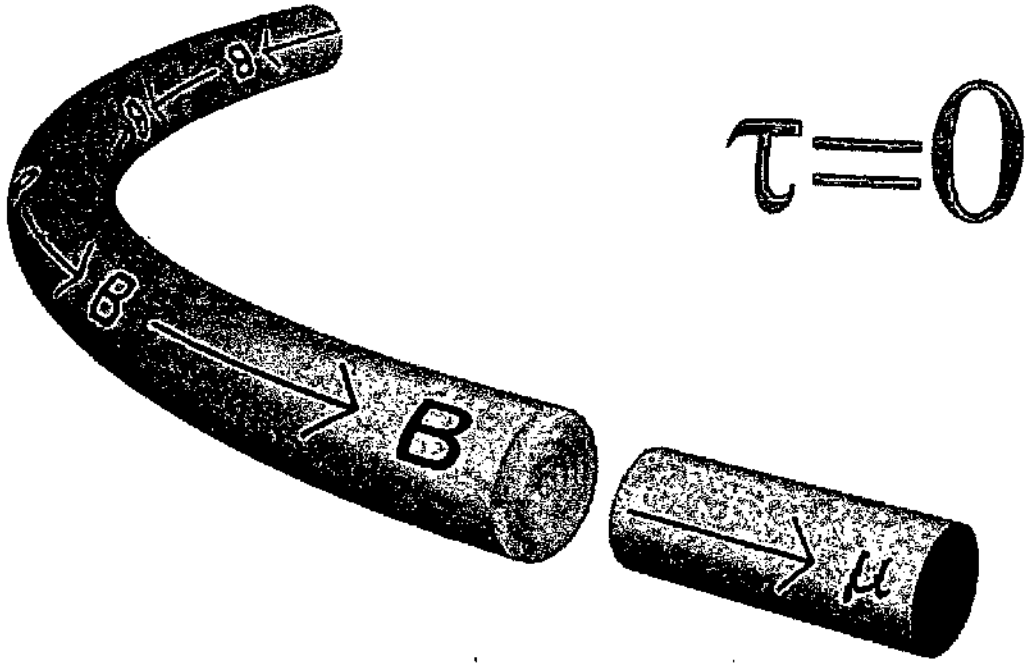

Figure 18

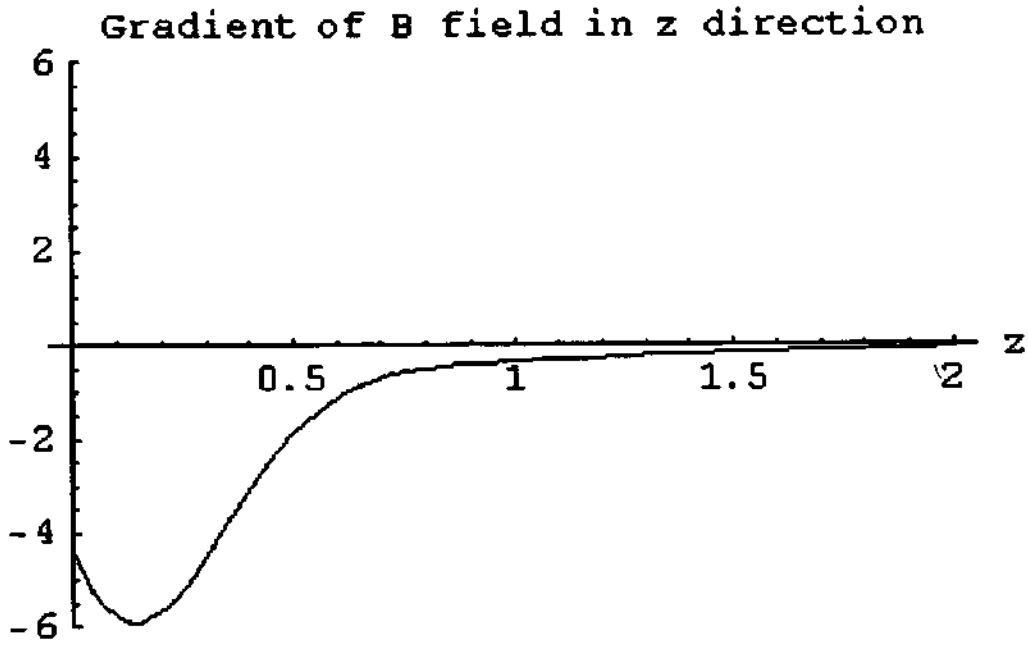

MAGNETIC MONOPOLE SPACECRAFT

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is a spacecraft propulsion system that generates a field of wormholes which are threaded with a magnetic field. Acting as two attracting magnets, the spacecraft's north magnetic field is attracted to the constantly regenerating south magnetic monopoles of the wormholes which provides lift on the hull.

BACKGROUND OF THE INVENTION

[0002] According to one of Maxwell's electromagnetic equations, the curl of the electric E field is equal to the negative time rate of change of the magnetic flux density B field.

$$\overline{V} \times E = -\frac{\partial B}{\partial t}$$

The curl can be thought of as a circulation around a closed loop specified by the right-hand rule where the fingers curl in the direction of the electric field and the thumb represents the changing magnetic flux density field through the area of the loop. At no time is the electric field diverging around the loop. That is, the divergence of the curl is zero which is a well-known vector operation

$$div\ \mathrm{curl}E = \frac{\partial}{\partial t}(divB) = 0$$

The partial derivatives of divB are zero at all points in space. Performing the integration, therefore, the divergence of B is equal to a constant

$$\mathrm{div}\ B = \mathrm{constant}$$

[0003] Referring to **FIG. 1**, the following discussion is made in cylindrical coordinates {r,θ,z}. In cylindrical coordinates, the divergence of the radial B field, div B, is equal to a constant C

$$Br'[r] + \frac{Br[r]}{r} = C$$

where the prime (') represents differentiation with respect to the radius r. The solution to this equation resides in determining the constant C. In the vacuum of space without any wormholes, the constant C is zero. Because the spacecraft is surrounded by a field of wormholes, there is a magnetic flux density field threading each one. That is, each wormhole is actually a magnetic monopole, and therefore the entire field of monopoles constitutes a large magnet with one pole in this dimension and the other pole in the hyperspace dimension.

[0004] The concept of the wormhole involves a new type of scientific thinking involving the creation of a gateway between our spacetime and that of a hyperspace co-dimension. The gateway is created electromagnetically as shown by my patent applications Rotating Magnetic Vortex Generator, Magnetic Vortex Wormhole Generator, and Sulfur 8 Wormhole Generator. The gateway can also be created ultrasonically through bubble cavitation as shown in my patent application Cavitating Oil Hyperspace Energy Generator. In one experiment, smoke was blown through one side of the coil of the magnetic vortex wormhole generator and no smoke came out the other side. The smoke was blown through the wormhole into another dimension.

[0005] The existence of hyperspace is not generally known in the scientific community. The reason it exists can be thought of in the following manner. Referring to **FIG. 2**, the corners of a tetrahedron (**2**) circumscribed by a sphere (**1**) touch the sphere at an angle (**3**) of −19.47°. Looking at the planets of the solar system, the Giant Red Spot vortex of Jupiter, which can hold two planets the size of Earth, is located at this angle. On Mars, the Olympic Mons volcano, which is the size of France, is located at north 19.5° Here in the Caribbean there is a slow moving rock mantle vortex at north 19.5° that curves the islands down toward Venezuela. So the geometry of space is related to the tetrahedron. What this suggests is that there is a subspace manifold whose tetrahedral geometry projects all the constants of physics into our dimension.

[0006] Referring to **FIG. 3**, this subspace geometry is shown in the tetrahedron diagram which plots the natural logarithm of mass on the vertical axis versus the natural logarithm of wavelength on the horizontal axis. With this diagram, it is possible to visualize the entire universe on a single sheet of paper. Triangle (**4**) is the tetrahedron whose vertical centerline shown by the small π circle (a) is equal to Planck's constant h divided by the speed of light c, known as the base constant. The base constant in logs is equal to −95.91546344. Line (**5**) is the diameter of the sphere (**6**). A circle (**7**), centered on (a), with a radius equal to the speed of light squared, is tangent to the tetrahedron. It can be shown that all the constants of physics, such as the speed of light squared and the Planck mass and the Planck wavelength, are determined geometrically by this logarithmic subspace tetrahedral geometry.

[0007] Referring to **FIG. 4**, the complex plane consists of a real horizontal axis, and a complex vertical axis where the value of the complex number z is given by a radius r and an angle θ

$$z = re^{i(\theta+2\pi m)}$$

The logarithm of z is

$$\mathrm{Log}[z] = \mathrm{Log}[r] + i(\theta + 2\pi m)$$

where m is an integer m=0,1,2 . . . corresponding to multiple rotations of 2π. What this means in terms of the tetrahedron diagram, referring to **FIG. 5**, is that there are multiple diagrams separated by 2π rotations. Each multiple is another hyperspace dimension. Only the log manifold has this characteristic. Referring to **FIG. 6**, the hyperspace dimension, shown as 2π circular surface (**8**), has a cut (**9**) on the undefined Log[0] origin line such that another hyperspace dimension is created below it (**10**).

[0008] Referring to **FIG. 7**, this branch cut does not bring one back to the original surface nearing the origin. It takes one down to another level of the universe into another hyperspace dimension. I can attest personally that I have been able to look into another hyperspace co-dimension as well as jump into another dimension.

[0009] Furthermore, Dr. Stephen Hawking of Cambridge University has shown that our dimension is connected to a wormhole through complex time. That is, the hyperspace dimension is rotated forward by 90° which makes it orthogonal to us. While this is the mathematical explanation as to why there are hyperspace co-dimensions, I can attest personally to the fact, as described in my patent application Full Body Teleportation, that I was teleported through hyperspace and returned to our dimension over a distance of 100 meters. Because hyperspace exists, it is then possible, using electromagnetic fields, to open wormholes between our dimension and other hyperspace dimensions.

[0010] Referring to **FIG. 8**, the constant C in the magnetic flux density B field equation is determined as follows. The end of a solenoid (**11**) is equivalent to a local magnetic source of flux Φ which represents the wormhole. A charge (**12**) encircling the solenoid has the same value at P_1 and P_2 but there is a phase difference of 2 π n where n is an integer equal to the number of times the charge encircles the solenoid. The change in phase is equal to the charge q divided by Planck's reduced constant times the flux for a solenoid of radius r=R

$$\Delta\theta = 2\pi n = \frac{q}{\hbar}\Phi = \frac{q}{\hbar}B\pi R^2$$

Solving for the magnetic flux density field threading the wormhole

$$B = \frac{2\pi n h}{q\pi R^2}$$

The differential equation becomes

$$Br'[r] + \frac{Br[r]}{r} = C[2]$$

Solving the equation for the radial field Br

$$Br[r] = \frac{C[2]r}{2} + \frac{C[1]}{r}$$

Equating this Br field with the B field and solving for the C[2] constant

$$C[2] = \frac{-2[-2\hbar n + qrC[1]]}{qr^2}$$

Substituting for C[2], the C[1] constant drops out and therefore the wormhole magnetic flux density field becomes a constant inside the throat radius R

$$Br = \frac{2\hbar n}{qR^2}$$

but the divergence moving from outside to inside the radius is a constant due to the discontinuity.

[0011] Referring to **FIG. 9**, the wormhole has a constant cylindrically-shaped magnetic field of radius R with a negative south pole due to the negative charge on the electron, Using a wormhole radius equal to one hundred times the electron radius with n equal to 10 turns, the magnetic flux density B field has a magnitude of 1.4×10^6 tesla.

[0012] Referring to **FIG. 10**, the wormhole surface (**14**) is a connection through a throat area (**20**) between space and hyperspace (**13**) to another surface in hyperspace (**15**). The electron path (**19**) is actually spiraling down the surface of the wormhole. The magnetic flux density field (**18**) points into the wormhole such that the cross product of the electron velocity (**16**) with the field (v×B) points toward the outside rim of the wormhole. Because the electron has a negative charge, the force (**17**) on the electron (−q v×B) is inward toward the centerline of the wormhole. Since one pole of the field is in space, and the other pole is in hyperspace, the wormhole appears to us as a magnetic monopole. The key to this invention is how to generate this magnetic wormhole field.

[0013] Referring to **FIG. 11**, the aluminum spacecraft is constructed of a flattened, shallow spherical lower hull (**21**), a circular upper hull with a flat sloping surface (**22**), a spherical dome cupola (**23**), and a cylindrical section (**24**) housing a circular array of radial microwave waveguides. Surfaces (**22**) and (**23**) are electrically charged, using high-voltage transformers, to an alternating electrostatic potential such that the potential on the dome is +V when the sloping hull has a −V potential and vice versa. This creates an electric field from the positively charged surface to the negatively charged surface.

[0014] Referring to **FIG. 12**, the dome (**25**) is charged to a positive potential. The spherical potential lines (**26**) emanate from the dome and curve around toward the sloping hull. The negative gradient of this potential field is the electric E field (**27**) which is perpendicular to the potential lines. The electric field lines from the dome then terminate on the sloping hull which can be seen in the lower right hand comer of the graph.

[0015] Looking down from above at the top of the dome, referring to **FIG. 13**, the oscillating electric field generates a circular oscillating magnetic field around the hull at various elevations. The last two graphs in the right-hand comer are near the top of the dome as seen by the smaller radius contour lines.

[0016] Referring to **FIG. 14**, the oscillating electric field lines (**28**) are between the dome and the sloping hull. The oscillating magnetic field (**29**) encircles the hull at the level of the microwave waveguides.

[0017] From gravitation physics, it is known that negative energy is required to open up the throat of the wormhole. In terms of differential forms mathematics, the negative energy is created by wedging the magnetic field with the radial

microwave beams of the waveguides. This generates an increasing time rate of change of negative energy ρ as shown by

$$*d(B\hat{}(B_{wave}+E_{wave}dt))=\frac{\partial(-\rho)}{\partial t}$$

where (*) is the Hodge Star operator, (d) the differential operator and (^) the wedge operator which joins the circular magnetic flux density B field with the electromagnetic wave (B_{wave}, E_{wave}).

[0018] Referring to **FIG. 15**, the interaction of the circular magnetic field (**33**), generated by the oscillating electric field (**34**), interacts with the radial electromagnetic field of the microwave beams (**31**) of the waveguides (**30**) to generate negative energy (**32**) over the sloping hull (**35**).

[0019] This combination of fields also creates the wormhole field over the hull. The spacetime curvature pressure T in the vertical z-direction is equal to the square of the circular magnetic flux density field

$$T^{zz}=\frac{B^2}{8\pi}$$

This stress-energy-momentum tensor can be thought of as a spacetime curvature proportional to the inverse of the radius squared, or as a pressure term which acts on the surface area of the hull. Thus there is the combination of a pressure stress and negative energy which creates the wormhole field over the sloping hull. Even though the magnetic flux density B field is oscillating, it is the square of the field which creates the stress. Thus the tension is still in the positive vertical z-direction.

[0020] Due to the low speed of light of hyperspace, the hyperspace energy is low density. Thus there is a positive gravitational potential between hyperspace and our dimension such that the hyperspace energy flows through the wormholes and onto the hull of the spacecraft. When this happens, a white mist forms over the hull. The effect of the hyperspace energy is to lessen the mass of the spacecraft, and relativistically increase the strength of the electromagnetic fields due to the smaller speed of light.

[0021] Referring to **FIG. 16**, the circular magnetic flux density field (**36**) is interacting with the magnetic monopole (**37**). The monopole acts as one pole of a magnet and therefore has a magnetic moment equal to the area times the electrical current circulating through it as the electrons move from our dimension into hyperspace. The great physicist Maxwell (**1870**) pointed out that the energy associated with charges and poles is potential energy and that therefore these objects tend to move in a direction that will decrease the potential energy, similar to a brick sliding down an inclined plane. Now to reduce the potential energy is the same as to reduce the field which gives a measure of the potential energy. If two like charges are brought together they strengthen one another's field, while opposite charges reduce one another's field. Thus like charges repel and unlike ones attract.

[0022] However, the energy associated with electric currents is not potential but kinetic in origin, because it is associated with moving charges. Now in mechanics it is well known that bodies move in a direction to increase their kinetic energy, if there is a source of external energy. The magnetic field of currents is a measure of kinetic energy and currents will try to move in a direction that will increase the field. Thus similarly-directed currents attract and unlike currents repel. In **FIG. 16**, the monopole will act so as to increase the field of the circular magnetic B field generated by the spacecraft. The monopole will then rotate into alignment with the flux tube. This increases the field strength of the flux tube. There is a torque τ on the monopole equal to the cross product of the magnetic moment with the B field

$$\tau=\mu\times B$$

[0023] Referring to **FIG. 17**, when the monopole is aligned with the flux tube, the cross product is zero and there is zero torque on the monopole. Notice that even if the oscillating B field points in the opposite direction, there is still zero torque since the torque depends on the sine of the angle between them. The sin(0°) or sin(180°) is the same zero value. With the monopole aligned with the flux tube, the kinetic energy is now maximized. That is, both the flux tube and the monopole point in the θ-direction.

[0024] The magnetic B field can be represented as a vector having three components. The only component is in the angular direction

$$B=\{B_r,B_\theta,B_z\}=\{0,\ B_\theta(z),\ 0\}$$

where the field varies, as was seen in **FIG. 13**, in the vertical z-direction. The magnetic monopole field also points in the θ-direction

$$\mu=\{0,\mu_\theta(z),0\}$$

where there is a negative gradient of the monopole field in the z-direction due to the location of the microwave waveguides near the sloping hull.

[0025] The force F on the monopole is the gradient of the monopole's magnetic moment μ with the magnetic flux density B field

$$F=\nabla(\mu\cdot B)=\{0,\ 0,\ \mu_\theta B_\theta'(z)+B_\theta(z)\mu_\theta'(z)\}$$

which says that there is a force on the monopole in the z-direction equal to the magnetic moment times the gradient of the magnetic field in the z-direction plus the magnetic field times the gradient of the magnetic moment in the z-direction.

[0026] Referring to **FIG. 18**, differentiating the magnetic field in the z-direction shows that the gradient is negative outside the hull. This can also be seen visually in **FIG. 13** where the graphs decrease in intensity.

[0027] A negative gradient for both the magnetic moment and the field means that the force on the monopole is negative. The force on the tube connected to the hull is therefore the negative of a negative, yielding a positive lift force.

$$F_{monopole}=-\{0,\ 0,|\mu_\theta B_\theta'(z)+B_\theta(z)\mu_\theta'(z)|\}=-F_{tube}$$

$$F_{tube}=+\{0,\ 0,|\mu_\theta B_\theta'(z)+B_\theta(z)\mu_\theta'(z)|\}$$

which says there is an upward lift force on the hull due to the combination magnetic monopole and flux tube. This lift

force is in addition to the vertical lift force generated by the spacetime curvature created by the electromagnetic fields themselves.

SUMMARY OF THE INVENTION

[0028] This invention is a spacecraft propulsion system that utilizes electromagnetic fields and microwaves to generate negative energy and a spacetime curvature over the hull. The hull consists of a hemispherical dome, a circular array of radial microwave waveguides, a sloping flat hull, and a shallow spherical hull on the bottom. Alternating current high voltage transformers connected to the dome and the sloping hull generate a curving oscillating electric field between the dome and the sloping hull. Due to this oscillation, a horizontal circular oscillating magnetic flux density B field is created around the dome.

[0029] By firing the microwaves at right angles to the B field, negative energy is created over the hull. The negative energy and spacetime curvature pressure generate wormholes between space and hyperspace. Because hyperspace has a low speed of light and positive gravitational potential, low density hyperspace energy flows through the wormholes and onto the hull. The effect of the hyperspace energy is to lessen the mass of the vehicle and to increase the strength of the electromagnetic fields. Because the resistance of hyperspace is less than the resistance of space, electrons spiral down the wormholes into hyperspace. This creates a magnetic field through the wormhole with one pole in our dimension and the other pole in hyperspace. Thus a field of magnetic monopoles is created over the hull.

[0030] The magnetic monopoles, which represent kinetic energy, align themselves with the magnetic flux tubes in order to maximize the total magnetic field. Because there is a gradient of the monopoles and field in the vertical direction, a negative force develops on the monopoles equal to the gradient of the dot product of the magnetic moment of the monopole with the B field. Thus the opposite reaction is a positive force on the flux tubes attached to the hull which is equivalent to bringing the north pole of a magnet together with the south pole of a second magnet. Because the hull constantly regenerates the wormhole field, the hull experiences a constant upward lift force. This is in addition to the lift generated by the spacetime curvature pressure which is proportional to the square of the magnetic flux density B field.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0031] **FIG. 1**. Perspective view of cylindrical coordinate system {r, θ, z}.

[0032] **FIG. 2**. Perspective view of tetrahedron circumscribed by sphere.

[0033] **FIG. 3**. Tetrahedron diagram showing speed of light squared is determined by the tetrahedron.

[0034] **FIG. 4**. Complex number z representation in the complex plane.

[0035] **FIG. 5**. Perspective view showing multiple log manifold hyperspace dimensions.

[0036] **FIG. 6**. Perspective view of orthogonal hyperspace dimensions.

[0037] **FIG. 7**. Perspective view of Log[z] showing cut along origin.

[0038] **FIG. 8**. Perspective view of charge phase shift around a magnetic flux.

[0039] **FIG. 9**. Perspective view of wormhole magnetic flux density B field.

[0040] **FIG. 10**. Perspective view of magnetic monopole wormhole.

[0041] **FIG. 11**. Perspective view of spacecraft.

[0042] **FIG. 12**. Graph showing electrostatic potential and electric field over dome.

[0043] **FIG. 13**. Animation showing circular magnetic field around dome at increasing elevation.

[0044] **FIG. 14**. Perspective view of electric and magnetic fields around hull.

[0045] **FIG. 15**. Perspective view of generation of negative energy.

[0046] **FIG. 16**. Perspective view of monopole misaligned with flux tube with torque.

[0047] **FIG. 17**. Perspective view of monopole aligned with flux tube at zero torque.

[0048] **FIG. 18**. Graph showing negative gradient of flux tube in the z-direction.

DETAILED DESCRIPTION OF THE INVENTION

[0049] 1. The aluminum hull is made by a technique called stretch forming which uses hydraulic cylinders to stretch a large sheet of aluminum to its yield point. This makes the aluminum sheet soft and pliable. Using a die which has been CNC machined to the desired hull profile, the sheet is then die pressed into a very rigid, smooth and lightweight structure requiring no other support. There are actually three dies consisting of a spherical dome, sloping hull, and shallow spherical dome.

[0050] 2. The rest of the hull consists of a cylindrical hull with a radius equal to the upper dome. A segment of this hull is designed on a 3D computer graphics program and stored as a stereolithography *.stl file. The file is then transmitted over the Internet to a server who prints up the part on an xy-plotter with an ultraviolet laser and ultraviolet light sensitive polymer bath. The computer model is sliced by a special program into many thousands of slices which are printed one over the other until the part is completed. The server returns the part next day by Express Mail. Several parts are then molded using liquid plastic such as to form the complete ring. A sand mold is then constructed from all the molds to form a plastic cylindrical hull having the waveguide slots molded into it. The waveguide silver-coated aluminum boxes are then installed in the slots and connected to the frequency generators and amplifiers. The purpose of the plastic waveguide cylinder is to separate the electrostatic charges on the dome and the sloping hull In this particular case we used a dome from another spacecraft design which saved on the cost of the die.

I claim:

1. A spacecraft propulsion system consisting of the following components:

a lower hull made of aluminum sheet having a shallow spherical profile;

a circular flat sloping hull made of aluminum sheet attached to the top of the lower hull on the periphery;

an electrically-insulated plastic-molded tubular cylindrical hull containing slots for mounting an array of radial microwave waveguides, attached to top of the flat sloping hull;

a hemispherical cupola in the shape of a dome made of aluminum sheet mounted on top of the insulated cylindrical hull;

an array of rectangular microwave waveguides mounted in the waveguide slots of the cylindrical hull;

a high-voltage alternating current transformer with one side electrically attached to the upper dome and the other side electrically attached to the flat sloping hull; and

a frequency generator and amplifier to drive the microwave waveguides.

2. By means of claim (1), an oscillating electric field is created between the upper dome and the sloping hull using the high-voltage alternating current transformer.

3. By means of claim (2), an oscillating circular magnetic flux density field is generated around the sloping hull and upper dome.

4. By means of claims (1) and (3), negative energy is generated by the radial microwave beams of the waveguide array impinging on the circular magnetic flux density field around the hull.

5. By means of claim (3), a positive spacetime curvature pressure constituting a lift force is developed over the hull in the vertical direction proportional to the square of the field.

6. By means of claims (4) and (5), a field of wormholes between space and hyperspace are generated over the hull.

7. By means of claim (6), due to the positive gravitational potential between hyperspace and space, low-density hyperspace energy flows through the wormholes onto the hull to reduce the mass of the spacecraft and strengthen relativistically the electromagnetic fields.

8. By means of claim (6), electrons, emitted by the charged hulls, spiraling down the wormholes, generate a field of magnetic monopoles with one pole in space and the other in hyperspace.

9. By means of claims (6) and (3), the magnetic monopoles maximize their kinetic field energy by aligning with the magnetic flux tube.

10. By means of claim (9), the gradient in the vertical direction of the dot product of the magnetic moments of the monopoles with the magnetic flux density field is a negative force on the monopoles and an equal but opposite positive lift force on the magnetic flux tubes attached to hull.

11. By means of claims (10) and (5), a dual method of providing apositive lift force on the spacecraft is constituted.

* * * * *

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(54) METHOD OF GRAVITY DISTORTION AND TIME DISPLACEMENT

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H01S	*3/09*	(2006.01)

(52) U.S. Cl. ..... 505/166; 505/180; 434/300; 73/382 G; 505/164

(57) ABSTRACT

A method for employing sinusoidal oscillations of electrical bombardment on the surface of one Kerr type singularity in close proximity to a second Kerr type singularity in such a method to take advantage of the Lense-Thirring effect, to simulate the effect of two point masses on nearly radial orbits in a 2+1 dimensional anti-de Sitter space resulting in creation of circular timelike geodesics conforming to the van Stockum under the Van Den Broeck modification of the Alcubierre geometry (Van Den Broeck 1999) permitting topology change from one spacelike boundary to the other in accordance with Geroch's theorem (Geroch 1967) which results in a method for the formation of Godel-type geodesically complete spacetime envelopes complete with closed timelike curves.

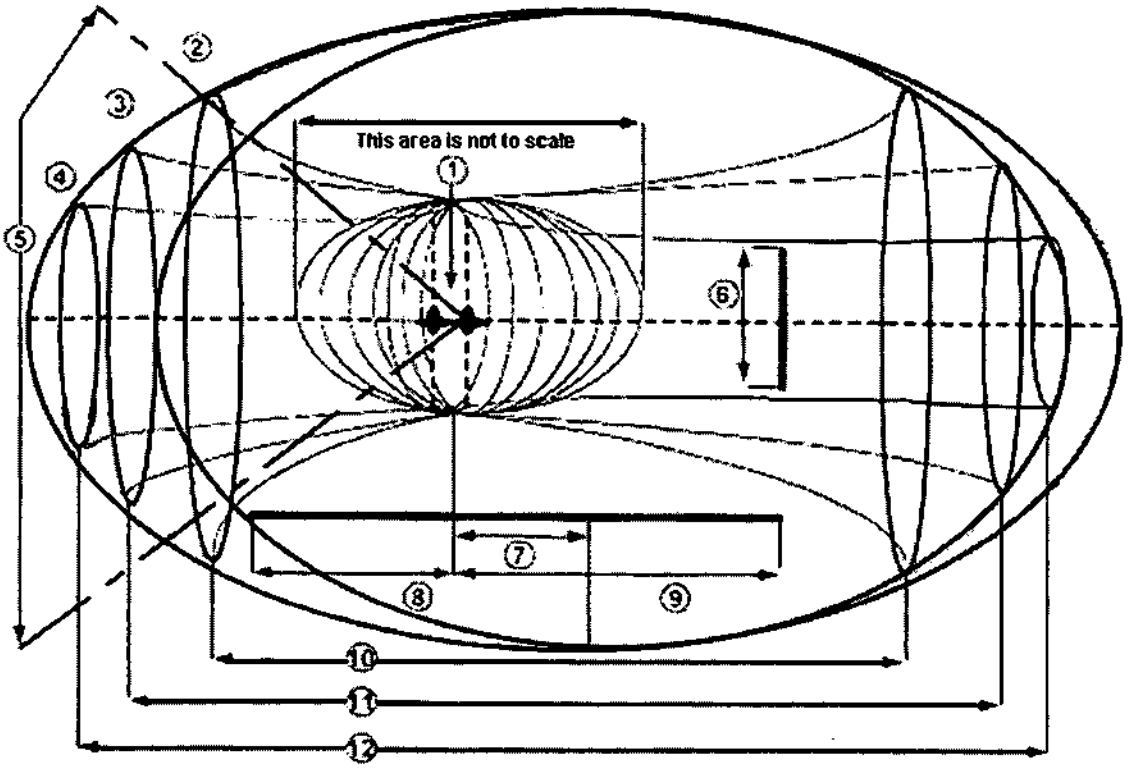

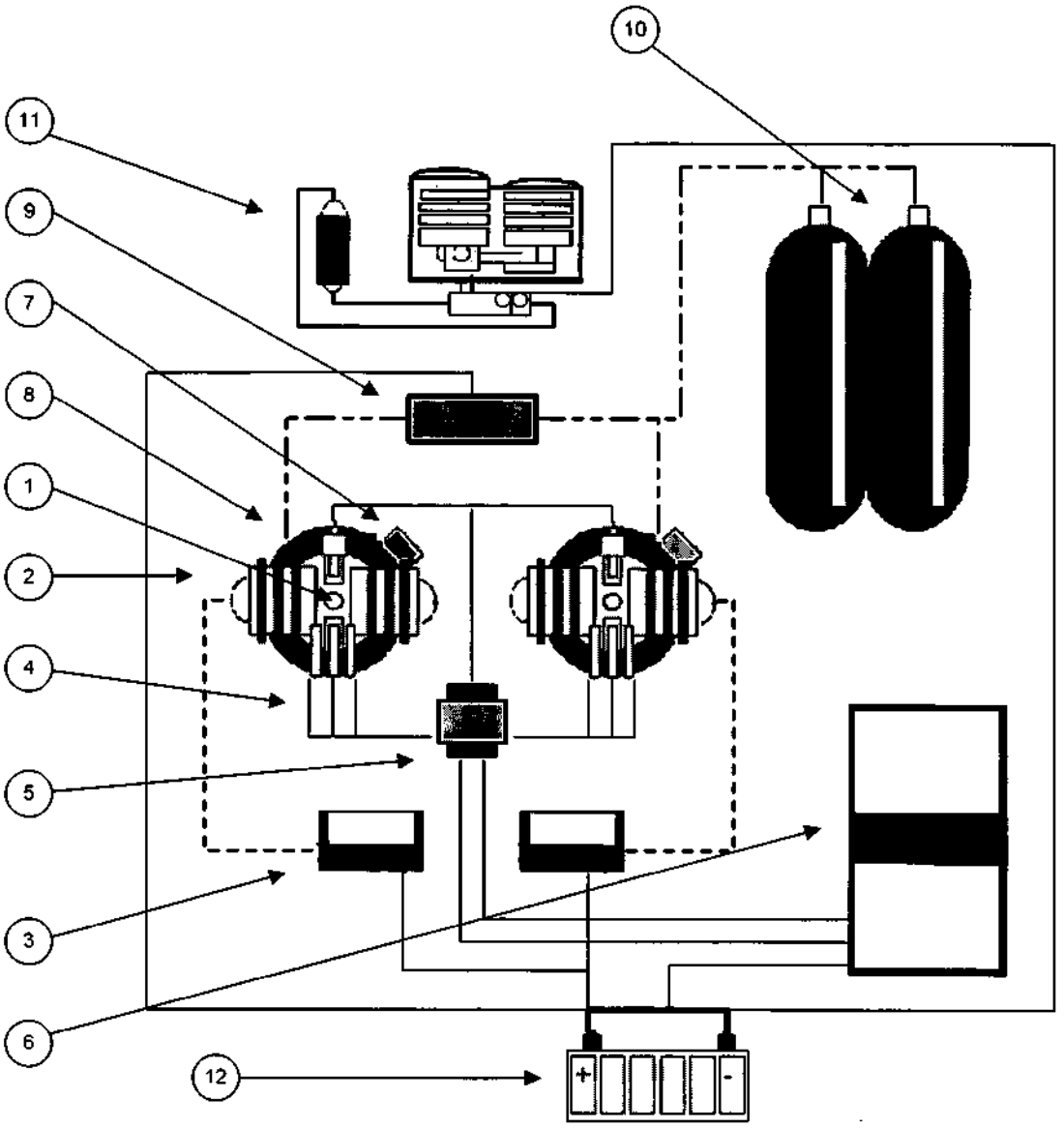

Figure 1

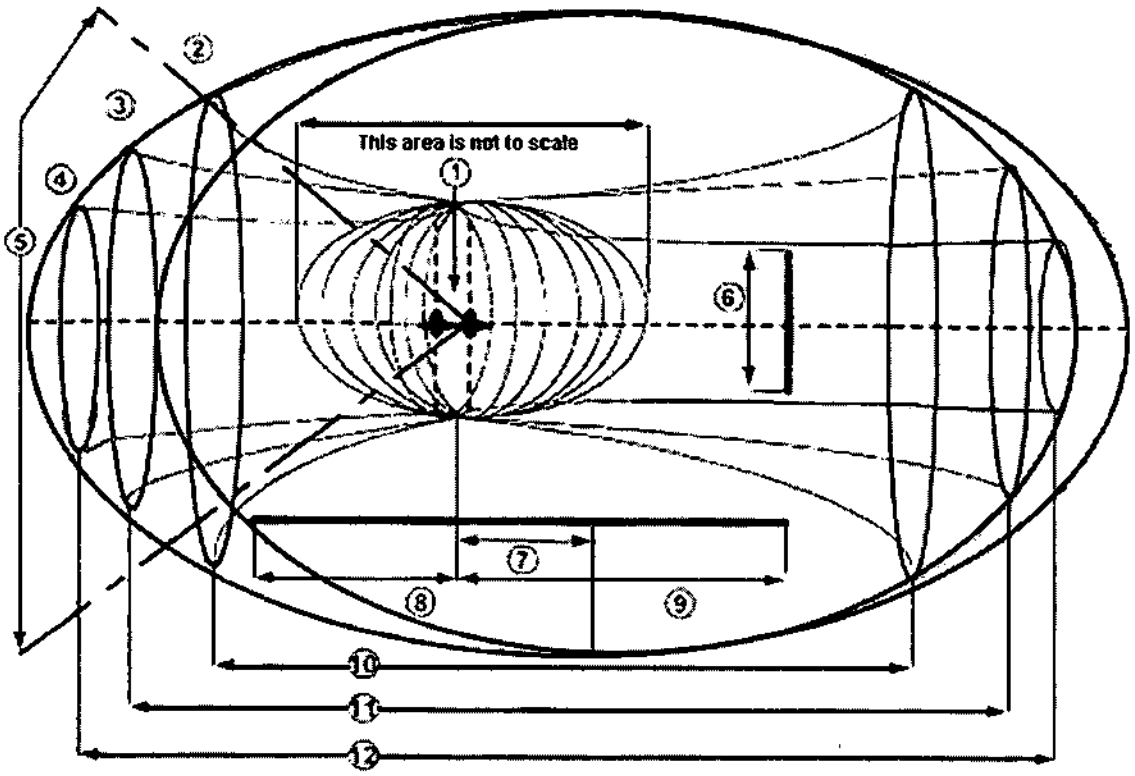

Figure 2

METHOD OF GRAVITY DISTORTION AND TIME DISPLACEMENT

FIELD OF THE INVENTION

[0001] The present invention relates to the use of technical time displacement devices, which operate by the modification of gravitational fields. These drive systems do not depend on the emission of matter to create thrust to take advantage of time dilation, but rather create a change in the curvature of space-time, in accordance with general relativity. This allows travel across topologies by warping space-time, to produce a topology change from one spacelike boundary to the other in accordance with Geroch's theorem (Geroch 1967)

THEORETICAL BACKGROUND OF THE INVENTION

[0002] The concept of gravity should be examined in the light of quantum gravity and in turn as a component of quantum physics itself. The fundamental minimal quantum of energy in quantum physics is Planck's constant; h. Thus in accordance with the energy equivalence formula $E=mc^2$, the fundamental minimum quantity of mass (m_q) can therefore be derived, from known constants by; $m_q=h/c^2$ (1). Taking this minimal mass, it is possible to show that the formation of all matter, the forces of nature and indeed space-time itself derive from this single quintessential quantity.

[0003] Thus if the number of quintessences in a system is; $n_q=m/m_q$; then the total Energy of the system is more logically given by, the energy of a single quintessence (h); directly multiplied by the number of quintessences (n_q) in that system, thus

$$E=hn_q=mc^2 \quad (1\text{ a}).$$

[0004] Furthermore, this minimal mass, termed quintessence, can form the basis of the existence of a quantum gravitational field in the form of a space-time lattice, from which quantum gravity may be derived from first principles. Furthermore, the conglomeration of these quintessences also accounts for the formation of the elementary particles and the forces acting between them, as in superstring theory. This concept explains the formation of matter and the forces of nature on a quantum mechanical basis and directly explains the existence of wave particle duality. Thus as $n_q=m/m_q$; the frequency of light and matter (f) is determined, directly, from the number of constituent quintessences. This leads automatically to the fundamental equation, derived from (1), $f=n_q=E/h$, where n_q is the number of quintessences, which leads directly to the frequency of both light and matter. This in turn leads directly to a Universal wave equation for matter and light $\lambda=c/\beta n_q=hc/\beta E$ (2), where β is the relative directional velocity, v/c. As the momentum, $p=\beta\times E/c$, then this equation also gives the standard de-Broglie wave equation, $\lambda=h/p$ in agreement with current theory and experiments[1].

[0005] Using the Universal wave equation, the standard equation for special relativity, $m'=m_o/(1-\beta^2)^{1/2}$, derives from first principles. Also from these observations, a modified Dirac wave equation may be derived, $E\psi=(-j\beta\cdot\nabla+\beta m)\psi$ (2a), the results of which have been recently verified by a paper in which the orbitals of electrons were experimentally directly visualised[2]. Moreover, a fundamental equation for general relativity can be formulated, where G is the gravitational constant and r_q is the given radius of quintessence; $G=9(r_q)^2c^4/\lambda\beta E$ (3), such that the Universal wave equation is in direct agreement with general relativity[3]. Thus special and general relativity and quantum mechanics can be unified.

[0006] From here it is possible to proceed in a number of ways; the geometric structure of the electron and the forces of Nature may be derived from first principles and in turn the structure of the quarks, including the top and bottom, otherwise known as truth and beauty can be seen. Moreover, the presence of a space-time lattice results in an understanding of quantum EPR effects. By allowing a theoretical flow of energy through the space-time lattice it can be shown that:

[0007] Energy is not bound by space-time

[0008] Thus logically accounting for phenomena such as entanglement and quantum tunnelling. Quintessence can also be used to explain, logically, the inner physics of a black hole, the missing mass of the Galaxy, the continuing expansion of the Universe, Guth's inflationary theory and the Big Bang. Hence, it is now possible to understand the Universe, including space-time, matter and the forces of nature from the radius, mass and vibration of a single quantity, quintessence.

[0009] With this understanding of space-time, matter and the forces of Nature, and in particular gravity, it is possible to demonstrate that the modification of gravitational fields, and in turn the warping of space-time, can be technically readily achieved.

[0010] Using standard equations for special relativity, $m'=m_0/(1-\beta^2)^{1/2}$, it can be demonstrated that by differentially increasing the velocity of electrons, by applying a differential current, their mass can be increased in a specific way. In turn by increasing the mass of electrons, by general relativity, the number of gravitons emitted from these electrons can be modulated. By multiplying this effect using an ultracentrifugational device the differential graviton emission can be manifestly amplified. This in turn, in accordance with general relativity, will cause a change in the curvature of space-time.

[0011] This effective warping of space-time does not, of necessity, imply superluminal velocities, but does allow the creation of warp drive systems, which do not depend on the creation of thrust by the ejection of material as used in current space technologies.

Part 1—Fundamental Laws of Physics

[0012] Quintessential Mass

[0013] The quantum physical, minimum component of energy is Planck's constant; h. To define the minimal component of mass, using the standard energy equivalence formula; $E=mc^2$, such a minimal mass (m_q) would be required to have the value equivalent to; $m_q=h/c^2$ (1). The total mass of a system (m) would then be; $m=n_qm_q$, where (n_q) is the number of these minimal units. Thence, the total energy of a system can be derived from the minimal energy; h, multiplied by the number of these energy units (n_q). Thus as, $E=mc^2$, then also $E=m_qn_qc^2$ and substituting $m_q=h/c^2$, the energy equivalence formula has the more logical formulation; $E=hn_q$(1a). Thus the energy of a system is equivalent

to the minimal energy unit; h, multiplied by the number of those minimal energy units (n_q).

[0014] Taking this minimal mass/energy, it is possible to show that all matter, the forces of nature and space time can be constructed from this single quintessential quantity. Moreover, using this quantity the laws of physics can be derived from first principles. Thus, a priori, all components of the physical universe, including space-time, can be constructed from this minimal mass component, termed quintessence.

[0015] Wave Particle Duality

[0016] If the presence of quintessence accounts for the structure of matter and if matter itself forms from the number of quintessences, then the frequency of matter and thus wave particle duality directly arises from first principles. Specifically the wavelength of matter derives from the vibration of quintessence from which it is constituted. Thus the frequency (f) and in turn the wavelength of light and matter is directly equivalent to the number of quintessences contained within it. We find that the actual frequency of light can be directly derived from first principles from the effective mass of the photon (m_γ) and thus by the number of quintessences (n_q) it contains.

[0017] Thus for light conventionally:

$$f=E/h$$

[0018] and if $E=mc^2$, and $h=m_q c^2$, then

$$f=m_\gamma c^2/m_q c^2$$

and

$$f=m_\gamma/m_q=n_q$$

Thus

$$f=n_q \tag{4}$$

[0019] Thus the formula for the frequency of light E=hf is now readily explained by the observation that the frequency is determined quite directly from the number of quintessences n_q within the photon.

[0020] The wavelength is thus also given by:

$$\lambda=c/f=m_q c/m_\gamma=h/p$$

[0021] We can now show that the frequency of matter also has the same derivation from quintessence, as has the frequency of light. The frequency of matter is again equivalent to the number of quintessences it contains. Thus the wave particle duality of matter itself can be explained by its composition from quintessence. The amount of quintessences contained within a electron sphere will depend on the number of quintessences constituting the electron and those passing through it as a result of its relative velocity β^2 (where $\beta=v/c$); effectively its relativistic momentum (p). The frequency will then be related to the total number of quintessences. Thus for matter,

$$f=\beta^2 n_q \tag{4a}$$

[0022] Thus it is possible to derive the conventional de Broglie wave equation for matter from first principles. Thus, as $\lambda=v/f$, we have:

$$\lambda=v/\beta^2 n_q \tag{5}$$

[0023] thus as $n_q=E/h$

$$\lambda=hc/\beta E \tag{2}$$

[0024] and as conventionally $\beta E/c=p$, then for matter:

$$\lambda=h/p$$

[0025] Provided that in the de Broglie equation, the momentum of the object is calculated using the relativistic mass, thus accounting for the total number of quintessences n_q in an object, this gives an accurate value for the wavelength of matter[1].

[0026] Thus the wavelength of matter follows directly from its constituents, quintessence. As matter is made of quintessence, similarly to light, its frequency depends on the number of quintessences n_q within it, traveling relative to the speed of light. Moreover, $\lambda=hc/\beta E$, underpins a fundamental relationship between wavelength and energy. Furthermore, this is mathematically the same as the term $\lambda=hv/\beta^2 E$, giving a relativistic expression for the wavelength of matter, from which the relativistic equations may be directly derived

[0027] Wave Equations

[0028] The derivation of wave particle duality from first principles also now allows the derivation of a modified wave equation for matter.

[0029] To derive his wave equation Shrodinger commenced with the de Broglie equation using momentum (p). For lower energies the momentum of an electron is conventionally derived from the kinetic energy of the electron and the mass of the electron m_0. Thus conventionally:

$$E_k = \frac{1}{2}mv^{1/2} \quad \text{and} \quad p = m_0 v$$

Thus

$$E_k = p^2/2m_0$$

then

$$p = \sqrt{(E_k \cdot 2m_0)}$$

[0030] and conventionally, the de Broglie equation can also be written as:

$$\lambda=h/p=h/\sqrt{(E_k \cdot 2m_0)}$$

[0031] In turn the Shrodinger wave equation directly derives from the square of the above classical non relativistic term for kinetic energy:

$$\lambda^2 = h^2/E_k \cdot 2m_0$$

$$\text{thus } E_k = \frac{h^2}{2m} \cdot \frac{1}{\lambda^2}$$

$$\text{As } E = E_k + V$$

$$\text{then } E\psi = -\frac{h^2}{2m} \cdot \frac{d^2\psi}{dx^2} + V\psi = jh \cdot \frac{d\psi}{dt}$$

[0032] However, the Shrodinger equation, may be refined by taking into account relativity. Thus the true values for the energy are given by the relativistic momentum (p).

[0033] A fundamental relativistic wave equation for ψ, and its logical derivation may now be developed through the concept of quintessence as a fundamental constituent of matter.

[0034] The amount of quintessences in the electron is determined by the number of quintessences forming the electron at rest, plus the amount of quintessences passing through it due to its relativistic velocity, which will determine the relativistic momentum (p) of a particle.

[0035] The frequency of matter can now be readily calculated from first principles to give a more accurate result. Thus as matter is made of quintessence, similarly to light, its frequency is equal to the number of quintessences n_q within it. The wavelength will depend on its velocity travelling relative to the speed of light and thus multiplied by the relative velocity compared to c(β=v/c);

[0036] Hence for matter as previously shown:

$$\beta = v/\beta^2 n_q = hc/\beta E \quad (2)$$

[0037] And conventionally

$$E = (p^2c^2 + m_0^2c^4)^{1/2}$$

[0038] Using these equations, we can now, also, reformulate the Shrodinger wave equation, which has the advantage that relativity can be treated in a quantum mechanical way. Thus if the wave energy of matter is defined as:

$$E_\lambda = \frac{\beta\sqrt{p^2c^2 + m_0^2c^4}}{c^2}$$

thus

$$E_\lambda = \sqrt{(\beta^2p^2/c^2) + \beta^2m_0^2}$$

[0039] which in complex space generalises to

$$E_\psi = (-j\beta\cdot\nabla + \beta m)_\psi \quad (2a)$$

[0040] As the term

$$\alpha = \frac{e^2}{hc}4\pi\varepsilon_0;$$

also represents the ground state ratio of the velocity of the electron to c. Thus α=β=v/c=1/137.

[0041] Thus, also

$$E_\psi = (-j\alpha\cdot\nabla + \beta m)_\psi$$

[0042] This is thus the standard relativistic equation that Dirac was able to construct from the Shrodinger wave equation. This relativistic equation can be derived from the modified wave equation. This takes into account the relative mass energy which the quintessential wave equation contains.

[0043] Where importantly the term β·m is the mass m, multiplied by the ratio of the relative velocity to light β=v/c, and the term a is also essentially the relative velocity of the electron.

[0044] The Dirac equation was an empirical formula which worked mathematically, nevertheless even Dirac admitted it was not logically understood. The importance of these equations is that they show that the existence of quintessence allows the waveparticle duality of matter to be explained and mathematically derived from first principles, Thus the frequency of matter or even light is simply determined by the number of quintessences it contains.

[0045] Indeed, a recent publication in Nature has suggested that the direct visualisation of the orbitals of electrons shows that these are in very close agreement with theory. However, there is a significant departure from theory, in the interstitial molecular regions, suggesting that the higher velocities of the electrons obey the modified Dirac equation. Thus these orbitals were in keeping with the modified Dirac equation, which itself may be derived from the wave equation above, λ=hc/βE

[0046] The Shrodinger wave equation will approximate to the correct values until v approaches c. Indeed the Shrodinger equation will give similar answers as that derived from equation, under most experimental conditions.

[0047] However, equation 2 and its derivative may have advantages over standard Shrodinger theory with relativistic speeds. Furthermore, equation 2, conceptually shows that the wave particle duality of matter derives from the principle that the frequency of matter is directly equal to the number of quintessences it contains. Importantly it also mathematically allows relativity and quantum mechanics to be united.

[0048] With v≈c, the modified Dirac equation will yield more accurate results, particularly compared with the Schrodinger equation. We also find that the equation λ=hc/βE is equivalent to the de Broglie wave equation, λ=h/p, provided we use the relativistic mass in the de Broglie equation. Given this, these equations yield accurate experimental results.

[0049] Thus we find that the modified formulation of de Broglie wave equation λ=hc/βE leads directly to a modified Dirac relativistic wave equation and is supported by recent experiments which measure the wavelength of matter and demonstrate the electron orbitals experimentally from these wave equations for matter.

[0050] Wave Particle Duality and Relativity

[0051] From here it is possible to proceed in several ways using the relativistic wave equation. It is apparent that the reintroduction of the term for relative velocity into the wave equations will enable the reintroduction of special relativity into quantum mechanics. In particular we should now be able to derive the term

$$\sqrt{\left(1 - \frac{v^2}{c^2}\right)}$$

as a special case of quantum mechanics.

[0052] Thus if:

$$\lambda = hc/\beta E$$

As $E = \sqrt{p^2c^2 + m_0^2c^4}$, squaring

$$\lambda^2 = \frac{h^2c^2}{\beta^2\cdot(p^2c^2 + m_0^2c^4)}$$

-continued

Conventionally $p^2c^2 = \frac{E^2v^2}{c^2}$

then

$$\lambda^2 = \frac{h^2c^2}{\beta^2\cdot((E^2v^2/c^2)+m_0^2c^4)}$$

Thus as $\beta^2 = \frac{v^2}{c^2}$ and $m_0^2c^4 = E_0^2$, then:

$$\beta^4E^2 + \beta^2E_0^2 = \frac{h^2c^2}{\lambda^2}$$

hence $\beta^4E^2 = h^2c^2\cdot\frac{1}{\lambda^2} - \beta^2m_0^2c^4$ thus

$$\beta^2 = \frac{h^2c^2}{\beta^2E^2}\cdot\frac{1}{\lambda^2} - \frac{\beta^2m_0^2c^4}{\beta^2E^2}$$

As $E^2 = m^2c^4$

$$\beta^2 = \frac{h^2c^2}{\beta^2m^2c^4}\cdot\frac{1}{\lambda^2} - \frac{\beta^2m_0^2c^4}{\beta^2E^2}$$

Substituting $h = m_qc^2$

$$\beta^2 = \frac{m_q^2c^6}{\beta^2m^2c^4}\cdot\frac{1}{\lambda^2} - \frac{\beta^2m_0^2c^4}{\beta^2E^2}$$

As $m_q/'m = 1/n_q$ (eq. 2)

$$\beta^2 = \frac{c^2}{\beta^2n_q^2}\cdot\frac{1}{\lambda^2} - \frac{\beta^2m_0^2c^4}{\beta^2E^4}$$

Thus if $f = \beta^2n_q$; (eq. 7a)

$$\beta^2 = \frac{v^2}{f^2}\cdot\frac{1}{\lambda^2} - \frac{\beta^2m_0^2c^4f^2}{\beta^2E^2}$$

As $1/\lambda^2 = f^2/v^2$

$$\beta^2 = \frac{v^2}{f^2}\cdot\frac{f^2}{v^2} - \frac{\beta^2m_0^2c^4f^2}{\beta^2E^2}$$

Thus

$$\beta^2 = 1 - \frac{\beta^2m_0^2c^4}{\beta^2E^2}$$

As $E^2 = m^2c^4$

$$\beta^2 = 1 - \frac{m_0^2}{'m^2}$$

Hence

$$m_0/'m = (1-\beta^2)^{1/2}$$

Thus

$$'m = m_0\Big/\left[1-\frac{v^2}{c^2}\right]^{1/2}$$

[0053] Thus this derivation now allows relativity as a universal case of the quintessential wave nature of matter.

[0054] The original premises on which special relativity was based were: that the speed of light is a constant and that all observers are equal. As the speed of light has dimensions of length and time but not apparently of mass, the relativistic change in mass is not accounted for. Using quintessence logically and directly accounts for the relativistic mass changes.

[0055] Moreover, relativity can be derived from the de Broglie equation, and visa versa, directly, thus linking relativity and quantum mechanics by taking into account the existence of quintessence mass.

[0056] Hence, it is now possible to derive the relativistic equations for mass and in turn for space and time from the quintessential wave equation, thus deriving special relativity as a universal case of quantum mechanics and thus uniting special relativity and quantum mechanics. This now allows a further understanding of the nature of space-time.

[0057] The Space-Time Lattice

[0058] The understanding of the true nature of space-time and how it is formulated in three dimensions of real space is crucial. To simply assume that space-time exists, and thence not to question the nature of that existence, denies a deeper understanding of the universe.

[0059] In order to understand the nature of space-time itself, at the quantum level a further look at the nature light and the photon is necessary. Since Einstein's description of light as a particle (the photon) and the description of the photoelectric effect, the standard picture of light as simply a wave can, no longer be applied. If light was to exist as a photon, it could not exist in one dimension, as ordinary waves do, it would need to be three dimensional, with the addition of time. Let us suppose, in this case, that a photon is a three dimensional helical ringlet of light, travelling in the x vector, and spinning around the x-axis. Conventionally this ringlet has a radius; $r=\lambda/2\pi$. The ringlet itself would be vibrating in the y and z vectors. The vectors x, y and z would represent the photon, the substance of which, would be travelling in the x direction and oscillating in the y and z vectors, which would represent oscillatory energy. This in turn would allow it to act as a wave, and create oscillatory electromagnetic fields.

[0060] It is important to re-examine space-time itself in this light, this would have one directional vector with two vector dimensions of energy, one of capacitance and one of electrical permeability, thus accounting for the well known constants of free space; the permittivity of free space (ϵ_0) and the permeability of free space (μ_0) respectively. The vector dimension of direction x, would be the direction of travel and those "quintessences" travelling in an outwardly direction would account for none other than the expansion of the universe. Three of these quintessences would naturally constitute three dimensional visible space-time. These constituents of space-time would interact with the generations of the other vector dimensions reciprocally. Thus one quintessence would sweep out one vector of permeability and one vector of permittivity, through which the other two quintessences could travel, and vica versa, creating a three dimensional space-time lattice.

[0061] The permittivity of free space, (ϵ_0) which is equivalent to capacitance, would as with capacitance plates, be determined by the effective separation between quintessences. The permeability of free space (μ_0) is in fact a force, measured as $4\pi\times10^{-7}$ N/A^2, would result from the force produced by the vibration of quintessence and would be

dependent on the density of quintessence. Hence these two parameters would be reciprocal and thus the product of these two would therefore be a constant, which is recognised as none other than the speed of light.

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

[0062] This space time lattice would in effect be created by quintessences travelling in all directions with a speed of c within the lattice. The quintessences of the space time lattice would in effect produce a non-static ether. A non-static ether is fully compatible with special and general relativity. Indeed such an ether explains how space time can be curved as in general relativity. Furthermore, the existence of a non-static ether, was espoused by Einstein in his University of Leyden lecture on general relativity of May 5, 1920. In Einstein's own words;

[0063] "According to the general theory of relativity space without ether is unthinkable."

[0064] Recent evidence from a number of sources now strongly support the presence of this non-static ether, in the form of quintessence. An editorial from a major journal states "combined with other observations such as those of distant Supernova, the QMAP results corroborate the prevailing theory of inflation with the twist that the Universe is only one third matter (both ordinary and dark) and two thirds quintessence, a form of energy possibly inherent in empty space".

[0065] If we take into account the existence of quintessence and as such a three dimensional space-time lattice, matter which is intrinsically made of constituents of charge would interact with this lattice to produce the effects of mass. Mass would be perceived as a result of matter (whose constituent particles appear to contain charge) interacting with this lattice directly due to the inhibition of motion by the lattice's electrical permeability and permittivity vectors, which would form the existence of complex space. These quintessences would in the direction in the y and z vectors produce small vibrations of the order of the Planck length (10^{-35} m), whilst passing through the vectors of permeability and permittivity, thus producing the effects of mass.

[0066] The vibration would endow quintessence itself a (non rest) mass m_q equivalent, to the minimal mass of:

$$m_q = h/c^2 = 7\times373\times10^{-51}\ \text{kg·sec} \quad (1)$$

[0067] The presence and magnitude of Planck's constant (h) and especially the speed of light (c) is thus explained. Indeed, the speed of light

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

is not in itself a fundamental quantity.

[0068] As the energy equivalence formula is $E=mc^2$, the minimal mass of a single quintessence, would thus be the minimal mass, h/c^2, hence again:

$$m_q = h(\mu_0\epsilon_0) = h/c^2 = 7.373\times10^{-51}\ \text{kg·sec} \quad (1b)$$

or

$$m_q c^2 = h \quad (1c)$$

[0069] It is postulated by general relativity that the shape of space time itself can be altered, indeed the presence of the space time lattice now allows this to be altered by altering the density of quintessence. It is further clear that if quintessences underly the structure of the space-time lattice, they may also underly the structure of matter itself.

[0070] With regards a single quintessence, this passing through an energy vector of the space-time lattice would appear as a vibrating string. In a similar way to string theory, the conglomeration of these quintessences would produce the constituents of ordinary matter. Thus the general equation for the number of quintessences (n_q) in an object of mass (m) would be

$$m/m_q = n_q$$

[0071] The mass of the electron (m_e) for example, would be directly determined by the number of quintessences in the electron, multiplied by the mass of quintessence.

[0072] Quintessence and Complex Space

[0073] Quintessence is postulated to constitute the fundamental nature of space-time. Three quintessences each travelling in their respective x vectors at 90° to each other would create three dimensional real space-time. These quintessences would in the direction in their respective y and z vectors produce small vibrations of the order of the Planck length (10^{-35} m), this would create the vector dimensions of permeability and permittivity. The result would give space-time 9 dimensions of space as in superstring theory. However, unlike superstring theory the six hidden dimensions would not be "curled up so as to be so small as to be invisible" these six dimensions would be present in complex space. Thus, only three of these dimensions would represent ordinary three dimensional particulate space time i.e. three dimensional objects. The other six dimensions produced by the vibrations of quintessence would form complex space.

[0074] The mathematics of complex space, using imaginary $\sqrt{-1}$ or (j) numbers, is assumed in the standard formulation of the Shrodinger wave equation. Thus the presence of complex space is an integral part of quantum mechanics.

$$-\frac{h^2}{2m}\cdot\frac{d^2\psi}{dx^2} + V\psi = jh\cdot\frac{d\psi}{dt}$$

[0075] The mathematics of complex space is also an essential and integral part of the principles and application of modern electronic and control engineering. Indeed it has been well recognised for some time that each direction vector in electronic engineering can, be associated with complex vectors.

[0076] As this complex space consists of the vectors of permittivity and permeability it would only be "felt" by charged particles as in the electron. Nevertheless, as all particles are fundamentally composed of charged particles

the effects of complex space would be felt by endowing these particles with mass and in turn kinetic energy.

[0077] In conventional complex space, a 2 dimensional Cartesian Argand diagram is mathematically used. However, in order to formulate the equations for particles a three dimensional Argand diagram is essential. This will have three dimensional vectors, one real vector and two imaginary vectors. Three of these diagrams will be required to fully describe the nature of particles, each with a real vector in the x, y and z vectors, respectively. Nevertheless, in the instance below the real vector is the x vector and the two imaginary vectors are given by $({}_jy_{-j}z)$

[0078] The Three Dimensional Argand Diagram

[0079] The beauty of a three dimensional Argand diagram is that the complex conjugate (i.e. the mirror image which confers mathematical reality on the coordinates) is formed by the value of the minus coordinate in the other complex vector dimension. Thus the complex conjugate of $(C_x^{1/2}+{}_jc_y^{1/2}+{}_{-j}c_z^{1/2})$ is $(c_x^{1/2}+{}_jc_y^{1/2}+{}_jc_z^{1/2})$. These two sums when multiplied thus give a real number solution.

[0080] Furthermore it is clear that nine dimensions of space time are necessary in the general relativistic equations. By including complex space we thereby create the nine dimensional spacial metrictensor and the metric energy tensor of matter necessary for computations for general relativity From here we can begin to understand the true structure of matter.

[0081] Energy and the Space-Time Lattice

[0082] The presence of numerous experimental data for quantum tunnelling. and indeed the recent observations by Nicholas Gisin, on the entanglement of distant photons now returns us to EPR experiments.

[0083] Using the quintessential modification of the de Broglie wave equation, gives us an insight into these teleportation and EPR effects.

[0084] As

$$\lambda=hc/\beta E \tag{2}$$

and

$$E=hm_q \tag{1a}$$

then

$$\lambda=c/\beta m_q \tag{2b}$$

[0085] Importantly, as indicated by equation (2b), energy having no quintessence; would have a wavelength of infinity. Specifically pure energy containing no quintessences, would have a lambda of infinity. According to quantum mechanics an infinite wavelength would result in the probability of that energy being anywhere. As energy itself has no electrical charge it would not be impeded by the permittivity and permeability of the three dimensional space-time lattice. Moreover, energy would not be detectable in three dimensional space-time, unless it interacted with matter, as in the EPR experiments. Indeed, energy is not observed when not bound to any form of mass or particle. Thus equation 9d, takes us to our original assertion

[0086] Energy is Not Bound by the Space-Time Lattice

[0087] Thus, as the EPR experiments suggest the existence of energy separate from matter and thus separate from the three dimensional space-time lattice, it is interesting to find that experiment suggests the existence of free energy in a continuum separate from space time to produce the effects of quantum teleportation

[0088] This is not, however, teleportation across an additional dimension, this is a term to describe in partially familiar terms the dissociation of energy from the three dimensional space-time lattice. As time is inextricably linked to each dimension of space, the effects of energy would be inextricably linked to the events, such as the creation of virtual particles, we see interacting within space-time.

[0089] It is unlikely that observers have any direct day to day experience to explain quantum events. Nevertheless, quantum physics may have given us a window into the hitherto hidden workings of the Universe. Thereby, the mystery of the uniformity of the Universe, across distances which the speed of light could not apparently traverse, is readily explained by the fact that the free energy contained in the Universe is not bound by the space-time lattice.

[0090] In the case of light, due to the exceedingly small masses involved, there would be relatively easy exchange of matter with free energy within a photon. This would make the photon the ideal experimental tool to look for energy which is not bound by matter and in turn energy which is not bound in space-time. Indeed, very recently Furusawa et at. have reported to have observed the transference of energy as photons from A to B, without those photons traversing space-time. This finding which has been supported using other experimental techniques, is very important as it suggests the existence of such a quantum continuum.

[0091] We have already seen strong experimental data using photons, atomic spins and other data for quantum teleportation which have recently been published which support these findings. According to the above equations the teleportation would vary in a predictable fashion, as with photons, in line with the wavelength of the light used, relative to the size of vibration of quintessence. As regards matter, the results do confirm that the effect of quantum tunnelling is indeed dependant on the wavelength of matter and the size of that matter.

Part II—Particle Physics

[0092] Electron Structure

[0093] Understanding the electron is fundamental to the understanding of the elementary particles. The hidden nature of the electron may recently have been revealed through observations by Horst Stormer, Daniel Tsui and Robert Laughlin for which a Nobel prize has recently been awarded. They describe a quasi electron particle of charge ⅓e. This has been described on a quantum basis as a vortex of energy, bound as a quasi particle in one dimension x, but not bound in the other two dimensions y and z, allowing dispersion in space-time as a vortex. What is more intriguing are the experimental conditions in which this occurs. First of all a two dimensional electron gas is created and held between two capacitance plates. A magnetic force is then applied in the remaining dimension, virtually creating a one dimensional passage through which only a quasi electron appears to be able to pass.

[0094] Given the presence of charge of ⅓e, then three of these quasi electrons could form an entire electron in three

dimensional visible space time. Nevertheless, each would have energy and hence a wave function which would be present in the other vectors. This electron could thus follow the probability functions as described by the Shrodinger wave equation for ψ (otherwise termed as "essence" by Shrodinger)

[0095] If the mass of the electron (m_e) is constituted from quintessence, using the formula:

$$m_e/m_q=n_q$$

[0096] Then an electron would be constituted from:

$$\frac{9.11\times10^{-3}\ \text{kg}}{7.373\times10^{-51}\ \text{kg}\cdot\text{sec}}=1.235\times10^{20}\ \text{quintessences/sec.}$$

[0097] Thus taking into account the mass-energy content of quintessence (m_q) it is independently possible to derive the magnitude of the charge of an electron (e) using the following equation.

$$e=\sqrt{\frac{m_q\varepsilon_0}{\left(\frac{4}{3}\right)\pi hc}}=1.61\times10^{-19}C$$

[0098] This is in close agreement with the experimentally observed charge on the electron of 1.602×10^{-19} C.

[0099] Interestingly substituting $m_q=h/3c^2$ in the above equation we have:

$$e=\sqrt{\frac{\varepsilon_0}{3\left(\frac{4}{3}\pi c^3\right)}} \tag{6}$$

[0100] This can also be written as

$$e=\sqrt{\frac{\varepsilon_0}{3\left(\frac{4}{3}\right)\pi c^3}} \tag{6a}$$

[0101] Equation (6) has a number of very special implications, if re-examined, firstly three of these quasi electron spheres appear to be required to constitute the charge of the electron. More intriguingly, it indicates that the charge is related to the volume of a sphere with an apparent radius of c. Thirdly it indicates that the square of the charge of an electron (e) is proportional to the permittivity of free space (so). The charge given from equation (3) is in close agreement with the measured charge of the electron. Furthermore a more exact value for the charge of the electron (to seven decimal places) can be deduced by taking into account the gravitational field of the Earth (see Gravity and the Charge of the Electron). Furthermore the charge of the electron (e) can now be derived from first principles. Thus, equation (3) corroborates the evidence that the electron is indeed composed of three quasi electrons in keeping with recent experimental findings.

[0102] The significance of the electron, composed of three spheres each with a radius of c, is not immediately clear, but can be understood if the frequency of rotation of the electron is taken into account. Thus if the diameter of the electron was approximately 10^{-19} m, then its spin would need to be

$$\frac{1}{c}\times10^{-15}$$

m approx. eq. 10^6 cycles/sec. Thus given a very high rotation rate an electron could have an effective radius of 1/c and still occupy subatomic sizes. Indeed these observations might be used to estimate the rate of rotation of the quasi electron and its size (see Appendix 1).

[0103] With regards a single quintessence, this passing through an energy vector of the space-time lattice would appear as a vibrating string. In a similar way to string theory, the conglomeration of these quintessences would produce the constituents of ordinary matter. The electron, for example, would be constituted from approximately 1.235×10^{20} quintessences.

[0104] The dimensions of the equation for the electron can be readily resolved by considering each of the three vector dimensions. The exact dimensions of the equation need to be considered in the light of the nature of space-time itself. These dimensional equations help explain the nature of matter. Indeed the equation for the electron may be necessary for the full understanding of gravity

[0105] Complex Space and Electron Structure

[0106] The presence of complex space also now further explains the conformation of the electron, and its formulation at the quantum level, and the presence of particles, anti-particles and their spin up and spin down characteristics.

[0107] Indeed the short form equation for the charge of the electron (−e) can now be rewritten as a metric tensor with three dimensions in real space and six in complex space.

[0108] Thus if three of the x, y and z vectors are in real space and six vectors in complex space, where c is the speed of light in the real space vector, $_jc$ is the speed of light in the complex vector and $_{-j}c$ is the complex conjugate of $_jc$, thus the electron can be mathematically represented by the equation:

$$-e=\varepsilon_{qc}\Big/\left(\frac{4}{3}\pi\right)^{1/2}\cdot\begin{matrix}(c_x)^{1/2}\cdot(jc_y)^{1/2}\cdot(-jc_z)^{1/2}\\ + \quad + \quad +\\ (-jc_x)^{1/2}\cdot(c_y)^{1/2}\cdot(jc_z)^{1/2}\\ + \quad + \quad +\\ (jc_x)^{1/2}\cdot(jc_y)^{1/2}\cdot(c_z)^{1/2}\end{matrix}$$

[0109] Which now elegantly gives the real number solution

$$e = \frac{\varepsilon_{qe}}{3\sqrt{\left(\frac{4}{3}\right)\pi c^3}}$$

[0110] Where $e=\epsilon_{qe}$ is given as the permittivity of free space for a single quasi electron Equation 4 represents a "complex" tensor

[0111] Whilst the two dimensional Argand diagram has four quadrants, the three dimensional Argand diagram has eight cubic sectors. Two of these cubic sectors are diametric opposites and can represent "real" particulate objects. These have the primary coordinates x, y, −z; as in the electron described above, and the −x, −y, z, with the real vector x now having a minus sign. These two "real" cubic sectors, therefore, mathematically represent particles and their anti-particles.

[0112] The mathematical presence of the two primary diagonal mirror images (x, y, −z and −x, −y, z) now allow the introduction of the concept of antiparticles. This extension of the maths into a three dimensional Argand diagram thus results in the automatic formulation of the maths of anti-particles. Thus the charge of the positron (^{+}e) is formulated by the shortened form equation, where the real vectors now each have the minus sign, and therefore exist in the −x, −y, z sector of the three dimensional Argand diagram.

$$e = \varepsilon_{qe} \Big/ \left(\frac{4}{3}\pi\right)^{1/2} \cdot \begin{matrix} -c_x^{1/2} \cdot -_j c_y^{1/2} \cdot j c_z^{1/2} \\ {}_j c_x^{1/2} \cdot -c^{1/2y} \cdot -_j c_z^{1/2} \\ -_j c_x^{1/2} \cdot j c_y^{1/2} \cdot -c_z^{1/2} \end{matrix}$$

[0113] The three dimensional Argand diagram also accounts for chirality and indeed the up and down spin of the electron. There are two other "real" primary coordinates in the Argand diagram, these are themselves the partial mirror images of the above coordinates (i.e. x, −y, z and −x, y, −z). In particular the y axis is of the opposite sign, thus in particles the y axis is in the downward direction, to form down spin particles and in anti-particles in the up direction, to form the antiparticle The up spin electron is given by eq. 8 and hence the down spin electron (−e|↓≦) is given by the equation

$$-e|\downarrow) = \varepsilon_{qe} \Big/ \left(\frac{4}{3}\pi\right)^{1/2} \cdot \begin{matrix} c_x^{1/2} \cdot -_j c_y^{1/2} \cdot j c_z^{1/2} \\ {}_j c_x^{1/2} \cdot c^{1/2y} \cdot -_j c_z^{1/2} \\ -_j c_x^{1/2} \cdot j c_y^{1/2} \cdot -c_z^{1/2} \end{matrix} \quad (9)$$

[0114] Thus the three dimensional Argand diagram accounts directly for the presence of antiparticles and the spin up and spin down particles seen in nature. It also accounts for the necessity of the electron to form a square root spherical object, as complex space depends on √−1, otherwise known as j.

[0115] Electron Pairing and Superconductivity

[0116] As the quintessences making up the electron are in a square root conformation, each of these quasi electrons would have a tendancy to pair to form an entire sphere.

[0117] The square root sphere structure of electrons with up and down spins can now superimpose to produce a complete sphere of varying extents. This produces electron pairing as seen at the atomic and molecular levels. It also accounts for the Pauli exclusion principle. This pairing thus accounts for the reactivity of the valence electrons and the electron probability densities, which in turn accounts for the existence of chemistry.

[0118] Furthermore, it is possible to account directly for superconductivity from first principles. For if both the complex and real vectors of the electron combine completely, the product of an up and down spin electron form a perfect superimposed sphere with radius c, with a charge of 2.59×10^{-38} C, denoted by the formula:

$$e^2 = \frac{\varepsilon o}{3\left(\frac{4}{3}\pi c^3\right)} = 2.59\times10^{-38} C \quad (6b)$$

[0119] As with standard superconducting theory, superconductivity can be explained by the formation of "Cooper" electron pairs, where the electrons are forced to pair by the presence of positive crystal charge in particular formation, at supercooled temperatures. In addition the electron pair now forms a stable entity whose angular momentum cancels.

[0120] It additionally becomes clear that the charge of two separate electrons (2e) is 3.2×10^{-19} C, but the charge of the combined electrons (e^2) is 2.59×10^{-38} C. This electron pair thus appears to have 19 orders of magnitude less charge than the electron and in turn 19 orders of magnitude less resistance. It is this effective reduction in charge and in turn resistance, which may account for superconductivity. When observed directly any electrical interaction with the Cooper electron pair will, however, result in the release of the full charge of both electrons, so that the full electrical charge put in will be equal to that coming out of the apparatus.

[0121] The Fine Structure Constant

[0122] Intruiginty from our knowledge of the electron we can further define the term .alpha., the fine structure constant; from the structure of the electron. Thus as the standard term

$$\alpha = \frac{e^2}{\hbar c \times 47\pi\varepsilon_0};$$

substituting the term

$$e^2 = \frac{\varepsilon_0}{3(4/3)\pi c^3} \quad \text{(eq. 6)}$$

and

$$h = m_q c^2 \quad \text{(eq. 1)}$$

we find:

$$\frac{2\pi}{\alpha} = m_q[3(4/3\pi c^3)]^2$$

or

$$\frac{2\pi}{\alpha} = \frac{m_q e^4}{\varepsilon_0^2}$$

[0123] For brevity we may represent the quasi electron structure as $(4/3)\pi c^3=\theta$; to signify its threefold symmetry, thus

$$\frac{2\pi}{\alpha} = m_q(3\theta)^2 \tag{10}$$

[0124] Indicating that the fine structure constant of the electron (a) is indeed related to its dimensional structure. Again taking into account the effects of gravity the fine structure constant can be derived from first principles to nine decimal places (see Gravity and the Charge of the Electron).

[0125] Fundamental Forces and Particle Structure

[0126] In order to understand the fundamental forces and the nature of fundamental particles, an overview is required. Thus, there are three major forces; strong, electro-weak and gravity, each mediated by three force particles the gluon, photon and graviton respectively. These in turn, influence three types of particle, the quark, lepton, and by general relativity space-time itself. Each of these are composed of particles with multiples of charge of ⅓, which are themselves in three generations, and are present in three dimensions of real space. It is important that a comprehensive view of nature explains this threefold symmetry.

[0127] Using the Standard Model of particles, it is well accepted there exist quark particle charges of −⅓, −⅔ and +⅓ and +⅔ in quarks and anti-quarks. Given that each particle is made up of three quarks the presence of these fractional charges support the association of the fractional charges in this way to form three dimensional charged particles. In stable particles each of the three quarks would have a vector in one dimension, giving the three quarks together an existence in three dimensional visible space time. The particles that bind the quarks (gluons) are themselves required, in stable particles, to have three different color charges, one color in each dimension, for the particle to exist in three dimensional space-time. Furthermore, there are three generations of quarks (and indeed leptons).

[0128] The Standard Model (or a modification of this) and in particular the observation of quarks and indeed quasi electrons with fractional charge of ⅓ and ⅔ in both cases, indicates that particles are constituted from the equivalent of three of these quasi particles to form an electron and quarks to form baryons. In the normal three dimensions the energy would be carried by the particle, However, because each particle is constituted of three quasi particles and in each quasi particle or quark one visible dimension would be the direction vector, in the other two hidden dimensions of each vector the waves would carry energy. Thus each particle would be associated with vibration, which would account for wave particle duality and Heisenberg's uncertainty principle in three dimensional visible space-time.

[0129] These observations lead us directly to the previous postulate that the structure of the electron is composed of none other than three (root) spheres, and that this equation for the electron allows the determination of the charge of the electron from first principles, thus:

$$e = \frac{\varepsilon 0^2}{[3(4/3\pi c^3)]} \tag{6}$$

[0130] In addition the mass of the proton (m_p) can be directly calculated from the ratio of the mass (m_e) of the electron, given by the equation:

$$\frac{m_e}{m_p} = 5.45\times10^{-4} = 3\frac{\pi}{\sqrt{c}} \tag{11}$$

[0131] Strictly we should write,

$$\frac{m_e}{m_p + m_e} = 3\pi\sqrt{c};$$

which is much more elegant.

[0132] Which now gives

$$\frac{m_e}{m_p} = \frac{1}{\sqrt{c}/3\pi - 1} = 5.4462\times10^{-3}$$

[0133] This is in very close agreement with the experimentally derived ratio of the proton to electron masses which is also; 5.4462×10^{-3}

[0134] Thus the correlation factor between theory and experiment has a maximum error <0.00001.

[0135] If we combine equation 3:

$$e = \sqrt{\frac{\varepsilon_0}{3(4/3)\pi c^3}}$$

and equation 13:

$$\frac{m_e}{m_p} = 3\frac{\pi}{\sqrt{c}}$$

the positive charge of the proton (e_p) is given by:

$$e_p = \sqrt{\frac{\varepsilon_0}{3(4/3)\pi c^3}} \times m_e \times 3\frac{\pi/\sqrt{c}}{m_p} = e \tag{12}$$

[0136] The stable nuclear proton conformation can thus be represented by the short form equation:

$$p=3^{+}\sqrt{3(4/3)\pi c^3}\times 3(\pi/\sqrt{c}) \tag{13}$$

[0137] This forms a stable 3×3 conformation as with the stable electron structure.

[0138] Importantly the term ($\pi/\sqrt{c}$) is the 90° solution to the Shrodinger wave equation for an electron confined in a space with radius c!.

[0139] Thus the standard equation for an electron confined in a one dimensional box is given by:

$$E\psi(x) = -\frac{h^2}{2m}\frac{d^2\psi(x)}{dx^2}$$

[0140] If the one dimensional box has a length 2L the quantum amplitude (A) can only be non zero between x=0 and X=2L and the standard solution for the amplitude is none other than:

$$A=(1/L^{1/2})$$

[0141] Thus in one dimension the standard solution to the Shrodinger wave equation is:

$$\psi(x)=(\pi/L^{1/2})\mathrm{Sin}\ x/L$$

[0142] Thus not only is the electron charge derived from the equation for three spheres each with a radius of c (eq. 3); but the proton mass and charge can also be derived from the standard solution to the Shrodinger wave equation for a an electron confined in a space of radius c!.

[0143] The term ($\pi/c^{1/2}$) itself would thus most logically represent the gluon which is present in the proton. These gluons would bind the quasi electrons together to form the fundamental particles

[0144] The masses of all the known particles, including the up and down quarks, the W boson, the muon, charm, strange, the tauon, truth and beauty can thus also be derived from first principles in this fashion, and have the quasi electron as their basic constituent particle (see Appendix 1).

[0145] Thus the structure of the muon (μ) can also be derived from the ratio of the mass of the electron (m_e) and the mass of the muon (m_μ):

$$m_e/m_\mu=4.7\times10^{-3}=c^{1/3}$$

Thus

$$\mu=\epsilon_0^{1/2}\times m_e/m_\mu\times 3^{-}(4/3=\pi c^3)^{1/2}\times(\pi/c^{1/3})$$

[0146] Where the charge of the muon is in this equation equivalent to that of the electron e. In this case ($\pi/c^{1/3}$) can be considered to represent a specific high energy photon. Thus the structure of the muon, written in short form is:

$$\mu=3^{-}(4/3\pi c^3)^{1/2}\times(\pi/c^{1/3}). \tag{14}$$

[0147] Moreover the structure of the tauon can be calculated from the ratio of the mass of the electron and that of the Tauon (1.79 Mev);

[0148] Thus

$$0.511\ \mathrm{Mev}/1.79\ \mathrm{Gev}=2.85\times10^{-4}$$

$$m_e/m_\tau=(\pi/c)^{1/3}\times(\pi/c)^{1/9}=2.85\times10^{-4}$$

[0149] As the charge of the tauon is equivalent to the charge of the electron, hence the structure of the Tauon is given by the above equation

$$e_\tau=\epsilon_{qe}\times(m_e/m_\tau)\times 3^{-}(4/3\pi c^3)^{1/2}\times(\pi/c)^{1/3}\times(\pi/c)^{1/9}=e$$

[0150] This equation accurately predicts the charge −1; and mass of the Tauon (.~1.78 Gev). Thus the structure of the Tauon can in short form be given by the equation

$$\tau=-3(4/3\pi c^3)^{1/2}\times(\pi/c)^{1/3}\times(\pi/c)^{1/9} \tag{15}$$

[0151] Furthermore a more exact value for the mass of the muon and tauon can be deduced by taking into account the gravitational field of the Earth in a similar way to identifying the exact charge of the electron. In addition it may be necessary to take into account a possible mass value of the neutrino to arrive at a precisely accurate mass value of the muon and tauon. Nevertheless, the mathematical proof of these short form equations lies in the fact that they can very closely identify the charge and the masses of these particles, from first principles, as in equations.

[0152] Overall the mathematical geometrical structure of all the particles can be derived from the quasi electron, which is in turn derived from quintessence. Thus, the short form particle structures can now be derived from first principles. This includes the quasi electron (qe) and electron (e), from which the quarks (u,d) and in turn the stable proton (p) and stable neutron (n) and alpha particle (a) respectively are derived. The general structure of the force carrying bosons the photon. (g) and the gluon (γ) and the intermediate vector boson (W) can be given. It will also intriguingly be possible to derive, according to their generation, the structure of the strange (s) charm (c), beauty (b, or bottom) and truth (t or top) quarks directly from the structure of the muon (μ) and Tauon (τ) respectively.

[0153] Using the term $\Theta=(4/3\pi c^3)$, where, −/+ represents the charge of the quasi electron, we find:

[0154] 1st Generation:

$$(q_e)=^{-}\Theta^{1/2} \tag{6c}$$

$$e=3^{-1/2} \tag{6}$$

$$d=^{-}\Theta^{1/2}\cdot 3(\pi/c^{1/2}) \tag{16}$$

$$u=2^{+}\Theta^{1/2}\cdot 3(\pi/c^{1/2}) \tag{17}$$

$$s=^{-}\Theta^{1/2}\cdot 3(\pi/c^{1/2}) \tag{18}$$

[0155] 2nd Generation

$$\mu=3^{-}\Theta^{1/2}\cdot(\pi/c^{1/3}) \tag{14}$$

$$c=2^{+}\Theta^{1/2}\cdot(\pi/c^{1/3})\cdot(\pi/c^{1/4}) \tag{19}$$

$$b=^{-}\Theta^{1/2}\cdot(\pi/c^{1/9})\cdot(\pi/c)^{1/4} \tag{20}$$

[0156] 3rd Generation

$$\tau=3^{-}\Theta^{1/2}\cdot(\pi/c)^{1/3}\cdot(\pi/c)^{1/9} \tag{15}$$

$$t=2^{+}\Theta^{1/2}\cdot(\pi/c)^{1/3}\cdot(\pi/c)^{1/9}\cdot(\pi/c)^{1/4} \tag{21}$$

[0157] Particle Gluons (g):

$$g_1=(\pi/c^{1/2}) \tag{22}$$

$$g_2=(\pi/c)^{1/2} \tag{22a}$$

$$g_3=(\pi/c^{1/4}) \quad (22b)$$

$$g_4=(\pi/c)^{1/4} \quad (22c)$$

[0158] Particle Photons (.gamma.):

$$\gamma_1=(\pi/c^{1/3}) \quad (23)$$

$$\gamma_2=(\pi/c)^{1/3} \quad (23a)$$

$$\gamma_3=(\pi/c^{1/9}) \quad (23b)$$

$$\gamma_4=(\pi/c)^{1/9} \quad (23c)$$

[0159] Intermediate Vector Boson ($W^{+/-}$):

$$W^{+}=3^{+}\Theta^{1/2}\cdot 2(\pi/c^{1/6})^6 \quad (24)$$

$$W^{-}=3^{-}\Theta^{1/2}\cdot 2(\pi/c^{1/6})^6 \quad (25)$$

[0160] Stable* Proton:

$$p=3^{+}\Theta^{1/2}\cdot 3(\pi/c^{1/2}) \quad (13)$$

[0161] Stable* Neutron:

Stable * Neutron:

$$n = \begin{matrix} {}^{+}\Theta\downarrow^{1/2}\cdot 2(3\pi/c^{1/2}),^{-}\Theta\uparrow^{1/2} \\ {}^{+}\Theta\downarrow^{1/2}\cdot 2(3\pi/c^{1/2}),^{-}\Theta\uparrow^{1/2} \\ {}^{+}\Theta\downarrow^{1/2}\cdot 2(3\pi/c^{1/2}),^{-}\Theta\uparrow^{1/2} \end{matrix}$$

* Stable nucleonic neutron and proton conformations differ slightly from the Standard Model, this is due to the sharing of quasi electron and quasi positron particles within the nucleus, which allows stabalisation of these particles by the formation of stable 3×3 structures. The Standard conformations which describe non-nucleonic neutrons and protons are additionally given in Appendix 1.

[0162] Alpha particle (α):

$$\text{Alpha particle } (\alpha) := \alpha = \begin{matrix} [3^{+}\Theta]\downarrow^{1/2}\cdot 2(3\pi/c^{1/2})\cdot[3^{-}\Theta]\uparrow^{1/2} \\ [3^{+}\Theta]\uparrow^{1/2}\cdot 2(3\pi/c^{1/2})\cdot[3^{-}\Theta]\downarrow^{1/2} \\ [3^{+}\Theta]\downarrow^{1/2}\cdot 2(3\pi/c^{1/2})\cdot[3^{-}\Theta]\uparrow^{1/2} \end{matrix} \quad (27)$$

[0163] The mathematical proof for these structures and their decay mechanisms is lengthy and is thus fully contained in Appendix 1. All the particle structures are accurately mathematically defined by the masses of these particles.

[0164] The structure of these particles all contain the quasi electron and thus the metric tensor structure necessary in the formulation of the gravitational equations is sustained. The respective forces created by the gluon and the photon are important as they tell us the behaviour of matter and also lead to the likely structure of the graviton

[0165] Particle Spin and Size

[0166] The significance of the electron, composed of three spheres each with a radius of 1/c, is not immediately clear, but can be understood if the frequency of rotation of the electron is also taken into account. Knowing the structure of the electron has led us to deduce its charge and thus may lead us estimate its size and spin. Thus these observations might be used to calculate the radius and rate of rotation of the electron.

[0167] Let us suppose, that nature is truly beautiful, and that the radius of the fundamental quasi electron is indeed 1/c, and in turn the radius was balanced by the velocity of rotation 2π/c. This can be directly confirmed mathematically by taking into account the known spin of the electron, h/4π. Thus the actual spin of the electron may be calculated form the known energy of the spin.

[0168] The radius of the electron is not up till now known, but the radius of a quark has been estimated, and this is the radius derived from deep inelastic collisions of the proton. These estimates reveal a radius of approx. $r_p=1.18\times10^{-15}$ m This value may be used to assist in confirming the spin of the proton in revolutions per sec. (revs) and in turn the spin and size of the electron. Firstly we may proceed to estimate the spin of the proton. Thus as h=E·t (Joules×sec) and h=E·t=F·d·t (Joules×sec), then the spin;

$$h/4\pi=F\cdot d\cdot t \quad (28)$$

[0169] As F=ma, where $\alpha=(revs\cdot 2\pi)^2 r_p$ and m=the mass of the proton, then

$$h/4\pi=m(revs\cdot 2\pi)^2 r_p\cdot d\cdot t$$

[0170] The actual distance (d) traveled in a circle of half integer spin in 1 second is: $revs\cdot\pi r_p$ thus:

$$h/4=m(revs\cdot 2\pi)^3 r_p^2/2$$

[0171] Hence:

$$revs=[h/m(2\pi)^4 r_p^2]^{1/3}$$

[0172] Taking the effective mass the proton as 1.6726×10^{-27} kg, then the rate of spin of the proton in revolutions/sec is:

$$revs=5.65\times10^6 \text{ cycles/sec}$$

[0173] From the frequency of the specific rotation of the proton, given the half integer spin associated with the proton, we can thus mathematically confirm the relationship between the radius of a particle and its spin:

$$r_p\times revs/2=1/c \quad (29)$$

[0174] Furthermore, the fundamental radius of 1/c seen in geometric structure the quasi electron, is also reflected in the rotation rate and radius for the proton, thus as above 1/c+½ revs=1.85×10^{-15} m. Moreover, this means the actual half integer velocity of rotation is none other than 2π/c in metres/sec. So that the particle is in harmonic balance.

[0175] Using the fundamental formula h/4π=F·d·t, it is possible to obtain accurate estimates of the radius and spin rates of the electron, or indeed any particle, using the same principle of harmonic balance. Using the formula:

$$revs=[h/m(2\pi)^4 r_e^2]^{1/3}$$

[0176] It appears there are two unknowns, the radius if the electron and its revolution rate, however, in accordance with the equation, $r_p=2/c.revs$, which gives the revolution rate of the proton, the same principle may also be used for the electron, by substituting $r_e=2/c.revs$, such that:

$$revs=hc^2/4m_e(2\pi)^4 \quad (30)$$

[0177] Taking the mass of the electron 9.109382×10^{-31} kg, the rate of revolution of the electron is:

$$revs=1.048\times10^{10} \text{ cycles/sec}$$

[0178] Which gives a predicted radius of the electron as

$$r_e=6.336\times10^{-19}\text{ cycles/sec}$$

[0179] So the half integer rotation velocity (revs.πr) is 2π/c !, for the electron in keeping with the harmonic balance of the electron.

[0180] The same principle may be used to obtain an accurate estimate of the spin and radius of the muon, or any other particle. Using the above formula

$$revs=hc^2/4m_e(2\pi)^4 \tag{31}$$

[0181] Then as the mass of the muon is 1.8823×10^{-28} kg then the revs of the muon $f_\mu=5.070\times10^{-7}$ cycles/sec and the radius r_μ is thus 1.316×10^{-16} m.

[0182] It is now possible to begin to explain how the muon and the other subatomic particles are formed. If a quasi electron is complexed with another structure the total geometric structure needs to maintain harmonic balance. So the frequency of rotation would need to match geometric structure with which the quasi electron was complexed

[0183] Intriguingly we find asymptotic convergence for the formulas for frequency and mass occurs, when the geometric structure complexed with the quasi electron has the structure represented by $(\pi/c^{1/3})$ [giving the frequency divided by two, because the single integer spin of the force carrying particles compares to a half integer spin for the muon]. So that

$$(f_\mu 3\pi/2)^{1/3}=f_\mu$$

[0184] When the ratio of the masses of the electron (m_e) and muon (m_μ) are related, such that:

$$m_e(3\pi/c^{1/3})=m_\mu$$

[0185] Indeed we find that (allowing for the neutrino) this ratio is very close to the actual ratio of the mass of the electron to the mass of the muon, determined experimentally.

[0186] Furthermore, we have seen that these geometric structures, representing harmonics of the speed of light, which either match the frequency or the amplitude of vibration of the quasi electron, mathematically define the masses of the particles and the fundamental forces of Nature.

Part III—Quantum Gravity

[0187] Quantum General Relativity

[0188] Given the overall energy "complex" energy tensor structure of the electron and the metric tensor, assumed in general relativity, the quantum nature of gravity itself can now be explored. The spherical complex tensor for the electron and the positron give the mathematical quantum structure and energy tensor for all the other particles. Together with the time dimension these nine space dimensions account for the 10 parameters present in the metric tensor necessary to formulate the equations for gravity using Riemann geometry and thus forms the basis of quantum gravity. Intriguingly the metric tensor at each point in space time is required to consist of a collection of ten numbers, Consequently, ten dimensional space-time hypotheses, such as this or superstring theory, do automatically yield general relativity.

[0189] Furthermore, the mathematical representation of the graviton and the gravitational constant may be directly estimated from the knowledge of the mass and radius of quintessence. Thence, the force of the vibrations of quintessence lead directly to quantum gravity.

[0190] The radius of quintessence should be approximately in keeping with the Planck length estimate (r), which is conventionally derived from the standard dimensional equation:

$$r_q^2=Gh/c^3 \tag{32}$$

[0191] Given the nine spacial parameters present in the metric tensor, used in general relativity we find that the actual formula for r_q^2 is mathematically in agreement with theory when:

$$9r_q^2=Gh/c^3 \tag{33}$$

[0192] This again supports the 9 dimensional view of space and the size of the vibrations of quintessence can thus be estimated.

$$r_q=1.35\times10^{-35}\text{ m} \tag{33a}$$

[0193] This value is in agreement with the Planck length. Indeed if the above equation is correct then we find that we can derive the standard equation for the general relativistic increase in radius, r', (eq. 34) directly from first principles and arrive at a more fundamental equation for quantum gravity. As

$$r'=GM/3c^3 \tag{34}$$

[0194] By substituting eq. 33) into equation 34, a fundamental relationship between r' and M is obtained.

$$r'/3r_q^2=GMc^3/Ghc^3=Mc/h$$

[0195] And substituting the quintessential equation, $h=m^qc^2$ (eq. 1) then:

$$r'/3r_q^2=M/m_qc=n_q/c \tag{35}$$

[0196] Hence the ratio of the change in radius to that of the radius of quintessence squared, is proportional, by a factor of c, to the ratio of the mass M of an object to that of the mass of quintessence, effectively the number of quintessences. Thus the change in radius, r' due to gravitation, is related to none other than the ratio of the mass and radius of an object to the mass and the square of the radius of quintessence. Thus again the gravitational change in radius is directly related to the number of quintessences.

[0197] Naturally, this would be exactly what would be logically expected if quintessence, like the equation for the charge of the electron (eq. 6) forms from a root sphere. Thus the change in spacial radius of a normal sphere is dependant on the square of the quintessential radius.

[0198] This increase in apparent radius represents none other than the (gravitational) binding energy for quintessence.

[0199] The meaning of the above dimensional equation (33) might itself be further understood by substituting the mass of quintessence (where $m_q=h/c^2$) into the equation. Thus in nine dimensions the gravitational constant (G) may be more logically given as,

$$9(\pi r_q^2/m_q)=G\pi/c \tag{36}$$

[0200] Where πr_q^2 is the cross sectional area of quintessence and m_q is the effective mass of quintessence, and thus

($\pi r_q^2/m_q$) represents the effective mass per unit area which quintessence exerts. This equation reduces to:

$$9r_q^2/m_q=G/c \tag{37}$$

[0201] From this we may derive the standard general relativistic relationship for the apparent change in radius (r') around a mass (M), from an understanding of the mass m_q and number (n_q) of quintessences. As $m_q=M/n_q$, then:

$$3r_q^2=G\cdot M/3c\cdot n_q \tag{38}$$

[0202] Then if

$$n_q=r'c/3r_q^2 \tag{39}$$

[0203] thus directly substituting for n_q in eq. 38:

$$r'=G\cdot M/3c^2 \tag{34}$$

[0204] The importance of this is that the gravitational change in radius now logically derives from equation 36, which describes the gravitational force as resulting directly from the mass of quintessence exerted/per unit area of quintessence.

$$9(\pi r_q^2/m_q)=G\cdot\pi/c \tag{36}$$

[0205] Thus equation 34 is the conventional equation for the general relativistic increase in radius (r') in a gravitational field, which is here derived from the underlying nature of quintessence. Thus the gravitational constant is derived from the mass and radius of vibration squared of quintessence from first principles.

[0206] Indeed it is apparent that a more fundamental equation for gravitation now exists, for equation (39) is mathematically accurate and numerically agrees with eq. 34:

$$r'/3r_q^2=n_q/c \tag{39}$$

[0207] These equations may be readily mathematically verified. If in accordance with standard general relativity, the apparent increase in radius r' is:

$$r'=GM/3c^2 \tag{34}$$

[0208] Then given that the mass of the Earth is 5.9745×10^{24} kg;

$$r'=1.478\times10^{-3}\text{ m}$$

[0209] Accordingly if $r'=3r_q^2\cdot n_q/c$; (eq. 39). Given the number of quintessences n_q constituting the Earth is M_E/m_q, then

$$n_q=5.9745\times10^{24}/7.3725\times10^{-5}=8.104\times10^{74}$$

[0210] As $r_q^2=1.823\times10^{-70}$ (eq. 33a) then:

$$r'=1.478\times10^{-3}\text{ m}$$

[0211] Thus equation 39 gives the same answer as the standard equation and may be understood on a logical basis. Indeed the meaning of c in the equation may be understood as it has been previously shown as being the basis for the radius of matter (eq. 6). Hence the general relativistic change in radius, r', is none other than the effective binding energy for quintessence.

[0212] Quantum Gravity and Wave Particle Duality

[0213] Quantum gravity can now be readily linked with quantum mechanics, indeed any observations which are self consistent must be able to do so easily.

[0214] The frequency of light has been previously derived

$$f=E/h=n_q$$

[0215] Thus the formula for the frequency of light (E=hf) has previously been explained theoretically by the simple observation that the frequency is determined quite directly from the number of quintessences (n_q) within the photon. The same principle has also been shown to apply to matter.

[0216] Let us now follow these equations for matter by calculating the wavelength of a photon from the Gravitational constant as an example; and also as a test of these observations and to demonstrate that the gravitational equations can also apply to the quantum world.

[0217] If

$$n_q=r'c/3r_q^2 \tag{39a}$$

[0218] where r' is the general relativistic increase in radius, and r_q is the radius of quintessence (eq. 33). Where $f=E/h=n_q$, substituting for n_q, then the frequency of the photon f_γ(where $\beta=1$) is given by:

$$f_\gamma=r'c/3r_q^2$$

[0219] Using the standard equation, $r'=GM/3c^2$ (eq. 34); we may substitute for r', thus we have:

$$f_\gamma = GM/9r_q^2c \text{ 15 Thus}$$

$$f_\gamma = \frac{G}{9r_q^2c^3}\cdot m_\gamma c^2 \text{ and as } E = m_\gamma c^2;$$

$$f_\gamma = \frac{GE}{9r_q^2c^3} \tag{40}$$

$$\text{Indeed as } 9r_q^2 = Gh/c^3, \text{ then } f_\gamma = E/h = n_q$$

[0220] It is possible to also demonstrate that the same relationship holds for the wave equation for matter. If we take the relativistic wave energy of matter, which has been previously derived,

$$f=\beta^2 n_q$$

[0221] This includes the term for the number of quintessences flowing through the electron, in the complex vectors of space-time, to give the relativistic electron momentum (p) and a term for the rest mass, thus substituting into (40)

$$f_\gamma = \frac{GE}{9r_q^2c^3} \tag{40}$$

[0222] As $f=\beta^2 n_q$ for matter then the equation expands to:

$$f_m = \frac{G}{9r_q^2c^3}\cdot\beta^2E \text{ As } \lambda = v/f, \text{ then}$$

$$\lambda = \frac{9r_q^2c^3v}{G\beta^2E} \tag{41}$$

[0223] Then the equation again reduces to:

$$G = \frac{9r_q^2c^4}{\lambda\beta E} \tag{3}$$

[0224] Equations 3, 40 and 41 are important as they show that the quantum wavelength of any particle of rest mass m can be derived from the gravitational constant G. Thus linking quantum mechanics to quantum gravity.

[0225] It is therefore important to confirm the numerical accuracy of the above equation (40). We can do this by comparing the result to the standard computation of the de Broglie equation, in a range where de Broglie itself is likely to be most accurate; which according to these observations is in the low energy range (see section on Wave Particle Duality).

[0226] If we take an electron with an energy of 0.1 KeV the wavelength is conventionally given (where the kinetic energy of the electron E_k is given by the product of the charge of the electron (C) and the potential applied eV=0.1 Kev), by the standard equation:

$$\lambda = h/p = h/(E_k \cdot 2m_0)^{1/2} \text{ thus}$$

$$\lambda = 6.63\times10^{-34}/[1.602\times10^{-19}\times1\times10^{2}\times18.22\times10^{-31}]^{1/2}$$

hence

$$\lambda \cong 1.23\times10^{-10}m \text{ Using}$$

$$\lambda = \frac{9r_q^2c^4}{G\beta E} \text{ Where } E = \gamma m_0c^2 \tag{3a}$$

[0227] At 0.1 Kev, electron velocity is 6×10^6 r/sec, thus $\beta=2\times10^{-2}$ and $\gamma=1/(1-v^2/c^2)^{1/2}=1.0002$. Thus:

$$\gamma = \frac{9\times1.82\times10^{-70}\times80.78\times10^{32}}{6.76\times10^{-11}\times\beta\times1.0002\times9.11\times10^{-31}\times8.998\times10^{16}}$$

$$\lambda = 1.21\times10^{-10}m$$

[0228] Divergence between the de Broglie equation and the above equation (2) occurs at intermediate and high energies where it is generally accepted that the standard de Broglie equation may be less accurate. The values for eq. 2 and de Broglie are compared to recent experiments, which demonstrate a relativistic curvilinear plot for wavelengths of matter in keeping with eq. 40.

[0229] The de Broglie equation in the non-relativistic format yields a simple log/linear scale, which is not in keeping with relativity; whereas eq. 3 is dependent on relativity and mathematically accounts for both relativity in calculating the wavelength. Indeed recent experiment on quantum tunnelling through a wire mesh strongly suggests that the relationship between energy and wavelength is relativistically curvilinear[ref 1]. Furthermore equation 3a suggests a fundamental relationship between energy (E), relative velocity (v/c=.β), gravity (G) and the quantum wavelength (λ)

$$\lambda = \frac{9r_q^2c^4}{G\beta E} \text{ Indeed as } {}^9r_q^2 = Gh/c^3\text{, then} \tag{3a}$$

$$\lambda = hc/\beta E \tag{2}$$

[0230] Equation 2 is the very same as the Universal wave equation derived form first principles for the wavelength of tight and matter, which allowed a relativistic solution to the equations for wave particle duality (see Wave Particle Duality). This now indicates that these quintessential equations are compatible with relativity, quantum mechanics and quantum gravity.

[0231] Graviton Structure

[0232] From these observations, if the value for the gravitational constant is substituted into the equation (35) we may now estimate the probable geometric structure of the gravitation, which is the force particle mediating gravity by acting on quintessence. Thus the Gravitational constant has been previously derived from the vibration of quintessence by the equation:

$$G\cdot(\pi/c)=9(\pi r_q^2/m_q) \tag{36}$$

[0233] This is in accurate agreement with the value for $G(6.67\times10^{-11}\ N\ m^2\ kg^{-2})$. This suggests that the most probable mathematical representation of the graviton (ϕ), the third force carrying particle is

$$\phi=(\pi/c) \tag{42}$$

[0234] Thus the gravitational constant (G) can be given by the mass and radius of quintessence and the structure of the graviton

$$G=9\pi r_q^2/\phi m_q \tag{43}$$

[0235] This shows the gravitational force to be related to the fundamental radius of quintessence space time, and the graviton.

[0236] Quantised General Relativity

[0237] The classical general relativistic formula, as given by Einstein is:

$$R_{\mu\nu}-1/2g_{\mu\nu}R=-\kappa T_{\mu\nu}$$

[0238] Where R is effectively the curvature of space-time, $R_{\mu\nu}$ denotes the contracted Riemann tensor of curvature and $T_{\mu\nu}$ is the "energy tensor" of matter.)

[0239] If we substitute the energy tensor matrix of the electron (eq. 9)×time, for the energy tensor of matter $T_{\mu\nu}$; and the metric tensor of the space-time lattice×time for the contracted Riemann tensor we can arrive at the same solutions for general relativity.

[0240] Furthermore, in his published paper on General Relativity, Einstein. defined the constant κ as:

$$\kappa=8\pi G/c^2$$

[0241] Therefore Einstein's equation should be written as

$$R_{\mu\nu} - 1/2g_{\mu\nu}R = \frac{8\pi G}{c^2}\cdot T_{\mu\nu} \tag{43}$$

[0242] Einstein himself was apparently not happy about the right hand component of the equation. However, we find that this part of the equation can now be explained and quantised by substituting the gravitational constant, $G=9\pi r_q^2/\phi m_q$, (eq. 42a),

[0243] Giving:

$$R_{\mu\nu}-1/2g_{\mu\nu}R=-\frac{8\pi^2 9r_q^2}{\varphi m_q c^2}\cdot T_{\mu\nu} \tag{44}$$

[0244] By substituting $m_q \cdot c^2=h$, and further substituting $h=h/2\pi$, we arrive at a quantised solution to Einstein's equations. Where A_q is the surface area of quintessence ($A_q=4\pi r_q^2$); ϕ is the graviton [$\phi=(\pi/c)$] and h is Plancks constant. thus:

$$R_{\mu\nu}-1/2g_{\mu\nu}R=-\frac{9A_q}{\varphi\hbar}\cdot T_{\mu\nu} \tag{45}$$

[0245] The gravitational equation can now be further understood on a logical basis. The term $A_q=(4\pi r_q^2)$, where represents standard term for the surface area of a sphere of quintessence for the 9 space dimensions of the space time lattice, h is the energy content of quintessence×time and ϕ is the graviton, thus the right hand term now represents a true "metric energy tensor" of matter.

[0246] This leads directly to the standard solution to the field equations, for the general relativistic increase in radius r' of an object, where A is the surface area of a sphere of a given mass M, such that

$$r=\sqrt{(A/4\pi)}-r=GM/3c^2 \tag{34}$$

[0247] Furthermore, although equation 45, gives the same solutions as Einstein's equation, which is essentially correct, the difference is that the equation is now dependant upon Planck's constant (h), and moreover the radius of quintessence, which now defines a quantised solution to the equations.

[0248] Graviton Force Characteristics

[0249] Similar to the photon, the previously derived equation (42) for the graviton [$\phi=(\pi/c)$] appears to also mathematically represent a helical ringlet of quintessence, but with a spin of 2. For the photon, taking the direction of motion as the x vector and its axis of spin also as the x vector, would account for the electromagnetic force and its attraction and repulsion characteristics. In the case of the gluon component ($\pi/c^{1/2}$), if the direction vector is x, then the axis of spin would be in the y vector, the same as quasi electrons, accounting for the particle binding characteristics of the gluon force. In the case of the graviton, if the direction of motion was in the x vector, the graviton spin axis would be in the z vector thus, as will be demonstrated, accounting for the gravitational force.

[0250] The spin axis of the graviton can also be derived using the known characteristics of the electron. If an electron is travelling in the x direction, then its spin axis is determined by the by the sign of the $_j$y vector (up or down). This view is in agreement with conventional theory, which indicates that the electron spin is similar to a rotating planet orbiting the sun, (the electron even appears to have orbital precession). As the electron passes through the space-time lattice, this spin would generate the formation of gravitons. This would occur as a result of the ejection of the excess quintessence passing through the electron. As the electron spins, the ejection of these gravitons would occur at a tangent to the electron's direction of motion. The ejection of the gravitons would occur, similarly to the ejection of energy of a pulsar or quasar, through the equivalent of the north and south poles of the electron. Thus, propelling the graviton in the direction of the electrons y vector. The ejection of the graviton would re-orientate and impart a specific angular momentum to the gravitons which would thus end up spinning on its own z axis. If for instance the graviton is released from an up spin electron the graviton will be rotating clockwise and its leading edge will displace quintessence downwards. In turn this will provide an upwards force.

[0251] This picture accounts for Fleming's left hand rule, is logical and provides an explanation for the magnetic force around a wire. According, to the left hand rule if the direction of the current is in the x vector, the magnetic field is in the z vector, and the force is upwards, in the y vector, in accordance with the above model. Therefore, this particular spin axis and the structure of the graviton results in its force characteristics. As the graviton is very small compared to the electron and both have different rather rapid spin axis it is difficult for these to bind and interact. Nevertheless, because the graviton has a spin of 2, and as it spin axis is perpendicular to its direction of motion, in the z vector, it readily displaces space-time quintessence to produce gravity. Thus because the graviton is able to displace space-time, it is capable of escaping a black hole. How else could the effects of gravity be felt beyond a black hole?

[0252] Quantum Gravity and Electromagnetism

[0253] With the above electron model of graviton production the nature of magnetism can be understood from first principles, Furthermore, the presence of a space-time lattice links relativity, and the forces of gravity with the electromagnetic and other forces of Nature. Indeed, evidence for these links may first date back to the 1820's, when Andre Ampere first defined the Amp. The force of attraction between two parallel wires 1 metre apart each carrying 1 Amp in a vacuum was defined as none other than the permeability of free space (2×10^{-7} N per metre of conductor). Thus conventionally the magnetic field strength around a long straight wire is given as:

$$B=\mu_0 I/2\pi r$$

[0254] Where I is the current and μ_0 is the permeability of free space ($4\pi\times10^{-7}$ N A^{-2})

[0255] The attraction between two wires both carrying negative charge is, however, counterintuitive as negative charges should repel. A conventional explanation overcomes this by invoking the presence of a magnetic field which is created by the current by the production of virtual photons. Thus we appear to have an explanation for the effects of magnetism which involves virtual photons, however, these photons are not observed. More accurately, according to conventional special relativity the magnetic field is none other than the electric field viewed relativistically.

[0256] A more satisfactory explanation, therefore, lies in the interaction between the electrons and the space time lattice. The moving electrons in the two wires interact with the lattice to produce gravitons; which are in phase when both streams of electrons are traveling in the same direction. The gravitonic waves interact constructively to disperse the space time lattice between the wires and induce an attractive force between the two wires, which produces in effect the permeability of free space. Thus this force results from the vibration of quintessence itself.

[0257] Conversely in two wires with current going in opposite directions the graviton waves are in anti-phase and would interact destructively between the wires. The gravitonic waves traveling radially outward from the wires would, however, disperse the lattice outside the two wires and produce apparent repulsion between the wires, which is exactly what is observed. These effects of electricity suggest that gravitons act as waves and that phase is important.

[0258] This effect is also seen with the north and south poles of ferromagnets. Nevertheless, with matter other than iron, cobalt or nickel, the graviton emission cannot be phased as the atoms are unable to align and magnets do not appear to exist with other materials.

[0259] In ordinary magnetic system the release of gravitons from the north pole would be exactly balanced by those released from the south pole of the magnet and hence there would be no net force on the magnet until an external magnet or electrical current were applied.

[0260] Overall the magnitude of the forces in electrical systems where electrical conduction occurs are well defined by the permeability and permittivity of free space μ_0, and ϵ_0. Where v is the constant velocity of the charge and ϵ is the electric field produced by the charge.

$$B=[\mu_0\epsilon_0]v\cdot\epsilon$$

[0261] These observations suggest that the forces of electricity which produce magnetism are indeed related to the permittivity and permeability of free space and that these quantities are exerted by an apparent vacuum. Thus the effects of magnetism could be explained by none other than the phased effects of gravitational waves on the space time lattice.

[0262] Electromagnetism is of further interest to quantum gravity, particularly if we combine the standard equations, $B=\mu_0 I/2\pi r$ and $B=[\mu_0\epsilon_0]v\cdot\epsilon$, substituting for B we have:

$$2\pi r=I/\epsilon_0 v\epsilon \tag{46}$$

[0263] Thus $2\pi r$ is proportional to the inverse of ϵ_0. Thus as space time is dispersed by gravitons the permittivity field will increase in the same way capacitance increases with separation of plates. Because of the inverse relationship between ϵ_0 and $2\pi r$, as ϵ_0 increases the circumference of a circle and the apparent ratio of π is to r, will appear to diminish in accordance with general relativity. This not an actual diminution in the circumference of a circle but the effective reduction of the resistance to motion in a circular path in this field.

[0264] Incidentally, the above observations, also lead us directly to Schrödinger's formula for the average equilibrium distance (r) between an electron with charge (e) in orbit around a proton, which is conventionally given by:

$$r=n^2 4\pi h^2\epsilon_0/me^2$$

[0265] Where ϵ_0 is again the permittivity of free space, m is the mass of the electron and n is an orbital integer, h is Planck's constant and e is the charge of the electron. Furthermore if $e=[\epsilon_0/3(4/3\pi c^3)]^{1/2}$ (eq. 3); then the equation at n=1, for the electron orbital radius elegantly simplifies to:

$$r=4h^2c^3/m$$

[0266] Hence the orbital radius of the electron is related to spin of the electron (h) and its mass (m).

[0267] Quantum Gravity and the Charge of the Electron

[0268] The equation for the charge of the electron (eq. 1) contains the term so (permittivity of free space) which according to these observations should vary in a gravitational field.

$$e=[\epsilon_0/3(4/3\pi c^3)]^{1/2} \tag{6a}$$

[0269] If we combine the standard equations, $B=\mu_0 I/2\pi r$ and $B=[\mu_0\epsilon_0]v\cdot\epsilon$, substituting for B we have:

$$2\pi r=I/\epsilon_0 v\epsilon \tag{46}$$

[0270] Thus $2\pi r$ is proportional to the inverse of ϵ_0. Thus as space time is dispersed by gravitons the permittivity field will increase in the same way capacitance increases with separation of plates. Because of the inverse relationship between ϵ_0 and $2\pi r$, as ϵ_0 increases the circumference of a circle and the apparent ratio of π to r, will appear to diminish in accordance with general relativity.

[0271] Thus ϵ_0 rises when space-time is dispersed by the gravitons that produce the gravitational field, This occurs in a similar way to the process by which capacitance increases with separation of plates in a capacitor.

[0272] Nevertheless, as c is a constant and as $c=[\mu_0\epsilon_0]^{-1/2}$, then if ϵ_0 rises then μ_0 falls. This is entirely consistent as μ_0, which represents the force that quintessence exerts, would be reduced if the quintessence space time lattice is dispersed.

[0273] Furthermore, as $\mu_0=4\pi\times10^{-7}$ N A^{-2}; then as μ_0 falls, then the apparent ration π to r, also falls in a gravitational field. This is largely the same as stating, as does general relativity, that the apparent radius r', rises in a gravitational field. So this view is consistent with general relativity.

[0274] Nevertheless, to derive an exact value for the charge of the electron we must account for gravity in the above equation. We will take the specific example of the Earth's gravitational field in order to obtain the exact value for the electron. If in accordance with standard general relativity, the apparent increase in radius r' is:

$$r'=GM/3c^2 \tag{34}$$

[0275] Then given that the mass of the Earth is 5.9745×10^{24} kg; then

$$r'=1.47864\times10^{-3}\text{ m}$$

thus

$$2\pi r'=9.29057\times10^{-3}$$

[0276] Which is the incremental factor by which ϵ_0 must increase in Earth's gravitational field. So to correct ϵ_0 to account for gravity, ϵ_0 must be divided by the incremental factor, $2\pi r'$. Similarly as effectively π decreases in a gravitational field, to correct π to account for gravity it must be

multiplied by this incremental factor. So the equation for an electron in a zero gravitational field is:

$$e=[\epsilon_0/3(4/3\pi c^3)]^{1/2}\div(1+2\pi r')=1.6022\times10^{-19}\ C \quad (6b)$$

[0277] This now gives the charge of the electron as measured in a zero gravitational field as 1.6022×10^{-19} C, which is the same as that measured on Earth. Notably these observations appear to suggest that the charge of the electron is the same irrespective of the gravitational field.

[0278] Virtually unlimited degrees of accuracy for the charge of the electron and for the fine structure constant (α), may be achieved by taking into account 2nd and nth order gravitometric effects. Thus if we take into account the effect of gravity upon the radius of the Earth it is also important to take into account an effect upon the instruments with which we measure quantities, this would be a second order gravitometric effect. Thus taking into account 2nd order effects (r''), we have a very small, but nevertheless relevant change, such that: $r''=r'(1+2r')$. Thus $2r''=9.3180486\times10^{-3}$, and thus:

$$e=[\epsilon_0/3(4/3\pi c^3)]^{1/2}\div(1+2\pi r'')=1.6021765\times10^{-19}\ C \quad (6c)$$

[0279] This agrees exactly to the nearest 7 decimal places with the maximum accuracy of the experimental value for the charge of the electron. Furthermore by taking into account the nth order gravitometric effect, it is theoretically possible to predict accuracy for the charge of the electron to 3n decimal places. This mathematically accuracy confirms the structure of the electron from first principles and indeed the theoretical effects of gravity on the permittivity of free space (ϵ_0).

[0280] This returns us directly to the fine structure constant for the electron which is conventionally given by: $\alpha=e^2/hc\cdot4\pi\epsilon_0$. If $\alpha=e^2=\epsilon_0/3(4/3\pi c^3)$, accordingly the quintessential equation for α is structurally given by: $2\pi/\alpha=m^q[3\Theta]^2$ (where $\Theta=4/3\ \pi c^3$; see The Structure of the Electron and Matter), we must now take into account the effects of gravity, as above, thus:

$$2\pi\alpha/m_q[3\Theta]^2\div(1_2\pi r'')^2=0.007297353$$

[0281] Where the gravitational term for the increase in radius r'' allows the mathematical derivation of $\alpha=0.007297353$, and the above equation is in agreement with the conventional experimental value for $\alpha=0.007297353$ to the nearest 9 decimal places.

[0282] Hence the term $(1_2\pi r'')^2$ is in accordance with these observations for the effect of gravity on electromagnetic forces. To a maximum accuracy governed by current knowledge of the mass of the Earth and the Gravitational constant and thus the term for the gravitational increase in radius r'. These observations can also be used to accurately predict the magnetic moment of the electron

[0283] Thus the presence of the fine structure constant can now be further understood, by deriving the constant from first principles; specifically from the actual dimensional conformation for the charge of the electron: $e=[\epsilon^0/3(4/3\pi c^3)]^{1/2}$ (eq. 6).

[0284] Overall the fine structure constant α (allowing for the term r' which is the general relativistic increase in the radius of the Earth due to gravitation) is given by none other than the formula for the mass of quintessence and from the structure of the electron, which can now be derived from first principles to seven decimal places or more.

[0285] Quantum Gravity and the Electron Magnetic Moment

[0286] The theoretical origin and nature of magnetism remains obscure in current electromagnetic theory. An explanation suggests these magnetic effects are produced by photons, although no photons have ever been observed. To get round this difficulty it is postulated by physics that magnetism results from "virtual" photons. However, Maxwell's equation for electromagnetism states that the photon has no net magnetic effect.

$$\delta B_x/\delta B_y/\delta y+\delta B_z/\delta z=0$$

[0287] Thus magnetism could not, by the above standard equation, be derived from a photon real or virtual.

[0288] In addition observational data suggests that black holes have powerful magnetic fields and as in theory photons are unable to escape from black holes (except for small quantities in the form of Hawking radiation), it would be difficult to explain these magnetic fields on the basis of photon emission.

[0289] Einstein postulated that magnetism was merely due to special relativity .sup.(ref 17). The postulate for the nature of magnetism in these current observations, states that the magnetic force results from relativity due to none other than the phased emission of gravitons (why postulate two invisible forces, magnetism and gravity, when one, the graviton, will do). This view as previously discussed (Quantum Gravity and Electromagnetism) is entirely compatible with standard relativity[ref 19]. Thus with the graviton origin of magnetism, the equation for the magnetic moment of the electron should have an expression in terms of quintessence and in turn the gravitational force and in particular the graviton.

[0290] The standard term for the magnetic moment of the Bohr Magneton (SIB) is:

$$\mu B=eh/4\pi m_e$$

[0291] In standard quantum mechanics the Bohr Magneton, μB, however, needs to be corrected to agree with experiment. The "correction factor" is termed "ϵ"; where $\epsilon=(\alpha/2\pi)-0.328\alpha^2/\pi^2=0.001159641$. Thus theory reveals μ_e, the magnetic moment of the electron where:

$$\mu_e=(eh/4\pi m_e)[1+(\alpha/2\pi)-0.328\alpha^2/\pi^2]$$

[0292] The conventional derivation of the term ϵ above, is given from the fine structure constant, $(\alpha/2\pi)$ which is theoretically consistent. However, a rather arbitrary mathematical correction term; $0.328\alpha^2/\pi^2$ needs to be used in this standard equation. This appears ad hoc and needless to say, more accurate measurements show, the electron magnetic moment to the Bohr magneton ratio, $1+\epsilon=1.001159652$, which suggests the correction factor is indeed incorrect. Nevertheless, this correction factor is essential for "renormalisation" and thus for quantum mechanics to work.

[0293] Quantum gravity readily explains the discrepancy between the theoretical Bohr Magneton (μB) and the actual measured magnetic moment of the electron (μ_e). In accordance with the above chapter (Quantum Gravity and the Charge of the Electron)

[0294] Thus the significant mathematical discrepancies can be removed by accounting for the effects of quantum gravity.

[0295] Thus taking the charge of the electron (e), using the equation for the Bohr magneton and the effects of quantum gravity such that gravitational change in radius is r". The magnetic moment of the electron is given by:

$$\mu_e=(eh/4\pi m_e)(1+[\alpha/2\pi+(1+r'')])$$

[0296] This gives an electron magnetic moment to Bohr magneton ratio of 1.00115968. Thus the mathematical term for the magnetic moment of the electron is given, avoiding the arbitrary and dubious term $0.328\alpha^2/\pi^2$ used in the standard equation, simply by accounting for quantum gravity.

[0297] It is now possible to unite the equations for gravity and magnetism by substituting the fundamental key equations of quantum gravity. Thus if: $h=3m_qc^2$ (eq. 1b) and $m_e=m_qn_q$ (eq. 2). Then we can express the magnetic moment of any particle with the charge of the electron, including the proton, in terms of the number of quintessences (n_q) in that particle.

$$\mu B=ec^2/(4/3\pi n_q); \tag{47}$$

[0298] Given that the postulated structure of the graviton is: ($\phi=\pi/c$) (eq. 42), then substituting we have

$$\mu B=3ec/4\phi n_q \tag{48}$$

[0299] Showing that the equations for the magnetic moment are compatible with the gravitational equations given earlier. Principally, the quintessential equations now allow the determination of the magnetic moment of any charged object from the equation for the graviton and directly from the number of quintessences it contains. In conventional physics the magnetic moment of the electron requires a correction factor, $(1+(\alpha/2\pi c)-0.328\alpha^2/\pi^2)$, to derive the correct experimental value. These observations herein, indicate that the correction factor is more logically (1+r"), where r" is the general relativistic increase in radius around a gravitational body. This suggests that magnetism is not only affected by gravity, but can, as shown as above, be derived using the quantum gravitational equations.

[0300] Quantum Gravity and Special Relativity

[0301] Ordinary matter passing through the lattice would produce gravitons which would interact with space-time as described by general relativity. The quantity of gravitons would be determined by the apparent mass and in turn these would apparently curve space time. The geometry of this "curvature" is elegantly described by general relativity using Riemann geometry, specifically using metric tensors. Intriguingly the metric tensor is not a single number, but at each point in space time it is required to consist of a collection of ten numbers, Consequently, ten dimensional space-time hypotheses, such as this or superstring theory, may automatically yield general relativity

[0302] General relativity is indeed very elegant, nevertheless there was a logical step yet to answer. That is, how do gravitons shape space time? This can now be readily answered by considering the interaction of a three dimensional space time lattice with gravitons themselves to produce the effects of gravity. The effects of gravity are as such to compel a body in motion towards the gravitational object and to a much smaller extent visa versa. This effect can only be produced If gravitons repel quintessence (the constituents of the 3D lattice). Indeed, it has been stated that in order to explain cosmic inflation and the "flatness" of the Universe that quintessence must shun (or be shunned by) matter.

[0303] In descriptive terms a body close to a large mass will have a tendency to move toward it because the three dimensional lattice would be less dense as it approached the surface of the large mass. Overall there would be less resistance to motion in the direction of the large mass, and the motion in this direction would be facilitated by the vibration of quintessence.

[0304] In general relativity the principle governing motion is the geodesic of least distance, this can be re-expressed using similar equations using least action. Furthermore, the concept of motion due to the vibrations of quintessence is more logically and experimentally compelling.

[0305] These observations can now be used to link general and special relativity. Thus as we approach the speed of light, the mass of an object travelling through the space-time lattice would approach infinity, directly because the number of quintessences passing through a body would increase with increasing velocity, hence the equation:

$$m'=m_0/(1-v^2/c^2)^{1/2} \tag{50}$$

or

$$m'=m_0/(1-v^2[\mu_0\epsilon_0])^{1/2} \tag{50a}$$

[0306] In turn this would generate increasing gravitons and accordingly this would explain the observed effects of special relativity. Time itself is due to passage through the space-time lattice, and where the space-time lattice is dispersed by gravitons, time and length are reduced with increasing velocity and hence increasing space-time lattice dispersion, similar to the way in which gravity alters space-time

[0307] As a result:

$$t'=t(1-v^2/c^2)^{1/2},\ l'=l(1-v^2/c^2)^{1/2}$$

[0308] Thus resulting in the effects of special relativity.

[0309] Quintessence and Black Holes

[0310] To address the relationship of the space-time lattice to gravity directly, it is important to discuss the concept of quintessence with regard to general relativistic equations. The standard general relativistic equation for the apparent increase in radius (r) due to the curvature of space time around a gravitational object, which has also been previously derived from first principles (eq. 36), is:

$$r'=GM/3c^2 \tag{34}$$

[0311] This can also thus be written as:

$$3r'=GM[\mu_0\epsilon_0] \tag{51}$$

[0312] This standard equation, is in keeping with the above observations. Specifically, as the mass increases, ϵ_0 increases, in turn the radius will appear to increase (relative to π).

[0313] The above observations now allow us to examine the effects with regard to the interior of black holes themselves. The event horizon would represent a critical density for quintessence, in which light could not escape. The Schwarzschild radius would now be given by:

$$R_s=2GM[\mu_0\epsilon_0]$$

[0314] The event horizon will occur at the point at which there is less resistance to circular motion than motion in a

straight or partially curved line. Given that π is proportional to $1/\epsilon_0$. The event horizon should occur when the permittivity has increased by a factor of π.

[0315] Effectively because the permittivity of free space rises, π decreases. This is entirely in keeping with general relativity which predicts the effective change in the ratio of the radius to the circumference as given by the conventional equation, where r', is again the apparent change in radius.

$$r'=GM/3c^2$$

[0316] Hence π will effectively decrease as we approach the event horizon of a black hole, When π decreases to 1, the circular circumference is equal to the diameter and moreover, inside this limit it is shorter for light to travel in a circle. Thus light cannot escape the event horizon.

[0317] This can give us great insights into the workings of space-time, for flat Euclidean space the standard equation is:

$$e^{i\pi}=-1$$

[0318] In accordance with general relativity, the ratio of the radius to the circumference changes in a gravitational field, and effectively $\pi=1$, at the event horizon, thus the boundary condition for the shape of space-time at the event horizon now has the direct equation:

$$e^{f}$$

[0319] Within a black hole as the permittivity of space increases by a factor of 2π an object within it will complete two rotations rather than travel in a straight line. In effect exceeding the speed of light by 2π. Hence, the condition for space-time is represented by the equation:

$$e^{i/2}$$

[0320] Thus an increase in the permittivity of free space by a minimum factor of π, to produce a black hole is estimated to result from an increase in mass by a factor of approx. 10^6 (the ratio of the mass of the earth and that of a putative black hole).

[0321] Continuing with the subject of a black hole, according to the model inside the black hole, the gravitons produced by the matter present would be in equilibrium with the density of the space-time lattice. Increasing the rate of rotation of the matter in the black hole for instance would thus increase the production of gravitons and its effective mass and increase the radius of the event horizon. A density gradient of the space-time lattice would continue to exist within the black hole. Progressively closer to the center of a black hole matter itself would be increasingly compressed and the spherical structure of the quasi electron would be predicted to collapse. This collapse would result in the formation of an exotic form of matter in the form of pure quintessence in a black hole.

[0322] This pure quintessence would produce the singularity at the centre of the black hole. The larger the black hole in terms of mass the more pure quintessence would exist at its core.

[0323] Quintessence and the Big Bang

[0324] Quintessence theory not only predicts the occurrence of the Big Bang, but allows a prediction for the value of the entire mass of the Universe, from first principles.

[0325] In accordance with quintessence theory the big bang resulted from the explosion of an immense black hole singularity, which was constituted from pure quintessence.

[0326] On the basis of quintessence, there will be a critical mass for Big Bang event; thus if entire space-time between quintessence is compacted so that no further quintessence can be accommodated, the addition of further quintessence would destabilize the immense black hole, resulting in the Big Bang.

[0327] It is possible to predict this critical mass, using the radius of quintessence as a benchmark. Given the nine spatial parameters present in the metric tensor, used in general relativity we find that the actual formula for the radius of quintessence; r_q^2, is mathematically in agreement with general relativistic theory when:

$$9r_q^2=Gh/C^3 \quad (33)$$

[0328] This again supports the 9 dimensional view of space (so crucial in superstring theory). Moreover, the size of the vibrations of quintessence can thus be calculated as:

$$r_q=1.35\times10^{-35}\ \mathrm{m} \quad (33a)$$

[0329] The volume of each quintessence is thus:

$$4/3\pi r_q^3=1.0306\times10^{-104}\ \mathrm{m}^3 \quad (33b)$$

[0330] So to be accommodated within unit volume of space time, with no intervening apparent space time, (given that each of 9 overlapping quintessences are required) would require approx.

$$9\times10^{104}\ \text{quintessences}$$

[0331] As the mass of quintessence is $m^q=h/c^2=7.373\times10^{-51}$ kg sec (eq. 1). Then the mass of the Universe, to two decimal places, is:

$$1.18\times10^{53}\ \mathrm{kg} \quad (33c)$$

[0332] This is in close agreement with a recent estimate of the mass of the Universe from COBE and other satellite data, which estimates the mass to be 100 trillion trillion trillion trillion tonnes (10^{53} kg)

[0333] Moreover, the early formation of the galaxies can be readily explained, it is likely that in such a big bang some very small black holes might have prevailed and that these formed the seeds of the galaxies we see today.

[0334] The event horizon, calculated from the Schwartzschild radius, of such an immense black hole is about 10^{26} m, which would have allowed Guth's inflationary component to the early expansion of the Universe.

[0335] In addition, inflation may result directly from the observation that once electrons have formed from the primordial soup of quintessence, they emit gravitons which in turn repel space time, which might also result in another cosmic inflationary cycle.

[0336] Most importantly quintessence theory explains the Big Bang from first principles and is capable of accurately predicting the mass of the Universe.

[0337] The Nature of Energy

[0338] These observations allow a fundamental understanding of energy. The quantum physical, minimum component of energy is Planck's constant; h. To define the minimal component of mass, using the standard energy equivalence formula; $E=mc^2$, such a minimal mass (m_q)

would be required to have the value equivalent to; $m_q=h/c^2$ (1). The total mass of a system (m) would then be; $m=m_q n_q$, where (n_q) is the number of these minimal units. Thence, the total energy of a system can be derived from the minimal energy; h, multiplied by the number of these energy units (n_q). Thus as, $E=mc^2$, then also $E=m_q n_q c^2$ and substituting $m_q=h/c^2$, the energy equivalence formula has the more logical formulation;

$$E=hn_q \tag{1a}$$

[0339] Thus the energy of a system is equivalent to the minimal energy unit; h, multiplied by the number of those minimal energy units (n_q)

[0340] This leads directly to a deeper understanding of wave particle duality and the wave nature of matter.

[0341] This is encapsulated by the quintessential energy formulae

[0342] As conventionally $\beta \cdot E/c=p$, then

$$\lambda=h/p=hc/\beta E \tag{2}$$

and

$$E=hn_q \tag{1a}$$

then

$$\lambda=c/\beta n_q \tag{2b}$$

[0343] Importantly, as indicated by equation (2b), energy having no quintessence; would have a wavelength of infinity. Specifically pure energy containing no quintessences, would have a lambda of infinity. According to quantum mechanics an infinite wavelength would result in the probability of that energy being anywhere. As energy itself has no electrical charge it would not be impeded by the permittivity and permeability of the three dimensional space-time lattice. Moreover, energy would not be detectable in three dimensional space-time, unless it interacted with matter, as in the EPR experiments. Indeed, energy is not observed when not bound to any form of mass or particle.

[0344] Thus equation 2b, takes us to our original assertion regarding the existence of pure energy.

[0345] Energy is not Bound by the Space-Time Lattice

[0346] Thus, as the EPR experiments suggest the existence of energy separate from matter and thus separate from the three dimensional space-time lattice, it is interesting to find that experiment suggests the existence of free energy in a continuum separate from space time and matter to produce the effects of quantum teleportation.

[0347] This is not, however, teleportation across an additional dimension, this is a term to describe in partially familiar terms the dissociation of energy from the three dimensional space-time lattice. As time is inextricably linked to each dimension of space, the effects of energy would be inextricably linked to the events, such as the creation of virtual particles, we see interacting within space-time. It is unlikely that observers have any direct day to day experience to explain quantum events. Nevertheless, quintessence theory may have given us a window into the hitherto hidden workings of the Universe. Thereby, the mystery of the uniformity of the Universe, across distances which the speed of light could not apparently traverse, is readily explained by the fact that the free energy contained in the Universe is not bound by the space-time lattice.

[0348] In the case of light, due to the exceedingly small masses involved, there would be relatively easy exchange of matter with free energy within a photon. This would make the photon the ideal experimental tool to look for energy which is not bound by matter and in turn energy which is not bound in space-time. Indeed, very recently Furusawa et al. have reported to have observed the transference of energy as photons from A to B, without those photons traversing space-time. This finding which has been supported using other experimental techniques, is very important as it suggests the existence of such free energy.

[0349] Overall, quintessence theory gives an a priori explanation for the concept of mass, the elementary particles, the forces of nature and quantum effects. It can equally be used logically to explain the inner physics of a black hole, the missing mass in the Galaxy, the expansion of the Universe, Guth's inflationary theory and predicts the Big Bang, from first principles.

[0350] Part IV: Applied Theory with the Intent to Create Closed Timelike Curves

[0351] Electron Bombardment of the Photosphere to Induce Gravitational Shift

[0352] Leveraging the above relationship between mass and quintessence we derive that if an electromagnetic radiation with velocity v strikes the event horizon singularity of rest inertial mass mi, and U is the electromagnetic energy absorbed by the singularity, then, according to Maxwell's prediction, a momentum $q=U/v$ is transferred to it. Mass shift $d \cdot m_b$, dependent on the external electromagnetic energy, equals the inertial mass shift dependent on the increment of energy in the particle. Since in this case the inertial mass shift does not depend on velocity V, i.e., it is related only to the momentum q absorbed, it can be obtained by making p=0 in variation $\Delta H=H'-H=c[q^2+(m_i c)^2]^{1/2}-(m_i c)^2$ from the particles inertial Hamiltonian. Consequently, the expression of d_{m_p}, is written as:

$$d_{m_p} = \Delta H/c^2 = m_i\sqrt{1+U/m_i c^2\left[\varepsilon_r\mu_{r2}\left\{\sqrt{1+d/we^2+1}\right\}^2=1\right.}$$

[0353] Comparing now the expression of m_i and m_g we have $m_g=m_i-2dm_b$. By replacing m_b in this equation, given by equation above, we obtain the expression of the correlation between gravitational mass and inertial mass, i.e.,

$$m_g = m_i - 2\sqrt{1+U/m_i c^2\left[\sqrt{\varepsilon_r\mu_{r2}\{[d/we]^2+1\}^2-1}\right.} \cdot m_i$$

[0354] We see that only in the absence of electromagnetic radiation on the event horizon (U=0) is the gravitational mass equivalent to the inertial mass. Note that the electromagnetic characteristics, e, m and s do not refer to the singularity itself, but to the outside medium around the singularity (photosphere) in which the incident radiation is propagating.

[0355] Stable CTC Solution From Modified M-Theory

[0356] Our innovation is a method of creating an event where a dual membrane or dual boundary condition exists. We do this using generalization from a Misner space which has been modified if one analytically continues the maximal extended Misner Metric so that $ds^2=-du^2+dw^2+(dx^2)^2+(dx^3)^2$ to the Euclidean section so that u=iota zeta we obtain a Misner instanton on the section where w and zeta are both real. The Euclidean time, t, and the closed spacelike coordinate are both periodic, the later having a period of $2\Pi t^2$. Going back to the Lorentzian sector we find that the period of the closed coordinate becomes linearly dependent on the physical time. Using automorphic fields in the Hadamard function one can obtain a quantized condition for time. This gives us a figure on the order of the Plank time. This confines such a stable wormhole condition to the general area of the Plank scale in its modified form which is that area defined by the Membrane itself. As such, these Plank scale wormholes are the true source of the true virtual aspects of the vacuum and quintessence. The effects of the dual singularity system can be viewed as an overlap zone of two distinct space-times which have boundary conditions on both sides. As an object accelerates towards C it is this same boundary or horizon that object encounters when the Time defined horizon solution for the universe is imposed. At this point drawing upon Van Den Broeck's alterations for this space-time geometry to create a single closed Friedman-Robertson-Walker spacetime the space-time geometry can be represented by this equation $ds^2=dct^2-B^2[(dx-\beta fdct)^2]+dy^2+dz^2$ B can be any function that is large near the displacement device. We then consider this transformation as extended to four dimensional space-time with arbitrarily time dependent acceleration. We also present the device frame energy density T00 from a four dimensional calculation and note that the 4d classical calculation is everywhere finite.

[0357] Consider an Alcubierre interval given according to a remote frame's cylindrical coordinates by:

$$ds^2=(1-\beta^2f^2)dct^2+2bfdctdz-dz^2-dr^2-r^2df^2$$

where f is a function that is 1 at the location of the device and zero far from it.

[0358] Starting out with the first transformation z'=z−òct beta dct. Where b is first expressed here as a function of time ct. With some algebra for simplification this results in

$$ds^2=[1-\beta^2(1-f)^2]dct^2-2b(1-f)dctdz'-dz^2-dr^2-r^2df^2$$

Let g=1−f and this becomes

$$ds^2=[1-\beta^2g^2]dct^2-2bgdctdz'-dz'^2-dr^2-r^2df^2$$

[0359] Notice that this returned the original intervals form with a reversal on the sign of b and a reversal of the boundary conditions for g. Now we notice that at r=0, this interval becomes the interval for special relativity transformed to cylindrical coordinates. Thus, we have found a transformation to a frame based local to the device. One can also verify that in these coordinates the relevant affine connections vanish at r=0. a further proposed modification to this field we will reintroduce a time dilation term into the devices frame's interval. Only we will use different boundary conditions for it. We will keep A=1 both at the location of the device, and far from it, but allow it to become large in the warped region. This is achieved by the simplest means possible in the proposed field generation method. Since rotating kerr singularity under bombardment would produce an equal negative energy region. With the effect focused outward away from the device slightly by the relative alignment of the kerr singularity the actual inward going portion of such fields would overlap and cancel their effect out in the region of the device. This yields a space normal time region, which is again restored at the fringes of the outward going field. From the standpoint of a geometric picture of space-time around the device and extending outwards one has actually created a dual event horizon situation as far as time goes. The inner one is the shell of the canceled out field inside of which normal time flow is restored. The outer one is formed at the boundary where normal time resumes and within which we have a negative energy field.

SUMMARY OF THE INVENTION

[0360] The present invention is A method for the generation of a pseudo 2+1 dimensional anti-de Sitter space (DeDeo & Gott 2002) using two Kerr type positively charged rotating dilation singularities where one singularity is maintained as a axis of rotation or "reference" singularity, and the other "target" singularity is subjected to a differential electron flow so as to simultaneously pass above the photosphere of said singularity in its direction of rotation—prograde orbit—and contrary to its direction of rotation—retrograde orbit—to release a directed flow of gravitons in a sinusoidal oscillation simulating a rotational effect of the "target" singularity around the axis of rotation provided by the "reference" singularity, resulting in the creation of timelike curves in a compact time-oriented manifold permitting topology change from one spacelike boundary to the other in accordance with Geroch's theorem (Geroch 1967) which results in a method for the formation of G odel-type geodesically complete spacetime envelopes complete with closed timelike curves.

BRIEF DESCRIPTION OF THE DRAWINGS

[0361] **FIG. 1** is a schematic representation of the mechanism employed to house the components necessary to generate a 2+1 dimensional anti-de Sitter space, resulting in the creation of timelike curves in a compact time-oriented manifold

[0362] **FIG. 2** is a schematic representation of the G odel-type geodesically complete spacetime envelope created by the mechanism complete with closed timelike curves

DETAILED DESCRIPTION OF THE INVENTION

[0363] Principles of Gravity Distortion Time Displacement Systems

[0364] The theoretical understanding of quantum gravity allows the design of time displacement systems from first principles. It is unlikely that gravitons or Kerr singularities can be controlled in a precise way using current technology. Nevertheless, an understanding of three dimensional space-time and matter, does allow the design of elementary displacement systems. That is, systems whose displacement rely on direct warping space-time as opposed to the ejection of material to provide thrust resulting in time dilatational effects.

[0365] The background for these systems are already partially understood and quintessence theory allows their

further development. For this invention, the formation of black holes in the laboratory represents a crucial step in understanding the mechanisms that underlay gravitational physics and in turn the warping of space-time. The existence of black holes permits the localized application of the Axial torsion Spin-Rotation Coupling Effect (Zhang & Beesham 2002) resulting in a Rotating Frame with Relativistic Factor (Zhang 2003) which can be used in the creation of a Alcubierre space time bubble under the Van Den Broeck modification of the Alcubierre geometry (Van Den Broeck 1999) resulting in a method for the generation of a pseudo 2+1 dimensional anti-de Sitter space (DeDeo & Gott 2002) using two Kerr type positively charged rotating dilation singularities where one singularity is maintained as a axis of rotation or "reference" singularity, and the other "target" singularity is subjected to a differential electron flow so as to simultaneously pass above the photosphere of said singularity in its direction of rotation and contrary to its direction of rotation to release a directed flow of gravitons in a sinusoidal oscillation simulating a rotational effect of the "target" singularity around the axis of rotation provided by the "reference" singularity. In this instance the space-time lattice would be repelled by gravitons in such a way as to disperse space-time quintessence in a circular fashion around each of the singularities, producing multiple event horizons around the simulated axis of rotation provided by the reference singularity.

[0366] The release of gravitons from the target singularity is controlled by differentially governing the electron flow across the photosphere with the use of powerful electric currents. In turn the differential direction of flow across the photosphere of gravitons would determine the direction of motion through the space time lattice and the resulting time displacement from one spacelike boundary to the other in accordance with Geroch's theorem (Geroch 1967) when implementing this approach it is important to remember that the black hole is not excited by the smashing of the clump as it "hits" the horizon. The hole is rather excited when the metric perturbation associated with the clump is "felt" by the background metric. The excitation event therefore constitutes a smooth process whereby in-fall of a clump from .rmb and through r+ serves as a source in the Teukolsky (1973) equation for small perturbations to the Kerr geometry (with appropriate boundary conditions at r+ and r∞). This is an important distinction with a great deal of relevance to the practical engineering of the displacement unit since we need to gauge the "driving" of QNR modes in terms of an e_ective coupling from clump in-fall.

[0367] What results is a method for resonant driving of the quasi-normal ringing (QNR) wave modes of the Kerr geometry of the target singularity. The micro black hole hyper-accreting at rates ÿ M. 1 M□sec. 1 from a neutrino cooled disk is pushed through to oscillate near resonance of its (l,m=2, 2) quadrupole QNR frequency due to the in-fall of compact mass over-densities from the cusp in e_ective potential on a dynamical time scale. This mode is induced via induced magneto-rotationally induced fluid dynamics in the ultra-relativistic region of the flow bounded from below by the marginally bound orbit radius: rmb If the QNR modes are fed resonantly for a few seconds of hyper-accretion, the enhanced amplitude of the oscillations yields a very high rate of energy deposition into gravitational waves. Indeed, the integrated energy deposition is large enough to "evaporate" the equivalent of a factor of a few times the total rest mass-energy of a single clump into gravitational waves, which in turn interact with the reference singularity

[0368] Application of the method described in the previous section results in translation outside of the cosmological horizon, where F(R)<0. The topology of the resulting geodesic, for large constant R, is mathematically equivalent to a Euclidean cylinder of the condition R×Sn where T is the coordinate along the cylinder. I± are located outside the future/past cosmological horizons, where R is timelike and T is spacelike. In the case of a rotating Kerr black hole, there are two circular photon orbits that can exist in the equatorial plane and be exploited to create a tipler sinusoid. One is a prograde orbit moving in the same direction as the black hole's rotation, while the other is a retrograde orbit moving against the black hole's rotation. Their radii are respectively given by

$$r1=2M(1+\mathrm{Cos}(2/3\ \arccos(-|\alpha|/M)))$$

$$r2=2M(1+\mathrm{Cos}(2/3\ \arccos(|\alpha|/M)))$$

where a is the angular momentum per unit mass of the black hole. The orbits fall in the range M greater or equal to r1 greater or equal to 3M greater or equal to r2 greater or equal to 4M The fact that a prograde photon or in or case cooper pair with Bose characteristics orbits the black hole at a smaller radius than a retrograde one can be attributed to the well-known Lense-Thirring effect, i.e., the dragging of inertial frames due to the black hole's rotation which we control and influence via electromagnetic induced load coupling with the open magnetic field lines threading the BH horizon. This dragging would cause charged cooper pairs to revolve around the black hole relative to a static observer at infinity. Thus, to such an observer, a prograde cooper pair would have to orbit at a smaller radius to compensate for the 'extra' angular momentum acquired, while a retrograde one would have to orbit at a larger radius to compensate for the 'lost' angular momentum. Indeed, in the limit of zero rotation, these two orbits coincide at r D 3M, giving the single circular orbit of the Schwarzschild black hole. Now, recall that orbits around the Schwarzschild black hole are necessarily confined to a plane passing through its center, because of the spherical symmetry of the space-time. However, the Kerr black hole space-time has only an axial symmetry (in addition to being stationary), and this raises the possibility of non-planar orbits. One could, for example, contemplate the existence of spherical Boseon orbits—orbits with constant coordinate radii that are not necessarily confined to the equatorial plane—around the Kerr black hole. Such orbits would be a nontrivial generalization of the two circular photon orbits that lie in the equatorial plane. At first it may seem a little surprising that such spherical orbits could even exist, but there is an interesting reason as to why they are possible. Note that an object in a spherical orbit would, in addition to moving around the black hole in the azimuthal direction, be undergoing some periodic motion in the latitudinal direction. This is only possible if there is a conserved quantity associated with motion in this direction, just as angular momentum is necessarily conserved by its rotational motion in the azimuthal direction. (This result can be seen, for example, using action-angle variable) Now, because the Kerr space-time has only axial symmetry, geodesics in it should have only two constants of motion, namely energy and angular momentum. However, Carter discovered the remarkable fact that geodesics in the Kerr space-time possess a third constant of motion. It turns out that Carter's new

constant governs the motion of geodesics in the latitudinal direction, although it is not related to any obvious space-time symmetry. Thus, spherical timelike orbits, which assume eigenlike properties around the Kerr black hole, are possible and when coupled with charged Bosons may be exploited to manipulate the relative event horizons of the "target" singularity. The location and the temperature of the modified event horizon depend on the time, charge and angle of incidence of the cooper pairs. The Fermionic spectrum of Dirac particles displays a spin-rotation coupling effect due to the interaction between the particles with spin-1=2 and the black holes with rotation. The effects arise from the interaction between the spin of Dirac particles and the rotation of the evaporating black holes. The feature of this spin-rotation coupling effect is its dependence on different helicity states of coupled particles with spin-½ and its irrelevance to the mass of particles.

[0369] In order to design a mechanism for time displacement exploiting the Carter asymettry cited above we utilize two positively charged top spin rotating kerr type black holes aligned on demand to create a simulated rotational effect around a central axis provided by the "reference" singularity. In the case of the Kerr blackhole (singularity), this is accomplished by an inverse Blandford-Znajek (BZ) process utilizing the magnetic flux of open field lines connecting the horizon and an induced remote load. (Ding-Xiong Wang, Kan Xiao & Wei-Hua Lei, 2001) permitting the microscopic blackhole (singularity) to be rotated along its horizontal axis in at relativistic centrifugational speeds. A differential current is then applied in such a way as to pass through the entire photosphere in the desired direction. As a result the gravity field can be manipulated by three factors that affect it in distinct ways. Adding electric charge to the singularities increases the diameter of the inner event horizons. Adding mass to the singularities increases the area of gravitational influence around the singularities. Rotating and positioning the polar axis of the singularities affects and alters the resulting gravity sinusoid

[0370] In order to create a sinusoid capable of inducing a topology change from one spacelike boundary to the other in accordance with Geroch's theorem The electric charge in the upper half of the photosphere would be maximised. The electrons will have a vector in the left to right direction as the singularity spins clockwise. If a maximised current is applied to the singularity in the same direction this will result in a increase in the velocity of the electrons relative to the centre of gravity of the singularity, due to the flow of current. In turn, according special relativity and to the space-time lattice model, this wilt result in an increase in the relativistic mass if the electrons and in turn by general relativity an increase in the release of gravitons.

[0371] Conversely in the lower half of the singularity the electrons will have a vector of motion in the right to left direction due to the spin of the singularity. This will be relativistically slowed by the differential current applied in the same direction as the current above, and hence in the opposite direction to the direction of rotation. The charge can be separately applied and adjusted to ensure that the electrons are relativistically stationary relative to the centre of gravity. In turn this will minimize the relativistic mass and result in a decrease in the release of gravitons for the lower half of the singularity.

[0372] The overall result will be a greater release of gravitons in one direction and a lesser release of gravitons in the converse direction. The effect will be enhanced by the use of a multi-phasic current simultaneously applied. This will result in the release of multi-phasic gravitons which will disperse space time in the singularity with increase in density in the converse this effect can also be produced and supplemented with the use radio frequency pulses, The radio frequency pulses must be designed to produce a change in the spin of the particle to enhance the release of gravitons in the desired direction

[0373] With the use of large currents the drift velocity of the electrons across the photosphere could be greatly increased. Within this region the electrical resistance is virtually eliminated. Thereby allowing large currents to be induced with minimum total power output.

[0374] The result is the production of cooper paired electrons of high speed and hence high relativistic mass in the desired half of the singularity, whilst producing low speed and thus low mass paired electrons at the converse of the singularity, in accordance with special relativity. The imbalance in the rotating singularity will be continuously present creating a dynamic warping of space-time. In effect, the differential current flow, will produce differential graviton production and in turn, by general relativity, the warping of space-time

[0375] As the cooper pairs cross the photosphere, accretion of the Bose particles results. Near-hole accretion across the target singularity is then motivated by magneto-rotationally induced, ultra-relativistic disk dynamics in the region of the flow bounded from below by the marginally bound geodesic radius rmb. As the particles impelled have high spin values, a largely coherent magnetic field in this region has the dynamical implication of compact mass segregation at the displacement nodes of the non-axisymmetric, MRI modes. This results in prolific gravitational wave emission coincident with the gamma-ray stage. The gravitational wave emissions are then manipulated to influence the reference singularity to produce a variable gravitational sinusoid which is then used to mathematically approximate the gravametric distortion, inducing a topology change from one spacelike boundary to the other in accordance with Geroch's theorem.

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[0529] Appendix A: The Synthetic creation of micro singularities. Throughout this patent application the creation of micro singularities has been maintained. While at first glance this may seem to be a deficiency in the patent application it is in fact an engineering problem that is in the process of being solved. In the International Journal of Theoretical Physics 41 (11): 2073-2090, November 2002 L. J. Garay published "Black Holes in Bose-Einstein Conden-

sates". In this article Garay showed that there exist both dynamically stable and unstable dilute-gas Bose-Einstein condensates that, in the hydrodynamic limit, exhibit a behavior completely analogous to that of gravitational black holes. This discovery coupled with creation of color glass condensate (CGC) an extreme form of nuclear matter in which a nucleus travels at near-light (relativistic) speed which flattens like a pancake in its direction of motion and spawns a large number of gluons hold the key to high energy singularity formation.

I claim:

1. A method for the generation of a pseudo 2+1 dimensional anti-de Sitter space comprising the steps of:

creating two Kerr type positively charged rotating dilation singularities, including the steps of

maintaining one of the singularities as a axis of rotation reference singularity,

maintaining the other of the singularities as a target singularity, and

subjecting the target singularity to a differential electron flow so as to simultaneously pass the differential electron flow above a photosphere of said target singularity in a direction of rotation thereof and contrary to the direction of rotation thereof, in order to release a directed flow of gravitons in a sinusoidal oscillation simulating a rotational effect of the target singularity around the axis of rotation provided by the reference singularity.

2. A method of generating a force around a body, comprising the steps of:

employing sinusoidal oscillations of electrical bombardment on the surface of one Kerr type reference singularity in close proximity to a second Kerr type target singularity to take advantage of the Lense-Thirring effect, wherein the electrical currents employed in the bombardment are passed simultaneously across the photosphere of said reference singularity in its direction of rotation and contrary to its direction of rotation to release a directed flow of gravitons in a sinusoidal oscillation simulating a rotational effect of the target singularity around the axis of rotation provided by the reference singularity;

creating timelike curves in a compact time-oriented manifold of Godel-type geodesically complete spacetime envelope under the Van Den Broeck modification of the Alcubierre geometry, resulting in the creation of timelike curves in a compact time-oriented manifold permitting topology change from one spacelike boundary to the other in accordance with Geroch's theorem.

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(54) CHI ENERGY AMPLIFIER

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(57) ABSTRACT

A Chi energy amplifier that utilizes a co-gravitational K field to generate a flow of hyperspace energy into or out of a ceramic dome containing a slot antenna.

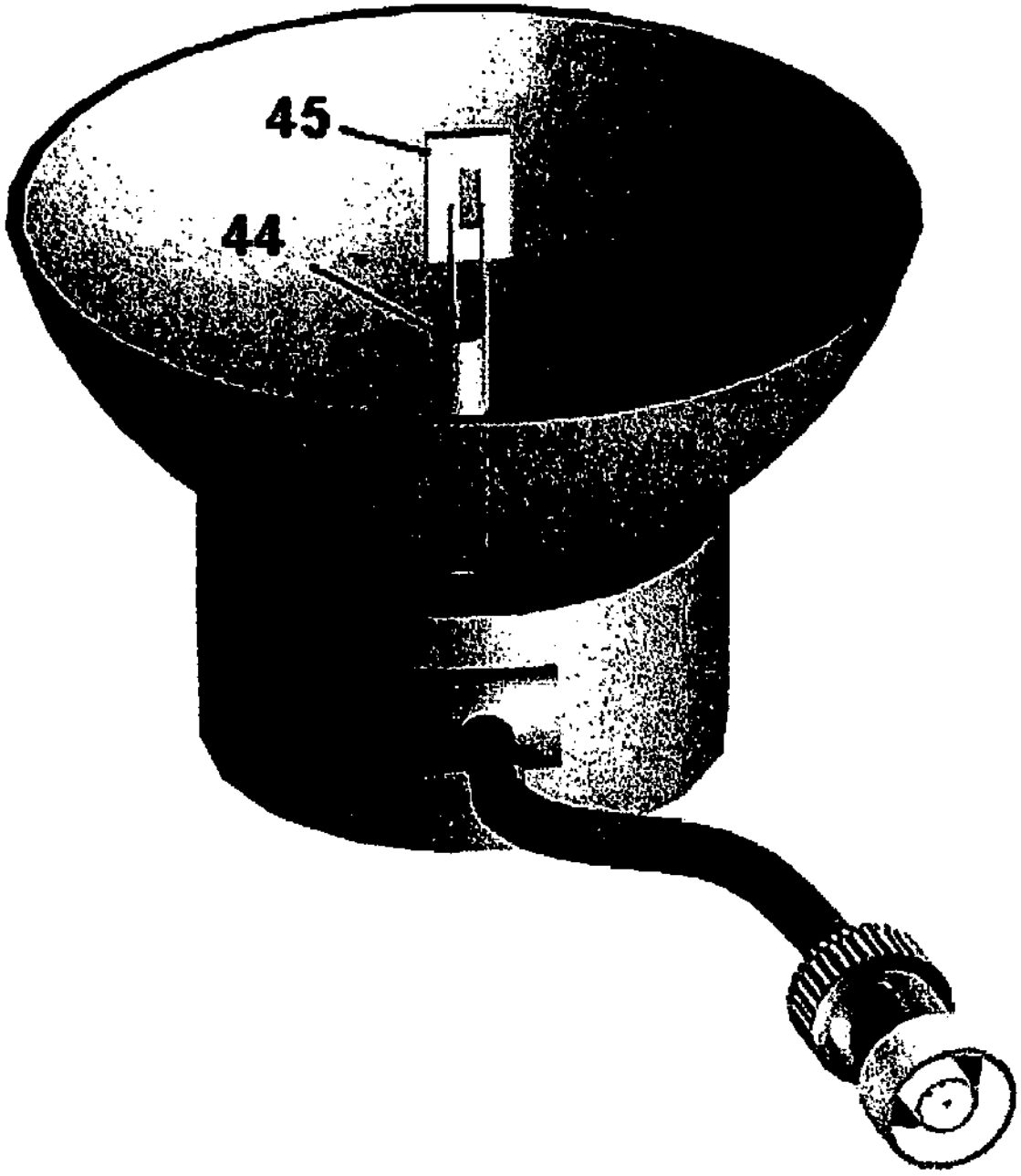

Figure 1

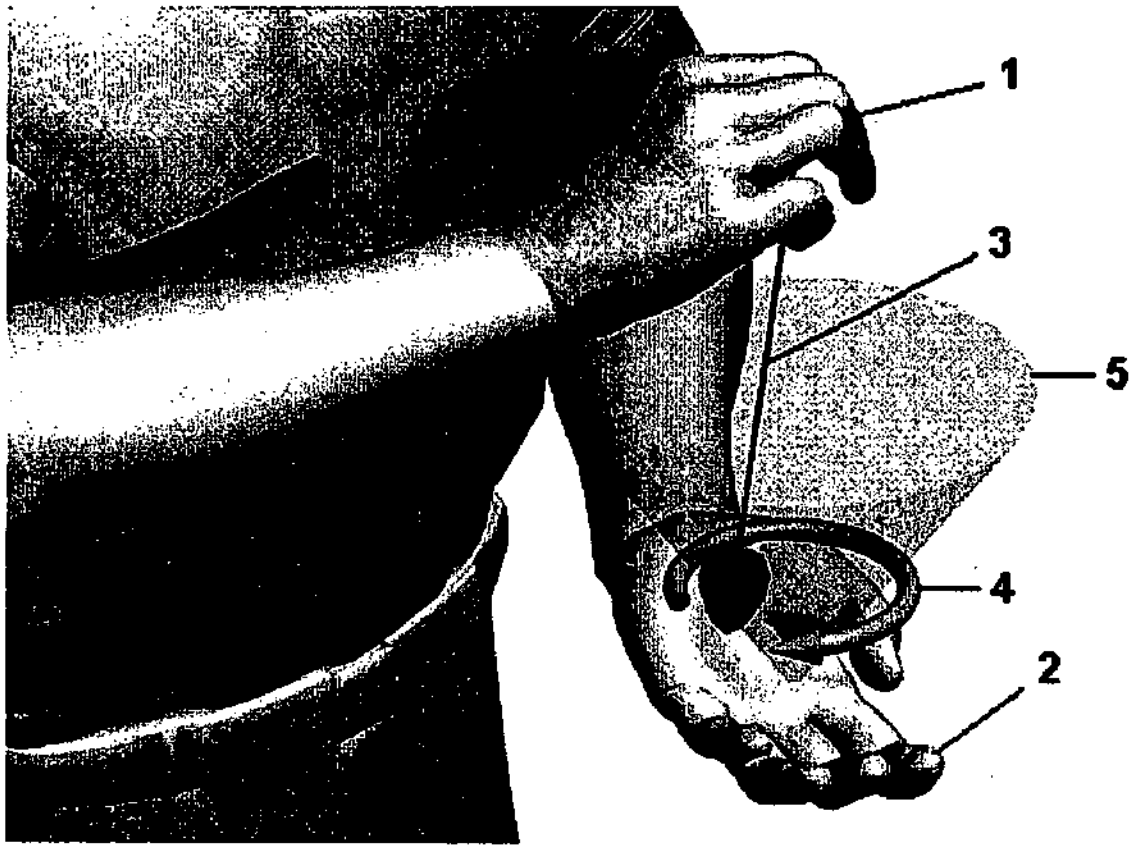

Figure 2

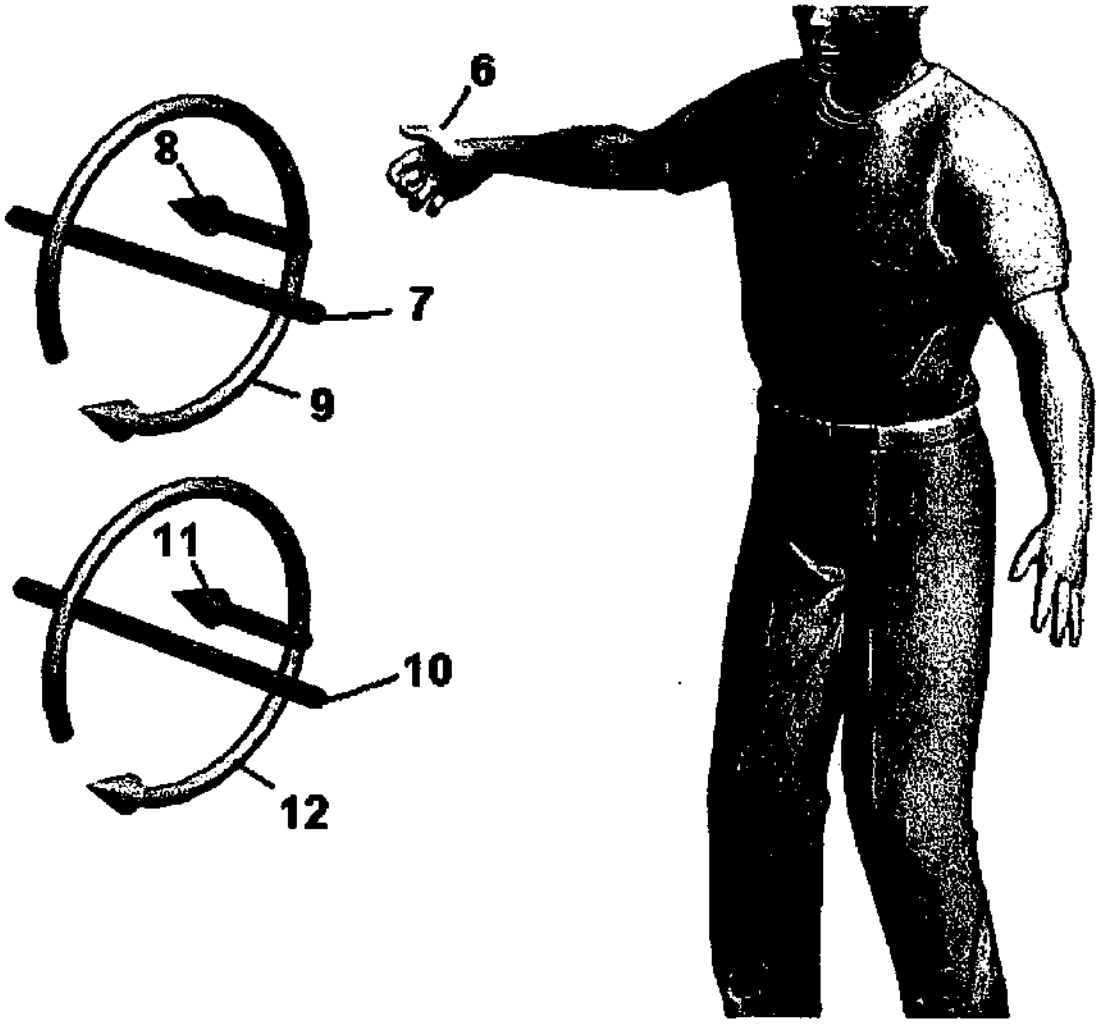

Figure 3

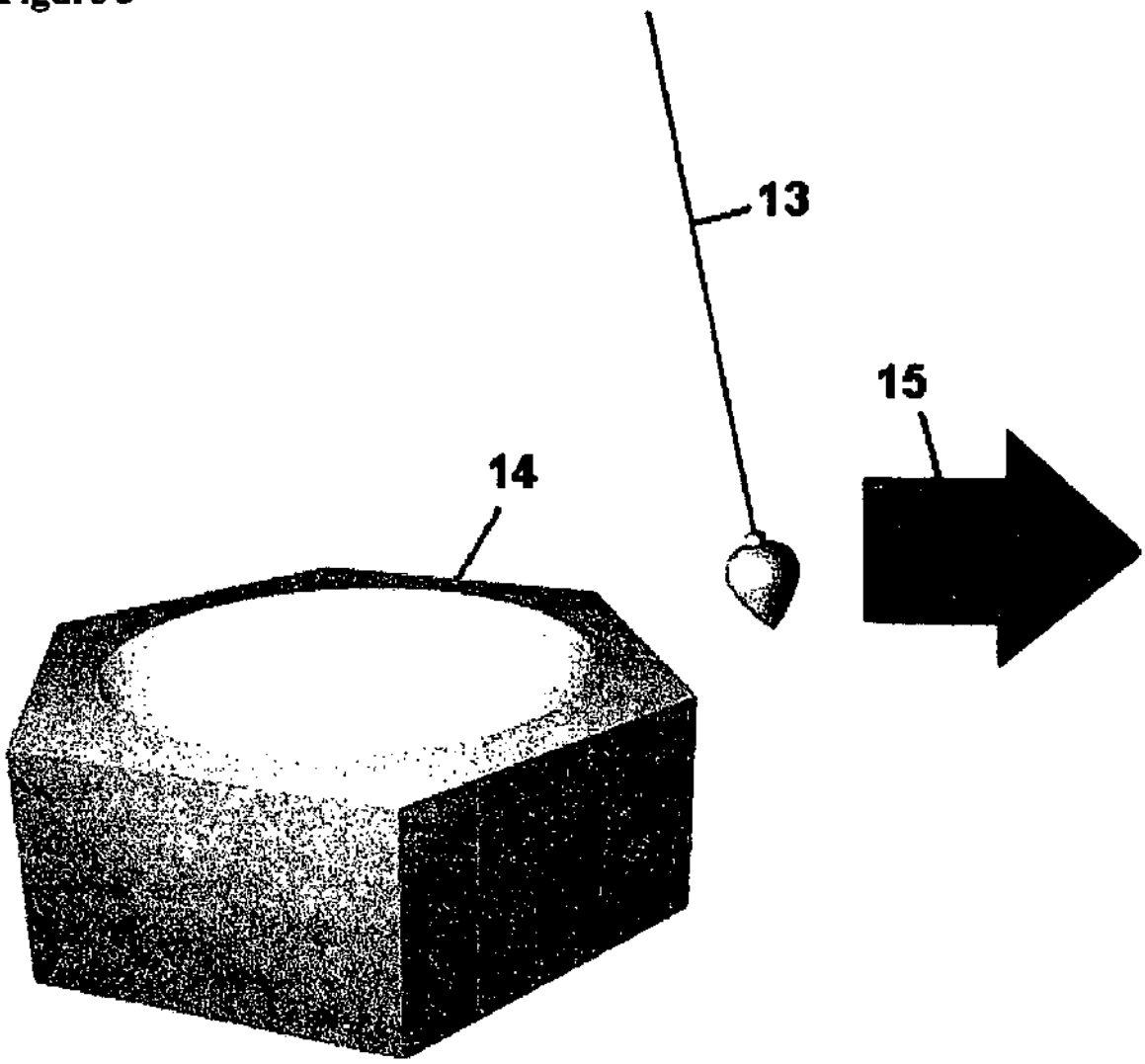

Figure 4

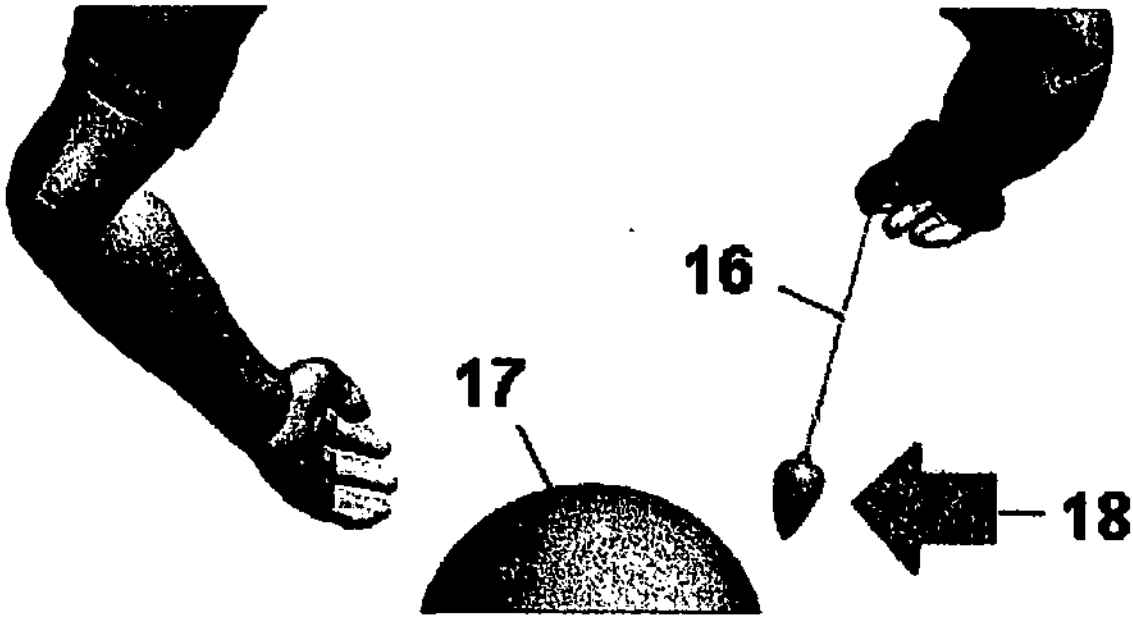

Figure 5

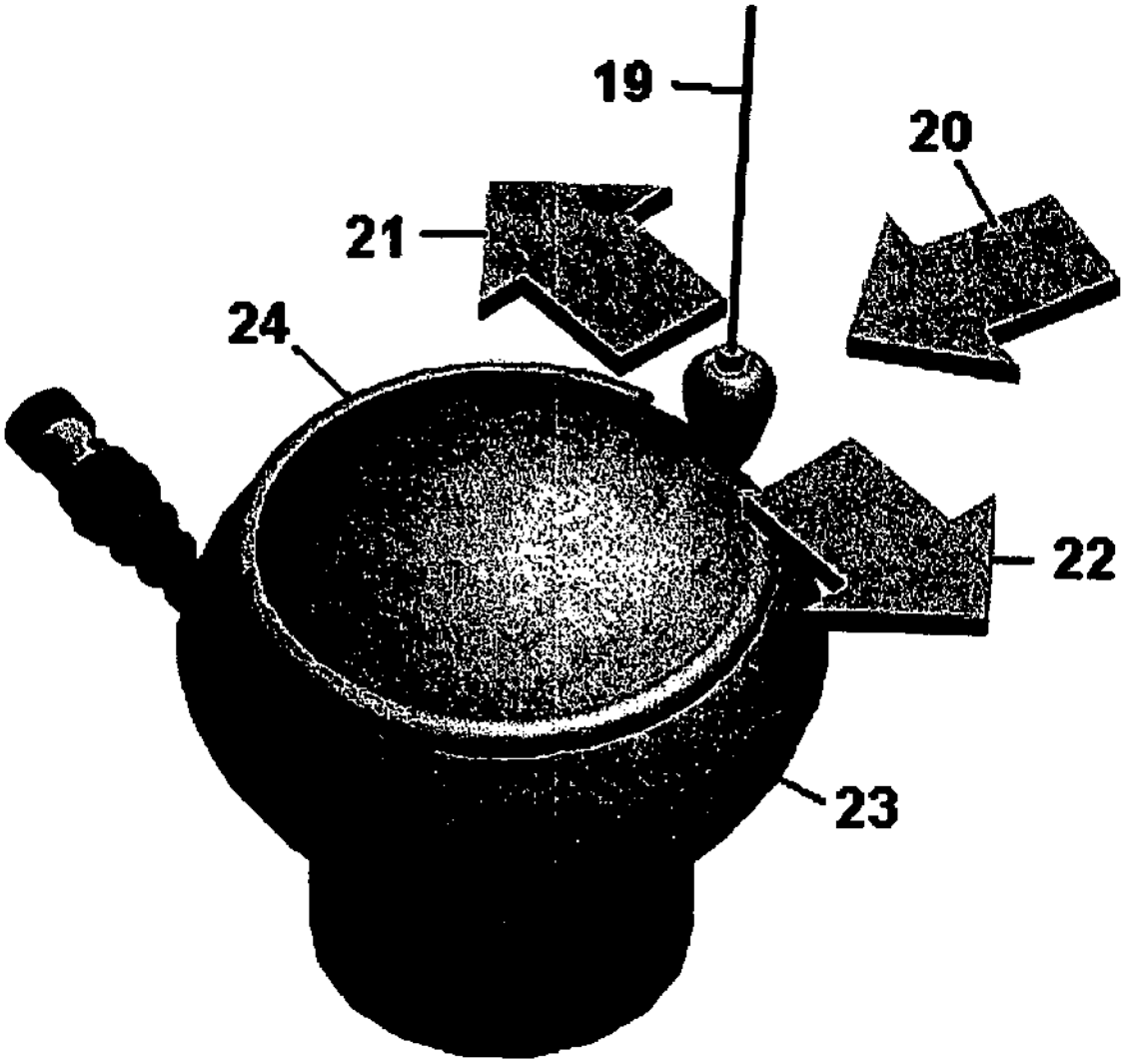

Figure 6

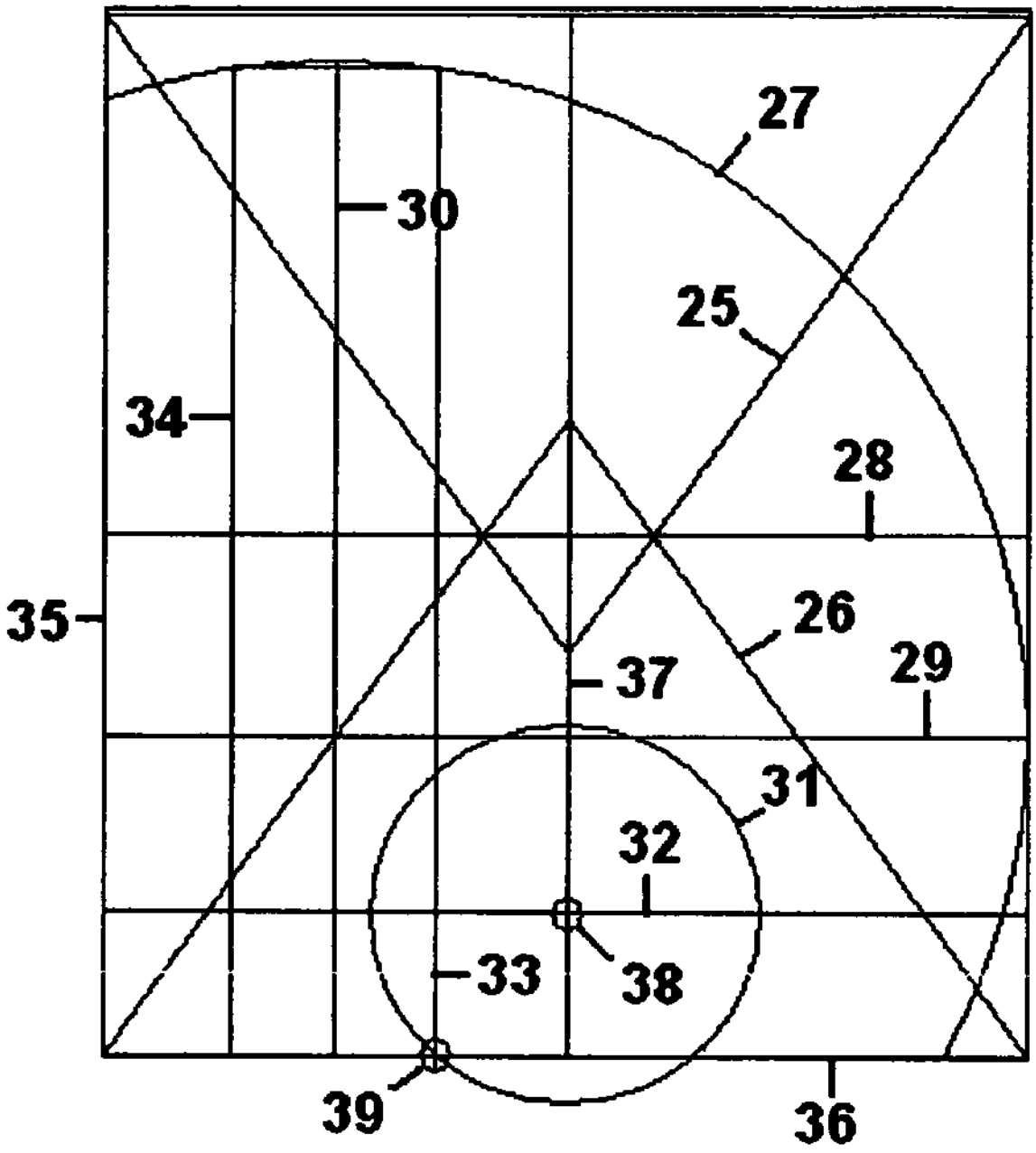

Figure 7

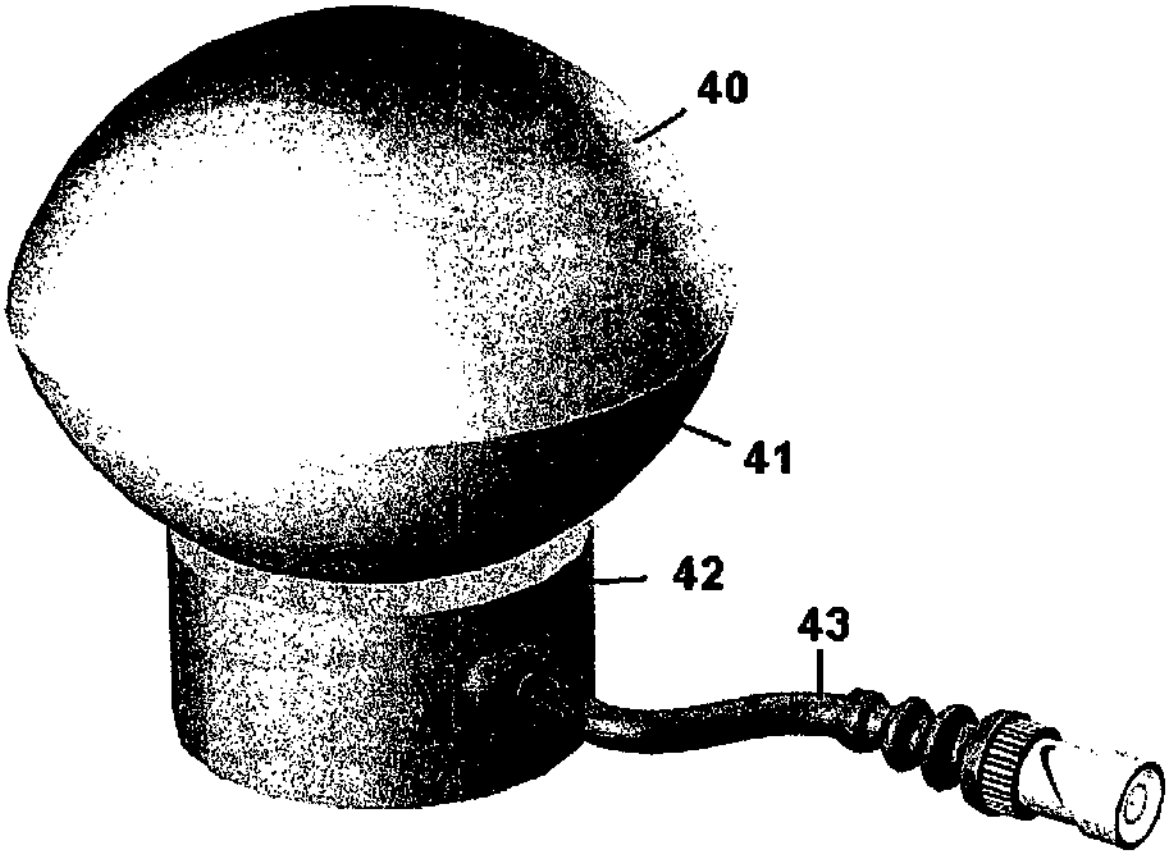

Figure 8

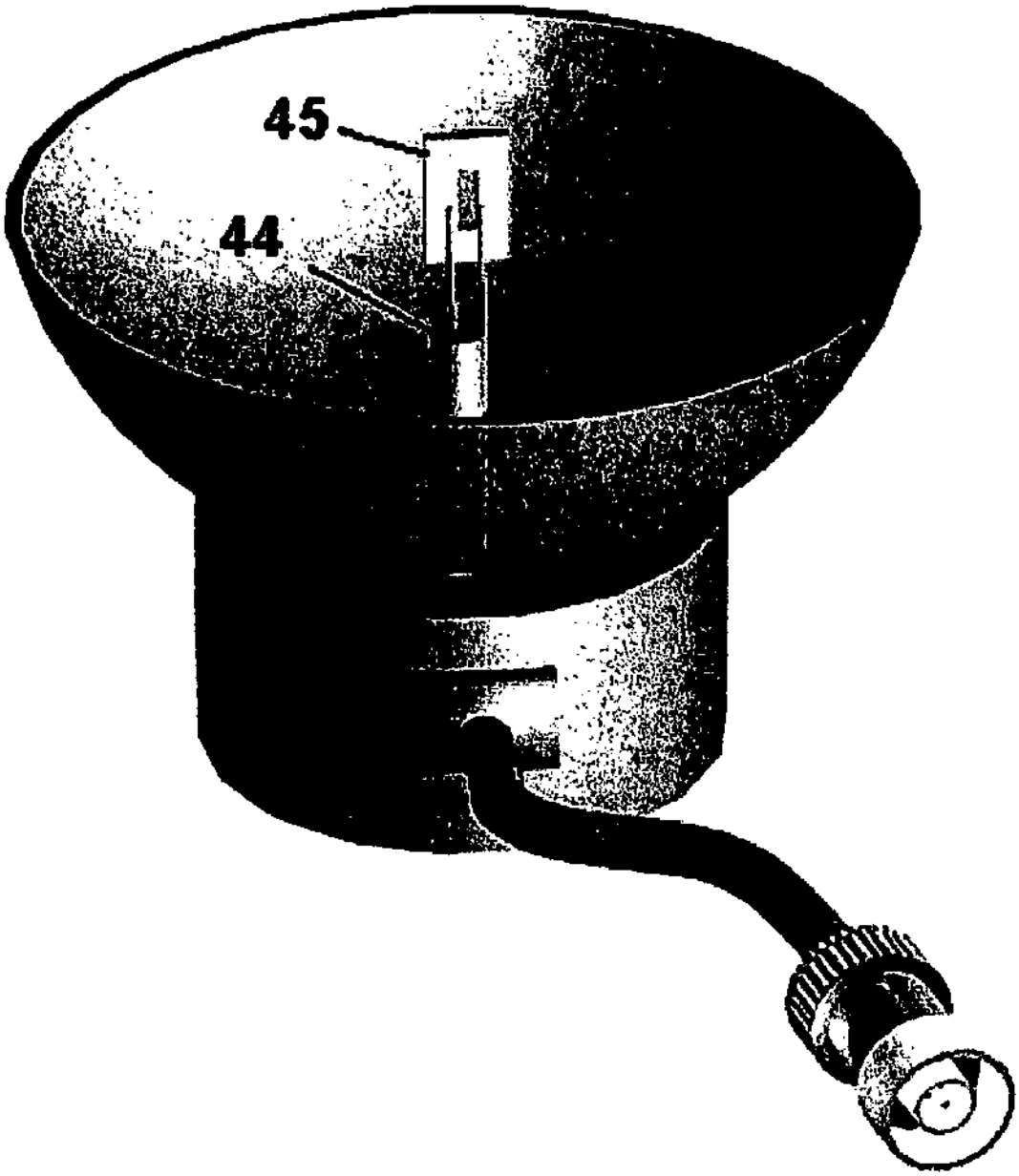

Figure 9

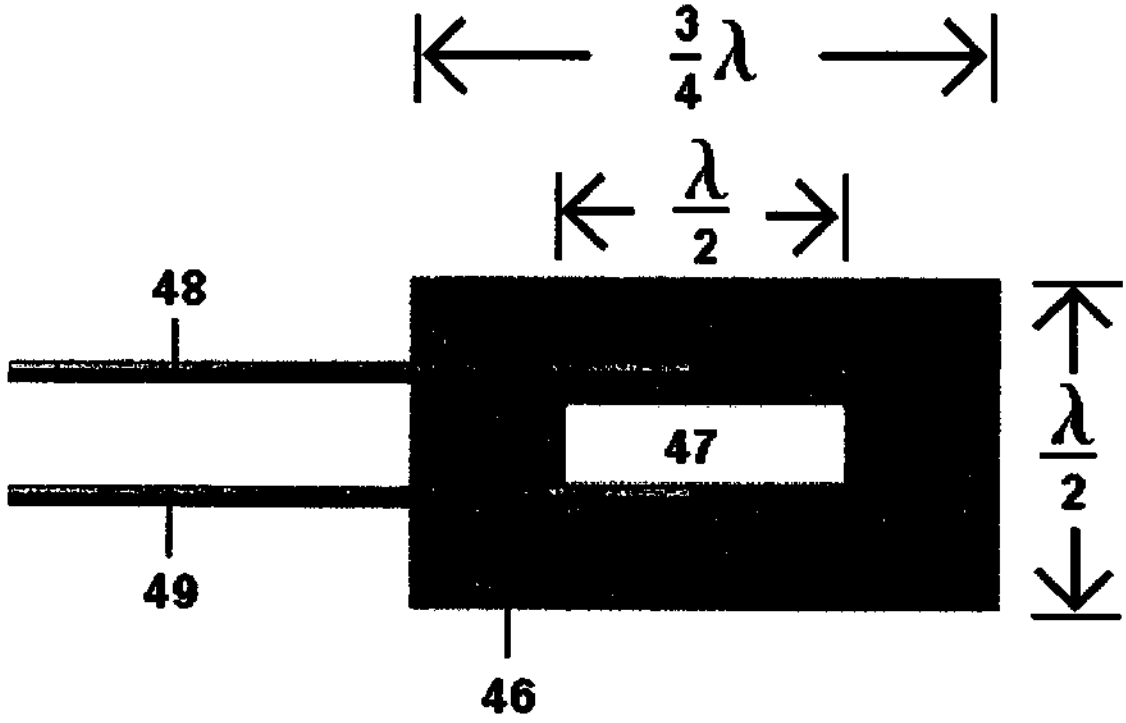

Figure 10

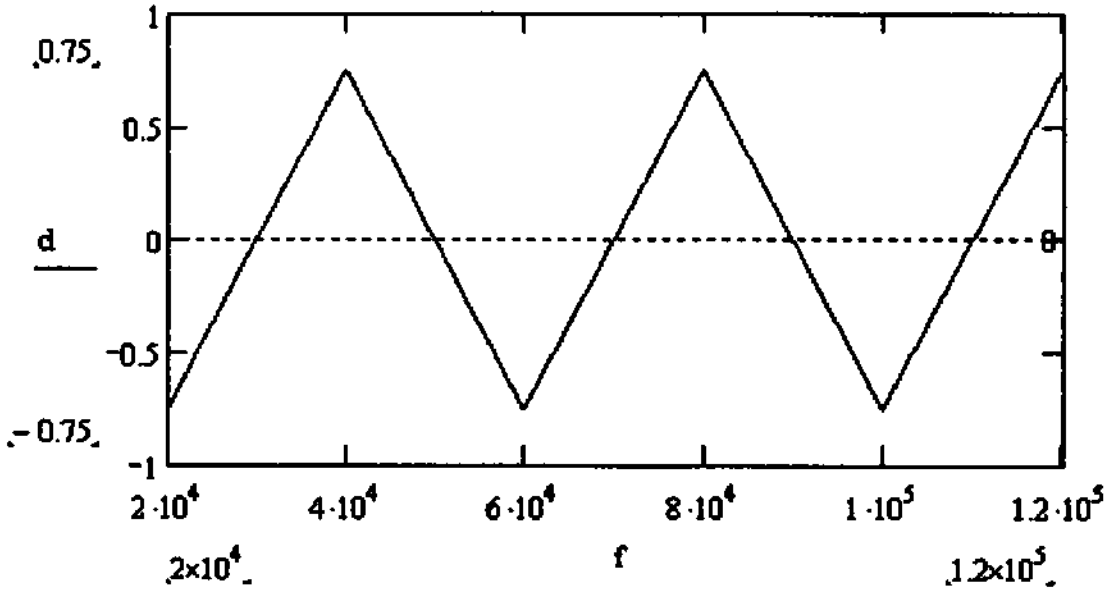

Figure 11

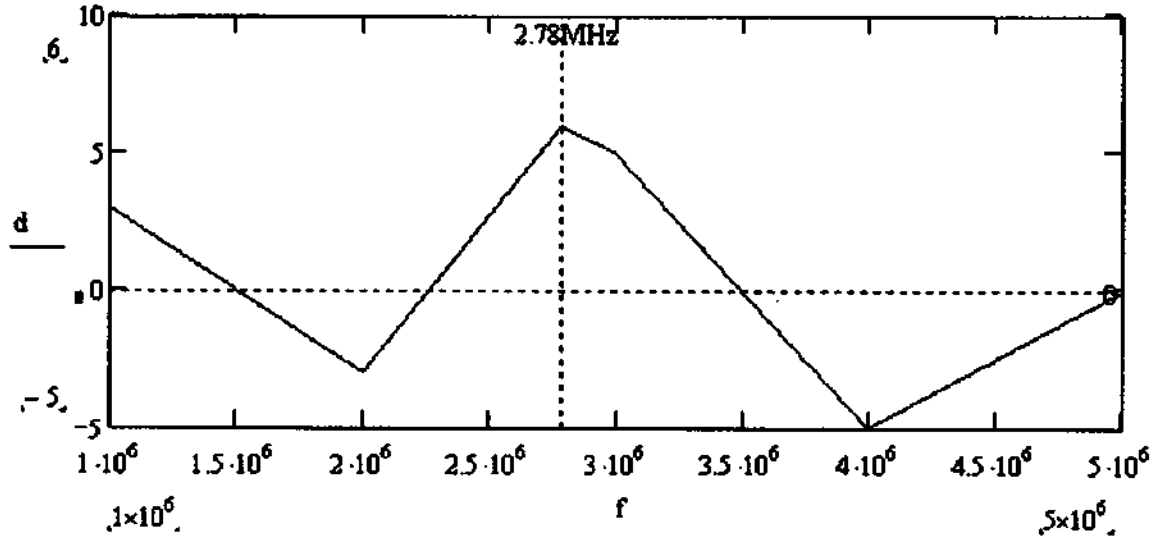
10
6
5
d
0
-5
-5
2.78MHz
1·10^6
1.5·10^6
2·10^6
2.5·10^6
3·10^6
3.5·10^6
4·10^6
4.5·10^6
5·10^6
1×10^6
f
5×10^6

Figure 12

CHI ENERGY AMPLIFIER

BRIEF SUMMARY OF THE INVENTION

[0001] This invention is an energy amplifier that controls the direction of the second co-gravitational K field by means of a slot antenna located in a resonating sphere. The hyper-space mass flow rate entering into this dimension is determined by the frequency of the antenna. This energy flow is used to increase the energy of the human energy field known as Chi.

BACKGROUND OF THE INVENTION

[0002] Referring to FIG. **1**, a pendulum suspended by a string (**3**) is held by the string with the right hand (**1**) over the upright palm of the left hand (**2**). The pendulum swings in circles shown by the clockwise direction of the arrow (**4**). The pendulum swings at a constant frequency at about 1 to 2 Hz. What this means is that there is a second gravitational K field (**5**) that can cause a mass to rotate in circles.

[0003] Everyone is familiar with the linear gravitational g field which is defined as Newton's gravitational constant G times the mass of the earth divided by the square of the radius of the earth. This is the field that causes objects to accelerate radially toward the earth's surface. Newton's gravitational constant G is equal to the speed of light c squared divided by the linear mass Ω of the universe. The speed of light is

$$c = 299792458\,\frac{\text{meters}}{\text{second}}$$

$$\Omega = 1.346812891\cdot 10^{27}\ \frac{\text{kilograms}}{\text{meter}}$$

$$G = \frac{c^2}{\Omega} = 6.673200002\cdot 10^{-11}\,\frac{meter^3}{second^2\ \text{kilogram}}$$

The mass and radius of the earth are

[0004]

$$ME = 5.977\cdot 10^{24}\ \text{kilograms}$$

$$RE = 6371.03\,10^3\ \text{meters}$$

$$g = G\frac{ME}{RE^2} = 9.82\ \frac{\text{meters}}{second^2}$$

[0005] From electromagnetism, the electric E field is linear and the B magnetic field is circular or forms closed loops. The electric field starts and ends on electric charges. Since there are two electromagnetic fields, it makes sense that there are also two gravitational fields. A flow of electric current through a straight wire causes a circular magnetic B field to form around the wire. In a similar manner, a flow of mass through a channel causes a circular gravitational K field to form around the channel.

[0006] Referring to FIG. **2**, the right hand rule (**6**) shows that if the flow is along the direction of the thumb of the right hand, then the field curls around in the direction of the fingers. If an electric current is flowing through the wire (**7**) in the direction of arrow (**8**), then a counter-clockwise magnetic field circles the wire shown by arrow (**9**). In the bottom view, a mass flowing through a channel (**10**) in direction (**11**) generates a counter-clockwise gravitational K field shown by arrow (**12**). This field is the reason that the pendulum swings in circles. The gravitational K field only exists if there is a mass flow. In the wire there is also an electric field driving the electrons, so it must be that there is a g gravitational field driving the mass along the channel.

[0007] The correspondence between electromagnetic and gravitational constants must be the following:

Electric	Gravitational
Charge q	Mass m
Electric Field E	Gravitational Field g
Magnetic Field B	Co-gravitational Field K
Linear Electric Charge λ	Linear Mass Ω
Permittivity of Space ϵ_0	$-1/4\pi G$
Permeability of Space μ_0	$-4\pi G/c^2$
Convection Current Density J	Mass Current Density J

[0008] Maxwell's equation for the curl or circulation of B involves the current density J and an electric field E changing with time t

$$\nabla\times B = \mu_0 J + \frac{1}{c^2}\frac{\partial E}{\partial t}$$

The corresponding gravitational equation is therefore

[0009]

$$\nabla\times K = -\frac{4\pi G}{c^2}J + \frac{1}{c^2}\frac{\partial g}{\partial t}$$

[0010] If the g field is constant with time, then the circulation of the K field only depends on the mass density flow through the channel. Notice the minus sign in front of the first term which says that if energy is entering our dimension through a channel, then the K field is in the counterclockwise direction as indicated by the pendulum. As seen in FIG. **1**, the energy is leaving through the left hand because the rotation is clockwise. On the right hand, the pendulum rotates in the counterclockwise direction indicating that energy is coming from the hand. Thus there is a flow of energy between the hands known as the Chi energy. The purpose of this invention is to amplify this energy.

[0011] The g gravitational field is due to a negative space-time curvature created by the mass of the earth. In many physics books this is depicted as a bowl. So the idea was to acquire a ceramic kiln which could produce ceramic bowls using earthenware clay and a bowl mold. The curvature created by the bowl, if any, could be detected by the pendulum.

[0012] Referring to FIG. **3**, a pendulum (**13**) held in the right hand with the left hand near the side of the concave mold (**14**) starts to swing toward the right, away from the plaster mold as shown by arrow (**15**).

[0013] Referring to FIG. **4**, a pendulum (**16**) held in the right hand over a positive curvature dome (**17**) swings toward the top of the dome as shown by arrow (**18**).

Supposedly the K gravitational field rotates in circles, but these experiments showed that the pendulum movement was radial.

[0014] Referring to FIG. **5**, the pendulum (**19**) swings radially (**20**) toward the top of the dome (**23**) because the forces (**24**) around the dome counteract each other as shown by arrows (**21, 22**). Thus there is no sideways pressure on the pendulum.

[0015] The next question was what is the value of the co-gravitational K constant? In electromagnetism the electric field is the speed of light times the magnetic field. So the g gravitational field should be the speed of light times the co-gravitational K field.

$$\begin{aligned} K &= \frac{g}{c} \\ &= \frac{1}{c} G \frac{MU}{RU^2} \\ &= \frac{1}{c} \frac{c^2}{\Omega} \frac{MU}{\frac{MU}{\Omega} RU} \\ &= \frac{c}{RU} \end{aligned}$$

$$\ln(K) = -40.34861143$$

[0016] where the radius RU of the universe is 10^{26} meters and c is the speed of light. The speed of light divided by the radius is angular frequency measured in Hz. Recall that the pendulum over the hand has a frequency f of 1 Hz which makes the angular frequency o equal to 2π radians per second since $\omega=2\pi f$ So the question is whether or not this value of K means anything in terms of hyperspace physics?

[0017] The universe has a geometrical sub-manifold based on the tetrahedron. All the physics constants of the universe are determined by this tetrahedral geometry. As shown in diagram tet0565 stored in the Library of Congress, the electron and proton are one and the same particle. There is a continuous clockwise path from the electron wavelength, through electric charge to electron mass and returning out-of-dimension back along a counterclockwise path as the proton. Because the paths are in opposite directions, the proton has a positive charge and the electron has the opposite negative charge. Because this path crosses into our dimension from hyperspace, we see two different particles. Thus Nature only has one particle. The tetrahedron diagram also shows that our dimension is offset from the origin of the diagram by the Cabibbo angle which is found in particle physics. Our dimension is determined by the Planck mass and the Planck wavelength which are the bottom limits of our dimension, known as the Planck box. If the proton mass is centered on the Planck mass, a tangent line to the circle can only be made by using the down quark and up quark which comprise the proton (duu). And the tangent line is drawn at the Cabibbo angle. So the diagram verifies some important experimental physics data.

[0018] Referring to FIG. **6**, the tetrahedron diagram is drawn with a vertical axis (**35**) corresponding to the natural logarithm of mass. The horizontal axis (**36**) is the natural logarithm of wavelength. The inverted tetrahedrons (**25, 26**) cross at the centerline (**28**) which is known through remote viewing as "the merging of two worlds." The centerline is the separation point between space and hyperspace. The circumscribing sphere (**27**) has a horizontal diameter (**29**) and a vertical diameter (**30**). The electron wavelength (**34**) reflects off the sphere and returns as the electron mass (**33**).

[0019] Because the K co-gravitational field is related to circular or spinning motion, as well as vorticity per area, it might be imagined that it has something to do with the spinning electron. The energy E of the electron is equal to the mass m_e of the electron times the speed of light c squared.

$$m_e = 9.1093897 \cdot 10^{-31} \text{ kilogram}$$

$$c = 299792458 \cdot \frac{\text{meter}}{\text{second}}$$

$$E = m_e c^2$$

$$\ln(E) = -30.13363019$$

[0020] The tips of the inverted tetrahedrons pass through the base constant, vertical line (**37**), which is equal to Planck's constant h divided by the speed of light.

$$h = 2.210260685 \cdot 10^{-42} \text{ kilogram meter}$$

$$\text{base} = \ln\left(\frac{h}{c}\right) = -95.91546344$$

[0021] On the tetrahedron diagram, the co-gravitational circle K (**31**) is centered on the base (**37**) at the electron energy (**32**) shown by the small π circle at the intersection (**38**). As can be seen, the K circle determines the electron mass (**33**) at the horizontal axis (**36**) as shown by intersection (**39**). Because the electron is the proton, it also sets the constants of the proton such as wavelength, charge and mass. Thus the K co-gravitational field determines our elementary particles. Because these particle paths go in and out of dimension, it means that hyperspace exists. And because the K field is circular, depending on the direction of the energy flow, another purpose of this invention is to control the direction of the field.

SUMMARY OF THE INVENTION

[0022] Referring to FIG. **7**, the Chi energy amplifier consists of two ceramic domes (**40, 41**) resting one on the other such as to form a hollow internal clam-like structure. The domes are mounted on a cylindrical ceramic base (**42**) containing a reinforced passageway for the coaxial cable and BNC connector (**43**). The BNC connector plugs into the frequency generator (not shown) which has a frequency range of 0.4 Hz to 5 MHz.

[0023] Referring to FIG. **8** with the upper dome removed, the coaxial cable (**44**) extends vertically through the base into the lower dome. The cable is soldered to a slot antenna (**45**). The center conductor of the cable is soldered to the left side of the slot and the ground shielding is soldered to the right side of the slot. Thus there is a voltage difference on the two sides which produces an oscillating electric field across the slot which radiates electromagnetic energy into the hollow dome.

[0024] A close-up of the slot antenna is shown in FIG. **9**. The antenna is a 0.050" thick copper sheet (**46**) with a width of ¾ wavelength by a height of ½ wavelength. A slot (**47**)

of ½ wavelength is electric-discharge machined into the copper sheet (**47**). The center conductor (**48**) from the coaxial cable is soldered to the top of the slot. The ground wire (**49**) is soldered to the bottom of the slot. This configuration produces a voltage difference between the inner top and bottom surfaces of the slot. The frequency generator produces an oscillating voltage across the slot which generates an electric field that radiates from the antenna into the ceramic cavity.

[0025] The wavelength of the antenna and the dimensions of the ceramic cavity have to be tuned to the geometry of our dimension. Newton's gravitational constant G is equal to

$$\ln(G) = -23.4303342$$

$$f = e^{23.4303342} * \text{Hz} = 15\ Ghz$$

$$\lambda = \frac{c}{f} = .020 \text{ meter} = .787 \text{ inch}$$

$$\text{slotwidth} = \frac{\lambda}{2} = .393 \text{ inch}$$

$$\text{antennawidth} = \frac{3}{4}\lambda = .590 \text{ inch}$$

The frequency of the antenna is the inverse of the gravitational constant. The reason for this is that when a circle of radius natural logarithm G is centered on the proton on the tetrahedron diagram, the circle intersects the corner of the Planck box which bounds our dimension between space and hyperspace. It is the low-density hyperspace energy that the amplifier will bring into this dimension.

[0026] The size of the ceramic cavity based on the angular frequency $\omega=2\pi f$ is

$$\frac{\frac{\omega^2}{c^2}+\frac{1}{ab}}{\frac{\omega^2}{c^2}+ab\left(\frac{\omega^2}{c^2}-\frac{1}{a^2}\right)\left(\frac{\omega^2}{c^2}-\frac{1}{b^2}\right)} = \frac{\tan\left(\frac{\omega}{c}(b-a)\right)}{\omega}\frac{c}{b-a}$$

where b is inside radius of the cavity, a is the radius of an object at the center of the cavity and c is the speed of light. Using the object radius as a=0.020 meter to account for the antenna, the inside radius of the cavity is b=4.25 inches which is the size of the 8.5 inch diameter ceramic dome using ¼ inch thick clay. The frequency is then equal to

$$f = \ln\left(\frac{\omega}{2\pi}\right) = 23.45$$

which is close to the inverse of the gravitational constant G of −23.43. Thus the amplifier is tuned to the gravitational constant of the universe both in size of the cavity and the frequency of the slot antenna. Using a SMD surface mount capacitor and inductor in the picofarad and nanohenry range, it is possible to get up to this high frequency, but it was found that it was not necessary because the amplifier works at lower frequencies that are pulsed.

[0027] Referring to FIG. **10**, the swinging movement of the pendulum measured in inches at the side of the dome is plotted against a range of frequencies from 20 kHz to 120 kHz. At 20 kHz, the pendulum swings ¾ inch away from the dome. Then at 40 kHz, the pendulum swings ¾ inch toward the dome. This pattern is repeated until 120 kHz. What this means is that the amplifier can control the direction of the co-gravitational field using frequency. The tetrahedron diagram shows that this phenomenon is related to the two axes of the circumscribing sphere of the tetrahedron.

[0028] Referring to FIG. **11**, the swinging of the pendulum is plotted for a range of frequencies from 1 MHz to 5 MHz. At a frequency of 2.78 MHz the pendulum was swinging strongly from the vertical to the horizontal, a distance of six inches. On the tetrahedron diagram, the distance from our base constant to the centerline between inverted tetrahedrons is equal to 14.838168. This corresponds to a frequency of

$$f=e^{14.838168}*\text{Hz}=2.780574169 \text{ MHz}$$

which is close to the experimental value.

[0029] Referring to FIG. **12**, the Chi energy flowing between the hands, shown by the arrows, is amplified by placing the hands across the dome. This energy from the right hand mixes with the hyperspace energy entering the dome from hyperspace. The combined energy is then absorbed in the left hand vortex. The effects of this amplified energy are simply amazing and have to be experienced to appreciate what it means.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0030] FIG. **1**. Perspective view of pendulum movement over left hand vortex.

[0031] FIG. **2**. Perspective view of right hand rule of physics showing similarity between electromagnetism and gravity.

[0032] FIG. **3**. Perspective view of plaster mold cavity showing negative curvature.

[0033] FIG. **4**. Perspective view of dome showing positive curvature.

[0034] FIG. **5**. Perspective view of dome showing radial pendulum movement.

[0035] FIG. **6**. Graph of co-gravitational K field on tetrahedron diagram.

[0036] FIG. **7**. Perspective view of Chi Energy Amplifier with BNC coaxial cable.

[0037] FIG. **8**. Perspective view of slot antenna in dome.

[0038] FIG. **9**. Perspective view of slot antenna showing dimensions.

[0039] FIG. **10**. Graph of pendulum movement versus frequency of antenna, 20 KHz.

[0040] FIG. **11**. Graph of pendulum movement versus frequency from 1 MHz to 5 MHz.

[0041] FIG. **12**. Perspective view of amplifying Chi energy.

DETAILED DESCRIPTION OF THE INVENTION

[0042] The dome of the amplifier is made of red earthenware clay from Minnesota having a cone 06 kiln firing temperature of 1828° F. over a period of 7.5 hours. The clay is placed between two hardwood ¼ inch thick slats. It is then rolled flat with a rolling pin. The sheet of clay is cut in half and one half is placed in a 9-inch diameter bowl mold using a soft sponge to push it into position. The second half is then added to the first with the seam between worked flat with a metal kidney and elephant ear sponge. The top of the mold

is scrapped flat to create the bowl shape. The moist clay is left to dry for one day after which it falls out of the mold due to shrinkage. After completely drying, the dome is then placed in a kiln which runs the computer-controlled cone 06 temperature firing profile. A preheat at 180° F. for one hour is required to make sure the dome is completely bone dry. It takes 7 to 8 hours to fire the dome with another 12 hours to cool down naturally.

[0043] The base is also made of ¼ inch clay. A circular shape is cut out and fitted with a ribbon of extruded clay from a clay gun to make the cylindrical wall. Using a hole cutter made of hollow tubing, a hole is made in the side of the base for the coaxial cable. The second lower dome has a hole cut in the bottom when the clay is leather hard.

[0044] A 0.050" thick copper sheet is EDM machined to cut a half wavelength slot in the copper. The inner conductor of the coaxial cable is soldered using silver epoxy to the one side of the slot. The ground shielding of the cable is silver epoxied to the other side of the slot. The other end of the coaxial cable has a BNC connector which plugs into the frequency generator.

[0045] The pendulum is made out of soft brass rod and machined on a lathe into a plumb bob shape. A hole is drilled in the stem to hold the 6" long string.

I claim:

1. A Chi energy amplifier comprising:

a. a hollow ceramic dome in the shape of a clam shell with a hole in the lower half that provides access to a coaxial cable;

b. a cylindrical ceramic base on which the dome is mounted with holes that provide access for a coaxial cable into item (a);

c. a slot antenna soldered to the coaxial cable, located midway inside item (a), such that the inner conductor of the cable is soldered to one side of the slot and the ground shielding is soldered to the other side of the slot;

d. a frequency generator connected to the other end of the coaxial cable by means of a BNC connector for the purpose of providing an oscillating voltage to item (c);

e. an electromagnetic wave generated by items (c, d) that resonates inside item (a);

f. a co-gravitational K field generated by items (a, b, c, d, e) whose direction can be controlled by the frequency of item (d); and

g. a flow of hyperspace energy into or out of the dome due to item (f).

* * * * *

455-619 AU 233 EX
FIP8106 OR 685,958

55

No. 685,958. Patented Nov. 5, 1901.

N. TESLA.

METHOD OF UTILIZING RADIANT ENERGY.

(Application filed Mar. 21, 1901.)

(No Model.)

Electric stepping motor energized by corpuscular energy from sun

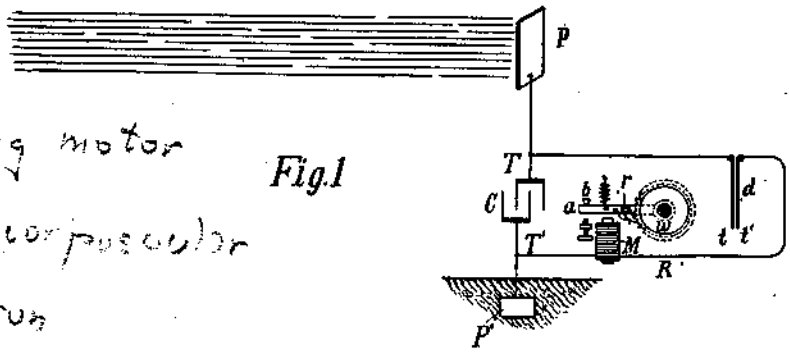

Fig.1

No rights.

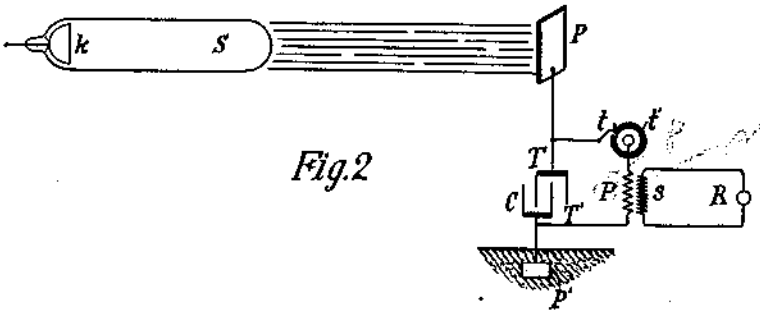

Fig.2

Witnesses:
Raphael Netter
M. Lamson Tyler

Nikola Tesla, Inventor
by Kerr, Page & Cooper Attys

UNITED STATES PATENT OFFICE.

NIKOLA TESLA, OF NEW YORK, N. Y.

METHOD OF UTILIZING RADIANT ENERGY.

SPECIFICATION forming part of Letters Patent No. 685,958, dated November 5, 1901.

Application filed March 21, 1901. Serial No. 52,154. (No model.)

To all whom it may concern:

Be it known that I, NIKOLA TESLA, a citizen of the United States, residing at the borough of Manhattan, in the city, county, and State of New York, have invented certain new and useful Improvements in Methods of Utilizing Radiant Energy, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

It is well known that certain radiations—such as those of ultra-violet light, cathodic, Roentgen rays, or the like—possess the property of charging and discharging conductors of electricity, the discharge being particularly noticeable when the conductor upon which the rays impinge is negatively electrified. These radiations are generally considered to be ether vibrations of extremely small wave lengths, and in explanation of the phenomena noted it has been assumed by some authorities that they ionize or render conducting the atmosphere through which they are propagated. My own experiments and observations, however, lead me to conclusions more in accord with the theory heretofore advanced by me that sources of such radiant energy throw off with great velocity minute particles of matter which are strongly electrified, and therefore capable of charging an electrical conductor, or even if not so may at any rate discharge an electrified conductor either by carrying off bodily its charge or otherwise.

My present application is based upon a discovery which I have made that when rays or radiations of the above kind are permitted to fall upon an insulated conducting body connected to one of the terminals of a condenser, while the other terminal of the same is made by independent means to receive or to carry away electricity, a current flows into the condenser so long as the insulated body is exposed to the rays, and under the conditions hereinafter specified an indefinite accumulation of electrical energy in the condenser takes place. This energy after a suitable time interval, during which the rays are allowed to act, may manifest itself in a powerful discharge, which may be utilized for the operation or control of mechanical or electrical devices or rendered useful in many other ways.

In applying my discovery I provide a condenser, preferably of considerable electrostatic capacity, and connect one of its terminals to an insulated metal plate or other conducting body exposed to the rays or streams of radiant matter. It is very important, particularly in view of the fact that electrical energy is generally supplied at a very slow rate to the condenser, to construct the same with the greatest care. I use by preference the best quality of mica as dielectric, taking every possible precaution in insulating the armatures, so that the instrument may withstand great electrical pressures without leaking and may leave no perceptible electrification when discharging instantaneously. In practice I have found that the best results are obtained with condensers treated in the manner described in a patent granted to me February 23, 1897, No. 577,671. Obviously the above precautions should be the more rigorously observed the slower the rate of charging and the smaller the time interval during which the energy is allowed to accumulate in the condenser. The insulated plate or conducting body should present as large a surface as practicable to the rays or streams of matter, I having ascertained that the amount of energy conveyed to it per unit of time is under otherwise identical conditions proportionate to the area exposed, or nearly so. Furthermore, the surface should be clean and preferably highly polished or amalgamated. The second terminal or armature of the condenser may be connected to one of the poles of a battery or other source of electricity or to any conducting body or object whatever of such properties or so conditioned that by its means electricity of the required sign will be supplied to the terminal. A simple way of supplying positive or negative electricity to the terminal is to connect the same either to an insulated conductor, supported at some height in the atmosphere, or to a grounded conductor, the former, as is well known, furnishing positive and the latter negative electricity. As the rays or supposed streams of matter generally convey a positive charge to the first condenser-terminal, which is connect-

ed to the plate or conductor above mentioned, I usually connect the second terminal of the condenser to the ground, this being the most convenient way of obtaining negative electricity, dispensing with the necessity of providing an artificial source. In order to utilize for any useful purpose the energy accumulated in the condenser, I furthermore connect to the terminals of the same a circuit including an instrument or apparatus which it is desired to operate and another instrument or device for alternately closing and opening the circuit. This latter may be any form of circuit-controller, with fixed or movable parts or electrodes, which may be actuated either by the stored energy or by independent means.

The rays or radiations which are to be utilized for the operation of the apparatus above described in general terms may be derived from a natural source, as the sun, or may be artificially produced by such means, for example, as an arc-lamp, a Roentgen tube, and the like, and they may be employed for a great variety of useful purposes.

My discovery will be more fully understood from the following detailed description and annexed drawings, to which reference is now made, and in which—

Figure 1 is a diagram showing typical forms of the devices or elements as arranged and connected in applying the method for the operation of a mechanical contrivance or instrument solely by the energy stored; and Fig. 2 is a diagrammatical representation of a modified arrangement suitable for special purposes, with a circuit-controller actuated by independent means.

Referring to Fig. 1, C is the condenser, P the insulated plate or conducting body, which is exposed to the rays, and P′ another plate or conductor, all being joined in series, as shown. The terminals T T′ of the condenser are also connected to a circuit including a receiver R, which is to be operated, and a circuit-controlling device *d*, which in this case is composed of two very thin conducting-plates *t t′*, placed in close proximity and very mobile, either by reason of extreme flexibility or owing to the charater of their support. To improve their action, they should be inclosed in a receptacle from which the air may be exhausted. The receiver R is shown as consisting of an electromagnet M, a movable armature *a*, a retractile spring *b*, and a ratchet-wheel *w*, provided with a spring-pawl *r*, which is pivoted to armature *a*, as illustrated. The apparatus being arranged as shown, it will be found that when the radiations of the sun or of any other source capable of producing the effects before described fall upon the plate P an accumulation of electrical energy in the condenser C will result. This phenomenon, I believe, is best explained as follows: The sun as well as other sources of radiant energy throw off minute particles of matter positively electrified, which, impinging upon the plate P, communicate an electrical charge to the same. The opposite terminal of the condenser being connected to the ground, which may be considered as a vast reservoir of negative electricity, a feeble current flows continuously into the condenser, and inasmuch as these supposed particles are of an inconceivably small radius or curvature, and consequently charged to a relatively very high potential, this charging of the condenser may continue, as I have found in practice, almost indefinitely, even to the point of rupturing the dielectric. Obviously whatever circuit-controller be employed it should operate to close the circuit in which it is included when the potential in the condenser has reached the desired magnitude. Thus in Fig. 2 when the electrical pressure at the terminals T T′ rises to a certain predetermined value the plates *t t′*, attracting each other, close the circuit connected to the terminals. This permits a flow of current which energizes the magnet M, causing it to draw down the armature *a* and impart a partial rotation to the ratchet-wheel *w*. As the current ceases the armature is retracted by the spring *b* without, however, moving the wheel *w*. With the stoppage of the current the plates *t t′* cease to be attracted and separate, thus restoring the circuit to its original condition.

Many useful applications of this method of utilizing the radiations emanating from the sun or other source and many ways of carrying out the same will at once suggest themselves from the above description. By way of illustration a modified arrangement is shown in Fig. 2, in which the source S of radiant energy is a special form of Roentgen tube devised by me having but one terminal *k*, generally of aluminium, in the form of half a sphere with a plain polished surface on the front side, from which the streams are thrown off. It may be excited by attaching it to one of the terminals of any generator of sufficiently-high electromotive force; but whatever apparatus be used it is important that the tube be exhausted to a high degree, as otherwise it might prove entirely ineffective. The working or discharge circuit connected to the terminals T T′ of the condenser includes in this case the primary *p* of a transformer and a circuit-controller comprising a fixed terminal or brush *t* and a movable terminal *t′* in the shape of a wheel with conducting and insulating segments which may be rotated at an arbitrary speed by any suitable means. In inductive relation to the primary wire or coil *p* is a secondary *s*, usually of a much greater number of turns, to the ends of which is connected a receiver R. The terminals of the condenser being connected as indicated, one to an insulated plate P and the other to a grounded plate P′, when the tube S is excited rays or streams of matter are emitted from the same, which convey a positive charge to the plate P and condenser-terminal T, while terminal T′ is continuously receiving negative electricity from the plate

P'. This, as before explained, results in an accumulation of electrical energy in the condenser, which goes on as long as the circuit including the primary p is interrupted. Whenever the circuit is closed, owing to the rotation of the terminal t', the stored energy is discharged through the primary p, this giving rise in the secondary s to induced currents which operate the receiver R.

It is clear from what has been stated above that if the terminal T' is connected to a plate supplying positive instead of negative electricity the rays should convey negative electricity to plate P. The source S may be any form of Roentgen or Lenard tube; but it is obvious from the theory of action that in order to be very effective the electrical impulses exciting it should be wholly or at least preponderatingly of one sign. If ordinary symmetrical alternating currents are employed, provision should be made for allowing the rays to fall upon the plate P only during those periods when they are productive of the desired result. Evidently if the radiations of the source be stopped or intercepted or their intensity varied in any manner, as by periodically interrupting or rythmically varying the current exciting the source, there will be corresponding changes in the action upon the receiver R, and thus signals may be transmitted and many other useful effects produced. Furthermore, it will be understood that any form of circuit-closer which will respond to or be set in operation when a predetermined amount of energy is stored in the condenser may be used in lieu of the device specifically described with reference to Fig. 1, and also that the special details of construction and arrangement of the several parts of the apparatus may be very greatly varied without departure from the invention.

Having described my invention, what I claim is—

1. The method of utilizing radiant energy, which consists in charging one of the armatures of a condenser by rays or radiations, and the other armature by independent means, and discharging the condenser through a suitable receiver, as set forth.

2. The method of utilizing radiant energy, which consists in simultaneously charging a condenser by means of rays or radiations and an independent source of electrical energy, and discharging the condenser through a suitable receiver, as set forth.

3. The method of utilizing radiant energy, which consists in charging one of the armatures of a condenser by rays or radiations, and the other by independent means, controlling the action or effect of said rays or radiations and discharging the condenser through a suitable receiver, as set forth.

4. The method of utilizing radiant energy, which consists in charging one of the armatures of a condenser by rays or radiations and the other by independent means, varying the intensity of the said rays or radiations and periodically discharging the condenser through a suitable receiver, as set forth.

5. The method of utilizing radiant energy, which consists in directing upon an elevated conductor, connected to one of the armatures of a condenser, rays or radiations capable of positively electrifying the same, carrying off electricity from the other armature by connecting the same with the ground, and discharging the accumulated energy through a suitable receiver, as set forth.

6. The method of utilizing radiant energy, which consists in charging one of the armatures of a condenser by rays or radiations, and the other by independent means, and effecting by the automatic discharge of the accumulated energy the operation or control of a suitable receiver, as set forth.

NIKOLA TESLA.

Witnesses:
M. LAWSON DYER,
RICHARD DONOVAN.

New Energy Technologies

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Editorial

Dr. Chernobrov and NET editor Olga Leontyeva.

The head of the Moscow research group "Kosmopoisk" Dr. Vadim A. Chernobrov (our readers certainly remember his articles on experiments with time) has recently visited the editorial office of New Energy Technologies in Saint-Petersburg, Russia. His visit was caused by discussion on the Time Machine project (investigation of active properties of time), started under agreement with Faraday Labs Ltd. Our magazine will inform readers on the topic in later issues.

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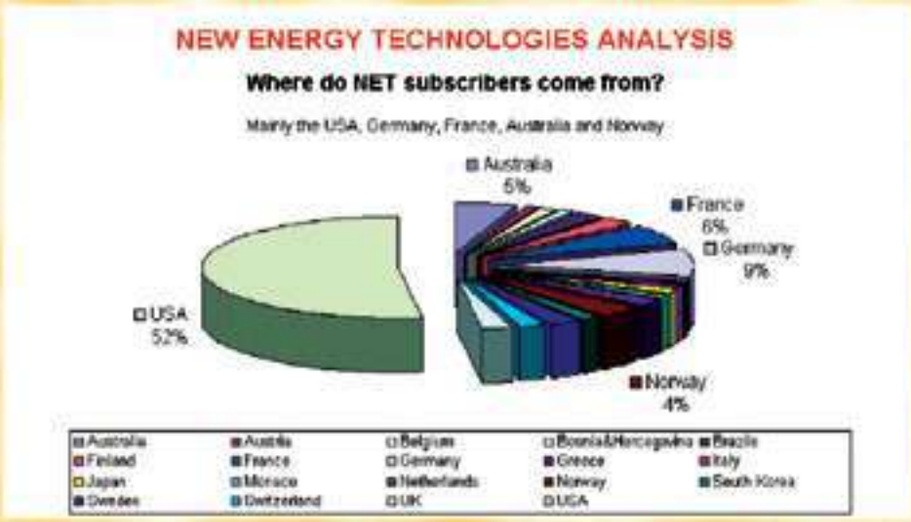

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John Christie (left) is the co-founder, CEO and chairman of Lutec (Aust.) Pty Ltd.

Ludwig (Lou) Brits (right, above) is the co-founder, managing director and head of development of Lutec (Aust.) Pty Ltd. He is Chairman and director of TTI Pty Ltd. TTI Pty Ltd is a state government recognised R.A.P. (remote area power) system provider.

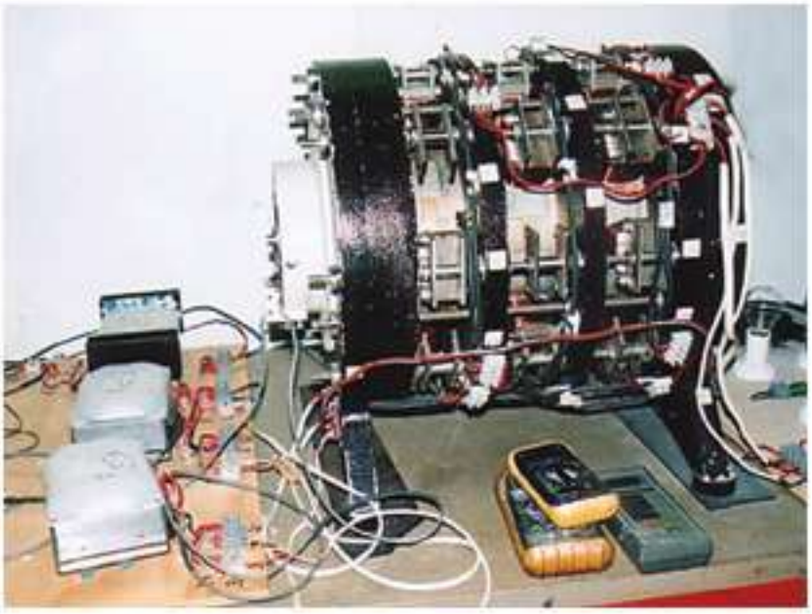

Electrogravity

by Tim Ventura
tventura@attbi.com

In this issue a report by Tim Ventura, USA on experimenting with asymmetrical capacitors.
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NEW ENERGY TECHNOLOGIES #6

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consequence of many commonly accepted concepts and dogmas of the modern "scientific perspective of natural phenomena". This crisis situation in modern physics is a direct consequence of many conservative scientific viewpoints, unfortunately supported and protected by modern official academic science. The evolution of our consciousness has been influenced by many undoubtedly well known experts and has been evolving for a long time in the environment of specific scientific vacuum and requires immediate revival. Even methods used for dissemination of new knowledge should be improved, if one actually wishes to accelerate the progress of Humankind.

The perspective for practical applications of new previously unknown scientific phenomena and effects looks very attractive, and they may be achieved by cooperative efforts of the human intellect. New breakthrough technologies of the 21st Century will require serious changes of many commonly accepted concepts and dogmas in fundamental physics. This process of progressive development cannot be stopped.

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Large-Scale Sakharov Condition

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Abstract

Recent far reaching theoretical results have used the quantum vacuum noise as a fundamental electromagnetic radiation field to derive a frequency (ω) dependent version of Newton's gravitational coupling term, $G(\omega)$. This paper reconciles the cut-off frequency with the observed cosmological constant, and then briefly puts forward a realizable laboratory test case in the 10 - 100 MHz frequency range. One analogy is drawn between the classical vacuum energy experiments with attraction between two closely spaced plates (Casimir cavity) and the arbitrarily dense material boundaries possible in Bose condensates, such as irradiation at MHz frequencies of superfluid helium or superconductors.

Theoretical Background

Zel'dovich [1] first suggested that gravitational interactions could lead to a small disturbance in the (non zero) quantum fluctuations of the vacuum and thus give rise to a finite value of Einstein's cosmological constant in agreement with astrophysical data. Using dimensional analysis and the suggestion by Zel'dovich, Sakharov [2] derived a value for Newton's gravitational constant, G, in only one free parameter, frequency, ω:

$$G \sim c^5 \Big/ h\int \omega d\omega \sim 1 \Big/ \int \omega d\omega$$

where c is the speed of light and h is the Planck constant. The free parameter in frequency when integrated over all values from zero to high frequencies must contain the usual integration cutoff value (Planck frequency on observable electromagnetic phenomenon).

Puthoff [3] and others [4 5] have extended Sakharov's condition in a relativistically consistent model to determine constants of proportionality. His model derives an acceleration term in first order expansion (in flat space time), then equates inertial and gravitational mass (by the equivalence principle) to make contact with the gravitational constant, G, directly as:

$$G = \left(\pi c^5 / h\omega_c^2\right) \sim 1/\int \omega d\omega$$

which is the Sakharov condition [2,3]. This paper revisits the meaning of the cutoff frequency, ω_c ,for radiation interactions, of which the quantum vacuum [6-10] and

Planck frequency are only the leading terms, and for which linear combinations of forces can introduce other plausible frequencies. One purpose of this reexamination is whether the resulting gravitational coupling constant, G, can be reconciled with the anticipated energy density of the universe [11] without resorting to extreme space time curvature and thus yield enough critical density to contain the expansion of the universe. Finally we particularize the case to the high-density fluctuations possible in Bose condensates [12], a potential experimental test case for how the effects of vacuum noise might manifest observably.

One far-reaching consequence of the vacuum energy model is the attractive force of gravity becomes reducible to the radiative interaction between oscillating charges, e.g. the zero point field (ZPF) applied to subatomic charges. Mass and inertia arise from the fundamentally electromagnetic ZPF oscillations.

This random background gives the usual quantum mechanical energy spectrum from particle field effects:

$$\rho(\omega)d\omega \sim \omega^3 d\omega$$

a very important dimensional relationship, since the third power in frequency avoids anomalous Doppler shifts from velocity boosts, or stated alternatively is the correct spectra for a Lorentzian (non accelerated) invariant radiation field [13].
More specifically, the energy spectrum [3] can be written as:

$$\rho(\omega)d\omega = [\omega^2/\pi^2c^3][h\omega/2]d\omega =$$
$$= h\omega^3/2\pi^2c^3 d\omega \sim \omega^3 d\omega$$

which is an expression in the first parenthesis of the density of the normal modes and in the second parenthesis of the average energy per mode. When this energy density is integrated over all frequencies, the ω^3 divergence produces well known infinities in the integration limit of high frequencies, thus an assumed cutoff frequency (appropriate to experimental observation limits at the Planck frequency), is usually introduced:

$$\omega_\rho = \left(c^5/hG\right)^{1/2}$$

For mass, m, moving in an accelerated reference frame $g = -a = Gm/r^2$, the resulting energy spectrum includes a gravitational spectral shift [3],

$$\Delta\rho'(\omega)d\omega = h\omega/2\pi^2c^5[Gm/r^2]^2 d\omega \sim 1/r^4 d\omega$$

a kind of short range ($1/r^4$) gravitational energy shift, but electromagnetic in origin when zero point fluctuations are included. (N.B. To account for equal gravitational mass effects in neutrons and protons, the ZPF oscillations must involve subatomic charges, or 'parton' effects. The assumption derives from high frequency interactions of ZPF wherein these subatomic particles are asymptotically free to oscillate as independent or free particles as quantum noise).

A further far reaching consequence [3] is mass itself becomes interpretable as a dependent quantity derived from a damped (with decay constant Γ) oscillation driven by random ZPF:

$$m = \Gamma c^3/G = 2h\Gamma/\pi^2c^3 \int \omega d\omega$$

with the only two free parameters, the damping factor Γ, and again the frequency, ω. The internal kinetic energy of the system contributes to the effective mass.

This leads to an overall average spectral density, written in terms of mass as:

$$\Delta\rho'(\omega) = m^2c^5\omega/2h\omega_c^4 r^4$$

for the electromagnetic field distribution near ($1/r^4$) to the mass, m, which in detail is half electric and half magnetic.

One additionally attractive feature is the correspondence between this derivation and the view of gravity as a dynamical scaleinvariance breaking model (e.g. symmetry breaking near the Planck mass energy [14]). A final result includes the force calculation between two ZPF radiation oscillators of the correct form yielding Newton's average force law

$$< F >= -Gm^2/r^2$$

Thus, for a Newtonian force to first order in a flat space time, Sakharov [2] could be credited for proposing gravity as not a fundamentally separate force and Puthoff [3] and co workers [4-5] applied the vacuum electromagnetic field to equate gravity to a long-range radiation force (e.g. van der Waals like force). Higher order oscillatory gravity modes vary as $\left(\sin[\omega_o/\omega_c]\right)^2$.

To first order, a weak G coupling constant, $G = \left(\pi c^5/h\omega_c^2\right)$, appears for high frequency cutoff at the Planck scale. A corollary in analogy to electromagnetic shielding by ordinary matter can be rationalized as the problem of frequency mismatch at high Planck frequencies, e.g. ZPF cannot be fundamentally shielded. In other words, frequency mismatch precludes gravity shielding by matter.

The purpose here is to revisit the only free parameter, the frequency cutoff, more in the spirit of a mass resonant frequency. The motivation for this approach

can be summarized as: 1) the generality of other complementary radiation effects without relying on ZPF alone (e.g. other isotropic, homogeneous radiation sources); 2) the weak coupling constant, G, yields a vastly smaller than observed size of the universe (e.g. too small cosmological constant) when the Planck frequency is used as a cutoff value; and (3) the particle mass, $m = \Gamma c^3/G$, can be viewed as a renormalized or 'dressed' mass with a resonant interaction potential that is frequency dependent in its coupling constant, G, and with 'bare' mass that is large, $m_o \sim \left(m_\rho^2 / m\right)$, where the experimentally unobservable, $m_\rho = \left(hc / G\right)^{1/2}$ is the Planck mass.

In particular, why this large 'bare' mass does not generate a large gravitational field is not a unique anomaly in the Sakharov derivation, since similarly large vacuum point energies are common to field theories. The important point is that the derivation $G(\omega)$ is general however to any isotropic radiation field with the Lorentz invariant energy spectra $\left[\rho(\omega) \sim \omega^3\right]$, thus the candidates for the cutoff frequency of the particular radiation source can be interpreted as a Planck scale only if the rest mass, m_o, is not composed of many terms, rather than just the ZPF leading term. Since the ZPF is akin to a van der Waals force [3 5], polarizability (in charge and mass) must be considered, but without also excluding any number of linear combinations that might have alternative cutoff frequencies, ω_c, or damping terms, Γ, 'ala particle physics interpretations for resonant masses during renormalization. In other words, once a gravitational energy spectrum, $\rho(\omega)$ is postulated that is Lorentzian invariant, many fundamental sizes (or corresponding frequency values) are smeared (or dressed) by any number of characteristic frequencies between zero and the high frequency electromagnetic (Planck) cutoff ω_ρ. Quite simply, is the expression, $\omega_c = \omega_\rho$, a requirement for all radiation sources?

Many types of particle oscillations may satisfy the general requirements of a Sakharov condition, each having a characteristic mass (and energy) as in calculating the mass of any fundamental particle at its resonant frequency (including underlying partial charges or dense bosons). This brings the calculation to a consideration of the high density fluctuations characteristic of a Bose condensate [15 19]. While the high density variation may intrinsically be of interest, the exploration has more to do with reconciling the ZPF interpretation of the Sakharov condition with the observed cosmological constant [14].

A "top down" view of calculating the cutoff frequency imposes the self consistency test for the cosmological constant, Λ, from the outset. To calculate, the total frequency integrated energy density of the universe must be included:

$$\rho(E) = \int \rho(E) dE = h\omega_c^4 / 8\pi^2 c^3$$

which must have a mass equivalent, contribute to the universe's curvature, and thus have a fundamental relation to the critical density to contain the expansion of the universe [14 15]. The mass - equivalent ZPF to reach the universe's critical density [15], $\rho \sim 10^{-29}$ g cm^{-3} would necessarily limit the cutoff frequency for gravity to the value, $\omega_c < 7 \cdot 10^7 s^{-1}$, or between 10 -100 MHz.

A higher frequency greatly overshoots the cosmological constant, Λ, and induces extreme curvature in the universe. This problem has been cited frequently and stated most bluntly, as either ZPF or the cosmological constant requires revision. The relevance here arises from similarly large positive coupling terms in quantum gravity [15], which also generate a local gravitational Instability for typical upper limits on the cosmological constant, $\Lambda/8\pi G < 10^{12}$ cm^{-4}.

Rather than to dwell on the inconsistencies that plague attempts to reconcile quantum gravity, we particularize the problem to a case where the restriction to Planck scale becomes less clew, namely the high density fluctuations and universal scaling introduced in a Bose condensate. A Bose condensate, such as superfluid helium or superconductors [15 19], becomes of potential interest, mainly because of its arbitrarily dense boundaries and the classic Casimir experiment [20 22] which allows such dense material boundaries (two closely spaced conducting plates), if available, to modulate the background quantum fluctuation of ZPF. In other words, the matter-ZPF interaction becomes measurable by the observed attraction between two material boundaries. What dense boundaries might generate in Bose condensates remains a subject of great interest.

The significant case to investigate is whether Casimir-like interactions [20 22] will not only couple to ZPF radiation at a scale comparable to the quantum noise (or other radiation field), but also alter the value imposed by the Sakharov condition for G. It remains an open question whether this potential coupling interaction shares, as in ordinary critical phenomenon, the density correlation function, Φ, that is both independent of the coupling strength (or universal in renormalization) and consistent with the observed average energy density of the visible universe.

Thus the purpose here has bow to restate the Sakharov condition in the gravitational coupling constant, G, based on its only free parameter, a frequency cutoff, ω_c. Any potential relevance arises from similarly large values for the positive coupling term in quantum gravity, which generate conditions for a local gravitational instability for typical upper limits on the constant, $\Lambda/8\pi G < 10^{12}$ cm^{-4}.

To restate the Sakharov condition, matter in the vacuum provides boundaries for reduced 'Casimir like' modes available for otherwise isotropic radiation from quantum fluctuations (broad spectral noise). That this view reproduces Einstein gravity has been examined, including the full relativistic derivation [4-5]. The details of the appropriate mass, however, remain buried in the kinetic energy of general internal particle ('parton') motion [3]. Any appeal to a specific parton representation is limited only by essentially free particles with high frequency interactions, including underlying partial charges or dense bosons. The basis of considering arbitrarily high-density fluctuations in Bose condensate in analogy to the ZPF-Casimir experiment remains both an empirical and theoretical case to examine. There exist laboratory scale cases [15-19] where resonant radiation in the required 10-100 MHz range appear to produce anomalous effect for such Bose condensates as superconductors, but further work to confirm these results would be needed. In other contexts, these effects have been discussed as the Schiff-Barnhill effect for superconductors interacting with a gravitational field [23], but for the static rest moss rather than an effective mass in a conduction band.

Experimental Propositions

J. Weber [24,25] proposed the use of a superconducting Bose condensate for gravity wave detection, principally because of its potentially higher signal to noise ratio in carrying electrical signals upon length dilations in a relativistic framework for gravity waves travelling near the speed of light. W. Weber and Hickman [26] derived an experimentally testable relation based on torquing of a charged capacitor parallel to a gravity field, with

$$\tau = 2E_g / \pi[\alpha / (1-\alpha)^{1/2}]$$

where the capacitor will rotate relative to the gravity vector, for $\alpha = 2GM / rc^2$, is Schwarzschild radial coordinate [$dR = dr(1-\alpha)^{1/2}$] , E_g is dependent on the capacitor charge and geometry of the plates, $E_g = [Q^2 d/2\varepsilon WL(1-\alpha)^{1/2}]$, for a plate separation, and radial dimensions,W and L, charge Q, and ε the permittivity of free space. For plate separations of 2 mm on Earth, the maximum torque is approximately $\tau = 10^{-12}$ Nm, when charged to 2/3 dielectric breakdown. While not entirely promising for detection of such low torques, the large separation (2 mm) distance between capacitative plates naturally prompts generalization to the classic Casimir force [21] experiments only recently confirmed experimentally [20]. In particular, we rewrite the torque values to include the frequency terms derived with the Sakharov condition

$$[G = (\pi c^5 / h\omega_c^2)]:$$

$$\alpha = 2M\pi c^3 / h\omega_c^2 r$$

The appeal of this formulation is that a frequency dependent torque is derived, which further makes contact with proposals to modulate the Casimir capacitative plates for continuous extraction of energy [27]. This result requires further investigation experimentally, particularly to compare with previous reports for anomalies in AC- tuned electrical capacitors [28].

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The Problem of Electron and Physical Properties of Time:

To the Electron Technologies of the 21st Century

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"...it is necessary to periodically subject to the deepest revision the principles, which were recognized as final and were no longer discussed".
Louis de Broglie

Abstract

The results of an approach based on the synthesis of standard quantum electrodynamics and of the ideas of self-organization in physical systems are briefly outlined. The quantum model of electron as an open self-organizing system is constructed, with the physical mechanism of self-organization consisting in the back influence of the own field created by electron on the same electron. The own field is considered as a physical property of electron, intrinsically inherent in electrically charged matter, which is included in the definition of the particle from the very beginning. The own field of electron endows the particle with wave properties and represents a bearer of superluminal signals, which can be used for the creation of qualitatively new communication systems. Because of the inseparable link between space and time, the force in relativistic mechanics is the cause of change not only of the velocity of particle, but also of the course of time along the particle's trajectory. For this reason the flow of time in some area of space depends on the character of physical processes, occurring in it, and, therefore, time can be controlled by slowing down or accelerating its course with the help of material processes. The conclusions of the paper are not in conflict with the special theory of relativity (STR); they are a direct consequence of relativistic equations of motion and represent an essential development of the generally accepted notions about space and time. At present all the necessary prerequisites are available, both theoretical and technical, for the practical mastering of the own fields of particles and of the physical properties of time.

1. Introduction. The Problem of Electron and Future Outlook

Electrodynamics, what is this? What is its value for man? Electrodynamics is the theory of electromagnetic interaction, one of four interactions existing in nature. Its role in the life of society is seen from the fact that the most part of natural phenomena, which we encounter at every step, is of electromagnetic origin: it is due to the interaction of electromagnetic field with electrically charged particles entering into atoms and molecules. It is fair to say that electromagnetism plays a crucial role in the life of mankind as it determines the ways of technical advance of society [1].

The key problem of quantum electrodynamics is the problem of electron, which can be formulated as follows: to construct from the first principles a non-contradictory model of electron, which takes into account experimental facts, i.e. to find the dynamical equation capable of describing the unique physical properties of electron, its internal structure, its behaviour when it interacts with electromagnetic field.

Electron was discovered a little more than 100 years ago, in 1897. With discovering the electron the revolution in physics began, which has resulted in unprecedented technical advance of society. The summit of development was reached in the middle of the 1950s and then the long period of evolutional development followed, when new physical principles were used to describe various physical processes and phenomena. The violent development of physics became slower in the 1970s and was replaced by stagnation in the subsequent years. The stagnation in electrodynamics continuing already over a period of several decades is gradually giving place now to a new ascent. The new scientific revolution is starting, which is associated with electron again, much as it happened hundred years ago. The reason is that electron is the most unique particle storing in itself the deepest mysteries of nature and the degree, to which they are disclosed, determines the

wants to stay anonymous, until his patent application is done and university verification tests will be done). The claims are: 1200 Watts coil out with about 1076.4 Watts in into the driving motor at 3450 RPM. 8 amps 117volts at no load 9.2 amps 117 volts at full load. The output of about 1200 Watts is already a total overunity operation! As they just increase the input power by about 140 Watts only between idle and load state and they get 1200-Watts output it seems indeed a case, where Lenz law is violated! This generator also has NO motor effect! If you supply current to the coil, the permanent magnet in the center will not rotate; cause the flux just stays inside the toroid core! There you can see, that the back drag does not influence the mechanical rotation of the magnet!" Stefan used very good criterion to prove high efficiency of the design: **There is no back-torque effect! It is most important aspect of Gramm's generator.** You can contact directly Stefan Hartmann: Keplerstr. 11 B, 10589 Berlin, Germany. Tel: +49 30 345 00 497, FAX: +49 30 345 00 498 email: harti@harti.com info@ccard.net (Please, note: Dr. Harman referred to my old web site www.time-machine.spb.ru which is closed now).

So, basic principles of MEG and Φ-machines are the same. It was patented more than 100 years ago. Primary magnetic flux is topologically separated in two (or more) fluxes, which are mutually compensated in the ring core. Advantages of MEG are absence of moving parts since special input coils produce changes of primary flux. Also level of saturation in ferromagnetic material obviously should be corresponding to intensity of primary magnetic field, which is created by the permanent magnet, Fig.4.1.

Besides MEG the same principle can be (and already was!) realized in many other systems. So, there is no any news in the USA patent #6,362,718 granted for "The Motionless Magnetic Generator". What did they claim? You can find it in the patent: "The first input coil and the first output coil **extend around portions of the first**

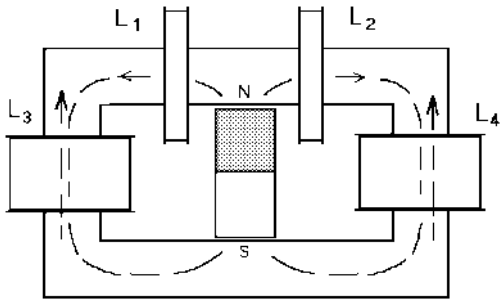

Fig.4.1

magnetic path, while the second input coil and the second output coil **extend around portions of the second magnetic path.**" Yes, it is the same bi-directional principle we discussed above: two parts of the magnetic flux and each coil produce effect to reduce flux due to this superposition.

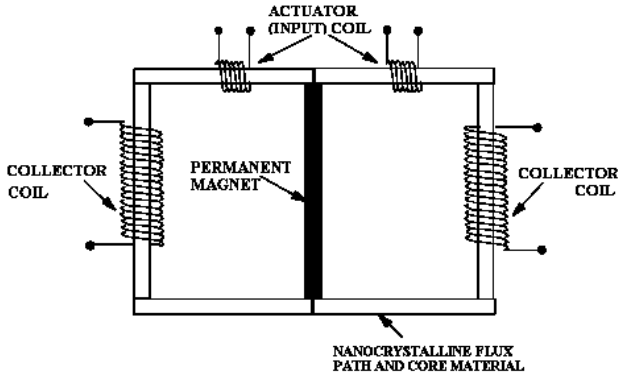

Fig.4.2
Diagram of prototype by Bearden.

In conclusion I'd like to confirm our sincere interest to develop joint work with all new energy research teams if they are not trying to obscure the issue of the technology by means of complex theoretical constructions and common words about zero point energy.

Matter as a Resonance Longitudinal Wave Process

Alexander V. Frolov

Abstracts

There is experimental data on gravitation anomalies for cases of resonance irradiation of the Bose condensates (superfluid helium or superconductor) at 10-100 MHz frequencies. It is developed by the author in frames of his aether theory that can be used for practical applications in aerospace and new energetics.

ZPF or aether fluctuations

The fundamental electromagnetic radiation field (Zero Point Field) ZPF or the quantum vacuum noise is a recently accepted physical notion. In the article [1] David Noever and Christopher Bremner used it to derive a frequency – dependent version of Newton's gravitational coupling term G. On the other hand we can consider the quantum vacuum noise as aether fluctuations. Dr. Alexander Mishin [2] described experiments on registration of these processes by means of special equipment. Both approaches (ZPF and aether fluctuation) allow to conclude that mass and inertia arise from these oscillations. However if we are considering the oscillation as some aether process then we can assume and describe some physical mechanism of this process.

One of consequence of the vacuum energy model, which is described in [1] is that "the attractive force of gravity becomes reducible to the radiative interaction between oscillating charges..." Let's clarify which kind of radiation can be created by oscillating electric charges.

There are many different sources to find the answer on this question and one of them is the article by Prof. Kirill P.Butusov [3] on symmetrization of Maxwell's equations and practical methods of generation of longitudinal waves in vacuum. So, ZPF model has a direct relation with the aether model since indirectly it leads to the question of longitudinal waves in vacuum. Physically they are waves of density of energy and in the aether model the waves are areas of more dense and more rarefied aether. Let's note that there are standing waves besides moving waves.

To consider the interaction of some mass particles and the fundamental field the notion of subatomic charges "partons" was introduced [1]. So, the mass itself "becomes interpretable as a dependent quantity derived from a damped oscillation driven by random ZPF" [1]. The authors wrote about "internal kinetic energy" of the mass particle and it can be considered as a function of ZPF oscillation frequency. In the aether theory of mass there is a similar notion of "aether vortex", which represents some cyclical process of some frequency and it is possible to calculate its kinetic energy. This aether vortex model of matter elements allows to assume real methods to change parameters of vortex and to get changes in parameters of existence of the matter. On the other hand we can discuss the possibility to change some physical parameters of aether in areas of the vortex to get the same result. This possibility follows from the well-known N.Kozyrev's experiments, which were named "investigation of active properties of time". N.Kozyrev used chronal (temporal) approach in his theory. We have to change his notion "the density of time" to "the density of aether" to get a direct link between his experiments and the aether theory of mass.

N.Kozyrev and others have [4,5,6] experimentally demonstrated that irreversible processes in matter produced changes of aether density in the area of the experiment. Detectors of different type can register this change. It is obviously that any matter element (i.e. the aether vortex) in this area of changed aether density should get more inner (kinetic) energy or slow the inner motion. From the chronal point of view these are changes of inner time of this matter element.

Gravity shield

One more interesting point that is discussed in the article by Noever and Bremner [1] is a problem of gravity shield. The authors show that resonance interaction with ZPF produces "the particle mass" and it can be viewed as "a renormalized or "dressed" mass with a resonant interaction potential. Similar resonance approach is used in the conception of de Broglie's matter waves. Also the authors [1] mentioned the existence of an experimentally unobservable mass. In this case ZPF cannot be fundamentally shielded by matter since "frequency mismatch precludes gravity shielding by matter" [1]. The only way to get screening of ZPF fluctuations seems to be very complex: it is necessary to provide frequency matching for whole wavelength band of the oscillations.

I think some specialization is necessary here to explain experimental gravity anomalies with Bose condensates experiments (superfluid helium or superconductors): **special process in matter can be used as the gravity screen and this approach does not involve the frequency-matching problem.**

We have concluded above that any matter element is a resonance process and its energy is derived from ZPF. It is useful to note that these are longitudinal wave oscillations of energy density in aether. In this case, the gravity shield problem can be solved in frames of the aether vortex conception of matter.

The longitudinal wave is a moving (or standing) areas of rarified and thickened aether. Let's consider the moving wave, which is responsible for gravitation attraction effect. How can we stop, re-direct or reflect longitudinal wave in aether by means of aether vortexes (matter elements)? **We can produce interaction with this wave only by means of other longitudinal waves.**

In macro-level this idea can be realized as longitudinal wave generator. Electromagnetic processes, which can be used as sources of directed longitudinal waves, are known and some of them are described in [3]. In other way the gravity shield can be produced as longitudinal waves generated by natural aether vortexes (i.e. by matter elements) if the matter exist in a special exited state, for example for cases of resonance irradiation of superfluid helium or superconductor at 10-100 MHz frequencies.

Matter element as resonance process

In [1] the authors wrote that it is possible to calculate "the mass of any fundamental particle at its resonant frequency." There is the question: what is the general basis of whole spectrum of stable elements masses?

In 1996 the author published the article "The concept of mass process" [7]. At first in this work physical sense and notion of 3-dimensional curvature was introduced. By analogy with known mathematical notion of linear curvature $\rho_1 = \frac{1}{r}$ (where r is radius) and uniform surface curvature $\rho_2 = \frac{2}{r}$ it was proposed to calculate curvature of a 3-dimensional space as

$$\rho_3 = \frac{3}{r} \qquad (1)$$

The radius r in this case means that in a 3-space there is some periodical process. In other words, 3-dimensional matter is a resonance process.

Further, de Broglie used formulations E=hf and E=pc (where p is momentum, h is Planck constant, f is frequency and c is velocity of light) to derive the following:

$$hf=pc \qquad (2)$$

that allows us to get the well-known formulation

$$\lambda = \frac{h}{p} \qquad (3)$$

There is another logical branch of this idea that leads to the understanding of the mass properties of matter as a resonance process. Instead of E=pc in [7] it was proposed to use $E=mc^2$. In strength of the wave-particle duality we can write the equation

$$mc^2 = hf \qquad (4)$$

and from this equation the mass can be presented as resonance electromagnetic oscillations

$$m = \frac{h}{c^2} f \qquad (5)$$

Let's note that f=1/T, where T is some period of oscillation. So, we can write the following

$$m = \frac{h}{c^2}\frac{1}{T} \qquad (6)$$

where $\frac{h}{c^2}$ is new constant between mass and period of time.

There is an important conclusion: any mass is a process and there is some period of time, which corresponds to this mass. In other words, there is no physical sense of time separate from some process of existence of mass. Product mass and period is a constant value, which was named as a chronal constant

$$mT = \frac{h}{c^2} = const \qquad (7)$$

The chronal constant is a parameter of some real space and it is equal to $0.73725 \cdot 10^{-50} [Js^2 / m^2]$

Also in this work [7] there was a demonstration of several examples of newly discovered physical law: spatial curvature of some natural objects (proton, planet, DNA molecule) is a whole number. There is some analogy with the nuclear physics notion of wave number. From this fact we can assume that main natural matter elements exist in main resonance states. For example, if Bohr radius is 0.52917 Angstrom, then we can find the wave-length $l = \pi d$ and the linear curvature is $\rho = 1/l = 3.0075 \cdot 10^9$ (m) and 3-dimensional curvature of this object is $\rho = 3/l = 1.0025 \cdot 10^9$ (m) that is unit of mater, corresponding to simplest atom, i.e. unit matter engine. Let's note that it is near the unit and some distortion of 0.0025 means non-ideal resonance state of the system.

Calculations for planet Earth in [7] were based on the known period of orbital rotation T=31557600 sec that corresponds to frequency of electromagnetic oscillations

$$f = 1/T = 3.168861 \cdot 10^{-8} (1/s) \qquad (8)$$

and wave-length

$$\lambda = c / f = 9.46... \cdot 10^{16} (m) \qquad (9)$$

The curvature (if this wave-length is considered as radius of the resonator) is following wave number

$$\rho = 1057.00 \cdot 10^{-20} (1/m) \qquad (10)$$

Also we can use other known data about the planet. Daily rotation period of our planet is known T=86400 sec and we can calculate its wavelength $\lambda = 3469{,}82(m)$ and corresponding curvature (wave-number). Sure, it is also a whole number with a good accuracy:

$$\rho = 2882 \cdot 10^{-7} (1/m) \qquad (11)$$

The laws of physics in macro cosmos and micro cosmos are similar. From these calculations it was assumed that whole formation of mass spectrum of stable chemical elements of matter is determined by similar physical mechanism.

Creation of mass

In short we can summarize that technology of longitudinal waves in aether is a real basis for creation of matter with mass and inertia properties. N. Tesla used this method to produce different objects: from ball lightning up to electrons. Velimir Abramovic says in his article [8]: "The principle of resonance and harmonic oscillation of aether seems to be so clear that all problems of modern physics, especially a problem of energy conversion, will be solved with its development. By means of his vacuum tube Tesla got protons, electrons and neutrons directly from aether and reproduced them at any distance. Instead of giving a possibility to the bundle of protons to move through space to some place, he created conditions for momentary appearance of arbitrary quantity of particles in the given place."

Any objects can be classified as aether vortex and parameters of this vortex determine its mass, electric charge and other properties of matter.

The "parton" as element of matter in [1] is a useful tool for description of physical properties of aether.

Longitudinal waves in Woodward's experiment

In [1] the authors state that resonant radiation in the required 10-100 MHz range appears to produce

anomalous effects for such Bose condensates as superconductors. In my opinion it is a particular case of discussed above technology of longitudinal waves in aether due to possibility of transformation of transverse electromagnetic waves in longitudinal waves in the superconductors. This transformation in plasma is a well known physical mechanism.

More facts to prove this idea: by Woodward [9] there is a special requirement, i.e. the frequency of mechanical vibrations should be twice the frequency of electrical oscillations in the capacitor, which demonstrates the weight anomalies. But from the other hand it is a common rule for creation of longitudinal weaves in plasma! Also it is a necessary condition for generation of parametrical oscillations! So, we can assume that basis of the effects in [1] and [9] is a generation of longitudinal wave in aether.

Conclusion

Any element of matter can be considered as resonance process of aether oscillations, which are longitudinal waves. There is an analogy with description of these longitudinal waves and well-known matter waves by de Broighl. Experimenting on the longitudinal waves generation and especially experiments on standing waves to get gradient of aether pressure allows to develop gravity control technology.

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Gerlovin's Theory of Activation

Alexander V. Frolov

It is a review of the famous book by Ilia L. Gerlovin "Basis of unified theory of all interactions in matter"published in 1990, St.Petersburg, Russia. We hope this article let you discover some new aspects of physical vacuum structure to develop more new experimental methods. Comments made by Alexander V. Frolov, Editor.

In [1] the author wrote about different methods to activate water solutions: mechanical, thermal, acoustic, magnetic and electrical. One of the known methods is an activation by means of electrohydraulic method. There is also some information about activation of other mediums, mainly liquids, but also some gases and solid bodies.

There are no theoretical explanations of these facts to explain all aspects of these phenomena. Furthermore, complexity of interpretation of these phenomena in frames of common physical notions induced some scientists to announce these phenomena as non-existing and "illegal".

Ilia L. Gerlovin formulated the physical principles of theory of activation of mediums on the basis of new physical theory, the Theory of Fundamental Field (TFF). These principles are based on his two important conclusions from the TFF:

a) "Space around us is not empty, physical vacuum consists of material physical objects, i.e. elementary particles of vacuum (EPV). These particles are responsible for main activation processes;
b) Force interactions between atoms in molecule, between molecules in crystals has not spherical symmetry in the crystals of solid bodies, but an axial symmetry and the interactions are changing in time with very high frequency of about 10^{18} Hz. This feature of force interactions also makes its own contribution to the activation of mediums." [1, p. 314]

So, it was assumed that the phenomenon of activation of mediums can be defined as anisotropy of force interactions, which leads to **"meta-stable state, which can be called *structurally activated state of the given structure".***

Here is some difference in principle between chemical term "activation", which characterizes a transformation of molecule or atom in some active state with an increased energy, which is sufficient to provide a chemical reaction. It is ***energy activation*. Gerlovin described new notion, a *structural activation:* "This phenomenon can be classified as some change of structure of activation object. With this, energy of molecule can have no changes, and *active properties***

Coupled with aetherodynamics time conception, which was suggested by Alexander V. Frolov, the works on the control of space-time parameters gain the possibility for development and commercial application. As a theoretical basis there are those N. Kozyrev works where his conception of "time density" are replaced by that of "aether density" according to Frolov.

In September 2002, Faraday Labs Ltd Company plans to complete testing of the first experimental system, and to start the patenting and research of applied aspects, first of all in medicine.

Physical Principles of the Time Machine

Alexander V. Frolov

Experimental success of research team headed by Dr. Vadim A. Chernobrov, Moscow was reported in [1]. The time course can be controlled as rate of any process in local space-time (inner space of the Time Machine). It can be decelerated or accelerated by means of special "converging electromagnetic waves". Ordinary waves move from the source whereas special "converging waves" move to some central point, i.e. into the focus of the system. In Chernobrov's design of the Time Machine this process is organized by means of several spherical envelops, which consist of several electromagnets. Electronic control unit controls the processes in this design. Dr. Chernobrov reported about 3% change of the time course in 4th version of the system, which was tested with a human inside. The goal of Dr. Chernobrov's work is to research the medical aspects and experimental investigation of the principles. Several important conclusions were obtained from the project: the time course can be controlled and character of the changes is different for acceleration and deceleration mode.

Other known publication and research projects on the same topic seem to be very far from any commercial and practically useful application. Obviously the topic is very new and fantastic for most of scientific community and at first we have to clarify the physical principles of the time control project, which is started by Faraday Labs Ltd.

In this project we believe that notion of time is one of possible description of real physical properties of our Universe. So, it is not mathematical abstraction but some aspect of physical reality and we can discover some physical properties of time. Russian astrophysicist N. A. Kozyrev [2] developed a theory of active properties of time and according to his point of view there are two properties: time course and time density. Prof. Kozyrev demonstrated experimentally that time density in area of some process (changes of matter) is dependent on entropy parameters of the processes. In [3] it was demonstrated that Kozyrev's experiments could be interpreted in aether theory and it has led to simple physical conclusions and clear experimental perspectives: **time course and its density can be explained and controlled as parameters of aether.** Directions of aether flow and density of aether are subjects of experimenting with non-reversible changes in matter, for example, in crystallization or melting processes. Also it is possible to use special electromagnetic processes, for example, Chernobrov's "converging waves" or other longitudinal waves as methods of aether compression or rarefaction. If we assume that process of existence of elements of matter physically can be explained as aether vortex processes then its rate is a parameter of **aether income/outcome balance** (aether inflow in element of matter and aether outflow from the element of matter). It was also described in Time Rate Control (TRC) theory [3]. To control this balance it is necessary to develop technology of longitudinal waves generation, its focusing and resonance effects. The previous research and experimenting on the topic has been made by N. Tesla.

Let's assume that we have some technology to change parameters of time course. How should we organize this local space-time (what is spatial topology of the design)? There is a very interesting experiment to get the answer: rotation of a heavy cone (for example, lead cone) entrains surrounding aether, so a vortex appears, which is a toroidal formation of aether (rings). The rings can exist in space for a long period. The further question is: Why does the beam of light (laser beam) directed to the cone by tangent create a luminous ring? We can assume that due to natural properties of photons (light propagates along the geodesic line in space) some autonomous closed toroidal space should be created in such experiment. The next thought is: since space and any matter exist in time then we can speak about some autonomous time. The general conclusion is to be the following: autonomous 4-dimensional space-time can be created as toroidal aether vortex.

Here is point to note some aspects of research project by Prof. Robert Mallett, Connecticut University, USA. In fact, sometime next year, he hopes to produce the first piece of technology that eventually will allow him to build a time machine. By Mallett it will be a device that employs lasers "to twist space". Why is he going to close the beam of light? His theoretical background is knowledge about black holes, i.e. understanding of the connection between gravity and curvature of space-time. In Einstein's theory both matter and energy can bend space and time. So Prof. Mallett assumes that curvature of space-time can be changed not only by mass (like a black hole) but it can be affected by energy of photons. This has led Prof. Mallett to consider the possibility of using a circulating beam of light to twist space and to create closed loops in time. It is predicted that a spinning neutral particle, when placed in the ring, is dragged around by the resulting gravitational field [4]. From the

first view it is the same approach we have considered above (experiment with aether toroidal rings). But proposals by Prof. Mallett differ in principle from the aether conception.

The main aspect of this technology is a creation of autonomous (self-closed) toroidal space-time. Autonomous geodesic world line of this space-time is self-closed. Any photon should be circulating in this system due to its properties: photon is always moving along the straight line of the space.

More deep understanding of this technology follows from the explanation of photon as oscillation of aether. Any photon can be considered as result of relative motion of the matter (observer) in absolute space (immovable aether). Usually a photon is considered as moving object in space. But we can assume that observer is in the motion and the photon is oscillations of the absolute space (immovable aether). Which approach is more real one? Sure, it is more easy to consider a photon as moving object but let's remember fact of our real motion in the Universe and fact of the Universe expansion.

So, ideas by Prof. Mallett are very far from the **aether nature of the time phenomenon.** He follows the black holes theory and general understanding of space-time distortion due to mass or energy presence. Also he knows that a light beam should be closed in a ring. However Prof. Mallett is very far from physical basis of the effects. **The key of time rate control is technology of artificial aether flow, creation of aether vortex systems (AVS), management on density and direction of aether flow.** There are several technical methods to produce it. Any light beam should be curved in self-closed "light ring" if it is placed in a toroidal aether vortex and we can say that this system has own space-time.

What does "some changes of time course" mean? We can measure it as some changes of standard rate of oscillation process, for example, some stable wavelength of laser beam or quartz oscillations. There is a well-known experiment with two atomic clocks (one of the clocks is placed on the roof of some building and another one is placed on surface of planet). Due to vertical component of gravity the time course should be different and it can be measured. How can we organize difference in these measurements if both atomic clocks are placed in the same altitude?

It is necessary to consider gravity nature in frames of the aether conception. Two atomic clocks demonstrate difference in measurements due to difference in aether flow density. Hence, by means of aetherodynamics methods it is possible to control the rate of oscillation processes in the atomic clocks and in any matter (i.e. time course itself).

The aetherodynamics methods have a clear analogy with electrodynamics: **motion of charge produce field and there is the induction law**. Really, classical electrodynamics can be considered as particular case of the aetherodynamics. So, physical sense of any field is stress or deformation (it is some static field) or oscillations of aether.

Let's introduce the notion of chronal (temporal) charge to consider some technical aspects. In electrodynamics we assume an electric charge as element of matter with positive or negative electric properties and we have to compare it with some reference (zero charge or test charge). Let's note that in any case we have to consider "charge of some particle" but not an "abstract charge". So, we can postulate that any element of matter has **zero chronal charge** if it is moving from Past in Future with standard (usual for measurements of surface of our planet) time course. If the time course (i.e. existence of some element of matter) is decelerated then it can be measured as decrease of standard oscillation frequency of the matter. Time course acceleration means some increase of standard oscillation frequency of the matter. Let's determine that in the first case it is negative chronal charge and in the second case it is some positive chronal charge. Atomic clock is one of possible methods to measure zero chronal charge or to find some relative positive or negative difference.

It is predicted here that motion of chronal charge should produce a chronal field. Some provisional data was received by Frolov from simple experiments on the rotation of a heat source. Accelerated motion of chronal charge (changes of density of chronal current) should produce aethero-induction effect that is an analogy (or more general case) of Faraday's induction effect. This effect can be detected as secondary (induced) deceleration of time course in nearest area of accelerated time matter. Another case is a secondary (induced) acceleration of time course in the nearest area of decelerated time matter.

Technical realization of aethero-induction method seems to be very close to idea, which is described in classical epic "Back to the Future". At first, it is necessary to create or to collect some chronal charge in a "flux condenser" and then to accelerate it in space up to some velocity. According to the aether conception, this creation of the chronal charge is a real technical process.

It is assumed that estimated chronal effects are demonstrated as some threshold field, i.e. space-time has some stable discrete energy levels and changes of its curvature should have discrete threshold mode. All new aspects disclosed in this paper are the subject of a patent process. Faraday Labs Ltd organizes experimental program on the topic. Practical application of this technology is new energy systems and propulsion methods.

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investigated completely yet. It was found also that harmful effect on biological systems is not related to the process of movement in Time itself but is a result of the difference of the Time rate value in various parts of a body (a biological system).

Inside of the laboratory setup it was also discovered that Time could be changed with some inertia. Areas of space having different Time rates have vague borders. With sufficient difference in Time rate the human can see an area with a different Time rate as some white mist. Higher the difference – the mist is denser, that can be used as an alarm signal for biological systems. It is possible to consider Time-travel as possible and (after experiments with mice) there are reasons to suppose it will be safe for travelers if they follow certain rules. It is especially necessary to emphasize: the trips through Time (due to new discovered properties of Time) can't affect the Past and they can't change our past history. All the so-called paradoxes for the traveler in Time (for example when "he meets himself in the Past" or "he kills his grandfather in his childhood" have clear solutions in 3-dimensional Time.

It is possible to consider as a proven fact that Time has more than one dimension, i.e. O. Bartini's theoretical calculations are confirmed by these experiments: Time has 3 dimensions. Hence our Earth world can be considered as a 6-dimensional object: length, width, height, age or date of Time, variant of a History or erosion of Time, density or rate of Time. The concept of "the Arrow of Time" as fourth dimension (moment of Time) is a particular case of the concept of sixth dimension (rate of Time) that leads to the physical concepts of gravitation and energy and they are simultaneously connected. Concepts of the " Einstein-Rosen bridges" known since 1916 or "worm-holes"

introduced into science by John Willer in the 50's, are travels in 5th and 6th dimensions, i.e. the "classical" Time travels, which were described by H. Wells.

Editor's: As the reader could note, the author does not disclosure the secrets of the TM design. From the photo you can see the electromagnets, which form the regular stereometrical construction as well as the cables from the TM to the control unit. Dr. Chernobrov mentioned the converging electromagnetic waves only. So, to understand how it works, it is necessary to get a clear notion of the converging electromagnetic waves. Let's imagine the ripple effect created by a stone in the water. The waves move from a central point to periphery. The converging waves are just an opposite process: the waves move from periphery to the central point. Is it possible in Nature? Yes, sure. Dr. Chernobrov wrote: "Let's throw a hoop on the water and inside of the hoop we'll see converging waves." The Time Machine technology by Dr. Chernobrov is based on the similar principle.

Time Machine Project

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Faraday Labs Ltd and Dr. Vadim Chernobrov have signed the agreement on scientific-research work on investigation of active properties of time.

In the course of the previous experimental works, carried out by Dr. Chernobrov's research team during the period from 1984-2002, four versions of Time Machine had been made and tested. At these devices (the biggest system is about 1 meter in diameter) the effects of deceleration and acceleration of time course were created and measured. The principles of control of time course velocity were based on the

Alexander V. Frolov, General Director Faraday Labs Ltd and Ph. Dr. Vadim A. Chernobrov have just signed the Contract

interconnection of electromagnetic processes and physical properties of space-time. Special electromagnets, operating in pulse mode, are placed at the spherical frame. They create the so-called "converging wave", which by Alexander Frolov is a longitudinal wave in nature.

Coupled with aetherodynamics time conception, which was suggested by Alexander V. Frolov, the works on the control of space-time parameters gain the possibility for development and commercial application. As a theoretical basis there are those N. Kozyrev works where his conception of "time density" are replaced by that of "aether density" according to Frolov.

In September 2002, Faraday Labs Ltd Company plans to complete testing of the first experimental system, and to start the patenting and research of applied aspects, first of all in medicine.

Physical Principles of the Time Machine

Alexander V. Frolov

Experimental success of research team headed by Dr. Vadim A. Chernobrov, Moscow was reported in [1]. The time course can be controlled as rate of any process in local space-time (inner space of the Time Machine). It can be decelerated or accelerated by means of special "converging electromagnetic waves". Ordinary waves move from the source whereas special "converging waves" move to some central point, i.e. into the focus of the system. In Chernobrov's design of the Time Machine this process is organized by means of several spherical envelops, which consist of several electromagnets. Electronic control unit controls the processes in this design. Dr. Chernobrov reported about 3% change of the time course in 4th version of the system, which was tested with a human inside. The goal of Dr. Chernobrov's work is to research the medical aspects and experimental investigation of the principles. Several important conclusions were obtained from the project: the time course can be controlled and character of the changes is different for acceleration and deceleration mode.

Other known publication and research projects on the same topic seem to be very far from any commercial and practically useful application. Obviously the topic is very new and fantastic for most of scientific community and at first we have to clarify the physical principles of the time control project, which is started by Faraday Labs Ltd.

In this project we believe that notion of time is one of possible description of real physical properties of our Universe. So, it is not mathematical abstraction but some aspect of physical reality and we can discover some physical properties of time. Russian astrophysicist N. A. Kozyrev [2] developed a theory of active properties of time and according to his point of view there are two properties: time course and time density. Prof. Kozyrev demonstrated experimentally that time density in area of some process (changes of matter) is dependent on entropy parameters of the processes. In [3] it was demonstrated that Kozyrev's experiments could be interpreted in aether theory and it has led to simple physical conclusions and clear experimental perspectives: **time course and its density can be explained and controlled as parameters of aether.** Directions of aether flow and density of aether are subjects of experimenting with non-reversible changes in matter, for example, in crystallization or melting processes. Also it is possible to use special electromagnetic processes, for example, Chernobrov's "converging waves" or other longitudinal waves as methods of aether compression or rarefaction. If we assume that process of existence of elements of matter physically can be explained as aether vortex processes then its rate is a parameter of **aether income/outcome balance** (aether inflow in element of matter and aether outflow from the element of matter). It was also described in Time Rate Control (TRC) theory [3]. To control this balance it is necessary to develop technology of longitudinal waves generation, its focusing and resonance effects. The previous research and experimenting on the topic has been made by N. Tesla.

Let's assume that we have some technology to change parameters of time course. How should we organize this local space-time (what is spatial topology of the design)? There is a very interesting experiment to get the answer: rotation of a heavy cone (for example, lead cone) entrains surrounding aether, so a vortex appears, which is a toroidal formation of aether (rings). The rings can exist in space for a long period. The further question is: Why does the beam of light (laser beam) directed to the cone by tangent create a luminous ring? We can assume that due to natural properties of photons (light propagates along the geodesic line in space) some autonomous closed toroidal space should be created in such experiment. The next thought is: since space and any matter exist in time then we can speak about some autonomous time. The general conclusion is to be the following: autonomous 4-dimensional space-time can be created as toroidal aether vortex.

Here is point to note some aspects of research project by Prof. Robert Mallett, Connecticut University, USA. In fact, sometime next year, he hopes to produce the first piece of technology that eventually will allow him to build a time machine. By Mallett it will be a device that employs lasers "to twist space". Why is he going to close the beam of light? His theoretical background is knowledge about black holes, i.e. understanding of the connection between gravity and curvature of space-time. In Einstein's theory both matter and energy can bend space and time. So Prof. Mallett assumes that curvature of space-time can be changed not only by mass (like a black hole) but it can be affected by energy of photons. This has led Prof. Mallett to consider the possibility of using a circulating beam of light to twist space and to create closed loops in time. It is predicted that a spinning neutral particle, when placed in the ring, is dragged around by the resulting gravitational field [4]. From the

Kozyrev-Dirak Radiation
Its influence on animals

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In the experiment with animals, that were made in the Center of Oncology Researches (COR) at the Russian Academy of Medical Sciences (RAMS), on the applying of Kozyrev-Dirak's Focused Radiation (KDFR), it has been found that KDFR decreases the quantity of glucose in the blood, reduces its tenacity, promotes the strengthening of immunity and the rise of the quantity of marrow cells.

Introduction

This time researchers in Russia and abroad experiment on ball lightnings by means of nonoriented circuits, which are similar to the electric analogues of Mobius band, also by means of Klein bottle and their combinations. Non-oriented fields are investigated very intensively now. Accordingly, organisms of the researchers, who observe the interactions of such fields with a matter, are also changed, thus they should take it into account on making such experiments. The aim of the article is to show in which way the fields of nonoriented circuits influence on animal and human organism. Besides the article has for its object the prevention of negative consequences, which can appear for experimenters through the research process.

Experiments with animals that were carried out in 1992-1993 in Russian Academy of Medical Sciences (RAMS) had not been published in proper time because there were no quantitative methods of radiation detection. Later, in 1996 they were developed [1] and KDFR parameters were measured in that geometry, which were applied in RAMS. In 1998 powerful and super-powerful KDRF sources were obtained. These sources were applied (and are applied now) in the researches at the controlled radioactive decay [2]. Kozyrev and Nasonov [3] and later also Lavrentyev with the collaborators [4,5] have proved experimentally that the Sun and some stars generate the radiation, which has early unknown properties. We suggest that the radiation, discovered by Kozyrev [3], and the radiation, which is researched by us and by other experimenters with nonoriented circuits, are of the same phenomenon. At first, it should be noted that on interaction between Kozyrev-Dirak radiation (KDR) and a matter made it colder. As it was demonstrated above [1], cooling effect can be explained by matter re-magnetization under the influence of KDFR beam (adiabatic demagnetization). According to the still unpublished data, KDFR bunch destroys matter lattice by the way of it's moving. However, after a couple of week matter reconstructs it to the almost tabulated points, without defects, blockness and other damages, which are peculiar to other natural crystal structures. **In the definite sense nature demonstrates the way to rejuvenate compound structures**. As it is well known, vital functions of biological systems on the Earth depend on the structure and composition of water. Therefore, we have a right to expect considerable changes in the vital functions of biological organisms under the influence of KDFR.

Experimental Devices

In experiments with animals there were applied the devices, which concentrated KDR (KDCR) and had 50 Wtt aggregate electrical power. The description is presented in [2].

KDFR indication was obtained by calorimetric method [1], along the way of movement of the main bunch (with 10 cm across diameter) and at angle of 45° from the geometrical axis of a device.

Researches of Bleeding Duration

Let us consider KDFR influence on the blood composition of animals. At the experiment 24-28 gram weighting, pelletized fed male mice were used. In the process of the experiment it was discovered that 3 and 4 hour processing of mice with KDFR at the distance 2.5 m and at the presence of animals in the sphere of maximum radiating power, caused some changes of fibrillation system. The bleeding duration was determined according to Duke method. Two groups of animals were used at the experiments: a group with 4-hour duration of KDRF processing and a group with 6-hour duration. Time of bleeding was considered in dynamics at 1, 2, 7, 14, 21, 28 and 35 day (Fig. 1). The bleeding duration of the intact animals was determined by the value 128±11 sec. After the applying of KDFR there was noticed some increase of bleeding duration to 261±15 sec and 223±21 sec on the first day after the stopping of the influence. In the subsequent periods bleeding duration gradually decreases up to the level of physiological norm. The whole normalization of the index is observed at the animals, which were processed by KDFR during 4 and 6 hours, on 28-35 day up to 115±12 and 133±18 sec correspondingly. In the process of observations at the animals, the correlation between time of fibrillation and periods of KDRF processing of the animals has not been revealed (Fig. 1).

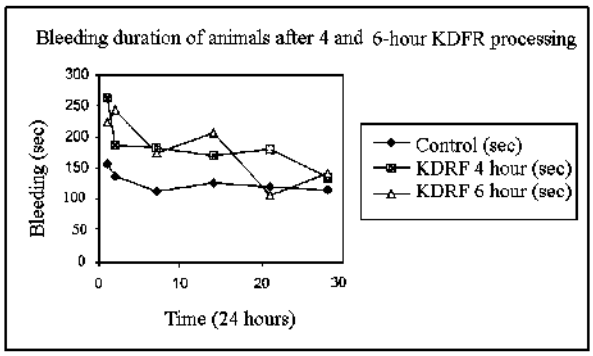

Fig.1

In the course of the experiment the strongly marked chronometric hypocoagulation was discovered due to the extension of the parameter "K" or, probably, because of the change of aggregation properties of platelets (Table 1).

For the determination of biochemical indexes serum was obtained from 5-8 ml of rats' venous blood. Beforehand (24 hours before the slaughter), forage was taken away from the animals. The determination of biochemical indexes was provided by means of biochemical analyzer HITACHI. As a result of the experiment it was determined that at the first day after influence of KDRF there was a tendency of decrease of the glucose content (Table 2). Other indexes varied in the limit of physiological norm.

Table 1 Parameters of thromboflexogramm after KDFR, 4 hours

Animal #	Parameters of thromboflexogramm			Fibrio gene	Fibrinal activity
	R (sec)	K (sec)	Ma (mm)		
1	72	∞	10	-	-
2	102	∞	18	-	-
1	90	∞	10	275	75
2	180	150	52	315	90
1	180	∞	5	-	100

Table 2 KDFR influence on the glucose content in blood of the rats

Time (days) after the experiment	KDFR 4 hours (mmole/l)	Test (mmole/l)	KDFR 6 hours (mmole/l)	Test (mmole/l)
1	3.14	6.12	6.39	7.27
10	7.59	9.35	8.90	6.69
30	6.05	6.69		

Research of haemopoiesis system

Several criteria were considered: the dependence of biological effect on the distance, on the power flux density, on the duration of processing. Besides, KDRF influence on mice survival was considered.

At the experiment 24-28 gram weighting, pelletized fed male mice were used. The marrow was examined in the dynamic at 1, 3 and 7 day after KDFR influence. Six animals were taken on each point. After the decapitation of the mouse their thighbones were taken out and after that the absolute number of myelokaryocytes was calculated by the standard method in Goryaev chamber.

Dependence of the biological effect on the distance

In all experiments the maximum flux density along the geometrical axis of KDCR device was a constant. There were used four temporal modes of the influence (1, 2, 3, 4 hours) and three points of long distance between KDSR and the biological object (0.5; 1.5; and 2.5 m). At 0.5 m distance there were no differences in the number of marrow cells in comparison with the control cells. With the increase of distance between KDCR and the object from 0.5 to 1.5 m some tendency to the increase of the number of marrow cells up to the 7th day was observed. Four-hour KDRF processing caused the increase of the number of karyocytes up to $29.99 \pm 1.25 \times 10^6$ ($P < 0{,}001$). Thus, any dependence of the biological effect on the exposition has not been revealed. For instance, at the 7th day after one hour of the exposition the number of karyocytes was equal to $28.45 \pm 1.87 \times 10^6$ at the same time after 3-hour processing it came to $27.65 \pm 0.74 \times 10^6$. Alongside with the change of the distance to the biological object from 1.5 to 2.5 m the tendency towards the increase of the number of marrow cells has kept within the same limits $28.27 \pm 1.32 \times 10^6$ and $29.57 \pm 0.88 \times 10^6$.

Dependence of the biological effect on the power flux density

The comparative investigation of KDFR influence on the biological object in the coverage of KDCR (along its geometric axis) and outside the coverage has demonstrated that alongside with the increase of the radiation intensity there was a tendency towards the decrease of stimulative influence of KDFR on haemopoiesis.

Dependence of the biological effect on the duration of processing

On processing the animals at distances up to 2.5 m from KDCR and on increase of exposition to 3-4 hours it is possible to obtain reliably significant difference in the number of marrow cells from the physiological norm to the 7th day.

KDRF influence on the survival of mice

The experiments, determining the survival reaction of animals, were made by means of gamma radiation. 30-day survival is the criterion of determination. Conditions for the experiments are the following: in the coverage of KDCR and aside the coverage, (the distance between the KDCR and the object is 2.5 m in the coverage of KDCR and 0.5m outside the coverage). Time of influence is 4 hours. Animals of both sex were used. Two groups of animals were used. The test group was put to the gamma radiation in the diapason of doses, which caused marrowy syndrome, i.e. from 7.5 to 8.5 Gr. The second group of animals after the irradiation in the same diapason of doses was repeatedly processed with KDFR. Time of the influence is 4 hours at 7.5 Gr gamma radiation on 15 mice in one bath and 8.5 Gr on 15 mice in another bath. Total gamma radiation of the animals was made by means of the source ^{137}Cs with the dosage rate of 5.2 Gr/min. Gamma radiation in this dose diapason causes death of the animals during the development of the marrowy syndrome, i.e. from the 6th to the 20th day along with the aplasia of haematogenic tissue. Combination of gamma radiation and KDFR sometimes leads to the slight increase of the number of survived animals. If the animals are irradiated by gamma rays at first and then by KDFR, the death control at 7.5 Gr radiation is equal to 5.5% from the total number of the animals and at the following KDFR processing 16% of the irradiated animals die. However, 67% of the animals in the tested group have died after KDFR processing and after the coming next gamma radiation with 8.5 Gr total dose. And in the group, which was processed with KDFR, only 46% of the animals died.

Immunity strengthening

For the investigation of KDFR influence the following tests were chosen: activity of natural killers and T-killers, which had been obtained by the immunization in vitro in the unidirectional mixed culture of lymphocytes and also in the reaction of blast transformation on the specific mitogen [6, 7]. All tests were made on the 7th day after a single KDFR influence. Unfortunately, data have been obtained with the applying of radioisotope preparations. Though the experiments of this kind were successful and though they have demonstrated the increase of some immune reactions' level, there is a certain doubt in the relevancy of radioisotopes application [2]. Thus the series of experiments was made. These experiments were aimed at the investigation of KDFR influence on the development of the swelling process. The aim of the experiment is the investigation of KDFR influence on the development of Ehrlich cancer and sarcoma-37, which were repeatedly inoculated to mice. At the first stage of the experiment there was a single KDFR influence on the mice repeatedly inoculated with sarcoma-37, on the 2nd day after the repeated inoculation of the swelling cells to the animals. The repeated inoculation was made intramuscularly in a right thigh, in a dose 10^6 of cells per a mouse. Time of KDFR influence for the first group of animals was equal to 1 hour; for the second one it came to 2 hours; and for the third one it came to 4 hours. Each group consisted of 6 animals. The test group consisted of six mice with repeatedly inoculated sarcoma-37 and which had not been processed with KDFR. As a result, the average lifetime of tested animals was equal to 9 days. The average lifetime of animals of KDFR groups came to 48 days (for 1-hour KDFR influenced group); to 12 days (for 2-hour group); and to 31 days (for 4-hour group). Thus, the average lifetime of the experimental group came to 29 days. Besides, in the group, which has been processing with KDFR during 1 hour, **the half of mice had survived (three of six mice).**

At the second stage of the experiment the repeated (5 times during 2 hours) KDFR influence on the mice was applied. These mice have been inoculated with sarcoma-37 at seven days before the beginning of the influence. As a result, the average lifetime of the animals was equal to 27 days, and for the mice, which were processed with fivefold KDFR influence, the average lifetime was equal to 76 days. The obtained results are the evidence of inhibition of swelling development for the animals, which were processed with KDFR influence. This leads to the increase of lifetime of such animals in comparison with the test. **Thereby, at a great extent the results of the previous experiments on the strengthening of immune status after KDFR influence were confirmed.**

Results and discussion

Let us make a conclusion. At the KDFR influence on animals' organism the following effects were observed: decrease of blood viscosity; strongly pronounced hypocoagulation; decrease of contents of glucose. Increase in the number of karyocytes and the extended lifetime of the animals, infected with Ehrlich cancer and sarcoma-37 were also observed.

As for human being, the researches in this area have not been carried out yet and they are still confined to the single observations. It is possible to give an example from the author's practice. In 1975 nonoriented circuit of 3kWtt power was examined. Field strength was measured. The author of the article had been working in the field for about 8 hours. And after five hours after the experiment I had felt bad. That time it was nothing known about the influence of the new radiation on human organism. The arrived ambulance has quickly diagnosed that I was close to hypoglycemic coma. On several hours after the intravenous glucose injection, my state has become normal. **Now we know that before the experiments with powerful KDFR bunches it is necessary to eat sugar.** Thus we believe that the data, which were obtained after the experiments with animals, can be applied to a human being. We can suggest that the manifestation of the symptoms of the KDFR influence on human organism depends on the power of the applied source, on the total mass of the organism and on the time of it in the coverage of the irradiation. From aforesaid it is clear that the experiment with powerful KDFR sources is far from being harmless

and it is better to make it distantly after exclusion of man presence near experimental stands and devices. At the same time it is quite obvious that on applying of small capacity and fixed time of irradiation it is possible to develop methods for curing of human diseases, which are considered now as incurable (for instance of diabetes, some diseases of haematogenic system, of cancer and possibly of AIDS.

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Effect of Magnetic Blow Wave Field on Wine Systems

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Introduction

Authors communicate the data on influence of Magnetic Blow Wave (MBW) field on several wineproducts. It was found, that MBW did not lead to significant changes in the major components of the wineproduct (sugar, organic acids, minerals). At the same time the taste and aroma of treated wine become more pleasant; content of heavy alcohols and wine stone in the treated samples was less than in non treated ones. A mechanism of transformations was also discussed.

Keywords: *Magnetic Blow Wave (MBW), Wineproduct, GLC of aroma compounds and ethanol, HPLC of sugars, Atomic Absorption Spectrometry (AAS) of minerals, Heavy alcohols and aldehydes, Wine stone, Turbidity tendency, Organoleptic evaluation*

Magnetic Blow Wave (MBW) was obtained for the first time during the investigations on ball lighting generation under the laboratory conditions (Shakhparonov 1994). MBW as a physical object is interesting because of some facts, which suggest that MBW is a magnetic monopole. The MBW can also interact with the matter and transforms it in a definite way. Typical example is an elementary carbon in the form of graphite, which is transformed by such magnetic treatment into ferromagnetic substance (ibid). The graphite, which is initially diamagnetic, transforms to paramagnetic one with general radiation doze of about $7 \cdot 10^{19}$ neutrons/cm^2. Other types of radiations could not affect this way (Svoistva 1975). So one unit of MBW can be considered as $1 \cdot 10^5$ of neutron masses. This fact may be regarded as an indirect evidence for assuming that MBW and magnetic monopole are the same things. In the absence of excited radioactivity a slow MBW [$v/c < 1 \cdot 10^4$] occurs, which does not ionize atoms (Devons, 1963). Therefore, their interaction with the matter can be observed only indirectly. No data exist on the interaction of MBW with organic substances. The experiments and results reported in the present communication may be a starting point for development of technology and to formulate the methods for vintage wine and best quality spirit production.

Materials and Methods

Assuming that MBW and magnetic monopole are the same things, a number of conditions were selected for all experiments. The MBW source and the samples were placed in the same axis and the axis was oriented according to magnetic meridian direction. Such magnetic orientation is appropriate, as the energy of magnetic monopole theoretically increases in a magnetic field (Devons, 1963). All of samples were placed at 250 cm distance from MBW source, in hermetically closed glasses. It should be noticed that MBW could penetrate through many other barriers, for example into cast iron reservoir with wall thickness of 5 cm (Amaldi, 1970).

The quality investigations were made by using of standard equipment. HPLC, equipped with refractometric detector was used for sugars estimation. Separation of organic acids in forms of their ethyl esters and acid esters was carried out chromatographically using a column packed with polyethylenglycol succinate and the following temperature option: initial temperature is 120°C, final temperature is 220°C, temperature growth rate: 8°/min. GLC was also employed for determination of ethanol. Minerals content

conclusion: in order to obtain complete information about any system, it should be destroyed. However, destruction of tissues of the man in order to get information about their state is a too high price to pay for the information about his health.

However, the above Van Hoven's criterion can be satisfied with the minimum influence, when the cells are not destroyed and the atoms of these cells, being primary sources of torsion spectrums to be registered, are bring into the non-equilibrium state by means of outer disturbing influence.

In order to choose the frequency of the disturbing torsion influence correctly, it is necessary to take into account the role of water in physical and biochemical organization of tissues of the human organism.

At the same time, it is necessary to take into account the resonance torsion frequencies of various human organs. Finally, it turns out that the signal of torsion disturbance should be rather sophisticated considering both these factors. The TORDI system is a ready-to-use production device. Nevertheless, it is important to understand that the model is not the limit of scientific and technical potential incorporated in it and that enhanced variants of the system will appear with the course of time.

Summing up, I would like to draw your attention once more to the fact that work on torsion technologies is not limited by the directions that were discussed here. Actually, as it was pointed out in the beginning, on-going development includes all branches of economy, industry, agriculture and medicine, as well as all problems of everyday life. Technologies that we mentioned are the forerunner of the fact that the mankind is on the threshold of the age of torsion technologies, which, we believe, will change our life in the 21st century more than all the scientific and technical revolutions of the 20th century.

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The Electrical Vortex Non-Solenoidal Fields

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A mistake was found in the electrodynamics: it is detected that all electrodynamics' postulates corresponds to the experimental facts, but vortex electric fields has unclosed inductive lines.

When the magnet is moving, then the current of magnetic induction is moving together with it. From known velocity of motion **v** and the value of magnetic induction **B**, it is possible to calculate the intensity **E** of appearing vortex field according to electrodynamics formula of transformation of fields **E=vB**.

If to change the E=vB on induction $D=\varepsilon_0 E$ in formula of fields' transformation, that will get $D=\varepsilon_0 Bv$, where D is electric induction, B is magnetic induction, v is velocity of motion, ε_0 is electric constant.

Herewith the appearing electric induction is always transverse to the direction of motion. It is possible to formulate the rule of origin for electric induction under the condition of rectilinear motion: if to dispose the right hand palm so four fingers shows the motion direction of the magnetic flow (the field), connected with moving magnet, and the vector B fells into palm, then the moved aside big finger will indicate the direction of vector D. The given rule is like the rule for Lorenz' force, but on the contrary (the difference is in frame). In the first case the charge moves, but the magnet rests. Here the magnet moves, but the charge, which points the direction for lines of force of electric induction, is immovable. So, there it is the rule for left hand, but here, on the contrary, it is the rule for right hand. Thereby, if the charge moves, but the magnet is immovable, then the rule of left hand uses for determination of the force. But if the magnet moves, but the charge rests, then the rule of right hand uses for determination of the force.

The origin of electric force is connected with that, the vortex electric field $D=\varepsilon_0 Bv$ appears around moving magnet (the magnetic field does not act on immovable charges).

In common literature on electrodynamics there is no any difference between electric vortex field and solenoidal field, but these are different notions. The sign of solenoidal field is the closed lines of electric induction (the flow of vector D through the closed surface is a zero), but for the vortex field the sign is following: the work of forces can be different from zero under the condition of motion along a closed line. That is to say, the vortex fields can agitate the rotational currents.

From the electrodynamics textbook: "The work of forces of vortex electric field can be different from zero, when the electric charge is moving along a closed line."

For instance, when the magnet moves, the vortex electric field appears and this field can be solenoidal or not, depending on magnet's orientation. Let's take such example: the magnet moves evenly, rectilinearly, and it's poles are oriented transversely to direction of motion. According to the rule of origin for electric induction ($D=\varepsilon_0 Bv$ that is the rule of right hand), the appearing vortex electric flow is not a solenoidal, since the lines of electric induction are not closed. Its begins in one conditional area of disturbance (+), accompanies the moving magnet, and it finish in another area of disturbance (-). For presentation it is enough to consider only two areas (+) and (-), represented on Fig.1. These dissimilar areas of disturbance appears because that flow of magnetic induction inside the magnet has the inverse direction, that outside the magnet.

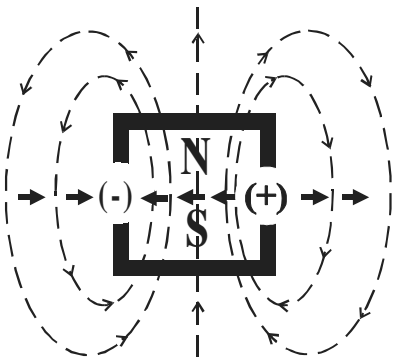

Fig.1

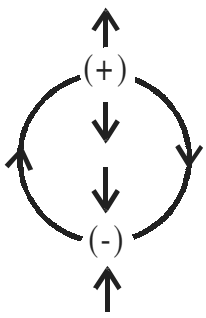

Fig.2

That moving disturbance of electric and magnetic fields presents itself as transverse electromagnetic disturbance. Also, it is necessary to notice, that under such magnet's motion, the appearing vortex electric field is not closed, but the current of electric displacement, connected with it, is closed (a currents are always closed). In given example, for clarity, it is possible to present a intensity of electric field through the Lorenz' force, if to take the frame, in which the magnet rests, and the test charge moves.

On the Fig.1 the moving magnet is conditionally represented (motion is toward to the text, magnet is moving away). N and S are poles of magnet. The direction of lines of electric induction, appearing when the magnet is moving, specified by arrows → and ←. Part of the lines begins in positive area (+) and finishes in negative area (-), the areas are placed on the ends of magnet. **The flow of electric induction through closed surface is not a zero; that is to say, these areas of disturbance are moving electric charges.**

From the electrodynamics textbook again: "The flow of vector D through any closed surface is equal to algebraic amount of external charges, covered by this surface. In the electrodynamics these postulates has the same role, as Newton' laws in classical mechanics."

Thereby, according to postulate, it is necessary to consider the appearing dissimilar areas of disturbance (+) and (-) to electric charges, or it is necessary to change the postulate.

It is interesting, that a part of lines of electric induction, which placed frontal and behind magnet, starts and finish at infinity, since the distribution of magnetic induction around magnet has not determined borders.

For clarity, it is possible to make following calculation. For instance, the coil (loop or turn) with current, as a magnet, moves evenly and rectilinearly, but its magnetic poles are oriented transversely on motion direction. Under such motion the lines of electric induction are not closed, and the dissimilar areas of electric field's disturbance appears in space on the edges of this coil.

On Fig.2 the moving coil with current is conditionally represented. It moves from left to right side of the page. The arrows on the coil indicate the direction of current. The appearing dissimilar areas of disturbance of electric field are marked by signs (+) and (-). Knowing, that in medium of the coil $B=\mu_0 I/2r$ and according to $D=\varepsilon_0 Bv$, it is possible to find the electric induction, appearing in the center, between two dissimilar areas $D=\varepsilon_0\mu_0 Iv/2r$, where I is current in the coil, r is radius of the coil, v is velocity of motion, ε_0 is electric constant, μ_0 is magnetic constant. The electromagnetic disturbances in transverse electromagnetic waves has the similar field construction, there also dissimilar areas of disturbance of electric field exists, that is to say the lines of electric inductance are not closed. Only the currents of electric displacement and magnetic induction are closed.

Let's consider another example: magnet moves rectilinearly, but its poles are oriented longitudinally to direction of motion. According to the rule for origin of electric induction ($D=\varepsilon_0 Bv$ is the rule of right hand), the appearing rotational electric flow is solenoidal, since in this case the inductive lines become closed lines. **Usually in books on the electrodynamics such moving magnet is considered, and the wrong conclusion is thereof done, that vortex electric field is always**

solenoidal, herewith it is forgotten, that poles of the magnet can be oriented not only along the direction of motion, but across also.

From the electrodynamics textbook: "The vortex electric field differs from electrostatic field that it is not related with any electric charges and its lines of intensity are closed lines."

From theory and from experiments it follows, that under transverse motion of magnet the lines of disturbance of vortex electric field can be unclosed and, accordingly, the flow of induction through the closed surface is not a zero. Then there is a direct discrepancy to facts in modern electrodynamics. It is strange, but for the whole history of researches in magnetism the transverse magnet's motion was not is considered. It leads to revising of electrodynamics' postulates, which plays such role in electrodynamics, as the Newton's laws plays in classical mechanics. The postulates, giving invalid belief about field processes, accordingly, do not allow to make some correct calculations. Fallaciousness of these postulates was one of the reasons, on which the electrodynamics could not to consider and to calculate the discrete electromagnetic waves (photons), where the magnetic field also is the transverse field (the field construction and calculation of photons are represented on the page http://www.comail.ru/~alemanov). **That is to say, not only particles has the charges, but areas of disturbance of field (without particles) are the charges also,** where the flow of electric induction through the closed surface is not a zero. Thereby, the vortex electric fields can be not only as closed flows of induction, but as well as inducted electric charges, accordingly, the laws for electric charges are valid for induced electric charges also. For instance, in the law of conservation of charge: if somewhere the area of disturbance with positive sign appears, that negative area appears also.

From the electrodynamics textbook: "The vortex electric field is generated by the variable magnetic field. Its force lines are always closed, like force lines of magnetic field."

But before this fundamental postulate, confirming, that force lines of vortex electric field are always closed, it was necessary to consider all variants of change for the magnetic field, including the variant of the transverse motion of the magnet. That is to say, the consideration of physical processes could not be unilateral. Faraday considered the longitudal motion of magnet and discovered the electromagnetic induction, but the transverse motion of magnet that have the principle importance for understanding of field processes in electrodynamics was not considered. Thereby, the longitudal motion of magnet brings to arising a vortex electric field with closed force lines, but transverse motion of magnet brings to arising a vortex electric field, where the lines of forces are not closed. In this case it lead to induced electric charges. It is necessary to notice, that this is first mistake, detected in electrodynamics postulates for all time of existence of electrodynamics.

From the electrodynamics textbooks: "…Gauss' theorem is valid not only for electrostatics, but also for electrodynamics, which using a variable in time electromagnetic fields. We are not sure if this hypothesis is valid or it is not valid… Only the experiment can give the answer on this question. The whole collection of experimental facts speaks in favor of this hypothesis." But, unfortunately, the experiment with transverse motion of magnet was not considered seriously in this textbook.

(Editor's note: Well-known Searl's experiments and Godin & Roshchin's experiments are based on such transverse motion of magnets (rollers). In Alemanov's article it was demonstrated that in this case the experiment should lead to induced electric charges. Really it was detected in experiments. Hence this missed aspect of electrodynamics is very important for development of the new energy technologies.)

Gravito-Inert Mass

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Nature of mass is one of the important problems of modern physics. It is accepted to consider that the mass of elementary particle is determined by fields, which are connected with it (electromagnetic, nuclear and others). However, we didn't create any quantitative theory of mass. There is no theory to explain why masses of elementary particles form a discrete spectrum of values and to allow determining this spectrum.

Mass (m) is a physical value, one of characteristics of matter, which defines its inert and gravitational properties. Accordingly, we distinguish inert mass (m_i) and gravitational mass (m_g).

Inert mass (m_i) characterizes dynamical properties of a body, its property to accelerate under the action of the force $(\vec{F}_i)$ and according to the second Newton's law is considered to be constant coefficient of proportionality for the given body between $\vec{F}$ and acceleration $\vec{a}$.

$$\vec{F}_i = m_i \vec{a} \qquad (1)$$

Gravitational mass (m_g) is a source of gravity field. Every body creates its gravity field, which is

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The Principle of Self-Organization, which can be formulated as follows: any material object represents an open self-organizing system whose internal structures are formed with the participation of the whole universe. Apparently, the Principle of Self-Organization, incorporated in nature as one of the integral properties of matter, is nothing more nor less than a spirit (or absolute idea, or creator) which operates the world and creates all its variety.

Physical Mechanism of Nuclear Reactions at Low Energies

V.P. Oleinik* and Yu.D. Arepjev

Tell me what the electron is,
and I shall explain to you everything else.
W. Thomson

Abstract

The physical mechanism of nuclear reactions at low energies caused by spatial extension of electron is considered. Nuclear reactions of this type represent intra-electronic processes, more precisely, the processes occurring inside the area of basic localization of electron. Distinctive characteristics of these processes are defined by interaction of the own field produced by electrically charged matter of electron with free nuclei. Heavy nucleus, appearing inside the area of basic localization of electron, is inevitably deformed because of interaction of protons with the adjoining layers of electronic cloud, which may cause nuclear fission. If two or more light nuclei occur "inside" electron, an attractive force will appear between the nuclei that may result in the fusion of nuclei. The intra-electronic mechanism of nuclear reactions is of a universal character. For its realization it is necessary to have merely a sufficiently intensive stream of free electrons, i.e. heavy electric current, and as long as sufficiently a great number of free nuclei. This mechanism may operate only at small energies of translational motion of the centers of mass of nuclei and electron. Because of the existence of simple mechanism of nuclear reactions at low energies, nuclear reactor turns out to be an atomic delayed-action bomb, which may blow up by virtue of casual reasons, as it has taken place, apparently, in Chernobyl. **The use of cold nuclear reactions for production of energy will provide mankind with cheap, practically inexhaustible, and non-polluting energy sources.**

Introduction

Nuclear reactions at low energies, occurring in physical and biological systems, and, in particular, the cold fusion (CF) of nuclei, attract ever increasing attention (see review articles [1,2]). This is explained by the fact that research on CF (in what follows, by cold fusion we shall understand any nuclear reactions at low energies) opens up the way to the solution of the problem which was set more than 50 years ago in the field of controlled thermonuclear reactions (CTR) and which has not been solved that is the problem to provide mankind with cheap fuel. An important point is that CF allows to create not only cheap, but also non-polluting energy sources, as nuclear reactions at low energies are not accompanied by radiations dangerous to health (γ-radiations, streams of fast neutrons and other particles). Note that the energetic problem facing mankind is presently of special interest in connection with the fact that, according to expert evaluations, the oil-and-gas resources in the world will suffice only for some decades. For this reason the study of CF is among the most important problems of physics.

It is necessary to note that, relying on the standard theory of nuclear reactions describing nuclear processes in vacuum, experts in the field of nuclear physics, engaged in CTR, reject the very possibility of existence of nuclear fusion at low energies. Two basic objections are raised against CF:

1. at low energies the penetrability of Coulomb barrier around nuclei is so small that the probability of nuclear fusion is practically equal to zero;
2. distinction between the atomic and nuclear energy scales is so great that the energy, which might be evolved as a result of nuclear fusion, could not be transferred directly to atomic lattice; therefore the energy above should be emitted in the form of streams of γ-quanta, fast neutrons and other particles. However, such streams of sufficient intensity have not been registered.

The answer to the first objection against existence of CF is that at the heart of CF are nuclear processes occurring in environment, and the basic role is played here, apparently, by collective effects caused by interaction of nuclei with particles of environment in which the nuclear reaction takes place. The laws governing the behavior of interacting nuclei in vacuum are inapplicable to the description of CF of nuclei [3]. Nuclear reactions occurring at low energies submit to completely different laws, which can be established only provided that collective effects mentioned above are taken into account. For this reason the standard theory of nuclear reactions in vacuum can by no means refute the existence of CF.

As to the impossibility of transferring the energy between levels of various scales, we can give an example of the phenomenon of sonoluminescence (luminescence of a liquid when a sound wave causing cavitation passes through it) [4], in which the energy transfer from an acoustic wave to electromagnetic field occurs with appreciable probability in spite of the fact that the distinction between energies of acoustic phonons and quanta of light reaches 11 orders.

As early as 10 years ago J. Schwinger, the Nobel winner and the known expert in the field of the theory of elementary particles and quantum electrodynamics, asserted that it is impossible to deny the reality of CF phenomenon [3,4]. Since then the CF phenomenon for nuclei was repeated hundreds times in laboratories all over the world, tens of patents on the ways of energy generation on the basis of CF were registered and enormous number of experimental works were published, which not only confirmed the existence of effect, but also contained its detailed analysis.

The most convincing evidence for the existence of nuclear reactions at low energies seems to give the mass-spectrometric research of reaction products [5] as well as research on biological systems [6]. Detailed study of electric explosion of foil made of especially pure materials in water, described in [5], suggests that at electric discharges transformation of chemical elements occurs. Study of optical spectrum of plasma arising at discharge and of the mass-spectrometric analysis of sediments, which remained after the discharge, shows that in plasma there is an appearance of a significant number of chemical elements which were not presented in the initial material of explosive foil and electrodes and also that the isotope structure of the foil material changes appreciably. The change of experimental conditions, for example, of energy contribution in foil, its mass and dimensions results only in redistribution of intensity of plasma spectral lines, i.e. in the change of statistical weight of chemical elements in plasma, but the composition of chemical elements remains unchanged and it essentially depends on the material of foil. As it is seen from the received results, nuclear reactions, which take place at electric discharge, are not accompanied by the occurrence of a neutrons stream and γ-radiation and proceed at low energies of atomic nuclei.

The research mentioned above as well as many others, carried out by different researchers in different laboratories, **allow to draw a conclusion that existence of nuclear reactions at low energies is reliably established.**

The development of research on CF is hampered by the absence of theory of the phenomenon. As noted by Schwinger [3,4], the situation in CF is closely parallel to that one in high-temperature superconductivity: reality of the last, as a result of careful experimental research, is completely established, though theory of the phenomenon is absent till now.

In [5], to account for the transformation of chemical elements, the hypothesis is put forward that at the electric explosion of foil in the plasma channel magnetic monopoles are formed which may overcome the Coulomb barrier even at insignificant kinetic energy due to the great magnitude of their magnetic charge. The monopole, appearing not far from a nucleus, causes its polarization: those nucleons of the nucleus, which are situated more close to the monopole, experience stronger influence of the last, than the nucleons situated on the opposite side of the nucleus. As a result, a deformation of the nucleus arises (the nucleus is lengthened), which may result in nuclear fission.

Obvious drawback of this mechanism of nuclear reactions is that magnetic monopoles have yet to be found out in nature.

Numerous attempts to construct a consistent theory of CF (see reviews [1,2]) have not been crowned with success. As it was noted above, for the CF to be described, the account of the collective effects may be important caused by interaction of nuclei with environment, in which nuclear reaction takes place. But does it suffice to take into account these effects in order that the theory of the phenomenon is constructed? The analysis of the experiments on transformation of chemical elements at low energies and on the CF of nuclei suggests that the discussed phenomenon does

not fall within the domains of exotic ones: it seems to occur in nature constantly, at every step, in both physical and biological systems. Therefore, it is natural to expect that nuclear reactions at low energies should have a simple physical explanation.

However such explanation, which is not beyond the scope of existing representations, is yet to be found. Does not it mean that we are facing here the situation similar to that which has arisen in physics at the end of the 19th century and which has been figuratively described in the words: on the light sky of physics there are only two small dark clouds – the radiation of absolutely black body and the Michelson experiments? Let us remind that in order for these clouds to be removed, it has taken the revision of physical notions about electromagnetic field as well as about space and time.

As is noted in [8], there is a simple physical mechanism of nuclear transformations at low energies which existence follows from the quantum theory of electron as an open self-organizing system [9]. If two or the greater number of light nuclei appear inside free electron, more precisely, inside the area of basic localization of the particle, because of interaction of nuclei with electrically charged matter of electronic cloud, a force of attraction appears between the nuclei which may result in fusion of nucleus. This means that **cold nuclear reaction represents an intra-electronic process** which character is defined by physical properties of the own field produced by electrically charged matter of electron. The purpose of this paper is more detailed consideration of the mechanism above stemming from the spatial extension of electron.

In section 2 physical ideas are formulated and basic results are schematically presented of quantum theory of electron as an open self-organizing system. The theory outlined is necessary to elucidate the origin of the mechanism resulting in the occurrence of nuclear reactions of fusion and fission at low energies. The essence of the developed approach consists in that **the own field created by electron is treated as a congenital, integral physical property of electron, intrinsically inherent in the particle by the very nature of things and for this reason the own field and self-action are included in the definition of the particle** at the initial stage of formulating the theory. As is seen from the received results, electron represents a quantum (elementary excitation) of the field of electrically charged matter. It is a solition, which physical and geometrical properties are described by the non-linear and non-local dynamical equation similar to the known Dirac equation.

In section 3 the application of quantum model of self-organizing electron to nuclear reactions at low energies is considered. It is noted that because of the presence of simple physical mechanism of nuclear reactions at low energies, which is of a universal character, nuclear reactors represent, in effect, nuclear delayed-action bombs, which from time to time may blow up by virtue of the casual reasons. Hence, though nuclear stations may provide mankind with energy, however atomic engineering is a very dangerous way of energy production. The only acceptable way of solving the energetic problem consists in the use of nuclear reactions at low energies.

Quantum model of electron as an open self-organizing system

The basis for the standard formulation of quantum electrodynamics (QED) is the hypothesis that electron is a structureless point particle which does not experience self-action. This assumption results in serious difficulties – the divergences of mass and charge of electron and the impossibility to explain stability of the particle (see, for example, [10-12]).

The difficulties mentioned above are very serious. According to Dirac, **the difficulties of QED "in view of their fundamental character can be eliminated only by radical change of the foundations of the theory, probably, radical to the same extent as transition from the Bohr orbits theory to modern quantum mechanics"** ([13], p. 403). "Correct conclusion", Dirac emphasizes, "is that the basic equations are incorrect. They should be changed in such a way that divergences do not appear at all".

The main reason of occurrence of difficulties is the assumption that electron is a point-like particle. Therefore, abandonment of this hypothesis is inevitable. As an analysis of the problem shows, the key to constructing a consistent quantum theory of electromagnetism lies in taking account of the Coulomb self-action of electron, i.e. the back action of the own field created by charged particle in environmental space upon the same particle. In the special case that the particle is at rest in an inertial reference frame, own field of the particle turns into static Coulomb field.

E.Schrödinger who suggested the historically first physical interpretation of quantum mechanics put one of the boldest ideas concerning the problem of electron forward. According to Schrödinger's hypothesis, the quantity $e\left|\Psi(\boldsymbol{r})\right|^2$ (e and $\Psi(\boldsymbol{r})$ are charge and wave function of electron, respectively) is the density of spatial distribution of electron's charge and, consequently, **the linear sizes of electron are the same as those of atom** [14,15]. However, they did not succeed in substantiating the interpretation and, for this reason, it was rejected by the majority of physicists [16].

An important step to the correct understanding of the physical nature of electron was made by A. Barut and by his collaborators [16-18] who formulated and developed quantum theory of electromagnetic processes on the basis of self-energy picture (the Self-Field QED). Using expression for the total own energy of electron, they managed to calculate the Lamb shift and other radiative corrections and to show that radiative phenomena may be described in terms of the

action function, without using the second quantization method. As is pointed out by Barut [17], "the correct quantum equation of motion for radiating electron is not the Dirac or the Schrödinger equation for bare electron, but an equation containing an additional non-linear self-energy term".

New lines of approach to the problem of electron are offered in [9, 19-24]. The formulation of electrodynamics is considered which represents a synthesis of standard quantum electrodynamics and ideas of the theory of self-organization [25]. The physical mechanism of self-organization of electron consists in self-action. Taking into account the self-action means that electron is treated as a feedback system.

Let us outline schematically the results of the formulation of quantum electrodynamics in which electron is an open self-organizing system.

Editor's note: The authors develop mathematics by using Lagrangian functions, 7 equations. You can contact the authors for more information about.

Thus, the negative result is received: we have tried to take into account self-action of electron in a natural way by supplementing the Lagrangian function with the self-energy term, but we came to an equation that has no reasonable physical solutions at all. This result seems to mean that the standard theoretical scheme reaches here the limits of its applicability and so, remaining in its framework, it is impossible to solve the problem of electron and elucidate the physical nature of electromagnetic interaction.

Essentially new point, which is introduced in [9] into quantum mechanics consists **in the replacement of the model of isolated system described by harmonic oscillator with the model of open system**. Let us advance the arguments indicating the inevitability of using the model of open system as a basis of the description of interaction between microparticles [26].

Note, first of all, that quantum particle theory based on the use of the models of isolated system is, strictly speaking, physically meaningless. Really, any observation conducted on a system represents a process of interaction of the system with the means of observation. But in case of microparticles (quantum particles) this interaction is not weak and consequently it is inadmissible to neglect it, i.e. microparticles should be necessarily considered as essentially non-isolated systems.

A starting point of the standard formulation of quantum mechanics is the physical idea that interaction between physical fields can be reduced to collision of the particles corresponding to these fields, the particles before and after collision being considered as free ones. According to these representations, quantum mechanics is based on the notions of "bare", non-interacting particles, with the interaction between them being considered as an additional factor which can only insignificantly alter the physical properties of non-interacting particles. However, such an approach to interaction between physical fields is obviously of an idealized character because particles constantly interact "with vacuum as with some kind of physical medium in which the particles move" [27]. Interaction of particles with vacuum fluctuations is not small and it cannot be removed.

It is well also to bear in mind that the necessary intermediary at studying micro-objects are the means of observations (the devices) with the classical field corresponding to them which should be taken into account in consistent quantum theory [28]. Inclusion in theoretical scheme of arbitrarily weak classical external field results in occurrence of non-zero width Γ of energy levels of "dressed" particles. The basic impossibility to isolate a real particle from vacuum fluctuations of the field and from the classical sources connected to the means of observation is indicative, thus, of necessity to take into account the non-zero width of energy levels of real particles [26].

The use of the harmonic oscillator model, when describing the interaction of electromagnetic radiation with substance, seems to be the main source of serious difficulties of the standard formulation of quantum theory, as such an approach means apparent neglect of those physical processes which, proceeding constantly, are responsible for inseparable coupling of real physical system to surrounding medium. Introducing artificial notion about switching on and switching out of interaction of oscillator with radiation field, we are able to calculate within the framework of existing theory the width of energy levels of oscillator, but we cannot assert with certainty that such an approach results in correct description of interaction.

From the reasoning given above it is seen that they are the models with energy levels of non-zero width that should form the basis for the description of interaction of radiation with substance. It is necessary to formulate such a quantum theory, which would take into account the energy levels of non-zero width Γ. The case in point is that one should introduce an infinitesimal damping Γ into the initial set of equations describing interaction of charged particles with electromagnetic field. Such an approach means the violation in infinitesimal of homogeneity of physical system relative to translations in time. Necessity of violating the homogeneity of time follows from that fact that in the usual approach (with $\Gamma = 0$) the states of the system of interacting fields have degeneracy of infinitely large multiplicity in relation to time translations. According to the fundamental Bogoliubov's concept of quasi-averages [29], when describing the behavior of degenerate systems, one should include into Hamiltonian an infinitesimal term removing degeneracy. In the theory presented here degeneracy of states of quantized fields relative translations in time is removed by introducing the infinitesimal damping Γ into Lagrangian. Thereby the degeneracy under study is removed already in the initial, zero-order approximation, which is of

fundamental importance for the approach based on perturbation theory.

Formulation of the physical idea that quantum friction arises at the very elementary level - at the level of one particle is given in monograph [26]. Impossibility to isolate real particle from the surrounding world is that property which should be taken into account already in the one-particle theory (for each kind of particles), even before switching on the interaction with other particles. Model of the particle as an open system ($\Gamma \neq 0$) is attractive owing to the fact that from the very beginning the degeneracy of states relative to time translations is absent in it, the degeneracy, which is removed in standard approach by taking into account the interaction of particle with vacuum field fluctuations and classical fields. The basis for the developed formulation is the fundamental concept of quasi-averages supplemented with the requirement that the equations of motion of the particle with $\Gamma \neq 0$ follow from the action principle. It should be emphasized that the non-zero damping Γ is introduced into electrodynamics with the aim to establish the structure of the Lagrangian function, which takes into account the property of openness of physical system. After establishing the structure, the limiting transition $\Gamma \to 0$ is fulfilled.

In our opinion, the development of quantum theory will be inevitably connected with the use of models of open system; as such models reflect more completely the physical essence of interrelations in the real world. It is necessary, thus, to define more exactly the concept of openness of physical system, which, on the one hand, would describe real system accurately enough and, on the other, would be simple enough to describe the particular physical processes.

As open system has the richer physical contents in comparison with isolated system, some essentially new mathematical ideas are needed for its description. First of all, it is necessary to increase the number of independent dynamical variables describing the particle as open system. In papers [9,19-24], as a basis for the description of self-acting electron, the simplest model of open system is used which can be described by the Morse-Feshbach-Bateman Lagrangian function [30,31] and which was successfully used for the description of dispersive medium (the review of articles, in which applications of the model of open system to electrodynamics of dispersive medium are considered, is given in monograph [26]). In this model the number of dynamical variables is doubled as compared with the isolated system, namely, to each dynamical variable of "bare" particle, Ψ, there correspond two dynamical variables, which are denoted by Ψ and $\tilde{\Psi}$. These quantities are considered as components of the wave function describing the quantum state of self-acting particle. One of them, say, Ψ, corresponds in a sense to the particle alone (to the "bare" particle) and the other, $\tilde{\Psi}$, to the surrounding medium, in which the particle moves.

Editor's note: You can contact the authors directly for more information (8-16 equations).

Equation (16) coincides in its appearance with the usual Dirac equation for charged particle in an external field described by 4-potential . However, in reality, it differs essentially from Dirac's equation. The distinction consists in that **equation** (16) **is non-linear and non-local**, with the non-locality being of both spatial and time character. Potential ($A_{||}$) and vortex ($A_{\perp}$) components of the 4-potential, entering equation (16), differ from each other by their physical nature: the former describes the Coulomb field and is expressed quadratically in terms of the wave function components of electron, and the latter describes transverse electromagnetic waves and is expressed in terms of vortex electromagnetic field. As a detailed analysis shows, solutions to the basic dynamical equation describe the clots of self-acting electrically charged matter, localized in space, i.e. the particle is a soliton.

The internal energy spectrum of electron is discrete with an indefinitely large number of levels, and to each value of internal energy E_k (k is the set of quantum numbers) there correspond certain linear dimensions and geometrical form of the region of localization of electron's charge. Dimensions and the number of extreme of wave function increase with increasing the value of energy E_k. The distribution of electric charge of atomic electron in the ground state consists of the range of basic localization with the linear dimensions of the order of Bohr radius a_0 ($a_0 \sim 10^{-10} m$) and of the tail stretching up to infinity. It is essential that because of non-linearity of the dynamical equation of electron, wave function does not obey the superposition principle. By virtue of this, electron acquires the properties of absolutely rigid body: the perturbation acting on electron at an instant of time in the range of basic localization becomes known at the next instant $t + 0$ at any distance from the particle.

In Fig. 1 the results of calculation are represented schematically, carried out on the basis of equation (13), of the distribution of electric charge in atomic and free electrons in the ground (a) and first excited (b) states.

According to [9,19], the atom represents a system of nuclear and electronic solitons interacting with each other, the internal energy spectrum of the hydrogen atom, due to electromagnetic interaction, being of a zoned character. The occurrence of zoned structure of energy spectrum of hydrogen atom is explained as follows. Free nucleus, because of existence of Coulomb self-action, has a discrete internal energy spectrum. As the interaction of nucleus with electron is small in comparison with the energy of Coulomb self-action of the nucleus, it can be taken into account by perturbation theory. From here it follows at once that each energy

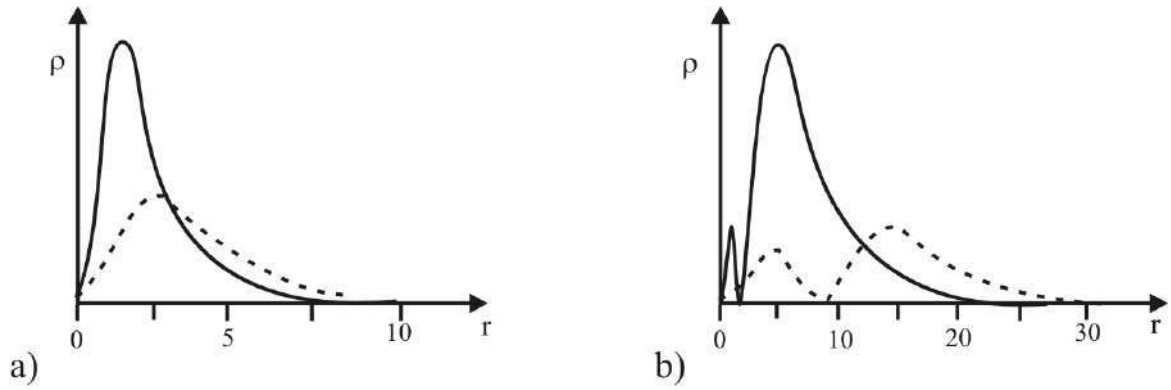

Fig. 1. Density of electric charge (ρ) of electron in the ground state (a) and in the first excited state (b): the continuous lines correspond to electron in the hydrogen atom, and the dotted ones to free electron, r is the distance from the center of mass of electron measured in Bohr radii.

level of free nucleus is split in a zone. There are indefinitely many zones (Balmer's replicas) and in each of them there are indefinitely many energy levels. The lowest zone coincides with the usual Balmer spectrum.

Physical mechanism of nuclear reactions at low energies

The quantum theory presented above schematically of electron as an open self-organizing system is indicative of the existence of the following mechanism of nuclear reactions at low energies [8].

If there occur in the region of basic localization of free electron, which linear sizes in the ground state of the particle are several times as large as those for hydrogen atom (see Fig. 1), two or the greater number of nuclei, each of them attracts on itself the adjoining areas of electronic cloud, resulting in compression of the electronic cloud as a whole. As a result, there appears automatically an attraction of the nuclei, which proved to be "inside" electron, on each other (see Fig. 2).

Calculation shows that the Coulomb barrier around nuclei is deformed, its height decreases and the probability of penetration through the barrier accordingly increases due to tunnel transition. Under certain conditions this process may result in fusion of nuclei. Obviously, the process in question can occur only at small energies of translational motion of the centers of mass of electron and nuclei: nuclei should be "inside" electron long enough for them to have time to come nearer to each other as a result of electron-nuclear interaction. This mechanism of nuclear fusion is of a universal character. In order for it to be realized, it is necessary to have only a stream of free electrons intensive enough, i.e. heavy electric current, and as long as sufficiently great number of free nuclei.

If heavy nuclei appear "inside" free electron, owing to their interaction with the electronic cloud there occurs polarization of nuclei. Because the own field of electron interacts with protons more strongly than with neutrons, nuclei are deformed (become extended), and this process may result in the decomposition of nuclei to fragments (in nuclear fission).

As is noted in [7], the official version of the reasons for Chernobyl accident contains serious contradictions, a number of facts concerning the accident has no convincing explanations, and this circumstance forces to search for the true reasons for the happening, since

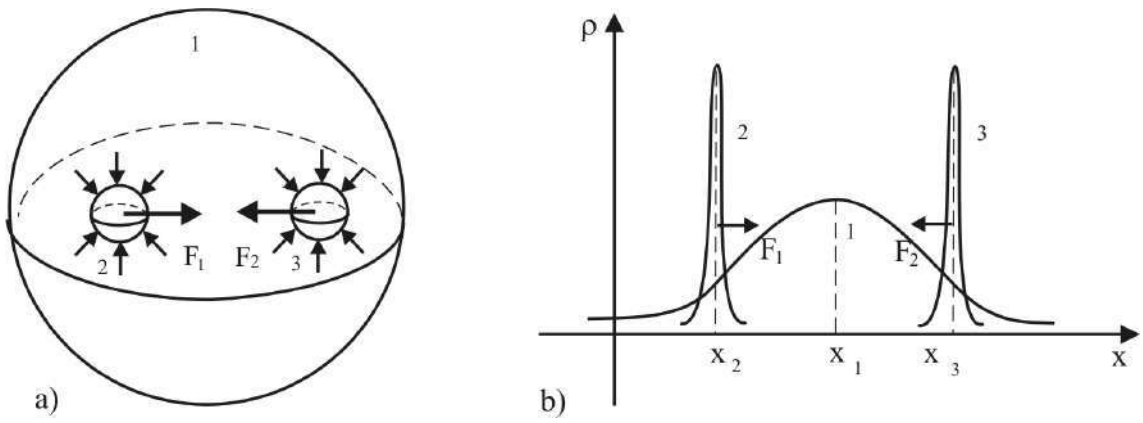

Fig. 2.
The schematic image of interaction of nuclei with electronic cloud: (a) 1 is the region of basic localization of electron, 2 and 3 are nuclei, F_1 and F_2 are the attractive forces between nuclei, which appear at the expense of electronic cloud compression induced by Coulomb forces; (b) ρ is the charge density, 1 is electronic soliton, 2 and 3 are nuclear solitons, X_n (n=1, 2,3) are coordinates of the centers of mass of particles.

"not having understood the mechanism of the one tragedy, we sooner or later shall become witnesses of the other". The authors hypothesize that the reason of the accident was penetration into the nuclear reactor of magnetic monopoles, which have caused the decay of nuclei ^{238}U, and this has resulted in production of delayed neutrons, growth of power output of the reactor and explosion. As an argument in favor of the assumption, the fact is presented that nucleus ^{238}U are disintegrated under the action of "strange" radiation appearing at explosion of foil.

In the opinion of the authors of [5,7], "strange" radiation is created by those magnetic monopoles, which form bound states with nuclei of atoms. These compound particles give the abnormally wide tracks similar to those of a creeping caterpillar, and also the tracks of complicated shape reminiscent of spirals and gratings. Character of tracks changes when imposing magnetic field, which, as the authors believe, is an argument in favor of the assumption above. There are also some special tracks very similar to scratches and ink spots. "Strange" radiation is of spherical form, it resembles a ball lightning, and its duration is more than ten times as great as that of the current pulse arising at electric discharge. With the course of time the luminous sphere (the ball-like plasma formation) is dividing into many small "balls".

It is our opinion that "strange" radiation is caused by free electrons in excited state arising in the area of electric discharge. According to [9, 19], linear sizes of the region of basic localization of such electrons can make many tens of sizes of atom. The heavy nucleus, for example, the nucleus ^{238}U, appearing inside the electronic cloud, is inevitably deformed because of interaction of protons with adjoining layers in the distribution of electric charge of electron, and this deformation can cause nuclear fission. If two or the greater number of light nuclei appears "inside" electron, then attractive forces arise between nuclei, which may result in fusion reaction. When electric discharge is strong enough, the areas of basic localization of some electrons can overlap, and if a nucleus lands in the area of overlap, because of Coulomb attraction of nucleus on the adjoining layers of electronic clouds, a bound state may be formed, of two electrons and the nucleus, characterized by the relative stability and significant spatial extension.

Obviously, if the concentration of free electrons is great enough, there may be formed some relatively stable bunch of plasma consisting of great number of free electrons and nuclei, which in virtue of chaotic movement of nuclei and because of the absence of preferred directions should have approximately spherical form. Let us note that atomic electrons, belonging to additional energy zones of atom (Balmer's replicas associated with nuclear self-action, see Section 2) can contribute to "strange" radiation.

As is seen from above, to account for the reasons for Chernobyl accident, there is no need to involve magnetic monopoles. The scenario of development of events during the accident, described in [7], seems to be quite plausible if only to understand by initiators of nuclear fission not hypothetical monopoles but free electrons, which powerful pulse might arise as a result of electric discharge in the region of turbo-generators.

The existence of simple physical mechanism of nuclear reactions at low energies, indicated in this paper, implies that nuclear reactors are, in effect, nuclear delayed-action bombs, which will blow up from time to time. Explosion of nuclear reactor may take place because of casual short circuit at an electric subcircuit, owing to which there appears an intensive stream of free electrons. This stream, having got for any reasons in nuclear reactor, may initiate explosion of the reactor. It follows from here that though nuclear stations may provide mankind with cheep energy, atomic energetics represents a very dangerous way of producing energy (as well as the energetics using controlled thermonuclear fusion). The only acceptable way of resolving the energetic problem consists in the use of nuclear reactions at low energies.

According to the results obtained, nuclear reactions at low temperatures occur "inside" electron under the action of own field of particle. Hence, to elucidate physical mechanism of CF, it is necessary to study in detail intra-electronic processes and physical properties of own fields of particles. Note that the own field, by its physical properties, essentially differs from the field of electromagnetic waves: this is the field of standing waves of matter, it is of purely classical character and may not be reduced to the set of photons. The own field of charged particle plays in nature a special role, consisting in that it transforms environmental space into the physical environment (physical vacuum) with the properties of absolutely rigid body [32].

As it was repeatedly noted in the literature [1,2], experiments on CF are badly reproduced, and this fact gives rise to doubt the very existence of the phenomenon. Bad reproducibility of results seems to be explained by the fact that CF depends upon great number of parameters: upon electric current density, concentration of free nucleus, concentration of impurities and dislocations in samples, sizes of samples etc. In order to obtain reproducibility of results, it is necessary that all these parameters, describing the environment in which nuclear reactions occur, be the same in various experiments, but to achieve this as a difficult task.

In conclusion we shall dwell upon the problem of linear dimensions of electron, which is of special interest in connection with the mechanism of nuclear reactions indicated here. The inference that the dimensions of electron in the ground state of atom are of the order of Bohr radius, i.e. of the order of atomic dimensions, following from dimension considerations [9,19] and confirmed by quantum model of electron, seems completely unexpected. At first sight, it is in conflict with both the theory of quarks and experimental data

on scattering of electrons. According to quark models, the radius of electron corresponding to its quark structure makes up the quantity of the order of 10^{-22} m [33]. It is necessary to emphasize, however, that the above-mentioned magnitude of linear dimensions of electron refers to the internal structure induced by Coulomb field. The last is long-distance and consequently the linear dimensions of internal structures produced by it (i.e. spatial inhomogeneities in the distribution of electric charge in various quantum states) should considerably exceed the dimensions of quark structures connected with electron. There seems to exist a hierarchy of internal structures of particle produced by Coulomb forces, nuclear forces, inter-quark interactions etc. characterized by the smaller and smaller linear sizes.

As to the experiments on scattering of high energy electrons, according to which the internal structure of electron is not manifested up to distances of the order of $10^{-16} \div 10^{-17}$ m, two arguments, at least, can be adduced in favor of that there is no contradiction here with the experiment. Firstly, in experiments on scattering, investigators were trying to register the details of internal structure of electron within intervals much smaller than Bohr radius, which is why it is not surprising that results of experiments proved to be negative: at high energies electrons behave like point particles, their internal structure has no time to be manifested. Secondly, the results of experiments were analyzed from the point of view of standard representations about electron, which refer to a point particle, but are obviously inapplicable to real, self-acting electron. According to the predictions of quantum theory of electron as an open self-organizing system, real electron is a special object - soliton, i.e. such a cloud of electrically charged substance which, when interacting with other particles, tends to keep its sizes and geometrical form.

At present there is as yet no scattering theory of this kind of particles and for this reason it is impossible to predict with certainty how can the internal structure of electron be manifested in experiments on scattering.

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The Evolution of Lifter Technology

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INTRODUCTION

Readers of the electric-spacecraft journal might know a little about the Lifter technology popularized recently be Jean-Louis Naudin, but they probably don't know the whole story. In the short amount of time that has transpired since the publication of that article, this technology has both literally and figuratively taken off – going from a "proof-of-concept" prototype by Naudin to an international group of researchers investigating how to give the lifter higher-performance and greater efficiency. With the first commercial products now on the horizon, if you haven't taken the time to read up on lifter technology, this is the perfect time to do so. . .
To give you a complete up-to-date overview of where this technology is, where it is going, and what I think it is capable of, let me start with the basics – an overview of how I became involved with Electrogravity research and what eventually led me to become involved with lifter technology.

MY BACKGROUND

I started college at 16 years old, back in 1992 – at the same time, I purchased a kit containing "hoverboard plans" from Hovertech, Inc. The moment that I received that $20 white-manilla envelope in October 1992 was the moment that I became involved with what has now been nearly 10 years of electrogravity research.

I worked with Bill Butler – the president and chief-scientist of Hovertech – on a variety of different antigravity, Electrogravity, and levitation ideas from approximately 1992 through 1996. While putting in my college time, I was also taking distinct advantage of the enormous college library at Western Washington University to read up on everything that might possibly relate to Electrogravity. I read books on standard electronics and physics theory alongside with books by the masters of this science, such as TT Brown and Nikola Tesla.

Bill and I played with several different ideas – many of them only peripherally related to Electrogravity. For instance, I published a manuscript initially in 1996 describing Tesla's theory on how to reliably produce Ball-Lightning using a standard Tesla coil – the information courtesy of WWU's excellent library. Bill also assisted me with obtaining video footage of a Searl-effect conference that he attended in Denver in the early 90's – this footage was an excellent overview of Searl's design and construction concepts for what he believes is the next major technological step in aviation and space travel.

Bill and I eventually found different paths, and in some ways drifted apart. Bill moved into Geomagnetic levitation research and started intense investigation on the patents of How Wachspress and the magnetic dipole levitator. I went to more traditional technologies – eventually becoming a UNIX system administrator for AT&T Wireless.

I hadn't heard from Bill Butler in about 6 months when he sent me a short email containing the words "hey, check this out" – and a link to Jean-Louis Naudin's "Lifter Experiments" home-page. I visited the site, watched all of the video clips, and then watched them again. This was the technology that I had been waiting for!

LIFTER TECHNOLOGY

I can say without a doubt that the lifter technology is completely revolutionary, but you might not realize how profoundly revolutionary it is until you've stopped to think about it for a bit. What is it about the lifter that makes it so unique, especially when so many inventions claim to produce more and better electromagnetic thrust? The answer is simple – the lifter works repeatedly.

Jean-Louis Naudin started a figurative bonfire when he decided to replicate a "proof-of-concept" experiment by a small Huntsville, AL aerospace contracting firm. The lifter initially came into being in the mind of Jeff Cameron – the chief scientist of Transdimensional Technologies – in the 1970's from experiments conducted with high-power military and research-grade lasers. A device in the lasers called a "pre-ionizer" was used to apply a high-voltage to the lasing-medium to facilitate better performance. Repeated operation of the pre-ionizer had a common side-effect of horribly twisting the wire and foil combination out of shape, which required a decent amount of work to repair.

Jeff Cameron realized that the torsional effect on the pre-ionizer was a side-effect of some unknown force acting on the pre-ionizer apparatus, and he began a long-term investigation into what was causing the apparatus to deform. His eventual results indicated that a force in the foil collector in the pre-ionizer was causing a net-thrust in the entire pre-ionizer apparatus that was making it twist and move on its mounts within the laser – the lifter came to him later as a three-dimensional device to demonstrate this force.

Naudin's genius became readily apparent not through a giant breakthrough in technology, but rather in a more subtle fashion – he replicated the lifter experiments of Transdimensional Technologies and published videos, articles, and complete construction plans on his website to allow others to do the same. In a manner similar to the open-source software movement, Naudin had taken an incredible scientific find that might have otherwise been overlooked and done and incredibly charitable and intelligent thing – he gave it away for others to play with. By following Naudin's instructions, inventors all over the globe began to slowly replicate the

Transdimensional Technologies experiments and thereby validate the proof of concept that Jeff Cameron had created to show that his "mystery force" was real after all. Naudin of course took advantage of these replications of the experiment by showcasing them on his own website – which in turn lends additional credibility to his research.

As far as technology goes, the lifter demonstrates that science and engineering have more than their share of humorous irony. For the years that I researched Electrogravity and antigravity claims, all of the devices that I had seen required something "magic" to make them work. For instance, Bob Lazar's UFO-claims could have been reverse-engineered except that they require 'element 115' to make them work – an element chemically related to Bismuth that is theorized to potentially have electrogravitic properties. I will come back to the possible electro-gravitational properties of Bismuth in a bit, as it turns out that this element may in fact provide some use for future lifter technology.

The Searl-effect disc is an even better example of the "magic" usually involved with building a working Electrogravity device. Searl's ideas seem valid enough, but although he supposedly demonstrated several working prototypes in the 1950's, he is currently pursuing millions of dollars in research funding in to replicate those experiments in a modern-day setting.

The irony involving lifter technology is that while inventors all over the world have been searching for the perfect electro-gravitational device for decades, the possible working proof of concept for many of these theories has been sitting in front of us the whole time – the lifter costs less than $10 in parts to build, and none of them are magic – in fact, for my experiments, all of them were at stores within 2 blocks of my house — balsa wood from the craft store, aluminum foil from the supermarket, 30-gauge magnet wire from the local Radio Shack, and an old computer monitor for the high-voltage power-supply.

LIFTER PHYSICS

Whether or not Jeff Cameron knew it at the time he constructed his lifter prototype, what he was actually building was a 3 dimensional representation of a drawing on a patent application by TT Brown in the 1950's. In the patent application, the drawing shows a positively charged wire suspended over a grounded foil body which was meant to demonstrate the most basic Biefeld-Brown effect generator. While Brown's drawing is a little different than Jeff's design, the resemblance is uncanny enough to indicate that both of these men had the same basic force in mind.

TT Brown's patent indicates that this Biefeld-Brown effect generator works due to a gradient electrostatic-field between the wire and the foil – in essence, these two elements compose a low-efficiency, high-voltage air-gap capacitor in which the difference in geometries between the two capacitive elements generates a net-directional force from the larger element towards the smaller element. Jeff Cameron seems to have a practical axiom that goes along with this scientific philosophy, which is that there must be both a leakage current and a capacitance between the wire and the foil in order for the lifter to function.

Conventional physics says that two capacitor elements of different sizes will not generate a net-directional force, so what gives? This is actually the thinking that convinced me to abandon my research into Biefeld-Brown effect technology in 1996 – physics says it doesn't work. What the books say will happen is that since the wire can only maintain a lower-capacitance than the foil, the overall capacitance between the two elements will be reduced to be equivalent to that on the smallest element (or plate) in the capacitor. This, of course, assumes a 2-element series-wired capacitor, such as the lifter.

I can give you the conventional physics answer to this small riddle by simply saying that the lifter uses a manifestation of ion-wind. This would state that the electrons crossing the air-gap cause a breeze that causes thrust – since the breeze would be traveling down from the wire to the foil, the thrust would be up, as demonstrated in testing. In the ion-wind explanation, the electrons are emitted from small-diameter of the positively charged wire in such great abundance that they move a significant airflow down to the foil where they are absorbed and transported electrically back to the HV power-supply's electrical ground.

Conventional physics would seem to have the theoretical answer to why the lifter causes lift, but in the experimental setting, which is what we now have an abundance of thanks to Jean-Louis Naudin, the conventional physics explanation doesn't suffice. Experimentally, there are several deviations from the ion-wind explanation that seem to invalidate it. For instance, if you completely contain the lifter in a plastic-enclosure, it will still generate lift – this would not be the case if a breeze was responsible for lifting the device. How could it be, if the breeze is limited to the inside of an enclosure which itself is levitating?

A more compelling proof that Biefeld-Brown is something other than ion-wind comes from Purdue University, where the lifter experiment was replicated inside a vacuum-enclosure with positive results. While ion-propulsion can work in space, it usually assumes that there is argon, krypton, or other noble gas to be used as the propellant – the vacuum enclosure showed that with no gas available for transport the lifter showed a moderate improvement in performance.

The vacuum enclosure tests are definitely compelling evidence that something else is going on other than ion-wind – at least compelling enough for NASA to file patent number 6,317,310 – "Apparatus and Method for Generating Thrust using a Two Dimensional, Asymmetrical Capacitor Module". The NASA patent description – which can be accessed from Naudin's lifter

website – is as vague is it is compelling in that NASA is basically requesting a patent on any technology that generates force using two geometrically dissimilar capacitive plates. Disregarding the fact that this patent was issued nearly 50 years after TT Brown's patent using nearly identical descriptions and pictures, and also disregarding the fact that NASA also doesn't understand why the lifter generates thrust, it seems apparent the this phenomena is gaining credibility in engineering circles while physicists seemingly continue to deny that anything is going on.

THE EVOLUTION OF LIFTER TECHNOLOGY

Every good movie always has a sequel, and in technology, if at first a major government agency 'liberates' your idea, it may seem that a sequel is in order. In the case of the lifter, it would appear that the NASA patent would cover this technology to at least some degree – at least until someone overturns this patent under the prior-art rule – which means that the next generation has to be considerably more advanced to escape having the research and development be forfeit to the government.

The pursuit of more advanced versions of the lifter technology is currently underway by several independent inventors, as well as Transdimensional Technologies themselves. Most of the private research by inventors has delved into improving the current lifter design to produce a greater force output and utilize less power to do so. Because the lifter is so simplistic in design, many of these enhancements have been of a very basic nature.

Jean-Louis Naudin was the first independent inventor to do serious work with improving the technology behind the lifter – and even so, the majority of his work has utilized similar materials in more complex arrangements. Naudin has demonstrated dramatically increased lifting forces by building a "lifter inside a lifter" for demonstration purposes. Naudin has also done a great deal of work in taking breaking up the concept of the single triangular lifter into a parallel series of lifting cells – which means that these cells, working in parallel, can contributed to greater stability and higher force output than any single lifting element.

Saviour – an independent inventor working with Jean-Louis Naudin – has done some of the most interesting improvements on lifter design since those by Naudin himself. Saviour's concerns have not focused around the "bigger is better" philosophy that many inventors have stuck by – he has done several experiments to determine the radiation output, remote-controlled applications development, and materials analysis and improvement on the lifter that others have not had the time or expertise to conduct.

A recent experiment by Saviour demonstrates just how this gentleman's foresight is helping other experimenters – Saviour substituted nichrome heating wire for the common lightweight wire used for the emitter, and demonstrated that the lifting force greatly increased when a higher potential 12-volt charge was used to heat the emitter wire in conjunction with the standard high-voltage charge coming off it.

Transdimensional Technologies – the developers of the initial lifter design – are taking the approach to optimizing lifter performance to another level. They are currently not-so-secretly working on a 2nd generation lifter, which will consist of a 1-piece layered material to replace the current wire and foil design.

The layered material approach to the lifter is an idea that Jeff Cameron may or may not have had after some lengthy discussions with Travis Taylor – the man responsible for testing some anomalous materials known as "Art's Parts".

Art's Parts were some pieces of material sent by an unknown person to the Art Bell radio talk-show with a note stating that the they were pieces of UFO wreckage taken from the often-cited "Roswell crash" in 1947. Whether or not the pieces of material actually came from that crash is unknown, but Art Bell did the honorable thing by sending them to an acquaintance in US Army research named Travis Taylor for a professional scientific investigation.

Taylor, who apparently tested the materials after-hours in a world-class research lab to avoid potential classification by his superiors, used an electron-microscope to determine that the layered materials were actually pieces of metal – containing several hundred microscopically thin layers of magnesium and bismuth. Taylor also tested the layered-metal with a high-voltage apparatus, which seemed to indicate that when a voltage was applied to the material, the layered metal would move – and in some cases levitate.

Taylor reported his findings to Art Bell and sent video clips of his high-voltage experiments, which eventually made it back to a permanent home on the Art Bell radio show website. In addition, Taylor conveyed his belief that the only manner in which the pieces of metal could properly be produced was through an advanced form of electron-deposition technology, due (apparently) to an absence of oxygen-molecules between the different layers of metals. Additionally, the layers of metal were too thin to have been mechanically produced.

Jeff Cameron indicated that Transdimensional Technologies maintained some contact at one point in time with Travis Taylor, apparently as professional colleagues in the defense community in Huntsville, AL. I am not an expert on this relationship, other than to say that to the best of my knowledge these two individuals knew and contacted each other, and that this is how Jeff Cameron might have come up with the 2nd generation lifter idea.

ADVANCED LIFTER TECHNOLOGY

As an inventor, I couldn't care less whether or not the idea for the technology came from a crashed UFO. To be perfectly honest, I'm not what you would call a "believer" anyways, although I have often wondered

about it. My point is not to attempt to lend any credibility to "Art's Parts", but rather to tie in the properties of the anomalous material's high-voltage movement with the underlying theory of lifter operation.

Even mentioning a UFO in a respected publication or article is the kiss of death in today's world – and I wouldn't do it if it wasn't an intricate part of the story. The other interesting thought is that the layered material is once again partially composed of Bismuth – which is thought to possibly have some of the same electro-gravitational properties as Bob Lazar's Area 51 "element 115". Is there a similarity, or merely a coincidence between a claim that hasn't gained credibility and a technology currently under development?

The lifter in its own right is essentially a layered material. One of those layers is the emitter wire, which is highly charged with about 30kV worth of electrons, another layer is the air-gap, which is approximately 3 cm in height, and the final layer is an electrically-grounded "skirt" of aluminum foil that surrounds the lifter. It is also reasonable to expect that there are only two possible forces at work in the lifter – one of which being a possible ion-wind effect moving down from the emitter to the foil, and the other being a possible Biefeld-Brown effect, moving up through the foil to the emitter.

There are a few shortcomings in the lifter as a design that might be overcome if we could transition the layered material from one containing an air-gap to one that does not. For instance, the lifter is currently a rather delicate object, in that having a wire under tension as the emitter makes construction difficult for future automated assembly. Additionally, because the air-gap requires struts to support the emitter wire, a trade off involving the weight versus the strength of the struts is additionally involved in any current implementation of lifter technology.

Some of the other changes that would be helpful to implement when transitioning lifter technology from one type of air-gap to another are changes in the materials used to increase the dielectric capacity. High-K dielectric materials may be used to increase the displacement of electrons in the material to enhance charge transport. And since increasing the dielectric potential of the layered materials also increases the breakdown resistance, it means that thinner materials can be used.

Designing a lifter without an air gap would accommodate lower voltage requirements between the foil and the emitter. The voltage would not have to create the large e-field gradient to create a leakage current across such a large void. Therefore the overall voltage across the device could be greatly reduced, without much cost in thrust. A lower operating voltage in turn means that a lower-output power-supply can be used for a given amount of current, which increases the overall efficiency.

Transdimensional Technologies recent research is utilizing the layered materials approach to eliminate the air-gap and substitute for it high-k dielectric materials that may allow higher overall performance. Although they have not yet released details about the exact composition or thickness of the materials that they are working with, they claim to currently have a 10% reduction in weight using a low-voltage current across the thickness of their newest device.

FUTURE LIFTER TECHNOLOGY

Thanks to the tremendous amount of research being done on lifter technology by Transdimensional Technologies and a loosely affiliated group of inventors around the world, the future of lifter technology seems very bright at this point.

Transdimensional hopes to release some breakthrough research to allow replication of their newest 2nd generation experiments in the very near future, and along with that stands the massive body of research and advancements being done by inventors and researchers such as Jean-Louis Naudin, Saviour, the Lifters-group, and myself.

My personal goals are to attempt to assist Transdimensional Technologies in popularizing this technology to increase awareness of it and help "spread the word" about what it is and how it can potentially help the world.

Imagine if instead of getting in your car and driving through the usual maze of thoroughfares and side streets you were able to simply type in your destination and have a flying vehicle take you there automatically. The lifter technology offers to potential to transform the current transportation market by offering point-to-point aerial transport without the need for roads or freeways.

Additionally, unlike the magnetic-levitation ("Maglev") technologies that are currently being promoted as the future of transportation, the lifter does not require a specially constructed and exorbitantly expensive track to operate – the greatly reduces the per-unit cost on the technology and opens the door for wider adoption by the general public for transportation solutions.

Other individuals are currently working to see if lifter technology may offer cost-effective methods of transport into space, which would reduce the cost greatly and allow a one-piece, reusable method of moving things into orbit.

LIFTER RESOURCES

All of the research involved with the lifter technology is available to the public on the internet. The list of resources below are some of the better and more common resources to obtain detailed lifter information.

American Antigravity
→ http://tventura.hypermart.net

→ The author's website that includes video clips, complete instructions, and other related lifter information.

Jean-Louis Naudin's "Lifter Experiments Website"
→http://jnaudin.free.fr
→ A very in-depth website containing video clips, complete instructions,

World-Wide Lifter Replications
→ http://jnaudin.free.fr/html/lftwrld.htm
→ An overview with photos and video from many of the independent inventors who have replicated the lifter experiments.

Transdimensional Technologies, Inc
→http://www.tdimension.com
→ The home page for Transdimensional Technologies, the developers of the lifter design.

Blaze Labs (Saviour's Research Website)
→http://bel.150m.com
→An excellent site on research into lifter enhancements, radiation testing, sealed devices, power supplies, and other topics relating to lifter technology.

Lifter Builders Group
→ http://groups.yahoo.com/group/Lifters
→ An email group for the exchange of research findings for those interested in building lifters or staying current on the state of the technology.

NASA Patent #6,317,310
→ The NASA patent regarding obtaining thrust from an asymmetrical two-dimensional capacitor, grant Nov 13, 2001.

Research on the Capacitance Converter of Environmental Heat to Electric Power

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Nickolay E. Zaev works on creation of the prototypes of converter energy, which do not require any fuel. The direct conversion of environmental heat to electric power is possible in the processes of "charge-discharge" in non-linear condensers or by means of "magnetization-demagnetization" of ferrites. Such converters of energy create cold and electric power without any fuel.

Theory of the converter, results of early experiments on the generation of microwatt power, methods and features of research are given in this article. The methods of generation of a few watts power are described in details. The possibilities and difficulties of creation of powerful capacitance converters are discussed in this article.

I. Grounds of research.

1.1. From positions of orthodox physics there is no subject of research. It is evident that the energy of charging (C) A_c condenser C_x is always equal or more than the energy of discharging (D) A_d, i. e. always $A_c \geq A_d$. Only the advanced analysis shows that it is not always true. Exactly, in C_x, where $\frac{\partial C}{\partial V} < 0$ an inequality $A_d > A_c$ is possible, and in C_x, where $\frac{\partial C}{\partial V} < 1$, then the work $A_c > A_d$. Therefore we should discuss the nonlinear capacitors (NC). In the end of 1969 I noticed a systematic inequality $A_d > A_c$ during the measurement of A_c and A_d of many capacitors with different dielectrics. Theoretical grounds and results of measurements of this phenomenon are given in the publications in 1984 [1], [2, page 73]. On the industrial standards NC (varicond), ceramic condensers VK2-ZSH, $4 \cdot 6{,}8 \cdot 10^{-9}$μF with an optimal voltage about 95 V it was stated that $\frac{A_d}{A_c} \sim 1{,}21$ with the power to about $98 \cdot 10^{-6}$ Wt and "generated" extra power is equal to $21 \cdot 10^{-6}$ Wt.

1.2. In [1] and [2] the strict theoretical proofs of realization of $A_d > A_c$ (there are four of them) are given. On 1m³ of dielectric $|A_d| - |A_c| = -\frac{1}{2} a \cdot \varepsilon_0 \cdot E_c^{\,3}$ (E_c is an intensity of the field, V/m; ε_0 is a dielectric constant of vacuum, a is a coefficient of nonlinearity of the capacitor). Below we state one more proof more connected with the parameters of circuit.

It is well known that with the charge of a linear capacity from the source of constant voltage V_0=const through the resistor R=const it gets an energy $A_c = \frac{C \cdot V_0^{\,2}}{2}$ exactly equal to the output energy in the time of charging t_c. The output energy irradiated from the load R is a Joule heat $\Theta = R \cdot \int_0^{t_c} i^2 \cdot dt$ [3, page 546]. If NC (nonlinear condenser) is charged, then there are no proofs of such equation. The NC are the variconds or other capacitors, which have $\frac{\partial C}{\partial V} > 0$ in the interval $V = 0 \div V_k$. For the variconds V_k is some voltage, which corresponds to the maximum C_v. If $V > V_k$, then $\frac{\partial C}{\partial V} < 0$. For some other capacitors V_k is a voltage breakdown.

For further consideration let's believe that in the operating area of the given sample of varicond a function

Reality and Consciousness in Education and Activity

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Relation of thought to existence is the main question of philosophy as science on general laws of Nature was formulated but it still did not interpreted and solved in the frames of generally accepted logic standards. The ways to solve it lead to futile discussions of materialists and idealists, to senseless disputes of determinists with eclectics and apologists of the "chance". This discussion lost its sense without a determination of terms under discussion and condemned debaters to have subjective "gustatory" senses, which were changing while aging and depended on the extent of received and conceived knowledge. Such is the situation in this link of World studying, which does not allow creating a logic chain of reasoning in the understanding of cognizable things.

A paradoxicality of all things that happen is connected with incorrect translations and interpretation of wisdom of ancient philosophers and scornful attitude both to the knowledge of distant past and classical heritage, which highlighted the elements of natural-science approach to Weltanschauung.

According to Plato, **an ideal thing** is a visual thing, which can be felt by our organs of sense. Therefore, the understanding of objective reality is mediated by the crowd of our feelings in such a way that perception of reality by means of these feelings gives us a notion of the World. Hence, **our notions about reality are the subject of research in science, but not the World itself, i.e. the World outside of our consciousness.** So, what should be studied in our notions about the World? Let us refer to the wisdom of ancient scientists again: " The World is given in motion and its laws are the laws of motion". Then, we should speak about laws, order, i.e. about relation and interrelation in the phenomena of motion. This is the distinctness in notions and actions (determinism) to predetermine further development of reality cognition logic, i.e. what has an influence on us and determines specific character of our perception. Further we can speak about formation of ideas about reality, which require some premises, principles to organize these ideas. These principles are given in classical heritage, in "Dialogues" by G. Galilee [1] and "Mathematical principles of natural philosophy" by I. Newton [2]. A notion of force as a measure for momentum was introduced, which manifests in action and disappears from the body after the action is over, and the body keeps its new state due to the inborn "inertia force". **But the force itself cannot do anything without its application with a certain speed.** Then we introduce a notion of action as a product of acting force F_A and the speed of action V_A.

We offer a law of interaction, which determines the interaction between action of the cause and the effect appeared during this action as a reaction, i.e. the product of the force of reaction F_R and the speed of reaction V_R. Thus, this interaction between the cause and the effect is determined by the transfer of action from one object to another in equal quantity, but with appearance of new quality, which is determined by specificity of interacting objects according to fundamental law of interaction:

$$\mathbf{F_A V_A = -F_R V_R}.$$

Unfortunately, an incorrect interpretation of interaction manifestation as an opposite counteraction became strong in our mind. This manifestation is perceived as a compensation of cause by action of the effect. Moreover, the incorrect way of writing of the mathematical form of Newton's third law manifestation established in textbooks and scientific literature due to the incorrect translation as $F_A = -F_C$. This very tragic situation for the science suppressed the development of logic in description of processes. Chance and statistic approach to the description of phenomena has taken place in our perception. This approach is based on the model of non-interacting elements, in which there is no order stipulated by the interrelation of elements. The science has developed this model and its properties, and this fact predetermined the evolution of notions about real World.

This ideology penetrated in mathematics, which for sake of physics began to study properties of objects, but not operations with them. Moreover, a possibility to reflect specific character of real physical processes in the interconnection of cause-effect relations by mathematical operations is not realized. It is essential, that fundamental law of interaction establishes manifestation and description of elementary act of cause and effect interrelation, **the law of manifestation of a Fact.** It means that order in the World is conceived through manifestation of concrete facts. The action of law of interaction lies in the basis of these facts.

So, there is a conclusion: the World is perceived through the discrete manifestation of motion forms evolution. Hence, the discrete mathematics of finite discrete aggregate can be applied to describe the World, but not the continual mathematics, which lies in the basis of traditional orthodox physics. All these circumstances lead to numerous problems and difficulties in description of our notions of reality, to the plenty of used principles, which are in contradiction to each other, as R. Feinmann noticed once [3].

And what we can get from determinism, which is based on fundamental law of interaction, law of cause and effect interrelation? **The change of force value in a reaction takes place, i.e. the change of value of the potential gradient, i.e. the change of energy**

concentration. This circumstance is visually demonstrated by the operation of Archimedean lever as well as in all phenomena of the real World. This is Archimedean lever, where the loss of speed takes place, but there is a gain in force. And the load raised on a lower height than the way, which was made by the applied force, will give a huge power during its free fall. This power is higher in so many times, in how many times the time of the load fall is less than the time of action spent on its raising! And this is the fact, which determines specific character of **creation in the real World**. We should attribute both quantitative and qualitative characteristics to energy. This is the side of energy manifestation, which is reflected in Plank's formula: energy is proportional to frequency.

Manifestation of fundamental law of interaction also lies in the basis of general universal regularity of evolution of real many-particle systems with the change in external conditions. This process develops in multistage way, and on the each stage the logarithm of the ratio between the event happened and the event to happen always is equal to the work of external forces. In other words, the relation of the event happened to the resource is in exponential dependence on the initial conditions and extent of external influence. Exponential character of development of processes is the evidence that Nature develops according to the law, which conserves itself during evolution. This regularity, which manifests everywhere, can be naturally called **the Principle of Order.**

Fundamental law of interactions and Principle of Order appeared to be enough to describe and understand phenomena in the observed World. And it is natural to expect that this principle of Nature manifest in finer World also. This World includes lower and higher frequencies, which are not available for us yet to watch this wide-range frequency-wave emanating Universe.

From all aforesaid we should make a conclusion that the logic, which exists in the traditional physical tool, appeals to the model and principles of the World of non-interacting elements using the range of regularities, which also reflect some features of the real World, but they do not include fundamental law of interaction and Principle of Order, which are necessary and sufficient to describe reality. Descriptions existing in traditional physics are phenomenological ones and concern only those aspects of the phenomena under investigation, which do not include possible qualitative changes during development of processes, because the main property of real processes of interactions (creation of new energy property) was excluded.

The current situation in physics had a strong influence on formation and development of other sciences, other fields of knowledge, since the logic of reflection of cause-effect links was initially excluded. These are the links to determine existence, i.e. existence of constant creation of the World. All these circumstances give grounds to fundamentally revise educational programs, first of all, in physics, philosophy, mathematics, chemistry and biology. A change to the offered logic of cognition, which is based on the Principle of Order and fundamental law of interaction, will fundamentally change our notions about the World as well as will open big opportunities for new technique and technology. A Man has got huge opportunities in cognition and existence, but due to his immorality and features of incorrect aims in the logic of cognition he cannot use these gifts of Nature. We present wider and deeper view on the World and a Man in it, which allow analyzing, watching and operating with those fields of reality, which manifest in finer World, World of higher-frequency energies and other structures of fields. Logic of cognition had not touched these structures yet.

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Old New Energy

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Two kinds of energy, accumulated energy [1] and free energy [2], are considered as an inexhaustible source of natural energy created by Nature itself. It is ecologically clean and possible to be renewed in natural conditions.

The energy accumulated in substance is released as a result of partial decay of substance in elementary particles. At that, the acquired defect of mass is so small that it does not change chemical properties of substance and is compensated in natural conditions. Physical mechanism of energy-release lies in the fact that an electron in plasma layerwise takes sufficiently smaller elementary particles (electrino) from positively charged atoms or fragments of substance (ions). Electrino give their kinetic energy to plasma, heat it up and move beyond the bounds of reaction zone in the form of thermal and optical radiation. There is no substance, which could not take part in such process of energy-release, i.e. phase transfer of higher form (PTHF). The most appropriate, available and low-cost substances are air and water, which play the role of nuclear fuel in PTHF. It is turned out that usual combustion is also a process of PTHF, in which oxygen is a nuclear fuel and organic fuel is a donor of electrons. In the process of combustion oxygen atoms get the defect of mass equal

concentration. This circumstance is visually demonstrated by the operation of Archimedean lever as well as in all phenomena of the real World. This is Archimedean lever, where the loss of speed takes place, but there is a gain in force. And the load raised on a lower height than the way, which was made by the applied force, will give a huge power during its free fall. This power is higher in so many times, in how many times the time of the load fall is less than the time of action spent on its raising! And this is the fact, which determines specific character of **creation in the real World**. We should attribute both quantitative and qualitative characteristics to energy. This is the side of energy manifestation, which is reflected in Plank's formula: energy is proportional to frequency.

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to 10^{-6} %, which constitutes the so small value that it cannot change chemical properties of oxygen and does not call killing radioactive emanation.

There is a possibility to use energy properties both of oxygen and nitrogen of free air in the process of PTHF. To do this it is necessary to destroy nitrogen molecule at least in atoms or smaller fragments by some initiating influence. It is achieved by electrical discharge, magnetic flow, explosion and other means. These means consume much less energy than produced in PTHF. In particular, such processes were achieved in combustion engines. Such nitrogen mode of operation and combustion is accompanied by oxidation to H_2O, but not to CO_2, which is more effective in energy and ecological aspects. Accordingly, the power of engine increases and organic fuel is saved. Exhausts from this process mainly contain water vapor [3].

PTHF processes with excessive power release (more than consumed power) were also obtained in heat-generators operating with water.

Free energy diffused in the surrounding space could be transformed into mechanical, electrical or another kind of energy by means of vibration-resonance, electromagnetic and other energy systems. Classification of these systems as well as physical mechanism of energy transformation is given in [2]. The known Searl's engines can serve as an example of energy systems working with free energy.

The developed physical mechanisms of energy-release processes will allow to create industrial, stably operating, ecologically clean energy systems, which do not consume organic and nuclear kinds of fuel, harmful for humankind.

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On General Nature of Forces

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Introduction

In techniques and in our life we got used to certain physical notions concerning force. We usually use these notions in creation of automobiles, airplanes, rockets and other techniques, but we don't think about **the origin of forces** in general. Usually appearance of force in continuum is connected with presence of momentum gradient.

A number of works, which describe various versions about origin of a force appeared [1, 2, 5, 8, 17, 21, 22, 23, 25, 30, 35, 36, 38, 39]. Different mechanisms of appearance of force are considered in these articles. Usually they consider origin of a force in one of the fields, which are: electromagnetic, gravitational and others. **There was a theoretical attempt to connect the force initiation with energy gradient [33]. Experimental proof of force initiation due to energy gradient was obtained in the works [7, 38].**

Below we made an attempt to show the general regularity of force initiation, which is connected with non-uniform distribution of energy in space. With this process, physical nature of any kind of energy and specific mechanism of force initiation does not play any role. These are only particular cases of general nature of force initiation.

General nature of forces

We are surrounded by space, which is full of energy. Here we mean the energy of any nature: mechanical, thermal, electromagnetic and others. Energy is related with material world and its value is connected with the volume.

Any particle (volume) of continuum has energy:

$$A = A(x, y, z, t) \qquad (1)$$

where *x, y, z* are Eighler's coordinates of the center of particle, *t* is time.

Transmission of energy from one point of space to another one can take place by various methods, both in connection with energy transmission by material particle itself (which is a "carrier" of energy in this case) and without such transmission (for example, with wave motion). For the volume degenerated in ideal point the energy will be zero. That's why it is more comfortable to operate with the energy density concluded in the

increasing constantly. We are the first who analytically got the law of gravity of the masses from the known equation of thermal conductivity. Appeared that on the relatively small distances (in the bounds of the Sun System) the law of gravity by Newton remains valid, but on the larger distances the sudden decrease goes on (Gauss integral), which naturally solves the famous Zelinger's paradox of gravity.

As a conclusion we should note that in the bounds of a stable galaxy of a spiral kind there is the circulation of ether. Ether moves from the periphery of the galaxy to its center (nucleus) by two spiral branches. This becomes apparent as a weak magnetic field (8-10 micro Gauss). In the nucleus of the galaxy there is the impact of two strings as well as there is formation of the spiral toroidal circles (protons). Then the protons form the adjoined vortexes around themselves (electron shells) and from the proton- hydrogen gas the stars are forming, which are moving to the periphery by the same branches. There they dissolve in ether at the periphery since the protons will loose their energy and stability due to the viscosity. Ether which have got the freedom will return to the nucleus of the galaxy and this process is going on in our galaxy for hundreds milliard years and it will keep going until the new center of vortex formation will begin to concentrate ether. Then the new galaxy will appear and our galaxy will disappear. But it will not happen soon and we have enough time to understand that we should return to the concept of ether in modern science.

Experimental Demonstration
of Cosmic Influence on the Earth Life in N.A. Kozyrev's Researches
("On the Influence of Time on Matter")

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Editor's note: this article represents a part of the big scientific conception "World models in the new scientific progress". On applying of this conception a great number of practical technical devices have been created (as an example of such device we offer the description of universal electrical bio-heater, which was created by the group of researchers from Bishkek, Kyrgyz Science Technical Center "Energy" during the *work on ceramic electroconvector).*

We have to note that the position of our editorial board concerning "time" and Kozyrev's work is not in a good correlation with the authors' one.

Nicolay Alexandrovich Kozyrev scientifically and experimentally discovered the action of relations' interconnection, which was falsely named as time. Time cannot cause action because it is absolute and does not have any physical sense (Samat Kadyrov. Monograph "Theory of unified field").

Author's note: relations' interconnection is an interaction of structurally similar objects. It is a nuclear resonant gain-frequency process: in a stationary electric field, which is modeled by systematic organization, there is a development of similar to structural one, in-focus rays of powerful regular coherent radiations. These coherent radiations are determined by properties of chemical components of interrelated substances.

According to N.A. Kozyrev, it is ought to expect not identical density of relations' interconnection in space. Some processes decrease density; others on the contrary increase density of relations' interconnection. Action of the increased density is weakened according to the law of reversed squared distances; it is shielded by a solid matter, at thickness about 5cm, and is reflected by a mirror, according to the familiar optics law. The action of the decreased density on a detector is shielded, but does not reflected by a mirror. Properties of a matter can be changed under the influence of relations' interconnection. In this sense there is a big advantage in changes of electric current conductivity of resistor, which is brought into Witson bridge and is located near some process. For instance, in order to increase density it is useful to realize the process of evaporation of a volatile liquid; and for density decrease the process of cooling of a warmed-up agent can be realized. Due to these processes, change of conductor resistance is actually realized with opposite signs. Increase of density of the conductor with positive temperature coefficient leads to decrease of its resistance. At negative temperature coefficient there is an effect of the opposite sign, in the direction of changes, caused by temperature changes. Such correspondence to fall in temperature should be observed at changes of other properties of a matter, **because disorder in a matter structure is reduced along with fall in temperature**. The researches have shown the following results at the resistor, which was situated near processes of acetone evaporation on cotton wool and of solution of sugar in water. The

relative resistance change of resistor was observed at the 6th or 5th digit after comma (or even at the 4th digit if resistors had especially high temperature coefficient).

There is now a possibility to study the Universal World not only by means of the investigated spectrum of electromagnetic oscillations, but also through physical properties of relations' interconnection.

At many researches the influence of relations' interconnection on resistor electroconductivity was investigated. Acetone evaporation (at 10-15 cm distance from the resistor) was applied there as the process, which controls sensitivity of a system. However, the process of evaporation can influence on the resistor not only with density increase, but also due to temperature increase that occurs at evaporation. In order to take into consideration this cooling effect, (in the area of evaporating acetone) temperature was measured by Beckman mercurial thermometer with 0.01°C multiplying factor. The first experiments (without thermal protection) have shown the fall in temperature by several hundredth of degree. This fall was enough to cause the changes of resistor electroconductivity. However, the thermometer had been keeping on the demonstration of practically the same fall in temperature at thermal insulation of the resistor. The thermometer reacted on the radiation of relations' interconnection at acetone evaporation.

The part of the thermometer with a placed in a pasteboard tube mercury tank was laid round with cotton wool and put into a glass retort. The experimental process was fulfilled near the retort, and the reading of mercury altitude in capillary was determined by the scale of the thermometer through the closed window in the next room. The mercury altitude was decreased at dissolution of sugar in water (with steady temperature) and it was increased at the release of the squeezed spring, which was placed near the thermometer.

The radiation of the relations' interconnection was observed from many stars. It is caused by the inner processes, which take place on these heavenly bodies. The Sun (with its turbulent processes) radiates the relations' interconnection besides the searched electromagnetic radiation. Actually, if sunlight is recovered with a thin screen, the significant influence on the resistor will be discovered. The influences of the Sun to the Earth through the relations' interconnection become doubtless. These influences of the Sun should have a particular significance in vital functions of organisms, because it brings the beginning for life support. The totality of the researches demonstrates the dependence of matter state from the changes of the general background of the relations' interconnection. The drift of the devices (that show daily changes) usually stops about at midnight and then changes its direction. As for the seasonal course, there is a density decrease of the relations' interconnection in spring and summer; and there is an increase of it in autumn and winter. It is connected with the absorption of the relations' interconnection by the vital functions of plants and with the return of it at their fading. There are indications at the seasonal changes of chemical processes. For instance, reaction of polymerization has more difficulties in its realization in springtime. V. Zhvirilis observations of minimum and maximum light admission by means of the crossed Nickolya prisms can be explained by the crystalline reconstruction of these prisms.

By Kozyrev, as being invisible, vital source is disseminated everywhere in Nature, thus possibility of its accumulation is the only necessary thing. Such a possibility is realized in vital organisms because all vital functions counteract to the usual course of systems' destruction. The ability of organisms to keep and accumulate this counteraction is the reason, which determines the great role of biosphere for the Earth life. But even if we assume, that spreading of life in Space is one of its peculiar properties, biosphere will not have a decisive significance.

Cosmic bodies (and first of all stars) can serve as the reservoir, which gathers vital source. Enormous stocks of energy flow out of stars in a very weak degree through the radiation of comparatively cold external layers. Inner stars energy is preserved so well, that even at the lack of supplement, matter of the Sun would become cold only at one third degree per year. For the Universe the creative source carries the relations' interconnection. Thus cosmic bodies are necessary for support of life.

Author's note: We apprehend relation's interconnection as natural radioactive background. In fact, it is a nuclear resonance gain-frequency interaction of inertial masses that depends on living systems, especially on its rituals and that regulates its survival. Cosmic bodies regulate this process. Humanity is able to control nature only obeying to natural laws. In-focus beams of powerful laser streams are formed in the electric field of living system organisms. The creation of proton-antiproton pair in the living cells, alongside with the process of the absolute release of energy serves as a creative vital force. The process of radiation, support, absorption of energy by the organization (assembly of particles) is realized through the relation's interconnection and regulates its total mass.

Humanity is able to control nature only obeying to natural laws.

Life without Diseases and Old Aging Preventive Electrical Heater with Programmed Features

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Universal electrical bio-heater is intended for heating of rooms and preventive clearing of an air atmosphere from disease-producing organisms at continuous exposition (continuous work). The principle of its work fundamentally differs from those of the existing analogues. Carbon crystals are in the basis of bio-heater, which makes it environmentally appropriate.

Bio-heater represents a range of ceramic cylinders, jointed with metal plates on top and underneath. These plates play the role of load-carrying structure. It is used in production areas and living rooms for heating alongside with destruction of pathogen microorganisms. One bio-heater with 0,2 kWtt power is oriented for heating of the area with volume 35-45m^3 (in the future production of modernized models powered from solar cells is planned).

As distinct from the usual oil heater, preventive electrical bio-heater destructs agents of infectious diseases, whereas, according to the researches, oil heater stimulates their reproduction.

Absolute ecological cleanness is obtained by release of the quarters from the effect of increased atmospheric dampness with the temperature, appropriate to sanitary code. Any type of mold or fungus disappears in the quarter and in the future these forms do not renew their existence (even after removal of bio-heater).

The absence of injurious radiations is attained by the following: features of raw material, which is used during the process of electrical bio-heater production; radiation is normal during bio-heater working. Pollution-free temperature influence is attained by favorable infrared radiation.

Among the other properties of electrical bio-heater there are following: fire-safety; explosion proof; chemical inertness; enormous effectiveness from the point of view of electric energy demand. Structural simplicity facilitates its durability; there is nothing in bio-heater to be broken.

Technical aspects (applied Know How): In the process of technologic production of ceramic cylinders, from which bio-heater is consisted, **diamond-like cellular ceramic structure** with superimposed combination of atoms of lattice elements is created. Rhythmic work of cells, which form ceramic mixture, leads to resonance and creates a kind of blow wave (at micro level). This blow wave physically destroys microorganisms that have no calcium framework. It is related only to those microorganisms that are agents of infectious diseases, such as: staphylococcus, enterococcus, enterobacterium, etc. Thus parameters of the evoked blow wave coincide with vibration frequency of the definite types of bacterium and elementals. These blow waves cause the similar effect in room near of bio-heater, e.g. colonies of microorganisms are noticeably decreased there (even at the absence of bio-heater in the nearest room).

Due to its self-organization, bio-heater works in the range of living systems, it is approached to them. There is a realization of active connection with living coaly forms of biological systems. Actually the work of bio-heater is adjusted to them. Bio-heater properties can be programmed at the process of its production.

Bio-heater is a patented product. Patent KR #464 MKI C 04 V 33/24 "Ceramic mixture, possessing heat-radiating properties". Application #20010075.1 at Patent KR #464 MKI C 04 V 33/24 "The way of creation of energy, renewable, programmed hard-phase ceramic-carbon mass structure". Application at Patent KR #464 MKI C 04 V 33/24 "Technology of producing of electrical heaters with anti-resonant air prophylactic effect".

Finale product (FP) purchase is not more expensive than those of existent models of electrical heaters. Cost value is noticeably brought down on organization of the scaled production. It is ought to take into consideration that from all existent types of heating, from the customer's point of view, this one is the most energy-efficient. Manufacturing of such bio-heaters can be organized on the base of acting industrial production of ceramic fabrics. It will require some expenses. Moreover production service is rather cheap because there is no need in maintenance staff.

Electrical bio-heater can be applied everywhere, where there is a need in: a) economical heating; b) decrease of air moisture; c) disinfections of rooms.

As for the life cycle of bio-heater it does not become obsolete morally and technically. It is produced from the materials, which are not liable to wear.

The invention has a certificate of KR Gosstandart. From the end of 1998 the first unimproved modification of bio-heater (with power 0,6 KWtt) were put into serial production in Bishkek (with small test production runs). This time bio-heaters are readily used as medical equipment in hospitals and maternity hospitals in Bishkek. **Inventor: Alexandra L. Belyaeva.**

Technical Report

The comparison of quantity of heat energy, required for heat of rooms, and of heat quantity, which is produced by Belyaeva's electroconvector.

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Editor's note: this calculatious demonstrates the advantages of the device, which at 340 Wtt energy consumption produces about 700 Wtt of heat power.

The calculation of heat output, coming from the ceramic electroconvector to a room, was based on the basis of research statement of EVNA-0.2/220 electroconvector's influence on air micro flora of industrial rooms at 23.10.01. - 06.11.01. period.

The researchers were carried out in the arbitrary room in a four-storied large-panel building. This room was on the 3rd floor, with facing east windows. The room was of 52.5 m^3 air-space, 3.5 m height and 15 m^2 area. The calculation of heat, was made on the basis of "Methods for calculation of the requirement in heat and electric energy of buildings". These methods were registered by Department of Justice of Kyrgyz Republic on 08.09.2000, #154. According to the normative data, temperature of inner air (t_{in}) in the room must be equal to +20° C. In Bishkek planned specified temperature of external air (t_{ex}) for heating is minus 23°C. The average temperature of heating period is t_{av}= -0.9°C, specific heat characteristic of the building is:
q=0.4 Kcal/m^3 h °C.

Medium quantity of heat energy, which is required for heating, is determined by the formula:

$$Q_{av}heating = q \cdot V \cdot (t_{in} - t_{ex}) \cdot 1.12 \cdot \cdot [(t_{in} - t_{av}) \div (t_{in} - t_{av})] \text{Kcal/h}$$

$$Q_{av}heating = 0.4 \cdot 52.5 \cdot (20+23) \cdot 1.12 \cdot \cdot [(20+0.9) \div (20+23)] = 492 \text{Kcal/h}$$

Thus at the average annual temperature of the heating period, which is: t_{av}= - 0.9°C, the quantity of heat energy required for this room, comes to 492 Kcal/h.

According to the research statement, the trials of the electroconvector with 200Wtt power were carried out at the following external air temperature: +10.2°C; +8.5°C; +10°C; +6.6°C. The calculation data and results of its examination are brought together in a table. The parameters of electroconvector with 340Wtt power are demonstrated in the same table.

Table 1
Table of determination of heat entry and heat consumption's correspondence in the experimental room

#	External air temperature, °C	Inner air temperature °C	Normative heat consumption KWtt (Gcal/h)	Experimentalheat consumption KWtt (Gcal/h)	Percentage depending on normative heat consumption %	Economy of heat energy kWtt (Gcal/h) comparing with power consumption of the device 0.2 kWtt (0.000172 Gcal/h)	Economy of heat energy kWtt (Gcal/h) comparing with power consumption of the device 0.34 kWtt (0.000292 Gcal/h)
1	- 0.9	+20	0.572 (0.000492)		100	-	
2	+10.2	+20	0.267 (0.00023)		100	-	
	+10.2	+16		0.158 (0.000136)	59	0.2-0.158=0.042	0.34-0.158= =0.182
3	+8.5	+20	0.314 (0.00027)		100		
	+8.5	+17		0.233 (0.000200)	74	0.2-0.233=-0.033	0.34-0.233= =0.107

4	+10	+20	0.273 (0.000235)		100		
	+10	+23		0.355 (0.000305)	130	0.2-0.355=-0.155	0.34-0.355= =-0.015
5	+6.6	+20	0.366 (0.000315)		100		
	+6.6	+19		0.338 (0.000291)	92	0.2-0.338=-0.138	0.34-0.338= =0.002

Calculation data demonstrate a considerable economy of heat energy at daily unevenness of external air temperature.

Heat productivity of the new structure of electric convector with 340Wtt power was calculated on the assumption on the suggestion that heating of the room is carried out by the irradiation at the process of heat exchange.

$$E = \varepsilon \cdot C_o \cdot T^4 \cdot 10^{-8} \quad \text{Wtt/m}^2$$

where: C_0 =5.67 Wtt/m^2 K^4 is a radiant emittance of blackbody, ε=0.93 is an emissivity factor of the surface of earthenware duct tube; T=70°C=343 K is the temperature of the surface of earthenware duct tube.

On substitution of the known values into the formula we get:

$$E = 0.93 \cdot 5.67 \cdot 343^4 \cdot 10^{-8} = 727 \text{ Wtt/m}^2$$

As the area of irradiation surface is equal to S=0.96 m^2, then quantity of heat, which is evolved by the convector, comes to:

$$E_k = S \cdot E = 0.96 \cdot 727 = 698 \text{ Wtt (or 600 Kcal/h)}$$

The quantity of heat, which is required for the heating of the room, is 492 Kcal/h (at the external air temperature equal to minus 0.90 and temperature in the room equal to plus 200).

Thus, electric convector with 340 Wtt power is able to heat totally the room with 60m3 area.

Editors note: 340 input and 700 output!!!

Longitudinal Waves in Vacuum: Creation and Research

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The author presents a new elegant system, which is the symmetrized Maxwell's equations. In practice it gives a possibility to create the longitudinal waves in vacuum. This system is of great importance in telecommunications and aerospace technigue.

There is a stable paradigm in electrodynamics that the existence of the longitudinal waves in vacuum is impossible. This paradigm played its negative role preventing scientific minds from solving this problem. However, Maxwell was not as categorical in his opinion on this question as his following were.

Particularly he wrote: "Science of electromagnetism as well as optics is not able to confirm or deny the existence of longitudinal oscillations."

Maxwell's dynamic equations are usually considered as partial derivatives in time. However, the total derivative in time includes the so called substantial derivative, which was shown in the equations for the moving coordinate system. In particular, one of these equations was written by Maxwell himself to explain the phenomenon of electromagnetic induction discovered by Faraday. This induction takes place in the conductor moving across the field lines of electromagnetic field:

$$\vec{E} = \vec{V} \times \vec{B}\,; \qquad \text{(I)}$$

Other equations were obtained later by other scientists. In the table I below Maxwell's equations are given in a split form. Their static and dynamic parts are given separately as well as the equations for moving and fixed coordinate systems. Such matrix concept of Maxwell's equations allowed finding their incompleteness. Really, the analysis of the matrix shows its high symmetry. However, full symmetry of the system of equations is broken by the absence of the equation (X). It seems to be strange and calls a desire to remove this defect in such an elegant system of equations.

A new equation is introduced in the Table 1 for the full symmetry of the matrix:

$$\nabla \cdot \rho = -\frac{1}{c^2} \cdot \frac{\partial \vec{j}}{\partial t}\,; \qquad \text{(X)}$$

Fundamental Properties of Aether

Alexander M. Mishin

Author's note: In the article the principles determining major properties of aether are formulated on the basis of an empirical material.

Real aether [1-6], the primary and superfine essence of which is still a secret, has turned out to be absolutely non-standard superfluid three-dimensional material medium, which simultaneously is at solid, liquid and gas phases. The first master phase of aether is a specifically solid absolute space or an energetical "bottom" of the Universe ("celestial stronghold"). At that the solid phase is considered as mesomorphic vortical-wave structure, which has particular holographic properties. Classical matter represents to be one of the stable and energetic space-time levels of the Universe. Aether vortexes exceed all conceivable space scales, have quasi-material properties and create a great number of stereo-dynamic subspaces (parallel worlds).

The first basic principle, to which aether entirely follows, is the principle of the least disturbance (the least action). Many well-known and unknown physics laws are the subsequent of this principle. In particular, any motion in macroscopic aether happens in such a way to minimize the interaction with the matter of our world, with zero moment of the disturbance momentum. In the classical physics this principle has been reflected as Le Shatelye principle, as variation principle, laws of thermodynamics etc.

The second principle is the principle of fractality, which confirms the similarity of forms and properties of quantum aether vortex structures regardless of their space scale. This principle also determines the Universe as stereodynamically multivariate system in the form of hierarchy of vortical-wave structures of the unified aether (fractal matreshka). On the researching of the macroscopic objects of the Universe it is possible to make a conclusion about microcosm structure if taking into account the changes of frequencies and velocities of action transmission.

In the third place there is a principle of physical autonomy, which confirms that any solitary mass (for example a planet) creates aether system. The particular principle of relativity, which reflects one of the fractal properties of the Universe, can be applied to this system. Such autonomous mass becomes similar to the miniuniverse with its aether subspaces, which repeat the basic phases of the Universe spectrum in more narrow (which depends on the size of mass) frequency band of space-time frequencies. Thus, in the local system of the Earth solid aether reproduces the structure of gravitational field with energy "bottom" in the mass center. As the result such spherical body occurs to be an energy drain and warms up from within.

The fourth is the principle of interaction between matter and vortex-wave forms, which do not depend to the spectral part of the Universe, that is quasimatter. This is the principle of new interaction in nature. The value of energy interaction in each experiment diminishes in time according to exponential law that is explained by the forming of energy informational or adaptation barrier, which separates parallel worlds and reflects the properties of vortex tenacity of aether as superfluid medium. At that, time of interaction is proportional to the size of quasimatter and the barrier for the earthly conditions is lowered at the indefinite period, on the assumption of only thrice-repeated observation of forces (triad law).

According to this principle, aether dynamic experiments in the earth laboratory do not have classical repeatability that, from the one hand, gives occasion to doubts in the objectivity and scientific character of the non-traditional experiments and from another hand it is the most reliable test feature of macroscopic aether motions. Biosystems have special relations with this principle.

The fifth is the principle of many-dimensional autobalance of forces. All vortex and linear motions of macroscopic aether organize themselves in the way that in the band of space-time spectrum of the local system (usually with the aid of fluid and gas aether) occurs to be self-balanced, that is they have zero resulting impulse and the moment of impulse due to the existence of the proportionate antivortexes and antistreams of another spectral structure at the same space volume. The self-balanced vortex structures and streams are practically closed for the outer watch from the direction of our material world, at least with respect to the methods of classical physics. The principle of autobalance of forces reflects aether properties as unified synergetic system and has a significant applied meaning.

Let call the principle of viability of aether dynamic systems as the sixth principle. Only a stereodynamic multivariate system is a viable one, that is a system, which during a definite period of time has the opportunity, called as life cycle, to realize interconcerted self-oscillating processes of vortex-wave character simultaneously at different phase states (subspaces, layers) of aether. The most important features of such a system are its space-time quasimaterial (vortex-wave) broadbandness and finite time of existence, which is determined by the conditions of creation of the energy-informational barrier. Self-oscillation regime demands the presence of an energy source, oscillatory circuit (a pendulum) of any character, intensive process (of negative tenacity) and a channel of positive feedback (negative entropy).

In the sense, referred above, any material system is viable and occurs to be a big system in the form of coordinated community of multivariate subsystems. In its turn each big system as a part of the hierarchy is a

constituent of bigger system, until everything is embraced by the Biggest System, that is the Universe.

The seventh principle of the universal energy interchange is the physical realization of the law of unity and struggle of oppositions. This principle determines spontaneous creation of thermodynamic and antigravitation potentials. Any local matter mass (a body), situated in the open space, creates an exchange process with the surrounding aether volume in the way that more fine-structure fluid aether is absorbed by the body, and the less power-consuming gas aether is radiated. As the result the body as a heat engine gets energy due to the cooling of aether exteriors. At that, antigravitation forces acts between bodies and aether exteriors, which have different temperature.

This principle, which establishes the existence of antipodes of the second law of thermodynamics and Newtonian attraction, is realized mainly in cosmic scales and explains in which way the energy is created in the bowels of planets and stars and why the Universe is stable as regards to gravitation. Obviously, the most unexpected for the modern Physics is the discovery of non-traditional nuclear processes where conditional reactions of decay and fusion occur at the usage of quasimatter.

More deep research of new experimental results and of the stated above scientific principles lets to determine the priority-driven strategic tendencies in Physics, to open more entirely the laws of mechanics and thermodynamics of many-dimensional aether, including the theory of non-traditional waves and new types of electromagnetism. At that, the supreme aim is the research of differences in aetherodynamics laws on the Earth (in a laboratory) and in outer space, the unknowing of these differences has caused logical insularity, false all-sufficiency of classical physics, which had refused as "not wanted" the aether conception and fundamental Universal laws.

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Irving Langmuir and Atomic Hydrogen

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Editorial

In this paper Dr. Nicholas Moller describes the history of development of Atomic Hydrogen technologies in details. It is remarkable that this technology can be applied not only for welding processes but also as a clean free energy source. It is important to note that in this case the hydrogen process does not involve a consumption of hydrogen, which is not combusted in the process. Atomic hydrogen is not really a fuel but rather a medium, gateway or a super-conductor of ZPE form the vacuum of space, converting ZPE radiation and ultra-high frequency electrical energy into infrared (heat) radiation.

This is the story of Irving Langmuir who was the first to develop a theory on Atomic Hydrogen on the basis of empirical research and experimentation. His work in this field lasted from 1909 to 1927. During this period he was employed by the Research Laboratory of General

Irving Langmuir.

Electric Company. Patents and discoveries developed by Langmuir during his time with General Electric were to a considerable extent instrumental in laying the foundations for what is today one of the largest corporations in the world.

The question that gave birth to this article, is why his work and discoveries on Atomic Hydrogen were the only work that received hardly any attention at all and why his revolutionary breakthrough was deprived of world attention for almost 100 years? This question becomes even more relevant when taking into consideration the high standing he enjoyed with his contemporaries (including being awarded the Nobel Prize in Chemistry)

and it is better to make it distantly after exclusion of man presence near experimental stands and devices. At the same time it is quite obvious that on applying of small capacity and fixed time of irradiation it is possible to develop methods for curing of human diseases, which are considered now as incurable (for instance of diabetes, some diseases of haematogenic system, of cancer and possibly of AIDS.

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Effect of Magnetic Blow Wave Field on Wine Systems

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Introduction

Authors communicate the data on influence of Magnetic Blow Wave (MBW) field on several wineproducts. It was found, that MBW did not lead to significant changes in the major components of the wineproduct (sugar, organic acids, minerals). At the same time the taste and aroma of treated wine become more pleasant; content of heavy alcohols and wine stone in the treated samples was less than in non treated ones. A mechanism of transformations was also discussed.

Keywords: *Magnetic Blow Wave (MBW), Wineproduct, GLC of aroma compounds and ethanol, HPLC of sugars, Atomic Absorption Spectrometry (AAS) of minerals, Heavy alcohols and aldehydes, Wine stone, Turbidity tendency, Organoleptic evaluation*

Magnetic Blow Wave (MBW) was obtained for the first time during the investigations on ball lighting generation under the laboratory conditions (Shakhparonov 1994). MBW as a physical object is interesting because of some facts, which suggest that MBW is a magnetic monopole. The MBW can also interact with the matter and transforms it in a definite way. Typical example is an elementary carbon in the form of graphite, which is transformed by such magnetic treatment into ferromagnetic substance (ibid). The graphite, which is initially diamagnetic, transforms to paramagnetic one with general radiation doze of about $7 \cdot 10^{19}$ neutrons/cm^2. Other types of radiations could not affect this way (Svoistva 1975). So one unit of MBW can be considered as $1 \cdot 10^5$ of neutron masses. This fact may be regarded as an indirect evidence for assuming that MBW and magnetic monopole are the same things. In the absence of excited radioactivity a slow MBW [$v/c < 1 \cdot 10^4$] occurs, which does not ionize atoms (Devons, 1963). Therefore, their interaction with the matter can be observed only indirectly. No data exist on the interaction of MBW with organic substances. The experiments and results reported in the present communication may be a starting point for development of technology and to formulate the methods for vintage wine and best quality spirit production.

Materials and Methods

Assuming that MBW and magnetic monopole are the same things, a number of conditions were selected for all experiments. The MBW source and the samples were placed in the same axis and the axis was oriented according to magnetic meridian direction. Such magnetic orientation is appropriate, as the energy of magnetic monopole theoretically increases in a magnetic field (Devons, 1963). All of samples were placed at 250 cm distance from MBW source, in hermetically closed glasses. It should be noticed that MBW could penetrate through many other barriers, for example into cast iron reservoir with wall thickness of 5 cm (Amaldi, 1970).

The quality investigations were made by using of standard equipment. HPLC, equipped with refractometric detector was used for sugars estimation. Separation of organic acids in forms of their ethyl esters and acid esters was carried out chromatographically using a column packed with polyethylenglycol succinate and the following temperature option: initial temperature is 120°C, final temperature is 220°C, temperature growth rate: 8°/min. GLC was also employed for determination of ethanol. Minerals content

was examined with Atomic Absorption Spectrometry (AAS). Electronic spectra of samples were obtained with double beams UV Vis spectrophotometer equipped with permanent wavelength scanning. Redox potential was measured with EV-74 potentiometer.

The aroma alterations in the wine samples were investigated by GLC method after preliminary concentration of aromas by solid phase adsorption. The concentration was carried out by barbotation of inert gas (nitrogen) through liquid and consecutive catching of volatiles with tube trap, filled by Polysorb 1 sorbent (Lur'e 1972). The well-known analogue of Polysorb 1 is Porapak Q. The tube may be regarded as a short chromatographic column, and volatiles go through it according to their retention times. The choice of sorbent was motivated by the fact, that retention times of water and ethanol was rather small (ibid). Thus, a concentration process can be ended at the moment, when water and ethanol have passed through the column, as the other volatiles remained bonded. The aroma desorption was made with ethyl ester. The analysis of the concentrates obtained was carried out with gas chromatograph equipped with flame ionisation detector (FID), column 3 m x 3 mm, packed by Carbovax M on the Supelcoport. Temperature for the analysis was programmed from 100 to 190°C with increase of 1°/min. Isothermal conditions in the borders had durations of 2 and 40 min respectively. The "mild" conditions of separation were also employed (initial oven temperature was 80°C with isothermal condition duration 5 min, temperature growth rate 1°/min, final temperature 150°C and isothermal condition duration 40 min).

Optical activity was tested with Spectropol at D line of Na (580 nm). The samples were evaluated organoleptically by a group (12 persons) of workers from Russian Institute of Canning Industry. Turbidity tests were made under the methods of Valuiko et al (1987). In some cases, qualitative tests were completed by MPL turbiditymetric measurements. Before testing samples were filtered. Determinations of heavy alcohols and aldehydes contents were carried out in accordance to National Standard (GOST, 5363-67) as follows below. Determination of the constituents of "heavy spirits"(i pentanol, i butanol) was based on reaction of the sample with salicylic aldehyde in a presence of H_2S0_4. Rose colour develops if sample contains the heavy alcohols. The density was measured with Vis-photometer and the quantative determination was carried out using standard graph made with mixture solution of i pentanol and i butanol. A method for determination of aldehydes content is based on a reaction of fuchsine sulphite. The developed colour was measured with Vis-photometer. Calibrating plot constructed basing on typed solutions was used for quantification.

Results and Discussion

Investigations of wine quality changes after MBW treatment were performed using two samples of portwine ("Zemfira") type wine. Sample 1 was a reference (non treated) and sample 2 was treated with MBW.

In both samples, the fructose and glucose levels were practically the same and amounted to 43.8 ± 3,32.22.5 g/*l* respectively. Sucrose and maltose were absent. Total sugar content was 76.0 g/1 though the level marked on the label was 80 g/*l*. It is thus apparent that the treatment of wine with MBW does not lead to noticeable changes of sugars content. Results of organic acids determinations are given in the Table 1.

Table 1
Main organic acids content, g/1

Acid	Treated wine	Initial wine
Lactic	0.0265	0.00187
Oxalic	0.010	0.0088
Succinic	0.209	0.18
Malic	4.56	4.22
Tartric	0.0805	0.0895
Citric	0.401	0.483

Standard deviation for the determination method was estimated as 7 %. This fact shows that differences in organic acids content are not significant. It should be noted that a tendency of slight increase in light acids (up to malic) in the treated wine was observed in contrast to noticeable change in more heavy acids. The ethanol content of both of samples was 181 and 184 g/*l* for non treated and treated samples, respectively, though the label on the bottle indicated 190 g/*l* concentration. Standard deviation was 5 %. Thus, MBW treatment does not lead to significant changes in alcohol content.

Atomic Absorption Spectrometry (AAS) data indicated that the samples were practically identical in terms of K, Na, Ca, Mg, Fe, Cu and Zn contents (data are not shown).

Similarly, spectra of treated and non treated wines, diluted 150 times before photometring, were practically identical, thereby pointed out that polyphenols are unchanged.

When wine is industrially treated with IR or microwave heating, ultrasonic, ultraviolet and g radiation, different reactions occur and there include redox reaction, esterification, condensation, hydrolysis, Maillard reactions, etc (Kishkovsky 1988). Most of reactions are accompanied by redox potential changing. Increase in Redox potential points out the increase in concentration of oxidants, i.e. oxygen, peroxides, and other compounds, which are electron acceptors. Redox decrease is a result of oxidation processes (ibid). Redox potential was practically constant ($\Delta E =$ 145 mV and 150 mV in samples # 1 and 2 respectively). Evidently, oxidation processes, like they occurred during heat treatment, were absent during the MBW treatment.

One of the important reactions to be considered is the Maillard reaction. Essentially it appears in form of browning, decrease in reducing sugars and amino acids, and new aromas formation. While our result evidences on absence of irrelevant aromas, alterations of wine colour, and sugar content, thereby indicating insignificant contribution of Maillard reaction on wine quality changes due to MBW treatment. Technological treatment often leads to esters accumulation that improves wine aroma. It's well known that the most important in this context are the esters of C_6-C_{14} fatty acids (Kishkovsky 1988). During heat treatment, storage and other physical influences, different kinds of acid esters accumulate. These have weaker aroma than esters of fatty acids. But their appearance proves the existence of esterification processes. A comparison of aromas chromatograms of the samples 1 and 2 proves occurrence of changes in concentrations of the individual substances (increasing of peaks length with retention times of 13.10, 100.9; decreasing of peaks length of 54.85 min). An order of peaks exit of different volatives is given in the Table 2.

Table 2

Exit order of different volatiles

Exit order, from published data for Carbovax 20 M	Retention time in our experiments, min	Exit order, from published data for Carbovax 20 M	Retention time in our experiments, min
Acet aldehyde	3.8	i-Pentanol	23.56
Ethyl acetate	4.71	i-Amyl butyrate	
Diacetyl	4.82	Acetone	
Methanol	4.91	n-Pentanol	27.92
Ethanol	6.01	i-Amyl valerate	
n-Propanol		Ethyl lactate	
i-Butanol	13.58	Ethyl caprilate	52.6
Butyl acetate	13.59	Acetic acid	
i-Butyl acetate		Diethyl succinate	
Ethyl valerate		Ethyl laurate	
n-Butanol	17.73	Phenyl ethanol	
Amyl acetate	20.70	Diethyl malate	

A comparison of retention times of components with peaks of standard substances of wine aroma indicates that butyl acetate and i-butanol are very close to peak 2. Data on chromatographic separation with mild condition showed that i butanol and butyl acetate peaks exited simultaneously. Organoleptic evaluation recorded a nice smell in the treated wine, thereby due to the formation of butyl acetate. Data indicated the presence of ethyl malate, ethyl tartrate and ethyl citrate in the samples, in addition to two peaks corresponding to ethyllactate and ethyl oxalate. The large experiment error does not allow any inference on changes of their height after magnetic treatment. Identification of peaks with retention time factor especially in such complex system is not unquestionable. However, the best way is to use the chromato mass spectrometer, which allows inference according to their individual mass-spectrum.

Organoleptic evaluation can depend on aliphatic alcohols content. Determination with GLC shows (Table 3), that their quantity in the both samples is rather small with respect to average values taken from literature for this type of wines. Thus such changes can not be recognized with such evaluation. For both of samples pH was equal to 4.0.

Table 3
Aliphatic alcohols content, mg/1

Alcohol	Sample #1	Sample # 2	Average literature values (Kishkovsky 1988)
Methanol			80-350
i-Propanol			0,3-3
n-Propanol	less than 20		5-50
i-butanol	less than 20	less than 20	20-100
n-Butanol	less than 10	less than 10	2-10
i-Pentanol	less than 20	less than 20	100-250

The results of optical activity measurements indicated, that both samples are not optical active. Filtration, clarification and dilution could not change the optical activity. Perhaps, there is a compensation of different forms of D- and L- compounds in the samples, thus total activity was very close to zero, and magnetic influences could not change equilibrium between the forms.

Organoleptic evaluation of more delicate taste and aroma of the treated sample with respect to non treated one, MBW treated sample as more complete, harmonic, noble, and natural in contrast untreated sample was recorded as excessively bitter and sour in spite of practically the same pH of samples.

It is interesting to test the tendency of wine to make a different kind of turbidity after the MBW treatment. Data showed that both samples were not positive for protein turbidity. In term of reversible colloid turbidity formation, after storage at 7.5°C for 1 day, the MBW treated sample was homogeneous, in contrast to the formation of different phases with different refractometric numbers in untreated sample. Both the phases in untreated sample were liquid, with a density very close to each other, but the borders of phases were like broken lines when crystallization begins in crystallization process. This alteration in untreated sample may be due to micelle state changes or of structurization of product.

The tendency test for polysaccharide turbidity based on the reaction with phenol in presence of H_2S0_4 and determination of the derivative formed by photometrically, indicated, that difference in concentrations of polysaccharide in the both samples are very small, the levels being 119 and 106 mg/*l* for untreated and treated samples respectively. These values are close to range of polysaccharide stability (150-200 mg/*l*), and thus do not allow any conclusion on changes of relative stability of the samples. A tendency for polyphenols turbidity, due to polyphenols associates precipitation upon addition of salt did not show differences. Turbidity, as determined in MPL apparatus, was 15 FEM as against value of 0.2 FEM before testing in untreated sample. These numbers were respectively 14 and 0.3 FEM for treated sample. Thus it indicates that both the samples are very stable with respect to polyphenols turbidity and that the magnetic treatment does not lead to alteration in the polyphenols stability.

The data on the colloid stability indicate, that both the samples showed rather high resistance against protein, polysaccharide and polyphenols turbidities. Besides, treated sample showed higher stability with respect to reversible colloid turbidities.

It is interesting to investigate as to how heavy alcohols and aldehydes, which are often produced, when low-grade technology is used, are affected by magnetic treatment. For these studies, a system of simple mixture, consisting only of spirit and water, was used. Commercial vodka bottled in standard 0.5 l bottles and artificial solutions, containing 40 % of food derived rectified spirit were used. Data showed, that MBW treatment significantly influenced the heavy alcohols content, as the reduction in heavy alcohol was more than two times. In addition, it reduced aldehydes by more than 3 times in vodka, and more than 30 % in rectified spirit. Data indicate that efficiency of aldehydes removal is higher when the sample contained higher level of aldehydes. Thus, the MBW treated vodka and rectified spirit will be better than untreated one. It is however stressed that untreated samples were also recorded as good by sensory panel. So, limits for aldehydes are usually present in high quality vodka established by National Standard (GOST 5363- 67) are 6 - 15 mg/*l*. Thus the organoleptic evaluation of samples does not allow to find difference in aldehyde levels in these samples.

Table 4

The main results of heavy alcohols and aldehydes determination (mg/1) in vodka and solution, contained 40 % of rectified spirit

Substance	Non-treated vodka	Treated vodka	Non-treated spirit	Treated spirit
Alcohols	8.7	2.55	3.38	1.5
Aldehydes	1.5	0.4	0.6	0.4

Sediments formation and its character were also evaluated. The sediment in treated grape juice was dense and more dark, the formless, non crystalline sort, and gel like form. The volume of the sediment occupied up to 30% of total volume. The sediment did not sink or float, nor it stick to the walls of glass. It was found that 100 ml of juice gave about 155 mg of dry sediment. Microscopic investigations showed an absence of any kind of bacteria or fungi in the sediments.

The effects of high energy of magnetic influences on sediment were also investigated. The experiments were carried out with "Portwine Erevanski, vol. 0.5 1, white, spirit content 19 vol %, sugar 10 %, prepared according to GOST (National Standard) 7208-84". Crystalline sediment appeared on the walls and especially on the bottom of the bottle after the BMW treatment. An amorphous precipitate was also presented, and it can be separated by decantation. Crystalline sediment, after washing with ethanol and drying to constant weight, weighted 69.2 mg, and was of bright brown colour. A tartrate content as a tartrate acid, of the sediment was 59% mass. If it is considered as a tartar (a wine stone) of potassium sodium tartrate, then tartar content in sediment works out to be 86%. If it is considered as a tartar of dipotassium tartrate, tartar content in sediment will be 93%.

Generalization of data shows the positive effect of magnetic treatment on the wine samples, leading to harmonic taste of treated wine and absence of non

pleasant tastes. Most of the changes were found to bein the flavour and taste components, which were minor substances in the product. For example esters concentration changes during the treatment. At the same time the content of major components, such as sugars, organic acids, particularly, heavy organic acids, and especially ethanol remain constant. It seems logical from kinetic point of view, when simple processes, like esterification, are preferable with respect to many stages reactions, and reactions with high activation energies, which can go at hard conditions. Also, it seems logical that magnetic treatment may influence on electrical state of colloid species. Thus magnetic treatment can be considered as mild, selective in the comparison with many other physical methods. Nevertheless, the changes lead to acceptable energetical and nutritious value of the product. Data show that difficult problems, such tartar removal, can be solved by MBW treatment.

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The Fundamentals of the New Principle of Motion

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The concepts of active and passive interaction between the moving object and the space form the basis of the new principle of motion.

So as to be more understandable, let's consider what is the old principle of motion. For this we will use the concept of a moving object and the space in which the object is moving. Naturally, material objects and the space can't interact between each other directly, because the space is the philosophical category. In this case we can understand physical essence of natural phenomena easily. In our view, the material objects interact with some fundamental energy of space (FAM), which fills all space with a different density. Thus the energy (FAM) is inalienably connected with the space. One of the first names of this energy is "ether" in the early scientific works. So, for the simplicity we will accept that the object and the space interact between each other.

Thus, all existing methods of motion which have been invented by mankind till the present time are based on activity of the material object that means the one expends some energy to produce the motion, and at the same time space is passive, it means that space does not need to spent any energy to move the object. And so in common case space tries to keep the object in the former state interfering with accelerated movements of the object (in accordance with **the 1st , the 2nd and the 3rd Newton's laws**).

It should be noticed that such method of motion (for the speed, which is much less than the speed of light) takes place both in animate and inanimate natures. In this case the level of energy of motion and reaction of space (or an environment) are not very high. Incidentally, the energy of object can be of different types: electrical, chemical, biochemical, mechanical etc. The common consequence of this type of motion is existence of the ***inertia***. The classical physics can't answer the question: "what is inertia?» The same situation is applied to the concept of ***mass,*** which is closely connected with inertia. The classical physics says that ***the mass is a measure of inertia.***

There is the new principle of motion of material object: the object is passive and space is active. In this case it's more favorably for space in the energy aspect to move the passive object and to spent some power then to keep the object in the present place in the former state of immobility (in accordance with **the 1st, the 2nd and the 3rd Newton's laws**). And so we should introduce **the 4th law of** Newton's **mechanics**. It says that ***there are the systems of coordinates in which the body is moving not rectilinearly with acceleration when this body is in the state of immobility***.

The basic and the main differences of the offered principle of motion from the existing methods at the end of the XX century are the following:

1) The absence of inertia of motion;

2) There are no limits for the speed of motion;

3) The absence of "fuel reserves" "on board" of the moving material object.

Nikola Tesla and Instantaneous Electric Communication

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Nikola Tesla (1856-1943), an outstanding inventor, was and still remains one of the most mysterious persons in the history of electrophysics. Whereas the most scientists were moving together in direction of microparticles investigations, as the basis of matter structure and of nature itself, he was going in opposite direction. He had a keen interest in the investigation of electric charge of the Earth as a whole. He was looking for the ways to influence on it, to control its state and methods of its regulation.

Therefore, exactly, the most of his searches, experiments, the purpose of constructions and buildings, created according to his conceptions, cause perplexity and misunderstanding of scientists even in nowadays.

The most mysterious of his main experiments were made in USA after 1904. After Nikola Tesla death in 1943, all his diaries and records over a period from 1904 year had mysteriously disappeared. Probably they were stolen (it was known, what to take). Lost records could "cast light" on one of the most "strange" of his buildings in the form of the enough tall tower, on the top of which a specially created toroidal transformer was placed. This transformer could create there a huge electric potential up to the billion volts.

Nikola Tesla switched on this tower-device, what caused the fright and even panic in mind of people from nearby settlements. Of course! Because of very high electric potential there began air ionization, which spread very high to the atmosphere accompanying by the effect of color play. Such luminous, color-playing sky caused even a horror of people, who knew nothing about the experiment made and its goals. They did not guess that Tesla by means of the electric charge, created of the tower, was influencing on the electric charge of the Earth as a whole (about 600000 Coulomb). There was a global scale in Nikola Tesla's investigations.

There is no point in detailed analysis of the fact that the potential of the tower top influenced on the Earth charge. Interaction of charges-balls with the distortion of field lines, distortion-distribution of charge on their surfaces, induced charge, is beautifully described even in school physics textbooks. In Nikola Tesla investigations the Earth had the role of one of the charged balls. It was possible by changing of charge on the tower to deform electric charge distribution on the whole Earth surface at once. This deformation (electric currents) could be fixed at once in every point of the Earth surface. It is alluring to use this effect for data transfer telecommunication, both on the Earth, and in space.

After such introduction the question "How does the system of instantaneous electric communication for any distance look like and work?" is still opened. First of all, the readers need to know, that such instantaneous communication is possible in principle. The proving it theoretical calculations, are rather difficult for popular interpretation. Some part of readers can take it on trust, and those who are most interested in can apply to works of Oleinik V.P. (quantum physics) the professor from Kiev Polytechnic University. At the minimum there are two necessary works: Oleinik V.P. "Faster-than-light transfer of a signal in electrodynamics. Instantaneous action-at-a-distance in modern physics" (Nova Science Publishers. Inc. New York. 1999) and Oleinik V.P. "Latest development of quantum electrodynamics: self-organizing electron, faster-than-light signals, dynamical heterogeneity of time." (Physical vacuum and nature. 4. 3-17. 2000).

"PC" magazine has devoted a rather significant article entitled "Computers and teleportation" to V.P. Oleinik works, concerning instantaneous electric communication ("PC" #6, 2000). Note, that the author of the given article has also found the possibility of instantaneous electric communication, but by means of materialistic methods, absolutely different from Oleinik's ones, what is most important – two different solutions point to the possibility of this communication. "PC" #6, 2000 in the article "Circles on fields" cited mathematical formulae of the structure of electron electro-magnetic field as an illustration (it refers to the Earth too) that the author of this article has got.

The most attentive readers of that article could notice, that one vector Hz absolutely "ignores" Special Theory of Relativity, since its mathematical expression does not include the velocity of light, whereas it presents in other vectors as a product of electric and magnetic conductivity. Magnetic line of this Hz vector goes to infinity and returns back from infinity. It surrounds the whole Universe. It is alluring to use exactly this (Hz) line for the **instantaneous** communication for any distance.

It is not so difficult to do it. In the Fig. 1 the easiest and most available for understanding line of the **instantaneous** electric communication is shown. A rotating charged dielectric ball (an "electron", isn't it?) is used as transmitter. The ball can be electrically charged up to the limit of charge flow-out into the ambient space. Around the charged rotating ball there appears electro-magnetic field, entirely analogous to the electro-magnetic field of the Earth (and of the electron too). The central magnetic line Hz goes to the infinity and returns

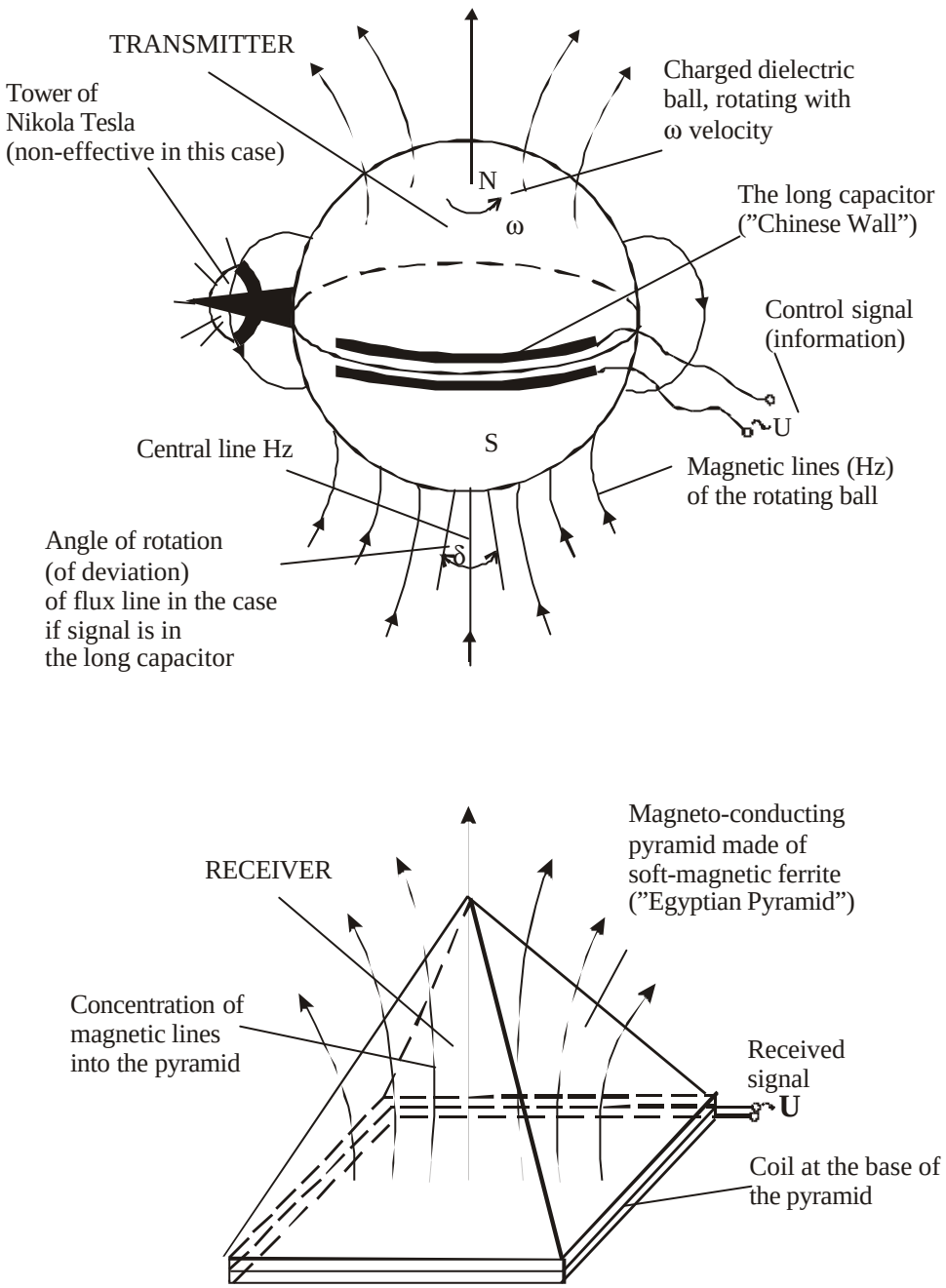

Fig.1

Line of the instantaneous electric communication on the basis of rotating charged ball and pyramid

back from it to the opposite side of the ball. In the same way the central magnetic line of the Earth (Hz) goes from one pole to the infinity through the whole Universe and returns from it to the center of the opposite pole.

If by the information to force the rotating ball (electron) to "wag by tail" (by Hz vector) which stretches through the whole Universe, then this "wagging" can be controlled instantly in every point of the Universe. While the rotating ball has a steady distribution of the surface charge, the line Hz does not change its dynamic position in the Universe.

If such distribution of the surface charge is broken, space position of the line Hz also will change. On mounting the Tower of Nikola Tesla on the surface of rotating ball and measuring the potential on this tower in time with an information it is possible to change the charge distribution on the ball, and, respectively, the space position of central magnetic line (Hz) in the whole Universe at once. Big disadvantage of the Tesla tower is that maximum influence on charge is executed in the point under the tower, and farther it began decreasing roughly (exponentially), according to physics laws.

Hence it is advisable to influence on the whole surface of charged ball, but not on some point of it. It is possible to influence at once on the very big part of surface by the long capacitor, placed on the perimeter (equator) of the charged rotating ball. Because of optimality reasons, this capacitor length should not exceed a quarter of the ball perimeter (equator) length. Charging and discharging this long capacitor on the ball equator by the data signal, only the position (angle 5) will be changed, not a value of the infinitely long magnetic line (Hz) in the Universe. It is a data transfer.

The natural question appears: "How to make on the Earth the most powerful transmitter for the **instantaneous** electric communication?" The answer suggests itself: "It is necessary to use the Earth itself as a rotating charged ball." It is not effective to use Nikola Tesla's Tower to deform the Earth electric charge. To place on the Earth very long (about thousands km) capacitor is quite easier. However, it must be placed not on the equator exactly, but moved a little bit because of the initial heterogeneity of the Earth surface charge distribution, caused by the presence of continents and oceans. It will be necessary to find the line of electric equator, where the amount of charge north and south of it is similar. This line will not be ideally straight and will be situated near the 30th parallel.

As a matter of fact, this grand capacitor is already built, but is half-broken. This capacitor is very well known – it is a Great Chinese Wall. The ancient, powerful Chinese Tzcin' Shi Huandi empire adapted and used it (capacitor) for the protection from nomads incursions. How unexpectedly and originally it is! In this case the electric iron would be the best tool for spiking. It is clear enough that the charged ball (as well as the Earth) will "wag by tail", which stretches through the whole Universe and does not change its energy, but only changes its position in space in time with information. Now we can go on to the question, concerning the way to control the Earth "wagging by tail" in the Universe, and thus to read information **instantaneously** in any point of the Universe.

In the Fig. 1 it is shown the input device of the electric communication receiver, made of the magnet sensitive material (it can be soft-magnetic ferrite) in the form of pyramid, with the proportions of well-known Egypt pyramids. Magnetic field lines of the far space pass through the pyramid from the top to the base and are concentrated by pyramid. If there is no signal (the "wagging by tail" of the far planet-transmitter is absent), then the magnetic flow, coming through the pyramid, does not change, and induced voltage in the coil, placed in the base of the pyramid, is absent (no information). If "wagging by tail" begins, then the magnetic flow, coming through the pyramid, will change, and it will cause the appearance of voltage on the coil in the base of the pyramid in time with the information.

Thus, the signal is received instantly. Here it is necessary to remind once again the difference between the instantaneous and usual radio transmission. The usual radio transmitter for the transmission of the information uses the **energy** distortion of space by the information. This energy change in space happens with the velocity of light and hence there is the loss of time for information passing. In the considered case there is no **energy** change in space, there is only a change of magnetic lines position (Hz).

This is exactly the vivid and fundamental difference between the usual electric communication and the instantaneous one. **In other words, in usual transmitter during the fixed time interval there is the change of signal energy (instantaneous value), whereas in instantaneous transmitter there is no this change (only information). This is exactly the fundamental difference.**

Evidently, to receive instantly the signal from the opposite part of our Galaxy, we need rather big pyramid, in order to concentrate a big amount of field lines into the oscillatory circuit under the pyramid. The question can appear: why the pyramid, why not a cone? The point is that lines of the Earth magnetic field (the very lines that compass needle reacts on) in the any place of the pyramid horizontal section have the same density of distribution and are directed strictly parallel to the pyramid base. The cone in its horizontal section cannot provide such uniformity of distribution that is why it is not advisable to use it. From the space magnetic field lines pass through and concentrate in the pyramid strictly at right angle to the pyramid base.

This is the riddle of pyramids wonderwork. Any person coming into a pyramid, at the same moment feels the change of mental and physical condition of organism; whish is very different from that it was before the entering into a pyramid. Of course! Visitors come inside, into concentrated magnetic field lines of the powerful and functioning magnetic core of the receiving electric circuit, what is absent outside the pyramid.

It is strange, but most of tourists are afraid of the ill effect, which can be produced by electrical systems on their health, but there they stand in a queue to feel this effect in pyramids. Concentration and division of magnetic field lines are the easy and effective way to reject a noise, created by the Earth magnetic field.

It is clear, pyramids should be oriented very thoroughly, so that lines of the Earth magnetic field would be strictly parallel to the base and to the opposite (East-West) sides of pyramid. To get such exactness of orientation in modern conditions is very problematically.

The most convenient place to build a pyramid (pyramids) is on the electric equator, in the place of its intersection with the electric meridian. Such place is located in Egypt, near its capital Cairo. And again we meet a paradox: such pyramids are already built on the Earth, but they are half-

broken. And Egypt was not less powerful than the ancient Chinese empire.

The Egyptian dynasty of Pharaohs has “completed” and adapted pyramids to burial-vaults, where mummies of dead Pharaohs were buried. Perhaps, it is even more incredible than in China. The impression is given that ancient powerful civilizations on the Earth had a competition between themselves, who will use radio-engineering constructions for instantaneous galactic communication in the most incredible way. Let’s give to a reader an opportunity to select a “winner”.

It must be noted that «PC» already published information that the Chinese Wall and Egyptian Pyramids are radio engineering constructions, intended for the instantaneous galactic communication (PC #114, 1997, etc).

There appears an interest in the possibility to produce very simple and manufacturable systems of instantaneous electric communication right now. Radio-electronic industry can produce them, but still does not guess about it.

Furthermore, such systems of instantaneous electric communication can be created at home, and even senior

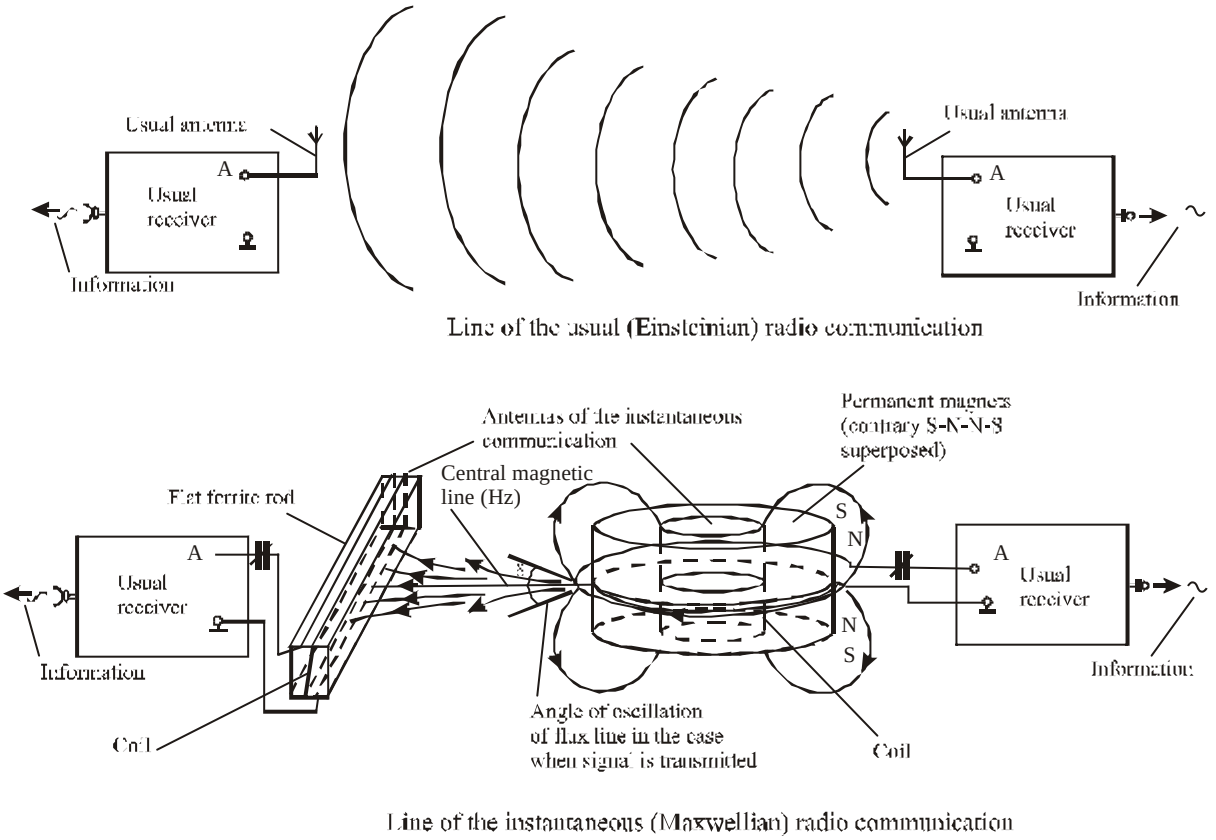

Fig. 2

Transformation of the usual line of communication of usual receiver-transmitter into the instantaneous one

pupils are capable to use them. In the Fig. 2 there is shown the construction of instantaneous electric communication line in comparison with the usual one. It can be produced even at home conditions. Two permanent magnets, connected between each other by analogous poles, are used as transmitting circuits.

Permanent magnets can be replaced by electromagnets. In the magnet connection point there is a coil, which while the signal passing through it will change its position (angle 5) in the space of the central magnetic line (Hz), coming out from the place of two magnets connection. Receiving circuit is available to be made of the flat ferrite, but coil must be winded along, through butt-ends of core, so that the whole internal part of the coil would be maximal (in area extent) filled by ferrite.

The obtained coil can be completely “winded” (screened) by flat ferrite of big size. For more clearness of the experiment the central magnet line of transmitting part must be directed strictly along the axis of the receiving coil.

Now, if we give the alternating voltage (information) from transmitter to the transmitting coil, fixed on the permanent magnet, then the receiver, connected to the circuit of the

transmitting coil, placed on the flat ferrite, will detect an alternating voltage (information). Maximum effect is achieved at the resonance (coincidence of transmitter and receiver frequencies).

It is checked. It works. The dullest experts in radio-electronic (after the reading above) can rejoin, without making an experiment, that it is an absolute nonsense that any communication is out of the question. Coils with absolutely perpendicular axes, besides one of them is screened, do not interact with each other.

And here the most interesting thing starts. In the Fig.2 as it was mentioned above, the usual communication line and the instantaneous one were compared. The usual transmitter cannot generate the vector Hz that is why systems of usual and instantaneous communication cannot see each other in strict sense. What does it mean? It means, that in the same city it is possible to transmit on the one-carrier frequency ("what a nightmare!") two absolutely different television channels without any noises of one to another.

Usually by frequency match of a transmitter to the working frequency of another one, the radio communication is broken, but here it does not happen. Here some additional explanation should be given. As the vector Hz, which "ignores" the theory of Einstein is received from Maxwell equations, it follows that the usual (Einsteinian) system and the instantaneous (Maxwellian) one work on mutually perpendicular electromagnetic field lines (vectors).

In the Fig. 2 such difference is shown clearly. These are just "jokes" of complex numbers, when one value is absolutely perpendicular to another and nevertheless together they form a single whole. In other words it means, that two greatest persons in science Einstein and Maxwell as a matter of fact are something like "Siamese twins", completely grown together at the angle of 90 degrees, even by heads. On the one hand every one is on his own, but nevertheless they are the common (complex) organisms.

Hence there are a lot of misunderstandings on happened phenomena. How many scientists tried to find some mistakes of Einstein? They produced very convincing proofs concerning instantaneous interactions in nature. These scientists did not suspect that time and still do not guess now that they already for a long time are "walking" in the complex physics, which still does not exist. Einstein and Maxwell ("Siamese twins"), each occupies his own part of the complex number (complex physics) and they cannot be already taken off from there.

The only third, free "vacancy" is left to throw on the both of them at once the common "collar" and "reins", i.e. to fasten them ("twins") together by module and argument as any complex number. In this case no matter how the one part of complex number "ignore" the other one, only its argument will change, and module always will be equal to the conditional unit. Only this single fact in principle changes the conception about "appearance" and "disappearance" of elementary particles! Even considered instantaneous and usual communications on the same receivers and transmitters in a complex conception (complex physics) eliminate appeared "misunderstandings" of all kinds.

Advantages of the instantaneous (Maxwellian) electric communication are especially evident during the connection with long-distance spacecraft. At present in the interval between sending of control signal to the station in region of Solar System peripheral planets and getting the reply it is possible to have a small break for dinner (it is very convenient).

In the case of the instantaneous electric communication use, duty operators will have "no dinner". Moreover, the system of instantaneous electric communication can realize two-way communication underwater and from underwater to overland. It is clear that input and output circuits of such system must be covered by slushing composite for the protection from aggressive effect of the salt sea-water. Such systems of instantaneous communication are very required to submarines.

Now, when readers know and understand the principle of operation of instantaneous (Maxwellian) electric communication systems and their advantages over usual ones (Einsteinian), we can only wait, when radio-electronic industry will start to produce these very required systems.

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The Unified Gravitation Theory

(The unified super-principle, which controls the Universe)

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(Editor's comments by Alexander V. Frolov)

A forum of the leading USA physicians took place in the White House in March 1998 in presence of President Clinton. There was only one question: "When will the nature of Gravitation be opened?"

The well-known USA physician-astrologer S. Hoking declared that it possibly would occur in twenty years and it would be **the Unified Theory of All.** So, the scientific world by default called it the greatest discovery of the future.

Some time later a new hypothesis pretending to this discovery has got its birth in Orenburg. Despite this fact this hypothesis would gain recognition and status of the **Greatest Discovery of Mankind** only by 2018 that was predicted by S. Hoking.

To present day there have been written a lot of hypotheses on this problem but they haven't been recognized. Many scientists consider our Universe as living and functioning according to the unified and rigid laws in Macro and Microworld, which provides automatic regulations of all its processes due to **circulation of radiant energy of the Universe life in cosmic space**. This energy is inexhaustible and environmentally clean, and Mankind may learn using it in the nearest time for the welfare and for prevention of **contradirectional irreversible ecological** catastrophe.

There is no alternative for humankind to escape and it will not appear in the future. Only cosmic energy will save us. From the book "Secret Doctrine" by E.P. Blavatskaya we can get complete information about the fact that a highly developed civilization of Atlases on the Earth had a "**General Theory of All**" yet 10-12 thousand years before our civilization. They had no automobiles, but instead they had flying objects (aircrafts) "Vimana" of various types as well as ships and submarines, on which they also used **Cosmic energy.**

While reading an abstract in General Soviet Encyclopedia, I got acquainted with the theory of "Aether wind", which was abolished in the beginning of the XX century, and then I understood that this theory contains a deposit to discover the nature of gravitation.

The nature of gravitation is the only one and there are no alternatives in theoretical as well as in physical sense. When scientific world of entire planet abolished the theory of "Aether wind", it lost the possibility to

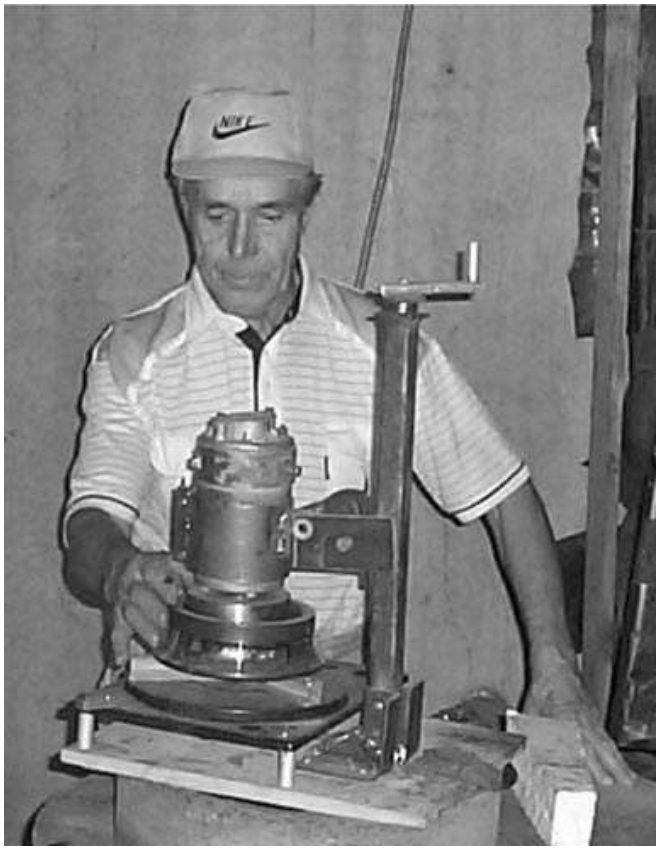

discover the nature of gravitation. The XX century was marked by a revolutionary development of scientific and technical progress, but there was an almost 100-year stagnation in cognition of the Universe elements.

The theory of "Aether wind" supposed that all Cosmos is filled with aether particles flying with the speed of light (these particles are "neutrino" according to modern understanding). **The role of gravitation, carrier of light and retarding medium in Cosmos** was attributed to this motion of particles.

But this theory allowed chaotic motion of particles, which is impossible in mechanism of the Universe, which is adjusted up to automatic mode. Besides, motion of these particles is not possible without an absolute buffer unit, which prevents their head-on collision at the speed of 600000 km/sec (it is thermonuclear explosion and death of matter, i.e. the Universe). E.P. Blavatskaya wrote that Cosmos is filled with radiant energy of the Universe life, luminophore, electromagnetic aether. Thereby she predicted a ready solution to make correction in the uncompleted theory of "aether wind". On the basis of above stated and due to the **un-assumed dawning up,** the theory of "aether wind" was completed. It was the ground to develop a hypothesis of radiant "aether wind". Particles of this wind (neutrino) are electromagnetic particles and move with the speed of light in all directions as **contradirectional paired single-stream flows** (like electrical current in twin-wire cable). Due to this, an absolutely stable concentration of these beams in cosmic space is provided according to the principle "what has come in, the same has gone out".

The hypothesis formulates new views on the problem of structure of elements of the Universe material world.

Some separate conclusions do not match the views of modern scientific thought on the problems of physical principles of material world structure and functioning of the Solar system.

List of topics of the hypothesis

1. The hypothesis disclosures the operating environment of a super-mechanism, which controls the Universe (it is a radiant "aether wind").

2. It disclosures the nature of retarding mechanism of flying objects in Cosmos (its name is Lorenz-Fitzgerald compression).

3. It proves the absence of Universal gravity and beams of light as we usually conceive it. (The beams of aether wind collide and compress matter. An alternative to the notion about beams of light is a temperature wave impulse on the beam of aether wind. It explains why the speed of light doesn't depend on the speed of the source of light. Light is a "passenger" on the beam of "aether wind").

4. This hypothesis disclosures the mechanism of stablization of rotary and orbital movement of the Universe matter in macro- and micro world due to retarding medium in Cosmos.

5. It disclosures the mechanism of reverse rotation of Venus due to the forces of autorotation.

6. It disclosures the mechanism of reverse orbital movement of planets and satellites of planets. (Such a planet had not been opened yet, but there are 6 satellites in the Solar system, which move counter to the others, and it is not an occasion, but **a particular case of the effect of aether wind beams**).

7. It disclosures a real nature of Tungusska catastrophe. (There were about 100 hypotheses, but **neither of them** was recognized to be true).

8. It disclosures **the nature of gravitation** and gives an explanation that gravitation can be:

- usual (vertical);
- horizontal;
- circular

It is important to note: not the entire matter takes part in gravitation, but 1/3, i.e. 33,3% of matter.

9. It disclosures the **nature of Levitation** and proves that 1 liter of water on the surface of the Earth can have the weight from 0 up to 3 kg.

10. It disclosures the role of gyroscope effect in life support of the Universe. The gyroscope effect allows transformation of translation energy of radiant "aether wind" to the rotational energy for practical needs of humankind.

11. This hypothesis gives scientific and technical recommendation for creation of cosmic energy converters.

12. It gives scientific and technical recommendation for producing of levitation effects for any technical systems.

13. It disclosures the possibility of cosmic flights with the super-light speed.
14. It explains experiments on metering of horizontal gravitation (The first experiment was made on February 27, 1999).

15. It disclosures the particle (neutrino) of original matter of the Universe and gives its characteristic. (Ancient thinkers called modern "neutrino" as "Aether", and it was not occasionally, because its diameter is in 10^{25} times smaller than atom's diameter.

All matter of the Universe consists of the same indivisible particles "neutrino" presented by three groups:
- "energy" group, which is in the beams of "aether wind";
- building group, which forms the part of any micro particle;
- free group (neutral-reserve) as a building material for new matter and operating environment of all electromagnetic processes.

All neutrino of three groups rotate with the speed of 3×10^{43} rps (equatorial speed of neutrino is equal to the speed of light).

Fields are formed in every particle as a result of rotation:
- strong field of a small volume doesn't allow particles to close up;
- weak field of a big volume is a general mechanism of gravitation.

As scientists write at the present time, the World is subdivided on a dense world (which we can see) and fine world (invisible). At that the density of such world is in 10^{15} times less than density of water.

It is known in science that all matter of the Universe both great and small rotates and is a gyroscope. Particles of matter get rotation with their birth, thus the fields are born in them simultaneously. **Matter cannot exist without rotation, which generates fields.**

All mechanism of interaction between three groups of particles is based on the mutual repulsion. This is the only mechanism, which always and automatically is able to create the necessary stable interval between the particles and only this mechanism provides the function of gravitation.

Many scientists of the late XX came close to the discovery of the nature of gravitation, but they didn't accept a thought to conceive **the motion of aether particles as a pair-counter flow**. And there are three necessary conditions to realize gravitation:

1. The particles should have the fields of repulsion.
2. The contradirectional flows should envelop the particle of matter from two sides.
3. While one beam is passing a matter mass then the force of fields should decrease and gravitation effect should appear.

Mechanism of gravitation

Gravitation appears due to the intersection *(Editor's note: interference)* of fields, produced by beams particles and fields of the visual matter. As it was mentioned above, the beams are paired and contradirectional. Usually the beams in cosmos are mutually balanced and they do not call gravitation effects.

But on the surface of the Earth the contradirectional beams are not similar in their power. The powerful beams come from above, i.e. they only penetrate the atmosphere, and the weakened beams come from below, i.e. they penetrated all the Earth. Thus, gravitation appears.

Gravitation is a unique property of "aether wind" beams to loose part of their power during penetrating of matter mass. **Gravitation** is the difference of forces of contradirectional beams. *(Editor's note: Really other authors reported this idea also. I cannot find who was the first in discussion about gradient of aether as nature of gravitation.)*

Horizontal gravitation

As a particular case, there is **horizontal** gravitation on the surface of the Earth. It appears on the boundary between lowland (of the sea) and plateau. In this case one beam goes above the surface of the Earth (water), and the counter beam penetrates mountain range and

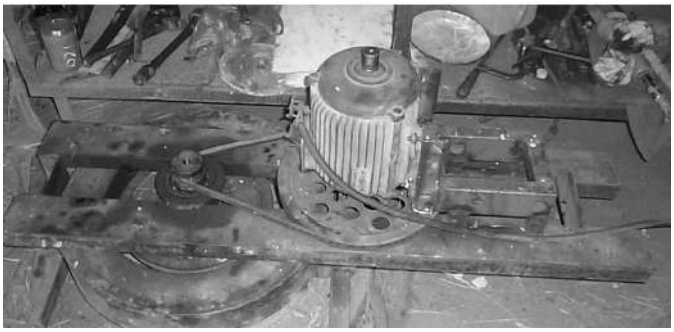

weakens. The first measurements of horizontal gravitation effect were made on February 27, 1999 on the route Orenburg – Samara at 49 km before Syrtinskiy slope.

A leaden load (0,5 kg) on the float (a piece of foam plastic) moved on the water surface (not in the sea but in basin) towards the mountain.

Horizontal gravitation is much more weaker than usual gravitation, but it can reach the value that makes water to flow at some angle upwards.

Circular gravitation

Only fast-rotating bodies can create circular gravitation.

All bodies rotate by their orbits around the Sun in the open space of Solar system **due to circular gravitation guided by rotating the Sun.** Furthermore; circular gravitation always is direct (co-directional to the Sun rotation) and reversed gravitation on the periphery of Solar system. A planet with reverse orbital movement had not been discovered until now, but 6 satellites of planets in the Solar system have reversed orbital movement.

Here is the proof of the fact that circular gravitation appears only around the fast-rotating bodies and **slow-rotating bodies, for example, the planets Venus and Mercury cannot form circular gravitation**, that's why they have no satellites.

Our Sun is a prototype of mechanism to transform translation energy of aether wind beams into rotary energy.

(Editor's note: According to Kozyrev, any star is a transformer of time (chronal type of energy) into heat energy. Really, the aether wind can be considered as the chronal type of energy in our understanding and for our usual three-dimensional measurement equipment. To my mind it is a clear link to notion of 4-dimensinal objects, i.e. the time. ***Time can be described by parameters of the aether wind, i.e. its velocity, direction and density. So, we can say that quantitatively time can be described by formulations for kinetic energy of the aether movement. From the other hand it is equivalent of heat energy, which can be measured by usual methods after transformation of the longitudinal waves of the aether in transverse electromagnetic waves).***

Therefore, any mechanical disk rotating very fast will create a circular gravitational field, which is able to rotate all bodies in the direction of the disk (for example, a rim mounted on its bearing co-axially with rotating gyroscope). I designed and tested a similar device in January 2000. A gyroscope (of 200 mm diameter and 3 mm thick) was over-speeded up to 18 thousand rpm. Rotation of gyroscope called slow (but with a good momentum) rotation of the rim of 15 kg weight.

The gyroscopes with the mass of 0,5 kg, 15 kg and 90 kg were tested during summer of 2001. All them called rotation of the rims.

(Editor's note: There are other experimental facts. Fast rotation of mass should produce rotation of some part of nearby aether. Self-closed aether forms vortex and if photon is trapped by this vortex, then

experimenters can see "ring of light" near rotating mass. The rings or self-closed photos can exist in the same place after the mass was stopped or removed away.)

Nowadays gyroscopes in military devices are over-speeded up to hundreds of thousands of rpm. The more rates the gyroscope has, the more energy the rim will produce if it is connected to some generator. But these research works led to single-valued conclusions that gyroscopes themselves cannot produce big quantity of additional cosmic energy not jointly with permanent electromagnets. The Sun as well as planets has natural electromagnetism and their circular gravitation increases in many times due to the presence of electromagnetic fields.

(Editor's note: I think it is obviously that a rotating magnet can involve into the rotation much more quantity of aether than any simple rotating mass. In some theories any magnetic field is considered as circulation of aether particles.)

Electromagnetic fields are the unique boosters of circular gravitation. So, the gyroscopes themselves cannot produce necessary quantity of cosmic energy per unit mass of gyroscope without using of electromagnetism.

In October 2001, I got a copy of 24 patents description. There were patents on "perpetual motion machines". But since such "perpetual motion machines" cannot exist in reality, then we can explain them as gyroscopical transformers of cosmic energy. Efficiency of these transformers varies from 150% up to 10^6 % and practically all of them work using gyroscope. But nowadays only the transformer (Bauman's machine) works in Switzerland, in Maethernitha theological community, Linden city. Some systems have been working from 1980 and producing total power of 750 kWtt, the gyroscopes of 2m diameters are provided with constant magnets.

Besides, there are ready transformers of cosmic energy in Russia. The Professor of Moscow State University, Academician of Russian Academy of Natural Science Leonid Leskov spoke about them in the first half of 2001. He actually said that Mr. Chubais does not allow innovation of energy transformers, which are ready for commercialization (see newspaper "Raduga", Samara, July 2001).

I assume that any kinds of such transformers work on the energy produced by "Aether wind" beams. Perhaps our earth ancestry (Atlases) used this energy to fly as well as extraterrestrials. I remember information about flying platforms, which were designed in Germany in 1943-1945. Nowadays there are publications that there are not less than 10 captured extraterrestrial's spacecrafts on the Earth, and some samples were tested in Russia and the USA.

On the basis of all above-mentioned it becomes extremely clear that the main secret of Nature was discovered, and let's representatives of conservative science don't pull the wool over people's eyes to prove that "it is impossible". It is possible! Physics is an experimental science in its main part, and there is no completed theory until now.

As a result, I'd like to make some conclusions: The secret of Gravitation nature was discovered not in connection with new scientific investigation, but due to dawning up and understanding of the fact that gravitation since earliest times was produced by "Aether winds", which fill all cosmic space. Instead of improvement of "Aether wind" theory, academician science abolished it and forgot it such as some scientists of nowadays don't have an idea of it. While abolishing of "Aether wind" theory, scientific world spent 100 years in vain to find an alternative to it. A real Cosmic scientific and technical progress was slowed down during this term. Without this progress all humankind will kill environment of the Earth in 30-40 years!

Rush hours for humankind to turn to cosmic energy came, we have not even an hour to wait, and otherwise we will loose a chance to survive. Today the scientific and technical level is such that taking into consideration the buildup made by inventors – enthusiasts, who created more than 50 types of Cosmic energy transformers, it is possible to begin repetition work in one year. Now there is the only barrier to do it, i.e. market relations in energetics developed during last 100 years.

Let's look into near Future. The process of energy resources (coal, oil, gas) formation in bowels of the Earth took hundreds million years. There was period of clean ecology in the World Ocean, on land and in the atmosphere. **And all it catastrophically had been diminishing during 2-nd half of the XX century**. **There are about 40 years for our civilization to reach the boundary of having no chance to support normal life on the Earth.** An irreversible process of struggle for survival using underground environment and protection from mortal ecology will begin. Our close posterity will not forgive us this betrayal.

Is there any solution? Yes, there is.

It is necessary to publish the descriptions of all "perpetual motion machines" models as well as unprofitable publication of short technical documentation in the Internet and magazines, which will give a chance to many companies, research groups and individuals to re-produce them. But at first we should choose the models, which are the most reasonable in technology and prime cost. Such a way of replication of the models will give people confidence, interest and reliable information on existence of inexhaustible salutary cosmic energy. And the victory will be the reward for courageous, enterprising and advanced people.

which generates electrical voltage $E_{\updownarrow} = \ell \frac{dB_{rot}}{dt}$ in the structure of vacuum. This voltage generates Gravitational Impulse itself $G = 4\pi E_{\sigma} S \cdot (\Delta r_g)^2$, where $\Delta r_g = e_0 \frac{E_{\updownarrow}}{b}$.

The supposed "Gravitational Impulse" in the experiment by Podkletnov is modeled by a quarter of cosine curve.

Duration of this curve is determined by the decrease of magnetic field "trapped" into the superconductor due to the partial heating of semi-conductor emitter after plasma passed the discharge of 2MV with the current strength of 10000 A. The formula of the model is the following:

$$X'' = Ae^{-2\pi f_0 D_0 t} \cos(2\pi f_0 \sqrt{1 - D_0^2}\, t) \qquad (1)$$

the calculation is made for the frequencies of 30, 3, 0,3 and 0,03 Hz and acceleration of 12 m/sec^2, which appears for the mass of the pendulum 30 g with the force horizontally to gravitation 0,03·12=0,36 N.

It can be supposed that it is necessary to make more careful solution of the problem to find the effect on the pendulum by its reaction, which is known from experiment. We should apply the more correct use of spectral method of solution of differential equation for the pendulum with setting of impulse effect. Further, having the recording of temporal function of magnetic field by Hall-effect devices and using Maxwell formulas, we should find electrical field acting in physical vacuum. This field will give us the force of gravitational impulse.

The experiment by V. Roshchin and S. Godin is simpler for physical modeling (Editor's note: the author assumes it is simpler than Podkletnov's effect). All input and output parameters are known to the authors, i.e. force of the magnets, frequency of variable magnetic field in the local place of space vacuum, change of gravity. Furthermore, there are known cylindrical formations of magnetic "loops" around the device and their approximate arrangement with the intervals divisible by the half of rotor radius. Effects of temperature decrease at 8° C in cylindrical atmospheric formations can be simply explained by adiabatic decrease of air pressure due to the decrease of gravitation between molecules of air. Formulas for estimation of decrease of gravitational and inertial forces are the same that for Podkletnov's experiment:

$$E_{\updownarrow} = \ell \frac{dB_{rot}}{dt}, \qquad (2)$$

$$G = 4\pi E_{\sigma} S \cdot (\Delta r_g)^2, \text{ where } \Delta r_g = e_0 \frac{E_{\updownarrow}}{b}. \qquad (3)$$

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New Sources of Energy from the Point of View of Unitary Quantum Theory

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Abstract

The Unitary Quantum Theory (UQT) is a new version of the field quantum theory, which has been developed by the principal author (Prof. L.Sapogin) of this paper for over 25 years. The theory is directly related to the problem of new energy sources, and this paper can be of interest for Journal of New Energy for it is the UQT (and not the classical Newton mechanics or the modern standard quantum mechanics) that provides a theoretical basis for the development of new sources of energy and for the explanation of the operation principles of the existing and functioning over unity devices.

The fundamental provisions of the UQT and a number of results received on the basis of it were published in many scientific journals and reported at international conferences (see [1-6], etc.). Generally, the UQT as expressed by the language of formulae and equations represents a new mathematical model of interaction and movement of elementary particles in the form of a complicated system of non-linear integral-differential equations, an important property of this model principally defines the trajectories and velocities of the particle movement in space (unlike the standard quantum theory, which directly defines only the probabilities of the presence of the particles at a certain point in space). Another, and the most essential (for the problem of new energy sources) property of the UQT is the absence of the energy conservation laws and the

impulse for single particles in it. That is why the UQT makes theoretically possible processes of energy generation as if from nothing, if they are regarded from the classical mechanics point of view or the standard quantum theory (while the UQT is able to explain the phenomenon), as well as creation of a device with efficiency above 1. In other words, the UQT provides for a theoretic possibility of making a perpetual mobile!

In the 1970's, when the UQT started to be developed, there was nearly no data of the observed phenomena, or any experimental results confirming this unusual theory. Today, such data are abundant. For example, such processes can be named as generation of excessive heat energy during cavitation of very small water bubbles; generation of excessive electric energy in an anomalous gas discharge; excess generation of electric energy when electric current passes through proton-conducting ceramics, etc. Besides, and still more important, operating devices that have been created much more energy than it was necessary for these devices functioning: electric current generators "Testatica" (Switzerland); thermal cell CETI (J.Patterson, USA); heat generators (Yu.S. Potapov, Moldavia, J.Griggs, USA); electric current generators (P.Correa, A.Correa, Canada); electric engines on magnetic ceramics (Japan), and others. The said phenomena and operation principles of the above-mentioned devices can be explained with the help of the UQT.

In this paper we will also touch upon such an important problem as cold nuclear fusion. The feasibility of this nuclear process, which is categorically denied by the standard quantum theory and nuclear physics specialists, was predicted by the author of the UQT as far back as in 1983. This phenomenon was discovered in 1989 (electrochemical experiments, M.Fleischmann, S.Pons). Many subsequently received experimental data confirmed the existence of nuclear reactions under very small energies, of nuclear transmutations in plants and biological objects, very slightly connected with generation of energy [7-8]. From the point of view of the UQT, which provides an explanation of the cold nuclear fusion mechanism, this process can be applied in practice (after the relevant devices are designed) for generation of energy, for production of isotopes, and for nuclear waste liquidation.

Introduction

Inventors, as well as swindlers of all kinds, had long ago been trying to construct, or at least design, a *perpetual mobile*, i.e. an imaginary machine that produced work without any outside energy. Peter the Great even founded the Imperial Russian Academy of Sciences for such research, but the modern Russian Academy of Sciences does not like to recollect this circumstance. On the other hand, the French Immortals in 1755 decided not to consider any *perpetual mobile* projects at all, and, as we would see, were quite right as regards the Newton mechanics. The brilliant success of the classic mechanics has strengthened still more the sacred belief of the mankind in the Divine Infallibility of the Conservation Laws, and today it is nearly indecent to express any doubts about these laws.

Let us first of all find out the origin of the conservation laws in ordinary mechanics. Practically any textbook will tell you that the Energy Conservation Law (ECL) follows from the homogeneity of time, the Impulse Conservation Law from the homogeneity of space, and the Angular Momentum Conservation Law from the isotropy of space. That is why many people have an impression that the conservation laws themselves follow only from the quality of time and space, which is today an undoubtedly relativistic notion. But, for example, the angular momentum is not a relativistic notion. So, such a narrow approach is not altogether correct, and it is necessary to turn to the second Newton law, or the equation of relativistic dynamics and the system insularity. However, *the qualities of the time and space ensue exactly from the analysis of the Newton mechanics*, though they are often construed incorrectly. Let us remind you the correct interpretation.

Homogeneity of time suggests that *if at any two moments of time two similar experiments are made in similar closed loop systems, the results thereof will not differ.*

Homogeneity and isotropy of space mean that *if a closed loop system is moved from one part of space to another, or is oriented differently, nothing will change.*

The making of the fundamental energy and impulse conservation laws from the Newton equation is very simple. Let us put down the main equation of dynamics as

$$\mathbf{F} = \frac{d\mathbf{P}}{dt}$$

For closed loop system $\mathbf{F}=0$ (no external forces operating) and the equation integral will be $\mathbf{P} = Const$ the impulse conservation law.
Now let us take the main equation of dynamics as:

$$\mathbf{F} = m\mathbf{a} = m\frac{d\mathbf{v}}{dt}$$

and multiply it scalarwise by $\mathbf{v}$

$$\mathbf{F}\cdot\mathbf{v} = m\frac{d\mathbf{v}}{dt}\mathbf{v} = \sum_{i=1}^{3} m\frac{dv_i}{dt}v_i = \sum_{i=1}^{3} m\frac{d}{dt}\left(\frac{v_i}{2}\right) = \frac{d}{dt}\left(\frac{mv^2}{2}\right)$$

where v is the module of the velocity vector $\mathbf{v}$. For closed loop system $\mathbf{F}=0$, and the equation integral will be

$$\frac{mv^2}{2} = Const$$

one of the forms of the energy conservation law. From the definition of the angular momentum for a particle,

$$\mathbf{L} = [\mathbf{r} \times \mathbf{P}]$$

Differentiating both parts by *t*, we get

$$\frac{d\mathbf{L}}{dt} = \left[\frac{d\mathbf{r}}{dt} \times \mathbf{P}\right] + \left[\mathbf{r} \times \frac{d\mathbf{P}}{dt}\right]$$

Since the impulse vector is parallel to the velocity vector, the first bracket will equal to zero. On the basis of the resultant equation and the definition of central force as not creating any momentum, we get

$$[\mathbf{r} \times \mathbf{F}] = 0 \quad \text{or} \quad \mathbf{L} = Const.$$

In case of the central force in an unclosed system, the angular momentum is preserved by value and direction. The angular momentum conservation law for a closed loop system results in the same way as the impulse conservation law from the equation of the rotary motion dynamics:

$$\mathbf{M} = \frac{d\mathbf{L}}{dt}$$

For a closed loop system, the momentum of external forces **M**=0 and the integral of the equation will be the angular momentum conservation law

$$\mathbf{L} = Const$$

In relativistic dynamics the emergence of the energy and impulse conservation laws separately can be easily received from the relativistic ratio for energy and impulse

$$E^2 = P^2c^2 + m^2c^4$$

Term m^2c^4 is an invariant, i.e. the same in all reference systems. In other words, it is a certain constant. This equation can be represented in a slightly different form

$$E^2 - P^2c^2 = Const$$

For the equation to be valid, it is required that

$$E = Const \text{ and } P = Const$$

and this none the other but conservation laws for energy and impulse.

Strictly, relativistic mechanics has a conservation law for 4-impulse vector P^{μ}, but we will not dwell on these details, because small energies are what we are interested in.

In the classical theory, the energy conservation law states that the energy of a closed loop system remains unchanged, so, if the energy of such a system is designated at a moment *t=0* as E_0, and at the moment *t* as E_t, $E_0 = E_t$.

Conservation laws in ordinary quantum mechanics

The standard quantum theory formulates the energy conservation law in the same way. In quantum mechanics we have the same movement integrals as in classic mechanics. A certain value *L* will be a movement integral, if

$$\frac{d\hat{L}}{dt} = \frac{\partial \hat{L}}{\partial t} + \left[\hat{H}, \hat{L}\right] = 0 \qquad (1)$$

Since $\left[\hat{H}, \hat{L}\right]$ is defined by commutator of operator $\hat{L}$ and of Hamilton's operator, any value *L*, *not depending explicitly on time*, will be the movement integral, if its operator commutes with the Hamilton's operator. When value *L* does not explicitly depend on time, the first item in (1) turns to zero. There remains

$$\frac{d\hat{L}}{dt} = \left[\hat{H}, \hat{L}\right] = 0 \qquad (2)$$

and for the movement integrals not explicitly depending on time the Poisson quantum bracket equals zero. From (1) and (2) it follows that the average value of the movement integrals does not depend on time:

$$\frac{d}{dt}(L) = 0$$

All good papers on the quantum theory prove that probability $w(L_n, t)$ to find at any moment *t* any value of the movement integral, i.e. L_n, does not depend on time. Further, is constructed as the movement integrals not explicitly dependent on time. Since operators $\hat{\mathrm{L}}$ and $\hat{\mathrm{H}}$ commute, they have common proper functions, which are functions of stationary states. Let us note that the latter follows from solutions of the equation without time, which was received from the full equation with imposition of requirement

$$\Psi(\mathbf{r}, t) = \Psi_0(\mathbf{r}) \exp\left(i\frac{E}{t}\right)$$

equivalent to search of only periodic solutions. Further, quite naturally, *there appeared an equation without time with actually imposed conservation laws, because now nothing depends on time*. Expansion by such proper functions looks as follows:

$$\hat{L}\Psi_n = L_n\Psi_n \qquad \hat{H}\Psi_n = E_n\Psi_n$$

where

$$\Psi(x,t) = \sum_n c_n \Psi_n(x) \exp\left(-i\frac{E_n}{\hbar}t\right) = \sum_n c_n(t)\Psi_n(x) \qquad (3)$$

$$c_n(t) = c_n \exp\left(-i\frac{E_n}{\hbar}t\right) = c_n(0)\exp\left(-i\frac{E_n}{\hbar}t\right)$$

Since (3) is expansion into proper functions of operator L_n, probability does not depend on time:

$$w(L_n, t) = |c_n(t)|^2 = |c_n(0)|^2 = Const$$

Since energy is a movement integral and probability *w (E,t)* to find at a moment *t* an energy value equaling E, does not depend on time, then:

$$\frac{dw(E,t)}{dt} = 0$$

Let us note once again that it is *the probability to find a certain value that does not depend on time, but not the value itself, which for any separate event is accidental and can assume a wide range of values.*

The quantum energy conservation law in the above form suggests a possibility of defining energy at a given moment without subjecting it to uncontrolled change, which raised no doubts in classic mechanics. But in the quantum theory the energy, without changing its value, can only be measured to

$$\Delta E \geq \frac{\hbar}{\tau}$$

where r - is measurement duration. Formally, it does not present any difficulties for the energy conservation law, since energy is a movement integral, and we have much time to make long measurement. For example, let us make measurements during time r, then leave the system to itself for time *T*, and then define energy again. The classic quantum energy conservation law states that the result of the second measurement will coincide with the result of the first measurement to $\Delta \mathrm{E} \approx \frac{\hbar}{\tau}$.

But even in the ordinary quantum theory all this is not consistent enough. For the real vacuum fluctuations can interfere, that always influences the results of a single process, but their influence disappears after the passage to an ensemble of events. Here we have a violation of the conservation law due to vacuum fluctuations, though existence of movement integrals, unlike in the Unitary Quantum Theory (UQT).

The generally accepted quantum theory carefully avoids the question of conservation laws for individual events in the case of small energies. This question is either not discussed at all, or it is said that *the quantum theory does not describe individual events. Yes, it does describe individual events, but it can only predict a probability of this or that result.* It is clear that in this case there are no conservation laws for individual events (it is wrong to speak about it in case of an accidental result of an individual event), and they appear only after the averaging by large ensembles of events. Essentially, it can easily be proved that classic mechanics follows from quantum mechanics after summing up by a large number of particles, because for a sufficiently big mass, the length of the de Broglie wave becomes much less than the body dimensions, and no quantum-wave qualities can be talked about.

Conservation laws in Unitary Quantum Theory

In the UQT [1-14] any quantum particle is not a point, but a source of field like in the ordinary quantum mechanics, but it represents a bunched field (wave packet) of a certain unified field. The dispersion equation of such a nonlinear field turned out to be such that the wave packet (particle) during its movement periodically appears and disappears, and the envelope of this process coincides with the de Broglie wave. Numerous particles during their periodic disappearance (spreading in the Universe) are repeated appearance from vacuum fluctuations. A theory of quantum measurements has been built, and the probability interpretation follows from the mathematical formalism of the quantum theory [10,11], and it is not postulated as in conventional quantum mechanics. Unfortunately, the main UQT equation turned out very complicated, for it is a system of 32 nonlinear integral-differential equations, which could require for their solution some new mathematical methods. But from this the relativistically invariant Hamilton-Jacoby equation, and the Dirac equation system strictly follow.

Papers [13,14] give a solution of the simplified scalar integral-differential UQT equation, which gave a localized solution for the form of a wave packet representing a particle. It turned out that the integral from a bilinear combination of such a solution for the whole volume gives with the precision of 0.3% the value of a non-dimensional elementary electric charge [13,14], which was essentially its first theoretical calculation. Then, this solution in the form of a periodically appearing and disappearing wave packet (which square describes the density of a spatial charge) can be replaced by an oscillating charged particle [15-18], the movement whereof will be described by the conventional Newton equations:

$$m\frac{d^2\mathbf{r}}{dt^2} = -2Q\mathbf{GRAD}U(\mathbf{r})\cos^2\left(\frac{mt}{2\hbar}\left(\frac{d\mathbf{r}}{dt}\right)^2 - \frac{m\mathbf{r}}{\hbar}\frac{d\mathbf{r}}{dt} + \varphi_0\right) \quad (4)$$

$$m\frac{d^2\mathbf{r}}{dt^2} = -2Q\mathbf{GRAD}U(\mathbf{r})\cos^2\left(-\frac{m\mathbf{r}}{\hbar}\frac{d\mathbf{r}}{dt} + \varphi_0\right) \quad (5)$$

where *m, Q,* **r** - mass, charge, and radius-vector of the particle, *U*(**r**) – external potential, φ_0 - initial phase.

Since $\mathrm{E} = -\mathrm{GRAD}U$, and a magnetic field also exists, the Lorenz force should also be calculated for $\mathbf{F} = \frac{Q}{c}[\mathbf{v}\times\mathbf{H}]$, but in the electromagnetic wave **E** and **H** are equal, and for small energies value $\frac{v}{c} \to 0$, and

force **F** can be ignored. Both these equations produce qualitatively similar results for different problems, but the first non-autonomous equation evidently does not have any movement integrals at all, and any hope for analytical solutions is very unreal. But for the second autonomous equation such hope still exists. Let us note that these equations describe more accurately the experimental results of scattering on the coulomb potential than the classic Rutherford formula! Application of these equations for the tunnel effect and scattering on short potential also produces correct results, but in this case passage through a high barrier (tunnel effect) will be defined by the initial phase. Of greatest interest, however, is the harmonic oscillator problem.

It is possible that a change in the properties of a material point in the process of its movement is just another step in the material point movement theory. In conventional mechanics this idea is not altogether new. There are Meshchersky's equations for bodies with a changing mass, and Tsiolkovsky's equation for a rocket. But so far, in the conventional quantum theory, the particle has a permanent and stable in space and time set of properties, and in the UQT all the parameters of the particle are changed and oscillate during movement.

It should be noted that *Newton did not introduce the notion of a material point at all,* and it would be ridiculous to think that he was not able to have this natural and rather trivial idea. Most probably, and it is not by chance, for today many troubles of the field quantum theory are rooted in the approach to the particle, as to the point, the most vivid example being a large bouquet of divergences. Nevertheless, this approach is very convenient and should only be used correctly. Let us also remember, that in accordance with the Newton corpuscular theory, beams of light were to be regarded as a flow of certain particles. They are emitted by a shining body in all directions and move in an empty space or a homogeneous medium evenly and straight, i.e. in the same way as the ordinary material particles do in the absence of any external or interaction forces. Newton explained reflection and refraction of light beams on the surface of border between two homogeneous mediums by the effect of certain forces on this border, in the direction perpendicular to the surface. These forces changed the normal velocity component, but did not touch upon the tangential one, which allowed to derive the reflection and refraction laws. However, the inability of such a theory to account for the light partial reflection and passage phenomena, as well as the Newton rings (which he himself discovered), led him to bouts (or fits) theory, which is quite modern, although nearly forgotten. Newton believed that for full explanation of all the processes it was necessary to suggest that some light particles could experience reflection bouts, and others – passage bouts. Let us imagine light falling to a flat surface, which is partially, reflects and partially passes. With quantum description of this phenomenon, a particle connected to the falling wave at the time of hitting the surface has a certain probability of passing or being reflected, and Newton simply used the word "bouts" in place of the word "probability".

It is absolutely clear that all descriptions of processes by the equation with an oscillating charge will be an approximation, because it is evident that no movement equations for a material point can describe even the simplest interference processes on a semi-transparent mirror, during which a material particle should be divided in two parts which will later eliminate each other by destructive addition. It is surprising, but the numerical solution of the problem of scattering on a short potential (the Ramsauer effect) for equations (4) and (5) gives the correct diffraction picture! But if we want to describe an individual particle correctly in the conventional quantum mechanics, the picture becomes inexact and purely probabilistic. At every given moment of time a particle can exist in only one of the mutually incoherent states, because one particle cannot move in different directions simultaneously (it cannot have many impulses at the same time). Nevertheless, there seems to exist a whole class of processes, where description with the help of equations (4) and (5) have certain sense. It is well known that in all experiments the local energy and impulse conservation law in individual quantum processes are true only under high-energy values. But under small energy values it is not so, at least because of the ratio of uncertainties and the probabilistic character of all the quantum theory predictions, and the idea of a global, not local ECL, is invisibly present in the quantum mechanics, and is certainly far from new.

In the strict UQT and the quantum measurement theory, a great role belongs to unavoidable vacuum fluctuations. It is clear that these fluctuations are totally unpredictable and non-invariant in relation to space and time translations. The same can be said otherwise: there are no habitual properties of time and space in this theory. Space-time is now not homogeneous and not isotropic. For example, if the system is transferred to a new point in space, or a certain experiment is repeated at another time, at the point where particle parameters are studied, and it interacts with the macro-device, a new value of vacuum fluctuations (different from the previous one) can appear and produce a different result. Of course, all this is only true for small energies and individual events.

Still more destructive is the UQT for the notion of a closed system. For individual events under small energy values this notion is simply unacceptable for the following reason: vacuum fluctuation at the location of the particle (e.g. in a potential pit) can be sharply changed at any moment. It can be caused by different factors – the nature of vacuum fluctuations itself, or the tunnel effect of another random particle.

Sometimes it is stated that conservation laws follow from the Nether theorem, though these results are present in the works by D. Gilbert and F. Klein. For any physical system, the movement equations from which can be received from the variation principle, each one-parametric continuous transformation that leaves the

variation functional invariant, corresponds to one differential conservation law, and there exists a clearly conserved value. It is easy to see, however, that vacuum fluctuations imposed on the varied function (integral of Lagrangian) do not in sum remain unchanged during parametric transformations (at least today it seems so), and this consideration does not work without preliminary of ensemble.

And now we are in for a little philosophy. The local Energy Conservation Law (ECL) in individual processes follows from the Newton equations for closed systems. It would be naive to think that its local formulation will be preserved forever, and would be a bad mistake to transfer the ECL from the Newton mechanics to the quantum processes without any changes, because the latter are more fundamental.

References to the first principle of thermodynamics are, strictly speaking, groundless, because this principle is a postulate. For example, well-known Russian mathematician N. Luzin, in a letter to an inventor wrote that the first principle of thermodynamics is the result of unsuccessful attempts of the mankind at building a *perpetual mobile*, and strictly follows from nothing. *Today it may be said with a great degree of certainty that no sophisticated machine in the framework of the Newton mechanics can be a perpetual mobile,* and the decree of the French Academy of 1755 not to consider any *perpetual mobile* projects is still valid. We will only add that now it is valid only for those projects that are based exclusively on the Newton mechanics.

There is the tendency in modern physics to reduce ECL, especially in theory, to the rank of a secondary derivation from the movement equations (movement integrals). Some physicists restrict the ECL to the framework of the first principle of thermodynamics, others, like D. Blokhintsev [37], think it quite probable that with the development of a new theory the form of the ECL will undergo certain changes. F. Engels wrote in his "Dialectics of Nature": "…none of the physicists actually regard the ECL as an eternal and absolute law of nature, a law of spontaneous transformation of the movement forms of the matter and the quantitative constancy of this movement in all its transformations". But many people do not share this opinion. M. Bronstein in his book "Structure of Matter" wrote: "The ECL is one of the main laws of the Newton mechanics. Nevertheless, Newton did not ascribe to this law the general character that this law actually possesses. The reason for this *erroneous* (italicized by authors) opinion of Newton of the ECL is very interesting…". It is now clear that in view of the above, such an opinion was not at all erroneous. Let us remind you that Newton predicted many things, even the UQT, in his "bouts theory".

On the other hand, the authors of quantum mechanics realized that there was no conservation law for single quantum processes under small energies at all. The idea that the construction of ECL, together with the second law of thermodynamics, was a statistical law, true only on the average and inapplicable to individual processes with small energy, first occurred to Schroedinger, and later to Bohr, Kramers, Slater, and Gamov. In 1923 Bohr, Kramers and Slater made a desperate attempt to develop the theory, where the energy and impulse conservation laws in case of scattering would be true only statistically, on an average for long periods of time, but would be inapplicable to elementary events. Lev Landau even called it "Bohr's wonderful idea".

Later, however, the authors gave up this approach and, besides, this idea at that time did not follow from the quantum theory equations, and the authors, *to come out of the predicament, simply declared that quantum mechanics did not describe individual events at all*. Thus, the most vivid paradox of the quantum science was removed by a simple ban on thinking about it! But the ingenious idea that conservation laws do not apply to individual quantum processes and emerge only after the averaging by the ensemble of particles remains alive. This idea might have been a little premature, and, possibly, should be a little different.

The Unitary Quantum Theory (UQT), on the contrary, individual particles, and the difference in their behavior is accounted for by the initial phase of the wave function. In this case, local conservation laws do not exist for a single particle, and measuring the initial phase or some other parameters for an individual particle is quite a different matter. It is not true that the UQT has given up probabilistic description. Probabilistic interpretation remains, but the probability now is strongly dependent on the initial phase. Although the equations with an oscillating charge can determinately predict a particle's behavior, the measurements can be made only with the help of a macro device, which will give only a probabilistic result. Impossibility to determinate measurements does not change anything, for the UQT provides for a possibility of influencing the probability value, which was earlier unavailable. The existing Von Neumann theorem about hidden parameters does not effect our result, but the relevant discussion is too cumbersome, and we will leave it out.

*In other words, **all the requirements**, wherefrom the classical conservation laws follow, are now absent. We can hardly expect the conservation laws for individual particles to be preserved under small energies in such a situation.* Today we are convinced that the classical energy, impulse and angular momentum conservation laws for individual quantum objects are not valid under small energy values because of periodic appearances and disappearances of the particle. All direct experimental tests of the conservation laws were made for large energy values, and for small energies of an individual particle only probabilistic results can be received, and, in this case, it would be indecent even to recall the conservation law.

Energy generation and perpetual mobile

Let us make the following imaginary experiment. For simplification purposes we will use in our reasoning a

certain quantum ball-particle. When a classical ball approaches a wall (perpendicularly for simplification), the speed of the reflected ball is always equal to the initial speed (we ignore friction and regard the ball and the walls as absolutely elastic). In the case of a quantum ball, the speed of the reflected ball will acquire in different experiments with absolutely equal initial conditions a whole range of values: some balls will be reflected at a speed greater than the initial speed, others – at a speed equal or lower than the initial speed, and all this is described by quantum mechanics.

Let us ask the following question: what if a second wall is found, parallel to the first one, in order for the ball to increase its speed after each reflection from the wall? Then we will have increased ball energy without any special efforts on our part. Such phenomena appear in the problem of particle oscillations in a potential pit (not necessarily parabolic) on the basis of equations (8) and (9), when four types of solutions are possible, three of which are most important for us: stationary, "maternity home", and "crematorium". In the two latter solutions traditional conservation laws do not work. These solutions are presented in Fig. 1. Such oscillator behavior explains many experimental facts. From the physical point of view, it means that in stationary solutions with fixed discrete energies (conventional quantum mechanics) the speed of the particle reflected from the wall will be equal to the speed of the falling particle. If the speed of the particle is decreased after each reflection, it will mean the "crematorium" solution, and if it increases, the "maternity home". Scenarios for situations will depend on the initial phase of the wave function and the particle energy. In ordinary situations the "crematorium" and "maternity home" solutions always compensate each other, and we find conservation laws.

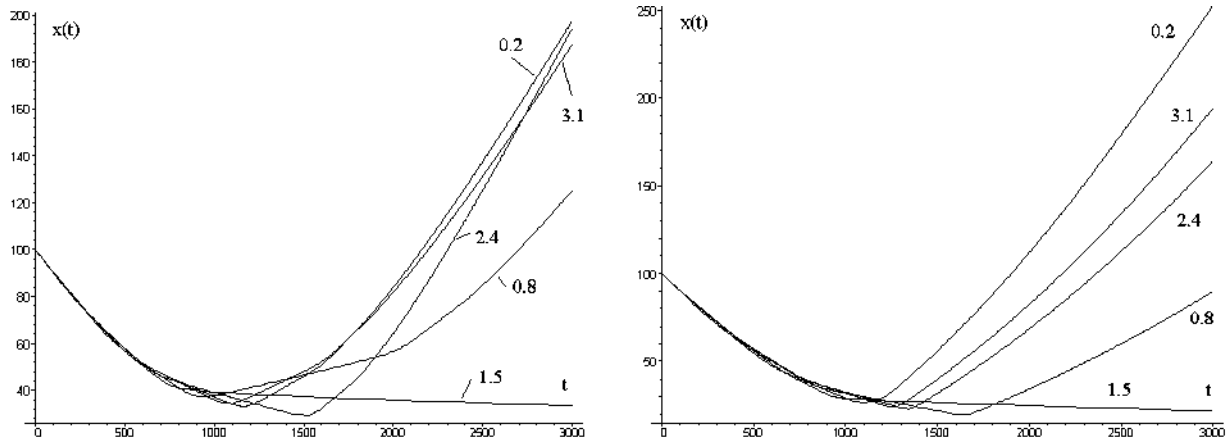

Fig. 1. Dependence of the distance between the moving charge and the nucleus on time for autonomous and non-autonomous equations.

The task of the future developers of new energy systems of the 21st century will consist in creating such initial conditions for a great number of particles making up a body that only the "maternity home" solution would be realized, and the "crematorium" solution would, if possible, be suppressed.

It follows from the above that if the unitary quantum theory ideas are applied correctly, there is no fundamental taboo for a perpetual mobile. Such a taboo, as it was shown, does not formally exist even in conventional quantum mechanics (no conservation laws for individual processes with small energies), and, in order to generate energy, they should be somehow accumulated (all random processes with excess energy should be grouped together). But conventional quantum mechanics refuses to describe individual events and is unable to offer any ways for such grouping. The unitary quantum theory seems to offer such an opportunity.

However, the great idea of free energy generation was distorted by effort of some research associations interested to keep their stability degree, that everyone who started speaking about it was considered to be a crazy man.

Modern experimental physics has verified the correctness of conservation laws either for very large energies in individual quantum events, or for big macroobjects, when automatic averaging by ensemble is made, but the area of very small energies for individual events today is a *terra incognita*.

In order to see how the conservation laws for reflection (repulsion) of an individual particle from the Coulomb heavy nucleus with different values of the initial phase are violated, we have solved numerically one-dimensional equations (8) and (9) under the different initial conditions:

$$\hbar = 1, m = 1,\ 2Zze^2 = 1,\ x_0 = 100,\ V_{x0} = -0.1$$

In the Fig. 2 the distances between the moving particle and repulsive nucleus are shown as a time function, for

different initial phases in cases of non-autonomous and autonomous equations.

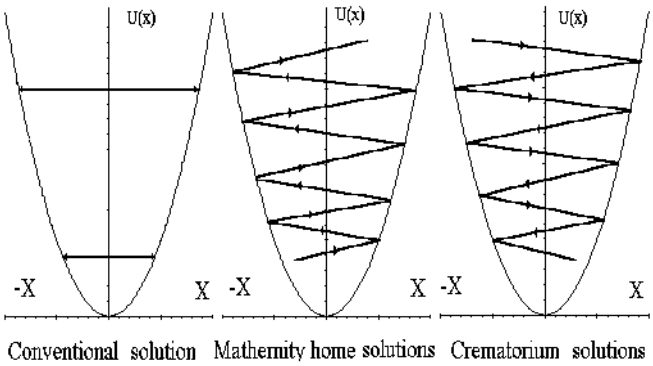

Fig.2 Three types of solutions for oscillator

It is evident from the calculations that the speed of a reflected particle can be equal, lower or higher than the speed of a falling particle. This situation seems to be true for all potentials.

Calculations were also made for other potentials: harmonic oscillator, Yukawa, Gauss, dipole, hyperbolic secant, and Wood-Saxon, and the quality results were nearly the same. If we sum up the impulse of all the particles falling with different phases and compare it with the summarized impulse of all the reflected particles, the summarized reflected impulse, for example, for the Coulomb potential, will be several percent higher than the summarized impulse of the falling particles. For other potentials such a small deviation can even be in the opposite direction. On the whole, this problem is very complicated and requires additional research, because all this is also dependent in quite a complex way on the initial conditions (initial speed, phase and distance).

Philosophically, any categorical taboos, like the impossibility of creating a *perpetual mobile*, are absolutely unacceptable. If everyone is convinced of it forever, the conservation laws and *perpetual mobile* taboos will remain unshakable as long as the human civilization exists. Of course, the funeral of the Conservation Laws can be very prolonged. Anyway, we are not going to do it, and our article might be just a cleanup for the future tomb, and the splendid funeral with all the necessary honors will be organized by future generations. *On the other hand, these laws will never die out completely and will surely be applied, but such spheres of science and technology will appear, though small at first, where these laws are not valid.*

The truth should be accepted irrespective of where it comes from. Words of F. Engels from the "Dialectics of Nature" will be quite appropriate here: "When the solar system ends its life circle and shares the fate of all the finite things, when it falls victim to death, what will happen next? Thus, we come to a conclusion that the heat emitted into the universe should have an opportunity, in a way yet to be established by the natural sciences, to turn into another form of movement, where it can be accumulated again and start functioning. And in this casethe main problem that prevented transformation of dead suns , back to red-hot nebulas will disappear".

The question of whether the conservation law exists in global form (we have already proved its not being local) remains open, because nothing leads to it except the inertia of the human mind. This inertia was based on the Newton laws, which were replaced by quantum laws. This mental inertia leads to a situation, when in case excessive energy is generated during solution of movement equations, a question arises how it can happen, and where it comes from. Of course, if a particle (e.g. a photon) falls on a semitransparent mirror, the packet is divided into two halves, which, due to imposition of vacuum fluctuations, will be recorded by photomultipliers as full-fledged photons [1-5]. The result is that energy is taken as if from vacuum: two photons appear in place of one. Another photon can be divided on the mirror into two halves, but they will not be recorded by the meters, and the energy will allegedly pass into vacuum. So, at one time we borrowed energy from vacuum, and then gave the same amount of energy back to vacuum at another place. You can think like that, and this process might take place. But if we consider the equation with an oscillating charge, the energy and impulse conservation laws are not valid there for solution of the movement problem, and vacuum fluctuations have nothing to do with it at all. As for the question of where the energy comes from, it is the result of our mental inertia, and is, essentially, an atavism imposed by the Newton mechanics. But the latter appears as a result of an extreme passage from quantum mechanics, which is more fundamental.

It is interesting to note that there is a bomb in the logical definition itself of the energy conservation law. If energy is something that cannot appear or disappear and always simply passes from one form to another, the only value satisfying this condition is zero. We are far from assuming that energy does not exist. But the problem of existence is solved differently in different philosophical systems, and the mathematical approach seems to be the most correct one: *an object exists if it is free from contradictions*. Energy has bad luck in this case, for under such an approach it should be zero.

Some cosmologists (for example, British prof. Fred Hoyle) are very willing to have a process, in accordance with which the Universe has certain places where energy appears from other certain places, in which it is eliminated. Besides, any philosopher at least a little bit familiar with astronomy, looking at the bright night sky, will see the birth of matter and its expansion into a still greater space. But for this purpose the Global Energy Conservation Law is superfluous and only denies what is observed. The head reels…

Cold Nuclear Fusion and Nuclear Transmutation.

Let us approach the epoch-making experiments made by Fleischmann and Pons in March 1989 [30] from the positions of the equation with an oscillating charge. One

of the authors predicted in 1983 [9] the possibility of such nuclear reactions under very small energies. Without going into well-known details, we will sum it up very briefly: cold nuclear fusion exists, and there are no people or theories capable of giving a clear explanation. The chain of various mechanisms meant to explain this intriguing phenomenon is growing, but few really believe in them. The reason is as follows.

When a charged particle interacts with the nucleus, the potential energy is like in Fig. 3, where the right top part of the curve is conditioned by mutual Coulomb repulsion between the nucleus and the charged particle.

The repulsion potential will be

$$U(r) = \frac{Zze^2}{r}$$

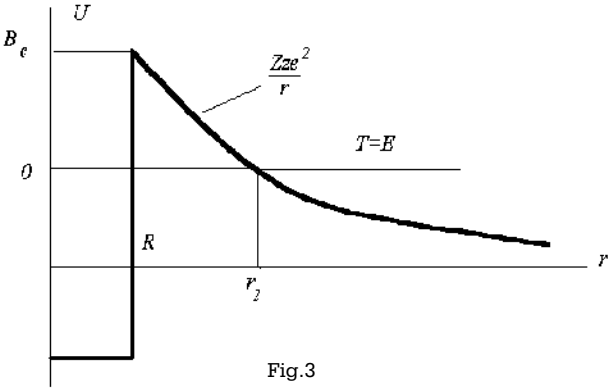

Fig.3

where Z – charge of the nucleus, and z – charge of the approaching particle, e – charge of the electron, r – distance between the particle and nucleus. When $r=R$ (critical distance), then the potential energy curve goes sharply down, which is due to the emergence of intense nuclear gravitation, the potential whereof today appears more complex than could be imagined mathematically. If the charged particle overcomes the Coulomb barrier with a height of

$$B_c = \frac{Zze^2}{R} \approx \frac{Zz}{\sqrt[3]{A}} MeV$$

it will further get into the nuclear gravitation area and a nuclear reaction will take place.

Let us look at the nuclear interaction of a charged particle with kinetic energy $T < B_c$. From the point of view of classical mechanics, there will be no nuclear reaction in this case, because the particle will approach the nucleus and at a certain distance $r < R$ from the top of the Coulomb barrier will turn back and be reflected from it. However, from the point of view of quantum mechanics, there exists a tunnel effect, and the probability of such a tunnel passage, or transparency of potential barrier D is described by a well-known formula:

$$D \approx \exp\left(-\frac{2}{\hbar} \int_{r_1}^{r_2} \sqrt{2\mu(U-T)}dr \right) \qquad (6)$$

where $\mu = \frac{Mm}{M+m}$ is reduced mass. The bottom integration limit r_1 coincides with the nucleus radius R, and the top limit r_2 can be found from the condition $T = \frac{Zze^2}{r_2}$. After integration we will get

$$D = \exp(-2g\gamma)$$

where $g = \frac{R}{\lambda_{B_c}}$; $\gamma = \sqrt{\frac{B_c}{T}} \arccos\left(\sqrt{\frac{T}{B_c}}\right) - \sqrt{1-\frac{T}{B_c}}$,

and value $\lambda_{B_c} = \frac{h}{\sqrt{2mB_c}}$, the de Broglie wavelength corresponding to the kinetic energy of the particle equal to the barrier height $T = B_c$. If $T << B_c$, expression (6) is easily transformed to look as

$$D = \exp\left(-\frac{2\pi R B_c}{\hbar v} \right) = \exp\left(-\frac{2\pi Z z e^2}{\hbar v} \right) \qquad (7)$$

where v is velocity.

Let us now see what the shocking cold nuclear fusion will look like on the basis of the above considerations. The deuteron energy in an ordinary electrolytic Fleischmann-Pons cell will be about 0.025 eV, and the height of the Coulomb barrier for this case is $B_c = \frac{Zze^2}{\sqrt[3]{A}} = 0.8MeV$. In classical mechanics it would be just naive to talk about overcoming such a barrier with a height dozens times greater than the kinetic energy. Let us now see how the tunnel effect will improve the situation. Let us assess the value of g and γ for the case of collision between two deuterons with such energy:

$$g = \frac{R\sqrt{2mB_c}}{\hbar} = 1.9;$$

$\gamma = \sqrt{\frac{B_c}{T}} \arccos\left(\sqrt{\frac{T}{B_c}}\right) - \sqrt{1-\frac{T}{B_c}} \approx 8883$ and the probability of such a process will be $\exp(-2 \cdot 1.9 \cdot 8883) \approx 10^{-7328}$, i.e. practically pure zero. The fusion cross-section will be defined by the product of nuclear cross-section and the tunneling probability:

$$\sigma = \sigma_{nucl} D$$

and, in the case under review, is also a very small value. If the clash parameter of deuterons is not zero, the emergence of centrifugal potential

$$U = \frac{\hbar^2 l(l+1)}{2mr^2}$$

will still further lower the probability of such interaction.

It is these very circumstances that make the nuclear physics scientist think that there is no cold nuclear fusion as such. For example, such a serious and responsible edition as Encyclopedia Britannica 2001 found no place for the notion of cold nuclear fusion at all. Such an official position can be understandable only from the point of view that quantum mechanics is absolutely true and unshakable. Despite this, for the 12 years since the Fleischmann-Pons experimental discovery, nearly 30 international conferences have been devoted to this subject, there are lots of books and magazines on this subject, and the number of articles on the problem is nearing ten thousand. Today the situation is gradually developing in the positive direction, and the research in the field of hot nuclear fusion, which has already wasted over $90 billion for 45 years, is slowly coming to naught.

But today there exist well known experimental data on cold nuclear fusion. They are numerous and various. We will dwell only upon the most important and sufficiently reliable results. Thus, the classical view of electrolysis of a palladium cathode saturated with heavy hydrogen in heavy water identifies an anomalous quantity of heat energy up to 3 kWt/cm^3, or up to 200 Mj per small sample. Products of nuclear reaction have also been found: tritium (10^7 - 10^9t/s), neutrons with energy of 2.5 MeV (10-100n/s), and helium. Absence of He^3 among the reaction products shows that heat is not generated by reaction $d+p$. Besides, emission of charged particles ***(p, d, t, γ)*** is observed. Similar processes are observed in case of a gas discharge on a palladium cathode, of phase passage in different crystals saturated with heavy hydrogen, irradiation of deuterium mixture with a powerful sound or ultrasound flow, in cavitating microbubbles in heavy water, in a tube with palladium powder saturated with heavy hydrogen under a pressure of 10-15 atm., etc. In certain reactions (e.g. $d + t \rightarrow \alpha + p$) neutrons of 14 MeV are absent, and such a strange situation occurs in other cases too. Activity of Li^6 , Li^7 in reactions with heavy hydrogen and protons failed to be discovered, whereas reaction

$$K^{39} + p \rightarrow Ca^{40}$$

was well recorded even in biological objects. But the most intriguing fact of all these processes is the shortage of nuclear reaction products for explanation of the emerging heat effects. Thus, in certain cases the number of nuclear reaction products (tritium, helium, neutrons, quanta) should be millions of times greater in order to account in some way for the quantity of the generated heat. Generation of such a big amount of energy cannot be accounted for by either chemical or nuclear reactions, or by phase passages. The well-known interaction $d+d$ goes along three channels:

D + D —> T (1.01) + p (3.03) *(Channel 1)*
D + D —> He (0.82)+ n(2.45) *(Channel 2)*
D + D —> He + γ(5.5). *(Channel 3)*

All these reactions are exothermal. The third channel has a very small probability. It was experimentally discovered that they could occur under very small energies. In a molecule D_2 the equilibrium position between atoms is 0.74A and in accordance with the conventional quantum theory, these two deuterons could accidentally enter a nuclear fusion reaction. But the interaction value is very small $\lambda_{D_2} = 10^{-64} c^{-1}$. There is a known estimate that in the water of all seas and oceans there are 10^{43} deuterons, and in 10^{14} years there will be only one fusion.

It follows from the aforesaid that the main problem impeding the occurrence of the $d+d$ reaction lies in the existence of a very high Coulomb barrier. Our approach allows for this problem to be solved, and there is such an opportunity in the UQT. The UQT equation solutions show that the distance to which deuterons can approach each other is strongly dependent on the phase of the wave function (by the way, it is absolutely clear intuitively).

Let us consider the one-dimensional problem [15-18,31]. There is a stationary nucleus with charge *Ze* at the point of origin, and another nucleus is approaching it along axis x (charge *ze*, mass *m*) at a certain initial velocity. The non-autonomous and autonomous equations of such a problem will look as follows:

$$m\frac{d^2x}{dt^2} = -\frac{2Zze^2}{x^2}\cos^2\left(\frac{m}{2\hbar}\left(\frac{dx}{dt}\right)^2 t - \frac{m}{\hbar}\frac{dx}{dt}x + \varphi_0\right) \quad (8)$$

$$m\frac{d^2x}{dt^2} = -\frac{2Zze^2}{x^2}\cos^2\left(-\frac{m}{\hbar}\frac{dx}{dt}x + \varphi_0\right) \quad (9)$$

Since an analytical solution was not found for all the areas of initial phases , numerical methods were applied with the following initial values: $Z=z=1$, $e=1$, $m=1$, $x_0=-10$, $\hbar=1$ for different initial velocities and initial phase values. As had been expected, braking or acceleration of the particle happens only when the charge is large. But at the last stage, under certain initial phases close to $\frac{\pi}{2}$, a wonderful process occurs: velocity, charge and repulsing force are very small. Due to phase ratios, the small charge is not changed for a long time, which means that the particle (or rather what is left of it) is not influenced by any forces, and it is crawling at a permanent small speed for a very long time ("the snail effect") inside the field of another particle, and can come very close to the center. Such movement with a very small charge and a small speed can last for several hours, and disconnection of the external field will not effect this movement. This process reminds of quiet and

invisible scout penetration into the enemy territory. This phenomenon occurs only in certain phase areas, and can be conveniently called a phase hole, which is illustrated in Fig. 4 resulting from the solution of equation (8).

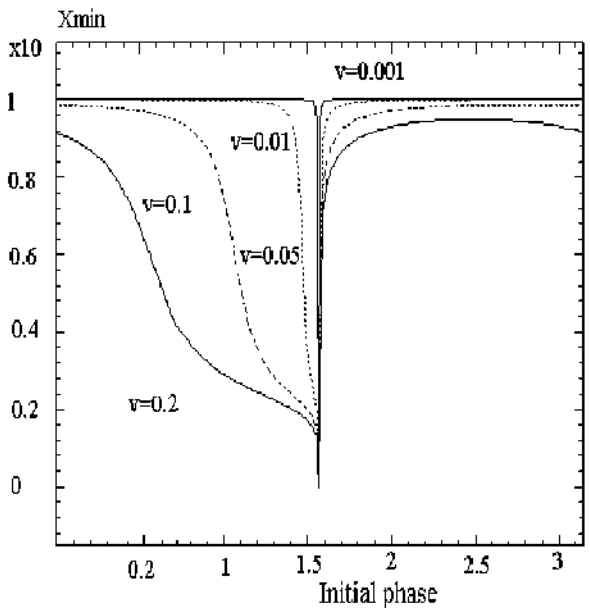

Fig.4. Distance to the turning point of the moving charge depending on the initial phase value for different initial velocities.

Let us note in passing that now we can account for one of the nuclear physics anomalies, which has a tendency to be totally ignored. Under a nucleon energy of 1 MeV, its velocity is 10^9 cm/s, nuclear radius is 10^{-12} cm, and the passage time of the nucleus is 10^{-21}s, but the time period in which the nucleon passes is usually anomalously long - 10^{-14} and even more, and it is absolutely unclear what the nucleon is doing in the nucleus so long. In our model it is easily explained by the "snail effect".

For the same equation, the minimum distance was calculated between the charges dependent on velocity (Fig. 5) for different initial phase values. For comparison, Fig. 5 also shows the result of the classical calculation based on the Coulomb law. It is obvious from Fig. 4 and 5 that the minimum distance to which charges can approach each other is nearly independent of kinetic energy, but with reduction of speed the initial phase area width is reduced as well. In other words, reduced energy brings also reduced probability of a nuclear reaction.

The same results are true for the autonomous equation (9). Under the conventional quantum theory, the ratio of the reaction speeds in the tritium and neutron channels should be close to unity: $\frac{t}{n}=1$. But in many experiments on cold nuclear fusion this value is very different from unity and equals $\frac{t}{n}=10^9$. In different

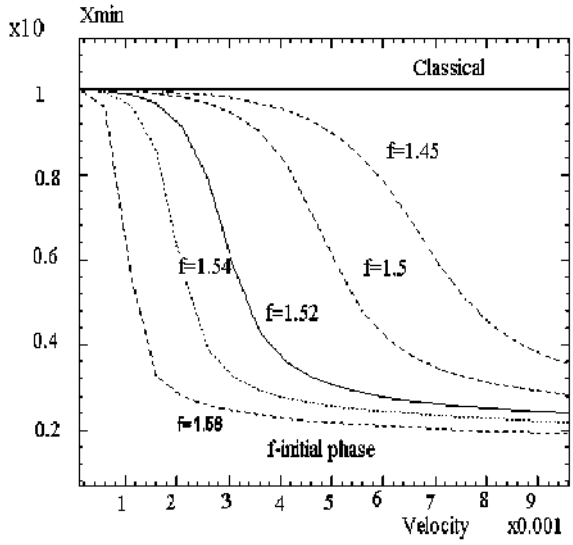

Fig.5 Minimum distance between charges depending on the initial velocity for different initial phase values.

experimental situations it is reproduced by different experimental groups with a very high accuracy. This very intriguing problem has so far received no simple explanation. Let us dwell on a possible cause for such aphenomenon. With a small velocity in the phase hole, neutrons are affected by nuclear gravitation forces, and protons are affected by electrostatic repulsion forces. Under the effect of this momentum, the deuteron will have enough time to turn in such a way that the neutron parts of the deuteron would faceeach other. After the neutron gravitation the nuclear forces will be saturated, which will weaken the proton connection, and one of the protons will leave the system. This reaction can be conditionally presented in the following form:

$$d+d \rightarrow p+(n+d) \rightarrow p+t$$

This reminds of the Oppenheimer-Phillips effect.

It is well known, however, that under big energies, the probabilities of the first and second reaction channels are the same, and this phenomenon should somehow be accounted for. Increased probability of the neutron channel with growing energy can be connected with the appearance of secondary neutrons in the reaction *T + D = He + n (14.1 MeV).* In a deuterium-rich environment, a big part of the resultant tritons will pass to neutrons in the process of this reaction, which has a cross-section of 5 barns under an energy value of 70 KeV. According to assessments in [32], the number of such secondary neutrons per one triton is $7.9\cdot10^{-12}, 1.7\cdot10^{-9}, 2.7\cdot10^{-6}$ for energy tritons 10, 20 and 100 KeV respectively. Thus, the prevalence of $\frac{t}{n}>10^6$ can be expected only in those reactions, where tritium is born with energies over 40 KeV.

It should not be assumed, however, that the phase hole phenomenon in its whole area leads to a nuclear reaction. It can be assumed that reduction of the Coulomb repulsion is followed by reduction of strong

interaction. But how? Today nobody knows the exact equation of the strong interaction potential. Besides, the particle approaches the turning point X_{min} is rather "thin". Will it be able to take part in a full-fledged nuclear reaction, or will it fly through, like it happens with the electron in the s – states of the atom? There are very narrow phase areas, when soon after the particle stops the charge grows quickly and is sharply accelerated. The charge can even be maximum in the nuclear force effect area. May be, it is this narrow phase area that is responsible for cold nuclear fusion, and in case of strong interactions the phase hole mechanism must be operating as well.

It was discovered long ago that nuclear transmutations have a mass character (especially in plants and biological objects), but they have little to do with energy generation. Examples of such reactions:

$$Mn^{55} + p \rightarrow Fe^{56} \ ; \ Al^{27} + p \rightarrow Si^{28} \ ;$$
$$P^{31} + p \rightarrow S^{32} \ ; K^{39} + p \rightarrow Ca^{40}$$

In reactions of this type, a very slow proton (with practically zero kinetic energy) penetrates the nucleus in the above-mentioned way and remains there. *No intranuclear energy is generated, because both before and after the reaction the nucleus remains a stable object.* In classical nuclear physics, the nucleus usually became unstable after it was penetrated by a charged nucleon with a large kinetic energy and always broke into parts, and the nuclear debris had an even greater kinetic energy. Reactions of the above type were considered impossible under small energies and for this reasons were not studied by classical nuclear physics. It seems to be *a completely new type of nuclear transmutations, not recognized by modern nuclear science, but experimentally discovered rather long ago.* Today there is a great deal of experimental material confirming mass nuclear transmutation phenomena. Moreover, there are many projects of neutralizing nuclear excess with the help of this technology. Journals *Infinite Energy, New Energy, Cold Fusion, Fusion Facts*, etc. and Internet are full of such projects.

Of course, a change in the nuclear charge will result in restructuring of electronic atom shells, but the energy related to this process will be about several electron-volts and is nothing in comparison with the energies of nuclear reactions from several to hundreds million electron-volts. By the way, nuclear engineers are accustomed to such energy ranges in nuclear reactions. It was this circumstance that made them deny *a priori* all nuclear processes in biology, because under such energy values of the debris dozens and hundreds thousand of complex biological molecules will be destroyed.

Quite a long time ago, Lois C. Kervran [33] wrote a book about nuclear transmutations in biology, and now, nearly 20 years later, its second edition was published! It gives, evidently for the first time, numerous *experimental* data of the above-mentioned phenomena. The reaction of the official science is very interesting. For example, well-known physicist Karl Sagan, after reading the book about such *experimental* data, advised Kervran to read elementary textbooks in nuclear physics!

Some time later a research was made by Panos T. Pappas [58], who studied one of the well-observed nuclear reactions in biological cells:

$$Na_{23}^{11} + O_{16}^{8} = K_{39}^{19}$$

Classical biology has long known about the existence of equilibrium, when the ratio between the number of K and Na ions is maintained with greatest accuracy despite the shortage or even absence of K ions in food. Later, in work [59] this nuclear reaction was even called the life equation, and the existence of such nuclear reactions in biological objects was proved by M.Sue Benford with the help of direct physical methods.

All thermonuclear fusion programs are based on blunt heating and compression of the reacting material. Despite the progress achieved, the head of the works in England, Dr. Alan Gibson [34], established several years ago that the model reactor design would be created not earlier than in 50 years. Today, this point of view is generally accepted. Even if the reactor is once made (although the authors have grave doubts about it), it will be very complicated, expensive, and harmful for the environment.

Classical approaches have so far not yielded any positive results, despite multi-billion investments and a great number of physicists, engineers, service personnel, and managers involved. It is only natural that this army of researchers is a potential impediment for all alternative projects of new power engineering. It has been noted that *"viability" of any idea is proportionate to the number of people involved and investments made.* For these reasons, the Fleischmann-Pons works were given a hostile reception in the USA and other countries.

All the controlled thermonuclear fusion programs are accompanied with the adjective "controlled", although there is no control whatever. It is simply that the initial quantity of the reacting substance is *prudently* made very small. For example, a ball of lithium deuteride during laser reduction has a diameter of several mm. So far no one has been seriously considering the question of utilizing the energy of an explosion of such a ball, which is approximately equal to the energy of an explosion of a box of antitank grenades.

The straightforward approach to fusion used by the modern science is very natural, because quantum mechanics has no methods of influencing this process. The future of really controlled nuclear fusion systems may be not on the way of primitive and blunt method of heating and compression of the material, but following UQT on the way of using collisions of nuclei having small

energy and corresponding fine adjustment of the wave function phase.

It is essentially possible in case of imposition of the external controlling electromagnetic field on the reacting system, which contains quasi-fixed ordered deuterium atoms and free deuterons. The same properties can be demonstrated by special atomic grid geometry. Diffraction scattering of a deuteron flow on such grids will lead to automatic deuteron selection by energies and phases.

It seems that in the Fleischmann-Pons electrochemical experiments such an ordered system existed in the *Pd-D* grid, and some phasing occurred, which accounts for the results of these experiments [30].

Today it appear to us that the cold nuclear fusion processes will be effectively used for nuclear waste liquidation and production of isotopes.

Many researchers [35,36] discovered that the quantity of heat generated in the process of electrolysis of ordinary water on nickel electrodes (there is no hope for nuclear reactions in such systems) is the same as in the electrolytic cell with heavy water. It confirms other measurements, which showed that the quantity of nuclear reaction products is millions times less than is required for such an amount of generated heat, and its origin remains a mystery.

Further we will give certain concrete data demonstrating the phase values of a deuteron with an oscillating charge, under which the deuteron can approach the nucleus to a critical distance of 10^{-12} cm or less, i.e. giving the data to estimate the value of the above-mentioned phase "hole" in the interval (0,π) of the phase change.

Assume that the stationary nucleus with the charge q is placed to the coordinate origin x=0 and the deuteron with the same charge q is placed at the initial moment t=0 to the point $x_0 < 0$on the x-axis, and the deuteron velocity equals $\dot{x}_0 = v_0 > 0$. The units of mass, length and time are chosen in such a way that $m = 1, \hbar = 1, c = 1$ (*m* - deuteron mass, *c* - light velocity). Charge *q* equals 0.085137266. Our units are connected (to 4 significant figures) with the system (kg, m, s) as follows:

1 mass unit = 3.345×10^{-27}kg,
1 length unit = $1.049\cdot 10^{-16}$ m,
1 time unit = $3.502\cdot 10^{-25}$ s.

The electron velocity corresponding to its energy of 1eV equals $5.931\cdot 10^{7}$ cm/s. The deuteron velocity corresponding to such energy will be assumed to be 3680 times less, and in our units it will be $5.372\cdot 10^{-7}$ (if $c = = 3\cdot 10^{10}$ cm/s). Then the deuteron movement towards the nucleus is described by the equation

$$\ddot{x} = -\frac{2q^2}{x^2}\cos^2(\frac{1}{2}(t+t_*)\dot{x}^2 + x\dot{x} + \varphi_0), \qquad (10)$$

where the parameter t_* is defined under the condition that the argument of cosine equals φ_0 for $t = 0, x = x_0, \dot{x} = \dot{x}_0$ (thus $t_* = -(2x_0)/\dot{x}_0$), and this parameter may be considered as the initial moment of so called local time.

In the interest for us are namely solutions of eq. (10) under very small deviation ε from phase φ_0 and so we put $\varphi_0 = \frac{\pi}{2} + \varepsilon$ and rewrite eq.(10) in the following form:

$$\ddot{x} = -\frac{a}{x^2}\sin^2(\frac{1}{2}(t+t_*)\dot{x}^2 + x\dot{x} + \varepsilon), \qquad (11)$$

where *a* = 0.0144967 Let the initial x_0 to be equal - 500000 of our length units (i.e. approximately $5\bullet 10^{-9}$ cm) and the initial deuteron velocity v_0 to be equal to the velocity v_{00} corresponding to the deuteron energy of 1 eV or less. But it turned out that the precision of numerical integration of this equation under such initial conditions and under values $|\varepsilon|$ = $10^{-15}$and less is small and besides the interval of the integration must be very large. That is why this equation also had to be transformed by passing to "slow" time $\tau = |\varepsilon| t$ to the equation relative to the variable $w = \left(\frac{dx}{d\tau}\right)^2$ as a function of *x:*

$$\frac{dw}{dx} = -\frac{2a}{x^2}\left\{\frac{1}{\varepsilon^2}\sin^2\left[|\varepsilon|(\frac{1}{2}(\tau+\tau_*)w + x\sqrt{w} \pm 1)\right]\right\}, \qquad (12)$$

where $\tau_* = -(2x_0)/\sqrt{w(x_0)}$ and +1 if ε >0, and -1 if ε < 0. It must be added also the equation for τ as a function of *x* :

$$\frac{d\tau}{dx} = \frac{1}{\sqrt{w}}. \qquad (13)$$

The system of equations (12, 13) is, so to say, a "model" system describing fairly accurately the deuteron movement under all values of |ε| from 10^{-24} to 10^{-6}. Numerical integration of this system was fulfilled under different values of e and under following initial conditions:

$$w(x_0) = 2.103, \tau(x_0) = 0, x_0 = -500000, \tau_* = 689573.18 \qquad (14)$$

It may be noted that the initial deuteron velocity v_0 equals 1.450172 (following the relation $\dot{x}_0 = |\varepsilon|\sqrt{w(x_0)}$) for given initial $w(x_0)$ and for |ε| = 10^{-7} , i.e. such velocity is approximately 3.7 times less than velocity v_{00} corresponding the deuteron

energy of 1eV. If $|\varepsilon| = 10^{-6}$ then the velocity v_0 is approximately 2.7 times greater than velocity v_{00} .

It turned out that the numerical tables for values of w, τ obtained under different values of $\varepsilon < 0$ in the interval (-10^{-24}, -10^{-6}) don't differ essentially from each other. The following table is true to three-four significant figures for τ and $\dot{x}/|\varepsilon| = \sqrt{w}$:

x	τ	$\dot{x}/\lvert\varepsilon\rvert$
-500 000	0	1.450
-50 000	$1.426 \cdot 10^6$	0.0493
-500	$1.002 \cdot 10^7$	0.000489
-200	$1.067 \cdot 10^7$	0.000440
-100	$1.090 \cdot 10^7$	0.000425
-80	$1.100 \cdot 10^7$	0.000423

If reducing the table values of x to centimeters, we obtain the following corresponding approximate values:

$$5 \cdot 10^{-9}, 5 \cdot 10^{-10}, 5 \cdot 10^{-12}, 10^{-12}, 0.8 \cdot 10^{-12}$$

The time interval ΔT , in which the deuteron reaches the critical distance 10^{-12} *cm* from the center, is $67350/|\varepsilon|$ of our time units or $(1.090 \cdot 10^7 / |\varepsilon|) \cdot 3.502 \cdot 10^{-25}$ seconds. If nuclear forces are not taking into account then the deuteron may approach the distance less 10^{-12} *cm* .

We present here the table, where are given the initial deuteron velocities v_0 in velocities shares v_{00} and the corresponding time intervals ΔT (in seconds) for different values of ε.

ε	$\frac{v_0}{v_{00}}$	ΔT (s)
-10^{-6}	2.7	$3.82 \cdot 10^{-12}$
-10^{-7}	0.27	$3.82 \cdot 10^{-11}$
-10^{-22}	$0.27 \cdot 10^{-15}$	$3.82 \cdot 10^{4}$ (≈ 10.6 hours)
-10^{-23}	$0.27 \cdot 10^{-16}$	$3.82 \cdot 10^{5}$ (≈ 10.6 hours)

Let us note that the given data change essentially under positive values of ε (10^{-6}, 10^{-7}, etc.). There is some asymmetry of solutions behavior under negative and positive values of ε. The calculations show the minimum distance $|x|_{\min}$ more than 500 of our lengths units even for relative big initial $w(x_0)$ = 10000. Thus, if we limit ourselves to the condition that the deuteron energy is not over $(0.27)^2$ eV at a distance of $5 \cdot 10^{-9}$ cm from the central nucleus, and the whole process of deuteron movement towards the nucleus does not exceeds approximately 10.5 hours, then the interval $(\frac{\pi}{2} - 10^{-7}, \frac{\pi}{2} - 10^{-23})$ is approximately the sought phase "hole" in the whole interval ($(0, \pi)$) of phase change φ_0 in eq. (10).

If many deuterons with the energy not more than $(0.27)^2$eV at the distance $5 \cdot 10^{-9}$ *cm* from the nucleus are equally distributed along their phases φ_0 , the ratio of the length of this "hole" to π, equaling approximately $0.3 \cdot 10^{-7}$, is equal to a share (or a relevant percentage of $0.3 \cdot 10^{-5}$) of deuterons overcoming the Coulomb barrier.

The above figures express at least the order of probability of the cold nuclear fusion occurrence, and this order is absolutely incompatible with the figures in the classical quantum mechanics mentioned above. Let us note once again that a one-dimensional problem was solved, and in case of an accurate analysis (not zero sighting distance will be taking into account) this probability will be lower. Let us also pay attention to the large time intervals ΔT calculated if $|\varepsilon|$ is very small. It explains well the effect (observed by many researchers) of continuation of cold nuclear fusion reactions during even many hours after the disconnection of the voltage in the electrolytic cell. This effect was named even "life after death".

As for the analysis of the deuteron movement with the help of the autonomous equation, the calculations lead to initial velocities v_0 , exceeding the above mentioned numbers, although the general motion picture is the same. But the autonomous equation is interesting, because in the area of those values $x, \dot{x}$, under which the product $x\dot{x}$ is modulo small, it is possible to replace $\sin(x\dot{x})$ with $x\dot{x}$, and the eq.(11) under ε=0 to replace with simplified equation (describing the deuteron motion from initial point $x_0 > 0$ to center)

$$\ddot{x} = a\frac{(x\dot{x})^2}{x^2} = a\dot{x}^2$$

This equation has a very simple analytical solution. Without giving very simple calculations, we will present the final formulas.
Let us take the following initial conditions:

$$x(0) = x_0 > 0, \quad \dot{x}(0) = -v_0 < 0$$

Then

$$\dot{x}(t) = -\frac{v_0}{1 + av_0 t}, x(t) = x_0 - \frac{1}{a}\ln(1 + av_0 t)$$

It follows from these formulas that the velocity of a particle moving in accordance with the initial equation never turns to zero, and under

$$t = t_* = \frac{\exp(ax_0) - 1}{av_0}$$

$x(t_*) = 0$, i.e. the particle reaches the center of the nucleus, its velocity at this moment being

$$\dot{x}(t_*) = \frac{-v_0}{1 + av_0 t_*} = -v_0 \exp(-ax_0) \ ,$$

so that it *passes through the nucleus and moves further..*

For example, let $a = 0.0144967$, $x_0 = 1000$ ($\approx 10^{-11}$ cm), $\dot{x}(0) = 5.37 \cdot 10^{-10}$ (≈ 16 cm/s).

Under such initial data, the product $x\dot{x} = -0.0000537$, so it is quite possible to replace $\sin(x\dot{x})$ with $x\dot{x}$. In this case,

$$t_* \approx 2.3 \cdot 10^7 \qquad (\approx 8 \cdot 10^{-18} \text{ s}),$$

$$\dot{x}(t_*) \approx -29.9 \cdot 10^{-17} \qquad (\approx 9 \cdot 10^{-6} \text{ cm/s})$$

These figures fit well into the reasonable framework, so the autonomous model can also be of use for the movement analysis in the problem under review. The phenomenon of particle passage through the Coulomb potential accounts very well for the existence of pendulum orbits in the Bohr-Sommerfeld model, when in states *1s,2s,3s* etc. the electron passes through the nucleus. Such states in the strict theory and experiment have no impulse, so in the Bohr-Sommerfeld model they were discarded as absurd. Now they have a right to existence. Further, the experimental data for angular distribution of non-elastic scattering by nuclear reactions (including reactions with heavy ions) reveal the big amplitude of the scattering forward. It is impossible to explain such effect by the formation of intermediate nuclei but it is may be explained from the viewpoint of our UQT.

General Principles of Creating New Energy Sources

In the ancient classical *perpetual mobile* idea it is supposed that energy is just created and not taken from outside (impossibility of *a perpetual mobile* is the first law of thermodynamics). There have appeared lately many articles and even books dwelling on the idea of energy generation from vacuum. We are not in complete agreement with many of these works, and we will dwell only on some of them, which, in our view, can be of interest. One of the main ideologists of this completely new sphere in science are Daniel C. Cole and Harold E. Puthoff, and their first serious work entitled «Extracting energy and heat from the vacuum» was published in Physical Review E, vol. 48, #2, (1993). In this work authors use the Casimir forces [60] making them produce useful work. The appearance of such forces in vacuum is understandable intuitively: if in a stormy sea we put vertically into the water two big parallel plates, on the outside part of these plates the waves will hit them at random, and between the plates there will be no waves. Then, the hitting of the waves outside the plates will produce a gravitation force between them (the Casimir force discovered experimentally long ago), which the authors of this interesting work are going to exploit. It is easily seen that in this idea energy is generated from vacuum fluctuations.

Our approach is altogether different. When the equation with an oscillating charge was solved for the quantum oscillator, 4 types of solutions were discovered. For us only two of them matter – "crematorium" and "maternity home". In one solution ("crematorium") the particle slowly falls to the bottom of the pit and finally turns into a "specter" (under the strict unitary quantum theory it disappears, spreads about the Universe and contributes to vacuum fluctuations everywhere). In the other solution ("maternity home") the particle can even be born of a very small fluctuation, or accumulate a sufficiently big energy. Let us underline once again that both these processes are not at all logically connected. In other words, there are such systems where energy will disappear completely (electrolytic baths), or increase unlimitedly (it might be our Universe).

It is the energy conservation law that presents the strongest impediment in all cosmological approaches. However, universes with birth of matter have long existed in scientific cosmology independently of us. There is known the theory of British astronomer Fred Hoyle based on the idea of continued creation of matter from nothing. The question of whether such an approach is realized in nature and whether the energy emitted by quasars is the result of work produced by a certain gigantic pit, is the most intriguing question of the future.

It is yet unclear whether the values of appearing and disappearing energy in these solutions are equal. But neither in the strict UQT nor in the equation with an oscillating charge vacuum (as a big set of random oscillations) is needed for energy generation. Of course, UQT admits of such an energy exchange with vacuum. For example, during split of a photon on a semitransparent mirror, at one time both halves of the photon will not be registered and will give their energy to the vacuum and disappear for the observers for good, at another time there will appear two photons out of one, and the lacking energy will be taken from vacuum. But *the movement equations (4) and (5) themselves know nothing about vacuum and can generate energy due to their nature* (they are noninvariant relative to the coordinate translations) and the conservation laws we are so accustomed to do not exist for them.

Let us remind you once again that the latter follow from the Newton equations, and the Newton equations result from averaging by a big number of events, while for individual events of small energies no conservation laws in quantum physics exist.

In other words, it can be said philosophically that a motion of a small wave packet, once started, will give birth to other movements (energy) and, consequently, to matter. Since most various and breath-taking speculations are possible, up to the creation of a universe, we will stop here.

Thus, the generated or disappearing energy in our approach can be manifest not only in the changes of the particle velocity during movement in a certain potential, but in the appearance or disappearance of the particles themselves as well. A change of the particle velocity in movement is most easily discoverable, and it is the velocity increase that can be used for generation of heat or electric current. There can be energy systems, which exploit the fact itself of charge oscillation and the consequence of it. It is very probable that these phenomena, contradicting the most fundamental laws of modern science, have been long discovered and even applied. But these are the very phenomena that are the easiest to be exploited at the first stage of development of such new energy technologies.

When an energy generation mechanism is used, crematorium-type solutions should be suppressed. But all the quantum processes are built on the basis of elementary acts, and each of them is impossible to be controlled separately. But if the probabilities of such processes are controlled, they, being multiplied by the great number of participants in the process, automatically become macroscopic variables of quantum kinetics, and the process itself becomes possible. It can easily be achieved, if process participants with correlated initial phases are selected.

Let us remind you that the Newton and relativistic classical mechanics follow from the strict UQT, while the Newton movement equations with the resultant energy and impulse conservation laws follow from the oscillating charge equation with averaging by the particle ensemble composing a classical body (material point). But these conservation laws are nonexistent for individual microparticles in our theory, and they appear only in case of averaging by the ensemble of particles. Thus, if the energy-generating processes are accumulated, and the processes where energy disappears are suppressed, a classical *perpetual mobile* can be created.

But the UQT and the oscillating charge equation have other differences not only from the equations of classical mechanics, but also from some equations of electrostatics and electrodynamics.

There is a fundamental theorem of circulation for the electric field. Let us dwell on it in more detail. Let us have a vector field **E,** which can be an electrostatic or a gravitation field.

$$\mathbf{E} = \mathrm{P}(\mathrm{x},\mathrm{y},\mathrm{z})\mathbf{i} + \mathrm{Q}(\mathrm{x},\mathrm{y},\mathrm{z})\mathbf{j} + \mathrm{R}(\mathrm{x},\mathrm{y},\mathrm{z})\mathbf{k}$$

Line integral

$$\Gamma = \oint_l \left(\mathrm{P}\,dx + \mathrm{Q}\,dy + \mathrm{R}\,dz\right) = \oint_l \mathbf{E}\mathbf{dl} \qquad (15)$$

is called circulation of vector field **E** by contour *l*. Of course, circulation depends not only on **E**, but also on the passage direction accepted in contour *l*; by changing the passage direction we will change the circulation sign. Form (15) is convenient for mathematicians, but for our purposes we will present equation (15) in a different way. If both parts of equation (15) are multiplied by electric charge *q,* on the right we will get the integral of force $q\mathbf{E}$ by way **dl,** i.e. work for moving the charge along a closed loop contour. It is well known that this value is zero.

$$\int_l q\mathbf{E}\mathbf{dl} = \mathbf{0} \qquad (16)$$

If this value were not zero, an energy source could be created. For this purpose a charge should be moved in electric field **E** from point *a*, located in the high voltage area of the field, to point *b,* located in low voltage area of the field, and then back, but along another route. The values of work from $a \to b$ and from $b \to a$ would be different, and we could extract work from the field without making any changes in the system. When the charge is constant, it is certainly true, so for a macroscopic constant charge this theorem is an analog of the energy conservation law. The authors have not come across such an interpretation of the energy conservation law in other works. If the charge is microscopic, then in the UQT it changes, depends on time, coordinate and velocity, so work from $a \to b$ and from $b \to a$ will be different, in this case work can in principle be extracted from the field without any changes made in the system.

Discussion of Experimental Results

Let us now get down to explaining some very unusual experimental results, which the authors have nothing to do with, and which they sometimes regard rather skeptically. The point is that the sphere of new energy sources is the headache of all the human civilization, and in this sphere, like nowhere else, the dividends can be exorbitantly high, and for this reason there are in this sphere a lot of swindlers (even among the theoreticians) and simply erring people. The official science of the world does not so far believe in such research, but the most suspicious fact is the great multiplicity of such works. The authors are not inclined to regard all these people as swindlers or erring, because the UQT can offer a beautiful and simple interpretation of certain phenomena.

There are strange plants with the efficiency over 100%. They are even manufactured in small quantities and are rated among energy-saving devices already termed over unities. Japanese researchers take these problems very seriously, and the leading role in studying this problem belongs not to the USA, but to Japan, which even finances many US institutes in this framework. The total Japanese expenditures for this research exceed $200.000.000 a year. It can be forecast that with the Japanese mentality and the state policy of exporting not natural resources, but superhigh technologies and intellect, Japan will find itself among the leading countries early in the 21st century. We think that our readers will not be surprised to hear that Russia has

not allocated a single cent for this program, and all research was made on pure enthusiasm.

In the USA such works do not get official governmental support either (like, for example, the dying out hot nuclear fusion problem), but a great number of private firms and individual businessmen are conducting large-scale research. The following US journals are devoted to the subject: *Journal of New Energy, Infinite Energy, Cold Fusion, New Energy News, Fusion Facts*, and *NET-Journal* (Switzerland).

Switzerland, Italy, Germany, and France are also among the countries where the new energy problems are seriously researched from the cold nuclear fusion point of view.

A very young sphere of power engineering has emerged and is quickly developing, which researches many new energy sources. In future those new energy-saving sources will first be used, which will considerably differ from the existing ordinary energy transformers in that they will generate additional energy that can be used in the interests of the mankind. The development of civilization will then be limited not by long-expected reduction of natural fuel resources, but by heat pollution of the environment.

Let us enumerate just a few of the new energy directions:
1. The Patterson fuel cell (CETI).
2. Supermagnet-superengines of Takahashi, Aspden and Adams
3. Swiss plant Testatika.
4. Engines operating on water.
5. Hypersound Griggs pump, the Potapov and Schaffer heat generators.
6. Schoulder and Fox cluster systems.
7. N – machines of Farade, Bruce de Palma, Newman, Searl, Tewari, etc.
8. PAGD reactor of Canadian researchers P. Correa and A. Correa.

This list can be complemented with the surprising experimental results received by physicists A. Samgin and A. Baraboshkin (Russia, Institute of High-Temperature Electrochemistry under the Russian Academy of Sciences, Ekaterinburg) [24,25] and T.Mizuno [26] (Japan). They appear to have used, totally independently of each other, special proton-conducting ceramics, which, when electric current runs through them, generate a thousand times more heat energy than the electric energy consumed. In some experiments by T.Mizuno this value even exceeded 70000(!). T. Mizuno in a personal talk with one of the authors of this report said that he feared very much the radiation sickness. But no α, β, γ radiation or nuclear debris was found, and the nuclear processes are not responsible for such energy generation. Such proton-conducting (or, to be more exact, deuteron-conducting) ceramics was made using the power metallurgy methods by agglomeration under high temperatures. In other words, all the chemical processes in it had long been over. The origin of such an amount of excessive energy is absolutely incomprehensible in the framework of conventional science, for they cannot be accounted for either by nuclear or chemical reactions, or by phase passages. At first the authors of this experiment supposed nuclear fusion reactions of the D+D type. At our request, A. Samgin replaced heavy hydrogen (deuterium) during ceramics production with ordinary hydrogen. If the effect of such huge energy generation was connected with the nuclear D-D reactions, all the anomalous heat effects would have disappeared, but they persisted. After such a large quantity of energy was generated, the tablet disintegrated into powder.

These effects can easily be explained by UQT from the harmonic oscillator theory point of view. When the tablet is agglomerated, there remain in it some caverns of a size of hundreds Angstrom units. When direct or alternating current flows through it, the protons and deuterons in their movement (there are few electrons in such ceramics) get into these caverns, and a process can start which is described by the "maternity home" solution. A particle accumulating energy, oscillates in such a pit, and finally the energy will be sufficient both for heating and for destruction of the pit walls (tablet turning into powder). The same processes seem to be taking place in a palladium electrolytic cell with heavy water, and in a nickel electrolytic cell with ordinary water, which accounts for anomalously large heat generation, not related to nuclear processes.

It would be good to verify experimentally the dependence of the tunnel effect on the initial phase. But it seems us that it is more important for our opponents, since both cold nuclear fusion (CNF) and discovery of nuclear transmutations *(which, from the point of view of modern science, are even more absurd than the existence of CNF*) evidently cannot be accounted for in any other way. Besides, such a direct experiment is of a fundamental value. There are today a lot of people and groups in the world, who pin great hope on exploiting the nuclear transmutation phenomenon for the purposes of processing and recycling of nuclear wastes, and the question of industrial generation of tritium for military purposes using CNF methods was under consideration in Los-Alamos. Internet magazines are full of such information. We are not giving Internet addresses here, because everything is constantly changing in this live system.

Let us analyze some of the above-mentioned devices. The first, the oldest and the most mysterious information was information about internal combustion engines operating on water.

Let us give just one example. When we were students, one of our teachers, the late Professor G.V. Dudko (1959) told us that in 1951 he had participated in the testing of an internal combustion engine [39,55-57]. The device represented a hybrid of a diesel and an ordinary carburetor engine, where a gas of petrol was needed to start it and then ignition was switched off, and an

ordinary fuel pump sprayed into the cylinder warmed up and strongly compressed water with special additives (which the inventor himself put into the tank in small quantities, and which, as we now understand, represented the principal secret). The engine was installed on a boat. The researchers were riding for two days in the Azov Sea, and only water vapor was the engine exhaust. Professor Dudko himself drew the water fuel overboard and poured it into the tank. They needed much water, several buckets a day, but there was no shortage of it… The question of why, if everything was so great, these engines are still not in use, can occur only to a person who has never lived in Russia.

From the point of view of the solutions of the harmonic oscillator problem, the following theoretical possibility exists [40,44,47,55-57]: if water with the necessary additives (which, evidently, represent the secret of many invented engines operating on water) is compressed and sprayed into the cylinder, each drop of water, when it gets into the cylinder after being compressed, will start dilating and will pass by inertia the equilibrium position. As a result, caverns (empty volumes) can be formed in it, with a size of several dozen of Angstrom units. If a free proton (or some other microparticle) gets into such a cavern in the required phase (it is supposed that the task of the additive is exactly this), the "maternity home" solution will be realized and some of the drops will explode… Later we heard and read many times about various Russian inventors, who had successfully created and tested engines operating on ordinary water with some mysterious additives.

Of course, the possibility of catalytic water decomposition with small energy consumption before spraying into the cylinder is not at all excluded. There are films and information in Internet about testing of cars operating on water, which is catalytically (with small energy consumption) decomposed into oxygen and hydrogen. Such power engineering would be ecologically absolutely clean, and the only restriction would lie in heat pollution of the environment.

An ideal solution for the motor transport could also lie in use of some new types of electric energy generators. The UQT even admits of the possibility, which was long observed in the experiments of Nicolas Tesla and in those made by Canadian physicists the Correas, who even received a patent for a system generating energy from vacuum fluctuations (as they believe) [45]. The readers could have got acquainted with our detailed theory of these processes in [46]. But the ideal system for the automobile would certainly be Testatika.

Any imagination will be amazed at the thermal cell CETI created by James Patterson, USA [27], in which takes place the electrolysis of specially made nickel balls in ordinary water. The US paper «Fortean Times» [1] 85, 1995, wrote about it: "December 4, 1995 will go down into history. On this day a group of independent experts from 5 US universities was testing a new source of energy with a stable output heat power of 1.3 kWt. The consumed electrical energy was 960 times smaller". All experts note that the generated heat is of mysterious origin and cannot be explained by chemical or nuclear reactions, as well as by phase passages. The US ABC TV showed on February 7 and 8 1996 in the «Nightline» and «Good Morning America» cycles of programs about the development by Patterson of a new energy source generating hundreds of times more energy than it consumes. The mysterious nature of the generated heat was again underlined. It is interesting [34] that Motorola tried to buy the CETI patent from its authors for $20.000.000, but met with a refusal. We are sure that Motorola had invested a certain amount of money into the study of this problem before making such a serious offer. All that happens within the Patterson element has nothing to do with nuclear reactions (although Patterson told one of the authors that he was of a different view), and, in our opinion, can be accounted for by exactly the same processes as were described above for proton-conducting ceramics.

The sonoluminescence phenomenon, when certain liquids start shining if weak ultrasound is run through them, also looks very mysterious. No satisfactory explanation has so far been found for this experimentally proved phenomenon, discovered by Moscow University Professor S.N. Rzhevkin in 1933. As Nobel Prize winner Professor Yulian Schvinger said, "it has no right to exist, but it does exist" [38]. This phenomenon can also be explained from the above-mentioned positions.

There are also heat generators (Yu. Potapov [21-23], Moldavia, James J.Griggs [28], and Huffman [29], Schaffer - USA). In them many cavitating bubbles are formed during circulation of ordinary water, in which excessive energy is generated, with the output to input energy ratio approaching 1.7. In these experiments and plants no chemical or nuclear reactions can take place, and thousands of Potapov's heat generators have been manufactured for heating homes. In such devices (they are very different in appearance) a great number of cavitating bubbles are created in a flow of water. This is achieved either with the help of interrupting the water flow with a special rotor (J.Griggs, Huffman, Schaffer), or the water flow is twirled by a special helix and then enters the zone of sharp dilation, where cavitating bubbles are formed (Yu. Potapov). In general, it should be said that cavitation remains a great puzzle for theoretical hydrodynamics and science. For example, forged multi-ton screw propellers of big nuclear submarines under certain operation modes and geometry of the surrounding forms can be destroyed by cavitation within only a few hours. It happens because of huge energy generated in cavitating bubbles.

Under certain values of phase and energy, a particle in the pit, each time reflecting from the walls, will have a greater velocity than that of a falling particle (this is within the uncertainty relation), and after many reflections will accumulate a fairly big energy which will be generated in the form of heat or bremsstrahlung when the pit is destroyed, and, finally, the energy of the oscillations of such a particle accumulated in the

pit will always be transformed into heat in an ordinary solid body or a liquid. This physical idea immediately accounts for both sonoluminescence (although for sonoluminescence in general this mechanism is less primitive), and energy generation in proton-conducting ceramics, nickel during electrolysis in ordinary water (CETI element), and water bubbles of commercial heat generators. The theory predicts that the samples should be fissure due to increased pressure on the walls of the potential pit with the growth of energy, which fact also takes place, since both ceramic samples and nickel balls in the CETI element finally disintegrate. It is evidently for these reasons that any metal containing much hydrogen in its grid becomes fragile and is quickly destroyed, which fact is well known to engineers.

The small number of experiments does not so far allow for making concrete conclusions as to what particles generate energy in pits (microbubbles). Besides, for at least an electron to disappear a pit of about 0.5 MeV is required, while in a solid body the pits are about several eV deep, and what seems to happen is only loss of kinetic energy, and not disappearance of particles. The fact that this process requires very deep potential pits, which do not exist in a solid body, does not change the essence of the matter.

Of course, under ordinary conditions, both competing solutions usually take place at once: "maternity home" and "crematorium", which compensate for each other and the energy is preserved. For energy generation, the "maternity home" solution should prevail. Both these processes take place simultaneously and compete with each other, but, formally, they are not connected in space and time. The complexity of the energy generation problem lies in suppressing the "crematorium" solution by a careful selection of different parameters and promoting the "maternity home" solutions. So far we cannot say for sure what the optimum dimensions of such cavitating bubbles are, or which object oscillates in them, because for this purpose special experiments are needed, which so far have not been staged.

Of course, the inexorable Robber in the form of the Carnot principle stands in the way of transformation of the heat generated in a heat generator or ceramics into electrical or mechanic energy. In accordance with this principle, all mechanic or electrical energy can be transformed into heat, but the reverse process is always connected with big losses.

If there are experiments and plants in which energy generation contradicting the conventional conservation laws is discovered, there should also exist opposite ones, where energy disappears completely, i.e. the "crematorium" solution prevails. It proved to be true. There are such modes during electrolysis in electrolytic baths, under which the temperature of the solution in the bath is strongly reduced for unaccountable reasons, and this fact has no explanation at all. This phenomenon long ago was noted by attentive industrial engineers, and it is called the "bath-freezing" mode [49,50]. Chinese physicist Swe-Kai Chen from Taiwan in his experiments [48] stably observed the same phenomena. It is quite easily explained: a particle with a velocity exceeding the most probable velocity in this distribution gets into caverns on electrodes and after some oscillations reduces its velocity, which becomes smaller than the most probable one, and then the particle leaves the cavern at a small speed, and the same process can happen to another energetic particle. This leads to the cooling of the cell in the case of such mass processes.

The problem of ferromagnet magnetization (the Easing model) can also be reduced to the orientation of a magnetic doublet by the external magnetic field, and then it is essentially the harmonic oscillator equation with a slightly different return force ($F = \frac{\mu}{r^3}$) and all the conclusions made earlier remain in effect. That is why magnetization should also produce energy generation effects. This proved to be true. For the general public everything began on May 17, 1996, when Frode Olsen from the research group "Free Energy" showed on the Norwegian TV (TV2) a surprising film about a "dynamic sculpture" made by artist and sculptor Reidar Finsrud from Skaarer, Norway. The author of this "dynamic sculpture" *had no idea about physics* and had been making it for 12 years. Einstein's idea of how discoveries are made conveniently comes to mind at this point: everyone knows that a certain thing cannot be done, but there is a man who does not know it, and it is he who makes the discovery.

This "dynamic sculpture" accompanied by an "explaining" poster «*perpetual mobile*» represents an iron well-polished ball with a diameter of 2.7 inches weighing about 2 pounds. The ball is rolling along a circle on close guides resembling two parallel skids with a diameter of 25 inches past the poles of three permanent magnets, where it is magnetized. In the area of three permanent magnets three more mobile magnets are installed on special mobile 5-inch long levers, and these magnets, when the ball passes them, are slightly inclined (due to the ball gravitation) and, after the ball passes them, are raised by the holding springs (sway like yokes). The ball makes a complete turn in 3 seconds. All this magic (***they say the ball had been rolling along the close contour for more than a year***) does not have any sources of energy and is installed for everyone to see in a Norwegian picture gallery on a special stand covered with a glass cover. The authors only saw a good TV film about this installation and were mostly surprised at the fact that the ball had not stopped during uninterrupted shooting (about 20 minutes).

We are well acquainted with circus tricks, but it is absolutely incomprehensible how such a trick could be staged using some secret methods. It is clearly seen that the ball in its movement always partially transfers its energy to the three long swaying pendulums, but there is no way to use them for pushing the ball and making up for friction, this being the only trick that could, in our view, be applied here. All the rest is clearly visible and contains nothing suspicious.

Let us estimate the generated energy. At an initial speed of about 1m/s the ball stops after 30 seconds, if all the magnets are removed. It means that the energy consumed in 30 seconds is about 0.5 joules, or 1/60 Watt. The total energy generated in a month is 43,200 joules, and this is huge energy, much greater than that of a good shell!

It is clear (if the word is relevant here at all) that when the ball is approaching the permanent magnet and the process of magnetization is going on, it is accelerated, but when it mechanically gets past the equilibrium position and, moving away from the magnets, becomes demagnetized, the gravitation (which now starts slowing the ball down) will be slightly less than it was at the moment of the ball's acceleration. This small difference in forces provides for small positive work to overcome friction. Energy generation and similar things during magnetization had been *predicted* by one of the authors in magazines *Infinite Energy* vol.1, No.2, p.38, (1995); *Proceedings of the ICCF*5, p.361, April 9-13, (1995), Monte-Carlo; *Cold Fusion*, No 11, p.10, (1995); *Chinese Journal of Nuclear Physics* (vol. 19, ¹2, 1997). The quantum-mechanic processes are very complicated, but some of them can be understood.

All keen physicists were quick to understand it, and J. Naudin in France made a similar, but much simpler experiment. A ball of a soft magnetic material is swaying along parallel U-formed skids in a system of four magnets. Near the bottom of the U-form there is a small smooth step. It may have been made to make the magnetization and demagnetization processes different in time, which is very important. If there are no magnets, nothing interesting happens and oscillations are quickly (in a few seconds) damped. If the magnets are present, oscillations go on up to 3 hours 27 minutes. It appears that in this case the author failed to find good material and parameters of the plant, so friction was not compensated completely. In all these experiments demagnetization of permanent magnets does not happen, because the experiment is repeated many times with the same results.

And now a few vague words about demagnetization processes. During magnetization of the ball, the magnetic moments of its atoms are oriented (like the hands of a compass) along the field lines. When the ball leaves the magnetic field area, the atom magnetic moments are disoriented under the influence of the heat motion, and it becomes demagnetized. In the unitary quantum theory the share of the oriented magnetic moments in the external field can be bigger than in the conventional quantum mechanics (the "maternity home" solution), and the ball gravitation can be stronger due to it. Disorientation of these moments happens similarly in both theories. It seems to be for this reason and due to the difference in magnetization and demagnetization time that a difference in magnetic forces occurs when the ball approaches the magnet or moves off from it.

The scientists of the older generation will remember that a similar toy was shown in the 30's to David Gilbert, who said it was the most interesting thing he had ever seen. A question arises as to why it has not yet been realized. We do not know a physical-mathematical answer to this question, and it is not our task to analyze the social reasons of this phenomenon. Japan has a different mentality, and there is a governmental program for generating energy from permanent magnets. Takahashi [51] even seems to have made an electric engine with an efficiency of up to 318%!

Still more mysterious is the long-known problem of energy shortage in many biochemical reactions with ferments (enzymes). For example, in the well-studied reaction of disintegration of polysaccharides in the presence of lysozyme the following happens: a polysaccharide molecule gets into a special cavern in a big lysozyme molecule, and some time later its debris are thrown out of it (Fig. 6). The broken binding energy of the polysaccharide is about 3 eV, while the energy of the heat movement is only 0.024 eV. From the standard science point of view, it is absolutely unclear where lysozyme takes the energy to break the polysaccharide. No satisfactory mechanism for explanation of such reactions (and they are very numerous) was found, and all this was "swept under the carpet", as physicists say. The UQT provides for a completely new look at the catalytic processes, which has an incomprehensible source of energy reducing the molecule activation energy. From our point of view, this process is a variant of the "maternity home" solution for oscillator.

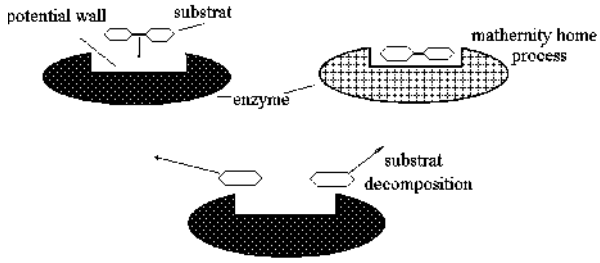

Fig.6. Break of polysaccharide molecule by lysozyme.

The most surprising thing is that in all the cases generation of excessive energy cannot be accounted for by chemical reactions or phase passages. If nuclear reactions do sometimes happen (which should not be according to modern science), they can account for only a hundredth or a thousandth share of the generated heat energy. There is no doubt that all these are effects of new physics, for in the framework of the old physics all this is simply unexplainable.

But the existence of a plant that produces *out of nothing* about 10 kilowatt of direct current electric energy with a voltage of 300 V seems nearly impossible. The story was described by one of the authors in three different magazines, and we will just give a brief resume [52-54].

In summer 1999, at the invitation of Swiss physicists (Director of the Institute of New Energy Sources in Egerkinhen Adolph Schneider), one of the authors

visited several research organizations. It is interesting that there is such an institute in small Switzerland, and there is none in big Russia. The purpose of the invitation was very simple: to explain the operation of a plant generating energy out of nothing, i.e. a *perpetual mobile*. In Switzerland such plants are called Testatik Machine M/L Converter from religious group «Methernitha» (Address: Methernitha, CH-3517 Linden, Switzerland, phone: ++41 31 97 11 24).

Such machines exist today in the Swiss town of Linden near Bern. Part of the town belongs to the Religious Christian Community, which is fenced and heavily guarded. There are about 250 members of the Community, many of them are physicists, graduates of the universities of Geneva, Lozanne, Bern. It is not only a research laboratory, they have their own TV center, a film studio, a small furniture plant, shops, garages, residential blocks, and support services. You will probably have guessed that this community does not consume any energy, and this is the most accurate fact in the whole story, for the inquisitive journalists have found out that no money from them comes to the accounts of the local power station, which provides power for all the town. In a cellar of one of the houses they have a power station that produces energy… out of nothing. The author of this inexhaustible source of free direct current energy is Swiss physicist Paul Baumann. Let us briefly describe these fantastic plants: they are of four types (sizes) with capacities of 0.1, 0.3, 3 and 10 kWt. Externally, the plant resembles very much the standard electrostatic machine with Leyden jars often used in physical demonstrations. There are two acryl disks with 36 pasted narrow sectors of thin aluminum, which rotate in different directions. In the first samples ordinary gramophone records were used for disks. The machine is started by pushing the disks in different directions by fingers. The rotation speed is 50-70 turns per minute. After the start disks rotate independently and can be easily stopped by hand, the direct current voltage is about 300-350 V, and the current is up to 30A. The mechanical energy used for rotation (only 100 mWt, according to measurements made by Austrian Professor S. Marinov) is hundreds of thousand times smaller than the generated electrical energy. The biggest plant for 10 kWt has plastic disks with a diameter of over 2 m, the smallest one – 20 cm, the weight of the plants is small enough, the 3-kWt machine weighing about 20 kg.

The charge separation process (which consumes energy!) practically does not slow down the disks. Connection of a load in the form of a 200-Wt bulb does not change the rotation speed either. No cooling or heating of the air or machine parts during long operation takes place, only a slight smell of ozone is felt. The system is noiseless, compact, environment-friendly, and can be installed anywhere.

The Community management thinks, and quite rightly, that wide spread of such systems in the world will lead to a heat explosion, because all the energy generated by the mankind finally finds itself in an energy dump (is transformed into heat), and all this can finally lead to overheating of the environment. They absolutely do not believe (and not without grounds) in the capability of the mankind as a whole to negotiate reasonable use of this invention, and they think that the harm caused by it will be greater than from nuclear, bacteriological, or conventional weapons. Their main idea for the mankind is to live in balance with the environment and to make full use of the energy of the wind, the sun, the water, etc. For this reason the Community is heavily guarded, and they are not going to donate their main discovery to the mankind.

Professor Stephan Marinov visited the Community twice (in July 1988 and in February-March 1989). He was even given such a plant with a capacity of 100 Wt (300 V, 0.3A), which he studied in his laboratory. As far as we now know, even the inventor of this machine does not fully understand its operation principle, so he contacted Marinov out of sheer curiosity of a scientist.

In 1989 Professor Marinov published a book "Thorny Path to Truth – Documents of Violation of Conservation Laws" in International Publishers East-West. The book contains a lot of photos, a measurement report, and a description of the plant. He also organized a research group called "Free Energy" within the Community (Methernitha Group Stephan Marinov Free Energy).

There are very interesting words in this book: "I can state without any doubts that this machine is a classical *perpetual mobile* in its pure form. After the initial push, it goes on rotatingby itself for an indefinitely long time, constantly producing electrical energy in the amount of 100 Watt… It is still unclear, however, how it all can happen…". As far as we know, nobody has managed to build a similar plant elsewhere.

We have an approximate idea of how the plant operates. The idea is as simple and ingenious as that of the wheel, which is absent from the surrounding nature, so the inventor could not borrow the idea. We will just show that the existence of such a plant is in full conformity with the UQT. It is natural that the plant operates on the basis of the charge separation principle. Let us have two metal spherical surfaces with a hole, isolated from the earth and from each other. If, with the help of an insulated stick, we transfer the first electron from Ball A to the internal surface of Ball B through the hole, a difference of potentials will occur, and if we transfer the second and the subsequent electrons, Ball A will attract the transferred charge, while Ball B will repulse it, and energy will have to be spent during the transfer of charges (Fig. 7).

Let us remind you that under the existing circulation theorem (16), the charge transfer work will consume the same amount of energy as will later be generated during the passage of electric current resulting from charge separation. But in the UQT the circulation theorem (16) for *an individual elementary charge* is not valid. Thus, we can select the time and route, along which the charge will be transferred in such a way, that

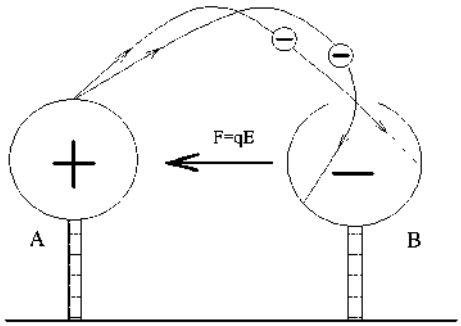

Fig.7. Work for moving the charge depends on method of movement and route.

the charge value during the transfer will be close to zero, and, consequently, the electrostatic force and the charge transfer and separation work will be close to zero too. For example, instead of selecting the route you can wait for the charge to be reduced to zero and then transfer it quickly, and when the charge increases, immediately stop the transfer and fix the charge. Or you can duly select the route and velocity. There are many options. This was evidently realized by Paul Baumann, who is *so far* practically unknown to the official science, and who can find consolation in the idea that the inventor of the wheel will never be known at all. The problem of simple arrangement of all this is just a matter of technique.

You cannot help, thinking that all these might be just tricks. The history of *perpetual mobile* abounds in evidence of downright swindling and frauds, and not a single positive result before, and who can guarantee that the information given above will not prove to be another swindle?

First of all, if all the people always piously believe in the unquestionable stability of the energy conservation law, there will never be any progress in this sphere, and it is then unexplainable how man got down from the palm at all. Secondly, to justify the proposed rebellious position, the following idea comes in mind: if 30 years ago somebody had told the authors (who were then already professors) that at the beginning of the next millennium they would deal in such research, it would have seemed not only a silly joke, but an absolutely impossible thing as well. But, as Voltaire said, "He is silly who does not change".

In conclusion we wish to express with certainty that the time of theoretical recognition and of practical universal using of overunity devices will come soon and become the epoch of new energetics. The people of our planet will regret that so much oil, coal and gas was burned causing terrible ecological losses.

The authors thank astronaut V.A. Dzhanibekov and Professor A.P. Buslaev.

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KOZYREV-DIRAC EMANATION.

INTERACTION WITH MATTER and METHODS OF DETECTING

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In this paper the authors show the possibility of creation of a new kind of emanation. The magnetic monopole beam can be made in space as a result of focusing of some natural substance. Special devices based on the Moebius band elements make the given focusing. This emanation is able to magnetize graphite and organics, decrease the radioactivity, and influence the oncology diseases .The time reverse technology is realized in such devices.

Experimental data, which allow making a conclusion about existence of previously unknown emanation, are presented in this report. Here are descriptions of experiments and methods of measurement. The effects of interaction between new type of emanation and matter have been obtained.

Till the present moment theoretical physics didn't pay attention to the nonoriented configurations and spaces. The reason of this situation is the fact, that from the philosophic point of view it is not possible to determine and locate the area of the nonoriented topological structures in our world. We (eight scientific teams) joined our forces and we needed more than 30 years to solve this problem by an experimental approach.

The fundamental tenet of the casual mechanics developed by Kozyrev can be formulated as follows. There are two types of energy in the Universe. The positive or «right» energy acts as a factor of the entropy increase. The negative, or «left» energy tends to decrease the entropy, i.e. it acts as a factor, which regulates the entropy increase. The «right» energy is transformed to the «left» one and this fact may be interpreted as a course of time from the past to the future. When the energy is transformed from the «left» to the «right» form, time is reversed. Kozyrev supposed [1] that through revolving of a body together with a

6. Activation by nuclear magnetic resonance;
7. Activation by electronic paramagnetic resonance;
8. Activation by electrochemical force.

All these methods can be used as possible way to high efficient energy systems. Gerlovin wrote: "Usually 1, 6 and 7-th methods of structural activation are realized in catalysis simultaneously. Besides, catalysis differs from macroscopic methods because it has the most minimal distances from the sources of activator fields to the activated molecules. And finally, an active participation of force fields created by nuclei of atoms and significantly more active participation of disturbed EPV is possible in catalysis. That's why catalysis is the most effective method of structural activation. The detailed account of this method exceeds the limits of this article and we can only annotate it." [1, p.333]

Information stated above is only a small part of the questions appeared under consideration in Gerlovin's theory of fundamental field (TFF). Other important questions should be considered with a new experimental data.

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Antigravitation Force and Antigravitation of Matter. Methods of its Creation

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Part I

For a long time there is an opinion in physics about antimatter as a possible source of antigravitation, but the researches on this subject came into a dead end. The existent presentations and formulas forbade the conclusion about antigravitation, but our conducted investigations brought us to the possibility to get antigravitation of substance and to the paradoxical conclusions concerning the next:

1. Two types of space exist:
   a) The Absolute space
   b) The Relative space

2.a The Gravitation Field is the relative space, which has accelerated motion, directed to the center of a planet.

2.b The Antigravitation Field is the relative space, which has accelerated motion, directed from the center of a planet.

3. Gravity force does not depend on mass of a body! The mass can be presented in three versions:

a) m_k –mass as amount of atoms.

b) $W_{m_A^e}$ - electronic-atomic energy in mass.

c) $W_{m_G^m}$ – mechano-gravitational energy in mass.

On the basis of the stated notions we offer to revise the essence of force not only in Coulomb's formula, but in Newton's formula too.

$$F = K\frac{q_1 \cdot q_2}{R^2} \qquad F = P\frac{m_1 \cdot m_2}{R^2}$$

It is well known, that mechanical energy can be bringing in electrostatic charge, where mechanical energy runs (turns) into energy of electric field, where

(mechanical energy) $F \cdot R \rightarrow \frac{E_2 \cdot V_{m^3}}{2}$ (electrical energy)

Similarly it is also possible to insert mechanical energy into mass of a body. As the result, the mechanical energy will turn into energy of gravitational field, where

(mechanical energy) $V \cdot F \cdot t \rightarrow \frac{g^2 \cdot V_{m^3}}{2}$ (gravitational energy)

Since the volume of the Earth is constant, the acceleration of gravitational field will be increased.

It should be logical to expect, that when removing the mechanical energy from mass the inverse process will occur, that is to say acceleration reduction of gravitation field will occur.

In his works I. Newton affirmed about existence of two spaces:

The Absolute space - is an immovable non-rotatable space, which represents a limited cube, with our planet in the center.

The Relative space – is a movable space. It can move with acceleration in the absolute space.

Editor's note: In aether conception this means two parts of aether: some part is involved into the motion with the mass, but another part of aether is immovable.

The main mistake in search of aether consisted in the following: Maikelson's experiments were aimed on

search of relative velocity between bodies and space. However, it was the **relative acceleration** between bodies and space that was necessary to search for.

To quote the conclusions of I. Newton: "Body can keep the quiescent mode or mode of rectilinear uniform motion …" By this, he postulates, that the relative linear velocity between solids and space does not exist. But we know that for rotation it exists (the famous experiments with revolving pail of water).

The gravitational field is the accelerated "falling" relative space, which represents a spherical form. If relative space moves, thus the question appears: where does it move? There is only answer: it moves in the absolute cubic space.

In Einstein's theory there is notion of unified and curved space in gravitational field, but the contradictions appear here, and on concerning that N. Tesla writes: "Only by presence of force field it is possible to explain the observed motion of celestial bodies, but thus the hypothesis of curvature of space is not necessary. The whole scientific literature on this subject is futile and doomed on oblivion". [1]

The fact that gravitation is the accelerated moving relative space can be proved by observation of accelerated moving rocket, where the acceleration in rocket is equivalent to the acceleration in gravitational field. Accelerated movement of rocket is relatively, that allows speaking about either acceleration of rocket motion in immovable space, or accelerated motion of space in immovable rocket!

The anti-gravitational field is the relative space, which has accelerated motion from the center of a body (for example: rotating cylinder, Earth satellite and etc.) But it is possible to create the model of anti-gravitation without rotations. On the basis of analogy between mechanical and electric energy comes to conclusion that gravity between bodies does not depend on mass of the body, but on mechanical-gravitation energy, contained in this mass, which is possible to contribute or to extract from. **Therefore, this is the internal gravitation energy.**

Part II

The "Mass" can be considered as a measure of three different conditions of matter:

m_k - as a measure of amount of atoms, representing a "framework" or "container", in which two types of independent energies are concentrated.

$W_{m_A^e}$ - as a measure of electric energy, which can be either accumulated or extracted, and it have a "compressed" form.

An example of accumulation of electric energy in mass is a big cylinder, rotating with linear velocity, close to velocity of light, in this cylinder the mass of electric and magnetic fields of atoms increases. There are another possible ways to contribute and to extract the said energy from mass.

And finally $W_m M_G$ is the mass, which can be a measure of mechanical energy, or it can be either inserted or extracted from the matter (it can be identified as the gravitational mass). This gravitational mass is what we put our attention on, because it affects upon gravitation and it is able to create antigravitation.

"In his time N. Tesla worked on more general problem, which is the problem of matter and energy. And he has found, as he believed, the new physical principle, on the ground of which he brought forth his gravitational theory that was named dynamic gravitation. But he did not tell about it until almost the end of his life". [2] **Really, dynamic gravitation is the energy of motion.**

Let's take the following indications:

V – mechanical velocity
F – force
t – time.
In this case the product $W = V \cdot F \cdot t$ has the dimension of energy. Hereinafter, let's take

I – strength of electric current
U – difference of potentials
t – time.

Then $W' = I \cdot U \cdot T$ has the dimensional of energy. Thereby, *W* ~ *W'* that is to say, the following products are accepted as equivalent:

1. $V \cdot F \cdot t \sim I \cdot U \cdot T$

2. In previous materials it was reported about untraditional way for accumulation of energy, under the condition, in which at constant current I the product $q = U \cdot t$ will depend on amount of inserted energy in unchangeable circuit L = const, in which the energy can be accumulated by untraditional way not only in electric capacity, but also in inductance.

Similarly the energy can be accumulated by untraditional way in a moving body, under the condition V=const and m_k=const (the product $qr = F \cdot t$ will depend on inserted energy and have unlimited value). **Exactly this charge will create the powerful gravitational fields.**

3. Let's take: F is mechanical force, R is distance. Then the product $F \cdot R$ has the dimensionality of energy. For the uniform electric field the product $E_a \cdot \frac{E^2 \cdot V}{2}$ also has the dimensionality of energy. In this case E_a is constant, E is intensity of electric field, V is volume. Thereby, $F \cdot R \sim E^2 \cdot V$. Similarly, $V \cdot R \cdot t \sim g^2 \cdot V$

We have received the correlations of resemblance for heterogeneous physical values, on the ground of which the following physical experiments can be offered:

On the grounds of the above-mentioned analogies it can be assumed that the accumulation of "compressed" energy is possible in mechanics, as well as in electricity. Since the velocity is relative, that the mass can have zero velocity relatively a observer, who moves with this mass, but the force field will remain unchangeable, since it depends on already invected mechanical energy.

Let's note that:
When the "compressed" electric energy is accumulated, the power field does not change.

When the "compressed" mechanic energy is accumulated, the power field increases.

Now we have come to the amazing conclusion that the gravitational force does not depend on mass of matter, but it depends on mechanic energy, which is included in this mass. This energy is unstable and at contact with land it is disappearing, and at zero gravity it can be saved for a long time.

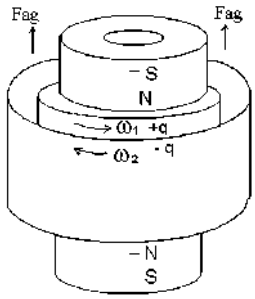

Fig. 1 The first way to obtain the antigravitational force.

1. The magnets are not revolved.
2. The cylinders of charged capacitor are revolving in different directions.

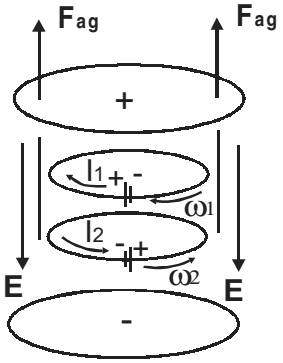

Fig. 2 The second way to obtain the antigravitational force.

1. The capacitor plates are charged and not revolving.
2. The current circuits are revolving in different directions.

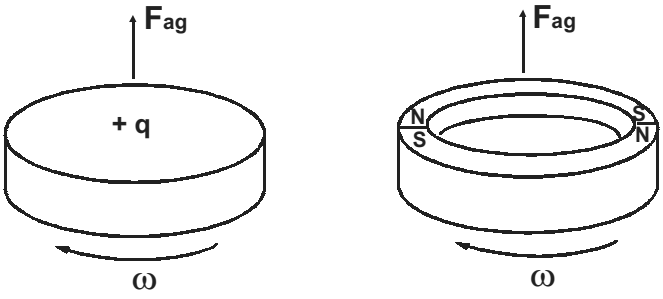

Fig. 3. The third way to obtain the antigravitational force

a) electric
b) magnetic

1. The disk and the ring are made from electrical current conductive material.

2. When these disks rotate, the currents, which emit the mechanic-antigravitational energy in the manner of heat, are formed there.

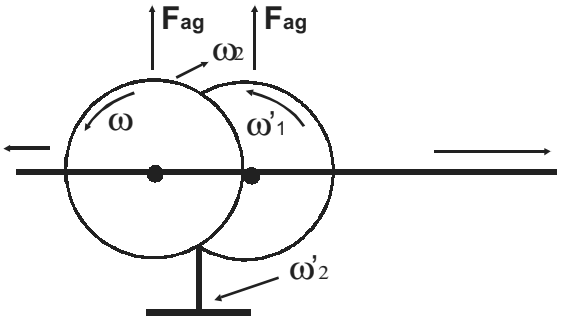

Fig. 4. The fourth way to obtain the antigravitational force. Mechanical method.

1. This is an extraction of energy from matter. It was reported in details on the 10 international symposium in Volgo-Donsk, Russia.

2. The difference with electric circuits is that it is possible not only to extract the mechanical energy, but also to insert additional energy in the system.

References

1. Magazine Inventor and Rationalizator, Russia, #9, 1979.

2. Magazine Inventor and Rationalizator, Russia, #9, 1979, p.28

The Capacitor, which has the Energy of an Atomic Bomb

(Review of Anatoly K. Gaponov's research by Eugenie and Marina Golomolzins)

Is it possible to place a pail of water into a one-liter jar? At the first look the answer is obvious: certainly not! However, the inventor from Novosibirsk, Anatoly Gaponov thinks differently. He does not "press" water, but electrical energy, placing an energy equivalent of atomic bomb into ordinary electrical capacitor.

Everybody using ordinary batteries knows its defect: they need frequent recharging. Gaponov's capacitor is slightly smaller than a matchbox. Just come home by electrical automobile, take out the capacitor from engine, and then put it into the pocket. For home needs you can just insert the capacitor into plughole to power the light, boiler, and TV system. In general, each electronic device can have its own capacitor, then an electrical wiring is not necessary. After one

On the grounds of the above-mentioned analogies it can be assumed that the accumulation of "compressed" energy is possible in mechanics, as well as in electricity. Since the velocity is relative, that the mass can have zero velocity relatively a observer, who moves with this mass, but the force field will remain unchangeable, since it depends on already invected mechanical energy.

Let's note that:
When the "compressed" electric energy is accumulated, the power field does not change.

When the "compressed" mechanic energy is accumulated, the power field increases.

Now we have come to the amazing conclusion that the gravitational force does not depend on mass of matter, but it depends on mechanic energy, which is included in this mass. This energy is unstable and at contact with land it is disappearing, and at zero gravity it can be saved for a long time.

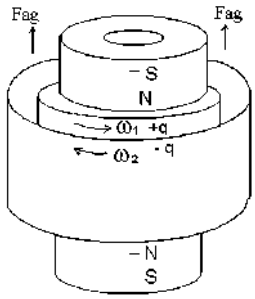

Fig. 1 The first way to obtain the antigravitational force.

1. The magnets are not revolved.
2. The cylinders of charged capacitor are revolving in different directions.

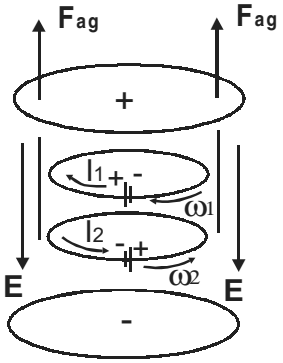

Fig. 2 The second way to obtain the antigravitational force.

1. The capacitor plates are charged and not revolving.
2. The current circuits are revolving in different directions.

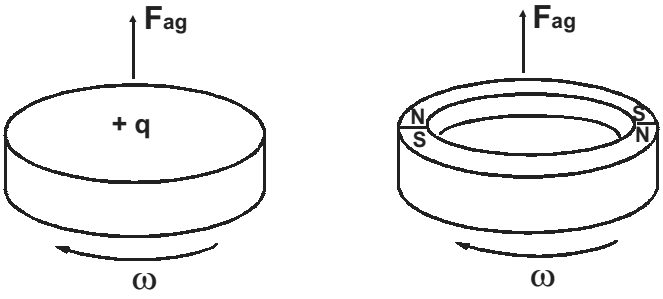

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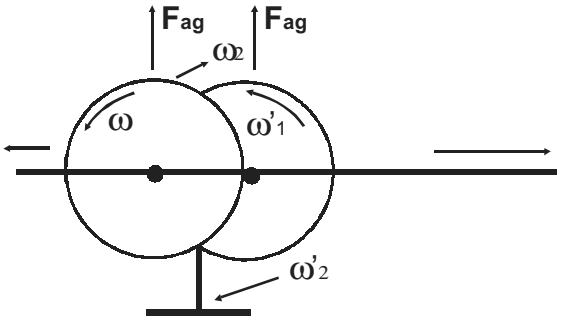

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or two years you will just have to come into electric service station and charge your magic capacitor like a gas balloon. Meantime, this research work began from hypnosis.

Anatoly Konstantinovich Gaponov (by birth from Kaluzhskaya region) is Ziolkovsky' countryman. In his youth Gaponov was brought by fate into Sakhalin, where he showed hypnotic abilities. As an inquisitive person Gaponov had organized a research group, started experiments and soon he understood that human brain had incredible possibilities.

A mental prick was made distantly to the hypnotized man, and he uttered a cry of pain. The ability to see people through, to define and to avoid organism's faults, was revealed in a hypnotic trance. It was possible to inspire pleasant emotions, to force "watching" a film on the given subject, as if on the screen. An uneducated person became an erudite, as if being connected to a certain global information database. Thus an idea to make an amazing experiment was appeared.

In one of the experiments Gaponov hypnotized the person with four classes education, and asked, if it was possible to transmit the electric current without wires? The hypnotized person gave the answer, that it was possible. For that it is required to convert the electric energy in x-ray radiation. And what afterwards? Afterwards it is required to focus that rays. By what? By the lens made from quartz glass, gold coated. It was a miracle! The person told about things that in usual condition he had no idea of! The information was received from somewhere outside.

Further quite an amazing thing has occurred. Gaponov asked the hypnotized person, if it was possible to intensify the abilities of hypnotist's brain?

He answered, that he could. "He turned me round and stared at the back of my head, - recalls Anatoly. - And suddenly the smile began to tear my mouth. I could not do anything with myself. When my mouth was sprawled literally from ear to ear, the hypnotized person in some inhuman voice declared that experience could not be continue since the cerebral hemorrhage would occur. I was hardly able to give the order to stop the experiment".

Thereby, the experiments with hypnosis gave the beginning to the thirty-years period of inventions in the field of accumulation and transmission of energy. After the return to native Kaluzhskaya region, Gaponov was occupied with physics, development of logical thinking and became the town champion in chess.

The necessary books fell into his hands by themselves: some time a certain acquaintance gave it to read; another time he found the last copy in a bookstore. As a majority of self-taught inventors, Anatoly preferred practical experimentation. In quest of laboratory for realization of his own ideas, he moved to Novosibirsk. **As a result, in 1980 Gaponov has made experimental system for compression of energy.**

From the school Physics we have known the notion of "electric arc" – it is a small blue lightning between two electrodes. Gaponov has tamed this lightning in such a way, that having drawn apart two wires, which executed the role of electrodes, by hands and got the arc by length up to half meter. Anatoly confirms that in principle, it is possible to create an arc of any desired length under any amperage.

One of the experiments found out one more enigmatic characteristic of electric discharge. During electric photography of arc a person happened to be between the camera and the system. On typing pictures, the researchers have found with surprise, that the electric arc was perfectly seen through the person. That is to say, it created the invisible field, for which material object was not an screening obstacle, and which was fixed on the film.

The further experiments with electric arc have allowed to get a new source of energy, as well as to open the possibility of setting light and sound on fire! Just imagine, you ring up a bell, it's sound waves spread at once in all directions, and then flash up with bright blaze.

(Editor's note: this experimental facts are rare modern evidences of possibility to create longitudinal electric waves. It is clear analogy here with sound waves in air since they are longitudinal waves also. Alexander V. Frolov)

When the problem of energy source was solved, Gaponov turned to the problem of energy accumulation. According to Gaponov, he has provedexperimentally the possibility of charging of an ordinary capacitor with any amount of energy. This statement sounds paradoxically: how it is possible to place the unlimited amount of contents in limited volume? However, this is not a simple way.

Gaponov believes that energy "placing" occurs not in space, but in time by means of his system! In what way? Imagine, that you fill one-liter jar with water. But already after an instant the water-filled jar is in past, and that present one is once again ready to be filled. And so ad infinitum. Water as if it fills a certain "time reservoir", and a jar is just a neck of this "time reservoir".

(Editor's note: This method is described in other articles also but usually it is pure mathematical discussion about Minkovsky space-time and theoretical proposals. Gaponov's experiments are realization of fantastical idea to take power from the time flow, i.e. from Past or from Future to get over-unity in Present space. Alexander V. Frolov)

"It is possible to demonstrate one more example, - Anatoly Gaponov adds. – Let's charge the capacitor with the expectation, that it will supply the light bulb

for one second. Thereby, on the Earth this light bulb will be on only for an instant. But if the same capacitor with light bulb is placed in rocket and dispersed around the Earth at the velocity, closed to velocity of light, time on the board of rocket will be so slowed that the light bulb on rocket will be glowing infinitely long for an observer from the Earth. It means, that in any case it is the same energy quantity, but in one case it's action is sprawling for a second, and in another one it is sprawling for eternity! It is possible to say, that in my system I have created the condition corresponding to this hypothetic rocket".

The system for accumulation of electric energy could be charged by ordinary wall plug 220 VAC. Time period of charging is different and depends on the certain scheme of the system. By the way, sea electric slopes are the certain natural analogues of such capacitor. Some elements of internal device of these sea creations reminds the "pump" elements for placing of electric energy into "temporal jar".

Finally, the third Gaponov's invention is the system for transmitting of energy without wires. As well as in two previous cases, there is an experimental device. Anatoly Gaponov speaks that he has succeeded in getting the essence of experiments for transmitting of energy, which were conducted by Tesla.

It is clear, that the main advantage of this method is an absence of wires and losses of electric energy. The electricity could be transmitted directly into any point, where receiving equipment placed, let say from Kaluga to Sahara. However, this is not so interesting for anybody, since for the present day Anatoly Gaponov's inventions don't have demand.

" The first system was created twenty years ago", - says Mr. Gaponov. – "Now I am fifty five, but things have not budged an inch". He adds dreamily: "Eh, if only I had a laboratory and some money...".

Gritskevitch's Hydro-Magnetic Dynamo

Oleg V. Gritskevitch

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Editorial: The article presents construction and operation of Oleg V. Gritskevitch's hydro-magnetic dynamo, which is an example of very powerful new energy system. The prototype in Armenia has been produced over 1500 KWtts power during several years.

The author was born on 14 August 1936 and grew up in Vladivostok, Russia. He is married and has a son Boris. Gritskevitch is a physicist by education. He worked in the Far - East branch of the USSR Academy of Sciences. Since 1985 he has been working independently as an inventor. He has more than 70 patents on inventions ranging from household engineering up to high technologies, which he has been trying to apply in our country and met big difficulties. After numerous attempts to receive the patents the author was convinced that outflow of the information occurred. Therefore he has received the state certificates as on know-how (on a French way of patenting), for all his inventions.

Introduction

During the Institute for New Energy 1999 Symposium, I lectured on my hydro-magnetic dynamo. This paper is my attempt to explain the construction and operation of my dynamo.

To fool investigators of my secrets, I have an occasion provided misleading information. For example, the drawing accompanying the Russian patent referenced below shows a cylinder across the toroid to fool readers. The real dynamo only has the toroid without the cylinder. Even its name "hydro-magnetic dynamo" is somewhat deliberately misleading.

I have some familiarity with the new energy field. Nearly all purported new energy devices are fairly small electrical generators. The dynamo may be the only new electrical generator which most nearly meets all the requirements of an ideal large-scaled electrical generator. My dynamo really is the single most valuable invention the world has ever known.

Alexander V. Frolov of St. Petersburg recommended me to contact with Dr. Patrick Bailey, Institute for New Energy since Pat has lots of contacts who could possibly help me with patenting my invention of a new source of energy in USA.

I conducted the work on the theory and creation of the electrostatic generator-converter «Hydro-magnetic dynamo» about 20 years. (See dynamo history below.) The first primitive equipment was created when I worked in Academy of Sciences. During that time various changes were introduced in the generator and in the theory of its work. It is now possible to manufacture, install, and apply it in industry.

For the first time I made the public report on this work in 1991 on a symposium in Volgodonsk city. The report received the positive replies and reviews of the experts of a nuclear industry in USSR. The same year I was accepted in International Nuclear Society. In these years I offered development of this technology to different state bodies and private enterprises. But there was the only answer: "It is very interesting and perspective project, but there is no money for it".

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New Energy Technologies

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Research on advanced space propulsion methods and new energy systems

History of invention: Poliakov's vortex drive

Patented by Research Institute of Space Systems named by Krunichev, Russia

Also in this issue:

* New gravidynamic paradox
* Experiments on weight reduction
* New possibilities of vortex energetics
* Experiments on homopolar motor
* Physical relationships of time

Gravitonics is Electronics of the XXI Century

Hypothesizes, Conclusions, Speculations

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Today we can easily insist that ways to solve main gravitonics problems are already defined, at that the practical realization of any of them will mean the break through in engineering. So, what successes has the Russian science already achieved in the area of gravitonics, and what priorities can we lose here in the nearest future?

Introduction to Gravitonics

The electronics of the "past century" uses electron as a ball, which has weight, radius, electric charge and magnetic moment. These very parameters define electron behavior in the electrostatic, magnetostatic and electromagnetic fields. But electron abilities are not limited by it; electron spin and internal microstructure features remain unaccounted and unclaimed. Evenly speaking, General Theory of Relativity (GTR) of Einstein was a power impulse for mathematical physics development and gave birth to many productive ideas. But the main problem, that is the secret of gravitation, remains undisclosed… In works of K.P. Stanjukovich [1] and A.Z. Petrov [2], who carefully followed GTR, it was shown that this theory described neither energy, nor impulse of gravitational radiation, i.e. it can not explain gravitation. About 20 years ago V.B. Braginsky, today's RAS Corresponding Member, came up with an idea: "if the propagation speed of gravitational signal is higher than the velocity of light, there will be already another theory, not GTR!" Maybe, the reason is the postulation of equality of gravitational and electromagnetic radiation velocities?…

Today the approximate theory of gravitational radiation sources can be built on the basis of the following simple considerations: if during annihilation of "electron-positron" pair there creates the pair of gamma-quantums with energy about 0.511 MeV, then the pair of back gamma-quantums with the energy about 0.511 MeV, could create "electron-positron" pair. Is it possible to assume, that electron, positron and gamma-quantum with the energy about 0.511 MeV are just three stages of one and the same object?! If it is possible, then for the rational description of the given object we will have to suppose the existence of subparticles, named by us uniquantums [3], or named by other authors microleptons [4].

On the basis of Heisenberg uncertainty relation conformably to the energy and duration of quantum of electromagnetic radiation, measured by laboratory means, it is possible to calculate the minimal "electrical length" of photon (i.e. quantum geometrical extension in free space in wave-length units), which is equal to 137λ, and in the uniquantum theory it is equal to 137 uniquantum-antiuniquantum pairs. On the basis of these conceptions it is possible to construct the spatial microstructure model of electron. So, what kind is it?

We think, that electron can be represented as thin-walled spheroid, walls of which are two light (C) barriers, separating the "internal" part of electron from the "external" one. From the traditional physics point of view "over-barrier" space is an "imaginary" one. This very space can contain the gravitational mass of electron. The radius of the gravitational spheroid is equal to the half of the classic electron radius, and its imaginary weight is 137 times more than the rest mass of electron. Being "cut" off by the double light C-barrier, uniquantums of the spheroid internal part are as if non-existent for the outer world, and the rest mass of electron is formed by magnetic energy of three uniquantums on the external orbit with the classic electron radius. This very spheroid, rotating with the tangential velocity C, let us get the precise value of the electron spin.

The study of presented model shows, that:

- The "electromagnetic" rest mass of electron is "magnetostatic";
- The gravitational mass of electron is an imaginary value and it is 137 times more than the rest mass of electron;
- The gravitational radius of electron is two times less than the "classical" one;
- The "internal" gravitational radius of electron is 45.7 times more than the external one, i.e. the internal space is compressed per 45.7 times (!);
- The spin is equal to the classical one, but this value is imaginary one (!);
- The value of the "effective" electron charge is three times more than the classical tabulated value;
- The native magnetic field of electron is equal to $8{,}9 \cdot 10^{13}$ Oersted;
- The gravitational constant is equal to 10^{33} cm^3/g.s^2, i.e. it is about 10^{40} more than the "world" gravitational constant of the Earth;
- The gravitational energy of electron is equal to 137·0.511 MeV, i.e. 137 times more than the equivalent energy of the rest mass of electron.

The model is paradoxical. But it can be tested experimentally! Comparing "electromagnetic" rest mass of electron with the relation of electromagnetic energy to gravitational one, it is possible to determine the connection between magnetostatic and gravitational energy of electron, and, therefore, with energy of the magnetized ferromagnetic.

Gravitational constants of the Earth and of the electron differ in about 10^{40} and can be described by the same simple equation:

$$\gamma_{loc} = 2k\gamma_0 \cdot \omega^{3/2},$$

where k - is a parameter of the gyroscope shape, γ_0 - is absolute universal constant, equal to 1/137 and ω - is native rotation frequency of the gyroscope.

Let us assume, that gravitational constants of all objects should be described by this equation. By substitution of the new gravitational constant into the known equation of the gravitational energy $W = \gamma m^2 / r$ we will get the equation of the gravitational energy of rotating gyroscope with any size (from electron up to the Galaxy!). Thus, the main point of the "non-Einsteinian" theory of gravitational energy sources comes to the thing that any rotating object and any magnetized ferromagnetic have their own gravitational energy, and the sources of gravitational radiation can be only nonlinearly moved objects, or objects which are in the state of change of phase (for example, permanent magnet during its demagnetization). It is the gravitational theory and explanation of "strong" and "weak" interactions!

Laboratory test of the equations

Magnetostriction

J.P. Joule found the effect of change of ferromagnetic linear sizes and volume during magnetization as early as 1842. Magnetostriction is widely used in modern technique, but in the physical encyclopedia of 1963 there is the following honest acknowledgement: "For the most ferrites both longitudinal and transverse magnetostriction is negative; the reason of it is still unclear."

In the scientific literature magnetostriction is usually defined as $\lambda = \Delta L/L$. However, during the change of external field to some arbitrary and enough small value ΔH, it is advisable to define magnetostriction as $\lambda = 1/L \cdot \Delta L/\Delta H$, since in magnetostriction experiments the value $\Delta L/\Delta H$ (or $\partial L / \partial H$) is changed. By means of the suggested equation $W = 137(BHV) = BHV/\alpha$, which connects magnetic energy with the gravitational one, it is possible to get enough simple equation for the magnetostriction:

$$\lambda = 1/L \cdot \partial L / \partial H = \alpha \cdot k / (B \cdot H)_s \cdot H^2 \cdot \partial \mu / \partial H$$

where $(B \cdot H)_s/\alpha$ - is the density of gravitational energy in the point of magnetic saturation, k – is the parameter of share of gravitational field in the magnetostriction effect, H - is magnetic bias, $\partial \mu / \partial H$ - is differential magnetic conductivity.

The new equation qualitatively corresponds to four known features of magnetostriction [5], namely:

- The magnetostriction sign is defined by the sign of $\partial \mu / \partial H$, i.e. by the course of the magnetization curve, measured in the direction of calculated component of the linear magnetostriction;
- Graphical sum of three linear components of magnetostriction, calculated by three main axes of the anisotropy form of the model, is always negative and numerically close to the value of the volume magnetostriction;
- Magnetostriction is an even effect, since the equation includes squared value of the external magnetic field;
- Dependence of magnetic conductivity μ from the filed H and hence dependence $\partial \mu / \partial H$ has a hysteresis nature. Therefore, the magnetostriction is a hysteresis phenomenon too.

So we have the right to "close" the question of physical encyclopedia on the cause of magnetostriction. **Magnetostriction is the secondary gravitational effect of ferromagnetic "self-constriction" in its own gravitational field.**

Gravitational-optic effects of GTR

Distortion of the light beam, passing near the Sun and the photon frequency bias in the field of terrestrial gravity (the Nobel experiment of Paunda and Rebki) are the main arguments in favor of GTR canonization. It is very attractive to repeat these experiments in laboratory conditions, basing on our conception of the origin of gravitational field.

The acceleration of gravity, used in experiments with ferromagnetic, reached the value $4.72 \cdot 10^{15}$cm/s^2, i.e. about $4.8 \cdot 10^{12}$g. At such values of acceleration there is no necessity to introduce a definition "space masses". In these experiments there was used the optically transparent ferromagnetic, which was the saturated solution of manganese chloride in water at room temperature. The experiment on the beam distortion was made in 1975 [7]. It was shown, that this effect is the result of two simultaneous processes. The first is an intense drift of magnetic ions, which forms the gradient of index coefficient that causes the light beam distortion. Another process is a relatively weak gravitational beam distortion, for which, nevertheless, the relation of deviation angle to the track length (the length of the dish is about 100 mm) is turned out to be about 10^{10} more than in "Einsteinian" gravitational-optic experiments.

The experiment on bias of the optic radiation frequency [8] was made in 1978-1980 and was repeated in 1983. With use of heterodyne and interferometrical methods of measurement we were succeeded to observe effects of "red" and "blue" frequency biases in the non-uniformly magnetized ferromagnetic by means of simple displacement of the working dish (with the length about 40 mm) from one side of the magnet gap to another. The maximum displacement is about 10^{-5}, that is about 10^{10} more than in the experiment of Paunda and Rebki.

Problem of the propagation speed of gravitational radiation

There are still only few publications about such fundamental parameter as the propagation speed of

gravitational radiation; it is able to speak only about pages, or even lines! Let us refer to major sources:

I. Newton: *"The propagation speed of gravitational interaction is equal to infinity."* It is an argument, because otherwise we would have to bring the "delay" parameter Δt into the Law of Gravity, what is not noticed in real conditions of star observations [9].

P.S. Laplace in 1787, taking into account observation errors of that time, showed, that gravitational interaction speed was about $50 \cdot 10^6$ times more than the light propagation speed, i.e. it was about $1{,}5 \cdot 10^{18}$ cm/s [10].

A. Einstein: *"The propagation speed (of gravitational interaction) is equal to the light velocity".* This statement is postulated.

Even during the change of propagation speed of gravitational radiation between the Earth and the Moon it is impossible to define the signal delay about 10^{-11} s, i.e. we cannot measure directly the propagation speed of gravitational radiation (supposing that we have both generators of the gravitational radiation and receivers of it). But this speed can be estimated by the reflection impulse, what exactly was made in 1987 [3]. And its value is about $9 \cdot 10^{20}$ cm/s!

On the basis of conservation law of impulse of unidirectional radiator with arbitrary energy type we can get a simple equation:

$$F/(dW/dt) \cong 10^4 \cdot V/C^2 \qquad \text{[g/Wt]}$$

where V – is the speed of radiation propagation, F – is tractive force in grams, $dW/d\,t$ – is power of radiation in Watts and C – is velocity of light.

For making the experiment there were constructed, produced and adjusted: sensible scales with one degree of freedom (sensitivity of balance is about 1g at the oscillator mass together with the moving element of scales which is about 50kg); the indication system of small mass changes (phase-meter receiver); gyroscopic system, changing the mass in the dynamic mode (there are 16 possible operating modes – from the rotation with steady and variable angular speed up to the forced precession with the variable angle of precession, with the "right" and "left" rotation of all load-bearings elements at option); power sources and commutation automated system. The period from idea up to its realization took about two years (1985-1987) [3]. Taking into account the real parameters of the system, the program of calculation was drawn and propulsive burns were calculated. The results of machine computation can be compared with real impulses, demonstrated on the screen of the oscilloscope.

If strange speed value 177 C^2 is discarded, then the middle speed value is close to C^2, i.e. to $9 \cdot 10^{20}$ cm/s! Of course, we would like to think that this is the second fundamental matter speed of our world, which we has approached experimentally …

Gravitational receiver

During the creation of gravitational antennas and receivers there appear almost insuperable difficulties from the modern fundamental science point of view. That is why it is advisable to look at this problem from another side. At first, it is necessary to consider gravitational radiation interaction not with the mass, which it goes through without losses, but with the gravitational field of independently gravitating mass, when the interaction must be the most effective because of the principle of physical processes reversibility. At second, it is necessary to choose some critical parameter of auto-gravitating receiver as a value, which is directly measurable by gravitational detector. For example, angular velocity of free rotation of thin disk with big diameter, the frequency of magnetization precession during NMR (nuclear-magnetic resonance) or NFMR (non-linear ferromagnetic resonance) etc. can be chosen as such a value.

In 1987 there was the first successful attempt to receive the gravitational impulse. The source of external signal was gyroscopic precessing system with the variable angle of precession (the propagation speed of gravitational radiation was measured by it). Double gyroscope, setting in motion by one electric motor, but with the opposite directions of rotation, was used as a detector. Between disks there was placed the source of light, impulses of which, passing through disks openings, were registered by photodiodes. Their signal came into differential circuit of data processing. The memory oscilloscope reproduced impulses of gravitational radiation. At that radiating system and memory oscilloscope was started up simultaneously. During the work process there appeared a problem of exciting of slow auto-oscillations of gyroscope-detector. This problem together with the low frequency of auto-oscillations of mechanical system led to a conclusion that this research direction is not very promising. However, the fact of detection was proved!

Gravitational engine of continuous action

Only about nine years passed since the appearance of the idea about engine up to its realization! In 1997 the engine was produced and tested. The engine with weight about 28 kg was made "weightless" on the magnetic hanger, and longitudinal draft, appearing in accordance with the impulse conservation law, was measured by micrometer detector of longitudinal shifts (sensitivity is about 50g/point). Such engine could be built still in the beginning of the last century… However, it has a secret **that is a gyroscope with the variable radius, working in the continuous mode.**

The engine power is defined by the formula

$$\frac{dW}{dt} = 5k\gamma_0\omega^{3/2}\left(\frac{m^2}{r^2}\right)\cdot\frac{dr}{dt}$$

In June of 2000 there were made experiments with the model of gravitational engine, which represents a

gyroscope with the variable radius (see photo on the 1st cover page). The mercury was used as rotating fluid. Tests were made in the Research Institute of Space Systems named by Krunichev. In three experiments, at a certain speed of rotating fluid there was fixed a decreasing of the engine weight (38,5 kg) up to 1.0-1.5 kg (2-3%). The specific impulse of the engine was equal to 2.5-3.0 kg per kilowatt of electric power. Analysis shows, that the increasing of propulsion force is possible at optimization of design and operating modes.

Some preliminary resume

In the magazine "Foreign Literature" #1, 1967 the article "For hundred years forward…" by Jack Marabini was published. There were made some conclusions about prognostic work of firm Rand Corp., including the area of gravitational technique. Namely:

- Development of communication facilities on gravitational waves in 2000;
- Creation of spaceships with antigravity engines in 2050;
- Transformation of gravitational energy into electric one in 2100.

In the article it was noted, that the most "fantastic" predictions of this firm, as a rule, come true passing ahead.

According to our crude estimations, the propagation speed of gravitational radiation is "C" times as much than the velocity of light, but we know neither laws of attenuation and propagation of gravitational waves, nor laws of their reflection and refraction, nor laws of their interaction with the substance… The large routine work is expected: making of measurements and investigations, tabulating of obtained data, publishing and society familiarization of the results, their "popularization". It is necessary to learn to use gravitational radiation and to protect oneself from its accidental influences, to design standards and dosimeters, etc., i.e. to repeat the way of radio engineering and nuclear physics comprehension.

For that we need generators and receivers of gravitational radiation. It means that the financial support is necessary. And engineers are sure to be ready to pay the highest price for the chance to give to the Mankind spaceships, systems of instanteneous communication with them and real perspectives for the very long history.

Conclusion

We have already passed the long way, if not in space, then in time. We have made:

- Gravitational engines of continuous action with the specific impulse about 2.5 kg/kWt [11];
- Transformers of gravitational energy into thermal and electrical ones [12];
- Communication system based on gravitational waves [13];
- Receivers of gravitational (microlepton) radiation of biological and mineral objects [5];
- Devices for control of "laboratory time" flow (time machine) [14].

The main goals of the authors were to attract readers' attention to the problems, which demand an urgent solution. Some questions were decided, and even seemed to be clear. It also seems to be clear what to do further. And what do you think about it?

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BEAMSHIP TECHNOLOGY

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Read in this issue a report by Russell Anderson, USA, on beamship Model Flying Craft

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Experimental Research on Gravitational Propulsion System

*Editor's: It is a review of the article by **V. A. Menchikov**, the Director of Research Institute of Space Systems, named by Krunichev, Russia. The article was published in"Polyet" magazine #10,2001, p.38-39, Russia. It scrutinizes the matters on development of propulsion systems based on the unconventional approach to the problem of gravity, i.e. gravitational engines. It also cites the results of the gravitational engine model research made by means of the experimental facility, created in the Khrunichev Research Institute of Space Systems.*

The device, transforming rotary motion into unidirectional motion, looks like S.M. Poliakov's one. It also operates with rotation of liquid, which causes the propulsive force. Truly speaking, Poliakov had an agreement with Research Institute of Space Systems named by Khrunichev in 2001. Some funds were assigned to develop the device, however the project, into which Poliakov had put a lot of work, still remains unrealized. Besides, the scientist's name is not even mentioned in the patent.

***

Scientific and technological advance opens to mankind more and more wide abilities to use space for the solution of global problems. In many respects the complete realization of these abilities will be defined by the developement of means used for delivery of payloads into the space. In the XXI century the dominating use of reactive chemical and electrical propulsion systems in rocket-space technique as well as low application level of engines with other physical principles can be the factor of an "inhibitory" influence for the development of such techniques. It is caused by the fact that created rockets practically do not correspond to noticeably increased standards of safety, operating costs, costs for transport operations execution and ecological influence on the environment.

Thus, there becomes to be urgent the problem of development of alternative approaches towards the creation of propulsion systems, made for the rocket-space technique on the base of unconventional ideas and engineering solutions. A rather old-established idea of creation of gravitational engine should be concerned as one of such ideas. It is based on the unconventional approach to the problem of gravity. Nowadays many countries take part in solution of the gravitational problem, namely Russia, USA, Japan, etc., and if till recently only some scientists and inventors showed the interest to this problem, then now it arouses interest of research-and-production majors. Unfortunately, now it is not possible to speak about sufficient theoretical or practical development of this idea. However, the interest is so considerable, that practically separate experiments on this subject were made earlier and they are still made nowadays. After all, stakes are very high and are defined by applied nature of the problem (the ability to create qualitatively new engines for the rocket-space technique), as well as by its scientific significance.

One of the directions to solve the problem of the creation of gravitational propulsion systems is the realization of associated theoretical and experimental methods of the search of physical processes, leading to the antigravity effects appearance, which cannot be adequately described by existed theoretical conceptions. V. Shauberger's patent, based on the postulate of gravitational energy radiation by "disturbed rotating mass" can be considered as an example of such practical realization. Taking into account a number of known experimental results, a model of gravitational engine and experimental system for estimation of this model parameters were made in Research Institute of Space Systems named by Khrunichev to provide the practical realization of Shauberger idea (Fig.1). It is the metal construction, which provides the model displacement in upward direction with the ability of its rotation around vertical axis.

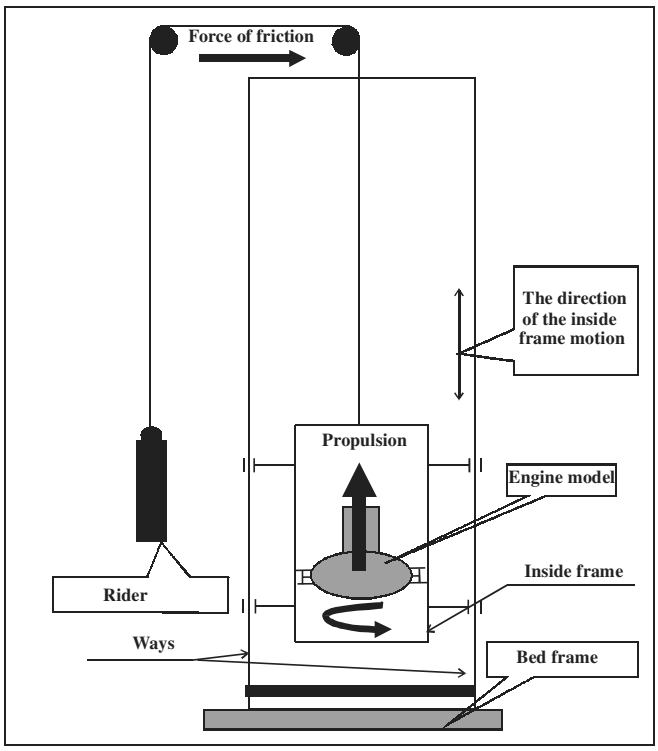

Fig.1
Schematic circuit of the experimental system

Later, to increase the system sensitivity it was improved and the block system of suspension was replaced by the lever frame.

Turning angle of the stand frame, where the model of gravitational engine is suspended, depends on the following: weight and geometry characteristics of the frame; weight characteristics of the engine (of counterweight); engine propulsion and frictional forces in bearings. Laser indicator of frame turning angle and vertical ruler let increase the gauge of lifting height of

the gravitational engine model proportionally to the arm of light beam.

On using this system there was made a wide cycle of tests, which qualitatively confirmed the presence of propulsion force. Tests were recorded by video. The analysis of experimental results shows, that acting time of propulsion was about 12 s at each switching. During repeated switching of the gravitational engine model in different conditions it is able to create the propulsion, the value of which at 40…50 s of operation can be about 3 standard units of propulsion force (1 standard unit of thrust is about 10gs), and while using the powerful electromotor it can be about 80 standard units of propulsion at the intervals up to 4 s.

Research Institute of Space Systems named by Khrunichev, works on automation of experimental researches and on development of laboratory resources for factor analysis of appearance of the propulsion vector with the usage of the described model of gravitational engine.

Patent

The patent was published in the Bulletin of Patent Information in 2001.
(11) 20946
(51) 7 F 16 H 27/00
(21) 2001121237/20
(24) 01.08.2001

Editorial: V.A. Menchikov together with A.F. Akimov, A.A. Kachegan and V.A. Svetlichnyi have got this patent. Dr. Spartak M. Poliakov, being the author of the principle, is not mentioned at all in the patent.

NEWS REVIEW

Boeing Tries to Defy Gravity

According to Jane's Defence Weekly (UK), http://www.janes.com, Boeing, the world's largest aircraft manufacturer, has admitted it is working on experimental antigravity projects. These projects are able to overturn a century of conventional aerospace propulsion technology and alter the entire aerospace business. Boeing uses researchers by Yevgeny Podkletnov, who claims to have developed a device, which can shield objects from the Earth's gravity. Many conventional scientists, who have not been able to reproduce Dr Podkletnov's results, view his project, named «GRASP» (Gravity Research for Advanced Space Propulsion) with suspicion.

Dr Podkletnov claims to have countered the effects of gravity in an experiment at the Tampere University of Technology in Finland in 1992. The scientist says he found that objects above a superconducting ceramic disc rotating over powerful electromagnets lost weight. The researches have shown that the reduction in gravity was small, about 2%, but the implications - for example, in terms of cutting the energy needed for a plane to fly - were immense.

His devise, named "impulse gravity generator" is capable to produce a beam of "gravity-like" energy that can exert an instantaneous force of 1,000g on any object – enough, in principle, to vaporize it, especially if the object is moving at high speed. Laboratory installation has already demonstrated the 4in (10cm) wide beam's ability to repel objects a kilometer away and that it exhibits negligible power loss at distances of up to 200km.

Applications of the device can include space launch systems, artificial gravity on spacecraft, aircraft propulsion and "fuel-less" electricity generation ("free energy"). However, observers say that Podkletnov's device could be engineered into a radical new weapon, for example, adapted for use as an anti-satellite weapon or a ballistic missile shield.

Documents, obtained by reliable sources, show that Boeing is taking Dr Podkletnov's research seriously. It is also possible, Boeing admits, that "classified activities in gravity modification may exist". The paper points out that Podkletnov is strongly antimilitary and will only provide assistance if the research is carried out in the "white world" of open development.

Boeing is the latest in a series of high-profile institutions trying to replicate Dr Podkletnov's experiment. The military wing of the UK hi-tech group BAE Systems is working on an anti-gravity programme, dubbed Project Greenglow. The US space agency, Nasa, is also attempting to reproduce Dr Podkletnov's findings, but a preliminary report indicates the effect does not exist.

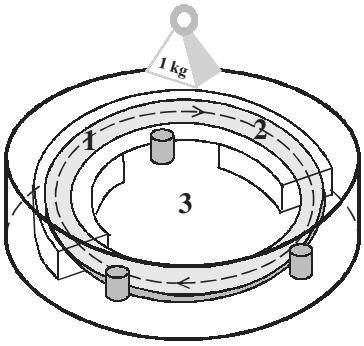

1. Solenoids create magnetic field
2. Spinning, super-conducting ceramic ring
3. Liquid Nitrogen acts as coolant

BEAMSHIP TECHNOLOGY

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Read in this issue a report by Russell Anderson, USA, on beamship Model Flying Craft

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Beamship Technology: a Re-working of Early 20th century Discoveries

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Some Basic Background

The concept of an electric aero-spacecraft with no moving parts was initiated by the Yugoslavian electrical wizard **Nikola Tesla**, who lit the entire world 100 years ago, at the turn of another century, with his revolutionary AC electric current. In 1916-17, Dr. Francis Niepher performed meticulous mass-deflection experiments under rigorous scientific conditions with lead spheres suspended by wires with shielded and unshielded containers. An accounting of this important series of experiments is in TRANSACTIONS OF THE ACADEMY OF SCIENCE OF ST. LOUIS VOL.23, 1916 and 1917. Related article is in THE ELECTRICAL EXPERIMENTER, March 1918.

Before 1905, **George S. Piggot** was routinely suspending small silver balls to water globules, corks, wood, using the electrostatic field from a specially designed Wimshurst machine in a glass container under several atmospheres of pressure to raise the current level. Output voltage was typically 500KV. The field was propagated by a charged sphere. A small curved conducting plate on the floor acted as a ground. He observed unusual patterns of blue dots with filaments over the suspended objects, sometimes with an anomalous 1/2 cm "dark band" on the suspended objects. Piggot states, "It is my firm conviction that that somewhere on the outer confines of our planet there exists a similar contracting belt thru which naught but the gravitational vibrations of the sun penetrate, and these vibrations absolutely annihilate or absorb all other less powerful ones". If the force was Coulombic in nature, objects would be first attracted, and then strongly repelled by the charged metal sphere. After the objects were suspended, Piggot found he could remove the conducting ground plate, and the objects still floated, suspended. The phenomenon of levitation was accompanied by "luminous halos".

In 1925-27, **Albert Einstein** released his scientific "gem", his "zur Einheitlichten Feldtherie", or the Unified Field Theory for Gravitation and Electricity, to the press and the scientific community. It combines electricity, magnetism, and gravitation into a single mathematical expression, showing how High-Voltage/Low Current electricity (Electrogravity) -and conversely Low-Voltage/High-current (magnetogravity) "acceleration-fields" (G-field) could be produced using then-available relatively LOW-technology. Indeed, a very simple technology. The unifying field is the electrical field (because it can produce gravitation and repulsion fields, as well as magnetism). His Crowning work was released with much press write-ups and fanfare, then it was quickly forgotten as if the scientific community and the world had suffered some kind of collective amnesia!

All of the readers of this magazine need no introduction to the pioneering work of American Scientist **Thomas Townsend Brown**, who was playing around with an X-ray tube around the same year as Einstein's Unified Field Theory was released. He filed his first patent for this newly and accidentally discovered "electrogravitational-effect" which causes motion in a high-voltage condensor or capacitor configuration. He was only 17 at that time. The discovery that high-voltage/low amperage electrostatic potentials applied to an object causes motion in the direction of the positive pole, and electrical charges naturally move to the OUTER surface of an enclosed charge-conductor, held strong prospects for what Brown would later name the "space-car", and wrote an article "HOW I CONTROL GRAVITATION". His pioneering work, and demonstration of devices in Hawaii during World War II, drew attention from the department of Naval Intelligence. He was invited to work on "Project-Rainbow" (the Philadelphia Experiment for Electromagnetic Stealth) because of his pioneering work on what was starting to be understood very covertly as a true WARP DRIVE. Experiments with certain new and classified arc-welding apparatus at the Philadelphia Navy Yards to weld armor-plate for battleships was (by use of banks of primitive but powerful avalanche-discharge capacitors) producing anomalous and unexplained effects, such as disappearing tools and other apparatus in the heavily shielded welding chamber. These strange effects were accompanied by a strange "blackout -zone" which, like Piggot's early work, was not optical in nature. TT Brown's devices in his AH Bahnson Labs home movies lift more than their own weight and move inside vacuum chambers in these films. TT Brown later founded NICAP in 1956, which became the most respected UFO data gathering and hard scientific organization in the world, besides the US department of Naval Intelligence itself, and the Foreign Technology Division at Wright-Patterson Air Force base in Ohio.

My background and work

I primarily have a background and degree in computer programming, electronics, most fields of science, Flying Saucer Technology research (almost 30 years worth), Radio/Control fixed and rotary-wing aircraft since 1972. I have been experimenting and working with high-energy and electrogravitic devices and systems since 1987. I built my first small High-Voltage generators starting around this time. I built kits from Information unlimited and elsewhere.

In late January 1990 I built my first working 2-foot flying discs, which were a direct replication of Thomas Townsend Brown's most important representation of his electrogravity-propelled scale-model vehicular concept, from US Patent #2,949,550. In January 1992, I built a 120KV high-voltage/low-current electrostatic generator from an Information Unlimited kit, primarily for force-field propulsion research.

In June 1999, I built a tower and rotor apparatus to complete the experiment, and I powered it with the output from a 100KV generator I built from an Information Unlimited Kit. The results were spectacular, and taught me a great deal about what was involved in producing and maximizing the Biefeld-Brown Electro-gravitational effect. **I suspected from my research, and my experiments, that the basic effect was not due to current-flow and resulting ion-wind. When there was current-flow, the effect is attenuated, power consumption goes up, and thrust goes DOWN.** In late June of 2000, I presented this working TT Brown Electrokinetic Apparatus with larger 1-meter discs at the 2nd Antigravity Conference in Reno, NV, hosted by Jim Cox. A VHS videotape of this working and spectacular presentation at the first part of the conference is available from
www.soundphotosynthesis.com

Now that I had mastered producing horizontal thrust, vertical thrust, or antigravity, was the next goal. About this same time, there was buzz all over the Internet about claims of two or three individuals who sounded credible at the time who had successfully replicated the many multi-layered "gravity-warp capacitor" or "electric rocket". Oddly, these claims could not be verified, and the individuals making the claims disappeared back into the woodwork. Such actions are bizarre and hinder the progress of true science, which is undergoing a shift in paradigms right now, if not a change in dogma.

I spent months die-cutting hundreds to thousands of tinfoil and aluminum-foil circular-notched conductor plates and wax paper and mylar rings. I did some initial testing with a Tin and wax-paper 400-layer gravity warp-capacitor heap, according to plans I had acquired from H & A Industries in 1992, and what was on Bill Beatty's amateur science site. No one else has come forward with positive results on this tedious and time-consuming device. So much work for so little effect! And, if you short out the stack with too much power, you must tediously and laboriously search thru hundreds of layers to find the dielectric layers with the telltale carbonized holes. The Electric rocket has been recently successfully replicated and tested in hard vacuum and patented recently by Hector Serrano. The Serrano effect is identical to the so-called Biefeld-Brown Electrogravitational effect. They are one in the same thing. I may dust off my completed 400-layer grav-cap, but I hardly find it worth the time and effort, because of my recent work starting in early October 2001.

The Lifter and The Evolution to Beamship Model Flying Craft

Although I had attempted a few small "Hagen" patent-type antigravity (VTOL) models in the early 90s, I found their performance poor at best and their power consumption high. In late summer, 2001, someone, I forget who, on the JLN's lab list of researchers and anomalous science-experiment and technology enthusiasts ran across a website owned by Transdimensional Technologies, of Huntsville, Alabama (famous for NASA research facilities, the late Dr. Rolf Schaffranke, author of the important ETHER TECHNOLOGY, under the pseudonym "Rho Sigma", and Dr. Tom Bearden) had produced a hovering device. From my previous work, I recognized it immediately as TT Brown's Electrokinetic Apparatus that I had successfully replicated and demonstrated before a live audience years earlier. I noticed the capacitors were made from Aluminum FOIL, not the thin-but-heavy Aluminum sheet stock from Home Depot that I had been using for years, (I had assumed that to make my 3-foot discs hover and ascend vertically, I would have to use voltages in the hundreds of kilovolt range, and generate high x-ray, UV, and possibly gamma-ray emissions as a by-product, in other words, a typical flying saucer with all the associated radiological effects that have been documented for over half a century) so they could lift their own weight. The result matches almost exactly the simplest graphical representations of TT Brown's patent from 1960, and De Seversky's Ionocraft patent from 1964, which was a thin foil cathode plate with a thin anode wire separated from the cathode by stand-off insulator posts. I was eager to reproduce these devices (I don't know how I overlooked this simple solution, it was all sitting in those old 1960s Brown and De Seversky patents I have studied for 15 years previously) and many people around the world, especially the webmaster of the JLN Lab's site French researcher Jean-Louis Naudin, who began replicating many different types of larger and more sophisticated devices, some of which resembled model spacecraft, and began amassing tables of very useful data, that researchers could use as basic guidelines to follow. I replicated the first hovering device, the "Lifter" (so-called by Transdimensional Technologies) as a 1-foot triangle, with 2-inch foil cathode and #42 enameled copper magnet wire. To energize it I used a commercial power supply from Gamma High-Voltage Research that I had acquired from Ebay some years ago. It was perfect

for antigravity research, having full metering, and variable voltage from 0 to 40KV, and current limiting from 0 to 1.5 milli Amperes of current. The heavy 1-meter discs of the Electrokinetic Apparatus were too heavy and the rotor-friction to great for this low-powered device (60 Watts, maximum), but for the lifter, it proved ideal.

My first "lifter" antigravity device worked, but its performance was less than ideal. It had to be stripped of its lower balsa-wood frame and some of its foil before it would degravitate (counterbary), and it "maxed-out" the current-limited power supply at 33KV I 1.5mA, for a stable hover (actually this is an upward flight configuration, because the device is tethered to the lab table with 3 sewing threads). That is 49 Watts. The concept of a hovering TT Brown Electrokinetic Apparatus had been proven to my satisfaction, however, and I initiated more research into past works and patents to raise efficiency to workable levels. The performance was slightly better than my early 1990s "wire-grid" type devices. I found this slightly encouraging.

After a couple months reading and research (why re-invent the wheel, its all been done before), I started to replicate larger models in February and March 2002, but kept coming up against a size-barrier with the Multi-cellular (grid) approach that many researchers had assumed would raise thrust, and efficiency. This approach obviously did neither, as no one seemed to be able to produce hovering devices above a certain size, the current consumed (adding to total wattage consumed) was prohibitive with the low-powered (still high-voltage, low-current) devices that most of the mostly amateur researchers were using. Researchers around the world started to replicate different versions of the basic lifter 1 (an 6 to 12-inch equilateral triangle). The lifters are always tethered to the testing surface with 3 strings to keep them from going dangerously unstable and possibly short-circuit when they reach the limit of the umbilical supplying power to the device.

From my previous Biefeld-Brown effect replications years earlier, and from carefully reading Brown's EK Apparatus patent, I knew that increasing the diameter of the wire would reduce leakage current created by coronal discharge, mostly coming from the forward electrode, which in the 2 and 3-foot saucers consisted of an arc of copper tubing in the front quadrant of the saucer, or disc. Corona robs power (amperage) from the disc that otherwise would be used to "propel" the disc. Increasing the diameter of the copper tubing, as per Brown's patent if the effect was due primarily to ion-wind, more current and current flow between the electrodes would be desired to effect more air movement. But this is not what I saw in the saucers. **There was apparently another, far more powerful but subtle force effecting silent propulsion of the saucers that had nothing to do with charge-transfer and ion-momentum.**

In February of this year, I undertook an effort to replicate and improve performance and reduce power consumption of the lifter device, based on data from my electrogravitic work of years past. I started by using thicker diameter enameled copper magnet wire, #35 to #30 diameters. I first built a 1-foot equilateral triangular basic "Lifter-1", weighing only 3.5 grams. On March 16th, I built a lifter with the thicker #35 enameled copper wire.

I made the three sides 1-foot long and exactly 2-inches high. After experimentation, I found the optimum spark gap for my High-Voltage power supply (Gamma High Voltage Research 40KV with current limiting to 1.5mA). The small silver-colored device leapt off the test table and pulled violently against its anchor strings to a distance of about a foot. This seemed like a great deal of force for such low power. The large discs of my TT Brown EK apparatus required a good deal higher voltage to initiate motion in the direction of the anode. The device consumed 26KV I 0.56mA DC, which calculates out to 14.56 Watts. I was getting more excited, because this was the best efficiency seen of any result yet posted.

On March 19th, I tested 2 lifters glued together in a "diamond" shaped configuration.

This 2-foot device weighed 6.0 grams, with the same #35 wire and a 2 and 5/8" air gap. It took 25KV to nullify the weight of the device, and it achieved a stable hover at 35KV I 0.8mA. That is 28 Watts. This is about what I had initially expected, double the power for double the Watts. Still, this was far less overall power going into the device to achieve a stable hover than my first primitive and radically shorn and trimmed device. After lift off to the extent of the anchors, I found I could reduce power slightly and maintain a stable hover. On march 22nd at 3:49 pm I got the diamond lifter to achieve a stable hover with a 2 and 5/8" air gap at 29.5 KV I 0.32mA. This was only 9 Watts! This was unheard-of efficiency. I was further encouraged to build and test larger hovering devices to see how large I could get them with my low-powered commercial power supply.

I then built a "lifter-2", which consists of three 1-foot triangular capacitor cells taped together. It weighs 11.4 grams. March 30th at 3:22 pm, the device achieved a stable hover at 38KV I 0.57mA for 19.76 Watts total power. The larger device was more energy efficient than a device 1/3 the size. I wanted to see how far this could go, so I added three more lifter cells to make a 6-cell device, 3 feet on each of its three sides. I was eager to check the performance of this fairly large device. This was the diameter of my horizontally propelled TT Brown Discs.

This device weighed 21.6 grams. I kept the spark gap the same distance on this device. However this device failed to achieve counterbary (lift). It just sat on the test table, filling the air with the smell of ozone and

making a sizzling sound (corona noise). I noticed that the current maxed-out on the power supply at a fairly low voltage and would not go any higher.

I concluded in my disappointment that all that wire from all the inter-connections to the cells was causing corona leakage and robbing current, which otherwise would be used by the device for propulsion.

The idea then hit me that perhaps I could make a device with the same outer diameter as the 3-foot device, but have greater efficiency because of a much shorter length of wire. I built basically a 3-foot (1-meter) version of the first 1-foot device. This device weighed 16 grams. It lifted off the table with amazing force and hovered stably with I 52mA 30KV which is 15.6 Watts. Not only had I achieved a larger-size device, but far better power efficiency for a much larger and heavier device. I was overjoyed! I saw that I had a great deal of lifting force to spare. I had not even come near the limit of my power supply. I added extra bracing at the corners and extra balsa and a triangular paper "payload -tray" in the center of the device, supported by three 1/16"x1/16-inch balsa stock. The extra bracing and payload area added approximately 2 more grams. With a 5 gram payload, the device consumed 39.9 KV I 0.99mA, for total power consumption of 39.5 Watts. I was really encouraged at that point, because I knew that these results were unheard-of, in terms of energy efficiency. I had solved the problem of decreasing efficiency by dispensing with a "grid-based" device. Increasing the area of the capacitor plate was one of the factors that increased performance and efficiency, lessening the input power requirements with increasing size. Now the Biefeld-Brown effect could be properly studied, now that most of the ion-flux had been eliminated, resulting conservation of energy by the device, and resulting in greatly increased propulsive force.

Since I now knew the limit of payload for the device at the power level I was using, I added a balsa framework that approximated a central cabin area, and three small styro-foam spheres on the center of the straight sides on short lengths of balsa. The device no longer looked like a test device, but now looked like a scale model spacecraft. I remembered the Edouard "Billy" Meier UFO contact case, and knew that all his original photographs and movie footage of extraterrestrial spaceships the extraterrestrials themselves called "beamships" (there are several styles and variations, all with different specific functions and capabilities, some manned, some remote-controlled "telemeter discs" that had a tri-hemispherical undercarriage that I knew from past research were propulsion condensors) and that the original un-tampered photos all passed rigorous analysis using the latest and most sophisticated computer and other equipment, case detractors not withstanding. Also the spiritual messages of these genetic brothers of Man and their accounting of humankind's history and origins from far across space rang true and struck a chord with me.

I decided to name this new 1-meter model spacecraft Beamship Variation I. The three sides of the device performed the same function on this device that the three spherical or hemispherical capacitors often seen on the underside of full-size "beamships" (Daylight-disc-type UFOs), which illustrates a similar if not identical propulsion methodology to full-size 3 to 7 meter and larger "off-Earth-built" aero-spacecraft. Clearly the propulsion methodologies were exactly the same in the model as in the full-size flight device.

I immediately built a 4-foot diameter model with a full cabin framework and internal payload area and achieved even greater performance and efficiency. I was ecstatic. This 4-foot device I dubbed Beamship Variation II. I received a suggestion from Mr. Tim Ventura of American Antigravity that performance could be increased by using small diameter stainless-steel wire. It seemed unlikely to me that smaller diameter wire would increase performance, it contradicted Brown's patent, and my own past research with large electrogravitic discs. But Stainless steel has a high number of free electrons in the outer valence atomic shells (electron orbits).

So I obtained some #40 stainless locally and the results confirmed Mr. Ventura's suggestion. Corona noise was heard at a much higher power level, and was greatly attenuated in volume. Leakage current was less, and the two Beamships now had more thrust with less power input. They even carried more payload at less power input. Variation II weighs 21 grams and loft a payload of 6 grams at 40KV I 1mA for 40 Watts total power. Again, this was unheard-of efficiency. The anode wires sang a strange harmony as the Beamships floated in the air, stably at any altitude, from floor to ceiling, without any fuel or visible means of support. This was very Beamship-like.

I thought that now since corona discharge on the anode wire was less, I could decrease the spark-gap distance without creating a spark (which kills lift). Thrust seemed initially to increase, but efficiency went down because there was current-flow now, and current consumption went way up. The supply would now max-out at 37KV I 1.5mA and would not increase because of the current limiting. The Beamships now were noisy, as the foils chattered loudly because of all the ion-wind that was now rushing downward along and past the foils. I used a concert fog machine to observe the ion-flux vector, and filmed it digitally with my Logitech web-cam, and with VHS analog video.

Analysis of the fog -tests showed a circular vortex of air surrounding the anode wire that flared out into a downwash of air below the Beamship. I was disappointed, because I thought then that the thrust action of the device was due to simple ion-transfer. A useful-enough effect, but of questionable use in the vacuum of space without an ionizing medium.

Beamship Variation III

I reasoned I had just about enough power in the supply to build and fly a 6-foot (2-meters) Beamship. Since the balsa came in 3-foot lengths, this was simple. As with all the lifter devices and the more evolved and efficient Beamship-series model aircraft, construction techniques are extremely simple and require little skill to assemble. Weight of the Beamship Variation III is 42 grams, with 6-feet of length on its 3 sides. Height of the foils was still 2". Full frame and cabin, with Searl "IGV"-type landing legs, to support the weight of this heavy and very large device. I set the spark gap at 2 and 1/2 inches. At 12:15pm EDT, May 12th, 2002 the Beamship was weightless at 32KV with current maxed-out at 1.5mA.

The device barely lifted off, and "hopped", across the floor once or twice at full power. It had the same loud rattling of the foils due to the terrific downwash of electrified air. I needed to raise the power level. I increased the distance of the spark gap to 2 and 3/4". Now the Beamship took off straight up with power to spare, as if it was one of the smaller craft. Beamship Variation III is weightless at 30KV I 0.85mA (25.5 Watts), and airborne into a stable hover at 35KV I 1.35mA. That is only 47.25 Watts. It can carry a payload of 5 grams, or 5 grams worth of additional framework and structure, to the limit of the power supply, which is 60 Watts (40KV I 1.5mA).

The 42-gram, six-foot model aero-spacecraft only consumes 47.25 Watts at hover, but my first small and trimmed device ate up 49 Watts! Clearly, using the single-cell Beamship methodology had a huge advantage over the "multi-cellular" design that other researchers had built and tested, seemingly reaching an impasse in terms of size and efficiency, which my large single-cell Beamship technique had seemingly solved. In early April my 1-meter Beamship, weighing 22 grams including 5-gram payload, consumed 39.6 Watts. So the 42-gram, 6-foot Beamship used only 7.65 Watts more total input power at stable hover that the 1-meter Beamship. Power-to-weight ratio for the 2-meter Beamship V. III works out to 1.125 Watts to lift 1 gram stably of scale model electric spacecraft. With little to no ion wind, the Beamship had plenty of upward force and achieved stable counterbary at greater efficiency than I had ever heard or read about. Also, I was not aware of any devices in scientific history that has achieved this type of counterbary for this little input power and this colossal size. I performed additional fog-tests with two red semiconductor-emitted laser beams in the plane of one side of the device, one above the wire, one below the foil. The Beamship without all the ion-wind was nearly silent again, except for "singing" and softly "thrumming" anode wires. These laser-beam tests further confirmed the marked absence of ion-wind with a larger spark gap.

At 1.125 Watts-per gram at 57KV I 1.4mA (78.8 Watts) would lift 89.775 grams worth of electric spacecraft. So not only is the larger size in a single cell far more efficient that the "grid" design, in thrust and power consumption, but the reduction in current from increasing the spark gap raised power level to the device, while dropping power consumption of the device. My initial suspicion of ion-wind producing most of the thrust in the Biefeld-Brown effect had been dis-proven also because of the great weight of the device. I never would have discovered this important fact if I had stayed with smaller devices, trying to raise their efficiency. And I never would have discovered the efficacy of the Biefeld-Brown effect if I had stayed with the multi-cellular "lifter" methodology. One of the factors that raises the level of propulsive force (if "propulsion" is the right word) is increasing the area of the plate, according to TT Brown's patents. So the larger size single-cell capacitor's ability to reduce power consumption and effect greater propulsive force and upward acceleration, was easily explained by the Biefeld-Brown Effect. Brown had been vindicated. My gut feeling had seemingly been confirmed: this was our first warp-drive (reaction-less drive).

My experiments had yielded greater efficiency, and greater size and weight of VTOL hovering models than any that I had ever heard or read about. I still am having difficulty taking in these facts; and it is very awe-inspiring to see such a large device de-gravitate and hover stably at any altitude, from floor to ceiling.

Next for me is a higher-powered supply (60KV), moving up to a three-meter Beamship Variation IV, improvements to the cathode such as a thin, symmetrical airfoil shape, as Brown suggests in his patents, tungsten wire, and then carbon-wire for the anode, and full heat-shrink coverings on the frames, running lights, onboard lasers, onboard digital/ proportional Radio/Control, and now that we know the power requirements, and have a good handle on efficiency, onboard power generation. I have already begun designing with my associates our own custom-made outboard and inboard battery-powered power supplies, and finally will cut the power umbilical to the model electric spacecraft permanently, and Beamship technology advances further. If the on/off duty cycle is pulsed at a low frequency, power input can be reduced by two-thirds, at least. Experiments conducted by Jean-Louis Naudin last fall (2001) confirm this phenomenon, suggested by Brown and De Seversky in their patents. Clearly, onboard power can easily be effected, using modern miniaturization and circuitry. Pitch and roll vector control can be achieved by electrically isolating the anode wires on the three sides of the ship, and varying pulses to these three wires. Yaw control can be achieved by simply installing a horizontal-double sided capacitor inside the ship near one corner. Simple full 4-channel flight control is thus achieved.

The Beamship series aircraft are fascinating research and entertainment devices (see cover page), and are the vanguard of a whole new generation of radio/ controlled antigravity model aircraft with no moving

parts and dead silent propulsion. But they are more than that. The Beamships, if allowed, could probably rise up at any speed thru the atmosphere, right up to near-Earth-orbit, and probably keep on going out into limitless space. No need to achieve ballistic escape velocities of miles-per-second. This is non-ballistic flight. They even have a certain amount of wind resistance outdoors and indoors because the electrical field causes air to flow AROUND the model flying craft, not into it. This is such a safer, environmentally cleaner, vibration and nearly silent and more pleasant method of aero- space travel than carrying tons of explosive reaction mass, which can and does explode. No more use of heat energy to effect transportation.

The 21st century has begun in earnest!

Beamship series aircraft are available for sale for research and hobby/entertainment use right now through the American Antigravity website: www.americanantigravity.com. Look for the Applied Electrogravitics antigravity technology website late spring, 2002. You can contact me, Russell Anderson for details on pricing, and new and improved variations, and power supplies for outboard and onboard drive, which are currently in design stages.

Editor's note: More ideas on development of T.T. Brown's patents are on our web site: http://www.faraday.ru. Read about T-capacitor!

Data Table 1

Antigravity device	Weight of device	Wire type	Voltage/current	Total Watts	Payload	Payload/power
1-foot "Flyer-1"	3.2 grams	#42 enameled copper	33KV I 1.5mA	49	None	————
1-foot "lifter-1"	3.5 grams	#35 enameled copper	26KV I 0.56mA	14.56	None	————
2-foot "diamond-lifter"	6.0 grams	#35 enameled copper	29.5KV I 0.32mA	9	None	————
2-foot, 3-cell "lifter-2"	11.4 grams	#35 enameled copper	38KV I 0.57mA	19.76	None	————
3-foot, single-cell "Beamship Variation I"	16 grams	#35 enameled copper	30KV I 0.52mA	15.6	None	————
Beamship Variation I-fully-rigged	18.5 grams	#35 enameled copper	————	39.5	5 grams	39.9KV I 0.99mA
4-foot "Beamship Variation II"	21 grams	#40 stainless-steel	————	40	6 grams	40KV I 1mA
6-foot "Beamship Variation III"	42 grams	#40 stainless-steel	35KV I 1.35mA	47.25	None	————

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SmartPAK Technology™

invention by William Alek

the world's first commercial all solid-state system that provides a "standard" platform for experimenters, researchers, and developers to do energy-related practical applications, experiments, and perform exploration of highly efficient alternate energy system

The theory of operation is based on the amount of energy that is required to magnetize and de-magnetize ferromagnetic materials utilizing a core/coil/magnet assembly. It has been discovered that it takes MORE energy to magnetize a suitable core assembly than to de-magnetize it. The SmartPAK system is designed to measure and collect the difference, and store the excess energy for later use.

The SmartPAK device is controlled by a 68HC908GP32 micrcontroller programmed to measure input/output voltages and currents, calculate COP, and contains software algorithms for a complete "turn-key" power management system. The device features a "standard" user interface, which allows the user to design their own custom core/coil/magnet "head assemblies", and immediately test and display in real-time its' performance.

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Commercial Antigravity

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Introduction

Let me begin by posing a simple question that I would like the reader to keep in mind throughout this article: How far away is commercial antigravity? I'm not talking about a laboratory experiment where a giant magnet is used to levitate a frog, or secret UFO experiments that the government isn't sharing with the business world, but a real, viable antigravity solution to what I consider to be the most pressing issue facing the world today – transportation.

Who can answer a question like that? How far away is commercial antigravity? The author has read numerous scientific texts on the subject, and is familiar enough with contemporary theories of gravity, antigravity, and electromagnetism to suggest that most scientists believe that commercial antigravity is at least 100 years away from existence. But the author believes that most scientists are wrong.

Defining terms

Any article about antigravity would not be complete without properly defining the terms to be used. In this article, antigravity is not used in the strict sense of the word. The author's intent is to discuss a method of propulsion, which for all intents and purposes can be considered antigravity, and may include antigravity – but also may include several other forms of similar propulsion. The reasoning behind this is that experience has shown that the majority of people in the world don't care how something works – they care what it can do for them. This article is about the effect of Antigravity – not the cause.

Real Antigravity would consist of an apparatus used to either reduce the apparent mass of an object or reduce the effects of gravitational attraction between the Earth and an object. An example of an apparatus that may in fact do this is the Podkletnov superconductor apparatus currently being tested by NASA.

This Podkletnov device essentially consists of a spinning superconductor that self-levitates above a pool of liquid nitrogen and supposedly creates a "beam" or "shaft" of antigravity (or reduced gravity) directly above it as it operates. The levitation of the superconductor itself is not antigravity – it is a well-known side effect of ceramic-superconductors called the "Meissner Effect". The Meissner effect is simply a side effect of the superconductor's interaction with the Earth's magnetic field, and is easily explained by physics.

Podkletnov claims that when he worked with a team of researchers investigating superconductors in Russia around 1991, the smoke from the tobacco pipe of a fellow researcher began to climb steeply in a column directly above the superconductor. The researchers began to think that they were on to something, and Podkletnov subsequently performed several follow-up experiments that led him to the conclusion that the levitating superconductor produced a shielding effect between the Earth and anything positioned directly above the superconductor. He reasoned that gravitational shielding would provide a "column" of reduced gravity above the superconductor that should extend up and away from the Earth indefinitely. Podkletnov calculated that with a rapidly spinning levitating superconductor he had achieved a 2% loss in weight for anything directly over the superconductor.

Podkletnov's research is interesting and compelling, and it would fall into the category of "real" antigravity – but I am writing about Podklentov's type of research as well as enormous amount of research and theory available on electromagnetic propulsion systems. These can be considered "effective" antigravity.

The Harrier jet fighter can swivel its engine exhaust-nossels to create vertical lift, which resembles antigravity in that it is VTOL takeoff. However, the Harrier does not use effective antigravity because it has all of the functionality and side effects of an aircraft. A helium blimp would be a closer example to "effective" antigravity, but it too is not – because it works on basic aerodynamic principles.

Aerodynamics is not effectively antigravity – aerodynamics is instead expensive, difficult to manufacture, prone to explosive failure, and highly unreliable. This is not to suggest that a jet aircraft is unreliable, because it has a variety of backup systems, but that the technology itself is unreliable in that a jet is adversely effected by the medium that it uses to propel itself. Air pressure, humidity, temperature, and strong winds all cause a degree of unreliability. In addition, turbine engines stretch the limit of what mechanical engineering can achieve – which is why they are prone to break if even something as small as a bird gets sucked in during flight.

Antigravity is not about moving the air around — it is about a medium-agnostic means of air transportation that produces vertical and/or directional lift without relying on air-pressure like a wing or blimp. Antigravity is an electromagnetic or electrogravitic system for reducing the weight of an apparatus to allow it to lift more easily. Antigravity is pushing a button and having your vehicle take off without runways, noisy engines, minimum flight-speeds, propellers, or any of the other drawbacks that limit conventional aircraft from achieving popularity similar to what an automobile might have.

The author's definition of Antigravity for the purposes of this article is confined to electromagnetic or electrogravitic devices that reduce the weight of an

object to enable it to take off without conventional thrust-producing apparatus. This definition might also fit many of the classical characteristics known at one time as "the electric spacecraft".

1. Business Analysis versus Scientific Analysis

The author disagrees with the majority of scientists as to when commercial antigravity will become possible for some very basic and obvious reasons. To begin with, the majority of credentialed physics-related scientists come from a theoretical school of thought, which tends to limit their world-view to only contain those things that are currently or potentially explained by theory. The author, however, comes from an experimental school of thought that seeks to capitalize on existing observational data without the rigorous need to explain every last detail of its functionality. The author is an engineer, not a scientist – and engineers don't need to totally understand how something works in order to make it better.

This difference between the engineering point of view and the physicists is also different in the manner in which they seek out observational data. A physicist looks towards naturally observable data, and in the event that none exists they look towards current theories to explain potential future observations. The engineer is more open to ideas that are less rigorously tested from the perspective of scientific method, but are currently observed as potential solutions to real-world problems.

2. Potential Technologies Overivew

Phycists currently tend to dismiss the entire concept of Electrogravity, and the reasoning behind their logic is very sound. To begin with, Electrogravity is not observable in nature. In addition, many of the claims by those persons who submit Electrogravity and antigravity devices for public review are faked, exaggerated, or just plain wrong.

Physicists are responsible for maintaining a working body of theoretical knowledge, and if they were to admit results such as Schnurer's without skeptical scrutiny it would undermine the very fabric of technology itself. If the Podekletnov results were to be accepted as fact at face value without rigorous prrof, imagine the amount of money that would be wasted in attempts to build enormous Antigravity vehicles based on this theory.

In the middle of the spectrum lies the concept of Maglev, which is mentioned here only for the purpose of specifying that Maglev is not commercial antigravity. It has been mistakenly thought of as antigravity by many because it utilizes a magnetically-levitated train to improve the velocity of the train and reduce transit time between stops. In reality, Maglev is not really a vehicle at all.

The definition of a vehicle would be a device that transports itself as well as its passengers and cargo between two points. This is why an automobile is considered a vehicle but an escalator or elevator is not – the automobile transports its entire propulsive apparatus to another location, but an escalator or elevator does not move – it merely repositions its cargo between points. The Maglev train is not really a vehicle at all – it is actually a very long electromagnetic armature that transports people and cargo between its ends at high speed. While it may serve a commercial need, it is not to be confused with Antigravity.

On the opposite end of the spectrum is the author of this article – who has built and successfully tested over 30 electromagnetic "Lifters" at the time of this writing. The Lifter is a device based on research by Transdimensional Technologies and related to research by Thomas Townsend Brown that demonstrates an antigravity effect when a High-voltage DC current is applied to it.

Currently, the exact method of propulsion for the Lifter is being debated. It is thought to be one of two things – either an effective form of "ion-wind" propulsion, or else a form of field-effect propulsion based on an as-yet unknown force. While the debate about the exact nature of this propulsion is important with regard to future research, in reality it does not change the observational data that demonstrate that this technology works perfectly, consistently, and reliably.

The Lifter design was demonstrated by the author in a continuous mode of operation for over 7 hours straight on Sunday, April 21st, 2002, at the Seattle Center "EarthDay and Renewable Energy Exhibition". During this seven hour period of time, the author's Lifter hovered at a tethered height of 12 inches from the surface of the table, powered by a 30 watt load from a simple computer monitor.

This article is not meant to get into the details of methods of antigravity, only to suggest that it already exists in the form of electromagnetic propulsion systems if nothing else. The author is confident that in time physicists will find a theoretical reason for why the Lifter operates as it does, but for the time being the fact of its operation overshadows the method of its operation.

3. Market Needs

Commercial Antigravity doesn't require a 2% loss in weight to operate – it will require something akin to a 200% loss in weight. A commercial antigravity device will have to demonstrate exceptional performance to gain market acceptance, but not for the reasons that might immediately come to mind.

One might believe that skepticism from the scientific community would prevent antigravity technology from gaining the scientific acceptance needed to become a commercially accepted engineering discipline. The long term view, however, shows that this is not the case – engineering and market forces drive innovation, and formal science plays a supporting role in explaining and

quantifying the innovations that engineers have already commercially qualified as valid.

The real roadblock to success for commercial antigravity is market acceptance. The author's demonstration of the Lifter technology at the Renewable Energy Exhibition helped him to realize that the vast majority of consumers have no idea what antigravity technology could be used for, much less what they themselves could use it for. The same thinking was apparent at the dawn of the age of personal computing, when the idea of having a computer in the home was a completely foreign concept.

So in brief, a market does not exist for antigravity technology, which is why inventors working with this technology have been unable to find appreciable support for their work. Many inventors look at this technology and ask, "how could the public not understand how valuable a technology like this is?" – but that isn't the problem. The problem is that most innovators with an interest in antigravity are so closely tied to the science behind the technology that they fail to review and address the business needs that drive the market acceptance of a new technology. In other words, people don't buy antigravity – they buy solutions. People don't buy cars to simply have a car – they buy cars because people need transportation needs that they have to fulfill. People don't buy computers because they want to have a computer – they buy computers because they want to share and process information and communications.

Marketing Requirements

How will antigravity technology gain the market acceptance to become a commercially viable technology? There are a variety of ways in that antigravity technologies will become commercially viable, but only after antigravity is no longer sold as antigravity – it needs to be sold as a personal or business solution.

The solutions that antigravity technologies are best prepared to provide at the moment are in the realm of transportation technology. This includes moving people and cargo to destinations in a similar manner to conventional transportation technologies such as aircraft or automobiles.

With regard to providing transportation solutions, antigravity has the ability to incorporate the best features of both contemporary automotive and aerospace technologies into a single technology that will serve point-to-point transportation needs better than either of the two aforementioned technologies could by itself.

For a moment, assume that a person wants to travel from Los Angeles to New York in a short period of time. Currently, the most convenient method of transportation to accomplish this would require the person to take an automobile to the airport, and from there take an aircraft from the Los Angeles airport to the New York airport. After departing at the New York airport, the passenger must then take another vehicle to their intended destination.

Commercial antigravity technology could serve a dual-purpose short and long-range transportation role, taking on the aspects of both ground transport as well as air transport.

Product Delivery Requirements

In order to deliver commercial antigravity as a viable solution to business needs, a variety of work will need to be completed on the various component systems of this technology to turn it from what is currently a "proof of concept" into a commercial reality.

Let us assume for a moment that we have developed a working device based on Antigravity or some method of Field-Effect Propulsion. While this is the critical stepping stone to success, this is by no means the end al be all of the development cycle.

To begin with, the technology must be perfected to the point of being both economical and reliable. As it stands now, the market already has technologies in place that fulfill some or all of the requirements for the technology that Antigravity is being developed to replace. In order to serve as an effective replacement for these technologies, antigravity technology must then demonstrate that it both costs less in terms of operation and manufacture, as well as being more reliable than conventional air-transportation solutions.

I mention reliability in light of the recent negative media attention surrounding several recent commercial airline crashes. From a marketing perspective, air-travel disasters provide a great deal of negative publicity for the airline industry. Since the airline industry has a mostly successful track record of delivering passengers and cargo, people are for the most part willing to forgive the occasional air-disaster. However, with a new technology such as antigravity-based air-transport, there is not a long enough track record to permit public acceptance of air-disasters. One substantial disaster in the early days of antigravity could serve to forever damage the credibility of this new technology.

With regard to being economical, any type of antigravity system that intends to surpass existing methods of air-transport must be able to do so at a less-expensive rate to own and operate, and must have a vehicular lifespan at the very least similar to conventional air-transport devices. This would allow the total cost of ownership (TCO) to be less for an antigravity vehicle than it would otherwise be for a conventional craft.

There is one caveat to acceptance of antigravity technology as compared to conventional aircraft, which is simply that if antigravity vehicles are able to operate in an environment or manner that precludes conventional aircraft, then they should be able to gain a market niche without immediately having to surpass conventional aircraft in the area of TCO.

Assuming that we can develop a propulsion system that is both more reliable and less expensive to operate for the transportation of passengers and cargo, we then have to build up the skeleton of a vehicle compatible with this form of propulsion around the actual propulsion system.

For instance, a conventional aircraft has pitch, yaw, and several other flight controls, but for an antigravity vehicle there is a high likelihood that some or all of these controls will not be required, thereby changing the dynamic of flight associated with the craft. This will require new methods of pilot certification and flight-qualification, as well as requiring a control-philosophy to be created surrounding how the craft will operate.

I use the phrase "control-philosophy" instead of simply "control layout" because one of my assumptions about antigravity propulsion systems is that they will allow more flexibility in the design process for engineers to determine how the craft "should" fly, as opposed to an aircraft or helicopter, in which the components determining speed and handling are based primarily on an interaction between the design of the craft and the atmosphere.

In brief, an antigravity cargo-transport may have very different needs for flight than perhaps a lightweight passenger vehicle would, although there would also need to be a consistency between the control-systems of these devices to reduce the need for extra pilot training and competency testing.

Therefore, it should be apparent from the last few paragraphs that not only are there several propulsion-system related challenges involved with developing a commercial antigravity device, but there are also several challenges in the design, training, support aspects of this technology that also factor into the requirements to be complete before a complete product can be delivered.

Conclusion

At the beginning of this treatise, I posed the simple question of **"how far away is commercial antigravity"**. The reader, I expect, probably interpreted that question in terms of time, which is the usual measurement of questioning when new technologies will become part of our lives.

However, as I have attempted to demonstrate throughout this article, **the time component is much less important to the development process than is the distance component – that is, how far away from commercial antigravity we are.** When I use the word distance, I mean specifically what tasks must be completed in order for antigravity to go from being a proof-of-concept approach to a new form of propulsion-system to being a completed vehicle ready for manufacture.

I have attempted not to address the legal implications of antigravity technology with regard to certification for general or specific use – my thought on this is that the discussion of legal ramifications of antigravity is best left for another time. This is due primarily to the size and scope of that discussion, which is beyond what I am attempting to analyze in this article.

So, in finale, how far away from commercial antigravity we are depends not so much on time as on the rate at which we can perform the work required to provide the underpinnings on top of which the technology can be built. This seems important to me, as it underscores how close we appear to be to a working method of antigravity propulsion, and how we might consider focusing resources and goals to achieve the realization of this common dream that we share.

EDITORIAL: PERPETUAL MOBILE OF 1902

There is one more interesting example of perpetual mobile, which was described in the collected articles [1]. The motor shown in Fig.1 was invented in 1902. The vessels *b, c, d* and *e* are mounted on a shaft *a*, and have one side *f* tangential to the shaft, and the other side radial. Compressed air is forced into each vessel through the valves *p*. It is stated that under "the action of the internal pressure of the vessels, and after a slight impulse has been given to same, in the direction of the arrow, the whole apparatus will begin to move and continue to do so without ever stopping, the velocity corresponding to the pressure established within the vessels".

Really simple... Let's try to examine it.

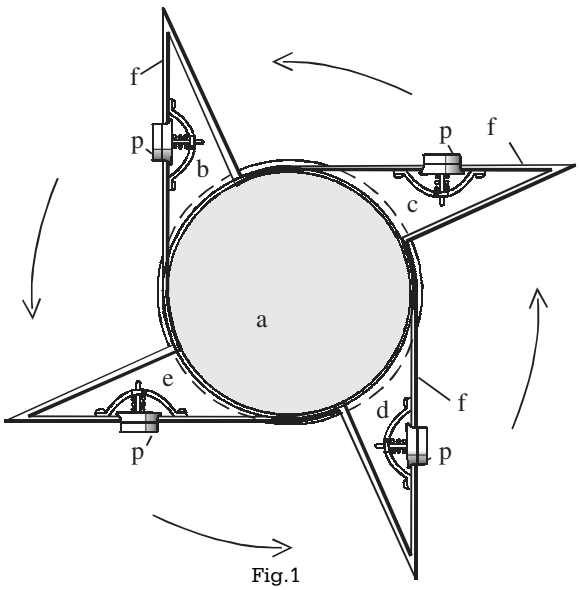

Fig.1

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Action without Reaction

New Gravidynamic Paradox

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Editorial: Yu.N. Ivanov discovered a new unusual physical phenomenon that is a gravidynamic paradox. The sense of the paradox is the existence of the situation, which is not forbidden by physical laws and which allows any man (even a child) easily hold suspended or carry things with 100kg or more weight by means of some simple device. This phenomenon is just a part of the significant applied topic and a demonstration of the possibility to cancel weight characteristics of any material object. Per se it is a work on the obtaining of the methods to eliminate aircrafts weight.

We can use only resistant things as a support!

Galilee-Newton's Laws are in the basis of classical mechanics. Thought concerned fundamental, these laws do not explain the main thing, i.e. the internal processual essence of the phenomena, described by them. There is another scientific line – the quantum mechanics, which tries to discover the essence of deep processes. There is no connection between these lines, therefore they as if exist independently. There are also long-time conversations about necessity to combine the quantum and the classical approaches. We suppose, that practically the combining has already happened, since thanks to rhythmodynamics, there appeared phase, frequency and velocity of light in formulae of classical mechanics (without these attributes the quantum mechanics is impossible). It was revealed, that phase-frequency method of late mechanics formulae presentation gives a real physical sense both to formulae themselves, and to concepts which seemed vague before *(namely: cause of motion, force, velocity, inertiality, gravitation)*. In this sense, the upcoming rhythmodynamics fills up the gap between the main physical lines and draws them together. But let's change the vector, since **the subject of the given article is to concern cases in which the third Newton law is not directly valid.**

Newton formulated the third law in the following way:

"Action always has equal and opposite interaction, in other words, actions of two bodies on each other are equal and directed in opposite sides".

This law represents the fact that one-way action of one body to another cannot exist in nature, but there is only an interaction between them, i.e. there is no action without reaction [1].

We must note, that the third Newton law is valid only for systems with 100% feedback, appeared in the interaction period. For example, during the magnet influence on the iron object it is revealed, that this object also starts to influence upon the magnet, i.e. to attract it with the same force. It happens because in the period of action of magnetic field the iron object itself becomes the source of magnetic field (Fig.1). Here the magnetic field, as an especial environmental condition, acts as a mediator, i.e. exists by itself in the interval between object and magnet .

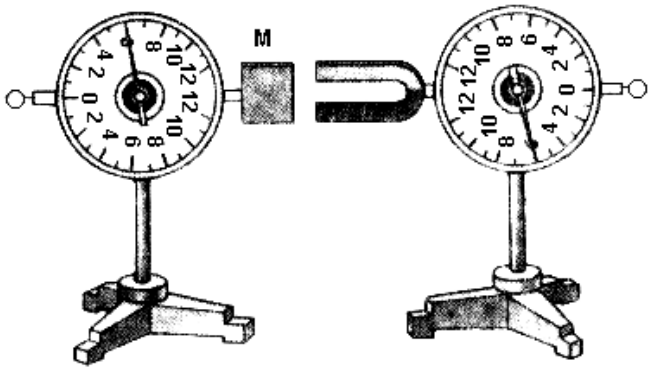

Fig. 1

Interaction of magnet and metal body M. Here the action is equal to reaction, i.e. the third Newton law is valid.

It is considered to be that magnetic field, created by electric current, spreads with the velocity of light. If current impulse is short, then the magnetic field spreads independently from the conductor and no matter if there is current in the conductor at present, or not. If the distance up to the object is big, then the magnetic field remains between source and object for some time, and has no influence upon the object. In this sense the portion of magnetic field, placed on the path between source and body, can be considered as moving independent "entity", i.e. the space by means of itself carries its changed state (magnetic properties) from one place to another. In this period magnetic properties in the form of quantum can influence neither on the source, from which the magnetic quantum is already detached, nor on the object, which the magnetic quantum still does not reach.

But having reached the object, magnetic field changes the state of this object. If as the result of influence the object becomes a source of magnetic field, then the part of the field is reradiated in the direction of source, i.e. the object itself becomes the source for some time, and by this it is able to influence on the first primary source. In this situation the principle of action and reaction works, because the feedback takes place.

If the feedback does not appear during the period of influence of one body to another, then the action and reaction law is not valid in the system. Let's demonstrate it by the example of the mechanical experiments, in which there is a feedback between objects.

Let there is a device (Fig. 2), which throws off two water (air) streams in the opposite directions in such a way, that reactive forces completely compensate each other. At that the thrown down stream compensates the gravity too. In this case the device will fly without falling, i.e. it will have zero weight.

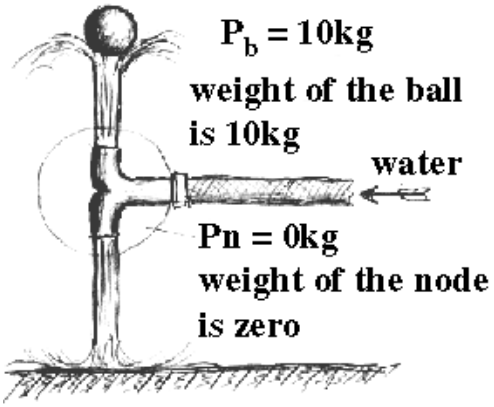

Fig. 2

The ball, suspended in the water stream, does not put pressure on the source. It happens because there is no feedback between the ball and the source. If you have such a device, then, lifting the ball by means of it, you will not feel the weight of the ball. The reason: the ball hangs due to the kinetic energy, which the stream passes to it and and this ball can not influence on the source through the water stream.

The appearance of the ball with the weight P_b does not influence on the weight P_n of the device. And even in the case if we press the ball down, i.e. essentially displace its location in the stream, the device will feel nothing.

The absence of device weight is evident for us; therefore we can easily move the device if its original (vertical) orientation remains unchanged.

Let's change the situation and place the ball (body with the shape, which is steady for hanging) in the upper stream. This ball with the weight about 10 kg is placed in a way to be kept by this stream at some distance, for example at 0.5 m. Will the device react on the changed situation, i.e. on the ball appearance? Will the weight of the ball, hanging in the stream, be added to zero weight of the device (0 + 10 kg)?

The calculation shows that it will not: $\Sigma P = 0 + 10 = 0$ [kg]. There is only an illusion that the ball is supported by the stream and that it is a part of the system. As a matter of fact, the ball is detached from the system and hangs due to the water kinetic energy. It is easy to check it by making an experiment in a bathroom: "Remove the douche sprayer, then direct the stream up and holding it by the one hand with the aim of weighting, try to influence on the source by the other hand through the stream. You will be surprised to feel that the hand, which is supported by the stream or any object, which is hanged in the stream, does not influence on the source".

At first sight the situation seems to be a paradox, however it very illustrates the possibility of the force action without reaction. So, the action can be one-way, i.e. calling no reply reaction in the form of pressure on the action source.

In such an unusual way it is possible to keep the ball of bigger weight (100 kg and more), at that to move it easily by means of the device and at the same time not to feel the presence of additional weight in the stream. **It is possible only in the case when there is no feedback between body and source,** i.e. the body, hanged in the stream, has no ability to act on the force source. Thus, we can both hold and move the heavy ball without additional efforts, and also lift it up to any height (for example, 100 m). As a matter of fact, we deal with the **new gravidynamic paradox**.

It is interesting then, how to solve the task of the following type: "Let the body with 100 kg weight is hanged in the water (air) stream in such a way, that it does not change the velocity and direction of liquid outflow from the source nozzle. How much energy the operator must spend to lift this body to the height about 10 m?" (Here it means that the operator must take the device, which supports the ball, and, moving upstairs, lift the body, which hangs in the stream, by means of this device to the height about 10 m). If to solve this problem correctly (the condition is that the operator lifts himself together with the device and the ball), we will find out, that operator's energy is spent only for lifting of the device, which creates water streams. The operator, lifting together with the device, will not even notice that in the stream there is a body with about 100 kg weight **(this is the sense of the paradox).**

The situation only seems to be absurd, and even paradoxical for theorists, but it is not a hopeless one.

We can also observe the effect of action without reaction in ultrasonic field of the source. If the source is fixed on scales (Fig.3) and body is hanged, as it was made in the stream, the scales will show only the precise weight of the source and will not react on the weight of the hanged body, no matter how heavy it is.

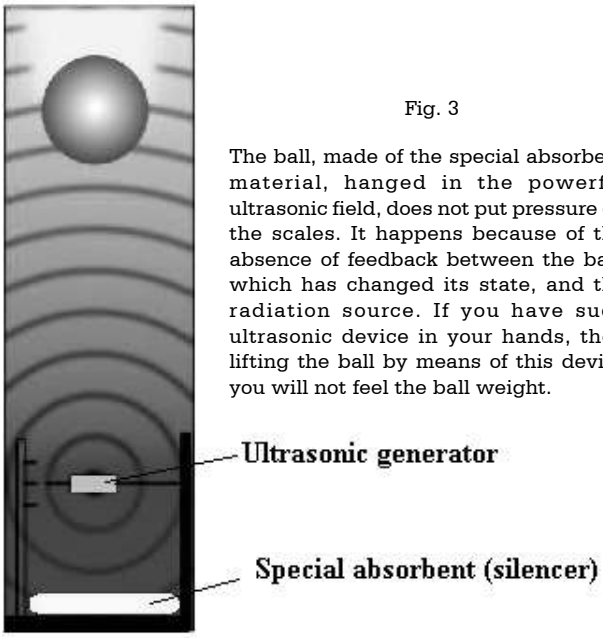

Fig. 3

The ball, made of the special absorbent material, hanged in the powerful ultrasonic field, does not put pressure on the scales. It happens because of the absence of feedback between the ball, which has changed its state, and the radiation source. If you have such ultrasonic device in your hands, then lifting the ball by means of this device you will not feel the ball weight.

The experiment of such type was made in one of the secret institutes. Water was used as an acoustic environment. The heavy ball easily floated up from the vessel bottom i.e. it behaved as if it had no weight.

The similar phenomena but such of the other organizational level, sometimes become apparent in nature. The phenomenon has its very name because the event happens unexpectedly and is not analyzable through laboratory research [3].

"A spherical ball lightning about the size of a football ball flew over a village Galtsovka of Altaisky Krai at a height of twenty to thirty meters. The first shed in its way, with ferroconcrete poles, was crushed and collapsed. Flying over a slated house, the ball lightning tore away the roofing slate together with nails, raised it into air and pulled it along, scattering its parts all over the village. Flying over a tractor station, the ball lightning crushed a frame, welded of metal angles and covered with tarpaulin. On the approaching of the ball lightning to another frame, it was at first dragged along the ground, and after the ball lightning had passed it, the frame was lifted and carried at a distance of 300 meters. The weight of the frame was no less than 100 kg".

Further the author analyzes the situation from point of view of the known physical laws: "The frame of hundreds kilograms weight was carried by fields of the flying ball lightning. However, for some reason the ball lightning kept on flying straight and did not note that some metal frame was caught to it. If the ball lightning, as it is usually considered, has a density of air and it is a weightless formation, then why the frame with the weight not less than 100 kg could not change its flight trajectory even in some extent?"

It draws attention that in some cases the ball lightning field pushed objects away, and in other cases it attracted them. It can be explained only by fact that in each case the ball lightning field specifically influenced on internal properties of objects, and then objects themselves somehow reacted on their new state (they changed their motion) . The feedback absence (in other way it happens between magnet and iron object) allows the ball lightning not react upon the things, which take place in its field. If these objects themselves became sources of similar field, i.e. reradiated it, they would influence on the ball lightning trajectory. **Most likely, in the given case, there was realized the situation when action caused no reaction.**

Conclusions

In the context of known physical laws the particular problem of direct action without feedback was formulated and solved. The solution of this problem provides deep understanding of how to control weight characteristics of material objects in open systems. As it was shown by the example with water (which is only an illustration of more fundamental processes) we can "deceive" the nature, but only through the deep understanding of the processual character of the concerned events.

By the example of ultrasound we show, that in principle there can exist such field flows, which are able to influence on bodies without the feedback effect. There were defined some conditions and criteria of bodies and methods of influence, at which the third Newton law is not directly valid (it is not published in this article).

The described type of influence can be called as pressure. But during consideration of processes at atomic or deeper level, i.e. from the position of rhythmodynamics, we find out something of another kind, that is phase-frequency one. It prompts to us, what kind of technologies will exist and how our aircrafts will look in nearest future. But not everyone is able to understand it at once.

Moscow 15.05.2002

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Our website: http://www.mirit.org

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Comment

In the gravitation field we have a balanced open system, in which appearance of the new body at first sight must cause this system reaction such as weight increase. However, this is not the case.

The given problem is solved in two independent steps:

1) examination of interaction between water source and water (reactive effect, which is compensated by counter flow);

2) examination of interaction between water, detached from the source, and the body (unit time impulse per unit area).

It is impossible to examine the interaction between the source and the body because water has no rigidity. There are no means to influence on the source through the intermediate stream, therefore the principle of action and reaction is valid for each step individually, but not for both! But in this case the third Newton law must be developed as following: "If there is a 100% feedback between two bodies, their interactions are equal and inversely directed. And if there is no feedback, the action of one body to another causes no reaction, i.e. the action is not equal to reaction". And this is already another law!

New Possibilities of Vortex Electric Power Devices

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The earlier published article [1] was devoted to the explanation of the excess energy output at the rotation of flow medium in vortex tube (VT). The researches on VT demonstrated by the real examples that the excess energy output is a real fact, which is determined by natural physical processes. These processes take place in the fluid at its vortex (rotational) motion in the closed volume by means of phase transformations (skips) of the fluid state. However, the practice shows that for obtaining of patents and benefits for the real vortex devices, which are made for heat generation, it is necessary to write a little about their real technical characteristics, though technical and constructive possibilities of vortex devices can be much better. Temperature of water of these devices could not be higher than 120°C, and value of fluid pressure is confined within 5…6 kg/cm^2. Circulation pumps of pressure over 6 kg/cm^2 are used to increase thermal power output of vortex heat generators (VHG). It causes the discredit of VHG since at such a method their generative possibilities reduces to 100% value and less! We set a problem to discover the ways and engineering solutions for the essential increase of the coefficient of VHG energy conversion to not less than 200% value.

Our experience in development and exploitation of deep-sea physical devices has given some engineering solutions in this way. Actually, we have the opportunity to use the generally applicable circulation pumps, which have pressure not more than 4.0 kg/sm^2. At the same time we can raise the temperature of the heat carrier to 300°C and higher! and the pressure can be increased to 1000kg/sm^2! Such fluid parameters allow to use this fluid as a heat carrier in powerful hot-water generators of steam engines, turbines etc. By the way, this method allows to make the value of temperature of water enough to supply its PYROLESIS! The main point of the method is the following: all the closed system of water-filled VHG works at pressure with the value under 1000kg/sm^2. It is provided by means of the special device, the so-called automatic pneumohydraulic block (APHB). This lets to raise the temperature of working fluid to 1000°C with no change in its aggregative state. The practical functional scheme of such a device is shown in Fig.1.

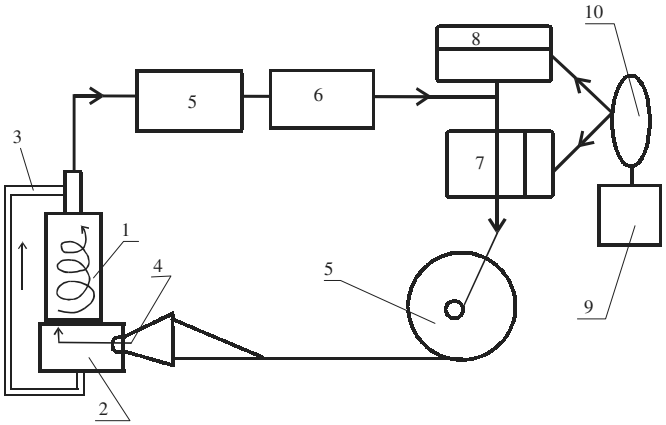

Fig. 1

1 – vortex tube; 2 – entry vortex chamber; 3 – by-pass; 4 – upstream end; 5 – circulation pump; 6 – heat-exchangers; 7 – APHB; 8 – volume of fluid leakage compensation; 9 - compressed-air flask; 10 - gas pressure regulator

The device works in the following way. The whole device is filled with working fluid without entrapped gas. At the operation of the circulation pump (5), fluid through the upstream end (4), placing in the entry vortex chamber (2), swirls, accelerates and gets into the vortex tube (1), where its "energy saturation" is realized. Then heated fluid gets into the heat-exchangers (6) for heating or for other purposes. After passing through the heat-exchangers, fluid gets into the pneumohydraulic device (7), where there is kept up the proper level of fluid pressure in the whole system. To prevent the system breakdown at the accidental fluid leakage, there is a device (8), which compensates such leakages. Compressed-air flask (9), with the volume under 1000kg/cm^2, and gas pressure regulator (10) keep up the selected level of the pressure in the system. The use of blocks (7,8,9,10) excludes evaporation in the system and prevents the breakdown of the circulation pump (5).

This VHG scheme allows to double the effectiveness of YUSMAR devices [2] only at the expense of rise in working fluid temperature in 2…3 times.

Observation of any fluid swirls and film documents of windspouts arrive to conclusion that all vortex structures are rotation bodies, created by the lines of the second order: $Y=aX^2$. In other words, as a result of the rotation in the swirl, air or fluid mass gets the acceleration of the second order. Taking into account the aforesaid, it is evident that in order to form the classical swirl in the VT, the very VT should be a tubular body of rotation. This body is created by the curve (see below Fig.2).

In YUSMAR and similar devices the vortex fluid motion take place in straight cylinder and 1/3 of this area is used for fluid deceleration that causes vortex flew

disruption. This results in the impossibility to increase additional heat in the straight tube in more than 1.54 times. It is caused by the fact that the main vortex formation takes place only in the vortex chamber and the flows separation does in the tube itself. Then, this vortex formation is right away disrupted by different plate brakes! It suggests itself that output part of VT should be made in the spiral form, expanding at the flow passage.

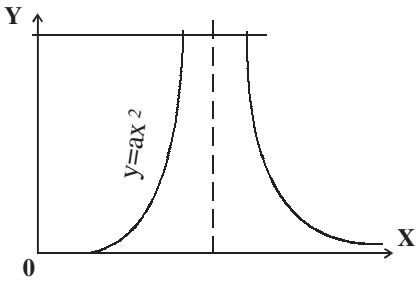

Fig. 2
Generatrix of the wall of vortex tube

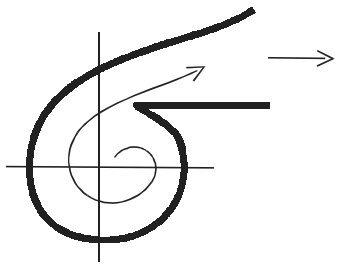

Fig. 3
Upper part of the tube

Such section, made on the outlet of the vortex tube, helps to slow down the flow avoiding its disruption, since axial-cold flow, placed along the tube axis, should stay intact. Two of such engineering solutions allow raising the level of the additional VHG energy up to 180…200%.

YSMAR devices are designed for one tube with the assigned heat output. However, if to take into consideration and to use the aforesaid conclusions, then we can raise energy conversion coefficient (ECC) above 200% at the series connection of two and more VT. The scheme of such a device is shown in Fig. 4.

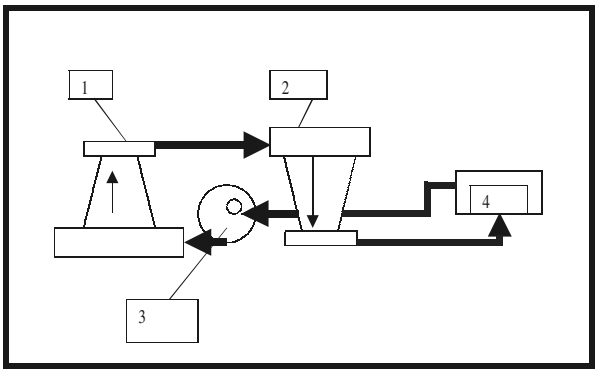

Fig. 4

Where: 1 – the first VT; 2 – the second VT; 3 – circulation pump; 4 – heat exchanger

According to Fig.4, the total energy output of the presented device is:

$$Q=K^2$$

Where: *Q* is the total output of the device; *K* is energy conversion coefficient of one VT; 2 – quantity of serially connected VT; *P* – the assigned power of the circulation pump.

In our earlier article [1], concerning VT application, we supposed that there is a straight transformation of vortex motion of ionized fluid into electric current. Under studying of many articles, devoted to the methods of water ionization, we discovered a significant one. It demonstrates that at the determined temperature, pure water increases its ionization capacity up to 3 orders without changing in the aggregative state [3]. The diagram in Fig.5 shows such dependence.

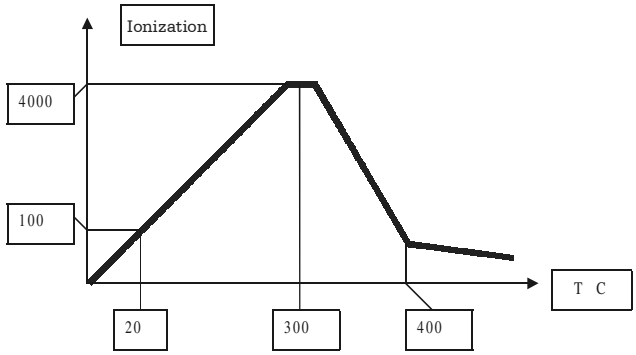

Fig.5
Diagram of the dependence of pure water ionization from temperature

The diagram demonstrates that water at 300°C temperature increase the quantity of ions in 4000 times as compared to 0°C and in 40 times as compared to 20°C. If to take into consideration that first experiments on VHG modernization help us to find the ways of fluid heating up to the practically any temperature without changing of its phase state, then on using the dependences (see Fig.5) it seems possible to create vortex fluid electric generators of the forward transformation. The aforesaid pneumohydraulic block, which is used for VHG functioning, allows to keep up water temperature at 300°C and pressure at about 90kg/cm^2 without threat of water evaporation! Presence of any rotation of fluid medium always causes appearance of two vortex flows. **These flows always move and rotate in opposite directions and if we do not put obstacles for their motion then they transform into each other and can exist without energy supply for an indefinite period of time.**

The presented VT form (see Fig.6) provides the producing of two fluid flows in the tube. These flows do not influence to each other and there is only their reciprocal overflow without disruption of the flows in the central part of VT. The tube presents a tubular body of rotation, which is created by hyperbola. There is positive angular acceleration of fluid in the lower part

of the tube; maximum speed of rotation of the axial and peripheral flows is in the middle part and negative angular acceleration, i.e. deceleration and transfer of kinetic energy into heat energy, is in the upper part of VT.

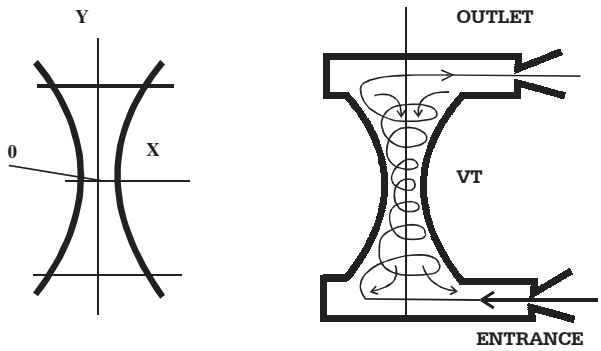

Fig.6

The maximum heating of fluid and its polarization is in the point Y=0. The polarization potential in the point can reach 10.000 V at 5m/sec flow speed for 10 cm diameter in the point. The cold flow, which comes along VT axis, is opposite to the peripheral hot flow. These flows close into one system in lower and upper chambers of VT. Thus, the presented VT classically modeled "rolling" and "unrolling" of water area.

There are no single vortexes in nature. Two vortexes, rotating in opposite directions, always appear while fluid mediums rotation! Science is not still able to describe energy overflows from one vortex center to the center of another one by means of mathematics. However we believe that this moment is close. There are maximum energy transformations of rotating water in the point Y=0.

The potential of the inner flow is equal to the outer flow by its value but is opposite by its sign. Potential difference is maximum in the point Y=0, in which removal of electric charges is the most effective.

It is appropriate mention here the name of Romanian engineer and researcher Henry Koanda, who in 20th of the last century discovered the so-called "Koanda effect" (attachment of fluid jet to the surface of usual kettle at pouring of it out the cups). Basing on this effect he suggested to make new type of aircrafts, which could have advanced bearing capacity and maneuverability. Unfortunately, money and conservatism of aircraft-industrialists did not allow realization of these engineering solutions.

At the same time, Koanda charged his disciple Patrick Flanagan with the job to research all **water properties**. The result was amazing! It was turned out that water actually has infinitely many phase states and when it is moving, then it can trap energy from the environment by some way. The publications on the point appeared in our press in the early eighties, late nineties of the last century. Most likely, they had become the basis of the invention, made by Potapov, i.e. vortex tubes for water!

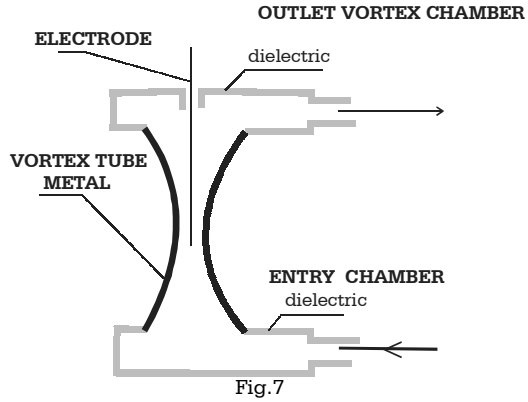

Fig.7
Scheme of vortex electric generator

In the presented scheme of electric generator the entry and outlet vortex chambers are made of dielectric material in the spiral form. This material certainly should withstand not less then 300°C of fluid temperature and about 100kg/sm^2 of pressure. Fluoroplastic or ceramic can be used as such a material.

From aforesaid it seems to be possible to submit the new scheme of electric generator for readers' consideration (see Fig.8).

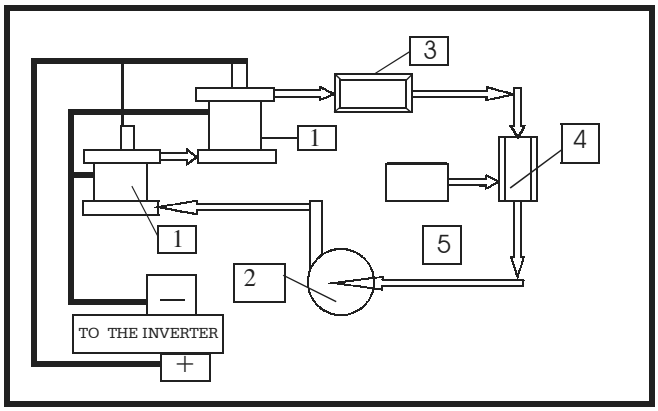

Fig.8
Generalized scheme of vortex electric generator
1 – vortex tubes; 2 – circulation pump; 3 – heat exchanger; 4 – automatic pneumohydraulic block; 5 - compressed-air flask

Actually we could finish the article if it were no disputes about excess energy, which is released at vortex motion of fluid in tubes. Having used a simple experiment, which any inquisitive person can repeat, we found the positive solution (see the scheme of the experiment in Fig. 9).

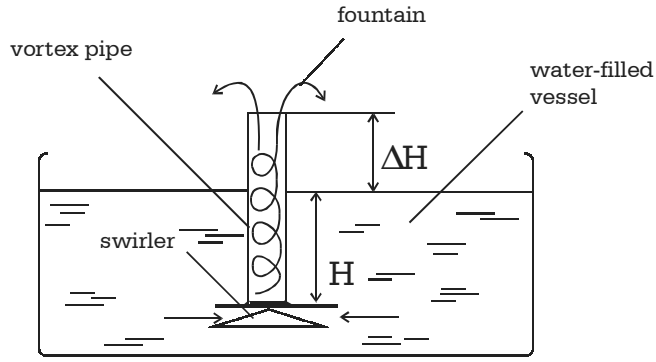

Fig.9
Demonstration of energy increase of fluid, rotating in vortex tube

A pipe with not less than 60 cm length and about 1-inch diameter is placed in a reservoir with not less than 50 cm depth. The lower part of the pipe is formed as an arm circular generator with about 15...17cm diameter. The gap width is about 2 cm. If we place the pipe with closed top end, which then will be open, into the reservoir, then water is splashed out above 20 cm of the reservoir level. Thus at the least 20% energy increase of energy mgH is observed.

By the way, we suggest orthodoxies of physics and other who have doubts to make one more simple experiment. Try to boil water in a can. When water starts to boil, swirl it with a spoon to the right or to the left. Then you will suddenly discover that all water surface is calm and only in the center of the can there is a water-steam mixture, which is about 20% higher than the level of water surface. You will also see that water is absolutely calm at walls of the can. This experiment can be reproduced anytime and anywhere, even in space, since it is a demonstration of **vortex** fluid motion and its actual influence on everything, which is around!

All presented engineering solutions are practically reproducible in any laboratory. The authors of the article would welcome the opportunity to co-operate with science and industry representatives for realization of the ideas in real serial production devices.

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2. Patent RF #2045715, 1993
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Investigation of Electric Energy Transmission Processes in non-Metallic Conducting Channels

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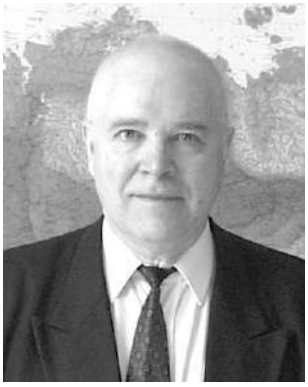

D.S. Strebkov

(Editor's notes by Alexander V. Frolov)

It has been found that at low frequency (1-25 kHz and higher) electric power can be transmitted with low losses from generator to receiver along single channel made of non-metallic conductive media such as water in plastic tube carbon thread, layer of damp soil, ITO films on glass substrate, laser and electronic beams. Transmitted power, as well as for traditional three phase lines, is limited by natural power of the transmission line and line capacity may reach at high voltage and pulse and operation modes the value 10^9 Wtt.

Introduction

The well-known methods of electric power transmission are based on transmission of active energy by means of conductivity currents in closed circuit. Electromagnetic energy spreads along power transmission lines (PTL) as progressing waves of electromagnetic field or field of charge [1]. Line wires made of aluminum or copper are conductive (guide) channels. Electromagnetic energy stream moves along these channels from generator to energy receiver and backwards to the generator. Maximum transmission possibility of 3-phase PTLs is limited by losses on the line resistance, by peak voltage (which is determined by electric strength of the insulation) and by electromagnetic stability of the line.

The modern approach to provide the electromagnetic stability consists in rigid regulation of line parameters by means of high-speed shunt reactor and consequence capacitive compensation for the purpose to except changes of electromagnetic power flows and to suppress resonant properties of a line [2].

In Tesla works [3] and in the researches of Russian scientists [4] a method of active power transfer was offered. This method supposes to transfer active power by means of electromagnetic capacitive current assisting with resonant properties of a single-wire line (SWL), made of a metal conductor. The purpose of the present work is a research of an opportunity to use non-metal conducting mediums for transmission of electric energy.

A pipe with not less than 60 cm length and about 1-inch diameter is placed in a reservoir with not less than 50 cm depth. The lower part of the pipe is formed as an arm circular generator with about 15...17cm diameter. The gap width is about 2 cm. If we place the pipe with closed top end, which then will be open, into the reservoir, then water is splashed out above 20 cm of the reservoir level. Thus at the least 20% energy increase of energy mgH is observed.

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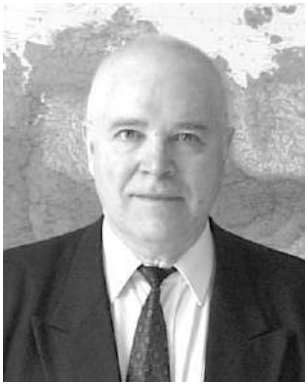

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Methods

For realization of the experiments a single-wire energy system (SWES) was used. Its electric circuit is shown in Fig. 1 a,b. SWES consists of the following parts: high-frequency generator (1) of 28V voltage AC and 1 kWtt power; transmitting (2) and receiving (3) Tesla transformer with conductive channel (4) between them; rectifier (5) and electric load (7) as an incandescent lamp or electric motor (220V, 1 kWtt power). High-voltage winding of Tesla transformer is made in the form of cylindrical winding on the ferrite core with 50-100mm in diameter, 4000-6000 turns. The internal end of a high-voltage winding is connected to the conducting channel, and the external end is not connected at all (free end). A low-voltage winding that consists of 40-60 turns provides power supply of Tesla transformer. At the submission of electric power from the high-frequency generator to the winding of power supply zero potential appears on the free end of the high-voltage winding, and voltage with corresponding to the generator 1-25 kHz frequency is formed on the conducting channel. Besides, Tesla transformer as the spiral antenna generates electromagnetic waves of 5-10 cm length , which corresponds to the turn length of a high-voltage winding. Current resonance mode is formed in a supply circuit of Tesla transformer. At the same time, voltage resonance mode (of frequency equal to the generator frequency) is formed both in the reception and transmitting circuit of high-voltage windings and in the conducting channel (1).

The following materials were used as the conducting channels: filled with water or sea water polythene tubes with 10 mm diameter and 1,5 m long; plastic tray with soil layer of 150×10×400mm; film of tin dioxide – indium oxide (ITO) on 0,3 micrometer thick and 300 Ohm resistant glass substrate; graphite thread of 0,1 mm diameter, 500 mm long and with 100 Ohm resistance. For comparison steel and copper wire of 0,1 mm diameter and 5 m long was used also.

The voltage on the conducting channel changed in limits 1-10 kV, generator frequency changed from 1 up to 25 kHz. Voltage, current and capacity were measured on SWES output and on the load by standard electric measurement equipment.

Results and discussion

The replacement of the metal conductive channel to the channel made of non-metallic conductive materials does not effect to any reduction of possibilities of transmitting SWES or heating of a material of conducting channels. The consecutive connection of the channels did not resulted in reduction of transmitted power. Circuits break in the conducting water channel by the creation of an air gap led to the occurrence of arc discharge of reactive capacitor current. However this discharge did not cause increase of water temperature at transmitted power 300 Wtt and voltage 4,5 kV within 1 hour, that confirms the absence of energy losses in the conducting channel. The increase of water temperature did not result in decrease of transmitted power. Water PH reduction from neutral value up to 4 was detected.

The increase of sea salt concentration in water up to the level of 5-7 g/l did not increase transmitted power in comparison with tap water. However the replacement of tap water to dionized water with 16 MOhm resistances resulted in 100 % decrease of transmitted power.

Thus, it is experimentally shown, that conducting channels, produced from non-metal materials, have quasisuper-conductive properties in SWES at resonant mode. Possible explanation of this effect is the absence of active conduction current in the channel and the dominant role in the process of energy transfer belongs to displacement current, for which Joule Lentz law is not valid [11]. In the supply circuit of Tesla transformer current is practically reactive, and in resonance conditions active values of inductive and capacitive currents are equal. Vectors of these currents are opposite in their phases. Current of the high-frequency converter is spent for losses (component less than 2 %) in supply circuit wires and in the core of Tesla transformer and also for creation of reactive current in the conducting channel. In the mode of voltage resonance we have measured voltage active values of high-voltage inductance windings and conducting channel, interturn capacitance of windings and the capacities of the conducting channel. **We have discovered that they were equal and their phases were opposite to each other.** Losses from transmission of capacitive current through active resistance of the conducting channel are insignificantly small. Corona discharged losses and leakage current could be decreased by isolation of conducting channel. In this case active current and magnetic field of the line are equal to zero. Electric field of the line has maximum value. As well as in usual PTLs, maximum transferred power is limited by charge power of the line. Angle between vectors of voltage is equal to zero in the beginning and at the end of a line. Quality factor of SWES at frequency 5 kHz is in 100 times above than usual PTLs at frequency 50 kHz. In the conditions of resonance it leads to the significant increase of voltage along the conducting channel and it also leads to transmission power.

In usual PTLs voltage changes along the line are insignificant. The angle between vectors of voltage in the beginning and in the end of PTL constitutes the value, which is proportional to the wavelength of line.

On the basis of the researches the methods and devices are offered for transmission of electrical energy through plastic water guide, electro-insulated from ground, through irrigational channels and through isolated pipelines, which are used for gas, oil, hot and cold water transportation. Also the energy can be transferred through fiber-optic cable with conducting film on the surface, through all-carbon composite cable and

through electro-insulated part of a ground and water surface, including highway parts. There are also methods and devices, designed for the following transmissions. These methods can be applied for transfer of power to stationary and mobile units. There are also generated requirements to electrical safety and to restriction of use of drinking and hot water from pipelines, which are under electrical voltage. These requirements and restrictions are generally the grounding of pipeline parts, which are located on certain distance from the generator. This distance is equal to the whole number of half-waves and for it SWES voltage is equal to zero. In the case of a side pipeline it is necessary to ground the parts of the pipeline that are placed on the distance of odd number of quarter-wavelength from the main pipeline. For 5kHz frequency the quarter-wavelength is equal to 15000 m.

N. Tesla grounded one end of high-voltage windings of his transformer on the receiving and on the transmitting end of SWES. Tesla considered this condition as the necessary one for the transfer of power along the Earth. The results of our researchers demonstrate that it is not necessary to use metal self-closed conductor (and current lines in the Earth) for transmission of electric energy on low frequency (1-25 kHz).

For this frequency energy could be transferred from the generator to the receiver if we have single-wire guide system created as non-metal conducting channel. By the similar way electromagnetic energy is transferred by laser beam or microwave-beam. But in our case we can obtain high degree of efficiency that is caused by slight losses on energy absorption and energy emanation. Thus one of the ends of high-voltage winding at the energy generator will have zero potential and remain free. The symmetric end of a high-voltage winding on the reception end should be connected to some natural capacity 6 (Fig. a), which can represent the case of a balloon or frame of a tractor. In our experiments we used metallic safe-box as such natural capacity.

Editor's note: In 1887, October 11, the famous Russian scientist Pavel Yablotchkov got the France Patent #120684, which described the method to increase efficiency of electrical circuit by means of "atmosphere electricity". It was confirmed in many experiments that output power can be twice more than power provided for the circuit from primary electric generator. For that it is necessary to use a single-plate capacitor. The special feature by Yablotchkov, that provides maximum efficiency, is the high degree of air ionization. For this Yablotchkov proposed to use the special capacitor, which consists of a big number of metallic needles. By its view this construction reminds of a hedgehog. Thus we can assumed; that above described natural capacity (balloon or frame of a tractor) serves as a collector of free electrons. By Yablotchkov the efficiency of such systems can be increased by means of maximization of ionization process. It will not lead to the increase of losses if the second end of the high-voltage winding is not grounded.

In the other method of energy transfer, a condenser-diode block 8 was connected to the conducting channel on the receiver end. This block is one of the known circuit of voltage doubling, Fig.1 (b). On the condenser 8 electric energy is transferred through electronic switch 9 to load 7. In this case the entire length of conducting channel 4 and Tesla transformer winding 2 at generator must be equal to odd number of quarter wave-lengths.

Non-metal conducting channel (for instance, fiber-optic or coal-plastic cable) can be used for transfer of electric energy not only along but also as perpendicular to the Earth (for example, to relay aerostat or sounding balloon).

SWES conducting channel can be also created by ionization of air ions with laser beam [13]. Neodymium laser with double frequency and with energy 1 Joule in impulse is able to create 10^{15} cm^{-3} ion concentration in air. This concentration is sufficient for streamer initiation and for transfer of electric energy through the conducting channel. Ionization potential, time of ion existence and of excited molecule state, coefficient of multiquantum absorption, all these determine the limiting length of conducting channel in atmosphere that is equal to 300 km and its wave resistance at 200-400 Ohm. Voltage which is necessary for SWES comes to the quantity 0,5 MV – 15 MV, that depends on the length of a channel.

We suggest to use relativistic electron bunches of high energy as the conducting channel out of the atmosphere. As distinct from laser bunches they do not have divergency. In this connection the Moon or artificial conducting body, where the energy receiver is placed, can be used as natural capacity 6. Whereas energy generator can be installed on the Earth or on its satellite. Transmission range of electric energy is determined by the length of the generated conducting channel. The entire length of the conducting channel in the beginning and in the end must be equal to the whole number of half-waves. Here the length of high-voltage windings of two Tesla transformers must be taken in considerations. Electric energy, transmitting through the conducting channel, can exceed the energy of electron and laser beams generators in 10-100 thousand times. These generators play the role of a directing system (of usual SWEG wires), along which the transfer of electric energy proceeds.

It was offered to use colliding and crossing electron and laser beams with conducting transitional bodies as conducting channels for transfer of energy from the Space to the Earth and back. On the heights up to 30 km compositional coaly and fiber-optic cables can be used. To create the global energy system of the Earth it was also suggested to apply single-wire energy system and conducting layers of the Earth ionosphere as the conducting spherical channel [14].

Thus for electric energy transfer at the frequency 1-25 kHz and higher in the resonance mode a single-wire channel from the following non-metal conducting

mediums can be used: water, damp soil, coal-plastic, oxide film, ionized air channels, that are created by laser beams in the atmosphere, ionosphere conducting layers, and also beams of relativistic electrons out of the atmosphere. These non-metal conducting channels in the resonance mode have negligibly small resistance losses especially if to be compared with metal conductors, which are used in the known non-resonance methods of energy transfer by means of active conduction currents in the closed circuit. Electric energy in the resonance mode can be transferred with small losses from the generator to the receiver along the single-wire channel, made of non-metal conducting materials. The transfer can be realized at the frequency 1-25 kHz and higher, to any distance and to any direction relatively to the Earth. The transmission capacity is limited by charge power of a line as well as in the usual PTL. At high voltage the transmission capacity can reach the quantity from 10 Wtt to 10^9 Wtt in the pulse and streaming modes.

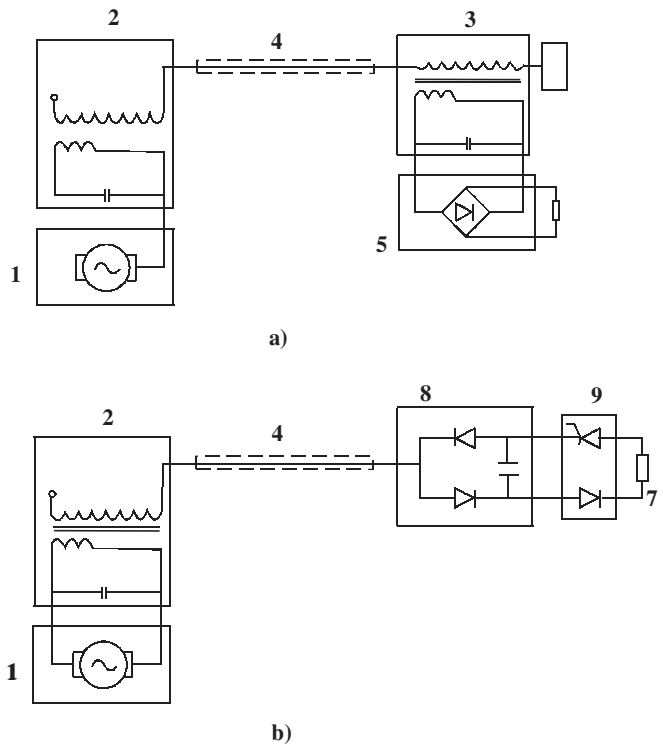

Fig. 1
Electric circuit of single-wire energetic system with non-metal conducting channel
a) SWES with symmetric array of Tesla generators

b) SWES with diode-capacitor block in the end of conducting channel

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Microcosm, Universe, Life

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The authors of this article have prepared the 3rd edition of the book "Microcosm, Universe, Life" and now they are looking for a publisher to edit Russian and English version. In particular, the mechanism of energy transformation in the Universe (Fig.1) is described in the book. Matter radiates energy in the form of photons (as well as neutrinos). In general this energy is observed in the form of Cosmic Microwave Background Radiation (CMBR). Photons and neutrinos transfer the most of energy to de Broglie longitudinal photons. Matter absorbs energy mainly in the form of longitudinal photons. Thus, a cycling process of energy transformation (as well as matter transformation) occurs in the Stable Universe.

The 3rd edition is devoted to the description of 6 World Systems (Table 1), at that the 6th System is based on Unified Field Theory, which is developed by the authors, and proceeds from the following:

(Editor's: The understanding of the energy transformation mechanism allows to develop new fuel-less energy sources based of mutual transformations: longitudinal photons $\longleftrightarrow$ transverse photons).

Table 1

System	Principal Ideas
The 1st – Geocentric (Ptolemaic system)	Geocentrism and Anthropocentrism
The 2nd – Classic (Copernicus – Newton's system)	Description of the Universe on basis of Newton's Law of Gravity
The 3rd – Compromise (Tycho Brahe's system)	The compromises between two first systems
The 4th – Fractal (Charlie's system)	Non-heterogeneity of Large-Scale distribution of matter in the Universe
The 5th – Relativistic (Einsteinian system)	Description of the Universe on basis of gravitational field equations. Anthrop principle
The 6th – based on Unified Field Theory	Electromagnetic nature of all physical interactions. Irreversibility of all elementary micro-processes in combination with circular character of transformations in Large Scale of space ($c/H=R$ order) and time ($t_H=I/H$ order).

1. For theoretical results, which agree with the facts, it is necessary to use assigned inertial system (as Lorentz did), which, as we have known, is connected with CMBR. Obtained by this way decisions can be applied to the other systems, in particular, with use of Lorentz transformation for mass, energy, momentum, time and length.

2. Theory must agree with the whole known collection of facts, starting with such established empirical generalizations as basic principles of Natural science (Giordano Bruno, Lyell) and conservation laws (Mayer, Joule, Helmholtz, Faraday, Newton, Huygens, Vernadsky).

3. All physical objects could be presented as the systems, consisting of quanta of positive electric charge (protons), quanta of negative electric charge (electrons in fermions or boson states, which are part of neutrons

and atomic nuclei) and quanta of energy, impulse, moment of momentum (apeirons).

4. The leading role in the Universe energetic belongs to de Broglie longitudinal photons (of the first class, i.e. with the spin I=0), energy of which is twice as much as apeiron energy and is equal to $h\,H$, where h – is Plank's constant, H – is Hubble's constant.

5. Longitudinal photons, polarizable and depolarizable by matter particles, are the carriers of gravitational, magnetostatic and strong interaction. Electromagnetic interaction is carried by photons with spin I=±1 and weak interaction is carried by neutrinos and apeirons with spin I=±0.5.

6. All elementary microprocesses are irreversible, that correlates with circular character of transformations in Large Scale of space and time.

7. In particular, there is an irreversibility of the process of photons and neutrinos motion. At each segment, equal to the length of de Broglie wave, photons and neutrinos lose energy $h\,H$, which is equal to longitudinal photon energy. In such a way, Hubble's law can be presented as the following:

$$\lambda = \lambda_1 \exp\left(\frac{r}{R}\right) = \lambda_1 \exp(Ht),$$

$$Z = \frac{\lambda}{\lambda_1} - 1 = \exp\left(\frac{r}{R}\right) - 1 = \exp(Ht) - 1,$$

where λ, λ_1 – are observable and laboratory wave lengths, r – is distance, R – is radius of gravitation interaction, which is equal to the radius of Metagalaxy, t – is time, Z – is cosmological red shift.

8. As resulted upon this process, the excess of longitudinal photons is absorbed by matter. At that, mass is considered as measure of capacity, which is absorbed by matter in form of longitudinal photons. Thus, energy of the matter should be increased according to the law:

$$E(t) = m_\circ c^2 \exp\left(\frac{\varepsilon'}{c^2} t\right) \approx m_\circ c^2 + m_\circ \varepsilon' t,$$

at that,

$$\frac{\varepsilon'}{c^2} = \frac{H}{137^2},$$

where ε'- is the capacity, which is absorbed by unit mass in form of longitudinal photons, c – is velocity of light. In particular, electron of the 1st Bohr orbit in hydrogen atom (i.e. in this case at de Broglie wave length) absorbs energy $h\,H$ at 1 period.

9. Being in ionization state, intergalactic matter is the general portion of average density of matter in the Universe ρ_{av}, besides, the average value of absolute velocity of baryon component is close to c/137. Let's consider this correlation to be exactly executed.

CMBR is the most powerful cosmic radiation. Its specter is close to that one of black body at temperature T_F=2.726K, i.e. its spectral density is maximal at frequency ν=160GHz. Cosmological red shift causes the increase of spectral density in radio-region (ν<160GHz) and the decrease of it in microwave region (ν>160GHz). Each of these processes is compensated by the inverse Compton effect, i.e. by the dispersion of radio-photons at matter corpuscle, first of all at protons. Calculations demonstrate, that average energy of absorbent radio-photons is equal to $0.45\cdot10^{-15}$erg (ν=68GHz) and average energy of radiated microwave photons is equal to $2.17\cdot10^{-15}$erg (ν=330GHz). There is one re-radiated microwave photon per one absorbed radio-photon. At that, the concentration of photons and CMBR spectrum remain unchangeable. Syunyaev and Zeldovich concerned the close inverse Compton-effect of CMBR dispersion on electrons in clusters of galaxies. Actually such an effect was discovered in 2 clusters of galaxies.

Thus, on transferring of energy to photons, matter corpuscles must fill the deficiency of energy by receiving it from longitudinal photons. In fact, there are observed demonstrations of longitudinal photons, they are "static fields". In this case it is a cosmic magnetic field, which accelerates charged particles of matter (Alfven). More detailed consideration let us to find a virial correlation between 4 main components of energy density:

$$\frac{\rho_{av} c^2}{137^2} = E_F = 2E_M = 2E_{kin},$$

where $r_{av}c^2$- is an energy equivalent of mass density of matter; E_F- is energy density of CMBR; E_M - is average energy density of magnetic field; E_{kin} - is average density of kinetic energy. Thus, some kinds of energy circularly transfer to another, which are interrelated (Fig. 1).

$$\frac{\varepsilon_{av}\rho_{av}V}{1.26} = E_F HV = 2E_M HV = 2E_{kin} HV = \frac{(\varepsilon_{av} - \varepsilon')\rho_{av}V}{0.26} = \varepsilon'\rho_{av}V,$$

where ε_{av} - is average capacity, radiated by unit mass in form of photons; V – is volume of 10^{81} cm^3 order, according to which the averaging is made.

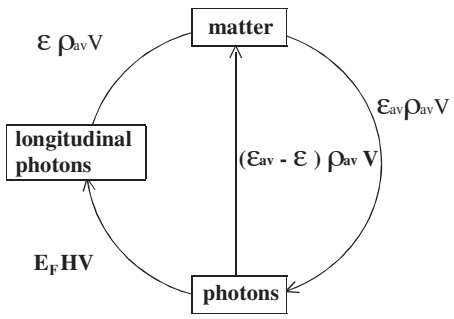

Fig.1
Energy transformation in Large Scale ε_{av}=0.0942 erg gr^{-1}sec^{-1} – is average energy, which matter unit radiates in unit time; ε'=0.07476 erg gr^{-1}sec^{-1} – is energy, which matter unit absorbs in form of de Broglie longitudinal photons in unit time; ρ_{av}=$0.8730\cdot10^{-29}$ gr cm^{-3} – is average matter density in the Universe; E_F=$4.18\cdot10^{-13}$ erg cm^{-3} – is energy density of cosmic microwave background radiation (CMBR); $V\approx10^{81}$cm^{-3} –is volume at which the averaging is made; H=$1.562\cdot10^{-18}$ Hertz.

10. These correlations include pressures, densities and temperature T_F, i.e. we have the equation of the state of intergalactic matter, and thus of Metagalaxy and the Universe. Let us present this equation in simple form:

$$E_F = \frac{\varepsilon' \rho_{av} R}{c} \approx \frac{\varepsilon_{av} \rho_{av} R}{c}$$

and let us compare it with correlation for density of radiant energy on surface of a star * or of star system

$$E_* = \frac{\varepsilon_* \rho_* R_*}{3c} \approx \frac{\varepsilon_* \rho_* R_*}{c}.$$

It is an especially amazing analogy between Metagalaxy (and the Universe) and large-scale cosmic system *g,* for which

$$E_g \approx \frac{\varepsilon_g \rho_g R_g}{c},$$

at that $E_g \approx E_F$, $\varepsilon_g \approx \varepsilon_{av} \approx \varepsilon'$.

This equation agrees with the whole observed data of globular clusters, galaxies, groups and clusters of galaxies, in particular, with empirical correlations, which are magnitude - angular diameter.

11. The stated approach lets to determine the values of many fundamental constants by different ways. As a case in point, the results of definite values ε_{av} and ε', erg g^{-1} c^{-1} are presented in the Table 2.

Table 2

#	Data	ε_{av}	ε'
1.	The boarder between two parts of the Main Sequence of stars	of 0.1 order	of 0.1 order
2.	The results of recalculation of observed star characteristics as respects to their centers	of 0.1 order	of 0.1 order
3.	The local minimum of star luminosity function near the Sun (according to G.A. Starikova's data)	of 0.1 order	of 0.1 order
4.	The correlation: mass - luminosity of white dwarf stars	of 0.1 order	of 0.1 order
5.	The correlation: mass - luminosity of neutron stars	of 0.1 order	of 0.1 order
6.	The correlation: mass - luminosity of globular clusters	less than 0.5	less than 0.5
7.	The correlation: mass - lumonosity of elliptic galaxies	more than 0.06	more than 0.06
8.	The correlation: mass - luminosity of spiral galaxies and irregular galaxies *Ir I*	less than 0.5	less than 0.5
9.	The correlation: mass - luminosity of galaxies as a whole	of 0.1 order	of 0.1 order
10.	The correlation: mass – luminosity of clusters of galaxies	of 0.1 order	of 0.1 order
11.	Empiric values of H, ρ_{av}, E_F constants	of 0.1 order	of 0.1 order
12.	The most exact values of h, e, G, E_F constants	0.0942	0.07476

12. Uncontradictory description of Microcosm and the Universe promotes the better understanding of Life, which is inseparably unified with them. The statistical data manipulation of more than 100 catalogues of microphysics and cosmic objects let us to get more than 1000 empirical correlations and diagrams, and to determine, that they agree with theoretical correlations, which were received according to the ideas on circular character of energy transformations (Fig. 1) and of matter in the Universe.

The Russian edition of the book is mailed out: the 1st edition (1995) at the cost of $3; the 2nd edition (1998) at the cost of $6.

The authors are thankful for valuable discussions to Yaroslav G. Klyushin and to Alexander V. Frolov.

HYPOTHESIS OF A THEORY OF EVERYTHING

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This work grew out of an interest in curious occurrences, physical, mathematical and metaphysical. Many things just do not fit normal knowledge or are of unknown origin. Items such as gravity, time, mathematical equations of higher order, ghosts, e.s.p., etc. After a number of years, the problem began to appear to be not of this physical dimension but of a grander scale. A multi-dimensional space-time format seems to offer solutions to understanding most of the problems. In the following hypothesis all known physics and mathematics are considered to be valid. Metaphysical aspects, while not accounted for by physics and mathematics, are considered to be present in nature, either real or as a defect in physical processes, simply because they are experienced by so many people. The hypothesis will be kept simple because the details require the work of many specialists beyond my abilities and there is an endless list of speculative problems to which the hypothesis could be applied. To save time and distractions to the reader the following is stated as fact, knowing full well it may not be so, in order to present the most concise statement of the hypothesis.

The Universe, from the smallest to largest unit, is a quantum probability based fractal illusion. All matter exists in three-dimensional space, both internal and external. Any grouping can be considered a fractal space. It is both real and imaginary at the same time acting according to Eulers equation:

$$(e \wedge (i*Pi))+1=0$$

more useful in this instance is the general form:

$$e \wedge ix = -1=\cos x + i \sin x = -\tan 45 \text{ deg}$$

which allows use of a variable where Pi , a constant, is used in the original. The key to understanding of multi-dimensional space time is the realization that Pi is a variable! As we know Pi is the lock on three-dimensional space. Because of its mathematical nature it can neither grow nor diminish, thereby locking in the three dimensional form of the fractal unit under consideration. Such a fractal unit is considered to be at rest. But Einstein's equation $E=mc^2$ includes speed or movement. When objects are moving relative to a fixed point, the moving object is foreshortened in the direction of movement. A circle becomes an ellipse and Pi becomes indeterminate letting the circumference fluctuate, according to its relative speed, between two and Pi in a circle of unit diameter. If one goes beyond the value Pi the Universe grows out of bounds without limit becoming unstable. If the value goes below two then the Universe blinks out. I.e., one has exceeded the value of the constant c. Since all matter moves relative to a fixed fractal point and there are infinitely many points in the Universe of constantly changing velocities, the Universe is constantly adjusting its reality to the relative speeds of its components. Thus you get at times some weird things. Since not only time changes but the structure and observable mass also, one finds such things a matter appearing and disappearing as the small units of chaos move through the Universe. Changes in the local probability structure cause matter or reality to change in the image structure of the Universe.

To delve further into the aspects of what is happening, let us consider the following. Einstein's familiar formula gives the relationships for our three-dimensional fractal space. The inverse of the formula gives the speed with which any fractal space can change, including the Universe. There is both a positive and negative component to the change. If we consider our fractal space to be positive then we may consider any other point to be negative. There are an infinite number of such points and while the effect on our space may be small from any one point; the effect adds up. Any moving or changing of mass must effect the entire Universe. Mass and inertia are tied together in such a system. Measured mass is the attempt of the mass to return to zero relative speed in its associated fractal space according to the laws of physics, i.e. return to its lowest energy state. Inertia is the same effect of the changing state of the mass from one-dimensional state to another. Both are the result of efforts to change the dimensional state of mass. The positive aspect of the square root of the ratio of energy/mass is the view we behold from our position in space while the negative is the view from the opposite position.

In addition to the view of the Universe as being made up as fractal space, all moving at different relative speeds to any other fractal space, one must consider the make up of space having at the same time dimensional space, according to Euler's formula given above. There are at any moment an infinite number of spatial dimensions, defined by the relative speed of the fractal units involved, extending throughout the Universe. Each fractal unit is constantly changing its position in dimensional space. There are thus constantly changing energy states throughout the Universe both in relative position in real space and in dimensional space. While on one hand the distances across the Universe are immense in relative space, many points across the Universe are present in the same dimension at the same moment, possibly allowing for instance travel across space without the time penalty. This results in what might be considered a tuned circuit for the Universe or its components.

If we consider the structure of the relative Universe to be stored energy analogous to magnetic fields and the dimensional fields to be capacitive, then we can plot the results on a conventional two-dimensional chart

where x is the horizontal axis and the vertical is the imaginary axis. A well-known construction in electrical physics and which is known to very often follow relativity closely. That throws the negative side of i into the second quadrant and the positive into the fourth quadrant, if we consider the Universe to be reflective and x to be negative when i is positive. Euler's equation does not reflect a totally positive or negative result. One wonders at this point as to other equations where unity is set to one or higher dimensional equations where the three dimensional components are factored out leaving another component. The fourth is considered to be time but how do the remaining fit into a Universe as this hypothesis describes? The line of thought can be followed further into electrical analogy, which I leave to the reader. The important result is that there should be a resultant *Q*, figure of merit, of the Universe resulting in nodes, or peaks, of probability. The resultant tuned frequencies of the Universe can be calculated from known factors of the Universe. Such an effect should show nodes of reality where matter occurs.

Properly applied the above hypothesis gives speculative answers to most of the problems facing science today. Questions such as:

Is the Universe open or closed?

Both. At each fractal component of the Universe there is a separate universe each reaching limits beyond which it cannot exist. At the same time there is somewhere a top Universe that must ever remain open.

What is the structure of time?

Time results from the ever changing fractal Universe and goes forward because all justification of the Universe causes a corresponding change in reality. Time moves slower at higher relative speeds and as all time is perceived to be slower in other fractal units, changes in our time are perceived to always go forward.

What are such phenomena as ghosts, spirits, apparitions, etc?

Events such as these are fragments of probability left behind due to sudden changes in the probability of the illusion we perceive to be reality. Having little energy they are perceived but are not able to interact with the more forceful real reality. They float free in probability space interacting at random intervals with the more forceful realities of the real world.

Where is the missing matter of the Universe?

There may be clouds of matter floating about in deep space, however, most of the approximately 90% of matter missing will be found in the layers of dimensions making up space and which, though interacting, do not appear in our reality. Calculations show only about ten dimensions are active in any one reality. The rest curl up in a ball or knot. While an essential part of space or reality they are not perceivable from the fractal Universe of which they are a part.

Parapsychology?

Events of this type can be attributed to interconnections on the dimensional, or imaginary, level where there can be interactions between fractal units though not directly associated with each other in relative space. The manifestation varies or is temporary due to the constantly changing and adjusting due to interactions of the probabilities of the Universe. Due to the innate probabilities of each individual, one may be more susceptible or sensitive than other individuals.

Bible, prophesies, angels, demons, aliens, etc.

If one takes the Bible at face value, with some leeway for it's age and many translations, it pretty well describes what it purports to describe. Historic predictions and conditions of today. If we assume this hypothesis has any value then the passage in which God says "Let us make man in our image." takes on new meaning. If we assume the probability basis of the Universe and the constant changing due to justification of reality and time then the miracles listed do not seem so in violation of the physical world. The miracles only require some ability to control reality. Certainly well within the providence of a creator. It speaks of heavenly beings capable of traveling through the Universe in real time and some who interfered with mankind on the Earth and that they are still doing so today. If this hypothesis is correct then it is readily seen how such events could occur. Creation events closely compare with the way todays computers are made and organized. If man can do it, why could not the original creator? If one ignores a creator, then one is hard pressed for an answer as to how the Universe was created.

UFOs

If one accepts any part of the above then the functioning of UFOs begins to be understandable. They move through space by making spatial jumps through fractal nodes. Their appearing around magnetic and electrical sources maybe due to some, on our part unrealized, easy entry and exit to other space at those points. They are able to make right angle turns at high speeds because the speed is only from our viewpoint. From the viewpoint of the craft it is simply changing locations in space. The turning on edge may be only a different orientation of space at that point.

Particles "Out of the Vacuum"

As we shoot atomic matter at higher and higher speeds into nuclei we are able to fracture the construction of the building blocks of matter. The high speed fractal construction of probabilities of the unit used smashes into the target with enough speed to mix the probabilities resulting in new nodes from the total probabilities present. Various probabilities are ejected resulting in short lived particles in unstable nodes. At times fragments of probabilities appear out of nowhere as they form up to combine into larger nodes. Travel distance and speed observed may give a clue to the basic frequency of the Universe.

Black Holes

The midpoint of the tuned circuit of the relative structure and dimensional structure of the Universe. As matter spirals in, from the relative structure, to be torn apart into its basic probabilities it passes through to the dimensional structure of space which holds 90% of the matter. There it is available for recollection and use by the relative space.

Probability. Basic structure of the energy of space.

Everything operates at random but within preferred patterns set by the frequencies involved. If you look long enough anything can be found. As a result we find odd bones of prehistoric creatures that may have never existed. Weird things can happen. Odd pieces of structure can occur such as metaphysical events. The Q of space is sometimes sharp and sometimes rounded, spreading out to include things not really meant to be in the overall scheme of the Universe. Christ said "If you had the faith of a mustard seed, you could say to the mountain move and the mountain would move". (For those not of the Christian faith, this may be considered not as any proof but as a representative statement of the meaning of this paragraph.) That is in keeping with the quantum statements that nothing exists until it is seen and that we have some control over the probabilities. If the structure of space is based on probability then the next important question is 'What is a probability'. We look to probability as a simple mathematical work. But, what makes probability work?

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The entire Universe is based on mathematics but we have no idea what is underneath the mathematics. Are dimensional planes perhaps better represented by other number bases? Are some of the unsolvable mathematical problems solvable in other number bases?

Gravity

All forces in the Universe are the same. Gravity happens to be the one that works on our fractal space. Others, molecular, atomic, and nuclear are the same but work in different fractal space. All are the result of matter trying to reach its lowest potential.

The above are only random questions chosen without any order. Most other problems can in some way be answered in line with the hypothesis, if not in detail. Too many questions can be fitted to the hypothesis not to take a serious look at it even though it may seem a little far out. The number of answers from one simple statement of the structure of the Universe defends the idea better than details.

One possible proof, and a relatively simple one, occurs to mind. Einstein's theory of relativity was proved when NASA flew a clock in space and then determined that time did slow down. To test the above hypothesis I would like to see four clocks used in the following manner.

Four atomic clocks in sets of two each. Two to be left on the Earth and two to be placed in space for an appropriate time. At the end of that time one of the clocks on the Earth to be taken into space and compared to the two already in space. Bring one of the clocks in space down to the Earth and compare to the clock left on the Earth.

The clock taken to space should read slower compared to the clocks in space because the ones in space were at rest compared to the one on the Earth.

The clock brought back from space should read slower, the same as the first one flown by NASA, because the clock on the Earth was at rest compared with the one in space.

The two clocks left in space should be returned after an appropriate time and compared to the ones on the Earth. The original in space should now be slower than the original on the Earth and its mate from space. The fourth clock is unpredictable.

The author apologizes for any errors in theory, mathematics, etc. There was no one to consult on the hypothesis which is an original work of my own and drawn on many references of others from the past If it has any value I am indebted to the work of all the others whose work I relied on. Any errors are entirely my own and not attributable to others. This work is freely published in the public domain to be used by any and all who wish to do so. It is not to be copyrighted or patented in any manner so as to restrict others rights to the hypothesis or it's use.

The Charge and Mass of a Photon

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Abstract

The discovery of true elementary particle named **electrino**, which has a constant mass and constant positive charge and which is a material carrier of magnetic field, electric current and all kinds of emanation, was firstly practically applied at the modernization of wireless telephone. In the review V. Anpilogov writes: "The question on the influence of low intensity microwave radiation on human health still remains open for discussion for more than 50 years" [3]. Discussion on this question has been already inappropriate still it was definitely proved in the patent application "Device, which is made to put away the charged particles flux from the head of the user of mobile wireless phone". During the talk on mobile wirelessphone $2{,}6\cdot10^{22}$ particle/sec pass through user's brain, whereas their energy is $7{,}65\cdot10^{-19}$ Joule, and the energy of binding of molecules in protein polymers ranges at $4{,}3\text{-}7{,}6\cdot10^{-19}$ Joule according to L. Poling. From that we can conclude that microwave radiation of the radiotelephone with top antenna leads to the destruction of user's brain tissue. The author of the patent application D. Baziev (#2001105456, 28.02.01. in Russia and #PCT/RU02/00054 of the international application) offers to fix the antenna on the low part of the radiotelephone and to produce radiotelephones with minimal length within 10 cm. In this case the diagram of the directional radiation pattern is on the level of the user's chin and the brain is out of the direct exposure area. This harmless of the microwave radiation could not be proved before the discovery of "electrino".

Introduction

A systems analysis of all experimental and observation material gathered in physics, astronomy, and astrophysics from the times of Galileo let us reveal the following:

1. Experimental materials do not agree with the existing physical theory.
2. There is a certain fundamental disadvantage of the experimental material, which prevents to build a consistent theory.
3. This fundamental disadvantage consists in the absence of a charge antipode of electron, which is in the form of a true elementary particle with a positive charge and finite mass.
4. The proton and positron are not true elementary particles and neither of them can be a charge antipode of the electron because they are subjected to splitting.
5. Discovery of the second true elementary particle with a positive charge could restore the charge symmetry in physics, thus leading to a radical revision of the existing theoretical physics and resolving its current crisis state.

Searching for this particle required to ascertain physical nature of Planck's constant. This became possible only after the structure of a light beam had been understood. Namely, it was the photon sector velocity, known as Millikan constant μ, rather than the speed of light *c*, that proved to be a constant, viz.:

$$\mu = \lambda_i^2 \nu_i = 119.916984 \text{ m}^2/\text{s} = \text{constant}, \qquad (1)$$

where λ_i and ν_i are the wavelength and frequency of the *ion* monochromatic beam in the light beam.

This new quantity elucidated the physical nature of Planck's constant:

$$h = m_\varepsilon \mu \frac{\sqrt[3]{4\pi/3}}{2} = \\ = 6.6262681\cdot10^{-34} \text{ kg m}^2/\text{s} = \text{constant}, \qquad (2)$$

where m_ε is the mass of the second (after electron) true elementary particle to be called "electrino". From this expression we have

$$m_\varepsilon = \frac{2h}{\mu\sqrt[3]{4\pi/3}} = \\ = 6.85575729963\cdot10^{-36} \text{ kg} = \text{constant}. \qquad (3)$$

The electrino has a positive charge ε determined by

$$\varepsilon = \frac{m_\varepsilon n_\varepsilon e}{m_u - n_e m_e} = \frac{-3.229526609098\cdot10^{-54}}{1.6578584539\cdot10^{-27}} = \\ = 1.98764431671\cdot10^{-27} \text{ C}, \qquad (4)$$

where $m_u = 1.66057 \times 10^{-27}$ kg is the mass of an elementary atom accepted as a mass equivalent of one atomic unit; $n_e = 3$ is the number of electrons in one elementary atom; $e = 1.6021892 \times 10^{-19}$ C is the charge of an electron; $m_e = 9.038487 \times 10^{-31}$ kg is an improved value of electron mass; $n_\varepsilon = 2.418198867 \times 10^8$ is the number of electrinos in an elementary atom.

Thus, it is obvious that Planck's constant is the angular momentum of the electrino. Moreover, it was Planck's constant that concealed the second true elementary particle, which is the charge antipode of the electron discovered by J.J. Thompson as far back as in 1897.

The solution of Planck's constant has become a basis for the synthesis of the new theory of physics [1]. This theory in particular shows that the electrino is the carrier of the magnetic field and electrical current. It is a photon of radiation of all ranges, and serves as a universal carrier of energy and information. The electrino plays the role of a neutrino in moving along the first order trajectories.

The first experiment

An extraordinary importance and novelty of the new theory required **an experimental proof of the electrino**. For that several experiments were made in the Institute of General and Inorganic Chemistry, Moscow. The experiment was based on the following effects predicted by the theory.

1. If assume that electrino exists and that light beam is a flux of particles having positive charge and finite mass [1] we can conclude the following. At the discharge of the dc source through an incandescent lamp in which the current is converted to light and irreversibly emitted, the source weight in charged state must differ from its weight in discharged state. If we prove this difference experimentally we may say that light does consist of material particles of finite mass and a dc charge carried away by light is positive because an incandescent lamp (W=15 Wtt) does not emit electrons, which are the carriers of negative charge.

2. The second effect to prove was that the weight of a discharging dc source is *increasing* whereas its weight when charged is *decreasing*.

To prove the validity of these predictions, several sealed containers with different dc sources inside were fabricated. The electrodes were brought out through glass insulators. The batteries were discharged through an electric lamp radiating in the visual and infrared ranges. The weight of containers was measured before and after discharge process with accuracy $\Delta W = \pm 0{,}02$ mg; balance error was equal to $\Delta = \pm 0{,}05$ mg the standard deviation of the measurements was within $\sigma = \pm 0{,}03$ mg; the buoyancy was calculated for each measurement of weight. In this paper, we present test results of only one container with four generally marketed GP rechargeable cells connected in series. The total battery voltage reached 5400 mV at 6000 mA/h charge capacity. The discharge was interrupted when the voltage dropped to 4000 mV, the duration of the discharge was measured accurate to one second. Two series of experiments were run: one in air, the other, under argon. Each series had ten charge-discharge cycles (Table 1 and Fig. 1). The total amount of the experiments and detailed discussion of results have been summarized in a recently published brochure [2].

The results of the above tests allow us to make the following conclusions:

1. Both galvanic and rechargeable cells during a discharge through an electric lamp show sufficient changes in their weight and charge thus proving that photons have a finite mass and a positive electric charge.

2. A new elementary particle, named electrino, derived from Planck's constant in August 1982, and published in May 1994, thus gets a complete and absolute experimental confirmation.

The second experiment

One of the concepts of the new theory is that the speed of light in vacuum is a function of photon frequency along the beam axis, according to the proportions:

$$c_i = \sqrt{\mu \nu_i} \quad [\mathrm{m/s}], \qquad (5)$$

$$\nu_i = \mu / \lambda_i^2 \quad [\mathrm{s}^{-1}]. \qquad (6)$$

According to the new theory, for the velocity of monochromatic light (solar light or mercury-discharge lamp, but not a laser) with a wavelength of $\lambda_r = 6.8 \times 10^{-7}$ m (mid-point of the red spectral line), we have

$$\nu_r = \mu / \lambda_r^2 = 2.59336038 \cdot 10^{14}\ \mathrm{s}^{-1}, \qquad (7)$$

$$c_r = \sqrt{\mu \nu_r} = 1.76348505882 \cdot 10^{8}\ \mathrm{m/s}, \qquad (8)$$

which is 58.823% of the speed $c_v = 2.9979246 \times 10^8$ m/s of a violet beam with a wavelength of 4×10^{-7} m.

We have to account that, according to this theory, the laser beam is not a true light beam though it is created of electrinos. The speed of laser beam is equal to the speed of beam plus the speed of current in the conductor, viz.,

$$\nu_0 = 2.8992629 \cdot 10^8\ \mathrm{m/s} = \mathrm{const} \qquad (9)$$

If we select a monochromatic beam of ultra-violet light with a wavelength of $\lambda_1 = 4 \cdot 10^{-8}$ m then its velocity will be $c_1 = 10$ C:

$$c_1 = \mu / \lambda_1 = \frac{119{,}916984 m^2/\sec}{4 \cdot 10^{-8} m} = $$
$$= 2{,}9979246 \cdot 10^9 m/\sec$$

$$\nu_1 = \mu / \lambda_1^2 = \mu / 16 \cdot 10^{-16} m^2 = 7{,}4948115 \cdot 10^{16}\ \sec^{-1}$$

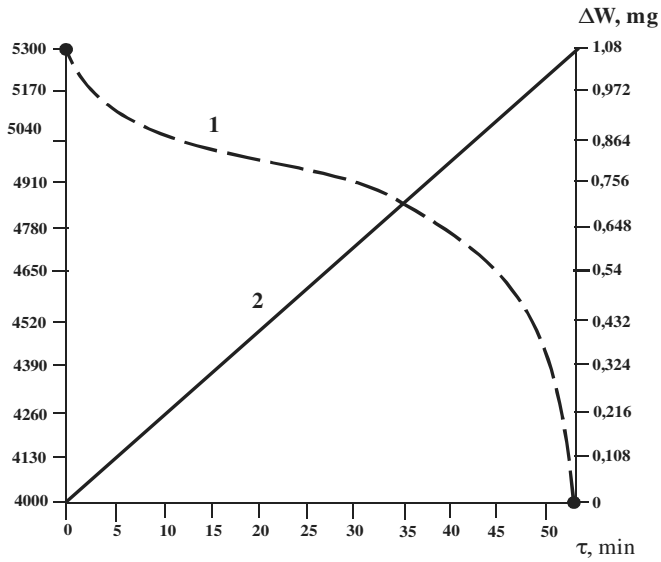

Fig. 1
Voltage drop [mV] of a battery and (2) weight increment [mg] of container #6 in an argon atmosphere during the second discharge cycle [minutes]. X-direction – is spark duration in minutes; Y-direction – is voltage of a battery; auxiliary Y-direction – is weight incensement (mg).

$$c_1 = \sqrt{\mu \cdot \nu_1} = \sqrt{8{,}987551907 \cdot 10^{18} m^2 / c^2} = 2{,}9979246 \cdot 10^9 m / \sec$$

This experiment has been run yet, and it is offered for experimental verification with further publication of experimental results.

Table 1

Weight of container #6 (under argon) in charge-discharge experiments

Run	Measured value $W \pm \sigma$, mg	Charged battery		Discharged battery			Charge weight $\Delta W_z = W_1 - W_0$, mg
		Buoyancy Gmg	Real weight $W_0 = W + G$	Measured value $W \pm \sigma$, mg	Buoyancy Gmg	Real weight $W_1 = W + G$	
1	126825.13±0,02	85.031	126910.166 ±.0.02	126825.901 ±0.01	85.002	12691.903 ±0.01	0.737
2	126825.107±0.02	86.572	126911.679 ±0.02	126826.221 ±0.01	86.538	126912.759 ±0.01	1.080
3	126825.21±0.01	86.782	126911.992 ±0.01	126826.279 ±0.01	86.560	126912.839 ±0.01	0.847
4	126825.187±0.01	86.563	126911.749 ±0.01	126826.493 ±0.02	86.385	126912.878 ±0.02	1.128
5	126825. 65±0,04	86.290	126911.941 ±0.04	126826.65 ±0.01	85.836	126912.941 ±0.04	0.770
6	126827.28±0.00	85.187	126912.467 ±0.00	126827.990 ±0.01	85.204	126913.194 ±0.01	0.727
7	---	---	---	---	---	---	---
8	126826.98±0.00	86.182	126913.162 ±0.00	12682 7.897 ±0.02	86.308	126914.205 ±0.02	1.042
9	126826.95±0.00	86.307	126913.257 ±0.00	126827.757 ±0.01	86.402	126914.159 ±0.01	0.902
10	126827.25±0.00	86.294	126913.544 ±0.00	126828.35 ±0.00	85.729	126914.079 ±0.00	0.535

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2. D.K. Basiev, Zaryad i massa fotona (The charge and mass of a photon), Pedagogika, Moscow, 2001
3. V.P. Anpilogov, "The century of quality", #3, 2001, p.60

About the Author

When a child Dzabrail Kh. Baziev became a political exile along with all Balkarian people; in 1956 he was rehabilitated and in 1957 graduated from the secondary school with steady purpose to become an outstanding chemist. His first higher education is biological and chemical (two-profile department of Kabardino-Balkarian State University). In 1965 Baziev also completed his post-graduate study in Biological Department of Moscow State University.

At 1979 Dz.Kh. Baziev had published 25 scientific articles on ornithology and ecology, however, this period became a sudden turn in his scientific work. In order to elaborate the basis of theoretical biology, he came to the conclusion that biological process could not be described without understanding of its physical essence. On the other hand, it had become evident that there was no any solution for physical phenomenon, which is the basis of biological process.

In 1983 the scientist gave descriptions of his first fundamental discoveries. He found the solution of the physical essence of Plank's constant and pioneered the use of it in gases analysis. It was a revolutionary step in science since the synthesis of science was realized at the fundamental level for the first time.

As the result of this considerable work there was a new interdisciplinary theory of physics. The author created new thermodynamics of real gases and new electrodynamics, which differs from maxwellian one and it considers *electrino* as the carrier of magnetic field and electric current.

Dzabrail Kh. Baziev has succeeded in the systematic analysis of the vast experimental material and discovered that ***electrino,* as the true elementary particle with positive charge, is able to provide the connection of physics with biology, chemistry and other parts of the fundamental science. Thus it leads us to the radical reconsideration of all conceptions, existing in natural science.**

The Homopolar Motor: A True Relativistic Engine

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This article discusses experiments, which enable the identification of the seat of mechanical forces in homopolar-machines. Authors provide a suitable variation on a recent work "The Unipolar Dynamotor: A Genuine Relational Engine" [3], where "relational" implies "absolutely relativistic". The authors' view agrees with both Weber's recognition in the 19th century of the importance of relative motion in electromagnetic phenomena [4] and Einstein's 1905 statement concerning electromagnetism [5].

The Faraday disk: a reversible engine

The essential components of the homopolar machine, first conceived by Faraday in 1832, are shown in Figure 1. A conducting disk, free to rotate in the neighborhood of a permanent magnet, is attached to the end of a shaft. A closing wire provides a conducting path between two arbitrary points of the disk. Such a device exhibits *reversible* behavior.

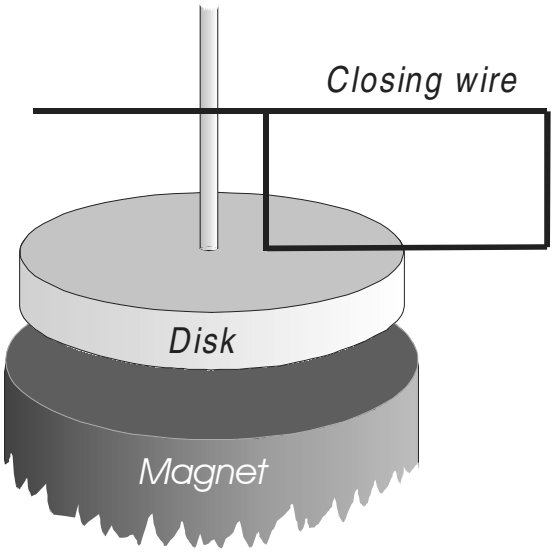

Fig.1
Faraday's setup magnet, disk and closing wire

A radial current path of length L takes place in a region of the disk when direct current (*dc*) from an external source is injected into the closing wire. The interaction of the current with the magnetic field produces a Laplace force [6]

$\boldsymbol{F} = \int_{a}^{a+L} I(d\boldsymbol{r}x\boldsymbol{B})$ causing the rotation of the disk. This set-up is the *motor configuration.*

When the disk is spun by an external source of mechanical energy, an *emf* appears in it. The displacement of free charges is produced in this case by the Lorentz force $\boldsymbol{f} = q(\boldsymbol{v}x\boldsymbol{B})$, converting the conducting disk into an *emf* source able to drive *dc* through the whole disk plus closing-wire circuit. This set-up is the *generator configuration*.

A seemingly curious fact occurs in the motor configuration, when *dc* is injected into the circuit with the disk attached to the magnet. Both disk and magnet turn together.

Two rival theories, a relativistic and an absolutistic one, have been applied to understand the observed facts:

In relativistic view, generator configuration makes sense only when there is relative motion of the magnet with respect to either the disk or the closing wire. Also, a motor configuration will only take place if the *possibility of relative motion* between magnet and either disk or closing wire is enabled.

Thus, in the relativistic framework, with the magnet attached to the disk, the closing wire becomes the "active" part for the production of mechanical forces or *emf*. In this case the disk itself behaves as a "passive" element providing a closing-circuit current path.

Conversely, in the eyes of an absolutist, a generator configuration is enabled only because of the disk or closing-wire *absolute* motion. Here, absolute means "relative to a frame where the preponderance of the mass of the universe is at rest" [7,8]. In our case, the lab frame acts as an acceptable absolute-motion reference. Thus, from an absolutistic view, the magnet's rotation with $\partial B/t = 0$ in each point of the surrounding space is unable to produce an *emf* on nearby conductors. When in a motor configuration, *dc* is injected in the circuit, and the absolutist assigns the observed rotation to the magnet "dragging" by the conductor. Here, the closing wire acts as a "passive" circuit element.

New experimental work, complementary to that currently known on the subject, introduces arguments in favour of the relativistic viewpoint. The related experiments, whose underlying physics rests upon a modified version of the original Faraday setup, are described in the following sections.

The asymmetrical rotor

Figure 2 shows the disk-shaped ceramic permanent magnet creating the axial magnetic field ***B***. The removal of a 12° sector introduces a field-reversion region. Outgoing and ingoing ***B*** field lines are represented by the and symbols, respectively.

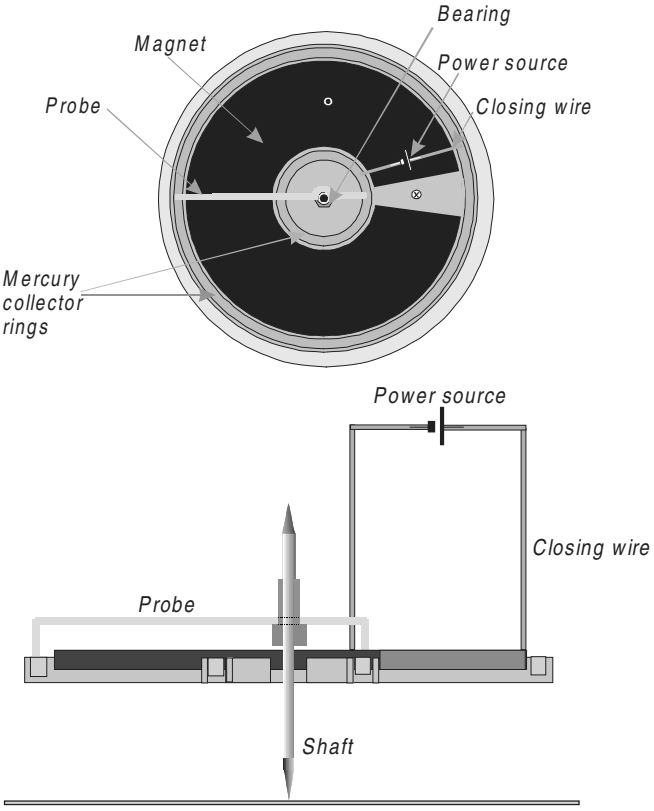

Fig.2
Layout of the Asymmetrical Rotor applied to the experiments

Two mercury collector rings are embedded in a wood cylinder. One is located close to the hollow-disk magnet inner rim and the other in the proximity of the outer rim. The magnet's inner and outer radii are 25 and 75 mm, respectively, and its height 25 mm. Its average flux density 2 mm above the magnet has been estimated to be 0.05 T based on a generator experiment with a rotating copper disk. The magnet-and-wood-cylinder body (the asymmetrical rotor from here on) is firmly anchored to a vertical shaft terminated in sharp points at both ends. While the lower one lays on a hard-polished surface, a conical bearing, enabling its almost frictionless rotation, centers the upper one.

Unlike the series-connected conductors diametrically anchored to the shaft in the Guala-Valverde case [3], only one radial conductor wire, a probe located 2 mm above the magnet's face, was considered. By mounting it on a bearing, its free rotation is permitted with its ends remaining in contact with both collector rings. A 12V lead-acid battery applied to the closing wire feeds the probe through the collector rings. In the first four experimental cases presented the closing wire remains firmly anchored to the lab. In two complementary experiments, rotation of the closing wire mounted on two shaft-centered bearings is allowed. Its behavior as a probe occurs by the injection of *dc* from an additional closing-circuit wire anchored to the lab.

Experimental

Six experiments performed are described below:

1. Rotor anchored to the lab, probe free to rotate above the magnet's upward magnetic-field region: A radially-ingoing injected *dc* in the 0.2 A range was enough to overcome conductor-bearing and mercury-wire contact friction. A net *counterclockwise rotation* of the probe took place.

2. Probe anchored to the rotor above the magnet's upward magnetic-field region, with both free to rotate: A radially-ingoing injected *dc* in the 5 A range was enough to overcome conductor-plus-rotor inertia and friction. A net *counterclockwise rotation* of the probe took place.

3. Rotor anchored to the lab, probe free to rotate above the magnet's downward magnetic-field region: A radially-ingoing injected *dc* in the 0.2 A range was enough to overcome conductor-bearing and mercury-wire contacts friction. A net *clockwise rotation* of the probe took place.

4. Probe anchored to the rotor above the magnet's downward magnetic-field region, both free to rotate: A radially-ingoing injected *dc* in the 5 A range was enough to overcome conductor-plus-rotor inertia and friction. A net *counterclockwise rotation* of the probe took place.

5. Rotor anchored to the lab, closing wire free to rotate above the magnet's upward magnetic-field region: A 0.4 A *dc* injected in the inner collector ring was enough to overcome conductor-bearing and mercury-wire contacts friction. A net *clockwise rotation* of the closing-wire took place.

6. Rotor anchored to the lab, closing wire free to rotate above the magnet's downward magnetic-field region: A 0.4 A *dc* injected in the inner collector ring was enough to overcome conductor-bearing and mercury-wire contacts friction. A net *clockwise rotation* of the closing-wire took place.

Discussion of results

Experiments (1) and (3) can be explained using either absolutist or relativistic viewpoints because of the coincidence of the probe motion relative to the lab with the probe motion relative to the magnet.

Experiment (2) can be explained by a trivial absolutist argument founded on a hypothetic probe "dragging effect" on the magnet. A relativistic viewpoint recognizes the "active" rotational torque on the closing wire rather than on the probe where, hinging on Newton's third law, the whole action may be split in two:

Magnet-probe. The magnet produces a counterclockwise torque on the probe, and the probe exerts an equal but opposite torque on the magnet.

Magnet-closing wire. The magnet exerts a clockwise torque on the closing wire, and the wire an equal but opposite torque on the magnet.

With the probe attached to the magnet, there is no chance for relative motion between them. Consequently, due to the action-reaction cancellation, rotation is forbidden. Conversely, with the closing wire mechanically decoupled from the magnet, relative motion of the latter is permitted. The torque exerted by the closing wire on the magnet is responsible for the observed rotation.

Experiment (4): Due to its similarity with (2) a trivial relativistic explanation is applicable to the counterclockwise torque exerted by the closing wire on the magnet. There is no known plausible absolutistic explanation for it. As quoted above, the hypothetical dragging effect would produce a clockwise rotation in this case. The consideration of the experiments (2) and (4) suffices to reject the dragging hypothesis.

Complementary experiments (5) and (6) confirm the short-range extension of the field-reversion region founded on the closing-wire *clockwise* rotation (6). Briefly speaking, the closing wire is not sensitive to the field reversion and the magnet's *counterclockwise* reaction explains at once the outcome of (4). Clearly, experiments (5) and (6) show that the torque on the closing wire is independent of its location on the magnet.

Figure 3 depicts the two rotational torques involved in (2) and (4).

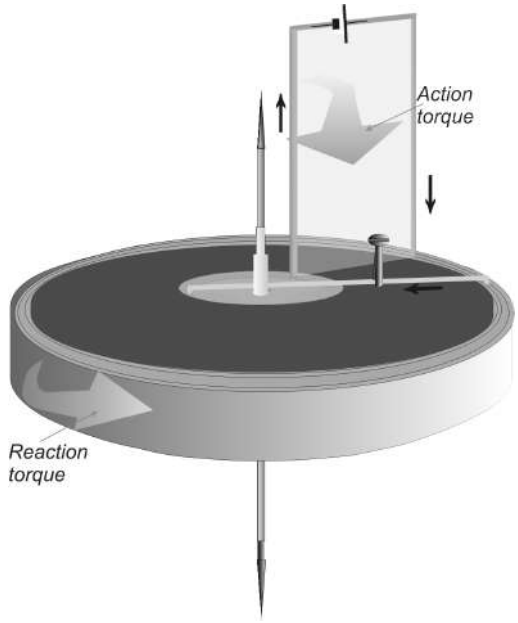

Fig.3
Rotational torques acting on the magnet and on the closing wire

Topological and miscellaneous considerations

One of the keys to the success of the above described experiments lies in the dynamotor's magnet design (see Fig.4). The short-range field reversion region allows the inversion of the Laplace force on the probe, making the force on the closing wire insensitive to that ***B**-field* reversion.

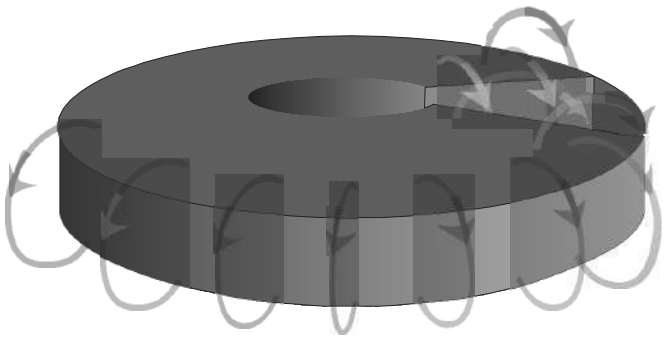

Fig. 4
The magnet's field-revision region

In all the above cases the electromagnetic forces between probe and closing wire were neglected because of its small magnitude compared to the predominant magnet-wire interaction forces.

The observed torques became, in all the experiments, independent of the location of the contact points between closing wire and collector rings. Also, the closing wire shape exhibited no noticeable influence on torques. These observations can be easily explained using the $div\boldsymbol{B} = 0$ fundamental law, Laplace force, and some elementary topological considerations.

Kennard [1], Bartlett [1], Panosky [7,8], Muller [9], Wesley [10] and some of this article's authors took absolutistic viewpoints when dealing with homopolar phenomena [11,12]. On the contrary, Weber [4], Assis [13], and Kelly [14] adopted a relativistic framework on the issue from the beginning.

By attaching the magnet to the disk in the original Faraday setup, the relative rotation between disk and closing wire remains unchanged. Therefore, in a generator configuration, the disk plus magnet rotation at with the closing wire at rest in the lab is entirely equivalent to the closing-wire rotation at – with the disk plus magnet at rest. This fact introduced a correct but physically "colorless" weak relativism to the homopolar generator description: the "unipolar generator really has three components, the magnet, the cylinder and the meter (including the contacts). A relative motion of the last two, not the first two, is required" [1].

A growing interest in basic electromagnetism [15,27] can not be ignored, and from time to time some authors, attempting to catch "free energy" from the space, have

claimed the design of homopolar engines with efficiency greater than unity, as can be checked by searching for *homopolar motor* on the Internet. The strict application of Newton's third law precludes the above non-physical possibility.

It is worthwhile to stress that the homopolar machine is a famous example where Faraday's flux rule fails. This fact worried Faraday himself and is clearly discussed by Feynman [28] who emphasized that the correct physics is always given by the Lorentz force law and the Maxwell fundamental equation *curl E = -B/t*. Homopolar induction is fully understood using only the Lorentz force. Our experiments enhance the relativistic structure of the Lorentz force because the only relevant velocity is the velocity of the conductor relative to the magnet.

Acknowledgments: To Profs. C.N. Gagliardo and A. Ipohorski-Lenkiewicz for the conceptual comments on this development.

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Weight Reductions Generated by Bucking-Field Permanent Magnets

LAB REPORT ON SmCo RING MAGNET EXPERIMENTS

Experiments conducted by:
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The following experiments were conducted at the *Coastal Environmental Laboratory* (CEL) at Avery Point, Groton, Connecticut. (41° 19' 0.17" N. latitude x 72° 3' 50.27" W. longitude x 35 feet elevation above mean sea level) I wish to thank the personnelat the CEL for their generosity for providing the use of their *Mettler Toledo*® Model AG104 electronic scale for the measurements taken in the proceeding experiments. The AG104 electronic scale is an enclosed pan unit with a maximum mass range of 101-grams with 0.0001-gram readability.

The purpose of these experiments was to see if there is any detectable weight change when permanent magnets are forced together with their like-poles facing each other. The magnets were weighed individually, in both directions, with their field poles oriented vertically. The sums of the two individual magnet weights (magnet #1 and magnet #2) in each vertical orientation were compared to the weight measurements taken when they were assembled using the nylon bolt and wing nut depicted in **DIAGRAM 1**. The specifications for the two Samarium Cobalt magnets used in the following experiments are shown in **DIAGRAM 1**.

The first set of experiments with the SmCo Ring magnets were conducted January 14, 2002. An inverted paper cup was used to raise the test sample magnets 2.75" above the AG104 electronic scale pan in order to minimize possible magnetic interaction with the scale-sensing element, as depicted in **DIAGRAM 2**. The tare adjustment was used to set the scale readout to 0.0000-gram with the cup in place. The magnets were weighed individually. Magnet #1 weighed 9.9450-gram with the N pole facing up and 9.9397-gram with the S pole facing up. Magnet #2 weighed 9.9520-gram with the N pole facing up and 9.9443-gram with the S pole facing up.

The second set of experiments with the SmCo Ring magnets were conducted February 4, 2002. These experiments were shielded with Mu 80 magnetic

Editorial: This article is one more link between magnetizm and theory of aether, to my mind. It is possible to assume that in his experiments the author creates small but detectable changes in density of aether, that demonstrates itself as the weight changes.
Alexander V. Frolov.

DIAGRAM 1

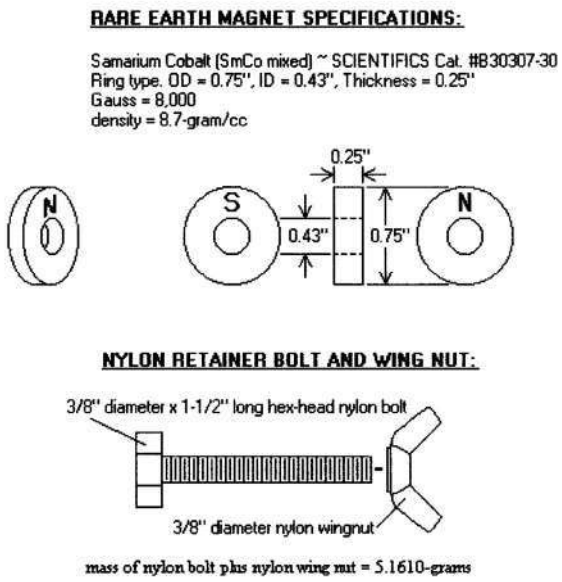

shielding material as depicted in **DIAGRAM 3**. The scale was tare adjusted to 0.0000-gram with the entire set of Mu 80 shield pieces in place. Then the magnets were weighed individually. Magnet #1 weighed 9.9483-gram with the N pole facing up and 9.9486-gram with the S pole facing up. Magnet #2 weighed 9.9527-gram with the N pole facing up and 9.9542-gram with the S pole facing up. The Nylon bolt and wing nut were placed in the Mu 80 shield can (without the magnets) and the scale was tare adjusted to 0.0000-gram. Therefore, the readouts would only be reading the weight of the bucking magnets.

The first column in **TABLE 1**, the vertical measurements, is the distance of separation d, or air gap, of the magnets. The second column shows the January 14, 2002 weight measurements of the two magnets, as shown in **DIAGRAM A**. The third column shows the January 14, 2002 weight measurements of the two magnets, as shown in **DIAGRAM B**. The fourth column shows the February 4, 2002 weight measurements of the two magnets, as shown in **DIAGRAM C**. The fifth column shows the February 4, 2002 weight measurements of the two magnets, as shown in **DIAGRAM D**.

The horizontal measurement, as depicted in **TABLE 2**, **TABLE 3**, **TABLE 4** and **TABLE 5**, are through the four basic magnetic compass headings; North, East, South, and West respectively. They are referenced to **DIAGRAM E** and **DIAGRAM F** for the January 14, 2002 experiments and **DIAGRAM G** and **DIAGRAM H** for the February 4, 2002 experiments. The corresponding graphs of the force change plots, **GRAPH 1**, **GRAPH 2**, **GRAPH 3**, **GRAPH 4**, and **GRAPH 5** accompany each table. The forces were converted from the mass readings, which are a scalar measurement, to dynes. The convention used for the force vector was chosen as plus (+) for up, or a weight reduction, and minus (-) for a weight increase.

DIAGRAM 2

01/14/2002 EXPERIMENNTS

CUP HEIGHT: 2.75" above scale pan. 1.75" upper diameter, 2.5" lower diameter

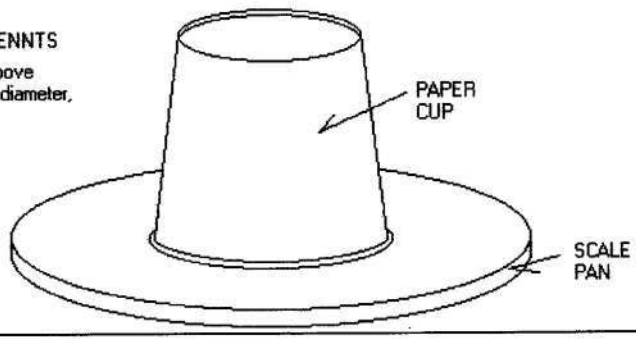

DIAGRAM 3

02/04/2002 EXPERIMENTS

MU METAL SPECIFICATIONS:

Source: NATIONAL ELECTRICAL ALLOYS
Oakland, NJ
SPECIFICATION: MIL N 14411C COMP 1
GRADE: HY MU 80 SHIELDING ALLOY
COLD ROLLED BRIGHT
DESCRIPTION: COIL
HEAT # 982011207
CHEMICAL ANALYSIS:
Ni: 80.16%
Mo: 4.6%
S: 0.0007%
C: 0.010%
P: 0.004%
Mn: 0.486%
Si: < 0.010%
Fe: BALANCE
MECHANICAL PROPERTIES:
HARDNESS: HV1 = 159
GRAIN SIZE: 8.5
COERCIVE STRENGTH:
HC = 0.0080 Oe
PERMEABILITY: MUMAX = 355000
SATURATION: 7900 Gauss
THICKNESS: 0.010"
DENSITY: 8.747-gram/cc

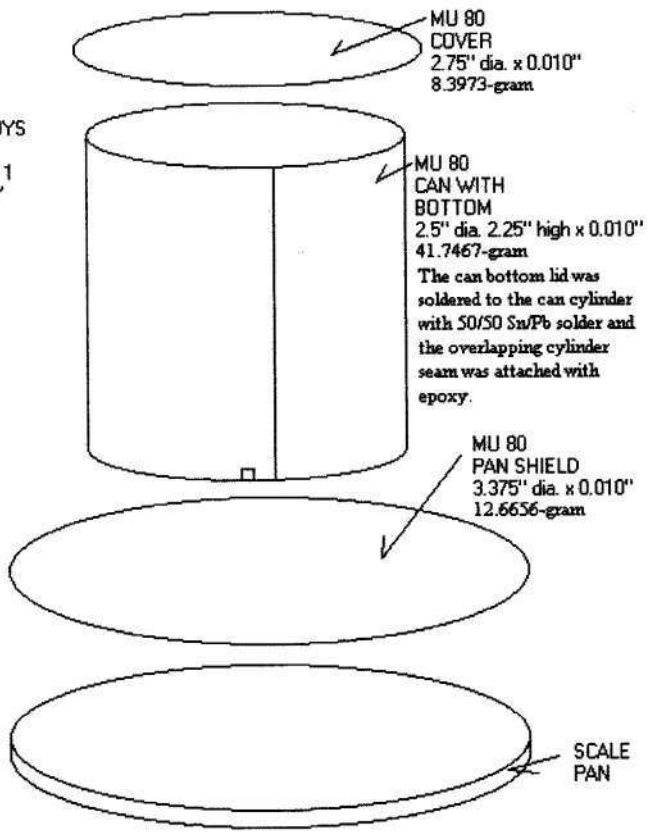

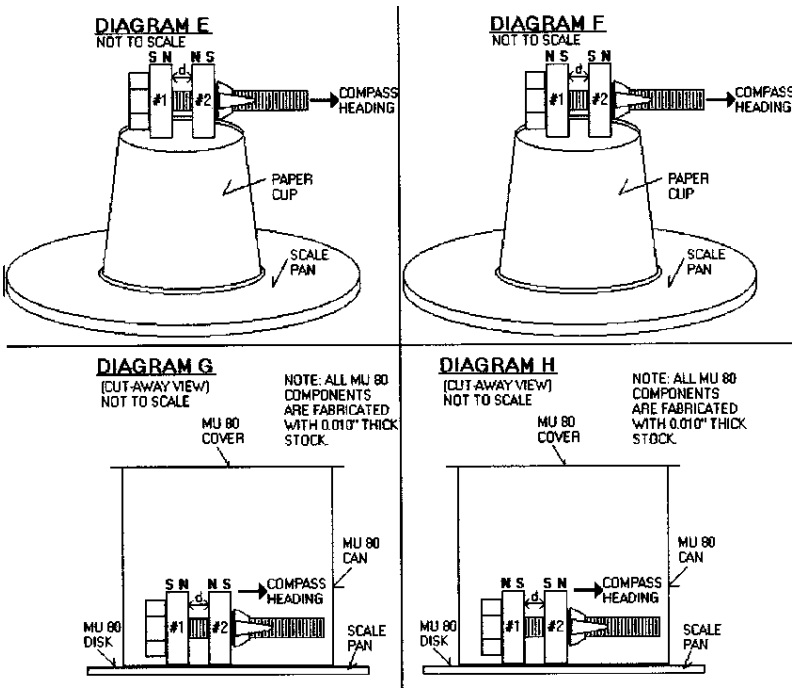

ELEVATION VIEW OF THE VERTICAL EXPERIMENTS

NOTE:

January 14, 2002 Experiments: Start time: 13:27 hours EST, End time: 15:40 hours EST.

February 4, 2002 Experiments: Start time: 13:18 hours EST, End time: 14:50 hours EST.

TABLE 1:

	01/14/2002 EXPERIMENTS OPEN, WITH PAPER CUP		02/04/2002 EXPERIMENTS WITH MU 80 SHIELDING	
Air gap d	**Diagram A** N to N vertical 19.8893-gram (Sum of 1 & 2)*	**Diagram B** S to S vertical 19.8917-gram (Sum of 1 & 2)*	**Diagram C** N to N vertical 19.9025-gram (Sum of 1 & 2)*	**Diagram D** S to S vertical 19.9013-gram (Sum of 1 & 2)*
0.0 Inch	19.8759-gram 0.0134-gram weight reduction (0.06737%)	19.8757-gram 0.0160-gram weight reduction(0.08045%)	19.8760-gram 0.0265-gram weight reduction(0.13324%)	19.8758-gram 0.0255-gram weight reduction(0.12821%)
1/8 Inch	19.8761-gram 0.0132-gram weight reduction(0.06637%)	19.8751-gram 0.0166-gram weight reduction(0.08346%)	19.8760-gram 0.0265-gram weight reduction(0.13324%)	19.8763-gram 0.0250-gram weight reduction(0.12570%)
1/4 Inch	19.8763-gram 0.0130-gram weight reduction(0.06536%)	19.8748-gram 0.0169-gram weight reduction(0.08497%)	19.8760-gram 0.0265-gram weight reduction(0.13324%)	19.8768-gram 0.0245-gram weight reduction(0.12318%)
3/8 Inch	19.8765-gram 0.0128-gram weight reduction(0.06436%)	19.8753-gram 0.0164-gram weight reduction(0.08246%)	19.8760-gram 0.0265-gram weight reduction(0.13324%)	19.8777-gram 0.0236-gram weight reduction(0.11866%)
1/2 Inch	19.8774-gram 0.0119-gram weight reduction(0.05983%)	19.8753-gram 0.0164-gram weight reduction(0.08246%)	19.8757-gram 0.0268-gram weight reduction(0.13475%)	19.8809-gram 0.0204-gram weight reduction(0.10257%)
5/8 Inch	19.8776-gram 0.0117-gram weight reduction(0.05883%)	19.8754-gram 0.0163-gram weight reduction(0.08195%)	19.8779-gram 0.0246-gram weight reduction(0.12368%)	19.8806-gram 0.0207-gram weight reduction(0.10408%)
11/16 Inch	19.8777-gram 0.0116-gram weight reduction(0.05832%)	19.8748-gram 0.0169-gram weight reduction(0.08497%)	19.8773-gram 0.0252-gram weight reduction(0.12670%)	19.8832-gram 0.0181-gram weight reduction(0.09100%)

* Magnets #1 and #2 were individually weighed in the orientation used in each experiment and their separate weights were added together.

The following equation was used to calculate the weight changes, in dynes, in the proceeding graphs.

$$\vec{\Delta F} = k \cdot \Delta mass \cdot g$$

where

$$k = 980.665 \times dyne \times gm^{-1}$$

and

$$g = 9.80665\ m \times sec^{-2}$$

which is the local rate of gravitational acceleration.

The product of the measured changes in mass, Δmass, and g is denoted as follows on the graphs:

$$NNopen_{n,1} = \Delta mass \times g$$

for N-to-N pole facings in the open (or unshielded).

$$SSopen_{n,1} = \Delta mass \times g$$

for S-to-S pole facings in the open (or unshielded).

$$NNshield_{p,1} = \Delta mass \times g$$

for N-to-N pole facings shielded with Mu 80 shielding.

$$SSshield_{p,1} = \Delta mass \times g$$

for S-to-S pole facings shielded with Mu 80 shielding. In the subscripts, $_n$ and $_p$ refers to the respective number of data points per plot. The subscript $_1$ refers to the vertical change in force (weight change) axis and $_0$ refers to the horizontal distance d axis. In **GRAPH 1**, $_n = {}_p$.

GRAPH 1:

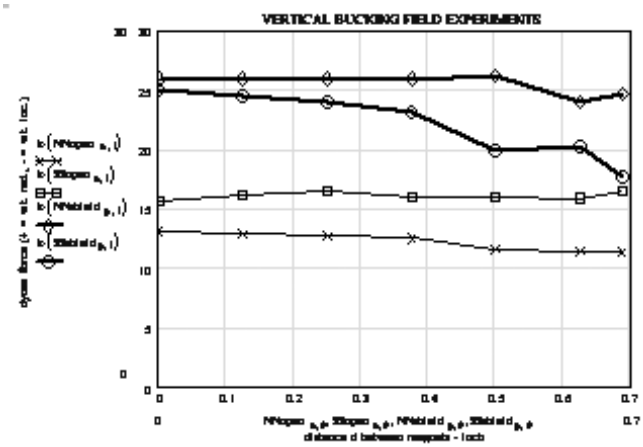

ISOMETRIC AND ELEVATION VIEW OF THE HORIZONTAL EXPERIMENTS

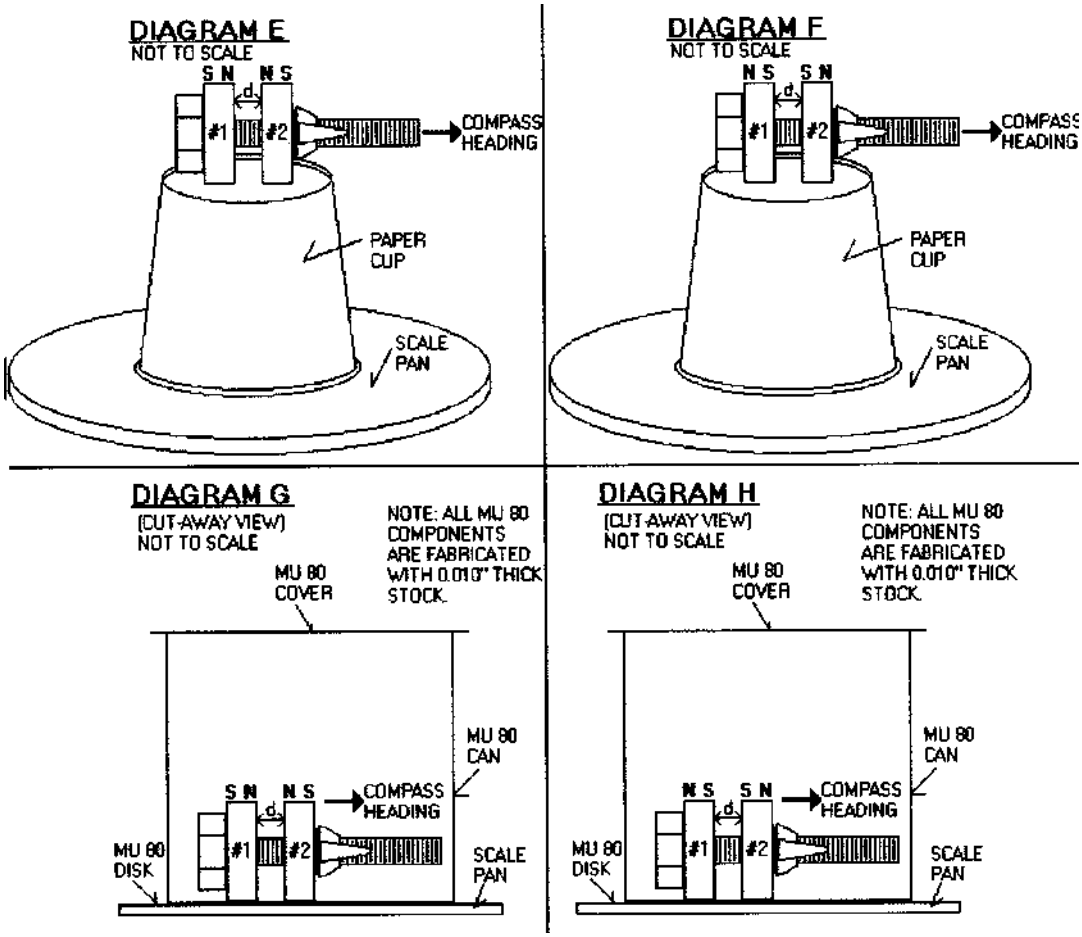

MAGNETIC DECLINATION FROM THE LOCAL TOPOLOGICAL MAP:

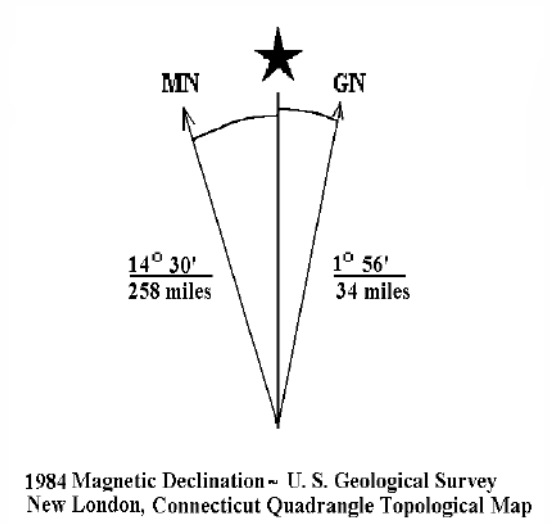

TABLE 2

North # **Heading**	01/14/2002 EXPERIMENTS OPEN, WITH PAPER CUP		02/04/2002 EXPERIMENTS WITH MU 80 SHIELDING	
Air gap d	**Diagram E** N to N horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram F** S to S horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram G** N to N horizontal 19.9019-gram (Sum of 1 & 2)*	**Diagram H** S to S horizontal 19.9019-gram (Sum of 1 & 2)*
0.0 Inch	19.8735-gram 0.0170-gram weight reduction (0.08547%)	19.8778-gram 0.0127-gram weight reduction(0.06385%)	19.8890-gram 0.0129-gram weight reduction(0.06479%)	19.8810-gram 0.0209-gram weight reduction(0.10497%)
1/8 Inch	19.8728-gram 0.0177-gram weight reduction(0.08899%)	19.8790-gram 0.0115-gram weight reduction(0.05782%)	N/A **	N/A **
1/4 Inch	19.8721-gram 0.0184-gram weight reduction(0.09251%)	19.8798-gram 0.0107-gram weight reduction(0.05379%)	N/A **	N/A **
3/8 Inch	19.8705-gram 0.0200-gram weight reduction(0.10055%)	19.8800-gram 0.0105-gram weight reduction(0.05279%)	N/A **	N/A **
1/2 Inch	19.8698-gram 0.0207-gram weight reduction(0.10407%)	19.8811-gram 0.0094-gram weight reduction(0.04726%)	N/A **	N/A **
5/8 Inch	19.8693-gram 0.0212-gram weight reduction(0.10658%)	19.8818-gram 0.0087-gram weigh t reduction(0.04374%)	N/A **	N/A **
11/16 Inch	19.8696-gram 0.0209-gram weight reduction(0.10508%)	19.8827-gram 0.0078-gram weight reduction(0.03921%)	19.9190-gram 0.0171-gram weight increase(0.08588%)	19.9029-gram 0.0010-gram weight increase(0.00502%)

Compass Heading is approximate
* Magnets #1 and #2 were individually weighed with pole faces oriented vertically, with N up then with S up, and the results were averaged and added.
** Due to time constraints, these measurements were not taken.

GRAPH 2:

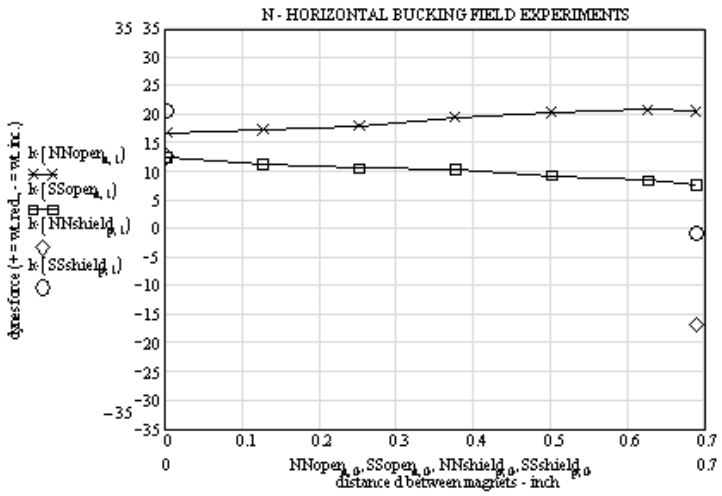

$$volume := \pi \cdot \left[\left(\frac{0.75 \cdot in}{2} \right)^2 - \left(\frac{0.43 \cdot in}{2} \right)^2 \right] \cdot \left(\frac{1}{4} \right) \cdot in$$

volume = 1.214963 cm^3

density = $8.7 \cdot gm \cdot cm^{-3}$

mass = density·volume

mass = 10.570177 gm.

This is higher than the magnetized mass of each magnet.

However, some tables give a lower density for the SmCo magnet, 0.300lb/in^3, which equals:

density = $8.303971 \cdot gm \cdot cm^{-3}$

mass = 10.089017 gm. .

This is still higher than the magnetized mass of each magnet. Does the SmCo material become slightly lighter in weight when it is magnetized?

NOTE:
The calculated mass of each magnet was determined by the following formula based upon the manufacturer's dimensions and density value.

TABLE 3

East # **Heading**	01/14/2002 EXPERIMENTS OPEN, WITH PAPER CUP		02/04/2002 EXPERIMENTS WITH MU 80 SHIELDING	
Air gap D	**Diagram E** N to N horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram F** S to S horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram G** N to N horizontal 19.9019-gram (Sum of 1 & 2)*	**Diagram H** S to S horizontal 19.9019-gram (Sum of 1 & 2)*
0.0 Inch	19.8763-gram 0.0142-gram weight reduction (0.07139%)	19.8755-gram 0.0150-gram weight reduction(0.07541%)	19.8928-gram 0.0091-gram weight reduction(0.04570%)	19.8731-gram 0.0288-gram weight reduction(0.14464%)
1/8 Inch	19.8777-gram 0.0128-gram weight reduction(0.06435%)	19.8750-gram 0.0155-gram weight reduction(0.07793%)	N/A **	N/A **
1/4 Inch	19.8782-gram 0.0123-gram weight reduction(0.06184%)	19.8743-gram 0.0162-gram weight reduction(0.08145%)	N/A **	N/A **
3/8 Inch	19.8779-gram 0.0126-gram weight reduction(0.06335%)	19.8722-gram 0.0183-gram weight reduction(0.09200%)	N/A **	N/A **
1/2 Inch	19.8792-gram 0.0113-gram weight reduction(0.05681%)	19.8715-gram 0.0190-gram weight reduction(0.09552%)	N/A **	N/A **
5/8 Inch	19.8814-gram 0.0091-gram weight reduction(0.04575%)	19.8712-gram 0.0193-gram weight reduction(0.09703%)	N/A **	N/A **
11/16 Inch	19.8815-gram 0.0090-gram weight reduction(0.04525%)	19.8720-gram 0.0185-gram weight reduction(0.09301%)	19.9338-gram 0.0319-gram weight increase(0.16021%)	19.9030-gram 0.0011-gram weight increase(0.00552%)

Compass Heading is approximate
* Magnets #1 and #2 were individually weighed with pole faces oriented vertically, with N up then with S up, and the results were averaged and added.
** Due to time constraints, these measurements were not taken.

GRAPH 3:

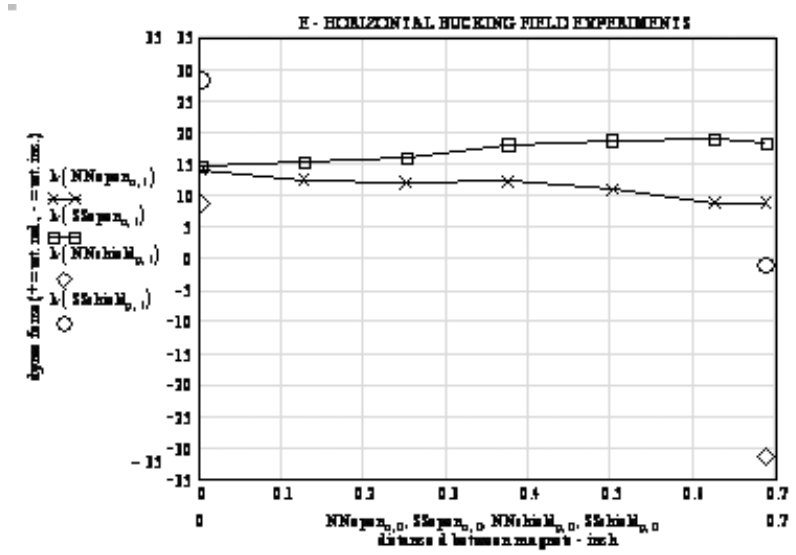

TABLE 4

East # **Heading**	01/14/2002 EXPERIMENTS OPEN, WITH PAPER CUP		02/04/2002 EXPERIMENTS WITH MU 80 SHIELDING	
Air gap D	**Diagram E** N to N horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram F** S to S horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram G** N to N horizontal 19.9019-gram (Sum of 1 & 2)*	**Diagram H** S to S horizontal 19.9019-gram (Sum of 1 & 2)*
0.0 Inch	19.8746-gram 0.0159-gram weight reduction (0.07994%)	19.8769-gram 0.0136-gram weight reduction(0.06837%)	19.8896-gram 0.0123-gram weight reduction(0.06178%)	19.8660-gram 0.0359-gram weight reduction(0.18030%)
1/8 Inch	19.8720-gram 0.0185-gram weight reduction(0.09301%)	19.8788-gram 0.0117-gram weight reduction(0.05882%)	N/A **	N/A **
1/4 Inch	19.8709-gram 0.0196-gram weight reduction(0.09854%)	19.8797-gram 0.0108-gram weight reduction(0.05430%)	N/A **	N/A **
3/8 Inch	19.8704-gram 0.0201-gram weight reduction(0.10105%)	19.8803-gram 0.0102-gram weight reduction(0.05128%)	N/A **	N/A **
1/2 Inch	19.8711-gram 0.0194-gram weight reduction(0.09753%)	19.8814-gram 0.0091-gram weight reduction(0.04575%)	N/A **	N/A **
5/8 Inch	19.8698-gram 0.0207-gram weight reduction(0.10407%)	19.8825-gram 0.0080-gram weight reduction(0.04022%)	N/A **	N/A **
11/16 Inch	19.8703-gram 0.0202-gram weight reduction(0.10156%)	19.8817-gram 0.0088-gram weight reduction(0.04424%)	19.9423-gram 0.0404-gram weight increase(0.20290%)	19.8810-gram 0.0209-gram weight reduction(0.10497%)

Compass Heading is approximate
* Magnets #1 and #2 were individually weighed with pole faces oriented vertically, with N up then with S up, and the results were averaged and added.
** Due to time constraints, these measurements were not taken.

GRAPH 4:

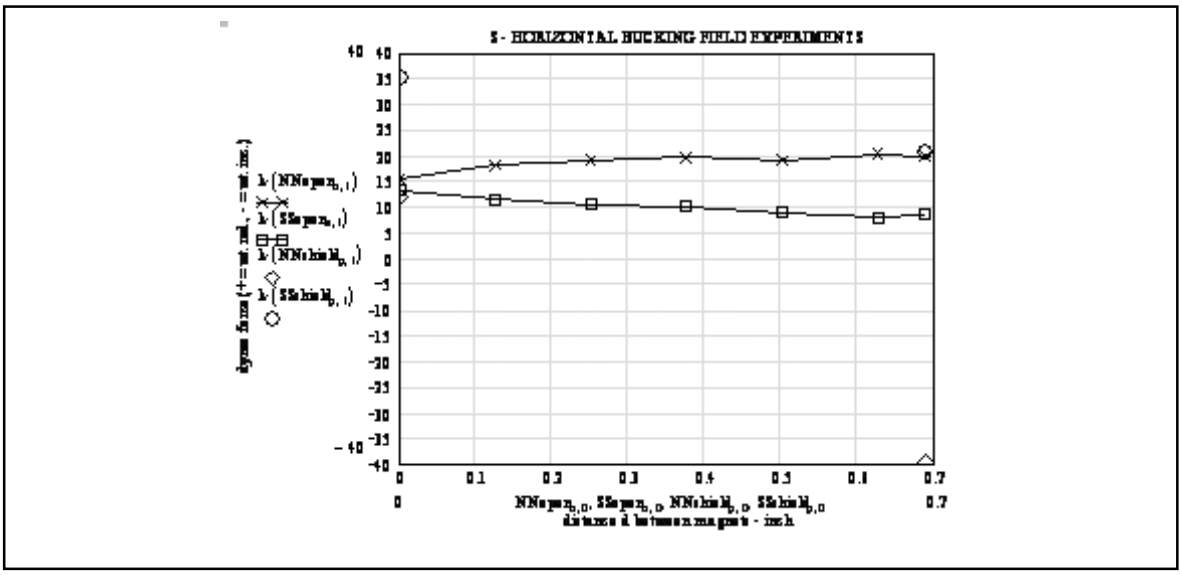

TABLE 5

West # **Heading**	01/14/2002 EXPERIMENTS OPEN, WITH PAPER CUP		02/04/2002 EXPERIMENTS WITH MU 80 SHIELDING	
Air gap D	**Diagram E** N to N horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram F** S to S horizontal 19.8905-gram (Sum of 1 & 2)*	**Diagram G** N to N horizontal 19.9019-gram (Sum of 1 & 2)*	**Diagram H** S to S horizontal 19.9019-gram (Sum of 1 & 2)*
0.0 Inch	19.8777-gram 0.0128-gram weight reduction (0.06787%)	19.8748-gram 0.0157-gram weight reduction(0.07893%)	19.8933-gram 0.0086-gram weight reduction(0.04319%)	19.8724-gram 0.0295-gram weight reduction(0.14816%)
1/8 Inch	19.8767-gram 0.0138-gram weight reduction(0.06938%)	19.8737-gram 0.0168-gram weight reduction(0.08446%)	N/A **	N/A **
1/4 Inch	19.8777-gram 0.0128-gram weight reduction(0.06435%)	19.8733-gram 0.0172-gram weight reduction(0.08647%)	N/A **	N/A **
3/8 Inch	19.8783-gram 0.0122-gram weight reduction(0.06134%)	19.8727-gram 0.0178-gram weight reduction(0.08949%)	N/A **	N/A **
1/2 Inch	19.8806-gram 0.0099-gram weight reduction(0.04977%)	19.8722-gram 0.0183-gram weight reduction(0.09200%)	N/A **	N/A **
5/8 Inch	19.8811-gram 0.0094-gram weight reduction(0.04726%)	19.8715-gram 0.0190-gram weight reduction(0.09552%)	N/A **	N/A **
11/16 Inch	19.8803-gram 0.0102-gram weight reduction(0.05128%)	19.8723-gram 0.0182-gram weight reduction(0.09150%)	19.9427-gram 0.0408-gram weight increase(0.20491%)	19.8976-gram 0.0043-gram weight reduction(0.02160%)

Compass Heading is approximate
* Magnets #1 and #2 were individually weighed with pole faces oriented vertically, with N up then with S up, and the results were averaged and added.
** Due to time constraints, these measurements were not taken.

GRAPH 5:

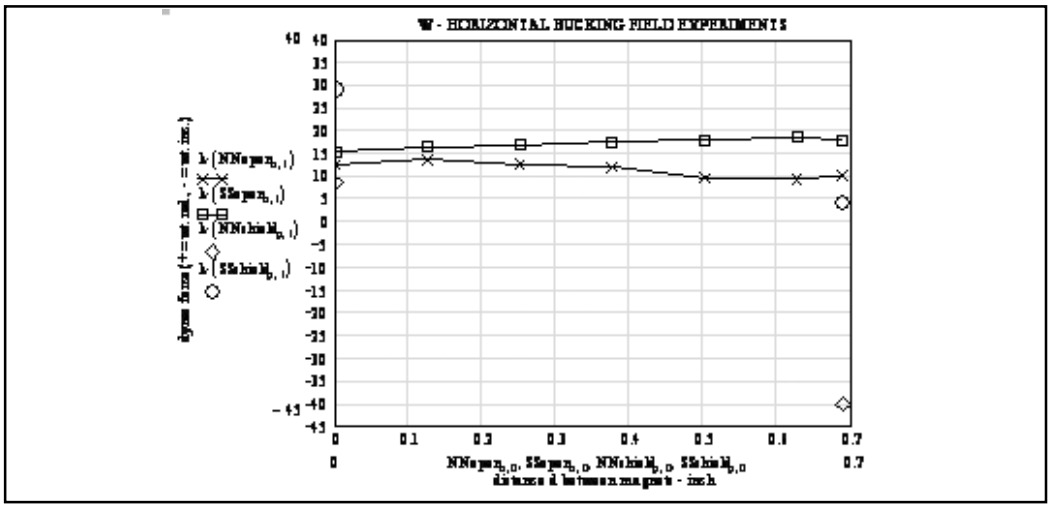

RING MAGNET #1, N UP: 9.9483-grams
RING MAGNET #2, N UP: +9.9527-grams
TOTAL WEIGHT: 19.9010-grams
WEIGHT INCREASE WITH OPPOSITE POLES ATTRACTING, AS DEPICTED IN **DIAGRAM I**, IN MU 80 SHIELD where 19.9861-grams was the measured value:
19.9861-grams – 19.9010-grams = 0.0851-gram weight increase.

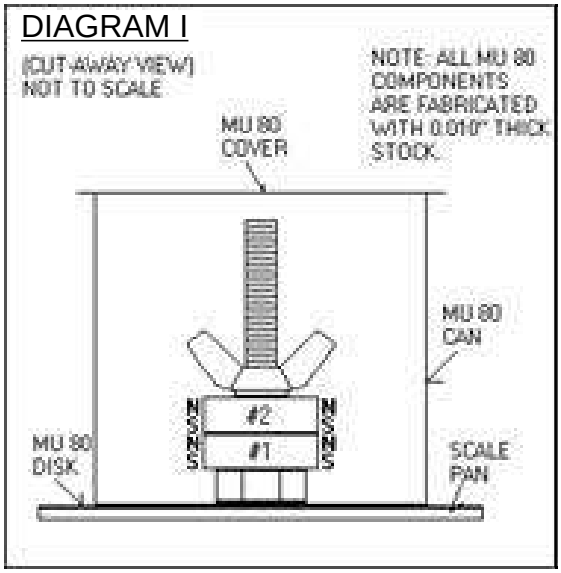

THREE RIVERS COMMUNITY COLLEGE, THAMES VALLEY CAMPUS LAB REPORT ON SmCo RING MAGNET EXPERIMENTS

The following experiments were conducted at the *Thames Valley Campus* (TVC) of the *Three Rivers Community College*, Room #207 Chemistry Laboratory, in Norwich, Connecticut on March 8, 2002. (41° 30' 34.62" N. latitude x 72° 6' 13.63" W. longitude x 115 feet elevation above mean sea level) I wish to thank the instructors at *Three Rivers* for their generosity for providing the use of their *Sartorius*® Model # 2442 analytical balance for the measurements taken in the proceeding experiments. The *Sartorius* Model # 2442 analytical balance is an enclosed pan unit with a maximum mass range of 200-grams with 0.0001-gram micrometer readability and a precision of 0.05-mg standard deviation.

The purpose of these experiments was to compare the Avery Point vertical measurements conducted on the *Mettler Toledo*® Model AG104 electronic scale, in **TABLE 1**, with the *Sartorius* Model # 2442 analytical balance measurements recorded in **TABLE 6**. The same two Samarium Cobalt magnets (magnet #1 and magnet #2) weighed individually in each vertical orientation were compared to the weight measurements taken when they were assembled using the nylon bolt and wing nut depicted in **DIAGRAM 1**. The specifications for the two Samarium Cobalt magnets used in the following experiments are shown in **DIAGRAM 1**.

The first column in **TABLE 6**, the vertical measurements, is the distance of separation d, or air gap, of the magnets. The second column shows the weight measurements of the two magnets, as shown in **DIAGRAM A**. The third column shows the weight measurements of the two magnets, as shown in **DIAGRAM B**. An inverted paper cup was used to raise the test sample magnets 2.75" above the *Sartorius* Model # 2442 balance scale pan in order to minimize possible magnetic interaction with the balance, as depicted in **DIAGRAM 2**. The fourth column shows the weight measurements of the two magnets, as shown in **DIAGRAM C**. The fifth column shows the weight measurements of the two magnets, as shown in **DIAGRAM D**. These experiments were shielded with

Mu 80 magnetic shielding material as depicted in **DIAGRAM 3**. The resultant data of **TABLE 6** is plotted on **GRAPH 6**. The results of the previous experiments at *Avery Point*, from **GRAPH 1**, and the recent *Thames Valley* experiments, from **GRAPH 6**, are plotted on **GRAPH 7** for comparison. The Mu 80 magnetically shielded experiments on the *Sartorius* Model # 2442 analytical balance at *Thames Valley* are in close agreement with the data collected with the AG104 electronic scale at Avery Point. However, the *Thames Valley* data collected for the unshielded experiments is somewhat smaller in weight reduction. I attribute this to external interference. The *Thames Valley* setup included a nonferrous tabletop, as did the Avery Point setup. However, the *Thames Valley* balance table consisted of a steel frame and legs, which may have altered the readings. The Mu 80 shielding provided a more intrinsic method for accurate data collection.

The horizontal measurements were not taken in this set of experiments due to time constraints. A final experiment was attempted to replicate the relative weight increase with the opposite poles of the ring magnets "stuck" together, as depicted in **DIAGRAM I**; however, the magnets shattered during assembly!

TABLE 6

	03/08/2002 TRCC EXPERIMENTS, @ TVC: OPEN, WITH PAPER CUP		03/08/2002 TRCC EXPERIMENTS, @ TVC: WITH MU 80 SHIELDING	
Air gap d	**Diagram A** N to N vertical 19.8734-gram (Sum of 1 & 2)*	**Diagram B** S to S vertical 19.8726-gram (Sum of 1 & 2)*	**Diagram C** N to N vertical 19.8912-gram (Sum of 1 & 2)*	**Diagram D** S to S vertical 19.8929-gram (Sum of 1 & 2)*
0.0 Inch	19.8699-gram 0.0035-gram weight reduction (0.01761%)	19.8696-gram 0.0030-gram weight reduction(0.01510%)	19.8691-gram 0.0221-gram weight reduction(0.11110%)	19.8706-gram 0.0223-gram weight reduction(0.11210%)
1/8 Inch	19.8699-gram 0.0035-gram weight reduction(0.01761%)	19.8699-gram 0.0027-gram weight reduction(0.01359%)	19.8688-gram 0.0224-gram weight reduction(0.11261%)	19.8707-gram 0.0222-gram weight reduction(0.11160%)
1/4 Inch	19.8695-gram 0.0039-gram weight reduction(0.01962%)	19.8695-gram 0.0031-gram weight reduction(0.01560%)	19.8687-gram 0.0225-gram weight reduction(0.11312%)	19.8712-gram 0.0217-gram weight reduction(0.10908%)
3/8 Inch	19.8695-gram 0.0039-gram weight reduction(0.01962%)	19.8699-gram 0.0027-gram weight reduction(0.01359%)	19.8692-gram 0.0220-gram weight reduction(0.11060%)	19.8730-gram 0.0199-gram weight reduction(0.10004%)
1/2 Inch	19.8689-gram 0.0045-gram weight reduction(0.02264%)	19.8699-gram 0.0027-gram weight reduction(0.01359%)	19.8695-gram 0.0217-gram weight reduction(0.10909%)	19.8738-gram 0.0191-gram weight reduction(0.09601%)
5/8 Inch	19.8686-gram 0.0048-gram weight reduction(0.02415%)	19.8699-gram 0.0027-gram weight reduction(0.01359%)	19.8702-gram 0.0210-gram weight reduction(0.10557%)	19.8746-gram 0.0183-gram weight reduction(0.09199%)
11/16 Inch	19.8680-gram 0.0054-gram weight reduction(0.02717%)	19.8699-gram 0.0027-gram weight reduction(0.01359%)	19.8707-gram 0.0205-gram weight reduction(0.10306%)	19.8756-gram 0.0173-gram weight reduction(0.08697%)

* Magnets #1 and #2 were individually weighed in the orientation used in each experiment and their separate weights were added together.

NOTE:
March 8, 2002 Experiments: Start time: 12:12 hours EST, End time: 13:47 hours EST.

GRAPH 6:

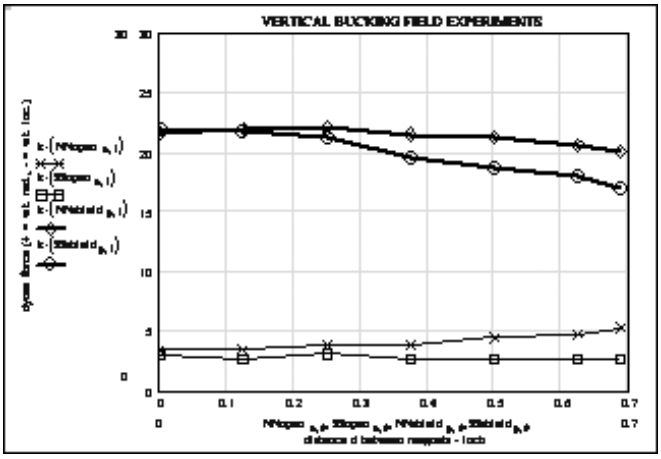

MAGNETIC DECLINATION FROM THE LOCAL TOPOLOGICAL MAP

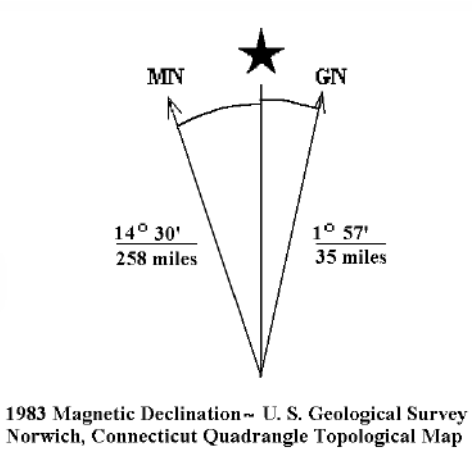

GRAPH 7:

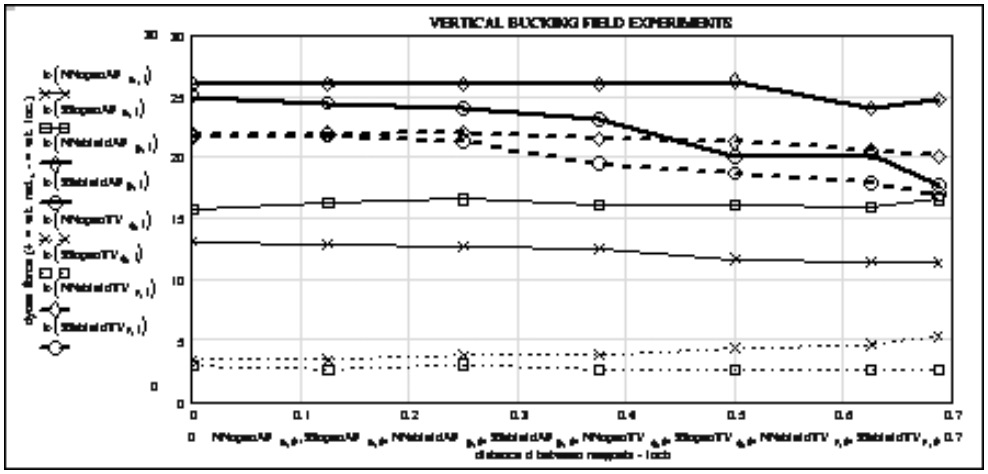

KEY TO **GRAPH 7**:

For N-to-N pole facings in the open (or unshielded) at Avery Point (AP):
NNopenAP
For S-to-S pole facings in the open (or unshielded) at Avery Point (AP):
SSopenAP
For N-to-N pole facings shielded with Mu 80 shielding at Avery Point (AP):
NNshieldAP
For S-to-S pole facings shielded with Mu 80 shielding at Avery Point (AP):
SSshieldAP
For N-to-N pole facings in the open (or unshielded) at Thames Valley (TV):
NNopenTV
For S-to-S pole facings in the open (or unshielded) at Thames Valley (TV):
SSopenTV
For N-to-N pole facings shielded with Mu 80 shielding at Thames Valley (TV):
NNshieldTV
For S-to-S pole facings shielded with Mu 80 shielding at Thames Valley (TV):
SSshieldTV

The subscripts for the data points $_n = _p = _q = _r = 7$ are all the same value in **GRAPH 7**.

Advanced Nuclear Waste Decontamination Technologies

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It is a review of nine alternative, peer-reviewed techniques as candidates for the global clean-up of nuclear waste.

The following is a reasonably comprehensive list of potentially effective nuclear waste treatment methods that might be employed to treat the entire range of radioactive wastes that have proven to be such a daunting and horrendously expensive problem for the nuclear industry (in all its forms) with major, long term implications for the environment.

A wide variety of methods will probably be required to accommodate the many different radioactive waste sources including high and low level, solids, liquids and gases. Process names used here are in some cases just convenient labels used to categorize and set them apart from each other.

Theories on several of these processes are still quite speculative and solid evidence that would pass conventional peer review is still lacking. This is after all a very new field of science.

Some of these technologies are already well protected by international or national patents, with additional US and international patents pending, and further patents may be obtained on new developments as they are made.

The Brown's Gas-Metal Matrix Process:

The BG-MMX process utilizes a patented electrolysis cell of the Australian Prof. **Yull Brown**'s design that is said to produce a stoichiometric mixture of monatomic hydrogen and oxygen or possibly a quasi-stable water molecule raised to a high-energy state. This gas has some very peculiar properties including the ability to sublimate tungsten (6000°C) with an implosive flame that burns cool in air with a temperature of only 130°C.

The gas is used to heat a proprietary mixture of metals and/or metal oxides including the radwaste to be neutralized. A highly exothermic radiant reaction appears to result in the immediate reduction of radioactivity approaching 95% of the original levels judging from preliminary tests, within seconds of treatment. The process is conjectured to be effective with high level solid wastes and possibly gasses, but probably not liquids. The high temperatures involved may also preclude the processing of more volatile wastes.

Since 1991, this technology has been successfully demonstrated, on a small scale, at least 50 times to US, Chinese, Japanese and United Kingdom officials on a variety of nuclear waste products including Americium, Cobalt, Uranium, and Plutonium. The technique can be applied for the immediate decontamination of stockpiles of nuclear waste materials being held near nuclear power plants. The process is very simple, safe, and inexpensive to develop further into robotics application for on-site treatment with no foreseen environmental effects.

Photoremediation

The *Photoremediation* process of the American Dr. **Paul Brown** is essentially conventional physics, *albeit* applied in a new and novel way. The process involves the use of a high-energy electron beam impinged on a target, which in turn produces a monochromatic gamma radiation that is tuned to induce *Photofission* and *Photoneutron* reactions in the target material causing rapid neutralization of radioactive isotopes. The efficiency claimed exceeds 500% due to the high cross-section reactions in the Giant Dipole Resonance region. The 10 MeV electron beam produces typical fission reactions in the 200MeV range effectively turning high level solid wastes such as spent fuel into an energy source. The process is apparently intended for on-site treatment with some waste-partitioning required, an aspect which may not be desirable in certain countries.

While this idea is similar in topology to a system being developed by **Los Alamos National Labs**, Dr. Paul Brown's approach offers several advantages: no need for extensive chemical pre-processing and the energy required to effect transmutation is greatly reduced. No new technology needs to be developed, yet the engineering of such a photon reactor must be completed and it could itself become a practical method for generating power.

ZIPP Fusion

The ZIPP fusion process, identified by **Mark Porringa**, induces a wide variety of fusion reactions, resulting from the radial compression of individual diatomic and other simple molecules dissolved or suspended in a light

water, carbon arc electrolysis cell. A variety of other cell configurations are envisioned.

The process appears to produce only stable isotopes, which should therefore make it capable of stabilizing a wide variety of radioactive waste materials. The theory on the process draws from Condensed Charge phenomena, Brown's Gas implosion, cavitation bubble collapse and sonoluminesence - all variations of the Casimir effect - which is believed to cohere the Zero-point energy of Quantum Vacuum Fluctuations. Transmutations using variations of this basic process may be applicable to a wide variety of nuclear wastes and appears capable of operating with an efficiency exceeding 100%.

A major implication of this process is that the Strong force of the nucleus is understood as an ultra close range Casimir effect. **Oakridge** Nuclear Laboratories in the US in conjunction with several international collaborators have just (this month, in fact) announced a deuterium cold fusion process based on the essential elements of the ZIPP Fusion process first reported in 1998. The process is very simple and inexpensive to develop.

RIPPLE Fission

The RIPPLE Fission process is an adaptation of existing potential technology utilizing a supersonic ionized gas to aerosol a counter flow heat exchanger that envelopes the radioactive waste aerosol in a vacuum induced plasma vortex which appears to disrupt the matter stabilizing influence of the Quantum Vacuum fluctuations resulting in "gentle" low recoil fission reactions which produce only stable fission products, with excess neutrons being prompt converted to protons via quenched Beta emissions. The process is apparently proven with conventional non-radioactive wastes and is believed applicable to the entire spectrum of radwaste without the need for waste partitioning. This process is also conjectured to operate with over-unity efficiency.

The LENTEC Processes

The Low Energy Nuclear Transmutation Electrolytic Cells of the Cincinnati group produce a variety of transmutation reactions using a variety of exotic electrolysis cell designs that generally produce condensed charge clusters composed primarily of up to 10^{11} electrons each. These electron charge clusters produced with the use of special electrodes can penetrate the nuclei of larger atoms in solution and transmute these atoms into stable elements.

The range of design and operating protocols and potential applications are essentially limitless provided for the waste that is dispersed in the electrolyte. The reported transmutation of thorium to stable titanium and copper by the Cincinnati Group and by the Salt Lake City group is one of the most dramatic examples of this type of treatment process. Application to other high-level liquid transuranic fissionable wastes such as surplus Plutonium seems likely. The glaring absence of normal fission yield energies is perplexing but probably explicable as another form of low recoil fission reaction, similar to RIPPLE fission.

The Plasma Induced/Injected Transmutation - PIT Processes (also known as HDCC)

Plasma Induced/Injected Transmutation processes run include a gamut from recent achievements dating back to the **Oshawa-Kushi** cold plasma transmutations reported in 1964. The patented high-density charge cluster process (HDCC) was first discovered by **Kenneth Shoulders** and added on to by **Harold E. Puthoff**. Later, the late **Stan Gleeson** discovered HDCC in properly processed solutions. Still later, **Alexander Ilyanok** of Belarus discovered HDCC, followed by **Vasiliy Baraboskin** in Russia.

The production of Condensed Charge Clusters and various plasma glow discharge phenomena in a variety of gaseous atmospheres is again implicated as the underlying cause with what should be by now an obvious connection with the coherence of Zero-point energy from the Quantum or Stochastic vacuum.

Desk-top high energy particle accelerators have also been envisioned, based on the "piggy back" principle, in which the clusters permit acceleration of "piggy-backed" heaver +ions to extremely high energies capable of causing fusion and transmutations in target materials including those in solution and the materials of which the electrodes are composed. Brown's Gas implosion and cavitation bubble collapse reactions are also believed to be prevalent in these types of cells due to the prevalence of electrolysis.

A high-density charge cluster technology was discovered and used by Stan Gleeson to stabilize radioactive liquid wastes and has been developed further in the last 4 years by a group led by **S-X Jin** and **Hal Fox**. Best results for radioactive liquids have been demonstrated in the processing of thorium for a 30-minute period and achieving a reduction of radioactivity of about 90% from a liquid sample.

Kervran Reactions

The very compelling evidence compiled by French Nobel Candidate Dr. **Louis Kervran** has identified a wide range of nuclear transmutations in biological systems that have not been adequately explained. Coherence of Zero-point energy via Casimir effects within the *Somatid* particles identified by the Canadian **Gaston Naessens** is implicated as a possible cause. A wide variety of *in vitro* and *in vivo* reactions are believed to be possible as proven in nature and numerous experiments typically involving a reaction medium composed of a dielectric fluid such as water. Highly radiation resistant microorganisms have been found

thriving in the core of nuclear reactors indicating the possibility of microorganisms being capable of transmuting some bioactive nuclear wastes in the course of the normal metabolism of such organisms.

The Monti Process

The Italian **Roberto A. Monti's** process involves confined explosions involving proprietary mixtures of materials that include radioactive waste. Ignition of such mixtures causes nuclear transmutations resulting in reduced radioactivity (to near-background levels) following combustion, gradually over 1 to 4 days.

This technique has been confirmed by the Italian **ENEA** and is supported by the French CEA scientists as a serious candidate for treatment of waste stockpiles. The system, as currently designed, required waste to be inserted into a chamber.

Higher group symmetry electrodynamics

Extremely weak, non-classical, higher group symmetry electromagnetic fields were found during a 1991 experiment made by **Glen Rein** to alter significantly the level of radioactivity in materials, even those in the environment. The experiments suggest that higher group symmetry electrodynamics modulate the quantitative and /or qualitative properties of radioactive species. If the non-classical fields directly affect the radioactive species, it is likely that the appropriate field parameters will be discovered to neutralize radioactive emissions. In 1999, a theoretical basis for the phenomenon was developed by the Welsh physicist, **M. W. Evans**, with the participation of Lt. Col. (retired) **Thomas E. Bearden**.

The technology is extremely simple and could be applied with minimum logistics for treating massive structures, *in-to* outdoors, such as the Chernobyl disaster site.

Psitronics Group Systems, International

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E-mail: wizzard9@earthlink.net Phone:1-(505)-836-7534

Psi/Group's Magnetic Motor - Funding for New Prototype Sought:

As the engineer who designed the self-sustaining magnetic motor being advertised by Psitronics Group Systems, International. It perhaps falls upon me to explain (as well as I am able) the methods used by me in this motor's design:

The actual "picture" description is totally Intellectual Property; Protected as a Trade Secret.

However: This magnetic motor is a "perpetually imbalanced configuration" of permanent magnets; an unequal number of magnets on the rotor & stator; that revolves in a "self-sustaining" manner as the magnets seek balance... There are no electrical components in the design unless one wished to insert alternator windings in the stator to provide an electrical output...

We have discovered: through a prior unsuccessful prototype that using a para-magnetic material (we used aluminum) for the rotor & stator was self-defeating; as with the powerful rare earth magnets used in the design aluminum destroyed the magnetic fields... On further analysis of the failed prototype it was deduced that a "latch up" condition would occur between rotor & stator magnets; unless the rotor magnets were canted or skewed at an angle from the stator magnets... The plastic prototype contemplated corrects both of these problems....

We are seeking an investor willing to put up $4000 (DUS) for the prototype and who can offer $40,000 return on investment "if it proves successful" ...We have a Global Distribution 'ready to go" as well as a pledge of $ Millions towards Manufacturing & Marketing from EarthTech, International on submission of a running motor...

Very Respectfully Yours,
Paul LeBreton

http://home.earthlink.net/~wizzard9
(Psi/Group Website)

Inquiries should be emailed to:
wizzard9@earthlink.net

Experimental Investigations of the Radioactive Isotope Half-Value Period Changing in the Local Volume of Cause-Effect Relations

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Nuclear-design methods of the elemental analysis are based on the property of the radioactive isotope decay rate constant. Half period as a constant quantity is defined by the time feature (the time flow is uniform in the every space point). The given postulate is confirmed by the long-term results and raised no doubts. But in last years some researches, investigating enough fine effects by change of the registered radiation intensivity, came to the conclusion about influence of space cycles on the time flow [1]. In his turn, N. A. Kozyrev during the investigation of active physical properties of time came to the conclusion about violation of its uniform flow in the local volume of the cause-effect relations, created by the cyclic motion (rotation, oscillation) of bodies [2,3,4].

Thus, the author get an idea to use a radioactive isotope cezium-137 as a "sensor", measuring the changes of time flow uniformity in the certain local volume of cause-effect relations. In basis there are following arguments: owing to a conception of time uniformity and considerable cezium-137 half-value period, the source activity must be permanent during the experiment time. By the time flow (period) change, i.e. changes of uniformity in the local volume of cause-effect relations, the half-value period – T is changing in the direct proportion. Source activity, respectively, is changing in the inverse proportion according to the law exp (1/T) in relation to the external space volume. Hence, registered gamma-quantum intension (amplitude impulse distribution) in the absence of the cause-effect relations is proportional to the function $N_0 \sim \exp(\ln 2/T_0)$. Then the proportion $N_0/\Delta N$, where $\Delta N = N_0 - N$ is made, and by means of it a half-value period difference is defined by the formula

$$1/\Delta T = |1/T_0 + \ln(\Delta N/N_0)/\ln 2| \qquad (1)$$

N_0 – selective average amplitudes of impulses at the case of static liquid (in the absence of the cause-effect relations);
N - selective average amplitudes of impulses at the case of rotation of liquid.

In this case, there were investigations of the determination of the gamma-quantum intension change (i.e. change of a half-value period) dependence on the angular velocity of the activator rotation, and also on the coordinates location and amount of cause-effect relations (Fig. 1).

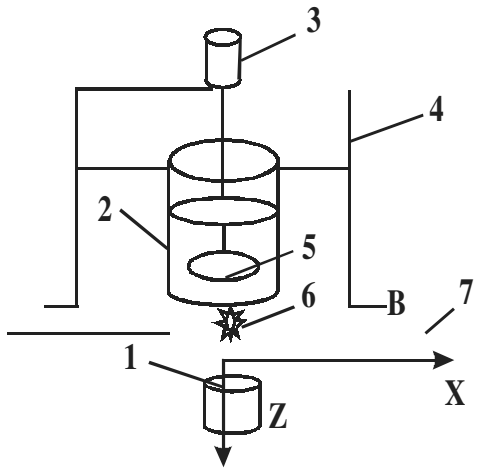

Fig.1

The following devices were used as measurement equipment: semi-conducting detector (SCD-63V) (1), preamplifier (PAG-2K), amplifier (BAI-3K) and analyzer (AMA-02F1). Energy gamma-line of 662 KeV was measured with the resolution 4 KeV. The gamma-quantum source was glued to the detector housing at the distance of 100 mm from its surface; so, any spatial change through coordinate axes was executed together with the detector to avoid even a tiny change of the source-detector geometry.

The vessel with a liquid (2) was placed above the source (6), vortex fluid motion was created by an activator (5), placed on the rod of electric motor (3). The glass with a liquid, connected with the motor and frame (4), was displaced regarding to the center of the revolved activator, what was the reason of the glass vibration in horizontal line, and, hence, one of frame sides vibration in vertical line (v). In its base, the frame was a square with the side of 200 mm. To assign the direction of the space cause-effect relations, one of frame sides was vibrating, and the opposite one (on the X axis) was fixed on the table (7). An experiment was made in such a way, that vibrating parts did not adjoin with the detector. The radius of glass is 50 mm, the distance from central axis up to the vibrating frame part is 100 mm. N-selection of the every value on the diagram (Fig. 2) corresponded to twenty measurements, roots from the average variance of numbers distribution $D \approx 160$ impulses.

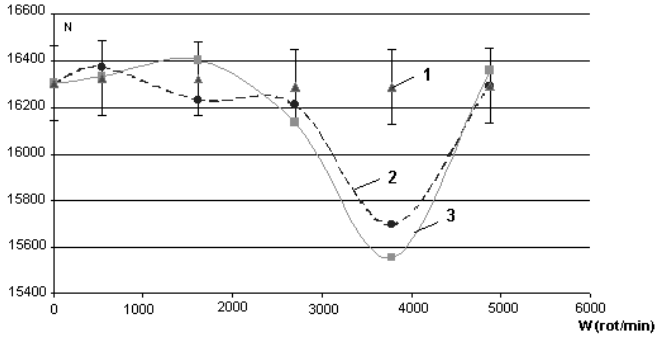

Fig. 2
Dependence of photopeak-N area from the angular velocity of rotation – W, where 1 – is photopeak area at static liquid, 2 – is photopeak area at clockwise rotation, 3 – is photopeak area at anticlockwise rotation

During two months eighteen experiments were made (at the one geometry) of the given effect fluctuation study, and there were no considerable deviation. An effect of the time deceleration always appeared at the angular speed of the activator rotation W=3780 r/min (during the vibration of the whole perimeter of the frame base). If there was a vibration on the only one side of the frame base (on the X axis), then this effect appeared at the higher speed of rotation. Unfortunately, the maximum motor speed of rotation W_{max}=4880 r/min did not let to define the precise position for the next rotation point. During the experimental results extrapolation $W_2 \approx 5930$ r/min ($W_2 \approx \pi W/2$) was obtained.

In the table there are selective middle amplitudes of impulses $-N=\sum N_n/n$ roots from the numbers distribution average variance D, dispersion of the simple average G at the different directions of the liquid rotation (for the rotation point W=3780 r/min). The half period is estimated by the equation (1) and formula $T=T_0+\Delta T$ where T_0=30.2 year (the cezium-137 half-value period).

Liquid motion	N, imp.	D	G	T, year
Static liquid	16304.0	160.7	35.9	30.200
Clockwise	15696.0	162.0	36.2	30.412
Anticlockwise	15553.0	165.0	36.9	30.423

During the investigation of the activator angular speed of rotation dependence on the registered gamma-quantum intension, **there was discovered the time deceleration effect in the fixed point of ambient space of the glass with the liquid.** The effect was versatile, during the further study of the reasons of the effect disappearance, the following regularities were found:

1. Intension change appeared only at the case of asymmetrically fixed glass, when there appeared horizontal oscillations, transmitted to the vertical oscillations of the frame;

2. An effect disappeared, if the gamma-quantum source was placed in the glass center (~ 2 ÷ 3 mm down from the glass bottom);

3. At the same speed of rotation but without liquid, with an eccentric activator, the time deceleration effect disappeared.

Will consider the system with liquid, its internal chain consisted of three cause-effect relations:

1. Activator-liquid;
2. Liquid-glass (frame);
3. Frame-table.

Glass oscillations were transmitted to the frame through the hard cohesion. There was only one cause-effect relation – an activator (a frame) – a table. Thus, amplitude of the time flow changing was, most likely, influenced on by the amount of cause-effect relation, and also, there was observed a quantum effect, dependent on the activator and liquid rotation frequency.

The time deceleration maximum amplitude appeared during the source displacement from the central axis of glass along the X coordinate to the distance ~ 5 mm. There appeared the necessity to check the given effect on space points along the all coordinate axes in the radius R ≈ 100 mm from the central point of the glass bottom (an extreme vibration point along the X axis was placed on this distance).

On this purpose there were made some experiments, results of which are shown on the (Fig. 3), (Fig. 4).

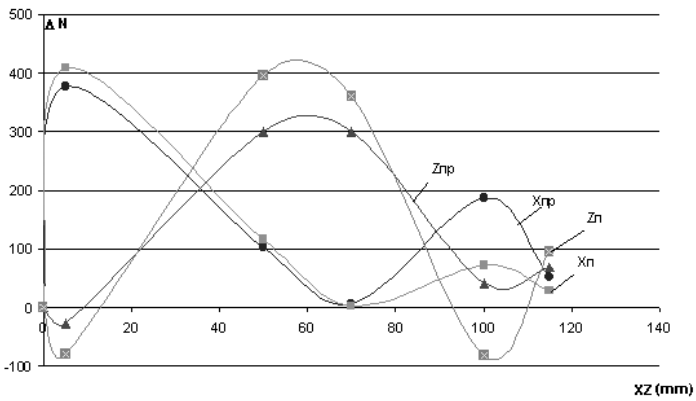

Fig. 3
Dependence of the increase of photopeak -ΔN area from the spatial interval in Cause-Effect Relations by X and Z coordinates, where X_cZ_c – is clockwise rotation, $X_{ac}Z_{ac}$ – is anticlockwise rotation

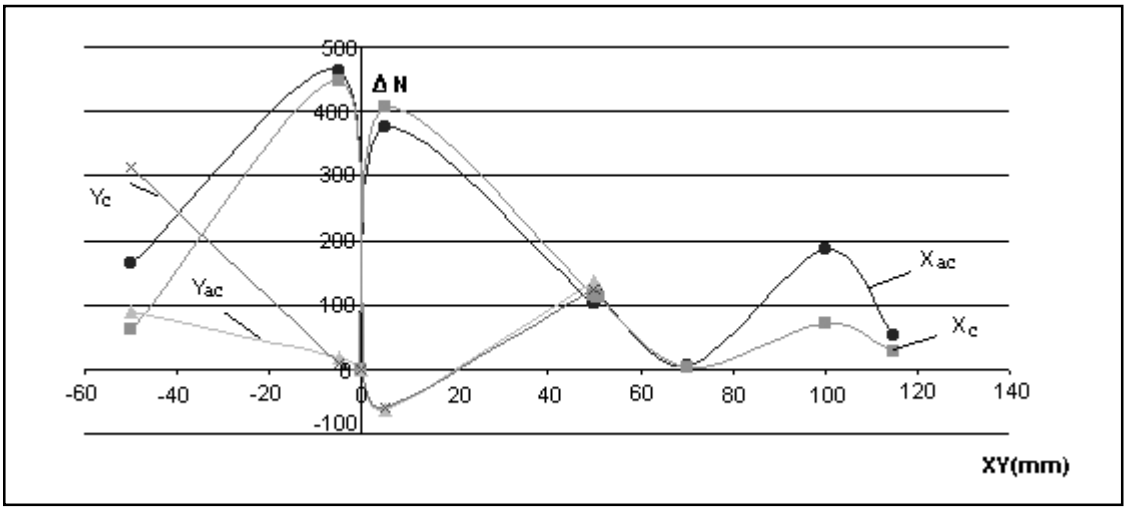

Fig. 4
Dependence of the increase of photopeak -ΔN area from the spatial interval in Cause-Effect Relations by X and Y coordinates, where X_cY_c – is clockwise rotation, $X_{ac}Y_{ac}$ – is anticlockwise rotation

Let us suppose that positive axis Z is directed from the glass bottom center to the ground and axis X – from the central axis of glass to the vibrated part of the frame (North-West), in this case Y is directed to the North-East. Along the all coordinates, in every adjusted space points on the distance R_i from the glass bottom center (R_i = 5; 50; 70; 100; 115 mm), there were forty measurements. At that in every point after ten measurements connected with the rotation there were measurements at the static liquid. It was made to avoid any systematic errors. The amplitude of the sample average impulses at the static liquid - N_0=10550 imp. In this case the root from the dispersion Δ=120, dispersion of the simple average G=19. Amplitude increment was calculated by the formula $\Delta N=|N_0-N|$. Following regularities were found:

1. If considering the difference of impulse amplitude (in the positive coordinate space) in the first cause-effect relation evidence (activator-liquid), i.e., to put the difference between the initial (5 mm) and final (50 mm) points of amplitude registration (their middle evidence between "clockwise" and "anticlockwise") $\Delta N_5^{50}=|N_5-N_{50}|$ into the formula (1), then relations $\Delta T_Z/\Delta T_X=\Delta T_X/\Delta T_Y\approx 1.11$ ($\pi/2\sqrt{2}\approx 1.11$)

2. Change of impulse amplitude difference along X is the antiphase of changes along Z and Y;

3. At the rotation clockwise and anticlockwise there takes place a periodical inversion of amplitudes difference relation;

4. At the liquid rotation clockwise and anticlockwise, there appears an obvious distinction in evidences of the increment ΔN in negative region of coordinate axes;

5. Along Y and Z-axes in points (5; 100 mm) there is observed insignificant time acceleration.

The whole cause-effect relation system was defined as an internal (activator-table), as an external one (ground - system center of gravity). **In the internal space volume time at the certain conditions breaks its own uniformity, at that the time period change is nonlinear and is defined by its quantum nature.** Therefore, standard clocks in causal relations must be considered regarding to the center of gravity and location of the measurement point in the internal system space.

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TILLEY ELECTRIC VEHICLE

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Nowadays there stays urgent the development of technologies, which could possibly be combined into a reliable, commercially successful advanced self powered vehicle with additional desirable but currently commercially unavailable features.

The advantages of electric vehicles seem to be evident – they are clean, quiet, powerful, require much less maintenance than gasoline or diesel-fueled vehicles, and are inherently much simpler and easier to manufacture. Their drawbacks have been a short range, long battery recharging time, and a heavy, bulky battery pack.

After several years of personal accomplishments in the alternative energy industry, **Carl B. Tilley, the inventor from USA,** was convinced that it was possible to build an electric car that could be powered without the help of external power to keep the battery charged.

The concept to produce a useful electric performance car that would last more than a few hours and would be economical to run, safe to drive around town or across the United States and never use a drop of fuel challenges the future of transportation as we know it today.

With the establishment of the **Tilley Foundation, Inc.**, in the year 2001, Carl Tilley set out to prove it could be done. It was an ambitious project and it broke ground on the facility in Tennessee that would build the first self-generating electric car.

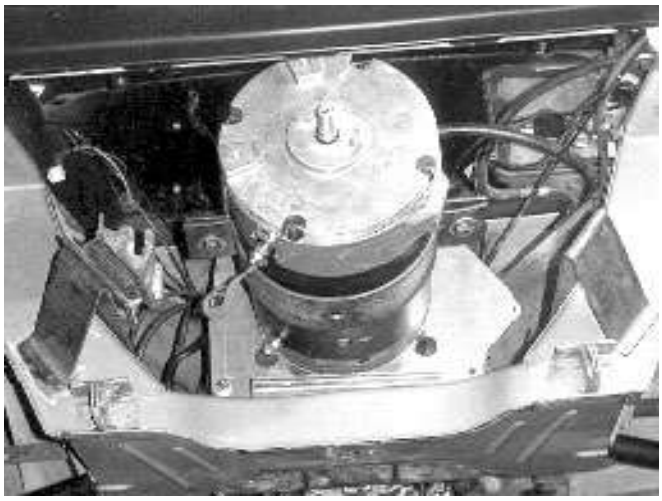

Construction of a 1,800 square foot building, that was powered with another recently developed electric device, began in the year 2002. Electricity for this car is provided from a different energy invention, which was void of any outside power supply. It is ironic that one alternative energy device actually built the invention to power and build the electric car.

The **Tilley Electric Vehicle** (**TEV**), converted from a 1981 DeLorean, energizes the imagination and defies what has been accepted as a standard in the area of transportation for years.

From the selection of the proper car to be converted, to the advanced technology, which is on board, the **TEV** performs comparably to gasoline-powered vehicles.The difference is you have no need for fuel and you do not have to stop the vehicle to charge it after driving. There is no pollution and you can cruise the highways at the same speed as any other vehicle.

There is a new car on the road today. A car built with technology that defies the concept of fossil fuel powered cars, and can run coast to coast without ever relying on the battery being charged from an outside source.

The long awaited transportation revolution and the end of our reliance on fossil fuel has now begun **....the Tilley Electric Vehicle.**

The demonstration of a DeLorean powered by an electric motor and 12-volt standard car batteries is supposed to be on September 7, 2002, at the Nashville Superspeedway, USA. The battery bank is kept in a charged condition by the "on board" charger which is the device invented by Carl B. Tilley. Racing legend Bobby Allison is one of the guest drivers for this demonstration.

Details and results of the demonstration read in our next issue

The Problem of Time: Force as the Cause of Change of the Course of Time

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Abstract

Material processes occurring in a physical system under the action of a force field necessarily influence the course of time along the trajectory of motion of particle. A general relationship is obtained which relates the course of time on one path section of a particle when moving in a force field to that on the other path section in the same inertial reference frame. According to the results obtained, the force in relativistic mechanics is not only the cause of acceleration of particle relative to an inertial frame of reference, but also the cause of change in the course of time along the particle's trajectory. ***Therein lies the physical content of the dynamical principle underlying the special theory of relativity (relativistic mechanics).*** *The applications of the theory developed to homogeneous fields - to the field of gravity and electromagnetic field, and to the gravitational field produced by a point mass particle are considered. Physical properties of the state of imponderability of particle in an external force field are investigated. It is noted that the change in the course of time in a force field is in no way connected with the change in space-time metric and is a direct consequence of the causality principle of relativistic mechanics.* ***The existence of dependence of the course of time on the state of motion of particle in a force field points to the feasibility of controlling the course of time using force fields.***

Time is among the most common concepts, which are used constantly both in everyday life and in science. This is because all the events and material processes in the world happen in space and develop in time and, hence, the laws that govern space-time connections are the most general and hold for all the forms of matter. Nevertheless, time remains one of the most mysterious concepts of physics; its physical essence is not adequately revealed up till now [1-4]. The concept of time with difficulty yields to logical analysis.

From the point of view of common sense the essence of time is that time characterizes the duration of events and processes, indicates their natural sequence, at which the present, going away to the past, gives place to the future.

Isaac Newton gave a clear-cut characteristic of the concept of time, to which the majority of physicists adheres: "The absolute, true, and mathematical time in itself and by virtue of its nature flows uniformly and regardless to any other object". Though, according to Newton, time flows equally and uniformly and does not depend on the processes, occurring in the world, the daily experience speaks in favour of the fact that the course of time is not uniform. Depending on circumstances in our history, it seems to us that time either flies swiftly or hangs heavy on our hands; sometimes it even changes suddenly, by leaps. In connection with these speculations the question arises of whether the subjective sensations of non-uniformity in the course of time familiar to everyone have an objective basis.

In Newtonian mechanics time is of an absolute character, it does not change as one passes from one inertial reference frame to another and represents merely a parameter, whose change at the will of explorer results in the change of state of a mechanical system in accordance with the equation of motion.

In relativistic mechanics time remains a parameter describing the development of system. But now time and space are intimately linked with each other to form a single system, i.e. the 4-dimensional space-time. In going from one inertial frame of reference to another time gets entangled with spatial coordinates, so that time in one reference frame represents a "mixture" of time and coordinates in the other. Time ceases to be universal, the same in all inertial reference frames; it takes on a relative character.

The indissoluble association of time and space takes on special importance in the light of the concept of physical field, which was called by Einstein the most important discovery in physics after Newton. According to this concept, the occurrence in space of a force field means that space turns into a physical environment, which is capable to interact directly with other bodies and gains, thus, physical properties, becoming an active participant of physical processes. In view of the fact that **space and time are indissolubly related to each other, the presence of a force field in some area of space must necessarily result in the appearance of physical properties of time caused by the motion of body in this area.**

Thus, from the synthesis of the notion of space-time and of the idea of physical field it follows with necessity that **the course of time in a given region of space should depend on physical processes in this region, i.e. time, as well as space, should have physical properties [5-8].**

It should be emphasized that in special theory of relativity (STR) time and spatial coordinates are independent and formally equal in rights quantities, which determine the position of elementary events in space-time. On the other hand, time stands out in relation to spatial coordinates. The special role of time is due, from the viewpoint of geometry, to the

pseudoeuclidity of geometry of the 4-dimensional space. From the physical point of view, it is associated with the dynamical principle (causality principle), according to which the state of motion of a physical system at an instant of time t uniquely defines its behaviour at the next instant of time $t + 0$. The significance of dynamical principle lies in the fact that it relates the temporal evolution of system to the physical processes caused by force fields and in doing so it allows one to determine the course of time in the system, its possible dependence upon the character of physical processes, and not just the sequence of events and their duration.

The idea about the existence of the physical properties of time belongs to N. Kozyrev [9]. By introducing into mechanics an additional parameter taking into account the directivity of the course of time, Kozyrev has formulated causal (asymmetrical) mechanics from which it follows that time has physical properties. According to the results of theoretical and experimental investigations conducted by Kozyrev and his followers [9-13], events can proceed not only in time, but also with the help of time, **information being transmitted not through force fields, but via a temporal channel, and the transfer of information happens instantaneously. The appearance of additional forces, associated with the physical properties of time and capable to fulfill work, testifies that time can serve as a power source.**

In the papers by I. Eganova [12] and M. Lavrent'ev and I. Eganova [13] it is stated the problem of direct experimental research of the physical properties of time to ascertain the relations of a new type between phenomena and to discover new methods to change the state of substance. In [14] O. Jefimenko investigated the dynamical effect of the slowing-down of time.

According to [6-8], the conclusion that physical properties of time exist follows strictly from relativistic mechanics, without introducing any additional hypotheses. The physical properties of time are of purely dynamical nature: their existence results from dynamical principle. **The availability of physical properties of time is manifested in that time has a local inhomogeneity: its course along the trajectory of motion of a point particle in a force field is continuously changed, and this change in the course of time is a result of the action upon the particle of a force field in the inertial reference frame, in which the motion is considered.**

Editor's note: The author gives a detailed consideration of the physical content of the local dynamical inhomogeneity of time. Considering the motion of a classical point particle under the action of a force field in the inertial reference frames, that moves relatively to each other, Valentin P. Oleinik derives 73 equations, that help him to obtain the following conclusion (mathematical details and physical reasoning may be found in
http://temporology.bio.msu.ru/OLEINIK/oleinik.htm*)*

The elucidation of the physical nature of time is one of the most important problems of theoretical physics. The purpose of research on the problem of time is to study the physical properties of time, i.e. to ascertain the possible interrelation between time and material processes. In particular, it is of interest to find out

- whether the flow of time depends upon physical processes and whether the back influence exists (i.e influence of the change of the time course on physical processes);
- what mechanisms of the change of the course of time are available;
- what factors are capable to speed up or to slow down the flow of time.

In papers [5-8] on the basis of Lorentz transformations relating to coordinates of points, lying on the trajectory of motion of particle in a force field, the phenomenon of local dynamical inhomogeneity of time is predicted. The main result consists in the proof that material processes occurring in a physical system under the action of a force field necessarily influence the course of time along the trajectory of motion of particle. The case in point is the change of the course of time along particle's trajectory in one inertial reference frame as compared with that in the other.

In this paper the next step is made: the relationship is obtained which relates the course of time on one path section of a particle when moving in a force field to that on the other path section in the same inertial reference frame. The main idea underlying the approach developed results from the analysis of Lorentz transformations and consists in that **the course of time of a particle moving by inertia, i.e. of a particle being not exposed to force, should be uniform.**

As is well known [17,18], the existence of dependence of the course of time upon the gravitational field potential is predicted with the general theory of relativity (GTR). According to GTR ([17], p.303), time flows differently at the different points of space in one and the same reference frame. Since "gravitational field is nothing more nor less than a change of the space-time metric" ([17], p.313), one can assert, apparently, that the change in the course of time is due, in the view of GTR, to the change of the 4-space metric. It should be emphasized that in the present paper gravitational field is considered as an ordinary force field, and the particle motion is supposed to occur in pseudo-Euclidian space-time. The main formulas of the article, (22) and (25), describe the change in the course of time in an arbitrary force field at different spatial points in one and the same inertial reference frame. As is seen from the results received, the change in the course of time in a force field is in no way connected with the change of space-time metric. It is conditioned by the force field action on particle in inertial reference frame and is a direct consequence of the dynamical principle underlying relativistic mechanics.

It should be emphasized that the existence of dependence of the course of time on the state of motion of particle in a force field points to the feasibility of controlling the course of time using force fields.

Note an important peculiarity of the non-inertial reference frame, in which the imponderability state of a particle is attained: **there is such a space-time region in which the reference frame at hand can be approximately considered as inertial.** In connection with the fact that such reference frames (it is natural to call them **quasiinertial** in contradistinction to the **true inertial** reference frames) are, generally speaking, not equivalent to each other (see previous section), the derivation of a rigorous criterion for inertial reference frame acquires especial significance. The dynamical criteria for defining the inertial and non-inertial states are considered in the papers by B. I. Peschevitsky [19]. The heliocentric reference frame seems to be among the quasiinertial reference frames, being inertial with adequate accuracy only in a restricted region of space (for example, within the limits of our Galaxy) [16].

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Time and its Physical Relationships

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Time cannot be absolutely defined, and there is no inseparable relation between time and signal velocity.
Albert Einstein [1]

Time does not exist by itself

The phenomenon of time emerges in relationships – as an expression of properties of physical bodies and changes that occur to them.

Time is a factor of energy. Time has to do with the *increase* and *decrease* of energy. For example, as energy is brought down to a "zero level", time is "eliminated", so in a sense, time cannot be "compressed" - only eliminated. In the zero-energy level, electrons occupying this level in unlimited numbers are available through state transitions for the building of matter and the vacuum [2]. So it is the extent and the nature of energy flow that determines the characteristics of time.

How do we know all this?

In his seminal foundations of physics work of the early 1900s, **Sir Edmund T. Whittaker** demonstrated by canonical quantization that there exist physical, time-like and longitudinal photons *in vacuo* [3,4,5]. The 2 scalar potential functions, *F* and *G* which completely characterize an electrodynamic field due to electrons in the ether are:

$$F(x, y, z, t) = \sum \frac{e}{4\pi} \sinh^{-1} \frac{\bar{z}'-z}{\left\{(\bar{x}'-x)^2 + (\bar{y}'-y)^2\right\}^{1/2}}$$

$$G(x, y, z, t) = \sum \frac{e}{4\pi} \tan^{-1} \frac{\bar{y}'-y}{\bar{x}'-x}$$

In these equations, for the fundamental case in which a field is due to any number of electrons moving in any way, we observe that time emerges only through the displacement of energy. Another way of putting it would be that time emerges through change in energy.

These photons have an independent physical existence. Whittaker himself observed, after computation that the "total disturbance at any point, due to this system of waves, is independent of the time, and is everywhere proportional to the gravitational potential due to the particle at the point" [6]. **A. D. Sakarov** admitted that the gravitational field is a "conglomerate of loose things and not a fundamental field of nature at all [7].

Everything electromagnetic, and probably gravitational, starts from these potentials, not fields, and under certain circumstances, there may exist photons without fields being present at all. In the *vacuo*, the longitudinal light photon travels in the direction of the beam, like an energy capsule, as a scalar four-potential-function energy standing-wave field, with many different frequencies, with an internal symmetry based on circular polarization [8,9], an energy field or nexus that "has an end, but no beginning". The time-like and space-like parts of the four potential are photons with spin –1, 0 and +1 that are longitudinally directed, and which are observed in the ***Compton*** and the photoelectric effect [10].

Movement of light affects time

Philip S. Callahan designed an elegant experiment that shows how variations in the movement of light affect time [11]. Changes in exposure settings of photographs of same objects, including coherent light laser spots results in shift of position of images. The more coherent the light, the less apparent is a shift in time. He suggested that time is neither absolute nor independent of photon activity of space.

We can also state, as a corollary, that the *movement* of light generates time. After all, the electrodynamics is associated with photons. This is particularly significant in time engineering, as will be seen later.

Time and life

Now, it is well known that the ability of cells to sense the presence of light is a primary function of life itself. If a cell can sense light, it is alive; if it cannot, it is dead [12]. Callahan was able to observe that time increments were detected on light-detecting surfaces of living organisms such as the cuticles of leaves.

The Russian time researcher, **Nikolay A. Kozyrev** considered that living systems "consume" time for their life-energy [13]. **Velimir Abramovich** suggests that living organisms are naturally-driven "time machines". They each have an inbuilt time that serves as a "code" to structure their own physical totality and to regulate their own functioning. Thus their "local time" acts as a "time operator" ("time condition") frequency [14]. The nature and level of electromagnetic fields in living systems could therefore be considered as indicators of their "energy level" and how it affects and adjusts the inherent rate of time-flow.

Time and consciousness

We append to these statements the notion that, yes, time is "consumed" by living organisms – but only if they are conscious. Essentially, time can be perceived by measurement, which always requires a conscious observer.

When we measure, we observe the differentials of energy flow. It is the measurement of these differentials - as we note from the Whittaker equations of scalar fluxes - that allows us to the measure the equivalence of time. When we measure differentials, we are effectively creating our notion of time.

It is difficult for humans to conceive that time does not exist when humans think about it. **Saint Augustine** speaks for all humans with his observation:

While I do not think about time, I know that time exists. When I begin to think about it, I stop understanding what it is.

With such conditioning, humans cannot come to grips with the notion that the Universe has no beginning and no end. It is like the paradigm of absolute nothingness – people cannot deal with the concept of no time because, effectively, consciousness, like life, consumes time. One could advance the notion that thought itself is time in motion. When we think, we are creating time. Life is movement – and the brain registers energy differentials and their associated fluxes of scalar potentials.

Time and causal mechanics

Since time is the result of movement of energy (and accordingly, light), then time is associated with the cause-effect processes linked to a first position of energy to the next. In other words, time is innate to causal mechanics.

Variations in energy flow, logically, lead to variations in the characteristics of time. They also permit variations in causality.

Conversely, changes in time lead to changes in physical structure [15]. This phenomenon was proven by Kozyrev and has been labelled as the ***Kozyrev effect*** [16]. He demonstrated that changes in the course of time affect the performance of electronic components. Figuratively speaking, a transistor is like a corral in which light behaves in a certain way. By changing the way that light behaves, a transistor becomes valueless.

To create an extra-temporal causality (with linkages to another level/dimension) one must change the light movement. Changing the light patterns means changing the behaviour of a wave, and its concordant photonic reality. By altering the photons, we make them go to another dimension.

Changes in time can effect change in living systems [17]. The engineering of "time-polarized" waves has the promise to target and amplify natural healing procession in living organisms. It is these natural activities that would restore diseased cells to their original and healthy condition [18]. Such time engineering may also include the reversal of the effects of AIDS, smallpox, anthrax, and most bio warfare agents, with treatment times of only a few minutes per week, with no more than 3 treatments required in all. Eventually it may also be possible to reverse the effects of genetic disorders, effect limb regeneration, and cure spinal cord injuries [19].

Engineering causality

Variation in the density of energy determines variation in the "the course of time". By the "speed of course of time" is meant the rate of causal transformation and the input of additional forces into systems (including mechanical tensions). According to Russian scientists [20, 21,22] there are interesting possibilities in deploying engineering for causal mechanics.

In preventive time engineering, one could delay the approach of a known cause and to artificially close the consequence loop, and thereby annulling it from ever achieving an effect. In other words, one can make the effect "happen" before its normal time, disrupting space structure with its related "speed of the course of time". One can also make it "happen" after its expected deadline. This technology could have interesting implication in strategic situations (preventing a extra-planetary body from attaining a collision course).

According to the Russian experience, when the spatial structure is disrupted by time-engineered causal mechanics, the affected region undergoes relative greater entropy (or, less order). The volume of space is forced out to somewhere else, generating torsion fields, much like a balloon will drift away from denser air. A similar phenomenon occurs when the velocity of a mass increases, the force emerges against it, called "inertia" [23]. Now, to increase velocity, the energy of the mass increases. In the case of time, as the movement of energy increases, interaction or reaction with another dimension ensues to compensate for that primary change [24].

The boundary layer between the two states of space can then act as a mirror and the approaching agent may be reflected back to its source. For example, a light beam may be reflected back to its emitter, in full, or in part, depending on the engineering.

With space-time engineering, we could develop teleportation systems [25]. The course of time goes from the past to the future, in the direction of greater disorder. Going back to the past represents deceleration. The etheric continuum is perceived by Kozyrev is containing variations of "density" of structural elements. The "denser" the etheric region, the slower is the course of time. A zone of accelerated time course would be forced out into "rarefied" ether. A zone of slowed time would be forced into denser ether, hence the basis for a teleportation technique.

***In vivo* experiments with a Time Machine**

For over 15 years, a Russian association of scientists has conducted experiments with acceleration and deceleration of time with 4 prototypes of time machines

[26]. Light-heartedly, the units are called "muskrat traps" since the experiments conducted in remote forest were disguised as a high-tech electromagnetic technology for trapping muskrats. The time machine units are spheres ranging in diameters of 30cm, 1 meter and 2.1-meter. The shells are encased with coils designed to produce convergent waves.

Team leader **Vadim A. Chernobrov** describes converging electromagnetic waves as moving from a periphery to a central point. They are observed when a hoop is thrown into the water and inside the hoop the waves converge. If a potential is applied to do work and to initiate the energy differential process, the other reverse direction scalar (the reverse-time energy flow) must react. Thus, compensation of time - in the form of the deceleration or acceleration of the rate of time - can take place [27].

The first trials involved mice, in which most (25 out of 31) died. Eventually, there were successful 2-hours runs of time travel. An experiment with a dog that was clearly frightened also showed no ill effects. This led to experiment with humans, the first being **Ivan Konov** who, on August 26, 2001 decelerated into the past by 3% of planetary time during a half-hour trial. Dozens of others have experienced the phenomenon and report such sensations as: quicker pulse, giddiness, itching skin, body twisting, numbness at extremities and a case of an out-of-body experience. Harmful effects on living systems do not appear to be linked to the change of the rate of time, but rather to the variations of the time rate value among regions of a living organism.

Some individuals reported visual experiences such as "starry sky", "luminous vortices" and colour spots. Individuals observing outside of the time travel machine noted headaches. The most interesting phenomena occurred just before the start-up: significant presence of ozone for several hundreds of meters around the machine, which was located in a forest. Also noted were strange lighting effects in the sky above the apparatus, accompanied by sounds that inexplicably appeared to generated from inside.

Factors affecting the rate of time

The experiments yielded interesting observations: the phenomenon of the rate of change of time varies according to the hour of the day and according to the lunar phase. The rate can be influenced by a variety of external inputs, including mechanical vibration.

The transition into the future differs from than into the past. It is like movement from any point in a tree – where downwards represents past time. There are many paths possible towards the future – upwards, along the branches, but only one towards the past – downwards to the trunk. The return from the past time is possible only if the time traveler does not interfere with occurring events – or the possibility of returning to another branch of the tree. However, a return move from any variant of future time is possible regardless of the behaviour of the traveller.

The Russian time-travel experiments point to a relationship between inertia and time. In changes of rates of time, the region adjacent to the spheres develops a boundary layer effect, appearing as an aura of "white mist". The greater the time differential, the denser is the mist.

A similar phenomenon has been observed, and captured on film, with some experiments conducted by **John Hutchison** involving remote-controlled lifting and disruption of objects [28,29]. It may be that the ***Hutchison effect*** involves causal mechanics.

Time and frequency

Time may be viewed as a process – or "change-of-space" in any direction that does not exist in our dimension [30,31,32]. In physics, new properties are commonly acquired as the result of change in some property: charge, current, induced magnetic field, etc. Here, the new property becomes a new dimension. For the frequency of oscillations, the formula is $f = 3/\lambda$ [l/s], where λ is wavelength in [m]. Here, the velocity of light is equal to 3 (the 10^8 mathematical degree is omitted since it is a question of scale of measurement only).

Therefore, the analogy between our dimension and frequency gives us a new notion, which is curvature ρ: $\rho=3/r$ [l/m] and $f = 3/\lambda$ [l/s]. The 3-dimensional radius is represented by $R=\lambda/\rho= r/3$ [m] and time as a period of oscillation has the relationship: $T = \lambda/f$ [s]. **Time can be considered to be equivalent to the radius of curvature ρ if the linear radius r and the wavelength λ are the same. This is a condition for the spatial resonance effect.** Note that in this analysis, *"m"* and *"s"* are unlike when length is measured in meters in our dimension. However, for a new dimension it is possible to use equal units for (m) of 4th dimension and conventional "second". Furthermore, light (photons) is possible in our dimension only as a process in such a spatial resonator.

Experiencing time dilation

Based on the above discussion, it is proposed that we experience changes in rate of time in our daily life. During sleep, as our energy level decreases, so it can be argued that time decreases and we "go" into another dimension. Aspects of what is observed during the dream-state do not obey the rules of our familiarity of physical existence, and conventional causality - because the rate of time is different. As we start our dreaming, and as we emerge from dreaming, the recalled experiences resemble more our regular experiences. Before and after sleep, our brain frequency tends to resemble the daytime's. In effect, understanding our dream state's sense of time may be a reference key to comprehending the physics and causality mechanics of time engineering.

Time and planetary gravity

The Earth's mass appears to be in continual growth. 250 to 350 million years ago, our globe may have been half size - with all of the continents as one landmass [33]. In ancient sediments, the natural angles of slope in sand beaches greatly exceeded those of today, indicating that gravity has on our planetary surface has increased 8-fold, several times, during the last 1.5 billion years. Yet the planet's average density may not have changed – only the acceleration of free fall [34,35].

There could also be another explanation possible for the change of slope of beaches. The pull of the moon may have been different in the past.

Also, the planetary magnetic fields could have increased over the millions of years, through interactions with the solar flux of hydrogen atoms. The sun is in constant explosion – production of energy differential. Earth and other planets could be responding with harmonics to compensate for the solar activity, leading to an overall increase in magnetic fields. Such a phenomenon may give the illusion that the physical body is growing larger. In other words, with time, the force of gravity would alter planetary mass and energy.

Assuming that the Earth's density has not increased, it is possible account for, mathematically, the relative increase – growth processes - of the nuclei of terrestrial atoms, including the doubling of mass of nucleons and of electrons [36]. Such calculation also accounts for the emission of 2 different photons by hydrogen atoms (also known as the "red shift" described by **E. Hubble**).

The phenomenon can be explained with the time-like and longitudinal photons described by the bi-directional 2 scalar potential functions [37,38]. Could it be suggested that matter is gravity minus time? In other words, gravity is related to accumulation of energy differential (time) in mass.

The value of gravity varies throughout the planet, in part because of the poles and in part due to local density of matter. **Kirill P. Butusov** has noted a correlation between places of civilization and regions of greater gravity. A faster rate of evolution may be associated with such gravity zones. In these zones there would be a greater influx of scalar potentials. Time would be more "authenticated" by these energy flows into conscious beings. Butusov reminds us that time has a "positive energy" and flowing into nuclei of atoms or a "negative energy" flowing out of the nuclei of atoms [39].

The outflow would be representative of gravitational energy. Longitudinal waves are known to be able to enter and to leave nuclei. Such flows of time must come from other dimensions. After all, the surface of any elementary particle separates our dimension from another. This leads to an interesting possibility in which all time-associated processes between dimensions are synchronized.

Time reconsidered

Arguments have been laid that suggest that time is equal to energy differential (including movement of light). Living systems "consume" time as part of their consciousness and measuring processes.

It is possible to engineer causality. An understanding of higher-order electrodynamics is required. Techniques exist for the generation of scalar potentials. Causality technology has many applications. They include: therapeutics, energy generation, consciousness technology, inter-dimensionality, defence systems, teleportation, and of course, "time travel".

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Time as Phenomenon of the Expanding Universe

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Preface

In 1992 the author of this words, having been stimulated by Kozyrev's book [1], started to reflect on Time meaning and Time and Space asymmetric roles during the Universe Expanding. The development of these ideas has led to the work [2], it is available now (the Russian version only) on the website of the Institute of time nature explorations (grant #00-07-90211 of the Russian fund of basic research).

I would like to thank the Chairman of the Russian Interdisciplinary Temporology Seminar Dr. A. Levich from Moscow State University for his constant support and friendly interest. Also I would like to thank A. Moskowsky for the 20-year discussion of the physics history and philosophy.

The said work [2] pretends to revise radically a number of basic physical concepts of the Space - Time, Motion and Energy nature. It includes a detail analysis and mathematical calculations. Only a brief account of the main part of this work is presented below.

Introduction

The nature of time is not yet enough clear for natural science. In Newton mechanics time was presented as some universal formal parameter. Its value rises steadily at every point of the Universe by unknown for us reason. Each physical process occurs in space in correspondence with the time course.

In the Special Relativity (SR) time and space are integrated to the common 4D-continuum. However, in this theory the time component having imaginary factor seems also to be "exotic". In this concept the increase of time is also implied in each reference frame.

The General Relativity (GR) allowed linking the time properties with gravitational fields and the space geometry. The time currency started to be associated with a spatial expansion of the Universe.

The theoretical physics traditional approach to the process description is based upon the considering of time course as primary (original) one. There are also in the modern physics [3] several attempts to deduce the time concept as secondary one from different fundamental (microscopic) concepts.

However, the third way (inverse to the first one) is possible and forms the basis of this paper. A starting point of this way is the following question: "Does any universal process exist which could *generate* physical time?"

(Editor's note: The same question was formulated and the answer was proposed by Alexander V. Frolov in 1996, report "Matter as process", Scientific congress "New Ideas in Natural Sciences". It was assumed that similar process can be produced by special technical methods also.)

Such fundamental cosmic process really exists and it is well known in the modern science. **It presents the Universe expansion** and was opened at the first third of the 20th Century by the American astrophysicist E. Hubble and others [4]. It means the general increase of distances between all 3D-bodies. The same scattering of two-dimensional-figures happens on the surface of some spherical balloon during air incoming. The centre of this sphere does not belong to the surface; all points of the sphere (the Universe) are equivalent.

Some time earlier the theoretical physics had come to the same results. As it is well known, the Einstein's GR was published in the 1916. After that Friedmann (1922) proposed the concept of the expanding Universe. For example, in the book [5] a description of the basic cosmic model is given. Hereinafter this model is called "Einstein-Friedman model", or "EF-model". In this model the Universe is presented as 3D- hyper surface of a 4D- sphere with increasing radius. Of course, the curvature of the 3D-hyper surface increases with time too.

Basic hypothesis relative to time nature

Some simple and pictorial views consist a basis of the new concept. Hereinafter it is called briefly as "The Spherical Expanding Universe Theory (SEUT)".

In the SEUT, as well as in the EF-model, in every time the Universe represents the 3D-hyper surface of a 4D-sphere. However, there is one very important difference. In the Einstein's theory the spatial components of the metric tensor are opposite in sign to the time's one. For example, we may consider time as imaginary quantity, then spatial coordinate as a real one. On the contrary, in the SEUT the 4D-continuum is considered as purely

Euclidean, all the four coordinates are real quantities. The usual spherical geometry can be used on a surface of the 4D-sphere.

As it is well known, in the GR the Age of the Universe can be *calculated* using the EF-model or a similar one. Usually, the radius-age dependence is not a direct proportionality in such GR models. However this result may be deduced if to neglect the global pressure of matter that fills the Universe. In [2] it is demonstrated, that an account of the static pressure of matter follows to the Universe radius linear dependence on its age (see below).

On the contrary, in the SEUT the time universal course is *manifested*. The Universe age is *identified* with a current Universe radius divided by the velocity of light. Numerous important consequences may be deduced from this statement. On the other hand, it allows avoiding many other arbitrary postulates in the model.

Mechanical motion and maximum velocity in the SEUT

The SEUT states, there is no unlimited set of independent mechanical motions. Only world lines of moving bodies exist. Each of them has some inclination relative to the time line, which presents a normal to the hypersurface of the 4D-sphere. It is *an inclination angle that defines the spatial motion velocity*. At the increase of sphere radius the intersection point of word line and current hypersurface "moves" with exact correspondance with a modern physics prediction.

In particular, immovable objects (stars) have zero inclination, their world line are normal to the hypersurface. Hence they "scatter" according to the Hubble law, their mutual velocity is proportional to mutual distance. If a body world line has some inclination relative to normal, the angle is more than zero. But it can't exceed 90°, therefore *maximum* mechanical motion *velocity* appears *naturally*, it is equal to the velocity of light.

Let us consider three variants of motion (see Fig.1).

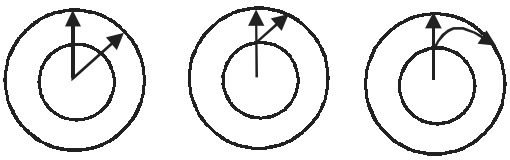

Fig. 1
Phenomenon of a "motion" of point on a sphere surface for immovable (at the left), uniformly moving (at the centre) and non-uniformly moving (at the right)

The left picture illustrates the Hubble effect. The right picture presents a general case of motion with acceleration. The central picture corresponds with an inertial motion; its world line is direct. In this case the moving body displacement increases proportionally to the Universe radius increment. So, *inertial* motion is not postulated in the SEUT, it appears as natural model consequence.

At a large 4-sphere radius values all the relationships of SR and usual mechanics laws are applicable approximately in the SEUT. A Special Relativity light cone transforms to all the hyper surface of the 4D-sphere. But the analogy is not complete, because an absolute remote SR area degenerates to this 3D- hyper surface in the SEUT (see Fig. 2).

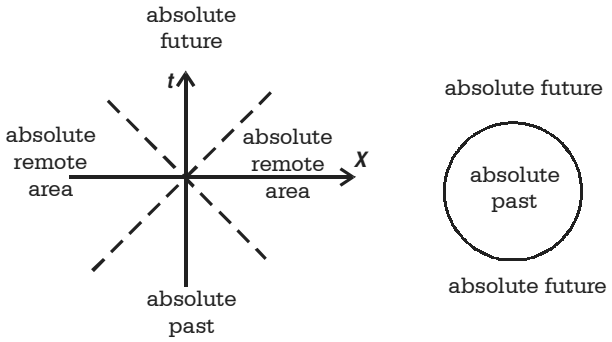

Fig. 2.
4D- continuum areas in the SR (at the left) and in the SEUT (at the right)

SEUT and Minkowski geometry

Let us consider small increments of time and space coordinates along body world lines during the Universe expanding. It is enough to consider a small area of the Universe, so we can neglect its curvature. Then it is acceptably to replace approximately concentric hyper surfaces ("isochrones") by parallel hyper planes. The space-hold corresponds with a representative point "drift" perpendicularly to isochrones, an inertial motion corresponds with displacement along inclined direct lines between isochrones.

At each time the Universe is represented by a certain isochrone that contains all the real spatial points. Let us accept that 4D-sphere radius increment divided by velocity of light presents invariant measure of (absolute) time increment. We will also state that this quantity has the same value in each *inertial* reference frame, i.e. at a motion along each *direct* world line.

Let the angles of world line inclinations from normal direction are enough *small*. Then metric relationships like Minkowski geometry ones appears in our purely Euclidean 4D-continuum. In particular, well known relationship

$$c^2\, ds^2 = c^2\, dt^2 - dr^2$$

can be deduced from the Pythagorean theorem. It connects a spatial component *dr* with a time component *dt* (at moving reference frame) through velocity of light *c*. Here *ds* is an absolute time interval (between two 4D-events at a immovable reference frame). **Hence, if velocities aren't very high, the Lorentz transform is correct in different inertial reference frames.**

On the Einstein's relativity principle

If the world lines inclinations from exact normal direction cannot be accepted as small, then Minkowski geometry relationships are correct approximately only. It means that Einstein's relativity principle is correct (in the SEUT) only for reference frames that move with velocities enough small relative to *selected* reference frame. Such reference frame is linked hardly with a body at (absolute) rest, i.e. drifting along radial world line.

The selected reference frame existing reminds of old ether theories that contradict to the Special Relativitiy views. It seems, these theories became a thing of the past irretrievably. In fact, the velocity of light in vacuum is constant everywhere and everywhen. However, the reference frame existing can be detected in principle as a light signal frequency bias, i.e. with the help of Doppler effect. Well, this phenomenon is really detected by the modern astrophysics!

The temperature diagram of the Cosmic Microwave Background Radiation (CMBR) coming to the Solar system from all the sides of the Universe is presented on Fig.3. The data was registrated during 4 years by the Cosmic Background Explorer (COBE) satellite (NASA Goddard Flight Centre, COBE Science Working Group).

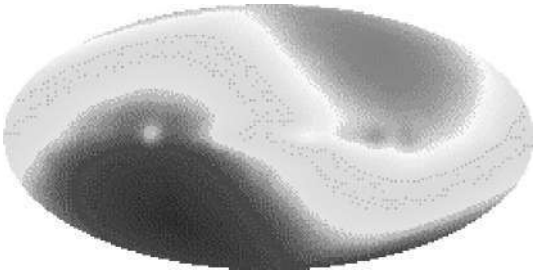

Fig. 3
The anisotropy of the Cosmic Microwave Background Radiation (CMBR)

The well-known Russian scientist J.B. Zeldovitch in the Editorial Addition to [6] in connection with earlier experiments notes that careful measurements **allowed to find out some anisotropy of CMBR.** An antenna oriented to the Lion constellation detects that the radiation temperature is 0.013% more, than mean temperature. The radiation temperature in the opposite direction is 0.013% less, than mean. **Generally, a temperature varies continuously between these two values.** The isotropy presents only for some imaginary observer. ***The Solar system, Earth move to the Lion constellation relative to this observer having velocity 390 ± 60 km/s.*** Hence, as a result of the Doppler effect, a incoming radiation seems to be more hot, and an overtaking radiation seems to be more cold. This example shows that for observer of any point of the Universe this CMBR is isotropic. We may consider this observer and the connected reference frame as selected one. The selected reference frame existence at the Universe every point looks like the physicists commonly held view preceding to Relativity. They thought that the light presented ether oscillations occupying whole the Universe. They thought also that a reference frame connected with ether was preferable, or selected. They tried to detect the Earth motion relative to ether. We know that these experiments gave the negative result: any ether doesn't exist. But the Universe evolution follows that when CMBR is observed (and only in this case!), the selected reference frame (called sometime "new ether") appears. ***The new ether or CMBR just realises the motion according to Hubble's law.***

The modern NASA's data allows to put the relation of the Solar system velocity to the velocity of light equal to 0,15%. It is enough small value justified Special Relativity and Minkowski geometry relationships application. But can we believe this phenomenon to be an exhaustive proof of the SEUT accuracy?

To test it we propose a not complicated observational experiment. If the CMBR anisotropy is due to the real selected frame existence, then it may be detected for any electromagnetic radiation. In particular, an anisotropy of solar radiation has to exist at the different year periods. It has to be detectable in August, when the both solar radiation and CMBR come to the Earth from the Lion costellation side (see Fig. 4). In February these sourses are opposite in disposition relative to the Earth, therefore the solar radiation anisotropy direction has to be opposite. The expected effect value (with account of the Lion constellation straight ascendancy and obliquity of the ecliptic) is approximately equal to 300 km/s, i.e. nearly 0,1% of the velocity of light. In November and May the anysotropy has to be practically absent.

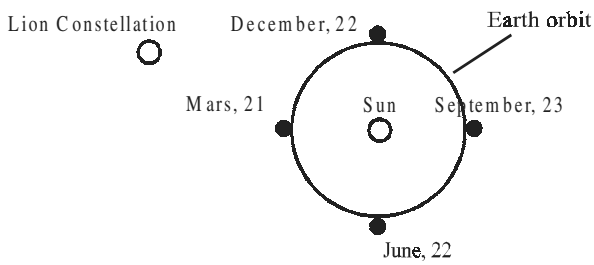

Fig. 4
The Sun and Lion constellation disposition relative to the Earth

Probably, an analogous SEUT test in a laboratry is realizable with help of artificial radiation sources.

Particle mass, energy and impulse

So, we consider the Universe as expanding 3D-hypersurface of a 4D-sphere. Mass localisation places in the Universe present the points of the hypersurface intersection by world lines. So, **these world lines have a real physical meaning, not abstract illustrative** this one. We may expect this physical meaning to be more essential than simple word expression.

Particularly, while the Universe global analysis is making, we may suppose that such fundamental

particle feature as its mass at rest presents some *relative* value. Such relation (some kind of a quantum number) may include, for example, 4D-sphere (the Universe) diameter and some characteristic size like de Broglie wave period that is inversely proportional to the mass. This hypothesis may make clear *inertia* nature as two characteristic times *relation*. It may also explain the *rest-energy* notion.

Meanwhile, the Universe radius increases with time. Well, what happens to mass? If a de Broglie wave period increased proportionally to time, we couldn't generally detect the Universe expansion, including famous "red shift". But if particle wave periods are constant, then *matter mass has to rise proportionally to the Universe age and size*.

In the Relativity (like Minkowski geometry) we use vectors having imaginary projection to time axis and real projections to space ones. Particularly, it is true for velocity, acceleration, and energy-impulse 4-vectors. As against, vectors having all the real components are only used in the SEUT. At that, a 4-interval value (length in pseudo-Euclidean space) of some relativistic vector answers the absolute time axis projection of a corresponding SEUT-vector, and imaginary component of a relativistic vector (time of motion) answers the corresponding vector length in purely Euclidean continuum of the SEUT. For example, the energy-impulse vector module presents such quantity. Its projection to absolute time axis is energy at rest divided by velocity of light, and its projections to spatial axis are impulse components. This quantity is *constant* while the particle movement is *inertial* one.

A jump to *non-inertial* motion in the SEUT is connected with a corresponding state vector *changement* law. So, if particle motion velocity changes, its *energy at rest* doesn't change, therefore full acceleration at a time interval can be calculated using the difference between new and old impulse values. Thus, the non-uniform motion equation in the SEUT can be found like SR as time derivative of an impulse expression.

The force-acceleration relation depends on a mutual orientation of force and velocity vectors in the both SR and SEUT. But in Relativity a reference frame velocity can be choised arbitrary, for example it can be zero, then the relation will be equal to one.

On the contrary, in the SEUT an *absolute* velocity is presented, it is defined by the world line inclination relative to the normal. Let the Earth move with any velocity relative to the immovable (selected) reference frame. Then we will be able to detect the absolute velocity using two measurements, the first one along the world line, and the second one in a perpendicular direction.

If this absolute velocity is really defined by direction and value following from CMBR anisotropy effect, then we can expect a relative difference near $2{,}25 \cdot 10^{-6}$ between longitudinal acceleration and transversal one.

Local gravitational fields of particles

What does the SEUT talk about body gravitational fields? Let us imagine all the bodies as immovable and drifting exactly along the *radial* world lines. If there is a mutual gravity attraction effect between two bodies in such Universe, an observer will detect some curvature of their world lines. They will seem to be bending one to another instead of a radial divergence. In essence, in this case we may replace a world line by a gravitational field line. Then the analogy allows us to identify an Universe isochronous intersection with an equal potential surface that these field lines have to be *normal* to this surface. So, we arrive to a presentation that a Universe isochronous intersection is not strictly concentric hypersurface. It is perturbed by some kind of craters (see Fig.5), that centres correspond with gravitating bodies.

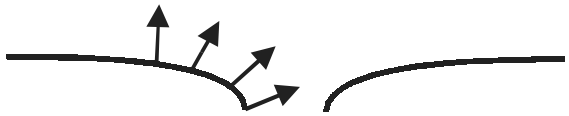

Fig. 5
Local body gravitation field

The inclination angle of a crater profile relative to non-perturbed sphere hypersurface is equal exactly to the inclination angle of a normal relative to strict radial direction. Hence, a local gravitation field intencity measure agrees practically in each point with body velocity measure that we used earlier. It authorizes energy concept using for both mechanical motion and gravitation phenomenon.

SEUT and General Relativity

Let us discuss some GR's aspects. Is it acceptable to neglect pressure of matter? When Einstein searched for his early cosmological static model solution, he had to introduce a cosmic constant in his equation. This constant answered a ***negative matter pressure***, that Einstein could not determine a meaning. In a non-stationary model a solution exists independently on cosmic constant presence, therefore it may be put often as zero. As rule, bodies' velocities may be put as zero too; therefore (*dynamic*) pressure is usually neglected.

However, we insist on necessity to account a *static* pressure of gravitating matter. Really, it can be ignored in the case when Einstein's relativity principle is applicable. Accordingly with it a gravitation field can be *always* replaced by reference accelerated frame. In this case a purely kinematical side is only accounted. However, *not every* field may be considered (even locally) as uniform one (see Fig. 6). Let the radius of a field source (or a *probe particle*) have the same order that the mutual distance. Then the Einstein's equation connecting space geometry with matter physical features seems to be incomplete. More precisely, it is incorrect to put exactly equal to zero a static pressure

in the matter density tensor, it is necessary to introduce its (unknown, calculable) value accounting **the *continuum deformation energy*.**

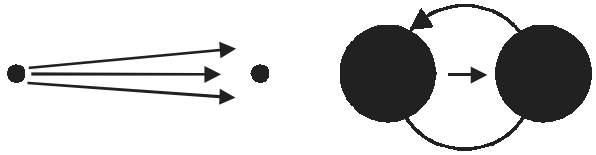

Fig. 6
At the left a locally uniform gravitation field is presented, the right field can't be considered as uniform one even locally

Are the proposed amendments important? Specialists know, that the Metagalaxy gravitation radius is *in fact* comparable with its real size. **In [2] we have showed that the Universe radius was *less* than its gravitation radius.**

It is shown also in the same work [2], that a resulting gravitational pressure in the Universe is *negative* and it is responsible for the Einstein's cosmic constant. This fact seems to be evident because a gravitation force aims to *gripe* any matter accumulation. **But it is possible to conclude it by a non-trivial way.** Let us consider a matter pressure as a reactive force operating within a uniform sphere of incompressible liquid. A pressure dependence on internal density is presented in [7]. We can see [2], **that if the sphere gravitation radius exceeds its geometric radius not more than approximately 1% (or it is still less), then a sudden negative change of the pressure appears at the internal abroad. This phenomenon may be explained as a volume "expansion" due to a metrics perturbation.**

The consideration of static pressure allows not only to find out a *new* (linear in time) cosmologic solution, but also to calculate a dependence of the Universe gravitational pressure on the radius of the Universe. This *negative* value has the representation like that one for a non-relativistic sphere (a star or a planet, for example). Also we would like to note, the formulation of density-Universe radius in the SEUT is exactly the same that the formulation of so-called *critical* density in the EF-model.

Two very important circumstances are clarified for all that. First, the **Universe mass was turned out as *linearly increasing* function of the 4D-sphere radius, and it is not a constant. A famous Einstein's programme is realized unexpectedly in the SEUT: a matter features (density) are reduced to a space features (curvature).** In other words, a necessity to introduce a mass distribution in the equations externally ("by hands") is eliminated in the SEUT. This operation is need in the GR to find out a spatial metrics changement law.

Secondly, the seeming paradoxicality of University mass (and energy!) non-conservation make us to reflect on conditions that the *accomplishment* allows to the energy conservation law correctness (see Fig.7).

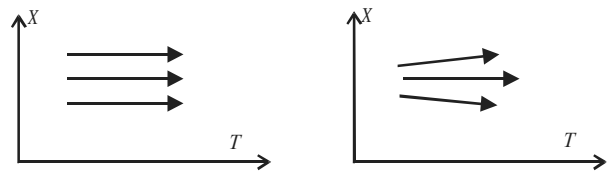

Fig. 7
If space features *do not depend* on time, then the closed system energy is *constant* (at the left). But if space features *evolve* in time, then the isolated system energy *have not to be constant*.

It is evident, we believe, that the energy can be exactly constant only in such physical system (or in whole the Universe) for which space features (in particular, a curvature) are strictly constant in time also. However, the both modern physics and SEUT issue from the opposite concept. Hence, this state can only be accomplished approximately, moderately of a bit of the modern rate of a relative space curvature evolution. This rate has order 10^{-10} per year for the modern Universe.

N.A.Kozyrev [1] basing on astrophysical observations stated the common star radiation origin that has to be due to the time-energy transformation. Accordinly with the SEUT, the relative increment of star mass (and its rest energy) is equal to the Universe age relative increment. It is interesting that the Sun mass relative lost due to the radiation consists in 10^{-15} per year, i.e. five orders less than mentioned above energy increment.

Universe origin and closed geometry

The cosmological EF-model could not say anything on the Universe origin. On the contrary, the work [2] approach allows an obvious way to study the problem.

As it is noted in [7], the metrics of any sphere area having a non-zero density is perturbed relative to Euclidean one, its geometry agrees with 4D-sphere hypersurface geometry. For non-collapsing sphere its gravitation potential relief is like a very small *"pit"* that gravitation radius is much less than its geometric size. However, when the density rises, the metrics perturbs more and more, and the pit transforms to some kind of *"crater"*. The crater is connected with the external surface by a narrow neck. Only this neck or its part is visible for an external observer, and the gravitation insurmountable barrier transmutes an object central area into "a lost world".

From the point of view of the external world, the central area presents a "black hole" absorbing irreversibly all the matter and radiation. On the other hand, for our Universe inhabitant the "navel-string" connecting with the external world has to seem a spherical "white hole", to which a matter and radiation are coming continuously (and, may be, carry out an information on the external world features). There is an old Russian fiction science book called "Sannikov Land", where an internal gigantic

trench concerning central small star is described. Our model seems to be like this picture.

Is it possible that we live in such a black hole? The present hypothesis answers affirmatively this question. The negative sign of the matter pressure due to continuously increasing of our world size allows to such conclusion. And the University self-closing can be physically explained by the way.

On the other hand, as it is shown in [2], in spite of matter average density negligibly small, the Universe gravitation radius is more than its geometrical radius; hence, it presents a black hole. This condition accomplishment agrees the Universe self-closing, the boundary absence in spite of its finite volume. Also, this fact confirms our assumption that the Universe rest energy localisation area does not exceed the gravity operation area.

A specific model of star collapse is created in the modern General Relativity. In general, it can study in *three* different reference frames. As a rule, the "point mass" models are used. *The first* model is linked with an external observer; the *second* one accompanies a matter falling to the black hole. *The third* model presents an internal reference frame, i.e. an observer within collapsing object.

From an external observer's point of view the matter falling time to the black hole is infinitely large. However, in an accompanying reference frame it is finite. Since in the accompanying reference frame time and space coordinates are expressed through the both types of external reference frame coordinates. What is more, in the internal reference frame the time and space coordinates quite trade places, the metrics tensor components are depending on time. Further, any matter point history in this accompanying reference frame starts at the zero moment and finishes after same universal time period in a special (singular) point, after which nothing exists ("time barrier").

As we believe, another lacing between internal and external collapse pictures will be possible, if we consider a non-point collapsing object. Nobody wonders now at a situation, when a time period can be finite in one reference frame and infinite in another one. **Therefore, we can believe, unlimited black hole *collapse* in the external Super-Universe may seem to present unlimited *expansion* of our Universe observing inside.** This expansion seems to *start* from a singular point, and the same point is the history end of all the matter of the external Super-Universe that fall to the black hole. I would like to note especially, it does not mean that internal time pass in opposite to external one. **Rather, it is possible to state, time within a black hole passes ortogonally to external one.**

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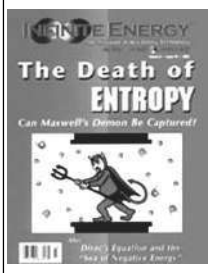

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The Experiments on Thermo-Gravitation

This review of the article by Alexander P. Schegolev, the scientist from Saint Petersburg, was received by NET editors from our reader vladrim@mail.ru and presents his own view about Schegolev's experiment [1]. The opinion of our editorial board is not fully in agreement with the author's conclusion. Also we have no information who is vladrim@mail.ru.

It is known from the science history that the very experiment gives a push to revising of old knowledge; it also checks the new designs and conclusions. The knowledge of physical theories is based on the experiment; the experiment confirms hypothesizes or refuses them. Making experiments, we ask questions to the nature. And it always answers us on the clear pointed question. However…

Michael Faraday was trying in vain to find out the relationship between gravitation and electricity. These experiments were repeated on the modern level. Further, there was made an attempt to screen gravity force, the influence of environment on gravity was also trying to be researched. Many efforts were spent on finding out of the gravitational radiation falling to the Earth from depths of the Universe, as well as artificial generation of gravitational waves.

The experimental studies of weight change must be under attention. In particular, the attempt to find the differences in weight after sharp turning of body from the quiescent state into the state of rotation around its own axis was undertaken. The experiments of the influence of strong magnetic field and temperature on the weight of a body were made.

But alas! No changes of weight were discovered in previous experiment *(Editorial: Perhaps, the author has no information about sucessful results. We reported about such results in our magazine)*. Analyzing these experiments and theoretical premises, the author of the given article has made an unusual experiment imitating the heat motion in the Earth from core to peripheries. For that experiment there was used the steel ball with 100 mm diameter. The cone hole was made in the ball up to its center. The ball was installed by the hole upwards on laboratory scales with 50 mg scale factor and laser beam was directed inside (into the hole). The directed heat flow outgoing from the center of the ball was created by this way. While the surface temperature increasing, the arrow of scales became to be rejected aside weight decrease. The temperature was measured by the contact thermocouple. After an hour and half, approximately, when the temperature was 300 degrees Celsius the laser was switched off. The difference (the decrease) in weight against initial value (in the cold state) was four grams per 4200 grams of the test body.

Further, the ball was getting cold slowly on the scales and its arrow was creeping to the initial position. For acceleration of this process, the ball was periodically

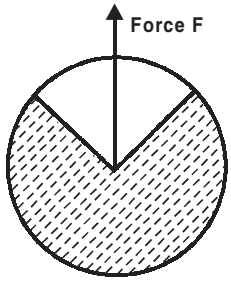

Fig. 1
The ball with cone hollow

blown on by pressure air. It was the check, if the air (heated by the ball) influences on scales or not. The stability of its data independently on actions of pressure air stream excludes such suggestion. When the temperature of the ball became the same with room temperature, its weight return to the value nearly initial. However it is necessary to add, that this "nearly" is about 200 mg. This confirms that the change of the weight was not occurred because of the evaporations of metal from action of laser beam, and we were the witnesses of absolutely unusual phenomenon. *(Editorial: Perhaps, it is necessary to take into account the deformation).*

That is all concerning the question, which was given to nature by the author of the given article. However, one more doubt remains: did the heat radiation (coming from the ball) affect on mechanism of scales? To check this, the control experiment was made, under which the same ball was heated by usual way in the electrical furnace. In spite of its temperature was about 600 degrees Celsius and the ball was placed on scales for a long time (until full cooling down), the arrow did not move from the initial position. Thus, we have really turned out face to face with a phenomenon requiring an explanation.

If the weight change in this experiment has happened in consequence of gravitational interaction, then, therefore we must revise some fundamental concepts. Today it is difficult even to assume the consequences. The only thing, which is possible to say certainly, is **that divergent on radius uni-directional (single-vector) heat flow** is the object for observation, absolutely unknown to us or unnoticed before, which holds the ensemble of surprises. Up to now, we have dealt only with **chaotic** heat motion, which was researched by the thermodynamics and heat transmission.

For analogy, it is possible to give the example **of the electric current arising, which is possible to get only under directed electrons moving.** In general, more than ten experiments were made, and all of them have given the same result: the weight of the body was decreased. Who will solve this enigma?

Editor's note: The question is presented above. The answer is the aetherodynamics theory. Any directed (unidirectional) heat flow is also a flow of aether. The mass changes are the demonstration of natural mechanism of existence of this mass as aether vortex (Alexander V. Frolov).

References

1. Collected reports "Untraditional scientific ideas about nature and its phenomena", #1, club FENID, Gomel, 1991.

The RotoVerter from arkresearch

Editor's: The description of this invention was received from Hector D. Perez Torrez, designer of the "RV" Rotoverter and TV transverter OU "transformation" devices.

Here is the first prototype, used to test a 3PH generator. Light bulb was a 100W 120V, AC generator required 380W for excitation to 120VAC plus the light bulb load for a total of 480W. Input to rotoverter was 240W for a total of 200% efficiency from the prime mover. Friction loss and prime mover loss was not calculated, PF unity, 120VAC unto a purely resistive load excitation pure DC120VDC3.1666667A (380W) + 100W = 480W. - 240W=240 excess.

It is a common 3PH dual winding 230/460V motor wired to 480V run at 120v as a ROTOPHASE converter. That's the beauty of it, OFF the shelve components preferably totally enclosed motors (so fan can be removed) low friction bearings, from 3HP to 7.5HP. Re-rating hp can be from 1/7 to 1/3 the original HP (some motors can run up to 1/2 HP capacity but will require extreme care and cooling.... and exact tuning to load).

System requires starting and running capacitance; the perfect starting capacitance is the one that gives same plate current value as 480V but running at 120V. The best running capacitance is the one that gives the lowest Amperage reading at programmed load. (ALL capacitors are AC 370V OIL "no electrolytic").

Some motors are better than others; also for generator use you must choose the over-unity generator and motor combination to obtain OU. It looks easy to gain it, but requires quite a good choice of items and common sense. In this Research we have found even a few turns or a run weld in stator can change drastically the results. Up to date best performance has being obtained from US (motors 7.5 HP, BALDOR 3,5, HP, GE 3HP totally enclosed, dual winding 230/460V). Higher HP will require professional expertise in industrial electricity and power eng. (not recommended for amateur experimenter). Anyone engaged in this experiments must be familiar with safety procedures and basic electric and mechanic knowledge. Voltages and rotating machinery must be handled with great care. SEE basic diagram and connection.

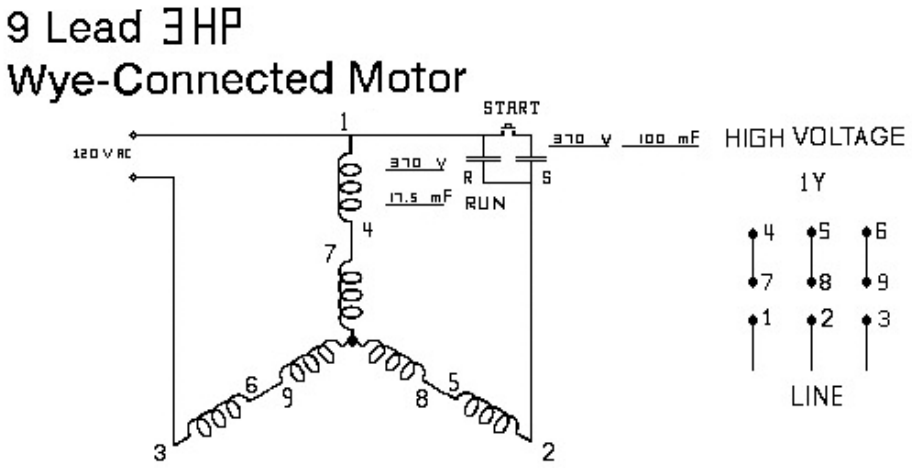

Fig. 1

Latest UPDATE BELOW 7-01-02

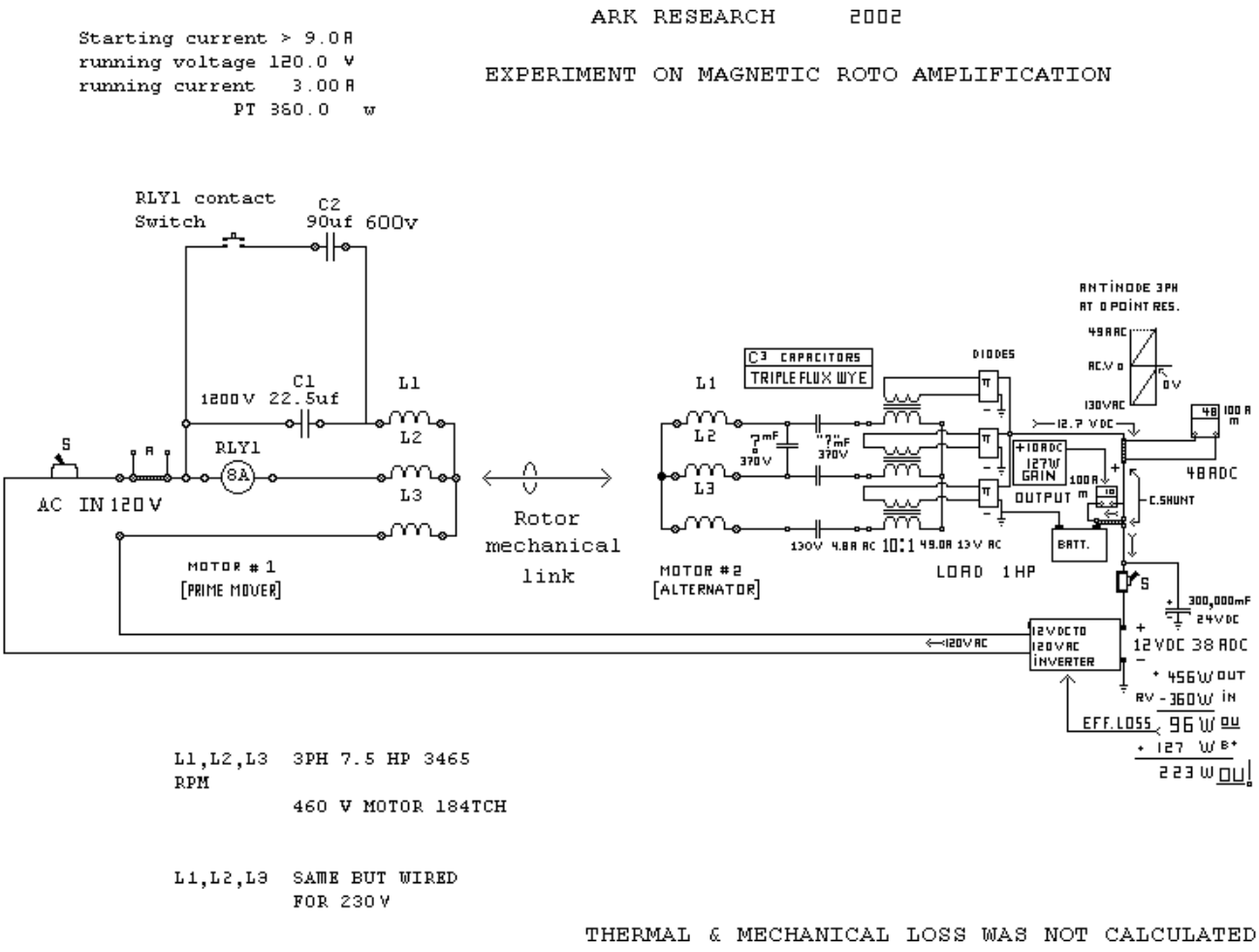

Fig.2

Subject: RV Basic level 1 Full MODEL Disclosure (Public domain)

This is the RV (Level 1) plan of a full looped RV system:

Battery provides primary power for 12VDC to 120VAC. As to run prime mover (Roto-converter), second motor acts as ansquirrel cage self-exited generator, a triple flux-capacitor LC tank tuned to best Standing wave condition as to create standing wave current node internally in battery at 0 voltage to battery "negative resistor". At 0 volts "voltage" a negative current is created as to maintain a reverse flow (charge) to battery exceeding the forward drain of the inverter demand, detuning system with a forward charge at 10 amperes with a voltage rise of approximately 0.83333 V over the battery. Voltage charge produces OU transform from the 0 point standing wave component. System gains energy from stochastic resonance within the LC tank components draining energy from "thermal" signature of the Aether and K thermodynamic-thermoelectric ambient heat (Electron spin). This is a full disclosure of an operational and tested device. System is made of standard off shelve items. Tuning is made by changing capacitor values and the proper selection of standard items for its construction, 3PH motors, 10:1 12V or 5:1 24V transformers with the proper core and winding values (standard) off shelve, diode bridges capacitor (all standard).

Warning: System opens (NON standard) space-time anomaly as time is reversed due to aether energy transform....
Extreme warning: Do not exceed 10KW Nor use of trans-uranic elements near unit as they may reach critical mass by regressive "inversed" decay. PB 206, U235, U238 must be maintained as far as possible from unit.
Extreme Warning: Dangerous Toy, Eldridge, Event horizon and hell raiser effects may be created by protoplasmic fields at extreme potentials PK.
Use wisely. You Can create Paradise or open the gates to Armageddon.

The choice is yours now....

Hector D Perez Torrez

Lifter Project

by Jean-Louis Naudin

http://www.jlnlabs.org

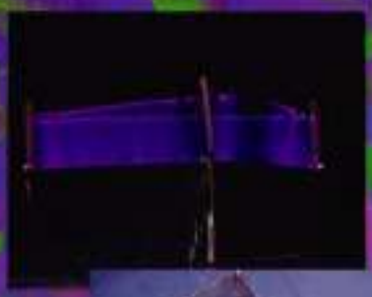

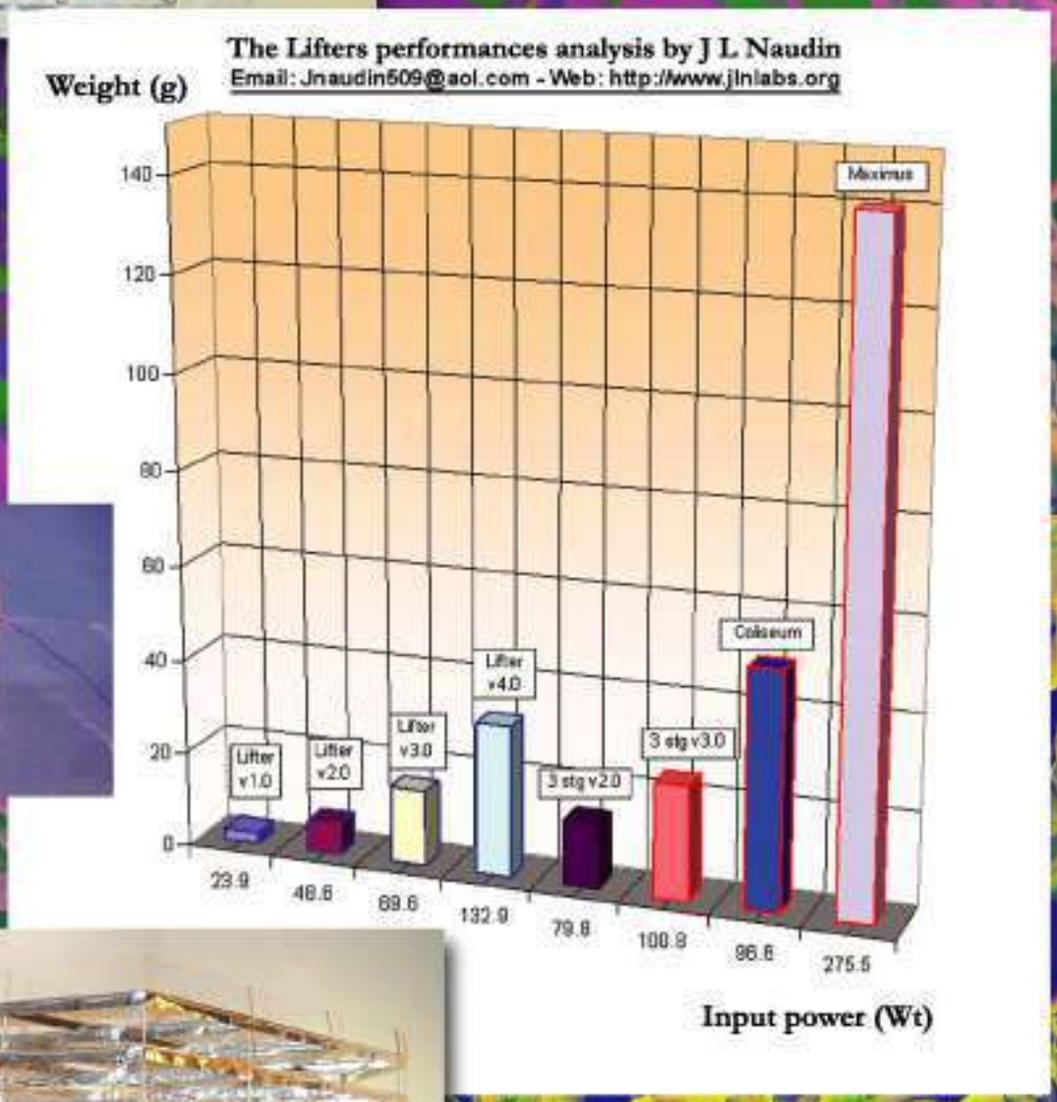

The 1st Worldwide
Electronaut Lifter Project

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News from France

Electrostatic propulsion: 60g payload

Also in this issue:

- Cold Fusion by Plasma Electrolysis of Water
- News of Hydrogen Energetics
- Unusual Permanent Magnet Motors
- New Energy and Propulsion Systems

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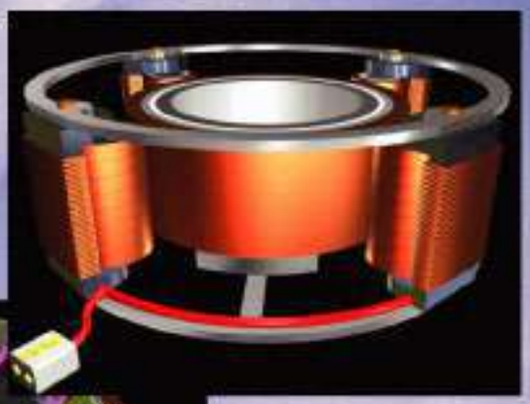

15 kWt Searl Effect Generator

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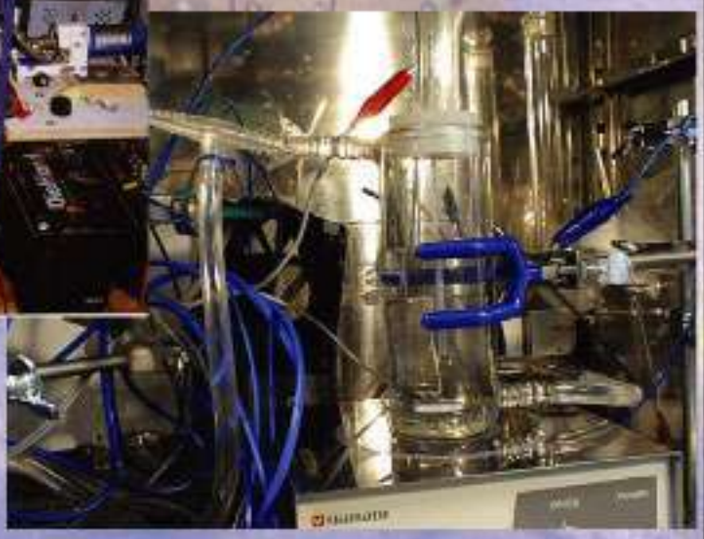

Read in this issue!

NEW ENERGY TECHNOLOGIES #10

1. Testatika. Review of well-known electrostatic system.
2. Cold Fusion by Plasma Electrolysis of Water. Ph.M. Kanarev, T. Mizuno
3. Cold Fusion: What is it and what does it mean to science and society? E. Storms
4. Technical Introduction to LENR-CANR (Low Energy Nuclear Reactions). E. Storms
5. It started in 1989… (History of Cold Fusion Development). P. Hagelstein
6. A Science Tutorial (Cold fusion). T. Chubb
7. LENR (Low Energy Nuclear Reactions) Experiments.
8. On Electrogravitation. A.V. Lemeshko
9. Avalanchedrive Propulsion Device. M.L. Filho
10. Hydrogen-Powered Vehicles. P. Behr, G. Schneider
11. Unusual Permanent Magnet Motors. T. Valone
12. Hydrogen Energetics. A. Pashova
13. On the Longitudinal Electromagnetic Waves. A.V. Frolov
14. Space and Terrestrial Transportation and Energy Technologies. T.C. Loder
15. Commercialising the “Searl Effect”.
16. Interesting Publications of the Last Year.
17. “Lifter” Project
18. New Electric Fire Technology. V.D. Dudyshev
19. New Effect of “Cold” Evaporation. V.D. Dudyshev
20. Conceptual Hurdles to New Millennium Physics. D. Reed
21. Resonant Phenomena Occurring in Alternating Current Circuit. A.V. Frolov
22. Books Review

TESTATIKA

Review of well-known electrostatic system

Editor comments by Alexander V. Frolov
General Director, Faraday Lab Ltd

A running "free energy" machine coming from Switzerland, Europe. It was developed over a 20 years Research period by a religious group called Methernitha. This group lives in Linden, Switzerland. The head engineer of this superb machine, Mr. Paul Baumann discovered its principles while observing nature. He claims its running principle was found by studying the lightning effects from nature. The documents being offered here shed light on this energy marvel.

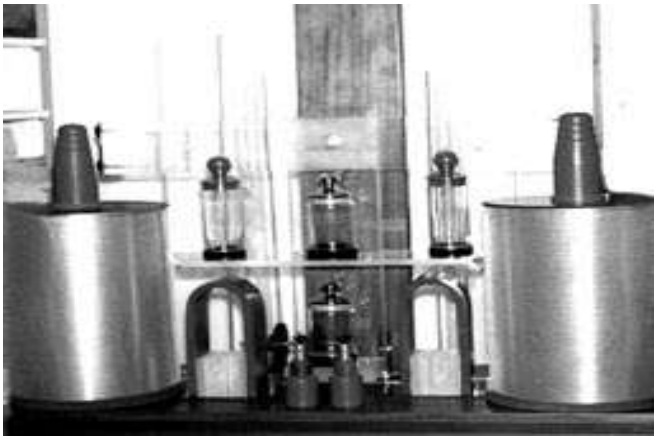

These documents are the result of work of people who have witnessed this wonder machine over the years... And here are the facts:

- The Testatika is a rotary-type machine that runs on it's own, once started by revolving it's two discs by hand!
- The machine not only runs on it's own energy, but produces also a huge amount of excess power, at least 3 KWtt of power! This is almost enough to supply a small house with one machine!
- The machine is about 70cm wide, by 40cm deep and is about 60cm in height!
- It delivers from 250 volts to about 320 volts direct current, depending on the humidity in the air! At this voltage it can supply at least 10 Amperes of pulsating direct current!
- Testatika is not a perpetual motion device, but an energy machine that collects it's huge amount of energy from the ions contained in air. However, there are some technological secrets implemented to overcome the normal drag-resistance of conventional generators. This is but one of it's secrets held by the Methernitha group.

There are many different sized Testatika machines, some of the smaller units deliver only about 200 to 300 watts, none of which are mass-produced. These devices are still laboratory prototype units.

Methernitha is a spiritual community (Christian Alliance) http://www.methernitha.com. They wrote: "We are fortunate in gaining the experience that paradoxically the most beautiful and useful results can be achieved by just using the most simple means. Never did we use any borrowed capital because we want to stay free Swiss citizens and do not want to be hindered or even bound in any way in the pursuance of our aims."

The two contrary-rotating discs generate an electrostatic charge. One disc represents the earth, the other the cloud. Using grid electrodes the charges are bound. After that they are collected by non-contacting so-called antenna keys and then sorted.

After being initially turned on by hand, the discs rotate by themselves according to the electrostatic laws about attraction and repulsion. A rectifying diode keeps the cycles in steady state. Otherwise the impulses of attraction and repulsion would accumulate and cause the discs to run faster and faster. The correct speed is of great importance and for optimal power generation the discs have to run quite steady and slow.

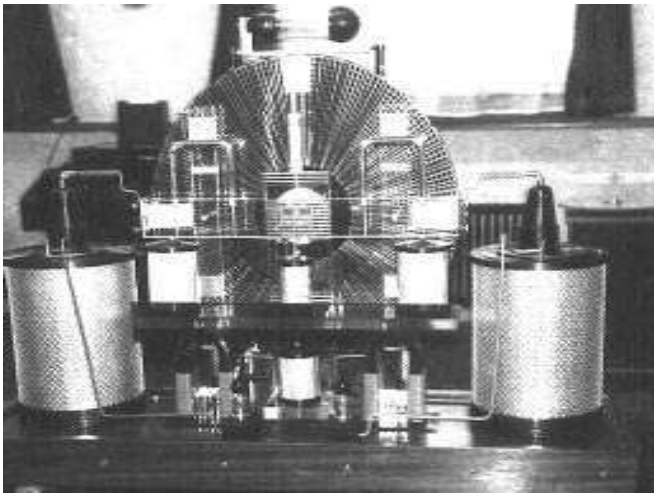

By means of grid condensers the energy is stored and then uniformly discharged, at the same time reducing the high voltage and building up power with additional devices. Finally the machine supplies a uniform direct current, which varies according to the size of the model. The machine furnishes about 3-4 kWt permanent output, depending on humidity, whereby the electric potential ranges from 270 to 320 Volt. High humidity of the atmosphere prevents the build-up of electric potential. The drier the air is, the better.

(Editor: It is necessary to note that the analogues method was used by Russian inventor Pavel N. Yablochkov who in 1877 take out a patent #120684 "The system of distribution and amplification of electrical currents by means of atmosphere electricity..." As it was shown by Yablochkov devices, power doubled in lamps, though current of consumption did not increse.)

No doubt, through the so far achieved results one main objective has been reached, namely to prove that it is possible to use Free Energy. Nevertheless the research work is not yet completed.

To the educated physicist many things of this machine may seem impossible, maybe even crazy. Maybe he is also offended by the conceptions used to explain the whole. Only partly we could use the concepts of conventional physical terminology to explain and define only approximately the functions and properties of the various parts of the machine.

After all it will be necessary to create some more new concepts like the one we have already used before, when we termed the non-contacting collectors of electric charges as antenna keys.

This machine puts experts, which are just trained in conventional physics to a very hard test, because its mode of action is not explainable with the state of the art of officially accepted physical knowledge, or at the most only partially explainable. However also a trained specialist should remain free and independent in his thinking, and should avoid to be limited by the temporal framework of publicly admitted knowledge in any science.

It has to be noted that the established science was already many times forced to change or give up some of its very fundamental concepts. Think about Galilee, to name only one example. Our human society almost condemned this man as a sorcerer and magician, just because he investigated and discovered a truth that seemed unacceptable by the established science of the days.

The book knowledge of any times is not wrong, but it is incomplete, and therefore allows to draw wrong conclusions.

There was used information from the official web site: http://www.methernitha.com

Official adress of Methernitha: Methernitha Genossenschaft Administration, Moosbuehlweg 2, 3517, Linden, SWITZERLAND

Official E-mail of Methernitha: info@methernitha.com

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COLD FUSION BY PLASMA ELECTROLYSIS OF WATER

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Abstract: It has been disclosed that transmutation of the atomic nuclei of alkaline metals and the atomic nuclei of the cathode material takes place during plasma electrolysis of water.

Key words: atom, nucleus, proton, neutron, electron, cathode, low-current.

INTRODUCTION

Cold nuclear fusion is the first hypothesis of a source of additional energy in heavy water electrolysis. Fleischmann and Pons, the American electrochemists, are the authors of this hypothesis [1]. They reported about it in 1989. Since that time a large number of experiments has been carried out in order to obtain additional energy from water [2], [3], [4], [5], [7], [8], [9], [10], [11], [12]. We continue to discuss this problem.

THE FIRST EXPERIMENTAL PART

In order to check this hypothesis, the following experiments were performed. Two cathodes were made of iron with mass of 18.10 g and 18.15 g. The first cathode operated during 10 hours in KOH solution; the second cathode operated during the same period in NaOH solution. Mass of the first cathode remained unchanged; mass of the second one was reduced by 0.02 g. The voltage by plasmaelectrolysis process was 220 V and the current (0.5-1.0) A (Fig.1). The indices of the consumption of the solution and the gases being generated were as follows (Table 1).

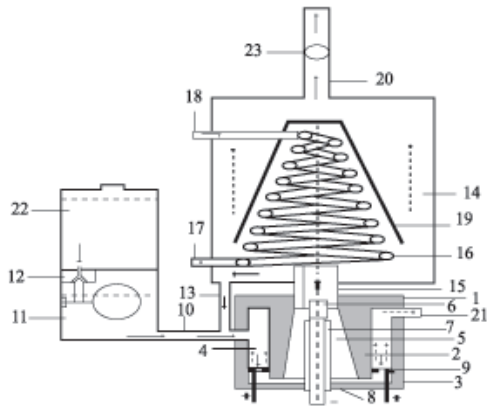

Fig. 1.
Diagram of gas generator. Patent # 2175027:
1 - lid of the reactor; 3 - body of the reactor; 6 - the cathode; 9 - the anode; 11 - solution dosing unit; 16 - cooler; 20 - pipe for gas release; 23 – anemometer

Table 1
Experimental results

Indices	Water consumption, kg	Volume of gases, m^3	Energy expenses, kWh/m^3
KOH	0.272	8.75	0.28
NaOH	0.445	12.66	0.21

In order to increase safety of experimental results, the volume of the gases introduced with the help of anemometer is reduced twofold.

It is known that from one litre of water it is possible to produce 1220 litres of hydrogen and 622 litres of oxygen. Quantity of the gases generated by the plasma electrolytic process is much greater than it is possible to get from consumed water (Table 1) [6]. It gives the reason to think that not only water molecules, but also the nuclei of alkaline metals and the atomic nuclei of the cathode material serve as a source of these gases. The analysing experiment has been performed in order to check this fact.

Tadahiko Mizuno, the famous Japanese scientist (the co-author of this article), who works at the Division of Quantum Energy Engineering Research group of Nuclear System Engineering, laboratory of Nuclear Material System, Faculty of Engineering, Hokkaido University, Japan, kindly agreed to perform chemical analysis of the cathode samples with the help of the nuclear spectroscopy method (EDX). Here are the results of his analysis. The content of chemical elements on the surface of non-operating cathode is as follows (Table 2).

Table 2
Chemical composition of the cathode surface prior its operation in the solution

Element	Fe
%	99.90

The new chemical elements have appeared on the working surface of the cathode, which works in KOH solution (Table 3).

Table 3
Chemical composition of the surface of the cathode, which operates in KOH solution

Element	Si	K	Cr	Fe	Cu
%	0.94	4.50	1.90	93.00	0.45

The chemical composition of the surface of the cathode, which operates in NaOH has proved to be different (Table 4).

Table 4
Chemical composition of the surface of the cathode, which operates in NaOH solution

Element	Al	Si	Cl	K	Ca	Cr	Fe	Cu
%	1.10	0.55	0.20	0.60	0.40	1.60	94.00	0.65

Thus, the hypothesis concerning the participation of the nuclei of alkaline metals and the atomic nuclei of the cathode material in the formation of gases during plasma electrolysis of water has experimental confirmation. Let us carry out the preliminary analysis of the data being obtained (Tables 2, 3, 4).

THE FIRST THEORETICAL PART

In any of these cases, the atoms and the molecules of hydrogen are formed. The part of it is burned and the other goes out with the steam. We have already shown that the processes of fusion of the atoms and the molecules of hydrogen and its isotopes result in occurrence of additional thermal energy [6]. Numerous experiments show that up to 50% of additional thermal energy are generated during the plasma electrolysis of water, it is less than the results of the calculations originating from the existing cold fusion theories [6]. That's why it is necessary to analyse energetics of the particle creation process during the atomic nucleus transmutation.

Having considered the model of the electron we have found out that it can exist in a free state only when it has a definite electromagnetic mass [6]. Being combined with the atomic nucleus it emits a part of energy in the form of the photons, and its electromagnetic mass is reduced. But stability of its condition does not become worse, because the energy carried away by the photons is compensated by binding energy of the electron in the atomic nucleus [6].

If the ambient temperature is increased, the electron begins to absorb the thermal photons and to pass to higher energy levels of the atom reducing binding with it. When the electron becomes free, it interacts with the atom only if the ambient temperature is reduced. As this temperature is reduced, it will emit the photons and sink to lower energy levels [6].

If the electron is in a free state due to an accidental external influence on the atom and the environment has no photons, which are necessary for it to restore its mass, **it begins to absorb the ether from the environment and to restore its constants in such a way**: mass, charge, magnetic moment, spin and radius of rotation. The electron acquires the stable free state only after it has restored its all constants [6].

Thus, if an interchange of the free state and binding state with the atom takes place due to the accidental influences on the atom, **the electron restores its electromagnetic mass every time due to absorbing the ether. It means that actually it plays the role of a converter of the ether energy into the thermal photon energy.**

The Japanese investigators Ohmori and Mizuno [4] registered neutron radiation during plasma electrolysis of water and reported that not only the nuclear process, but also the process of the electron capture by the free protons can be the source of this radiation.

As hydrogen plasma is generated during the plasma electrolytic process of water electrolysis, there exists a tendency of the capture of the free electrons by them.

It is known that rest mass of the electron is $m_e = 9.109534 \times 10^{-31}$ *kg*, rest mass of the proton is $m_p = 1.6726485 \times 10^{-27}$ *kg*, and rest mass of the neutron is $m_n = 1.6749543 \times 10^{-27}$ *kg*. The difference between the mass of the neutron and the mass of the proton is equal to $\Delta m_{np} = 23.058 \times 10^{-31}$ *kg*. It is $23.058 \times 10^{-31} / 9.109 \times 10^{-31} = 2.531$ of the mass of the electron. Thus, the proton should capture 2.531 electrons in order to become the neutron. The question arises at once: what will happen to the remained of electron mass $(3.0-2.531)m_e = 0.469m_e$? The disturbed balance of masses in this process is explained by modern physics in a simple way: a neutrino is created [6].

As the neutrino has no charge, it is very difficult to register it. If the neutrino takes the excess mass away or replenish the lacking one, can the elementary particles execute this process by themselves?

As the photons are emitted and absorbed only by the electrons, the proton, which absorbs the electrons, cannot convert the remainder of mass of the third electron into the photon. If the electron is absorbed by the third one and gives more than a half of its mass to the proton in order to convert it into the neutron, the remaining part of mass ($0.469m_e$) of the electron, which has no possibility to become the photon, is converted into a portion of the ether, which "is dissolved" and mixed with the ether in the space. The fact that plasma has no photons with the mass corresponding to the part of mass of the third electron, which has not been absorbed by the proton during its conversion into the neutron, can serve as a proof of such affirmation. Let us calculate energy of such photon [6].

The difference the mass of the neutron and the proton is equal to $\Delta m_{np} = 23.058 \times 10^{-31}$ *kg*. If we subtract this value from the mass of three electrons, we'll get mass m_F, from which the photon should be formed [6]

$$m_F = 3m_e - \Delta m_{np} = 3 \times 9.109534 \times 10^{-31} - 23.05810^{-31} = 4.270602 \times 10^{-31} \text{ kg} \quad (1)$$

If the photon is formed from this remainder of mass m_F, its energy will be [6]:

$$E_{ph} = m_F \times C^2 = \frac{4.270602 \times 10^{-31} \times (2.997924 \times 10^8)^2}{1.602189 \times 10^{-19}} = 23.956126 \times 10^4 eV \quad (2)$$

This value of energy corresponds to roentgen spectrum, that's why the creation of each free neutron should be accompanied by the creation of one roentgen photon. If it does not take place, we have two opportunities: the first one – we should think that in the case when the neutron is created, the neutrino was formed from mass m_F=4.270602 × 10_{-31} *kg* and flew away in the unknown direction; the second one – there were no conditions for the formation of the photons in the process being considered, and mass, which failed to be formed as a particle, "was dissolved" in the ether. Which variant is closer to the truth [6]? There is no exact answer, but it is known that the Japanese scientists registered only neutron radiation with intensity of 50,000 neutrons per second, and they failed to register roentgen radiation [4].

If in this process the roentgen photons were created, they would not exceed heat efficacy of the plasma electrolytic process, because they would not be the thermal photons. The thermal photons are radiated and absorbed when the electrons make the energy transitions to the energy levels, which are the most remote from the atomic nuclei, where the infrared photons and neighbouring ones from the optical range of the spectrum with energies of ≈(0.001-3.3) eV are generated (Table 5) [6].

Table 5
Electromagnetic spectrum bands

Bands	Wave-length, m	Energy, eV
1. Low- frequency band	$\lambda \approx (10^{7}...10^{4})$	$E \approx 10^{-15}...10^{-11}$
2. Broadcast band	$\lambda \approx (10^{4}...10^{-1})$	$E \approx 10^{-11}...10^{-6}$
3. Microwave band	$\lambda \approx (10^{-1}...10^{-4})$	$E \approx 10^{-6}...10^{-3}$
4. Relic band (maximum)	$\lambda \approx 1 \times 10^{-3}$	$E \approx 1.2 \times 10^{-3}$
5. Infrared band	$\lambda \approx (10^{-4}...7.7 \times 10^{-7})$	$E \approx 10^{-3}...1.6 \times 10^{-2}$
6. Light band	$\lambda \approx (7.7 \times 10^{-7}...3.8 \times 10^{-7})$	$E \approx 1.6 \times 10^{-2}...3.27$
7. Ultraviolet band	$\lambda \approx (3.8 \times 10^{-7}...10^{-9})$	$E \approx 3.27...1 \times 10^{2}$
8. Roentgen band	$\lambda \approx (10^{-9}...10^{-12})$	$E \approx 10^{2}...10^{5}$
9. Gamma band	$\lambda \approx (10^{-12}...10^{-18})$	$E \approx 10^{5}...10^{9}$

Thus, the neutron fusion processes in plasma electrolysis of water will not generate additional thermal energy. But the appearance of the neutrons in plasma will promote the formation of the nuclei of deuterium and, possibly, of tritium. As the balance of masses remains almost unchanged, we have no reason to expect that **additional energy will take place** when deuterium and tritium are formed. But it is sure to appear during **fusion of the atoms of deuterium and tritium, i.e. the hydrogen atoms [6].**

In order to become a proton, the neutron should radiate something, which mass is Δm_{np}=23.058 × 10^{-31} *kg*. Let us convert this mass into energy [6].

$$E_{ph} = \Delta m_{np} \times C^2 = \frac{23.058 \times 10^{-31} \times (2.998 \times 10^{8})^2}{1.602 \times 10^{-19}} = 1.294 \times 10^{6}\ eV \qquad (3)$$

This energy corresponds to the gamma range photons, i.e. not to the thermal photons, and this process does not give additional energy. Thus, if the process of the formation of the helium atoms takes place during plasma electrolysis of water, it should be accompanied by gamma radiation. If there is no such radiation, but the helium atoms are formed, the neutrino takes away the above-mentioned portion of mass Δm_{np} or this mass, which has no opportunity to be formed as the photon, "is dissolved" in the environment, i.e. it is transferred into the state of the ether [6]. As the roentgen photons and the gamma photons are not the thermal ones, this process gives no excessive thermal energy [6].

Another variant is possible. When the atoms of alkali metal bombard the cathode atoms, they are destroyed completely and destroy the atoms of the cathode materials. Under the notion "completely" we'll understand such state when both the atom and the nucleus are destroyed. In this case, the protons of the destroyed nuclei begin to form the hydrogen atoms. The process of fusion of the atoms and the molecules of hydrogen generate additional thermal energy [6]. But one should bear in mind that if plasma disintegrates water molecule into hydrogen and oxygen and if these gases contact plasma, hydrogen is combined with oxygen, and water is formed. Noise generated by plasma is hydrogen microexplosions. Taking into consideration the above-mentioned fact the larger the volume of hydrogen burnt in plasma, the smaller its volume in the gas-vapour mixture. It means that such reactor operation modes are required when quantity of burnt hydrogen is minimal one. Our theory allows us to have such results.

As iron is the cathode material, the nuclei of its atoms are the targets of the atomic nuclei of potassium, alkaline metal. During the transmutation of the iron nuclei (Fig. 2 b), the atomic nuclei of chromium (Fig. 2 a) and the atomic nuclei of copper (Fig. 2 c) are formed [6].

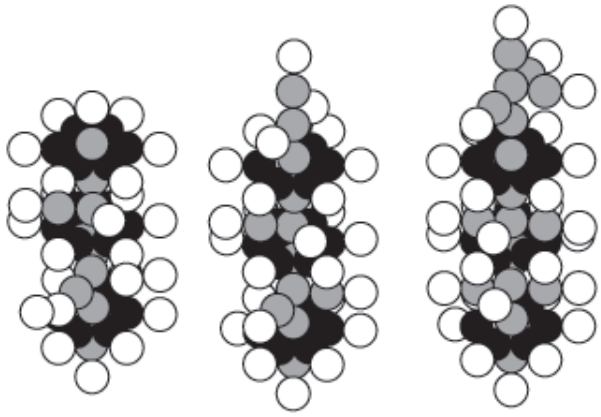

a) Cr (24,28) b) Fe (26,28) c) Cu (29,34)

Fig. 2.
Diagrams of the atomic nuclei of: a) chromium, b) iron, c) copper

When the atomic nucleus of iron (Fig. 2 b) pass into the atomic nucleus of chromium (Fig. 2 a), two protons and two neutrons are released; two atoms of deuterium or one atom of helium can be formed from them. If the neutrons pass into the protons, four atoms of hydrogen are formed.

It is easy to see (Fig. 2) that the atomic nucleus of iron (Fig. 2 b) should lose two upper protons and two neutrons in order to pass into the atomic nucleus of chromium (Fig. 2 a).

Three additional protons and six neutrons (total 9 nucleons) are required for the formation of the atomic nucleus of copper (Fig. 2 c) from the atomic nucleus of iron. As on the cathode surface (Table 3) the number of chromium atoms, which probably are formed from the atomic nuclei of iron, four times more than the number of atoms of copper, then the solution is sure to have superfluous protons and neutrons of the destroyed atomic nuclei of iron, and we can determined their approximate relative quantity.

Let us suppose that four nuclei of the iron atoms pass into the nuclei of the chromium atom. The total quantity of free protons and neutrons (nucleons) is equal to 16. As one atom of copper falls on each four atoms of chromium, 9 nucleons are spent for the formation of one nucleus of the copper atom, and 7 nucleons remain free.

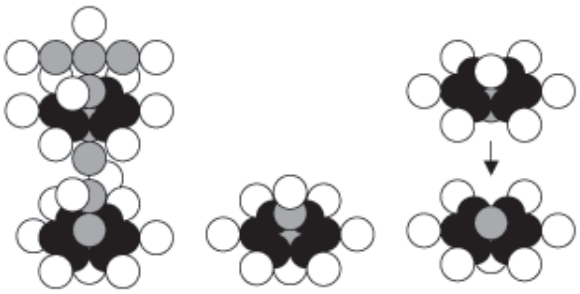

a) K (19,20) b) O (8,8) c) Si (14,14)

Fig. 3.
Diagrams of the atomic nuclei of:
a) potassium, b) oxygen, c) silicon

Let us see what is formed when the nucleus of the potassium atom is destroyed. Potassium is situated in the first group of the fourth period of the periodic law. Its nucleus contains 19 protons and 20 neutrons (Fig. 3 a) [6].

In Fig. 3 a, we can see a weak link of the nucleus of the potassium atom [6]. It is situated in the middle of its axis neutrons. When the transmutation of the nuclei of the potassium atoms takes place, the nuclei of the oxygen atoms can be formed (Fig. 3 b) as well as its isotopes and the nuclei of the silicon atoms (Fig. 3 c).

The analysis of the structure of the nuclei of the potassium atom (Fig. 3 a) shows that it is the most probable source of the nucleus of the silicon atom (Fig. 3 c), which atoms appear on the cathode (Table 3).

It is easy to count that during the destruction of one nucleus of the potassium atom and the creation of one nucleus of the silicon atom 5 free protons and 6 free neutrons, i.e. 11 nucleons, are formed.

Thus, the transmutation of the nuclei of the iron atoms and the potassium atoms results in the formation of free protons and neutrons. As the protons cannot exist in free state, the hydrogen atoms are created from them. If the protons are connected with the neutrons after the destruction of the nuclei of the iron atoms and the potassium atoms, the formation of deuterium, tritium and helium is possible.

Let us pay attention to the main fact – absence of the sodium atoms in the cathode material. It is natural that the potassium atoms have appeared on the cathode, which operated in KOH solution (Table 3). Why are no sodium atoms on the cathode, which operated in NaOH solution? The answer is as follows: the nuclei of the sodium (Fig. 4,a) atoms are completely destroyed during the plasma electrolytic process. The presence of potassium on the surface of the cathode, which operated in NaOH solution (Table 4), can be explained by insufficient ablution of the reactor after the operation with KOH solution.

As free protons and neutrons appear during the destruction of the nucleus of the sodium atom (Fig. 4,a), some nuclei of this element begin to form the atomic nuclei of aluminium (Fig. 4, b), chlorine (Fig. 4, c) and calcium (Fig. 5).

But not all free protons and neutrons are spent for the construction of the atomic nuclei of aluminium, chlorine and calcium. A part of them is spent for the hydrogen atom formation.

If we knew the total quantity of transmutating atomic nuclei of iron, potassium and sodium as well as the exact composition of the gases generated during the plasma electrolytic process, it would be possible to determine the atomic nuclei being formed from additional nucleons. Now we can only suppose that the majority of new nuclei are the protons, i.e. the nuclei of the hydrogen atoms. The increased volume of the gases generated during the plasma electrolytic process is explained by it [6].

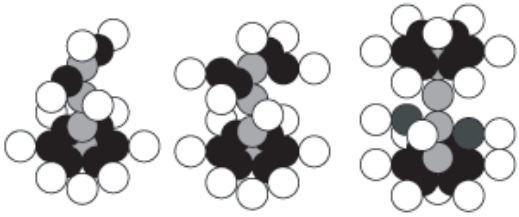

a) Na (11,12) b) Al (13,14) c) Cl (17,18)

Fig. 4.
Diagrams of the atomic nuclei of:
a) sodium, b) aluminium, c) chlorine

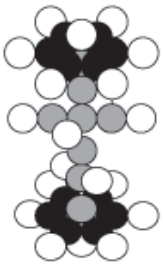

Ca (20,20)

Fig. 5.
Diagram of the nucleus of the calcium atom

The analysis of these Tables shows that transmutation of the nuclei of iron, of which the cathodes are made, results in the formation of chromium and copper in both cases. Apparently, aluminium, chlorine and calcium are formed from the destroyed sodium nuclei. In any case, free protons and neutrons are formed.

But not all free protons and neutrons are spent for the formation of the atomic nuclei of copper, aluminium, chlorine and calcium. A part of them is spent for the formation of the hydrogen atoms. In any case, the atoms and the molecules of hydrogen are formed. The analysis has shown that plasma electrolytic process extracts not more than 0.005 kg of alkaline metal from one litre of the solution. It appears from this that if all neutrons of the atomic nuclei of the molecules of water and alkali metals are transferred into the protons and the atoms and the molecules of hydrogen are formed, the formed volume of gas will be considerably less than the one registered during the experiment (Table 1). A question arises: where do additional gases come from? In order to get the answer on this question we made the next experiment.

THE SECOND EXPERIMENTAL PART

First of all we take into account, that high temperature of plasma forms the conditions when a set of various processes takes place at the cathode. First of all, water is boiled and evaporated. At the same time, one part of water molecules is disintegrated with a release of the atomic hydrogen; another part of the molecules forms the orthohydrogen molecules. A part of water molecules is disintegrated completely and is released at the cathode together with hydrogen and oxygen. A part of hydrogen is combined with oxygen again generating microexplosions (noise) and forming water.

During plasma electrolysis of water, water vapor, hydrogen and oxygen are released simultaneously. If vapor is condensed, gas mixture is released. In order to measure gas flow rate the electronic anemometer have been used. Diameter of the electronic anemometer was equal to internal diameter of the gas make tube (23, Fig. 1). Its readings were registered and processed by the computer. The experiment was performed dozen times, and each time its readings were reproduced with small deviations [11]. But we had no hydrogen analyzer, that's why the results being obtained cannot be considered as final ones. We admonished it in all editions of the book Water is a New Source of Energy with such a phrase: "We abstain from lending an official status to these results with the hope to get necessary financing and to repeat them with a complete set of the necessary devices" [12, page 176].

In the middle of the year of 2002 we received small financing, which allowed us to make a new reactor and to buy some measuring instruments, in particular the scales with the measurement limit up to 600 g and accuracy of 0.02 g. Careful preparation allowed us to increase duration of continuous operation of the reactor (to 10 and more hours) and to register solution consumption for gas production.

The main difficulty of operation with the hydrogen is in the fact that its mixture with air (4-74)% or oxygen (4-94)% is combustible, and the fact was emphasized more than once during the experiments that made the researches be very careful. The second difficulty during hydrogen quantity measurements generated by the plasma electrolytic reactor is in the fact that its molecule has the smallest dimensions, that's why it penetrates easily to the places where the molecules of other substances do not penetrate. Molecular hydrogen diffuses easily even into metals. For example, one volume of palladium absorbs up to 800 volumes of hydrogen.

Gas flow speed was measured with the help of various anemometers, its readings being registered with the help of the computer. Numerous measurements and numerous analysis of gas flow speed measurement accuracy with the help of the anemometers showed that error of a conventional anemometer can be 100%.

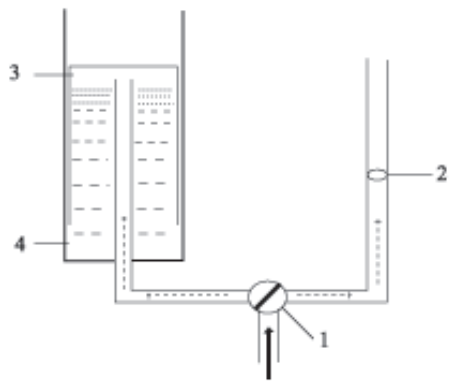

Fig. 6.
Diagram of measurement of flow rate of the gas and its volume:
1 - tap for gas flow movement direction switching,
2 – anemometer, 3 – graduated tank, 4 – water tank

It is known that it is possible to produce 1220 litres of hydrogen and 622 litres of oxygen from one litre of water. Quantity of the gases generated by the plasma electrolytic process is much greater than it is possible to get from consumed water (Table 1). It was a strong reason for a search of the measurement error. For this purpose, the diagram of measurement of flow rate of the gases and their quantity was used (Fig. 6).

The results of the measurements were as follows. The anemometer showed that 200 litres of gas mixture penetrated through it during 10 minutes. Nearly one litre of gases was in the graduated tank during this period.

Thus, the measurement of gas flow with the help of the anemometers distorted the result 200 fold. It should be mentioned that the reactor operated in the production mode of hydrogen and oxygen in the cathode zone. As a result, their mixture burst. The pulses of these explosions increased the readings of the anemometer.

It has become necessary to return to the reactor operation modes when no oxygen is released in the cathode zone. Our theory allows us to do this easy.

PROTOCOL
of tests of the first model of low-current Electrolyzers

It is known that it is possible to produce 1.22 l of H_2+ 0.622 O_2= 1.843 (H_2+O_2) from 1 ml of H_2O

Table 6
Experimental results

Indices	1	2	3	Average
1-duration of experiment, hour	1	1	1	1
2-voltage, V	70	70	70	70
3-current, A	0.038	0.080	0.098	0.072
4 – power, W	2.7	5.60	6.44	4.91
4-volume of consumed solution, ml	1.67	3.98	4.32	3.32
5-density of the solution, kg/l	1.04	1.04	1.04	1.04
6-volume of consumed water, ml	1.60	3.83	4.15	3.19
7-volume of the gas mixture being produced, l	2.95	7.06	7.85	5.95
6-volume of hydrogen being produced, l	1.95	4.67	5.07	3.80
7-energy consumption per 1 l of hydrogen, W·h/l	1.38	1.20	1.27	1.28
8-energy consumption per 1m^3 of hydrogen, kWh/m^3	1.38	1.20	1.27	1.28
9-existing energy consumption for production of 1 m^3 of hydrogen from water, kWh/m^3	4.00	4.00	4.00	4.00

CONCLUSION

Transmutation of the atomic nuclei of alkaline metals and the atomic nuclei of the cathode material during plasma electrolysis of water existed. Plasma electrolytic process opens new prospects in study of matter on the nuclear, atomic and molecular levels. The low-current electrolysis allows us to get the inexpensive hydrogen from water.

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LENR
(Low Energy Nuclear Reactions)

http://www.lenr-canr.org

Editorial: There is a collection of some papers on LENR (Low Energy Nuclear Reactions), also known as Cold Fusion. CANR, Chemically Assisted Nuclear Reactions, is another term for this phenomenon. These original scientific papers are reprinted with permission from the authors and publishers.

Website http://www.lenr-canr.org features a growing library of scientific papers about LENR and an extensive bibliography of journal papers, news articles and books about LENR.

COLD FUSION: What is it and what does it mean to science and society?

Edmund Storms

Cold fusion is important because it promises to be a new source of pollution-free, inexhaustible energy. In addition, it is important because it reveals the existence of a new way nuclei can interact that conventional scientific theory predicts is impossible. What then is this phenomenon that suffers such promise and rejection?

Energy can be obtained from the nucleus in two different ways. On the one hand, a large nucleus can be broken into smaller pieces, such as is experienced by uranium in a conventional nuclear reactor and by the material in an atom bomb. This is called fission. On the other hand, two very small nuclei can be joined together, such as occurs during fusion of deuterium and tritium in a Hot Fusion reactor and in a hydrogen bomb. This process, called fusion, also takes place in stars to produce much of the light we see.

The fission reaction is caused to happen by adding neutrons to the nucleus of uranium or plutonium to make it unstable. The unstable nucleus splits into two nearly equal pieces, thereby releasing more neutrons, which continue the process. As every one now knows, this process produces considerable waste that is highly radioactive. The uranium used as fuel also occurs in limited amounts in the earth's crust. As a result, this source of energy is not ideal, although widely used at the present time.

The normal hot fusion reaction requires two deuterium or tritium nuclei to be smashed together with great energy. This is accomplished by raising their temperature. However, this temperature is so high that the reactants cannot be held in a solid container, but must be retained by a magnetic field. This process has proven to be very difficult to accomplish for a time sufficient to generate useable energy. In spite of this difficulty, attempts have been under way for the last 40 years and with the expenditure of many billions of dollars. Success continues to be elusive while the effort continues.

Cold fusion, on the other hand, attempts to cause the same process, but by using solid materials as the container held at normal temperatures. The container consists of various metals, including palladium, with which the deuterium is reacted to form a chemical compound. While in this environment, the barrier between the deuterium nuclei is reduced so that two nuclei can fuse without having to be forced together. Because the process causing this to happen is not well understood, the possibility is rejected by many conventional scientists. Difficulty in producing the process on command has intensified the rejection. While this difficulty is real, it has not, as many skeptics have claimed, prevented the process from being reproduced hundreds of times in laboratories all over the world for the past 13 years. As you will see by reading the reviews and papers in our Library (see http://www.lenr-canr.org/LibFrame1.html), the process continues to be reproduced with increasing ease using a variety of methods and materials.

What is the nature of this process and why has it been so hard to understand? To answer this question, a person needs to understand the nature of the barrier that exists between all nuclei. Because all nuclei have a positive charge in proportion to their atomic number, all nuclei repeal each other. It is only the surrounding electrons that hold normal matter together, with the nuclei being at considerable distance from each other, at least on the scale of an atom. When attempts are made to push the nuclei closer, the required energy increases as the nuclei approach one another. However, when deuterium dissolves in a metal, it experiences several unique

conditions. The surrounding metal atoms produce a regular array that is able to support waves of various kinds. These waves can be based on vibration of the atoms (phonons), vibration of the electrons, standing waves of electromagnetic energy, or a wave resulting from conversion of the deuterium nuclei to a wave. In addition, the high density of electrons can neutralize some of the positive charge on the deuterium nuclei allowing a process called tunneling, i.e.. allowing passage through the barrier rather than over it. The mechanism of this neutralization process is proposed to involve a novel coherent wave structure that can occur between electrons under certain conditions. All of these wave processes have been observed in the past under various conventional conditions, but applying them to the cold fusion phenomenon has been a subject of debate and general rejection.

While the debate based on wave action has been underway, people have proposed other mechanisms. These include the presence of neutrons within the lattice. Normally, neutrons are unstable outside of the nucleus, decomposing into a proton, an electron, and a neutrino. Presumably, this reaction can be reversed so that neutrons might be created in a lattice containing many free electrons and protons. Having no charge, the neutron could then interact with various atoms in the lattice to produce energy. These neutrons might also be hidden in the lattice by being attached to other nuclei in a stabilized form, to be released when conditions were right. Several particles normally not detected in nature also have been proposed to trigger fusion and other nuclear reactions.

While search for a suitable mechanism has been underway, an understanding of the environment that triggers the mechanism has been sought, the so-called nuclear-active-environment. Initially, this environment was thought to exist in the bulk of the palladium cathode used in the Pons-Fleischmann method to produce cold fusion. It is now agreed that the nuclear reactions only occur in the surface region. Recent arguments suggest that this surface layer does not even require palladium for it to be nuclear-active. Nuclear reactions have now been produced in a variety of materials using many methods. The only common feature found in all of these methods is the presence of nano-sized particles of material on the active surface. If this observation is correct, four conditions seem required to produce the nuclear reactions. First, the particle must have a critical small size; second, it must contain a critical concentration of deuterium or hydrogen; third, it must be constructed of certain atoms; and fourth, it must be exposed to a source of energy. This energy can take the form of a sufficiently high temperature, a significant high flux of hydrogen through the particle, application of energetic electrons or charged particles, or application of laser light of the proper frequency. Until, the importance of these factors is understood, the effect will continue to be difficult to replicate.

Technical Introduction to LENR-CANR

Edmund Storms

At low energies, the Coulomb barrier prevents nuclei from coming together and fusing to form a single nucleus. To initiate a nuclear reaction, several methods are used. Nuclear reactions are normally initiated by pushing two atoms together with enough force to overcome the Coulomb barrier by brute force, or by using neutrons which penetrate the nuclei without seeing a barrier. (Neutrons have no electrical charge, so the Coulomb barrier does not stop them.) These forces are normally provided by high-temperature plasma or by accelerating ions to high energies. In contrast, LENR describes the mechanism and conditions that cause a variety of nuclear reactions to take place with relatively low activation energy. These unique conditions reduce the need for excessive energy. The normal method forces the nuclei together, while the new method encourages them to come together. The challenge has been to understand the unique characteristics of the necessary solid structure such that this structure could be generated at will.

Because the proposed method is unique, at odds with current nuclear theory, and is still difficult to reproduce, support for studies in many countries, but not all, has been very limited. Nevertheless, considerable information has accumulated over the last 13 years since Profs. Stanley Pons and Martin Fleischmann showed the world the possibilities inherent in this phenomenon. Much understanding is buried in conference proceedings and reports that are not available to a serious student. This information will, as time permits, be made available on this site. Students of the subject are also encouraged to use this site to interact with other people in the field and provide objective critiques of the work published here.

PHENOMENA DISCUSSED IN SOME OF THE PAPERS

At least 10 ways have been demonstrated to produce anomalous heat and/or anomalous elemental synthesis. A few of these methods will be described here. For course, not all of the claims are worthy of belief nor are they accepted by many people. Nevertheless, the claims will be described without qualifications in order to provide the reader with the latest understanding.

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The most studied method involves the use of an electrolytic cell containing a LiOD electrolyte and a palladium cathode. Current passing through such a cell generates D+ ions at the cathode, with a very high effective pressure. These ions enter the palladium and, if all conditions are correct, join in a fusion reaction that produces He-4. Initially palladium wire and plate were used, but these were found to form microcracks, which allowed the required high concentration of deuterium to escape. Later work shows that the actual nuclear reaction occurs on the surface within a very thin layer of deposited impurities. Therefore, control of this impurity layer is very important, but rather difficult. The use of palladium is also not important because gold and platinum appear to be better metals on which to deposit the impurity layer. This method is found, on rare occasions, to generate tritium within the electrolyte and transmutation products on the cathode surface. Different nuclear reactions are seen when light water (H_2O) is used instead of D_2O, although the amount of anomalous energy is less when H_2O is used. These observations have been duplicated hundreds of times in dozens of laboratories.

Application of deuterium gas to finely divided palladium, and perhaps other metals, has been found to generate anomalous energy along with helium-4. Both palladium-black as well as palladium deposited as nanocrystals on carbon have shown similar anomalous behavior. In both cases the material must be suitably purified. Palladium deposited on carbon can and must be heated to above 200/260°C for the effect to be seen. When deuterium is caused to diffuse through a palladium membrane on which is deposited a thin layer of various compounds, isotopes that were not previously present are generated with isotopic ratios unlike those occurring naturally.

A plasma discharge under H_2O or D_2O between various materials generates many elements that were not previously present. When the electrodes are carbon and the plasma is formed in H_2O, the main anomalous element is iron. This experiment is relatively easy to duplicate.

Several complex oxides, including several superconductors, can dissolve D_2 when heated. When a potential is applied across a sheet of such material, the D+ ions are caused to move and anomalous heat is generated.

If deuterium ions, having a modest energy, are caused to bombard various metals, tritium as well as other elements not previously present are generated. These ions can be generated in a pulsed plasma or as a beam.

When water, either light or heavy, is subjected to intense acoustic waves, collapse of the generated bubbles on the surrounding solid walls can generate nuclear reactions. This process is different from the fusion reaction claimed to occur within a bubble just before it disappears within the liquid because neutrons are not produced in the former case, but are produced in the latter case. This method has been applied to various metals in heavy water using an acoustic transducer and in light water using a rotating vane which generates similar acoustic waves...

HOW TO EXPLAIN THE CLAIMS

A major problem in deciding which model might be correct is the absence of any direct information about the nature of the nuclear-active-environment. At this time, two important features seem to be important, the size of the nanodomain in which the reactions occur and the presence of a deuterium flux through this domain. The domain can apparently be made of any material in which hydrogen or deuterium can dissolve. Until the nature of the nuclear-active-state (NAS) is known, no theory will properly explain the effect and replication of the claims will remain difficult.

When fusion is initiated using conventional methods, significant tritium and neutrons are produced. In addition, when other elements are generated, they tend to be radioactive. This is in direct contrast to the experience using low energy methods. These products are almost completely absent and, instead, helium-4 is produced. When radiation is detected, it has a very low energy. This contrasting behavior, as well as the amount of anomalous energy, has made the claims hard to explain using conventional models. This difficulty has been amplified by a failure of many skeptics to recognize the contrasting effect of the environment, a plasma being used in the older studies and a solid lattice of periodic atoms being present as the new environment.

Over 500 models and their variations have been proposed, some of which are very novel and some are variations on conventional ideas. Most models attempt to explain the nuclear reaction once the required environment has been created, without addressing what that unique environment might be like. These models involve conversion of a proton (deuteron) to a neutron (dineutron), creation of an electron structure that is able to neutralize the barrier, conversion of deuterium to a wave which interacts without charge, and the presence of otherwise overlooked neutrons and/or novel particles. Many of the models will have to be abandoned or seriously modified once the nature of the nuclear active environment is understood.

It Started in 1989 . . .

Peter Hagelstein

Many of us recall the controversy surrounding the announcement of claims of observations of fusion reactions in a test tube that were made in 1989. At the time, these claims were greeted with considerable skepticism on the part of the physics community and the scientific community in general.

The principal claim of Pons and Fleischmann

The principal claim of Pons and Fleischmann in 1989 was that power was produced in palladium cathodes that were loaded electrochemically in a heavy water electrolyte. The evidence in support of this was a measured increase in the temperature in the electrochemical cell. There was no obvious evidence for nuclear reaction products commensurate with the claimed heat production. Fleischmann speculated that perhaps two deuterons were somehow fusing to He-4 through some kind of new mechanism.

Rejection by the physics community

This claim was not accepted by the physics community on theoretical grounds for several reasons:

First, there was no mechanism known by which two deuterons might approach one another close enough to fuse, since the Coulomb barrier prevents them from approaching at room temperature.

Second, if they did approach close enough to fuse, one would expect the conventional dd-fusion reaction products to be observed, since these happen very fast. Essentially, once two deuterons get close enough to touch, reactions occur with near unity probability, and the reaction products (p+t and n+He-3) leave immediately at high relative velocity consistent with the reaction energy released. To account for Fleischmann's claim, the proposed new reaction would seemingly somehow have to make He-4 quietly and cleanly, without any of the conventional reaction products showing up, and would somehow have to arrange for this to happen a billion times faster than the conventional reaction pathway. Most physicists bet against the existence of such a magical new effect.

Third, the normal pathway by which two deuterons fuse to make He-4 normally occurs with the emission of a gamma ray near 24 MeV. There was no evidence for the presence of any such high energy gamma emission from the sample, hence no reason to believe that any helium had been made.

Finally, if one rejects the possibility that any new mechanisms might be operative, then the claim that power was being produced by fusion must be supported by the detection of a commensurate amount of fusion reaction products. Pons and Fleischmann found no significant reaction products, which, given the rejection of new mechanisms, implied an absence of fusion reactions.

An alternate explanation is proposed

The physicists decided in 1989 that the most likely reason that Pons and Fleischmann observed a temperature increase was that they had made an error of some sort in their measurements. When many groups tried to observe the effect and failed, this led most of the physics community to conclude that there was nothing to it whatsoever other than some bad experiments.

The claim of Jones

A second very different claim was made at the same time in 1989 by Steve Jones. This work also involved electrochemistry in heavy water and the observation of reaction products corresponding to the conventional dd-fusion reactions. The initial publication showed a spectrum of neutron emission that Jones had detected from a titanium deuteride cathode loaded electrochemically. The response of the physics community was skeptical, as the signal to noise ratio was not particularly impressive. Given the polarization of the physics community in opposition to the claims of Pons and Fleischmann (which were announced essentially simultaneously), the physicists were not of a mood to accept much of any claims that fusion could happen in an electrochemical experiment at all. Jones went to great lengths to assure fellow scientists that his effect was completely unrelated to the claims of Pons and Fleischmann, and was much more reasonable.

Also rejected

Physicists had reason to be skeptical. Theoretical considerations indicated that the screening effects that Jones was relying on were not expected to be as strong as needed to account for the fusion rates claimed. As this experiment could not seem to be replicated by others at the time, it was easy for the physics community to reject this claim as well.

Cold fusion, weighed and rejected with prejudice

Cold fusion, as the two different claims were termed, was dismissed with prejudice in 1989. The initial claims were made near the end of March in Utah, and the public refutation of the claims was made at the

beginning of May. It only took about 40 days for the physics community to consider the new claims, test them experimentally, and then announce loudly to the world that they had been carefully weighed and rejected.

Following this rejection, physicists have treated cold fusion rather badly. For example, Professor John Huizenga of Rochester University was selected to be co-chair of the DOE ERAB committee that met to review cold fusion and issue a report. Shortly afterward, he wrote a book entitled Cold Fusion, The Scientific Fiasco of the Century, in which he discusses the claims, the experiments, and the extreme skepticism with which the new claims were greeted. Robert Park discusses the subject in his book entitled Voodoo Science. You can find many places where physicists and other scientists happily place the cold fusion claims together with claims of psychic phenomena.

A Science Tutorial

Talbot Chubb

First it is important to recognize that there are four distinct types of energy production:
1) chemical energy, that powers our cars and most of our civilization;
2) nuclear fission energy, as used to generate about 15% or our electricity;
3) hot fusion nuclear energy, which powers the sun and most stars;
4) cold fusion nuclear energy, which appears as unexplained heat in a few experimenter's laboratory studies and which most scientists believe is impossible.

The three types of nuclear energy produce 10 million times as much heat per pound of fuel than occurs with chemical energy. How do these types of energy differ? To understand this question you need to know some chemistry and physics.

Lesson 1

Nature has provided us with two types of stable charged particles, the proton and the electron. The proton is heavy, normally tiny, and has a positive charge. The electron is light, normally large and fuzzy, and has a negative charge. The positive charge and the negative charge attract each other, just like the north pole of a magnet attracts the south pole of a magnet. When you bring two magnets together with the north pole of one facing the south pole of the other, they pull together, bang! When they bang into each other they release a little bit of energy in the form of heat, but it is too small an amount to easily measure. To pull the magnets apart you have to do work, which is another way of saying you have to use up energy. It's almost like pulling a rock back up a hill. Rolling the rock down a hill actually creates a little heat, and pulling the rock back up the hill takes energy. In the same way the positive charge of the proton pulls on the negative charge of the electron and they stick together releasing energy in the process. The result is a hydrogen atom, designated H. A hydrogen atom is nothing but a fuzzy electron hugging a compact proton. The proton is the nucleus of the hydrogen atom. If you knock the electron off the hydrogen atom you get a positive ion H+, which is nothing more than the original proton. An ion is the name applied to an atom or molecule that has lost or gained one or more electrons, hence is no longer electrically neutral.

Lesson 2

As you know, nature has provided us with more than one type of atom. We have oxygen atoms, nitrogen atoms, iron atoms, helium atoms, etc.. How do these atoms differ? The answer is that they all have different types of nuclei (plural of nucleus, from the Latin). And these different nuclei all have different numbers of protons inside them, which means they all have different plus charges. The nucleus of the helium atom has 2 protons inside it, hence has plus 2 charge, and requires 2 electrons to neutralize its charge. When 2 electrons stick to it, it becomes a helium atom. The oxygen nucleus has 8 protons and has charge 8. When 8 electrons stick to it, it becomes an oxygen atom. The nitrogen atom has 7 electrons, and the iron atoms something like 26. But all the atoms are built more or less the same way, with a compact positively charged nucleus embedded in a cloud of fuzzy electrons. The difference in size between the compact nucleus and the fuzzy electrons is enormous. The sun has a diameter only about 100 times that of the earth. The electron cloud on an atom has a diameter which is about 100,000 times that of the nucleus. Cube these numbers to get the difference in volumes.

Lesson 3

We now are in a position to understand what chemical energy is. The atoms, all electrically neutral, can actually join with each other and release more energy. This is another way of saying that they can join into more stable configurations. The electrons in an atom try to configure themselves so as to get as close as possible to their nucleus, but their fuzzy nature requires that they take up a certain volume of space. However, if they join together with the electrons of another atom they can usually find a tighter configuration that leaves them closer to their beloved

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nuclei. For example, 2 hydrogen atoms can join together into a more compact configuration if each hydrogen atom contributes its electron to a 2-electron cloud, which the separate protons share. In this manner they form a grouping of the 2 electrons in a single cloud, together with the 2 isolated protons spaced apart from each other but still within the electron cloud. The result is a heat-producing chemical reaction H + H => H_2. (The => means "goes to" or "becomes".) The H_2 configuration is the hydrogen molecule, and when you buy a tank of hydrogen gas, H_2 molecules is what you get. Furthermore, the 2 electrons of the H_2 molecule and the 8 electrons of the O atom can find a still more compact configuration by combining their electrons to create the water molecule H_2O, plus heat. The water molecule is really a single cloud of electrons in which are embedded the three point-like nuclei to form a minimum energy configuration. So when we burn oil or coal we reconfigure the electrons to produce more stable configurations of point-like nuclei embedded in electron clouds, liberating heat. So much for chemical energy.

Lesson 4

We have slid over one point in the above discussion. How does Nature make a nucleus containing two or more protons in the first place. After all, each of the protons has a positive charge, and the positive charges repel each other very strongly when they are separated by a tiny distance, equal to the distance across a nucleus. The repulsion of like charges is just like the repulsion between the north poles of two magnets when they are pushed together the wrong way. Something must overcome this repulsion, or else the only kind of atoms we would have would be those of hydrogen. Fortunately, this is not what we observe. The answer is that there is a second kind of force which acts on protons. This is the nuclear force. The nuclear force is very strong but requires particles to almost sit on each other to have any effect. Also, there is a second kind of heavy particle, which is just like a proton, except that it has no positive or negative charge. It is not pushed away by the proton's plus charge. This other kind of particle is called the neutron, since it is electrically neutral. A peculiar fact of life is that it exists in stable form only inside a nucleus. When not in the nucleus it changes into a proton, an electron and a very light anti-neutrino in about 10 minutes. But it lasts forever inside a nucleus. Anyway, the neutron and the proton very strongly attract each other once they get close enough together, and then they combine to form a highly stable pair called a deuteron, which we designate D+. The single deuteron, when it combines with a single electron, forms the heavy hydrogen atom called deuterium, designated D. A second nuclear reaction occurs when two deuterons make contact. When they can be forced together so as to make contact, the 2 deuterons fuse, making a doubly charged particle. The grouping of 2 protons and 2 neutrons is even tighter than the proton-neutron grouping in the deuteron. The new particle, when neutralized by 2 electrons, is the nucleus of the helium atom, designated He. Larger groupings of neutrons and protons exist in nature and serve as the nuclei of carbon, nitrogen, oxygen, and iron, etc. atoms. All of these groupings are made possible by the very strong nuclear force, which is felt between particles only when they are in contact or share the same nucleus-size volume of space.

Lesson 5

We can now understand normal nuclear energy, which is really nuclear fission energy. During the early history of the universe massive stars were formed. In the explosion of these massive stars, lots of different types of nuclei were formed and exploded back into space. Second and later generation stars and planets were formed from this mix, including the sun. In the explosion process probably every possible stable configuration of protons and neutrons was produced, plus some almost-stable groupings, such as the nucleus of the uranium atom. There are actually 3 different types of uranium atom nuclei, called uranium-234, uranium-235, and uranium-238. These "isotopes" differ in their number of neutrons, but they all have 92 protons. The nuclei of all uranium atoms can go to a lower energy configuration by ejecting a helium nucleus, but this process occurs so rarely that the Earth's uranium has already lasted over 4 billion years. But the uranium nuclei are unstable in another way. In general, groupings of protons and neutrons are happiest if they have about 60 protons-plus-neutrons. The uranium nuclei contain more than three times this number. So they would like to split in two, which would release a lot of heat. But nature doesn't provide a way for them to split apart. They have to first go to a higher energy configuration before splitting in two. However, one of the three forms of uranium nucleus found in nature called uranium-235 and designated ^{235}U, gains the needed energy if it captures a neutron. The energized nucleus that results from neutron capture then splits apart with the release of an enormous amount of energy, and incidentally with release of additional neutrons. The additional neutrons can then split more uranium-235 nuclei, keeping the reaction going. This is what happens in nuclear power plants, where the heat, which is the end product of the nuclear splitting process, is used to boil water, generate steam, and turn electrical generators. (One also gets lots of radioactive products, which are a nuisance to dispose of safely.)

Lesson 6

We are now also in a position to understand hot fusion nuclear energy. As mentioned in lesson 5, the groupings of protons plus neutrons is most stable when the numbers of neutrons and protons approximate those

found in the nucleus of an iron atom. Just as uranium has too many neutrons plus protons to be comfortable, so the light elements like hydrogen, helium, carbon, nitrogen and oxygen have too few. If the nuclei can be made to make contact under proper conditions, they can combine to create more stable groupings, plus heat. This is the process of fusion. Nature has found a way of doing this in stars like the sun. All Nature has to do is heat compressed hydrogen hot enough and wait long enough and hot fusion will occur. If Nature were to start with deuterium, which already has a paired proton and neutron, the task would be relatively easy in a star. Temperature is a measure of how much speed an atom of a given type has as it bangs around inside a cloud of such atoms. The higher the temperature, the higher the speed and the closer the atoms get to each other momentarily during a collision. In a star the temperatures are high enough that all the electrons quickly get knocked off the atoms, so one is really dealing with a mixed cloud of electrons and nuclei. At very high temperature the nuclei occasionally get close enough during collisions for the pulling-together short range nuclear force to turn on. Then the nuclei can stick together and go to a lower energy grouping of protons plus neutrons, releasing heat. Hot fusion nuclear energy is an attempt to carry out this process in the lab, using deuterium and mass-3 hydrogen (whose nucleus is a compact grouping of 1 proton and 2 neutrons) as the gas. Hot fusion requires that the gas be contained at temperatures of hundreds of millions of degrees, which can be done with the help of magnetic fields, but only for 1 or 2 seconds. The hope is to contain the gas for longer times. During the period of high temperature containment nuclear reactions occur during collisions. The main form of energy release is ejection of high energy neutrons and protons. The proton energy quickly converts to heat. The neutron energy can also be converted to heat but makes the equipment highly radioactive. It then becomes difficult to repair the equipment, which could make hot fusion a poor candidate for commercial power production. In any case hot fusion power is a dream that is still probably at least 50 years away. But most scientists view hot fusion as the only way to achieve fusion power. Hot fusion produces less radioactivity than fission power, is environmentally benign, and has a virtually limitless fuel supply on earth (many millions of years at present energy usage rates).

Lesson 7

So now we come to cold fusion. Cold fusion may provide an easier and non-radioactive way of releasing nuclear fusion energy. Cold fusion relies on a different way of letting the protons and neutrons in one nucleus make contact with those in another nucleus, so that the nuclear force can bring them into a more stable configuration. The requirement for any nuclear reaction to occur is that the reacting nuclei occupy the same volume of space. This condition is called particle overlap. In hot fusion particle overlap is brought about briefly by banging the nuclei together so as to overcome momentarily the repulsion of the two positive charges which try to keep the particles apart. In cold fusion particle overlap conditions are achieved by making deuterium nuclei act as fuzzy objects like electrons in atoms, instead of like tiny points. When either light or heavy hydrogen is added to a heavy metal, each hydrogen "atom" occupies a position inside the metal where it is surrounded by heavy metal atoms. This form of hydrogen is called interstitial hydrogen. With interstitial hydrogen the electrons of the hydrogen atom become part of the pool of electrons of the metal. Each hydrogen nucleus oscillates back and forth through a negatively charged electron cloud provided by the electrons of the metal. They can be thought of as moving back and forth like the pendulum in a grandfather clock. This vibration exists even at very low temperature, due to a peculiarity of a branch of physics called quantum mechanics. The vibration is called zero point motion. The nucleus then becomes a fuzzy object, like the electrons in an atom. But this amount of fuzziness is not enough to permit a hydrogen nucleus to make contact with another hydrogen nucleus. To get two or more hydrogen nuclei to share the same volume one must go one step further. In a metal electrical current is carried by electrons that act more like vibrating matter waves than like point particles. If electrons did not become wave-like inside solids, there would be no transistors and no present day computers. This wave-like kind of electron is called a Bloch function electron. The secret of cold fusion is that one needs Bloch function deuterons. One needs wave-like deuterons inside or on the surface of a solid in order that two or more deuterons share the same volume of space. But once the Bloch function deuterons are created, the nuclear force comes into play and the protons and neutrons making up the deuterons can rearrange themselves into the more nuclearly stable Bloch function helium configuration, with release of heat. To study cold fusion the experimenter has to force deuterons to assume the wave-like form and keep them in the wave-like state. Cold fusion experiments demonstrating release of excess heat show that this can be done. But at present no one knows how to do it reliably. Since cold fusion promises millions of years of energy without the problems of global warming or radioactivity, a real effort should be made to learn how.

For more tutorials go to www.hometown.aol.com/cffuture1 and www.hometown.aol.com/cffuture2

LENR (Low Energy Nuclear Reactions) Experiments

Review from
http://www.lenr-canr.org

Have you ever wondered what a physics laboratory looks like? They are seldom spacious or organized the way they are shown in movies. Most LENR researchers work at universities or home laboratories, with tight budgets in a crowded space. They keep old, broken equipment on shelves to scavenge parts for new experiments. In this section we present some photographs of equipment provided by researchers, and close up pictures of equipment. The actual cells, cathodes and other equipment used in electrolysis experiments often have an ad-hoc, home-made appearance, because they are made by hand. They have to be; they are unique, one-of-a kind prototypes. Nothing quite like them has ever been made before.

A visitor seeing a LENR experiment the first time may feel disappointed. It looks like any other electrochemical experiment. The heat or neutron flux produced by the experiment are so small they can only be detected with sensitive instruments. A null cathode that produces no effect looks exactly like an active cathode. The difference between one cathode and another is in the microscopic structure, or the traces of elements mixed in with the palladium. Only one kind of cold fusion looks dramatic i. e. the glow discharge reaction.

Here are a few photographs of cold fusion cells and devices (also see the cover page).

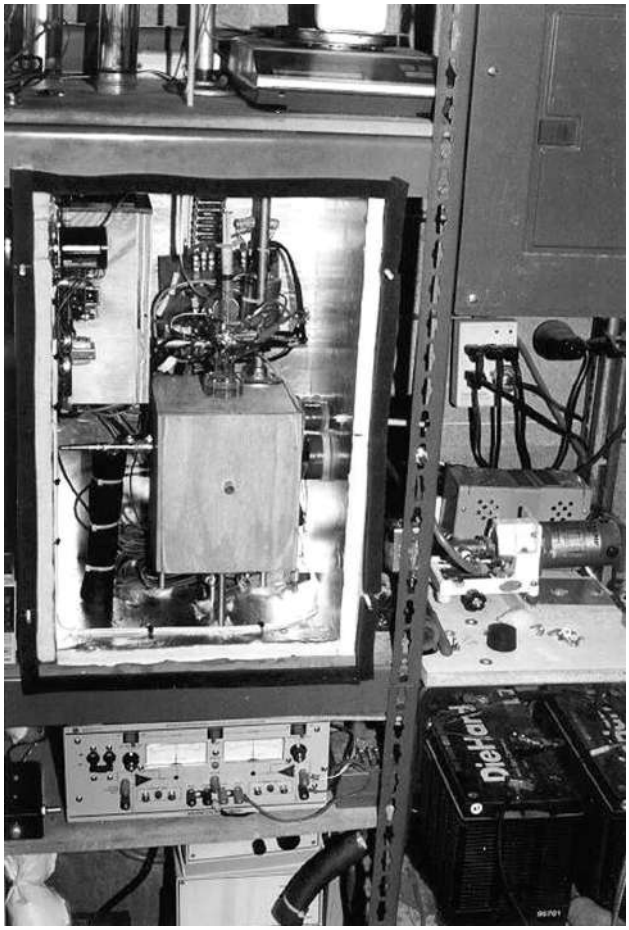

Fig.1
Box Calormeter

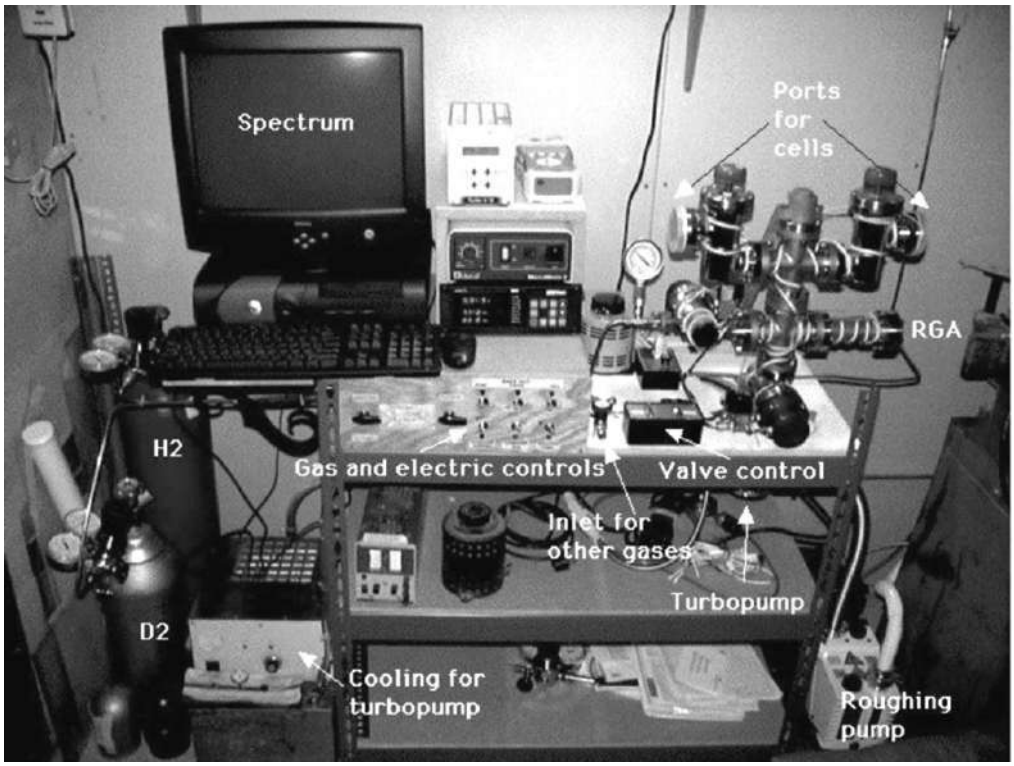

On Fig. 1 there is a calorimeter constructed by Edmund Storms. Note the DieHard® battery, lower right, that serves as an unninterruptable power supply. A power failure can ruin an experiment. Whenever possible, inexpensive, ordinary materials and instruments are used. However, experiments are never cheap, and they cannot be done on a shoestring. The equipment, arranged for another experiment (see Fig. 2), costs about $40,000.

Fig.2 (On the left)
Vacuum system to prepare particles for gas loaded cold fusion cells, courtesy E. Storms.

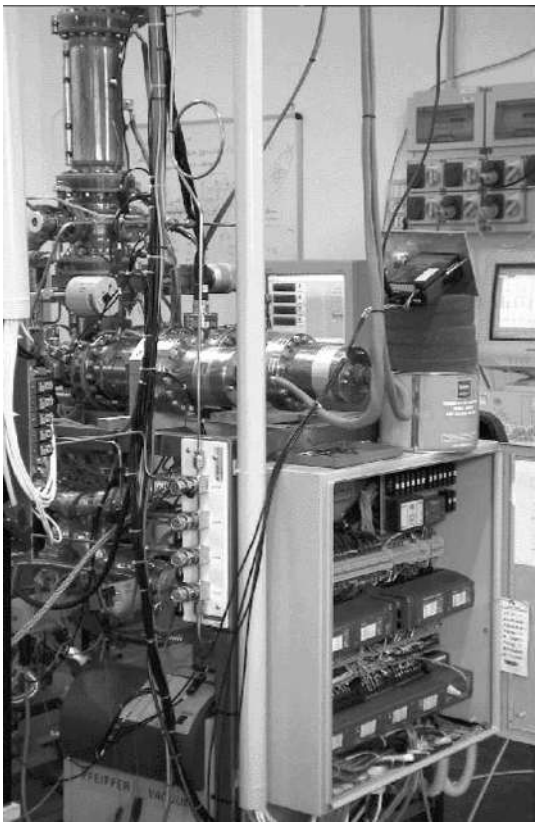

Fig.3
A high resolution mass spectrometer used for on-line helium detection during a cold fusion experiment at C. R. ENEA Frascati. (http://www.frascati.enea.it/nhe/)

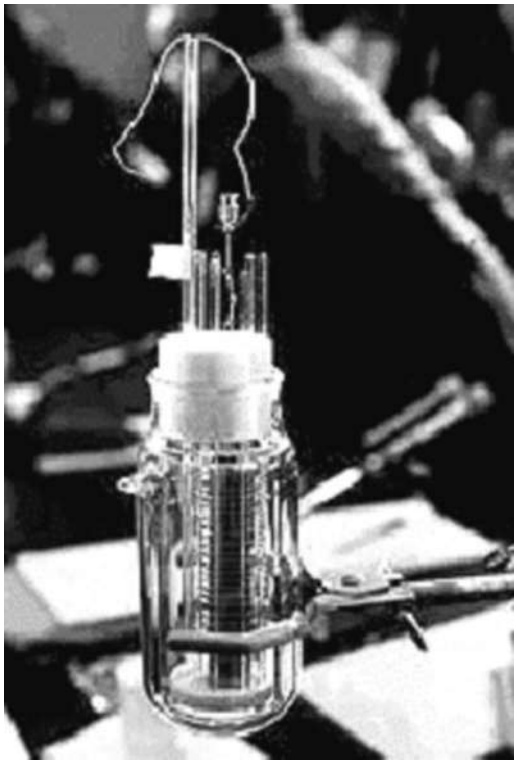

Fig.4
A cell at ENEA Frascati

Fig.5
A flow-type cell, courtesy E. Storms

Fig.6
Close up of a Miley-style cell, courtesy E. Storms

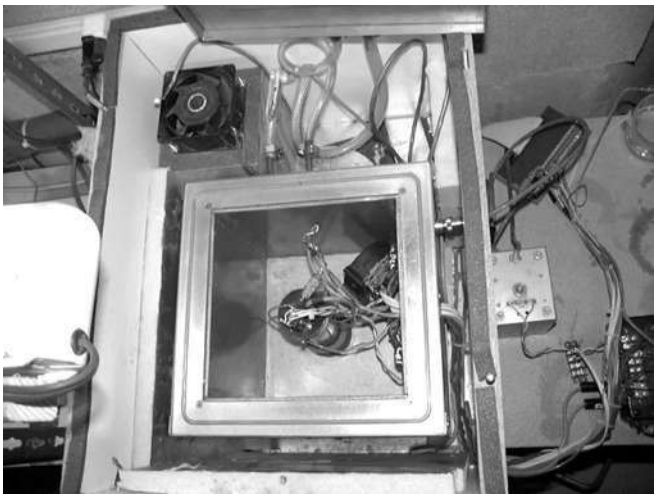

Fig.7
A cell installed inside a Thermonetics Seebeck calorimeter with the lid removed, courtesy E. Storms

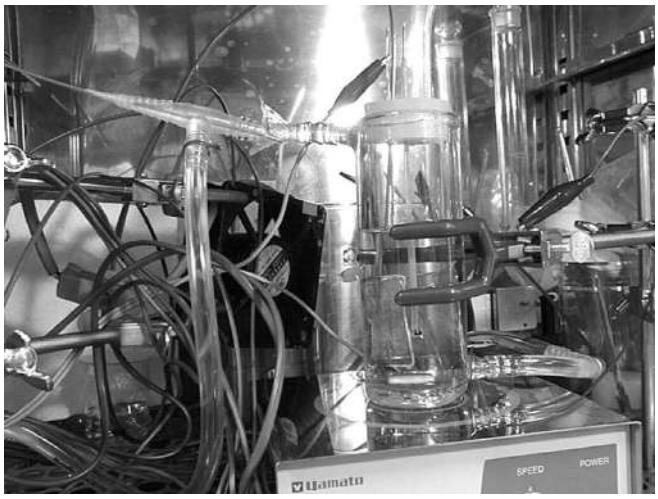

Fig.8

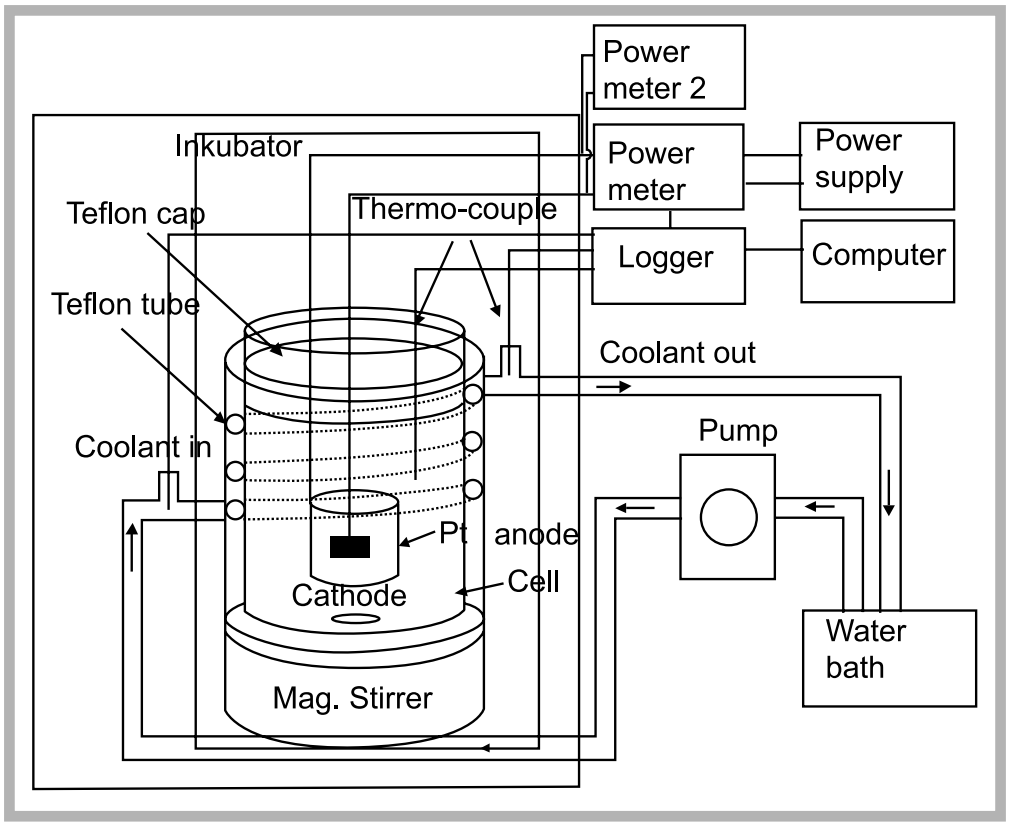

On the Fig. 8 you can see a glow discharge electrochemical cell at Hokkaido University, courtesy T. Mizuno. The cell is installed inside a crowded constant temperature air-cooled chamber. It placed on a magnetic mixer. Cooling water is pumped through the plastic tubes attached to the top and bottom. The muffin fan at the back circulates the air in the chamber

Fig.9

A schematic of the calorimeter shown above.

Hydrogen power engineering

Faraday Laboratories Ltd, Moscow, and Spectrum Investments Ltd, London, started joint R&D project on hydrogen power engineering. Photo: Alexander V. Frolov, Faraday Laboratories Ltd and Nicholas Moller, Spectrum Investments Ltd. The project includes designing and building of prototype to use hydrogen recombination process for heat generation.

On Electrogravitation

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Part I

"let's go to the Mars!"

Nowadays it becomes evident that exploration of deep space by means of rocket equipment is impossible. Aircrafts, which run on jet thrust, are too expensive and unreliable. Besides, they are too slow-speed if were considered on a scale of solar system. For example, the flight to the remote areas of our planetary system can drag on tens years. But the main disadvantage of rockets is their low load-carrying capacity. Thus, the most powerful transport system "Progress" can deliver less than 100 ton of load to the orbit of the Earth, and only 1 ton to the orbit of the Mars. Rather natural question arises as to whether any alternative ways of space exploration exist? Are there any transport systems, which can compete with rocket equipment on the interplanetary routs of future? Actually, at present there is only one technology, which is alternative to rocket ones – it is the so-called light sailers, using light pressure for acceleration. Laser and maser can be also used for their acceleration from satellites. However, there are also some disadvantages here.

There is also one more transport system, which is undeservedly consigned to oblivion. It uses electricity in acceleration aggregate. This transport system or the electric propulsion system is a result of researches and investigations of two little-known, but extremely talented American physicians and inventors, Thomas Townsend Brown and Paul Alfred Biefeld (the last one was also a professor of Astronomy).

Thomas T. Brown was the first who discovered electric principle of this propulsion system. Thus, in twenties of the XX century Thomas T. Brown, being the student of secondary school, became interested in X-rays. He wanted to reveal if the rays, outgoing the X-ray unit, could take positive effect. For his researches the inventor had got Coolidge Tube, the device, which radiates X-rays and consists of a glass tube. Deep vacuum is created in this glass tube. Anode and cathode are placed in the tube. Cathode radiates electrons and anode brakes them. X-rays are created at striking of electrons against anode. Brown used Coolidge Tube in the way nobody had done before. For ease of handling the researcher suspended the device on wires, which run to anode and cathode parallel to the Earth. During the operation of the device he noticed that every time when current fed to the tube, the tube was moved aside and tended to make slight progressive motion. Subsequent experiments demonstrated that the deviation value depended only on the value of voltage, which is between anode and cathode. The higher voltage is, the more deviation. X-rays were neither here not there. Much later at participation of Paul A. Biefeld, the same tendency to move was revealed at plane disc capacitors. The reason, which causes this motion, is the same, i.e. voltage, which exists between plates and not between anode and cathode as in Coolidge Tube.

Having run series of experiments, the researchers proved that electric energy could be directly transformed to mechanical. They also devised the physical principle, which were included in the scientific annals as Biefeld-Brown effect.

Editor's: Let us note that earlier Ampere and Faraday have been working on Electrokinetic effects which are easily detected at strong current. Modern researches on this point are known as "Sigalov's effect" (force appears in electric conductor which is bent at angle and at current impulse).

The essence of this effect lied in the fact that charged disc electric capacitors tend to move in the direction of their positive pole. At formulating of the essence of this effect the scientists consciously did not mention Coolidge Tube in order to demonstrate that according to their experimental observations, electron streams were not involved in generation of electromotive force. This effect of the direct transfer of electric energy to mechanic one (Biefeld-Brown effect) is observed, when current is fed to the Coolidge Tube or to the plane disc capacitor.

However, all this was realized much later, when in 1923 Brown became a student of Dennis University in Greenville, Ohio, where he met his teacher and later on a coauthor, Paul A. Biefeld. In school time the inventor came to the conclusion that the reopened by him phenomenon has nothing in common with X-rays and that high voltage, used for rays generation, is the basis of this phenomenon. Besides, Brown designed a device named "Gravitor". It looked like a usual bakelite box and was made as a simple construction, which consisted of several flat aluminum plates. The plates were placed as coins in a rouleau and separated with dielectric. It had only to place the box on the scale and connect it to some energy source with 100 kV voltage as the device either lost or put on about one percent of its weight that depended on polarity. An outside observer, who was not familiar with the essence of this effect, could think that mass was really changed. *(Editor's: Weight but not the mass is changed here. Weight is the force. There is a possibility of partial compensation of the weight by another force.)* But this was not the case. For better understanding of the processes, which take place at gravitor operating, let us make a mental experiment. Let us take a weight, put it on the scale and then raise it a little. The scale will certainly show that the weight has become lighter. After that let us press the weight then the scale will show that it has become heavier. However, in fact mass does not change. In the same way motive force, caused by high voltage, slightly raises the gravitor and at changing of polarity presses it. At that it seems that there is some change in weight. Thus, as if by chance, the scientist has discovered effect of direct transition of electric energy into mechanical one. *(Editor's: Let us specify the author's terminology. In T.T. Brown's Patent of 1927 it was mentioned that there*

was generated a force which partially compensated weight. The matter was always about the generation of x-force while gravitational field remained unchangeable).

Having graduated from the University, from 1926 up to 1952 Brown already by himself was being occupied with development of his electrical propulsion system. At the same time whether in chase of fame or in hope to obtain money for his researches, T.T. Brown began asserting that he had discovered something new in physics, viz "electrogravitation", i.e. some connecting effect between gravitation and electricity. *(Editor's: In my opinion, T.T. Brown has never posed a problem in such a way. The matter always concerned the fact that X-force appears while gravitational field does not change.)* As for the development of the invention, it came to the decrease of weight of the device and increase of DC voltage, which fed the plates of the "gravitor". As a result the devices could fly and lift weight which greatly exceeded their own. Thus in 1953 in his laboratory Brown demonstrated the flight of aircraft which had a disk form. The device made 51 m/c (180 km/h), flying at circular course of 6 m diameter. This device was nothing but very lightweight capacitor in which by means of the special construction electromotive force was redirected in two planes upward and sideward. It made the device rise in air and fly around the mast. Current of 50kWtt voltage was supplied to the central mast by the wire. Then speed of "flying disks" became higher, the payload capacity was increased but that was again resulted by decrease of weight and increase of the supplied voltage. T.T. Brown so succeeded in decreasing of the thickness of capacitor plates and in making his devices superlight, that the witnesses of these demonstrations called these devices as "air films".

Later on all works in this area were placed on secret list and then closed because of lack of prospects. Thus, accounts and experiments demonstrated that it was impossible to overcome terrestrial attraction entirely and go to outer space by means of the gravitor because there are no such natural materials which could take huge electric and heat loads. Besides, sufficiently massive electric power station would be needed to produce required currents. *(Editor's: Thereupon the following question appears: why the author looks for "currents" while the essence of the technology is in applying of high voltage but not of the currents?!)* Moreover some alternative was made, i.e. jet engines. Gravitor could not compete with them by above-mentioned and quite objective reasons. In time, since the mechanism of transition of electric energy into mechanical one was not disclosed and Brown's populist idea has received some publicity, this effect became surrounded with idle talks and guess-works. However the scientists who researched this very effect, has developed only three theory wh ich could explain its existence.

The first theory was suggested by T.T. Brown, the discoverer of this effect. To his dying day Brown asserted that he had discovered the effect which could connect gravitation and electricity, i.e. "electrogravitation". But this theory can be easily refuted by practice. It is enough to put Brown's bakelite box to the scale in such a way as to place the plates of the "gravitor" at right angle to the surface of the scales. Then poles of the "gravitor" will be placed at the same level and parallel to ground and as a consequence electromotive force will influence in no way on the scale, since this force is directed sideward but not upward or downward. The scale will accurately show that there are no changes in weight and hence there is no **electrogravitation**. *(Editor's: The author will obtain propulsive force and it is directed not upward and downward but sideward. However the effect exists in any case. The changing of weight appears only when propulsive force generated by the device is directed against the weight force, i.e. upright.)*

The second theory was suggested by T. Brown's opponents. They asserted that electromotive force appears as a result of the so called "electron wind", i.e. electron streams which exist between the plates of the "gravitor". In their argumentations Brown's opponents rest upon the following facts which are well-known to every physicist. Fast electrons, as well as photons, have dual properties, i.e. interacting with matter and environment, they behave both as a wave and as a material particle. Since light or photons carry energy, then they heat bodies which are in their way and put pressure on the illuminated surface etc. Similarly electron streams carry heat or kinetic energy and hence they can put pressure on the anode of Coolidge Tube and get it moving forward. This theory seems to be interesting, however it explains appearance of electromotive force only in Coolidge Tube, but there is no explanation why discoid capacitors tend to move. Point is that there are no free electron streams in the capacitors. Usually between the plates of capacitors there is a dielectric which brings electron streams to nothing. If there is no electron wind, then what makes capacitors move?

Editor's: There is always a surface charge and reactive outflows of ions. But it is just a partial explanation of Biefeld-Brown's effect.

The third theory is based on the following fact. It is well known that electrons can have heat or Brownian chaotic motion. Free electrons, placed in a conductor, are in the similar chaotic heat motion before voltage is applied to this conductor. The higher temperature of the environment is the higher speed of this heat motion. According to school course of physics, heat energy or energy of chaotic motion of molecules (electrons) can be entirely transferred into mechanical one. If all molecules (electrons) start to move simultaneously and in the same direction, and if they push some piston toward this direction then heat energy of molecules (electrons) will be entirely transferred into mechanical work. In other ways, this piston will move until molecules (electrons) calm down. It is considered that this process is unrealizable in practice.

However, it seems that this is not quite the case, i.e. it is possible to regulate chaotic heat motion of electrons. Obviously this process takes place in the capacitor and in Coolidge Tube. It is no secret that when negative electrons try to move to the neighbor positive charged electrode, then dielectric layer which is placed between the plates of the capacitor prevents it. Electrons rest upon this layer and start to heat. Their internal energy is also increasing. The higher voltage is the higher heating of electrons, i.e. their capacity to have chaotic heat motion increases. However, chaotic motion of

electrons is not observed on the capacitor plates, since the directed force (voltage) influences electrons. Electrons tend to move upward, downward, to the right and to the left, but voltage prevents it. Thus they just are forced to move in space in one direction and with the same speed. Capacitor or gravitor has to move alongside with electrons because plates of the capacitor (gravitor) become a piston which is pushed by heated electrons. This piston is in progressive motion. It starts to move under the influence of electrons, or rather together with electrons. The higher voltage is, the higher temperature of electrons and hence the higher their speed. Therefore speed of capacitor (gravitor) increases at voltage increase. There is a usual chain, i.e. electric energy transfers into heat energy and heat energy transfers into mechanical one. Approximately the similar process takes place in Coolidge Tube, but there the heat of electrons is caused by thermoelectric emission on the cathode. Electrons evaporate from the cathode surface. Voltage, existing between anode and cathode, makes electrons move in one and the same direction. They move towards anode, which serves as piston and takes heat push upon itself, i.e. it transfers heat energy of electrons into mechanical work. It is clear that the higher voltage is the more intensively electrons are heated. Therefore electrons more intensively influence anode and the suspended tube is deviated to a greater extent. (*Editor's: Nowadays this very explanation is the most admitted one.)*

Resting upon Biefeld-Brown's theory and experimental results and at sufficient financing, already within the next few years it would be possible to create a unique electric engine which can operate on hot or quick electrons. Besides there will appear a possibility to orbit the first spaceship equipped with a propulsion system similar to gravitor one's. In near future scheduled cargo-and-passenger service could be organized within planetary system. First of all such transportations can be organized between the Mars, Moon and Venus orbits that will let to start active colonization of these planets.

Thus, more than 200 flights to the Moon and back and about 70 flights to the Mars are possible by means of the gravitor which is made of modern fusions and dielectric materials and which is placed on the Earth orbit. At that there is a minimum risk for its breakdown during the flight, because gravitor has no movable parts and no explosives are used. Negative consequences for the crew in an improbable emergency are insignificant. Even if high voltage causes disruption of dielectric layer between the electrodes and voltaic arc appears then the spaceship, equipped with such a propulsion system, will mechanically arrive its destination. The source of energy will be its only trouble spot and it will happen only if nuclear reactor instead of solar batteries is used. There is also an idea to attach dwelling capsules and cargo bays, equipped with such electric engine, one after another, like carriages are attached to a locomotive. It will let to equip this interplanetary vehicle in several stages by compactly packed modules which are delivered from the Earth. Unfortunately, this project exists only on paper and support of government or financial institutions is not expected in the near future. Faint hope is rested upon enthusiasts but there are too few of such people, besides almost all of them are rather hardly related to space flights and science. Most of scientists even hear nothing about Biefeld-Brown Effect, because it has never become widely known, since all works of this field, except the very first experiments from the USA, were run and then closed in secrecy.

Part II

"...it's time to go to the stars"

Due to the theory of relativity there is an ingrained belief of several generations that it is impossible to move with more than 300 000 m/c speed, i.e. to move faster than light, since the postulates of this theory read that mass is directly depended on speed. Calculations demonstrate that while speed of some accelerated body verges towards light speed its mass will increase and in the point of equilibrium (V=c) it will unrestrictedly increase. Hence acceleration will tend to zero and speed will not virtually increase, no matter how long acceleration speed acts on the object. In other words, the accelerating mass dissipates speed. In principle it is correct but another conclusion can be also drawn from the dependence of mass and speed, for example, the following one: to accelerate an object to the speed which exceeds light speed, mass of the accelerated body should decrease and its speed should increase. Any physicist will say that this statement is correct. At first sight it is practically impossible to realize this idea therefore it was wrongly give to writers of science fiction. They added this idea to their armory and the hypothetical device, which realizes it, was named as gravitational engine. Let us realize this idea from the practical point of view and basing only on facts and logic.

Thus let us apply to the facts and give the description of one experiment. Professor of Pulkovo Observatory N.A. Kozyrev is the author of this experiment, he was also the first to discover the phenomenon of lunar volcanism. Kozyrev used a gyroscope, i.e. the device consisting of two rings of different diameter. These rings are placed athwart one in another and movably jointed. Top is attached to the inner ring through the cardan. The scientist put usual thermos filled with hot water near the beam scale. The top of the gyroscope was preliminarily spun up counterclockwise. At that balance indicator showed that gyroscope top at 90 gram weight became 4 milligram lighter in weight. Then Kozyrev started to pour water of room temperature inside the device through the vinyl chloride tube fixed into the hole, which was made in the plug of the thermos. Seemingly it is impossible to influence upon the gyroscope operating and its weight by a balloon filled with hot water, which is being cooled. Besides the thermos consists of a double-walled container which practically entirely excludes heat exchange with the environment. However balance indicator moved at one or two points, i.e. such connection existed.

This experiment can be divided into two steps. At the first stage the thermos filled with hot water is placed near the gyroscope and we can register the decrease of the top weight. At the second stage water of room temperature is poured into the thermos and the scale again shows that the weight has been changed. Somehow Kozyrev explained the second stage of this

experiment. He assumed that when we pour cold water in the thermos, then the equilibrium of the system is broken because some irreversible processes take place there. Cold water can not cause temperature increase of water in the thermos. Until the system come to equilibrium at a new level, i.e. until the same temperature is set in the whole volume of the thermos, this process will cause the condensation of time which "additionally" influences the top. However the scientist missed that the weight of the top had decreased long before the moment when cold water was poured into the thermos, i.e. before irreversible processes appeared there. *(Editor's: Evidently, the author of the article is not well familiar with Kozyrev's researches and with works of other experimenters who investigated this problem.)* In other words, at the first stage of the experiment there is nothing to condense time and that insignificant weight condensation, which was equal to 4 milligram, absolutely does not fallen into his theory. Some other process is presented there.

It is quite possible that at the first stage of the experiment we deal with nullification of the top weight, i.e. mass of the top tends to zero. Some conclusion arises from this assumption, i.e. hot water can influence the mass of the top in some still incomprehensible way. *(Editor's: The point is not in water temperature but in the process of changing of the entropy.)* Thus there is a simplest and primitive model of the gravitational engine, viz there are hot water along with gyroscope and the required decrease of mass at the "outlet". Certainly, it is very bold assumption but it can be easily checked. Near the gyroscope there should be placed thermos filled with not boiling water (of 100°C temperature) but with water of 50°C temperature. If the weight of the top decreased by one half (for example, by 2 milligram instead of 4 milligram), then we can surely ascertain that the hotter water in the thermos is the more decrease of mass. Besides, each 100°C of water heating will decrease mass of the top by 4 milligram. It is not very difficult to calculate the temperature at which mass of the top will verge toward zero and the top will start accumulating negative mass.

Let us now assume that our experiment was successful then water as well as any other matter cannot be heated to such high temperature. However it is possible to heat electrons. They are very compact and have insignificant mass and can be heated to very high temperature. It is necessary to take several plates then to place a dielectric between them and to apply voltage. Electrons rest on the dielectric and start heating. The top can be rotated anti-clockwise by means of electric engines, i.e. capacitor and gyroscope should be combined in one system with common center of gravity. It is not very difficult, as the saying goes, it is just an engineering problem. The higher temperature of electrons is the more decrease of the top mass. Finally there is a moment when mass of the capacitor-gyroscope system will reach zero and this electric machine will rise to the surface of the gravitational field of the Earth or any other planet. It will be Biefeld-Brown's force that will make our apparatus taking off the gravitational field of the Earth. This very force will start to accelerate our apparatus in the space vacuum and top of the gyroscope will lose its mass which appears at acceleration. Thus it is quite possible to reach speed, which is close to the light one, or even to overcome the threshold of light speed.

Part III

"...what is new?"

What is implied by gravitational waves? This question has been exciting the scientists from the half of the XX century. But still nowadays, in spite of all attempts of the scientists to dissolve the problem, these waves were not discovered. There is a standard way to discover them, which is based on general relativity. Basing on this theory, scientists assume that gravitational waves should change in some way the weight of material objects. According to this assumption the scientists suspend very heavy balls to very precision scale and then try to trace changes of their weight. There were only negative results. It seems that mass changes so quickly and to such short period of time that scale fails to react upon these changes. However there is another way which seems to be very promising.

Dependence of time and gravitation is a well-known fact. Thus speed of time course depends on force of the gravitational field of an object. Stars and planets can be considered as an example. The more intense attraction near them the more slowly time passes there. In other words, the greater mass of the planet the more slowly time passes near it. It is possible that oscillations of masses, which generate gravitational waves, in some way change speed of the time course along the whole way of the propagation of gravitational waves. In other words, gravitational waves are always attended with slight time fluctuations. Time starts to pass a little faster or a little more slowly as compared with its usual course. These changes can be traced by means of usual quartz plates. Let me remind of the fact that quartz plates are used at some models of clocks to keep time. Thus, oscillations of gravitational masses produce in space both gravitational waves and time fluctuations (chronowaves), which can be easily detected. Possibly these chronowaves are the part of gravitational waves. This assumption is already a scientific fact which is unfortunately ignored by more than one generation of researchers.

Professor N.A. Kozyrev was the first who surmised about the existence of time ways (chronowaves). He called them as "time flows". The scientist worked out and run a simple experiment to confirm his hypothesis. Telescope and quartz plates were used. Quartz plates were placed in focus of the telescope, which was pointed to some bright star. Its objective lens was covered with black paper or tin plate in order to exclude the influence of light beams. At that quartz plates reacted upon the presence of chronowaves. Thus there was changed the frequency of oscillations of plates which were placed in focus of the telescope.

Besides the scientist discovered that in focus of the telescope there were changed electroconductivity and volume of some matters. It is explainable since some parameters of space as well as speed of passing of some physical processes and phenomena depend on the speed of time course. Outwardly it appears in change of electroconductivity and volume. In spite of the fact that during the experiments tin plate (thick metal cover) was used some skeptics insisting that the point is in infrared radiation which is produced by the heated cover. However they was silenced by Kozyrev's researches. Basing on the fact that we usually see stars not where they really are, but at the place they were at the moment

of emanation of light signal, the scientist calculated the location of Procyon star, which is the nearest to the Earth. Kozyrev pointed the telescope to this "clear" part of the sky zone that allowed to avoid the influence of infrared radiation and to fix the location of the star. Thus it is nothing but chronowaves generated by the star that can change oscillation frequency of quartz plates.

After Kozyrev's death this field of research is not considered by official science and the very existence of chronowaves is denied. Only some theorists warily impute the above-listed effects to the action of some torsion fields and waves the existence of which is rather questionable. However chronowaves exist and they can be used in practice, for example, to get information from any point of our galaxy in several seconds. **It is quite possible since chronowaves have no mass and thus they are propagated more quickly than light waves.** However it is still a question what will transmit this information to us because the transmitter of these waves yet has not been invented. *(Editor's: It is interesting what mass of light waves the author means. It is a pity that the author of the article did not read 9 previous issues of NET magazine! There was a detailed demonstration of the connection of Kozyrev's theory and experiments with the theory of longitudinal waves in aether. If to replace Kozyrev's notion of "waves of time density" by the notion of "waves of aether density" then we will get a real experimental approach which can help to solve the problem of antigravitation and time control.)*

Of course theoretically chronowaves can be also generated without participation of great gravitational waves (it seems that heat processes can also generate them). However no particular success was achieved in this field. Thus by means of chronowave transmitter it is possible just to "listen" to remote stars the light of which will reach the Earth in many years. This receiver is very simple and it can be made by anyone who knows a little about radio engineering. *Under home conditions it is better to use a miniature incandescent bulb (lamp with filament tungsten) as a receiver and usual ohmmeter as measuring instrument.*

If in usual receivers radio waves are excited by weak electric currents existing in antenna then chronowave antenna is constantly under tension. Chronowaves do not excite current there but change some characteristics of it, influencing on electroconductivity of the matter which was used for the antenna (let us remember Kozyrev's experiments). Later on these insignificant changes are transferred in audio signal or fixed by any other means. That is the principle of operation of the device.

Editor's: These experiments on the registration of flicker effect in more detail are described in A.M. Mishin works which were published in previous issues of our magazine. As the reader could notice, the editors' opinion in many respects does not coincide with the author's point of view. (Alexander V. Frolov)

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Time Machine

Alexander V. Frolov gave this interview to the Spain magazine "Mas Alla de la Ciencia" ("Science"). The interview concerns some questions about scientific-research work on investigation of active properties of time. Let us remind that in 2002 Faraday Lab Ltd and Vadim A. Chernobrov (Moscow) started the join Time Machine Project.

Miguel Segui: How does it value the results obtained by the prototype of time machine?
Alexander V. Frolov: Usually it is about 3% changes, i.e. 3 sec per 100 sec of experiments.

M.S.: How other devices are preparing inside the project Time Machine?
A.F.: Now we have project with special electromagnets, which are emitters of the longitudinal waves. So, other devices are electronics parts to provide impulse current. But it is not the only one version of the system. If the emitters of the longitudinal waves are based on other principles so all device has other design.

M.S.: Do you believe that some day the time trips will be possible?
A.F.: Yes, sure. We have the clear theory for it and it is based on understanding of physical sense of the aether,

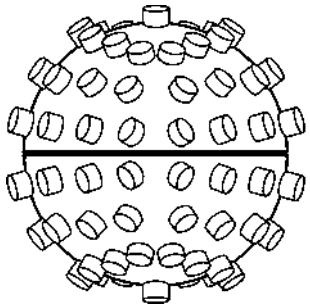

its relation with notion of time and with concept about existence of elements of matter in space-time. According to aether-vortex theory any element of matter is created from aether and its temporal parameters depend on density of aether.

M.S.: What practical applications can have the prototypes that are developing?
A.F.: Any change in the time course is the method of influence onto biological systems and the medical aspect is the main application. Also any physicist know relation between G (the gravity constant) and time course (rate of time). For example, time is slower on the surface of Earth than in space. So, local time changes (which are changes in density of aether or direction of aether wind) can be used to get propulsion force without reactive mass

flow. Also we can hope that some new materials can be produced in special area of slowed or accelerated time course.

M.S.: Which are the main difficulties of developing of these devices at the moment?
A.F.: For us now it is a part of the work that is related with designing of the powerful current electronics circuits. Also there are no known analogies for patent work, but we hope to complete our patent claim in March of 2003.

M.S.: Is it foreseen that they carry out experiments with human beings and the machine of modification of the time, just as V. Chernobrov carried out?
A.F.: We, i.e. Faraday Laboratories Ltd, are developing small unit for testing of the principles. In future we'll work with other design and with participation of the pilot (human passengers). But it will be the system of other kind. Let me explain: now we are working to get small local change of the aether density, so called "chronal charge". It is analogy with electric charge, which produces electric field in space. If the electric charge is moving then it will produce magnetic field. According to our plans after confirmation of the principles we are going to create design with moving "chronal charge" to generate "chronal field". There are suppositions that this field can be used practically for antigravitation propulsion transport.

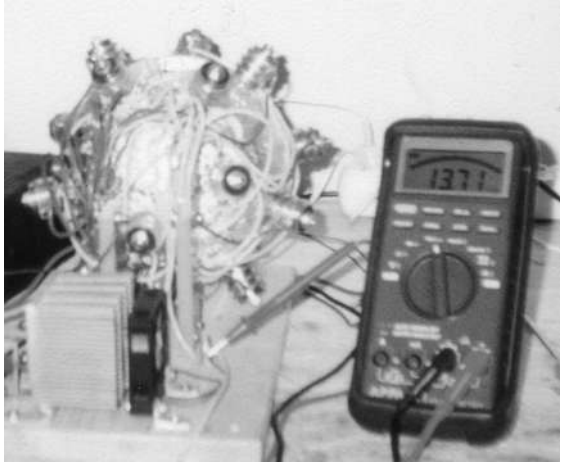

"FRCM" – Avalanchedrive
Fractioning and Replacement of a Constant Mass

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For the while, this project has only these two names, as above. There is still a lot to do upon this development that involves free energy and / or "over-unity". It is designated to be of free use and application by everybody and everywhere, without any royalties just like it was a very old idea, which is now opened for entire community use. The inventor has enough strong reasons for this will.

This is a kind of donation, a personal donation, for the very best future of the Earth. Pioneers are needed (late pioneers?) Any person may be involved in this development to make money since there are no barriers for that. This means that this is an open idea and in this way it must stay. The principles are new and original and the energy involved is quite huge. In the inventor's mind there is realized the possibility to create an expert hands-on group to finish the project. In this article there is a rough draw which seems to be enigmatic but in fact it can clear the understanding of the principle and show the situation at which body may offer controlled spatial variation of length for the same weight.

The short text and a schematic draw (see Fig.1) are the way to show the principles and a few possible construction solutions. The photo shows a part of the device which can clear the so called weight localized rarefaction. Possibly the understanding of capacity for an observer will be a little forced. If necessary author can send the full patent requirement text, which contains 54 pages and 32 figures, not in English but in Portuguese.

FRCM – "AVALANCHEDRIVE"

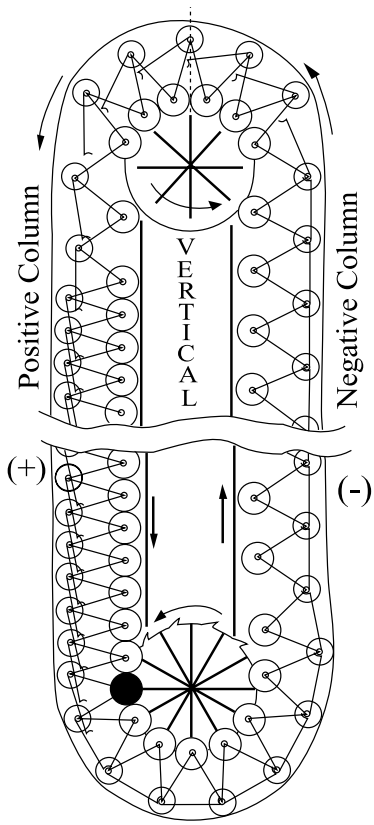

Fig. 1

Understanding of **FRCM / avalanchedrive** is a challenge in itself. When you start to learn about FRCM you will find complete original problems to deal. **Free your mind basing on some mechanical and physics knowledge and then avalanchedrive will come to make a part of your life. Feel free to work.**

PATENT REQUIREMENT RELEASE

This patent requirement is basically the application of a new physical principle which could be defined and found at least 400 years ago, so simple it is. Surely it is one of such things which was let behind by human mind and concern. FRCM is odd and amazing. The key for this project is a special body that can behave like a solid and like a fluid, at the same time, with combined characteristics just as designed and required.

The mass potential of a specially designed segmented body is hold and managed, and throughout proper means is sequentially fractured while suspension balance is kept. This causes, after start, a constant and cyclic movement, since arrangement goes, and the conducting and forcing form of the mass is not interrupted.

Also called "avalanchedrive", this principle work is based on just three main parts or components: 1st is the special segmented body – a chain; 2nd is the stationary and external assembling to hold and conduce the chain; 3rd is the straight vertical, in order to achieve the maximal weight storage position in the arrangement.

The chain is an endless repetitive zigzag construction with weights and defined angles that looks like an entire and elongated ellipse. Its design makes easy the change of its profile and form (mutant profile) that will be contracted or elongated, according to the way it is organized, supported and driven. When contracted or expanded, the chain assumes its maximal or minimal weight, in comparatively the same heights and level, but at different cross sections (tunneling?).

For distribution of the chain track the external assembling forms a kind of duct or rail, which is also elliptical. It allows to the chain to be contracted and expanded, to change direction, move, and pass away, as desired. The chain follows the way that the rail allows, in four different zones: mass-united zone, or positive column, or weight capacitor; the lower reversion input zone; the liberation zone, or negative column, with same height of the positive one; and the upper reversion zone, and its "zero point", or non-resistance top.

Both reversion zones are composed mainly of wheels. However, while the lower zone has to hang, open and bolt the chain, in order to change its profile and natural falling-down trajectory, the upper has a very passive function, that is just to let the chain cross over, and avoid any turn back possibility.

Fact is that in all circuit the chain follows with passivity the "voids" of trails, but assumes a very strong positive and pressure action in mass-united zone, especially in the button, where to the wheel there is applied all the active potential weight of the device, formed by the entire stack of the full contracted state, forcing movement.

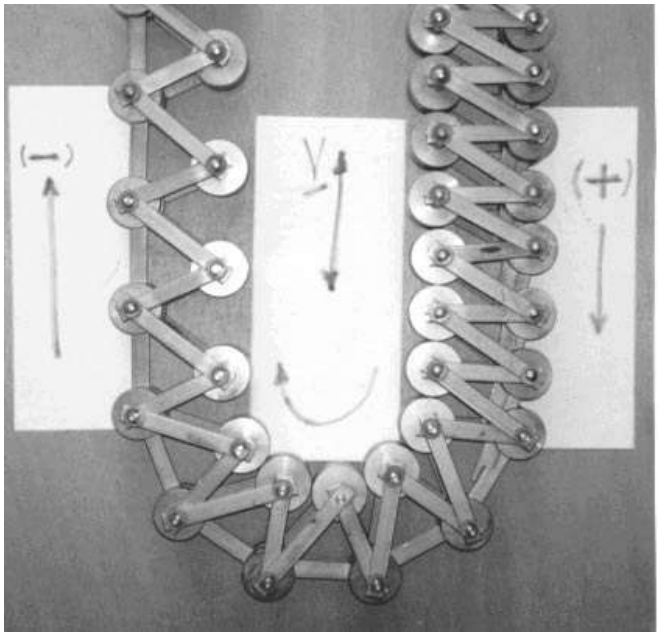

Photo of FRCM (Avalanchedrive)

It is easy to understand how and why FRCM works. Weight of the positive column is directly connected – as a compressed spring – against the relatively lighter negative column, through lower reversion wheel, where happens a kind of flux (the "solid flux") of the chain, that never can find a state of rest. Cycles of "breaking" of the chain can beconsidered as the instant of touch of each corner of the chain to the lower step wheel. To complete the circuitry, the chain excess, which is much lighter, passes over the upper wheel and turns back to the positive column top. It is impossible to turn the full subtracted potential to its source but mechanically the easier job to be done in FRCM.

FRCM manages and converts mass in energy...

The chain flows from the positive column, naturally finds changed profile and reverses to opposite way, and then it is pushed up to the negative column and to top. Finally it is collected, friendly, to restore the potential, at non-stop run! The only alternative to the chain is to move and move, and apply the positive surplus of weight to wrench under axle of the wheel.

This FRCM principle allows develop the equipment which is going to be able to take energy, work and force from gravity potential, so as it happens from wind and water at electrical generator machines, today. The potential is kept in such critical situation, that the only way for it is to escape and move. Besides in consequence of the suspending mass state the linear constant repetition of event will suffer. Water and other fluids do not offer "mutant profile" with fixed value of pressure, just as solid materials. There are many arguments for this view.

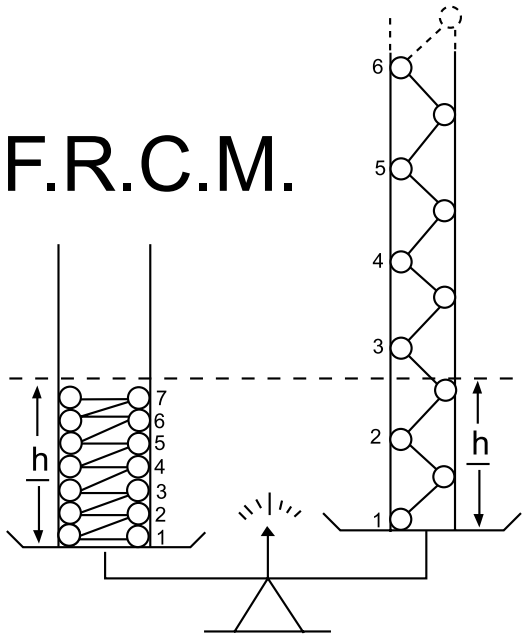

Fig. 2
Segment of a chain

Considering all mechanical losses, a part of the mass will be very active and applied in eccentric, or radial position to the wheel, even with the risk to cause too high speed. FRCM manages and converts mass in energy.

See a non-scale schematic draw (Fig. 2) and photo of a chain segment to compare densities between columns at right and at left.

A theoretical case can be calculated: at total chain weight - 100, general losses - 20, total negative resistance - 30, active or positive surplus is 50 – 30 = 20. This surplus that may be of 2kg, 200kg or 2,000kg, depending on scale, will force and free edge of the wheel, while the total weight keeps confined in the device. In the above case the difference of balance is 1.66. This means that the flowing velocity of the negative pile is 1.66 times higher than the falling of opposite positive pile. Just like a "solid venture", this change and relation is fixed, and in other cases may be varied or calculated to 3, 4 or even more! In all cases the speed must be hold that is not very easy job while one faces gravity acceleration.

The author of FRCM conceptions feels like these ideas have been around for many centuries, and that they are now discovered just like old draws. And this can be the bigger and the best moment to release this. Many thousands of different designs and solutions are coming in the future at looking for the better performance, costs and durability. Author thinks it to be strange that previous guesses could not reach this macro-physical concept. To build FRCM circuits, even re-applied or used old pieces, for example from ships and trains, will be useful.

This is only a start to a "new-old" development and clue to the sources of the modern mechanical engineering. Certainly some oppositions should be overcome. It is expected that other names are also going to be created and proposed to FRCM, but "avalanchedrive" seems to be a good one.

Author expects to get the invention and concept credits but not royalties and would also be glad to keep working on this concern. So, this message is a kind of invitation...

Editor: Unfortunately we have no photo or video documents of the operative device. We wait for readers' comments on this invention.

Complete text of the patent is avaible in Pourtuguese only.

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Hydrogen-Powered Vehicles at Least a Decade Away

Peter Behr
Greg Schneider

Washington Post
http://www.washingtonpost.com/wp-dyn/articles A635122003Jan29.html
Thursday, January 30, 2003; Page A09

This information is forwarded as a courtesy from:
http://www.integrityresearchinstitute.org

President Bush's vision of a hydrogen-powered, non-polluting "Freedom" car for the next generation of American motorists pulled out silently from a Newport Beach, Calif., garage with Gregg Kelly at the wheel, bound for his office 10 miles away.

Kelly, president of a California robotics company, happens to drive a Toyota prototype of a hydrogen-fueled car, one of a handful in the United States today.

It will take at least a decade before a host of technological, economic and political barriers are overcome, permitting a fleet of these revolutionary vehicles to appear on U.S. highways, industry experts said. But by including the goal of hydrogen fuels in his State of the Union message Tuesday, Bush has opened the door to a fledgling movement that has already attracted a surprising coalition of supporters.

Environmentalists, automakers, oil companies and coal producers, engineering labs and strategists have seized on hydrogen as an almost too-good-to-be-true power source. It is abundant in water and air, it burns cleanly and it could free the nation from its dependence on Middle Eastern oil.

"For President Bush to frame the goal as he did is significant," said Jeremy Rifkin, consultant and author of a book advocating a transition from oil and gas to hydrogen. "How much is made of this, time will tell."

The president said he hoped that Americans born today would learn to drive in hydrogen-powered cars, a schedule that auto experts said could technically be met. But whether these vehicles will be commercially available depends on a huge array of variables.

First, the technology is still incomplete and unaffordably expensive. The specially equipped Toyota Highlander that Kelly drives has no price tag. The Japanese manufacturer, after investing millions of dollars in research, lent the vehicle to a University of California research project that Kelly's company supports. "My checkbook isn't fat enough," Kelly said.

The car is powered by electricity generated in a fuel cell by chemically combining hydrogen and oxygen. The engine spits out water drops instead of the carbon dioxide and other pollutants generated by burning gasoline.

With foreign manufacturers committed to press ahead, Detroit's carmakers have had to accelerate their research programs. In June, Ford Motor Co. will unveil a prototype car that uses hydrogen to power an internal combustion engine – part of a "bridging strategy" to help ease hydrogen into the marketplace until fuel cells are fully developed.

General Motors Corp. has developed a fuel cell-powered, car-sized "skateboard" – four wheels attached to a platform less than a foot thick, to which any kind of car body could be buckled.

Rather than use fuel cells, BMW has refitted 10 of its $70,000 Model 745 sedans with hybrid engines that burn either gasoline or liquid hydrogen directly. It could be mass producing them by the end of the decade at a "reasonable" cost for its customers if there were enough hydrogen fueling stations to power them, said spokesman Gordon Keil. "We're trying to get [fuel suppliers] interested in hydrogen. We've not met with a lot of enthusiasm."

As daunting as the engineering challenge is the need for a national hydrogen fuel infrastructure – factories to produce the fuel, pipelines and trucks to distribute it and stations to store and sell it. Environmentalists dream of a totally "green" strategy in which solar or wind power is used to separate hydrogen from water – an approach whose costs now would be prohibitive. A nearer prospect is producing hydrogen from natural gas or coal, however in either case, the carbon dioxide byproduct would have to be injected underground to avoid a huge increase in greenhouse-gas emissions, experts say.

Rifkin argues that an eventual scarcity of oil and gas, decades ahead, will push prices of these fuels up to a point where hydrogen becomes cost-competitive. "It isn't a problem that will yield to technology alone," agreed David M. Nemtzow, president of the Alliance to Save Energy.

While all the major automakers are developing fuel-cell technology, most are cautious about hyping it. "We don't want to get too exuberant about it in that sense, overselling it," said Greg Dana, vice president for environmental affairs at the Alliance of Automobile Manufacturers.

Fresh in some minds is the experience of the Clinton administration, which launched a high-profile, $1.5 billion research venture with the

Detroit automakers a decade ago to produce an 80 miles-per-gallon family car. No cars emerged, and the Bush administration halted the venture in favor of its hydrogen strategy.

Some of the president's political opponents contend the hydrogen option is a way of deflecting criticism over administration policies favoring energy production over conservation. "The president seems content with the auto industry's approach: 'Don't make us do anything today'," said the Sierra Club's Daniel Becker. Others say it does not go nearly far enough. Sen. Byron L. Dorgan (D-N.D), chairman of the Democratic Policy Committee, said recently, "It's moving in the right direction. But his proposal is rather timid. I think we need a bolder plan."

Bush's spending plan for the hydrogen project, $1.5 billion over five years, represents a $500 million increase over his current budget. The administration proposes to earmark $273 million for the 2004 fiscal year, but did not offer many specifics yesterday. The funding would support research on fuel cells, vehicle technology and distribution issues.

The magnitude of the goal demands an effort on the scale of the Apollo Moon project, Dorgan said yesterday. "You have to set benchmarks for five, 10 years out."

UNUSUAL PERMANENT MAGNET MOTORS

Thomas Valone

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Abstract

Permanent magnet motors that try to achieve unusual overunity efficiencies with changes in wiring geometry, electronic switching schemes and magnetic configurations often are not successful. There are some designs that should be regarded as conventional and others as promising. Hopefully this article will help the reader to tell the difference before investing or accepting investment. Note: patents can be viewed for free at www.uspto.gov and also http://gb.espacenet.com/espacenet.

Introduction

An article about permanent magnet (PM) motors would not be complete without first reviewing the basic configurations that are present on the market today. Commercial PM motors are necessarily DC motors since their magnets are permanently polarized before assembly. Many PM motors which use brushes are switching to brushless motors that promise less friction and wear. Brushless motors include electronic commutation or step motors. A step motor, often used in the automotive industry, offers more continuous duty torque per unit of volume than any other electric motor but it is often a lower speed motor. The electronic commutation design is applicable to the switched reluctance (SR) motor. The SR motor substitutes soft iron in the place of higher cost permanent magnets for the outer stator and instead has an inner PM rotor.

Brushless motors in general produce torque from current in the armature by the application of Faraday's Law. The ideal PM motor has a linear torque vs. speed curve. There are both outer rotor and inner rotor designs that are standard in PM motors.

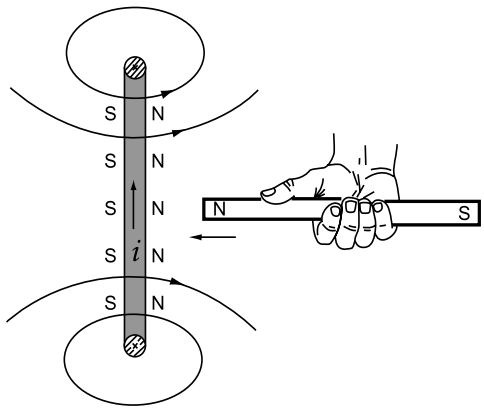

Fig.1

Lenz's Law
Induced B-field opposes motion.

To point out the focus of many of the problems with analyzing motors, the *Motion Control Handbook* (Designfax, May, 1989, p. 33) says that there is a "very important relationship between torque and back emf that is sometimes not understood." This relates to the electromotive force (emf) that is produced by the application of a changing magnetic field (dB/dt). In engineering terms, the "torque constant" (N-m/amp) equals the "back emf constant" (V/radian/sec). In physics, the motor terminal voltage

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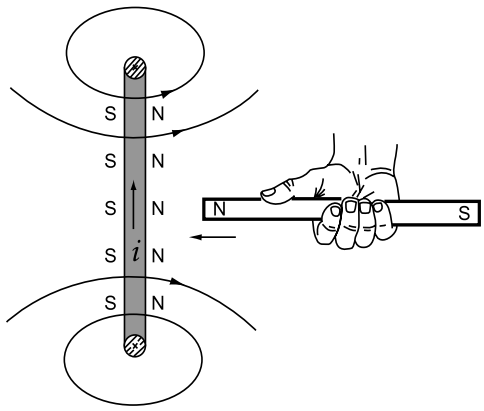

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is equal to the back emf minus the IR drop due to internal resistance. (Example: V = 8.3 v, back emf = 7.5 v, IR drop = 0.8 v.) This physics principle, also referred to as **Lenz's Law**, was discovered by Friedrich Lenz in 1834, three years after Faraday invented the homopolar generator. The oppositional nature of Lenz's Law, and its back emf, is built into a physical law called **Faraday's Law**, which is at the root of motor drive. The back emf is the reaction of the changing current in the coil. In other words, the changing magnetic field naturally creates a back emf because they are equivalent.

Therefore, it is recommended that Faraday's Law be carefully reviewed first before proceeding. An article such as "Faraday's Law—Quantitative Experiments" (*Amer. Jour. Phys.*, V. 54, N. 5, May, 1986, p.422) will help convince the valiant new energy experimenter that the change in flux which causes a back electromotive force (emf) is INHERENTLY equal to the back emf. It cannot be avoided or circumvented for excess energy benefit, unless the amount of magnetic flux change per time is also altered. They are two sides of the same coin. The energy into an inductive coil style of motor will naturally equal the energy out. Also referred to as "electrical induction," the changing flux "induces" a back emf.

Switched Reluctance & Field Switching Motors

To explore an alternative method for inducing motion, the "Permanent Magnet Motion Conversion Device" by Ecklin, patent #3,879,622, uses rotatable shutters for alternately shielding the poles of a horseshoe magnet. Repeated again in the Ecklin #4,567,407 "Biased Unitized Motor Alternator with Stationary Armature and Field," the idea of switching the magnetic field with a "flux switch" is common to these types of motors. To illustrate the underlying principle, Ecklin states, "The rotors of most of today's generators are repelled as they approach a stator and are attracted back by the stator as soon as the rotor passes the stator in accordance with Lenz's law. Thus, most rotors face constant nonconservative work forces and therefore, present generators require constant input torque." However, "the steel rotor of the unitized flux switch alternator actually aids the input torque for half of each rotation as the rotor is always attracted and never repelled. This construction makes it possible for some of the current or power fed to the motor windings to magnetically feed through a solid magnetic path to the AC output windings ..." Unfortunately, Ecklin still to this day has not achieved a self-running machine.

Also related is the Richardson patent #4,077,001 which discloses a low-reluctance keeper physically moving in and out of engagement with the ends of a magnet (p.8, line 35). Lastly, the Monroe patent #3,670,189 uses a related principle but accomplishes gating with the passing of rotor poles between permanent magnet stator poles. Monroe's claim 1, seems by its length and detail, to have almost guaranteed its patentability but of course its utility remains questionable.

It seems unlikely that as a closed system the Field Switching Motor can become self-running. In many examples, a small electromagnet will be necessary to help push the keeper into a synchronized rhythm. The Magnetic Wankel from Popular Science (June, 1979) can be compared in a basic manner to this type of invention. Also, the Jaffe patent #3,567,979 can also be compared (see abstract). The Minato patent #5,594,289 is also of a similar type as the Magnetic Wankel and quite intriguing to many people.

It has been found with inventions such as the Newman motor (U.S. Patent Application Serial No. 06/179,474), a nonlinear effect such as an impulse voltage is advantageous for overcoming the Lorentz force conservation effect of Lenz's Law. Also similar is the mechanical analog of the Thornson inertial propulsion device which uses nonlinear impact to transfer momentum along an axis perpendicular to the plane of rotation. A magnetic field contains angular momentum which only becomes apparent under certain circumstances such as Feynman's Disk Paradox, where it is still conserved. The impulse technique may possibly be used to advantage in this Field Switching Motor if the field switching can be done fast enough, with a rapid rise time, but more research is needed.

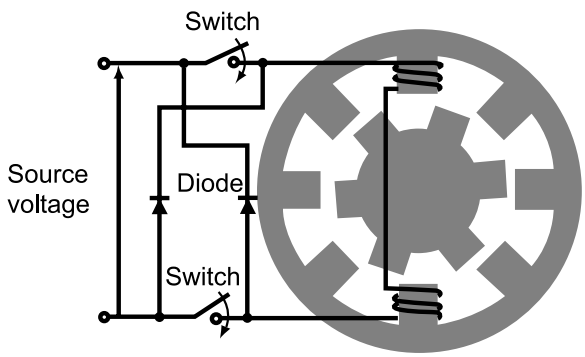

Fig. 2
Switched Reluctance Motor (*IEEE Spectrum* 1/97)

The best Switched Reluctance Motor that also has full accommutation is the Dr. Harold Aspden patent #4,975,608 which optimizes the performance of the coil input and operating above the knee of the B-H curve. Switched reluctance motors are also explained and praised in *IEEE Spectrum* (1/97).

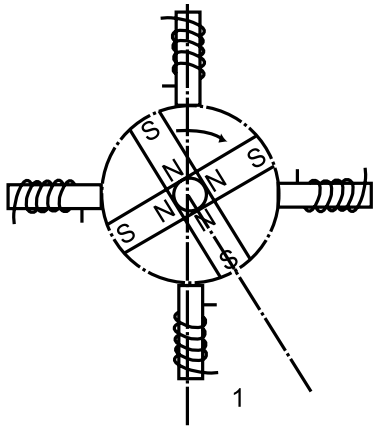

Fig. 3

Adams Motor

The Adams motor has attracted many followers including an endorsement from *Nexus* magazine as the best free energy motor they have seen. The performance of the machine, however, can be fully explained by Faraday's Law. The pulsing of adjacent coils which moves a magnetized rotor is actually following the same configuration as a standard switched reluctance motor. The delay that Adams speaks of in an Internet posting of his motor can be understood from the exponential voltage (L di/dt) of the back emf. The latest addition to this category, which gives credit to the Adams motor, comes from down under with PCT WO 00/28656 awarded to Brits and Christie in May, 2000. The simplicity of this motor is immediately obvious with the switchable coils and permanent magnet on the rotor. The patent also makes it clear that the "input DC current as supplied to the stator coil produces the magnetic repulsion force and is the only outside input to the overall system for total movement...." It is a well-known fact that all motors work on this principle. The key to their design is on p.21 of their patent where the inventors want to "maximize the influence of back EMF which tends to maintain rotation of the rotor/armature in a single direction." All of the motors in this field-switching category try to achieve this effect. Figure 4A of Brits and Christie disclose the voltage sources "VA, VB, and VC." Then, on page 10 it is stated, "At this time current is applied from the power source VA and continues to be applied until the brush 18 is no longer in contact with one of the contacts 14 to 17." There is nothing unusual about this design compared with the more sophisticated attempts listed previously in this section. All of these motors require an electrical power source and none of them are self-running.

When pulsing a coil with the passing of a permanent magnet, a suggestion that would help prove the claim for free energy is not to use battery power for the coil current. Instead, the amazing Weigand wires are recommended (*Pop. Sci.*, May, 1979) that exhibit a huge Barkhausen jump of magnetic domain alignment and a very well-defined pulse shape. Having a coil wrapped around a Weigand wire produces a substantial pulse of several volts with a changing external magnetic field passing a certain threshold. No electrical input power is required for this pulse generator.

Toroidal Motor

As compared to motors on the market today, the unusual design of the toroidal motor is similar to the Langley patent #4,547,713 with a two-pole armature in the center of the toroid. If a single-pole design is chosen, with for example North poles at each end of the armature, this would resemble the radial magnetic field for the armature which the VanGeel patent #5,600,189 uses. The Brown patent #4,438,362 assigned to the Rotron company, utilizes varying magnetization segments for a rotor in a toroidal air gap. The best example of a carousel toroidal motor is the Ewing patent #5,625,241, which also resembles the Langley patent mentioned above. Based upon magnetic repulsion, the Ewing invention uses a microprocessor-controlled carousel, basically to try and take advantage of Lenz's law and get a jump ahead of the back emf. The Ewing invention may be seen in operation, with co-inventor David Porter, in the commercial video, "Free Energy: The Race to Zero Point." Whether it may be more highly efficient than other motors on the market remains an open question. As the patent states, "it is also possible to operate the device as a motor using a pulsed direct-current power source" (col. 7, par. 30). It also contains a programmable logic controller and power control circuit which the inventors thought would send it over the top of 100% efficiency.

Unless a prototype proves to be successful in achieving a torque or force conversion linkage, the internally propelled magnet may be left without a practical application. Commercialization of these types of motors may not be favorable, since many competing designs are currently available on the market, with high flux linkage.

Linear Motors

The area of linear induction motors is well known in the literature. Schaum's Outline Series, *Theory and Problems of Electric Machines and Electromechanics* (McGraw Hill, 1981), explains that these are the same as cutting the rotor and stator of a standard induction motor and laying them out flat. The late Dr. Laithwaite, author of

Motion Without Wheels, was famous for monorail designs for trains in England based on linear induction motors.

The Hartman patent #4,215,330 is an example of one that achieves a linear motor transportation of a steel ball up a magnetized incline of approximately 10 degrees. Another invention in this category is the Johnson patent #5,402,021, which uses permanent arc magnets on a four-wheel cart, exposed to a parallel track of alternating permanent magnets which are in a fixed position. An even more amazing permanent magnet patent is the Johnson #4,877,983 which an eye witness has seen operating at the Johnson home in a closed loop for hours. It is reasonable to assume that a pickup coil could be positioned nearby so that each trip would result in a pulse of electricity to charge a battery. The Hartman patent could also be arranged in such a circular track so that perpetual motion of the first kind can finally be demonstrated.

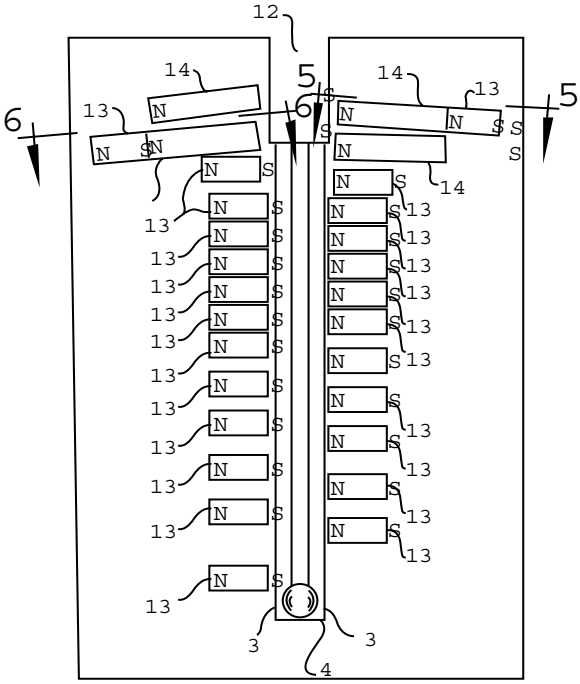

Fig. 4

Hartman patent #4,215,330

The Hartman patent is based upon the same principle as the famous electron spin experiment in physics called the Stern-Gerlach experiment. With an inhomogeneous magnetic field (one that is non-uniform) the force on an object with a magnetic moment is the gradient of the potential energy. Every physics textbook points out that this type of field, that is strong at one end and weak at the other end, will result in a unidirectional force on the magnetic object equal to dB/dx. That is exactly what the Hartman patent possesses (note spacing of magnets). Therefore, the resulting force propelling the ball up a ten degree incline, in the x direction, is in keeping with the laws of physics.

With state-of-the-art magnets, including ambient temperature superconducting magnets which are now finishing the development stage, a demonstration of impressive cargo weight will be shown to be transportable without maintenance electricity costs. Superconducting magnets have the unusual property of retaining the initial magnetized field for years, without the need for periodic energization to restore the initial field strength. Examples of the state of development of the superconducting magnet market can be found in the Ohnishi patent #5,350,958 (lack of cryogenics and lighting system output) as well as the reprinted article from *IEEE Spectrum*, July, 1997 on magnetic levitation.

Static Electromagnetic Angular Momentum

In a provocative experiment with a cylindrical capacitor, Graham and Lahoz (*Nature*, V.285, No.15, May, 1980) have expanded upon the proof published by Einstein and Laub in 1908 that the Lorentz force needs an additional term to preserve action and reaction. The article they cite has been translated and published in my book, *The Homopolar Handbook* (described below). Graham and Lahoz emphasize that there is a "real angular momentum density to r x (E x H)/c^2" and suggest how to see this energy effect in permanent magnets and electrets.

This is encouraging work, with an impressive source of Einstein and also Minkowski for its information. It is possible that it may have a direct application for the homopolar generator as well as the magnetic energy converter mentioned below since both have an axial magnetic field and a radial electric field like the cylindrical capacitor experiment of Graham and Lahoz.

Homopolar Motor

My book, *The Homopolar Handbook* (HH), covers experimental tests and history of the Faraday discovery, including Tesla's contribution to it. Recently however, there have been new developments into a multi-rotor design of a homopolar generator, similar to the invention of John R. R. Searl.

Recurring interest in the Searl device, as pictured on the cover of *Antigravity*, the biography of Searl by John Thomas, should also center on the

homopolar generator (HG). Preliminary analysis reveals that there are actually two separate HG phenomena occurring simultaneously, one which can be called the "revolution" effect (#1) and the second that could be called the "rolling" effect (#2). The first effect can be visualized as magnetized segments of an imaginary solid ring revolving around a common center. As suggested by drawings in HH, p.141-2, there are precedent designs that allow for segmenting an HG rotor.

With this model in mind, the #1 effect can be calculated, for 1 Tesla strength magnets, magnetized axially, adjacent to a single ring 1 meter in diameter, to produce more than 2 volts emf across each roller, (E-field directed radially from outer diameter of rollers to outer diameter of the adjacent ring) with say, 500 RPM. Note that this #1 effect is independent of any rolling of the magnet. The magnetic field in an HPG is tied to space and not to the magnet so rolling will not affect this large scale homopolar generator's Lorentz force effect (HH, p.10).

The #2 effect, located within each roller magnet, is the one noted in *Electric Spacecraft Journal*, Issue 12, 1994, (HH, p.160) where each roller, is a small homopolar generator. This effect is found to be somewhat weaker as it generates electricity from the center of each roller to its periphery. This design is like Tesla's HG (HH, p.81) where a rolling belt is contacting the outer edge of a circular magnet. With rollers in the vicinity of a tenth of a meter in diameter rolling, without slipping, around a 1 meter ring, approximately a half of a volt will be generated. The Searl design of ring magnetic material will normally strengthen the roller's B field.

It is important to realize at this point that the principle of superposition applies to these two effects. The #1 effect is a uniform E field across the diameter of the roller. The #2 effect is a radial effect as stated above (see HH, p.6-8). However, only the emf in the section of a roller between the two contacts, say at the center of the roller and its edge which contacts the ring, will actually cause current flow in any external circuit. This realization means that the effective voltage from the #1 effect will be half of the available emf, or a little more than 1 volt, which is still about double of the #2 effect. Upon applying superposition in the limited region indicated, we also find that the two effects oppose each other and the two emfs must be subtracted. The result of this analysis is that approximately one half of a volt of regulated emf will be present to generate electricity from a single set of rollers and one ring about 1 meter in diameter. As current is drawn, a Ball Bearing Motor effect will also take place (HH, p.54) that actually pushes the rollers along, assuming the roller magnets have a reasonable conductivity *(Thanks to Dr. Paul La Violette for this reminder)*.

In a related work, (*Tech. Phys. Lett.*, V. 26, #12, 2000, p.1105-07), Roshchin and Godin have published experimental results of their one-ring device, called a "Magnetic Energy Converter," with rolling magnets on bearings. It was designed as an improvement to the Searl device. Though my above analysis does not depend upon the ring being made of magnetic material, Roshchin and Godin did so. Their findings are encouraging and detailed enough for researchers to find renewed interest in this type of magnetic motor.

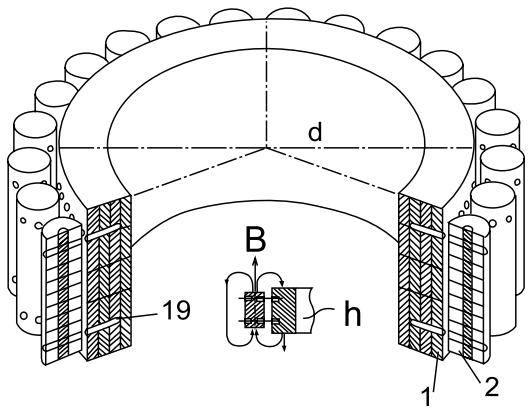

Fig.5

Magnetic Energy Converter in the experiment by Roshchin and Godin (Russia)

Conclusion

So far, a couple of permanent magnet motors may have achieved perpetual motion, which exceeds 100% efficiency. Of course, conservation of energy concepts have to be considered and the source of the alleged extra energy examined. If permanent magnet field gradients do offer a unidirectional force, as the textbooks predict, then it is about time for its conversion toward useful work. The roller magnet geometry, now called a "magnetic energy converter" is also a unique style of magnetic motor. Exemplified in the Russian patent #2155435 by Roshchin and Godin, it is a magnetic motor-generator that shows potential for excess energy output. Since it relies upon the circulating cylindrical magnet rolling around a ring, the design is actually a generator rather than a motor. However, as they utilize the torque produced by the self-sustained motion of the magnets to run a separate electrical generator, it is working as a motor.

Reprint from Proceedings of Institute for New Energy Conference, 2001

Hydrogen Energetics

Review by Alla Pashova

A Russian writer Ludmila Ulitskaya, who is rather far from energy problems, says: "I'm quite sure that cheap electric energy sources have been already worked out and are hidden in oil king's safes. However such projects won't be taken out of the safes until the last oil drop is combusted. They don't want redistribution of money, world, power, and soon". Experts are sure to agree with the writer.

Now only ideas which can coexist together with the traditional oil power engineering and with a system of world oil distribution can escape the safes. Some expensive scientific toys promising future universal welfare are created to reassure ecologists, viz automobiles equipped with hydrogen engine. According to estimation of Japan representatives of motor car industry, installation of the hydrogen engine into such a car as a classical Sedan now comes to about $700 000. Approximate cost of a hydrogen bus named Kitaro achieves the astronomic amount of $1.25 million.

The hydrogen engine consists of several fuel elements, which are known as fuel cells. Hydrogen under pressure of 1.5-2.7 atmospheres comes to an anode. A cavernous catalyst splits the molecules into electrons and protons. The electrons set the electric engine in motion, and the protons come through a membrane acting to a cathode as an electrolyte. Here the catalyst combines them with the working electrons and with atmosphere oxygen into water molecules. It should be noted that the Europeans and the Americans are extremely charmed by this water streamlet which is exhausted instead of poisoning gases. Moreover, output of the fuel cell is 3-5 times more than output of the petrol engine.

The first hydrogen power station inaugurated in Las Vegas, Nevada, in 2002, (see Fig.1, 2) represents a system of the fuel cells with the proton penetrable membrane as an electrolyte (they are designed and produced by experts of Plug Power Inc.). The station produces hydrogen transforming and cleaning natural gas and generates electric power combining hydrogen stored in reservoirs with atmosphere oxygen. The USA Energy Department and Air Products Inc. together paid $ 10.8 million for this project.

It is necessary to note that the priority branch of the hydrogen engineering is providing new means of transport with fuel, and electric power production is just the second aim. The mentioned station produces electric power in addition to its main function. Nevertheless, if fuel market begins to decrease then the electric power payments will provide the "hydrogen magnates" with stable profit.

Fig. 1
Hydrogen power station

Nowadays the hydrogen automobiles allow oil kings keep the system of centralized fuel distribution and the infrastructure of service stations which will provide the means of transport with methanol, natural gas with hydrogen blend, and liquefied or gaseous hydrogen. Thus interested companies control the hydrogen engineering and scientific thought.

Moreover, oil can be applied as it is useful for board reforming (conversion), i.e. it can be used as a hydrogen source. The systems based on conversion have been known for a long time but there was need to work at them.

Russian experts improved the conversion system by replacement of the catalyst by plasma. Thus the conversion occurs in gas discharge of HVF appearing in the blend which needs to be converted. According to experts' opinion the Russian system is portable and has high output. In 2001 a group of experts of Russian Centre of Automobile Engine represented experimental prototype basing on Chevrolet Pickup S 10.

The ideal of modern hydrogen engineering is the following: "There should be minimal changes in the system of fuel distribution, non-polluted air, and thin streamlet of distil exhausted". However, evidently, the exhausted water is an ideal source for hydrogen fuel reproduction by means of high effective electrolyzing. If the closed system is worked out we would obtain an energy source powered by continuous chain of electrolyzing and recombination whose efficiency would be more than 100 %.

What are the known ways of hydrogen production? The greatest amount of the gas is produced on the base of catalytic conversion of hydrocarbon with water vapor. Temperature of the process depends on the catalyst composition. It is known that temperature of propane reaction can be decreased to 370° using bauxite as a catalyst. Approximately 95% of by-product carbon monoxide is further used in the reaction with water vapor.

A significant part of the total hydrogen production is given by a method of water gas. The essence of the method lies in reaction of water vapor with coke that is followed by the producing of carbon monoxide with hydrogen mix. The reaction is endothermal, it occurs at 1000°C. The heated coke is processed by the vapor; extracted purified mix of gases contains some hydrogen, some carbon dioxide, and great share of carbon monoxide. Further vapor processing of the carbon monoxide at 370°C increases the hydrogen extraction. The amount of carbon dioxide increases as well however it is easy to be removed by passing the gases mix through a scrubber sprayed by a water contraflow.

Fig. 2

There is a well-known iron-vapor method according to which vapor is passed above iron at 500-1000°C. Hydrogen obtained by this method is usually applied to hydrogenise fats and oils. Composition of the iron oxide depends on the process temperature. Iron-3 oxide (Fe_3O_4) prevails at the temperature below 560° C. If the vapor is passed above the iron at the temperature above 560° C then iron-2 oxide (*FeO*) share increases. A slight admixture of carbon monoxide is removed when the heated mix passes above a catalyst. At this time the carbon monoxide is transformed into methane.

In the processes of oxidation and thermal cracking of hydrocarbons at soot production hydrogen is produced as a by-product.

The next effective method is methanol-vapor one. It is an endothermal reaction which is proceeds in common iron reactors at 260° C temperature and at 20 atmospheres pressure.

There should be also mentioned a catalytic reaction of ammonia decomposition at which nitrogen and hydrogen is produced. The reaction can be profitable if it is necessary to produce great amount of hydrogen. The method is useful if the obtained hydrogen is directly applied.

Electrolysis is the oldest method to produce hydrogen. Direct current comes to electrodes, the cathode collects hydrogen, and the anode accumulates oxygen. The technology makes hydrogen to be too expensive energy carrier. There is often used a technology of hot processing of water vapor at 700-900° C accompanied with light petrol and heavy liquid fuel which bleeds oxygen. This method is quite expensive as well.

As it is known, **wasteful power consumption of classical electrolysis** is caused by the fact that it is used to overcome forces of hydrate bound of ions with water molecules and to compensate endothermal effect of water decomposition. Therefore, ions reduction at corresponding electrodes requires more current intensity than in the case of absence of this physical phenomena. Hence production of 1 cubic meter of hydrogen requires 18-21.6 MJ, and total power consumption exceeds 50 MJ (taking into account the electric power production). Therefore hydrogen becomes too expensive.

In 1888 D.A. Lachinov patented a method of non-contact electrolysis. Improvement of this method promises huge amount of cheap hydrogen and appearance of high effective energy source operating as a closed cycle. The main problem of Lachinov's method is a gas layer covering the electrode in some time and impeding the reaction. It was proposed by I. A. Goryachev to prevent the gas layer using pulsating electric field. A.V. Frolov has proposed to increase electrolysis efficiency by means of rotation. Centrifugal force causes more swift detach of gas blebs from electrodes surfaces. Power consumption to overcome frictional force in the construction and to generate potential electric field is insignificant as compared with output. Hence efficiency of the system may exceed 100%.

There is also described the experimental device for production of hydrogen and oxygen from water where modulated voltage (not dc voltage) is applied to the electrodes. Modulation frequency is in connection with proper oscillation frequency of water molecules as well as with spatial structure. Possible efficiency of water electrolysis in spark discharge which removes oxygen admixture should be investigated . Water electrolysis at the radiation

by electromagnetic waves of light range needs to be investigated as well.

Ikar Research Centre informs that plasma electrolysis can be the most probable source of cheap hydrogen. In 1987 a group of Russian scientists patented the first plasma-electrolytic reactor. Since the reactor had been worked out at a defense establishment then the patent was restricted and not covered by press. The patent contains a structural scheme of the reactor and some results of cleaning and disinfection of water by plasma. The patent does not represent any information of additional energy generated by plasma or hydrogen production.

In April of 1989 American scientists Pons and Fleishman published their experimental results on additional energy production at common water electrolysis. They claimed cold fusion to be source of this energy. However there is no reliable proof for this phenomenon.

In 1996 Yu. Beklyamishev, one of the co-authors of the first plasma-electrolytic reactor, published his experimental results. They demonstrated that there was additional energy in the plasma-electrolytic process. However he did not explain the energy source.

In 1998 there were published new experimental issues of appearance of additional energy in the plasma-electrolytic process. A group of Russian scientists tested one of the plasma-electrolytic reactors and officially fixed the additional energy. A report of the testing session was published in issue #22 of "Infinite Energy" magazine. In May of 1998 the third edition of a book named "Crisis of Theoretical Physics" was published by Prof. F. M. Kanarev. It contains data of additional energy production at plasma electrolysis of water defining the energy source. Soon Ohmori and Mizuno (Japan) published their results in works of Vancou ver conference on cold fusion and in issue #20 of "Infinite Energy". Ohmori and Mizuno observed neutron radiation occurring at a plasma process as well as iron, chrome, nickel, and carbon appearance on a wolfram cathode. That seemed to be a strong evidence of cold nuclear fusion at plasma electrolysis of water. Ohmori and Mizuno have explained neutron radiation as a result of electrons captured by protons. Nevertheless their conclusions raise doubts as cold fusion would have produced much more additional energy than it was fixed.

In 1996 there appeared the first publications where hydrogen atoms fusion instead of nuclear fusion was supposed as the additional energy source at usual electrolysis as well as at plasma source. In Russia first experimental results demonstrating energy consumption decrease for hydrogen production at plasma electrolysis of water were published in 1999 by Prof. F.M. Kanarev. (See F.M. Kanarev's article in this issue of NET).

Fig. 3

Honda FCX-V3 uses hydrogen as a fuel. Hydrogen is fed under high pressure in the engine.

Nevertheless we have to note that high efficiency electrolysis is possible! O. Hvolson in his "Physics" (Berlin, 1923) explains a method of designing of a machine which can produce heat due to positive difference between energy of hydrogen combustion and energy consumed to hydrogen production by means of water electrolysis. In this case we do not consume energy to split the atoms. It occurs due to intermolecular forces at water dissociation by sulphuric acid ions. Energy is consumed only to neutralize charges of existent hydrogen ions and acid residue ions. Hydrogen combustion produces the energy which would have been consumed to split the atoms in the air. **Hence 67.54 Kcal of energy can be produced at 5 Kcal consumed. (F. Lepehin)**

High effective electrolysis application is clear future of energetics. Nowadays Stuart Energy Inc applies water electrolysis as a hydrogen source in a frame of hydrogen-fuel project. Experts of Stuart Energy Inc have designed a refueling unit which produces hydrogen and stores it in a 104-pound reservoir. Thus several auto are provided with fuel and it takes a couple of minutes to refuel.

It is quite simple to predict social and economical consequences of innovation of high effective energy source operating as a closed cycle energy system. Economic activity and private life of people will be independent of cities, of their industry and power engineering. People will move out of the cities and they will use compact and powerful energy sources there. Hence, decentralization of world economics will happen.

Regions of any country become more free from the central authority, the power of which nowadays is based on centralized fuel energetics.

On the Longitudinal Electromagnetic Waves

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Concerning acoustic waves, we deal with longitudinal oscillations of the medium, since degree of air (medium) compression and rarefication changes along the direction of the wave spreading. Notion of the medium of electromagnetic waves propagation, i.e. notion of "aether", as well as the very possibility of the existence of longitudinal electromagnetic waves is disputable for some scientists. Let's clarify the situation and demonstrate that usual photon is longitudinal wave of energy density, which can be described as Umov-Poynting vector.

The transverse character of electromagnetic waves means that vector of electric field and vector of magnetic field are directed across the wave line. However, these vectors are just our subjective way to describe the process. Notions of electric and magnetic fields can be replaced by the notion of **unified helical field**, since to describe the motion of the point along the helical line there should be concerned the linear transfer (it is detected as electric field) and the process of rotation (it is described with the magnetic field). Thus notions of electrodynamics are just one of the ways to describe reality. Energy density of the given point of space is the real (objective) parameter of the wave. This energy density is described by the known Umov-Poynting vector $\overline{S} = \overline{E} \times \overline{H}$.

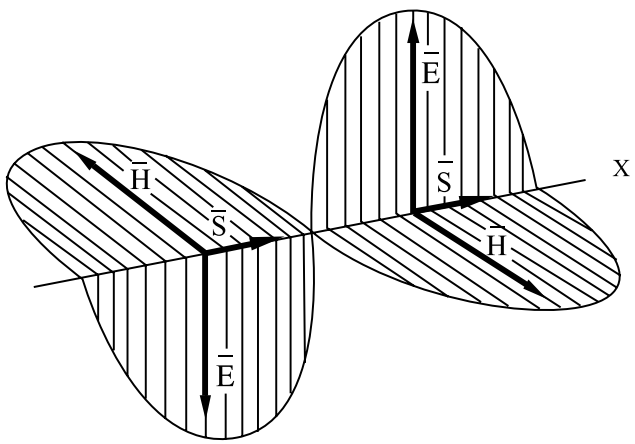

Fig.1

Let us consider electromagnetic wave in classical representation (Fig.1). Then we discover that direction of Umov- Poynting vector coincides with the wave line. The vector is unidirectional and "pulsating", because its quantity changes from zero to some maximal value and then it is reduced to zero, besides it takes place at half of the period of transverse wave. So, it is the explanation of the fact that frequency of longitudinal oscillations is twice as much than frequency of transverse oscillations (Fig. 2). **Previously it was known from the mechanism of energy interchange between longitudinal and transverse plasma oscillations and from the phenomenon of parametrical resonance. However the physical meaning of this phenomenon was not disclosed.**

From the presented here conception it follows that from the physical point of view, electromagnetic waves are **longitudinal oscillations of energy density**. In usual case these oscillations are unidirectional pulsations that determines the ability of the photon to be moving unidirectionally. Practically it is possible to create other types of photons, i.e. types of oscillations of energy density with qualitative new physical properties. It can be achieved by setting of definite functions and superposition of $\overline{E}$ and $\overline{H}$ vectors.

For example, in 1996 a conference "New Ideas in Natural Science" was organized by us in Saint-Petersburg, with the participation of 30 foreign guests and more than 100 Russian scientists. The report made by Academician Ignatyev, Krasnoyarsk, aroused great interest. During the experiments with rotating of crossed vectors $\overline{E}$ and $\overline{H}$ (see Fig. 3) there was created Poiting's vector, which corresponds to propulsion force of 60 N (about 6 kg).

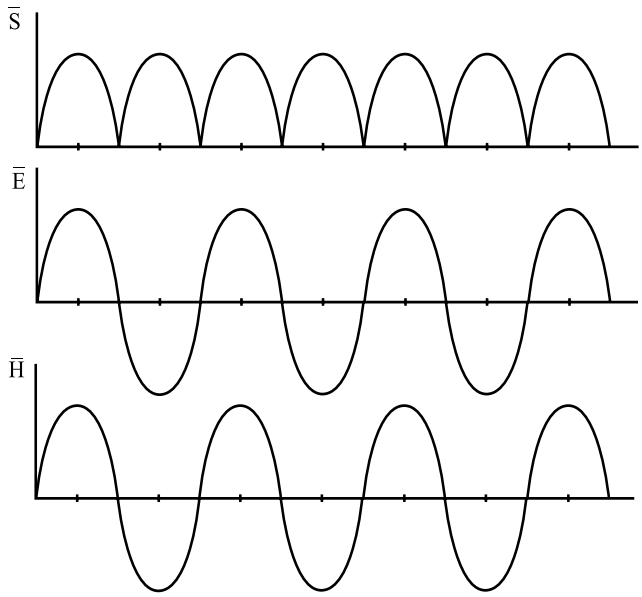

Fig. 2

The experiment is demonstrated on the photo (see Fig. 4), where the diameter of the device is equal to 4 meters and ends of the coils are to toroidal capacitors. This experiment was made in Krasnoyarsk.

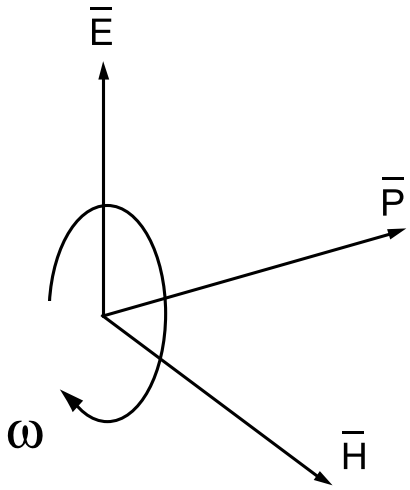

Fig. 3

Since it is impossible to consider vacuum, where some form of energy can exist, as "emptiness" then we can speak about vacuum as about some medium. Faraday and Maxwell, classics of electromagnetic theory, wrote exactly about deformations, stresses and expansion of aether. From this point of view electromagnetic waves are analogues of the waves of longitudinal deformation of elastic medium. More than 60 years ago Nicola Tesla wrote: "I showed that the universal medium is a gaseous body in which only longitudinal pulses can be propagated, involving alternating compressions and expansions similar to those produced by sound waves in the air. Thus, a wireless transmitter does not emit Hertz waves which are a myth, but sound waves in the ether, behaving in every respect like those in the air, except that, owing to the great elastic force and extremely small density of the medium, their speed is that of light." [1]

Nowadays, the development of engineering and the new views upon the phenomena of electromagnetism, impel us to consider physical **vacuum as material medium of the special type**, which has the well-known properties, in particular electrical and magnetic properties. Moreover, this medium has energy, and energy density can be changed in case of propagation of any photon. Thus, as Tesla stated in his article "The True Wireless": "The Hertz wave theory of wireless transmission may be kept up for a while, but I do not hesitate to say that in a short time it will be recognized as one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history".

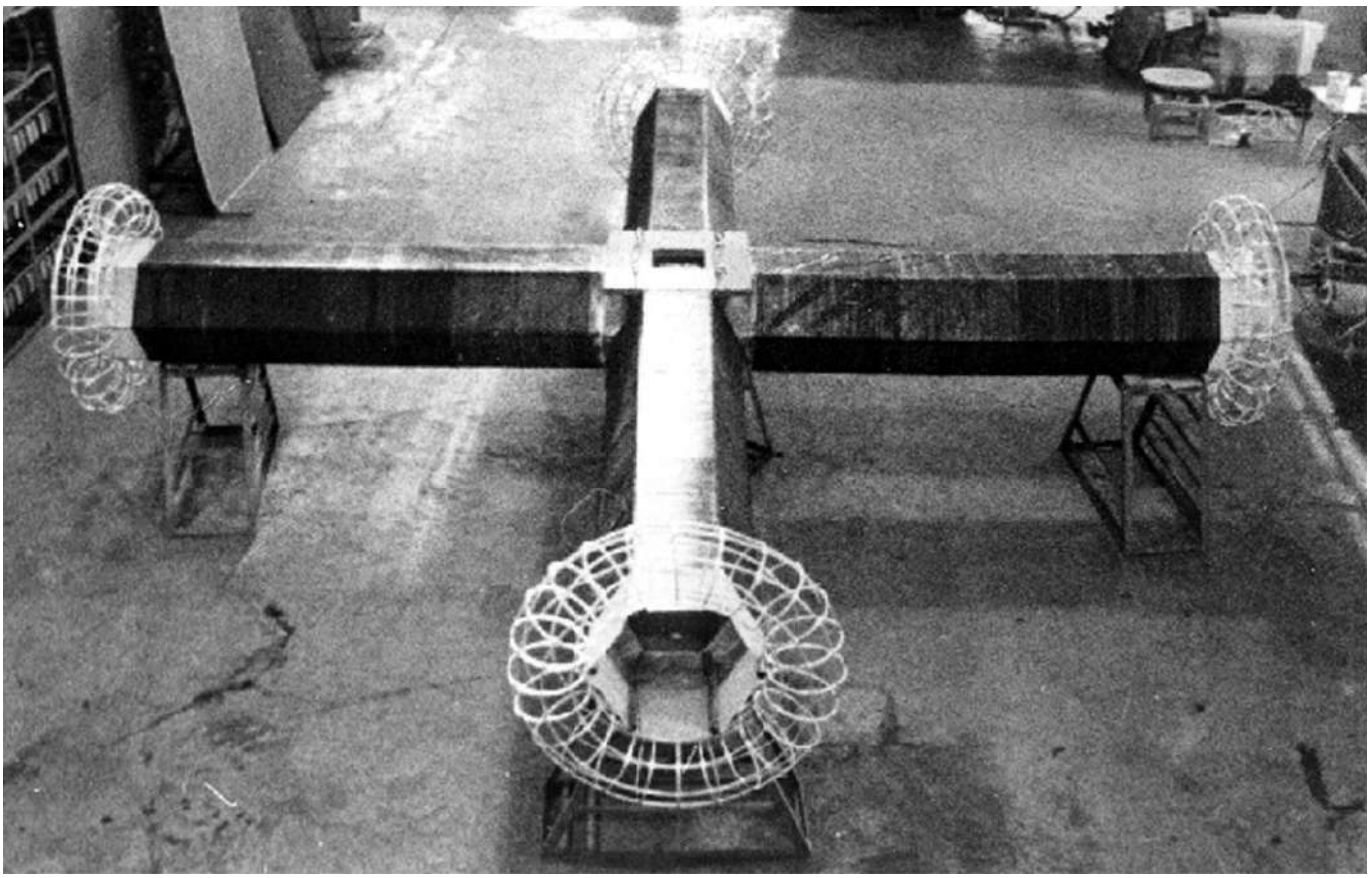

Fig. 4

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"OUTSIDE THE BOX" SPACE AND TERRESTRIAL TRANSPORTATION AND ENERGY TECHNOLOGIES FOR THE 21ST CENTURY

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Abstract

This paper reviews the development of antigravity research in the US and notes how research activity seemed to disappear by the mid 1950s. It then addresses recently reported scientific findings and witness testimonies - that show us that this research and technology is alive and well and very advanced. The revelations of findings in this area will alter dramatically our 20th century view of physics and technology and must be considered in planning for both energy and transportation needs in the 21st century.

Historical Background

Townsend Brown's Technology of Electrogravitics [1]

In the mid 1920's Townsend Brown [2] discovered that electric charge and gravitational mass are coupled. He found that when a capacitor is charged to a high voltage, it has a tendency to move toward the positive pole. His findings, which became known as the Biefeld-Brown effect, were opposed by conventional minded physicists of his time.

The Pearl Harbor Demonstration. Around 1953, Brown conducted a demonstration for military top brass. He flew a pair of 3-foot diameter discs around a 50-foot course tethered to a central pole. Energized with 150,000 volts and emitting ions from their leading edge, they attained speeds of several hundred miles per hour. The subject was thereafter classified.

Project Winterhaven. Brown submitted a proposal to the Pentagon for the development of a Mach 3 disc shaped electrogravitic fighter craft. Drawings of its basic design are shown in one of his patents. They are essentially large-scale versions of his tethered test discs.

Review of Issues from the 1950s

In 1956, a British research company, Aviation Studies (International) Ltd. published a classified report on Electrogravitics Systems examining various aspects of gravity control. They summarized the pioneering work of Townsend Brown and then described the use of electrogravitic thrust as follows:

"The essence of electrogravitics thrust is the use of a very strong positive charge on one side of the vehicle and a negative on the other. The core of the motor is a condenser and the ability of the condenser to hold its charge (the K-number) is the yardstick of performance " [3].

In one of their conclusions, based on Brown's work, they suggested that: "Electrostatic energy sufficient to produce a Mach 3 fighter is possible with megavolt energies " [4].

In spite of Brown's solid research, they later stated that, "One of the difficulties in 1954 and 1955 was to get aviation to take electrogravitics seriously. The name alone was enough to put people off" [5]. It seems that is as true today as it was in the 1950s.

A report by another British company, Gravity Rand, Ltd. in 1956, agrees with this assessment and states: "To assert electrogravitics is nonsense is as unreal as to say it is practically extant. Management should be careful of men in their employ with a closed mind or even partially closed mind on the subject." [6]

However, a trade press magazine, The Aviation Report, made numerous references to antigravity projects and listed many of the companies pursuing research in this area. Quotes from The Aviation Report listed in the Aviation Studies (International) Ltd. Report [7] are suggestive of what was going on behind the scenes.

In 1954 they predicted that: "... progress has been slow. But indications are now that the Pentagon is ready to sponsor a range of devices to help further knowledge."... "Tentative targets now being set anticipate that the first disk should be complete before

1960 and it would take the whole of the 'sixties to develop it properly, even though some combat things might be available ten years from now." (Aviation Report, 12 October 1954) [8].

During this time period many of the major defense and technology companies were cited as either having research projects or activities in this new field. For example: "Companies studying the implications of gravitics are said, in a new statement, to include Glenn Martin, Convair, Sperry-Rand, and Sikorsky, Bell, Lear Inc. and Clark Electronics. Other companies who have previously evinced interest include Lockheed, Douglas and Hiller." (Aviation Report, 9 December 1955) [9].

Others of these reports mention: AT&T, General Electric, as well as Curtiss-Wright, Boeing and North American as having groups studying electrogravitics.

During the same time period, the Gravity Rand report notes that: "Already companies are specializing in evolution of particular components of an electogravitics disk." [10]

However, in the area of predictions, the Aviation Report stated the following based on an extrapolation of technology development: "Thus this century will be divided into two parts – almost to the day. The first half belonged to the Wright Brothers who foresaw nearly all the basic issues in which gravity was the bitter foe. In part of the second half, gravity will be the great provider. Electrical energy, rather irrelevant for propulsion in the first half becomes a kind of catalyst to motion in the second half of the century." (Aviation Report, 7 September 1954) [11].

Looking back it is easy to say that they missed the mark. Did they really miss it by a half a century? Reading through these reports it is quite obvious that there was much interest in antigravity among a number of very high profile companies, as well as in the Department of Defense. What happened to this interest and why was it all downplayed during the following four plus decades? After all, T. Brown had shown that there is a demonstrable connection between high voltage fields and gravity. Why has it taken until the 1990s for more than just a few scientists to look at these results and publish on them in the open literature? A review of recent statements by former military personnel and civilians connected to covert projects begins to shed light on research activity in these areas over the last half century. **And it appears that there had been significant breakthroughs during this time period, well shielded from both the scientific and public eye.**

Recent Scientific Developments

In this section we consider developments in the antigravity field since the late 1980s and why the confluence of scientific findings and the testimony of witnesses associated with the military and covert groups indicates that a gravity solution with technological implications has been found.

Although general relativity has not been able to explain Brown's electrogravitic observations, or any other antigravity phenomenon, the recent physics methodology of quantum electrodynamics (QED), appears to offer the theoretical framework to explain electrogravitic coupling. Recent papers by members of the Institute for Advanced Study Alpha Foundation are putting a solid theoretical foundation onto the antigravity effects within the theory of electrodynamics and include papers by Evans [12] and Anastasozki et al [13].

Earlier in a 1994 breakthrough paper, Alcubierre showed that superluminal space travel is, in principle, physically possible and will not violate the tenants of the theory of relativity [14]. Puthoff [15] later analyzed these findings in light of the present SETI (Search for Extraterrestrial Intelligence) paradigms that insist that we could not be visited by extraterrestrial civilizations because of the speed-of-light limitations dictated by the general relativity theory. He suggests that super-luminal travel is indeed possible. This leads to reduced-time interstellar travel and the possibility of extraterrestrial visitation, which our limited under-standing of physics and scientific arrogance has "forbidden" in some sectors for most of the 20th century.

The second aspect of these physics findings deals with the zero point or vacuum state energy shown by the Casimir effect [16], which predicts that two metal plates close together attract each other due to imbalance in the quantum fluctuations. The implications of this zero point or vacuum state energy are tremendous and are described in several papers by Puthoff [17] starting during the late 1980s. Bearden [18] and colleagues have also written extensively on the theoretical physics of zero point energy and additionally have described various technological means of extracting this energy (for example see the recent paper by Anastasozki et al [19].). A theoretical book on zero point energy (and antigravity) was published by Bearden in 2002 [20]. There is significant evidence that scientists since Tesla have known about this energy, but that its existence and potential use has been discouraged and indeed suppressed over the past half century or more [21].

The coupling of the electrogravitic phenomena observations and the zero point energy findings are leading to a new understanding of both the nature of matter and of gravity. This is just now being discussed in scientific journals (though some evidence suggests that it has been understood for decades within the black project covert community). The question that is being addressed is: what keeps

the universe running? Or more specifically, where do electrons get their energy to keep spinning around atoms? As electrons change state they absorb or release energy, and where does it come from? The simplistic answer is that it is coming from the vacuum state. Puthoff [22] describes the process as follows: "I discovered that you can consider the electron as continually radiating away its energy as predicted by classical theory, but **simultaneously absorbing a compensating amount** of energy from the ever-present sea of zero-point energy in which the atom is immersed. An equilibrium between these two processes leads to the correct values for the parameters that define the lowest energy, or ground-state orbit (see "Why atoms don't collapse," NEW SCIENTIST, July 1987). Thus there is a DYNAMIC EQUILIBRIUM in which the zero-point energy stabilizes the electron in a set ground-state orbit. It seems that the very stability of matter itself appears to depend on an underlying sea of electromagnetic zero-point energy."

Furthermore, it appears that it is the spinning of electrons that provides inertia and mass to atoms. These theories, linking electron spin, zero point energy, mass, and inertia have been presented in a number of recent papers, such as those by Haisch [23] and colleagues and provide us with a possible explanation of the Biefield-Brown effect. It appears that an intense voltage field creates an electromagnetic barrier that blocks the atomic structure of an atom from interacting with the zero point field. This slows down the electrons, reducing their gyroscopic effect, and thus reducing atomic mass and inertia, making them easier to move around.

Evidence of Extensive Antigravity Technology

The B-2 Advanced Technology Bomber

In 1993, LaViolette wrote a paper [24] discussing the B-2 bomber and speculating on its probable antigravity propulsion system, based on a solid understanding of electrogravitics, [25] the aircraft's design and the materials used in its manufacture. It appears that the craft is using a sophisticated form of the antigravity principles first described by T. Brown. Support for this thesis came from the Aviation Week and Space Technology (March 9, 1992), which reported that the B-2 bomber electrostatically charges its leading edge and its exhaust stream. Their information had come from a small group of former black project research scientists and engineers suggesting the B-2 utilizes antigravity technology. This information was supported by Bob Oechsler, an ex-NASA mission specialist who had publicly made a similar claim in 1990. These findings support the contention that there have been major developments in the area of antigravity propulsion which are presently being applied in advanced aircraft.

LaViolette later states the obvious that "the commercial airline industry could dramatically benefit with this technology which would not only substantially increase the miles per gallon fuel efficiency of jet airliners, but would also permit high-speed flight that would dramatically cut flight time." [26]

The Hunt for Zero Point [27]

This recent book contains some of the strongest evidence yet for major efforts and success in the field of antigravity technology. The author, Nick Cook, who for the past 15 years has been the Aviation Editor and Aerospace Consultant for Jane's Defense Weekly, spent the last 10 years collecting information for the book. This included archival research on Nazi Germany's antigravity technology and interviews with top officials at NASA, the Pentagon and secret defense installations. He shows that America has cracked the gravity code and classified the information at the highest security levels. **Because antigravity and its allied zero point energy technologies potentially offer the world a future of unlimited, non-polluting energy it has been suppressed because of the "huge economic threat".** His findings support those reported by many of the Disclosure Project witnesses cited above.

Antigravity Technology Demonstrations

Although T. Brown reported many of his findings nearly a half century ago, other experimenters have just recently begun to reproduce his work and report on it in the open literature and on the WWWeb. For example, Davenport [28] published the results of his work in 1995 supporting the findings of T. Brown, while Bahder and Fazi [29] in 2002 described their assessment of the forces associated with an asymmetric capacitor. Transdimensional Technologies [30] in the USA and J. Naudin [31] labs in France have posted on the WWWeb: diagrams, web videos, and data on their versions of antigravity "Lifters" based on an extension of Brown's work. It is a sad commentary on this whole area of research to see that public science is requiring us to demonstrate principles that were demonstrated nearly fifty years ago.

There have also been a number of other demonstrations of "antigravity" phenomena by researchers throughout the world. This includes the work of Brazilian physics professor, Fran De Aquino, and such devices as: the Searl Electrogravity Disc, the Podkletnov Gravity Shield and Project Greenglow, the Zinsser Kineto-baric Field Propulsion and the Woodward Field Thrust Experiments on Piezoelectrics. All of these are described in more detail by Greer and Loder. [32]

Implications of This Research

Antigravity and zero point energy research and their applications are finally being addressed by some of the open scientific community. This means there will have to be a rewriting of textbooks in this area so our new generation of students can apply this "new knowledge." Its application will lead to major breakthroughs in transportation technologies both earthside and in outer space. The implications are that we have the potential for human exploration of our solar system and beyond, if we have the will, within our lifetimes. It also means that the majority of 20th century space technology will be obsolete and in fact may already be so.

The zero point or vacuum state energy source is seen as a totally non-polluting energy source, which has the potential to replace all the fossil fuels on this planet. It also will provide the energy needed for long range space flights. This means that fuel cells and solar cells in common use today for space flight energy applications will only be needed until we transition to these new energy technologies.

Based on an analysis of trends in antigravity research over the last half-century and the information provided by numerous witnesses, it appears that there is both good and bad news. The good news is that it appears that we (at least covert projects) have already developed the theories of antigravity, and additionally have developed working spacecraft based on these principles. The bad news is that these technologies have been developed for at least several decades, at the public's expense and that human kind has been deprived of these technologies, while continuing to waste energy using less efficient and pollution enhancing technologies.

Supporting this contention is the following quote from Ben Rich, former head of the Lockheed Skunkworks. Just prior to his death, he stated to a small group after a lecture [33] that: "We already have the means to travel among the stars, but these technologies are locked up in black projects and it would take an act of God to ever get them out to benefit humanity…" He further went on to say that, 'anything you can imagine we already know how to do.' Strong words from a knowledgeable deep insider and words that support what a number of the witnesses stated as well.

As the reality of this knowledge begins to be understood, there will be an outcry among space scientists not on the inside for release of these technologies to allow all of us to explore space. There will be major changes in the way that NASA does its business, though predicting these changes is difficult.

Not only has space exploration in the public sector suffered, but our planet's environment has suffered as well. Thus as this knowledge begins to sink in there will be an outcry among all concerned citizens on this planet for release of these technologies to allow all of us to reduce and ultimately eliminate global warming and environmental pollution that so threatens our way of life. These technologies will not only affect space travel technologies, but will also have a profound effect on transportation and energy production on the earth's surface.

In conclusion, we might consider the observation made by Halton Arp [34]: "We are certainly not at the end of science. Most probably we are just at the beginning!"

Acknowledgements

I thank the following people for many discussions while preparing and writing this paper including: S. Greer, A. Craddock, T. Bearden, P. LaViolette, M. McCandlish, D. Hamilton, T. Valone, E. Mallove, T. Loder, C. Loder, S. Patel and many of the courageous Disclosure Project witnesses.

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Congress "The Time Machine"

Faraday Labs Ltd invites to participate in scientific congress devoted to experiments on changing of space-time properties. It is planned April 12, 2003, Moscow. Main topics of the congress are time and gravitation in the context of eatherodynamics, experiments and applied aspects of these technologies. The main report is "Method to Control Temporal Parameters of Physical Processes" by Alexander V. Frolov.

Organizing committee: Vadim A. Chernobrov (KOSMOPOISK research center) and Alexander V. Frolov (Faraday Labs Ltd). The registration fees are not required.

Please, contact us http://www.faraday.ru or **email** congress@faraday.ru **Phone/fax 7-812-380-3844**

Please send this pre-registration form by post: P.O. Box 37, St. Petersburg, Russia 193024 **or e-mail:** congress@faraday.ru

***PRE-REGISTRATION FORM* for participation in the congress "The Time Machine"**

Last name:
First name:
Title/ Function:
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Address:
Postcode:
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Country:
Tel.:
Fax:
e-mail:

☐ I would like to submit an oral presentation (report). (Please, enclose one-page abstract).

☐ I intend to participate as a guest

☐ I'm interested in further information.

Date Signature

COMMERCIALISING the "SEARL EFFECT" for ENERGY and PROPULSION SYSTEMS

Review from web site http://www.sisrc.com/
Email address: admin@sisrc.com

The "Searl Effect", discovered by J.J.R. Searl, is a method of extracting energy. Some current expressions for the source of this energy being The Space Fabric, Quantum Space Field, and Zero Point Energy.

SISRC Ltd has been formed to develop and license Searl Effect Technology (SET) on a global basis.

THE COMPANY

SISRC Ltd is the company formed to administer the implementation of the Searl Effect Technology, (SET) invented by J. R. R. Searl. SISRC Ltd designs, develops and implements Searl Effect Technology as it is initiated in various applications and territories. SISRC Ltd is the administrative hub of the group and will continue to be based in the UK. SISRC Ltd will grant production and marketing licenses for Searl Effect Technology applications to different companies in specific territories. Currently proposed related companies include:

* SISRC -Germany, SISRC -Iberia, SISRC - Sweden, SISRC - Australia, SISRC New Zealand.
* SISRC -AV (Audio Visual) provides computer graphics presentations of the SET.

BACKGROUND

The Searl Effect Generator (SEG) technology, as applied to the commercial market, had been previously developed to the point where a few prototype SEG generators were made, and used for electricity generation and motion. Commercial interest at that time focused on the SEG's transport potential and, under commercial pressure to deliver a fully functioning system, the original generators were used and lost in a series of vehicular propulsion experiments and demonstrations. Funding was insufficient to continue with the manufacture of the required larger-scale pressurized cabin machines - resulting in the termination of the project at that time.

Although all the operating principles, precise proportions and weights of the required materials are known for three of the four required operating materials, the precise data of the original magnetic layer is uncertain. The objective of the current R&D programme is to re-establish the original magnetic layer using modern and more efficient materials.

Originally, the layered materials were constructed and magnetized by the now-defunct Midlands Electricity Board under the direction of John Searl (see colored photo of the experimental craft construction on the cover page).

Modern magnetic materials have advanced considerably, and old ones discontinued, so a series of tests need to be conducted to establish the optimum materials and processes. These tests need to comply with the working criteria required and must lead to a cost-effective manufacturing process.

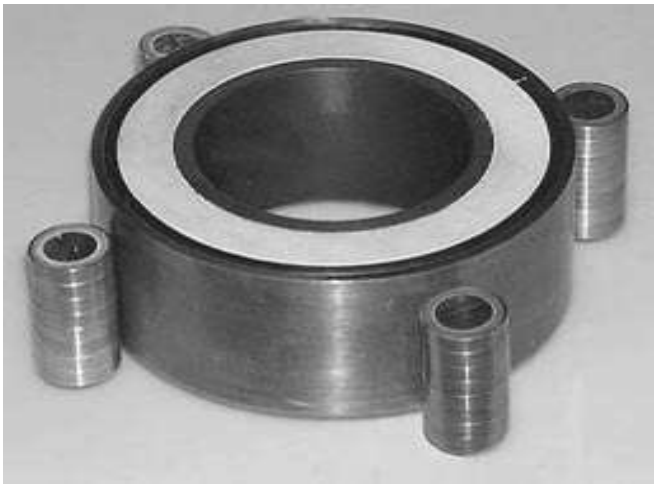

Fig.1
Experimental ring and rollers

In recent times SISRC has been re-establishing the original research. Due to the very limited funding that has been available, only a partially functioning demonstration prototype of the SEG principles has been possible. This prototype consists of the innermost of the three composite rings required and several rollers.

We would like to hear from anyone who worked on or was involved with Searl Technology prior to 1983. Also anyone who has any old technical data, photographs or films relating to the technology. Such information could greatly assist this technology to reach the marketplace for the benefit of all and would be dealt with in the strictest of confidence.

TECHNICAL DESCRIPTION

Physically the Searl Effect Generator (SEG) consists of three concentric rings each made of a composite of four different materials which are also concentrically attached to each other. The three rings are fixed to a base. Surrounding each of the rings, and free to rotate around them, are rollers - typically 10 on the first ring, 25 on the next and 35 on the outer ring. Surrounding the rollers on the outer ring are coils which are connected in various configurations to supply either AC or DC current at a variety of voltages.

Multiple magnetic poles are imprinted on the rings and rollers to form frictionless magnetic bearings. These also arrange the static charge into opposing charge clusters which cause the rollers to rotate around the circumference of the ring (as shown in Fig. 2).

Some expressions currently in use to describe the source of the energy for the SEG are The Space Fabric, Quantum Energy field of Space or Zero Point Energy. This is an unlimited and constant source of energy which can be made to flow when the correctly proportioned masses concerned are stimulated by the correct frequencies creating an 'open system'.

The idea of utilising this source of energy is currently the subject of various devices and experiments such as the 'Lamb shift', 'Casimir Effect' and the work of the Russian Nobel Prize winner Ilya Prigogine. However these devices and experiments tend to only prove the existence of the energy and not a method to create a coherent, ordered flow to produce useful power.

Fig. 2
15 KWt Searl Effect Generator (SEG)

In contrast, John Searl has discovered that, in order to create a steady and stable flow, all the masses of the device (and the stimulating frequencies) must conform to precise values determined mathematically by the 'Law of the Squares'. A machine constructed to these principles produces a stable and useful power output.

DEFINITION OF A SURFACE OPERATING S.E.G. (J. Searl) 15.09.00

A Linear motor operating on a magnetic bearing with the characteristics of an auto-transformer. The S.E.G. is defined as a device, which is constructed from 2,124 component parts, which make up 3 plates and 66 roller sets (see figures on the cover page). 12 of the 2,124 components create the 3 plates, which act as reaction components. 2,112 components are employed to create 66 roller sets, which act as active components. Each roller set consists of 8 segments constructed from 32 components. Each segment cannot be less than 34 grams in weight, as the law of the squares defines that value as the lowest value suitable for the reasonable generation of electricity. Therefore the smallest roller set must weigh 272 grams, making a grand total of 2,244 grams per roller set for the smallest surface bound SEG.

Tolerance should be about 0.05 gram per roller set. The larger the error the greater is the loss of power within the unit. Therefore the total tolerance for the smallest SEG roller set must not be greater than 3.30 grams - above this factor the SEG will not function. **For the best results, the tolerance across the total 66 roller sets should not exceed 0.05 grams!**

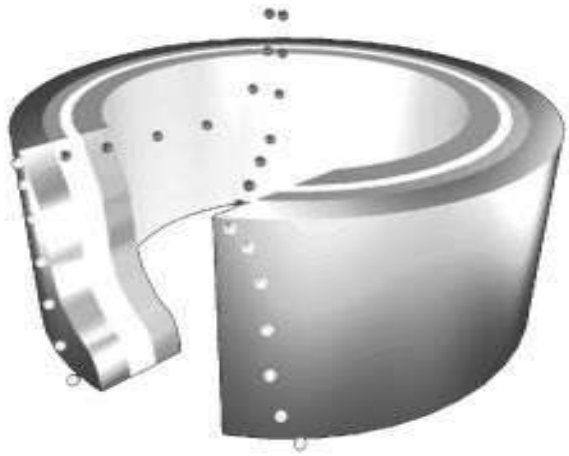

Fig.3

The S.E.G. is a step up rotary transformer. In fact it's a 'three rotary transformers' operational system, within a unit. The inner transformer output is fed in to the input of the second plate which increases the output of the second unit, which output feeds as an input to the final unit, thereby increasing its finaloutput to a very high voltage. Therefore the S.E.G. is just a prime mover for the production of clean electrical energy. The output windings must be designed to step down this output to 240 volts at 15KWt's.

During 1968 it being upon this issue, as development progress both here and in the USA, new findings are being created, and updates will be added to this page, as they are certified. When the SEG rollers are brought into close proximity to the SEG Ring, the Searl Effect resonant magnetic field causes negative ions and electrons to be drawn into and accelerated through the machine. This process is assisted by the highly electron-attracting rare earth metal Neodymium.

The unique mechanical and material arrangement of the SEG pulses the neodymium to continually release and replace the surplus electrons to provide electrical or mechanical power, or both.

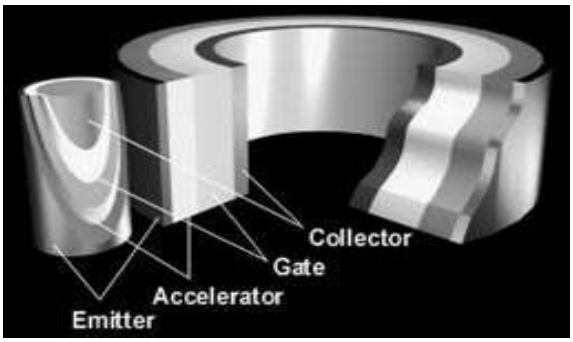

Fig.4

DEVELOPMENT

Prior to the production of complete 15KWt Searl Effect Generators (SEGs), a minimum of two demonstration Ring & Roller prototypes are to be produced.

The "Ring" is typical of the innermost of the three rings required to make a complete SEG. The 69-roller sets in a complete three ring SEG are identical. Six roller sets will be made for the prototype inner rings so that the Searl Effect can be demonstrated.

The production of a self-running Ring & Roller prototype will establish the precise sequence and parameters of electrical, magnetising and material processes required for the SEG and will demonstrate electrical power generation. An operating single inner ring with 1-8 rollers will also determine if a particular material will function correctly and at what level of power output.

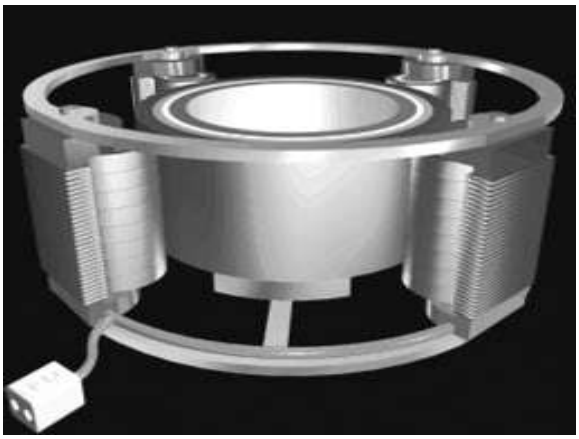

Fig. 5
Demonstration ring and rollers

The five phases of the development programme that commenced in October 1999 have been completed and the rollers successfully magnetised with 'Searl Effect' magnetic fields. A sixth phase is now required to apply the technology developed in Phase five to the "Ring". This sixth Phase resulting in a demonstration Ring & Roller prototype has duration of 6 months.

NEWS REVIEW

Scientific Breakthrough Liberates Energy Users from Fossil Fuel Dependence

Information from
http://www.genesisworldenergy.org/genesis_world_energy.htm

Story originally published by Diana Echeverria, USA

Director of Public Relations
Guy Rome & Associates, Inc.
208-345-4143 208-602-0325 (cell)

Technology breakthrough harnesses energy from the molecular structure of water

BOISE, ID - Dec. 5, 2002 - Genesis World Energy, a privately funded consortium created by a group of military and space program research and development specialists, today unveiled a scientific breakthrough that allows consumers to easily access the energy contained within the hydrogen and oxygen molecular structure of ordinary water. This scientific breakthrough provides a limitless, low cost and environmentally clean source of energy that can be implemented with minimal cost and effort. The viability of using water as an energy source, previously a theoretical concept, is now a reality. "Water has always been the source of life on this planet, now it will also transform the way we create energy" said Charles Shaw, corporate counsel and spokesperson for Genesis World Energy. "The implications for worldwide energy generation and consumption are nothing less than staggering."

The Edison Device

The first application of this technology is represented in the "Edison Device", a self-contained, self-sustaining energy generation unit. Roughly the size of an outdoor air conditioning system, the power source can be quickly and easily installed in any home or business to provide virtually unlimited energy from any available water source. The Edison Device utilizes the existing electrical wiring and natural gas plumbing in a home or business to replace the energy provided by utility companies. The home version of the Edison Device produces approximately 30 kWtt of combined gas and electrical energy per day. By comparison, the typical home uses between five to six kilowatts per day. The commercial model is capable of producing 100 kilowatts of energy per day. The energy generation portion of the devices has no moving parts. In fact, the only "mechanical" aspects of the equipment are small circulation pumps and micro-valves, making the Edison Device both silent and virtually maintenance-free. A minimum amount of water is used over an estimated 20+ years of service life.

Interesting Publications of the Last Year

Discovery by a Group of Scientists Headed by Valerian Sobolev

Some time ago mass media announced that a sensational discovery was made by a group of Russian scientists headed by Valerian Sobolev. This discovery aroused ambiguous attitude of physic community. We have written about this fundamental and, to a certain extent, revolution discovery. Let us revise the fact that Sobolev claimed 7 scientific discoveries which were made, i.e. the process of depletion (a special electrochemical process), magnetic discharge, a new energy source, a method of low temperature plasma generation and superconductor. A laboratory system of the experimentally disclosed process as well as its industrial prototype is easy to be realized in practice for creation of new energy sources and wide-ranging production of ultrastrong materials. In many cases these materials can replace existing constructional materials.

The materials produced as a result of the process are multielement chemical compounds which are new states of matter. This new state of matter has **a time-changing magnetic field that can be EMF source in a coil of a generator.** Ordered structures of matters which are in the new modified state are nothing but a magnet charge. Materials containing the magnet charge and representing a continuous matters are **new energy sources.** Due to the new state matters become able to produce electric power as well as to generate low temperature plasma. It is easy to be realized in the process of common technological procedures. That promises designing of propulsors for "unsupported" transportation systems in near future.

Basing on realization of the disclosed process and using new materials the group of Russian Scientists headed by Sobolev together with American businessmen has created superfine and flexible glass for packing. The glass was called as "strong glass". It seems to demonstrate higher pressure stability than steel. A method of production of these materials was patented in 1999. In the patent the scientists of Valerian Sobolev's group are represented as authors of this new method, and the owner of the patent is Dynelec Corp (Columbus, Ohio, USA). You can read about the patent at the Web-site of http://patft.uspto.gov/netahtml/srchnum.htm (patent #5,964,913, October 12, 1999).

Sobolev's group has appeal to the Russian government for sponsorship; however only foreign investors have provided funds for new energy sources developing. According to Russian Information Agency "News", Sobolev's group has signed a $168 million contract with one of Canadian companies for developing industrial production of energy sources. Manufacturing of such energy sources **can change energy supply system all over the world**. According to the contract the Canadian company is going to finance building of at least two plants. One of the plants is going to be built in Russia, and the other one is planning to be established in Canada. Each plant is supposed to produce 70 thousand of the self-running energy sources a year. Power output of the sources will come to 3-10 kWt. In other words, in the nearest future every person will be able to buy such an energy source and to apply it in household.

Single-Wire Electric Power System

(see photo on the cover page)

Experimental Results of Russian Scientists

Scientists of the All-Russia scientific research institute of electrification of agriculture (VIESH) academician D.S. Strebkov, engineer S.V. Avramenko, dr., A.I. Nekrasov, post-graduate student O.A. Roshchin developed a new method and the equipment for transmission of electric energy on a single-wire line using resonant idle operation mode and reactive capacitive currents for transmission of active electric power. Tesla transformers and frequency converter were used at the experiments.

First there was created the experimental sample of single-wire electric power system (SWEPS) with **10 kW** electric capacity and 3000 V voltage. As a result, obtained SWEPS electric parameters a hundred times exceeded parameters of a usual two-wire or three-wire alternative and direct current line.

In the end of 2002 there was made an attempt to increase transmitted capacity by using of more powerful condensers, which were installed in resonant circuit. There was developed the electric technique of **20kW** single-wire electric power system (SWEPS) with two Tesla transformers. As a result parameters of a low-voltage winding of the step-down transformer were changed. They **exceeded parameters of a usual two-phase or three-phase ac line or dc line in two hundred times.** At room temperature effective specific transmitted electric power was 4 MW/mm^2 and specific current density was 600 A/mm^2. These parameters could be achieved for existing methods of electric energy only at use of special materials in a mode of low temperature superconductivity. The measurements which were made at wire with diameter of 1mm, 100 microns and 80 microns, demonstrated that parameters did not depend on diameter of a wire. There was also experimentally confirmed the property of a single-wire line to transfer active power without essential losses on line resistance. Irradiation losses at low frequency 3,4 kHz were small. In single-wire power system the 80 microns wire plays a role of directing system for an electromagnetic energy flow, which runs from the generator to the load.

We present update information on the experiments with Lifters or asymmetrical capacitors, which use High Voltage to produce a thrust. ***By Jean-Louis Naudin it was demonstrated with "Maximus" experiment, that a Lifter can be scaled up and also that such a device is able to lift up to 60 g of payload (total weight: 194 g). According to Naudin, it is now possible to build a craft which will use the Biefeld-Brown effect to fly silently and without moving parts only powered by electrical energy.*** *It was also declared that on January 8th, 2003, there was successfully done two historical flights with a mouse as a test pilot of the Lifter "Maximus"* ***(propellantless electrokinetic craft)****. Below there is an analysis of electrogravitation experiments made by Jean-Louis Naudin and Tim Ventura. (See color photos on the cover page).*

Review of Electrogravitation Experiments made by Jean-Louis Naudin and Tim Ventura

Tim Ventura

Tim Ventura Website: http://www.americanantigravity.com
Email: TVentura@seattle.telecomsys.com, tventura6@atbi.com

There is a spreadsheet containing a jpeg-snapshot of data that I have assembled based upon Jean-Louis Naudin's published results (JLN Labs Website: http://jnaudin.free.fr. and http://www.jlnlabs.org). In the graphs that I've created, it seems to indicate that current plays more of a role in propulsion than voltage does — i.e.: for a given amount of power in watts, raising the current and decreasing the voltage seems to create a higher level of thrust.

In light of this, I have been increasing the thrust of my own Lifters by creating an electrical-bypass of the "load-resistor" on my power-supply's high-voltage output. This has an interesting result:

I use a current-driven power-supply, which means that if no load is connected to it the voltage will build up on the high-voltage output until arcing occurs. In my case the voltage will build up to around 65kV, at which point the power-supply will automatically shut down. Conversely, if a very light load (such as a short circuit) occurs, the opposite effect happens and the power-supply will deliver much higher current at a much lower voltage until the supply is overdrawn and once again shuts down.

Normally the output load-resistor constrains the current, and in doing so it maintains the voltage on the high-voltage output at the nominal 50kV output level. However, bypassing the output load-resistor allows the power-supply to deliver voltage and current that are based almost entirely on the type of load connected to it.

When I connect a normal Lifter to the bypassed power-supply, the voltage will build across the air-gap until ions begin to flow in a conduction-current across the air-gap. Although this begins to happen at approximately 15kV, it seems to have some type of "peak efficiency' at approximately 22.5 kV. The amount of current climbs to approximately 11mA at this voltage.

This method of experimental setup seems to allow the Lifter to "find its own sweet-spot" for operation, instead of using the output-resistor to "force" a specific voltage on it for operation. This appears to maximize the thrust output during operation.

Lifter Efficiency Spreadsheet

Description	Lift capacity (grams)	Length (cm)	Efficiency (g/m)	Lifter Weight (grams)	Voltage (kilovolts)	Corona Air-Gap (centimeters)	Current (mA)	Power (watts)
Lifter 1	3.3	60	5.5	2.3	41.9	3	0.57	23.9
Lifter 2	9.6	180	5.3	6.6	43.35	3	1.12	48.5
Lifter 3	20	360	5.6	16	27.5	3	2.53	69.5
Lifter 4	36	720	5	32	44	3	2.01	132.9
3-Stage Lifter 3	54	1080	5	24	30	4.5	8.06	240
Coliseum Lifter	90	2160	4.16	50	31.769	4.5	8.06	254.15

New Electric Fire Technology

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Abstract

The article proves importance and prospects of development of combustion technologies. In particular there is considered application of a new electric fire technology for environmentally appropriate combustion of any matters and gases. The technology uses electric fields as combustion catalyst. There is observed application of technology in heat-and-power engineering, transport heat engines, disposal units etc. [1, 2]. It is demonstrated that the new technology allows intensify combustion processes and increase their controllability (i.e. the control of temperature, gases pressure, gradient of heat conductivity, and so on). There is made a conclusion about availability of the technology to solve critical energetic and ecological problems of the civilization.

We hope that this article will excite interest of a wide circle of readers, i.e. of professionals in the area of combustion and heat technologies, physicists, ecologists, and those people who are interested in new scientific ideas.

Global Ecological Problems are the Problems of Ineffective Combustion of Hydrocarbon Fuel

The ecological problems become more and more serious and threaten to grow into world ecological catastrophe. The main cause of the atmosphere pollution in megapolises is imperfection of combustion technologies (of heat-and-power engineering, heat machines, transport engines, waste combustion…). It has been proved that their share of pollution of the planet atmosphere comes to 70-80%. The combustion technologies mean any technologies of combustion of fuel, matters and gases. The combustion technologies are the most popular technologies in the world. The modern civilization without the combustion technologies is impossible. There are many industries, which apply these technologies, such as heat-and-power engineering, transport, metallurgy, food industry, oil-and-gas refining industry, chemical industry, waste combustion neutralization.

Therefore the global ecological problems will not be solved until the mankind develops the combustion technologies. The article describes and discloses the essence of the new technology of ecologically appropriate and effective combustion of fuel and wastes of any type.

Why is it difficult for ecologists to conserve nature?

Modern methods and technology used for solving of the ecological problems consist in **analysis** of extent and sources of the environment pollution (ecological monitoring), and, moreover, in **refinement of atmosphere, water and soil, which are used in different technologies or have been polluted due to the imperfection of the technologies** (it is refinement from such toxic components as drinking and run-off water, exhaust and waste gases etc.).

Unfortunately, methods of measuring of the huge spectrum of toxic matters, which are thrown into the atmosphere at matters combustion, as well as the methods of their utilization are impartially difficult, expensive and imperfect. Even using of an ideal technics for measuring of the atmosphere pollution is not effective since it is a struggle with **consequences** of the combustion and other technologies imperfection but not with **causes** of the atmosphere pollution.

Ecological and energetic effectiveness of the known combustion technologies

It is known that real effectiveness of transformation of chemical energy of fuel in the combustion process is low. For example, in heat engines it comes to 25%, effectiveness of transformation of heat energy into electric energy in thermoelectric power stations does not exceed 40%. If energy consumptions of mining, processing and delivery of the fuel to consumers are taken into account then the summary efficiency of the existent combustion technologies (of heat machines and devices) comes to no more than 10 – 15%! It means that more than the half of chemical energy of the fuel is transformed into heat and different toxic matters and waste gases, which pollute the planet atmosphere. They cause acid precipitation, a global "greenhouse" effect, which threaten to cause the climate warming, the world flood, and final poisoning of the living nature. Thus the share of imperfect power engineering in the nature pollution comes to 70 – 80%! How is it possible to cleanse the planet atmosphere, especially the environment of world megapolises, in the situation when the amount of toxic matters produced by transport and industries is comparable with the amount of rest pure air?

Until the mankind learns burn matters and gases by effective and ecologically appropriate way the planet atmosphere will remain polluted and in near future it can become uninhabitable. Thus we will not solve the ecological problems until we gain the understanding of the combustion processes and processes of combustion transformation of matter chemical energy into heat energy, and then into other useful types of energy (i.e. electric energy, mechanical energy, light energy).

Physical Essence and Problem of Classical Combustion of Matters

Combustion is one of the most difficult phenomena, which are known by the humankind. From the scientific point this phenomenon is a chain reaction of sequential fragmentation of fuel particles into smaller charged radicals; it is physical chemical processes of transformation of chemical energy of intermolecular connections as well as combustion also includes physical processes of transformation of energy into heat and light on molecular and atomic levels. Many other processes, which proceed simultaneously, are involved.

From school years we know that combustion is a process of interaction of fuel with an oxidant that is accompanied by heat and light energy generation. In higher school the words of "as well as by cryptic energy of chemical connection of waste gases" are added to the school definition. The combustion processes are studied and improved by scientists and experts of different areas (chemists, physicists, heat-and-power engineering specialists, thermalphysicists etc.). There are known fundamental investigations of combustion chain reactions made by such Russian scientists as N.N. Semenov, Ya.B. Zeldovich and their followers.

Until now intensiveness of fuel combustion is increased by air blowing into the combustion zone that increases the amount of waste toxic gases thrown into the atmosphere. **Let us arouse several questions, which seem naive at first sight. Why is an oxidant (air or oxygen) needed for matter combustion? Is it possible to do it without any oxidant?** How does the combustion process begin and proceed? There are a lot of vague questions in physics of combustion. For example, how can the temperature and the intensiveness of the combustion be regulated? Can the heat conductivity of the flame be controlled? How can heat motion of particles be regulated in the flame and in the waste gases, and what can it cause? There is another problem of combustion. It is the very hydrocarbon fuels, which are applied at modern heat processes. The great Russian scientist, D.I. Mendeleev stated that to use oil is the same thing as to stoke a stove with banknotes.

Since the hydrocarbon fuels are complicated chemical matters and the combustion processes are imperfect then in the process of their combustion a great amount of different by-product matters and toxic gases are produced. They waste unused self-energy of fuel into the atmosphere and pollute our planet.

Physical essence of the new electric combustion technology

How is it possible to burn the hydrocarbon fuel by environmentally appropriate way? How can this environmentally appropriate technology be realized in practice? A brief answer is following**: it is necessary to make such conditions of combustion of organic fuel, and to introduce such a combustion catalyst that the energy of intermolecular and intramolecular connections of the organic fuel becomes absolutely free. At that the chemical energy can be transformed into energy of electromagnetic radiation, for example, into light energy and heat energy without generation of by-product polluting matters and gases. Then a working body (for example, water) is effectively heated by this directed concentrated electromagnetic radiation. In this process effects of electromagnetic waves reflection and concentration are used, or the electromagnetic radiation is directly transformed into electric energy.** In this case there is a new opportunity to regulate flame temperature and to extremely decrease quantity of the oxidant, i.e. to create organics combustion with minimal quantity of waste gases.

Is it principally possible to burn organic matters and gases without the atmosphere pollution using electric field as a catalyst? It is possible if parameters of this field are correctly chosen. More precisely it is possible if huge Coulomb forces of the electric field are correctly regulated by interaction of electrically charged particles of the fuel and the oxidant with force lines of the electric field.

One variant of an experimental device is represented in Fig. 1.

Devices for approbation of the new electric combustion technology

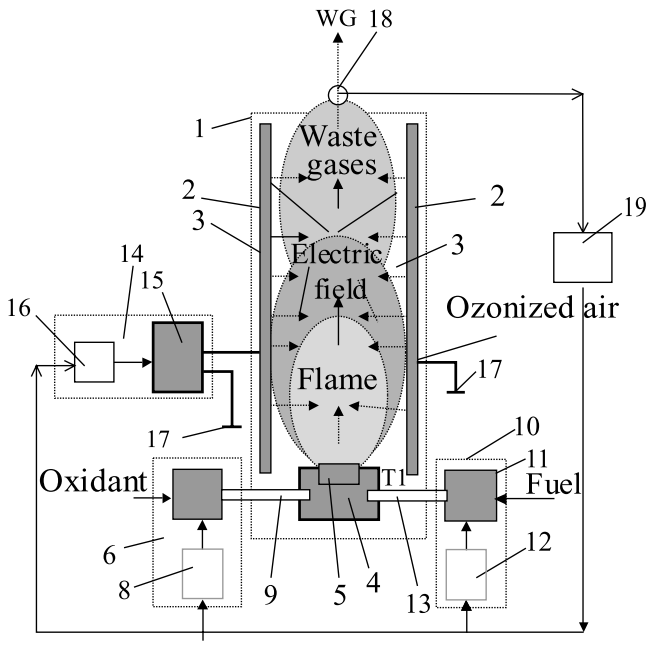

Fig.1 a
Plan of the experimental device

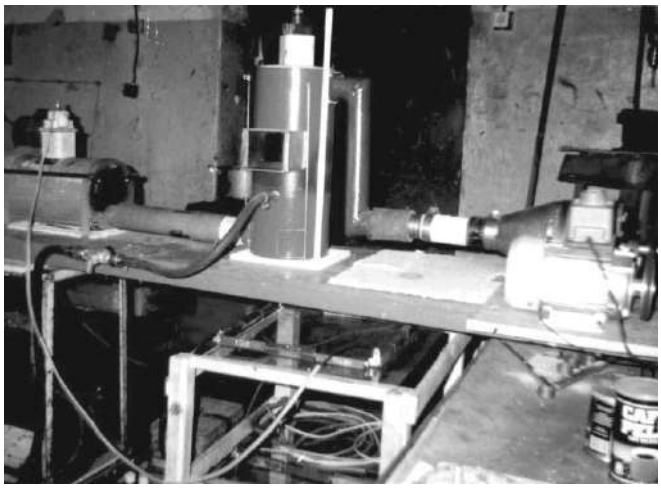

Fig. 1 b
Photo of the experimental system

A structure chart of the experimental device, which was designed to investigate the new electric combustion technology, is demonstrated in Fig.1a. The device contains a body (1) equipped with flat electrodes, which are insulated from the body (2), (they can be placed in either horizontal flat or vertical flat). The electrodes (2) are located on opposite inner walls of a combustion chamber (3). The device is equipped with a mixer (4) with a device for supplying of blended fuel to the zone of combustion. At the same time the device (5) is used for electrical combustion of the blend. The described device is equipped with an air track (6), which contains an oxidant activator (7) joined with a regulator (8) by a control circuit and with the mixer (4) by an air pipe (9). The regulator (8) serves for regulation of the oxidant activation extent. At the end of the air pipe it is possible to place a vortex device (it is not shown in the figure). Also the device is equipped with a fuel track (10) containing a fuel activator (11) and a regulator (12) of the activator and consumption of fuel. The block (11) is joined with the mixer (4) by a fuel pipe. The device is equipped with an electric combustion activator (14) containing a high-voltage transformer (15) of intensity and frequency joined to its regulator (16) by a control circuit. An electric outlet of the block (15) is joined to one of the electrodes (2), and the second outlet is safely electrically grounded by a grounding mat (17). The high-voltage wire of the outlet of the block (15) is connected with the electrode (2) through a bushing insulator (it is not demonstrated in Fig.1a). The device is equipped with a gas toxicity calculator (18) joined to the inlet of a mode optimizer (19), which is a control system for interacted regulating of all the parameters of combustion. For that the outlet of the mode optimizer (19) is joined to the inlets of control of the regulators (8), (12), (16).

The device operates in the following way. At first an activated oxidant of O1 is applied through the air track (6), activator (7) and air pipe (9) to the mixer (4). Then an activated fuel of F1 is applied through the fuel track (10) and the activator (11) to the same mixer (4). A blended fuel is prepared in the mixer (4) and then is atomized and combusted by a sparkle of the block (5). In the combustion chamber (3) flame and waste gases are processed by strong alternating electric field, which is generated by the block (14) in a gap between the electrodes (2). In the process of combustion waste gases toxicity is measured by the special toxicity sensor (18). Depending on current toxicity the parameters of flame combustion are regulated by the mode optimizer (19). More precisely the oxidant consumption and the extent of its activation are changed by the regulator (6), the fuel consumption and the extent of its activation are changed by the regulator (12), the intensity and frequency of the alternating electric field generated by the block (14) in the combustion chamber (3) is changed by the regulator (16). Let us note that the electric field in the combustion chamber (3), viz in the gap between the electrodes (2), catalytically influences on both the flame and the waste gases. The essence of the process lies in the fact that the processes of fragmentation and oxidation of fuel radicals and of toxic oxide molecules are accelerated. Intensiveness of combustion and of toxic gases refinement increases as well as the intensity of this field and its frequency do. As a result of the interconnected regulation of all the listed parameters fuel of any kind can be fully, intensively, "cleanly" combusted.

In Fig.1b there is a photo of the operating experimental device designed to investigate the processes of influence of electric field on the process of matters combustion and of cleaning of waste gases. The photo represents following things.

1. In the left side there is a furnace with a high-voltage electrode in a higher part of its body.
2. In the centre there is a vertical column of the electric combustion cleaning (after-burning) of toxic gases in the electric field; on the top of the column a high-voltage electrode can be seen. Gas pipes designed for toxic gases supply–withdrawal are connected with the column and located to the right and to the left from it.
3. A regulable blower is represented in the upper right side of the picture. It is designed for toxic gases withdrawal and connected with the gas pipe by the column.
4. At the foot of the picture there is a regulable high-voltage tension source (the electric field source), which is connected with the furnace and the column of toxic gases cleaning by high-voltage wires.

It is experimentally proved that combination of two stages of the combustion activation (i.e. in the furnace and the column) ensures ideal cleaning of toxic gases at combustion of any toxic matters.

Some Results of Experiments

Our experiments and investigations of many-sided influence of electric and high-voltage electromagnetic fields on the combustion process have proved that such practically ideal condition of fuel and matters combustion is possible to be realized in practice [1].

Low-powered static and alternating electric fields (i.e. the fields of constant sign and of variable sign) of more than 1kV/cm intensity were used as combustion catalysts as well as high-frequency electromagnetic fields of low power with some frequency of oscillations of molecules in the flame (flame power is 0.1 – 1% of heat power of the flame of the combusted organic fuel).

Peculiarities of Oxidants Application in the New Technology

It is known from the thermodynamics and combustion theory that optimal ratio of the oxidant mass, for example air, and the fuel is approximately 1:16 in an average combustion process. In our experiments with the electro-field catalyst the ecologically appropriate combustion of the hydrocarbon fuel (mazut, straw oil) was achieved at oxidant deficiency (for example, at the ratio of oxidant mass and the fuel of 1:1). For experts it means that there is a real possibility for 10 – 15 times decrease of amount of waste gases of any heat machines and to while their former power is the same. As the experiments demonstrate carbon and hydrocarbon are absolutely removed from the waste gases. In the experiments oxides of hydrogen and nitrogen were 4 – 8 times decreased and flame existence was 5 – 10 times increased.

The issues of the experiments prove the hypothesis about possibility of effective environmentally appropriate combustion as a process of direct transformation of chemical energy of organic fuel into electromagnetic radiation energy of the flame (including heat and optic diapasons). The transformation is accompanied by removal of polluting toxic components from the waste gases that occurs due to many times intensification of the combustion process under action of electromagnetic catalysts.

Operations of regulable activation of fuel oxidants (simultaneous or separate), which are introduced into the combustion technology, ensure additional improving of the combustion process. Especially it occurs at heavy oil fuel combustion and water-fuel emulsion combustion that was experimentally tested by us. The process becomes especially effective if the flame of the combusted activated blended fuel is additionally processed by alternating electric field. Due to introduction of the operation of all the combustion parameters regulation (of consumption of fuel, oxidant, of their activation extent, and of their combustion intensiveness extent), according to the information of the waste gases toxicity, it is possible to achieve effective combustion of fuel and waste products of practically all kinds.

Our experiments demonstrate that combination of the very flame procession with procession of the waste gases and air (i.e. an oxidant) by electric field is very effective for the waste gases cleaning. The essence of this additional cleaning of the waste gases lies in fragmentation of carbon particles and exhaust opacity by electric forces of an alternating field as well as in after-oxidation of some toxic oxides in the medium of an ozonized oxidant. Energy consumption for activation of the flame combustion by strong electric fields is small and does not exceed 1–3% of heat energy of the flame. Advantage of this invention is universality of the application for combustion of any inflammables. It is possible due to widening of the diapason of the electric field parameters regulation (of intensity and frequency), especially in the mode of their interconnected regulation.

The essence of catalytic action of the alternating electric field on the flame combustion process consists in effective breaking of dipole radicals of fuel by an activated (dipole) oxidant. Moreover, the essence lies in better mixing of layers of combusting flame with the oxidant that occurs due to removal of a doubled electric layer from the limit line of the flame. Thus this technical solution allows achieve new positive effects due to its significant peculiarities, i.e. extending of application area of the known electric combustion method over the combustion process of any inflammables as well as it allows significantly increase controllability of the flame combustion process.

Let us note that in the experiments on the combustion of organic fuel in strong electric fields the regulation of the flame temperature and of its existence was achieved at unchanged consumption of fuel and of oxidant. That was achieved by changing of the parameters of the combustion electric-field catalyst (intensity and frequency) of a longitudinal electric (electromagnetic) field. Rotation and stabilization of the flame was achieved by a rotating transversal electric field. Changing of the flame height was realized by the longitudinal electric field.

The investigation, which has been performed by us, proves that directly acting on the flame the very electric field which directly influences on the flame and emission of electrons flow (ideal type of oxidation) into the flame can most effectively intensify the combustion process and make it harmless for the humankind and for the environment!

It has already been experimentally proved that energy consumption required for generation and regulation of this electric field and of the electrons flow for intensification and environmental

appropriateness of the combustion is quite small relatively the combustion energy and comes to fractions of a percent of the flame energy. Thus our experiments prove that the best **"oxidants" and combustion catalysts are** not superfluous air but **the electron and the electric field!**

Regulation of Heat Conductance of the Flame and the Heat Flow

As our experiments have demonstrated, the electric field can act as an effective combustion catalyst as well as a regulator of its intensiveness; moreover, it can control even a vector of heat conductance. It is proved by the experiments that the parameters of this field can be regulated as well as temperature of the flame and gradient of the flame heat conductance. Interesting experimental results were obtained measuring full heat of combustion of the same quantity of fuel at the usual method of fuel combustion and at the method, which uses combustion electric catalysts, even in the case of oxidant deficiency. In the last case the energy of fuel combustion almost 1.5 times increases that can be explained by fuller transformation of fuel chemical energy into electromagnetic radiation. At the usual combustion methods the chemical energy of the organic fuel was not completely used and remained as a cryptic summary chemical energy of intermolecular connections of many toxic waste gases, which were exhausted into the atmosphere by heat devices. Basing on the performed experiments it may be supposed that, evidently, specific heats of matters are 20-50% higher at this method than at their usual combustion method. The essence of the new electric combustion technologies consists in this new physics of combustion.

The author has already got patents for invention of Russian Federation [3 – 12] for the methods of regulation and intensification of matters combustion processes.

Some peculiarities of atomization, inflammation and combustion of organic fuel in electric fields

We have not discussed all the potential capabilities and advantages of the new electric combustion technology for different areas of technics. Let us demonstrate them in more details.

One of characters of the new electric combustion technology is **effects of oxidant ozonization, of electrostatic atomization and electrostatic injection of electrically charged particles of fuel and the oxidant that is followed by generation of the finest aerofuel opacity on a molecular level in a combustion chamber**. Naturally, such fine atomization of the fuel causes its easier evaporation, inflammation and combustion especially in the medium of the ozonized oxidant. **The mechanism of fuel electrostatic fragmentation is physically explained by Coulomb interaction of repulsion from each other of electrically likely charged fuel drops (particles) that is accompanied by their progressing fragmentation and corresponding decrease of their mass and electric charge**. As the experiments have shown the extent of the fuel drops (particles) fragmentation depends on initial electric potential of fuel charging and initial size of injected fuel drops (particles), which for their part depend on configuration and size of a fuel-injection nozzle as well as on pressure occurring in a fuel line of the heat machine.

Generated by dipolar high-voltage potentials catalyzing electric field can be introduced into the atomization zone or (and) the combustion zone of the combustion chamber of an engine. Its Coulomb forces accelerate motion of electrically charged particles of fuel and oxidant to an opposite electric potential, which is connected with, for example, a piston of an engine. Thus electric field acts as an electrostatic pump that allows decrease pressure in a fuel line as well as allows practically ideally atomize the fuel and mix it with the oxidant. Moreover, it lets simplify and improve the systems of injection and inflammation of the blended fuel in heat machines and devices, for example, in internal combustion engines or in boiler plants. Their application can cause additional improving of energetic and ecological characters of the combustion technologies. According to our information, such high-performance fuel-injection nozzles have yet been unknown in technics therefore they have not been applied in heat machines (injector internal combustion engine).

Is it possible to combust water? Water as a fuel!

More amazing experimental results were obtained at 40-80% dilution (emulsification) of liquid organic **fuel**, for example diesel oil, with **habitual water**. Summary energy as heat and light, which is generated in the process of such blend combustion, was not practically changed that can be explained by liberation of energy of chemical connections of water as well as of fuel. In the process of the experiments on combustion of the emulsion at first **it was transformed into the finest water vapor on the molecular level by means of capillary electroosmosis and of electrostatic atomization. Then dipolar water molecules, which had been electrified by field, were fragmented into hydrogen and oxygen, and then the hydrogen was effectively combusted in the medium of the ozonized oxygen.** Let us note that at this mechanism of water "evaporation" and of following splitting of water molecules into hydrogen and oxygen the electric field expends energy, and heat of organic fuel combustion just accelerates (catalyze) this process.

Editor: It is necessary to note that electric field can not expend energy. If there are no conduction currents then the field source does not decrease difference of potentials. Hence it can be concluded that effectiveness of such power systems is possible to be UNRESTRICTEDLY HIGH. The author writes about it below as about an "incomprehensible phenomenon".

The most amazing and incomprehensible fact is that the electric field transforms water into "vapor" and breaks the water molecule into hydrogen and oxygen practically **without any expenditure at minimum of energy consumption**. Electric power of the intensity high-voltage transformer, which is necessary for strong field generation, lies in the interval from several watts to tens of watts. As the experiments have demonstrated electric consumption of the high-voltage source practically is not changed at correct shunting of the flame by the electric field (i.e. through an air gap). Current consumption practically did not increase depending on mode of fuel atomization and its combustion (of flame height, of combustion intensiveness...).

There are only two conditions of effective work of static electric field as an electrostatic pump-atomizer of fuel and as a catalyst of blended fuel combustion. The first one is intensity of the field in the zone of fuel atomization and in the zone of flame combustion. The second one is enough emission of electrons into the blended fuel flow. In this mode Coulomb forces make work of electrostatic pressure generation and of electrostatic fragmentation of particles and molecules of fuel and water. The forces repulse likely charged drops of water. Heat motion of fuel radicals, which are combusted and fragmentized in the flame, impedes their chemical recompounding into water molecules in the zone of combustion. Moreover, it causes proceeding of a very physical chain reaction of hydrogen combustion in the flame.

Therefore additional light and heat energy, which is generated in the flame by combustion of hydrogen generated from water molecules that occurs in the ozonized oxygen, does not decrease summary energy of combustion of blend of fuel with water but increases it.

Thus using of electric and electromagnetic fields as the strongest catalysts of combustion of organic fuels and any matters clears great **prospects** of combustion technologies improving. Moreover it allows create ecologically appropriate heat machines and devices and 20-50% increase their effectiveness due to fuller transformation of chemical energy of inflammables into heat or light energy.

Ways of radical improvement of heat machines or about a new mechanism of transformation of heat energy into mechanical energy and into kinetic one

For clear realization of causes of extremely low output of modern heat machines that has generally lead the civilization to the ecological catastrophe it is necessary to understand their common principle of operation as well as a cause of heat energy non-effective using in them.

A mechanism of transformation of heat energy, which is generated by fuel combustion, is the same for all known heat machines. It consists in generation and transformation of superfluous pressure of a heated working body (i.e. gas, vapor etc.) into kinetic energy of a working element of the heat machine (i.e. a piston of an internal combustion engine, a turbine of an aviation engine, a reaction jet flowing out a rocket nozzle etc.) in special chambers of the machines.

It is also known that the higher the temperature of the heated working body, for example of a gas, the higher initial pressure in the working chamber of a heat machine. **Why output of heat machines is so low?** Any expert of thermal physics, thermodynamics, and heat machines can answer that efficiency (output) of heat energy transformation into mechanical one is defined by the second law of thermodynamics and is clearly illustrated by Carno heat cycle. According to these postulates, **output** of an ideal heat engine does not depend on a working matter and on the engine construction but is defined by temperatures of the working body in the starting point and in the final point of the cycle, i.e. by the temperatures of the heater and of the refrigerator of the **heat machine**. Real output of the heat machines is limited by heat stability of materials and by imperfection of engine constructions.

Nevertheless known thermodynamic processes and lows of heat motion of particles and molecules are significantly changed in strong electric fields and demonstrate new prospects for improving of heat machines.

A solution of the problem can be briefly formulated as: to increase output of heat machines it is necessary to use a new mechanism of redistribution of heat energy into energy of directed pressure of a compressed working body (i.e. gas, vapor, etc.) on the working element of the heat machine. At the minimal pressure it should be redistributed on sidewalls of the working chamber.

Can it be realized in practice? On the face of it the technical solution is unrealizable nevertheless it exists. It is possible to redistribute and to regulate heat motion

(pressure) of heated gas inside a closed reservoir and, hence, its temperature in a certain direction. To achieve this aim **it is necessary to introduce static electric field into the combustion chamber of a heat machine and to orient heat motion of electrically charged and dipolar molecules of expanding working bodies (i.e. gas, vapor) along force lines of the electric field by electric Coulomb forces**. Something similar occurs, for example, in liquid crystal cells of electronic timer, in Kerr cells (electric optic effect) at periodical application of electric field to them that causes dipolar molecules turn along a field vector as well as change of light penetrability of these matters.

There is a difference between this known in electrooptics phenomenon and our case. The difference lies in the fact that polarized gas molecules remain movable along force lines of the electric field in contrast to liquid crystals, which do not. This fact causes redistribution of parameters of heat energy (i.e. pressure, temperature, and heat penetrability) of dipolar molecules of heated gas just along force lines of the field. The more the intensity of the field at the initial temperature of the working body is the more the difference of pressures on the sidewalls of the chamber and on the working element, for example, on an engine piston.

Heat motion of polarized particles of heated gas can be decelerated by combination of three electric fields of constant sign in accordance with all three coordinate axes; hence it is possible to significantly and quickly decrease temperature and pressure of the gas. In this case the heat energy of the heated gas makes jump transformation into electromagnetic radiation.

Editor: Historically this method, i.e. plasma retention by electric field, was proposed by Oleg Lavrentiev in 1948. He had 7-grade education and served as a sergeant in Armed Forces in Sakhalin. After he sent Stalin a letter containing a phrase, as "I know a secret of hydrogen bomb creation" he was invited to Moscow to set his ideas out to academicians. His ideas were not lost nevertheless the scheme of plasma electrostatic retention was not applied ("Expert" magazine #23, 18 of July of 2001). In 1950 Sakharov and Tamm proposed a scheme of a toroidal magnetic thermonuclear reactor which has been developed until now. Why is it so? It is difficult, expansive and practically unreal…

Thus introduction of strong electric fields into heat machines allows significantly increase effectiveness of transformation of heat energy of a working body into mechanical and kinetic energy of working elements of the machines by means of directed regulation of temperature and pressure of heated gas, for example, in the starting point and in the final point of a working stroke of a piston. In other words it allows increase output of the machines.

APPLICATION AREA OF NEW ELECTRIC COMBUSTION TECHNOLOGY

Practical application of the new combustion and thermal technologies

The new technology is universal and applicable in practically all spheres of technics. Therefore we believe that further development and application of this new technology of fuel and waste products combustion is very important for radical improving of all the heat machines and of all thermal technologies. As the civilization uses hydrocarbon fuel and matters in its life circle then just this new technology can solve critical ecological and energetic problems of the civilization.

It is impossible to view in details all proposed perspective technical solutions based on this technology [1-25] within one article. Therefore we give only one striking example.

Environmentally appropriate engine for motor transport

Since the transport, which uses thermal internal combustion engine (ICE), is most harmful for the environment then let us discuss ways of their ecological and energy improving. Several years ago the author patented "method of intensification of ICE operation" [7]. The essence of the invention consists in introduction of controllable electric field into combustion chambers during the whole operation period of an engine by special monoelectrode spark-plugs (Fig.2).

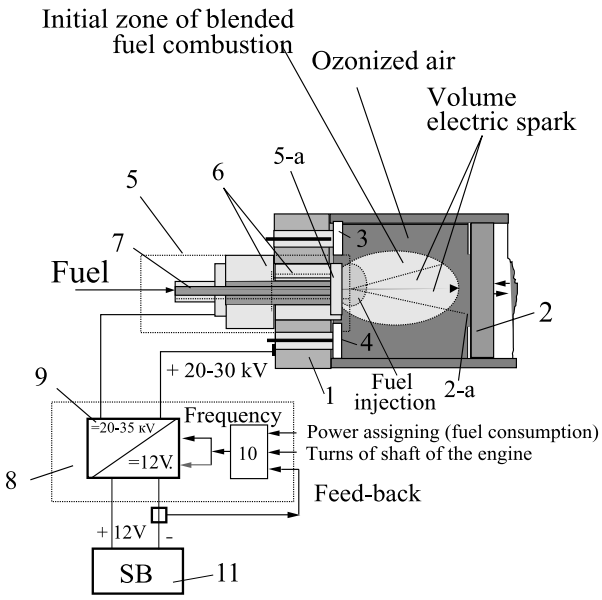

Fig.2a
Plan of an environmentally appropriate ICE (for transport)

1. – combustion chamber;
2. – piston, 2a –heat-resistant surface of the piston (zone of electric-spark discharge)
3. – admission valve (its canal is not indicated)
4. – exhaust valve (its canal is not indicated)
5. – combined mono-electrode spark-plug; 5a – fuel nozzle with hollow central electrode and end disk electrode
6. – electric insulator of the spark-plug – fuel nozzle
7. – fuel pump (for example, an electrostatic one)
8. – high-voltage regulable transformer (electric field source)
9. – force block of tension high-voltage transformer (=12V/25kV)
10. – system of regulation of electric field source (9)
11. – board current network =12V (SB is a storage battery of an automobile).

This structure chart briefly demonstrates basic components of a new ICE, where there is directed pressure of gases on a piston. In particular, many inventions of the author are realized in practice here, i.e. semi-digital spark-plug, electrostatic fuel nozzle (5), electrostatic fuel pump (7). A new mode of volume inflammation of blended fuel has been realized in practice, i.e. "a spark coming from a disk electrode (5-a) to a piston (2-a)". Since it is possible to regulate the electric field intensity generated by a high-voltage source of tension then an advance angle of blended fuel inflammation can be regulated, gases pressure on the piston at explosion stroke of ICE operation can be regulated as well.

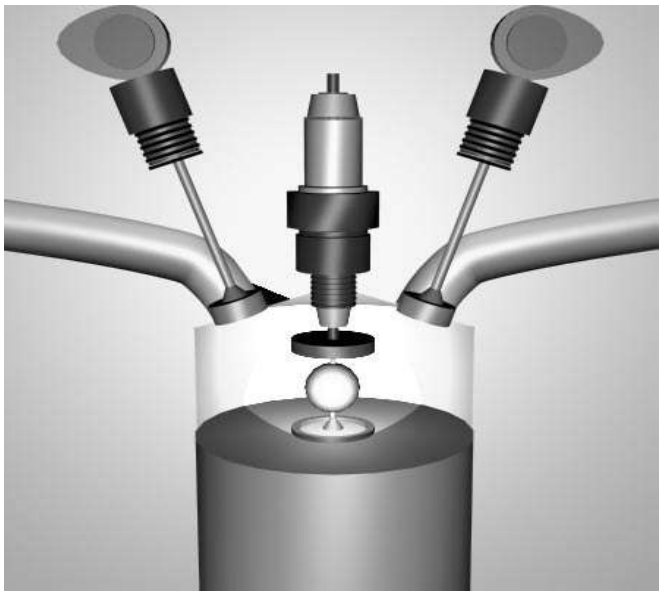

Fig.2b
Photo of a simplified construction of the new ICE

Fig.2b demonstrates simplified three-dimensional construction of the proposed energetically and ecologically perfect ICE. There are observable elements such as a combustion chamber, a piston, valves, a monoelectrode spark-plug, and an electrostatic fuel nozzle (in the centre on top), which is connected with the spark-plug. In the centre of the combustion chamber it can be seen volume inflammation of the blended fuel at spark appearance from end electrode to the piston.

As a result a summary positive effect of ecological, construction and energetic improving of ICE is achieved, i.e. effective cleaning of exhausted gases directly in the combustion chambers of the engine, significant simplification and perfection of a fuel injection system, improvement of system of distribution and electric inflammation of the blended fuel. In this engine a distributor (as well as its analogues) is removed at all since sparking and intensive inflammation of the blended fuel automatically appears between central electrode of the spark-plug and the piston which comes to the upper "dead" point. The central electrode of the spark-plug is constantly under high tension. The advance angle of ignition is regulated by change of the electric field intensity. Powerful multipoint ignition causes simultaneous intensive inflammation of the blended fuel that occurs throughout the whole chamber. The electric field as a powerful combustion catalyst intensifies the process of the blend combustion at the explosion stroke of the engine and at after-burning of waste gases directly in the combustion chambers at the following output stroke of the engine operation. Directed along the axis of the piston in the combustion chambers this electric field serves as a transformer of gases heat energy into mechanical energy of the thermal engine pistons. That is caused by the fact that the field orients heat motion of the expanding gases along the axis of the pistons in combustion chambers of the engine at explosion stroke of ICE just. It causes redistribution of heat energy and increase of the gases pressure on the very pistons that significantly improves effectiveness of transformation of heat energy of the fuel combustion into mechanical energy of the piston motion (theoretically the improvement is by two-three times), i.e. it two-three times increases output of a classical thermal engine making it come to 70-80%.

The electric field, which is introduced into the combustion chambers of an internal combustion engine, ensures significant economy of fuel (up to 30-40%) at saving of its working characteristics. It occurs due to fog electrostatic spray of fuel and to the fuel electrization as well as due to oxide ozonization. Moreover it occurs as a result of deep after-burning of hydrocarbon components of fuel, combusting blend and waste exhaust gases. This method allows effectively regulate temperature of the blend combustion in the chambers while required compression in cylinders is the same, for example, to minimize nitric oxide generation in the exhaust gases. As a result there is no necessity in external devices for cleaning of exhaust gases of internal combustion engines; ecological appropriateness improvement can be simultaneously achieved. Additional aerosol hydro-alkaline processing of these gases can allow totally clean **exhaust gases** of the transport, which operates on thermal engines.

Workability of such an environmentally appropriate engine in two-stroke and four-stroke variants is experimentally demonstrated. There are also experimentally shown decrease of all toxic components in exhaust gases, 20-30% increase of useful power of the engine, and simultaneous decrease of fuel consumption.

Thus practical application of the new electric combustion technology can exert revolutionary influence upon propulsion engineering development and upon increasing of ecological compatibility and effectiveness of the transport, which operates on thermal engines.

Diagram of operations of technology of effective using of refinery wastes in heat-and-power engineering

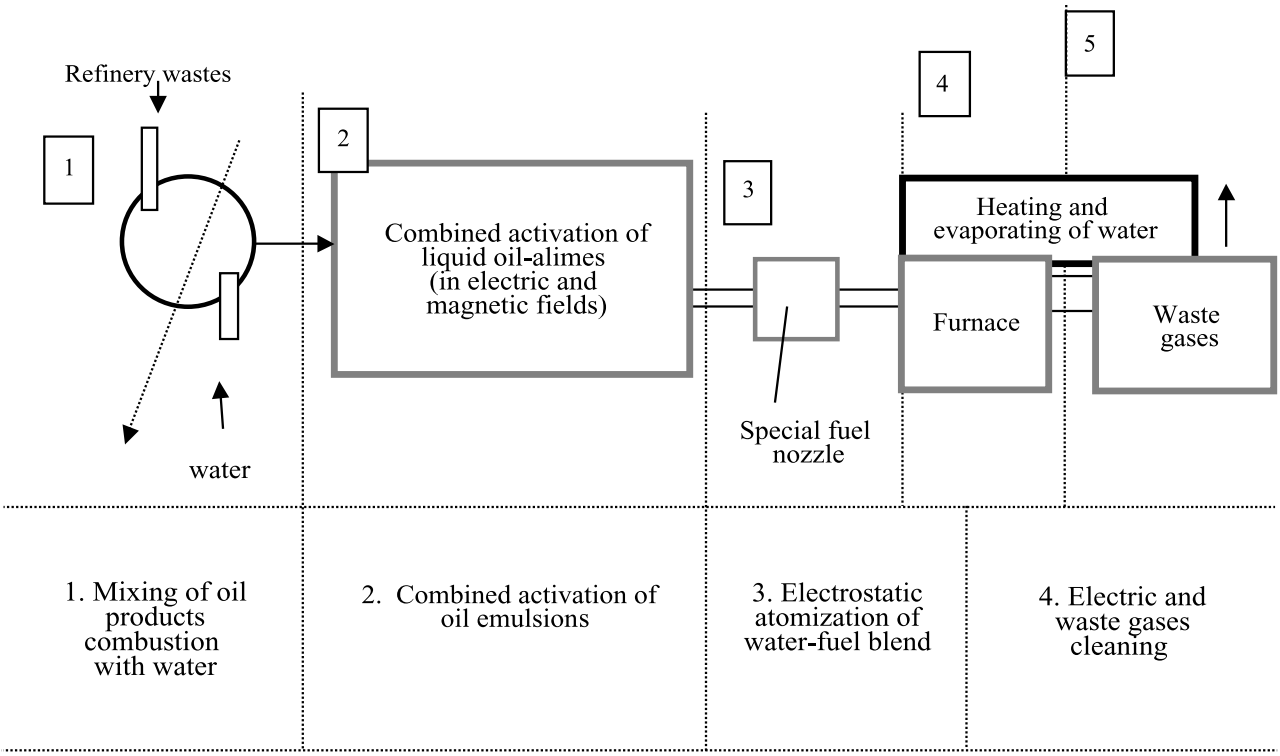

Fig.3

Technology of environmentally appropriate combustion of refinery wastes as fuel for boiler plants

The author has patented other technical solutions of improvement of different devices, which are based on these technologies. These solutions concerning boiler plants, gas turbine engines and jet engines and many other heat machines and devices allow increase their effectiveness and simultaneously significantly improve their ecological factors. As an example of application of this technology in heat-and-power engineering there is a diagram of operations of the technology of the environmentally appropriate combustion of refinery waste as a fuel for boiler plants (Fig.3). Unfortunately the limits of one article do not allow discuss these inventions in details nevertheless the author will realize it in practice in future works.

Conclusions:

1. The existent methods of solving of the ecological problems are ineffective as well as work of organizations, which deal with ecological and nature conservation activity. It is caused by the fact that they are oriented to search and remove consequences of ecological pollution of the nature instead of their causes.
2. The article demonstrates real causes of global ecological problems, which consist in imperfection of technologies of generation and transformation of energy.
3. Using of strong electric and electromagnetic fields of low power as combustion catalysts allow significantly improve ecological factors of combustion technologies and of devices, which realize the technologies in practice. In other words it allows realize in practice "clean combustion of fuels and wastes and possible existence of "clean" heat technics".
4. Application of electric and electromagnetic fields in the combustion technologies allows significantly increase effectiveness of transformation of chemical and heat energies of fuel into mechanical and electric energies.
5. The electric combustion technology allows realize in practice principally new ways to control combustion process as well as to control many thermal and kinetic processes (i.e. processes of pressure, heat conductance, temperature, etc.), i.e. allows increase output of heat machines.

6. The new electric combustion technology is a universal method of solving of ecological and energetic problems of the civilization and a universal way of radical improvement of technics (i.e. of the transport, boiler plants, oil-and-gas processing plants, combustion wastes recycling plants, etc.).

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New Effect of "Cold" Evaporation and Dissociation of Liquids Based on Capillar Electroosmosis

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There is discovered new electric physical effect of intensive "cold" evaporation and dissociation of liquids and aqueous solutions into fuel gases **without any energy consumption** due to high-voltage capillar electroosmosis [1].

Prospects and problems of hydrogen engineering

Effective obtaining of hydrogen from water is a long-standing tempting dream of the civilization. That is connected with the fact that there is a huge amount of water on the planet, and hydrogen engineering promises the possibility to obtain unlimited quantity of "free" energy obtained from water. All the more, the very process of hydrogen combustion in oxygen medium, which is obtained from water as well, ensures ideal high-calorie and environmentally appropriate combustion.

Ecological and energetic problems are very actual nevertheless they have not been effectively solved. All known methods and devices of production of hydrogen and other fuel gases are ineffective since there is no a real high-performance technology of evaporation and splitting of liquid molecules. The main cause of ineffectiveness of the analogous consists in their difficulty and in energy consumption for breaking of intermolecular connections at dissociation of water liquid fractions.

Physical-chemical structure of even habitual tap water is quite complicated since there are numerous intermolecular connections, chains and other molecular structures in water. In particular, in habitual tap water there are different chains of oriented water molecules, which are peculiarly connected with admixture ions (cluster formations), its various colloidal compounds and isotopes, mineral matters as well as various dissolved gases and admixtures.

It is a paradox but in the living nature there is a long-standing effective way of electric capillar delivery and "cold" evaporation of liquid, which allows transform it into gaseous state without heat energy and electric energy supply line. This natural effect is realized in practice by plants, which deliver aqueous solution and make its "cold" evaporation by capillar electroosmosis. It is quite comprehensible that this natural energetically perfect technology is applicable in methods of liquids transformation into fuel gases. The author of this article has designed such experimental devices of cold electric capillar evaporation of liquids according to electric pumps of trees (Fig.1-3).

The simplest operating device, which experimentally realizes in practice the effect of high-voltage capillar electroosmosis of the "cold" evaporation and dissociation of water molecules, is demonstrated in Fig.1.

New Electroosmotic Capillar Method of Obtaining of Fuel Gas from Water

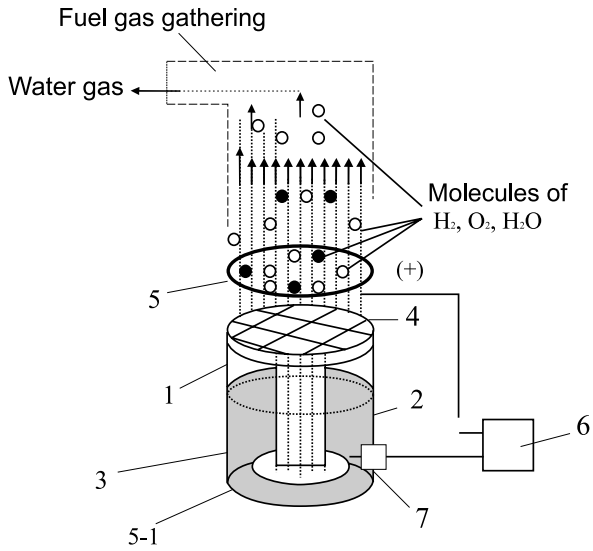

Fig.1
Simplest device of capillar electroosmosis of liquids

First experiments on the electric capillar dissociation of liquids were made with using of habitual water as well as its solutions and water-fuel emulsions of various concentrations as liquids. In all these cases fuel gases were successfully obtained in spite of the fact that these gases greatly varied due to their composition and heat capacity. The experiments on the electroosmotic evaporation and dissociation of liquids are realized in practice by the following way. First a wick (3) and a porous evaporator (4) are moisten with a water-fuel blend (emulsion) (2) then the blend (2) is poured into a reservoir (1). Then a high-voltage source of tension (6) is switched on and high-voltage difference of potentials (about 20 kV) is supplied to the liquid at some distance from the capillaries (i.e. from the wick (3) and the evaporator (4)). The source of electric field is joined to the device by electrodes (5-1) and (5). A plate perforated electrode (5) is placed above the evaporator (4) surface at a distance, which is enough to prevent an electric breakdown between the electrodes (5) and (5-1). Electrostatic forces of longitudinal electric field acts on the liquid. As a result dipolar polarized molecules of the liquid move along capillaries of the wick (3) and evaporator (4) from the reservoir to an opposite electric potential of the electrode (5) (i.e. electroosmosis occurred). Liquid molecules are detached from the evaporator (4) surface by these forces and transformed into a visual fog, i.e. the liquid is transformed into another aggregative state at minimal energy consumption of the electric field source (6). After that they provide electroosmotic elevation of this liquid. In the process of detaching and collision of evaporated liquid molecules with molecules of air and ozone as well as with electrons there is occurring partial dissociation between the evaporator (4) and the upper electrode (5) in an ionization zone. At the process a fuel gas is produced, which can come thorough a gas collector (7), for example, into combustion chambers of motor transport engine.

It has been experimentally shown that change of intensiveness of process of evaporation and dissociation of vapor molecules depends on change of distance from the electrode (5) to the evaporator (4). Moreover, this dependence is conditioned by the following factors, viz by changing of the evaporator area, kind of the liquid,

quality of capillar material of the wick (3) and the evaporator (4), parameters of the electric field as well as the source of intensity (of power) (6).

The author's first experiments on this simplest device, which were organized in 1986, demonstrated that "cold" water fog (i.e. gas) appears in capillaries from liquid (i.e. water) at high-voltage electroosmosis without any observable energy consumption but just using potential energy of the electric field. This conclusion is evident since in the process of experimenting consumed electric current of the field source was the same and equal to the consumed current of the source idling. This current was not changed depending on the appearance of the liquid evaporation.

The experiments demonstrated that capillar electroosmosis evaporated quite significant quantity of water (1 liter) without any energy consumption for 10 minutes at a 10-centimeter-diameter capillar cylinder. That is to say that the consumed electric power (10 Watts) of the electric current source, i.e. of the tension high-voltage transformer (20 kV), was unchangeable and did not depend on mode of its operation. It has been experimentally stated that the whole consumed energy supplied by the current network is insignificantly small comparably with the energy of liquid evaporation. It can be explained by the fact that power was consumed only to generate the electric field and did not increase at liquid capillar evaporation that occurred due to work of an ionic pump and of a polarized pump. Hence the effect of cold electric-capillar evaporation of liquid is very economical in respect to the process energy consumption.

In spite of the fact that energetic essence of this process has not been disclosed it is evident that both "cold evaporation" and water dissociation are realized in practice by potential energy of the electric field. More precisely, the visual process of evaporation and water splitting into H_2 and O_2 at the capillar electroosmosis is realized by powerful Coulomb forces of this strong electric field.

Editor: It is not the most surprising fact. The most astonishment is aroused by school-day stereotypes that work of a field at a closed cycle is equal to zero. These stereotypes have been kept in mind of people for a long period of time. Everybody understands that a field can do work but if a body falling from some height is accelerated in a potential field and its kinetic energy increases then it requires energy consumption to relevate the body up to this height. Nevertheless, the analogy of a gravitation field with an electric one is not one-valued since the electric field may be generated only at a part of trajectory of the accelerated body motion. An electric field can be pulsating, it can be screened or it is possible to change its direction at the reverse part of the trajectory in such a way that the field constantly accelerates the body. Hence a principal conclusion can be made: summary work of a potential field may not be equal to zero. This conclusion has earlier been proposed by A.V. Frolov in his article published in the USA (Newsletter of the Institute for New Energy. May 1994. p. 1-4).

In principle this uncommon electroosmotic pump-evaporator-splitter is an example of the perpetual motion machine of the second type. Thus the high-voltage capillar electroosmosis of aqueous liquid provides really intensive and energetically free evaporation and splitting of water molecules into the fuel gas (H_2, O_2, H_2O) by means of using of potential energy of the electric field.

To produce more complete dissociation of water molecules into the fuel gas it is necessary to make the whole water molecules collide each other and be split into molecules of H_2 and O_2 in an additional transversal alternating field (Fig.2).

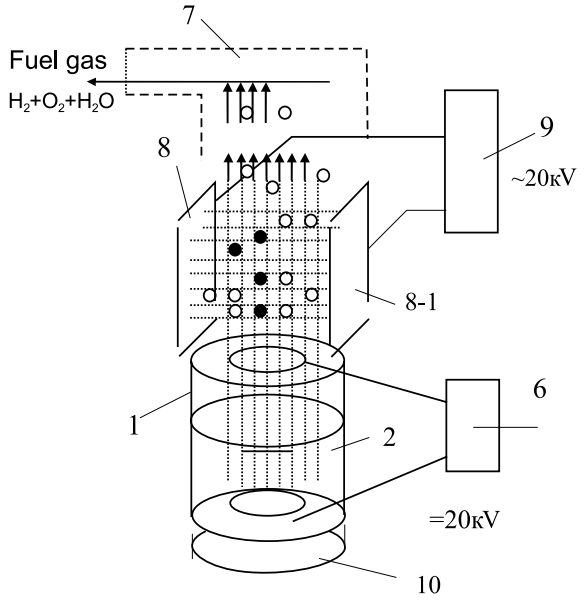

Fig.2

Device for production of fuel gas by electroosmosis. The device is equipped with an additional high - voltage splitting center of liquid molecules by electric alternating field.

At the second stage of water dissociation the energy of the second electric field is used, more precisely, powerful electrostatic forces are used to intensify oscillation resonant process of "collision-repulsion" of electrified water molecules represented as water gas. The result of this process is complete breaking of liquid molecules and generation of fuel gas molecules.

Conditions of optimal dissociation vary due to a kind of the liquid, to capillaries properties, and to the field parameters. These conditions are caused by required productivity of the process of dissociation of concrete liquid. Fig.2 demonstrates in details functional structure and composition of the device equipped with two sources of the electric field.

In the case of preliminary division of initially chemically neutral water into chemically active fractions (i.e. acid fraction and alkaline fraction) realization of the technology of production of fuel gas from water becomes possible at temperature below zero (up to –30°C). In winter it is quite important and useful for motor transport. This "fractional" electrically activated water does not freeze at degree of frost; hence the device designed for hydrogen production from such activated water can operate at environment temperature below zero and at degree of frost.

This principle of additional chemical activation of water (or liquid) is realized in practice in the device

(Fig.3). In contrast to the devices mentioned above (see Fig.1, 2) this device is supplied with an electrochemical activator of liquid (3) with evaporators (4).

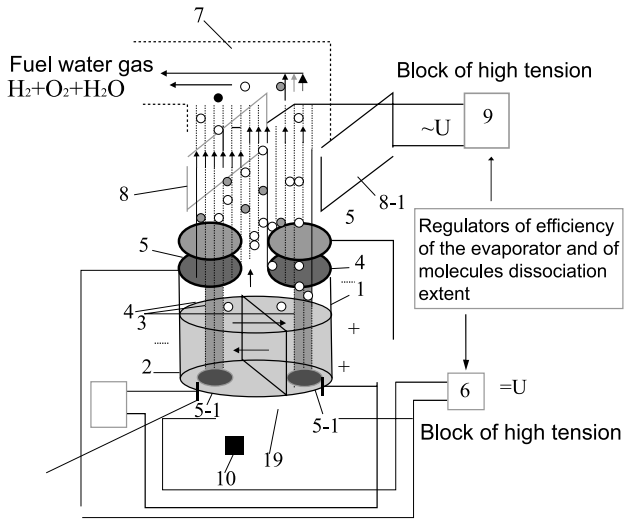

Fig.3

Hybrid device equipped with two sources of electric field and liquid electric activator

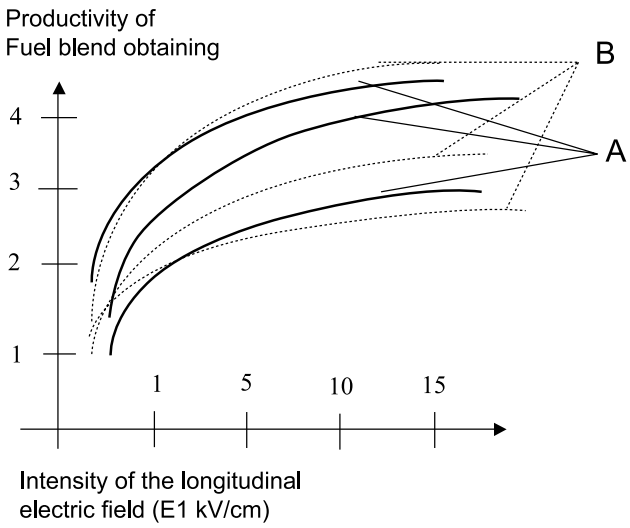

Fig.4

Productivity of the method increases as well as oscillation frequency of the second transversal electric field (A) and evaporating area (B) increase.

There is a known and low-expenditure progressive electric technology by Stanly Mayer, which has been worked out to obtain fuel gas from water (Mayer cells). Our technology is more progressive and ensures higher productivity than Stanly Mayer's technology does [3]. It can be explained by the fact that this electroosmotic effect of evaporation and liquid dissociation combined with a mechanism of the electrostatic pump and the ionic pump ensures intensive evaporation and dissociation of liquid as well as effective detachment of gas molecules from the dissociation zone. The process of gas molecules detachment is accompanied by acceleration from the upper end of the capillaries. Therefore in our case the effect of screening of the working zone of molecules electric dissociation is not produced. All these processes proceed at minimal energy consumption, which is similar to analogous energy consumption. Moreover, the process of fuel gas production does not slow down as the process in Mayer's technology does therefore gas productivity of our method is significantly higher than that of this progressive analogue at similar minimal energy consumption.

Some technical and economical aspects of the new technology realization

In the near future production run of these high-effective electroosmotic generators of fuel gas from practically any liquids (including tap water), which are based on the proposed new technology, can be established. At the first familiarization level it is especially easy and economically appropriate to realize in practice a variant of the device of transformation of water-fuel emulsion into fuel gas. A prime cost of the production-run device for generation of fuel gas from water of 1000 m^3/hour productivity comes to approximately 1 thousand of US dollars. Consumed power of such an electric generator should come to no more than 50-100 Watts. Therefore such compact and effective fuel electrolyzers can operate practically in any motor car. As a result heat engines can work on any hydrocarbon liquid or even on habitual water. Mass application of these devices for the motor transport can cause immediate energetic and ecological perfection of the motor transport as well as designing of an environmentally appropriate and economical heat engine. Approximate financial expenditures for working out and designing of the device for fuel gas obtaining from water, and for bringing the investigation of the first testing device of 100 m^3/sec productivity to an experimental-industrial model come to about 450-500 thousands of US dollars. That contains the expenditures for projecting and investigation, for designing of the very experimental device and of a testing bed, which is necessary for approbation and engineering development of the device. The author is interested in business and creative cooperation with those companies, which can provide this project with investments to bring the device to the experimental-industrial model and introduce the perspective technology into practice.

Conclusion

Electroosmotic "cold" evaporation and dissociation of water and aqueous solutions through capillaries is a perspective way of highly productive fuel gas production at minimum of energy consumption.

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Conceptual Hurdles to New Millennium Physics

Donald Reed

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Abstract

Time, space, energy and mass form the four-fold conceptual basis for gauging physical reality. The following paper, as a follow-up to a previous exposition [1] which focused on the necessity to change the current paradigm for time, continues in this same vein, but will also consider in greater depth the interrelations of this phenomenon with the other three yardsticks cited above. Again, information garnered from a wide variety of sources will be considered. We hope to provide, through just such a unique eclectic format, the beginnings of a possible fresh understanding of the workings of nature and perhaps ultimately furnish a conceptual basis for extending the structure of current physical theory to compatibly encompass the elements of a unified framework of physics and metaphysics.

Introduction

In the former article cited above, by investigating the following varied sources and research [2-17], we came to the inescapable conclusion that the phenomena of time and space are considerably more intimately related than is currently suspected by modern science, and will require a drastic re-working to fit the conclusions of the various evidence cited. Towards this end, the adoption of a more expansive paradigm for these yardsticks was suggested, which incorporates a fluid-field nature for time and space where both are derivatives of the fundamental ground-form of energy in flux or oscillation. These new approaches involve the inclusion of a Kozyrev-type of "substantial"(active) time-flow as opposed to the conventional "relational"(passive) concept of time, where it is used as a static parameter signifying duration. The substantial aspect of time pre-supposes that it is an essence which can and does affect physical processes, and that those same physical systems can cause a reverse action on time [8]. Such active fluctuating (deformable) types of time or space, implies the establishment of a revolutionary notion: positing completely *non-scalable* metrics for both time and space. This is in direct contrast to all contemporary orthodox models for physical reality, either in Einsteinean relativity (Special or General theory), quantum field theory, or even superstring/supersymmetric theory, all of which continue to consider both of these yardsticks from their relational (length or durational) standpoints. Consequently, all these formalisms require scalable metrics of some sort for their proper description (for refreshing viewpoints on this matter, see [7]). For instance, in the standard equations of quantum theory, time is regarded merely as an unchangeable static parameter. When we later consider applying these novel substantial aspects of time to the edifice of quantum theory, we will see that time must then become a "hidden variable". It will be seen that by considering time in this manner, a clearer and more tractable explanation of the inevitable probabilistic aspects of quantum theory, evidenced in the signature Uncertainty Principle, complementarity and non-locality will arise, without having to invoke the counter-productive and ill-conceived Copenhagen Interpretation.

Oscillatory Models for Time and Space

Upon accepting non-scalable metrics for time and space, we observe that a similar field nature for **energy** and **mass** must in turn also be postulated. Moreover, from the Killick description of how (sub-atomic) tachion-pairs operate [6], shuttling their energy back-and-forth in a free-wheeling but purposeful manner and creating oscillatory features of time and space by their action, we should consider the possibility of another unprecedented concept: a "value-motivated" energy might be at the foundation of the structural integrity of physical matter. This is conceivable when considering Killick's description of the tachion-pair dynamic/evolutionary cycle as necessarily including the 3-step process of observation – reflection – action (**trinitivity** of motion). Along the same lines, from the Smith book **The New Science** [5], we learn that a so-called "tempic field" energy exists, which could be described as the parent structure out of which our standard conception of "clock-time" (entropy changes) results. The tempic field is essentially a scalar (but not static) function which has vectorial nature only in terms of its distribution or *gradient* in space. Because of the nature of the tempic field, its derivatives – the electric and magnetic fields can operate on each other in a specific geometric/topological manner, to produce a local change in the *time-frame* of matter, to use a term coined by the entity Kryon [4]. This theoretical description of the alteration of inertial/gravitational mass and time-frame has possibly seen recent actual demonstration in the dramatic experiments of John Hutchison [10] and Rudolf Zinsser's "kinetobaric" effect [11], as well as unpublished research of both Wilbert Smith and Ken Killick with electric caduceus-wound coils [5,6].

New Models for Relativistic-Fluidic Vacuum-Structure and Possibility of its Manipulation

All of this evidence allows us to conclude that measurable changes in relativistic parameters of time, space, mass and energy might not only be a feature accompanying rapid uniform movement of physical objects (Special Relativity), or representative of large gravitating astrophysical objects (General Relativity). Indeed, by relying on current limited paradigms, contemporary physics may have missed ascertaining the possibility of being able to alter these same relativistic parameters by the artificial technological manipulation of the tempic (vacuum) fields of sub-atomic particles in stationary matter, by use of specific electromagnetic fields. Tom Bearden, for one, has articulated on these various "futuristic"-type technologies in his many writings over the years [15]. We have recently seen that some of the novel theoretical conceptions of the more visionary physicists such as David Hestenes on the zitterbewegung (vacuum "jitter") phenomenon exhibited by the electron [12-14], has finally caught up with some of these advanced ideas by presenting new mathematical demonstrations (using geometric Clifford-algebraic) manipulations of the Dirac equation. In summary, the Hestenes' study concludes that the Dirac wave function and its properties, including

the Dirac equation and relations to physical observables such as energy-momentum, spin and position probability current, all possess heretofore obscured important geometric relations. These results imply that probabilistic features of the quantum theory of the electron/positron arise principally from the electromagnetic interaction of the accompanying zitterbewegung-spin field of these particles with the ambient dynamic vacuum. This is, of course, in direct contrast to the conventional received view that ascribes wave-particle duality as a property of matter that is completely independent of the nature of its interactions. This revolutionary geometric interpretation of electron dynamics incorporates in its model an electron spin which arises from a helical or spiral world-line in space-time. The essential unprecedented feature of the Hestenes' zitterbewegung idea is the association of the spin with the local circulatory-helical motion characterized by the *phase* of the electron wave function. Thus, we reach the conclusion that the complex phase factor of the electron wave function can be directly associated with an objective helical motion of the electron which is, in turn, a derivative of the zitterbewegung. One intriguing feature of this structure is a frequency of oscillation that is inversely proportional to the scalar radius of curvature of the particles' helical world-line. Moreover, the Clifford-algebraic analysis reveals that this oscillation frequency is identical to electron/positron *mass*, revealing a possible key variable particle mass-energy (*frequency measure*), which is in inverse relationship to particle size. It is clear that this new model has important classical implications not yet considered by established physics which nevertheless directly correspond to some of the key features of sub-atomic behavior enumerated above and previously. Here, we refer to the tachion-pair dynamics [1,6], and also to the microscopic dynamics of elementary particles revealed by the selected esoteric sources previously considered [1-5].

Another researcher who echoes many of these conclusions is C. Sano [21]. Sano built on the work of A.P. Smirnov [22] who postulated that Newton's Third Law of action/reaction actually modeled "screw" structures, implying that elementary particles (specifically electrons/positrons) possess chiral-spiral field configurations. Accordingly, Sano posited that all actions/reactions are transmitted between actors and reactors by parallel or perpendicular clutching of the rotating chains of electromagnetic spirals of the hidden electrons and positron-pairs of the vacuum. Also, similar to the Hestenes' development cited above, Sano postulated that the radius of the outer electromagnetic spiral surrounding the electron/positron pair can change, oscillating in size around either particle, and thus producing the particles' electric or magnetic character. Supporting his theory, Sano cites the key research of I.M. Shakhporanov [23] whose experiments claimed that magnetic monopoles were generated, by employing an electrical circuit based upon Moebius band topology. Some of the unusual phenomena demonstrated by this apparatus, tending to support the magnetic monopole hypothesis, was transformation of diamagnetic substances into paramagnetic, the ferromagnetization of normally non-magnetizable materials (graphite, etc.), acceleration of chemical reactions, acceleration or deceleration of the decay of radioactive materials, etc. Sano also claimed that extraction of energy from the vacuum was possible using rotational action/reaction using magnetic monopoles.

Referencing this research to the current exposition, we recall that the key element of Killick's hypothetical tachion-pair operation was the similar non-linear/non-orientable Moebius-type dynamic cycle which results in the corresponding deformation (compression or rarefaction) of time/space/energy parameters [1,6]. In this regard, the remarkable similarity of this model to the research of Sano and Shakhporanov may be much more than mere coincidence. In fact, later we shall examine new research outlining an apparatus (yet untested), which claims to overcome the Coulomb barrier in low energy nuclear reactions (LENR), and achieves nuclear fusion by producing local time-dilation of soft photons in proximity of the deuteron reactants.

Additional Key Russian Research

To motivate the reader's sensibilities towards consideration of some of these unorthodox ideas, we defer to the previous article [1] in which many of these notions and mentioned research are explored in greater depth, as well as consider the following corroborative research.

One intriguing example of such experiments is the work of V. Chernobrov, from which he has claimed to demonstrate both acceleration and deceleration of local time-rate, within a small spherical enclosed volume conducted since 1988 [18]. The experimental system to produce these effects, was a set of electromagnets, connected in series and parallel and installed inside the globe-shaped surface in several layers. In various arrangements including up to 3 to 5 of such layers, these electromagnetic working surfaces (EWS) of various diameters were installed inside each other (similar to the Russian toy doll "matrioshka") with the maximum EWS diameter was about 1 meter, and the minimum (internal) diameter of 115 mm. With this configuration, Chernobrov claimed to measure small but detectable deceleration (-30 sec/hr.) and acceleration (+30 sec/hr.) of time within the sphere to time monitored outside its field of influence. One interesting difference was noted between the slowing down vs. the speeding up of time. The deceleration occurred considerably more smoothly and steadily whereas with acceleration, sharp discontinuous jumps were observed. These instabilities accompanying time-acceleration was observed in connection with cycles of the moon, diurnal fluctuations, and also operator presence. Chernobrov also noticed another phenomenon that also was reported in connection with the alleged legendary Philadelphia experiment, where matter in different time-frames apparently exhibited strange relative optical phenomena [see 1,4]. Specifically, the human eye in the time-frame exterior to the experiment perceives matter within the time-frame created by the apparatus as either transparent or surrounded by a vague white mist. We note with interest that transparent "shimmering" effects of substances in the target area were also occasionally a feature of Hutchison effect [10].

Academician A. Chernetsky produced what he termed a self-generating discharge (SGD) in a plasma that exhibited longitudinal energy density waves from a

structured vacuum. Some unusual effects noted were over-unity energy generation (C.O.P. > 1), as well as change of the electrical conductivity of matter (reduction of the resistance of resistor) placed between the capacitor plates of the SGD. A local structured vacuum was definitely produced since the resistance value remained unchanged even when the generator was turned off. Here reference must be made to the Kozyrev experiments [1,8], in which a type of similar *memory* process was activated ostensibly within the vacuum. Specifically, it turned out that in experiments with a vibrating torsion balance (or pendulum), at points of support the emerging additional forces did not disappear when the irreversible process (vibration) was stopped, but remained in the system for an appreciable time. The SGD plasma device may have also produced a detectable change in local time-flow rate as evidenced by decrease in frequency of a quartz oscillator placed in the discharge of the generator. The Chernetsky generator thus possibly caused anomalies in time-rate at a local space position. There were also basically anecdotal phenomena where psychic ability of personnel in proximity to the SGD was apparently enhanced [19]. The latter effects are not inconceivable once the intimate connection of consciousness to space and time is ascertained, from consideration of not only hypothetical "value-motivated" tachion-pair dynamics, but from the more prosaic studies as we shall see next.

Pathological Studies in Time-Perception

We can motivate further understanding for the claimed intimate connection of time to space by considering the results of a recent study of patients possessing a disjointed sense of time by Metod Saniga of the Slovak Academy of Sciences [20]. Saniga discovered the brain is hard-wired to perceive space and time as interconnected. Specifically, time pathology is apparently always accompanied by space pathology, in a sense that space either loses dimensions or acquires other dimensions. To quote Saniga "When time seems to stop, people often feel as if space becomes 2-dimensional. On the other hand, when the subject feels they perceive the past, present and future all at once, they simultaneously have the impression that space has infinite dimensions". This phenomenon is apparently not culturally endemic since Saniga illustrates that both pathologies cross cultural lines, evidencing similar studies cited from Italian, German and English psychological journals. In his report, Saniga combined mathematical models ("pencil-conics") and pathology reports of schizophrenic, drug-induced and other abnormal perceptions of time. His current work also encompasses studies of near-death experiences. He found that most of those who claim to have allegedly crossed over to the "other side" and back, tell similar tales. For that brief moment of near-death, the universal subjective experience of all individuals in this state of consciousness is that time loses its meaning. Although such evidence can at best be considered as anecdotal, since subjective conscious experience transcends the possibility of scientific proof, nevertheless perhaps these results from pathological and near-death studies also give us a hint towards new conceptions of time and space that necessitate both phenomena to be inextricably linked.

Investigation of the Possible Internal Properties of Time

One inescapable conclusion that results from all the above varied studies, either scientifically or psychologically based, and which cries out for future experimental verification, is the possible existence of an internal structure for time. Such a structure also implies the necessity for constructing a new edifice for physical reality that incorporates non-scalable metrics for the four fundamental yardsticks. We shall first investigate supporting evidence for internal time structure and subsequently the various implications of space, time, energy or mass that is non-scalable.

First, accepting an internal time structure, we are led to conclude that in quantum theory, time must then attain "hidden variable" status. One recent study that brilliantly articulates this notion, is the thought-provoking paper by X. Chen [24]. By positing 3 time variables as quantum hidden variables, Chen derives the Dirac equation classically. Moreover, he demonstrates that the non-intuitive property of "spin" of an electron or positron , arises naturally as a topological property of 3-dimensional time + 3-dimensional space. By extrapolating from this model, Chen then concludes that the inherent probabilistic aspects of quantum theory itself, as evidenced in wave-particle duality, Uncertainty Principle, quantum non-locality ("entangled" particles), etc., can be interpreted as the behavior of a single particle in 3 + 3 time-space. Chen postulates that the three dimensions of time geometrically form a "time sphere", with a generic point on the sphere possessing the following 3 coordinates: time radius, and two "time angles". The mathematical formalism arising from the process of stereographic projection from the north pole of this sphere, having radius of one-half, to any point on the spherical surface, incorporates both the positive-energy (north hemisphere) and negative-energy (south hemisphere) solutions to the Dirac equation (see Fig. 1 for clarification; note Z is a four-component spinor wave function). Also, by considering the evolution of a single particle, from the standpoint of this model of internal time-space, we can derive a picture of different paths on the time sphere of different weights, and on each path causality is satisfied. Through this process, Chen derives a purely classical explanation of the originally quantum-mechanically canonized Feynman Path Integral concept. This result emerges since each path from the time-sphere center to the surface corresponds to each Feynman path, and the surface of the sphere corresponds to the "surface" of the wave function. Chen also classically explains the processes inherent to Bose-Einstein-condensation (BEC) and superconductivity with this model. In such phenomena, two particles with the same spatial coordinates, cannot possess the same time angle, and thus will not have any interaction with each other and occupy the same quantum state as evidenced in BEC and superconductivity. Finally, Chen's solutions of the Dirac equation for a free particle correspond to Hopf bundles in monopole theory, and each Hopf fiber corresponds to each plane wave with different momentum states. This picture corresponds to wave packet diffusion in quantum theory. When a particle is in a fixed momentum state, each space point can contain only one Hopf bundle (one time angle), and various different time angles will be distributed in the whole

space but with the same Hopf bundle. Consequently, that particle can be found everywhere. This picture appears to describe the Uncertainty Principle classically using 3 + 3 dimensional time-space. Along similar lines R. Kiehn [25] has also recently underscored the important but overlooked classical connection between spinors, minimal surfaces and the Hopf map.

Recently, Chen's work has been further developed by H. Kitada [26] who, by introducing both 3-dimensional time and energy operators, sheds new classical light on the uncertainty relation that holds between these two parameters as well. Moreover, Chen is not the only reseracher to derive the Dirac equation classically. R.A. Close has published a paper which presents a classical mathematical description of circularly-polarized waves in 3-dimensions [27]. It turns out that these chiral space waves are satisfied by a four-component wave function which satisfies a Dirac equation. Furthermore, much like the Hestenes' zitterbewegung interpretation of quantum theory, the term normally associated with electron mass in the Close equation, introduces a rotation or oscillation frequency of the propagation direction.

Classical models for nuclear processes have also recently been proposed which incidentally also imply internal time structure. Notable among these, C. Cagle claims to have developed a fusion energy device employing LENR based upon such a classical theory [28]. Normally, Deuterium nuclei are diffuse in momentum space (having high relative velocities). The process Cagle outlines produces a compactification of their momentum space (low relative velocities), so that the deuterons develop a common de Broglie wavelength that is greater than or equal to the inter-particle distance. This is claimed to be accomplished by passing soft x-ray photons near the region of two deuterons in a lattice structure of Lithium Deuteride. **The soft x-ray, when absorbed , produces a region of total *time-dilation*, causing two effects: first, ionization of atoms by strongly repelling any associated electrons in the area, and secondly and most importantly, the physical extent of the time-dilation causes two adjacent normally repelling Deuterium nuclei to overlap in a common momentum space; that is, their relative velocities achieve very low values.** Consequently, due to the time dilation, for a very short time their common de Broglie wavelength exceeds their inter-particle distance. Thus, they become strongly attractive and undergo nuclear fusion.

Cagle also claims to clarify misconceptions about the fusion process in a thermonuclear bomb. He maintains that it is not due to extreme kinetic energies (high temperatures) of particles as supposed in current paradigms, but due to nuclear processes caused by absorption of a time-dilated soft photon flux, produced by Compton scattering of hard x-rays from a fission igniter, passing through a foil of depleted Uranium. Again, just like the controlled nuclear fusion process, this causes overlapping of deuterons in momentum space (low kinetic energies) for a few pico seconds, and subsequent fusion with normal exothermal processes ensuing.

Furthermore, as a fundamental component of his LENR fusion device, which ostensibly produces time dilation and controls energy production from the fusion process, Cagle incorporates a topological field structure termed an electromagnetotoroid. The toroidal field current oscillates between toroidal and poloidal modes in a dynamic cycle which is amazingly virtually identical to Killick's description of the oscillation dynamics of a single unit toroidal tachion [1,6](also see Cagle's website for animated simulation).

Regarding dynamics of astrophysical structures, Cagle further claims that the stellar jet core star of HH30 is also a gigantic electromagnetotoroid. During the poloidal current mode, vast quantities of matter are produced and ejected along the poloidal axis when the mode changes from poloidal to toroidal. This leads one to consider the possibility that the source of superluminal gamma ray bursters, which have heretofore mystified astrophysicists and defied explanation in terms of current paradigms, might be the result of large- scale abrupt changes in the time-frame of celestial vacuum regions, subsequently causing a boost in light velocity.

Implications of Non-scalable Metrics

When postulating fluid-field natures for the four yardsticks of physical reality: time, space, energy and mass, we must assume the existence of a *non-scalable* metric for our vacuum structure. Such a non-scalable vacuum, absent of a defined reference frame, must of necessity possess a *dual* nature. That is, the primary feature of a dual vacuum structure implies that infinitely small quantities must be treated on an equal footing with those that are infinitely large. In other words, information encoded into infinitesimal elements, is also instantly present in the unbounded infinite extents as well. This is tantamount to the existence of a holographic information encoding and transmitting vacuum field, which would structure events in space and time as a non-Markovian chain. In a non-Markovian chain of events, the prediction about the next link in the chain, requires a knowledge of **all** links, not just the one preceding it.

Metod Saniga's research into mystical perceptions of superconscious reality appears to support such a primordial non-Markovian holographic mapping of time and space. To quote from a transcript of such a vision: "I wake up in a whole different world…a different space…This space was distinct from the one we all know. It had different dimensions, everything contained everything else. One was situated in a state of being in which the 'will be' (future) and the 'vanishing' (past) were already included, and this being was my consciousness. It contained it all. The 'being contained' was present very vividly in a geometric way in the form of circles of different sizes which again were all part of a unity since all of the circles formed exactly one circle. The biggest circle was a part of the smallest and vice versa."[20].

Such a structure of time and space can best be topologically encoded in a non-orientable structure such as the Moebius band or Klein bottle. Similar to the data presented in the above mystical revelations and in the previously treated Killick tachion-pair dynamics [1,5], in such configurations "inside" and "outside" lose their meanings and meld into one another; ordinary dichotomic relations distinguishing thesis from antithesis are sublated and supplanted by a higher unity defining the evolutionary process of the system. In the

mathematical edifice abstracted from such a vacuum structure, duality rather than exclusivity of field structures holds sway. This in turn, presupposes a static-dynamic triality of fundamental field structures, characterized by the three magnitudes: zero, infinity and the mediating factor of unity, the latter being an indication that each of the other two field extremes are in perfect balance. Accordingly, we will assume that the stability (coherency) of non-scalable fields results whenever more than half their reality is in common.

Further development pertaining to a specific algebraic-geometric structure that would inherently incorporate this field model, will be carried out in a future paper. Nevertheless, the interested reader can skirmish on this frontier by consulting the relevant recent references to a Clifford-algebraic structure which encodes the projective duality of "space" and "counterspace" into a model for mechanics on the quantum level [29]. This promising model accounts classically for the phenomenon of quantum non-locality. It also heralds a new version of quantum field theory which, by treating electron-positron pairs as topologically non-orientable, is free of the detrimental divergences in self energy and charge, thus obviating the necessity for the ad hoc prescription of renormalization so endemic to current theory [30].

However, due to the limited scope of the current treatment, here we shall only make general comments on the significance of the above-mentioned concept of field triality. Although this model may appear foreign to current physical theory, we underscore that exactly such a system was delineated by W. Smith in the book, The New Science [5]. Observing, as we have [1], that this book in some parts of its exposition can cause confusion, we carefully choose the following selected passages that are most instructive in clarifying the notion of non-scalable metrics and in pointing the way to new paradigms (my comments in parentheses). General comment on non-scalable metrics: "Unity is half way between zero and infinity and always remains the fulcrum about which all other values regardless of scale pivot". On the electric field: "Between the two limits of zero and infinity and through unity there is divergence which we recognize as the electric field, but with the exception that there is no point charge at zero. Our awareness establishes the charge at radius unity with exactly half of it being 'inside' and the other half being 'outside'". On tempic field dynamics: "The tempic field being purely scalar in nature merely contributes to the manner in which changes can occur in the system. If, however, through some characteristic of configuration, the tempic field within a composite particle displays some irregularity, this will manifest as a 'vibration', and if the magnitude of the vibration is sufficient as to cause the interpenetrating fields to exceed the half-and-half point , the whole system will come apart: radioactivity. When a system does come apart, those field which were coherent and interpenetrating in the correct proportion will remain so and take off down the tempic field gradient and become radiated energy". On velocity of light/Planck's constant: "Within the universe we perceive, we are reasonably satisfied that the maximum value of all the coherent fields involved in our particles and radiated energy have the same value. Planck's constant is the numerical expression of this value, and the velocity of light is the expression of the numerical value of the (local) tempic field intensity". On nuclear fusion: "If a region is selected in which there are two fields of the same kind, same magnitude, same direction, such that very nearly half the reality of each is within the region, then the two fields are just on the verge of becoming coherent. If the fields are not coherent, the total energy in the region is the sum of the energies of the two fields; i.e., twice the square of the field intensity of each integrated over the region, or twice the energy of the two fields incoherent. This represents the 'packing energy' of bits and pieces of atomic nuclei, and also points the way to the precipitation of energy out of the cosmic background (vacuum engineering)". Notice how this description, written 45 years ago, of how a tempic field gradient (time-stress) operates between atomic nuclei to produce coherency (half-in half-out condition), perfectly parallels the recent Cagle view, which claims the fusion process takes place only as a function of time-dilation [28]. Finally, on gravitation: "With the exception of skew electric fields (electric field possessing tempic field gradient) all the other fields of an aggregate mass may be considered as static because they have no component of the tempic field at right angles to them. The skew fields (spiral-helical?) on the other hand, are dynamic because they do have a quadrature tempic field component. Furthermore, skew fields are largely incoherent (gravitation cannot normally be shielded) simply because the usual almost random orientation precludes their meeting the half-in requirement of form to become coherent. Since the gravitational field is due to the skew electric field, or stated differently, to the induction from the 'motional magnetic field' (longitudinally moved magnetic field), this is the logical region to explore for the mechanism by which fields may be produced to combine with the gravitational field (of Earth) to produce a resultant more to our liking (alteration of local gravitational potential)".

This last quote describes the gravitational field of a mass as a residual field phenomenon, similarly to the Sakharov and Puthoff conclusions which attribute gravitational and inertial mass to the interaction of accelerated or gravitating matter with the zero-point-vacuum-fluctuations (ZPF) causing a vacuum reaction force [31]. Moreover, similar to the Hestenes' claims, in their recent papers [32], Haisch/Rueda/Dobyns propose that, via this new interpretation of inertial mass as an acceleration-dependent electromagnetic (Lorentz) force, that a former postulate of quantum mechanics appears to be derivable classically via the interpretation of rest mass as the energy of the ZPF driven zitterbewegung; that is, the de Broglie wavelength of a moving particle, may be derived from Doppler shifts of the Compton frequency oscillations associated with zitterbewegung that occurs when a particle is placed in motion.

For further studies of physical theories with non-scalable metrics, the reader is directed to the excellent work of A.A. Nassikas [16]. Like few theories hitherto postulated, Nassikas posits a fundamental probability density function for vacuum energy, out of which oscillatory-deformable sub-atomic level physical aspects of time and space then emerge. This is the reverse to most contemporary paradigms, which view energy as a derivative of matter, time and space, even at the quantum level. Finally, A. Frolov has used Nassikas' theory to explain over-unity energy generation that has been demonstrated in some LENR electrolytic cells of the Pons-Fleischmann variety [17].

Editor: Actually Prof. Nassikas wrote in this patent that the idea which is described in the patent was proposed by Alexander Frolov. In 1996 these questions were discussed by us in Saint-Petersburg. Specifically, a Palladium cathode over-saturated with protons produces an imbalance of the vacuum engine in this area, with an accompanying change in the local time-rate and subsequent breakdown in the Coulomb barrier of the nuclei as per schemes articulated by C. Cagle [28] and T. Bearden [15].

Conclusions

In this journey through the latest research and speculations involving new interpretations of the four physical yardsticks: time, space, energy and mass, we hope the reader and technical specialists/theorists have been inspired to continue research along the lines suggested in the above dissertation. In this regard, certain open-ended questions present themselves that focus squarely on the viability of technological future developments in the new energy field. First, could the missing element in our eventual understanding of all devices featuring documented over-unity energy generation, change in mass (gravitational potential), LENR-based transmutation of elements and the amelioration of radioactivity, etc., be due the alteration of local time-flow in sub-atomic vacuum fields within the apparatus? Secondly, could the frustrating feature of the capriciousness of over-unity power and the like to yield to testable replication in many cases, be due to currently unperceived uncontrollable aspects of time and the vacuum which must be addressed in order to solve these problems? Thirdly, could incorporation of non-orientable topological structures such as the Moebius band, Klein bottle, etc. in new models of electrodynamic field structure, be instrumental in finding the answers to both of the previous questions? With sufficient probing for possible answers to such questions, the present author has the firm belief that new paradigms are certain to soon result that will crystallize these thoughts into viable scientific hypotheses subject to experimental testable verification. As an offshoot and definite bonus of this process, possibly a new more expansive understanding of the role of the vacuum in both nature and consciousness will be in the offing.

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Resonant Phenomena Occurring in Alternating Current Circuit

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There is a classical (according to manuals) notion that resonant phenomena can not influence on efficiency of a transformer or a motor as in a capacitive circuit or in an inductive circuit power produced at minimal power at the input of an oscillation circuit is reactive (let us remind that active power is measured at active resistance).

At the beginning of the last century this aspect was viewed differently. Advantages of a resonant case in alternating current circuits were used in practice. Let us appeal to a rare book by J. Claude-V. Ostwald named "Electricity and its applications by popular language" (I.N. Kushnerev Press, Moscow, 1914, p. 463).

"The phenomenon proceeds in a corresponding electric circuit as well as it occurs in hydraulic model: if self-induction and capacity parallel connected with each other are under influence of an alternating electric propulsion force then the total current coming through the system is equal to the difference of currents which pass two certain paths.

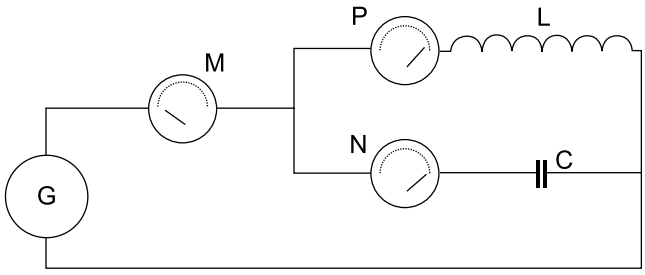

Fig.1

… join ammeters to the general circuit (M) and to either path (P and N). If P demonstrates 100 Amperes and N demonstrates 80 Amperes then the total current will be equal to 20 Amperes instead of 180 Amperes. Thus alternating current has its own "summary" so we should consider its condition. …capacity introduction compensates self-induction action in some way… let us begin to change the self-induction by moving a core into. What will happen if the current coming through the coil achieves 80 Amperes, i.e. is equal to the current observed in the path with a capacitor?

As you guess, since the total current is equal to difference between currents passing the paths then now it will be equal zero. It is an incredible case:the device produces zero current dividing into two paths and in each of these paths current is equal to 80 Amperes. It is a good example for the first acquaintance with alternating current, isn't it?"

Andrey A. Melnichenko (Moscow) is one of modern investigators who research this phenomenon. Any motor of alternating current can be considered as inductance. A circuit consists of motor coils and some capacitor connected in series with the motor winding. Thus if we take the circuit, consisting of motor coils and a capacitor which is connected in series to motor winding and adjust it in resonance, then mechanical power occurring on the motor shaft is produced at zero (minimal) power consumption of an alternating current source.

Melnichenko applied a simple method of voltage increase by meanse of resonance: he succeeded in obtaining of normal voltage for operation of standard motors of 50 Hz 220 V from a source of 50 Hz 110 V and 70 V. The circuit consumption for overcoming of its active resistance (of coils) can be considered as insignificant. Low frequency currents require a large capacitor. Nevertheless even at higher frequency, for example at 400 Hz, the system can be compact and effective. This method is worth to be applied in a scheme consisting of an alternating current motor in resonance mode and an electric generator which has a stable load. Change of load causes change of rotation speed therefore the system requires to be readjusted for resonance.

Experiments with powerful alternating current motors (about 100 Amperes as J.C. Ostwald wrote) working in resonance mode should demonstrate all advantages of the resonance mode application.

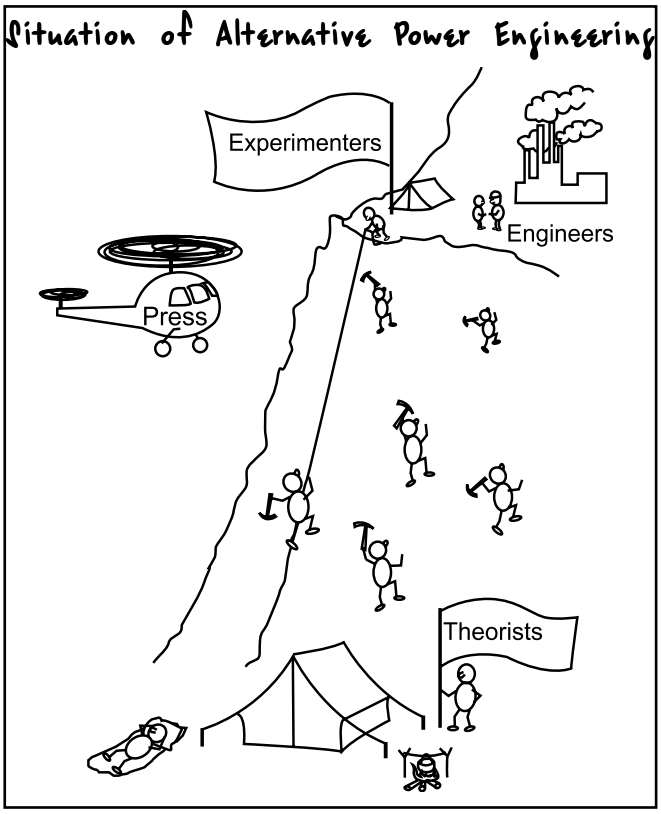

Space Power Generator and Paramahamsa Tewari Update

Submitted by Toby Grotz, USA

http://www.tewari.org

A new generation of Space Power Generators is being built by Paramahamsa Tewari. The new design is expected to achieve substantial gains over previous models which has been measured over unity by experts in the utility industry as well as by independent consultants. Details are presented on the web site http://www.tewari.org.

From the Electron to a Perpetual System of Motion

Paramahamsa Tewari, B.Sc. Engg

As is well known, an electron, despite high-speed interactions with electric and magnetic fields and other particles of matter, remains unaffected structurally—maintaining its mass, charge, inertia, and locality after the interactions. This single fact itself is sufficient to postulate on the existence of some unique universal entity constituting the electron, such that the structure explains the known properties and behavior of the electron – as to how it sustains the collisions with the other particles and, yet, remains permanently indestructible without any reduction in the quantities of its basic properties. A theory that explains this enigmatic fact is framed and described in detail elsewhere. It reveals that the electron is a perpetually rotating system, a space-vortex (vortex of absolute vacuum) that through the process of motion in electric current, and interaction with external magnetic field can also lead to the development of a system partially violating Lenz's law and, thereby, capable of achieving perpetual motion in a machine. Such a conclusion has a new theoretical basis, as well as experimental confirmation – briefly outlined in this paper.

The basic understanding of the interaction of electric current with magnetic fields requires deeper knowledge of the fundamental nature of the electric current as well the magnetic field; this, in turn, leads to an inquiry on the nature of "electric charge" and its distribution in the electron structure. The origin of electron mass and charge, electrostatic and electrodynamic forces are described below with the vortex structure of electron, which further facilitates explanation of atomic structure and, thereafter, an over-unity efficiency generator. Due to brevity, predominantly qualitative-descriptions of the physical processes involved have been presented.

The full theory and diagrams are presented in From the Electron to a Perpetual System of Motion at http://www.tewari.org.

Universal Principles of Space and Matter (A Call for Conceptual Reorientation)

A new book, *Universal Principles of Space and Matter* has just been published by Paramahamsa Tewari. Arangements are being made with the publisher to provide these books outside of India. The price is expected to be about $30 depending on shipping costs from India.

A new theory of matter, that confronts with the existing concepts of space in the contemporary physics.

The basic phenomena dealt with are:

* Structural interrelationship between space and matter
* Origin of mass, inertia, and electric charge
* Creation of the electron from space

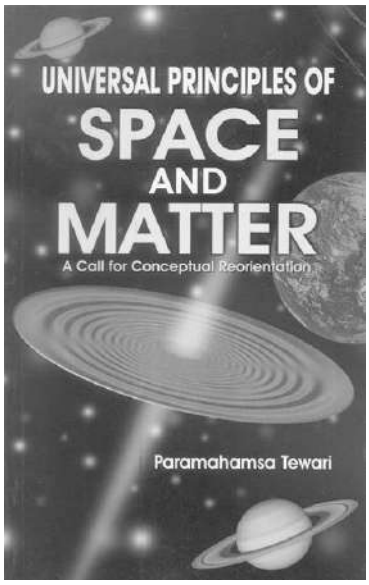

* Discovery of new fundamental equations on mass and charge
* Derivation of the presently known universal constants (gravitational, Coulomb's constant, dielectric, magnetic permeability, electron charge, electron mass, Planck's constant etc.) with the postulate of a single universal costant – the speed of light in the absolute vacuum
* Discovery of an inward force in nuclear structure against the Coulomb repulsive forces, hitherto unknown
* Relationship between light and gravity
* Theoretical derivation of the surface gravity of the Earth, Sun and the planets
* Discovery of electrical repulsive forces between the Sun and the planets, unknown in celestial mechanics
* Derivation of the planetary orbits
* Prediction of the continuous creation of universal matter at glactic centers and existence of electrical forces of interaction btween the stars and galaxies, so far least suspected
* Identifying the fundamental particle of matter
* Revelation of conceptual errors in the modern understanding of the basic nature of light
* Vindication of Einstein's conclusion of the speed of light as the limiting speed
* Vindication of Descartes' principle of property-less ether.

New Reviews of P. Tewari's work

New reviews of P. Tewari's work have been received from Dr. John A. Wheeler and Prof. Umberto Bartocci. A copy of Universal Principles of Space and Matter was forwarded this summer to Dr. John A. Wheeler at his summer residence in Maine.

Dr. Wheeler saw the development of modern physics while working with Neils Bhor at age 27 and was a colleague of Albert Einstein's at Princeton. Credited with being the "father of the Black Hole Theory", Dr. Wheeler is well schooled in quantum mechanics and relativity.

After receiving his copy of Universal Principle of Space and Matter Dr. Wheeler called the book "a unique gift". Further reviews of P. Tewari's work by Dr. Wheeler can be found at: http://www.tewari.org/Critical_Reviews/critical_reviews.html.

Prof. Umberto Bartocci

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Tel.: (39)-075-5002494
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This is a very singular book, in front of the current paradigm of contemporary Physics, a "cartesian-inspired" work which calls for reorientation in the foundations, by wisely warning that:

The conclusion of the modern physics that absolute space, time, simultaneity, and space filling media are discredited ideas is certainly premature (p. 178).

The books deals with arguments such as: Discovery of Charge and Mass Equations; Fundamental States of Cosmic Energy, Fields and Forces; Gravitation; Universal Constants; Motion of Electron; Atomic Structure; Light; Creation of Cosmic Matter (about Tewari's physical conceptions see also the second section of this Episteme's special issue http://www.dipmat.unipg.it/~bartocci).

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New Energy Technologies collection of articles Japanese Version

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President Yama Trans Co. Ltd.

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Rotating device powered by permanent magnets

Minato Wheel

http://fdp.hemsida.net

Experiments made in Sweden

by Eric Vogels

Read about launch vehicle "Lightcraft" in the review "Commercial exploration of space"

http://www.lightcrafttechnologies.com

"Lightcraft" is made for space flights by means of megawatt laser beam

Lightcraft Technologies, Inc.

Ball Lightning control

Experiments by Russian scientists

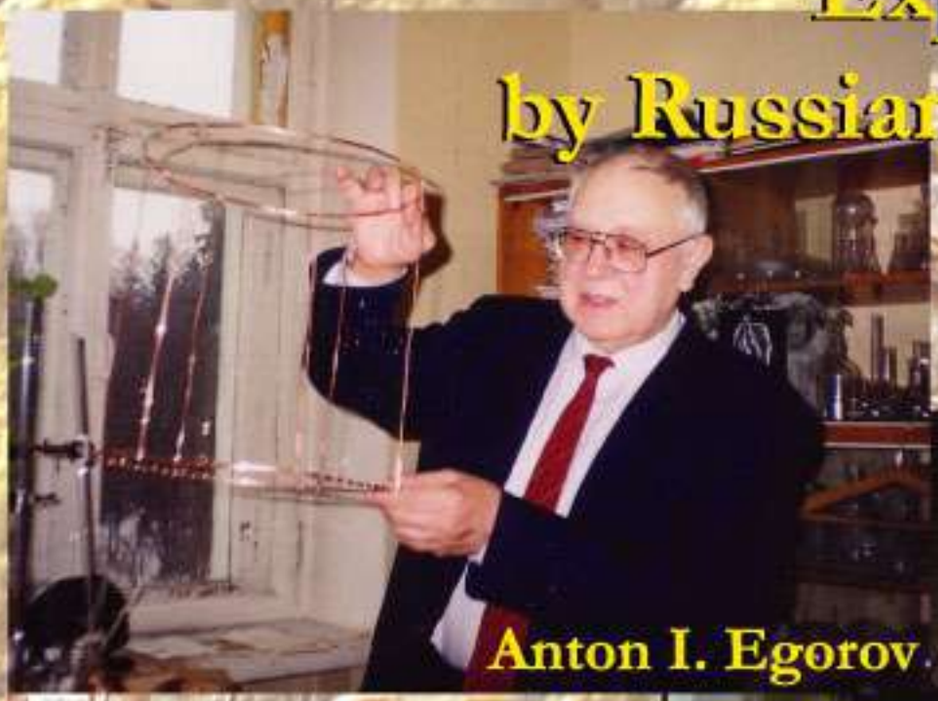

Anton I. Egorov

The standard ball formation

Read in this issue!

Tilley Foundation, Inc.

http://www.tilleyfoundation.com

K. Tilley Electric Vehicle (TEV) - automobile of the future generation

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New Energy Technologies

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Research on advanced aerospace systems and new energy sources

Commercial exploration of space

Also in this issue:

- New experiments on magnetic motors
- Ball lightning in laboratory environment
- Alternative aircrafts and space propulsion systems

NEW ENERGY TECHNOLOGIES #11

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3. Production of Ball Lightning in Laboratory Environment. Report by A. Pashova (Russia)
4. Electric Discharge Produced into Air Half-Space. G.D. Shabanov, O.M. Zherebtsov (Russia)
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Perfect Energy Source

Minato wheel. Experiments in Sweden

Eric Vogels, Sweden

E-mail: fdp@hemsida.net
http://fdp.hemsida.net

The self-running bicycle wheel was shown to the public at the First International New Science Symposium in 1997, held in Korea. The inventor of the wheel, Mr. Kohei Minato, was a speaker during the symposium. On www.keelynet.com you can find the quote of an eye-witness:

"The motor is actuated by moving the N pole of a large permanent magnet (the drive magnet) toward the wheel. As this magnet is moved toward the wheel, the wheel starts to spin. As the magnet is moved closer to the wheel it spins faster.

The acceleration of the wheel is rapid. So rapid in fact, as to be startling. To put it another way I was very impressed. The motor works. And it works very well. In the film clip (see http://fdp.hemsida.net) a slight pumping action of Minato's hand holding the magnet is apparent. When I braced my hand so that there was no pumping action, the motor still ran. In fact it seemed to run better.

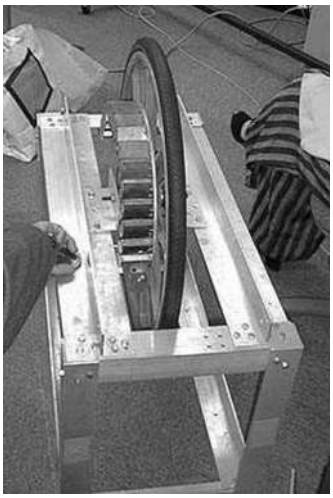

Fig. 1

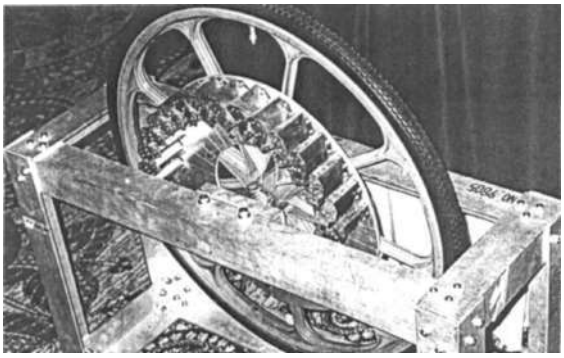

Fig. 2

Pumping action by the hand held magnet **is not** the power that drives the motor. When the drive magnet is moved away from the wheel it coasts rather quickly to a stop and comes to rest in a manner typical of any spinning bicycle wheel. Again when the wheel is at rest and a large magnet is moved up to the wheel it starts to spin. At no time it is necessary to touch the wheel to get it rotating."

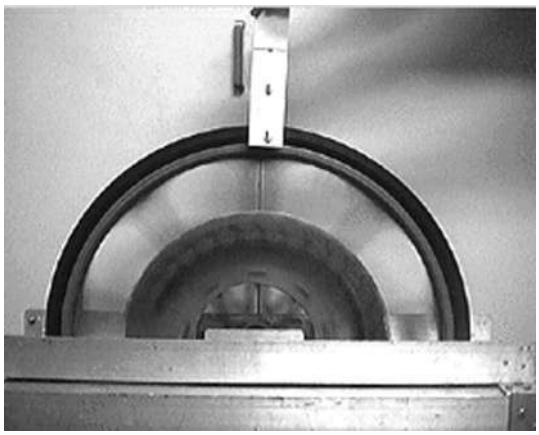

Fig. 3

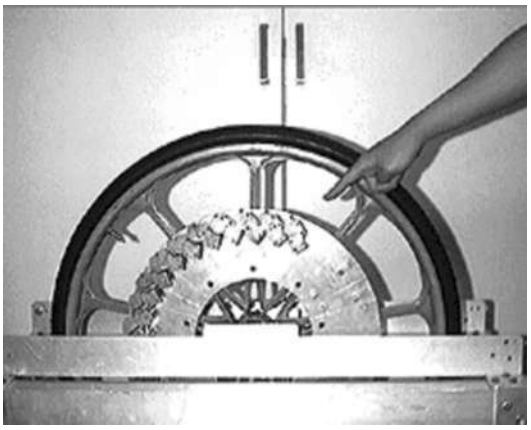

Fig. 4

Since the symposium in 1997 and the first publications in the Internet several people have tried to replicate the wheel, as it seemed to be a **perfect energy source for the future**. Some claims are made that replication was successful but no proof in the form of pictures or video clips are given.

Because I have a great interest in magnets and free energy and the fact that I did a lot of experiments to find a device that could be rotated only by means of permanent magnets, I decided to try to replicate the wheel by myself.

This journey started by searching on the Internet and collecting all the material that was available. A good way to sort all the found material was building my own website at http://fdp.hemsida.net where all my findings are presented.

One of the devices I build was made from a 'how to build a Minato wheel'-manual that I found on the Internet.

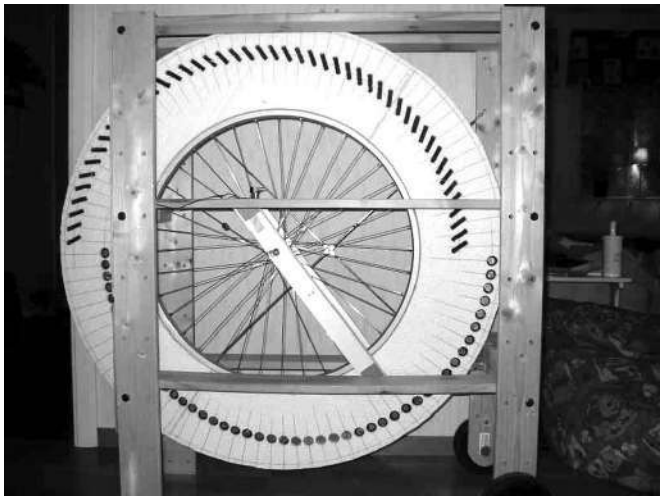

Fig. 5

Unfortunately this wheel did not show any movement at all. I mounted the magnets at several angles and distances from the rim without achieving any positive results. Since the size of the wheel (1 meter diameter) was not very practical to handle and since the results were negative I searched for an easier way for testing. I found that the use of Styrofoam, an old turntable and Neodymium disc magnets kept the whole project within the edges of my kitchen table. I developed a computer program to help me design wheels, since I want to be able to replicate my own wheel, in case I find a model that works. I do not believe in an engine that works after several weeks of tuning and that fails to function as soon as one magnet is replaced. Individual tuning is okay to optimise a working design but if a design does not show the potential to rotate by itself it's a flawed design.

After optimising the way to build the small wheels, I could design and make a wheel in 30 minutes. I made a test scenario and the results for every test were posted on the web site.

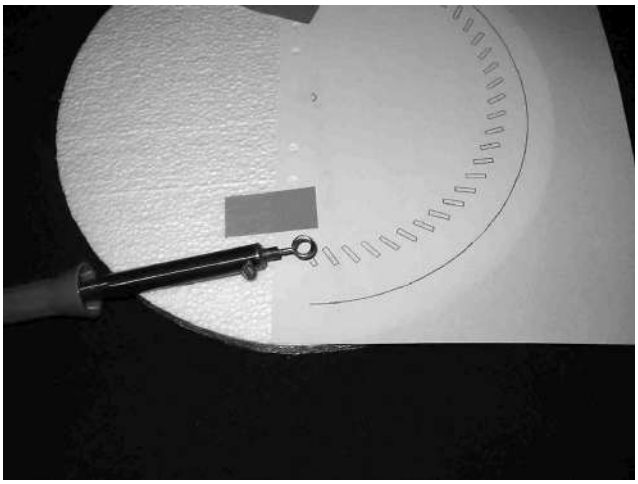

Fig. 6

I searched for the 'perfect' angle, number of magnets and position. The set-up with the strongest thrust was used as the base for the other experiment. By this time I realized that I was not really trying to rebuild the Minato wheel but that I wanted **a rotating device, powered by permanent magnets.**

When for the first time I decided to split a track of magnets that covered 180 degrees of the wheel in a number of smaller tracks, **the results became much better**.

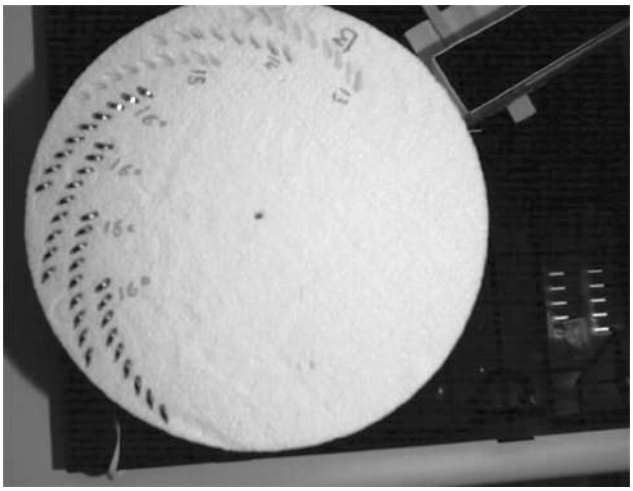

Fig. 7

By using this way of placing the magnets, every track differs a little bit from the next track, depending on its place on the wheel. The angle of the magnets influences on the thrust that is given by the stator magnet, depending on the speed that the track is entering the magnetic field of the stator. In other words: the track at the beginning of the wheel, with magnets covered side of the wheel, gives less thrust than the track at the end. This is important since a track with a lot of thrust has a big 'sticky spot' that should pass the stator. This 'sticky spot' stops the wheel during its rotation just before the first track enters the magnetic field of the stator.

During the last experiments the stator magnet changed place and pushed against the magnetic fields of the tracks from above. Simply because more thrust was developed by this way. The next wheel will have the tracks mounted on a different level. It means that the first track will have a bigger distance to the stator magnet than the last track. This should make the sticky spot weaker and the final 'kick off' stronger. The final wheel will be mounted vertically, like the Minato Wheel.

Thanks to the invention of the Neodymium magnet in 1983, magnets became much more powerful while the size and length decreased. Before 1983 a lot of the experiments could not be done since the size of the magnets made the positioning of several magnets in tracks like this was impossible. It is my personal believes that the strength of these magnets will lead to results that are impossible according to the physical law books, because these magnets did not exist when those books were written.

Until the moment I write this I have not found the perfect energy source yet but by exploitation all the material and findings on my web site I hope that more people get interested and will help searching for a great energy device that will not pollute the air which our children and grand children have to breath.

Mechanism of Drive-Free Motion

Sergey A. Gerasimov, Russia

Physics Department, Rostov State University, Rostov-on-Don, 344090
Email: GSIM1953@mail.ru

The article presents results of the experimental study of the motion created by vibrations of an internal mass of the system of bodies accompanied by impacts of the unbalanced load with the external body. This type of propulsion drive is known by a number of names. Among these are the ***vibrational propulsion device*** *and* ***reactionless machine****. Sometimes it is called the* ***inertioid*** *[1, 2]. The vibrational transposition is proved to go on by means of internal forces of a system of bodies [3-5]. The Tolchin's inertioid [6] is considered to be the first device that used the forces of inertia to create the reactionless infinite motion in space. We are not in a position to be a judge of this. There exist a number of projects of such machines but experimental results concerning such kind of motion are very limited. Below there are the experimental results on average velocities of such a motion and the description of a propulsion device a main particularity of which is absence of wheel-drive.*

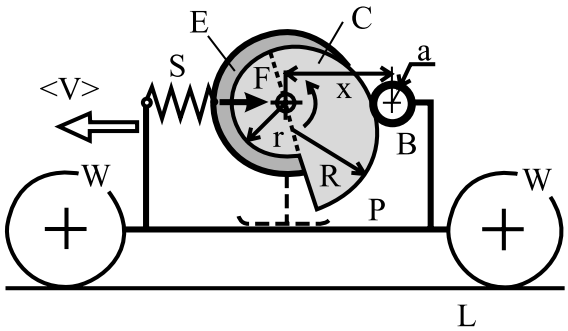

Fig. 1

Scematic representation of a vibratory-impact self-transposition

The unbalanced load in this device is an electric motor *E* of mass *m* that executes undumped vibrations relative to a platform *P* of mass *M* with four wheels *W* which can roll on a horizontal surface *L* with rolling friction the coefficient of which is *k*. The frictional force is determined to be a force which adjusts to keep the cart from motion across a surface. A disk cam *C* at one end of the axle of the motor ensures a prescribed character of the vibrations and elastic impacts between the load *m* and the follower *B* of radius *a*. In present experimental device, the cam *C* consists of two semicircles of different radii *r* and *R* as it is shown in Fig.1. In this experiment r=0.03m, R=0.05m and a=0.01m. The electric motor and the platform are coupled by a connecting spring *S*. The force *F* by means of which the electric motor is pressed to the follower varies linearly from F=4N at x=0.04m to F=4.8N at x=0.08m. The compressed spring *S* is necessary not only for creating close contact between the cam and the follower. The restoring force of the spring produces the transposition of the cart in a direction opposite to **F** when the follower moves without contact from x=2R-r+a up to an impact at $x=r+a$. The impact suppresses the transposition. Another mode of transposition is also possible when the impact of the cam on the follower is a reason of the transposition of the cart in the direction of the force **F**. In this case the frictional force extinguishes the transposition of the cart.

Friction between the load of mass *m* and the cart is negligible since the corresponding effective coefficient is less than 0.001. The same is for the friction between the cam and the follower. The mass of the spring is m_S=0.007 kg , and the mass of the cam is m_C=0.019 kg. The total mass of the wheels is m_W=0.082 kg. This value can be useful for a theoretical

During the last experiments the stator magnet changed place and pushed against the magnetic fields of the tracks from above. Simply because more thrust was developed by this way. The next wheel will have the tracks mounted on a different level. It means that the first track will have a bigger distance to the stator magnet than the last track. This should make the sticky spot weaker and the final 'kick off' stronger. The final wheel will be mounted vertically, like the Minato Wheel.

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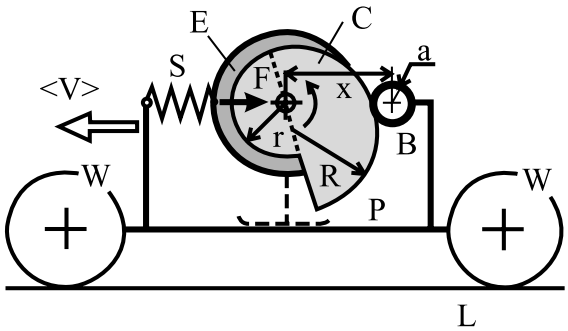

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analysis. Thus, the total mass of the unbalanced body is chosen to be much larger than the mass of the cam or the spring: $m = m_E + m_C + m_S \approx m_E$.

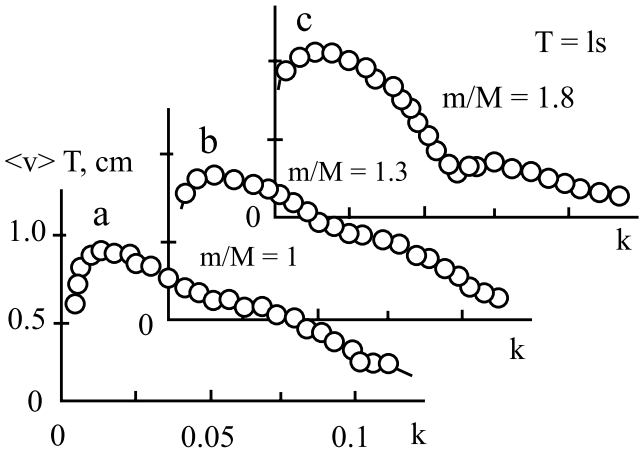

Fig. 2
Frictional coefficient dependence of average velocity of the platform at the period of vibrations T=1s for various mass ratios m/M:
(*a*) M=0.9 kg , (*b*) m=1.2 kg , (*c*) m=1.6 kg

At least in the case of irreversible mode, one could expect that the value of average velocity of transposition $<v>$ must be proportional to the number of impacts per unit of time. In the other words the path traveled by the cart per one impact must not depend on frequency of vibrations. This is a reason why the dependence of the product $<v>T$ versus the value of the friction coefficient k and ratio of masses d = m/M is investigated in this work. Measurements were carried out for two magnitudes of rotation period T= 1s and T=6s of the cam. The obtained results are presented in Fig. 2 and Fig. 3. First of all, the assumption mentioned above is not confirmed.

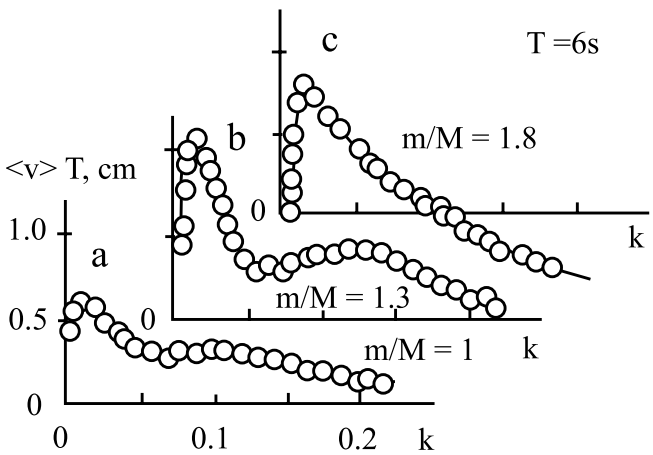

Fig. 3
Average velocity of the platform $<v>$ as a function of frictional coefficient k at T=6s for various mass ratios m/M: (*a*) M=0.9 kg , (*b*) m=1.2 kg , (*c*) m=1.6 kg

The value $<v>T$ for the period of the rotation T=1s sufficiently differs from that for T=6s measured at the same conditions. Besides, when the mass ratio is large the cart can change its direction of transposition. The reason of these results is not clear but this device provides a challenge to explain and investigate this kind of motion that enables us to discover the reactionless motion if it is probable. One should pay attention to a fact that the infinite transposition of the platform takes place even if the friction coefficient k is small.

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Sergey A. Gerasimov graduated from Faculty of Experimental and Theoretical Physics of Moscow Physical Engineering Institute in 1976. Received Degree of PhD in Physics and Mathematics in 1987. Author of about 70 articles on Astrophysics, Atomic and Radiation Physics, Classical Electrodynamics and Mechanics. In present - Associate Professor of Department of General Physics of Rostov-on-Don State University. The fields of scientific interests are questionable problems in physics: self-interaction, self-transposition, unipolar induction.

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Production of Ball Lightning in Laboratory Environment

Report by our correspondent Alla Pashova

Three years ago a working device producing a ball lightning in laboratory environment was designed in Saint-Petersburg Institute for Nuclear Physics (SPINP). The produced ball lightning is accessible for detail investigation and quite stable. The lifetime of the ball lightning comes to about one second that is rather significant for alike artificial formations. The experiments on the device made by scientists of SPINP, i.e. A. E. Egorov, G. D. Shabanov, S. Stepanov, are not supported or financed. Let us note that every scientist of the group searches proofs for his own hypothesis of nature and structure of the ball lightning at all.

A leading expert of SPINP, Anton I. Egorov, pays attention to dethronement of scientific myths:

— There is a myth of ball lightning that is created by mass media. The mythical ball lightning is a concentrate of mysterious energy which is extremely dangerous for a human. It destroys houses, kills animals, pursues people. After meeting it a human can lose his hair or teeth and different misfortunes begin to happen. Supposing a simple story of a farmer-eyewitness: "It thundered, and a fist-sized fire ball rolled down along a drainpipe. It fell into a barrel of water, the water gurgled. I came up to it and put my hand into the water. The water seemed to become warmer…". After republishing of the story by several newspapers a dramatic story about a ball lightning which has evaporated a barrel of water appears. No wonder that such familiar attitude to facts causes hundreds of hypotheses of ball lightning nature.

— **What is your hypothesis about ball lightning structure?**

— At the beginning of 90th I. D. Stakhanov, a member of Institute of Magnetism (IZMIRAN), developed a special method to interview eye-witnesses that resulted a right notion on ball lightning phenomenon. According to Stakhanov, ball lightning is a clot of hydrated plasma which is generated in wet air at electrical discharge.

Water as a chemical compound is remarkable for its anomalous properties: combining of two lightest elements does not generate gas but produces a high-boiling liquid. This is caused by extremely irregular distribution of electrons in a water molecule. Due to this property it acquires properties of an electric dipole. Water molecules interact with charged ions, aerosol particles, and with each other in a special way.

If a positive ion and a negative ion are introduced simultaneously into a puff of warm wet air then water dipoles immediately produce hydrate shells around the ions. When the hydrated positive ion approaches the hydrated negative ion additional water molecules are drown into gaps between them. As a result, there is a stable cluster in which the charged ions are conserved. The cluster consists of two ions of opposite charges and the hydrate shell. Water molecules prevent the ions' approaching and recombination, hence, lifetime of the ions in the cluster increases up to tens of minutes, i.e. in 12-13 orders. Interaction of clusters causes open-chain structures followed by space structures. That is to say, there is appeared a clot of cold hydrated plasma that accumulates great energy (up to 1 kylojoule per liter). The clot of plasma loses this energy at recombination of ions.

— **Could you, please, tell about the design of the device? What processes proceed when the device is operating?**

— Our task is to introduce an abundant population of ions into a puff of warm air saturated with water vapors. A base of the device for laboratory reproduction of ball lightning is a capacitor bank which is able to be charged up to 5.5 kV. The positive pole of the capacitor bank is connected to a ring electrode by means of a copper bar. The ring electrode is placed on a bottom of a polyethylene reservoir filled with water. The negative pole of the capacitor bank is connected to a carbonic electrode which is placed in the centre of the reservoir near water surface. A quartz pipe encloses the electrode in such a way that it is possible to drop water or to put some natural matter on it.

To generate a ball lightning 2-3 drops of water are put on the electrode. When impulse discharge occurs a bright plasma spout escapes the centre of the electrode that is accompanied by a quiet plop. A glowing plasmoid which is an artificial ball lightning parts from the plasma spout. It comes up slowly in the air and then disappears falling to pieces in 0.2-0.3 seconds.

We have made thousands of experiments for investigation of ball lightning properties, i.e. defining size, lifetime, colour, average temperature, excessive charge, content of a dust component.

It was ascertained that the artificial ball lightning is generated in a narrow interval of breakdown tensions. The average size of such a ball lightning is 12-20 cm,

and its lifetime comes to 1 second. Temperature of the ball lightning is not very high, i.e. 50° C. This can be defined if to take into account speed of rising of the ball lightning. If the plasmoid is accepted as a puff of warm wet air of 14-centimeter diameter which in atmosphere comes up at 293 K at speed of 1-1.2 m/sec then, consequently, its temperature should not exceed 330 K.

Colour of the lightning varies greatly and depends on presence of aerosol of matter trapped in the moment of discharge. Usually the lilac central part of the plasmoid is surrounded by a diffusive yellowish layer. Some admixture of natrium salt and calcium makes the core of the plasmoid yellow or orange.

If the central carbonic electrode is replaced by an iron or copper or aluminum one then the fundamental character of the phenomenon does not change. However, colour of the plasmoid depends on a radiation spectrum of excited atoms of the electrode, i.e. iron plasmoids are whitish, copper plasmoids are greenish, aluminum ones are white with reddish shimmer.

— **A generated ball lightning exists for about 1 second. How can it be made more stable?**

— Lifetime of an artificial ball lightning depends on many conditions, i.e. size and geometrical form of the central electrode, voltage between the electrodes, value and duration of a current impulse, temperature and electroconductivity of water which is put on the central electrode. Besides, lifetime of the plasmoid can be changed by introducing an additional dispersive phase into it. We have tested tens of matters and begun to investigate suspensions of colloidal graphite and fine-dyspersated ferric oxide.

A suspension of 3 g of colloidal graphite, 8-10 ml of acetone (which played role of penetrating agent), and 90 ml of water is put on the central carbonic electrode. When an electrical discharge occurs a layer of the suspension forms a flying spherical plasmoid. It comes up slowly and disappears in 0.3-0.8 seconds. The core of the plasmoid has a colour of flame, i.e. colour of burning carbon.

To prolong the existence of the generated ball lightning without application of aerosols it will be possible to use the so-called "Faraday's cylinder" whose production has been already begun. For the same purpose G.D. Shabanov proposes to put a stopping potential on a probe of detention.

— **There is an opinion that physical nature of ball lightning is similar to the process of controlled thermonuclear fusion. In this case, if your work on generation of a stable ball lightning is successful then you will be a competitor of the expensive project of controlled thermonuclear fusion**.

— I think that it is totally incorrect. Hydrated plasma is the first enemy of the thermo-nuclear fusion as water molecules do not allow neutrons approach each other. Effective cold fusion should be realized in organic liquids, for example, in heavy acetone or in a water-free medium. Somehow, it should be an absolutely "dry" process. No experiments on real "dry" cold fusion have been realized in practice. It has not been also examined the surfaces on which the combination of heavy hydrogen atoms produces maximal heating.

Scientists should pay attention to two most effective cold fusion processes. The first one expects association of two atoms of deuterium occurring on a totally dry deuterated surface which consists of, for example, zirconium deuteride. In the moment of fusion of a deuterium molecule local heating appears, and neutrons depart. The other perspective method of realization of the cold fusion process requires an absolutely "dry" organic liquid, i.e. liquid acetone in which hydrogen atoms are replaced by deuterium atoms (C_3D_6O) or by atoms of cyclic compound of $C_6(D_2)_6$. A tellurium or zirconium tip of an ultra-sonic dispersant is placed into a reservoir of this liquid. Cavitation blebs are formed on the surface of the dispersant. Neutron output comes to 10^4 particles. Maximal neutron output, which was achieved by Lipson, an American experimenter, consists of 10^8 neutrons at a desired result of 10^{13}. Certain quantity of neutrons can be obtained during ultrasonic cavitation which is accompanied by a phenomenon of sonoluminescence. Due to sound resonance the only cavitation bleb is generated in acetone. When the bleb collapses weak glowing is observed. The cause of this phenomenon consists in gas heating occurring in the bleb that is the result of high pressure produced by its collapse. The burst can last from 1/20 up to 1/1000 sec. Light intensiveness depends on quantity of gas in the bleb. If gas is absent in the bleb then the glowing does not occur. Light emission of the bleb is very weak, it becomes visible if it is strengthen or in absolute darkness.

— **Is it rightful that cold fusion is the future of world power engineering?**

To my mind another direction seems to be more perspective, i.e. extraction of uranium from sea water and then its burning in heavy hydrogen reactors like one which exists in Canada. Photo voltaic accumulators can also become a successful approach of the alternative traditional fuel engineering. By the way, a working model of such a device to utilize free solar energy has recently been created in our Institute (official web site: http://www.pnpi.spb.ru).

Editor: Read the publications on this theme in following issues of our magazine. Below there is a description of other attempts to generate a ball lightning in laboratory environment or at home. Besides, we publish an article dedicated to the problem of laser control of ball lightning. In the article there are photos (also see the cover page) and a scheme of the working device designed by this scientific group.

Ball Lightning Experiments

Information from
http://www-personal.umich.edu/~reginald/ball_l.html

Ball Lightning in the Microwave

This is a great experiment to try at home. It requires a microwave oven, a candle, a toothpick and a lighter. First you put the candle (~1-2 inches in height) in the microwave (remove glass plate from bottom so candle sits on metal). Put the toothpick in the candle sticking straight up. Light the toothpick on fire so that flames are leaping off the tip. Shut the door quickly and turn on oven full blast. There will be loud popping noises and then balls of fire will leap from the toothpick and fly around inside the microwave while making a buzzing sound like a bee. If it doesn't work at first try to move the position of the candle in order to find the "hot spot" in the oven for it to work.

Real Ball Lightning Generated by Pulsed Power Inductor

This experiment is very DANGEROUS. The author did this one a few years ago. The Idea was got from an article about a guy generating ball lightning using a high current transformer (TBA). The author had an idea of using an inductor to store large amounts of electrical energy. The conductor on the end of the stick touches the metal ring. This completes the circuit, and start the inductor. Then there was used the air compressor nozzle to blow out the arc as the wire was pulled away. The copper wire explodes and creates rapidly rotating and burning molten balls of copper. These 'Balls of Fire' exhibit many of the properties of real ball lightning.

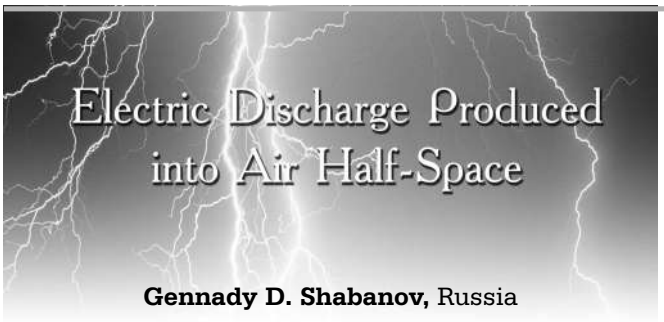

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In the article a possibility of streak lightning control by means of low intensive laser emission is observed.

During investigation of an electric discharge into air half-space [1] it was noticed that this discharge can be controlled by a low intensive laser beam. Now there is a problem of laser control of lightning discharge [2]. However, numerous works on this approach demonstrate that "the hope to get a quick solution of the problem of lightning control by laser emission has not been confirmed" [3].

Careful observation of this problem in [2] has shown ways out the situation. The authors of [2] consider plasma channel produced (by means of laser) in free atmosphere at a possible greatest height to be of doubtless interest of the science of lightning. Finally, creation of the plasma channel should be of benefit for lightning protection. The authors of [2] give notice that "there are many difficulties of fundamental and practical importance on this path".

Weak theoretical understanding of lightning generation causes pessimistic estimations of solution of the problem. The article [2] notes particularly that "there are neither adequate theory, nor numerical calculations and qualitative understanding of the phenomena defining the speed of a leader… The situation of a theory of the leader channel is little better (from quantitative point of view)…".

Realistically the following statement can refer to the lightning discharge: "The electric discharge appeared to be very "unhandy" for theoretical description but the most interesting phenomenon in the experimental aspect" [4].

Experimental Part

In this work a capacitor bank with 0.6 mF capacity, which can be fed up to ~5 kV, was used to produce impulse discharge into air half-space. A scheme of the device is presented in Fig.1. At connection/disconnection of a discharger 5 a "spout" is let out of an electrode 3. The spout carries the potential of the cathode (virtual cathode) at a significant height into air half-space. A probe placed at the height of ~15 cm fixes a potential which is similar to the potential occurring at the cathode. The researches have demonstrated that the produced formation continues to glow for several hundreds of milliseconds (the glow is fixed from a zone located at 15-45 cm above the cathode). Typical time of the discharge comes to 100±20 msec and depends on the cathode material. Electric field generated in the spout comes to less than 8 V cm^{-1}.

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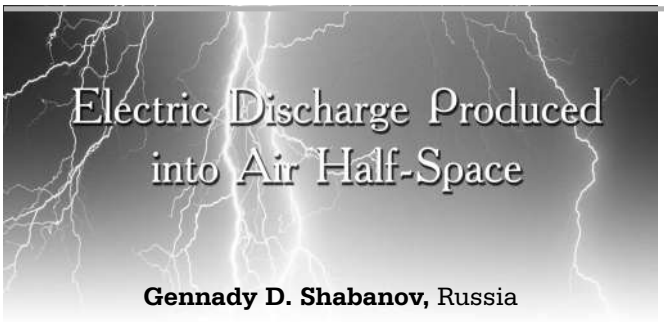

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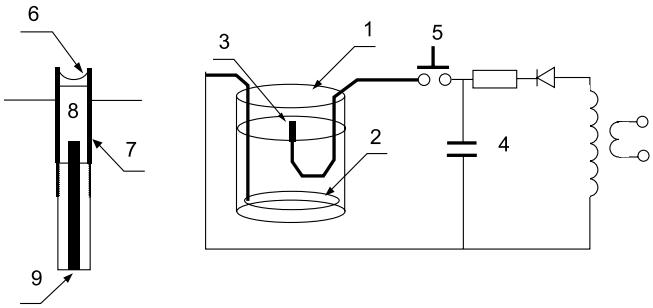

Fig 1
A scheme of a device made for producing of long-living plasmoids

1 – a polyethylene reservoir, 2 – a ring electrode, 3 – a central electrode, 4 – a capacitor bank of 0.6 mF capacity, 5 – a discharger, 6 –water or aqueous suspension drop, 7 – a quartz pipe, 8 – a carbonic or metal electrode, 9 – a copper bar.

The spout was acted by weak laser emission of less than 1 mW at 22-centimeter height. The laser beam was directed perpendicular to the discharge axis, the spout achieving the laser beam moved along the beam towards the laser.

In Fig.2 the spout has moved ~8.5 cm along the laser beam, and a usual sphere formation was generated. Due to the horizontal motion it was distorted if to be compared with usual sphere formation. The usual sphere formation is represented in Fig.3 (also see the cover).

Fig. 2
Motion of the leader channel (spout) along the laser accompanied with the sphere formation

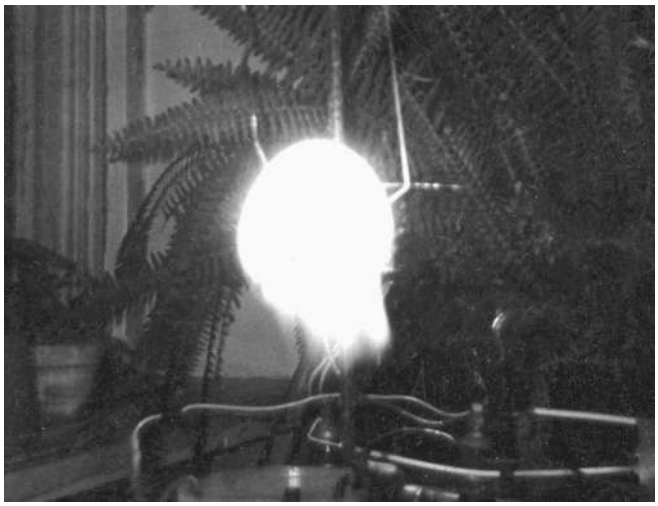

Fig.3
The standard ball formation

Discussion

As it is evenly mentioned in [5], results of model experiments are difficult to be applied directly to laser control of lightning because in short intervals characteristics of the discharge differ from characteristics of lightning discharges. Actually, at comparing considered current and the field existing in a lightning (i~100 A, ~3 V cm^{-1}) with these phenomena occurring in a laboratory spark (~1 A, ~300 V cm^{-1}) incorrectness of modeling of this process becomes obvious. From the other hand the authors of [2] note that "the leader channel is like a channel of electric arc… At current strength of ~100 A plasma of the channel of the arc is supported by fields the densities of which come to several volts by a centimeter. The lightning has such leader currents".

Even an air arc of atmosphere pressure has a field of about 100 V cm^{-1} at currents of about 1 A. The generated discharges (spout) accompanied by the field of less than 8 V cm^{-1} (maximal current appearing in the discharge gap is 50-60 A) are more appropriate for modeling the leader channel of the streak lightning than typical discharges used for investigation of these processes, for example, like [6].

At first approximation the leader channel is considered as an ideal conductor in the article [2]. We make research to define the field in the discharge (spout) more exactly. The article [2] makes the following consideration about a cause of occasional generation of new leader heads: "the surface of *equipotential* plasma conductor (channel) *has* a property of *instability*. There is an occasionally generated sharp jut. An intensified field appears at the jut along the edge. Under the influence of the field the jut becomes to grow in any direction including at the significant angle to the weak outer field". The aforesaid seems to explain why our leader channel changes its direction and runs at right angle to its initial motion. (Fig.2). Weak harmonic action of the laser beam to the leader channel causes generation of a new head which continues motion "on the significant angle".

The effect of plasma motion towards a light beam is a demonstration of a general tendency of propagation of the discharges to an incident electromagnetic field [7]. "Area occupied by plasma usually increases towards the laser emission" [8]. Leading character of motion of this formation is confirmed in [9] as well as the interaction with the laser beam is confirmed in [10]. It should be taken into account that in the works [9-10] experiments were performed at devices which generated such a discharge. However, that discharge was by 2 orders weaker than the discharge generated by the device represented in this work. Naturally, the results were less defined. Comparison of the discharges is presented in [11].

According to our data, the leader channel (spout) has a very abrupt bound (less than 1 mm). In this layer the field can come to ~30 kV cm^{-1} (at height of 15 cm).

Conclusions

Due to the assumption [2] about *instability* of the surface of the *equipotential* leader channel there has been successfully performed the "control" action on an electric discharge which models a streak lightning. It has been achieved by means of weak harmonic oscillations made by the laser. This mechanism is supposed to be applied for streak lightning control.

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In general the conception was formulated in 1995 and today we can say that the concept of physical vacuum, which is a new source of energy, finds more and more supporters. The fundamental works about nature of "zero point energy" are published, for example, Andrew D. Sakharov [1], Hal T. Puthoff [2] and many other interesting works. It is clear now that space or "physical vacuum" has its internal structure, therefore it can be used as a new source of energy if we organize the process of changing of this structure. Moreover, according to some theories, the existence of reality (i.e. the World of some certain parameters of space and time) is defined by the function of probability of energy density. For example, Dr. Nassikas, Greece [3], proves that it is not possible to consider the space without its energy, and there is no space without energy. The internal structure of reality is coexistence of two forms: gravitational energy and electromagnetic energy. Any local increase of the first one should produce decrease of the second one, so the sum amount of the change is zero.

In some other articles about energy transformation processes (gravitational form of energy into electromagnetic heat radiation of mass, for example) we can find that both increase of entropy and the inverse processes (decrease of entropy) are possible and in this case the electromagnetic energy can be converted into the gravitational form, that is shown in details in the works of Nobel laureate I. Prigozhin, Order and Haos. Man's new dialog with Nature, London, 1984. Since **the direction of time** (the time course) **and direction of the entropy change** (increase or decrease) are related notions then free energy technologies are considered by Kozyrev as methods of practical application of natural time course [4] that is presented in aether-dynamics by Frolov as aether flow of some density and this aether density determines the time rate as hardness of cause-effect connections for any process, and also for the process of existence of matter in space-time of this aether density.

According to this theory, in any point of space it is possible to get power by means of energy transformations without any consumption of mass-fuel. We can say also that in this case some change of the energy density of space should be detected.

Let's clarify some determinations:

1. The Potential (lat. Potentia that means "force"). In physics this is scalar parameter, it's gradient expresses the intensity of field of a certain force. In common sense, the potential is possibilities, which exist for execution of some task, for completion of some work.
2. The Work is a quantitative parameter of energy transformations. The transformation means here change of form.
3. The Energy (Greek "Energie" means "action, activity") is a quantitative characteristic for different forms of motion.
4. The Power is amount of work per unit of time.

According to the given determinations by The Soviet Encyclopedic Dictionary, edition of 1988, Moscow, **the fact of presence of potential (scalar) field, for example, electrical or gravitational filed, is real possibility to produce some work if we can organize change of energy forms. Let's note that power source is not required to keep the potential field in force. It is free.**

...the potential (scalar) field can produce real work!

The example of this work, which is produced by the field: body falls in gravitational field and when it strikes on the ground then some part of its potential energy is transformed to heat, that is the work as transformation of energy forms. So, there is a conclusion: the potential (scalar) field can produce real work! But we have considered only a half of cycle and in classical case in the second half of the cycle it will be necessary to produce the same work against the field to raise the body to the initial point.

Let's formulate the task to produce the work periodically and to get the power in load from this process. Usual mistake is to accept the particular case (the same body returns back in the same field) as a single possible case. But in special case changes of the system are possible, for example, the field intensity is not a constant but some variable value (alternating or pulsing), or the body changes its own parameters. In this case in each of half-cycle of the process the field can produce real positive work to accelerate the body.

The main technological solutions are obvious: **it is necessary to create gradient of field in space** (full or partial screening of trajectory of the body, which is moving in the field) **or gradient of field in time** (pulsing mode of field). This is quite easy for electric and magnetic fields, but for system, which uses gravitational field to produce the work, we can assume changes of parameters of the body only.

It is possible to understand why professional physicists dislike the question about possibility to use scalar (potential) fields to produce useful work in a load since they think about The Law of Energy Conservation. To find mutual understanding it is necessary "to upgrade" this Law for 4-dimentsional case of real physical system. It is necessary to introduce **the notion of the structure of space-time** where the considered process is created. In other words, for real practical engineering tasks it is necessary to consider **space-time of the real process** but not an abstract space-time. Usually the energy density of technical processes is small in comparison with natural energy density of space (aether density), which is a result of real astrophysical processes, i.e. motion of planet, star, galaxy. If we discover structure of this real rhythm of the space-time of our planet then we'll be able to design it in our technical devices to use aether-dynamics as theoretical basis.

So, in orthodox physics there is the unchallengeable formulation: the work of potential field on closed trajectory of motion is equal to zero. Yes, it is right for only case: if one part of work is positive (the acceleration) and another part is negative (the deceleration). But one part of the trajectory or a part of periodic process with the negative work can be excluded by different methods: by means of spatial superposition, pulsing mode and change of interaction polarity or by the screening of electromagnetic interaction.

For example, minor changes in vacuum tube design (the grid is located under cathode) allows increasing the kinetic energy of electrons and to increase emission current by means of the potential on the grid only. Also vector potential of magnetic field or gravitational potential can be used by similar way.

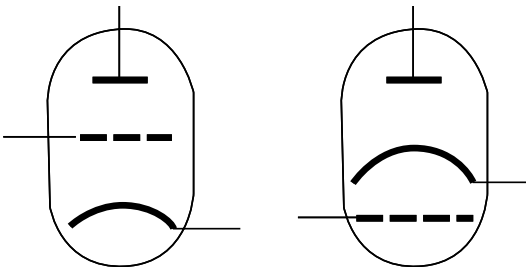

Fig. 1

Besides this way it is possible to use pulsed mode and switch-off the primary energy source before the emission electrons will reach the anode, Fig.2. In this case there is not the conductivity current between anode and cathode and the primary source is not discharging during its work.

Therefore, it is not a news that potential field can produce real work. In any textbook there are examples of positive and negative half-cycles that result to zero net work. But for the case of consequent execution of two processes the parameters of one of the processes can be changed, that **the work, which is produced on the closed trajectory can be formed as two or more parts of positive work.** Important aspect is following: it is necessary to determine the point (moment) of change the sign of the interaction and at that point (moment) to change the parameters of the process accordingly.

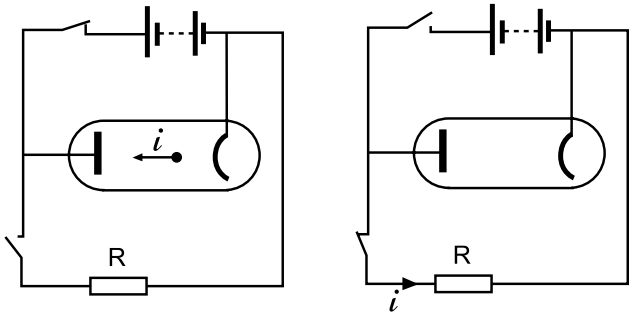

Fig. 2

The good sense requires the answer: what is the source of the power to produce this work if this proposed concept is right? Let's notice that before the considered examples, the existence **of power interactions of potential fields** must make the same question. For example, how the ordinary permanent magnet (i.e. its vector potential) holds a piece of metal making work against force of gravity without any fuel? How the potential field can move and accelerate ions, i.e. kinetic energy of ions can be increased without any fuel? What provides the forces of elasticity? Let's try to find answers from consideration of inner structure of electric and magnetic field, especially let's develop **our understanding of the notion of gradient, which describe properties of space-time design in area of this field.**

The concept of potential as bi-directional flow of photons and anti-photons was proposed by English mathematician E. Whittaker, and then it was developed by Dr. Thomas E. Bearden [5]. In this concept, the generalization of the Third Newton's law looks as the requirement of complementary pair to the process of the electromagnetic radiation. Since "process" means a change of information in time, this paired anti-process is reversed in time. Of course, it is development of process to its own future, but from our point of view, it goes from future to past. According to generalized Third Newton's law the radiation of photon is paired with anti-photon. In this case, the internal space-time structure of electric potential field is formed by two contrary flows of energy: photons spread from charge source and the anti-photons "inflow" into the charged mass. Let's notice that this concept defines the relationship of charge and mass. The charge without mass does not have any sense.

The flow of energy outgoing from charged mass is responsible for all phenomena of radiation. Incoming flow of energy is responsible for the gravitational interaction. Therefore, the notions "radiation" and

"gravitation" can be considered as complementary pair; that is considered in details in concept of Josef Hasslberger [6].

...it is impossible to get "something" from "nothing"

There is a quite correct question: since "something" can not be created from "nothing" then what and where will be changing if we create the process of free power dissipations in local area of our space-time by means of asymmetrical potential interaction?

Let's try to present a "process" as some change of "information" in time and from this point we'll get the conclusion about results of this energy disbalance of the natural internal structure of potential field: in this case the entropy process in direct time (heat dissipation in load) should be balanced with equal anti-entropy process in reversed time. In other words, the disbalance is change of the space-time curvature and changes in the time rate.

So, it is impossible to get "something" from "nothing" but if we have understanding of the balance (process in time and anti-process in reversed time) then in the Universe the 4-dimentsional balance is not violated. It is assumed here that it is impossible to create one process but it is possible to create two opposite balanced processes, and each of them produce real work in the load. In astrophysical consideration it was stated in 1964 by Academician Gustav Naan, Estonia, Tartu. He wrote [7]:

"In our real world we could extract any amount of energy from vacuum if some technology provides at the same time the extracting of the same amount of energy for anti-world. Total sum value of energy is equal to zero."

Let's note also that similar conception of "dynamical zero" was applied in ancient India mathematics, i.e. "zero" is not "nothing" but it is hidden possibilities (balance of forces).

One more interesting question appears: what is about reality of the particle of matter after we have claimed that its mass-parameters are parameters of certain process? With this idea the material world as a whole is certain process and "stability" is not a property of some object but a parameter of its existence, which is a process in space-time of some certain energy density and some certain structure. By analogy the vortex in liquid is a process but it is not a liquid.

Thereafter, as electron was presented by Shredinger as wave packet and by Whittaker as function of two scalar potentials, the old idea of instability or **dynamic structure of matter** has the possibility of experimental testing and development as a teleportation technology. This idea is technology of space-time engineering, i.e. creation of the space-time with some certain parameters where curvature (or rate of time) determined rate of existence of the matter in space. It is related with some energy density, which can be increased or decreased. Since by this way it is possible to consider any material particle of substance as certain process, which is balanced by corresponding time-reversed process, so there is no theoretical difficulties to develop technologies of chemical transmutation, materialization, dematerialization, teleportation etc.

So, the using of potential energy to create a process of dissipation of power in load does not violates the Law of Conservation, and this Law can be generalized: the total energy of four dimensional system is amount of energy of processes in time and energy of processes in reversed time, it is constant and it is equal to zero.

Now let's try to review some free energy projects (the systems to produce work without consumption of fuel). Russian Peter the Great had intention to visit Germany in 1725 to test the Orferius' device. There is a very old description of "perpetually rotating wheel", which was made in India by inventor Bhaskar in 1150! From that times the mind of inventors is developed to other modern systems but due to the efforts of scientific groups, which are interested to keep in force the ideas of primitive materialism, the great idea of free energy transformation is distorted to such extent that any person, who began to speak about free energy, had a chance to get the name of "mad". Why? The reason is common understanding of the "power", which is "some work per unit of time" and generally it can be presented only as result of some transformation of matter structure, i.e. disintegration, chemical reaction, nuclear decay, nuclear synthesis or any change of structure of a matter. In any case, a material (the firewood, oil products or nuclear fuel) is considered as the fuel, regardless of its transformation method.

Some concepts did not consider the fields (electromagnetic, gravitational and others) as a kind of matter. So hypotheses, and even successful experiments on transformation of "non-material" type of energy in energy of material object (into the work) were not taken into consideration. The physics is a study about measurable and tangible quantities. New measurement methods let us work with a new physical phenomenon. So, we can see that **real situation in alternative energy is changing due to experimenters efforts** but not from the great theoretical team.

Some time ago the electric energy was not considered as a material object, but gradually people have been able to refuse the gas pipes, which were real material source of power for the gas light lamp, in favor of electric wires for electrical illumination. In a short time, I think, it will be possible to refuse the wires and we'll

consider the aether (physical vacuum) as unlimited energy source if we organize **the process of transformation of space-time parameters.** It will be necessary to drop the old conception of "primary source of power", which should be connected with the consumer by some method and to develop conception of free energy source in any place "on-demand".

Let's consider, what the term "free energy" means today. The energy in general sense means the "ability of body to produce some work". The energy of closed system is constant. Certain device can look like "perpetual mobile", but nobody will be shocked because the way of energy "inflow" is known. For example, solar panel battery is obtaining its power from external source of light. But in general case, 3-dimensional observer can see nothing similar to the inflow of energy into the system if multi-dimensional energy balance is not analyzed. In other words, "perpetual mobile" is a right name since for its description it is necessary to use notions of "Time", "Eternity", "Causality" and other categories, which are more related with philosophy and religion but not with modern physics.

The "perpetual mobile idea" is really value to be the purpose of serious scientific work. In the book "Great experiments in physics" published by "World", 1973, Professor G. Lipson wrote: "Joule was the person of a very practical kind of mind and he was enthusiast of the perpetual mobile idea". I hope that it is not necessary to explain here who was Joule. However, "practicality" of free energy generators is obvious only for energy customers, but not for energy producers, who created the centralized system of energy distribution. This is the main reason of absence of alternative fuel-less energy systems in the modern market.

Let's consider the existing classification of "perpetual mobiles":

1. "Perpetual mobile" of the first kind is a design, which can "create energy". It is disputable aspect and all patent offices refuse to consider the patent claim of such type. They answer that "energy can not be created or destroyed" but energy can be transformed from one type into another type.

2. "Perpetual mobile" of the second kind is the collector of environmental heat. It is not a "thermo-pair" which uses temperature difference to produce electricity, but it is the "heat pump". This type of devices works with negative entropy, or more exactly, with sintropy. The terminology still is not defined but we can say that in entropy systems the produced work is equivalent to the dissipated heat and the work, which is produced by sintropy systems is equivalent to some absorbed environment heat.

3. The "perpetual mobile" of the third kind is a demonstration of perpetual motion without friction. The analogue is electric current in superconductors. Development of this idea is creation of systems with negative friction. In electromagnetic systems it corresponds to the known cases of the "negative conductivity", i.e. some electrical circuits in this mode can generate output power.

Additionally, let's show that "creation of energy" is possible in theory, for example: two processes of equal power compensate each other $A + B = 0$. Let's assume that some technology creates another (inverse) process as: $0 = A + B$ i.e. two processes of some power in sum create zero result. In general principle, also there is possibility to use many processes balanced situation as $A + B + C + \ldots = 0$ and this interesting conception is known as theory of multipolarity.

Let's consider some quite real (to my mind) examples from the history of development of free energy technologies. Nikola Tesla's investigations are not well known to modern scientists and engineers. In his works on development of wire-less telecommunication Tesla used flat spiral coils as a secondary winding of transformer. The magnetic field of such coil is radial and it is placed in the plane of the coil. In 1995 the author of this article experimented with similar flat spiral coils. I have to claim that when such coil is operating as secondary winding and the solenoid is the primary winding of the transformer then we can measure asymmetrical mutual induction, i.e. connection of active load (lamp) to output circuit of the transformer is free from input power in the primary winding. It is the simplest example of technical realization of the asymmetrical cause-effect connection, described by Kozyrev in his theory of active properties of time.

... "creation of energy" is possible in theory...

Another Tesla's invention is his resonance transformer. Modern electrical engineering describes transformer with forced electrical oscillations and radio engineering considers operation of resonance systems mainly. Tesla put the question on transformation of power in resonance transformer and by this way the efficiency can be more than 100%. With high frequency currents and high power level Tesla used single-wire terminals as loads, i.e. the lamps and other single-wire receivers of power (motors) were powered from high frequency changing electric field. Such single-wire terminal does not consume any power from primary source because it uses the change of potential in point of connection to conductor (let's note also that for maximum efficiency this point of connection should be one of the maximums of standing wave).

The notion about "free vibrations" belongs to Tesla and this term describes sinusoidal oscillations in electric circuit that is created after short non-sinusoidal impulse due to real vibrations of the free electrons. Resonance mode of the free vibrations can be the real way to excess power output.

Original Tesla's approach to electrodynamics allowed him to build in 1934 fuel-less car with electromotor, which was powered from some 12 vacuum tubes generator of unknown design.

The standing waves of electric field that were observed by Tesla during thunderstorm brought him to conclusion about possibility of the system to power remote energy consumers from energy generator without any transmission lines and without radiation methods. He assumed that it is necessary to create special standing wave of electric potential (or variable in time electric potential field) around the generator, then the unlimited number of loads (lamps, motors) in area of this potential field can be powered if they are tuned in resonance with oscillations of the generator. Let's notice that in each receiver the power can't be more than power of this generator but it is possible to install many independent "receivers" without mutual interference.

The modern investigations on these problems sound as sensation, because Tesla's works are unknown for the modern generation of scientists. Of course, modern electronics components and the tools facilities allow to create real "miracles" in comparison with the past age experiments. For example, engineer Avramenko described his work on single-wire power transmission in Journal of Russian Physical Ideas, 1991, No.2, and in journal "Inventor and rationalizator" 1992, No. 5, 6. The light bulb (or ventilator) was used as load of the single-wire power transmission line. This line can be made of high resistance material, for example, tungsten, but the power can be transmitted without heating of wire! It is possible to say that in this experiment a wire does not transmit power from the generator to the load, but the wire is the conductor of information signal, which is created by polarizational current opened and described by M. Faraday.

It is not difficult to repeat the experiments with single-wire line: it is necessary to place two diodes on the end of a line, which is connected to secondary windings of high voltage transformer (I used television set high voltage unit) by such a way that different poles of the diodes are connected to the line, Fig.3.

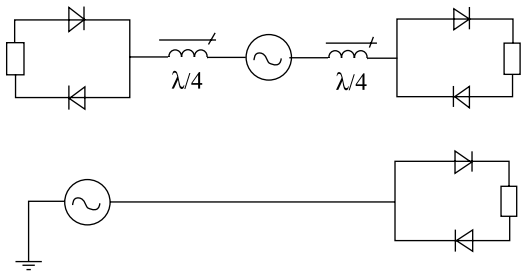

Fig.3

Two other poles of diodes create the source of potential difference (voltage), from what it is possible to charge the capacitor or to power the load (luminescent bulb). This diodes scheme is named as "Avramenko's diodes plug". In my experiments it was determined that high efficiency mode is resonance mode in real line and in this case the maximum change of potential is created in the point of connection of the "Avramenko's diodes plug". There is well known formulas to calculate this resonance as quarter-wave antenna vibrator system. Of course, high frequency and high potential allow creating high power in the load. In 2001-2003 New Energy Technologies magazine have published new experimental results on single-wire power transmission reported by research team from Moscow (Prof. Strebkov, Avramenko, Nekrasov and others). For example, they built and tested lines from 20 to 100 Kwtt power level!

... the electric potential field can create non-compensated force in the system and to produce a work without any power input.

One more well known researcher on the subject of free energy was Thomas Townsend Brown. He considered creation of reactionless propulsion force by means of electric forces only. Ionization is not considered here! According to his works, the electric potential field can create non-compensated force in the system and to produce a work without any power input. English patent by T. T. Brown #300,311 of August 15, 1927 describes the method to create propulsion force and power from electric energy source only. In this first patent it was claimed that in ordinary flat electric capacitor (two flat plates and dielectric between them), which is charged up to 50 kilovolts and more, Brown discovered propulsion force. This force moves the capacitor to positively charged plate direction. It is only one of his ideas and in his other patents of 1930 - 1965 Brown has described many new methods to create propulsion force and free power in load by means of electric field only (scalar potential field as a source!).

... the efficiency of "electric system can be million to one"

We have to exclude ideas on electrokinetic apparatus since it is just a reactive method and propulsion force is result of ionization flow. Especial case is Brown's **idea to create the asymmetry of electrostatic forces** by means of some special form of surface, USA patent #3187206 of June 1, 1965, application of May 9, 1956 (Fig 4).

The schemes and descriptions by the Brown's patents are undoubtedly the work of great practical value. As was mentioned by Brown, the efficiency of "electric system can be million to one" because the potential field can produce real work, for example, rotate some electro generator, but it does not change the primary source of field.

In 1927 T. Brown demonstrated the devices in Ohio, later he worked in France. His works in France were

stopped and he returned in the USA. Detailed information on his works can be received from descriptions of patents http://www.soteria.com/brown and from the book “Electrograviticis Systems” by Thomas Valone, Integrity Research Institute, USA.

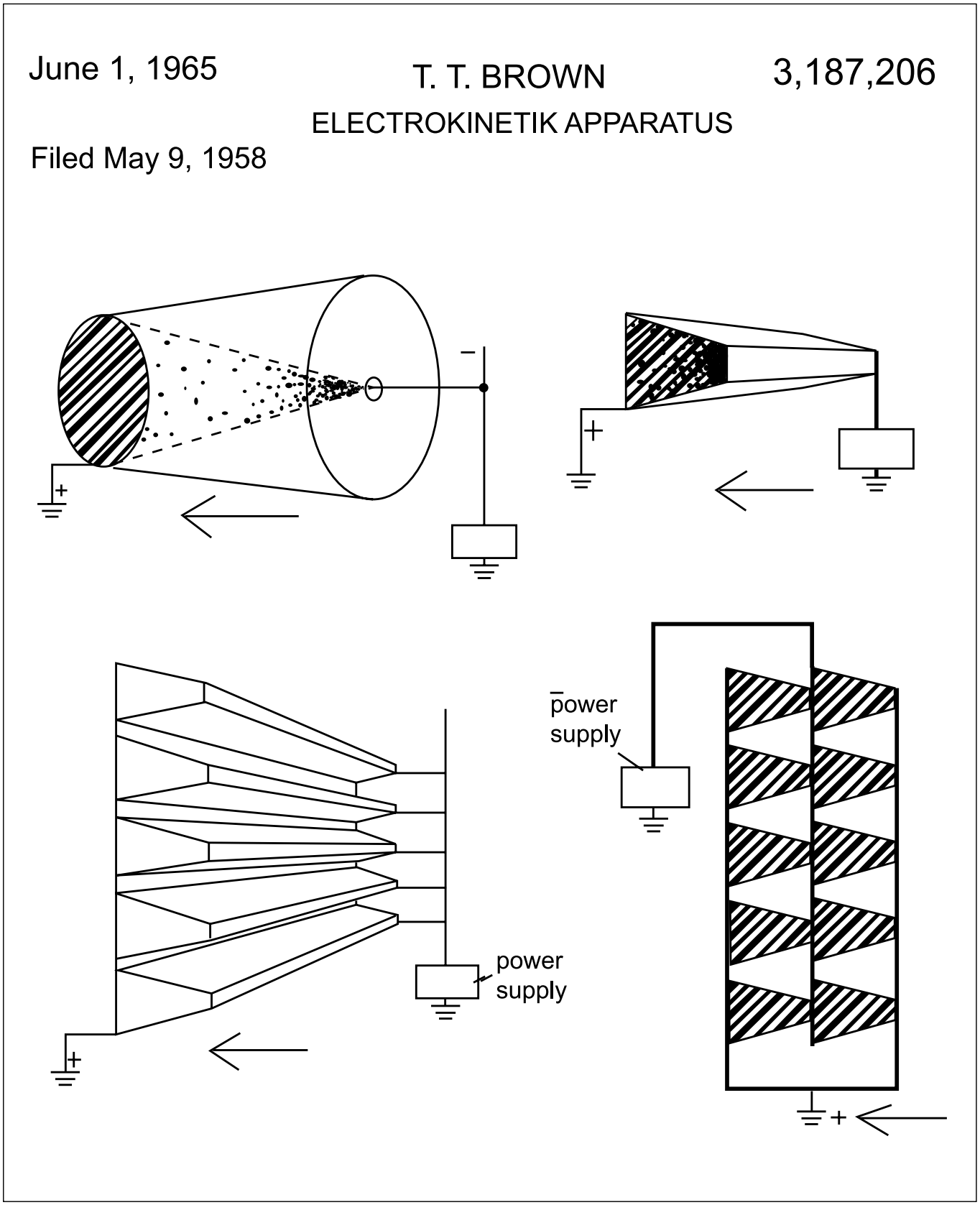

Fig. 4

Electrokinetic apparatus by T.T. Brown

Besides, there is the simplest example of creation of real work by means of potential field that is also resulting from the Brown's works. Usually two plates of electric capacitor are equal to each other. However, if one of the plates is small and another one is large then the electric field between them is not isotropy field and in this case there is some **gradient of intensity of the field**. In such field any dielectrical object, for example a ball, will be polarized unevenly and due to this fact some force should make it to be moving aside, where the field has the greater intensity. I have to note for mathematicians that since the intensity is "gradient of potential" then gradient of intensity is the **gradient of the gradient**, i.e. it is the second derivative of potential. This idea is an example of the well-known rule: the change gives the new quality.

The example of creation of the propulsion force by means of potential field is also connected with "perpetuum mobile" task, since conductivity currents in the capacitor are very small and it almost does not require power consumption (after being charged once time) and the system can produce mechanical work permanently, in this case it is the work against the gravity force. In general case, if the design allows asymmetrical energy transformations, then the surplus output power and reactionless propulsion force can be created in this system.

Most likely future aerospace systems, which are based on the electrogravity, are the most perspective direction of free energy technologies. Why not for the power engineering? It is clear that now there are some existing fuel heating systems, heat stations and power industry to provide by some traditional way all current needs of the society and due to this fact the innovation of any free energy technology is related with hard competition. However, for commercial programs for cosmos the reactive rockets principles are not acceptable more. Each satellite during its operation should produce profit to compensate large expenses for the rocket-carrier. Only fuel-less propulsion systems can allow developing space commercial programs that are new infinite market. Let's note that the gravitational (reactionless propulsion) technologies are not related with cosmodrome and their cost can be quite acceptable to realize the project with private funds.

... future aerospace systems, which are based on the electrogravity, are the most perspective direction of free energy technologies.

There are some known examples of free energy systems.

In 1921 The Seattle Times, as well as Denver Post of August 8, 1921 published the articles about inventions of Alfred Earl Hubbard. His device included the central core with coil and eight remote coils placed around the central core. After primary impulse, the impulses in all coils were powered and rotating magnetic field was created in central coil. The power produced in the central coil was quite sufficient for self-excitation of the system and for producing of useful work in the load (motor). The boat and the car with electromotor, which was powered from the Hubbard's generator, were demonstrated.

In 1928, Lester Hendershot invented the electric generator of 300-Watts power. This device was designed of details used in radio-receiver to get oscillator (500 kilohertz) and non-inductive coil. Later, in 1970, William Cooper experimented with non-inductive bifilar coils. He used induction phenomenon in the case of zero magnetic component (two-wire winding or flat spire coil).

The Cooper's USA patent 3610971 of 1971 describes **the principle and the device to create power in secondary circuit without reaction on primary circuit**, as well as method to get reactionless propulsion force for aerospace application. Cooper also has found that specially designed coils can produce the field, which can not be screened and this field has some common parameters with the gravitational field.

The gravitation is considered by Cooper as a polarization of atoms in gravity field of planet. So he declares in description of his patent: "the electronic generator... of super high frequency creating the pulsing electric field of single polarity... acting in opposite direction to the Earth gravitational field... that to depolarized the atoms and to release them from the gravitation".

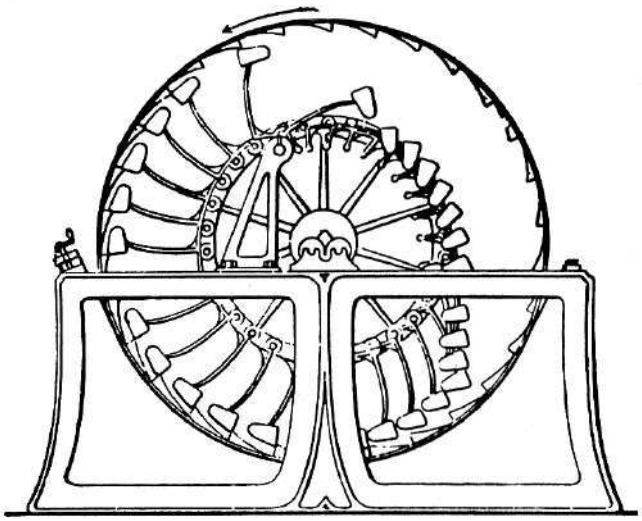

Fig.5

By the way, the gravitational field itself can be used to get a power. "Unbalanced wheel" is a well known design. The weights on the one side of the wheel, which is rotating in vertical plane, can be organized to be moving to axis, but on the another side the same weights can be organized to be shifted from the axis to the periphery of the wheel. By this way there is some

constant shifted center of gravity in the system and it can be permanently rotating system. One of the inventors who built such wheel is Hugo R. Fraga, Havana, Cuba (The Perpetual Motion Mystery. R.A. Ford, Lindsay Publications Inc., Bradley, IL 60915, USA, 1987, see Fig. 5).

The earliest information about such systems is dated of 1150 and the name of inventor is Bhaskar, India. He used the tangential disposed pipes, which were half-filled with water. In France (1235-1240) William de Onnecure demonstrated self-rotation wheel with seven weights. In Italy (1438) Mariano de Jacopo has built the system made of eight bars disposed in the plane of rotation, and the bar can be fold up in the middle like elbow joint to provide rotation. One of the well-known and documented events of real demonstration of perpetual rotation wheel was mentioned in 1620. Edward Somerset (Second Marquis of Worcester), author of the book "Century of Inventions", 1963, has built and tested the wheel of about 4 meters in diameter, 14 weights of 25 kilograms each. The test of this machine was organized in London, in witness of King Karl, Grand Duke Hamilton and Grand Duke Richmond, and there are files in royal archives about this test. The descriptions of these and other systems are published in the book "Perpetual mobiles: past and present time" by Brodiansky, Moscow, Energoatomisdat, 1989.

Fig.6

In different idea, which is known from Leonardo Da Vinchi drawings, lifting of water is produced by the helical "Archimedes' screw" of small diameter with large centrifugal acceleration, which reduces weight, but lowering of water was organized with the screw of other (large) diameter, so the force of weight is working to rotate this screw by the weight of the falling water. The paradox of these systems will be removed if to consider them as systems of variable topology, as it was done at the beginning of the present article. Practically, the **cycle is separated here into two processes** (the lifting and falling of mass) in the system with different parameters (the topology) for the first stage and the second stage of the cycle, but herewith **it is necessary to consider two different physical systems, not one and the same.** In that case, the classical theory can explain the work created by potential gravitational field of our planet as energy exchange between two different systems.

Other well known topic is research projects by John Searle, i.e. the "Searle's disks" (Fig. 6). It is necessary to note that the inventor mentioned in his articles anti-gravitational effect and free energy output also. The address is: John Searle, 13 Blackburn Lower Strand, Graham Park Estate, London MW9 5 NG, United Kingdom.

In several words we can say that rotor makes free electrons to be displaced to the peripheries of the system. With sufficient velocity it was mentioned that there is phosphorescence and ionization around the disk. It is possible to assume that main effect is based on well known Lorenz forces and understanding of the Poynting vector, which is circulating in this system. The ionization currents are closed through the space from periphery to the center, and self-rotation of the disk is provided by the classical Lorenz force, since the current interacts with magnetic field of the rollers.

In Russian experiments of 1992 Roshin and Godin built similar system of 7KWtt power output and they claimed that 100 kg axial force and areas of decreased temperature in environmental also were detected. Fig.7 demonstrates main parts of the system by Godin and Roshin.

It is necessary to note that similar anti-gravitational effects appearing for the case of over-unity operation were observed by different inventors independently. For example, in 1990 Floyd Sweet demonstrated his invention named as "vacuum triode amplifier" VTA. The barium magnets were pre-conditioned by special method to be used in special "trigger mode". This "bi-stable condition of magnet" provides possibility of transition from one direction of field to another direction due to the weak control signal, which was provided from external generator. It is known that if the material was pre-conditioned by the magnetic switching of 60 Hz frequency then its control signal must have the same 60 Hz frequency. A part of output power was closed to provide feedback and additionally some power can be used in output coil for the load. Tom Bearden studied the scheme of vacuum triode amplifier and confirmed that it demonstrates the work with negative energy. It means that the work in the load is connected with use of negative time. In this negative time, according to Bearden, the gravity is repulsing force. The experiments on VTA demonstrated that VTA decreased its weight according to level of the power, which is extracted from vacuum. Additionally we can

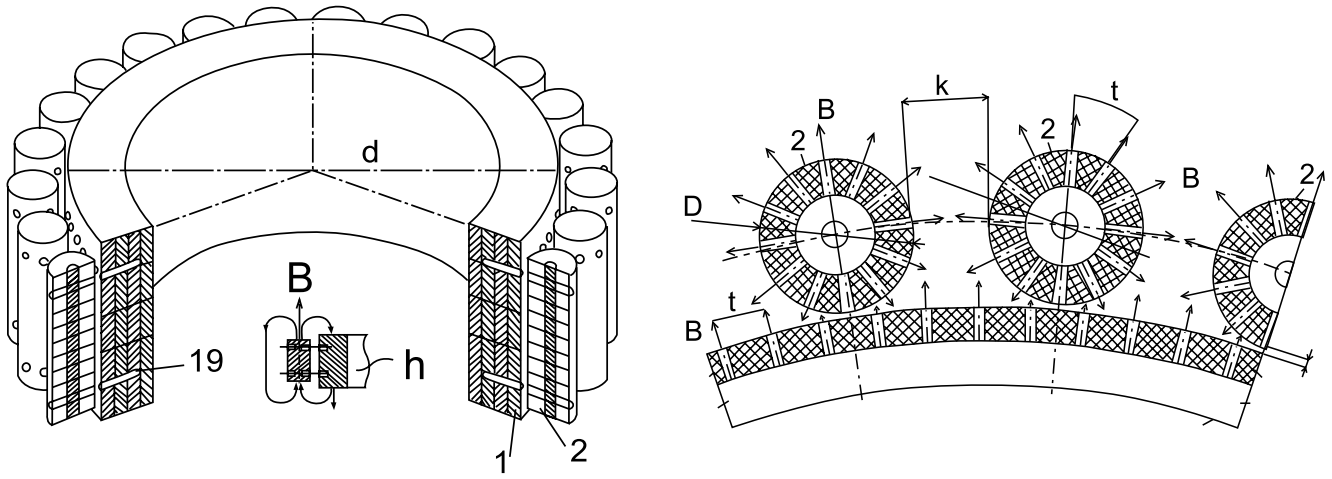

Fig.7

say that permanent magnets and coils of VTA were self-cooling during operation and the temperature difference was about 20 degrees in contrast with the environmental temperature.

One of VTA schemes includes two sets of magnets 4 x 6 x 1 inch, placed on two walls of frame. The attraction is created between them. Output and controlling coils are located between them. The axes of output coils are parallel to the magnetic field lines, but the axis of control coils are placed under 90 degrees angle. The secret of system is the "conditioning process", which "brings the magnets to the special condition". It is necessary to create great number of micro-cracks in the magnet due to re-orientations of magnetic domains. In such "half-magnet" the domains get the ability to be orientated in the same direction in a weak "control" magnetic field. In fact, they are not domains but large parts of magnet's material, separated by micro-cracks, that is to say acoustic domains. Many researchers repeat Floyd's works. Let's note that arc discharge of alternating current through magnet barium ceramics directly can provide the best results of the "conditioning" process. The coil of "conditioning" is not necessary in this case. The frequency of alternating current must be corresponded to the frequency of the control signal. Thereby, Sweet was creating **the bi-stable solid-state condition of magnetic substance.** The acoustic resonance is the reason of oscillations with the frequency according to the control weak magnetic field. Floyd Sweet died on July 5, 1995 at age of 83 years old. It is known, that his widow sent the archives to some great Automobile Corporation.

... the extraction of space energy is result of transformation of vacuum energy but from the other hand the energy density in this case determines so called "time rate"

It is interesting to note again that the magnets of VTA demonstrated self-cooling during operation, up to 20 degrees difference in comparison with the environmental temperature. It is one more example of relation between notion "density of time" and "energy". We can say that the extraction of space energy is result of transformation of vacuum energy but from the other hand the energy density in this case determines so called "time rate".

Kozyrev's articles [4] on causal mechanics theory and experiments describe possibility to use "time course for producing of useful work". Kozyrev introduced notion "density of time" and he demonstrated experimentally several methods how to change the density of time, which depends on irreversible processes intensity. Powerful "generator" of such processes is biosphere of our plane and it creates **season and daily changes of the density of time**. It is known that VTA power output also was variable in different time of day and night. It can be explained by Kozyrev. Next step in logical development of this idea is **to change notions from the "density of time" to "density of aether"** [10].

Relation between magnet phenomena and aether circulations was known from the beginning of the electrodynamics and now we can assume that VTA was real example of asymmetrical cause-effect connection, where the hardness of this connection depends on the density of aether. In this case the season and daily variation of the aether density are reason of VTA output power variations. So, we can make a conclusion: conception of **asymmetrical cause-effect connections** should be used as theoretical basis of all over-unity systems.

Generation of extra power in nonlinear materials (ferrites and dielectrics) was considered by Nikolay E. Zayev, Journal of Russian Physical Ideas, #1, 1991. Discovery was claimed as "Cooling of some dielectrics by changing electric field with generation of energy", Russia discovery #32-OT-10159, November 14, 1979; the inventions were also claimed as "Method of transformation of heat energy of dielectrics into electric

energy", Russian patent claim #3601725/07 (084905), of June 4, 1983 and "Method of transformation of heat energy of ferrites into electric energy", Russian patent claim #3601726/25 (084904), of April 3, 1983. This theory is not about some transformation of space-time structure but in any case the practical application of conversion of environmental heat is very important because this work is real basis of free energy systems.

In one of Zaev's articles, which were published in Journal of Russian Physical Ideas, he quoted from K. Zialkovsky: "If the heat can be transmitted from cold body to hot body, then it must have enormous importance, and not only philosophical or scientific, but also practical importance. The Clausius postulate is not confirmed in this case. The gravitational force, as well as other reasons (number of the reasons is unknown) break this postulate... heat can be transmitted from cold body to hot body but only as the result of some exclusive conditions", published in Russian, "The Second beginning of thermodynamics", Kaluga, Russia, 1914. So, the inventor of free energy system should provide this "exclusive conditions" to organize collection and transformation of environmental heat in his free energy system.

Another well-known free energy system is Swiss electrostatic machine. In spiritual commune Methernitha, Linden in Switzerland, since 1980 several free energy devices have been generating total power of 750 kilowatts. From the technical point of view, these devices are modernized electrophore generator. Permanent magnets also included into design of these devices. The machine of 20 cm diameter produces about 200 watts, and a big machine has the disk of 3 meters and it produces about 30 kilowatts, Fig. 8.

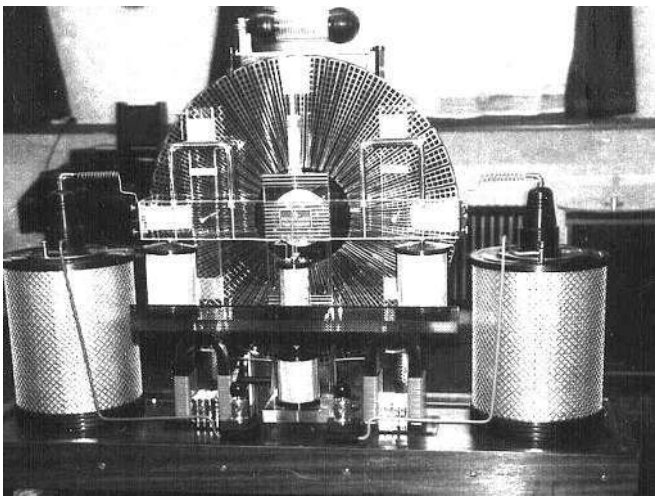

Fig.8

One of the modern technical decisions, which are very close to this Swiss machine is patent USA No. 4897592 by William Hide, January 30, 1990. This device is "system to generate power from electric field". It is one more example of work, which can be produced by potential field, in particularly by means of electric field that can be used as free source of power. The energy (the potential energy) is the possibility to produce work and the power is a work per unit of time, i.e. it is a process. The properly organized process, for example acceleration of rotor in Hide's machine, uses the potential field on the part of positive work (acceleration) and the author of the patent provides meta screen on the part of the trajectory, where the field decelerates the rotor.

... it is "perpetuum mobile" and it can not be patented even if it really works!

One more example is Reed's motor, which uses energy of permanent magnets. By the description of 1991 it is made of four disks (two immovable discs and two rotating discs), and eight magnets are placed on them. Howard Johnson used similar method, USA patent #4151431, Fig.9

U. S. Patent Apr. 24, 1979 Sheet 1 of 2 4, 151,431

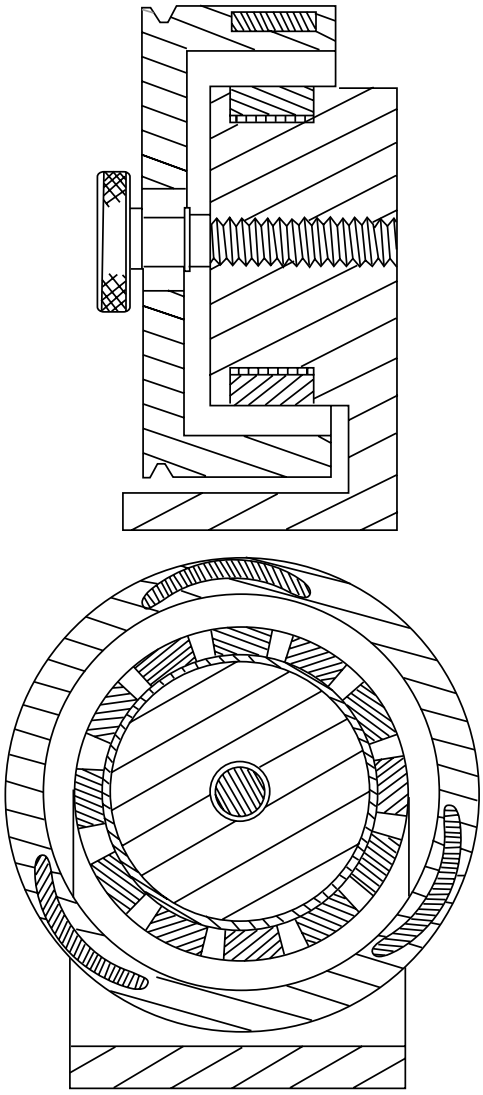

Fig.9

Journal "Science & Mechanics" of 1980 describes this invention. Hovard filled the application in 1973 but he has got the confirmation only in 1979! The reason of delay is very clear: it is "perpetuum mobile" and it can not be patented even if it really works! Johnson found clear and simple description of generation of power in his device and explained it as "extraction of power from inner energy of electron spin in ferromagnetic material".

From text of his description it follows that USA patent #4,151,431 of April 24, 1979, "Permanent magnet motor", author Howard R. Johnson, application #422,306 December 6, 1973 was developed from the prototype that is USA patent #4,074,153 of 1978, class of international classification H02K 41/00E:

"The invention is directed to the method of utilizing the unpaired electron spins in ferromagnetic and other materials as a source of magnetic fields for producing power without any electron flow as occurs in normal conductors, and to permanent magnet motors for utilizing this method to produce a power source. In the practice of the invention the unpaired electron spins occurring within permanent magnets are utilized to produce a motive power source solely through the superconducting characteristics of a permanent magnet and the magnetic flux created by the magnets are controlled and concentrated to orient the magnetic forces generated in such a manner to useful continuous work, such as the displacement of a rotor with respect to a stator. The timing and orientation of magnetic forces at the rotor and stator components produced by the permanent magnets to produce a motor is accomplished with the proper geometrical relationship of these components."

...conception of asymmetrical cause-effect connections should be used as theoretical basis of all over-unity systems.

It is reported that functioning Johnson's model produced about 5 kilowatts power free of any primary source of energy. Let's note that Johnson writes in his patent about permanent magnet as about system with "super conductive parameters". The currents of electrons in permanent magnet are manifestation of real superconductivity and for this case it is not necessary to provide the cooling for zero ohmic resistance. Moreover, the "resistance" must be negative since the magnet could save and renew its magnetized condition. Thereby, any permanent magnet is the example of perpetuum mobile of the third kind on the micro level. Also we can say the same about each atom.

Also, let's note that in general case motion (rotation) can be created due to the discussed above gradient of field, which in Johnson's device is result of asymmetry in "rotor-stator" system. By the similar way the gradient of velocity of airflow above and below wing creates the gradient of pressure and this fact produces great lifting power in airplanes.

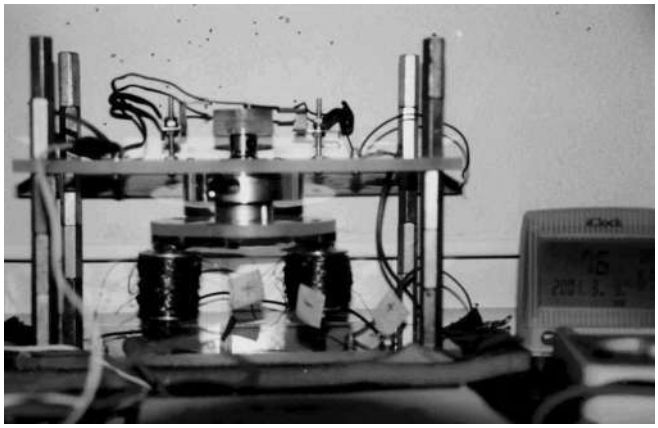

Fig.10

Well-known variant of permanent motor-generator is Adams motor, Fig.10. The rotor with radial orientated (the same pole outward) permanent magnets is rotating and creating inducted currents in stator coils, which are placed around rotor in the plane of rotation. From the point of traditional electrical engineering, any motor-generator without closed magnet flux is not high efficient device. However, exactly open magnetic flux of the Adams motor allows to take off power without deceleration of the rotor. We can assume that in this case phenomenon of electromagnetic induction is not important but in this design there is magnetic induction only, i.e. magnetization and demagnetization of cores in the field of the moving magnet. It is a perfect analogy with phenomena of electric induction that is "electrization by influence". Similar "magnetization by influence" differs from electromagnetic induction and secondary magnetic field in winding of generator is not related with deceleration of the rotor. Robert Adams works with Harold Aspden under patenting of their system. Adams is more than 70 years old but from our correspondence with him we can say that he is going to build demonstration version of 10 Kwtt generator.

...any permanent magnet is the example of perpetuum mobile of the third kind on the micro level.

There is also special name "alternators" for this class of devices, which use interruption of magnetic flux, for example it is the device by USA patent of John Echlin #4567407.

The experiments to investigate the alternator principles were organized also by the author of this article and it was demonstrated that ferrite core of the generator coil is self-cooling. The simplest experiment is based on electro motor, which rotates iron plate and it periodically appears in the gap between magnet and coil. But it is necessary to note that change of the flux in the coil area should be organized by such a way to decrease the flux of the field in the rapprochement half-cycle and to increase the flux for the moving off half-cycle. In this case the

rotor is accelerated by the secondary field (back-EMF). From 1994 to 2003 several experiments were produced and main principles were claimed in the patent description, Fig.11.

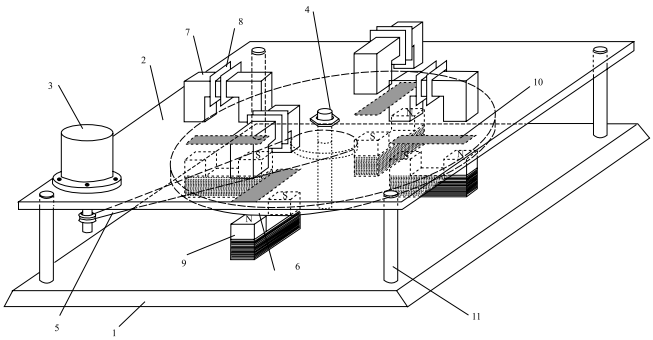

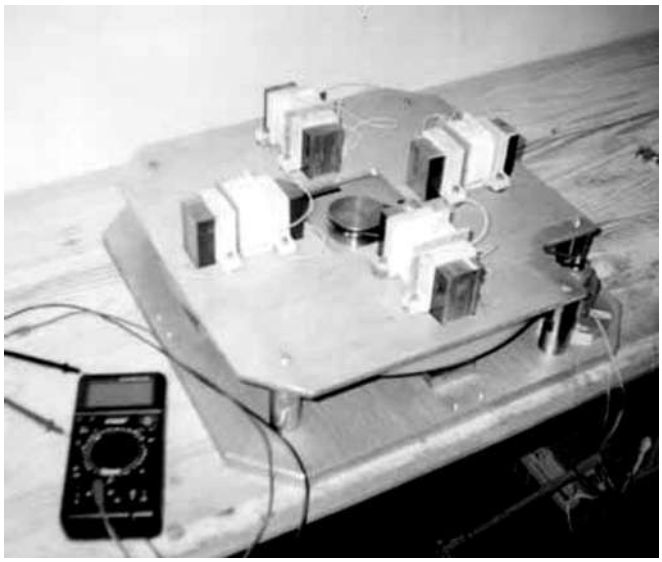

Fig.11

One more topic is "extraction of power from air" and Josef Swenson has conducted the series of simple experiments to develop it. The frequency of natural pulsations of electric field of planet is about 7.5 Hz and it is well known from Tesla's age. Swenson works with frequency 375 kilohertz and antenna of 10 meters. Please, contact for more details: Josef Swenson 423 North 15th Street, Moorhead, Minnesota 56560, USA. However, everybody remembers from the school story about simplest electrical experiments by Lomonosov and Rihman, who investigated arc discharge in gap between iron wire from a roof ("antenna") and ground wire. Let's include the resonance circuit "inductance-capacity" and diode rectifier to get some useful work in the load "from atmospheric electricity", Fig.12.

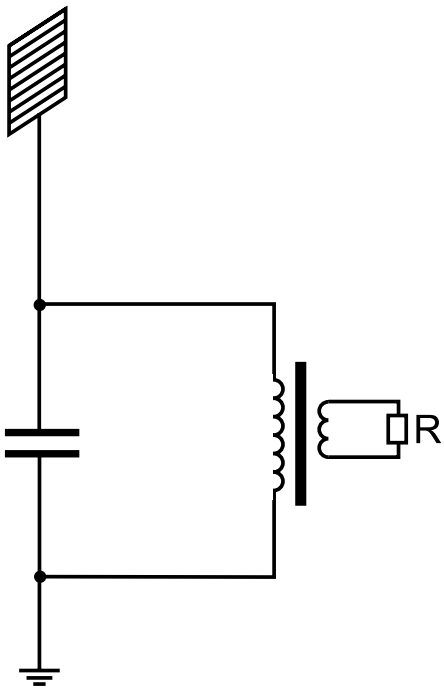

Fig.12

In 1900-1930 a lot of articles were published in technical press about Henry Moray. His demonstration systems produced more than 50 kilowatts free power output. It is known that Mr. Yakovlev (from USSR Foreign Department headed by Mr. Molotov) visited Morey in November of 1929 in New York to test his devices. The devices consist of capacitors, coils and special electronic-vacuum lamps.

In 1990 journal "Magnets", 2 (3) published article, which describe analogy between Moray's devices and Hubbard's coils, which can extract power by means of inner energy of nucleuses of materials if special resonance is created. In 1978 Cospray Research Institute has published the well-known book "The Sea of Energy" by T. N. Moray, in which theory of Moray is presented most completely.

RQM Raum-Quanten-Motoren Corporation (Schmiedgasse 48, CH-8640 Rapperswil, Switzerland, fax 41-55-2125209) offers for free energy devices of different power level: RQM 25 kilowatt and RQM 200 kilowatt. The principle of work is based on an invention by Oliver Crane and his theory. Web site http://www.rqm.ch. But I have to note that in present time they are developing capitalization of the company

mainly (actives are above 650 million dollars) than innovation of the new technology.

One more historical example: in 1925-1945, Hans Koler demonstrated his free energy devices. The system was built in Germany and it produced 60 kilowatts of free power. The description includes six permanent magnets and coils, which were superposed in plane of hexagon form. Each magnet is core of the coil.

Another interesting topic is unipolar induction effect, which is well-known from Faraday. This effect creates electro motive force (EMF) in rotating disk if axial magnetic field is applied to the disk. One of the well-known practical developments in this area is device by Bruce de Palma. In 1991 he has published the results of his tests, from which it follows that deceleration of the rotor due to back EMF in the case of unipolar induction is less than in traditional electro generators. So output power of system can exceed the power, which is necessary to rotate the rotor.

Really, motion of electrons in magnetic field, which is perpendicular to plane of rotation, is the reason of the Lorenz force and this force acts in radial direction that can not be the reason of deceleration. Indian research on this topic is developing by P. Tewari. In New Zealand there is research group headed by Dr. Ashley Gray. In 1994 the leader of Japanese market MITI published report about progress in 40 KWtt unipolar generator, which uses superconductors for its electromagnets. The interest of Japan to alternative energy projects can be explained by the position of Japan on fuel market.

There is a well known rule: Demand is related with Proposals. It is easy to imagine the prospects of local introducing of free energy systems in one or several countries, if some producers of product will be able to exclude expenses on electricity and fuel from cost sales. Other countries of their own rich natural resources (for example, oil) will be in problematic position on the new international market, mainly due to the fact that their industry and transport are oriented to conversion and consumption of oil fuel that increase the cost of all products.

... increase of the spark gap produces more surplus power in the load of the circuit.

One more modern free device was invented by Wingate Lambertson, USA. In his device free electrons get the additional energy passing through the number of thin metal-ceramic composed layers. The units were designed by the authors and each unit can generate 1600 watts, and it is possible to connect them in parallel. The address of author: Dr. Wingate Lambertson, 216 83rd Street, Holmes Beach, Florida 34217, USA.

Especially the researches on free energy with plasma processes should be noted here. In 1980-1990 Alexander Chernetsky, Yury Galkin and others have published the results of experiments on creation of "self generated discharge" SGD. The electric arc was placed consecutively into secondary circuit of electromagnetic transformer and it produces real increase of power in load and reduction of consumption power in primary circuit of transformer. The author of the present article produced simplest experiments to investigate the arc (electric discharge) in electric circuits and possibility to create the mode of "negative resistance" in this circuit was confirmed. One of the effects was demonstrated in 1996 during the conferences "New Ideas in Natural Science", St.-Petersburg.

Adjusting parameters of arc (distance between two electrodes) it is possible to see that consumption current is decreasing until zero and then it can change its direction i.e. this system begins to generate the power. During similar experiment of 1971 by Dr. Chernetsky substation transformer in Moscow Aviation Institute was destroyed in result of strong "reversed current" impulse, which exceeded consumed power in 10 times more. According to Chernetsky's concept, the reason of this mode is well known phenomenon of plasma instability and **pinch-effect for great currents.** However, the author of this article tested device, which demonstrated similar effect (switching on the load in secondary circuit of transformer and in the presence of arc in this circuit, consumption power does not increase, but reduces) for small currents about 300 mA.

Since for pinch-effect it is necessary hundreds Amperes then it was offered another explanation: the surplus power in this circuit appears due to the acceleration of electrons in the gap between electrodes, i.e. particles of plasma are **accelerated by means of electric potential field between two electrodes**. It is noted during the experiments that increase of the spark gap produces more **surplus power in the load of the circuit.** To avoid mistakes the measurements of the consumed power were organized in DC (direct current) battery circuit and therefore there is no any reason to speak of phase shifts mistakes to try to explain skeptically this effect.

... waves of density of time are used by organisms for their vital activity.

Today theory and experiments on self-generating discharge are quite well developed to build free energy systems of any power scale. The reason of delay in its practical development is a complex problem: this work leaves the frames of classical physics. In his book "About physical nature of bio-energy and its simulation", Moscow, Publ. VZPI, 1989, Dr. Chernetsky considered the structure of biological fields and bio-energy processes in living organisms from the point of **longitudinal waves conception.** Self-generating discharge in the mode of negative resistance produces such longitudinal waves and they are self-sustaining (self-powered energetically) and it is considered as field of living object.

Really experimentators of the Chernetsky's group, who worked with SGD device detected influence of biologically active radiations and fields, which can be not screened by usual methods. It was reported by Chernetsky that parameters of this radiation can be selected to accelerate the development of plants and biomass or to suppress it. So, we should speak about artificial living biological system or biological form of energy for this class of free energy devices. Perhaps by the same plasma oscillation way all living organisms provide its vital activity, since long time ago it was known that metabolism and food can not provide enough energy for vital processes.

Nikolay A. Kozyrev also wrote about "reason of life" and he confirmed that waves of density of time are used by organisms for their vital activity. Between "waves of density of time" and "waves with longitudal component" there is a clear analogy. Kozyrev and Chernetsky experimentally demonstrated methods of creation of such waves.

...any free energy system should change the causality in surrounding space-time.

New Energy News magazine, March 1996, wrote about attempts to innovate for American aerospace stations special power source, which uses similar plasma technology: anomalous electric discharge. The USA patents #5416391 and #5449989 belong to Dr. Paulo Correa and Dr. Alexandra Correa, Canada. In their report on free energy Denver conference it was claimed that efficiency is about 483% .

Let's note one more free energy topic: high efficient electrolysis. Classical electrolysis as decomposition of electrolyte in electric field is a wonderful example of work, which is produced by field and it can be organized by such a way to be free from the primary energy source (battery). The traditional scheme uses closed circuit of current through electrolyte and the battery, so the battery is discharged during the operation with electrolytic cell. However any physics textbook confirms that **ions in electrolyte are moving due to electric field only, i.e. work to organize the displacement of ions and heat power, which is connected with this work, are produced by the potential field and expenses of the primary power are not required.**

The current through the battery, which is created in usual closed electric circuit destroys the primary difference of potentials in the battery but it is not some necessary condition. For correct organization of the experiment the products of electrolysis (gases) can be created almost free and their utilization (burning) can provide more heat power than input electric power.

Prof. Latchinov, the real member of Russian Physic-Chemical Society, who patented his method of electrolysis in 1888, mentioned that in some cases the electrolytic cell is freezing during its operation. This is an effect of the law of Conservation, which forces to return the surplus power by means of heat environmental energy. In the experiment by Latchinov the electrolytic cell can create gases of high pressure and consumed power is the same as for the case of low pressure gases. However, it is clear that high pressure gases can produce more work than low pressure gases do. This question was sensational problem in scientific societies of 1888 and it is not solved yet completely.

One of other variants of high efficient electrolysis was investigated by Igor Goriatchev, Russia. Instead of usual 3 Volts level of electrolysis, Goriatchev uses 0.2 Volt pulsing mode. He claimed ratio output/input as 1500% efficiency and he hopes to increase this value twice in more perfect design.

Professor Kanarev from Krasnodar wrote about his experiments on plasma electrolysis and has proved that in electrolysis of water output power can be more than input power.

Real example of "perpetuum mobile of the second kind" is invention by Russian engineer Albert Serogodsky (Moscow) and German engineer Bernard Sheffer (Berlin). They have patented new system for direct transformation of environmental heat into electricity, Germany patent #4244016. Retro-condensation of mixture of benzine and water is organized in closed system under temperature of 154 ^{0}C degrees. You can try to get more info from: Werkstatt fur Dezentrale Energleforschung, Pasewaldtstrasse 7, 14169 Berlin, Germany.

The fundamental theoretical researches on direct transformation of environmental heat to useful work were provided by Real Member of The Russian Physical Society Mr. Gennady N. Buynov, St.-Petersburg. The description of his project on "The Mono-thermal device" was published in journal "Russian Ideas" #2, 1992.

In 1995 the scientific journal of Russian Physical Society #1-6 published article "Perpetuum mobile of the second kind (paired gas-chemical cycle)". The author Gennady N. Buynov proposed to consider that **entropy function can be abortive**, i.e. it can be undetermined in some place if reversible chemical reactions are presented in the system.

Herewith, the circular integral of entropy is not a zero and in this case the heat function but not entropy function (according to the Gess law) becomes the function of condition.

Buynov offers to use four–oxide of nitrogen as working matter for this cycle. His works are excellent example of scientific enthusiasm, which (in combination with financial interest of the customers) could produce real results for Russia many years ago. Let's note that

priority of this discovery belongs to Russia in spite of attempts of other scientists to claim and develop this idea now as their own work.

We can make a very interesting conclusion if we analyze history of so called "cold fusion" discovery. According to de-classified materials of 1960, priorities of Russia in this topic are obvious. In 1989 Pons and Fleshman have reported about results of their experiment. In 1995 Russian Journal "Inventor and Rationalizator", #1 has published article about invention made by Ivan S. Filimonenko that was named in 1957 as "warm nuclear syntheses". In 1957 he detected **extra power output in process of heavy water electrolysis** and he mentioned several applied aspects, for example, propulsion force and possibility to reduce radioactivity by means of this process. In 1960 Kurchatov, Korolev and Zhukov have supported the ideas of the author. Russian Government adopted secret resolution on this work:

1. Investigation of energy generation.
2. Development of propulsion without reactive mass flow.
3. Research on protection from radioactivity.

But in next several years this work was suppressed by people of nuclear power plant team. The only system of such type named as TOPAZ was innovated for Russian aerospace systems. World-wide innovation of this technology is a real way to introduce "warm reactors of syntheses" and it is not necessary to wait for results of high-cost "Tokomak" project and other thermonuclear researches. Let's note that secondary effects (propulsion force and influence on radioactivity) are possible due to using of "free energy" aspect if output power is result of change of space-time parameters.

In 1994 Journal "Russian Ideas", #1-6, it was published an interesting document "Conclusion of The Moscow City Council Commission on the question about Ivan Filimonenko's discovery and its development". In this document it was recognized that it is vitally necessary to renew this works. But in 2003 we still have nothing new on this topic. Why? It can be assumed that the Problem of innovation for this technology is possible military application of the methods since influence on radioactivity (for example, remote reduction of radioactivity of some object) is area of interests of the Defense Department. The fact that energy generators by Filimonenko can be used for quick restoration of the present ecological balance is not so important in this case. The same conclusion is about propulsion method, which was proposed by Filimonenko. Mr. Korolev knew about this method; however present space programs are still based on rockets and reactive principles, and anti-gravity flying machines we can see only in fantastic movies.

At the same time, development of commercial cold fusion projects was started in some countries, for example: Patterson Power Cell is introduced in Texas, USA (Clean Energy Technologies Inc., Dallas, Texas, fax 214-458-7690). More than thirty patents were owned by ENECO Corporation, which is collecting the main technological solutions in this area. The production of electrolytic thermal cells was started by Nova Resources Group., Inc., Colorado.

In August of 1995 Atomic Energy of Canada, Ltd. Company, which is member of The Planetary Association for Clean Energy, has published the review on modern methods of conversion of nucleus wastes and deactivation. Two new technologies were offered for introduction: contact processing by "Brown's gas" and remote processing by scalar (torsion) fields. Let's note that the technology proposed by Canadians and Filimonenko's technology demonstrate the effect of influence on the rates of radioactive decay.

These examples are only small part of real situation. Main references on publications are foreign and it can lead to wrong conclusion that Russia is delayed in this direction of new technologies development. In fact, Russia has more talented inventors and researchers than any other country. However, condition for work, patenting and publications of ideas are not the same, and usually Russian technologies cannot reach the level of international market. This problem depends only on real and official state policy with respect to inventors and scientists. In real life financial support of scientific institutes is mainly subsidy for management of the institutes, but not for science. The inventions and discoveries always were made by a certain real person, but not by Institute or some scientific team.

In Russia of last age and in the other world on the whole the institutes and laboratories have been creating for a new scientific problems, discoveries or new directions in science. It was necessary to claim about discovery and provide priority for own country to get official support. Main schools of thought appear by this natural way. By the same natural way the necessary in existing of some scientific institute can be removed when the idea grows up to serial production stage. If there are no any fresh ideas in this school then the institute should be transformed in design office of the production plant on this topic. It is almost impossible to create a new research institute in modern Russia, so really new ideas (if they are not ranged in frames of some existing scientific directions) can not be developed and they can not create a new school of thought in Russia.

... it is possible to make a conclusion about grandiose misinformation of society...

People (carriers of the new ideas) have to leave Russia to realize their sensational ideas on free energy and antigravitation topics. Why they do not work with Russian Academy of Sciences? It is the

rhetorical question. Usually after many years of correspondence with patent office or with official science bodies the authors can find that their ideas are published in "serious scientific magazines" but without any respect to their names...

Attachment 1 presents some information about patented technologies. When we study old and modern patent documents, it is possible to make a conclusion about **grandiose misinformation of society**, which leads to appearance of two different Worlds, separated by the level of knowledge: evident and hidden knowledge. The achievements of the second hidden world could change our planet, give a chance to remove all energy and ecological problems. Besides, we have discussed that some free energy systems (for example, self generated plasma discharge) have also the medical-biological aspects. This "influence" from free energy system is related with negative entropy processes in area of the operation of the system so some components of biological systems can be changed to less entropy. The design of free energy system defines the type of this influence. It was noted before that operation of any free energy system should be considered in high topology space-time as multidimensional system to see what the reason of the effect is.

So, since the rate of time course is determined by Nikolay A. Kozyrev as rate of cause-effect transformations, then any free energy system should change the causality in surrounding space-time. In this case we can assume that it creates quantum physics effects on the macro level. It is interesting to assume Heisenberg's uncertainty, tunnel effect and manifestation of wave characteristics (up to diffraction of objects) for macro level.

Some experimental data by Kozyrev is related with quantum effects, which were detected in his experiments with rotating and vibrating gyroscopes. This technology is the basis to design real teleportation systems, which will change parameters of space-time to allow changes of position of some material object from one point of space to another point of space (without transference on the distance between these points) by means of combining these points in the same place of space for some time.

The process of study of new technologies in alternative power industry and gravitation is developing actively in the world. Besides secret programs and institutes, it is possible to make a conclusion that activity of this work in countries of limited fuel resources is more efficient. Now Russia has rich **natural materials and oil resources but in the short time this advantage will not play any role in development of economy.**

Industrial and defense power of any country will depend on free energy technologies, knowledge on the biologically active energy and reactionless propulsion methods.

The new technology creates not only a new technical systems but also **new economical systems**. It is not physics but policy… Development of great Russian territories with industry of free energy technologies for home and commercial application is the way to change world economical balance in favor of Russia. It is difficult to say now what financial-economical group of modern Russia is most interested in development of this direction of science. The purpose of any financial-economical group is power on the market of energy resources, but when the free energy technologies are developing, then people and industrial or agricultural producers will be more independent from centralized system of energy and oil distribution, therefore, they will be more independent from influences of central authorities.

From the point of view of serious business, there is only one real argument in favor of developments of any really new technology: it should lead to increase of profit and expansion of the market. In this sense, it is possible to compare the new energy technologies with beginning of the steam machine age or with appearance of electric machines and illumination. This means the super profits and serious fight with competitors. To develop this way any efforts of scientists are not sufficient work. It is necessary to join them with the efforts of large business structures, which are interested to create new market of energy and power engineering in parallel to present monopoly fuel-energy market or to develop commercial exploration of space by means of new propulsion principles. In particular, telecommunication space satellites and projects on colonization of space could be the nearest commercial directions of the new market.

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Attachment 2

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· ADAS, Association of Distinguished American Scientists, P.O. Box 1472, Huntsville, AL 35807, USA.
· Borderland Sciences Research Foundation, P.O. Box 429, Garberville, CA 95440-0429, USA.
· Center for Action, P.O. Box 472, HCR 31, Sandy Valley, NT 89019, USA.
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· Quantum Biology Research Laboratory, P.O. Box 60653, Palo Alto, CA 94306, USA.
· SEA, Space Energy Association, P.O. Box 11422, Clearwater, FL 34616, USA.
· Tesla Book Company, P.O. Box 121873, Chula Vista, CA 91912, USA.
· Tesla Incorporated, 760 Prairie Av., Craig, CO 81625, USA. Fax 303-824-7864.
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· Journal 21st Century Science & Technology, P.O. Box 16285, Washington, DC, 20041, USA.
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Some General Properties of Matter and Energy Sources

Devoted to memory of Academician A.A. Harkevich

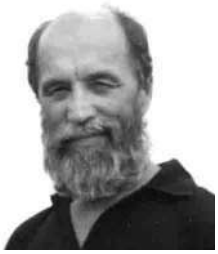

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Introduction

Nowadays there are appear more and more attempts to disclose new methods of obtaining energy from the ambient space, i.e. from heat, electromagnetic, gravitational fields, physical vacuum, aether, etc. (See, for example, publications in New Energy Technologies [1-3]). The publications demonstrate that researchers meet various incompletely investigated physical processes. These scientific areas are difficult to be investigated. All this makes obstacles for development of works on creation of new energy sources. **In this work there is made an attempt to demonstrate general properties of energy sources of any physical nature. This attempt is based on a general analysis of properties of matter.** A theory of transformers is used to investigate general properties of matter.

Action of all physical, technical and biological systems is expressed in energy transformation. Numerous theories based on particular (specific for some system) methods are applied for description of these systems. However, if the number of degrees of freedom and of elements inside a system increases then many theories are not able to describe operation of the systems. First these problems appeared in electrical engineering, radio engineering, automation and acoustics. The theory of transformers is applied to these fields of science. The theory represents a complicated system as a "black box" having several inputs and outputs. Operation of the numerous elements occurring inside the box is represented as some equivalent functions reduced to the inputs and outputs.

In the last decades methods of solution of mechanical dynamic tasks by the method of complex resistances are developed as well as representation of elements as linear transformers [11] and finite elements in liquid [14]. This tendency can be applied to the mechanics of liquids and gases. Now there are successfully developed those concepts which assume observation of models having very few degrees of freedom to be enough for analyzing processes in hydrodynamic systems [10]. However, a mathematical apparatus for description of transformers operation which is well-developed in these areas of science and engineering has a special view and is applicable only for these scientific areas.

Academician A.A. Harkevich developed a theory of a linear transformer up to the level of the general theory of transformers which is applicable for transformation of any types of energy [24]. The general theory of transformers proposed by A. A. Harkevich is applicable for description of various energy sources, flying and swimming objects, functioning of different animals' organs, and technological processes. In this work some general properties of matter and energy sources are investigated, according to the general theory of transformers.

General theory of energy transformer

The whole ambient space, from the microworld to the macroworld, is filled with energy. According to different theories, space is represented as a compact medium (i.e. having distributed parameters) or a medium consisting of a limited number of discrete elements (i.e. having concentrated parameters). On the analogy of hydrodynamics [10, 14] the compact medium can be represented as an equivalent system with a limited number of degrees of freedom. Hence, the whole space can be represented as some system consisting of elements and communications between the elements with a limited number of degrees of freedom. Energy exchange occurs due to the degrees of freedom. Energy transmission occurs if energy gradient is presented in the ambient space. Due to the energy gradient a force tends to realize transmission in the space [4]. The elements can be systems as well.

Hence, the more we observe dividing the elements on the systems and the systems on the elements the more we will penetrate into the microworld (i.e. atoms, elementary particles, physical vacuum, aether, etc.). The more we combine the elements in the systems, and the systems in the new larger systems the more we observe the macroworld (the Solar System, galaxies etc.). All the systems and the elements are interconnected. The systems and their elements are

transformers of energy. Energy motion occurs in the smallest part of space. Consequently, the whole space can be represented as a system consisting of the energy transformers. In the general case due to every type of energy limits of a transformer consist of outer limits (i.e. communications with the macroworld) and inner limits (i.e. communications with the microworld). Dividing into the macroworld and the microworld occurs in relation to the size of a transformer for every type of energy. Types of energy coming through communications of a transformer and inside it may differ, i.e. mechanical, heating, electromagnetic, chemical and other known and unknown types of energy.

The processes in which a great number of interacting elements and different types of energy participate are very complicated and do not allow describe the processes accurately by modern mathematical methods. Hence, there is a problem to find such methods of solution of the tasks which without disclosing all the communications inside the element can give the understanding of the way an element moves in the system. The following premises can be made for the method of solution of the task of a system and its elements' motion:

1. Motion of all the elements in the space is characterized by energy exchange occurring among them;
2. We are interested in a certain limited area for every individual type of energy. The chosen limited area will be called as **a transformer**;
3. The transformer has degrees of freedom both on its limits (sides) and inside it (inner degrees of freedom);
4. Further this limited area (the transformer) which has or is able to have a limited number of degrees of freedom (sides) at its limit will be observed;
5. Interaction between this transformer and the ambient space occurs only through these degrees of freedom (sides) by means of energy exchange;
6. Motion of energy between the elements of the transformer occurs according to its degrees of freedom inside the transformer. There can be a limited or unlimited number of degrees of freedom.
7. All the space is full of the transformers. All the transformers adjoin each other without gaps. Energy exchange between the transformers occurs through their sides which do not have a size but reflect general kinematical and dynamic characteristics of the energy transferred through these sides.

Editor: The full variant of the article includes mathematical description of operation of energy transformers which is followed by these conclusions:

- There can be any number of different types of elements having a corresponding number of degrees of freedom and any type of energy inside the transformer. However, on every side of the transformer a generalized force has the same value and depends only on change of energy according to this degree of freedom. Therefore, two transformers are considered to be equal if the generalized forces (energy changes) on all the sides are equal. In this case it is not necessary for the inner structure of the transformer, number of inner degrees of freedom, and energy types of these two transformers to be equal. This is **a principle of equivalency of transformers at the equivalency of the forces acting at the sides of transformers**.

- In the general case the generalized force at any side depends not only on energy exchange occurring at this side but on energy exchange occurring among the sides or at other sides of the transformer. The generalized forces are produced by energy distribution in the space.
- A transformer is characterized by the fact that there are different types of energy at its different input sides (or the energy can be of the same type but having other characteristics of motion).

Resistances of the interaction provide information about physical properties of the transformer, in particular, about physical interaction between the sides. At that a number of inner degrees of freedom in this transformer as well as the reactions at the other sides do not play any role. Proper resistances of the sides and resistances of the interaction provide information about inner physical characteristics of the transformer reduced to equivalent values at the sides. Hence, it is possible to have two transformers having equal equivalent resistances of interaction for all the sides. However, according to their geometrical and constructional characteristics and types of energy, the transformers will be different. The resistances may be a function of kinematical characteristics **(a nonlinear transformer)** or of time **(a parametrical transformer)**. Moreover, it can have constant values **(a linear transformer)**.

It is appropriate to consider physical properties of matter included in the volume of a transformer only due to resistances at the sides of the transformer.

Structure of the transformer

Every inner degree of freedom can be represented as a series circuit. By analogy with electric circuits [6, 7, 11, 16-18] the transformer can consist of various circuits. An unlimited number of degrees of freedom allows represent a transformer consisting of an unlimited number of chains. The circuits have series, parallel, or mixed junctions. A part of a circuit whose elements have the same generalized displacement is called as a branch. The branch can consist of one or several elements. A place where three or more branches are joined is called as a multiple junction. A circuit is considered to be a closed path including several branches and multiple junctions. All the elements of a chain connected in series have equal generalized displacement (as well as equal speed and acceleration). The generalized force acting on the

whole circuit is equal to the sum of forces acting on the elements of the series circuit.

The elements connected in series can be replaced by one element in such a way that the generalized displacement and the summary generalized force would not change. In the case of a parallel connection all the branches of the circuit are joined to the same pare of multiple junctions and are under influence of the same generalized force. Parallel circuits can be replaced by series equivalent circuit and vice versa [6, 7, 11, 17, 18]. Hence, a number of inner degrees of freedom and a quantity of chains may be decreased as well as increased. In this case resistances occurring on all the sides will be constant.

Structure of the linear transformer

The simplest transformer is a one-side transformer having one inner degree of freedom…

If to the input of the transformer we deliver generalized displacement (or force) which depends on time as a pure sinusoidal signal then the linear transformer will have sinusoidal reaction of the same frequency. For the sinusoidal signal with fixed frequency the linear transformer (including a transformer having an unlimited number of inner degrees of freedom) can be represented as an equivalent transformer reduced to this input as one chain. An equivalent transformer placing at this input at other fixed frequency of sinusoidal disturbance will be represented as a chain having one degree of freedom but different values of chain elements.

If the signal at the input of the transformer is of complicated time-periodical form then it can be decomposed to Fourier series. Every harmonics of the Fourier series will produce its own chain. The general complicated signal will produce the complex chain consisting of compound sum of elementary series chains. This complicated chain consists of elementary chains interconnected in series or in parallel and combined in multiple junctions and circuits. The construction principles of this complicated chain can be based on methods of identification and synthesis which are well developed in electrical engineering, automation for linear and non-linear transformers [9, 12, 13]. These principles are formally useful for transformers which transform energy of any physical nature. Identification produces so much elementary chains as the number of inner degrees of freedom. Every elementary chain reflects motion by one inner degree of freedom. Physical analogy occurring among motions of different nature is actual here [11, 16, 18]. Values of the generalized masses, elasticities, dissipative and active elements can depend on kinematical variables (non-linear chains), on time (parametrical chains), or they can be constant (linear chains).

If a series circuit includes mass and elasticity then it will have resonant frequency. At this frequency reaction of mass and elasticity will be absent in the summary reaction. It is equal to the fact that we will know nothing about the value of mass (and elasticity) and, moreover, about its presence at all. The mass can have huge value, but it will be absent for us. Hence, if we assume a transformer as an atom then the atom may include elementary chains having huge masses (much more than the mass of the Earth), but we will not know about it until we apply such frequency to the input which explicates this mass.

Any energy transformer including a transformer with distributed parameters can be represented as a system of elementary series and parallel chains connected in a certain way. A concrete transformer can have various types of these connections. All of them can be included into another combination of connections that is accompanied by change of values of masses, elasticities, dissipative and active elements. However, in this case equivalency of reaction should be fulfilled at a certain diapason of frequencies on all the sides of the transformer.

There is a special spectrum of resonant frequencies for every combination of connections of the transformer. There will be an unlimited number of degrees of freedom and, hence, an unlimited number of resonances for the transformer with distributed parameters (for example, an elastic nail, a compressible fluid having a limited size). Our influence on the transformer usually has a certain diapason of frequencies. As the result of a limited diapason of excitation frequency the transformer will represent a system having a limited number of inner freedom, even if the transformer has distributed parameters.

Values of equivalent elements depend on oscillation frequency. Moreover, according to known laws, several parallel circuits can be transformed into a series one and vice versa. Taking it into account the following conclusions can be made:

1. The generalized mass, elasticity and dissipative elements do not have constant values in nature. Their value depends on frequency of the process, i.e. they depend on the character of time-change of the disturbance acting on the transformer.
2. The generalized mass, elasticity and dissipative elements are products of time-space change of energy.

Types of energy transformers

Transformers can be nonlinear, parametrical and linear. The transformer can be **active** (having an internal source) and **passive** (having an external source). The passive transformer can never be an energy source (by definition). A transformer can accept or transform one type of energy (monoenergetic transformers) or several types of energy (polyenergetic transformers). The polyenergetic transformer includes a mechanism and

corresponding elements and chains which allow transform one type of energy into another one. Fundamentally, all the transformers are polyenergetic transformers of energy, however many of them can be represented as monoenergetic ones since other types of energy participate weakly in them. Designing a transformer it is more convenient to put the energy source out the transformer. Let us further classify the passive transformers.

The passive transformers can belong to the following types:

1. Simple transformers

In this case energy is produced at the output due to transformation of energy coming to the inputs into energy of another type or having other characteristics. The following transformation can serve as the example.

An electric transformer: resistance of one value comes to the input, and the resistance of another value comes from the output (a type of energy is the same).

A furnace for combustion of fuel: energy of chemical connections comes to the input and heating energy comes from the output (energy of radiation may be neglected).

A Wind Generator, Hydroelectric Power Station: kinetic energy of moving air or water comes to the input, and electric energy comes from the output.

2. Energy intensifiers

In this case a transformer intensifies energy coming to one of the inputs due to energy coming to the other inputs (or to the other input). Below there is an example for a *monoenergetic transformer*. Energy (an electric signal having certain parameters) comes to the input of a transformer, and the output energy has the same characteristics but it is more intensive. It can occur due to electric energy coming to the other input of the transformer.

A heat pump represents an example for a *polyenergetic transformer*. Low potential heat energy of the ambient space (air, water, ground) comes to the input of the heat pump, and electric energy from a power network comes to the other input. The output heat energy has value which is equal to the sum of the coming heat energy of the ambient space and electric energy coming from the power network through the electric engine of the compressor. The output heat energy excesses energy coming from the power network by several times. The output energy is always lower than the sum of the low potential heat energy and the electric energy coming to the input. Hence, the output of a heat pump is always less than unit.

Efficiency of the heat pump consists in the fact that a consumer pays for electric power produced by power network only (use of the low potential heat of the ambient space is free). However, the output heat energy is several times more than the energy which can be produced by the electric power coming to the input.

3. Active oscillator

An active oscillator is a device of a certain type. Energy of time-constant characteristics comes to its input, and at output there is energy of time-periodical characteristics. Energy with time-periodical characteristics can come to the input as well since these characteristics are not connected with the time-periodical characteristics of the output energy. The transformer can operate in a mode of an active oscillator if it has the following features:

1. Indirect connection as a series circuit: one of the outputs is connected to an additional transformer whose output is connected to one of the inputs of the transformer. The additional transformer provides certain changes of the input signal (time delay).
2. Energy comes to the input (it can be time-constant or time-periodical).
3. The transformer must have a certain type of non-linearity.

Examples of the active oscillator

Internal combustion engine: the indirect connection is the system of combustion, the non-linear element is the system of admission and exhaust valves, and the energy source is energy of chemical connections of fuel.

Various electric generators: all of them have the indirect connection, the non-linear element, and the energy source.

The active oscillators differ from the electrical intensifiers qualitatively. The difference consists in the fact that the active oscillator can operate and receive energy from the ambient space without additional energy coming to it (from a power network, for example).

Theorists and experimenters try to create a self-supporting self-organizing system in their works on creation of alternative sources. This fundamentally correct tendency requires using theory of active oscillators. There is the developed theory in electrical engineering, automation, and other scientific fields [25]. To simplify application of these theories it is necessary to use analogy between equal processes which take place in different physical fields.

4. Rectifiers

Time-periodical energy comes to the input of the transformer. The output energy has time-constant or practically time-constant characteristics. If the transformer has a non-linear element or elements of a certain type (a diode or a one-sided valve) then it can

operate in the mode of a rectifier. The examples are electrical rectifiers and pumps of a valve type.

Properties of energy transformers

General properties:

1. A transformer can transform energy of one type as well as transform one type of energy into another type.
2. The generalized kinetic, potential and dissipative energies are specific peculiarities of energy change in the space and time.
3. The generalized masses, elasticities and dissipative elements are products of energy change in space and time.
4. Values of the generalized masses, elasticities and dissipative elements (existing inside the transformer as well as reduced to the equivalent values on the sides of it) depend on a temporal character of changes of kinematical or dynamic disturbances. Values of the generalized masses and elasticities at the sides of the transformer are lower than the corresponding values inside the transformer.
5. Energy interchange between macrostructures and microstructures can occur through a transformer.
6. One area of space can "know" about another area of space through energy exchange only, i.e. through generalized dynamic and kinematical interactions. In the light of the fact that chains of different transformers can have similar physical properties (for example, an equal resonant structure) interference of these transformers seems to be possible including interference occurring at a great distance.

Properties of the passive monoenergetic transformer:

1. Transformation of characteristics of the same energy type.
2. The output energy can be both equal or lower than the sum of energies coming to all the inputs. The sum of the output energies decreases due to dissipative losses occurring inside the transformer.

Properties of the passive polyenergetic transformer:

1. One energy type coming to an input can be transformed into another energy type coming from the output.
2. The sum of energies of all the outputs can be equal to the sum of energies of all the inputs or less than it. The sum of the output energies decreases due to dissipative losses occurring inside the transformer. The output will always be lower than unit. If the energy coming from certain of the outputs (within the limits of one output) is considered as a positive effect then the output will be less than the mentioned value.
3. Energy of one and the same type comes to the input and from the output while other energy types can come from other outputs. This property can allow increase one type of energy coming from an output at the expense of the other types of energy coming to the inputs.

Analysis

This article is aimed to provide general properties of the energy transformers and to analyze some problems of creation of renewed energy sources, according to these properties. There are made various attempts to design a renewed energy source which would produce energy without fuel consumption. In the light of the above mentioned results, the researches on creation of the renewed energy source may be represented by the following way. Energy can be produced from the macrostructures and the microstructures.

In the case of the macrostructure, energy can be produced by a simple transformer, an electric intensifier or an active oscillator. Methods of production of energy from the ambient space by means of simple transformers (thermoelectric and hydroelectric power stations, wind generators, etc.) are developed sufficiently by the humankind. Works on producing energy from the ambient space by means of energy intensifiers are on its initial stage. Heat pumps, which utilize low potential heat energy by means of Freon-compressor heat pumps, are successfully introduced. One of the perspective approaches is replacing such a heat pump by a vortex oscillating heat pump which does not contain Freon and a compressor [3, 5, 19, 22]. In future it will be possible to replace the energetic pump by a new energy transformer of the type of an active oscillator. In this case the energy source will always obtain energy from the ambient space without using additional energy from a power network. Energy sources of the type of the active oscillator are internal and external combustion engines, stream engines, etc.

In the general case a transformer can contain different energy types and has communications with **outer microstructures**. It should be noted that the outer microstructures can be included in the geometrical size of the transformer. Energy of this microstructure can be huge; hence, this energy can be obtained from them for a very long period of time. Atomic reactors can serve as an example for this fact. The types of energy in these microstructures can be represented by known types (electromagnetic energy, nuclear energy) and unknown types (whose numerous quantity can be considered). These energy types exist in the ambient space. However, almost all the transformers of energy produced by a human (except the nuclear reactors) do not interact with the energies, and we do not obtain energy from these microstructures.

The task of creation of a new energy source consists in designing such an energy transformer which could obtain energy from the microstructures and transform it into the type of energy which is needed to a consumer. In this case all the designed transformers will not have over unit output. Efficiency of these transformers will be defined by the cost of the energy produced by them. This energy depends on a ratio of

energy coming to one of the inputs (electric power) (for example, in heat pumps) to the output energy. If the output energy is much more than the artificial energy which comes to one of the inputs then this transformer can be very useful for a consumer.

New high effective energy sources are often claimed to be created. According to the observed facts, existence of such sources is practically possible. Nevertheless, realization of this source will depend on our knowledge of physics of the microstructures and methods of transformation of energy of the microstructures into such type of energy which can be used by a consumer. Physics of microstructures is investigated badly, and many types of energy are totally unknown. Therefore, modern scientists try to create the new energy sources at random. In this case the following results can be achieved:

1. The high effectiveness of an energy source (over unit output) does not correspond to reality.
2. The output energy of the energy source is actually higher than the input energy (the source of the energy intensifier type).
3. The energy source actually produces energy without artificial input energy (the source of the active oscillator type). It can occur if an inventor failed to recognize the source of energy coming from the microstructures. It can be connected with particular or total lack of exploration of physics of the microstructures. Moreover, the fact is caused by transcendent difficulty of disclosing energy sources from the macrostructures.

Conclusions

It is principally possible to create an energy source whose output energy would be higher than its input energy (an energy intensifier) or an energy source which would produce energy without additional input energy (an active oscillator).

1. Various energy sources or transformers of energy of the macrostructures and microstructures can be designed.
2. Practical value of the energy source is defined according to cost of its output energy instead of the output value.
3. Designing new energy sources it is useful to consider them from the point of view of transformers. It is worth to define all the communications of the transformer and to state experimentally energy at all the accessible communications of the transformer.
4. Developing theories of sources it is expedient to use physical analogy and to take into account ready results of works on theories of transformers, chains, etc. of electrical engineering, radio engineering, automation and other scientific fields.
5. In the light of the fact that it is planned to obtain energy from the microstructures it is necessary to pay attention to new probable types of radiation and to their influence on a human.

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Commercial Exploration of Space

Review
by Olga Leontyeva, Editor
http://www.faraday.ru

Of late years the mankind has greatly advanced in space exploration. New spaceships are created, automatic apparatus are launched to the planets of solar system, space stations are orbited. A man has passed to outer space and begun exploring the planets of solar system. More and more specialists and people of different professions are involved in the development of space industry. However to present day only a few of them has succeeded flying into space.

At the present state of affairs space flight is very expensive and a serious reason should exist to forward a man into space if he or she does not relate to the aims of professional cosmonautics. However in last years there has appeared a certain breakthrough in the solving of the problem. Nowadays space technologies gradually turn from the sphere of experimental and scientific researches to the area of practical application. The time has come for a man to realize the real space flight without being the professional cosmonaut.

What are the ways to solve the problem? No doubt that special attention should be paid to the development of new space technologies, search of new types of fuel and attraction of investments to the sphere of space tourism.

April 28, 2001 can be considered as official date of birth of space tourism, when there was launched the space ship "Soyuz TM-32" with the first space tourist aboard. Almost in a year, on April 25, 2002 the space tourist #2 South African Republic person Mark Shattlword started on his space journey.

Today many companies give the opportunity to make a real space flight for all comers who have enough money and health. It is promised the providing of the most modern space technologies and the most perfect space equipment. It can be created a furor by the "Minimum program" of the Russian company "Atlas Aerospace" which is made by the members of Yu.A. Gagarin Center of training of cosmonauts.

In recent years at the international market there appear more and more companies which deal with search and encouragement of inventors who work on creation of alternative propulsion systems. Activity of "X Prize Foundation" company can be considered as an example.

The X PRIZE Foundation

722-A Spirit of St. Louis Blvd
St. Louis, Mo. 63005
Tel: 636-519-9449, Fax: 314-533-6502
http://www.xprize.org
E-mail: press@xprize.org

The X PRIZE is a $10,000,000 prize to jumpstart the space tourism industry through competition between the most talented entrepreneurs and rocket experts in the world. The $10 Million cash prize will be awarded to the first team that:

- Privately finances, builds & launches a spaceship, able to carry three people to 100 kilometers (62.5 miles)
- Returns safely to Earth
- Repeats the launch with the same ship within 2 weeks

The X PRIZE competition follows in the footsteps of more than 100 aviation incentive prizes offered between 1905 and 1935 which created today's multibillion dollar air transport industry.

For more than 30 years, the general public has waited for an opportunity to enjoy the space frontier on a first-hand basis. The X PRIZE Foundation is working to make space travel possible for all. The spaceships that compete for the X PRIZE are designed to carry passengers.

Since its inception in May 1996, the X PRIZE Foundation has registered more than 20 teams from seven countries to compete for the prize. The X PRIZE is fully funded through January 1, 2005, through private donations and backed by an insurance policy to guarantee that the $10 million is in place on the day that the prize is won. Additional funds are still being raised by the X PRIZE Foundation to implement the competition (judging, media, event management, etc.) and continue the Foundation's education mission.

The X PRIZE was inspired by the early aviation prizes of the 20th Century, primarily the spectacular trans-Atlantic flight of Charles Lindbergh in The Spirit of St. Louis which captured the US $25,000 (US$) Orteig

prize in 1927. Through a smaller, faster, better approach to aviation, Lindbergh and his financial supporters, The Spirit of St. Louis Organization, demonstrated that a small professional team could outperform a large, government-style effort.

The Societal Benefits of the X PRIZE include:

* Creation of a new generation of heroes
* Inspiring and educating students
* Focusing public attention and investment capital on this new business frontier
* Challenging explorers and rocket scientists around the world; and,
* Vehicles built for the X PRIZE will eventually serve four different industries:
- Space Tourism
- Low-cost satellite launching
- Same-day package delivery
- Rapid point-to-point passenger travel.

In Fig. 1 it is demonstrated the typical X Prize trajectory.

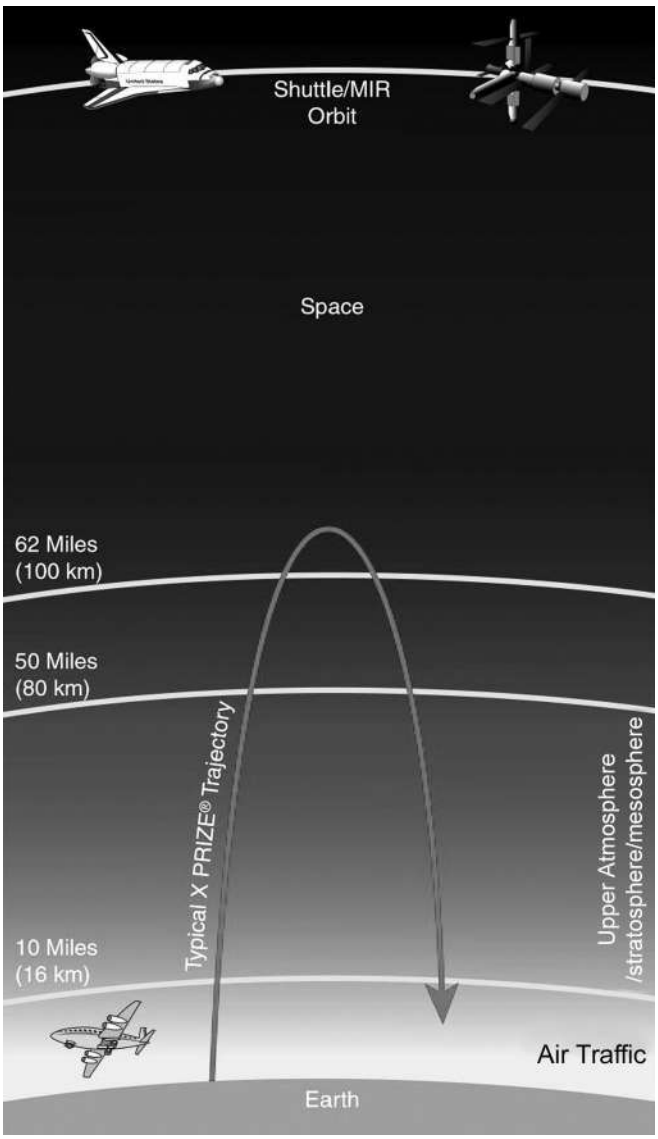

Fig. 1

Editor: Below we publish photos and brief comments about some official X PRIZE registrant teams. More detailed information you can find at http://www.xprize.org/imagefacts/photo1.html.

The Da Vinci Progect

http://www.davinciproject.com

Fig. 2
"Wild fire"

The **da Vinci Project** will launch its spacecraft ("Wild Fire") from the world's largest helium balloon. The 3,270 kg (7,200 pound) rocket will be tethered 720 meters (2,400 feet) below the balloon and lifted over the course of an hour to an altitude of 80,000 feet. The 10,000 pound thrust, liquid oxygen, kerosene engines will fire the first stage and the rocket will fly an initial angular trajectory to clear the balloon. The spacecraft then will transition to vertical flight to its apogee of 120 km in space. The rocket will reach a maximum speed on both its ascent and re-entry of Mach 4, or 4,250 kph (2,650 mph).

An innovative ballute will protect and stabilize the rocket on re-entry. A flyable parachute will be deployed at 25,000 feet and the rocket will descend under control, guided by GPS, to a predetermined landing zone. The da Vinci Project has already successfully conducted full-scale rocket motor test and has built a full-scale mockup of their vehicle.

"Discraft" corporation

http://www.xprize.org/teams/teams.html

John Bloomer, the team leader, is an aerospace engineer and he has worked on many aerospace progects, including Apollo and holds more than 60 patents on a disc plattorm aircraft. Bloomer's ship utilizes "Blastwave" Pulsejets.

Flight Sequence

Fixed, 7850-ft^2-area, laminar-flow wing take-off at about 60 mph within about 150 ft, featuring climb with gradual air-breathing acceleration (according to a fixed program) at fixed angles, to exit the atmosphere at Mach 10 on an unpowered ballistic arc to reach 75-mi. altitude: return on down-leg of same unpowered arc to gradual power-on flare-out re-entry of the atmosphere in simple reverse sequence of the take-off velocity profile. Range above 100,000 ft is about 480 mi. which is covered in about 5 minutes.

"Kelly Space & Technology"

http://www.kellyspace.com

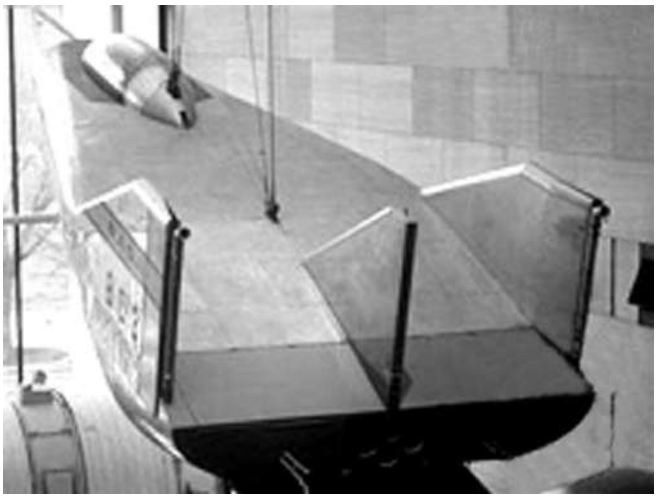

Fig. 3
"LB-X"

The vehicle is a rocket-powered delta wing glider with a liquid oxygen and kerosene liquid rocket engine. The spacecraft is prepared and fueled at the takeoff airport. The spacecraft is towed to release altitude behind a conventional jet powered aircraft such as Boeing 747 aircraft. Upon release from the tow aircraft, the main engine is throttled up for boost phase. The vehicle nominally coasts to an apogee altitude of 100 kilometers. The vehicle then glides to a landing at the takeoff airport for checkout and refueling prior to the next flight.

Flight Sequence

The lifting body will be towed to launch altitude behind another aircraft, and the rockets will be ignited. The craft will return to the landing site and make an unpowered, horizontal landing.

"Lone Star Space Access"

http://www.dynamicar.com

The Cosmos Mariner employs air-breathing jet propulsion for take-off and landing from conventional airports and rocket propulsion for ascent from cruise flight in the stratosphere to 30 or 40 nautical miles altitude. From there, the vehicle coasts to a target altitude of around 65 nautical miles. The air frame is designed to interface with two jet engines (turbofan or turbojet) each with 20,000-lbs static thrust or less. For rocket propulsion, the Cosmos Mariner will use the Aerojet AJ26-NK31A, a staged-combustion kerosene engine. The vehicle is designed to take off and land from conventional runways.

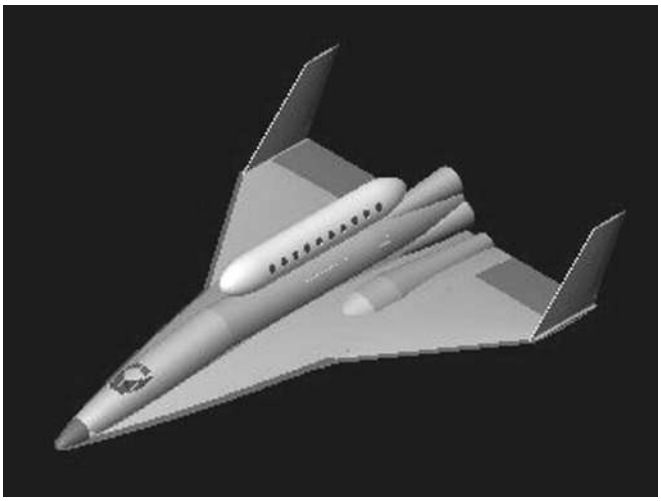

Fig. 4
"Cosmos Mariner"

*Along with X Prize Foundation it should be mentioned **ALLTRA** Company (Germany). ALLTRA consists of a small group of space experts. The main objective of ALLTRA is to 'sell' the space idea to a broad public and to identify future commercial opportunities in the space sector.*

On the official ALLTRA website http://www.alltra.de you can find collection of artist's views of the projects which are aimed at decrease in space ships value by means of using of new types of engines. Besides the Company deals with the development of space hotel projects.

JNET

New Energy Technologies collection of articles Japanese Version

Collection of articles from New Energy Technologies magazine, 2001-2002 is published in Japan.

On purchasing of the book, please, contact

Eiichi Yamamoto,
President Yama Trans Co. Ltd.

Email: admin@yamatrans.co.jp or eyama@yamatrans.co.jp

Alternative Aircrafts and Space Propulsion Systems

Editor: Nowadays all over the world there are made numerous attempts to create new types of aircrafts and alternative space propulsion systems. Below we publish the review of some interesting devices which are presented in the modern market.

"Arbortech Pty.Ltd"

http://www.airboard.com.au

Fig. 1
Airboard 2000

General Technical Specifications

Total payload, including rider — 100 kg (220 lb)
Operating time — 1 hour on full tank of fuel
Construction — Fiber glass/High-impact plastic shell, Aluminum frame, Rubber skirt
Starting — Electric key-start, Battery included
Engine — Briggs & Stratton 4-stroke
Fuel tank capacity — 5 litre (1.3 US gal)
Fuel type — 85 Octane unleaded

How does it work?

Airboard uses Hovercraft air cushion principles to glide just above the ground. The air cushion is generated from a purpose designed engine and fan which are suspended below the Airboard shell. In addition to providing an air cushion for the Airboard to ride on the fan also provides a fast stream of air exiting from the rear of the craft to provide forward thrust – just like a hovercraft. To help provide better acceleration the Airboard also includes a unique friction drive wheel at the rear. When the rider wishes to accelerate forward, weight transfer is used to bring the friction drive into contact with the ground. By engaging the friction drive clutch the Airboard can be accelerated forward without losing the feel of hovering above the ground. The control of the Airboard is provided by weight transfer of the rider, similar to surfboards, skate boards and snow boards. In operation the Airboard can be started, stopped and steered in a controlled manner and this means that riders can perform stunts, trick maneuvers and race around tight tracks against each other. In this unique way the Airboard is the first ever vehicle to deliver the advantages of hovercraft vehicle without the disadvantages of proof acceleration and handling.

"Trek Aerospace, Inc."

http://www.solotrek.com

Fig. 2

Trek Aerospace

Preliminary Specifications and Predicted Performance

Normal Gross Take Off Weight	800 Lbs.
Fuel (15 U.S. Gallons)	98 Lbs.
Mission Payload, net of fuel	352 Lbs.
Takeoff/Landing Distance	0 (VTOL)
Maximum Speed	70 Mph
Range	120+ Miles
Hover/Loiter Endurance	2+ Hours
Engine Type	Advanced Int. Combustion
Fuel Requirements	Heavy-Fuel or Gasoline

Special Features: 100% fly-by-wire control system with electronic stability augmentation; Intuitive, easy to fly safely; Minimal field service requirements; Rugged, efficient power train.

DM AeroSafe

http://dmaerosafe.freeservers.com

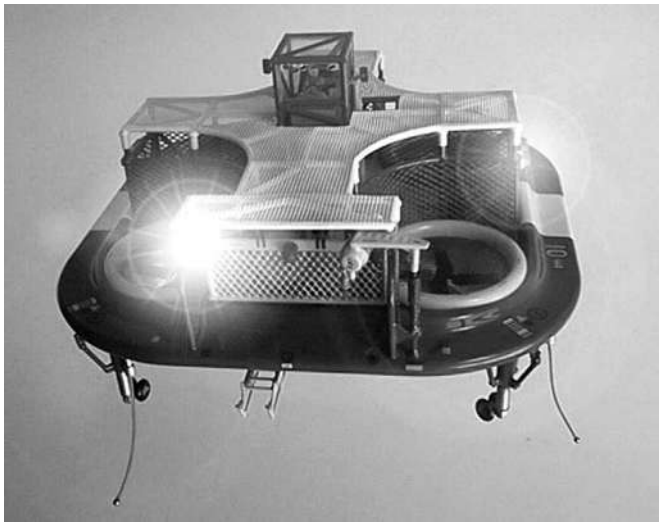

Fig. 3

EAGLE vertical take-off and landing aerial rescue platform

DM AeroSafe is a small research and development team, which has developed a totally new high-rise rescue technology to retrieve trapped people from areas which cannot be reached by conventional aerial ladder, conventional helicopter or a helicopter equipped with a Heli-Basket.

This technology could give rise to a new class of air transportation means, used for safe close-in maneuvering around tall structures, even inside the highly populated areas.

Eagle Aerial Rescue Platform's Performance Summary

Dimensions:

Length - 42 feet (12.8 m)
Width - 42 feet (12.8 m)
Height - 16 feet (4.8 m)

Weights:

Max. Gross weight - 5000 pounds (2268 kg)
Payload (Crew of two plus 10 rescued people) - about 2000 pounds (about 900 kg).

Propulsion System:

Four (4) variable collective pitch Ducted Propellers
Propeller Diameter - 7.8 feet (2.4 m)
Engines - four (4) four-cylinder radial piston aero engines with forced air cooling system 250 hp each (1000 hp total)

Performance:

Max. Duration - about 5 hours without refueling
Max. Airspeed - 40 knots (75 km/h)
Max. operating altitude - about 7000 feet (about 2200 m).

"LTAS/CAMBOT, Inc."

http://www.lvcm.com

Passenger Craft "Ltas 30-Xb"

The ships have rigid monocoque hulls, hybrid powered vectored thrust control and full active buoyancy control. (LTAS US Patent Pending).

This small 2-3 person craft at 70 to 80 feet in diameter will demonstrate ALL production systems and is designed for the LTAS FAA Type Certification program.

NASA's Langley Research Center

http://science.nasa.gov

NASA researchers are studying insects and birds, and using "smart" materials with uncanny properties to develop new and mind-boggling aircraft designs.

The "personal aircraft" that replaces the beloved automobile in people's garages may still lie in the realm of science fiction or Saturday-morning cartoons, but researchers at NASA's Langley Research Center (LaRC) are developing exotic technologies that could bring a personal "air-car" closer to reality.

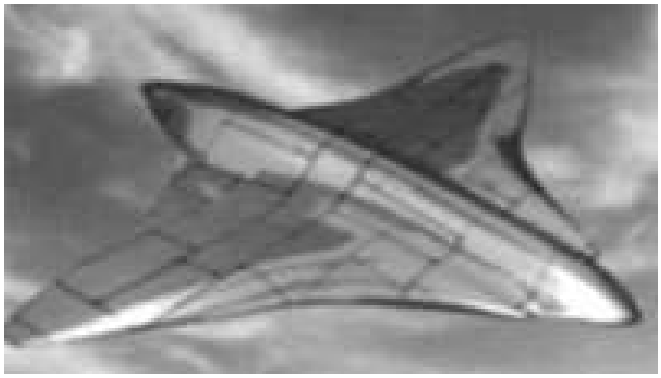

Fig. 4

And air-cars are just the beginning! Self-healing wings that flex and react like living organisms, versatile bombers that double as agile jet fighters, and swarms of tiny unmanned aircraft are just a few of the science-fiction-like possibilities that these next-generation technologies could make feasible in the decades ahead.

Laser Beam Flight

Lightcraft Technologies, Inc. (LTI)

http://www.lightcrafttechnologies.com

Lightcraft Technologies, Inc. is a new company committed to providing low-cost access to space through the use of beamed energy propulsion. (See color photos on the cover page).

Fig. 1

In 2000 at the High Energy Laser Systems Test Facility (HELSTF), Lightcraft Technologies, Inc. (LTI) set a new world's altitude record of 233 feet (71 meters) for its 4.8 inch (12.2 cm) diameter laser boosted rocket - in a flight lasting 12.7 seconds.

Although much of the flight was spent hovering at 230+ feet, the Lightcraft sustained no damage and will fly again. Besides setting the new altitude record, the craft demonstrated the longest ever laser-powered free flight and the greatest "air time" (i.e., launch-to-landing/recovery). LTI launched a total of seven vertical flights between 8:30 am and 11:30 am with three Lightcraft weighing less than 1.8 ounces (51 grams). Two of the flights by Lightcraft #3 reached 159 and 184 feet with the same propellant load!

...set a new world's altitude record of 233 feet!

The record flights were powered by the 10 kW pulsed carbon dioxide laser named "PLVTS" by the organization that owns it: the Directorate for Applied Technology, Test and Simulation (DATTS). Even though PLVTS was suffering from an arcing or grounding problem that caused it to run erratically, the laser power was still adequate to propel the craft to record altitudes.

What is a Lightcraft?

A Lightcraft is a 1kg launch vehicle, made from high temperature ceramic materials, that flies into space on a megawatt laser beam.

Fig. 2

The Lightcraft is both a single-stage-to-orbit launch vehicle and a satellite. If you have any further questions or comments, write or call LTI headquarters in Bennington,VT. The company representatives would be delighted to send you more information, or answer any inquiries over the phone.

How does it work?

A ground based laser is the power source that propels the Lightcraft into orbit. Lightcraft can deliver payloads into space for a fraction of the cost of traditional rockets because most of the engine stays on the ground, thereby unburdening the craft from having to lift the energy source for its propulsion system.

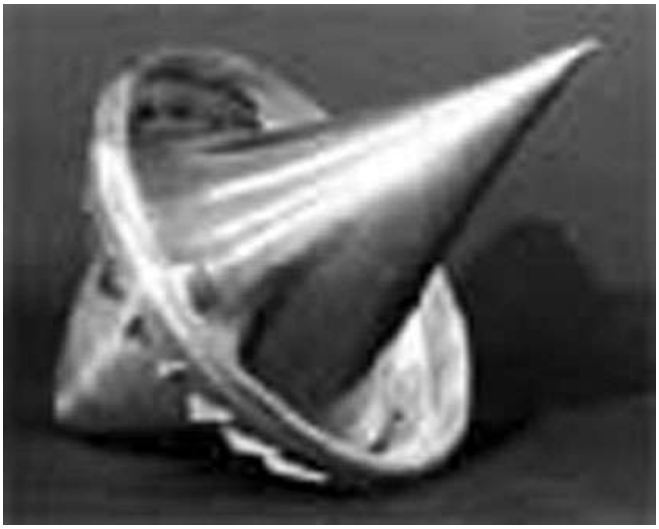

Fig. 3

The back side of the craft is a large, highly polished parabolic mirror that is designed to capture the laser beam projected at it from the ground. The mirror focuses the beam, rapidly heating the air to 5 TIMES the temperature of the sun, creating a blast wave out the back that pushes the vehicle upward. As the beam is rapidly pulsed, the vehicle is continuously propelled forward, on its way to orbit.

History of Lightcraft

1987 — Prof. Leik Myrabo invents Lightcraft for SDIO.

1997 — First successful wire-guided tests at WSMR. Solved flight stability difficulties, much like the Wright brothers did with the airplane.

1997 — Lightcraft broke Goddard's 41 ft., 1926 first successful rocket flight - but this time with no on-board fuel.

1998 — Record flight of 99 ft. with air breathing Lightcraft engine.

1999 — Record flight of 128 ft. with first rocket Lightcraft engine.

2000 — LTI sets new world record for highest flight (233 ft), longest flight time, and heaviest vehicle.

How can LTI reduce launch costs?

Conventional Launch — $175,000,000
The Lightcraft — $46,000

Chemical Rockets:

- carry massive propulsion source on board
- are expendable
- extremely costly
- prone to explosion due to fuel on board

Laser Propulsion:

- propulsion energy source remains on the ground!
- Lightcraft are inexpensive to manufacture and extremely light weight
- highly reusable power source is never subjected to the risks of flight

Lightcraft Technologies, Inc.

1914 Walloomsac Rd.
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Office: 802-447-6275
FAX: 802-447-8216
E-mail: tmyrabo@lightcrafttechnologies.com

Alternative space propulsion systems Star Drive

Mark R. Tomion, USA
http://www.stardrivedevice.com

Re: U.S. Patent **6,404,089** for the **Electrodynamic Field Generator**, **(EDF),**
issued June 11, 2002 to Mark R. Tomion.

The 'official' name of the "StarDrive device", per the U.S. Patent and international PCT Applications, is **Electrodynamic Field Generator.** The EDF Generator uses banks of permanent magnets and rotating Field Coils to produce a very-high DC rotor voltage, and plane-parallel ring electrode arrays to electrostatically expand and control that voltage *as applied to the hull*, so that huge quantities of external Field electrons may be accelerated to energy levels that are usually reached only with a particle accelerator! It's somewhat like a glorified arc welder whose output is deliberately shorted to its own housing, and the DC voltage and current across the emitter and collector housing sections can be thermionically increased to values that are generally observed only in lightning**:** but the Field's *current density* is limited to a value which falls short of damaging the hull!

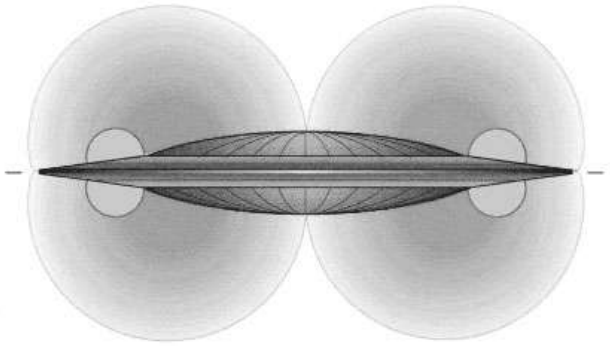

Fig. 1
StarDrive device hull & electrodynamic Field configuration

As depicted above (Fig. 1), electrons circulating in the external Field envelope can achieve an impact velocity at the central collector sections which is very nearly that of light, and applied magnetic fields allow broad modulation of the Drive Field current's properties. The *Primary Arrays* shown in the generalized schematic diagram below (Fig. 2) have control grids which allow an arc resistance imbalance to be imparted to the otherwise symmetrical Field current, so that they *render the two relativistic current impulses variably non-isometric:* thereby yielding thrust that is essentially **reactionless**! And the simple DC *Primary Power System*, like the early Faraday disk dynamo, *is wholly rotor-based* **. . .**

Note: It can be seen that the propulsive thrust developed by a StarDrive vessel is essentially brute-force in nature – it's produced simply by means of a controlled variable imbalance in the continuous *physical impact* of the two external hemitoroidal electron current streams with the collectors! If these two Field currents were of equal magnitude, no net force would be developed. However, if the "lower" current stream is stronger than the "upper", the vessel will be propelled away from the stronger current – in the "upward" direction. Since there's no 'backward' exhaust produced in the process, this type of thrust is truly and demonstrably reactionless in nature.

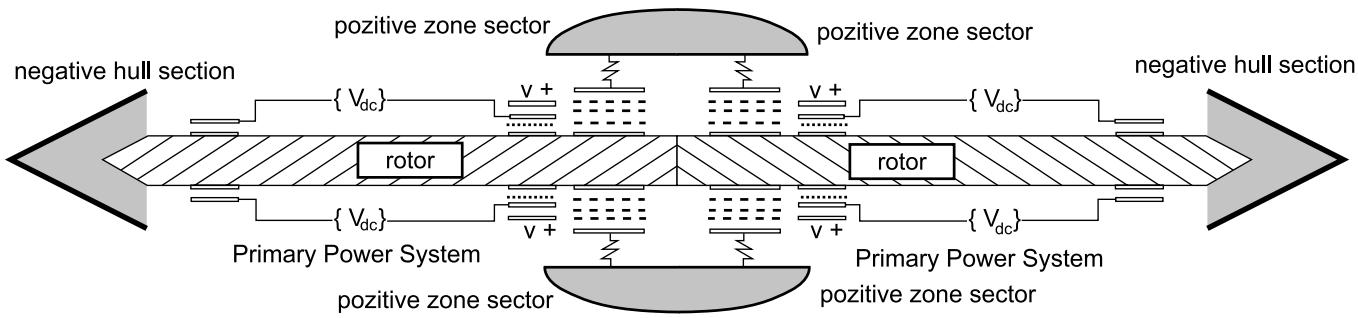

Fig. 2
Generalized schematic of rotor & dual induction ring assemblies

Needless to say, tremendous quantities of heat are produced in the StarDrive device's electron "targets" or collector housing sections, and liquid sodium must be pumped through each Primary Array's ceramic resistor network as a coolant. However, this excess heat in ground-based units may be used in the *commercial generation of electric power and desalinization of seawater*.

In fact, because an intense arc discharge field has the unique capacity to absorb vast quantities of quantum background energy, the EDF Generator is so efficient that the latter task may become truly cost-effective for the first time! And not only will large ***over-unity*** StarDrive Dynamo units be able to produce electric power at 60 to 720 MW output levels, they'll be able to do so for many years before the permanent magnet banks must be remagnetized!! *The only truly external input energy required* in the interim *is that necessary to initially bring the rotor up to speed . . .*

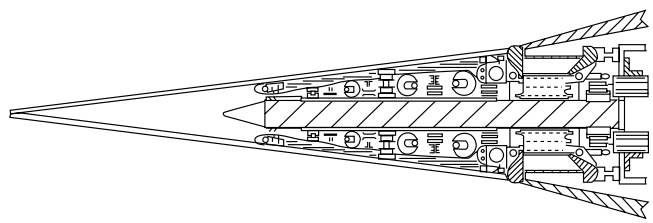

Fig. 3
A denumbered version of Fig. 1 from the EDF Generator Patent

Those of you who find this advanced technological prospect for the 21st century as exciting and fascinating as we do should consider making the

inventor's book *StarDrive Engineering* a valuable addition to your personal or reference library.

A Layman's Description of the StarDrive Device

Nearly anyone who endeavors to gain an initial understanding of the *Electrodynamic Field Generator*, even a scientist or engineer, is likely to ask for a concise layman's explanation of "how it works". This isn't easily accomplished, for this device represents an unorthodox and multidisciplinary technology. However, the overview provided below will discuss the operative characteristics of the machine's simplified *electric power generation variant* in what is hoped to be the most direct manner possible. In this case, when people ask the question above, what they generally mean is: "By what means is *over-unity* operation achieved in a 'StarDrive' Dynamo?". It is assumed here that the reader has not only already become acquainted with certain basic aspects of the design, but also understands that over-unity operation is an absolute prerequisite for any viable system of light-speed interstellar propulsion.

By way of further background, the formative mechanical design basis of the EDF Generator is of course the original Faraday disk dynamo. For whatever reason, no one seems to have bothered trying to develop this simple machine into a more sophisticated *and patentable* form before now. The principal limitation of Faraday's disk dynamo in its original form was that, when one or more permanent magnets were used to pass flux directly through the plane of a solid conductive rotor, a rather high-loss heavy current at very low voltage was produced. The first design improvement was therefore to use rotor-mounted toroid field coils in order to generate a much higher-voltage primary current, and to segment the rotor to reduce "eddy current" losses. Also, the toroid coil configuration absolutely minimizes Lenz losses, or the magnetic "drag" that is experienced by any conventional generator's rotor.

To eliminate the use of brushes, it was necessary to apply traditional vacuum tube design and operating principles. Fortunately, most of the original patent work in this field has passed into the public domain, so incorporating certain aspects of that work into the EDF Generator presented no impediment to its patentability. By using plane-parallel electrode arrays instead of brushes to charge the rotor, it is possible to limit that portion of the induced rotor current which passes through the field coils to a very low level – effectively isolating them from the actual output circuit. More importantly, however, it then becomes possible to thermoelectrically charge the Generator's housing itself in such a way that *it* carries the device's full output circuit current instead!

The reason for this unorthodox design parameter is that it was desired to actually incorporate a standing electric arc field into the output circuit, to take advantage of the electron's inherent ability to absorb quantum background energy [including *zero point energy*, if and as necessary]. As a result of a thorough study of lightning, the inventor of the StarDrive device reasoned that the electrons comprising any naturally-occurring bolt of lightning had to *recover* (or absorb) an amount of ambient photonic energy equal to that which they expended in transit – in order to satisfy the conservation of energy principle. In such a case, it is not necessary that "we" do the *work* of moving charge *against* a potential gradient; the work may be done by the charge itself in being attracted *along* the potential gradient (or voltage level).

And since it is known from the field of welding that it takes less energy to sustain an arc than it does to initiate it, it therefore becomes possible to create an electrical circuit that outputs more energy than it requires as input. This is exactly what the EDF Generator does – by incorporating a standing arc field in its output circuit. Using the StarDrive device as our mechanism, "we" only provide the work-energy required to establish and maintain the external field's potential gradient, by initiating rotor rotation and bringing the thermoelectric elements up to temperature. The electrons in the electrodynamic field do all the rest . . .

Further Notes from the Inventor

In conjunction with one of our *StarDrive Generator* prototype project funding proposals, we are presently working on an interim proof-of-concept experiment for our proposed 24 kW air-cooled EDF Generator prototype. This full-scale mock-up of the 30"-dia. Generator's rotor and dual induction ring assemblies is intended to demonstrate the fundamental design principal discussed at the close of the Technical Overview (linked to our website's Method of Operation Summary page), whereby the voltage electrostatically induced on the rotor anode rings which power each Primary Array should be roughly one-third (1/3) of the Field Coil voltage (because of the capacitive dual induction ring geometry of the Primary Power System). For safety reasons, the Field voltage in all *air-cooled* StarDrive *Generators* will be limited by design to 850 VDC, and to 1,400 VDC in the larger *liquid-cooled* StarDrive *Dynamos*.

The experiment will also assist greatly in the derivation of remaining production model specifications, and will in fact incorporate production-quality rotor segments and electrode rings. Should this proof-of-concept experiment be successful, not only will the ability of our over-unity 24 kW Generator prototype to deliver large-scale DC output that's compatible with standard AC inverters (for utility grid distribution or off-grid conventional use) be virtually assured, but a major milestone incentive in our existing funding proposals will have been fulfilled as well. Further

updates like those below will be forthcoming on the *News* page of http://www.stardrivedevice.com.

01/28/03 - International Patent Filings Secured!: We are very pleased to report that we were successful in our efforts to secure numerous international (PCT) Patent Application filings for the *Electrodynamic Field Generator* by the final deadline of January 21, 2003! These important filings were effected in Australia, Canada, the People's Republic of China, the European Union (including France, Germany, Italy, Spain, and the United Kingdom), India, Japan, Mexico, the Russian Federation, and South Africa.

The securing of these key Patent Application filings adds immeasurable value to our StarDrive Engineering Project overall, as it will greatly protect and enhance our investors' upside global market potential (assuming, of course, that our *24 kW StarDrive Generator prototype* is successful)! Be sure to check back from time to time for further updates as we proceed into the development phase of the Project.

11/07/02 - Academic Reference: Those of you kind visitors to our website who would like to have the benefit of an informed and unbiased academic opinion regarding the Electrodynamic Field Generator are welcome to contact John J. Tulip, Ph.D., Exec. Vice-Pres. of *American International University*. This consideration also applies of course to those parties who may be interested in securing a direct participation in our forthcoming EDF Generator Prototype Project. Dr. Tulip has not only expressed much-appreciated support of our efforts to introduce this important new technology, but has also had the opportunity to review our technical manual *StarDrive Engineering*. You may contact Dr. Tulip via e-mail at TulipJJ@aiuniversity.edu although we ask that you expect him to field serious and respectful inquiries only. Should you desire to speak with him by telephone, please be assured that he will endeavor to return your call whenever circumstances permit if you provide him with the proper phone number.

10/07/02 - Joint Venture Agreement Announced!: Mark Tomion, founder and president of Archer Enterprises and inventor of the recently-patented *Electrodynamic Field Generator*, is very pleased to announce that he has signed a Joint Venture Agreement with Affirm Technology Partners of Carlsbad, California to build a working prototype of his over-unity 'StarDrive' device's electric power output variant. The co-developers are planning to commence construction of a small air-cooled **StarDrive Generator** unit with a projected output rating of 24 kW and a housing diameter of only 30 inches, at a total weight of under 50 lbs., before the end of November 2002.

Should this exciting project be successful, it would represent an historic milestone in the development of over-unity electric power generation technology. Not only is this small prototype EDF Generator expected to demonstrate *a minimum Coefficient of Performance in excess of 20:1*, but the design employed is completely linearly-scalable in a very broad range of sizes that would include liquid-cooled ***StarDrive Dynamo*** units with output ratings of up to 1 gigawatt! The most remarkable feature of these large Dynamo units is that an amount of recoverable thermal energy comparable to their respective electrical outputs will be made available for desalinating seawater, or for use in centralized municipal and industrial hydronic heating systems. And this capability would make the large-scale desalinization or distillation of water truly cost-effective for perhaps the first time ever.

Interested parties are welcome to contact Mr. Tomion at office@stardrivedevice.com (585-526-6817) for further information.

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Prospects of Hydrogen Energetics

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Hydrogen is the only pollution free and inexhaustible energy carrier. But the implementation of such attractive properties of hydrogen is restrained by large expenses of energy for its production from water. Modern level of knowledge gives the opportunity to reduce these expenses [1], [2], [3].

It is known that a gram-atom is equal numerically to atomic mass of the substance, and a gram-molecule is equal numerically to molecular mass of the substance. For example, the hydrogen gram-molecule in the water molecule is equal to 2 grams, and the oxygen gram-atom is equal to 16 grams. The gram-molecule of water is equal to 18 grams. As the mass of hydrogen in the water molecule is 2x100/18=11.11% and the mass of oxygen atom is 16x100/18=88.89%, the ratio between quantity of hydrogen and oxygen is preserved in one litre of water as well. It means that 1000 grams of one litre of water contain 111.11 grams of hydrogen and 888.89 grams of oxygen.

One litre of hydrogen has mass of 0.09 grams, one litre of molecular oxygen has mass of 1.47 grams. It means that from one litre of water it possible to produce 111.11/0.09=1234.44 litres of hydrogen and 888.89/1.47=604.69 litres of oxygen. Thus, one gram of water contains 1.23 litres of hydrogen [1].

Now energy consumption for production of 1000 litres of hydrogen from water is 4 kWh and of one litre – 4 Wh. As it is possible to produce 1.234 litres of hydrogen, then 1.234x4=4.94 Wh are spent for production of one gram of water now.

Instruments and Equipment Used for the Experiment

A special experimental low current electrolyzer, a voltmeter of the highest accuracy (accuracy class 0.2, GOST 8711-78), an ammeter of the highest class of accuracy (accuracy class 0.2, GOST 871160), a balance with value of a division of 0.10 grams and 0.010 grams, and a stopwatch with value of a division of 0.1s.

Experimental Results

Indices	**Sum**
1 – duration of electrolyzer operation connected to the supply line, in 6 cycles t, min	6x5=30.0
2 – readings of voltmeter V, volts	13.6
3 – ammeter readings I, amperes	0.02
4 – power consumption (P=VxIxτ/60), Wh	0.136
5 – duration of electrolyzer operation disconnected from the supply line, in 6 cycles t, min	6x55=330.0
6 – solution mass change m, grams	0.44
7 – mass of evaporated water m', grams	0.02x6=0.12
8 – mass of water converted into gases m''=m-m', gram	0.320
9 – power consumption per gram of water converted into gases P'=P/m", Wh/grams of water	0.425
10 – existing power consumption per gram of water converted into gases P", Wh/grams of water	4.94
11 – reduction of power consumption for hydrogen production from water, K=P''/P', times	11.62
12– quantity of released hydrogen, ΔM =0.320x1.23x0.09=0.035, grams	0.035
13 – power content of hydrogen being produced (E=0.035x142/3,6)=1.397, Wh	1.397
14 – energy efficacy of water electrolysis process (Ex100/P), %	**1027**

Note: Gas output is clearly observed during many hours after the electrolyzer is disconnected from the electricity supply.

Conclusion

Low ampere water electrolysis is a way for production of inexpensive hydrogen from water and hydrogen energetics.

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2. http://book.Kanarev.innoplaza.net
3. hppt://www.n-t.org/tp/ns/if.htm.

Heater Producing Healthy Effect

The First Device of Healthy Life Support in Fuel-Energy Industry

A. Belyaeva, L. Savelyeva, O. Bondarenko, Kirghizia

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Nowadays problems of rational use of resources including energy resources are very important. Lack of energy-efficient technologies causes consumption of great amount of electric power, coal, and mineral oil. From another hand, in the XXI century one of the main approaches of human society development is turned to healthy life-style and development of ecologically appropriate technologies. Hence, basic direction of heating systems development should correspond to, at the least, two requirements, i.e. effectiveness (energy-saving) and ecological appropriation (ecological functioning). Moreover, it is necessary to take into account additional requirements for modern works:

- Relatively low prime cost of the systems;
- Minimal operating costs;
- Availability of a system of temperature mode control;
- Use of domestically produced materials for the systems.

The aim of the work is creation of a universal electric device of natural ecologically appropriate materials. The device should maintain relative air humidity of natural atmosphere in a quarter, make its ecology healthier, meet all the listed requirements, and represent new generation energy-saving system designed for heating of industrial and domestic areas according to features of technical solution.

A.L. Belyaeva is the author of this work. The invention of this heating device was acknowledged as the best invention of Kirghiz Republic of the last two years. A.L. Belyaeva was called as a laureate of a competition of "The Best Inventing in Kirghiz Republic in 2001-2002".

Solving this problem the author based on work experience existing in the area of semi-conductors production. Actually, the model was worked out in the common area of electric engineering and industrial crystals growing. Using of knowledge and skills of the both areas made creation of this device possible.

It should be noted that initially the invention of the heating device, which is discussed here, was connected with necessity to improve microclimate and air atmosphere in a semi-conductor shop since the industrial process required optimal conditions. Hence, the device was observed as an element of the industrial process. However, soon other positive characteristics of the device were disclosed, i.e. when it was installed in a quarter all visible mould disappeared. Laboratory investigations stated that the operating device annihilated all pathogenic microflora. This rediscovered feature allowed using the device both in domestic and industrial area. After series of following laboratory investigations and bench tests construction of the device was changed and improved that allowed prepare it for line production.

Ceramic electroconvector: general characteristics

The working name of the final version of the model is *Ceramic Electroconvector TY 2971-006-22997241-2002.* Ceramic Electroconvector is an industrial and domestic electric heater of direct stationary action. It has high effective heat emission and satisfies ecological, sanitary, medical, and fire-prevention requirements.

At the same time it should be mentioned that by several characteristics this electroconvector differs from other known models of electroconvectors as well as from other existent heaters. It may be observed as a representative of an independent, specially created group of heating devices.

One of the main characteristics of the electroconvector is presence of constructive heating carbonic elements made of ecologically appropriate natural *non-metal* materials. Essentially, the electroconvector construction does not contain metal (the only metal part of the device is its supporting construction).

Production of heat of physiologically comfort zone requires 0.3 kW/h energy consumption which is 3-10 times less than energy consumption of known models of heating engineering. The Ceramic Electroconvector influences positively on ecology of a room. Room heating occurs better and more softly

as conducting carbonic elements can be heated maximally up to 100° C. As a result oxygen is not burnt, and air is not overdried in a room. Achieved minimization of metal content in the constructive elements of the device increases the level of ecological compatibility both of electroconvector constructions and operation.

The device accumulates no static electricity, neutralizes harmful magnetic field generated by alternating current in the conducting element (it is typical for all the other electrical household appliances). Therefore, **the additional positive effect** is produced and higher ecological characteristics of functioning of this electroconvector are confirmed.

Insulating strength of ceramics prevents electrical shock accidents. Ecological compatibility of the electroconvector is provided by materials of the construction. The base of the device is a studied natural silicate fiber which has quantitative and qualitative content of useful chemical elements which are the closest ones to the group of medical adsorbents listed in a medical encyclopedia. The ceramics is adjusted to emit electromagnetic waves only in infra-red spectrum.

The electroconvector produces heat waves in the average IR spectrum (8.4-8.6 mkm) which is maximally approximated to the diapason of heat waves generated by a human (9.37 mkm). It annihilates humidity of buildings independently of outer space humidity. At the same time it neither burns oxygen nor overdries air.

Healthy effect is produced by all the constructive elements made of ecologically appropriate natural materials. Electric power is transformed into heat emission by conducting elements. This process causes a mode of generation of a continuous heat spectrum of radiation. The heat radiation is similar to heat spectrum of radiation generated by a human. At the same time, this feature together with resonant oscillations of the crystal lattice of the ceramic cylinders produces a destroying effect on pathogenic and conditionally pathogenic microorganisms.

From the point of view of room ecology the proved healthy effect of the operating electroconvector becomes very significant. The effect considers continuous presence of a human in the room, i.e. risk of pathogen infection through respiration objectively decreases.

Application of the ceramic electroconvector is especially actual in patient care institutions and children's institutions, in special precision industries and space technologies. It can also be used in saunas with dry vapor.

The ceramic electroconvector is designed for unsupervised continuous work.

Structure of the electroconvector producing the healthy effect

Shortcomings of known electric heaters are: great electric power consumption (0.75-3.0 kW/h), big number of metal details, complex technical performance, and use of a necessary additional blower as a ventilator. Big number of metal details decreases ecological compatibility and productivity of the heaters. The listed devices have to use high temperatures on heat-release surfaces for warming up rooms up to the level of physiological comfort. This causes increase of energy consumption. Moreover, using of metal heating elements influences on air and relative humidity in the room. According to available data, no existent electroconvectors have healthy influence on ecology of a room.

The represented ceramic electroconvector contains a carrying frame with horizontal boards which have convective gaps. The carrying frame has heat-release monolithic hollow ceramic cylinders whose walls contain longitudinal through holes. Heating carbonic conducting elements and de-energized carbonic rods are built in the through holes. The heating conducting elements are connected in parallel-series circuit at the output of the cylinders with it's ends placed into insulating supports of the carrying frame.

Constructive heating elements are the main differences of the device. All the heat generating constructive elements, i.e. conducting and de-energized heating elements, as well as heat-release surfaces of ceramic cylinders have contiguous spectra of infra-red radiation.

Energy-efficient effect

The electric scheme of connection of the conducting elements provides different modes of work of the device. According to these modes, energy consumption is in the interval of 0.05-0.3 kW/h. The mode of 0.05 kW/h is calculated on a supporting level of warming-up of a room. Maximal energy consumption (0.3 kW/h) corresponds to the superior limit of the temperature mode of heating of working heat-release surfaces of the ceramic cylinders. In this case temperature of the heat generating elements, i.e. de-energized carbonic rods and conducting carbonic elements) lies in the limit of max 100°C. This produces a significant potential resource of electric strength and of durability of the used elements. The de-energized carbonic rods function as heat accumulators at switching on and switching off the device. Heating the conductors the de-energized rods accumulate heat through the ceramic walls of the cylinder till their temperature becomes equal to the temperature of the conducting elements. Appearing electromagnetic resonance between the conductors and the de-energized carbonic rods

intensifies infra-red radiation of the ceramic wall. Accumulative heat potential of the de-energized carbonic rods allows maintain uniform radial heating of the heat-release ceramic surface of the cylinder without decreasing energy consumption. In this case additional conducting elements of infra-red radiation become unnecessary.

The heating efficiency of the ceramic electroconvector was estimated by independent experts. Surface density of the radiation flow was calculated by formula of Stefan-Boizmann distribution law. Taking into account heating of the cylinders' surfaces up to 70° C this value came to 727 W/m^2. **Total heat generated by the electroconvector per hour comes to 600 kcal or 698 W** at the total area of the radiation surfaces of 0.96 m^2 (on the basis of 1 kcal=1.163 W/h according to [1]). The electroconvector consumes 300 W/h and produces 698 W/h. That is to say that it effectively transforms electric energy into heat energy. Operational modes of the electroconvector are based on analysis of the heating effect produced by different devices, i.e. a tube metal heater (TMH) having a conducting metal element of Nichrom, a ceramic cylinder having a Nichrom conducting element, and a ceramic cylinder having a conducting element of carbonic ribbon. The carbonic ribbon produces high heating efficiency. Temperature on the surface of the ceramic frame is up to 80° C and temperature on the conducting element is 100° C. Hence, the device equipped with the conducting element of the carbonic ribbon does not produce excessive heat radiation.

The electroconvector consumes 300 W/h and produces 698 W/h.

After one-year operation of the preproduction models in a private school it was noticed that number of respiratory illnesses and influenza among the pupils slumped, condition of skin became better, attacks of bronchial asthma among the teachers stopped, and allergic itch left the patients who suffered from allergy. A side effect was that flowers began to grow better, and those which had not blossomed began to blossom at least. Obviously, a combination takes place there: air cleaning of microorganisms, humidity normalization, warming comfort, and influence of pyramidal ceramic structures on water vapors which are transported by warm blasts.

Applied Know How

Ambient air in rooms is a complex substance including various chemical compounds, ions, dust parts, water vapors, infectious and potentially infectious microflora, etc. The electroconvector is represented by a ceramic hardphase crystal structure. Cold air blast moves close to the ceramic surface. It meets combined oscillation of crystal microlevel structures of ceramics. *Filtering electromagnetic screen* appears that breaks shell of pathogens and potential pathogens. It is a performance of **sanitation properties**. Atmospheric water contacts with structures of ceramics, then it is cleaned and structured. After that water cleans air which is breathed in by a human. Hence, the organism becomes healthier. It is a performance of the **healthy effect**. A clean room warmed uniformly improves human's health.

Main Performance Attributes of the Ceramic Electroconvector Producing Healthy Effect

Nominal required power	0.05-0.3 kWt/h
Voltage of the feeding network	220 ± 22 V
Frequency of alternating current	50 Hz
Temperature of the conducting element in operation mode	50…110° C
Temperature of the heat-release surface of the cylinder	39…90° C
Surface density of radiation flow	727 Wt/m^2
Quantity of radiated heat	600 kcal/h
Class of protection	1
General area of heat-release surfaces of the cylinders	9600 cm^2
Sizes	410 x 400 x 75 mm
Weight	18-21 kg
Durability	30 years

The ceramic electroconvector is designed as a floor construction for repetition work.

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About the author

After graduating from Polytechnic University of Frunze city Alexandra L. Belyaeva (1953) participated in launching of semiconductor production. She was given a rank of Perfect Inventor and Rationalyzer for invention and rationalization action. In 1987 her invention named Method of Production of Monosilicon Seed Crystals was introduced into manufacture, according to close copyright of USSR. Since that year this introduction has allowed grow monosilicon having better semiconductor properties. She was given a rank of Inventor of USSR for the invention.

Alexandra L. Belyaeva has acknowledged and given a rank of Inventor of Kirghiz Republic. Since 1994 in collaboration with Russian specialists of ceramics she has been dealing with organization of ceramic productions in Kirghizstan. Here are the inventions by Belyaeva: Method of Production of Seed Crystals and Its Variants (Patent #42 KG), Ceramic Mass for Insulators' Production (Patent #43 KG), Ceramic Mass Having Heat-Radiating Properties (Patent #464 KG).

In 1992 Belyaeva was rewarded with a Silver medal of VDNH (Exhibition of Achievements of National Economy, Moscow) for development of technologies for production of constructive nitride-cadmium items of semiconductor wastes.

Her Method of Production of Nonexpendable Seed Crystals is at introduction stage. The seed monocrystals produced by the new method will allow grow ribbon monocrystals having certain properties. It will be possible to produce items made of the monocrystals which will meet requirements of energy-saving and ecological appropriation. These devices represent non-aging powerful energy sources, various semiconductive devices with no inner microdeffects and with unlimited durability, structural water filters.

Since 2002 she has been dealing with organization of production of ecologically appropriate industrial-domestic appliances causing healthy effect. The invention of Ceramic Electroconvector Producing Healthy Effect is now introduced. Energy-saving of the new ecologically appropriate electroconvector exceeds energy-saving of all the existent heating systems.

Belyaeva is a laureate of competition of The Best Inventing in Kirghiz Republic in 2001-2002.

Inertial Propulsion Device

Vitaly E. Senkevich, Russia

E-mail: hhhhha@mail.ru

A body is at rest or moves linearly and uniformly until it is not influenced by an external force.
(School course of physics)

Forget everything that you were taught at school.
(Arkady Raykin)

This propulsion device consists of an engine and a body. The engine (see Fig.1) is remarkable for its movable stator (S) which can make free rotation as well as a rotor (R). When the engine starts the stator and the rotor begin to rotate in opposite directions. Thus the engine has two ends and one of them is connected to a flywheel (F). This flywheel begins accelerated rotation.

A cross-beam (CB) is connected to the second end of the engine where a rotating momentum appears. Under the influence of this momentum the cross-beam presses down one of the supports placed on the body (for example, Sup.1). As a result a force which is compensated by acceleration of the flywheel (F) appears on the support. When the flywheel is accelerated up to certain speed a control system (CS) switches the windings of the engine to change the direction into the opposite one (reverse). At that the cross-beam also tends to turn to the other side and presses down the second support (Sup.2). Thus the cycle repeats. It should be noted that forces acting at the supports are **codirected** and they move the whole device.

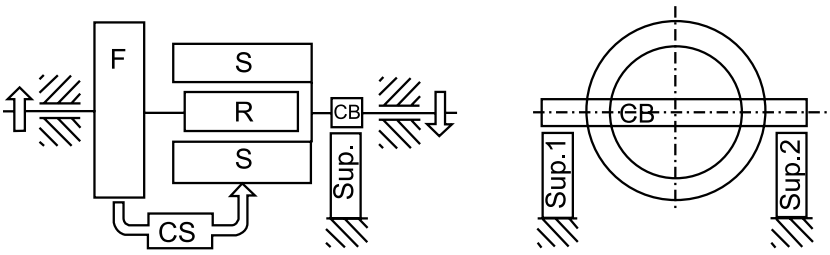

Fig.1

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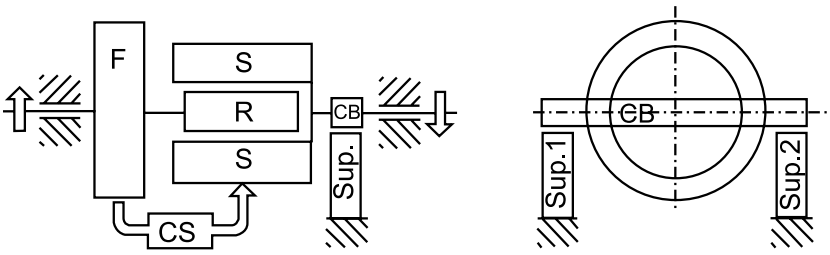

Fig.1

Unlimited Accelerated Nonreactive Motion

by G.P. Ivanov

Information from http://tts.lt/~nara/ruspopul.htm

Bias of centre of inertia of the closed system is a phenomenon exceeding the bounds of modern scientific conceptions. At the same time it is a way to the new marvelous world of earlier unknown laws and phenomena of nature. Researches made by G.P. Ivanov, Russia, have allowed him come to the following conclusion: it is a quite realizable task to create technical devices which can move under the action of nonreactive forces. However a purposeful scientific-research spade-work is required for the reliable registration of them by modern experimental facilities. According to the author during the whole XX century the known idea of latent impulse were misleading the scientists from the serious research of impulse-energy processes existing in systems at the presence of quasi-stationary electric and magnetic fields. According to G.P. Ivanov, it is related with the fact that the notion of "latent impulse" has nothing in common with the real momentum, since the very existence of "latent impulse" and "latent energy" which attends it, would make it impossible, for example, to adjust radio equipment since all effective capacitances change their value a hundred and thousand times as much (it depends on their orientation with respect to the magnetic field of the Earth).

Fig. 1, 2 demonstrate the patented by G.P. Ivanov method of realization of nonreactive motion (G.P. Ivanov, Yu.G. Ivanov. Method for production of propulsion. Patent #2172865, M., 2001). Fig. 1 demonstrates a device which consists of magnetized core with the attached metal electrodes.

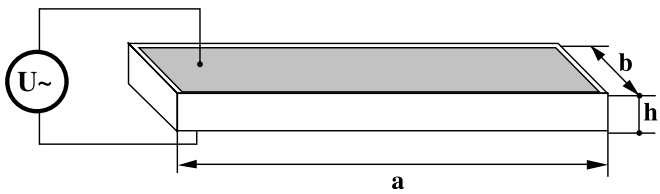

Fig. 1
The simplest "nonreactive" element

When alternating voltage is applied the device together with the center of inertia of the whole system (including power source and lead) will oscillate under the action of nonreactive force. It will move along the direction which is perpendicular to the vectors of electric and magnetic fields inside the core.

On Fig. 2 there is an analogous device supplied with a cylinder core. Magnetization of the core is defined by current of the coil which is wound around it (see Fig.2).

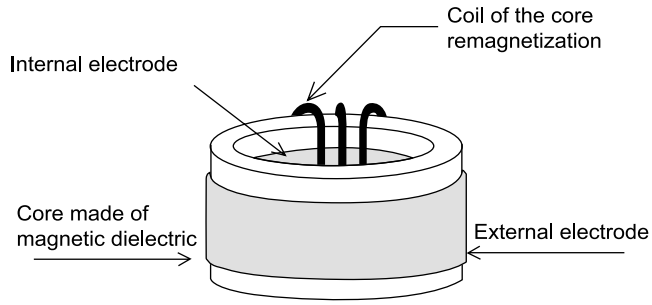

Fig. 2
Diagram of the device which can be in unlimited accelerated nonreactive motion

Let us supply the electrodes of the device with such voltage which is enough to change field density in the core (for example, according to the law $E = E_0 \sin\omega t$), and the coil with voltage enough to change the magnetization (according to the law $M = M_0 \cos\omega t$). Then nonreactive force which is constant in its direction will act on the device along the axis of the cylinder. The average of the force is $F_{cp} = \pi f E_0 M_0 V/c^2$, where E_0, M_0 are the amplitudes of density values of the electric field and amplitudes of the core magnetization, **f** is frequency, **V** is core capacity. As a result the device can either move with acceleration or act against external forces. The researches allow the author to prove the validity of the following theorem: **At motion of the open-loop system (device) the work made by nonreactive force could not be realized by means of decrease of energy of the proper (appurtenant to the system) power source.** Where this energy comes from if there are no artificial power sources outside the device? However everywhere there is such form of matter as electrovacuum. It allows us come to a conclusion that nonreactive forces make work by means of decrease of electrovacuum energy.

Existence of electrovacuum does not contradict to the modern physical picture of the world. On the contrary providing the realization of laws of momentum and energy conservation, this idea originates from and organically supplements it. The theory of electrovacuum opens quite realizable prospects in different fields of human activity which seem to be fantastic and impossible. It also proposes unusual ways to solve many problems which are considered as insoluble. For example, it becomes possible to create nonreactive cosmonautics and private aircrafts. Energetics will be changed beyond recognition since power sources which require no material fuel will occupy the place of big and small modern electric power stations. The analogous list could be continued. There are presented quite realizable prospects related to inexhaustible reserves which are hidden in the ambient space.

Revolutionary Current

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Electricity is one of the most wonderful inventions of the 18th century. It can be produced by various methods in which different types of energy are used such as mechanical or chemical energy. In this article we discuss a new type of methods in which ***electrostatic energy*** *is used.*

In this method we use **electrets** as an energy source. Electrets are permanent polarized dielectric material which is made by cooling dielectric material in a high intensity electric field. When we place an electron in the electric field of a point charge, it is influenced by a force. If the direction of the force is such that the electron moves in a closed path then it represents a current in the opposite direction along the closed path. Here closed path means a metal wire loop in which the electron movement is responsible for the current.

The charge of the electrets remains constant for many years (100) and there is no loss of energy because we use only the property of electrets that they apply force when a charge is placed in its electric field. Since here we create energy in the form of electric current then it violates the Law of conservation of energy.

Let us discuss the method in three steps:

1) Fundamental
2) Equivalent circuit
3) How we can use it as a potential source of electricity.

1. When we put a metal rod in the electric field of a point negative charge then the electron is influenced by repulsion force which moves in arrow direction and the electric field is cut by putting an earthed metal plate from any direction. When we place four charges on the corner of the metal frame and shield the electric field in particular direction as shown in Fig.1 then the force on the electron which is placed in metal frame will be in the direction of arrow and this makes a loop. The force influencing on the electron will be continuous, so the current which moves in direction opposite to the electron movement will induced in the metal frame.

2. The equivalent circuit of Fig.1 is shown in Fig2. It demonstrates that a 'V' volt battery and a resistance 'R' can be replaced by an arm of the metal frame. The polarity of the battery is shown in Fig. 1. A current of magnitude (V/R) will be induced in the circuit by this method.

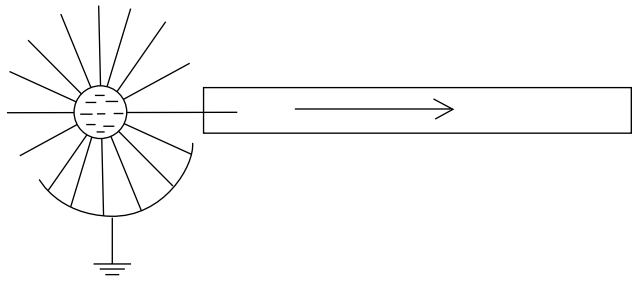

Fig. 1a

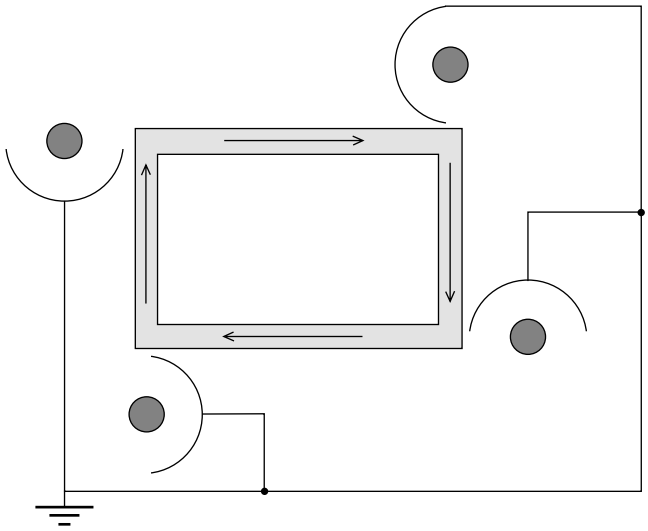

Fig. 1b

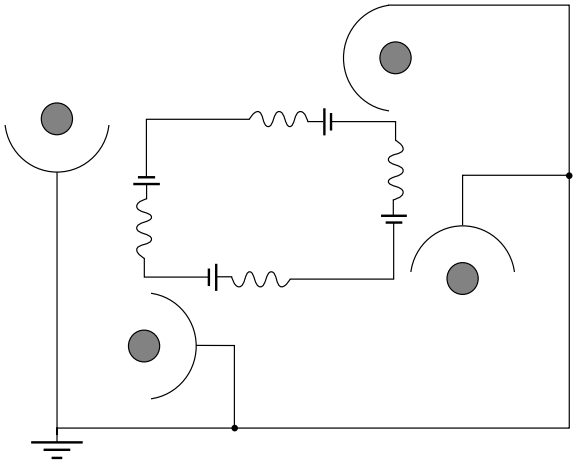

Fig. 2

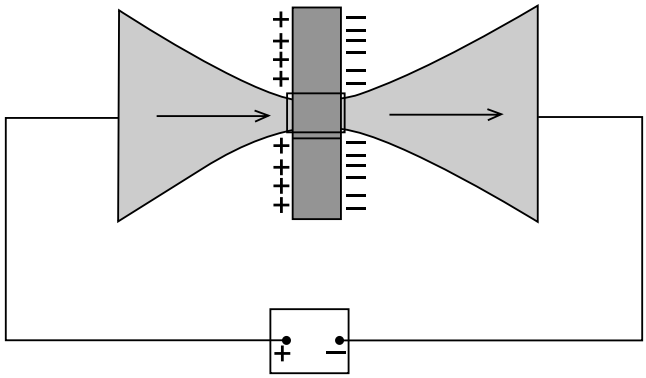

Fig. 3

3. We can use another device as a potential source (see Fig3.). Let us take an electret and make a hole at the centre. A hollow thin walled metal cylinder is fitted in the hole and a metal frame is taken as shown in the Fig. 3. We can use this metal cylinder as an electric field shield which may affect the direction of the force influencing on the electron. We may use this device as a potential source of electricity which will give electricity until the charges on the electrets vanish. The charge on the electrets remains constant for many years. Thus we can create energy and the problem of energy shortage can be solved by this method forever. We are trying to make a prototype of this but due to lack of equipment facility we are not able to demonstrate a working model. However we are trying to modify it.

NEWS REVIEW

Russian scientists are preparing new application of energy of geothermal waters

http://www.sciteclibrary.ru

A way for economical use and utilization of energy of geothermal waters was found in the Institute of Geothermal Problems (Russian Academy of Sciences). The new technology can be applied for heating in different purposes, and can compete with the power engineering, which uses the conventional energy carriers.

Geothermal springs are ideal for generating electricity by means of using of their permanent heat. This is especially important for Kamchatka, which is rich in these springs; however they are almost never used in mass power engineering, but only serve as an attraction for tourists, who admire beauty of Kamchatka geysers. At the same time the region itself freezes every year because of shortage of fuel for electric power stations.

What prevents us from using the geothermal springs?

The problem is that the storages of most of geothermal water fields have low and medium temperatures. This does not allow providing their competitiveness as regards conventional energy carriers. During tens of years this fact was an obstacle to the development of geothermal energy.

A solution was found in the Institute of Geothermal Problems. It was brought out that at many exploited geothermal fields wellhead overpressure exceeds 5-10 MPa and more. These waters contain fair quantity of dissolved organic gases. The scientists have found out that methane content of these waters exceeds 90 %. And until now at exploitation of the fields these types of energy have not been properly utilized.

The scientists of the Institute of Geothermal Problems have developed a technology of the optimum utilization of energy of geothermal waters and have increased the thermodynamic effect of the process.

This aim was fulfilled by means of transmission of thermal energy of geothermal water through the intermediate heat exchangers to the secondary heat carrier. Chemical energy of dissolved gases was used as an additional source of energy. The transmission was held by the use of primary and secondary separators. The distinctive feature of their technology is that associated potential energy of geothermal water is used as an additional source of energy. Expander and compressor placed on the same shaft are used as potential energy converters. Gas-holder and gas control point are used for utilization of energy of dissolved gases.

Thus on the bases of this technology geothermal energy can be effectively developed that will be competitive with fuel hydrocarbon energy.

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Editor: The advantages of electric vehicles were proved more than once. No fuel is required to set them in motion. Along with evident advantages of electric vehicles, such as their powerful characteristics and harmlessness for environment there is a side benefit, i.e. much less maintenance as compared with gasoline or diesel-fueled vehicles is required. Moreover it is easier to manufacture such vehicles.

In the previous issues of New Energy Technologies magazine we have already acquainted our readers with Tilley Electric Vehicle designed by Carl B. Tilley (USA). Below there is some up-to-date information and photos from the inventor. Besides we also publish an article devoted to the similar types of fuel-less motors.

After several years of personal accomplishments in the alternative energy industry, Carl B. Tilley was convinced that it was possible to build an electric car that could be powered without the help of external power to keep the battery charged.

The concept to produce a useful electric performance car that would last more than a few hours and would be economical to run, safe to drive around town or across the United States and never use a drop of fuel challenges the future of transportation as we know it today.

With the establishment of the Tilley Foundation, Inc., in the year 2001, Carl Tilley set out to prove it could be done. It was an ambitious project and it broke ground on the facility in Tennessee that would build the first self generating electric car.

...you have no need for fuel and you do not have to stop the vehicle to charge it after driving.

Construction of a 1,800 square foot building, that was powered with another recently developed electric device, began in the year 2002. Electricity from the building built the car from a different energy invention, that was void of any outside power supply. It is ironic that one alternative energy device actually built the invention to power and build the electric car.

From the selection of the proper car to be converted, to the advanced technology which is on board , the **Tilley Electric Vehicle TEV** performs comparably to gasoline powered vehicles. The difference is you have no need for fuel and you do not have to stop the vehicle to charge it after driving. There is no pollution and you can cruise the highways at the same speed as any other vehicle.

The rear mounted electric motor provides over 130 SAE net horsepower at 5,500 rpm. It offers a 3 speed automatic transmission that is smooth shifting and totally silent running. All this is combined with rack and pinion steering and a 35/65 rear weight bias that enables fast, sensitive handling and needs no power assistance.

...battery system will be fully charged at all times while in use.

It has 4 wheel disc braking for fast progressive, fade-free stopping. Counterbalanced gull-wing doors need only 14 inches of clearance. The rear sporty louvers are aerodynamic designed so that it almost eliminates any drag effect. All this with a stainless steel body makes for a great car.

Control center for the battery bank only allows what is needed to keep the batteries charged while in operation no matter what the speed or discharge from the battery bank. Your battery system will be fully charged at all times while in use. Simply get in, start the car and drive like any other vehicle.

A 1981 DeLorean was converted as the Tilley Electric Vehicle.Conversion of the car began in late June of 2002. State of the art metal fabrication to construct support for the electric motor, battery bank, control center and the TEV device was completed in July of 2002.

Several tests were made to validate the TEV technology. One of the last tests was made on September 7th, 2002. It has been demonstrated that after 17.3 miles driven on the Superspeedway at speeds ranging from 80MPH to 96MPH independent engineer certified batteries were full.

Assembly Pictures (see also the cover page)

Photos by Robert Gaither

Fig. 1
Removing Gas Motor

Fig. 4
Fitting Parts

Fig. 2
Fabrication

Fig. 5
Transmission Work

Fig. 3
Drive Motor

Fig. 6
Motor Mounted

Fig. 7
Making Connections

Fig. 9
Special Wiring &Guages

Fig. 8
About Ready

Fig. 10
Car Unveiling

Trends in the Application of Motor-Generators

Adrian Akau, USA

E-mail: adrianakau@aol.com

If the Tilley generator-motor should enter into the world market, some curious consequences may result, the most important being the transition of the Honda and Toyota hybrid cars into full fledged electrics.

First of all, a comparison should be drawn between the Tilley and the two hybrid cars presently being sold, the Honda Civic and the Toyota Pirus should be made.

The Honda Civic and the Toyota Pirus both use charging systems with a gasoline motor for better milage. The Tilley motor-generator is a stand-alone electric vehicle. The Honda motor-generator is just 60mm thick and provides (10kW or 13hp). The Toyota Pirus has a 44hp unit (American Version) which feeds power into electric motors at the wheels. Both Honda and Toyota gasoline motors are off at 0 mph. Only the electric system is used until the power demand reaches 10 kW; then the gasoline motor automatically kicks in. The Pirus is able to get higher milage in city driving than in country driving from the fact that the ratio of the power from the electric part to power to the gasoline part of the motor is greater at lower than at higher speeds, that is, less power is needed to run the car in city driving than in country driving because of the lower speeds and air resistance.

Fig. 7
Making Connections

Fig. 9
Special Wiring &Guages

Fig. 8
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Fig. 10
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American car companies are beginning to develop their own starter-generators to "save an extra 10% on the gas milage". Are they doing this because they don't want to be left behind in the milage competition or because they really understand the nature of the starter-generator motors used by the companies producing the hybrids?

With the advent of the Tilley motor-generator, a new factor enters into the situation. If the system proves valid, does this mean that Honda and Toyota are out of the running? Hardly not! It is likely that these companies have allowed or even planned for this contingency with larger capacity motor generators which would do a similar job. With their fine cars and superb engineering, the transition from a hybrid to a pure electric might be costly but not too difficult to engineer. Each of the two hybrid companies may already have been built, tested vehicles of this nature. However, since the primary purpose of the car companies is to make money it is doubtful if this full-fledged fossil fuel-less type will be placed on the market unless competition so requires. A car using the Tilley motor-generator might certainly push them in this direction.

Should the Tilley remains undeveloped, one might expect the second level hybrid car to arrive in a few years from Honda and Toyota. These cars should have greater electric generator-motor capacities and smaller gasoline engines. These systems could give small cars much higher gas milage and could also be placed in larger, more elegant vehicles such as the Honda Accord and the Toyota Camrey.

The transition to fuel-less motors should hopefully be slow and painless for both the pocket book as well as the human psych. If scientists cannot be convinced by studying conventional scientific laws on how these motors work, perhaps they will better see the need for the promulgation of new laws in this area.

We know that at the present time, both Honda and Toyota motor generators (M.G.) have a powers assist function while the Tilley stands alone. Let us look at the present situation (we will use the Toyota U.S. M.G. because it is the more powerful version):

Honda and Toyota classify their M.G.'s as permanent magnet types; Carl Tilley says his is and advanced D.C. motor.

Power output:

Honda is given at 10 kW at 3,000 rpm or 13 hp
Toyota is 33 kW at 1,040-5,600 rpm or 44 hp
Tilley is up to 135 hp depending on rpm's

Voltage/Battery (Ni-MH=Nickle Metal Hydride, AH=amp hours)

Honda: 144V, 120 Ni-MH cells@1.2V ea., 6.5 AH
Toyota: 274V, 228 Ni-MH cells@1.2V ea.
Tilley: 144V,12-12V lead acid (Wal-mart), 1200AH

Physical Characteristics of each M.G.

Honda: 60 mm wide
Toyota: unknown
Tilley: 9" dia., 146 pounds

The main effort should be to implement the transition away from the use of fossil fuels. We know this can be done but it takes proper attitude. Proper attitude takes knowledge and knowledge takes willingness to learn. Willingness to learn takes desire to learn and desire to learn takes humility. Unfortunately, humility is a characteristic that many people, especially learned ones lack. *Editor's: Carl Tilley's comments are also given below.*

Very Good...you seem to know what we already were aware of...before we could mass produce our Tilley car I am sure some auto company would come out with basically the same thing...I do believe they already have it and they are just waiting for the right time. The good news is that at least the Tilley car lighted their fire to get them started.

Carl Tilley

Read in the next issue!

In April 12 of 2003 scientific conference "The Time Machine" was organized by Faraday Laboratories Ltd in Moscow. There were presented the reports by V.A. Chernobrov, A.V. Frolov, A.V. Rykov, E.D. Sorokodum, V.J. Kosyev, A.N. Solonyi, V.A. Atsukovsky. There was discussed design of the device made by Faraday Laboratories Ltd. as well as main principles of control on temporal characteristics of physical processes by changing of density of space energy, i.e. aether density according to patent claim.

Details are in the next issue!

Electric Vehicle in Russia

Review by Correspondent Alla Pashova, Russia

The director of *EV* (*Electric Vehicles*) company located in Tolyatti (Russia), Alexander Mukhanov states: "If during 2 centuries intellectual efforts of a scientific thought were concentrated on an electric engine instead of the internal combustion engine then now we would have driven electric vehicles, and the greenhouse effect would not have exist".

The electric vehicle has driving-wheels which are set in motion by an electric engine, and it is powered by an electric battery. The electric vehicle appeared in Great Britain and France in 1880 and it is significantly older than the automobile equipped with the internal combustion engine.

At the beginning the speed and the fuel distance of the electric and gasoline vehicles were approximately the same. The main disadvantage of electric vehicles was a complicated system of recharge since there were no usual transformers of alternating current into direct one. Hence, the electric vehicle was recharged in a quite difficult way. An electric engine operated on alternating current was used to recharge it. The electric motor rotated a shaft of the generator which was connected to batteries of the electric vehicle. However in 1906 a rectifier which was simple to operate was invented. Despite its principle of operation was quite complicated (mercury vapor was used for transformation of alternating current into direct one) it has given a great stimulus for development of automobile industry.

There were no essential proves of advantage of gasoline vehicles as compared with electric vehicles. Nevertheless, even at that time there was an opinion that electric vehicles run more slowly and to shorter distances. However "gasoline" records were also insignificant and comparable with results produced by the electric vehicles. At the same time producers of electric vehicles did their best to demonstrate the advantages of these vehicles. If you remember, Walter Baker, one of the most famous American constructors and producer of the electric vehicles, achieved the speed of 130 km/h driving his car. An electric vehicle produced by Borland Electric company run from Chicago to Milwaukee (the distance of 167 km/h along non-asphalted road) without recharge. Next day after recharging the electric vehicle returned to Chicago by its own power without meeting any incidents. During the journey its speed came to 55 km/h.

In 1899-1900 a hereditary Russian nobleman Ippolit Romanov made an experiment on designing of the first Russian electric vehicle. Since these vehicles had been designed to run in Saint Petersburg then the city council required to produce them in the same place. In 1899 Romanov's first electric vehicle was made. Its general design was borrowed from English cabs in which a cabman sat on a high dickey placed behind passengers. Romanov's electric cab had two passenger seats situated in front of the dickey in a half-cabin having side and back windows. The cabin was equipped with a hood. The seat of a driver was placed behind and above the cabin; a box containing an accumulator was located under the driver's seat. The vehicle was four-wheeled. Diameter of the front wheels was smaller than those of the rear wheels. The front wheels were fixed by elliptical springs and were driving ones. They were connected to two independent electric motors by a roller chain drive. The regulated rear wheels had a smaller diameter and were fixed by spiral springs.

This first electric vehicle was equipped with lead accumulator which had 36 banks. It required recharging every 60 versts (1 verst – 3500 feet). The total power of both the electric motors was equal to 4 hp. Design of the vehicular part of Romanov's electric vehicle was borrowed from the models produced by an American company named *Morris-Salom*. This company had produced electric vehicles since 1898; however those models had wheels of greater diameter as they were equipped with pneumatic tires, while Romanov's vehicle had wheels with light rubber rims. Both the electric vehicles had two electric motors, but the distinction of Romanov's electric vehicle consisted in the presence of 6-row ball bearings in the wheels.

Romanov's second cab was built in 1900. This model had entirely closed and glazed cabin for passengers. The chain drive was replaced by a gear; however the basic sizes remained the same. This model was equipped with an accumulator designed by Romanov. The general weight of the electric vehicle was 45 poods (750 kg), and the weight of the accumulator came to 22 poods (362 kg). It should be noted that weight of American and French electric vehicles exceeded these figures. The speed of both Romanov's models of the electric vehicles came to 15 km/h.

Romanov's first electric bus was built in the same 1900. The electric bus weighted 100 poods (1600 kg) could make speed up to 10 km/h. For reasons beyond Romanov's control, traffic of the electric vehicles in Saint Petersburg was not organized.

A vehicular company named *"Frezer and Co."* participated directly in production of Romanov's

electric vehicles, i.e. a running gear of these vehicles was created by this company. In January 1900 *The Cyclist* magazine reported that this company had built an electric vehicle which had already been tested. A picture of this first electric vehicle by *"Frezer and Co."* can be found in advertising publications of those years. Various firms proposed the innovation for sale and described its technical characteristics.

Frezer electric vehicle was four-seated, had two engines whose total power came to 7 hp. The advertisement booklets reported as following: "The accepted system of accumulator is remarkable for its solidity and life-time. Capacity of the elements is about 15 Amperes/ hour per a kilogram of electrodes. The size of the battery is defined according to calculation of 120 W/h per one ton and per one-kilometer of the distance; its weight is equal to 30-40% of the total weight of the vehicle including a payload". Weight of Frezer electric vehicle came to 70 poods (1120 kg). It made the speed of 15-18 km/h and required recharging every 35-50 versts of the path. The second variant of Frezer electric vehicle differed from the first one for less weight of the accumulator which was located above the rear axle.

In addition to the four-seated vehicles, *Frezer* Company produced two-seated electric vehicles equipped with engines of 3.5-hp power. The two-seated electric vehicle was remarkable for its more perfect steering tube. There is known one specimen of this model purchased by somebody from Riga (Latvia). Moreover, on the territory of *"Frezer and Co."* there was a station for recharging accumulators of the electric vehicles.

In the period of the Soviet Union pilot batches of electric vehicles began to be produced only after the II World War. In general there were small lorries applied for transportation inside great buildings, for example, in a main post office or an airport.

Now there is a great probability that Moscow will be the first Russian city where the electric vehicles can find mass application. Russian capital suffers from gas pollution which is especially heavy in the center of the city. At the same time the budget of the city allows acquire own ecologically appropriate transport. Now financing of production of the electric vehicles is realized through the Fund of Ecologization of Moscow Transport. The means are assigned due to income taxes coming to the budget of the city.

To tell the truth, citizens of big cities know electric vehicles very well, i.e. usual trolleybuses and trams are electric vehicles despite they are not autonomous. An autonomous public electric transport has one advantage which is especially valuable in the conditions of the cities overcrowded by cars. This advantage is their mobility. Trolleybuses are inseparable with their wires that causes decrease of their maneuverability. For example, they cannot pass several cars which have been parked wrongly. In this case a maneuverable and autonomous electric vehicle will run to the center of the road and pass the obstacle with ease.

A Moscow company named *Eltran* which deals with exploitation of electric transport has developed a model of EV which runs the distance of 60 kilometers without recharging. Total recharging of this electric vehicle takes about 5 hours, however a half of required energy they can obtain for 1 hour. Hence, if the accumulators are recharged before their full discharge then this vehicle can operate constantly. However, a developed infrastructure of charging stations is necessary for this aim.

From the economical point of view, EV does not yield to trolleybuses and trams which house more passengers but run twice more slowly than the autonomous and compact EV. Therefore EV does not experience difficulties in jams in the conditions of the traffic of the city. It maneuvers easily in thick traffic current.

Unfortunately, now EV cannot replace automobiles equipped with internal combustion engines. Imperfection of its accumulator batteries does not allow it to become a public vehicle. The battery imperfection causes a small run on one recharging, long cycle of recharging, and high price of the electric vehicle.

To tell the truth, EV has important advantages. Maintenance charges of EV are lower than the charges of the standard automobile requiring expenditures for support of cooling systems, powering systems and exhausting systems. The lifetime of the electric engine comes to 10 thousands hours. Quantity of operations for maintenance of the engine is minimal. For example, it is necessary to change brushes in the dc motor from time to time. As for a modern three-phase electric motor and synchronous ac motor they are practically maintenance-free.

EV is easy to drive. To start the car you should only insert the key, turn it and press the accelerator pedal. You do not need to make any manipulations with adherence or gearshift.

Use of EV is justified in so called zones of higher environmental requirements that are cities, parks, vacation resorts. Electric buses, developed by *Eltran* run in the public green space of All-Russia Exhibition Center. There are about ten compact commercial EV operating in Moscow.

Taking care of environmental sanitation the management of AZLK (big automobile plant) has developed EV on the basis of two production automobile models "Moskvich-2141" and "Moskvich-pikup-2335". "Moskvich-Elektro" (Fig. 1-2) at fully loaded mass of 2060 kg accelerates up to 60 km/h at 15 seconds. Maximum speed of the load-free vehicle is 110 km/hour. Cruising range at one battery charging

is 100 km, and it comes to 80 km with 400 kg of load. At present Electrical Vehicle "Moskvich" is filled with imported component parts, which are cheaper but functional. In time it will be supplied with Russian equipment that will make it cheaper.

Fig. 1

Fig. 2

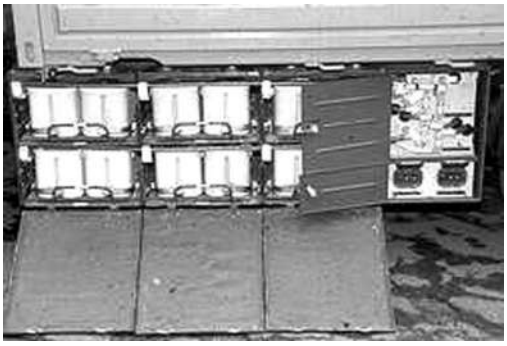

Fig. 3

The model of truck equipped with electric motor "ZIL-Electro", the authors of which being called "AVEKS" and "Optimum-electro", also enjoys the support of the Fund of Ecologization of Moscow Transport. Various privileges and free passage to any location in public green zones are promised to the future owners of "ZIL-Electro".

Forty-eight lead-acid traction batteries of roll type (Optima battery) are hanged in pairs along the ramps of the truck. They are united into 4 sections (Fig.3). Capacity of these batteries is enough for 70 km running. Probable charging station for these machines is the loading/unloading point. Charging time varies from 30 to 60 minutes. Substantial disadvantage of the model is that batteries take away a great percentage of carrying capacity. Among the advantages of the model there are small internal resistance, fast recovery (to 400 A), discharging to zero level without serious consequences.

A traction induction unit "ATAD-Optimum 50/120" serves as the engine for "ZIL-Electro". Its weight is only 100 kg and it doesn't require any diesel generator or transmission that compensates a little the loss of carrying capacity.

The engine is very simple. It is a non-contact rotor of a "squirrel cage" type rotating on the bearings. No brushes are used. Thus expensive maintenance is postponed for uncertain date. On the other hand there is asynchronism. It means that some equipment is needed for converting into three-phase current and further frequency and amplitude adjustment. However it is expensive and complicated.

In spite of all existing disadvantages, Electric Truck is considered to have a bright future ahead of it. There several reasons for that:

1 The vehicle is manufactured from cheap production component parts.
2 The system of optimum vector control of the drive is introduced. (The torque and shaft speed of rotation is regulated precisely, energy of the batteries is used rather efficiently.)
3 Microprocessor system with feedback coupling and great number of sensors (current sensor, heat sensor, velocity sensor, voltage sensor) minimizes losses, prevents the motor and batteries from overheating, protects mains from short circuit in case of an accident.
4 The vehicle is reasonably priced (for such an exotic object) – about $26 000 USD subject to serial production.

Volzhsky automobile plant has already been engaged in research of EV for a quarter of a century. Over 10 original models have been designed and produced for these years. They have been appreciated abroad as well as in Russia. These are electric vehicles "Poni", "Oka", "Elf", "Gnom", "Niva", "Rapan" "Lada-golf", etc.

The models manufactured on the basis of VAZ-1111 "Oka" became the most popular among them. These EV received many different rewards, and became world-renowned. For example, VAZ-111E "Oka", manufactured in 1993, kept all merits of a production midget car. Use of electric motor makes it a non-toxic and noiseless vehicle. Efficient fast-acting short circuit protection eliminates current rush, providing absolute car operating safety.

In EV of VAZ manufacture two direct-current motors are commonly used as a power-generating set. The first is a 25kW capacity motor with torque of 110 Nm.

Another one has 40 kW capacity and torque of 190 Nm. Motors of the first type are usually mounted on light vehicles, such as "Golf", "Oka-Electro", "Elf", while high-power motors are usually used for VAZ-2108, VAZ-2109, "Niva".

The first models of electric vehicles used to be equipped with nickel-zinc batteries. But as life time of these batteries is not long, it was decided to start using nickel-cadmium batteries, manufactured at Saint-Petersburg plants "Rigel" and "Istochnik". Nickel-cadmium batteries are power-consuming, they withstand temperature of –40°C. The only drawback of these batteries is their cost, and as a consequence a high cost of the vehicle itself. Because of that the final choice has been made in favor of lead-acid storage batteries, which were mounted at "Gamma Golf" in particular, thus reducing its price by several times. The batteries are located under the driver and passenger seats. They allow discharge of 80-85% and provide cruising range without recharge of up to 100 km within city area and several times more on a highway. Power current is transmitted from the electric motor to the front wheels through single-reduction gear unit, which substitutes the transmission.

For the present time electric vehicles are not developed to take the place of automobiles with internal-combustion engine in all industries and spheres of application, but only as a specific vehicle for highly specialized utilization. They are utilized when use of internal-combustion engine is objectionable or impossible.

It is considered that so-called hybrid models of EV would be able to replace automobiles with internal-combustion engines. These are vehicles with two motors, an electric motor and an internal-combustion engine usually running on diesel oil. In this case the combustion engine works constantly, but under the operation modes of little air pollution. Besides, fuel consumption is also much reduced.

In this direction real commercial success is possible. For example, "Toyota-Pirus" has already been chosen as a personal vehicle by tens of thousands of customers, this being a good result for such an original construction.

Nowadays three circuits of hybrid propulsion system are generally known. The simplest one is a series circuit, in which combustion engine operates together with a generator, and battery or generator powers electric motor providing propulsion. Actually this is the same circuit of electric transmission that is used at quarry trucks. Its main disadvantage is great losses of energy at transmitting the torque to the wheels. In parallel circuit the output shafts of the motor-generator and combustion engine are rigidly bound, and it doesn't allow working in steady-state mode (i.e. with permanent rotations and load).

In the third circuit, which is also the most commonly used there are an electric motor, combustion engine and a generator. The output shafts of all these units are bound by planetary differential. This allows almost lossless distribution of power between the units, and provides sustained performance of the combustion engine. The disadvantage of this circuit is the extreme complexity of coordination of units operating.

A hybrid EV was produced in Russia by automobile plant "Izhmash" though it has not been put in mass production yet. At the developing of the propulsion system instead of unique components there were used units of Russian mass automobile production that is one of the fundamental design solutions. "Orbit" Izh-21261 was used as a base for the device. It was equipped with gasoline engine (of 30 hp power and 650 cm^3 capacity), drive dc motor ПТ-125-12 (of 120V voltage and 49 H/m torque) and eight accumulators 6CE-55. Twin-engined propulsion system works according to the parallel circuit of engine joint. Electromotor serves as starter and at the acceleration it operates simultaneously with internal-combustion engine. On reaching some definite speed the electromotor changes its operation mode to the mode of generator and charges the accumulators. When the loads at gasoline engine increase then the electromotor begins to operate together with it. Operation of the hybrid propulsion system is controlled by starting regulation electronic equipment. Control unit, speed transducer of crankshaft of the internal combustion engine, detector of the accelerator pedal etc. are responsible for coordinated work of the engines.

During the tests fuel consumption of the hybrid vehicle "Orbit" was less by 20% than that of the usual model. For Russian prototype it is a good qualitative characteristic, however foreign designers reach better results, for example, "Crysler ESX3", which was presented in 1998 at Geneva auto show, consumes 3.3 liter of diesel oil per 100 km of path.

Representatives of specialized Moscow companies producing EV assert unanimously that these are hybrid electric vehicles which should change public transport with internal combustion engine. To encourage the automakers it is useful to create the proper laws drawing on foreign experience. For example, in California, USA, automakers whishing to present their production in the state market should put out 2% of automobiles with null blast. Legal system also supports an automobile user who is provided for free parking and free or cheap recharge. The user is granted with maximum of discounts to encourage him buying EV which is still twice as expensive. However it is said that in one of the villages situated near Moscow where the so called new Russians live, everybody drive electric vehicles leaving their cars with gasoline engine outside the gates. It would be quite good if EV turns to the real vehicle from the extravagancy of nouveau riches and beloved creation of ecologists.

The Richard Clem Motor and the Conical Pump

An Investigation of the Clem Motor

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In December of 1992 Jerry Decker posted an article on the KeelyNet BBS, about a self-running motor that developed excess useable power. The information, gathered from newspaper and individual sources, gave an anecdotal account of the motor invented in 1972 by Richard Clem of Flower Mound, Texas. New information has since been added and can be found on http://www.keelynet.com/energy/clem1.htm.

Richard Clem worked with heavy machinery for the city of Dallas. He used asphalt-spraying equipment, which pumped liquid asphalt. He noticed the asphalt pump would continue to run for up to 30 minutes after the power was turned off. It was this discovery that led to the development of the motor. Modifications he made eventually resulted in a substantial 350 horsepower output from a 200-pound motor. Clem is said to have often driven a car, powered by this motor, up and down Central Expressway in Dallas. He claimed it didn't use any fuel, and only needed a change of oil every 150,000 miles.

The motor had only one moving part, a cone shaped rotor mounted vertically on a hollow shaft. Spiral channels cut into the cone wound around its length and feed into peripheral nozzles at its large end. When fluid flowed through the spiral channels it was ejected out the nozzles and caused the cone to spin. At a certain velocity, the rotating cone became independent of the starter pump and began to operate by itself. At an operating speed of 1800 to 2300 RPM the fluid heated up to 300 F, requiring a heat exchanger. Vegetable oil was used because at 300 F water boils and conventional engine oil breaks down. A 12-volt battery was the only other power source. Clem never applied for a patent because his motor design was derived from the asphalt pump that was already patented. Fifteen companies turned him down before a large coal company offered to back him and signed contracts to sell the motor. Soon after the deal was signed, Richard Clem died of a heart attack

The above account contains only what I considered to be relevant for analysis of the Clem motor. Visit http://www.keelynet.com/ for the original material.

The gear pumps, typically used for asphalt spraying, do not match the description of the pump used by the city of Dallas back in 1972. There should be public records showing what equipment manufacture the asphalt sprayer was purchased from. Since the asphalt pump was patented, I searched for a pump patent that met the following criteria:

1) Patent issued on or before 1972.
2) Delivered pressure equivalent to a positive displacement gear pump.
3) Cone shaped rotor with spiral channels.
4) Self-propelling action.
5) Capable of pumping a viscous fluid like asphalt.
6) Large heat transfer to pumped fluids.

The following illustration (Fig.1) is from US Patent 3,697,190 (Truncated Conical Drag Pump). The patent was issued October 10, 1972 (criteria 1) and appears to match the description of the asphalt pump that Clem converted into his motor.

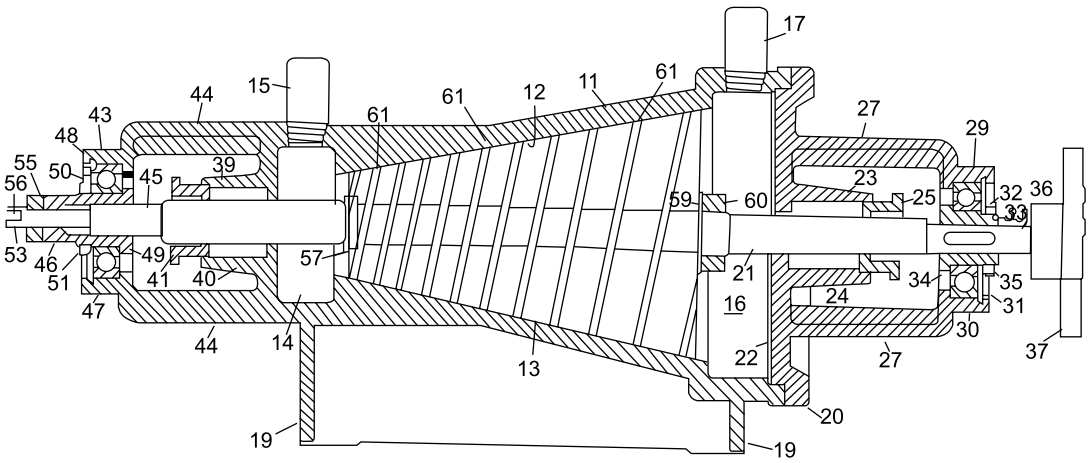

Fig.1

Housing 11, Conical interior wall 12, Conical rotor 13, Inlet chamber 14, Inlet pipe 15, Outlet chamber 16, Outlet pipe 17, Support feet 19, Detachable end cap 20, Rotor shaft 21, End cap wall 22, Boss 23, Packing 24, Adjustable gland nut 25, Bracket arms 27, Bearing boss 29, Bearing 30, Snap ring 31, Inner race 32, Sleeve 33, Shoulder 34, Retainer nut 35, Reduced diameter outer end 36, Coupling 37, Packing 39, Retainer 40, Gland nut 41, Bearing boss 43, Integrally formed bracket 44, Shaft reduced diameter 45, Bearing sleeve 46, Bearing 47, Snap ring 48, Inner flanged 49, Inner race 50, Nut 51,Shaft reduced diameter 53, Lock nut 55, Flat faces 56, Snap ring 57, Washer 59, Nut 60, Helical channel 61, Channel base 63, Channel sidewalls 64.

This is a high-pressure, low volume drag pump that can be used in place of conventional positive displacement pumps (criteria 2). It has a conical rotor that has a close fit clearance with the stationary housing wall. Delivered pressure is limited by back flow across the radial clearance and is inversely proportional to the square of the clearance. As a result, even a small increase in radial clearance would rapidly reduce pressure. The rotor is cone shaped so that the clearance can be controlled by axial adjustment of the rotor relative to the housing wall.

The conical rotor has two helical channels (criteria 3), in the form of square threads, spaced 180 apart for balance. The channel depth decreases as the rotor diameter increases. Fluid enters the channels at the small end of the rotor. The fluid is induced to rotate with the channel by boundary layer drag. The boundary layer is the thin layer of fluid adhering to the channel surface. Molecular cohesion tends to drag the adjacent fluid with the boundary layer. The fluid is also in contact with the housing wall. The boundary layer drag against this stationary wall slows the rotation of the fluid in the channels. Because the fluid rotates slower than the rotor, it is forced through the channels towards the large end of the rotor. In addition the fluid is forced towards the large end by centrifugal force.

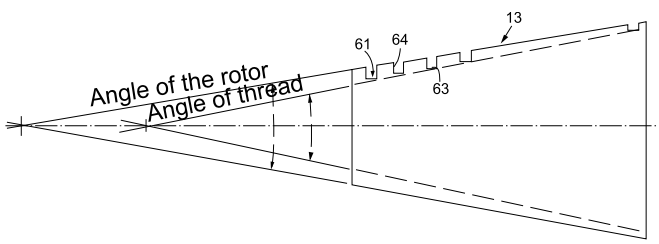

Fig.2

The above drawing illustrates the proportional decrease in channel depth as the rotor diameter increases. Why was this done? Note that as the diameter doubles so does the circumference. This means the fluid has to travel twice as far in the same time to maintain a constant slip velocity. By reducing the channel depth in half (cross-section area = depth x width) the fluid velocity is doubled thereby keeping the slip constant.

The spiral channels could be thought of as very long convergent nozzles. The increase in fluid velocity is in the opposite direction of the rotor spin. We should expect a reaction force from the acceleration of the fluid. This thrust would be directed tangent to the circumference and would increase the spin torque on the rotor. Even without the peripheral nozzles, that Clem later added, the pump rotor experiences a thrust force in a direction that would self-propel it (criteria 4).

Because fluid drag is the primary pumping force, it is well suited for viscous fluids like asphalt (criteria 5). The long channels also represent a large sliding surface area with frictional losses that would transfer heat to the pumped fluid (criteria 6).

All six of the patent search criteria have now been met. Of course this doesn't prove that it is the asphalt pump Richard Clem worked with.

A peculiar condition indicated by the patent is that as the velocity increases in the channels the pressure also increases. Bernoulli's Law requires the pressure to drop proportionally as the velocity increases. Assuming an ideal fluid without losses, when the channel depth is reduced in half, the cross section area is also half and this doubles the fluid velocity and the fluid pressure should drop in half. So what is going on here? There is a centrifugal component that would add to the fluid pressure.

My guess is it's too small to overcome the predicted pressure drop. Here is what I think may be going on. As the diameter and velocity increases the drag force propelling the fluid through the channel is proportionally greater. Energy is being added all along the length of the channel. Whatever the reason, if this high-velocity, high-pressure fluid is feed into tangent peripheral nozzles at the rotor large end, the energy will be converted to shaft horsepower.

The Clem motor is producing 350 shaft-horsepower and a large heat energy component. Where is this huge amount of energy coming from? Recent quantum mechanics zero-point field (ZPF) theories may point to the answer. From an article available at "BEYOND $E=mc^2$" Bernhard Haisch, Alfonso Rueda & H.E. Puthoff [1]:

"Our work suggests inertia is a property arising out of the vast, all-pervasive electromagnetic field we mentioned earlier, which is called the zero-point field (ZPF). The name comes from the fact that the field is held to exist in a vacuum-what is commonly thought of as "empty" space-even at the temperature of absolute zero, at which all thermal radiation is absent."

ZPF researchers theorize that mass, inertia and gravity are not intrinsic properties of matter but the interaction of matter with the zero-point field. By all pervasive it is meant that the ZPF exists not only in empty space but it is passing through your body right now and everywhere else. When you throw a stone you are interacting with this field since the ZPF resists change in motion. In essence the ZPF is the modern day aether.

The amount of energy making up the ZPF is thought to be enormous. Is the fluid acceleration in the Clem motor interacting with the ZPF in such a way as to rectify it and draw energy from it? Is it a hydraulic aether-diode? The fluid, in the Conical Drag Pump, flows through long convergent channels. Disregarding the boundary layer, is this accelerated flow laminar? Would such a long orderly flow entrain the aether energy?

From the perspective of the rotating channels the fluid appears as the discharge from a long nozzle. To exaggerate, if the fluid was held fast to the housing wall, the rotating channel would travel through the stationary fluid. This would be equivalent to achieving 100% efficiency. In reality the fluid is slipping against the stationary housing wall so that the rotating channel (nozzle) is moving faster than the fluid discharge velocity. Assuming the reaction thrust as the only propelling force, this would give efficiency greater than 100%. So, as the slip increases the reaction thrust decreases, but the efficiency increases.

Assuming the Conical Drag Pump is the pump Clem used, can it answer the following?

1) Why was a hollow shaft used?
2) Why was the cone mounted vertically?
3) Why was a starter pump needed?
4) How were the peripheral nozzles added?
5) How was the motor RPM regulated?
6) How did a large coal company get involved?
7) Was this kind of pump ever used in asphalt sprayers?

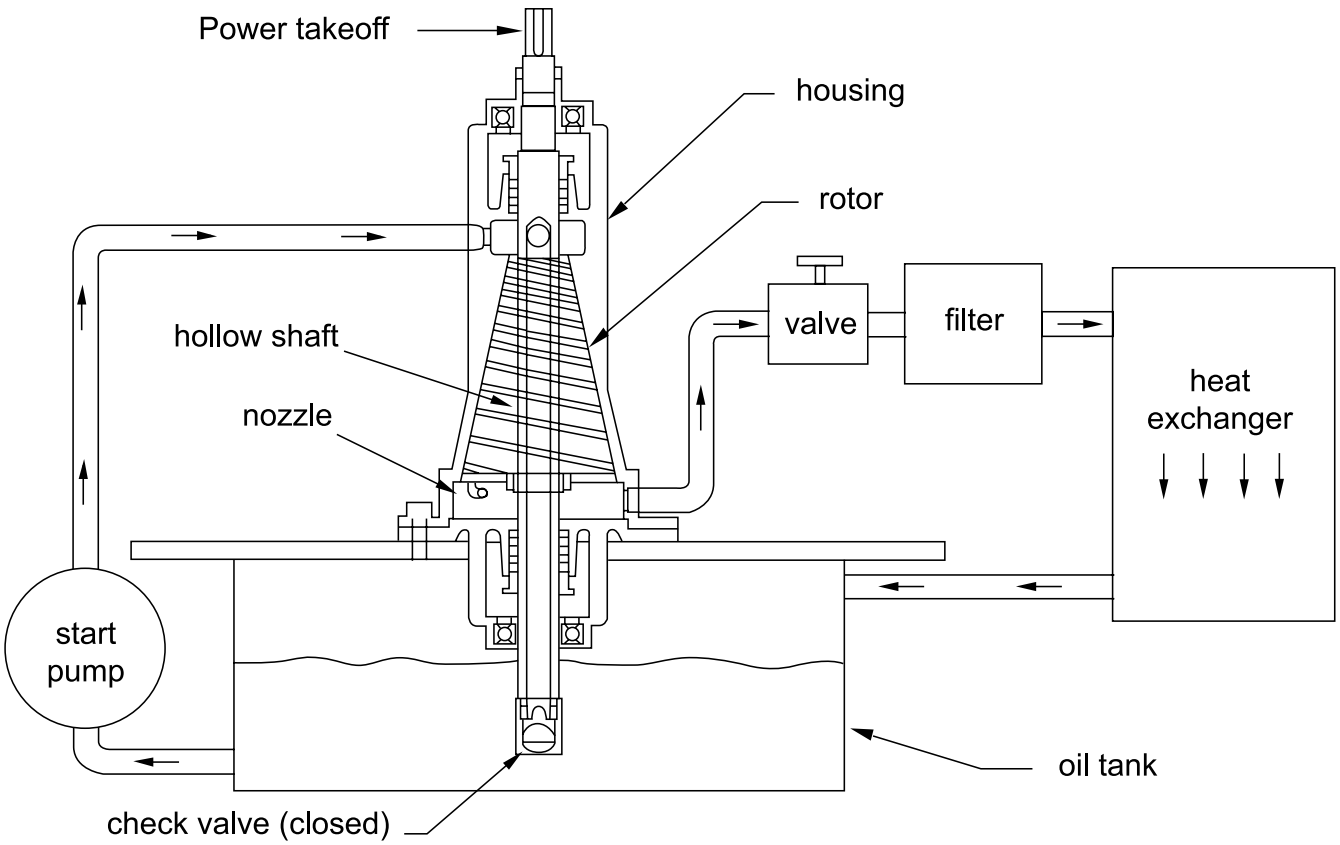

Fig.3

Clem motor shown in start mode
The arrows show oil flow

The above drawing shows a hypothetical Clem motor based on the Conical Drag Pump. The motor is mounted vertically so that the check valve on the hollow shaft is submerged down in the oil tank. The hollow shaft extends from the oil tank through the rotor into the inlet chamber. The start pump draws oil from the tank and forces it up

the external feed line connected to the inlet chamber at the small end of the rotor. This fills the hollow shaft and forces the check valve closed. The oil flows into the spiral channels and out the peripheral nozzles. The reaction thrust of the nozzles spins the rotor. The oil flows through the return line, through the valve, filter, and heat exchanger and back into the tank. The start pump is most likely a standard hydraulic gear pump. It continues to pump until the rotor spins up to its operating speed. The combinations of a start pump and check valve would be a simple way to both prime the motor and spin up the rotor.

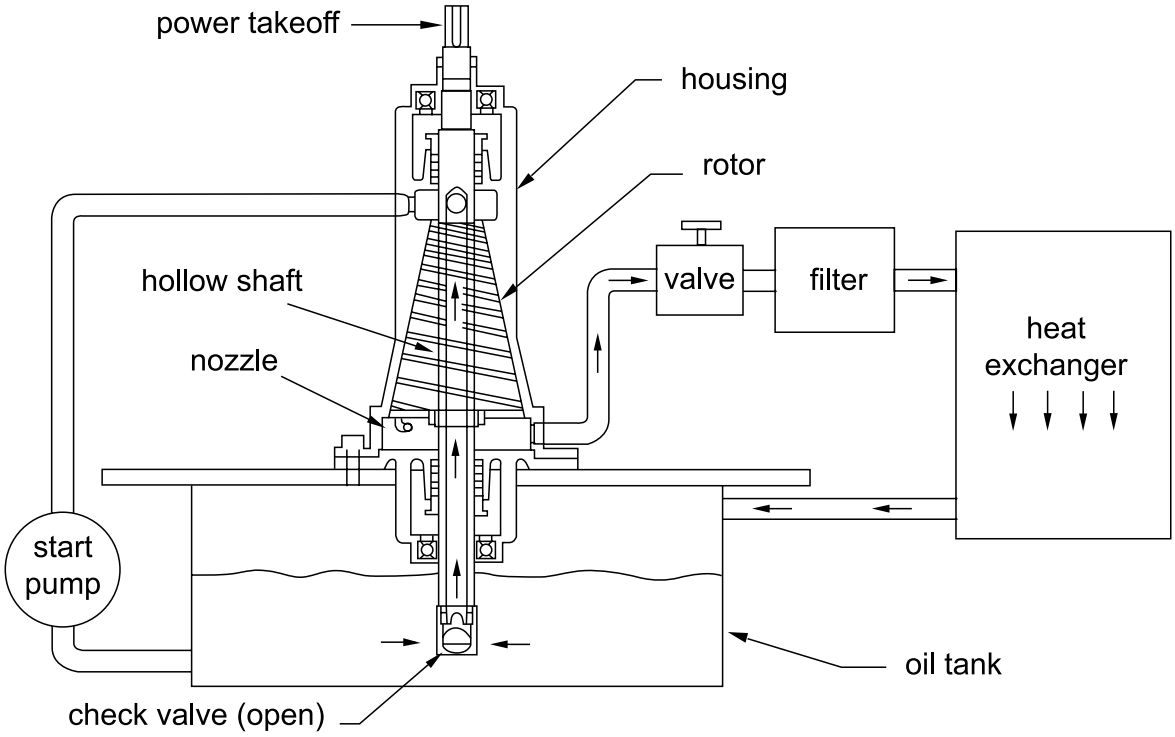

Fig.4

Clem motor shown in operation mode
The arrows show oil flow

Once the start pump is shut off the check valve is free to open. Oil is drawn up into the hollow shaft to the inlet chamber at the small end of the rotor. The spiral channels pump the oil down towards the large end of the rotor. A plate is attached to the large end of the rotor and fits with a close clearance with the housing wall. Nozzles attached to the outer edge receive high-pressure oil from the spiral channels. The jet reaction thrust from the nozzles delivers shaft horsepower to the power takeoff at the shaft top. Adjusting the valve to create hydraulic backpressure regulates the motor RPM. Closing the valve stops the motor.

When I first read about the Clem Motor I found it odd that a deal had been made with a coal company. Was there a connection with the pump? After finding the Conical Drag Pump patent, I wanted to contact the inventor Walter D. Haentjens of Barrett, Haentjens & Co., Hazleton, Pennsylvania. Otto Haentjens founded Barrett Haentjens & Co., in 1916. The business began in the coalmines of Pennsylvania with Otto Haentjens original patent on the balanced opposed impeller multi-stage volute pump. The company still supplies pumps to the coal industry. They have expanded to other markets and their pumps are installed in many industries worldwide. It is now known as Hazleton Pumps Inc., after its acquisition by The Weir Group.

I contacted Peter Haentjens, the VP/General Manager of Hazleton Pumps, by e-mail to find out if this pump had ever been put into production. He replied that they had not done anything with the patent.

An unusual pump design would have a tough time competing in the market with an industry standard like gear pumps. The Dallas asphalt sprayer may have been a one of a kind field test of the pump design. Or the pump manufacturer offered it for testing to an asphalt equipment company in the hopes of generating interest in it.

References

Bernhard Haisch, Alfonso Rueda & H.E. Puthoff, "BEYOND $E=mc^2$" //The Sciences, Vol. 34, No. 6, November / December 1994, pp. 26-31 copyright 1994, New York Academy of Sciences.

Spontaneous Flow Heat Pump

PACES : The Alternative Energy

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"Paces" is a new high performance electronic process. It is not a traditional heat pump fitted with some electronic gadgets to improve its output, but a truly revolutionary process totally unused up to now. There are no moving parts, not even a moving fluid in it. "Paces" is an electronic process because for its development the pump's fundamental element uses micro-electronic techniques.

...an average of 9000MW could be produced, that is to say the equivalent of several nuclear power stations.

The principle consists in attracting the gas neutral molecules onto a so-called "electrostatic" plate, to accelerate them and heat the plate. An intense electric field is applied in a capacitor with micro-pores covering the plate. The neutral molecules are polarized and accelerated when they penetrate these micro-pores where the intense electric field exists. Each molecule accelerates and absorbs electrical energy when it enters into a pore. But in turn it decelerates and gives off an equal amount of energy upon its exit from the pore.

The molecules, by going back and forth between the plates, continually give off and take energy, thus resulting in a total consumption equal to zero.

The gas fluid does not undergo any change of thermodynamic state, contrary to all other heat pump processes. A thermodynamic cycle remains at the level of each gas molecule, but not at the level of the entire set of molecules.

There is more to this new process, it is not just heat pump process added to an already long list: **these new characteristics also enable some new applications.** Besides the traditional heat pump applications, due to its excellent coefficient of performance this process makes it possible **to produce electricity by cooling the environment.**

For instance, if the Rhine was equipped with heat exchangers into which diverted water could flow, thus cooling its temperature by just one degree, an average of 9000MW could be produced, that is to say the equivalent of several nuclear power stations. Please note that this process would also enable **both electricity and fresh water to be produced from seawater,** an interesting application for areas of the world where water is a scarce resource.

Thus we have at our disposal an ecological process for producing electricity, it would become conceivable to produce hydrogen in great quantities; vehicles would be hydrogen powered. Ozone, CO2 or any other type of pollution would become a thing of the past.

It will most probably be the energy source of future generations, ecological and excellent, inexhaustible, powerful yet completely harmless, stable and steady (contrary to the sun and wind); an invention capable of re-launching the world economy, in particular giving impetus to the currently depressed new technology sector.

However, you have probably noticed that this invention requires advanced technology, and the few French laboratories capable to develop this process have proven inaccessibility to do it for independent researchers such as the author of the article. Besides, the invention's claimed qualities, the revolutionary aspect was very often interpreted by examiners as 'utopian', even before they read the document! Having tired of battling against concept fixed for the past two centuries, the author of the article **has now decided to place this project within the hands of the international scientific and technological community,** in order to give the best chance of success to the invention.

It will most probably be the energy source of future generations!

Initial development requires the construction of a prototype; three possibilities are described on the website (http://www.new-energy-paces.com). As there is no longer legal protection abroad, anyone is free to experiment and to market, as he or she wishes, in all other countries outside of France.

Please help me to spread the word about this project, for example through scientific forums on the Internet. This will allow you to receive feedback and gather other opinions. Your participation, even the most modest, will be of use. To those of you who help this project to see the light of day, all of humanity will be indebted.

Registration of Gravitational Waves

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Registration of gravitational waves is one of fundamental problems of physics. At the beginning of the last century A. Einstein's works predicted existence of these waves. Nevertheless, despite numerous attempts are made in different countries of the world these waves have not been fixed up today. Josef Veber, an American physicist working in 60th of the XX century, is sure to be called as the first experimenter who disclosed gravitational waves. Nowadays lots of many-million projects on registration of gravitation waves are developed and realized (LIGO (USA), GEO-600 (Germany-England), VIRGO (Italia), and TAMA (Japan)). However no positive results were achieved.

Failures in registration of gravitational waves can be explained by the fact that researchers have erroneous notion of the essence of these waves. This erroneous notion is laid in an experimental project that causes negative results.

Many researchers believe that influence of gravitational waves on the bodies should be resulted in deformation of these bodies (i.e. in change of mutual place of particles of a material body). All the attempts to disclose the gravitational waves are based on this notion. Now two types of ground gravitational antennas are supposed as priority.

The first type supposes the registration of mechanical oscillations of a massive test body that is initiated by influence of gravitational waves on it.

The second can register changes of a distance between space-apart free masses when gravitational waves act upon them. Great attention is paid to the second type of antennas in the developed projects. Failure attempts of registration of gravitational waves can be explained by their low intensiveness and insufficient accuracy of existing measuring equipments. Therefore, now there are made various attempts to register gravitational waves produced by such great cosmic phenomena as confluence of black holes. More accurate instruments and measuring equipments, for example, a laser interferometer, are developed. Nevertheless, positive results are hardly to be obtained.

Here is one of the fallacious explanations of action of gravitational waves on a body: *"Passing of gravitational waves changes an interval between objects transferring them one from another like two boats sometimes are approached sometimes moved from each other by sea waves".*

Following this example to explain influence of the gravitational waves on bodies placing on the Earth, it can be said that all bodies are in one boat and raising or sinking of the boat on sea waves does not cause change of the distance between the bodies. However, this example seems to be very simplified for explanation of influence of the gravitational waves on bodies. In fact, the case is much more difficult.

According to A. Einstein's theory, bodies moving with variable acceleration will radiate gravitational waves. **Gravitational waves represent the essence of changes of gravitational field occurring at light speed.** Since the gravitational field is a deformed space-time then the gravitational waves cause change of deformation of the space-time. Change of deformation of the space-time is accompanied with change of deformation of geodesic lines (i.e. lines by which all the bodies move).

A body moving by a geodesic line whose deformation is changed changes its acceleration. Change of acceleration of the body will change gravity applied to the body in this area of space. Hence, influence of gravitational waves on the body occurs through gravity which influences on it.

It is known that a fundamental difference between gravity and other forces appearing at a direct contact with a body consists in the fact that gravity provides all the elements of the body (all its points) with equal acceleration (deformation can not occur), and other forces influence on certain parts of the surface of a body and so cause its deformation.

Hence it is senseless to try to measure deformation of a body or change of a distance between test bodies occurring under influence of gravitational waves. It is necessary to note that, in particular, when a body is placed on an unmovable support relatively to the Earth, value and the direction of gravity coincides with weight of the body. Therefore, in this case gravitational waves can be registered at measuring of changes of the body weight.

An experiment on registration of the gravitational field of the Earth by measuring change of weight of

a test body was made. Before the beginning of the experiment there was set a problem to register gravitational waves produced by the Mercury and the Venus at approaching to the Earth. The gravitational field in which the Earth moves changes due to superposition of gravitational waves of other planets on it. These changes were necessary to be registered.

The experiment was as follows: a test body (a 100 grams weight) was weighted on an electronic balance in equal time intervals of 14 days. The experiment was lasting for 12 months. In the experiment it appeared that change of a distance between the Earth and the mentioned planets causes change of weight of the test body. The change of weight of the body occurred in proportion to the distance between the planets. The test body was weighted in the same conditions and in the same place. The performance of the experiment is so easy that every person can made it.

It is known that weight of a body changes (decreases) at moving along the Earth surface from its pole to the equator. Change of weight of a body locating in the same place has not been fixed until now.

The fixed change of weight of the test body proves change of gravity applied to it and, consequently, change of the gravitational field in which the test body moves as well as the Earth does. **These changes of the gravitational field were caused by motion (superposition) of the gravitational waves produced by the mentioned planets at their approaching towards the Earth at the distance of the existent gravitational field.**

Hence, the Earth and all the bodies locating on it move in the constantly changing gravitational field, therefore, constantly change their weight. Nevertheless, as it is known, change of the gravitational field is the influence of gravitational waves on it. Hence, measuring changing of weight of bodies we can speak about registration of gravitational waves.

In search of the 4th dimension

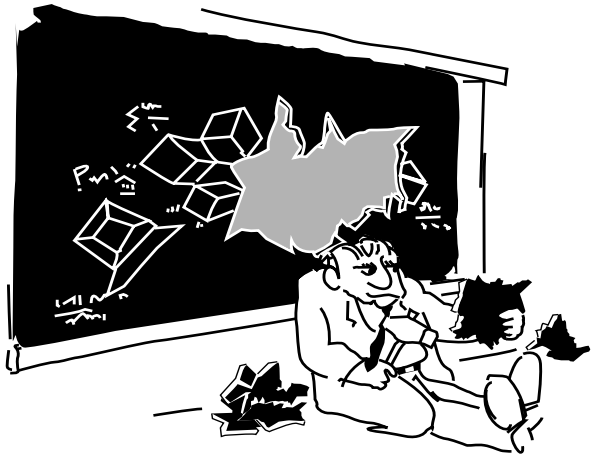

From http://home.ural.ru/~meop/index.html

High-Energy Hyper-Low-Frequency Electric Field

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The article represents a practical and theoretical research on possibility of existence of a high-energy hyper-low-frequency electric field which is interpreted by modern measuring instruments and subjective perception as a static field. Besides there are observed a problem of the field registration, a hypothesis of relic origin of the registered field and a hypothesis of wave nature of the Universe.

A passenger on board a ship sailing in the ocean will never notice action of waves of high and low tide. At the same time, weathering waves of several numbers produce a dangerous storm. However, an ocean liner is designed for such a storm therefore the passenger would just experience some discomfort. It is another case if tide wave hides reefs… I wish our ship, i.e. the Earth, the Solar System, the Galaxy, and the Universe, not to be lead to such a place by any ignorant "navigator"!

One of the most mysterious persons in the history of electricity physics was an outstanding inventor Nicola Tesla (1856-1943). When the majority of scientists developed researches of microworld particles he followed the opposite scientific path. He was interested in the electrical potential of the whole Earth. He researched ways to influence on it, control its state and methods of its regulation. Therefore many of his patents, experiments as well as a purpose of constructions and devices built according to his ideas arouse perplexity and misunderstanding of modern scientists.

a test body was made. Before the beginning of the experiment there was set a problem to register gravitational waves produced by the Mercury and the Venus at approaching to the Earth. The gravitational field in which the Earth moves changes due to superposition of gravitational waves of other planets on it. These changes were necessary to be registered.

The experiment was as follows: a test body (a 100 grams weight) was weighted on an electronic balance in equal time intervals of 14 days. The experiment was lasting for 12 months. In the experiment it appeared that change of a distance between the Earth and the mentioned planets causes change of weight of the test body. The change of weight of the body occurred in proportion to the distance between the planets. The test body was weighted in the same conditions and in the same place. The performance of the experiment is so easy that every person can made it.

It is known that weight of a body changes (decreases) at moving along the Earth surface from its pole to the equator. Change of weight of a body locating in the same place has not been fixed until now.

The fixed change of weight of the test body proves change of gravity applied to it and, consequently, change of the gravitational field in which the test body moves as well as the Earth does. **These changes of the gravitational field were caused by motion (superposition) of the gravitational waves produced by the mentioned planets at their approaching towards the Earth at the distance of the existent gravitational field.**

Hence, the Earth and all the bodies locating on it move in the constantly changing gravitational field, therefore, constantly change their weight. Nevertheless, as it is known, change of the gravitational field is the influence of gravitational waves on it. Hence, measuring changing of weight of bodies we can speak about registration of gravitational waves.

In search of the 4th dimension

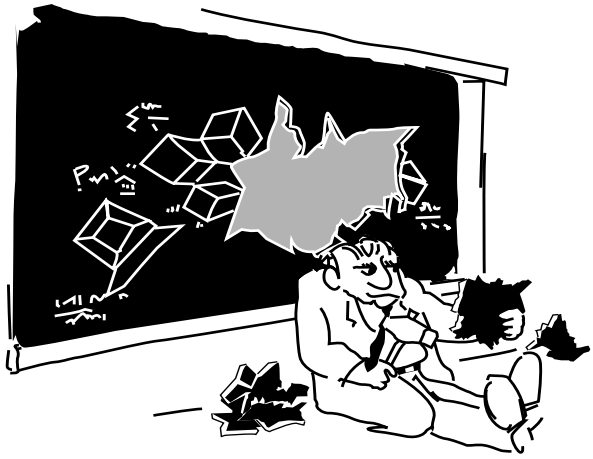

From http://home.ural.ru/~meop/index.html

High-Energy Hyper-Low-Frequency Electric Field

Yury V. Ivanko, Ukraine
E-mail: ux01w@hotmail.com

The article represents a practical and theoretical research on possibility of existence of a high-energy hyper-low-frequency electric field which is interpreted by modern measuring instruments and subjective perception as a static field. Besides there are observed a problem of the field registration, a hypothesis of relic origin of the registered field and a hypothesis of wave nature of the Universe.

A passenger on board a ship sailing in the ocean will never notice action of waves of high and low tide. At the same time, weathering waves of several numbers produce a dangerous storm. However, an ocean liner is designed for such a storm therefore the passenger would just experience some discomfort. It is another case if tide wave hides reefs… I wish our ship, i.e. the Earth, the Solar System, the Galaxy, and the Universe, not to be lead to such a place by any ignorant "navigator"!

One of the most mysterious persons in the history of electricity physics was an outstanding inventor Nicola Tesla (1856-1943). When the majority of scientists developed researches of microworld particles he followed the opposite scientific path. He was interested in the electrical potential of the whole Earth. He researched ways to influence on it, control its state and methods of its regulation. Therefore many of his patents, experiments as well as a purpose of constructions and devices built according to his ideas arouse perplexity and misunderstanding of modern scientists.

Having formulated my own hypotheses I often think why such a Great Genius as Nicola Tesla took his invention away with him.

Danger of this invention lies in simplicity of production of devices for generating (detecting) energy.

Practical Prerequisites

Prerequisites of this and other hypotheses were some undeclared effects occurring in practical wireless communication as well as investigation of devices for distant transmission of electric power.

Distant energy transmission was demonstrated by Nicola Tesla in 1892 in London and in 1893 in Philadelphia. However, even now the way he did it remains unknown.

In 1977-1985 I had to work a lot with radio transmitting equipment of different power of middle-wave (MW) and short-wave (SW) diapasons. According to fundamentals of physics, intensive electromagnetic field is produced around antenna curtain connected to a radio-frequency transmitter. There are brightly glowing gas-discharge electrovacuum devices at the distance up to several meters in this field. Attention was paid to the fact that more than ten daylight lamps of 80 W were successfully "glowed" at 40 W power of a transmitter. In this case a distant correspondent did not note significant decrease of a level of a received signal at the indicator of the receiver. It had to return to this fact in many years. The data of this experiment are represented in a particular document.

There is one more interesting effect which is disclosed when transmitting equipment (TX) and antennas (ANT) are adjusted. An incandescent lamp, which is connected to a certain place of a break of the antenna curtain or of a power feeder (L), glows brightly. The antenna circuit is not closed as galvanic element. (See Fig. 1).

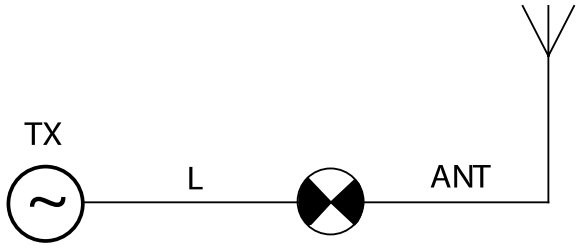

Fig. 1

Hence, the power line of the incandescent lamp is as if it is single-wire. It also had to return to investigation of this effect in many years. The data of this experiment are represented in a particular document. As in the case of the incandescent lamps, the correspondent did not note significant decrease of the level of the received signal at the indicator of the distant receiver.

S. V. Avramenko designed a plug of semiconductor diodes. Connecting this plug to a generator of alternating voltage of 10-10000 V by means of a single-wire line in the load of the plug he discovered current, which was continuous by the direction but pulsating by the value. Electric current measured in the single-wire line is very little, hence, the impression of superconductivity is produced, i.e. it is possible almost to avoid energy losses in the wires.

My experiments also represent a visual demonstration of the effect. For example, several links of light-emitting diodes connected inverse-parallel glow in the single-wire line. Garlands of light-emitting diodes and lamps having a single-wire power line can be produced. It is interesting that in this case power consumed by the generator do not increase practically (See Fig. 2, 3, 4). It was noted that if a standing wave is created around the generator "then an unlimited number of consumers would be able to apply a change of a value of this field to produce power in a load in their place" *(Editor: This phrase is in inverted commas since it is a part of the well-known article "Free Energy" by Alexander V. Frolov (Read in this issue, p. 15)).*

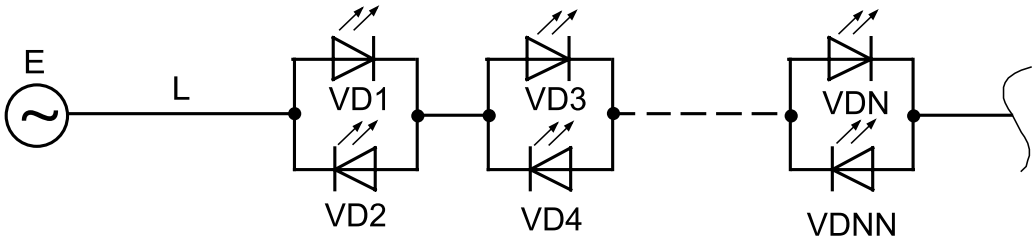

Fig. 2

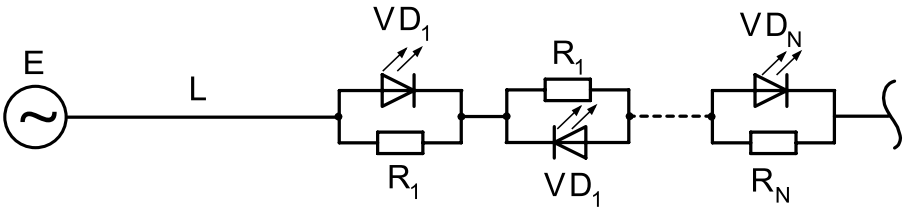

Fig. 3

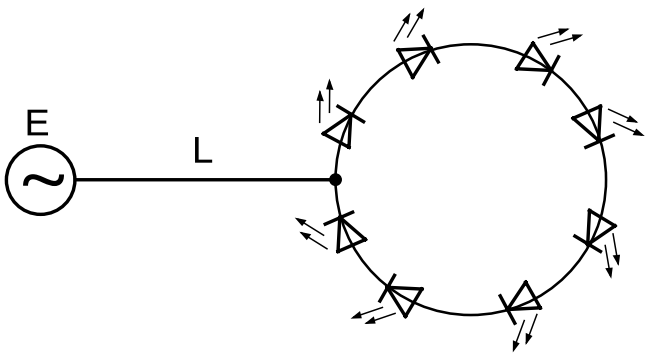

Fig. 4

Russian scientists investigated this phenomenon and proposed an explanation of producing active power in the load by means of reactive capacitive current. This was made applying resonant properties of the single-wire line made of a metallic conductor. Further, possibilities of application of nonmetallic conducting mediums for transmitting electric power were investigated. However, the researchers pay attention for the fact that this explanation is insufficient.

A task group named "Analysis" from Voronezh city (Russia) made a qualitatively new explanation of results of S. V. Avramenko's experiment. The works of this group from Voronezh are devoted to the comparison of properties and characteristics of so-called inertial and inertialess currents occurring in circuits at low frequencies. Their general and particular features have been disclosed. In the works there are demonstrated conditions at which conductivity caused by inertialess discharges predominates in conductors and conditions at which currents caused by conduction electrons predominate. There are demonstrated a description of S. V. Avramenko's experiments and the conclusions made by the researchers. The authors cite data of their test experiments which prove a part of conclusions made by S. V. Avramenko and his colleagues.

However this explanation does not have a right to exist as it does not have variants for practical application.

Results of my theoretical and experimental researches allow provide a **fundamentally new (!)** explanation of energy "transmission" having occurred in the experiments performed by S. V. Avramenko, investigations by D. S. Strebkov, V.A. Kuligin and other investigators. *(Editor: See publications of these works in previous issues of our magazine*). Moreover, they allow explain origin of many physical phenomena and processes including the origin of non-inertial charges and currents and their visualization.

First Hypothesis

Recently a number of scientists all over the world have declared a thought that surplus power is produced in the systems having overunit output due to inability to identify correctly all the existent energy sources. And a so-called phenomenology is observed due to the inability to deal with different types of energy (or fields).

In physics a negation of an overunit device follows a well known state which is considered to be true in other fields of knowledge, i.e. energy conservation law. It should be noted that it is formulated for isolated (closed) systems. I have devoted some time to the investigation of this state and to practical experiments and come to the following conclusion: there are **no isolated (closed)** systems in the nearest cosmos which can be observed by us!

Particular physical, chemical and other processes may actually be observed in closed circuits for making calculations with sufficient approximation.

Show me an isolated system, and I will prove that it is open.

Hence, according to fundamental physical laws, energy does not appear from nothing and not disappear to nowhere. However, the source of oscillations, i.e. our generator, does not provide a load with energy; nevertheless, power is produced in the load. Energy conservation law must be fulfilled! The classical formulation of the energy conservation law is as following: total energy of an isolated system is not changed in the course of time. According to this, the only fact remains valid, i.e. the single-wire system is not isolated from outer influence, hence, energy is consumed from some other source which is outer in relation to the system?! In this case our generator is one of sources of information about an amplitude, frequency, and phase.

Calculations and experiments have allowed made a following supposition. Avramenko's diode plug is a particular case of a device known in radio engineering for a long time, i.e. AM detector (a peak-detector, a limiter, a frequency mixer). I have examined the other known circuits of AM detectors and frequency mixers. The investigations are continued and by this time the supposition has been confirmed.

Let us accept an artificial generator (Tesla's transformer or any other one) as a main generator (or a main oscillator) and a hyper-low-frequency (HLF) oscillation of a huge amplitude as an envelope curve. Let us name it as RW ("relic wave") without placing emphasis on the sense of the name.

Let us suppose that the field can be of:
- local origin (artificial radio transmitters);
- atmospheric origin;
- geomagnetic Earth origin;
- the Moon – the Earth;
- the Sun – the Earth (the Sun as a nuclear reactor producing electromagnetic radiation, the Solar System);
- galactic origin;
- Universal origin – the Relic Wave; in contrast to the relic radiation occurring in the diapason of SHF (i.e. in

contrast to the convenient notion) it is the diapason of HLF. - Etc.

The researches have demonstrated that the field of local and atmospheric origin may be excluded. The other variants require to be developed. Nevertheless, the variant of the Universal scale seemed to be the most probable. There is some reason for this supposition: the modern notion of the birth and the state of the Universe, i.e. the Big Bang and the expanding Universe. The known variants of scenarios of the Big Bang are based on a nuclear explosion of enormous power. The nuclear explosion is accompanied by an electromagnetic impulse (disturbance). It can be supposed that the Big Bang caused forming of a field having enormous amplitude values and long (great) period of oscillations. Probably, we deal with this field.

The second hypothesis about inconstancy, i.e. about wave nature of the Universe

A Russian proverb says: "Everything passes, everything changes". Constant electric voltage does not exist (!). That, what is considered as the constant voltage, really is a constant component (occurring at a certain time interval). This component is formed by combining of variable sinusoidal oscillations and/or is a quite low frequency fundamental. Hence, it is a non-sinusoidal "changing" having amplitude linear part at the time interval of the observer.

For example, in reality a usual storage battery of "direct current" can not support invariable voltage, i.e. when a discharge appears the voltage decreases (changes in time, oscillates with a non-sinusoidal oscillation and a quite low frequency fundamental), when a charge appears the voltage increases.

It is necessary to observe the constant voltage occurring after a rectifier and even a stabilizer as a constant component existing in the time interval from switching on to switching off. This will correspond to that is proposed by Fourier!

Show me a device producing constant voltage, and I will prove that the voltage is not constant.

Conclusions

If the supposition is totally confirmed then the statement that an electric field plays a fundamental role in the Universe will be valid.

We live in an electric field of a huge potential but we do not notice it. Since **our reference point is the amplitude value of RW field in our point of space** then the potential is equal to zero for our perception and for measuring instruments. Besides, **RW has an amplitude linear part at the time interval of the observer**. Hence, we consider RW field existing as unrevealed or as weak interactions in natural processes. Nevertheless, this influences directly on the whole surrounding material world.

Artificial production of heterogeneities in the RW field can cause its significant visualization.

According to the concept of the physical field, which was called by Einstein as the most important discovery in physics since Newton's time, every body generates a force field in the ambient space (for example, the electric field occurring if the body has an electric charge). This force field becomes apparent when a test body located in a certain point is influenced by a force.

Discovery of the fields of this scale allows define this concept more accurately. I would like to restate the information mentioned above in the following way: every non-homogeneity of physical vacuum (aether), which is registered by our perception or by measuring instruments as a physical object or a physical field, interferes with RW (according to other interpretations, it absorbs or rereflects RW, or becomes excited) producing new wave fields. This perceived physical field has frequency which is higher than RW frequencies. It is perceived as static in the time interval of observation. Hence, the field generates a charge and not the reverse. Any linear or non-linear transmission (motion) of a material or field object changes non-homogeneity which is generated by this object.

A question about measuring of parameters of the Universe remains open. Can an oscillation of the period of T=14 billions years and of the amplitude of A~T be seen, perceived, registered or measured?

The used literature and references are not cited in the article due to its great volume. The reader can familiarize with them at the web-site of http://www.efir.com.ua. The complete text of the article and other materials can be received from the author.

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To the Question of Work Made by Electrostatic Field

Alexander V. Frolov, Russia

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We know some simple examples of work making due to the forces, which appear in electrostatic field. Since the field itself does not require energy consumption from the source (not taking into account the charge leakage), then free energy can be received with these forces. The first phenomenon that we are going to consider is a phenomenon of **electrostriction**. Mechanical forces appearing in dielectric under the influence of electrical field tend to deform it. Sometimes these forces are small, but they can be huge in special dielectrics. The character of deformation also depends on non-linearity of electrical field. Suffice it to remember that heating of a body takes place during deformation, and we can make a conclusion on possible using of the given effect in practice. Periodical deformation can be created due to the rotor or any other methods to change the field.

The second effect is not so popular. It was found by Hertz in 1881 that there is a rotation of dielectrical cylinder (or ball) in permanent electric field if it is created in some liquid or in gas (see Fig.1).

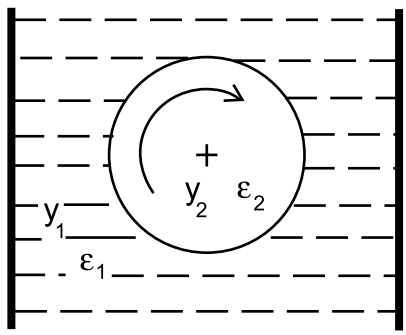

Fig.1

Here **ε1** is a dielectrical permittivity of the liquid, **ε2** is a dielectrical permittivity of the rotor, **γ1** is a conductivity of the liquid and **γ2** is a conductivity of the rotor. This effect was discovered by Hertz, then it was described by G. Quincke, Germany. Also Japan scientist I. Sumoto studied the effect in 1955. Modern research work was made by K.M. Polivanov, Moscow. There is the so called equation by Polivanov describing special conditions, which are necessary to begin rotation (**ε1/ ε2=γ2/γ1** is the Polivanov's condition).

Forces of electrostatic field produce this rotation and it is a real free energy system that can trap energy from inner structure of potential field. Let's try to describe the mechanism of this effect and then we'll be able to increase the power of the system up to the level of industrial application. So, why does it work? To my mind, there are some differences in conditions for polarization of the rotor and molecules of liquid or gas those are surrounding the rotor since there is a difference in permittivity and conductivity.

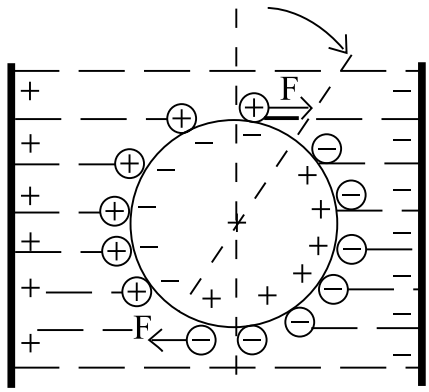

Fig.2

Due to this reason the molecules are polarized both by the field of electrodes and by the field of rotor. The rotor is polarized in the electrical field of electrodes, and molecules of liquid on its surface are polarized by the electric charge of the rotor, but not according to direction of the field. So, the rotor is surrounded by "screen" of molecules on its surface. The electric charge of this screen partially compensates the field of electrodes.

When some angle is created by the first initial turn, there is some part of the rotor surface, where molecules of liquid on the surface of the rotor are attracted to electrodes and it is the reason for future rotation. After some angle of the turn the polarization in this point of the rotor surface is changed but new molecules are incoming in the so called "sector of attraction" and the rotation is always accelerated. This well-known effect of 1881 is a very good example of possibility to produce useful work in load by means of electrostatic field only.

One more interesting effect is known as Faraday effect. In 1836 Faraday noted that raising of liquid upwards takes place in condenser with liquid dielectric (plates are installed vertically). During this process electrostatic field makes the work against gravity. A. Gyemant in 1926 established that value of this force is proportional to the square of voltage on condenser. Later in 1955 this phenomenon was studied in details by I. Sumoto, Japan. That's why in physical encyclopedias this effect is called "Faraday-Sumoto effect". In Tareev's book [1] it is pointed: "Under high voltage this phenomenon leads to flowing and turbulent boiling of liquid". I should remember for those, who see nothing unusual here, that it does not necessary to consume the power from initial source. Creating an initial field in electric capacitor, then we can use the received mechanical work. It is evident that the gradient of electrical field creates the conditions for movement of liquid dielectric. A task to create conditions for liquid circulation is more complex, but it has solution, if we take into account the presence of one more static field, i.e. gravitational field. Joint action of electrostatic and gravitational fields stipulates the circulation of liquid dielectric even in the simplest constructions. Besides, electrostatic filed can be partially screened.

The analyzed examples should draw attention of experimenters to these obvious ways of how to create useful work by means of electrostatic field.

References

1. Tareev B.M. Physics of dielectrical materials, Moscow, Energoisdat, 1982, p.199 – 200.

Editor: Below we publish the comments of our reader.

Letter On
Hertz-Quincke-Sumoto Effect

from Doug Marett
Email: doug.marett@sympatico.ca

…As far as I can tell, the original reference by Hertz is "On the Distribution of Electricity over the Surface of Moving Conductors", Wiedemann's Annalen, 13, pp.266-275,1881. Hertz's discussion of this phenomenon is cursory at best, having very little experimental work included. The real phenomenon appears to have been discovered by W. Weiler in 1893 (Zeitschrift fur den Physikalischen und Chemischen Unterricht, Vol.6, pp194-195). Weiler observed that a glass cylinder placed in a poorly conducting liquid between two spherical electrodes began to rotate when the electrodes were connected to an electrostatic generator. In 1896, George Quincke reported the same phenomenon and published a comprehensive report on it. This was in Annalen der Physik, Ser.3, Vol. 59, pp.417-486. Subsequent investigators have tended to attribute the discovery to Quincke, when in fact Weiler was the first to pioneer the work.

I do know that P.E. Secker et al. performed work on this field, references of which are available in the English language. These are:

P.E. Secker, et al., (1968) Journal of Applied Physics, Vol. 39, pp.2957-2961, and
P.E. Secker, et al., (1970) Journal of Physics D: Applied Physics Vol.3, pp 216-220.

I hope that this information might be of use to you.

The Foundations of Physchemistry of Micro World

Ph. M. Kanarev

The Second Edition

The book was published in Russian and English; you can also read it at http://book.Kanarev.innoplaza.net

The new axiomatic of natural sciences is given in the book; on its basis, quantum physics and quantum chemistry have been returned to the classical way of development. The first steps are made on this way, which have led to discovery of the structure of the photon, the electron, and the principle of the formation of the atomic nuclei, the atoms and the molecules.

The Planck's Law of radiation of perfect blackbody is given on the basis of classical concepts, and the connection of quantum phenomena with the laws of classical physics is proved.

The application of the new theoretical results to the solution of practical energy tasks on the basis of plasma electrolysis of water is shown. Due to this electrolysis, additional heat energy and the energy containing gases (hydrogen and oxygen) are generated. Cold Nuclear Transmutation of the atomic nuclei of alkaline metals and the atomic nuclei of the cathode material takes place during plasma electrolysis of water.

The book is intended for physicists, chemists and other specialists who are seeking the new directions for understanding the foundations of the micro world and the new energy sources.

Comments to Electro-Reactive LIFTER News

Alexander V. Frolov, Russia

General Director, Faraday Laboratories Ltd
E-mail: office@faraday.ru
http://www.faraday.ru

March 21, 2003 we got news from France about electro-reactive propulsion system.

Blaze Labs reached 100g PAYLOAD level.

You will find all the details of the Saviour's experiment at: http://blazelabs.com/exp14.htm.

This electro-reactive ionization-flying model requires 46 kVolt, 4 mA, i.e. about 200 watts to fly with 100 g useful load.

It is interesting to note that Jean-Louis Naudin's previous opinion of 1997 – 1999 about priority of the Frolov's asymmetrical capacitor now is changed. Sometimes people wish to re-write the history. It is possible and it is easy. Naudin's web page about http://jnaudin.free.fr/lifters/story.htm (see Fig. 1) is not started from the real beginning of the story. He forgot our discussion of 1997 and also photos and MPEG video I have send to him when he has started his way in electrograviticis.

If you remember the name of Naudin's first asymmetrical capacitor "Frolov's Hat" (see Fig.2) then you know why there is this name of this technology. But really it is not important to try for some serious reply from Jean since he has no personal post address, phone, or his photo on the web site…

Also it can be useful to visit this page http://www.faraday.ru/t-cap.html to know about something **more important than electric ionization flying models (Lifters),** since it is just a reactive ionization way, which is similar to rockets.

Ideas now developing by us are not aimed to increase the power level (from 1 gram to 100 gram propulsive force). It is **a qualitatively new idea**; it is really electrograviticis instead of "electro-reactive Lifter".

So**, what is about real "history of the question" instead of the French version?** The question here is not about a priority, it is nonsense after T.T. Brown's patents. As an example the NASA patents on asymmetrical capacitors can be mentioned since the ideas were opened before the NASA patent and there is nothing new in it. The problem is that people who develop reactive ionization Lifters develop only primitive reactive technology. **It is not essence of T.T. Brown research but it is the distortion of his ideas.**

So, the team in France is working to develop and support ideas of secondary and wrong method. Why? Perhaps they either do not see the real way or have payment for the wrong way **to mask a real work.**

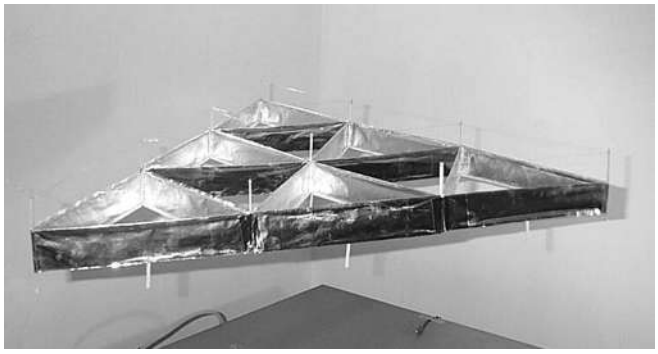

Fig. 1

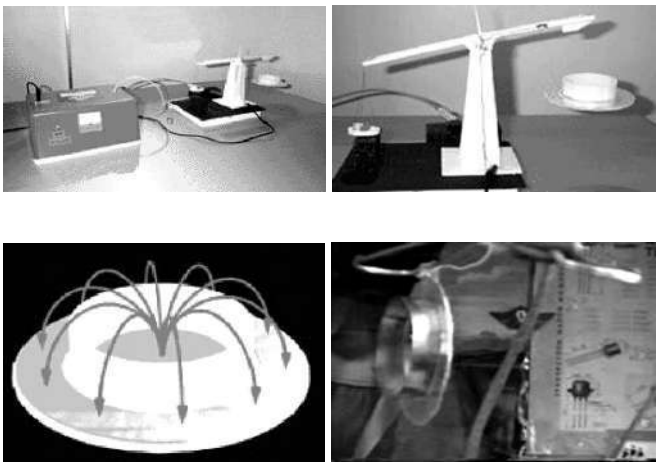

Fig. 2

Josh Werrmann (Email: jsh111@yahoo.com): I wanted to ask you a few questions about an article titled "Highly Efficiency Electrolysis" by A.V. Frolov. In this article it is stated that Dmitry A. Latchinov patented a method for electrolysis, where one of the electrodes is insulated completely from the water. It is also stated that another scientist, Igor Goryachev, used a method of pulsed electric fields. I don't know if you know, but inventor Stanley Meyer has a patent that covers both of these processes together, in a way. His patent is U.S. patent number: 4936961. Take a look at this. In the patent it states EXPLICITLY that there is a pulsed electric field, where a condition of NO CURRENT is preferred. This is very similar to the above to Russian scientists, except that the patent states a condition of resonance is necessary. I am wondering do the two scientists that are described require resonance in their devices? Or just plain pulsed electric fields, where one electrode is insulated from water.

Another patent I would like to refer you to is Archie Blue's electrolyser, U.S. patent number: 4124463. This device is similar to A.V. Frolov's idea, to get the oxygen and hydrogen bubbles off the electrodes, except he uses a blower to blow air in the cell, instead of rotating the cell like A.V. Frolov does. His invention also uses the conductivity current to work.

Alexander V. Frolov: As far as I know resonance is not created in this case. The main idea is the removal of gaseous film which appears on the surface of electrodes by rotation or some other methods.

NEWS REVIEW

Giant magnets lead the world to the new source of energy

http:// www.sciteclibrary.ru

The system of 150-tons magnets which have been developed by scientists of the USA, Japan and Russia opens a new era of safe and unlimited energy. In this system nuclear fusions serve as a source of energy. They accumulate heavy chemical elements not by means of nuclear reactions but by ultrahigh plasma pressure.

After supplementary research is held which aims to reduce manufacturing costs of the giant magnet weighing 925 tons, this magnet will be produced and demonstrated at the opening of the International Thermonuclear Experimental Reactor (ITER). This magnet in its turn will become a part of a bigger system, that is combined into a magnet weighing approximately 10 000 tons. The task of ITER is the demonstration of the process of nuclear fusion, as an energy source. During the process of nuclear fusion the light elements are combined by immense pressure, thus producing heavier elements. During this production process a lot of energy is emitted. The task of giant high-power magnets is to create magnetic fields, which must hold and control plasma, or to charge electrically the gas, in which the fusion is being held.

In Japan the system of 150-tons magnets serves as adjustment system of 925-tons magnets, which will be finally put into operation and heat up the ITER plasma. Two additional giant magnet systems will confine the plasma and will control its form. The model for one of them is presently being examined in Germany; the model of the other is in project.

Cylindrical 150-tons magnets have three main parts: external module, built by the Japanese team, internal module, built by the American team and a thin rod in the core which is equipped with process control equipment. Three different rods were separately checked, two of them were built in Japan, another in Russia.

Harnessing the Wheelwork of Nature

*(*340 pgs. Adventures Unlimited Publishers, 2002)

Thomas Valone
Email: iri@erols.com

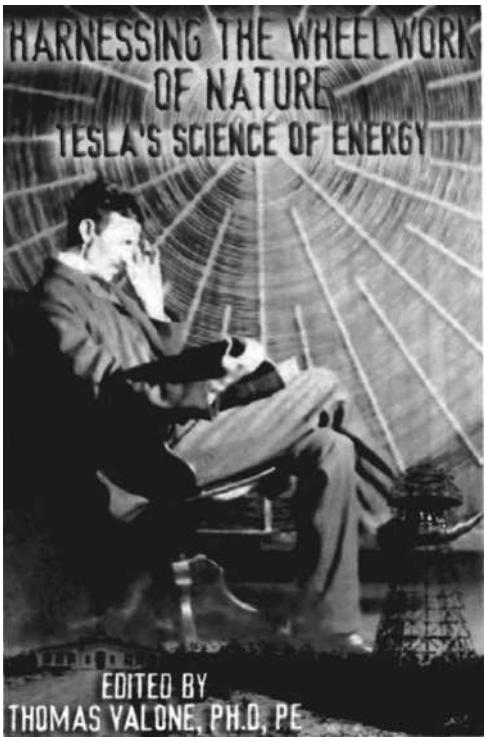

It is a new book by **Thomas Valone**, who edited this anthology in time for the **Wardenclyffe Tower Centennial (1903-2003)**. This book presents for the first time, the feasibility argument for Tesla's most ambitious dream, the wireless transmission of power. Pictured on the book's cover near his feet, the 187-foot Wardenclyffe Tower was Tesla's means to deliver natural 8 Hz electricity anywhere in the world, by longitudinal waves.

Unknown to most electrical engineers, Nikola Tesla's dream answers the energy crisis worldwide, saves electrical conversion losses, and provides a real alternative to transmission lines. In Dr. Corum's contributed papers, he explains Tesla's magnifying transmitter, which Tesla compared to a telescope. Corum points out that "the tuned circuit of his magnifying transmitter was the whole earth-ionosphere cavity resonator." This fact helps explain why Tesla stated, "When there is no receiver there is no energy consumption anywhere. When the receiver is put on, it draws power. That is the exact opposite of the Hertz-wave system...radiating all the time whether the energy is received or not." Thus, with Tesla's futuristic transmission of power, source dissipation will only be experienced when a load is engaged in a tuned receiver somewhere on the earth. This fact alone represents **a major leap forward** in electrical transmission efficiency, even one hundred years later.

Why wasn't the prototype of Wardenclyffe finished in 1903? Tesla offered this visionary conclusion: "The world was not prepared for it. It was too far ahead of time. But the same laws will prevail in the end and make it a triumphal success... Let the future tell the truth and evaluate each one according to their work and accomplishments. The present is theirs; the future, for which I really worked, is mine."

Up until now, there has been a general malaise regarding the lack of scientific comprehension of Tesla's greatest dream. For example, the Serb National Federation notes, "With the exception of the first biography of Tesla by John J. O'Neill, science editor of the *New York Herald Tribune*, and published in 1944, unfortunately no biographer since has had the necessary scientific/engineering academic credentials to discuss Tesla's work in the various fields." Contributors to ***Harnessing the Wheelwork of Nature*** are primarily physicists and engineers who are experts in Tesla technology. Their wealth of knowledge demonstrates their mastery of this extraordinarily progressive and technical subject. Finally, the best academic credentials have been brought to bear on the world's greatest electrical futurist.

This is a very readable and profusely illustrated reference volume on wireless transmission of power, besides being an excellent biographical gold mine of Tesla history. Nick Cook, editor of *Jane's Defence Weekly* and author of *The Hunt for Zero Point* says, "Tesla is one of the great overlooked geniuses of science and electricity. His full story deserves to be told. Tom Valone sheds important new light on his life and work."

Integrity Research Institute will hold a Tesla Energy Conference & Expo on November 8-9, 2003 to celebrate the Wardenclyffe Tower Centennial (1903-2003) in conjunction with the Tesla Wardenclyffe Project, Inc. (www.teslascience.org).

See www.IntegrityResearchInstitute.org for more details.

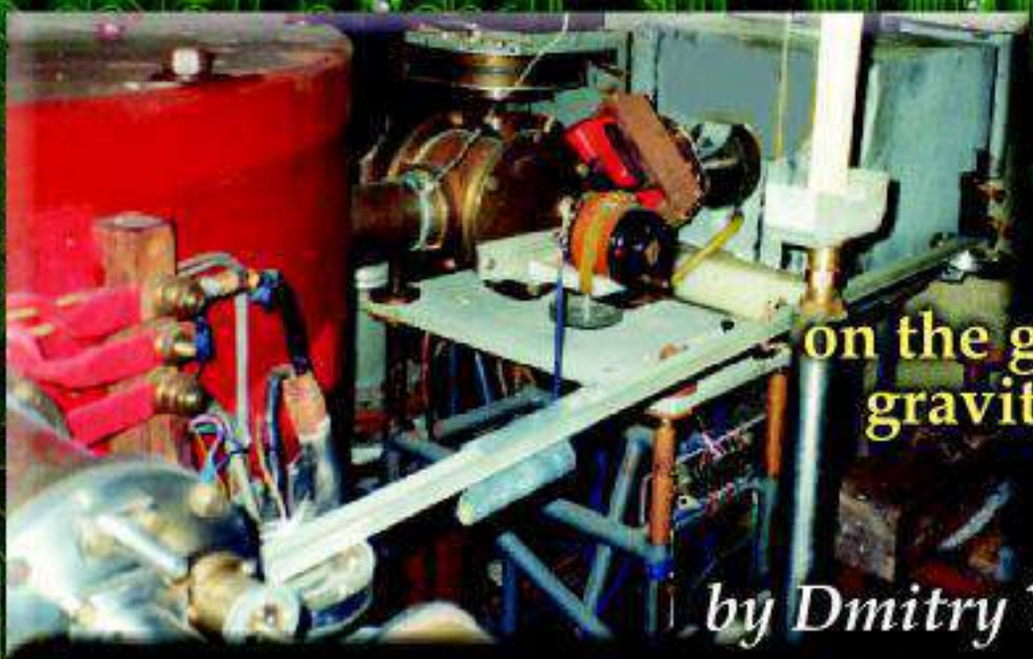

Experiment on the generation of gravitational field

by Dmitry Yu. Tsipenuk

Sergey S. Abramov

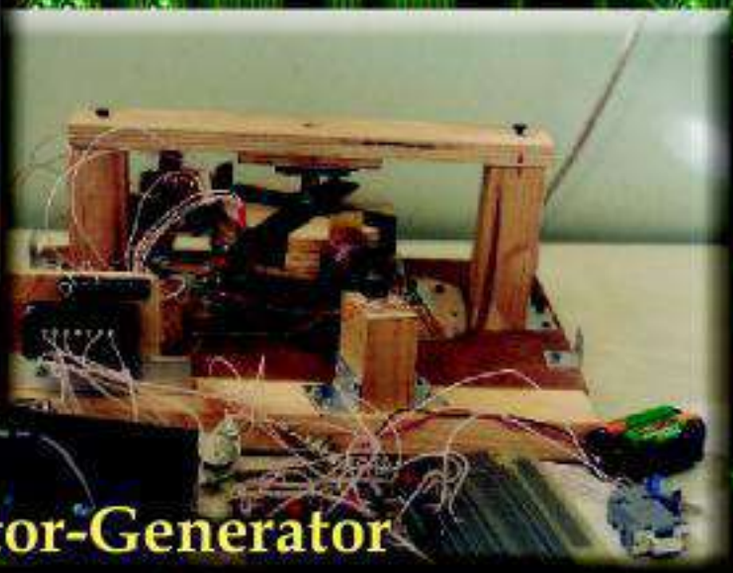

Model of Adams Motor-Generator

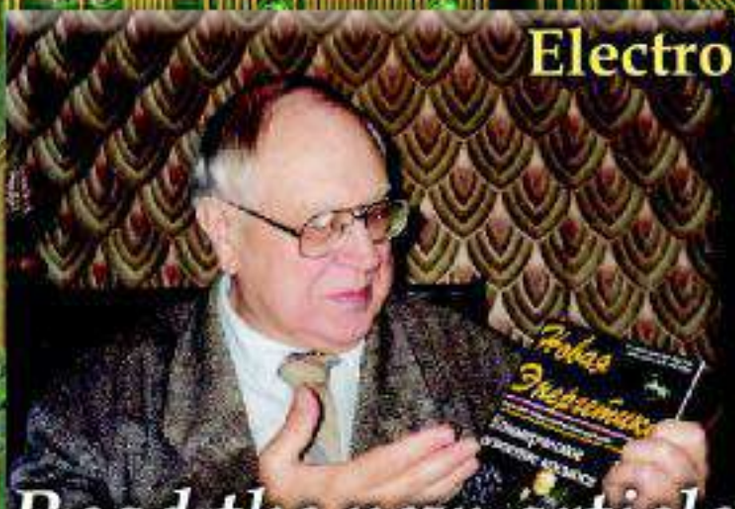

Electrolytic photoaccumulator for the XXI century energy systems

Read the new article by Anton I. Egorov

Flynn Generator

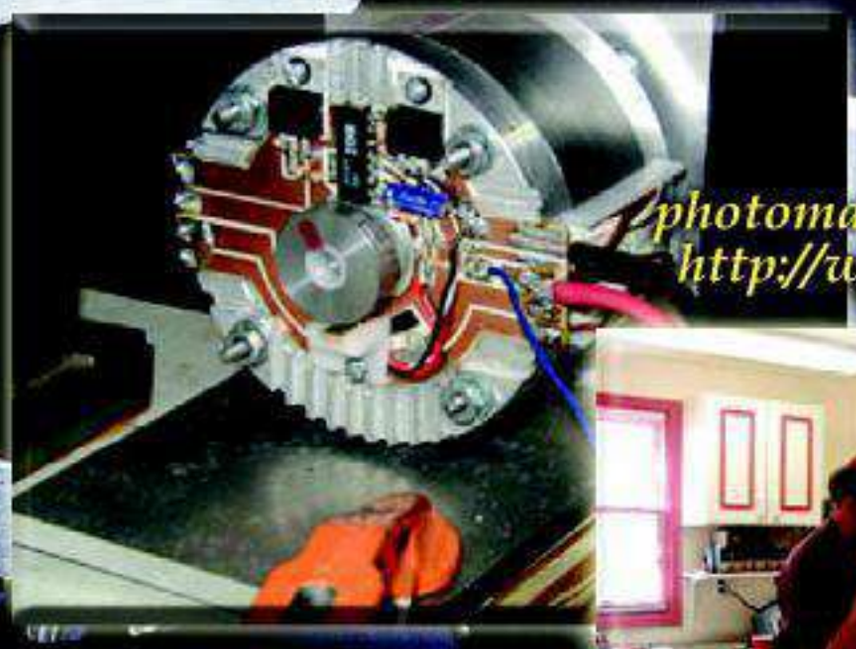

Original version of photomaterials is presented at http://www.flynnresearch.net

Joe Flynn Laboratory, USA

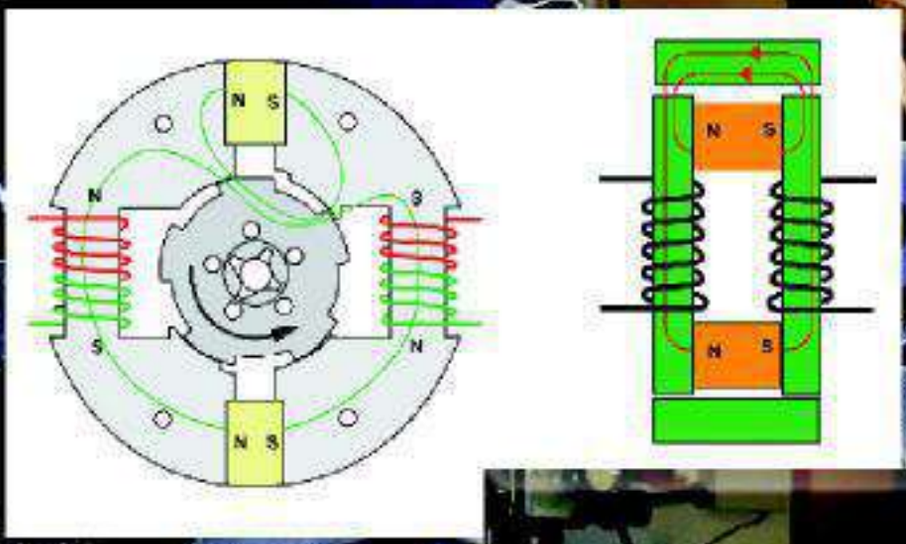

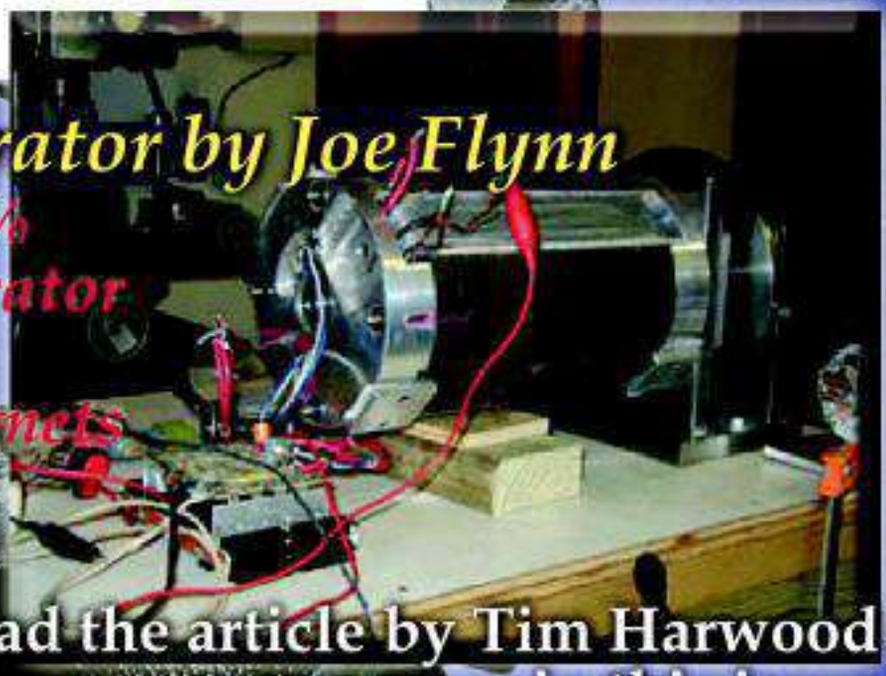

Electric generator by Joe Flynn

More than 350% efficiency generator operating on permanent magnets

ISSN 1684-7288

Read the article by Tim Harwood in this issue

New Energy Technologies

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Research on advanced aerospace systems and new energy sources

Time Machine

Conference in Moscow: discussion of the patent application on the method and device to control temporal parameters of matter

Time Machine

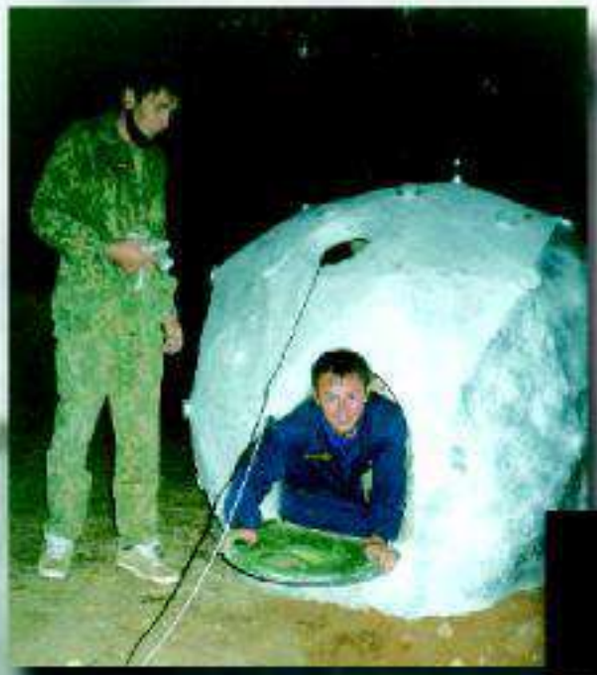

Experiments by research group "KOSMOPOISK"
Summer, 2001

Device designed
by Faraday Lab Ltd, 2002

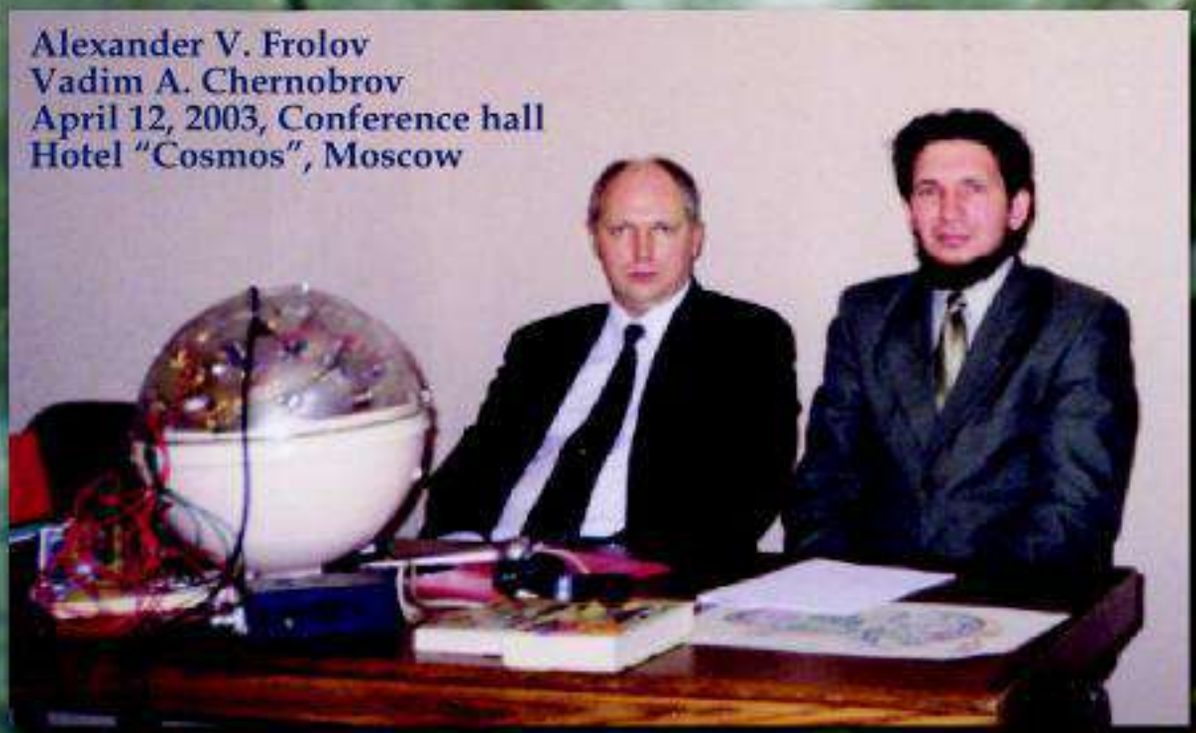

Alexander V. Frolov
Vadim A. Chernobrov
April 12, 2003, Conference hall
Hotel "Cosmos", Moscow

NEW ENERGY TECHNOLOGIES #12

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Editorial: On April 12 of 2003 a scientific conference "The Time Machine" was organized by Faraday Laboratories Ltd in Moscow, Russia. It was devoted to the experiments on control of space-time physical properties. At the conference there were discussed problems of time and gravitation in the context of etherodynamics, experiments and applied aspects of these technologies. Below we publish a review of the main reports presented at the conference.

The First Results of the Works on the Designing of Devices to Control Parameters of Physical Processes (of Time)

Further Plans on Designing of the Time Machine

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To conduct the experiments on the influence upon physical Time (density of space energy) some special devices were used as a general method of such influence. These devices can create converging waves which can cause the appearance of quasi-monopole in the confined space. *Quasi-monopole* is a part of space which has some parameters of hypothetical unitary monopole or bunch of such particles (in particular, it allows registering one magnetic pole by means of measuring equipment from the outside at some distance from this pole).

The pilot experiments have shown that it is very difficult (if not impossible) to create long-living quasi-monopole by means of permanent magnets or electromagnets operating on direct currents (in this case quasi-monopole represents a space with one outer and one inner magnetic pole). It can be explained by the fact that lines of force of the "inner pole" invariably find a weak spot in the heterogeneous surface of magnets and break out. As a result, at the device along with one "outer" magnetic pole there is a local output of magnetic lines of the "inner" pole.

During the designing of new devices there was a task to create a quasi-monopole situation in the confined space. This situation should be created not uniformly but transiently by pulsation method. Frequency of work of electromagnetic oscillators first of all was selected depending on linear dimensions of the devices. Selection of the frequency was made in such a way that one period of pulsation does not exceed the period of time which is necessary for electromagnetic waves to reach the center and opposite waves of the device.

At the designing of laboratory devices, which generate converging longitudinal waves, several different principles to obtain required parameters were considered in the multi-layer quasi-monopole, which works in high-frequency mode. Several types of the devices were realized at different degrees of development and with different success. It was shown that the simplest devices were that ones which used electromagnetic (solenoid) oscillators connected in series and in parallel. In different experiments between 3 and 5 such surfaces were used. These surfaces were called electromagnetic work surfaces (EWS). All layers of EWS of different diameters were mounted in series in each other (like matreshka). The outer layer was either mounted at force shell or simultaneously represented such a shell by itself.

The size of the maximal EWS was about 0.9 m, the diameter of the minimal (inner) EWS was equal to 115 mm that was enough to place laboratory animals inside the control detection devices. Laboratory animals were used to determine the consequences of the influence of converging spherical electromagnetic waves. Payload, (i.e. that which was directly used for transfer in Time-Space), included the afore-mentioned detection devices and (occasionaly) laboratory animals. The term "payload" was coined by analogy with the term which is used in cosmonautics. Volume of payload section was placed in the center of symmetry of the Time Machine (TM). In all the earliest Machines (except the 7th model) this volume still has not exceeded the volume of a football. The device with an outer diameter of 2.1 m and inner payload section of 1 m has the maximum size. It allows making human-aided experiments.

At different stages of the experiments the calculations were made by all available known modern methods to fix time. All types of electronic, quartz, mechanical and several specially made doubled quartz generators were used (there were compared frequency readings of measuring and etalon heat-insulated generators which were placed at a distance). Certain experiments used lightguiding diodes and some other methods. Before and after the experiment (more rarely during the experiment) readings of measurement clocks were periodically compared with those of an etalon clock and with signals of exact time which were transmitting by radio. Other physical factors causes side effects upon some types of measuring devices, for example, upon quartz-crystal clocks. However, doubling of measurement methods allowed essentially decreasing inaccuracy of measurements.

At some operating modes (which were not always predicted) the change of Time speed was attained (Prof. Nikolay A. Kozyrev called it density of Time t/t_o). This change came to about a fraction of a second per an etalon hour. Let us take usual "etalon" earth time as $t_o=+1$ then it becomes clear that it is speed range of $+0.99<t/t_o<+1.01$ which is researched in the experiments. Thus being placed inside the device, the inanimate objects and animals were transferred in the Future (with "above-zero" speed) more slowly or faster than those around them. It occurred at all operational modes of the device (deceleration or acceleration).

Difference of Time (gradient of Time speed or curvature of Space-Time field) was observed not only inside the TM, though there is no doubt that a maximal value of changed Time was registered inside the smallest "matreshka". As was expected, during the experiments Time change was also registered outside the device. However such change which had an opposite sign was smaller than the change inside the device approximately by an order of magnitude. It entirely corresponds to geometric laws, i.e. in proportion to the cube of the distance).

In other words, TM influences not only its inner part and pay load but also the environment. It bears a strong resemblance to jet propulsion but in Time and not in Space. It is a flight which is realized by rejection of Time instead of mass.

Thus it was determined that the processes of deceleration and acceleration of Time distinctly differ in their nature and consequences. In such a way the deceleration was considerably smoother and more stable. During acceleration there were observed sudden changes in readings and this operational mode was characterized by general instability and dependence on any (or many) external factors. Particularly, acceleration instability also consisted in the following: at fixed power the value speed of Time depended on the time of day and situation of the Moon. Possibly it also depended on some other factors including the presence of an operator or other people near the device. Even insignificant external influence, for example, mechanical shaking, caused the change of speed value which sometimes was rather significant.

Inside the laboratory devices there was also registered that **Time can change with some sluggishness**. After the changed Time speed influenced some physical object (for example, soil) then residual effects were observed at it for some period of time. These effects can be eliminated only by the influence of another speed of Time.

Preliminary general conclusions

The Present is the transfer or transformation of the polyvariant easily changeable Future into the univariant unchangeable Past. Thus flights in the Past (at "negative" density-speed t/t_0) and in the Future will happen in different ways. They can be compared with the motion of an ant along the tree: from any point of the tree (i.e. from the Present) there is only one way downwards open to the ant (i.e. in the Past) and many different ways upwards (i.e. in the Future). However among all the ways to the Future undoubtedly there are most probable, low-probable and almost improbable variants for development of the Future. The less probable this variant of the Future the more unstable and energy-intensive the motion to the Future will be. According to

the "law of the crown of tree", return to the Present is possible only if when being in the Past the traveler does not interfere in the course of events and does not change the course of the past History. Otherwise the chronotraveler will return to the parallel Present from the Past by another branch of History. Penetration to the Future from the Present is hampered by the choice of the branch for transference. However return from any variant of the Future into the Present is possible at any scenario if there are no fusions of different variants of History…

In other words, we have a circumstantial evidence of the assumption that Time has more than one dimension. Thus there is an affirmation of the theoretical inferences of R. Bartini who believed that Time has 3 dimensions. Hence we can consider our terrestrial globe as 6-dimensional where the dimensions are: length; width; height; age or date of Time; variant of History or blur of Time; density or speed of Time. Thus the notion of "Arrows of Time" is completely absent in the fourth dimension (date of Time) but it is a special case of the notion of the sixth dimension i.e. speed of Time. At the same time the notion of speed of Time also relates to the physical notions of gravitation and energy. Thus the notion of "Einstein-Rosen bridge", which was introduced in 1916, or notion of "worm course", which was introduced by John Willer in the end of the fifties, are connected with transference in the 5th and 6th dimensions.

Method and Device to Control Temporal Parameters of Physical Processes by Means of Changing of Energy Density of Space

Alexander V. Frolov, Russia

General Director, Faraday Lab Ltd
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This invention belongs to the methods and devices to provide control on rate of physical processes (that includes the process of the existence of matter in space-time) by means of increasing or decreasing of energy density of space (i.e. energy density of physical vacuum or density of the aether).

Let us consider the history of the invention:

Earlier there were proposed some methods and devices to influence the rate of physical and chemical reactions, biological processes or period of oscillation of the system. In the works by N.A. Kozyrev [1] there is a description of the experiments on the influence of some process (for example, process of evaporation or crystallization of matter) upon the period of another process, which serves as a detector and can be compared with reference oscillation process. In one case, the rate of oscillations of the detector decreases in the surrounding area near the process of matter evaporation. In another case, the rate of detector oscillations increases in the surrounding area near the process of matter crystallization. If we use a term of "entropy" then it is possible to say that the processes which are accompanied with entropy increasing (for example, conversion of matter from solid state into liquid one) influence on the matter (surrounding processes) in such a way that entropy of systems decreases. In another case, for example, near the process of crystallization, entropy of systems increases in the surrounding area near this process. Kozyrev used the term "wave of density of time" and he made a conclusion that in addition to "directivity" of time (time course) there are active properties of time, for example, "density of time".

To develop this approach for applied purposes it is necessary to use in-depth analysis of the physical sense

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To develop this approach for applied purposes it is necessary to use in-depth analysis of the physical sense

of the "time density" notion. Connection of notions about "time directivity" and "entropy of the system" was demonstrated in the work "Introduction into thermodynamic of irreversible processes", 1964 by Ilya Prigozhin [2]. In the work "Quantum fluctuations of vacuum in curved space and theory of gravitation" by A.D. Sakharov [3] the conception of vacuum structure was suggested. In the USA the work "Can the vacuum be engineered for space flight applications?" by H.E. Puthoff [4] is well-known. The author considered the applied aspects for study of vacuum structure and described the method and device to obtain propulsive force by means of changes in vacuum properties.

A substantive conception of time and methods for creation of waves of energy density were also considered by Prof. K.P. Butusov in the work "Time is a physical substance", 1991 [5]. In the book "What is The Time?" by Yu. G. Belostotsky [6] the connection between the notions of time and aether was demonstrated. This connection was considered from the point of view of astrophysics there.

We can also say that the modern conception of aether is successfully developed by V.A. Atsukovsky in his works [7].

In my articles, for example, "Physical principles of the Time Machine" [8], it was demonstrated that to develop experimental works on the topic it is useful to clarify the terminology and to consider **"waves of time density" as longitudinal waves of energy density in space.** In this case the notion of "time density" has a physical sense of energy density (aether density).

This approach can be realized practically by means of classical electro-technical and radio engineering methods and it is a development of aether-dynamical conception on the nature of electricity and magnetism by M. Faraday, "Experimental researches on electricity", volume 3, [9].

Let us consider a usual bipolar magnet from the point of view of aether-dynamics. Then it is possible to say that it is inflow and outflow of aether, i.e. it is a balanced energy system which does not change energy density in space. In this case it is evident that creation of magnetic monopole or modeling of quazi-monopole by means of electro-dynamical methods is a technical basis to create some local change of energy density in space.

Electric processes could also be used alongside with the magnetic phenomena. For example, in another book "Symmetrization of Maxwell-Lorenz equation" by Prof. Butusov [10] the creation of longitudinal wave was also considered. It was demonstrated that an electrically charged sphere can radiate longitudinal wave when the sphere radius is changing, i.e. when its surface is changing while the value of electric charge is constant.

One more well-known method is described in the book "Experimental gravitonics" by Polyakov [11]. There is a consideration of the generation of gravitational waves at the high-frequency magnetization and demagnetization of ferromagnetic material, i.e. at the powerful volume magnetostriction. Since at this phenomenon there are changes of matter density (i.e. changes of energy density in space, which is occupied by matter), then volume magnetostriction is a special case of changes of energy density.

Earlier Vadim A. Chernobrov had described a method and device to control temporal characteristics of physical and chemical processes by means of creation of the magnetic monopole (quasi-monopole). In this magnetic mono-pole there is a convergent wave, which is created by several sources situated in the spherical frame. According to this method in the multilayer spherical structure where every layer (the so called "electromagnetic work surface") is an assembly of electromagnets, by means of series connection of the layers the wave is created, which converges to the center of the device. The device has the same outside magnetic poles of the electromagnets (and the same inner poles) and thus a model of macroscopic magnetic monopole is created.

We assume that at in-phase operation of all sources of waves, interference of longitudinal waves provides some change of value of energy density of space in the focus of the system.

Experimental facts prove that detectors installed in the center of the device (for example, mechanical or electromagnetic oscillators) show change of period in their own oscillations. We have protected them by shielding them from heat radiation as well as from other kinds of electromagnetic influence. Thus it is possible to assert that the detectors decelerate or accelerate their oscillation period depending on the energy density, which is generated in the center of the device.

However for the experiments made by means of such a device, accurate adjustments of all wave sources are required to provide their in-phase operation. At the same time, operational stability of the system depends on the operational stability of each of the wave sources. Increase of the impulse frequency causes increase of

the effect; however, it is limited by the parameters of electromagnets and generator of impulses. Besides, to increase the effect it is necessary to use more powerful energy sources since the current in the windings of electromagnets determines the value of the magnetic field of the created quasi-monopole.

Since the efficiency of such systems directly depends on the frequency and the value of changes of energy density in space, then in the next version of realization of this technology we suggest using of plasma shells instead of electromagnetic working surfaces. This will allow significant improvment in the specific parameters of the device.

Thus let us consider general engineering principles of operation and outline the ways to develop this method. Fig. 1 represents a three-layered electromagnetic emitter. This electromagnetic emitter is designed according to the invention in which the directed radiation of wave of energy density is created along the axis of the device.

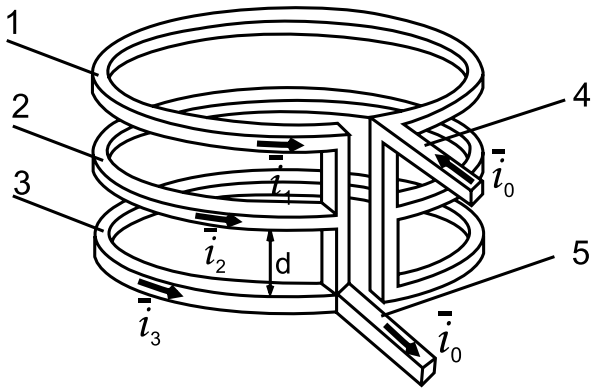

Fig. 1
Three-layered electromagnet

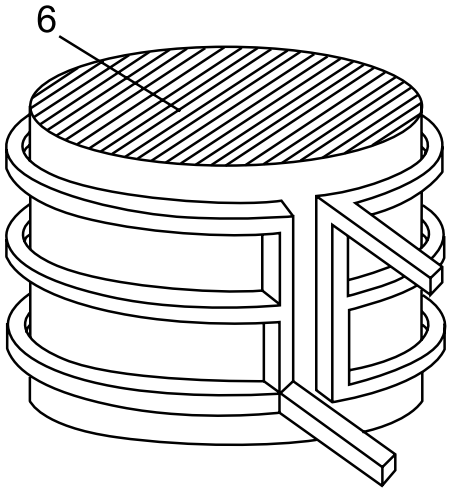

Fig. 2
Three-layered electromagnet with ferrite core

The device is designed according to the idea by Vadim A. Chernobrov for creation of the directed wave of energy density by means of phase shift in propagation of impulse front in three current branches, namely i_1, i_2, i_3. These branches are displaced along the electromagnet axis at some distance d.

The device works in the following way. When the pulsed generator is activated, front of current pulse i_0 appears at the output 4. Impulse front at branch 1 advances impulse front at branch 2 that is caused by spatial shift of current branches 1, 2, 3 relatively to each other along the electromagnet axis at the distance d. Impulse front at branch 2 in its turn advances impulse front at branch 3 for a certain time T. The second output of the electromagnet 5 is placed in such a way that impulse front at branch 1 will phase lag behind the impulse front at branch 2 (which in its turn will phase lag behind the impulse front at branch 3) for the same period of time T. Therefore at branch 5 the united impulse front is generated again.

Time T can be calculated in the following way:

$$T=d/c \text{ (seconds)} \qquad (1)$$

where c is a constant of propagation of impulse front. This constant is known as velocity of light.

At each impulse the T (i.e. the value of relative lag of impulse front) is a constant value. Thus high-frequency consequent excitation of layers of the electromagnet appears at each impulse. The frequency of the excitation is calculated in the following way:

$$f=1/T \qquad (2)$$

where T is relative lag of impulse front in seconds.

There is an example of frequency calculation: for the shift distance d=7 mm we can calculate a lag $T = (7/2.997924)\times10^{-11}=2.335\times10^{-11}$ (seconds) and frequency f=1/T approximately comes to 4.28×10^{10} (Hertz).

Thus this design of three-layered electromagnetic emitter allows creating the waves of super-high-frequency band (for example of millimeter range) without the use of a semiconductor or other radio components.

It is very expedient to use the electromagnets designed with magnetostrictive material cores, that will significantly increase energy density of the longitudinal

wave, which is generated by the multilayer electromagnet. In Fig. 2 there is an emitter with the core. In the case of high-frequency ferromagnetic magnetostrictive materials 6 the efficiency of emitter operation significantly increases.

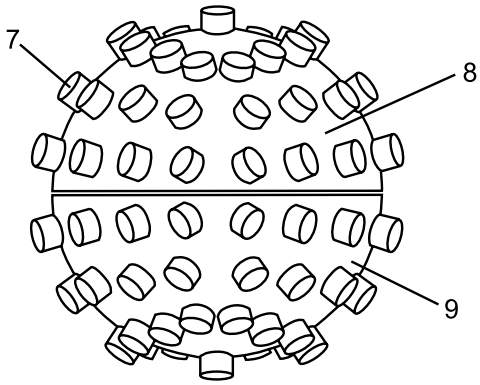

Fig. 3
Spherical design

Fig. 3 represents the spherical distribution of emitters 7 at the upper 8 and lower 9 hemisphere of the frame which could be opened in order to place detectors and different objects inside. It can also allow to establish in what way the changes of density of space energy influence the properties of different materials, velocity of physical and biological processes as well as chemical reactions. The installation of detectors 10 inside the device is shown on Fig. 4.

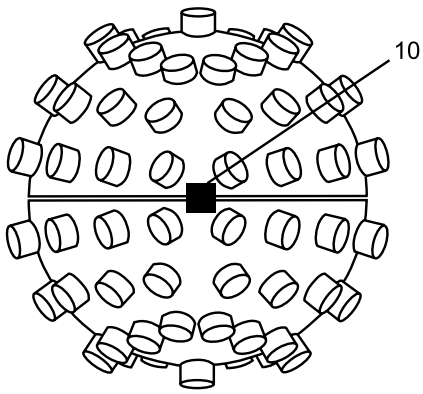

Fig. 4
Detectors inside the system

Another version of design is represented in Fig. 5, where the suggested method is realized by means of a spherical electric capacitor with three coats 11, 12, 13. Each capacitor coat is connected to the outlet of three-phase pulsed generator 14.

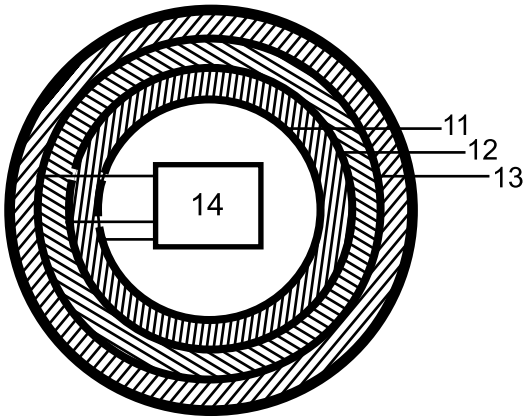

Fig. 5
Three-layered spherical capacitor

In this case the wave of energy density is created without electromagnetic emitters and this principle is not related to the modelling of magnetic quasi-monopole. The device operates due to the control unit, which provides the high-frequency changes of electric potential at each coat in such a way that the mode of high-frequency converging or diverging wave of energy density is created. In fact it is a standard three-phase generator but it produces not the rotation of the rotor of some electromotor but **"compression" or "decompression" of aether.** Aether is "pumped" in the center of the device or "pumped out" of the center.

In this case there is no need to tune separate sources of waves to make the device work in in-phased mode. It ensures reliability of the device operation if to be compared to the quasi-monopole. Besides, much less energy is necessary for the processes of charging and discharging of multi-layer spherical electric capacitor than for creation of magnetic field by means of conductivity currents.

Since the efficiency of such systems directly depends on the frequency and value of changes of energy density in space, we suggest the use of plasma shells instead of electromagnetic work surfaces for the next version of the device. It will allow significantly improvment in the specific parameters of the device. For that it is enough to place the electrodes of the multi-layers capacitor in a low-pressure gas area and these electrodes should be made as gauze electrodes. At that the wave is created in plasma, which is excited layerwise by several gauze electrodes placed in a spherical space between the inner and outer spherical bodies of the device. Therefore this version of design of the device can be considered as **the manipulation of the plasma method**.

Fig. 6 is a plan of one more design version. It is made as an inner frame 15 and outer frame 16, the space between them is filled with some gas 17. Three electrodes 18, 19 and 20 are connected to the three-phase pulsed generator 21. **Consequent excitation of plasma layers by electrodes 18, 19 and 20 creates the wave of energy density.** Propagation of this wave can be directed both to center of the device and from the center of the device.

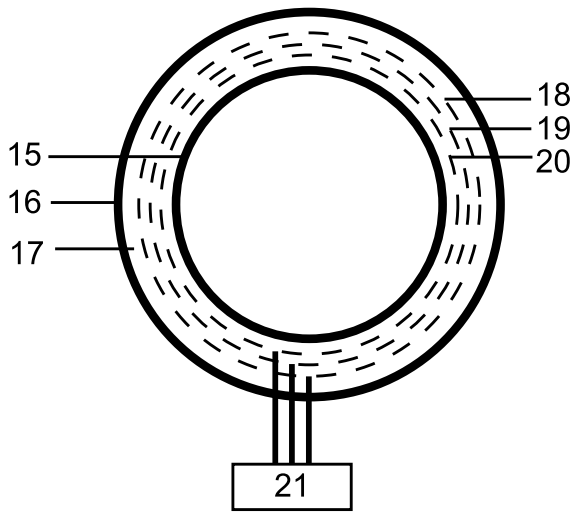

Fig. 6
Wave in plasma

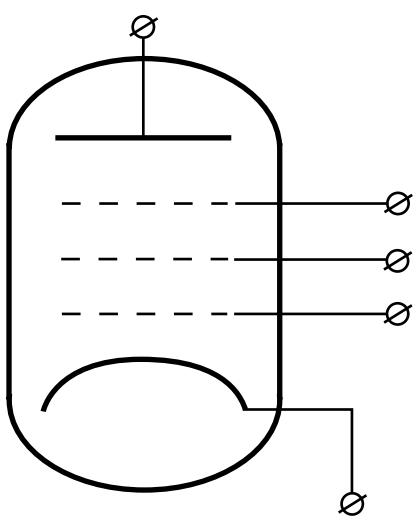

Fig. 7
Schematic electric circuit

In Fig. 7 there is a schematic electric diagram of the design.

To conclude. The work on time control has just started. We have clearly determined the main physical principles of operation of such devices, which can change the aether density in some given volume of space and thus influence temporal parameters of any physical process. The small experimental results today allow us to make real positive condusion on availability of this method and on the possibility of its practical application in applied aspects. The first aspect is antigravitation propulsion technology and we are developing the methods to detect mass (weight) changes in the time control experiments to prove this applied possibility. Another area is medical applications of the changes in the aether density.

Russian Federation patent claim #2003110067 was filled April 9, 2003. At present time we are interested in marketing for this technology as well as in search of additional investment and partners.

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Aetherodynamics as a New Field of Physics

Theory and Experiments

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A crisis exists these days both in Natural science on the whole, and, in its basis, i.e. physics. This situation is caused by fundamental errors in the methodology of its theory. The postulate method and predominance of mathematics above physical sense can be also considered as the reasons for this. Crisis situation has also taken place in the past and the way out was always to use a deeper level of matter organization than the accepted one.

A large amount of material on elementary particles of matter is collected in physics. It was discovered that all these particles can be transformed in each other. Besides that, there was discovered the ability of vacuum to create such particles at strong electromagnetic fields. In this connection it becomes clear that all these particles and vacuum have a common building material, i.e. a physical medium which fills all the world space. This medium was renamed **aether** and the element of the medium was renamed **amer**.

The worked out methodology of aetherodynamics allowed determining that aether is a usual viscous coercible gas for which all laws of usual dynamics of gases are valid. It has allowed to determine its characteristics for near-Earth space and then to describe the structures of primary stable elementary particles (i.e. proton, neutron, electron, photon, atomic nuclei, atoms and some molecules) as well as physical essence of general fundamental interactions (i.e. strong and weak nuclear interactions, electromagnetic and gravitational interactions) and some physical phenomena.

Also developed was the model of aether circulation in the Universe within the limits of perpetually existent matter, usual Euclidean space, and evenly flowing time. Formation and decay of matter, formation and decay of celestial bodies and galaxies as well as functional classification of galaxies are also included there.

To confirm some theses the author and his research team conducted several experiments mainly on electromagnetism that gave positive results. The research was conducted on testing of the presence of aether wind. These research works have confirmed the results obtained by D. Miller in 1925.

Report by Vladimir A. Atsukovsky

Electromagnetic Gravitational Interaction

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In the artide some mechanisms of electromagnetic gravitational interaction will be considered in the view of the Unified Theory of Field, Space and Time. See the complete description of The Unified Theory of Field, Space and Time at http://uic.nnov.ru/~kovy2; http://uft.h1.ru or in the book [1] which has the same title.

First of all, let us consider the structure of Space-Time where the radiation propagates. In our World gravitation is the unique substance which exists everywhere and gets over any obstacles. There are no known methods of insulation of gravitational field in modem science. It is impossible to imagine space and gravitation separately. Gravitation exists everywhere where there is some space. The gravitational field created by all masses of our metagalaxy is the aether in which cosmic objects moves and electromagnetic oscillations are propagated. The space surrounds us since the whole matter carries gravitational charge of only one sign. From astronomical research of cosmic space it follows that radius of metagalaxy is equal to the critical (gravitational radius) and hence gravitational potential is equal to $c^2 \sim 10^{17}$ $[m^2/c^2]$ in each point of space.

In our space the sum potential of the electric field is equal to zero. All bodies and space-time as a whole are electrically neutral. This assertion follows from two unique properties of gravitational space-time:

1. Values of electric charges of different signs of elementary particles are exactly equal.
2. There is an equal number of elementary particles which carry electric charges of different signs.

If electric potential is equal to zero in the given point of space then energy of alternating magnetic field passes entirely to the electric field and radiation gains the parameters of electromagnetic oscillations. However electric potential of positive and negative signs can prove its properties at the simultaneous charging of different local spatial regions. In the electric field the character of radiation differs from that one which is observed in ideal gravitational space-time (without electric potential).

In the presence of electric potential some part of magnetic energy is spent to create gravitational alternating field. Radiant energy is absorbed. Electrically charged spatial regions are perceived by us as filled with a strong absorbing substance. At the same time if the potential of the electric field can be compared to the potential of the gravitational field then spreading of radiation becomes impossible.

Change of both electric and gravitational field results in the creation of a magnetic field in the region of space-time which has a dual electrogravitational nature. Change in the magnetic field results in the creation of both electric and gravitational fields. The amplitude of electromagnetic and magnetogravitational constituents of the unified electromagnetic gravitational oscillations depends on field potential of opposite nature. The electromagnetic constituent is determined by gravitational potential and the magnetogravitational one is determined by electric potential. Transference of gravitational masses of matter in electrogravitational field-aether causes the creation of the proper magnetic field. Coming from the direction of magnetic field some force influences upon the moving electrically neutral masses. This force is similar to Laurence force.

Electromagnetic gravitational converter designed according to the Searl Effect (Fig. 1) visually demonstrates the mechanisms of electromagnetic gravitational interaction. A detailed description of the experiment is presented in the article [2] by Vladimir Roshschin and Sergey Godin (see http://www.n-t.org/tp/ts/dms.htm).

The device consists of a cylindrical stator of about 1 meter in diameter which is surrounded by 24 cylindrical rollers. Stator and rollers are made of magnetic material and they are magnetically linked (there is no contact between them). Vector of the magnetic field of the stator and rollers is vertically oriented along the axis of the cylinder but it has opposite direction. Rollers are mounted on the movable separator which circles round the stator. Each roller rotates on its axis in the same direction. The weight of the device is 350 kg. During rest, the device is electrically neutral and has proper gravitational charge, inertial mass, magnetostatic field of the stator and rollers.

On rotating of the magnetic system the following effects were observed:

- Depending on the frequency (up to 35%) the weight of the device was decreased.
- At a frequency of 550 rpm there is a spontaneous acceleration of the system and turns of the rotor abruptly increase (in quadratic dependence). To stabilize the mode it had to take off the excess energy to active load (up to 7 kWtt) by means of electromagnetic transducers.
- Magnetic field was distributed in a room as concentric surfaces of 5-8 cm thickness and 50-60 cm period. Depending on speed of rotation of the magnetic system there was a fixed temperature decrease from 0 to 8° within the regions of space which were curved by magnetic field.
- The glowing (corona discharge) appeared around the working converter.

Appearance of all mentioned effects is caused by the simultaneous presence of electric, magnetic and gravitational fields in the area of the converter.

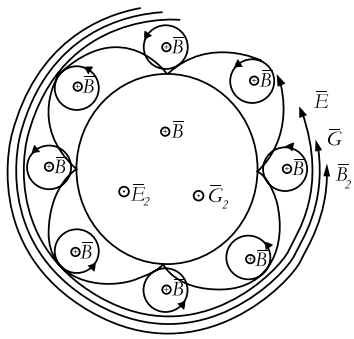

Fig. 1
Electromagnetic gravitational converter

Because of the Searl Effect a very complicated configuration of electric, magnetic and gravitational fields appears in the device. Rollers having their own field $\boldsymbol{B}$ rotate around the stator which has its field $\boldsymbol{B}$. Cycloidal motion of numerous magnets which are built in the rollers causes change in the magnetic flux. EMF $\boldsymbol{E}$ appears in the area of rotation of the rollers. EMF is directed along the perimeter around the device. The electric field creates stationary waves which are registered around the device as concentric electromagnetic gravitational walls. Magnetic rollers should be made non-conducting in such a way as to allow electric field penetrating inside. In the presence of the electric potential change of the magnetic flux causes appearance of gravitational field $\boldsymbol{G}$. This field is directed along the perimeter around the device. In the presence of electric potential the Lorenz force influences the gravitational masses of the rollers. These gravitational masses move in the external magnetic field of the stator. The Lorenz force is directed transversely to the velocity along the cycloid and in the direction of the field $\boldsymbol{B}$. The value of the Lorenz force depends on the electrical potential, magnetic intensity, mass of the rollers and their traverse speed. The electric potential in its turn depends on speed of rotation of rotor of the magnetic system. As a result the Lorenz force depends on speed according to square law. Rotating gravitational masses of the rollers generate magnetic field $\boldsymbol{B}_2$. Field $\boldsymbol{B}_2$ generates derived fields $\boldsymbol{E}_2$ and $\boldsymbol{G}_2$ etc.

Spontaneous acceleration of the system does not depend on the direction of rotation. Directions of fields and forces change at change of the direction of rotation that corresponds to acceleration in the opposite direction. When the direction of rotation is changed the weight of the device changes. When rotation is in one direction the field $\boldsymbol{G}_2$ is directed upwards (decrease of weight), when rotation is in another direction, it is directed downwards (increase of weight). In the presence of electrical potential many other interesting but still unstudied phenomena are observed (for example, curve of space, change of speed of time-flow, changes of ambient temperature…). Magnetogravitational converter transforms gravitational energy of space-time into energy of electric field which in its turn is transformed into mechanical energy of the rotating magnetic system and electric energy of the load. Energy resources of the future are not coal and gas reserves or nuclear power. They are in the inexhaustible energy of gravitational aether of our space-time.

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Medium For Existing of Matter in Nature

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By medium for existing of matter in Nature we understand physical vacuum which is a category determining all spheres of matter "life" (from particles of microworld to gravitational interactions in the Universe). Matter can not exist without this medium. Thus a question emerges, viz: how physical science can be developed without taking this fundamental aspect into consideration?

According to the Einstein postulate, in a void light always propagates with limited speed, which does not depend on the motion mode of a radiating body. It is a statement of deep physical sense which lies in the fact that only some physical medium can possess such a property. Indeed, if velocity of light, which was radiated by a body, further does not depend on speed of this body then it is possible only in a certain medium. For example, in air sound propagates with a certain speed which does not depend on the speed of the source and is determined only by density and volume elasticity of air. Thus, according to the Einstein postulate, there is a physical medium instead of void and velocity of light depends on the parameters of this medium (as is well known, velocity of light is equal to the square root from the product of inverse values of electrical and magnetic conductivity of vacuum).

The author of this article made an attempt to research this physical medium [1]. The author used a well-known experimental fact that at interaction of a photon with a charged real particle this photon transforms to electron-positron pair. Besides, it was taken into consideration that photon is an electromagnetic phenomenon. The research allows the following conclusion: the medium named in physics as vacuum (before the XX century it was called aether) is created by electric dipoles from (+) and (-) elementary charges. These dipoles are surrounded by magnetic (mass) continuum. There were determined dipole intervals, elasticity of decompression and ultimate strength of this interval. What does this model of medium mean?

1. This model is a physical validating for the "birth" of electron-positron pair at energy which is necessary to break dipole and create the "clot" of mass of these two particles. A certain model for the "birth" of mass must exist. It is not clear as yet but can be represented as a vortex of magnetic continuum inside the charge shell of electron and positron.

2. Let us suggest that values of (+) and (-) charges differ at 7.848981×10^{41} Coulomb, then this difference is sufficient for the medium to be a source of gravitation and inertia. According to Newton's law of gravity, a weak electric charge of medium (all material bodies exist in this medium) causes all bodies to attract one another (under Coulomb's law). On the other hand, weak medium charge of a like sign creates repulsive forces which manifest themselves in the form of the expanding Universe. Thus it becomes clear the amazing uniformity of gravity and forces of negative pressure for the Universe. The mentioned difference of values of (+) and (-) charges of medium dipoles is not used as arbitrary parameter but it logically follows from its electrical structure [2].

3. Hypothesis of nature of gravitation is confirmed by calculations of the deflection angle of electric waves by the Sun. Calculated angle differs from the experimental value only in the fifth sign, which depends on the accuracy of several physical values used in calculation formula. There is practically an absolute coincidence with Einstein's theory. The difference is that it is a concept of space and time (i.e. geometry) which prevails in the general theory of relativity while in the nature of gravitation physical basing is used. Velocity of light is unstable and determined by medium state which depends on electric, magnetic and gravitational potentials.

4. The existence of "black holes" relates to medium structure and nature of gravitation. At the edge of "black holes" the ultimate acceleration from gravity is realized. It causes breakdown of connections in electric dipoles of medium, creation of matter and antimatter (the so called "evaporation" of black holes which was theoretically predicted by E. Hoking, England). However at the border of a black hole the velocity of light is equal to zero since its propagation

medium disappears. According to Einstein's theory it is such a deceleration of time that electromagnetic oscillations gain zero frequency.

5. Naturally the medium is a carrier of all types of electromagnetic radiation, beginning at stationary electric voltage and ending with super-high-frequency "photons", which can be determined not as electromagnetic but as magnetoelectric phenomenon. In the latter case magnetic continuum of medium has a crucial importance since it determines very small degrees of magnetoelectric disturbance. These degrees are thousands of times less than those of a hydrogen atom. It is reasonable that such small degrees creates illusion that a photon possesses properties of particles.

6. Medium structure directly leads to the notions of Quantum Mechanics, beginning at quantification of electronic "orbits" in atoms. This medium determines the "allowed" spots for electrons to be placed around a nucleus. Thus medium is a necessary place for the existence of all matter or matter of the Universe. The so called Compton length of electron wave is one of the validations of this statement. It is directly calculated to a high accuracy according to electric structure of vacuum.

7. Thus Plank's constant is not a mysterious "quantum of action", on the contrary it is entirely determined by medium parameters. Thereby the crisis (which conventional physics is accused of) can be logically overcame by the introduction of medium which is capable to take radiation in electromagnetic region only by quanta. Plank's constant is always presented at all quantum approaches. It is additional evidence in favor of the necessity to take into account the medium as natural place for existence of all the matter in Nature.

8. It is still a question what processes take place in the centers of galaxies. The observations show that the centers of galaxies create star matter. They often flow out the centers and settle themselves at approximately the same plane. It is an evidence of the fact that centers of galaxies quickly rotate and the favorable conditions for stars to reject matter are created. Similarly planetary systems are created around the rotating stars. It is thought that centers of galaxies are gigantic black holes. In the context of the concept of medium for matter existence it can be set up a hypothesis that being at some special state the medium creates stellar systems, i.e. galaxies.

9. Astrophysicists more and more trend to accept the existence of unknown "dark" matter, which occupies approximately 70% of all matter. It is said that due to antigravitation property this dark matter is responsible for the expansion of the Universe. Hypothesis on the nature of gravitation gives the affirmative replies to such suggestions as: expansion of the Universe is caused by weak electric charge of the medium and distributed mass of magnetic continuum is the very dark matter.

10. All elementary particles (electrons, positrons, mesons, protons, neutrons etc.) are in the medium and interact with it. In the case of electrons and positrons this interaction causes the great extension of dipoles of medium which directly adjoins to borders of particles. This extension helps photons to break the particles. In case of protons, there is such a breakdown of the medium at their borders that protons turn to be dressed in "coats" of virtual electrons and positrons. And medium is shown to be in entire state only when reaching the first Bohr orbit. This interaction of the medium and particles leads to the factors which determine the life time of some of them. Thus life time of a neutron is up to 30 minutes depending on the state which it has while leaving the nucleus. For mesons "the tearing" Coulomb forces, which exist between the medium and particles, are very powerful that makes the life time of mesons very short. However if the particles moves with a high speed relatively to the medium, then these forces noticeably decrease and if the speeds of motion is close to velocity of light then these forces become very small. The life time of such particles noticeably increases. In Einstein's theory it is said about "deceleration" of time. Finally the life time of particles is determined by the inner steadiness and outer influence of the medium. Protons have fantastic binding energy and they cause such great external destructive effect that their life time becomes immense.

11. When particles move in medium with high speeds, there is a concentration of magnetic continuum which is recognized as increase of mass of particles at increase of their speed. Evidently, we can continue the list of physical phenomena which relate to the presence of medium for existing of matter in Nature. However it seems to be enough to admit that medium (physical vacuum, aether) is of a great importance for the very existence of the Universe and for the processes which take place there. "Mechanism" of gravitation and inertia has a special importance since

it is the only thing which can make clear the real mechanism of Nature. It is possible that the methodology, which is accepted in physics, is necessary for more accurate description of phenomena but it is not enough for understanding of the nature of "space" and matter. Research of the medium for existing of matter will be able to meet the conditions sufficiency.

The understanding of vacuum structure, which is created by electric lattice from charge dipoles, surrounded with magnetic continuum, gives an opportunity to control the forces of gravitation and inertia. The medium of vacuum can be influenced by:

1. The radiation which has frequencies coming to the frequency from point #11 of the list of parameters.
2. Electric voltages which exist in vacuum (it is not very promising because of real matter breakdown).
3. Magnetic intensities (magnetic flux density). It is the most promising influence method (1-10 Tesla is enough to compensate terrestrial gravity).
4. Transformations of low accelerations to high accelerations of impact type.

Potential electric and magnetic energy is immense in vacuum medium. Reasoning from energy of one dipole, which is equal to 1.6x10 (-13) Joule, we will derive the value of electric energy equal to about 10 (+31) Joule per one cubic meter of the medium that is equivalent to mass annihilation of 10 (+15) kg!

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Spartak M. Polyakov

(09 January, 1931 – 04 June, 2003)

Spartak M. Polyakov, a legendary physicist-experimentalist, known for his research in the field of gravitation, has died. Polyakov was the author of more than 50 research works, among them "Introduction into experimental gravitonics». Polyakov was the creator of the new model of photon. He also conducted numerous research in the field of electrodynamics, gravitational phenomena and superlight connection.

Spartak M. Polyakov graduated from Kishinev State University with degree in "General Physics". For many years he worked at the top secret military engineering department "Istok" (Russia).

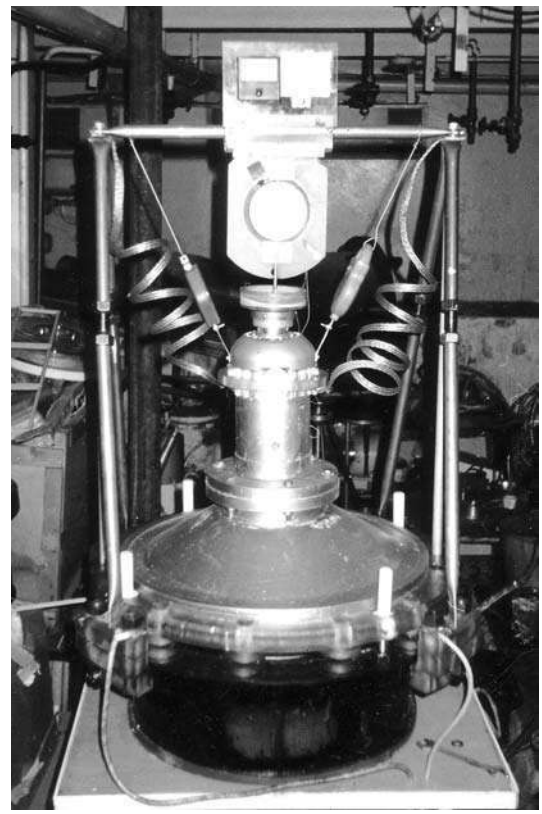

Plyakov's alternative physical theory allows explaining such phenomena as magnetostriction and optical magnetization. The basic postulate of this theory states that the speed of propagation of gravitational waves is dozens of times faster than velocity of light regarded by the traditional science as the limit. In his experiments Polyakov demonstrated such methods of generation of gravitational waves as precession of gyroscope and remagnetization of ferromagnetic.

While working for "Istok", Polyakov designed on his own a device which is possibly the first gravitational motor in history. Total specific thrust produced by rotation of gravitating mass comes to 2.5 kg/kWt. This index is close to that produced by the engines of modern helicopters, which is equal to 8 kg/kWt. Practical application and further development of Polyakov's ideas can provide humanity with new kinds of communication, gravitational engines and free energy devices.

Adams Motor

Principle of Operation and Experimental Data

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Adams' motor-generator represents the type of devices which use, as their creators claim, so-called "free energy". The term "Zero point energy" is also used in some sources [1, 2]. Due to quanta-mechanical fluctuations, this energy exists even at zero temperature. Adams' motor-generator belongs to the group of Switch reluctance motors [3]. Robert Adams, **former Chairman of the Institute of Electrical Electronics Engineers, USA (New Zealand section)**, designed this machine in the late sixties of 20th century. Similarly to all the devices utilizing free energy (referred to in come sources as "overunity devices"), Adams' device remains practically unknown to the general public. **The device is rather simple to assembled even at home, which I experimentally proved. However, it is necessary to be very careful while choosing the model parameters. As to the latter I have managed to collect quite a big number of instructions from existing sources; the summary of these instructions is presented below in this article. Based on these instructions, a low-power model can be assembled even without a mathematical analysis and modeling of electromagnetic field. Such model would certainly facilitate optimization of the device.**

Adams' motor is most frequently a DC machine; however, it can also use an AC source through a rectifier. In the latter case only the adjustment of the device and its control system can be provided.

Editorial: We disagree with some assertions of the author; however this article is of great interest.

My experiments on my own model do not yet allow me to make an unambiguously positive conclusion concerning the possibility to generate excessive energy. Experiments with my new control system designed on the base of AVR controller AT90s2313-10PI (it is produced by Atmel company (http://www.atmel.com) will allow to be more specific. Below there is a general analysis of the motor principle of operation and a number of recommendations concerning the construction and technology. I do not propose to take this as compulsory rules to follow; other technical solutions are possible.

Basing on the principle described in this article, R. Adams (the link to his articles is available at: http://www.aethmogen.com/wri/intro.shtml) created a few DC motor-generators which operate on permanent magnets. Some of them, according to information found on the Internet, have manifested 690% electrical efficiency and 620% mechanical efficiency. These devices operate at room temperature without overheating. My device has shown between 1 and 3 degrees overheating after an hour of functioning. However, it is easy to prove that such overheating is predictable for an average current of 0.15 A in coils of 35 mm long and 25 mm in cross sectional diameter. I have not been able to prove the data published on the Internet concerning the Adams motor capability to operate when the stator temperature is a few degrees lower than that of the environment. The temperature of the coil and of the power transistor is a good indicator of correctness of the circuit set-up and of functioning of the control circuit. There were cases when transistor and coil were noticeably heated after adjustment. Usually this was explained by a bad choice of points of transistor switching or by too extensive current impulses in the stator (which must amount to approximately 25% of period length). After the required adjustment the motor continued to operate almost without overheating.

Adams' motor was first mentioned in Australian Nexus Magazine in 1992. Later, Harold Aspden (Britain) proposed a slightly improved version of the motor and received Great Britain patent No. 282708 [4], which strongly reminds of the original version published by the above magazine. **Adams' device** represents an electrical motor and/or generator consisting of a rotor

with radially directed permanent magnets and of a stator also constructed with a few radially directed and periodically magnetized cores with winding. (Fig. 1). In some models axial orientation of magnets and coils are also used.

Permanently magnetized poles of rotor can include any number of poles, even an odd number. Analogous poles of the magnets (all N poles or all S poles) are directed outside. A version with alternating poles is also possible; such model allows the torque to increase. In this case, after passing a rotor pole the stator is demagnetized by the current impulse and begins to be attracted by the magnet of different polarity. This circuit requires a more complicated control; on the other hand, it manifested rather good results in certain models.

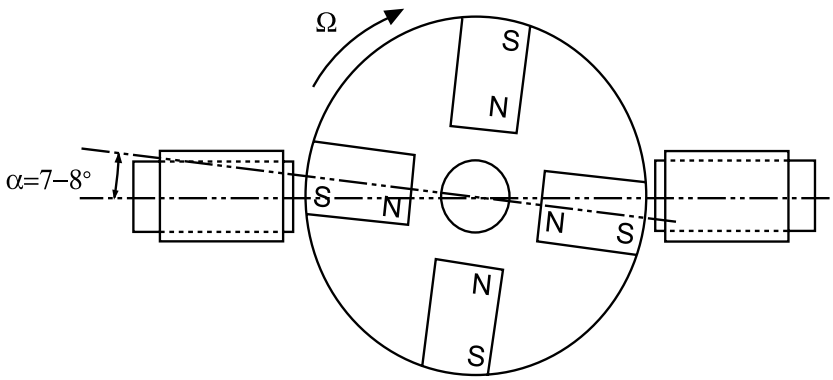

Fig. 1

Poles with winding placed on the rotor are radially oriented in order to obtain a supply of energy emerging as a result of the influence of counter emf from the rotor poles. Steel or iron cores are used for the poles of the stator with winding. It is also possible to use other materials, at that the core must have high magnetic inductivity and low level of magnetization reversal losses. The stator winding consists of a few hundred turns. The current inducted by the magnet in this winding will have the polarity which will cause repulsion of the magnet. Since the electromagnetic state of stator changes quite significantly and quite fast, then the stator core can be considered to be the most crucial element of the device. Ignoring this fact was one of the most frequent mistakes made by those who tried to reproduce Adams motor.

The current inducted in the stator is the function of:

- field size,
- number of winding turns,
- speed of flux changes.

Resultant parameters of this device cause each pole to be attracted or repulsed by stator poles when the rotor is in certain position in case when the rotor is unbalanced. To achieve this effect it is required to switch the input current in control coils after the signal from sensor of rotor position. R. Adams used a mechanical switch as a sensor. My device and a number of other devices use the signal from two Hall sensors. However, according to experimenters' information, better results are achieved if a position optical sensor is used.

Time of switching of impulses is determined by the size of the motor itself, i.e. the speed of motor rotation, location of rotor magnets towards the stator windings and the distance the rotor magnets pass while moving by the poles with stator winding.

It is necessary to take into account that any part of this motor can be modeled based on the existing electromagnetic theory and no part of the motor is in conflict with any laws of electromagnetism. There are so many ways to construct Adams' motor that any version may be considered to be correct.

One can say that the frequently pulsating electromagnetic process in the stator core is what allows Adams' device to function as a kind of diode which borrows energy from the field of permanent magnet but then does not return that energy in full.

5 stages can be defined in the periodical process which takes place in stator:

1. The magnet is attracted to the stator core. The permanent magnet is attracted to the iron core of the stator with winding. While doing so no consumption of electrical current takes place. It is as if kinetic energy is borrowed from an internal ferrite magnetic source and is supposed to be returned into the stator.
2. Stator core is magnetized. During the period when the magnet is positioned in front of stator core they both comprise a single magnetic conductor with an air gap and the stator core becomes an extension of the magnet side it faces. It is usually supposed that the energy "borrowed" on the first stage is getting back now.
3. Stator core is demagnetized. When the stator core becomes rotor magnet extension, the circuit closes and current impulse gets to stator windings. I have seen the instructions saying that the angle between

stator axles and rotor magnet must amount to 7-8 degrees as shown in Fig. 1. However, my model made it clear that at increase of speed of rotation it is necessary to start the coil a little earlier, when the magnet axle has not reached the stator axle. Probably this applies to the circuit with a Hall sensor only and if an optical switching is used the making angle will be different.

Magnetic field of this current acts to compensate magnetization of the stator, which is caused by the field of rotor magnet. Consequently, the summed current significantly compensates attractive force between rotor and stator and the rotor can freely rotate by using the inertia obtained at stage 1. This process is characterized by the fact that this current impulse is amplified by the current inducted in the stator winding by rotor magnet which, in accordance with Lentz law (1834), counteracts the power which induced it. Consequently, kinetic energy obtained as a result of attraction of the rotor to the stator at stage 1 is transformed into electrical demagnetizing impulse in stator winding during the period when the rotor and stator directions are congruent. This is the unique overunity characteristic of this model. However it is obvious that instead of returning this energy the motor transforms it into electromagnetic demagnetizing field.

4. Restoration: when the rotor is removed from the stator attraction zone the latter looses energy and returns to its initial demagnetized state. Decreasing electromagnetic field creates a current wave of reverse polarity which can be stored in the capacitor.
5. Reiteration of the process: This periodical process is renewed as described in stage 1 during the next magnetization of the stator, excluding the fact that emf preliminarily stored in the capacitor, on term of presence of suitable electrical circuit, can be used for facilitating stator demagnetization or even used to supply the load.

It may be briefly summarized that the frequently pulsating electromagnetic process in the stator core is what allows Adams device to function as a kind of diode which borrows energy from the field of the permanent magnet but does not return that energy in full. The important characteristic of such motors is that the stator windings are used for demagnetizing and not for magnetizing as it could seem from the first sight.

It is noteworthy that there is a small pause between attraction to the stator and repulsion from the stator. The effect of attraction to the core takes place a split second before the repulsion effect manifests clearly. This pause being the reason of electromagnetic asymmetry creates conditions necessary for achieving overunity effect. If the attraction to the core and repulsion by means of Lentz currents were taking place simultaneously and with the same power there would not be any overunity characteristics. That is why the rotor must be as lightweight as possible. From this point of view, T. Harwood's model is the most lightweight of the known models. In Harwood's device the magnets are mounted between two CD disks fixed on the shaft by means of plastic washers and glue. My model is heavier, which can be considered as one of its disadvantages.

The principle of operation of Adams' motor is based on the balance, which creates the electromagnetic asymmetry. To get the motor to operate the magnet must be attracted to the stator core which must have a smaller cross-section area in order to create attraction without any significant repulsion effect from the stator windings mentioned above. When stator and rotor axles are congruent the Lentz induced current must be sufficient for compensating the natural attraction of the magnet to the stator core. Consequently, stator windings must have enough turns for demagnetizing effect, but not to the extent that this effect fully manifests before the rotor reaches the stator axle when Lentz current has its maximal value.

During my experiments at 12 V voltage and on using two independently controlled stator coils the speed of rotation reached 3400 rpm. Please note that while reproducing such device it is necessary to take certain measures in order to ensure safety in case of possible breakdown. **The magnet disconnected from the rotor may be dangerous!**

Technological recommendations are as follows:

1. The device must be low power. It is better not to try to begin with a motor functioning in kilowatt range. This is feasible only on condition of having all necessary technological documentation which is not available at the moment.
2. The preferable voltage for the first model is 12 V. If the voltage is less the speed of rotation is too slow for indicating the expected characteristics of the device.
3. The best magnets are ferrite ones with dimensions 4x4x5 (where 5 is the magnet length). The practice has shown that at 12 V voltage neodymium-iron-boric (NdFeB) magnets cause a jerky rotation of the rotor.
4. The side of the stator core facing the rotor must

Control circuit with hall sensors

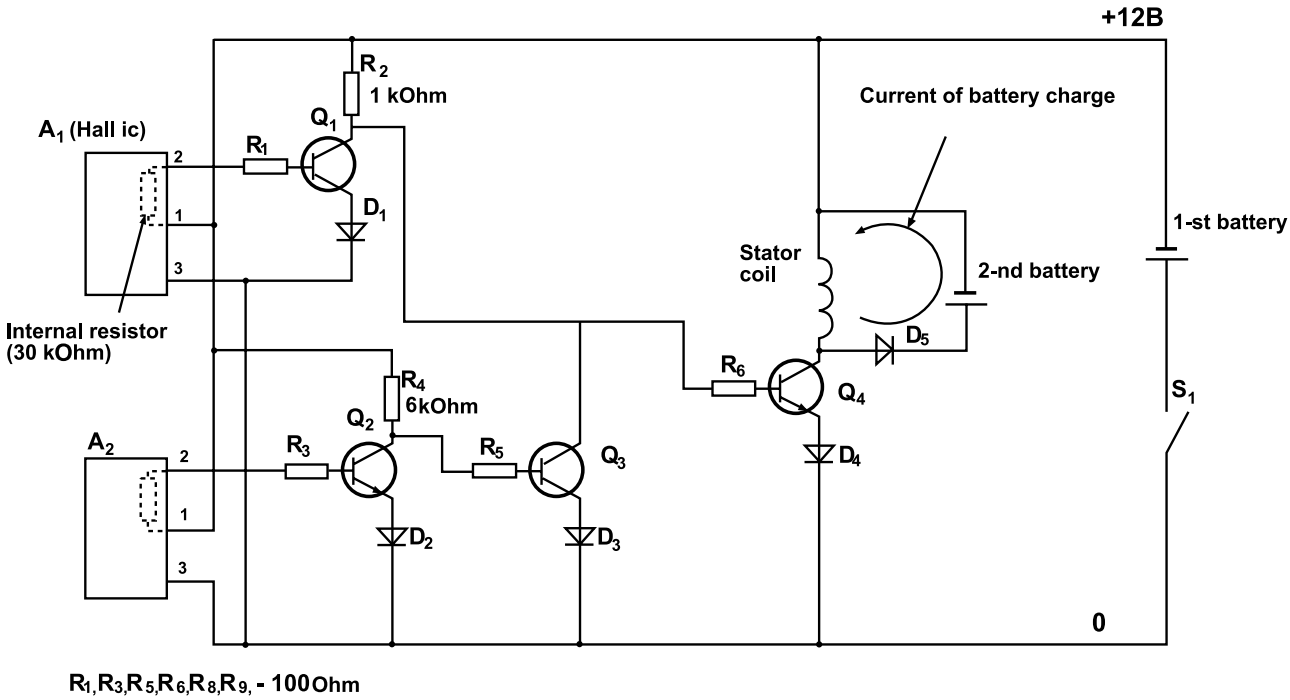

Fig. 2

have the size which is 4 times smaller than the corresponding side of the magnet. If cross-section area of the stator is larger, a bigger part of magnet field comes to the stator core when their axles coincide and thus there is nothing to induce Lentz' currents in the stator windings. It is a common point of view that it is necessary to try to minimize the volume of a device and to obtain the maximum efficiency at minimal material expense. In practice, it has always been the goal while designing electrical machines to decrease losses in stator I^2R. As for the Adams motor, it requires not only the use of disproportionate magnets but also stator windings with disproportionate number of turns specially designed to obtain maximum Lentz' currents that is achieved by hundred of turns of winding.

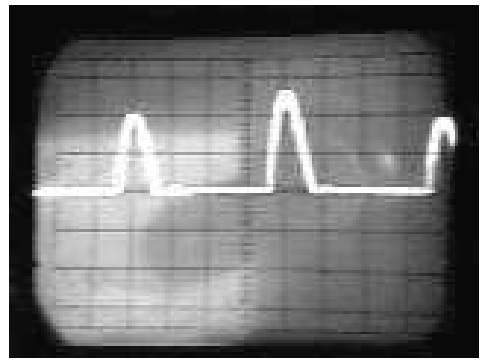

5. It is necessary to define approximately the effective zone of the magnet field. If practically applicable magnet field is equal to, for example, 8 cm, and the stator has a 10 cm long winding, then more than 20% of turns will not be efficiently crossed by magnetic force lines and will only create an excessive mass of the device. To define the degree of effective action of the magnet we can put a paperclip on the table and move it gradually in direction of the magnet until the paperclip is attracted to it. Actually if we take into account friction losses then the magnet influence zone will be a little larger. That is why the stator winding in the axle direction can be 10% larger than that in this experiment. The description of this test has been found on Tim Harwood's website (http://www.geocities.com/theadamsmotor/cdmotor.html).

6. The air gap clearance between the stator and the rotor must not exceed 1 1.5 mm.

7. Use as little metal in the device as possible. It is preferable that the metal is used in the core and stator windings only.

In order to increase the efficiency of this motor, it is necessary to build it in a manner, which allows removing the counter emf from the stator windings. To do that, this emf may be taken off and stored in the capacitor. The article published by Nexus magazine and Great Britain patent No. 282708 consider special generator windings; however, no sufficiently detailed data on operating rules are provided. Michael Smith (Australia, http://www.Fortunecity.com/greenfield/bp/16/content1.htm) has unequivocally informed me in one of his letters that

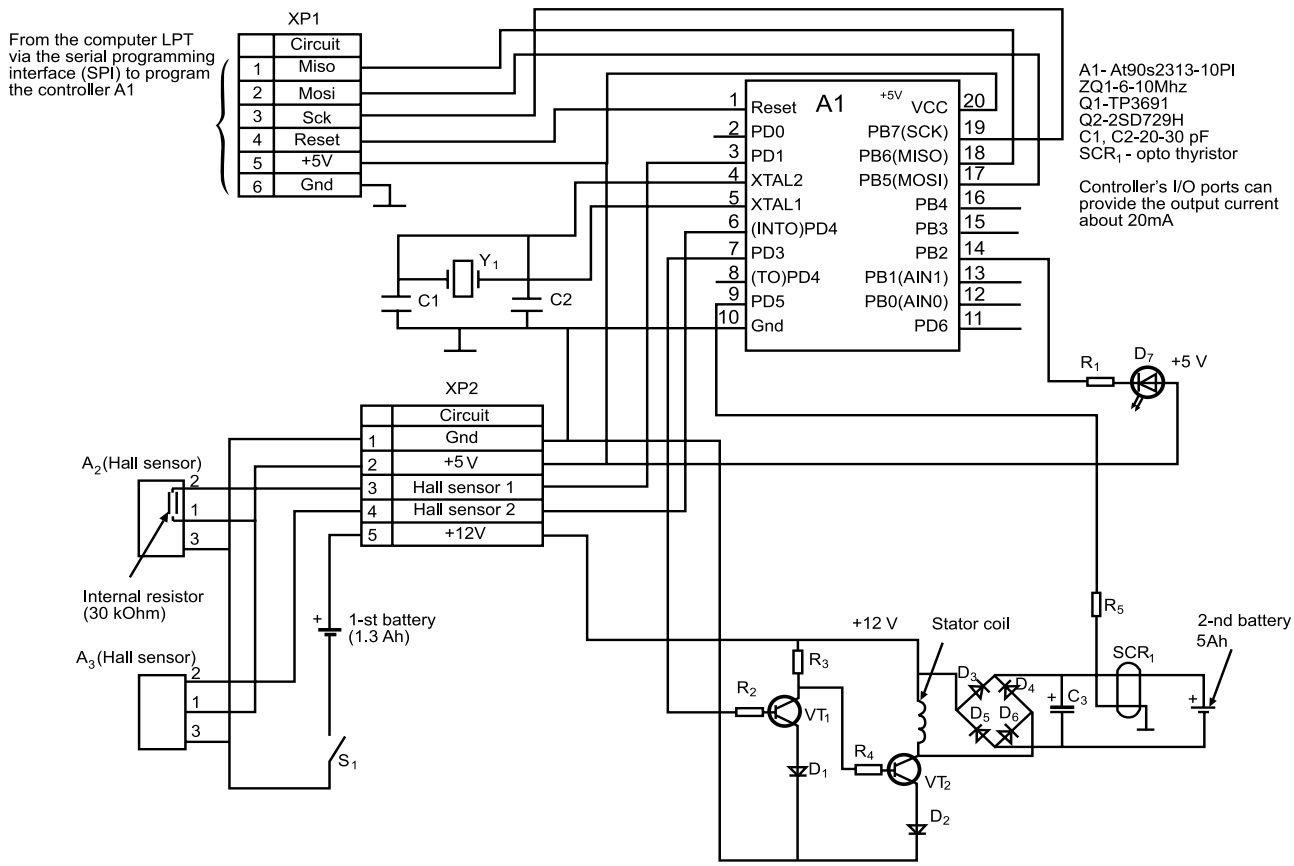

Fig. 3

he has not achieved generation of excessive energy in such a system. During his experiments a two-battery circuit proved to be more effective. In this circuit, during a part of periodical process the energy is stored in the capacitor and then a command is transferred to a thyristor, which discharges it into the second battery. At that capacity, the second battery must be no less than 4 times more than the capacity of the first one. Otherwise the excessive energy does not have enough time to be stored during the discharge. I have also managed to provide the charge of the second battery, but the control circuit has not been assembled fully yet, as it is shown below in Fig. 4. Better results are expected when its final adjustments together with AT90s2313 controller program have been made.

In order to increase the efficiency of this motor, it is necessary to build it in a manner, which allows removing the counter emf from the stator windings.

I managed to start my first model of the motor in April, 2002. Afterwards, I spent approximately six months increasing its rotational speed from 750 to 3200-3400 rpm, decreasing vibrations and improving control circuit. In order to achieve a better rotor balance I had to re-construct it twice. It is very important to align the axles of the bearings with maximum precision; otherwise a considerable decelerating torque will manifest. The shaft penetrates the lower moving base. It is possible to rotate the base at a small angle for the precise alignment of axles and then to fix it with screws and nuts.

In order to decrease aerodynamic losses, two veneer parts are mounted between the magnets. Thus I managed to increase the speed, although the rotor weight has also been increased.

Stator cores are made of plates taken from a disassembled radio transformer. Tim Harwood used nails with winding, however, my own results with such core proved to be poor. Dimensions of the core are 10x11x50 mm.

The type of power source is also important. First, I connected a 9 Volt accumulator of "Krona" type in series

with three metal-hydride 1.2 V accumulators. The speed of rotation did not exceed 1500 rpm. But when I used a lead/acid accumulator with 1.3 Ah capacity, the speed increased to 2600 rpm if there was one coil on the stator.

Four magnets mounted on the rotor have the dimensions of 20x20x35 mm and are fixed on a 105 mm glass fiber laminate disk. The current impulses proved to be too wide, by up to 40%. In order to make them shorter (down to 25-30%), I had to use the control circuit (Fig. 2) with two Hall sensors. At the signal from the first sensor the stator current is started, the second sensor switches it off. Many experimenters used a timer to control the impulse length while working with Adams' motor that is more practical since impulses are supposed to be wider during the start. I took this factor into account while designing the controller circuit. Current impulses are shown in Fig. 3. Their fronts are supposed to be shorter; it is probable that the coil has more inductivity than necessary. The impulses amplitudes are slightly different which is explained both by the difference in volume of induction of the magnets and by difficulty in achieving similar air gaps while working at home.

I have provided the charge mode of the 2-nd battery at my two-battery design. After 75 minutes of operation of the device the source lost 0.17 Volt whereas the second battery was charged at 0.36 Volt. The capacity of both batteries in this experiment was equal. Besides after such charging the second battery started to discharge quickly. The circuit where stator current charges the battery directly has to be considered ineffectual (see Fig. 1). To evaluate the charge, which is gained in non-hermetic accumulators, the density of electrolyte can be measured.

To obtain a more uniform torque I added the second stator which is controlled independently. This required installing two more Hall sensors and an additional power transistor. The angle between axles of the coils amounts to 135 (180-90.2=135) degrees. When the current is present in one part of the stator it is absent in another and vice versa. The speed has increased up to 3200-3400 rpm, and I deemed the further increasing of this characteristic unnecessary.

Increasing the number of circuit elements does not seem a good idea. Futhermore the adjustment process becomes more complicated. In order to improve the circuit of battery charge adding a timer circuit is required. Thus, I decided to use a controller circuit. A simple Basic program has been developed for AVR controllers. This program operates in mode similar to transistor circuit, but its capability can be significantly increased due to the built-in processor timers. Today program improvement is the most efficient way to solve the task of generation of excess energy in this circuit.

This article is meant to elucidate the principles of operation of one of the simplest devices which pretend to become an "overunity device", "free energy machine", "perpetual motion machine", whatever you call it. Probably someone will try to create such motor-generators on their own. I hope that my article will serve as a guide and will help to avoid the mistakes made by many experimenters (including myself) before they managed to build their own model.

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Prediction and Experiment on Field Transformation in the Model of Extended Space

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A series of preliminary experiments on checking the possibility of generation of gravitational field at deceleration of charged massive particles in matter was carried out.

Introduction

In previous works [1-3] generalization of the special theory of relativity (STR) for the five-dimensional extended space with metric (+;-,-,-,-) was offered.

The model of extended space (ESM), combining electromagnetic and gravitational interactions, was made. For this, there was made (1+3)-dimensional space extension $M(T;\vec{X})$ of Minkovsky to (1+4)-dimensional space $G(T;\vec{X},S)$. Let us call it extended space. As the 5-th additional coordinate the value already existing in Minkovsky space, i.e, S interval

$$s^2 = (ct)^2 - x^2 - y^2 - z^2 \qquad (1),$$

is used.

Let us note that attempts to combine gravitation and electromagnetism have a substantial background.

Modern approaches to this problem trace back to the work of F. Klein [10] in which he proved that classical Hamiltonian mechanics can be represented as optics in the space of a great number of dimensions.

Then T. Kaluza tried to generalize Einstein's theory of gravitation to include electromagnetism in this theory as well [11]. He proposed to consider (1+4)-dimensional space with metric depending on potentials of the electromagnetic field. Kaluza's idea was evolved by O. Klein [12], G. Mandel [13] and V. Fock, and the model they had created got the name of the Kaluza-Klein theory. They proved that the trajectory of a charged particle has the form of a geodesic line with zero-length in 5-dimensional space.

In his works on 5-optics Y. Rummer [15] proposed to assign action dimensionality to the new dimension and to consider it periodical with the period equal to Plank's constant. Note that rest mass of particles in all these constructions unlike the model of extended space evolved in the works [1-7] was considered a fixed value. Subsequent development of multidimensional theories is given in the monograph [16].

A separate approach is represented by multidimensional constructions in the theory of strings and superstrings [17].

Approach to construction of (1+4) dimensional space evolved in [18] is close to the proposed model of extended space. Here it is proposed to use mass (matter) as the 5-th coordinate. However, in this model, as its originators admit, it is impossible, for example, to create the energy-pulse tensor. There is no such disadvantage in the extended space model [8].

Mechanics of a material point [1, 2, 7] and electrodynamics [1, 8] were made in the introduced extended space. Besides Lienar-Vihert potentials [6, 19] corresponding to such a model were also considered and properties of solutions of Maxwell augmented system of equations which are in conformity with these potentials were analyzed there.

Gravitational effects in extended space, such as the second orbital velocity, red shift and light deflection [4, 20, 21] were considered. It is proved that the formulas received in the general theory of relativity for calculation of values of these effects can be received by an absolutely different method within the framework of the extended space model as well.

It was proved [6, 19] that the fields in the model of extended space can change their signs. Such change of field-intensity sign and, consequently, change of sign of Lorenz force can be associated with radiation reaction of these fields which occurs when charged particles move with acceleration.

Thus, on the one hand, it was proved in the model of extended space that it is possible to get certain formulas describing gravitational effects of the general theory of relativity [4,20] using the technique of turns in extended space. On the other hand, it was proved that the electromagnetic field can be a source of gravitational field [6, 19].

Besides, a moving massively charged particle under deceleration can create a variable gravitational field around itself [9, 6, 19]. The following experiment was offered for experimental check of the latter assumption. In this experiment probable occurrence of gravitational field at deceleration of relativistic electrons was determined by change of oscillations of a massive torsion pendulum.

Experimental device

A narrow bunch of relativistic electrons from a microtron 1 (average power of the bunch is 450 Wt, electrons energy is 30 MeV) was directed to a brake target (position 2 or 3) made of wolfram exactly where deceleration of accelerated electrons took place.

A special torsion pendulum suspended on a vertical suspender 5 made of a springy metallic string with 1,8 mm diameter was placed near the brake target to register gravitational field which could probably appear at electrons deceleration. The length of the suspender made is 85 cm. The pendulum could rotate freely on the suspender only in horizontal plane.

The pendulum consisted of a light aluminum rod 4 (with a length of 120 cm) on the ends of which massive loads 6 and 7 made of non-magnetic material were fixed. The weight of each load was equal to 4kg. In the center a pendulum was fastened to a vertical suspender 5 by a special mounting preventing slippage during turns. To reduce the influence of magnetic inducings the pendulum was grounded and additionally screened by metallic grid from all sides. The period of free oscillations of the pendulum made were about 40 s.

Rigidity of the pendulum vertical suspender could be changed by means of limiting the length of effectively operating part of the suspender. As a result, the period of oscillations could be continuously changed within the limits of 40 to 27 s.

To reduce the influence of mechanical noise and to introduce additional attenuation in pendulum oscillations two liquid dampers 10 and 11 located near the pendulum massive loads were used.

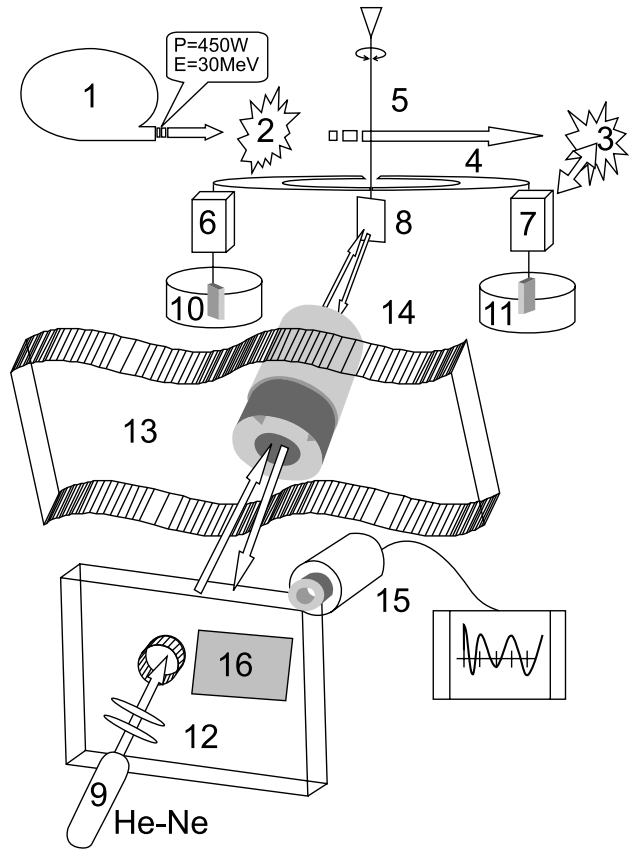

Fig. 1
Experimental device
1 – microtron, brake target made of wolfram – positions 2 or 3, 4 – rod, 5 – vertical suspender, 6 and 7 – massive loads, 8 – mirror, 9 – He-Ne laser, 10 and 11 – liquid dampers, 12 – optical system, 13 – concrete protection, 14 – observation channel, 15 – video system, 16 – screen.

Pendulum deflections were observed on a graduated screen by deflection of a laser beam reflected from a flat mirror 8. For this, the beam from a continuous He-Ne laser 9 through the optical system 12, which constricts the divergence angle of the laser beam, was directed to the mirror through a special narrow channel 14, located in concrete protection 13 around the microtron. By means of a video system 15 the beam reflected by the mirror was registered on the screen 16 located at a distance of 500 cm from the mirror. The video system allowed remote checking of vibrations of the laser spot and additionally enlarged the visual angle up to 12 times. The diameter of a focused laser beam on the screen was made 0.15 mm. The maximum turn angle of pendulum for the reflected beam to remain within the receiving channel was approximately 2 degrees. The accuracy of turn angle registration of the whole system was $5x10^{-4}$ degrees.

The pendulum was placed in such a way that one of the massive loads were close to the brake target at a distance

of about 20 cm. There was also an opportunity to move the brake target from one end of the pendulum (position 2) to the other (position 3). This allowed changing the place of deceleration of electron bunch at constant parameters of all unaccounted mechanical noise and magnetic inducing. Thus, direction of pendulum torsion was changed under probable exposure of occurring gravitational radiation.

Below there is a photo of the experimental plant (see also the colored photo on the cover page).

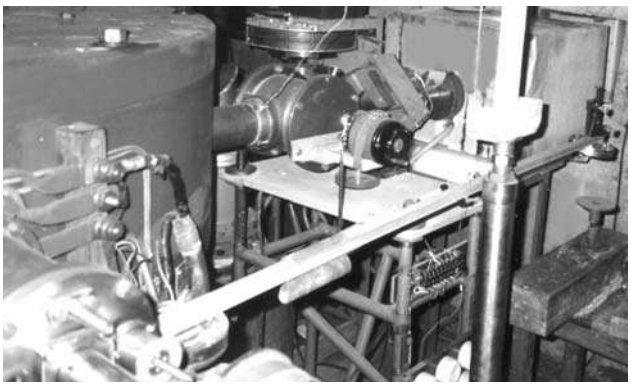

Calibration Measurements

To make measurements it was necessary to select optimal parameters of the pendulum (masses of loads, suspender rigidity and the value of oscillations attenuation). On the one hand, while carrying out the measurement it is desirable that the amplitude of pendulum oscillations should be as maximal as possible. On the other hand, the beam reflected from the mirror should not go outside the limits of observation, restricted by the diameter of the narrow observation channel in radiation protection around the accelerator. Besides, the typical operating time of the loaded accelerator usually is 10-15 minutes. Necessity to accumulate the minimum of sufficient statistical data within this time limited oscillations period and the time of setting of the pendulum in a new equilibrium position at outside influence. All these requirements were as far as possible taken into account during selection of the final setting parameters.

An example of free oscillations of the pendulum in the presence of minor mechanical vibrations caused by the operating of vacuum pumps is given in Fig. 2, series I (the experiment took place on 31 May, 2001). The diagram shows the amplitude of laser beam oscillations on the screen 16 (upper and lower rows of values) depending on the number of oscillation. The laser beam is reflected from the mirror 8 which was fixed to the pendulum. The diagram also shows the current central equilibrium position (the central row) calculated by these amplitudes. Series I represents oscillations at influence of the background mechanical noise. Series II represents the response of the pendulum to minor permanent outside force. Accuracy in determination of position of the center of a light spot was 0.1 mm.

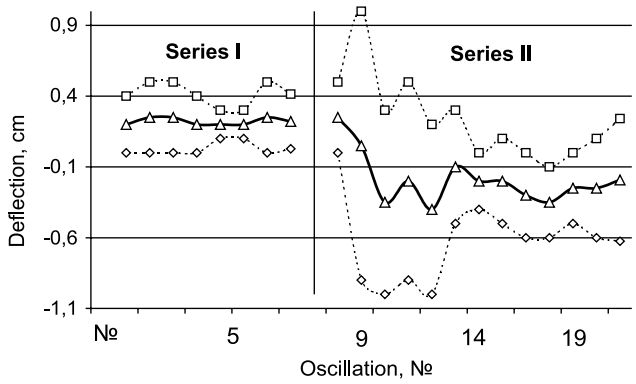

Fig. 2
Calibration Measurement 31 May, 2001

Measurement was carried out with one liquid damper in service and with increased rigidity of suspender (it was made by means of limiting the effectively operating suspender length). The period of free oscillations in these series was 29 sec. In this case there were set continuous oscillations of the pendulum around the average value of balance of 2.2 mm with the average amplitude of values fluctuation of about 0.2 mm.

Air cooling of one of the massive loads by a very light continuous air flow was carried out to study response of the pendulum to a minor constant external force. In this case (Fig. 2 Series II) noticeable change of pendulum oscillations already took place after 3-4 periods. Absolute setting of a new balance took place after 7-8 oscillations.

In the case of another series of calibration measurement (held on 7 June, 2001) both liquid dampers were used and rigidity of suspender was decreased. The period of free oscillations of pendulum was about 40 sec.

Addition of the second damper and decrease of suspender rigidity caused, on the one hand, increase amplitude of pendulum oscillations at influence of the external force and, on the other hand, in that case noticeable change of the equilibrium position of the pendulum took place after 1-2 oscillations.

Periodical checking of the invariability of initial central position of pendulum balance in time was also carried out. Thus, for example, in the series of measurement of 7 June 2001 measurement of equilibrium position was checked not only before the start of the main series of measurement, but also 2 hours after completion of the main works.

Experimental Results and Their Analysis

Within the period from 17 May, 2001 to 7 June, 2001 7 measurement series were carried out at various operation modes of the accelerator and at various pendulum parameters.

A record of check of equilibrium position of the pendulum was carried out before and after switching off the electron bunch (as well as during calibration measurement). At the same time, all electric inducing and mechanical noise remained stable within the whole measurement period. This was achieved by means of additional switching on all the devices which were used during measurement (water and vacuum pumps, magnetron, deflecting magnets, etc.) and their switching off only on completion of the measurements.

In Fig. 3 there are results on measuring the central position of the pendulum when brake target is in position 3 (see Fig. 1). Series I and III on the diagram correspond to check measurement directly before switching on and several minutes after switching off the electron bunch. Series II-A and II-B totally reflect pendulum oscillations at the time when the accelerator is operating (for about 10 minutes) and for some time after the bunch is off. Additionally, a trend line is drawn (averaging by 3 points).

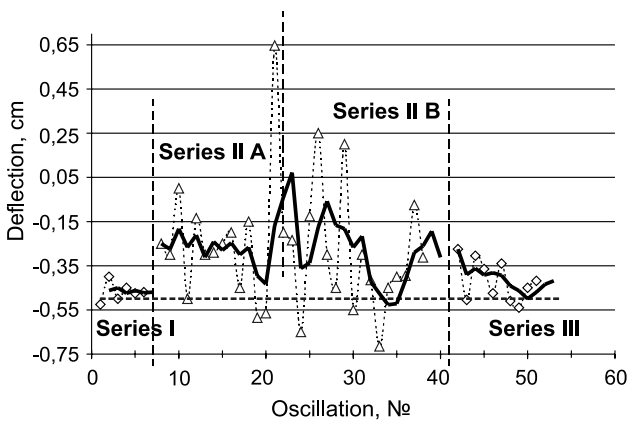

Fig. 3
Measurement of central position of pendulum equilibrium when brake target is in position 3.

Results of a similar experiment are given in Fig.4. The only difference in this experiment is that the brake target is in position 2. Also a trend line is added (averaging by 3 points). Series I and III are check measurements made directly before switching on and after switching off the electron bunch. Series II are pendulum oscillations at the time when accelerator is operating.

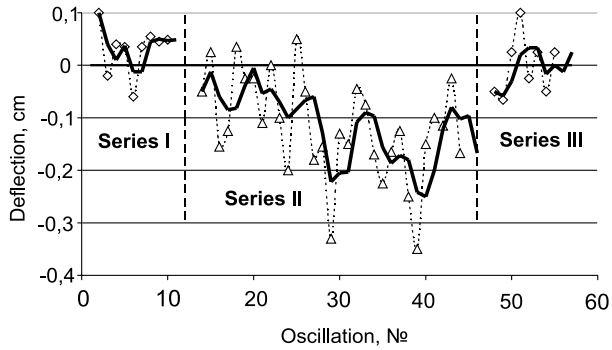

Fig. 4
Brake target in position 2

From qualitative comparison of trend lines (Fig. 3 and Fig. 4) it can be derived **that there is a correlation between switching on the electron bunch and the average deflection of the pendulum from equilibrium position if compared to checked series before and after switching on. At that, direction of deflection changes depending on what pendulum load the brake target is close to.**

Unfortunately, due to circumstances beyond the control of the author it seems to be difficult to improve experiments accuracy or to accumulate much of statistical data by now. Estimate of the value of the force which may cause such a shift of position of pendulum equilibrium was carried out. In the experiments this deflection did not exceed 1-2 mm (in the units of registering scale). Calibration of a rigid suspender (if it applies to a massive load at a pendulum end) gives the upper boundary of this force of not more than 10^{-6} N.

Conclusion

A series of experiments were made on checking the possibility to generate a field at deceleration of charged massive particles in matter.

Electrons accelerator was used as a source of charged particles. A narrow bunch of relativistic electrons (average beam power is 450 Wt, electrons energy is about 30 MeV) was directed at a brake target made of wolfram where deceleration of accelerated electrons took place.

Measurement proved appearance of statistically reliable deflection of a torsion pendulum, one of massive loads of which was located close to a brake target by the time of deceleration of relativistic electrons.

Change of direction of pendulum torsion at shift of a brake target from one end of the pendulum to the other was also registered. The value of the force which causes pendulum deflection has the upper boundary of N.

Of course, these first experimental results on checking the predictions made on the basis of development of the model of extended space are of preliminary nature and need more thorough checking. That will be the basis of future experiments.

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Joe Flynn's Parallel Path Magnetic Technology

Tim Harwood, USA

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There is a widespread opinion common to the mainstream academic community and also to various alternative scientific forums, that some kind of exotic new physics will be required to design and implement over-unity technologies. That is to say electrical motors, electrical generators, or other apparatus, which produce an excess of magnetic force or energy above the value actually inputted.

However, this has recently been experimentally demonstrated not to be the case, as I have validated myself in simple $20 experiments undertaken at home with parts bought from the local hardware store. It is the purpose of this article to educate readers that with care, thought, and a little work, it can be demonstrated that existing textbook physical law, freely allows for the extraction of excess electrical energy from magnetic systems.

The Flynn Research Project

Joe Flynn has been engaged in magnetic flux research for over 25 years now. His work is long standing, comprehensive, and in later years, well funded. It is reported $7m has been spent to date, with over $1m alone developing a revolutionary high performance magnetic motor. His equipment is validated, and apparently already in mass production for select customers. Yet few researchers have heard of Joe Flynn. This surprising situation will hopefully shortly be changed, and Joe Flynn awarded the scientific accolades he deserves, for being the genius master mind behind one of scientific history's most outstanding research projects. Since many lines of research have been formulated and explored by Joe Flynn, the following article presents only a brief summary of some of his best art apparatus, but is nonetheless sufficient to convey the basic ideas.

The first illustration (Fig. 1) is taken from Joe Flynn's US patent 6,246,561, and explains a simple magnetic force multiplication experiment, which forms the basis for the Flynn magnetic art. If the windings on either side of the central magnet, which are normally connected in series, are properly pulsed, the field of the permanent magnet in the center will be diverted to the opposite side of the core flux path provided. Or in alternative language, the side of the core that is pulsed is demagnetized, relative to the field of the permanent magnet used in the apparatus. This is elementary textbook physics anyone can understand.

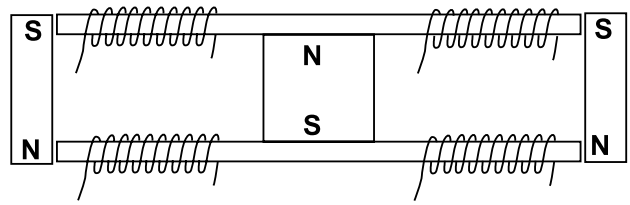

Fig. 1

1.75 times more force is delivered to the legs of the core than is provided by the electrical input to the control coils

So what is surprising about this apparently simple apparatus is that the armature on the side of the flux core will contain 1.75 times more units of magnetic force, that could be manifested by the electrical input to the apparatus alone. Since the ability to arbitrarily move the force from one point to another is the basis for motion or work, however simplistic, we therefore have a basis for a system that can be developed for practical technological purposes. Expressed in alternative language, we also have the capability to engineer a time varying magnetic field, without the need for moving parts, which will allow development of systems that output electrical energy. Both capabilities are highly desirable, and offer substantial opportunity for technical development.

Following on from this basic experiment, there is a second simple and logical improvement in layout illustrated in Fig. 2, which should be obvious, but has been shown not to be the case. In this instance, the pulse is centrally located, and a dual flux field layout employed, which both demagnetizes the core relative to one magnet, and magnetizes it relative to the other. Since the two actions are complementary, the input required to manifest the flux switching effect is halved, therefore doubling 'efficiency.'

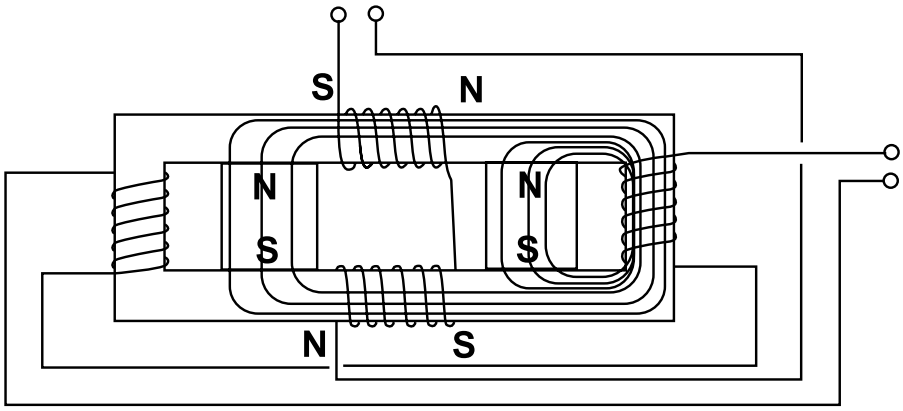

Fig. 2

3.47 times more force is delivered to the legs of the core than is provided by the electrical input to the control coils

It should be noted that while the efficiency is doubled, the absolute output may not be significantly improved. This is because the major weakness of this effect and technology is flux saturation of the core, with values depending upon the specific properties of the B-H curve of the core material employed, limiting the absolute output of both layouts the same.

The previous statements are not required to be taken on trust, and simple experiments have been proposed by Joe Flynn, such that anyone can validate this effect for themselves. Figure 3 is a simple experiment taken from the Flynn website (http://www.flynnresearch.net), that can be used to validate the principals put forth in this article.

Simple Magnetic Force Multiplication Experiments

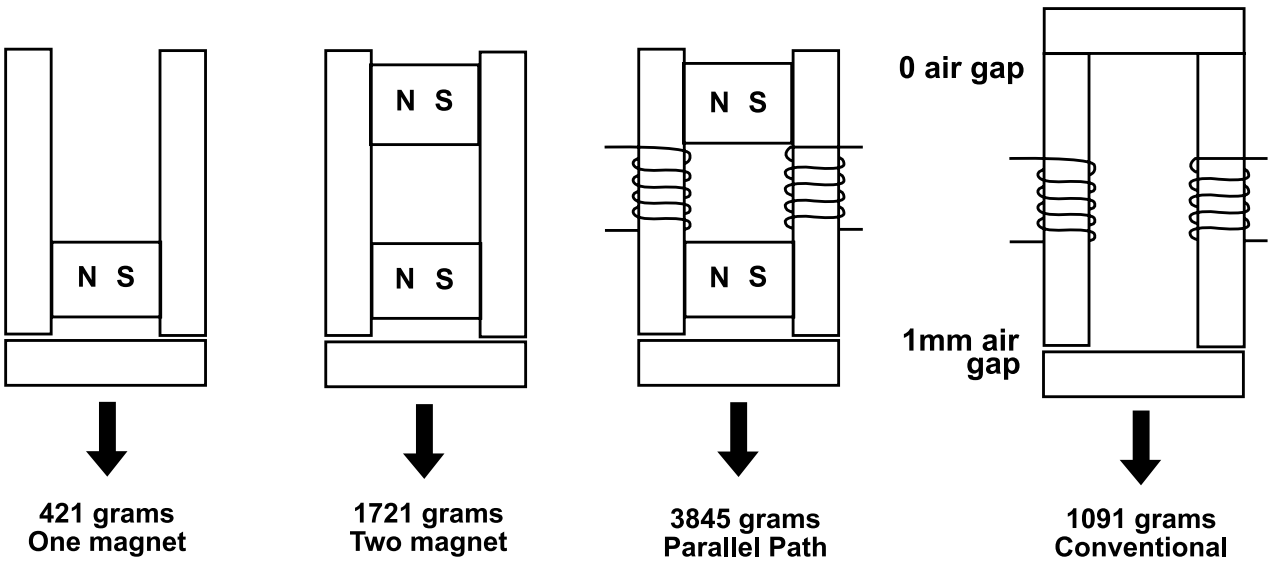

Fig. 3

Parallel Path can deliver 3.47 times more force to the legs of cores than any competing conventional technology

An even simpler non electrical flux experiment was proposed by GM in the Parallel Path Egroup. My apparatus is illustrated below in Figure 4. It is no more than magnets and steel staple strips, bought from a local hardware store for a total of under $10. The Parallel Path effect can be replicated with identical apparatus, at only a slight increase in cost and complexity, with the addition of a simple 12V polarity reversible power supply, such as those commonly sold to power computer speakers, among other applications.

Simple Magnetic Force Experiments

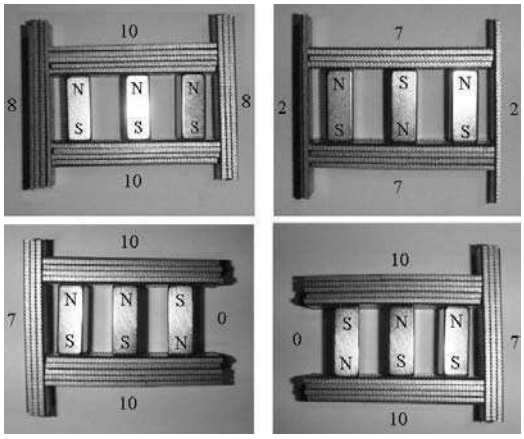

Fig. 4

Relatively small changes in layout produce large changes in force

Conservation of Energy / Field Potential

One of the aspects of the Flynn technology people find most difficult to understand, is how you can have a device that delivers 3.47 times more magnetic force than is electrically inputted, yet not violate accepted principals of text book physics, as stated in the introduction. The key point here is conservation of energy. Magnetic fields do not gain energy – they are conservative. You can only ever obtain less energy from a magnetic field minus losses, than is in fact present. I feel this apparent puzzle can not be better explained, than by reference to Joe Flynn's own words:

"Since the Parallel Path System produced 3.47 times more force than the conventional system, with the same electrical input, it appears to violate conservation, this is only true when observed from a traditional view point. The system contains three flux producing sources (2 magnets and an electromagnet) which together are capable of producing a far greater force than is actually produced. All of the flux sources together can produce a force of 13.11 units, therefore in the physical sense a loss of 1 - (9.01 / 13.11) = 31% is realized."

So the system is 350 % efficient, in terms of delivered magnetic force compared to net electrical input, yet still conforms to the accepted physical principals of energy conversation, by being only 69 % efficient, in terms of the fields present in the system. However surprising this result may appear, the analysis presented is in outline correct, with the difference between fields present in the system, and net electrical input, being the important concept presented.

Losses in the System and Optimisation

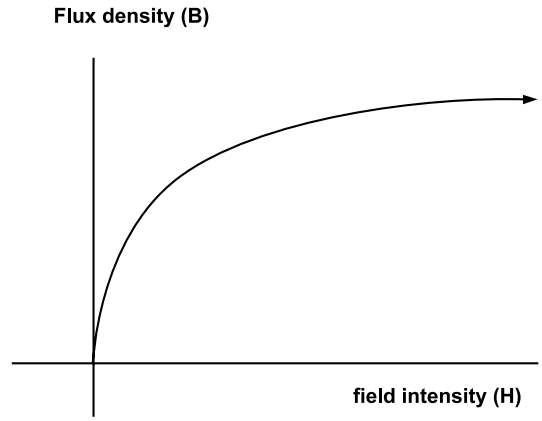

Fig. 5

In order to properly optimise flux cores, an appreciation of the physics that underlies the transfer of flux within a core is required. The normal magnetization curve, or B-H curve, is a mathematical relationship between applied field intensity H, and resultant flux density manifested in the core B. It varies according to core material, and the curve will shift, if there is a starting magnetism within the core, such as that provided by the field of a permanent magnet. If the start magnetism is excessive, the core is saturated, and will not properly respond to the applied force H. A simple B-H curves is illustrated in Fig. 5.

Hysteresis is a delay between applied magnetic force H, and resultant flux density B, that again varies according to material type. It also manifests as a delay between the termination of force H, and the manifestation of flux density B. So, the system will not turn on instantly, and will not turn off instantly, in simple terms. This is because the magnetic memory of the core, means a flux vector remains within it, even when the application of magnetic force H has been terminated. If we apply a reversed force H to the core, the basic B-H curve is now expanded as in Fig. 6, with the memory effect also illustrated.

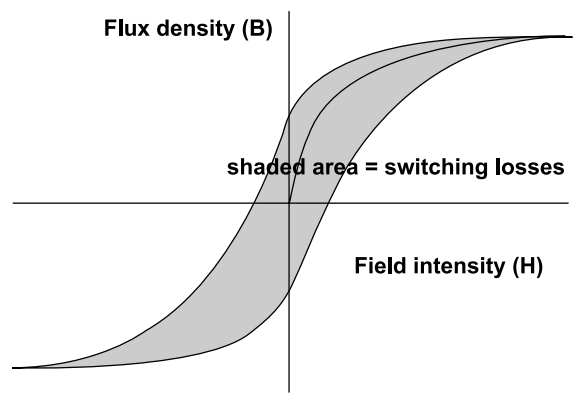

Fig. 6

Thus as can be seen, to return to the initial switched state, the remnance magnetism must now be overcome, hence input once in operation, will be greater than that required for the very first pulse. The area within the hysteresis curve gives a rough estimate for the amount of wasted energy, and along with other conventional sources of losses resultant in flux transfer within a core, is what reduces the efficiency of flux cores from maximum values of 2, or 4, down to values such as 1.75 or 3.47, typically.

Motor Apparatus

Simple Parallel Path Technology Demonstrator Motor

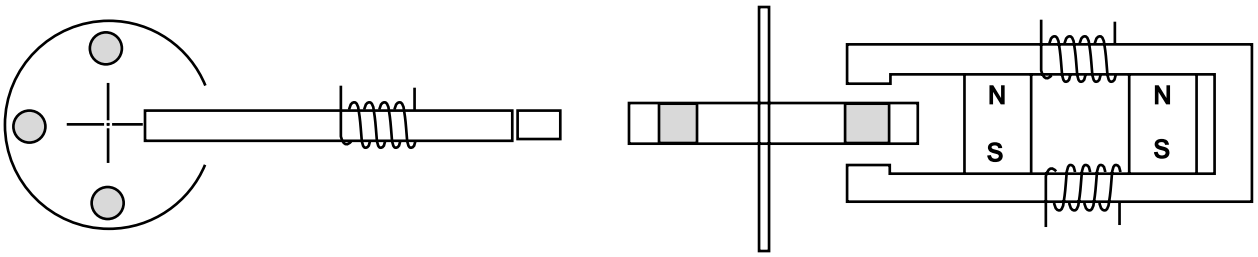

Fig. 7

Designed to demonstrate core principals, not provide over-unity

Although numerous practical applications abound for this effect, electric motor design remains the most outstanding opportunity. To this extent, again a few simple images, should be sufficient to explain how the basic flux switching apparatus, can be turned into a highly efficient electrical motor.

The first motor shown in Fig. 7 is one I have proposed to validate the flux switching effect at a most basic level. It illustrates the point made in the Flynn patent, that the armature of the core can be removed, and replaced with a motor flux path. This first motor is not claimed to be highly efficient, but it helps one to understand how the transition from simple flux core to motor takes place.

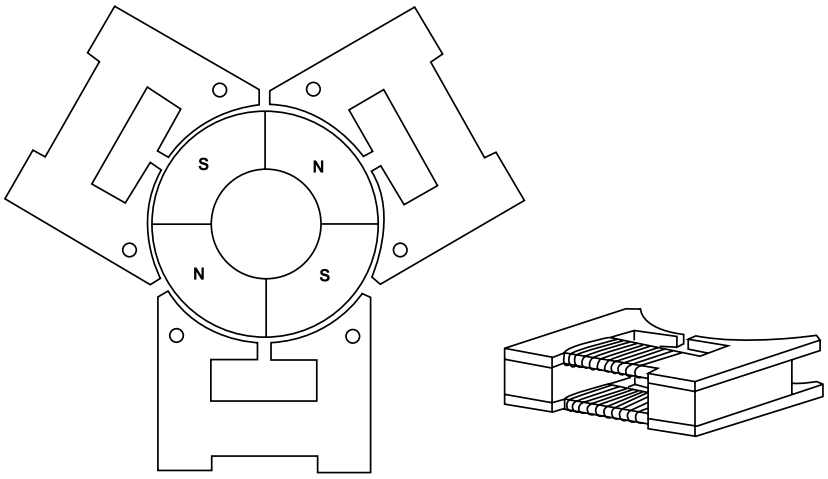

Fig. 8
Magnetic force is alternately switched from one leg to the other, imparting motion to the rotor sections

The next motor shown in Fig. 8 is again taken directly from the Flynn patent, and illustrates the next intermediate step to motor design. The fields of the permanent magnets are alternatively switched from one side of the surrounding flux cores to the other, alternately interacting with N and S poles on the rotor, imparting motion to the central rotor shaft.

With proper financial support, and the facilities to have metglas cores custom moulded, Joe Flynn was able to develop his final best art, shown in Fig. 9. No detailed performance numbers have been released for this motor, whose precise performance characteristics remain proprietary to Joe Flynn at this time. But the optimisation is so expert, it is stated to posses certain exotic properties, such as cool ambient operation, even during prolonged periods of continuous load. This 'cold running' is said to be of great interest to the American military, as it offers excellent stealth performance characteristics.

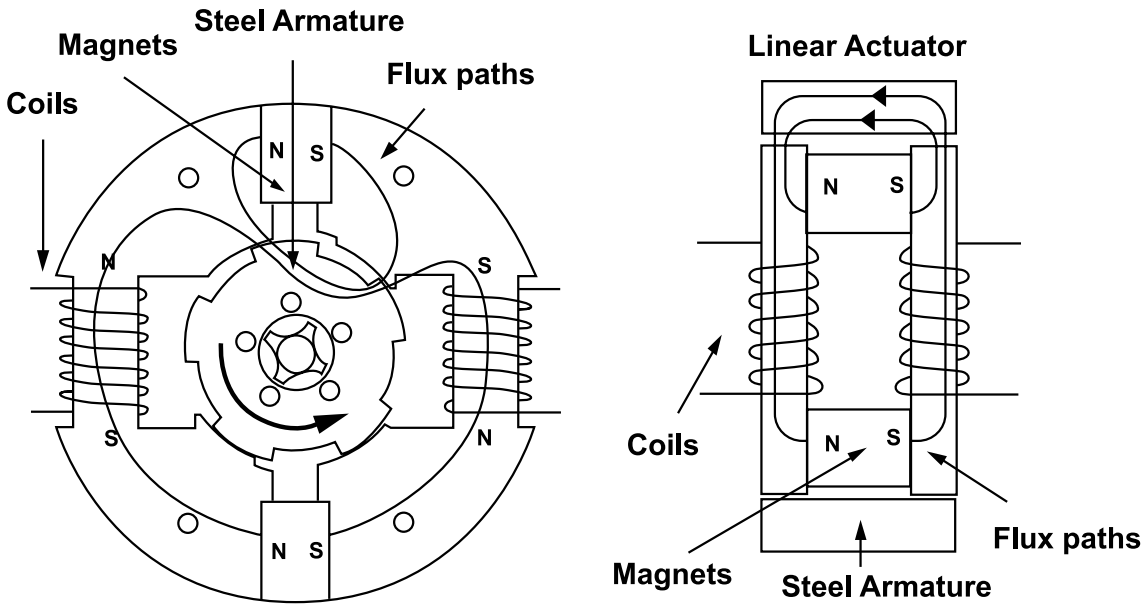

Fig. 9
Optimal Flux Core Motor Construction

Electrical Apparatus

Many readers will no doubt have noticed the similarity of the first illustration presented in this document, to the so called 'Tom Bearden MEG.' This is fair comment, and Joe Flynn has always highlighted this issue. However, it has been commonly stated Joe Flynn has simply developed mechanical apparatus, and the MEG with its electrical functionality, is distinct art, more advanced than the mechanical Flynn apparatus. However, this is shown not to be the case by a careful examination of the Flynn patent, in which the following is stated in the 'Power Conversion' section:

'The construction (shown in Fig.10 A) utilizes four control coils and a single permanent magnet and the construction (shown in 10 B) uses two control coils and two permanent magnets. The flux that would normally be supplied by a primary winding is supplied by the static flux of the permanent magnet or magnets and the control coils convert this static flux into a time varying flux in a novel way. Both arrangements use two secondary coils, the secondary coils are placed in the region of the continuous flux path that would be occupied by an armature or rotor in the linear or rotary arrangements. The regions of the flux paths that perform work are the same in all cases.'

'By alternating the polarity of the control coils during one cycle, one working region experiences an increasing flux and the opposite region experiences a decreasing flux and during the next cycle the opposite occurs. This results in the induction of a voltage in the secondary coils that is decided by the magnitude of the change in flux in the working region and the time in which this change occurs. The novelty of this discovery is that the primary flux inducing the voltage in the secondary coils is supplied by the permanent magnet or magnets and is far greater than the flux supplied by the control coils.'

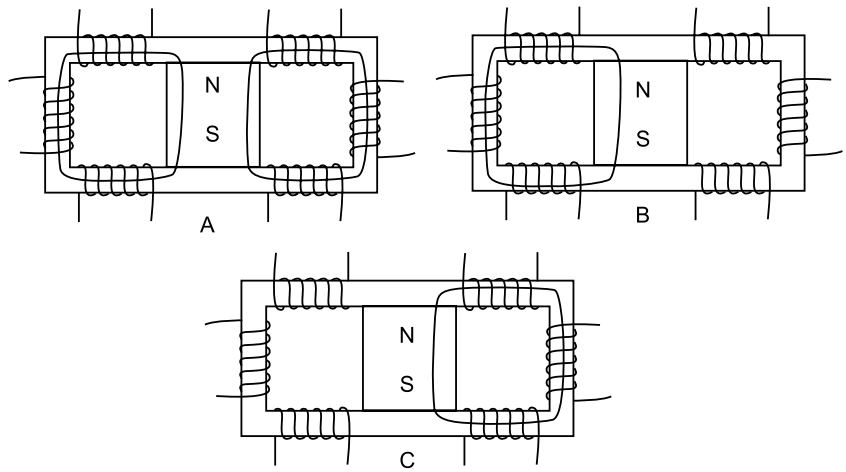

Fig. 10

Fig.10 taken directly from the Flynn patent makes the point even clearer. As can be seen, the device illustrated is in all functional respects absolutely identical to the so called 'Tom Bearden MEG.' This identical prior art, therefore calls into question the intellectual property rights of Magnetic Energy LTD, as the same invention can not be patented more than once. Joe Flynn has also stated that his intellectual property rights will be robustly defended, by legal action if necessary, and he regards himself and his company as being in possession of exclusive rights to the so called 'MEG' unit.

the input and output circuits must be closed in series. The disclosure of this technique amounts to putting the basic MEG methodology fully into the public domain.

As regards replication of electrical output orientated flux core devices, certain important details need to be stated. For example grade 8 ceramic magnets should be used, so as to avoid flux saturation of the core. A basic error, many early experimenters wasted time on. The requirement for strong magnets to obtain over-unity results, is as much of a myth, as the idea new physics is required.

But perhaps the greatest trade secret of the electrical devices, one which several lengthy non disclosure agreements are required to be signed before it can be disclosed, is that the input and output circuits must be closed in series. The disclosure of this technique amounts to putting the basic MEG methodology fully into the public domain.

The reason for this circuitry requirement is obvious enough, with only a little analysis. If the output circuit is closed when the input circuit is activated, then the input energy simply leaks into the output circuit, as in an ordinary transformer. So no flux switching effect is manifested, and the field of the permanent magnet is static in time. Thus you have an ordinary transformer, with reduced efficiency, because of the core flux saturation effect provided by the permanent magnet.

This is one of the most important point to make about the Flynn apparatus. If you approach it as if it is a normal piece of scientific equipment, then proper optimisation is not greatly problematic. For example more turns on the output coils, simply means more voltage and less current, exactly as standard textbook equations predict. Generally, problems only occur, if you imagine the effect is based upon exotic scalar type or vacuum energy physics, when in fact it is ordinary flux manipulation within a core.

Present Status of the Flynn Project

Initially Joe Flynn was remarkably open about his work and research. However, since performing a working demonstration of various advanced hardware samples for the American Department of Defence, little has been heard.

I want to clearly emphasize I do not speak for Flynn research, nor am I in any way connected with Flynn research, and by consequence, have no inside information whatsoever as to the present status of the project. But we all sincerely hope, that the project has not been swallowed whole by the American deep black military industrial research complex.

However, even if this is the case, it does not mean the technology is lost. Extensive and generous details have been provided by Joe Flynn of his research, both in his patent deposition, website, and other comments, such as to enable persons of scientific training and skill, to replicate the effects stated.

While replication of the electrical effect remains extremely demanding, the mechanical apparatus is very easy both to understand and replicate. There is no reason why scientists and home tinkers together, can not build Flynn type flux core motors, and explore over-unity flux manipulation for themselves. The future has arrived, and it is simpler and cheaper than anyone imagined to be possible.

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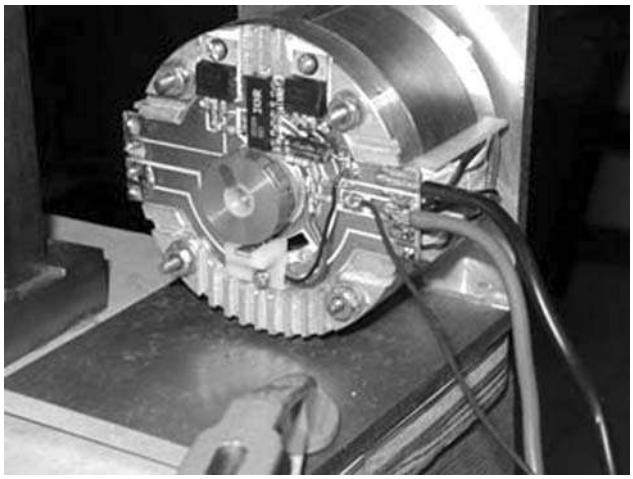

Photo 1

3.3" 1.2" stack height 1/2 hp weight 59 oz

Photo 2

Dynamometers, Power Analyzer etc.

Editor: Below we publish information and photos, represented on Flynn Research Company website (http://www.flynnresearch.net), and a description of the patent on methods for controlling the path of magnetic flux.

Flynn Research is dedicated to research focused on the novel application of permanent magnet and electromagnetic technology. Magnetism is a field that has potential for tremendous growth from both a science and application perspective. The researchers of Flynn Research Company believe that magnetism is one of the least understood and most misinterpreted of the natural forces, with the exception of gravity.

Everything known about magnetism is based on "effect and relationships" without a clear understanding or provable definition of what is a line of magnetic flux.

Even though much work has occurred in the advancement of magnetic materials, little advancement has occurred in the basic understanding of magnetism. The field of magnetism is based on both theory and 'myth' and is generally described as a 'phenomenon'.

We still do not know what a line of flux is and how it travels through space. We know flux "appears" to originate within a permanent magnetic material, forms a loop from one end to the opposite end of the magnetic material, appears to occur without a time constant, produces a force (attractive and repulsive) between other permanent magnets and "magnetically permeable materials and has a relationship to current flow. Everything known about magnetism is based on "effect and relationships" without a clear understanding or provable definition of what is a line of magnetic flux.

The research is based on the "magnetic force of attraction effect" that is related to magnetic flux by the number of lines of flux occupying a given area or flux density squared. The simple fact that if the number of lines of flux occupying a given area "doubles" the force of attraction becomes four

Photo 3

8" dia x 8" height motor presentation

Photo 5

Technology Discussion

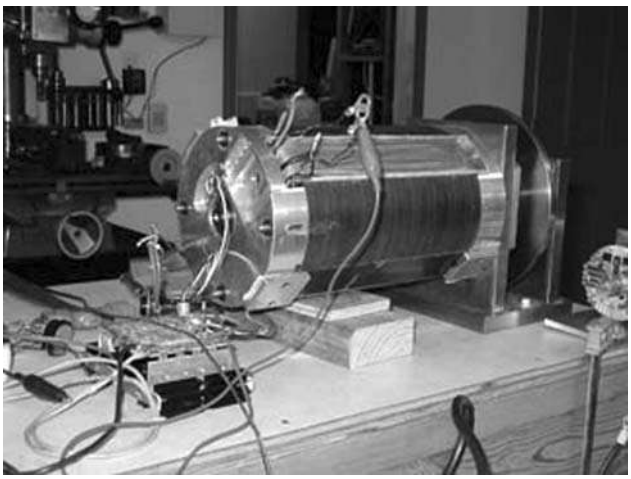

Photo 4

8" X 8" motor testing

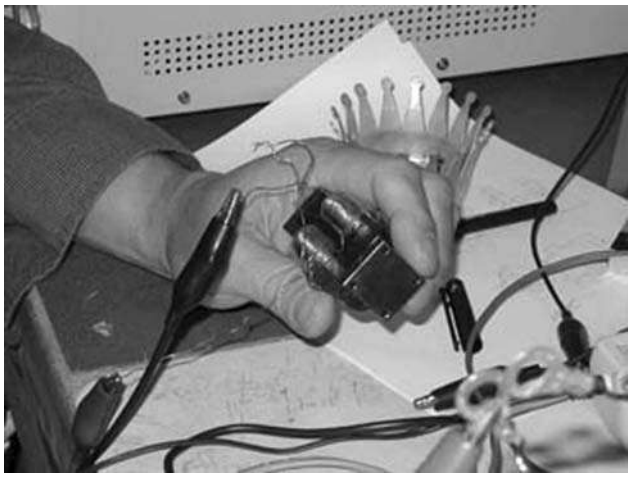

Photo 6

Parallel Path Test Apparatus

times greater. The basic model shows that with specific structures electromagnetism acting with permanent magnet materials can divide and multiply force in a manner that cannot be explained with conventional physics.

Rotary devices, linear devices, reciprocating devices and power conversion devices are now a patented product of this research. The goal of the Company is to commercialize their devices for use in an energy dependent world. Flynn Research is a research & development company and in cooperation with Magnetic Revolutions LLC licenses their technologies for use in the electric motor and power conversion industries.

The researchers do not construct their own test equipment nor write capture and data evaluation programs but use industry / scientific accepted products. Close to $1.5 million has been expended developing, protecting and evaluating the technology. Many fine minds have been involved in the development and evaluation of the technology. Many presentations have been given both to motor companies and academic groups. The prototypes have all been professionally built, which include a 1/2 hp 3.3" dia 1.2" stack height, the assembled motor weighs 59 oz and a motor 8" dia with a stack height of 8" currently undergoing testing.

United States Patent No. 6,246,561
June 12, 2001

Methods for controlling the path of magnetic flux from a permanent magnet and devices incorporating the same

Inventors: **Flynn; Charles J.** (Greenwood, MO)
Assignee: **Magnetic Revolutions Limited, L.L.C** (St. Louis, MO)
Appl. No.: **127056**
Filed: **July 31, 1998**

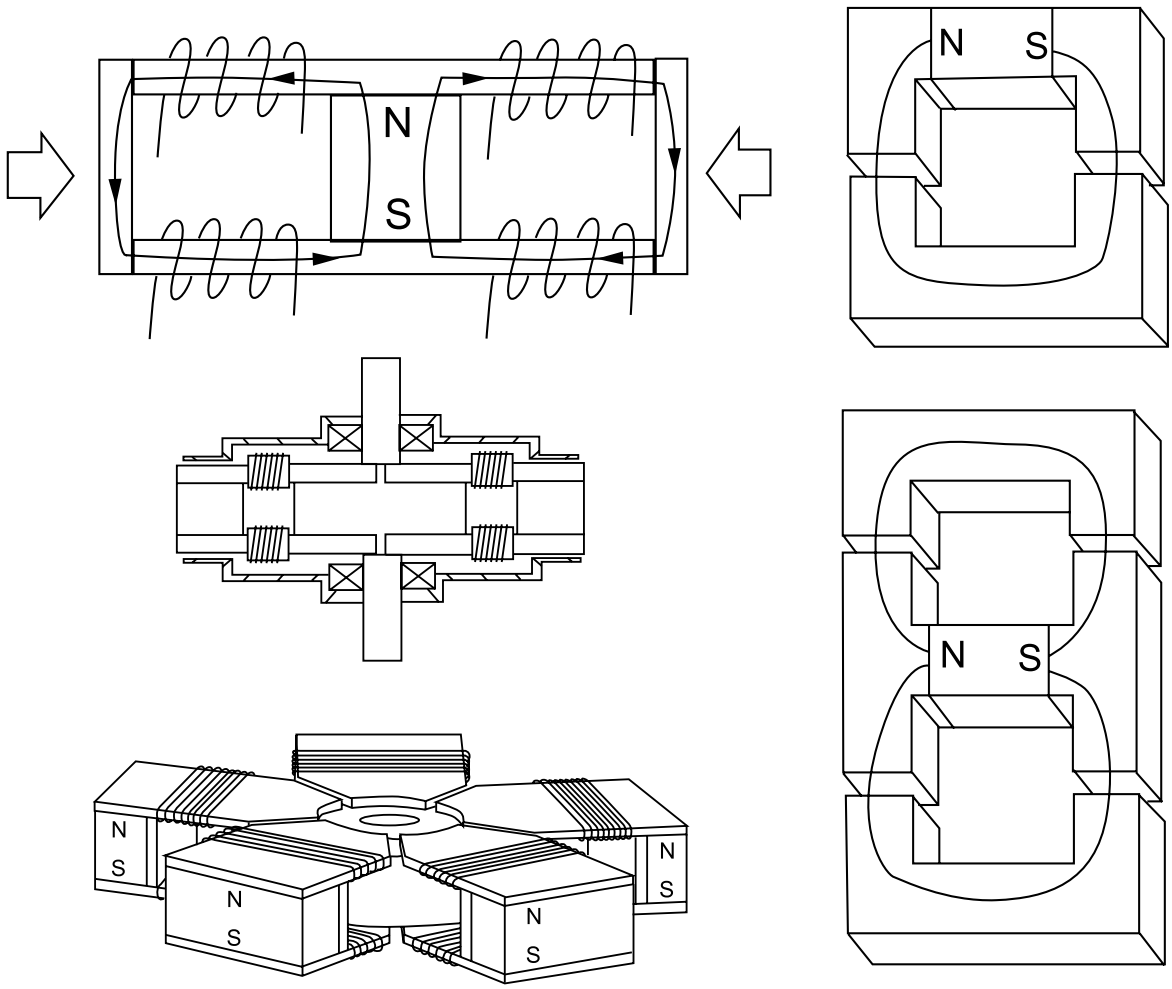

A permanent magnet device includes a permanent magnet having north and south pole faces with a first pole piece positioned adjacent one pole face thereof and a second pole piece positioned adjacent the other pole face thereof so as to create at least two potential magnetic flux paths. A first control coil is positioned along one flux path and a second control coil is positioned along the other flux path, each coil being connected to a control circuit for controlling the energization thereof. The control coils may be energized in a variety of ways to achieved desirable motive and static devices, including linear reciprocating devices, linear motion devices, rotary motion devices and power conversion.

Editorial: The principle of designing of the device (two counter parts of the flux are used) resembles Φ-machine or Gramm's generator. Read in this issue more details on these devices.

Flux-machine And Its Analogues

Review prepared by correspondent Alla Pashova, Russia

Flux-machine (or Φ-machine, since configuration of its field resembles the Russian letter "Φ") was designed by Alexander V. Frolov during the first half of 1990s. Φ-machine description was published more than once on the pages of scientific periodicals (1994, Institute of New Energy, Newsletter, June 1994, p.9.; 2002, New Energy Technologies, 2002, p.3), and it is well known to many researchers concerning themselves with such kinds of engineering.

Let us consider the arrangement of Φ-machine; see Fig. 1 (first published in 1994). A report was presented at the conference «New ideas in natural science», 1996 in Saint Petersburg (see photo in Fig. 1). The primary coil is mounted in the center of generator; two secondary ones are diametrically wound on a ring core. An air gap between ring and central magnetic circuits are of particular importance. **Two magnetic fluxes from two coils are balanced, and, thereby, there is no reaction in the primary circuit.**

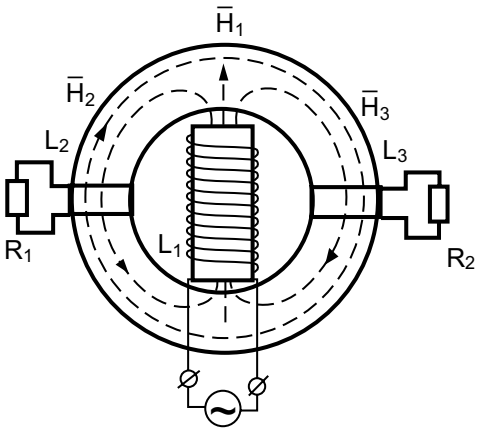

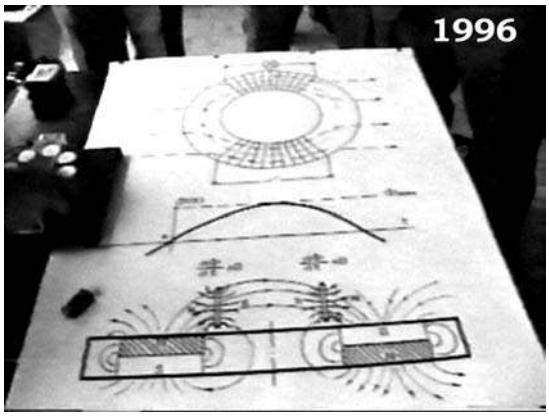

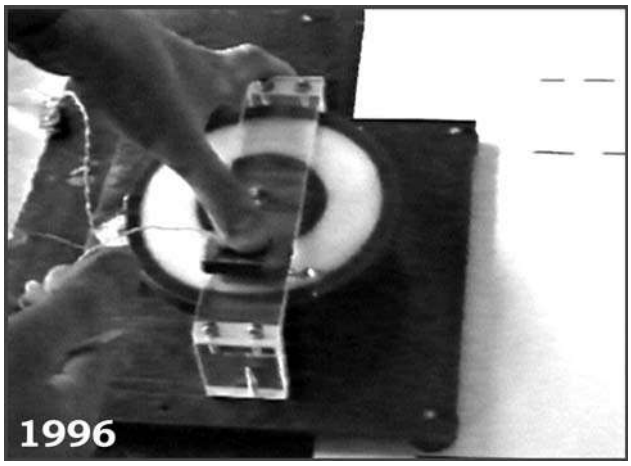

Fig.1
See also Fig. 7, p.29 – the analogy is evident

The device bears some similarity to the Gramm's generator (Zenob Theophyl Gramm, 1826-1901, Belgium-France, took out a patent for an electric ring-rotor generator in 1869). In Gramm's generator (Fig. 2) the ring rotor with a toroidal winding rotates. The toroidal winding touches two diametrically located conducting brushes. It turns out that in the ring of the rotor all winds of one rotor half create a field which is directed towards a field created by the other rotor half.

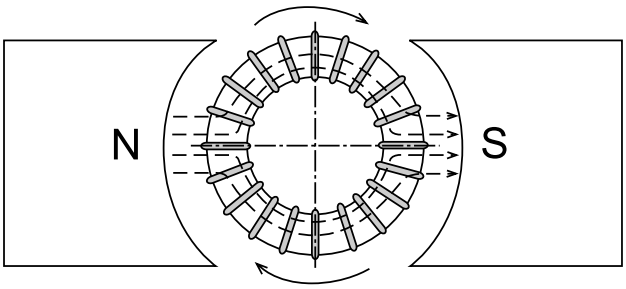

Fig. 2

An example of analogous device is represented in Fig. 3 (information is from the website: http://www.skif.biz/energy/arhiv1-6.shtml), and also in Fig. 4 (we have written about this invention in New Energy Technologies, Issue #5 (8), 2002, article by V.I. Boryak, Email: spin@i.com.ua).

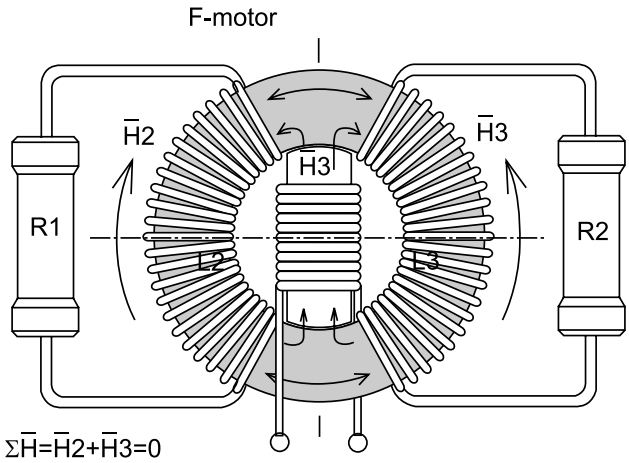

Fig. 3

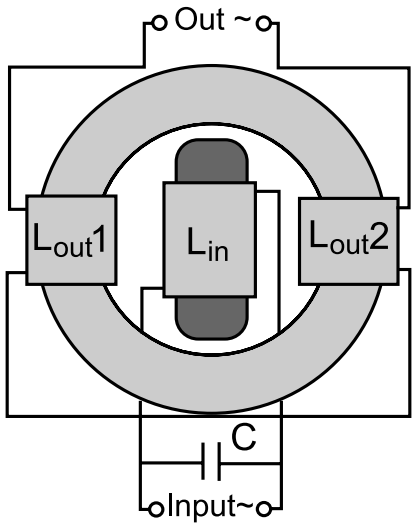

Fig. 4

In August 1999, according to Stephen Hartman (Hartman Multimedia Service, Email: hart@harti.com, info@ccard.net), a German research team designed a toroidal generator. As stated by the researchers, it obtained more than 1.200 W by load while efficiency exceeded 100%!

This subject has become very popular among different researchers. Fig. 5 illustrates a design with a magnet rotating in the center (designer - Olaf Berens, Email: olaf.berens@prognost.com).

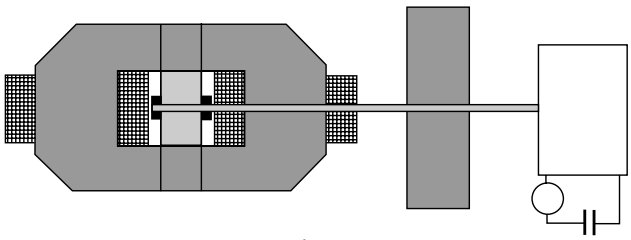

Fig. 5

One more example from the USA: in February, 2003 Donald Hofmann (USA) filed an application for patenting "Generators and transformers with toroidally wound stator winding». Below we publish the description of the patent.

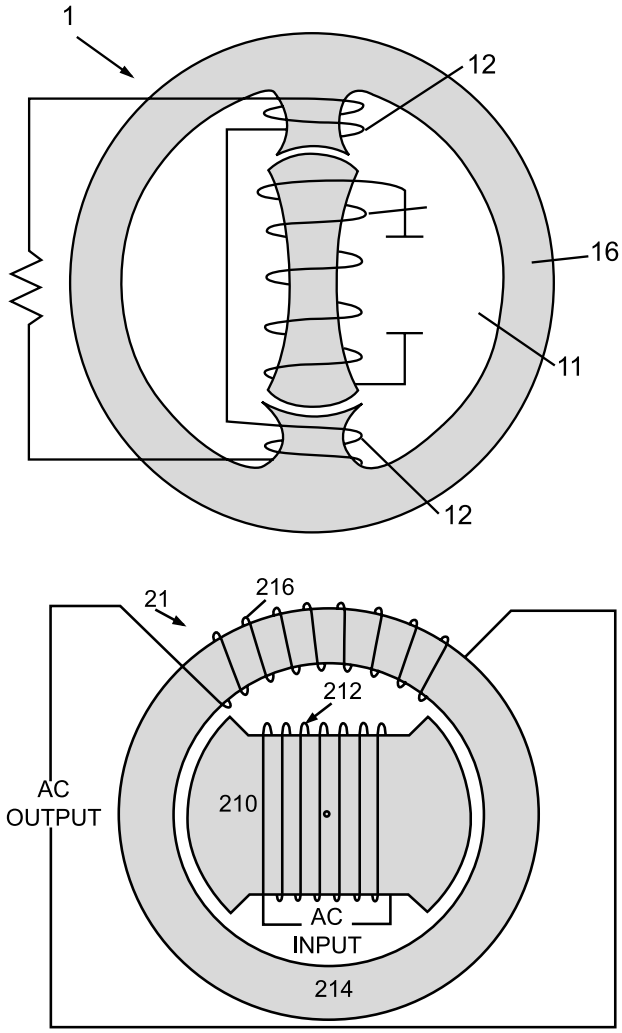

Fig. 6

Inventors: **Steven L. Sullivan, USA; David L. Goulet, USA; Donald Hofmann ,USA.**

Electrical generators are provided with toroidally wound stator windings electrically connected in series; a high permeability stator core, preferably an amorphous magnetic alloy material, glassy metal or HYPERCO™ 50 laminations; and a rotor. The toroidally wound stator coils and the stator core trap essentially all of the flux fields generated by the stator coils within the stator core. Since there is essentially no magnetic field leaving the stator, there is essentially no flux field interaction with the field generated by the rotor. The reduction of flux field interaction also reduces counter torque.

According to another embodiment of the invention, open positions of a rotor may be filled with magnetic material, preferably iron. Filling open portions of the rotor may assist in reducing undesirable flux leakage from the rotor. By trapping substantially all of the flux within the rotor, interaction between rotor and stator flux is reduced. In this manner, counter torque is reduced thereby increasing the overall efficiency of the device.

A prototype of this embodiment was constructed using a standard 10 kWtt gas-powered generator. The stator was removed from the generator and its housing. The stator windings were removed from the stator and rewound by hand using a No. 10 size copper wire with 180 winds wrapped in a toroidal fashion around approximately 180 degrees of the stator.

The stator was then reinstalled in the modified housing and re-attached to the gas-powered generator. A standard 12 volt car battery was attached to the input of the rotor. A 12.92 volt input with 0.8 Amps was measured as the input to the rotor. The output was measured as 6.5 volts with a 40 Amp output. A series of input and output measurements were taken for various inputs.

Editor: Thus input power is 10 Wt, and output power is 260 Wt.

So, the old well-known ideas have found new ways of embodiment, though their essence remains unchanged. Let us note that Faraday Labs Ltd has been working on creating a prototype of □-machine with a toroid of 200 mm in diameter.

Please, read more about this in the next issue!

Editorial: We publish the specification of several interesting patents, which were taken out by Russian inventors for recent years.

Russian patents on alternative energetics

- №93001754, 1996.06.27, Converter of gravitational forces into energy, V.V. Mironov and others
- №92008720, 1995.02.10, Slavic method to produce energy by conversion of gravitational forces, V.V. Mironov
- №93006696, 1995.04.30, Supporting converter of gravitational forces into energy, V.V. Mironov
- №2001121071, 2003.04.10, Method to create energy in liquid, heat-generator and heat-and-power device, A.Yu. Baurov and others
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- №2001120796, 2003.04.10, Electric power device, D.M. Beliy
- №98116077, 2000.05.10, Heat engine (monotherm, "perpetual mobile of second-type"), V.I. Likhachov and others
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- №2001115954, 2003.03.20, Potential amplifier by Prokopenko, V.F. Prokopenko
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- №93006851, 1995.04.30, Principle, method and device for circulation of mass by force of gravitation and inertia, G.S. Kirichenko
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- №2143170, 1999.12.20, Method to convert energy of mechanical loading into energy of repeated transference, V.I. Rahovsky and others
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- №99121374, 2001.11.10, Perpetual mobile, E.M. Volodin
- №94026259, 1996.05.20, Device to convert magnetic field energy into kinetic energy, P. Imrish

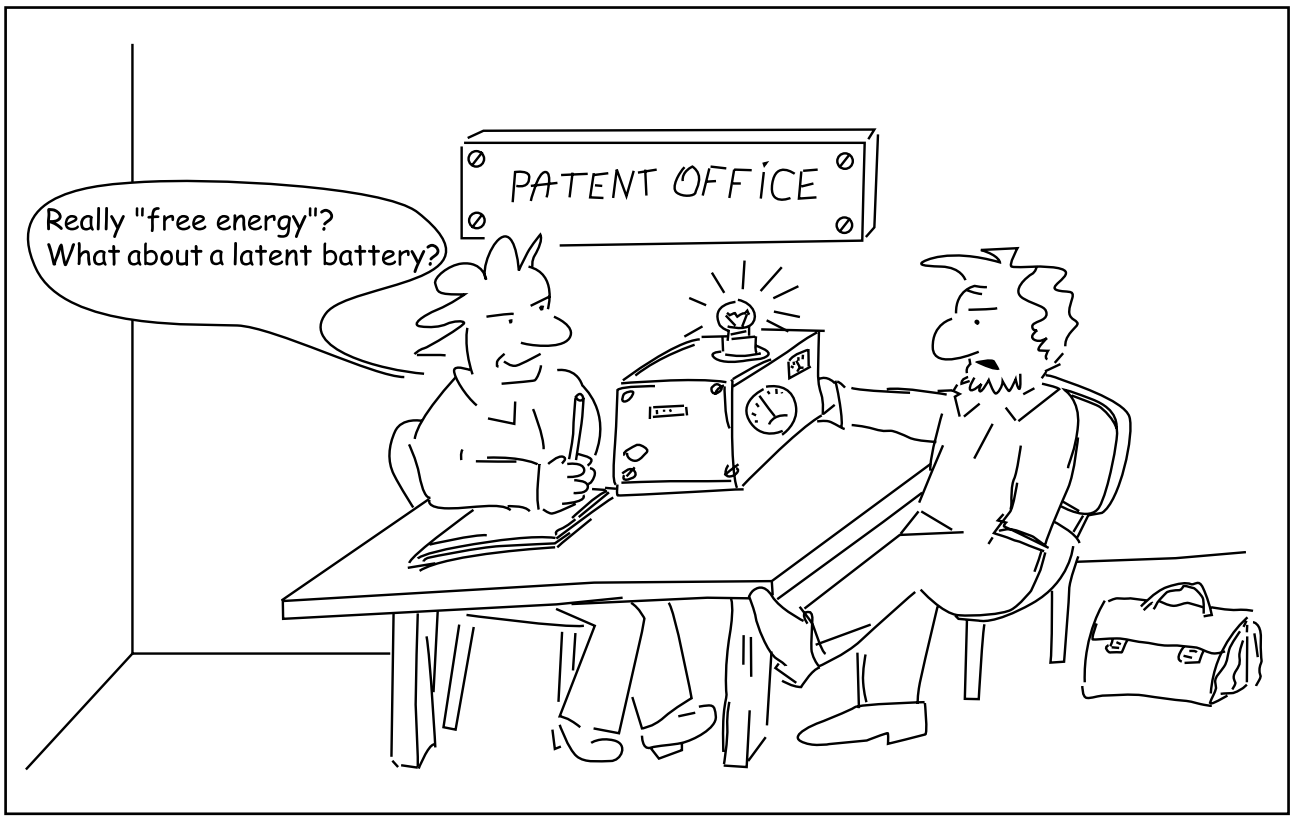

Device for conversion of magnetic field energy into kinetic energy

No. 94026259, 1996.05.20

Author: Pavel Imrish

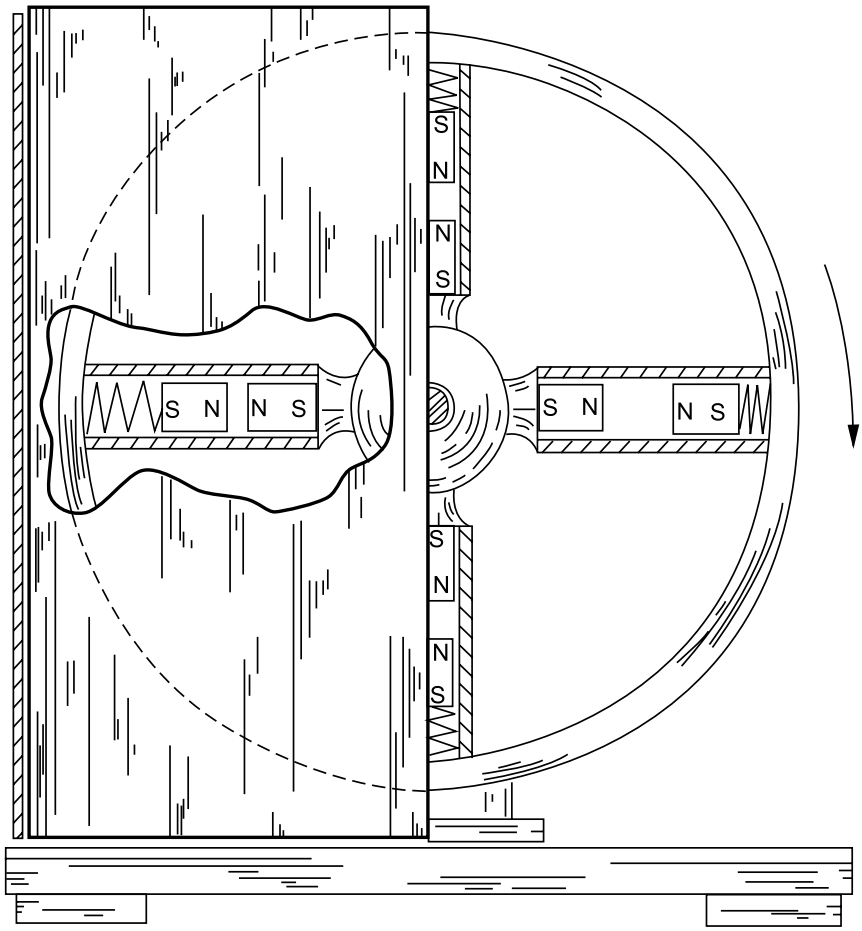

Fig. 1

The invention refers to a device for conversion of magnetic field energy into kinetic energy. The device has a rotating wheel with at least two radially opposing non-magnet holders used as guide ways for at least two permanent magnets, respectively. The permanent magnets are mounted in the holders so that there is a possibility to remove them. From the both sides of the wheel plates made of magnetic material are mounted axially; the plates surround the wheel partially. Depending on direction of the both poles, namely on location of the similar and opposite poles towards each other, compression element is situated on the holders, or between the wheel and the outer end of the permanent magnet located at the furthest radial distance from the axle of the wheel, or between two permanent magnets. (The device operation principle is obvious from Fig. 1).

Editor: We have found an example of a similar device whose description is presented in the book by R. Ford The Perpetual Motion mystery [1].

In this case, there is an analogous process, during which half of the cycle is screened and the rotor is supposed to rotate permanently (see Fig. 2).

1. RA. Ford, The Perpetual Motion mystery. Lost Technology Series, p.23.

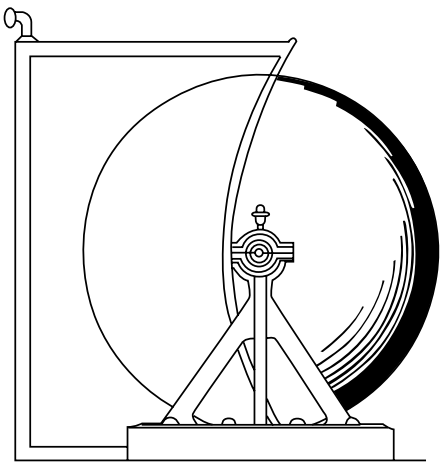

Fig. 2

Gravity spaceships

Review on Grigory R. Uspenskiy's works, Russia

http://space21.boom.ru/gravity.htm

The level of development of modern astronautics is primarily determined by the energy capabilities of space carriers. So, nowadays, the single-mission carrier rockets equipped with chemical engines allow space exploration within the solar system. These carriers have delimited the near-earth space in the form of a geostationary orbit, where the practical-purpose space complexes operate.

Newer and higher levels of quality will be reached by cosmonautics upon its mastering gravity power engineering. Flights towards the nearest stars will become possible and by the end of the next century this will be followed by travels throughout Galaxy.

Gravity engines are structurally simple (**two bodies of different density are rigidly connected**). To form some practicably significant value of thrust it is required to use absolutely new technology regarding creation and retaining of matter of high density which can be compared to that of atomic nuclei. For instance, at an engine mass of about 2 t, it is possible to attain 10 N thrust using bunches of aluminum and lead nuclei. The nuclei are approached to each other at a distance comparable with sizes of these bunches.

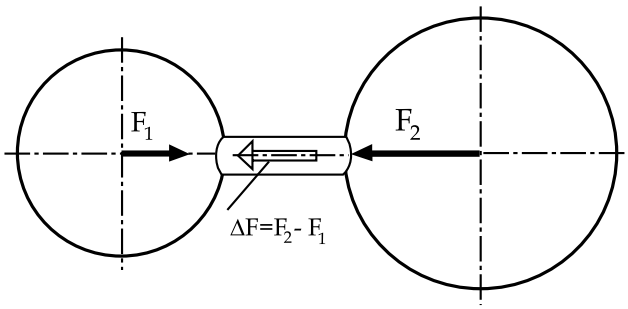

Fig. 1

Use of matter which is denser than nuclei bunch, increase of mass of the gravitating bodies, and reduction of the distance between the bodies causes increase of thrust. So, for a level of density of gravity holes (i.e. for extremely dense state of matter in which it is not attracted by other bodies) limit value of acceleration of the gravity engine reaches the order of 10^{100} ms^{-2}.

In engineering, we usually use units of distance as meters, centimeters, millimeters, and microns. Let us consider one of them – millimeters. With such a size of the gravitating bodies and distance between them, it is possible to obtain substantial thrust forces of the gravity engine and, accordingly, accelerations of its motion.

So, using an engine of 20 ton mass we will get the thrust of $2x10^4$ N, with mass of 200 ton we will get the thrust of $2x10^6$ N, and so on. Thus, by increasing the engine mass by one order of magnitude, we obtain increase of thrust by two orders, while sizes of the bodies remain unchanged. But acceleration, in this occasion, remains constant and equal to approximately 1 m/s^2.

Decrease in size of gravitating bodies of the engine leads to the corresponding increase of thrust by an order. Decrease of size is realized by increase of density of these bodies by 3 times up to 0.3 mm at the same masses. The acceleration they produce is increased by an order as well, i.e. up to 10 m/s^2. Decrease of sizes of the gravitating bodies and the distance between them down to 0.1 mm results in further increase of engine thrust by one more order and also increase of acceleration up to 100 m/s^2. If size of the bodies is 1 micron then acceleration increases up to 10^6 m/s^2.

It is apparent that even with up-to-date technological possibilities of miniaturization the gravity engine with masses of dozens and hundreds of tons is capable to create great thrust forces and form accelerations considerable enough to fly across the Galaxy. Therefore, the problem of creating a gravity engine is, mainly, the problem of producing and retaining the high-density matter. It will be possible after studying the mechanism of interaction between matter & gravitational substance followed by developing techniques for synthesizing of high-density, large-mass, and small-size substance from this matter.

It is possible to control the value of thrust of the gravity engine changing the distance between gravitating bodies. Thrust direction can be changed by turning the rigid connection of the gravitating bodies. The engine can

be activated by bringing the gravitating masses together, and switching-off by moving them apart.

In a 24-hour period, such a ship can reach a speed of 10^6 m/s and cover a distance of about 10^{10} m. In a month, with a top speed of 3x 10^7 m/s the ship will cover the distance of 10^{13} m; in a year, with a speed of 4x 10^8 m/s the ship will cover a distance of 10^{15} m; in 10 years - 4x 10^9 m/s and 10^{17} m, respectively. Apparently, the ship with sufficient over-load can be used for flights within the solar system and for manned flights towards the nearest stars.

When transporting unbreakable and non-urgent cargoes, the acceleration can be increased up to a few dozens of unities. The flight duration might be also increased by several tens of years. This extends the area of utilizing the gravity ships with over-loads of several unities. Besides these ships can be used for transporting operations within near vicinities of the Galaxy.

The high-speed flight will demand protection against approach flow of matter. So, per second (with a ship speed of 10^{10} m/s) 10^{-12}kg of matter will approach the ship. At that density of interstellar material is 10^{-24} kg/m^3 and midship area is 10^2 m^2.

The great speed of approaching matter will create a substantial resisting force. At a speed of 10^{10} m/s, this force will come to the order of 10^{-2} N, whereas with a speed of 10^{18} m/s it will come to 10^{14} N. This is a great value, but as compared to thrust of such a ship which is to equal to 10^{17} N, the former value is a small one. That is why it is possible to overcome such resisting force.

Intercommunication with these ships might be, most likely, realizable by means of distortion of gravitational field. It is possible that the gravitational field distortion will be formed, on the contrary, by generating the matter from the gravitational field, and, most probably, by a method as yet unknown.

Monograph **"General Etherodynamics. Modeling of matter structures and fields on the basis of conception of gas-like aether" by Vladimir A. Atsukovsky.** 2nd edition, M., Energoatomizdat, 2003;
Brochure **"12 experiments on etherodynamics"** Zhukovsky, Publisher "Petit", 2003.

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Floyd Sweet Bench Test DVD

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During these two tests, the unit, which weighed about 6 lbs., can be seen to be putting out well over a million times more power than was put into it.

This DVD makes an excellent educational or instructional tool, and is priced at USD 9 including US domestic shipment. Running time is about 20 minutes.

Note: the full length Sweet DVD, which includes Sweet's proprietary conditioning process for the magnets, is also still available.

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On Velocity of Drive-Free Motion

S.A. Gerasimov , V.V. Stashenko, Russia

Physics Department, Rostov-on-Don State University,
Zorge St. 5, 344090, Rostov-on-Don, Russia

Editorial: *We publish a summary of the article. The original text you can receive from the authors.*

A drive-free system made on the basis of a planar mechanism is described. The experimental results on average velocities of the drive-free propulsive system are presented in a scaled view.

During usual motion, a system is repealed from the surface in the case of its motion on a plane or from the medium when it moves in a resistance medium. This kind of motion is achieved by using a drive mechanism. In contrast to the usual motion, the drive-free propulsive system moves due to interaction of a body of a system with another body of the same system. Sometimes such machines are called inertioids [1] or vibration propulsive devices [2]. To produce such kind of motion it is sufficient to provide anisotropy of the resistance force [3-5] or asymmetry of the internal force [6]. One of the simplest ways to do it is to use a simple two-link planar mechanism. A device for such a motion is shown in Fig. 1.

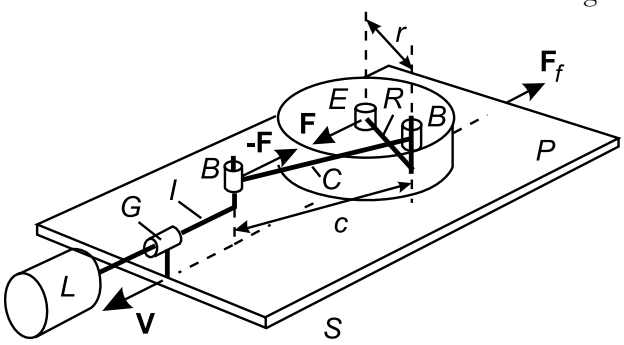

Fig. 1

Experimental device

This device with a total mass of M+m consists of a platform P on which an electric motor E rotating a drive rod R of length r is mounted. This is only one part of the planar mechanism. Another link is the connecting rod C of length c which connects the unbalanced load L and the drive rod R by means of two bell bearings B. The unbalanced load L of mass m on the rod I slides in guide G. The basic distinction of this mechanism is in that this variant of drive-free machine allows us to analyze the experimental data on average velocities of motion. Actually the only forces, which act on the platform and are collinear to the moving direction, are the force **F** caused by vibrations of the load L and the frictional force $\mathbf{F}_f$. The platform starts to move when the force acting on the platform becomes greater than the frictional force.

Let us discuss possibilities of the real propulsive system shown in Fig. 1. Measurements were made at r=0.01 m and at three mass ratios m/M. The values of frictional coefficients were measured for each parameter of the system and vary from k=0.25 to k=0.4. The system starts moving when theoretically the drift does not take place. When motion becomes reversible, the velocity of drive-free drift does not decrease.

Thus drive-free motion is possible even if the frictional coefficients are very small. When increasing the frequency of vibrations velocity does not decrease. We can not discuss the existence of some third force acting on the platform (we can suggest the existence of frictional force $\mathbf{F}_f$ and the internal force **F** caused by vibrations). Let somebody else take the liberty of making such a conclusion!

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ELECTROMAGNETIC SELF-ACTION

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The torque of a self-action exerting on the mobile part of the reactionless engine is measured. It is shown that there exists a value of the height of the mobile electrode at which the torque of self-action is maximal.

There is an opinion that a body can not act on itself [1]. The existence of the so-called force of self-action is believed to contradict to the law of conservation of momentum. This is nothing but prejudice. Though the experimental confirmations of existence of self-action [2-4], conventional science is ready to refuse modern electrodynamics and make up a new theory of electromagnetism [1, 5] in order to save Newton's third law in use. It is comprehensible. First of all, these are the theoretical [5] and experimental [3] errors. The equivalence [5] of the Biot-Savart force is mathematically coarse since in this case the highest terms of expansion of force of self-action are cast out. This equivalence violates law of action and reaction and Ampere force law for which the principle of equality and collinearity of action and reaction forces is valid. Non-linearity of dependence of the torque of self-action on the current intensity [3] makes us doubt in the validity of these results. Moreover, typical values of force [2, 4] and torque [3, 6] are too small even if direct current in the circuit is significant. It is required to pass through the direct current of hundred amperes to produce the considerable displacement or turn of a body. As a result, small values of the effect caused ambiguity in the explanation of the phenomenon [1].

In fact, searching the reactionless propulsive devices we usually forget about the magnetic self-action which arises when a body consisting of a magnet and incomplete electric circuit can move violating law of action and reaction [7]. This violation is proved theoretically [8] but peculiarities of this motion are not well discussed. The principle of such a motion is shown in Fig. 1. This is the magnetic interaction between two current elements one of which is a part of a closed circular loop L and another is perpendicular to the first one. Since the force $d\mathbf{F}_{jm}$ acting on any current element of the loop L is perpendicular to the density of current $\mathbf{j}_m$ then the **Z**-component of the torque $d\mathbf{N}_m = [\mathbf{r}_m \mathrm{x}\, d\mathbf{F}_{jm}]$ is equal to zero while torque which exerted on the second current element by the magnetic field of the loop, does not.

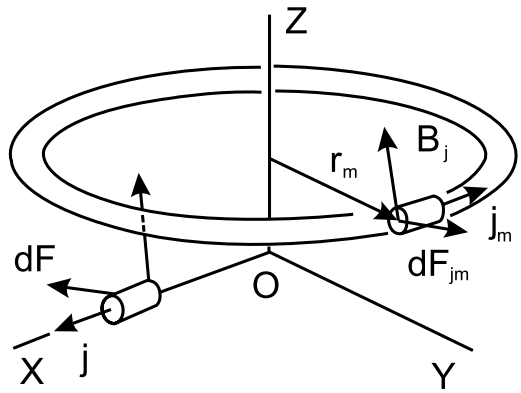

Fig. 1

Violation of law of action and reaction.
The force $d\mathbf{F}_{jm}$ with which the magnetic field $\mathbf{B}_j$ of another current element acts on the current of density $\mathbf{j}_m$, is not equal nor opposite to the force $d\mathbf{F}$ with which the magnetic field **B** of the first current element acts on the current of density **j**.

An experimental device is shown in Fig. 2. A commercially available ring-shaped carbon-steel magnet M (inner radius – 20 mm; outer radius – 55 mm, height – 25 mm) of 2.2×10^5 A/m magnetization is located on the cover of a cylindrical electrode E suspended by thread T. The electrode E is furnished with a central electrode C of the same height h and 5 mm diameter. The radius of the electrode E is 130 mm. The open end of electrode E and the central electrode C are submersed in a conducting liquid L_+ and L_- placed in two volumes of a vessel V so that the depth of submergence of these parts is about 5 mm. In this experiment the conducting fluid is 10% solution of copper sulfate ($CuSO_4 5H_2O$). The vessel V consists of two thin coaxial plastic cylinders of 2 mm thickness. The radii of the plastic cylinders having the common bottom are equal to 10.5 cm and 18 cm. The height of the vessel is 12.5 cm. A disk and a ring-shaped electrodes S_+ and S_- of 1.5 mm thickness are placed on the bottom of the vessel to supply the direct electric current of intensity I. All conducting parts of the device are made of copper. The thickness of the electrode E is 1.5 mm.

When the direct current ***I*** of density **j** flows through the electric circuit, the magnet and the electrode ***E*** rotate in the direction of the magnetic force ***d*F** which is proportional to the vector product [**j**x**B**] as shown in Fig. 2. This is a force of self-action by means of which the mobile part of this device consisting of the magnet ***M*** and the electrode ***E*** acts on itself. However there is no force of reaction which could cause such a rotation. This is really true since a ring-shaped magnet is equivalent to two cylindrical surfaces with the surface current of density $\mathbf{j}_m$. The force of self-action ***d*F** acting on the cover of the electrode is compensated by the force of self-action $d\mathbf{F}_*$ acting on the cylindrical part of the electrode ***E***. Magnetic induction field $\mathbf{B}_*$ "does its part" as shown in Fig. 2. Therefore, it would be appropriate to find out how the height of the electrode ***E*** influences the value of the torque **N**. Such an influence is demonstrated in Fig. 3.

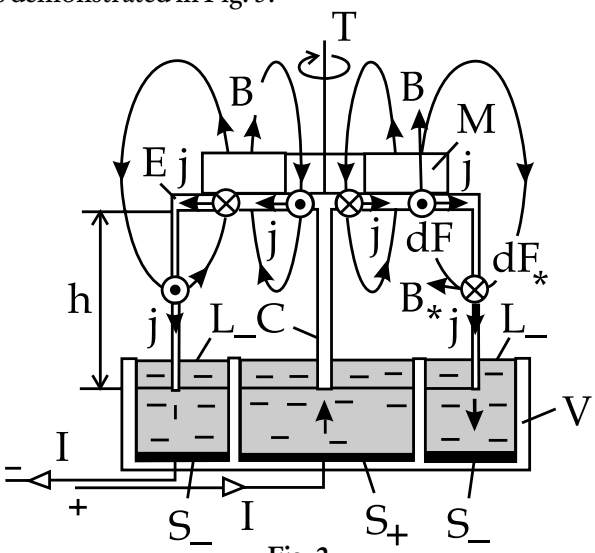

Fig. 2
Experimental device
(•) and (x) – directions of magnetic forces acting on various parts of the mobile electrode ***E***

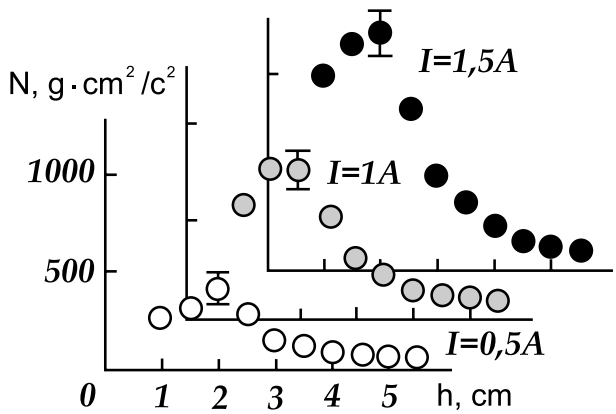

Fig. 3
Dependence of the torque ***N*** on the height of the electrode ***h*** at various values of the direct current ***I*** in the circuit

Thus there exists the value of the height ***h*** at which torque of self-action is maximal. This is the first result of the present work. At ***I***=1 A and ***h***=2 cm the electrode ***E*** turns at angle of 2.2 radian (126 °) with respect to the equilibrium position. Such a turn corresponds to 3.4×10^2 gxcm^2/s^{2}rad, i.e to the constant of torsion of the thread. The second result is that the maximum value of the torque of self-action ***N*** at the current ***I***=1 A is even larger than the value of the torque produced by the traditional unipolar device [3] at the current 50 A.

In fact, this work represents an attempt to draw attention to a more effective and simple practical application of the self-action. It remains only to transfer electric current in an unclosed electrical conductor and such a possibility really exists.

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Uranium Photoaccumulator

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Photoaccumulators are galvanic elements consisting of two communicating vessels, one of which is exposed to light and another is kept in darkness. Ionic composition of electrolyte, which fills these vessels, depends on intensity of illumination. If an inexpensive electrode is placed in each vessel, then a potential difference will appear. If the electrodes are closed at external working resistance the electron stream will begin to equalize ionic composition and the difference in illumination intensity will tend to disbalance it. As a result, a certain working mode will be established which will allow to utilize the photoaccumulator for production of industrial electrical energy. As distinct from the solar battery, which works while exposed to the light, the photoaccumulator stores some part of solar energy in its electrolyte which is supplied with electrical energy after sunset too.

The idea of photoaccumulator is not a new one. It was established in the end of 19th century that it is feasible to create a photoaccumulator containing electrolyte made of the following mixture: $Fe^{2+} + Hg^{2+} = Fe^{3+} + Hg^{+}$.

This photoaccumulator was not adopted in practice because of high toxicity of the electrolyte and very low EMF (approximately 0.018). Development of technology is accompanied by a widening range of materials and matters which can be used in large scale production and power industry. Among such materials are, in particular, titanium, depleted uranium and rare-earth elements. Nuclear power industry uses U235 isotope only. Naturally occurring compound contains only 0.72% of U235. Hundreds of thousands of U238 from which U235 has been extracted are kept as useless stock.

In the end of sixties in one of radiochemical laboratories of LINP (Leningrad Institute of Nuclear Physics) P.N. Moskalyov repeated the same experiment over a long period of time. In the morning he placed a tightly closed retort filled with uranyl-chloride soluted in compound of water, spirit and hydrochloric acid on the window-sill. The solution in the retort changed its color from yellow to emerald-green. Before leaving the laboratory Moskalyov removed the retort with green solution from the windowsill to a closed chest. In the morning Moskalyov retrieved the retort with the solution (which was already yellow) from the chest and placed it on the sill. The solution became green again and the whole process repeated daily.

Chemical processes in uranium electrolyte are rather complicated: first, under the light influence the uranyl ion oxidizes ethyl alcohol, which is then transformed to aldehyde: $UO_2^{+2} + C_2H_5OH^{+} = U^{iv}(OH)_2 + C_2H_4O$.

In the dark ions of urany-4 interact with aldehyde and are transformed to UO_2 uranyl ion and spirit again. Thus, **this cyclic process can take place over a significant period of time being supported by the energy provided by light quanta of visible light which are transformed into the heat.**

The idea of utilizing this process in order to obtain electrical energy emerged in the late nineties. The mechanism of uranium photoaccumulator is very simple (Fig. 1): two glass vessels, one made of transparent glass and another of non-transparent glass, are connected with a black acid-proof rubber tube. The communicating vessels are filled with aqueous electrolyte containing 40% of spirit, 80-100 g/l UO_2Cl_2 and 0.2 m HCL. The electrolyte is previously activated by multiple cycles of exposing it to light and then placing it in darkness in order to obtain a significant volume of aldehydic fraction. The major difficulty of designing uranium photoaccumulator is connected with the choice of the material for electrodes. In galvanic elements carbonized platinum electrodes are usually used. For practical use platinized titanium gives the best fit. Titanium foil covered with superfine layer of platinum is currently widely used in electrochemical industry and is procurable.

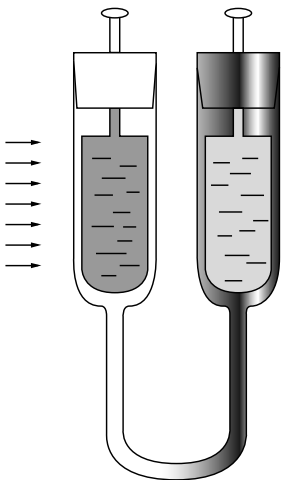

In the transparent vessel the titanium petal-shaped electrodes are parallel the light flow, so the light quanta move freely through the solution.

In working condition each photoaccumulator produces 10 mA of current at 0.3 volt voltage, so they are to be connected in large batteries, both in series and in parallel.

It is also necessary to consider the aspect of safety. Until now, the depleted uranium has been used for one purpose only, namely, for manufacturing of cores for armor-piercing shells. When used in this manner, the uranium is pulverized, which leads to environmental damage. The battery of photoaccumulators is placed in hermetic metal chest; the front panel of the latter must be made of solid safety glass. Such a system will protect the photoaccumulator battery from malicious intent and the security staff from weak uranium radioactivity.

International Prize on Power Engineering "GLOBAL ENERGY"

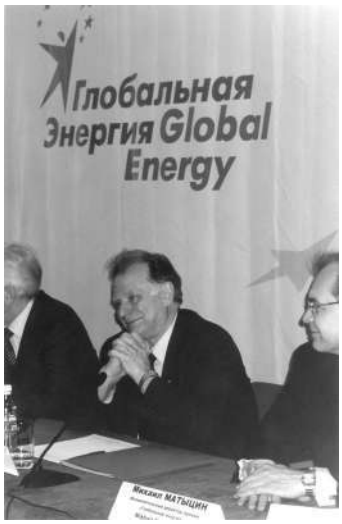

Zhores I. Alferov

International Prize "Global Energy" was first presented in St. Petersburg on June 15, 2003. The bonus fund of $900,000 was shared between three scientists "whose work has been and is still important both to the last century and future research", said Zhores Alferov, Chairman of the Global Energy Prize Award International Committee.

Nick Holonyak, Professor at the University of Illinois (USA), was awarded for "fundamental contributions to the development of power silicon electronics and invention of the first semi-conducting light-emitting diodes in a visible part of the spectrum". Thyristor invented by Holonyak allows the transformation of direct current into alternating and vice versa, to direct this process, to store and accumulate energy. This device is used for every electric locomotive, for frequency transformation. Such devices help to save significant amounts of energy, thus, about 30 percent of all energy produced in the world is processed through thyristors.

Nick Holonyak's other invention, i.e. semi-conducting light-emitting diodes in a visible part of the spectrum, has led to development of a new field of the modern power engineering. Supposedly, efficient and safe light-emitting diodes will replace daylight lamps in the next ten years.

"Although Nick Holonyak's invention dates back to the end of the 50ies of the last century, it remains current" said the Chairman of Expert Commission, Academician Vladimir Fortov. "This is one of the key inventions leading to the search of new ways of sustainable energy saving".

Diploma of Global Energy Prize laureate

Gennady Mesyats, Academician of Russian Academy of Sciences, and **Ian Douglas Smith**, Senior Scientist at The Titan Pulse Science Division, were awarded for giving birth to a new direction in the field of power engineering, i.e. power pulse energy. Due to their research, commutation of high-level currents at megavatt levels of voltage has become possible; a number of powerful current choppers have been created, futhermore, there have been developed transformer constructions which allow avoiding energy loss in power transmission lines. These research and innovations resulted in the creation of a number of unique pulse power machines and devices widely used in Russia and abroad ("Aurora", "Helia" (USA), "Sinus", "Gamma", "Maus", "Pik" (Russia) and others).

Teleportation

Review prepared by correspondent Alla Pashova, Russia

For conventional science, the term "teleportation" is not worthy of serious consideration unless ascertained by compulsory "quantum" teleportation. Thus, teleportation is unconditionally referred to microworld phenomena and, in fact, comes to distant information transfer. Spatial transference of a macroobject of definite mass has been excluded.

Teleportation of states

What does **quantum teleportation** mean? During active development of quantum theory, in 1935, the so-called EPR-paradox (Einstein-Podolskiy-Rozen paradox) was formulated in the well-known work "Can quantum-mechanical description of reality be full?" written by Albert Einstein, Boris Podolskiy, and Natan Rozen.

The gist of the paradox is as follows. There are two particles interacting for some time, thereby forming a common system. From the position of quantum mechanics, this coupled system can be described with a certain wave function. When interaction is over and particles scatter within arbitrarily large distances, they still will be described by the same function as before. At that, state of each separate particle cannot be known in principle that is apparent from uncertainty relation. Only when one of the particles enters a receiver, which records its parameters, the relevant characteristics of the other one emerge (exactly emerge, but not become known!). Thus instant unlimitedly distant "transmission" of quantum state of the particle is possible. Therewith, teleportation of the particle itself and transference of mass do not take place.

Einstein and his colleagues believed that existence of such particles predicted by quantum mechanics prove theory incompleteness. Thereof, the scientists inferred the necessity of other parameters (besides wave function) to describe quantum states. Otherwise, from the local viewpoint, correlations between elements of such a system could not be understood. It was far much later, when Bell showed that some of measurements could define these correlations and exclude any local hidden parameters. It was not until early 1980-s that famous experiments were performed finally eliminating a possibility of local hidden parameters.

In 1980, Alan Aspect experimentally proved that EPR-paradox in quantum world takes place indeed. Special measurements of state of EPR-particles indicated that EPR-pair not only has a common origin, but in addition, that one of the photons somehow "get to know" the way the second one was changed. In further experiments, existence of EPR-paradox was affirmed, even if particles of EPR-pair were removed from each other over a distance of 10 kilometers or so.

In 1993, Charles H. Bennett and his colleagues worked out a method to transfer the quantum state of some object of the microworld to another quantum object by means of EPR-pair and called this method "quantum teleportation". In 1997 a group of experimentalists under the direction of Anton Zeilinger for the first time implemented quantum teleportation of the photon state in the University of Innsbruck.

In such a way, researchers keep on improving the process of quantum teleportation. In 2001 Danish scientists managed to link gas particles spaced at a substantial interval from each other, by transmitting information about quantum state from one particle to another by means of laser. The quantum teleportation between two gaseous clouds were attained by Eugene Polzik and his colleagues in Orkhus University. They succeeded in coupling about million of cesium atoms, whereas the previous record was only four atoms.

Scientists of Australian National University destroyed a laser beam and nearly instantly recreated it in another point in space; in other words, they teleported photons of the laser beam. In contrast to previous similar experiments, the physicists managed to obtain the required result in 100 percents of cases. Ping Koy Lam, the head of the task group of Australian University, claimed that the first atom of solid substance was likely to be teleported within near three to five years. However, as most scientists admit, a task to teleport a human remains almost impracticable. Even teleportation of atoms, as compared to that of photons, is much more complicated process. It is even harder when dealing with molecules. It is basically possible (though practically very difficult) first to transfer a molecule to a minimum-energy state (ground state) causing it to radiate a certain

sequence of photons. These photons will find themselves in a certain superposition containing all the "quantum" information, which was available in the molecule. Thereafter, it is possible to teleport photon states by means of EPR-pairs. Moreover, it is also required that the classically measured information about a molecule. If molecule of minimum-energy state is present in the receiver, then this molecule, by interacting with teleported photons in a required order, will transform to the quantum state identical to that of the initial one. Consequently, the quantum state of molecule of a certain material will be transmitted, actually with velocity of light. When that happens, the quantum state at the transmitting side will be destroyed.

The human organism comprises about 10^{27} atoms. To save and transmit information on properties of that number of particles seems to be practically unachievable. "Theoretically, nothing prevents us from doing that, but complexity of the problem is such that now no one seriously thinks about the solution" – states Ping Koy Lam.

Being a method of information transmission, quantum teleportation has found its application in quantum computers, whose information is stored in the form of a set of quantum states. Impossibility to wiretap and copy transmitted information is considered to be an advantage of such computers. Those researchers, who, nevertheless, wish to answer the question of "How to teleport matter, but not its state?" have to seek for more perspective theories and techniques.

Teleportation of material objects

Those people, who really want to realize instant spatial transportation of objects, i.e. teleportation, should refer to studying properties of Space and Time. Quantum teleportation has a certain finite velocity that cannot exceed that of light. The genuine teleportation assumes that an object should set off from a starting point to a finishing point (these points differ by a certain distance X), at that the transference time comes to zero. The object to be teleported is not changed or taken to atoms to be gathered later at a distant point of space according to information transferred to this point. (Fig.1).

The object disappears from one place and simultaneously appears in another place. How is that possible? A body will disappear from point A and appear in point B if to bend space in such a way as to let point A and point B coincide. Then the object will instantly appear in point B since there is no interval between points A and B. Teleportation could be realized by a device, which would make it possible to superpose points A and B.

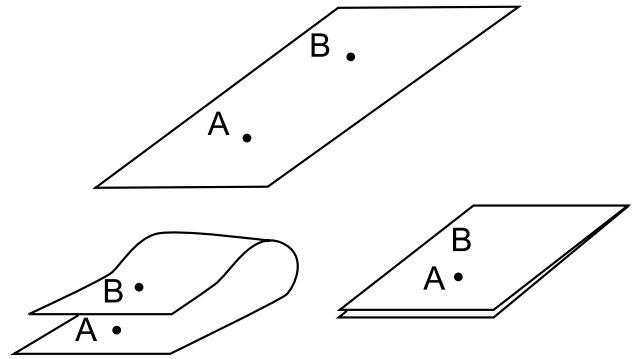

Fig. 1

Space is supposed to be unbendable without enormous energy consumption. However, Alexander V. Frolov points out that this issue is not so unambiguous: "Normally we consider space in connection with "natural" course of time existing in it. That is some degree of space curvature. Let us assume that it can be changed. The space curvature can be considered as acceleration or deceleration of time. Acceleration always demands, for instance in mechanics, some energy consumption. But if we "decelerate" time, energy is liberated and it can be accumulated for subsequent use".

K.Z. Leshan suggests surrounding a transferred object with a closed surface consisting of vacuum holes. Inside such a "hole sphere" there is geometry similar to that of a black hole. This place is absolutely isolated from the external Universe. No radiation is able to penetrate through the hole in space and time. For an observer, who is inside the hole sphere, the distance between sphere center and its border is infinitely large, since spatial metrics is ever-varying from the center to the border. Distances between the points is continuously shortened so that the distance between any couple of points comes to zero at the very hole surface. A matter transmitter can have inner or outer hole surface. In the first case a teleportation station has a spherical chamber to place the object. Equipment to produce holes should be located upon the outer side of the sphere. Such a station is capable to provide hundreds of launches a day by instantly expulsing spaceships to deep space over distances of millions of light years.

From microcosm towards macrocosm

Simeon Bocharov (member of Chemistry and Biochemistry Department, University of Delaver, Newark, USA) considers teleportation phenomenon using microobjects as an example and applying an interesting conception of protomatter.

In S. Bocharov's opinion, many paradoxes of the present-day science could be solved under condition of considering the whole existing matter to be a single continuum, i.e. protomatter. At this approach, the microcosm objects are not independent ones, being represented in the form of distortions of the very continuum and its manifestations here and now. Protomatter, whose distortion degree is beyond modern possibilities of detection, corresponds to vacuum. In the present-day paradigm redistribution of protomatter distortion corresponds to motion of particles. The important peculiarity is a refusal of such concepts as structure, dimensions, mass and other macroscopic characteristics with respect to microcosm objects, since here they are not considered as separate entities.

For experimental justification of his theory, S. Bocharov suggests to consider teleportation of microobjects incorporated in fullerens under low temperatures and pressure.

As a basis for reasoning he takes the fact that identical or similar conditions, whereon distortions are located, bring them to the state of identical or similar by lability/diffuseness. And vice versa, distortions, which are similar by lability/diffuseness, influence their near surroundings, creating, as a result, similar macroscopic states. In such a case protomatter distortion (in some spatial domains and under similar conditions) will cause appearance of similar distortions in another domain, whose degree of removal depends on presence of other distortions and their characteristics. In other words matter will be teleported from one spatial domain to another.

Possibility to realize teleportation of microobject causes the well-known phenomenon, which is nowadays described as embedding of particles into inner hollows of spheroid fulleren molecules without reacting with them. As object of teleportation there can be used distortions classified as elementary ones, such as hydrogen, helium or stable matters (noble gases). In both cases the influence of objects upon surroundings is minimized.

The researcher believes that in case of successful experiment, new pattern of matter structure will be confirmed, and valuable teleportation of microobjects (with prospects of such possibility for macrocosm objects) will be demonstrated.

One more approach to teleportation of physical macroobjects was considered in the work "Practical application of time rate control" (New Energy Technologies No. 3, 2001) by Alexander V. Frolov. It is assumed that density of space (aether) energy determines rate of passing of any processes including the very process of matter existence. Changes of aether density (increase or decrease) must result in the emergence of a force analogous to that of buoyancy, though acting towards the fourth dimension. This "chrono-motive force" (CMF) is also an analogue of electromotive force (EMF) and can be generated by analogy with electrodynamics. According to Alexander V. Frolov, laws of quantum mechanics as to discretization of levels of energy of material system, which exist in the domain of increased or decreased aether density, are valid in the macrocosm as well. Teleportation (as a transition from one state of the system to another one) can be studied with electron transference from one orbit to another as an example with the only difference that for the teleported object not only its location, but also the very spatial properties are changed. In aether of different density (after discrete transition) the same object will have different space around it, wherein time is decelerated or accelerated. Experiments of this field have already been in development stage.

Therefore, modern theoretical physics has handed the problem of teleportation to researchers-experimentalists, who possess sufficient breadth of mind. Perhaps, using teleportation technologies, they will manage to fundamentally alter the process of space exploration and raise our civilization up to radically new development level.

ELECTRIFYING TIMES

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"Mass defect" in Home Conditions

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The idea to conduct experiments on "mass defect" demonstration appeared after a cycle of seminars, which took place in1993-1996 at the Moscow Aviation Institute under the direction of V. I. Patrushev, Doctor of Technical Sciences, Professor of "Designing of aerohydrodynamic systems" Department (the author of the article is also a graduate of the Department). At the seminars, an enterprising group studied and developed an applied theory of "Displacing fields" by Alexis V. Murlikin and an associate "Theory of energy exchange processes". Later the group was called **"Group studying non-inertial transference"** (non-inertial natural processes).

The experiment was aimed to test some theoretical suppositions, namely, that it is possible to influence on existent energy flows which input and output to the matter. At that the simplest way to influence indirectly is to change the medium the flows come through. In general, optic experiments on luminous flux refraction show the same. But light refraction and change of speed of light propagation at passing through different mediums is one thing; and change of mass of a material body is something new that has not ever been dealt with. Moreover you can consider light (i.e. electromagnetic radiation) to be the secondary manifestation of output energy flow. Besides mass defect is very important for nuclear physics because it "helps" to develop this branch and stimulates drawing "energy dividends" in splitting reactions, decay reactions and nuclear fusion reactions. But unfortunately we can not touch element nucleus and even million nuclei while we can easily touch metallic balls of 1 gram weight.

Let us note that a concept of mass is one of the most uncertain in physics. We can not measure mass directly. It is possible to do it only indirectly, by gravity, using scales (it does not matter what kind of scales are used), or by kinetic momentum (in this case mass is a measure of inertia) by means of dynamometers.

Thus it is evident that change of WEIGHT shown by scales is not MASS change as measure of matter quantity. Since one of the most important points of the theory of "Displacing fields" is creation of a vehicle of new generation, then one of the major tasks is to overcome gravity (to decrease weight). And this "home experiment" shows the way to solve it. However we can call it "home" only in part, because for weighing there were used electronic scales (mass-comparator with measurement accuracy of 0.1 microgram. (See Fig. 1).

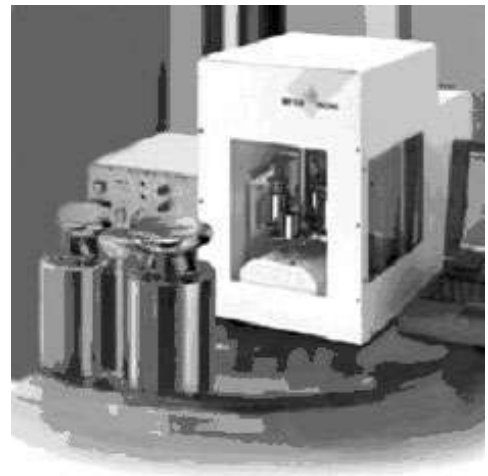

Fig. 1

Precision scales METTLER TOLEDO allows making:
High-accuracy weighing in the range
from 0.1 microgram to several tones
Measurement with resolution up to milliard points

Two sets were designed for weighing. The first one had an aluminum (Al) ball-kernel which weighed 1 gram and a lead (Pb) casing-shell consisted of two parts (half-spheres) which also has weight of 1 gram. The second set had on the contrary a lead kernel and an aluminum casing. The sets were disassembled and then hermetically assembled to make a single device with no gaps (See Fig. 2).

Since it had to be done with great accuracy and it was a piece article, not a Moscow product company undertook to produce it. And only one of the students, Nicholas Sorokin, a young boy with skilful fingers, had

helped. He invented a technology which allowed making balls of the necessary size at home conditions. He was literally pickling every micron of metal with acid and finally got the necessary size and weight.

So, the weight of a non-assembled set was: 1 gram (weight of kernel) and 1 gramm (weight of shell). Weight of an assembled set, according to the "Theory of energy exchange processes" by Murlikin, is not equal to the simple sum of the non-assembled components, and mass defect would be different for various sets right up to the change of sign.

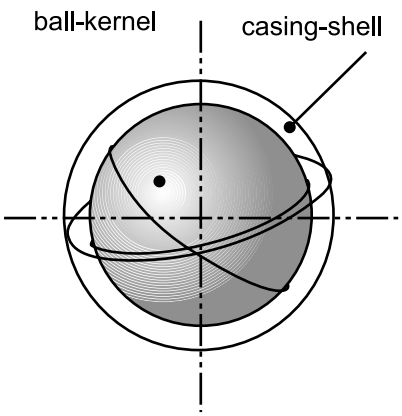

Fig. 2

Set of experimental balls

More than 50 experiments was carried out on weighing for every set. Assembled sets as well as non-assembled sets were weighed. **It was confirmed that there was an interaction between input and output flows for MATTER MAINTENANCE. It became apparent in the form of mass defect. Defect appeared in the sixth sign, i.e. it comes to the range from 0.0002% to 0.0007% of "kernel" mass (or "shell" mass). At that the lesser mass defect corresponds to aluminum shell, while the greater one corresponds to lead shell. Accuracy of weight measuring by the mass comparator exceeded the acquired result by 10 times. So we could not tell about inaccuracy of measurements.** So we had to apply to the "Russian center of testing and certification" which was very famous all over the world (Rostest-Moscow).

In general that is all, we have got an answer for ourselves, and the period of testing is behind. We have to advance; very much is still to be done. In addition let us mention one more surprise we got during the experiments. The matter concerns some time delay in receiving final results of every weighing. A qualitative picture of it is represented in Fig. 3. We did not expect that this effect would appear at such a rough level of measurement of energy exchange processes.

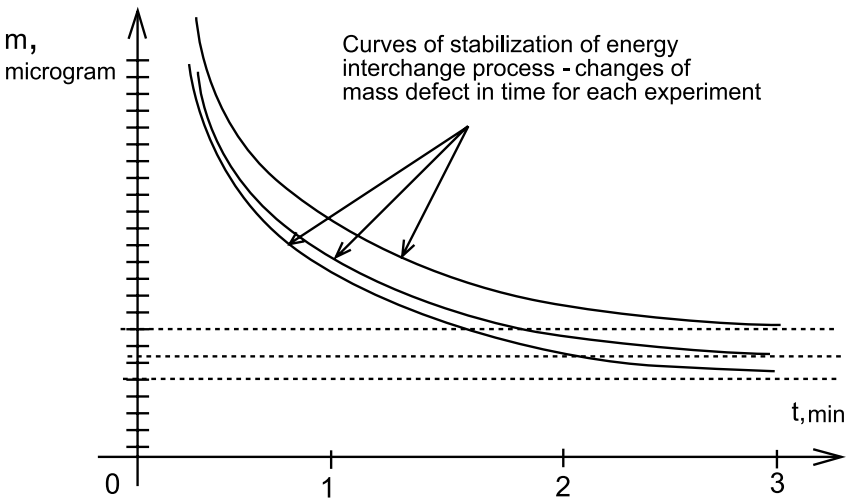

Fig. 3

Time stabilization of the process for receiving final weight

The subsequent report and detailed discussion of the experimental results by specialists (including physicists of various specializations) resulted in an unexpected non-recognition of facts and distrust. The main argument was a demand to increase the number of experiments up to 5-10 hundreds. And only then scientists would be ready to accept facts. It was quite a predictable reaction for the orthodox science in the middle of 90s. It remains to hope that if the discussion took place today it would have a paved way. However it is not a fact.

In conclusion let us note that this experiment on revealing mass defect ranks with famous experiments, in which rotating gyroscopes also demonstrate mass defect (decrease of weight) and even one of higher order than in our experiment. But in return we have no rotation, no chemical and nuclear reactions, while mass defect is presented.

Let us add that it is possible to complicate the task: to make a double casing and to choose other materials for "kernel" and "shell". (See Fig. 2). In our case low prices and availability made us use Al and Pb. The results will be more interesting, for example, with Li and Os (and with other supertransuranic elements).

Aether as Unified Field

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Based on the original observations and experiments, the article gives more precise definitions of aether model, than which was previously elaborated. General laws of the Universe aetherodynamic are considered. There is described a new physical reality in the form of quasi-real aetherodynamic structures ("topological harmonics") generated by dynamics of the substantial world.

At the present-day stage of physics development words of Maugham, an English philosopher, take on particular topicality: "The great verities are too important to be new". Indeed, we are increasingly making certain that our remote ancestors were familiar with fundamental laws of the Universe; furthermore, they knew these better than we do. But which methodology of cognition of Nature and what kind of information sources did the ancient scientists have? Today, we can openly say: they had not ordinary experience only, but also esoteric, pretersensual one, without feeling any necessity to be divided into materialists and idealists. For more details on evolution of physical ideas, refer to work [1].

In discovering all over again, I also had to elaborate a "cellular taction" strategy, which enables the most important characteristics of aetherodynamic processes to be sensually perceived and evaluated. The main thing is that all my sensory observations are definitely reproduced at laboratory experiments while the simplest physical equipment is used.

We may get reliable knowledge about Nature from Nature itself only. Thus foundation of classical physics describing usual substantial world is also based on empirical facts studied by Galilei, Newton, Faraday and many other physicists-natural philosophers. I also would like to defend great Newton against attacks on his adherence to inductive methods which really brought imperishable values into science.

A new convolution of cognition is possible on condition of introduction into science of new concepts based on empirical study of physical entities previously unknown. Thereupon, I share the thought of Elena Ventzel, professional mathematician: "Mathematical methods are not useful, but harmful until phenomenon is not studied at a pre-mathematical, humanitarian level". It is ideological and logical language that may be used today to discuss the aether problem, whose solution calls for comprehension of natural-science facts, which are beyond traditional notions settled over centuries.

The long-term investigations have confirmed that exhaustive definition of a fundamental natural entity was given by Rene Descartes: "Universe does not contain anything but aether and its vortexes". This is not merely a postulate; this is an objective summary of empirical observations of Nature phenomena. In any academical model of microcosm there is no answer to the question: what kind of substance are electrons, quarks, strings made of? That is the very substance our forefathers called aether. Aether is unified field indeed; and it appears that for nearly his whole life Einstein had been searching for something that was under his foot.

It must be recognized that there is no undistorted, quiescent aether in Nature; as well as no zero-size vortexes exist. Therefore, in a customary sense, the aether concept is pushed behind transcendental horizon and turned into an inconceivable entity whose mystique is tantamount to religious ideas. However, all quantum vortex-wave distortions of the superfluid three-dimensional aether, which have an appearance of tori, threads, solitons and occupy spatio-temporal spectrum from zero to inter-universe scale, are material and contain energy under scientific interpretation. Any spaces such as turbulent fields, physical vacuum, gravitational fields and, of course, matter are material. All of them are etherodynamic structures of the real world. Spatial hierarchy of aether vortices is referred to as quantum stairs, fractal structure or "matreshka" [2-5].

To understand basic laws of aetherodynamics it is necessary to give a general definition for classical matter

and other aether states. As a first approximation, let us give the name of matter to aether microscopic **left-screw** self-oscillating vortex-wave systems (elementary particles), whose existence and parameters are conditioned by higher hierarchical systems. This is our displayed world, with its electromagnetic fields and fundamental constants. Let us refer to vortex-wave structures of any vortex size, which in the considered space domain are **balanced** by a number of left- and right-screw vortices corresponding to matter and antimatter with prefix "quasi" to a free aether. Stable vortex lattices with alternating direction of helicity can be also considered in this case. Under natural conditions everything but classical matter or electromagnetic and gravitational fields can be related to the free aether. In the first place, these are the so-called physical vacuum and vortex fields, which attend gravitation. They represent anisotropic nonlinear subspaces and occupy definite places on spatio-temporal spectrum of the world aether. Particular free subspace creates an aggregate of topological harmonics [5] attending all the physical processes. Satellite of the gravitational field is distinguished because it belongs to specific class of stable vortex lattices.

Apparently, in general case, energy of free aether is virtual for our world due to its helical symmetry and quasi-matter, from the view of difference in sizes of typical vortices which correspond to protomatter. But this is not the entire point. There is also superfluidity of aether, whose vortex viscosity has marvellous properties. As a result, there are created phenomena of inertia and energy-information barrier separating material world from constant influence of quasi-real structures or turbulated space.

Classical inertia, as vortex viscosity, arises in the microscopic and more fine-structure free aether (in Newtonian space) and ever regularly reveals itself during acceleration of material bodies. However everything is different at stage of macrovortex aether, where inertia has properties of adaptation. Here it is affirmed that inertia phenomenon is "spread" throughout the spatial-temporal spectrum of vortex distortions of aether field. At that nature of inertia is changed. Within topoharmonic subspace in laboratory scales, the inertia law "diminishes" in time according to exponential dependence, whose time constant is determined by specific conditions and varied over wide limits (from seconds to many days). On the expiry of this time, inertial intercoupling transforms to the law of flicker effect. It may be said that flicker effect specify penetrability of energy and information barrier after expiry of time of paraphysical regular phenomenon [6]. Consequently, most of time the interaction with free macroaether is of random character and should be evaluated by mean observation.

To extend conceptual scope of our investigation it may be added that in classical hydrodynamics a liquid, along with ordinary inertia, has determined vortex macroinertia, which is created by vortices of the liquid itself. Therefore, it is necessary to keep on comparing processes at all levels of the unified field of aether. For instance, electric inductance is a kind of specific inertia, and topological harmonics of electromagnetic and other phenomena are subjected to the energy-information barrier (under laboratory conditions).

In the above arguments, the principle of relativity is latently and unconsciously presented. However, this complicated question needs to be separately considered. Physical nature of the energy-information barrier and reason for dependence of the inertia properties upon the size of vortices of free aether remain unclear, too. However, it can be supposed that classical elementary particles, as distinct from protomatter, have self-oscillating properties and are commensurable with vortices of the surrounding free world; and that the above-mentioned energy-information barrier does not exist for them on microscopic section of the spectrum. The gist of the barrier itself comes to "memorizing" topoharmonic processes by Earth's gravitational fields and laboratory equipment. Turbulent fields (physical vacuum) do not have such a "memory".

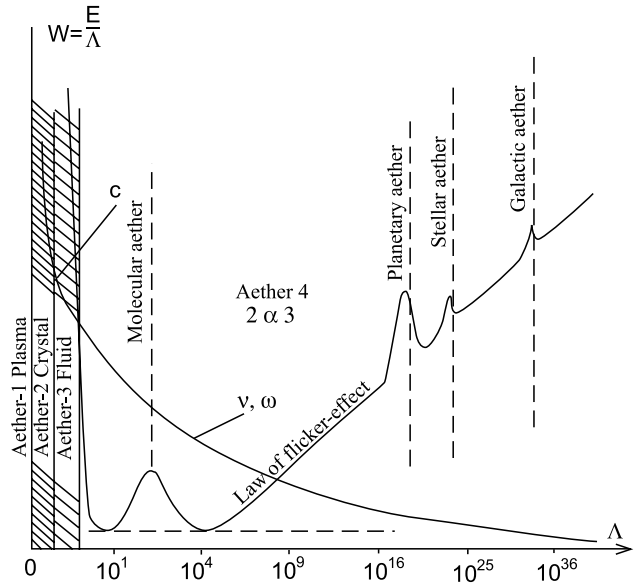

Fig.1

Fig.1 depicts diagrams of spectral density of vortices' energy; diagrams of rate of interaction transfer v and circular frequency ω depending on sizes of vortices of the world aether Λ (in picometers). As we can see, velocity of distortions propagation v is equal to velocity of light C in the physical vacuum, i.e. in electron sizes, exceeds C in nanocosm and tends to zero toward megacosms. Circular frequency of vortices rotation and course of physical time have the analogous qualitative dependence. However, vortices energy W has a feature and grows toward both ways from the lab scales; the aether numbers have been assigned conditionally, but all the specified phase states reflect some physical reality.

One of the most complicated questions is a definition of vortex matter in each particular case. The diagram demonstrates energy of free aether in the form of protomatter (simplest elementary particles – vortexes), and energy of classical elementary particles as helically definite self-oscillating emissions of aether field is localized in the most nonlinear subspace (physical or substantial vacuum). Unification of the elementary particles into atoms and macrobody does not denote direct transition to parallel world with different fundamental constants, whereas change of vortex size in the diagram exactly implies such a transition, though at a level of protomatter. This is a very intricate and crucial point. For example, a star is, unconditionally, an elementary particle of the relevant level of the Universe, even though comprising the ordinary matter.

Left wing of energy spectrum reflects property of the turbulent field of aether to gravitate, to sink down to the "bottom" transferring energy to the vortices of lesser scales. This phenomenon of distributed "gravitation" is available in every space point and explains a least-action principle. An illustrative analogue of this regularity is represented by the Earth's gravitational field and structure. Dense plasma assumed as iron core is situated in the center, and higher - there are magma, solid crust, water and air. These phase states exist in free aether within universe scales as well. Consequently, in femtocosm, and maybe at an even deeper energetic "bottom", there must be a plasmic subspace; evidently, it is assignable that aether translated from Greek means "fire".

Increase of energy to the right is connected with extending a dynamic band of the vortices spectrum, as the scale increases. In our world, this increase follows the flicker effect law, but this is only what we perceive across the energy-information barrier. Actually, at this section the vortex energy must increase well more strongly, because **our observation capabilities are limited** by accessible matter processes. Turning back to stars, one may affirm that modern science is unable to evaluate their real energy (evaluations are considerably underrated). The Galaxy vortex entrains such deep levels of multidimensional space-aether to its rotation that this causes violation of the Newton's law of inertia. Notion of "hidden mass" is unnecessary for explaining dynamics of galaxies. It is quite enough to take into account that differential rotation entrains the fine-structure aether (inertial subspace), and this process results in decreasing the inertia and external centrifugal forces. Unfortunately, Fig. 1 reflects only a characteristic size of the galactic vortex and does not visually demonstrate its active band of the spectrum. The finer is the space structure, the more inertial and closer to the absolute reference frame is the space. Obviously, the non-homogeneous, stereodynamically multidimensional and multiphase aether requires a perfectly new theory of random fields, which would also make allowance for the phenomenon of the material world.

Energy motion processes or spectral energy-cascades along abscissa axis are of decisive importance for existence of our world and the Universe. These processes have unusual properties. The "violet" cascade is attended with reduction of vortices size, absorption of matter energy and tends to increase energy concentration at the "bottom" of the world aether (near ordinate axis on Fig.1). This regularity experimentally confirmed in both spatial and temporal domains is a direct consequence of the above-mentioned phenomenon of distributed gravitation and clarifies an existence of the left wing of the spectrum. In classical physics "the violet" cascade effect is reflected in the least-action principle as well as in the thermodynamics laws.

The "red" energy cascade (right wing of the spectrum) corresponds to increase of vortices size and is accompanied with energy liberation. To start it up under earthy conditions special technologies are called for [7]. This has been confirmed with laboratory experiments and underlies the "perpetual motion" theory, where energy is pumped from nanocosm to the classical material world. Conception of artificial biofield [6], I have developed, considers methods of creating the aether vortex-wave macroscopic-scale distortions in physical systems. As a matter of fact, we deal with **ways of extending of natural spatio-temporal spectrum of aether (which settled into itself) by creation of a subspace of the topological subharmonics of the classical elementary particles, atoms and molecules**

(physical bodies), within the context of the etherodynamics fundamental law [5].

Even within action of fluctuating energy-information barrier, the spectrum right wing exhibits existence of natural processes in Nature that, supposedly, violate the known laws of thermodynamics [8]. But, as far as Nature cannot conflict with itself, we have to recognize that there is another physics, which "works" in geographic and greater scales, where role of the energy-information barrier demands to be reappraised. To all appearance, the universe vortex partialyl entrains plasmic subspace of aether into its rotation, and conditions for realizing "red" energy-cascade and generating matter are created on the sections of the maximum density gradient ("spectral" non-linearity). But the same way as a fish in ocean does not know reasons for storms and currents, we will never learn which force untwists the Universe handwheel, whose energy feeds our substantial world.

There are two components of free aether field that are the most essential for the present-day physics. The first one (left wing) is positioned on the spectrum beside the "bottom" in the form of dense liquid-crystalline "plasmatic" medium transforming to the Newtonian inertial subspace (physical vacuum). Since inertia is as regular as electric inductance is, the first subspace proves to be especially material and not such free, because it has properties which were imposed by the Universe rotation and distributed "gravitation". Let us conventionally limit the spatial spectrum of the first component with a nucleon size. The second component of aether space (right wing of the spectrum) stretches towards larger scales.

Except for known cosmic objects, this is an unknown ocean of the macrovortex and really free aether, or topoharmonics, which are born by dynamics of the substantial world. It is an experimentally proven fact that topoharmonics are generated by photons, electrons, and all the moving bodies [5, 9].

The second component has an ability to conversely affect the matter it was generated by as well as other material objects via "flickering" forces [10, 11]. This special subspace turns out to be doubly virtual, a genuine phantom. That is why, it has been winning the status of a real physical entity with such a difficulty, while Chinese philosophers were familiar with the same thousands years ago, separating entities "yang" and "yin".

The laboratory experiments indicate that topoharmonics have not only properties described in [5], but also an ability to interact with the space, creating a static domain of the excited aether in the course of propagation of the vortices-waves. At that physical bodies placing within this space volume are "charged" [2, 9]. The mentioned active domain (horizontal route) is "separated" by the Earth's gravitational field as follows: quasi-substantial constituent rapidly settles down creating vertical flow, but some phase structures are disintegrated very slowly (days, months, years).

The surprising thing is that biosystems equally belong to both aether components, not experiencing any constraint from the side of the energy-information barrier. The so-called human biofield is a topoharmonic part of physical body. It occupies its place on the spatio-temporal spectrum (Fig. 1). Quasi-substantial constituent (yang) and antiquasi-substantial one (yin) are strictly balanced, and acupuncture points and chakras are an analogue of Hartmann's geophysical grid, which is well-known to paraphysicists.

Conceptual generalization of physical ideas in the context of unified field of aether gives a constructive, cognitive impulse in solving of different problems, such as Nature's choice of exclusive laws for existence of "left-screw" material world as well as the problem of flicker-effect. At that, researching into the physical processes responsible for proton positive charge is of fundamental importance.

In conclusion, let us take note of conventional character of dividing the aether field into two components by the form of energetic spectrum. As a matter of fact, topoharmonics are generated by matter towards both larger spatial frequencies (subharmonics) and smaller ones (harmonics) and fill all levels of the Universe. The aforesaid is aimed at making perception of the most studied aspect of the **new physical entity** (vague due to diversity of hypothetical descriptions which exist in publications on this subject) more accessible.

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GLOBAL ENERGY

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Lately, the notion "Global energy" has become widely spread as a prize corresponding to this notion has been instituted in Russia. Since the Euclidean times, an unwritten law exists in science: to give definition to the notions, which are involved in scientific analysis. It is done for the purpose that everybody who uses this notion can understand the sense implied in it.

The Global energy problems have been discussed for a long time; they are well known. Depletion of natural energy carriers (oil, gas and coal) is the first problem. Environmental safety of energy carriers is the second problem. It is generally recognized that the solution of the issues connected with the aggregate of these two problems is of a global character. The results of scientific research, which should deal with global energy, originate from it. First and foremost, they are such scientific investigations, which result in the possibility to use an inexhaustible and environmental friendly energy carrier. It has been known for a long time. It is hydrogen produced from water.

Why hydrogen and why from water? At combustion of hydrogen, water is regenerated; thus, the energy carrier is inexhaustible. As far as inexhaustibility and environmental safety are concerned, hydrogen has no competitors. However implementation of these qualities is restricted by large energy expenses for hydrogen production from water. For hydrogen production, modern electrolyzers use from 10 to 20% more energy than it is produced at combustion of hydrogen.

It is easy to imagine what financial and intellectual resources of the world are included in the search of the ways to reduce energy expenses for hydrogen production from water. In Russia many scientific institutions of applied research and educational institutions deal with this problem. There is a Research Hydrogen Institute.

The associations of scientists on hydrogen energetics have been established in USA and Europe. This year, they carry out their regular scientific conferences, to which the author of this article has been invited.

Editorial: Let us note that it is not necessary to coin new scientific term "global energy", since quite for a long time the notion of "free energy" is used. This term represents the idea of the possibility to freely use energy by a consumer.

Energy problem is global not due to depletion of oil and gas, but due to their environmental unsafeness. However the confirmations exist that the world owners of energy resources do not bother about the problem of environmental unsafeness of modern energy carriers.

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Energy problem is global not due to depletion of oil and gas, but due to their environmental unsafeness. However the confirmations exist that the world owners of energy resources do not bother about the problem of environmental unsafeness of modern energy carriers.

In history of science, the facts of annihilation of the scientists who have won success in reduction of energy expenses for production of hydrogen from water have already been registered. The requesters of these actions think that they will lose their profits with the coming of hydrogen energetics. They do not understand that this process cannot be abrupt. It is impossible to replace the infrastructure of the existing energy carriers by infrastructure of hydrogen energetics within one or even ten years. Besides, infrastructure of hydrogen energetics will not be created on a blank place. It will be integrated into the existing infrastructure of energetics gradually; and its owners will automatically become the owners of hydrogen energetics. The first step has already been made in this direction. In the USA, a decision has been taken to equip all filling stations with pumps to fill the cars with hydrogen.

It is known that a priority of results of theoretical investigations is their publication in press. Usually, such priority is a personal one. Generally a patent is a priority of the results of experimental investigations. As a rule, this patent belongs to a group of authors. A published patent is a genie released from a bottle. No finesse of the authors to hamper a reproduction of experimental data given in a patent without the participation of the authors can stop the process of their implementation. Thus, the authors or a group of the authors who have filed an application for a patent are deprived automatically of the opportunity to influence the process of practical realization of their ideas.

In Russia, the state is a main patent holder of the global patents. Due to the well-known reasons, it has proved to be unable to control the course of scientific investigations and to forecast significance of their results.

It is known that if it becomes possible to reduce energy expenses for hydrogen production of water fivefold, it will be the cheapest energy carrier. Russia has already got technology, which reduces these expenses tenfold and more. However another way of looking is more perspective. Is there any use to decompose water into hydrogen and oxygen and to use hydrogen as fuel for heating, for example, of water in heating systems? Is it possible to make water generate heat? It turned out that, it is possible.

In Russia, three firms ("Yusmar", "Termovikhr" and "Noteka") sell cavitation heating equipment with energy performance index up to 150%. Official science looks awry at this activity, since such results conflict with one of the main laws of physics: law of conservation of energy. But market profit is stronger than this law.

Meanwhile, engineering practice has already proved that additional energy in the form of heat is generated in the ventilation systems and in the systems of water cavitation. Thorough scientific analysis of this problem shows that physical vacuum is the most probable source of additional energy in the systems of ventilation and water cavitation. Valence electrons of destroyed molecules of water take energy from physical vacuum and release it during repeated fusion of these molecules.

Why is additional energy generated in the air systems of ventilation and in systems of water cavitation? Because they are mechanical systems and mechanical destruction of chemical links requires half energy as compared with thermal destruction of these links. This is the main reason why one fails to increase energy performance index of cavitation processes over 200%.

Certainly, an increase of efficiency of any process by 30 or 50% is a good result; if it is obtained, it is possible to get even better one. But what if a water molecule is destroyed not mechanically, but electrodynamically? In this case, it becomes possible to find resonance frequencies of influence on the molecules and therefore to reduce considerably expenses of electrical energy for their destruction. Subsequent fusion of destroyed molecules will release determined quantity of energy unavoidably. It is a simple idea, and it has already been implemented. At electrodynamic influence on water molecules, electrical energy is converted into thermal energy with tenfold energy performance index. It means that if we spend 1 kWh of electric energy, we will get 10 kWh of thermal energy. To obtain such results, it is necessary to have knowledge of physchemistry of the microworld, which corresponds to knowledge of the 21st century, and it has already been published. Every month more than 1000 foreign scientists become familiarized with this knowledge at
http://Kanarev.innoplaza.net and
http://book.physchemistry.innoplaza.net.
The Russian speaking readers get this information from:
http://www.n-t.org/tp/ns/if.htm,
http://www.ikar.udm.ru/sb28-2.htm and
http://www.n-t.org/tp/ts/eb.htm.

I hope that now the readers will know the essence of the notion "global energy" and will understand those results of scientific researches which can really solve the related problems.

Energy Balance of Fusion Processes of Oxygen, Hydrogen and Water Molecules

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There is revealed the cause of appearance of additional energy during formation of covalent bonds in the fusion processes of oxygen, hydrogen and water molecules, besides the source of this energy is described.

Introduction

Engineering practice connected with servicing of ventilation systems allows revealing appearance of excessive thermal energy in circulated air. Similar phenomenon has been registered in systems of water circulation with the devices for its active cavitation. The results of our investigations explain not only a cause of these phenomena, but they give an opportunity to perform quantitative calculations for energy processes, which generate additional thermal energy [1], [2], [3], [4], [5].

Theoretical part

An oxygen atom is the eighth element of the periodic table. It is situated in the sixth group. The structure of its nucleus is given in Fig. 1 [1], [2], [3].

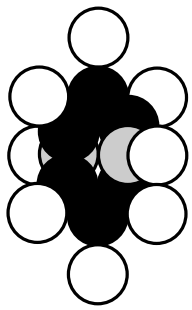

Fig. 1
Diagram of nucleus of oxygen atom: light – the protons, dark and grey – the neutrons

In Fig. 2 a diagram of the oxygen atom originating from the structure of its nudeus is given (Fig. 1). It has eight electrons. The electrons situated on the axis of symmetry are the most active ones (1, 2). Other six electrons situated in the plane, which is perpendicular to the axis line (a line of symmetry), by means of their total electric field remove electrons 1 and 2 from the nucleus at a large distance at that forming conditions for their large activity during the interaction with the electrons of the neighbouring atoms [1], [2], [3].

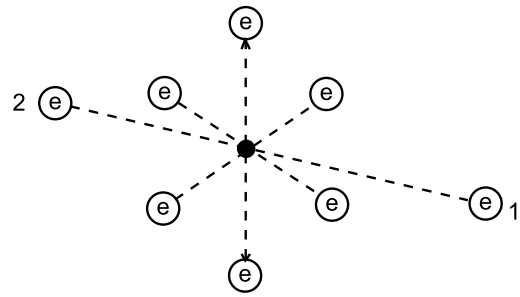

Fig. 2
Diagram of the oxygen atom

The least ionization energy of the electron of oxygen atom is equal to E_i=13.618 eV. Binding energy of this electron with the atomic nucleus corresponding to the first energy level is equal to E_1=13.752 eV. Let us call this electron the first one. The calculation of energy indices of this electron, including its binding energies E_b with the atomic nucleus, according to the formulas (1) and (2), gives the following results (Table 1) [1], [2], [3].

$$E_{ph} = E_i - \frac{E_i}{n^2} = E_i - \frac{E_1}{n^2} \qquad (1)$$

$$E_b = \frac{E_1}{n^2} \qquad (2)$$

Table 1
Spectrum of the first electron of the oxygen atom

Values	n	2	3	4	5	6
E_{ph} (exp.)	eV	10.18	12.09	12.76	13.07	13.24
E_{ph} (theor.)	eV	10.16	12.09	12.76	13.07	13.24
E_b (theor.)	eV	3.44	1.53	0.86	0.55	0.38

The oxygen molecule structure is given in Fig. 3, a. It is formed by means of a connection of unlike magnetic poles of axis electrons of two oxygen atoms [1], [2], [3]. It is known that the fusion process of the oxygen molecules is accompanied with a release of 495 kJ/mole of energy, or in calculation for one molecule

$$E_b = \frac{495 \cdot 1000}{6{,}02 \cdot 10^{23} \cdot 1.602 \cdot 10^{-19}} = 5.13eV. \quad (3)$$

What principle does the Nature follow by distributing energy of 5.13 eV between the electrons of oxygen molecule (Fig. 3, a)? Energy of 5.13 eV is a thermal binding energy between the electrons 1 and 2' of two oxygen atoms (Fig. 3, a). When the oxygen molecule is formed, it is emitted in the form of the photons by the electrons, which enter into the bond. Hence it is equal to an amount of energies of two photons emitted by these electrons. Consequently, each contacting electron emits a photon with energies of 5.13/2=2.565 eV=E_b (Fig. 3). According to Table 1, in this case the valence electrons are situated between the second energy level and the third one [1].

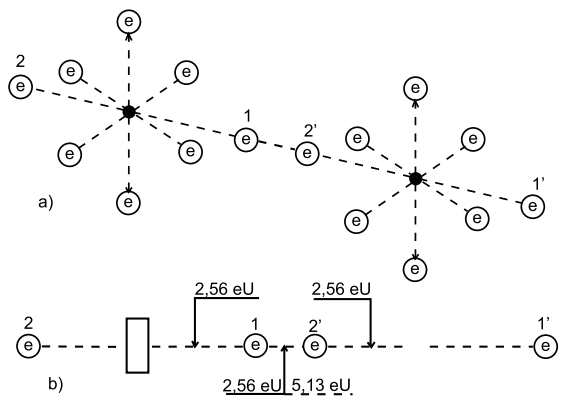

Fig. 3
Diagram of binding energy distribution between the electrons in the oxygen molecule

Two oxygen atoms are combined into a molecule in an excitation state. The excitation state is the state of an atom when its valence electrons are situated at such distances from the nuclei when the binding energy E_b between them is reduced to the thousandth of fractions of an electron-volt. In such state the atom can loose an electron and become an ion. Otherwise, without loosing electrons it is combined with an electron of the neighbouring atom by the valence electron, and a process of formation of oxygen molecule begins. It is an exothermic process when the axis valence electrons 1 and 2' emit photons, descend on lower energy levels and release 2.565x2=5.13 eV.

Let us pay attention to the fact that energy 5.13 eV is released by two electrons, which form a bond with energy of E_b=2.56 eV. In modern chemistry this bond is called a covalent bond. In order to break this bond it is necessary to use 2.56 eV of mechanical energy. For thermal cleavage of this bond, double quantity of energy is required, i.e. 5.13 eV. It is explained by the fact that the photon energy of 5.13 eV is absorbed by two electrons simultaneously. Only in this case, both electrons will be transferred to the highest energy levels with minimal binding energy E_b when they are disconnected, and each oxygen atom becomes a free one.

Thus, energy expenses for destruction of oxygen molecule depend on the method of influence upon the bond. During thermal action upon the bond it is destroyed when energy is 5.13 eV. During mechanical effect upon the bond, it is necessary to spend 2.56 eV of energy in order to destroy this bond. Therefore energetic of fusion process of the oxygen molecule depends on method of its destruction.

After thermal destruction of the oxygen molecule process of its formation begins from emission of the photons with energies of 2.56 eV by both valence electrons, and the previous electrodynamics binding energy (E_b=2.56 eV) is restored between the electrons of both atoms.

Thus during thermal destruction of the oxygen molecule the same amount of thermal energy is spent than that which is released during its further formation. No additional energy appears during thermal dissociation of oxygen molecule and at its further fusion.

If oxygen molecule is destroyed by a mechanical method, then it is necessary to spend 2.56 eV of mechanical energy for this purpose. Valence electrons of oxygen atoms are in a free state at lack of energy, which corresponds to such state, as there is no process of absorption of 2.56 eV of energy by each of them. The electrons cannot remain in such state; they should replenish immediately the energy, which they have failed to receive during a mechanical break of the bond between them. Where should they take it from? There is only one source: the environment, i.e. the physical vacuum filled with aether. They convert aether into energy of 2.56 eV immediately. The next stage is a connection of two oxygen atoms, whose valence electrons have replenished the reserves of their energy by means of aether. This process is accompanied by emission of the photons with energies of 2.56 eV by two electrons. Thus energy of absorbed aether is

converted into thermal energy of the photons. If we spend 2.56 eV of mechanical energy for destruction of oxygen molecule, we will get double quantity of energy (2.56x2=5.13) eV during further fusion of this molecule. Additional energy is equal to 2.56 eV.

Much experimental data show that in ventilation systems thermal energy of circulated air exceeds electric energy spent for a fan drive. Now we know that this energy is generated at mechanical destruction of covalent bonds in the molecules of gases, which the air consists of.

Using the above-mentioned method, let us analyse energetic of water molecule, which sometimes generates additional thermal energy. A water molecule consists of one oxygen atom and two hydrogen atoms. Binding energies E_b of the hydrogen atoms with its nucleus are given in Table 2 [1], [2], [3].

Table 2
Spectrum of hydrogen atom

Values	n	2	3	4	5	6
E_{ph} (exp.)	eV	10.20	12.09	12.75	13.05	13.22
E_{ph} (theor)	eV	10.198	12.087	12.748	13.054	13.220
E_b (theor.)	eV	3.40	1.51	0.85	0.54	0.38

It is known that combination of hydrogen and oxygen is accompanied by an explosion, but its cause remains unknown. Let us try to find it.

Energy of fusion of hydrogen molecule is equal to 436 kJ/mole, or 4.53 eV per a molecule. As the molecule consists of two atoms, then the above-mentioned energy is distributed between them. Thus energy of one bond E_b between the hydrogen atoms is equal to 2.26 eV (Fig. 4). At mechanical destruction of this bond 2.26 eV is enough. At thermal destruction of this bond double quantity is required (2.26x2=4.53 eV) [1].

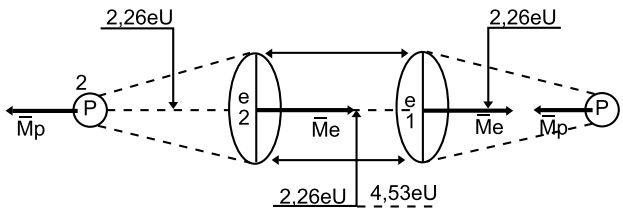

Fig. 4
Hydrogen molecule

In order to form two water molecules, it is necessary to break two hydrogen molecules and one oxygen molecule into atoms. At mechanical destruction of covalent bonds 2.26x2=4.53 eV is required to break two hydrogen molecules and 2.56 eV to break an oxygen molecule. Sum of these energies is equal to 7.13 eV. If the destruction processes of the above-mentioned molecules are carried out with a thermal method, then 4.53+4.53=9.06 eV is required for the destruction of two hydrogen molecules, and 5.13 eV is required for the destruction of one oxygen molecule. In total, it is equal to 14.19 eV. The difference between the energy spent for mechanical and thermal destruction of covalent bond of hydrogen and oxygen molecules is almost double.

It is known that during fusion of one mole of water 285.8 kJ or $285.8 \times 1000/6.02 \times 10^{23} \times 1.6 \times 10^{-19}$=2.96 eV per a molecule are released. As a water molecule consists of one oxygen atom and two hydrogen atoms, 2.96/2=1.48 eV falls per the bond (Fig. 5). Hence the electrons of hydrogen and oxygen atoms in water molecule are between the forth energy level and the fifth one at the usual temperature (1.48/2=0.74 eV = E_b), Table 1, 2 [1].

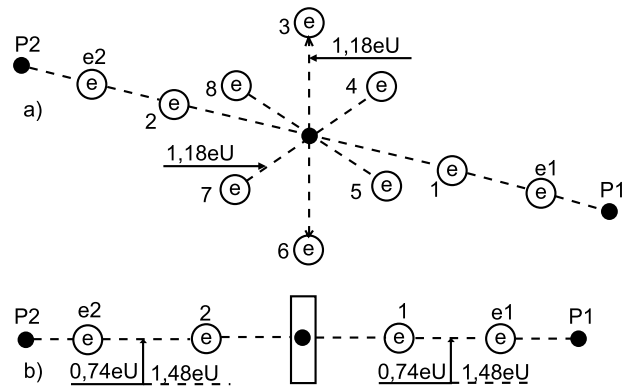

Fig. 5
Diagram of water molecule:
1, 2, 3, 4, 5, 6, 7, 8 are the numbers of the electrons of oxygen atom; P_1, P_2 are the nuclei of the hydrogen atoms (the protons); e_1 and e_2 are the numbers of the electrons of hydrogen atoms

Thus when two hydrogen molecules $2H_2$ and one oxygen molecule O_2 are destroyed by the thermal method, 14.19 eV are spent. As a result of fusion of two water molecules ($2H_2O$), 2.96x2=5.98 eV is released. There is some disbalance here since fusion process of water molecule is an exothermic one and 2.96 eV is released by one molecule. The given calculation shows that (14.19-5.98)/2=4.10 eV is absorbed during fusion of one water molecule. What is the cause of this contradiction?

The oxygen atom in the water molecule should reduce its volume when the transition from gaseous state into

liquid state takes place. It will happen when the ring electrons of oxygen atom descend on lower energy levels (nearer to the nucleus). They will emit the photons and their total energy will be equal to energy spent to destruction of two hydrogen molecules and one oxygen molecule, i.e. 14.19 eV. Since two water molecules have 12 ring electrons, each of them will emit 14.19/12=1.18 eV= E_b (Fig. 5). It is more than energy (E_b=0.74 eV) of binding of axis electron with the nucleus, and it shows that the ring electrons are situated nearer to the nucleus than the axis ones.

In this case quantity of energy produced due to fusion of two water molecules (14.19+5.98) eV exceeds energy, which was spent for the destruction of two hydrogen molecules (9.06 eV) and one oxygen molecule (5.13 eV). Energy difference of 5.98 eV is divided between two water molecules. It means that 5.98/2=2.99 eV or 285.8 kJ/mole fall per a molecule. It corresponds to the existing experimental data completely [1].

The above-mentioned facts clarify a cause of the explosion, which takes place when hydrogen is combined with oxygen. Simultaneous transition of six ring electrons of each oxygen atom in the nascent water molecules to lower energy levels is accompanied by simultaneous emission of the photons, which generate explosion phenomenon.

Let us pay attention to the fact that two binding energies E_b between valence electrons e2 and 2 and between 1 and e1 are shown in Fig. 5, b. Energy of one electrodynamics bond is equal to E_b= 0.74 eV. If this bond is destroyed by the thermal method, 0.74x2=1.48 eV is required. This energy will be released during further fusion of the water molecule from hydrogen atom H and hydroxyl ion OH^-. In this case, no additional energy is generated.

Therefore the given bond is destroyed by the mechanical method spending 0.74 eV per a bond, each electron will have energy deficit equal to 0.74 eV after bond destruction. This energy will be immediately absorbed from the environment and will be emitted during the repeated fusion of the water molecule from the hydrogen atom H and the hydroxyl ion OH^-. At mechanical destruction of one bond of water molecule, the covalent chemical bond forms E_b= 0.74 eV of additional thermal energy, which is registered in systems of water cavitation constantly (as we have already noted) [1], [2], [3].

It is known that water molecules combine and form clusters. If the bonds between the molecules in the clusters are covalent ones, mechanical destruction of these bonds should be accompanied by a release of additional thermal energy as well [1], [2], [3].

Experimental Part

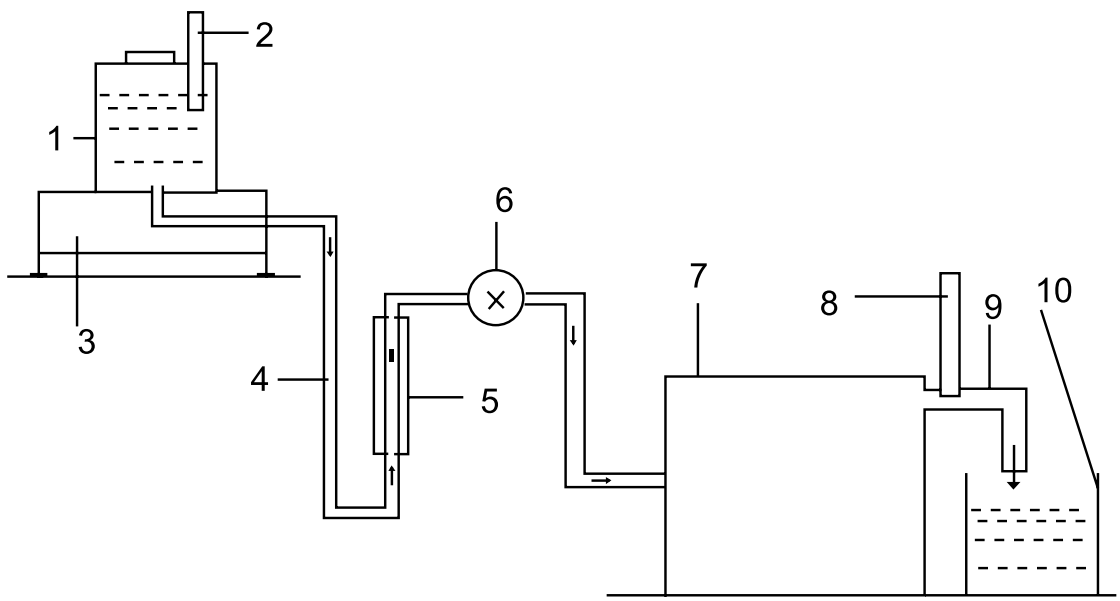

Fig. 6

Diagram of the experimental device: 1 - reservoir for solution; 2 - thermometer; 3 - electronic scales; 4 - solution supply duct; 5 - rotameter; 6 - feed solution regulator; 7 - a special thin plasma reactor is in the process of patenting; 8 - thermometer; 9 - discharge of heated solution; 10 - inlet reservoir

Thus, chemical bonds between the atoms in the molecules and the molecules in the clusters can be destroyed mechanically, by electrodynamic and thermal influence. We have already shown that the mechanical way of destruction of such bonds requires half energy as compared with thermal energy. It appears from this that energy expenses for electrodynamic destruction of these bonds should be less than thermal expenses as well. Electrodynamic impact on the bond gives the opportunity to form the resonance modes where energy expense for the destruction of these bonds is reduced to greater degree. In order to check this hypothesis a special experiment was carried out. It was connected with electrodynamic destruction of chemical bonds of water molecules with a changing frequency of impact. To test this hypothesis the check experiment was prepared and carried out by (besides the author of this article) A.I. Tlishev, G.P. Perekotiy, D.A. Bebko, D.V. Korneev. A diagram of the experimental device is given in Fig. 6. The results of this experiment are given in Table 3.

Table 3
Protocol of control test

Indices	1	2	3	Mean
1 – mass of the solution, which has passed through the reactor m, kg.	2.112	2.153	2.118	2.128
2 – temperature of solution at the input of the reactor t_1, degrees	24	24	24	24
3 – temperature of the solution at the output of the reactor t_2, degrees	33.5	33.5	33.5	33.5
4 – differential temperature of the solution $\Delta t = t_2 - t_1$, degrees	9.5	9.5	9.5	9.5
5 – durability of the experiment $\Delta\tau$, s	300	300	300	300
6 – reading of voltmeter V, B	25.0	25.0	25.0	25.0
7 – reading of ammeter I, A	1.40	1.40	1.40	1.40
8 – electric power consumption according to indices of voltmeter and ammeters, $E_2 = I x V x \Delta\tau$, kJ	10.50	10.50	10.50	10.50
9 – power spent for heating of the solution, $E_3 = 4.19 x m x \Delta t$, kJ	84.10	85.70	84.31	84.70
10 – reactor efficiency index according to the reading of voltmeter and ammeter $K = E_3 / E_2$	**8.00**	**8.16**	**8.03**	**8.06**

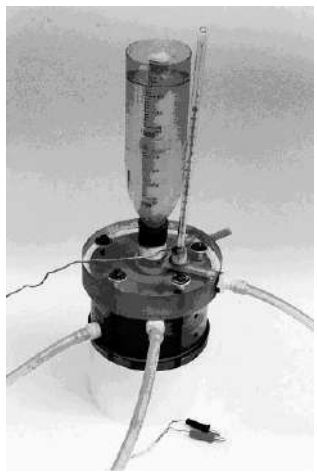

Fig. 7
Photo of heat reactor

In the Russian market three firms (Yusmar, Termovikhr and Noteka) sell cavitation water heating equipment with energy efficiency index of 150%. Soon, an air heating devices with the same efficiency will be produced. The processes of mechanical destruction of covalent bonds of the air gas molecules, molecules and clusters of water and their further fusion serve as a source of additional energy generated by these devices [1], [2], [3].

Conclusion

Analysis of energy balance of the molecules with covalent bonds shows the possibility of additional thermal energy formation during mechanical and electrodynamics destruction of these bonds.

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The Fourth State Of Matter (Plasma Energy) Power Generation

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Under the proper configurations and in the correct pre glow discharge environment more electrons can be released than what is required to trigger the release. This release of energy attains a high frequency oscillation that is indicative of the metal or metals involved in its release.

The release of high frequency energy from metals and semi metals (semi conductors) through the mechanism in the pre-glow discharge leads to the generation of radiant energy. This correlation has been identified through my findings. The release of high frequency energy from the atoms of electrical conductors is credited to my identification of the mechanism in the pre-glow discharge, or fourth state of matter. This has lead to extremely efficient alternative energy circuits.

The release of high frequency energy from the atoms of electrical conductors is credited to my identification of the mechanism in the pre-glow discharge, or fourth state of matter. This has lead to extremely efficient alternative energy circuits.

The pre-glow discharge condition occurs when a sufficient amount of charge difference is applied across the gap of two electrical conductors. It makes a hissing sound if the electrodes are surrounded by air. The electrical properties between this gap change: electrons become "stripped" from their respective atoms and are liberated. In this state, air is **ionized** and is transformed into a **plasma** and is no longer a gas. It is now in the fourth state of matter, the other three being solid, liquid, and vapor (gas). The fourth state of matter is a good conductor of electricity, its average resistance being much lower than that of the same substance in its gaseous state.

A good readily available spark gap combination is lead and iron. This combination generates plenty of radiant energy and causes noise to be heard on a radio in its vicinity. As a general rule, the better the thermoelectric difference between the dissimilar couple the more radiant energy that will be generated when it is exposed to a plasma field.

Early in the summer of 1981, the pre glow had first caught my attention. This is where I had observed it between two plastic insulated hook-up wires from radio shack. The plasma between the two wires was called into existence because of a high voltage power supply that I had obtained for my electrogravitic experiments. The two wires were twisted together and given a charge of around ninety kilovolts.

It was not until 1989 when I observed a high frequency signal on my oscilloscope coming from the pre-glow discharge phenomenon. These signals were coming from across the room and originated from a crude component that I had built. This crude component consisted of a guitar wire that was centered through a section of PVC tubing. Around this tube was wrapped a coil of insulated transformer wire. This was my first ion-valve. It was excited with the same power supply where I had observed the plasma effect several years previous.

I knew that my ion valve was generating high frequency oscillations using air ions but did not find any practical applications for it until six years later. It was in this year (1995) when I realized the importance of the ion valve and its associated high frequency ion field, known as radiant energy to Moray, it being the essential principle behind his energy receiver.

In one experimental set-up, it was confirmed that when a charged capacitor is discharged through a spark gap that the stored energy is transferred by way of high frequency electrical oscillations. It was found that these oscillations occur directly before the discharge of the capacitor, thus the term, pre-glow discharge. It was found that during the pre-glow discharge plateau, energy is transferred from a primary to a secondary electrical coil. Directly after pre-glow discharge, a surge of current is measured. At the point of current surge is where most

of the stored energy in the capacitor is released as wasted heat. It was apparent that by maintaining the pre-glow discharge plateau a very efficient mode of energy transfer and conversion can be obtained. Logically what is required is a control mechanism. This is where my ion valve finds its niche. Upon further investigation, it is found that it keeps pre-glow discharge oscillations at their plateau, and suppresses current surge in a spark gap. It is a self-regulating quenching device. When it is placed in series with an air-core transformer and arc gap, its plasma hisses smoothly, the arc in the spark gap is almost silent and is very small. Continuous oscillations can be seen on an oscilloscope. A light bulb connected to the secondary will glow brightly. This result is not possible without the ion valve included in the circuit. The ion valve has the added feature of preventing back electromotive force, generated from inductive loads, from being discharged back through the circuit. Without the ion valve, energy is normally lost when it is discharged and is transformed into heat. Using the ion valve therefore has the effect of conserving energy.

Fundamental Radiant Energy Device

"Standard" scientific principles are not being violated. There is no fringe science involved with radiant energy power generation. This is a very old source of energy being extracted and harnessed in a unique way through my discoveries. What I have discovered is practically a limitless source of energy. Radiant energy has existed since the beginning of time. What I hold daim to is an improved method to generate and to convert radiant energy, kinetically active ions, cosmic energy, call it what you will, into useful electrical power. Think of the radiant energy power generator as a type of energy detonator that liberates great quantities of energy with only a small exciting spark. No laws of physics are being violated. No new laws are being implied. They are being expanded. The concept is not that much different from how a lighted matchstick is able to start a bonfire.

The power generated from my circuits comes from the transformation of matter into radiant electricity. It does not come from the splitting of atoms. To obtain high wattage from a spontaneously radioactive substance would require unsafe amounts of radioactive material.

Under the right conditions, ordinary matter can be made to generate intense surges of radiant energy that can be heard on a radio receiver as static noise. Build a device that can efficiently capture this energy and convert it into useful electrical currents and you will have yourself a powerful source of electrical power. This device will be powered by artificially disintegrating matter as described by Gustave Le Bon in his book "The Evolution of Matter" and in his book "The Evolution of Forces".

Energy and matter are two distinct entities of the same manifestation. Matter represents a stable condensed form of energy. Heat, light, electricity, etc., are uncondensed vibrations of matter oscillating at differing rates. "Cosmic Energy" is the term that Le Bon used to define matter and energy as being one and the same manifestation. He theorized that when stable matter is disintegrated it is transformed into energy that we recognize as heat, light, electricity, radioactivity, etc.

Semiconductors will generate intense surges of electron oscillations that become powerful sources of radiant energy. A simple **ion valve**, or call it what you will, can be used to generate and convert this form of radiant energy into useful electromagnetic oscillations. A tuned transformer can be used to directly convert these oscillations into to a practical voltage and amperage. This unique valve is shown in Fig. 1. Before it can function it must be connected to a suitable voltage source. The circuit in Fig. 2 demonstrates the full working concept. Other embodiments are also possible. The proof of concept circuit reveals how radiant energy can be generated and converted into useful electrical currents. Many additional stages can be added for more power. Many other circuit and component configurations can also be used but the fundamental conversion principle remains the same. The circuit and components shown should give you a very clear idea of how the technology works. The actual mechanics and electronics of building and validating a radiant energy prototype are relatively simple. Contrary to what some people might think, dangerous levels of radioactivity are never used in my devices.

Ion-valve Converter Technology Explained

The ion-valve converter (ion-valve) shown in Fig.1 has an axial negatively charged tungsten cathode wire that extends the length its cylinder and is capable of emitting secondary electrons. The anode cylinder is positively charged and is made from a semiconductive material that will readily capture electrons.

Within a few milliseconds the accumulated negative ions are attracted to the positively charged onrushing atomic ions. When the negative and positive charges collide they

neutralize each other generating high frequency electrical oscillations.

There appears to be a common thread shared between several alternative energy devices. It is the pre-glow discharge. The report on the **Hans Coler** device released by the British Government indicates that there is excess energy released when electrical contacts are opened and closed. The **Lester Hendershot** device utilized a buzzer circuit that opened and closed its electrical contacts. In the **Alfred Hubbard** coil pre-glow discharge flowed through electrical contacts, a distributor cap and radium soaked spark plug. The **Joseph Newman** motor used a sparking commutator. **Thomas Moray** invented a glowing, cold cathode discharge tube that was the heart of his radiant energy device. **Hermann Plauson** was granted U.S. Patent No. 1,540,998 that used spark gaps to convert atmospheric energy. **Frank Wyatt Prentice** was granted Canadian Patent No. 253,765 that detailed his invention, which lighted 50 sixty-watt carbon lamps with an input of only 500 watts. His invention utilized a spark gap driven high frequency tuned resonant system. **Chancy Britten** used ion-valves constructed with a central wire that was surrounded by a coil of wire which is described in his US Patent No. 1,826,727. Britten's valve was said to have lit up his home in the 1930's according to a local newspaper article of that time period. **Alexander Chernetski** experimented with what appears to have been a type of ion-valve that was filled with hydrogen gas. It is said that he got up to five times more energy out of his device than what he put into it. **Edwin Gray** was granted U.S. Patent No. 3,890,548 for his efficient spark gap driven capacitive-discharge motor. He improved on this patent by replacing the spark gaps with a pre-glow discharge switching tube. His U.S. Patents No. 4,595,975 and No. 4,661,747 describes this tube in detail. Gray's patents claim to conserve battery power by sending unused energy back to the supply batteries. On close examination, we also find that his switching tube is actually a quenching device.

Radiant energy was generated during the pre-glow discharge cycle that also contributed to recharging the batteries. **Paulo N. Correa** and **Alexander N. Correa** obtained patents to a pulsed pre-glow discharge system that recovers energy and recharges a battery.

I have found that radiant energy is generated when a plasma field is in contact with the atoms of an electrical conductor. Most importantly, the quantity of radiant energy is greatly increased when the plasma field occurs between the inter-electrode couple of two differing electrical conductors. That, the wattage produced will depend largely on the type of electrode materials that are used. I do not suspect that the above referenced inventors were aware of this amplifying mechanism.

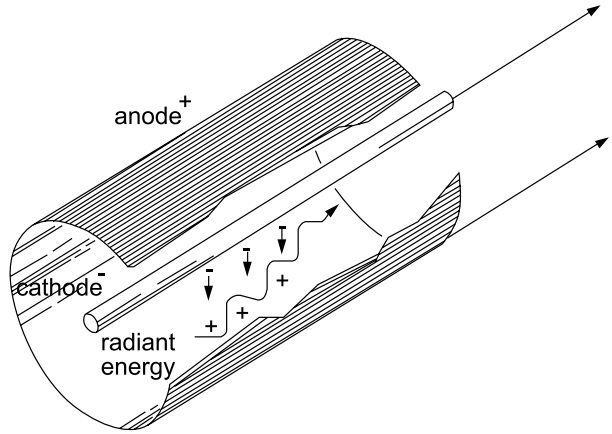

Fig. 1

Ion Valve

In the embodiment in Fig. 1 the negative charge on the wire in the ion-valve negatively ionizes any gas that contacts it. These ions rush towards the positively charged cylinder. When a metal ion that carries an excess electron hits head-on with an elementary differing positively charged onrushing metal ion a violent union of the two metals occurs. This causes the newly formed bimetallic alloy to violently oscillate, break up (dissociate) and to liberate a burst of electrons. The **"sea electron model"** helps to explain this effect. According to the sea electron model metals are bonded to each other through electron sharing. The model suggests that metal atoms be bathed in a sea of valence electrons. If this model is taken one step further it can be seen that when metallic atoms are dissociated from each other excess electrons are released in the form of electrical oscillations of high frequency (radiant energy). This occurs because the electrons no longer take part in the inter-atomic binding force that existed before the dissociation took place. It becomes clear that the freed electrons will add amperage to the output circuit to which it is connected. Henceforth, the equation **I x E = P** holds true in this system. Where, "I" represents the electrons (amperage), "E" electromotive force (ionic voltage), and "P" the power generated.

Obtaining Electrical Energy from the Transformation of Cosmic Energy

Matter is cosmic energy in a condensed state according to Le Bon and Moray. What this means is that matter can be excited its plasma state and caused to rapidly disintegrate transforming itself into electricity.

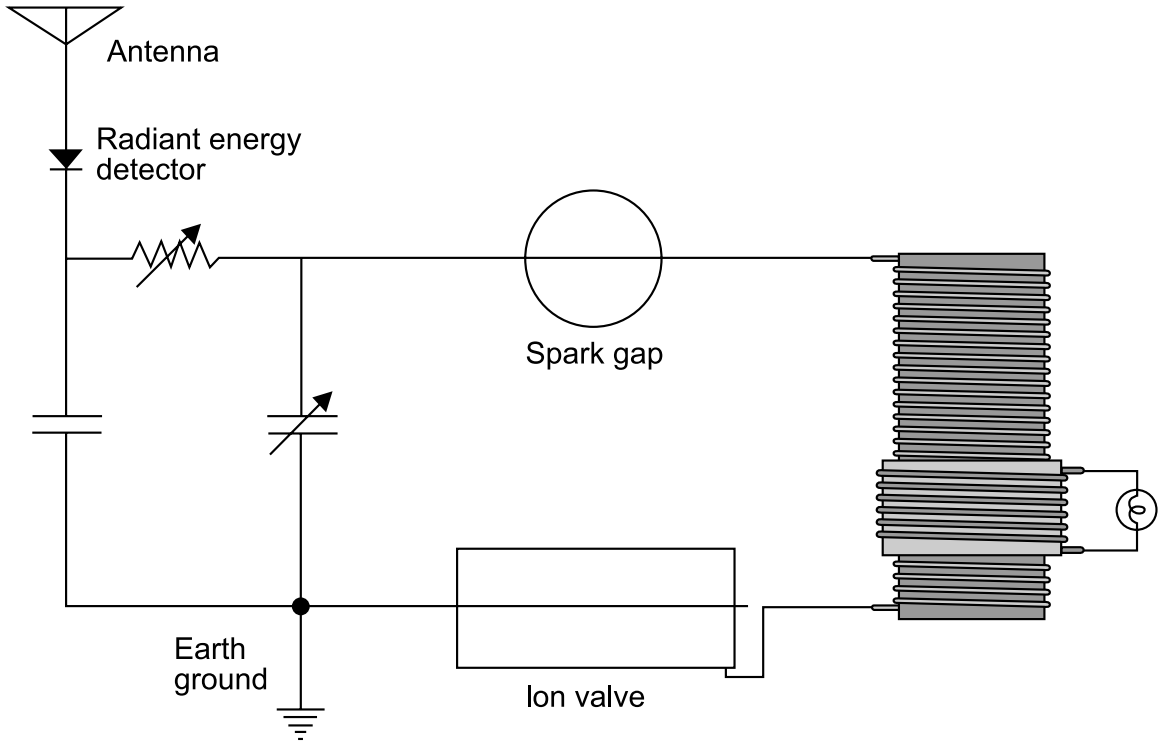

Fig. 2

Proof of Concept

The proof of concept shown will obtain energy from the dissociation of matter bringing the circuit to life. It does this by creating a plasma field between differing electrical conductors. Electrons are unleashed and feedback to the circuit where they are converted into useful power.

Plasma oscillating on the correct wavelength will act like a spark on a mass of explosive material but releasing electrical particles instead of heat. This is to say that the excited fourth state of matter (plasma) causes condensed energy (solid matter) to become uncondensed (radiant energy). The reaction will be far superior to the force that invoked it in the first place because the energy stored in matter is released. The energy that is condensed in the elements of matter is immense. The result is that an enormous amount of energy is released with only a slight loss of matter. Gustave Le Bon proved this when he demonstrated that the action of solar light and from electric arcs on bodies produced electric particles similar to those of uranium. He showed that it caused all bodies to disintegrate to different degrees.

the excited fourth state of matter (plasma) causes condensed energy (solid matter) to become uncondensed (radiant energy). The reaction will be far superior to the force that invoked it in the first place because the energy stored in matter is released

According to the law of conservation, when we give to a material body a determined quantity of energy, this energy might be transformed, but the body will never give back a quantity in excess of what it received. This principle is considered too self-evident to be disputed. It makes sense that matter can only give up energy that is given to it and is unable to create excess energy. Without violating this law, matter can be excited into giving up its stored inter-atomic energy. Condensed matter can become uncondensed if its oscillations become violent enough and henceforth transforming itself into radiant energy. No laws have been violated. They have been expanded. The first law of thermodynamics describes the principle of the conservation of energy. It states that "energy is not created or destroyed; it merely changes form". The fact is that the creation or destruction of energy is a result of matter being broken down or built up. They both go hand in hand.

Naturally occurring radioisotopes were created through the billions of years of **cosmic ray** bombardment of ordinary matter. Their matrixes became unbalanced. The

correct trigger will cause these isotopes to seek their original balanced state. Enormous amounts of electrical energy can be obtained from the transformation of stored cosmic energy. These isotopes contain a very old energy reserve that can be released in a unique way with my discoveries.

Have you ever wondered about spontaneous radioactive decay? Is it really a super charged state of matter? If an atom can become ionized by either gaining or by losing electrons then why can there not be a nuclear ionization too? I hypothesize that atoms do become ionized on the nuclear level by gaining or losing neutrons. This may appear incidental but could be at the very heart of an ultra-chemistry. It is highly probable that this hypothesized phenomenon is behind natural spontaneous radioactive decay and explains many unanswered questions about nuclear science.

Liberated Energy

With a slight excitement from a pre-glow discharge in a spark gap, or even with no excitement at all, as we observe in spontaneously disintegrating radioactive bodies, such as U235, we can obtain large quantities of energy. Clearly, we did not create this liberated energy, since it already exists in matter, but we release it under the right conditions. This is being done without violating the law of energy conservation. The idea that matter could be transformed into energy was absurd before the acknowledgement of nuclear transformations.

A Nu Science is on the horizon. It involves the means of transforming matter into energy without splitting atoms. This science recognizes several isotopes of matter that spontaneously liberate energy as observed in naturally occurring radioisotopes. My research indicates that it is also possible to artificially speed up the natural decay process of condensed energy (matter) using a minute plasma field, as from a pre-glow discharge, etc… With a very small quantity of energy, we will be able to produce a very large quantity of energy without splitting the atoms.

Capture Capacitor

Nature offers us cosmic energy that manifests itself in many different forms. Electricity is only one of its manifestations. From this knowledge, we can obtain electrical power with no moving parts. The natural world contains many storehouses of this cosmic energy. Energy is all around us just waiting to be transformed. The capture capacitor is one such example. It is called a capture capacitor because it captures and transforms electrical charge into electrical current. It does this with the aid of naturally occurring radioactive matter (N.O.R.M.). Put a pair of dissimilar metal electrodes together with a porous ceramic dielectric material sandwiched between them, along with a weak electrolyte and you have built a capture capacitor. In a low power capture component there exists a minute impurity of N.O.R.M. It is always present in clays and is usually present in ceramic materials.

If you want a capture capacitor to generate more power all you have to do is to add additional amounts of radioactive material to the dielectric. Lead–210 is the optimum choice because it has a half-life of around 22.3 years and is a pure beta (electron) emitter. Its half-life is almost twice as long as tritium. This means that it is feasible to build a component that will put out power for several years with little maintenance. Lead-210 is a decay product of radon gas. The parent source of radon is uranium. Therefore, uranium ore can be powdered and mixed into the ceramic material.

The atomic ions emitted from naturally occurring or artificially induced radioactive transformations can be directly converted to electrical power. The circuit shown can be used to convert radiant energy into useful electrical currents. Additional stages can be added for more power. The circuit shown gives a general idea of how such an energy conversion device functions. By no means is this technology limited to this one circuit, configuration, or source of radiant energy.

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A new type of high field superconducting magnet from Oxford Instruments has enabled physicists at the University of Nottingham to balance the force of gravity and levitate heavy and dense materials such as lead, gold and diamonds. The patented Minimum Condensed Volume™ (MCV™) Cryofree™ superconducting magnet, developed and manufactured by Oxford Instruments in collaboration with the University of Nottingham, is the first of its kind in the world. Unlike conventional superconducting magnets, the MCV magnet never needs to be refilled with liquid helium and yet can generate a field over 300,000 times stronger than the Earth's magnetic field. MCV has a very small footprint and, operating at 4.2 K with a room temperature bore, can generate highly stable magnetic fields up to 16 Tesla.

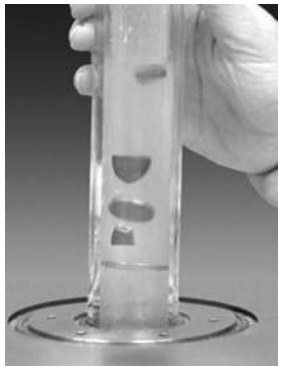

http://www.oxford-instruments.co.uk

Polish inventor Zygmunt Orlowski called attention of the scientific society to his perpetual motion machine **METOZ**, which according to the author after further improvement will be able to extract energy from the earth's gravitation.

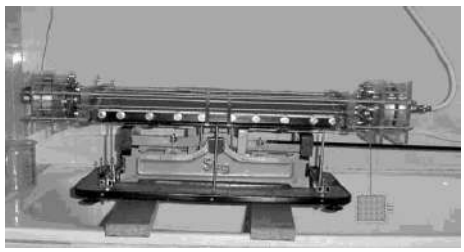

http://www.nets.pl/~metozor/perpetual_motion_machine.htm

It is necessary to change behavior of people in order to decrease environmental damage. This was the message of **"Green Week 2003"** which took place since June 2 through June 5 in Brussels.

The conference's key issues were three aspects of United Europe environmental policy: sustainable production and consumption, renewable energy and water supply.

Green Week is the first environmental forum of such a scale. Three thousand participants from all over the world represented governments and funds, industry and mass media. The exhibition organized in the framework of Green Week included 62 displays from 14 European countries and were dedicated to the newest environmental technologies and projects. During the Green Week 26 conferences and seminars took place, as well as a great number of press conferences and actions for young people.

British researchers (Gardner Watts company) **believe that they have made a groundbreaking scientific discovery after apparently managing to "create" energy from hydrogen atoms.**

The device represents "thermal energy cell" which appears to produce hundreds of times more energy than that put into it. If the findings are correct and can be reproduced on a commercial scale, the thermal energy cell could become a feature of every home, heating water for a fraction of the cost and cutting fuel bills by at least 90 per cent.

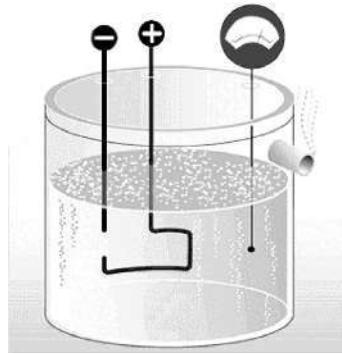

http://www.telegraph.co.uk

Gravity Conversion Rotary Device

The below figure is from
http://www.theverylastpageoftheinternet.com/newclaims/GravityMotor/gravity_motor.htm

Does it really work?

THE MARCUS DEVICE CONTROVERSY

Tim Ventura, USA

Email: tventura6@attbi.com
http://www.americanantigravity.com
http://www.americanantigravity.com/marcus.html

Editorial: This overview is devoted to the fantastical device created by inventor Marcus Hollingshead that encountered more than its share of publicity and controversy between November 2002 and March 2003. You can participate in discussion on aggroup@yahoogroups.com.

The problem with Marcus has been that he was pressured by too many people to produce too fast results. I started talking to him in November, and he is always sounded like an honest, rational man with a good heart. The problem is that once people started to hear his private claims that he could lift something like 2 tons of weight, things kind of went south.

While people in general have been very well-meaning, they are desperate to solve many of our current energy-problems, and when Marcus appeared with a potential solution it got out of control. Pretty soon film crews were showing up at his house unannounced, and he was getting unwanted phone calls from people who had looked up his number online.

In my opinion, it is really a problem of a "social dynamic" at work here – too many people, with too much access, all at once. This also correlates to the type of person that different people are. For instance, I am a very open person, and I really do not value my privacy a heck of a lot — therefore, when TV crews drop by with 5 minutes notice (and they have), I tend to just let them in for a demo. However, Marcus, who is much more of a private person, seems to have become a bit overwhelmed at this proposition.
Also, keep in mind that I had initiated working with the media because I felt that it was time for the excellent work in the Lifters groups to see the light of day. There was some debate about this, but the Lifters group as a whole has greatly benefited from being about to tell people about this new technology.

Marcus had not actually "gone public" about his work. He had leaked information about his research to a few people, and from there it was leaked to several others, who in turn told their friends about it. Unlike the Lifter technology, which has hundreds of people that can talk about how it works and where it came from, Marcus technology was represented solely by himself. That means that everything surrounding his device came back ultimately to him alone. Without any real group ownership of the expertise behind the device

As I said before, Marcus was new to the publicity, and did not have time to prepare the resources that the rest of us have had to answer questions, provide demo materials, etc. Naudin and Saviour have a masterful manner with regard to teaching people about Lifter technology, but they have had years to prepare this information and perfect a method of presenting it to people.

Most of us in the AG groups tend to proselytize for the technologies that we believe in. I know that I do, and if you haunt the newsgroups much you will notice that everybody there believes in something and can go on for months non-stop telling the world about it (again, I do this). Marcus, however, does not really have this personality — he is more of a "take it or leave it" type of person.

For me, this was another indicator that he was the "real deal". You have to understand that I have never seen working prototype pictures of the Marcus device, and all that I had to go on was the feeling that I got from interacting with him on the phone and online. The fact that he did not try to "sell me" on the idea was a big plus. He told me about the device, and his story was always consistent. The other people that he talked to also had a consistent story – I have not talked to anybody and heard a different version than I heard from Marcus himself. That is a big plus from the credibility perspective.

Marcus initial goal (from when I started talking to him in November) was to gradually ease into working with

the public to tell them about the technologies he was working on. Unfortunately, I probably aggravated the issue a great deal, because his early descriptions of the technology might have gone unnoticed if it had not been for some of the things he had mentioned about his research.

When I read Marcus' firsts posts on the device, my very first thought about his claims was that they were bogus. Judging from the reaction of the Antigravity newsgroup, I gathered that a few other people also had the same initial reaction. The reason might be a little selfish – after you hear claims but do not see results for a long enough period of time, you tend to protect yourself emotionally by becoming skeptical to the idea that somebody can be lifting hundreds of pounds of weight using a completely new and revolutionary technology.

Nonetheless, something that Marcus had said resonated with me. I remember that he was talking about his results being based on a study of the Earth's fields, which is something that I had read about myself during the college years. Telsa had done a lot of work involving the Earth's electrical and magnetic-fields, and I had always felt that this research might come in handy later as a potential basis for Antigravity research. However, I did not have any specific ideas, and began asking Marcus questions offline to find out more about his research.

In reality, I am nobody special, so I think that perhaps this would have happened in any event no matter what my reaction would have been. Certainly I am not the only person that took an early interest in his work, and from what I learned later he had already been a little bit too honest in the BBC online newsgroup before he ever became involved with the Antigravity newsgroups.

From January to mid-February Marcus became like somewhat of an addiction in the newsgroups. This was a strange phenomenon to watch, but if he did not answer questions in the newsgroups for even a day people started asking whether he had been kidnapped or the government had assassinated him.

You have to understand that most inventors tend to segregate their time into "public" and "private". I do, Naudin does, and everybody does this. When you talk to the public about what you have built, you really get into it — but when you are actually working on it, you tend to hole up in the garage and put the entire world on "ignore" until you have finished with whatever it is that you are doing.

Marcus really started to get publicity in late November 2002, and it built up over a few week period of time. By mid-December, he had a healthy following in the Antigravity newsgroup and people in the 5 or 10 other AG newsgroups were developing more than just a passing interest. Great stuff for Marcus – he had thought that he was the only person doing this research, and it turned out that lots of people shared this common interest with him. We had lots of really valuable and productive exchanges.

Marcus bided his time working on the projects – he had initially stated that he could lift around 200 pounds of weight with his November version (prototype #161, if I remember correctly). He did not have a digital camera, and he did not want to publish photos until he had a better prototype anyways. That was OK with me – I am used to work with a variety of inventors and came to realize a long time ago that everybody has their own style. I was content to wait until Marcus had additional data, and the only thing that I insisted upon was that sooner or later he ante-up and provide some photographic evidence.

Despite lacking photos or video evidence, Marcus did have documentation. In fact, he wrote more documentation about his device than I had ever hoped to receive. He cranked out about the equivalent of 30-pages of "real" documentation in a very detailed form within 1-month, and had the email equivalent of many more pages in postings about how the device worked online. Marcus had already been publishing details online for about 2.5 months.

Despite the incredible amount of published data that Marcus was able to complete, in some ways it made things worse for him than not having anything at all. The reason was the nature of his research. My work, currently focused on Lifters, was in a technology that is easy to explain – the device is built like this, it works like that, and it can be described in a manner similar to some other thing ....basic, easy to explain, and easy to compare.

After all, Lifters have been accused by science of being ion-wind devices. If nothing else, rebutting this claim gives us someplace to start – something to compare against to provide people with an idea about how the device works. Additionally, we had tons of video and photographic evidence to back up our claims. In Marcus case, the documentation that he provided made things worse because his technology is so utterly different. It is not ion-wind, nor the Biefeld-Brown effect, nor

apparently the Searle effect. In fact, the more than you tried to pin down exactly what it was, the harder it became to describe it.

Also, its not like he could simply fall back onto describing the construction of the device **– reason being that it contained a series of interrelated coils with a unique configuration that were intrinsically tied to the operation of the device.** Every time he wrote a detailed summary of the construction of the device, we had come away with more questions than we had started out with. After a time I gave up trying to understand how it was constructed, because I only had bits and pieces.

Marcus was using an arrangement of 6-coils, and what are described as "bifilar windings". Essentially, this means that you wind two wires together around a coil and then tie one of the ends to another, making the two wires essentially one long wire wound "against itself" down the length of the armature its on. There are 6 of these armatures on the device, mounted around a central RP (or reference point).

Marcus created all of the terminology for these parts – this lends additional credibility to the idea that he had had 7 years of experience with it. These are ideas that you just do not "make up" for publicity. For instance, the bifilar windings on the armature-coils are self-cancelling fields, and even a basic-electronics education will tell you that. However, the interesting thing is that once you really start to get into the advanced "post-scientific" research on magnetic fields you start to see self-cancelling magnetic coils all over the place. The reason is apparently that while the "B-field" *(Editor: i.e. magnetic field)* of the coils cancels, the "A-field" *(Editor: i.e. vector potential)* that Tom Bearden keeps talking about does not, which means that you can isolate the really interesting effects from the coil without having to deal with the high field-intensity effects from normal electromagnetism.

Marcus had described these six armatures as being activated in a series, or order, to obtain results. Each of the coils was spun by an electric motor mounted on the armature, and when the coil was spun up to a certain speed and "stubs" mounted a periodic intervals on the side of the armature were fired in sequence the antigravity effect was created.

Marcus Antigravity effect was a directional force that was applied in a unique manner depending on which coils were activated. This means that by activating (for instance) coils 1 and 3, he could create an antigravity effect and move the device left – or something to that effect. Turning on and off each set of coils gave him movement on one axis of thrust, which corresponded to X, Y, or Z in a standard 3-D geometric graph. Since you can move in either direction down any given axis of thrust, this means that you have 6 axis of movement height (up and down), width (left or right), and depth (forward or backward). His device provided movement on any axis by either one coil or an arrangement of coils.

For a while Marcus did not want to talk about side effects, but I pressured him into it. The reason was that I have seen side-effects that were pretty darned strange in a number of different experiments, and I was willing to bet that if I pressured him a bit he would talk about what he had seen but did not want to reveal (for fear that people would not take him seriously). It turns out that I was right.....

Marcus had talked about the RP, or "Reference Point" upon several occassions. This is a multi-layered device that acts somewhat like a capactive element. It sits in the direct center of the Marcus device, and it is the reference-point for the entire device. The RP is manufactured from cast-iron, and Marcus says that he has a local company build them for a few bucks each by pouring iron into a mold based on one of his designs.

You can active the RP at the same time that you activate the coils. You have coils rotating around the RP, with "stubs" on the coils firing periodically at points corresponding to spots on the surface of the RP. Meanwhile, you also have an electrical charge on the RP itself, which means that there are a lot of elements interacting at once to create a very complex dynamic.

One of the interesting side effects was a darkening and "blurring" effect of the RP, as if light was being reflected off it. Another was a Star-Trek like "force shield" around the RP. These only occurred when all of the coils were activated at once. Also note that since the coils are opposing in nature (one for each direction on each axis), that when you are creating the force field effect the device cannot be levitating. However, the device is operational, and you have a force-field that you can apparently bounce a heavy hammer off without being able to penetrate it (Marcus description).

Another interesting note is that the force-field effect can be modified to create a vacuum. I am not sure how

Marcus noticed this, but he had said that it appeared to create a vacuum inside of the field's boundaries during operation. Interestingly, it also ran very cold – apparently down to a hundred degrees below zero, but only within the localized boundaries of the field.

I am not a professional physicist, but this is something that has been reported with the Searl effect and several other experiments, and the reason that I believe it occurs is because you are taking the kinetic energy of the device as well as some of the kinetic energy of its molecules (i.e.: heat energy), and injecting it into another dimension. After all, anytime we directly modify a gravitational field we are creating a dimensional effect, but in normal life we do not notice it because the boundaries between gravitational fields are very gradual.

Well, in the Marcus device the boundary between gravitational fields is not a several thousand mile-long gradient like the Earth's field is – instead of you have a gradient perhaps 10-times more intense focused within a 3 to 4 inch area. That means that you are creating essentially a rift in time and space (self-healing) that is kept open by the energy that you are pumping into the device.

the energy input is used only in putting the device into another frame of reference, but that any interaction between us and our "normal" frame would have to be modified for any interactions with the "modified" frame.

To the best of my knowledge, this is the most accurate description that I have seen yet for why his device does this. Marcus himself could not explain why these effects occurred, and to be honest I scared him more than a little when I told him my theory.

In the hypothesis that I just put forth on the origin and functionality of the Marcus device effect, the interesting this is that there really is not a direct correlation between input energy and the effect itself. That is because you are not using the input energy to actually cause an effect – you are essentially using the input energy to translate the device into another dimension (although it is still partially within ours).

Einstein called these "frames of reference". The idea is that the energy input is used only in putting the device into another frame of reference, but that any interaction between us and our "normal" frame would have to be modified for any interactions with the "modified" frame.

Again, this takes place in normal physics – but usually it involves motion, and normally it takes place over a vastly larger gradient of time/space/whatever. The difference between two frames is the difference between two locomotives moving at different speeds – the energy input goes into accelerating each locomotive up to that speed, but the actual work is performed if those two trains interact is solely a product of the frame of inertial reference (mass & velocity = energy).

Another excellent example is a helium-balloon. You put the energy into condensing the helium and pumping it into the balloon, but it is not the helium that creates lift – it is the surrounding atmosphere. In a very real sense a helium balloon gets its energy from the surrounding environment. The energy that you put into "maintaining flight" in a helium balloon is only the strain on the fabric used in holding the helium into the confines of the bag that encloses it. With the Marcus device, I would bet money that it is not the input energy creating these effects – it is instead the difference in frames of dimensional/inertial reference between "our" environment and the "device's" environment, whatever that difference may be.

You see, even though this sounds like a load of BS, magnetism is not real. This is not an idea that I am making up – in fact, it is an entire chapter in the physics 101 textbook kicking around downstairs in my house. Take two magnetic fields, and project them in the same direction at the same speed. Field A can not interact with Field B, because neither of the fields really exists – they are merely ripples on a pond, and that pond is the background of the time-space continuum. People that believe in relativistic gravitational effects take for granted that things like this happen – after all, gravity is not a force per se in relativity – only a modification of the dimensions of time-space. Well, most people do not realize that Einstein based his theory of gravitational force on his study of magnetism. Magnetism is the same thing – it is a modification of the fabric of time-space.

Take two magnetic fields that did not interact from a moment ago, and now change the direction that one of them is traveling in. Suddenly, the two fields that could not even see each other a moment ago now create an incredible "torque" – this is the same thing that we see in bar-magnets and electric motors. This is the "torsion field" research.

Bar magnets are different than pure fields because they are composed of the discrete fields of thousands of tiny magnetic "domains". That is why the fields from bar-magnets are never "invisible" to each other – it is because that the fields in bar magnets are too jumbled to ever really "line up" to the point of being invisible. Pure fields can do this, however, reinforcing the supremacy of Einstein's relativistic effects with relation to electromagnetism.

Anyhow, that is about it for now – I will try to come up with a more detailed picture for you on this if you like, but I expect that you will probably have more questions about Marcus theory and device in near future. It is a very complex idea underlying his research, but the basis of it is the idea of "rotating magnetic fields".

If you want to do additional research on your own into related fields of study, I would definitely look up "relativity and magnetism" – it provides an excellent example of how to visualize relativity theory in the study of magnetic field interactions. This is something that electronics engineers are not taught, which is why you have never heard of this in an engineering sense before. However, in physics is a well-known concept, although most physicists prefer to work with quantum mechanics rather than relativity these days.

In terms of rotating magnetic fields, you can look up "torsion fields" – again, the Russians have the best understanding of advanced torsion field physics, although their best material probably has not been translated yet. Additionally, rotating magnetic fields are the basis for the Searle Effect and the Hamel device.

Marcus was intrigued by Searle's claims, because they appear to have matched many of his own results. Interestingly, Marcus had developed his work within an "intellectual vacuum" and had never heard of Searle before I told him about the similarities. Nevertheless, force-fields, ice-cold operating temperatures, and antigravity seem to be a pervasive similarity between all manners of experiments that have been reported using rotating magnetic fields. I had assumed that Searle's claims were bunk, but after hearing about similar effects from Marcus research it led to reconsider some of the criticism surrounding Searle lately.

One a final note – one group that may lend additional credibility to this research is Godin and Roshchin in Russia. They obviously benefit from the years of knowledge that the Russians accrued in magnetic field systems theory, and they attempted a replication of the Searle effect device some years back (and claimed to get some results). I hear that they have been working on a revised version of their experimental setup recently and hope to have even better results in the very near future.

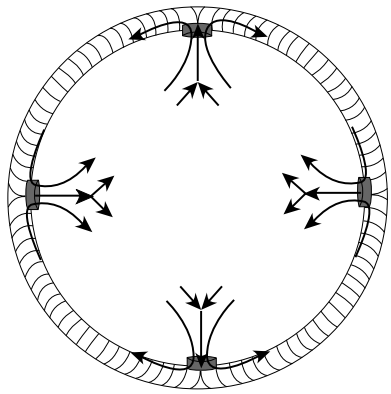

Fig. 1

Magnetic flow for a bifilar-wound toroid that is split at four points on the toroid. This configuration occurs when the coils in the nubs are charged to match the charge on the toroidal coil. The configuration is a quadra pole with a minimum magnetic field at the center

Fig. 2

Marcus recommends the Kikusui 6000L and 18000L multipurpose AC power-supplies

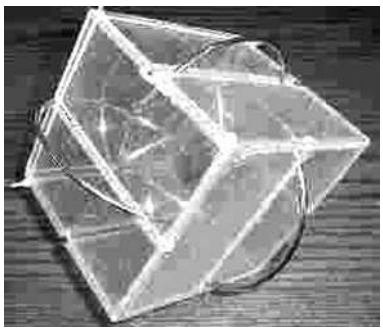

Fig.3

A scale-model mockup of the ring-arrangement within the Marcus device, showing the interlinking coils

Systems of conversion of thermal energy to mechanical one

Review prepared by correspondent Alla Pashova, **Russia**

There is a wide class of closed-cycle heat engines using differential temperature of water and ambient air. This kind of systems enables thermal energy to be directly converted to mechanical one so as to perform a useful work. We publish patent specifications of two analogous devices of this kind.

PATENT FOR INVENTION

Specification

of the engine, which uses differential temperature of water and ambient air.

To the patent by **P.I. Dobrokhotov** filled on October 22, 1928 (#34248).

Patent grant is published on March 31, 1930.
Patent is valid during 15 years from March 31, 1930.

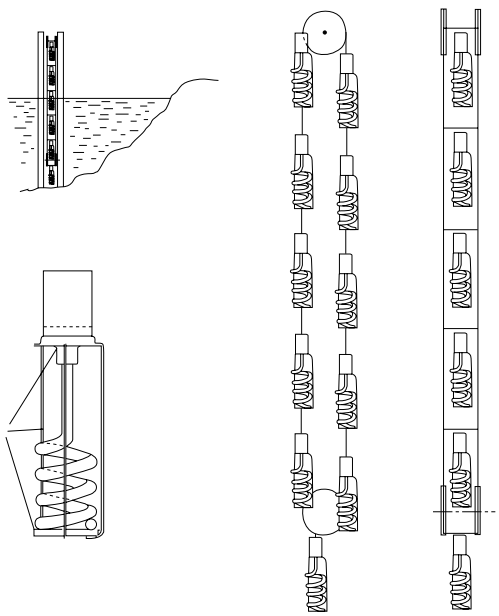

In 1928 **P.I. Dobrokhotov** proposed a design of such an engine. It represents an endless chain thrown over a pair of blocks and partly immersed into water. The chain consists of coiled pipes filled with a volatile liquid (such as sulfurous anhydride or ammonia). One end of each coil is fastened to a frame, while another end is fastened to a cylinder piston mounted on the same frame. When overwater elements are heated by means of ambient air, the liquid inside the coil evaporate. Vapor put pressure upon the pistons which being in motion compress air in the cylinder, and thereby reduce volume of each element. When submerging, the element gradually cools down, thereupon causing a decrease in pressure of vapor of the liquid, which is enclosed within coils. The pistons move in backward direction, and the volume of air available inside the cylinder increases. Increase of volume results in increase of water buoyancy force that sets the device in motion.

INVENTION SU1404681 A1

23.06.88
Yu.S. Grigoryev
Prototype: USSR patent #13534
F 03 G 7/06, 1928

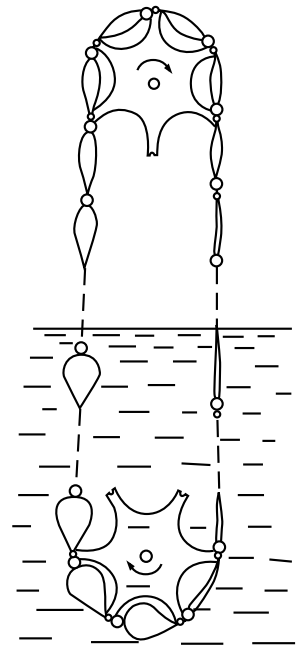

In 1980, **Y.S. Grigoriev** developed his forerunner's idea by improving the system described above. The inventor aspired to enhance the effectiveness of this method of conversion of heat energy to mechanical one. He suggested fixing the volume of chambers filled with a heat-sensitive actuating medium at its minimal magnitude before immersing of those chambers into warm water. In water the actuating medium heats and partially evaporates. At a maximum depth of submersion, the chambers are released from fixation to be expanded during emersion. Thus one may avoid expansion of the chambers during their submersion. Futhermore, there is a possibility to activate the device and get the useful work without preliminary spinup from an external drive.

Iliya R. Prigozhin
(25 January, 1917 – 28 May, 2003)

Iliya R. Prigozhin, aged 86, Nobel Prize Winner, Belgian scientist of the Russian origin, died on 28 May in Brussels. Prigozhin made a number of prominent discoveries in the field of thermodynamics and statistical mechanics of nonequilibrium processes. In particular, he developed a concept of irreversibility as applied to thermodynamics. Prigozhin was studying time as a physical phenomenon. In 1977, he was awarded the Nobel Prize for chemistry "for works on thermodynamics of nonequilibrium processes".

The scientist formulated one of the major theorems of the theory of nonequilibrium processes. This theory was later named after him. According to Prigozhin's theorem, stationary state of the system corresponds to minimal entropy generation. The outstanding physicist was also an initiator of applying methods of theory of nonequilibrium processes in biology.

Thermodynamics principles were enunciated in the middle of the XIX century after the invention of a steam-engine, when interaction of heat, electrical, and mechanical work aroused a higher interest. In accordance with the first law of thermodynamics representing an energy conservation principle, energy neither disappears nor appears in any closed system, but transforms from one form to another.

The Prigozhin's theorem sounds as follows: stationary state of the system (under conditions impeding attainment of equilibrium state) corresponds to the minimal generation of entropies. If there are no such impediments, then production of entropy reaches its bare minimum, i.e. zero. The theorem was proved by Prigozhin in 1947.
In thermodynamics the nonequilibrium specifically open systems were of most interest for Prigozhin. In such systems either or both (matter and energy) interchange in reactions with an environment. At that, quantity of matter and/or energy increases or decreases in the course of time.

It is obvious that human society as well as the biological environment is an example of dissipative and nondissipative structures. In the 60s and 70s, Prigozhin developed his theory of dissipative structures and described the formation and development of embryos. Critical points of bifurcation in his mathematical model are correlated with a point, where a biological system becomes consecutive and stabilized.

For his scientific career time, the physicist was awarded over 40 scientific rewards and admitted as an honorary member into national academies of many countries all over the world.

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The 11th Russian Conference on Cold Nuclear Transmutation of Chemical Elements and Ball-Lightning (RCCNT&BL-11) is to be held during September 28- October 5, 2003. The place of the Conference is in Dagomys near the city of Sochi.

The program of the Conference includes the following subjects:

- Experimental research in cold nuclear transmutation (fusion) and ball lightning;
- Theoretical models with respect to cold nuclear transmutation (fusion) and ball-lightning effects;
- Applied to these problems technologies and devices.

The Organizing Committee of the Conference is pleased to invite you to attend the Conference. The terms of your participation are as follows:

The full cast is $900, which will include the registration fee, hotel reservation and living, three daily buffet meals, conference proceedings, transportation from the Sochi airport and back, social dinner and special excursion or entertainment.

The languages of the Conference are Russian and English.

The total cost can be reduced to $800 if transferred before August 10 to the account of the Organizing Committee, which is to be announced on having received from you a confirmation about your decision to attend the Conference.

If you make a decision to take part in the Conference, please, let us know before July 1 about the title and abstract of your report.

Contact telephone: (7) (095) 196-9476 (ask Mr. Igor Goryachev), Fax: (7) (095) 196-6108
Email: gnedenko@kiae.ru; Bazhutov@erzion.madi.ru; bazhutov@izmiran.rssi.ru; bychvl@orc.ru
Address: I. Goryachev, Russia, 123182 Moscow, 1 Kurchatov Sq.,
Research Institute of High Technologies at RC "Kurchatov Institute"

Letters from our readers

Thank you for publication of my article. Your magazine becomes more and more popular.

My special thanks to Editor-in-Chief Alexander V. Frolov. Whatever they say or write in the press, he has done a great work and it is not only my own opinion. He has managed to do that everybody had been waiting for a long time. My colleagues (not only from Rostov-on-Don State University but also from other Rostov Institutes of higher education) ask me personally send the best regards to the editorial staff of your magazine.

Sergey A. Gerasimov

Free energy?

The scientific community says that it cannot exist. Where did we hear that before? Academician Valery Sobolev from the Academy of Sciences, the head of the research group working on the experiment says: "This is not some new physics, but just experiments that have been performed very seriously. Make surge of electrons from the environment, remove them, deplete the fused electrolyte with basic typical metals; what you derive from it is what cannot be produced by chemical methods. This is a new state of substance." As the researchers say, first they discovered a particular electrochemical process where high-temperature materials in a new state are the product. This in its turn allowed to discover a new state of substance, new class of materials, a new source of energy, a new method of cold plasma generation, a new superconductor. See whole article at: http://english.pravda.ru/science/19/94/379/9675_energy.html

Josef Hasslberger

Personal home page on physics, energy technology, social and economic issues: http://www.hasslberger.com

Interference disc generator with permanent magnets

Inventor Alan Francoeur, Canada

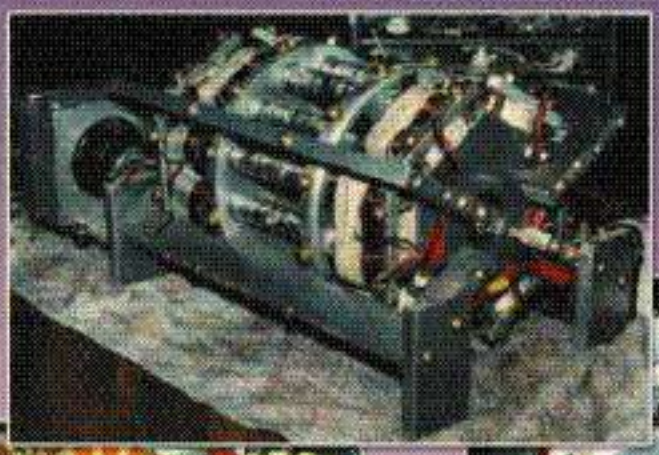

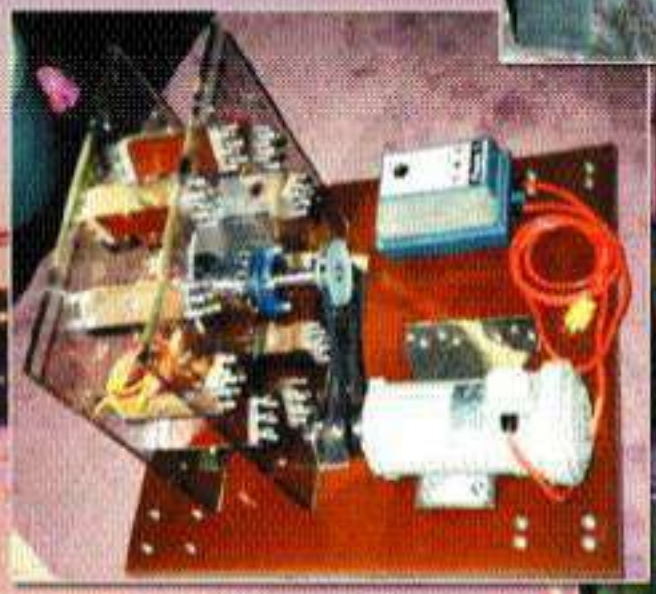

Carl Reich

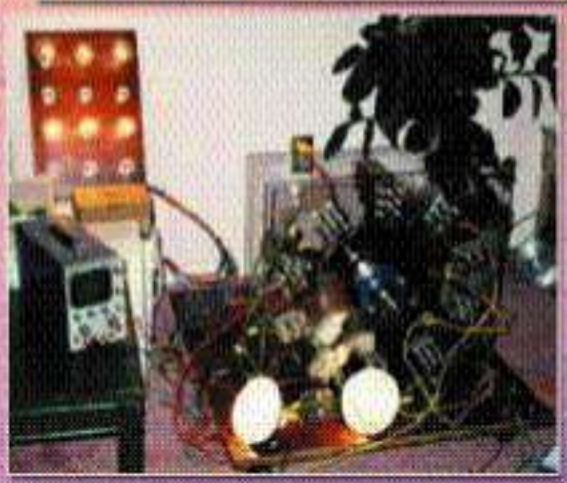

Bud Johnson

Vortex heat pump

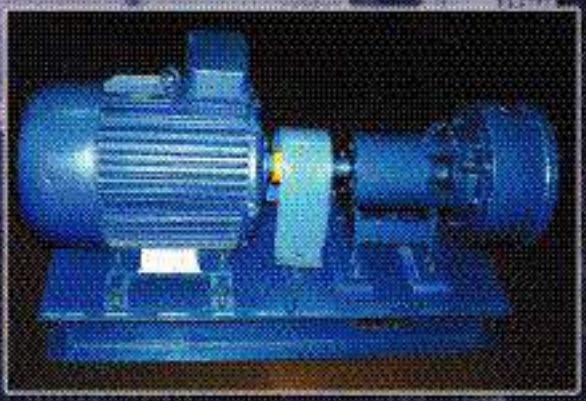

Efficiency 200% and more!

Inventor: Vladimir Susorov
(812) 342-2652
8-901-976-5151
susorow@rol.ru

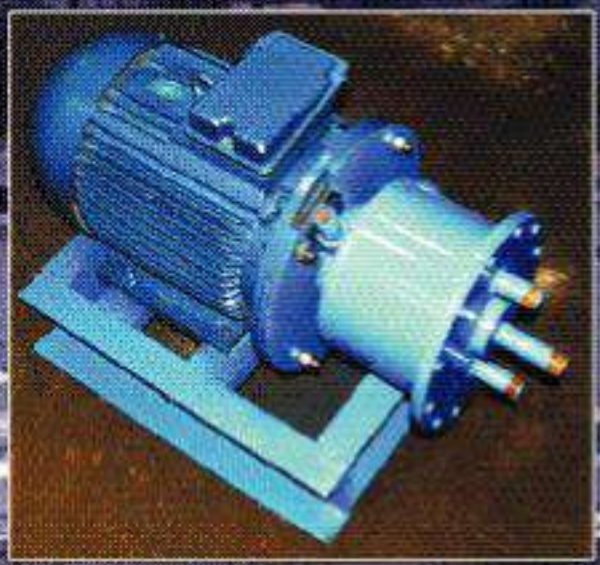

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Gravity-heat power system

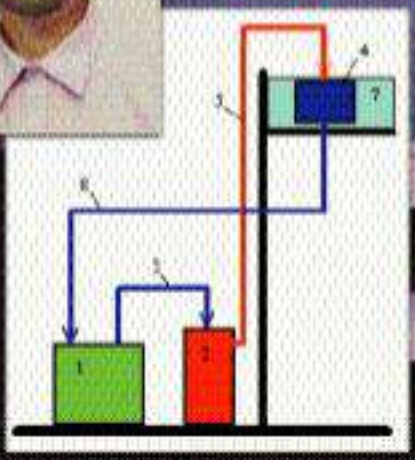

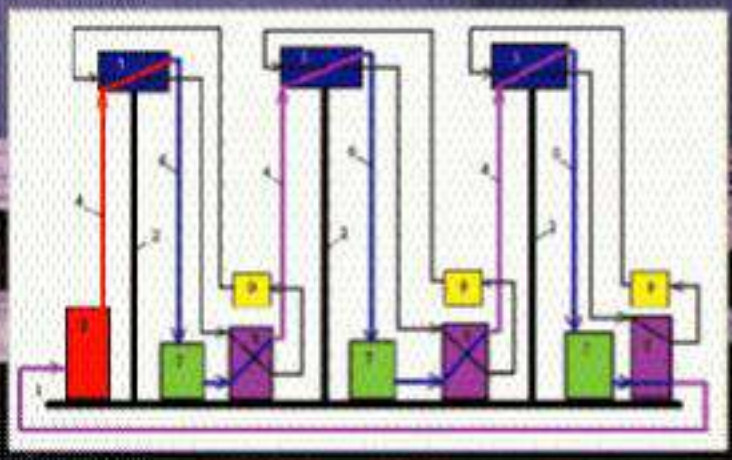

Author: Vladimir Sukhanov Wladimir.Sukhanov@soros.ksu.ru

New Energy Technologies

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Research on advanced aerospace systems and new energy sources

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- magnetic generators
- capillary perpetuum mobile
- Hutchison effect

Photos from Faraday Laboratory: test bench for measuring the effectiveness of hydrogen dissociation and recombination processes

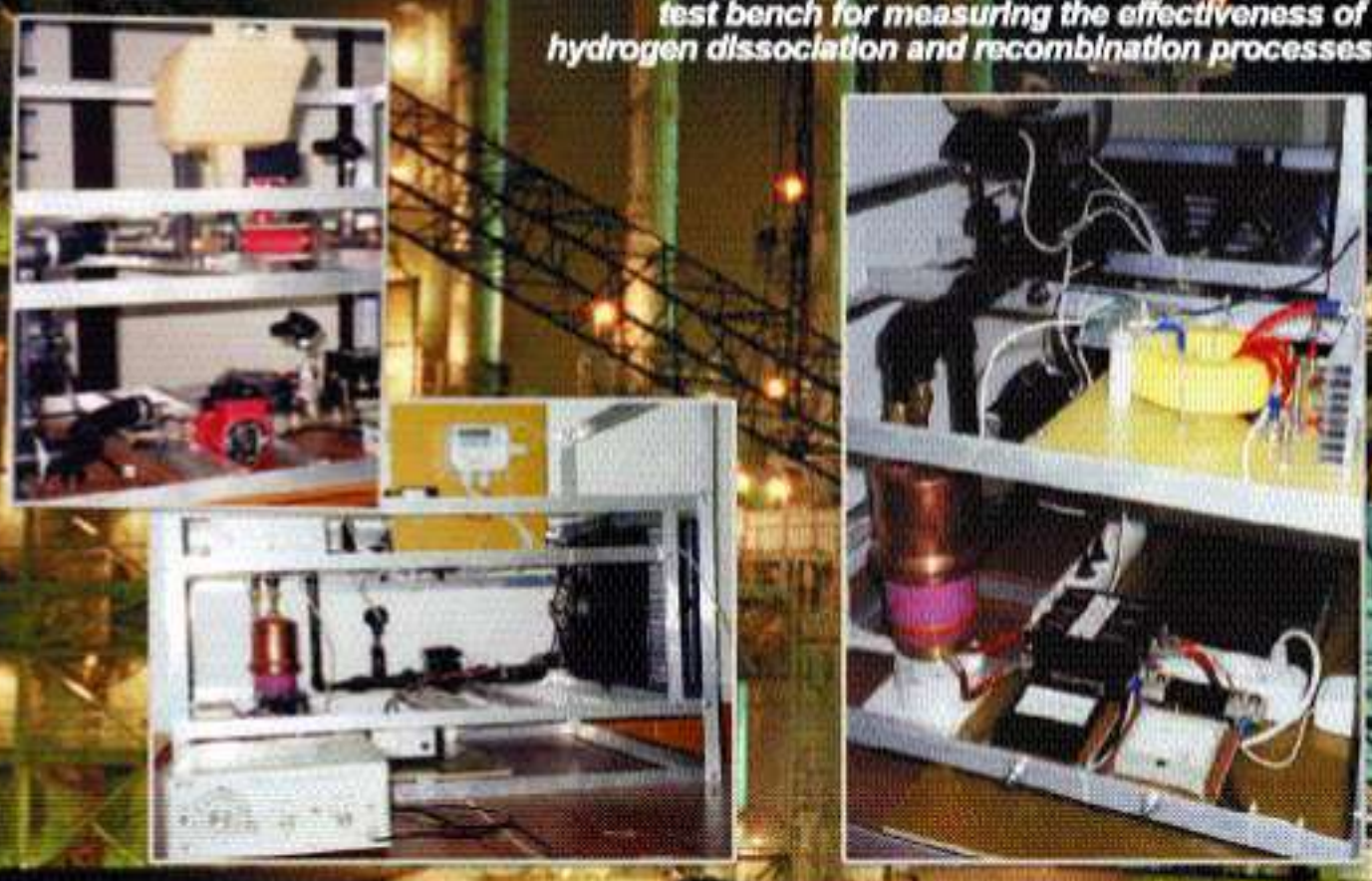

Bogomolov's Invention

Over-unity from elastic forces of spring, compressed by rotation.

Read in this issue!

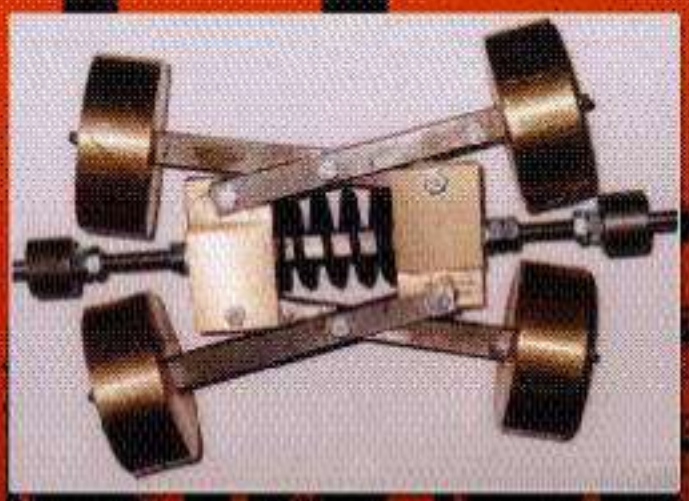

Spin Wave Laser of Ines Espinoza, USA

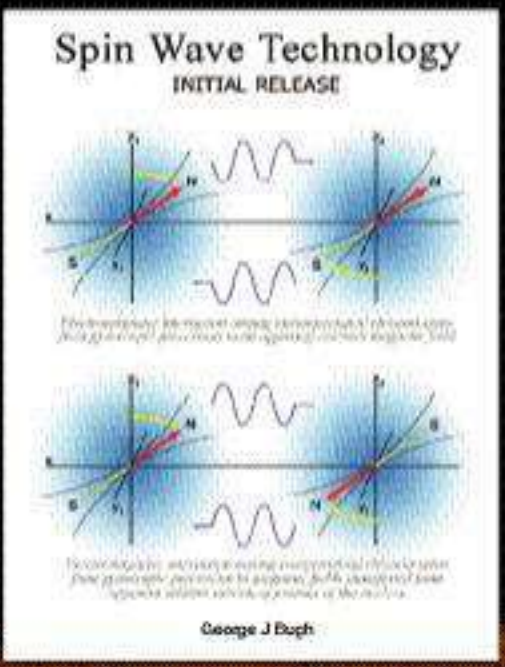

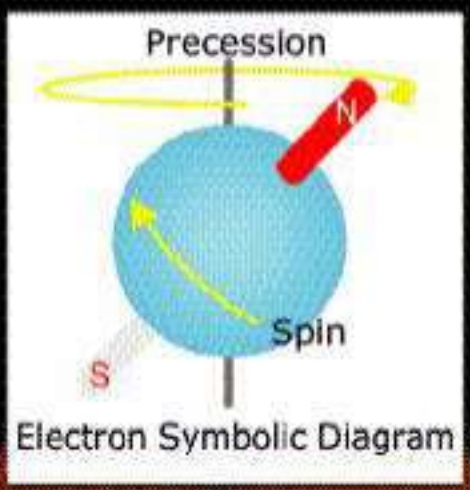

NEW ENERGY TECHNOLOGIES #14-15

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Faraday Lab News

One of the most interesting research projects of our company in the year 2003 has been the research on hydrogen dissociation and recombination processes. It has taken us about half a year to build a special vacuum tube and in October, 2003 we obtained some experimental results on the heat output and efficiency of the system. The system we designed in our laboratory is shown in Fig.1 and also on the cover. The water-cooling system and the heat measurement system make it possible to measure the heat output within the range of 100 W to 5 kW with pinpoint accuracy. In the year 2004 we are planning to go on with our research work.

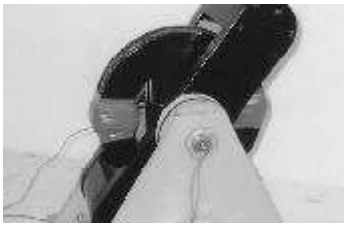

Fig.2

We have completed the second stage of designing and developing a high-efficiency magnetic generator with the neodymium permanent magnets of 1.25 Tesla. We confirmed the possibility of double output increase from the usage of two magnetic induction counter fluxes produced by the two coils wound on the generator core (Fig.2).

Our laboratory continues designing and perfecting a powerful "alternator"-type generator with permanent magnets and a drum-type rotor. We will give our readers more detailed information after we are aware of the patent examining result.

Our research on "The Control of Temporal Characteristics of Physical Processes by means of Ether Energy Density Change" is also awaiting the results of the patent examining group. This research on time and the construction of the "time machine" is not a pure theory but it has quite real prospects of being applied to the aerospace industry as a propulsion method.

Fig.1

It is worthy to note that now the alternative energy prospects in Russia do not entirely depend on financial factors. The cooperation is important between researchers, investors and organizations interested in the innovative development of Russian industry rather than in the development of Russia as the world primary natural resource is also important. Progressive political and public organizations should develop and introduce alternative energy programmes as well as render support to local researchers. The successful innovation of new technologies is impossible without this support and lobbying government. Let us hope that the year 2004 will bring along new opportunities and promising contacts.

Alexander V. Frolov
General Director Faraday Laboratory Ltd
http://www.faraday.ru

Novozhilov's Motor

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Tel.: (80912) 72-12-72

An interesting but a very simple motor has been designed. It operates on the basis of heating differences of its components due to temperature variations of contacting environments or due to variable radiation intensity.

Motor structure

The motor structure (see Fig.1) includes a metal or plastic wheel (1). In the center of the wheel there is an axis (2), on which spoke ends are fixed (3). Other spoke ends come through a hole in the wheel rim. On the spoke end there are weights, for example, in the form of small balls (4).

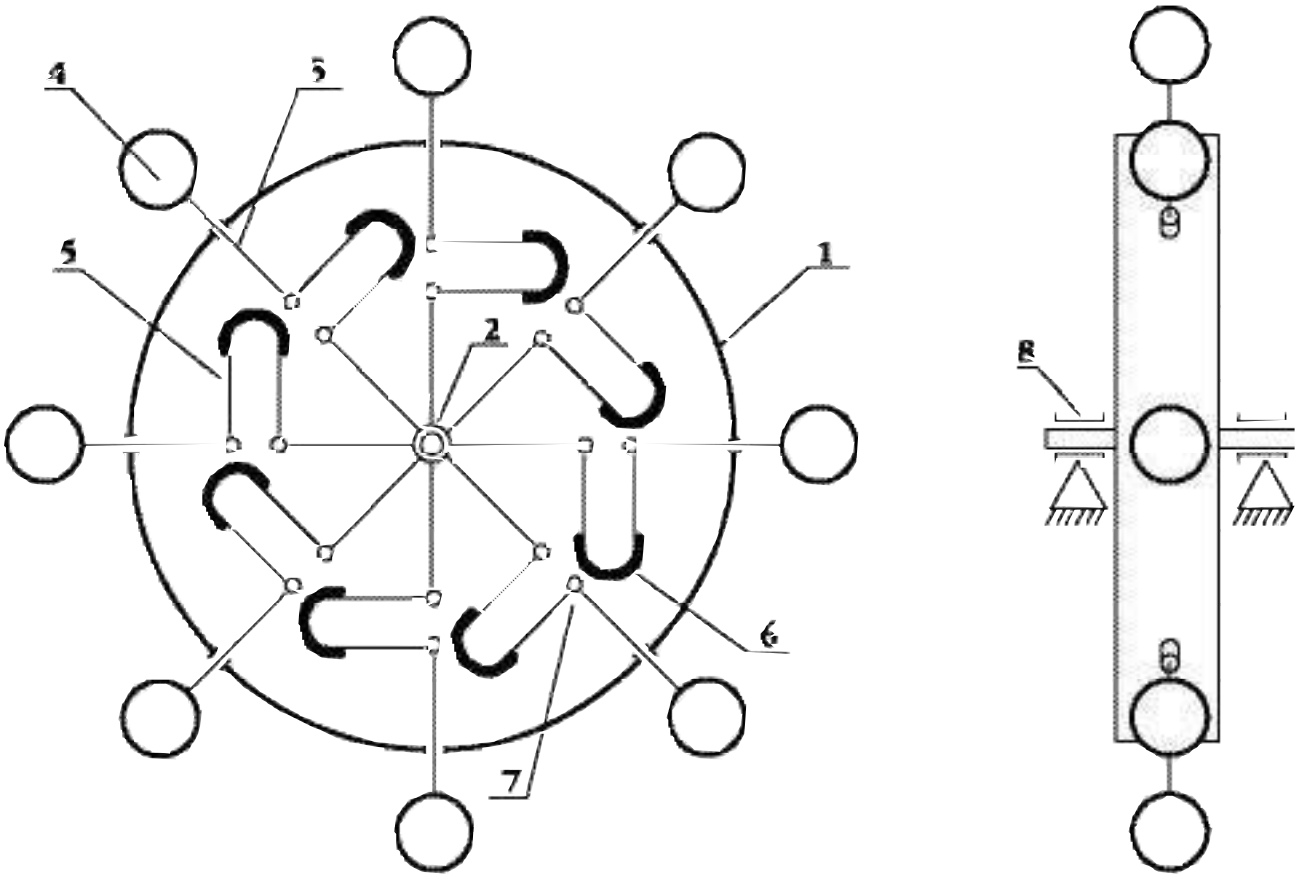

Fig.1
Motor

The structure peculiarity is preconditioned by a loop-shaped part placed on each spoke (5), which has a form of a metal strip or core. An arched bimetal component is built in the center of each loop-shaped part (6). Joints can be fixed at the joining point of loop-shaped parts and spokes to simplify the motor movement (7).

In the motor structure described arched bimetal components become straight when heated. The motor axis ends are placed in bearings (8).

To initiate the motor movement the loop-shaped parts need to be in mediums (zones) with different temperature. For instance, the lower part of the wheel may be placed into hot water (9) and the upper part will stay in the air (10).

Motor operation

When the motor is in a medium with identical temperature, for example, in the air, the temperature of all bimetal components will also be the same; therefore, they have identical form. In this case all spokes will similarly project over the wheel rim and all weights have similar distance from the wheel axis.

This state makes the whole system balanced and immovable. But if the motor wheel is partly placed into water with the temperature exceeding that of the ambient air **the bimetal components in water will become straight and shift the axis weights from the wheel axis.** This phenomenon initiates motor operation.

Let us consider this process in more detail.

On touching water, the bimetal component in the loop-shaped part becomes straight and shifts a weight from the wheel axis. The wheel becomes unbalanced, obtains torque and turns clockwise. This rotation makes the following bimetal component on the next loop-shaped part of the following spoke touch water. This bimetal component also becomes straight and shifts a weight from the wheel axis, generating an increased torque that turns the wheel clockwise.

At the same time a bimetal component comes from hot water on the left side of the wheel in zone "A". The component cools and restores its initial form, i.e. it curves more and pulls the weight on the spoke to the rotation axis. This leads to a decrease of its counterclockwise torque that affects the wheel.

The loop-shaped parts on the left side (A) and the right side (B) of the motor wheel will cause asymmetry in the number of weights projected by the spokes. On the motor left side (A) the weights will be projected from the wheel axis when the spokes are located in corner "C". On the right side (B) the weights on the spoke axes will be shifted from the axis when the spokes are located in corner "D". Fig.2 shows that corner "D" is far larger than corner "C". This means that more weights will be shifted on the right side of the wheel in zone "B" than on the left side in zone "A".

Fig.2 shows that the wheel weights generating a clockwise torque are projected on the right side. On the left side in zone "A" only one weight is projected and it generates a counterclockwise torque. More weights shifted from the wheel axis on the right side will generate a greater clockwise torque than the weights shifted from the wheel axis on the left side. This is the cause of the wheel clockwise rotation.

This interesting effect is achieved due to the loop-shaped parts on the wheel spokes with bimetal components placed on them. When the next wheel spoke reaches corner "D", the bimetal component connected with it touches hot water, becomes straight and shifts the corresponding weight further from the wheel rotation axis. The motor wheel continues rotation, making the next bimetal component touch water. It is also heated, becomes straight and shifts the corresponding weight from the wheel rotation axis. The wheel continues rotation. Bimetal components are touching water in succession. On the left side, in zone "A", the bimetal components successively come out of hot water, cool in comparatively colder air, return to the initial sharply curved form and pull the weights on spokes to the wheel rotation axis. This is the reason for the wheel torque to decrease.

Mass movement from the axis in a rotating object commonly causes reduction of rotation speed. And, on the contrary, the rotation speed increases when the mass comes close to the axis. In motor zone "A" the weights come close to the rotation axis after the corresponding bimetal components come out of hot water, and the same number of weights move from the center in zone "B", i.e. these effects on the rotation wheel compensate each other.

In essence this is a heat machine. The heat transfer from a warmer medium – water – to the cold medium – air – is achieved owing to the heat capacity of the band-form bimetal component. This is the reason for fast heating and cooling processes. Due to the fact that bimetal components are not large, not so much heat is needed for their heating.

The motor will operate when the air temperature exceeds that of water but in this case it rotates counterclockwise.

There is another model of this motor when nitanol components are used instead of bimetal ones. Nitanol is a memory metal alloy that changes shape when reaching certain temperature. In this instance, the nitanol component is normally curved but becomes straight when heated (for example, up to 50^0 C), and the weight on the spoke end moves from the wheel rotation axis initiating rotation of the wheel. That means similar operation of a nitanol-based and bimetal-based motor.

The motor structure is very simple and its operation does not require power or fuel supply: it is enough to place its wheel into the water the temperature of which is different from that of the air.

The motor structure may be further developed: for example, a focused sun ray can be used for the heating purposes; the bimetal component can be heated with a common electric lamp on one side of the wheel, the required heat may come from a heating radiator, stove or burning gas-jet. Such motor may be heated when installed on a mantelpiece, etc.

This article describes the motor model that can be used as a toy. Being supplied with looking-glass units it may be applied to get various luminous effects or may be installed in the shop showcases, or else at exhibitions. This motor is also able to operate in a gravity force environment, even on the Moon. There direct sun rays may heat bimetal components to 200^0 C, and the temperature of the components located in the shadow almost reaches absolute zero, i.e. the temperature difference in this instance is over 400^0 C, which enables constant efficient motor operation.

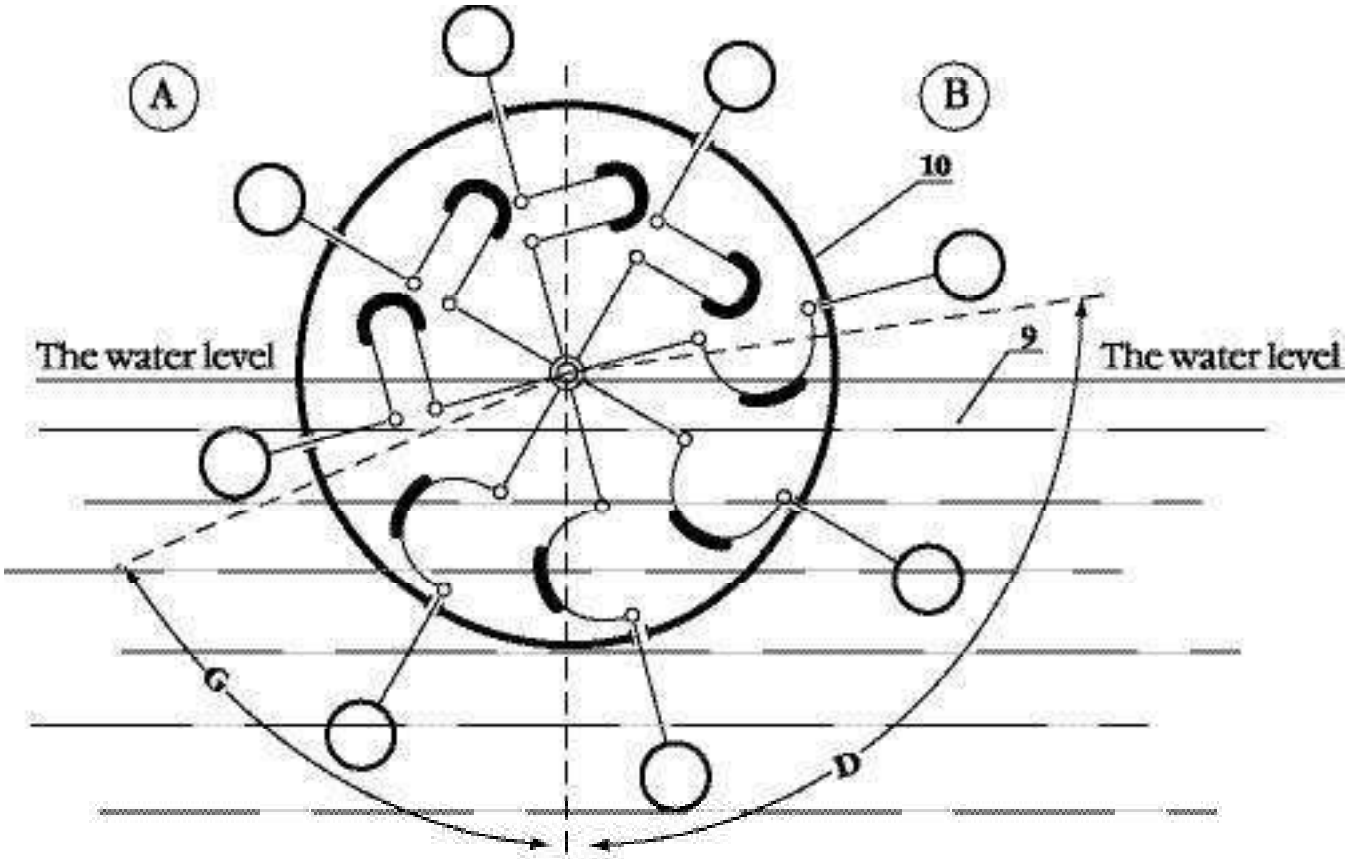

Fig.2
The motor in operation

Self-Interaction in Electromagnetic Rotation

S.A. Gerasimov , V.V. Stashenko, Russia
Physics Department, Rostov State University, Rostov-on-Don, 344090
Email:GSIM1953@mail.ru

Introduction

The electromagnetic rotation is the motion of a magnetized body ina direction perpendicular to both the vector of magnetization J_m and the direction of the electric current j in a liquid inside which the magnet is located (Fig. 1).

Editor: Readers can compare this vector composition and the device scheme of Godin and Roschin with the Searl experiments. The similarity is evident. *A. V. Frolov*

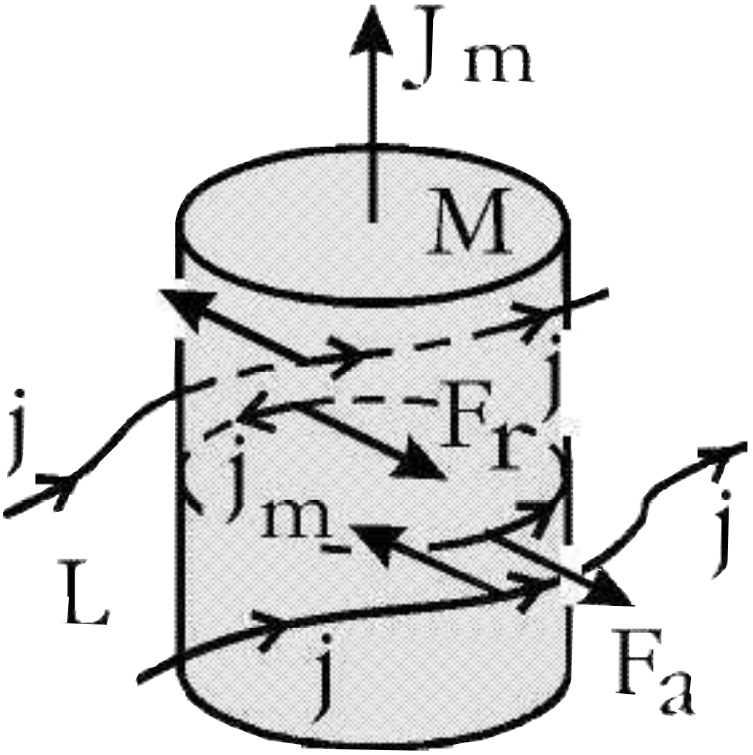

Fig.1
Electromagnetic rotation. A magnet M of magnetization J_m that is partly or entirely submerged in a conductive liquid L with a direct current of density j is moving in the direction of the force F_a+F_r

The force producing such a motion is sufficiently weak and, normally, the phenomenon is observed at rotation. Although, this is quite a well-explored phenomenon [1-6], nobody knows what makes the magnet rotate [4]. There is an opinion [2,3] that the motion of the magnet in the conductive liquid is caused by the forces of attraction $\mathbf{F}_a$ and repulsion $\mathbf{F}_r$ between currents of density **j** flowing in the liquid and surface magnetization currents $\mathbf{j}_m$ of the magnet, often called the Ampere currents as shown in Fig. 1.

The external magnetic field of a long cylindrical magnet originating far from either pole is zero. Therefore, no force is exerted on charges moving in the liquid far from the ends of the magnet. Nevertheless, the magnet still moves in the liquid with the direct current even if it is only a thin magnetized needle [5]. Thus, the deeper the magnet is immersed in the conductive liquid, the more liquid gathers around it. The deeper the immersion is, the higher the total force must be. That should be so.

In reality, it is quite different. During intermediate immersions when the magnet is partly submerged in the liquid, the torque N does not depend on the depth of immersion, in the other words, currents flowing round the cylindrical magnet do not influence the exerting force acting [6]. Moreover, during shallow immersions, the magnet moves together with the liquid. **This is none other than *the self-interaction* [7].** The conductive liquid under the magnet experiences the magnetic action. The direction of this force coincides with the direction

of the magnet motion. **Thus, the part of the conductive liquid moving in this direction under the action of the magnetic field B, affected by the frictional forces in the liquid causes the motion of the magnet in the same direction.** The only way to find out the role of the self-interaction in this phenomenon is experimental investigation. It would be appropriate to exclude the currents flowing under the magnet. In this case the magnet must rotate in the opposite direction.

Experimental system

A commercially available cylindrical magnet M of magnetization J_m=1,95•10^5 A/m and a balanced load *P* connected by a rocker R are suspended by a thread *T* as shown in Fig. 2.

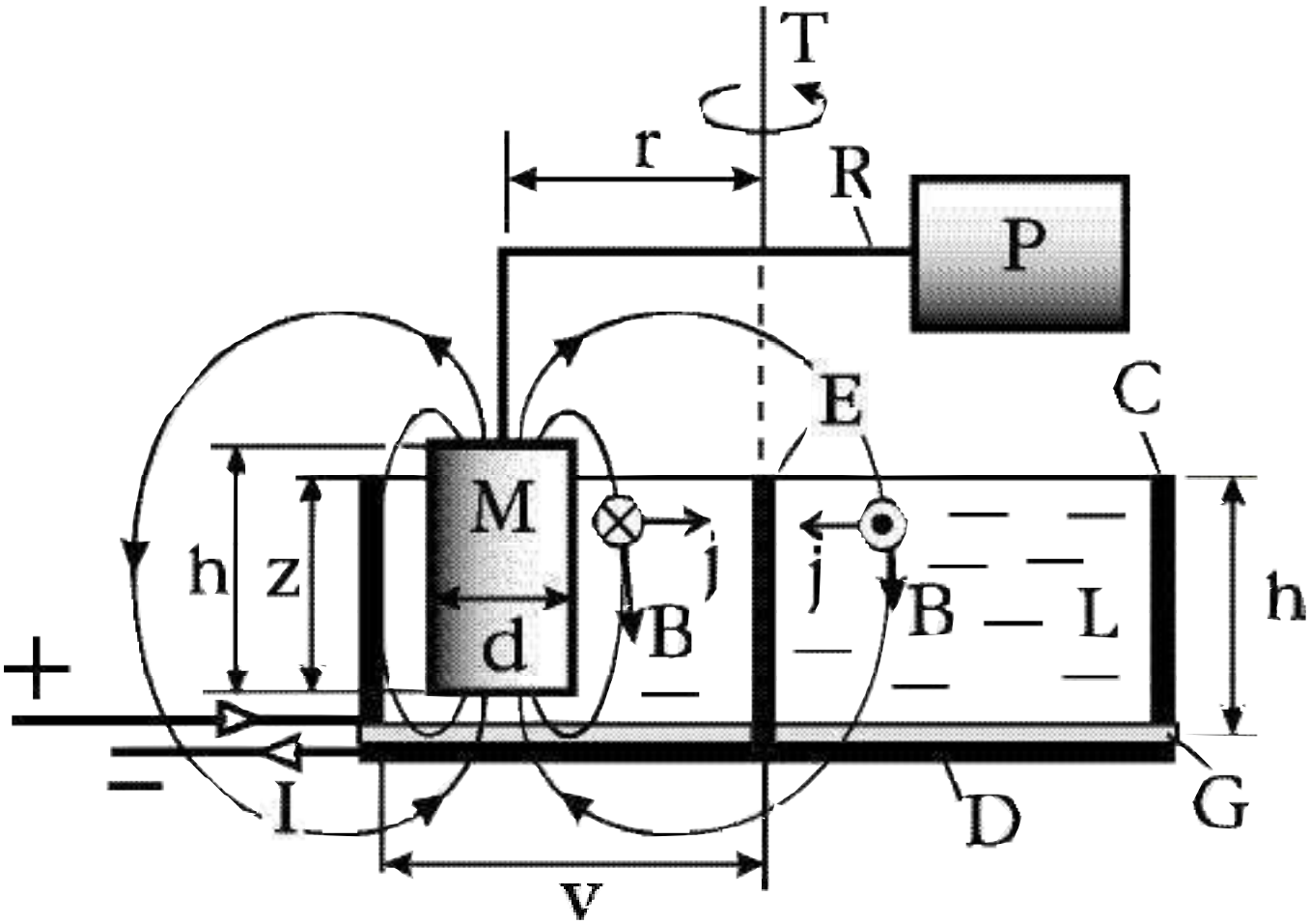

Fig.2
The experimental set and its parameters: h=50 mm, r=35 mm, d=25 mm, v=70 mm, the diameter of the central electrode E is 5 mm, the thickness of the bottom G is 2 mm. (×) and (•) are directions of the force acting on current elements of current density j in the magnetic field of inductance B

The magnet is immersed in the 5% copper sulfate solution ($CuSO_4$) so that the depth *z* of immersion can vary. A vessel containing the conductive liquid *L* is large enough for the magnet to be almost entirely immersed. The cylindrical surface *C* of the vessel and the central electrode *E* of the system are made of non-magnetic materials. The bottom of the vessel *G* is, of course, insulator. The magnet is coated with an insulating moisture-proof varnish. The length of the electrode *E* equals the height h of the vessel. A direct current of strength *I* passing through the cylindrical electrode *C*, the conductive liquid *L*, the central electrode *E* and the disk electrode *D* generate a torque of electromagnetic origin which results to the rotation of the magnet. The disk electrode *D* is intended to provide the system with the symmetrical supply of the current.

Experimental results

The size of this experimental device differs from that described previously [6]. **As a result we have obtained the torque N, which is about ten times more intensive than the former one.** But the main result is that the torque does not change its sign when the magnet is being immersed in the conductive liquid (Fig. 3).

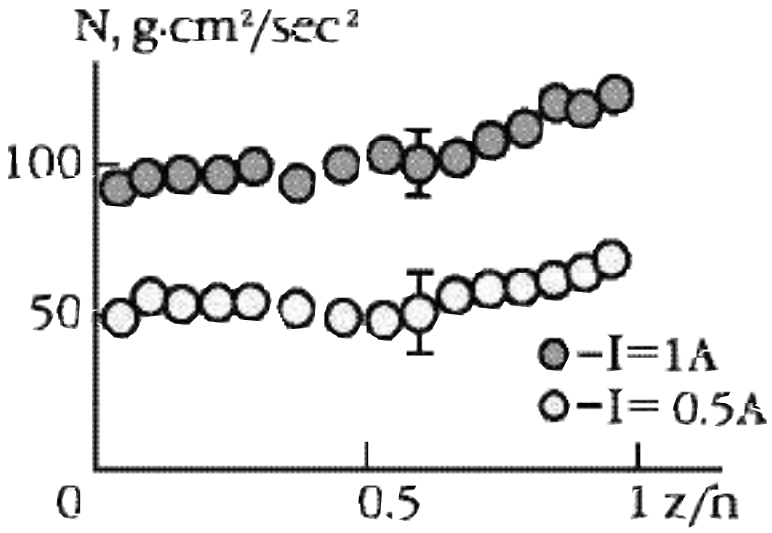

Fig.3
A typical experimental dependencies of the torque N
acting on the magnet depending on the depth of immersion z

When the magnet is almost entirely submerged in the liquid the depth of which equals the height of the magnet, no currents are flowing under and above it. In this case the rotation of the magnet is expected to be the result of drag action of the rotating liquid located in the intermediate field relative to the magnet. This part of the conductive liquid is rotating in the direction opposite to that of the motion of the magnetized body. It seems to be the right way. The magnet pushes the liquid away and, therefore, is moving in the opposite direction. No, this is wrong. If it was correct, this effect would also occur during the shallow immersion. At small z the magnet and the liquid rotate together. So far we still do not know what makes the magnet rotate.

S.A. Gerasimov

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Capillary Motor

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For several decades the author has been organizing a contest for young inventors on the radio, television, in mass media and the Internet. There have been accumulated thousands of engineering solutions that belong to schoolchildren and youth. There are many original ones, including perpetual mobile. Though unfeasible in principle, they have interesting structure and competent engineering solutions.

For example, a child's dream to create an oblique roof over a city or field and direct the rain flow to a turbine to obtain mechanical work is of little use. But it's quite another matter if this child takes a pencil, a sheet of paper and tries to make a sketch or a drawing of such construction. Even if the construction is primitive and unfeasible, the child will get his first engineering experience and self-reliance.

I can still remember one peculiar case. Once the editors were instructed (it was in the times of the USSR) to assist an honored inventor of new machines. It was a Stalin Prize laureate, creator of a special type of lime that was widely applied in construction (I will not disclose his name). The inventor was given (that was not common practice) a large room in a shared apartment situated in a prestigious block of apartments in Moscow. It turned out that all room space, except for narrow passages at the walls, was occupied by a huge table. On the table up to the ceiling there were some pipelines, glass and metal vessels, retorts and other laboratory ware. The most impressive thing was retorts heated by gas coming through a hose from the shared kitchen. All that staff was bubbling, hissing and steaming. The inventor was creating a perpetual mobile!

I will give one more example of a situation common for the editors of the "Inventor and Rationalizer". Once we had a respectable-looking visitor who made an odd request to get the President of the French Academy of Sciences to respond to his letters about a perpetual mobile plan. The essence of Alexander Rodionov's (Maloyaroslavets, Russia) invention was that "in accordance with Newton's and Guerin's laws fluid flows up through capillaries and turns a wheel when flowing down (see Fig.1).

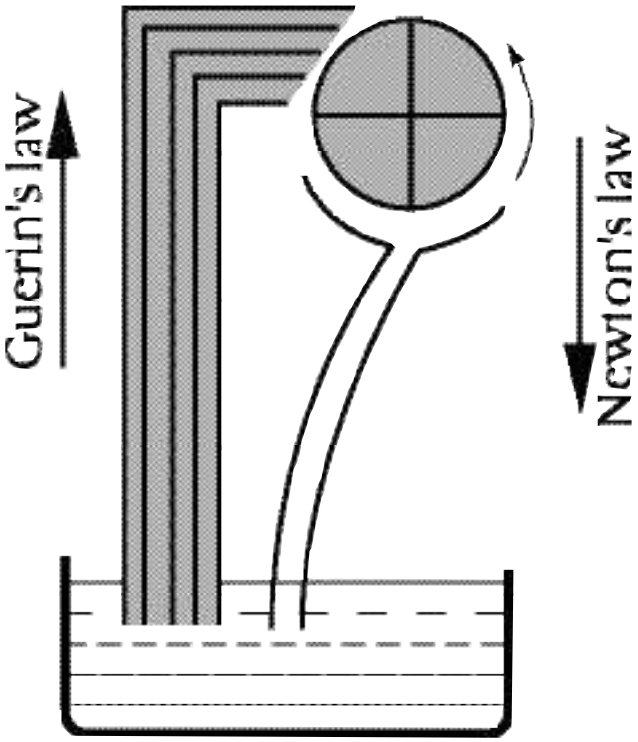

Fig. 1
Perpetuum-mobile

There are many similar projects in the history of engineering. Hence, this case may be considered as typical. We all know that the molecular adhesion forces (moistening) that push the fluid upwards will stick to it and the capillary motor will never work. But is the idea totally unfeasible? Since false modesty is inappropriate when it comes to perpetual mobile, I will present my ideas on this not so honorable subject for the reader's judgment.

It seems that all perpetual mobile inventors start not with a pencil and a sheet of paper but with experimenting on magnets, oblique plane, wicks, wheels, springs and other materials at hand. My first heat (perpetual) motor was also the result of an experiment.

The "Capillary" idea of Alexander Rodionov haunted me. I recalled that the great Lomonosov devoted lots of time to studying molecular adhesion and capillarity. They are present in everyday life, let alone the nature, especially in plants that would not be able to exist without them. How else would moisture flow up the trunks and stems? But, on the other hand, according to Mikhail V. Lomonosov's data, water flows up only for the maximum of several dozens of millimeters even through the thinnest capillary. But trees may have the height of several dozens of meters! If, as it is customarily considered, moisture flows from one capillary to another of its own accord, why not suppose that a capillary perpetual mobile is feasible? Explanations that moisture in plants flows up due to root pressure do not sound plausible. So where is the truth?

Years have passed since that visit of A. Rodionov. Now, just like I used to sympathize with, as it then seemed, a rather odd inventor, now my relatives sympathize with me. One can not blame them: for weeks and months there have been flowerpots all around the apartment - on the tables, window-sills and bookstands. With bottles, tubes and self-made water manometers to follow.

Once, when I was assembling a device, I could not find two similar glass tubes and had to put in the tube of thin polyethylene. But no matter how hard I worked the water in the communicating vessels was at different levels. In the glass tube the water level was always higher. It could not be otherwise, if you come to think of it, but isn't it the right time the words "made of equally wettable material" were inserted into the communicating vessels law?

Here is a primitive experiment: make a hole in the bottom of a plastic flowerpot containing soil and a plant, and insert there one end of an elastic tube. The other end is inserted into the bottom of a plastic bottle containing water (see Fig. 3). In accordance with the communicating vessels law, the water will flow from the bottle into the flowerpot. When we see that the soil has been made wet, the experiment shall get more complicated: elevate the flowerpot so that its bottom is higher than the liquid level in the bottle. In some days we shall notice that the soil has not dried up and the water level in the bottle has lowered. One should not be a Solomon to guess that the soil or the roots of the plant transfer the water from the lower to the higher level. Here is a typical natural perpetual mobile!

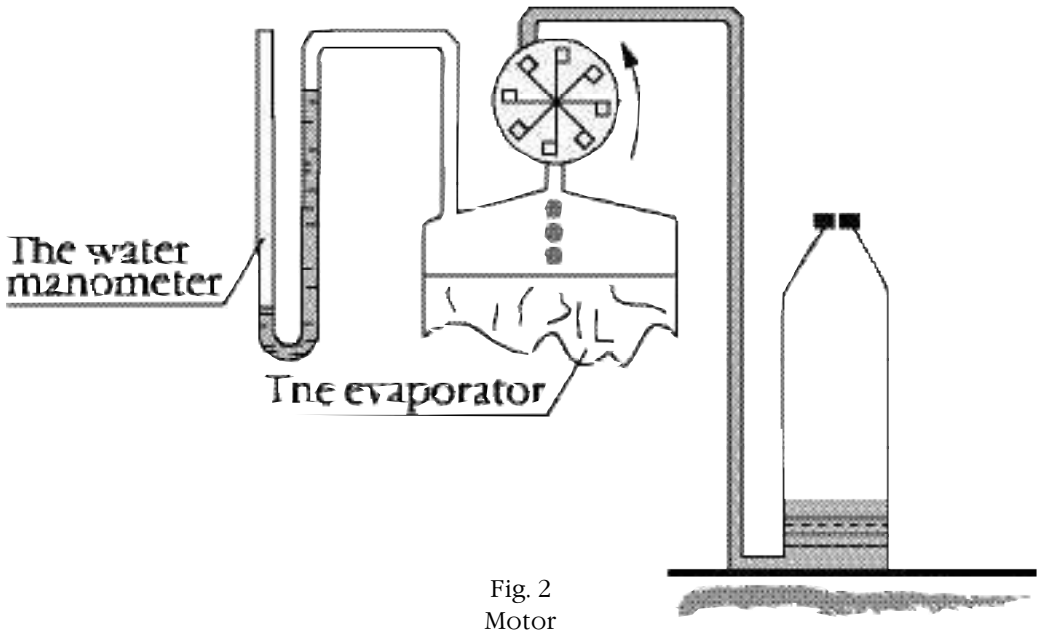

Fig. 2
Motor

It is no use referring to the molecular adhesion forces since they can not be applied at such height differences. What is it then? A molecular collision as in a boiling kettle? But a leaf has neither high temperature nor much space. Nevertheless, water evaporates both from the soil and leaf surfaces. At the same time there is rarefaction under the evaporating surface. Can it be the rarefaction that pulls up new portions of water?

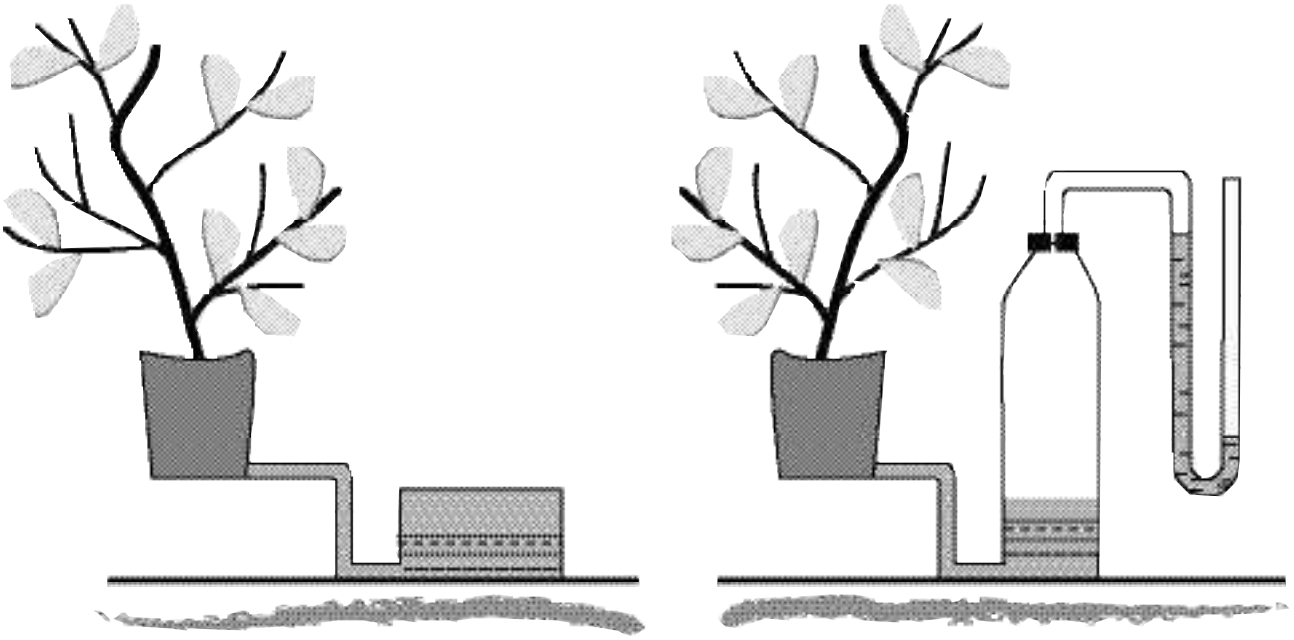

Fig. 3
Rarefaction

Let us make the experiment still more complicated. Put the leg pipe of a liquid manometer into the bottle cork. (Fig. 3) Almost immediately the water level in the closest leg to the bottle will start rising. It means that there is rarefaction in the bottle. Can it be the rarefaction that "rules" the plants?

Most likely, the essence of the mistake made by Rodionov and other authors of capillary motors consisted in attempts to get the water outflow from the capillary. **If it is not flowing out but evaporating, as it is common for the soil or plants, then, probably, vacuum will manifest itself and the capillary perpetual mobile will start working.**

I made my first capillary perpetual mobile many years ago (see Fig. 4). And it worked: though slowly, the wheel was steadily turning. No doubt, it was due to the heat inflow from the air. Therefore, such motor will work if there is a temperature difference and relative humidity of surrounding air is below 100%.

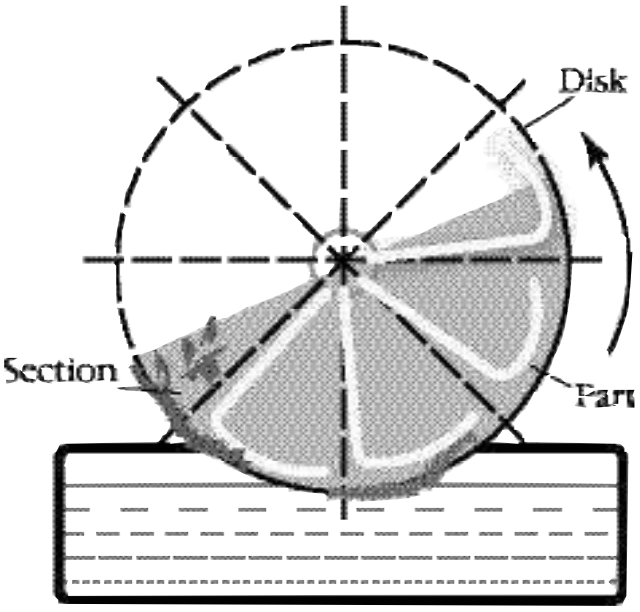

Fig. 4
Capillary Motor

The heat motor operating principle is clear from this figure. The disk (many disks on the common axis) is divided into isolated sections. Their surface is covered with a moisture-proof piece of material (filtered paper, cloth, etc.). The part of each section somewhat gets under the base of the next one. Hence, a small part of the base of one section and a part of the part following the section can get into water simultaneously. Due to the capillary moistening the section and the part will start to absorb water. Since the section is shifted about the center of gravity, the turning moment is bound to appear. The section that is out of water starts to dry up, the moment will increase and the wheel will start turning.

Having determined that, though slowly, the motor is turning, the author applied to a patent authority for a patent on the invention of the "Perpetual mobile", meaning it as a joke. I hoped that the experts (I knew some of them personally) will understand this joke. But, unexpectedly, the device was considered an invention, though under the name of the "Heat motor" (certificate of authorship USSR # 1455040).

Basically, the motor is similar to the project of A. Rodionov. I would not be surprised if he protested. The same capillaries and the spontaneous rise of liquid on the moisture-proof material. The only difference is that the liquid does not flow out but evaporates from the capillaries.

Almost without any reason - one can not predict his eccentricities - I have recently made one more capillary motor (see Fig. 3). Perhaps, it resulted from my experiments with plants. This motor directly and spontaneously lifts water to a higher level, which is more convincing. Moreover, water flows in the form of drops (or a stream) and turns the propeller! The motor is quite operable and has even been shown on TV. But do not try to verify it on your own - such work is useless without certain know-how. The author would not like to disclose the "secret" yet. I could still make a patent application.

NEWS

The Continuous Rotation Device

The essence of this invention is that in a closed circle the rotation of the object occurs without any outer influence or any power sources (electric energy, oil, diesel oil, etc.), which results in the rotation of the rotating part of the device. The torque can be easily enhanced by means of transmitting it to the reduction system. At that rate, the necessary rotation speed and rotation power can be acquired.

The device is small, easy to transport, mobile (both, in operation and switch-off), simple and inexpensive to make and assemble. It is economical, ecological and weather independent.

The device can be used in any industrial or household appliance field where the continuous rotation is required. It is especially important to note that this device can be used to generate energy on a large industrial scale as well as in small laboratories, in mountains and remote districts, in tunnels, at sea, etc. for it does not require any power lines.

Patent Claim Priority:
#20030059, April 19th 2003

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Gravity-heat Power System

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Natural hydrologic cycle is a widely recognized phenomenon. Water evaporates from the ground and water reservoir surfaces, generally, due to the Sun heat, then moves to the superstructure atmospheric layers where it is condensed, and precipitates onto the ground surface, but on higher levels compared with evaporation surfaces. In this process water is also purified and desalted. From the higher levels water flows to its main evaporation points, forming streams like brooks and rivers where water power plants could be established. Flowing to the lower surface layers with lower potential energy, water in the Earth's gravitational field performs work that can be utilized.

Natural hydrologic cycle principle is used in the gravity-heat power system (USA patent No. 3953971, International class. F03G7/04 of May 4, 1976).

In this system the temperature difference between ground surface layers (the mountain foot and its top) is used to produce electric power and obtain fresh water. The temperature difference does not change much with change of height, and the system effectiveness is quite moderate, which can be named as its drawback.

The system utilizes free environmental energy. Its efficiency (converted to the process maintaining energy) tends to infinity.

The author proposes a new gravity-heat power system that can substitute modern heat power plants. It contains all installation components as per USA patent No. 3953971 except for the heat exchanger on the ground surface whose functions are performed by a conventional steam boiler.

Gravity energy component **G** in the proposed system:

$$G = X_m \cdot T\, g\, H\,,$$

where

- X_m – fluid flow,
- **T** – time of operation,
- **g** – acceleration of gravity,
- **H** – tower height between the steam boiler and the freezer (condenser).

This formula does not allow for vapor density of operating fluid.

The vapor density is insignificant as compared with the operating fluid density.

Energy **P**, required to maintain operation:

$$P = X_m \cdot T\, q\,,$$

where **q** – specific fluid vaporization energy

Efficiency **K** – of the system should not be lower than 80%

To obtain efficiency that equals 120% the following is required:

$$H = 2{,}2q/g$$

Or **H** = 25,4 kilometers.

Construction of such towers is too complicated for modern technology. Therefore, a stratospheric balloon that is linked to the ground surface by a flexible twin-core hose rope may be used. One core is designed to send down fluid and the other to send up vapor. Flowing down to the ground surface through the hose, the fluid will generate fluid column pressure. The fluid will cross water-turbine generator cascades, after each of which the fluid pressure will decrease and the fluid will continue its way down.

There is an alternative. To make the tower several times lower the evaporation (at the tower foot) and condensation (at the tower/mountain top) should be phased (in the form of cascade) at various pressure values and with utilization of the same heat energy. For this purpose a heat carrier is used that will transfer heat from the tower (mountain) top to its foot. This operation will enable the tower height segmentation into **H/n** sections where **n** is the number of grades in a cascade.

Cascade structure is shown in Fig. 1

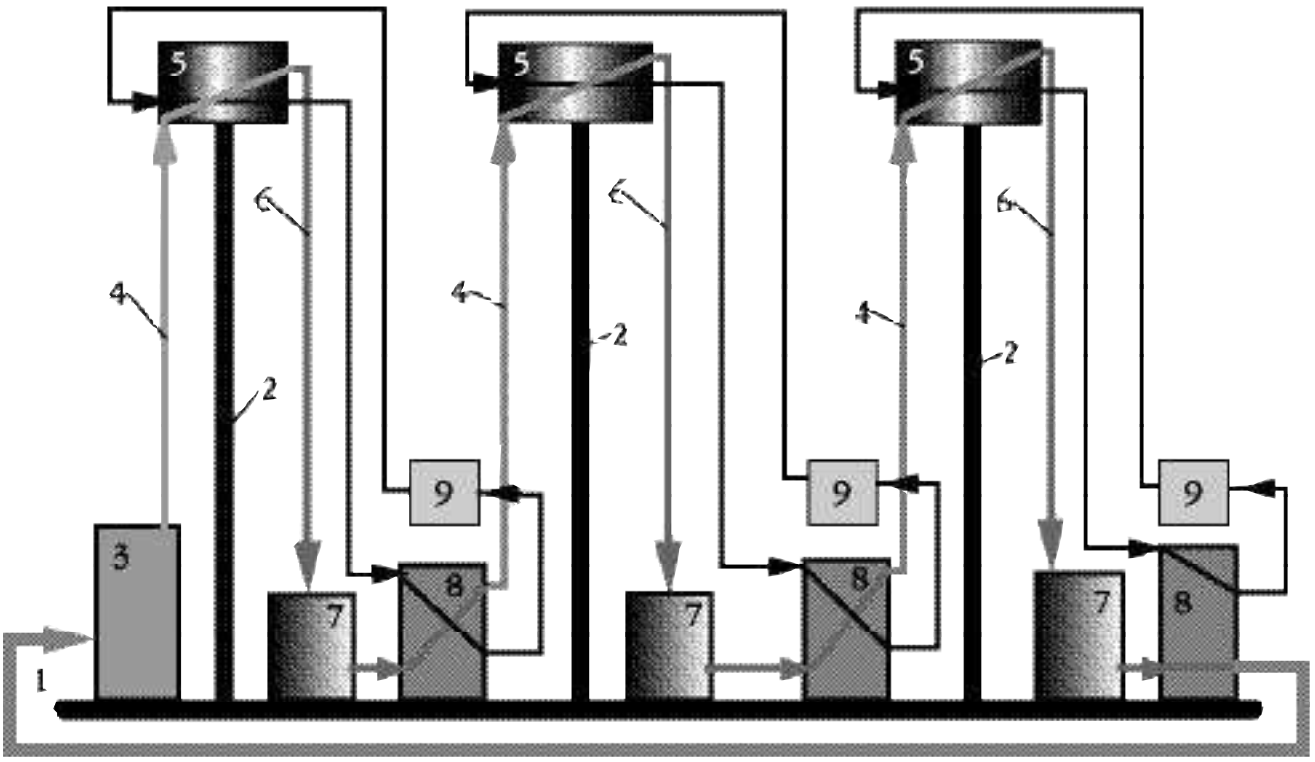

Fig. 1
Cascade

where

1 – ground surface,
2 – tower component or the smoke-stack of the steam boiler,
3 – steam boiler,
4 – steam pipe,
5 – heat exchanger and condenser,
6 – pressure pipeline,
7 – water-turbine generator,
8 – heat exchanger and evaporator,
9 – circulation pump,
10 – pipeline of the heat carrier circulation.

Cascade (operating fluid, water) with 500 meters of height can contain several dozens of grades (50 and more). **In this case the cascade efficiency may approach 120%.**

Decreasing the tower height to 500 meters (for water) will allow for utilization of conventional water-turbine generators and standard equipment.

In the proposed cascade the heat energy is required to maintain the cascade working capacity when Earth's gravitational field energy is utilized. In the author's opinion there are still other ways to use gravitation.

The system scale is its main drawback. Therefore, partial utilization of the proposed principle may

seem more attractive. The proposed engineering solution was simple.

In a thermal power station the condenser is installed on the top of the tower (mountain). After the condenser the water lift in the water tower finished at the steam boiler pressure pipe (omitting the pump that was no longer necessary). Energy required for pressure pipe operation was saved. In other words, the water tower was utilizing the Earth's gravitation at the conventional juncture of vapor condensation in the steam plant.

Such proposal was made on June 17, 1982 in the patent application USSR N3453603/06, (101161) expert code 060701KH. However, the utilization of free and environmentally friendly gravity energy did not arouse interest even on the part of patent experts.

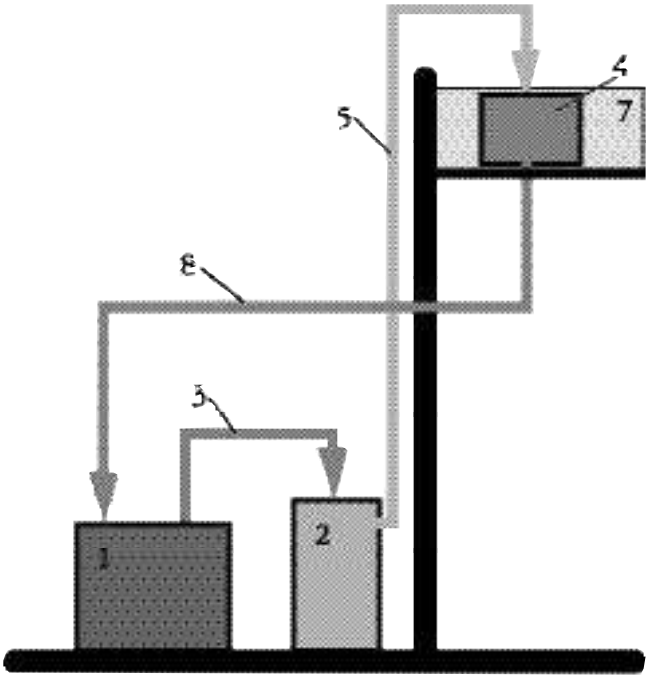

Fig. 2
System

The author is looking for serious partners.

The Alternative Energy Potential in Russia

According to the International Energy Agency (IEA) calculations, total investments into the energy industry constitute approximately 330 billion dollars annually. Almost half of this sum (150 billion annually) is allotted to the development of the electric power industry. This information only partially reflects the potential of the alternative energy development and does not include the market growth factor upon the introduction of autonomous power system technologies. Vast territories of the planet have not been sufficiently developed yet due to the absence of local energy resources and power lines. From this point of view, Russia is the country with an enormous consumer demand potential provided that the mass production of autonomous fuel-less energy systems guarantees low production prices.

Alexander V. Frolov
Editor-in-Chief

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Modern Perpetual Mobile

Review prepared by correspondent Alla Pashova, Russia.
Based on the Internet pages and other information sources

It is common knowledge that any experimental information, which is against a conventional scientific paradigm, is considered to be false, extracted from the society and finally is turned into something **classified and elite.**

Politics-oriented science as a whole and natural science in particular often result in misrepresentation and falsehood of **popular knowledge** that turns it into the fighting weapon of socio-political organizations, states and their groups.

World-outlook and political contradictions of any society often determine science development strategies. In 1885 Nicola Tesla presented his transformer in action by means of which he lit carbon lamps in a 25 miles circle without any cords, conductors or switches using the 5000-HP turbine of the Niagara hydroelectric power station. Afterward, he obtained financial support for one of his energy projects.

On a special testing ground Nicola Tesla built vacuum-energy systems. However, in 1885 the systems, as well as the testing ground, were destroyed as it became evident that if they went on the mankind would never need organic fuel again. But the destruction of the systems and testing ground does not at all mean the destruction of papers and documents...Ever since that moment people have been trying to find "free energy".

The experiment of distant lighting of carbon lamps without using any cords was repeated only once by the physicist Filippov. He managed to light the lamps in Tsarskoe Selo employing the electric generating systems in St. Petersburg. Filippov died in 1914 under mysterious circumstances.

In 1917 the Portuguese American Andres invented non-convetional fuel for an internal

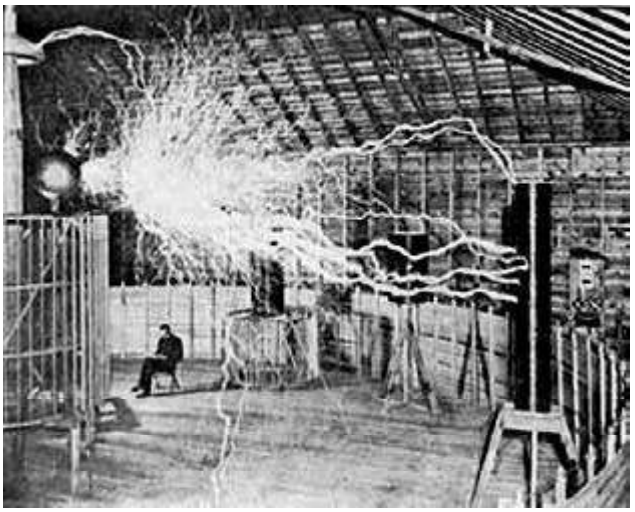

combustion engine. The essence of his invention was in some inexpensive chemicals, which he dissolved in water (some drops of chemicals per pail of water). A special state committee tested the new fuel during the New York - Washington - New York automobile races. After the races one of the largest oil monopolies in the U.S. offered Andres 2 million dollars in cash for the documents and all rights for his invention and later locked all the information in their safes. Two days later after getting the money Andres disappeared. (The information was disclosed by V. Vasilevsky, the former chief of the scientific and technical intelligence department of the KGB of the USSR, who had been in charge of the department since 1930).

The above-mentioned examples show that there were a lot of attempts to develop revolutionary energy technologies. But what then are the grounds for the 'energy crisis' complaints? The answer is simple: the desire of a group of financial and energy multinational corporations for an economic, political and, finally, for a total control of the world. That is why there is no room for "free-energy" hunters in our science, not even as laboratory assistants, not to mention some higher positions.

Practice often negates scientific dogmas, especially when it comes to the efficiency of different devices. In general, the traditional understanding of efficiency is quite limited and should be forgotten. Instead of the traditional notion "efficiency" we should consider the notion "energy-conversion efficiency" (ECE), which has no limits. In 1974 in the USA a six-stroke internal combustion engine was designed which had a double ECE. The fifth stroke of the engine operation included water injection; the sixth was characterized by the water vapor introduction. Firstly, the engine had a higher ECE than that of the Carnot cycle. Secondly, taking the 55 % ECE of the contemporary internal combustion engine, the ECE of a six-stroke engine exceeds 1.

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Before the war there appeared "studebekkers" with the fuel consumption of 5.5 l per 100 km. But the fuel-economy record was set by the Japanese. In 1986 they built up an automobile, which used only 0.055 l of fuel per 100 km (about 44 g). Unfortunately, now we do not have plants, which could manufacture automobiles of the kind.

In 1832 Tomson came up with the idea of **a heat-pump unit**. Stating the unity and interconvertibility of substance movements, he proved that the mechanical energy consumption can restore stray heat. At that time cross-Atlantic ships had low-temperature steam engines, which employed exhaust steam and ether vapors. The efficiency of those engines was already higher than the Carnot cycle efficiency.

Now with the help of the facts acquired during the last century we will prove the scientific inconsistency of the orthodox model of the second stage of thermodynamics. In 1941 the English physicists O. Hougen and K. Watson published their work featuring the experimental fact that the ammonia-saturated vapor pressure in liquids was higher than the general pressure. For example, with the general pressure of 50 atm and the temperature of 0^0 C, such pressure was 17 % higher. This means that having placed a semitransparent partition and a turbine between two containers it could have been possible to build up a natural-heat vapor-converter. This method was used by **von Platen, the Nobel prizewinner from Sweden, who constructed a self-rotating centrifugal machine, which provided a 1000 atm pressure when ammonia interacted with water. The heat emitted was enough to compensate friction losses**. It is also known that the Carnot principle cannot be applied to closed cycles. W. Vielstich, 'Combustion Cells', 1968: "**If an entropy change of a reaction is negative, it can exceed 1**. It means that a certain amount of energy can be obtained from the natural heat. Such an effect is possible in electrochemical generators, which employ a direct oxidation process before oxidation and dioxidation".

A demonstrative example of scientific experiments withdrawn from science is discovery # 13 "The knock power-transfer regularity" made on December, 18th, 1962, which makes it possible to create a mechanical "perpetual mobile". The experiment shows that the conventional "knock theory" does not work in practice: **the bouncing energy of a body after it has been knocked can be higher than its energy before it has been knocked**.

Trying to get some recognition, **E. Aleksandrov, Doctor of Engineering Science, made his demonstrative experiment in front of many different commissions: a chilled-steel ball when falling from a 10 m height onto a firmly-fixed chilled-steel plate made a 14-15 m-high bounce**. That was the notorious 'perpetual mobile' as it is. It went on like this until somebody decided to explain the result of the experiment by a metal lattice internal

energy. At once, everything was clear. Since that moment the above-mentioned principle has been successfully employed in percussion-action machines. This principle can also be used in simple electric-power systems.

Now we can see that electro-technicians had already constructed demonstrative 'perpetual mobile' machines 10 years before politicians and economists started to speak about the 'energy crisis'.

In 1921 the mass media wrote about A. Hubbard who invented an electromagnetic generator without any external energy supply. The Hubbard generator was used as a boat motor.

> *...now we can see that electrotechnicians had already constructed demonstrative 'perpetual mobile' machines 10 years before politicians and economists started to speak about the 'energy crisis'...*

In 1928 L. Nidershot invented a 300 W electric generator, which did not require any external energy supply. The device consisted of a radio-technical oscillation generator (500 kHz) and a coil. After 68 years there appeared publications about A. Melnichenko who repeated the experiment.

In 1927 T. Brown (England) obtained a patent on the ways of originating a moving power and energy using an electric field. Later, in 1955 while working in France, he presented a system with the speed-capability of several miles per hour using a 2000 eV field. After that he had to stop his experiments and was sent to the USA.

In 1943 N. Tesla presented an electric-motor automobile. The energy was generated by a previously-unknown generator.

In 1960 Stovbunenko (whose research work results were subject to a special verdict of the Military-Industrial Complex) presented his motor, which made it possible to move in his old automobile 'Moskvich' around the city for the whole day utilizing the power of a standard automobile battery.

In 1980 there was a qualitative break through in electro-technical "perpetual mobiles". Baumann's electrostatic machines of the total capacity of 750 kW started functioning in the religious community of Liden (Switzerland), serving all daily needs of the village. (See the photos below)

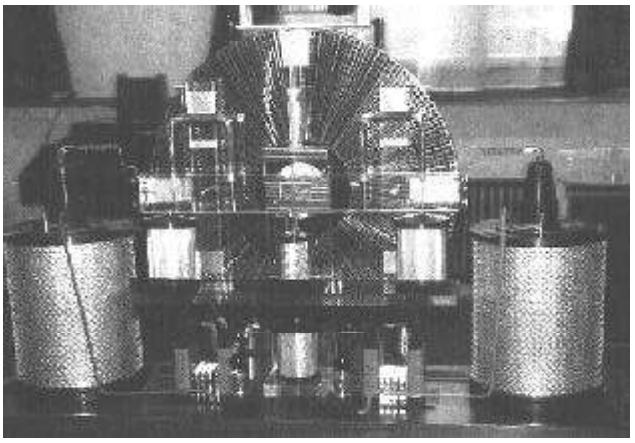

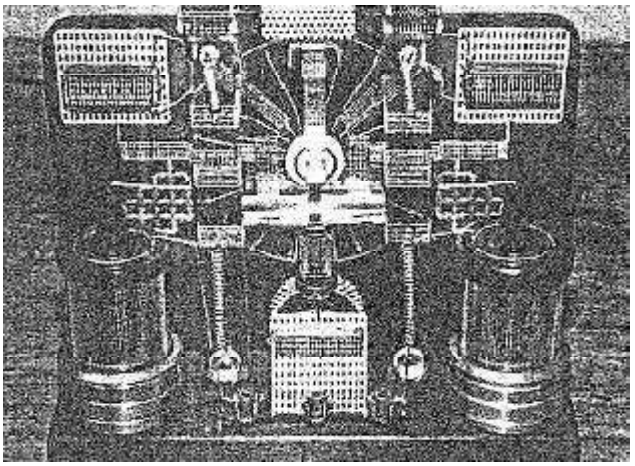

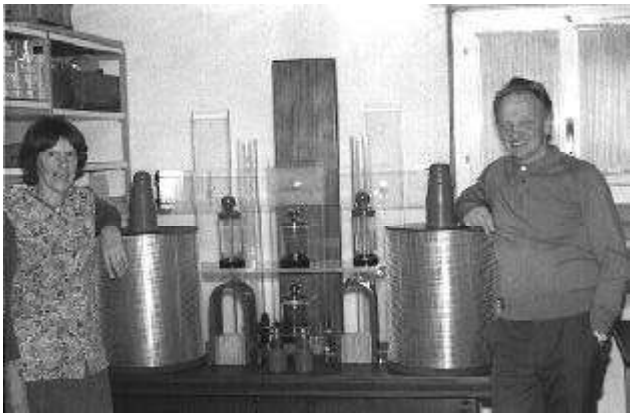

The photos are taken from www.free-energy.cc

Thus, in 1980 there appeared a community with no energy problems, no need for organic fuel and no fear for the 'energy crisis'.

In 1881 N. Sluginov discovered an energy imbalance that occurred in the water electrolysis process. In his experiments he got that the output energy was 30 % higher than the input energy. In 1980 American scientists recreated this energy imbalance and proved that while employing the steam turbine rejected heat, the water electrolysis efficiency reaches 120%.

This information introduces a story about an energy system invented in 1957 under the guidance of I. Filimonenko. The system did not simply generate energy in the form of a high-pressure vapor and output hydrogen and oxygen but also absorbed radiation. In 1960 the USSR Central Committee and Cabinet Council gave a special secret ruling, known as "The Three 'K's'" (Keldysh, Kurchatov, Korolyov) to go on with the research in this system. However, after Kurchatov's death the project was "oppressed" and later on after the death of Korolyov the project was completely cancelled. The special committee of the USSR Academy of Sciences stated that the system was functioning against "the Law of Nature". I. Filimonenko was dismissed and expelled from the party. Later, in 1980-1991 the experiments were partially renewed. Several testing systems were constructed in the Chelyabinsk region but the construction was never finished and the use of a mobile system for eliminating the damage caused by the Chernobyl accident was refused. This story is a demonstrative example of the traditional rejection of promising projects by science, which could be very beneficial for Russia.

Theoretical Background of 'Perpetual Mobile'

Originally, the term 'entropy' was used only in connection with the reasoning about limited or eternal nature of the Universe. Later it came to be used to describe the functioning principles of thermal machines. Now there exist more than 600 contradictory definitions for 'entropy', which are actually the results of a long and unfinished discussion between the supporters of Dekart and Leibnitz, who defined 'motion' in different ways. It is these permanent contradictions in the theoretical fundamentals of physics that make it impossible to explain the existence of a 'perpetual mobile'. However, standard physics has never denied the possibility of creating energy technologies allowing the ECE higher than 1.

We should remember that the basis of the so-called variational calculation is the mathematical apparatus technique of the conventional mechanics. It seems that if system behavior equations directly depend on time, this system cannot fall under any conservation laws. **This is the proof of a complete failure of the conventional energy conservation law!**

It is these permanent contradictions in the theoretical fundamentals of physics that make it impossible to explain the existence of a 'perpetual mobile'

In time-independent thermodynamics the existence of 'perpetual mobile' can be explained by the system internal energy usage. There exist two kinds of thermodynamic systems. Some of them when being heated or affected in some other way start increasing their internal energy while other systems show the internal energy decrease. The latter are called negative absorption systems. The standard version of the first law of thermodynamics does not cover all the processes occurring in such systems. The output of a negative absorption system can be higher than its energy. The additional output is acquired by the gradual internal energy loss.

To cap it all, there are more than a hundred experimental facts that show the limited nature of the Maxwell theory. They were obtained by scientists from different research institutes and construction bureaus, were tested and registered. Thus, for example, in 1973 in the USSR the acoustic magnetoelectricity effect was discovered. The author of the discovery proved the

interaction of electrons with ultrasonic waves with a 1000-times energy increase. This is against the Maxwell theory, which absolutely denies effects of the kind. But the limited nature of the theory was never accepted.

However, the examples of the machines in action prove that since 1834 when the first refrigerator was invented, when the cross-Atlantic ships were equipped with low-temperature ether-vapor steam-engines, the contemporary science had no right to introduce 'the second holy principle', especially in the orthodox form of 'the Carnot cycle efficiency'. The modern theoretical physics cannot provide grounds for the negation of creating over-unity devices. That is why we should rely on the physicists-experimentalists who develop the science in a practical rather than theoretical way.

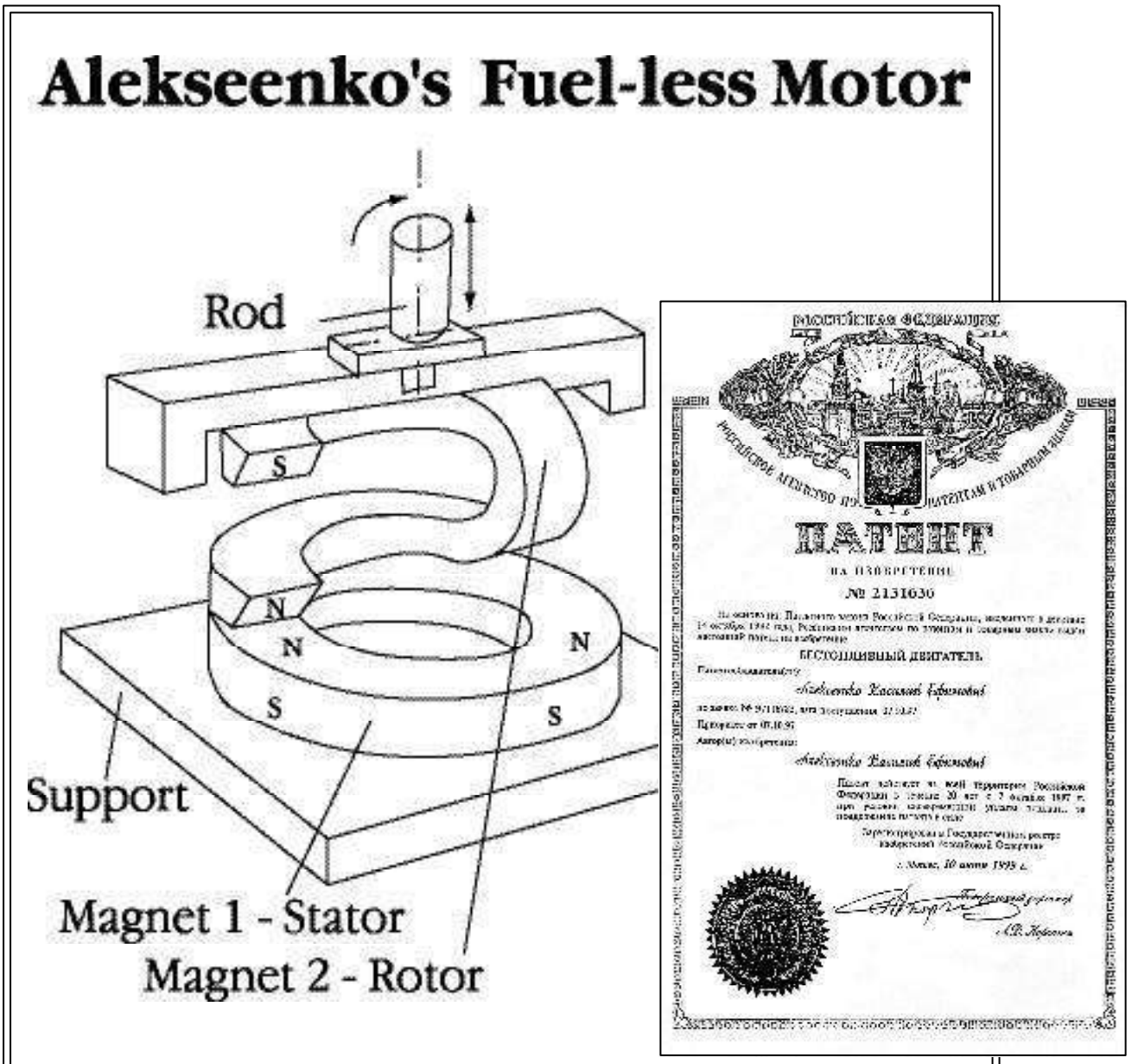

Patent # 2131636
Vasiliy E. Alekseenko

Aerospace Defense Research Finds Free Energy and Antigravity Possible

Dr. Ines Espinoza, USA
email: dr.ines@vasantcorporation.com

Editor: it is worth mentioning that the first gravitational-wave physical mechanism and the mechanism of spin-effect "grazer" (gravitational lasers) designing were described by S. M. Polyakov and O.S. Polyakov in the book "An Introduction to the Experimental Gravitational Studies", Moscow, 1991.

After a 7-year research study, a senior staff aerospace defense engineer, George J. Bugh, concludes economically free energy and even antigravity are possible.

A 7-year study of "free energy" devices, sometimes called "over unity" devices, was done to determine if any of these devices generated power by transferring energy from unknown sources and if so to determine where the energy was coming from. Included in the study is research of related devices with claimed antigravity effects. The study attempted to determine validity of claims, commonalities of device characteristics and to determine how these devices could work. **The results conclude that some devices can generate economically free energy. This study also concludes there is a possible link between gravity and electromagnetism that can be exploited to generate antigravity or electrogravity effects.**

The majority of the study was to come up with a theory to explain how the devices could work. In his research, Mr. Bugh used mostly classical electrodynamics rather than quantum electrodynamics. In Quantum theory, the wave-like characteristics of matter are described using abstract probability waves. However, Bugh proposes that the wave characteristics of matter may also be described as coming from a very real sea of unseen electromagnetic standing waves among all matter. There is a slide show presentation at the website that explains the differences between the Quantum and Classical way of explaining particle interactions.

According to classical electrodynamics, all electrically charged particles, like quarks of protons and neutrons as well as orbital electrons for example, **should radiate away energy from precessional and precessional plus orbital motion**.

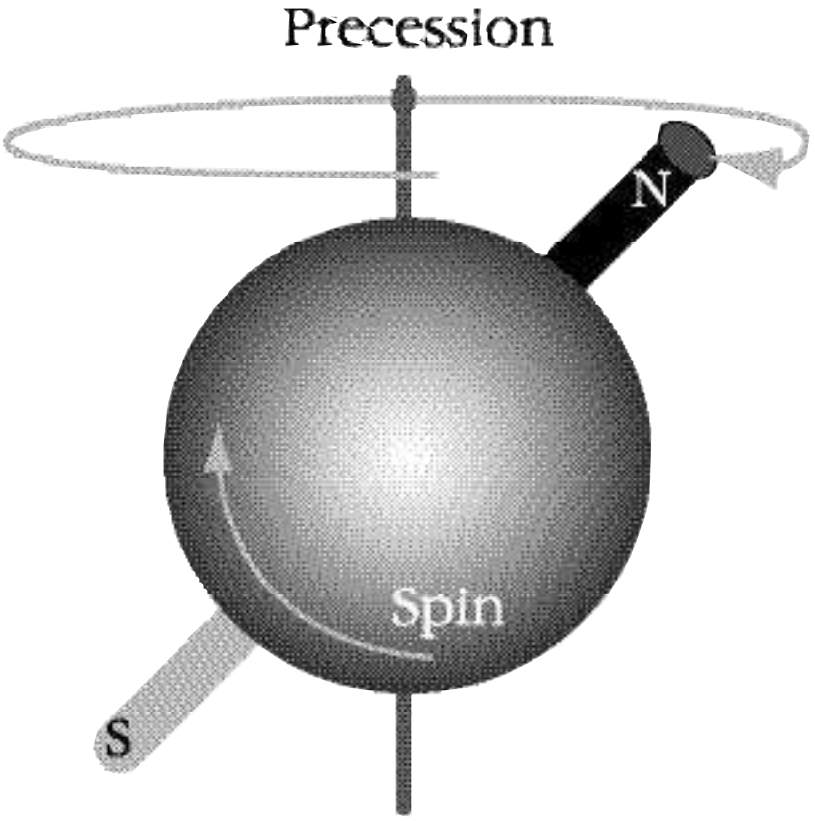

Fig.1
Electron motion

If in fact this really happens then all electrically charged particles can be radiating away energy all the time. However, all particles can also absorb just as much energy from all other radiating particles. The absorbed energy applies electromagnetic forces that naturally move all similar type particles into harmonious precessional motions with all other particles. This results in a vast sea of electromagnetic standing

waves among all matter. Even free particles would move into precessional motions that are in sync with the established sea of standing waves.

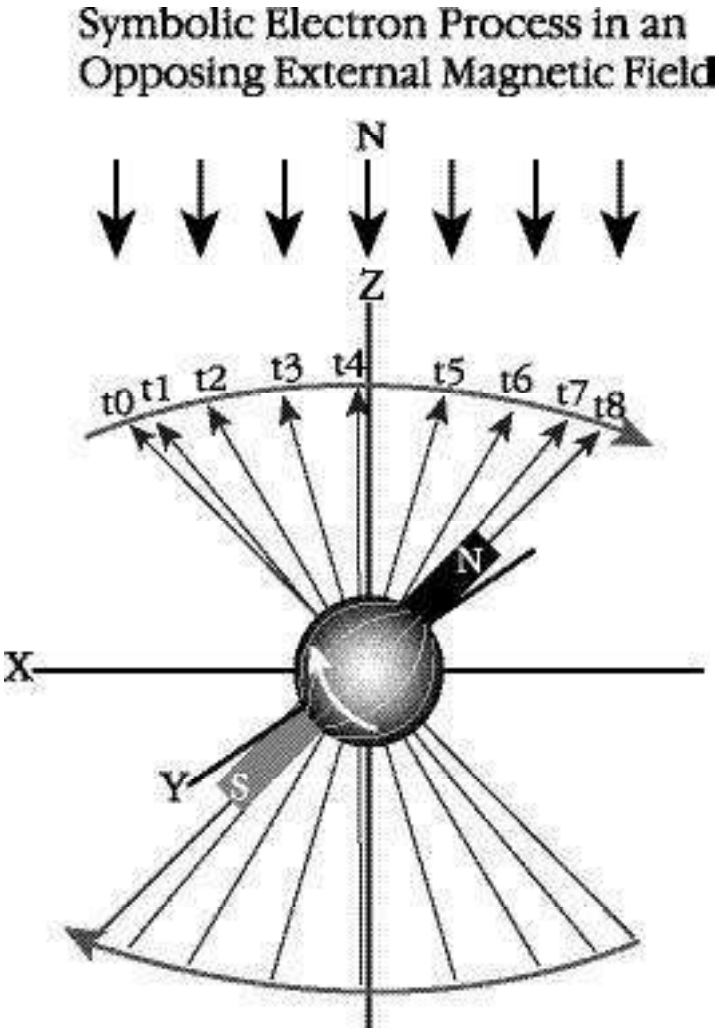

Fig. 2
Electron precession

There can be a hidden yet strong tendency towards harmony among all matter in the universe due to these unseen standing waves and spin interactions among all matter. This tendency can overcome to a great extent the tendency towards chaos and heat death of the universe. This tendency can also be exploited to perform work.

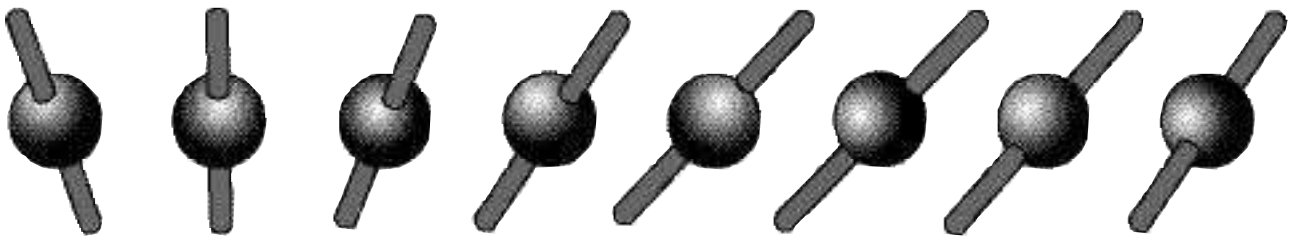

Fig. 3
Spin wave

This is an interaction among all matter that Ernst Mach alluded to as necessary to cause matter's characteristic of inertia. Einstein later called this Mach's Principle. Einstein studied Mach's ideas while developing his theory of General Relativity.

Bugh describes inertial resistance to acceleration as caused by electromagnetic forces. Changes in position of a mass will cause phase differences to develop between the precessional motions of the particles of that mass relative to the sea of standing waves. This in turn causes electromagnetic force that resists a mass from changing its position.

The research papers are published in a book and a CD titled "Spin Wave Technology Initial Release".

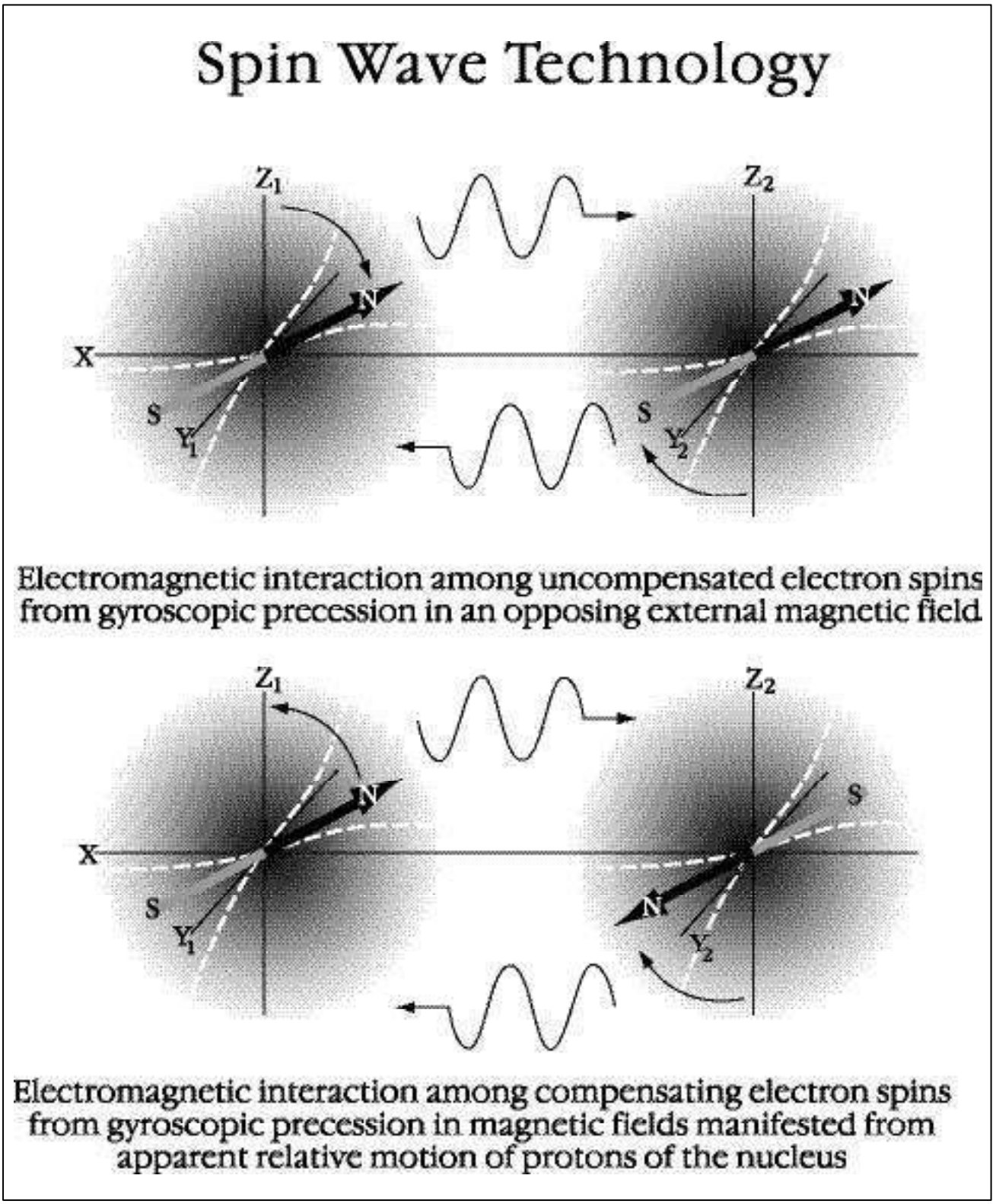

Fig. 4.
Spin wave technology

At the end of the book it suggests that it should be possible to create computer simulations of particle interactions using classical electrodynamics to demonstrate both inertial resistance and gravitational attraction and it should be possible to simulate devices that manipulate these particle interactions to demonstrate antigravity effects.

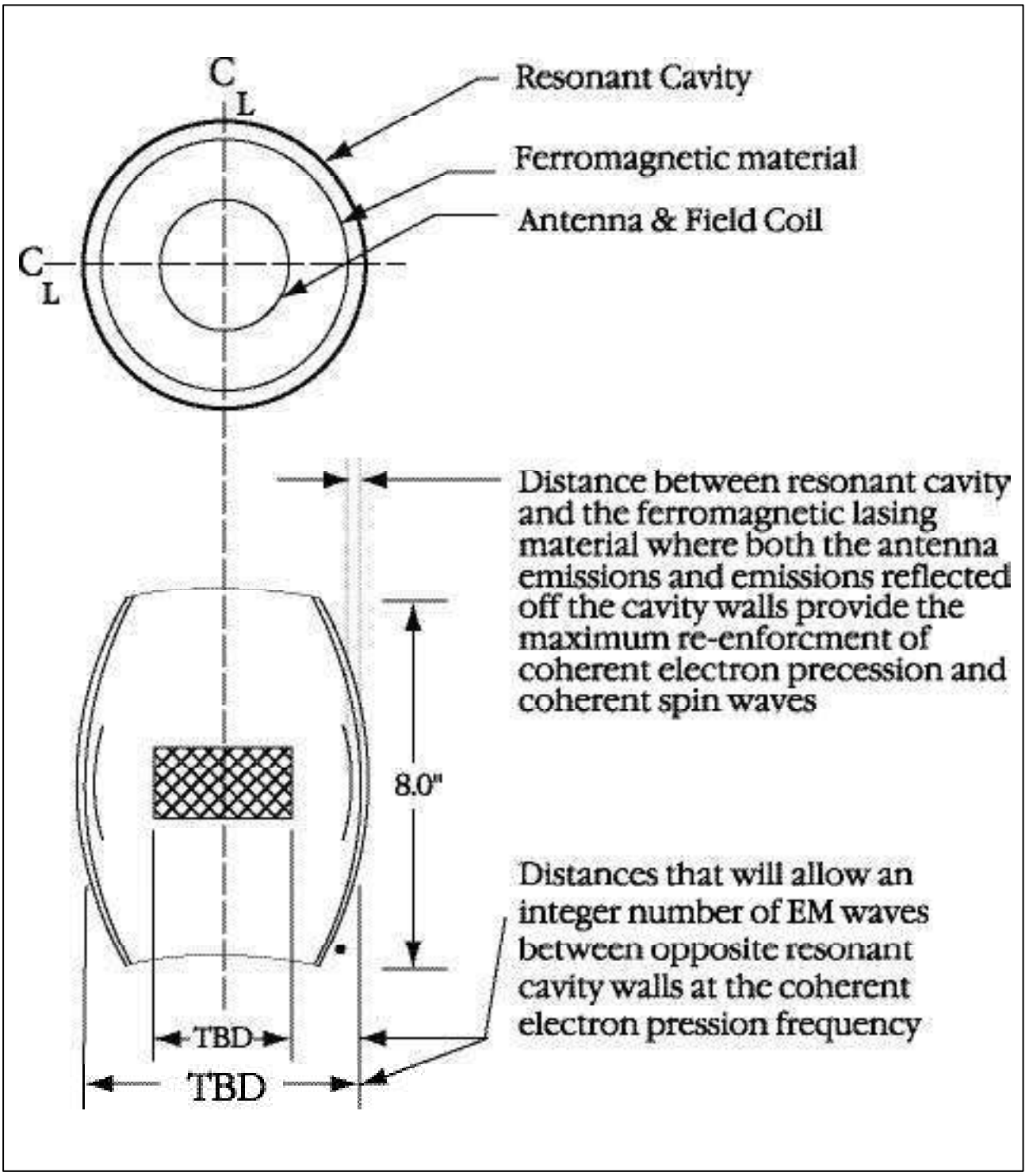

Fig. 5
Spin wave laser

More information is available about the research results at the website: www.vasantcorporation.com.

On Physics of Electromagnetism
Mechanical Analogue or Pure Mechanics?

Yury V. Ivanko, Ukraine
E-mail: ux0lw@hotmail.com

After publication of the article "Study of possibility of a high-energy hyper-low-frequency electric field" in the "New Energy Technologies" magazine, Issue #2, 2003 I am often asked why I have mentioned the Big Bang in my hypothesis.

I would like to reassure atheists since I do not back the Big Bang hypothesis. But I had to base myself on something. At present the origin of the Universe as a result of the Big Bang has priority and is recognized by the academic science.

Both theorists and experts have long noticed a deep analogue between vortex motion of air currents and electromagnetism. My vision of the physics of electricity and electromagnetism is fully based on existence of a vortex capable physical environment. What is considered to be and is measured **as electric voltage, electric current, magnetic or gravitational interactions is nothing but similar-originating phenomena - the result of vortex flow environment affecting our detectors - dissimilar formations for these vortex flows**.

For instance, let us consider three vectors for the flow along the skin-layer of the line conductor - aerial emitter, together with alternating voltage attached to it (Fig.1):

1) longitudinal - showing as electric voltage, the gradient of potentials between the emitter feeding point and the emitter cold end, U;

2) tangential - showing as amperage - electric current, I;

3) radial - showing as the interacting force of two flows - magnetic field (attraction/repulsion), H (not to be mixed with the commonly used term of magnetic intensity).

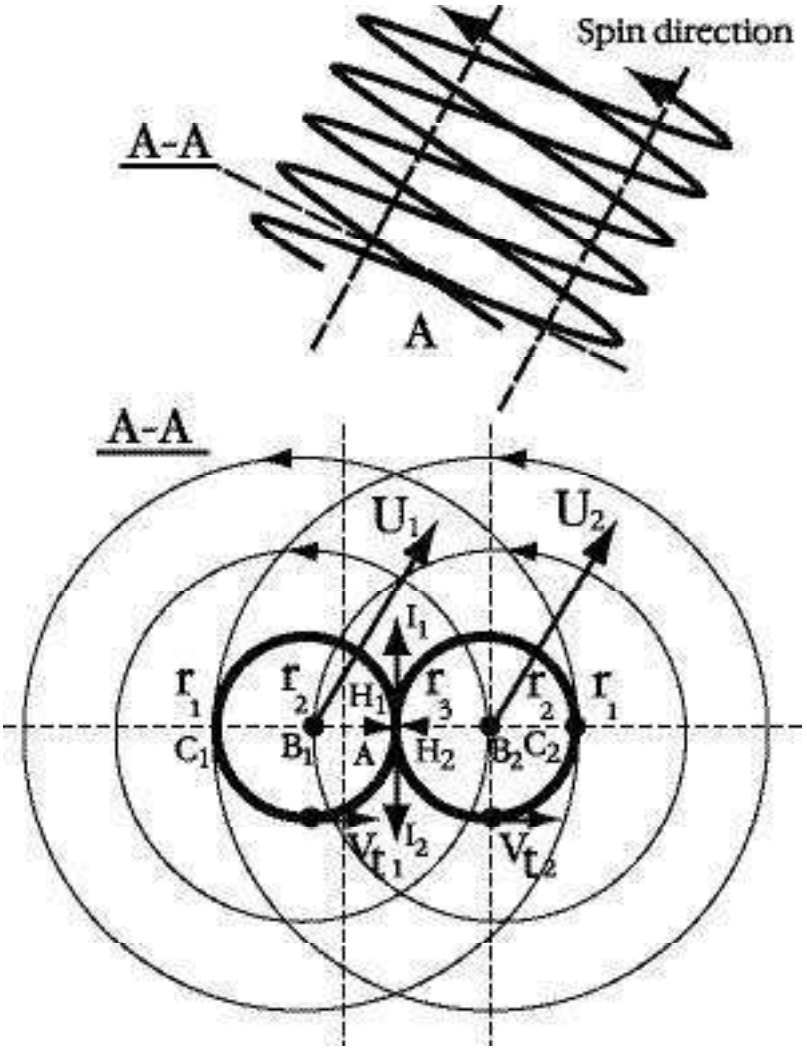

Fig.1
Interaction of two left-handed homogeneous parallel flows.

Let us consider it step by step:

Consider line conductor AB with length L in free space (Fig. 2).

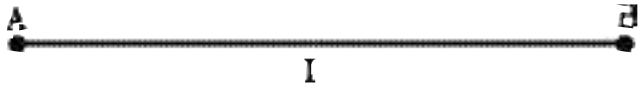

Fig.2
Line conductor in free space.

Let us assume that he is not affected by and fields. Then the gradient of potentials between A and B equals zero. Let us apply sinusoidal voltage from the generator output to point A (Fig. 3).

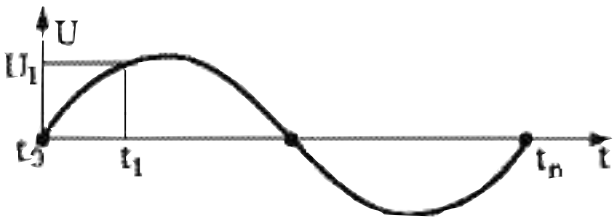

Fig.3
Sinusoidal voltage at the generator output.

Let us consider the initial time point t_0. The generator output voltage is U=0. At time point t_1 the generator output voltage has changed and took on value U_1.

It is necessary to note that (See Fig. 2) the propagation speed is finite: c=300000 km/sec. Point B will "learn" about the voltage alteration only in time $t_B=t_1+L/c$. Therefore, at time point t_1 between points A and B appears gradient of potentials $\Delta\varphi = U_1$. So what is the direction of vector U_1? Right, along conductor AB.

What practice says

One should not be a physicist or radio mechanic to notice small electro-shock of ungrounded metal objects close to aerials of powerful transmitters. Specialists term them as "electromagnetic inducers". Has an expert ever measured the actual characteristic of the field intensity distribution along a line conductor? Why should he? Everyone knows from school lessons how alternating voltage is distributed along the conductor, the length of which is comparable with the wave length (Fig. 4).

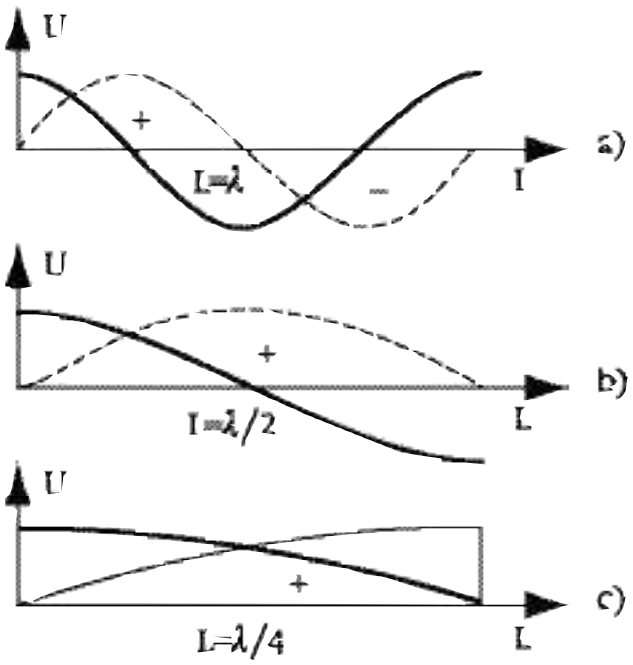

Fig.4
Classical representation of voltage distribution along a linear vibrator a) for λ, b) for $\lambda/2$, c) for $\lambda/4$.

Now let us consider what experimental measurements suggest.

An experiment of measuring the field intensity distribution along the line conductor is shown below. A classic field indicator (FI), assembled as per scheme in Fig.5, was used as an intensity measuring instrument.

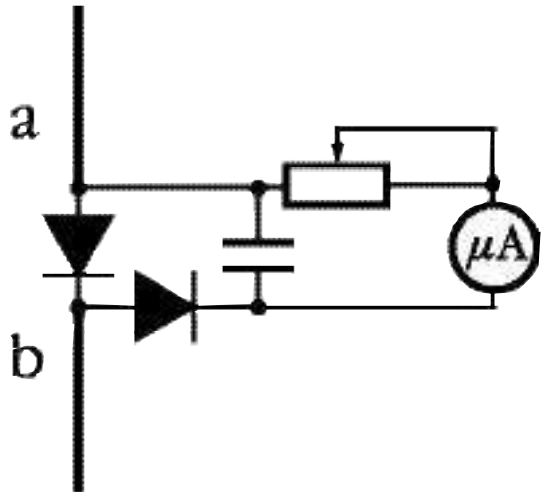

Fig.5
Field indicator principle diagram.

FI was located in immediate proximity to the vibrator but had no galvanic contact with it. Experimental frequencies were selected in

accordance with the standing wave coefficient minimum (SWC) for λ, $\lambda/2$, $\lambda/4$. Sinusoidal signal generator was connected to one end of the vibrator (Fig. 6a).

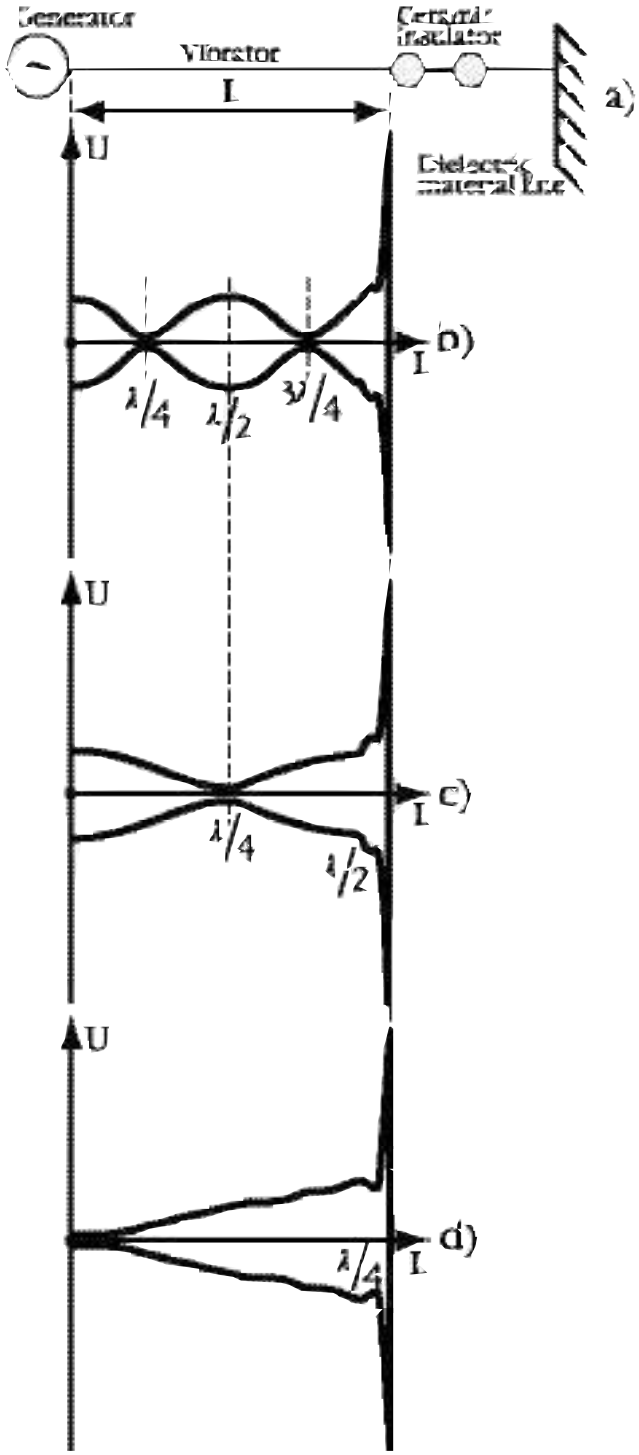

Fig.6
Measured field intensity along a linear vibrator.

To better understand diagrams in Fig. 6 curves are drawn at the upper and lower ends of each axis L that corresponds to the vibrator location. The curves were run with FI horizontally located on both sides of the vibrator.

From Fig. 6d it is clear that the diagram is axisymmetric and looks like a conic funnel.

Meanwhile, the vibrator directional diagram measured by the monitor receiver far more distant than λ, shows the characteristic that coincides with the simulated one through the Matlab-6 system (See Fig.7). As you can see from this figure, the spatial characteristic of the directional diagram is in the form of a toroid.

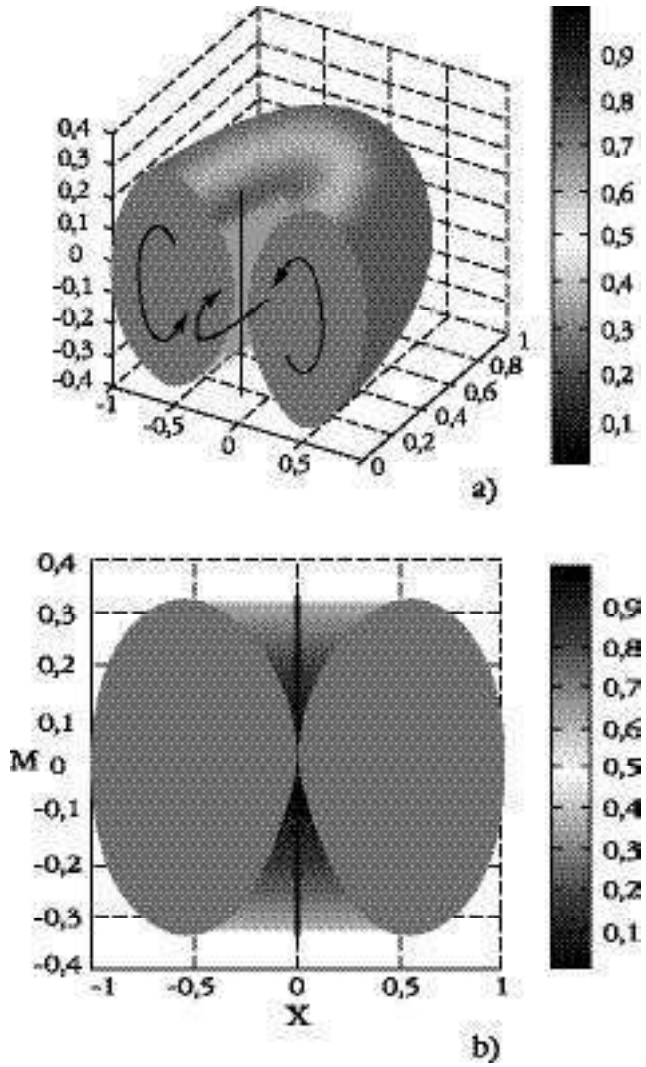

Fig.7
Matlab-6-simulated directional diagram of the semi-wave vibrator

A series of alterations was made to explore vortex ether dynamic processes with variable wave length and frequency in line conductors, solenoidal and flat coils, etc.

For certain purposes the solenoidal coil may be considered as a shortcut linear vibrator. On respective frequencies the field intensity distribution along the solenoid corresponds to the linear vibrator. This data may prove useful to many modern engineers of the Tesla transformers and generators. To increase voltage on the cold end a toroid capacitor is set in the Tesla transformers. Nuclear physicists use the hemisphere capacity for the particle accelerators. Thus, a voltage of millions of volts may be achieved.

Flat coils are best explored in terms of field intensity distribution (See Fig. 8)

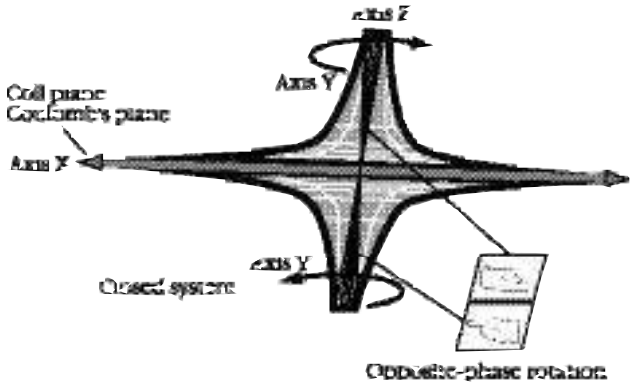

Fig.8
Field intensity distribution for a flat coil in a closed resonance circuit.

Field intensity distribution on a resonance frequency is correct.

The practical experiment for the case in fig. 6d has shown that the neon lamp that is connected with the vibrator end will be off. And this is with a 100 W generator! It is a paradox, one would say. The measurement diagram shows a "splash" of the field intensity at the vibrator end but we feel nothing. Indeed, when the FI is located as shown in Fig.9 for $\lambda/4$, the "electrodynamic vacuum" will generate. The device showed "0" intensity, which conforms neither with the diagram in Fig.6 nor with the diagram in Fig.7.

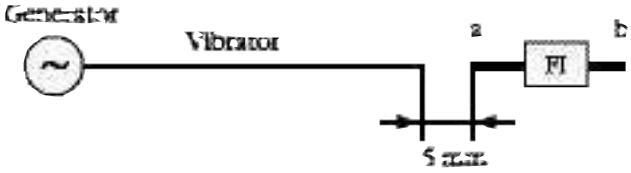

Fig.9
Field indicator shows "0" - "electrodynamic vacuum".

The same "vacuum" in the center of tornado was observed by people in the epicenter.

Remember what is measured with the field indicator (an ampere meter) along the linear vibrator. The Ampere force!

So, both people and their environment are in rotation process. The Earth rotates around its axis and around the Sun. The Sun rotates around the Galaxy center. The Galaxy rotates around the center of the Universe. The Universe rotates...

Every space point has an inceptive rotation impulse (torque). Let us remember the analogy. Water flowing out of the tub rotates counterclockwise in the northern hemisphere and clockwise in the southern hemisphere. If you set a right-handed torque in the northern hemisphere, the water will continue to flow counterclockwise.

The electromagnetism is the same. It has a natural left-handed rotation. Nevertheless, practical radiotechnology is familiar with right-handed fields artificially generated by transmitters.

The commonly used term of magnetic interactions is easier to understand if we consider the electromagnetic field as a vortex flow. Two left-handed homogeneous parallel flows are shown in Fig.1. At the point of interaction A of vector projection, the speeds of flow propagation on section plane **A-A** have opposite direction and compensate each other. The actual flow density is $\rho_1 < \rho_2 < \rho_3$. Reduced pressure occurs at point A. The flows are attracted. The resulting attraction vector for the whole flow is radially directed. The counter parallel flows will have composition, i.e. overpressure, and will repel.

One should note that graphic presentation in Fig.1 for vectors H and I for the etherdynamic systems is possible only in special cases. In dynamic vortex flows the current intensity vector is actually directed towards the flow movement and coincides with the vector direction of its propagation speed (V). The resulting vector H remains a radius-vector only for the considered point of interaction of two flows. The flow energy parameters are defined by its propagation speed V (Fig.1).

I am convinced of existence of ether vortex flows in the Universe. Modern astronomic and cosmological surveys confirm my hypotheses of aether Hyper-fields existence on a Universal scale.

The commonly used term of magnetic interactions is easier to understand if we consider the electromagnetic field as a vortex flow.

Even an amateur in aerodynamics and dynamic of gas vortex may make cosmological conclusions:

♦ vortex initiation implies the initial gradient flow of at least two counter flows;

♦ energy parameters of the emerging vortex flow can not exceed those of the parent flows

♦ there exist ether flows with energy exceeding that of our Universe

♦ our Universe has not originated from a point and is not finite. It is the spiral (vortex) structure of our Universe that testifies against the Big Bang hypothesis.

Conclusions:

Practical radiotechnology is familiar with the key difference between the field intensity distribution diagrams of aerial emitters in near and far zones. After combining diagrams 6d and 7b (Fig.10) it is possible to draw certain conclusions.

When transverse waves (radio waves) are formed around the aerial vibrator, the double transformation of the initial flow geometry starts:

♦ **the first flow is a homogeneous spiral flow on the conductor skin-layer;**

¨ **the second flow is a non-homogeneous vortex flow of the near zone;**

¨ **the third flow is a toroidal flow of the far zone.**

The toroid volume alteration in the far zone (as per the transmitter vibration frequency) forms volumetric planar transverse vibrations (spherical waves) that are called electromagnetic or radio waves. The gradient of potentials alterations (as per the transmitter vibration frequency) provoke changes of the Coulomb plane, which form longitudinal vibrations with a narrow directional diagram.

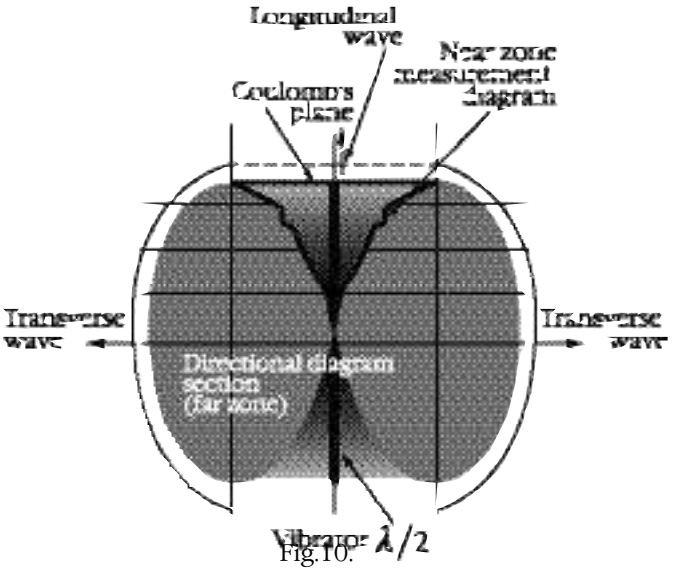

Fig.10.

The longitudinal flow is assumed to be formed as a chain of toroids (like smoke rings)

Ether-dynamic approach provides grounds for more substantial conclusions and assumptions. A new approach to energy and communication systems is made real. Further results of the experiments with transmitters and aerials, assembled on ether-dynamic principles, enabled to draw the following conclusions:

- all reasons, preventing transformation of the transmitter power into the power of transverse radio waves, are evident;
- all reasons for the transverse wave phase lagging with the increase of distance from the emitter, are also evident;
- besides the toroid that forms the transverse wave, the second flow generates a crucially new radiation that has a very narrow directional diagram along its longitudinal axis;
- the aerial ignores wave geometry for the second flow and its longitudinal derivative;
- the radiation along the second flow axis has a very high penetrating power;
- the radiation along the second flow axis has no signs of polarization.

The list of references is not shown in this article due to its size. It can be looked up at **www.efir.com.ua.**

NEWS

In October 2003 the second stage of the research on the "time control" was completed. In the photo below you can see Chernobrov V. A. and Frolov A. V. in the laboratory, October 31st 2003.

The second stage conclusions are quite interesting, however the usage of timers (chronometers) as detectors is proven to be inappropriate for they are subject to magnetization and their indication variations cannot be reliable in this case.

The next stage will feature the following method of detection of the time rate changes (the rate of the matter existence) that is the radiation wave-length measurement. If it is possible to achieve significant results then we will be able to detect the change of the laser ray colour in the area of the effect and its linear path deviations. The experiments will be held to register the weight changes of the detector at the expected influence of the produced effect on the ether density.

Our company looks for cooperation with corporations, which are interested in the application aspects of these technologies.

Frolov A. V.
General Director, Faraday Lab Ltd
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http://www.faraday.ru

CELL OF THE THIN PLASMAELECTRIC HEAT GENERATOR

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E-mail: kanphil@mail.kuban.ru

EC 28 / 1 !

The main task of the experiment was to check the hypothesis: "Electrodynamic influence on the water molecules gives the possibility to significantly reduce energy expenses on destruction of their chemical bonds; further fu-sion of these molecules considerably increases the output of additional energy in the form of heat".

Photo of the Thin Plasmaelectric Heat Generator

In order to solve this task, special experiments were carried out as regards the electrodynamic destruction of chemical bonds of water molecules by electric pulses of various frequencies.

CHECK TEST RECORD FOR PLASMAELECTRIC HEAT GENERATOR

Table 1

	Indices	1	2	3	Avg.
1	mass of the solution, which has passed through the reactor *m*, kg.	0.470	0.432	0.448	0.450
2	temperature of solution at the input of the reactor t_1, degrees	22	22	22	22
3	temperature of the solution at the output of the reactor t_2, degrees	66	66	65	65.67
4	temperature difference of the solution $\Delta t = t_2 - t_1$, degrees 44	44	43	43.67	
5	durability of the experiment $\Delta\tau$, s	300	300	300	300
6	reading of voltmeter V, V	4.50	4.50	4.50	4.50
6'	**Reading of oscillograph , *U'*, V**	**4.47**	**4.47**	**4.47**	**4.47**
7	reading of ammeter I, A	2.1	2.1	2.1	2.1
7'	**Reading of oscillograph , *I'*,** A	**2.2**	**2.2**	**2.2**	**2.2**
8	electric power consumption according to indices of voltmeter and ammeters, $E_2 = I \cdot V \cdot \Delta\tau$, kJ	2.84	2.84	2.84	2.84
9	power the heated solution, $E_3 = 4.19 \cdot m \cdot \Delta\tau$, kJ	79.64	80.01	80.72	80.46
10	**reactor efficiency index $K = E_3 / E_2$**	**28.04**	**28.17**	**28.42**	**28.21**

Supply voltage and current were measured with the help of a voltmeter, an ammeter and an oscillograph (Fig. 1-4)

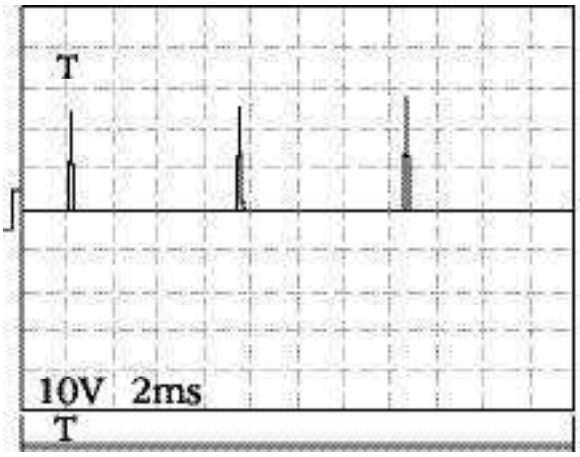

Fig. 1
Voltage

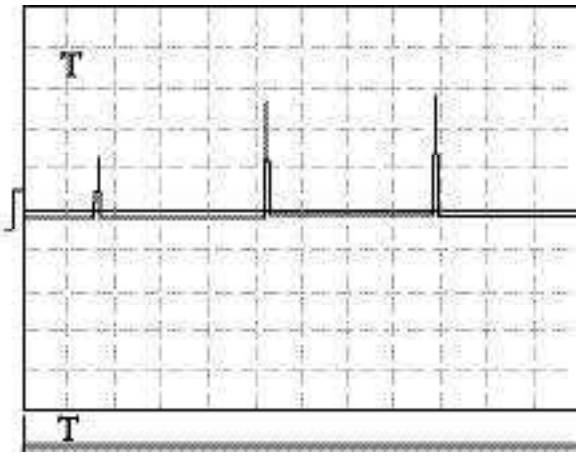

Fig. 2
Voltage

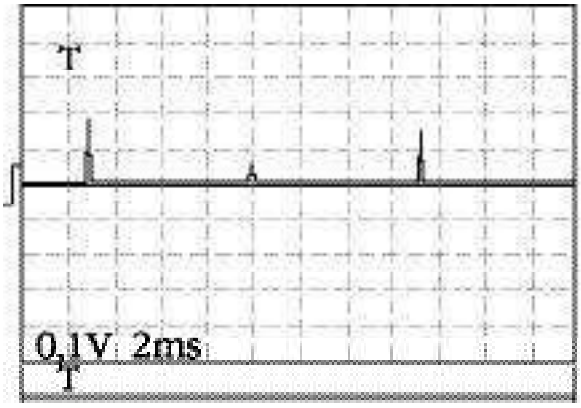

Fig. 3
Current

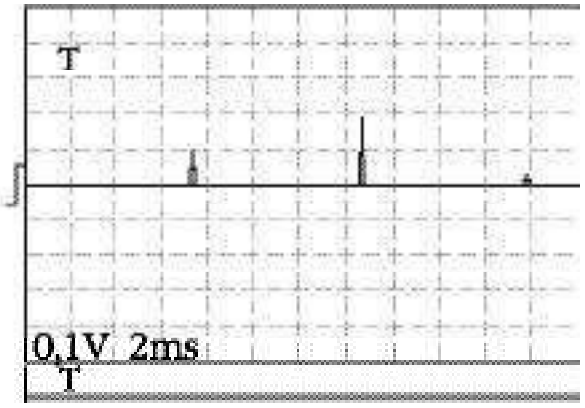

Fig. 4
Current

Process parameter calculation according to the oscillograms (Fig. 1-4) to the check test record (Table 1) gave the following results:

- Pulse scale 10.

- Average voltage amplitude according to Fig.1 and Fig. 2: Ua_{av} = (23+25+28+10+26+29) x 10/6 = 235 V.

- Average current amplitude according to Fig. 3 and Fig. 4: Ia_{av} = (20+6+17+7+10+19+3) x 10/7 = 117 A.

- Pulse repetition period T = 7.4 ms. Pulse duration t_p = 0.28 ms.

- Pulse frequency f = 1000/7.4 = 135.1 Hz. Relative pulse duration S = 7.4/0.28 = 26.32.

- Space factor Z = 0.5/26.32 = 0.019.

- Average pulse voltage U_{av} = 0.019 x 235 = 4.47 V.

- Average current in pulses I_{av} = 0.019 x 117 = 2.22 A.

Thus, it is possible to consider that the experimental test of energy efficiency of the water electric heat generator with the help of two methods gives practically identical results and confirms the above-mentioned hypothesis concerning the possibility to generate additional energy in the processes under consideration. It should be noted that as during measurements the pointer instruments of high class of accuracy of 0.2 have been used (relative conventional gauging error does not exceed 0.2%), and oscillographic measurement accuracy is much lower (usually, about 5%), the readings of the voltmeter and the ammeter should be considered more accurate.

Commercial efficiency of the water electric heat generator will depend on pulse generator economy. Since effi-ciency of powerful pulse

generators can be near one unit, energy efficiency in industrial plants that use the considered heat generators should not differ greatly from the data obtained during laboratory research.

Simplicity and one hundred per cent reproducibility of the described experiments open a prospect for quick commercialization of the water electric heat generator.

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2. Kanarev Ph.M. The Foundation of Physchemistry of Microworld. The second edition. (In English). http://book.physchemistry.innoplaza.net
3. Kanarev Ph.M. Water Electric Generator of Heat. http://Kanarev.innoplaza.net

Professor Kanarev looks for co-projects with prospective investors.

Fantastic Projects

Smith's Generator

Review

TransWorld Energy,

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http://altenergy-pro.com

Don Smith is a University degreed professional in science & engineering. Served in three wars; WWII, Korea and Vietnam. He has enjoyed a long and successful profession as an executive in the petroleum industry. His life long outside interests include electronics and engineering. A popular walk on substitute for University Professors in physics, chemistry, biology and computer assisted drafting. Teaching style similar to Richard Feynman. He enjoys celebrity status in Japan and Saudi Arabia.

About 20 years ago, the book "Inventions, Researches and Writings of Nicola Tesla", resulted in his reconstructing, as a way of understanding the many theories and devices shown in the book. From this encounter, a very strong bonding resulted. The object then became putting his thinking inside that of Tesla, such that expanding upon and extrapolating areas not yet reached by Tesla. Technological advances in materials provide sourcing for devices not possible at earlier periods. For example, magnetic permeability which is the counter part of negative resistance is an open field for experimentation today.

Don does not sell his inventions, but trades licenses for shares in companies which then incorporate the new technology into their marketing systems. As such, he is on the Board of directors of several well established ventures located in Japan, Brazil, Mexico and Saudi Arabia.

Successful reproductions of Don's technology are present in Finland, Saint Petersburg - Russia, Yugoslavia, Romania, Japan, Hong Kong, and numerous other Countries. His book "Resonance Energy Methods" has a circulation of 40,000 copies in worldwide in many languages.

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Abstract

Mr. Don Smith has discovered that Ohm's Law of Resistance does not apply to Magnetic Resonance that travels unrestricted for great distances. Therefore, multitudes of electrons are disturbed. The Magnetic moments are translated into usable electric energy. The Magnetic Dipole provides an unlimited source of electrical current. Mr. Smith's "Dipole Transformer" has been pending since last September.

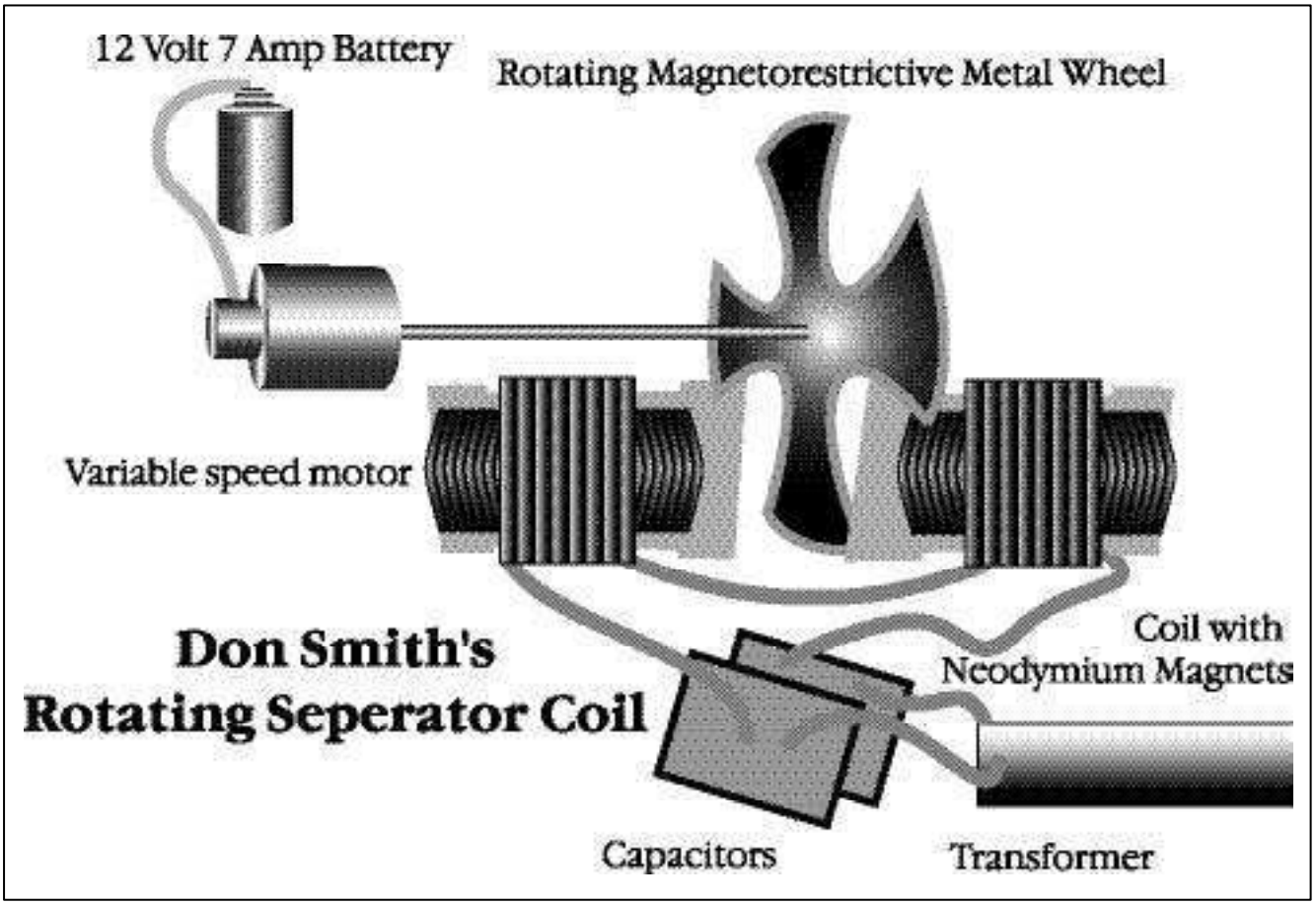

Fig.1
Smith's Energy Receiver

Useful energy occurs as the result of imbalances of ambient background energy and it is a transient phenomenon. In conventional circuits, the electrical field is in a closed system that is damped out with heat loss, which severely limits its utility. **The flip side of the electron generates magnetic waves, which is an open system, not subjected to heat loss. These being unrestricted are the universal source of energy. Universally present electrons are flipped to their electrical position, resulting in useful energy.** When properly constructed an electrical circuit can become self sustainable once started. An obvious corollary would be that the number of radio or television receivers in operation does not deplete the magnetic wave source providing the service. The key source of unlimited energy is Magnetic Resonance. To understand this requires putting a stake through outdated physics. An obvious example is the piano where the key impacts the one note giving one sound, which resonates with its two side keys providing a much higher level. Magnetic Resonant Energy clearly amplifies demonstrating more energy out than in. **Excess energy consequent to a reaction is called Free Energy and can be very large as is in the case of Magnetic Resonance.** The intentionally ignorant physicist makes a habit of ignoring this fact.

Useful electricity is obtained from disturbed electrons, which radiate magnetic fields and waves. The generator disturbs and collects this

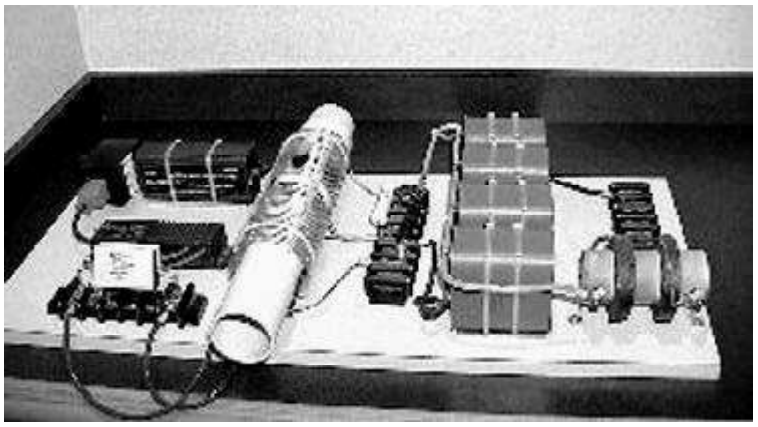

Fig.2
D. Smith's Energy Receiver

emitted electron energy. These electrons remain fully in tact and undiminished until the end of time. This Energy is free and the cost of accessing it depends on the ignorance of the collector. With an appropriate collector system an unending source of environmentally benign, inexpensive, available energy everywhere, is provided.

Editor: in September 2003 Donald Smith took part in the annual "Inventor's Week-end" Conference where he presented the report on his invention. In this issue you can find more details on the conference.

It is worth of a note that we have received ***a number of negative comments on this inventor's work****. However, we thought his articles to be quite interesting and decided to publish them. We would be glad to get readers' comments, who are familiar with the work and inventions of Donald Smith.*

NEWS

News from Farady Lab

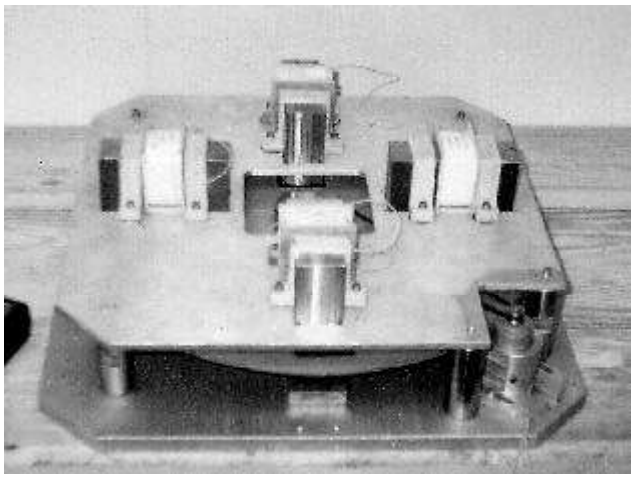

Disk permanent-magnet generator
Faraday Lab Ltd

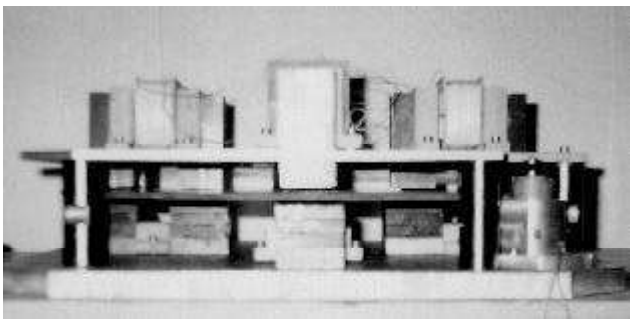

In our lab we are still working at the optimization of the alternator design (electro-magnetic generator with the permanent magnets). We have introduced the drum rotor instead of the disk rotor into the new design of the alternator. The operation mechanism is the same, namely, the alternation of the magnetic flux near the generator coils occurs as a result of the rotating elements operation of the rotor, which "shunt" the magnetic flux.

Frolov A.V.

Strategies for Launching a New Over-Unity Device

Ryan S. Wood, USA
14004 Quali Ridge Drive, Broomfield, CO 80020

Problem description: With any singly successful over-unity energy device comes a host of business, technical and financial problems and opportunities. A public announcement permanently will lead to a "Pons & Fleishman" effect that at best delays public success and at worst derails the entire technological effort. Careful attention needs to be applied to the marketing launch, replication, patents, legal defense and finances.

Potential Solution: With a few working devices that generate100-500 horsepower it is relatively easy to hook these units to the electrical gird and generate monthly checks from the utilities. The law states that major utilities must purchase electricity from any supplier at "cost avoidance" rate now typically, between 6 and 10 cents per kilowatt-hour. This law, California Public Utilities Commission - Rule 21, for example, is designed to help small hydro-electric producers and solar or wind farms. There is a safety requirement of grid transfer switches, but they are not terribly complicated or expensive. The entire equipment set-up must be approved by the utility, however, if you start with a diesel electric generator or small hydro plant it can be approved, operating and stable before the clandestine switch or hybrid operation with an over-unity machine. The law is strongly supportive of the energy producer and disconnection for non-safety or maintenance reasons is exceeding rare.

A key benefit of this approach is that you have established repeatability by having multiple working sites, you have established that it can generate money and the technology does real work and you have created several independent locations where press and scientists can visit to validate the over-unity effectiveness in-situ.

Typical revenues would be as follows:

Generator Horse Power	100	200	300	400	500
Annual $, 90% uptime @ 6 c/kWh	$ 35,100	$ 70,199	$ 105,299	$ 140, 398	$ 175, 498
Monthly payment @ 6 c/kWh	$ 2,92	$ 5,850	$ 8,775	$ 11,700	$ 14, 625
Annual $, 90% uptime @ 10 c/kWh	$ 58,499	$ 116, 999	$ 175, 498	$ 233,997	$ 292, 496
Monthly payment @ 10 c/kWh	$ 4,875	$ 9,750	$14, 625	$ 19,500	$ 24, 375

It will take money without the strings of investors to champion and defend a new breakthrough technology into the energy marketplace and this strategy offers a quiet way to prepare for the ultimate launch and resulting scientific and media frenzy that will ensue. It will take years for the business to form, products to be built and marketing and acceptance and industry confidence to be established. All during those years this strategy can generate cash to support engineering and operations.

Please call if there are questions at 303-941-9663 (cell),
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Fantastic Projects

The Hutchison Effect – An Explanation

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People often ask, "What exactly is the Hutchison Effect?" This brief essay is an attempt to answer that question to the satisfaction of the majority. First of all, the Hutchison Effect is a collection of phenomena which were discovered accidentally by John Hutchison during attempts to study the longitudinal waves of Tesla back in 1979. In other words, the Hutchison Effect is not simply a singular effect. It is many.

The Hutchison Effect occurs as the result of radio wave interferences in a zone of spatial volume encompassed by high voltage sources, usually a Van de Graff generator, and two or more Tesla coils.

Editor: We can call this effect "The H. Wells Effect" because he was first to describe it in his book "The Invisible man". The main character of the book used two sources of electro-magnetic vibrations and Wells said that they were not Hertz waves but something else. "But the essential phase was to place the transparent object whose refractive index was to be lowered between two radiating centers of a sort of ethereal vibration..."("The Invisible Man", chapter 20).

A. V. Frolov

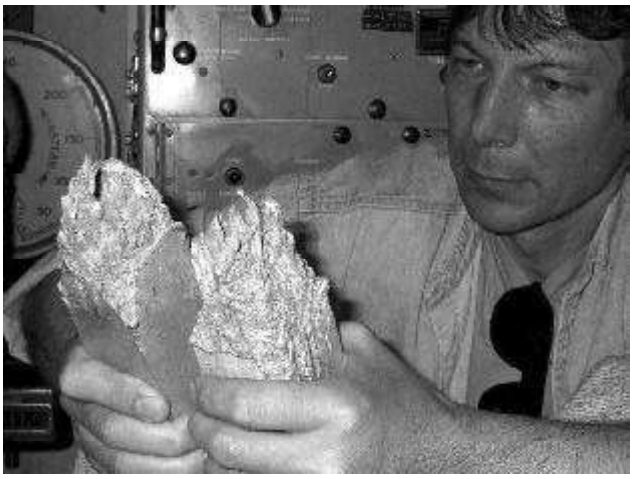

The effects produced include levitation of heavy objects, fusion of dissimilar materials such as metal and wood, the anomalous heating of metals without burning adjacent material, spontaneous fracturing of metals (which separate by sliding in a sideways fashion), and both temporary and permanent changes in the crystalline structure and physical properties of metals.

Fig.1 represents the proof of Hutchison Effect based on metal blocks. Deformation occurred at room temperature as a result of complex interaction of electromagnetic fields.

The levitation of heavy objects by the Hutchison Effect is not - repeat not - the result of simple electrostatic or electromagnetic levitation. Claims that these forces alone can explain the phenomenon are patently ridiculous, and easily disproved by merely trying to use such methods to duplicate what

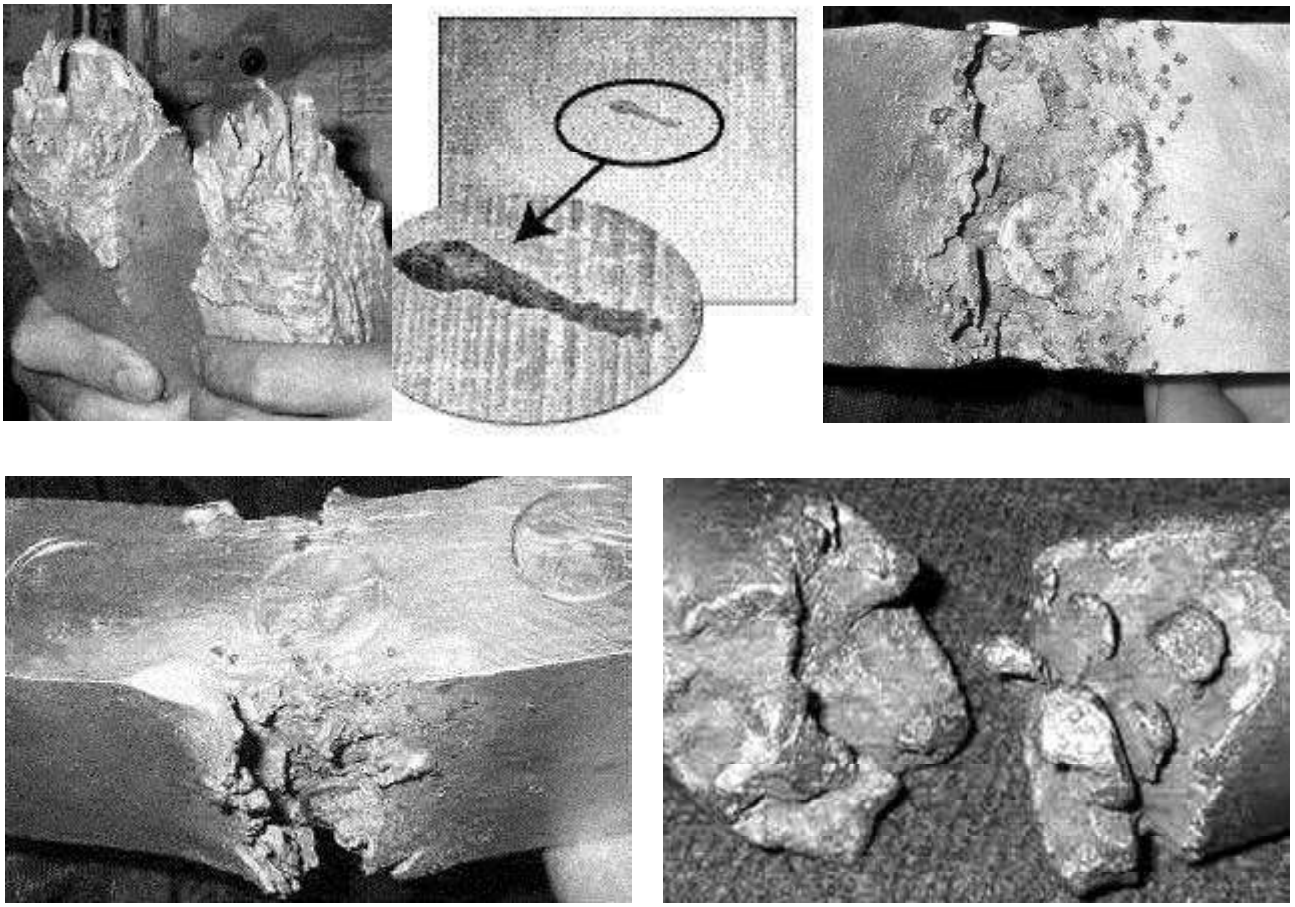

Fig.1

Cold melting of metals

The upper left: steel, The lower left: aluminium with coin prints and with a coin inserted in a partially open split; The lower right: fully torn aluminium bar; The middle upper and right: a section part of the aluminium block, into which a wood block is fused (brown matter)

http://www.rumormillnews.com/JOHN-HUTSHISON2.htm

the Hutchison Effect has achieved, which has been well documented both on film and videotape, and has been witnessed many times by numerous credentialed scientists and engineers. Challengers should note that their apparatus must be limited to the use of 75 Watts of power from a 120 Volt AC outlet, as that is all that is used by Hutchison's apparatus to levitate a 60-pound cannon ball.

The fusion of dissimilar materials, which is exceedingly remarkable, indicates clearly that the Hutchison Effect has a powerful influence on Van der Waals forces. In a striking and baffling contradiction, dissimilar substances can simply "come together," yet the individual substances do not dissociate. A block of wood can simply "sink into" a metal bar, yet neither the metal bar nor the block of wood come apart. Also, there is no evidence of displacement, such as would occur if, for example, one were to sink a stone into a bowl of water.

The anomalous heating of metal without any evidence of burning or scorching of the adjacent materials (usually wood) is a clear indication that possibly the nature of heat may not be completely understood. This has far-reaching implications for thermodynamics, which hinges entirely on the presumption of such knowledge. It should be noted that the entirety of thermodynamics is represented by the infrared portion of the electromagnetic spectrum, which is insignificant in a

context of 0 Hz to infinite Hz. The anomalous heating exhibited by the Hutchison Effect shows plainly that we have much to learn, especially where thermodynamics and electromagnetism meet.

The spontaneous fracturing of metals, as occurs with the Hutchison Effect, is unique for two reasons: (1) there is no evidence of an "external force" causing the fracturing, and (2) the method by which the metal separates involves a sliding motion in a sideways direction, horizontally. The metal simply comes apart.

Doctor John Hutchison

Some temporary changes in the crystalline structure and physical properties of metals are somewhat reminiscent of the "spoon bending" of Uri Geller, except that there is no one near the metal samples when the changes take place. One video shows a spoon flapping up and down like a limp rag in a stiff breeze. In the case of permanent changes, a metal bar will be hard at one end, like steel, and soft at the other end, like powdered lead. Again, this is evidence of strong influence on Van der Waals forces.

The radio wave interferences involved in producing these effects are produced from as many as four and five different radio sources, all operating at low power. However, the zone in which the interferences take place is stressed by hundreds of kilovolts.

It is surmised by some researchers that what Hutchison has done is tap into the Zero Point Energy. This energy gets its name from the fact that it is evidenced by oscillations at zero degrees Kelvin, where supposedly all activity in an atom ceases. The energy is associated with the spontaneous emission and annihilation of electrons and positrons coming from what is called "the quantum vacuum." The density of the energy contained in the quantum vacuum is estimated by some at ten to the thirteenth Joules per cubic centimeter, which is reportedly sufficient to boil off the Earth's oceans in a matter of moments.

Given access to such energies, it is small wonder that the Hutchison Effect produces such bizarre phenomena. At the present time, the phenomena are difficult to reproduce with any regularity. The focus for the future, then, is first to increase the frequency of occurrence of the effects, then to achieve some degree of precision in their control.

The spontaneous fracturing of metals, as occurs with the Hutchison Effect, is unique for two reasons: there is no evidence of an "external force" causing the fracturing, and the method by which the metal separates involves a sliding motion in a sideways direction, horizontally. The metal simply comes apart.

Editor: On November 17th 2003 we got to know that the inventor John Hutchison can eventually lose his home laboratory. The property can be confiscated upon court order due to neighbours' complaints. Apparently, it is dangerous to conduct experiments of the kind at home and even within a town. We wish him success!

A. V. Frolov

A SIMPLE DEVICE FOR HEAT TO ELECTRICAL ENERGY CONVERSION BY MEANS OF FERROELECTRICS

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Introduction

A few years ago, Zaev [1, 2] demonstrated experimentally the possibility of heat to electrical energy conversion by means of ferroelectrics. A capacitor filled with a ferroelectric material was charged and discharged periodically at a temperature just a little lower than the Curie point. According to Zaev, the capacitor must have a nonlinear capacitance dC/dV > 0, which means the capacitance increases with rising voltage. Besides these experimental results, it was proven by a theoretical calculation that the electrical energy obtained during discharging can reach up to 1.35 of the energy introduced to charge the capacitor. The present paper presents an inexpensive and simple electric circuit which can be used to prove heat to electricity conversion experimentally. Moreover, the physical mechanism of heat to electricity conversion is explained in the form of a thermodynamic cycle.

Thermodynamic cycle for energy conversion

The following thermodynamic cycle is composed of four reversible steps. It works only at a temperature just a little lower than the Curie point, where the dielectric constant is highly temperature dependent. Fig. 1 shows the relative dielectric constant of a representative ferroelectric ceramic as a function of temperature.

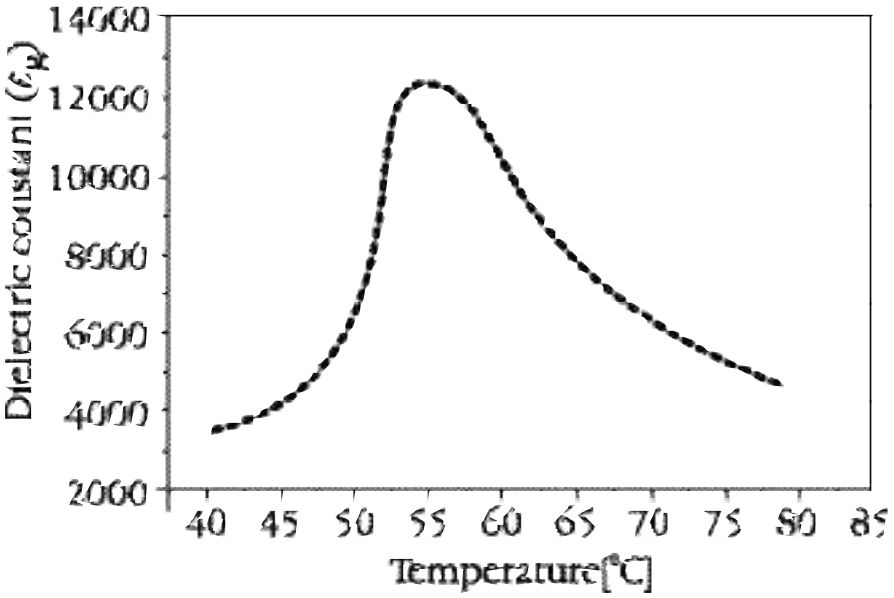

Fig. 1
Relative dielectric constant versus temperature for a barium strontium titanate ceramic (80% Ba, 20% Sr) prepared by the author. Curie point = 55^0 C.

As it can be seen, just below the Curie point in the range from 50 to 55^{0}C, small changes of the temperature cause high changes of the dielectric constant.

Furthermore, to understand the conversion mechanism, it is necessary to understand the electrocaloric effect. When an electric field is applied to a dielectric medium, the latter is polarized. For ferroelectric materials, the parallel domain alignment is the most important part of the total polarization. During the successive alignment of the domains, some material parameters in particular entropy, heat capacity and temperature change. Since the material possesses less degrees of freedom in the polarized state, its entropy and heat capacity are reduced. As a consequence, provided that no heat exchange with the environment is possible (adiabatic conditions), the temperature increases. It is very important to understand that the energy for warming of the dielectric is not taken from the polarizing electric field. The increase in temperature is a result of the decreased heat capacity only.

From this, it can be derived easily what means "nonlinear capacitance".

When a capacitor is charged adiabatically which means its voltage increases faster than any heat exchange with the environment is possible, due to the electrocaloric effect, the temperature of the dielectric must also increase. As it can be seen from Fig.1, below the Curie point, an increasing temperature leads to a higher dielectric constant. Assuming that both temperatures, the one before charging and the other after charging are still below the Curie point, one can say that the dielectric constant increases with an increase in voltage.

Since the capacitance is proportional to the dielectric constant, the capacitor has a nonlinear characteristic $dC/dV > 0$. In the same way it can be concluded that adiabatic charging just a little above the Curie point reveals a nonlinear capacitor characteristic with $dC/dV < 0$.

Quantitative experimental measurements on the electrocaloric effect in some representative ferroelectric and antiferroelectric materials were published by Thacher [3].

STEP 1: Adiabatic charging of the capacitor

We consider a capacitor filled with a ferroelectric medium at an environmental temperature a little lower than the Curie point.

An adiabatic charging of a capacitor (no heat exchange) effects an increase in temperature and capacitance due to the electrocaloric effect. We assume that this increase in temperature is so small that the temperature remains below the Curie point. Finally, the capacitor is completely charged while the dielectric medium has a higher dielectric constant and therefore a higher capacitance than it posseses at the environmental temperature.

To go further to step 2, the capacitor is hold under conditions where no discharge is possible, e.g. it is disconnected from the power supply.

STEP 2: Thermal equilibration

After a short time, the charged capacitor has cooled down to the environmental temperature. While cooling down, the dielectric constant and capacitance decrease. But the charges of the capacitor plates remain constant. As a consequence, the voltage and the electrical energy increase. This can be readily recognized from the general capacitor equation $q = C V$ (q = charge, C = capacitance, V = voltage):

$$q = \text{constant} = C_1 V_1 = C_2 V_2$$

STEP 3: Adiabatic discharging of the capacitor

While discharging the capacitor the temperature and capacitance decrease (again heat capacity changes) due to the electrocaloric effect, leading to a further increase in the available electrical energy. The ferroelectric medium posseses now a final temperature below the temperature of the environment.

STEP 4: Thermal equilibration

In order to proceed with step 1, it is necessary to reach the environmental temperature. An inflow of heat from the environment to the dielectric material is required.

Electric circuit to observe energy conversion

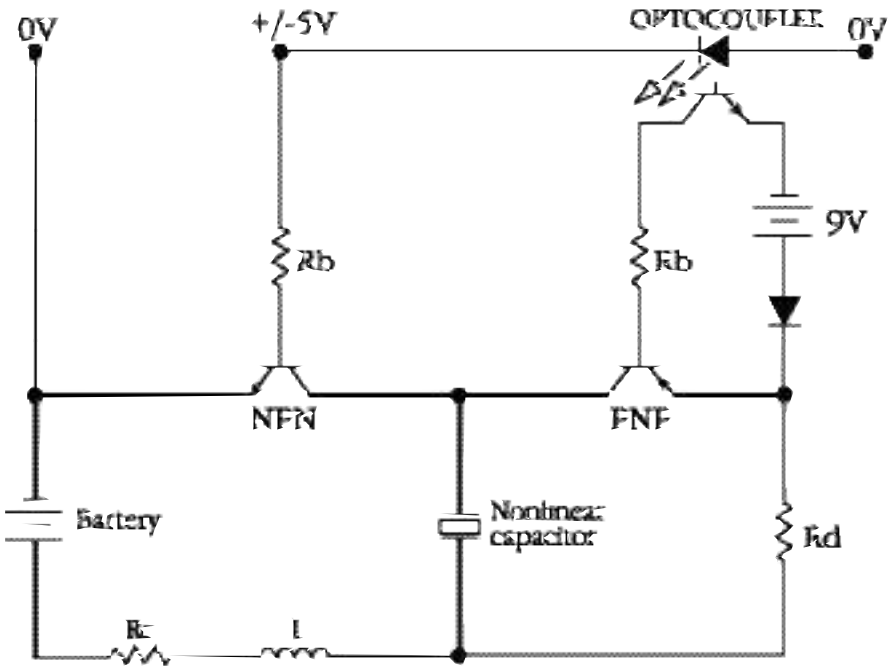

Fig. 2
Electric circuit for testing the energy conversion effect. The connections to the square wave generator are labeled with 0V and +/- 5V, the resistors Rb are to adjust the maximum base current of the transistors.

Assuming the experimenter has a nonlinear capacitor, the set-up shown schematically in Fig. 2 is proposed as a possible conversion device. The circuit contains two different types of transistors (NPN and PNP) which fulfill here the function of a switch.

The NPN junction transistor consists of two n-type semiconductors (called the emitter and collector) separated by a thin layer of p-type semiconductor (called the base). On the other hand the PNP junction transistor consists of a thin layer of n-type semiconductor lying between two p-type semiconductors. The base is the ON/OFF switch for the transistors. If a current flows to the base, there is a path from the collector to the emitter, where a current can flow (switch is ON). If there is no current flowing to the base, then no current can flow from the collector to the emitter (switch is OFF).

The charging-discharging process is controlled by a square wave generator which produces an output signal switching from +5V to -5V. The switching frequency is adjustable from 0.1 Hz up to at least 10 kHz. This output signal is applied to the bases of both transistors.

During the time the square wave generator output signal is +5V, a base current flows through the base-emitter junction of the NPN transistor which creates a low resistance path between the collector and the emitter. As a consequence, the capacitor is charged by the battery. The collector-emitter junction of the PNP transistor has a very high resistance, because here no base current flows. Therefore the capacitor is not discharged at the same time. When the output signal switches to -5V, a current flows to the base of the PNP transistor and not to the base of the

NPN transistor. Now the capacitor is discharged.

In order to understand the function of the inductance in Fig. 2, we analyze the thermodynamics of the charging process.

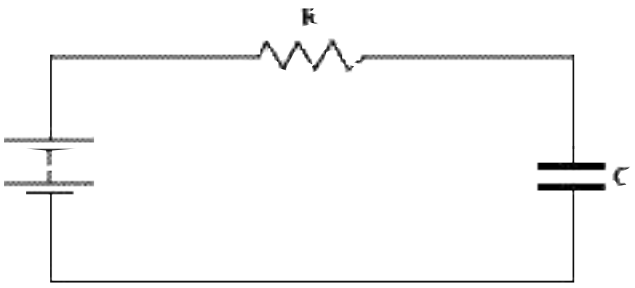

Fig. 3
Simple circuit for charging a capacitor

If a linear capacitor of capacitance C is charged to a voltage V through the load R according to Fig. 3, the energy $W = 0.5\ C\ V^2$ is stored in the capacitor. During the charging process, a time-dependent current I(t) flows:

$$I(t) = V/R \exp(-t/RC)$$

This current develops the heat Q in the load:

$$2Q = R \int I^2(t)dt = 0{,}5CV^2$$

Here the integration limits are from zero to infinity. This calculation shows, that the energy taken from the battery is the energy stored in the capacitor after charging plus the heat produced in the load, also 2•C V2. One can see that the heat Q is not dependent on the resistance value R.

The above used equations are only valid in case of a one-step charging process.

If the capacitor is charged stepwise to the final voltage V, e.g. using a ramp generator, and each voltage step effects a voltage increase , the total heat produced in the load is (N = number of voltage steps):

$$Q = N\ 0{,}5\ C\ (V/N)^2 = 0{,}5\ C/N\ V^2$$

Now the energy taken from the source is:

$$W = 0{,}5 \cdot (1 + 1/N) 1/2\ CV^2$$

If the number of steps N tends to infinity, the heat Q tends to zero.

This energy loss in the load dramatically influences the efficiency of any conversion device and must be taken into account, otherwise all experimental attempts to observe energy conversion would fail.

A more detailed discussion on charging a capacitor and the unavoidable energy losses was given by Heinrich [4] and Gupta et al. [5].

The inductance in the circuit (Fig. 2) effects a slower rising of the current during the charging process (due to self induction) and can reduce the heat generated in the load dramatically.

Acknowledgments

Financial support of this work was provided by the Brazilian agency FAPESP (www.fapesp.br) and the German Academic Exchange Service (DAAD), (www.daad.de).

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Fantastic Projects

The Gates Motor

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The Gates motor company has produced a motor that does not run on fossil fuel or on electricity. It comes in a 28 HP and a 5,000 HP version. When linked to an electric generator, the larger motor will produce 2,200 kW.

My name is Adrian Akau. I am a recently retired school teacher, having taught science and math in the public school system, state of Hawaii for the past 36 years. One of the classes I taught was on energy.

Our world should be reaching the half-way mark in easily accessible oil by about the year 2016. Since the rate of oil usage is becoming higher each year, it is unlikely that the oil supply will last as long as the 140 years since the first well was drilled in Pennsylvania. We will become more dependent upon OPEC with all the political pressures and problems that accompany this type of dependency. As the easy oil is consumed, we must look for ways to extract less accessible oil such as from shale. The added expense will be passed on to the consumer.

The burning of coal is not the answer either because coal cannot supply convenient energy as does oil. An oil-based economy cannot transfer over readily to natural gas; there is not enough natural gas available and it is again, not a convenient and concentrated source as is oil. We also have serious pollution problems with the burning of fossil fuels (natural gas being the exception) but the burning of all fossil fuels have contributed to the serious problem of global warming.

It may take all of 50-80 years to transfer to a non-fossil fuel economy. The transfer must be made slowly so as not to disturb the infrastructure of our economy which is presently based upon fossil fuels. We must gradually create a new infrastructure that is non-fossil fuel dependent.

The motor incorporates a unique spring configuration to provide rotation

The production model of the motor is 24 inches high by 48 inches in length. Connected to a generator it will provide sufficient power for about eight hundred US homes. It is designed to be tough and to last a long time. It uses a high grade airplane synthetic engine oil

to prevent friction and the build up of heat. Only the oil filter needs to be changed. The motor has special needle bearings and portions of the motor are made of high quality steel.

The Gates motor is designed to run 24 hours/day, 365 days/year without incurring any fuel costs. The larger size motor would come in pairs; the spare motor being used as a back-up unit should the regular motor be turned off for maintenance such as to change the oil or in case there should be any problems with the first motor. The company is willing to enter into a contract for maintaining the motor after installation.

The Gates motor represents a major breakthrough in motor design technology and provides practical solutions to environmental and fuel conservation concerns. **Finally, a completely mechanical motor has been developed.** It can deliver the power needed in a wide variety of service applications without any waste products or emissions to adversely affect the environment. This revolutionary new motor utilizes spring power technology. Unlike conventional motors which must reach a maximum rpm level before the desired horsepower, the Gates motor provides maximum horsepower instantly by virtue of the torque stored in the springs.

The basic operating principle of the Gates motor involves a series of springs configured to provide the required motor rotation and power delivery. Consider, if you will, the operating principle of a grandfather clock. Once the clock is wound, it continues to operate until it runs down and stops. The springs must then be rewound so it will operate again. Suppose the clock is continually being rewound as it operates. Then the clock would run continuously. This condition is what forms the basis for the operating principle of the Gates motor. The motor incorporates a unique spring configuration to provide rotation. The springs inside the motor are wound and preset at the factory at the time the motor is assembled. The amount of torque wound into the springs at the factory determines the horsepower of the motor. Inside the motor are a multiple of springs positioned horizontally in a circular arrangement. As the motor operates, the springs are unwound a set number of degrees. A double ratchet system at one end of the motor rewinds the degrees used back into the springs. As the springs are unwinding, **the power generated from all the springs reset each spring (one at a time) during each revolution of the motor**. It is this reset action that produces and delivers power from the springs to the flywheel located at the opposite end of the motor. The flywheel serves to ensure the smooth operation of the motor and to convert the springs into useable horsepower. The smaller motor has 50 foot pounds of torque at a shaft speed of 3000 RPM and will produce 28 HP. The HP can be altered by factory adjustment. The speed of the engine is controlled by a hydraulic pump which provides pressure upon the power shaft.

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Editor: We tried to get the video of this device operation from Gates Motor Co., but after a long consideration it was not provided since the authors are competitor-conscious.

Alexander V. Frolov

Longitudinal Waves

Cold Electricity

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Dr. Peter Lindemann in his book "The Free Energy Secrets of Cold Electricity" presents the story of this type of electricity which really is not electricity as electricity is normally meant to be understood. Cold electricity behaves differently than normal electricity. Regular electricity may be used in the process to generate this cold form but this transformation is not the type of change in voltage and current that occurs in a transformer. Rather, it is the extraction of a form of current from "normal" electricity by a process that uses high voltage.

In discussing the Edwin Gray motor, Dr. Lindemann relates a demonstration by Gray. Gray used a 6 volt car battery with lead wires running to a system he had devised using a voltage booster and a series of capacitors which raised the voltage to 3,000 volts. He then closed a switch that ran the high voltage into two electromagnets which caused a loud popping sound and cause the top electromagnet weighing a pound and a quarter to be propelled over two feet into the air. Gray claimed that only 1% of the system's energy was used with 99% going back to the battery. He said that he had 'split the positive' with his system.

Other evidence of using this fractionated electricity was Gray's use of a small motorcycle battery (15 amps which would normally produce W=V x A = 6 V x 15 A= 90 watts) to run concurrently six 15-watt electrical light bulbs, a portable 110 volt T.V. set and two radios. A glowing 40 watt light bulb running off the system was dropped into water without the glass breaking; the bulb gave off light but not the heat that accompanied a bulb run by regular electricity. This would mean that tungsten in the filament of the light bulb was not resisting the flow of this fractionated electricity and that this "cold electricity" was causing the luminous glow by some other means.

According to Gray's Patent #4,595,975, low voltage was chopped into pulsating DC by passing it through a multi-vibrator (buzzer like a door bell). Then the pulsed DC was sent through the low voltage winding (primary) of a transformer which changed it to pulsating high voltage DC current at the secondary side. The pulsating high voltage DC was rectified by a full wave bridge and changed into high voltage DC.

The high voltage DC was used to repeatedly charge a capacitor as the current was sent to briefly discharge across a spark gap (rated at 3000 volts). The discharge of the spark across the gap had to be in one direction only and its duration was controlled by the size of the capacitor and by the strength of a magnetic field encompassing the gap. This magnetic field had a quenching effect because it caused a back EMF each time the discharge occurred. The current from the discharge across the gap was then sent through a resistor and then to a vacuum tube (the conversion switching element tube).

Another of Edward Gray's patents "Efficient Electrical Conversion Switching Tube Suitable for Inductive Loads" (April 1987, patent 4,661,747) described the switching tube. It utilizes a low voltage anode (positive plate), a low voltage anode (positive plate) and one or more electro-static or charge receiving grids (located between the positive

plates and the cathode or negative plate supplying the electrons). This tube's function was to 'split the positive'. A normal vacuum tube usually uses only a single anode at a particular voltage to control the voltage flow within the tube. The function of the charge-receiving grids was to collect the "cold electricity".

The most unusual part of this Power Supply circuit consisted of devices specifically designed to remove excess energy when the Switching Tube was functioning. A spark-gap protection device, served to "protect the inductive load and the rectifier elements from unduly large discharge currents". As stated, the rectifier elements are the two anodes and the grids in the Switching Tube. In a normal vacuum tube, no protection would be necessary because the maximum power of the tube would be based upon the electricity provided to heat the tube filament and to charge the anode (voltage x amps). Therefore, the excess energy comes from the process occurring as the spark gap affected electrical pulses pass through the Switching Tube. The process of extracting the "cold electricity" places danger of overload upon the system. (Please take note that the "electricity" from the Switching Tube is no longer the normal type of electricity we have from our batteries or from an electrical outlet but rather a completely new form with entirely different characteristics.)

The description continues, "Should the potentials (voltages) within the circuit exceed the predetermined values fixed by the mechanical size and spacing of the elements within the switching tube, the energy is dissipated (bypassed) by the protective device to the circuit common (electrical ground)" by two strategically placed diodes (devices that permit the passage of electricity in one direction only). The question now arises "What is the cause of this large amount of excess energy which must be dumped to ground through device acting like a lightning rod in order to prevent the circuit from burning out?"

To examine the cause of the excess energy source, we must go back over a hundred years to1889. Heinrich Hertz had just announced in 1887 that he had discovered electromagnetic waves and Nicola Tesla was attempting to duplicate Hertz's experiments. Tesla used abrupt and powerful electric discharges produced with banks of capacitors charged to very high potentials and was able to explode thin wire (copper bus bars). He came to the conclusion that Hertz had mistakenly associated electrostatic inductions (electrified shockwaves in air) for true electromagnetic waves.

The explosion of the copper bars by means of the "disruptive discharges" from the capacitor bank produced sharp shockwaves which struck Tesla with great force across the entire front of his body. Tesla said they felt more like powerful gunshots rather than electrical sparks. They produced effects similar to lightning or to those produced by high voltage DC generators previously discussed; the simple closing of a high voltage DC generator caused a stinging shock. AC generators were not in use in this pre-AC era and it was shown, later on, that AC generators did not produce these effects.

This shock was first assumed to be the result of residual static charging. It stood straight out of highly electrified conductors, seeking ground paths which included workmen and switchboard operators. In long cables, Tesla estimated that this electrostatic concentration was several orders in magnitude greater than any voltage the DC generator could actually produce. It caused a hedge or crown of bluish needles or spicules to point at right angles to the cable or straight from the electrical cable line into the surrounding space. The bluish needles appeared the very instant the switch was closed and disappeared a few milliseconds later, after which the system functioned normally. However, anyone through whom the blue needles passed, especially in large regional power systems which used high exceptionally high voltages, usually did not survive. Generators rated at a few thousand volts produced hundreds of thousands or even millions of electrostatic volts during the start-up pulse. Highly insulated, heavily grounded relay switches had to be installed to protect workers from certain death.

Engineers at this time assumed **the effect to be caused by a "bunching" action which occurred when a powerful force was not able to move charge sufficiently quickly through a system.** (A similar "choking effect" also happened with large steam engines; if steam was introduced too rapidly, the steam engine could explode.) The metal of which the wire was composed somehow offered resistance to the charge carriers before they were able to move away from the generator terminals. It seemed that the wire acted as a blocking force to the electrons or to some unknown part of the electrons for the first few milliseconds, rather than as a conductor. The powerful, deadly bluish spikes sprang from the line until the current charges actually "caught up" with the applied electrical field. It was as if the spicules were a form of relieving pressure on the system by converting the voltage impulse into some other form.

Tesla began wondering why the electrostatic field moved faster than the actual charges. He believed that this effect could help him find electric waves better than his capacitors because the line resistance caused the electrostatic charges to bunch together into a density much greater that obtainable with his capacitors.

Tesla understood that ordinary capacitor discharges were oscillating currents or spark currents which "bounced" between each capacitor plate until their stored energy was dissipated. The high surge voltage of the DC generator exerted such a high one way pressure on the dense line charges, due to the millisecond resistance of the metal, that possible voltage "bounces" were also oscillations of current as was true with the capacitors. Tesla used every means possible to block the "back-rush" (bouncing) of the oscillating current in order to prevent the supercharge to prematurely decline; he wanted to maintain this powerful "bunching" effect as long as possible in order to study it and to make use of it.

His face and hands experienced a penetrating shockwave; a sharp pressure and an electrical irritation were brought on at the sudden closing of the switch. His face and hands were especially sensitive to these shockwaves which caused a "stinging" effect at close range. Tesla believed that he was being struck by material particles approaching the vapor state as they were thrust from bluish crowned wire.

Later on, he was to discover they were not gas particles. **He placed himself behind a glass shield but to his amazement, he still felt the shockwaves and stinging effects; the glass shield did not protect him.** These stinging rays could be felt at great distances from their sources and, to his amazement, would penetrate shields of both glass and copper. Tesla knew that normal electrostatic charges spread over the surface of a metal (copper, for example) shield so that the stinging effect could not have an electrostatic origin and therefore was not electrostatic in nature but was from some other yet unknown source.

Joseph Henry in 1842 had noticed the magnetization of steel needles by the discharge of a Leyden Jar (type of primitive condenser made with a glass bottle). The Leyden Jar was at the top floor of a building while the needles were in the basement. Dr. Henry, noting the passage of these magnetizing rays through brick walls, oak doors, stone and iron flooring and tin ceilings believed that the spark given off by the discharge released "light-like rays" that passed through the material obstacles with ease before magnetizing the needles.

Elihu Thomson, a physics instructor in 1872 had been attempting to make sparks from a Ruhmkorrf Spark Coil more clearly visible for his physics students. He attached one pole of the coil to a cold water pipe and noted that the previously blue spark changed to white. He then attached the other pole to a large metal table top and produced a silver-white spark that would be clearly visible to all attending his lecture. He went to the door of the room to notify his colleague but received a strong shock from the door knob. Turning off the Ruhmkorrf coil prevented the brass knob on the oak door to stop shocking. He returned with his friend, again turned on the coil and discovered that all metal objects in the entire building, no matter how distant

from the coil or insulated from the floor, produced long and continuous white sparks upon the touch of a penknife or screwdriver.

The device Tesla perfected was far superior to the Ruhmkorrf Spark Coil. The effect of his disrupter device was so strong that a single wire placed in an oil bath produced what he had originally but mistakenly thought to be gaseous streams so powerful that they visibly depressed the oil into a depth of about two inches. Tesla concluded that "besides the air, another medium is present".

> *...he placed himself behind a glass shield but to his amazement, he still felt the shockwaves and stinging effects; the glass shield did not protect him. These stinging rays could be felt at great distances from their sources and, to his amazement, would penetrate shields of both glass and copper...*

Tesla had been able to perfect his device by placing a capacitor between the switch and the D.C. generator thus increasing the power and protecting the generator windings in much the same manner as the diodes Edwin Gray's Switching Tube protected Gray's circuit. Tesla also raised the voltage and quickened the "make-break" rate of the switch to increase the power level by placing a powerful permanent magnet crosswise to the discharge path of the high voltage output of the DC generator wires. The magnetic field caused the discharge arc to automatically "blow out"; the charge passing through the wires in the presence of the magnetic field built up reverse emf (electromotive force or voltage).

Tesla believed he had discovered a new type of electricity with special characteristics. This form of electricity did not consist of alternating waves. **They were longitudinal waves** composed of successive shocking waves with effects that could be seen and felt at a distance. **Vector components of these shock waves were unidirectional. They were able to force charges in the direction of their propagation.** In his patent #787,412, "Art Of Transmitting Electrical Energy Through The Natural Mediums" (April 18, 1905), Tesla calculated the mean velocity of the waves propagated by his device to be 471,240 Km/sec. Knowing that the velocity of light is 300,000 Km/sec would indicate that the type of transmission to which Tesla is referring is different than standard electromagnetic radiation; these special longitudinal "Radiant Energy" waves moved faster than the speed of light.

After conducting hundreds of experiments, Tesla found that "Radiant Energy" longitudinal waves **could penetrate all materials and cause "electronic responses" in metals such as copper and silver.** Impulses exceeding 0.1 millisecond duration produced effects such as pain, mechanical pressures, explosion of thin wires and vibration of objects. Impulses of 1.0 microseconds caused the sensation of physiological heat; at still shorter lengths white light would fill the room. Impulses less than 100 microseconds were safe to work with and Tesla planned to use them for his power broadcast system since they could pass through all matter.

In 1890, Tesla discovered that placing a long single turn copper helix near his magnetic disrupter became covered with an envelope of white sparks. Effects were strongest when the helical coil was placed within the disrupter wire circle. In this "shockzone", the coil was surrounded by a blast of long, fluid like silvery streamers which clung to the surface of the coil, flowing over the coil at right angles to the windings. Tesla hypothesized the electrostatic-like effect was due to radiant transformation rules requiring measurements of discharge lengths and attributes of the helix used (number of turns, diameter, etc.). (Editor: resonance)

The new induction law he discovered showed that radiant shockwaves became much stronger when encountering segmented objects. The radiant shockwaves

"flashed over" the outer skin of the helix from end to end without passing through the windings of the coil; shockwaves of 10,000 volts introduced to a 24 inch coil rise to 240,000 volts. The greater the resistance in the helix turns, the higher the maximum voltage. This was completely different from magneto-induction. Remember that he was not working with electricity but with radiant shockwaves.

> *Aether particles were incompressible and could easily pass through space and matter with a speed much greater than the speed of light. This was pure radiant matter but, at the same time, pure Radiant Energy. Cold electricity is one of the forms of this Radiant Energy*

This transformer he invented used radiant shockwaves to produce pure voltage without current. Each transformer had to be "tuned" by adjusting the disrupter to a specific impulse duration. At that point, voltage impulses could flow smoothly, flowing over the copper surface much like a stream of water in a pipe. No amperage could be detected but if the stream was aimed at a distant metal plates, "current" was produced which reached several hundred or even thousands of amperes. Tesla then began to wonder what made up this white, currentless stream.

Tesla determined that normal charge carriers (electrons) could not travel as quickly as the radiant pulse; no current moved the coil because the electrons were choked in the metal lattice of the coil. **The radiant pulse moving over the surface of the coil was not electronic in nature.** He placed the legs of a heavy U-shaped copper bus bar directly to the disrupter primary and then connected the short-circuited system to several incandescent lamps. These lamps glowed with a brilliant cold white light as with Gray's light bulb, proving that the power for the light was not electrical in nature. Tesla believed that the electrons were blocked from flowing through the wire while the radiant pulse was released over the coil surface as a "gaseous" pulse (splitting the positive, according to Gray).

Tesla came to believe that voltage could be viewed as streams of aether under various states of pressure and that his transformers affected the aether as to produce the luminous effects he observed. In his patents, he describes his "light-like rays" as tightly constricted aether streams propelled from his transformers along infinitesimal ray lines along which an incompressible movement occurs instantly through space on all points along its path. Aether streams were being drawn in through his transformer at higher natural pressure and then accelerated in the electrical discharge. The voltage in his transformer could control the brilliance of light in a room but this type of light was almost impossible to register on film. He could heat up a room or cause cool breezes by controlling the voltage in impulse duration in his transformer.

Tesla saw electrical current was really a complex combination of aether and electrons. Through the application of a disrupter, the electrons were removed from the gap by the magnetic field while the aether steams continued to flow through the circuit. He considered aether particles highly mobile with infinitesimally small mass and cross-section as compared to electrons. They were incompressible and could easily pass through space and matter with a speed much greater than the speed of light. This was pure radiant matter but, at the same time, pure Radiant Energy. Cold electricity is one of the forms of this Radiant Energy.

Edwin Gray, Dr. Nicola Tesla and Dr. Thomas Henry Moray all used radiant energy technologies. It is important to understand that the Laws of Thermodynamics and Maxwell's equations do not pertain to "Radiant Energy" technologies.

Fantastic Projects

Gravity Conversion Rotary Device

Review is prepared by editor Tatiana Ezhova

Here another fuelless perpetuum mobile is presented.

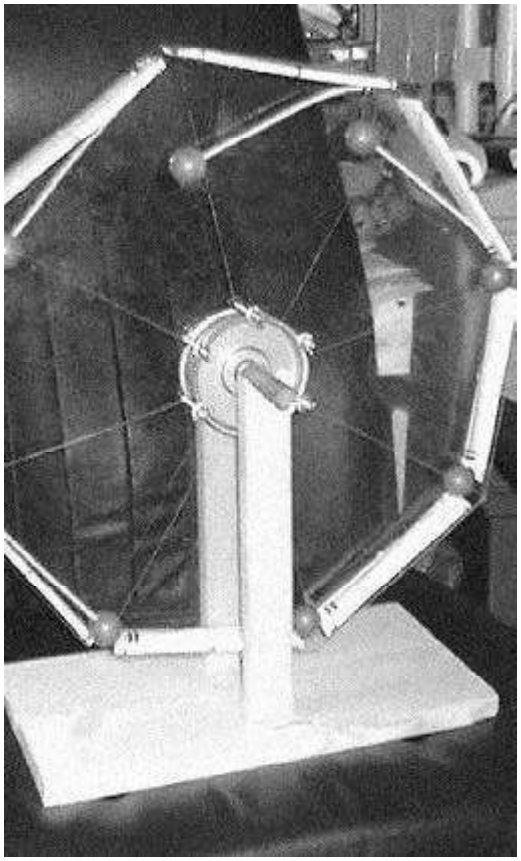

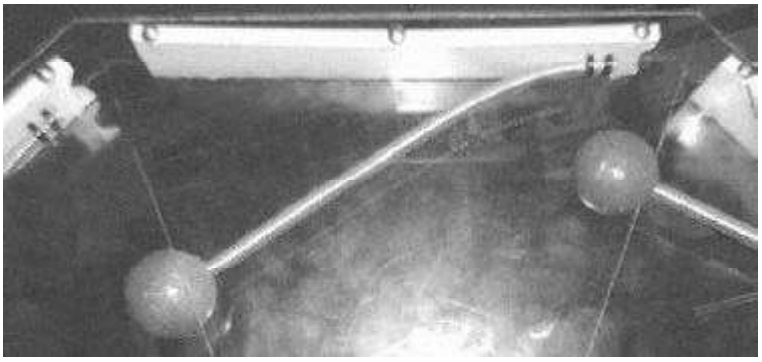

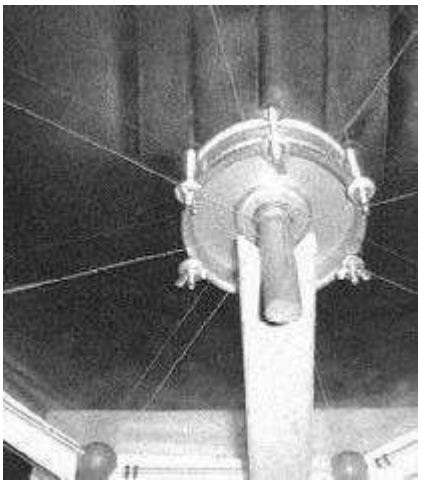

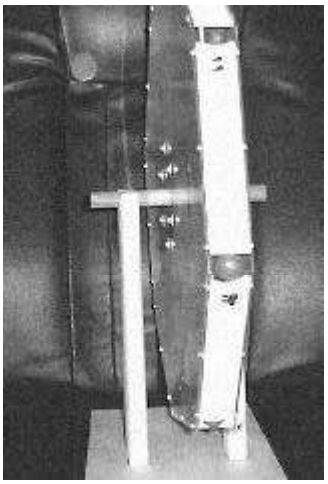

The system design

The design includes a wheel with spring spokes. Pegs may be fixed inside the wheel to balance movement of weights on springs. All parts should be homogenized as to dimension and weight. The author used 4 oz. lead balls and the 3/16" springs. The wheel measures 9" in radius as measured from hub center to center of each lead ball at outer periphery. This device is actuated and stopped by the hand. Its speed is self governing, it ramps up to speed quickly and simply stays there.

Note: you can find more detailed information about the device at http://www.greaterthings.com/News/FreeEnergy/Directory/GravityMotors/photos/. Also read in this issue article "Novozhilov's motor" that describes another wheel motor that does not require any fuel for its operation.

Torsion Technollogies

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ABSTRACT

Highly localized nuclear activation in electrochemical systems and other electrical discharge processes have been observed by many laboratories in the world. This report is an attempt to explain such anomalous phenomena by using torsion field theory and axion model. Anisotopic behaviours of radiation products, burst character, "heat after death" of excess energy release in electrical discharge systems are considered to be interpreted by the torsion coherence of vortex dynamics with the zero-point energy induced by localized intense field emission of micro-protrusion of the cathode, and the dynamic Casimir effect of transient evolution of triple region of gas, liquid solution, and electrode protrusion. Axion model and Primakoff's effect are proposed for explanation of nuclear transmutation without noticeable gamma radiation.

Nuclear products with high concentration, unidentified tracks with highly collimated lines of low energy nuclear reactions in the electrochemical systems were recorded by CR-39 solid detectors and photo-films, and localized spots with chemical alterations were observed at our laboratory. It is suggested to carry out intensive study of vortex dynamic for explaining the anomalous phenomena in wide area of nature and laboratories. Analysis of vortex dynamics with wide range from pitting corrosion of electrochemical system, laboratory plasma, tornado, to quasar spiral model with extremely high energy cosmic rays in the center region, leads to a conclusion for that vortex dynamics creates torsion fields responding to the anomalous effects.

I. INTRODUCTION

Many laboratories in the world have observed nuclear reactions and **excess heat** in electrochemical systems. The mechanism of such anomalous phenomena is not being well understood according to normally accepted physics.

Nuclear products with high concentration and tracks with highly collimated lines of low energy nuclear reactions in the electrochemical systems were recorded by CR-39 solid detectors and films at our laboratory [1,2]. These facts suggest that quasar model with spiral structure and extremely high enrage cosmic rays in the center could be used to explain the mechanism. It is supposed to use the concept of torsion field to interpret the observed phenomena, typically, the properties of axion acceleration, memory effect, and the polarized nuclear reactions with torsion effect [3].

II. PHENOMENA IN NATURE AND AT LABORLATORIES

The vortex and spiral structures are the archetype that appears at all levels of nature and laboratories, for example, atom structure, vortex lattice in superconductors, dense plasma focus, lightning, quasar etc.

Recent report of dark matter annihilation at the galactic center describes that the cold dark matter near the galactic center is accreted by the central black hole into a

dense spike [4]. Particle dark matter annihilation makes the spike to be a compact source of photons, electrons, positrons, protons, antiprotons and neutrinos. It reminds us for that there is a similarity among pitting corrosion with electrochemical noise, laboratory plasma pinching (dense plasma focus, for example), fast laser induced ion beams [5] and quasar spiral model with high-energy cosmic rays in spiral center in spite of large dimension difference. Comparing the experimental results of electrochemical cells with excess heat and nuclear transmutation to astrophysics phenomena, it is supposed that the investigation of vortex dynamics of torsion coherence with the zero-point energy is essential for tapping the zero-point energy.

As it is predicted by quantum mechanics that the vacuum is seething with active energy, even at temperature of zero point Kelvin. This zero-point energy (ZPE) can be thought as an infinite number of virtual photons that are popping out of the vacuum and going back in, but should be a measurable effect en masse. To exam the origin of ZPE background, the interaction of matter with the ZPE can be treated on the basis of charged point particles interaction with a background of electromagnetic zero-point radiation with spectral-energy density.

Based on observation in the experiments, the following features are considered in order to understand the experimental results with electrical discharge systems.

A. ELECTROCHEMICAL DOUBLE LAYER

In an electrolytic cell, the electrolysis with high conductivity and the electrochemical double layer with large layer-capacitance lead to a typical structure of the cathode potential distribution similar to the cathode drop of glow discharge in low gas pressure. For a compact layer the thickness of the double layer is equal to one ionic layer, across which there is a linear fall of potential. Thus, high electric field exists in some regions on the surface of the cathode. The local enhancement of the electric field on the cathode surface with the double layer is related to the protrusions and cracks similar to the tip discharge in air or in a vacuum. The current distribution depends strongly on the surface roughness and the work function of the electron emission. A high transient current density ($> 10^8 A/cm^2$) could be expected due to enhanced field.

B. ENERGY CONCENTRATION

On the cathode surface, the high persistent electrical fields ($>10^7 V/cm$) and large equivalent capacitance ($>25 \mu F/cm^2$) lead to a high energy concentration in the double layer [6]. The concentrated field on the tips of the protrusions or cracks after a long-loading period with deuterium on the palladium cathode surface creates a high transient electron flux because of the large distributed capacitance and the negligible inductance in a localized discharge mini-network. The experimental data show that the reactions take place only in some restricted areas that have specific properties. The idea of micro fusion due to the results of energy concentration and the high deuteron flux could be used to explain the nuclear transmutation.

C. TORSION FIELD AND THEIR EXPERIMENTAL MANIFESTATIONS

Elementary particles have the moment of quantity of motion, i.e. spin. If in any substance the spins of particle have a preferable direction, then it is interpreted as spin polarization of the substance. Every substance creates a torsion-field (or called spin-field or axial field) in the space surrounding it when polarized by spins [7]. The superposition of torsion field, generated by the atomic and nuclear spins of each molecule, determines the intensity of torsion field in the space surrounding each molecule. Torsion field has strong penetration ability and does not interact with the crystal lattice of substances. The torsion field created by rotation of some sort of matter is concentrated in two opposite beams propagating along the rotation axis. The intensity of torsion-field with some

lower constant value can be retained for several weeks after the rotation is stopped. Such property of vortex mater has been recently observed in type II superconductors with magnetic flux line lattice [8]. The studies of vortex matter of type II superconductors have shown a number of puzzling phenomena associated with vortex motion, including: low-frequency noise and slow voltage oscillations; a history-dependent dynamic response, and memory of the direction, amplitude duration and frequency of the previously applied current.

Some behaviors of the torsion-field effect have been observed in the experiments of electrolysis regarding the so-called cold fusion, such as when the gas bubble chains come out from the protrusions of the cathode surface a long time after switching off the electrolysis potential. The more surprising thing is the heat after death, which has been recorded by many labs. This phenomenon could be explained by the persistence effect of the torsion-field produced by vortex dynamics of tip effect.

D. EXPERIMENTAL RESULTS IN THE ELECTROCHEMICAL CELL

CR-39 plastic films possessing with a high degree of optical clarity and isotope in track response, and are sensitive to neutron, proton, tritium, alpha, and other charged particles, were used to detect the products of nuclear reactions. The films of CR-39 were immersed in the NaOH electrolyte of heavy water and placed adjacent to the tips of the cathode [9]. After 110 hours, electrolysis experiment with the applied voltage 1 V and current 2 ma, the solid detector was etched by 6.25 N NaOH solution in 70^{0}C for 11 hours. The photomicrograph shows the cluster of tracks with a cycle crater of 100 μm in diameter and 25 μm in depth. According to the etching condition, the energies of the most of the particles, P, T, α are estimated roughly to be in the range of 1-4 MeV. On the backside of same region of the CR-39 film detector, one can clearly see a few of tracks in the circle area or nearby. Such tracks are believed to be created by recoil-protons of forward incident neutrons. High concentration of the cluster of nuclear tracks could be explained by the quasar spiral model and by the crystal channeling effect [Fig.1]. The experimental results of the generation of tritium with single crystal metal of Pd show that none of the generation of tritium has been revealed by using non-single crystal electrodes [10]. The importance of the crystal channeling effect for nuclear reactions in the electrochemical systems can be inferred.

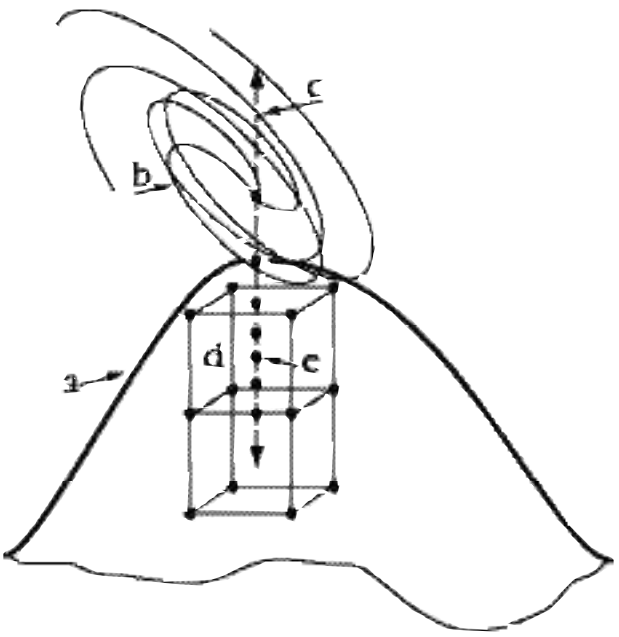

Fig.1
Schematic presentation of a micropinch spiral by tip effect in the electrolysis cell:
a) tip of the electrode; b) spiral structure of micropinch; c) electron beam; d) crystal channel; e) ion beam

To determine the spatial distribution of radiation active sites (RAS), Black-white 135 films of 27 DIN have been used to image the position of the RAS. After a 1,5 year of deposition in glass tube of finishing electrolysis experiments with light water electrolyte for more than 200 hours running, the patterns of RSA were clearly formed on the films after exposure of 100 hours [2]. The bright spots corresponding to the tips of palladium cathode edges can be seen due to

the tip effect. The effect of magnetic field on the traces of the charged particles has been observed while the Pd samples exposing to the films, which were folding and wrapping up the sample, were inserted between couple magnets. The tracks stretching along the film surfaces confirm that the tracks were created by charged particles, electrons for example, with low energy about some keVs. Highly oriented tracks can be observed by autoradiography by using normal films locally[Fig.2].

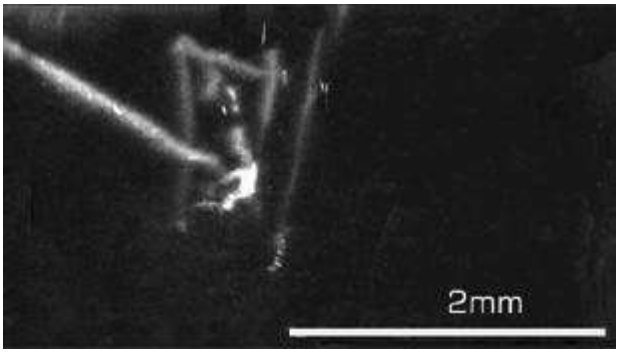

Fig.2
Autoradiography of charged particle tracks of beta delay isotopes on the surface palladium cathode. Some tracks of beta particles are paralleling the cathode surface.

E. SONOLUMINESCENCE AND "BUBBLE NUCLEAR FUSION"

Some scientists of Oak Ridge National Laboratory in America reported their articles of bubbles experiments in Science. Experimental results show that the radiation lights of sonoluminescence possess three characters: short duration with picoseconds; wide continual spectrum; highly oriented thin beams. **Based on those characters, vortex dynamics with axial acceleration of bubble collapse could be inferred.** Nuclear reaction with abnormal gamma radiation was observed [11]. Dr.Claudia Eberlein describes her conclusion on sonoluminescence that only the ZPE spectrum matches the light emission spectrum, which must be a ZPE phenomena [12]. The effect of torsion field on nuclear reactions along the axis of vortex should be taken into consideration for the low ratio of the nuclear products of n/T due to spin polarization of reaction particles.

Axion model and the Primakoff effect are proposed for explanation of nuclear transmutation without noticeable gamma radiation. Many laboratories in the world have been engaged in several experiments to search for axions, light neutral pseudoscalar particles yet to be discovered. The axion would be produced in the solar core through the Primakoff effect if its mass is a few electronvolts and could be detected in the laboratory.

III. CONCLUSION

Researchers of new energy study of "cold fusion" type should pay great attention to the general processes of electrolysis to find the key points, which could play a major role in the transit from the electrochemical processes to processes of torsion and the nuclear processes. From the authors' point of view, the evolution of double layers is of importance to understand the anomalous effect, typically on the protrusions of cathode. The change of space-time near the tips due to torsion field generated is expected to delivery the zero-point energy, and dynamic Casimir effect for the evolution of gas bubbles on the tips are expected to generate photons and excess heat [1]. The yields of transmutation products are related to the current distribution on the cathode surface. The cathodes of thin wire were benefit to the generation of nuclear reactions and excess heat for electrochemical systems. Careful examination of the evolution of electrochemical double layer will lead to a good understanding of pitting corrosion with electrochemical noise, and further to recognize the anomalous excess heat and nuclear reactions.

Heat after death was observed at many laboratories. It is believed that the persistence behaviors of torsion field can be used to explain such anomalous phenomena.

The contact between beads coated with a thin metallic layer or multilayered film and

palladium black particles could be regarded as point-contact similar to the tip-effect [13].

We may say that it is expected to reveal the puzzles of the mechanisms of high-Tc superconductivity with pinning vortices by the torsion field theory [14,15].

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Fantastic Projects

The Invention of Roman Solomyanny

Our previous issue featured an article about Roman Solomyanny who came to our office and told us amazing things. He said that during his army years (according to his words, he was in the military intelligence) he made a radio technology invention and later on built a free energy generator. The inventor claimed that his device had been working for a certain period of time without any fuel and had been producing power enough for heating and lighting his countryside house. We could not ignore such an intriguing piece of information. Moreover, Roman promised to build and present his device in 2003. We paid him for this interesting story to be published in the issue and prepared for the continuation...

Alas, to no avail... His mobile phone was silent and we started to worry about the inventor's health. Fortunately, we managed to contact his parents on his home telephone (Roman lives in St. Petersburg) and they told us that the chap was OK. It seems he's lost his interest in us. But we still hope that Roman did invent something really exciting and not only polished up his talent for writing science fiction articles. Those people, who want to know the details about this invention or discuss it with the inventor himself, can get in touch with us for his contact information. Anyway, we will be very pleased to see him again full of new exciting stories. We have already introduced the 'Humour' section into the magazine and are planning to start the 'It Just Can't Be So' section.

Editor

Physicists are Joking

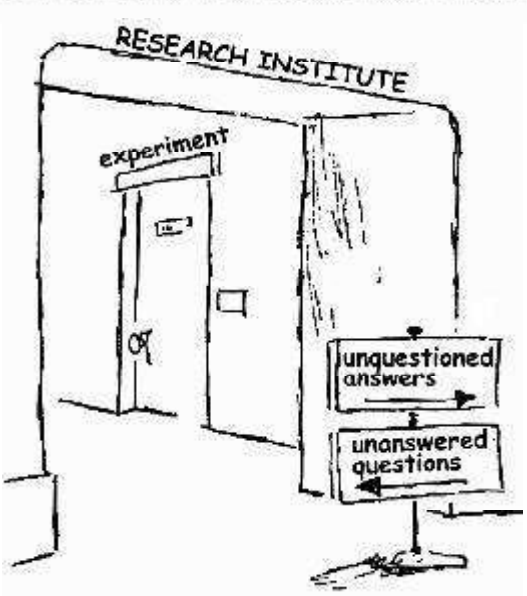

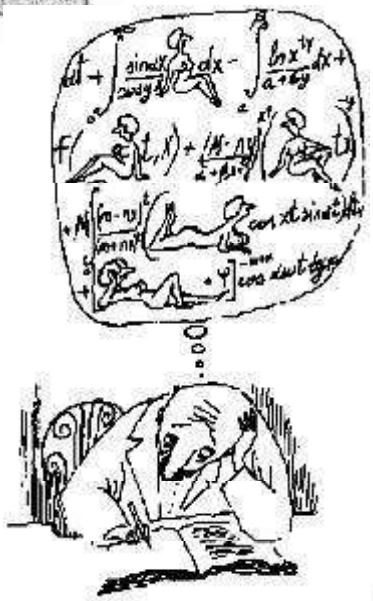

Anti-Gravity: The Holy Grail of the 21st Century

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A Primer on the Role of Electromagnetic, Electrostatic, and Torsion Fields in Anti-Gravity and Field-Effect Propulsion

Before visiting a University of Washington physics professor to talk about electrostatic propulsion, and hopefully anti-gravity, I realized: *Birds defy gravity. So do 747's for that matter. They apply the laws of physics and lift off the ground. That's anti-gravity, isn't it?* Yes, that's true, I suppose, in a metaphorical sense. But seagulls, jumbo jets and space crafts manifest anti-gravitation effects strictly speaking. What I want to address here is not the overcoming of gravity but the neutralizing of it.

Dr. Eugene Podkletnov, one of the foremost researchers in anti-gravity, and whose work is sought by NASA, Boeing and British Aerospace (now known as BAE Systems) describes the hunt for anti-gravity the greatest scientific quest of this century. He calls for an international effort, akin to the Manhattan Project that developed the atomic bomb, to conquer the secrets of anti-gravity, and usher in a new era of scientific understanding whose technological development will be at a scale so vast that the potential outcomes are merely hinted at by our previous achievements.

Just getting such a project off the ground will require unprecedented international cooperation, and public disclosure as well; the potentials are that vast, that scary, and that dangerous. Dr. Dan Marckus, noted British avionics expert, states in The Hunt for Zero Point, the seminal work-to-date on anti-gravity written by Jane's Defence Weekly aviation editor Nick Cook, that the secrets of anti-gravity in the wrong hands will make thermonuclear weapons look like firecrackers.

The secrecy surrounding anti-gravity research is phenomenal. Boeing refuses to publicly acknowledge any activity in anti-gravity development despite the fact that its competitor and sometime sub-contractor, British Aerospace (BAE Systems) is, the latter providing funds for four university research efforts as part of its Project Greenglow, one of which was a Podkletnov replication experiment headed by Dr. Clive Woods at the University of Sheffield,. Further, Nick Cook publicly, and privately to me in an email, states quite directly that George Muellner, former director of Boeing's ultra secret Phantom Works, claims Boeing sought the services of Dr. Podkletnov to unlock the secretes of his gravity-shielding research. Cook says that Muellner states Boeing was denied Podkletnov's services due to the objections of Russian officialdom, which the Russian-born Podkletnov must pay attention to, apparently, despite the fact that he works in Tempere, Finland. Dr. Podkletnov, wisely perhaps, chooses not to clarify these particulars despite our several emails.

Perhaps Boeing can deny any activity on anti-gravity because NASA is doing its own research, and as a prime contractor to NASA, such as by running the Space Shuttle Program, Boeing probably knows what NASA knows. NASA spent $600,000 recently in its Breakthrough Propulsion Physics program (BPP) to purchase Podkletnov replication equipment. Inexplicably, that equipment sits in boxes in NASA's Marshall Research Center in Huntsville, AL, awaiting more funding; according to an email I received from NASA propulsion researcher, Ron Koczor.

But enough with this business; what do we know about anti-gravity?

The search for that answer has taken me to some exciting and obscure places in this world, like the Aeronautics and Astrophysics lab at the Seattle campus of the University of Washington. I called those folks because Nick Cook in The Hunt for Zero Point, mentions that UW received a NASA contract to study theories of inertia as part of its BPP program. *That's a good place to start,* I thought, but it took backtracking to BPP Project Director Marc Millis at NASA's Glenn Research Center in Cleveland to find Dr. John Cramer at the UW Physics Department. His mission was to confirm with Dr. James Woodward the latter's 1996 preliminary research into the loss of gravitational mass in a targeted piece of metal from oscillating capacitors. Although Woodward's initial data appeared encouraging, NASA's Millis told me that their funding dried up before completing their research. Furthermore, the entire BPP became unfunded in 2002 and now in 2003 has become a hazy, privatized version of its former NASA subset self.

However, UW is continuing related research, such as magnetically confined fusion energy generators and that, for me, by using electromagnetism to contain an inner field makes it a close cousin of anti-gravity and field-effect propulsion. I spoke with Professor Uri Shumlak who told me that he and other UW staff from the Department of Aeronautics and Astronautics, along with a bevy of their grad students, are building a prototype of a fusion generator called HIT, which stands for Helicity Injected Torus.

This donut ring-shaped torus encloses a roundish chamber. Within that chamber a vacuum is first created, and then a volume of hydrogen gas is introduced and heated to a few million degrees Celsius, which separates the electrons and protons from their atoms turning the whole stew into a quasi-neutral foam of plasma. Then the torus envelopes the plasma with a magnetic field to keep it away from the sides of the chamber enabling the plasma mass to stay hot, and keep the rest of Seattle cool. (While I was standing next to his little eight foot long gizmo, Prof. Shumlak assured me there was no danger of a couple million degrees of heat escaping. The heat density of the plasma was "too low" for me to, well, break a sweat over. His quote was, "There's no more heat mass inside that chamber than what's contained in a cup of coffee." I sure hope you're right, Doc.)

Then, once the plasma field is contained, the magnetic field squeezes the plasma, fusing the nuclei of one hydrogen atom into another. As the hydrogen couples combine, a helium atom is created and a neutron is released, along with lots of energy in the form of heat. One day, such a generator will give us unlimited amounts of electricity, as the heat can produce electric voltage.

Lots of electrical power on the cheap the UW predicts; and the Department of Energy agrees, once the details of building reliable magnetic field generators are solved. What does magnetic fusion have to do with anti-gravity? Two things: first, magnets. Electromagnetism seems to be one of the major players in anti-gravity, particularly the use of electromagnetic fields to contain other fields, such as plasma fields in the HIT, or torsion fields, but more about that later. Secondly, the HIT works, or is about to. It's real and mainstream science embraces it, while anti-gravity is, well, a little more out there and reliable data is harder to obtain. So the technology of HIT lays a base that other research can build upon, such as not only containing other fields, but also building field effect propulsion systems, the most elementary of which is electrostatic propulsion, and aspects of that are already being applied by NASA.

Electrostatic propulsion uses electrical fields differently than electromagnetism does. In EM a current flows and creates a field, while in electrostatic systems the current is static and a charge builds up a field, such as in a capacitor.

These theories are utilized on NASA's Deep Space I, a probe bound for the outer reaches of our solar system. On Deep Space I, the

propellant, a tankful of xenon gas, is excited electrostatically into positive ions. The engine has a negative charge at the exit end, so the charged xenon rushes out the tail pipe with a greater thrust than if it was just using conventional chemical propellants. In fact, the electrostatic propulsion system on Deep Space I allows it to fly at 60,000 mph, or 10,000 mph faster than it would with a conventional rocket. In addition, only 82 kg of xenon is needed for its entire mission, so with its smaller mass and weight Deep Space I will fly along side its intended target, a comet, and drag race on equal footing while filming and conducting studies. Again, not anti-gravity per se, but electrically charging Deep Space I's fuel-field sets the stage for a closer look at electrostatic propulsion.

Taking that closer look is Tim Ventura and his fellow researchers at American Antigravity, an organization based in Kirkland, WA. Ventura and his crew use electrostatic asymmetrical capacitors to create a field that levitates objects, such as their small, kite-like "lifters." These lifters are very light, weighing only a few ounces, and have balsa wood struts that support the capacitors. When two capacitors of different size receive their share of a 30,000 volt charge, the lifter lifts- no motors or wings.

How, no one really knows in my judgment; and the phenomenon is replete with controversy and mystery. But as one who has seen a lifter fly, let me tell you what one looks like and what I saw when Tim Ventura's took off.

Tim has been building lifters since he was a kid and has perfected a four-foot, by-four-foot, by four foot triangular lifter which has flown so many missions in his garage that the silver aluminum foil has turned white. The thin, chopstick-like balsa wood ribs that hold the aluminum foil in place are joined every few inches by a vertical strut (much like a telephone pole on a HO model railroad set) which sticks up and secures the copper or stainless steel wire of the upper capacitor. The ribs are intersected every ten inches or so by the strut of an interior triangle, since the whole lifter is composed of interconnected isosceles triangles which give the necessary strength to the balsa wood frame. All told there is about 30 linear feet of aluminum foil and a similar run of wire.

The lower and larger capacitor is a strip of aluminum foil stretched between the horizontal balsa wood struts. The second capacitor is a thin strip of 50 gauge wire mounted about one inch above the aluminum foil. As capacitors they store electrical charge but don't pass it on in a current.

Fig.1
Lifter

The negative lead goes to the lower aluminum foil and the positive lead is attached to the upper wire. The three corners of the lifter are tethered to the work table so that the electrical leads from the power source are not broken off in flight.

The power source kicks out 15,000 volts at 250 watts. Tim uses a voltage generator made by Information Unlimited, Inc, but before the current reaches the capacitors, the voltage is stepped up to 30,000 volts by Tim's homemade voltage multiplier stack. At full throttle the lifter is straining at the tethers, bending the balsa wood frame near the point of fracture.

Throw the switch and at around 17,500 volts the lifter begins to quiver in take-off. At the full power of 30,000 volts the lifter is roaring and a noticeable downward breeze is observed. Many physicists call it "ion wind," and say that it is how the lifters fly. But what exactly is ion wind, and can it be the cause of flight?

"Ion wind is the movement of ionized air particles," according to Ventura, "which flow downward according to electrical charge." Here's his theory:

The positively charged wire on the top part of the lifter steals elections from the surrounding air, leaving the effected air molecules positively charged. These positively charged air molecules, or ions, then head downward toward the large source of negatively charged electrons generated by the aluminum foil. These air molecule ions are bigger and heavier than the electrons seeking them, so there is a net thrust downward pushing the whole lifter up. That's the theory, and frankly all I can do to verify the theory is to tell you what others tell me. Before I do that, though, let me tell you what I experienced standing next to a levitating lifter.

In flight the lifter emits a high whining, hissing buzz, and I could feel a good breeze coming up at me from the work table underneath the lifter. Also, standing next to the lifter but not touching it, the hair on the back of my head started to rise up in electrostatic-like fashion.

Fig.2
Lifter

To analyze the air currents Tim blew baby powder at the top of the lifter. The majority of the particulate cloud was drawn into the middle area of the lifter and then sucked downward. A kind of vortex was created at times, for intermittently I could see a cloud forming into an organized column beneath the lifter and then spreading out in 360 degrees once it hit the work table surface.

Electrostatic propulsion uses electrical fields differently than electromagnetism does. In EM a current flows and creates a field, while in electrostatic systems the current is static and a charge builds up a field, such as in a capacitor

Is that ion wind? Well, there certainly was a breeze, and it sure felt like air, but how would I know if it was ionized? Something definitely sucked the baby powder down, but was it more than just regular air blowing past me? Again, I don't know.

Is the movement of wind why lifters fly, regardless of whether it is ionic or not, or is the wind just a by-product and not the propulsion? Could the capacitors be creating a field that neutralizes gravity, allowing the craft to levitate? Or are they creating some kind of new field that is localized and the surrounding ambient field pushes this "field-bubble" up, much like a helium balloon is pushed up by the surrounding heavier air trying to fill the emptier "field" of the lighter helium?

Ventura thinks at least two phenomena are at work. Ion wind is definitely one he feels, for the breeze is self-evident. However, he thinks a second effect is at work, too, and many agree with him. Most speculation concerns what is called the Biefeld-Brown effect, the "Brown" being T. Townsend Brown, whose name is well known in early quantum research and whose work is prominently discussed in Nick Cook's The Hunt for Zero Point.

The Biefeld-Brown effect, according to Ventura, is the theory that high voltage, air-gapped capacitors with different or asymmetrical capacities generate a net

directional force upwards from the larger element to the smaller element, which on the lifter is from the aluminum foil to the wire. This force then pushes against the ambient energy field of the surrounding area, perhaps pushing against a more rigid energy field of the zero point energy field.

Brown apparently made his case for these electromagnetic effects, receiving patents in the 1960's for his research. NASA's Dr. Jonathan Campbell at Marshall Research Center in Huntsville confirmed to me that he also, has received a patent recently for his research into the thrust effects of asymmetrical capacitors.

Editor: By the way, this patent is meaningless from the point of view of a prime claim. Before that there had been many publications on the subject.

A.V. Frolov.

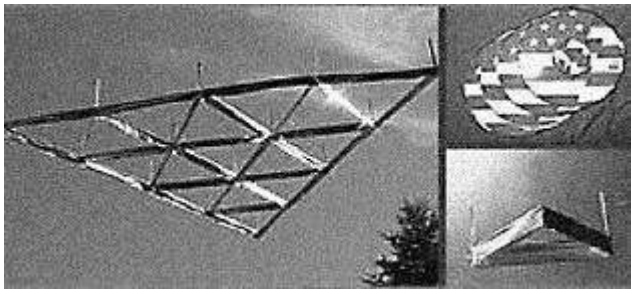

Fig.3
Lifter

However, prominent physicist Hal Puthoff, whose research is a broad swath across the fields of the 'new physics', featured in both The Field and The Hunt for Zero Point, and who was also the military's "Top Psychic" as the twelve-year director of the CIA's remote viewing squadron, has a different perspective: "I'm quite certain at this point that the so-called 'lifter' phenomena is just an electrostatic ion wind phenomena, not 'antigravity.'"

But Dr. John J. Rusek, Adjunct Professor of Aeronautics and Astronautics at both Purdue University and the United States Air Force Academy, says that "Initial findings of 'classroom' experiments with lifters show ionic wind to be way too small a factor, by three orders of magnitude." Dr. Rusek has formed a technological company, Swift Enterprises, to continue this research and bring it to the level that is "presentable to the mainstream physics community."

Along these lines, Jean-Louis Naudin shows on his extensive web site, not only how to build a lifter, but also several photos of research into the ion wind issue. Naudin's team has wrapped test lifters in plastic yet they still produce anti-gravitational effects.

Others may have a clue to the second or even a third force at work. Researcher Fran De Aquino, professor of physics at Maranhao State University in Sao Luis, Brazil, is described in the literature as showing that "bubbles of localized space-time" can exist in variance to the surrounding fields. Anecdotal experience suggests that the lifters may be undergoing such space-time anomalies.

Editor: At this point we need to interrupt the author as he has already completely confused the reader. I would recommend referring to Thomas T. Brown's patent: USA patent #3,187,206, 1965.

Alexander V. Frolov

The Hunt for Zero Point states that NASA sought the services of Dr. Eugene Podkletnov, and although their replication research languishes, The Hunt claims that researcher Ning Li, of Huntsville, AL is pursuing this line of research as a private contractor to NASA.

Another Huntsville operation, Transdimensional Technologies, is exploring these multi-faceted phenomena as well, and its extensive web site shows it to be a frequent contractor to NASA, including research into "asymmetrical capacitive propulsion," and capacitor-based devices to test "ion wind" forces. Jeff Cameron, of Transdimensional, is said by Ventura to be "the father of the lifter," having developed them while exploring anomalous torsional effects of high energy lasers. The lasers twisted and at the time it was considered a nuisance. But the unknown forces at work later led Cameron to found Transdimensional, develop lifter technology to a commercial level, and subsequently patent many pieces of related technology. Unfortunately, I have been unable to reach Jeff

Cameron or anyone at Transdimensional for any kind of confirmation.

Nevertheless, how would gravitons be blocked, or gravity shielded?

Dr. Hal Puthoff says there are two ways of looking at it. First, one can look at the issue from a quantum point of view, that there is a particle exchange between the gravitons and something else, and the net effect is anti-gravity. The how's and why's of that are speculative, so Puthoff turns to a classical approach for answers. He prefers looking at "engineering the vacuum." To do that one must first look at the vacuum.

As I understand it we are all in the vacuum, everything is. The "vacuum" is the matrix that contains all matter and all energy. It is the engineering perspective of the zero point energy field, or the *"Field"* as popularized by Lynn McTaggart in her masterpiece The Field. Puthoff shared with me statements from fellow researcher Dr. T. D. Lee that state: "The vacuum is the seat of energetic particle and field fluctuations, and ... is the seat of space-time structure ... that encodes the distribution of matter and energy.... The vacuum is energetic in its own right."

Thus energy can be drawn from the field; and spacecraft can have "vacuum propulsion systems, or propellant-less propulsion," in other words, field effect propulsion.

At any rate, more and more physicists are thinking that the vacuum can give them a whole lotta oomph, enough to propel spacecraft; and when they learn how to corral it, a whole bevy of new phenomena may be encountered, including anti-gravity. This new potpourri of research is being called by many the "new physics." And although his approach is classical, Dr. Hal Puthoff seems to be sensing what's out there waiting to be discovered.

Puthoff's current research as been to explore "the perturbation of atomic or molecular ground states, hypothesized to be equilibrium states involving dynamic radiation/ absorption exchange with the vacuum fluctuations. In this model atoms or molecules ... are expected to undergo energy shifts that would alter the spectroscopic signatures of excitations involving the ground state." Puthoff says he's had no success so far with this approach, but his words remind me of De Aquino's speculation that objects lose mass as they absorb energy. Pull energy from the field around you and you lose weight. Bingo, lift-off. **But how does one pull energy from the field?**

Editor: Some solve this problem by means of the ether density changes, which are performed with the help of vortex longitudinal-wave technologies.

A.V. Frolov

Torsion fields might play a role here according to many, and the literature on anti-gravity is filled with the phrase, "torsional effects." But what exactly is a torsion field? "It has something to do with spin," Nick Cook told me on the phone. "You have a torsion field when you spin something. Add a little electromagnetism and you might have anti-gravity." That's the short-hand version of it and here's a deeper look.

Mike Wright, resident physics expert at BeyondTheOrdinary.Net web stream radio, told me this: "When forces create curvature (such as rotation) in more than two planes, a torsion field results. Not only does the object go around, but it goes around and 'down' or 'up', and the up/down movement is an additional acceleration in that dimension. EM and gravitational fields differ by having a magnitude of force and only one direction of movement.

"A tornado is a structure of air in air. A whirlpool is a structure of water in water. So, because more than two planes are involved, objects can be created from 'nothing'; that is to say that objects can be created from the medium of the environment, such as a tornado from two air masses of differing temperature."

So spin plus movement is the key. Again, Tim Ventura is on the hunt. He demonstrated to me **that spinning magnets will cancel out their magnetic fields sufficiently so that two magnets facing each other with like poles will not push each other away if one of the magnets is rotating**

perpendicular to the force of opposition. It's not anti-gravity, but it gets us closer to the heart of the matter.

Further, Russian physicists have been researching the torsional effects of both sub-atomic particle spin, and the loss of gravitational mass in planets from the angular momentum of their orbits. Spinning makes something happen, but what? Tornadoes and Mother Nature might have a few clues.

Tornadoes spin, in a sense, although no one is Oklahoma who has spent a night in a storm shelter during an F5 event would describe the tornadoes in the night sky as *spinning*. Nevertheless, tornadoes have anomalous effects that are legendary: blades of grass stuck into mirrors, a piece of straw embedded flawlessly into a tree trunk. How? It seems as if the laws of mass, gravity and inertia are melted as winds swirl at speeds up to 300 mph in an organized vortex pattern. Is this a clue to melting the pull of gravity?

Getting information to this question has not been easy. Many scientists claim not to have even heard of torsion fields, including particle physicists at major US universities. So, again I turn to Nick Cook and The Hunt for Zero Point

Dr. Dan Marckus says that if "you generate a torsion field of sufficient magnitude the theory says you can bend the four dimensions of space around the generator. The more torsion you generate the more space you perturb. When you bend space you also bend time."

Marckus continues, "If you dipped ...one of these whirlpools ... into the zero point energy field, the seething mass of latent energy that existed on an almost undetectable level all around us [in the field would] ... react in an almost magical way by directing that energy."

The torsion field, in effect, is "a pump, a 'coupling' device that could dip into, and then direct, energy out of the zero point energy field." "But," Marckus continues, "the vortex wasn't a three-dimensional phenomena or even a four-dimensional one. It couldn't be. For a torsion field to be able to interact with gravity and electromagnetism it had to be endowed with attributes that went beyond the three dimensions of left, right, up and down, and the fourth-dimensional time field they inhabited; something that the theorists for convenience sake labeled a fifth dimension-hyperspace."

Cook concluded that the torsion fields "bind with gravity ... to produce a levitation effect -- an antigravity effect," but "it wasn't doing so in the four dimensions of this world, but somewhere else." That somewhere else is hyperspace. **So how do we activate torsion fields and enter hyperspace?**

Dr. Eugene Podkletnov may have a clue.

Podkletnov, the Russian researcher working in Finland, has studied the gravity shielding effects of superconductors. Again, Nick Cook in The Hunt, relays vital information. Cook says Podkletnov claims, "If the superconductors are rotated considerably faster than 5,000 rpm ... the disc experiences so much weight loss that it actually takes off." Thus, torsion field creates levitation. I emailed Dr. Podkletnov to find out more about this issue. He replied: "[A] fast rotating object can, under certain conditions, cause the polarization of the volume that it occupies in space and around it. This polarization causes the gravitational effect as it modifies [the] local gravity field. The vortex of the polarized particles will create a vertical thrust with a certain force and spatial momentum. Some scientists call these polarized particles gravitons. The term graviton is an artificial one and at present we are not sure if it is a wave or a particle and what type of particle. Maybe it is a usual tachyon or a superluminal neutrino (a faster-than-light-particle). Polarization of the media means that the spins of electrons, protons, neutrons and of small subatomic particles that constitute the fabric of space or vacuum would be parallel. Then a kind of gravity well is formed and the objects tend to fall into this well. We observe this picture as an object rising to the sky. Polarization of the media (of space) causes some glow around the object as it acquires additional

energy and because of it, the glow around some objects is observed."

What I understand from Dr. Podkletnov is that gravity is the effect of spin -- the spin of all subjected particles, from the sub-atomic level and up being parallel; thus they are all aligned to fall into the gravity well of earth. And spinning objects, such as his superconducting discs, when influenced additionally by an electromagnetic field, will experience a shift in the spin of the sub-atomic and atomic elements. They will be turned and not be aligned in parallel. Thus, they are able to levitate.

But how to polarize the media and get things spinning? Enter Dr. Marcus Hollingshed, an enigmatic figure allegedly from Cambridge University. Dr. Hollingshed claims to have built a six-ringed toroidal coil antigravity device, which achieved great effect using rotating magnetic fields. In January 2003 he announced on the Internet that he has developed a 160kg vehicle able to lift in excess of 2000kg and that it has both horizontal and vertical drive features. His device cannot only go up and down and sideways, but it can push things away and pull objects to it.

In addition, the field that the device purportedly generates is capable of being broadened and weakened, or narrowed and amplified in a lensing effect, with the field producing an absolute vacuum of 2.2m spherical diameter. Best of all, when it's cranked up the core of it goes invisible, although the term Dr. Hollingshed uses is that there is a "loss of reflected light." There are no reports of independent confirmation, and Nick Cook says he hasn't been invited to see it, so, he's skeptical.

Where does this leave us? Perhaps Dr. Podkletnov's words sum up our current situation."Modern theoretical physics cannot give you the direct answer to your questions (levitation, torsion fields, etc.,) and a scientist who would agree to give you the answer cannot be regarded seriously, softly speaking. If you had asked Dr. Einstein if he were an expert on gravity, the answer would be NO. I can repeat his words: No, I am not a magician, yet; I am still learning."

Wayne Macleod, USA
Email: dynamars2100@yahoo.ca, cwleod@shaw.ca

Gravity is the incremental slowing of time as we move closer to its source. If we imagine panes of glass stacked on top each other, one pane slightly denser than the one immediately above, a ray of light coming from above will constantly refract in a curved beam downward as it enters the stack. The same is true of a ray of light entering a gravity field. The analogy is not too far fetched because refraction is caused by a slowing of light in the denser medium. Of course, gravity affects material objects as well as light, but this is explained by every object traveling on a 'world line' in spacetime. We can use light as in the glass example because light is its own world line.

Why the world lines of objects take the paths they do can best be understood by compressing our normal 3 dimensional space into 2 dimensions, length and height only. When we throw a stone into the air it rises and falls in a parabolic arc in these two space dimensions. That path in space is a complete mystery until we consider another dimension, time, a dimension we can imagine measured at a right angle to the plane of the 2 space

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dimensions. By multiplying the time of the object in flight by the speed of light, we have a three-dimensional coordinate system, not of space but of spacetime. We can then graph the world line of the object. So why does the object fall? It is because spacetime near massive bodies is curved. A remarkable fact is that the curved world lines of all objects in the same gravity field, whether of a thrown ball or fired bullet, have the same radius of curvature. Hence all objects fall with the same acceleration.

To neutralize gravity we must somehow 'straighten' the world lines of objects traveling in curved spacetime. It would be as if we had in our stack of glass panes a bubble, around which the density of glass became less on approach to the bubble. Then the ray of light, when close to the bubble, would refract opposite to the path it would normally take when traveling thought the rest of the glass. Similarly, if we could manufacture a 'time bubble' in a gravity field opposite to the time slowing known as gravity, we would have any object embedded in the time bubble isolated from that gravity field.

The Electrical Levitation theory can best be understood by first considering an analogy. Let us imagine a wheel spinning on an arm like a child's propeller toy. The arm also rotates, in a direction opposite to the spinning wheel. We consider the rate of spinning of the wheel from the point-of-view of two observers, one observer stationary on the ground, the other observer rotating with the arm. Obviously the two observers will not see the same rate of spinning on the wheel. Because the arm is rotating opposite the spin of the wheel, its rotation must be subtracted from the rate of wheel spin as seen by the stationary ground observer. This is not true of the observer rotating with the arm, who will see the spin of the wheel as if there were no arm rotation.

The concept is easier to envision with linear motion, such as of a man throwing a ball on a moving train. The velocity of the ball seen by the pitcher on the train will not be the same as its velocity seen by a stationary observer on the ground. As the stationary observer sees it, that velocity will have the train's velocity subtracted from it if thrown against the train's velocity. It is the same with rotary motion: the velocity of the wheel for the stationary observer is slower because the arm's rotation is subtracted from it.

But suppose the wheel rotation is *the same* for the two observers! Something must be different between them, and that is time. As explained by Special Relativity for linear motion, time is not a universal constant; it differs between observers depending on their relative motion. The property of nature that *is* constant, that produces this relative time difference, is the speed of light. So we must look for a similar constant in nature for a relative time difference between observers in our rotary example. We have one in electron angular momentum, known as electron "spin," $h/4\pi = 5.28 \times 10^{-35}$ kg-m^2/sec, where h is Planck's constant. Like the speed of light, this quantity is constant for all observers, whether the observer is on a rotating system or stationary on the ground. Here is the tool for producing our time 'bubble'.

Let us now imagine a series of concentric rings, all rotating in the same plane and in the same direction. Electric current is pushed through these rings in the same direction as the ring rotation. (Current here is considered the flow of electrons, not conventional positive current.) The rotating rings are sandwiched between two magnetic plates, the function of which is to maintain the angular momentum of the current electrons oriented properly with ring rotation.

Analogous to the above example, each electron takes the place of the spinning wheel and the rotating arm is replaced by the rings. Thus, because electron angular momentum is a universal constant, an observer of the electrons in this rotating system will not have the same time as a stationary observer outside it. If each current electron has its "spin" oriented opposite the rotation of the rings, time on the rotating system would run faster than for a stationary ground observer, the same as in empty space relative to the Earth. The rotating system would therefore have the world line of empty space, not that of the

gravity field. Its spacetime would not be curved. Since gravity is a time phenomenon, such a system in a gravity field could not have the behavior of a normal object. This conclusion may seem erroneous considering that ring rotation could never reach relativistically significant velocities, but we have an analogy with magnetism that is caused by a Lorentz contraction of the distance between moving electrons. If we considered the diminutive drift velocity of electrons alone we would never conclude that magnetism was possible, but the effect is *accumulative* over trillions of electrons. The hypothesis here is that the same is possible with the trillions of free electrons oriented with a spinning ring, to produce an accumulative time effect.

We now come to the controversial part of this theory because the above treats electron angular momentum the same as angular momentum of a normal physical object, whereas the electron is a quantum particle and quantum particles have their own realities with bizarre consequences when analogized with our macro universe. For instance, the electron has quantum spin number 1/2, and such a particle would have 720 degrees in one rotation, not 360. Nevertheless, the electron *does possess* di-pole magnetism. It *does behave* as a spinning ball with negative charge. Electrical Levitation is therefore an empirical theory. The property of the electron that gives electron di-pole magnetism cannot be an actual physical rotation, but whatever that quantum property, if it produces di-pole magnetism there is reason to expect it to produce other macro physical phenomena as if it were.

The theoretical finding of General Relativity that time runs slower in a gravitational field was confirmed by the Pound-Rebka experiment in 1959. **It is not that gravity causes time slowing, gravity *is* time slowing.** Since time and energy are reciprocal, more time on our rotating ring system would mean less energy seen by an observer in that frame of reference than seen by a stationary observer on the ground, the opposite of the red shift of a gravity field. This energy difference must equal the energy of the mass in a gravity field that is to be levitated, its energy of weight, and lost. Experimenters should therefore be aware that their device might radiate. But this is not a free energy machine. The energy of levitation comes from its magnetic field, and the electron magnetic moment energy turns out to be $V_e = mc^2$ divided by the electrical current, *m* is the mass to be levitated and *c* is the speed of light. This is an enormous amount, but becomes practical if enough electrical current can be sent through the rings. That means the electrical resistance of the ring material must be very low. For copper it is not. No material currently exists with sufficiently low electrical resistance at room temperatures, but **superconducting materials** exist that at cryogenic temperatures experience a dramatic loss of electrical resistance.

An experimental device can therefore be envisioned using a superconducting disc substituting for the electric rings. The disc would serve as a conductor for an electric current and would therefore need to be sliced along one radius with an insulator placed in the notch. Both edges of the notch would be connected to a power source by brushes rotating with the disc. With a counterclockwise disc rotation as seen from the top, to have clockwise electron "spin" the magnetic field between the plates would have to be up. Only the moving free electrons of the current will be available for any time alteration effect. These will also **produce a magnetic field, which it is reasonable to assume would be of the same time alteration effect as the electrons, thus producing the required alternate time "bubble".**

The resources required for an experiment using superconducting material at cryogenic temperatures are beyond this writer's means and an experiment has not been attempted, but an experiment at the Tampere University, Finland, 1992, using a superconducting disc suggests that gravity shielding is possible. Owing to the immense advantages gravitational shielding would give to the present interest in space exploration, effort toward its development would be logical. This essay may offer clues on how to begin.

Editor: I find the article by Wane McLeod quite interesting as his approach is very similar to the idea I first presented in my report at the "Space, Time and Gravitation" Conference which took place in St. Petersburg in 1998. The report was included into The Proceedings of the Conference, Part I, 1999. Before that the brief version of the article was published in English in the 'ELECTRIC SPACECRAFT' magazine, Leicester, North Carolina 28748 USA, Issue 27, 1997 p.30-31.

I managed to demonstrate that the ideas of Thomas T. Brown, especially his USA patent # 3,187,206 of 1965, are something more than just the force asymmetry in the electric capacitor. According to the concept presented in my report, by creating a matter property gradient (in particular, the dielectric permittivity gradient) we actually change the curvature of the electric force line in space. Normally, the natural space curvature accounts for the electric field potential decrease with the distance increase from the surface of the charged object. By creating the dielectric permittivity gradient (described by T.T. Brown in his patent of 1965) we change the natural distance potential gradient law. We can both increase and decrease this change and even reverse it. With the dielectric permittivity change square function, the natural space curvature is completely compensated and with more extent it is reversed and can be turned to negative. At that rate, the potential is not decreased but increased with the increase of the distance from the surface of the charged object. This is the essence of my concept that has never been considered before by any author. By creating the gradient described by the quartic function we get the same distance potential gradient law as in the natural conditions only with a different sign!

T.T. Brown, who discovered a force in capacitors with a special dielectric, offered the practical application of this concept. However, he did not find the source of this force, which, according to my concept, is conditioned by two factors: the corresponding dielectric property gradient function and the elastic properties of the dielectric material, which is of no less significance. Normally, dielectric particles are attracted to the charged surface but when the reversion of the curvature of electric field force lines occurs, they are repulsed from it and we can use this propulsion force. Elastic deformations (including those occurring during the pulsating operation of the field) account for the reaction forces equivalent to the generated propulsion force. Thus, the momentum conservation law is in action, however, the device is still moving.

T.T. Brown also considered other ways of generating a force, such as the material magnetic property gradient. Logically, by analogy with the electric field we can consider the gravity field, which can be "designed" and "reversed" by means of creating a matter with the density gradient. At that rate, the gravity potential must change in accordance with a certain law when the distance from the gravity field source being increased.

We should also note that the local space volume levitation effect with the accelerated or decelerated time rate was first described in my articles "Physical Principles of the Time Machine", NET #3 (6), May-June 2002 and "Practical Application of the Time Rate Control (TRC) Theory", NET #3, November-December 2001.

Our company conducts experimental researches on creating new materials that possess the properties described. We are interested in serious business contacts with companies in the aerospace industry to further discuss eventual cooperation projects in this field, including *co-patenting*.

Alexander V. Frolov

Perpetuum Mobile Not in the Past but at the Present

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In several issues of the "Nature and man. Light" magazine in 1995-97 my colleague E.Oparin and I wrote on the unscientific character of absolutizing the law of degradation of energy, on the important issue of creating the perpetuum mobile of the second kind utilizing infinitely available *environmental heat energy*. We even send a letter to Yury S. Osipov, the Russian Science academy President, but received no reply. Notwithstanding many official discussions, there are no well-reasoned objections to our arguments or proof on the part of "high" official science, because, in fact, we are right.

I have recently received one more confirmation: bright and feasible data on the negentropy cycle (the cycle with spontaneous reduction of entropy) with a chemically active working substance that will be described later.

After the publication of Victor M. Brodyansky's book "Perpetuum Mobile in the Past and at Present. From Utopia to Science and from Science to Utopia", Second Edition, one can not but return to these issues. More so because the foreword of V.A. Fabricant, member of the USSR Academy of Pedagogical Sciences, claims the law of degradation of energy to be the "law of nature" and supports shamefully the deformation of the monothermists, especially P.K.Oschepkov, by academicians P.Kapitsa, L.Artsimovich and I.Tamm ("Pravda" of November 22, 1959), followed by E. Velikhov, A.Prokhorov and V.Sagdeyev ("Pravda" of June 22, 1987).

After the publication of Brodyansky's book I met the author several times (notably at a special seminar in The Moscow Energy Institute) and expressed my opinion about his book: the book avoids serious discussion of the monothermists, stresses their failures which are quite normal in the initial development of perpetuum mobiles of the second kind.

For example, Brodyansky knew about Tsiolkovsky's discovery. Guay's book "On the Little-Known Hypothesis of Tsiolkovsky" is listed among the First Edition references. But Vladimir Brodyansky avoided analyzing this discovery both "in the past" and "at present". The Second Edition references even list the "Physical Thought in Russia" magazine, issue #1 of 1991, that contained for the fist and only time the modern edition of the "Law of Degrading of Energy" by Tsiolkovsky. "At present" V. Brodyansky knows my analysis of Boltsman's mistakes but he paid no scientific attention to my analysis either.

In Brodyansky's book the description level of chemical reaction cycles is even lower than that of Schpilrine. Schpilrine at least tried to present his arguments but here we see unsupported statements "justified" by the phrase "the detailed discussion would take too much space". Vladimir Brodyansky's analysis of anti-Stokes luminescence (pp.216-219) is also superficial. Dissipative and entropy processes prevail in it. But if there is evidence supporting higher frequency quanta than the frequency of radiating flux, **it is the evidence of negative entropy**. Vladimir Brodyansky not only is familiar with it and also shows it by the example of investigating the Sun and the Earth (p.247).

Vladimir Brodyansky's analysis of Rank's tube (pp.235-237) displays the same tendency. In the Rank's tube the dissipative processes also prevail. Its effectiveness as a refrigerator is lower than in the traditional schemes.

But one can not deny the existence of negentropy processes in it. It is these processes that "originate" the cold gas flow. And Brodyansky's "origination" on p.236 "The vortex tube in fact divides the coming gas into two fluxes: heated and refrigerated" - is totally false. That can be performed only by "Maxwell's demon" that does not exist in substance.

The refrigerated flux in the Rank's tube is formed by the "Tsiolkovsky's flux" by way of heat transfer "from cold to hot", from the tube center to its circumference by **centrifugal accelerations**. On its basis (to be more exact, on the basis of Finko's tube) the perpetuum mobile of the second kind can be created. And we have this engineering solution. E.Oparin and I made the corresponding patent application for an invention but the Federal Institute of Industrial Property again refused to consider such applications. Here one can see similarity with the causes of re-edition of Vladimir Brodyansky's book. And one need not be a big politician to admit the reality and understand the sources.

Environmental and, especially, anti-nuclear movement is invincibly expanding. Danger to human life and threat of ecological catastrophe are quite real. The Second Edition of Brodyansky's book protects behind scientific arguments those who use Russia as a source of easy money and then flee.

But we like our country - vast and austere. This austerity and space form REAL PEOPLE and support humanity and materialistic humanism of the energetic and talented, not just the rich.

In modern Russia the powerfully spread alcoholism, debauchery and drugs are the instruments of slavery. But the monothermy and development of alternative power engineering will become basis for Russia's revival and unprecedented prosperity.

Russians learn slowly, sometimes, very slowly, even disgracefully slowly. But we will learn. And then no one will stop us. The following tips are meant for those who are ready to risk their efforts and facilities in order to build alternative energy knowledge base: dissipative and negentropy processes are inseparable and very often their mechanism is the same. In our environment the dissipative processes are more effective and hide the negentropy ones. No dissipative process combination can generate the negentropy cycle. Look for examples in Brodyansky's book. To create the negentropy cycle and use the environmental energy at least one negentropy process is required that has effectiveness and negentropy exceeding entropy growth at all levels of the cycle.

News from "IntAlek" Company

William Alek [alekws@intalek.com] has updated the latest and greatest ZPOD system drawings:

hhtp://www.intalek.com/Index/Projects/SmartPAK/Projects/ZPOD/ZPOD_System05.pdf

This is release 5.0

Here is the latest electrical schematic: http://www.intalek.com/ZPOD/ZPOD_System05.gif

Based upon his "preliminary" tests thus far, he estimates the COP is around 2.0. This estimate is interpreted from the following scope traces:

http://www.intalek.com/ZPOD/in.GIF

Alan Francoeur's Generator
Canada

Alan L Francoeur, Canada
Email: al.f@shaw.ca

This is my writing and development about the Interference disc generator, and the permanent magnet dynamo machine, and other related inventions. I have always been intrigued with electricity and magnetism and aetheric energies starting at a young age. Back in 1980 I wanted to do something to help get my large vehicles better fuel economy. With this goal in mind, I experimented and designed my first heat exchanger vaporizer system to do my part to clean up our cars and trucks, fig. 1, 2, and 3 are two earlier vaporizer units under construction. For more information about this fuel system, please refer to my vaporizer fuel system report. The main body of this writing is referring the permanent magnet dynamo system that has been in the making since 1987, starting after the development of the interference disc generator.

Fig. 1

Fig. 2

Fig. 3

I invented the Interference Disc generator concept while I was employed at Giant Yellowknife Mines NWT from 1983 to early 1986. The idea of using metal blocking plates to shield magnetic fields stirred in my mind while working around heavy electrical mining equipment, and 1000hp and other electric motors with exposed coils that have heavy metal around the outer casing. I did a search at the time and found John Ecklin's work very interesting with his application of the shielding effect. During my off time in Yellowknife, I was experimenting with the interesting effect of producing induction with a stationary coil mounted beside a stationary magnet with a small air gap maintained between the magnet and the coil. During the construction of my first disc machine, I called it the Interference Shielding effect because of the interference the blocking disc does to cause induction, thus the Interference Disc Generator fits the description. The first transformer coils I used to test the interference shielding effect were used from old radios, and the magnets were alnico types. Back in 1986 in Calgary Alberta, a friend Bud Johnson and I constructed the first test disc generator model using alnico magnets, fig. 4, and later ceramic magnets were installed. Months later I designed and began construction of another larger Interference Disc machine with horseshoe shape neodymium 35 grade magnets mounted on the outside, and with the N and S magnetic poles facing toward the coils in the center portion of the machine. The coils and magnets in this larger machine are mounted in reverse of the first Interference Disc generator, fig. 5, 6.

Fig. 4

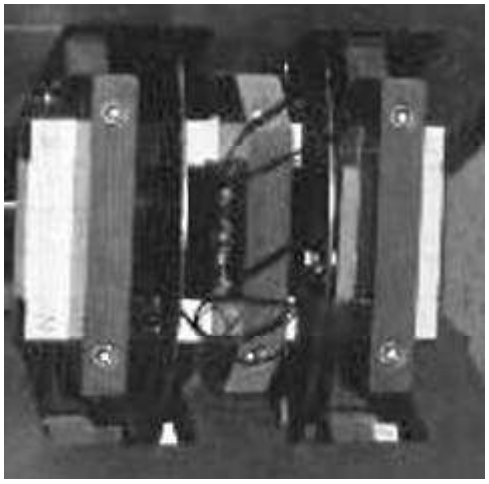

Fig. 5

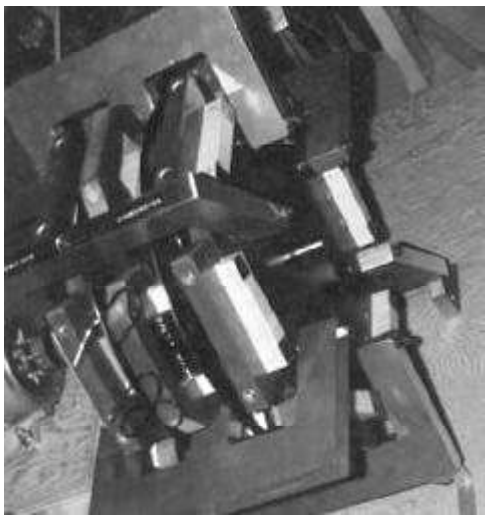

Fig. 6

General description of the interference disc generator

The Interference Disc electrical generator is made of a stator (114) consisting of an array of even number parallel mounted bar magnets (112) arranged and supported (114) in a circular fashion equidistant from each other, where the polarity of the magnets (112) are alternating when viewed at either end. Fig. 7

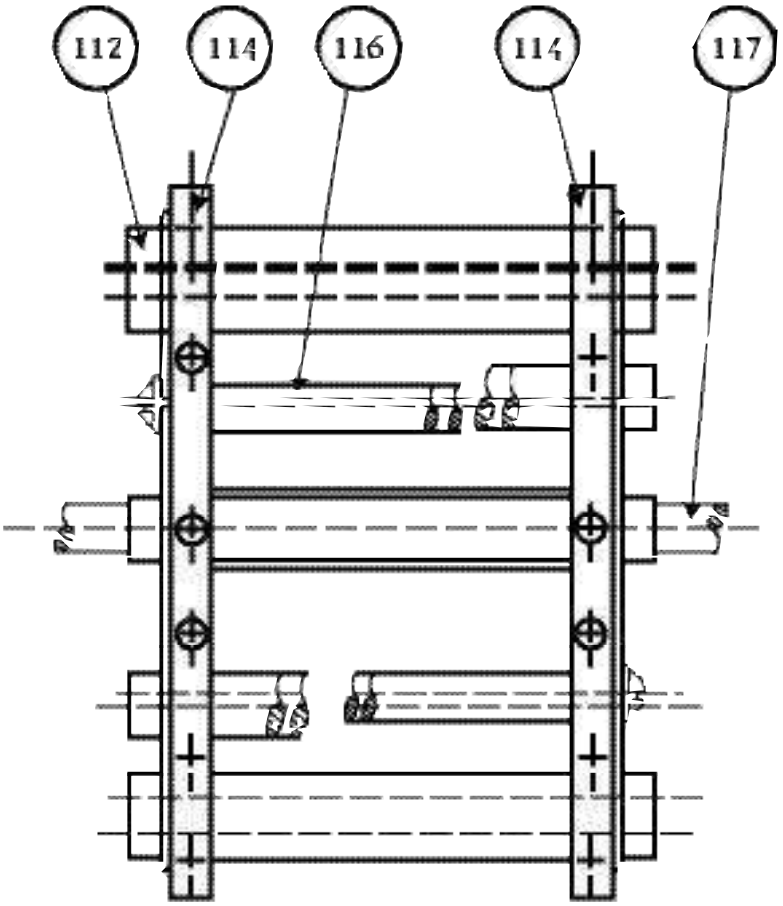

Fig. 7
Magnetic bars assembly (rotor)

Also in the stator fig. 8, (102) there are twice the number of coils (111) as bar magnets (112) wound in pairs on U-shaped cores (110). One half of the coil pairs mounted at one end of the bar magnets (112) in the same circular fashion, each corresponding to and aligned opposite to a pair of bar magnets (112) and separated from it by an air gap. On the other end of this pair of bar magnets (112) there are another set of coils (111) aligned likewise.

The rotor is made of two magnetically susceptible circular plates (109A or 109B) (such as iron or steel) Fig. 9, centrally mounted on an axle (107) fig. 7, which is in respect to the array of magnets and coils Fig. 9a.

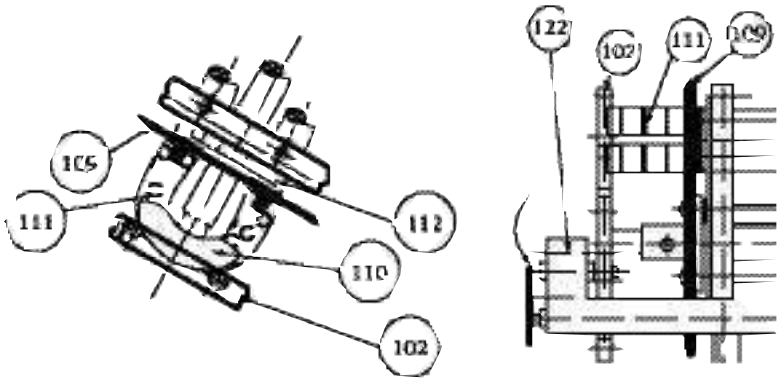

Fig. 8

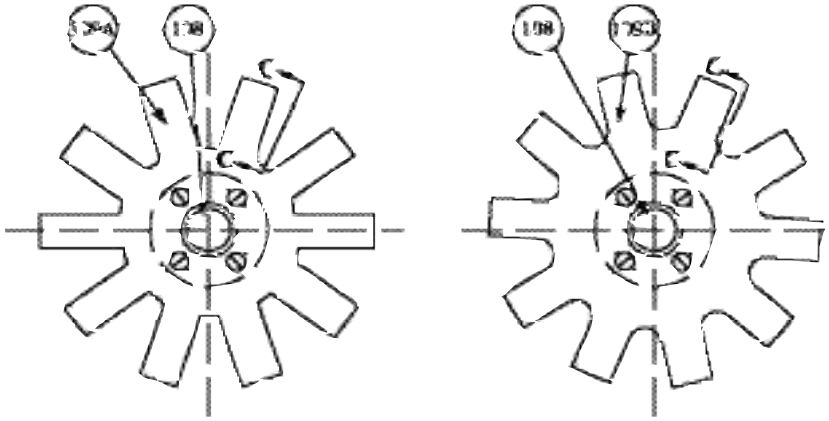

Fig. 9

The interference discs (109A or 109B) are separated from each other so that they can rotate in the air gaps between the magnets (112) and the coils (111). The interference discs (109A or 109B) have a number of **equidistant opening, either more or less in number than the number of the bar magnets (112)**.

The arrangement and size of the openings are such that when the discs (109A or 109B) are rotated by an outside motive force, they open the magnetic field between adjacent bar magnets (112), and the opposing coils (111) at both ends of the stator (114) simultaneously. Hence inducing an alternating electric current in the stationary coils (111) fig. 10.

By opening and closing the magnetic influx to the core (110) of the coils (111), an alternating current will be generated in the coils

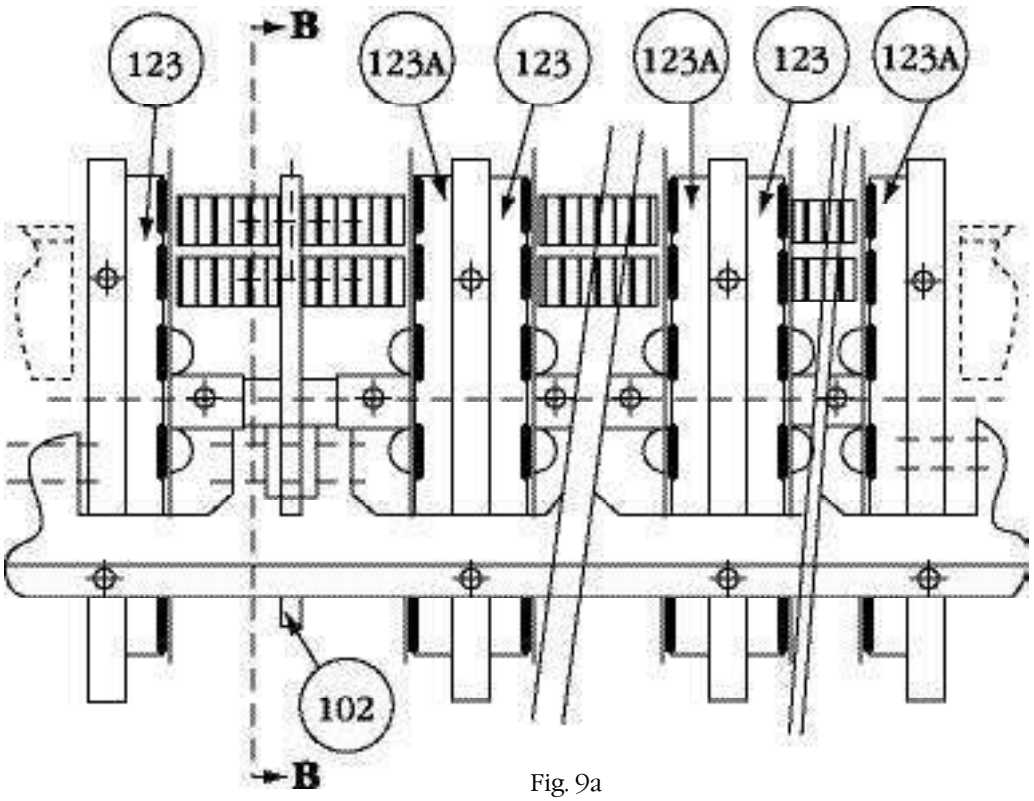

Fig. 9a
Magnetic bars assembly (stator)
Option II: multable magnetic coil-disk assembly

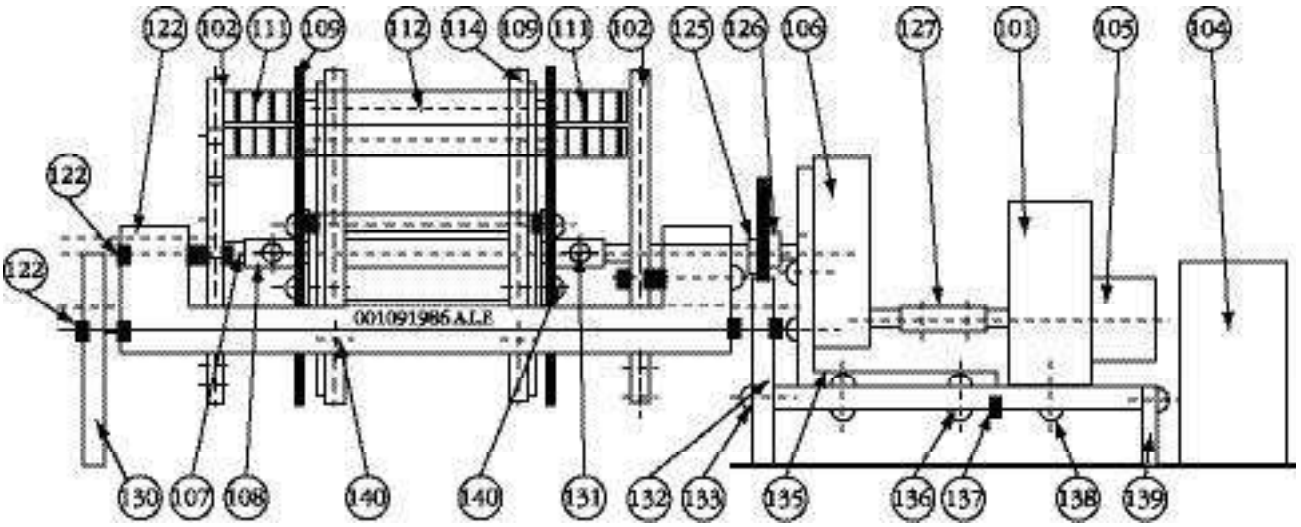

Fig. 10

(111) in a retro-order to the rotational direction of the interference discs (109A or 109B). Depending on the number of magnet-coil assemblies three phase AC current can be obtained. The regulation and attenuation of these currents can be achieved by known electric engineering methods (Fig. 10).

The efficiency of the unit would vary greatly depending on the speed of rotation, the width of the air gap, the strength of the magnets, and the materials used to construct the coils. I used nickel base amorphous metglass in the coils in both the smaller and larger machines, which as a result, shows greater efficiency as compared to conventional core laminates. Less energy is needed to spin the balanced disc rotor while causing a larger moving magnetic field to cause induction in the stationary coils. With this effect, it is easy to visualize the advantages this design has over conventional generators and motors. New testing of the coils will be conducted after the machine goes through all the upgrades to eliminate the problems with the warping interference discs.

The Interference Discs Generator described in this document **has the potential to produce more than unity effects**byeasy turning of a magnetically balanced (non-warping) interference disc. Optimizing the device with closer tolerances and correctly selected materials and incorporating internal magnetic balancing, will add to the success and improved performance of this unique generator design.

Improvements can be made with this design while the operating principal remains the same. Looking at the photographs included you will see the 1st proof of concept generator frame is constructed mainly from aluminum, this metal was used only because it was inexpensive material and easy to work with fig. 11. Non magnetic and non-conductive materials should be used to construct the generator frame supports to eliminate the eddy current losses. All of the nuts and bolts used to hold the disc generators together worked well for making the test machines capable to have adjustable air gaps, however, they can all be eliminated with design changes that preset the gaps and tolerances to optimize the conditions of the interference disc effect.

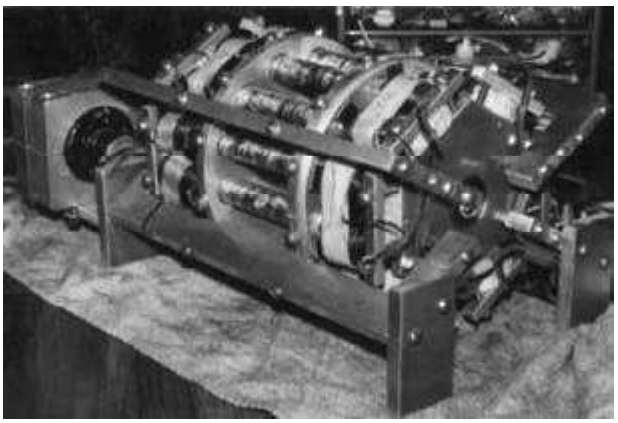

Fig. 11

Many improvements were adopted in the next larger #2 version of the Interference Disc generator fig. 12. Phanolic materials (non conductive and non magnetic) were used in the frame supporting the magnets and the coils, thus eliminating eddy current losses within the frame support. Large aluminum E bars were used to support the magnet frame support and the coil frame support with no noticeable eddy current losses. The aluminum used is positioned further away from the coils and magnets in the larger generator so as not to be affected by the magnets. Larger more powerful neodymium magnets and I shaped transformer coils were installed and tested in the larger machine which showed an increase in output power over the 1st machine fig. 13. Using more powerful neodymium magnets in this larger disc machine created some problems with the interference discs. Not only did they warp the discs they caused them to vibrate and chatter causing the fins to hit the magnets and the coils. I increased the air gap to over half an inch and moved the disc further away from the magnets to prevent damage. The effect was a reduction of magnetic flux reaching the coils that reduced the power output. The discs must be constructed much stronger and rigid if using neodymium magnet grade 35 or greater, then the air gap can be closed so more magnetic flux will reach the coils allowing for a greater electrical output.

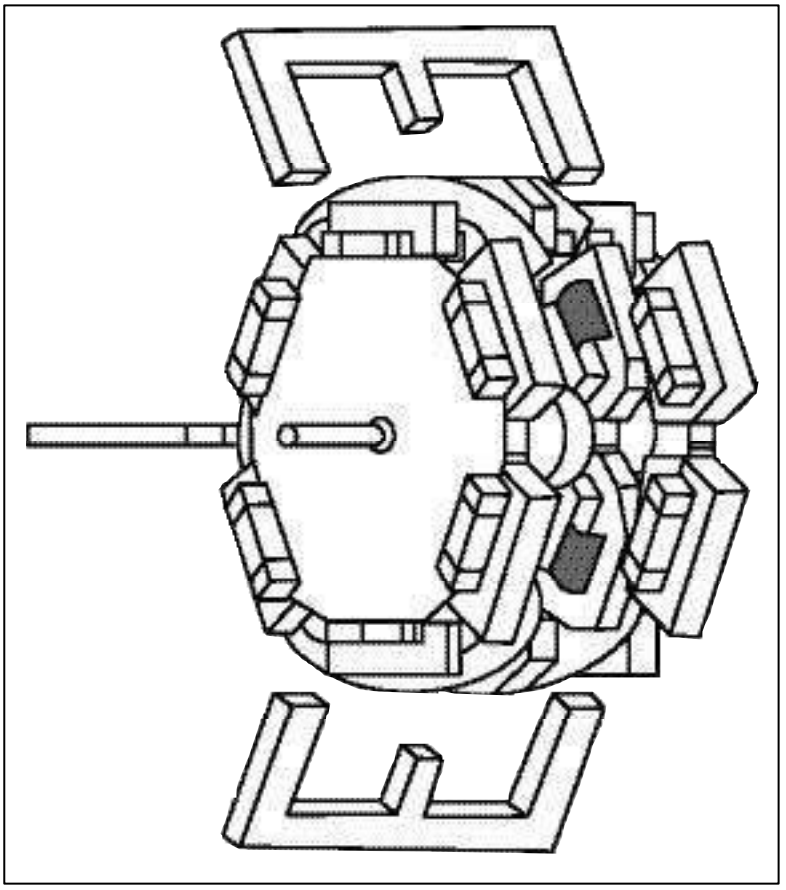

Fig. 12

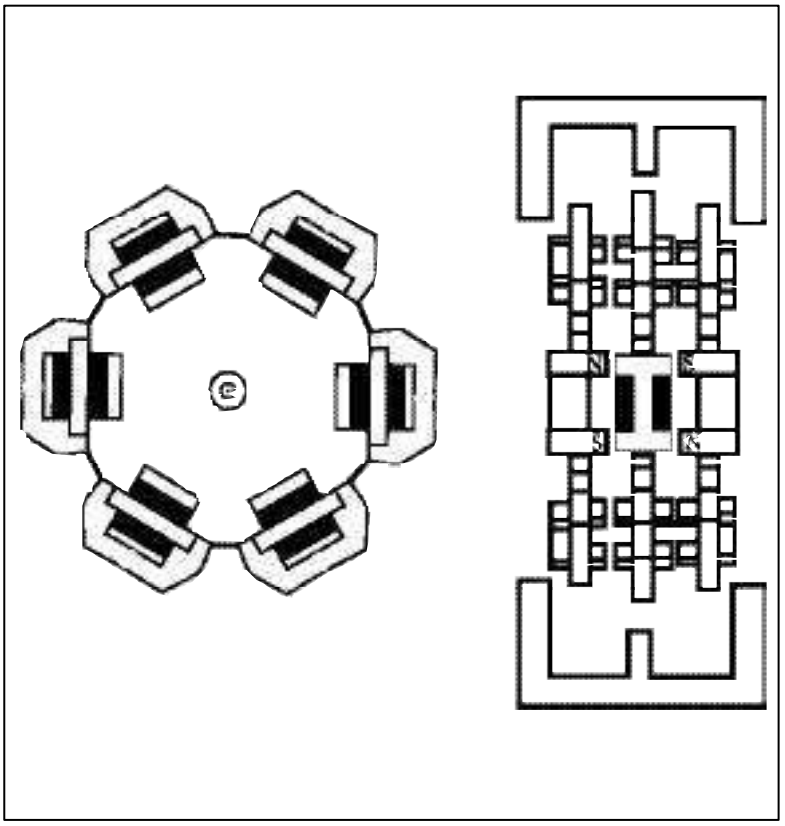

Fig. 13

The wiring of the coils circuit can be constructed by known engineering methods to achieve AC or DC power, and like any conventional transformer, wind the coils with heavy wire for more amps and more turns for more volts. The coils are stationary in this machine which makes it easy to harness AC power directly from the coils without brushes. All coils that are in phase can be wired in series or

parallel, the number of the blocking plates on the interference disc determines the phasing of the coils.

The diagram in fig. 14, 14a shows the path of the magnetic flux movement in relation to the position of the blocking plates of the interference disc. The magnetic field in the core/coil is switching polarity as the interference disc fins alternately moves in and out of the air gaps on each side of the coil. As you can see, depending on the position of the disc, positive and negative induction takes place for AC output of the coils. John Ecklin has achieved this effect using rotating blocking plates. I have achieved the same effect using balanced rotating interference discs with multiple stacks of isolated coils and poles mounted in a circle equal distance from each other.

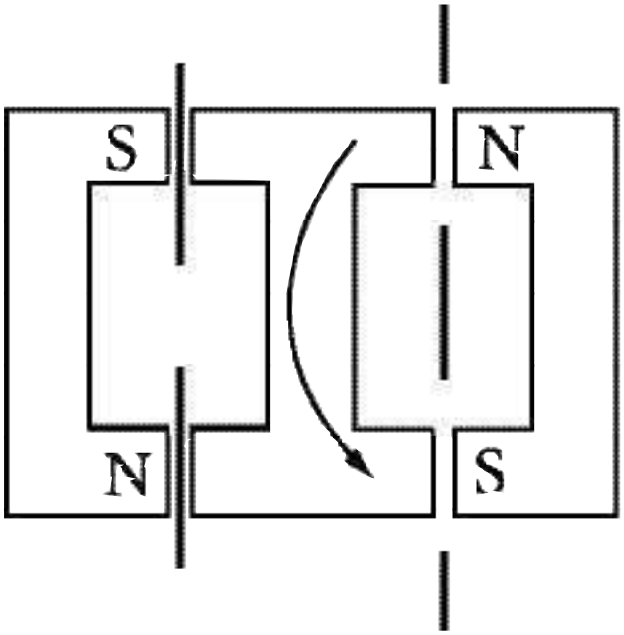

Fig. 14

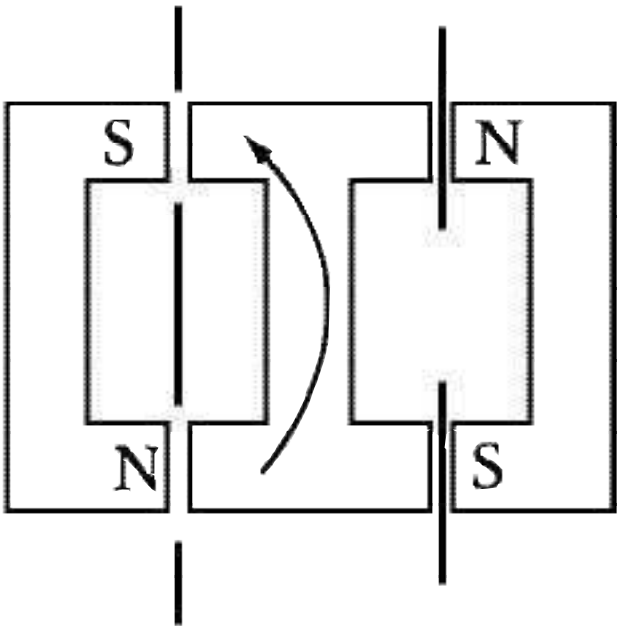

Fig.14a

The effect I reproduced with Gary Wesley's permanent magnet motor is related to the Interference Disc generator in the fact that blocking plates are used to shield the magnetic field, only we differ on methods to balance the blocking shields. Gary Wesley used springs to carefully balance the blocking plate, and I used a different number of interference fins working with the magnets to balance the blocking plates. The magnets in my Interference Disc machine become the springs.

More photos of both Interference Disc machines are shown in fig.15, 15a and 15b below.

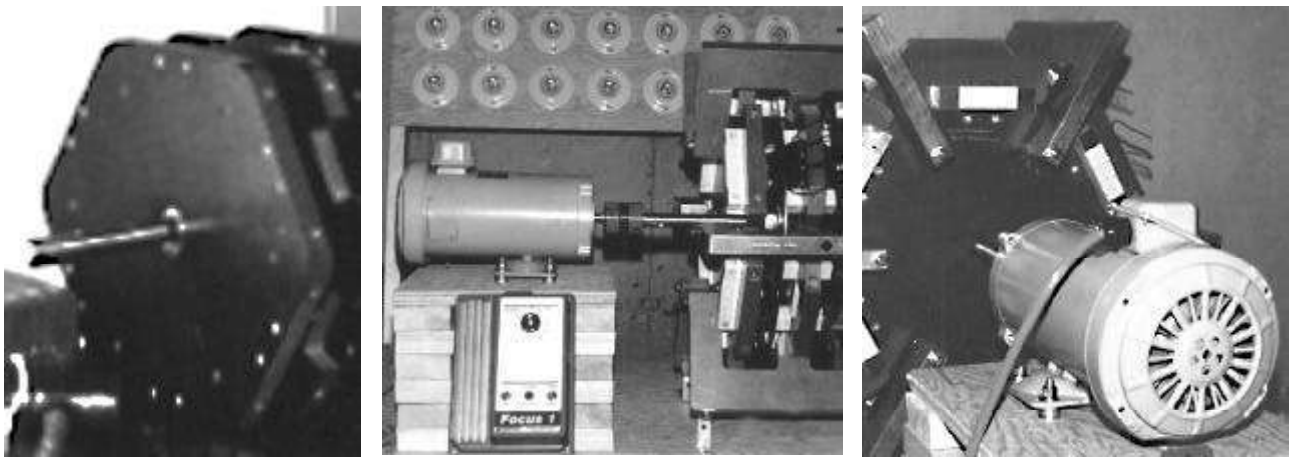

Fig. 15

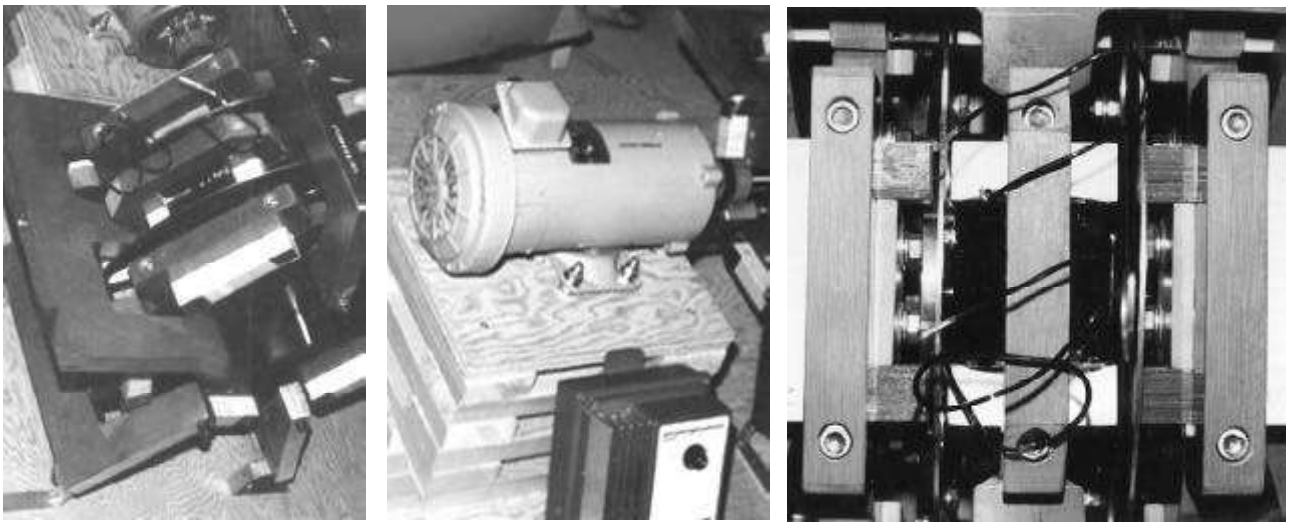

Fig. 15a

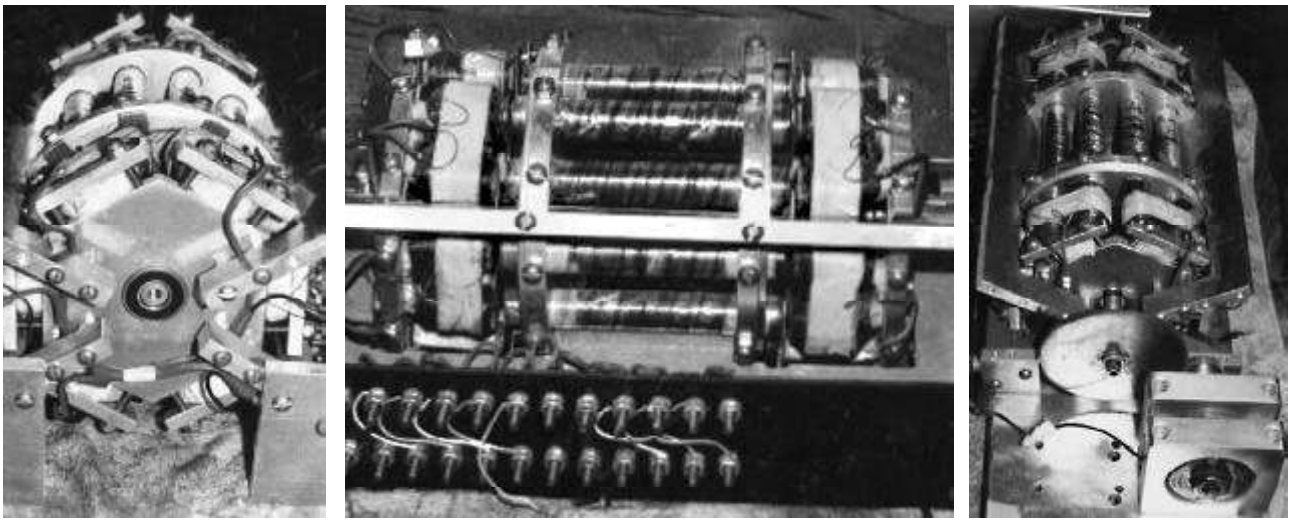

Fig. 15b

Closing comments on the disc generator

In closing this discussion of the Interference disc generator, I would like to go over and point out some of the concepts that I incorporated into the design of my permanent magnet dynamo.

As I made further progress and completed the later stages of the Interference disc generator, it became clear to me to use certain concepts of the machine and incorporate them into the design of my multiphase permanent magnet dynamo. Some of these concepts are explained here.

I have constructed several interference discs that have a different number of blocking shields, some with 10 blocking fins and some with 11 blocking fins and others with 12 blocking fins. They are all interchangeable on the machine to change the phase relations between all the isolated coils. The 12 finned disc will produce a single-phase dynamo with all the coils in phase, and the 10 finned disc on the machine will produce a three phase dynamo. One phase represents four groups of isolated coils, and the second phase represent the other four coils, and the four coils left are the third phase, for a total of twelve coils. All just by changing the number of fins on the interference disc and or adding more layers. Using 12 magnet poles and the 10 or 11 interference fins on the disc, the rotor discs becomes magnetically balanced and easy to rotate in spite of the load on the coils. The 12 finned disc has a larger holding force because

of the same number of fins as magnetic poles. However, it can be reduced to almost nil by adding more layers of interference disc and balance them against each other. Many in phase coils can then be added in series or in parallel to build your power levels to any desired potential.

Both machines have stationary coils, and the disc generator has 12 magnetic poles (6N and 6S), and the permanent magnet dynamo also has 12 magnetic poles (6N and 6S). The disc generator uses 10 or more fins on the interference shielding plate per rotor, and the permanent magnet dynamo has 10 or more coils around each rotor. There is the same number of interference blocking plates as there are induction coils on each of the two difference machines and the number of blocking fins and or coils are interchangeable. The back emf effects are different on both machines, the Interference disc generator demonstrates easy turning of the discs while the stationary coils are loaded, and when producing alternating current the permanent magnet dynamo rotor slows down when a load is placed on the stationary coils. Both machines produce AC power out of the coils and the Interference Disc generator has a closed magnetic circuit through the coils, and the permanent magnet dynamo has open magnetic circuit through the coils.

The Permanent Magnet Dynamo

I would like to begin this topic at this point by describing my permanent magnet dynamo machine.

I designed this machine to be completely interchangeable into many different motor generator combinations. These combinations involve different number of magnetic poles and different number of interchangeable coil poles in the same machine, two versions are possible, one with isolated coils and another with the coils that share a common core fig. 16.

We can change the magnetically balancing effect (*holding force*) by changing the number of coil poles or (*interference disc fins*) in relation to the magnetic poles. This turns the machine into a multipurpose, multiphase, variable output, and variable frequency ac dc permanent magnet motor generator system. I first designed this unique multi purpose dynamo in 1987 after I built my third Interference Disc generator.

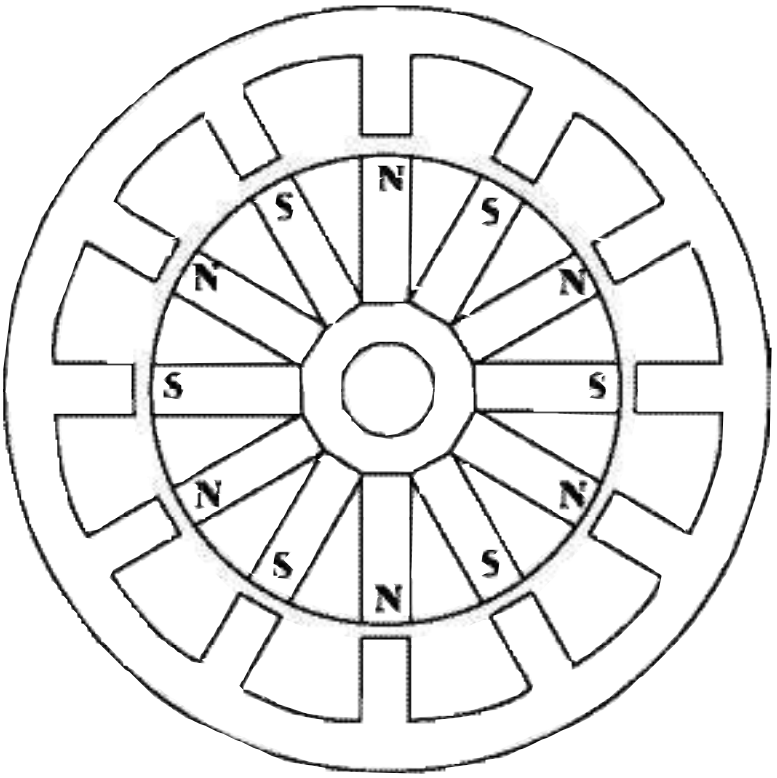

Fig. 16

Dynamo description:

Rotor:

It is well known that a bar magnet has its magnetic field concentrated at the N and S pole ends, and the half way line between the poles of a magnet is the neutral zone, this is the region where the magnetic field is canceled or neutralized. The *ferrous* keeper ring I designed for this rotor is mounted near the axle and it has machined flat decks so the magnets attach flush to the deck of the

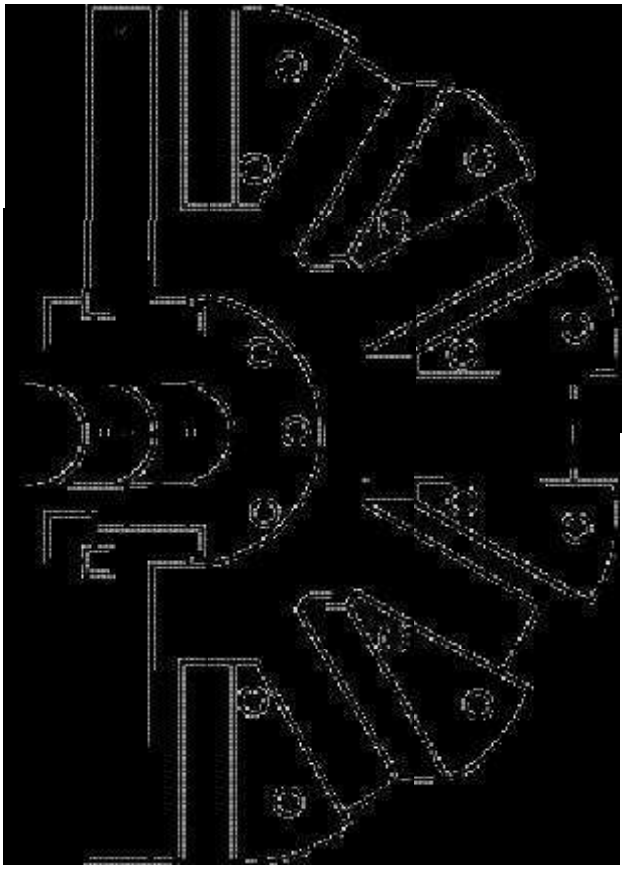

Fig. 17

keeper ring. Because of this feature, flux leakage is reduced at the keeper ring and the magnetic field concentrates at the rotor poles. With the poles of the magnet positioned near the axle and attached to the keeper ring in the rotor, the magnetic field that was there is now forced to add magnetic field density to the outer magnetic poles on the rotor rim. The density of the magnetic field at the poles is now greatly increased which makes a very powerful small size rotor. The *ferrous* inner keeper ring (*active iron*) that is installed inside this rotor design, is also the *neutral zone* of the magnetic field when viewing all the combined permanent magnets in the rotor. Shown is a cut away view diagram of the rotor, fig. 17.

I utilize rare earth rectangular shape neodymium grade 35 bar magnets with the dimensions of 3" long and 1"x1" on the end poles. There are 12 bar magnets mounted 30 degrees apart in NSNS configuration, and the bar magnets are attached to a precision machined inner keeper ring which makes the active iron the region of the middle of the magnetic field (the neutral zone). Another way to view this is to imagine two 3" long bar magnets attached together, you now have a 6" long magnet. Bend this magnet in half and install iron at the U and it now becomes a horseshoe magnet with two 3" long pole ends. It's a powerful rotor design in the fact that each of the 3" long bar magnetic poles has the field strength of a 6" long bar magnet. More poles on the rotor will allow for higher frequency ac generation at lower rpms, twelve magnetic poles on each rotor is shown in fig. 18, 19.

Fig. 18

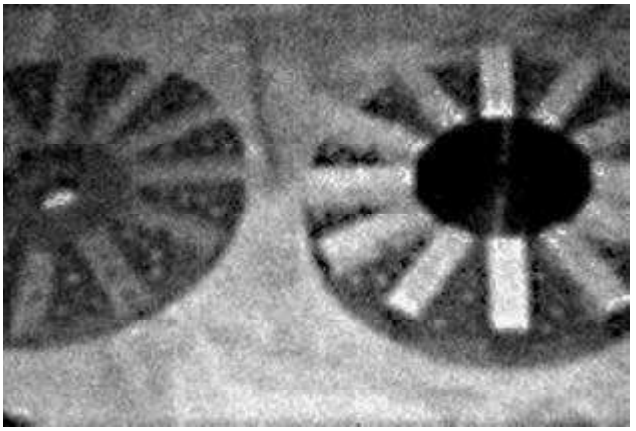

Fig. 19

The drawing in fig. 20 and picture in fig. 21, shows twelve magnet poles in each rotor in relation to the position of the coils. Ten *amorphous* cores are shown mounted around each of three rotors before they were wound with magnet wire fig. 21. The machine I have constructed houses a total of three rotors side

by side that are mounted 10 degrees apart in relation to their *magnetic poles*, each rotor has twelve magnets installed for a total of 36 magnetic poles shown in fig. 20. This dynamo concept can be constructed to any size with unlimited numbers of rotors and coil combinations to fit any power requirements.

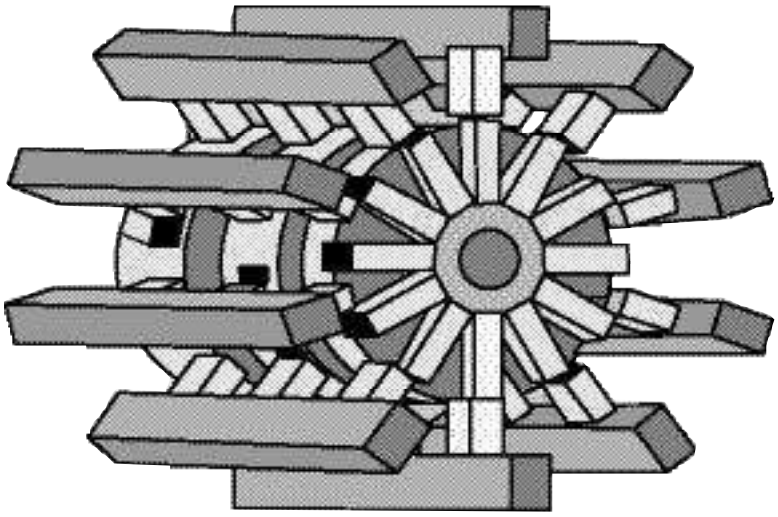

Fig. 20

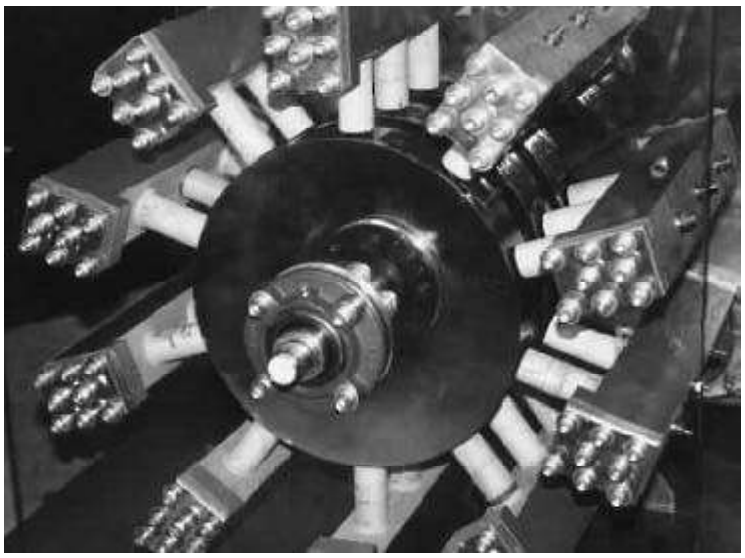

Fig. 21

It is well known that a magnet exerts a force of attraction to iron bringing them closer together, after they have come together, they are in their **static position**. A force must be exerted to either the magnet or the iron in order to pull the magnet and the iron apart, removing them from their static position. The term **static position** is used to describe the point when the magnet and the iron bar are at their nearest point.

As in the Interference Disc Generator, this Permanent Magnet Dynamo I am describing also uses an internal magnetic balancing effect which reduces startup torque on the rotor.

In this system, one set of magnets is in their static position in relation to the coils, such as the impulse coils. Another set of magnets on one side of the rotor is not in the static position, and there is another set of magnets that is not in its static position on the opposite side. One side is half in to the coils, and the other side is half out the coils, allowing the rotor to have minimal start up torque in turning the rotor. The magnets function in two jobs, the first with its velocity is to cause induction into the transformer coils producing ac power.

The second function, is the opposite pair magnetic fields on the rotor balancing each magnet out of their static position in relation to the coil positions at any given time, they cancel their holding force which puts the rotor at equilibrium. This reduces the amount of start up energy required to rotate the rotor resulting in higher efficiency. It allows the rotor and or multiple rotors to turn easily and efficiently despite the inherent powerful holding force of the rare earth neodymium magnets. With the three rotor machine configuration, I have connected 6 impulse coils in three phase to function as the motor impulse circuits with a hall effect brushless motor controller fig. 22.

Star wound three phase motor impulse coils.

Fig. 22
Star wound
three phase motor impulse coils

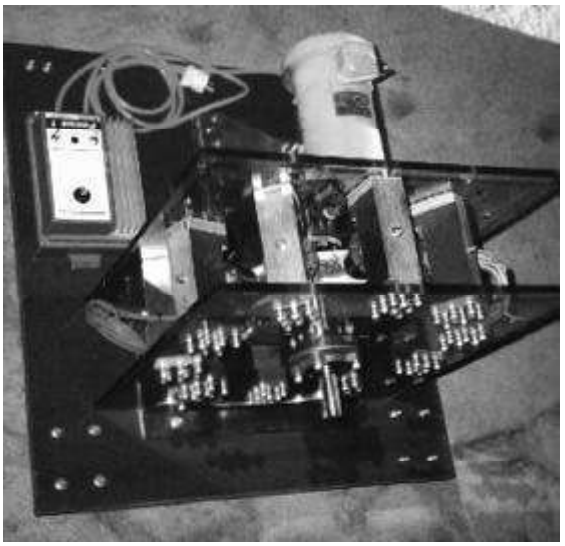

Fig. 23

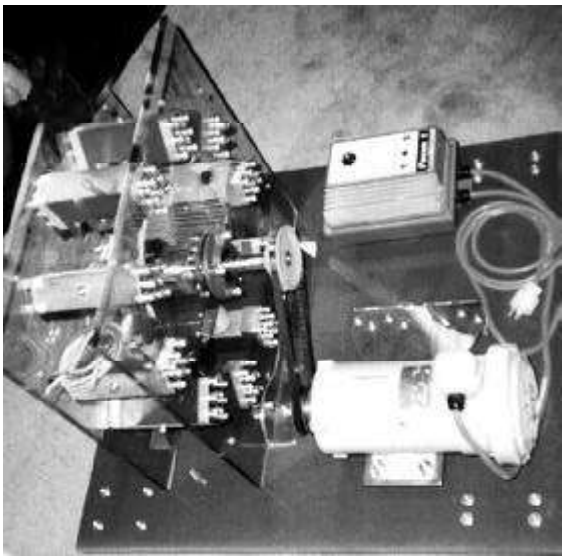

Fig. 24

Two more pictures of the one rotor dynamo option are shown with a 1hp dc motor turning the rotor with an 800 watt load on the coils, six 100 watt AC light bulbs, and two 100 watt 12 volt DC light bulbs, Fig. 25, 25a.

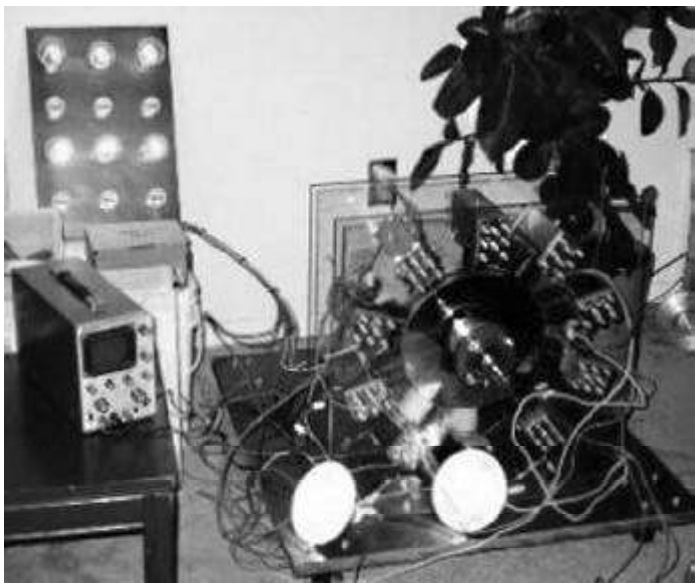

Fig. 25

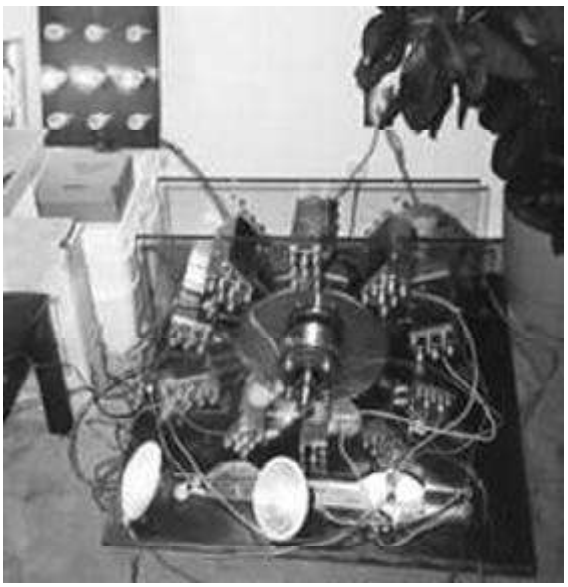

Fig. 25a

The efficiencies of this dynamo are so far inconclusive with regards to producing an endless self running machine. Our research is continuing to improve the efficiency by eliminating all conventional type ac and dc motors from this dynamo, and incorporating high voltage dc impulses of very short time duration's as Ed Gray did with his technology years ago. However, a description of my early self running attempts is included near the end of this dynamo report. These tests have manifested an abundance of heat in the 24 volt dc drive motor.

Another picture of the three-rotor dynamo configuration is shown with 12 regenerating ac to dc coils, and with the motor impulse coils removed fig. 26.

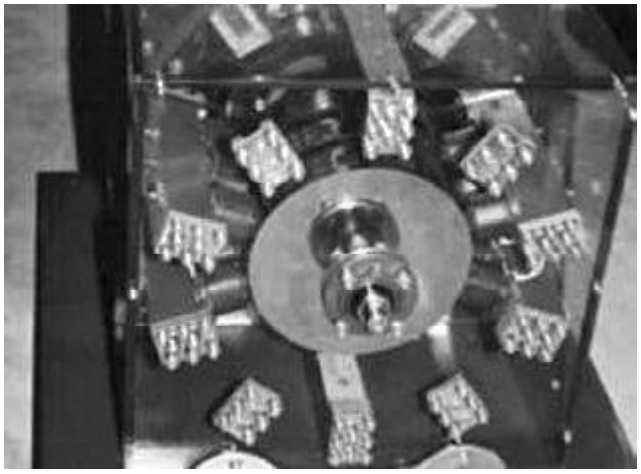

Fig. 26

Fig. 26a

Another close up of the regenerating coils and three phase motor impulse coils is shown on the dynamo fig. 27.

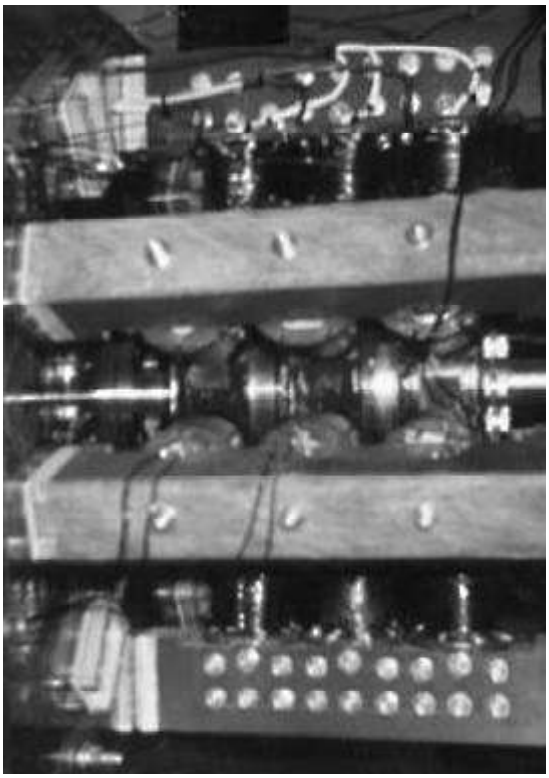

Fig. 27

Tests to produce an abundance of heat

I have testing the machine so as the output coils are connected to regenerate a 12 volt battery as the motor is turning the rotors. I used a bran new conventional permanent magnet 1/4 hp 24 volt dc motor that is running on 12 volts to turn the 110 pound 3 balanced rotors, and or the 35 pound 1 balanced rotor version.

The regenerating output coils produce AC to DC power with no noticeable ripple on the scope. The generated direct current from the coils is connected to go back into the battery, in which the motor uses to produce the torque needed to rotate the rotor. As this happens, the regenerated dc power from the coils is again going back into the battery first, and then to the motor. The result is that the battery supplies less power to the motor when the regenerating DC current is going into the battery. The motor takes on a load from two sources, one is from free wheeling the rotor with out loading or drawing current from the coils, and the other is the load induced on the motor when the coils are loaded to produce current.

The dc permanent magnet motor has shown that during one of many switch mode tests, it consumes 15 amps at 12 volts from the battery while a chosen number of regenerating coils supply ? the amount of current going back to the battery. The battery supplies 50% of the amps and the regenerating coils supply the other 50% amps. This effect can be changed depending on how many open isolated regenerating banks of coils are activated and loaded.

This test shows a 15 amp draw the motor while it is turning the rotors under load while regenerating current from the coils. It may be they balance each other and both battery and coils supply 7.5 amps each that make the total 15 amps draw on the motor. This accounts for the 15 amps total load that is shown on the dc drive motor. It produces an excessively large amount of heat in the dc motor that is useable output energy. On a larger scale the heat generated in a given motor can be enormous. More accurate measurements are needed to determine the true energy in verses energy out.

However, this electric heat pump effect can be altered to produce more or less heat depending on the size and type of the drive motor, and the amount of regenerating coils that are placed under load. Cooling tubes wound around the motor with water flowing through them is a way to pull the heat out for useful applications. Hot water from the drive motor and electric power from the coils at the same time.

After running the machine, the amorphous regenerating coils remain cool to the touch where as the conventional dc motor gets very hot with higher amps going through it. The machine also has a longer running time when the coils are regenerating the battery, as compared to running an outside equal load with the same amp draw, in that case the battery drains much faster.

This sheds light with the observation of high heat build up in the motor side (less efficient side) of the circuit while being cooler on the generator side (amorphous side) of the circuit. After hours of run time the battery begins to drain, when this happens, the battery begins to show tangible temperature changes from one side of the battery to the other. The whole negative side of the battery remains cool to the touch (temperature drop), while the whole positive side of the battery gets warmer to the touch (temperature rise). The effect is repeatable and only happens when the regenerating coils are connected to charge the battery as it is running. It may be approximately 20 degrees difference in temperature, depending on how many regenerating coils are activated sending its current to the battery. There must be exothermic reactions and endothermic reactions going on inside the battery motor generator combination that is causing this temperature difference. The load and heat generated can be changed the on the motor from the flick of a switch that activates and loads the output coils, which in turn dumps it's energy back into the battery pack or outside load. The efficiency ratio of the machine changes depending on how many and which banks of regenerating coils are activated, which again also effects the temperature difference manifesting on each side of the battery, motor, and amorphous coils.

Other tests

An Automotion dc brushless 3 phase motor controller with hall sensors was used to test the machine in fig. 26a. Tests have shown the 1hp dc motor and the three phase brushless dc motor controller will not be the answer to closing the loop on this motor generator machine. The brushless controller has a 50% duty cycle which will not manifest the electro radiant effect, and it also has a constant draw on the battery as a regular dc motor does. It is much less efficient than using very fast and short unidirectional dc impulses in the motor impulse coils to kick the rotor around. This brings the subject of Nikola Tesla's magnifying transmitter and Ed Gray's radiant energy impulse motors to light, and a possibly answer to closing the loop for a real auto-rotating machine.

Before I go further with this, I want to point out the many phase possibilities this dynamo has. If you look at the coil arrangements in the 10 coil machine, you can clearly see the coils that are in phase with each other. When a second and third rotor is installed with all the coils attached, one pair of coils on the first rotor is in phase with another pair of coils on the second rotor, and another pair of coils is in phase on the third rotor. With the ten coil to twelve magnet pole rotor assembly, the machine has five phases of isolated banks of coils. If twelve coil mounting bars are attached around the three rotors, and the three rotors are spiraled off set by 10 degrees, you will have a powerful three phase dynamo. If the rotors are not off set by 10 degrees and are lined up in phase with each other, all the coils on the machine will be in phase for a powerful single phase dynamo. The volts and or amperage can be tailored for an application by the winding of the transformer coils, and the machine produces 60hz at 600 rpm. This dynamo machine concept is also interchangeable into many other motor generator combinations, and sizes, and any volts or amps requirements, it all depends on the needs of the end user.

Cooling tubes wound around the motor with water flowing through them is a way to pull the heat out for useful applications. Hot water from the drive motor and electric power from the coils at the same time.

It is possible to have super efficiencies with this system using unidirectional hv dc impulses of very short duration's at the make brake contact at the closure of the switch.

I have acquired two of Ed Gray's radiant energy impulse motors #4 and #5 to revive an almost lost technology. I am proposing to combine a special permanent magnet dynamo with less back EMF that is tailored to produce 5kv dc under 2000rpm. This dynamo will energize a 5kv dc capacitor bank and replace Gray's 12 volt to 5kv dc converter. The energized capacitor bank will discharge through the conversion tubes in the very same manner as in Gray's original circuit, only the capacitors will get energized from the high voltage dc dynamo instead of from a battery through an inverter. This version of a high voltage dc dynamo will be connected to and turned by Ed Gray's EMA motor, a starter motor will disengage after it begins running.

There are three banks of high voltage coils that are connected 120 degrees out of phase from each other, each bank represents 12 - 100 watt coils for a total of 1200 watts per phase. All isolated coils in each phase are wired in series to produce the high voltage dc potential to energize the capacitor bank. The isolated capacitor bank will discharge their potential through its conversion tubes in 120 degree increments each time the impulse coils are at their closes point toward each other. One isolated capacitor bank will discharge through the conversion tube with it disconnected from the dc dynamo circuit. The second isolated capacitor is at this point beginning to receive its charge from the dc dynamo, while the third capacitor phase is fully energized just before the switching circuit disconnects it from the dc dynamo for it discharge phase. This fully aligns all the isolated 3 coil phases in this permanent magnet dynamo system to the 120 degree three phase radiant energy impulse system of Ed Gray's EMA motor #5.

The plan is to eliminate all the batteries and converter and use a rotating high voltage dc dynamo in its place. Nikola Tesla used high voltage dc dynamos with capacitors as part of his magnifying transmitter to produce radiant electricity. So it seems logical to do the same thing, merging Ed Gray's radiant energy motor and our version of a high voltage dc permanent magnet dynamo. Could it regenerate a car, or power a home, and or a factory?

Shown below are pictures of Ed Gray's motors in fig 28, 29.

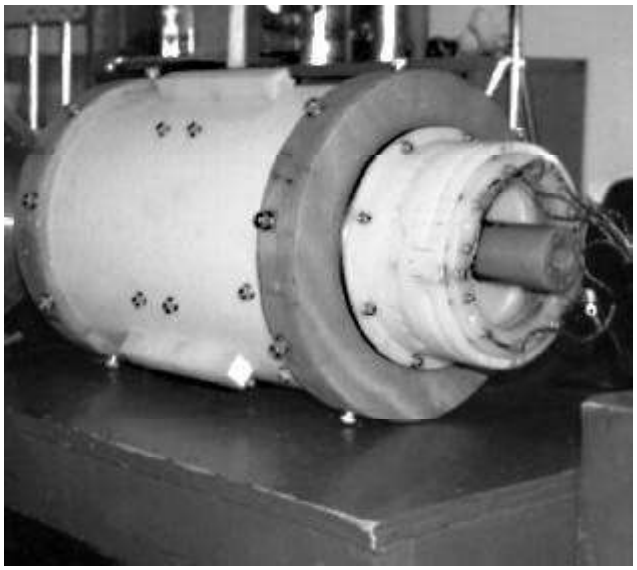

Fig. 28

Fig. 29

I would like to acknowledge two friends of mine who have helped make the Interference Disc machine possible, Bud Johnson 1986 shown in fig. 30 and the late Dr. Carl Reich shown 1987 in fig. 31. I would also like to acknowledge Wilbert Griffith and Brian & Rose Langan for their contribution in helping us make these projects possible, and there are others who wish to remain anonymous. Bud Johnson also an inventor, was one of the first people who I met after relocating to Alberta from the NWT, he made arrangements for us to construct the first disc machine in a machine shop.

Fig. 30
Bud Johnson

Fig.31
Dr. Carl Reich

Dr. Carl Reich was a pioneer in the alternate medical field and he published a book along with Robert R. Barefoot called "The Calcium Factor", copyright 1992. Through Carl's dedication and hard work with alternate health and energy, Dr. Carl Reich contributions have also helped made the Interference Disc machine and our Permanent Magnet Dynamo possible.

I also would like to thank my wife Jan Francoeur for being part of making this research possible, she has spent countless hours to prepare this report and assist in the reconstruction of these machines.

The test results and hypothesis I have written are not complete, and the research and development of the described magnetic energy machines is on going, and as such, the potential and performance and true efficiencies of these machines are still yet to be determined. This author knows that the aether is real and free energy systems are possible, and I will continue to work until I have completed the integration of Ed Gray's radiant energy motors with our larger version dc dynamo machine. When this happens, a new round of testing will begin with our attempts to run the two machines together in closed loop regenerating mode.

I hope I explained these energy machines in a way that you all can understand, and more information will be released as progress is made. ***You may find this information useful with your quest to be energy independent. However, if you profit from any of my ideas I have described in this writing, then in all fairness, please remember to reward the inventor so research and development can continue.***

This is my gift to humanity.

Interesting Information

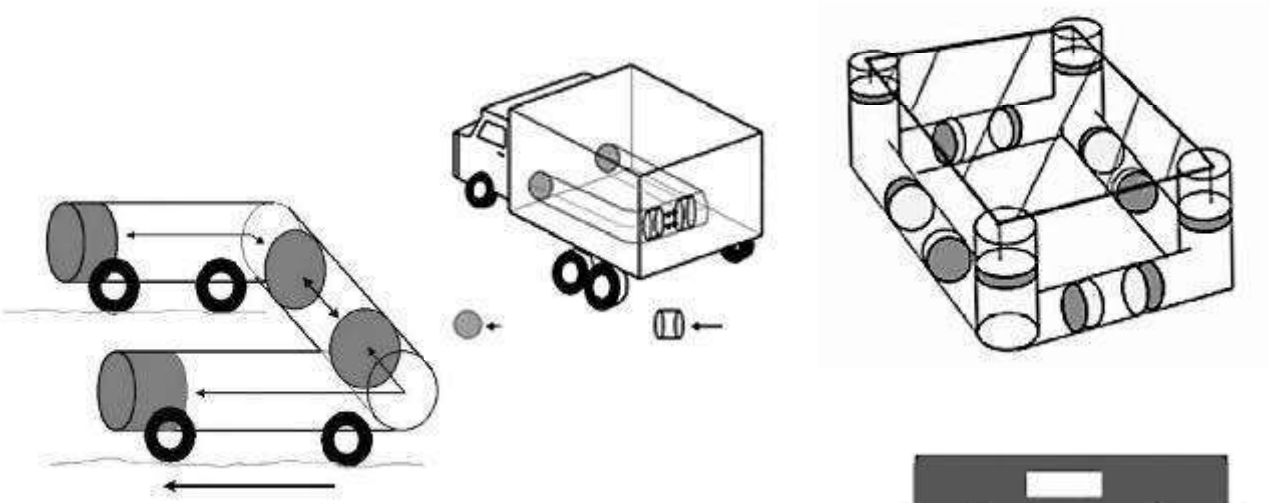

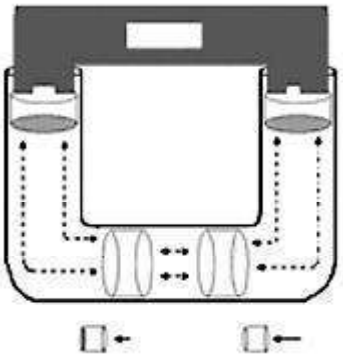

New Propulsion Letter
from Paul Toomer <jorjencar@leeds322.fsnet.co.uk>

Please take a look at this new web site on how to challenge Newton's third law of motion at

http://magnetic.propulsion.mysite.freeserve.com

A NEW PARADIGM FOR TIME

EVIDENCE FROM EMPIRICAL AND ESOTERIC SOURCES

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The author of this article presents an experimental approach to the teleportation problem and time pace control and space regularity questions.

Part I of II

ABSTRACT

The following essay seeks to establish awareness, through a far-ranging careful examination of various empirically documented anomalous research results in the field of new energy, the long-suspected evidence provided by associated key legendary secret government project work in the USA and former USSR, maverick new theoretical models in foundational physics for elementary particles/fundamental electromagnetic wave-field structures, as well as remarkably corroborative related information from esoteric (psychically channeled) sources, of the necessity for the development of a new paradigm for mass, energy and especially time. After having been guided through this process, the reader will hopefully be motivated to acknowledge the importance of this imperative for a new understanding of the workings of nature, as well as gain hints for the associated future development of new viable sustainable energy sources and related technologies.

Introduction

When we come to examine the annals of physics over the past century, we find them replete with several competing core theories of the physical world, each attempting to demonstrate a unified conception of space, time, energy and matter. Notable among these, the most successful and formally canonized in academia, are special and general relativity, and quantum theory, the latter of which includes quantum electrodynamics and quantum chromodynamics as recent offshoots.

However, even these fundamental theories have fallen short in achieving this coveted goal, due to many reasons, not the least of which is their failure to account for the anomalous but substantial documented evidence continually presented over the years by new energy research and other related empirical evidence considered outside mainstream science. In this author's opinion, these weaknesses in current physics and its relative ignorance and/or selective omission of the findings of non-orthodox scientific research, stem primarily from an ill-conceived institutionalized conception of **time**, as an immutable linear flow against which everything involving **change** can be measured. This "relational" concept of time treats it as a specific passive property of physical systems and changes happening to them. It is a one-dimensional continuous and homogeneous entity geometrically describing the property of duration. This antiquated relational view of time is abstracted from our unique prejudiced viewpoint as sentient beings whose particular point of waking conscious focus is this camouflage physical reality, which is apprehended through the limitations circumscribed by the physical senses.

Accordingly, modern physics is built on the basis of this relational conception of time. However, the use of this conception has not

so far resulted in resolving all the problems associated with time. Moreover, so far even an essential definition of time has not been formulated in physics, there are only operational definitions indicating different methods of measuring time intervals.

In contrast, the "substantial" conception of time, advanced in this paper, implies that time is an independent phenomenon of nature existing side by side with matter and physical fields, whose active essence can and does affect objects and processes occurring in the universe. Moreover, the following dissertation argues, by positing that active substantial **change** is the basic concept and relational **time** is its derivative, that those objects and processes can also have a reverse action on time.

Accordingly, we will attempt to show, through a wide-ranging examination of new energy research and other information, the necessity for the establishment of a fluidic, elastic, field nature for true active time which is malleable; one in which even the local pace of time, and mass and energy content can be influenced artificially by intelligent technological control, or naturally by conscious intent, or by a combination of these two methods. To help motivate the reader's awareness for this imperative, we will also examine several esoterically-based sources from key selected psychically channeled transcripts. These will be taken from the following sources: unpublished comments by Jane Roberts on an altered state of consciousness[1] (indicated in this manuscript by J.R.), or published transcripts from **The Seth Material** and The **"Unknown" Reality** (indicated in the manuscript by UR)[2], published chronicles from the entity Kryon, channeled by Lee Carroll [3], and concepts from Wilbert Smith's legendary discourse: **The New Science** (NS) [4]. For easier reference, all psychically channeled transcripts will appear in italics, with my additional explanatory comments in regular type within parentheses.

Granted, our unique investigative foray, ranging as it does from the concrete arena of knowledge represented by the cutting edge of visionary science to the intangible arcane realms bordering on the spiritual, will of necessity lack the exacting logic of scientific rigor.

Nevertheless, we hope to provide, through just such a unique eclectic format, the beginnings of a possible fresh understanding of the workings of nature and perhaps ultimately furnish a conceptual basis for extending the structure of current physical theory to compatibly encompass the elements of a unified framework of physics and metaphysics.

As "unscientific" as this proposed venture may appear, especially to the contemporary physicist or theoretician, we unabashedly press on, secure in the belief that the currently perceived "mutually exclusive" bodies of knowledge defined through psychic means and that of orthodox physics are more closely linked than is currently suspected. Indeed, it will be demonstrated that that some of the psychically defined data bears a striking resemblance to the tenets of present empirical knowledge.

New Research

Theories Indicate Necessity for Novel Time Concept

A body of work which postulates a fluid-field substantial nature for time, is the esoterically-based book written by Wilbert Smith in the early sixties, **The New Science**. Here, Smith outlined a unified theory of all physical interaction by positing that an active mass-free field energy he termed the *tempic field* exists, and is the parent field structure out of which our passive relational linear clock time emerges. To be sure, this book and its specific format of exposition has its weaknesses, not the least of which is a writing style which taxes one's comprehension to the limit. All researchers who have attempted to connect Smith's knowledge with the frontiers of current scientific knowledge, new energy research, etc., have been frustrated by his introduction of terms which may or not have the same meaning as the corresponding terms in mathematical science. This practice

causes many passages to appear so vague as to cause total bewilderment on the part of the reader.

> *...the establishment of a fluidic, elastic, field nature for true active time which is malleable; one in which even the local pace of time, and mass and energy content can be influenced artificially by intelligent technological control, or naturally by conscious intent...*

In coming to investigate the source of Smith's theory 25 years ago, I came into contact with Kenneth Killick of Canada. Killick was the individual who served as the original mentor and for a time a colleague of Smith in the mid-1950's. Smith, whose background was in electrical engineering, found it very difficult to accept or understand the philosophical overtones of Killick's thought. Consequently, he resorted to the use of psychic mediums to try to verify the information provided to him by Killick. This is the origin of Smith's association with discarnate entities known to those familiar with his work as "the boys topside". Thus Smith's subsequent writings promote such confusion perhaps because he only obtained a partial understanding of these cosmic ideas, and he opted to writing in a kind of code basically to try to hide his own confusion. Through my own association with Ken, I discovered that The New Science is able to be put into reference with known facts once the spiritual-philosophical elements of Killick's teachings are duly integrated. When this is done, "Wib" Smith's book can teach much and can become a cornerstone to new energy science. Otherwise, it remains at best, a fragmentary enigma.

The work by Smith and Killick is pertinent to the theme of the present paper, since they both showed through experimentation with a special caduceus-wound coil, that so-called relativistic parameters of mass and gravity, energy, and time-flow, can be altered through intelligent artificial control. Adequate delving into some of the elements of these theories will enable us to glean new insight for transforming the current paradigm of time. Further details on Ken's so-called tachion energy theory can be found in this author's earlier expositions on this subject in issues of **Energy Unlimited** (1978-1982)[5].

Smith's main error is in postulating a fundamental "spin" dynamics based upon conventional continuous rotation. As Killick points out, such a concept of spin on the microscopic level, precludes any possibility of true evolutionary change, in the cosmic sense.

Also, as we shall see presently, the continuous spin concept obviates expression by anything in the universe, of its personal moral responsibility. However, with tachion energy theory intact and untrammeled, the impersonal dualistic concept of interaction between two polar entities, such as is expressed not only in ordinary classical Newtonian physics, but its 20th century successors, relativity and quantum theory, is supplanted with the omnipresent workings of a **trinity** at all levels and manifestations of reality.

Indeed, the fundamental tachion field (mass-free) energy has **three** components: two polar opposite entities (a positive "charge" and a negative "charge"), and the ability for these two to be in what is called "static-dynamic balance". The static-dynamic balance completes the trinity.

A simple physical macroscopic manifestation of static-dynamic balance can be seen in two people arm wrestling. As the energy of one participant is brought to bear against that of the other, we will see a vibration or oscillation once a balance of their energies is obtained. As more effort is expended, the vibrations will increase in frequency and decrease in amplitude. At this point we will see a static state relative to the two arms; neither causes loss of arm position of the other. But simultaneously we also have a dynamic situation in the rapid oscillation which

maintains, and is in turn sustained by the muscular energy which produces the static state of the arms. Both states mutually support each other's existence. The two component entities (the arms) resonate together, but without losing their own identity.

The implications of this last statement, missing in current physical theory, is unique to the system of tachion energy. We will see in the following that the dynamic functioning of these sub-atomic tachions is such that by their inherent ability to manipulate space and the time-frame of matter through static-dynamic balance, they do not harm anything else in their environment, nor are they affected (forced to lose their own identity) by the ambient environment. Accordingly, inertial mass is not an inherent component of tachion energy, but is a derivative of certain tachion field modes.

We spoke earlier of tachion "charge". We keep the word in quotes to underscore that this is not to be equated to electrical charge, but merely signifies two polar energy states of the primordial ground-form, out of which all known physical forces come to be manifest. These tachion energy states can be defined in terms of "rotational" motion. Again "rotation" must also be placed in quotes as it does not signify the common idea of continuous spinning. Such a concept was suggested above in connection with evolutionary progress in its cosmic interpretation.

The tachion-pair could be described as executing a "back-and-forth" ratcheting movement. The tachion-pairs are analogous to the ends of a drum majorette's baton. But unlike the twirling motion of the baton, the tachion-pairs do not demonstrate the classic macroscopic continuous spin motion, but oscillate in a 3-component "clocking" action.

In Fig. 1 we have drawn a circle and have divided it into three 120 degree arcs. The first motion in the tachion cycle is an arc from the 0^0 -360^0 location, to the 240 degree position. This movement is stated philosophically as the question, "Can I go?" In the second phase it swings back from the 240 degree position to the 120 degree point, and then returns to the 240 degree position. This graphically represents an analysis of the first question, and can be phrased as the "Let me think" component. Finally, then it proceeds forward another 240 degrees taking it past the 360 degree point to 120 degrees. This last stage is the action motivated from the analysis in stage two, and is entitled, "Yes I can". In this activity it will be observed that all path lengths are 240 degrees.

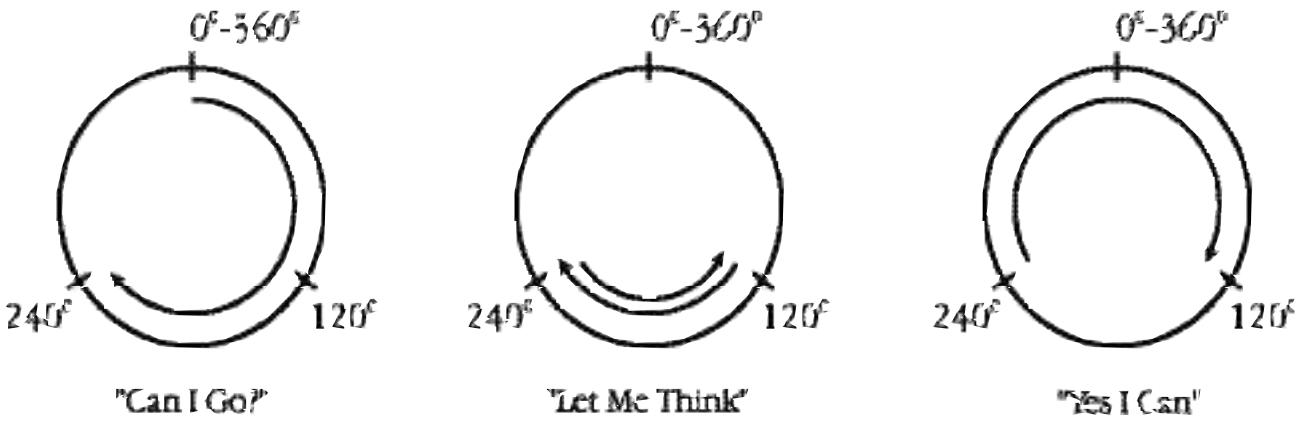

Fig.1
The 3-Component Tachion Movement

However, as representative of true evolutionary progress, the tachion-pair does not remain confined to the plane in its 3-phase cycle. After each "Let me think" stage, the entire pair unit could be considered to advance "upward", perpendicular to its plane of "rotation". The

combined motions can be viewed as an elevation up an inclined ramp, screw-fashion (Fig. 2).

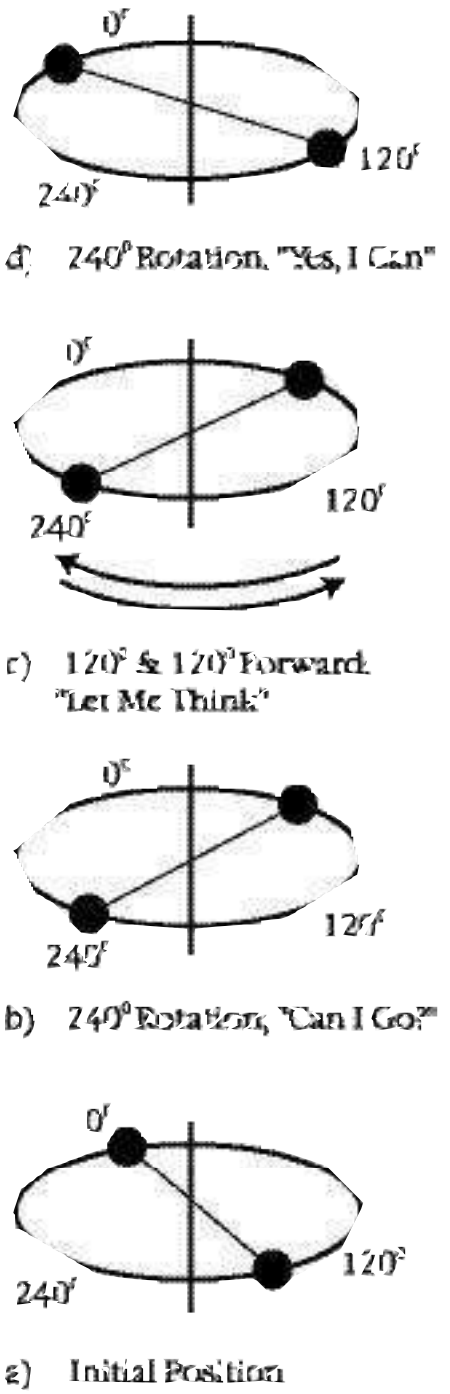

Fig.2
Tachion "Ratcheting"

Thus, while they clock themselves backwards in the plane, they never go back to where they were originally but only seem to do so from the point of view of an observer in the plane. This entire activity can be visualized as a diametrically opposed pair "rotating" in a plane, but there must still be considered an upward ratcheting movement. They execute the clocking motion simply because they adhere to the three principles of observation, analysis and motivation. A meaningful application of this idea to the structure of physics would eliminate the necessity for a totally impersonal type of interaction governed solely by force. Unlike all current theories of elementary particles, the tachion-pair, by its unique activity, thus expresses a personal moral responsibility. So this elemental energy of the universe never goes where it is not wanted, but only where it will not disturb its immediate environment.

The topological structure of each tachion in the pair is also significant in regards to this "ethical" modus operandi. First, tachions in their primordial state are massless, toroidal shaped fields which always occur in pairs. Like toroids, tachions will singly exhibit three motional degrees of freedom, to wit;

1. rotation around its major axis.

2. inner (P), or outer (N) rotation about its cross-sectional (poloidal) axis.

3. expansion and contraction of the field (each toroid pulsates radially about its cross-sectional axis).

As a pair-unit, the combined motions will give rise to the following possible orientations: two identical (N) rotations; (N) rotation - (P) rotation; two identical (P) rotations (Fig. 3).

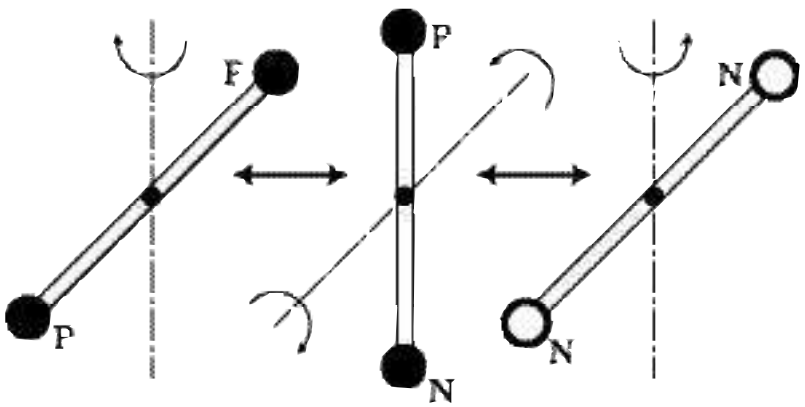

Fig.3
The Three Tachion Modes

The dual (P) or (N) rotations will always lie in the same plane, whereas in the "mixed" rotation mode, the orientations of the tachions will be mutually perpendicular. In the pair unit, the energy will shuttle

back and forth between the tachions by virtue of their harmonious expansion and contraction. The contraction of one pair partner is immediately compensated for by an equal amount of expansion in the other. When one is fully expanded and the other completely contracted, they will reverse roles executing the second portion of the cycle. There will be two points in the clocking cycle where the tachions will share an equal amount of energy ("field equity") stage. In each cycle of a tachion-pair the field equity stage is passed twice, a fact which is significant when topology of the field dynamics is considered (see [5]). Now, looking at the field geometry for the tachion-pair unit at the two field equity stages of the cycle, we observe that the two geometries are not identical but are *mirror images* of one another via a non-orientable field structure. See Fig. 5, which shows the isomorphism between the dynamics on a Moebius band (a non-orientable topological structure) and the tachion pair clocking cycle.

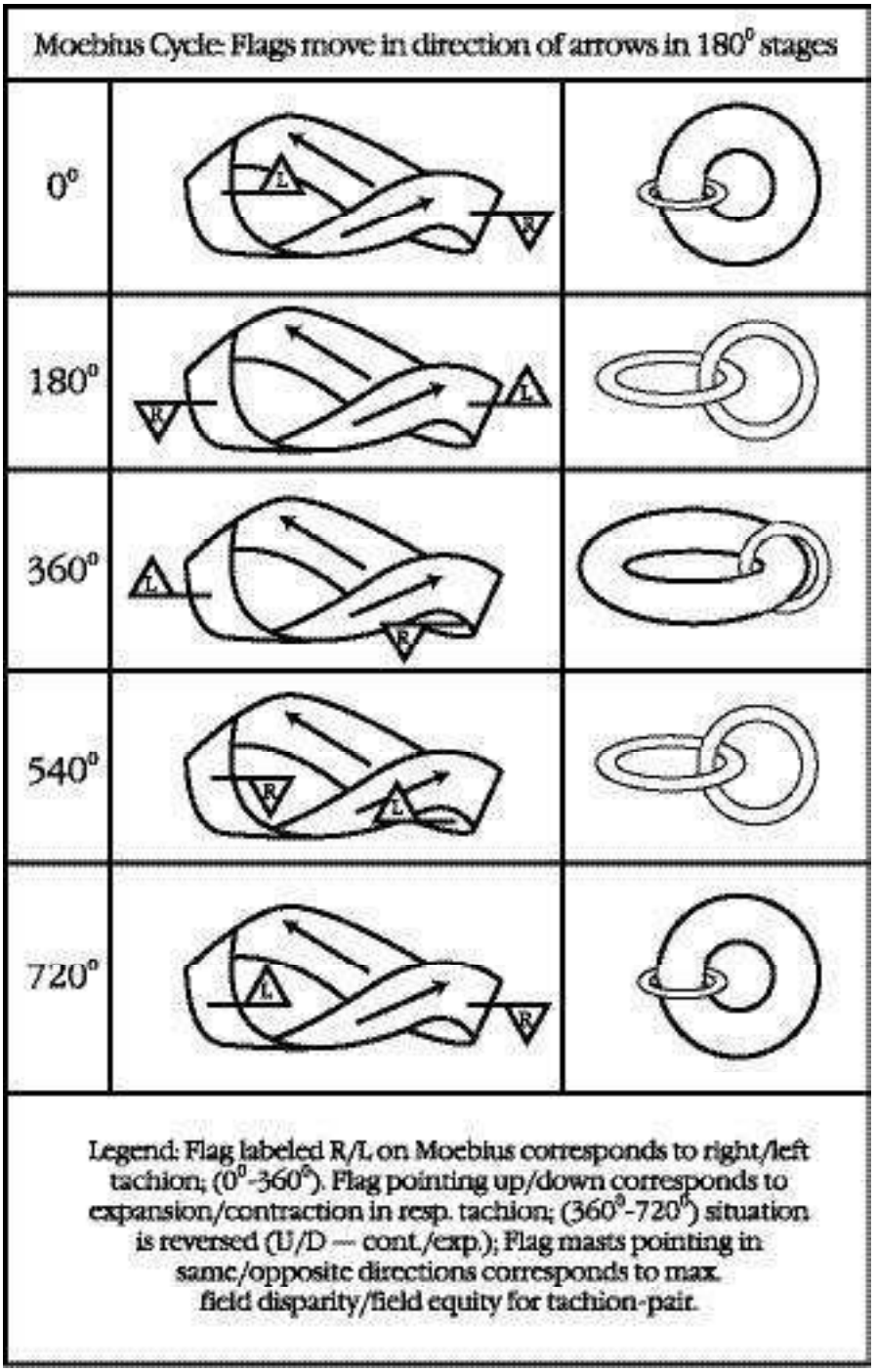

Fig.5

This suggests the remarkable idea that the space time points that the pairs generate are not, as commonly assumed, identical, static, and bereft of intrinsic character, but exhibit *enantiomorphic* topologies, which by virtue of their mirrored relationship exert upon one another a potential for dynamic interaction. For now we present a second diagram to illustrate the three pair energy modes: N-N, N-P, P-P, as well as one sequence of oscillation of the N-P pair (Fig. 4).

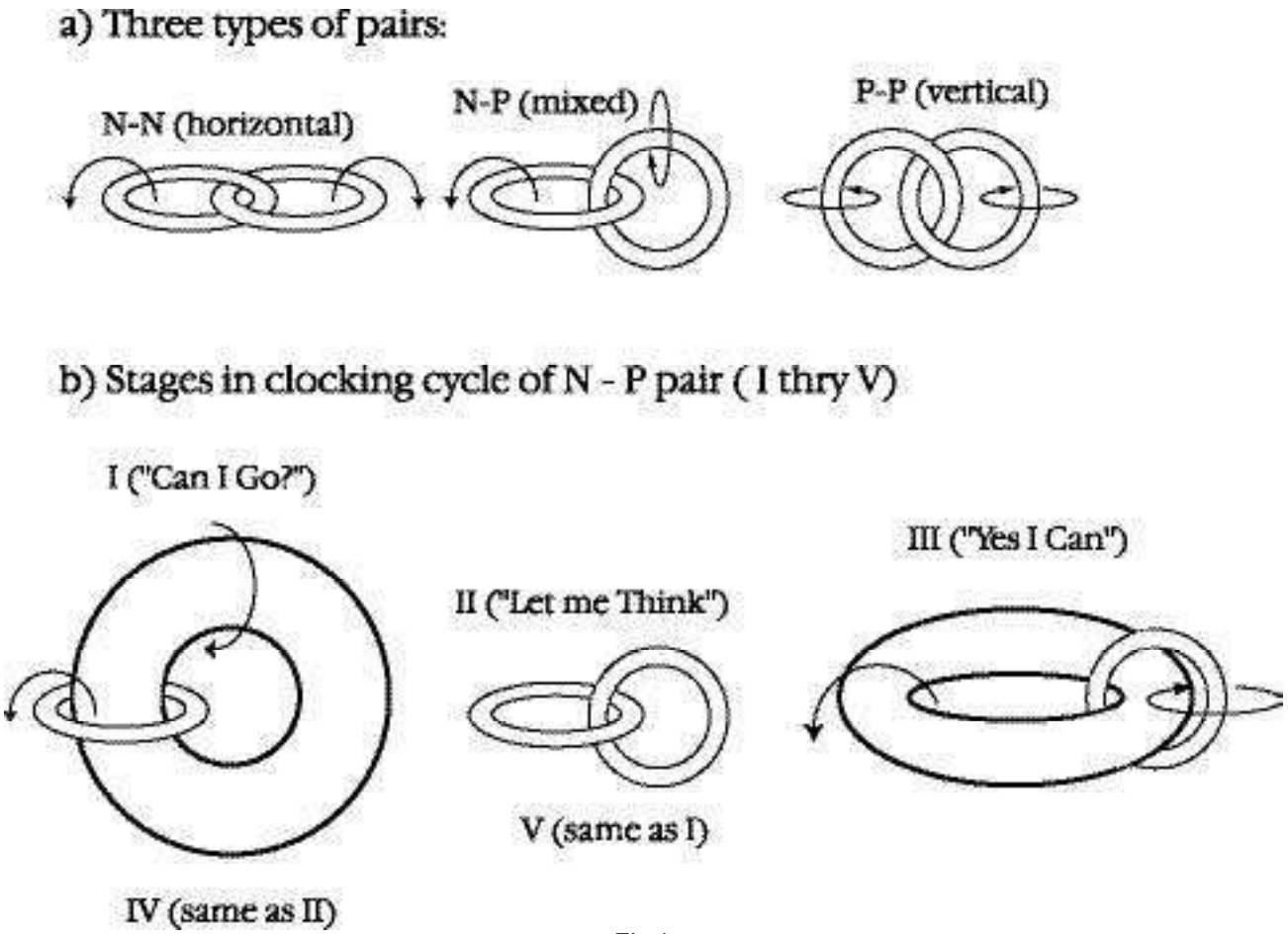

Fig.4

In this figure we note a unique trinity of field operation: two stages of maximum field disparity (I and III) connected by the intermediate condition of field equity (II). Upon postulating the additional requirement that the pair will create a new space-time location every time the field equity state is reached, we see that with each cycle the unit will not return to its original state with respect to the environment, but will advance to new evolutionary states with each pulsation. In accordance with the above comments, the tachion-pair unit "ascends" the evolutionary spiral via this unique action we have termed "clocking" motion. In acccordance with the description in Fig. 4A, in Fig. 4B, stage I represents "Can I go?", stage II represents "Let me think", and stage III represents "Yes I can".

Now, in this regard, the previous analogy of the tachion-pair as likened to the ends of a baton, where the baton rises and falls as it rotates, is quite apt. However, unlike the ends of the baton tachions are not rigidly connected but possess much freedom of movement outlined above. On the other hand, much like the baton ends, they are mutually supportive of each other's activity and requirements, never seeking to overpower, or to be eclipsed by the identity of their partner. In this manner they exhibit personal moral responsibility, as we have previously stated. By their mutual

harmonious action tachion-pairs will progress in a true evolutionary fashion, while never harming anything else in the universe by their action.

> *...the dynamic functioning of these sub-atomic tachions is such that by their inherent ability to manipulate space and the time-frame of matter through static-dynamic balance, they do not harm anything else in their environment...*

Now, the above is an inherent characteristic of tachion-pairs as long as they go about their business individually- that is, in their pre-physical state. Now, when the three fundamental tachion-pair energy modes described above exhibit a slow clocking frequency, there is opportunity for them to join together whereupon we begin to see matter being formed. The element of mass, or inertia is provided by the binding activity of the (N-P) mode, which is a function of the slow oscillation of the pair unit. Besides the clocking frequency, the factor of inertial mass or density of physical substance is also dependent upon the amount of separation between the two pair components in each individual sub-atomic tachion-pair unit. In general, the denser or more massive an object is, the slower its microscopic tachions will clock, and the farther apart will be the individual toroid components. This is a classic push-pull situation, i.e., there is a key inverse static-dynamic balance relationship between tachion-pair pulsation frequency and their area of operation (density of field). The rest mass that any physical substance displays to macroscopic observation, is thus a direct function of the amount of energy supplied by the master field to sustain the oscillation of the pair-unit. Thus, a primary feature of tachion dynamics is the following: if we change the energy, we must expect to observe a corresponding change in the manifestation of the mass, and vice versa. Consequently, in tachion dynamics there is a built-in interchangeability of energy and mass, an idea which concurs with similar conclusions in Einsteinean relativity (notably, $E = mc^2$).

But here is where tachion theory and relativity part company. We have seen that our postulated "clocking" pulsation of the pair is the factor, which determines both space and time. Both **space** (area of pair operation), and **time** (frequency of pulsation) are mutually dependent on what **we shall call the master field of thought and intention, which determines the clocking frequency**. From the dynamic influence of the master field arises subsidiary conditions of time and space which are truly "fluid" qualities of tachion operation. This is indeed consonant with the assumptions of a proper unified field theory in which all the factors of our objective world as apprehended by the physical senses, are subsumed under the relative state of a guiding master field. Moreover, under the geometrical constructs of such a theory neither space nor time should be subservient to the other but should retain their unique qualities in a mutually supportive relationship. This is guaranteed in tachion theory under the fluid give-and-take of the pair operation. Relativity, on the other hand, despite its logical consistency, does not meet the above requirements. To his great credit Einstein recognized the need to integrate time with space in a synthesis that would retain the distinctive qualities of both. The result was a theory, which extended the classical Euclidean concept of 3-dimensional space as a kind of "cosmic container" of matter, to embrace a structure of space, which arises from the laws interrelating its material content. Thus, for instance, in his General Relativity theory gravitation became interpreted as a distortion of the spatial fabric by sources of mass-energy in a non-Euclidean framework. Unfortunately, as a foundation of his theory, Einstein mistakenly assumed a subservient role of time to space. He tried to "freeze" time down into spatial-like dimensions utilizing metric equations, which were variants of a basic form. Before a true understanding of

gravitation is developed, the rationale for applying such metrics to this end should be seriously re-appraised. In short, instead of freezing time down into a spatial dimension in order to make it fit a world ruled by nothing but gravity, we must develop a conception of space sufficiently fluid to let true time have its proper place therein.

These and other similar ideas are articulated by Andrea and Paulo Correa in their recent insightful essay on the various serious shortcomings of relativity theory. They write: "Time is not treated by relativity as distinct in nature or in quality from the set of topological locations or lengths between points. Whether in the SR (Special Relativity) form of a flat Minkowski spacetime or in the GR (General Relativity) form of a curved Riemannian spacetime, the essence in relativity lies in its treatment of time as the fourth length of a 4-dimensional space. As the actual metric of a length of time is not fixed, only the intervals being invariant, one can no longer speak of the reality of timelines or of synchronicity" [6].

In their second installment, the Correas even imply the existence of a mass-free energy, which is an integral element of the Killick tachion energy theory: "From a strict physical viewpoint, only an energeticist position can make sense. While space and time may be considered to exist outside the function of matter, independently from it, *they cannot be conceived outside the function of energy*...the field remains conceptualizable (in Einsteinean relativity) only by the pseudo-Riemannian manifold, which, on its own, fails to analytically treat the difference in dimensionality between Space and Time, fails to differentiate between them as distinct manifolds, and fails to account for them as the intrinsic properties of energy in flux".

The tachion theory is such a model that delineates the functions of time and space in terms of a basic mass-free energy substratum. Now as we have seen, since tachion dynamics pre-supposes a static-dynamic balance feature connecting frequency of the pairs (fundamental time elements) with their area of operation ("fluid" space configurations), it represents such a foundation upon which to construct such a theory which will harmoniously treat time and space on an equal footing without neutralizing the unique structural features of each. Since the decrease/increase in the clocking frequency of the tachion-pairs will result in a corresponding increase/decrease of area of operation, the local *pace of time* will also decrease/increase at that space-time location. This is due to the push-pull relationship between energy and time. The intrinsic energy of a tachion-pair will be defined to be its energy of "motion" (energy in the "convergent", pre-physical state). Thus we see that an increase/decrease in the clocking frequency also implies that the intrinsic energy of the pair will also follow suit. Consequently, the intrinsic energy available for a manifestation will increase/decrease as time pace allotted for this purpose decreases/increases. Moreover, the product of intrinsic energy and time interval will always be constant due to the perfect trade-off between both factors in the tachion clocking action. This relationship is remarkably similar to the quantitative statement of the Uncertainty Principle in quantum mechanics in the form: $E \cdot t = h$. This formula states that the product of the energy exchange of a quantum mechanical particle and the time interval required for that exchange to take place, is equal to the so-called "quantum of action", or Planck's constant.

Thus, as a concomitant of tachion dynamics, which is argued could also be the basis of electron spin geometry among other things (see [5]), *time* is made malleable; no longer continuous, or rigidly uniform as in Newtonian conceptions, or subservient to space as in Einsteinean relativity, time "flow" can go to zero, and can even reverse under the application of certain electrodynamic field configurations such as provided by the caduceus coil and other devices [5]. With tachion dynamics even the laws of causality will no longer hold. This is due to the fact that tachions have a much broader field of operation than the purely physical realm. Thus, many unusual demonstrated features relative to quantum theory, such as the principle of Indeterminacy, quantum non-

locality (EPR experiment), "entangled particles" as well as hypothesized qualities of an *aether* of space, can find their source in this microscopic non-linear electrodynamic clocking oscillation attributed to the tachions. In fact, the ultimate expression of time as well as space to our sensory perception, could be a direct function of these substratum pulsations. From this consideration there emerges a new dynamic model for **fundamental time** as a "fluid-elastic" field effect arising from the unique ratcheting oscillatory motion of tachion-pair entities. Ultimately, it will be seen that tachions may even form the structural essence of consciousness itself, thus providing the long sought-for unifying link between physics and metaphysics.

N. Kozyrev

Other Recent Russian Research Implying New Dimensions for Time

Another key researcher who postulated an active substantial role for time was the Russian astrophysicist Nikolai Kozyrev [7]. He argued that the gap between the exact (physical) sciences and the natural sciences will not vanish until the principle of causality differentiating cause and effect is placed at the basis of the exact sciences. This implies the objective directionality of time or its flow. We encounter numerous manifestations of this principle in our life and in natural science. Yet this principle is new in both mechanics and physics as a whole. The natural scientist's time is not Minkowski's geometrical time, nor is it the time of mechanics, theoretical physics, etc.

Nikolai Kozyrev argued that the gap between the exact (physical) sciences and the natural sciences will not vanish until the principle of causality differentiating cause and effect is placed at the basis of the exact sciences

As Kozyrev argued, mechanics has been using only the "geometrical" property of time, its duration size, i.e., the intervals between the events under study. Timed, these intervals acquire the same passive properties as the interval measured between two points in space. It is only this property of time that the objective sciences assumed to be existing objectively, postulating that all other time properties are subjective. However, if we want to differentiate causes and effects, in reality the *flow of time* must be a physical quantity, duly expressed mathematically and entering the equations of mechanics. The physical meaning and mathematical expression of the flow of time can be obtained from the space-time properties of causality. Thus, processes in the world occur not only in time, but also *with the aid* of time. Time flow is an active property owing to which time may act on a material system. Consequently, it is in the properties of time that the source maintaining the vital processes of the world must be sought.

From these arguments, we can also derive a fundamental property of time. Let us assume that we have changed by a certain technique the flow of time in a material system. In this process we have perhaps changed the stresses within the system and hence its energy.

However, it is impossible to change the total amount of motion of the system, i.e., to obtain a momentum equivalent to an external action. In other words, time may carry energy but no momentum. Time is a non-momentum material reality. From the above property of the flow of time, Kozyrev concluded that it follows directly that the rotation of a body may be used as a device for changing the flow of time in a system. Time flows into the system in the cause-effect direction, the rotation increases the flow, and hence the system obtains additional energy.

In attempt to verify his theories, in the 1950s, Kozyrev thus performed experiments with spinning gyroscopes and discovered, in agreement with his predictions, that the weight of the spinning system changes slightly depending upon the magnitude of the angular velocity and the direction of

rotation. Although the effect detected was not large, the nature of the arising forces could not be explained by existing theories. By applying a vibrating framework to the gyroscope, Kozyrev also found that not only does time deliver an energy, but that near the cause-effect system *time density* changes. Time is rarefied near the generator and becomes denser near the receiver. In other words, time becomes stretched by cause and compressed by effect. In addition, the variation in time intensity is in inverse ratio to the first degree of the distance. This can be seen by the following consideration: Time is expressed by rotation and hence involves planes passing through a pole of the rotating system with any orientation in space. **In the case of lines of force issuing from a pole, their density decreases in inverse ratio to the square of the distance, while the density of planes can readily be shown to decrease with the first degree of the distance.**

Kozyrev discovered another property of time when investigating irreversible processes such as crystallization of a substance, condensation, or evaporation. This influence can be effected by any irreversible process and is registered by a measuring system without any preliminary excitation, i.e., when the cause and effect positions are not separated. In other words, apart from flow and density, time seems to have another property, causal orientation, resembling in a way the polarization of light [8]. This property proves to be so variable that even the sign of the observed influences may change and hence the reciprocal cause and effect positions become reversed.

Continuing his studies on the properties of time, Kozyrev (with V.V. Nasonov) conducted astronomical observations using a receiving system of a new type. When the telescope was directed at a certain star, the special detector positioned within the telescope registered the incoming signal even if the main mirror was shielded by metal screens. This fact implied that electromagnetic waves (light) had some component that could not be shielded by metal screens. When the telescope was directed, not at the visible but at the true position of the star, the detector registered a signal that was much stronger. The registration of the true position of different stars could only be interpreted as the detection of star radiation that had velocities billions of times the velocity of light. It was concluded that the radiation from stellar bodies hence had a component, which was non-electromagnetic. Kozyrev also found that the detector measured an incoming signal when the telescope was directed at a position symmetrical to the visible portion of the star relative to its true position. This fact was interpreted as a detection of the future positions of stars [9].

From the 1960's onward, additional Russian research groups continued and expanded upon the work began by Kozyrev on the unique non-electromagnetic radiation that was apparently a concomitant of all rotating bodies, whether accompanying macroscopic spinning objects of great mass (cosmological or terrestrial), or at the quantum level exhibited by elementary particles possessing recorded anomalous spin features which were not accountable by standard theories. This emanation which was exhibited by rotating bodies was termed torsion radiation [10]. Subsequently it was learned that this unique radiation was a part of all living or inert substances. This so-called "torsion field" research was carried on mainly in secret in the former Soviet Union, and only became known to the Western nations after the fall of the Iron Curtain. Many effects attributable to alterations in time and gravity have been reported through this research. For more information on this topic the reader is directed to this author's review in reference 10 and references therein.

Part II of II

Summary of Part I

It is the intention of this multi-part dissertation to motivate an imperative for considering the eventual establishment of a more expansive paradigm for the phenomenon of time, one which views time from the "substantial" as opposed to the orthodox "relational" standpoint. The

substantial concept of time implies the existence of an **active** essence which can and does affect objects and processes occurring in the universe. Furthermore, approaching time from such a fundamental basis implies that by positing active substantial change as the ground form **prime mover** and relational time (**passive** "clock-time", or entropy changes) as its derivative, that those objects and processes can also have a **reverse** action on time.

Towards this end in Part I (hereinafter referred to as I), we considered the key research of the late astrophysicist N.A. Kozyrev who, in carefully controlled experiments which were subsequently successfully replicated, recorded phenomena which have hitherto been unexplainable by standard contemporary received knowledge- whether from the standpoints of Newtonian, Relativistic or Quantum physics. Kozyrev pointed out that only by considering time as an active essence, could these cited "anomalous" phenomena, which are virtual conundrums from the viewpoints of a relational (passive) concept of time, be duly formulated on a logical basis. Accordingly Kozyrev's associated "causal mechanics" incorporates an objective directionality of time flow, implying differentiation between "cause" and "effect". **Consequently, by applying a thermodynamically irreversible process to a physical system (example: vibration to a spinning gyroscope), the rotor in this instance would be observed to lose (or gain) a small but detectable percentage of its weight, depending upon the direction of rotation.** Moreover, in this process **linear momentum** (linear speed of rotation) is not changed, but energy is nevertheless delivered to the system by additional forces directed along the axis causing a change in **angular momentum**, and that near the cause-effect system of the irreversible process, **time density** is altered - rarefied near the generator and concentrated in proximity to the receiver. Kozyrev concluded that time is a non-momentum material reality.

Other experiments of an astrophysical nature showed that registration of the true position or future position (as opposed to visual-present-position) of different stars via the non-electromagnetic component of star radiation, demonstrated the existence of an energy essence, which was apparently instantaneous, or had a propagation velocity of at least a billion times the velocity of light. In this regard, Kozyrev opposed the conventional astrophysical paradigm, which posits energy generated/ emitted by stars is a physical consequence of thermonuclear conversion. Instead he maintained that via rotation, stars converted time essence into non-physical (or pre-physical) energy. The latter was nevertheless detectable on Earth by transduction through reflecting telescopes shielded by metal screens, of stellar radiation by a Wheatstone bridge. Hence the "impact" of time was detected by resistor electric conductivity changes (see I and references therein).

Leaving no stone unturned in our investigation, we also took up a discussion of the related Killick-Smith tachion energy model for fundamental (pre-physical) reality. Here we coined a new term- a **trinitivity** of action, which was underscored as a key feature of the operation of tachion-pair entities. Accordingly, we posit the existence of two polar topologically orthogonal toroidal fields, with the unique ability, by the mutual shuttling back-and-forth of their energies, to exist in a third auto-generated state called "static-dynamic balance". Now, since tachions are hypothesized to transfer energy instantaneously, inertial/gravitational mass is not a primordial component of tachion operation (see I). Here we see a striking similarity to the Kozyrev conception of the operation of time in interaction with a physical system - where energy changes are manifested without linear momentum alterations delivered. Likewise, the Smith book, **The New Science** (see I) treats **the hypothetical tempic field as a scalar quantity, which only has direction in relation to its distribution (or "density" change). Only through establishing what Smith termed a *tempic field* gradient does the tempic field possess vectorial nature.** Similarly,

Kozyrev viewed time like space as possessing both geometrical and physical properties. The geometric property of time is duration (its scalar component), while physically the course of time is similar to vectorial field propagation and the density of time to field intensity. Although Smith and Kozyrev apparently never were aware of each other's research, the following quote from Kozyrev reveals that they both made key profound discoveries about nature which indeed bear more than a superficial similarity: "Time density is a scalar quantity, just the one observed in the above experiments. Time density decreases with increasing separation from the process creating it. Therefore, a vector property corresponding to density gradient and tractable as time obtaining, should also be observed"[7]. However, in I we also enjoined the reader to observe caution and selectivity when attempting to separate the wheat from the chaff in Smith's book.

Accordingly, the previous ideas are substantially correct, whereas his concept of "continuous spin" of tempic field energy is basically flawed. Killick replaces this outmoded counter-productive notion with a key ratcheting motion, like the escapement of a watch, which is performed by the tachion entities composing a pair-unit. Through this unique "clocking-motion", a cycle of tachion-pair operation exhibits what could only be described as an **ethical modus operandi**, passing through the three stages of observation - reflection - action. By virtue of this 3-stage process, tachion-pairs demonstrate in their individual activity and in interaction with their environment - *personal moral responsibility*.

This is indeed an unprecedented notion which implies that a type of conscious thought process can be ascribed to tachion operation. This can be related to current notions from quantum physics, relative to quantum coherence of states - such as wave-function collapse, Indeterminacy, quantum non-locality (EPR experiment), "entangled" particles, etc. This may be an indication that in such cases, whenever the Principle of Causality is breached or at least compromised, we may be witnessing the unique effects of the inherent conscious microscopic non-linear clocking oscillation of the tachions.

Along these lines, although Kozyrev did not report observing any effects of time energy, which could be considered as "value-motivated", he did report on an equally mysterious "after-effect" in many experiments, which could only be construed as signifying a **memory** process. For instance, it turned out that in experiments with a vibrating torsion balance (or pendulum), at points of support the emerging additional forces did not disappear when the vibration was stopped, but remained in the system for an appreciable time. Interestingly, **their relaxation times were found to be independent of the mass of a body but were dependent on its density**. The largest effects with maximum preservation times were observed on porous materials like brick or volcano tuff. In enumerating on this unusual preservation action Kozyrev observed: "...a body placed for a certain time near an (irreversible) process and then brought to a torsion balance, produced the same effect on it as the process itself...aluminum showed no memory. The largest memorizing effect for processes of both signs has been shown by sugar"[7]. Also, his colleague Danchakov later observed in conjunction with biological experiments that water with decreased viscosity due to having been subject to the action of a process, exerted a distant action on water that had not been under such an action, causing its viscosity to decrease as well.

In this second part of the current dissertation, we will examine other important related information gleaned principally from esoteric sources, referenced in I. These have been obtained from books by Jane Roberts: **The Seth Material**, **The "Unknown" Reality** (UR) [2], unpublished transcripts (J.R.)[1], and transcripts from the entity Kryon channeled by Lee Carroll [3]. This information is remarkably corroborative with that from Kozyrev research and the tachion energy theory. Finally, we will cap off

our exposition with a brief examination of a bold new maverick physical theory of sub-atomic electron structure, featuring variable time/mass attributes, which could be the catalyst for bringing the cited elements from esoteric knowledge and empirical physics research (Kozyrev, etc.) out from their hitherto relative obscurity, to the forefront in our ongoing mainstream investigations in probing the cutting edge frontiers of not only physics, but those of the natural sciences as well.

Other evidence

When one compares the transcripts from various esoteric sources it's remarkable how similar is their description of nature's fundamental operations at the pre-physical level. For instance, a careful reading of the Jane Roberts' channeled transcripts from the entity Seth, reveals a remarkable close connection with the particles termed EE (electromagnetic energy) units and the above Killick teachings on tachion pair dynamics. But first a word of caution to the reader. We should resist the tendency to put into the frame of reference of our sentient physical experience, structures whose essence is fundamentally non-physical. The customary physical characteristics of duality and dichotomy of fields, and the related yardsticks of mass, length and time, for the most part, may not apply in this situation.

It would be impossible, however, to formulate a comprehensive model for the EE unit dynamics were none of the factors for gauging physical reality to be able to be applied to higher dimensional realms. Fortunately, one characteristic does survive the transition to the non-physical framework- the element of **pulsation**. Seth reports in [2] how EE units, much like tachion-pairs are built up and dynamically pulsate in response to thought patterns. First, depending upon the relative intensity of the emotional energy, they will instantly be drawn together in clumps or may just as quickly disperse. Furthermore, being of a pulsating nature, these units can expand and contract. Theoretically, there is no limit to their size or frequency of pulsation. Seth describes their operation in the following manner: **Now, there are electromagnetic structures, so to speak, that are presently beyond your instruments, units that are the basic carriers of perception. Their size varies. Several units may combine, for example. To put this as simply as possible, it is not so much that they move through space, as that they use space to move through. There is a difference**.

On this point, if our conceptions remain "earthbound" we will not perceive any difference between these actions, but once we cast our mental gaze beyond physical experience, an important distinction becomes apparent. To understand this, we need only reflect on the similar non-classical logic that is the basis for the non-orientable Moebius topology that we have seen governs the dynamics of the tachion-pair unit [5]. Tachions, whose translational movement is governed by the relative pulsation frequency, apparently enter and leave our level of reality at two times (field equity stages) during each pulsation cycle. Before leaving our plane, the tachion-pair constitute what we call a space-time point.

Upon returning to our level, due to the Moebius topology of the clocking cycle, their essence creates a new space-time point with enantiomorphic (mirror image) characteristics to the first. The resulting progress of the units in physical reality is thus manifested by a "jerkily discontinuous" movement. Summing up, since the units **are** the point they create, it can now be understood that the units **use** space (or the nature of the space-time points) to move through, rather than the case of macroscopic matter which moves continuously (or appears to) through space.

Seth continues his description of the EE unit dynamics: *Laws of attraction and repulsion are used and, in a manner of speaking, thermal qualities are involved, and this is the only hint that your scientists have received of them so far. The units charge the air through which they pass, and*

draw to them other units. The units are not stationary in the way that, say, a cell is stationary. These units have no "home". They are built up in response to emotional intensity. They are one form that emotional energy takes. They follow their own rules of attraction and repulsion. As a magnet will attract with its filaments, so these units attract their own kind and form patterns which appear to you as perception. They are electromagnetic, in your terms, following their own patterns of positive and negative charge. In this instance, like definitely attracts like. The units are just beneath the range of matter. None are identical. However, there is a structure to them. The structure is beyond the range of electromagnetic qualities as your scientists think of them. Consciousness actually produces these emanations, and they are the basis for any kind of perception, both sensory and extrasensory. These emanations can also appear as sounds and you will be able to translate them into sounds long before your scientists discover their basic meaning. One of the reasons they have not been discovered is precisely because they are so cleverly camouflaged within ***all*** *structures.*

Being just beyond the range of matter, having a structure, but a non-physical one, and being of a pulsating nature, they can expand and contract. They combine qualities of a unit and a field, in other words. Since they are beyond the range of matter, upon which matter is formed, they will not follow the laws of matter, although at times they may ***mimic*** *the laws of matter. It is almost impossible to detect an individual unit, for in its dance of activity it constantly becomes a part of other such units, expanding and contracting, pulsating and changing in intensity, in force, and changing* ***polarity****. It would be as if the positions of your north and south poles changed constantly while maintaining the same relative distance from one another, and by their change in polarity upsetting the stablility of the planet- except that because of the greater comparative strength at the poles of the units, a newer stability is almost immediately achieved after each shifting.* Even the altruistic motives of the tachion-pair as cited by Killick parallels similar behavior of these EE units.

Again from J.R.: *The behavior of these units changes in the following manner. When a unit is in the act of combining with another, it aligns its components in a characteristic way. When it is separating itself from other units, it will align its components in a different way. The polarities change in each case, within the units. The unit will alter its polarities within itself, adapting the polarity-design of the unit to which it is being attracted; and it will change its polarity away from that design on breaking contact.*

Ken Killick has described the mutual action of several tachion-pairs bonding, as the origin of standard sub-atomic particles possessing features known to modern science such as mass, charge, spin angular momentum, magnetic moment, etc. Thus, according to tachion energy theory, the electron attains its validity, and maintains its structural integrity, by virtue of relations between the component pair dynamics [see [5]). Since for the bulk of their independent existence, tachion pairs are in the pre-physical state, we can speculate that they may actually be superluminal entities. Remarkably, J.R. echoes this view with similar notions: *...the electron achieves its validity because of these* (possibly superluminal) *orbital units* (tachions?). *What we see as an electron is not made of the same things as the orbital units, however; it is an* ***effect****... when you change the structure of the electron, you are changing the relationships between the orbital units. This change will require an application of energy. It may be possible to construct a chamber that would give the electron more freedom.*

Whatever we do now in the handling of electrons is not giving them enough freedom and we are structuring the way in which they can appear. The next observation made by Seth could prove to be essential in clarifying the true nature of time: *... If electrons were given more freedom they would affect* **our notion of time in perceiving them. The way the measurements (on electrons) are made forces the electron to appear**

in a particular way, but actually it's flitting around, seemingly in many places in rapid succession (pulsing in and out of physical reality). Turning to the structure of elementary particles in [2], Seth offers a similar observation in which he describes the electron as commonly perceived by scientific measurement apparatus, as merely a shadow or facade of the actual electron entity which constitutes a multi-dimensional structure.

In terms of a structural model for the electron, Seth says it would be more appropriate to view these units as composed of *interrelated fields* rather than as the current conception of a particle or a wave. Correspondingly, both of these criteria are key elements of the tachion theory, which posits the electron as composed of two-pair tachion fields. The electron achieves its stability-integrity from the interaction of these free-wheeling units.

Electron Spin and Structure of Fundamental Time

The electron "spin" feature is also claimed to be integral to the exhibit of "time's arrow" in UR [2]: *The electron spin determines time "sequences" from your viewpoint. In those terms, then, a reversed spin is a reversed time motion... electrons, however, spin in many directions at once, an effect impossible for you to perceive. You can only theorize about it. There are "electromagnetic momentums" thus achieved and maintained- certain stabilities that operate and maintain their own integrity, though these may not be "equal" at all portions of the spin. There are equalities set up "between" the inequalities... time, in your terms, then, is spinning newly backward as surely as it is spinning newly into the future. And it is spinning outward and inward* (pulsing inward and outward of physical reality) *into all probabilities simultaneously.*

It is vital that you understand this inward and outward "thrust" of time, however, and realize that from this flows the consecutive appearance of the moment. The thrusting gives dimension to time that so far you have not even begun to realize... This inward and outward thrusting allows for several important conditions that are necessary for the establishment of " relatively" separate, stable universe systems. Such a system may seem like a closed one from any viewpoint within itself. Yet this inward and outward thrusting condition effectively sets up the boundaries and uniqueness of each universal system, while allowing for a constant give-and-take of energy among them. By their unique operation , the EE-units, which form the elementary particles such as the electron, serve as the conduit for this energy flow once it is transduced by elements of thought that Seth terms "consciousness units"(CUs). Continuing in UR on this subject Seth **describes how time can be alternately created or "broken down"**: *The consciousness units serve as source points or "holes"* (Black holes or White holes?) *through which energy falls into your system or is attracted to it- and in so doing, forms it. The experience of forward time and the appearance of physical matter in space and time and all the phenomenal world, results. As CUs leave your system, time is broken down. Its effects are no longer experienced as consecutive, and matter becomes more and more plastic until its mental elements become apparent*. These observations are corroborated by Kryon in his dissertations to follow.

Specifically, in the Kryon channelings, further insight on this electron "freedom" is given in the context of change of frequency: *...There is something we call the electron haze which is around the nucleus of the atom. The space between the energy haze and the nucleus (which is great), varies more than you think in matter. As the space varies, the speed (*frequency*) of the haze must change. It is in the physics where the speed of the haze is strong and fast that you have a different time-frame than your own... you have not yet accepted that an object can seem to be stationary- yet traveling (*vibrating*) very fast. Not in a linear time from point A to point B, but in the electron haze of its vibrating parts.*

J.R. corroborates these comments in this dissertation: *Einstein considered relationships of this sort that hold in the far universe as one increases velocity towards the speed of light,*

*but there are also "inner" situations (*altered **stationary** states*) that relate these quantities, and that are much easier to get into.* In regards to atomic structure to allow for frequency changes, Kryon adds:*What is it that makes the distance between the parts change? This is the puzzle for the scientists. For the area between the nucleus and the energy haze although vast, is not void. It is a patterned soup of energy (*the so-called "vacuum"*), and it is within the pattern of this null that changes the distance, and therefore the speed* (frequency*) of the haze.*

Mass, gravity and time are intimately related to this frequency change in the atom. Witness the comments from J.R.*: **Time exists as an invisible drag on matter and this is interpreted as gravity. Time exerts a definite force like gravity, and this is connected with the behavior of the electron.** However, since we always look at electrons in a certain way and gravity in a certain way, we miss the connection.* And this related comment as well: *There is another equation to be discovered that expresses the relation between time, mass and gravity.* Kryon reiterates this sentiment, along with relatively detailed scientific information: *Gravity is an absolute product of the characteristics of mass and time... one of which you may change.*

*What has been missing so far in your thoughts is how gravity is related to time, and that the entire issue of gravity, mass and time is non-linear. You have yet to develop the formula of physics. It is not here yet, and we are going to give you three attributes of the formula, but without the formula. These attributes are understood but the way they relate are misunderstood. Your science is just now beginning to see the shadows of them, however. The first attribute of the formula is the ability to understand the **density** of mass. Why is the electron haze so far from the nucleus? We have told you that you can change this distance, and in doing so, the density will change in the mass that is defined by the atoms being shifted. The electron haze will have to vibrate faster (this is possibly the "freedom" referred to earlier by J.R.), the closer it is to the nucleus; when the electron haze vibrates faster, its **time-frame** will shift. Therefore, the second attribute of the formula is a time-shift, and they go together. Also, be aware that you make an erroneous assumption that the actual speed (frequency?) of the electron haze must always be the same no matter what the distance. This is not understood yet either. There is a difference between speed (velocity/ translatory rate) and vibratory rate, and it has to do with the actual physical definition of the **electron haze**.*

Mass discrimination is the ability to control the density of mass. With a density shift will come a time-shift, and with a time-shift will come a third attribute...we will call the **reality of location**, or where the matter is... in which dimensional reality it goes to when shifted. Here is an axiom: **shifts in dimensionality when matter is changed in this fashion create a reality where the matter has to be to exist in its new form**. It might be inches from where you changed it or miles. That depends on how much it got changed. The difficult thing to explain to you is a concept that has not been recognized... that matter has a **reality index**, and that its core attributes are linked to where it exists in time and space. Therefore, the three attributes that must work together are **density, time-frame and location**.

Electromagnetic Field Manipulation of Cosmic Lattice and Time-Space-Matter

In regards to tapping this (mass-free) energy-haze-soup, between the atomic nucleus and electron shells, Kryon speaks thusly: *There's something we are going to call APD (atomic phasic displacement). This is a term that is going to refer to the ability to tap the (Cosmic) Lattice for unlimited energy. The Cosmic Lattice is balanced, but it is not quiet. The Lattice has astounding power. It has a flow of energy that I cannot explain to you, for there is no paradigm model for it yet in your thinking. Therefore, you would not easily understand. The Lattice has vents that we can best describe as necessary for the flow of energy. It balances the slight inequity of the*

polarity. The vents also have to do with time... you will always find two vents together. One will be prominent, the other will be secondary. You might graphically and clearly see one, but you will have to look carefully to see its partner. There are always two. This is an axiom or physical rule of the Lattice energy, and of the universe: This information remarkably parallels Killick's teachings on tachion energy pairs.

Witness this Kryon pronouncement:*Hiding within common atomic structure is a marvelous peek at something that will totally and completely mystify you, for it will seem to break all the laws of time and space. The" twins" are a pair of atomic parts that always relate to each other, and are always found in pairs. You will discover that when stimulated correctly, they will always move together as a pair. When you start separating them by distance to experiment, they will continue to move exactly together. If one's energy is converted, then the other will do the same. This will cause you to totally reexamine your ideas of time and space, for this condition will not follow the "ultimate speed" of transmission that you thought was correct... that of the speed of light. You will have discovered something that travels faster than you can ever measure*. Compare this statement with the torsion energy claimed by the Russians to travel at a billion times light speed [10].

In returning to the discussion on how to tap the Cosmic Lattice for energy, Kryon continues: *The vents are very necessary for the balance of your universal energy. The vents are also energy portals, (drains, to you), and are where the front of each Lattice cell touches the back... Like so many other physical processes, however, its going to take a tremendous amount of energy in order to unbalance even one cell's null attribute... Once you understand how to" prod" the null to unbalance itself, you will be rewarded with a steady flow of energy, far beyond what you put into it. This is accomplished since you create your own tiny "vent". An unbalanced cell creates a situation where the other cells around it will try to" feed" energy to the one that is unbalanced. This creates a tap that will pull upon the Lattice indefinitely, as long as your work matches the properties the Lattice expects to see.* Kryon further expands on the specific method to accomplish this...*Here's how it works. Two magnetic fields together, postured in the correct way- a way that is very three-dimensional in your thinking process- will create a "designed magnetic field" that is very specific.*

> *...your math told you that there might be a possibility of invisibility and that was your goal. This was again because you did not understand that because the distance between the parts change, it doesn't necessarily mean that the overall size will dramatically change or that it might vanish...*

It's one you have never seen, and does not exist naturally. Start with trying several magnetic fields postured against one another- of unequal force and pattern, and at right angles. Don't make any assumptions. Think freely. Done in the right fashion, these two fields will create a third pattern which is unique and is the product of the original two. This third custom-created pattern is the one that you want to deal with, and is the one that has the potential of manipulating the Lattice. Once you have created it, you will know of its special qualities by how dramatically it changes the physics around it. And this important admonishment is given: Here is a caution. *Keep this experiment away from your body. Keep the experiment in check with your scientific methods. Go slowly. Understand what you're seeing before you go on to the next step. Do not expose yourself to any magnetic fields. Remotely conduct all energy experiments. Remember that magnetics also plays an important part within your body (DNA components).*

Here is another. Understand that if you unbalance the Lattice too grandly and too greatly, you will have a ***time displacement****,*

for the process also involves the property of ***time****... One of the actual physical players in the creative process of unbalancing the Lattice is the manipulation of the time-frame of matter.* ***This is not time travel, but time displacement.*** *It is where you are actually addressing tiny parts of matter, and changing the time-frame they are in. When the inequity of time-frames meet one another (*matter mixed up with differing time attributes*), the result is a displacement of distance (*reality of location*). Although there is no horrendous danger for Earth within this time displacement, it can and will affect the local situation within the experiment. In other words, it can create a matter-distorting effect, completely stopping the experiment, and actually dislocating the parts. We are not going to say any more about this at the moment, but the more astute scientific minds reading this will go to the next obvious step... and the answer is "yes", the Lattice is also the key to quick travel of large physical objects... even of very short distances.*

Possible Documented Demonstrations of Time-Space Warping

Such fantastic transformations were possibly evident in the Hutchison experiments [11], in which metal samples were catastrophically fractured when exposed to radiation from the unique electromagnetic field effect. It was also noticed that many physical objects of different composition which were separate in space before the electromagnetic field was applied, became inexplicably embedded in each other once these objects were radiated by the field effect. For instance, **pieces of wood contained metal knives**, etc. Other metal samples were catastrophically fractured in their molecular-atomic crystal arrangement, producing a substance which was uniform and geometrically symmetrical at one end but appeared to have the resemblance of corrugated cardboard at the other.

Also, similar to Kryon's assertion of the inevitability of time-shift with mass altering phenomena, in Hutchison's work anomalous inertial impulses were recorded on film, sometimes resulting in the complete lift/levitation of various substances of different mass. We notice also anomalous inertial impulses were a feature of the Zinsser "kinetobaric" effect [12], in which due to excitation by **sawtooth microwave impulses with very fast rise time**, a sample attached to a torsion balance, deflected the balance for days and weeks after the original excitation was extinguished. Notice the similarity between these results and those of the Kozyrev experiments, some of which reportedly featured a memorizing preservation effect on a torsion balance, etc.

We also find additional confirmation from the basically anecdotal evidence from the alleged legendary Philadelphia Experiment in 1943, which apparently caused either large time- or space (teleportation) shifts in a Navy ship. In fact, in another piece Kryon himself possibly speaks directly about the Philadelphia Experiment, providing us with further insight into important possible new paradigms for time, mass and energy: *In all your questions regarding magnetics and the massless condition, you have never asked about what happened in your year 1943. You tried to create a massless condition with coarse equipment and little understanding of what you were doing. In the process you actually did create an unstable massless condition for a moment. Its instability created a situation where, instead of a true massless condition, you received one where the time-frame changed but the parts within the sphere of the time change did not have the fine-tuned synchronicity needed for a massless object. The result was an actual distance displacement of the object instead of a true massless condition. Indeed, humans were involved on the large object and their biology was damaged greatly. Your experiment was done in an atmosphere of desperation, and your goal was flawed. For your math told you that there might be a possibility of invisibility and that was your goal. This was again because you did not understand that because the distance between the parts change, it doesn't necessarily mean that the overall size will dramatically change (or that it might vanish).*

Although this may seem like a paradox to you, the internal mechanics of small particle behavior supports this. The change is measurable but very small, much like what happens with heat and chill...Many of you have guessed correctly that ***magnetics and electricity play a critical role in the determination of the real attributes of mass****... and the magnetic variables that determine the mass product, are often working within very small particles to create the density of an object and also its time-frame. The time frame of a massless object is slightly different than your own, making you to appear slightly slower than the massless object. Its reaction to more traditional mass molecules around it is also predictable: because of the very slight time displacement, it tends to change the number of electrons within the atoms directly in contact with it. This is a clue on how to detect a massless object even if you can't see it.*

*The reason you felt the object (*ship*) would vanish was that you were able to simulate a "vanishing" in the laboratory with smaller objects. This observation was not consistent however, so you again were in desperation to try this experiment on a larger object. The "vanishing" was an illusion and was due to a distance displacement rather than an "in place" vanishing... does this give you a clue to long distance travel using magnetics and the vibratory rate of matter?... Only one human on the planet has ever captured a true massless condition, and even this was a coarse one and lasted for only for a few moments that were uncontrollable in scope. This massless condition was created in the primitive workshop of a great electrical scientist in your culture on the American continent not too long ago. If you were able to visit his workshop, you would note the holes in the ceiling and the patched glass-covered light port where his massless objects took off and wildly flew everywhere. If he had been born 50 years later he would have been able to control the attributes of the experiment. As it was, he did not have the precision tools you have now to direct and control such an experiment. It was his great passion to understand this phenomena, but because it was so uncontrollable and sporadic, he was never able to bring others to see it work, for he could not accurately create it consistently. This depressed him in his later years, for his was a great three-dimensional mind...* When asked the identity of this scientist Kryon replied*: The inventor of your multi-phase current, born in the land you now call Yugoslavia.*

From the above information, there emerges a remarkably consistent picture suggesting that atomic structure may not be as rigid or immutable as formerly thought. Changing the fundamental frequency of vibration of atomic structure can perhaps apparently not only change the density of matter by altering the distance of electron shells from the nucleus, but in so doing alter the time-frame of that object, its mass and also the reality of location of that substance. Certainly, the implications of the Kozyrev research, among others, can possibly form the basis for the eventual technological implementation of these futuristic principles. Perhaps those experimenting with the relatively detailed data provided by Kryon on APD can actually realize this coveted goal.

Maverick New Theories in Physics Suggest Fluid Nature for Time, Space, Energy

The Dirac theory is to be understood as a theory of the electron with electromagnetic interactions. It consists of the Dirac wave function and its properties, including the Dirac equation and relations to physical variables such as energy-momentum, spin and position probability current. In spite of its indisputable mathematical successes, the Dirac theory is still without a completely satisfactory physical interpretation. In particular, the so-called *zitterbewegung* ("jitter motion") is a distinctive feature of the Dirac theory which continues to be the subject of conflicting interpretations in the standard scientific literature. The concept of zitterbewegung was introduced by Schrodinger to interpret high frequency oscillations in free-particle wave packets of the Dirac theory. These oscillations with angular frequency $2mc^2/h$ arise from

interference between positive and negative energy components of a wave packet. Schrodinger interpreted the oscillations as fluctuations in position of the electron about an average motion. However, this concept has not been interpreted in the bulk of the literature as having an objective significance, but has erroneously been viewed by standard theory as a mathematical artifact of the one-particle Dirac theory which does not appear in a correctly formulated quantum field theory.

However, as noted theoretical physicist David Hestenes suggests in the first of his recent article series in the journal, **Foundations of Physics** [13], it is only by interpreting the zitterbewegung literally and objectively as point particle motion, that a complete and coherent interpretation of the Dirac theory can be achieved. Moreover, this model has implications that have not yet been previously considered by established physics that relate directly to some of the key features of sub-atomic behavior enumerated in the tachion energy theory and also in the microscopic dynamics of elementary particles revealed by the selected esoteric channelings that we have previously considered in the present exposition.

In particular, it implies that the electron is the seat of a fluctuating electromagnetic field which oscillates with the DeBroglie frequency of the electron (1.6×10^{21}cycles/sec).

Thus, it tells us that a kind of electromagnetic wave-particle duality is implicit in the Dirac theory. Of course, this contradicts the conventional view that wave-particle duality is a property of matter which is completely independent of the nature of its interactions. If the zitterbewegung is an objective phenomenon, then it originates from electron self-interaction, since it persists in the absence of external fields. In this new theory which considers the zitterbewegung as an objective physical phenomenon, the electron mass and spin can be identified with the energy and angular momentum of electromagnetic interaction. It suggests that the self-interaction is such that there exist certain stable, non-radiating but accelerated states of motion; in particular, for a free particle, this implies motion in a circle with the radius of a Compton wavelength- the zitterbewegung. The zitterbewegung implies that some of the mass, at least, is kinetic self-energy associated with a spin, and it reconciles the mass with a zero mass of the bare electron. Thus, according to this bold new theory, the electron spin arises from a helical world-line in spacetime. To be sure, some researchers have previously postulated such a helical electron dynamics. Unfortunately, such models have failed to explain why a helical motion for spin should depend on interference between positive and negative energy states or why the zitterbewegung should depend on the way a wave packet is constructed, or even how the zitterbewegung can be the origin for electron spin despite the fact that it vanishes for plane wave states that certainly describe a particle with spin.

The Hestenes model does offer an explanation for such effects and accounts for the ubiquitous feature of spin angular momentum as a function of the zitterbewegung. The essential unprecedented feature of the Hestenes' zitterbewegung idea is the association of the spin with a local circulatory-helical motion characterized by the phase factor of the electron wave function.

Thus, we reach the conclusion that the complex phase factor of the electron wave function can be associated directly with an objective helical motion of the electron, which is, in turn, a derivative of the zitterbewegung. Although the idea of helical motion connected with the electron has been considered before, it has not previously been related to electron phase to produce a complete interpretation of the Dirac theory.

Moreover, in the next installment of his dissertation [14], Hestenes argues that the zitterbewegung is not only an objective dynamical phenomenon associated with the electron, but is a ubiquitous phenomenon, with manifestation in every area of quantum mechanics, even in the non-relativistic domain. For instance, by showing that spin angular momentum can

be regarded as angular momentum of the zitterbewegung fluctuations, the zitterbewegung interpretation of the Dirac theory begun by Hestenes in reference 13 provides an explanation for the electron spin and magnetic moment in the physical circulation of momentum and charge. It also explains the mass as the energy of this circulation. Thus, the origin of the zitterbewegung is attributed to self-interaction of the electron with its own electromagnetic field. The relations derived by Hestenes in this article suggests that the interaction is of magnetic origin, since it has the form of a Larmor precession energy if spin angular momentum is proportional to a self-generated magnetic field. The so-called "rest mass" of the electron is thus a kinetic energy of self-interaction. It is this that gives the electron its inertial properties, and the flywheel-like nature of this inertia may be the ultimate origin of spin dependence in electron scattering. And the Heisenberg Uncertainty relations can now be attributed to the "zitterbewegung fact" that an electron cannot be confined to a region smaller than a Compton wavelength. Also, the stationary states of a bound electron exhibit a resonance of the orbital frequency with harmonics of the zitterbewegung frequency, which is imposed formally in the standard theory by requiring single-valuedness of the wave-function. Evidently, such resonances, so prominent in quantum mechanics, can be interpreted as zitterbewegung resonances. This leads to a new explanation of penetration of a potential barrier by sub-atomic particles as due to zitterbewegung fluctuations in momentum, and the Aharonov-Bohm effect as a shift in zitterbewegung phase. The zitterbewegung phase factor literally represents a physical rotation. The rotation rates of this phase in time and space directions are the source of the electron's energy, mass and momentum.

In his third paper [15], Hestenes draws a closer relation of the zitterbewegung dynamics to the Dirac theory by suggesting that the latter actually describes a statistical ensemble of possible electron motions, which are actually governed by the zitterbewegung sub-structure. Since the energy-momentum of the electron can now be interpreted in terms of a rotation rate in the spin-plane, Hestenes then derives a corresponding relation which defines a variable mass for the electron-another unprecedented idea which is in agreement with the information given by Kryon in his dissertations and Ken Killick's tachion theory. The mass m, the scalar radius of curvature r and the zitterbewegung frequency all covary with changes in the rotation rate in the electron spin-plane. Hestenes obtains a relation demonstrating that the electron mass is inversely proportional to the zitterbewegung frequency. This conforms to the relativistic concept of mass as a measure of energy content. But here, mass is concluded to be primarily a **frequency** measure. This also conforms to DeBroglie's original idea that the electron contains an internal clock with frequency determined by its mass, though for a free particle, the zitterbewegung frequency differs from the DeBroglie frequency by a factor of 2. Moreover, the new key relation derived by Hestenes: $m \cdot r = 1/2h$ (h, Planck's constant), says that this frequency measures the radius of curvature of the electron world-line, so it is a thoroughly geometrical quantity. Thus, as mass increases the radius of curvature decreases, in concert with the tachion dynamics as well. All this suggests that the electron mass relates our externally imposed time scale to a time scale intrinsic to the electron.

The reader can see that the information transmitted by J.R. is also remarkably similar in this connection. It should be evident that there is introduced a new concept of mass here, though, to a certain extent, it was already implicit in the Dirac theory. The formerly vague concept of mass as some kind of material stuff is completely gone. Also, no longer is vanishing mass a distinguishing feature of particles moving with the speed of light.

Corroborating Research on Oscillatory-Fluid Nature for Time

In his recent thought-provoking dissertation [16], Tom Bearden relates of

the dynamic influence of time on a material system: "But we can also legitimately state that 'time is energy' and be rigorously accurate...Time is extremely compressed EM spatial energy...Without further elaboration, we speak of a 'mass' in which a small portion exists as 'masstime' rather than mass, as having been 'time-charged' or 'time-excited'.

The t-polarization wave in the time dimension is quite unique: The *spatial* energy of the wave is in equilibrium and not vibrating at all; instead, the photons comprising the wave are vibrating in their **time**-components... In short, mass m is changed into masstime mt by photon absorption... Rigorously, a mass does not really 'travel through time' continuously, per se, but proceeds with an overall serial change mechanism, driven by its total virtual and observable photon interactions, as m→ mt→ m→ mt→...We propose that this may account for the duality of particle and wave...The particle actually oscillates at a high rate between the m and mt states... Mass 'travels through time' by an extremely high oscillation between corpuscle-like state and wave-like state". Notice how Bearden's description of the macroscopic operation of time on a physical system closely parallels Hestenes' proposed model for of the zitterbewegung dynamics at the sub-atomic level which provides the electron (and possibly photons, etc.), with a time-substructure (its internal "clock").

We can see many other places in Bearden's treatise where the unique terminology chosen can now be put into direct reference with equivalent concepts and unique phraseology employed by many of the researchers examined in the current exposition. This cross-referencing certainly provides much needed clarification about key ideas for researchers currently involved with the development of this fledgling discipline that we shall term causal mechanics, after Kozyrev's designation.

All such efforts will help to place investigative endeavors currently scoffed at by establishment science on a firm rational foundation, as well as assist in synthesizing seemingly disparate but surprisingly related "anomalous" phenomena. For instance, to implement the science he has termed "vacuum engineering", Bearden often speaks of the necessity of establishing a "local time-stress of the **vacuum potential**". This process, which as we hope to have shown here is completely legitimate, is identical to what Smith calls creating a "tempic field gradient", Kozyrev's "alteration of time-density", or Alexander Frolov's "change in the local time-rate".

It can clearly be seen that such ideas can only be perceived as science fiction fantasy, if we observe strict adherence to all current received paradigms (even in superstring theory), which consider space and time purely from their relational standpoints. These theories must of necessity involve models employing scalable metrics for their proper description. However, once we embrace the novel view posited here that vacuum energy is primary and both local space and time are derivatives of this mass-free non-scalable dynamic non-local oscillating substratum, then we can conceive of space and time properly as complementary aspects of non-local conscious reality, neither fixed in a scalable manner or subservient to the other, but fluid and mutually interdependent features of energy in constant flux (see the related ideas voiced by A. Correa and P. Correa in I).

With this approach we will then come to acknowledge the technological feasibility of many of the "futuristic" claims made in the channeled transcripts. For instance, we can see that it will no longer be necessary to propel elementary particles to relativistic velocities, or to probe astrophysical systems possessing large gravitational fields, to recognize alterations in space, time and mass parameters, since these phenomena can equally as well be accomplished in the laboratory by modifying atomic structure of stationary matter through electromagnetic means. Once again, peruse the Kryon dissertations on this process, for it may be key to future technology.

For those who wish to further investigate these theoretical possibilities, the papers of **A. A. Nassikas** are recommended. Nassikas has postulated what very few researchers before him have theorized: the existence of a ground-form probability density function for energy, as a necessary precursor to the malleable (deformable) characteristics of time and space [18]. One of Nassikas' conclusions is significant in light of ideas articulated in the present exposition concerning the hypothetical tachion-pair model for reality (see I). Here we refer to the key push-pull oscillatory ("breathing") operation between space and time, which may be responsible for the structural integrity of matter as we know it (again re-read the Hestenes zitterbewegung model).

Researcher **Alexander Frolov** has taken Nassikas' theory even further to suggest an explanation for the **anomalous over-unity effect** that has continually been demonstrated in low-energy nuclear reactions (LENR) over the past decade [19]. In such so-called "cold fusion" cells the Palladium cathode is over-saturated with protons, producing a local imbalance in the vacuum engine, causing a local alteration in the time-frame of the experiment to compensate the local change in energy density. **Subsequently, as Frolov claims, this time-frame change converts non-local time-energy directly into heat energy, similar to Kozyrev's description of energy production by stars.** Perhaps this observation might provide the hitherto missing key in our understanding of fusion by electrolytic action.

Conclusions and Prospects

In the preceding paper it is sincerely hoped that the author has demonstrated ample evidence that will spur on researchers of a kindred spirit towards the development of new paradigms for space, energy, mass and especially time. All these concepts, as well as the foundations of current classical electromagnetic theory, are in need of a drastic overhaul before we can fully appreciate and understand the operations of nature as it interrelates the metaphysical-mental realms with the physical level of reality.

At any rate, the continual appearance of research results, such as the Kozyrev effect, which up to present apparently resists explication in terms of conventional scientific paradigms, certainly offers clear evidence of the incompleteness of our knowledge of nature, even in this enlightened era since the dawn of the new millennium.

Accordingly, hints as to how the Kozyrev effect arises in association with the postulated active properties of time, and how the latter interacts with known physical forces, can assist us towards the development of a more comprehensive paradigm which embraces a wider spectrum of human knowledge - one in which the current conundrums rampant in the foundations of theoretical physics, and biological science disciplines as well, which have hitherto prevented the establishment of a unified model of all physical interaction, can find satisfactory solution. Also, such empirical evidence which generally flies in the face of current scientific wisdom, presents the greatest challenge to our ongoing search for new sustainable energy sources which will be of absolute necessity in the future.

In this light, if formally integrated into scientific thought, the tenets of tachion energy theory, which is based on an altruistic modus operandi, also may hold profound implications for the status of our very social, political and religious structures as well. Indeed, unlike the impersonally motivated interactions believed to be the basis for force interactions in modern sub-atomic physics, which help sustain our illusory belief in the supremacy of the ego, the philosophical basis of tachion dynamics is an able reminder of the humility of purpose which should be the guiding force whatever our walk of life. Like tachion-pairs, in the ideal social structure individuals will work side-by-side, yet achieving a common accord. United in the circle of their activity they will work together joyfully in freedom, each with his own task, yet always conscious of the common bond.

With the full import of these simple truths appreciated, tachions may afford a rational justification of the formerly "unprovable" mystical doctrine of the omnipresent intelligent plan behind the working of the universe at all levels of conscious reality. We will come to realize the profound truth of Einstein's vision of ultimate reality couched in his heretofore cryptic statement, *"God is subtle, never malicious"*.

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On the Rotating Permanent Magnet System

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In one of our issues we published an article about the results of the experiment conducted by S.M. Godin and V.V. Roschin. They started in 1990 at Moscow Aviation Institute (MAI) when a technical physics laboratory was created in Machine Industry Projects Institute at the "Aeropromservice" Association. Their research work was financed by private investors and was continued in close cooperation with Chair 310 of MAI, especially with Prof. PhD. L.K. Kovalev, Prof. PhD. V.V. Rybakov and PhD. K.V. Ilyushin. By 1991 "a device for inner energy of matter conversion" had been designed and tested (according to the Technical Design Assignment). The prototype was finished in the middle of 1993 (Fig.1).

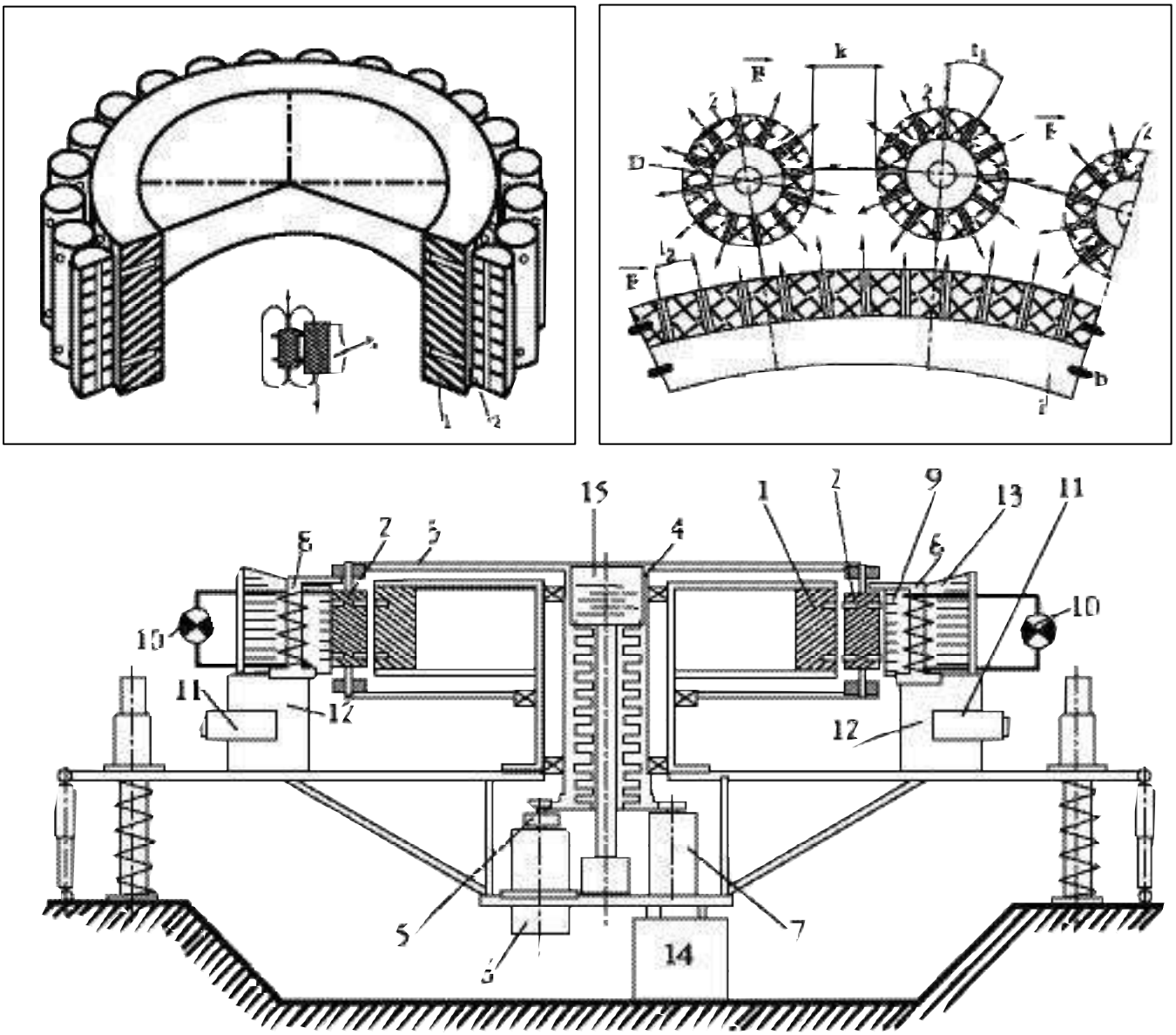

Fig.1

The experiments resulted in the possibility of creating a 7 kW output power in load after the rotor was sped up to 10 rps, but in the autumn of 1993 the laboratory was closed due to the investors' financial problems. Now their research work is continuing in Moscow and we hope the scientists will obtain new experimental results.

You can email S.M. Godin for more information at: smgodin@online.ru

Considering the theoretical basis of the functioning of these systems I should suggest a number of interesting details for prospective researchers.

S.M. Godin, V.V. Roschin et. al. (Physics of Negative Viscosity Phenomena. Prof. Victor P. Starr. Massachusetts Institute of Technology) spoke of vacuum (quantum medium) as **a physical medium possessing negative viscosity.** At that rate, it is worth making assumptions that can be useful to the developers of this topic. I think that standard (positive) viscosity of matter, from the physical point of view presupposes the presence of positive friction and a "work-to-heat" entropy transformation. Consequently, **negative viscosity** should correspond to the **negentropy cycle** "heat is converted to work". This is exactly the stray heat conversion once described by Tsyolkovsky in 1914. Apparently, **the medium of the kind supports self-sustained vortices** characterized by the surrounding medium heat absorption, which was mentioned yet not explained by S.M. Godin and V.V. Roschin.

It is possible that all the elements of matter are the self-sustainable vortex structures. To mathematically describe these physical mechanisms, the notions "heat-work-heat" transformation and "time" or "gravitation" should be interrelated. Russian philosopher Pavel D. Uspenskiy had been making related research since the year 1910.

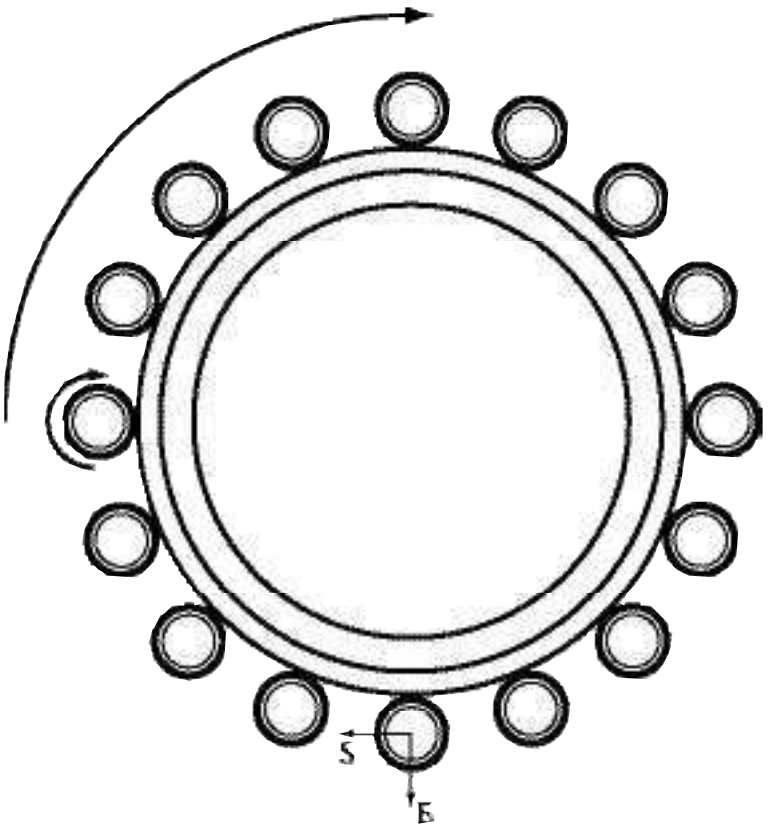

Fig.2

From the conventional point of view, this device (Fig.1) creates a circulating energy flux described by the Umov-Pointing vector (toroidal vortex) as the roller magnet field vector is vertical and the electric field is radial.

S.M.Godin (on the left) and A.V.Frolov (on the right), St. Petersburg, June 2001.

Inventor's Week Conference 2003, USA

Review is prepared by Editor Tatiana Ezhova

This year the annual Inventor's Week-end Conference was held on September 19-20 in Seattle, Washington. The conference featured several interesting inventions, including MEG.

Bill Alek demonstrated a device that he believed could let him detect Vortex-Energy. It was attached to a meter, and his belief was that if he walked into a naturally-occurring energy vortex carrying the device it would show him changes in gravitational and other energies. He cited the Vortices in Santa Cruz and Oregon as examples that might be good for experimentation.

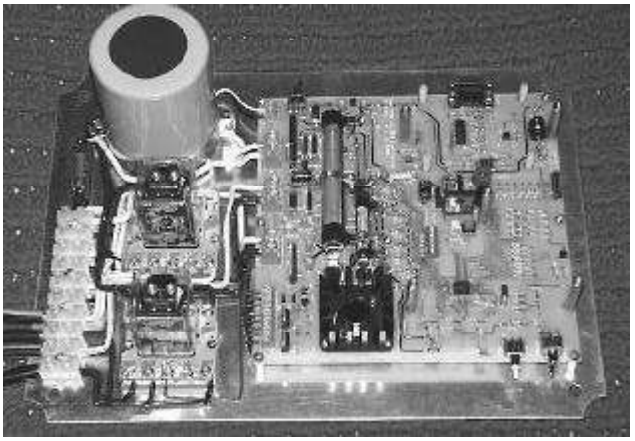

Bill Alek

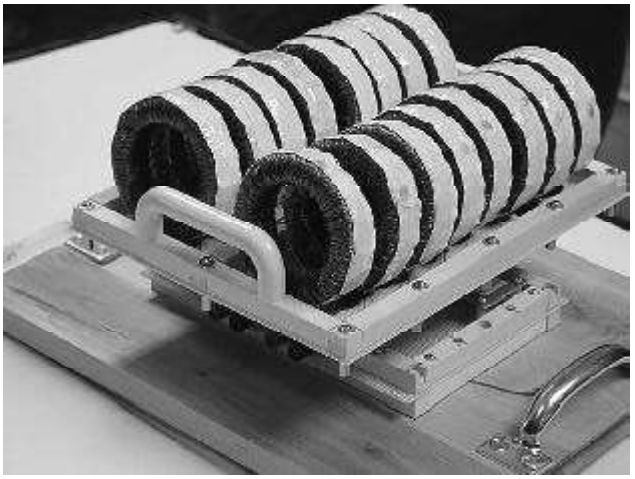

Z-Pod, Bill Alek

In his report "Introduction to Parametric Mass Fluctuation - a breakthrough in Energy and Inertialess Field Propulsion" Bill Alek presented the Z-Pod, developed to test a theory of solid-state parametric mass fluctuation. Here is the URL for a good overview of the device that he published online at www.intalek.com:

http://www.intalek.com/Index/Projects/SmartPAK/Projects/ZPOD/ZPOD_System03.pdf

Rio Von Sternberg

Rio Von Sternberg was presented as the original inventor of the MEG. He apparently has a patent on the device; however, from his presentation I understand that his configuration is somewhat different than the model that J.L.Naudin and T.E.Bearden have been experimenting with.

Alexander Peterson had a very interesting presentation on optical-mirror magnetic field systems. The crux of his presentation involved cutting precise notches into magnetic coils to separate them into identical optical-isomeric shapes. Apparently, by cutting a thin line directly down the center of the transformer-core is believed by Peterson to increase the efficiency of electric motors by up to 50%.

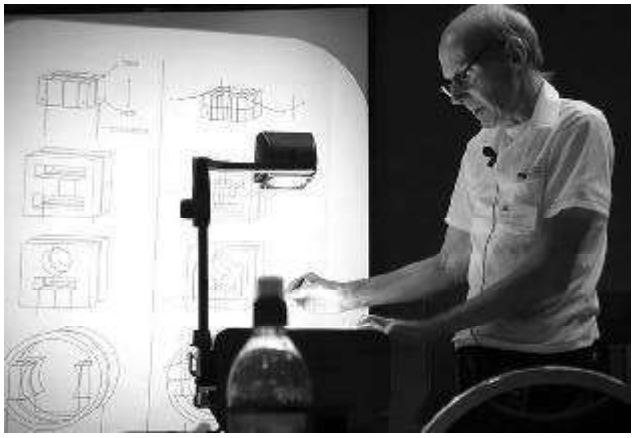

Alexander Peterson

Mark Plotkin, a well-known Washington DC attorney also took part in the conference. He is interested in new energy technologies and works with new technologies in collaboration with Mark Whitford at www.awetec.info. The photo of Mark shows him rotating a steel coil apparatus that was passed around the conference by Slim Spurling.

Mark Plotkin

Slim Spurling is an inventor from the Southwest, shown holding a helical-wound coil that he claims provides health benefits through an interface with zero-point energy. Spurling's belief is that this specific circumference of the coils provides a "Casimir-like Effect" that concentrates the energy.

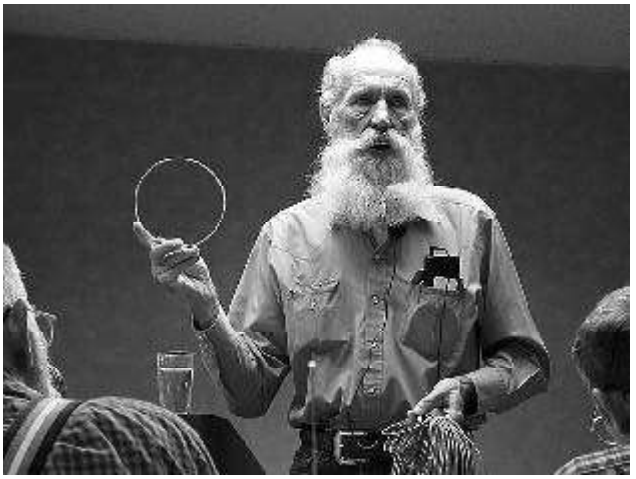

Slim Spurling

Donald Smith

Note: Donald Smith, a well-known inventor, also took part in this year's conference. His work is described in more detail in a separate article of this issue.

Full information on the conference and reports is presented at http://ionvalve.com/iw/2003/conference2003.htm.

USA "Inertia" Patents

Information from www.rexresearch.com/inertial/

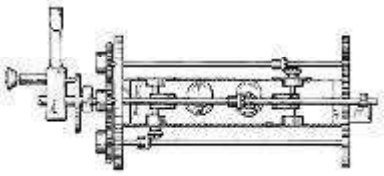

№ 6,290,622 (7/18/01)
Mechanical Force Generator
Murray, Lawrence D.

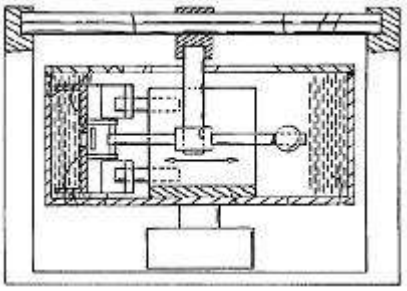

№ 6,259,177 (7/10/01)
Motion Imparting System
Deschamplain, Daviv

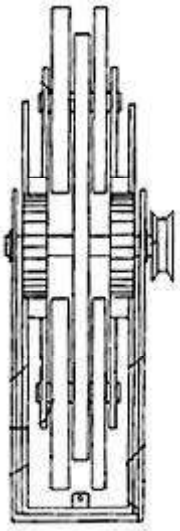

№ 5,890,400 (4/06/99)
Apparatus for Generating a Propulsion Force
Oades, Ross A.

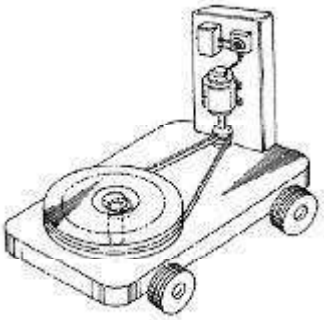

№ 5,937,698 (8/17/99)
Centrifugal Propulsi on System
Kunz, William T.

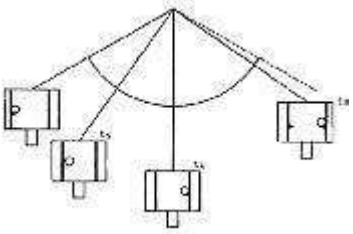

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Method & Apparatus for Propulsion
Rasmussen, James K.

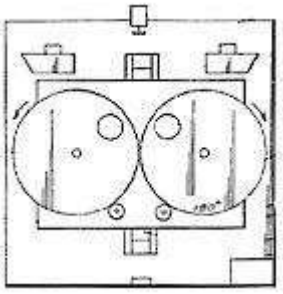

№ 5,966,986 (10/19/99)
Propulsion System
Laul, Virgil R.

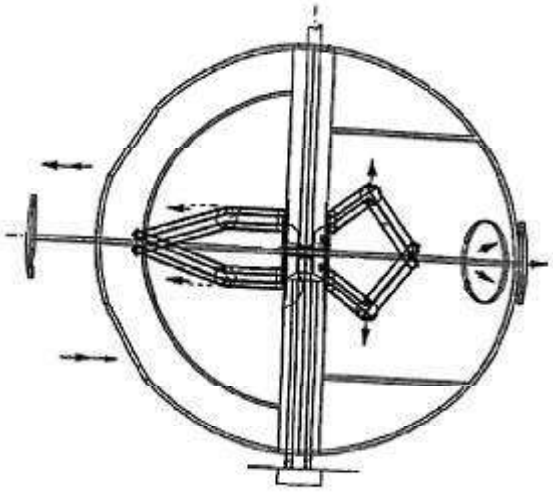

№ 5,673,872 (10/7/97)
Apparatus for Energy Transformation & Conservation
Shimshi, Ezra.

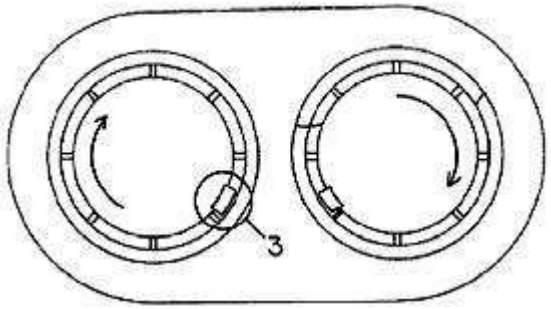

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Bootstrap Propulsion System
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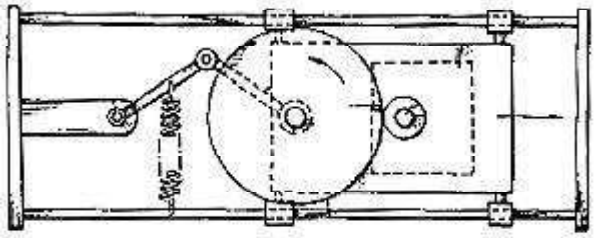

№ 3,492,881 (2/3/70)
Prime Mover
Auweele, Albert J. v.

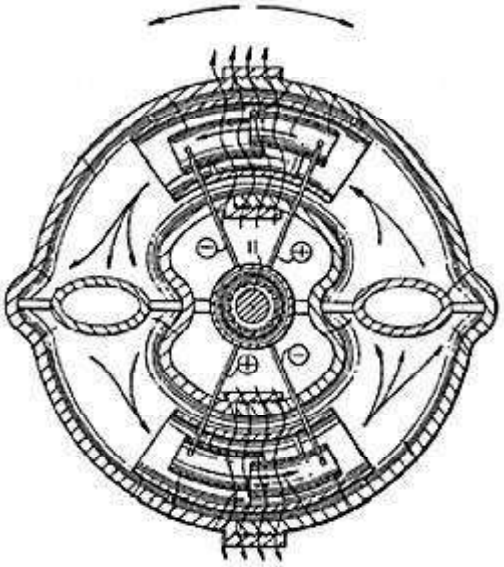

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Propulsion System
Butka, Kemal

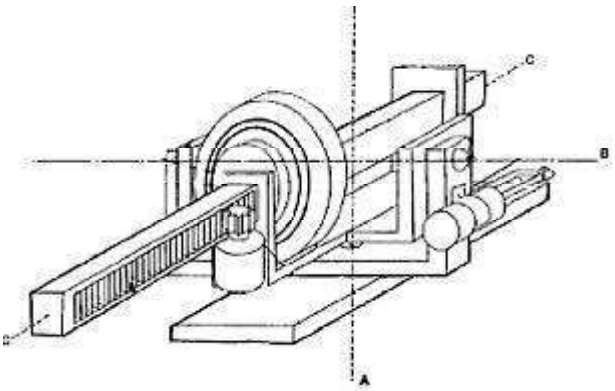

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Gyroscopic Propulsion System
Laithwaite, Eric R. & Dawson, Wm.

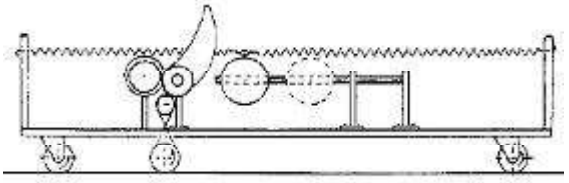

№ 5,685,196 (11/11/97)
Inertial Propulsion Plus Device & Engine
Foster, Richard E.

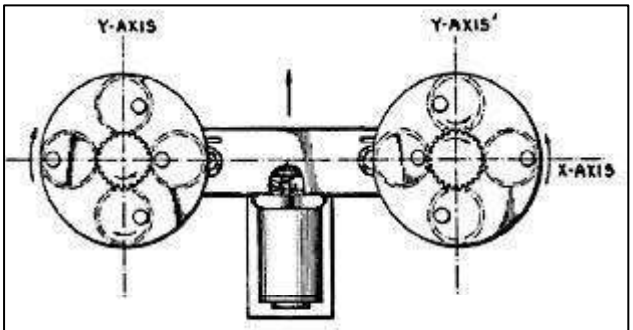

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Energy Transfer Device
McMahon, John C.

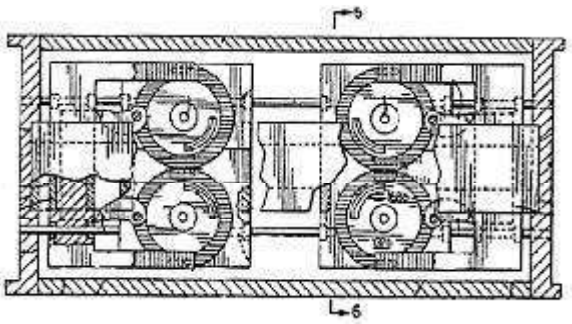

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Non-Linear Propulsion & Energy Conversion System
Black, James W.

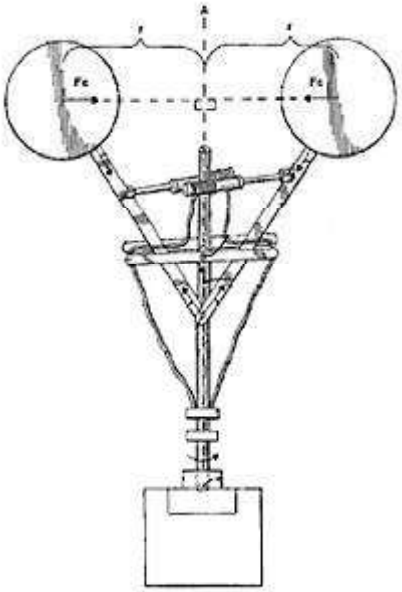

№ 5,557,988 (9/24/96)
Centripetally Impelled Vehicle
Claxton, John C.

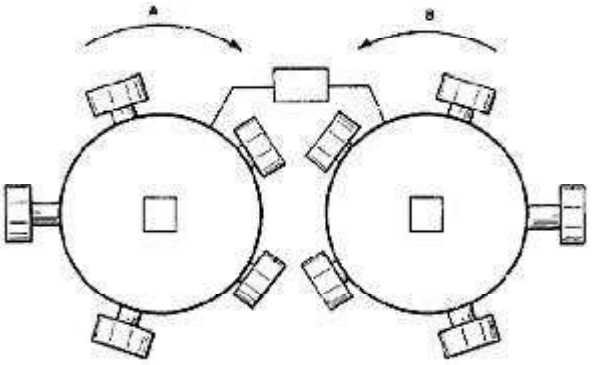

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Electromagnetically Actuated Thrust Generator
Bouden, James D.

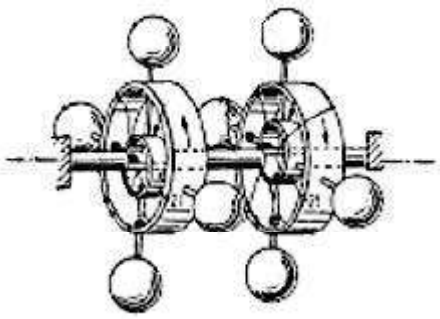

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Converting Rotary Motion to Lineal Motion
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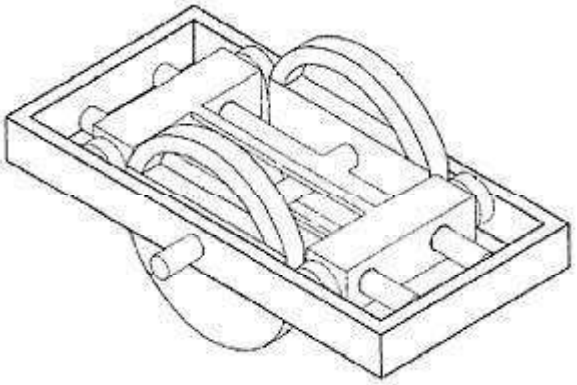

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Centrifugal Inertia Drive
Lieurance, Richard L.

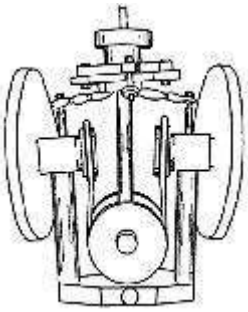

№ 5,024,112(6/18/91)
Gyroscopic Apparatus
Kidd, Alexander D.

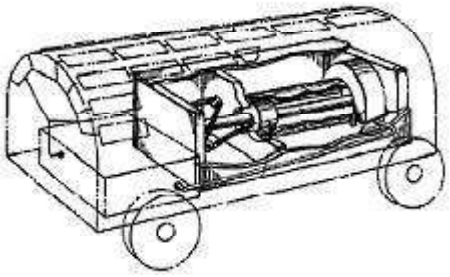

№ 4,801,111(1/31/89)
System for Propulsion & Positioning
Rogers, Charles E., et al.

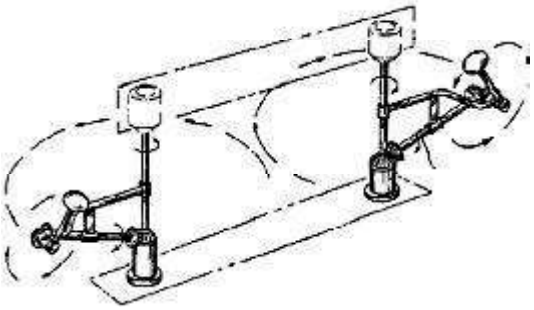

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Centripedal Device for Concentrating Centrifugal Force
Mason, Lyle M.

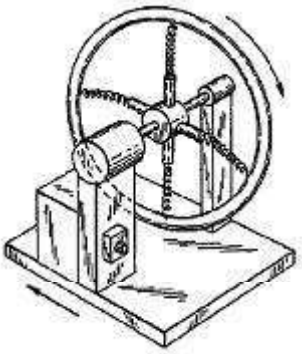

№ 4,784,006(11/15/88)
Gyroscopic Propulsion Device
Kethley, Lancelot I.

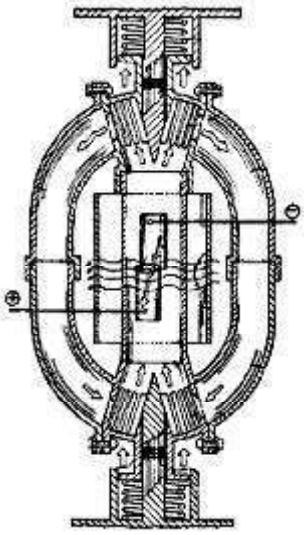

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Propulsion System
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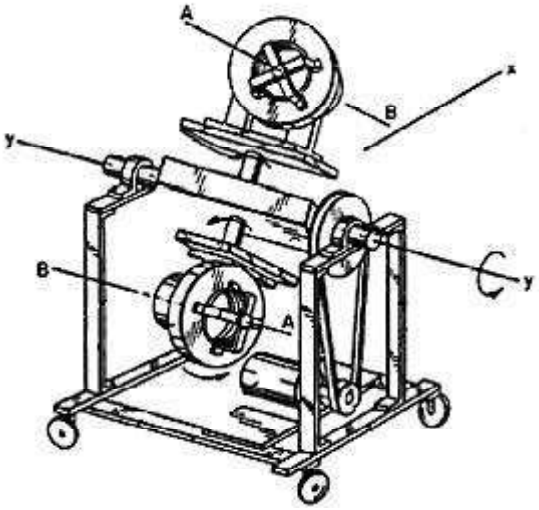

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Gyrostat Propulsion System
Derloy, M.S.& Derloy M.

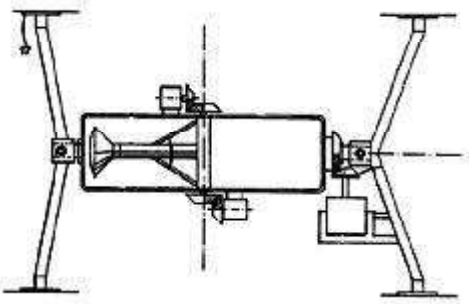

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Centripedal Device for Concentrating Centrifugal Force
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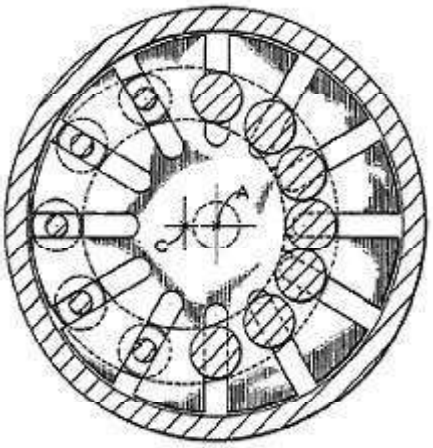

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Flywheel
Fulop, Charles.

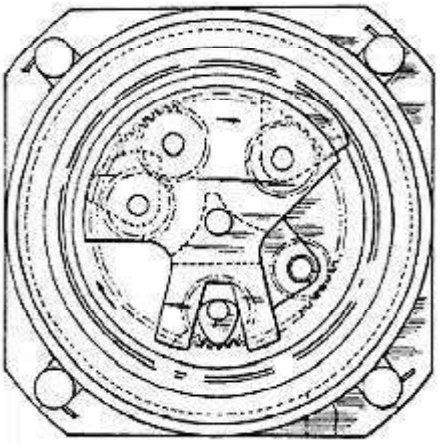

№ 5,042,313(8/27/91)
Conversion of Rotational Output to Linear Force
Montalbano, Paul J.

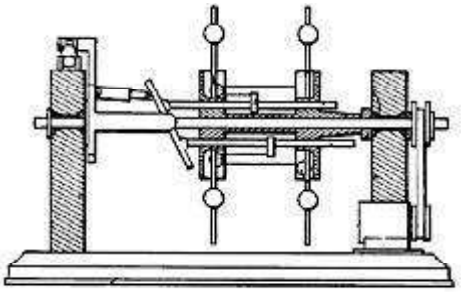

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Controllable Gyroscopic Propulsion Apparatus
Rodgers, A.T.

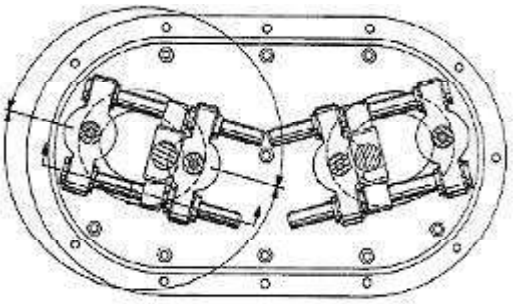

№4,770,063(9/13/88)
Universal Propulsion Powerplant & Impulse Drive Unit
Mundo, James D.

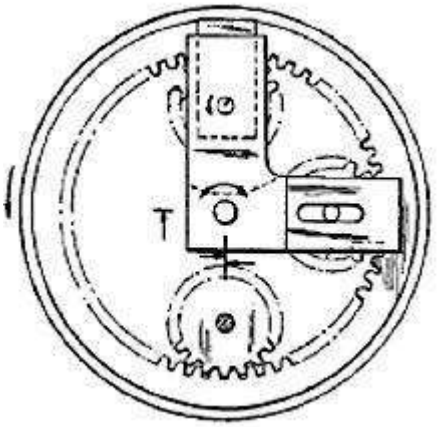

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Conversion of Rotational Output to Linear Force
Montalbano, Paul J.

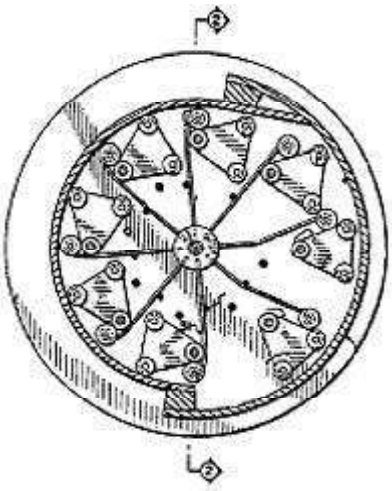

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Apparatus for Producing a Directional Unit Force
Peterson, Oscar F.A.

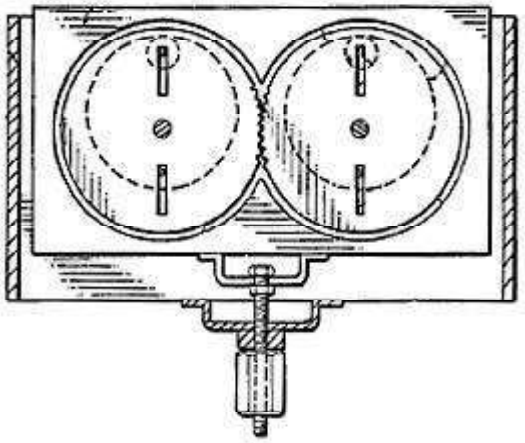

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Apparatus for Producing a Force
North, Henry.

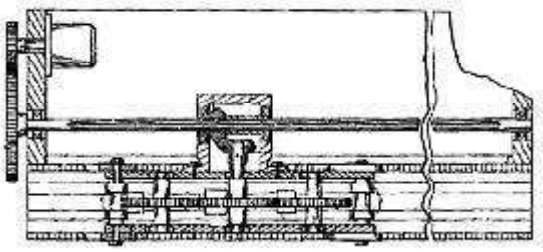

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Mechanical Propulsion System
Srogi, Ladislaw G.

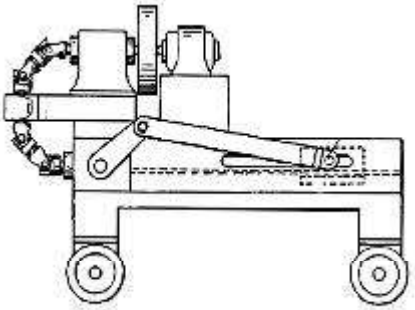

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Impulse Drive
Peppiatt, Alvin C., et al

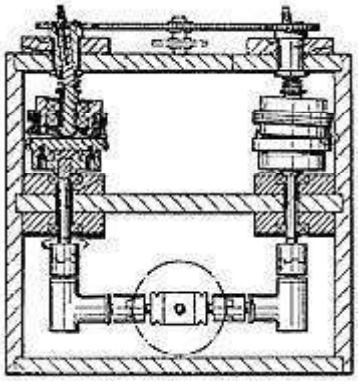

№4,409,856(10/18/83)
Propulsion System
de Weaver, Fred, III.

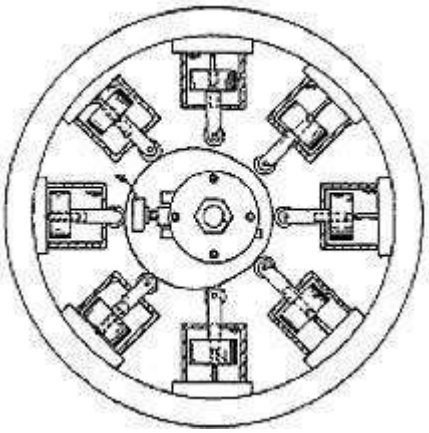

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Propulsion Apparatus
Dobos, Elmer M.

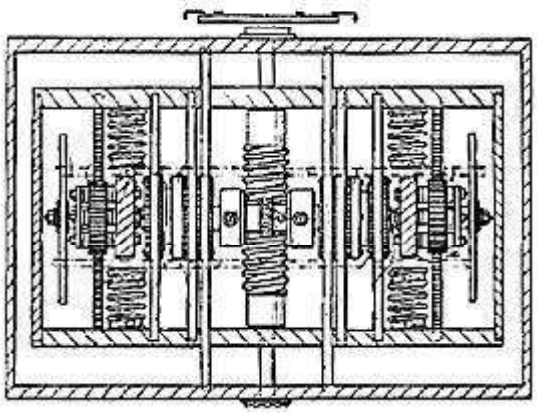

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Mechanical Propulsion System
Colla, Joseph.

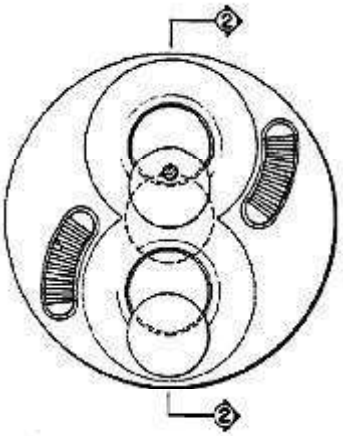

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Apparatus for Developing a Propulsive Force
Thornson, Brandson R.

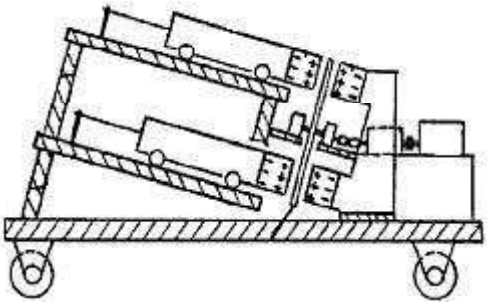

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Propulsion System
Mast, Oscar.

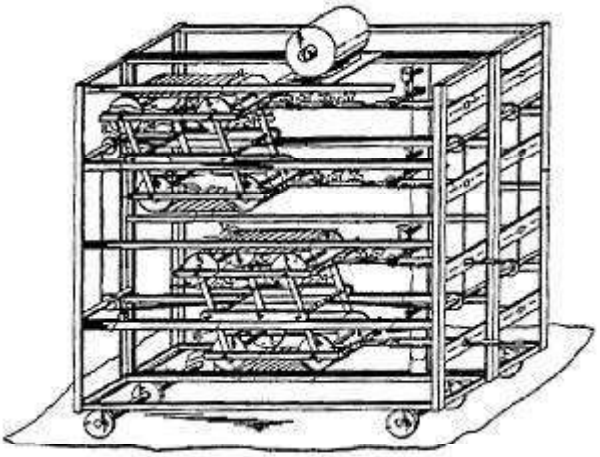

№4,726,241(2/23/88)
Continuous Force & Impact Generator
Melnick, Harry S.

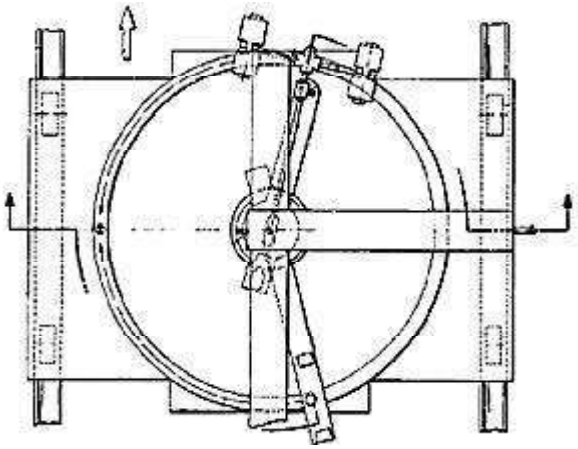

№4,238,968(12/16/80)
Conversion of Centrifugal Force to Linear Force & Motion
Cook, Robert L.

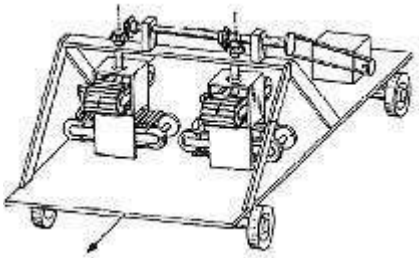

№4,261,212(4/14/81)
Unidirectional Force Generator
Melnick, Harry S.

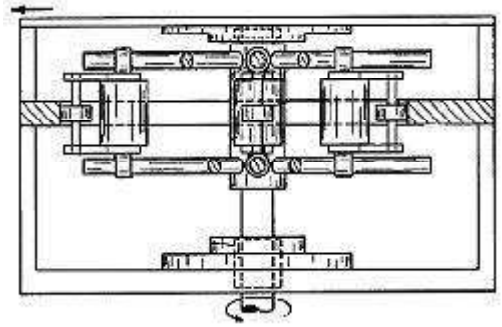

№ 3,968,700(7/13/76)
Converting Rotary Motion into a Unidirectional Linear Motion
Cuff, Calvin I.

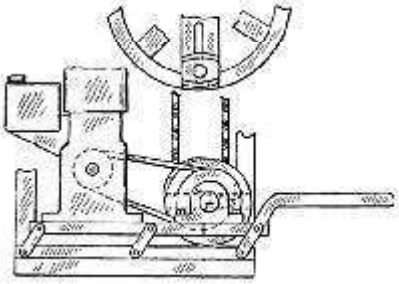

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Converting Rotary Motion to a Rectilinear Force
Dehen, Frederick L.

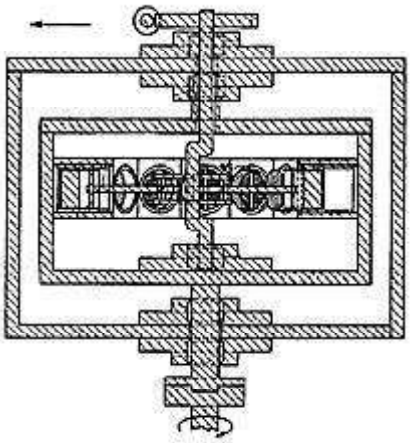

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Converting Rotary Motion into a Unidirectional Linear Motion
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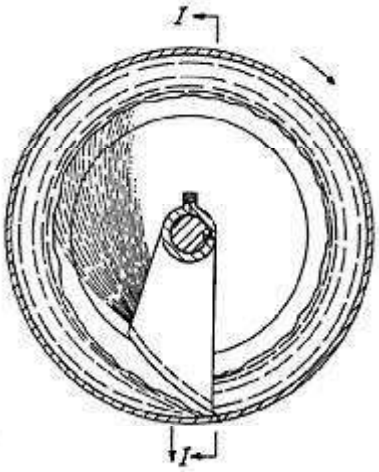

№ 3,979,961(9/14/76)
Propelling an Object by an Unbalanced Centrifugal Force...
Schnur, Nicolas J.

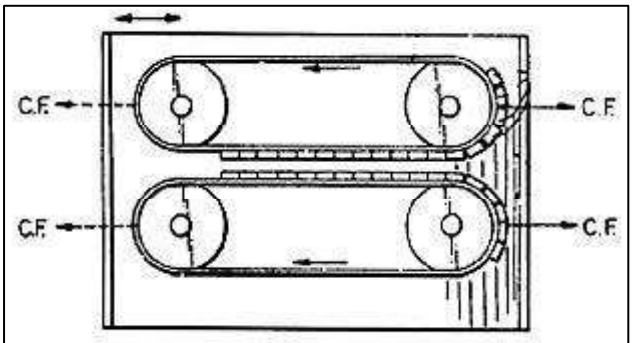

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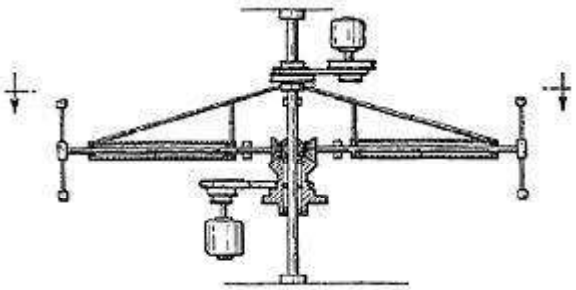

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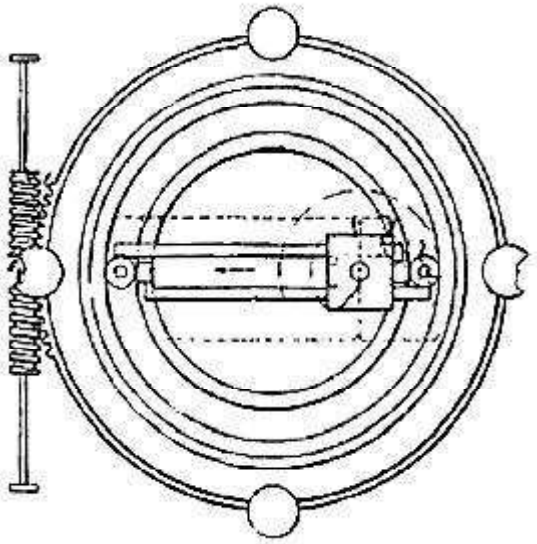

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Thrust Motor
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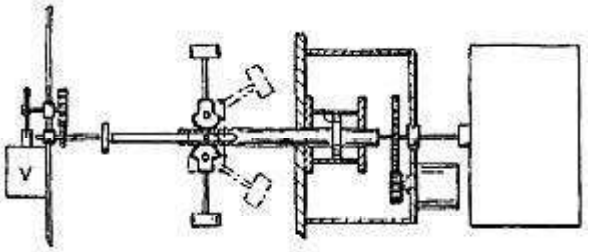

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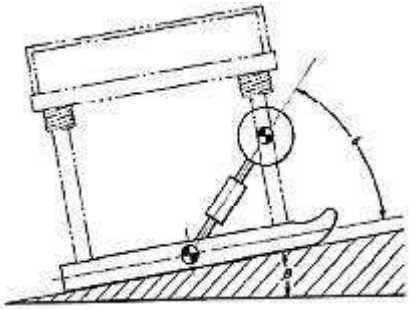

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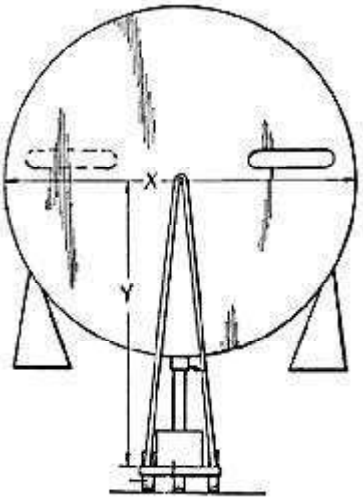

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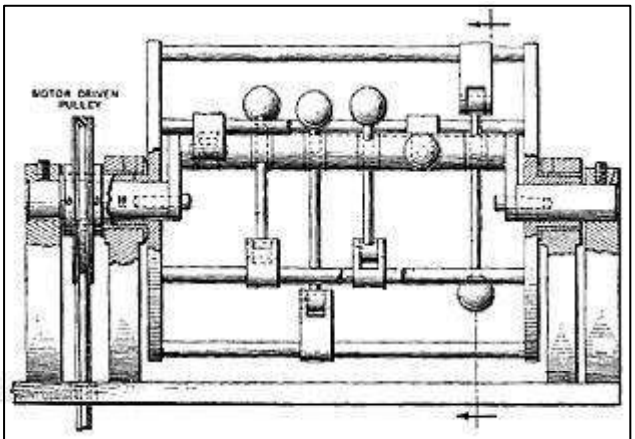

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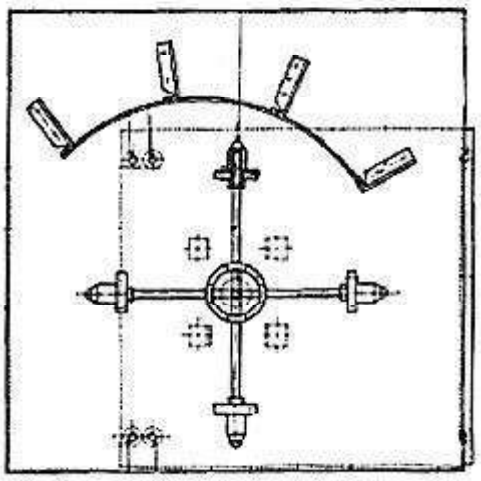

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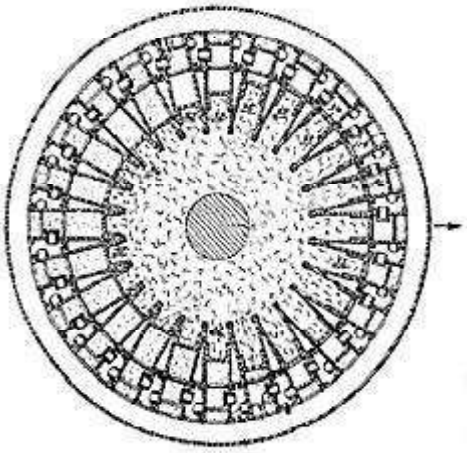

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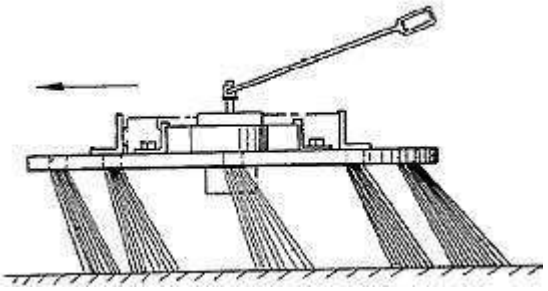

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Toy Vehicle Having...Self-Contained Drive Means
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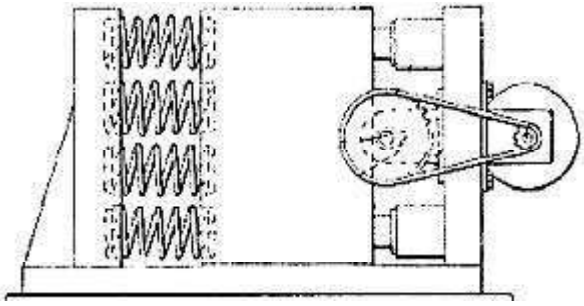

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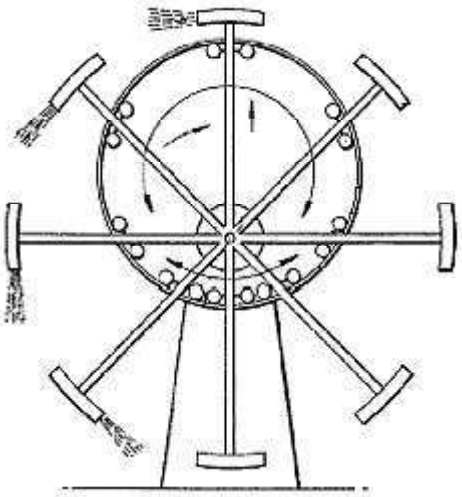

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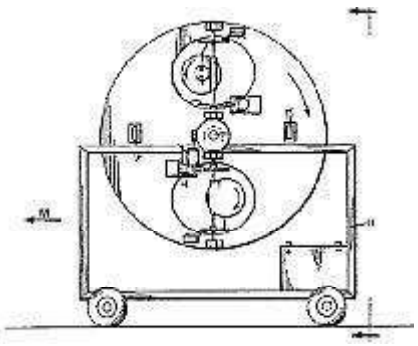

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Converting Rotary Motion into Unidirectional Motion
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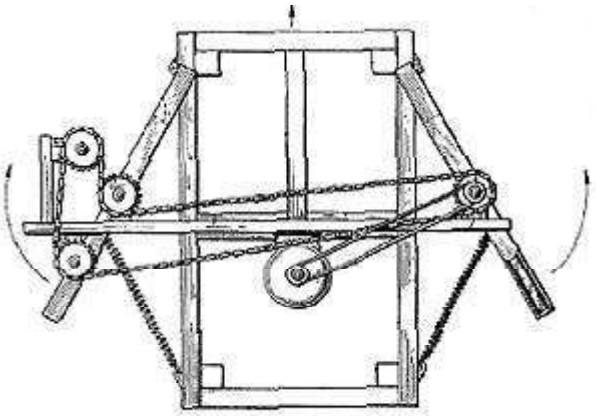

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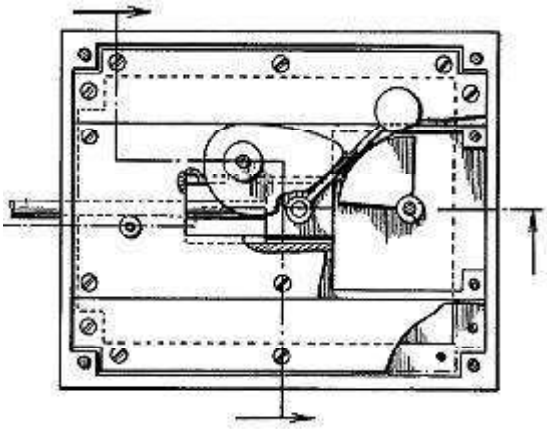

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Variable
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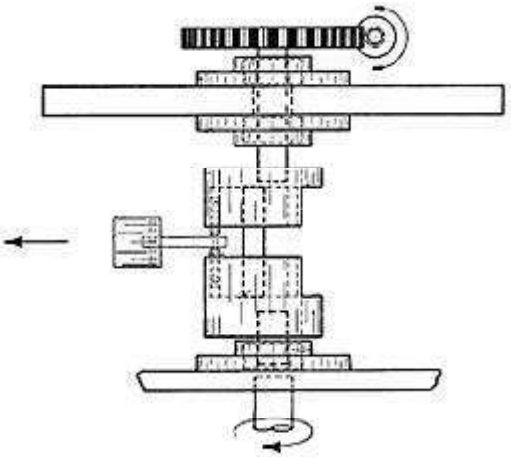

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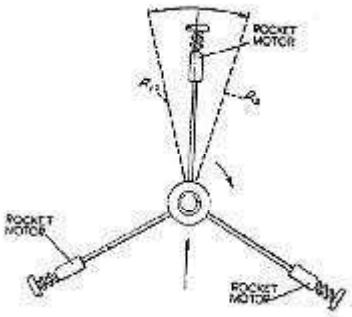

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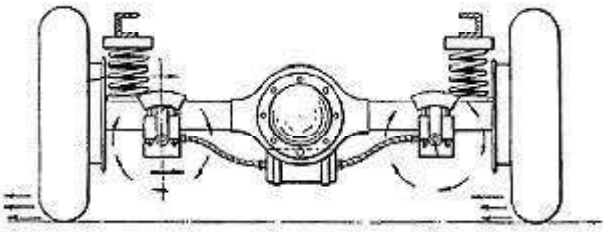

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Method & Device for Imparting
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Dull, Marshall L.

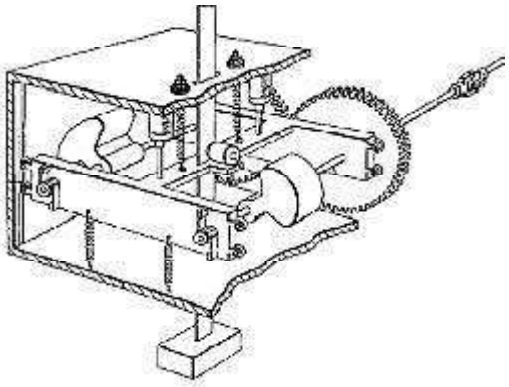

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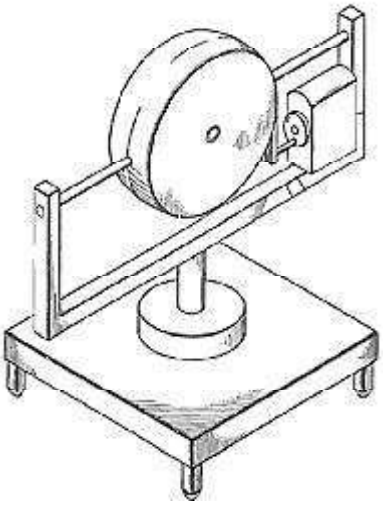

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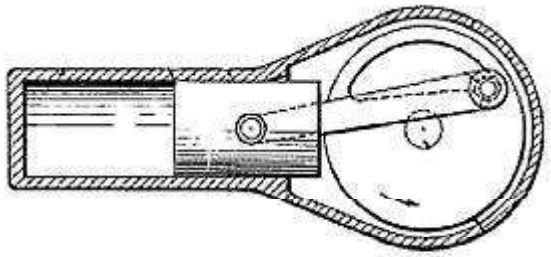

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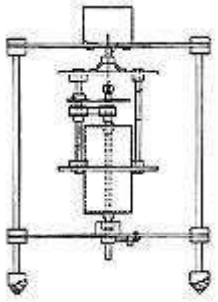

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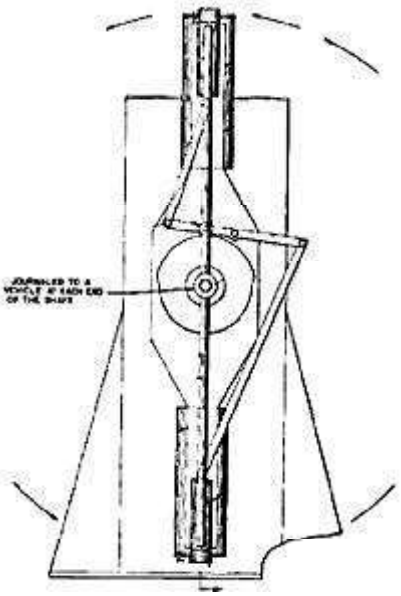

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Thrust Motor
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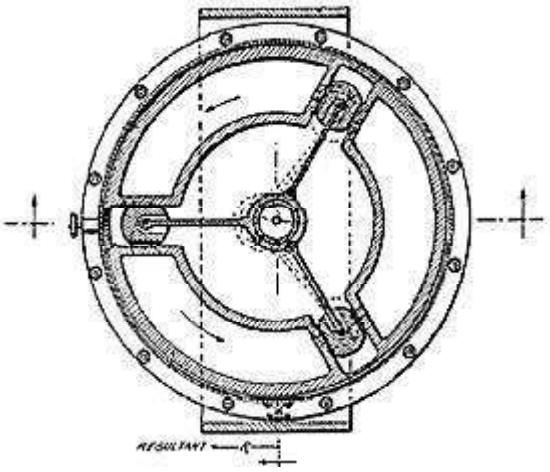

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Centrifugal Variable Thrust
Mechanism
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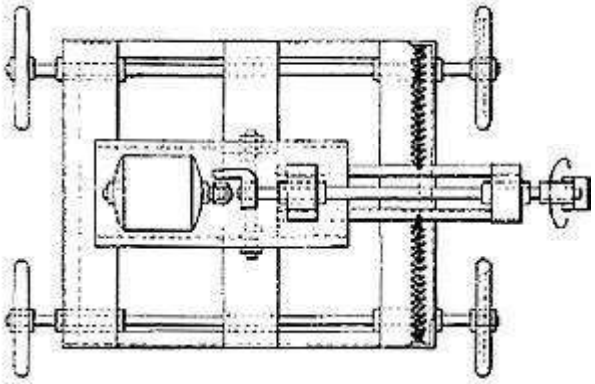

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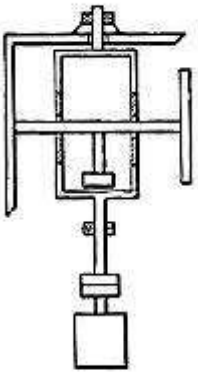

№ 3,404,854(10/8/68)
Apparatus for
Imparting Motion to a
Body
di Bella, Alfio.

The Free Energy Centrifugal Force Experiment

This experiment is conducted by Faraday Lab Ltd in cooperation with V. I. Bogomolov

In the previous issue we wrote about the invention of Bogomolov V. I. The device shown in Fig.1 (and also on the cover) was constructed and tested in our laboratory.

Fig. 1
The Device

The simplified diagram is known as "Maxwell's Pendulum" (Fig.2). This is a disk set onto the horizontal axis with two attached strings. The upper ends of the strings are fixed to the crossbar.

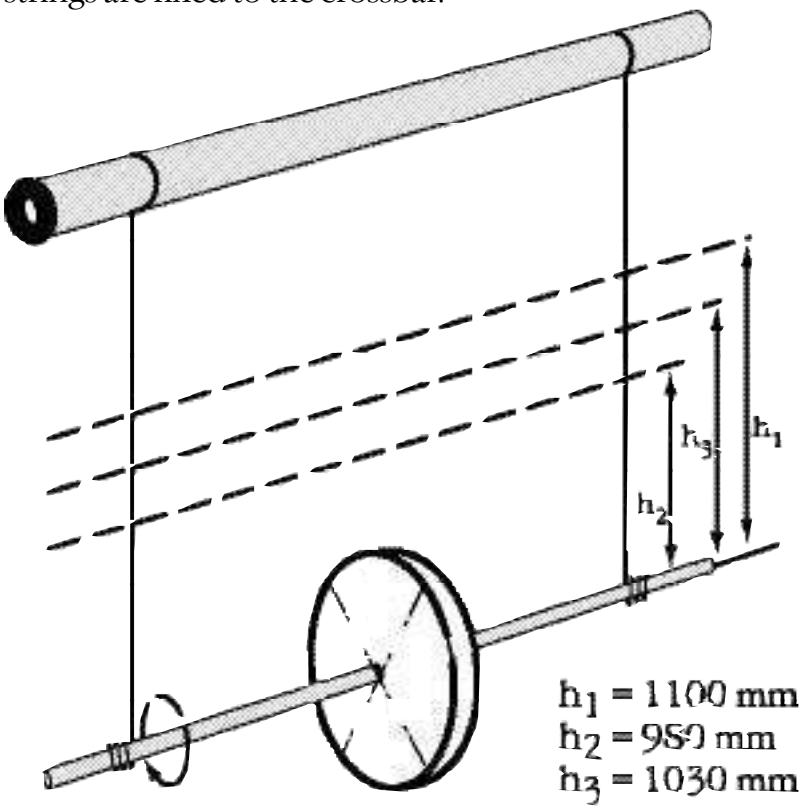

Fig. 2

If we wind the strings about the axis, the disk will lift (the height h) and store the potential energy of the Earth's gravitational field E = mgh (m - mass of the flywheel; g - free fall acceleration; h - the height of the mass fall). If we let the pendulum go, we can observe periodic "up-and-down" damped oscillations: first, the string spins and potential energy converts into rotation kinetic energy; upon reaching the lowest point the disk, still rotating, goes up using rotation kinetic energy and then converts it again into potential energy. This device is interesting: due to the energy conservation law we can observe the usage of rotation kinetic energy of the flywheel, measuring only the h-parameter, the lift height of the flywheel strings in the second semi-oscillation compared to the height with which the pendulum started falling in the first semi-oscillation, the difference h1 - h2 of the two semi-oscillations is directly proportional to the losses of rotation kinetic energy for air resistance work and friction.

We have made "Maxwell's Pendulum" more complicated by substituting the flywheel disk for the Watt centrifugal governor in accordance with its description in the article (1). The main difference of the device from Maxwell's flywheel is that the flywheel inertia momentum changes by the centrifugal force operation at the lever transferring of weights (the total weight - 1200 g) from the minimum radius position (40 mm) to the maximum radius position

(90 mm). At that, the levers compress the string with the force of about 16 N.

There have been three stages of the experiments. During the first stage we define the necessary lift height of 1100 mm at moment when the string winds around the axle. When the flywheel falls from this height, the rotation speed and centrifugal force are achieved, which move apart the loads to the maximum radius (90 mm) and which **completely compress the string**. During the second stage the loads are fixed at the minimum radius position (40 mm), thus the compress string centrifugal forces are not involved any more and we can measure the air resistance and friction **losses of kinetic energy**. At this stage the flywheel lifts up to 980 mm losing 120 mm. During the third final stage the load fixing rods are taken away and ***centrifugal forces are applied***. Just like during the second stage the Watt governor starts spin-falling from the height of 1100 mm. It compresses the string and lifts up to the height of 1030 mm thus **exceeding the second stage height by 50 mm**!

The experiment conclusions of the author:

1. At the third stage the flywheel exceeds the "loss height" h=980 mm. This means that the compression of the string was performed "for free".

2. At the third stage the flywheel converted kinetic energy into potential energy and lifted up 50 mm more. This means that in accordance with the principle of conservation of moment of momentum, the **outer compressed string energy force** has caused the moment of momentum change of the rotating masses, thus giving the additional acceleration to the flywheel and **increasing its kinetic energy "for free"**!

3. For the practical application of the Bogomolov generator in order to generate free energy it is necessary to achieve a high rotation speed (more than 10 000 rpm) and involve centrifugal forces to transfer the rotating mass to the less possible inertia radius difference.

The described centrifugal regulator diagram is not sufficient for larger experiments. For the industrial generator the author has a hydraulic-principle pneumatic string device drawing (know-how).

Editor: Also in this issue: the article on "Glen Gates Motor" by A. Akau. The principle is almost the same. The further implementation of this ideamay soon design purely mechanical power-generating systems, which use inertia and centrifugal forces.

References:

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Magnetic Power Inc. (MPI) is developing Self-Powered Generators. Together with its subsidiary, Room Temperature Superconductors Inc., (see the website www.ultraconductors.com), MPI has raised a total of more than $7 million from Angel investors to date.

Due to a pleasant surprise, solid-state electric power generators might be fabricated by modifying off-the-shelf utility hardware. If confirmed in coming weeks, this could result in serial fabrication by this time next year, since large devices of the type needed for conversion are presently manufactured worldwide.

Multiple modules may prove able to replace power plants. Smaller units appear practical for powering homes. Later, optimized designs might replace engines in every variety of vehicle. These generators may make possible very rapid utilization of fuel and pollution free electric power --a revolutionary, new, renewable energy alternative.

Accredited Angel investors can help speed the work needed to bridge into major capital, and accelerate this remarkable alternative. Multi-million dollar funding is on the horizon. Additional information is available privately. We welcome due diligence by qualified parties.

History of Perpetual Motion and Free Energy Machines

Web site http://www.phact.org/e/dennis4.html

Hundreds of people for centuries have attempted to solve the holy grail of energy production - **Perpetual Motion Machines**. Still to this day Eric Kreig gets weekly emails from people who feel they are about to get one working. Eric is very skeptical about free energy. But his collection of information is very interesting. Eric offered a special prize for those who will agree to publicly test their over-unity devices.

♦ **Villand de Honnecourt** 13th century had a drawing of one.

♦ **Leonardo da vinci** made a number of drawings of things he hoped would make energy for free.

♦ Jesuit priest, **Johanes Taisnerius** worked on a magnetic based perpetual motion machine.

♦ **Mimara** in 1518 designed a "self-blowing windmill".

♦ **John Dee** of 16th century reported seeing one - but wasn't allowed a closer look.

♦ **Cornelis Drebbel**, 1610, was an alchemist and magician supposedly made one.

♦ **Robert Fludd** 1630 proposed many machines -people were trying to patent variations of Fludd's device in the 1870's.

♦ **Edward Somerset** 1638 demonstrated many free energy water wheels to the king of France.

♦ **1635** - first of many English perpetual motion machine patents granted. - By 1903, 600 such patents had been granted. Free energy claimants love impressing people with patents.

♦ **Ulrich von Carnach** in 1664 in Germany designed a perpetual ball-moving machine.

♦ Scientist **Jean Bernoulli** (1667 - 1748) proposed a fluid energy machine.

♦ **Bockler** in 1686 made designs for self powered water mills.

♦ In 1712 **Johann Bessler aka Orffyreus** investigated 300 different perpetual motion models and claimed he had the secret of perpetual motion and got much investment money.

♦ **Dr Conradus Schiviers** in 1790 made a belt driven wheel.

♦ **Sir William Congreve** in 1827 tried a machine running on capillary action.

♦ Britisher **Henry Prince** 1866 described the first partially submerged perpetual motion machine.

♦ **Mark Zimara** of Italy had a huge air powered machine that never worked.

♦ **Horace Wickmam** of the USA got a patent to a machine with many balls that just rotate around.

♦ Austrian, **Alois Drasch** patented a machine in the US in 1868.

♦ German, **George Andreas Bockler** proposed 'self operating mills' using variants of Archimedes screws.

♦ **E. P. Willis** of Connecticut made money off a perpetual motion machine in 1870 - people eventually found out a secret source of power to it.

♦ **Charles Redheffer** in 1812 in **Philadelphia** made much money on a perpetual motion machine, tried to restrict scientific evaluation, but was eventually debunked.

♦ Scottish shoemaker **Spence** designed a magnetic based machine, which was debunked.

♦ **John Worrel Keely** of Philadelphia in 1872 (he also had a traveling show of exhibitions). He fooled many scientists with a machine, which appeared to run on water.

♦ **John Gamgee** in 1881 got considerable support for a machine very similar to Dennis Lee's, which used liquid ammonia - it got vaporized from heat readily available, thus expanding it would drive a piston. Gamgee thought the vapor would condense to liquid to start the cycle over again. The Navy appeared to have been fooled and showed it to president Garfield - it never went anywhere Tom Napier agrees that Dennis Lee may have resurrected Gamgee's engine.

♦ **J. M. Aldrich** was arrested for getting investors for his free energy machine in 1899 - he some how was able to avoid conviction and conned many investors. One of whom was finally able to inspect the machine found a hidden spring.

♦ **T.H. Moray** in the 20's demonstrated a "radiant energy device" to many people who were unable to find a hidden power source. Some how, the secret was said to have been forgotten.

♦ **Lester Hendershot** in 1928 got an Army commandant to endorse his free energy machine - but it was later found to have a hidden power source in the motor. His sons believe Lester lost his notes and that maybe they can rediscover how to get it to work.

♦ **Viktor Schauberger** claimed to have discovered some special vortex energy in water. Since he died in 1958, I don't know if his claims have been replicated, but people are still studying his works.

♦ **Mr Papf** in 1966 was a conspiracy believer alternative car engine got a few investors but killed someone during a demo. He tried to blame the problem on an investigating skeptic. He disappeared and became part of urban legend of scores of people, which the big conspiracy has been silencing for generations.

♦ **Guido Franch** was convicted of fraud in 1954 and 1973 of selling rights to distribute little green pills that would convert water into gas. He hid behind conspiracy theory and secrecy to avoid fair testing. A number of people have run this scam and many people still believe there are pill repressed by the oil companies.

♦ **Garabed T.K. Giragossian** in 1917 claimed to have a free energy machine. He was one of the early frauds to hide behind conspiracy theory. Woodrow Wilson signed a resolution offering him protection from some kind of conspiracy. After much fanfare, and delaying tactics his machine turned out to be a giant flywheel, which was charged up with energy slowly and put out a lot of energy for just a second. In spite of lack of proof of anything significant his followers still bothered the US congress for recognition.

♦ **Otis Carr** in 1958 sold stock for a company to manufacture UFO's and free energy machines from Oklahoma. He claimed inspiration from Tesla.

♦ **Edgar Cayce** even babbles about "Motor's with no Fuel".

♦ **McClintock** was claimed to use air as a fuel and had a patent.

♦ The **Evgray** machine scammed many investors (who didn't know how to test 'depleted' batteries).

♦ **Arnold Burke** in 1977 collected $800,000 of investor money (again, mostly from bible believing farmers) for a 'self acting pump'. He tried to hide behind religion. He called his device Jeremiah 33:3' Finally, an open test was done in 1979 and found a hidden source of electricity. His believers (with

an infinite supply of denial) still raised $250,000 to get out of a fraud conviction. He still went on making lots of claims with no evidence.

♦ **Robert Adams** in 1977 made all kinds of conspiracy and OU claims in New Zealand. Many still believe in the Adams Motor. - He had the obligatory battles over patents, debates over theory, debates over power measurement and dabbling in other areas of alt physics. He's 80 years old and said to have a scientific education. He has a lot of theories about Aether. Skeptical information.

♦ **Robert Stewart** in 1978 got over $3,000,000 of investment money (much from farmers) for a closed cycle engine using freon rather than water. This 'engine' used the same scheme John Gamgee tried to sell the navy in 1882. -Eric Krieg thinks this is the same approach Dennis Lee's free energy machine works on. I think he just faded away (people claim he was silenced).

♦ **Rory Johnson** of Elgin Illinois, claimed to have invented a cold fusion, laser activated, magnetic motor that produced 525 HP, weighed 475 lbs, and would propel a large truck or bus 100,000 miles. After signing a number of dealers, he moved all his equipment out of his labs, moved to CA and died. (To this day, folks say he was silenced by OPEC).

♦ **RJeseph Maglich** was a physicist and claimed to have a device in 1978, which harnessed fusion power from seawater. They say they put power in and get more power out. I've never heard of them since.

♦ **Howard Johnson** got a patent for a device that claimed to make free energy from a motor like device. As of 11/02, Stephen was claiming he would soon mail out samples of working ones. By 12/12/02, Stephen dropped out of contact.

♦ **Keith Kenyon** had a device claimed to produce more energy than consumed. Calculations seemed to not take power factor (also known as phase angle) into account. It never openly had its output hooked up to its input. Even Dennis Lee tells his followers that all the *over unity motors* (claim to make more electricity than consumed) usually just fool people who can't measure power factor.

♦ **Muller:** Bill Muller and Carmen Muller of Germany raised money on an over unity motor and got a few followers, but never actually demonstrated one working.

♦ **Dennis Lee** Since 1988 has been promising to demonstrate free electricity "in a month or two". He is much like Newman in his mixture of religion & extremist politics, evasion of qualified investigators, endless promises, threatening detractors, etc. He had a Fischer engine, a CRD device and now, and OU motor device. Dennis has invested in Searle and Stanley Meyer and joined Pantone in 2001 in a 50 state tour.

♦ **Stanley Meyer** 1996 claimed to have a water powered car and was also big on mixing Christianity and patriot politics in with fringe science. Meyer was found guilty of fraud after his Water Fuel Cell was tested before an Ohio judge. It is rare for an inventor to be prosecuted for an invention that does not work, but Meyer's problem was that he had been selling "dealerships", offering investors the "right to do business" in Water Fuel Cell technology. Meyer refused to allow anyone else to measure his device. Dennis Lee invested in him. He died in early 1998.

♦ **Joseph Newman** in 1984 claimed to have a free energy machine based on alternative physics. Like many perpetual motion inventors, he sued the US patent office. Many people wrongly measured the true power output of this machine, (they didn't realize you must specially calculate power for non sinusoidal current consumption). He now refuses to ship a unit for testing. Ten years ago, inventor Joseph Newman gave an open week-long demonstration in the Super dome in New Orleans. Over 9,000 people attended from across the country (including Dennis Lee who reportedly wanted to join his ideas with Newman). Newman is suing some former

investors he claims are trying to steal his invention. I give more information. Evan Soule of Newman's organization offers a rebuttal.

♦ **Bruce De Palma** had a machine in 1986, which appeared to one Electrical Engineering professor to put out 4 times more power than consumed. Turned out it was just a measurement error. (We could go on and on with such examples).

♦ **Dr. Potapov** sold a device that was claimed to produce more energy than consumed.

Editor: Eric's skeptical remarks can be tolerated but sometimes he writes about the things he does not know. Potapov and his team have created a technology, which have been replicated and sold by dozens of companies in Russia (see the cover picture of the Susorov heat generator). There are several devices in St. Petersburg to be tested. The efficiency is 200 % and more. The operation principle: electric motor rotates in water and causes the heating of water. We have also received the information about another Russian invention, namely the close cycle vortex generator: "water rotation – vapour – turbine – electric power " (the power is from 100 kW).

Alexander V. Frolov

♦ **John Bedini** claims to have a free energy device.

♦ **Mr. Finsrud** is a Norwegian artist who made a sculpture where a metal ball moves for weeks apparently with no outside influence.

♦ **Don Watts** of Las Vegas in around 1990 had a patented **CEACU**, which stands for Centrifugal Energy Amplification and Conversion Unit - it turned out to be one more investment fraud.

♦ **Stephan Marinov** claimed to have proven much alternative physics and to have contacted a Methernitha that claims to have a Free Energy Machine. He committed suicide on July 15, 1997 but he left behind some intense rants.

♦ **Greg Watson** sold kits for a rolling ball and track that were thought to have over unity in 1997. Attempts of replication I know of have failed.

♦ **CETI** These people have claimed to have a device that puts out anomalous yet small amounts of heat - maybe cold fusion. They raised millions. As of 10/97, they have not been willing to have me come over and see for myself. They have said, *we want people to think it doesn't work so we won't have competition.* I've wondered if the energy may have come from not accounting for friction effects from the cooling flow through the pellets. (**Jed Rothwell**, a rational editor of Infinite Energy Magazine says *"however, tests with CETI cells at Motorola, SRI and the French Atomic Energy Commission show no measurable friction"*). Milton Rothman has a response: "I openly admit that I have not followed all the history of cold fusion claims and am generally ignorant on the subject".

♦ In January 1998 **Barbara Hickox** allegedly has a patent dating from 1981 for a fusion powered free energy system.

♦ **Paramahamsa Tewari** of India claims to have a device that is 200% efficient.

♦ **RQM** is a Swiss company selling FE machines found at www.rqm.ch.

♦ **Ted King** is looking for people to buy stock for a car he plans to drive across the country using just 2 12-volt batteries. You can contact Ted if you want to buy shares.

♦ **Bruce Perreault** has claimed to have discovered a new element, the plasmatron, ion pump, radiant energy device, etc.

♦ **Daniel Pomerleau** of Canada claims to have something that works, but he isn't interested in releasing it (as 12/97).

♦ **Entropy Systems** of Ohio 1999 Sanjay Amin got 1.6 million investment dollars for a device that would violate the 2nd law of thermodynamics. I've asked them to apply for my prize for proof. - They seem to have folded. See a rational review of Amin's claims.

♦ **Brian Collin** of Australia claims revelation from God *(like most of these people)* to make a free energy device. A Stephen Mark claimed he invented it.

♦ **Kawai** and **Takahashi** - both of Japan claimed in the 90's to have overunity devices.

♦ **Carl Cella** claimed to have one of the many cars said to run on water.

♦ **Robert LeBreton** in 1999 claimed to be making a 600 hp free energy machine.

♦ **Renzo Boscolio** in 1999 in Italy claimed to have low-energy nuclear reactions but refused to supply real proof that he promised to people who came out from Infinite Energy Magazine.

♦ **Doug Konzen** of Seattle says he has an overunity motor in Jan of 2000 that anyone can see.

♦ **Troy Reed** of Oklahoma was ready to issue licenses for manufacturing his permanent magnet motor etc. He's taking investment money for a device he claims puts out more heat energy than input energy. He says he's dumped a few million into his designs over the last 10 years and had little interest in my prize offer when I contacted him in 2001.

♦ **Kipper Motor.** In 10/00, Steve Elswick thought it was overunity. But David Sligar who paid $175 for plans could not get it working.

♦ **Ludwig Brits and Victor Christie** in 2001, claim the **Lutec** free electricity over unity motor/generator will soon be in Australia.

♦ **Jasker** in 2002, an Irish company has claimed to have free electricity. (Some have said it is just a joke).

♦ **Confidential Technology -Wayne Cochran** died 12/29/02 Crazy Jack Carey took over. They have been promising FE soon for about 20 years now.

♦ **Tom Bearden's MEG device:** many articles on the Internet.

♦ **Gurbakhsh Singh Mann of India** claims to have invented gravity and buoyancy perpetual motion machines.

♦ **Michael J. Marshall** in Las Vegas has a device called QSFG , which stands for quick start fuel-less generator he says 64 nations have asked him to build factories.

♦ **Carl Tilley and Robert Kibbey** in 6/2001 in Tennessee have claimed some over unity device and other stuff. Their demonstration failed in 9/02 and as of 11/02, they have been evading proper demonstrations.

♦ **Stephen Walker** in 9/2002 promised to send me and several others a free energy machine in mail.

♦ **PerEnDev** promised to make some kind of free energy by means of magnets.

♦ **Bill Muller** of Canada in 2003 claimed to have some kind of OU device. Independent tests found it under unity.

♦ **Energie:** In 2003 this Greek company promised a homopolar magnet (De Palma design) FE design by June of 2003. They actively seek investors.

♦ **GWE Genesis World Energy** In 2002 this group claimed to have 400 people who developed some device that sounds like it separates water into H2 and O2 using less energy than mainstream science says is possible. As of 2003, they have evaded independent confirmation. More information is available.

♦ **Steven Greer (Disclosure Project)** In 02.2003, Steven announced he had discovered some real sources of Free energy, which he promised to make sure get proven to the general public.

Tesla Energy Science Conference and Exposition

1220 L Street NW, Suite 100-232 Washington DC 20005
Tel: 800-295-7674
Fax: 301-513-5728
www.IntegrityResearchInstitute.org
Email: iri@erols.com

Saturday, November 8, 2003
Wireless Electricity Seminar

9:30 AM 10:15 AM

Opening Address: "Space Solar Power" – Dr. **Paul Werbos** Program Director, National Science Foundation

10:15 AM 12:15 PM

Special 2-Hour Presentation: "Nicola Tesla and the development of RF Power Systems" - Dr. **James Corum**, Physics Professor, research Scientist and Inventor and **Kenneth Corum**, Physicist, teacher, consultant.

2:00 Pm 3:00 PM

"Power Engineering Scalar Field Theory: Faraday vs. Maxwell and Longitudinal Wave Demonstration" – Professor **Konstantin Meyl**, Engineer, Author, Inventor of the Demo-Set, Professor at the University of Berlin

3:15 PM 4:15 PM

"Wireless Energy Through the Earth-Ionosphere Cavity" – Dr. **Elizabeth Rauscher,** Nuclear and Astrophysicist, Inventor of the ELF Earthquake Predictor and Triangulator.

4:15 PM 5:15 PM

"Masters of the Ionosphere HAARP Modifies the Polar Electrojet" – **BBC Video on Tesla Technology**, with Wiliam Terbo, demonstrating ionospheric excitation by radio waves.

6:30 PM 7:15 PM

Masters of the Ionosphere – BBC Video Presentation **repeated** for the Special Tesla Evening Event attendees

7:30 PM 8:30 PM

"The Wardenclyffe Dream: Tesla's Plan for Wireless Worldwide Distribution" – **Dr. Marc Seifer** Professor, Author of the best-selling book *Wizard, The Life and Times of Nikola Tesla*, presents an illustrated historical account.

8:30 PM 9:00 PM

High Voltage Tesla Coil Demo – **High Voltage Device** with **Music**: The Tesla Tower wind ensemble composition by Prof. **Holland**, Skidmore College

Sunday November 9, 2003
Electrotherapeutic and Tesla History Day

9:30 AM – 10:30 AM

"A Family Perspective on the Personality of Nikola Tesla. Review of the Popular Interest in this Scientific Icon" with Q and A Session – **William Terbo**, Engineer, Closest living relative of Tesla (Grand-nephew). Founder and Director of the Tesla Memorial Society.

10:30 AM 11:30 AM

"The Search for Free Energy: Genius, Vision and Psychology of Invention" – **Keith Tutt**, British Writer and Author of the book *The Scientist, The Madman, The Thief and their Lightbulb* that includes Tesla.

11:30 AM 12:15 PM

"Electrotherapy with Tesla Coil Design: Intorduction to Bioelectromagnetics" – Dr. **Thomas Valone** Physicist, Professional Engineer, Author of the new book, Bioeletromagnetic Healing: A rational for its Use.

12:15 PM 1:00 PM

Exhibitors Presentations – **Brief Presentations by exhibitors** (5-10 minutes each)

2:00 PM-3:00 PM

"Emerging Opportunity: cancer Electromagnetic Frequency Therapy" – Dr. **Mark Neveu** President, the National Foundation for Alternative medicine.

3:00 PM 4:00 PM

"Turn of the Century Electrotherapy Discoveries" – **Jefrey Behay** Director, The Turn of the Century Electrotherapy Museum.

4:00 PM 5:00 PM

"How a Crushed Leg Helped Me Discover High Voltage Electromagnetic Healing Device" – **Ralph Suddath**, Third generation Tesla Electrotheraphy Inventor, radio Host, Entrepreneur.

5:00 PM 5:15 PM

Closing Remarks – **Thomas Valone** Program Coordinator

The Conference Report Compilation can be purchased from T. Valone, Integrity Research Institute.

"Nornikel" and Alternative Energy

"Norilsky Nikel", the largest Russian non-ferrous metal producing company has announced the beginning of the cooperation with the Russian Academy of Science. Metallurgists are planning to invest into the development of the hydrogen energy and fuel cell R&D projects of the Russian Academy of Sciences. Accordingly, last week an agreement was signed. **Mikhail Prohorov**, the General Director of "Nornikel" said that they are ready to invest 20-40 million dollars annually into R&D projects of the Academy in this field.

"Expert" magazine, # 43, November 17-23, 2003

PERENDEV Magnetic Motor

Review

www.perendev.co.za/products/magnetic_motor/index.html

Shown below is a Magnetic Motor with Alternator (Patent Pending):

Fig.1

This is the "PerEnDev" (Perpetuum Energy Devices) company latest motor predicted to deliver some 60 kW. Motors can be built up to 4 mW.

Background of the Magnetic Motor

The Company started in 1969 with the development of a magnetic motor to drive an alternator to produce electricity. The concept was sound but the problem they faced was that the magnets that were available at the time (ferrite magnets) were not very powerful. The unit ran but had very little power and the project was abandoned.

In 1996 the "Perendev" company started to investigate the possibility of reviving the original idea, magnets had now come a long way and were very powerful (rare earth).

Fig. 2
Rare earth magnets

After the engineers successfully designed a new model, the company developed a 3 rotor system producing 6 kW, coupling this to an alternator through an 11:1 gearbox to produce electricity in 220volt and 380volt, single or 3 phase.

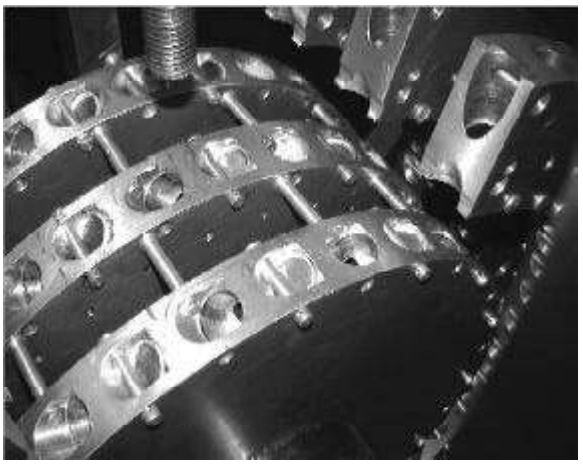

Fig.3

The units will be ideal for the small and large user, such as emergency, military, farms, plots,

industrial and large users... in fact any application requiring power.

Key Benefits Foreseen:

- No fuel costs
- Constant running
- Reliable
- Cost Effective
- Portable (6kw-120Kw)

Editor: In 2002 "Faraday Lab" got an offer from the company to buy their 6 kW generator for testing at the price of about $6,000. However, no contract was signed. The company is currently engaged in redesign of their motors and is looking for regional partners but they are not yet ready to produce on the line. In our issues we will try to inform the readers on their activities. Alexander V. Frolov

Internet Pages

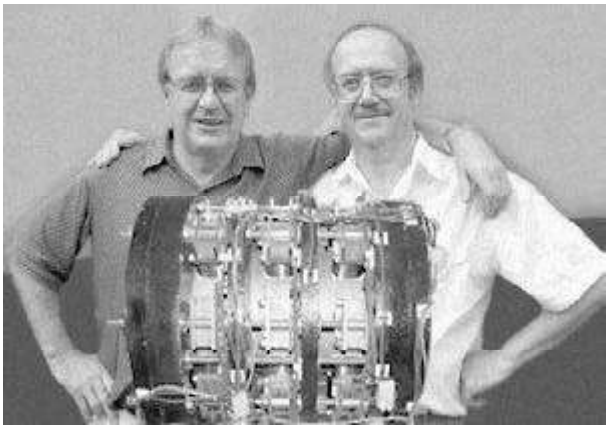

Lutec 1000

Jasker Power System

Electric Radial Motor

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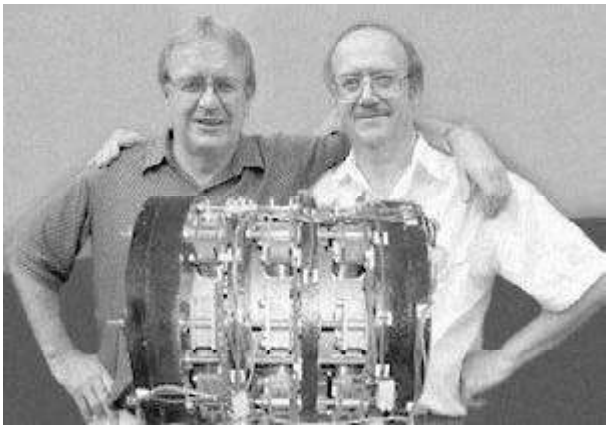

Lutec 1000

Jasker Power System

Electric Radial Motor

18 Meter Perpetual Wheel

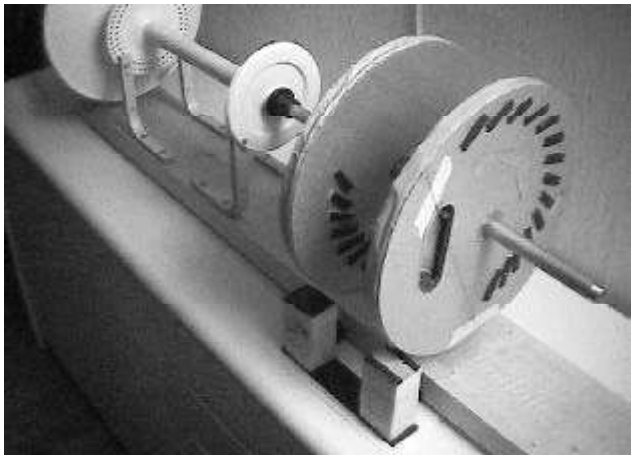

Minato Wheel, E. Vogel, Sweden

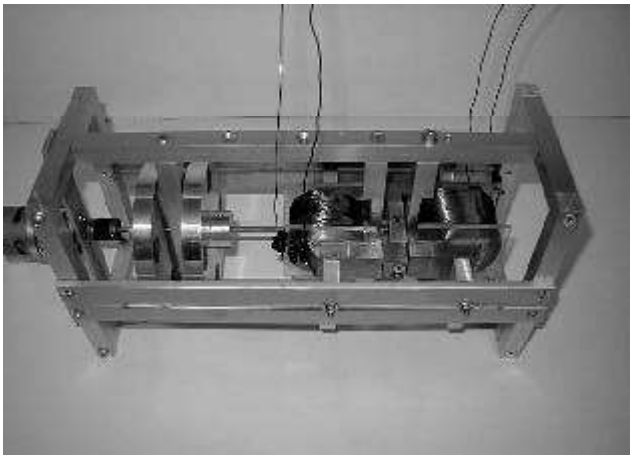

Generator from James W. German

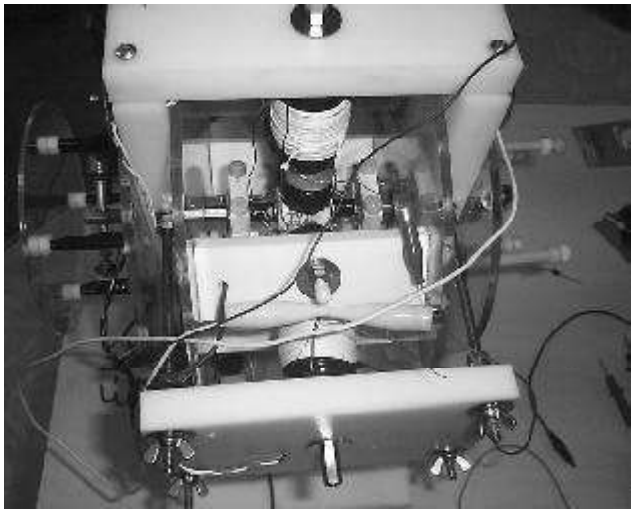

Konzen
Pluse Motor

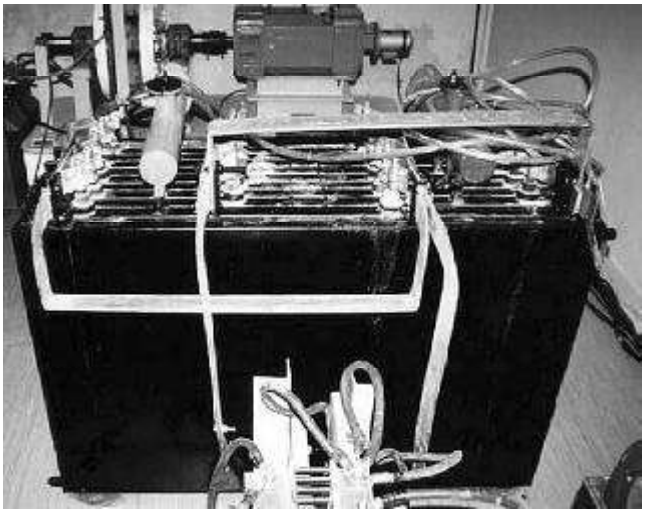

200-300 percent over-unity energy Space
Power Generator

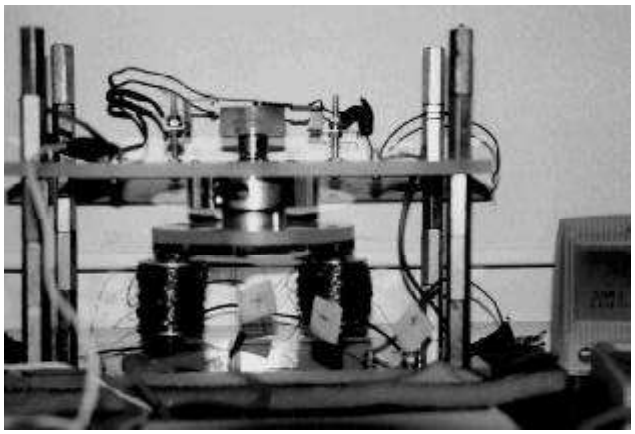

Adams Motor, Robert Adams

The RotoVerter

Bendini Pulse Motor

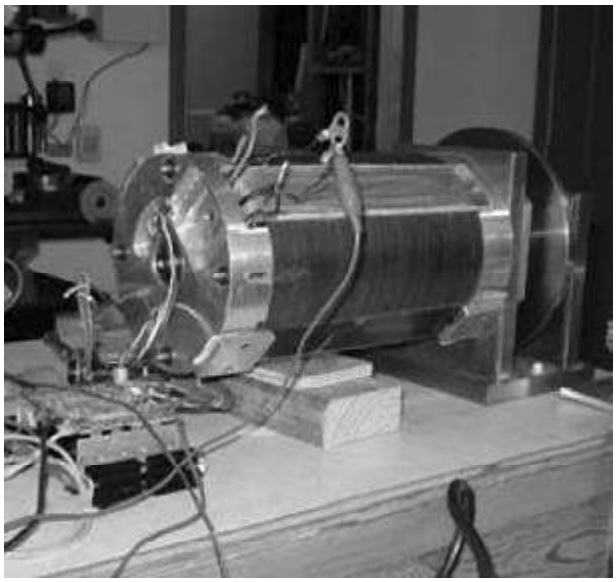

Motor based on Flynn Technology

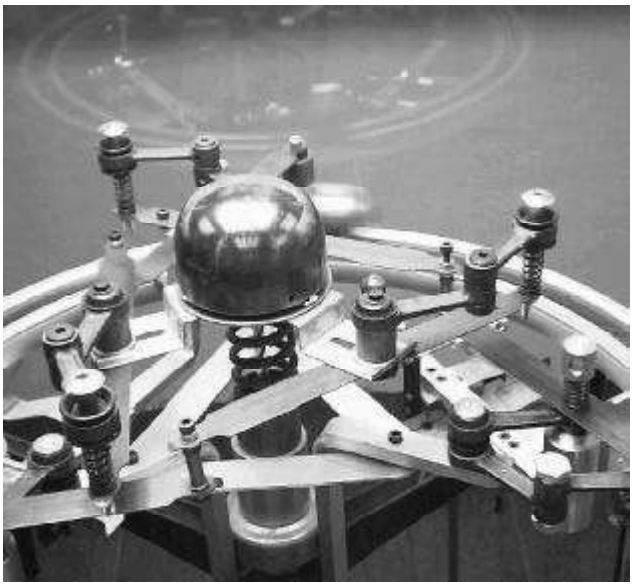

Finsrud Device

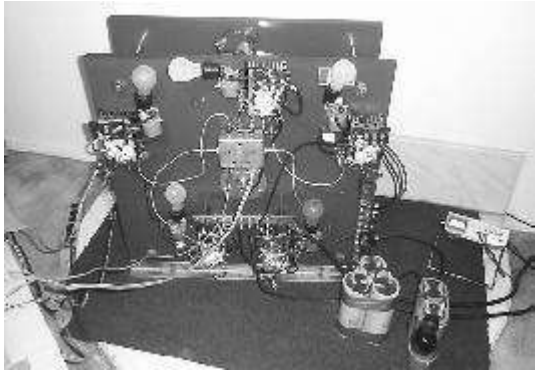

The Muller Unit

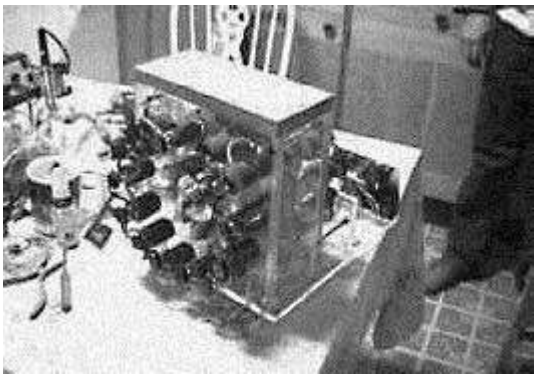

Alte Olsen Generator

Vladimir Matveev's Electrical Generator

Entirely New Kind Of Generator Invented!

(1-26-2003) TASHKENT, Uzbekistan (UPI) – An Uzbek inventor said he has created a type of electrical generator that does not rely on the principle of electromagnetic induction – on which all existing generators are based.

The new generator employs a concept called **magnetic conductivity modulation** and it has potential applications in industry, communications, households and even the military, explained Vladimir Matveev, the inventor, a specialist in electronics.

Matveev said he is convinced he has created a fundamentally different machine.

"All electrical machines I know are based on the principle of interaction between the magnetic fluxes (lines of force) of their rotor (rotating member) and stator (portion that remains fixed)," he explained.

Such machines, Matveev said, are based on electromagnetic induction, a property of energy discovered by Michael Faraday, an English physicist and chemist, in the 19th century. The machines produce electrical current either by moving a conductor across a magnetic field or by regulating the flux of that field.

"My machine has a principal difference," Matveev told United Press International. "The magnetic field of its stator does not interact with the magnetic field of the rotor (because) its rotor is not a magnet – the rotor only changes the magnetic resistance of the stator," he said.

The stator in Matveev's generator contains a magnetic core with a permanent magnet and a detachable winding. A rotor with changeable magnetic resistance is placed at a cutoff point in the core's magnetic field. It is composed of alternating magnetic and air parts and can operate in either linear or rotary form.

When the rotor is set in motion, its alternating components pass through the magnetic core's cutoff point. When the magnetic part passes through the cutoff point its magnetic resistance decreases. When the air part passes through, its resistance increases.

This pulsing of resistance results in changing the magnetic conductivity of the magnetic core, which in turn produces an alternating electrical current in the core's winding. The frequency of the winding's current can be controlled by regulating the rotor's speed or by changing certain qualities of its magnetic or air parts. Also, the generator's electrical

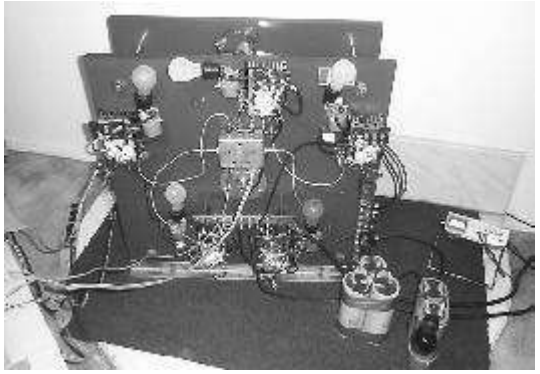

The Muller Unit

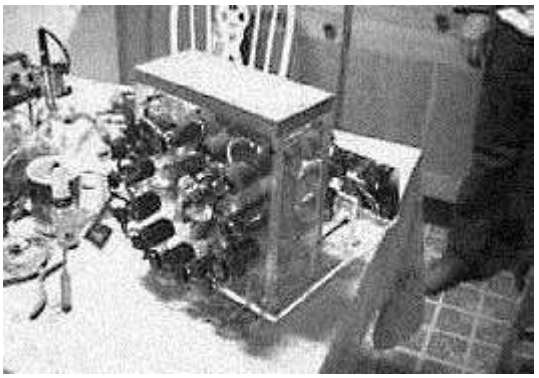

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output – its voltage – can be controlled by changing the configuration of the rotor's components, Matveev explained.

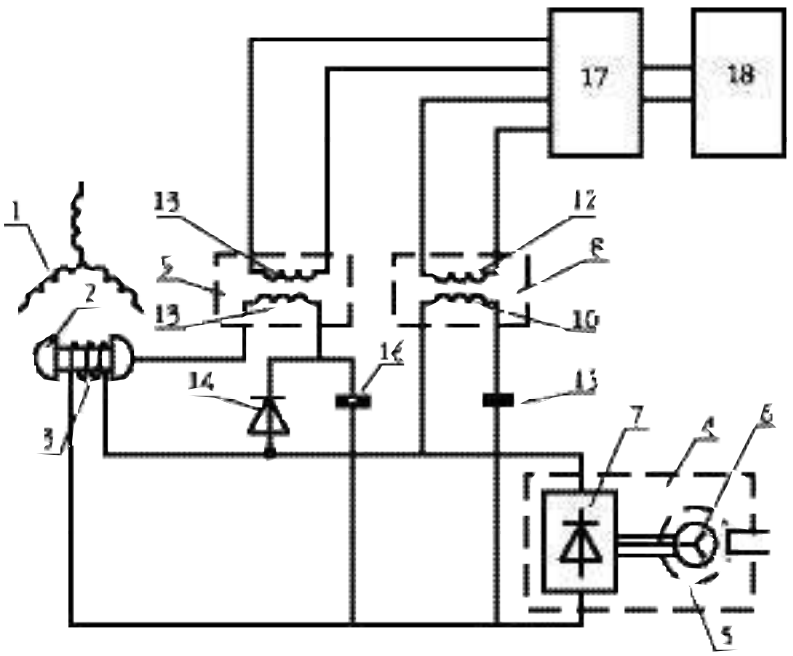

Electrical machine assembly - FEDORO V F 1996.10.10 1996RU-119822 (1998.09.27) G01R 31/34, 31/02

Addnl.Data: VOROBEI V K MATVEEV V A

NOVELTY - Device has electrical machine, non-brush field exciter with diode rectifier, two dynamics double-winding transformers, which primary windings are located on rotor and secondary windings on stator. One end of primary winding of second transformer is connected to rotor housing; another end is connected to common point of conductor which is connected between capacitor and cathode of semiconductor diode, which other terminals are connected to direct current terminals of diode rectifier. Semiconductor diode is connected to cathode group of rectifier; capacitor is connected to anode group. Secondary windings of transformers are connected to actuating member through generator of signal, which is proportional to resistance of insulation in excitation winding circuit.

USE - Electric power production

Matveev said his generator is different from an invention by Howard Johnson of the United States. Johnson discovered how to build motors that can run without input of electricity or any other kind of external energy. He obtained a patent in 1973 for describing electrical generation using only the energy contained in the atoms of permanent magnets.

Matveev also said some Russian inventors have experimented with a generator similar to his. Their generator changes its magnetic conductivity by changing temperature. However, the machine requires a lot of time to be heated and cooled alternately and results in a current frequency much lower than what generally is used in industry. Moreover, the Russian generator requires high steel density and greater mass.

Matveev's machine generates electric energy of industrial frequency. Furthermore, he said his machine is simple, reliable and requires less steel and mass than conventional generators. It also can be adapted to flows of low speeds, such as weak water or wind streams. Matveev tested the generator in his former household in Kazakhstan before he patented it in Uzbekistan.

"I want to pass the invention on to all mankind," he said.

Boris Abdurakhmanov, director of the Uzbek Koinot (Cosmos) design office and head of the laboratory of semiconductors and photoelectricity of the Institute of Electronics of the Uzbek Academy of Sciences, told UPI: "Matveev has offered a fundamentally new approach to a problem of the creation of electric power generators."

Utilization of the Gravity Force in Power Engineering

Editor: In the previous issue we made a review of Mikhail Smeretchanski's invention "Perpetual motor with magnetic control elements" (# 4, 2003). This invention was patented; shown below are some pages from the patent itself. You can contact the author by e-mail: smeretchanski.mikhail@wanadoo.fr, or the postal address: 13 av. Rochambeau 3800 GRENOBLE FRANCE

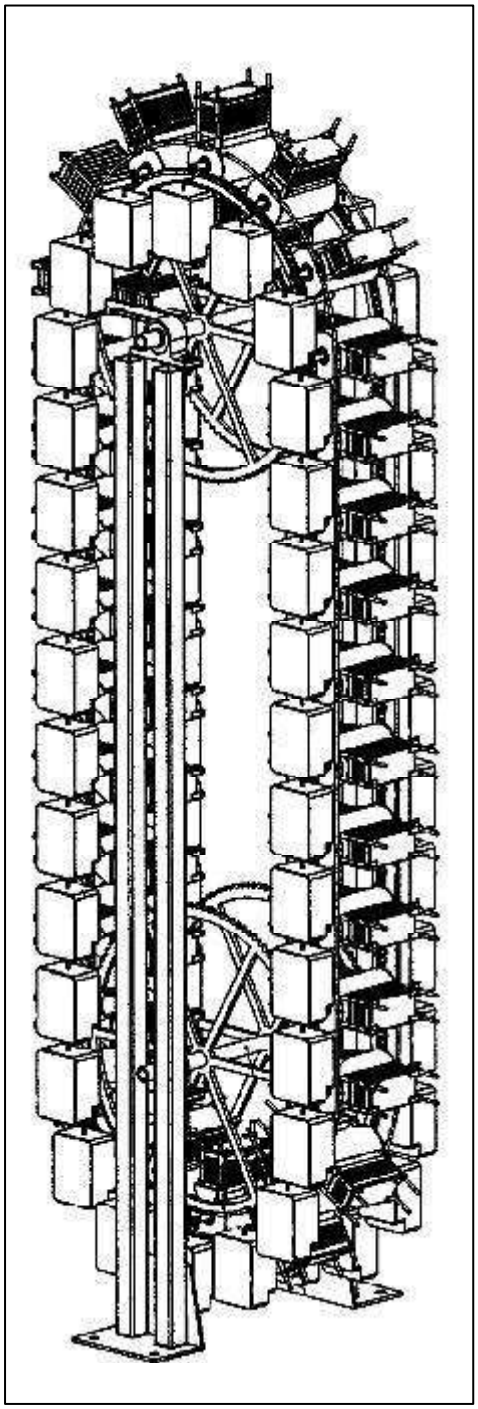

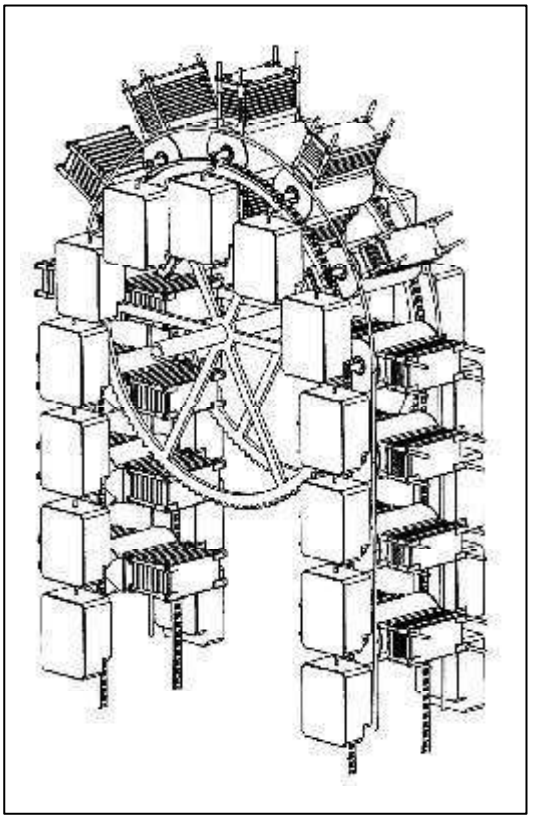

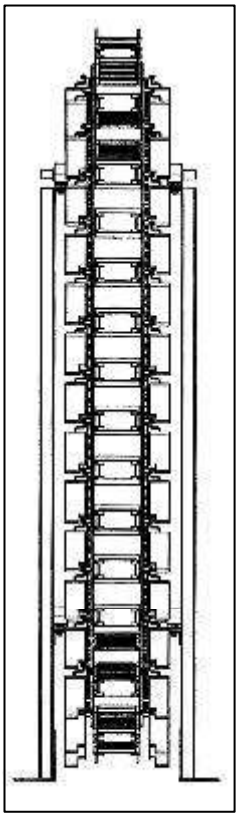

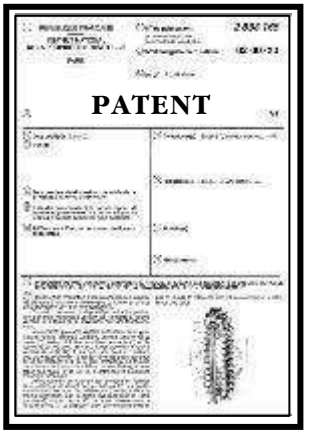

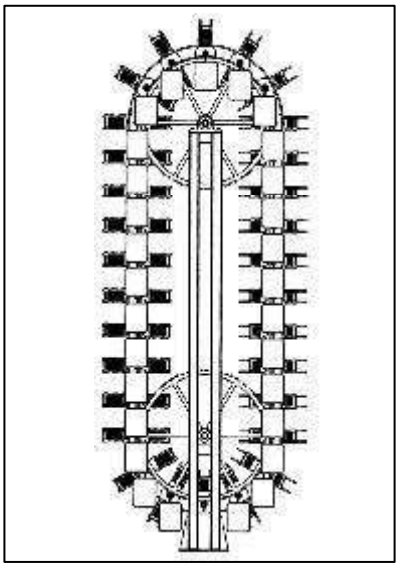

The Most Interesting Articles - 2003

In the year 2003 we have published more than 120 articles, mainly on the alternative energy, new propulsion principles and the development of ether dynamics.

"Cold fusion", low energy nuclear reactions (LENR) and highly-efficient electrolysis were represented by the works of Professor Kanarev, E. Storms, P. Hagelstein, T. Chubb and E. Cartlidge.

Almost every "New Energy" issue features articles on highly-efficient permanent magnet motor or generator experiments or patents of the kind. The articles by T. Valone, E. Vogel, A. Akau, T. Hardwood, A. Francouer and S. Abramov are of great value for engineers and researchers in this field.

The interesting articles by M. Filo, R. Koontz and V. Bogomolov reveal several principles of designing and building purely mechanical energy generating systems. All these systems possess one common feature: namely, the fact that a substance (a solid or fluid working mass) is accelerated in the gravitational field or in the centrifugal force field. The design characteristics of the system make it possible to obtain free energy.

We have published several articles by S. Gerasimov and his colleagues on the reaction-less propulsion device experiments. We hope that in the future we will keep in touch with these researchers.

The article by D. Reed on the new physics development concepts is worth mentioning too. The article by E. Sorokodum on new energy sources and the article by V. Chernobrov on the research into the active properties of time are of no less importance.

A. Egorov's article on the ball lightning makes it possible to form a number of experimental approaches to the problem of creation multi-purpose stable plasma objects.

Electrogravity questions, water-powered vehicles, longitudinal electromagnetic wave technologies, the Searl effect commercialization, capillary engines, resonance high-efficiency power-engineering, single-wire power lines, heat pumps and other similar research works were presented to our readers in the year 2003. We have minimized theoretical articles and we hope that the magazine has become more interesting and useful for the new energy practice development.

Alexander Frolov
St. Petersburg, Russia

There is interesting newsgroup of the site: http://www.overunity.com, Stefan Hartmann, email: harti@harti.com

Stefan Hartmann writes: This is the answer I got from Finsrud; it seems that the film they have done about him will be shown [on Discovery Channel] in 2004 when [if] I interpret this norwegian text right...

Subject: Documentary Film
Reidar Finsrud,

Dear Sir,

The Australian Broadcasting Company together with The Discovery Channel, have funded my company to make a documentary film entitled 'A Machine To Die For', the story of Perpetual Motion and the search for 'Free Energy'.
I have read extensively about your Perpetual Motion sculpture and we would be interested in traveling from Australia to Norway in order to film this now famous piece of work. At the same time we would request an interview with yourself.
If you are in agreement with this it is our intention to be in Norway on the 10th and 11th of July 2003.
This documentary will be released worldwide and should produce considerable interest in your Gallery.

Mark Eliot
Catherine Jarvis and Mark Eliot
Romany Mill Studios

Hydrogenics Secures $3 Million from Japan Auto Makers

Letter from RemyC remyc@prodigy.net
Contacts: investors@ hydrogenics.com

Hydrogenics Secures $3 Million in Test Equipment Orders Japanese Auto Makers Select Greenlight Power for Fuel Cell Testing Equipment

TORONTO, Sept. 30 – Hydrogenics Corporation (Nasdaq: HYGS; TSX: HYG), a developer and manufacturer of fuel cell products, announced today that its wholly owned subsidiary, Greenlight Power Technologies (Greenlight) has received orders totaling US $3 million for fuel cell test stations from two leading Asian automotive customers. Both are repeat orders for multiple machines.

Cumulatively, Greenlight is providing seven Fuel Cell Advanced Test Stations (FCATS) to two major customers. The first order is for three 3 kW PEM FCATS L-Series test systems. The second is for three 12 kW PEM FCATS H-Series test systems and one 60 kW PEM FCATS HX-Series testing station. The stations are expected to be delivered over the next two quarters.

"Our decision to open an office in Tokyo, Japan over three years ago continues to pay dividends," said Pierre Rivard, President and CEO of Hydrogenics. "The Japanese market is advancing quite aggressively towards the commercialization of fuel cell technology, as evidenced by our growth in test equipment sales to the region over the past three years. We are delighted to secure these major contracts with customers who are clearly setting the pace in fuel cell development."

Greenlight fuel cell testing systems provide high precision instrumentation, combined with full-featured software. They deliver fuel cell testing results that prove the reliability, repeatability and versatility required for world-leading fuel cell development programs.

About Hydrogenics Corporation

Hydrogenics Corporation (Nasdaq: HYGS; TSX: HYG) is a leading clean power generation company, engaged in the commercialization of fuel cell technology and test stations for fuel cells. The company is building a sustainable business, in a potentially "game changing technology" for transportation, stationary and portable power. Hydrogenics, based in Mississauga, Ontario, Canada, has operations in British Columbia, Canada, Japan, the United States and Germany. For more information, please visit www.hydrogenics.com .

About Greenlight Power Technologies, Inc.

Greenlight Power Technologies Inc. (http://www.greenlightpower.com), a wholly-owned subsidiary of Hydrogenics Corporation, is a leading global supplier of testing and diagnostic equipment to the fuel cell industry. It has supplied fuel cell test equipment to the world's premier fuel cell stack manufacturers, component manufacturers, system integrators and research organizations. Greenlight provides a full suite of test equipment for fuel cell stack, stack component, reformer and system testing for companies focused on portable, stationary, and transportation fuel cell applications.

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www.anuvu.com/home.html

Now our readers can get familiar with some hydrogen fuel cell development photos. It is worth of a note that the prices are high for the majority of people. For example, a hydrogen fuel cell car costs 100 000 dollars FOB Sacramento, CA. The next picture features a fuel cell van, which costs 150 000 dollars.

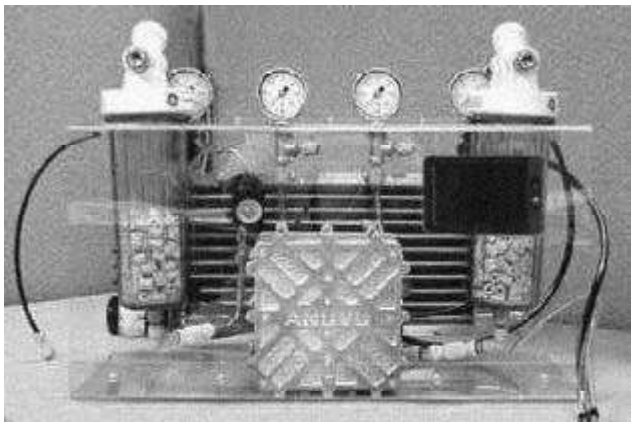

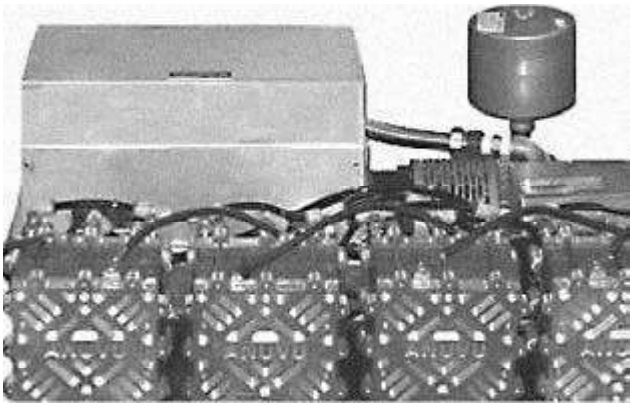

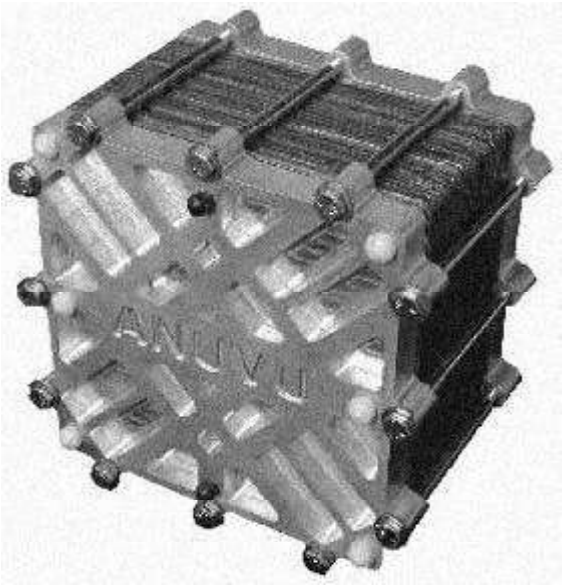

EXCESSIVE OUTPUT BY MEANS OF AIR IONIZATION

We have received an interesting article from California. Here is the short version of the article.

The Mechanism of The Electric Spark

Review of the research
by Leonard B. Loeb
Professor of Physics, University of California at Berkeley
and
John M. Meek, Research Engineer
Stanford University Press, Stanford University, California

Dedicated to Professor J. S. Townsend whose pioneer research and theory laid the whole foundation for the study of the mechanism of the electrical spark discharge.

Although the electric spark has been known to mankind in its various manifestations from time immemorial, its mechanism has to date been little understood. The initial clarification of the mechanisms involved is due to J.S. Townsend as a result of his brilliant researches in the early nineteen hundreds. On the basis of his theory of ionization by collision by electrons and positive ions, the fundamental mechanisms active and especially the coefficients required in their application were made available.

In 1936 the present senior author was forced to describe the mechanism of spark discharge in terms of a modified but distinctly unsatisfactory Townsend theory. In 1935 the discovery of photo-ionization in air by corona discharge indicated a solution was not far off. The turning point of a more successful theory came in the discovery of streamers in positive point to plane corona in 1936. The quantitative analysis of the self-propagating positive streamer in all breakdown phenomena became clearly evident as a result of the data concerning electron avalanches. As a result a qualitative mechanism of sparking by streamer propagation from anode to cathode functioning by means of photo-ionization in the gas was established.

The Townsend Sparking Criteria

It will not be necessary here to derive the famous equation of Townsend for the current [i] in a gap between electrodes as a function of the photoelectric current [io] from the cathode, the gap length [x] and the coefficients [a] and [B]. For this the reader can go to any standard text. *(Editor: the equation is omitted)*

In this equation the first Townsend coefficient [a] represents the number of new electrons created in the gas by an initial electron in its advance of 1 cm along the field axis from the cathode.

The second Townsend coefficient [B] in Townsend's original theory was the number of new electrons created by a single positive ion in its advance of 1 cm along the field from the anode.

The quantity [a] has been extensively studied in various gases. It varies with the ratio of field strength to pressure, X/p, where [X] is in volts per centimeter and [p] is in millimeters of Hg.

Note: the reason we are going through this is to determine the actual increase in current provided by the spark gap, and thus be able to design the circuit to avoid blowing out semiconductor components. It also provides a

sound and already proven scientific theory to work from giving us a good foundation and the confidence to proceed with technical design work.

The quantity [B] has been evaluated, albeit rather inaccurately, from the variations of [i] with [x] at various higher values of X/p, by many observers in different gases. Inasmuch as it has now been shown that there are numerous other mechanisms other than impact with positive ions, which can liberate the secondary electron, needed in discharge.

There has been an inclination to give up the mechanism of impact ionizations by positive ions in gas. The discovery of measurable photoelectric ionization in gas has now made it possible to explain such cases. The exact way in which photo-ionization in the gas could operate to cause a spark, was not clear until the development of the present **streamer theory**.

The Streamer Theory of Spark Discharge Anode Space-Charge Field Due to an Avalanche

Assume a spark gap of 1 cm in length. Assume that in air at atmospheric pressure the potential across the plates is 31,600 volts, which is the conventionally observed sparking potential [Vs].

Let us then calculate what happens in the field to one of those electrons. It starts across the gap, quickly acquiring an average random energy of some $E=1/2mC^2= 3.6$ electron volts and a drift velocity [v] in the field direction of about 1.5 to 2 times 10^7 centimeters per second. As it moves it creates new electrons at a rate of [a] per centimeters in the field direction so that in a distance [x] it and its progeny amount to e(ax) electrons, forming what is called an **electron avalanche**.

Therefore, e(ax) positive ions have been left behind by the electron group, virtually where they were formed in the 10^{-7} second of advance for the electrons in the distance x=q across the plates. As the electron avalanche advances, its tip is spreading laterally by the random diffusive movement of the electrons.From these data it is possible to compute the density of positive-ion space charge left behind at any point [x]. The value of [a] under these conditions is about 17, making e(aq)=e(17). The first ion pair is created at 0.0407 cm from the cathode. At 0.5 cm from the cathode there are 4914 ions, at 0.75 cm there are 3.66 times 10^5 ions, and within 0.0407 cm from the anode there are 1.2 times 10^7 ions. **Most electrons will be drawn to the anode except for some few that are bound by the positive ions, making a sort of a conducting discharge plasma in the avalanche.**

Such a distribution of ions does not make a conducting filament of charges across the gap, and hence in itself an avalanche that has crossed does not constitute a breakdown of the gap. Thus one must look further for the mechanism of the spark.

If Loeb and Meek are correct then if we assume a spark gap of 3 mm and a voltage of 5,000 voltsthere are roughly 2,000 electrons created by avalanche for every one electron leaving the cathode. They state that most of these 'free electrons' are absorbed by the anode. [This would certainly explain why the semiconductor components cannot handle the current gain.]

NOTE: Loeb and Meek make little reference to initial amperage. There are only two values they refer to 10^{-5} ampere and 10^{-12} ampere.

In conclusion: Sparks and Arcs are two different beasts. My initial research into the amperage necessary to form an arc does not apply to spark and the process of avalanche where this huge gain mechanism is possible.

Photoelectric Ionization in Gas as a Secondary Mechanism

Accompanying the cumulative ionization there is produced by electrons from four to ten times as many excited atoms and molecules. Some are excited to an energy exceeding the ionizing potential of some of the atoms and molecules present, either by excitation of an inner shell, by ionization and excitation, or in a **mixed gas like air by the excitation of molecules of higher ionizating potential, e.g., N2**. These excited atoms or molecules emit radiations of very short wave

length in some 10^{-8} second. This short ultraviolet radiation is **highly absorbed** in the gas and leads to ionization of the gas. In fact, the whole gas and the cathode as well are subjected to a shower of photons of all energies traveling from the region of dense ionization with the velocity of light. Thus nearly instantaneously in the whole gap and from the cathode new photoelectrons are liberated which almost at once begin to ionize cumulatively.

The Mechanism of Positive Streamer Formation

The photoelectrons created at points in the gas and at the cathode at any great radial distance from the avalanche axis will merely create other avalanches. Those in the gas will be short and those coming from the cathode region will be long and like that of the initial avalanche. Being smaller and, in any case, later in creation than the parent avalanche, such avalanches will be of no interest in breakdown. However, those photoelectrons created near the space-charge channel of positive ions, and especially near the anode, will be in an enhanced field, which exerts a directive action drawing them into itself. If the space-charge field [X1] is in the order of magnitude of the imposed field [X], this action will be very effective. In addition the values of [a] will be much enhanced.

The electrons from the intense cumulative ionization of such photoelectron avalanches in the combined fields [X] and [X1] which are drawn into the positive space charge feed into it, making it a conducting PLASMA which starts at the anode. The added fields will be most effective along [X] and so will the ionization. The positive ions they leave behind will therefore extend the space charge towards the cathode. These electrons also create photons, which produce electrons to continue this process. **In this fashion the positive space charge develops toward the cathode from the anode as a self-propagating positive space-charge streamer.**

As the streamer advances towards the cathode it produces a filamentary region of intense space-charge distortion along a line parallel to the field. The conducting streamer of a plasma consisting of electrons and ions extending to the anode thus makes a very steep gradient at the cathode end of the streamer tip. As this advances toward the cathode the photoelectron avalanches produced by radiation at the cathode, especially at the intercept of the extended streamer axis at the cathode, it begins to produce an intense ionization near the cathode. Hence the positive ions created there may increase the secondary emission. Thus, as the space-charge streamer approaches the cathode a cathode spot is forming which may become a source of visible light.

When the streamer reaches the cathode there is a conducting filament bridging the gap. As the streamer tip reaches the cathode the high field produces a rush of electrons towards the end of the streamer. This if followed by a current of electrons, gives a high-potential wave, which passes up the preionized conducting channel to the anode, **multiplying the electrons present by a large factor**. The channel is thus rendered highly conducting. If the metal can emit a copious supply of electrons because of the formation of an efficient cathode spot, the current of electrons continues the channel maintaining its high conductivity and **ever increasing in it**. This current, unless limited by external resistance, will then develop into **an arc**. It is, however, the intense increase in ionization by the potential wave, which gives the highly conducting channel characterizing the spark.

Conclusion: According to Loeb and Meek there are three means by which a spark in open air will provide a very large current gain. If this is true, it should be fairly easy to prove with inexpensive and unsophisticated equipment. Once the actual amount of current gain has been determined for the design parameters of the spark gap, then the rest of the circuit can be designed for the increased current value.

Editor: It is worth of a note that the current gain by means of ionization was patented by Pavel N. Yablotchkov (the patent of France # 120684, October 11th 1887). Some two years ago one of our issues featured an article about him. We think it is worth being published again.

PATENT of 1877 by Pavel N. Yablotchkov

Alexander V. Frolov
Faraday Lab Ltd,
Lev Tolstoy St., 7 St. Petersburg, 197376 Russia
Tel: 7-812-380-3844

Pavel N. Yablotchkov was born in 1847 near Saratov, Russia. He graduated as a Military Engineer in 1866 and spent several years in the Russian Army.

In 1872 he came to Moscow and started his activities in electrotechnical field. Since 1875 he had been working in Paris with the famous Louis Breget and his first French patent # 110479 of November 29th, 1875 was dedicated to an electromagnetic transformer. Then he developed and patented a lighting system (the well-known Yablotchkov electrical candle). In 1876 he patented a new electromagnetic transformer for industrial purposes, France # 115793 of November 30th, 1876.

The most interesting patent claim on over-unity devices by Pavel N. Yablotchkov is known as France patent # 120684, October 11th, 1877, "The system of distribution and amplification of electrical currents by means of atmosphere electricity..." The patent describes special capacitors connected in series with the load to increase the output current by means of ionization. Experiments were conducted together with the well-known physicists such as Dr. Maskar, Dr. Varren-Delaru and others and **they confirmed the 200 % efficiency of the circuit**. Now we will try to explain the method.

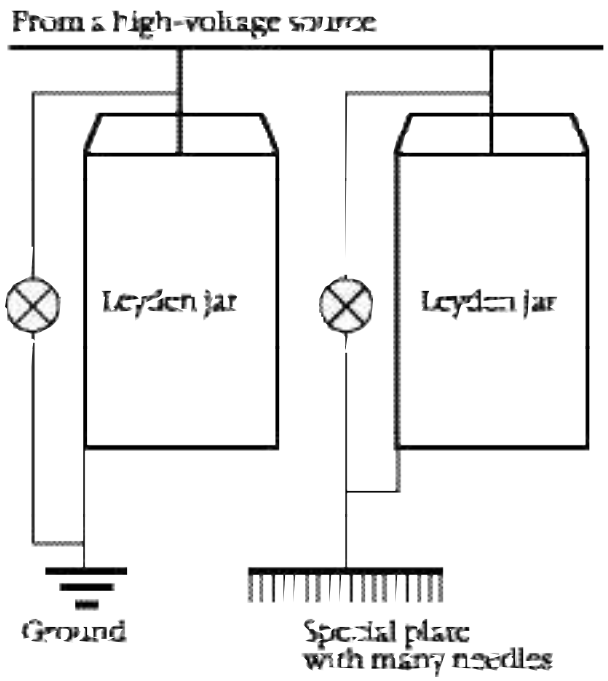

Fig.1 features a schematic drawing taken from Yablotchkov's patent. The Leyden jar is an asymmetrical capacitor, i.e. it is different in principle from a two-plate flat capacitor. The inner electrode of the jar should be connected to a high-voltage source and in this case the changes of the potential have an effect on the potential changes on the external electrode. It does not work in the opposite case and if you connect a high-voltage source to the external electrode no potential changes will be detected on the inner electrode. Connection to the ground or to a special plate (which is covered with many needles to increase air ionization) is necessary to attract the maximum number of electrons to the plate surface or to return the maximum electrons from the plate surface when potential changes on the external electrode are produced by means of electrical induction in the Leyden jar.

In conclusion I should mention one more supposition of the secrets of the well-known Swiss M-L converter (Methernitha). The main elements of the design are Leyden jar capacitors, which have the external surface made of perforated metal.

The other known fact is that great ionization of air is observed when the converter is in operation. So, the electrostatic machine can produce pulses of a very high voltage (potential difference) but it cannot be used as a source of a powerful current. In order to increase the current in the circuit we should apply a certain method and Yablotchkov's technology seems to be appropriate. A large surface of the external electrode of the Leyden jar can be a good solution to the problem. Maximum strong ionization allows us to obtain the output current several times stronger than the weak current generated by the electrostatic machine.

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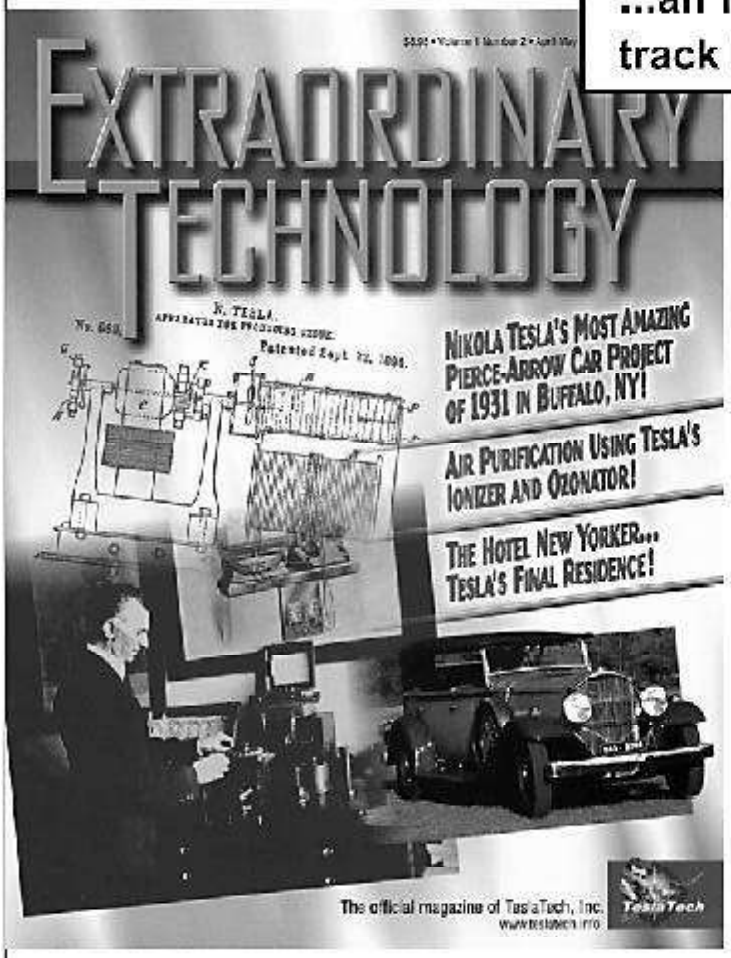

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Konstantin Meyl

Scalar waves

From an extended vortex and field theory to a technical, biological and historical use of longitudinal waves.

Edition belonging to the lecture and seminar „Electromagnetic Environmental Compatibility"

Preface to the lecture, 1st Edition 1996

The theme encloses the electromagnetic compatibility of both technical and biological systems. Only part of the electromagnetic wave can be considered for function troubles, namely the part that was absorbed and has rolled up to a vortex. The activity depends on the number of created vortices and of their lifetime, their decay.
The eddy current only manifests in conducting materials. In the air and in dielectric materials on the other hand the vortex of the electric field will form, also called the potential vortex. To calculate and to measure this vortex is our goal.

First we'll carry out a survey of the problems and the usual methods. From the analysis of unsolved problems the need for the introduction of the new vortex phenomena is deducted and an adequate field-theoretical approach will be chosen. Afterwards the potential vortices are calculated and their properties are discussed and interpreted.
For the purpose of proving their existence, on the one hand the Schrodinger equation will be derived and on the other hand the quantum properties of the most important elementary particles will be calculated and compared with the well-known measured values.
Measurement and calculation are in excellent agreement for weight, charge, magnetic moment and spin. So the theory not only proofs it's correctness, in addition it demonstrates it can achieve much more. The theory takes us to the unification of the well-known interactions and physical phenomena and shows itself as an unified theory.
In the practical conversion and usage of the theory there will not only be informed but by all means also be provoked as an entrance in a fruitfully discussion. Fundamental questions will be taken up like: What is information, energy, temperature or smell? The connection to the theme of the electromagnetic environmental compatibility is formed by the technical and the biological usage of the potential vortices, the energy transmission of Nikola Tesla exactly like the in a similar way functioning nerve conduction. Here we already can expect biological reactions.

This lecture, held for the first time in the winter semester of 1995/96, is available in book form, as an edition belonging to the lecture. This lecture will not deliver ready recipes or instructions. The goal is reached when the critical sense of the listeners and readers has been inspired and discussions have been set going. Everybody has to draw the consequences out of such a theory by him- or herself.
In addition to this lecture a seminar is offered, wherein several themes are supplemented or deepened, different theories are compared and possible consequences are discussed.
The appearance of an edition belonging to the seminar has started in 1998<i>.
Regarding the conversion of consequences both politicians and scientists are equally addressed, because the electromagnetic environmental compatibility has developed to one of the most urgent problems of today's world. But in last consequence all of us bury the worldwide responsibility for our environment.

<i>: K. Meyl: Electromagnetic environmental compatibility, Part 2 and 3 of this book, Edition belonging to the seminar.

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1. Introduction

Here the extremely controversially discussed question of the environmental compatibility of electromagnetic fields will be persuaded. Limits should inform what is incompatible and what is compatible. But there are as many limits as there are commissions and specialists. And besides that differ the results from each other for several powers of ten. In course of time the legitimate doubts become unmistakable and the representatives of science slowly get to feel the burden of proof.
For the sake of efficiency, the actual discussion concerning the theme of electro-smog is analysed and the necessity to involve an until now unnoticed field phenomenon in the discussion about limits is derived: It concerns vortices of the electric field. These potential vortices, as they are called, have the corresponding properties to show biological effects even at the lowest field strengths. In any case it is not possible to exclude that at present the wrong physical phenomena are measured and made responsible.

A parable should bring clarity.
Lets imagine that the to us well-known and over our sense of touch understandable physical phenomenon of the temperature is unknown to us, neither measurable nor perceptible. Our weather station only exists of a barometer that could show us the air pressure and deliver us indications if good or bad weather is to be feared. We ready realize that there exists a connection between the air pressure and our health and make the to us well-known phenomenon responsible. When the pointer points to good weather we can go out lightly dressed. With bad weather we should take a coat, so we know from experience.
"Now we imagine the realistic situation that in winter we have a weather situation of high pressure but it's stone-cold outside. The weather station will display high temperatures with the result that some people will walk around with short-sleeved and open shirt, only to lie in bed with a cold in the evening. Of course the air pressure was to blame! Logically the "pressure sensitive", as they are called mocking, demand the limits for the allowed pressure to be reduced so far that no consequences for health are to be feared. Concerning the theme of allowed limits, science is asked and science proceeds in a systematic way: the pressure is investigated in the laboratory, isolated from all other parameters and so it is discovered that man catches no cold even at a substantially higher air pressure, so there is no reason to alter the limits.
Actually we would expect these at any time reproducible results to have a calming effect on the minds of the participants of the discussion and on the population. Instead the pressure sensitives time and again cite new knowledge that won't fit in the scheme. So is for instance stated that draught causes the same health problems although this pseudo effect has nothing at all to do with the air pressure. So owing to incomprehensibility and emotions the discussion about limits becomes a farce.

The fact that sensitive people react to effects of air electricity and possibly get ill without proof that some today measurable physical quantities are responsible should make us think. It is little calming watching our scientists poking at the dense fog whereas at the same time among the runners of the new telecommunication networks there spreads something like a gold-digger mood.
To introduce a new technology is not difficult, but to abolish it for reasons of the electromagnetic environmental compatibility is almost impossible!

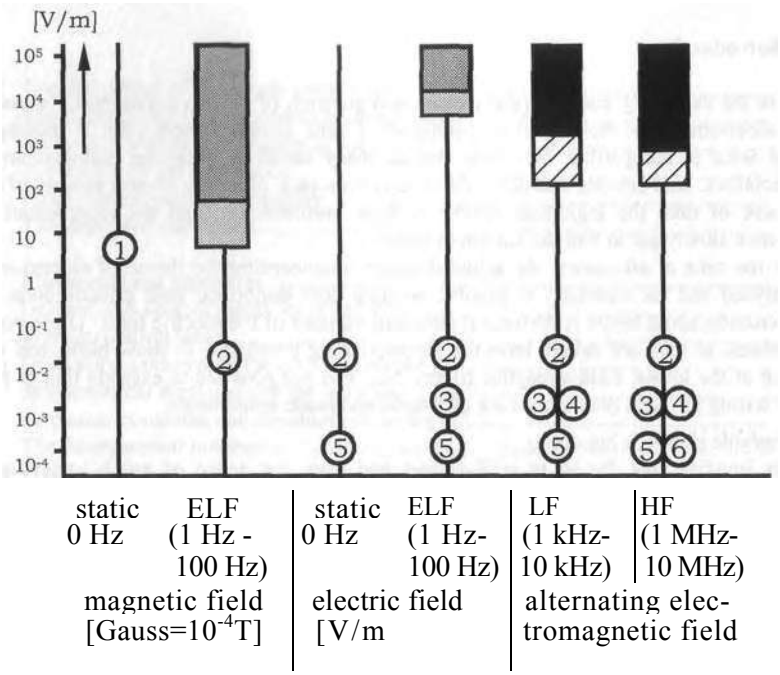

Fig. 1.1: Discussion about limits

Limits for professional exposition (electronics engineers) and
Limits for non-professional exposition (population in general) according to the Recommendation of IRPA/INIRC<ii>.
Limits according to VDE 0848 / 1989
Limits according to VDE 0848 / 1992
experimentally determined threshold values of reactions of biological systems <i>:

1 Increase of the activity of movement of birds
2 deflection of divining-rods
3 influence on the time of reaction of men
4 conditional reflexes of fish without electrical organs
5 conditional reflexes of fish with electrical organs
6 conditional muscular reflexes of men

taken from:
<i>: H.L. Konig: Unsichtbare Umwelt (Wetterfuhligk.), 5. Aufl., Bild 111, S. 123 Verlag Moos & Partner Munchen, ISBN 3-89164-O58-7
<ii>: Habiger u.a., EMV, Verlag Technik, Berlin 1992, S. 152

1.1 Discussion about limits

Whoever follows the public discussions concerning electro smog always sees two arguing parties, whose standpoints lie so far apart that they inevitably talk at cross purposes and there can be found no consensus.

On one side the "affected" find together who maintain to have found the electromagnetic radiation as the damaging cause for their problems. They are to be taken serious, even when only their personal sensitivity serves as means of measurement and proof and a more or less distinct sensitivity against electromagnetic phenomena. This group occasionally finds support of homeopaths who can base on reproducible laboratory results that fit as few into the view of life of science as the empirical statements of affected and possibly hurt people.
On the other side stand the representatives of the energy-supply companies and the runners of radio networks who argue with the needs of our modern industrial society and give "limits" prescribed to them by scientists. These, for their part, proceed according to strictly scientific methods. Their presented results are reproducible and there's no doubt about them.
The limits after all are fixed far below those that are recommended from a scientific viewpoint. Nevertheless both groups are separated from consensus by powers of ten. When we want to know how deep the ditch is we want to bridge, we should take a look at the determined limits (Fig. 1.1).

The limits stem from the 1RPA (International Radiation Protection Association) an organ of the World Health Organization that in turn has appointed the INIRC (International Non Ionizing Radiation Committee). These now state to have used all available scientific research results as basis for the given guidelines.
Moreover a safety range was worked into them. So the limits were fixed at substantially lower levels to guarantee that no health damage arises. In this way first the limits were determined for the people who for reasons of profession are exposed to electromagnetic fields.
For the population in general the limits for the so called non-professional exposition were reduced further to one half till one fifth for reasons of caution and care. In Fig. 1.1 these limits are registered. Thereby is distinguished between magnetic fields and electric fields that appear stationary or at extremely low frequencies (ELF describes frequencies between 1 Hz and 100 Hz). Moreover limits for low-frequency (1-10 kHz) and high-frequency (1-10 MHz) alternating electromagnetic fields are given.
The graph should serve as a rough orientation and show us the proportion of scale. As further information some thresholds of measured reactions of biological systems are registered (after Konig*[1]*). Because a logarithmic scale was chosen to fit all the values on one graph it becomes clear that between the first reactions and the recommended limits there lie up to five powers often. The ditch seems to be insurmountable.

Fig. 1.2: Set of problems of environmental compatibility by means of the example of the handheld wireless telephones (handy).

<i>: L.v.Klitzing: Neurophysiologische Einflusse durch elektromagnetische Felder wahrend und nach der Exposition, Med. Universitat zu Lubeck

1.2 Wireless telephones

Measuring technical surveys with regard to the influence of brain currents by digital radio signals by the university hospital in Lubeck have startled handy manufacturers and users equally <1>. Although in this case measurement errors could be detected, the ,,bugaboo on the wall" remains that we are sitting unsuspecting in a restaurant and a neighbour draws his handy out of his pocket to make a digital telephone call. Thereby synchronizing the brain currents within a radius of 100 meters on the broadcasting signal and occupying our brain useless with technical signals. The derivation will show that from the start this can't happen to all visitors, because as a prerequisite conditions of resonance must be fulfilled. But would there be an affected, he or she for sure would have considerable problems, because informations that are not picked up over the sense organs can neither be classified timely nor as regards content.
An affected whose brain has picked up technical signals not even is able to register by itself that it was fed with incorrect informations. It would be reasonable when the visitors of the restaurant would defend themselves and put the radio operator on the doorstep. The number of restaurants where apart from cats and dogs also handy's have to stay outside is increasing. How should we keep out of the way of electromagnetic fields? Should we walk around permanently with a steel helmet or even better in a knight's armour and even go to bed with them? It would be worse than in the dark middle ages.

Summarizing: it should be guaranteed that the operation of electro technical apparatus causes neither health damage nor unintentional influence or irritation. A systematic and scientific procedure should investigate in the laboratory all relevant physical phenomena individually for their interaction. Electro physics bases on two phenomena in connexion with electro-smog: on the one hand the radiation and on the other hand the thermal effect, but at a close look both factors prove to be of only little importance!
In radiation measurements the intensity of the electromagnetic wave at a certain place is determined. In laboratory experiments the field strength is increased so long till biological reactions are observed. Thermal limits are determined in a similar way. As said, the values lie about powers of ten above those that possibly bother you when you hold a handy to your ear. It is true that the microwave radiation penetrates into your head but we also know that it marches out again on the other side and this visit in your head happens with the speed of light.
Exactly like this are guest in your body constantly your local radio station, your local television station the satellites with hundreds of programs and anyway the whole radio technical world even when you did not invite them.
For an electromagnetic wave to become receivable, the field strength must lie clearly above the common noise signal and this can only be achieved by a permanent overlap, by standing waves, like in a cavity tuned to a specific frequency or an antenna. As long as people don't let themselves grow antennas on their heads they hardly have to fear direct biological effects of electromagnetic waves.
That leaves as the second phenomenon the thermal effect. With a handy held to your cheek there comes into being a local fever in your head. But that is not at all unusual or unnatural for the human body. Something like that happens to a far greater degree when you take a hot foot bath or let yourself be irradiated at one side from the sun at a tourist grill.

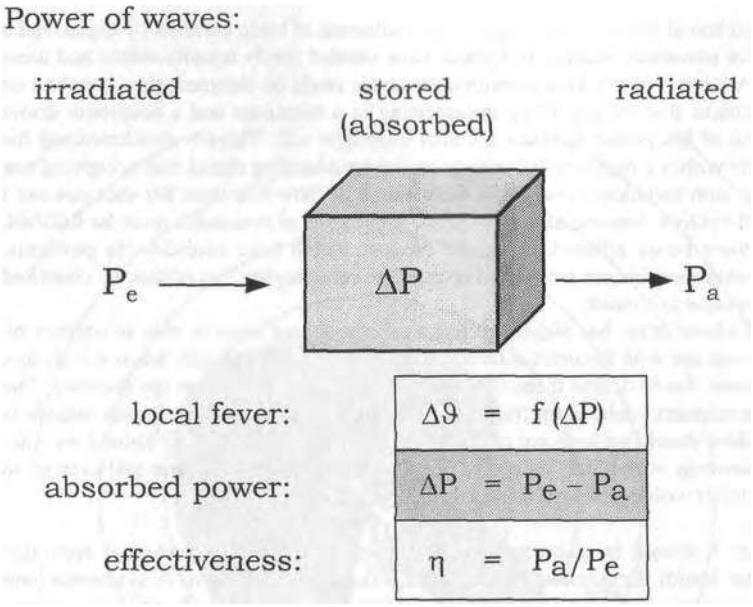

Fig. 1.3: Damping of waves and ability to absorb of a body
(our head) if we are making a phone call with a handy.

---

a contribution to the theme dielectric losses

- capacitor
- high-frequency welding
- microwave oven

<i>: K. Meyl: Potentialwirbel Band 1 [Al] (only in German),
INDEL Verlag, Villingen-Schwenningen 1990, ISBN 3-9802 542-1-6
<ii>: K. Meyl: Potentialwirbel Band 2 [A2] (out of print),
INDEL Verlag, Villingen-Schwenningen 1992, ISBN 3-9802 542-2-4

1.3 Absorption of waves

The with the theme dealing physicians logically have to put up with criticism that they work only with two phenomena that not at all can be involved authoritative in the causes for biological effects. A third factor can be considered, a field phenomenon until now stayed unnoticed by science: the vortex of the electric field, the so called potential vortex. A vortex is to be considered as an oscillation around a fixed point. Through that a permanent overlap is caused, like what happens at an antenna only that the vortex is not bound to the dimension of an antenna. The potential vortex is contracting and in this way reaches extremely high energy densities at very little spatial measurement, densities that lie far above those that field strength measurements are pretending to us [Al][<i>].

When again you take the handy at hand with which you ,,blow" the pulsed microwaves into your head. Don't worry, because with the speed of light and without provable damage almost everything comes out again on the other side, but only almost everything. A little damping of the wave has taken place and your head has absorbed this part of the irradiated wave (Fig. 1.3). Who claims this is already the thermal factor actually should realize that there exists no corresponding term in the wave equation. Here there are found merely two dual vortex phenomena as a possible damping term: the eddy current and the potential vortex. An eddy current damping is ruled out because of the bad conductivity of the head. But this favours his dual anti-vortex, the potential vortex [A1][<i>].

Seen physically the following is taking place in your head: the absorbed waves roll themselves up to vortices and through that become localized and overlap themselves permanently (Fig. 1.4b). In the course of time the vortices decay and produce the well-known eddy losses that lead to the measurable increase in temperature. When reactions or biological effects arise, simply and solely the vortex can be considered as the possible cause. Thereby play two points an important role: the number of the generated vortices and their lifetime that is determined by the time of decay.

In anticipation of the mathematical calculation of the potential vortices it is pointed out here that these are favoured not only by a low conductivity, but also by a high dielectricity. Because water has an unusual high dielectricity (ε_r = 80) and our head consists predominantly of water doubts in dealing with handy's are reasonable.

Also the relaxation time constant representative for the lifetime can be calculated [A2][<ii>]. We must proceed from the assumption that both the number of the vortices and their lifetime, that is all the at a fixed point in time in our head existing and effective vortices, can be a cause and therefore have to be considered and investigated scientifically.

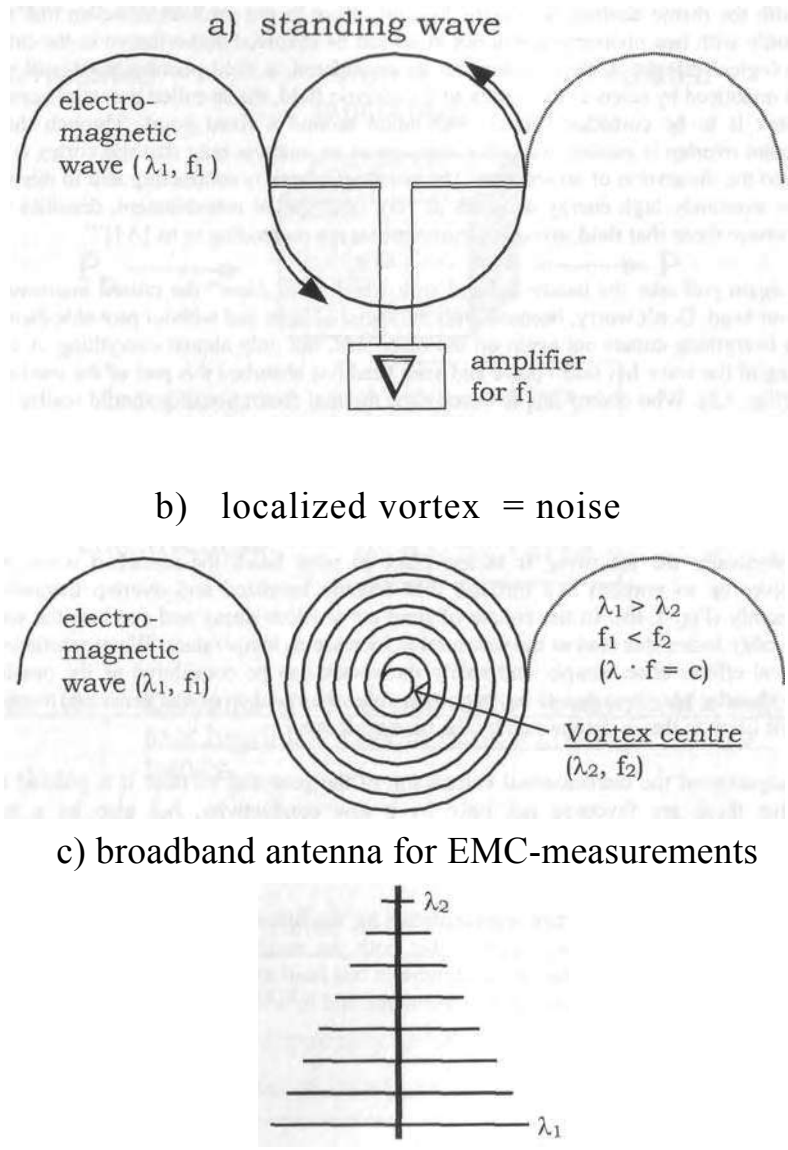

Fig. 1.4: Measurement of localized waves and vortices

1.4 Overlap effect

The graph at the left (Fig. 1.4) should clarify once more that only the in space localized and permanently overlapping field appearances can be considered as a cause for biological effects. This can concern an over an antenna standing wave (a) or a vortex (b) which is to be taken as localized by nature.
It would be allowed to in general speak only of a vortex because the standing wave can by all means be understood as a special case of the vortex. The essential difference is that the vortex is not bound to the size of a fixed antenna and can contract itself at any time to achieve in this way a substantial higher energy density. As a result this than will lead to an increased biological effectiveness.

It should be pointed at a further omission. In the discussion about limits, without exception, the absolute field strength of the broadcasting signal is valued and not the type of modulation. The last mentioned should actually not at all play a role according to the prevailing scientific opinion.
Totally different is the case with a vortex that acts damping. Such a vortex shows near it's centre a considerable smaller wavelength than more to the outside and through that it has a big frequency bandwidth [A5][<i>]. It is to be expected that in the extremely broadband pulsed signals of the digital networks the creation of vortices (or eddies) will be favoured considerably stronger than in amplitude- or frequency-modulated signals (AM/FM/C-network). In connexion with analog modulated radio- or handy-signals until now there never has been reported of any synchronization of the brain currents with handy-signals from a comparison of the EEG with the broadcasting signal.

Interestingly the for EMC-measurements usual stepped broadband antennas have exactly the construction that certainly would be favourable to the measuring technical registration of vortex phenomena (Fig. 1.4c).
With the dipole antennas of different lengths for different wavelengths there still are measured waves and not vortices but these measuring techniques is certainly accommodating to the until now unnoticed and stayed undiscovered vortex phenomenon. So there are some good reasons that the vortex is a dominating influential factor for EMC-problems.

By means of the example of the handheld wireless telephones can be studied and discussed with which set of problems the very young discipline of science of the environmental compatibility has to fight in the future. And in which ways there can be found approaches towards a solution of the problem. When the comfortable and trodden out ways of textbook physics do not lead to the goal than we will have to force our own way through the jungle of science.
At first we'll have to obtain a short overview of the actual level of research and knowledge. From the criticism to this we than can derive the tasks of the electromagnetic environmental compatibility and in particular the unsolved tasks.

<i>: K. Meyl: Wirbel des elektrischen Feldes, eine neue Storquelle? EMC Journal 1/95, 6. J, S. 56-59.

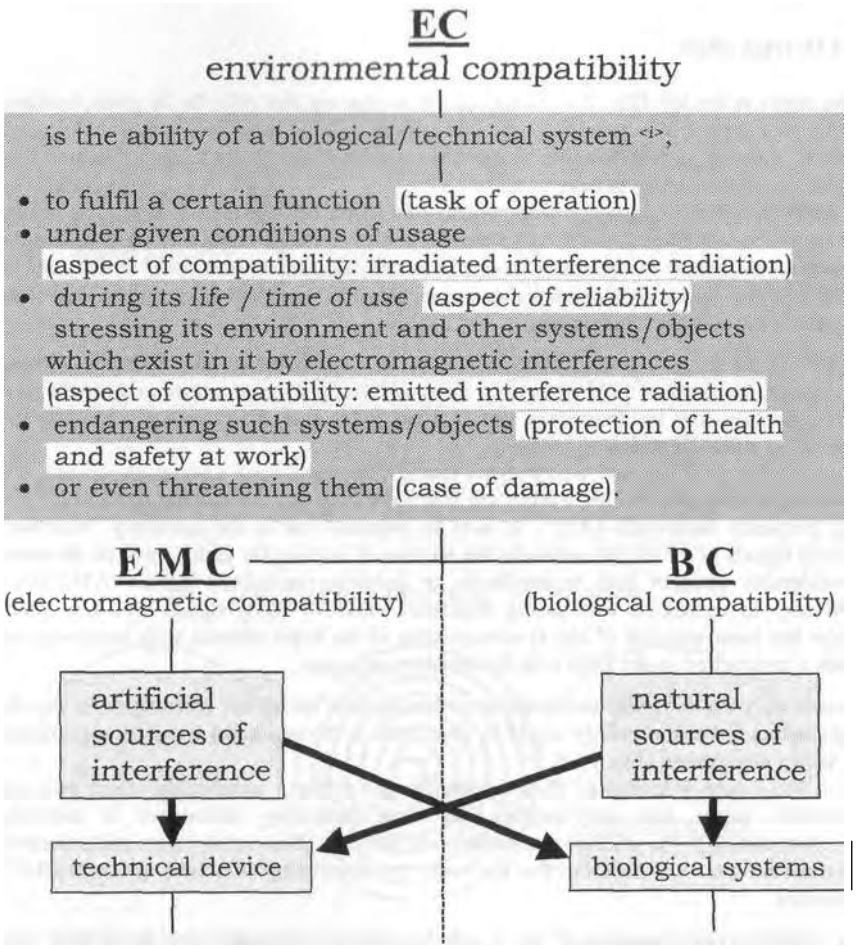

Regulations of the German Post Office since 1992: EMC-law<ii> from 1996: EU -regulation	called EMEC thirties: radio operator disease today. E-Smog, HF-, SW-therapy diathermy, etc.	know how of druids magic esoteric medicine biology

Fig. 2.1: Overview concerning environmental compatibility

<i>: E. Habiger: EMV-ubergreifende Aspekte zu benachbarten Problemfeldern, Elektrie 48 (1994), Heft 5/6, Seite 163-161

<ii>: EMVG: Gesetz uber die elektromagnetische Vertraglichkeit von Geraten, Bundesgesetzblatt Teil I vom 9.11.1992, S. 1864

2. Tasks

2.1 Tasks of the electromagnetic environmental compatibility

The environmental compatibility (EC) forms the generalization that includes both the electromagnetic compatibility (EMC) and the biological compatibility (BC). Besides the technical and functional goals of an undisturbed functional course it also pursues ethical and moral goals.
Technology should benefit to humanity and at the same time be in accord with nature. This goal will not be reached when this technology directly or indirectly is endangering humanity.
A direct attack on the health of people poses for instance the military usage of technical apparatus or the negligent usage, by pretended ignorance and unsuspicion.
Is a technology posing a danger to the environment so humanity endangers itself indirectly with this technology. After all are human beings a product of their environment. We always should reckon on the environmental sins taking revenge on us sooner or later.

In fig. 2.1 a formal definition is given that in particular concerns the claims for an undisturbed functional course: it concerns the compatibility aspects of unallowed emitted and irradiated interference radiations, the reliability and quality safety with which a function and task is fulfilled and finally the questions of the protection of health and the safety at work.

Moreover fig. 2.1 provides an overview and the structure of the 2nd chapter. First we'll treat the electromagnetic compatibility (EMC) that first of all deals with the influence of artificial but also natural interference sources on technical apparatus.
After that we'll throw a glance at the appearing fields in nature. The biological compatibility (BC) deals with the influence on biological systems.
An especially sensitive area of the environmental compatibility (EC) than describes the with a cross-link hinted influence of artificial interference sources on biological systems that is popularly described as „electro smog".

The numerous aspects of the environmental compatibility for instance in the areas of chemistry and biology that certainly are important, but do not fall in the area of electromagnetism, can't be treated in the here marked framework.

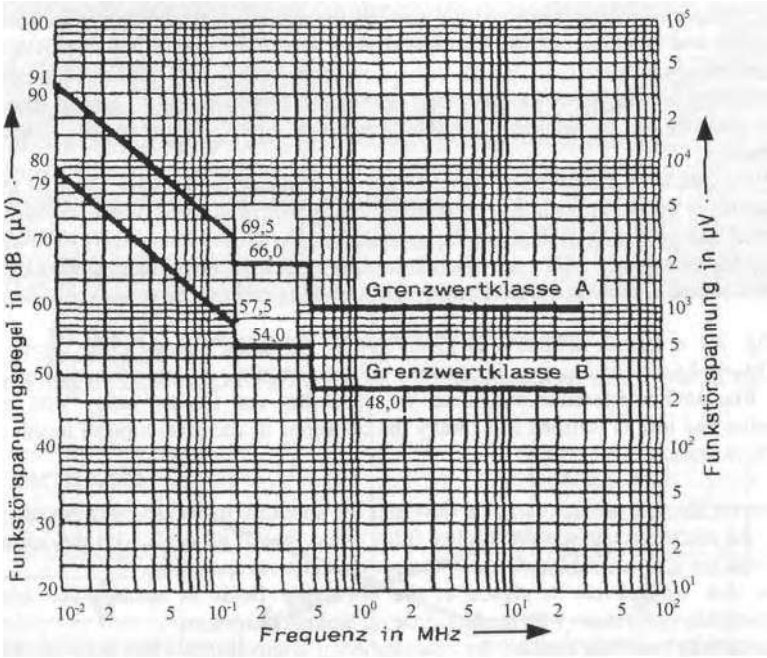

Fig. 2.2: Classes of limits according to VDE 0871
(since 1-1-96: VDE 0875)<i>

<i>: Anton Kohling: Grundlagen der Funkentstorung in der Bundesrepublik Deutschland, etz Bd. 108 (1987), Heft 10.

2.2 Tasks of the electromagnetic compatibility (EMC)

First of all the EMC (electromagnetic compatibility) is concerned with the function of technical apparatus. Correspondingly rational and dry sounds the official definition: "electromagnetic compatibility (EMC) describes the ability of an electrical setting-up (i.e. of a construction element, of a construction group, of an apparatus or of an installation) to function in an electromagnetic environment without stressing this environment by electromagnetic effects in an unallowed fashion ".

Actually it concerns an old need for protection that should be as old as the usage of electro technical apparatus. But in the beginning no one cared about it. The spark gaps with which Heinrich Hertz 1888 in Karlsruhe has carried out the first radio technical experiments were genuine ,,polluters", that would have been detectible at several hundreds of kilometres distance with modern receivers. For these installations that he had assembled in the lecture room with his students, today he would hardly get a permission of operation and the since 1996 required declaration of conformity he would get not at all.

1925, as in Germany the number of radio listeners had exceeded the limit of one million, for the first time a need for protection appears in the certificate of approval for radio receivers: "The public telegraphs and telephone installations must not be disturbed by the radio receiver".
Later on every backside of the good old steam radios there was found the following hint (translated): "This apparatus meets the interference radiation regulations of the German Post Office". So the manufacturers were urged to measure the emission of their apparatus and in particular to screen the HF-oscillators in the superhet-receivers.

Since the fifties, in the VDE-institute EMC-examinations in the present day sense are taken. The main point of the measurements and the by the VDE recommended limits, however is about interferences bound to a circuit. On the supply lines of the network the prevailing conditions are reproducible so that standards can be put through (Fig. 2.2).

For measurements of interference radiation maybe the time was not ripe enough or the necessity was not big enough. The usual argumentation was: what we can't measure reproducibly, can not be forbidden and certainly not be put under punishment. Therefore merely recommendations were issued or impositions weak as wax were made like: "the interference field strength ... must be so small that an undisturbed reception is guaranteed as soon as the minimum field strength for utilization exists at the place where the antenna is mounted"[<1>].

In common parlance that means something like: "as long as no one bleats, everything is allowed". Within a connected industrial area there even existed an officially legitimized fools freedom. Merely at the fence of the industrial area limits had to be fulfilled.

Specially for the line-frequency of the screen one has decided to build a loophole in the law so that one didn't have to throw the TV sets, that so successfully had conquered the living rooms, out of the window. Of course the flickering screens did interfere exactly as before but this EMC-interference now was officially approved.

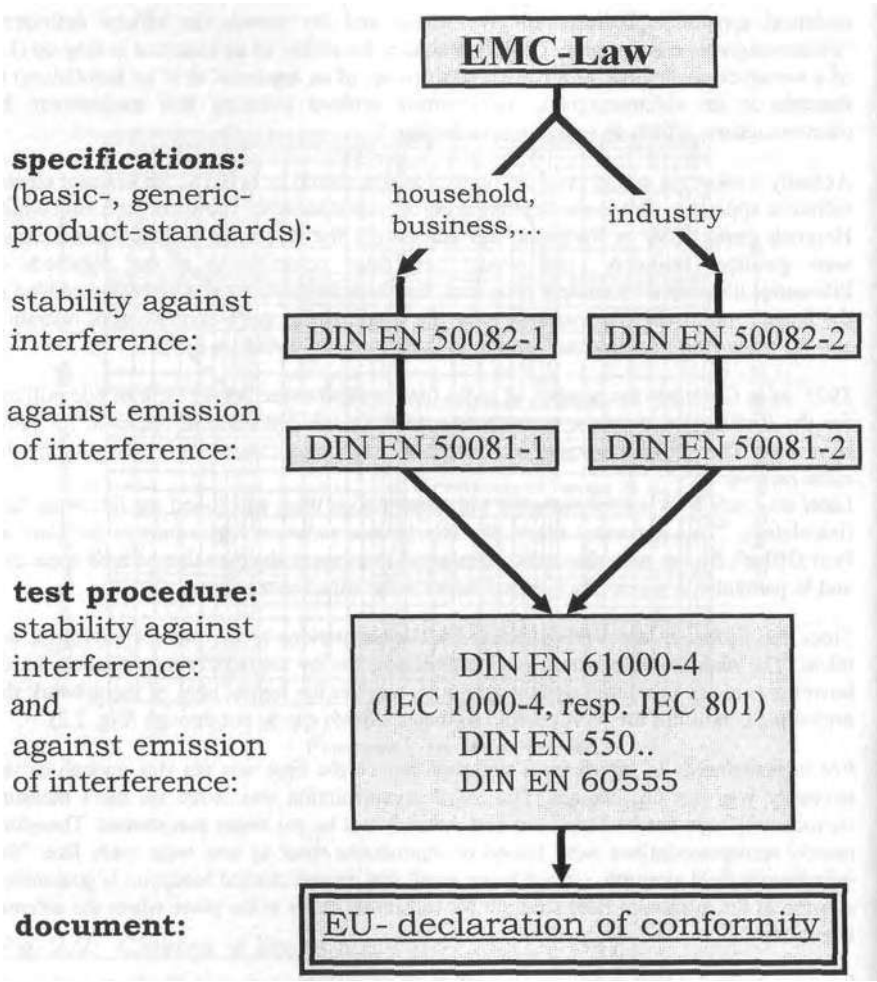

Fig. 2.3: The way to EU conformity

2.3 Declaration of conformity

In the EMC times seem to have gone as the standardizers had to fit in with the insufficiencies of technology. Meanwhile the conditions have turned up. We owe this circumstance first of all the EMC-law of 1992 that doesn't name any limits but it states the political intention to demand from technical apparatus and installations an appropriate stability against interference and at the same time limit the sent out interference. As a consequence of this law the measurement facilities and measurement processes had to be standardized to get reproducible measurement results that are not influenced by the electromagnetic environment. That goes so far that even the floor covering of a measurement hall is dictated because the conductivity of the floor influences the degree of reflexion. Normally the examinee is situated on a revolving plate that is turned around for 360° during the measurement of the radio interference field strength. Is it however not possible to turn the examinee than the antenna has to be led around it, thereby again increasing the dimensions of the measurement hall. The distance to the antenna should be up to 10 meters. Moreover it must be possible to move the antenna, up till a height of 4 meters to register the influence of the reflexions on the floor.
Moreover there is to plan a reflexion free zone around the measurement track (in elliptical form) that depends on the reachable damping of reflexions of the used absorber. Used are pyramids of foam material soaked with carbon and increasingly tiles of ferrite or shieldings of wallpaper.
Taken all together for a measurement hall doing justice to standards there result considerable measurements of for instance 18 m length x 10 m width x 7 m height.
Let's again come to talk about the EMC-law with which only the intention but not the way is fixed. To form the claims catalogue in a way that is fulfillable in general, some concrete prescriptions, the so called standards, have to be worked out. This task was transferred to the European committee for electro technical standardization CENELEC, which has established the workgroup TC 110 to at first work out some standards:
The basic standards deal independent of product with general questions of the EMC, of the testing process and of the measurement environment.
The generic standards likewise deal independent of product with the so called fundamental technical standards for apparatus in their dependence of the respective electromagnetic environment (protected computer room or medical room, environment of the house, office or industry).
The product standards concern the EMC-standards referring to products (7 product families / approx. 50 products).
In Fig. 2.3 the arduous way through the jungle of paragraphs for a technical apparatus is outlined. Corresponding to the requirements of use, first the relating ES-standards for the apparatus have to be determined and than have to be measured according to own test standards based on the fundamental technical standards. When the allowed limits for stability against interference and for sending out interferences are not exceeded, the EC-declaration of conformity is handed out. Since 1.1.96 that declaration is needed when apparatus are commercialized or - stated more exactly - "put in circulation" and operated. When still further EC-guidelines are met in the end the CE-hallmark is awarded. Since 1.1.96 only with this hallmark the access to the common market of the EC is possible. Violations can be punished with fines and if need be with imprisonment. But there are great national differences in the EC. The Federal Republic of Germany with fines of up to 50.000 Euro counts as expensive for criminals.

Simulation of network for the measurement of the interference voltages U_{st1} and U_{st2}.

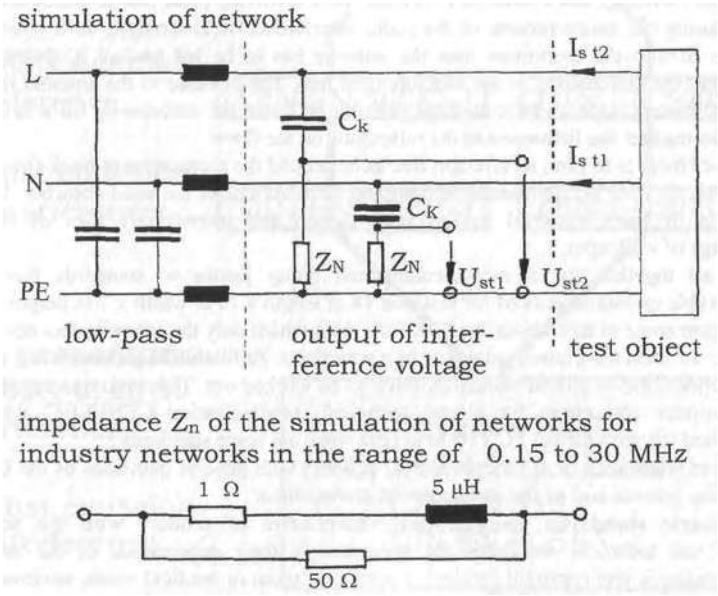

Fig. 2.4: Simulation of network for the measurement of interference voltages.<i>

<i>: acc. to Ernst Habiger: EMV, Huthig Buch Verlag Heidelberg (1992), ISBN 3-7785-2092-X

2.4 EMC-techniques to measure the emission of interference

Actually we already can be glad that it came to an europe-wide agreement for the regulation of the EMC-set of problems. But the question if we can be satisfied with what we have reached is still outstanding. All too often the lowest common denominator of the measurable and checkable was sought and not so much the technical possible was taken into consideration.

The main emphasis is put on the measurement of the emission of interferences. Traditionally the interferences bound to a circuit are registered in a frequency range up to 30 MHz. The corresponding wavelengths thereby can correspond with the length of the supply lines and form standing interference waves. Primarily the spectrum of the interference currents is measured e.g. over a HF-current converter. These currents produce a voltage drop over the internal resistance of the feeding network. Because the properties of the networks can vary very strong, a standardized end-resistor is required for the measurement of the interference voltage. For this purpose an imitation of the network is switched between the network and the examinee. This imitation in addition has the task to keep away the interference signals that come from the supplying network with the help of filter-elements (Fig. 2.4).
The measurement of the interference radiation, the field-bound interference emission, lakes place between 30 MHz and 1 GHz. For that a free field or an absorber-hall with little or no reflexions is required. The standardized distances of measurement are 3, 10 and 30 meters. The electric field strength is determined with dipole broadband antennas, the magnetic field strength with frame antennas. It must be possible to both vary the receiving antenna between horizontal and vertical polarization and to adjust the receiving antenna in the height and the position to the test object.

Typical measurement set up to measure the emission of interferences bound to a conductor[i]

A: shielded link conductor
B: bundle of conductors folded like a meander
C: connection to the reference mass
ME: receiver of interference signal
NNB: Simulation of network
PO: test object

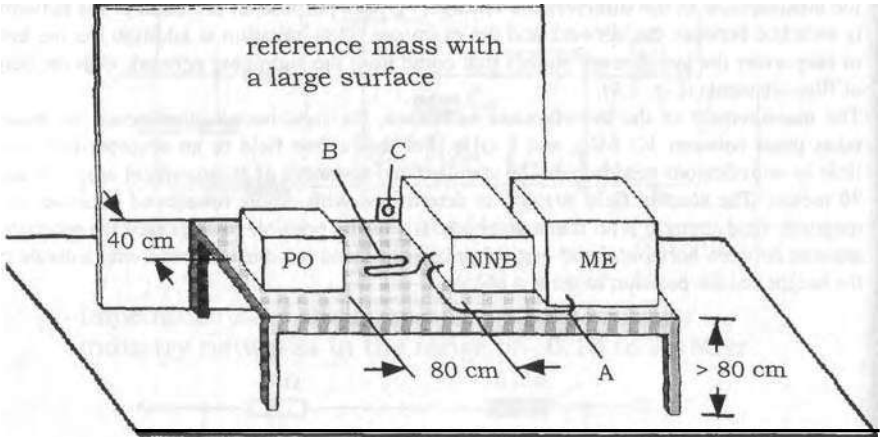

Fig. 2.5: Measurement set up to measure the emission of interferences bound to a conductor,[i]

<i>: Ernst Habiger: EMV, Huthig Buch Verlag Heidelberg (1992), ISBN 3-7785-2092-X

2.5 Electro-Smog

There is almost no end to the possibilities of variation and one needs already a lot of overview and experience to determine the field strength maximum. Nevertheless we have to ask ourselves if in this way really all emissions of interference are understandable, that popularly are described as „electro smog".

Smog is the combination of the terms Smoke and Fog. It therefore describes a pressure on the environment with fog like smoke. When for instance in the case of smog alarm all interference sources are switched off, which means all kilns are brought to a stop and all automobiles are stopped, than the fog like smoke therefore still is not vanished from the air. It just distributes itself and dissolves only very slowly.

The transfer of the smog idea on the electromagnetic interference radiation is bound to fail because, when the test object is switched off no emission of interference at all is detectable with the usual measurement means. Nevertheless the rainbow-press is trying to enumerate almost all electromagnetic field phenomena under the term „electro smog" without consideration of the fact that this term is not at all a collection term. From the sight of an expert one can only speak of smog when something like smog remains and stays active further after the switching off of an electro technical apparatus. It should be a phenomenon that is not understandable by the standardized measurements of interference radiation. Such a phenomenon would be e.g. the vortex of the electric field. However vortices are virtually not measurable in a direct way because they have the unpleasant property to whirl about around the measurement probe. But they will be detectable by their eddy losses and in the case of the electric field vortex appear as noise. Until now the standardizer however haven't planned to investigate the influence of an apparatus on the noise in the environment. Here we still grope in the dark.

At least the vortex shows a storing property that would justify the use of the idea "smog". We'll have to investigate the phenomenon.

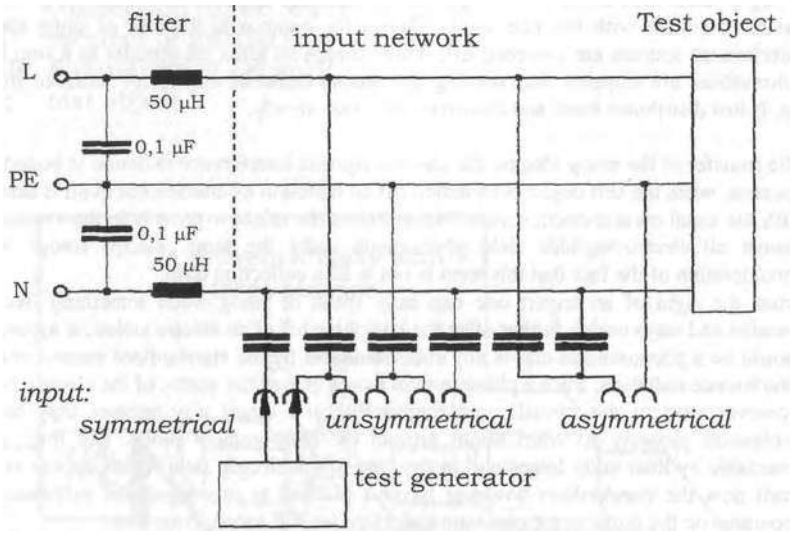

Fig. 2.6: Picking up of interference voltages in network lines.<i>

<i>: Ernst Habiger: EMV, Huthig Buch Verlag Heidelberg (1992), ISBN 3-7785-2092-X

2.6 EMC-techniques to measure the stability against interference

The question is: what kind and what intensity of an electromagnetic interference can an apparatus cope with without limiting it regarding its technical function. For that test generators are used and with their help interference signals are produced in the test object. Fig. 2.6 shows the possibilities of a symmetrical, of an unsymmetrical and of an asymmetrical production of interference voltage signals in the power supply lines of an examinee. Over and above that the testing possibilities and testing methods are numerous. In principle the following processes are used:

1. The simulation and production of interference factors typical for the network like harmonic waves on network voltages, overlapping signal voltages, changes of network voltage, decrease of network voltage, network interruptions, network unsymmetries and network frequency changes.
2. The production of both energy-poorer and energy-richer interference impulses like they can form in energy-networks by switching acts or by the effect of lightning (burst).
3. The simulation of the course of events when static electricity discharges.
4. Low-frequency magnetic fields like those that can form by network frequency operating and loading currents or by short-circuit and lightning currents in the form of a pulse.
5. The stability against interference against the influence of an electromagnetic field also called radio interference firmness. For this purpose high-frequency generators and broadband antennas are used to expose the examinee to electromagnetic fields in a frequency range between 10 kHz and 18 GHz. At the moment tests are only performed between 27 and 500 MHz. The modulation of the carrier wave should be possible to be able to imitate the interferences by radio technology as realistic as possible. Thereby the field strength values can by all means reach up to several 100 V/m.

In accordance with expectation the result of this irradiation with an outside field is that every conduction path and every wire can act as an antenna and therefore can produce high-frequency currents and measurable potentials. Building parts of the analog technology as a consequence battle with problems of drift whereas with digital logic parts and computer parts the danger exists that switching states change unintentionally. Let us remember again the overlap effect of fig. 1.4. The electromagnetic wave itself marches with the speed of light through the examinee. When a small part of the wave finds an object that it can use as an antenna than the localized overlap comes into play. This than as a cause is responsible for the effective and measurable antenna currents. Until here the text books help us to explain the problems that happen and to remove them logically.

However time and again cases are reported where textbook physics can't help us any further. Spectacular cases even came to court like e.g. the ABS (Antilock Braking System) of a truck that had failed due to EMC-interference radiation. As a consequence the brakes had failed. When after that the local radiation pollution is measured no anomaly at all can be discovered. The measurable field strength is not higher as is usual in the whole area. Maybe you also have made the experience that often the causes can't be found when your computer suddenly "crashes" out of the blue.

Here the mentioned vortex of the electric field is capable to deliver plausible explanations because it is not bound to the geometry of an antenna and in addition is highly active without being detectable with the usual EMC measurement methods of the interference radiation measurement!

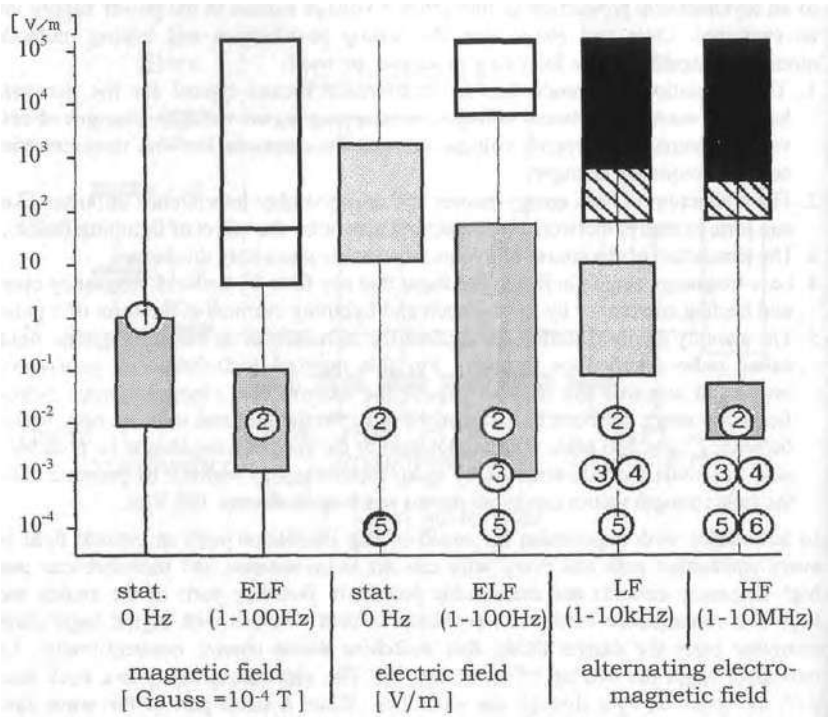

Fig. 2.7: Intensities of natural electromagnetic fields (electric, magnetic and electromagnetic fields)

In addition to fig. 1.1, page 3,
magnetic field in Gauss (= 10^{-4} T),
electric field in V/m.

<i>: A.S. Presman: Electromagnetic Fields and Life.
Plenum Press, New York - London, 1970

2.7 Tasks of the biological compatibility

The second leg of the environmental compatibility (EC) forms the biological compatibility (BC) besides the electromagnetic environmental compatibility. Whereas the interests of the EMC are looked after by electrotechnical engineers and electrophysicists, with the BC also doctors, biologists and architects are addressed.
Moreover this leg is already very old and already existed long before artificial interference sources could be created by mankind. The interaction between the arising interference sources in nature and the biological systems in general and specially men always interested the doctors, the priests, the druids and geomants, that not seldom looked after several functions in personal union equally. Unfortunately they as a rule have kept their knowledge and capabilities as secret knowledge, didn't make any recordings and merely initiated and trained their respective successors. Through that a great deal got lost and today non-medical practitioners, homeopaths and esoterics trouble themselves to take up to the far-reaching buried knowledge.
Because this concerns pure knowledge by experience, often the with the topic occupied persons themselves are not capable to say anything about the physical backgrounds and causes. One concentrates entirely on the under certain circumstances reachable results and only in rare cases on reproducable effects. In some areas the scientific assignment already has succeeded, have parascientific phenomena managed their admission in the so called "exact sciences", but in most experience disciplines the assignment is still due. There still is a lot to do here.

In the time as there not yet were operated any artificial interference sources on our planet, the senses of man naturally were a whole lot sharper for his electromagnetic environment as today. Today, where there scarcely is a place on earth where we are not irradiated by terrestrial transmitters, by satellites or by the netfrequency that is measurable everywhere. In the bluntness of our senses perhaps the hybris of modern man is founded, with which he wants to rise himself above esotericism, geomancy and other sciences of experience and thereby dispute the electric and magnetic fields their biological effectiveness.

The fields of natural origin form an electromagnetic environment for men, that they have adapted to and that they probably need for a life in accord with nature. The evolution has taken care for a corresponding adaptation.
In fig. 2.7 in addition to the limits from fig. 1.1 the intensities of natural electromagnetic fields are registered[<>]. They lie clearly lower as the recommended limits but exactly in the area wherein the first reactions of living beings are observable.

When we ask us how much electromagnetism is good for us and how much harms us so the obvious answer is: exactly as much radiation as nature dictates in the fluctuations between day and night, between the months, years and in the end between the cycles of sunspots of 11 years. Here the guide value is found that man and nature have adapted themselves to. In fig. 2.7 the corresponding area between the natural minimum and maximum values is given.

Irradiation strengths of the field radiation in the biosphere and how the optical windows are situated in the atmosphere<i>.

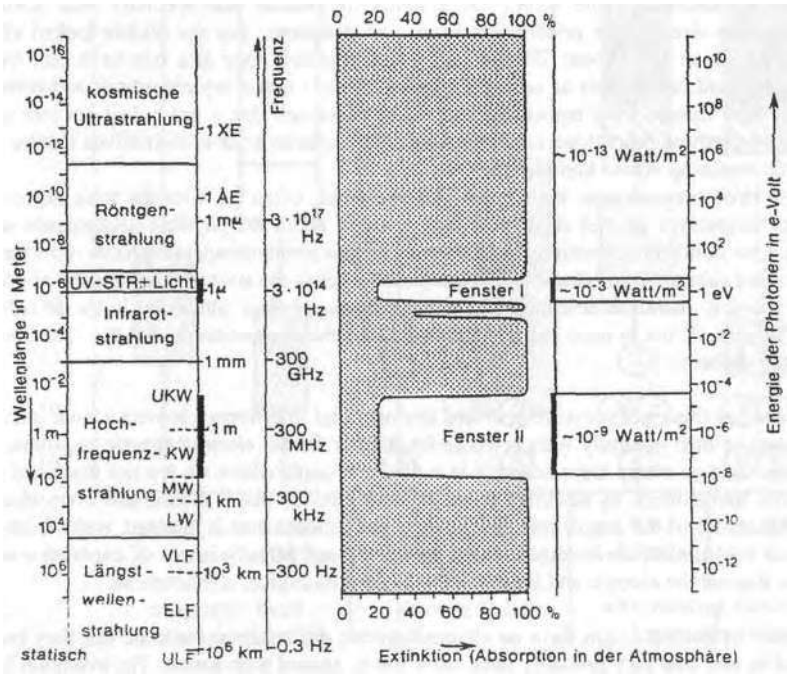

Fig. 2.8: Absorption dependent on frequency in the atmosphere

<i>: entnommen aus: H.L. Konig: Unsichtbare Umwelt (Wetterfuhligk.), 5. Aufl., Bild 8, Seite 14, Verl. Moos & Partner Milnchen, ISBN 3-89164-058-7

2.8 Natural fields

Our electromagnetic environment has something to offer:
From the magnetic north pole to the magnetic south pole of the earth run the field lines of the earth's magnetic field that we are exposed to. With a compass we use the vector character of the magnetic field to fix our position. The induction averaged over time is approx. 50 uT. But it is overlapped by short-time fluctuations caused by geomagnetic storms in the ionosphere.

These storms again are caused by the eddy currents and the currents of charged particles that come from the sun. At the same time these eddy currents in the ionosphere together with the earth's magnetic field form a protective shield with a excellent screening effect for us inhabitants of earth.
In several layers like for instance the ozone and Heaviside layers a filtering and damping until the complete suppression of the very broad cosmic spectrum is caused. This extraterrestrial spectrum of radiation doesn't leave a single frequency out and has a lethal intensity for us.

Only for a little window in the frequency spectrum, radiation can pass almost undamped, as can be seen in fig. 2.8: the light with the spectrum of the colors. For this nature has donated man a sense organ so that man can protect himself against too high dose values. After all, who will look voluntarily into the sun? We only get into trouble when our sense organ doesn't function any more (for instance in the fringe range of the visible spectrum, the UV-range).

For other frequencies of electromagnetic radiation man neither has a sense organ but that doesn't mean that he is not influenced by these. Here, as in the UV-range he only indirectly notices that he has got too high a dose when he has to discover some influences on his well-being and his health. Without the help of neutral measurement apparatus he himself by no means is in a position to make a connection between an excessive exposition to radiation and his health problems.

When natural field strengths should be used as a measure for technical limits, so there should be paid attention to the fact that nature doesn't know intense continuous irradiation. The values are subject to powerful fluctuations that leave men and nature the chance to regenerate.
The television stations not even think it is necessary to reduce their broadcasting power after the end of broadcasts and further sprinkle the sleeping population with test signals, with senseless pictures of going by underground or nonstop program advertisements. People need the intermissions. That again shows how good nature means it with us.

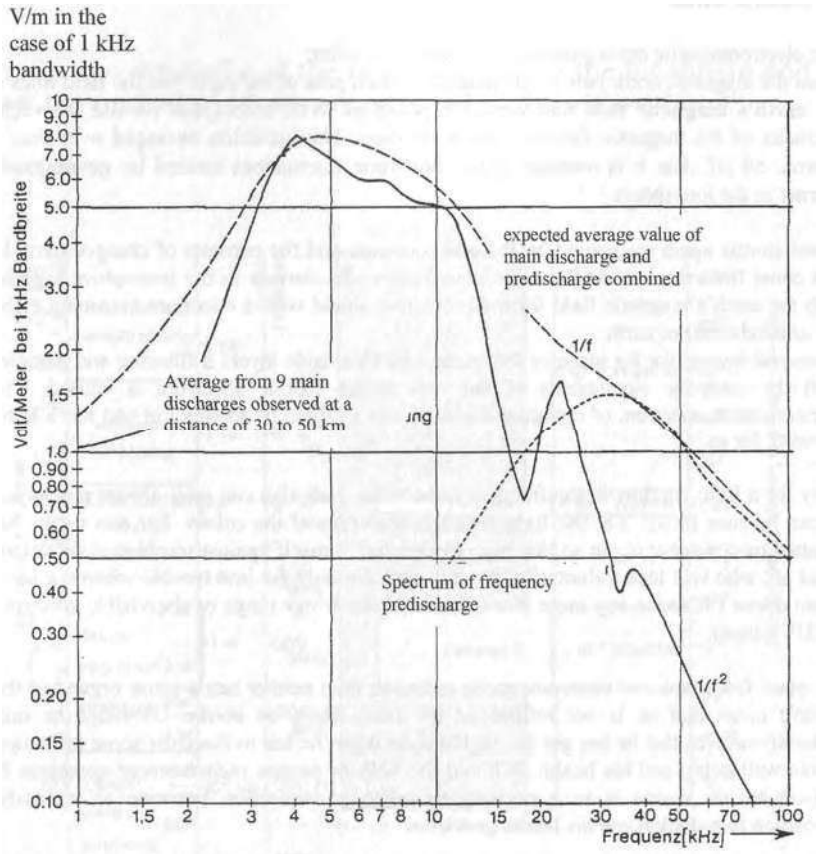

Fig. 2.9: Spectrum of frequency of one lightning, measured
field strength at a distance of 1.6 km from the place of origin. See Watt and Maxwell:[<i,ii>]

____ from: _____
<i>: H.L. Konig: Unsichtbare Umwelt (Wetterfuhligk.), 5.Aufl., Bild 38, Seite 27, Verl. Moos & Partner Munchen, ISBN 3-89164-058-7, see <ii>.

2.9 Electricity of the air

The electrostatic field strength of the earth lies between 50 and 500 V/m. That is a whole lot considering that voltages off 60 Volts can be lethal for man. But a living person distorts the terrestrial E-field for reason of his own field and his electric conductivity, so that there exists no danger for him as long as he doesn't grow into the sky.

Maybe the dinosaurs had to become extinct because they were to big and for instance the E-field near the ground had risen with a jump by a meteorite that brought a high charge from the cosmos. That would explain why the smaller living beings could survive the natural disaster.

Also the thunderstorm electricity can become life-threatening. Burns, heart and brain failures are the most common consequences. After all the probability to be struck by lightning is four times higher as to have six right ones in the lottery.
Over the lightning channel of approx. 1 meter in diameter charges between 10 and 200 C are transported what results in current strengths of 2000 up to 200,000 A. The main discharge lasts between 10 and 50 usec. With the preceding and all the following discharges it lasts over a second.
Field strengths on the scale of 4,000 V/m are typical but in a distance of 5 km these wear off to 8 V/m. The frequency spectrum of a lightning reaches 4 powers of ten into the range of the radio waves. In fig. 2.9 is shown the field strength measured in a distance of 1.6 km from the place of origin[<i,ii>].

The origin of lightnings is still an unsolved problem after the well-known models (Wilson) arc not in a position to explain the reason for the origin of the potential difference of more than 100 million Volts required for the ionization of the air. Also the lightnings that struck in the direction of the ionosphere still are mysterious. We'll have to come back to this[<iii>].

<i>: H.L. Konig: Unsichtbare Umwelt (Wetterfuhligkeit), 5. Aufl., Bild 38, Seite 27, Verlag Moos & Partner Munchen, ISBN 3-89164-058-7, according to <ii>.

<ii>: A. D. Watt and E. L. Maxwell: Characterisic of Atmospheric Noise from 1 to 100 Kc/s. Symposium on the Propagation of VLF Waves, Boulder, Col., Paper 35, Jan. 1957.

<iii>: see Part 1, chapter 5.4 and part 2, chapter 14.11.

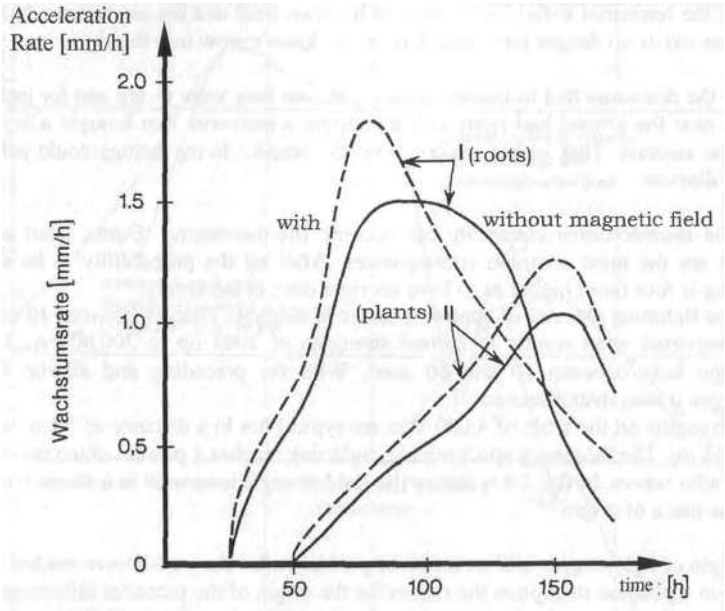

Fig. 2.10 A: Effect of a static magnetic field of 100 kA/m (0,12
Tesla) on the root (I) and on the plant (II) of barley seeds.
plants in the magnetic field: dotted line
plants for checking: drawn line
according to Novitskii<iii>

<iii>: Novitskii, Yu.I.: Effects of a magnetic field on the dry seeds of some cereals. Proceedings of Conference on the Effect of Magnetic Fields on Biological Objects, Moscow, p. 52, 1966.
Taken from: H.L. Konig: Unsichtbare Umwelt (Wetterfuhligkeit), 5. Aufl., Bild 72, S. 73, Verlag Moos & Partner Munchen, ISBN 3-89164-058-7

2.10 Biological effects

The in fig. 2.1 indicated connection between the EMC and the BC, by some authors inofficially described as EMC-environment (EMCE), describes the effect of artificial fields on biological systems. This concerns the sensitive range of tasks that is discussed extremely controversially in the public. The problem thereby is that the artificially produced field strengths lie above the natural field strengths for several scales. In the thirties first reports about troubles were provided by navy radio operators that complained about headache, dizzyness, concentration failure and indisposition. Besides these negative reports concerning the so called "radio operator disease" at the same time medical usages concerning high-frequency therapy were tested. In the beginning this diathermy called healing method still was a short wave irradiation. Today it is extended into the microwave range and uses the thermal effect of electromagnetic rays. The increased temperature of the tissue causes an increased local blood flow. This supports healing processes, loosens cramped muscles and can help in case of rheumatic fever. The advantage of the HF-irradiation compared to contact heat by a hot-water bottle or by infrared rays is the higher penetration depth. Herein short waves are superior to microwaves. But microwaves can be better focussed on a certain part of the body. Is the temperature further increased, so the tissue is damaged. This is used for the treatment of cancer and is called hyperthermy. Because cancer cells as a rule are flowed with blood worse than healthy cells, they are more sensitive to heat and therefore are faster destroyed than healthy cells at a correspondingly increased temperature. In this way for Instance in the USA cattle with a so called cancer eye are treated. For that the spot suffering from cancer is irradiated with 2MHz-waves for 30 seconds with a handheld apparatus of 10 Watts broadcasting power. The rate of succes is given to be 90%! The method of hyperthermy has not yet been able to establish in the area of the medicine for humans. Also at our college corresponding research work is carried out in co-operation with the radiological clinic of the university of Freiburg (Germany)[<i>].

The thermal effects of high-frequency fields are therefore well-known and subject of scientific research. On the other hand and in spite of numerous publications, non-thermal effects even today are denied by some scientists as non-existent[<ii>]. Here only a few counter-examples will be listed.

Fig. 2.10 A shows the effect of a static magnetic field of 0.12 Tesla on the root (1) and on thc plant (II) of barley seeds. The readable effect is an acceleration of the growth of the treated seeds (dotted line) compared to the plants for checking (drawn line)[<iii>].

<i>: H. Schulz, W. Oppitz: Lokale Hyperthermie durch hochfrequente Wirbelstrome, Medizin Technik 1, 1987.

<ii>: G. Nimtz: Mikrowellen, Einfuhrung in Theorie und Anwendung. 2. Aufl., BI-Wissenschaftsverlag 1990, ISBN 3-411-03203-0

<iii>: Novitskii, Yu.I.: Effects of a magnetic field on the dry seeds of some cereals. Proceedings of Conference on the Effect of Magnetic Fields on Biological Objects, Moscow, p. 52, 1966; taken from: H.L. Konig: Unsichtbare Umwelt, fig.72, p. 73, Verlag Moos & Partner Munchen, ISBN 3-89164-058-7

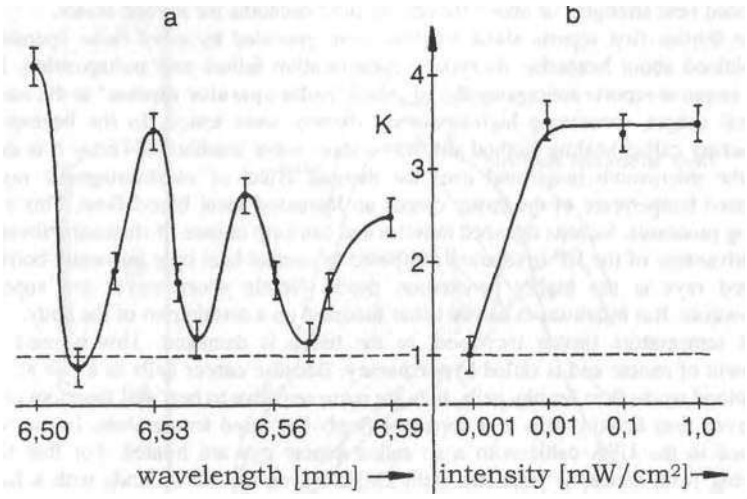

Fig. 2.10 B: Measured increase in the production (K) of colicin by colibacteria as a microwave effect

a) as a function of the wavelength,
b) as a function of the intensity of the microwaves,

according to Keilmann<i>.

____ taken from: _____
<i>: H. L. Konig: Unsichtbare Umwelt (Wetterfuhligkeit), 5. Aufl., Bild 106, S. 111. Verlag Moos & Partner Munchen, ISBN 3-89164-058-7

A static field naturally produces no induction and hence no heating will arise. In the case of alternating fields the thermal effect in experiments is excluded by working with cxtremly low stimulations. The example after fig. 2.10 B shows the measured increase in the production (K) of colicin by colibacteria at only 0.01 mW/cm^2 microwave power<1>.

In addition the example provides the interesting information that obviously only a certain frequency and it's harmonic waves increase the production, other frequencies on the other hand remain inactive. Because only minimal field strengths are used it more likely concerns an information-technical as an energetic effect (curve a). This statement is supported by the observation that an increase of the intensity not at all necessarily as a consequence also increases the production (curve b). What the colibakteria need is obviously neither energy nor heat but only a certain frequency that stimulates the colicin production or the growth.

Should it really be confirmed that biological effects of electric and magnetic fields can be produced by certain frequencies and can't happen by an energy transition so the discussions about limits must seem ample meaningless.

Maybe the one or the other in thought already draws a connection to the acceleration, the acclerated growth of kids, which is observed world-wide and stronger in cities than in the country. It started for approx. 100 years simultaneous with the electrification of the homes in the towns. In Asia the acceleration and also the electrification have started later. Other growth stimulating effects like radio waves, X-ray examinations, atomic tests and provable also the nourishment with vitamin B6 happened only until much later and at the most could support the actual effect.

But how should a proof be offered when anyway the field strength not at all can have a decisive influence on the growth of man after the statement of fig. 2.10 B? Which information is authorative? Where lies the responsible frequency window? Does the information actually manifest as frequency? Is the authorative influential factor also in this case not at all noticed and measured?

A lot of pressing questions are still outstanding. But in any case the numerous influential factors detected in experiments do not at all let themselves reduce to a sole factor, for instance the nourishment. For a family doctor it may be comfortable to be able to give an easy explanation: „Cause is the nourishment!" With such a reductionism on the other hand the actual cause stays in the dark and the asked questions in this way won't let themselves be answered.

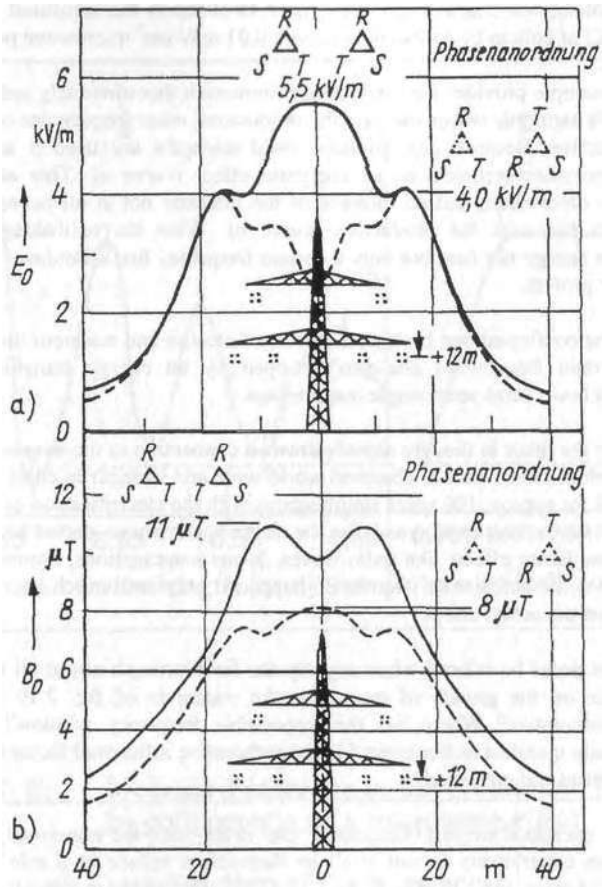

Fig. 2. 11: ____ profile of the 50-Hz-field on the ground at 380kV/1kA in each circuit.<i>
a) electric field,
b) magnetic field.

____ taken from: _____

<i>: E. Habiger u. a.: Elektromagnetische Vertraglichkeit, fig. 7.3, page 147 and Fig. 7.1, page 146, 2nd Ed., 1992. Berlin, Miinchen: Verlag Technik.

2.11 Artificial fields

The scepticism of people feeling close to nature is especially directed against artificial fields that man can't see nor hear nor smell. Objects of doubt are first of all the installations for the creation, distribution and conversion of electric energy.

An essential role plays the fact how close the supplying and the draining conductors are to each other, so that the respective fields can compensate each other. The worst solution one can think of is realized at the electrified railway. Here the rails and the earth are used as the draining conductor for the current while there exists an ample large distance to the supplying conductor. A compensation is almost impossible thus causing gigantic interference fields that are detectable even at a distance of 10 kilometers. The increased putting on of railway engines feeded by rectified current is likely to aggravate the set of problems because the non-sinusoidal absorption of current is strongly afflicted with harmonic waves.
With high tension transmission lines (fig. 2.11) the interference field strength is reduced when the three cables are suspended with only little distance between them. But even the selected phase order can play a role. Of course the optimal compensation effect is guaranteed with cables in the earth. But these are expensive and technically not realizable for such high voltage levels.

In the eighties also the computer screens got in the headlines. The terminals are furnished with a cathode ray tube and have a very broad radiation spectrum that already starts at 0 Hz. Here already static maximum values of 64 kV/m are measured[<1>]!

I'requency range	Measured maximum values E_{max} resp. H_{max}	30 cm in front of the screen
static field (0 Hz)	64 kV/m	
30 Hz. 60 Hz	10 V/m and	
	0.2 - 1 A/m	
5 Hz - 1 kHz	1800 V/m and 4 A/m	10 V/m and 0,6 A/m
50 Hz - 0,5 MHz	1 A/m	
15 kHz-220 kHz	50 V/m and	15 V/m and
	1.1 A/m	0,17 A/m
3 MHz -300 MHz	< 0,2 V/m	

Fig. 2.11: Electromagnetic fields from screens[<1>]

system about	used frequency	measured value
radio broadcasting station (MW 2O kW)	6OO kHz	2...17 V/m
radio broadcasting station (SW 1OO kW)	15 MHz	1...25 V/m
SOS-transmitter on a ship (1OO W)	41O kHz	1...3 V/m
Epitaxiedevice (induction oven)	45O kHz	37...4OO V/m
HF-welting press (welding of plastic foils)	27,12 MHz	70...85 V/m
radar on a ship (TRN 311)	9,3 GHz	1...3O uW/cm^2
radar of an airplane	9,2 GHz	45O... 28OO uW/cm^2
domestic appliances measured in a distance		of 3O cm:
hand mixer	5O Hz	5O V/m
refrigerator	5O Hz	6O V/m

Fig. 2.12: ____ the electric field strength resp. Power density in our environment.<i>

____ taken from: _____
<i>: E. Habiger u. a. : Elektromagnetische Vertraglichkeit, Fig. 7.2, page 146, 2. Ed., 1992, Berlin, Munchen: Verlag Technik, ISBN 3-341-00993-0

2.12 Protection against artificial fields

Artificial fields more or less always occur in the neighbourhood of electric apparatus and installations. Especially problematic are those that work with the free radiation of electromagnetic fields, that is all the radio broadcasting stations, handheld and radar transmitters.
Herewith it is important that not needed parts of the antennas are shielded, that antennas with little close by field pollution are used and that the stand should be situated at least 3 km remote from inhabited areas. For instance at radar installations damping values of 10 dB and more can be obtained only by using a corresponding tree growth.
This obviously concerns a damping of the waves in a dielectric manner. We'll have to come back to this because textbook physics does not know a corresponding damping term in the wave equation.

The radiation leaking out in case of the high-frequency welding of plastic foils and of the microwave oven should be minimized.
In the case of induction ovens or of motors an active shielding often causes problems so that for simple domestic appliances like a hand mixer and especially for the electric hair-dryer non proportionally high field strength values are measured. Fig. 2.12 informs about it.
Protective measures for the operator are hardly possible. To protect uninvolved people not only the apparatus but also the rooms and eventually whole parts of buildings had to be shielded and grounded.

Sometimes also fairly simple possibilities are helpful like e.g. the usage of a remote control. By clearing away the cable salat at the workplace and at the sleeping place induction loops can be removed. Alarm-clocks operated by batteries should have preference over those operated by the network. Mattresses with metal in them and spring-beds which clearly act as an antenna should be avoided. In extreme cases even so called "current-free switches" and shielded network lines are recommended (fig. 2.13).

In the area of the network supply lines a choking coil can help decrease the spreading of high-frequency interference radiation. It is especially important that all the conducting metallic objects like e.g. water pipes, heatings, steel racks, machines, switching racks, steel armaments and metallic windows should be grounded properly, because otherwise extremly high static charges could result instead of a shielding. Construction biologists recommend to when possible do without metals when building houses and furnishing, what of course is only realizable with limitation.

In any case numerous measures are known that to a lesser extent find their legitimation in classical physics, but more likely in precaution. As long as we do not know which phenomenon causes the electrosmog and we don't have a measuring-instrument at our disposal, precaution is really the only thing we can do irrespective of the effectiveness of the measures and of the arising costs!

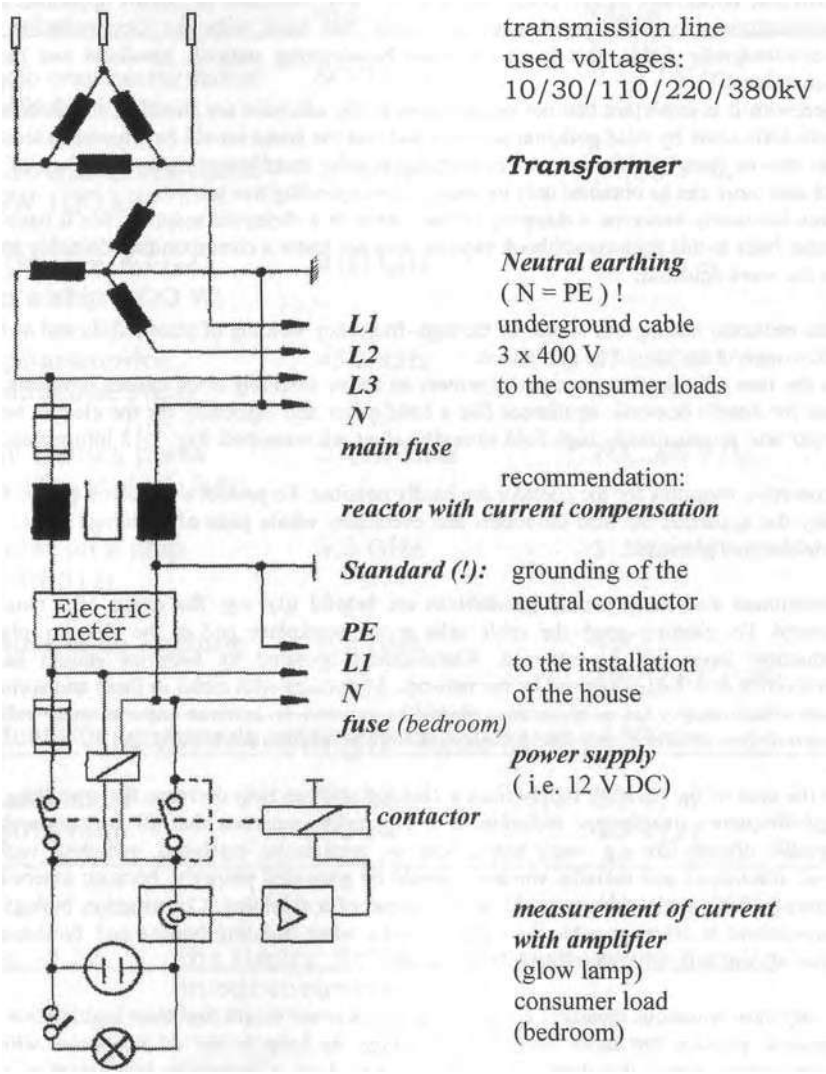

Fig. 2.13: About the circuitry and the problems involved with a "current-free switches" installation

2.13 Unsolved tasks

The report concerning the actual state of research could be continued at will. But the expositions should suffice, to understand what are the tasks of the electromagnetic environmental compatibility (fig. 2.1) and which questions still have to be supplied with a solution. One can get deeper into every of the addressed points and then discover that some questions can be expressed sharper and maybe conceivable answers can be found, but at the same time and unavoidable the number of new questions increases faster.

Let us again take up the example of the handheld wireless telephones (chapter 1.2). At least it now is clear to us that the usage of the built-in microwave antenna of a handy is problematic. In the interior of an automobile it never should be used. If, however, one uses the antenna installed on the outside on the sheet metal then the damping and screening effect of the sheet metal chassis is advantageous at least for the handy user.

With that of course the central question is not answered. The question of what the cause is for the interfering and at worst health endangering effect of the HF-radiation. Field freedom we can't find anywhere on this world. Possibly we even need the fields. But then the question is how much is necessary, how much is healthy and how much makes us ill.

The gap of explanation especially gets clear in the case of the static or of the low-frequency magnetic field: away from technical interference sources normally fields on the scale of 10 nT are measurable. Construction biologists say that 20 nT, so twice that value, should not be exceeded at the sleeping place and maybe 50 nT at the desk. These values however are determined purely empirical.

When a person is examined in a nuclear magnetic resonance tomograph that person is exposed to a field that lies between 0.2 and 1.5 Tesla. that is a value 7 till 8 powers often higher than before mentioned without this leading to the death of that person. Entirely on the contrary this method is regarded as especially caring and safe compared to the X-ray examination.

Here again the legitimation of the thesis put forward is entirely comfirmed. The thesis that the well-known physically measurable and controllable phenomena can not be considered as a cause and that possibly a until now undiscovered field phenomenon should be called to account.

Should such a phenomenon exist it should be derived, calculated and proved. We must go to endless troubles and try everything. The actual difficulties wherein the electromagnetic environmental compatibility is stuck are a challenge.

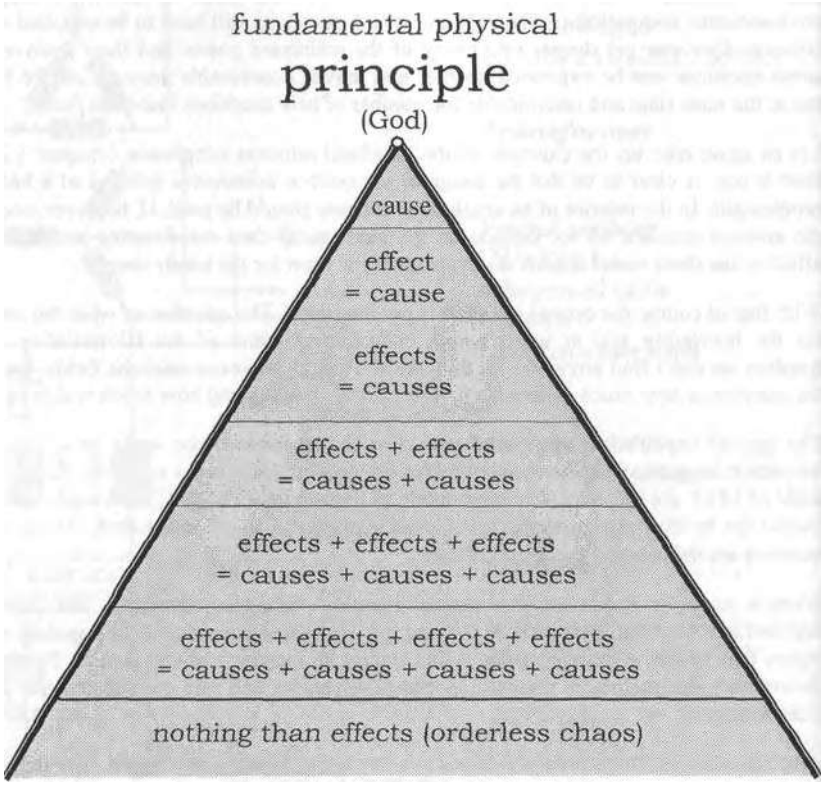

Fig. 3.0: pyramid of causality

vortices are a consequence of the principle of causality

3. Approach

In the question, if there exists a still unknown phenomenon that influences the electromagnetic environmental compatibility, we must fall back far until upon the roots of our physical understanding. Here we find a fundamental principle that until today is not doubted and that is regarded as elementary, the principle of causality. Every result of a measurement, every interpretation is checked for causality and only after passing this examination it is accepted and published.

This principle of cause and effect has established, not only in physics but also in many other disciplines of science. Is an effect observed, so there immediately is asked for the cause. This principle encounters us in daily life[<i>].

When all observable and measurable effects ever can be assigned to a cause without force and without exceptional regulations then the logical result is a pyramid of causality. On top a fundamental physical principle is found, that is regarded as given by nature or as given by god and that with its properties is responsible as the cause for different effects. These effects again appear as the cause for new effects and so on (Fig. 3.0). Sometime we have removed us so far from the top of the pyramid that a direct reference to the describable effects can't be made anymore, so the impression could arise that it concerns an isolated and independent discipline. We should take care not to think in such a monocausal way, because both delimitation and avoidance of interdisciplinary working methods will inevitably steer us into a dead end!

This pyramid of causality stands for the vision of a "unified theory", like it is demanded and sought-after by numerous research scientists. But as long as it is not found, we'll have to do with unsolved problems of causality. About this any number of examples can be given.

A physical principle based on the principle of causality is the vortex. This the eddy current demonstrates us clearly. The cause for its origin is an alternating field. According to Faraday's law of induction this induces a voltage that in a conducting medium results in a current according to Ohm's law. Around this current according to Ampere's law an alternating field forms, that points perpendicular to the current and overlaps the original alternafing field. This induced field first of all is an effect that overlaps the cause and itself becomes the cause. The effect that follows from that further overlaps and forms a new cause etc. In this way vortices form.

Vortices quasi represent the principle of causality.

<i>: When for instance a woman complains: "Doctor, my left knee hurts" (effect). The doctor diagnoses the cause: "Yes, that comes with age!" With that causality is established. "But doctor", says the woman, "my right knee is exactly as old as my left knee!" And already the doctor has a new problem of causality.

Principle of Causality:

	cause →	effect
quantum physical approach:	quanta →	fields
field-theoretical approach:	fields →	quanta

violations of the principle of causality:

1. monopoles exist
2. starting point for the strong interaction
3. fields and quanta are a cause at the same time
4. hypothetical particles (gluons, quarks, etc.)
5. transmission of information with speeds faster than light
   - with photons (University of Berkeley)
   - with microwaves (University of Cologne)
   - with laser beams (Technical Univ. of Vienna)
6. transmission of energy with speeds faster than light
   - with scalar waves (Nicola Tesla)

Fig. 3.1: Causality or the principle of cause and effect

3.1 Principle of causality

Our physical view of life strictly obeys the rules of causality, the principle of cause and effect. But there are numerous cases, where causality at first could not be fulfilled anymore. Here alternate solutions had to be found to not endanger this very successful principle. A few examples should clarify this:

1. Technically it is impossible to produce a magnetic monopole. When a north pole is produced then the accompanying south pole is also formed. In the same way only the positive and negative pole can be assembled as the so called dipole. In the microcosm however we find monopoles. Electrons are such particles. To restore causality we must grant the microcosm its own laws that are not valid in the macrocosm! But this monocausal hypothesis contradicts the observation that the microcosm represents an image of the macrocosm and vice versa. Doubts if this assertion is allowed are reasonable.
2. Like charges repel each other and that the more the smaller the distance gets. In an atomic nucleus positively like charged protons are together at the smallest possible room without any repulsion happening. Arithmetically seen all atomic nuclei would have to explosively fly to pieces. But because this doesn't happen, shortly a new and supposedly fundamental interaction, the strong interaction, was introduced to save causality. Nevertheless this interaction now holds the like particles in a not explained manner together. Causality could be obtained only by the introduction of a new fundamental phenomenon.
3. When causality should hold as the supreme principle, it should be demanded with priority for the fundamental phenomena of physics. Instead, in quantum electrodynamics the particle is attributed the same physical reality as the field. With the wave-particle duality Heisenberg has given out the corresponding formula of compromise. This slaps the face of the principle of cause and effect.

Causality on principle allows only two approaches for a solution: the quantum physical approach. which holds the quanta as the cause for the fields, and the field-theoretical ašproach. wherein only the fields act as the cause. For both approaches there are good arguments. The field theorists cite that fields can exist also in the vacuum, so that there exist fields without particles but never particles without fields. Against that the quantum physicists hold that somewhere, even when quite far away, there exist particles and that the measurable fields merely are their action at a distance.

Both approaches first arouse the impression to be fully equal. In the course of the discoveries in the area of quantum physics, the corresponding approach has been able to establish. But it demands that all phenomena have to be understood as a consequence of particles. So should gravitons make gravitation possible, should gluons hold everything together and the quarks form the basic building parts. Meanwhile there is only worked with hypotheses. Out of poverty quantum physics meanwhile has said goodbye to strict causality, after the number of the violations of causality has risen that much and in every respect there is a lack of models of explanation. It seems as if the end is reached, as if the quantum physical approach to a large extend is exhausted.

Field-theoretical approach:

3rd Maxwell equation		4th Maxwell equation	
$\boxed{\text{Div}\,\mathbf{B} = O}$	(3.3)	$\boxed{\text{Div}\,\mathbf{D} = \rho_{el}}$	(3.4)

With the relations of material:

$\boxed{\mathbf{B} = \mu \cdot \mathbf{H}}$	(3.5)	$\boxed{\mathbf{D} = \varepsilon \cdot \mathbf{E}}$	(3.6)
$\mu \cdot \text{Div}\,\mathbf{H} = O$	(3.3*)	$\varepsilon \cdot \text{Div}\,\mathbf{E} = \rho_{el}$	(3.4*)
H: source free vortex field		**E**: non-vortical source field	

New <u>field-theoretical approach</u>: $\boxed{\text{Div}\,\mathbf{D} = O}$ (3.7)

thus: $\text{Div}\,\mathbf{H} = O$ (3.3**) and $\boxed{\text{Div}\,\mathbf{E} = O}$ (3.7*)

H <u>and</u> **E**: <u>source free vortex fields!</u>

Einstein:

"Is it conceivable, that a field theory permits us to understand the atomistic and quantum structure of reality? This question by almost all is answered with No. But I believe that at the moment nobody knows anything reliable about it"[i].

Pauli:

"The electric elementary quantum e is a stranger in Maxwell-Lorentz' electrodynamics"[ii].

Fig. 3.2: The field-theoretical approach

<i>: A. Einstein: Grundzuge der Relativitatstheorie, S 162, Anhang II; 5. Aufl., Vieweg, Braunschweig 1974.

<ii>: W. Pauli: Aufsatze und Vortrage uber Physik und Erkenntnistheorie. Vieweg, Braunschweig 1961, entnommen aus:
H. G. Kussner: Grundlagen einer einheitlichen Theorie der physikalischen Teilchen und Felder. Musterschmidt-Verlag Gottingen 1976, S. 161.

3.2 Field-theoretical approach

The field-theoretical approach is the very much older one. Until the last turn of the century the world in this respect still was in order. Max Planck, by the discovery of quanta, has plunged physics into a crisis.
Albert Einstein, who, apart from his lightquanta hypothesis, in his soul actually was a field theorist, writes: ,,Is it feasible that a field theory allows us to understand the atomistic and quantum structure of reality?". This question by almost all is answered with No. But I believe that at present nobody knows anything reliable about it[i]".

By the way the "No" can be justified by the fact that the field description after Maxwell is by no means able to the formation of structure so that it is not possible for quanta to appear as a consequence. The field-theoretical approach could, obstructed by Maxwell's field theory, not further be pursued and to this until today nothing has changed.
Nevertheless it would be an omission to not at least have tried this approach and have it examined for its efficiency. Maybe the above mentioned problems of causality let themselves be solved much more elegantly. For this however the Maxwell theory must be reworked to a pure field theory. With the well-known formulation it offends against the claim of causality, since it is field theory and quantum theory at the same time. To Maxwell himself the quanta were still unknown, but today we know that the fourth Maxwell equation is a quantum equation:

$$\mathrm{div}\,\mathbf{D} = \rho_{el} \quad (3.4)$$

After this the electric field is a source field whereby the individual charge carriers, like e.g. electrons, act as sources to form in their sum the space charge density p_{el}. The other three Maxwell equations are pure wave equations. In this way the third equation identifies the magnetic field as source free:

$$\mathrm{div}\,B = O \quad . \qquad (3.3)$$

This for Pauli probably was the reason to call, "the electric elementary quantum e^- a stranger in Maxwell-Lorentz' electrodynamics"[ii].

Let's return to the principle of causality according to which in the field-theoretical approach the fields should act as a cause and not the particles. In a corresponding field description quanta logically have not lost anything. It is only consistent to likewise demand freedom of sources of the electric field:

$$\mathrm{Div}\,D = O \quad . \qquad (3.7)$$

When the electric field is not a source field, then what is it? The magnetic field is a vortex field. Hence it would be obvious to also conceive the electric field as a vortex field. Numerous reasons speak for it:
1. A non-vortical gradient field, like it is formed by charge carriers, merely represents a special case of the general vortex field. Only by the generation of quanta a source field can form as a special case.
2. The electromagnetic wave teaches us the duality between the E- and the H-field that are directed perpendicular to each other and are in a fixed relation to each other. If one of them is a vortex field then also the dual field must be a vortex field.

Duality:

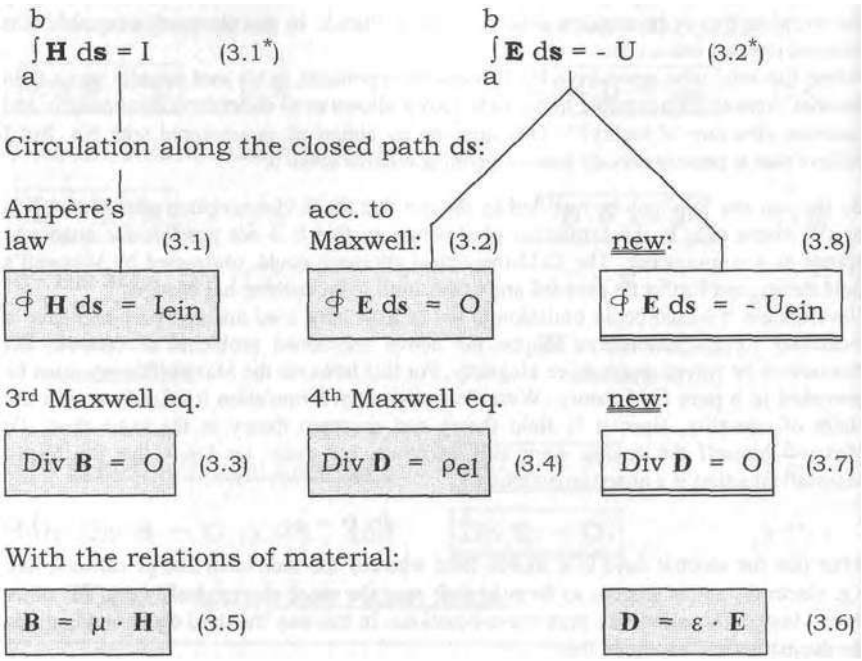

Fig. 3.3: The dual field description

Dual approach according to Jackson<i> or Lehner<ii>:

Div B = ρ_{magn} because of the 4th Maxwell equation: Div D = ρ_{el} (3.4)

ρ_{magn} = magnetic monopoles should exist,
otherwise dual extension (3.8) not allowed!

Caution: closed loop conclusion!
Maxwell theory proves the correctness of the Maxwell theory.
Result: search for magnetic monopoles unsuccessful.

<i>: J. D. Jackson, Classical Electrodynamics, 2nd Ed. , John Wiley, New York, 1975, S. 251 - 253

<ii>: G. Lehner, Elektromagnetische Feldtheorie, Springer-Verlag Berlin, Heidelberg 1990, S. 35 - 36 und S. 533 ff.

3.3 Duality

Duality is a fundamental physical principle. Opposite, but one another complementing phenomena can be assigned to each other in pairs, like e.g. (see fig. 8.8):

	Yin (female)	——		Yang (male)
	south pole	——		north pole
	$\ominus$	——		$\oplus$
R [Ω]	resistance	——	R^{-1} [Ω^{-1}]	conductance
U [V]	voltage	——	I [A]	current
E [V/m]	electr.field strength	——	**H** [A/m]	magnet.field strength
Q [As]	charge	——	ϕ [Vs]	magnetic flux
D [As/m^2]	electr.displacement	——	**B** [Vs/m^2]	magnetic induction
ε_0 [As/Vm]	electr.field-constant	——	μ_0 [Vs/Am]	magnet.field-constant
ρ_{el} [As/m^3]	electr.charge density	——	ρ_{magn}[Vs/m^3]	magnet.charge density
	induction law	——		Ampère's law
	potential vortex	——		eddy current
	(vortex of the electric field)			(vortex of the magnetic field)

First of all we find the duality confirmed in the case of the electromagnetic wave spreading in a homogeneous medium. Here the field pointers of E and H are directed perpendicular to each other and are in a fixed relation to each other. But if the wave is damped in the presence of matter, for instance by eddy currents, then by basing on Maxwell's field theory the duality will vanish.
A good example for perfect duality provides the integral of a field strength vector along the path from a to b:

$$\int_a^b \mathbf{H}\, ds = I \quad (3.1^*) \qquad \text{and} \qquad \int_b^a \mathbf{E}\, ds = U \quad . \quad (3.2^*)$$

Urn if the integration takes place along a closed path then the circulation yields:

$$\oint \mathbf{H}\, ds = I_{eing} \quad (3.1) \qquad \text{and} \qquad \oint \mathbf{E}\, ds = O \quad . \quad (3.2)$$

According to Ampere's law (3.1) the magnetic field can thus form enclosed currents and spatially spreading eddy currents. The electric field on the other hand should be irrotational (3.2).
Let's take the case that the electromagnetic wave is damped by eddy currents and the magnetic field in this way becomes a vortex field. The electric field itself that, as said, is in a fixed relation and perpendicular to the vortex field H, will show all the vortex-typical properties. Hence nothing would be more obvious as to also grant the electric field a formation of vortices:

$$\oint \mathbf{E}\, ds = -U_{eing} \quad . \quad (3.8)$$

Critics of this dual approach, like for instance Jackson<i> or Lehner<ii>, point out that with reference to the fourth Maxwell equation the electric field should be understood as a source field:

$$\text{div}\, \mathbf{D} = \rho_{el} \quad . \quad (3.4)$$

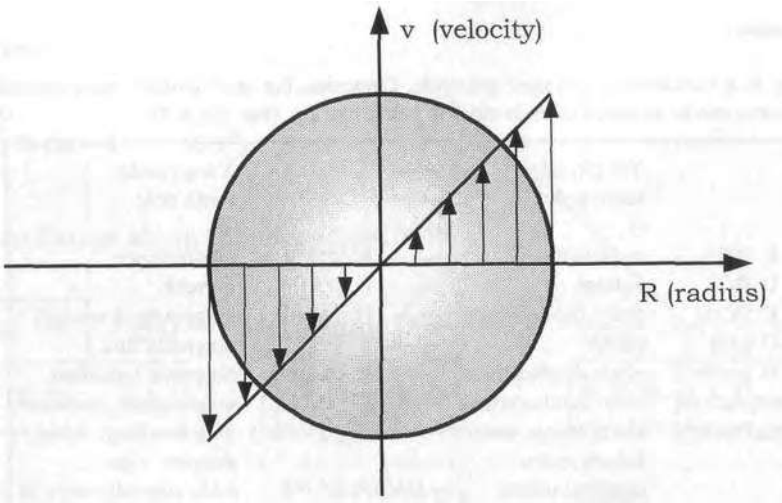

Fig. 3.4a: Velocity distribution v(R) for a vortex with rigid-
body rotation

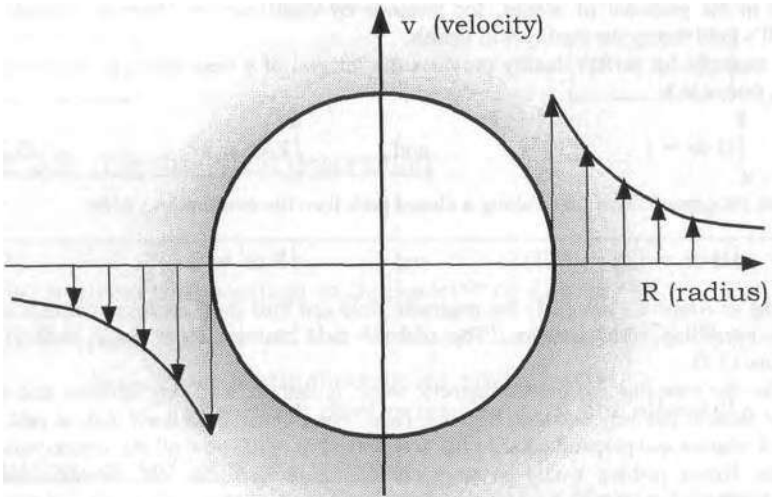

Fig. 3.4b: Velocity distribution v(R) in a potential vortex (see Lugt[<i>]).

<i> Lugt, Hans J.: Vortex flow in nature and technology. Krieger publishing company, Florida 1995; page 30 and 31, ISBN 0-89464-916-7

For a complete duality from the existence of electric monopoles, individual in the space charge density ρ_{el} contained charge carriers, the claim for magnetic monopoles is derived.
In spite of intensive search such north or south pole particles however until now could not be found. Herein from the sight of criticism is seen a confirmation for the assumption that Maxwell's field theory is self-contained and hence in principle may not be extended. The critics have a problem of causality: They postulate source fields that at the same time should be vortex fields. But if one asks how one should imagine such a field that is scalar and at the same time vectorial, then it looks as if no one has ever made any thoughts about it.

The from causality derived solution of the problem of lacking duality requires to extend the Maxwell theory in one point, by introducing the potential vortex of the electric field here and at the same time make a cut in another place:

$$\text{div } D = O \tag{3.7}$$

With this formulation, the assumption of a freedom of sources in principle, the complete duality already is reached: Now neither magnetic nor electric monopoles exist (Fig. 3.3)!
At first we have to accept the loss of the electron hoping that the calculation in the end works out: the "exchange" vortices against particles, by which the quanta can be banned from the field theory, suggests that the elementary particles themselves are nothing else as spherical vortices that have found to an own physical reality.

3.4 Flow vortices

In fluid engineering convincing and strong indications for the correctness of the chosen approach can be found. It benefits us that hydrodynamic vortices are visible or can be the injection of smoke, e.g. in a wind-tunnel.
Already Leonardo da Vinci had observed at liquids that there exist two dual basic types of plane vortices: "Among the vortices one is slower at the centre than at the sides, another is faster at the centre than at the sides."
A vortex of the first type, also called "vortex with rigid-body rotation", is formed for instance by a liquid in a centrifuge that due to its inertia of mass is pressed to the edge because there the largest velocity exists. In an analogous way the electromagnetic vortex in electrically conductive material shows the well-known "skin effect" (Fig. 3.4a).
To explain the other vortex Newton describes the experiment where a rod is dipped into a liquid as viscous as possible and then is turned. In this potential vortex the velocity of the particle increases the closer to the rod it is (Fig. 3.4b).
The duality of both vortex phenomena becomes obvious when we make ourselves clear that in the experiment with the centrifuge the more liquid presses to the edge the less viscous the medium is. And that on the other hand the potential vortex forms the stronger the more viscous the medium is. As conclusion we read in text books that the viscosity of the liquid decides whether a vortex with rigid-body rotation or a potential vortex is formed.

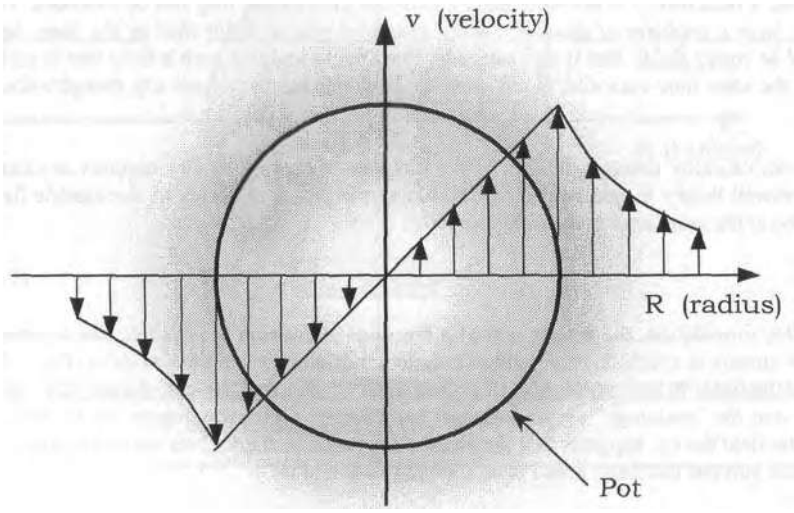

Fig. 3.5: Combination of a vortex with rigid-body rotation and a potential vortex (Lugt[i]).

<i> Lugt, Hans J.: Vortex flow in nature and technology. Krieger publishing company, Florida 1995; ISBN 0-89464-916-7

3.5 Rankine vortex

When we, in a third experiment, immerse the centrifuge filled with water into a tough medium and let the centrifuge rotate, then inside the centrifuge a vortex with rigid-body rotation forms and outside the centrifuge a potential vortex forms (Fig. 3.5).

It is obvious that one vortex always causes the other vortex with the opposite properties and so the existence of one causes that of the other. So in the first case, that of the vortex with rigid-body rotation, outside the centrifuge potential vortices will form in the surrounding air, whereas in the second case, that of the potential vortices, the turning rod itself can be interpreted as a special case of a vortex with rigid-body rotation. Hence in all conceivable experiments the condition always is fulfilled that in the centre of the vortex the same state of "peace", that we can fix as "zero", prevails as in infinity.

When we take a tornado as an example, thus a whirlwind. In the "eye of the cyclone" there's no wind at all. But when I go away from this spot, then I'm blown to the outside. I can really feel the vortex with rigid-body rotation in the inside. If. however, I am standing on the outside, then the potential vortex tries to pull me into the vortex. This potential vortex is responsible for the structure and in the end also for the size of the tornado.

At the radius of the vortex, the place with the largest speed of the wind, an equilibrium prevails. The vortex with rigid-body rotation and the potential vortex at this point are equally powerful. Their power again is determined by the viscosity, which thereby fixes the radius of the vortex!

Therefore meteorologists pursue with interest whether a tornado forms over land or over water. Over the ocean for instance it sucks itself full with water. In that way the potential vortex increases in power, the radius of the vortex gets smaller and the energy density increases dangerously.

If the knowledge from hydrodynamics is transferred to the area of electromagnetism, then the role of the viscosity is taken over by the electric conductivity. The well-known current eddy occurs in the conductor, whereas its counterpart, the postulated potential vortex, forms in the bad-conducting medium, with preference in the dielectric. The duality of both vortices is expressed by the fact that the electric conductivity of the medium decides whether current eddies or potential vortices can form and how fast they decay, i.e. convert their energy into heat.

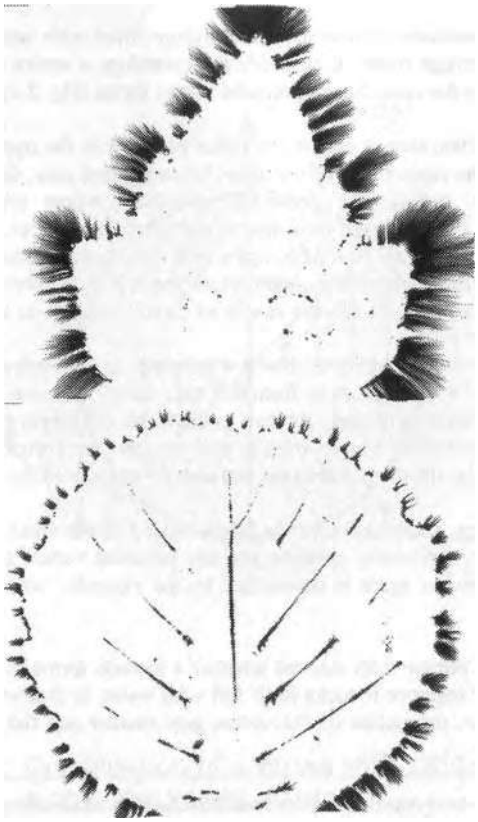

Fig. 3.6: Kirlian photograph of leaves[<i>] structured corona discharges

<i>: (produced by students of electronics in the laboratory for power electronics of the Author, University of Applied Sciences Furtwangen 1991)

<ii>: Kupfmuller, Karl: Einfuhrung in die theoretische Elektrotechnik, Springer-Verlag Berlin, 12. Auflage 1988, page 453

<iii>: Kupfmuller, Karl: Einfuhrung in die theoretische Elektrotechnik, Springer-Verlag Berlin, 12. Auflage 1988, page 208

3.6 Vortex and anti-vortex

Fig. 3.5 shows that vortex and dual anti-vortex mutually cause each other. In high tension transmission lines we find a striking example for the combination of current eddy and potential vortex. Within the conductor current eddies are formed. Thus the current density increases towards the surface of the conductor (skin effect). Outside of the conductor, in the air, the alternating fields find a very bad conducting medium. If one follows the text book opinion, then the field outside the conductor should be an irrotational gradient field! But this statement causes unsolvable problems.

When vortices occur inside the conductor, then for reasons of a detachment of the vortices without jumps at the interface to the dielectric, also the fields in the air surrounding the conductor must have the form and the properties of vortices. Nothing would be more obvious as to also mathematically describe and interpret these so-called gradient fields as vortex fields. When looking exact this argument even is mandatory!

The as laws of field refraction known boundary conditions<ii> in addition demand steadiness at the interface of the conductor to the dielectric and don't leave us any other choice. If there is a vortex field on one side, then also the field on the other side is a vortex field, otherwise we offend against the law! Here an obvious failure of the Maxwell theory is present.
Outside the conductor, in the air, where the alternating fields find a very bad conducting medium the potential vortex not only exists theoretical; it even shows itself. Dependent among others on the frequency and the composition of the surface of the conductor, the potenial vortices form around the conductor. When the thereby induced potentials exceed the initial voltage, then impact ionisation takes place and the well-known corona discharge is produced. Everyone of us can hear this as crackling and see the sparkling skin with which high tension transmission lines cover themselves.
In accordance with the text books also a gradient field increases towards the surface of the conductor, but an even shining would be expected and not a crackling. Without potential vortices the observable structure of the corona would remain an unsolved phenomenon of physics (Fig. 3.6).

But even without knowing the structure-shaping property of the potential vortices, that in addition acts supporting and that we'll have to derive, it can be observed well that especially roughness on the surface of the conductor stimulate the formation of vortices and can produce vortices. If one is looking for a reason why with large frequency the very short impulses of discharge always emerge from roughness<iii>, then very probable potential vortices are responsible for it. By means of a Kirlian photograph it can be shown that the corona consists of structured separate discharges (Fig. 3.6).

With this the approach is motivated, formulated and given reasons for. The expositions can't replace a proof, but they should stand a critical examination. Mathematical and physical evidence will be furnished later.

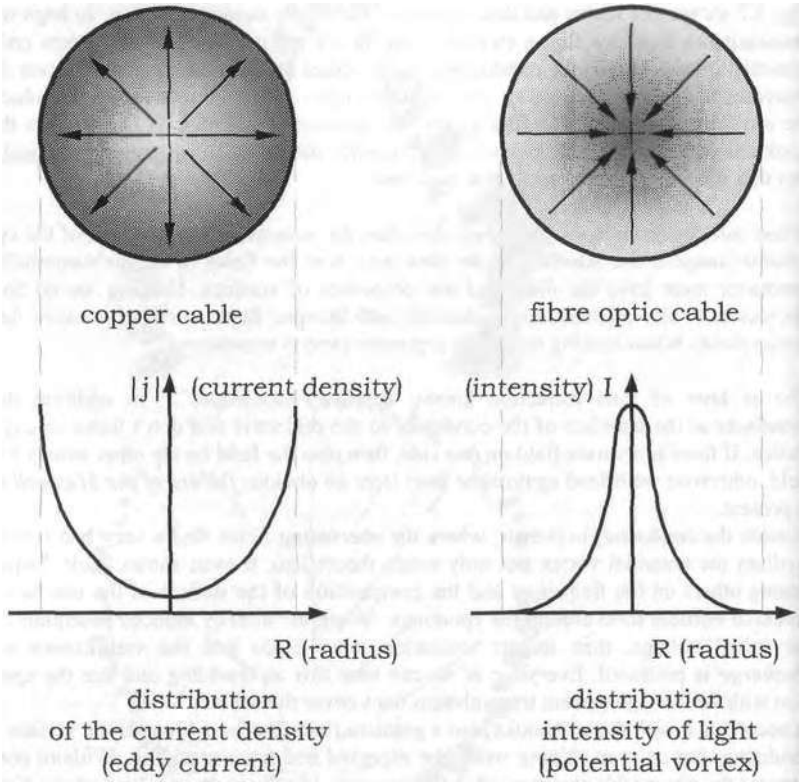

Fig. 4.1: The distribution in principle of the intensity of light
within a fibre optic cable<i> compared to the distribution of the current density in a copper cable

<i> Meyl, Konstantin: Potentialwirbel, Band 1: Diskussionsbeitrage zur naturwissenschaftlichen Deutung und zur physikalisch-technischen Nutzung, basierend auf einer mathematischen Berechnung neu entdeckter hydrotischer Wirbel, INDEL GmbH, Verlagsabteilung, Villingen-Schwenningen 1990, ISBN 3-9802-542-1-6

4. Properties

4.1 Concentration effect

It can be assumed that until now there does not yet exist a technical application for the here presented potential vortex theory unless the phenomenon was used by chance and unconsciously. About this the transmission of optical light signals over fibre optic cable can be given as a typical example.
Compared to a transmission of energy impulses over a copper cable fibre optic cables show a considerable better degree of effectiveness. The derived potential vortex theory provides a conclusive explanation for this phenomenon and therefore is put here to discussion: If we cut through a fibre optic cable and look at the distribution of a light impulse over the cross-section, then we observe a concentration in the centre of the conductor (fig. 4.1).

Herc the duality between the vortices of the magnetic and of the electric field comes to light. Whereas the current eddies in a copper conductor cause the "skin effect" as is well-known, potential vortices show a "concentration effect" and align themselves with the vortex centre. The measurable and in fig. 4.1 shown distribution of the light intensity in a fibre optic cable may confirm this phenomenon, the orientation of the potential vortex on the vortex centre.

For instance the calculation of the resistance of a copper cable provides as an important result an apparent decrease of the resistance directed towards the conductor surface. There the associated better conductivity as a consequence causes an increased current density. In the reversed direction, towards the centre of the conductor, consequently a decrease of the effective conductivity would be present, and this result is independent of the used material. According to the rules of duality this is a condition for the formation of potential vortices. As already said the conductivity is responsible for it, if the expanding eddy current with its skin effect or the contracting potential vortex with its concentration effect is predominant.

Usual fibre optic materials possess not only a small conductivity, but in addition a high dieletricity. This additionally favours the formation of vortices of the electric field. If one consciously or unconsciously supports the potential vortices, then there is a possibility that the life of the fibre optic cable is negatively influenced because of the concentration effect. Of course it can not be excluded that other effects, like e.g. reflections or the modes of the light are involved in the concentration effect. But it should be guaranteed that this actually concerns is causal phenomena and doesn't concern only alternative explanations out of ignorance of the active vortex phenomenon.

The formal mathematical reason for the concentration effect provides the reverse sign in Faraday's law of induction compared to Ampere's law (see also equation 3.1 and equation 3.8 in fig. 3.3).

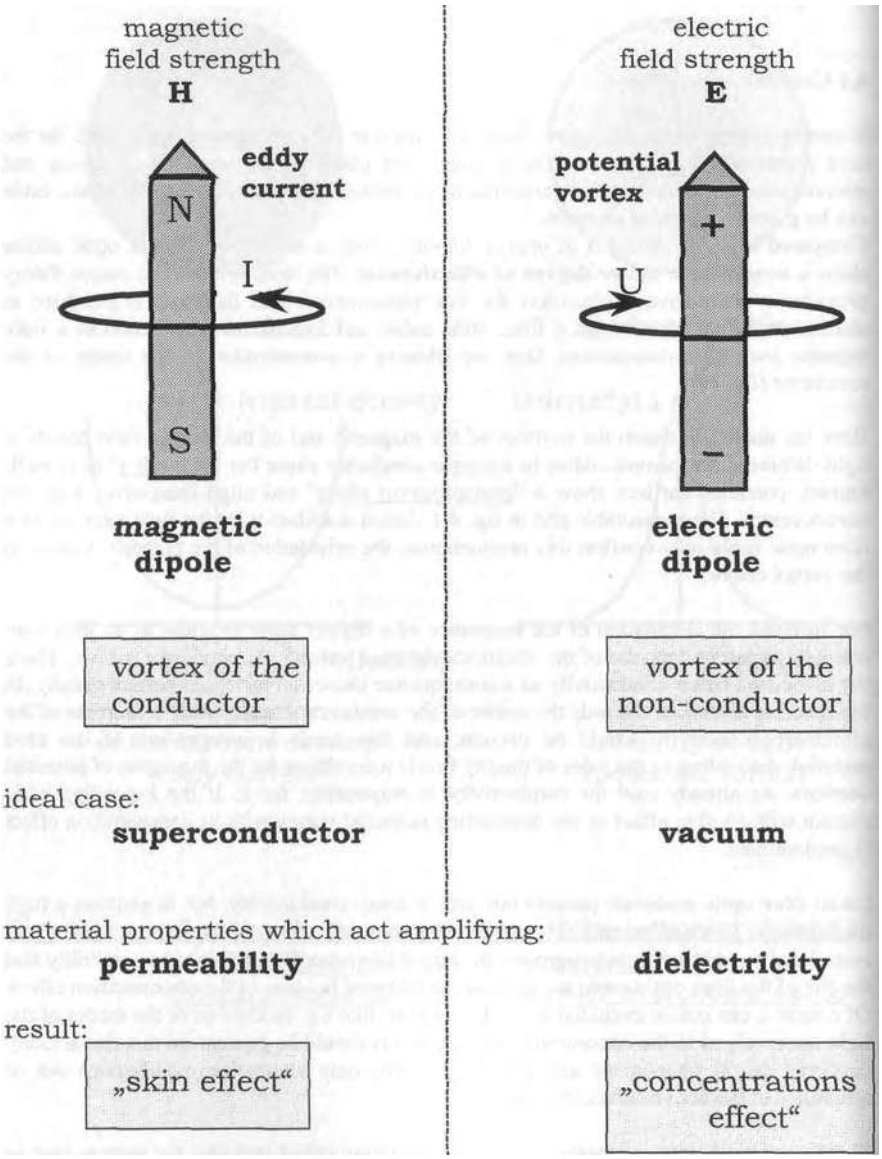

Fig. 4.2: The acting as a dipole of current eddies and potential vortices

4.2 Duality of the vortex properties

The rules of duality dictate for the vortex of the electric and of the magnetic field the following characteristics:

1. Whereas currents and eddy currents demand a good conductivity, potentials and potential vortices can only form with bad conductivity, thus in a dielectric and best in the vacuum.

2. Eddy currents run apart, strive towards infinity and thus show the well-known "skin effect" with a spatially limited arrangement of the conductor. According to the rules of duality the potential vortex will strive towards the vortex centre and in this way will show a "concentration effect".

3. Another property of vortices is shown in fig. 4.2.
On the left side a plane eddy current is indicated. Since the discovery of Ampere's law it is well-known to us that such a circular current (I) forms a magnetic dipole standing perpendicular to the vortex plane.
On the right hand side the dual phenomenon is sketched. Here charges are piled up circularly to a planar potential vortex (U). Thereby an electric dipole forms, standing perpendicular to the vortex plane. This relation directly follows from the equations of the field-theoretical approach.
Whereas circular currents and current eddies produce magnetic dipoles, the postulated potential vortices will form electric dipoles.

With these three interesting properties some key questions of quantum physics, that until now have stayed a mystery to science (fig. 4.4), can be answered conclusively and without compulsion e.g.:

I.Why are there no magnetically charged particles?
The better the conductivity of a medium is, the higher as a consequence the number of free charge carriers is. the more strongly eddy currents are formed. The answer to question I is inferred from the opposite case:
In the ideal vacuum no charge carriers at all are present, why no currents, no current eddies and consequently no magnetic poles can exist.
With this well-known fact the first question already is answered. The question why in the microcosm there can not exist magnetically charged elementary particles, why the search for magnetic monopoles doesn't make any sense. Let's ask further:

II. Why are there only electrically charged particles?
Let us for that consider the dual conditions. The worse the conductivity of a medium is, the more the potential vortex -will be favoured that because of this property also can be understood as the vortex of the dielectric.
In the mentioned extreme case of the ideal vacuum, no electric conductivity is present for reason of the missing charge carriers. But this circumstance favours the potential vortex and that, according to fig. 4.2, forms electric poles and with this also the second question would be answered clearly.
It can be traced back to the boundary conditions of the microcosm that without exception electricallv charged particles are entitled to exist; a realization derived from the field-theoretical approach, that covers all experiences.

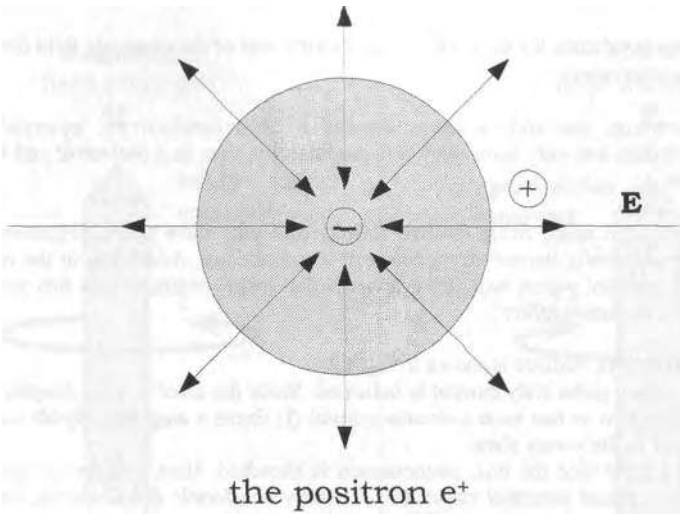

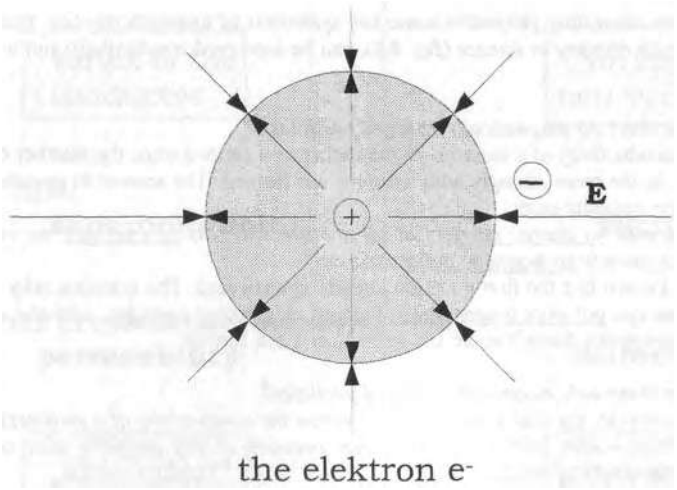

Fig. 4.3: Elementarv particles as configurations of potential vortices

4.3 Derivation of the electron as an elementary vortex

The next key question necessarily has to be brought to a conclusive answer to save the principle of causality, so that we no longer have to postulate an own physics with its own laws for the microcosm:

III. Why do these particles show as monopoles?

More concrete the question has to read:
Where is the positive pole in a negatively charged electron, if it should be an electric dipole?
The only possible answer is:
In the centre of the particle!

Thus in the centre of the electron its positive pole is hidden and in the centre of the positron its negative pole is hidden. But we only observe these particles from the outside and for reason of the field conditions of the electron we measure a negative charge and for its antiparticle, the positron, a positive charge. If in each case we wanted to measure the electric fields included in the inside, we had to destroy the particle. Then a proof would not be possible anymore.

Here also a persistent mistake is eliminated by the for a long time known axiom that monopoles can not exist at all if one considers continuity! By means of technical-physical experiments this axiom is sufficiently secured.
The quantum physical approach is standing on uncertain ground if it is postulated that other laws of nature should apply to particle physics, if a second approach, the field-theoretical approach, is conceivable that does not know these problems!

The discussed concentration effect gives the potential vortex a structure shaping property. With that also the fourth key question can be answered:

IV. Why do the particles have the form of spheres?

The potential vortex is favoured in the particle-free vacuum of the microcosm because of the missing conductivity. In connection with the concentration effect the following conclusion can be drawn:
The extremely mighty potential vortex exerts a high pressure on the microcosm and on each particle.

With that also the fourth key question, why stable elementary particles are spherical, can be answered by the potential vortex theory:
Only the sphere is able to withstand a high outside pressure.
All other forms, like e.g. dipoles formed like a rod or a club would be instable in the presence of the extremely concentrating potential vortex. They would be immediately destroyed by the pressure of the potential vortex.

I. Why are there no magnetically charged particles?
(the vacuum has no conductivity!)

II. Why are there only electrically charged particles?
(in the vacuum only potential vortices can exist!)

III. Why do these particles show as monopoles?

(the other pole is locked up in the inside of the vortex oscillation!)

IV. Why do the particles have the form of spheres?

(for reason of the outside pressure by the concentration effect!)

V. Why is the elementary quantum stable?

(without conductivity no decay of vortices takes place!)

VI. Why does for every particle of matter exist an antiparticle?

(there are two swirl directions with equal rights!)

VII. Why are particles and antiparticles incompatible?
(contrary swirl directions!)

Fig. 4.4: Key questions of quantum physics

4.4 Quanta as field vortices

The fied-theoretical approach demands removing the electron from the field equations (eq. 3.7) and at the same time introducing the potential vortex of the electric field. With this vortex phenomenon there now is a possibility that the electromagnetic wave spontaneously rolls up to a vortex in case it is disturbed from the outside. The vortex particle that is formed in such a way owes its physical reality on the one hand the concentration effect of the potential vortex, that compresses this particle to the dimension of a tiny sphere and on the other hand its localization for reason of the oscillation around a fixed point.
The sphcrical elementary particles are being compressed to inconceivably small dimensions. Therefore they are capable to bind a comparatively high energy in their inside. This is confirmed by the mass-energy relation $E = mc^2$. (4.1)

The fact that the energy is dependent on the speed of light can be judged to be a clear indication that quanta actually are nothing but oscillating electromagnetic packages, vortical oscillations of empty space!
The next question reads:

V. Why is the elementary quantum stable?
The worse the conductivity is, the more the potential vortex will be favoured, the more strongly the concentration effect will form, the smaller the spherical phenomena will get - the larger the authoritative relaxation time will be, i.e. the slower the decay of vortices and with that the more stable the vortex phenomenon will be.
In the microcosm, that comes the ideal case of a particle-free vacuum very close, the spherical vortices because of the missing conductivity have an absolute stability.

VI. Why does for every particle of matter exist an antiparticle?
Since every vortex can also oscillate
in the opposite direction, there always exist two forms of formation of spherical vortices with equal rights, one of them is assigned to the world of matter and the other to the world of anti-matter.

VII. Why are particles and antiparticles incompatible?
For reason of the contrary swirl direction they are incompatible to each other. They have the tendency to destroy each other mutually, like two trains that want in the opposite direction on a single-tracked distance.

The quantum physical approach does not have an answer to these key questions. Until now scientists have merely thought about to what the observable contraction in the microcosm and the macrocosm can be traced back. Because the approach was not able to furnish an answer, without further ado some new matter was introduced: the sluons. These binding particles should be able to exert the necessary pressure. But until now no one has been able to observe or detect this fabulous matter. Nobody knows its structure and its composition. Despite missing evidence it is stated that this matter is mass less and at the same time lumped; it is invisible because it can't interact with any other matter, not even with the supposed building parts of the atomic nuclei, the quarks. But at the same time there should be exerted a pressure on the quarks, for which reason quarks again should be able to interact with gluons!

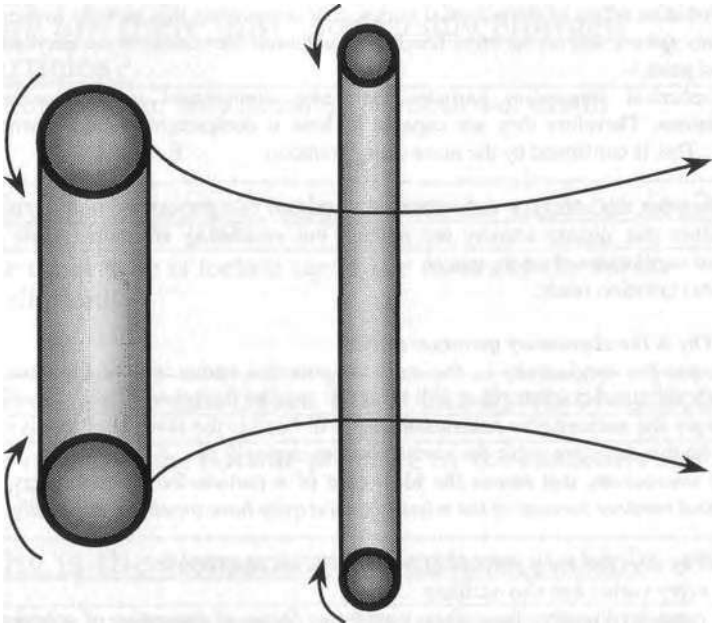

Fig. 4.5: Two coaxial oscillating vortex rings (Lugt[i]).

[i] Lugt, Hans J.: Vortex flow in nature and technology. Krieger publishing company, Florida 1995; page 42, ISBN 0-89464-916-7

4.5 The photon

The ability to form structures as a consequence of the concentration effect gives the potential vortex a number of highly interesting properties. To derive these properties we can make work easier when we fall back upon the observations and experiences of flow dynamics.
Here the vortex ring takes a special place. Its vortex centre is not closed, for which reason it is not stationary and propagates in space with a constant speed. It can be observed that the velocity of propagation increases with the ring diameter becoming smaller. By means of the vortex rings, that skilful smokers can produce with pointed lips, these properties can be made visible.
Now if two vortex rings run into each other with the same axis and direction of rotation then both oscillate around each other, by one vortex attracting the other vortex, thereby accelerating and thus contracting it. The second vortex then slips through the core opening and gets again slower and larger. Now the first vortex accelerates and plays the same game (fig. 4.5).
It would be obvious for the vortex of the electric field to have a corresponding property. The electron e- and with the opposite swirl direction the positron e+ will form such a potential vortex corresponding to the derivation. Two electrons, as like charged particles, would repel each other and surely will be out of the question for such a configuration. An electron and a positron however will attract each other and because of their incompatibility they will mutually destroy unless they open their vortex centres to form a vortex ring. Now the e- shows its positively charged centre that shows the same swirl direction as the e+ seen from the outside. Therefore the vortices don't hurt each other, when the positron slips through the opened vortex centre of the electron and vice versa.
This oscillating electron-positron pair has strange properties: seen from the outside one moment it is negatively charged and the next moment it is positively charged. Therefore over time on the average no charge will be measurable and no electromagnetic interaction will take place.
One moment the particle is matter and the next moment it is anti-matter. Hence no mass at all can be attributed to the particle. Interactions primarily takes place between both dual vortices. We can predict, the particle has neither mass nor charge. The environment merely sees a fast oscillating particle that only within every half cycle is capable of an interaction.
The centre of the oscillating particle is open, for which reason it is not stationary anymore. Instead it propagates in z-direction with the swirl velocity, which is the speed of light, in this way preventing a rotation around the x- or y- axis (fig. 4.6). In this way a polarizability is present.
The only possible and, as we will see, necessarily taking place rotation around the z-axis gives the particle a spin of the magnitude of a quantum of angular momentum. After all the rotation for e^- and e^+ is of the same magnitude with a spin of each time $\frac{1}{2} \cdot \hbar$. There should be paid attention to the fact that for the case of an opposite sense of direction of the respective rotation around the common z-axis the spin on the average will be zero.
In addition the particle is characterized by an outstanding property: a periodically taking place oscillation with any frequency, but that frequency has to be constant. We now only have to take a table of particles to hand. Actually we will find a corresponding particle that has all these properties: the γ-quanta, also called photon.

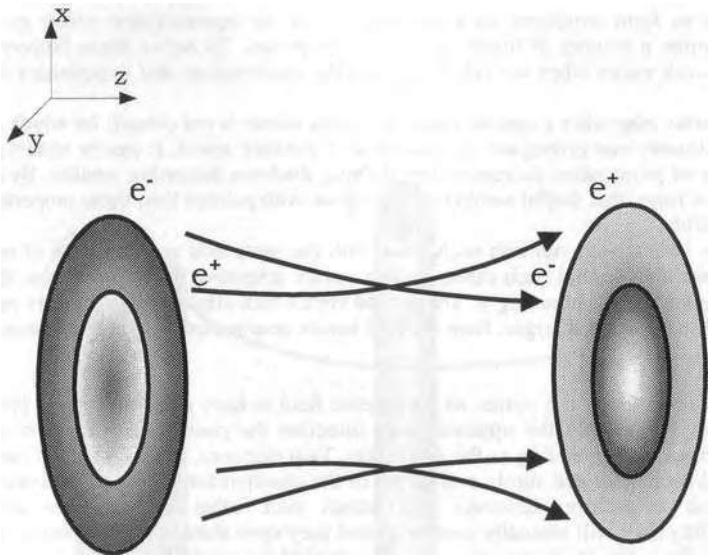

Fig. 4.6: The photon as oscillating electron-positron pair

The decay of the γ- quanta (photon)[i]
(= pair creation = Bethe-Heitler-process 1934):

$$\gamma \longrightarrow e^- + e^+$$

(4.2)

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[i] Nachtmann, Otto: Phanomene und Konzepte der Elementarteilchenphysik, Vieweg, Braunschweig 1986, S. 135, ISBN 3-528-08926-1

4.6 Pair creation

Proof for the correctness of the model concept provides the decay of the photon in an electron and a positron in the presence of a strong field, as for instance in an atomic nucleus. This observable decay is called pair creation or Bethe-Heitler process[<i>]:

$\gamma \longrightarrow e^- + e^+$ (4.2)

In this process the elementary vortices for a short time get back their localization and are therefore detectable. Otherwise the electron and positron have the form of a sphere, the photon however rather has the form of two oscillating discs.

The photon doesn't participate in the electromagnetic interaction, because the electric field lines run from one disc to the other (from + to -). The field lines are not open as they are for e^- or e^+ (fig. 4.3). To open up the field lines an energy is necessary that corresponds to the sum of the two formed particles. But from this it by no means follows that this amount of energy will be released in the reversed and much better known process, where matter and anti-matter annihilate under emission of γ-quanta. At the end of the derivation the vortex model will provide us the desired answers on questions of the energy of photons.

Here first of all only the properties will be concerned. Experiments, in which light shows as a particle, are the photoelectric effect, the Compton effect and a lot more. According to the by Maxwell developed classical theory of light however is light an electromagnetic wave that is not quantized in any way, neither as sphere nor as disc, the wave nature of light as well has a physical reality and is secured by experiment. This is witnessed by the interference patterns of overlapping coherent light beams.

A concept in which light could exist at the same place and the same time both as wave and as corpuscle could never be brought into accord with the principle of causality. Formulas of compromise, like the uncertainty principle of Heisenberg that refers to the point of view of the observer, can't change anything about this dilemma. The dual nature of light, that in this context is gladly spoken of, rather consists of the fact that dependent on the local field conditions, any time and spontaneously the wave can roll up to a vortex.

As an example of a violation of the principle of causality it has been indicated under point 3 (fig. 3.1) that both fields and quanta at the same time should be the cause of something. This concept was formulated by Maxwell and written down in modern quantum electro-dynamics by Dirac but in the field-theoretical approach we have dropped this concept because it violates all rules of causality in an elementary manner. Therefore it only is consistent, if we hold the view that the light is either wave or particle but never is both at the same time!

In the spontaneous transition of the wave to the particle all the important properties are conserved: the propagation with the speed of light, the characteristic frequency of the oscillation and the mentioned polarizability.

The process of rolling up possibly takes place already in the laboratory, in a bubble chamber and at the latest in our eyes. To receive the electromagnetic wave, we had to have antennas. We actually see the photons. It therefore would be obvious if our cells to see only could perceive vortices, in this case photons. We don't possess a sense organ for fields and waves.

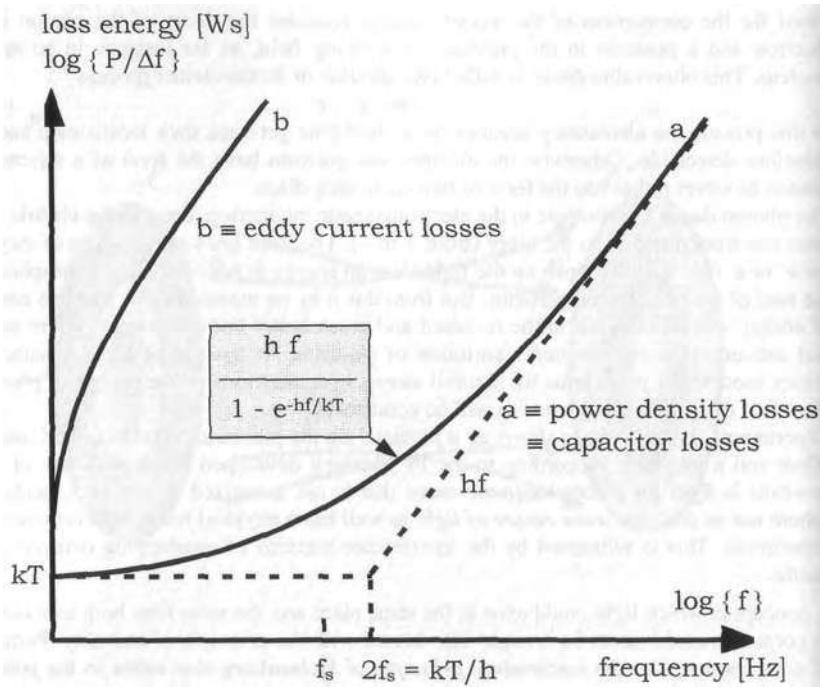

Fig. 4.7: The power density shown against frequency for noise
(a) according to Kupfmuller<i>,
as well as for dielectric losses of a capacitor (also a) and for eddy current losses (b) according to Mevl<ii> (b in visible duality to a).

<i> Kupfmuller, Karl: Einfuhrung in die theoretische Elektrotechnik, Springer-Verlag Berlin, 12. Auflage 1988, ISBN 3-540-18403-1
<ii> Meyl, Konstantin: Dreidimensionale nichtlineare Berechnung von Wirbelstromkupplungen, Dissertation Universitat Stuttgart 1984

4.7 Noise

If, according to the field-theoretical approach, there exist electric field vortices then they will not only form the elementary particles in the vacuum, but will also macroscopically form and have an effect in larger dimensions.

Assuming a wave that rolls up to a plane vortex it would be obvious if polarization and velocity of propagation are conserved in the process. But how does it stand about the frequency?
The wave now will walk round a stationary point, the vortex centre. The propagation with the speed of light c will remain existent as the swirl velocity. For a plane circular vortex, where the path for a revolution on the outside is very much longer than near the vortex centre, there arises a longer wave length and as a consequence a lower frequency on the outside as more to the inside. With this property the vortex proves to be a changer of frequency: the vortex transforms the frequency of the causing wave in an evenly spectrum, that starts at low frequencies and stretches to very high frequencies (fig. 1.4). Exactly this property we observe in "white noise". The consistent conclusion would be that this concerns the vortex of the electric field. Anyone can, without big expenses, convince himself or herself of the localization, of the property to change the frequency and of the circumstance that vortices can be very easily influenced, that they avoid or again whirl about a place of disturbance, for instance an antenna. For that one only needs to tune a radio receiver to a weak and noisy station and move oneself or some objects around, then one is able to directly study the influences from the manipulation of the receiving signal.
But already the fact that the using and measurability of signals is limited by noise makes clear. which attention the potential vortex should be given.

Within a limited frequency range the power of the Nyquist or resistance noise is independent of frequency (fig. 4.7). This should be clarified particularly by the term "white noise" analogous to white light, where all visible spectral ranges independent of frequency have the same energy density.

But this relation doesn't hold for high frequencies of any magnitude. Here another noise-effect appears, that is said to have its cause in the quantum structure of energy[<i>]. Untouched by possible interpretations an increasing power of the noise is measured, that more and more turns into a being proportional to frequency (fig. 4.7, curve a). Interestingly this curve shows a remarkable duality to the power curve of eddy currents, likewise shown against the frequency, that for instance can be measured at eddy current couplings[<ii>] (fig. 4.7, curve b). This circumstance suggests a dual relation of the potential vortex of the electric field in bad conducting media on the one hand and the eddy current in inductive materials on the other hand [<iii>].

<iii>: Meyl, Konstantin: Wirbel des elektrischen Feldes,
EMC Journal 1/95, 6. J, ISSN 0945-3857, S. 56 - 59.

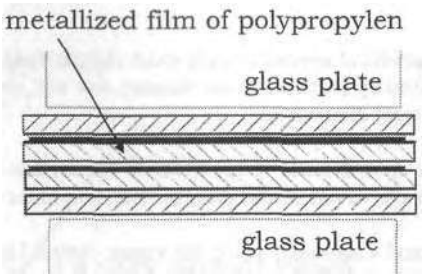

a) measurement set up according to Yializis and others<i>

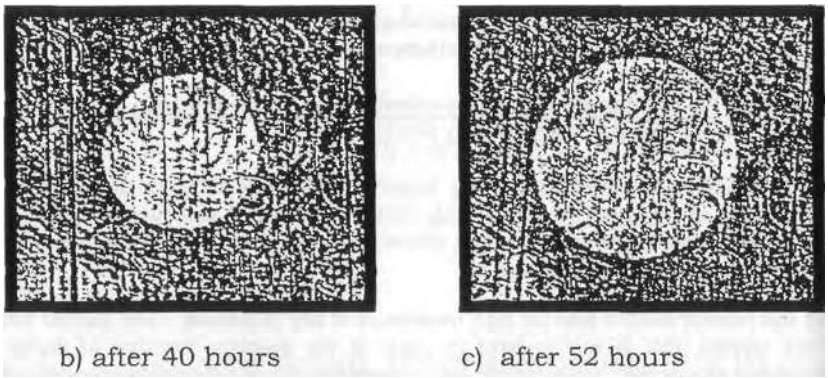

Fig. 4.8: Measurement set up (a) and photo of vortex structure
in a metallized polypropylen layer capacitor (at 450 V/ 60 Hz/ 100°C)
Observation of the formation of a vortex (b) and (c). (110 fold magnification), according to Yializis et al.<i>

<i>: A. Yializis, S. W. Cichanowski, D. G. Shaw: Electrode Corrosion in Metallized Polypropylene Capacitors, Proceedings of IEEE, International Symposium on Electrical Insulation, Bosten, Mass., June 1980;

4.8 Capacitor losses

Next the dielectric losses in a capacitor fed with an alternating voltage are measured and likewise put on against the frequency. At first the course is independent of the frequency, but towards higher frequencies it increases and shows the same characteristic course of the curve as the before mentioned power of the noise (fig. 4.7, curve a).

This excellent agreement suggests the assumption that the dielectric losses are nothing but eddy losses.
These vortex phenomena, caused by time-varying fields, are not only found in ferro-magnetic and conductive materials, but equally as dual phenomena in dielectrics and non-conductors.

As examples of practical applications the induction welding or the microwave oven can be mentioned. The process can be described in other words as follows: in both examples the cause is posed by high-frequency alternating fields that are irradiated into a dielectric as an electromagnetic wave, there roll up to potential vortices and eventually decay in the vortex centre. The desired and used thermal effect arises during this diffusion process.

The striving in the direction of the vortex centre gives the potential vortex of the electric field a structure shaping property. As a consequence of this "concentration effect" circular vortex structures are to be expected, comparable to the visible vortices in flow dynamics (e.g. tornados and whirlwinds). At the same time the dual anti-vortex arises, the diverging eddy current. It takes, as is well-known, the given structure of the conductor, so in the technical literature one correspondingly talks of a "skin effect". Now if conductor and non-conductor meet as they do in a capacitor, then at the boundary area visible structures will form. Circles would be expected, if the eddy current in the inside and striving to the outside is equally powerful as the potential vortex that comes from the outside and concentrates.

Actually such circular structures are observed on the aluminium of high tension capacitors, when they were in operation for a longer period of time. The formation of these circles, the cause of which until now is considered to be unsolved, is already experimentally investigated and discussed on an international level by scientists (fig. 4.8) [i, ii].

These circular vortex structures can be seen as a visible proof [iii] for the existence of potential vortices of the electric field.

<ii>: D. F. Taylor, On the Mechanism of Aluminium Corrosion in Metallized Film Capacitors, IEEE Transactions on EI-19,August 1984,No.4,pp.288-293.

<iii>: Meyl, Konstantin: Wirbel des elektrischen Feldes, EMC Journal 1/95, 6.J, ISSN 0945-3857, S. 56-59.

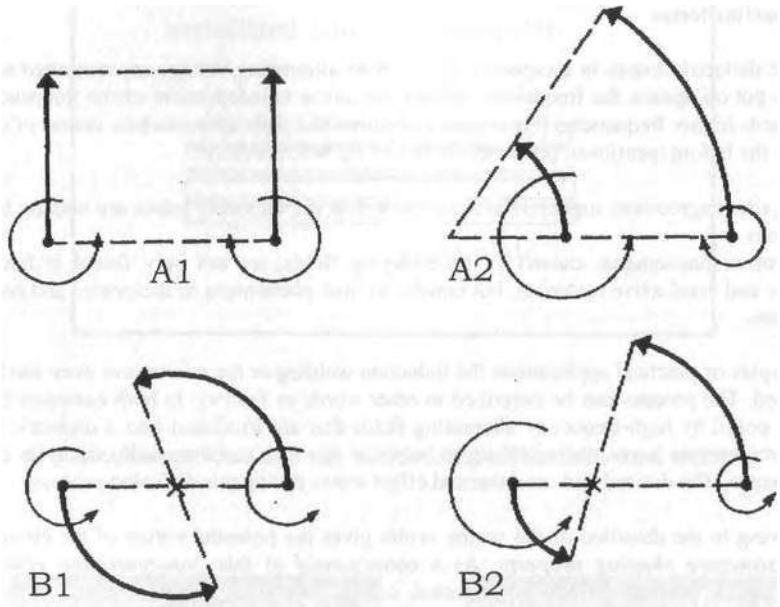

Fig, 4.9: Motion of two point vortices. (Lugt[<i>])
A. with opposite direction of rotation
B. with the same direction of rotation
1. for equal vortex strength
2. for unequal vortex strength

Example from practice for case Al:
vortex pair behind an airplane

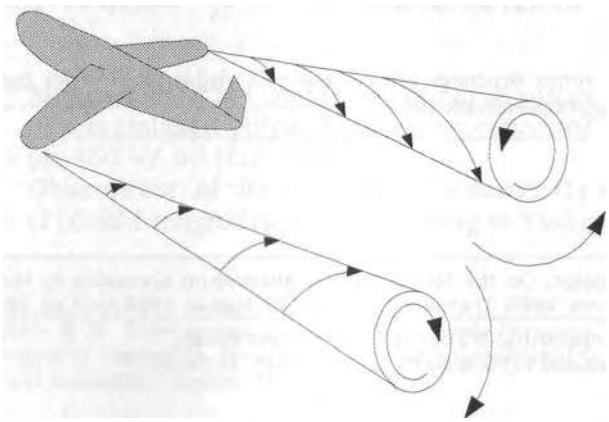

4.9 Vortex lines and vortex streets

It can be assumed that the vortex of the electric field is relevant with regard to the electromagnetic environmental compatibility. This then holds not only for microcosmic and microscopic vortices, but also for macroscopic and larger dimensions. The individual vortices can join together to balls and lines. For the study of this process it is useful to again fall back upon experiences of flow dynamics.

The co-operation of individual point vortices has been investigated thoroughly in flow dyamics. Without any outside manipulation an individual vortex rotates on the spot. That changes in the case of two neighbouring vortices. Now it depends on their mutual strength and sense of rotation. If they have the opposite sense of rotation and equal strength then their centres of rotation move straight forward in the same direction. If however the direction of rotation is the same then both vortices rotate around each other (fig. 4.9).

In this way a multitude of point vortices is capable, to form in the first case whole vortex streets and in the second case spherical vortex balls. In principle a vortex string can also consist of a multitude of potential vortices pointing in the same direction; but it has the tendency to roll up to a vortex ball in case it is disturbed from the outside, as can be shown very clear by means of computer simulations[<i>].

As a starting-point for a discussion the thesis can be put forward that also electric field vortices, in nature usually consisting of a multitude of individual point vortices, appear as vortex strings and vortex balls.

Perhaps historians see in this property an answer to the question, how it was possible for the Romans to build streets straight as a die in the wilderness. Their land surveyors, the Augures, had at their disposal neither laser, nor any other suitable gauges. Their most important tool was the Lituus, the crook, that at its upper end was rolled up like a vortex in the sense of a flat coil shaped like a spiral.
The question poses what this strange object was used for. Perhaps the roman land surveors tracked down any vortex lines with this crook and then used them to orientate themselves?
History still holds a lot of secrets, but for now only this indication is given. The following seminar will give enough opportunities for speculations and discussions[<ii>].

<i>: Lugt, Hans J.: Vortex flow in nature and technology. Krieger publishing company, Florida 1995; p.38, fig. 3.25, 3.26 and 3.27, ISBN 0-89464-916-7

<ii>: K. Meyl: Elektromagnetische Umweltvertraglichkeit Teil 2 und 3 Seminar-umdrucke, INDEL Verlag VS; see part 2 and 3 of this book.

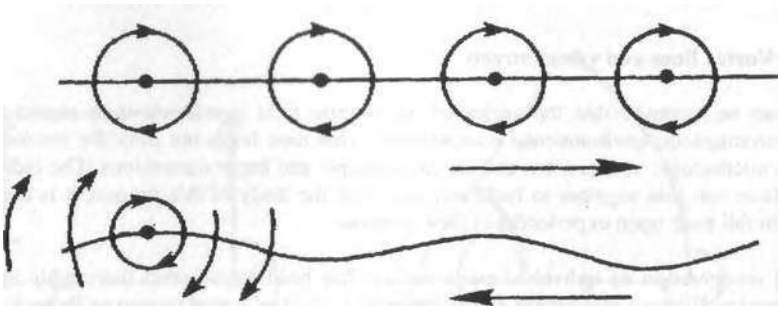

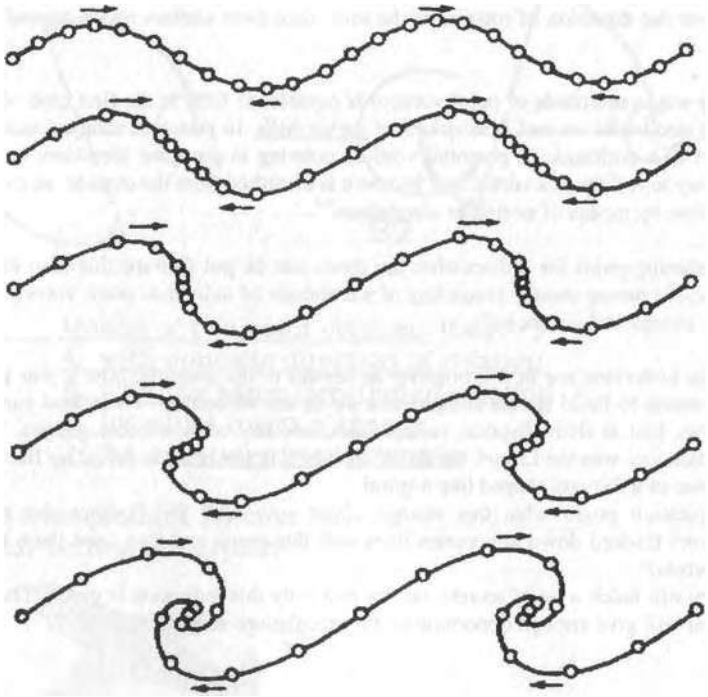

Fig. 4.10: The rolling up of a vortex chain to a vortex ball for the smallest disturbance
(case Bl in fig. 4.9) (Rosenhead[i]).

<i>: L. Rosenhead: Formation of vortices from a surface of discontinuity. Proc. Roy. Soc. A 134, 1931, 170. taken from:

Lugt, Hans J.: Vortex flow in nature and technology. Krieger publishing company, Florida 1995; page 39, figure 3.29, ISBN 0-89464-916-7

4.10 Water colloids as vortex balls

We have to realize that in the biosphere we are staying in a relatively ideal dielectric. The two "capacitor plates" are being formed by the ionosphere and the earth. The potential vortex will, as said, be favoured by a bad conductivity and by a high dielectricity. Consequently it will dominate and take effect in the biosphere. In which way it takes effect is the central theme of the electromagnetic environmental compatibility.

Life in this world consists predominantly of water and water has a very high dielectricity! With that the effectiveness and the long life of the potential vortex increases. The human head for instance contains 7O% and plants contain over 90% water! But it does not simply concern H_2O, but structured water in a colloidal form. These water colloids could be vortex balls because they consist of a large number of water molecules in a spherical arrangement They form independent and insoluble particles with a negative electric charge (fig. 4.11).
Water is not equal water thanks to this structure. One can buy healing water and corresponding sources are well-known and famous. Many an effect can be explained by means of a chemical analysis but not everything.

The highest age in this world is reached by the inhabitants of Hunza, in the mountains of norhern India at the foothill of the Hindu Kush, at an altitude of 2500 meters. They drink some muddy glacial water that is strongly colloidal. Hence it would be obvious that plants and also we ourselves need such water for our physique. Processes are known with which the advantageous vortex balls, say colloids, are produced artificially by mechanic or chemical treatment[i]. Levitated water, as it is called and as it is for sale nowadays, is said to be more healthy. Unfortunately people predominantly work empiric in this area, because science occupies itself with this topic only little or not at all.
Another problem is the fact that the colloids again fall apart quickly. The like negative charge favours this process. The liquid crystals have to be stabilized from the outside. In the case of the Hunza-water the colloids are surrounded by a vegetable layer of fatty acid and are protected in this way [ii]. It possibly is very obliging to nature, if the water colloids also in biological systems are stabilized in that way.
Everyone of us knows that fresh spring water tastes much better than stale, bottled water, even if the chemical analysis turns out of be absolutely identical. For this fact classical science is not able to give a cause - a further problem of causality. In any case should potential vortices with their structure shaping property be considered as a cause for the formation of water colloids. It surely causes no difficulties at all to interpret the colloids as vortcx bulls.

<i>: V. Schauberger: Die Entdeckung der Levitationskraft, Implosion 1995 Nr. 112 und:
N. Harthun: NaturgemaSe Technik - Wege fur die Forschung nach Viktor Schauberger, Verlag Delta Design, Berlin 1996.

<ii>: Flanagan: Elexier der Jugendlichkeit, Waldthausen Verlag Ritterhude 1992, orig.: Elixir of Ageless

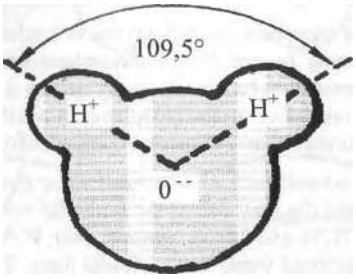

H_2O: the angle of the bond between 2 H molecules = 104,5°
angle of the bond in excited state = 109,5°

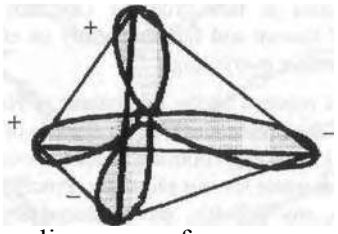

electron orbital diagram of energy (excited H_2O) = tetraeder
most stable liquid crystal = 8 tetraeder = star of octaeder

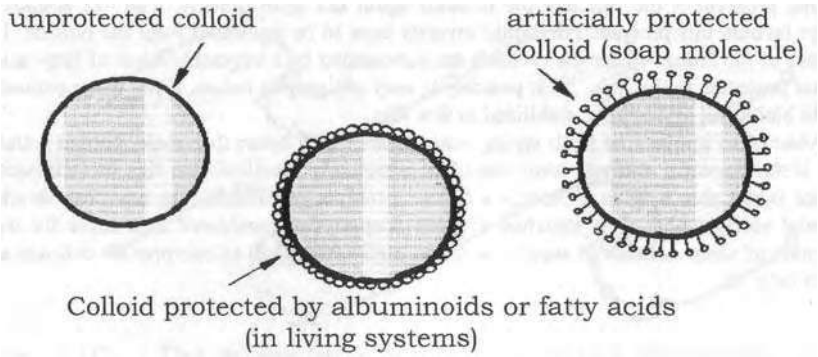

Fig. 4.11: Water molecules and water colloids

4.11 Phenomenon of transport

The vortex principle is self-similar. This means that the properties of an individual vortex also for the collection of numerous vortices again appear and can he observed in a similar manner. That's why a vortex ball behaves entirely similar as an individual isolated vortex. The same concentration effect, that keeps the vortex together, shows its effect for the vortex ball and keeps it together also.

Something corresponding holds for a basic property of potential vortices, being of a completely different nature. It is the property to bind matter in the vortex and carry it away with the vortex. Well-known are the vortex rings that skilful cigarette smokers can blow in the air. Of course also non-smokers can produce these air eddies with their mouth but these remain invisible. Solely by the property of the vortex ring to bind the smoke it becomes visible to the human eye.

If out potential vortex transports something then it rather should be a dielectric material, so preferably water. Therefore if in the environmental air we are surrounded by potential vortices that we can detect for instance as noise, then they are capable with their "phenomenon of transport", to pick up water and to keep it in the vortex. In this way the atmospheric humidity is explicable as the ability of the air particles to bind comparatively heavy water molecules. If the vortex falls apart then it inevitably releases the water particles and it rains. This is merely a charming alternative for the classical representation without claim to completeness.

Already the Romans have made use of this phenomenon to find water and sources. About this Vitruv[<i>] (from 23 BC) in his 8th book about architecture writes: "Before sunrise one has to lie down on the earth at the places, where to search for water,... and one has to look at the area... Then one has to dig at the place where there appears curling and in the air rising moist steam. Because this characteristic can not occur at a place where there is no water". The at a certain time of day and in certain seasons occasional in meadows and corn fields observable streaks or circular mostly moist places with differing vegetation, have to be judged as an infallible sign for the existence of this phenomenon.

This phenomenon of transport again appears for the discussed water colloids. The involved water molecules form a spherical object with a negative charge. They turn their negatively charged side to the outside and point with the positively charged end in the direction of the middle of the sphere. There, no longer discernible from the outside, a negatively charged ion can be, that is stuck, that no longer can escape and that gives the whole colloid a characteristic property. In this way nature knows various water colloids that constitute plants and animals. But starting at a temperature of 41°C the liquid crystals fall apart. This not by chance is the temperature at which a person dies. Already 10 millivolts per liquid crystal suffice for the electrically induced death.

The to a colloid identical structure we find in the structure of the atoms. Here the atomic nucleus is held in the inside of a vortex-like cloud of electrons, the atomic hull. We'll hit the phenomenon of transport a last time, when we derive the elementary particles. For the photon is already discernible the tendency of an elementary vortex, to take another vortex in its inside. Merely because the electron and positron are evenly matched a stable configuration is prevented for the photon.

<i>: Vitruvius Pollio, Marcus: Ten Books about architecture, WBG 1987

In chapter vortex calculation used differential operations:

field pointer (vector = **bold**):

$$\mathbf{A} = \mathbf{e}_x \cdot A_x + \mathbf{e}_y \cdot A_y + \mathbf{e}_z \cdot A_z$$

Gradient of the scalar function of position V:

$$\text{grad } V = \mathbf{e}_x \cdot \delta V/\delta x + \mathbf{e}_y \cdot \delta V/\delta y + \mathbf{e}_z \cdot \delta V/\delta z \quad \text{(R1)}$$

Divergence of the vector **A**:

$$\text{div } \mathbf{A} = \delta A_x/\delta x + \delta A_y/\delta y + \delta A_z/\delta z \quad \text{(R2)}$$

Curl (vortex density) of the vector **A**:

$$\begin{aligned} \text{rot } \mathbf{A} = \; & \mathbf{e}_x \cdot (\delta A_z/\delta y - \delta A_y/\delta z) + \\ & + \mathbf{e}_y \cdot (\delta A_x/\delta z - \delta A_z/\delta x) + \\ & + \mathbf{e}_z \cdot (\delta A_y/\delta x - \delta A_x/\delta y) \end{aligned} \quad \text{(R3)}$$

Laplace operator Δ:

$$\Delta \mathbf{A} = \delta^2\mathbf{A}/\delta x^2 + \delta^2\mathbf{A}/\delta y^2 + \delta^2\mathbf{A}/\delta z^2 \quad \text{(R4)}$$

arithmetic rules:

$$\Delta \mathbf{A} = \text{grad div } \mathbf{A} - \text{rot rot } \mathbf{A} \quad \text{(R5)}$$

$$\text{div rot } \mathbf{A} = 0 \quad \text{(R6)}$$

$$\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A} \quad \text{(R7)}$$

$$\text{div } (\mathbf{A} \times \mathbf{B}) = \mathbf{B} \text{ rot } \mathbf{A} - \mathbf{A} \text{ rot } \mathbf{B} \quad \text{(R8)}$$

$$\text{rot } (\mathbf{A} \times \mathbf{B}) = (\mathbf{B} \text{ grad})\mathbf{A} - (\mathbf{A} \text{ grad})\mathbf{B} + \mathbf{A} \text{ div } \mathbf{B} - \mathbf{B} \text{ div } \mathbf{A} \quad \text{(R9)}$$

$$\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) = \mathbf{B} \cdot (\mathbf{A} \cdot \mathbf{C}) - \mathbf{C} \cdot (\mathbf{A} \cdot \mathbf{B}) \quad \text{(R10)}$$

* important equations are given in a box
* new equations are underlined twice.

Fig. 5.0: Collection of formulas for vector analysis

5. Derivation and interpretation

Vortices cause big problems to every measuring technician. They have the unpleasant property to whirl around the sensor even if it is as small as possible. Vortices avoid the smallest disturbance and then can hardly be detected reproducibly.

From the well-known eddy current we know of this problematic. Instead of the vortex, we are forced to measure and analyse any effects that arise from the vortex. These can be measurements of the eddy losses or effects back on the stimulating field. But only provided that the effect actually occurs.
The prerequisite for an increase in temperature by eddy losses is that the vortex falls apart. In an ideal medium it unfortunately will not do us this pleasure.

As vrtex of the dielectric the potential vortex will find fairly ideal conditions in air or in water. How should a vortex be detected, if it does not produce any effect? The classical measuring technique is here at its wits' end.

From the duality to the well-known eddy current and by means of observation in the previous chapters numerous properties of the potential vortex have been derived. But these are not all the properties. The mathematical calculation of the electric vortex field, that we want to turn to now, will reveal still further meaningful and highly interesting properties.

The observation is important, but it can't replace an exact calculation. A strictly mathematical derived result has occasionally more expressiveness than a whole book full of explanations. It will be a big help to derive and to discuss the field equation that all considerations are based on.

We facilitate the mathematical work by vector analysis. Therefore it is useful that we choose the differential form (equation 5.1 and 5.4) instead of the integral form (equations 3.1 and 3.2 resp. 3.8).

1. Ampère's law:

$$\text{rot}\,\mathbf{H} = \mathbf{j} + \delta\mathbf{D}/\delta t \tag{5.1}$$

with $\mathbf{H} = \mathbf{H}(\mathbf{r},t)$

and Ohm's law: $\mathbf{j} = \sigma \cdot \mathbf{E}$ (5.2)

dielectric displacement: $\mathbf{D} = \varepsilon \cdot \mathbf{E}$ (3.6)

relaxation time: $\tau_1 = \varepsilon/\sigma$ (5.3)

$$\boxed{\text{rot}\,\mathbf{H} = \varepsilon \cdot (\mathbf{E}/\tau_1 + \delta\mathbf{E}/\delta t)} \tag{5.1*}$$

2. Faraday's law of induction (extended according to duality rules)

$$-\text{rot}\,\mathbf{E} = \mathbf{B}/\tau_2 + \delta\mathbf{B}/\delta t \tag{5.4}$$

with $\mathbf{E} = \mathbf{E}(\mathbf{r},t)$

and the flux density: $\mathbf{B} = \mu \cdot \mathbf{H}$ (3.5)

$$\boxed{-\text{rot}\,\mathbf{E} = \mu \cdot (\mathbf{H}/\tau_2 + \delta\mathbf{H}/\delta t)} \tag{5.4*}$$

$$-\text{rot rot}\,\mathbf{E} = \mu \cdot (1/\tau_2) \cdot \text{rot}\,\mathbf{H} + \mu \cdot \delta(\text{rot}\,\mathbf{H})/\delta t \tag{5.5}$$

insert equation 5.1*:

$$-\text{rot rot}\,\mathbf{E} = \mu \cdot \varepsilon \cdot (\mathbf{E}/\tau_1\tau_2 + (1/\tau_2) \cdot \delta\mathbf{E}/\delta t + (1/\tau_1) \cdot \delta\mathbf{E}/\delta t + \delta^2\mathbf{E}/\delta t^2) \tag{5.5*}$$

$$-\text{rot rot}\,\mathbf{E} = \Delta\mathbf{E} - \text{grad div}\,\mathbf{E} = \Delta\mathbf{E}\,, \tag{R5}$$

if: $\text{div}\,\mathbf{E} = O$ (3.7*)

abbreviation: $\mu \cdot \varepsilon = 1/c^2$ (5.6)

3. fundamental field equation:

$$\underbrace{\Delta\mathbf{E}\cdot c^2}_{a} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{b} + \underbrace{(1/\tau_1)\cdot\delta\mathbf{E}/\delta t}_{c} + \underbrace{(1/\tau_2)\cdot\delta\mathbf{E}/\delta t}_{d} + \underbrace{\mathbf{E}/\tau_1\tau_2}_{e} \tag{5.7}$$

Fig. 5.1: Derivation of the fundamental field equation.

5.1 Fundamental field equation

We'll start from Ampere's law which provides a value for the current density at any point pace and this value corresponds to the vortex density of the magnetic field strength

$$\text{rot}\,\mathbf{H} = \mathbf{j} + \delta\mathbf{D}/\delta t \qquad (5.1)$$

We'll use Ohm's law: $\mathbf{j} = \sigma \cdot \mathbf{E}$, (5.2)

the dielectric displacement: $\mathbf{D} = \varepsilon \cdot \mathbf{E}$ (3.6)

and the relaxation time: $\tau_1 = \varepsilon/\sigma$, (5.3)

that indicates how fast the current eddies decay. So far we can fall back upon well-known relations.

The result is:

$$\boxed{\text{rot}\,\mathbf{H} = \varepsilon \cdot (\mathbf{E}/\tau_1 + \delta\mathbf{E}/\delta t)} \qquad (5.1^*)$$

The new electric field vortices demand the introduction of a corresponding time constant tau_2 that should describe the decay of the potential vortices, as an extension. The extended Faraday law of induction now provides a potential density, that at any point of space corresponds to the vortex density of the electric field strength:

$$-\text{rot}\,\mathbf{E} = \mathbf{B}/\tau_2 + \delta\mathbf{B}/\delta t \qquad (5.4)$$

with the flux density $\mathbf{B} = \mu \cdot \mathbf{H}$. (3.5)

The result fulfils the required duality to equation 5.1*:

$$\boxed{-\text{rot}\,\mathbf{E} = \mu \cdot (\mathbf{H}/\tau_2 + \delta\mathbf{H}/\delta t)} \qquad (5.4^*)$$

If we again apply the curl to equation 5.4*

$$-\text{rot rot}\,\mathbf{E} = \mu \cdot (1/\tau_2) \cdot \text{rot}\,\mathbf{H} + \mu \cdot \delta(\text{rot}\,\mathbf{H})/\,\delta t \qquad (5.5)$$

and insert equation 5.1*, we obtain:

$$-\text{rot rot}\,\mathbf{E} = \mu \cdot \varepsilon \cdot (\mathbf{E}/\tau_1\tau_2 + (1/\tau_2) \cdot \delta\mathbf{E}/\delta t + (1/\tau_1) \cdot \delta\mathbf{E}/\delta t + \delta^2\mathbf{E}/\delta t^2) \qquad (5.5^*)$$

which according to the rules of vector analysis can still be further simplified: = rot rot E = $\Delta\mathbf{E}$ - grad div E , where we should remember that the divergence has to vanish (div E = O. fig. 3.2, equation 3.7), should the corresponding field vortex be inserted!

Furthermore the following well-known abbreviation can be inserted: $\mu \cdot \varepsilon = 1/c^2$ (5.6)

With that the relation with the speed of light c simplifies to the sought-for field equation:

$$\underbrace{\Delta\mathbf{E} \cdot c^2}_{a} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{b} + \underbrace{(1/\tau_1) \cdot \delta\mathbf{E}/\delta t}_{c} + \underbrace{(1/\tau_2) \cdot \delta\mathbf{E}/\delta t}_{d} + \underbrace{\mathbf{E}/\tau_1\tau_2}_{e} \qquad (5.7)$$

This equation describes the spatial (a) and temporal (b, c, d) distribution of a field vector. It describes the electromagnetic wave (a, b) with the influences that act damping. As dumping terms the well-known eddy current (c) and in addition the newly introduced potential vortex (d) appear.

Field vector: ψ = E, H, j, B or D

1. elliptic potential equation:
(stationary: $t \longrightarrow \infty$ resp. $\delta/\delta t = O$)

$$\underbrace{\Delta\psi \cdot c^2}_{a} = \underbrace{\psi/\tau_1\tau_2}_{e}$$

(5.8)

2. hyperbolic equation:
(undamped wave equation)

$$\underbrace{\Delta\psi \cdot c^2}_{a} = \underbrace{\delta^2\psi/\delta t^2}_{b}$$

(5.9)

3. parabolic equation:
(vortex equation)

$$\underbrace{\Delta\psi \cdot c^2}_{a} = \underbrace{(1/\tau) \cdot \delta\psi/\delta t}_{c/d}$$

(5.10)

decay time of the eddy currents = relaxation time: $\tau_1 = \varepsilon/\sigma$ (5.3)

decay time of the potential vortices = relaxation time: $\tau_2 \sim \mu \cdot \sigma$ (5.11)

Fig. 5.2: mathematically divisible individual cases.

5.2 Mathematical interpretation of the fundamental field equation

Every specialist will be surprised to find the Poisson equation (a, e) again as a term in the wave equation. This circumstance forces a completely new interpretation of stationary fields upon us. The new damping term, that is formed by the potential vortices (d), is standing in between.

Let us start with a mathematical analysis. We have applied the curl to equation 5.4*, then inserted equation 5.1* and obtained a determining equation for the electric field strength E. Of course we could as well have applied the curl to equation 5.1* and inserted equation 5.4*. This would have resulted in the determining equation for the magnetic field strength H.

If we insert Ohm's law (5.2) and cancel down the specific conductivity, or we put in the relations of material (3.5) or (3.6) and cancel down by u respectively ε, then the field equation can likewise be written down for the current density j, for the induction B or for the dielectric displacement D.

It just is phenomenal that at all events equation 5.7 doesn't change its form at all. The field vector is thus arbitrarily interchangeable! This circumstance is the foundation for the claim of this field equation to be called fundamental.

It does make sense to introduce a neutral descriptive vector ψ as a substitute for the possible field factors E, H, j, B or D.

The fundamental field equation 5.7 consists of three different types of partial differential equations: a hyperbolic (b), a parabolic (c and d) and an elliptic (e) type. On the left-hand side each time the Laplace operator (a) is found which describes the spatial distribution of the field factor.

The potential equation of the elliptic type (e) is known as Poisson equation. It describes the stationary borderline case of a worn off temporal process ($t \rightarrow \infty$, resp. $\delta/\delta t = O$).

With this equation potentials and voltages can be calculated exactly like stationary electric currents (5.8).

The hyperbolic equation (b). known as wave equation, shows a second derivative to time. which expresses an invariance with regard to time reversal; or stated otherwise: the direction of the time axis can be reversed by a change of sign of t, without this having an influence on the course of frequency. Wave processes hence are reversible. Equation 5.7 makes clear that a wave without damping by no means can exist in nature. For that both time constants (τ_1 and τ_2) would have to have an infinite value, which is not realizable in practice. Seen purely theoretical, undamped waves could withdraw themselves from our measuring technique (5.9).

Both vortex equations of the parabolic type (c and d) only show a first derivative to time. With that they are no longer invariant with regard to time reversal. The processes of the formation and the decay of vortices, the so-called diffusion, are as a consequence irreversible. Seen this way it is understandable that the process of falling apart of the vortex, where the vortex releases its stored energy as heat e.g. in form of eddy losses, can not take place in reverse. This irreversible process of diffusion in the strict fhermodynamic sense increases the entropy of the system (5.10).

Because it poses an useful simplification for mathematical calculations, often the different types of equations are treated isolated from each other. But the physical reality looks different.

field vector: ψ = E, H, j, B or D

1. Borderline case: no conductivity (vacuum)
(σ = O; $1/\tau_1 = \sigma/\varepsilon$ = O):

$$\underbrace{\Delta\psi \cdot c^2}_{a} = \underbrace{\delta^2\psi/\delta t^2}_{b} + \underbrace{(1/\tau_2)\cdot \delta\psi/\delta t}_{d}$$

(5.12)

(damping by potential vortices)

2. Borderline case: ideal conductivity (superconductor)
($1/\sigma$ = O; $1/\tau_2$ = O):

$$\underbrace{\Delta\psi \cdot c^2}_{a} = \underbrace{\delta^2\psi/\delta t^2}_{b} + \underbrace{(1/\tau_1) \cdot \delta\psi/\delta t}_{c}$$

(5.12*)

(damping by eddy currents)

3. Diffusion equation

$$\underbrace{\Delta\psi \cdot c^2}_{a} = \underbrace{(1/\tau) \cdot \delta\psi/\delta t}_{c/d} + \underbrace{\psi/\tau_1\tau_2}_{e}$$

(5.12**)

(vortex)

Fig. 5.3: Two borderline cases of the damping of waves and
the diffusion equation for the decay of vortices

5.3 Physical interpretation of the fundamental field equation

In nature the different types of equations always occur in a combined manner.

1. Let's take the concrete case of the particle-free vacuum. Here the specific conductivity is zero. The relaxation time constant $\tau_1 = \varepsilon/\sigma$ responsible for the decay of vortices tends towards infinity according to equation 5.3 and the terms (c) and (e) are cancelled from the field equation 5.7. What remains is the by potential vortices (d) damped wave equation (b) (equation 5.12).

2. The reversed case (with $\tau_2 \longrightarrow \infty$) will consequently occur in materials without resistance, super conducting materials. We now are dealing with the well-known case of the wave damped by eddy currents (equation 5.12*).

Virtually all in nature existing materials however don't fulfil these boundary conditions, from which it follows that both damping terms always occur together and in addition the stationary term (e) becomes active.
It is true that every antenna demonstrates that the electromagnetic wave is convertible in high-frequency alternating currents and voltages, which then are amplified in the receiver. But until this fundamental equation was written down it however was not understood that this transition takes place by means of a vortex. Used are either antennas from well conducting material, or wave guides and horn radiators, which only have a minimal conductivity, because they are filled with air. Actually the wave can be converted in two dual ways; by means of the rolling up to current eddies or to potential vortices (fig. 1.4). Now we finally are capable to explain, why wave guides make possible a better degree of effectiveness: Owing to the concentration effect of the potential vortex the HF-power is bound in the inside and not emitted until the antenna is reached as happens for a wire for reason of the skin effect.
Therefore, physically, one has to imagine this relation, which describes the transition of an electromagnetic wave into a vortex, in the way that the wave spontaneously can roll up to a vortex in case it is disturbed from the outside. The more vortices are generated, the larger consequently is the damping of the wave (equations 5.12 and 5.12*).

3. The life span of the vortices is limited and is determined by the electric conductivity. The at first stored vortices decay with their respective time constant τ. This process is described by the diffusion equation 5.12**. The final stage of the decaying vortices finally is described by the Poisson equation (a, e: equation 5.8).

If the vortex falls apart, it converts the in the vortex stored energy in heat. These processes are known from the eddy current. We speak of heating losses, that the stationary currents cause in the conductor material.
But new is the concept that such vortex phenomena can occur as dielectric losses in capacitors or in the air. The microwave oven or induction welding are good examples of this.

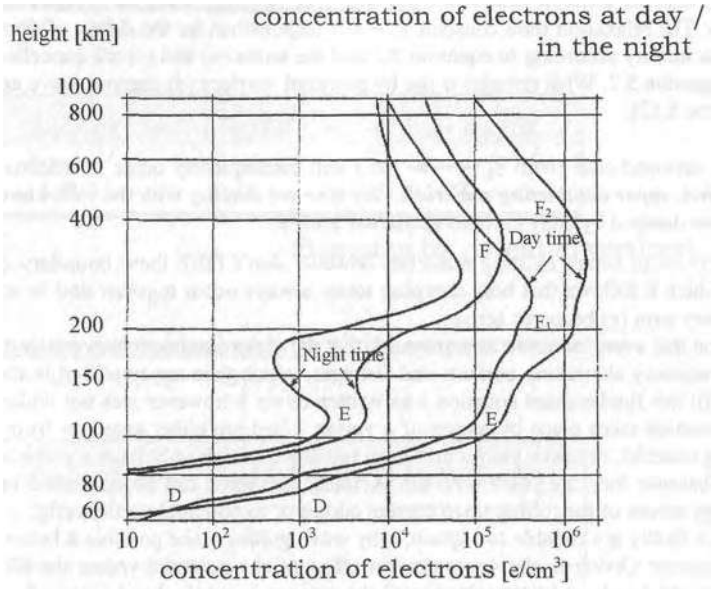

Fig. 5.4: The dependency on height of the ionisation in the ionosphere for medium latitudes .[<i>]

left curve: for a minimum of sun spots

right curve: for a maximum of sun spots

<i>: H.L. Konig: Unsichtbare Umwelt (Wetterfuhligkeit), 5. Aufl., Bild 6, Seite 11, Verlag Moos & Partner Milnchen, ISBN 3-89164-058-7

5.4 Phenomenological interpretation of the fundamental field equation

How does a damping by vortices take effect in practice? First of all we notice that the reception of broadcastings gets worse. "The information signal is neglectable regarding the noise" explains the radio engineer and means, the number of vortices increases at the expense of the wave intensity.
Why, does the pupil ask, is it so cold in space? There the sun shines day and night and in addition much more intensely than on earth! The correct answer would have to read that because of the extremely small conductivity no diffusion process can take place. We owe the warmth on our earth solely the here taking place decay of vortices. Responsible is the conductivity of the atmosphere.
In 60 km to 500 km height over the earth's surface, the region which is called the ionosphere, the gases predominantly exist in ionized form. There a very good conductivity prevails and eddy current losses are the result. Correspondingly high are the measurable temperatures. Besides the diffusion process the eddy currents carry out a damping of the cosmic radiation. We say the sunlight is filtered and reduced to a for nature bearable intensity.
But not all frequencies are damped in the same way (fig. 2.8). We observe a blue shift, if we look into the actually black sky. The blue sky doesn't show any spots or clouds. The reason is to be sought in the skin effect of the eddy currents, which strive outwards. Since no edge of a conductor is present here, no skin can form. The vortices spread evenly over the ionosphere.
The potential vortex however is able to structure. It merely needs a bad conductivity and this it finds in lower heights between 1 km and 10 km. It damps the wave and with that also the light, for which reason we say it becomes darker, the sun disappears behind clouds.

The clouds well visibly form the discussed vortex balls and vortex strings. Clouds can form virtually from the nowhere during intense solar irradiation, i.e. the waves can roll up to vortices. But as a rule this takes place above the oceans. Here also the phenomenon of transport has an effect. Because of the high dielectricity the water surface favours the formation of potential vortices. So the vortices bind individual water molecules and carry them away. If a diffusion process takes place, in which the vortex decays, then it rains. This can happen in two different ways:
1. Either the conductivity increases. If for instance during intense solar irradiation air ions form, the sun is able to break up clouds and fog. Or when the air is raised in higher layers with better conductivity, because a mountain forces this, then it rains at the mountain edge.
2. For potcntial vortices the electric field is standing perpendicular to them. If at one point an exceptionally lot of vortices join together, which let the cloud appear particularly dark to black, then the danger exists that the ionization field strength for air is reached, in which case a conductive air channel forms along which the stored up charges discharge. Also lightning is a diffusion process, in which potential vortices decay and rain can form.
In connection with the electromagnetic environmental compatibility great importance is attributed in particular to the storage and the decay of electric vortices. There not only is an academic-scientific interest in the question, how many potential vortices are generated, how many are stored and how many decay, if we make a telephone call with a handy, if we are staying under a high-tension line or if we are eating food, which has been heated up in a microwave oven. The necessary mathematical description is provided by the fundamental field equation 5.7.

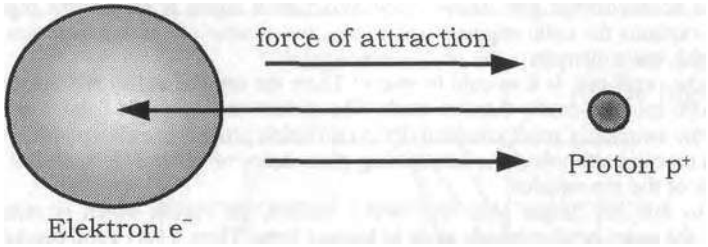

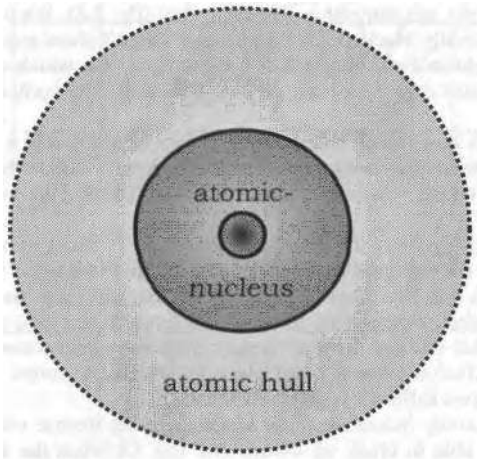

Fig. 5.5: The structure of atoms in the view of the fundamental field equation

condition for equilibrium: $\tau_1 = \tau_2$ (5.13)

5.5 Atomistic interpretation of the fundamental field equation

Let's again turn to the smaller, the atomistic dimensions. Here positively charged protons and negatively charged electrons are found. Both are matter particles and that means that seen from the outside both have the identical swirl direction. For reason of the unequal charge conditions they attract each other mutually and according to fig. 4.9 rotate around a common centre of mass as differently heavy pair. Chemists say: "the light electron orbits the heavy atomic nucleus". With small balls they try to explain the atomic structure.
But the model is no good: it contradicts causality in the most elementary manner. We are dealing with the problem that according to the laws of electrodynamics a centripetally accelerated electron should emit electromagnetic waves and continuously lose energy, to eventually plunge into the nucleus.
Our experience teaches that this fortunately is not true - and Niels Bohr in order to save his model of the atom was forced to annul the laws of physics with a postulate founded in arbitrariness.
Actually this state only exists for a very short time and then something unbelievable happens: the electron can't be distinguished as an individual particle anymore. "It is smeared over the electron orbit" do certain people say; "it possesses a dual nature" says Heisenberg. Besides the corpuscular nature the electron should in case of its "second nature" form a matter wave, "the position of the electron is to be looked at as a resonance which is the maximum of a probability density", do explain us de Broglie and Schrodinger.

These explanations can hardly convince. If the electron loses its particle nature in its second nature, then it also will lose its typical properties, like for instance its mass and its charge. but this is not the case.
THE vortex theory provides clear and causal answers: if the electron were a ball it continuosly would lose energy, therefore another configuration forms that does not know this problem. Here the phenomenon of transport takes an effect. The electron opens its vortex centre and takes the tiny protons and neutrons as atomic nucleus up into itself. The Bohr electron orbit with that is not a path anymore, but is occupied by the whole particle as spherical shell. This is confirmed by the not understood measurements exactly like the photos of individual atoms with the scanning electron microscope.
But now an electron does in its inside have the opposite swirl direction as the proton seen from the outside. As a consequence a force of repulsion will occur, which can be interpreted as the to the outside directed current eddy, the force of attraction for reason of the opposite charge works in the opposite direction and can be interpreted as the potential vortex effect.
If both vortices are equally powerful: $\tau_1 = \tau_2$ (5.13)
or if both forces are balanced, as one usually would say, then the object which we call an atom is in a stable state.
It probably will be a result of the incompatible swirl direction, why a very big distance results, if the electron becomes an enveloping electron. On such a shell not too many electrons have room. Because of the rotation of their own, the electron spin, they form a magnetic dipole moment, which leads to a magnetic attraction of two electrons if they put their spin axis antiparallelly.
As a "frictionless" against one another rotating pair they form two half-shells of a sphere and with that occupy the innermost shell in the hull of an atom. If the positive charge of the nucleus is still not balanced with that, then other electrons is left only the possibility to form another shell. Now this next electron takes the whole object up into itself. The new shell lies further on the outside and naturally offers room to more as only two vortices.

approach:

$$\boxed{\mathbf{E}\,(\mathbf{r},t) = \psi\,(\mathbf{r},t)\cdot e^{-\omega t}} \tag{5.17}$$

with

$$\omega = 1/\tau = (1/\tau_1 + 1/\tau_2)/2 \tag{5.18}$$

we insert the approach 5.17 and its derivations:

$$\delta\mathbf{E}/\delta t = -\,\omega\cdot\psi\cdot e^{-\omega t} + (\delta\psi/\delta t)\cdot e^{-\omega t} \tag{5.17*}$$

$$\delta^2\mathbf{E}/\delta t^2 = \omega^2\cdot\psi\cdot e^{-\omega t} - 2\omega\cdot(\delta\psi/\delta t)\cdot e^{-\omega t} + (\delta^2\psi/\delta t^2)\cdot e^{-\omega t} \tag{5.17**}$$

into the fundamental field equation 5.7:

$$\boxed{\Delta\mathbf{E}\cdot c^2 = \delta^2\mathbf{E}/\delta t^2 + (1/\tau_1)\cdot\delta\mathbf{E}/\delta t + (1/\tau_2)\cdot\delta\mathbf{E}/\delta t + \mathbf{E}/\tau_1\tau_2}$$

and divide by $e^{-\omega t}$:

$$\begin{aligned}\Delta\psi\cdot c^2 = {} & \psi/\tau_1\tau_2 && \text{(a) = (e)}\\ & -\,\omega\cdot\psi\cdot(1/\tau_1 + 1/\tau_2) && \text{(c, d)}\\ & +\,(1/\tau_1 + 1/\tau_2)\cdot\delta\psi/\delta t && \text{(c, d)}\\ & +\,\omega^2\cdot\psi - 2\omega\delta\psi/\delta t + \delta^2\psi/\delta t^2 && \text{(b)}\end{aligned} \tag{5.19}$$

insert the frequency according to equation 5.18:

$$\begin{aligned}\Delta\psi\cdot c^2 = {} & \psi/\tau_1\tau_2 && \text{(a) = (e)}\\ & -\,(\psi/2)\cdot(1/\tau_1 + 1/\tau_2)^2 && \text{(c, d)}\\ & +\,(1/\tau_1 + 1/\tau_2)\cdot\delta\psi/\delta t && \text{(c, d)}\\ & +\,(\psi/4)\cdot(1/\tau_1 + 1/\tau_2)^2 && \text{(b)}\\ & -\,(1/\tau_1 + 1/\tau_2)\cdot\delta\psi/\delta t + \delta^2\psi/\delta t^2 && \text{(b)}\end{aligned} \tag{5.19*}$$

summarized with equation 5.18:

$$\boxed{\Delta\psi\cdot c^2 = \psi/\tau_1\tau_2 - \omega^2\cdot\psi + \delta^2\psi/\delta t^2} \tag{5.20}$$

Fig. 5.6: Derivation of the Klein-Gordon equation (5.20) from the fundamental field equation (5.7)

5.6 Derivation of the Klein-Gordon equation

The valid model of the atom today still raises problems of causality, as has been explained. An improvement was provided by an equation, which was proposed by the mathematician Schrodinger 1926 as a model description. This equation in this way missed the physical root, but it nevertheless got international acknowledgment, because it could be confirmed experimentally. Looking backwards from the result then the physical interpretation of the probability density of the resonance of the waves could be pushed afterwards.

$$i \cdot \hbar \cdot \delta\psi/\delta t = U \cdot \psi - (\hbar^2/2m) \cdot \Delta\psi \quad (5.14)$$

The Schrodinger equation is valid for matter fields (of mass m), while the interaction with a outside force field the energy U indicates. It can be won from a wave equation by conversion, which possibly is the reason why it usually is called a wave equation, although in reality it is a diffusion equation, so a vortex equation!
For the derivation Schrodinger gives the approach of a harmonic oscillation for the complex wave function ψ:

$$\boxed{\psi(\mathbf{r},t) = \phi(\mathbf{r}) \cdot e^{-i\omega t}} \quad (5.15)$$

if the entire time dependency can be described by one frequency f = W/h (de-Broglie relation):

$$\omega = 2\pi f = W \cdot 2\pi/h = W/\hbar \quad (5.16)$$

The high-put goal is: if the structure of the atom is determined by the fundamental field equation 5.7 then one should be able to derive the experimentally secured Schrodinger equation and to mathematically describe the discussed special case. Also we select at first an approach periodic in time:

$$\boxed{\mathbf{E}(\mathbf{r},t) = \psi(\mathbf{r},t) \cdot e^{-\omega t}} \quad (5.17)$$

with

$$\omega = 1/\tau = (1/\tau_1 + 1/\tau_2)/2 \ . \quad (5.18)$$

We insert the approach 5.17 and its derivations into the field equation 5.7 and divide by the damping term e^{-wt}:

$$\Delta\psi \cdot c^2 = \psi/\tau_1\tau_2 - \omega \cdot \psi \cdot (1/\tau_1 + 1/\tau_2) + (1/\tau_1 + 1/\tau_2) \cdot (\delta\psi/\delta t) + \\ + \omega^2 \cdot \psi - 2\omega\,\delta\psi/\delta t + \delta^2\psi/\delta t^2 \quad (5.19)$$

If as the next step the angular frequency according to equation 5.18 is inserted, then summarized the provisional intermediate result results:

$$\boxed{\Delta\psi \cdot c^2 = \psi/\tau_1\tau_2 - \omega^2 \cdot \psi + \delta^2\psi/\delta t^2} \quad (5.20)$$

The derived equation 5.20 represents formally seen the Klein-Gordon equation, which is used for the description of matter waves in quantum mechanics and which particularly in the quantum field theory (e.g. mesons) plays an important role. Even if it often is regarded as the relativistic invariant generalization of the Schrodinger equation, it at a closer look is incompatible with this equation and as "genuine" wave equation it is not capable of treating vortex problems correctly, like e.g. the with the Schrodinger equation calculable quantization of our microcosm.

$$\boxed{\text{Schrödinger approach} \quad \psi(\mathbf{r},t) = \phi(\mathbf{r}) \cdot e^{-i\omega t}} \tag{5.15}$$

with: f = W/h; de-Broglie relation:

$$\omega = 2\pi f = W \cdot 2\pi/h = W/\hbar \tag{5.16}$$

the derivation:

$$\delta\psi/\delta t = -i\,\omega \cdot \psi$$

rewritten for ψ:

$$\psi = (i/\omega) \cdot \delta\psi/\delta t \tag{5.21}$$

2. derivation:

$$\delta^2\psi/\delta t^2 = -i\,\omega \cdot \delta\psi/\delta t \tag{5.22}$$

inserted in equation 5.20:

$$\boxed{\Delta\psi \cdot c^2 = \psi/\tau_1\tau_2 - 2\,i\,\omega \cdot \delta\psi/\delta t} \tag{5.23}$$

= sought-for Schrödinger equation (usual notation):

$$\boxed{i \cdot \hbar \cdot \delta\psi/\delta t = U \cdot \psi - (\hbar^2/2m) \cdot \Delta\psi} \tag{5.14}$$

comparison of coefficients is needed:
Einstein relation (with the speed of light c):
with (5.16): $W = m \cdot c^2 = \omega \cdot \hbar$ (5.24)
coefficient of the
imaginary part: $-2\,i\,\omega = 2(\omega/i) = 2mc^2/i\hbar$ (5.25)
comparison of coefficients
for the !
real part: $\boxed{1/\tau_1\tau_2 c^2 = U \cdot 2m/\hbar^2}$ (5.26)

kinetic energy of a particle moving with the speed v:

$$\tfrac{1}{2} \cdot m \cdot v^2 = W - U \tag{5.27}$$

v = group velocity of the matter wave:

$$v = hf/mc = \hbar\,\omega/mc \tag{5.28}$$

Eq.5.27: $U = W - \tfrac{1}{2} \cdot m \cdot (\hbar\,\omega/mc)^2$ (5.27*)

Eq.5.24: $W = \omega \cdot \hbar$; $(\hbar\,\omega/mc) = c$; resp.: $m/\hbar = \omega/c^2$

In eq.5.27* the sought-for coefficient reads (according to eq. 5.26):

$$U \cdot 2m/\hbar^2 = 2\omega/c^2\hbar \cdot [\omega \cdot \hbar - \tfrac{1}{2} \cdot m \cdot c^2]$$

$$= 2\omega/c^2\hbar \cdot [\omega \cdot \hbar - \tfrac{1}{2} \cdot \omega \cdot \hbar] = \underline{\underline{(\omega/c)^2}} \tag{5.29}$$

Fig. 5.7: Derivation of the time dependent Schrodinger equation

5.7 Derivation of the time dependent Schrodinger equation

With the Schrodinger approach 5.15 and its derivations the derivation is continued:

$$\boxed{\psi(\mathbf{r},t) = \phi(\mathbf{r}) \cdot e^{-i\omega t}}\ , \qquad (5.15)$$

$$\delta\psi/\delta t = -i\omega \cdot \psi\ , \quad \text{bzw.} \quad \psi = (i/\omega) \cdot \delta\psi/\delta t \qquad (5.21)$$

$$\delta^2\psi/\delta t^2 = -i\omega \cdot \delta\psi/\delta t \qquad (5.22)$$

The for a harmonic oscillation won relations according to equation 5.21 and 5.22 are now inserted into equation 5.20:

$$\boxed{\Delta\psi \cdot c^2 = \psi/\tau_1\tau_2 - 2i\omega \cdot \delta\psi/\delta t}$$

This is already the sought-for Schrodinger equation, as we will see in a moment, when we have analysed the coefficients. Because, besides equation 5.16 for the total energy W, also the Einstein relation is valid (with the speed of light c):

$W = m \cdot c^2 = \omega \cdot \hbar$, (5.24)

we can replace the coefficients of the imaginary part by:

$2(\omega/i) = 2mc^2/i\hbar$ (5.25)

To achieve that equation 5.23, as required, follows from the Schrodinger equation 5.14, a comparison of coefficients is carried out for the real part:

$$\boxed{1/\tau_1\tau_2 c^2 \overset{!}{=} U \cdot 2m/\hbar^2} \quad (5.26)$$

If thc kinetic energy of a particle moving with the speed v is:

$\frac{1}{2} \cdot m \cdot v^2 = W - U$, (5.27)

then acccording to De Broglie this particle has the wavelength h/mv. The consideration of the particle as matter wave demands an agreement with the wave length c/f of an electro-magnetic wave (with the phase velocity c). The particle hence has the speed v, which corresponds with the group velocity of the matter wave:

$v = hf/mc = \hbar\omega/mc$, (5.28)

if we insert v into equation 5.27 :

$U = W - \frac{1}{2} \cdot m \cdot (\hbar\omega/mc)^2$ (5.27*)

According to equation 5.24 on the one hand the total energy is $W = w \bullet h$ and on the other hand the relation 5.28 gives $(\hbar\omega/mc) = c$ resp.: $m/\hbar = \omega/c^2$

Inserted into equation 5.27* the sought-for coefficient reads (according to eq. 5.26):

$$U \cdot 2m/\hbar^2 = 2\omega/c^2\hbar \cdot [\omega \cdot \hbar - \tfrac{1}{2} \cdot m \cdot c^2]$$

$$= 2\omega/c^2\hbar \cdot [\omega \cdot \hbar - \tfrac{1}{2} \cdot \omega \cdot \hbar] = \underline{(\omega/c)^2} \qquad (5.29)$$

comparison of coefficients 5.26 is fulfilled if:

$$1/\tau_1\tau_2 c^2 \overset{!}{=} U \cdot 2m/\hbar^2 = (\omega/c)^2 \tag{5.30}$$

the angular frequency is given by equation 5.18. Therefore has to be valid:

$$1/\tau_1\tau_2 \overset{!}{=} \tfrac{1}{4}\,(1/\tau_1 + 1/\tau_2)^2 \tag{5.31}$$

resp.:

$$\sqrt{1/\tau_1\tau_2} \overset{!}{=} \tfrac{1}{2}\,(1/\tau_1 + 1/\tau_2) \tag{5.32}$$

arithmetic average = geometric average, if:

$$1/\tau_1 = 1/\tau_2 \text{ and: } \boxed{\tau_1 = \tau_2} \tag{5.13}$$

is valid. Eq. 5.23 is divided by c^2 and
eqs. 5.30 and 5.25 are inserted:

$$\boxed{\Delta\psi = U \cdot \psi \cdot (2m/\hbar^2) + (2m/i\hbar) \cdot \delta\psi/\delta t} \tag{5.14*}$$

= *time dependent Schrödinger equation* 5.14.

replace $\delta\psi/\delta t$ acc. to eq. 5.21 with $\omega = W/\hbar$ acc.to eq. 5.24:

$$\Delta\psi = U \cdot \psi \cdot (2m/\hbar^2) + (2m/i\hbar) \cdot \psi \cdot (-i) \cdot W/\hbar \tag{5.33}$$

Schrödinger approach 5.15 for the function of position $\phi(\mathbf{r})$:

$$\Delta\phi = (U\,2m/\hbar^2 - W \cdot 2m/\hbar^2) \cdot \phi \tag{5.34}$$

$$\boxed{\Delta\phi = -2m/\hbar^2\,(W - U) \cdot \phi} \tag{5.35}$$

= *time independent Schrödinger equation.*

Fig. 5.8: Derivation of the time independent Schrodinger equation

5.8 Derivation of the time independent Schrodinger equation

The goal is reached if we are capable to fulfil the comparison of coefficients 5.26:

$$U \cdot 2m/\hbar^2 \overset{!}{=} (\omega/c)^2 = 1/\tau_1\tau_2 c^2 \qquad (5.30)$$

The angular frequency w is given by equation 5.18. Therefore has to be valid:

$$\tfrac{1}{4}\,(1/\tau_1 + 1/\tau_2)^2 \overset{!}{=} 1/\tau_1\tau_2 \qquad (5.31)$$

$$\tfrac{1}{2}\cdot(1/\tau_1 + 1/\tau_1) \overset{!}{=} \sqrt{1/\tau_1\tau_2} \qquad (5.32)$$

As is well-known the arithmetic and the geometric average only correspond in case the variables are identical. In this case, as already required in equation 5.13:

$$\tau_1 = \tau_2 . \qquad (5.13)$$

has to hold.
From this we can draw the conclusion that the Schrodinger equation is just applicable to the described special case (according to eq. 5.13), in which the eddy current, which tries to increase the particle or its circular path and the potential vortex, which keeps the atoms together and also is responsible for the stability of the elementary particles, are of identical order of magnitude.

As a check equation 5.23 is divided by c^2 and equations 5.30 and 5.25 are inserted:

$$\boxed{\Delta\psi = U\cdot\psi\cdot(2m/\hbar^2) + (2m/i\hbar)\cdot\delta\psi/\delta t} \qquad (5.14^*)$$

This is the time dependent Schrodinger equation 5.14 resolved for $\Delta\psi$.

Next we replace $\delta\psi/\delta t$ according to equation 5.21 with $\omega = W/\hbar$ acc. to equation 5.24:

$$\Delta\psi = U\cdot\psi\cdot(2m/\hbar^2) + (2m/i\hbar)\cdot\psi\cdot(-i)\cdot W/\hbar \qquad (5.33)$$

If we separate the space variables $\phi(\mathbf{r})$ from time by the Schrodinger approach 5.15 we obtain:

$$\Delta\phi = (U\,2m/\hbar^2 - W\cdot 2m/\hbar^2)\cdot\phi \qquad (5.34)$$

This quation 5.34 for the function of space coordinates $\phi(\mathbf{r})$ is the time independent Schrodinger equation:

$$\boxed{\Delta\phi = -2m/\hbar^2\,(W-U)\cdot\phi} \qquad (5.35)$$

The solutions of this equation which fulfil all the conditions that can be asked of them (of finiteness, steadiness, uniqueness etc.), are called eigenfunctions. The existence of corresponding discrete values of the energy W, also called eigenvalues of the Schrodinger equation, are the mathematical reason for the different quantum postulates.

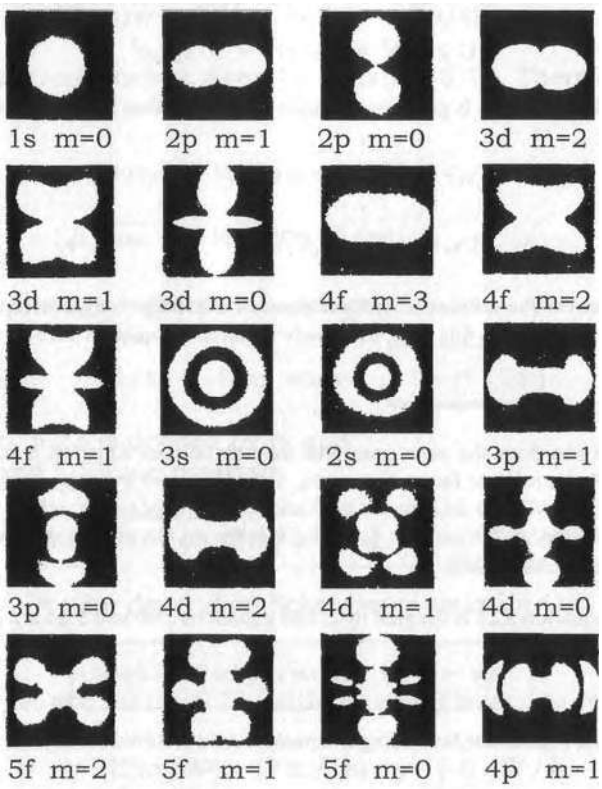

Fig. 5.9: Photographs of models of the probability densities for
different states of the hydrogen atom.
The densities are symmetrical if rotated around the vertical axis<i>

taken from:

<i>: U. Gradmann/H. Wolter: Grundlagen der Atomphysik, AVG, Frankfurt a. M. 1971, P. 190.

5.9 Interpretation of the Schrodinger equation

The interpretation of the Schrodinger equation is still disputed among physicists, because the concept of wave packets contradicts the corpuscular nature of the elementary particles. Further the difficulty is added that wave packets at a closer look never are connected, run apart more or less fast, and really nothing can hinder them doing that. But for a particle the connection represents a physical fact. Then there can be no talk of causality anymore. The monocausal division into two different levels of reality, in a space-timely localization and in an energetic description, does not represent a solution but rather the opposite, the abolition of the so-called dual nature. As has been shown, the potential vortex is able to achieve this with the help of its concentration effect.
But from the introduction of this new field phenomenon arises the necessity to interpret the causes for the calculable and with measuring techniques testable solutions of the Schrodinger equation in a new way. Laws of nature do not know a possibility to choose! If they have been accepted as correct, they necessarily have to be applied.

Three hundred years ago the scholars had an argument, whether a division of physical pheomena, like Newton had proposed it, would be allowed to afterwards investigate them in the laboratory individually and isolated from other influences or if one better should proceed in an integrated manner, like for instance Descartes with his cartesian vortex theory. He imagined the celestial bodies floating in ethereal vortices. One absolutely was aware that the whole had to be more than the sum of every single realizaton, but the since Demokrit discussed vortex idea had to make room for the overwhelming successes of the method of Newton. And this idea after 2100 years was stamped, to in the meantime almost have fallen into oblivion.
Today, where this recipe for success in many areas already hits the limits of the physical possibilities, we should remember the teachings of the ancients and take up again the vortex idea It of course is true that only details are calculable mathematically and that nature, the big whole, stays incalculable, wherein problems can be seen.
If we consider the fundamental field equation 5.7, we find confirmed that actually no mathematician is capable to give a generally valid solution for this four-dimensional partial differential equation. Only restrictive special cases for a harmonic excitation or for certain spatial boundary conditions are calculable. The derived Schrodinger equation is such a case and for us particularly interesting, because it is an eigenvalue equation. The eigenvalues describe in a mathematical manner the with measuring techniques testable structures of the potential vortex .
Other eigenvalue equations are also derivable, like the Klein-Gordon equation or the Lionville equation, which is applied successfully in chaos theories. So our view opens, if chaotic systems like turbulences can be calculated as special cases of the same field equation and should be derivable from this equation.
The in pictures recorded and published structures, which at night should have come into being in corn fields, often look like the eigenvalues of a corresponding equation. The ripe ears thereby lie in clean vortex structures flat on the soil. Possibly potential vortices have charged the ears to such high field strength values that they have been pulled to the soil by the Coulomb forces.

Consequences resulting from the derivation of the Schrodinger equation from the fundamental field equation 5.7:

1. *Any experiment which confirms the Schrödinger equation is with that able to confirm at the same time the existence of the newly discovered potential vortex and the correctness of the field-theoretical approach.*

2. *Properties of the atomic hull and of the atomic nucleus, which can be described with the Schrödinger equation, can as of now be interpreted as an electromagnetic phenomenon.*

3. *There exist no particles or wave packets from matter waves, but only configurations consisting of potential vortices and current eddies.*

4. *There exists no matter! What we call matter is nothing but an electromagnetic state of oscillation of empty space.*

The relation between the energy of oscillation and the mass is described by the relation named after Albert Einstein

$$E = mc^2 \quad . \qquad (6.1 = 5.24)$$

Fig. 6.1: Derivation of the Schrodinger equation, power of proof and consequences

6. Theory of objectivity

6.1 Proof

A new theory only has chances on acknowledgment if it is provable. For that physical phenomena in the sense of the new theory are calculated and independently of this experiments are being carried out. If the calculations are confirmed by reproducible measurement results, then with that the correctness of the approach is proven.
In the here presented case we have chosen the field-theoretical approach instead of the usual quantum physical approach. As a consequence of this we had found as a new phenomenon the vortex of the electric field. With regard to the normally used Maxwell theory this resulted in changed field equations in a dual formulation. If both equations, each of which describes a source-free vortex field, are inserted into each other the result is an only in time and space formulated, generally valid and hence fundamental field equation (5.7, fig. 5.1).
This equation has many special cases; one of them, the Schrodinger equation, could be derived by using an approach which was harmonic in time. We renounced to give special solutions of the Schrodinger equation, because these are printed in numerous text books. On the other hand experiments are known, which are capable to confirm the theoretical solutions and thus to prove the Schrodinger equation. The eigenvalues of the equation describe for instance the shell-shaped structure of the atoms with the by Niels Bohr given radii.
Now this already proven equation was derived from the new field-theoretical approach. Thus for the special case, the area where the Schrodinger equation is valid, the new theory can be said to be proven (fig. 6.1).
We still are not content with that and put another stone on top: we will calculate the quantum properties of the elementary particles for ourselves. These until now have only been measured. Today is merely sought for symmetries and for models of explanation, like e.g. the quark-hypothesis. From a calculation science is miles and miles away. We will compare the calculation results with the measurement values. Then everyone can check and compare for him or herself.
The conditions in an elementary particle are completely different. Here it concerns the vortex itself, whereas the model of the atom merely describes vortex properties, so-called actions at a distance. The differences in size and distances for an atom lie more than five powers of ten over those of a particle!
Here a new problem of causality comes to light, at which we now must have a critical look: the question of the by Einstein postulated constancy and universality of the speed of light. Seen from a relativistic and subjective point of view of an observer, Einstein by all means may be right. But may such a theory be generalized? How are the measurements concerning the speed of light and the relativity of space and time to be judged when looking at them objectively?
The current measurements of speeds faster than light speak a clear language and represent a challenge (fig. 3.1, violation of the principle of causality no. 5).

The electron as a spherical capacitor (see fig. 4.3):

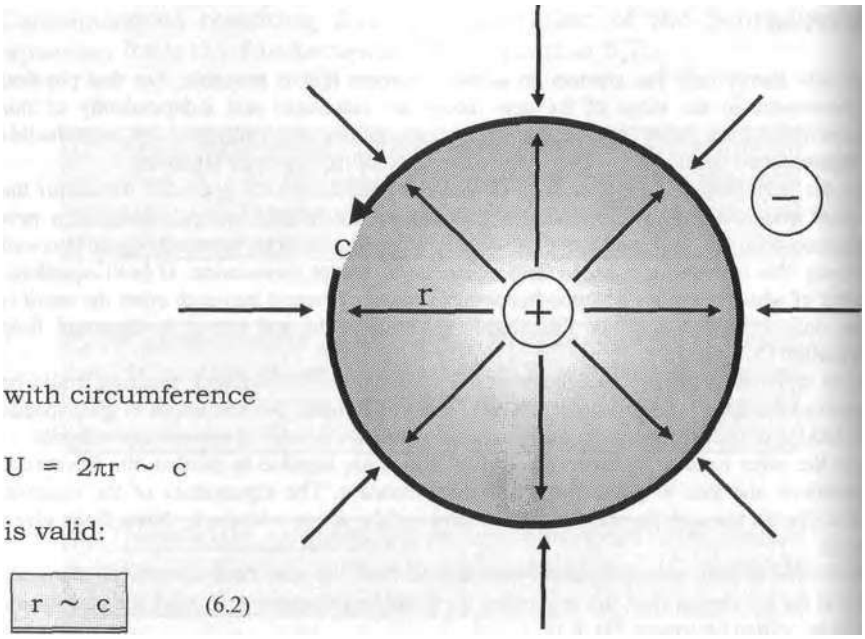

field theoretical approach (vortex particles):
The amount of energy bound in the inside of the particle is identical with the free and measurable amount of energy on the outside of the particle.

(If the number of particles is left unchanged):
In an isolated system the sum of the energy is constant

(particle = electromagnetic vortex)
Energy is a state description of electromagnetism.

Fig. 6.2: Derivation of the law of conservation of energy

6.2 Law of conservation of energy

Let the starting-point for our considerations be the electromagnetic wave in a particle-free vacuum. Here no vortices appear, so that the plane wave can propagate undamped with the speed of light, and in this way a transport of energy takes place. Electric and magnetic energy each are the same magnitude.
Let's now imagine the symmetry is disturbed as the wave is "slowed down" on one side. As a possible result the wave rolls up to a spherical vortex.
As we will see such a process is possible, for instance at impact on a strong field. Thus part of the energy is bound in the inside. This part from now on withdraws itself from every possibility to measure it. We can only measure the second part of the field energy, with which the particle interacts with its neighbourhood.
We can assume that:

The amount of energy bound in the inside of the particle is identical with the free and measurable amount of energy on the outside of the particle.

The same energy W_e = 0,51 MeV, we attribute to the electron for reason of its mass with the help of the Einstein relation (6.1), is also bound in its inside. This conclusion is also applicable to other elementary particles and with that to all matter.
We here again recognize the principle of the duality between the to the outside striving eddy current in the inside of the elementary vortex and the concentrating potential vortex on the outside. Thus also seen energetically both are of the same magnitude. Whereas in the case of the electromagnetic wave it concerns a symmetrical oscillation around "zero", by the process of quantization, by the rolling up to a spherical vortex, there forms an energetic state of space different from zero. The order of magnitude is determined by the number of elementary vortices, of which the particles and all matter consist.
Anti-matter forms the opposite energetic state and this again is for the particles of matter available in their inside in a bound form.
As long as we do not artificially produce new elementary vortices and thus keep the number of available vortices constant, the energetic state will not change, or as it is formulated in text books:

In an isolated system the sum of the energy is constant.

THE law of conservation of energy is not an axiom, but follows without compulsion from the vortex theory. It is not elementary, but a consistently derivable consequence of the field-theoretical approach, according to which solely the field acts as cause for all other physical phenomena, also for the conservation of energy! Because the cause of it is the electromagnetic field, the following has to hold:

Energy is a state description of electromagnetism.

Now we finally can explain why energy can be converted. Different forms of energy only are different forms of formation of the same phenomenon!
Of course this statement of the field-theoretical approach does not yet explain what, for instance, the temperature has to do with electromagnetism. I ask for some patience; no question will be left unanswered.

From

$$c \sim r \tag{6.2}$$

follows:

The speed of light determines the size of the elementary particles.

Energy of a capacitor:

$$W = Q^2/C, \tag{6.3}$$

written down for the electron (with the Einstein relation):

$$W_e = e^2/C_e = m_e c^2 = 0{,}51 \text{ MeV} \tag{6.1}$$

Capacity of a spherical capacitor:

$$C_e = \varepsilon_0 \cdot 4\pi r_e \tag{6.4}$$

"classical" radius of the electron<i> is:

$$r_e = e^2/\varepsilon_0 \cdot 4\pi \cdot W_e \tag{6.5}$$

$$r_e = 2{,}82 \cdot 10^{-15} \text{ m} \tag{6.6}$$

in the case of Kuchling<ii> the radius of the electron is:

$$r_e = 1{,}41 \cdot 10^{-15} \text{ m}. \tag{6.7}$$

Fig. 6.3: Calculation of the radius of the electron.

<i>: Mende, Simon: Physik, Gl. 10.39, VEB-Leipzig, 4. Aufl.

<ii>: Kuchling: Physik, Gl. At4, VEB-Leipzig, bis einschl. 11. Auflage 1974

6.3 Radius of the electron

For the crucial process, in which the electromagnetic wave rolls up to a vortex, it is for reasons of continuity to be expected that the velocity of propagation remains equal that thus for the vortex oscillation exactly like for the electromagnetic wave the speed of light is determining. The direction of propagation in the case of the vortex takes place perpcndicular to the in fig. 6.2 shown field direction of the electric field strength. Not even in that both field-phenomena differ.
Summarizing: the propagation takes place with the speed of light c along a circular path with the perimeter $U = 2\pi r$. Therefore holds:

$$c \sim r \quad (6.2)$$

According to this equation the radius and with that the size of the electron is determined by the speed of light. Therefore the question of the size of the electron is raised.

The energy interpretation predicts that for the theoretical case of a change of size the energy density in the inside of the particle is influenced that however the quantity of the included energy remains unchanged. We therefore can further proceed from the assumption that the bound amount of energy is independent of the size of the particle!

Consequently for the elementary quantum the energy W_e = 0,51 MeV is assumed, which it has acccording to the Einstein relation $W_e = m_e c^2$. For the electron of mass m_e the with measuring techniques determined value is inserted.
The spherical electrode of a spherical capacitor with the above given energy W_e (according to eq. 6.1) and the capacity C_e (according to equation 6.4, fig. 6.3) represents a very realistic model of the negatively charged particle.
In this manner the classical radius of the electron is calculated to be<i>: $r_e = 2{,}82 * 10^{-15}$ m.

But in the case of Kuchling it only is half this size<ii>, what according to equation 6.2 would mean that in the case of Kuchling the light would be on the way only half this fast <iii>. Therefore if one is careful, one prefers to be silent concerning this delicate theme and if one is honest, one admits not to know anything exact.
Not only the electron but also all the other elementary particles are according to the field-theoretical approach formed from concentrated potential vortices. For these equation 6.2 hence has to hold in the same manner, so that more generalized we can conclude:

The speed of light determines the size of the elementary particles.

This statement is incompatible with the assumption of a constant speed of light! Because then all elementary particles would have identical size. As is known, however, are the building parts of the atomic nucleus, the protons and neutrons very much smaller than individual electrons. The constancy of the speed of light is to be questioned. This question is of such an elementary importance that we are not content with these considerations and in addition undertake a mathematical derivation in the sense of the field approach.

<iii>: Difference = Thomas factor

The Maxwell laws, source free (figures 3.2 and 3.3):

$$\mathrm{Div}\,\mathbf{D} = O \quad (3.7) \quad \text{and} \quad \mathrm{Div}\,\mathbf{B} = O \quad (3.3)$$

Faraday's law of induction	and	Ampère's law
$\mathbf{E} = \mathbf{E}(\mathbf{r},t)$ with $1/\tau_2 = 0$:		$\mathbf{H} = \mathbf{H}(\mathbf{r},t)$ with $\mathbf{j} = 0$ resp. $1/\tau_1 = 0$
$\boxed{\mathrm{rot}\,\mathbf{E} = -\,\delta\mathbf{B}/\delta t}$ (5.4)		$\boxed{\mathrm{rot}\,\mathbf{H} = \delta\mathbf{D}/\delta t}$ (5.1)
with: $\mathbf{B} = \mu \cdot \mathbf{H}$ (5.5)	and	$\mathbf{D} = \varepsilon \cdot \mathbf{E}$ (3.6)

if we again apply the curl to equation 5.4 and insert equation 5.1 (cf. fig. 5.1, eq. 5.5):

$$-\,\mathrm{rot}\,\mathrm{rot}\,\mathbf{E} = \mu \cdot \delta(\mathrm{rot}\,\mathbf{H})/\delta t = \mu \cdot \varepsilon \cdot \delta^2\mathbf{E}/\delta t^2 \quad (5.5)$$

thanks to missing divergence: $\mathrm{div}\,\mathbf{E} = O$ (3.7*)

(fig. 5.2):

= wave equation: $\boxed{\Delta\,\mathbf{E} \cdot c^2 = \delta^2\mathbf{E}/\delta t^2}$ (5.9*)

with the speed of light c: $\mu \cdot \varepsilon = 1/c^2$ (5.6)

Hertz' wave = transverse wave = plane wave with:

direction of propagation: $\boxed{v = dx/dt}$ (6.8)

$\boxed{\mathbf{E} = E_z}$, $\boxed{\mathbf{D} = D_z}$, $\boxed{\mathbf{H} = H_y}$, $\boxed{\mathbf{B} = B_y}$ (6.8*)

curl operation (in y-direction): with equation 5.4:

$$\mathrm{rot}\,\mathbf{E} = -\,d\mathbf{E}/dx = -\,d\mathbf{B}/dt \quad (6.9)$$

with 6.8: $d\mathbf{E} = (dx/dt) \cdot d\mathbf{B} = v \cdot d\mathbf{B}$ (6.9*)

or generally: $\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$ (6.10)

Fig. 6.4: Derivation of the laws of transformation

<i>: Prof. G. Bosse in his text book in reversed direction derives the Faraday law of induction from the law of transformation 6.10, which he again derives from considerations about the Lorentz force. G. Bosse, Grundlagen der Elektrotechnik II, BI 183, Hochschultaschenbucher-Verlag, Mannheim 1967

6.4 The Maxwell field equations

The laws of transformation of the electromagnetic field shall form the starting-point for the coming up considerations. To exclude any doubts with regard to the interpretation, the equations will be derived from the Maxwell laws under the assumption that no sources or charge carriers are present (fig. 3.2 and 3.3) and as a consequence no current density (j = 0) is to be expected. This corresponds to the vanishing of the time independent terms, which consequently are responsible for the occurring of force effects like e.g. the Lorentz force. Only at the end of this derivation we can understand the sense of this assumption (with $1/\tau_1 = 0$ and $1/\tau_2 = 0$). The procedure at first corresponds to that of fig. 5.1. Here the fundamental field equation had been derived from Faraday's law of induction and Ampere's law. With the assumptions made this time the in fig. 5.2 treated undamped wave equation is left (5.9, here 5.9*). Whom the derivation is still present can go in at this point.
In a sufficiently great distance from the source we are dealing with a plane wave, in which the field factors only depend on the direction of propagation x. The Hertz' wave is a transverse wave, in which the field pointers oscillate perpendicular to the direction of propagation and in addition stand perpendicular to each other:

$$\boxed{v = dx/dt} \quad (6.8), \qquad \boxed{\mathbf{E} = E_z, \quad \mathbf{D} = D_z, \quad \mathbf{H} = H_y, \quad \mathbf{B} = B_y} \quad (6.8^*)$$

The curl, applied to the electric field pointer, itself points in the y-direction:
rot E = - dE/dx . This for the transverse wave carried out curl operation is now compared with Faraday's law of induction (5.4):

$$\text{rot } E = -dE/dx = -dB/dt \qquad (6.9)$$

The relation won in a mathematical way, with the speed fixed by (6.8), reads:

$$dE = (dx/dt) \bullet dB = v * dB \qquad (6.9^*)$$

The result of this derivation at first only is valid for the introduced simplification, for instance for the case of the transverse electromagnetic wave. Better known is apart from that the generalized formulation, which among others by G. Bosse<i> is called law of transformation.

$$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}} \qquad (6.10)$$

With Ampere's law (5.1) we now should proceed in an analogous manner. The result is:

$$\boxed{\mathbf{H} = -\mathbf{v} \times \mathbf{D}} \quad (6.10^*)$$

This equation 6.10* is given among others by Simonyi<ii>. Now that we know, under which circumstances these equations of transformation can be derived from the Maxwell equations, the actual work can start.

<ii>: K. Simonyi, Theoretische Elektrotechnik, 7. Auflage VEB Verlag Berlin 1979. pp. 921 - 924; In addition see chapter 27.8 in part 3 of this book.

Laws of transformation:

$$\mathbf{E} = \mathbf{v} \times \mathbf{B} = \mathbf{v} \times \mu \cdot \mathbf{H} \qquad (6.10)$$

$$\mathbf{H} = -\mathbf{v} \times \mathbf{D} = -\mathbf{v} \times \varepsilon \cdot \mathbf{E} \qquad (6.10^*)$$

and

We experience the magnetic field as an electric field and the electric field as a magnetic field simply and solely for reason of the same relative motion!

The component of the direction of motion perpendicular to the area defined by the field pointers:

$$E = v \cdot \mu \cdot H \qquad (6.11)$$

and

$$H = -v \cdot \varepsilon \cdot E \qquad (6.11^*)$$

with the relations of material:

$$B = \mu \cdot H \qquad (3.5)$$

$$D = \varepsilon \cdot E \qquad (3.6)$$

with the speed of light:

$$c = 1/\sqrt{\mu \cdot \varepsilon} \qquad (5.6)$$

additional field:

$$E_z = -v^2 \cdot \mu \cdot \varepsilon \cdot E = -(v^2/c^2) \cdot E \qquad (6.12)$$

resp.

$$H_z = -v^2 \cdot \varepsilon \cdot \mu \cdot H = -(v^2/c^2) \cdot H \qquad (6.12^*)$$

basic field: E resp. H (at v = O)

measurable overall field: (if $v \neq O$)

$$E_o = E + E_z \qquad (6.13)$$

resp.

$$Ho = H + H_z \qquad (6.13^*)$$

Fig. 6.5: Properties of transformation of the electromagnetic field.

6.5 Equations of transformation

As a consequence of the in fig. 6.5 again written down laws of transformation of the electromagnetic field (6.10 and 6.10*) magnetic phenomena can be traced back to electric phenomena and vice versa. The mathematical formulation reveals us the two sides of the same medal and points to a perfect duality between both fields and their factors of description.

Because a way exists, as is shown here, in which the equations of transformation can be derived from the Maxwell field equations, the same generally valid and extensive importance should be attributed to them. They can with the same right be called the foundation of electromagnetism. Wherein does lie its message for physics, the always curious researcher will ask? For that the relations of material 3.5 and 3.6 are completed:

$\mathbf{E} = \mathbf{v} \times \mu \cdot \mathbf{H}$ (6.10) und $\mathbf{H} = -\mathbf{v} \times \varepsilon \cdot \mathbf{E}$. (6.10*)

The here presented equations state, that we measure an electric field strength E, if we are moving with regard to a magnetic field H with the speed v and vice versa. The electric and the magnetic field therefore prove to be an experience of the observing person and we can say:

We experience the magnetic field as electric field and the electric field as magnetic field simply and solely for reason of the relative motion!

Let's assume, v is the component of the relative velocity (6.8), which stands perpendicular to the area defined by the field pointers (6.8*), then the equations of transformation (6.9* with 3.5) now read:

$E = v \cdot \mu \cdot H$ (6.11) and $H = -v \cdot \varepsilon \cdot E$. (6.11*)

If we are moving with the velocity v in a basic field which is present with the field strength E, then according to equation 6.11* we observe a magnetic field, which again according to equation 6.11 is to be interpreted as an additional electric field E_z:

$E_z = -v^2 \cdot \mu \cdot \varepsilon \cdot E = -(v^2/c^2) \cdot E$ (6.12)

In duality equation 6.11 inserted into equation 6.11* provides for the magnetic field strength a corresponding additional field H_z:

$H_z = -v^2 \cdot \mu \cdot \varepsilon \cdot H = -(v^2/c^2) \cdot H$ (6.12*)

W e obviously owe the measurable overlap fields in a laboratory simply and solely to the relative velocity v with which the laboratory is moving. But now we must pay attention to the fact that a terrestrial laboratory rotates along with the earth, that the earth orbits the sun and the sun again rotates around the centre of the milky way. Eventually the whole milky way is on the way in the cosmos with a galactic, for us hardly understandable speed. If we further take into consideration that for every subsystem an additional field occurs as a consequence of the relative motion with regard to the super ordinate system, then one additonal field follows after the next and overlaps this one.

Let's imagine, the relative velocity could be reduced towards zero - and maybe we are moving around such a cosmic point - then here no overlapping field would be measurable.

<*>: A derivation using vectors is written in chapter 28 (part 3).

Additional field (from fig. 6.5):

(6.12)
(6.12*)

$$E_z = -(v^2/c^2) \cdot E \quad \text{and}$$
$$H_z = -(v^2/c^2) \cdot H$$

Superposition of the fields:
The additional field (E_z resp. H_z) overlaps the basic field (E resp. H) to produce the measurable overall field (E_0 resp. H_0):

(6.13)

$$E_0 = E + E_z = E \cdot (1 - v^2/c^2) \qquad (6.13^*)$$
$$H_0 = H + H_z = H \cdot (1 - v^2/c^2)$$

transformed:

$$(1 - \frac{v^2}{c^2}) = \frac{E_0}{E} = \frac{H_0}{H}$$

(6.14)

for the Lorentz contraction holds apart from that:

(6.14*)

$$(1 - \frac{v^2}{c^2}) = (\frac{l}{l_0})^2$$

From the comparison
Follows

(6.14**)

$$\frac{E_0}{E} = \frac{H_0}{H} = (\frac{l}{l_0})^2$$

the proportionality:

$$E, H \sim 1/l^2 \quad \text{and} \quad E_0, H_0 \sim 1/l_0^2 \qquad (6.15)$$

Fig. 6.6: The field dependency of the Lorentz contraction

6.6 Field overlap

Field vectors can be superpositioned. In this manner the additional field E_z resp. H_z which depends on the velocity, according to equation 6.10, overlaps the respective basic field (E resp. H) to produce the measurable overall field (E_0 resp. H_o):

$$E_0 = E + E_z = E \cdot (1 - v^2/c^2) \quad (6.13)$$

$$H_0 = H + H_z = H \cdot (1 - v^2/c^2) \quad (6.13^*)$$

In the result something surprising the factor $(l\text{-}v^2/c^2)$ appears, which is well-known from the special theory of relativity and for instance appears in the Lorentz contraction.
If we rewrite both equations for the characteristic factor and compare with the in a purely mathematical way, over the Lorentz transformation, won length contraction $(1 - v^2/c^2) = (l/l_0)^2$, then it becomes clear that the Lorentz contraction physically seen should have its cause in the changed field conditions which a with relativistic speed moving body finds with regard to a resting body.

$$1 - \frac{v^2}{c^2} = \frac{E_0}{E} = \frac{H_0}{H} \overset{!}{=} \left(\frac{l}{l_0}\right)^2 \quad (6.14)$$

The equation is a compulsionless consequence of known physical laws. In this derivation actually no new factor was introduced and nevertheless a completely new picture for the natural scientific reality results<i>.

In our observer system, where the field E_o exists, a rule has its proper length l_0. In another system, which is moving with the speed v relative to the observer, as a consequence of the here prevailing field E the corresponding rule has a length 1. In which relation the factors stand to each other, is described by equation 6.14. Accordingly the following proportionality holds:

$$E, H \sim 1/l^2 \quad \text{and} \quad E_0, H_0 \sim 1/l_0^2 \quad (6.15)$$

If we are exterior to a very fast moving body with velocity v, we immediately can observe how this body for reason of its relative velocity experiences the calculated additional field and in this way experiences a length contraction. If the observer is moving along with the body, then he purely subjective seen doesn't detect a length contraction, because he himself and his entire measuring technique is subjected to the same length contraction. From the axiomatic approach what would be, if the field, which itself only represents an experience, would determine perceptible space and its dimensions, quickly a fundamental realization can develop if the described experiences should coincide with real observations.

<i> : Because in this point of view the subjective status of the observer is determining, it is not completely impossible that there is an error in the interpretation of the equations of transformation (6.10 and 6.10*). But because we started from the same point of view of the observer for the derivation of the length contraction from the Lorentz transformation, here the same error is to be expected. In putting both results equal (6.14), a like constituted error on both sides will cancel out in any case and the result stays above all doubts!

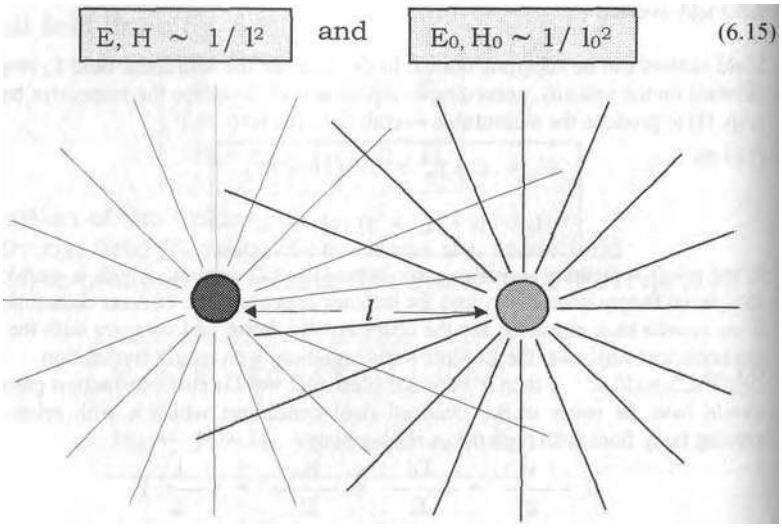

(Model):

Two particles of matter each in the field of the other particle.

Two elementary particles or two accumulations of matter consisting of these are able to reduce the distance to each other for reason of their fields, which we interpret as a force of attraction.

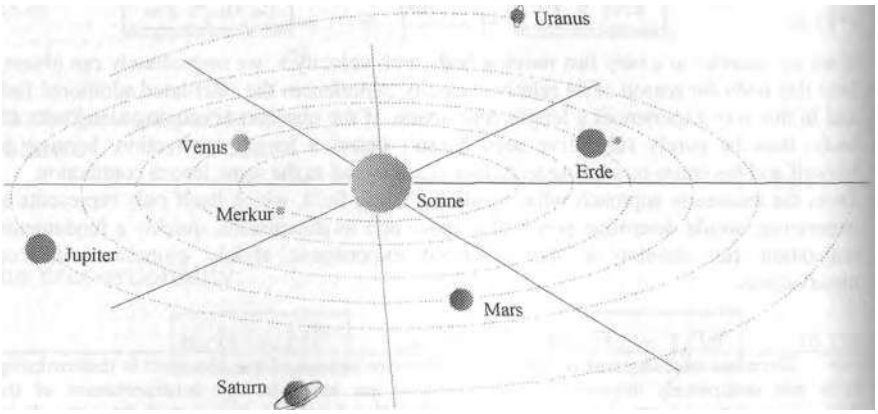

B: (Example): The orbits of the planets in the field of the sun.

Fig. 6.7: The influence of the field on interactions.

6.7 Field dependent curvature of space

Let's assume, an accumulation of matter, as big as our earth, wanted to fly past the sun in the distance earth-sun. But it would not succeed. Because the fields arising from the sun decreases with increasing distance and according to equation 6.15 as a consequence the size of the particles of matter increases. The planet hence is more strongly contracted on its side turned towards the sun, as on the turned away "night side". It bends towards the sun and its flight path becomes a circular path around the sun. That is the interaction known as gravitation!

To an earth inhabitant this curvature reveals itself merely in the observation that the duration of sunshine at daytime is longer, than it would be expected to be under the assumption of the earth as a homogeneous sphere. In this context one willingly speaks of a curvature of space. Actually it is a curvature of matter under the influence of the field dependent length contraction.
Exactly this contraction the planets owe their circular orbits around the sun and by no means the equilibrium of forces between the force of attraction and the centrifugal force (fig. 6.7 B). It obviously is a fundamental mistake to think that gravitation would causally be connected with a force effect!
If, in this context, we speak of a force of attraction for the sake of our subjective observation, then we must realize that it merely can concern an auxiliary term founded in usefulness.

A thought experiment should bring us clarity (fig. 6.7 A). The field, which surrounds every particle of matter, reaches till infinity but becomes less effective with increasing distance. If the distance between two particles is 1, then one particle is in the field of the other particle. As a consequence of the field the length 1 reduces and in this way the size determining field increases, which again leads to a further reduction of length etc. As a consequence it can be observed that both particles are moving towards each other. We speak of a force of attraction, because we can't register the influence of the field with our senses.
In this way the consistent result that we and our environment at daytime must be smaller than in the night will as well remain hidden. We experience the effect only indirectly as gravitational pull of the earth.

Because we don't see the cause of a subjectively observed force effect, for the electromagnetic interaction, just as for the gravitation, the field dependency of the length contraction will be responsible. Hence the following conclusion holds for both interactions equally way.

Two elementary particles or two accumulations of matter consisting of these are able to reduce the distance to each other for reason of their fields, which we interpret as a force of attraction.

Now the question still is open, why gravitation only knows forces of attraction, whereas the electromagnetic interaction also permits forces of repulsion and which are the causal fields for each.

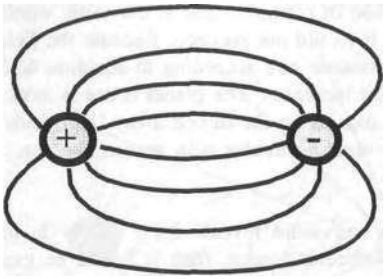

A: The field lines of the E-field for unlike charged particles

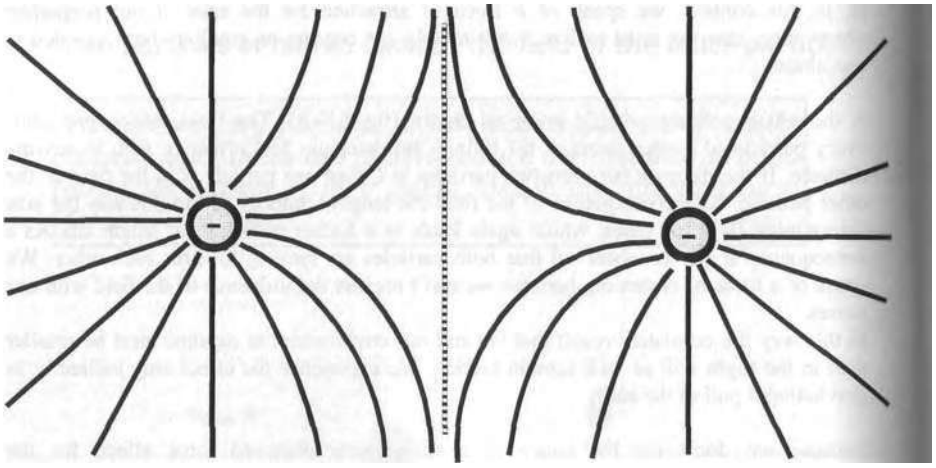

B: The field lines of the E-field for equal charged particles

The electromagnetic interaction of a particle is a result of the influence of the open field lines arising from it on the dimensions of space.

Fig. 6.8: The influence of the open field lines of the E-field

6.8 Electromagnetic interaction

A convincing answer to the open question provides us the analysis of the course of the field lines, on the one hand for charged particles and on the other hand for uncharged particles, which do not participate in the electromagnetic interaction.
If at first we consider electrically charged particles, like e.g. electrons, protons or ions.
Then all in common is that the towards infinity running field lines of the electric field are open. With this field the particle is able to interact with its environment. We measure a charge and an electromagnetic force effect. In the case of unequal charges, as is well-known, a field amplification and attractive acting forces are observed whereas for equal charges a field reduction results and repulsion is observed.

If we make a connection between the field conditions and the electromagnetic interaction in the sense of the proportionality (6.15), then the particle in reality is able to influence the distance to other particles merely with the help of its electric field. For unequal charges a compression of field lines arises, in which one particle stays in the focussed field of the other and vice versa. In this way a contraction of all lengths occurs and the observable attraction happens (fig. 6.8 A).
For equal charges the opposite case is present, in which even a local field freedom can occur (fig. 6.8 B). If the field tends towards zero on the dashed line, then the distance will go to infinity (according to eq. 6.15). Consequently, the observable effect that both bodies go away from each other, will reach to infinity.

Actually the electromagnetic interaction proves to be a result of the field dependent length contraction.

The electromagnetic interaction of a particle is a result of the influence of the open field lines arising from it on the dimensions of the space, in which it is.

It is important that the field lines are open, for which reason they are bent away from like charges and are directed towards unlike charges. Subjectively seen we find out that as a consequence of the field reduction repulsive force effects and as a consequence of the field compression attractive acting force effects are observed (fig. 6.8).
The consequence of is every electric field is, as is well-known, a magnetic field standing perpendicular on it. The field lines of the magnetic field run parallel to the surface of the particle and have a closed course (fig. 6.9 A)!
Therefore no magnetic poles form, which would be measurable. Seen from the outside the particle behaves neutral magnetically seen, because of the closed course of the field lines.
An artificial field reduction and as a consequence observable forces of repulsion, like in the case of the electromagnetic interaction, hence in principle are impossible.

The effect of the magnetic field thus is limited to a geometrical manipulation of the environment, namely the curvature of space, with which we have founded the phenomenon of the attraction of masses and of the gravitation.

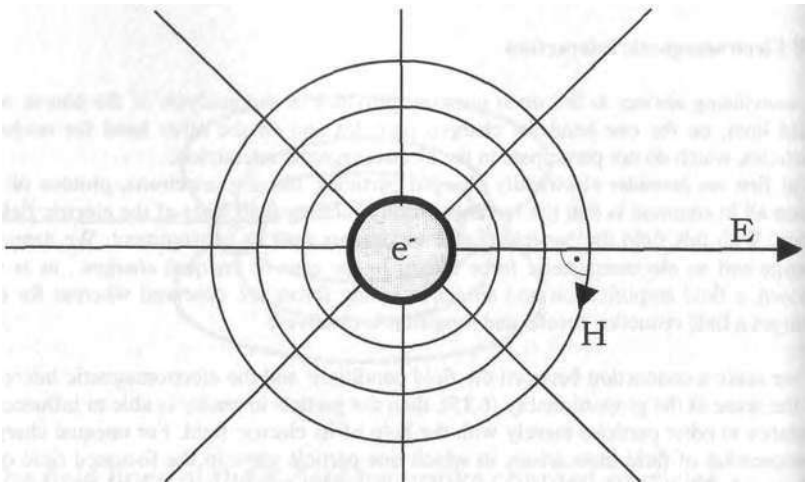

A: The open field lines of the E-field and the closed field lines of the H-field of an electrically charged particle (e.g. e-)

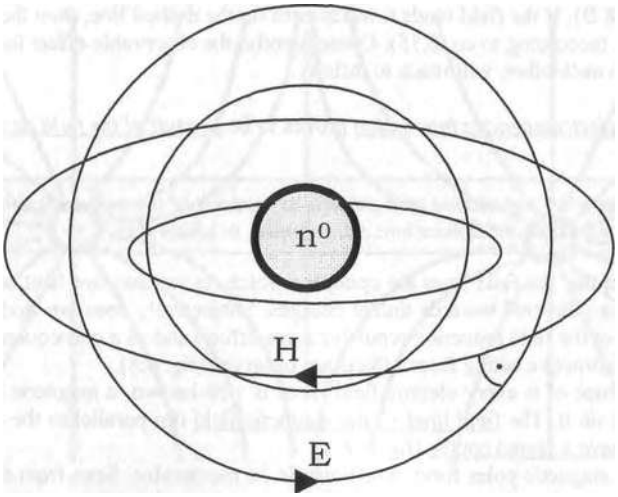

B: The closed field lines of the E-field and H-field of an electrically uncharged particle (e.g. of the neutron n°).

Gravitation is a result of the influence of the field lines with a closed course running parallel to the surface of the particles on the dimensions of the space, in which they are.

Fig. 6.9: The influence of the closed field lines of the H-field.

6.9 Gravitation

For uncharged, neutral particles (neutron, atom, molecule etc.) both the magnetic and the perpendicular on them standing electric field lines have a closed course. Now both run parallel to the surface of the particle (fig. 6.9 B).
As is said, the density of field lines with a closed course can't be influenced from the outside. If we approach a particle, the consequence of an increase of the density without exception is a decrease of the linear measures and thus a larger force of attraction. For this case of field lines with a closed course, for which in general it doesn't give a field attenuation and no forces of repulsion, there holds:

Gravitation is a result of the influence of the field lines with a closed course running parallel to the surface of the particles on the dimensions of the space, in which they are.

Both interactions logically have an infinite range. Both form a whole in the influence of the fields on the size conditions.
It surely is of the greatest importance that for this derivation of the field dependency of the Lorentz contraction from the known equations of transformation of the electromagnetic field we could do completely without the introduction of new factors of description or neglects.
Solely by consistent derivation and interpretation of the result the unification already has suceeded and the electromagnetic interaction and the gravitation could, with the derived field dependent Lorentz contraction, be traced back to a single basic phenomenon. Doing so we have to pay attention to the fact that the observer is subjected to the same Lorentz contraction as his measuring technique and therefore he can't see the field dependency at all. Merely as being an exterior observer it in rare cases will be possible to him to see the curvature of space in the presence of strong fields.

From this for an astronaut practical consequences result. If he namely would land on Jupiter, he would think flat hills to be gigantic mountains, that small he would be! Vice versa if he landed on the moon, high mountains would appear to be insignificant hills, not because of wrong altitude readings of the terrestrial mission control and measurement centre, but only because of his own body size. The astronauts of the Apollo missions were not prepared for this circumstance and after their landing on the moon were completely surprised, how little validity learned textbook physics has, hardly has one left the earth. They have brought photographs with them which prove the Lorentz contraction to depend on the field and therefore on gravitation.

The fact that force effects should arise from the interactions is an auxiliary concept and auxiliary description of the observing person founded in pure usefulness. The Lorentz force therefore shouldn't be regarded as cause anymore. It actually appears only as property of the field factors. Seen this way it only would be consistent to do without space charges and currents as a result of moving charges and to assume a source-free and quanta-free field description (fig. 6.4: $j = 0$).
From an unified theory it is demanded that it besides the electromagnetic interaction and the gravitation also is able to integrate the strong and the weak interaction. We will also solve this problem.

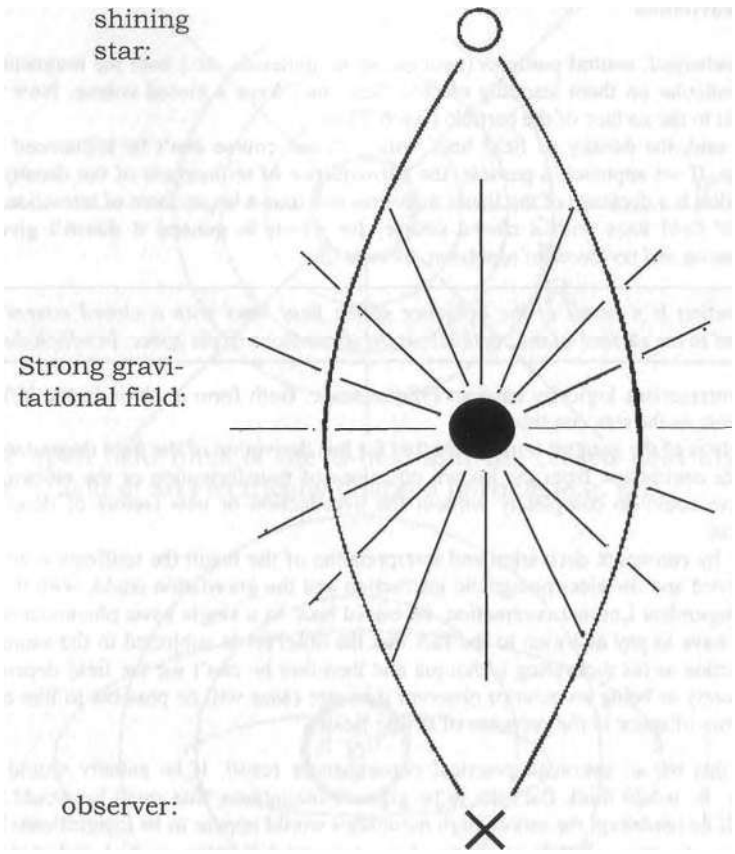

Fig. 6.10: Diversion of the light by a strong gravitational field.

Speed of light of the wave: $c = \lambda * f$ (6.16)

For the wavelength λ holds (because of eq. 6.15): $E, H \sim 1/\lambda^2$

From equation (6.16) follows (with f = constant):

$$E \sim 1/c^2 \quad , \quad H \sim 1/c^2 \qquad (6.17)$$

The speed of light depends on the field!

6.10 Field dependent speed of light

But not only matter is bent towards a gravitational field. If we only think of the much cited phenomenon that the ray of light of a star is diverted towards the sun, if it passes very close to the sun on its way to us, like this has been observed for the first time during an eclipse of the sun in 1919 (fig. 6.10).
Quite obviously the field of the sun also slows down the speed of light. On the side of the ray of light which is turned towards the sun, the field is somewhat larger and the speed of light correspondingly is slower than on the side which is turned away, and with that the ray of light changes its direction in the observable manner. Exactly this relation willingly is interpreted as a consequence of a curvature of space.
The extremely strong field of a black hole can divert the light down to a circular path, in order to in this way catch and bind it. The light now orbits the black hole like planets the sun.

At this point the open-minded reader already might have tapped the confirmation of the proportionality 6.2 ($c \sim r$), which has been derived from the vortex model (fig. 6.2).
The sceptic is offered still another derivation: for the borderline case that the relative velocity v tends towards the speed of light c (fig. 6.6), according to equation 6.13 the measurable overall field E_o (and also H_o) will go to zero and equation 6.12, with $E_z = - E$ (and $H_z = - H$), will again turn into the wave equation (5.9*) after double differentiation (fig. 6.4).
The speed $v = c$ so to speak forms the escape velocity, with which the electromagnetic wave runs away from the cosmic field. Under these circumstances of course neither an attraction of masses nor an electromagnetic interaction can be exerted on the wave.
If E_0 goes to zero at the same time l_0 tends to infinity (equation 6.15, fig. 6.6): i.e. the wave spreads all through space. This result entirely corresponds to the observations and experiences.

For the wave length λ and in the end for the velocity of propagation c only the self-field of the wave E resp. H is responsible. Because of

$$c = \lambda \cdot f \quad (6.16)$$

and the proportionality from equation 6.15: $E, H \sim 1/\lambda^2$ (6.17*)

obtain the new relation: $$E, H \sim 1/c^2 \quad (6.17)$$

If the speed of light in the presence of matter decreases, then we now also know why. It is the field, which surrounds matter, that slows down the speed of light. Therefore a gravitational field is able to divert a ray of light in the same manner as matter which flies past. Finally moves the speed of light in the proportionality 6.17 to the place of the linear measure (in 6.15).
But if the rule fails one will try to replace by an optical measurement arrangement. In this manner the field dependency of the Lorentz contraction should be measurable; but it isn't!

From the comparison of the derived proportionalities:

$$E, H \overset{(6.15):}{\sim} \frac{1}{l^2} \overset{(6.17)}{\sim} \frac{1}{c^2}$$

follows:

$$\underline{1 \sim c} \qquad (6.18)$$

The speed of light is proportional to the measurement path. The variable speed of light is being measured with itself. The result at all events is a constant value.

The constancy of the speed of light is based on a measurement which is faulty from the principle!

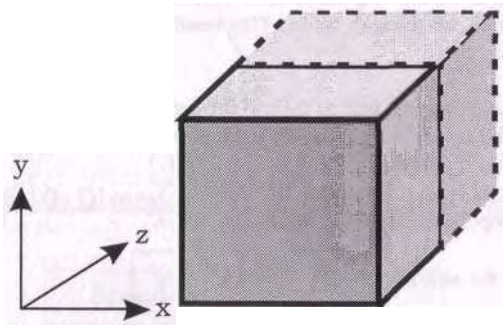

Because of c ~ r: physical length contraction

Fig. 6.11: Derivation of the length contraction (field dependent Lorentz contraction)

6.11 Universality

Why can't the rule be replaced by an optical measurement arrangement? The crucial indication provides the comparison of both derived proportionalities 6.15 and 6.17. According to them holds the same field dependency for both the Lorentz contraction and the speed of light:

$1/l^2 \sim 1/c^2$ or $\underline{\overline{1 \sim c}}$ (6.18)

If the rule has proved to be useless, then we will experience the same disaster if we measure optically, i.e. with the speed of light.
Obviously both, the length 1 and the speed of light c as a length per unit of time, depend in the same manner on the respective local field strength. On the one hand do both measuring methods lead to the same result; but on the other hand will anything which can't be measured with one method, neither be measured with the other method.
If now the speed of light is being measured optically, then the measurement path will be proportional to the speed of light and as a result will the unknown factor be measured with itself. The result of this measurement, which is faulty from the principle, at all events is a constant value, because here two variables which stand in direct proportionality to each other are related to each other.
Was the famous experiment of Michelson and Morley unnecessary, the result trivial? And how does it stand about the postulate of the universality of the speed of light?
If we for that consider a cube (fig. 6.11). And we assume that the speed of light is a vectorial quantity, which in our experiment is for instance in one direction twice as large, as in the direction of the other two space axes. By means of the mentioned influence of the speed of light on the spatial length is, as a consistent consequence, the cube along this edge pulled apart to a cuboid. We however register this spatial body with our eyes, which is with the speed of light and that has increased proportionally to the length of the edges, for which reason we as subjective observer still see a cube in front of us and not a cuboid.
If we trust an apparent objective measurement more than our sense organ and measure the three lengths of the edges of the cuboid again with a rule then we get three times the same length, which is a cube.
We probably are dealing with an optical deception using the true meaning of the word.

If the by Einstein postulated universality and constancy of the speed of light in reality doesn't exist at all, we in no way would be capable to register this; neither to observe nor to measure it!
The Galilean theorem of the addition of speeds objectively seen still is valid, even if the fact that the speed of light apparently is independent of the speed of the source pretends us the opposite.
If for instance a light source is moved towards a receiving device or away from it, then the speeds will overlap, like for the passenger, who marches in a driving train against or in the driving direction through the corridor. For the ray of light also the fields, which influence the speed of light and the measurement equipment, overlap. As a consequence will a measuring technician, who himself is exposed to this overlapping field, always observe and "measure" the identical speed of light. The observer as a result imagines, there is an universality of the speed of light.

The field takes over the function of the aether.

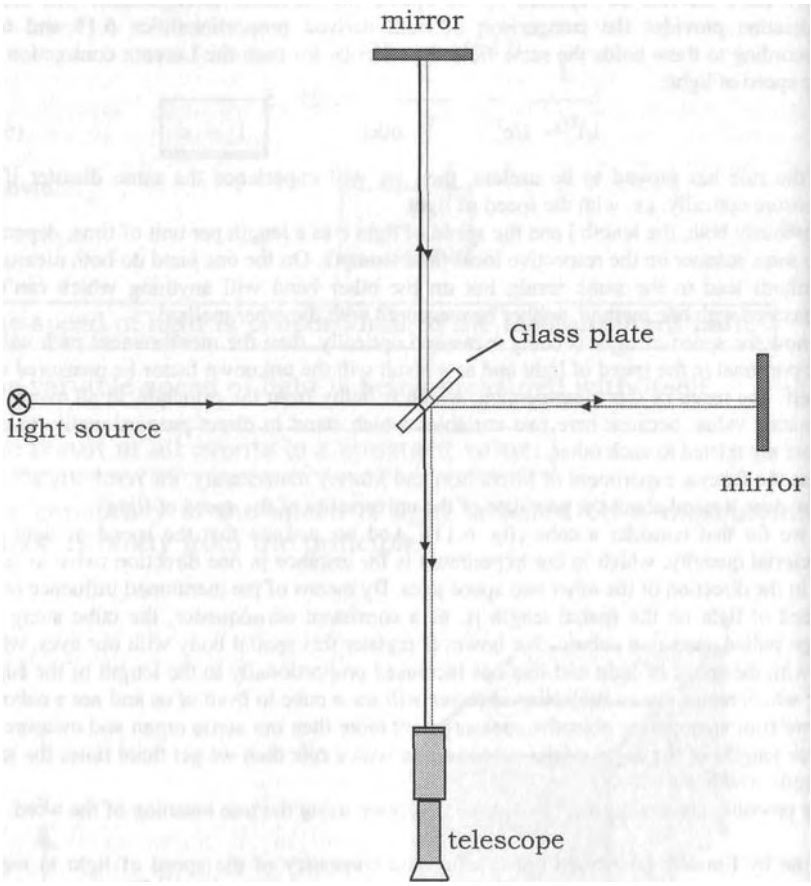

Fig. 6.12: Experiment of Michelson and Morley to detect an aetherwind[<i>]

<i>: A.P.French: Special Relativity, Massachusetts Institute of Technology, 1966.

<ii>: Nikola Tesla: "This is the same as writing a business letter and forgetting the subject you wish to write about". To Einstein's Theories, Rare Book and Manuscript Library, Columbia University, 15.4.1932.

<iii>: Einstein proceeds in the same manner with the time dilatation, by assuming a time constant by definition for the derivation to present at the end of his derivation a variable time. And with that he presents a result which contradicts his approach completely.

6.12 Aether

Important experiments like the one of Doppler concerning the redshift or the one of Bradley concerning the aberration of the stars show only to clear, where the influence of the speed of light subjectively still is perceptible, or for laboratory experiments like the one of Michelson and Morley, where the influence isn't perceptible anymore, because the length of the interferometers always changes proportionally to the speed of light. The look in the stars at the same time is a look in cosmic areas, where completely other field conditions prevail and as a consequence completely other values for the speed of light and for the dimensions of space are present. The mentioned observations suggest that we together with our measuring station are moving through the cosmos and therefore a relative velocity has to be present with regard to an aether which determines the respective speed of light.

If we however constrict our range of vision and retire in a laboratory, then we no longer are capable to observe the influence of the field on the speed of light. The experiments of Michelson which Maxwell had prompted to and which Morley with a higher precision had repeated with the goal, to detect the aether, inevitably had to turn out negatively. The laboratory experiments resulted in the misleading picture, as if the earth was resting in the aether.

The not understood measurements will suggest any observer, he forms the centre of the universe and everything rotates around him, entirely in the sense of the Ptolemean view of life, which, although long ago abolished, here belated has experienced support. With a Swabia caper Albert Einstein has prevented a relapse into the dark Middle Ages and removed the open contradiction in the question of the aether, which once is measured as moving and another time as resting, by without further ado abolishing the aether. With that he undoubtedly has solved a central problem of physics and at the same time created a new one. As is known does the speed of light have a certain value, and therefore the question is raised, what determines is size. Exactly for this purpose a luminiferous aether had been introduced, however it is constituted.

Scientifically it does make little sense, to make an assumption, if at the end of the derivation the prerequisite is deleted without substitute. In such a case either in the approach or in the derivation is a principal error*[1]"*. Nikola Tesla comments on the working method of Einstein with the applicable comparison, as if Einstein had, while he was writing a business letter, forgotten completely the subject he wanted to write about (fig. 6.12[ii]).

The answer, which removes all contradictions and is entirely in accord with all observations and measurements, is obvious. Naturally a luminiferous aether exists, which determines the velocity of propagation and of course it by no means is bound to the observer.

As has been derived in figures 6.5 and 6.6, will for a relative velocity v arise a field, which according to proportionality 6.17 determines the speed of light. With that we have derived completely.

The field takes over the function of the aether.

The equations 6.10 also answer the question, why no aetherwind is being observed, although such a wind actually is present: we experience, as we have discovered, an E-field with ,,head wind" as a resting H-field and vice versa and therefore we aren't capable to detect the head wind in the aether!

Key questions of quantum physics (fig. 4.4 + continuation):

IV. Why do the particles have the form of spheres?
(with increasing E-field decreases c)

VIII. Why is the elementary quantum localized?
(in the vortex centre: c = 0, see figures 4.3 and 6.2)

IX. Why do the elementary particles have a spin?
(spherical form demands field compensation)

X. Why is the magnitude of the spin quantized?
(cosmic basic field determines the need of E_z)

XI. Why can speeds faster than light occur in a tunnel?
(a reduction of the cosmic basic field can only be realized locally in a tunnel)

to XI:

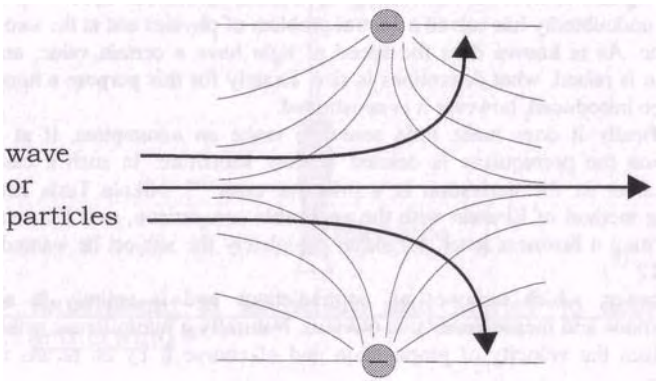

Fig. 6.13: Consequences concerning the field dependency of the speed of light: spin effect and tunnel effect <i,ii>

<i>: Nimtz,G.: Instantanes Tunneln, Tunnelexperimente mit elektromagnetischen Wellen, Phys.B1.49, VCH Weinheim (1993) Nr.12, S. 1119-1120<*>
<ii>: Thoma, P., Weiland.T.: Wie real ist das Instantane Tunneln? Phys.Bl.50, VCH Weinheim (1994) Nr.4, S. 359-361<*>
<*>: The measurement results are in accord with the theory of objectivity, not however the contradictory attempts to interpret them <i> and <ii> et al.

6.13 Spin and tunnel effect

Only with the field dependency of the speed of light (6.17) we can understand, why the elementary quanta can form as spheres, like is drawn in the figs 4.3 and 6.2. In the centre the field lines run together, i.e. the field increases and the speed of light decreases. Only in this way it will be possible for the vortex oscillation to everywhere occur with the speed of light, even in the inside of the particle! In the centre of the vortex particle the field in theory will become infinitely large and the speed of light zero. This circumstance again is the foundation why the elementary particles are localized and it answers key question VIII of quantum physics. The absence of a speed after all is the characteristic of an immobile thing.

The field dependency of the speed of light answers also further basic and up to today unanswered key questions of quantum physics, like why the elementary particles have a spin (IX) and why the magnitude of the spin is quantized (X).

A vortex particle after all does not exist alone in the world, but it is in the field of other particles. We can call this the cosmic basic field (E resp. H). This basic field overlaps the self-field and takes effect the strongest in the area of the spherical shell, where the self-field is correspondingly small. In order to keep the form of a sphere, this influence of the basic field has to be compensated. The additional field (E_z resp. H_z according to eq. 6.12) necessary for the compensation is produced by the particle, by rotating in a spiral around itself with a speed v which increases towards the outside of the spherical shell. Therefore does the elementary particles have a spin. The electron spin is therefore determined by the cosmic basic field.

Another effect of the field dependent speed of light is the tunnel effect. As an example we consider the two differently charged particles shown in fig. 6.8 A. The open, outside of the particles running, field lines of the electric field are predominantly bent towards the each time oppositely charged particle. If another particle wants to pass between the two, then it gets into an area of increased field strength. As a consequence it will be slowed down, because here a smaller speed of light is present.

Water molecules show with their polar nature exactly this property. Water has a remarkably high dielectricity e and slows down the speed of light correspondingly according to equation 5.6 ($\varepsilon \cdot \mu = 1/c^2$). The refraction of light at the water surface is an observable result of the reduced speed of light in the presence of matter.

If we now examine the case in which the two particles have the same charge as is shown in fig. 6.8 B (and fig. 6.13 belonging to XI). The field lines repel each other, so that exactly in between the two particles a field free area forms, in which the speed of light goes to infinity! This area acts like a tunnel. If we send through a particle exactly here, then purely theoretically seen it won't need any time to run through the tunnel, and for a short time the signal becomes infinitely fast.

If a particle hits only slightly besides the tunnel, then it will one-sidedly be slowed down and diverted by the respective field. We call this process reflection or scattering. Only the few particles, which exactly hit the tunnel, arrive behind the hurdle and in the ideal case even almost without loss of time!

The current measurements of speeds faster than light demonstrate in a convincing manner the superiority of the field-theoretical approach with regard to the nowadays normally used quantum physical approach.

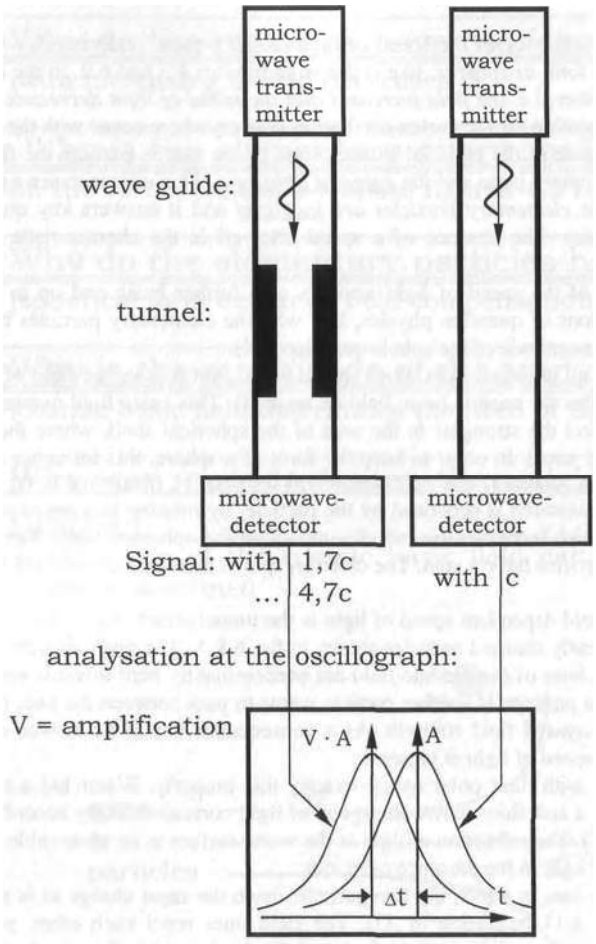

Fig. 6.14: The microwave experiment at the II. Physical Institute of the University of Cologne to measure speeds faster than light.[i]

<i>: Nimtz, G. : New Knowledge of Tunneling from Photonic Experiments, Proc. of the Adriatico Research Conference, 1996, World Scientific Publishing Company

6.14 Interpretation of the measured speed faster than light

Now the attempt can be undertaken, to interpret the spectacular experiments, in which a speed faster than light has been measured. It is reported[i] that in experiments with photons at the University of California in Berkeley on an average a speed of 1.7 times the speed of light has been measured by Prof. Raymond Chiao and his co-workers. At the Technical University of Vienna Prof. Dr. Ferenc Krausz already has obtained 2.4 times the, according to Einstein at maximum obtainable, speed of light with tunnelling laser light.

The first measurements of speeds faster than light have been carried out with microwaves at the University of Cologne[ii] by Prof. Dr. Gunter Nimtz and co-workers. They at first had published the measurement of a speed 2.5 times the speed of light. In the meantime they even have transmitted a symphony of Mozart with a speed almost 10 times the speed of light and with that have contradicted Einstein's hypothesis, according to which the speed of light in vacuum would be the highest possible speed for the transmission of signals. The different experiments only resemble each other in the point that the particles have to tunnel, because one has put a barrier in their way. This "tunnelling" apparently is the cause for obtaining speeds faster than light. With the prevailing physical view of life these measurement results are incompatible.

In the measurement set up in Cologne the microwaves are sent through a wave guide, which they pass with the speed of light. If a parts with narrowed cross-section is inserted, where the microwaves actually don't fit through at all, then the signal gets damped strongly. Now however arrives nevertheless a small part of the signal at the other end of the wire, but much faster than allowed, namely with the measurable speed faster than light.

The answer of the here presented potential vortex theory reads as follows: the waves picked up by the wave guide run up to the entry of the tunnel, in order to find out that they don't fit through. They are reflected or absorbed. A small part however rolls up to potential vortices and these fit through the tunnel. They however have to be compressed additionally. In the derivation of the photon (fig. 4.5 and 4.6) we had seen that the inner vortex always is faster than the bigger one, through which it slips through. The compression therefore causes an increase in speed. In flow dynamics is known an analogy: the Venturi-tube. The flow-technical potential vortices also confirm exactly this property. One can as well start with the Lorentz contraction (fig. 6.6, eq. 6.14*). This states that a particle moving with a higher speed actually becomes smaller and not only appears to be smaller as an optical deception of the observer. Because only smaller particles fit through the tunnel, the particles, measurable at the other end, must be correspondingly faster: quod erat demonstrandum. In the same manner also the experiments of Berkeley can be explained physically, because here is worked with photons from the start[i]. With that the process of rolling up the wave can be left out. The tunnel lets pass only compressed and therefore faster light particles.

<i>: R.Y.Chiao, P.G.Kwiat, A.M.Steinberg: Schneller als Licht? Spektrum der Wiss. 10/93

<ii>: B. Schuh, Gespenstisch fixe Wellen, DIE ZEIT Nr. 45, 5.11.93, S. 43.

<ii>: Enders, A., Nimtz, G.: Photonic-tunneling experiments, Physical Review B, Vol. 47, No. 15 (1993), pp. 96O5-96O9.

<ii>: Enders, A., Nimtz, G.: Evanescent-mode propagation and quantum tunneling, Physical Review E, Vol. 48, No.l (1993), pp. 632-633.

"The theory of relativity is not a physical theory... it is a mathematical poetic idea, a deduction from impossible premises."[<i>]
Oskar Kraus

"The theory of relativity is a mathematical masquerade, behind which is hidden an inextricable ball of a mixing up of ideas, contradictions, fallacies, arbitrary assumptions and ignoring of healthy logic."[<i>]
Erich Ruckhaber

"The theory of relativity not only is fantastic, but also of an inconsistency which in the history of science not yet has been present."[<i>]
Harald Nordenson

"A physics of hybrids, of contradictions and fantastic confusions, nonsense!"[<ii>]
Johann Marinsek

"This is absurd."[<iii>] (regarding mass-energy interpretation) _____
Nikola Tesla

"In my experiments I have destroyed billions of atoms, without having observed any emissions of energy. "[<4i>]
Nikola Tesla

Fig. 6.15: Some statements regarding the theory of relativity.

<i>: Walter Theimer: Die Relativitatstheorie, Seite 7, Francke Verlag, Bern, 1977, ISBN 3-772O-126O-4
<ii>: Johann Marinsek: Rationale Physik, S. 163, dbv-Verlag TU Graz, 1989, ISBN 3-7O41-O176-1
<iii>: Nikola Tesla, To Einstein's Theories, Rare Book and Manuscript Library, Columbia University, 15.4.1932. Entnommen aus J.T.Ratzlaff: Tesla Said, Tesla Book Company, pp. 238, ISBN O-914119-OO-1
<4i>: Nikola Tesla, Franz Ferzak World and Space Publications 1985.

6.15 Definition of the speed of light

If a light signal propagates in space, then as a consequence of the velocity of propagation c, it at a certain point in time t is in a distance r of the light source:

$$r = c * t \qquad (6.19)$$

Should the speed of light become smaller for instance by Δc, then the light signal obviously has covered a distance less by Ar or the time interval has changed by Δt:

$$r + \Delta r = (c + \Delta c) \cdot (t + \Delta t) \qquad (6.20)$$

This equation describes purely mathematically the most general case which can be assumed. By writing out the multiplication and subtraction of equation 6.18 the change in distance considered for itself is:

$$\Delta r = c \cdot \Delta t + t \cdot \Delta c + \Delta c \cdot \Delta t \qquad (6.21)$$

The answer of mathematics is that the change in distance can have its cause in a change in time, in a change of speed or in both. We now want to turn to the physical interpretation and have a closer look at the two possibilities, in which either c or t is to be taken constant (see fig. 6.16).

In the first case the speed of light c is constant and as a consequence the change Δc = zero. The mathematical formulation (according to eq. 6.21) therefore reads:

case 1: $$\boxed{c = \frac{\Delta r}{\Delta t}} \qquad \text{(relativity)} \qquad (6.22)$$

If in this conception world a change in distance is observed, for instance the Lorentz contraction, then in order to save this relation inevitably a change in time, for instance a time dilatation, has to make the compensation. Einstein in an applicable manner speaks of relativity, because according to his opinion in the case of both variables, the length contraction and the time dilatation, it only concerns observed changes.

For the time dilatation experiments are given. But for the measurement of time always only atomic clocks are available and their speed of running of course could also be influenced by the Lorentz contraction. In any case it can't be claimed the time dilatation is proven experimentally as long as we do not know the mechanisms of decay of atoms. Otherwise the statements of the theory of relativity are familiar to us, for which reason further remarks seem unnecessary.

In the second case the time t is constant and consequently the change At = zero. At a closer look this case is much more obvious, since why should time change. After all time has been stipulated by definition.

After all, we are the ones who tell, what simultaneity is!

The mathematical formulation for this case reads (eq. 6.21 with Δt= 0):

case 2: $$\boxed{\Delta c = \frac{\Delta r}{t}} \qquad \text{(objectivity)} \qquad (6.23)$$

This equation does open up for us an until now completely unknown and fundamentally other way of looking at the physical reality.

Concerning the definition of the speed of light c [m/s]:

r [m] = distance of the light source:

$$r = c \cdot t \tag{6.19}$$

For changes, observed or measured:

$$r + \Delta r = (c + \Delta c) \cdot (t + \Delta t) \tag{6.20}$$

$$= c \cdot t + c \cdot \Delta t + \Delta c \cdot t + \Delta c \cdot \Delta t$$

Change in distance:

$$\Delta r = c \cdot \Delta t + t \cdot \Delta c + \Delta c \cdot \Delta t \tag{6.21}$$

2 possible causes:

with $\Delta c = 0$ case 1:	with $\Delta t = 0$ case 2:
$c = \frac{\Delta r}{\Delta t}$ (6.22)	$\Delta c = \frac{\Delta r}{t}$ (6.23)
c = constant	t = constant
$\Delta r \sim \Delta t$ (6.23)	$\Delta c \sim \Delta r$ (6.25 = 6.2)
= time dilatation	= universality
Δr = observable length contraction	Δr = physical length contraction
Theory of relativity	Theory of objectivity

Fig. 6.16: Theory of relativity and theory of objectivity, derivation and comparison.

6.16 Relativity and objectivity

New to the second case (equation 6.23) is particularly the proportionality contained in it:

$$\Delta c \sim \Delta r \quad (6.25 = 6.2)$$

But to us it is not new, because we have derived the same proportionality from the model conept (equation 6.2, fig. 6.2), in which the elementary particles are understood as spherical vortices.
Equantion 6.25 unconcealed brings to knowledge that any change of the speed of light c [m/s] in the same way leads to a change of the radius r [m], the distance between two points in space or even the length of an object, e.g. a rule. Such a rule after all consists of nothing but spherical atoms and elementary particles and for their radius r again the proportionality 6.25 holds. Therefore it is to be set:

$$r \sim l \qquad (6.26)$$

and taken both together we already had derived as equation 6.18 (fig. 6.11) from the field dependency. Here the vortex model as well finds a confirmation of its correctness, as in the derivation from the equations of transformation of the electromagnetic field. Because all three, the derivation according to the model, the physical and the mathematical derivation, lead to the same result, this second case should be called "objective".

With that the first case, which describes the subjective perception of an observer, is not supposed to be devaluated. It contains the definition of reality, according to which only is real what also is perceptible. The theory of relativity of Poincare and Einstein is based on this definition.

With the second case, the case with a variable speed of light, we however get serious problems, since we observe with our eyes, and that works with the speed of light. If that changes, we can't see it, as already said. If we could see it, then "reality" would have a completely different face and we surely would have great difficulties, to find our way around. In this "objective world" neither electromagnetic interactions nor gravitation would exist, so no force effects at all. Because all distances and linear measures depend on the speed of light, everything would look like in a distortion mirror.
The concept of an "objective world" at first has not a practical, but rather a theoretical and mathematical sense. The distinction between an observation domain and a model domain is founded in pure usefulness.

The observation domain should correspond to case 1 and the model domain to case 2. The mathematical derivation tells us, how we can mediate between both domains (equation 6.21): This mediation amounts to a transformation, which provides us the instruction, how a transition from the observation into a not perceptible model concept, from the relativity into an objectivity has to.

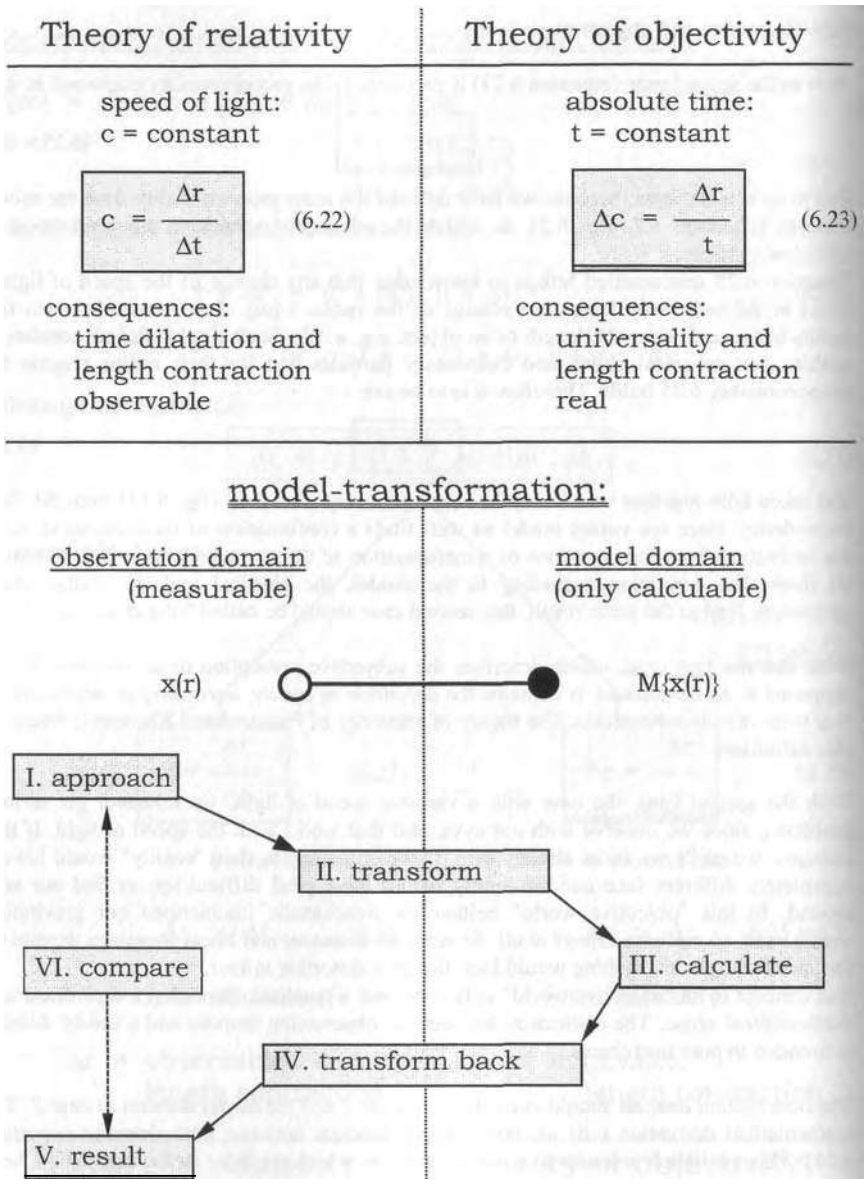

Fig. 6.17: Model-transformation between theory of relativity and theory of objectivity.

6. 17 Transformation

The observation domain is, as the name already expresses, perceptible (observable) with the help of our sense organs and measurable with corresponding apparatus. The special theory of relativity for the most part provides us the mathematics needed for that. And in that is assumed a constant speed of light. Because a length contraction is being observed and can be measured, a time dilatation must arise as a consequence. Such is the consistent statement of this theory. Because we already could make us clear that it concerns a subjective theory, of course caution is advisable if generalizations are being made, like the one of the inductive conclusion of the length contraction on the time dilatation. We'll come to speak about that in this chapter (fig. 6.20).

The model domain however is not observable to us and only accessible in a mathematical manner. Here the time is a constant. On the other hand do the radii of the particles and all other distances and linear measures stand in direct proportionality to the speed of light. If that changes, then does that lead to a change in length. The length contraction occurs physically, which means actually. We propose the name "theory of objectivity" for the valid theory which is derivable with this prerequisite and independent of the point of view of the observer.

The importance of this model domain and of the possible model calculations is founded in the circumstance that many physical relations within our observation domain aren't recognized by us and can't be mathematically derived. Besides is only all to often worked with unallowed generalizations and with pure hypotheses. Such a thing does not even exist in the model domain.

The model domain can be tapped over a transformation. For that we select an approach x(r) in the to us accessible observation domain. This then is transformed into the model domain by a calculation instruction M{x(r)}. Here we can calculate the sought-for relation In the usual manner and transform back again the result according to the same calculation instruction $M^{-1}\{x(r)\}$ but in the reversed direction. After being returned in our familiar observation domain, the result can be compared and checked with measurement results (fig. 6.17).
In this way we will derive, calculate and compare the quantum properties of the elementary particles with the known measurement values. Here we remind you of the fact that all attempts to calculate the quantum properties conventionally, without transformation, until now have failed. Not even a systematization may succeed, if it concerns for instance explanations for the order of magnitude of the mass of a particle.

A transformation at first is nothing more than an in usefulness founded mathematical measure. But if a constant of nature, and as such the quantum properties of elementary particles until now have to be seen, for the first time can be derived and calculated with a transformation then this measure with that also gains its physical authorization. We now stand for the question: how does the instruction of transformation M{x(r)} read, with which we should transform the approach and all equations from the observation domain into the model domain?

general relations:	special theory of relativity	theory of objectivity	
domain of validity:	observation domain	model domain	
speed of light c [m/s]:	$c = c_0$ = constant	$c \sim r$	(6.25)
field strengths (6.15)	(6.15) + (6.18)		
H [A/m] :	$H \sim 1/r^2$	$H \sim 1/r$	(6.27*)
E [V/m] :	$E \sim 1/r^2$	$E \sim 1/r$	(6.27)
because of eq. (5.6) $\varepsilon \cdot \mu = 1/c^2$ is valid:			
μ [Vs/Am] :	μ_0 = const.	$\mu \sim 1/r$	(6.28*)
ε [As/Vm] :	ε_0 = const.	$\varepsilon \sim 1/r$	(6.28)
relations of material: $B = \mu \cdot H$ (3.5): B [Vs/m²]	$B \sim 1/r^2$	$B \sim 1/r^2$	(6.29*)
$D = \varepsilon \cdot E$ (3.6): D [As/m²]	$D \sim 1/r^2$	$D \sim 1/r^2$	(6.29)
e.g. spherical capacitor capacity: C [As/V]	$= \varepsilon 4\pi r$ (6.4)	C = const.	(6.30)
charge: Q [As]	$= C \cdot U$ (6.31)	Q = const.	(6.32)
energy: W [VAs]	$= Q^2/C$ (6.1)	W = const.	(6.33)
with energy-mass relation: (5.24) and (6.1)	$W = mc^2$		
mass	m [kg = VAs³/m²]	$m \sim 1/r^2$	(6.34)
relaxation time	τ_1 [s]:	τ_1 = const.	(6.35)
with	$\tau_1 = \varepsilon/\sigma$ (5.3)		
specific conductivity	σ [A/Vm]:	$\sigma \sim 1/r$	(6.36)

Fig. 6.18: Transformation of the dependencies on radius

6.18 Transformation table

The attempt to write down at this point already a closed mathematical relation as instruction of transformation, would be pure speculation. Such an instruction first must be verified by means of numerous practical cases, i.e. be tested for its efficiency and correctness. But we not even know the practical examples necessary for this purpose, if we apply the transformation for the first time!
For his reason it unfortunately is not yet possible, to calculate absolute values in a direct
We have to be content to work with proportionalities and to carry out comparisons.
In fig. 6.18 the proportionalities are compared in the way, how they would have to be transformed: on the left side, how they appear and can be observed in the view of the special theory of relativity, and on the right side, how they can be represented and calculated in the theory of objectivity.
The change, which here would have to be transformed, is the physical length contraction, which is the change in length as it depends on the speed of light. For spherical symmetry the length l becomes the radius r (eq. 6.26), of which is to be investigated the influence. In the observation domain we had derived the proportionality (6.15 + 6.18):

$E \sim 1/r^2$ and $H \sim 1/r^2$.

The field of a point charge or of a spherical capacitor confirms this relation:

$$E = Q/\varepsilon 4\pi r^2 .$$

Because the speed of light in our observation is constant, also both constants of material which are related to it (eq.5.6: $\varepsilon \cdot \mu = 1/c^2$), the dielectricity ε and the permeability μ, are to be taken constant.
With that the same proportionality as for the field strengths also holds for the induction B and the dielectric displacement D:

$$B \sim 1/r^2 \quad \text{and} \quad D \sim 1/r^2.$$

In the model domain everything looks completely different. Here the radius and any length stands in direct proportionality to the speed of light. In this way we get problems with our usual system of units, the M-K-S-A-system (Meter-Kilogram-Second-Ampere). The basic unit Meter [m] and as a consequence also the unit of mass Kilogram [kg = VAs^3/m^2] appear here as variable. It would be advantageous, to introduce instead the Volt [V] as basic unit.
But in any case does the dimension of a quantity show us, in which proportionality it stands to the unit of length. This in the model domain then is authoritative! As an example does the speed of light have the dimension Meter per Second. In the model domain there consequently has to exist a proportionality to the length r [m].
The speed of light determines with equation 5.6 again the constants of material:

$$\mu\,[Vs/Am] \sim 1/r \quad \text{and} \quad \varepsilon[As/Vm] \sim 1/r \qquad (6.28)$$

According to the model holds unchanged:

$$B\,[Vs/m^2] \sim 1/r^2 \quad \text{and} \quad D\,[As/m^2] \sim 1/r^2. \qquad (6.29)$$

But if we insert the proportionalities 6.28 and 6.29 into the equations of material 3.5 and 3.6, then holds for the field strengths:

$$H\,[A/m] \sim 1/r \quad \text{and} \quad E\,[V/m] \sim 1/r. \qquad (6.27)$$

Further dependencies of the radius can be read in the same manner either by inserting into well-known laws or immediately from the dimension.

In the observation domain:

energy density of a field:

$$w = (\varepsilon \cdot E^2 + \mu \cdot H^2)/2 \sim 1/r^4 \quad (6.37)$$

energy: $W \sim 1/r$ (6.38)

with c = constant and $W = m \cdot c^2$: $\boxed{m \sim 1/r}$ (6.39)

e^- is bigger and lighter than p^+ or n^0!

$$\boxed{\frac{m}{m_0} \overset{(6.39)}{=} \frac{r_0}{r} \overset{(6.26)}{=} \frac{l_0}{l} \overset{(6.24^*)}{=} \frac{1}{\sqrt{1-(v/c)^2}}} \quad (6.40)$$

In the model domain:

e.g. spherical capacitor

capacity:	C [As/V]	$= \varepsilon 4\pi r$	(6.4)	$C = \text{const.}$	(6.30)
charge:	Q [As]	$= C \cdot U$	(6.31)	$Q = \text{const.}$	(6.32)
energy:	W [VAs]	$= Q^2/C$	(6.1)	$\boxed{W = \text{const.}}$	(6.33)

(6.33) means: law of conservation of energy!

relaxation time	τ_1 [s]:			$\tau_1 = \text{const.}$	(6.35)
with	τ_1	$= \varepsilon/\sigma$	(5.3)		
specific conductivity	σ [A/Vm]:			$\boxed{\sigma \sim 1/r}$	(6.36)

(6.36) means: elementary vortices are indestructible!

Fig. 6.19: Interpretation of the dependencies on radius

6.19 Interpretation of the transformation table

The transformation should tell us, what we would see if the variable speed of light would be observable to us. Doing so highly interesting results come out.
The energy density of a field is as is known $w = (\varepsilon \cdot E^2 + \mu \cdot H^2)/2$. (6.37)
In the observation domain will, according to fig. 6.19, decrease the energy density w proportional to $1/r^4$. Multiplied with the respective volume we obtain for the energy itself the proportionality: $W \sim 1/r$. (6.38)
If we make use of the Einstein relation $W = m \bullet c^2$
with c = constant holds also for the mass m: $m \sim 1/r$. (6.39)
In this manner we finally find out, why the small nucleons (protons and neutrons) subjectively seen are heavier than the very much larger electrons. As a consequence does a relativistic particle experience the increase of mass (with the length contraction according to equation 6.24*):

$$\frac{m}{m_0} \overset{(6.39)}{=} \frac{r_0}{r} \overset{(6.26)}{=} \frac{l_0}{l} \overset{(6.24^*)}{=} \frac{1}{\sqrt{1-(v/c)^2}} \quad (6.40)$$

This result is experimentally secured. Our considerations therefore are entirely in accord with the Lorentz-transformation. There at least is no reason to doubt the correctness.
In the model domain we with advantage assume a spherical symmetry. As easily can be shown with equations 6.4 and 6.31, are the capacity and charge of a spherical capacitor independent of the radius (6.30 and 6.32). In that case also the from both values calculable energy (6.1) must be constant. We come to the same conclusion, if take we the above equation 6.37 for the energy density of a field or if we carry out a verification of dimensions:
W [VAs] = konst. . (6.33)
This simple result is the physical basis for the law of conservation of energy! With that we have eliminated an axiom.
The result states that the energy stays the same, even if the radius, the distance or the speed of an object should change. To the subjectively observing person it shows itself merely in various forms of expression. Consequently is the energy, as is dictated by the here presented field theory, formed by binding in the inside of the quanta the same amount of energy but of the opposite sign. The amount of energy therefore is bound to the number of the present particles, as we already had derived.
Under the assumption of a constant time (6.35) there results for the electric conductivity σ, by calculating backwards over the equation of the relaxation time (5.3), the proportionality: (6.36)

$$\sigma\,[A/Vm] \sim 1/r \quad (6.36)$$

Maybe the result surprises, because it can't be observed. Actually we know that the (microscopically observed conductivity in reality only represents an approximated averaged measure for the mobility of free charge carriers. In a particle-free vacuum however this well-known interpretation doesn't make sense anymore. Hence it is recommended, to only work with the relaxation time constants. Who nevertheless wants to eontinue to work with σ as a pure factor of description, can do this. But he mustn't be surprised, if in the model domain with decreasing radius the conductivity suddenly increases. But this is necessary, because otherwise the elementary particles would collapse. Only by the increase of the conductivity, which is produced by the spherical vortex itself, will the expanding eddy current build up in the inside of the particles, which counteract the from the outside concentrating potential vortex.

Approach:

a.The particles don't decay by themselves, but only by a corresponding disturbance from the outside.

b.The decay time is the statistical average in which such a disturbance can occur and take effect.

c.The elementary particles consist of an integral and finite number of elementary vortices, which can't decay anymore for their part.

d.If the compound particles get into the disturbing range of influence of high-frequency alternating fields, then they are stimulated to violent oscillations and in that way can be torn apart into individual parts.

e.As disturbing factor the high-frequency fields of flying past neutrinos are considered primarily.

f. Authoritative for the threshold of decay and with that also for the rate of decay is the distance, in which the neutrinos fly past the particle.

g.The distance becomes the larger, the smaller the particle is. If the particle thus experiences a relativistic length contraction, then it will, statistically seen, to the same extent become more stable!

That has nothing to do at all with time dilatationl

We are entitled to demand a simultaneity, after all we are the ones, who tell what that is!

Fig. 6.20: Proposal for an interpretation of the particle decay

<i>: Walter Theimer: Die Relativitatstheorie, Seite 106, Francke Verlag, Bern, 1977, ISBN 3-772O-126O-4

6.20 Particle decay

We still have to get rid of a fundamental misunderstanding. It concerns the problem of the time dilatation. Here the model domain doesn't give us any difficulty, because it dictates a constant and therefore by us definable time. In the relativistic view however should in moving systems clocks go wrong! But how does one want to explain a time dilatation physically, if it merely represents a purely mathematical result of the actually taking place length contraction on the one hand and the postulate of a constant speed of light on the other hand?

Nobody has troubled more about the physical interpretation than Einstein himself. But he had as less as we nowadays the possibility to verify the so-called phenomenon experimentally, by accelerating a laboratory clock to values close to the speed of light. Only atomic particles can, e.g. in accelerator systems, be brought on such high speeds and then be observed for their properties. But also these experiments don't have any power of proof, as long as we don't know the atomistic structure of the particles and there exists the danger of misinterpretations.

So the slowing down of the rate of decay of instable. particles at high speeds willingly is cited as "proof for time dilatation<i>. "The most cited example for the time dilatation is the "long-living" meson. The μ-meson is a charged particle, which exists only $2{,}2 * 10^{-6}$ seconds if it is observed in rest. Then it decays ... About 10 % of the mesons reach the earth's surface. Even if they fly with approximately the speed of light, they at least must have used $30 \cdot 2{,}2 * 10^{-6}$ seconds, in order to reach the earth. Their "life" therefore by the movement has been extended for a multiple... to the supporters of the theory of relativity here the time dilatation is revealed..."

This "proof however is worthless, as long as "the structure and the mechanism of decay of the particle are not known", like W. Theimer<i> expresses himself.

On the basis of the new field theory the approach standing on the left page is dared (fig. 6.20). Accordingly the particles don't decay by themselves, but only by a corresponding disturbance from the outside, which for instance is triggered by the high-frequency fields of flying past neutrinos. The closer the neutrinos fly past the particle, the sooner it will decay. But the distance becomes the larger, the smaller the particle is. If the particle thus experiences a relativistic length contraction, then it will, statistically seen, to the same extent become more stable!

That has nothing to do at all with time dilatation, as this proposal for an interpretation shows (fig. 6.20). The same effect of course also occurs, if atomic clocks are taken for a fly in a plane and compared to identically constructed clocks on earth.

The time was stipulated by us and therefore should be able to keep its universal validity. We are entitled to demand a simultaneity, after all we are the ones, who tell what simultaneity is!

An interesting technical use would be the acceleration of the rate of decay in order to dispose of radioactively contaminated waste. For that the waste has to be irradiated by collecting and focussing free neutrinos or with the help of a neutrino transmitter, like one which will be discussed in chapter 9. After such a neutrino shower dangerous radioactive waste would be reusable or at most be harmless domestic refuse.

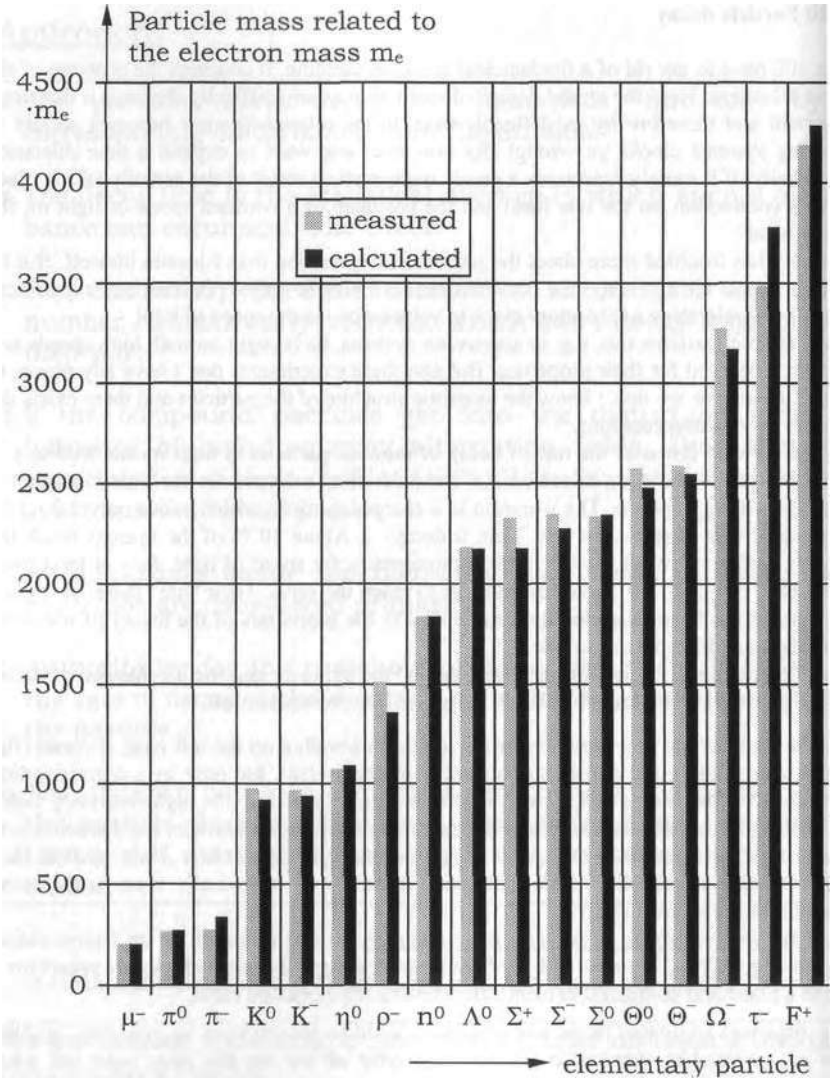

Fig. 7.0: The comparison with power of proof: ▒ the measured particle mass ▌ the calculated particle mass

7. Proof

Ample evidence is available for the correctness of the theory of objectivity. The field dependent change in length is observed and used as magnetostriction or electrostriction. If a ferromagnetic material, e.g. a nickel rod, is brought into an alternating magnetic field, then field dependent longitudinal length oscillations are observed. In the same manner barium titanate or quartz crystal oscillates in the electric field if a high-frequency alternating voltage is applied.
A practical application forms the production of ultrasound.

In this chapter are, as already announced, the quantum properties of the elementary particles calculated and in this way is furnished perhaps the most convincing proof for the existence of potential vortices and for the correctness of the field-theoretical approach and the theory which is based on it.
A special challenge represents the calculation of the particle mass. This mass stretches from 207 electron masses of the myon over 1839 of the neutron into the order of magnitude of 18513 electron masses (Y°). Doing so not only can be tested, if the calculated values correspond with the measured ones. Also the gaps have to correspond, i.e. where there doesn't exist a discrete mathematical solution also no particle should exist. The fig. 7.0 standing on the left page anticipates the result and shows that even this strict condition is fulfilled! The agreement of the calculated with the measured results is excellent. If in individual cases small deviations become visible, we always have to bear in mind that the measurements as a rule are analysed statistically and the results are falsified if small particles creep in unrecognized. Particle physics nowadays has at its disposal extremely precise gauges, but even here remaining errors can't be excluded.

Quantum physics is occupied with further taking apart the elementary particles into hypothetic particles, the quarks, and to sort these according to properties and symmetries. Seen strictly causal this procedure thus corresponds to the quantum physical approach. We however have taken the field-theoretical approach, and this excludes the introduction of hypothetic particles from the start. It should be our goal to derive and to explain the quantum structure as a field property. Yes, we even want to calculate it, with which we would have overtaken quantum physics in the scientific competition with one leap!

Strong support our approach has experienced by current experiments, in which matter was transformed in electromagnetic waves - practically the reversal of the rolling up of waves to vortices. To do so at the Massachusetts Institute of Technology (David Pritchard and others) sodium atoms were dematerialized in waves by lattice scattering[<i>]. According to Einstein one surely could have blown the whole M.I.T. in the air with the occurring mass defect; but don't worry, no emission of energy whatsoever has been observed, entirely as predicted by the vortex theory.

<i>: J. Teuber: Materie und Energie, Ganze Atome wurden zu Energiewellen,
Illustrierte Wissenschaft Nr. 7 (1996), S. 56

With the classical radius of the electron $r_e = 2{,}82 * 10^{-15}$ m:

$$C_e = \varepsilon_0 \cdot 4\pi r_e = 3{,}135 \cdot 10^{-25} F \qquad (6.4^*)$$

$$U_e = e/C_e = 511 kV \qquad (6.31^*)$$

(constant independent of r_e)

Formation forms (vortex properties):

I. Amassing (formation of vortex balls):

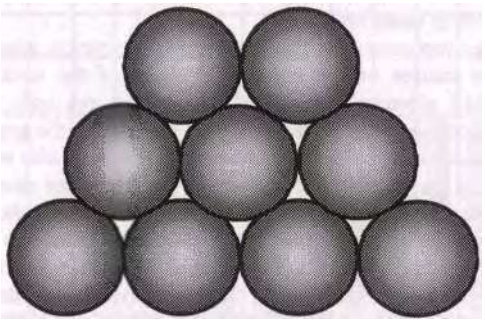

II. Overlapping (phenomenon of transport)

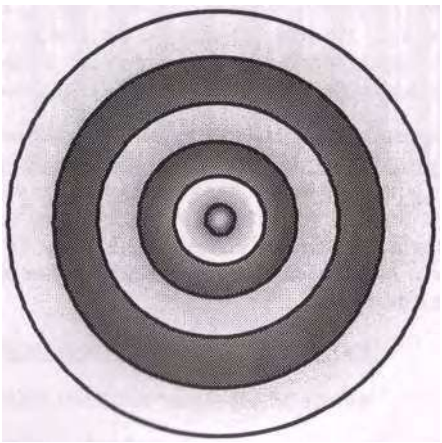

Fig. 7.1: The amassing and overlapping of elementary vortices

7.1 Elementary vortices

We had derived the electron and the positron as elementary vortices (fig. 4.3). Before we can go in the calculation, we must gain a clear picture of the possible configurations of vortices, which for reason of the derived properties are possible. For that we start with the elementary vortex and afterwards we predict the behaviour of interaction which can be expected.

Actually only one single particle is really elementary. According to the realizations of the new theory it is an elementary vortex in the form of a sphere. Its size is determined by the speed of light and this again by the local field strength; its stability is founded in the concentration effect of the potential vortex. The whirling takes place everywhere with the speed of light, even in the vortex centre, where all field lines run together, where the field increases infinitely and the speed of light goes to zero. This last circumstance owes the elementary vortex its localization.

We can attribute a charge to this vortex for reason of the field lines which on the outside run towards infinity and which we can measure (fig. 4.3). This is the smallest indivisible unit, the elementary charge e. Structure and course of the field lines suggest to understand and to calculate the elementary vortex as a spherical capacitor. By basing on the classical radius of the electron r_e given in fig. 6.3 the capacity according to equation 6.4 is calculated to be:

$$C_e = \varepsilon_0 \cdot 4\pi r_e = 3{,}135 \cdot 10^{-25}\,\mathrm{F} \quad (6.4^*)$$

Here the theory of objectivity has provided us the realization that even for a change of the radius of the electron the capacity remains unchanged constant (6.30), and this entirely corresponds to our observation.

Between the hull of the elementary vortex, measured at the radius r_e, and its centre, respectively also with regard to infinity, there exists according to equation 6.31 the tension voltage of:

$$U_e = e/C_e = 511\ \mathrm{kV} \quad (6.31^*)$$

It as well is constant and independent of the size of the elementary vortex.

Since a different solution is refused, we'll have to assume that all elementary particles consist of an integer multiple of elementary vortices. For that the amassing, like closely packed tennis balls, or the overlapping of individual vortices in the form of shells, like in the case of an onion (phenomenon of transport) can be considered.

The among each other occurring forces of attraction can be traced back to the fact that every elementary vortex is compressed by the field of its neighbour as a consequence of the field dependent speed of light. This field as a rule is for the small distances considerably larger than the field on the outside. Therefore do compound elementary particles not have the twofold or triple mass, but at once the 207-fold (myon) or the 1836-fold (proton) mass. After all there is no other explanation for the fact that there don't exist lighter particles (with a mass less than 207 electron masses)!

a. The electron-positron pair

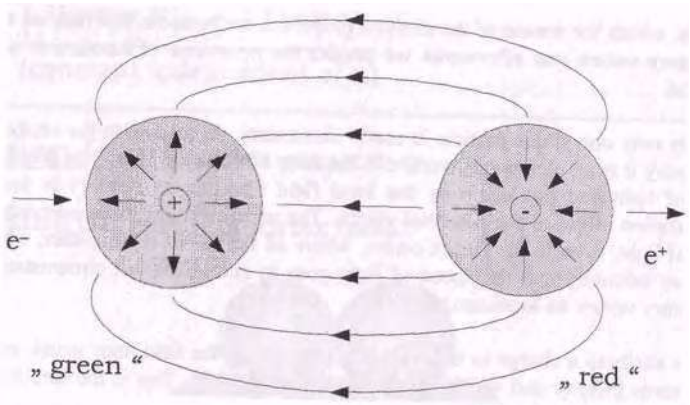

b. . The e^- - e+ pair for a small distance:

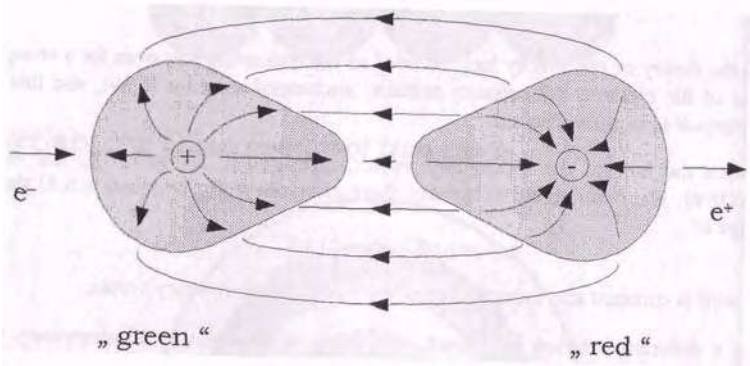

Fig. 7.2: The electron-positron pair annihilation

7.2 Matter and anti-matter

For the amassing or overlapping of elementary vortices several cases must be distinguished, because two inverse forms of formation are possible for the elementary vortex: the negatively charged electron and the positively charged positron. Whereas in the case of the electron the vortex produces a component of the electric field which points from the inside to the outside, has the field in the case of the positron the opposite direction for reason of a reversed swirl direction.

This statement can be generalized: if we consider the elementary particles from the outside, then we assign the particles with a swirl direction identical to that of the electron to the world of matter and call the particles with the opposite swirl direction anti-matter. It now is strongly recommended, to take colours to hand, in order to optically clarify the properties of vortices. The electron will be marked as a green sphere and the antiparticle, the positron, as a red sphere.

If we now look into the world of matter, then appears our world of matter to us "green", the world of anti-matter however "red". The uniform green colour of all the in our world existing elementary particles however doesn't exclude that red anti-vortices can exist hidden in the inside of the green vortices, where we can't discover them. But they must be completely covered, otherwise a disastrous reaction occurs, the pair annihilation, as a consequence of the oppositely directed property of the vortices which cancel out. By means of the pair annihilation a dematerialization can occur, because every elementary vortex keeps in its inside the same amount of energy with opposite sign and the fusion of two inverse particles can result in a zero sum of the energy. The best known example is the annihilation of an electron-positron pair under emission of radiation discovered by Klemperer in 1934. In the upper representation (fig. 7.2a) the elementary vortices still are symmetrical, but the outside field lines already are "bent" and linked together in such a way that, with the exception of the ones in the direction of the axis, no interaction takes place which can be measured.

The two particles for reason of the different charge approach each other quickly, and the closer they are, the larger the mutual force of attraction becomes; a vicious circle, which leads to the asymmetry shown in the lower sketch (fig. 7.2b) and only comes to rest, if both particles have destroyed themselves mutually.

The electron and the positron had the same amount of, but oppositely directed swirl activity, so that purely arithmetically seen a zero sum of the rest energy results. But it should be paid attention to both particles having some kinetic energy on the occasion of the relative motion to each other and if they rotate around their own axis also rotational energy. An emission of annihilation radiation occurs, is the explanation of particle physics.

With the knowledge of the photon (fig. 4.6) we can interpret the annihilation radiation as a consequence of the phenomenon of transport. The faster and consequently smaller vortex, for instance the green one, slips into the red one and sees the green inside, which is compatible for it. Unfortunately it only can remain there, as long as it is smaller, thus is faster, and therefore it shoots out on the other side again. Now the electromagnetic force of attraction fully takes effect. It is slowed down and the red vortex correspondingly accelerates. The process is reversed.

These around each other oscillating vortices, so we had derived, have a characteristic frequency (colour), are polarizable and are moving forward with the speed of light as a consequence of the open vortex centre. It therefore concerns the photon.

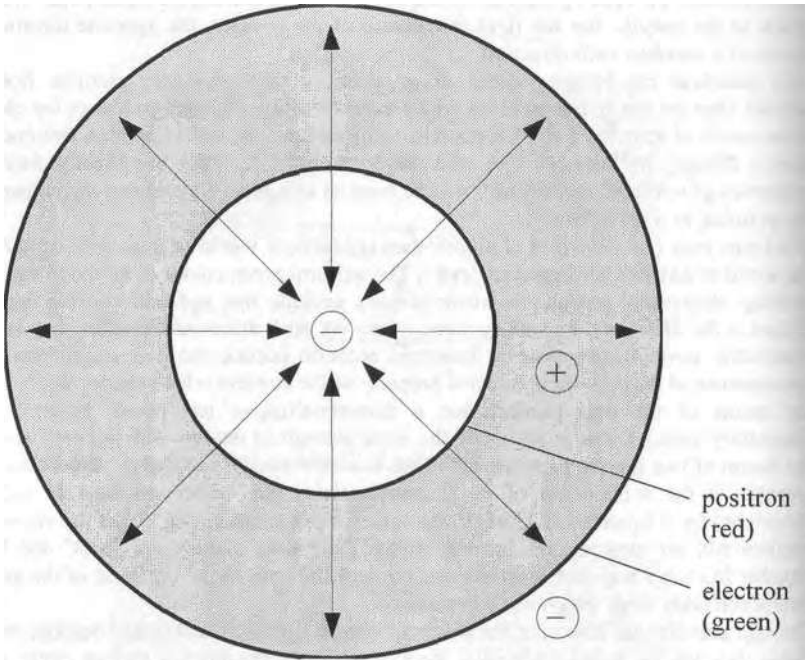

Fig. 7.3: Theoretical final state of the positronium = static γ-quant (photon).

7.3 Positronium

But before the two elementary vortices, the electron and the positron, are annihilated under emission of radiation, they will for a short time take a shell-shaped, a bound state, in which one vortex overlaps the other.
Its formation we can imagine as follows: an electron, flying past a resting positron, is cached by this for reason of the electromagnetic attraction and spirals on an elliptic path towards the positron. In doing so its angular velocity increases considerably. It will be pulled apart to a flat disc for reason of the high centrifugal forces, to eventually lay itself around the positron as a closed shell.
Now the red positron sees the electron vortex so to speak "from the inside" and doing so it sees as well red; because the green vortex has a red centre and vice versa! The result is the in fig. 7.3 given configuration.

The number of field lines, which run from the red border of the positron in the direction of the centre, is identical to the number, which point towards the green border of the electron. Here already the same state has been reached as in the centre, which corresponds to the state at infinity. That means that no field lines point from the green border to the outside; seen from the outside the particle behaves electrically neutral. It doesn't show any electromagnetic interaction with its surroundings.

If the particle were long-living, then it undoubtedly would be the lightest elementary particle besides the electron; but without stabilizing influence from the outside the positronium can't take the in fig. 7.3 shown state at all. The positron takes up the kinetic energy which is released if the electron becomes a shell around it. But before the bound state can arise, which would identify the positronium as an elementary particle, the equal rights of both vortices comes to light. With the same right, with which the electron wants to overlap the positron, it itself vice versa could also be overlapped.
If the stabilization of the one or the other state from the outside doesn't occur, then the stated annihilation under emission of y-quanta is the unavoidable consequence (fig. 4.6).

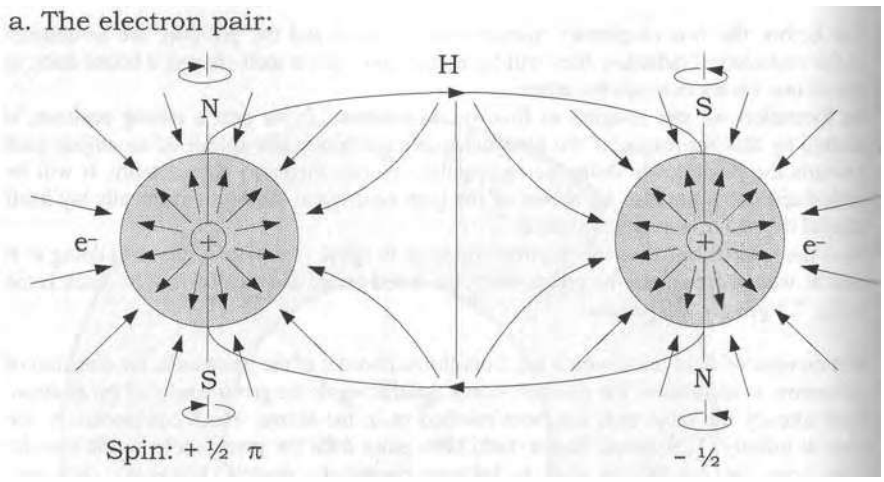

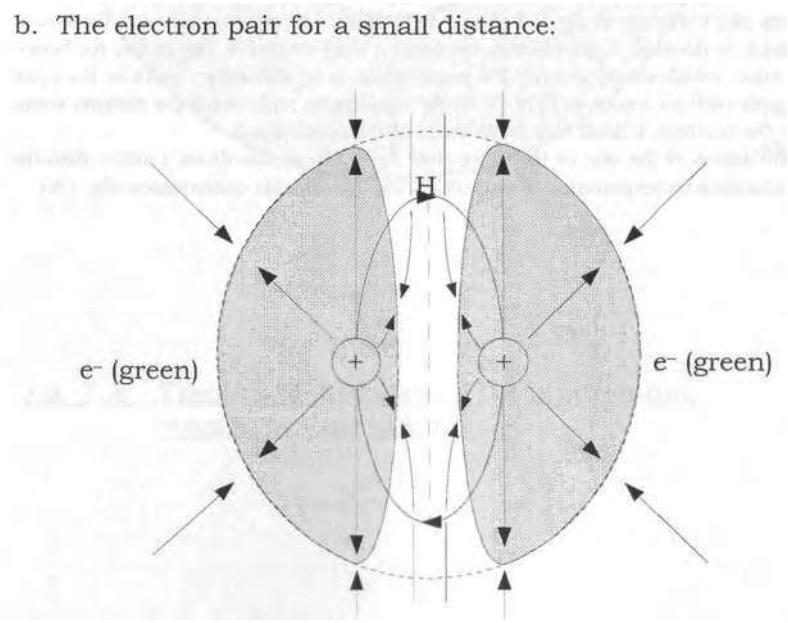

Fig. 7.4: Two electrons with oppositely directed spin

7.4 Dipole moment

As electrically charged spheres elementary vortices have a magnetic dipole moment along their axis of rotation as a consequence of the rotation of their own (fig. 7.4). This is measurable very precisely and for the most important elementary particles also known quantitatively. In contrast to the angular momentum the magnetic moment can't be constant according to the here presented theory. It should slightly change, if we increase the field strength in the laboratory.

In a particle consisting of several elementary vortices the vortices mutually increase the local field strength. Therefore we measure at the proton, which consists of three vortices, not the triple, but only the 2,793-fold of the nuclear magneton which can be expected for reason of its mass. Also the neutron has instead of the double only the 1,913-fold nuclear magneton. The deviations therefore are explicable as a consequence of the surrounding fields.

Prerequisite for this point are two other, still unanswered, key questions of quantum physics:

> XII: Why is measured for the proton approximately the triple of the magnetic dipole moment which can be expected for reason of the charge?
>
> XIII: Why does the neutron, as an uncharged particle, actually have a magnetic moment?

These questions can only be brought to a conclusive answer, if we have derived the vortex structures of the respective particles.

The elementary vortex, as a consequence of the spin along its axis, forms a magnetic north pole and a south pole. Another possibility to interact with an external field or with other particles is founded on this property. This shall be studied by means of two electrons. which form an electron pair.
For reason of the equal charge the two electrons at first will repel each other. If they rotate of their own they however will mutually contract, which, seen from the outside, is interpreted as a force of attraction. And in addition will they align their axes of rotation antiparallelly. While they now rotate in the opposite direction, a magnetic force of attraction occurs.

As is shown in fig. 7.4, the magnetic dipole field in this way is compensated towards the outside, as is clarified by the field line (H) with a closed course. Between both electrons a space free of E-field stretches. If both vortices are a small distance apart they lay themselves around this space like two half-shells of a sphere. A particle forms which seen from the outside is magnetically neutral, but it carries the double elementary charge (fig. 7.4b).
The exceptional affinity is always restricted to two vortices of equal charge with an opposite direction of rotation. Further vortices can't be integrated anymore and are repelled. This property of vortices covers the quantum condition (Pauli's exclusion principle) for the spin quantum number perfectly.

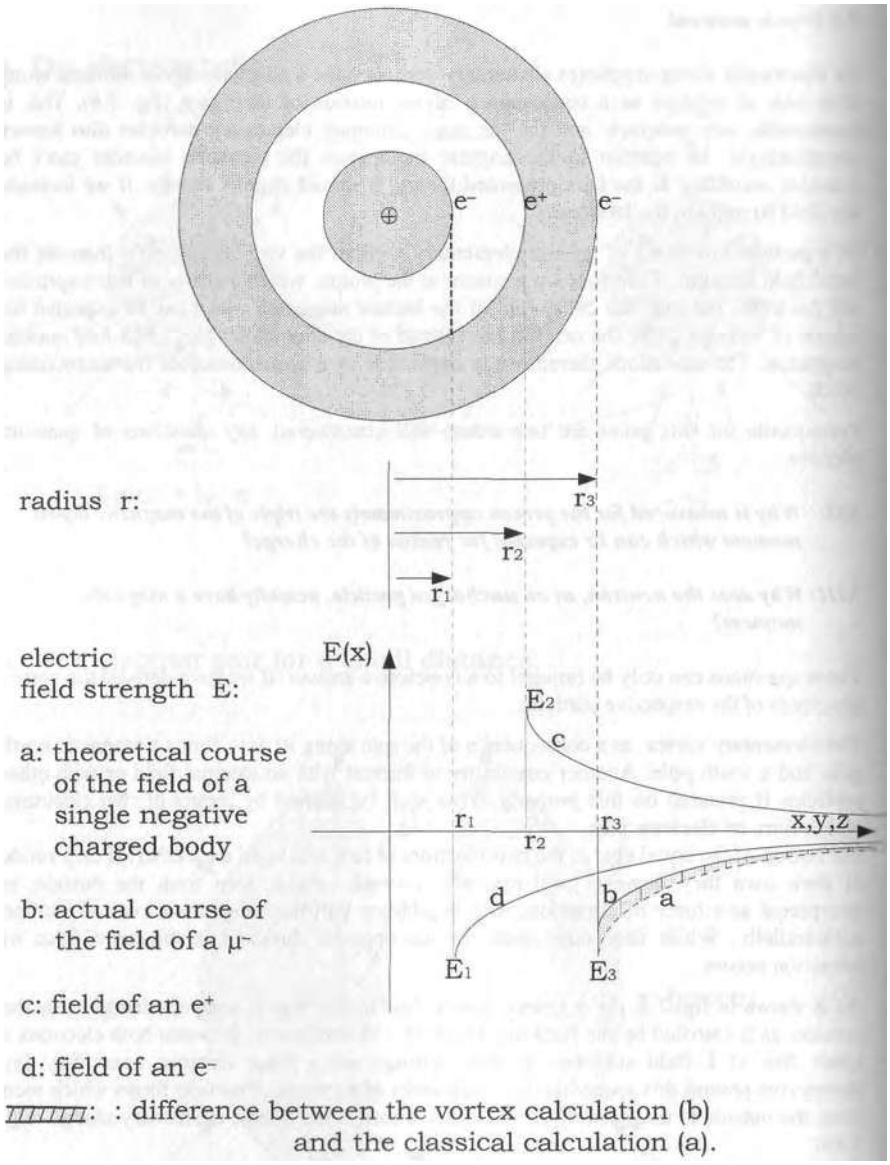

Fig. 7.5: The mvon and the electric field E(x) of the three elementary vortices

7.5 Myon

We now have discussed all conceivable possibilities, which two elementary vortices can form: the creation of a pair for like charge and the annihilation under emission of photons via the formation of the positronium as an intermediate result for unequal charge. Next another elementary vortex shall be added and all different possibilities and configurations will be derived, which can be formed by amassing or overlapping.

The positronium can, as said, only take the in fig. 7.3 shown bound structure, if it is stabilized from the outside. This task now a further electron shall take over. According to the shell model the innermost elementary vortex an electron (e^-), is overlapped by a positron (e^+) and that again overlapped by an electron (e^-).
With an in the sum single negative charge, a completely symmetric structure as well as a half-integer spin this particle will show a behaviour corresponding to a large extent to that of the electron. Merely the mass will be considerably larger, because every vortex each time compresses the other two.

It therefore concerns the myon (μ^-), which also is called "heavy electron". The myon was discovered 1937 in the cosmic radiation (Anderson and others).
In fig. 7.5 are drawn above each other the shell-shaped structure of the myon and the electric field E(x) of the three elementary vortices.
It is visible that merely in the proximity of the particle the actual course of the field deviates from and is smaller, than the course which theoretically can be expected for a single negatively charged body. The difference is marked by a hatching.

We now can tackle the calculation of the myon. For that the following considerations to begin with are useful:
Mass is an auxiliary term founded in usefulness, which describes the influence of the electromagnetic field on the speed of light and with that on the spatial extension of the "point mass".
Without exception the local cosmic field E_o has an effect on a free and unbound elementary vortex, thus on an individual e^- or e^+, and determines so its size and its mass.
But as long as we haven't determined this field strength, the calculation of its quantum properties won't succeed.
Instead the masses of compound particles will be compared to each other, which are so heavy that the field strength of the neighbouring vortices is predominant over the basic field E_0, so that a neglect of E_o seems to be allowed. The course of the calculation is made for all elementary particles in the same manner, which is explained hereafter.

Spherical capacitor: (r_i = inner radius; r_a = outer radius)

$$U = \int_{r_i}^{r_a} E\,dr \tag{7.1}$$

Electron ($r_i = 0$ and $r_a = r_e$): $U = 511\ \text{kV} = \text{const.}$ (6.31*)

$$U_1 = U_2 = U_3 = U_4 = \ldots = U_n \tag{7.2}$$

At The radius r_1 is valid: $E(r_1) = E_1$ and

$$U_1 = \int_0^{r_1} E_1\,dr = E_1 r_1 \overset{!}{=} U_2 = \int_{r_1}^{r_2} E_1\,dr = E_1 (r_2 - r_1) \tag{7.1*}$$

At the radius r_2 is valid for the 2nd and 3rd shell $E(r_2) = E_2$:

$$U_2 = \int_{r_1}^{r_2} E_2\,dr = E_2 (r_2 - r_1) \overset{!}{=} U_3 = \int_{r_2}^{r_3} E_2\,dr = E_2 (r_3 - r_2) \tag{7.1**}$$

comparison of the radii:

$$\Delta r = \overset{(7.1*)}{r_1 = r_2 - r_1} \overset{(7.1**)}{=} r_3 - r_2 = \ldots = r_n - r_{n-1} \tag{7.3}$$

resp.:

$$r_2 = 2 \cdot r_1; \quad r_3 = 3 \cdot r_1; \quad \ldots; \quad \boxed{r_n = n \cdot r_1} \tag{7.4}$$

comparison of the field strengths: (7.1* with 7.1** with Eq. (7.2):

$$E_1 = E_2 = E_3 = \ldots = E_n \tag{7.5}$$

Theory of objectivity, fig. 6.18: $\boxed{E \sim 1/r}$ (6.25)

see fig. 7.5:

$$E_1(r_3) = E_{31} = -E_1 \cdot (r_1/r_3)$$
$$E_2(r_3) = E_{32} = E_2 \cdot (r_2/r_3)$$
$$E_0 = \text{cosmic basic field} \quad \text{(negligible)}$$

$$E(r_3) = E_{31} + E_{32} + E_0 = E_1 \cdot (r_2 - r_1)/r_3 + \cancel{E_0} \tag{7.6}$$

$$\boxed{\frac{E(r_3)}{E_1} = \frac{2 \cdot r_1 - r_1}{3 \cdot r_1} = \frac{1}{3}} \tag{7.7}$$

Fig. 7.6: Calculation of the electric field strength E(r) of the myon from its dependency on radius

7.6 Calculation of the vortex fields

The tension voltage of an elementary vortex, like for a spherical capacitor, is determined by integrating over the electric field strength from the inner radius r_i up to the outer radius r_a:

$$U = \int_{r_i}^{r_a} E\, dr \quad (7.1)$$

For the electron ($r_i = 0$ und $r_a = r_e$) we already have carried out the integration and determined the tension voltage to be 511 kV (equation 6.31 *).
Doing so we further had discovered that it won't change, if the radius r varies. Even for a shell configuration, in which electrons and positrons alternately overlap, the approach is valid:

$$U_1 = U_2 = U_3 = U_4 = \ldots = U_n \quad (7.2)$$

At a certain radius all elementary vortices show the same density of field lines and with that also the identical field strength, so that we can solve the integral (7.1) for the each time neighbouring vortex shells and can compare the results:
At the radius r_1 with $E(r_1) = E_1$ the agreement, according to equation 7.1* (fig. 7.6), is valid for the innermost and the overlapped vortex shell.
At the radius r_2 with $E(r_2) = E_2$ the agreement according to equation 7.1** (fig. 7.6) is valid analogously for the 2nd and 3rd shell.
If still more shells are present, then we can arbitrarily repeat this procedure. For the radius of each shell we always obtain relation 7.3, which, related to the innermost radius, provides the following simple expression for the individual radii:

$$r_2 = 2 * r_1 ; \quad r_3 = 3 \bullet r_1; \quad \ldots ; \quad r_n = n * r_1 \quad (7.4)$$

From the comparison of the integration results 7.1* and 7.1** follows further that all elementary vortices produce the same field strength:

$$E_1 = E_2 = E_3 = \ldots = E_n \quad (7.5)$$

We infer from the transformation table (fig. 6.18, eq. 6.27) that the field strengths E and H decrease with 1/r. In fig. 7.5 the decrease of the fields with 1/r is shown. Up to the radius r, the field of the innermost vortex E_1 has worn off to the value $E_{31} = - E_1 \bullet (r_1/r_3)$. This field is overlapped by $E_{32} = E_2 * (r_2/r_3)$ as well as the cosmic basic field E_o:

$$E(r_3) = E_{31} + E_{32} + E_0 = E_1 \bullet (r_2 - r_1)/r_3 + E_o \quad (7.6)$$

The local basic field E_o is not known, but it is very small with regard to the field of the neighbouring vortex shells, so that a neglect seems to be allowed. From equation (7.6) in this way follows with the radius relation (7.4):

$$\frac{E(r_3)}{E_1} = \frac{2 \cdot r_1 - r_1}{3 \cdot r_1} = \frac{1}{3} \quad (7.7)$$

For the shell-shaped configuration of the myon (fig. 7.5) relation (7.7) indicates, which field the outside vortex shell is exposed to. From this can already be seen, how much it is compressed thanks to the field dependent speed of light and how much its mass as a consequence is increased.

Structure of the proton p^+:

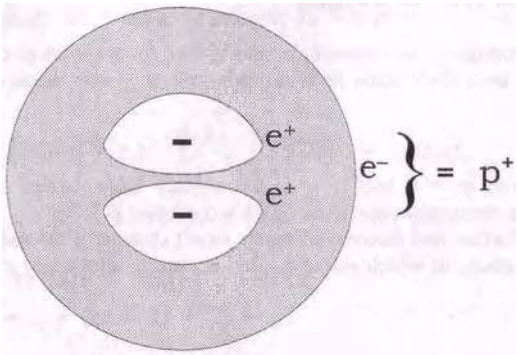

Calculation:
structure consisting of two shells, inner vortices with $2 \bullet E_1$,
field strength at the outer radius r_2:

$$E(r_2) = 2 * E_{21} = 2 * E_1(r_1/r_2) = E_1 \qquad (7.8)$$

Comparison of p^+ (7.8) with u^- (7.7) (z_e = number of the elementary vortices being involved with) in building up the structure, here each time $z_e = 3$):

Comparison of the radii with $E \sim 1/r$ (6.27)

$$\frac{r_p}{r_\mu} = \frac{z_{e\mu}}{z_{ep}} \cdot \frac{E_\mu(r_3)}{E_p(r_2)} = \frac{3}{3} \cdot \frac{1/3}{1} = \frac{1}{3} \qquad (7.9)$$

Theory of objectivity (fig. 6.18): $m \sim l/r^2$ (6.34)

$$\frac{m_p}{m_\mu} = \frac{z_{ep}}{z_{e\mu}} \cdot \left(\frac{r_\mu}{r_p}\right)^2 = \frac{3}{3} \cdot \left(\frac{3}{1}\right)^2 = 9 \qquad (7.10)$$

$$m_p/m_e = 9 * (m_u/m_e) = 9 * 207 = 1863 \qquad (7.11)$$

Measurement value, proton mass: $m_p = 1836 \bullet m_e$
Resp.:
measurement value myon mass $m_u = 207 * m_e$
myon calculated value: $m_p = 204 * m_e$. (error = 1,5%)

Since we, by using this calculation method, for the first time succeeded in deriving the mass of an elementary particle from that of another particle, the particle mass isn't a constant of nature anymore!

Fig. 7.7: Calculation of the proton

7.7 Calculation of the proton

If we again remember the affinity of two elementary vortices, which rotate with opposite spin. They align their axis of rotation antiparallel and form a very probable, but not particularly tight bound pair (fig. 7.4).
If we this time start with a positron pair, then does this pair have a double positive elementary charge. The two e^+ hence exert a particularly big force of attraction on electrons flying past them. If they have cached one and put it round as a shell, like a coat, then they will never again give it back! To again remove the electron, a triple positive charge would be necessary. But such a particle can't exist at all. The new particle therefore has an absolute stability and a very big mass, because the positron pair is considerably compressed by its outer shell. The total charge is single positive. With these properties it actually only can concern the proton. Its structure is shown in fig. 7.7.
We can start from the assumption that both positrons are very close together in the inside and thus each forms the half of a sphere. For the calculation of the proton mass we then can assume as an approximation a structure of two shells, in which the inner vortex will have the double charge and the double field ($2 * E_1$). With equation 7.4 the field strength at the outer radius r_2 is:

$$E(r_2) = 2*E_{21} = 2*E_1*(r_1/r_2) = E_1 \qquad (7.8)$$

If we want to compare the results of the p^+ (7.8) and the μ^- (7.7), then it should be considered that the field of the innermost elementary vortex E_1 only is equal, if the number z_e of the elementary vortices involved in building up the particle is identical. Here with each time $z_e = 3$ this is the case. Because of equation 6.27 (E, H ~ 1/r) now also the radii are comparable:

$$\frac{r_p}{r_\mu} = \frac{z_{e\mu}}{z_{ep}} \cdot \frac{E_\mu(r_3)}{E_p(r_2)} = \frac{3}{3} \cdot \frac{1/3}{1} = \frac{1}{3} \qquad (7.9)$$

The mass of a particle first is determined by the number of the elementary vortices z_e. According to the theory of objectivity (fig. 6.18) however also the radius has an influence on the mass:

$$m \sim 1/r^2 \qquad (6.34)$$

This proportionality should be applied to the p^+-μ^-- comparison.

$$\frac{m_p}{m_\mu} = \frac{z_{ep}}{z_{e\mu}} \cdot \left(\frac{r_\mu}{r_p}\right)^2 = \frac{3}{3} \cdot \left(\frac{3}{1}\right)^2 = 9 \qquad (7.10)$$

The calculation provides a nine times bigger mass for the proton with regard to the mass of the myon. Therefore the mass of the proton related to the mass of the electron is:

$$m_p/m_e = 9*(m_\mu/m_e) = 9*207 = 1863 \qquad (7.11)$$

It would be favourable, to start from the with measuring techniques determined value for the mass of the proton $m_p/m_e = 1836$ and calculate backwards the related mass of the myon.
Then we obtain 204 as the calculated value instead of the measurement value m_μ/m_e= 207.
The reason for the deviation of 1.5 percent is caused by the neglect of the cosmic field E_o with regard to the field of the neighbouring elementary vortex. This neglect takes very much less effect for the relatively heavy proton than for the light myon.
The cosmic field therefore will compress the myon more strongly and increase the mass more strongly as is calculated here, in agreement with the measurement results.
Summarizing: since we, by using this calculation method, for the first time succeeded in deriving the mass of an elementary particle from that of another particle, the particle mass isn't a constant of nature anymore!

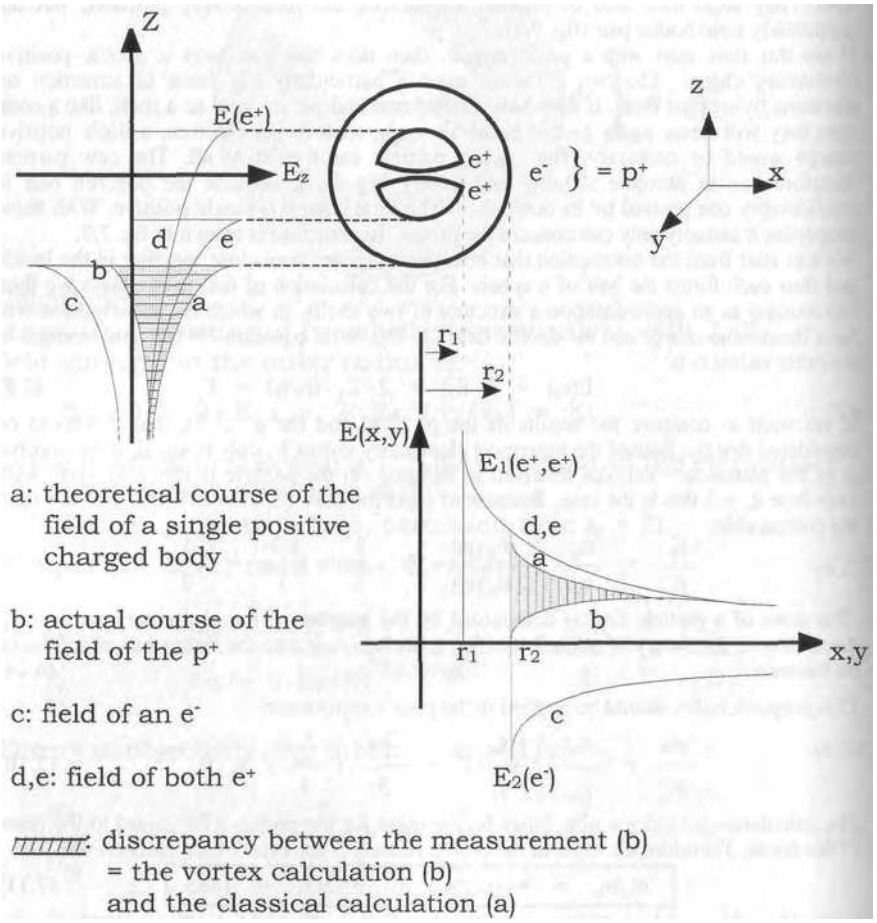

Fig. 7.8: The proton and the electric field of the three elementary vortices in x-, y- and z-direction

7.8 "Strong interaction"

A central question of nuclear physics concerns the forces which keep the atomic nucleus, which consists of many neutrons and protons, together and give it its very good stability in spite of the like positive charge (key question XIV fig. 7.13).
According to today's textbook opinion (course of the field indicated with a in fig. 7.8) the forces of repulsion between the individual protons increase further as the distance gets smaller, to obtain immense values within the nucleus. They theoretically had to be overcome by new and unknown nuclear forces. Therefore physicists assume the hypothesis of a "strong interaction". But they are mistaken.
The answer to this open question is provided by the course of the field (b) for the proton, sketched in fig. 7.8. We see that the electric field at first indeed still increases if we approach the proton, but in the proximity it contrary to all expectations decreases again until it is zero. With that then also any force of repulsion has vanished! But the course of the field follows without compulsion from the overlap of the three individual elementary vortex fields.
The field direction in the z-direction even is reversed! In this topsy-turvy world, in theory, an electromagnetic force of attraction between two like charged protons can occur. We conclude:
A strong interaction doesn't exist at all. The usually given values for "range" and "strength" just represent a misinterpretation. The hatched drawn area marks the difference which is misinterpreted by quantum physics. The model concept over and above that answers another mysterious property of the proton. As an electrically charged particle with a spin it first of all should form a magnetic moment for reason of the rotating charge. But until now the measurable order of magnitude couldn't be explained.

7.9 Magnetic moment of the proton

If the inner positrons rotate around each other with oppositely pointing spin, then the magnetic field line is already closed within the particle and no effect in x- or y-direction is observable from the outside.
As pair they however still can rotate together around the z-axis and they'll do that. The overlapping electron for reason of its rotation of its own will likewise build up a magnetic dipole moment along its axis of rotation. It also will align its axis in the z-direction, so that now all three elementary vortices have one field axis. Being comparable to individually "elementary magnets" aligned in the same direction they produce a triple magnetic moment (key question XII fig. 7.13).
If we namely would start with a single positively charged body according to the theory of quantum mechanics, then we would have expected the value of the nuclear magneton<i> p_m as the magnetic moment for the proton $p_m = e \cdot \hbar/2m$. Opposite to that provide experiments with protons the approx. threefold value as already predictable by the new vortex theory. In addition does the direction of the vector p_{mp} correspond with the spin-axis, so as if the proton were negatively charged. The reason for that is that only the outermost elementary vortex determines the spin of the particle, and that is actually a negatively charged electron! Also this excellent agreement in the case of the proton can be judged as proof for the correctness of the vortex model.

<i>: The nuclear magneton has the value of: $p_{mk} = 5{,}0508 \cdot 10^{-27}\ Am^2$

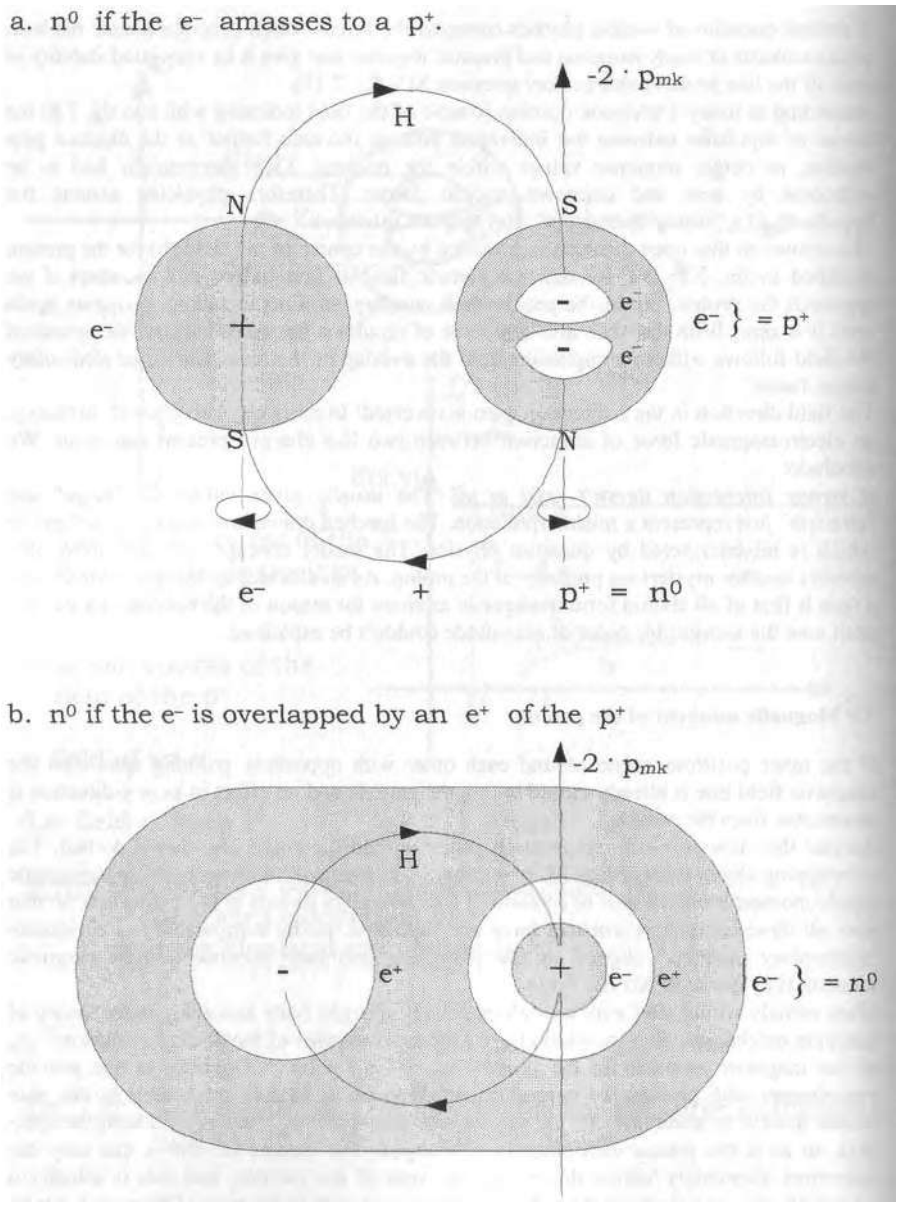

Fig. 7.10: The neutron with magnetic dipole field H

7.10 Structure of the neutron

Until now could not be solved, why despite its missing charge also the neutron n° has a magnetic moment. The experimentally determined value is approx. the double of the nuclear magneton. Further was with measuring techniques an only 0,14% bigger mass with regard to the proton determined. The difference is approximately two and a half electron masses. And how reads the answer in the view of the potential vortex theory? It is obvious that a positively charged proton and a negatively charged electron mutually attract and amass together (fig. 7.10a). A pair annihilation can't occur, because the electron, which jackets both positrons, prevents this. The formation of an outer shell is not permitted by the high stability of the proton. It would have to be a positron shell, which instead of neutrality would produce a double positive charge. Conceivable is however the configuration, in which one of the two e^+ of the proton takes up the e^- in its inside and overlaps it (fig. 7.10b).

At first appears the amassing of p^+ and e^- to be the obvious answer to the structure of the neutron also in view of the small increase in mass. Since both elementary particles (p^+ and e^-) have a spin, will they align their axes of rotation antiparallelly and rotate against one another, exactly like an electron pair. But we now have unequal conditions: the proton brings the triple magnetic moment, the electron however only the single, and its field line will be closed by the proton. The difference which remains is the measurable double nuclear magneton, with which key question XIII (fig. 7.13) would be answered exhaustively.
This structure is shown in fig. 7.10a and has as rest mass the by only one electron mass increased proton mass, but it will deviate from this value, when the unequal partner come closer. Doing so the electron will be more strongly compressed by the heavier proton as vice versa.
Mass, magnetic moment and charge thus correspond to a large extent with the measurement values. Problems are seen concerning the spin and the stability.
Set of problems concerning spin: both the e^- and the p^+ have a half-integer spin, for which reason this configuration should have an integer spin.
Set of problems concerning stability: the neutron decays as is well-known in a p^+ and an e^- , but this object should be shorter-lived as determined by experiments. If namely the partner come each other very close, then the field strength of the p^+, contrary to expectation, doesn't increase but decreases, as is shown in fig. 7.8. The e^- therefore can only be bound very, very loosely; in z-direction it even will be repelled!
For these reasons is the open structure, which is shown in fig. 7.10a, not feasible as an isolated elementary particle, but only in a spatially extended network, like it is present in an atomic nucleus. In this case the neutron is, as is well-known, lighter by the mass defect, which is interpreted as binding energy.
Possibly it only concerns an intermediate stage. The heavier final product of the n° then could look like is shown in fig. 7.10b. For this version the line of the magnetic field already is closed partly within the particle, so that also here the approx. double nuclear magneton remains as a rest with a sense of orientation, as if the neutron were negatively charged.
Without charge and with the 1/2 spin it in this configuration fulfils all important quantum properties of the neutron, even that of the stability.

the field of the e^-: $E_{31}(-) = - E_1 (r_1/r_3)$,

the field of the e^+: $E_{32} = E_2 (r_2/r_3) = E_1 (r_2/r_3)$

and in addition the e^+: $E_{31} = E_1 (r_1/r_3)$.

$$E(r_3) = E_{31}^{(-)} + E_{32} + E_{31} + \underbrace{E_0}_{\text{negligible}}$$

With the radius relation (eq. 7.4): $r_2 = 2*r_1$ und $r_3 = 3* r_1$
The total field is:

$$\frac{E(r_3)}{E_1} = -\frac{r_1}{r_3} + \frac{r_2}{r_3} + \frac{r_1}{r_3} = -\frac{1}{3} + \frac{2}{3} + \frac{1}{3} = \frac{2}{3} \quad (7.12)$$

With z_{en} = 4 elementary vortices

$$\frac{r_n}{r_p} = \frac{z_{ep}}{z_{en}} \cdot \frac{E_p(r_2)}{E_n(r_3)} = \frac{3}{4} \cdot \frac{1}{2/3} = \frac{9}{8} = 1{,}125 \quad (7.13)$$

n_0 is 12,5% bigger than p±

$$\frac{m_n}{m_p} = \frac{z_{en}}{z_{ep}} \cdot \left(\frac{r_p}{r_n}\right)^2 = \frac{4}{3} \cdot \left(\frac{8}{9}\right)^2 = 1{,}05 \quad (7.14)$$

n^0 is 5% heavier than p±

Fig. 7.11: Calculation of the mass of the neutron

7.11 Calculation of the neutron

The calculation of the mass for the structure of the neutron according to fig. 7.10b has still remained open.

Because in this book for the first time has been shown, how the mass can be calculated, if the particles are understood as potential vortices, we also in this case again want to make use of this possibility.
We have, like for the μ^-, a structure of three shells with the radii r_1, r_2 and r_3. At the outer radius r_3 the fields of the elementary vortices on the inside have an effect on the electron On the outside: like is the case for the μ^-

the field of the e^-: $E_{31}^{(-)} = -E_1(r_1/r_3)$,

the field of the e^+: $E_{32} = E_2\,(r_2/r_3) = E_1\,(r_2/r_3)$

and in addition the e^+: $E_{31} = E_1\,(r_1/r_3)$.

The total field is, with the radius relation equation 7.4:

$$\frac{E(r_3)}{E_1} = -\frac{r_1}{r_3} + \frac{r_2}{r_3} + \frac{r_1}{r_3} = -\frac{1}{3} + \frac{2}{3} + \frac{1}{3} = \frac{2}{3} \quad (7.12)$$

If we compare the neutron, in which now $z_e = 4$ elementary vortices are involved, with the proton:

$$\frac{r_n}{r_p} = \frac{z_{ep}}{z_{en}} \cdot \frac{E_p(r_2)}{E_n(r_3)} = \frac{3}{4} \cdot \frac{1}{2/3} = \frac{9}{8} = 1{,}125 \quad (7.13)$$

then we infer from the arithmetically determined result that the neutron according to the radius is 12,5% bigger than the proton. The mass is calculated to:

$$\frac{m_n}{m_p} = \frac{z_{en}}{z_{ep}} \cdot \left(\frac{r_p}{r_n}\right)^2 = \frac{4}{3} \cdot \left(\frac{8}{9}\right)^2 = 1{,}05 \quad (7.14)$$

The particle therefore has a mass which is 5% larger than for the proton, slightly more as has been measured for the neutron. The difference is acceptable. The particle after all is structured very asymmetrically, in which the reason is to be seen, why the uncharged particle, looked at from close up, nevertheless shows an observable charge distribution.

Decay equations if neutrinos are involved:

$$n^0 \longrightarrow p^+ + e^- + \bar{\nu}_e \quad (7.15)$$

$$n^0 + \nu_e \longrightarrow p^+ + e^- \quad (7.15^*)$$

$$\mu^- \longrightarrow e^- + \bar{\nu}_e + \nu_\mu \quad (7.16)$$

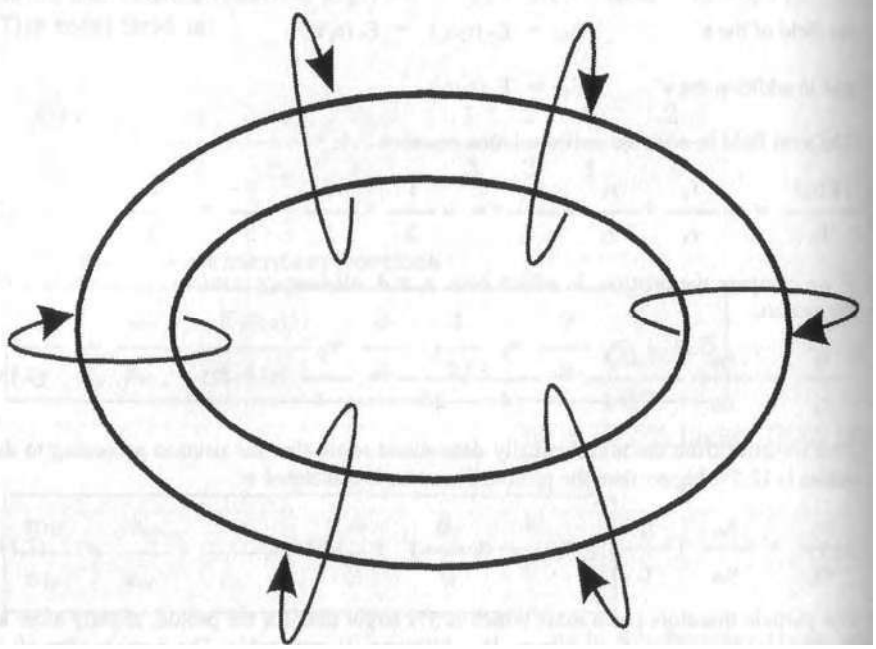

Fig. 7.12: The electron-neutrino as a ring-like vortex

7.12 ß-decay

In the case of the calculated quasistable particles, the μ^- and the n°, the verification by means of the well-known decay processes is still due. Also free neutrons, those which are not bound in an atomic nucleus, decay. But with an average life of 918 seconds they are by far the longest living among the quasistable elementary particles. Should the neutron decay be triggered by neutrinos, then obviously a distant flying past does not suffice. For that the electron is bound in the proton too tight. There probably has to occur a direct "crash", in which a neutrino is used, since the decay equation reads:

$$n^0 \longrightarrow p^+ + e^- + \overline{\nu}_e \quad (7.15)$$

As could be expected a proton p^+, an electron e^- and the mentioned electron-antineutrino ν_e are formed. What here is written down as the emission of an antiparticle, is equivalent in the absorption of the particle<i>, in this case of the neutrino. The reaction equation 7.15 can be reformulated accordingly<i>:

$$\boxed{n^0 + \nu_e \longrightarrow p^+ + e^-} \quad (7.15^*)$$

Also for the decay of the myon an electron-neutrino is used. In both cases it provides the energy necessary for the decay. But we can really understand the β-decay only, after we have got to know these particles better.

Without charge and without mass neutrinos show hardly any interactions with matter and as a consequence they possess the enormous ability of penetration - as is well-known. They are said to participate in the „weak interaction", which should trigger a conversion of the concerned particles, which is their decay. Pauli already has postulated the neutrino 1930 theoretically, because the transition from a half-integer spin to an integer spin for the n^0 -decay otherwise wouldn't have been explicable.

If we imagine an elementary vortex is being born, but the local field strength and energy isn't sufficient for obtaining a quantized state. The result is an incomplete potential vortex, which has an open vortex centre and as a consequence shows no localization at all. In the form of a vortex ring it oscillates around itself, while it continually turns its inside to the outside and then again to the inside.
One moment the vortex ring is green, then it is red again, one moment matter, then anti-matter, one moment positively charged and the next moment negatively charged. In contrast to the photon the number of the involved elementary vortices z_e for the neutrino is odd (for the ν_e $z_e = 1$). Perpendicular to the direction of propagation the neutrino has a spin $(s/\hbar = ½)$ for reason of a rotation, which overlaps the pulsating oscillation. This vortex ring is, as said, not a member of stationary matter, because it doesn't form a "black hole" in its centre, where the speed of light becomes zero. But it has an absolute stability like every elementary vortex, even if it only occurs incomplete and hence not in any quantized form,. This concept of the electron-neutrino as an open oscillating elementary vortex in the form of a ring-like vortex covers the experimentally determined realizations unexpectedly well.

<i>: Kussner, H.G.: Grundlagen einer einheitlichen Theorie der physikalischen Teilchen und Felder, Musterschmidt, Gottingen 1976, S.155

A strong interaction doesn't exist. The electric field in the proximity of the proton goes to zero within the range which is determined with measuring techniques.

A weak interaction doesn't exist. That interaction only is a special case of the electromagnetic interaction which appears in a weakened form. _____

XII: Why does the proton have approximately 3 times the magnetic moment which can be expected for reason of the only single charge?
(3 elementary vortices)

XIII: Why does the neutron as an uncharged particle anyway have a magnetic moment?
(Structure of the n°)

XIV: What owes the atomic nucleus, which consists of like charges, its stability?
(Course of the field of the p^+, instead of "strong interaction")

XV: Why does the free neutron decay, although it is stable as a particle of the nucleus? _____
(Interaction with neutrinos)

XVI: Why do neutrinos nevertheless participate in the "weak interaction", although they have no mass and no charge? _____
(Oscillating charge)

XVII: How can be given reasons for the finite range _____of the "weak interaction"?
(Reaction cross-section for particle decay)

Fig. 7.13: Further key questions of quantum physics (Continuation of figures 4.4 and 6.13)

7.13 "Weak interaction"

Let's now look again at the ß-decay of the neutron, in which a neutrino ν_e is used. But this by no means will be a process of the weak interaction. Instead will neutrinos, contrary to the textbook opinion, participate in the electromagnetic interaction. They after all are one moment positively charged and the next moment negatively charged. With slow-acting gauges this it is true can't be proven, because the interaction is zero on the average. But this charged oscillating vortex ring can exert a considerable effect while approaching a neutron, which is based solely on the electromagnetic interaction.
The neutron is stimulated to synchronous oscillations of its own by the high-frequency alternating field of the neutrino, until it in the case of the collision releases the bound electron, which takes up the energy provided by the neutrino and transports it away. The interaction obviously is only very weak due to the oscillation. But a physical independency of it has to be disputed.
The finite range, which is given in this context, indicates the reaction cross-section around the n°-particle, within which the "crash" and as a consequence the β-decay occurs. This range is considerable larger as the particle itself. The electromagnetic interaction for such small distances after all is so violent, even if it only occurs in pulses, that the neutrino is thrown out of its path and can fly directly towards the neutron.

Perhaps we now understand also the β-decay of the myon. It actually were to be expected that without outside disturbance an absolute stability could exist because of the ideal symmetry of the μ^-. On our planet we however are in every second bombarded with approx. 66 milliard (billion) neutrinos per cm^2 <i>. Obviously it takes 2,2 µs on the average till a neutrino ν_e flies past a myon so close that it decays. In doing so it stimulates the outside elementary vortex to violent oscillations by trying to synchronize it. In this case the electron-neutrino ν_e carries away with it the two outer, and therefore weaker bound, elementary vortices of the myon, which meanwhile are oscillating synchronously. The innermost vortex, an electron e^-, is left behind. The decay of the myon which takes place with a probability of almost 100 % reads:

$$\mu^- \longrightarrow e^- + \overline{\nu}_e + \nu_\mu \quad \text{resp.} \quad \mu^- + \nu_e \longrightarrow e^- + \nu_\mu \qquad (7.16)$$

Thus a different neutrino ν_μ, is formed which can be distinguished from the ν_e and is called myon-neutrino since it forms from the μ^-. Actually it even has a similar structure of three shells, as is shown in fig. 7.5. But the vortex centre is open and the particle isn't stationary anymore. In the picture now only a momentarily state is shown, in which the ν_μ appears green on the outside and red in its open centre. As already for the ν_e oscillates also here the inside to the outside and vice versa, this time merely as a packet of three shells, so that also this particle shows all the typical neutrino properties discussed for the example of the ν_e.
The for potential vortices typical and already discussed phenomenon of transport here has an effect. In particular in connexion with vortex rings this property is known from hydrodynamics. It thus can be observed, how vortex rings bind matter and carry away with them. Because the neutrino is not quantized, it neither is restricted with regard to its ability to transport elementary vortices. Consequently even bigger configurations are conceivable, like configurations of 5 shells, 7 shells etc..

<i>: "Zeugen aus der Sonne", VDI-Nachrichten Nr. 45 vom 9.11.90, Seite 26

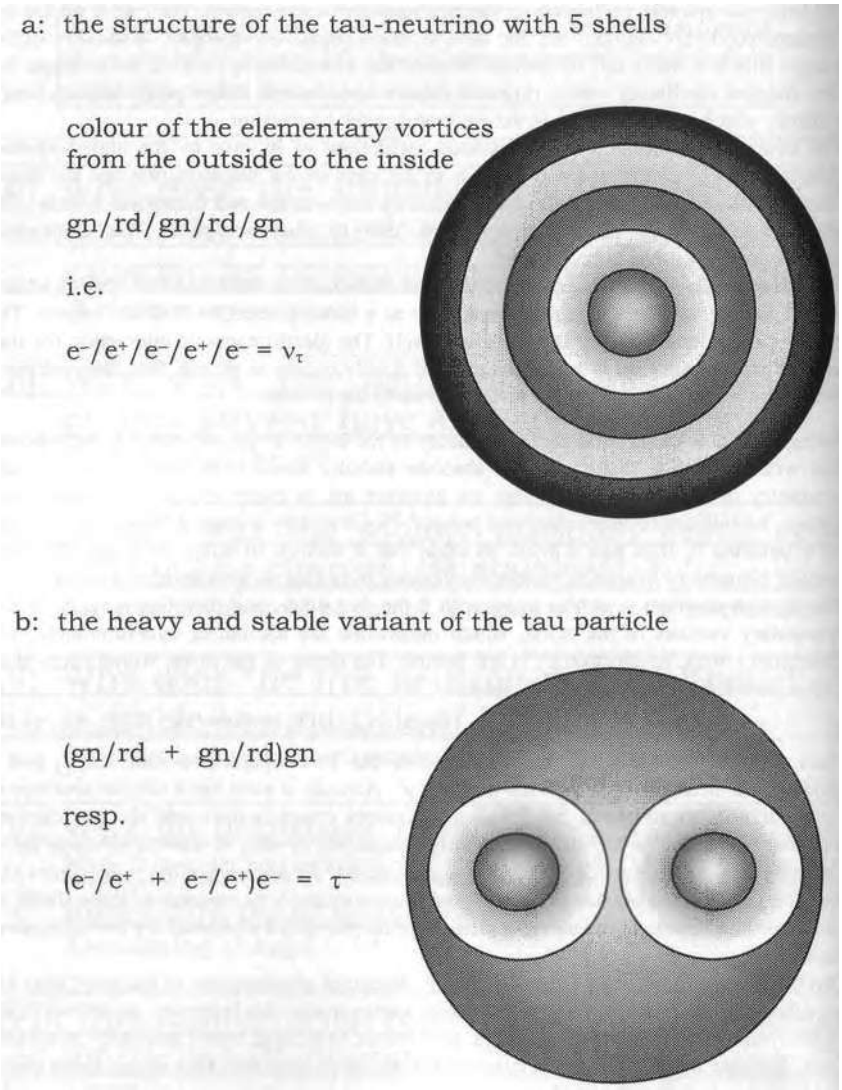

Fig. 7.14: Tau-neutrino and tau particle

7.14 Tau particle

In the table of the leptons after the e^- and the μ^- as the next particle the tau particle τ^- is found with its accompanying neutrino ν_τ. The obvious solution for the tau particle is the structure of five shells, as is shown in fig. 7.14a. With that the electron would have another particularly heavy relative with otherwise very similar properties.
For the myon the neutrino was stable, the particle itself however instable. We after all huve explained the particle decay as a consequence of an outside disturbance, and disturbances always are based on interactions. Correspondingly should, with the small possibility for an interaction, also the neutrino ν_τ of the tau particle have a better stability than the particle τ^- itself.
Without doubt this structure of 5 shells fulfils all known quantum properties like spin, charge etc. Merely the check of the mass is still due. This we now want to calculate for the structure shown in fig. 7.14a.

$$m_5 = m_p \cdot \left(\frac{z_{e\tau}}{z_{ep}}\right)^3 \cdot \left(-\frac{r_1}{r_5} + \frac{r_2}{r_5} - \frac{r_3}{r_5} + \frac{r_4}{r_5}\right)^2 \quad (7.17)$$

$$m_5 = 1836 \cdot \left(\frac{5}{3}\right)^3 \cdot \left(\frac{2}{5}\right)^2 \cdot m_e = \underline{\underline{1360 \cdot m_e}} \quad (7.17^*)$$

But the for the tau particle measured value is considerable higher!
Even if this structure is the only possible in the case of the neutrino ν_τ for reason of the complete symmetry, will the tau particle however change its structure by itself if another structure exists, which is more stable, thus in which the particle can take a bigger mass. Such a maximum provides the structure shown in fig. 7.14b after checking all possible configurations with five elementary vortices:

$$m_\tau = m_p \cdot \left(\frac{z_{e\tau}}{z_{ep}}\right)^3 \cdot \left(\left(-\frac{r_1}{r_3} + \frac{r_2}{r_3}\right) \cdot 2\right)^2 \quad (7.18)$$

$$m_\tau = 1836 \cdot \left(\frac{5}{3}\right)^3 \cdot \left(\frac{2}{3}\right)^2 \cdot m_e = \underline{\underline{3778 \cdot m_e}} \quad (7.18^*)$$

This value now lies 8% above the measurement values. It would be obvious, if unbound tau particles predominantly would take the structure shown in fig. 7.14b. The remaining error becomes explicable, if a very small number of tau particles in the lighter structure according to fig. 7.14a are involved with a correspondingly smaller probability.

The enormous variety of kinds of decay, and not a single one of the dominating ones has a probability of over 50%, makes it more difficult for us, to be able to directly infer the inner structure of a particle from the decay products. It nevertheless should be mentioned that after all 35% of all decays take place by taking up and using a neutrino ν_e or ν_τ, entirely in accordance with the model of the myon decay (equation 7.16).

name	mass (m/m_e) measured	mass (m/m_e) calculated	el.-vortices z_e	charge Q	radius r/r_p	inner structure of The elementary vortices, colour: (gn=green; rd=red) from the inside to the outside
e^-	1	-	1	-1	-	Fig. 4.3 gn
γ^0	-	136	2	0	3	Fig. 7.3 rd/gn
μ^-	207	204	3	-1	3	Fig. 7.5 gn/rd/gn
η^0	1072	1088	4	0	1,5	rd/gn/rd/gn
(ρ^-)	1509	1360	5	-1	1,5	Fig. 7.14a gn/rd/gn/rd/gn
D^0	3650	3672	6	0	1	rd/gn...rd/gn
D^+ or F^+	3658 till 4188	4284	7	+1	1	gn/rd...rd/gn
(B^0)	10321	8704	8	0	0,75	rd/gn...rd/gn

7.15 Table of vortices of the calculated leptons and mesons compared with measurement values (Part 1).

7.15 Pions

Unlike the leptons, which we could derive and calculate fairly completely, the mesons don't have a half-integer spin. With this characteristic property they therefore can't represent an individually overlapped elementary particle and they probably will consist of the amassing in pairs of individual configurations of potential vortices. This kind of bond can't be particularly tight. Consequently we don't know any stable mesons.

The most important basic building part of the mesons we have got to know over the positronium in fig. 7.3. It necessarily has to amass to another particle, otherwise it annihilates under emission of a γ-quanta, as already mentioned. This γ^0-particle, as it will be named here, has the mass of:

$$m_{\gamma 0} = (2/3)^3 \cdot (1/2)^2 \cdot 1836 \cdot m_e = 136 \cdot m_e \quad (7.19)$$

which only can be determined arithmetically. As a partner, to which the γ^0-particle can amass, first of all another γ^0-particle should be considered. Because both partner will rotate against one another, this new particle would not have a spin and moreover would be uncharged. The mass now would be twice as big with:

$$m_{\pi 0} = 2 \cdot m_{\gamma 0} = 272 \cdot m_e . \quad (7.19^*)$$

But the two γ^0-particles will come very close together and mutually feel the local, in the same direction orientated, distribution of the field, which will lead to a weakening of the field and as a consequence to a slight reduction of the mass.
With these properties it probably concerns the uncharged pion π^0. This model concept finds an excellent confirmation in the two possible kinds of decay, which can be regarded as equivalent:

$\pi^0 \longrightarrow \gamma + \gamma$ with a probability of 99%
and

$\pi^0 \longrightarrow \gamma + e^- + e^+$ with a probability of 1%

Also in the case of the charged pion $\pi^\pm$ the observable decay offers a big help, which will take place with a frequency of almost 100 %:

$$\pi^\pm \longrightarrow \mu^\pm + \nu_\mu$$

The equation doesn't state anything about the fact, if a neutrino ν_e is used in the process. But it points at the circumstance that the partner of the γ^0-particle for the $\pi^\pm$ most likely is a myon $\mu^\pm$. The mass will be smaller than the sum of both building parts:

$$(204+136) * m_e = 340 * m_e.$$

name	mass (m/m_e) measu-red	masse (m/m_e) calcu-lated	elem.-vorti-ces z_e	char-ge Q	inner structure of The elementary vortices, colour: (gn=green; rd=red) from the inside to the outside
B^-	11194	9793 +?	9 +?	-1	$r/r_p = 0{,}75$ gn/rt...rt/gn
(Y^0)	18513	17001 +?	10 +?	0	$r/r_p = 0{,}6$ rt/gn...rt/gn

Some compound configurations

π^0	264	272	4	0	2 x fig. 7.3 $\gamma^0 + \gamma^0 = \pi^0$
π^-	273	340	5	-1	fig. 7.3 + fig. 7.5 $\mu^- + \gamma^0 = \pi^-$
τ^-	3487	3778	5	-1	fig. 7.14b (2x gn/rd)/gn
(K^0)	974	918 +?	6 +?	0	$r/r_p = 2$ (2x rd/gn)/ rd/gn
(K^-)	967	939 +?	11 +?	-1	(rd/gn + gn)/ rd/gn + 3 γ^0

Fig. 7.16: Table of vortices of the calculated leptons and mesons compared with measurement values (Part 2).

7.16 Table of vortices of the mesons

The numerous kinds of decay for K-mesons suggest that these strange particles will consist of various combinations of amassed together and in pairs rotating γ^0- and $\mu^{\pm}$-particles. The possibilities of combination now already have increased in such a way that for every kaon and other mesons several solutions can be proposed. To avoid unfounded speculations, only a few clues will be given.

Besides the γ^0-particles also heavier arrangements should be considered as partner for the spin and as a building part for kaons and other mesons.
If for instance a π^0 is overlapped by a γ^0, then this particle has an arithmetically determined mass of 918 m_e. It therefore can concern a building part of the uncharged kaon K^0.

The likewise with three γ^0 formed configuration of 6 shells however, if it actually would staystable for the duration of a measurement, would have the mass of 3672 electron masses<i>.

A very much better detectability must be attributed to the configuration of 4 shells which consists of two γ^0, so to speak a heavy relative of the γ^0 and the π^0. It among others should be able to decay like a π^0.With this property and with an arithmetically determined mass of 1088 m_e it actually only can concern the η^0-meson. Solely according to the numeric value the η^0-meson could also consist of four π^0-mesons; but the decay in only two light quants speaks against it.

The kaon-puzzle in addition is made more difficult by the spontaneously possible ability to change of the involved γ^0-particles during a process of decay, as is made clear by the numerous kinds of decay. These dependent pion halves can be "swallowed" or "spit out" by neutrinos in the process, they can form from incident light or be emitted as photons and eventually they even can break up in their individual parts.

In fig. 7.16 the possible configurations of potential vortices are sketched and the respective, according to the new theory calculated, mass is given. If above that the other decay products and quantum properties, which can be given for the vortex structures, are added, like e.g. charge, spin and if need be magnetic moment, then an assignment without doubts to the until now only from measurements known elementary particles is possible. In order to better be able to assess the efficiency of the potential vortex theory, the measurement values are compared to the calculated values.

Some terms are put in brackets, because it can be assumed that the calculated part only concerns the dominating part, to which further γ^0 or other small configurations of vortices will amass for reason of its high mass. Correspondingly should the mass in that case be corrected slightly.

<i>: It could e.g. concern the D°-meson.

name	way of decay	mass (m/m_e) measured	mass (m/m_e) calculated	elem.-vortices z_e	charge Q	Inner structure of the baryon vortices
p^+	stable	1836	- (reference value)	3	+1	fig. 7.8 $r/r_p = 1$ $(2x\ e^+)/e^-$
n^0	$p^+ + e^- + \bar{\nu}_e$ (100%)	1839	1837	4	0	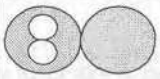 figure 7.10a $p^+ + e^-$
			1934	4	0	figure 7.10b n^0 $r/r_p = 1{,}13$
Λ^0	$p^+ + \pi^-$ (64%)	2183	(2176)	8	0	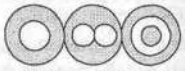 $\gamma^0 + p^+ + \mu^-$ (64%)
	$n^0 + \pi^0$ (36%)		2187 (2206)	8	0	$\gamma^0 + n^0 + \gamma^0$ (36%)
Σ^+	$p^+ + \pi^0$ (51%)	2328	(2108+?)	7 + ?	+1	$\gamma^0 + p^+ + \gamma^0$ (+?) (51%)
	$n^0 + \pi^+$ (49%)		2142+? 2177	9	+1	$\gamma^0 + e^+ + p^- + \mu^0$ (49%)
Σ^-	$p^+ + \pi^-$ (100%)	2343	2274	9	-1	$\gamma^0 + n^0 + \mu^-$ (100%)

Fig. 7.17: Table of vortices used for the calculation of the most important barvons with suggestions for the structure (Part 3).

7.17 Table of vortices of the baryons

The number of possibilities of combination quickly increases, if only a few elementary vortices extend the structure of a particle. This probably is the reason for the large number of observable hyperons, which recently have been produced artificially and observed with the help of particle accelerators.

Both the neutron and the lambda particle can exist in a lighter and a heavier variant. At the moment of the decay, as it for instance is observed in a bubble chamber, according to expectation the state with the smaller mass takes the bigger probability. But in the amassing with further particles as building part of bigger and heavier hyperons the heavier structure is more likely. This circumstance should be considered in calculating the mass of the hyperons.

In figures 7.17 and 7.18 the most important baryons are listed, which are characterised in the way that one of the amassed together packets of vortices is a nucleon, thus a proton or a neutron.

The given, from measurements known, kinds of decay are able to confirm the inner structure pretty good. Of course an infinitely lot of combinations are conceivable and numerous predictions are possible. But speculations are unnecessary from the time on where we are able to calculate the particles!
The restriction to the few in the table listed particles seeming to be important hence doesn't limit the universal importance of the theory of objectivity in any way!

name	way of decay	mass (m/m_e) measured	mass (m/m_e) calculated	elem.-vortices z_e	charge Q	Inner structure of the baryon vortices
Σ^0	$\Lambda^0 + \gamma$ (100%)	2334	2342	10	0	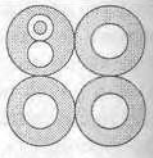 $n^0 + \gamma^0 + \gamma^0 + \gamma^0$ (100%)
Θ^0	$\Lambda^0 + \pi^0$ (100%)	2573	2478	12	0	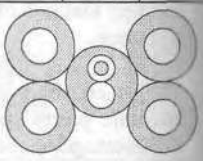 $n^0 + \gamma^0 + \gamma^0 + \gamma^0 + \gamma^0$ (100%)
Θ^-	$\Lambda^0 + \pi^-$ (100%)	2586	2546	13	-1	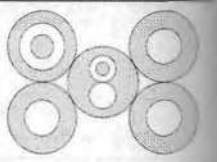 $n^0 + \gamma^0 + \gamma^0 + \gamma^0 + \mu^-$ (100%)
(Ω^-)	$\Lambda^0 + K^-$ (69%)	3273	3172 +?	17 +?	-1	$n^0 + \gamma^0 + \gamma^0 + ?$ (31%: ? = div.)

Fig. 7.18: Table of vortices used for the calculation of the most
important baryons with suggestions for the structure (Part 4).

8. Unified theory

With the theory of objectivity the longed for goal of a "theory of everything" (TOE), of an universal theory, seems to have moved within reach. If in the nineteenth century still promising field theories and approaches were being discussed, then has at the latest Einstein's theory of relativity destroyed all hopes in such a theory. Science as a consequence has become very much more modest and understands a TOE only as the unification of all known interactions.

Einstein has stated the minimum demand so: "a theory should be favoured by far, in which the gravitational field and the electromagnetic field together would appear as a whole" <i>. It is evident that a subjective or relativistic observer theory never is able to achieve this.

The presented theory of objectivity made it possible that the unification here for the first time actually has succeeded. This undoubtedly brings science a whole lot further, but it still is not sufficient to lie one's hands in one's lap being content with oneself. After all we still know very much more phenomena, which likewise should be unified. After all it is no accident that both Maxwell and Einstein, to name only two prominent representatives, after completion of their well-known works have struggled for the question, what sort of phenomenon it concerns in the case of the temperature and how this could be integrated in their theory.

The requirement reads: We must be able to derive all basic factors, which influence our system of units with their basic units, as a compulsionless result from the new theory. Besides the dimensions of space and time which determine our continuum, the explanation and unification of the basic factors mass and charge has to be tackled. If we have succeeded in doing so, we'll also tackle the problem of the fifth and last basic factor, which until now has put itself in the way of any unified theory as the question of fate, the problem of the temperature!

<i>: Einstein, A.: Grundziige der Relativitatstheorie, Vieweg+Sohn, Braunschweig 1973, 5. Aufl., WTB 58. Seite 97.

"A theory should be favoured by far, in which the gravitational field and the electromagnetic field together would appear as a whole"<i>.

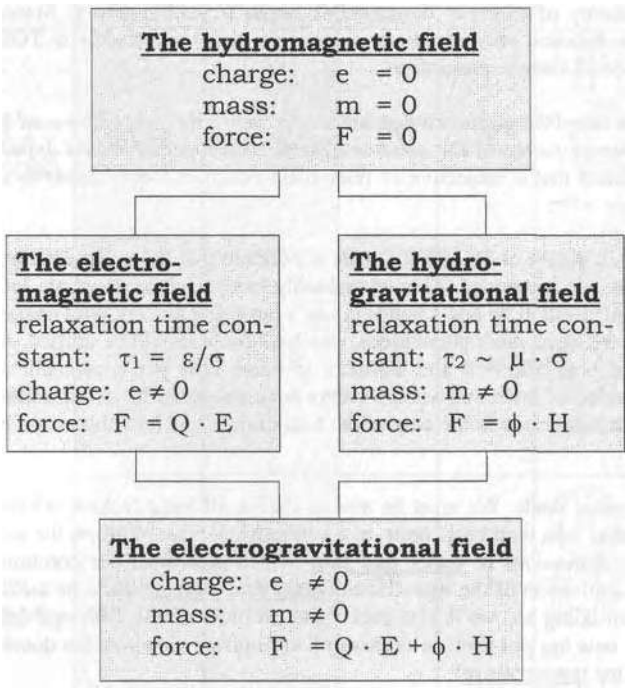

Fig. 8.1: Structuring of the fields and definition of terms

<i>: Einstein, A. : Grundziige der Relativitatstheorie, Vieweg + Sohn, Braunschweig 1973, 5. Aufl. , WTB 58.

<ii>: derived from the Greek hydro (= water).

8.1 Structure of the field theory

In contrast to Maxwell's theory the new field theory, which we derived from duality, is also able to describe fields, in which no particles and no quanta exist. It probably is justified and useful in the sense of a clearer communication, to give the new field a name of its own.
The author recommends the introduction of the term "hydrotic field". In it should be expressed, which importance water has for both the like named potential vortex and this field<ii>.
As we already have worked out, the hydrotic field is favoured particularly by polar materials and by a high dielectricity. Water is a corresponding and in the biosphere of our planet dominating material.

Whereas we had to correct the concept of a vortex free electric field, we had until now, considerable, we can take over the description of the magnetic field unchanged. This then should also be valid for its name. The new field which consists of both correspondingly is called hydromagnetic field.

In fig. 8.1 we recognize the structure. At the top stands the "hydromagnetic field", which is described mathematically by the equations of dual electrodynamics in fig. 3.3. It does not know quanta and as logical consequence neither charge nor mass! If we insert these equations, Ampere's law and the dual formulated Faraday law of induction, into each other, then there results as a mathematical description of our space-time-continuum the fundamental field equation (5.7, fig. 5.1). As a new physical phenomenon the potential vortex appears, which gives the hydromagnetic field a new and important property: this field can be quantized!

Starting-point is the wave, which for corresponding interference effects can spontaneously roll up to a vortex, which as highly concentrated spherical vortex finds a new right to exist and finds to a new physical reality.

The in the described manner formed particles show specific properties of their own. We now are able to attribute them for instance a charge or a mass. And these properties also can be investigated and described individually and isolated from each other. Thus are formed the two special cases, strange by nature, on the one hand the well-known, with the help of the Maxwell equations describable "electromagnetic field" and on the other hand the new "hydrogravitational field".

If we overlap the results of the two special cases, e.g. by adding the force effects of electric charges and accelerated masses, then we summarized obtain a field, which we accordingly should call "electrogravitational". This case is not at all unknown. Already Niels Bohr in this way has calculated the radii of the electron orbits in the hull of his model of the atom, to mention only one example. We can summarize:

The hydromagnetic field is the all encompassing and with that most important field. Apart from that the electromagnetic field of the currents and the eddy currents and the hydro-gravitational field of the potentials and the potential vortices merely describe the two possible and important special cases. For reasons of pure usefulness for every special case a characteristic factor of description is introduced, the charge and the mass!

Auxiliary terms (description of quantum properties):
* mass * charge * temperature * Planck's quantum of action

The hydromagnetic field does not know any quanta!

Structure of the fundamental field equation 5.7 (fig. 5.1):

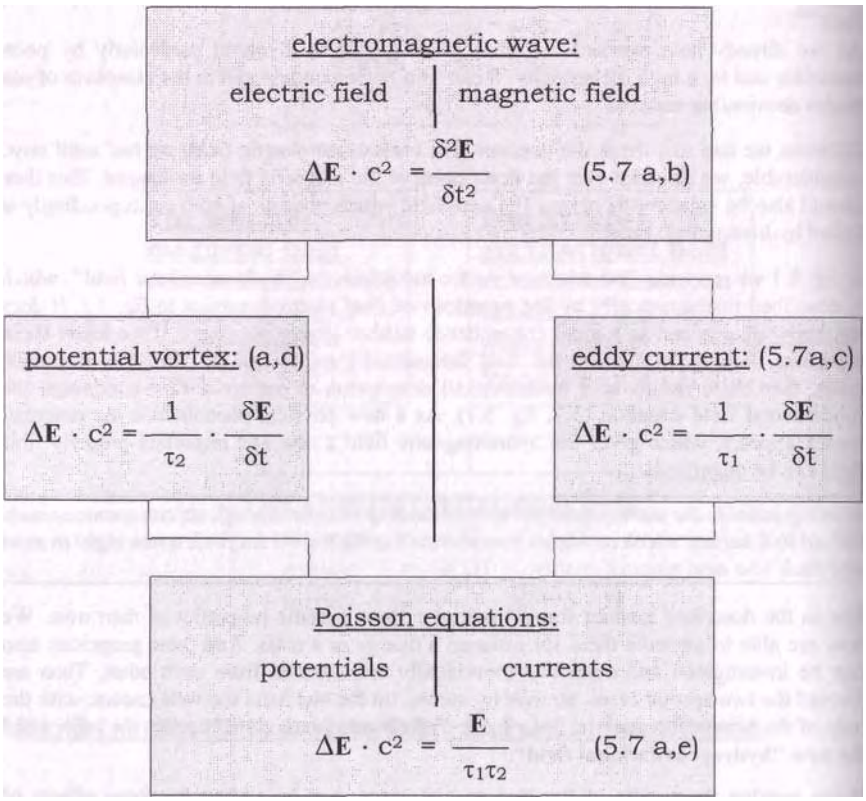

Fig. 8.2: Unified theory

*electromagnetic interaction (open field lines)
*gravitation (closed field lines)
*strong interaction (does not exist)
*weak interaction (only special aspect)

The interactions are a result of the field dependent speed of light!

8.2 Unification of the interactions

The discovery and introduction of the hydromagnetic field makes the desired unification possible, because the electromagnetic resp. Maxwell field, which describes the electromagnetic interaction, and the hydrogravitational field of the gravitation can be derived from this field as a consequence of the formation of quanta.
The kind of the interaction is caused by the course of the field lines of the field quanta which form as spherical vortices: the open field lines make the electromagnetic interaction possible. And the field, lines with a closed course lead to gravitation. Both are a direct result of the field dependent speed of light. A more perfect unification seems hardly possible.

As the next step the unification with the strong and the weak interaction is required, but it could be shown that those don't exist at all. It just concerns misinterpretations with much fantasy, which should help explain the difference between a wrong theory and the physical reality.

Numerous auxiliary terms for the description of the quantum properties exist, like for instance mass, charge or Planck's quantum of action. The prerequisite for their usability naturally is the existence of the quanta. But until these have found to a physical reality, the auxiliary terms are unnecessary. The hydromagnetic field does not know quanta, quantum properties or auxiliary descriptions. It will be shown that, according to expectation, also the temperature is a typical quantum property, which comes within the group of the auxiliary terms. In this way also the temperature is fitted into the unified theory without compulsion.

Without the by us for reasons of usefulness introduced auxiliary terms the fundamental field equation is left with its description of a spatial-temporal principle. If a world equation should exist, then this field equation 5.7 has the best prerequisites. For the fundamental field equation the division in four parts is repeated like already for the hydromagnetic field (fig. 8.1). It likewise consists of four individual parts, the wave (b), the two vortex phenomena (c and d) and the time independent term (e) (fig. 8.2). Whereas the duality still is combined in the wave, it comes to light clearly for the vortices to again be combined in the fourth case. Here arise however potentials and currents, which again can react and oscillate with each other, for instance as L-C-resonant circuit in an electronic circuit, with which the principle is repeated.
This principle is shown clearer for the phenomenon of the temperature as in all other cases. If we start at the top in the picture in fig. 8.2 we have an electromagnetic wave, which is absorbed and thus becomes a vortex. If the vortex falls apart, then eddy losses are formed. We observe that the temperature rises and propagates in the well-known manner. We have arrived in the bottom box, but this again can be taken as the top box for the now following process, because the equation of heat conduction is a vortex equation of type c or d! We discover a self-similarity:

The spatial-temporal principle formulated mathematically by the fundamental field equation can be carried over into itself time and again.

Temperature is the oscillation of contraction of the elementary vortices resulting from the speed of light depending on field strength.

a. at absolute zero temperature:

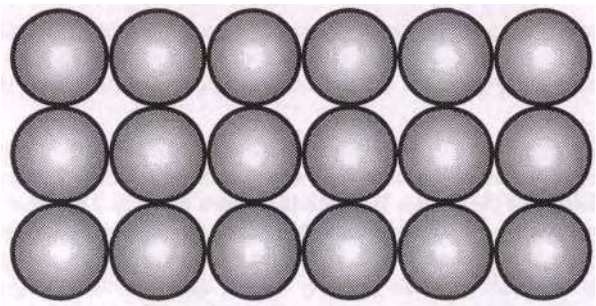

b. if thermally excited:

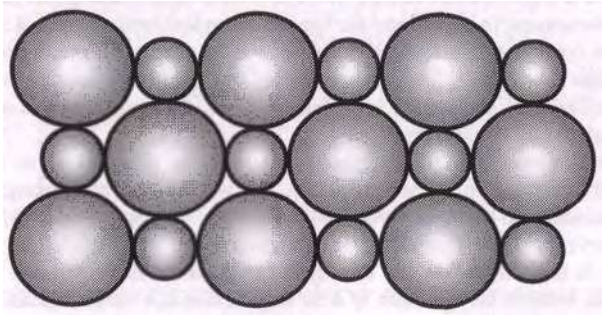

Fig. 8.3: Temperature as an oscillation of size for the speed of light depending on field strength

8.3 Temperature

Following the atomic view, in the case of heat it concerns kinetic energy of the molecules, which carry out more or less violent oscillations. In the case of gaseous materials with this concept, basing on mechanical models, actually successful calculations are possible, like for instance the speed distribution of gases won by Maxwell from theoretical considerations concerning probability.

But the attempt to apply the formulas of the kinetic theory of gases to solids and liquids only succeeds, if additional supplements and improvements are introduced. Since at all events it concerns temperature, thus the same physical quantity, of course also an uniform interpretation should be demanded, which in addition should stand in full accord to the presented design of an integrated theory (TOE).

Against the background of the new theory of objectivity we consider, what happens, if for instance the local field strength is increased by a flying past particle. The matter located at this point is contracted for a short time. By coming closer to each other, the individual elementary vortices mutually reinforce their field and are further compressed. Sometime this process comes to a standstill, is reversed and swings back.

At the same time every single particle, which in this way carries out an oscillation of size, has an effect on its neighbours with its field, to also stimulate these to the same oscillation, but delayed by some time. This phenomenon spreads in all directions. The propagation only will become stationary, if all neighbouring elementary vortices pulsate with the same amplitude. It now should be recorded:

> The oscillation of contraction of the elementary vortices we call temperature.

Also this thermodynamic state variable therefore is a result of the variable speed of light. At the absolute zero of temperature no oscillation takes place anymore, whereas the upper limit lies in infinity. Since the cause for temperature represents an oscillation of the local electromagnetic field strength around the cosmic field strength, the following phenomena must be considered as excitation and cause, as dictated by the fundamental field equation 5.7:

1. Electromagnetic waves (b) are able to stimulate matter particles to synchronous oscillations of contraction by their alternating field. In doing so energy in form of heat is transferred to the particles, with the result that their temperature is increased. The wave is absorbed completely, if the thermal oscillation corresponds with the frequency of the wave.

We speak of thermal radiation.

2. But also the two dual vortices, the eddy current (c) and the potential vortex (d) can cause oscillations of contraction. This immediately becomes clear, if we consider a vortex as the special case of the wave, in which the oscillation takes place around a more or less stationary vortex centre. In the case of the decay of vortices, of the transition of energy from vortices to matter, the increase in temperature is measurable.

In the case of this process of diffusion we speak of eddy losses and of loss heat.

Answers to open questions of thermodynamics:

1. Temperature occurs independent of the state in which the matter is (unified theory).

2. Temperature even occurs in solids, where a purely kinetic interpretation fails (unification).

3. Each elementary particle is carrier of a temperature.

4. Expansion with increasing temperature because of the increasing need for room for larger amplitude of oscillation (principle: bi-metal-thermometer).

5. For solids the thermal oscillation of size is primarily passed on by the electrons in the atomic hull. Good electric conductors therefore at the same time also have a high thermal conductivity. (principle: electrical resistance thermometer).

6. For gases the entire atoms carry out this task, for which reason a kinetic auxiliary description becomes applicable.

7. For extreme amplitudes of oscillation the atoms partly or entirely lose their enveloping electrons, when they change into the plasma state.

8. The second law of thermodynamics loses its claim to be absolute and at best reads: with today's technology we are not capable, to design a cyclic working machine, which does nothing else, as to withdraw heat from a heat container and to convert it into mechanical work.

Fig. 8.4: Questions concerning thermodynamics

3. Flying past particles, in particular unbound and free movable charge carriers (e) produce an alternating field for other fixed particles. Doing so kinetic energy can be transformed in temperature, thus in energy of pulsation. A good example is the inelastic collision. But it can also be pointed to numerous chemical reactions. Whoever searches for a concrete example, takes two objects in his hands and rubs them against one another. In that case the particles which are at the frictional surfaces are being moved past each other in very small distance, in this way causing oscillations of pulsation, which propagate into the inside of the objects according to the thermal conductivity. We speak of friction heat.

This model concept provides sound explanations for a whole number of open questions (fig. 8.4), i.e. why the temperature occurs independent of the state (1) and even in solids, where a purely kinetic interpretation fails (2). Every single elementary particle after all is carrier of a temperature (3).
With increasing temperature most materials expand, because the need for room, purely geometrically seen, increases for larger amplitude of oscillation (4). This principle is used in the case of a bi-metal thermometer.
In the case of solids the thermal oscillation of size is passed on primarily by the electrons in the atomic hull (5). Good electric conductors therefore at the same time also have a high thermal conductivity. An example of an application is the electric resistance thermometer.
In the case of gases the entire atoms carry out this task, for which reason a kinetic theory becomes applicable as an auxiliary description (6).
For extreme amplitudes of oscillation the atoms partly or entirely lose their enveloping electrons, when they change into the plasma state (7).
Finally the model concept even limits the second law of thermodynamics, which contains the postulate that it is impossible to design a cyclic working machine, which does nothing else, as to withdraw heat from a heat container and to convert it into mechanical work (8).

8.4 Heat energy

The discussed oscillation of contraction shows two characteristic properties, which must be looked at separately: the amplitude and the frequency.

Temperature describes solely the amplitude of the oscillation of size.

The heat energy however is determined by both,
by the amplitude as well as by the frequency.

Consequently the ideas of temperature and heat energy should be kept strictly apart. It therefore isn't allowed to set this oscillation equal to the electromagnetic wave in tables of frequency.
To be correct two tables should be given, one for the wave, characterized by a propagation with the speed of light, and another one for oscillations of contraction, thus for stationary phenomena and phenomena bound to matter. The latter indeed can likewise propagate relatively fast by fluctuations of pressure in the case of acoustical sound frequencies or by free movable charge carriers in the case of heat conduction, but the velocity of propagation for sound or heat is as is well-known still considerably smaller than the speed of light. Thus an assignment without doubts can be made as to which kind of oscillation it concerns.

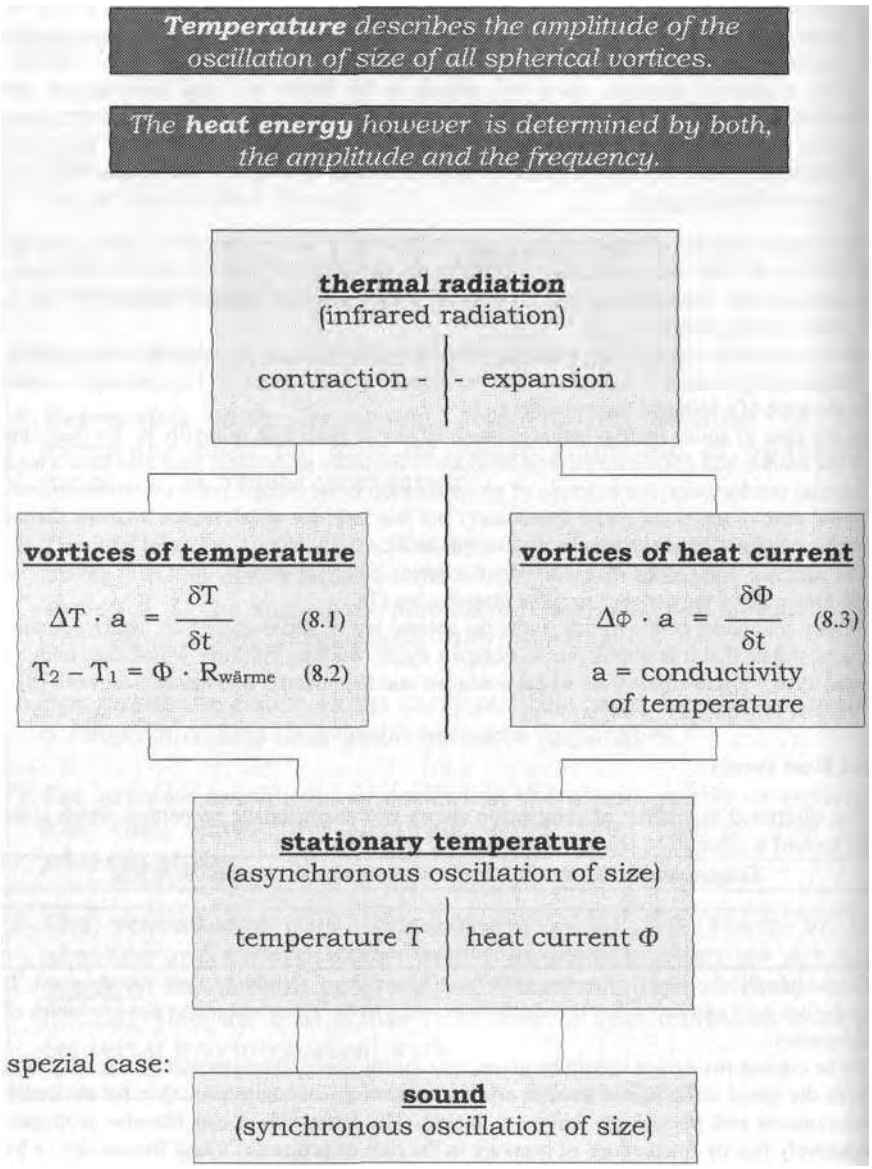

Fig. 8.5: Heat conduction resp. sound

8.5 Sound

The close relationship of longitudinal sound waves with the oscillations of contraction of thermally heated matter becomes particularly clear for ultrasound, where the arising heat in the inside of the body which is exposed to sound can be measured directly. The fundamental difference consists of the fact that the produced sound waves not only have the same frequency, but also the same phase, what needs not be the case for the temperature. The apparently uncoordinated occurring oscillations of size of the temperature, which as a rule occupy more space if the intensity increases, form a "thermal noise".

The oscillation of size with the same phase is not realizable at all in a spatial formation of particles, with one exception, the case that all particles expand and afterwards again contract simultaneously and in the same time. We can observe such a synchronization of the pulsation oscillations of all elementary vortices in the case of a pulsar. For us a pulsar looks like a "lighthouse" in space which shines with a fixed frequency. In reality it as well can concern a constantly shining sun, which carries out a synchronized, thermal oscillation of size, like a gigantic low-frequency loudspeaker. During the phase of contraction of the star its emitted light stays back. To us the pulsar looks dark. In addition the field strength is extremely increased and the light becomes correspondingly slow. During the phase of expansion the conditions are reversed and we observe a light flash. Exactly the pulsar unambiguously confirms the here presented theory of the variable, field dependent speed of light.

The well-known fact that the microcosm represents a copy of the macrocosm, already suggests that each atom is capable of the same oscillation of size as a pulsar: if next to the oscillating atom a resting one is placed, then does this one see a smaller field during the phase of contraction because of the increasing distance. It hence becomes bigger itself. If the pulsating neighbouring atom afterwards expands, it however becomes smaller. The at first resting atom in this way becomes a "pulsar" oscillating with opposite phase. The oscillating atom has stimulated the neighbouring atom as well to an oscillation of size, and this process will be repeated with the closest neighbouring atom. We speak of heat conduction.
To which extent the average distance between neighbouring atoms is influenced while a material is heated, solely depends on the structure of the atomic lattice. For matter with a fixed lattice according to expectation a smaller heat expansion will occur, as for the unordered structure of gases, in which we find confirmed well-known relations.

In a for potential vortices characteristic property sound waves and thermal waves of contraction correspond:

The propagation of potential vortex fields takes place as a longitudinal wave.

In this point vortex fields clearly differ from the transverse propagating electromagnetic waves!

1. Ampère's law (see fig 5.1):

$$\boxed{\text{rot}\,\mathbf{H} = \varepsilon \cdot (\mathbf{E}/\tau_1 + \delta\mathbf{E}/\delta t)} \qquad (5.1^*)$$

with relaxation time $\tau_1 = \varepsilon/\sigma$ (5.3)

transformed: $\delta\mathbf{E}/\delta t = (1/\varepsilon) \cdot \text{rot}\,\mathbf{H} - \mathbf{E}/\tau_1$ (5.1**)

integrated: $\mathbf{E} = \int [(\text{rot}\,\mathbf{H})/\varepsilon - \mathbf{E}/\tau_1]\,dt$ (5.1***)

2. Faraday's law of induction (in analogy):

$$\boxed{-\text{rot}\,\mathbf{E} = \mu \cdot (\mathbf{H}/\tau_2 + \delta\mathbf{H}/\delta t)} \qquad (5.4^*)$$

transformed: $\delta\mathbf{H}/\delta t = -(1/\mu) \cdot \text{rot}\,\mathbf{E} - \mathbf{H}/\tau_2$ (5.4**)

integrated: $-\mathbf{H} = \int [(\text{rot}\,\mathbf{E})/\mu + \mathbf{H}/\tau_2]\,dt$ (5.4***)

3. Signal flow diagram of the field equation 5.1***:

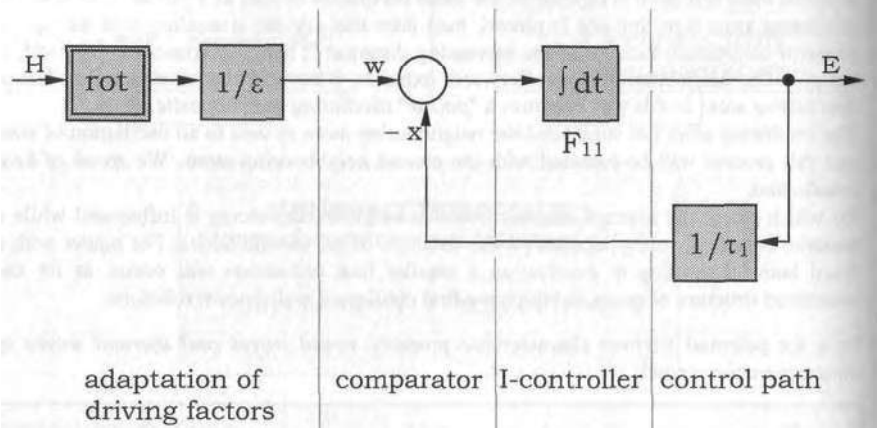

Fig. 8.6: Control technical analysis of the dual equations of the hydromagnetic field.

8.6 Basic principle of cybernetics

Surely can be attributed also information to the potential vortex. But how should information be formed? Is information a form of energy? Energy occurs as a consequence of the formation of potential vortices. Without this phenomenon there wouldn't be any energy!
Can information be described by means of a mathematical equation?
To be able to answer these questions, we subject the fundamental field equation to a control technical analysis. If it actually concerns a world equation, then an answers should be possible.

We again take up Ampere's law 5.1* from fig. 5.1 and remodel it according to the time derivative (5.1**). If the equation now is integrated over the time (5.1***), a signal flow diagram can be drawn (fig. 8.6).
The structure of a regulatory circuit is clearly visible. The individual paragraphs are described in an analogous way as for a technical control system. The execution of the curl operation on the field pointer of the magnetic field strength H and the multiplication with $1/\varepsilon$ accordingly form an adaptation of driving factors. In the comparator the difference for control from driving factor w and controlling factor x is formed and supplied to an integral controller. The control path has a purely proportional behaviour and consists of the processing of the measurement value of the electric field strength E with $1/\tau_1$, in which τ_1 describes the relaxation time of the eddy currents.
In technical control systems such a structure is found remarkably seldom, although it has an invaluable advantage: it possesses a stability in principle. Not a single adjustment of the controller exists, in which the closed regulatory circuit could become unstable, because it shows a proportionally delaying behaviour of first order. Possible changes of the adjustment of the controller or of the control path merely take effect on the speed, with which the regulatory circuit is able to follow changes of the driving factor.
This control technical basic principle convinces by its simplicity and efficiency. It meets us again in identical form in the second field equation 5.4*, the extended Faraday's law of induction. In dual formulation the electric field strength now appears as input factor and the magnetic field strength as output factor. Both regulatory circuits are coupled and connected with each other, by deriving their driving factor each time from the controlling factor of their dual partner. Is this structure actually efficient and meaningful?
Every regulatory circuit needs a target value, which is dictated from the outside. Let us think of the numerous control systems in nature. At all events a higher intelligence would be necessary for all the target values. This problematic is comparable to the question, what existed first: the egg from which a hen hatches or the hen without which no eggs can exist. Without a given target, evolution would not exist.

The connected regulatory circuit structure provides the matching answer: cybernetic systems, which usually and as is well-known strive to a state of balance, get their target value from their dual "partner". It is crucial that correspondingly dual systems are self-sufficient and can form and develop independently out of themselves without target values of a third side. This basic principle of cybernetics undoubtedly is brilliant.

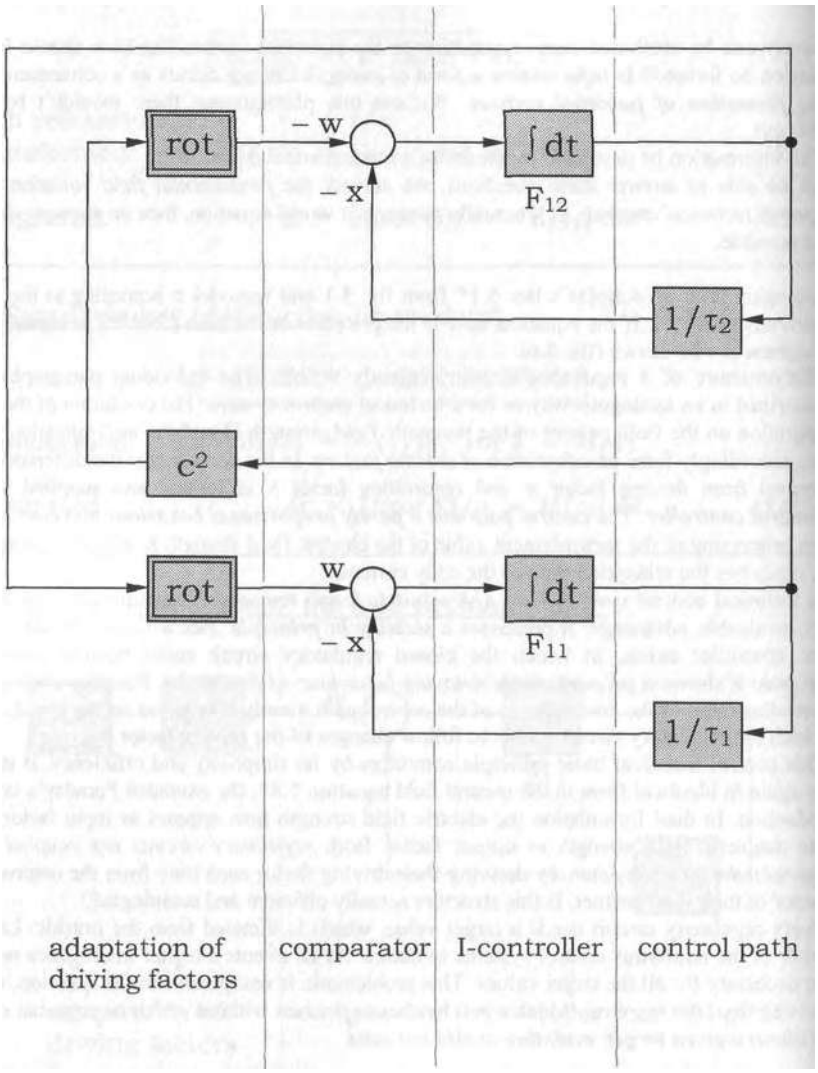

Fig. 8.7: Signal flow diagram of the fundamental field equation
with adaptive structure.

8.7 Adaptive regulatory circuit structure

If out of the nowhere something like the cosmos or like life on earth should form, then the connected regulatory circuit structure basing on duality probably is the only possible and conceivable. Thus it merely concerns the control technical representation of the fundamental field equation.

The question for the efficiency not only concerns the stability, but equally the possibility of both systems, to oscillate and to communicate with each other by the coupling and the associated exchange of information.

Fig. 8.7 shows the signal flow diagram of both regulatory circuits. These are switched in line and form a coupled circuit, which itself can be interpreted as a third regulatory circuit. Also this one shows a change of sign in the circuit like the other two circuits.

The information technical interpretation could turn out as follows: information about a regulatory process in the lower regulatory circuit F_{11} caused for instance by a disturbance is communicated over the coupled circuit to the upper regulatory circuit F_{12}. In this case F_{11} acts as transmitter and F_{12} as receiver of the information. Afterwards both exchange their places, because F_{12} for its part reacts by a regulatory process and reports to F_{11}. The regulatory circuits adapt to each other. Obviously it concerns the basic structure of an adaptive regulatory circuit.

To analyse the coupled circuit the examination of individual special cases is recommended. If the regulatory circuits F_{11} and F_{12} are opened up in the way that the time constants tau_1 and tau_2 go towards infinity, then the double integral effect is left. Analyses of technical regulatory circuit teach us that such systems always tend to instability. Because in addition the target value is zero, an oscillation around zero will arise, which we call electromagnetic wave.
If one of both time constants becomes finite, e.g. τ_2, then damping of the waves will occur. The "subordinate" cascade regulatory circuit F_{12} will adjust itself and now has a proportional delaying behaviour of first order. Together with the integral controller of the open F_{11}- circuit the coupled circuit will show the typical and more or less optimal regulatory behaviour of a damped oscillation.

These special cases correspond with the mathematical (fig. 5.2) and the physical (fig. 5.3) interpretation of the fundamental field equation. In addition a spatial rotation, a swirling will occur because of the double execution of the curl operation.

If interpreted control technically then vortices are the temporally stable, spatial swing of a field pointer around a centre, the vortex centre.

Without potential vortices no stability, no matter, no energy nor information would exist!

As can be looked up in Goethe's Faust, it always has been a desire of humanity, to find out, "what keeps the world together in the heart of hearts".

electric field	——	magnetic field
potential	——	current
capacitor	——	coil
Faraday's law of induction	——	Ampère's law
potential vortex	——	eddy current
convergence	——	divergence
dielectricity	——	permeability
non-metal	——	metal
isolator	——	electric conductor
tuned cavity	——	antenna
cold	——	hot
Yin	——	Yang
female	——	male
minus	——	plus
introverted	——	extroverted
stability	——	dynamics
water	——	fire
implosion	——	explosion

Fig. 8.8: Table of dual correspondences
(as a supplement to chapter 3.3 and fig. 4.2).

8.8 Information

The search for an answer for numerous philosophers and physicists was tantamount to the search for a world formula. Of course mustn't be forgotten that a formula only is a mathematical description and never the physical reality itself. It is a mathematical tool in the hand of a person and not the world or the cosmos itself, which he tries to understand. What keeps the world together in the heart of hearts, has to be more than only a pure apparatus of formulas. Actually the fundamental field equation tells us more. It reveals us a basic principle basing on duality in which the dual partners mutually dictate target values and goals. This principle convinces by its simplicity and efficiency. Apart from the "self regulation" it obviously also has the fundamental possibility of a "self organization" and the "generation of information". The field equations of the hydromagnetic field thus are the starting-point for the formation not only of matter and energy, but also of information. Accordingly holds:

Information is nothing but a structure of electromagnetic vortex fields!

This statement is new and to a large extent incompatible with the conception world of Norbert Wiener, who goes as the founder of cybernetics. From N. Wiener stems the sentence: "information is information, not matter and not energy".

We hold against it that obviously a fairly direct connection exists. We have worked out that only the vortex can show a stable adaptive regulatory circuit structure. Only the vortex and not the wave exists in two forms of formation dual to each other, and the principle of duality again is the prerequisite for the formation of information, of self organization and finally for the evolution. In fig. 8.8 well-known dual partnerships are listed. From it follows in a consistent way that for the production of information without exception the electromagnetic vortices should be considered.

But how can this so important duality occur, how can it form? This question is closely associated with the question of the formation of vortices. The signal flow diagram (fig. 8.7) to that says that the dual regulatory circuits F_1 and F_2 can only exist by the coupled circuit, which provides them the necessary target values and at the same time forwards the respective information. In this way of the oscillations and the more or less damped wave F_1 and F_2 communicate with each other.

The electromagnetic wave serves solely the mediation of information and energy.

With that falls a central role upon the wave, so that vice versa is valid:

Without wave no vortices, no duality and
consequently no evolution can exist.

According to the to date state of knowledge the basic principle of cybernetics forms the basis for matter and energy as well as for information. Since the wave can only serve the transmission of information, the principle of duality and the vortex will function as carriers of information. We are entitled, to speak of vortex information, this by no means is characterized by special frequencies or modulations of frequencies. This is prevented by the property of the vortices which allows them to change the frequency. On the other hand various configurations of vortices are possible and numerous combinations and modulations are conceivable.

If technical apparatus generate vortices, then they produce information. Here a serious danger with regard to the environmental compatibility can not be excluded!

Equivalent things:

* elements of the fundamental field equation 5.7
* elements of the Greek philosophy of nature
* temperaments
* (impulses of growth)

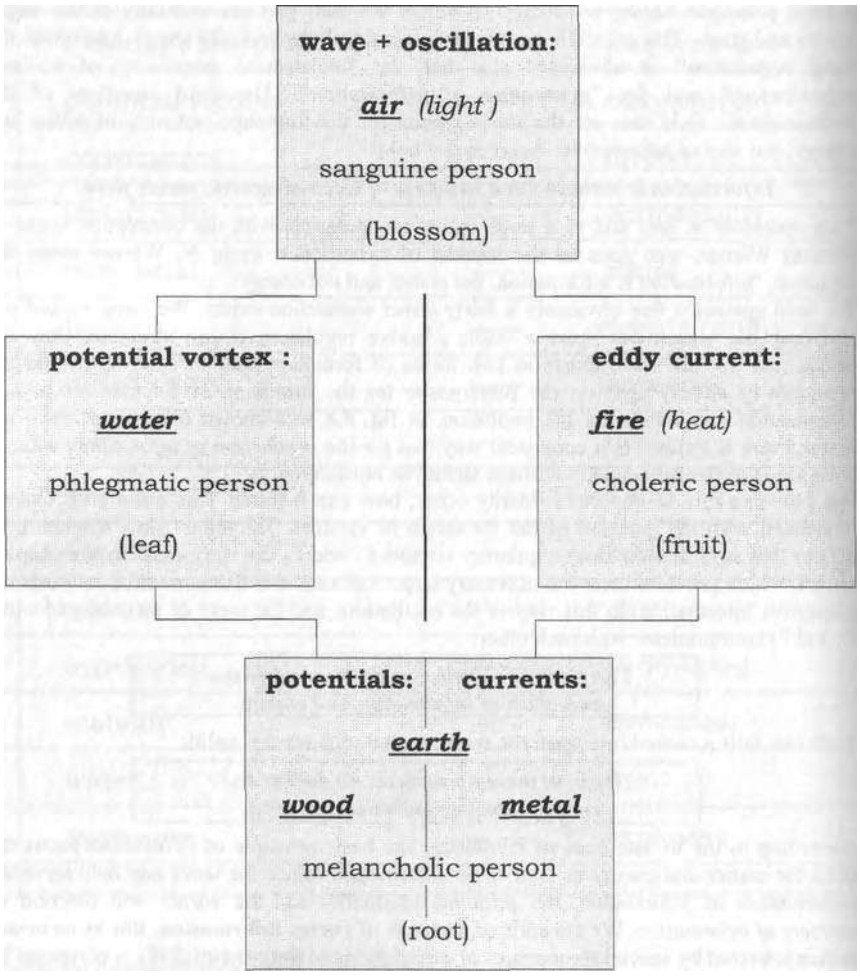

Fig. 8.9: The theory of four elements of the old Greek philosophy of nature (Aristotle and others)

8.9 Philosophy of nature

Seen in the view of the philosophy of nature now two dual points of view are possible.
The optimistic one would be:
We and our environment on the one hand are a result of the cybernetic principle and on the other hand of our observation point of view which should be valued relativistically. If really everything should be electromagnetism, a phenomenon which can't be grasped directly by humans, then the pessimist would come to the conclusion: everythins is nothing. What we observe is nothins but a deception of the senses. Perhaps therefore famous philosophers of antiquity, like Empedokles or Demokritos have ended their life in the crater of the Etna. According to the theory of the atom of Demokritos (470 to 380 B.C.) the formation of matter, earth and celestial bodies will occur by means of formation of vortices!
Empedokles (482 to 420 B.C.) was the first to develop a theory basing on four elements, which was continued and improved by Plato (428 to 348 B.C.) and Aristotle (384 to 322 B.C.). Accordingly these elements are changeable into each other and mixable with each other. From them all bodies are build up.
The terms "air, water, fire and earth", with which the philosophers have described the four elements, are of course not identical with the ones in our translation and conception world, but they were used in a philosophical sense as a substitute for the description of the respective basic principle.
There also have been different approaches, to translate these terms differently, e.g. by an assignment to the four states of matter (solid, liquid, gaseous, plasma). But the ancient texts don't get easier to read in that way.

Fig. 8.9 shows the obvious assignment to the four building parts of the fundamental field equation 5.7. It would be worth an attempt, to exchange the terms in the translations of ancient texts and to translate air with wave, water with potential vortex and fire with eddy current. The term earth has two sides, which should be translated with potential instead of wood and current instead of metal.

Let's try the translation this way with the theory of Plato[<i>], by correspondingly translating anew the talk of Timaios about the formation of the world. The perception of smell then is described as follows: "...as the potential vortex turns into waves (or) the wave into potential vortices, the smells are formed during this transition, and smells are smoke or fog. But fog is the transition of waves into vortices, the transition of the vortex into waves however smoke".
Plato here provides an indisputable and conclusive interpretation of the fundamental field equation. In this equation the potential vortex acts as damping term in the wave equation, what in the case of waves rolling up to vortices will show to the observer in the way that the electromagnetic waves and therefore also the light will be damped. We say, the visibility gets worse and speak of fog. If the damping phenomenon disappears again, as the potential vortices break up, then Plato speaks of smoke.
Numerous ancient texts, which until now only could be "interpreted" philosophically, in this way turn out to be a rational textbook description of natural scientific phenomena. They anyway only get readable and understandable for the general public with the modern technical terms.

<i>: Platon: Samtliche Werke 5, Rowohlts Klassiker Nr. 47, S. 188, 66e

Optimist:

We and our environment on the one hand are a result of the cybenetic principle and on the other hand of our observation point of view which should be valued relativistically.

Pessimist:

Everything is nothing. What we observe is nothing but a deception of the senses.

Plato[<i>] (talk of Timaios about the formation of the world) description concerning the perception of smell:

"...as water (the potential vortex) turns into air (waves) or air (the wave) into water (potential vortices), the smells are formed during this transition, and smells are smoke or fog. But fog is the transition of air (waves) into water (vortices), the transition of water (vortex) into air (waves) however smoke"

changed translation with the technical terms:

air_____ = ____wave
water = ___ potential vortex
fire_____ = ____ eddy current

As a consequence:

smell is vortex information

Fig. 9.0: The explanation of Plato concerning the formation of smell, smoke and fog[<i>]

<i>: Platon: Samtliche Werke 5, Rohwohlts Klassiker Nr. 47, S. 188, 66e

9. Usage

If the newly discovered vortex phenomenon of the vortex of the electric field exists, then it will be possible to practically use it. Whereas we still think about possibilities for technical usage, there by all means exists the possibility, that nature already is successfully using the vortex for a long time. We should look precise at things. We can only learn of nature!

Remarkable about the passage of Plato (fig. 9.0) is not only the fact, that the potential vortex already was known for two and a half thousand years and was taken into consideration for an interpretation, but also the realization of Plato, that during the described transition the smells form. Smell thus would be a vortex property!

After all vortices are able to bind information as can be inferred from the basic principle of cybernetics. With this vortex property and the statement of Plato smell obviously would be nothing else than pure information which by potential vortices is stored, distributed and eventually is caught by the hair cells for smell of the nose.
If now a dog takes up a track, does it then run after vortices which remained behind or does it analyse, according to the encyclopaedia, the chemistry left behind, or does it combine both? Does the bloodhound for instance interpret the vortical oscillations of chemical substances like lattice oscillations or the movements of the electrons in the atomic hull? A lot of work awaits the research scientist of vortices here. The seminar will offer opportunity, to deepen this topic[<i>].

Only if technicians exist, who put an electronic box on the table with a button, at which they adjust the wanted scent of rotten eggs to lavender, we honestly can claim to have understood the phenomenon of the smell.

For the majority of the people a theory only wins its sense by the practical applicability, and therefore we'll have to develop and present a technical usage on the basis of the vortex theory.

<i>: Suggestions for appropriate seminar themes: the meaning of smell, taste, the aroma therapy, the homeopathy or the effect of aetheric oils. (To that in part 3, INDEL Verlagsabt. 2003)

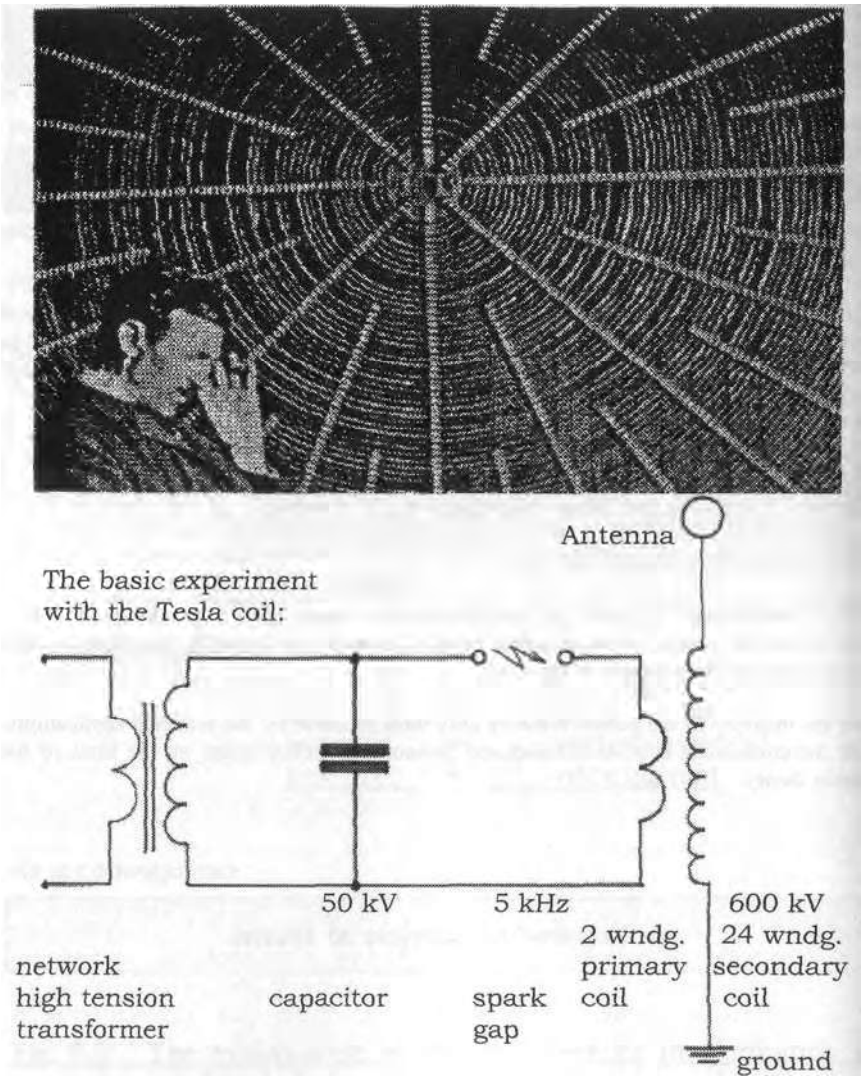

Fig. 9.1: High tension transmitter of Nikola Tesla

9.1 Longitudinal electric waves

It is important, that experts struggle for problem solutions. Only if the discussion about limits doesn't come to a result which can be grasped and verified, then also in the environmental compatibility the willingness will grow, to accept a not yet known phenomenon as a further and possibly crucial influential factor.
Already for a hundred years there has been a dispute of experts. At that time scientists all over the world were trying to verify the experiments of Heinrich Hertz. Then from America the message came, Hertz had been mistaken and the electromagnetic wave would have completely other properties. The scientists in Europe were indignant, but they had to take the message seriously, because it after all came from the important experimental physicist Nikola Tesla (1856-1943), who with his inventions of the rotary field and of the asynchronous motor has stamped today's electric energy technology as no other.

As a result Lord Kelvin boarded a steamship as a mediator and sailed 1897 to New York to convince Tesla from the opposite. But the experiments, which Tesla presented his Lordship, didn't give rise to any doubts[<i>], and thus Kelvin returned to Europe with the message: "Both are right, Tesla as well as Hertz! Whereas the electromagnetic wave which Hertz has detected, is a transverse wave, does Tesla work with a longitudinal wave"!
Lord Kelvin as a result started to draw most different vortex models, because it was clear to him, that a propagation as a longitudinal standing wave analogous to the sound wave only is conceivable, if quantized structures exist, which knock each other mutually. Kelvin therefore assumed vortex structures of the electromagnetic field. His vortex models were published and landed in the curiosity box of orthodox science.
Heinrich Hertz did have a big advantage. He could refer to Maxwell and calculate his wave with the field equations. For modern technology the mathematical calculability is almost an indispensable prerequisite!
For Tesla wave there however neither was a mathematical nor a physical theory. The only thing Tesla had, were presentable experiments.
In Colorado Springs he had build a 10 kW transmitting installation and lighted 200 fluorescent lamps of 50 Watt each on a mountain in the Rocky Mountains in a distance of 25 miles. With that he had completely transmitted the transmission power of 10 kW, as can be inferred from the press reports at that time. With Hertzian waves, which propagate spatially, this experiment even today, after over 100 years, wouldn't be realizable technologically. According to the law of the square of the distance one isn't even able to let glow a tiny little lamp in such a distance.

For sure his rotary field theory was a big help for Tesla in all experiments. Actually a rotary field can be seen as the special case of a planar vortex.
Thus Tesla obviously was able, to use the potential vortex without even knowing it. Tesla has stimulated a loosely coupled high tension coil wound like a spiral to self-resonant oscillations and emitted the produced vortices over an antenna (fig. 9.1). On the receiver side the process was then reversed.

<i>: N. Tesla: III. The Singular Misconception of the Wireless (Famos Scientific Illusions), Electrical Experimenter, Feb. 1919, p. 732.

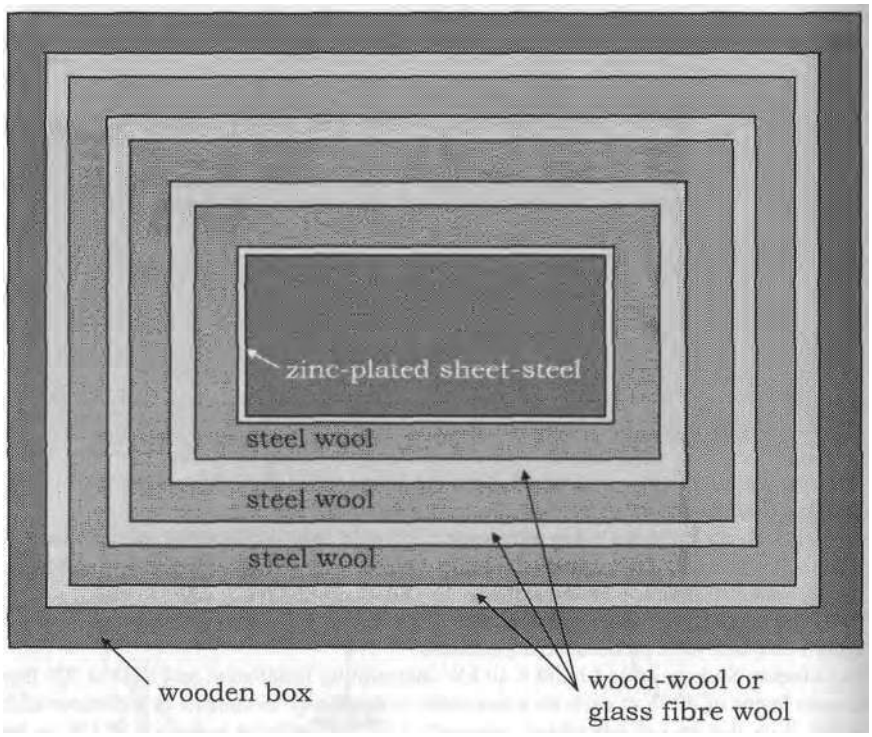

Fig. 9.2: Orgone accumulator according to Wilhelm Reich.[<i>]

<i>: Dr. James DeMeo: The Orgone Accumulator Handbook, ISBN 0-9261855-0-7

9.2 Medical technical usage

Nikola Tesla at his time was extremely popular in the area of medicine. With his inventions injuries were cured and pain eased. Modern diathermy goes back to his work. But Tesla at that time has treated the patients with vortices, whereas today, possibly out of ignorance, electromagnetic waves are used. These however have in contrast to potential vortices only a small penetration depth. Today in addition only the effect of heat is considered and in no way the information technical effect of electric vortices. Here we are missing the comparison, to be able to say. if the treatment with a Tesla apparatus was more successful than with modem microwave radiators.

The experiments of Wilhelm Reich (1897-1957) aimed in the same direction. Exactly as Tesla 55 years before also Reich emigrated to America in 1939. He had specialized in catching and collecting vortices, which he called "orgone", from the air. In this way he could store up high energies over time and then use them purposeful. With his "orgone accumulator" he was able to cure wounds faster and to ease pain. He also treated cancer and a lot of forms of anaemia. Technically Reich could demonstrate, that charged capacitor plates discharge faster under the influence of his apparatus. His orgone accumulator for instance is a wooden box, filled with wool of steel and wood, which alternate in layers. He said that the reason for this construction is, that metals repel the orgone energy, whereas organic materials become charged and accumulate it. That holds in his opinion to a particularly high degree for water.
Reich concludes that no material and no device are known, with which the orgone energy could be shielded. This with regard to the environmental compatibility of the vortex phenomenon should make us thoughtful.
As a supplement it should be mentioned, that Reich already at the end of the forties has pointed to the dying of the forests and he has made a direct connection to the orgone energy. Reich was slandered and mocked and died in the prison of Connecticut, while his writings were burned publicly.

Not much better fared the Austrian forester Viktor Schauberger (1885-1958), who also can be described as visionary. He was able to produce water with a particularly good conductivity. His water in addition goes for medicinal and healthy. Also to him travelled cancer patients of far away to get this water.
Schauberger spoke of the natural treatment of the water, whatever he meant with that. In any case he build with great success installations to transport wood by floating it and even installations to mine ore with so-called double twist pipes, which made possible a transport without friction even of materials, which are heavier than the "means of transport" water. It could be proven that no contact with the pipe took place. This was scientifically investigated and confirmed at the university of Stuttgart 1952 by Prof. Popel. Quite obviously in the double twist pipe vortices have formed, which have bound the material to be transported (see phenomenon of transport).
Today you can buy levitated water at over 100 selling points in Europe, of which is claimed, that it is prepared according to instructions of Schauberger. Unfortunately we aren't able to ask him anymore, if he agrees with such a "centrifuged" water. Thus the test of the effectiveness has to be left to everyone himself or herself.

A: Concerning the functioning of the Faraday generator (E = v x B):

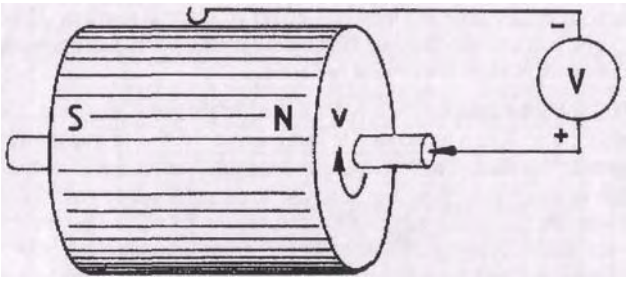

B: Construction of the flying disc:

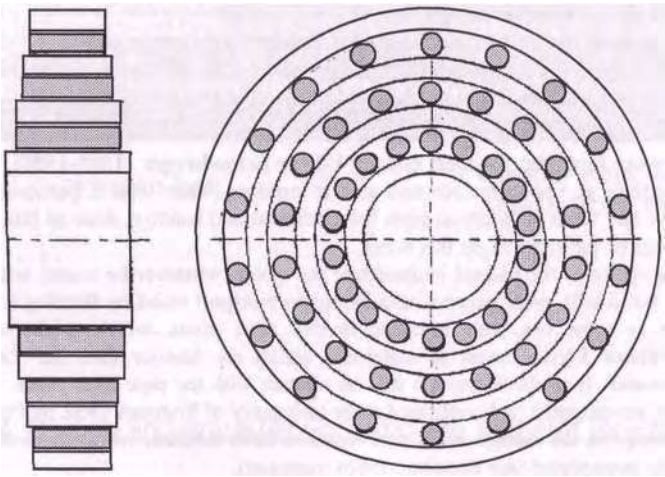

Fig. 9.3: Applications of the Faraday generator[i] in the flying disc of Prof. John Searl

9.3 Flying objects

The medium of Viktor Schauberger always was the water. He could produce light effects and very high temperatures with it with only minimal excitation in the form of impulses. An installation, which had been built according to his plans at the company of Siemens, eventually melted at 4000°C by improper operation, as he himself stated. According to that the machine would have released more energy than used, thus a perpetuum mobile. The authorities of the state in the Third Reich were impressed and put Schauberger in a concentration camp, where he was instructed to build a "flying saucer" under permanent supervision together with fellow prisoners. For him it's all about the concentration effect and the usage of the as a result occurring implosion in contrast to our today's " technology of explosion and fire" as Schauberger was accustomed to express himself. It is not known, if Schaubergers "repulsine" ever has took off.

A disc, which has proven its suitability to fly, was constructed and built by the english technician John R. R. Searl, although he said he can't explain the effect. He also had big difficulties, to get the apparatus under control. A disc broke through the ceiling and the roof of his laboratory and disappeared to never be seen again. Five other flying discs, which he after this experience started in the open, went lost in the same manner. Without knowing the effect, he of course neither could assess the dangers. His experiments have claimed serious injuries and a casualty. While he 1985 was put in prison under a pretext, his laboratory and his house were burned down and all documents destroyed. Now he works on a technical usage. According to the principle it concerns a Faraday machine. Thereby a permanent magnet, magnetized in axial direction, is turned. Now the magnetic induction B for a relative velocity v is measured as an electric field strength E according to equation 6.10: $E = v \times B$. (6.10)

Because the vectors are arranged as standing perpendicular to each other, will arise a tension voltage in radial direction (direction of E-field) which can be taken off. Apart from the friction no further force of reaction occurs in the case of the Faraday generator. Because of the small gain of energy until today no application ready for the market exists. But this principle, to convert magnetic field energy into electric, already has moved the nature of many inventors. Professor Searl has reversed this old principle. Whereas normally the component of the velocity towards the centre of rotation decreases, it increases in Searls case. For that he works with roller pivoted concentric rings, which he drives by a small electric motor (fig. 9.3). Doing so something inexplicable for him happens: After switching off the motor the revolutions per minute don't decrease again, but increase audibly and increase further, until the produced electric field shows the well-known high tension phenomena: corona discharges, formation of ozone, ionisation of the air and production of a vacuum in the inside of the disc.

The rings and rollers consist of several layers, which are built up similar to a bi-metal. The only explanation I can think of is that a change in structure would occur as a result of the physical length contraction which is caused by the increase of the E-field in the direction of the centre of rotation. The bi-metals try to withdraw themselves from this change by an increase of their rotation of their own (fig. 6.5). To compensate the field the disc builds up a spin, as also the elementary particles do (fig. 6.13). While the formation of vacuum prevents sparking in the inside of the flying disc, and the revolutions per minute further increase because there is no air friction whatsoever, the disc weighing 5 tons all of a sudden lakes off the ground and according to reports of eyewitnesses shoots vertically upwards.

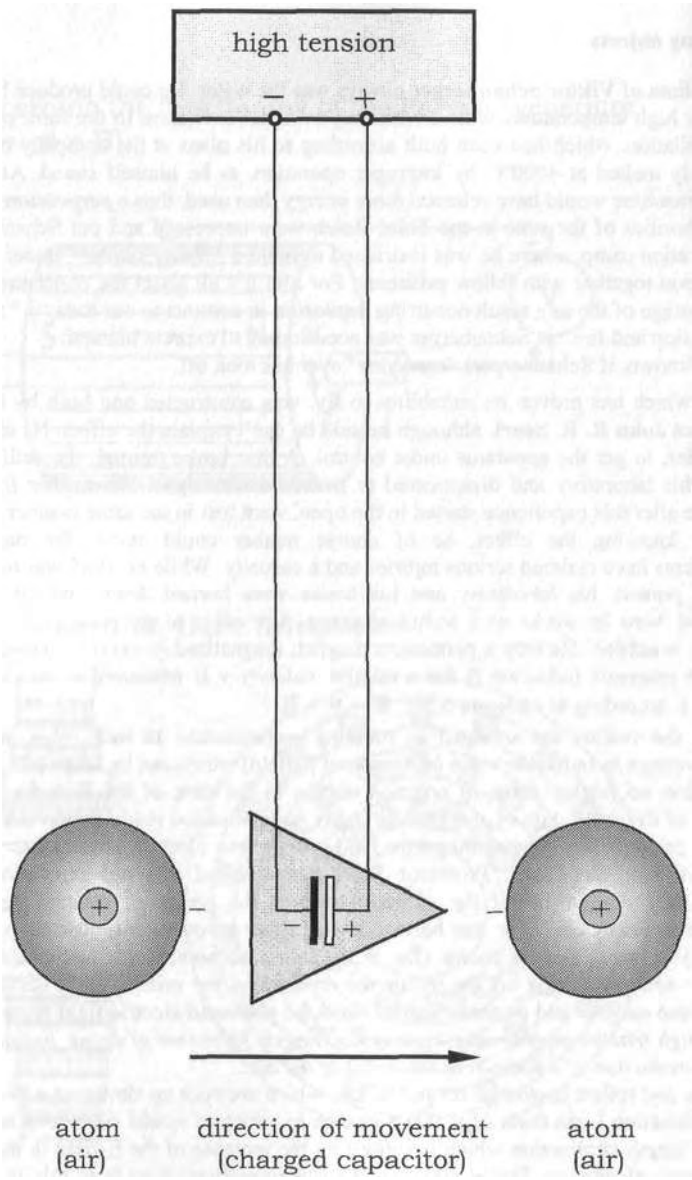

Fig. 9.4: Capacitor experiment concerning the so-called electro-
gravitation according to Prof. Biefeld / Dr. Brown

9.4 Electro gravitation?

Wild speculations circulate about the mechanism of the flight of a "flying saucer", which should function without sound and without combustion, and for which no sound barrier exists, as pilots have observed. The talk is about cancelling gravitation or about an "electro gravitation".
Reproducible in any case is an experiment, which has been systematically investigated by the american professor Biefeld and his pupil T. Brown from 1925. Accordingly does a body charged to high tension show a force effect in the direction of its positively charged note. As a check for oneself a capacitor can be suspended on its connection wires and it can be observed, how it moves visibly in the direction of the positive pole in case it is charged (fig. 9.4).
Because the Biefeld-Brown effect depends on direction, it actually can't concern gravitation at all but merely a not understood electromagnetic interaction. In the neighbourhood of the capacitor pole air molecules are found, and their negatively charged atomic hull is attracted by the positive pole. At the same time the atomic nucleus is repelled. By that the air atoms in the presence of the high tension capacitor become unsymmetrical, causing the force of attraction due to the smaller distance to exceed the force of repulsion. At the negatively charged end the conditions are exactly reversed. There a repulsion occurs. Because the polarized air atoms and molecules are sucked in, no pressure can build up and as a result no sound barrier can occur. Experiments with charged and uncharged rockets have brought the interesting result, that the electrically charged rockets flew many times as far as the uncharged ones (5-6 times as high)[<i>].
Many a person now perhaps starts to dream of the flying carpet but, as said, it isn't an "effect of antigravitation". Does "free energy" actually exist, we have to ask ourselves? From the gravitation the soviet physicist Landau calculates an energy density of 16 megawatt hours per cubic meter for the earth's surface. Immediately inventors are found, who want to use this gravitational energy.

Nikola Tesla in his laboratory in Manhattan has incidentally built resonators, of which he could bring all electric, magnetic and mechanic factors in resonance. On an evening stroll he fastened a battery operated vibrator to the tubular steel scaffolding of a new building and let everything shake and wobble. In his laboratory such a device once got out of control by inattentiveness and triggered an earthquake. In that way the road surfacing and pipes were burst and window panes got broken. The police penetrating his laboratory only could see, how Tesla forcible finished the experiment with a sledge-hammer.
The experiments which got out of control of Tesla, Searl and Schauberger have one thing in common: it concerns constructions with an unipolar arrangement of the field.
Tesla had arranged the magnetic field in a unipolar way, as he has reported himself, Searl had realized electric unipolar fields in a construction similar to the electron, and Viktor Schauberger had specialized in producing unipolar structures with water vortices.
In the case of the corresponding technical usage, which can be interpreted as making use of the occurring "spin coupling", therefore in principle utmost caution is imperative.

<i>: Rho Sigma (Dr. Rolf Schaffranke): Forschung in Fesseln, das Ratsel der Elektro-Gravitation, Ventla-Verlag, Wiesbaden, 1972, Page 67.

Nikola Tesla: „Ere many generations pass our machinery will be driven by power obtainable at any point in the Universe This idea is not new, we find it in the marvellous myths of Antheus, who derives energy from the earth... Everywhere in the universe there is energy. Is this energy static or kinetic? If static, our hopes are in vain; if kinetic, and this we know it is for certain, then it is a more question of time when men will succeed in attaching their machinery to the very wheel work of nature". New York, the 20th may 1891, American Institute of Electrical Engineers.

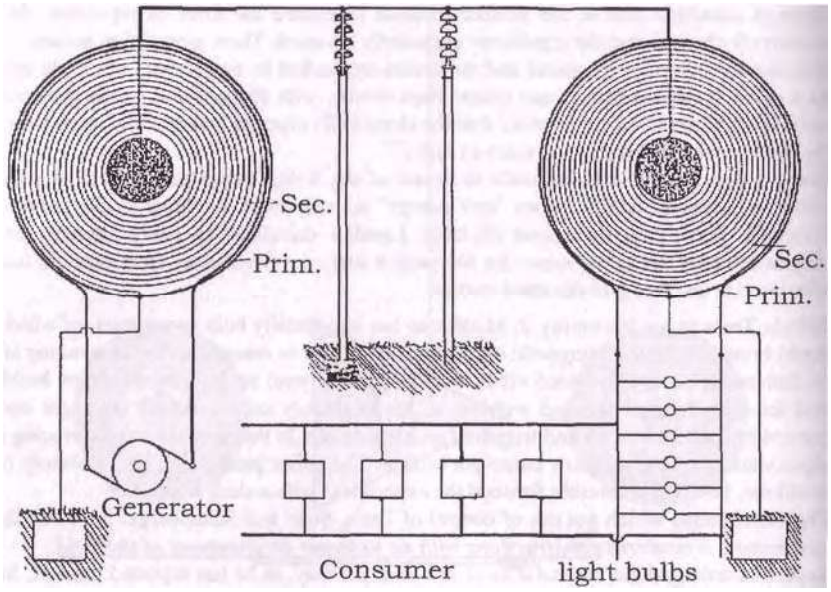

Fig. 9.5: Energy transmission bound to a wire, Patent No. 593,138 (1897) of Tesla.

<i>: Philadelphia Public Ledger, Nov. 2, 1933
<ii>: Dr. Nikola Tesla: Complete Patents, Tesla Book Company, New Edition 1983, Compiled by J. T. Ratzlaff, ISBN 0-960356-8-2, page 301-304.

9.5 Free energy?

Furthermore is reported of Tesla, he would have developed a "converter for space energy" and 1931 have built it in a luxury car (Pierce Arrow)<i>. The car was a 145 km/h fast, doing so the asynchronous motor (presumably built by Westinghouse) furnished 80 HP at 1800 Rpm. The "free energy" the converter, build by Tesla himself, got from a 1.8 m long antenna. Because the motor ran without adaptation of frequency in slipping operation, it had to be cooled correspondingly. It was on the way in trial run for over a week. Now we of course want to know, of what this "free energy" consists, which Tesla will have used and of which he already 1891 had spoken in the American Institute of Electrical Engineers.

For the electron as a spherical vortex we have calculated an electric tension voltage of 511 kV between its surface and its centre respectively infinity (equation 6.31*, fig. 7.1). The highest level of tension voltage normally used for the high tension transmission lies at 380 kV (effective value); for a direct current transmission it is 500 kV. Although still higher tension voltages would be desirable, they are avoided. This is no accident. Experiments with higher tension voltages namely have resulted in inexplicable high losses. We have an explanation: the electrons are taken apart on the way! Their inner energy amounts with the outer energy to zero. The charge carrier, which in the power station as result of an energy conversion has been sent on a journey, is in danger to vanish into thin air (e.g. corona) for tension voltages above 511 kV. The transmitter of Nikola Tesla however (fig. 9.1 and 9.5) worked with 600 kV and more. He said, with his experiments he had destroyed billions of particles without being able to observe an emission of energy and made fun of the misinterpretation of Einstein of the already at that time well-known mass-energy relation $E = mc^2$.

For the purpose of a one wire or a wireless energy transmission the tension voltage therefore has to be higher than 511 kV. With Teslas equipment however the electrons shouldn't be destroyed, but merely be pulled apart to plane circular vortices with help of the today is Tesla coil known winding. These then could be sent on a journey over the antenna, to again be caught and formed back in spherical electrons by the receiver antenna. As long as the electrons don't fall apart, they keep their structure and quantum property. Quanta pass on an excitation, for instance a bump, in form of a longitudinal standing wave, by one particle bumping the neighbouring particle, analogous to sound waves, where one gas molecule passes the bump on to the neighbour. The transmission hence takes place as longitudinal scalar wave.

Electrons pulled apart to planar vortices in addition haven't got a closed vortex centre anymore on their journey. For the by Tesla in his laboratory used and publicly presented one wire energy transmission (1897, Patent Nr. 593,138) the transmission hence doesn't take place in the wire, but as vortices around the -wire. That explains, why only a relatively thin conductor, which normally should have melted, was necessary for a demonstrated power transmission of 10 kW. Tesla however could show, that the wire stayed cold and virtually no heating losses were measurable<ii> (fig. 9.5). He himself said, that this one wire transmission technology is much better than the alternating current technology full of losses, which stems from him as well. Tesla must have known the limit of 511 kV very exactly, because on several photographs one can see, that he changed the coiling technique off this value!

<i>: Philadelphia Public Ledger, Nov. 2, 1933

<ii>: resp. Tesla's lost inventions, VAP, page 36 and page 48, 49.

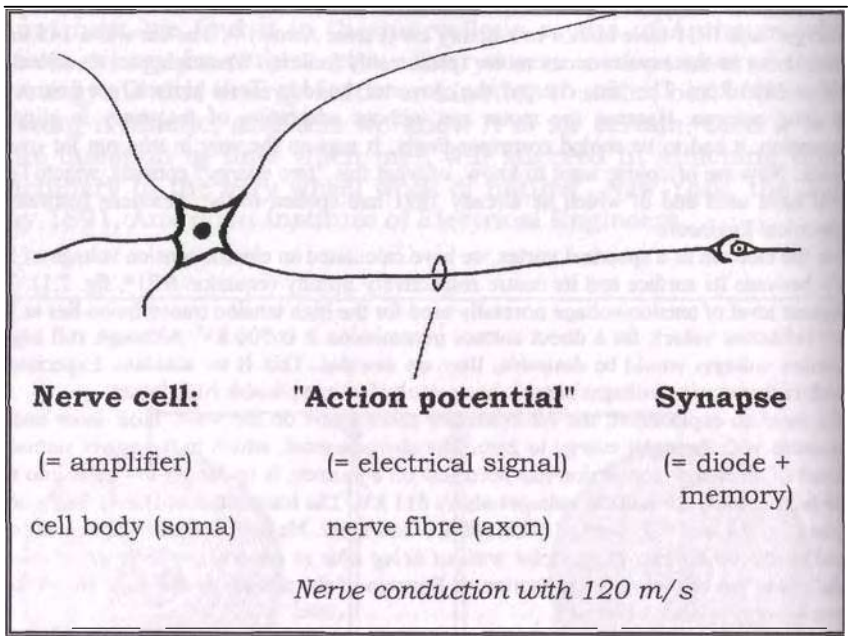

Fig. 9.6: Nerve cell and message processing (neurons)

- Material information conduction: at plants
- Information conduction with hormones: at simple animals
- Electrical information conduction: at higher developed creatures
- Analog transmission: from 10% and more difference in potential, and
- Digital transmission: number of the action potentials
- Modulated information: i.e. complex modulation of the action potential (the potential vortices)

9.6 Nerve conduction and action potential

Technical solutions often are only a suboptimum and many times they are anything but an optimum. In many cases the feasibility stands in the foreground. In the question of the current distribution at that time the decision was made for the worse system, the full of losses three phase system, because no current meters were available for the free of losses one wire technology. Without being able to collect money from the consumer, it wouldn't have been possible for the energy distribution installations to pay for themselves. Compared to that is nature with its selection principle merciless and without compromises. Only the most efficient system has a chance to survive and to spread. If it's about transmittining information in an electric way and two different principles present themselves, then in nature only the better one will be brought into action.

Let's take a look at the nerve conduction in the human body. In the synapses ion concentrations and electric potentials of 70 to 90 mV arise. Here with conventional gauges the activity of a nerve can be detected. From a measurement of the transmission time of synapse to synapse the velocity of the signal is determined. If we however want to measure between the switch points on the line, then we have to find out, that for instance with an ammeter actually nothing is measurable. In addition the nerve fibre has a miserable conductivity.

The biologist calls the electric signal just "action potential" and draws a vortex-like ring around the nerve fibre and speaks of a mixed digital and analogue information transmission.

The doctor on the other hand knows two different types, fast and slow nerves. In the inside both are built up virtually identical. A characteristic difference consists of the fact, that the fast nerves are jacketed with a thick fat layer.

The technician would say, they are better isolated, but why they therefore should be faster, he hardly would be able to answer. If we however assume, that the action potentials or OUT potential vortices oscillate around the conductor, thus exactly in the isolation layer and are forwarded there, then possibly an explanation would have been found.

The nerve conduction moreover has much in common with the one wire system of Tesla:

1. Charges and electric potentials are transmitted
2. Doing so a transport of charge carriers, thus an electric current on the line, isn 't detectable.
3. Consequently no losses worth mentioning occur.
4. Decisive for the functioning is the dielectric insulator material which surrounds the conductor and not the electric resistance of the conductor.
5. In contrast to electric circuits a draining conductor is unnecessary.

It looks as if the one wire system is not new at all, as would nature use it already for ages in the highest perfection. We realize immediately, why our head does without a ventilator and how the high of signal processing density can be explained. Compared with our brain modern personal computer (PC) with their backward cable technology are far less than a suboptimum.

With regard to the pressure on the environment by interference radiation we had derived, that currents and eddy currents with the skin effect direct their radiation to the outside, whereas potential vortices with their concentration effect direct it to the inside. Probably for this reason the radiation field of a person is environmentally better compatible than that of a PC.

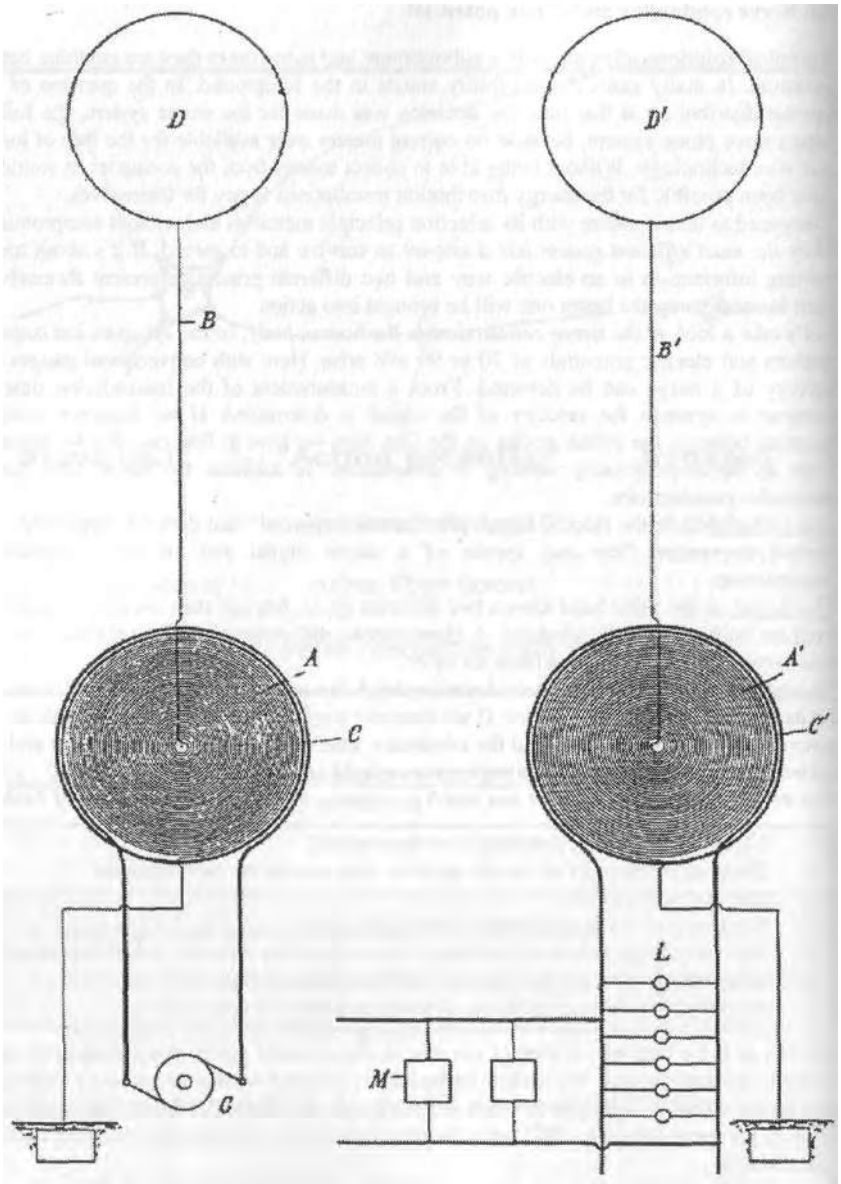

Fig. 9.7: Wireless energy transmission,
Patent No. 645,576 (1900) of Testa.<i>

<i>: Dr. Nikola Tesla: Complete Patents, Tesla Book Company, page 311-321.

9.7 Wireless energy transmission technology

Tesla still went a step further. He has cut the wire connection between transmitter and receiver (fig. 9.5) and instead has installed each time a spherical electrode (fig. 9.7). With this facility he now was able, to transmit energy completely wireless (1900, Patent No. 645,576). Building on this principle Tesla already 1890 had built a radio remote control for a battery operated submarine and had presented his patented system the navy. But they weren't able, to recognize the strategic importance of the radio technology and rejected with the words: "It's too advanced!" (fig. 9.8).

Tesla further had proven with this technology the mentioned proof concerning the existence of longitudinal electromagnetic waves. There exist descriptions, partly of Tesla himself, how he, inside or also outside his laboratory, goes in search of oscillation nodes of the standing wave with a measuring receiver[i].
He names several conditions for the wireless energy transmission:

1. "perfect resonance" (same frequency) of transmitter and receiver
2. Installation of the receiver on an "oscillation node" (maximum).

Important is also the measurement of the velocity of propagation, and that isn't constant from the start for a wave, which oscillates in the direction of propagation. From the research of earthquakes we know, that the longitudinal waves are faster than the as well occurring transverse waves. Usually the distance to the epicentre is determined from the difference in transmission time.
In the patent specification the measurement is described[i]. Tesla has sent longitudinal radio signals from his transmitter in Colorado Springs once around the earth along the earth's surface and determined a transmission time of 0,08484 seconds. This corresponds to a frequency of approx. 6 Hz. He saw his result confirmed, as he could find the oscillation node of the standing wave again (according to $\lambda/2$) in his laboratory (on the ground plate).
For the full wave length λ the Schumann resonance, which describes a standing wave of an around the earth running Hertzian wave, lies as is well-known at 7.8 Hz! Tesla calculates for his wave a speed 1.6 times the speed of light assuming the polar radius of the earth to be 6363 km.
Also this measurement result confirms, that Tesla didn't use the Hertzian wave. Tesla found the off-beat concept of Einstein, the speed of light would be the fastest possible velocity of signal transmission, only funny. If however today is claimed, 1993 in tunnelling experiments for the first time a speed faster than light has been measured, then this just isn't true. Possibly also the Tesla wave tunnelled, as the vortices for a small conductivity of the air contract and as a result of the length contraction become correspondingly fast.
Later Tesla after several goes in vain even succeeded in building a high tension tube as a tunnel, with which the velocity of the signal could be increased arbitrarily. Tesla with that pursued the goal to be able to make radio contact with other worlds[ii].

<i>: N.Tesla: Art of Transmitting Electrical Energy Through the Natural Mediums, US-Patent No. 787,412, 18.4.1905, Complete Patents pp. 397-402.
<ii>: M. Cheney: Tesla, Man out of Time, Barnes & Noble Books, New York, 1993, und S. 309, Omega-Verlag, 1996, ISBN 3-930243-01-6

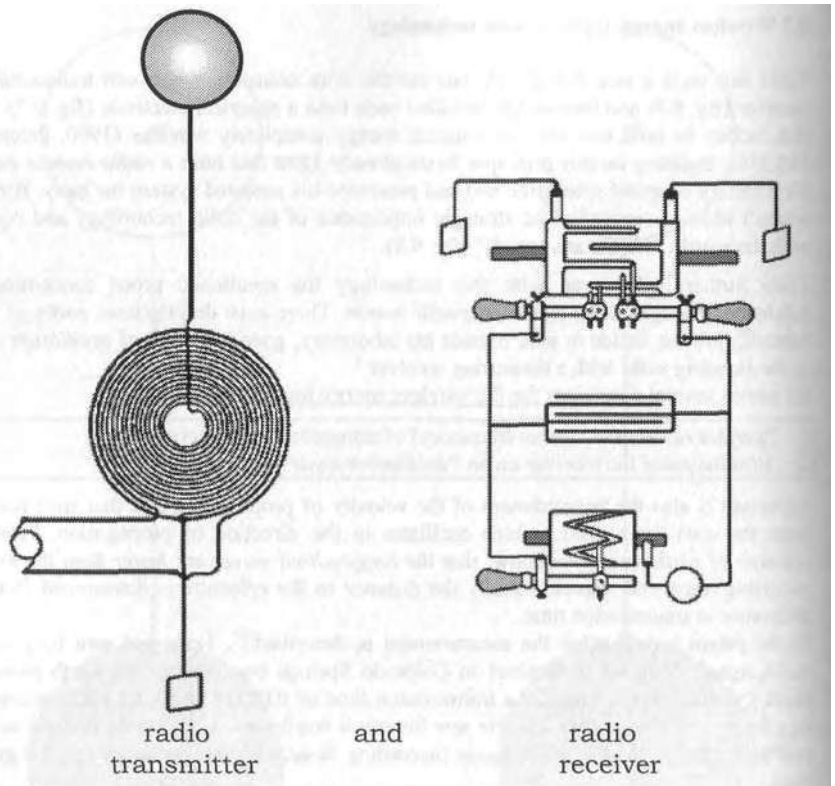

Fig. 9.8: Energy wave broadcasting system, Patent No. 787, 412 (1900) of Tesla.

In today's switching technical notation:

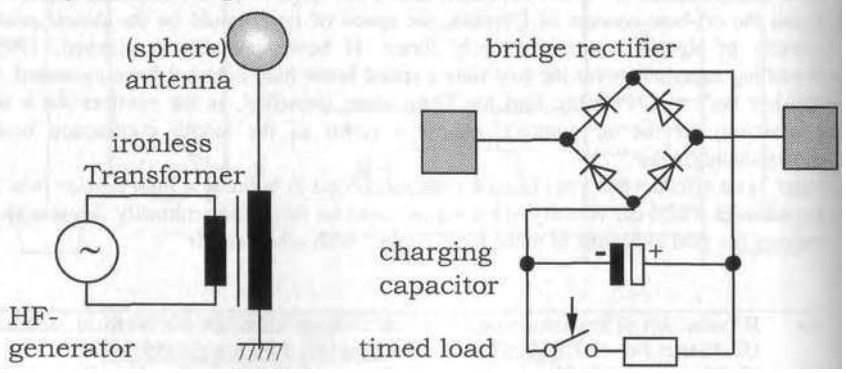

9.8 Measuring and switching technique of Nikola Tesla

As an important and accepted experimental physicist with 14 doctor titles and carrier of the Edison medal Tesla always has held on to his measurement results. Not a theoretical interpretation but exclusively correct carried out measurements have shown him the physical reality. But the by Tesla won measurement results were already for 100 years hard to digest and couldn't be brought into accord with any theory. Therefore a switching technical analysis of the by Tesla described and carried out experiments should give us now information over the nature of the free energy, the tachyon energy, the orgone, or however fantastic the terms may read.
The Tesla coil, according to the instructions of the inventor, is a flat coil wound like a spiral in contrast to the copies today on sale which, surely out of ignorance, are mostly cylindrical. Its peculiarity probably is to be seen in the circumstance, that charges moved through the wire of the coil inevitably increase their angular velocity towards the centre, In this way the electrons, which at first are spherical elementary vortices, are pulled apart to vortex rings like planar discs.
Tesla switches the "secondary" called flat coil between two "terminals". Following he sends, stimulated by his "primary", charge carriers from one terminal to the other and back again and produces a standing resonant oscillation.

Mostly replaces Tesla one of both terminals by the earth. He thus assumes, that now the earth as a spherical electrode takes over the function of one terminal. That he again infers from the observation, that a by the transmitter wireless fed little lamp goes out, if he cuts the connection to the ground. Doing so the oscillation collapses. Radio sets on the other hand can also be operated without grounding, as we know!
The degree of effectiveness of today's distribution technology of current due to the heating losses lies clearly beneath 100 per cent. Without the losses of the wiring it lies close to 100 per cent for the discussed one wire energy transmission. There the vortex rings are guided nicely one after another along the line like beads drawn over a string. This result even is to be expected, as far as no vortex "jumps off the wire or "falls apart". For the wireless version Tesla however to his own surprise had to find out that more energy could be received, than his transmitter produced. The measured degree of effectiveness lay above 100 per cent! He therefore called his transmitter a "Magnifying Transmitter" (fig. 9.10). The further transmitter and receiver were away of each other, the further the received energy increased. Tesla inferred from this, that there had to exist free energy and that he had caught that too.

Consequently he had built a receiver for free energy and registered for patent (1901, Patent No. 685,957, fig. 9.9). Tesla states that the amount of energy depends on the size of the "terminal". Of today's sight we could be willing, to describe this receiver plate as a solar panel, but we should know, that the apparatus produced energy even at night! In addition the energy gain was considerable higher than for today's solar panels. Tesla spoke of "radiations ", of an unknown radiation and he in his lifetime has in vain sought-for help of explanation.
The vortex model will also in this question be a valuable help to us.

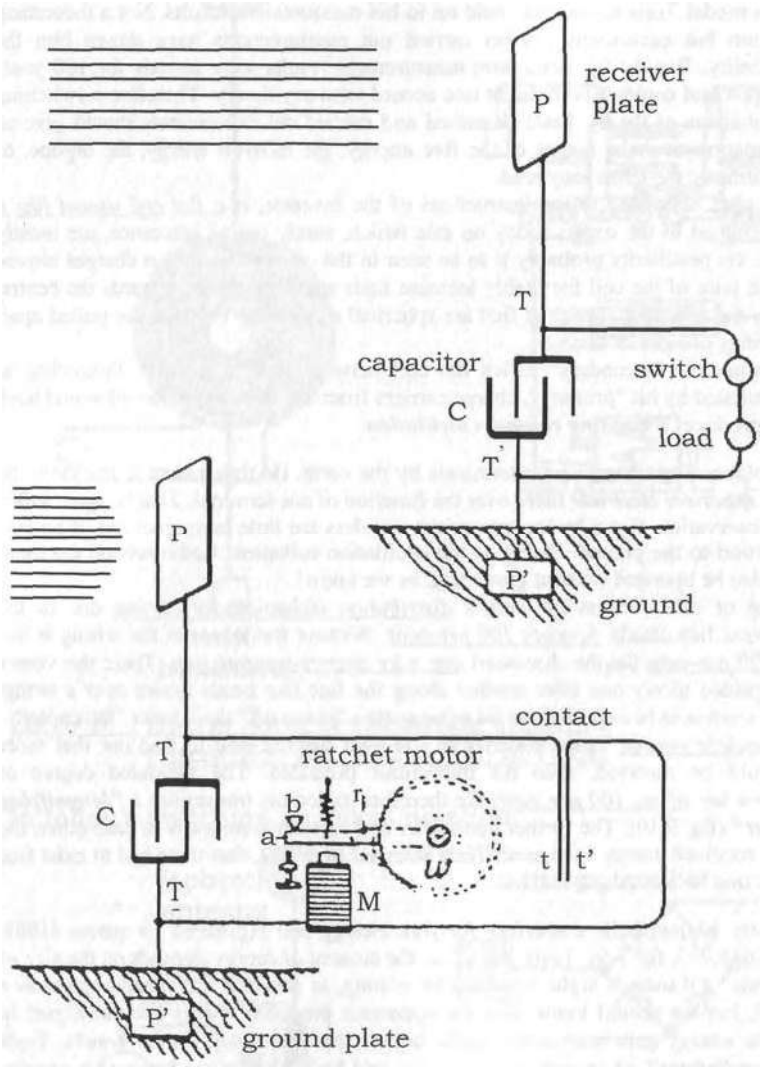

Fig. 9.9: Receiver for "free energy",
Patent No. 685,957 (1901) of Tesla

9.9 Energy technical usage

The answer of the potential vortex theory could turn out as follows:
If at the transition of the one wire to the wireless transmission the ring-like vortices is purloined the guiding wire the vortices immediately begin to turn around each other, as is observable for flow-technical ring-like vortices,. In this way the ring-like vortex the next moment shows its inside. If it before was an electron vortex (fig. 4.3), then it now shows as positron, if it was negatively charged, then it now is positively charged. Following it oscillates back again, etc. Wit that the ring-like vortex on the average has no measurable charge and no mass, because it alternately forms matter and anti-matter. Without interaction it has an enormous ability of penetration . In physics such particles are called neutrinos.
Tesla thus had, apart from his transmitted energy wave, which turned out to be neutrino radiation, by chance also caught neutrinos which oscillated synchronously.

According to the actual level of knowledge do neutrinos penetrate the earth and appear also on the night side. The order of magnitude in every second amounts to approx. 66 billion neutrinos per square centimetre. It is a true bombardment. If we would be able, to collect and convert all neutrinos, the won energy would be entirely sufficient, to cover the need for energy of the world population (approx. 27 W/m^2). We merely have to materialize them, thus give them mass, charge and the necessary localization. Tesla was able to do that experimentally! Let's record:
The ring-like vortices, which Tesla with his transmitter has sent on a journey as electrons with an open vortex centre, are neutrinos (fig. 7.12). Tesla requests that transmitter and receiver operate in resonance, thus with the same frequency. Under this condition the receiver collects in all oscillating vortices, so that no one is lost.
If the neutrinos for instance are just positively charged when leaving the transmitter electrode, then an electromagnetic force of attraction takes place, if the receiver electrode at the same time is negatively charged. The required operation with the same frequency and opposite phase guarantees that also the next moment, if both, the neutrino and the receiver, have changed their polarity, the electromagnetic attraction is preserved.
It is obvious, that strange neutrinos which fly past and by chance oscillate synchronously are as well attracted. In that way the power collected in the receiver capacitor will increase further and degrees of effectiveness of over 100% are obtainable. Tesla discharges the receiver capacitor timed with the frequency of resonance (fig. 9.9) and points to the difficulty of an exact keeping of the condition of synchronisation.
Tesla indeed did work on a theory of his own, but never published it. The patent office and his lawyers had to proceed from the Maxwell theory, although Tesla knew only too good, that his apparatus in no way could be described with this theory. It therefore can't be excluded, that important facts in his patent specifications haven't been mentioned at all - or even worse - consciously or unconsciously in an inapplicable manner have been explained with the Maxwell theory.
Perhaps this is the more profound reason, why the numerous Tesla imitations don't want to function quite so well. With the new theory there should be some changes, and we should accept the challenge for the sake of humanity.

The transmitter tower of Tesla (57 m high with a spherical electrode of 21 m) for the transmission in multiplex mode of operation (according the inventor) of:

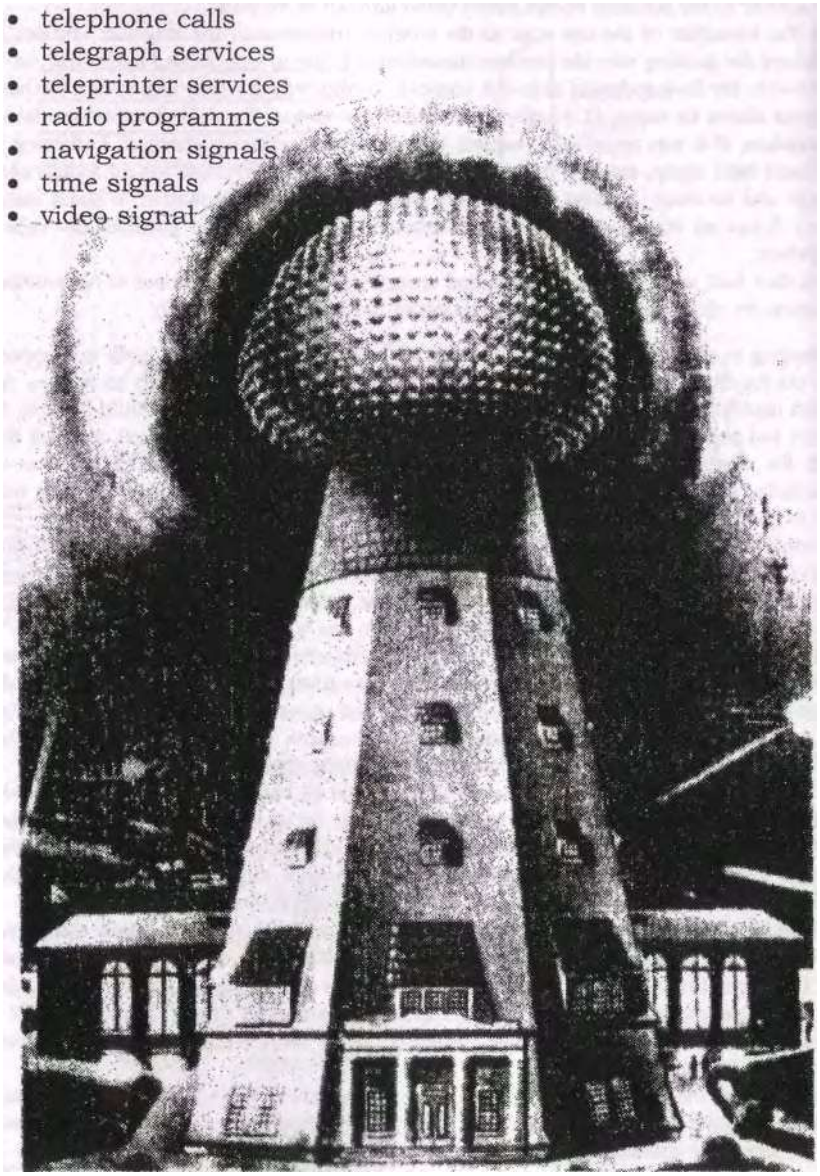

Fig. 9.10: The planned transmitter Wardencliff of Tesla on Long Island, 7.5 MW (1902).

9.10 Environmental compatibility

We now can summarize the different observations and try to find answers for the in the first chapter raised questions concerning the electromagnetic environmental compatibility.
The by Tesla used longitudinal energy wave is a potential vortex wave in the sense of the vortex model of Kelvin, which we again could identify as neutrino radiation (Dirac).
Also other, partly quite fantastic terms, are known like "radiations" (Tesla), "orgone radiation" (Reich), "tachyons" (Feinberg), "grid radiation" (Hartmann), "bioradiation" or "water veins".
Actually these rays have nothing to do with water as a cause. Water with its high dielectricity however favours and influences the course and the local distribution of the radiation. The maximums of the standing wave considered for themselves result lines in straight as a die in the landscape. Of Tesla is known, that he measuring technically could detect the cross points of the lines, which he called oscillation nodes.
There exist so-called dowsers, who can make these standing waves out even without technical aids. For that they hold a fork in their hands, which suddenly moves over such lines.
Let's remember that the same potential vortices are used at the nerve conduction as reaction potentials to conduct stimuli. If ring-like vortices arrive at a muscle, it contracts without knowing, if the signal was sent from the brain over the spinal cord or picked up from the environment over the fork and the hand.

Thus if the same signals, which we use for the tasks of controlling and thinking, are also produced by technical apparatus, then this touches the question of the environmental compatibility in a direct way. Above extremely strong points of resonance, which are called "geopathic zones", now and then even is warned about "psychotronics", a function trouble of the brain, which can show in a disturbance of the waking consciousness.
A possible explanation would be that the brain is occupied with so much vortices picked up from the outside, that it isn't able anymore to accomplish its actual tasks. For muscle cramps or an inexplicable crash of a PC an correspondingly interpretation would be obvious.
As long as no gauges are available, the highest caution is imperative!

If Tesla had been able to put into operation his transmitter tower for longitudinal waves ("World Telegraphy", Wardenclyffe, Long Island, s. fig. 9.10) with the estimated power of 7.5 Megawatt and thus had been able to realize his dream of a world-wide wireless communication, then this could have had hardly estimable consequences for the health of the world population.
Shortly before the completion of the project, in the year 1905, Tesla without notice let stop all work. He to that never made an explanation to anyone. Officially it was said, his financial backer J. P. Morgan would have withdrawn his financial means. In any case was Tesla financially ruined with this step.
Perhaps also T. A. Edison was behind it, who was his opponent at that time. Edison committed himself engaged for the use of direct current. Against the alternating current, preferred by Tesla, Edison argued with unhealthy risks, and with that he perhaps wasn't so wrong at all.

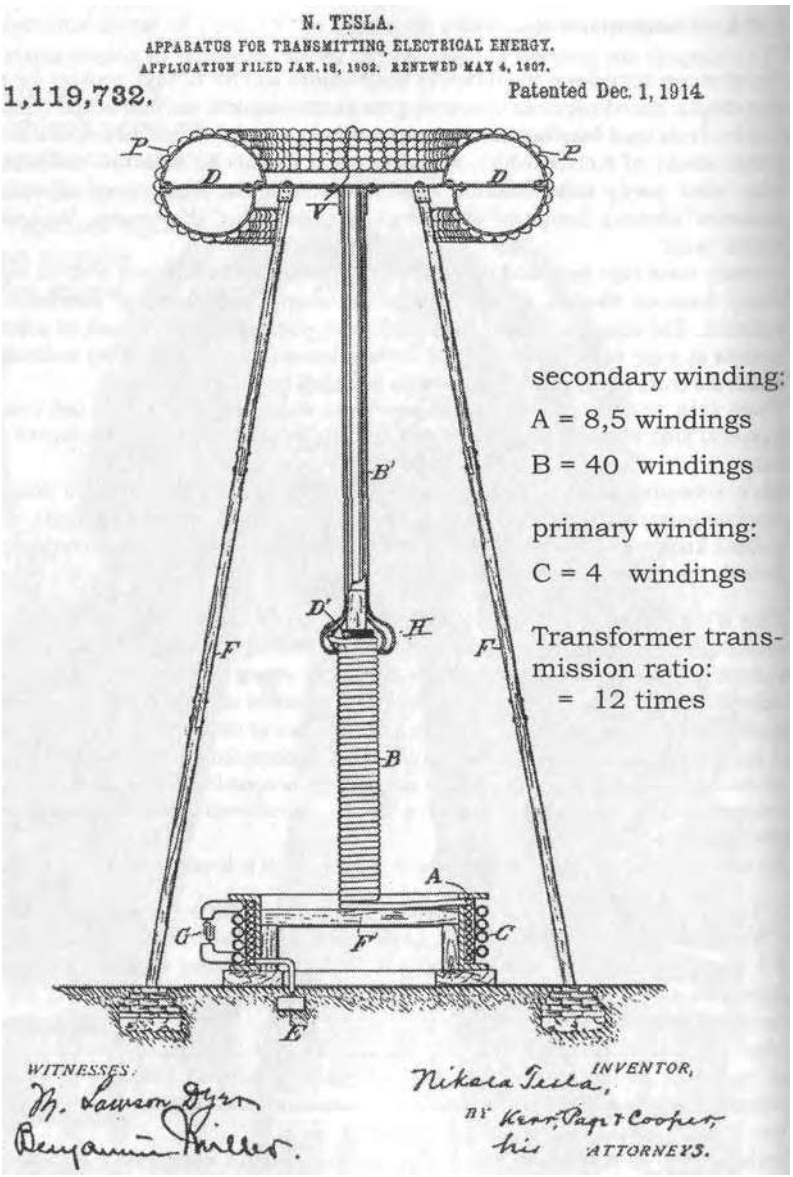

Fig. 9.11: Concerning the technology of the Wardencliff transmitter (fig. 9.10).<i>

<i>: Dr. Nikola Tesla: Complete Patents, (J.T.Ratzlaff), Tesla Book Company (1983), ISBN 0-960356-8-2, P. 435.

9.11 Ecologically fair usage

Tesla not only has stimulated ecologically fair usages of the energy radiation. To that can be counted the use of a Tesla transmitter as a radiation weapon<i> as well as the mentioned building of a Tesla interferometer, the low-frequency interferences of which can lead to mighty gravitational waves and with help of which it should be possible, to produce earthquakes, to sink ships or to shoot down planes from the sky<i>. Against the background of two world wars it can be understood, why Tesla has drawn attention to the possibilities of a use of his system for the purpose of defence.

In today's sight a technology like Tesla's wireless energy transmission (fig. 9.11) hardly would have any chance of a large technical use, because it should be reckoned with enormous problems of environmental compatibility. After all had come out in our considerations, that entirely in contrast to the Hertzian wave just of the Tesla energy wave direct biological effects are to be expected. A purposeful medical use of the Tesla rays however can be imagined.

The collecting of "free" energy waves with a neutrino receiver at first undoubtedly would be a clean and ecologically fair alternative to the present energy technology, with which we heat or nuclearly contaminate our environment. But even the use of free energy converters has limits. Should it turn out that the Photosynthesis uses such a materialization, in which the necessary free electron for the chemical reaction actually is produced from a caught neutrino in the so-called reaction centre and thus the reaction energy is won, then for an as usual excessive use by men it can't be excluded anymore, that the plants on earth die and nothing grows anymore!

I in contrast attribute big chances to the one wire transmission technology. Because for an use of alternative and regenerative energy sources, like the sun in the desert or the geothermal energy in Iceland, the transport of energy has to be made over large distances through the oceans the small losses and the possibility to be able to use sea cables, play a big role. In the residential areas and conurbations on the other hand it has a positively effect, that by the concentration effect of the potential vortices the interference radiation is directed inward. Laid on the bottom of a sea or of a river, such a line in addition is protected against the effects of lightning and sabotage, and it neither spoils the countryside, as the old-fashioned high tension pylons do.

For transportation tasks the mentioned making use of the spin coupling would surely be the most suitable drive. The denser the medium, the more efficient would be the driving effect, for which reason not only flying objects, but quite particularly also ships and submarines could be operated non-polluting in this way without combustion and without exhaust fumes. Build up effects by the water pressure or the sound barrier don't occur. But control might not be entirely unproblematic. If for the reason of a unipolar arrangement of the field a relative velocity to compensate the field becomes necessary, then a correspondingly build up arrangement will do so without considering losses. It is no accident that most apparatus which got well-known have flown the builder sooner or later "past his ears" (note of the translator: broke into pieces). Till a commercially utilizable flying saucer has been built, many technological hurdles have to be taken.

Claims to an up-to date environmental policy in view of longitudinal electromagnetic energy waves
= Tesla waves = neutrino radiation = scalar waves
= potential vortex waves:

1. Gauges must be developed and built, with which the energy waves can be measured.

2. All technical apparatus should be tested regarding the emission of energy waves. Harmful radiation should be avoided.

3. Only such transmitter antennas may be brought into action, which emit a minimum of energy waves.

4. The ability of biological systems to absorb energy waves should be determined. To that also belongs the question, how many vortices collect locally and how fast they fall apart.

5. Limits for allowed pressure produced by artificially energy waves should be fixed, regulations and laws enacted.

6. The in nature available energy waves should be brought to a technical use, with the goal of a natural energy production.

Fig. 9.12: Catalogue of claims concerning the environmental compatibility in the view of the new field theory.

9.12 Claims concerning the environmental compatibility

Now we still not know, if the using of a handy or another electronic device poses a danger to the user. Now, we surely can't exclude a danger, and the statement of the manufacturer, it is safe because all limits have been met, is worth nothing, as long as the part of longitudinal waves isn't measured. Therefore stands at the very top of the list of the catalogue of claims (fig. 9.12) the development and the building of gauges to measure Tesla radiation. More than half the 700 patents of Nikola Tesla concern the building of transmitter and receiver installations for energy waves. Here a lot of valuable clues are found, especially as he himself has built and used some of the switching circuit designs. In the seminar a rebuild is discussed, with which 1995 the existence of longitudinal waves could be proven [A7].

For an earthquake always both, the transverse and the longitudinal wave, occur simultaneously and, taken exact the same is valid for the sound wave, even if the transverse part doesn't get too far in the air. The emission of both parts in analogy is almost to be expected of an electromagnetic wave generator or transmitter. Actually both waves are detectable at the receiving point: The useful transverse wave and the longitudinally propagating vortices, which show as noise (fig. 4.7). If the vortices are predominant and the useful signal goes under in the noise, then a interruption of the radio operation occurs. Also small gardeners immediately near a radio station have made experiences as e.g. in a distance of one kilometre from the transmitter of RIAS-Berlin. They were able to light their allotments day and night with a neon tube, to which they merely had tied a free wire. The radio station immediately insinuated, that they in an illegal manner had tapped their useful wave and damped it. But it can't be excluded, that the transmitter has sent a longitudinal part in the ether too, which was responsible for the energy transport. But that suggests, that also at other transmitter antennas, thus for the mobile phones, the unwelcome parts is transmitted even than, if we don't use it at all.

Still another problem is added. If in a modern receiver radio waves arrive, then they roll up to a standing wave and according to fig. 1.4 to a vortex over the antenna. According to that we aren't able anymore to distinguish, if the transmission took place as Hertzian wave or as Tesla wave. The separation of both sorts of waves has to take place before the antenna is reached.

An up-to date measurement arrangement would look as follows: In front of the receiver antenna a path with a tunnel, which represents an insurmountable obstacle for the transverse waves (fig. 6.14), is placed. Then only the longitudinal waves pass the tunnel, and these at the end of the tunnel can be recorded and analysed with conventional technology. The tunnel is an elegant possibility, to make use of the part of Tesla waves. After all only this part is relevant with regard to the electromagnetic environmental compatibility. Concerning the above asked question we can take home at least one important realization. The probability is quite high, that you actually notice nothing of the handy radiation, because not every system react in the same manner to certain vortices. The resonance conditions regarding frequency, phase and position always have to be fulfilled, if an absorption of energy waves should occur. (fig. 2.10 B, E. coli bacteria). On the other hand it however can't be excluded, that just you or me synchronize according to frequency and collect 100 % of the transmitted energy radiation. In contrast to the Hertzian wave plays for that the distance to the source of interference only a secondary role! Seen that way worries would by all means be entitled ...

From Indian mysticism:

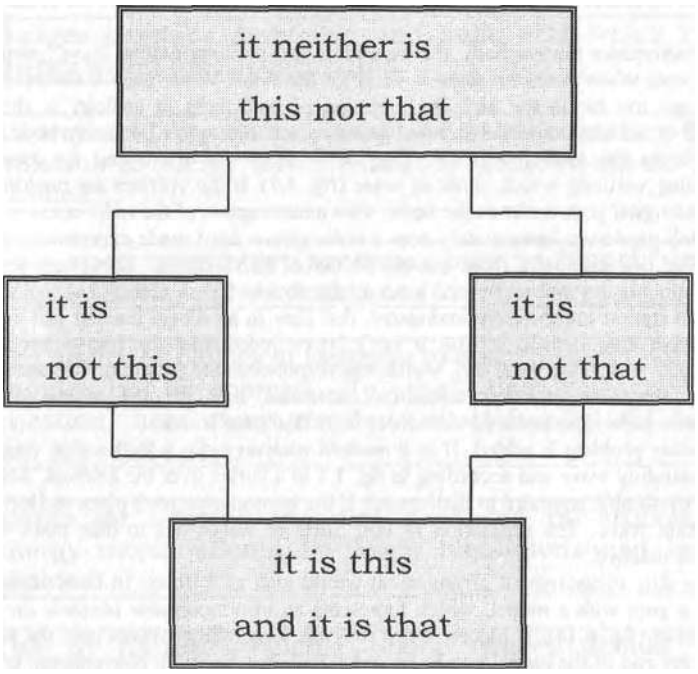

Fig. 9.13: The structure of the world equation, an example from
Indian mysticism

9. 13 Epilogue belonging to part 1

The correctness of a new theory not by all means guarantees, that it also is accepted! A new theory must be used. Only if a concrete need exists then an acknowledgement is to be expected if at first only by the direct beneficiaries.
In november 1994 in Munich the trade fair "Electronica" took place. Here invited by the Deutschen Gesellschaft fur EMV-Technologie (German association for EMC-technology, note of the translator) the books about potential vortices [Al, A2] were honoured with a prize by an internationally renowned EMC-scientist. The number of people, who the potential vortex theory helps further to find answers to problems, which until now aren't explicable, grows further.
Nevertheless, nobody should believe that something will be changed to the content of the text books in the shelves that fast. Habit and laziness encourage to further use the to date interpretation, even if a new theory has ready a better and convincing answer. It will take some time, to give an example, till the heating of water in a microwave oven is explained as eddy losses, as is described sound by the potential vortex theory already today. The discovery of a physical phenomenon may happen in a fright second. Its acknowledgement on the other hand as a rule is a lengthy procedure. If we look back in history we find out that even in the past it hasn't been otherwise.

Of the four fundamental phenomena in fig. 8.2 at first the tension voltages and the charges have been discovered by Coulomb (5.7e).
(5.7c): An effect of the eddy currents was observed already 1825 by the French physicist Arago. He discovered that a magnetic needle suspended above a rotating disc tends to rotate along. Out of ignorance he named the effect "rotational magnetism".
But the eddy currents could only be mathematically described with the help of two laws, the law of Ampere (1820) and the law of induction of Faraday (1831). Because the effect due to the eddy current losses rather was regarded as disturbing, technical applications or patents at first have stayed out. At first Riidenberg has carried out fundamental calculations for eddy current brakes in 1906. The discovery and usage of the "skin effect" is to be attributed to Tesla.
(5.7b): The electromagnetic wave for the first time was mathematically described by Maxwell (1864). He had aimed to calculate the light and he could show, that his theory actually could correctly describe all properties of the light. With that he was able to prove the correctness of his theory. But he had to deal with many sceptics, because he had postulated the dielectric displacement, without however in his lifetime being able to measure it because of its smallness.
This may be the reason, why the discovery is attributed to Heinrich Hertz and was and is spoken of the Hertzian wave. Neutrally seen Hertz at first was nothing more than a enthusiastic pupil, who had worked through the "Treatise"[<i>], Maxwells books. All results, which Hertz could observe experimentally, already were contained in the Maxwell-theory and published.

<i>: James Clerk Maxwell: A Treatise on Electricity & Magnetism, vol. 2, Chapter XX: Electromagnetic Theory of Light. Dover Publ. New York

But the great mathematical description of Maxwell at first had a purely academic importance. The interest of the general public on the other hand concentrates on the practical applicability. Hertz had experimented with antennas and has laid the foundations of the building of a gauge for electromagnetic waves (1888). The wireless transmission of invisible waves was convincing. It was an entirely new technology, which stimulated fantasy in view of a technical usage. A practical man, who was stimulated by the theoretical realizations, was Marconi. He goes for the inventor of the radio (1895, Nobel prize: 1909).
Between the three summits, first the calculation and at the same time discovery, second the measurement and third the usage of the wave phenomenon lay 31 years, and the radio technology is developing still further, even today. In the area of the cellular phone network and the telecommunication even a kind of gold mining mood prevails, which can't be impressed much even by hints of an electromagnetic environmental compatibility.

In the euphoria of the past 100 years is fallen into oblivion completely, that besides the by Hertz detected transverse wave in the wave equation according to Laplace and according to the original version of Maxwell also a longitudinal wave was described mathematically. This one was discovered and detected by Tesla in numerous experiments. With reference to his discovery Tesla initially had asserted publicly, Hertz had been at fault, with which he undoubtedly was wrong and had incurred the wrath and the scorn of the scientific community. As a result of this development his experiments haven't been reproduced and the discovery of the scalar wave could fall into oblivion.
Not enough with such sanctions against the inconvenient freethinker Tesla a series of professors like Gibbs and Heaviside have made cuts and discarded all parts from the original version of the Maxwell equations, which by that time weren't considered to be experimentally proven by experiments of Ampere, of Faraday, of Ohm and Hertz. With that the scalar waves fell victim to the axe, what, though it had encountered severe criticism, finally entered as textbook opinion into all textbooks, after Hertz also had sanctioned this measure.
If the field equations according to Maxwell in today's revised version don't describe scalar waves anymore, then all orthodox scientists, who want to bear reference to that, have to bear one thing in mind: discarding a term of an equation is the same as neglecting it. But the term only may be neglected if it is sufficiently small. The first thing every student learns in the physical practical training is that this first has to be tested. For that the term has to be measured and its order of magnitude must be determined. Then it is little helpful and extremely unscientific, if at first is neglected and on the basis of the revised field equations, which have put all scalar waves to zero, is demonstrated that the neglect was allowed or even necessary.
A practical example are the longitudinal wave parts, like they occur and are proven in the near-field of a transmitter antenna. Considering the order of magnitude a neglect is out of the question. On the other hand they should not exist at all according to textbook physics, because they had fallen victim to the axe. Since most scientists in present time do not know about the cutting action anymore, they are postulating field vortices anew in the proximity of an antenna. Field vortices, which are propagating longitudinally in the direction of a field pointer as a scalar wave.

With that they calculate their own arbitrary assumption<i>.
If in the practical training of physics a student unevaluated neglects an essential factor of influence, then his experiment goes as not passed. The experiment must be repeated so long until according to the approved methods of scientific soundness all used neglects have been tested individually and have undergone an error consideration.
Do we now have to deny the cutting action, which had been plotted by Gibbs, Heaviside and others, having the necessary scientific soundness? Do we have to review and rework all textbooks concerning the illegal neglect? Since the cutting action a gap gapes in the field theory!

(5.7d): The potential vortex fills the remaining gap in fig. 8.2. Several research scientists and scientists can be named, who already could observe this phenomenon: in front of all goes Nikola Tesla for discoverer of the Tesla currents, very weak currents which are said to cause extremely high potentials. Here presumably cause and effect have been mixed up, because weak currents never can produce high potentials. Actually the potentials prove to be a result of the potential vortices, whereas the currents aren't more than a result, nothing but leak currents. At least Tesla could use the vortex, but without a usable theory he neither could calculate nor adequately explain it. Besides Tesla Wilhelm Reich should be mentioned, who has collected the vortices in his orgone accumulator.
Mostly only certain aspects were observed and investigated: by Tesla the planar vortex, by Reich the influence on the weather, by Schauberger the water vortices and by all three the medical and biological aspect. The list of names is incomplete and could arbitrarily be continued.

With the discovery of the potential vortex (1990) the basis for the building of a gauge and the technical usage of the physical phenomenon is laid [Al]. It not only concerns the search for water, but also the detecting of the vortex balls and vortex streets, of the standing waves of the energy radiation in the air, at the workplace, at the bedroom, in clinics, in recreational areas and hotels. As explained at the start, neither the field strength of a Hertzian wave nor the arising heat development can be made responsible for biological or technical harm.
It primarily are the newly discovered vortices of the electric field, which take effect. The effects can, as we have seen, as well be good for health as bad for health. Intensity, plane of polarization, vortex configurations and many other characteristics play a role here. To research these influential factors gauges for vortices will be needed as well.
We have to realize that in the technical domain the electromagnetic compatibility of an apparatus is determined by its sensitiveness to vortices, thus by the fact how many and which vortices can cause a function trouble. To determine the environmental compatibility of a product the emitted vortices, the energy radiation, have to be measured. Limits for high tension lines, for screens or handheld phones must be given in units of the potential vortices. The potential vortex has shown us the way to a unified theory and has brought along a new picture and understanding of our environment. It with that wants to show us the correct way for an ecologically compatible dealing with nature.

<i>: Zinke, Brunswig: Lehrbuch der Hochfrequenztechnik, 1. Bd., 3.Aufl. 1986 Springer-Verlag Berlin, Seite 335

Part 1: Edition belonging to the lecture:
"Electromagnetic Environmental Compatibility"

Prof. Dr.-Ing. Konstantin Meyl

Scalar waves

Abstract: 1. Auflage 1996, 4. Auflage and 1st English Edition 2003

Both technical and biological systems can be influenced by electromagnetic fields, whereby numerous questions still are open, like e.g. concerning limits and the nature of physical interference fields. The book shall do justice to the circumstance, that a fact oriented discussion about „electrosmog" implies an analysis of possible reasons, a mathematical derivation and a physical argumentation.

We proceed from the assumption, that only that part of the electromagnetic wave should be considered for malfunctions, which has been absorbed and which has rolled up to a field vortex. The effectiveness depends on the amount of the produced vortices and on the life span, the decay of vortices.

Analogous to the sound wave vortices in space are propagating as longitudinal waves. In this context is pointed to numerous effects. Examples for the technical and biological use of these standing waves are the energy transmission of Nikola Tesla as well as the nerve conduction, which functions in a corresponding manner. If the same vortices, which man uses for conduction of information, are emitted by technical devices, then biological reactions can't be excluded anymore and worries with regard to „electrosmog" seem to be justified.

Causes, phenomena and natural scientific consequences

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Scalar Waves

From an extended vortex and field theory to a technical, biological
and historical use of longitudinal waves.

Part 2

by

Professor Dr.-Ing. Konstantin Meyl

Edition belonging to the lecture and seminar "Electromagnetic environmental compatibility"

(Original title: "Elektromagnetische Umweltvertraglichkeit")

Translated out of the German language
by Ben Jansen
(2000-2003)

* * *

Part 2: Edition belonging to the energy technical seminar

Free energy and the interaction of the neutrino radiation

* * *

INDEL GmbH, Verlagsabteilung

Villingen-Schwenningen 1996-2003

ISBN 3-98O2 542-4-0

Preface to the seminar

The point of a seminar is, to deepen, to practise and, as far as possible, to practically appy the material of a lecture. The knowledge of the content of the lecture hence is a prerequisite for the participation.
For the reader of this book that's tantamount to the recommendation, to have read the first part, the edition belonging to the lecture, before*[1]*. Here the questions concerning the „electromagnetic environmental compatibility" are asked and the necessary bases for their answering is laid. Also practical consequences for various areas of science are indicated. The deepening most suitable should be made in form of a seminar, subdivided into the here presented part 2 to the energy technical seminar and a part 3 to the information technical seminar. Part 2 correspondingly concerns the energy technical aspect of electric or magnetic longitudinal waves, whereas part 3 is dedicated to the information technical aspect<ii>. Because it concerns a book which merely for reasons of usefulness is published in three parts, the chapters are consecutively paginated. References to chapter 1 to 9 hence automatically relate to part 1. The numbers of the figures and tables as a rule are identical with those of the chapters, in which they are discussed.

The seminar should lead on over the pure reading, consuming or listening and should stimulate to join in. All involved persons may and should give ideas and ask questions, even if these may sound little orthodox. The scientific working method takes, that is struggled for answers and even is argued, if necessary. To reach this goal, it mustn't exist any obligation or censorship, neither for the leader of the discussion nor for the participants of the seminar.

The seminar is being carried out since the summer semester 1997. The works of the seminar written by students treat the knowledge of text books of the respective theme. Following the lecture the answers are discussed and compared to those of the theory of objectivity<i> and other models of explanation. This procedure in this edition belonging to the seminar is reflected at some points, if for instance a chapter is completed with a „discussion".

The first edition of this 2nd part still was incomplete and has been handed out to the participants of a congress in Switzerland instead of a manuscript belonging to the lecture the 17th of Nov 1998. The here presented second edition in the meantime to a large extent is complete, but surely not yet perfect. In accordance with the experience made with the first part of the book also for this 2nd part a third and revised edition, in which the ideas of the participants of the seminar and of the readers find consideration, will be due to be dealt with after a year. The reader of the second edition has to console himself with the fact that a lively seminar constantly is changing and developing further. And that has to be so!

Villingen-Schwenningen, January 1999

<i>: Electromagnetic environmental compatibility, Part 1, Edition belonging to the lecture, INDEL Verlagsabteilung, 1996, see page 1-218 of this issue.

<ii>: Electromagnetic environmental compatibility, Part 3, Edition belonging to the information technical seminar, 2002, see page 443 - 625 of this issue.

10. Oscillating interaction

A theory is not an end in itself, even if it sounds very convincing. It has to be measured by its applicability. As an entry into the practical consequences, which result from the theoretical part[i], the question about the validity of Kepler's laws is raised.

10.1 Kepler's laws

The "radius vector", a line drawn from the sun to a planet, sweeps out equal areas in equal periods of time. At least has teached us Johannes Kepler it that way (fig. 10.1). The balance of forces, the gravitation on the one and the centrifugal force on the other hand results in the innermost planets of our solar system orbiting the sun very much faster than the outer planets (Mercury in 88 days, the Earth in 365 days, Jupiter in 4333 days and Pluto in 90465 days!).
For the inner planets as well as the big planets Jupiter and Saturn Kepler's laws are still found confirmed. But that shouldn't apply anymore for the outermost planets of the solar system. Beyond Saturn should prevail changed rules as is said, based on observations of the Voyager spacecrafts[ii].

If we direct our view to an unknown galaxy, then does it rotate around its centre and in doing so to a large extent keeps its form. Despite rotation of its own an elliptic, a barred or even a spiral galaxy virtually doesn't change its characteristic form. From this follows, that the inner stars of a galaxy are considerably slower on their way than the outer stars! But we expected exactly the opposite.
According to Kepler's regularity the outermost stars would have to orbit extremely slow, In order not to be hurled into space as a result of the centrifugal force. But then a galaxy wouldn't keep its structure. The spiral form, as it already has been observed and classified by Hubble (fig. 10.2), merely would be an accidental exception as a momentary picture, but by no means the rule.
We have to take note, that the structure and in particular the cohesion of a galaxy can't be explained with Kepler's laws[iii].

<i>: Konstantin Meyl: Electromagnetic environmental compatibility, Part 1 of this book: Causes, phenomena and natural scientific consequences.
<ii>: Kendrick Frazier: Das Sonnensystem, Time-Life Bucher, Amsterdam (1991)
<iii>: The basic laws of the universe start to rock: ,,What is the matter with the galaxies? They rotate in their fringe ranges much faster, as is allowed by the laws of physics. Or is something wrong with these venerable laws? The astronomers and physicists stand for the dilemma to have to decide between the two alternatives: feign the observations us an other world or do we calculate wrong since centuries?" (translated), Bild der Wissenschaft Nr. 2, 1989

Kepler's 1st law:

The planets move in elliptical orbits, with the sun at one focus.

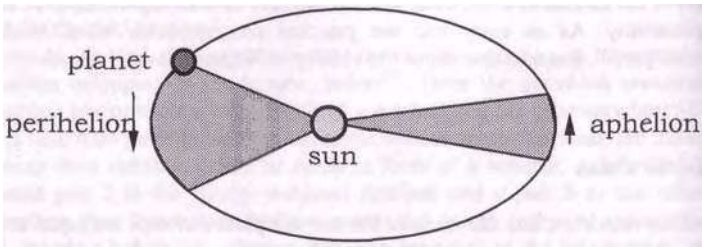

Fig, 10.1: Kepler's 2nd law (concerning the conservation of angular momentum):

The line drawn from the sun to the planet sweeps out equal areas in equal periods of time.

Kepler's 3rd law:

The ratio of the squares of the revolutionary periods of two planets is equal to the cube of their average distance to the sun:

$$\frac{t_1^2}{t_2^2} = \frac{r_1^3}{r_2^3} \quad (10.1)$$

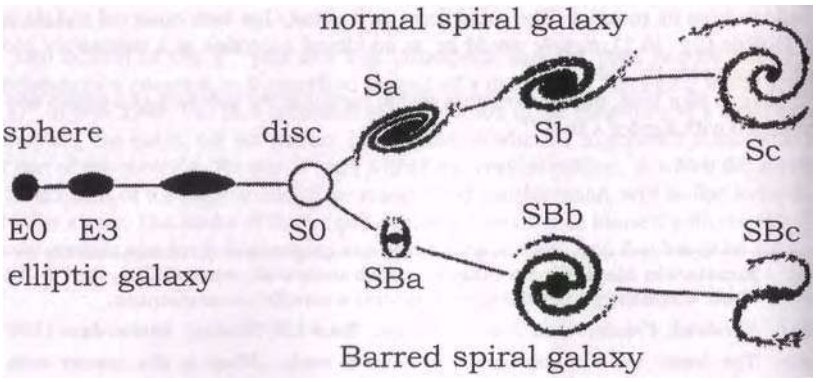

Fig. 10.2 The classification of the galaxies according to Hubble<i>

<i>: according to H. J. Lugt: Vortex Flow in Nature and Technology, page 223

10.2 Unknown interaction

So which interaction keeps a galaxy together? We today believe to know four different sorts.

I. The gravitation[i]: But since Kepler's law isn't valid in this case anymore, the gravitation is ruled out from the start. Obviously for the distances in a galaxy it hardly is effective.

II. The electromagnetic interaction: It is responsible for the structure of the atoms. Looked at from the outside atoms carry no charge, i.e. the charge conditions are balanced. A binding of our sun to the centre of the Milky Way by an electromagnetic interaction thus is ruled out as well.

III. The strong interaction: Since for the proton another charge distribution is measured, as a single positively charged particle should have according to the normally used theory, the strong interaction was introduced as a nuclear force, to explain the big error, the grave difference between measurement and calculation. The good advice hence reads: instead of giving birth to postulates at random, first of all the fault should be searched for in the normally used theory[ii]!

IV. The weak interaction: It quite obviously is involved in the particle decay[ii]. Both, the weak and the strong interaction, only have an extremely short range. With this property they consequently won't be able to keep a galaxy together.

Conclusion: In a galaxy a still unknown interaction takes effect, and science is requested to search it.

Both interactions with infinite range, the electromagnetic interaction and the gravitation occur as a result of static fields, therefore assume a constant charge or a constant mass. Considered more exactly in that case it merely can concern special cases. Gravitational waves, which reach our earth and which are detected in very costly experiments[iii:>], already show that the existence of alternating fields can't be excluded and oscillating interactions by all means are conceivable! The physical research at present probably is on the right track. The researchers however don't have ready an usable explanation yet. We accept the challenge!

<i>: Derivation of Kepler's 3rd law in fig. 11.10

<ii>: Konstantin Meyl: Potentialwirbel, Band 2
INDEL-Verlag, Villingen-Schwenningen 1992, ISBN 3-98O2542-2-4

<iii>: Gero v. Randow: Wenn kosmische Katastrophen Raum und Zeit verbiegen, zum Thema Gravitationswellen-Detektor, VDI Nachrichten Nr.9, 1.3.91, S.32

Analogy:

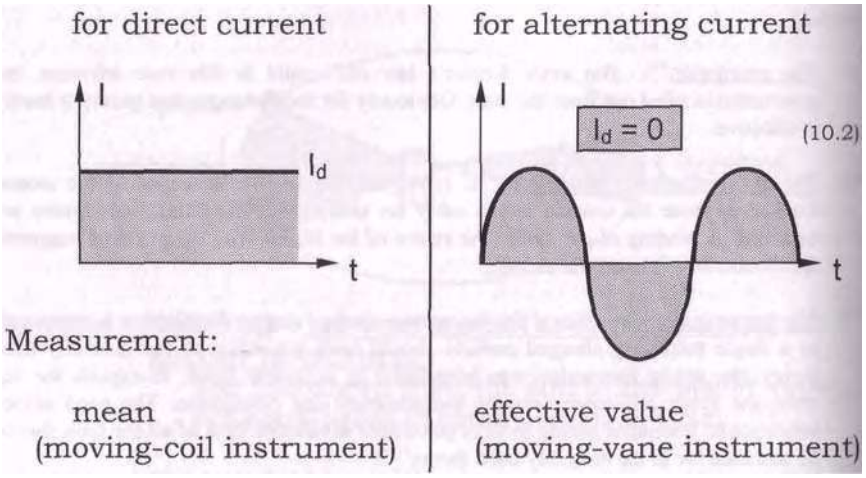

Fig. 10.3: Direct current and alternating current

constant charge: **Electromagnetic Interaction**	oscillating charge: **Resonant Interaction**
constant mass: **Gravitation**	oscillating mass: **Levitation**

Fig. 10.4, a: The four fundamental interactions

10.3 Harmony of the alternating current engineers

Today's situation can be clarified by the following picture: you engage a "direct current engineer" to measure the tension voltage in the socket of our power supply system. The „dyed-in-the-wool direct current engineer", who never has heard anything of alternating current, reports: „No tension voltage is measurable". If he for reason of your doubtful expression looks still more exact he will realize: „The pointer of my moving-coil instrument strangely fidgets around zero, but the swing is so small that one confidently can touch it", (fig. 10.3)
Modern science is accustomed to say, without a valid theory and without technical measurability nothing can exist, what mustn 't exist. If you drop dead after the experiment, then you probably had a weak heart or other afflictions. In such cases as a rule the victim himself is to blame and by no means theoretical physics!

In the case of our power supply system the answer is known: The mean of the alternating voltage of the network is approximately zero. The pointer of a moving-coil instrument for reason of its inertia can't follow the fast changing anymore and only fidgets on the spot. The effective value however amounts to around 230 Volts. But to measure it you need another device, for instance a moving-vane instrument. Seen so, direct current describes the special case of alternating current with frequency zero.

The properties of alternating current can be depicted best by an extraterrestrial observer. He will tell us: Seen from a distance at least at night a great harmony seems to prevail on earth. All lights in the streets and cities twinkle completely synchronously. All generators are in resonance among each other and with all consumers. There are two big races: The 50 Hertz race and the 60 Hertz race, which appear if the earth turns further and the 50 Hertz race is switching off again its twinkling lamps.

The synchronization necessary for an exploitation of alternating fields is so obvious for us, that hardly anybody realizes, that a consumer operated with only one Hertz difference to the frequency of the network can't be supplied with power anymore. Apart from the correspondence in frequency it even depends on the correct phase. The phase angle must be between 0 and +90°. This corresponds to an efficiency factor $\cos\varphi$ between 1 and 0. The cable connections serve both the transport of current and the synchronization of all the generators and consumers connected to the network. The frequency is kept so constant that simple clocks, switching stations and even old record-players can be operated synchronously with the frequency of the network.
The synchronization of the feeding in power stations is supervised by a station of its own, which dictates the time. It is true that we aren't capable of seeing the twinkling of the lamps anymore for reason of the inertia of our eyes, but it can be detected and filmed with high-resolution cameras. Even if we can't perceive the harmony of the alternating current engineers, it nevertheless exists.

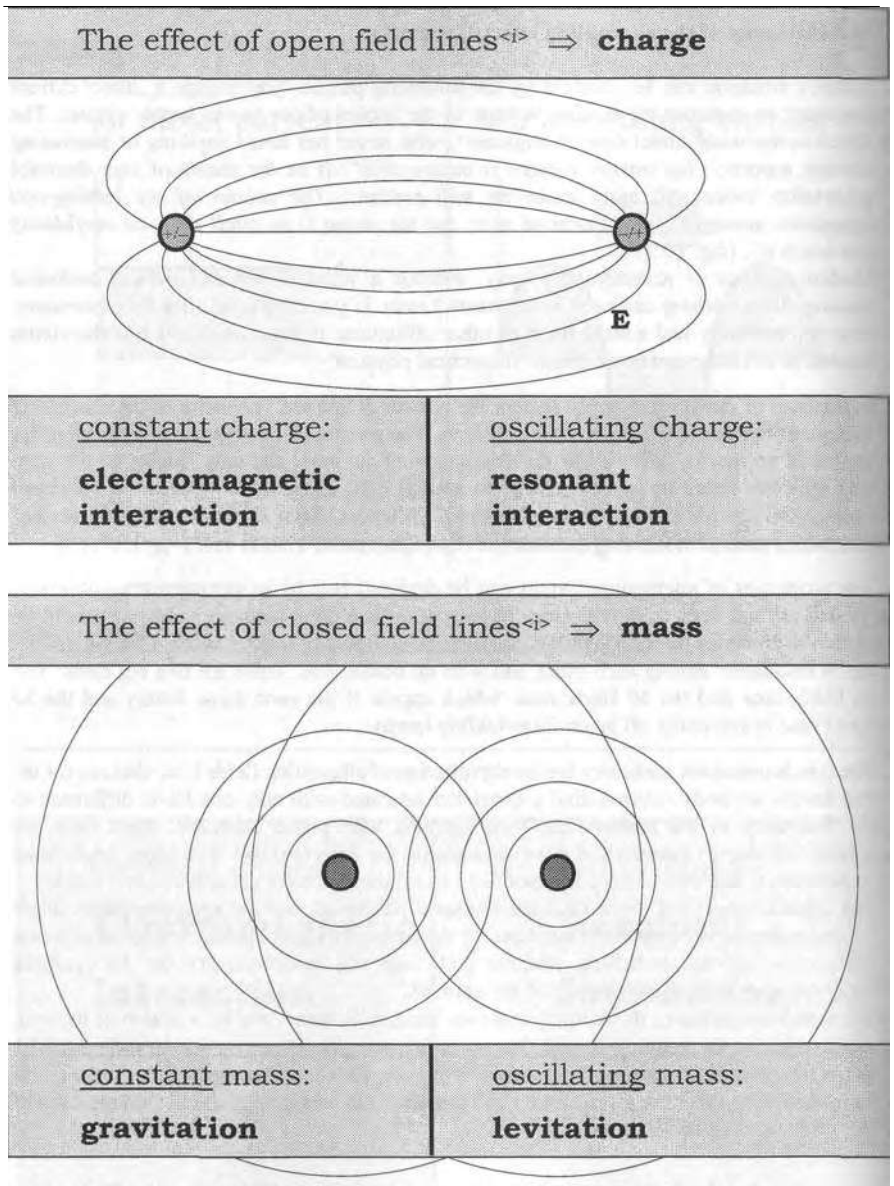

Fig. 10.4, b: Explanation of the fundamental interactions

<i>: Konstantin Meyl: Potentialwirbel, Band 2, INDEL-Verlag (1992)
see also in Part 1, chapters 6.8 and 6.9

10.4 Four fundamental interactions

These considerations suggest, that also gravitation and electromagnetic interaction merely describe the special case of oscillating interactions with frequency zero. To avoid confusions, we'll have to think of new names.
The electromagnetic interaction can be clarified by means of open field lines, which start at a charged body and end again at another body of unequal charge. In physics classes it is normal to make the field lines of a magnet visible with iron filing. Between the unlike poles a force of attraction is observed<◁>.
If we this time assume that both magnetic poles change their polarity at the same time, then the force will decrease for a short time during the changing of polarity, to afterwards be active again in full magnitude and in the same direction. Therefore a force of attraction is observed again even for a reversed polarity.
The generalization hence reads: The electromagnetic interaction will occur also in the oscillating case, but in weakened form, if both bodies involved in the interaction change their polarity synchronously and if they are in resonance. A name by analogy would be "resonating interaction" (table 10.4).

It is known of the electromagnetic interaction, that its effect is larger than that of the gravitation by powers often. This presumably has to do with the described and observable bundling up of the open field lines, whereas closed field lines can't be bundled up. The gravitation hence is linked with the closed field lines, which surround all elementary particles, every atom and every body<◁>.

The opposite of the bundling up is the repulsion of open field lines, for which reason here also forces of repulsion can occur. For the gravitation however no repulsion is observed, because closed field lines virtually can't be influenced.
Apart from the circumstance that the effect generally will be smaller in the oscillating case, similar properties are to be expected. Also its range will be infinite as well. It is recommended to call the case of oscillating charges, as already said, "resonating interaction" and the case of oscillating masses, the oscillating gravitation, ,,levitation" (table 10.4).
The term ,,levitation" is very appropriate, but not new. Unfortunately until now no generally binding definition existed, what should be understood by that, for which reason misinterpretations and irritations can't be excluded. Mostly levitation is linked to a cancellation of gravity, up to a state of free floating, but we will see that quite other phenomena become describable with this term.

10.5 Resonating interaction

The question, what keeps a galaxy together, now can be answered unambiguously. The well-known interactions already have been excluded. If for the enormous distances the gravitation can't keep the outer stars anymore in accordance with the Kepler rule, then the levitation won't be able at all.

Example: central star S_z with 3 planets P_1-P_3
and with 4 neighbouring stars S_1-S_4

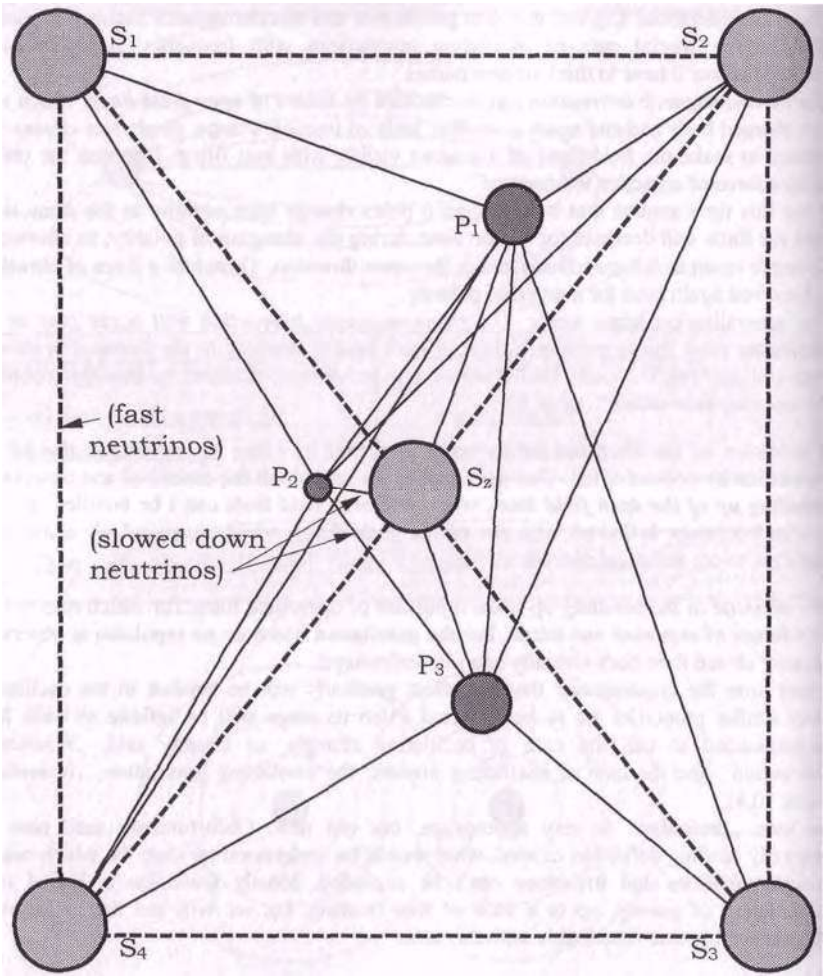

Fig. 10.5: The invisible threads of a resonant interaction

milky way-radius: $15000pc*3*10^9 = 45*10^{16}$ km
sun system-radius: $50\ a*15*10^7 = 7{,}5*10^9$ km

$\frac{45\cdot10^{16}}{7{,}5\cdot10^{9}} = 1{,}27\cdot10^{8}$	the resonant interaction is more than eight decimal powers bigger than the gravitation!

Therefore the oscillating charge is left. Actually the resonating interaction will reach to the outermost areas of a galaxy. The bundling up of the field lines results in the centre of the galaxy and one of its stars to stand in an exclusive resonance to each other, what looked at from the outside looks like, as if the star hangs at an invisible string or a "rubber band" and thus turns around the centre.
Because quite a few stars hang at the centre of a galaxy, it can be assumed that it provides correspondingly many resonance. The centre perhaps is comparable with an extremely broad banded transmitter, which operates on all channels simultaneously. The stars then pick as a receiver the for them suitable channels and hang themselves by „rubber band" at the heap (fig. 10.5).

Should there exist any particles with an oscillating charge, which synchronize between centre and star with the resonating interaction, then they will mediate between both partners. If we assume that the centre at one channel just is positively charged, then all at the same time negatively charged particles will be attracted, the positively charged particles however repelled. Whereas the unlike particles in the centre participate directly in the production and maintaining of the oscillation, the like positively charged particles will be hurled into space.
But at the same time does a star, which clings to the centre, have to be negatively charged. It hence attracts the repelled particle. The particle thus drifts from the centre to the star, even then if all three, the centre, the star and the particle, change in polarity. The result is, that the stars grow in diameter by collecting the particles. Only because our sun actually grows, it has the chance, to sometime become a red giant!

Since the sun radiates, as is well-known, in every second a radiation equivalent of 5 million tons, it permanently has to be supplied with a substantially greater amount of matter. If a resonating interaction should occur, then our sun will get its „material" supplied from the centre of the Milky Way and that is a black hole! But no particle with a mass comes out of such a hole, yes not even light. For a particle to be able to leave the black hole, it should have neither charge nor mass. At most an oscillating charge and mass would be allowed. Such a particle would have an enormous ability of penetration as a result of the missing static interaction. It would be able to rush through the earth unhindered.

According to actual knowledge only neutrinos have the described properties. One also knows that the centre of our Milky Way represents a mighty source of neutrinos. From this derivation follows:

1. As mediators of the resonating interaction serve synchronously oscillating neutrinos.
2. Starting with the proof of the neutrinos it should be able to backwards also prove the existence of the resonating interaction.
3. If, as a practical consequence, we imagine that the centre of the Milky Way wouldn't supply neutrinos anymore. Then the whole galaxy would fall apart and not one of its stars would shine anymore.

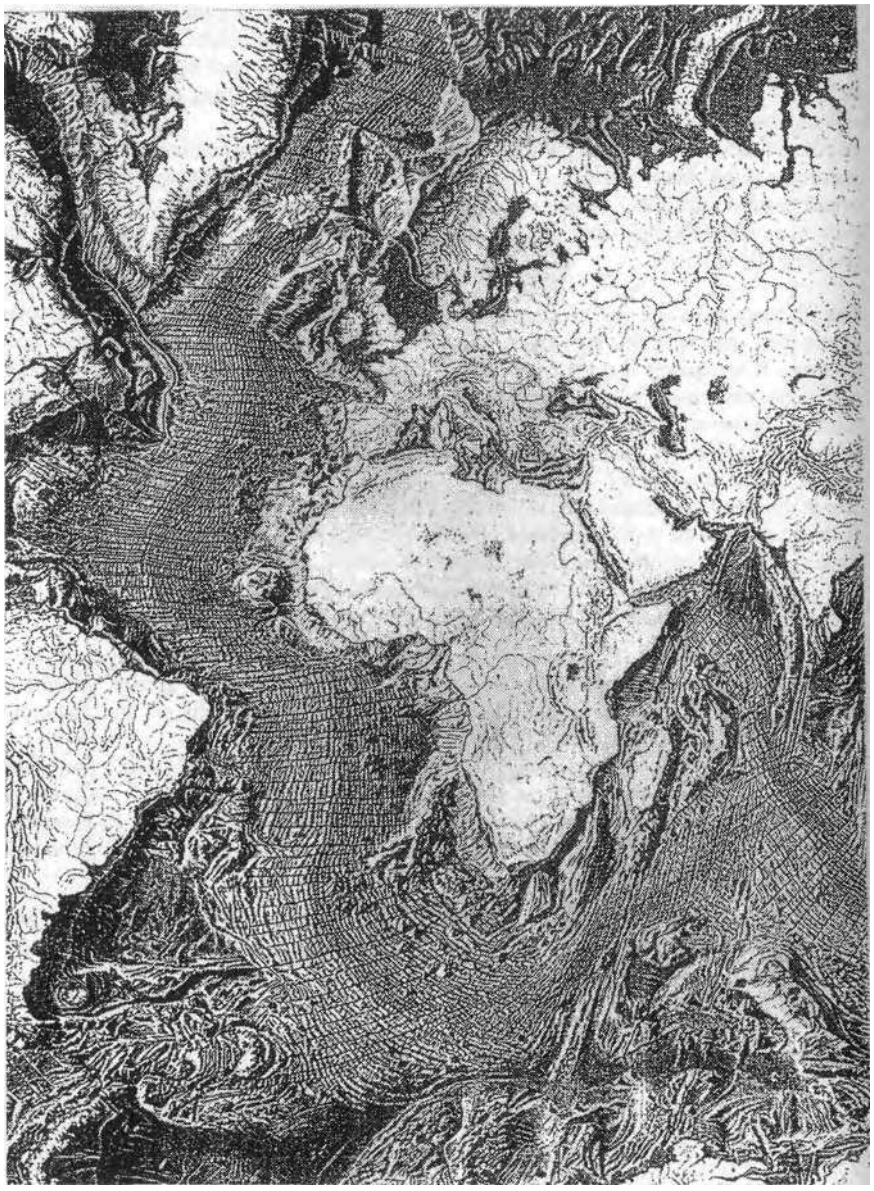

Fig. 11.1: The Atlantic ocean floor[<i>]

<i>: Miller, R.: Driftende Kontinente, Time-Life, Amsterdam 1991, S. 79

11. The growing globe

11.1 Long-distance effect of the neutrinos

The long-distance effect thus lies in the circumstance that the neutrinos, in the case of a resonance of the source of neutrinos and the receiver, span an invisible „rubber band" between both, which is called resonating interaction and keeps the two together.

As a transmitter of neutrinos functions for instance a supernova, the death of a star, in which 98% of the mass annihilates under emission of neutrinos or a black hole, which continually swallows light and matter and spits them out again as neutrinos after a still unexplored „process of digestion". The process, which in the case of a supernova takes place as a singular occurrence, in a black hole possibly takes place permanently. The hurled out neutrinos on the other hand serve the sun as a source of energy. A receiver of neutrinos then for instance is our sun. So that the hard and very fast cosmic neutrinos become utilizable for the sun, they at first have to be slowed down. But that is only partly successful:

1. Some very fast ones manage to pass through the sun and fly out again on the other side of the sun. The compared to the cosmic neutrinos strongly slowed down neutrinos then are called solar neutrinos.
2. Another part can be further slowed down and materialized. As a result of the oscillating mass of the neutrinos as well particles of matter as also some particles of anti-matter are formed. The particles of matter make the sun grow.
i. The with matter incompatible anti-matter annihilates under emission of light as is well-known. For this and for no other reason our sun shines!

Also the planets have such a neutrino reactor at their disposal. Only so the heat in the inside of the earth is explicable! It can be assumed that the planets materialize less the fast and hard cosmic neutrinos and that they are served more by the slowed down solar neutrinos, which our sun releases again unused.
As is well-known radiates the planet Jupiter already today twice as much radiation energy, as it from the sun receive. In this typical encyclopaedia type balance the involved neutrinos of course are not considered. But it shows that Jupiter is on the best way to become a sun itself. Its moons then will become planets.
From this the example we also see that with increasing mass the crust of the planet becomes thinner and thinner at the expense of the neutrino reactor in the inside, until it finally is eaten up and the celestial body openly starts to shine. Astronomers report for reason of their observations of the formation of more and more new stars.

One part of the collected neutrinos thus is materialized by the planet. In the case of our earth it contributes to its growth.
Who doesn't want to believe that the earth becomes bigger, should look at modern maps of the oceans, on which the topography of the ocean floor is shown. According to the theory of Alfred Wegener concerning the continental drift North and South America on the one hand and Europe with Africa on the other hand steadily drift apart since 200 million years. The result can be read at the atlantic ocean floor. The gaping, chequered rift zones to the right and left of the Mid-Atlantic Ridge show how the earth is torn apart (fig. (11.1).

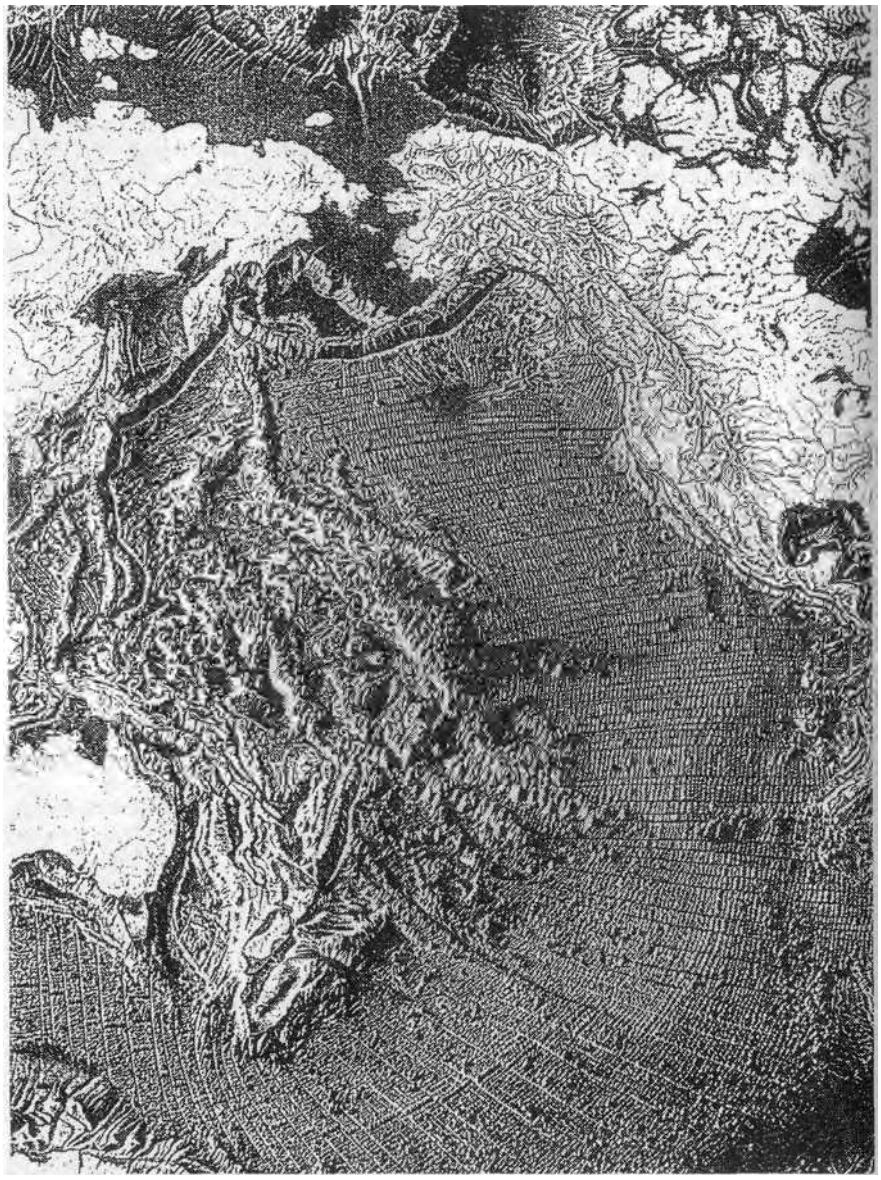

Fig. 11.2: The pacific ocean floor[<i>]

<i>: Miller, R.: Driftende Kontinente, Time-Life, Amsterdam 1991, S. 78

11.2 Model of expansion

Geographers assume that at another point to the same extent continental plates are subduced and molten. That thus has to happen in the Pacific Ocean. But the sea maps tell one just the opposite (fig. 11.2). At the ocean floor of the Pacific Ocean the same rift formations are found as in the Atlantic Ocean (fig. 11.1). That means that America drifts away from Australia and Asia exactly as from Europe, without being crushed or molten in doing so!
The only possible answer thus is: the earth grows.
The characteristic rift zones in addition are found around the Antarctic. From this the conclusion can be drawn that the 7th continent slowly is moving away, while the biggest habitable mass of land predominantly stays behind on the northern hemisphere, by Eurasia and North America forming a clip around the North Pole.

Concerning the evolution of the earth there are and were numerous approaches in various directions. Paul Dirac<i> at his time postulated, the brightness of the sun should decrease as a result of a decrease of the gravitational constant as well. In contrast to that Astrophysicists today observe just the opposite (Ingersoll 1987). According to the hypothesis of Carey<ii> energy will transform in matter in the universe. According to the idea of Oesterle<iii> aether particles are absorbed, which make our globe grow. Also other research scientists share the idea of the growth of the earth with him in their reports<i4,5,6>. As a geologist Oesterle<iii> cites his colleague Herzig: „The at the Mid-Oceanic Ridge newly produced oceanic crust has to be consumed again at other points, because otherwise the earth would expand" and criticizes the „plate tectonicians" that they would postulate their model without physical grounds.
He gives some arguments for the correctness of the model of expansion <iii>:

a) Subduction: The already discussed missing of zones of subduction and of melting of continental plates to the assumed extent.

b) Paleomagnetism: errors and mistakes in the hypothesis of the migration of the poles.

c) Continental depth drillings: They brought much higher temperatures in depths from 4000 meters, as expected and calculated according to models.

d) Stand of the sea water: Only if the water can spread in newly forming oceanic basins it can be explained, why the covering with water on earth continually is going back. This argument we want to investigate with a derivation of our own.

<i>: Dirac, P. A. M. Nature 139, p. 323 (1937)
<ii>: Carey, S. W.: Theories of the Earth and Universe. Stanford University Press: 1-413, Stanford, California
<iii>: Oesterle, O.: Goldene Mitte: Unser einziger Ausweg, Universal Experten Verlag, Rapperswil (1997), ISBN 3-9520261-9-0
<i4>: Hilgenberg, O. C: Vom wachsenden Erdball, S. 1-56, Eigenverlag, Berlin (1933) und Neues Jahrb. Geol. Palaont. Abh. 116, 1, Berlin (1962)
<i5>: Jordan, P.: Die Expansion der Erde. Vieweg 1-180, Braunschweig (1966)
<i6>: Giancarlo Scalera, K.-H. Jacob: Why expanding earth? Institute Nationale di Geofisica e Vulcanogia, Roma and Technical University of Berlin 2003

Today's earth:

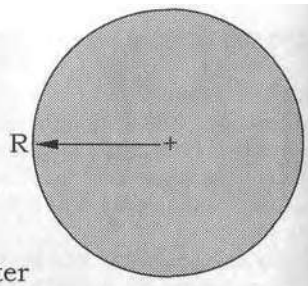

equatorial radius: $R = 6378$ [km]

earth's surface: $O_E = 4 \cdot \pi \cdot R^2$
(sphere) $= \underline{5{,}112 \cdot 10^8}$ [km²]

29% of this area is land and 71% is water
for an average water depth of $t_w = 3.8$ [km] results a

water volume of: $V_w = 0{,}71 \cdot O_E \cdot t_w = \underline{1{,}38 \cdot 10^9}$ [km³] (11.1)

The earth **200 million years ago** (super continent: **Pangaea**):

today's land area (29%) was 100% of the earth's surface!

Pangaea surface area: $O_p = 0.29 \cdot O_E$
$= \underline{1{,}48 \cdot 10^8}$ [km²]
$= 4 \cdot \pi \cdot r_p^2$ (11.2)

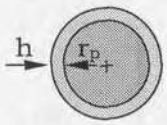

Pangaea radius: $r_p = \sqrt{O_p/(4 \cdot \pi)}$
(corresponds to $= \underline{3435}$ [km]
the radius
of the sphere of shelf): = 54% of today's radius

Pangaea volume: $V_p = \frac{4}{3} \cdot \pi \cdot r_p^3 = \underline{1{,}697 \cdot 10^{11}}$ [km³] (11.3)

Pangaea was covered with water h [km] high:

volume: $V = V_p + V_w = \frac{4}{3} \cdot \pi \cdot (r_p + h)^3 = \underline{1{,}71 \cdot 10^{11}}$ [km³] (11.4)

= 15,7% of today's volume of the earth

$r_p + h = (3 \cdot V/4 \cdot \pi)^{1/3} = 3443{,}8$ [km] (11.5)

Pangaea water-level h above the NN (sea-level) at that time:

$$\boxed{h = \underline{8{,}78} \text{ [km]}} \quad (11.6)$$

Fig. 11.3: The calculation of the covering with water on earth 200 million years ago

11.3 Ancient Egyptian legend of Genesis

We don't have to search long for evidence. If we go back 200 million years in the history of the earth, as all continents still were united and formed the super continent Pangaea, as the 29% landmass of today thus constituted 100% of the earth's surface. At that time the diameter of the earth was almost half of today's diameter (exactly 54%). But if one distributes the amount of water of our oceans of today over the smaller earth, then possibly the water stood the young earth up to its ears in a first rough estimate. We now want to calculate how high the water stood.
For that we determine at first the water volume of today's oceans, by multiplying 71% of the earth's surface O_E with the average water depth. In doing so it is supposed that the water volume has not changed in the course of time. As an approximation this assumption could be correct if the factors, which influence the water volume, mutually compensate. On the one hand it has to be taken into account that in the process of fusion in the inside of the earth apart from other materials also juvenile water is formed, but on the other hand the water volume is reduced by photosynthesis and by the splitting of water molecules. In the case of the newly formed water it should concern roughly one cubic kilometre per year[<i>]. The photosynthesis however possibly can be estimated by means of the formed oxygen of the air just as the splitted water by the content of oxygen of the waters and the seas. Since the processes are subject to temporary fluctuations, the exact estimate is difficult. At least should an effect of compensation more or less be taken into account.

Next we calculate the surface of the earth 200 million years ago, the super continent, which Alfred Wegener called Pangaea. If the 29% continental land mass of today at that time constituted the whole surface, then the diameter of the earth at that time was determined at 54% of today's diameter, then the volume together with the water volume would amount to only 15.7% of today's volume and the water stood 8.78 kilometres high above the level NN at that time (fig. 11.3). With that even the highest peaks were under water.

Consequentially stands in the legend of Genesis of the ancient Egyptians:
„ They tell us that the earth was completely covered with water and that the earth rose from the water. It is talked about a primeval hill, of which creation took its start, on which the first sunrise and sunset was observed[<ii>].

If at that time life only existed in the water, of which we today still can detect the remains in excavations in mountains and plateaus, then it surely wasn't because the evolution had forbidden living on the land. There existed no land! All land was lying under water. But if, looked into the future, the land area increases further at the expense of the surface of the sea, then our earth sometime will dry up, as already other planets before us, e.g. our neighbouring planet Mars.

<i>: Oesterle, O.: Goldene Mitte: Unser einziger Ausweg, Universal Experten Verlag, Rapperswil (1997), ISBN 3-9520261-9-0
<ii>: Robert Bauval und Graham Hancock: Der Schlussel zur Sphinx, List Verlag (1996), S. 253 and in der Sendung: Die grossen Ratsel VII am 25.5.97 in S 3

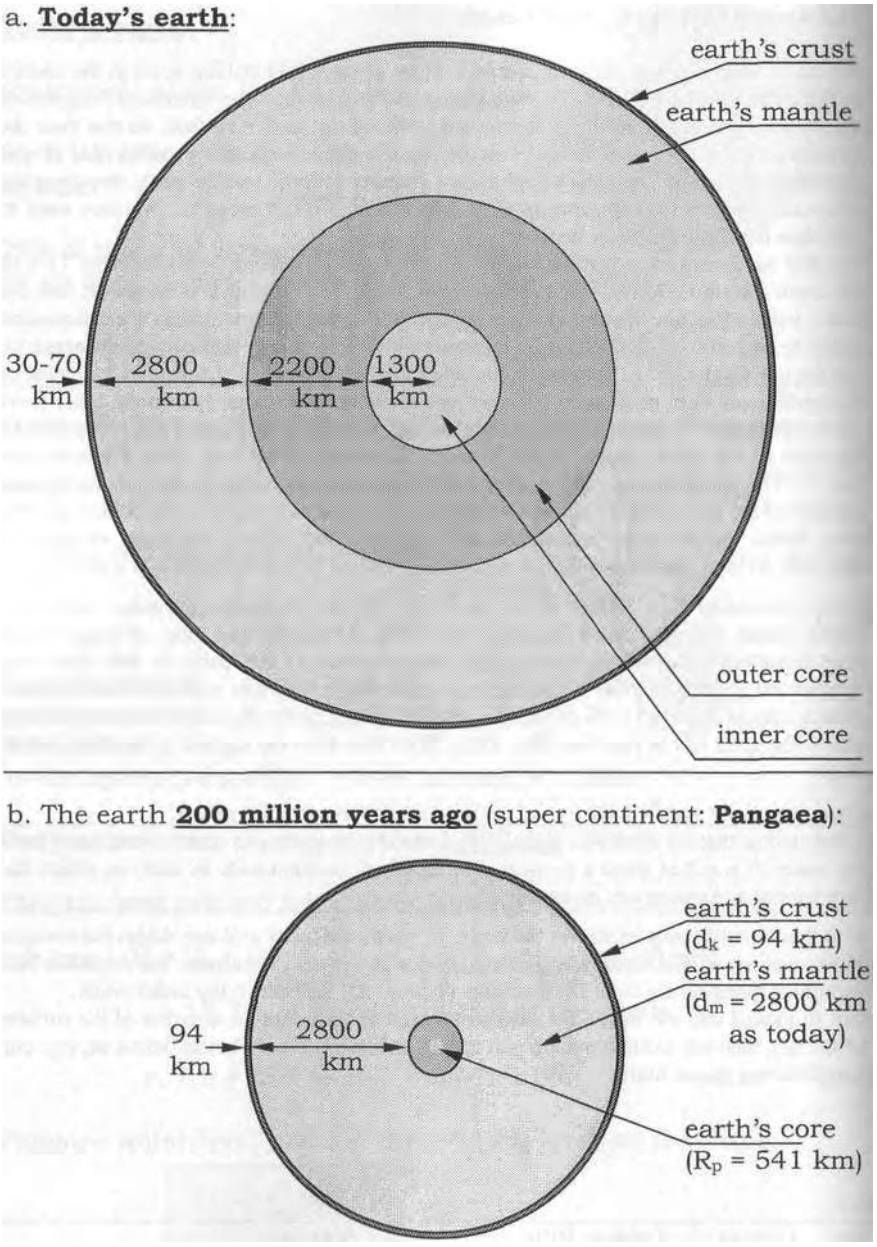

Fig. 11.4: The inner structure of the earth on an average

11.4 Inner structure of the earth

Next the question is raised: How fast does our earth actually grow? The calculated growth, distributed over the 200 million years, results in a yearly increase in the diameter of the earth of less than 0.1 mm. Carey[<i>] assumes 0.04 mm per year and Owen[<ii>] only 0.01 mm per year.
Actually the young earth must have been somewhat bigger than calculated, because as a result of the smaller gravitational acceleration the density of the matter must have been smaller. But this changes nothing to the relations, because the less dense earth was surrounded by likewise less dense water, the water-level nevertheless reached the peaks, as already calculated.
For indicating absolute linear measures and the calculation of the gravitational accleration the respective density should be considered. In most calculations the density is cancelled out, so that as well can be calculated with an unchanged density.

A grave error however lies in the assumption of a linear growth. Hilgenberg assumes an exponential growth[<iii>] and gives as a reason for the empirical approach of the e-function the „law of organic growth". In order to now not to speculate or to postulate in the same manner, we will derive and found our approach.

If namely the earth grows, then its core of fusion also grows, which causes the growth to take place accelerated, etc. A customer of a bank, who sees his amount of money grow according to such a regularity, will be given information immediately about the growth rate with a compound interest calculation.
But how big is the growing fusion reactor of our planet? According to today's level of knowledge about the structure of the earth the inner core is surrounded by the outer core and that again by the earth's mantle. On top floats the thin, but firm earth's crust, on which we live. The inner core has a radius of nearly 1390 km, the outer core stretches to a radius of 3500 km, whereas the crust is only between 10 and 78 km thick, dependent on the geographical latitude[<i4>] (fig. 11.4).

<i>: Carey, S. W.: Theories of the Earth and Universe.
Stanford University Press: 1-413, Stanford, California

<ii>: Owen, H. G.: Has the Earth increased in size? - In: New Concepts in Global Tectonics, Texas etc. University Press (1992), p. 289-295, Lubbock

<iii>: Hilgenberg, O. C: Vom wachsenden Erdball, Berlin 1933, Eigenverlag, Seite 31 und 32

<i4>: Mitton, S. (Herausg.): Cambridge Enzyklopadie der Astronomie
(The Cambridge Encyclopaedia of Astronomy), Orbis Verlag (1989)

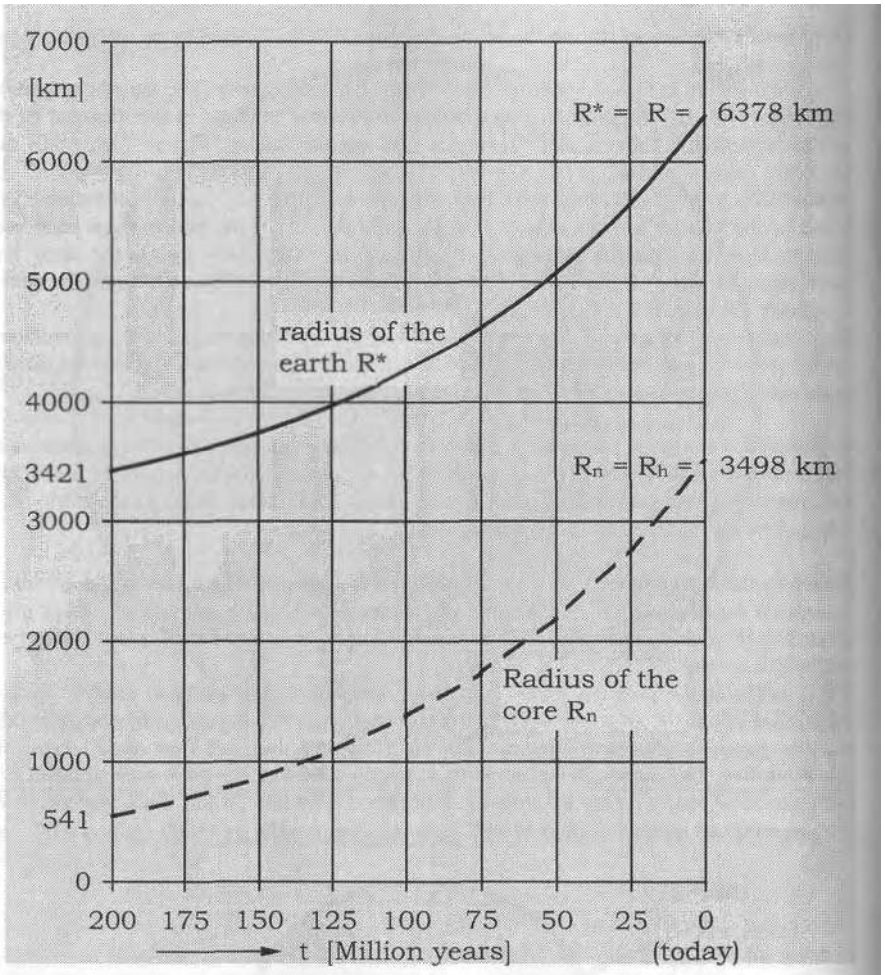

Fig. 11.5: The change in the radius of the earth and of the core in the course of millions of years until today.

calculation: (see fig.11.6)

$$R^* = 2879{,}5 + 541 \cdot q^{n/3} \text{ [km]} \quad (11.7)$$

t years ago: with: $t = 2 \cdot 10^8 - n$ [a] and: $q = 1 + 28 \cdot 10^{-9}$

correspondents to the approximation:

$$R^* = 2880 + (6378 - 2880) \cdot e^{-t/\tau} \text{ [km]} \quad (11.8)$$

with the time constant: $\tau = 107{,}1$ Mio. Jahre

11.5 Earth's core as a converter of neutrinos

I proceed from the assumption that the conversion of neutrinos and materialization in elementary particles takes place in the inner core. For the conversion no energy at all is used, because the inner energy together with the outer energy of the particle amounts to zero. The neutrinos merely have to be remodelled into another structure and for that they at first have to be slowed down with the help of the oscillating interaction.
During this process of slowing down, as said, no heat is formed because in the case of a mass less particle no energy can be set free in the domain where the classical law of conservation of energy is valid. Only after completion of the process of materialization we are able to detect mass and energy of neutrinos.
But if the oscillating interaction is taken as a basis, the oscillation with opposite phase between particle and earth's core, then contrary to all expectations a cooling down takes place. If the particle has reached its region of destination in the core, then the oscillations are overlapping. Mathematically seen they are added with reversed sign; they thus are subtracted. The result of the mutual compensation is the decrease of the thermal oscillation and the cooling down of the region which was expected.
In addition the formed particles with a mass mutually contract (see part I, chapter 8.3 and 8.4) and in doing so are further cooling down, as we will derive (chapter 12.7 with fig. 12.8). The physical limit of the process of contraction and cooling down is formed by absolute zero, at which no thermal oscillation at all occurs anymore, so that superconduction becomes possible with the result of giant electric currents and magnetic fields, which can be detected even at the earth's surface in damped form, for instance with a compass.

The necessary heat energy is flowing towards the quick-frozen inner core from the outside, principally from the outer core. Here, in the core, from the neutrinos slowed down to the speed of light various elementary particles are formed. Most of them immediately fall apart, to form other configurations. In the end only electrons and protons are preserved, which, as the only stable particles, can't fall apart anymore. These again are trying hard to take the state of an atom, which however needs very much space with the large distance between atomic nucleus and hull. Under the high pressure the enveloping electrons therefore will time and again fall into the nucleus to form neutrons together with the protons.
The neutrons need no atomic hull and can, as is well-known of neutron stars, take an extremely high density. In the case of the earth's core the neutrons however cannot be stabilized. The contraction to a neutron is accompanied by a corresponding drop in pressure, so that the neutron falls apart again. A continual oscillation of size is formed, with which the neutrinos again interact. With that also the high density of the earth's core would be explicable simultaneously.
In earth's outer core the various atoms and isotopes are formed, which in the sum release more energy than they absorb in their fusion processes. Here the fusion oven rages, which supplies the inner core with heat energy.
The formed matter is pushed further to the outside, rolls as a viscous mass through the earth's mantle and collects the surplus radiation and heat from the fusion oven.

With this model of explanation we now can tackle the calculation of the growth of the earth (fig. 11.6).

Growth in volume in analogy to the compound interest calculation:

duration: $n = 200$ million years

starting capital: V_p = Pangaea volume $V_p = (4/3)\cdot\pi\cdot r^3$

final value: V_h = today's volume $V_h = (4/3)\cdot\pi\cdot R^3$

savings bank formula: $V_h = V_p * q^n$ (compound interest) (11.9)

with „interest rate": $q = (V_h/V_p)^{1/n}$ (11.10)

---

radius of the core of the Pangaea sphere:

$$R_p = r - d_m - d_k = 541 \text{ [km]} \qquad (11.11)$$

with

Pangaea radius: $r = 3435$ [km]

earth's mantle: $d_m = 2800$ [km]

earth's crust: $dk = 94$ [km] (incl. covering with water).

core radius today: $Rh = R - d_m - d_k = 3500$ [km] (11.12)

earth's crust today: $d_k^* = 34\text{-}78$ [km].

From $V \sim r^3$ the growth factor q is calculated to be

$$q = \left(\frac{V_h}{V_p}\right)^{\frac{1}{n}} = \left(\frac{R_h}{R_p}\right)^{\frac{3}{n}} = \left(\frac{3500 \text{ km}}{541 \text{ km}}\right)^{\left(\frac{3}{2\cdot 10^8}\right)} = 1 + 28\cdot 10^{-9} \qquad (11.13)$$

core radius after n years: $R_n = R_p * q^{n/3}$ (11.14)

radius of the earth after n years: $R^* = R_n + d_m + d_k^*$ (11.15)

Fig. 11.6: The calculation of the growth rate of the earth

11.6 Speed of growth

200 million years ago in the centre of the globe a core of fusion has formed and taken up its operation, probably under the influence of a cosmic occurrence connected with a high neutrino radiation. As a result the thin crust of the earth was torn apart and the oceanic basins were formed.

If we assume that the might of earth's mantle (with d_m = 2800 km) and crust (with less than 100 km) haven't fundamentally changed, then earth's core at that time had a radius of only 541 km. The „savings bank formula" now only may be applied for the core and only for its volume. On the condition of a constant neutrino density the volume of the core in every year will grow for one order of magnitude, which again depends on the respective volume itself. There results the in fig. 11.5 presented course of the radius of the core and of the earth.

According to our calculation the earth at present grows every year for $915*10^{11}$ tons, which corresponds to an increase in volume of 16500 cubic kilometres and an increase of area of 5.2 square kilometres. The earth momentarily grows for 6.5 cm per year in diameter, from which follows that the perimeter increases pi-fold and a continental drift of 10.2 cm per year is to be expected across both the Atlantic Ocean and the Pacific Ocean. Geologists today actually measure a plate movement of typically 10 cm, at individual points of up to 12 cm per year[i]!

Whoever likes to do handicrafts, can build together a globe of shells by himself. Hilgenberg for that gives a handicraft instruction[ii]. He draws the continents of a globe of today and cuts them out. Doing so, not the coast line of today is authoritative, but that of the edge of the shells, at which the mainland plates are breaking off into the deep sea. He hence also speaks of a sphere of shells and helps the handcrafters with the words: ..Because the paper shells of the sphere of shells owing to their strong curvature are difficult to nestle, we cut slits in the paper, which suitably lie there, where mountain ranges stretch and now can start with the gluing". Doing so it shows that the slits in particular in the case of the Ural and the Himalayan gape far apart, that in reversed direction in the case of the enlargement of the sphere of shells the lifting out of the mountains necessarily had to occur at these points by means of upsetting. Under these circumstances our model concept should be further rendered more precisely, If the change of the curvature of the growing surface of the earth is the cause for the lifting out of the mountains, then the surface of the earth 200 million years ago was structured merely by impact craters and by volcanic cones, then the amount of water may have been correspondingly smaller. The additional water of the oceans of today was collected by the earth either from the cosmos, by crossing the flight path of a comet with a water tail, or by the here discussed idea of a core of fusion in the inside of the earth it has produced the water itself!

How ever such detail aspects may have had an effect, it therefore nevertheless changes nothing to the model concept on the whole. Hilgenberg's globe of shells[ii] in my opinion to still makes more sense as all the models of explanation, as they are spread in today's text books.

<i>: Miller, R.: Driftende Kontinente, Time-Life, Amsterdam 1991, S. 78

<ii>: Hilgenberg, O.C.: Vom wachsenden Erdball, Berlin 1933, Eigenverlag

Actual data<i>:

mass of the sun	$m_s = 1.99 \cdot 10^{30}$ [kg]	
radius of the sun	$r_s = 696\,000$ [km]	
distance to the earth	$r_e = 149\,597\,870$ [km] (averaged)	
mass of the earth	$M = 5.976 \cdot 10^{24}$ [kg]	
moment of inertia	$J_e = M \cdot r_e^2$ (of the earth orbit)	(11.16)
orbital velocity	$v_e = \omega_e \cdot r_e = 2\pi r_e / t_e$	(11.17)
averaged<i>:	$v_e = 29.79$ [km/s] = constant	(11.18)
revolutionary period	$t_e = 365.25637$ [days] t_e = sidereal year	
equatorial radius	$R = 6378$ [km]	
moment of inertia	$J = (2/5)\, M \cdot R^2$ (of the rotation of its own)	(11.19)
rotational velocity	$v_E = \omega_E \cdot R = 2\pi R / t_E = 0.465$ [km/s]	(11.20)
sidereal time of rotation	$t_E = 1$ [day] $= 86\,164.1$ [s]	
distance to the moon	$r_m = 384\,390$ [km] (averaged)	
radius of the moon	$R_m = 1738$ [km]	
mass of the moon	$m_m = 7.350 \cdot 10^{22}$ [kg] = constant	(11.21)
moment of inertia	$J_m = m_m \cdot r_m^2$ (of the moon orbit)	(11.22)
orbital velocity	$v_m = \omega_m \cdot r_m = 2\pi r_m / t_m$	(11.23)
of the moon averaged:	$v_m = 1.026$ [km/s] = constant	(11.24)
revolutionary period	t_m = 1 sidereal month (from fixed star $t_m = 27.322$ [days] to fixed star)	
observed revolutionary period	t^*_m = 1 synodic month (from new moon $t^*_m = 29.53$ [days] to new moon)	

Fig. 11.7: The data of sun, earth and moon of today<i>

<i>: Mitton, S. (Herausg.): Cambridge Enzyklopadie der Astronomie (The Cambridge Encyclopaedia of Astronomy), Orbis Verlag (1989)

It is an exciting matter, if one can experience for oneself, how the pieces of the puzzle fit together, how the southern end of America is wound around the Cape of Good Hope and the Falkland islands surface for the east coast of South Africa, in the vicinity of Australia how the Antarctic occupies the Pacific basin as a neighbour of Australia, von South, Middle and North America, run through by the equator, etc.
The corrections to the view of life of Alfred Wegener and the geographical evidence, which Hilgenberg gives, are sound, well founded and even after 65 years still highly actual. The physical statements of the geologists however, for instance the earth in the course of time would rotate faster and faster, cannot be followed.

11.7 Conservation of angular momentum

The question about the rotation of the earth is raised. Is it not changing at all, is it getting faster or slower? In the case of a with time growing earth there is only one possibility: The rotation of its own will decrease and not increase, as Hilgenberg supposes. For that you only need to place yourself on a turntable, to turn and if possible with weights in your hands stretch out your arms sideways, to feel, how the rotation of the table is decreasing. It surely would have done the geologist Hilgenberg good, to leave his desk for a short time for a stroll to the most nearby playground, for the purpose of the described physical experiment with himself.

In this case the law of conservation of momentum authoritatively has an effect in the formulation of the law of conservation of angular momentum for the rotating motion. According to that all angular momenta in the solar system should amount to zero. If we look at the planets which have no moon, then is remarkable that these need an eternity for a revolution around their own axis (Venus for instance needs 243 days). According to the law of conservation of angular momentum our earth owes its rotation of its own primarily the moon.

For reason of this relation we can assume a proportionality between the angular momentum of the moon J_m*w_m and that of the rotation of its own of the earth $J*w_E$ (eq. 11.39, fig. 11.10). They even have to be identical, if the partner of rotation earth and moon are seen as a closed system.
If the earth would be approached as a homogeneous, spinning sphere, the angular momentum at first would be too small for a factor 4.1 (eq. 11.29, fig. 11.9). The law of conservation of angular momentum dictates as a necessary result, that the dense core of the earth must rotate faster than the earth's crust! From the correspondence of orbital angular momentum of the moon on the one hand and the sum of the angular momenta of their own of earth's mantle and earth's core on the other hand results a 31 fold higher angular velocity of the earth's core compared to the rotation of the earth's surface (eq. 11.38, fig. 11.9).

Does our earth owe its geomagnetism this rotation of the core? At least the possibility exists that there exists a causal relation between the rotation of the earth's core and the geomagnetism. We'll further collect arguments and put the question concerning the formation of the geomagnetism under consideration.

Concerning unipolar induction (Faraday): $\mathbf{E} = \mathbf{v} \times \mathbf{B}$ (11.25)
(see part 1, eq. 58, fig. 6.4)

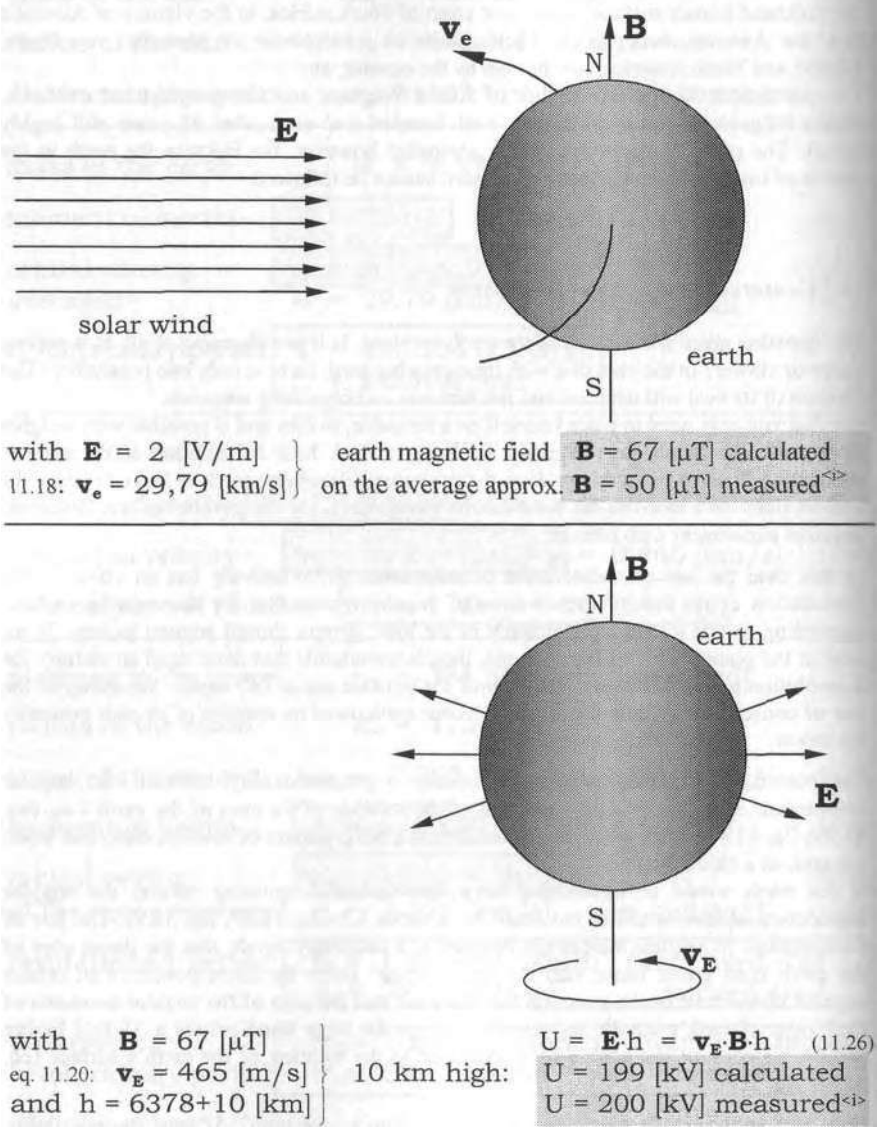

with $\mathbf{E}$ = 2 [V/m] } earth magnetic field $\mathbf{B}$ = 67 [μT] calculated
11.18: $\mathbf{v}_e$ = 29,79 [km/s] } on the average approx. $\mathbf{B}$ = 50 [μT] measured<i>

with $\mathbf{B}$ = 67 [μT] } $U = \mathbf{E} \cdot h = \mathbf{v}_E \cdot \mathbf{B} \cdot h$ (11.26)
eq. 11.20: $\mathbf{v}_E$ = 465 [m/s] } 10 km high: U = 199 [kV] calculated
and h = 6378+10 [km] } U = 200 [kV] measured<i>

Fig. 11.8: The magnetic and the electrostatic field of the earth
as a result of an unipolar induction

<i>: Measurement values in chap. 2.8, e.g. reference entry <i> (Prof. Dr. L. Konig)

11.8 Set of difficulties concerning the change of magnetization

Now investigations of the polarity of the magnetization of rocks have resulted in the fact that in irregular intervals, on an average every 500,000 years, a change of polarity of the geomagnetism has occurred and no one knows why.
If the rotation of the core should produce the magnetism, then it in any case also is responsible for the process of change of magnetization. That purely theoretically is possible in two ways: Either the core tilts out of its plane of rotation for 180° and rotates suddenly in the opposite direction or earth's mantle together with earth's crust, on which we live, is turned upside down.
It surely isn't my intention to produce any panic, but from a physical point of view only the second case is possible. Usually not the tail wags with the dog, but vice versa, the dog with the tail. The high rotational velocity of the earth's core exerts an extremely stabilizing influence. After all its angular momentum is 4.85 times larger than that of the mantle (eq. 11.33, fig. 11.9). Therefore the rotation of the core and the direction of earth's magnetic field always are preserved seen from the sun.

I further proceed from the assumption, that an electrostatic field arises from the sun accompanied by a particle flux, the solar wind, through which the earth flies through in a perpendicular direction. According to the Faraday law of induction E = v x B (eq. 11.25)
it experiences, as a result of the unipolar induction, a magnetic field which stands perpendicular on the ecliptic and thus dictates the orientation of earth's magnetic field. With that also the direction of rotation would be determined. The core thus by no means can tilt!
On the condition that the core doesn't rotate completely frictionless, the earth's mantle will in the case of the same direction of rotation be accelerated, in the case of unequal direction, after a changing of polarity, it will be slowed down again. If the process, for reasons of conservation of angular momentum, takes place alternatingly with a certain regularity, then the inhabitants of the earth for every changing of polarity might experience, how the North Pole in the shortest time turns over the equator to the South Pole, how the sun sets at the point, where it before had risen. As said, after a changing of polarity our earth is standing on its head! In the Bible corresponding clues are found<ii>. It can be taken from the media that one reckons with such a changing of polarity in the foreseeable future. When and if it actually takes place, stands however in the stars.

If magnetism thus is produced by the rotation of the core, or by electric currents in the earth's core as a result of the superconduction or by both, then the earth is aligned in the field of the sun like the magnetic needle in a compass. If we take as a cause a solar wind with an electric field strength of just 2 V/m, then this would not only determine the direction of earth's magnetic field, but also the order of magnitude, and that at present lies at 50 uT averaged over time (chap. 2.8).
With the same mathematical relation an electrostatic field around the earth of 199 V/m results as a result of the rotation of the earth. That fairly exact corresponds to the measured values!<i> Quite obviously all is related to each other. In the question for the „how" at this point consciously no definite answer is strived for. It rather should be discussed and worked to together in the seminar.

<ii>: The Bible, OT, The 2nd book of kings 20,9-11 (king Hezekiah) and Joshua 10,12-14, literally cited on the page after the next page (chap. 11.9), note<ii>

Angular momentum $J_m \cdot \omega_m$ of the orbiting moon (with eq. 11.22 + 11.23):

$$J_m \cdot \omega_m = m_m \cdot r_m^2 \cdot \omega_m = 29*10^{33} \ [kgm^2/s] \qquad (11.27)$$

Angular momentum $J \cdot \omega_E$ of the rotation of the earth (eq. 11.19 + 11.20, same direction of turning):

(theoretically) $J \cdot \omega_E = (2/5)\ M \cdot R^2 \cdot \omega_E = 7*10^{33}\ [kgm^2/s]$ (11.28)

$$\frac{\text{Orbital momentum moon}}{\text{Angular momentum earth}} = \frac{J_m \cdot \omega_m}{J \cdot \omega_E} = \frac{29}{7} = 4{,}1 \qquad (11.29)$$

Angular momentum $J_M \cdot \omega_E$ of earth's mantle and crust (R_h = core radius)

$$J_M \cdot \omega_E = (J - J_K) \cdot \omega_E = (2/5) \cdot (MR^2 - M_K R_h^2) \cdot \omega_E = 6*10^{33}\ [kgm^2/s] \quad (11.30)$$

$$\text{conservation of angular momentum:} \quad J_m \cdot \omega_m = J_K \cdot \omega_K - J_M \cdot \omega_E \qquad (11.31)$$

Angular momentum $J_K \cdot \omega_K$ of the earth's core

$$J_K \cdot \omega_K = J_m \cdot \omega_m + J_M \cdot \omega_E = 35*10^{33}\ [kgm^2/s] \quad (11.32)$$

$$\frac{\text{Angular momentum core}}{\text{Angular momentum mantle}} = \frac{J_K \cdot \omega_K}{J_M \cdot \omega_E} = \frac{35}{5} = 7 \qquad (11.33)$$

$$J_K \cdot \omega_K = (2/5)\ M_K \cdot R_h^2 \cdot \omega_K \quad (11.34)$$

With the mass of earth's core $M_K = \rho_K \cdot V_K = \rho_K \cdot (4/3) \cdot \pi \cdot R_h^3$ (11.35)

and the averaged core density $ro_k = 12000\ kg/m^3$

the angular velocity

of earth's core amounts to: $\omega_K = 3{,}3*10^3\ [s^{-1}]$ (11.36)

and that at the earth's surface: $\omega_E = v_E/R = 0{,}073*10^{-3}\ [s^{-1}]$. (11.37)

$$\frac{\omega_K}{\omega_E} = \frac{3{,}3}{0{,}073} = 45 \quad (11.38)$$

Fig. 11.9: Calculations concerning the conservation of angular momentum and the rotation of earth's core (One turn of the earth's core lasts 32 min. It results contrary to the earth rotation. Of the surface of the earth a period duration of 31 min should be observable.)

11.9 The weakly damped moon

The increasing angular velocity in the direction of the centre of the earth surely has something to do with the set of difficulties concerning the conservation of the spherical structure, comparable to the reason for the particle spin (chapter 6.13). The increasingly missing radial component of the gravitational field has to be compensated by an additional field produced by the rotation (according to part 1, equation 62, fig. 6.5).

The moon apparently doesn't know this set of difficulties. We can assume a constant mass for it (eq. 11.21). On the one hand is the moon smaller than the earth 200 million years ago, as it started to grow. On the other hand are doubts concerning the existence of an active core of the moon legitimate. In the Apollo-15 mission seismic gauges had been installed at the ground of the moon and at the start from the moon the produced seismic waves had been recorded<i>. The surprisingly small damping as the lunar module fell back onto the ground of the moon more likely allow the conclusion that the moon is hollow inside!
Also the small density of the moon points in the same direction, and finally no clues at all can be seen on the surface of the moon, which would point to a growth of the moon.

Apart from the mass also the orbital velocity of the moon is taken constant, what surely is true, as long as nobody and nothing drives the moon extra (eq. 11.24). The analysis of the law of conservation of angular momentum provides the in fig. 11.10 derived provisional result (eq. 11.41).

<i>: Moonquakes ever more mysteriously: ,,The by Apollo 12 triggered moonquake by ,,bombardment" of the surface of the moon with the clapped-out Lunar Module ,,Intrepid" at thursday evening puts scientists for bigger and bigger mysteries. An exact analysis of the measurement data now resulted in the by the astronauts Conrad and Bean installed ,,seismic station" on the moon ... to have recorded and to have sent to the earth 55 minutes long. ... The seismologist Dr. Gary Latham spoke of ,,important information about the structure of the moon" and meant, one now can ,,throw away the text book". One had reckoned that the impact of the Lunar Module on the moon would trigger a quake of at best some minutes", (translated) Frankfurter Rundschau vom 22.11.1969

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concerning reference entry <ii>, chap. 11.8:

<ii>: The Bible, OT, Joshua 10,12-14: There stands in the ,,book of Jasher ": So the sun stood still in the midst of heaven, and hasted not to go down about a whole day. And there was no day like that before it or after it, ...

The 2nd book of kings 20,9-11: king Hezekiah: This sign thou ... let the shadow return backward ten degrees. And Isaiah the prophet cried unto the LORD: and he brought the shadow ten degrees backward, by which it had gone down in the dial of Ahaz.

For the proportionality of the angular momenta of the earth:

$$J \cdot \omega_E \sim J_M \cdot \omega_E \sim J_K \cdot \omega_K$$

With: $$J \cdot \omega_E = (2/5)\, M \cdot R^2 \cdot 2\pi/t_E \qquad (11.28)$$

and the orbital momentum of the moon:

$$J_m \cdot \omega_m = m_m \cdot r_m^2 \cdot v_m/r_m \qquad (11.27)$$

is valid the

$$\boxed{\text{conservation of angular momentum: } J \cdot \omega_E \sim J_m \cdot \omega_m \qquad (11.39)}$$

or: $$M \cdot R^2/t_E \sim m_m \cdot r_m \cdot v_m \qquad (11.40)$$

with $\underline{m_m = \text{constant}}$ (11.21)
and $\underline{v_m = \text{constant}}$ (11.24): $$\boxed{M \cdot R^2 \sim t_E \cdot r_m} \qquad (11.41)$$

$$\boxed{\begin{array}{ccc} \text{centrifugal force} & = & \text{gravitational force} \\ \dfrac{m_m \cdot v_m^2}{r_m} & = & \dfrac{G \cdot M \cdot m_m}{r_m^2} \end{array} \qquad (11.42)}$$

or with eq. 11.22: $$v_m^2 = G \cdot M/r_m = (2\pi r_m/t_m)^2 \qquad (11.43)$$

---

if $\underline{M = \text{constant}}$: $$\boxed{r_m^3 \sim t_m^2} \qquad (10.1)$$

<u>Kepler's 3rd law.</u>

Here $\underline{M \neq \text{constant}}$, instead $\underline{v_m = \text{constant}}$ (11.23) and therefore follows from eq. 11.43:

(month) $$\boxed{t_m \sim r_m \sim M} \qquad (11.44)$$

with eq. 11.41:

(day) $$\boxed{t_E \sim R^2} \qquad (11.45)$$

and for an analogous derivation: (year) $$\boxed{t_e \sim r_e \sim m_s} \qquad (11.46)$$

with $\underline{v_e = \text{constant}}$

<u>Fig. 11.10: Calculation of dynamic celestial mechanics</u>

11.10 Calculation of celestial mechanics

We still need a further relation and try the balance of forces between the centrifugal force and the gravitational force. Both the to the outside directed centrifugal force and the to the inside directed gravitational force depend on the mass of the moving body, here the mass of the moon m_m, so that it is cancelled from equation 11.42.
As determining mass only that of the earth is left and that is taken constant in accordance with the knowledge of text books. The result of this assumption is Kepler's 3rd law (eq. 10.1). But beware, it here merely concerns a momentary picture! In the course of time, according to the derivation, the mass of the earth increases so that this assumption is untenable.

Instead, as already said, the average orbital velocity of the moon, one kilometre per second, can be taken constant (eq. 11.24). Since the orbital velocity is calculated from the proportion of the perimeter of the circular orbit $2 \cdot \pi \cdot r_m$ with regard to the revolutionary period of a month (11.43, left page), and at the same time from the balance of forces a dependency of the mass of the earth M and the radius of the orbit of the moon follows (11.43, right page), the interesting relation (11.44) results:
Here the mass M, the radius r_m and the revolutionary period t_m stand in a direct proportionality to each other, and that means: if the mass of the earth increases in the course of time, then the moon will go away from us to the same extent, then also every month will get correspondingly longer.

Clarified with numeric values follows from a growth of the earth for $915*10^{14}$ kg per year a going away of the moon for yearly 5.88 meters (fig. 11.11). The going away of our satellite could be confirmed by means of measurements with laser reflectors, which had been put up on the moon by Apollo astronauts, according to dpa message<i>.

In addition every month lengthens for 3 milli seconds. That is valid for the sidereal month (= 27.322 days), for which a fixed star serves as a reference point for the measurement of a revolution, as well as for the synodic month, as it is observed from the earth from new moon till new moon (= 29.53 days). The synodic month today is longer than four weeks. But 3.7 million years ago it once actually lasted exactly 28 days, as we can calculate easily (fig. 11.11).

But now also the length of a day is changing. If we insert the proportionality (11.44) from the balance of forces in that of the conservation of angular momentum (11.41), then it is shown that a day depends quadratic on the radius of the earth (11.45), that a lengthening of every day for $4.5*10^{-9}$ s can be determined with the help of the growth curve of the earth (fig. 11.5). This is really very small, but 200 million years ago the day had just 19 hours, if extrapolated to 900 million years only 18.04 hours! The result of the american geologists around Dr. Charles Philip Sonett of the University of Arizona in Tucson also is 18 hours in their analysis of correspondingly old sediment formations, as the US science magazine Science has reported<i>. The correspondence of this measurement with our calculation without doubt has force of evidence!

<i>: 900 million years ago a day had 18 hours, Washington (dpa) 1997

Going away of the moon per year with $M \sim r_m$ (according to eq. 11.44): for

$\Delta r_m = r_m \cdot \Delta M/M = 384390[km] \cdot 9.15 \cdot 10^{16}[kg/a] / 5.976 \cdot 10^{24}[kg] = 5.886\ [m/a]$

lengthening of month per year with $M \sim t_m$ (11.44) (sidereal): for

$\Delta t_m = t_m \cdot \Delta M/M = 27.322\ [days] \cdot 86164\ [s/day] \cdot \Delta M/M = 36\ [ms/a]$

synodic month (from new moon till new moon) of 28 days:

$\Delta t_m = 29.53\ [days] - 28\ [days] = 1.53\ [days] \equiv 132 \cdot 10^6\ [ms]$

linearly calculated $132 \cdot 10^6\ [ms]/36\ [ms/a] = 3.6674$ mio. years ago.

Day length 200 mio. years ago, with $t_E \sim R^2$ (11.45) amounted to t* hours

shortening: $\Delta t_E/t_E = \Delta R^2/R^2 = (R-R^*)^2/R^2 = (6378-3420)^2/6378^2 = 21.5\%$

$\Delta t_E = 0.215 \cdot 24\ [h] = 5.16\ [h]$ and $t^* = 24\ [h] - \Delta t_E = 18.84\ [h]$

Day length 900 mio. years ago, (R^*=3200 km) amounts to 18.04 hours

present lengthening per day amounts to: $\Delta t_E/t_E = 4.5 \cdot 10^{-9}\ [s/day]$

but: the year increases 130,000 times faster than the individual day!

according to the measurement of Aristarchos 2300 years<ii> ago

is $\Delta t_e = 365.25637\ [days] - 365.25062\ [days] = 0.00575\ [days]$

and $\Delta t_e/t_e = 0.00575 \cdot 24 \cdot 60 \cdot 60 \cdot 1000 / 365.25637 \cdot 2300 = 0.59\ [ms/day]$

going away of the earth from the sun per year, with $t_e \sim r_e$ (acc. to eq. 11.46)

for: $\Delta r_e/t = r_e \cdot \Delta t_e/t_e \cdot t = 149.6 \cdot 10^6\ [km] \cdot \Delta t_e/t_e \cdot t = 1.024\ [km/a]$

growth of the sun per year/second, with $t_e \sim m_s$ (according to eq. 11.46)

for:

$\Delta m_s/t = m_s \cdot \Delta t_e/t_e \cdot t = 1{,}99 \cdot 10^{27}\ t \cdot \Delta t_e/t_e \cdot t = 1.36 \cdot 10^{19}\ [t/year]$

resp. in a second for: $= 4.3 \cdot 10^{11}\ [t/s]$

and at the same time a loss due to radiation of: $5 \cdot 10^6\ [t/s]$

Fig. 11.11: Figures according to analysis of some examples concerning dynamic celestial mechanics

11.11 The biblical age

We therefore owe the growing diameter of the earth that every day gets longer and longer (eq. 11.45) and from the going away of the moon a lengthening of the month results (eq. 11.44). Not only the months and the length of the days increase, but also the whole year. A corresponding derivation for the revolution of the earth around the sun, as it has been carried out for the revolution of the moon around the earth (eq. 11.44), delivers analogous results (eq. 11.46): The sun determines the length of the year and the distances to the planets. To the extent, to which the sun grows, the solar system increases in extension. Also the distance to the earth increases proportionally with the mass of the sun. By the going away from the sun the temperature on the planets however not necessarily decreases, because at the same time the radiation intensity of the growing central star increases. According to measurements it has increased for 30% since the formation of the solar system<i>.

If both the rotation of the earth and the revolution around the sun get slower, then by all means is conceivable, that the number of days per year approximately stays the same and mankind nevertheless gets less old. If we take the 2300 years old writing of the Greek Aristarchos about the sizes and distances of the sun and the moon<ii>. He determined, assuming a heliocentric view of life, the year to be 365.25062 days. Because the correction taken by Aristarchos concerned even the fifth place after the comma, we must assume that correspondingly precise gauges were available in Alexandria already 310 BC.
The today measured sidereal year with 365.25637 days has lengthened for whole 0.00575 days. From this follows that the year increases considerably faster than the individual day.
It of course would be nice, if we could calculate the lengthening of the year, but unfortunately no data about the growth of the sun are available.
If we proceed from the measurement of Aristarchos, without being able to verify or reproduce its reliability, then from that would result a going away of the earth from the sun for yearly one kilometre, then the sun should grow for $4.3*10^{11}$ tons per second. In any case the sun materializes mass considerably faster, as it loses mass in the same period as radiation equivalent, and that surely is correct (fig. 11.11). Today one generally assumes that „since its formation the earth has gone away from the sun for in total 30,000 km"<i>.

But if in the past the year consisted of less days and every day moreover was shorter, if therefore the biological life time was divided in shorter periods, then mankind could get older, then obtaining a biblical age possibly by no means was unrealistic. If Adam still should have got 930 years old, according to the 1st book of Moses, then his lifetime already must have been quite long ago. While Abraham still did get 175 years old, no successor of him has reached his age anymore. In the Bible it is said: „And the LORD said, My spirit shall not always strive with man, for that he also is flesh: yet his days shall he an hundred and twenty years "<iii>. Today even the limit given by the LORD isn't reached anymore!

<i>: Is the sun loosing her Gravitation? Illustrierte Wissenschaft, Nr.l, 1995
<ii>: Hermann Wild: Technologien von gestern, Chancen fur morgen, Jupiter-Verlag Bern (1996), ISBN 3-906571-13-0, Seite 22
<iii>: The Bible, King James Version, Genesis 6.3

The balance of forces (equation 11.42 generalized):

$$\text{centrifugal force} = \text{gravitational force}$$

$$\frac{M \cdot v_k^2}{r} = \frac{G \cdot M \cdot m}{r^2} \quad (12.1)$$

results in the cosmic velocity v_k:

$$v_k^2 = G \cdot m / r \quad (12.2)$$

independent of the mass M of the satellite or planet!

For	$v < v_k$	falling back into the central mass m
For	$v > v_k$	taking the leave into space
For	$v = v_k$	stationary orbit

written down for the nth planet in the solar system:

with $r(n) = r_n$ average orbital radius of the planet

and $v(n) = v_n$ average orbital velocity

as well as: m_s mass of the sun

$$v_n = \sqrt{G \cdot m_s / r_n} \quad (12.3)$$

or:

$$v_n = G \cdot m_s / v_n \cdot r_n \quad (12.4)$$

Fig. 12.1: The first cosmic velocity v_k

12. New cosmology

Astronomy still hasn't satisfactorily solved the question of the formation of the solar system. It thereby however concerns a central problem, because it includes the origin of the earth. But as long as we not yet have understood the relations in our nearest environment, the processes, which we observe with giant telescopes in the depths of pace, will remain a book with seven seals, will lose models of explanation concerning the Big Bang and concerning the so-called unavoidable heat exitus every reliability.

12.1 Concerning the formation of our solar system

2-8-1972 the observatories of the sun reported an unusual high solar activity and 6 days later a slowing down of the rotation of the earth occurred, which was recorded as the lengthening of a day for more than 10 milliseconds. This effect hardly can be explained by the tidal friction alone already just concerning the energy balance. Instead this observation makes clear two things to mankind. On the one hand, how much our earth depends on the solar processes and on the other hand, that the changes by all means can occur not continuously, but periodically and if need be even sporadic.

If, as a result of the conservation of angular momentum, the sun determines the orbital velocity of the earth, if it dictates the rotation of the earth by its neutrino activity and the growth of the earth and if the earth in the same manner determines the orbit of the moon, then it would be obvious that the moon originally has been a part of the earth and this in turn sometime a part of the sun. As it came off, the necessary angular momentum then has been passed on proportionately to the celestial companions, with which the cause for evolution and rotation of their own would be clarified. In addition the moon goes away from the earth and the earth again from the sun, so that looking back it by all means would be obvious, if they once had belonged together.

If we assume that cosmic dust particles meet and accumulate, then all collected rubble contributes to the rotation of its own of the forming celestial body. The more matter finds together, the larger its force of attraction gets, the faster it will grow like a celestial vacuum cleaner. In the course of time this process however is slowed down again and eventually comes to a standstill, because as matter condenses, volume and spherical radius decrease and the rotation of its own increases to the corresponding extent. The celestial body rotates faster and faster and reaches at its surface the cosmic velocity vk, which is given by the mass m and the radius r of the star (eq. 12.2). Now the centrifugal force has reached an order of magnitude, for which the celestial body hurls exactly as much matter into space, as it on the other hand collects by its gravitational effect.

Our sun was lucky to have been supplied with neutrinos in the range of influence of our galaxy. It went in resonance and started to grow, this time from out of the inside. It however could not yet shine, because a crust had formed on its surface around its core of fusion and its mantle, a crust on which permanently was falling cosmic matter from the outside. The increasing viscosity of the sun becoming compressed caused a slowing down of the core of the sun and the corresponding acceleration of the mantle and crust.

Titius-Bode law of 1766:

$$a = 0{,}4 + 0{,}3 \cdot 2^{\nu} \quad (12.5)$$

in astronomical units a with:

$$r_n = a \cdot r_e \quad (12.6)$$

(r_e = 149 598 000 [km] average orbital radius of the earth)

Planet	*orbital radius acc. to the law:*		*measurement value.*
Mercury:	$\nu = -\infty$	$a = 0{,}4$	*0,39 (measured)*
Venus:	$\nu = 0$	$a = 0{,}7$	*0,72 (measured)*
Earth:	$\nu = 1$	$a = 1$	*1 (by definition)*
Mars:	$\nu = 2$	$a = 1{,}6$	*1,52 (measured)*
Asteroids:	$\nu = 3$	$a = 2{,}8$	-
Jupiter:	$\nu = 4$	$a = 5{,}2$	*5,2 (measured)*
Saturn:	$\nu = 5$	$a = 10$	*9,54 (measured)*
Uranus:	$\nu = 6$	$a = 19{,}6$	*19,2 (measured)*
Neptune:	$\nu = 7$	$a = 38{,}8$	*30,1 (measured)*
Pluto:	$\nu = 8$	$a = 77{,}2$	*39,4 (measured)*
circumsolar cloud of planets:	$\nu = 9$	$a = 154$	-
etc. ... :	$\nu = 10$	$a = 308$	-

Table 12.2: The Titius-Bode series of the planets (the theoretical values compared to the measurement values)

Sometime our like mad spinning sun had increased that much, that the crust came off like the ,,tread of an old car tyre" and was catapulted into space. The repulsion was achieved by the centrifugal force exceeding the gravitation for the force of cohesion, which at the moment of the separation of crust regions suddenly tears off. Like snowballs the planets lulled off the sun's surface in this process and were hurled away. Their velocity of rotation at this time was identical to the cosmic velocity of the sun v_k and with that for many a planet large enough to produce its own satellites out of its own surface, which perhaps was not yet completely ideally spherical.
With every planet, which the sun gave birth to, it gave away a part of its own angular momentum to its child as orbital momentum. Only from this time on the sun reduced its angular velocity steadily until this very day. By losing the crust it also started to shine openly. Thus at least could our solar system have been formed.

12.2 The birth of the planets

From this observation various consequences result. If stars are observed, which are rotating very fast, then they either are very young, or they have no planets. Stars, which compared to our sun are rotating less fast, have given away the angular momentum to their planets and such, which hardly are rotating, have their planets already sent away into space. But if the last planet leaves its solar system and the sun stops to rotate, then the sun, which meanwhile has grown to a red giant, without a, the spherical form stabilizing centrifugal force, will collapse. The supernova is the death of a star and thereby neutrinos are set free, the material for new life.

After the coming off of the planets these first clear free their flight paths, by together with the sun collecting the flying around matter. Even whole planets thus can collide, are slowed down and form bigger units. Finally only some few planets in very particular orbits are left. Their average distance to the sun obeys in an until now completely inexplicable manner the Titius-Bode series (equation 12.5, table 12.2).
In the case of the by the german scientist Titius 1766 formulated regularity it concerns a rule of thumb founded purely on experience. But it is remarkable, that the planet Uranus could be predicted (Bode 1772) and after systematic searching also be found (Herschel 1781) with it.

The most distant planets Neptune and Pluto however don't obey the law. Their distance should be very much larger. But this circumstance we already had given reasons for with the fact, that for them the resonating interaction already overlaps and exceeds the gravitation in its effect (chap. 10.1 note<ii> and chap. 10.5).

The arbitrary seeming series of numbers 0, 3, 6, 12, 24, 48, 96, 192, 384, ... with a respective doubling of the value, starting with the 3, the addition of 4 and the following division by 10 at first are nothing but pure acrobatics of numbers, which now really has nothing to do with physics (table 12.2). A physical background can be supposed however because of the tried and tested applicability and that should be fathomed.

Orbital angular momenta $J\cdot\omega$ of the nth planet with: $J = m\cdot r_n^2$ and $\omega = v_n/r_n$:

$$J\cdot\omega = m\cdot r_n\cdot v_n \quad (12.7)$$

By using	equation 12.3:	equation 12.4:	
amounts the orbital angular momentum to: $J\cdot\omega$	$= m\cdot\sqrt{G\cdot m_s\cdot r_n}$ on r_n	$= G\cdot m\cdot m_s/v_n$ on v_n	(12.8)

change of the angular momentum (1st derivation) with the ordinal number n

$$\frac{d(J\cdot\omega)}{dn} = m\cdot\sqrt{G\cdot m_s}\,\frac{d(\sqrt{r_n})}{dn} = G\cdot m\cdot m_s\,\frac{d(v_n^{-1})}{dn} \quad (12.9)$$

$$\frac{d(J\cdot\omega)}{dn} = \frac{m\cdot\sqrt{G\cdot m_s}}{2\cdot\sqrt{r_n}}\cdot\frac{dr_n}{dn} = -\frac{G\cdot m\cdot m_s}{v_n^2}\cdot\frac{dv_n}{dn} \quad (12.10)$$

with eq. 12.8:

$$\frac{d(J\cdot\omega)}{dn} = \frac{J\cdot\omega}{2\cdot r_n}\cdot\frac{dr_n}{dn} = -\frac{J\cdot\omega}{v_n}\cdot\frac{dv_n}{dn} \quad (12.11)$$

By comparison of the left and the right solution (of eq. 12.11), after introduction of the constant:

$$\frac{1}{N} = \frac{1}{r_n}\cdot\frac{dr_n}{dn} = -\frac{2}{v_n}\cdot\frac{dv_n}{dn} \quad (12.12)$$

the differential equations read:

$$\frac{r_n}{N} = \frac{dr_n}{dn} \qquad \frac{v_n}{2\cdot N} = -\frac{dv_n}{dn} \quad (12.13)$$

and the general solutions:

$$r(n) = r_n = r_o\cdot e^{\lambda\cdot n} \qquad v(n) = v_n = v_o\cdot e^{\lambda\cdot n}. \quad (12.14)$$

The 1st derivation: and the comparison with eq. 12.13 and eq. 12.14:

$$\frac{dr_n}{dn} = r_o\cdot\lambda\cdot e^{\lambda\cdot n} \qquad \frac{dv_n}{dn} = v_o\cdot\lambda\cdot e^{\lambda\cdot n} \quad (12.15)$$

$$\frac{dr_n}{dn} = \frac{r_o}{N}e^{\lambda\cdot n} \qquad \frac{dv_n}{dn} = \frac{-v_o}{2N}e^{\lambda\cdot n} \quad (12.16)$$

determine the coefficient λ:

$$\lambda = 1/N \qquad \lambda = -1/2N \quad . (12.17)$$

The result is for a planet in the nth orbit:

for the average orbital radius	for the average orbital velocity
$r(n) = r_n$	$v(n) = v_n$
$r(n) = r_o\cdot e^{n/N}$	$v(n) = v_o\cdot e^{-n/2N}$
(12.18)	(12.19)

Fig. 12.3: Calculation of the distances and orbital velocities of the planets

12.3 The derivation of the Titius-Bode law

Even if Bohr's atomic model should be wrong, it gladly is compared to the system of the planets. The radii of the electron orbits mathematically result as eigenvalue solutions of the Schrodinger equation, and that we have derived from the fundamental field equation (chap. 5.1, eq. 15) (chap. 5.5 - 5.9). The orbital radii are calculated in increasing order in accordance with the sequence of whole numbers with n = 1, 2, 3, 4, ...

From the same sequential regularity of the planetary orbits can be derived, that they also obey the eigenvalues of the same fundamental field equation, which isn't called a world equation in vain. The quantitative distances from the sun are determined by the size of the sun: if the sun increases, then also all distances increase to the same extent.

Now result identical distances between the orbits from Bohr's model, whereas this distance in the case of the planets with increasing distance from the sun gets larger. The reason for this unevenly grading can be calculated just like that (fig. 12.3).

We arbitrarily pick a planet, which occupies the orbit n, where n again represents the sequence of whole numbers (n = 0, 1, 2, 3, ...). If the orbit of this n^{th} planet changes, then also its distance to the sun $r_n = r(n)$, its orbital velocity $v_n = v(n)$ and the orbital momentum $J \cdot \omega$ (12.7) are changed.

We try (as in equation 11.42, fig. 11.10) the balance of forces between centrifugal force and gravitational force (eq. 12.1, fig. 12.1) and solve equation 12.2 for the orbital velocity. The orbital angular momentum of the planet written down once in its dependency on r_n and in the right column next to it on v_n (eq. 12.8, fig. 12.3), is derived for the orbital ordinal number n, to record the change in angular momentum (equations 12.9 to 12.11).

In fig. 12.3 the paths to the solution for both cases are given. For the average orbital radius r(n) as well as for the average orbital velocity v(n) of the planet an exponential course (eq. 12.18 and 12.19) and in logarithmic representation a straight line (fig. 12.4) results.

Even the orbits of the distant planets Neptune and Pluto, for which the Titius-Bode series fails, now are correctly recorded, so that with good cause can be claimed, to correctly have derived the regularity of the distances of the planets physically and mathematically.

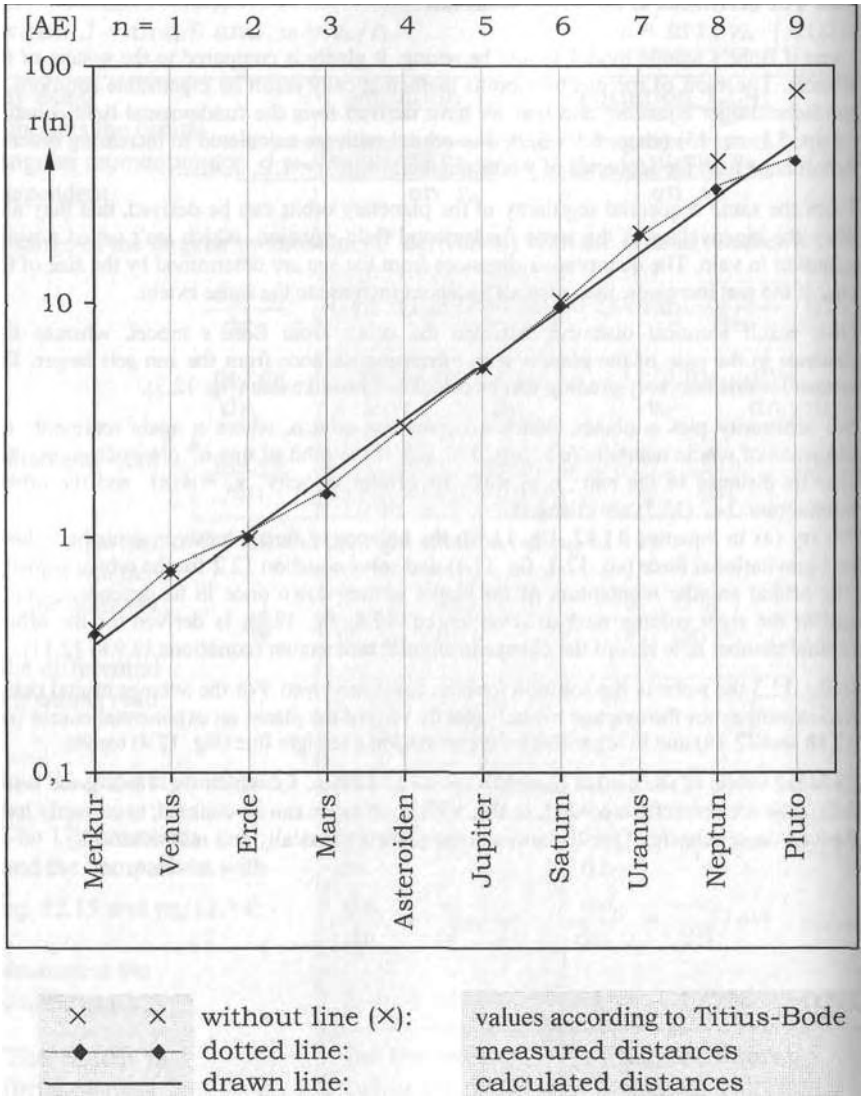

Fig. 12.4: Representation of the distances of the planets

result of the calculation: $$r(n) = 0{,}3332 \cdot e^{\left(\frac{n}{1{,}82}\right)} \quad [AE] \qquad (12.20)$$

12.4 The hollow planet

The numerous accompanying moons of the big planets obey in the same manner as the planets this regularity, so that for the found result every coincidence is excluded. The orbits of the moons of Jupiter (fig. 12.5), of the moons of Saturn (fig. 12.6) and of the moons of Uranus (fig. 12.7) in logarithmic representation lie almost on a straight line. Some orbits certainly are occupied several times, while many an orbit has remained unoccupied. Other orbits again are occupied by a ring of countless chunks of rock, so-called planetoids. Best known representative is the asteroid belt (n = 4) between the orbit of Mars (n = 3) and that of Jupiter (n = 5). The Titius law requested the planet "Aster", but what one found (Piazzi, 1801), at first only was Ceres, the biggest representative of the small planets.
As a second asteroid, as they are called, was found (Olbers 1802) its discoverer proposed the explanation that both, Ceres and Pallas, could have formed in a cosmic catastrophe, which a bigger celestial body had suffered.
Perhaps the sought-for planet Aster actually had imploded after a collision and had been torn apart in countless fragments, of which today still more than half a million pieces are flying around. Most of the fragments however have been collected by the neighbouring planets Jupiter and Mars. Also in the case of the moons of Mars and the outer moons of Jupiter it could concern scrap of Aster. Some presumably fell on the young earth and triggered natural disasters and left deep scars.

It can be imagined that the planet Aster was hollow from the inside and thus was built up similar to the moon. Such a hollow sphere could have formed, if the sun, or in the case of the moon, the earth still was rotating with the cosmic velocity and as a result of the centrifugal force at the perimeter parts of the crust came off as connected sheets and rolled up to a tube.
The fast spinning tube then remodels into a hollow sphere with openings at the poles. In the inside of the sphere, near the equator, protected conditions and the best prerequisites for an undisturbed development, for instance of intelligent living beings, are found by the way. Apart from the advantages the hollow sphere however has as a fundamental disadvantage, that the normally protecting shell in the case of a collision with a bigger celestial body can becomes instable and can implode.

In the case of the moon the pole openings in the meantime are closed and a presumed gas pressure in the inside in addition provides stability. The wall of the spherical shell however is not evenly thick, so that the moon all the time turns the same, namely the heavier, side towards the earth. In view of the seismic measurements of the Apollo-missions, which revealed an extremely small damping of the ground of the moon (chap. 11.9, note <i>), we should look after our moon well, because a comet, which lets the moon implode, would be able to bring about more damage on earth, than if it would hit the earth directly.

Should there exist a hollow and possibly even on the inside habitable planet in our solar system, then surely Saturn should be considered. Its density is smaller than that of water, so that water would be distributed over the inside area of the hollow sphere, if it would be existent. One should examine more detailed the extremely flat pole regions of Saturn for possible openings! Also Uranus and Neptune are possible candidates. This only is thought as an idea.

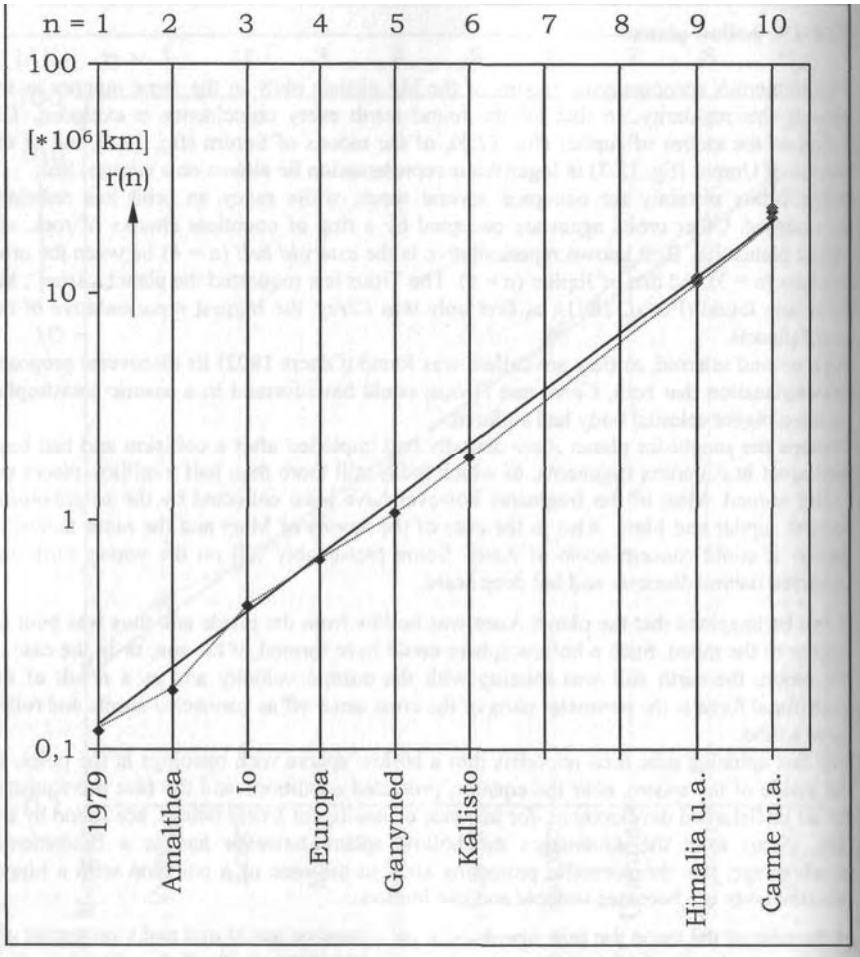

dotted line: measured distances
drawn line: calculated distances

in position n = 9 stand: Leda, Himalia, Lysithea and Elara
in position n = 10 stand: Ananke, Carme, Pasiphae and Sinope

Fig. 12.5: The distances of the moons of Jupiter

Result of the calculation: $r(n) = 67608 \cdot e^{\left(\frac{n}{1,743}\right)}$ [km] (12.21)

<i>: Note to chapter 12.5:

What we observe as and call cosmos, is nothing but a structured state of space.

12.5 Concerning the formation of the universe

The widespread concept of an expanding universe bases on the observation of a red shift of the spectral lines of galaxies, which increases with their distance. As the physical explanation for the discovery of Hubble, the Doppler shift for a light source, which is moving away from us, is used. But this concept of an against the attraction of the gravitation taking place expansion is nothing more than a work hypothesis.

The by Christian Doppler in acoustics investigated effect treats the observable shift in frequency, if the source of sound or the receiver is moved with regard to the medium of propagation. But according to today's version there doesn't exist such a medium at all for light, because Einstein has abolished the concept of the aether. According to that the Doppler effect neither can be applied to changes in light frequency.
In the case of the expanding universe, for a decrease of the density and the tracing back to a Big Bang, it therefore should concern a misinterpretation!

Here another effect has to take effect, which one is not yet clarified. Perhaps the changing field relations of the observer environment play a role, after the earth moves away from the sun. But perhaps the galaxies only influence the propagation of their own light, or the light ray on its millions of years lasting way through space slightly loses energy, what is expressed by gradually increasing its wavelength and shifting its spectrum towards the red frequencies.
The hypothesis of the Big Bang moreover contradicts every causality. It is not able to give an answer concerning the origin and the future of the universe and on the question of the origin of the energy and the particles. With that its physical value of explanation goes towards zero.

If we again hold the theory of objectivity against the theory of relativity (part 1), we come to quite other answers. Here apart from the waves also vortices are found. Specially in the case of the spherical vortex a part of the wave power is enclosed in the inside, so that looked at from the outside a from zero differing energetic state results, which even is accessible measuring technically (chapter 6.2).
Wave and vortex are two possible forms of state, so that for the conversion of one state in the other state at first no energy is necessary. The change of state depends on the local field relations.
If we assume that in the beginning the cosmos was free of energy and particles. Then the first vortex was a possible product of chance with an infinite extension. This first spherical vortex, which was contracted under the potential vortex pressure, gave structure to space, gave it energy and field and took care for the rolling up and formation of new vortices[1].
It can be assumed, that even today new particles continually are being formed in the fringe areas of the infinitely extended cosmos, which fly towards us and in doing so contract. They are attracted and at the same time shrunk by the fields of the celestial bodies. They form the source of all matter and energy for our observable universe, which permanently is changing its structure. Because the same oscillation with reversed sign is enclosed in the inside of the spherical vortex, the sum of the energy present in the cosmos is exactly equal to zero. With that the question concerning the causality is superfluous.

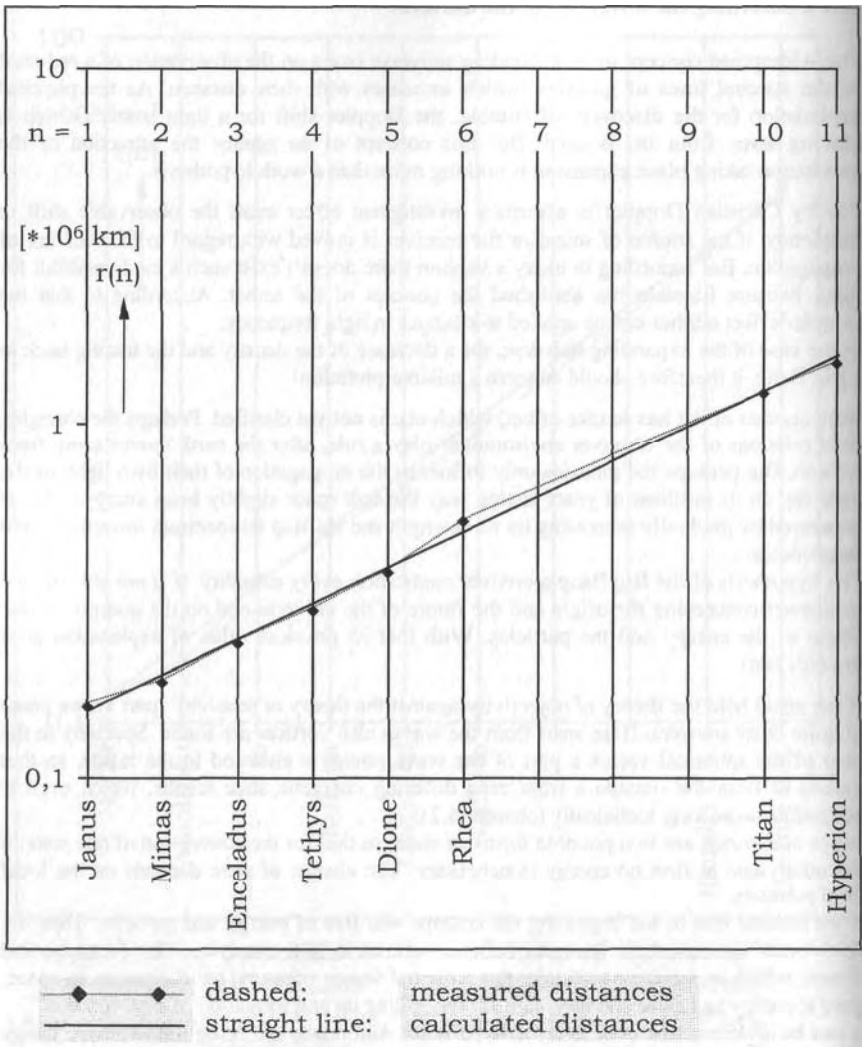

Fig. 12.6: The distances of the moons of Saturn

Note to chapter 12.6 (2nd law of thermodynamics<i>):

Heat cannot completely be transformed into mechanic or electric energy.

<i>: see Electromagnetic environmental compatibility, Part 1, fig. 8.4

The formation of the universe also can be explained causal and completely without a hot Big Bang, even if a supernova surely represents something like a "local Big Bang" for the concerned celestial bodies. According to the observations of the sky expansion and contraction, explosion and implosion occur everywhere in form of oscillations.

On the whole the expanding universe, which once was in thermodynamic equilibrium with matter, should cool down further and further. But stop, the 2nd law of thermodynamics teaches one just the opposite. If the entropy only increases, as the law dictates, then the whole universe should end in a heat death, just as mysteriously and inexplicable, as it should have been formed with the Big Bang. Perhaps something is wrong with the law (fig. 8.4)?

12.6 Counter examples concerning the 2nd law of thermodynamics

Most likely a small experiment convinces us. We heat two spheres, one somewhat less, the other somewhat more. Then we focus the heat radiation of the less hot sphere with help of a parabolic mirror and point it to the hotter one of both. That as a result becomes hotter, whereas the colder is cooled down. The heat thus has flown from the colder to the hotter sphere. Is it allowed to do that?
According to the 2nd law of thermodynamics it of course isn't. There the heat always can only flow from the hot to the cold sphere. But in this primitive experiment it measurable and verifiable flows in the wrong direction. Here the entropy, which is said to always only increase, actually decreases. Here entropy is being destroyed!
Shall we now let the carrying out of the experiment be forbidden under threat of penalty or shall we secretly put the law of entropy to sleep? It can't be denied that this law until now has quite well helped us along, at least for terrestrial processes, at least if one dispenses with the poor inventors, whose inventions offend against the since 100 years tried and tested 2nd law of thermodynamics. They haven't really arrived at the patent office at all, then they already are outside at the door again. Such inventors with their illegal behaviour even today must feel like criminals.

Just what that observed experiment can, each refrigerator and each warmth pump is using as well. And it is not an isolated case: also our sun clearly functions and operates illegally! The surface temperature amounts to only 5800 degrees Kelvin and supplies the atmosphere of the sun with energy. The energy thus flows from the sun to the corona, and that is with values above 1,000,000 degrees Kelvin for some powers of ten hotter!

Only the vortex concept resolves the many question marks without compulsion. In the case of the sun certainly vortices are at work. Here the high temperature in the corona arises as a result of vortices falling apart. We also speak of eddy losses. The transport takes place by heat radiation, exactly as in the experiment with the two spheres.
The possibility exists therefore in vortex processes as well as in technical circle processes that heat could flow from the colder to the hotter sphere. Whether this is an offence against the 2nd law of thermodynamics, is in the end a question of interpretation of the law and up to the opinions of the scholars.

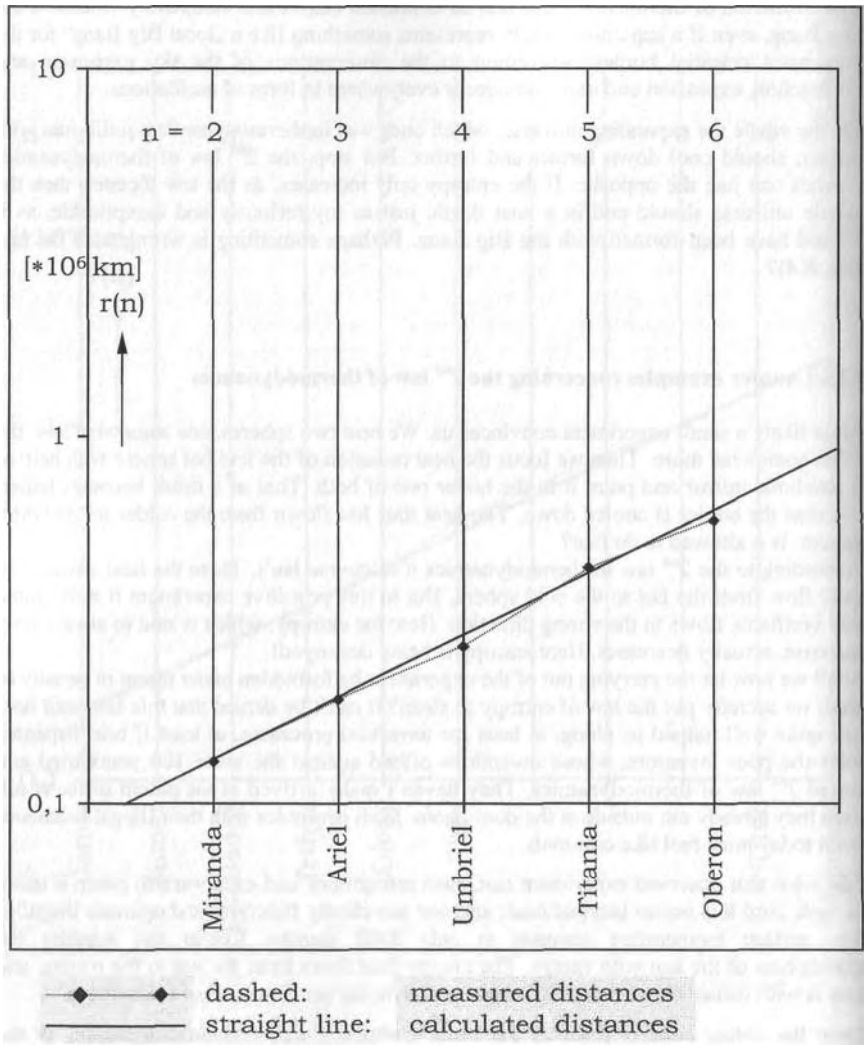

Fig. 12.7: The distances of the moons of Uranus

Note to chapter 12.7 (law of entropy):

The entropy of a closed system never can decrease. It is increased in the case of all irreversible processes. In the case of reversible processes it remains constant.

12.7 Entropy destroying potential vortices

Vortices in addition can amalgamate to balls and to planar vortex systems (4.9 and 4.10). In that case similar consequences, as they can be observed in flow-technical potential vortices in hydrodynamics, can be expected. As a result of the concentration effect (4.1) and because of the conservation of angular momentum an increase of the velocity of rotation of the vortex occurs. Like in the case of the pirouette in figure skating a spontaneous acceleration of its own is observed. In that way the kinetic energy of the system is increased, and that has to come from somewhere.
If we don't supply the contracting vortex with any additional energy for the increase of its rotation of its own, then as a source of energy only the heat energy is left. For this reason every contracting vortex generally converts heat in kinetic energy, it therefore cools down its environment! It moreover destroys entropy and offends against the 2nd law of thermodynamics (fig. 12.8).

It isn't an accident, if in the inside of a tornado it starts to hail. The whirlwinds really furnish visual instruction of the contraction and acceleration of their own of ring-like vortices. If then, even in tropical regions, hail stones are formed, the cooling effect has to come from somewhere, and it can be assumed that the vortex withdraws the heat energy from its environment (calculation in fig. 12.8).

If in specialist books is talked about matter or stars condensing, then vortex physics teaches us that they in reality are contracting and by doing that cooling down. That also is valid for whole galaxies. We owe solely the vortex laws that the continual heating by absorption of radiation is prevented and our sky in the night is dark and doesn't shine as light as day.

The cosmic background radiation, which as a result of vortices lies at almost 3° Kelvin, actually can only be given account for with a contracting of vortices of the Milky Way galaxy. If the cooling down in a compression resp. condensation process has arrived at absolute zero, the vortex becomes stationary, the contraction becomes dependent on the irradiated energy or it wholly comes to a standstill without supply of energy. An example for that is earth's inner core, which at zero Kelvin can't contract further.

From the point of view of causality it is suggested that we galactic and perhaps even cosmic to a large extent are in thermodynamic equilibrium, completely without Big Bang and heat death<i>.

Numerous inventions, as mentioned, are based on the principle of converting environmental heat in useable energy by contraction of vortices. If however the inventors don't know the vortex laws and if they have developed their concept empirically and less physically, then it very often happens that erroneously gravity is made responsible, then is talked of gravitational converters, of the use of a gravitational field energy. But the inventors don't do themselves a favour with that.

<i>: In the seminar it is desired to think about this. Doing so the philosophical faculty may feel as well addressed, as the sandpit of physics, in which completely unsuspecting is played and juggled with Big Bang hypotheses by ignoring all physical regularities and every common sense.

Evidence to counter:
planar, contracting ring-like vortex

$$\boxed{\text{conservation of angular momentum: } J\cdot\omega = m\cdot r\cdot v = \text{constant}} \quad (12.7)$$

$$\text{conservation of energy:} \quad E_{kin} = \tfrac{1}{2}\, m\cdot v^2 = \text{constant} \quad (12.22)$$

	before (r_1, v_1)		afterwards (r_2, v_2)	
contracted ($r_2 < r_1$):	$m\cdot r_1\cdot v_1$	=	$m\cdot r_2\cdot v_2$	(12.7*)
with the consequences:	v_2/v_1	=	r_1/r_2	(12.23)
and: kinetic energy:	$E_{kin1} = \frac{1}{2}\cdot m\cdot v_1^2$	≠	$E_{kin2} = \frac{1}{2}\cdot m\cdot v_2^2$	(12.24)

increase of the kinetic energy:

$$\boxed{\frac{Q_2}{Q_1} = \frac{E_{kin2}}{E_{kin1}} = \frac{v_2^2}{v_1^2} = \frac{r_1^2}{r_2^2}} \quad (12.25)$$

notice: *Because of the change in energy/heat* ***no adiabatic change of state!***

change of volume:
with $V = \pi\cdot r^2\cdot h$

$$\boxed{\frac{V_1}{V_2} = \frac{r_1^2}{r_2^2}} \quad (12.26)$$

notice: *Because of the change of volume* ***no isochore change of state!***

assumption: ***isobar change of state*** *(with p = const., Gay-Lussac):*

result:
(vortices of gas)
involved with the:

$$\boxed{\frac{T_1}{T_2} = \frac{V_1}{V_2} = \frac{v_2^2}{v_1^2} = \frac{r_1^2}{r_2^2}} \quad (12.27)$$

* ***acceleration*** $v_2 > v_1$ *is the contraction of vortices* $r_2 < r_1$, $V_2 < V_1$

* ***the cooling:*** $T_2 < T_1$ and $\Delta T = T_1 - T_2 = T_2\cdot\left(\frac{r_1^2 - r_2^2}{r_2^2}\right)$ (12.27*)

* ***withdrawal*** *of heat* $Q_2 - Q_1 = \Delta Q = Q_1\frac{\Delta T}{T_2} = Q_1\cdot\left(\frac{r_1^2 - r_2^2}{r_2^2}\right)$ (12.28)

* *and* ***entropy destruction:*** $\Delta S = C_p\cdot m\cdot \ln\left(\frac{T_2}{T_1}\right) = C_p\cdot m\cdot \ln\left(\frac{r_2}{r_1}\right)^2$ (12.29)

Fig. 12.8: The cooling and entropy destroying effect of contracting potential vortices (calculations concerning chapter 12.7)

13. Recording of space and time

If observations should force us to touch the sacred physical laws, then we should first of all judge our measuring technique critically of all sides and bring it in an usable state. I suggest, we start completely from the beginning with the devices, with which the dimensions of space and time are recorded, with the tape measures for the measurement of length and the chronometers, our clocks.

We must find out, why comets are slowed down if they approach the sun like by the hand of a ghost and in going away again are accelerated, although no forces at all act on the celestial bodies from the outside.

We must find out, why in mines deep under the earth another value for the gravitational constant is being measured as on the surface of the earth[<i>]. The results hardly can be imagined, if an universal constant should lose its constancy.
Thereby can Newtonian mechanics and the well-known laws be used very successfully from today's point of view, as the derivations in the last chapters have shown. We even could verifiably and mathematically correct calculate the growth of the earth and the solar system with them. The physical laws in the normally used formulation in spite of that seem to be bound to certain limits. Some observations contradict all experience[<ii>].

<i>: H. Schuh: Eine Konstante verliert ihre Konstanz; neue Experimente nahren Zweifel an Newtons Gravitationsgesetz, Die Zeit Nr. 40 vom 25.09.97. From it the following quotation (translated):
„It already is suspected for several years, that a fifth force could exist, this suspicion goes back to exact measurements of the gravitational constant G in Australian mines and shafts. Physicists of the University of Queensland in Brisbane had determined, that G for measurements underneath the earth is about one percent larger than the corresponding, since centuries in laboratories determined size. Their proposal for explanation, namely a fifth repelling force, at first met with sharp disapproval. But an at 21 august in the journal Science (Bd. 237/87, P. 881) published work, which bases on measurements in a drilling hole in Michigan, confirms the Australian data".

<ii>: Already the nobel prize winner of physics, Lenard, pointed to the circumstance, that the relativistic representation of the astronomical aberration is incorrect, after no distinguishable aberration could be observed at binary stars, as it had been expected. With that Lenard by the way also has confirmed the existence of an aether.
P. Lenard, Annalen der Physik, Bd. 73, S. 89 (1924)

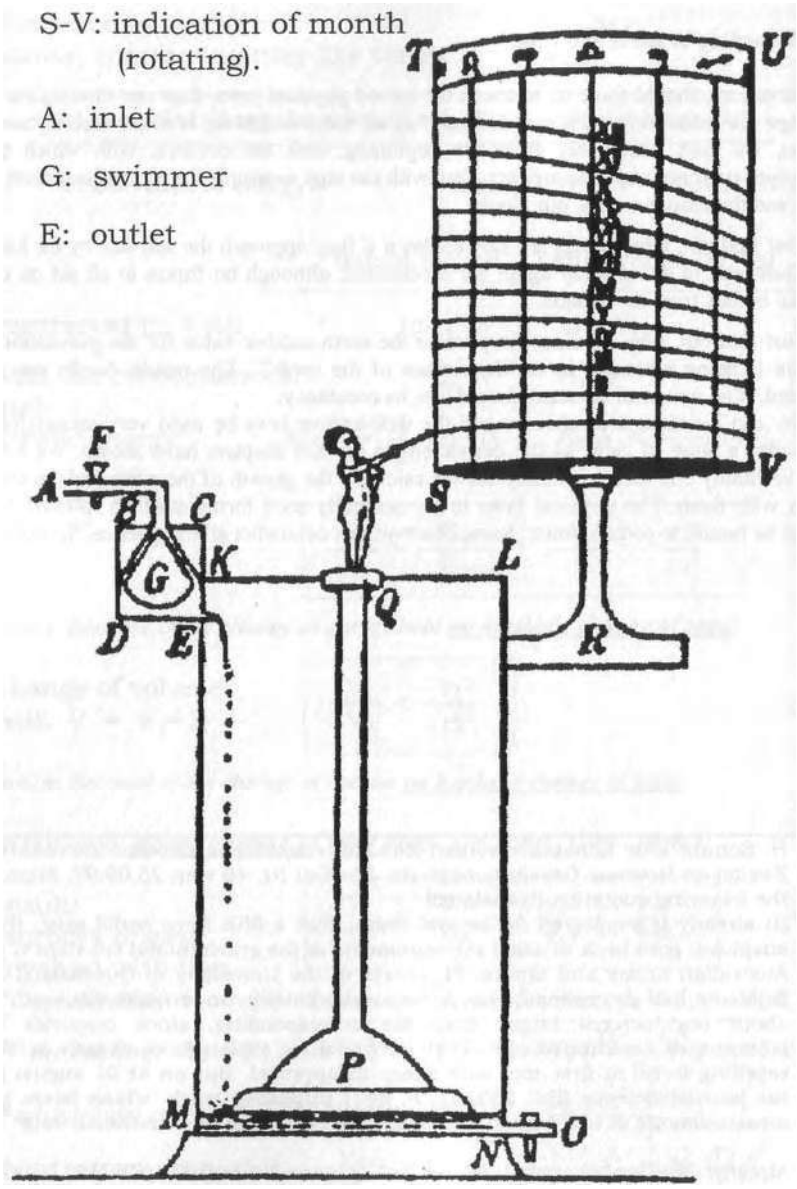

Fig. 13.1: The water meter of the Ktesibios (approx. 250 BC)
(with regulation of the water-level)

13.1 The measuring technical debacle

We are standing for a measuring technical debacle, because we have fixed our calendar to the rotation of its own of the earth. We call a 360° turn a day, divide it in 24 hours of 60 minutes each and every minute in 60 seconds. With that we determine the duration of a second.
A clock according to this definition only then is exact, if it follows the changes of the earth to the same extent. Obviously this in particular is the case for atomic clocks. An objectively seen precise going clock however would land at the waste disposal site as completely unusable.
Alter all nobody wants to know, how late it really is. Everyone only wants to find confirmed his subjective feeling, and our experience of time simply is directed after the course of the sun, thus after the rotation of the earth!

For the moment and as an approximation also for the life time of a person, this determination of time may be sufficiently exact, but seen over larger periods of time, one doesn't get around a conversion. Actually the 200 million years since the beginning of the Creation on the mentioned primeval hill are considerably less long ago. The earth and the whole solar system are very much younger, than was assumed until now!

If we as an example again take the cited research group of the University of Arizona (chap. 11.10[<i>]), which by means of an analysis of sediment formations have found out, in accordance with our calculation, that 900 million years ago a day only had 18 hours[<i>]. Such traces in geological deposit layers can be very informative, if they are analysed correctly, since here the measurement technician himself is not subject to the process. He stands outside and hence can exactly measure the time difference.
If a geologist of that time had looked at his watch during the formation of the layers, then a day obviously would have had 24 hours, and he wouldn't have been able to understand the whole excitement at all. The accusation, he would suffer from chronic blindness caused by his job, he of course would repel resolutely. Can you now imagine, from which disease our science of today suffers?

Our chronometers are nothing but the improved model of a sundial[<ii>].

We live in the dimensions of space and time, but we quite obviously have the biggest possible difficulties with the dimensioning of both. Possibly we already aren't capable of that at all by principle. Most suitably we clarify the situation by means of examples concerning the two problem spheres.

Let us at first stay at the dimension of time. It may have become clear, how problematic the chosen determination of the time scale in seconds is and which contradictions can result if larger periods of time are considered. More and more often science fiction authors romp about on the playground of time, fantasize about some time travel, or they occasionally make jokes about it[<iii>].

<i>: 900 million years ago a day had 18 hours, Washington (dpa) 1997.
<ii>: There also exist models, of which is asserted, they go according to the moon.
<iii>: A passenger, who got on the 10 o'clock bus, passes by the church steeple clock, which only reads 5 to 10 and curses: Damn, I took the bus in the wrong direction!

Centrifugal force $\boxed{F_{1,2} = (m/R)\cdot(v_E \pm v_f)^2 = m\cdot R\cdot(\omega_E \pm \omega_f)^2}$ (13.1)

with: $R = 6378$ [km] (radius of the earth),

$v_E = \omega_E\cdot R = 0{,}465$ [km/s] (rotational speed of the earth), (11.20)

$v_f = \omega_f\cdot R = \pi\cdot R/t_o$ (speed of the plane) (13.2)

and: t_o [s] (duration of journey)

energy of the moving steering quanta:

$$E_{1,2} = \int_O^R F_{1,2}\,dR = m\int_O^R R\cdot(\omega_E \pm \omega_f)^2\,dR = \quad (13.3)$$

$$E_{1,2} = \frac{1}{2}\cdot m\cdot R^2\cdot(\omega_E \pm \omega_f)^2 = \frac{1}{2}\cdot m\cdot(v_E \pm v_f)^2 \quad (13.4)$$

energy balance (generally of a quantum of radiation):

$\boxed{E_{1,2} + E_q = E_{ges}}$ resp. $\boxed{E_{ges} - E_q = E_{1,2} = \Delta E}$ (13.5)

in general: $E = h\cdot f = m\cdot c^2$ resp. $m = h\cdot f/c^2$ (13.6)

and (Gl. 13.4 mit 13.6):
specifically: $\boxed{\Delta E = h\cdot\Delta f} = \boxed{E_{1,2} = h\cdot f\cdot(v_E \pm v_f)^2/(2c^2)}$ (13.7)

$\Delta f/f = \Delta t_{1,2}/t_o$ resp. $\Delta t_{1,2} = t_o\cdot\Delta f/f$ (13.8)

(eq. 13.7 inserted into eq. 13.8)

resulting in: $\boxed{\Delta t_{1,2} = t_o\cdot(v_E \pm v_f)^2/(2\cdot c^2)}$ (13.9)

time of travel around half the earth: $t_o = \pi\cdot R/v_f$ (13.2)

results in a difference in going of: $\Delta t = \Delta t_1 - \Delta t_2$ (13.10)

$$\Delta t = [(v_E + v_f)^2 - (v_E - v_f)^2]\cdot\pi\cdot R/(v_f\cdot 2\cdot c^2) \quad (13.11)$$

result calculated: $\boxed{\Delta t = 2\cdot v_E\cdot\pi\cdot R/c^2 = \underline{207}\ [\text{ns}]}$ (13.12)

measured by Hafele and Keating<i>: 214 [ns]! (13.13)

Fig. 13.2: The difference in going of two atomic clocks
(caesium resonant clocks)

<i>: Hafele-Keating-Experiment, Oktober 1971; s. a. W. Bauer: Klassische Physik, Graphia Druck, Salzburg (1975), Eigenverlag

13.2 The clock paradox

The theme „time dilatation" in connexion with the particle decay already has been treated (part 1, chapter 6.20). It has been shown, that a fast moving and with that length contracted particle to exactly the same extent (Lorentz's square root) becomes more stable and longer-living. If relativists pack an atomic clock based on radioactive decay in a plane and detect a difference in going between the one, which has been flown around and a second identically constructed clock, which has stayed at the ground, then they have with that detected experimentally a very small length contraction, which really occurred, and by no means a time dilatation, as they claim.

Now we in addition owe Einstein, that the aether has been abolished and from that follows, that it can't play a role in which direction the plane flies. If therefore both clocks are taken along each in a separate plane, one plane flying to the west and the other to the cast, both planes meeting again for the first time on the other side of the globe, then according to Einstein's theory it shouldn't be possible to determine a difference in going, if both planes constructed identically were on the way with the same velocity. But this is not the case!

Actually a difference in going is measured, which however can't be calculated with the theory of relativity, yes, which is completely incompatible with this theory and clearly brings anyone to the eye, that the effect actually can't have to do anything with a time dilatation, that the moving clocks merely go wrong and we have to ask us, why[1].

These experiments were carried out with atomic clocks, which are constructed as caesium resonators and work with an exactness of one second in 300000 years. As a resonator serves a quartz crystal, which is controlled by an ion current of caesium atoms, which have lost their outermost enveloping electron. The system is fed back, because the oscillating quartz controlled by the caesium ions again adjusts the caesium vapour by radio wave and finally its own atomic controlling current (fig. 13.7).

The reason for the measured difference in going is seen in the field and here specially in the different gravitational field. The centrifugal force directed opposite to the gravitational force at least is not the same, because for a westward flight along the equator the speed of the plane v_f should be subtracted from the velocity of rotation of the earth v_E, whereas in eastward direction it should be added (eq. 13.1).

For the steering quanta supplied by the caesium resonator now the energy balance is put up (13.5 with 13.4) and the change of the reference frequency is calculated (13.7). With the change in frequency is connected directly a change of the at the two clocks readable times $t_{1,2}$ (13.8). For a journey around half the earth, where one clock is flown westwards and the other one eastwards, the difference in going should, according to the calculation, amount to 207 ns. Interesting of the result (13.11) undoubtedly is, that the velocity of the planes doesn"t play a role. It is cancelled out.

October 1971 caesium atomic clocks were sent around the world in scheduled planes in the Hafele-Keating experiment. To be able to estimate the inaccuracy in going of the clocks and with that the measurement error, four clocks were used. Between the westward journey (273 ±7 ns) and the eastward journey (59 ±10 ns) a difference in time of 214 nanoseconds was determined. This under strict scientific conditions determined result once more proves the correctness of the theory of objectivity by confirmation of the calculated value. That however is not valid for the special theory of relativity, because that doesn't appear in the calculation at all!

Who now believes, we would have less problems with the dimension of space, I must disappoint. The determination of the linear measures equally ends in a fiasco.

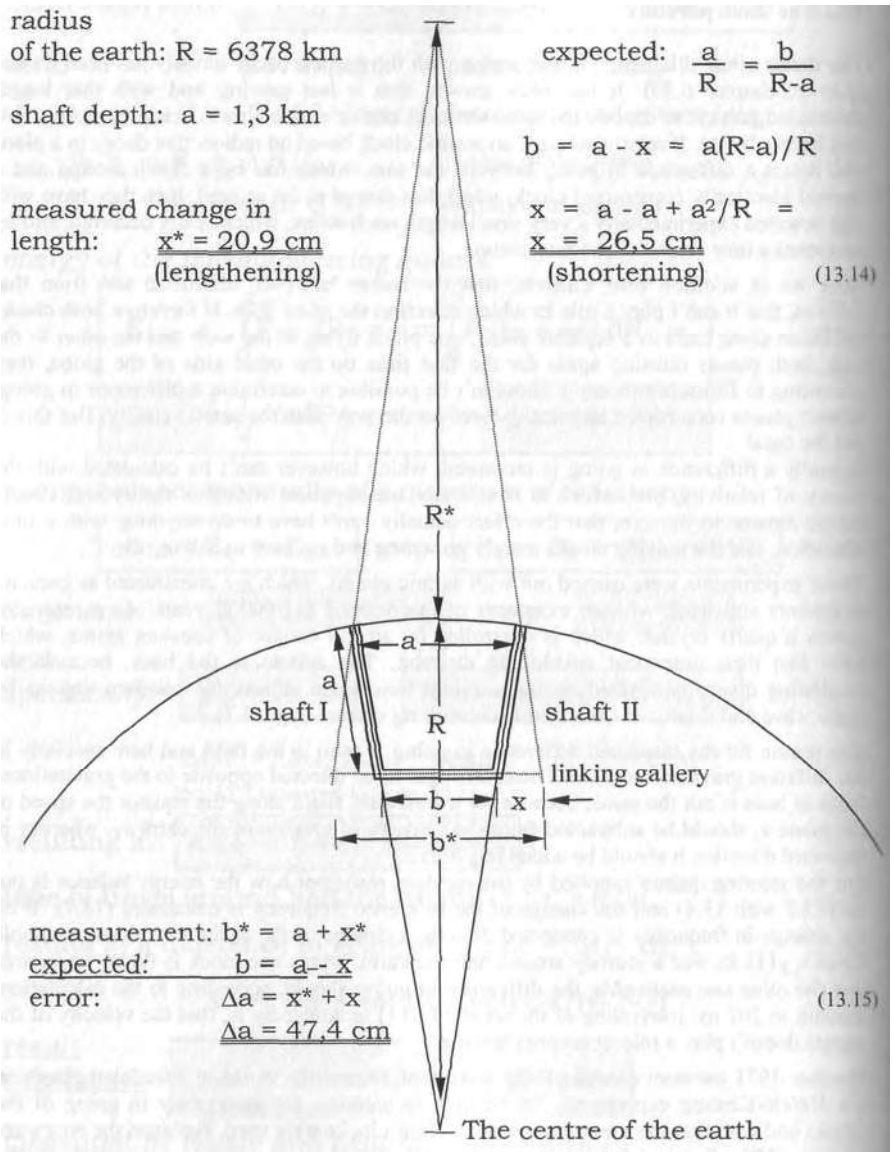

Fig. 13.3: Expectation and measurement in the Tamarack mines

(The curvature of the earth and the length of the shaft a are drawn strongly exaggerated for clarification)

13.3 The Tamarack mines experiment

As long as the „foot measure" depended on the shoe size and the „cubit" on the forearm of the tailor, the world still was OK. The sciences however request a reproducible quantity for comparison, and that can be fetched at the Bureau International des Poids et Mesures in Sevres near Paris. The original meter is a Platinum alloy. Because the length of the metal always depends on temperature, it is stored at a constant kept temperature of 0° Celsius. Now there in addition still exists a field dependency, an electrostriction resp. magnetostriction. And how is the measurement bar behaving, if the earth grows and the density increases? Is it then shrinking just like other objects in its environment? At this point already chaos is proliferating.

The newest definition of the length measure meter acts as a blow for liberty and thus marks the abyss, at which we are standing: The length is determined by means of a measurement of transmission time of an electromagnetic wave, e.g. of a light signal. It is said that with this determination a higher reproducibility should be obtained. Actually a photo optical facility to measure length is as exact as the built-in facility to measure time, and there we use it again, our sundial. In addition a constancy of the speed of light is taken as a prerequisite, and that is given in meters per second. From a change of the speed of light for forinstance 10% a change in length for 10% as well would result[<i>]. Because we see this process with the help of our eyes as well with the speed of light, we never can see the change. We neither can technically measure it, because all gauges we construct are built up corresponding to our sensory impression. We ourselves have shovelled the hole, in which we fall.

Only if we succeed in taking a neutral standpoint outside of the events, the true relations will become visible to us. For the field dependency of the space measures a very clear experiment has been carried out, of which I now want to report[<ii>].

1901 the French government was offered the possibility to carry out an experiment in the shut down Tamarack mines near Calumet (Michigan) with the goal to determine the diameter of the earth more exact. For that the geophysicists let down two plumb-lines of 27.2 kg each in two perpendicular winding shafts, which were at a distance of 1.3 km from each other. The plumb-lines were tied to hardly expandable piano wires of as well 1.3 km length. It now was expected, since the plumb-lines hung in direction of the centre of the earth, that in a linking gallery between the two shafts a length of (1.3 - x) km should be measurable. From the shortening x one wanted to infer the diameter of the earth (fig. 13.3). But it came completely different.
Instead of a shortening a lengthening for x* = 20.9 cm was measured in the gallery! The point of intersection of the lines through the two shafts had to be not in the inside of the earth, but in space! Immediately „hollow earthers" appear, who claim we would live on the inside of a hollow world[<ii>]. Perhaps one should shoot them to the moon, because from there the earth without doubt is seen as a sphere. Obviously we aren't dealing with a surprise of a fair, but with a fundamental measuring technical problem.

<i>: for that see also part I, chapter 6.11 and 6.12
<ii>: http:/www.t0.or.at/subrise/hollow.htm

Volume of the globe: $V = (4/3)\cdot\pi\cdot R^3$ (13.16)

and of the inner sphere in depth a: $V_a = (4/3)\cdot\pi\cdot(R-a)^3$ (13.17)

resulting in the relative change:

$$\boxed{\frac{\Delta V}{V} = \frac{V-V_a}{V} = 1-\left(\frac{R-a}{R}\right)^3 = 1-\left(1-\frac{a}{R}\right)^3} \quad (13.18)$$

from $m = V\cdot\rho$ for a constant density ρ (13.19)

and<iii>: $m = \phi/\sqrt{G\cdot 4\cdot\pi\cdot\mu} = A\cdot\mu\cdot H/\sqrt{G\cdot 4\cdot\pi\cdot\mu}$ (13.20)

follows: $\boxed{m \sim V \sim H}$ (13.21)

resp. the relative change:

$$\boxed{\frac{\Delta H}{H} = \frac{\Delta m}{m} = \frac{\Delta V}{V} = 1-\left(1-\frac{a}{R}\right)^3 = \underline{0{,}061\%}} \quad (13.22)$$

According to the theory of objectivity the length of the measurement wire is field dependent<ii> with:

$$\boxed{H \sim 1/a^2} \quad \text{and} \quad \boxed{H_a \sim 1/(a-\Delta a)^2} \quad (13.23)$$

and the relative change:

$$\boxed{\frac{\Delta H}{H} = \frac{H_a-H}{H} = \left(\frac{a}{a-\Delta a}\right)^2 - 1} \quad (13.24)$$

Shortening of the rule Δa is calculated from the comparison of equations 13.22 and 13.24:

$$\boxed{\frac{\Delta H}{H} = 1-\left(1-\frac{a}{R}\right)^3 = \left(\frac{a}{a-\Delta a}\right)^2 - 1} \quad (13.25)$$

$$\Delta a = a\cdot\left(1-1/\sqrt{2-(1-a/R)^3}\right) \quad (13.26)$$

$\underline{\Delta a = 40}$ [cm] (result of the calculation)

$\underline{\Delta a = 47}$ [cm] (measurement value for comparison, 13.15)

Fig. 13.4: Calculational verification of the measured shortening

13.4 Field dependent linear measure

If a measurement result delivers just the opposite, as was expected by the experimentators, then the layman is amazed and the expert is surprised, at least at first. But then, out of a feeling of panic, the whole view of life could collapse, as many as possible scientists and renowned professors are being informed and integrated, if they want it (Prof. Mc.Nair) or not (Prof. Hallock, Columbia University) and eventually the matter is buried third class and a guise of silence is spread over it. The censorship of the scientific making of opinion in advance doesn't permit publications, which are not in accord with our view of life, out of the animal survival instinct[<i>].

A science, which deserves this name, should look different. There it must be permitted, to ask questions and to publicly discuss about it.
I proceed from the assumption, that the earth is a sphere, which we inhabit from the outside; I have no doubts about that. With this as a prerequisite there is only one possible answer to the Tamarack mines experiment: The 1.3 kilometres long measurement wire, which in the gallery in a depth of 1.3 km had to jut out for 26.5 cm, instead is too short for 20.9 cm, from which immediately follows that it, howsoever, is shrunk for 47.4 cm in the depth.
At first of course the experiment was checked for possible measurement errors. The shafts were covered to exclude any draught. The measurement path was optically checked, but the result remained unchanged. But if the cause for the unexpected result doesn't lie in the experiment, then theoretical physics is addressed, after all it is still the experiment which shows us the physical reality and not some theoretical model concept.
In the 1st part of the book already the derivation of a useful explanation is found: The speed of light and with that also the linear measure depends on the field[<ii>]. The measurement wire accordingly gets shorter, if it is exposed to a larger field strength (eq. 13.23). We can verify the measured shortening calculative (fig. 13.4).
For that we at first determine the change of the field strength, as it is to be expected in a depth of 1.3 km. We here are dealing with the closed H field lines, which are responsible for the gravitation. In a past derivation it has been shown, that a gravitating mass can be converted into a magnetic field[<iii>]. Between a mass m and a field strength H hence exists a proportionality (13.21), in the same way as between the same mass and its volume, if a constant density is present (13.19).
The result accordingly is a relative decrease of the volume of the earth and the corresponding mass being under the measurement place, as well as a relative decrease of the radial component of the field strength, but a corresponding relative increase of the tangential component of the field for 0.061% (13.22 with 13.18).
In the gallery the measurement wire however is spread out in the direction of the tangential component of the field lines, and that shortens the measurement wire as a result of the field dependency of the linear measures[<ii>] (13.23). From the above increase in field the calculational shortening of the rule for 40 cm results, which compared to the measurement result also should be rated as a confirmation of the theory of objectivity which was taken as a basis[<ii>]!

<i>: Example: K. Meyl: Potentialwirbel, Bd. 1, reference entry /5/
<ii>: for that see also part 1, chapter 6.6, equation 65 and chapter 6.10
<iii>: K. Meyl, Potentialwirbel Band 2 (1992), page 27, equation 20

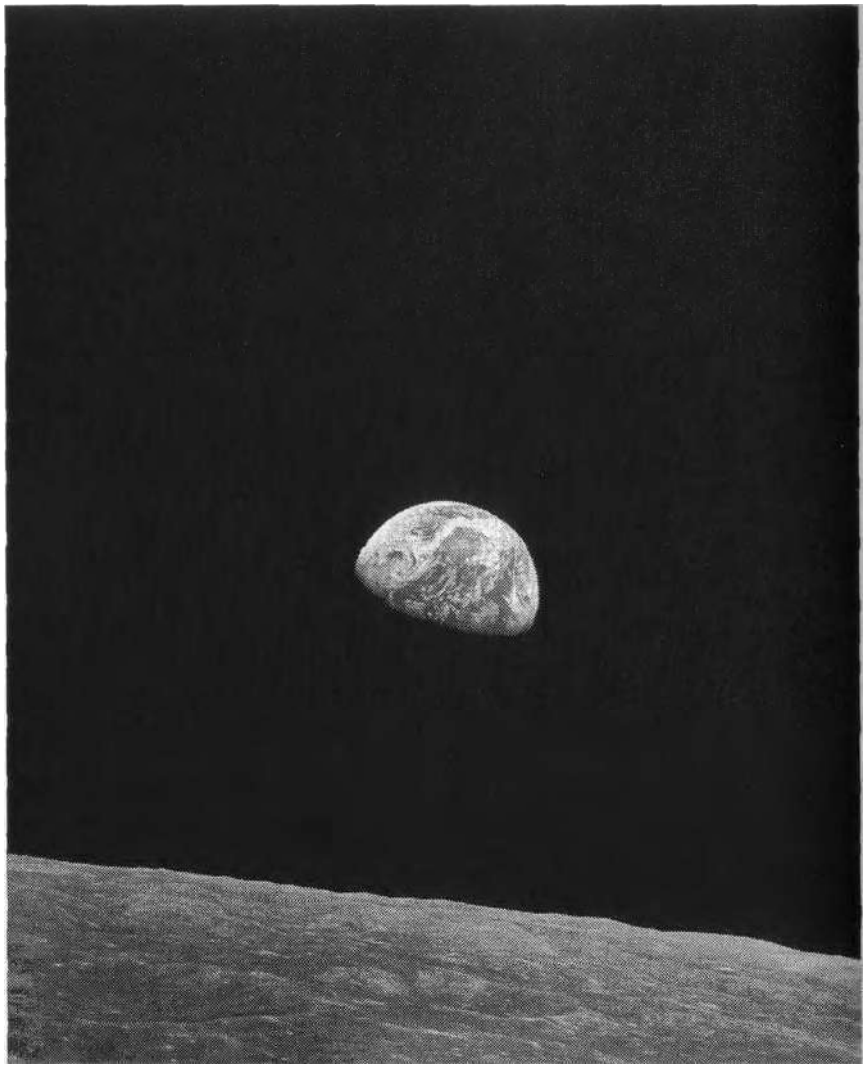

Fig. 13.5: Rise of the earth over the horizon of the moon""

<i>: Mitton, S. (Herausg.): Cambridge Enzyklopadie der Astronomie, Orbis Verlag (1989), note: No star is seen!

<ii>: see also the references in part 1, chapter 6.9

13.5 Experiences from space travel

The good correspondence of the calculated shortening of the measurement wire and the until now not understood measurement in the Tamarack mines shows both qualitatively, and quantitatively the correctness and useful applicability of the theory of objectivity of the field dependency of the linear measures. Our measurement laboratories normally are situated on the earth's surface and there everywhere are found approximately identical field relations. But if we leave the usual measurement environment and move the laboratory for instance in the sky, then we experience a complete mystery. Here however prevail the reversed conditions as in the mines experiment, in which in the inside of the earth. for an increase of the field strength, a length shortening was measured. In the sky the field strengths decrease and the linear measures correspondingly increase.

This experience astronaut Roosa made in the Apollo 14 mission. While he alone in his capsule orbited the moon, he depicted mission control, he could see the lunar module and observe his two colleagues at their work on the moon. Nobody wanted to believe the astronaut, since he was flying in a height of 180 km!

Commander Armstrong (Apollo 11) at the first landing on the moon indicated, the target crater Mackensen, 4.6 km in diameter measured from the earth, just has the size of a soccer field! Astronaut Scott (Apollo 15) called Mount Hardley, which is said to be 4.8 km high, a practice hill for skiing. Perhaps they somewhat have exaggerated, but a true core in the statements always is present!

Actually the gravitational field of our satellite is very much smaller than that of the earth. On the surface of the moon there is only one sixth of the gravitational pull of the earth. If we, to be able to compare, stick to the details of size, as they are measured by our laboratory on earth, then the astronauts on the way to the moon together with the lunar module and their rover had grown for a factor $\sqrt{6}$, then the first footprint is 2.5 times as large as on earth, then the astronauts were moving like giants in the scenery of a model of the railroad (eq. 13.23 and note<ii> at fig. 13.4).

On the moon there exists almost no atmosphere, for which reason the astronauts had imagined a wonderful view of the star-spangled sky, at least before they started. After the landing they were bitterly disappointed. The sky was black and not one single star could be seen! They have brought many photographs, but nowhere stars have been photographed, they apparently have moved outside the range of vision (fig. 13.5 and 13.6).

Many will still remember that the first pictures, which the space telescope Hubble supplied 1990, were completely blurred. The problem obviously was, that the mirrors had been adjusted on earth and not in space. Only after the optics had been given glasses in 1994, sharp pictures could be radioed to earth. Somehow the distance to the stars had changed. The telescope had become short-sighted, resp. the distance to the star-spangled sky appeared to be gotten larger. We already know why. If we remove us from the gravitational field of the earth, the field strength decreases and the observable distances increase! The highly sensitive telescope already sufficed the 5% deviation, with which should have been reckoned for the near earth orbit, to be fatal.

One should have familiarized the astronauts before with the laws of physics. Then this disappointment would have been spared to them, and in the case of the Hubble telescope the NASA and the european ESA could have saved a lot of money for the sake of the tax-paying population<ii>.

Fig. 13.6 a: Illustrierte Wissenschaft Nr. 11 (1997) Page 62

1st example: landing on the moon gravitational ...

$$\frac{\text{...pull of the earth}}{\text{...pull of the moon}} = \frac{g_E}{g_m} = \frac{M / R^2}{m_m / R_m^2} = \frac{M}{m_m} \cdot \frac{R_m^2}{R^2} = 6{,}0375 \quad (13.27)$$

in space everywhere on the surface of a sphere is valid: $A = 4\pi R^2$

eq. 13.20 (fig. 13.4<iii>): $m \sim \phi = A \cdot B = 4\pi R^2 \cdot \mu H \sim R^2 \cdot H$

as well as eq. 13.23 (fig. 13.4<ii>) for the field dependency: $H \sim 1/l^2$

and further:

$$6{,}0375 = \frac{g_E}{g_m} = \frac{H_E}{H_m} = \frac{l_m^2}{l_E^2} \quad (13.28)$$

resulting in the length dilatation (expansion) on the moon:

$$l_{m\,(Mond)} : l_{E\,(Erde)} = \sqrt{6{,}0375} = \underline{2{,}457} \quad (13.29)$$

2nd example: communications satellite in a geostationary orbit (at h = 36000 km above the equator, R = 6378 km).

$$\frac{l_h}{l_E} = \sqrt{\frac{H_E}{H_h}} = \frac{R+h}{R} = \underline{6{,}64} \quad (13.30)$$

Fig. 13.6 b: Examples of calculation for length dilatation<i>

<i>: If the theoretical value of 6.64 could be quantitatively confirmed by observations from off the earth with a telescope at a corresponding magnification, then with that would have been proved, that in the case of the spherical aberration it actually concerns the calculated influence of the field.

<ii>: U. Seiler-Spielmann: Das Marchen vom toten Mond, Zeiten Schrift 5/94,S.39

13.6 Spherical aberration

It is true that the problem of the changed length relations is known to the experts under the term of a "spherical aberration". But with that it is neither qualitatively nor quantitatively understood. Only the theory of objectivity soundly gives reasons for, why the astronaut Roosa has seen his colleagues almost 3 times as large, why weather satellites in a height of 1500 km are approx. 25% larger and why communications satellites in a 36000 km high geostationary orbit even increase to the 6.64 fold of their original size[i]. It also explains, why the neutral point between earth and moon, at which the attraction of masses of both celestial bodies mutually cancel, wasn't reached at the point where it had been expected by the moon rockets[ii].

We, the inhabitants of the earth, are adapted completely to the conditions on the earth's surface. If we find our way well in the dimensions of space and time, as we observe them, then that must not be valid by all means for science, because that has made it its business to find out the secrets of nature.

If it wants to deserve the name science, then it on the one hand has to consider, that we, the organic materials, as well as all inorganic materials are assembled from the same atoms and molecules and with that are exposed to the same length relations. If changes in length between day and night (as a result of the gravitational field of the sun (see chap. 6.7), between summer and winter or as a result of changes in field occur, then we aren't able to register this at all. That even today the „foot" is used as a measure, for instance in the air traffic, shows only too clearly, how man raises itself to the measure of all things. Science asks for modesty!

On the other hand it should be paid attention to the fact, that man eyes everything with speed of light with the optics of his eyes, and that speed by no means has to be constant. Solely the definition of the speed of light c as a linear measure per unit of time points to the direct proportionality between c and a length 1 (see chapter 6.3):

$$c \sim l \qquad (13.31)$$

If a rule has proven to be unusable for measuring a distance, then we'll experience the same disaster, if we measure optically, i.e. with the speed of light. Obviously both, the length 1 and the speed of light c depend in the same manner on the respective local field strength. On the one hand both measurement techniques lead to the same result, but on the other hand what can't be measured with one method, neither can be measured with the other.

To prove the constancy, it is normal to measure the speed of light optically. But since there exists a proportionality between measurement variable and measurement path (53), the unknown variable is being measured with itself. This measurement faulty by principle in all cases delivers a constant value. In contrast to the textbook opinion of today by no means a constancy of the speed of light can be assumed. In the case of the in a vacuum measurable 300,000 km/s it concerns a capital measurement error, at best a constant of measurement, but never ever a constant of nature!

With the postulate and the misinterpretation of a constancy of the speed of light as a universal constant of nature Einstein already let several generations of physicists run into the same dead end, in which they today are stuck altogether. It surely is no accident, that the big time of discoveries abrupt came to an end with Einstein.

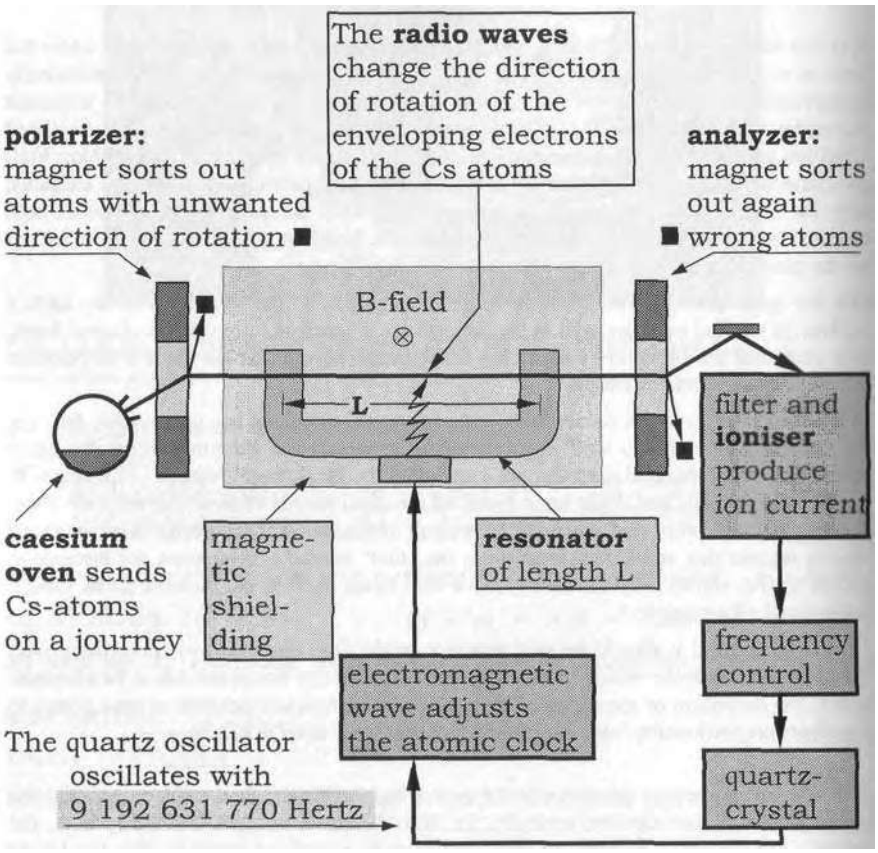

Schematic representation concerning principle of functioning
L = length of resonator determining the exactness
The B-field is a weak magnetic field, which eliminates the influence of magnetic stray fields.
The arrangement in addition is situated in a vacuum tank.

Fig. 13.7: Set-up of a caesium atomic clock

13.7 Irony of the measuring technique

Let's record: The linear measure is determined and defined by a measurement of transmission time. As a reason is given, that with today's clock technology a higher precision and reproducibility can be obtained, as with a rule or original meter. The exactness of going of the atomic clocks again depends on the free flying path (L in fig. 13.7) of the atoms. For the caesium clocks of the Physikalisch Technischen Bundesanstalt in Braunschweig the resonator length amounts to several meters! The clock is used world-wide as a standard.

The irony thus lies in the fact, that a geometric length dictates the measurement of time and the measurement of time again determines the measurement of length - poor science!

How does one free oneself from a capital closed loop conclusion? Why and how do signal transmission times or clocks actually depend on the gravitation? Who once got stuck in a dead end, knows that he only can get out in the reverse gear.
A possible way goes back to the roots of classical physics and to the theory of objectivity in the 1st part of the book, which is free from the limits of a subjective and relativistic observer standpoint. That isn't a dead end and in addition explains, why all atomic clocks react sensitive to magnetic fields (magnetostriction) and what these fields have to do with gravity (see chap. 6.9)!

Today's clocks are so exact, that even differences between a clock stationed on a mountain and one at sea-level can be recorded. Even more clearly was the depending on gravitation determined at an atomic clock, which was shot in a rocket 10000 kilometres high into space. The result of the analysis without doubt was, that the clock in that case doesn't „tick" correctly anymore.
But what does theoretical physics say about it? It claims, here the „red shift" has been measured; it thus concerns a confirmation of the special theory of relativity. But since it concerns a clock experiment and not a light signal, it clearly contradicts this theory, which isn't able to describe any gravitational effect at all, as is well-known. For this case in the spheres of theoretical physics one helps oneself with the general theory of relativity, with which actually only would be proven, that the two theories from the legacy of Einstein completely incompatible contradict each other. We come to the following conclusion:

Whoever gives details about length or time, is obliged to also indicate the reference system.

He also has to inform where his laboratory is situated and with which devices he measures!

With the conclusion also the discussion would be opened. Throughout the last four chapters a main idea can be found. It should be worth, to again think about the brought forward arguments and to dare a comparison with text books.
In the text books there doesn't exist such a thing as an oscillating interaction. Here no answer is found to the question, why the solar system isn't hurled out of the galaxy as a result of the high velocity, why the inside of the earth is hot, how the geomagnetism is formed, why the continents drift and why the ocean floor nowhere is older than 200 million years, as samples from the ocean floor prove<i>. How would you answer these central questions?

<i>: Kendrick Frazier: Das Sonnensystem, Time-Life Bucher, Amsterdam (1991).

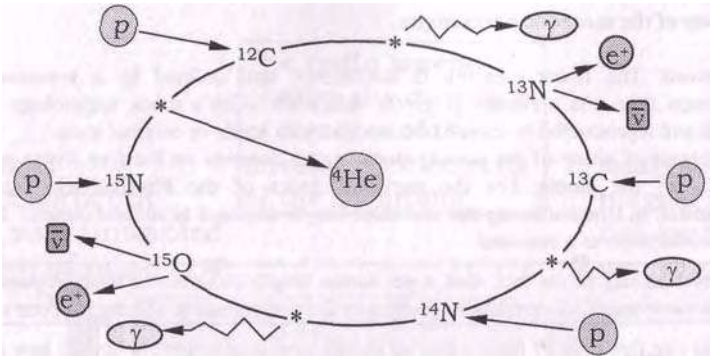

Fig. 13.8: The Bethe-Weizsacker cycle (concerning the sun's fire)
(meaning of: ^{12}C = carbon nucleus, ^{4}He = helium nucl., γ = gamma quant, ^{14}N = nitrogen nucleus, p = proton, e^{+} = positron, ν= anti neutrino, ^{16}O = oxygen nucleus

Fig. 13.9: The top of the unfinished obelisk in Assuan<i>

<i>: Hermann Wild: Technologien von gestern, Chancen fur morgen, Jupiter-Verlag Bern (1996), ISBN 3-906571-13-0

13.8 Discussion of the cosmological insights

The numerous models which are offered, of a geodynamo, an iron core, of assumed zones of subduction and of plate tectonics may be helpful for the explanation of individual isolated phenomena. But they physically don't give a uniform picture and partly contradict each other.

Lord Kelvin had calculated a period of shining of 5000 years on the basis of a sun consisting of coal[<i>]. The german physicist Hermann von Helmholtz landed at 15 million years, in which case the sun yearly should shrink for 100 meters. He already assumed a temperature of 15 million degrees centigrade, as also the Bethe-Weizsacker cycle has as a prerequisite, which according to today's concept should describe the process of nuclear fusion taking place in the inside of the sun (fig. 13.8). The only thing is that this extreme temperature is completely incompatible with the high density in the core of the sun! There are more than good reasons to assume the opposite of the widespread textbook opinion and assume that the core of the sun is cooled by the collected neutrinos in the same manner as the inner core of the earth and that superconducting areas are formed, which powerful fields even cause the protuberances on the surface of the sun. Since in the sun no measurement is possible, with which a model could be verified or disproved, terrestrial arguments naturally suggest themselves. Here the pieces of evidence for the growth of the earth can be taken in the hand and photographed. We already have discussed some facts. But there are found a multitude of other ones, for instance from the domain of archaeology, for which text books of today until now as well provide no explanation.

Possibly the stones and monoliths weighing several tons, as they were used for prehistoric buildings, should be linked with the growth of the earth. If the earth was smaller at the time they were build, then they perhaps by no means were as heavy as today!
Then the stones for reason of the smaller density in addition were softer and with that easier to work on. Dr. Wild points to the building technical peculiarity, that the stones formed like cushions originally must have been soft. He proves with the photograph of the top of the unfinished obelisk in Assuan (fig. 13.9), that the traces of working stem from a spatula in a plastic mass.
Also the perfect fitting of the stones used for the building of the pyramids can only be explained in this way. In the joints not even a knife point can be inserted!

If even stones in the course of time increase in density and hardness, then it is easier for us to comprehend, how small rivers in past time could dig large deep valleys in the earth's crust, then we perhaps also understand, why very old bones today are petrified[<ii>]. It is obvious, that also bones in the course of time increase in density and hardness. Even if science should succeed in breeding living dinosaurs, then their chance to survive in spite of that would be equal to zero, because the dinos would collapse under their weight of their own of several tons. Their bones would be much too thin and brittle for their weight of today!

<i>: Kendrick Frazier: Das Sonnensystem, Time-Life Bucher, Amsterdam (1991)
<ii>: The indication to petrified bones stems from a participant of the seminar.

25-07-1996:	Assistant head of government department Acceptance of the common standpoint.
11-12-1996:	European parliament Resolution of the guideline.
	commission Statement concerning proposals of change of the european parliament.
19-12-1996:	Assistant head of government department Resolution of the guideline.
19-02-1997:	Coming into effect of the guideline Publication in the official paper of the EC.
19-02-1999:	Period of translation of two years
	Reduction of the threshold values for current consumers:
19-02-1997:	to 40 million kWh (opening of the market 23%)
19-02-2000:	to 20 million kWh (opening of the market 28%)
19-02-2003:	to 9 million kWh (opening of the market 33%)
until 2006:	„Anti imbalance clause" A nine years period of transition to preserve equal opportunities in the competition. Report of the commission.
19-02-2006:	Further stage of the liberalization European commission tests by means of the made experiences, if the current market should be opened further.

Fig. 14.1: Timetable of the EC single market guideline electricity[i]

[i]: Grawe, S. Thiele: Vorbereitung der Stromversorger auf den Wettbewerbsmarkt, ATW Atomwirtschaft-Atomtechnik 43. Jg. 1998, Heft 1, S. 10 - 13

14. The way towards free energy

Can energy actually be produced? No energy supply enterprise is capable to do that. Fact is, that energy only is converted and not produced. For that the available resources on earth are tapped and brought into a utilizable form of energy. As different the conversion processes may be, finally always heat is formed. We thus gradually burn the globe, on which we live. How long can something like that go right?

Science gives all-clear: „stock of energy is sufficient for the next 100 years. Newest calculations disprove the fear of a scarcity of energy on earth. There exist large stocks of coal and oil"[i].

But what are 100 years compared to the age of the earth? How will our descendants judge our thinking and acting? They will condemn it and curse us, that much is clear already today.

We have an obligation to preserve the environment, and we only will be able to fulfil it, if we look to nature, how it covers its need of energy, if we finally understand and meaningfully copy nature.

We still are miles away of the goal.

14.1 The liberalization of the energy markets

It is important in the interest of a member of the executive that the stock of energy doesn't draw to an end, as long as he carries the responsibility for the enterprise of the economy of energy. The interest in the environment and the environmentalists for obvious reasons is less distinct. The problems are more of a commercial kind. Concerning that an actual example is given.

A special kind of problem is the meanwhile Europe wide valid decree of the EU concerning the liberalization of the energy markets (fig. 14.1). The list of the consequences starts with the fact, that the concluded licence contracts for power supply between energy supply enterprises and the communities, which are valid till 1997, are only wastepaper. Every customer of electricity as of now can conclude an individual contract with every "producer of electricity".

So an environmentally aware Black Forest person decides to obtain his power from a wind power station, which is situated in Denmark. That truly sounds very liberal. But how should that function, if there is no wind at all in Denmark for a week, or the connection is interrupted by a flash of lightning? The windmill further delivers power and the runner writes its bill truly believing, its power has arrived. The consumer then reads the bill at candlelight and puts with understandable anger his claim for compensation together. Pointing to the fact that such difficulties can be solved by book-keeping, the consumer again is calmed down; but that the not by contract obtained power will cost him dear, is another story.

<i>: Illustrierte Wissenschaft Nr. 6, Juni 1996, page 48-51.

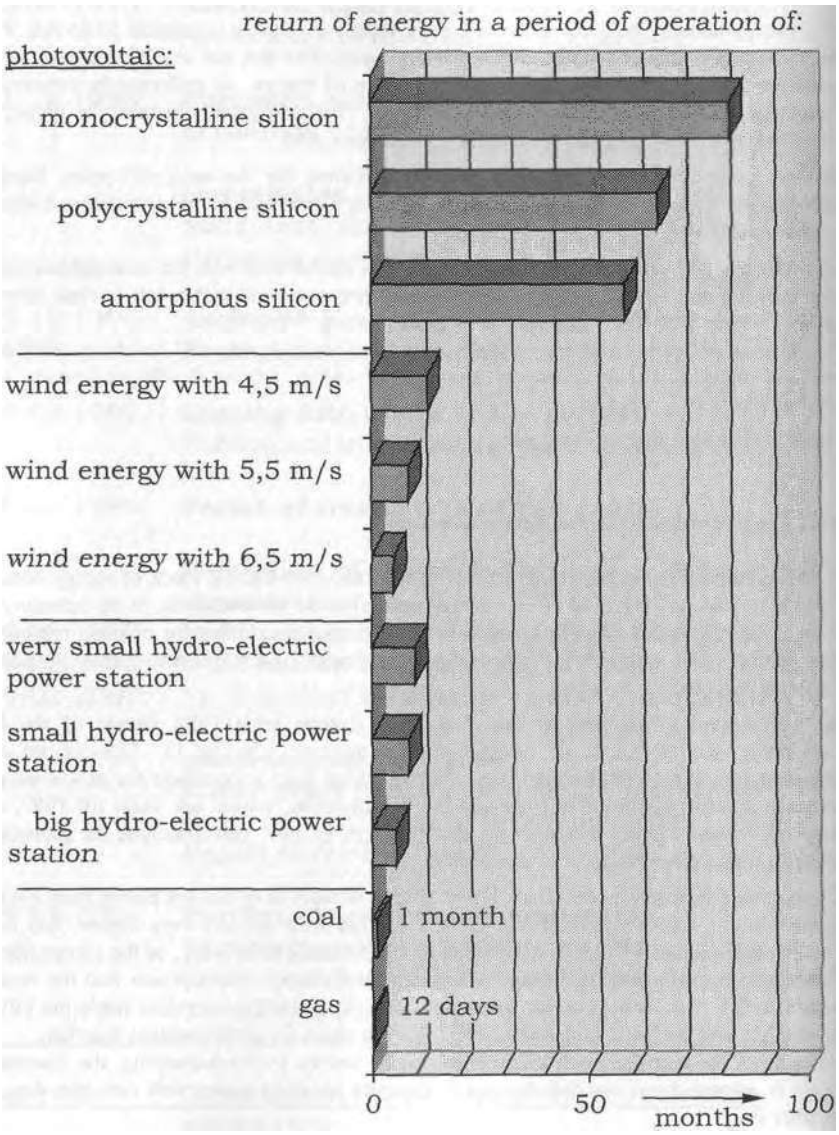

Fig. 14.2: Average time of paying for itself for the spent energy (return of energy)

14.2 The consequences of the liberalization

With the EU decree the monopoly only has shifted towards the runners of the distribution nets, after all only one net is present. Competition however would require at least two nets, thus a doubling of all house connections and all high-tension pylons, but that fortunately is unrealistic.

To prevent fleecing of the consumers by means of the net monopoly, politics introduces in the place of the free market economy dirigisme and plan economy with the well-known concomitants: no-one will look after the existing nets, no-one feels responsible anymore, because after all they have become public good by decree. One thus lets the pylons rot slowly and repairs only in emergencies. This possible development really can't have been the good intention of the EU.

In the next few years we however will be able to observe for the producers of energy exactly the development, which the EU-commissioners have imagined: Total competition contest, price war and a struggle for power to survive economically. A chance only has the nuclear power station, which gets rid of its refuse cheaper and if need be even illegally or which lives of indirect state subsidies, or the brown coal power station, which increases its efficiency at night, when no-one watches, by switching off the expensive filters.

The first power stations, which are selected out by the liberalized energy market, are the hydro-electric power stations which stand closest to nature. They simply are too small and too intensive of personnel, to be able to survive.

Gas turbine power stations, which deliver the power for half the price, than are ranking first. Then there is no place for regenerative systems anymore.

Solar energy, how many roofs a supporting program may have, stays a toy supported by the state. For a photovoltaic installation the „Return of Invest" still lies at more than 80 years, whereas is reckoned with a theoretical life of 20 years. In practical use on the other hand photovoltaic installations occasionally already have failed after seven years, after the photocells had gone blind. In this case not even can be talked of an ecologic energy, because the return of energy lies still above that. The supposed Idealist who spoils his roof with photovoltaic to reassure his ecologic conscience, would have spared the environment more, if he had covered his need of power from the socket, because already the production of the photovoltaic installation gobbles up more energy than can be produced with it. With regard to the environmental compatibility the ecologic balance sheet of a power station is attached a central importance (fig. 14.2).

With the law of feeding in power the state intervenes dirigiste, supposedly to protest the consumers. With this law the state orders, that not it, but the energy supply enterprises have to take the subsidizing of the regenerative energy, that they have to take over the power delivered at the inappropriate time in exactly so less suitable amounts at a price, which exceeds the market value by a factor of two and for falling prices of power even by a factor of four. With the law the politicians very fast and without agreement of the effected enterprises have shifted the „black Peter" further to these, which will get problems to preserve their competitiveness in the international comparison with the subsidy duty. It can't have been the intention of the EU-commissioners, that on a national level the price of power increases to finance some energy technical playground.

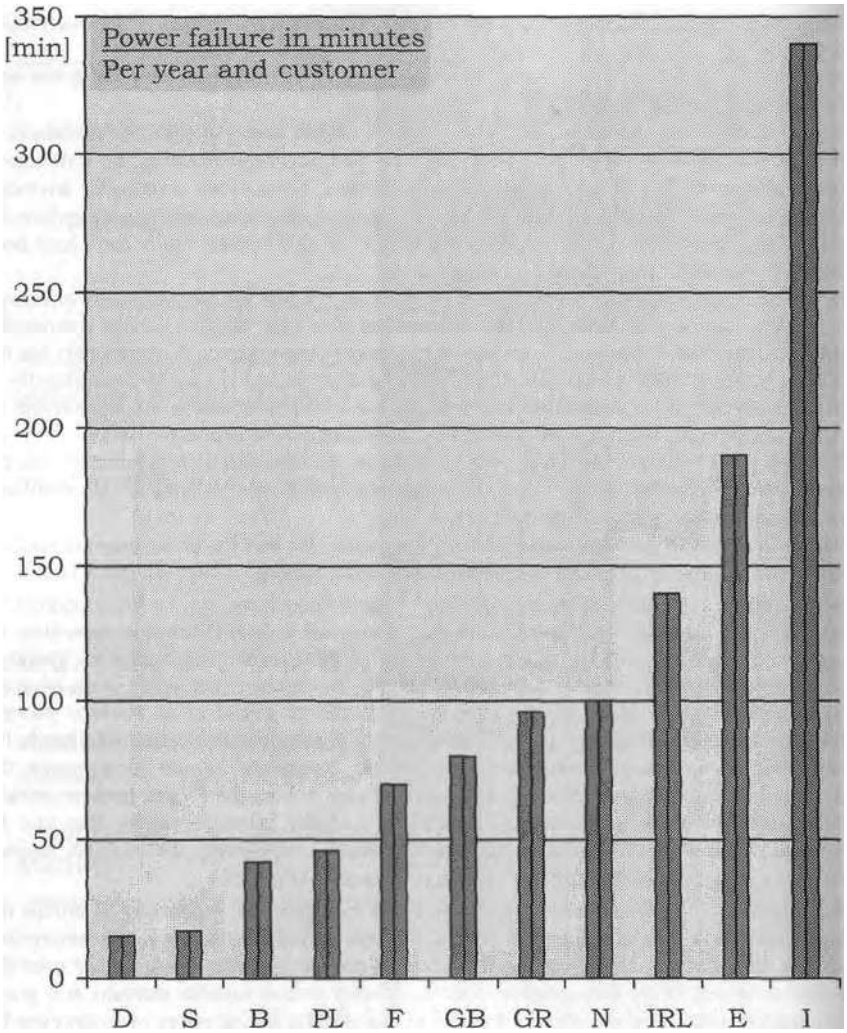

Fig. 14.3: Power interruption and not being at disposal

<i>: ETG, Energietechnische Gesellschaft im VDE: Qualitat der Stromversorgung, Dialog Nr. 1, Jan./Feb. 1998, S. 21

14.3 The chances of the wind energy

Meanwhile, as a result of the law of feeding in power, no longer the politicians but the energy suppliers are the ones, who around the North Sea look out of the window every day with the worry, some wind could blow and the mills could turn, because every kilowatt hour of a windmill must be subsidized strongly. Every windless day however reduces the power bill, with that helps the consumer and raises the chances of competition of our economy.
If it should be neglected, to tip over the law of feeding in power in due time with help of the EU, then the consumers will get their power in future abroad, then at the Preussen Elektra, damaged most by wind energy, as the first the lights will go out, then economic power and prosperity in Germany in future are dictated from abroad.
But if the law is dropped, then with that the duty to subsidize the regenerative energy carriers drops back to the state. Now all tax payers may foot the bill, even those, who don't use any power at all. The well-known Justice of subsidy" comes into effect.

Without support by the state only few types of power stations will be left behind. In addition are overcapacities being reduced, because they only cost money. But both is at the expense of the reliability of the delivering of energy and of the safety of the consumer. We owe the high stability of our network of today the large number of most different providers of power, which cover the basic load up to the peak load according to their suitability (fig. 14.3). But let us not talk of the golden past. The network after all isn't able to store power. From that follows, that without redundancy and without free power station capacities which can be activated at any time a short overload is sufficient, to let the network collapse.
Once the EU guideline concerning the liberalization of the energy markets is in effect, when persons selling power wend their way from front door to front door, to convince the housewives to obtain the power from them and not from other hawkers, when the power stations only live of stock and the depreciated overhead power lines only are entered in the hooks with the scrap value, then we should be dressed warmly and always have ready sufficient candles <i>.

14.4 The chances of being self-sufficient concerning energy

The only way out is the decentralized energy supply, the getting out of the large energy union and the way towards being self-sufficient. The argument sounds convincing in view of missing alternatives. But now it no longer is possible to plug the plug in the socket and then switch on whenever it pleases us. First it has to be calculated, if the windmill or the installation for solar energy supplies sufficient power or if a cold meal should be made. In contrast to today's consumer habits the runners of such installations will have to adapt their need of energy to the prevailing weather conditions.

<i>: A baby-Boom, like after the big power failure in New York, would be the smaller evil. The inhabitants and shopkeepers in the New Zealand metropolis Auckland will long and frightened remember the power failure in february 1998, which lasted weeks and was a result of not carried out maintenance works of high-tension pylons.

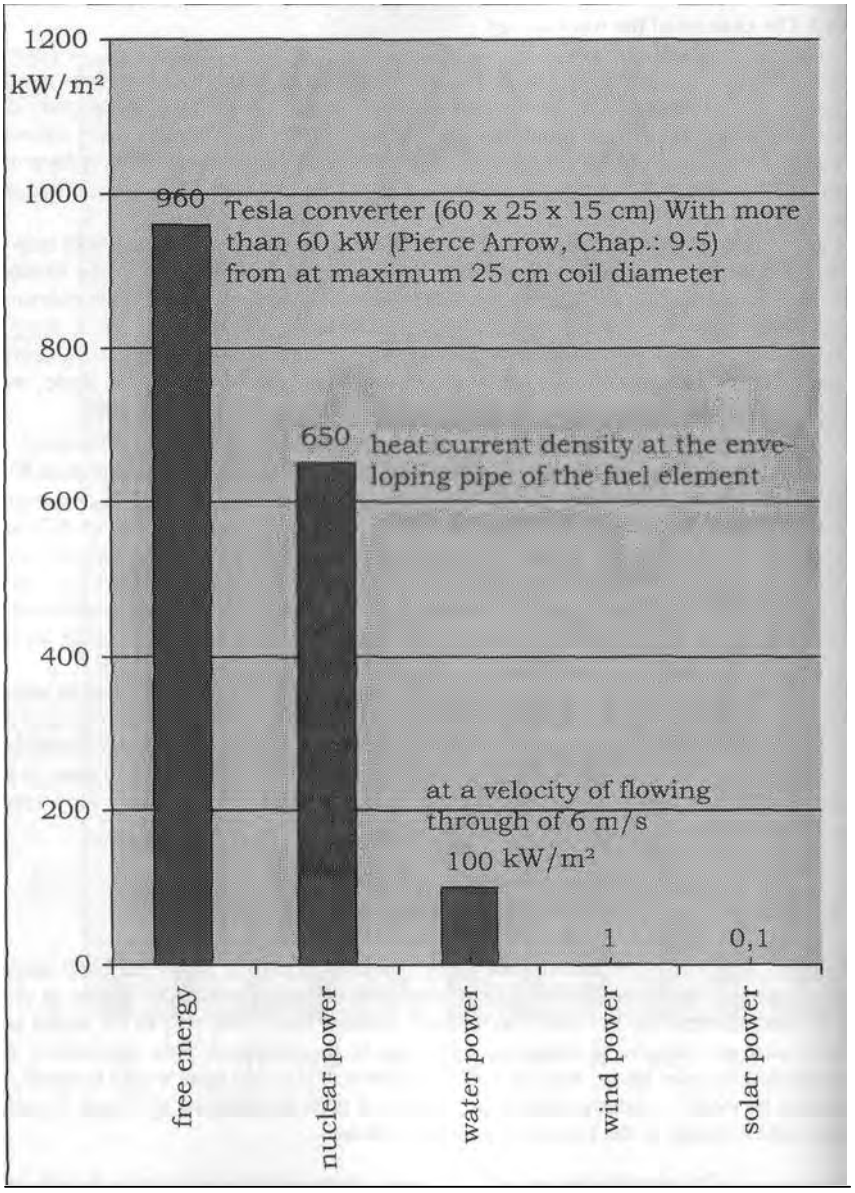

Fig. 14.4: At maximum obtainable power density of different carriers of energy

<i>: ETZ, Heft 19/1995, S. 40

Block heating power stations, propagated as stand-alone solution for people being self-sufficient, deliver power and heat at the same time. But if I don't need any heat on a hot summer day, then also no power is available or I uselessly heat into the open. For that one may leave all electric consumers switched on in winter, even if they aren't used at all, only to get the hut warm. Does a stand-alone solution look like that?

The situation truly is demotivating. Even the energy suppliers meanwhile may have realized that the energy politic way is a dead end. But for real alternatives in energy technology the pressure by suffering still doesn't seem to be big enough.
The intention to learn of nature is present in principle. The solar fire one wants to kindle on earth in a fusion oven, but the oven does not as it should.
Obviously the sun functions completely different, as physics imagines today (see fig. 13.8).
Before copying stands understanding, and in there seems to be a hitch!

14.5 The space energy technology of nature

Also nature needs energy, even very much. But it hasn't got any connecting pieces for tanking and no oven lid to fill in the fuel, it doesn't know our ecologically harmful combustion technology and environment destroying explosion technology at all. Nature rather works with the opposite, with implosion and fusion.
The sun, we have derived, materializes the matter which it needs for growing and shining from the neutrino field. The earth and other planets imitate the sun.
The concept is simple and convincing. The source of energy lies in the air and mustn't be dragged about in tanks. Collected and materialized is just as much, as is needed at the moment. In that way the resource energy is spared. In addition there can be done without any sort of storing. In addition it can show a substantially higher power density, than all today known and used energy carriers (fig. 14.4).
Such a source of energy solves all described energy problems at once. Nature wouldn't be as we know it, if it wouldn't have this ideal energy, also called „free energy". The balance sheet of energy alone brings it to light, because as a rule it doesn't work out for biological systems. Often more energy is released than is taken up by the food.
In that case some migratory birds materially seen should have completely used themselves up before reaching their destination, if the energy necessary for the flight would be of purely material nature. From a concrete example the following is reported[<i>]: „migratory birds have - depending on kind - a maximum range velocity between 24 and 83 km/h and at their Atlantic flights no opportunity for an intermediate landing. They are thousands of kilometres on the way and hardly lose weight. For instance an Albatross with a body length of up to 1.20 meters and a wing span of up to 3.50 meters uses per kilometre only 8.5 grams of weight at a non-stop flight. How is that possible without additional supply of energy?"

<i>: K. E. Rathgeb: Wie man die freie Energie anzapft: Vogel machen es uns vor, Raum & Zeit 79/96, S. 74

Fig. 14.6: Freiherr von Reichenbach (76 years old)

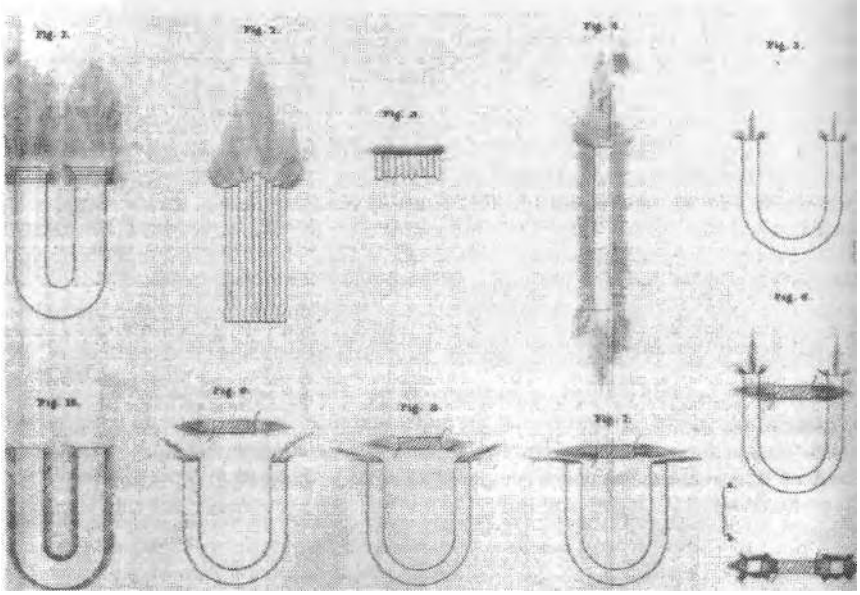

Fig. 14.7: Odic emanations of magnets according to pictures of
sensitives .[i]

<i>: H.-P. Thietz: Tatort Erde, VAP (1996), ISBN 3-922367-62-3, Seite 13 und 15

14.6 The gap in the energy balance of man

Even man appears to tap an additional source of energy, because for reason of scientific tests with recruits these over longer periods of time are able to physically release more than twice the amount of energy they take of calories with the food. Obviously living beings don't rely on one source of energy alone. Possibly the taking up of food predominantly serves the metabolism, and the energy aspect plays only a secondary role.
This interpretation at least would be obvious, since we scoff several times a day, sort the necessary and useful building-materials out and hand over the rest to the purifying plant and nature, where some bacteria and organisms search the sorted out again for useful things. "Food chain" we call this kind of building-material trade.
If the whole had anything to do with energy or with a „ combustion process without fire ", then no animal nor any human being could do without the taking up of food for longer periods of time. But Franciscus of Assisi could fast 90 days, as is handed down to us [ii]. There exist numerous examples, which reach into the time of today.

The mitochondria, the energy centres of each cell, by no means are capable of the "combustion process", which man ascribes to them. Here in all probability a taking up of space energy independent of food takes place.

A research scientist only has to look at nature with open eyes, what unfortunately happens rarer and rarer, because the laboratory scientist always is troubled, to keep the disturbing factor „nature " away from the experiments.

14.7 Carl Freiherr von Reichenbach

In this context no-one can go past two natural scientists: Carl Freiherr von Reichenbach (1780-1869) and Dr. Wilhelm Reich (1897-1957).

Reichenbach called the by him investigated life energy „ Od-energy " in the style of the Teutonic God Odin. He worked with test persons, who could perceive actually invisible light phenomena and worked out the special properties of this Od-energy field with the "sensitives", as he called them.

A quotation from his work shows however that the knowledge about the life energy must be a lot older[iii] than his own discoveries: „On paintings saints often are shown with a ring-like aureole around their head, something I before this would have dismissed as a pure figment of imagination. But it was shown that this glowing ring actually can be perceived by the sensitives as an Od-phenomenon and so the aureole obviously can be traced back to real impressions of particularly sensitive persons."

Reichenbach also found out that water has a big endeavour to take up this Od-energy or in the language of the present day, to absorb the field energy. This circumstance we find confirmed in technology, since water absorbs high-frequency waves, whereas an insulator or a vacuum lets them pass through. But without vortex physics it however remains entirely unclarified, why!

<ii>: H.-P. Thietz: Tatort Erde, VAP (1996), ISBN 3-922367-62-3, page 110
<iii>: H.-P. Thietz: Tatort Erde, VAP (1996), ISBN 3-922367-62-3, page 16

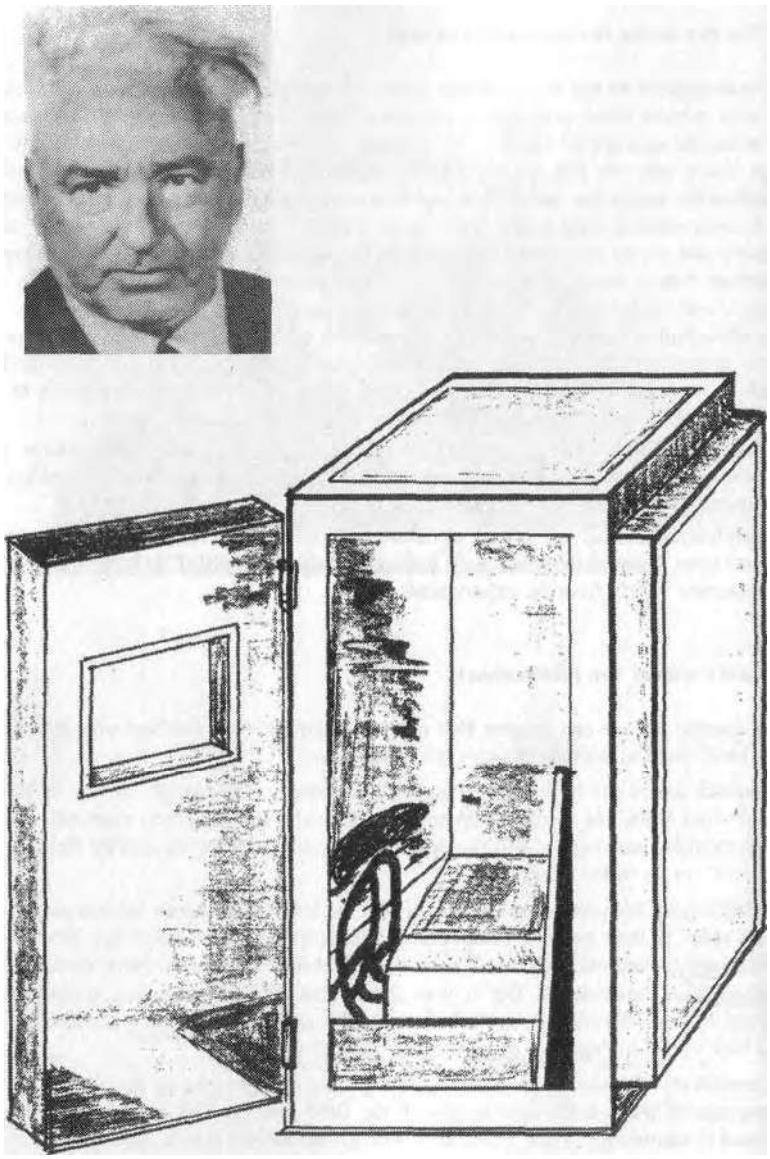

Fig. 14.8: Wilhelm Reich and the model of an Orgon accumulator
for applications of the whole body.[i]

[i]: taken from: H.-P. Thietz: Tatort Erde, VAP (1996), ISBN 3-922367-62-3, pages 38 and 89.

14.8 Cold fusion and Genesis

Chronologically the doctor and psychologist Wilhelm Reich followed in the footprints of Reichenbach. He merely altered the name for Od and spoke of Orgon. His speciality was the accumulation of Orgon radiation, I would say the focussing of neutrino radiation. Actually the properties like e.g. the missing possibility to shield Od, Orgon and the neutrinos are identical, so that we can proceed from assumption, that it also concerns the same physically.

We already talked about Wilhelm Reich (part 1, chapter 9.2). He could show that the measurable temperature in a closed box, constructed like an „Orgon accumulator", is increased in a mysterious manner without supply of energy from the outside. He even could prove, that this energy actually concerns the sought-for life energy, as he observed the creation of life in the laboratory under the microscope. For that he cooked muscle fibres, vegetables or other cells so long until the cell structure had been destroyed entirely. But from the educts entirely by itself new living beings, like protozoa or algae, were formed[<i>].

Reich at his microscope actually followed the transition of dead to living matter. What is of interest here, at first only is the energy technical aspect of this conversion. Later we will occupy us with the at the same time occurring information technical aspect.

Worth mentioning seems to me the experiment with the „silly" chickens, which have at their disposal astonishing abilities besides the laying of eggs[<ii>].

The test chickens were handed chicken food, from which to a large extent all calcium had been extracted. But the chickens showed themselves unimpressed and further laid keenly their eggs. The experimenters were surprised, where the chickens actually got the lime for the egg shells. How solves such a chicken the problem of raw materials? For that further materials were extracted from the food and look, at the removing of silicon the laying of eggs was over. The experiment actually only allows the conclusion, that the "stupid" chicken is capable of a cold fusion, that it itself „produces" the necessary calcium from silicon presumably by using carbon. Every alchemist here has to go pale with envy. But what says the research scientist of fusion to that, who actually should know, how fusion functions? After all he is paid for it by the tax payer! The chicken uses the fusion already today and the other living beings presumably also, but for that energy is needed and the balance sheet should work out!

The neutrino radiation therefore has to be factored into the balance sheet of energy. If the balance sheet then works out, it could be proven with that, that here neutrino energy is put to use. In addition the process of the conversion of neutrinos has to be investigated, which surely has something to do with the frequency and the wavelength of the radiation. After all a child has cells exactly as big as an adult. It only has less cells! So that an interaction can occur, the cell size has to fit in with the wavelength, which obviously is very small, presumably in the range of the radioactive radiation, with which circumstance the biological incompatibility with this electromagnetic wave would be explicable.

<i>: H.-P. Thietz: Tatort Erde, VAP (1996), ISBN 3-922367-62-3, S. 39

<ii>: Louis Kervran: Biological Transmutations, s.a. J. Heinzerling: Energie, S.278

1. Primary reaction
   (light reaction in the centre of reaction):

   ring-like vortices/neutrinos are being collected
   electrons are formed
   energy is produced
   e^- is attracted by the water dipole
   water molecule is being splitted (photolysis):

2. Secondary reaction (dark reaction):

   carbon dioxide is reduced with the hydrogen splitted off from the water to carbohydrate

Reaction equation of photosynthesis:

	6 mol CO_2	(carbon dioxide)
+	12 mol H_2O	(water)
+	675 Kcal	(vortex energy, light)
	1 mol $C_6H_{12}O_6$	(glucose)
+	6 mol O_2	(oxygen)
+	6 mol H_2O	(water)

Fig. 14.9: Concerning photosynthesis

14.9 Photosynthesis

The materialization of free electrons is a prerequisite to start the photosynthesis. The normally used explanation, the free electron necessary for the splitting of the water molecule was knocked out an atom by light, doesn't seem to be correct, after until now all attempts of a technical realization according to this model concept have failed. At the photosynthesis the plants obviously help themselves with the neutrino radiation, which according to an estimation of today with 66 billion particles per second and per square centimetre might be more than sufficient for a green earth.

If we put a seed in a water glass, then a plant grows from it and forms small leaves, which get bigger and bigger. A wonder of nature, we say. Where does it actually get its building-materials? From the water or from the air? Necessarily the plant obviously produces a part of the matter itself!

Experts think they have understood the process of photosynthesis: Take light and water and carbon dioxide and handicraft from that sugar and oxygen. But from where does the plant take the necessary energy for the rebuilding and the splitting of the water molecule, the photolyse? The taken up solar energy hardly is sufficient for that, especially since the plants only absorb about 1% of the photosynthetic utilizable sunlight incident on earth[i]. By means of reception molecules, which look like small antennas, pigments less than 30 nm in diameter, such is the level of knowledge, the sunlight is collected and led into a photochemical centre of reaction. Here the reaction should take place, provided that an electron set free by the light jumps into the middle of the centre of reaction. But exactly this favour the electron doesn't make the research scientists, who want to imitate the process. Copying nature still doesn't succeed.

The mistake presumably lies in the circumstance that the light doesn't set free any electron at all. The electron actually first of all is produced in the centre of reaction. By means of the antennas a neutrino vortex is collected, which at first occupies the entire space, to afterwards contract to an electron, which as a result automatically is centred in the centre of reaction.
In the process of materialization at the same time the necessary energy of the process is formed. The reaction equation after all also has to work out energetically, because the plants doing so get neither hot nor cold (fig. 14.9).
Because curiously the light reaction even can be observed in the dark[ii], one could be inclined to in principle call into question the influence of light on the photosynthesis. But such an influence nevertheless seems to be present, after all does a plant react on the irradiation of light and changes its spectrum of absorption through its colour. But it for sure is another influence and not the one, which one attributes the green plants today! It would be important to finally understand the way of functioning. The plants and particularly the algae are the ones, which actually first have made possible life on this planet with the photosynthesis, the most original form of a production of matter and energy.

<i>: Luttge, U. u.a.: Botanik, VCH, Weinheim (1994) ISBN 3-527-30031-7, S. 136
<ii>: Luttge, U. u.a.: Botanik, VCH, Weinheim (1994) ISBN 3-527-30031-7, S. 126

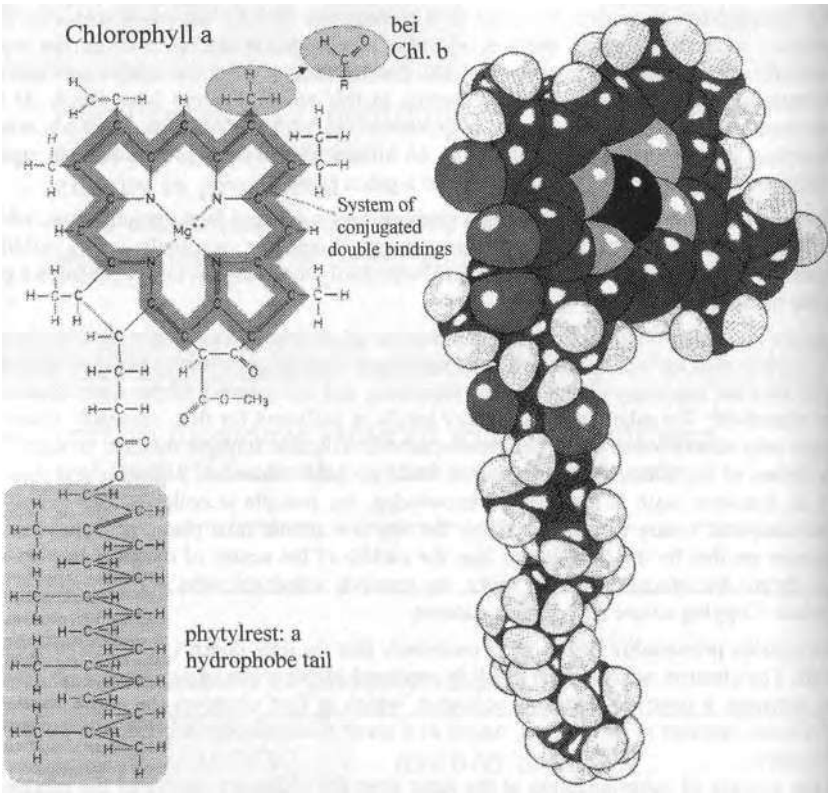

Fig. 14.10: Formula of structure and spatial model of the photosynthesis pigment chlorophyll.<i>

<i>: Luttge, U.et al.: Botanik, VCH, Weinheim (1994) ISBN 3-527-30031-7, p. 118

14.10 How nature materializes

The structure of the receiver antenna allows us a deeper insight into the manner, how free energy is tapped during the photosynthesis. For the dimensions determining the frequency of the photosynthesis pigments, as the antennas are called, we have to go down to the molecular structure. Fig. 14.10 shows the formula of structure and next to it also the spatial model of the pigment chlorophyll[i].

Two points point at the function for free energy conversion. On the one hand is situated in the centre of the molecule a double positive ionised Mg atom, surrounded by four nitrogen atoms and a carbon ring consisting of 20 atoms, from which arises a polarization of the entire molecule. This in addition is oscillating because the electron cloud of the enveloping electrons, which hold the molecule together, perform swirl oscillations depending on the temperature. With that chlorophyll is able to go into resonance with oscillating neutrinos.
A role play the unipolar field configuration and the effect of resonance of the molecular oscillation of its own forming as a result of the polarization. A further role in addition seems to play the spatial structure.

The model of the ,.receiver antenna" chlorophyll taken out of a textbook[i] and shown in fig. 14.10, consists of a stalk and a spirally wound head, which resembles a Lituus or crook, which Etruscan and Roman Augurs have taken in the hands for land surveying, a precursor of the crosier (see fig. 16.10). This again has the form of a Tesla coil and that, as already derived, is able to withdraw rotational energy from the collected neutrinos (chapter 9.8). Doing so free electrons are materialized, and these then start the process of photosynthesis. An explanation concerning the way of functioning of the antenna pigments here for the first time is getting available.
By the way also the mitochondria, which form the energy centres in every cell, have as well the form of a Tesla coil. Whoever wants to understand the energy economy of a cell or the photosynthesis first should occupy himself with the Tesla coil (chapter 9.8).

The open question, how land surveying should be possible with a Tesla coil, we at first still have to shelve, because in this chapter it concerns the way towards free energy and the chance to learn of nature. Examples to be looked at are on the one hand the core of fusion in the inside of the earth and on the other hand the humus layer on the surface of the earth, which has been materialized in the course of time with the help of photo-synthesis.

The goal seems to be worth striving for. If we in the first place have learned to produce energy exactly like nature, then we'll further try to produce matter purposeful, with which ageold alchemist dreams could be fulfilled. We wouldn't need to scrape and to search in some mines any longer. We would materialize the products without refuse, naturally and just for the environment, direct in the final form. I admit that at present it sounds pretty futuristic.

With another example, the lightning and particularly the ball-lightning, the collection concerning the use of free energy in nature shall be completed.

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i>: U. Luttge, M. Kluge, G. Bauer: Botanik, 2. Aufl.- Weinheim, VCH (1994) ISBN 3-527-30031-7, S. 118

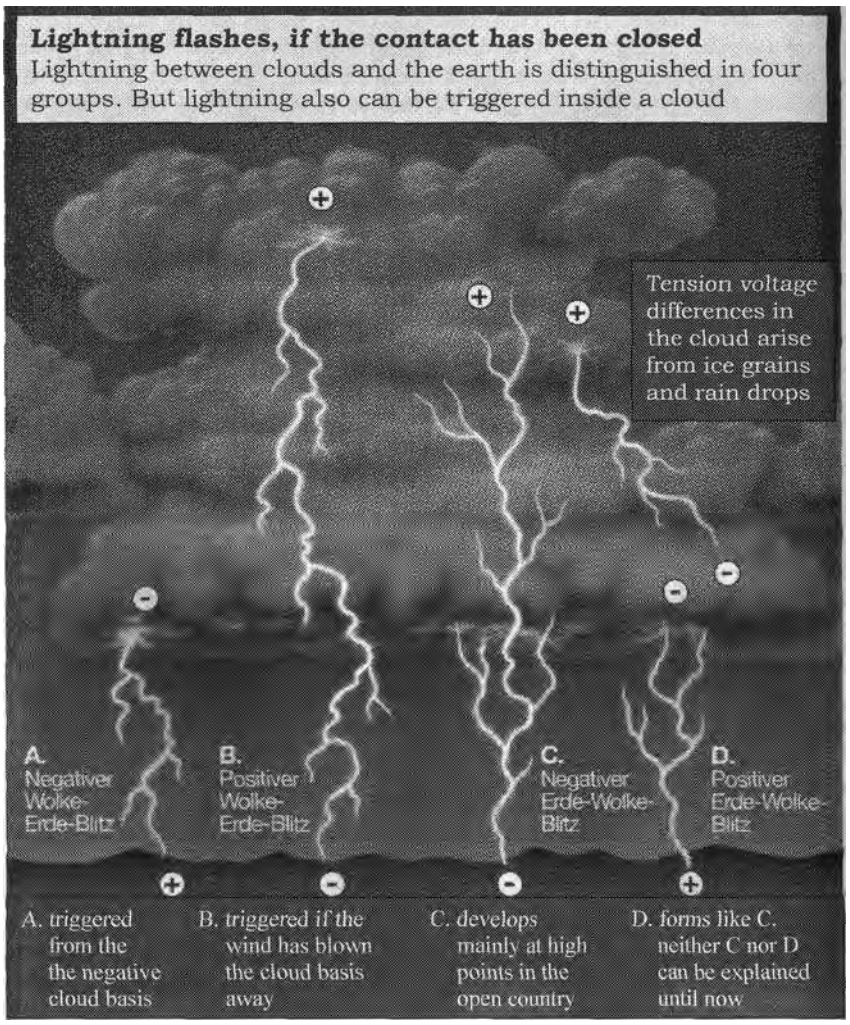

Fig. 14.11: Concerning lightning.<i>

<i>: taken out of: Illustrierte Wissenschaft Nr. 8, August 1995, Das unverstandene Phanomen der Blitze, S. 13

14.11 Lightning

Lightning is a spectacle of nature just as imposing as unsolved. It concerns an electric process of discharge, in which to the amazement of all experts arrive for several powers of ten more charge carriers at the surface of the earth, than hefore were contained in the cloud! Furthermore unsolved is, why lightning glows. Let us start with the open question for the difference of potential necessary so that the air is ionised and a lightning channel is formed.

If at first the electric tension voltage of 200,000 volts between the surface of the earth and a height of 10 kilometres is available, which according to our calculations results from the rotation of the earth and the magnetism of the earth (fig. 11.8). Another source of tension voltage is not known. By air movement and supposed processes inside a cloud locally an additional accumulation of charge carriers may occur, so that in the case of a thunderstorm the by Tesla assumed, twice as big value doesn't seem unrealistic[<i>].
On the other hand a tension voltage between 4,000 and 10,000 volts is necessary so that a blow can occur for an air gap of one centimetre depending on the atmospheric humidity[<ii>]. Linearly projected the thunderstorm cloud theoretically should hover just one meter above the earth if there is lightning.
Here somehow a huge gap gapes between theory and practice!

At the latest at the spikes, the mysterious lightning, which strike out of a thunderstorm cloud upwards in the direction of the ionosphere and the still more mysterious ball-lightning it has to get clear, that the actual source of tension voltage of a lightning by no means is known. Without knowledge about the cause we'll never understand lightning.

The potential vortex theory offers an useful approach, according to which the necessary difference of potential is formed from a formation of vortices[<iii>]. The vortex again, as damping term in the wave equation, occurs as a result of intense sun irradiation. That explains why lightning always strike from the part of a cloud, which is the darkest, where the most sunlight is absorbed and the damping is the largest.

The possible formation of ice in a lightning channel is a further confirmation for the correctness of the vortex explanation. After all it has been derived that contracting potential vortices withdraw heat in principle (fig. 12.8).

But now we also want to know from this efficient theory, why photons and electrons are formed during the lightning and where they come from. Here obviously energy is formed by means of materializing of vortex particles.

<i>: R. L. Clark: Tesla Scalar Wave Systems, The Earth as a Capacitor, The Fantastic Inventions of Nikola Tesla, ISBN 0-932813-19-4, S. 265

<ii>: Karl Kupfmuller: Einfuhrung in die theoretische Elektrotechnik, Springer-Verlag Berlin, 12. Auflage 1988, ISBN 3-540-18403-1, S. 221

<iii>: K. Meyl: Potential vortices, Part 1: Discussion contributions to the natural scientific interpretation and concerning the physical-technical usage, basing on a mathematical calculation of newly discovered hydrotic vortices, (only in german) INDEL GmbH, Verlagsabteilung, Villingen-Schwenningen 1990.

Fig. 14.12: Contemporary representation, how 1753 lightning
research scientist Prof. Richmann is struck deadly by ball-lightning in his laboratory.[<i>]

<i>: Illustrierte Wissenschaft Nr. 8, August 1995: Das unverstandene Phanomen der Blitze, page 13

I proceed from the assumption that lightning collects and converts neutrinos. The process corresponds to the one at the sun, but on a smaller scale and only for a very short time. The lightning channel is polarized by the charge carriers. Change of temperature and field lead to a spatial oscillation, which by the way also functions as a source of sound, as anyone can hear. Taken both together lightning, seen from the outside, becomes an unipolar resonator, which is capable to attract neutrinos and to go into resonance with them. Now the predominant part is converted into electrons, because also the air molecules and air ions in the lightning channel belong to the world of matter. But it can't be avoided that a small part of antiparticles is formed, which then annihilate with particles of matter under emission of radiation. Doing so photons are emitted and lightning glows, as anyone can see!

14.12 Ball-lightning

If in the case of lightning there still exist excuses, the difference of potential preferably is traced back to neither understandable nor measurable processes inside a cloud, then at the latest in the case of ball-lightning most experts are at their wits end. Only for very simple natures explanations circulate in the direction that here for instance the organic remnants of a bird struck by lightning are burnt off.

Actually ball-lightning is observed very seldom. It is a ball flashing with reddish till blue-white colour. Its diameter lies between 10 and 50 centimetres. The glowing phenomenon can last several seconds to minutes. Doing so ball-lightning rolls over a street, temporary floats in the air, goes apparently unhindered through every wall and disappears from time to time without a trace or discharges with loud moise and formation of sparks. Some stink of poisonous gases and some also cause noise.

Famous has gotten the ball-lightning, which 1753 of all people should have struck the lightning research scientist Professor Georg Wilhelm Richmann in St. Petersburg. In his laboratory during a thunderstorm a ball of fire as big as a fist should have jumped from a iron tube to his head and should have hunted him down, so eye witnesses have reported (fig. 14.12).

Since ball-lightning has a closed structure, it has to drag about its source of energy with it. If this however consists of organic or other matter, the ball wouldn't be able to float, after all the brightness of a spherical vortex and with that the need of energy is enormous! We have to proceed from the assumption that just ball-lightning covers its need of energy from free energy and serves itself from the neutrino field.

The spherical form is a consequence of the structure shaping property of the potential vortex<ii>. Scientists are increasingly interested in this not understood phenomenon. In their experiments they try to artificially produce ball-lightning with more or less great success in the laboratory. By means of the experiment they then want to learn to understand, what the textbooks don't give away.

If we want to learn of nature something about free energy, lightning in the laboratory offers us in the form of a blow or of a spark gap relatively good possibilities. It surely is no coincidence that the father of free energy, Nikola Tesla, in his experiments almost all the time has worked with spark gaps!

<ii>: for that see in the 1st part the chapters 4.8 till 4.10

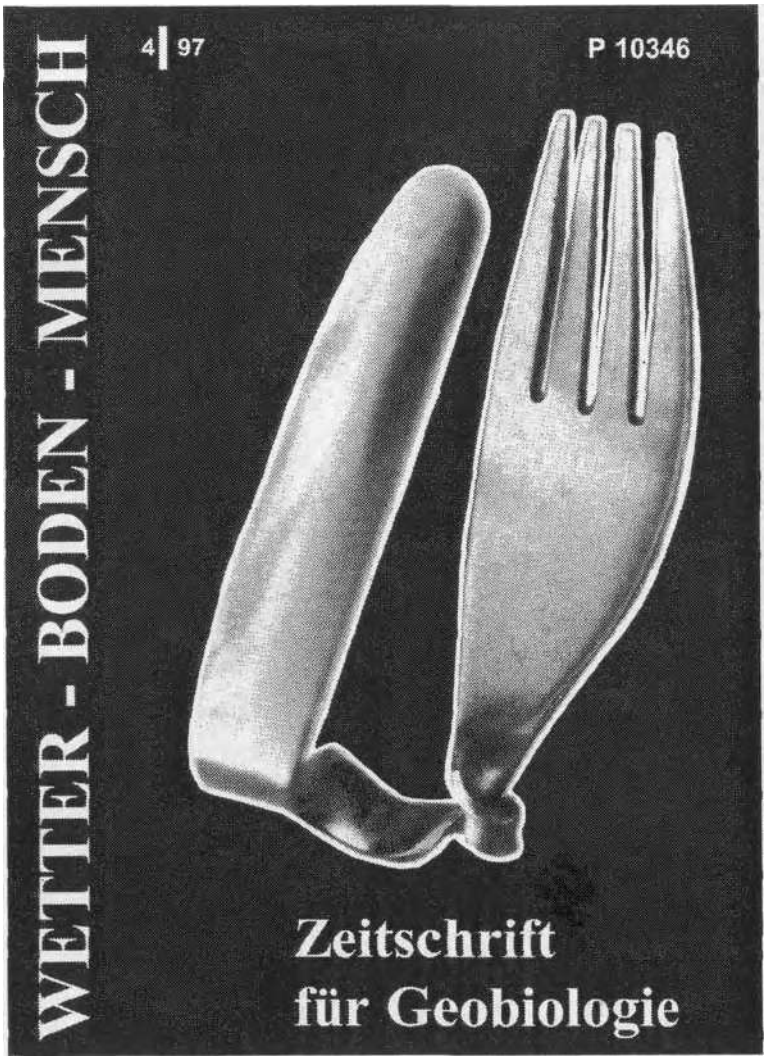

Fig. 14.13: Fork bent by „pure manual work".<i>

<i>: Whoever has to eat with bent flatware in the Hotel Adler in Waldkatzenbach (Odenwald, Germany), mustn't believe that the food didn't taste well to some rude fellow here. It is the host himself, who in a sociable round shows his guests from time to time that he not only can cook well. I could personally convince myself from the fact that Robert Hartmann doesn't use any aids. The picture shows the title page of the magazine „Wetter Boden Mensch" 4/97. A comment concerning this on page 3: Robert's 50ieth birthday.

14.13 Discussion concerning the neutrino conversion

In nature two different principles for the use of the neutrino radiation can be observed. In one case of use a glowing phenomenon occurs, in the other cases not.

The glowing lightning should be assigned to the first case. Here not only the neutrinos crossing the lightning channel are used, but also neutrinos from the environment oscillating in resonance are collected. Around the lightning channel a kind of reaction radius is formed, inside of which all synchronously oscillating neutrinos are attracted under the resonant interaction. During the discharge process the radius can increase like an avalanche, to collapse again with the transition into the stationary discharge current. A corresponding technical concept, which is discussed in the next chapter (15.5), is very efficient, but almost uncontrollable. A characteristic is the formation of antiparticles, of positrons, in the course of the materialization, which then annihilate under emission of radiation and cause a shining. Also spark gaps and fluorescent lamps possibly help themselves from the neutrino field, as still has to be to worked out.

In the second case nature works without any avalanche effect and without any glowing phenomenon. To this counts for instance the photosynthesis or the mode of operation of the mitochondria, the energy centres of a cell. All cells, whether vegetable, animal or human, only use the neutrinos which just that moment pass by them and only in those amounts, as they just are needed. They thus handle their energy very caring. Without exception electrons are materialized and no positrons.
If nevertheless unwantedly an avalanche effect occurs, something which happens fortunately only very seldom, then a self-inflammation and self-burning occurs, then it should happen, that a person burns off himself<ii>. This risk also is known of hay.

There also exist rare talented persons, who can control and regulate the process of materialization by concentration. These people can bend spoons or other metallic objects<i>. For that they concentrate themselves some time and send the materialized charge carriers into the object, which they hold in their hands. Since the metal lattice solely is kept together by the enveloping electrons of the individual atoms, the additional electrons make the metal structure sodden. Now for a short moment the metal can be bent and distorted at will. Doing so neither heat is produced nor is the colour changed. The result of the process can be produced neither by cold working with raw force nor under a flue. Also here nature shows us a technology for an ecologically compatible metal processing (fig. 14.13).

The way from the conventional over the regenerative towards free energy is predrawn. It only has to be gone! After the existence of the neutrino radiation goes as proven and 1998 for the first time concrete amounts have been determined measuring technical and published by a Japanese team of research scientists, with that also the question for an energy technical use of the particle radiation has been answered clearly. Now only the question of the mechanics is open. The Japanese research scientists by the way have found out that at night only half as much solar neutrinos can be detected than at daytime. The other half according to that is absorbed in the inside of the earth. This in the meantime published measurement result in brilliant manner confirms the working hypothesis of a growing globe (chapter 11).

<ii>: Zu Asche pulverisiert, Illustrierte Wissenschaft 6/ 1997, S. 61 acc. to an examination of the American SCI-COP in 1984.

cause/ field lines	interaction	F = force effect *mediation:*	see chapter: effect/ *application*
1. open **H**-field lines	magnetic (static)	F_{M0} = magnetic force (permanent magnet)	chapter 15.4 *E.-engine, solenoid*
2. open **H**-field lines	resonant (oscillating)	F_{MS} = magnetic force (AC-magnet)	15.4 + 15.5 - 15.7 lightning, *railgun*
3. open **E**-field lines	electric (static)	F_{E0} = Coulomb force *by charge carriers*	15.9 + 15.10 atomic bond, *Testatika*
4. open **E**-field lines	resonant (oscillating)	F_{ES} = Coulomb force *by neutrinos*	chapter 16 + 17 weak interact. galaxy bond *Tesla converter*
5. closed **H**-field lines	gravitation (static)	F_{MG} = gravity *by particles with mass*	chapter 6.9 + 7 elementary particle mass
6. closed **H**-field lines	levitation (dynamic)	F_{ML} = reduced gravity	chapter 18.3 gravit. waves *Casimir effect*
7. closed **E**-field lines	gravitation (static)	F_{EG} (force hardly detectable)	chapter 18.7 *superconduc-ting ring*
8. closed **E**-field lines	levitation (dynamic)	F_{EL} (no longer detectable)	18.5 + 18.6 *Keely-/Searl-flying devices*

electromagnetic and resonant interaction		gravitation and levitation
$F_{M0} = 1{,}4 \cdot F_{MS} > F_{E0} = 1{,}4 \cdot F_{ES}$	$\gg$	$F_{MG} = 1{,}4 \cdot F_{ML} > F_{EG} = 1{,}4 \cdot F_{EL}$
for reason of open field lines		resp. closed field lines

Table 15.1: The force effect of interactions, ordered according to size, with examples

15. Principle of functioning of space energy

In this chapter we want to turn us towards the technical concepts and techniques concerning "space energy", which occasionally here and there already should have existed or have been operated with quite different success. After Nikola Tesla having pointed the direction more than 100 years ago, the way towards free energy appears to be predrawn. Never before the public interest in the topic of space energy was as big as today. Unfortunately this concerns more the collecting and gathering of rumours and speculations. As in every branch of science also here hunters and collectors can be found. But obviously the hunters, the inventors and theorists have bigger problems, to put something useful on the table. They are fighting against their own not knowing, unuseful textbooks, general ignorance, intolerance and an all-powerful energy lobby. What the collectors on the other hand come up with does make appetite but not full.

An useful and efficient theory might be the most important prerequisite just with regard to the reproducibility of an effect and the product liability of a SET-device. That's why one mustn't expect a complete list of devices of that kind in this chapter, because in the foreground stand the physical and technical explanations concerning the way of functioning, the understanding for constructive and guiding details and the learning from the mistakes and errors of the inventor.
For a better survey the possible courses of the field lines according to the theory of objectivity are listed in detail (table 15.1) and discussed from the top one after another, starting with the strongest known interaction. To complete examples and concepts are presented.

As is well-known there exist electric (E-) and magnetic (H-) field lines. Further exist open and closed field lines and finally is distinguished between the oscillating and the static case. The results are two to the third power, thus eight possibilities of combination in total. In table 15.1 all eight versions are given, even if one or another case is of more theoretical nature. For the objective of a systematizing of different concepts concerning space energy technology the taking apart in any case is helpful. The figure opposite is survey and structure at the same time for the following chapters.

15.1 The course of the field lines

In chapter 6 a relation between the course of the field of a body and its observable interaction has been made (part 1, chapter 6.7 till 6.9). Here a point of approach is offered. For instance to maximize the force effect a magnet or to optimise an electric motor, the engineers nowadays help themselves with costly programs working according to the method of finite elements. In this way they obtain a picture of the field lines, the course of which makes possible conclusions concerning the production of force or torque. The relation without doubt is given, the only question is in which order of magnitude.

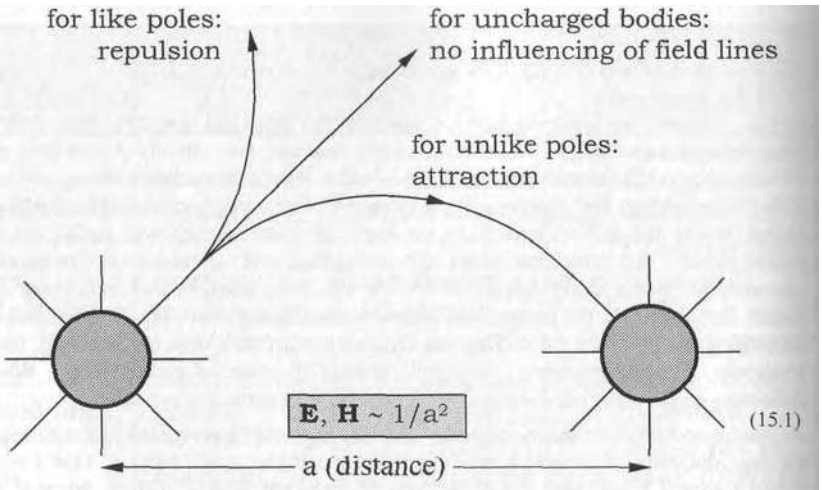

(15.1)

Fig. 15.2 A: The course of the field lines leads to a force effect (repulsion or attraction)

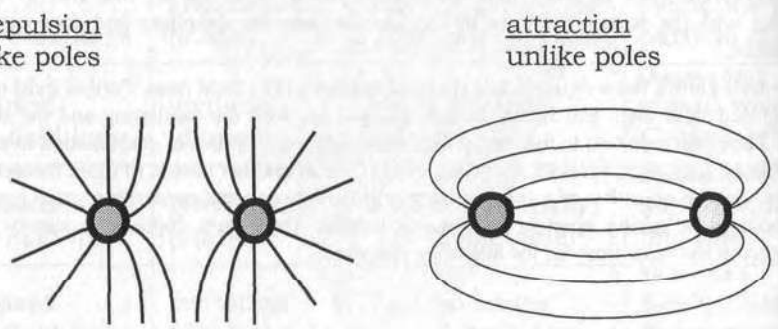

Fig. 15.2 B: The course of open field lines

$$\frac{F_{\text{Coulomb force}}}{F_{\text{magnetic force}}} = \frac{Q \cdot E}{\phi \cdot H} = \frac{\mu \cdot Q^2}{\varepsilon \cdot \phi^2} \quad \text{with} \quad E = Q/\varepsilon \cdot A \quad \text{and} \quad H = \phi/\mu \cdot A \quad \text{where} \quad \phi^2 = m^2 \cdot G \cdot 4\pi \cdot \mu \quad \text{(Gl.13.20)} \tag{15.2}$$

i.e. e^-:

$$\frac{F_{el}}{F_{magn}} = \frac{e^2}{\varepsilon \cdot m_e^2 \cdot G \cdot 4 \cdot \pi} = \underline{4{,}2 \cdot 10^{42}} \tag{15.3}$$

Fig. 15.2 C: The proportion of forces at the example of the electron.

The theory of objectivity answers the question from the equations of transformation with the proportion 13.23 (fig. 13.4). According to that the electric or the magnetic field strength stand in inverse proportion to the square of a length or of a distance:

$$E, H \sim 1/a^2 \qquad (13.23) \text{ bzw. } (15.1)$$

Less mathematically expressed this, for two bodies in the distance a, where one body is situated in the field of the other, means nothing else as that the distance is reduced. Nearer to the body the density of the field lines again increases, in that way the distance further decreases and we observe an approximation.
Usually the idea of force is introduced as a factor of description and there is spoken of a force of attraction. But that not necessarily is required, because the force only represents an auxiliary description. The cause for the observed attraction rather is the spatial distribution of the field strength.
In this case the two bodies come closer and the mutually active fields get bigger and bigger, until the parts eventually run into each other (fig. 6.7 A). There one comes the thought to increase the force of attraction by an artificial compression of the field lines. In the case of the electromagnetic interaction such a compression actually takes place, since the field lines arise from one pole and end at an unlikely charged pole, which so to speak collects and bundles up the field lines (fig. 6.8 A).
At last we find out the reason, why electromagnetic forces of attraction are bigger than gravitational forces for many powers of ten (between 10^{30} and $4.2\text{-}10^{42}$ for the electron, derivation see fig. 15.2 C)! For table 15.1 this means, at the top have to stand the open field lines, which bundle up at the poles. Then very long nothing comes and after that the effects of closed field lines are being found.

For open field lines however also the opposite of a bundling up is possible. In the case of like poles the fields run away of the other pole (fig. 6.8 B). Between both a space is formed, which is free of field lines, where thus the field tends towards zero, whereas the distance between the poles according to the proportion 15.1 grows towards infinity. In this case we observe, how the bodies are going away from each other. We speak of a force of repulsion, which actually reaches until infinity. This gives reasons for the occurring of both forces of attraction and forces of repulsion in the case of the electromagnetic interaction.

15.2 Gravitation

In the case of closed field lines in principle no repulsion can occur, since no pole, neither north pole nor south pole, neither positive pole nor negative pole is able to influence the position of such a field line. This circumstance as well as the order of magnitude of a possible force of attraction suggest, to settle gravitation here.

It gladly is forgotten, that the field pointers of E- and H-field normally occur together and like in the case of the electromagnetic wave stand perpendicular to each other. It is normal to calculate only the electric field pointers for a charge carrier, without paying attention to the circumstance that the H-field is present as well. The textbooks as a rule remain silent about this dark chapter or they lapidary remark, the dual field lines are closed in themselves and hence inactive anyhow, which however is incorrect.

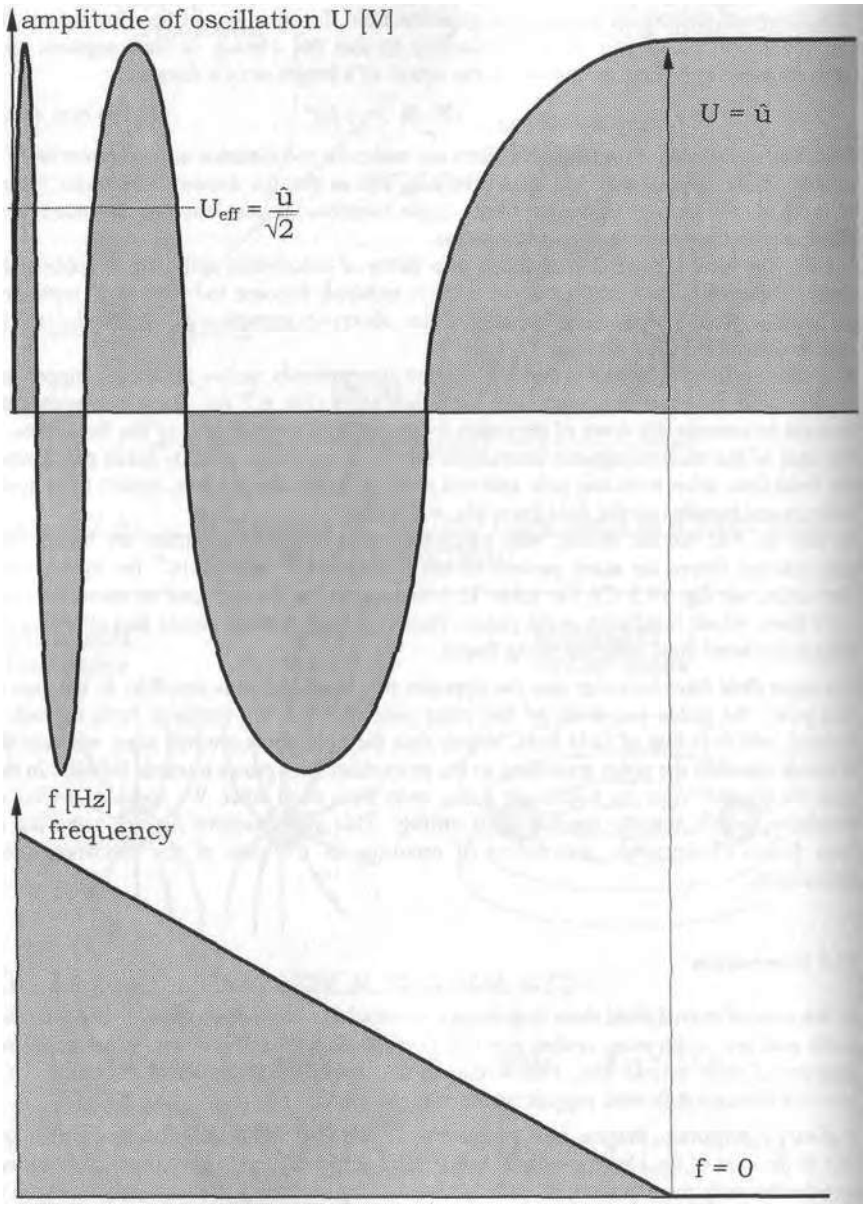

Fig. 15.3: The transition of an oscillating into a static interaction

But, according to the proportion 15.1, they actually develop a force of attraction, even if this is relatively small. No one really needs to be surprised that gravitation is not understood until today, if a whole group of fields simply is overlooked by science! We now also can explain, why there don't exist any massless charge carriers. Namely only the E-field or the H-field can form open field lines and never both at the same time. Otherwise they wouldn't be able to stand perpendicular to each other anymore. The each time other field, in the case of electrically charged bodies it is the H-field, then is wrapped perpendicularly around the E-field lines, independent of the circumstance if electrically an attraction or a repulsion occurs and without exception it forms a weak force of attraction, the gravitation.

15.3 Systematizing the interactions

Next we should know, from which field is to be expected a larger force effect: from the E or from the H-field? At the example of an electromechanical converter this question can be answered concretely.

The forces which occur and form the torque in an electric motor customary in trade are produced by magnetic poles in stator and rotor, which repel each other in the case of like charge and attract each other in the case of unlike charge. Now there in principle exists the possibility to build a motor which works with Coulomb forces, thus with positive and negative poles, instead of the magnetic forces. About such designs numerous patent specifications exist, but no customary version on the market.

The reason very simple is that a magnetic motor for the same torque is many times smaller and better priced. From this the conclusion can be drawn that for the same construction volume a magnetic force F_M is considerably larger than a Coulomb force F_E, which for instance binds together atomic nucleus and atomic hull.

Thus in table 15.1 the magnetic forces are ranked before the Coulomb forces.

Finally we have to distinguish between the static and the oscillating case, which are distinguished in the frequency. In fig. 15.3 an oscillation is shown, which by chance just at the moment of the vertex value changes into the steady state, thus takes the frequency zero. In this case the effective values between a static and a sinusoidal oscillating interaction are distinguished by the factor $\sqrt{2}$ = 1.4.

If we operate an universal motor with direct current, then it releases more power, than for a corresponding feeding with alternating current. Even a high-tension line, which stands at maximum 511 kV, is operated with alternating current up to 380 kV, with direct current on the other hand up to 500 kV. Consequently in table 15.1 the static interactions stand before the oscillating interactions.

The strong interaction naturally isn't found in the list, after it has been derived that it doesn't exist at all (see chapter 7.8), whereas the weak interaction is hiding behind the oscillating interaction. It shakes other particles so long till they fall apart (see chapter 7.13).

We now would be as far, to discuss the 8 cases listed in table 15.1 one after another by means of practical examples.

The principle of the side-pole machine

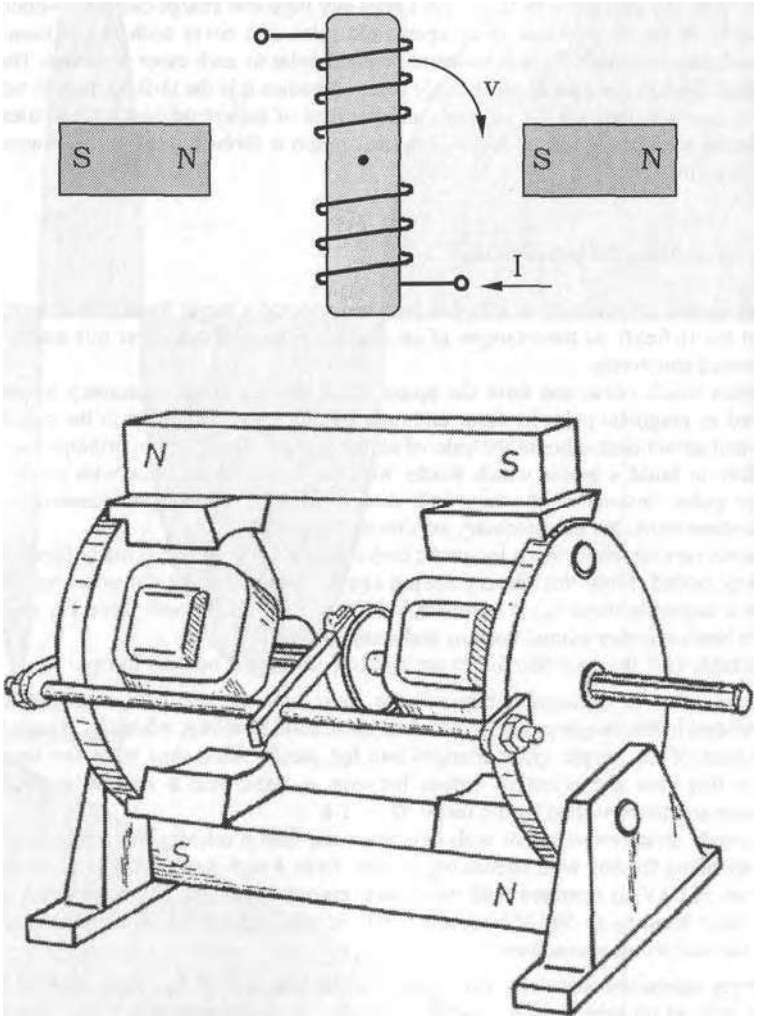

Fig. 15.4: Alternating current dynamo, according to the inventor
(Kromrey) a magnetic converter for free energy with a degree of effectiveness of more than 100 %.[i]

<i>: Raymond Kromreys Molekularstromrichter, NET-Joumal 6/98, S. 5

15.4 Magnetic force converter

As a result of the systematizing of all eight possible interactions, the largest force effects are to be expected as a result of static and of open magnetic field lines. It is questionable, if this statement is generally valid and is true everywhere in space. But it is valid at least for a terrestrial laboratory and only here, on earth, a solution for the energy problem is strived for. No wonder therefore, if the electric energy technology nearly without exception is using these force effects. We find them at a solenoid, at a relay coil, at a magnetic tuning cylinder and equally between the stator field and rotor field of an electric motor.

The motor however takes a special position, because its rotor is turning. In that way a switching of the winding and commutating of the currents is necessary or the field of the stator winding is being turned, for instance in the case of an alternating current motor. This is necessary, so that in the air split of the motor the fields from the stator and rotor always are standing opposite like for the solenoid and a driving force can be formed. For the operation therefore oscillating currents are necessary, so-called alternating currents, which are fed in into the winding with the right frequency and phase. There can be spoken of an operation in resonance. It surely is no coincidence, that Nikola Tesla, the founder of the rotary field theory and inventor of the alternating current motors at the same time is the discoverer of the neutrino radiation!

The electric motor slides already into the second column from the top in table 15.1, as we see, and should be assigned to the case of the oscillating interaction of open magnetic fields. The frequency for motors usually is very small.

But also at high frequencies there can't be reckoned on some free energy which would show or even be utilizable, as can be heard from the inventors who tinker with magnets, mostly with permanent magnets (Fig. 15.4). The reason very simple is that there exist no physical particles, which could mediate this interaction. Magnetic monopoles would be necessary, thus north pole or south pole particles, so that an interaction with the open H-field lines can occur.
Such particles could form as a result of currents and eddy currents, but for that a good conductivity would be necessary and that isn't present in the vacuum. Therefore magnetic monopoles can't exist at all! This point we already had worked out (fig. 4.4, question I). The same statement then also applies to the oscillating case.

If nevertheless something like free energy should show in the case of some magnetic field converters, then unnoticed by the inventor still other physical effects are added. By means of concrete concepts this circumstance can be studied and discussed. The meanwhile well-known railgun is a corresponding example, for which besides the used magnetic force unintentionally a further principle is used. A more detailed occupation with this device is worthwhile, because here some fundamental concepts of space energy get clear.

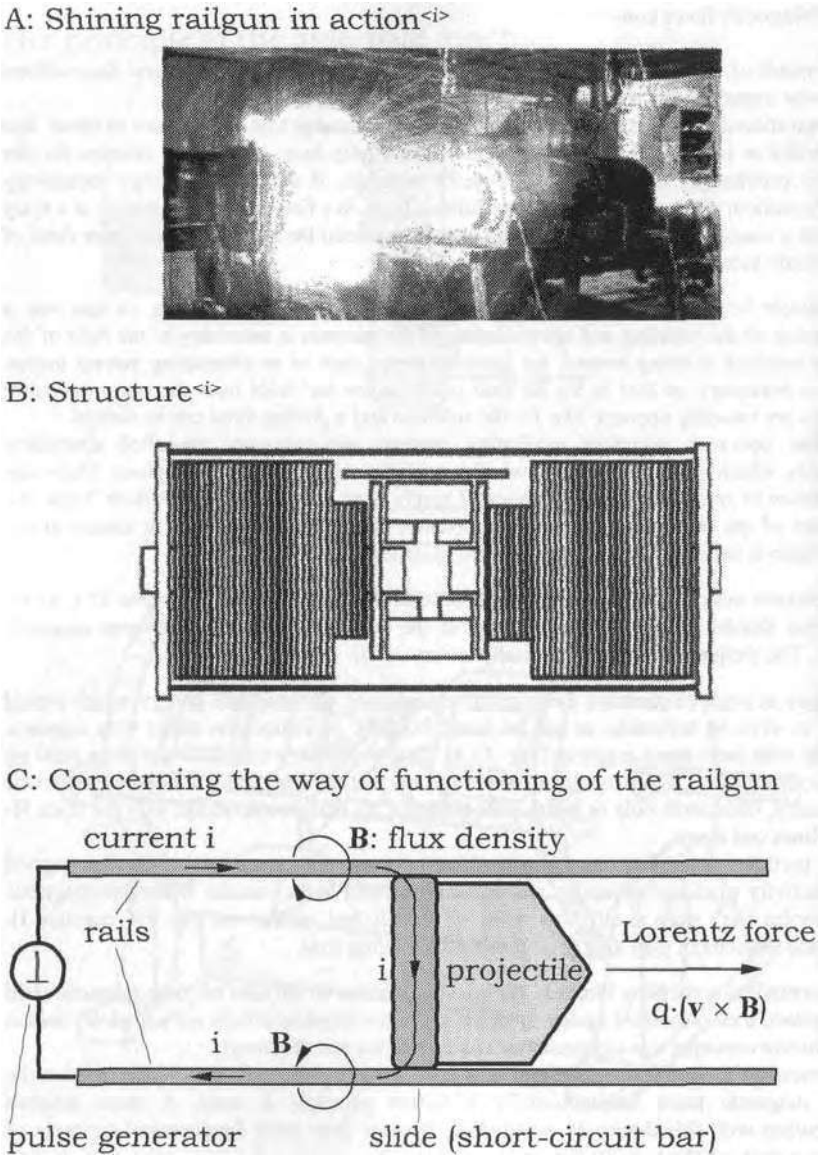

Fig. 15.5: Structure and way of functioning of the railgun

<i>: in the internet under: www.glubco.com/weaponry/railgun.htm

15.5 The railgun

The engineers and physicists involved in the SDI-project were quite astonished, as they had a close look at the bent rails of their gun. During the test operation the equipment was really flying around their heads.
They were very sure to only have fed in 16.7 MJ of energy, from the rotation of a homopolar generator, because more was not available for the experiment by any means. The projectile with mass m_0 = 0.317 kg lying on the rails thereby should have been accelerated to the velocity of 4200 m/s. Instead huge forces were at work here, which the construction couldn't counteract at all. There is talk about the released energy having amounted to 399 GJ, what corresponds to an over-unity effect of 24000[ii]. This factor describes the proportion of the released to the taken up power or energy. If these details should be correct then this would be the most efficient converter for free energy, which has been developed until now.

Behind the project name SDI (Strategic Defence Initiative) is hiding the by the United Slates prepared "Star wars". But how one fares a war, which nobody can pay anymore and no-one wants, entirely according to the motto: There is a war and no-one goes there? This war undoubtedly the strategists and initiators themselves have lost, who even had to watch, how their space gun appears in the internet with design drawings and rich visual material to be called by anyone[i].
Today, where we are surrounded by nothing but friends, where in Russia and at other potential opponents is fought more against internal problems and one lets the expensive space toy rot for lack of money, the coat of the military secrecy obviously no longer can be held over such an explosive project as the railgun.

Thus informative details have reached the public. In the pictures a bright lightning can be seen at the moment of launching (fig. 15.5 A). Here presumably is being materialized, in which the part of anti-matter annihilates with the particles of matter under emission of light. There thus takes place the same process as in the case of lightning or the shining of the sun.
In addition is being reported that heat energy is withdrawn from the environment, a circumstance, which is typical for all functioning converters for space energy. We thereby are reminded of the possible formation of ice in a lightning channel.

Like for a lightning also the railgun is stimulated with a very high excitation voltage and with extreme speeds of change of the tension voltage (high du/dt) (fig. 15.5 C). From the setup it concerns a bridge of Ampere, which in various respects appears to be superior to the rocket engines, after the costly transport of the propellant into space isn't necessary, since the capacitor batteries can be recharged by solar power.

<i>: e.g.: www.glubco.com/weaponry/railgun.htm

<ii>: Galeczki, G., P. Marquardt: Requiem fur die Relativitat, Verlag Haag + Herchen (1997), S. 139

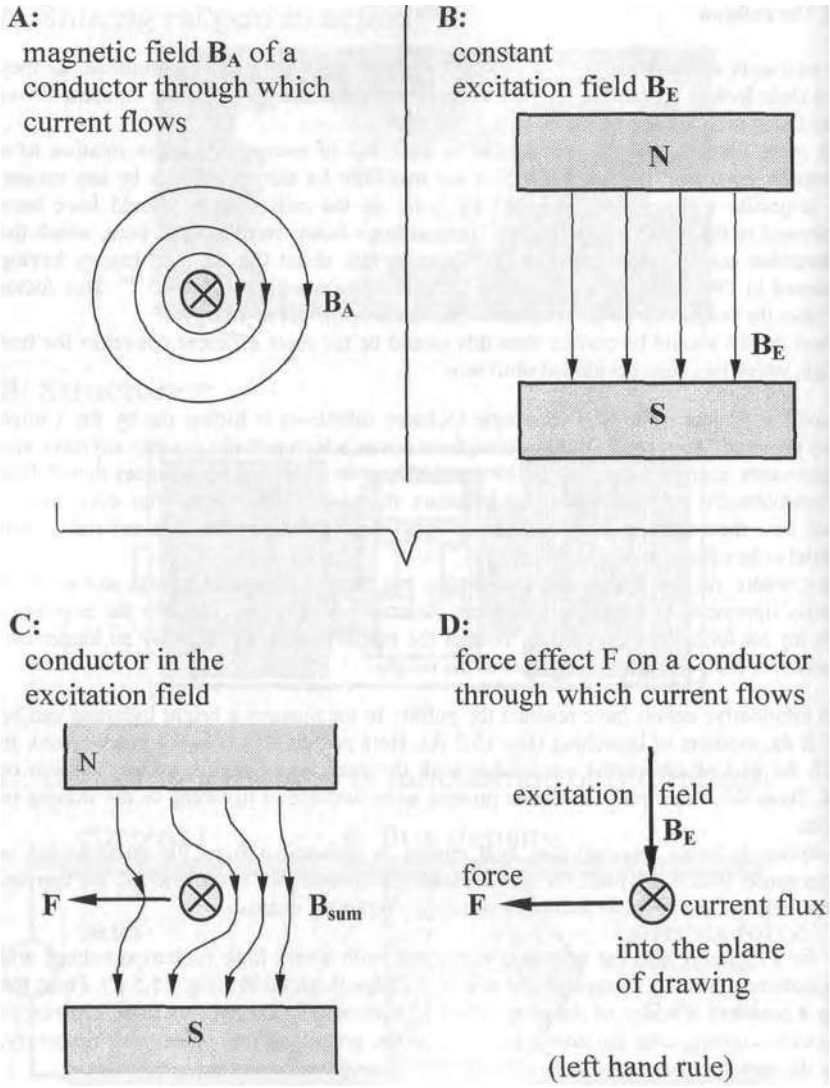

Fig. 15.6: ____ The distribution of field lines and force effect on the slider of the railgun through which current flows in a permanent magnetic field

The projectile has the form and the function of a short-circuit bar and is guided slidable between both rails of the railgun. The high-tension capacitors are switched on both rails at the moment of launching, so that in a very short time an extremely high short-circuit current of several thousands of Ampere flows through the bar.
Since the bar in addition is situated in a static magnetic field, there acts an accelerating force on it (fig. 15.6 D). It is the force effect of a conductor through which flows a current in a magnetic field, like it is active in every electric motor. If we overlap the fields of the conductor (fig. 15.6 A) and of the magnetic field (15.6 B), then we observe a bending and lengthening of the field lines (15.6 C). There exists the effort to re-establish the original state, which represents the smallest magnetic resistance, and for that the conductor is shifted out by means of the arising force. In the sketch it is accelerated to the left. That far the explanation concerning the bridge of Ampere. That has nothing to do with free energy. For the enormous degree of effectiveness, as it has been determined, further effects have to be added.

15.6 Unipolar induction

The projectile, or from the function let us rather speak of the short-circuit bar or the slider, at first is entirely conventionally accelerated and experiences, mathematically expressed, a dv/dt. The magnetic field B stretching perpendicular to the movement is constant, so that according to the Faraday relation<i> E = v x B from the velocity v an electric field strength E results and from the acceleration dv/dt a field change dE/dt. These open field lines along the length of the slider, in particular the oscillating part, appears to interact with oscillating particles and to collect these particles<ii>. It concerns presumably neutrinos, which primarily materialize in charge carriers. These contribute to the current flux in the slider and to the acceleration, whereupon still more neutrinos are collected.
A hardly controllable avalanche effect is formed. Only if the change in tension voltage has worn off and the capacitor is completely discharged, also the resonant interaction will again collapse.

The inventors, who want to construct a civil version of the railgun, is given a warning on the way which should be taken seriously. At first it doesn't take particularly much imagination to imagine a rotating arrangement of the gun, a construction with one axis, whit which a generator driven, which produces power. A small part is supplied the system again as supply for itself. The rest would be available free to the consumers as non-polluting, regenerative energy.
That really sounds good, if there wouldn't be this one obstacle.

<i>: The equation of transformation concerning the unipolar induction already was treated more detailed in chapters 6.4 and 9.3

<ii>: It is the resonant interaction according to table 15.1, line four

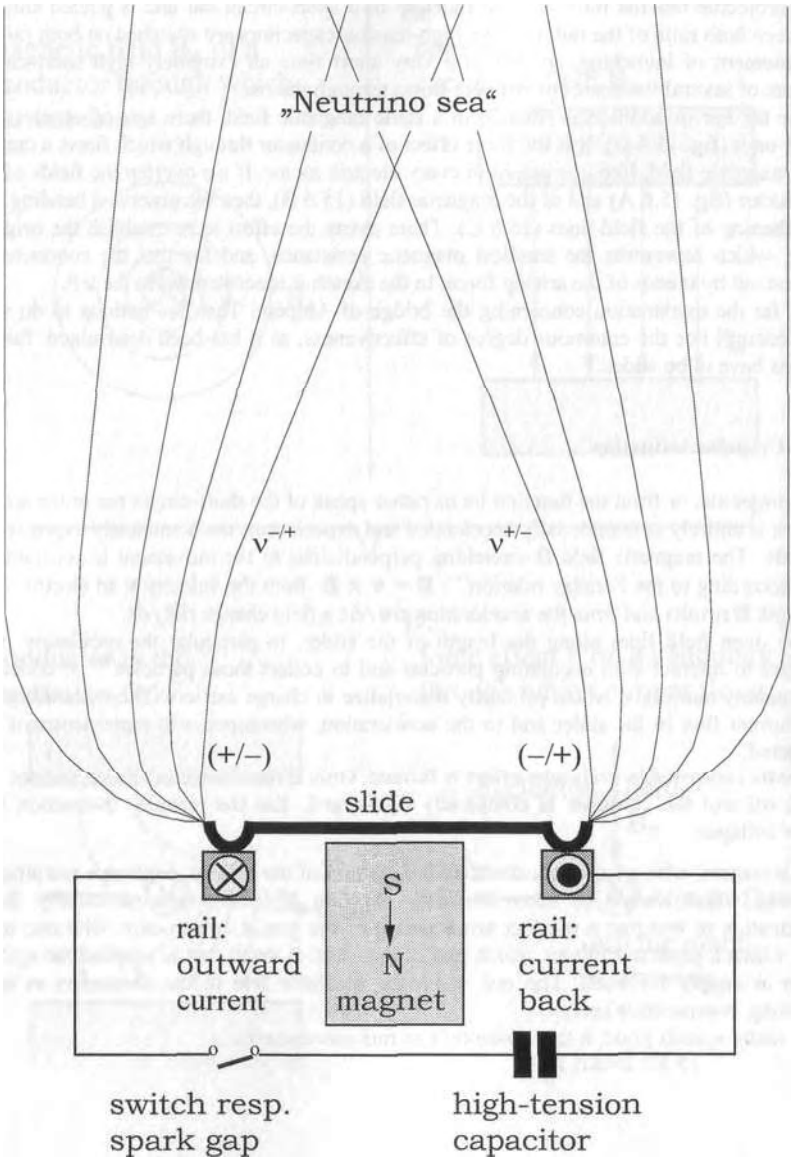

Fig. 15.7: The collecting of neutrinos by oscillating open field lines

15.7 Tendency to instability

In a continuously working machine the discharging of the capacitor cannot remain a single event as in the case of the gun. The discharging and the recharging has to take place cyclic depending on the revolutions per minute. To obtain a rotating movement even to a certain extent ignition has to follow ignition. But if the new ignition takes place, although the avalanche effect of the last one still hasn't worn off, then inevitable a catastrophe will occur, then the work of wonder is taken apart under the eyes of its creator. Numerous inventors already have had to collect such painful experiences. It is assumed that not even Nikola Tesla had escaped, as he had to put away again his stately luxury car with electric motor and energy converter in a barn near Buffalo already after one week of test operation in the year 1931[<i>].

Of course also for this problem solutions in accordance with engineering are offered. Meaningful would be a restriction of the revolutions per minute and a power regulation. Only most inventors don't think that far. On the one hand, because they handicraft without an useful physical model and on the other hand they think they already have reached the goal, if they observe something like free energy for the first time. Just as fast as the joy then the disillusionment comes, because a converter which doesn't work, is not able to convince anyone.

Tesla already was aware of this set of difficulties. He fastened his converter to the dash-board and not in the engine compartment, presumably to adjust the coupling of the coils from the drivers seat during the drive by means of two metallic rods, which he pushed into the case. But sometime even this regulation by hand has to go wrong, because the collected neutrinos on their part collect further neutrinos (fig. 15.7), so that in the case of an unfavourable order of ignition an additional amplification is possible. For a reliable operation according to that directly or indirectly the phase of the ignitions to each other should be checked.

At the example of the railgun space energy technologists and inventors can study the relations and the way of functioning very concretely and even calculate these relatively simple. It is a big relief, that all three vectors stand perpendicular to each other: the E-field, the B-field and the velocity v. Ideal conditions both with regard to a maximizing of the wanted accelerating force and for the resonant interaction, increase at the same time the collecting of space quanta, which probably may be set equal to the neutrinos. This is made possible by the Faraday's law of unipolar induction. In that way at the right and left end of the slider a positive a negative pole each are formed. The further the two poles are away of each other, the more the field lines are opened and the more neutrinos can go into resonance. In this place still considerable improvements and optimisations are possible.

In addition to the two discussed the phenomenon of the electrostriction is added as a third phenomenon, which authoritatively contributes to the conversion of neutrinos into electrons. It is a field dependent change of length, which in the case of lightning takes care of the thunder and in both cases, therefore also here, is active as a charge carrier producer.

<i>: see also chapter 9.5 Free energy,
A. Schneider: Energien aus dem Kosmos, Jupiter-Verlag 1989, Kap.ll, S. 20 and H. Nieper: Revolution, MIT-Verlag 1981, S. 194

A: electric dipole (e.g. electrostatics, see also fig. 6.8)

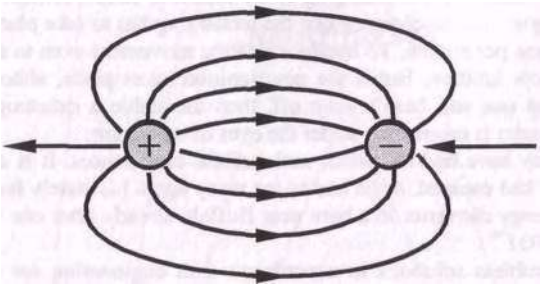

B: electric monopole (e.g. electron e~, see also fig. 4.3)

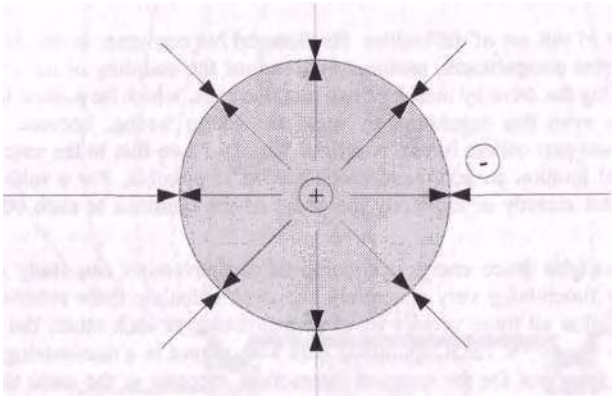

C: Mixed form in the case of cylindrical symmetry

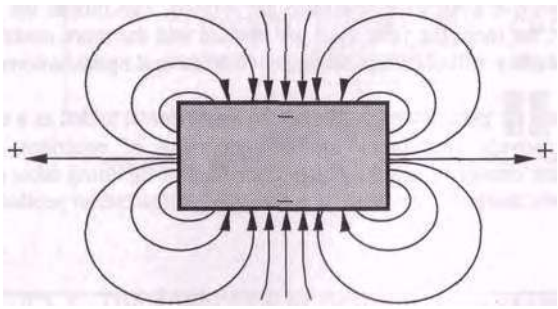

Fig. 15.8: Dipole fields with unipolar parts

15.8 Unipolar field configuration

If we again go back to fig. 5.1 and continue our considerations with examples concerning line 3. The obtainable force effect of open electric fields indeed is for powers of ten smaller than that of magnetic fields, but then particles are mediated, an invaluable advantage and an indispensable prerequisite with regard to the generation of space energy. As long as the particles are considered in the balance sheet of energy then in addition by no means can be claimed, space energy converter are perpetuum mobiles.

In the question, why only electric particles can be mediated, has to be pointed to the repeatedly mentioned circumstance that only electric particles can be formed as a result of the concentration effect of potential vortices. Magnetic particles however plain and simple cannot exist, since for missing conductivity in the vacuum no eddy currents are possible (see fig. 4.4).

In the case of the arising Coulomb forces again is distinguished between the static and the oscillating case. We want to start with electrostatics.

The range of technical applications of static electricity is large. It stretches from varnishing technologies and filter technologies till the fly grill in the arbour. In all cases the field is built up by charge separation. By means of a high-tension generator a positive pole and a negative pole are produced, between which the field is stretching. The field lines now start at one pole and end at the other, unlike pole (fig. 15.8 A).
In this manner almost no open field lines are available, which point to the outside and could interrelate with free particles. If one for instance intends to attract and collect charged particles from the solar wind, from the cosmic radiation or from the electricity of the air, then the design in one point has to be changed fundamentally.
A unipolar field configuration is necessary. What is meant with that, answers a glance at the spherical vortex model of the electron (fig. 15.8 B resp. fig. 6.2). Here it as well concerns a formation of dipoles as a result of the charge separation, but one pole is hiding in the inside of the other pole . In that way its field lines are captured and don't have a chance anymore to come out, to reach the other pole.
But if the pole lying on the outside for its part can't close its field lines any longer, then these point helpless into space and search in their neighbourhood, in the distant world and if need be even in the infinity of the universe an unlike anti-pole, which as a result interacts and is attracted.
The measuring technician analyses these open field lines and falsely calls the construction then a monopole, only because he isn't able to reach the locked up pole. To blame is the unipolar field configuration, which with that probably would be explained to a certain extent.
The designer and inventor as well might have realized how he has to construct his device, with which he generates open field lines to collect space quanta. He has to lock in one of the two poles as good as possible. Optimal would be of course a spherical symmetric construction like in the case of the elementary vortex. Compared with that a cylindrical symmetry indeed is suited far less good, but it offers constructive advantages (fig. 15.8 C).
We now will report of such a functioning device.

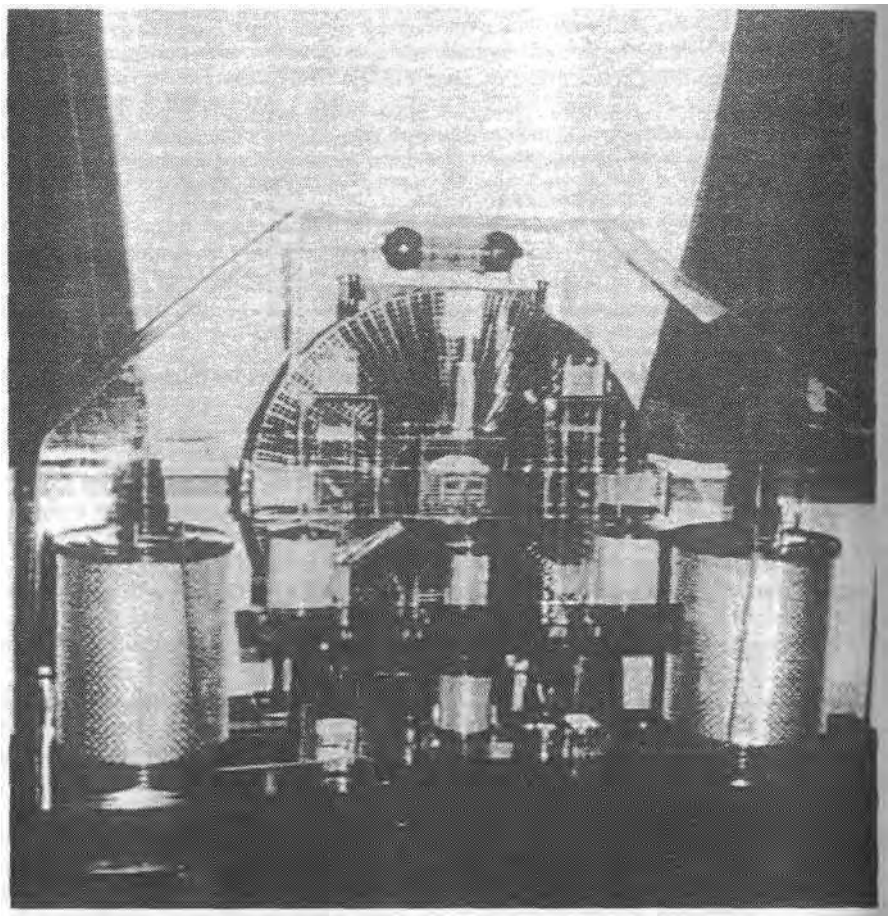

Fig. 15.9: Demonstration converter "Testatika".[i]

<i>: A. Schneider: Energien aus dem Kosmos, Jupiter-Verlag 1989, S. 29,
I. Schneider: Neue Technologien zur Freien Energie, Jupiter-Verl. 1994, p. 13 and in the NET-Journal, Heft 8/9, 1997, S. 16 as well as iss. 12, 1997, p. 6.
D. Kelly. Der Schweizer ML-Konverter, Raum & Zeit Special 7, S. 164

15.9 The Testatika

An electrostatic device, which produces open electric field lines, is situated in Linden in Switzerland. It optically is very imposing and belongs to a religious community, which has called it Testatika and is of the opinion that it is a free energy converter. Inexplicably the Testatika does not serve the community, which generates their electric power conventionally and to a large extent by itself, as a source of energy. Instead the 2 kW device only very seldom is demonstrated for special occasions or to select groups of visitors. The religious community after that explains the astonished observers humanity not yet is mature for the technology.

Perhaps just the opposite is correct and the technology not yet is mature. According to my personal assessment such an electrostatic device in principle is entirely unsuitable for the continuous operation.

It can be expected that the open field lines sooner or later will interrelate with the electricity of the air and thunderstorms are being attracted by the infernal machine so long until lightning strikes and the demonstration with that has finished. That's why the Testatika may be switched on only for a short time, only at sure weather situation and not too humid air, and many a registered visitor has been sent away without having seen the "thunderstorm machine".

As an object of demonstration and study the Testatika however is well suited. Alone the circumstance that no cable leads to the device and it nevertheless releases energy in the order of magnitude of 1 till 2 kW, surprises all visitors. At least the impression is mediated as if the machine would violate the law of conservation of energy, which is not correct. The Testatika is similar to an induction machine, which works with friction electricity. Thereby the unlikely charged bodies do not have to unconditionally touch and rub at each other, it already is sufficient, if they are brought in the immediate vicinity of each other. In the case of the Testatika the electrostatics of two against one another rotating discs is taken off by brushes.

The excitation energy presumably is taken out of the natural E-field, which just like that can amount to 200 Volts per meter (see chapter 2.9). The large diameter of 80 cm of the discs and their bad conductivity (acrylic glass) permit this conclusion. The charge taken off by the brushes afterwards is temporarily stored in two capacitors of 2 Farad at 300 Volt, so-called Leyden jars. This far one actually is reminded of a Wimhurst generator, in which the energy is supplied the system by turning the disc. Large powers cannot be drawn by that. Plans to build such an induction machine by yourself have been published[i].

In the case of the Testatika however two discs are used and by hand stimulate to rotate oppositely. This rotational energy in this case isn't used to produce power, otherwise the discs quickly would stand still again, but that doesn't happen.

Until now apparently no-one has discovered the secret, which is kept strict by the members of the community. In my opinion the energy situation on our earth however is too serious, as that we would be able to afford playing hide-and-seek and egoistical secretiveness.

<i>: I. Schneider: Neue Technologien zur Freien Energie, Jupiter-Verl. 1994, S.14

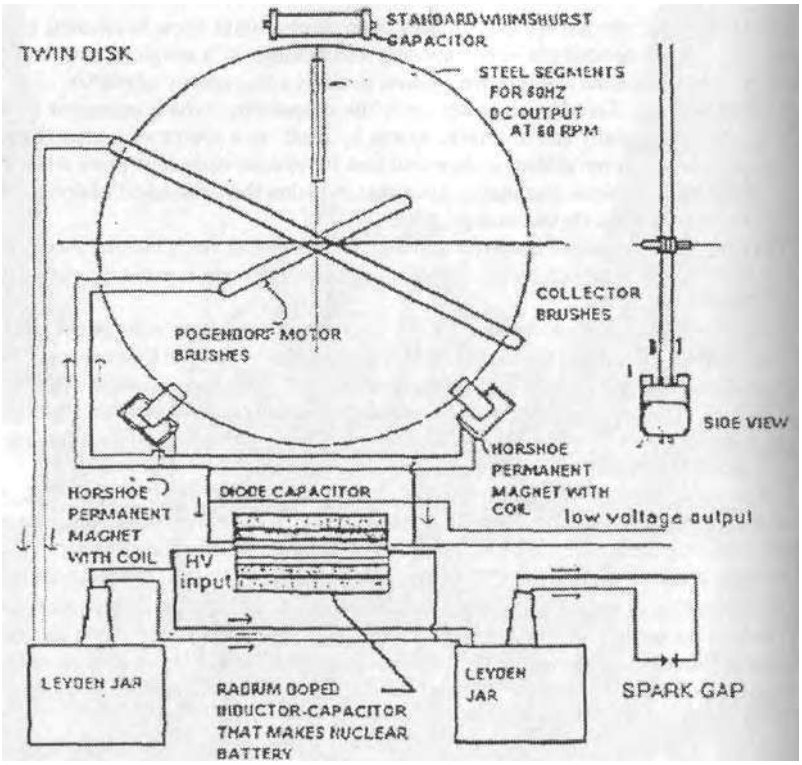

Fig. 15.10: Sectional drawing of the Testatika according to Don Kelly, (Clearwater, Florida, USA)

<i>: Der Testatika generator, NET-Journal, Dezember 1997, page 6 similar picture is found in Raum & Zeit Spezial 7, page 164

15.10 The secret of the Testatika

The crucial point is the opposite direction of rotation of both discs. If we assume the static earth electric field is the cause and serves as an excitation field, then as an effect a field arises, which stands perpendicular to that. The axial component now points out of the centre of the disc.
In the case of only one disc the field lines in front and behind the disc again are closed, so that no open lines can form. With one disc or with two discs rotating in the same direction hence no unknown charges can be attracted.
In the case of two oppositely rotating discs however shows one component along the axis of rotation to the observer, that of the other disc exactly in the opposite direction. In that way between both discs a pole is „pinned", which no longer is able to close all field lines on the outside around the machine. Thus open field lines and a, however incomplete, unipolar arrangement are formed.
The charge carriers sucked from the electricity of the air as a result support the natural electrostatics and speedy recharge the capacitors, even if up to 10 Amperes are taken out by the consumers.

The ingenious thing of the machine is its extremely simple construction and the simple concept.
If one includes the collected particles also in the balance sheet of energy, then it thus will turn out that the law of conservation of energy is not violated at all. There thus can't be talked of free energy. In this context the Testatika may rather be given as a counterexample. Air ions are the carriers of the electricity of the air and not carriers of free energy.

Negative air ions are indispensable for our welfare. One should only remember the first men in space, who after the landing were pulled out of their capsule more dead than alive, after they had to stay in the unhealthy atmosphere of the capsule for a longer period of time. Only the installation of ionising devices for negative air ions made possible longer staying in space.
The taking out of the air of negative ions hence is not unproblematic and not particularly ecologically compatible. An atmosphere harmful to life is formed which Dr. Wilhelm Reich has called DOR-state. He by the way has designed a Cloud-Buster, with which he could take static electricity, forming above the desert sand, out of the air. In that way the negatively charged rain clouds no longer are repelled and driven away. Reich has tested his weather machine 1954 in the desert of Arizona. After he had freed the atmosphere of the „DOR-strain", as he expressed himself, in the desert area the atmospheric humidity steadily increased from 15% up to 95%, there grew prairie grass and everything started to turn green, and eventually after many years for the first time rain fell again.

Static electricity, as far as the right polarity is chosen, may conditionally be used for the mechanics of rain making. For free energy concepts it however isn't suitable. Already Nikola Tesla has pointed to the circumstance that our hopes will be in vain if the free energy would be of static nature (see fig. 9.5). He in his speech, which he gave 1891 before the AIEE, has left no doubt that free energy exists, which is kinetic and with that energy technically usable for us,.
Chapter 16 will be occupied solely with this case<i>.

<i>: according to point 4 in table 15.1

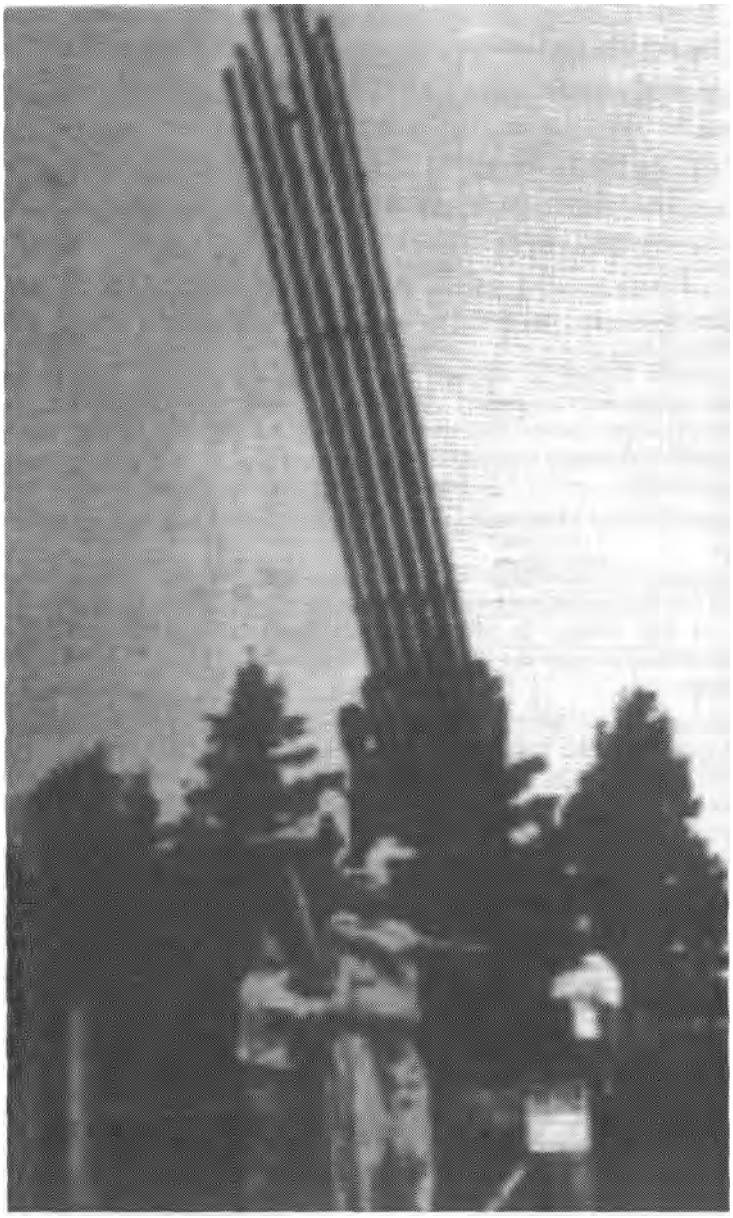

Fig. 15.11: The Cloud-Buster of Dr. Wilhelm Reich 1954.[i]

<i>: H.-P. Thietz: Tatort Erde, VAP (1996), ISBN 3-922367-62-3, page 122
<ii>: Part 1, fig. 9.3; concerning the unipolar induction see also fig. 6.5 and 11.8

Fig. 15.11 shows the weather machine of Reich, the Cloud-Buster. It can be understood only hard, why Reich directs a 3-4 m long metallic pipe with a diameter of 4 cm to the sky and connects the rear end with a deep well or with flowing waters. The effect should have been increased considerably with a few milligrams of radium. An indication that he must have worked with static electricity, delivers however a tragic accident, in which one of his collaborators was lamed on one side. He carelessly had touched the charged apparatus and suffered an electric shock[i].

15.11 The key to free energy

As a contribution to the discussion the individual principles of functioning of space energy again are collected and the attempt is undertook to value them.
In the case of an oscillating dipole configuration, for instance the railgun, open field lines are present only along the mutual line of connection (fig. 15.8 A). With that not particularly many space quanta can be reached. It hence has to be operated with gigantic excitation powers in the range of many thousands of Ampere, so that further field lines fling open and interact. The wanted over-unity effect therefore can only be reached at an enormous expense of technical apparatus.
An unipolar arrangement here is considerably more advantageous, where holds: the more unipolar, the fewer excitation power is required. But in that way it can take longer until the collecting of neutrinos like an avalanche again has worn off. In the case of an ideal spherical arrangement (fig. 15.8 B), as the ball-lightning takes, the process can even last for minutes. This explains why unipolar systems can be kept under control only very hard. If the neutrino avalanche is rolling then it purely theoretical only can be stopped with a still larger excitation power, for instance by phase shifting, what can hardly be realized in practice. The rolling avalanche can't be stopped anymore by normal means. A synchronous operation between the neutrino oscillation and the converter can, apart from the technologically hardly realizable high frequency, by no means really be recommended. As a rule one single steep flank of the change of the excitation voltage is sufficient to start the avalanche. By means of the repetition frequency or by means of the duty cycle of the excitation voltage then resonances to the neutrino field can be made or avoided. On the other hand can't be done without the avalanche effect. The utilizable power of the neutrino converter otherwise would be much too small. This case should be pursued further in the design of a longitudinal wave gauge.

All converter systems at first work based on a well-known and tried and tested physical principle of functioning. In the case of the railgun it is the bridge of Ampere. The thus used force effect on a conductor through which flows current is advantageous due to the obtainable order of magnitude and as a basic concept extremely recommendable. But also Coulomb forces or other physical principles can be used.
Despite that a further relation still must be added, which produces the interaction with the neutrinos. Closely associated with the unipolar arrangement it is the unipolar induction, which in virtually all space energy concepts is put to use. It already could be shown that the railgun uses the effect as well as John Searl in the case of his flying disc[ii]. The Faraday law of induction turns out to be the key to free energy.

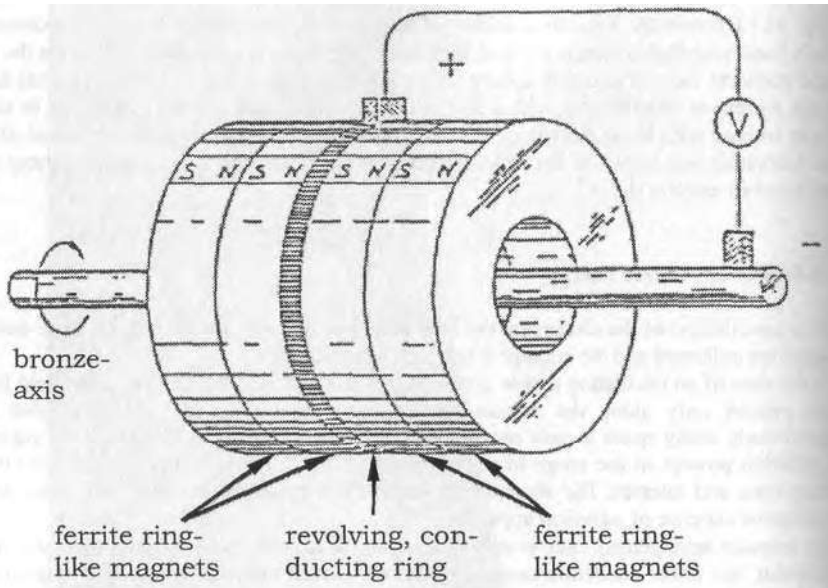

Fig. 16.1: The Faraday generator, which with rotating magnets is called N-machine.<i>

According to chap. 6.5, eq.60 the equations of transformation are:

$$\mathbf{E} = \mathbf{v} \times \mathbf{B} \quad \text{and} \quad \mathbf{H} = -\mathbf{v} \times \mathbf{D} \tag{16.1}$$

where: $\mathbf{v} = dx/dt = v \cdot \mathbf{e}_x$ = component of the direction of motion perpendicular to the area being stretched by the field pointers $\mathbf{H} = H \cdot \mathbf{e}_y$ and $\mathbf{E} = E \cdot \mathbf{e}_z$.

Thus in addition to the basic fields E and H (at v = 0) additional fields E_z and H_z, depending on motion, occur and the overall fields E_o and H_o are measured (which corresponds to eq. 63 in chapter 6.5):

$$E_o = E + E_z \quad \text{and} \quad H_o = H + H_z \tag{16.2}$$

(which corresponds to eq. 62 in chapter 6.5):

with: $$E_z = v \cdot B \quad \text{and} \quad H_z = -v \cdot D \tag{16.3}$$

Table 16.2 A: The equations of transformation of the electromagnetic field.<ii>

16. Space energy technology (SET)

It quite concretely concerns the question for a technology concerning the use of the resonant interaction (according to line 4 in fig. 15.1). For that open and at the same time oscillating electric field lines are needed, which mediate neutrinos and pass them on to a receiver working in resonance. The sun, some planets and other celestial bodies, as we already have worked out, use the effect. Even an entire galaxy is kept together in this way. This interaction plays the crucial role for the theme of space energy and the question is asked, with which technology it can be produced artificially.

16.1 The unipolar generator

The most direct way obviously leads over the Faraday relation concerning the unipolar induction. With the classic Faraday generator, where a permanent magnet is turned along its axis, at first a static electric field can be produced. By rotating in opposite direction or magnets rotating in the same direction but oppositely poled, relatively simple one pole can be „pinned" between the magnets and an unipolar construction can be built. Numerous research scientists already have worked in the area of the Faraday machine more or less successfully (fig. 16.1)[<i>]. There is reported of instabilities and of the picking up of unknown energy at high revolutions per minute. In the majority of the cases it in a sense of the Testatika will concern collected electricity of the air.

The Faraday relation in addition also appears to be hardly understood correct physically by anyone. A scientific magazine in this context takes the opinion: "Faraday proves Einstein wrong", and the production of electricity with Faraday's unipolar inductor violates the laws of physics ![<ii>]

<i>: A. Schneider: Energien aus dem Kosmos, Jupiter-Verlag 1989, S. 44

<ii>: „Faraday in his experiment did let rotate a copper disc above a resting cylinder magnet; as expected in a loop of wire a tension voltage was created (F-machine). Than he let the magnets rotate, and the disc stood still; now again a tension voltage should have resulted - but there was no voltage. In the third experiment the magnet rotated with the disc in the same direction and with the same speed. Because there was no relative motion between both, an induced tension voltage wouldn't have been expected - but it was measurable! (N-machine, see fig. 16.1).
What does that mean? If the relative movement between magnet and disc is not always crucial for the formation of an induced tension voltage, then also the absolute movement has to play a role - because something has to move, for a current being formed. But an absolute movement according to the theory of relativity can't be detected - thus Faraday's experiment proves Einstein wrong! Therefore you won't find anything about this experiment in the textbooks".
Taken out of the article: Faraday widerlegt Einstein, PM-Magazin 11/ 1998, P. 133

from table 16.2 A:

$$\boxed{H - H_o \overset{(16.2)}{=} - H_z \overset{(16.3)}{=} v \cdot D} \tag{16.4}$$

with the velocity $v = dx/dt$,
not accelerated $dv/dx = 0$ (inertial system) and derived for x:

$$\boxed{\frac{dH}{dx} - \frac{dH_o}{dx} = \frac{dx}{dt} \cdot \frac{dD}{dx} = \frac{dD}{dt}} \tag{16.5}$$

The curl of the H-field pointer points in the z-direction:

$$\boxed{\text{rot}\,\mathbf{H} = \frac{dH}{dx} \overset{(16.5)}{=} \frac{dH_o}{dx} + \frac{dD}{dt} \overset{!}{=} \mathbf{j} + \frac{d\mathbf{D}}{dt}} \tag{16.6}$$

comparison of coefficients with Ampère's law:

$$dH_o/dx = \mathbf{j} \quad , \tag{16.7}$$

integrated over dx and ds and formulated generally valid:

$$\boxed{\oint \mathbf{H_o}\, d\mathbf{s} = I_{ein}} \tag{16.8}$$

thus follows from that: <u>magnetic field = vortex field</u>!

<u>Faraday's law of induction</u> (analogous derivation):

$$\boxed{\text{rot}\,\mathbf{E} = \frac{dE}{dx} = \frac{dE_o}{dx} - \frac{dB}{dt} \overset{!}{=} - \frac{d\mathbf{B}}{dt}} \tag{16.9}$$

cause for measurable electric field E_o is missing:

$$dE_o/dx = O \quad , \tag{16.10}$$

integrated over dx and ds and formulated generally valid:

$$\boxed{\oint \mathbf{E_o}\, d\mathbf{s} = 0} \tag{16.11}$$

thus follows from that: the <u>electric field = irrotational</u> (according to Maxwell)!

<u>Table 16.2 B:</u> <u>The derivation of Maxwell's field equations (Ampère's law and Faraday's law of induction) from the equations of transformation of the electromagnetic field</u>

The author of the article proceeds from Maxwell's formulation of Faraday's law of induction, according to which arises a tension voltage in a wire if the wire cuts magnetic force lines, thus is moved relative to a magnet.
If he had read my books, then he would know that Faraday not only has found the older, but also the more comprehensive law, whereas Maxwell only describes a special case. Starting-point for the by me developed theory of objectivity are on the one hand Faraday's law of induction and on the other hand the regularity dual to that, which both together are called equations of transformation of electromagnetism (fig. 6.5, eq. 60 and fig. 16.2 A, eq. 16.1).

16.2 Derivation of Maxwell's field equations

For the derivation we assume, as already in fig. 6.5 for sake of simplicity, that the movement $v = v_x$ takes place perpendicular to the area stretched by the field pointers $H = H_y$ and $E = E_z$. If we derive the equation of transformation, written down for a field component depending on motion, for the coordinate x by using the equations of material and compare the result with Ampere's law resp. Faraday's law of induction, then it becomes clear that the comparison is successful only under certain prerequisites. This circumstance proves that the Maxwell equations only describe a special case and that the equations of transformation are more general valid and causal (table 16.2 A and B).

But in this place is crucial that Faraday's law of induction according to Maxwell only is able to describe a formation of dipoles. For the formation of unipolar field structures however must be fallen back upon Faraday's law concerning the unipolar induction. Whoever wants to understand or even develop by himself concepts concerning space energy, first must have understood Faraday's law in its whole range.

Usually the Faraday generator is, like in the original building shape, equipped with permanent magnets and operated in a steady operating state. Doing so consequently only static electricity is formed. We however need oscillating fields, and for that either the rotation, or the magnet should be changed in polarity with high frequency. Expressed with the precision of mathematics, the first case is described by: $E(t) = v(t) \times B$ and the second case by $E(t) = v \times B(t)$. Both cases have to be investigated and discussed, because both $v(t)$ and $B(t)$ are possible in principle. It is added that in both cases mechanically moving, as a rule rotating, designs but just as well resting designs are conceivable, in which only the moving charge carriers themselves realize the component of velocity v.

This time the crucial point is, that in both cases equally a change of the electric field strength E(t) is produced, with the help of which neutrinos should be collected. Because of the extremely high oscillation frequency of the neutrinos large field changes dE(t)/dt and associated with that large changes of tension voltage dU/dt seem to be the optimal solution, which can be handled with today's technology. Apart from that further difficulties are added, which require a managing in accordance with engineering. If we namely work with a large acceleration dv(t)/dt, then the inertia of the accelerated masses should be overcome, then only very small and light projectiles can be launched like in the case of the railgun. If we however work with fast changes of the magnetic field dB(t)/dt, then the inductance acts slowing down.

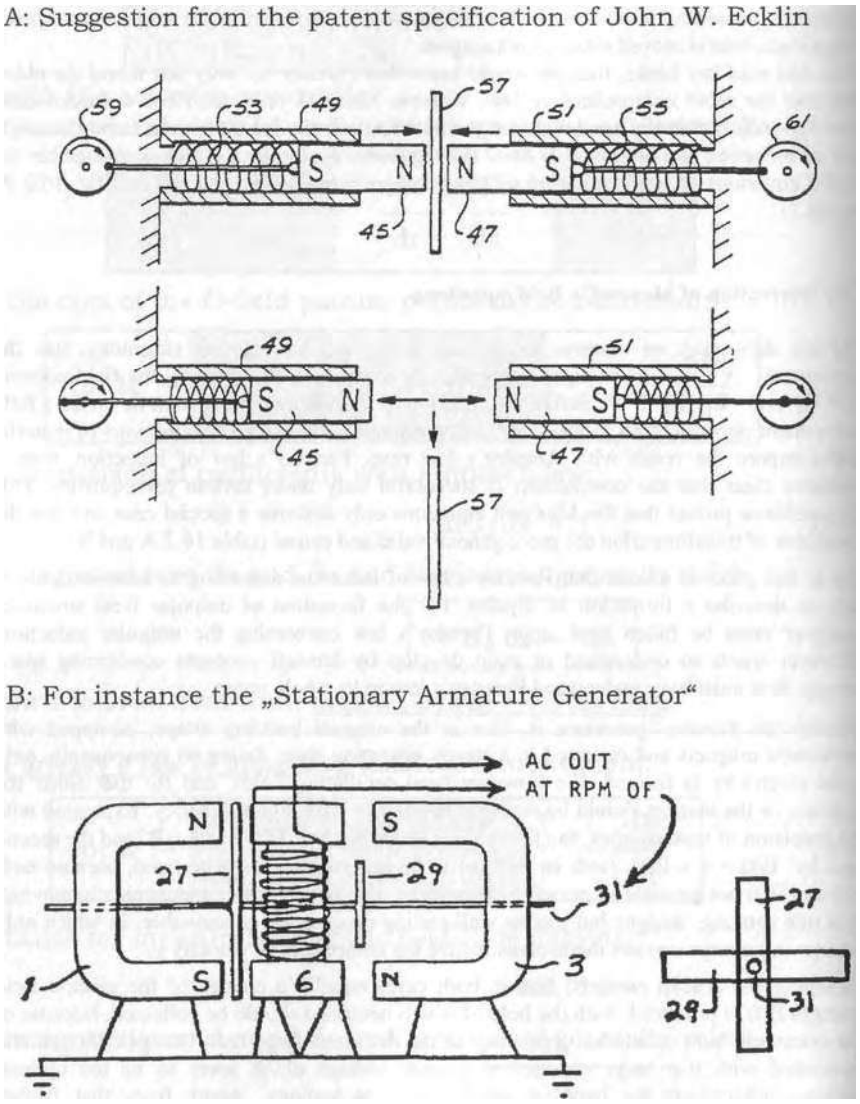

Fig. 16.3: Principle of the Ecklin generator.[i]

[i]: A. Schneider: Generatoren mit Ferritkernumpolung, NET-Journal 6/98, S. 9
Ecklin: Permanent Magnet Motion Conversion Device, U.S.Pat. 3'879,622

16.3 SET-devices with rotating magnetic fields

If we again come to speak of the Faraday generator, which can be built up in two variants. In the case of the F-machine the magnets rest and only the disc rotates, whereas in the case of the N-machine the magnets rotate along. In this case can't be avoided that some of the induced charge carriers roam about in the magnets and sensitively disturb the structure of the material. One only thinks of the bending spoon effect!
The consequences stretch from a loss of the permanent magnetism, over a shattering and bursting up to a pulverizing of the magnets. Adventurous rumours and alarming reports in this direction are sufficiently available.
An improvement could be obtained by an isolation layer between the conductive disc and the magnets, but against induced charge carriers inside the rotating magnets this measure is not able to achieve anything.
Anyhow the best thing to do will be to completely do without permanent magnets in neutrino converters! If we replace them at least in our minds by electromagnets, then a feeding with alternating voltage is possible. That also is necessary if oscillating neutrinos and not air ions should be collected.
As a result of the alternating voltage at first large eddy currents occur in the disc. The losses can be reduced by radial slits in the disc. The induced currents then only can, as wanted. flow radially to the outside.
Bigger headaches causes us on the other hand the inductive and with that current storing effect of the excitation coils. If a too large excitation inductance should prevent a fast increcase in current, then also the induced electric field will increase correspondingly comfortable and hardly be able to persuade a single neutrino to stay.
A coil core of iron or dynamo sheet metal with that is ruled out from the start. Even ferrite would be suitable at most conditionally. Usable are air coils with as possible as few turns.
In an advantageous design the slit copper disc rotates between two air coils, if need be flat coils built in the way Tesla did, which are fed with pulsed tension voltage.
The highest speed of change in current surely is obtainable by means of a spark gap, like already Tesla has used (fig. 9.1). But also other techniques are thinkable as pulse driving. For instance semiconductor power amplifiers with MOS transistors not only can be switched fast and hard, but in addition frequency and duty cycle can be adjusted freely with reproducible exactness. These are niceties, which will gain importance in connection with the control and regulation of a converter.

Und the heading "generators with magnetic flux variation" Mr Adolf Schneider has collected and commented on some concepts<1>. The generator of the american research scientist John W. Ecklin registered for patent at 22-4-1975 thus stands as an example of a whole group of inventions, in which the magnetic conductivity in the magnetic circuit and with that the flux is changed with a jump.
Fig. 16.3 B shows a building form consisting of two horseshoe magnets (1, 3) with a likewise resting coil in between (6). In rest the magnetic circuit experiences no change and consequently no tension voltage is induced in the coil. The trick is that an axis (31) is pinned right through the arrangement which is turned with two soft iron anchors, which magnetically short-circuit alternating the left (27) and the right (29) horseshoe magnets.

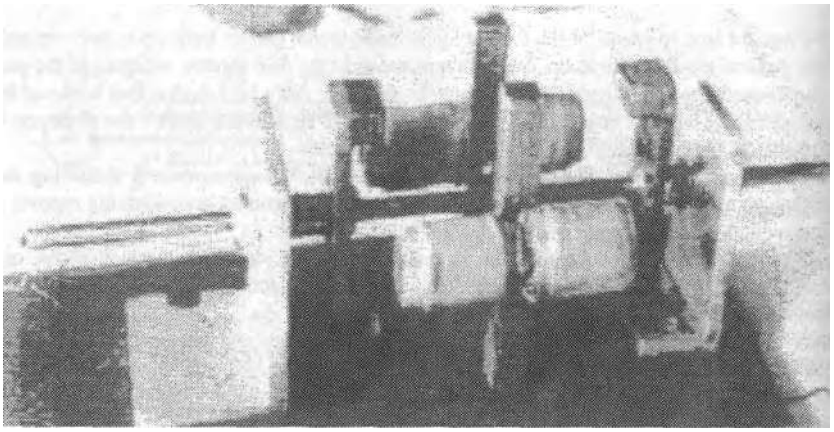

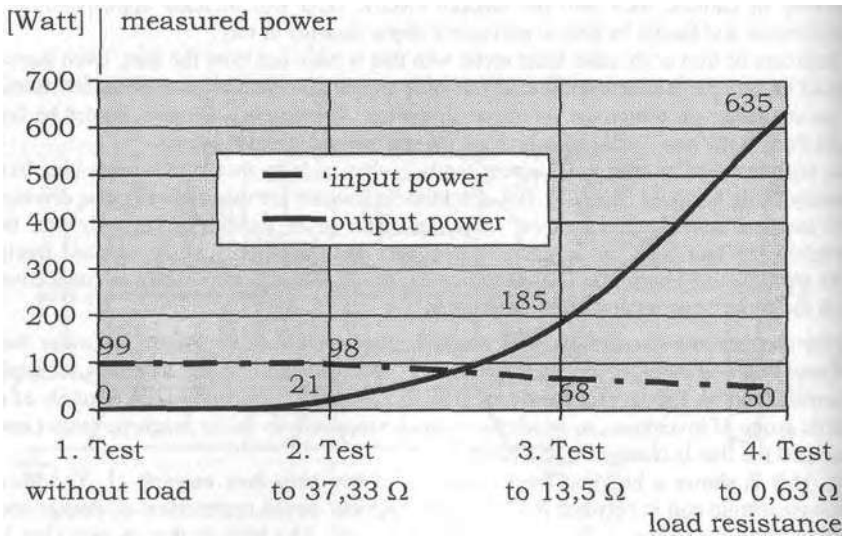

Fig. 16.4: Bedini magnetic converter.[i]

[i]: A. Schneider: Generatoren mit Ferritkernumpolung, NET-Journal 6/98, S.10

Besides the moment of reluctance, which should be compensated by the physical principle, and the friction of the bearing actually no further moment of reaction can occur which would have to be gotten over, not even then if current is taken out of the coil. If the flux change is large enough, purely arithmetically it should be possible to take off an electric power which is considerably larger than the friction power. John Bedini has 1985 measured an over-unity effect of up to 12.6 at a similar constructed generator, where with increasing strain also the factor could be increased (fig. 16.4).

16.4 Commentary concerning magnetic SET-devices

I judge these measurements rather sceptical, after I already in three cases had to break the message gently to the inventors, that their device unfortunately was nothing but an energy destroying machine and they merely had measured wrong, where admittedly the measuring of pulsed tension voltages and currents is not quite simple. So that you don't become a victim of wrong hopes and self-deception, I recommend all SET inventors to realize the closed-loop. If in the continuous operation power can be taken out of such an arrangement without supply of energy from the outside, and be it as small as possible, then that convinces everyone even any journalist and any non-expert.
Unfortunately in the case of numerous concepts at this place already the end is reached. As charming the variation of the magnetic circuit may be, in most cases I miss the unipolar arrangement of the fields. Perhaps here no neutrinos are needed at all and energy merely is withdrawn from the environment heat? I'm not able to answer this question and I surely don't need to, as long as no magnetic converter is demonstrated to me as closed-loop. such a converter, if it can be realized, presumably will at least partly hide one of its poles and produce some open field lines; that at least would be expected.

a still bigger measuring technical problem represent the neutrinos bound to a line, which oscillate around the conductor in the form of ring-like vortices. We have become acquainted with these in the case of the single-wire transmission technique of Tesla (fig. 9.5). They are formed, if neutrinos are slowed down and collected, but not yet have materialized to charge carriers. Tesla did use them for his loss-free energy transmission technology, but he couldn't supersede the alternating current technology full of losses, which also stemmed from him but which he called the worse technology, from the market because there were no power meters available for the single-wire-technology.

Today we still aren't one step further. The energy supply enterprises still decline this technology, as I had to learn myself, although this would be the only way to transport solar energy from the desert or energy from the geothermal energy of Iceland by a sea cable to Central Europe, where it is needed.
Today still no gauges exist for such neutrinos bound to a line. Therefore will every measuring technician experience his Waterloo at SET-devices, in which they occur! I now will report of such a converter and the odd measuring problems.

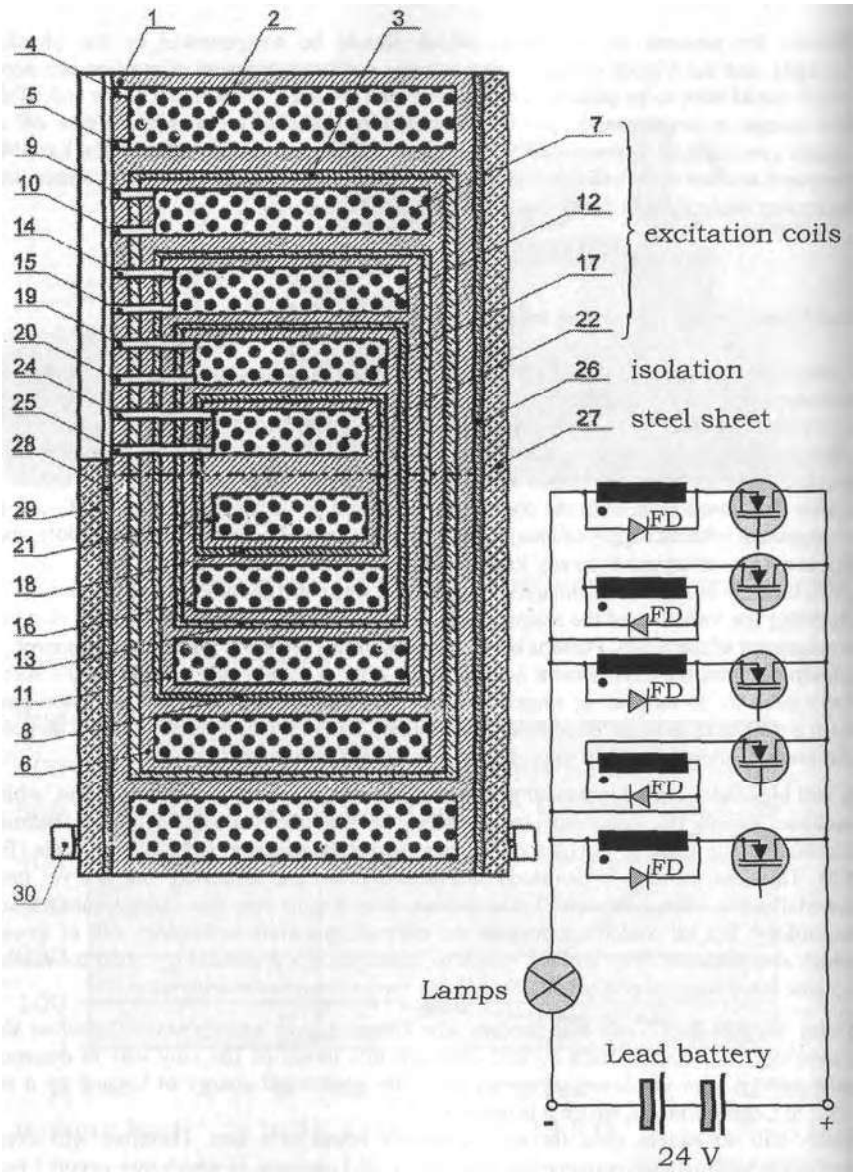

Fig. 16.5: Space quanta manipulator of the Firma ROM AG<i>

<i>: Gibas, Greilinger, Lehner, Rusterholz: Strom aus dem All, Mega Link, Fachzeitschrift fur Elektronik, Nr. 6, Marz 1998, S. 18-23 resp. Bau: Glaube kann Berge versetzen, Bulletin SEV/VSE 25/97, S. 31

16.5 RQM and the space quanta manipulator

If an employee or one of the numerous shareholders of the Swiss Firma RQM AG in Rapperswil speaks of space quanta, then he with that presumably means the neutrinos. An oscillating source of neutrinos is called central Space Oscillator and an operation in resonance of the energy receiver, the so-called space quanta manipulator, is required.
Mr Ludwig Sigrist, the creator of this world of imagination, was not a physicist but crane operator (pseudonym Crane O.) and inventor, whom textbook physics couldn't help further in his considerations anyhow. His concept, if it can be translated into a scientific comprehensible language or not, at least helped him personally and gave him the position to create the space quanta manipulator (fig. 16.5).

It consists of several pot coil systems, which are build up and boxed into each other according to the Matrjoschka principle of scaling down. The ferromagnetic core material of the pot spheres (1, 6, 11, 16, 21) should show magnetostrictive properties as distinct as possible. As we will see, this measure gains its actual importance first in connexion with the interaction with neutrinos!

Each pot sphere carries an excitation winding (2, 7, 12, 17, 22), through which alternatively flows a current in opposite direction. By means of this measure, which seems useless according to classic design concepts, one of both field poles is pinned in the centre, in which way the necessary open field lines are produced.

The individual pot spheres are insulated from each other, where the isolation layers (3, 8, 13, 18, 26, 28) should have a high dielectricity. The pot spheres thus in addition form capacitors with each other; even the ending plates at both sides (27, 29) function as capacitor plates.
This construction, the core piece of the planned RQM converter, is driven by a transistorised power amplifier with excitation impulses as steeply flanked as possible. According to patent specification[<i>] the pulse widths are freely eligible in steps of 5 ns betweeen 200 nanoseconds and one second. Besides the frequency also the polarity and DC voltage offset are adjustable.

Every visit of the laboratory leaves a lasting impression: Carefully the engineers grope forward, turn at the frequency and the duty cycle, until the effect suddenly occurs and neutrinos, the space quanta, are being collected. One realizes that tuning parameters with still stronger reactions would be possible, but entirely without any regulation and limitation of power that can't be controlled anymore. The avalanche effect would destroy everything, and so one is further dangling along the brink of the abyss in the development laboratory of the RQM, all the time trying hard to gain control of the hardly understood effect.
Concerning the setup and the mode of operation of the pot system the inventor did let his posterity have explanations, but why a diode in free operation FD suddenly loses its rectifying function, for that neither the employees nor specialist visitors of as high as possible scientific rank in the laboratory until now had ready an answer.

<i>: Gibas, Lehner, Greilinger: Vorrichtung und Verfahren zur Erzeugung elektromagnetischer Pulse, Patentschrift CH 687 428 A5 vom 7.5.1996

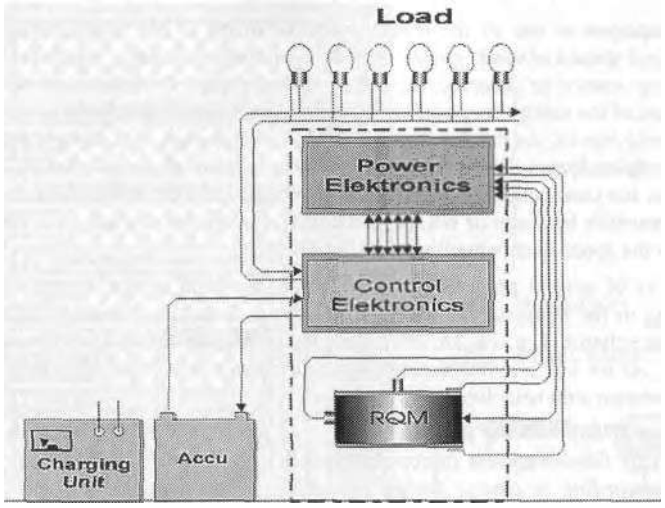

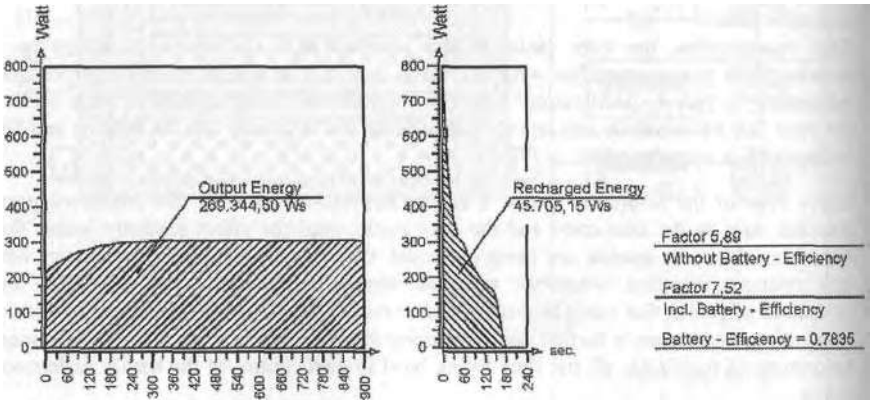

Fig. 16.6: The RQM test installation of 23-9-1996<i>

<i>: F. Greilinger: Der Weg zur erfolgreichen, stabilen Energieauskopplung, RQF Magnetik, Sonderausgabe 1996, page 10

As said, the neutrinos no longer are free but bound to a line, if they leave the pot system. They oscillate around the wire, even around every semiconductor and rove through the entire switchboard. Doing so they can cause quite something, also bring about quite some disaster.
Lead batteries are being recharged, which without doubt is desirable, but in the continuous operation they are destroyed by the same vagabonds. In normal light bulbs for instance some of them materialize to charge carriers, so that according to a gauge more current leaves the light bulb, as on the other side flows in to it. It indeed glows completely normal, but measuring technical for the installation nothing is normal anymore.
The visitor can be shown by means of a high precision measuring facility of vibrations that the pot coils oscillate not only electrically and magnetically, but also mechanically. But the effects alone don't make a converter, which can be produced and which await already numerous buyers of options and licenses.
On the one hand measures for the purposeful conversion of the roving space quanta in utilizable charge carriers here still are missing. On the other hand any controlling facility is missing, to adapt the power taken up from the neutrino field to the momentary need of the consumers. The brave engineers of the RQM still have quite some way in front of them. but the line of approach is right and the reached can be looked at.

16.6 SET-devices with pulsed magnetic fields

In the case of the space quanta manipulator mechanically nothing is moving. In the copper coils the charge carriers merely are on the way with the velocity v. We here have present a typical example of a SET-system with pulsed magnetic field. Compared to the before discussed SET-devices with rotating magnets, for instance the N-machine, the space quanta manipulator clearly has its nose in front. Without brushes, without friction and wear and tear it theoretically has a unlimited life.
In addition it is simpler to produce the necessary large steepness of the flanks in an electronic way as by a mechanical variation of the magnetic field. By means of electronically driving the process it also can be checked, controlled and regulated easier.

The question for an optimisation of the concept still remains. At present one already can be satisfied with a study of possibility, but sometimes one will question the design. There as an example the eddy current losses in the iron pots will be at discussion. About sheeted or sintered materials could be thought, if not at the same time the inductance of the coil would increase in that way, which slows down the increase in current. Ferrite materials again are very brittle and would crumble to dust under the mechanical oscillations of size. I proceed from the assumption, that also here an arrangement with air coils could turn out to be an optimum. It does make sense, if Tesla at higher frequencies always did experiment with air coils.
Now it still depends on the coiling technique. One single conductor loop doesn't provide any open field line. For this purpose if need be two loops have to be supplied with current in opposite direction, like it is the case for a so-called Mobius winding. In this way possibly just as many neutrinos interact as in the case of the pot coils of the space quanta manipulator, which are alternatively supplied with oppositely phased current. To clarify the situation we now should occupy us with the coiling technique.

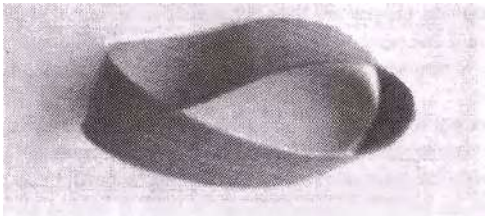

Fig. 16.7 A: The Mobius band

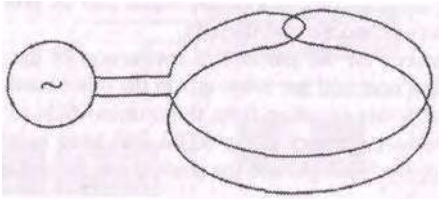

Fig. 16.7 B: The Mobius strip

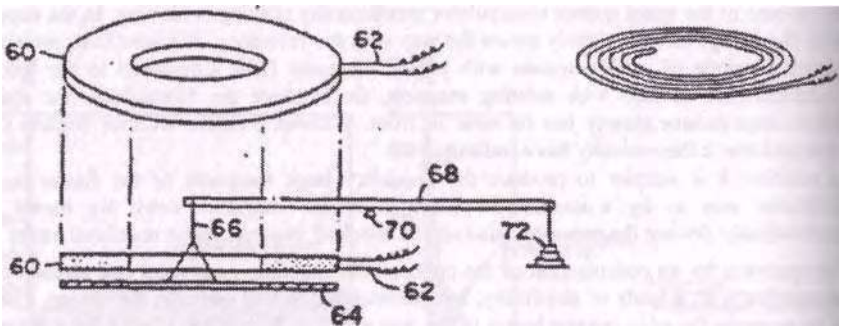

Fig. 16.7 C: Bifilar wound flat coil

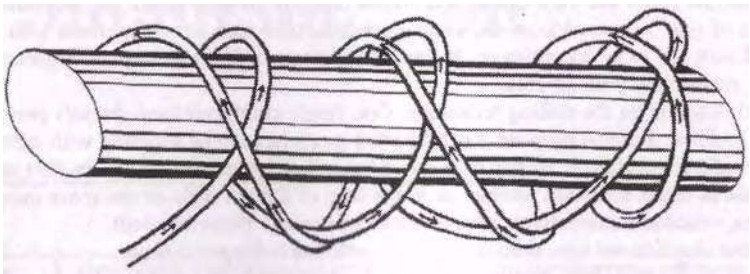

Fig. 16.7 D: Mobius winding arranged like a cross

16.7 SET-devices with Mobius winding

In connection with space energy devices often is talked about the use of a Mobius winding. That is traced back to the Mobius band, which one obtains, if one for example one end of a long paper strip after a half turn glues together with the other end. The result is a strip, which has neither top side nor underside and neither right nor left border. This object with only one side and only one border is a creation of the German mathematician August Ferdinand Mobius (1790 - 1868), fig. 16.7 A.

A distant relative of the Mobius band is the strip with the same name, where the magnetic field lines mutually cancel out. It is the same compensation, as we know of a two core electric cable, where the supply and return cable are run close together. For that the sense of winiding of a conductor loop simply is reversed (fig. 16.7 B).
If the magnetic field vector is wrapped right-handed around the supply cable and left-handed around the return cable, then both amount to zero, so that measuring technical no rest field can be detected anymore at some distance.
THE pointer of the electric field stands perpendicular to the magnetic field vector and points in the direction of the conductor and the movement of the charge carriers. From the coupling of magnetic and electric field follows, that the compensation of one of them also leads to the compensation of the other one. But if the electric field actually is compensated, then there may not flow any current in the winding!
There however flows a current if an electric tension voltage is supplied to the Mobius winding. As a result of this forced current flow both electric and magnetic fields have to occur, which are not compensated! Some field lines will fold outward the expected direction and stand in space as open field lines. These we, in the oscillating case, owe the interaction with the neutrinos.

A perfect compensation would be expected for a two core, bifilar winding. The American physicist William Hooper was able to obtain interesting effects with a bifilar wound flat coil. With help of a balance he could detect attracting or repelling force effects on different, electrically or magnetically neutral discs (fig. 16.7 C)[<i>].
But he feeds the flat coil with direct current, so that a contribution of neutrinos can't be expected. Such effects only will occur, if one works with pulsed signals, because the bifilar wound flat coil quite obviously is able to form wanted, open field lines.

<i>: Schneider, Adolf: Energien aus dem Kosmos, Jupiter-Verlag 1994, page 28, taken out of:

Mielordt, Sven: Tachyonenenergie, Hyperenergie, Antigravitation, kaum & Zeit Verlag 1984

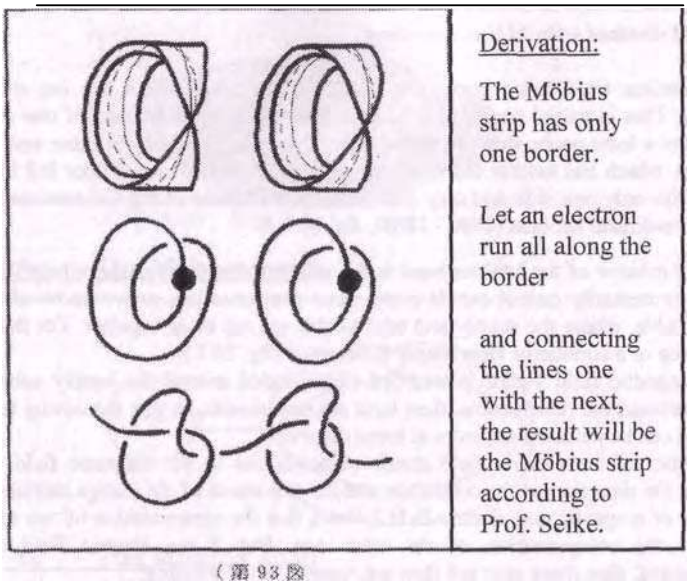

Fig. 16.8 A: Derivation of the Mobius strip acc. to Seike<i>

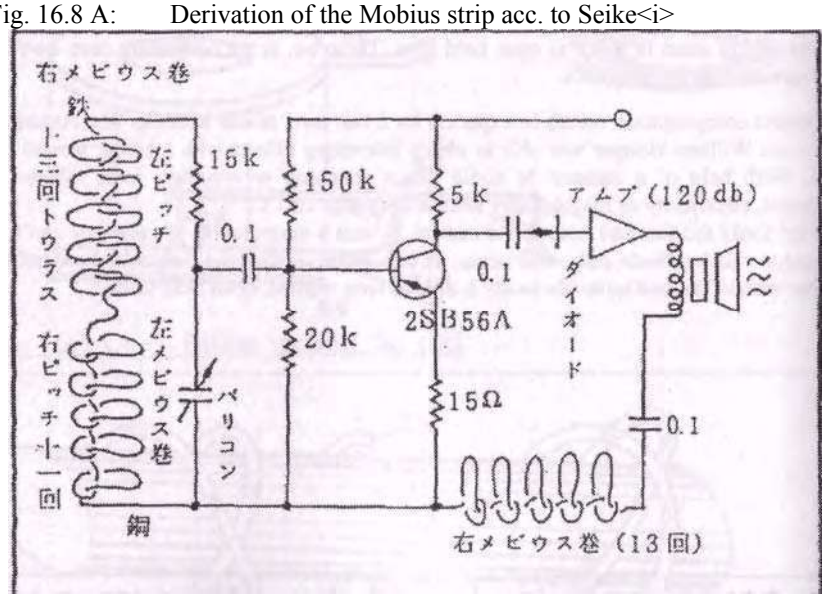

Fig. 16.8 B: Scalar wave radio according to Prof. Seike<i>

<i>: Seike, Shinchi: The Principles of Ultra Relativity, Space Research Institute 1990, ISBN 915517-1

16.8 Mobius converter of Seike and Coler

Concerning construction it can be an advantage to wind a Mobius coil not purely bifilar and in that way to do without a perfect compensation. It often already is sufficient, if two conductors cross and only individual components of the field vectors partly cancel out. In the case of the coil, which is pulled apart and wound like a cross, drawn in fig. 16.7 D the conductor current and the fields of supply and return cable belonging to it stand under an angle of almost 90°. This in individual cases should already be able to cause the formation of open field lines.

Similar field conditions are formed, if after every turn the wire is looped under the last winding. At the knots again the angle conditions of approx. 90° occur. The Japanese professor Shinichi Seike preferably works with this kind of winding, which he directly derives from the Mobius band (fig. 16.8 A)[<i>]. He has designed an electro-gravitation motor basing on this principle. He also speaks of weight reduction and of an artificial anti-gravity field. It could be confirmed experimentally, that his setup cooled down slowly during the operational tests, despite the expected heating up by the copper losses of the current[<ii, S.29>]. Unfortunately I don't known anything more exact.
In his book further is found the wiring diagram of a radio for the reception of scalar waves (fig. 16.8 B). He thereby quite simply replaces all coils in the high-frequency part with his Mobius coils. If longitudinal waves already are measurable and receivable with this simple measure, first has to be checked.

The German captain Coler more than 50 years ago has developed another Mobius converter. His "Magnetstromapparat", with approximately 6 kW power and an at least four-fold over-unity effect uses six coils with permanent magnetic core. As a peculiarity he in addition runs the coil current through the core under an angle of 90° with regard to the coil current (fig. 16.8 C).

More detailed details can be seen in the footnote[<ii, S. 22>].

<ii>: Adolf Schneider: Energien aus dem Kosmos, Jupiter-Verlag 1994

S.22: "Scientists of the Technical University Charlottenburg in Berlin and Munich confirmed that the device functioned without objections, but they didn't find a theoretical explanation for the production of energy. The professors Kloss and Franke of the Technical University of Berlin found a degree of effectiveness of 450%. Prof. Schumann confirmed that 4.8 to 6.7 times more energy came out, than was put into the device. Prof. Schumann excluded a deception entirely as the records prove.
But it wasn't simple to set the device going and the stability for longer periods of time wasn't guaranteed. The war confusion set an end to further research. After the end of the war the British secret service confiscated all available documents and apparatus. Part of the report was declassified in 1962".

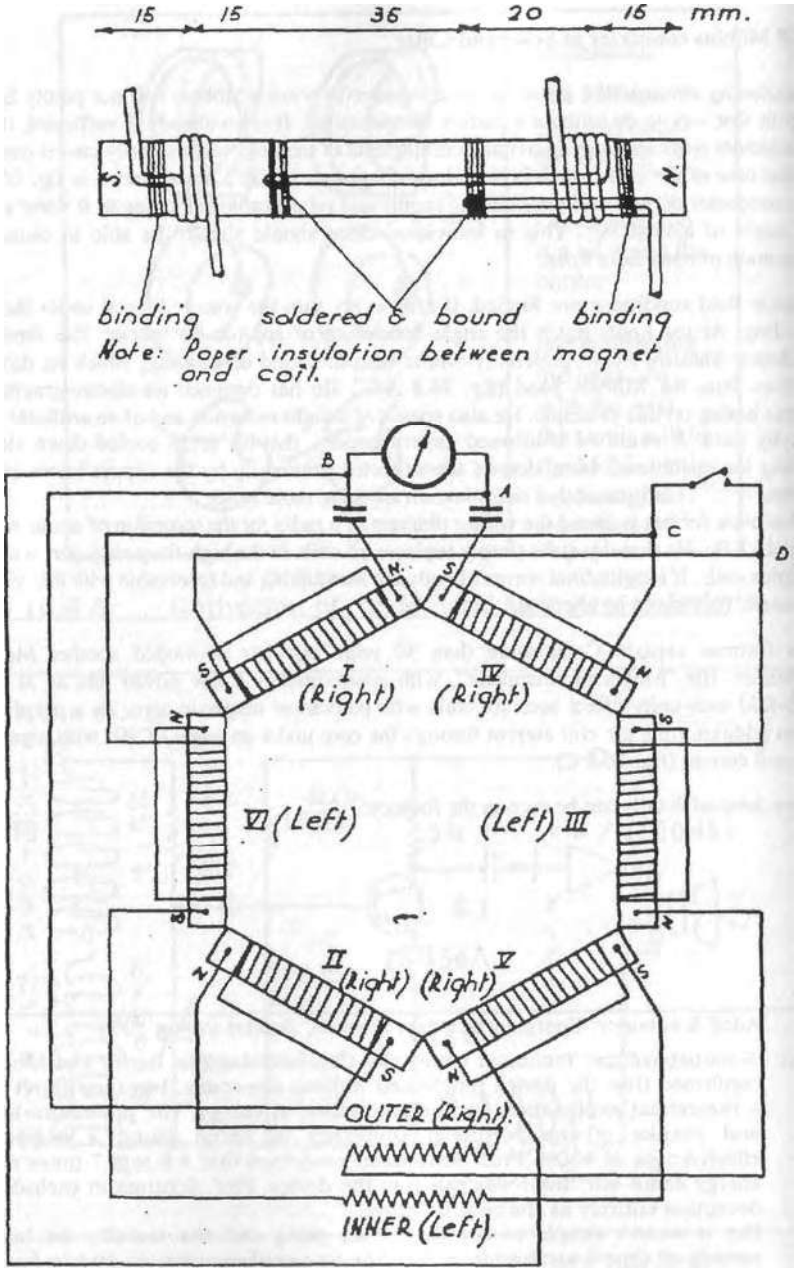

Fig. 16.8 C: The Coler converter

16.9 Tesla's flat coil

In the category of the unconventional coiling techniques without doubt the Tesla coil may not be missing. If in schools and high schools such coils were standing in the laboratory for teaching purposes, then as a rule it are cylindrical coils. In reality Tesla worked with flat coils but that, so is said, isn't necessary anymore today, since we have at our disposal better isolating materials than 100 years ago. Actually Tesla contended with problems of osilation, which he could solve with the help of the flat coil, but it should turn out that the coil geometry is attached a crucial importance.

Everything had started with Tesla having to leave the Technical Highschool in Graz without diploma. He ran out of money and he had dared to criticize the venerable Professor Poeschel and his sparking Gramm dynamo. With that he had put himself under compulsion to succeed. Two years later he had ready the solution. In the year 1882 he discovered the rotary field in Budapest.
In the time to come he designs and builds an alternating current motor, but no-one wants to have it and surely Thomas Alva Edison not. Tesla after this disagreement very fast gives up his job at the Edison Company again and again stands under pressure to succeed. With that the eternal bachelor Tesla urges himself to ever higher efforts. He wants to prove himself and the rest of the world that his alternating current system is superior to the direct current system.
Direct current, as is well-known, can't be transformed, and thus the advantage of Teslas alternating current lies in the possibility of power transport by high-tension cable over large distances. But for that the high-tension transformers first had to be developed and thereby the said problems of isolation occurred.
With each turn the tension voltage at the transformer winding increases. The distance to the grounding point lying on the outside has to be chosen bigger with each turn, so that no blow inside of the high-tension winding occurs. A consistent solution of the problem in accordance with engineering is the flat coil used by Tesla, wound spirally from the inside to the outside (fig. 16.9 A)[<i>].

It thus is correct that isolation technical reasons led to the flat coil, since Tesla himself was completely surprised as he had to find out that this coil can lose its self-induction, that scalar waves can be detected with it and that it is cooled down during operation in an inexplicable manner.

This cooling effect Tesla has investigated more detailed and after all even used. In his patent specification concerning the superconductivity he describes, that the flat coil also loses its Ohmic resistance, if he in addition previously cools it with liquid air. The remaining cooling down to absolute zero his flat coil obviously has carried out entirely by itself with help of the neutrinos (fig. 16.9 B)[<ii>].

<i>: Nikola Tesla: Coil for Electro-Magnets, Patent No. 512,340 (1894)

<ii>: Nikola Tesla: Means for Increasing the Intensity of Electrical Oscillations, Patent No. 685,012 (1901)

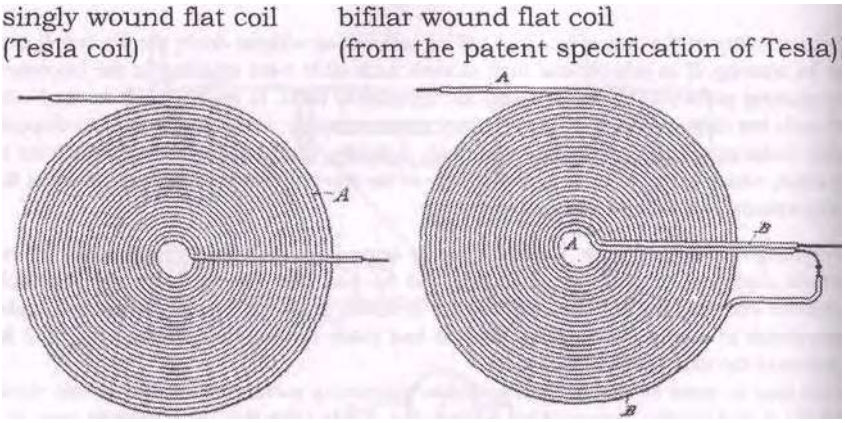

Fig. 16.9 A: Coiling techniques of Tesla's flat coil.[i]

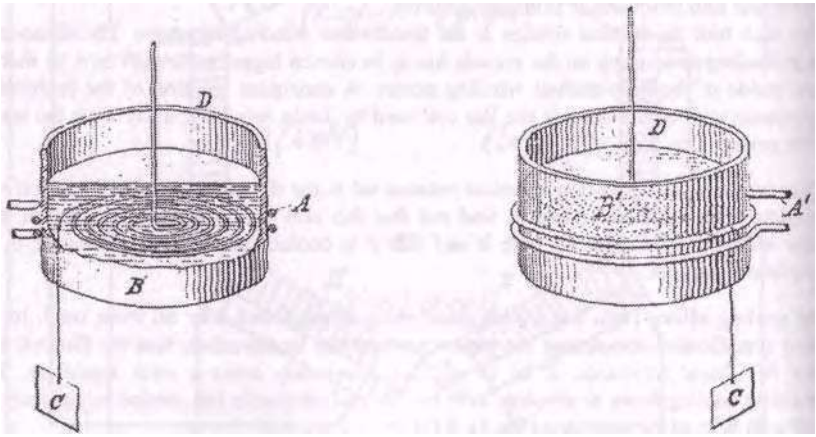

Fig. 16.9 B: Patent specification of Tesla concerning Superconductivity.[ii]

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[i]: Nikola Tesla: Coil for Electro-Magnets, Patent No. 512,340 (1894)

[ii]: Nikola Tesla: Means for Increasing the Intensity of Electrical Oscillations, Patent No. 685,012 (1901)

16.10 The secret of the flat coil

The technical function could be explained in the way that the charge carriers of a flat coil by induction are set into motion for excitation from the outside. The transmitted energy shows in form of kinetic energy. The spiral flat coil becomes narrower and narrower towards the inside, the length of each winding shorter and shorter, so that the kinetic energy inevitable has to decrease in favour of a rotational energy. The faster and faster rotating spherical vortices are pulled apart to flat discs and eventually to ring-like vortices by the centrifugal force. The electrons at first become neutrinos bound to a line and finally free neutrinos. Tesla has technically used the first ones in the single-wire-transmission technique (fig. 9.5) and the last ones in his wireless energy transmission (fig. 9.7).

Like many other inventors, Tesla owes also the inventions, which he counts his greatest, like the radio technique and the Magnifying Transmitter, first of all his industriousness. his persistence and a great deal of inventor luck. A magician, as he is called in his most important biography, he by no means was[<i>]. The flat coil, to which led him chance and which plays a central role in all these inventions, gave him the lucky position, to collect neutrinos and materialize them to charge carriers or in reversed direction to dematerialise electrons to neutrinos.

The technology however is everything else but new. Already the Lituus of the Etruscan and Roman Augurs and the crook of the priests had the same spiral structure (fig. 16.10). In the case of the devices, which the Augurs for instance served at land surveying, it clearly concerns flat coils according to Tesla. We will go into this strange „gauge" more in detail in part 3 of the book[<ii>].

The trick probably is, that one component of the electric field pointer is directed towards the centre of the coil and as a result some open field lines are generated, which then collect neutrinos from space.
In this process the neutrinos thanks to the resonant interaction are slowed down to the speed of light and following, as discussed, materialized by means of the flat coil, as in addition rotational energy is withdrawn from the neutrinos. Since the receiver oscillates resonant with opposite phase, in addition the thermal oscillations are reduced and the receiver becomes cold!

If one compares the Mobius coil with the Tesla coil, then besides numerous properties in common the strength of the first coil lies in the production of open field lines and the collection of neutrinos, whereas the special and additional property of the flat coil lies in the materialization, in the conversion of neutrinos into charge carriers. But the advantages of the flat coil have to be bought at the expense of having to work with very high tension voltages (above 511 kV) and with large changes in tension voltage (du/dt). With this set of difficulties we will have to deal in more detail.

<i>: Margaret Cheney. Nikola Tesla, Erfinder, Magier, Prophet (Orig.: Man Out Of Time, 1981), Omega-Verlag Diisseldorf 1995

<ii>: K. Meyl: Electromagnetic environmental compatibility, part 3, edition belonging to the information technical seminar, INDEL Verlagsabteilung 2003.

Fig. 16.10: The Lituus or crook of the Augurs in ancient Rome

16.11 Discussion concerning the technology of the neutrino collectors

Let us again collect the facts for the discussion: A SET-device is distinguished by a more or less unipolar design and open field lines, with which interact neutrinos, which are oscillating in resonance. These then are slowed down and collected. For the transient process a large change in tension voltage (dE/dt) is required, which can be obtained directly, for instance by means of a spark gap, or indirectly by means of Faraday's law concerning the unipolar induction (E = v x B).
The discussed possibilities concern the acceleration of a machine part (dv/dt), the variation of the magnetic field (dB/dt) by pulse-like excitation signals (16.5) or by magnetic flux variation (16.3) and the railgun. which even can be operated without foreign magnetic field (fig. 15.5 C) and for which in that case occur both a dv/dt and at the same time a dB/dt.
For resting arrangements the velocity v is that of the charge carriers moving in the conductor. So that Faraday's law thereby doesn't lose its influence, the pointers of E and v mustn't point in the same direction, as in the case of "normal" coils. Unconventional windings, which for instance can be knotted like Mobius strips (16.7), take remedial action. Also the ancient crook, rediscovered as flat coil of Tesla (fig. 16.10), proves to be suitable in principle. Here one component of the electric field pointer points in the direction of the centre so that the wanted, at least partly, unipolar arrangement can be formed.

The first step, the collecting of space quanta, shouldn't pose an insurmountable obstacle anymore in view of the numerous possibilities and the detailed explanations. A real difficulty we still have before us, because in most cases some ring-like vortices bound to a line are formed, for which no electronic construction element exists and for which functioning converters hardly are known.
There spoons are bending, some lumps are flying through space, radioactivity is disappearing without a trace, light phenomena are formed and the device suddenly is becoming cold. Almost all inventors, who have arrived in this place, are enthusiastic about the not understood effects or with that are wanting to get attention, but hardly anyone really starts something with that. Until now the necessary system and an useful theory were missing.

Only too often isn't considered, that only an indirect conversion into charge carriers is possible, that during the materialization of neutrinos a intermediate product is formed, which can be described with the model concept of a neutrino bound to a line or of an oscillating ring-like vortex. The technologies collected in this chapter concerning the collecting of neutrinos only form the first step from the free to the bound ring-like vortex. The coming chapter is dedicated to the second step. Here we should try to understand the properties of space quanta bound to a line and loudly think about for which purpose we could use them in practice[<i>].

<i>: Reference: Both chapter 16 and chapter 17 treat point 4 according to table 15.1 concerning the resonant interaction (page 86).

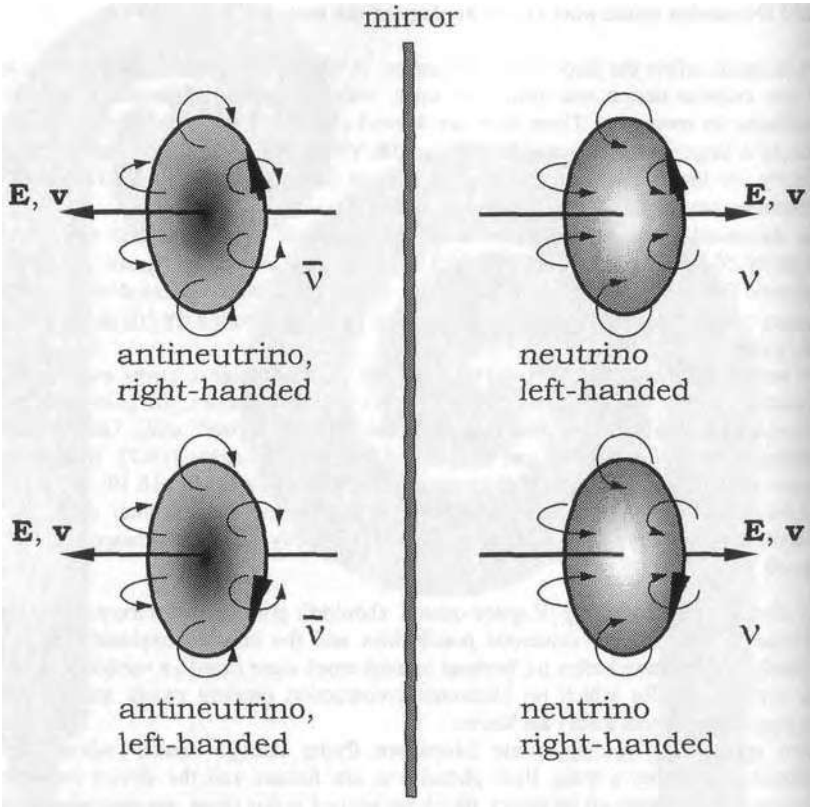

Fig. 17.1: _____Application of the mirror transformation to the neutrinos

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<i>: Kleine Enzyklopadie Atom, Verlag Chemie GmbH, Weinheim 1970, S. 119:
„For the neutrinos the quantum number parity isn't defined, because they have a fixed association of the direction of momentum and spin; the sense of rotation of the spin and the direction of momentum in their case form a left-hand wound screw, in the case of antineutrinos a right-hand wound screw. By the shown mirroring the direction of momentum is reversed, but the sense of rotation remains unchanged; i.e. reactions, in which neutrinos occur, are not mirror invariant, they violate the law of conservation of parity". (translated)

Note of the author:, an antineutrino by no means can be assigned to the anti-matter, since it exactly like every neutrino alternatingly takes the matter state and the anti-matter state, by oscillating around itself (see fig. 7.12). The description merely follows a definition founded in usefulness.

17. Technical use of the weak interaction

17.1 Radioactivity caused by neutrinos

Neutrinos are standing in a weak interaction with other elementary particles. This circumstance is known in general. According to the considerations and derivations expressed in the book the neutrinos mediate the resonant interaction, what leads to the conclusion, that the weak interaction represents a partial aspect of the resonant interaction, in which case it merely concerns the proximity.
Efforts are further being undertaken, to combine the weak interaction with the electromagnetic to an electroweak interaction, after it was remarked that a certain coupling constant corresponds in both cases. We of course aren't surprised, because the electromagnetic interaction anyhow describes only the special case of the resonant interaction with the frequency zero.
The weak interaction concerns with the very small range of just 10^{-16} meters only the proximity of the neutrinos, for instance the ß-decay, where the neutrinos for the reason of their oscillating charge a free neutron rattle and shake so long, until it eventually decays. on the average after approximately a quarter of an hour.

The Austrian physicist Wolfgang Pauli had remarked, that half the decay energy after a beta-decay is missing and the balance sheet of energy isn't working out. In addition also the balance sheet of angular momentum isn't working out, because the nuclear spin is being changed for a whole unit. Pauli as a result 1930 has introduced a hypothetical particle without mass and without charge, which he called neutrino.
With that Pauli and his co-working Italian colleague Fermi it is true are the givers of the name of the neutrinos, but not by all means the discoverer. If Cowan and Reines l956 have detected these particles with large expenditure of devices, then also that by no means was a premiere, as falsely can be read in textbooks and encyclopaedias. After all Nikola Tesla already decades ago had demonstrated, that the neutrino radiation not only exists, but even can be used energy technically.

Now the radioactive decay a ß-radiation occurs, triggered by the conversion of neutrons in protons or vice versa. This obviously takes place under the influence and participation of neutrinos in the atomic nucleus. The ß-radiation to a special extent consisting of electrons and positrons, as it occurs in the case of nuclear fission, is quite unhealthy and by no means ecologically compatible. Under the influence of free charge carriers not only metal lattices become soft and spoons can be bent, but also an electrolysis takes place, where the water molecules are splitted into their parts. That isn't a good prerequisite for the flora and fauna on our planet, which predominantly is built up of water structures.

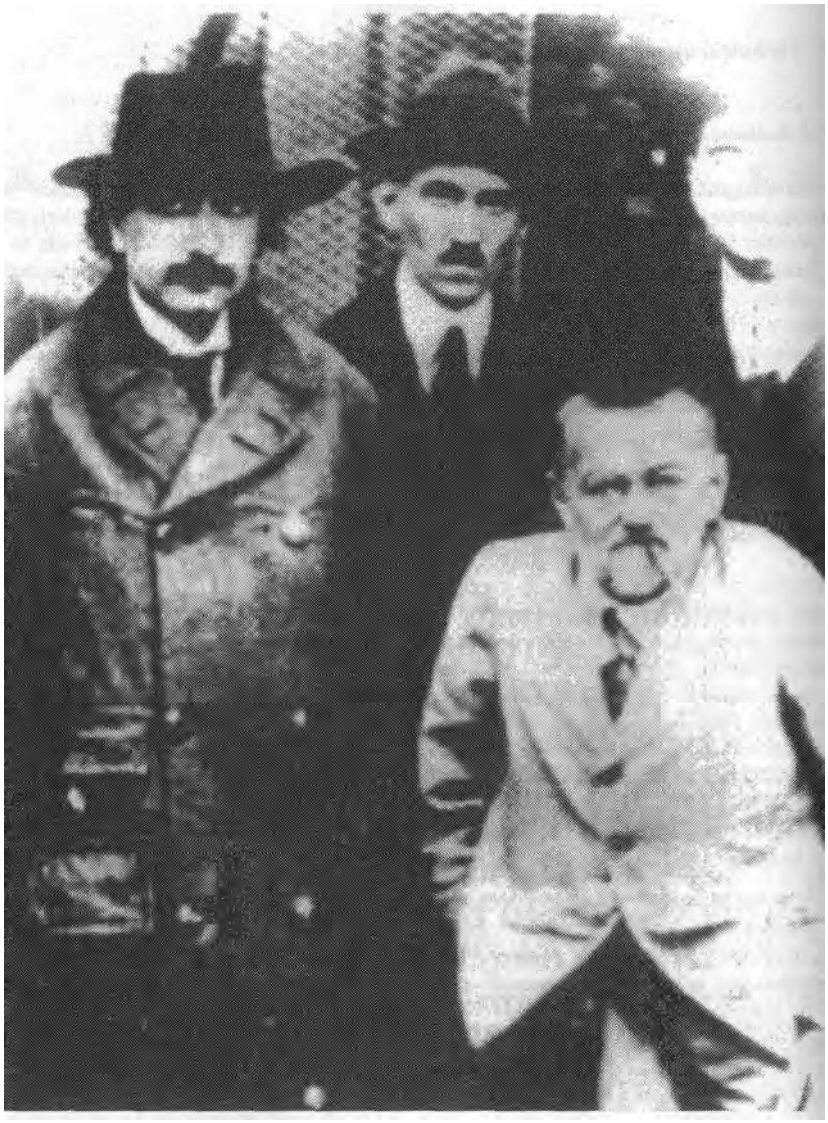

Fig. 17.2: Einstein, Tesla and Steinmetz[i]
(from left to right)

[i]: Franz Ferzak: Nikola Tesla, Eigenverlag, S. 103

17.2 Nikola Tesla, the discoverer of the neutrino radiation

The discoverer of the neutrino radiation himself will best be able to explain the connexion. In the New York Times Tesla writes, that he has discovered and investigated the phenomenon of the cosmic radiation, long before others started their researches[i]:
"According to my theory a radioactive body is only a target, which constantly is being bombarded by infinitely small balls (neutrinos), which are projected from all parts of the universe. If this, at present unknown, cosmic radiation could be interrupted completely, then no radioactivity would exist any longer.
I made some progress regarding the solution of the mystery, until I in the year 1898 attained mathematical and experimental evidence, that the sun and similar celestial bodies emit energy-rich radiation, which consist of inconceivable small particles and have velocities, which are considerable faster than the speed of light. The ability of penetration of this radiation is so large, that it penetrates thousands of kilometres of solid matter, without their velocity being reduced noticeably. "
It must be admired how Tesla guided by experimental observations and a reliable instinct comes to the correct result. He merely with the conclusion, because of the missing interaction the neutrinos have to be inconceivably small, isn't quite right. Their size rather depends on the velocity, because the overfast neutrinos are being length contracted stronger. Tesla however hits the nail exactly on the head, if he on the occasion of the press conference for his 81st birthday declares, the radioactivity is a clear proof of the existing of an outer radiation of cosmic origin[ii]. „ If Radium could be shielded against this radiation in an effective way", Tesla writes in an essay of 1934, „then it wouldn't be radioactive anymore". At this occasion he contradicts Albert Einstein, without thereby pronouncing the name and is indignant at the wrong working method of the scientists[iii].

Me personally fascinates, how here until now ignored results have been presented, which I first had to work out theoretically myself with difficulty. Tesla, to the best of my knowledge, hasn't taken theoretical derivations, at least none have been handed down. As a brilliant experimental physicist he must have reached his conception world by means of the measuring technique. The perfect correspondence of his experimentally determined and the by me theoretically won insights should be judged as evidence for the correctness of this view.

<i>: Dr. Tesla Writes of Various Phases of his Discovery, New York Times, Feb. 6, 1932, P. 16, col. 8

<ii>: Tesla Said (J.T. Ratzlaff), Tesla Book Company, ISBN 0-914119-00-1, P. 272

<iii>: "The scientists of today think profound instead of clear. One has to be mentally sane, to be able to think clear, but one can think profound and nevertheless be completely insane. The scientists of today have substituted experiments by mathematics, and they travel from one equation to another and eventually build up a construct, which has absolutely no relation to reality"...

taken from N. Tesla: Radio Power will Revolutionize the World, Modern Mechanics and Inventions, 7/1934, (Tesla Said, P. 264)

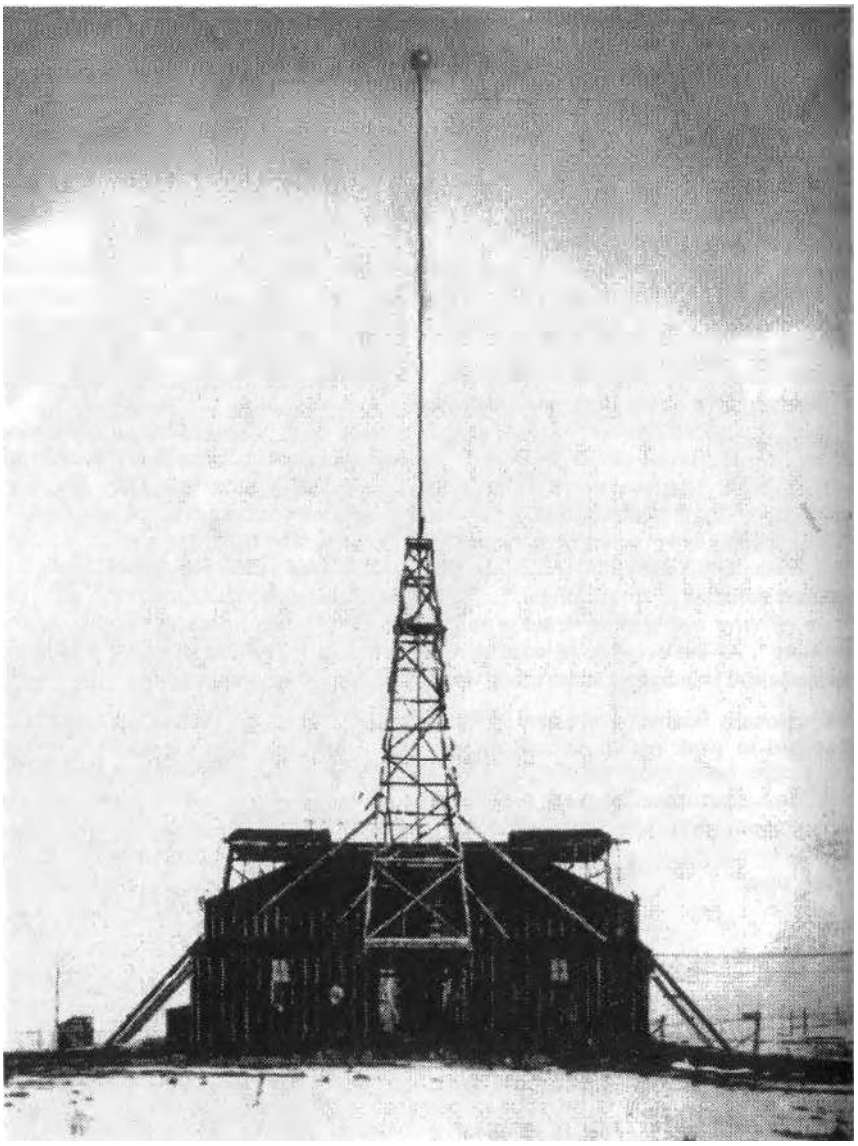

Fig. 17.3: The Magnifying Transmitter of Nikola Tesla Would the research station in Colorado Springs (1899 - 1900) have been suitable for transmutation?

17.3 Transmutation and reduction of radioactivity

If we are capable to collect and bundle up neutrinos, then should with that an influencing of the radioactive decay become possible, then also a decontamination of radioactively contaminated material and a so-called transmutation should be possible. We here have a concrete possibility before us, to use the produced ring-like vortices directly for the benefit of humanity. Dangerous transports with Castor containers, permanent and temporary storage and the contamination of whole areas by radiation, like around the nuclear power station Tschernobyl, which got out of control, wouldn't be necessary at all. If namely burned out fuel rods and objects contaminated by radiation have undergone a concentrated neutrino shower, then the radioactive decay takes place accelerated, so that the half-life can be drastically reduced. After the treatment the dangerous special waste would have been changed to harmless domestic rubbish. Even recycling or reuse are feasible.

The topic is at least as explosive as the energy question and as well completely unsolved. That's at different places and in some companies is already feverish researched about technologies concerning transmutation. Often it are the same people, who also work at the theme of space energy. The reason quite simple is that in both cases neutrinos have to be collected and bundled up. In the case of transmutation however the necessity of materialization can be dropped, so that the goal can be obtained faster and simpler. Consequentially is reported of more cases of a successful decontamination and of transmutation, than of functioning energy converters. Until now most techniques however still hardly are suitable for bringing into action technically on a large scale, but they carry clues of a solution of the problem already in them.
At the congress "New Energy technologies from USA" 6.12.1997 in Zurich I have lectured concerning the theme[<i>]: ,,Presumably as the first one the doctor Dr. Wilhelm Reich has carried out corresponding experiments with his ,,Orgon accumulator" (fig. 9.2). From him also stem warnings about biological effects, which should be taken serious, if radioactive material is put under his Orgon accumulator and the process of decay takes place accelerated".
If one dares an interpretation of his experiments with only 1 mg radium, then numerous charge carriers materialized at hitting upon his sample of the bundled up neutrino radiation with the consequence of high electrostatics in the environment, which Reich has called DOR-state (Deadly ORgone) (chap.15.11).

Another way would be the rebuilding of a neutrino transmitter according to the plans and patent specifications of the experimental physicist Nikola Tesla (fig. 9.11). He 100 years ago had realized a real neutrino-broadcasting and for that developed an unconventional switching technique. Tesla called his transmitter a ,,Magnifying Transmitter" (fig. 17.3). He choose the name ,,Magnifying Transmitter", after he had received more energy than he had transmitted in experiments and this effect moreover was increased with increasing distance to the transmitter. He obviously also had collected free and synchronously oscillating neutrinos, and that would be the best prerequisite for a successful transmutation and decontamination of radioactive material!

<i>: Konstantin Meyl: Die Wechselwirkung der Neutrinos; uber Massnahmen, die Halbwertszeit beim radioaktiven Zerfall herabzusetzen. NET-Journal Jg. Nr. 3, Jan./Feb. 1998, S. 14-20

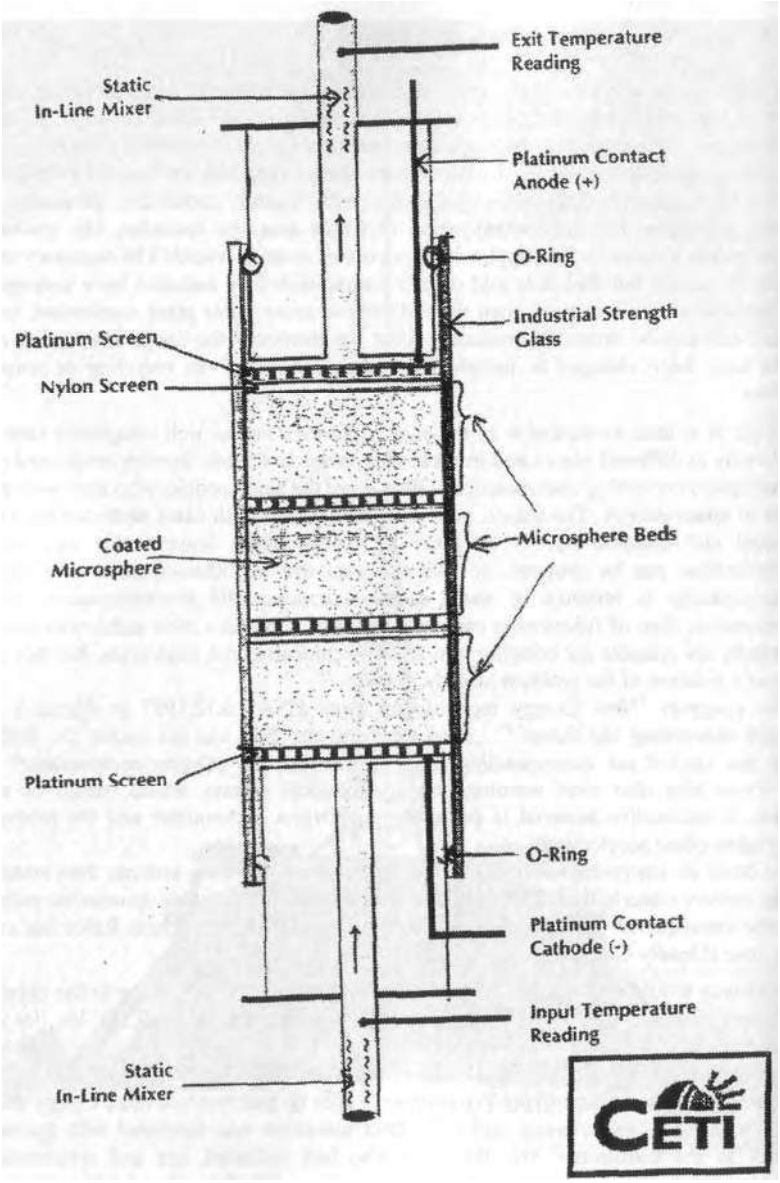

Fig. 17.4: 1 kW Patterson Power Cell.[<i>]

<i>: Patterson, J. A.: System with electrolytic cell and method for producing heat and reducing radioactivity of a radioactive material by electrolysis. US Patent No. 5.672.259 of Sept. 30, 1997, as reprinted in Infinite Energy, July-Nov.1997, pp. 13-16

17.4 The Patterson Power Cell

As an example worth paying attention to, the Patterson Power Cell should be mentioned, which not only can be used for generation of energy but, how could it be otherwise, also for reduction of radioactivity and for transmutation. The energy cell invented by the chemist Dr. James A. Patterson is researched and developed further by the company CETI (Clean Energy Technologies Inc.) in Sarasota (Florida, USA). According to latest reports such a device supplies at most one kilowatt of heat energy at an over-unity of up to 4000; thus 4000 times the energy is released than is taken up as required for the operation!
In fig. 17.4 one single cell of the energy converter is shown. The glass container consists of three chambers of approx. 4 cm height each time and about 1.9 cm in diameter and works like a continuous-flow water heater. From the bottom tapwater or distilled water is supplied and at the top connection again taken away in heated form. The excitation takes place electrostatically by means of two platinum electrodes. The anode situated at the top is connected with the positive pole and the cathode with the negative pole of the source of direct current.
In the three chambers are situated tiny, filmy coated small balls, which form the real principal item of the cell. Production method and structure of the beads are oriented to the task to be mastered. In the case of a variant conceived for the generation of energy the barely one millimetre in diameter small synthetic beads carry after each other a thin layer of palladium, a layer of nickel and once again one with palladium<i>.

The small balls remind with their layered structure at first of the Orgon accumulator of Reich. They also seem to function as collectors of neutrinos, but for smaller wavelengths and much higher frequencies. In addition is chosen a concentric arrangement with the spherical form, which with the electrically conductive surface and the dielectric core fulfil the function of a cavity resonator. Resonance actually is possible with flying past neutrinos, which have a wavelength which amounts to an integer multiple (1,2,3,..) of twice the diameter of the sphere.
The arising resonant oscillation however concerns not only the electric and magnetic fields, but by means of electrostriction and magnetostriction also a mechanic oscillation of size. The oscillation of size in reverse causes again oscillating electric and magnetic field pointers, which are partly open along the spherical structure and can interact resonant with further neutrinos. In this repercussion field the actual secret of the functioning of a Patterson-cell is hidden.

The president of the German association of space energy, Prof. Dr. Dr. Josef Gruber on the occasion of his visit at the company CETI and of a conference about ,,cold fusion" in Vancouver has published a report<ii>:

<ii>: Gruber, J.: Kalte Fusion und Raumenergie, report concerning the 7th international conference about "cold fusion" of 19.-24.4.1998 in Vanvouver, B.C., Canada (Infinite Energy, Issue 19, 1998) and report concerning "International Symposium on New Energy" of 23.-26.5.1997 in Denver, Colorado, USA (Denver-report of the remote University Hagen)

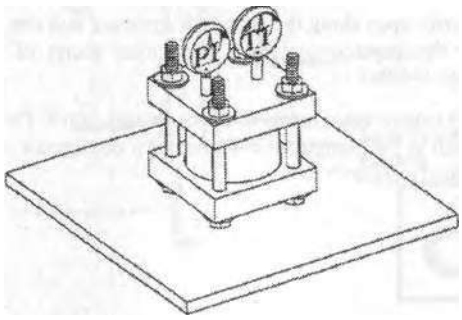

Fig. 17.5: _____ Low Energy Nuclear Transmutation Cell,[i] the kit for experiments LENT-1 (Showing Temperature and Pressure Gags)

<i>: taken from the NET-Journal, 10/11 1997, S. 7

17.5 Report concerning the cold fusion

"In the case of the Patterson transmutation cell it concerns a special electrolysis cell, in which the radio nuclides are charged. During the electrolysis the decay activity measured by means of a Geiger-Muller counter decreases drastically. Within a few hours reductions of up to 80% are obtained. In such an electrolysis system with electrodes consisting of specially coated beads low-energetic nuclear reactions can be observed. In this case elements are detected in the metallic layers of the beads, which before were not contained in these. Further are measured changed (unnatural) proportions of isotopes. From these transmutation can be inferred, which is used in the cell for the conversion of radioactive elements.
Until now natural uranium and thorium were used as radioactive material. The reproducibility already now is very good. The applicability for commercial purposes, for the reduction of the radioactivity of burnt up fuel elements and for the conversion of plutonium is easy to see".
At his visit in the laboratory of CETI in Sarasota 28.5.97 Prof. Gruber has witnessed an experiment to annihilate radioactivity with the Patterson transmutation cell. He reported about it: "In the presence of N. J. Olson from Pacific Northwest Laboratory (operated by Batelle for the U.S. Department of Energy) a team of the television station ABC conducted by the science journalist Dr. M. Guillen made recordings for a television program, which meanwhile has been broadcasted all over the country. The original tension voltage - among others a Geiger counter rattled - subsided as the expected success became apparent in the experiment: After one hour 50% of the radioactivity stemming of uranium nitrate were removed, in another half an hour further 13%. Doing so also a considerable lot of surplus heat was produced.

New techniques of this kind to reduce radioactivity have an important advantage: One brings the SET-device there where the radioactive material is situated and reduces the radioactivity on the spot. For the conventional technique, still being in research, in contrast to that the radioactive material first is wrapped in a complicated manner and then transported to a special factory, where radioactivity is reduced at great technological expenditure and use of energy - altogether a procedure which is relatively costly and politically only hard to carry through".

Patterson cells already can be obtained commercially for research purposes. The same goes for a demo-kit[<i>] of the company Trenergy, Inc. of Hal Fox, who has built up the biggest database of the world concerning the theme "Low Energy Fusion" in the "Fusion Information Center" at the university of Salt Lake City. He is editor-in-chief of the "Journal of New Energy".
If one believes the statements on their web-site[<ii>], then one is capable of converting 10 g of radioactive thorium in 900 mg titanium and some copper in less than an hour with the kit for experiments LENT-1. Under a pressure of 3200 psi sodium already is said to have fusioned to gold, something of which alchemists dream, as an unintentional side effect, as researchers in Cincinnati/Ohio say[<iii>].

<i>: NET-Journal, Jan. 1997, S. 24
<ii>: see Internet: http://www.hal-fox@slkc.uswest.net
<iii> : NET-Journal, 10/11 1997, S. 7

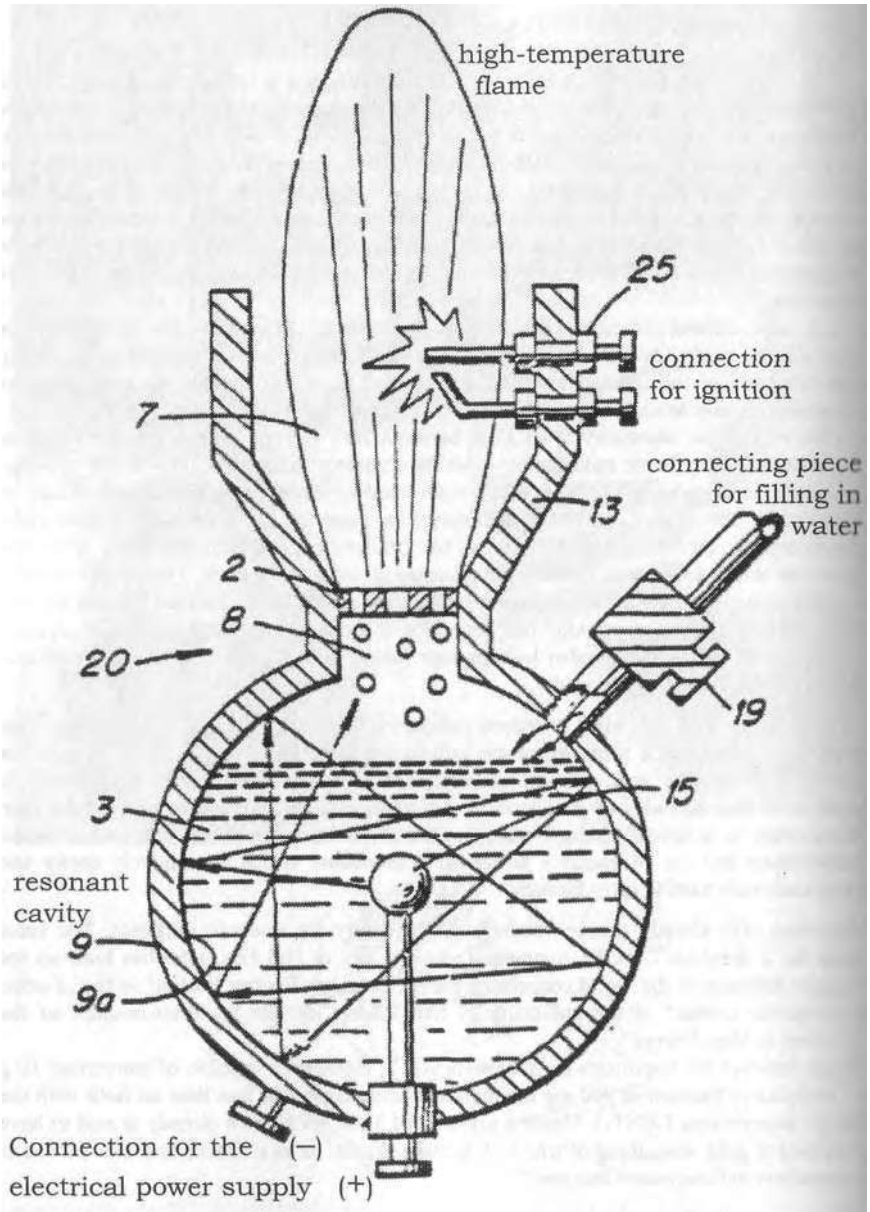

Fig. 17.6: The water-fuel-cell according to Stanley Meyer<i>

<i>: H.-J. Ehlers: Stan Meyers Wasser-Zellen-Technik, Raum & Zeit special 7, p. 201, taken from the Canadian patent specification 1234 773 of 5-4-1988

17.6 Water-Fuel-Cell technology

The United States are, just what concerns spectacular techniques like the removal of radioactivity or the transmutation of new materials, obviously still the land of unlimited possibilities. Nowhere the list of researchers of cold fusion is as long as in North America.
But there also in many places only is tried and tinkered without visible system or usable theory. Then in many cases unfortunately only a show-effect is to the fore, while construction plans and details concerning the way of functioning, as far as they actually exist, are kept secret. In total there, besides a lot of hot air and wrong hopes, is left behind little to be used and cited.
By the way, in my opinion cold fusion has to do very much more with space energy and neutrinos than with hot fusion. How much disaster a wrong referring to and an unusable theory can bring about, has become clear at the example of the "cold fusion researchers" Fleischmann and Pons. They have placed themselves into the scientific offside with their misinterpretation concerning cold fusion.
Moreover are both primarily scientists and theorists. Practice however is, according to general definition, "if in spite of all it functions!" The American Stanley Meyer is such a practical man and his water-cell-technology actually seems to function, although he in his 18 patent specifications gives theoretical explanations, which he just as well could have saved himself. With that his effect isn't explained.
An usable interpretation would be that this device, comparable to a cell of a plant during photosynthesis, splits water molecules into its parts by putting on neutrinos. Even without knowledge about space quanta the buggy of Stanley Meyer already runs with a air-cooled 1500 cc VW-engine, and it consumes no gasoline at all. The tank is filled with water; it even may be sea water. The consumption of water lies at 2.8 litres at 100 kilometres and thereby is formed predominantly hot steam again as a combustion product.
If thus cold water is converted into hot water and at the same time mechanical energy is available. then inevitably another source of energy must be involved. According to my interprelation it must concern the neutrino field. If the here presented details are correct then the over-unity effect lies at approx. 100, the degree of effectiveness thus at 10000 percent.

American companies, with which Stanley Meyer had concluded contracts, should make the "Water-Fuel-Cell technology" mature for series. Also the financing seemed secured. But then per internet the message came, he 21.3.1998 was having supper in a restaurant in Grove-City, as he suddenly jumped to his feet from the table and called out, he had been poisoned. He died on the spot<i>.

Alarge number of inventors is known, who tap space energy with the help of water. It concerns an increase of the content of oxygen or of the content of colloids, thus an improvement of the water quality. Or it concerns formation of vortices as already in the case of Walter Schauberger, glowing phenomena or also the generation of free energy from the neutrino field. In this concert the concept of Stanley Meyer takes an outstanding place, as particularly efficient, instructive and clearly understandable for us, for which reason we cast our eyes over the design (fig. 17.6 and 17.7).

<i>: Zum Hinschied von Stanley Meyer", NET-Journal April/Mai 1998, S. 25; see: obituary in Infinite Energy Magazine

A. The pattern of the pulses of the excitation voltage:

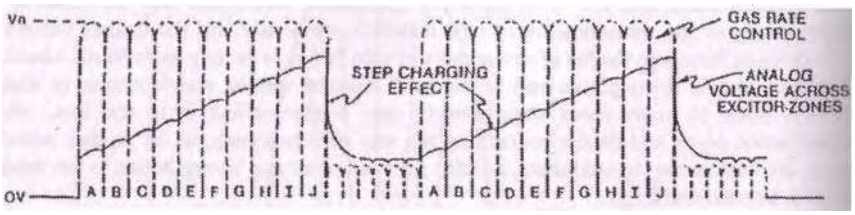

B. The wiring diagram:

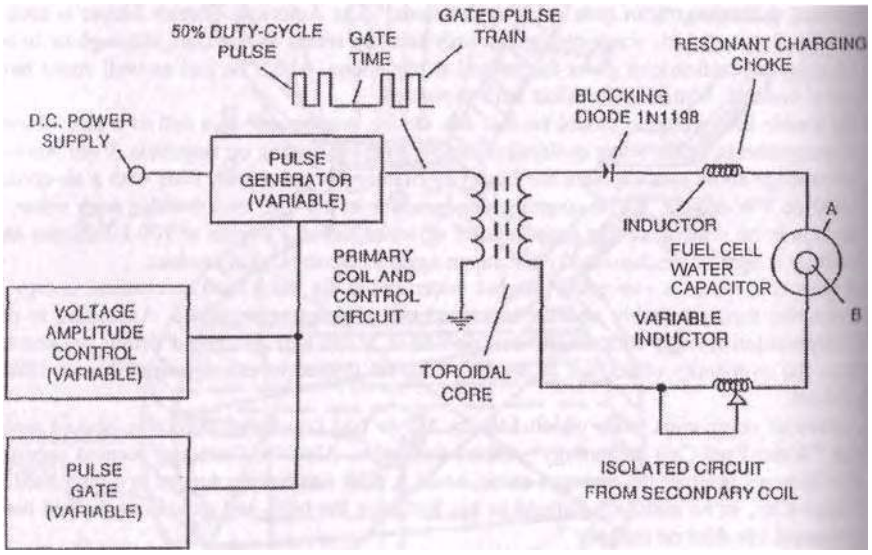

Fig. 17.7: Wiring diagram for the driving of the water-cell[<i>]

<i>: Stanley, A. Meyer: Process and Apparatus for the Production of Fuel Gas and the Enhanced Release of Thermal Energy from such Gas, 15.06.89, US-Pat. 207,730; International Publ. WO 89/12704; Int.Appl. PCT/US89/02622

17.7 Unconventional electrolysis

Numerous of the by Stanley Meyer used construction principles already have been treated, be it the excitation with pulses of electric tension voltage or the spherical structure of the resonant cavity (fig. 17.6). As a spherical capacitor with the positive pole in the centre and the negative pole at the outside edge it corresponds to the model of the electron and fulfils in an almost ideal way the conditions of an unipolar arrangement according to fig. 15.8 B. The use of certain patterns of the pulses and steep flanks of the pulses (large dU/dt) make possible effects of resonance at frequencies starting at ten kilohertz, in which neutrinos participate increasingly. First the series resonant circuit, consisting of the adjustable, external inductance and the spherical capacitor, is stimulated by means of the current rectifying wiring (fig. 17.7). In the case of resonance, which is carried out by comparison of the inductance, the excitation current drops, whereas the tension voltage at the same time teaches values of more than 1000 Volts. If in addition a neutrino resonance occurs, then the known avalanche effect will occur. The equipment then takes up virtually no current.

As a dielectric serves water, with which the container is filled permanently. The dimensions are oriented after the velocity of movement of the water molecules according to details of the inventor. Also the oscillating water molecules should go into resonance. Then they can help to materialize the neutrinos. Their rotational energy partly passes to the water molecules and as soon as the neutrinos have been converted to charge carriers, they will take the water molecule from the oppositely charged side and split it without further ado. The oxygen and hydrogen gases leave the capacitor through fine openings at the upper edge of the spherical chamber, which are so small, that no ignition back can occur, and in the simplest case reach a combustion chamber, where they burn again to water as a high-temperature flame (fig. 17.6).
The gases of course also can be guided into the cylinder of a Otto engine and be ignited there, as in the case of the experimental buggy. In the sectional drawing can be seen a filler by means of which, according to the consumption, water is refilled. The round resonant cavity not necessarily has to be spherical. Stanley Meyer more frequently differs from the ideal form and works with a cylindrical symmetry (fig. 17.8), with which obviously in spite of that the goal can be obtained, if perhaps not quite so good. To this compromise the explanations of fig. 15.8 C apply.
If we, to conclude, cast our eyes over the wiring diagram which Stanley Meyer discloses in his patent specification (fig. 17.7 and 17.8)[1]. In the centre is a transformer, which should produce an if possible high tension voltage. A rectifying diode, which takes care that only positive tension voltage pulses serve the excitation, is switched in series with the reaction capacitor, which is filled with water, a fixed and a variable inductance. In that way the positive pole is always situated in the centre of the reaction chamber. If both connections would be exchanged or the diode be turned over, then the neutrinos presumably would materialize in positrons and not in the wanted electrons. But if one leaves out the diode entirely and one has a tension voltage changing both in positive and in negative direction, then maybe electrons and positrons are equally generated, which annihilate each other under emission of gamma quanta. Doing so no gas is formed, but at most light, as long as the effect of collecting neutrinos isn't lost also. The concept should be worth to be examined more detailed already of pure scientific interest.

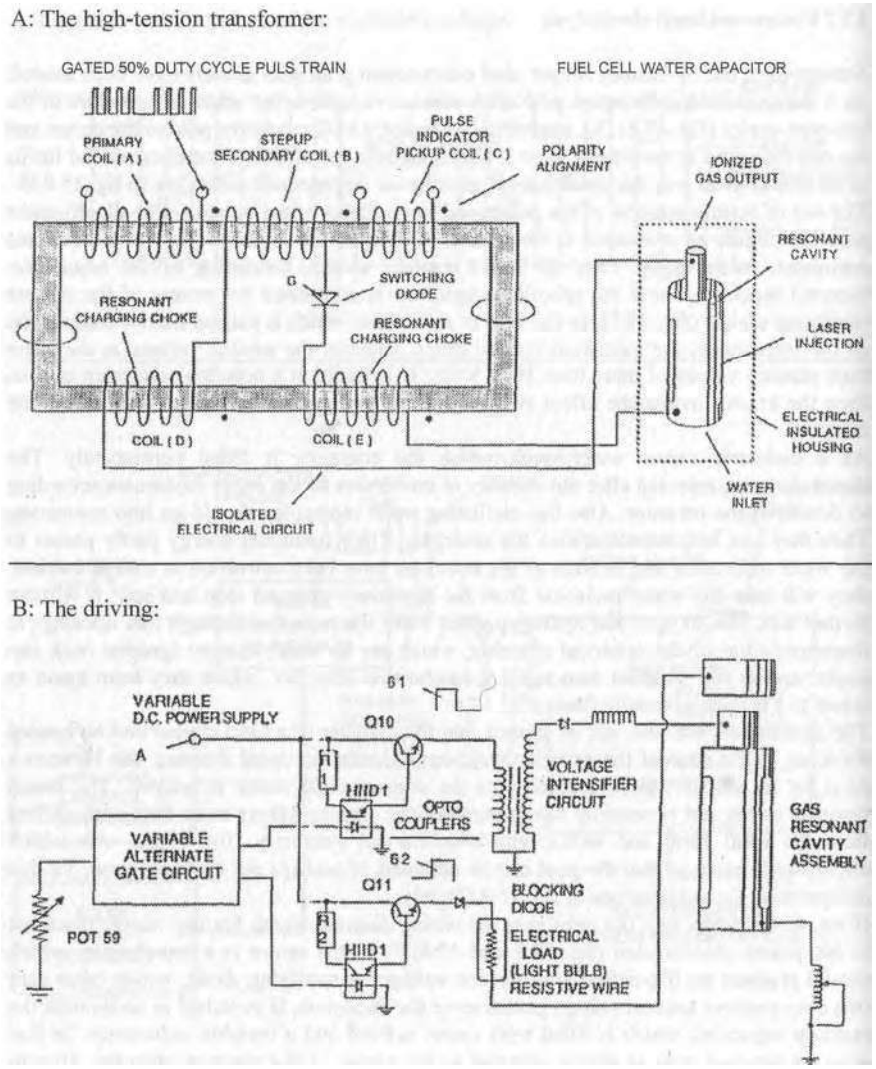

Fig. 17.8: High-tension transformer and driving of the cylindrical water-cell<i>

<i>: Stanley A. Meyer: Process and Apparatus for the Production of Fuel Gas and the Enhanced Release of Thermal Energy from such Gas, 15.06.89, US-Pat. 207,730; International Publ. WO 89/12704; Int.Appl. PCT/US89/02622

17.8 Materialization of neutrinos

In the centre of attention of the water-fuel-cell of Stanley Meyer is on the one hand the unipolar arrangement (according to fig. 15.5 B or C) to collect the neutrinos and on the other hand the water for slowing down and materializing. Over and above that a lot was tinkered and tried, as can be inferred from the patent specifications (fig. 17.8). That starts at the. coiling technique of the transformer and concerns the experiments with laser stimulation as well as the top part, which according to the inventor should extract the electrons (Electron Extractor Grid). The measures may bring an improvement, but are insignificant for our considerations.

At this place it primarily concerns the question of the materialization of neutrinos. But if such a materialization has to be made complete, if water molecules must be splitted, depends on how long the process lasts. If everything goes very fast, then perhaps it is sufficient that a neutrino for a short time is showing as an electron, before it again oscillates back. In this short time the splitting process already could have taken place. The used neutrinos for that had to be very low-frequent and very slow. They after that could again leave the reaction chamber and fly on as neutrino.

Possibly the fishes, which live in stagnant waters or in the deep sea, owe the slow neutrinos the content of oxygen in the water. Because here no bundling up takes place, the splitting of water takes place rather by chance. The volatile hydrogen atoms escape very swiftly, whereas the big oxygen atoms are left behind in the water.

Now we still don't know how charge carriers can be won. At the RQM unit resonant oscillations of size had been measured and that can be judged as an important clue. If namely a space quantum is slowed down then it becomes bigger. The inverse case we already had made us clear: If a particle is correspondingly fast then it is sufficient length contracted to fit through the tunnel (fig. 6.14).

To slow down neutrinos according to that the target area should carry out an oscillation of size with opposite phase. Organic material and biological systems are excellently suited for that. Every contraction of a muscle brings that to mind. Inorganic matter and our technology however normally don't know this phenomenon. Technical energy converters simply are built up fundamentally else than biological muscle machines.

In historical sources at certain places is pointed to the fact that priests had experimented with quartzes and miraculous phenomena were observed. Of course the question is asked, if such experiments today still can be reproduced. Because the density of the earth slowly increases due to the growth in volume, also the wavelength of these oscillation quartzes is changed. The same neutrino radiation therefore today can't be active anymore. It thus would be completely inappropriate wanting to reject a historical source only because a described effect today doesn't want to function anymore.

Magnetostrictive or electrostrictive material could be a solution. For instance a piezocrystal, which contracts under the influence of an outside field. As an ultrasound converter an applied alternating voltage leads to the emission of a sound wave. If we reverse the function, then a received longitudinal wave should lead to an electric tension voltage and then at last the materialized charge carriers could be taken off,!

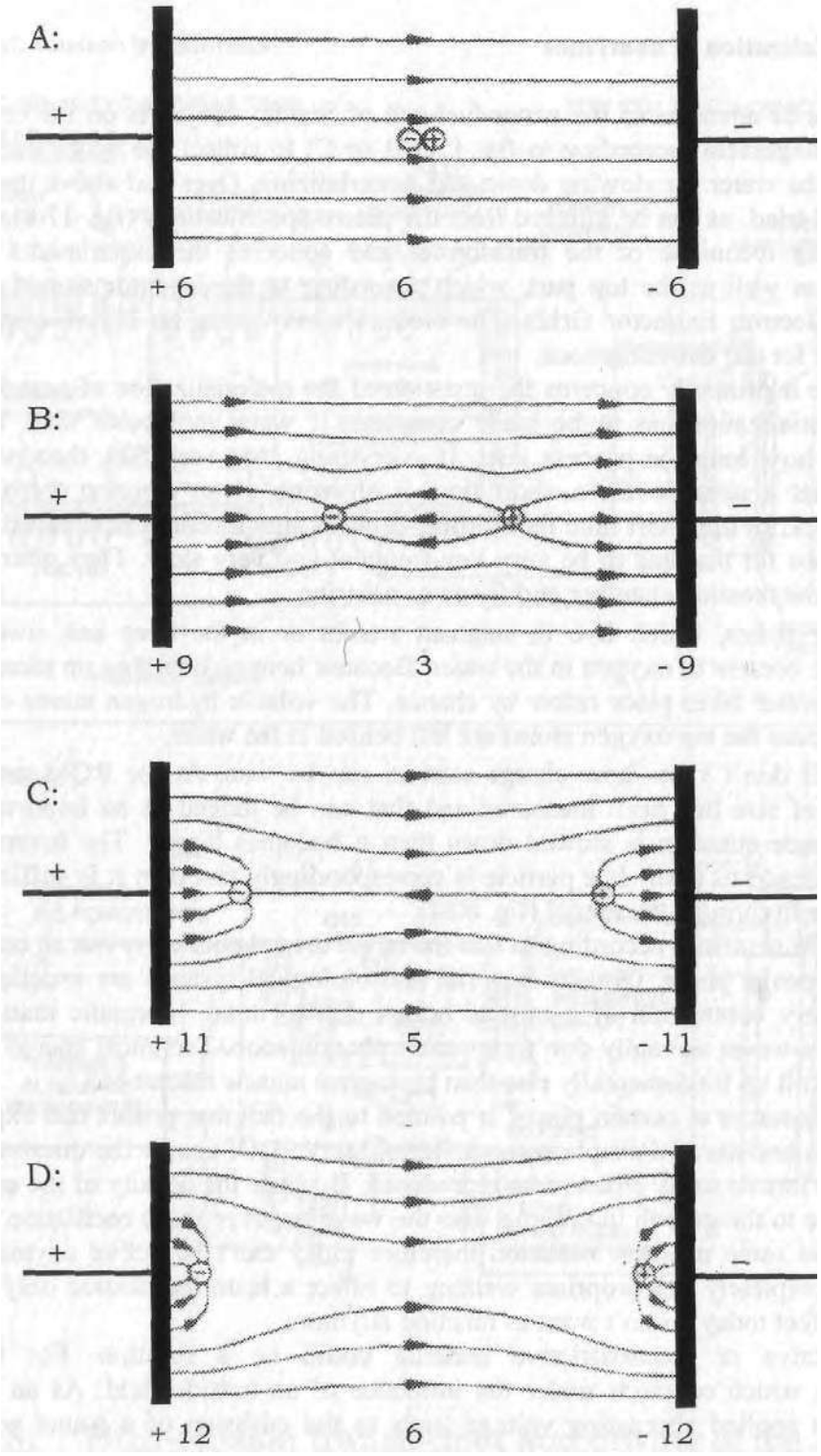

Fig. 17.9: The course of the field in the case of a glow-discharge<i>
(The numeric values indicate the active field lines, as they can be read from the representation).

<i>: K. Kupfmuller: Einfuhrung in die theoretische Elektrotechnik, 12. Aufl. Springer-Verlag (1988), S. 197

17.9 Oscillation of size and luminescence

There exist substances, which at high temperatures start to glow. In the sense of the theory of objectivity presented in the first part of the book in the case of temperature it actually concerns an oscillation of size of the involved elementary particles (fig. 8.3). If this oscillation of size lies in the visible frequency range, then we can directly perceive it and it can be used for instance in a light bulb for the purpose of lighting.
In the case of an arc. fluorescent tubes or glow-discharge lamps light is formed as well even without a thermal effect. These glowing phenomena are called luminescence. They can be caused by chemical processes, by friction, by crystallization or by electric fields. As can be shown speedily, in these cases it also concerns an oscillation of size.

If we for that consider the model on the left (fig. 17.9). Between two electrodes there is a non-conducting gas, e.g. air. If now a tension voltage is applied then, under the influence of the electric field, some gas atoms are splitted into positively charged ions and negative electrons (case A) and pulled apart (case B). This process of enlargement of the glow-discharge fast as lightning comes close to that of the thermal oscillation of size and obviously in the same way is perceived as light.
The ionised gas parts are attracted by the unlike poled electrodes and move towards these (case C, D). Whoever takes the effort to count the number of the field lines, will find out that between both electrodes the electric field drops, whereas it at the same time increases at the electrodes. The first thing causes that the process of ionisation is stabilized by itself and a state of equilibrium will result; the resulting current takes a constant value.
The increase of the tension voltage at the electrodes on their behalf causes that an arc remains standing or the glow-discharge lamp glows on, even if the feeding voltage is reduced. For this reason a fluorescent lamp needs a starter, since the network voltage is too small to start the effect of luminescence.

We indeed know, that the gain of light of a fluorescent lamp is at least three times better than that of a light bulb. As a rule a degree of effectiveness in spite of that can't be given, since it merely concerns a comparison measurement in the case of the measurement of the lighting intensity with a luxmeter. It hence can't be excluded, that we already are dealing with an over-unity effect in individual cases and neutrinos are involved in the effect of glowing.
A necessary oscillation of size would be present, as the perceivable noises of open spark gaps prove. Also in the case of lightning the thunder occurs as a consequence of a longitudinal oscillation of size and at the same time a glowing phenomenon occurs as a consequence of materialized neutrinos (fig. 14.11). It almost is obtruding a scientist that here the same principles are at work.

One however hardly can prove that neutrinos are involved in the luminescence, because the configuration is symmetrical with regard to the resonance of neutrinos and just as much particles materialize as anti-particles, which afterwards again annihilate completely as an impulse of light. They hence can't be measured directly. It gets interesting if an asymmetrical arrangement with unipolar character is chosen.

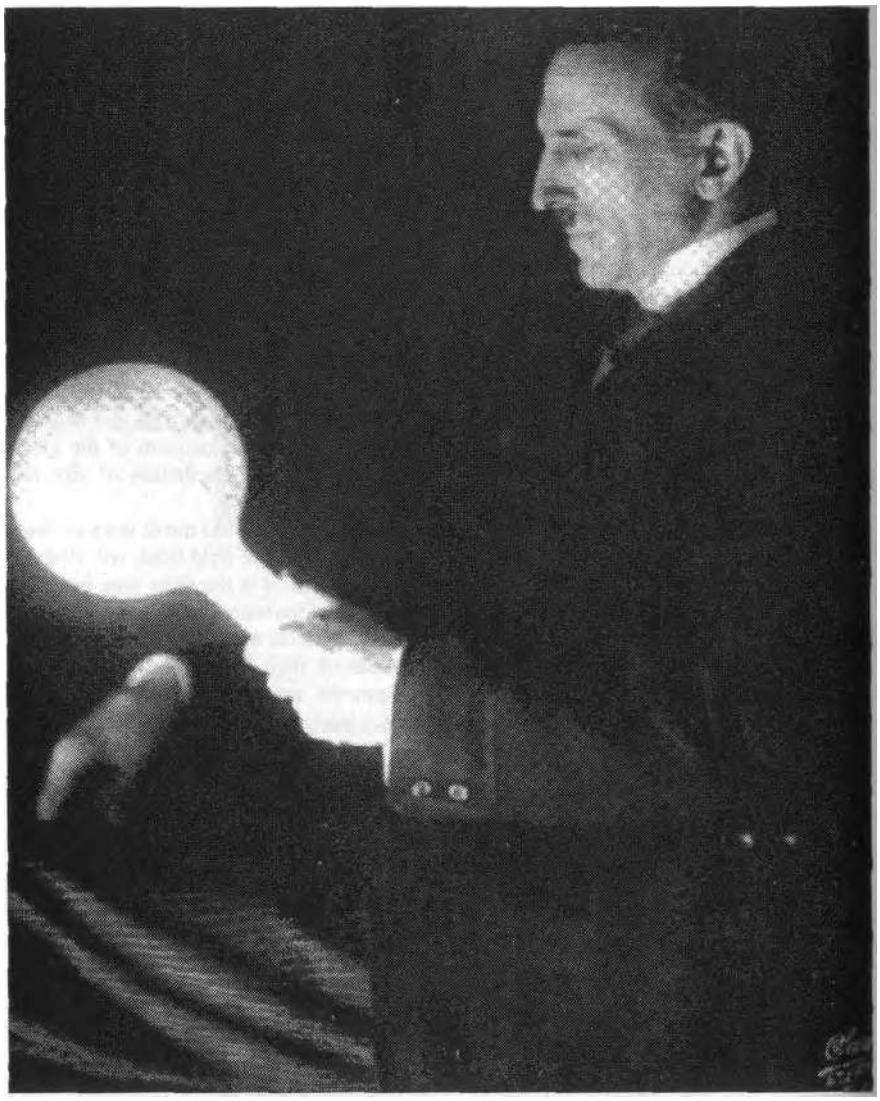

Fig. 17.10: Tesla with a wireless light bulb[i]

<i>: A Sarony-Portrait from 1894, Tesla-Museum, Belgrad

<ii>: R. Hiller, K. Weninger, S. J. Puttermann, B. P. Barber: Effect of Noble Gas Doping in Single-Bubble Sonoluminescence, University of California, Los Angeles, USA, Science, Vol. 266, 14.10.1994, P. 248-250

and: D. Lohse: Wenn sich der Schall in Licht verwandelt, Mechanismus liegt noch im dunkeln; (University of Twente, NL) Mitteilungen der DFG 4/98, S. 19-21

17.10 Phosphorescence and sonoluminescence

Let us first look at the observable after-glowing at fluorescent lamps or at a screen, the phosphorescence. It presupposes a storing effect, and that in accordance with prevailing textbook opinion can be traced back to the excited state of some atoms. Doing so electrons in the atomic hull change from one level of resonance, an instable state of energy, to another orbit, which represents the ground state. Doing so the difference in energy is emitted in the form of light. The process obviously not only takes place as luminescence during the switching on of the excitation voltage, but also as phosphorescence after the switchng off.
An enveloping electron now doesn't fly as a tiny planet around the nucleus, but occupies the entire orbit as an inflated spherical vortex (fig. 5.5). Seen from the outside it is a matter vortex. It however sees the enveloping electrons on the further on the outside lying orbit from the inside and there they are showing as anti-matter vortices. As long as the distance of respect is kept, nothing happens. If however an inner spherical vortex presses to the outside or the outside one to the inside, then the incompatibility of the vortices takes effect and both annihilate under emission of a photon. In this respect the explanations of the vortex model are very helpful.
But now, after this flash of light, two electrons are missing in the atomic hull. The positively charged atomic nucleus never would allow this loss. Replacement has to be fetched and that actually only can stem from the neutrino field. Therefore the enveloping electron doesn't change the orbit immediately, but instead has to wait, until a suitable neutrino passes by, with help of which the game of changing places can be executed. This explains the time delay and gives reasons for the observable after-glowing.

The form of the unipolarly charged sphere (according to fig. 15.8 B) forms almost ideal prerequisites for an interaction with neutrinos and the step-like change of size from one orbit to the next ideal prerequisites for their materialization. The longitudinal wave connected with the change of orbit without doubt can be called a high-frequency sound wave. It however can't be detected because of missing gauges for such high frequencies.
But if we take the frequency down into the range of the ultrasound, which can be handled technically, then effects arise which brilliantly prove this interpretation and the participation of neutrinos in the luminescence.

The not understood phenomenon is called sonoluminescence and at present is researched at numerous high schools primarily for academic interest. The structure is conceivably simple. One takes a ball of glass filled with water and positions at the edge one piezocrystal next to another. Then one with the piezo loudspeakers, operated with the same phase, sounds the whole with ultrasound and see there, the water glows mysteriously! The sound waves change the pressure. Inferring from the observations, during the phase of low pressure small bubbles are formed, which at the following rise of pressure collapse and emit a ultrashort flash of light. There thus takes place an oscillation of size, which leads to the luminescence phenomenon!
So far so good; but such a flash of light is much shorter than the collapsing of the gas bubble lasts. With less than 50 picoseconds it is faster than the otherwise usual atomic transitions of electrons. The whole thing obviously has nothing to do with this kind of luminescence. Also the spectrum doesn't fit and finally the over-unity effect lies at one trillion, the light energy thus is 10^{12} times larger than the energy part which is taken up from the sound wave by every atom[ii]!

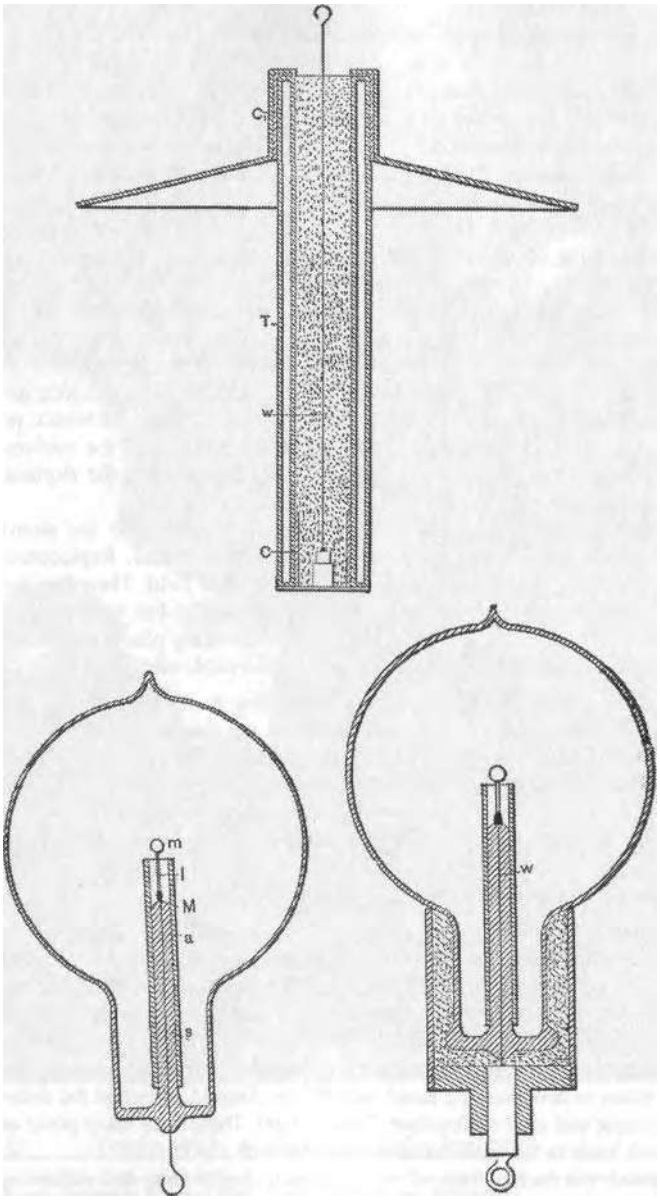

Fig. 17.11: Light bulbs according to plans of Tesla<i>

<i>: N. Tesla: Experiments with Alternate Currents of High Potential and High Frequency, Lindsay Publications Inc, ISBN 0-917914-39-2, Fig 18, P. 70+103

17.11 Discussion concerning the use of the weak interaction

In the case of the luminescence the conditions lie similar like those for lightning. The science of today it is true has some problems of explanation at detail aspects, but again and again manages to protect the ivory tower of physics from collapsing, with supporting auxiliary explanations. But at the latest in the case of an unipolar arrangement, in the case of a ball-lightning or the sonoluminescence, the participation of the neutrinos clearly comes to light, the auxiliary concepts prove to be unusable.

It surely is no accident that the discoverer of the neutrino radiation also was the first, who has experimentally investigated the luminescence. The lamps of Tesla (fig. 17.11) all were without wear and didn't have filaments like those of Edison. They however had to be operated with high tension voltage and relatively high frequency. Both a single-wire and a wireless transmission technique were possible (fig. 9.5 and 9.7). In his laboratory Tesla only needed to hang a fluorescent lamp without any return cable on a wire, then he had light. Famous also are the pictures on which he holds a lamp in his hand, which glows entirely without any connection, but only if he takes it in his hand! (fig. 17.10).

If we again turn through the chapter, then it is remarkable that in most cases, from the transmutation to the luminescence, neutrinos can be used for reason of their resonant interaction which in the proximity can be put equal to the weak interaction. A real materialization however poses an enormous difficulty. If namely the translatoric motion of the space quanta is slowed down, then the risk exists that for balance the rotation increases. But that as well has to be slowed down for a materialization! Only if both processes of slowing down take place, the goal can be reached. In that case the described cooling down effect occurs.

For a measurement technical check it therefore offers to record the slowing down of the translatoric motion and the collecting of the neutrinos by means of the measurement of the radioactive decay of a sample. And to read the materialization as the slowing down of the rotation from a measurement of temperature. In addition are helpful proofs about oscillations of size, glowing phenomena and deviations in the balance sheet of energy. With that it should be able to obtain a system for the exploration of these phenomena with the goal of a practical exploitation of the neutrino radiation for the benefit of humanity.

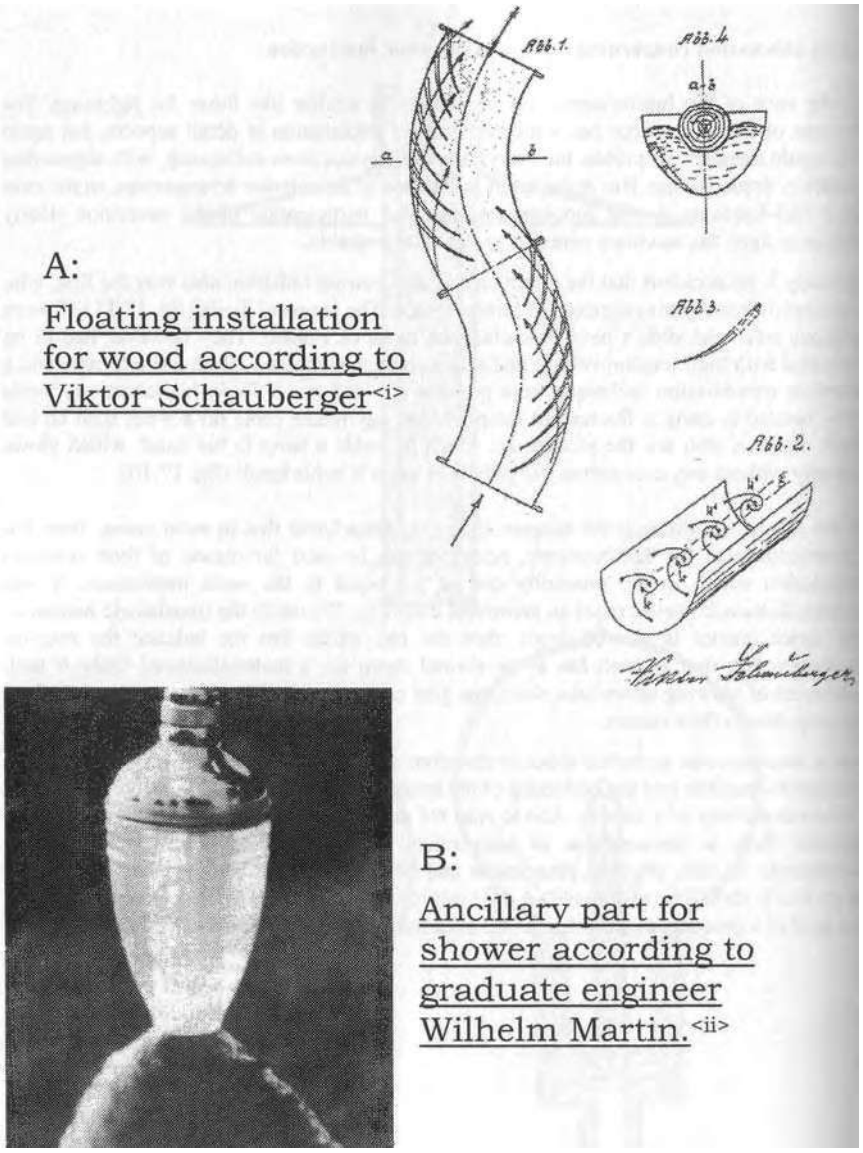

Fig. 18.1: Mechanical whirling of water

<i>: N. Harthun: Naturgemasse Stromungsfuhrung nach Viktor Schauberger Analyse einiger seiner Patente und Zitate; MuT Nr. 4, 1980; s.a. Kap. 9.2
<ii>: O.Alexandersson: Lebendes Wasser; W.Ennsthaler Verlag Steyr, 1993, S.156
<iii>: V. Schauberger: Die Entdeckung der Levitationskraft, Implosion 112, S. 39.
<i4>: Do we owe the taste of bubbling spring water to neutrinos?

18. Physical phenomena

In this chapter it on the one hand concerns indirect effects of the resonant interaction and on the other hand effects of gravitation and levitation.

18.1 Water as a catalytic converter for neutrinos

Already the Austrian forester Viktor Schauberger has pointed to glowing phenomena at whirled water. He first had observed such in nature at torrents and waterfalls in the Alps. Later he was capable, to produce and to demonstrate this effect even artificially[iii]. One could speak of hydroluminescence, where still the question would be left open, how it actually functions.

Already in chapters 4.10 and 4.11 has been talked about the special properties of water. It here at first concerned the property of transport of a vortex, which even is capable to bind particles in the vortex, which are heavier than the whirling medium itself. Schauberger had become famous by letting build floating installations, in which not only tree-trunks, but also gravel could be transported down to the valley, without the sides of the channel actually having been touched by the rubble. This phenomenon has been examined and confirmed on the scientific side [i].
Basing on this principle today different devices for processing water are offered and sold, which bind lime, mineral materials and suspended matter in the vortex and in this way prevent deposits in the pipes. The methods, to whirl the water, are however very different. Some whirl the water mechanical, others magnetically and again others electrically.
Here the dipole nature of the H_2O-molecules has an effect. If I turn a water molecule with its electric charge distribution, then from the moving charge a magnetic field results. If thus in the pipe a hydrodynamic flow vortex is produced, then an electric and a magnetic vortex, the potential vortex and the eddy current, are the result (see fig. 4.2). The wanted flow vortices vice versa also can be obtained, by guiding bubbling whirled water past permanent magnets, or by feeding in alternating magnetic fields with the help of coils, or finally by working with pulsed electric potentials. Each of these systems, operated passively or actively, has its specific advantages and disadvantages (fig. 18.1 B and C).

It can be assumed that with the vortices also the water quality is changed. As a rule the content of colloids increases, due to which the surface tension falls. In the colloids negative ions are bound, for which reason also the electric conductivity decreases. Finally the content of oxygen increases and that actually only can come from an electrolysis. The neutrinos thereby are suspected [i4].

As an extreme dielectric medium water favours the formation of potential vortices, which immediately after their formation contract swiftly. This oscillation of size of the electrically charged potential vortices makes possible actually an interaction with neutrinos, and that on the one hand has as a consequence the water splitting and the increase of the content of oxygen in the water and on the other hand the above depicted, observable glowing phenomenon, the hydroluminescence.

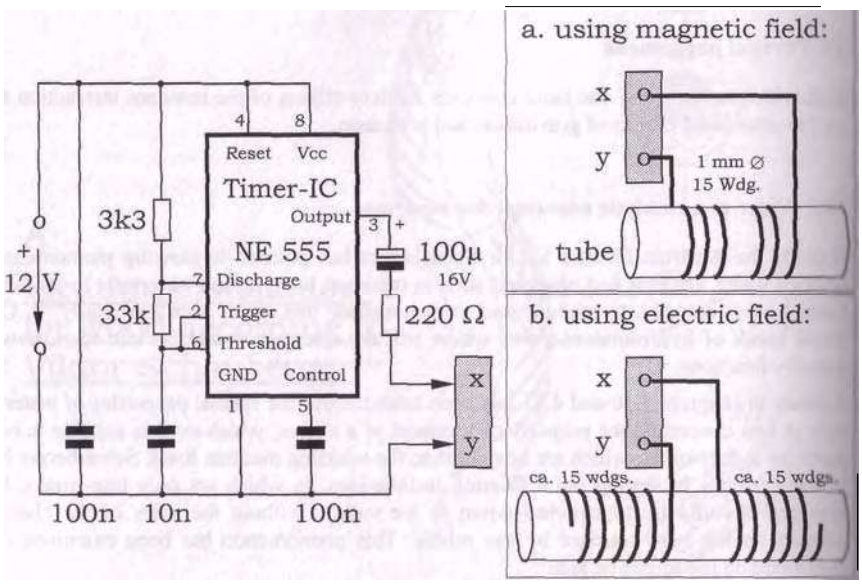

Fig. 18.1 C: Wiring diagram for a simple water processor
with pulsed field (2 kHz rectangular signal)
a: for magnetic field excitation
b: for electric field excitation

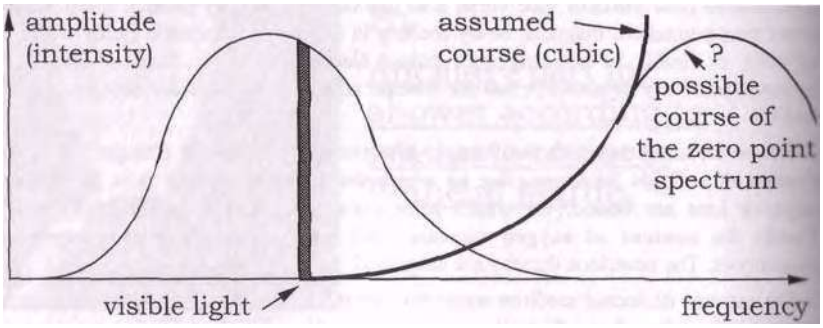

Fig. 18.2: The spectrum of frequencies of light and of the zero
point radiation.[i]

[i]: A. Waser: The Puzzling Nature, AWVerlag Luzern 1996, p. 88

To complete in fig. 18.1 C the wiring diagram of a simple water processor is shown, which works with pulsed electric (b) or magnetic (a) fields.

If we temporarily again leave the theme water and take along the notion, that it must be attributed a great importance in connexion with the interaction and the materialization of neutrinos

18.2 Background and zero point radiation

Whathappens really, if cold matter or interstellar gas molecules are hit or touched by the everywhere present neutrinos? Then it can be expected that oscillations are being stimulated and as a result the temperature slightly increases. If we thus at a space flight hold a thermometer out of the shuttle window, then we will measure everywhere such a remaining temperature of a few degrees Kelvin, which is called cosmic background radiation.

By popular scientific small talkers the background radiation is called remnant of a so-called Big Bang. It even is misinterpreted as evidence for the Big Bang. Even if a certain value of entertainment can't be denied, the Big Bang from a physical view until now only has raised questions and contradictions.

If we stay at the fact that oscillating neutrinos depending on their radiation density and velocity of propagation produce a thermal oscillation, which can be detected as a slightly increased lemperature. To measure that we don't need immediately to undertake a space flight. We also can install the thermometer in an artificially produced vacuum. In vacuum physics out of ignorance of the relations the neutrino radiation then is called zero point radiation.

In the case of the neutrinos it of course concerns an oscillation around a mean value, which for a symmetrical form of oscillation has the value zero. The term nevertheless is misleading and chosen very unfortunate. After all we don't speak of zero point current in the case of alternating current!

Since every supernova and every black hole emits neutrinos and correspondingly in physical experiments until now no preferred direction could be determined for the zero point radiation, it is taken as homogeneous and isotropic in space. From the Lorenz invariance again is inferred a cubic course of the zero point spectrum, an increase of the radiation intensity with the third power of the frequency. With this assumption the radiation density of the vacuum however strives with increasing frequency towards infinity. Here an error has to be present in the considerations!

I proceed from the assumption that in the case of the spectrum of the neutrino radiation it rather concerns a spectrum of resonance, the maximum value of which lies above the frequency range measurable with devices of today. It of course would be very important to find out, where the radiation maximum lies, but without being able to measure it that lies unfortunately in the range of pure speculations (fig. 18.2).

Half the wave length in any case should be tuned to the length of the antennas of the energy centres of the cells, the mitochondria and the chloroplasts which are capable of photosynthesis. In both cases the head diameter of the ATPhases amounts to approx. 5 nanometer. It would be obvious, if the resonance point would lie here. But it could as well lie at still smaller wave lengths in the domain of molecular dimensions.

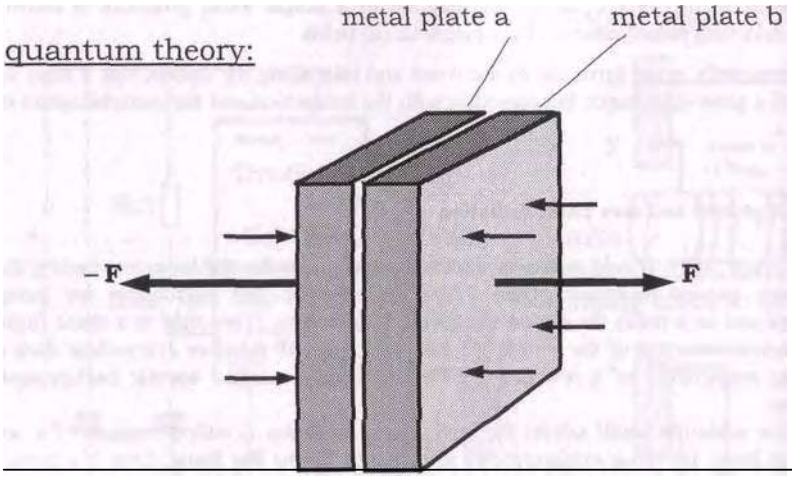

outside cause<i:>: pressure force by bombardment of quanta?

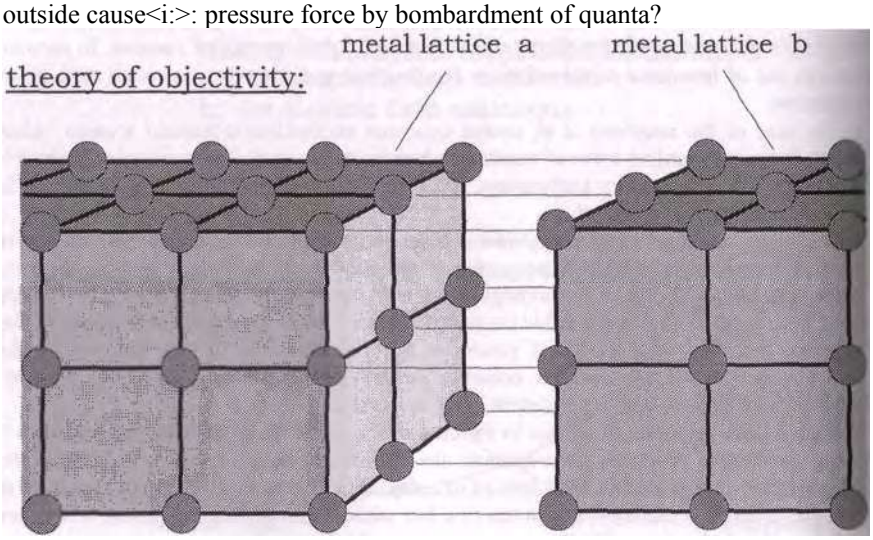

inside cause<i>: levitational force by resonance effects?

Fig. 18.3: The Casimir effect

18.3 The Casimir effect

If this zero point radiation actually would be the cause of the Casimir effect, which is generally assumed today, then neutrinos would have to be involved, if the zero point raditation would be to put equal to the neutrino radiation. The effect even is quoted as evidence, but I have my doubts.

The experiment is relatively simple and functions also in a vacuum. Two absolutely plane and smooth polished metal plates are placed very close to each other. Doing so the distance should only amount to one thousandth till one millionth of a millimetre. If the force, with which both plates are attracting mutually, is measured then it exceeds by far the gravitational force. We are dealing with an unknown force, neither electric nor magnetic.
Because the force of attraction still arises near the absolute zero of temperature, some make the zero point radiation responsible. In our translation that would be tantamount to the neutrinos exerting a pressure from the outside on the metal plates, if need be with their small rest mass, as far as this should not be based on an offset-error of the detecting devices. For that the plates would have to damp the neutrino radiation effectively and by mutual shielding reduce the radiation pressure from the split. The question is asked, if the from the outside hitting bombardment of quanta, as it is called, actually can exert a pressure which would be compatible with the nature of the neutrino radiation.

If we now try an entirely other interpretation, which does without the postulating and designing of new force effects. Now the from the unified theory won interactions according to table 15.1 form the basis. In the Casimir effect, as said, neither magnetic nor electric forces are involved, so that open field lines and the corresponding force effects (1 till 4) are ruled out. It has to be the work of closed field lines and that in the static case we know as gravitation (5). Now the mass of the metal plates is too small, as that an acceptable force of attraction of masses could result.
The measurable force is much larger, even if it according to its nature could be a gravitational force. Here oscillations, as they actually take place in the hull of the metal atoms, seem to play a role. If between the oscillations of the two plates standing opposite occurs resonance, then a levitation is possible (6), which describes an oscillating interaction, produced by closed magnetic field lines<i>.
At extremely low-frequency signals this interaction is known as gravitational wave and object extravagant and costly physical experiments.

<i>: The question, which interpretation is correct and which one should be rejected, could be verified as follows: at first the force between two plates of a certain metal and afterwards that of another metal has to be measured. If in a third experiment a plate from the first and one from the second experiment are brought together and the force effect goes back measurably, then the quantum physical interpretation would be wrong clearly. With that would have been shown that here resonance effects are used, which presuppose an identical metal lattice structure of both plates.
If the force effect however doesn't go back, then both statements are possible, then one has to think up another experiment.

Fig. 18.4: The flying disc of Searl on a german title page.[i]

<i>: Special 7, Raum 8s Zeit Dokumentation aus dem EHLERS Verlag

18.4 Effects under high tension

It crackles in the laboratory of high-tension. The air smells electrically charged. Only in a corner someone sits and waits with much perseverance and patience, until something happens. Then he lets thunder down lightnings of several millions of Volts on a small sample. It flashes and crashes and still nothing happens.
No, it doesn't concern Tesla! Tesla has worked purposeful. In addition has Tesla only called himself inventor. But the man in the corner feels himself a discoverer and as it is proper for a discoverer, he has immediately named the effect after himself. As a real American he lets market himself and his discovery by the media and a video tape.
Doing so he obviously doesn't know at all, what he wants to have discovered, of what this Hutchison effect actually consists. It perhaps is an event of pure chance, for which he sometimes has to wait hours. If it very suddenly would occur, then it is a real potpourri of all already discussed effects: metal spoons are bending (fig. 14.13), massif steel rods are breaking, light effects are being observed (chapter 17.9 PP), water starts to dance and to cook (chapter 18.1), without getting hot and finally do some samples take off and fly crosswise through the room. He then speaks of anti-gravitation.
In the video tape can be seen, how he brings about a physical length contraction as a result of a locally produced field concentration with two as an interferometer configured Tesla coils. In a bottle for instance the air volume is changed. This confirms the correctness of the here presented theory of objectivity (chapter 6.6 PP).
In any case no-one is amazed more about the results of chance than John Hutchison himself. Overwhelmed by the magic, the charm of the effects and the feeling to be able to move freely outside the trodden out ways of physics, he still sits in his corner with the video camera and waits, until finally something happens again.

There is worked with tension voltages, which are considerably higher than 511 kV, the calculated tension voltage of their own of the charge carriers (fig. 7.1). One thus by no means has to be amazed, if under the influence of several millions of Volt electrons are taken apart and metallic objects are breaking or bending.
The extreme tension voltage and field change we owe an oscillation of length and of size, which spontaneously can lead to an interaction with neutrinos. Materialized neutrinos again are responsible for glowing phenomena and for the electrolysis of water, which under the impression of the rising gas bubbles seems to dance and to cook. For my readers and participants of the energy technical seminar therefore models of explanation are available.

One effect we still haven't discussed and analysed more in detail: the antigravitation resp. the levitation. As long as no reproducible field conditions are present and the chunks are accelerated in any arbitrary direction, it will be difficult to understand the physical course of a levitation.
In chapter 9.3 we already had become acquainted with and discussed a levitation device with the flying disc of John Searl. for which the field conditions are comprehensible. This time we should have a somewhat closer look at the flying device (fig. 18.4)[<i>].

<i>: Some reports can be found in Special 7 ,,Freie Energie", Raum & Zeit Dokumentation aus dem EHLERS Verlag, Seite: 141 bis 157 und 174 bis 185

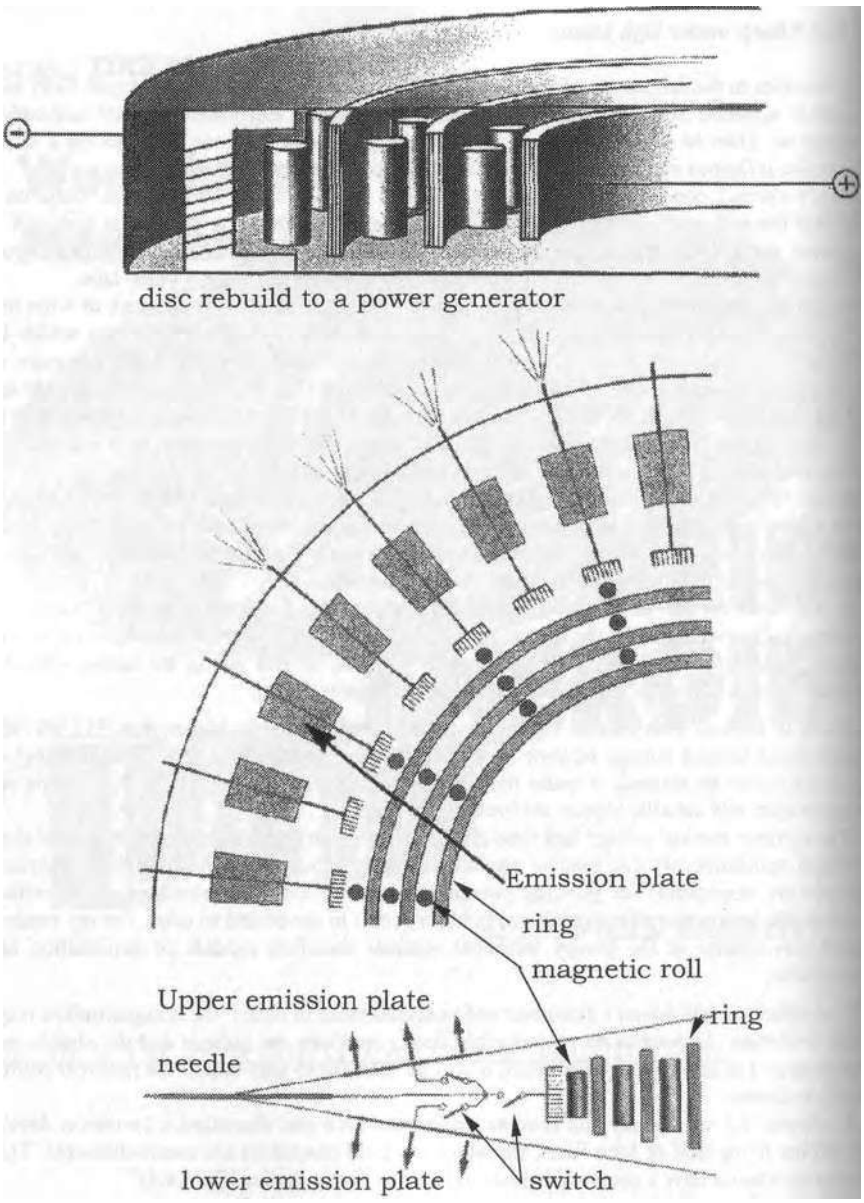

Fig. 18.5: Concerning the controlling of the flying discs according to Searl.[<i>]

<i>: H.Schneider, H.Watt: Dem Searl-Effekt auf der Spur, Special 7, Raum & Zeit Dokumentation aus dem EHLERS Verlag, Sauerlach, 1. Aufl. (1994), S. 183

18.5 Flying discs

The Searl-disc can be calculated relatively good with the Faraday equation concerning unipolar induction. To estimate the order of magnitude, we just suppose the roller magnets produce an induction of one Tesla and the radius is one meter, then between the centre of the flying disc and its edge 511 kV is applied, if the revolutions per minute has reached the value of 80000 revolutions per second. As soon as the revolutions per minute is reached, the neutrino conversion can start.
The at the edge of the disc arising corona, which consists of individual electrostatic discharge flashes, takes care for the necessary dU/dt, by every blow and every spark is drawing the potential for a short time towards ground. The tension voltage jumps in swift order between values of above 511 kV and zero Volt to and fro. In connection with the already discussed unipolar field configuration neutrinos are being collected in this way.

A technological challenge represents the layered construction of the roller magnets and the rings, which have to withstand extreme centrifugal forces (fig. 18.5). Friction however is not a theme, since on the one hand the air inside the disc ionises and a vacuum is formed and on the other hand the air split between rollers and discs increases by the field dependent contraction of the metal parts.

Actually one in this case by no means can speak of antigravitation, because the gravitation isn't really vanishing. The disc even in flight still is heavy tons. Here merely a resonant interaction is built up which is larger than the gravitational pull of the earth. The disc is attracted by the cosmic source of neutrinos, with which it has built up the resonance.
Exactly there it will fly!

The by Searl designed controlling[<i>] in my opinion actually can't have functioned satisfactorily. He uses emission plates, as he calls them, which alternatively are switched on by means of switches and are able to form electrostatic forces with some air charge carriers. In reality the drive probably is comparable to that of a sailing ship, for which the wind always blows from one direction. The ship isn't pushed by the wind, as one erroneously could think, but rather by the under pressure behind the sail pulled forward. Without steering facility the object always is driven in direction of the drain. The sailor would say, the ship without helmsman drifts towards lee.
Searl in this way has lost all flying discs which were started. By using solar neutrinos they presumably have fallen into the sun and burnt. The controlling should function analogous to a sail, then one would stand a chance, by "traversing" against the "wind", to sometime again come back to the starting-point.

<i>: H. Schneider, H. Watt: Dem Searl-Effekt auf der Spur, Special 7, Raum & Zeit Dokumentation aus dem EHLERS Verlag, 1. Aufl., Seite: 183

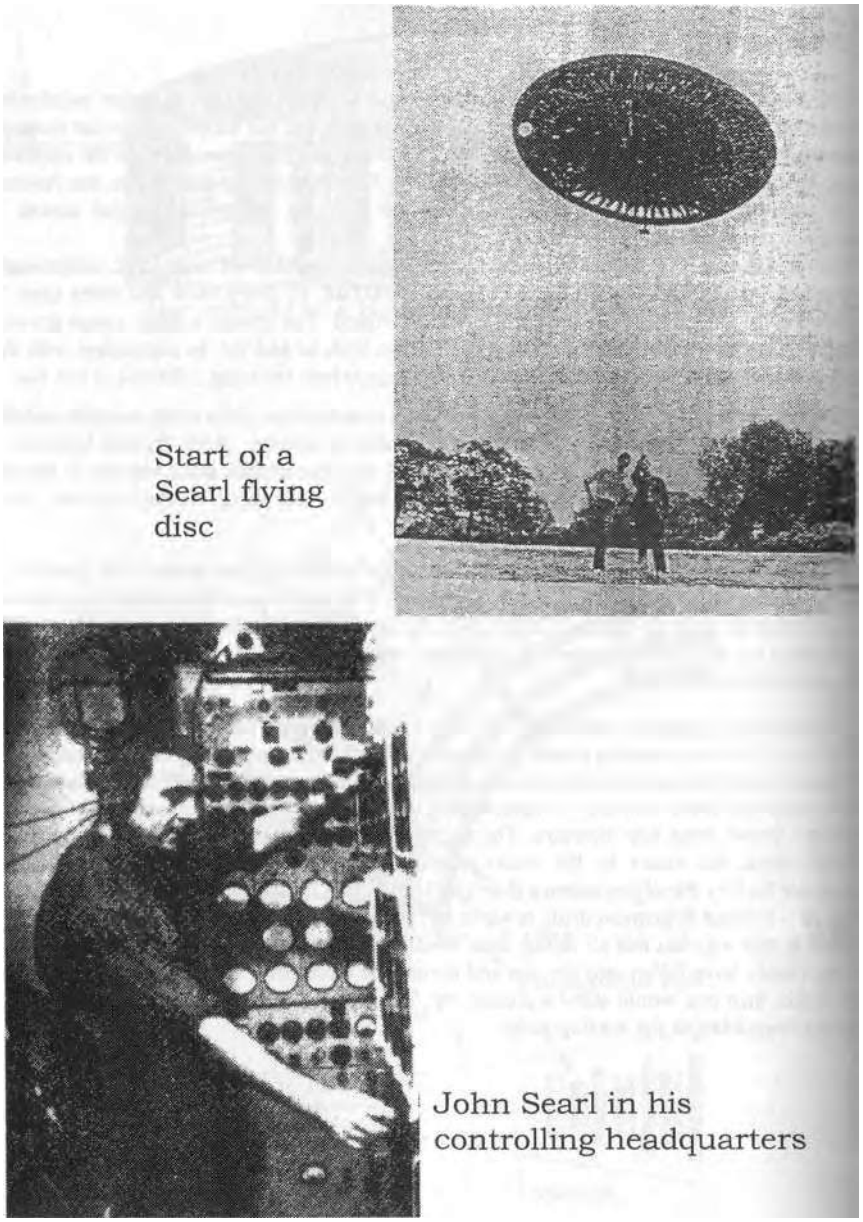

Fig. 18.6: The remote controlled flying discs of John Searl.[i]

[i]: Special 7, Raum & Zeit Dokumentation aus dem EHLERS Verlag, S. 152

18.6 Propulsion with neutrinos

In search for an ideal propulsion system for spacecrafts the flying discs of John Searl still have demonstrated a further possibility. After the start occasionally were left strange particles on the ground, which hadn't be there before. The flying device obviously had materialized them and dropped them at the start.

With this materialization of neutrinos the chance is showing of a very efficiently working recoil propulsion. If namely the neutrinos are converted into matter then they by that gain back their rest mass. If this takes place in flight then the materialized particles also bring along kinetic energy. It then works as ajet engine for which the direction of the jet can be directed and in that way the vehicle can be controlled comfortable.

In the case of the Searl-disc the materialization of neutrinos rather happens as a not understood side effect. In the case of a systematic use however the principle will show a characteristic property. Instead of a vapour trail a beam of light will shine out of the flying object in the direction of the emitted particles, but it will break off abruptly after a cartain distance.

To blame is the part, which has become anti-matter, which it is true as well contributes to the recoil, but simultaneously annihilates with incompatible particles of matter under emission of particles of light. If in some distance all antiparticles are used up then also the beam of light comes to an end.

It here concerns necessary properties of a corresponding propulsion technology for spacecrafts, which don't have to drag their propelling energy along with them. Our space technicians finally could handle another than the "hammer throwing method", in which case the "hammer" by means of terrible fuel consumption after a phase of acceleration only staggers uncontrollable through space under the influence of its inertia.

With a neutrino propulsion on the other hand one at any time can accelerate or brake. It will strongly influence the field around itself, so that can be reckoned that for every acceleration a field dependent change of size should be perceptible by an outside observer. If therefore a corresponding flying device is accelerating then it will suddenly become smaller and that then looks so as if it would have moved away with a jump without temporal delay, but that isn't the case at all.

The jerky movements only would be a result of the perception with our eyes by means of the propagation of the light. Since the passengers are exposed to the same field, they change their body size along with that of the vehicle. They actually notice nothing of an apparently infinite acceleration, which only observers on the outside would observe and which indeed no living being could stand.

Nowhere the explanation crisis is larger than in space travel! The theory of objectivity represents a real help, because it perhaps as the only one puts us in a position to conceive and understand not understood observations as necessary technological consequences. Only by uncovering parascientific as purely physical phenomena man of today will be able to free himself from the constraints of magic and his own illusions.

Is the until now discussed cases resonant or other force effects are being used, whereas the gravitation remains unchanged. Closed field lines after all cannot be influenced, normally at least. Perhaps an indirect possibility exists to have an effect on the gravitation?

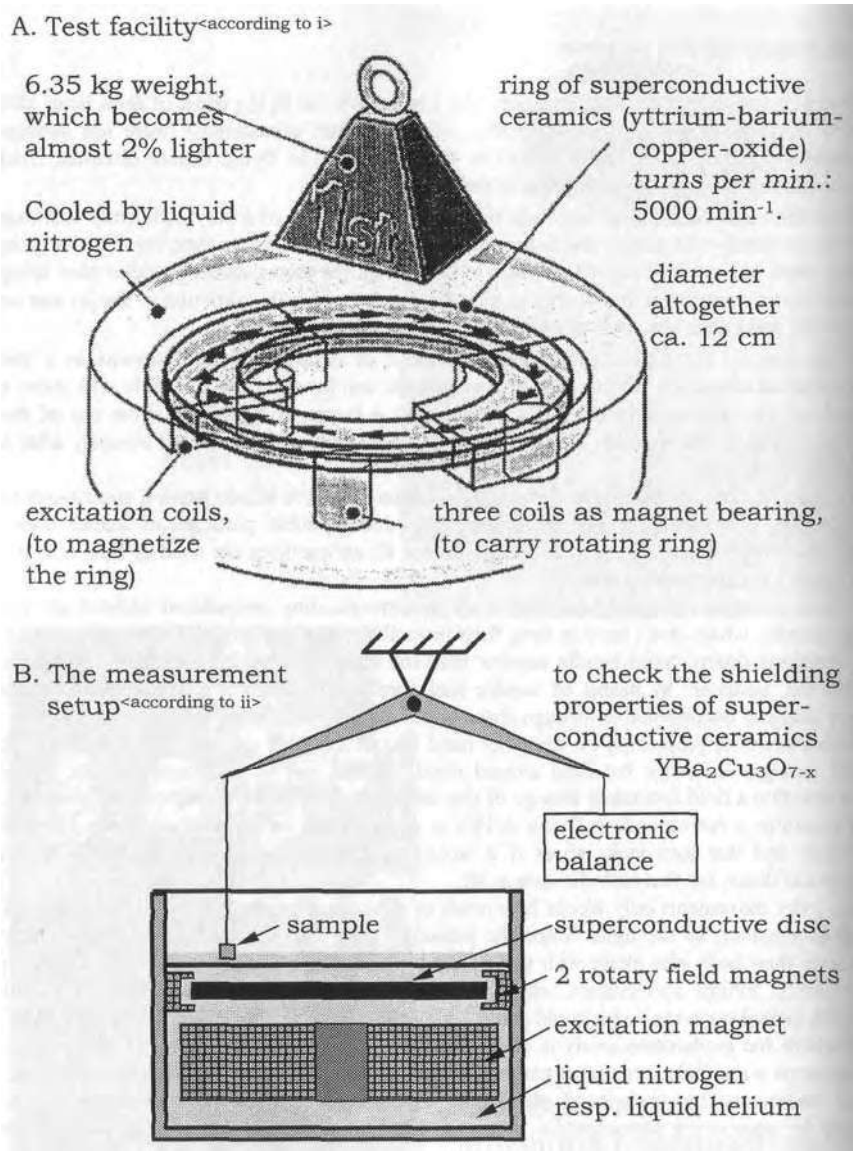

Fig. 18.7: Experiment for the manipulation of the gravitational pull of the earth.

<i>: Schneider: Anti-Gravitation im Labor nachgewiesen?, NET-Journal Januar 1997, S. 14,15; s.a. Internet: http://www.keelynet.com/gravity/fingrav.htm

<ii>: E. Podkletnov, R. Nieminen: A possibility of gravitational force shielding by bulk $YBa_2Cu_3O_7$-x Superconductor, Physika C 203 (1992), P. 441-444

<iii>: Force field Implications of Anti-Gravity, The Journal of Ideas, Art.191, 7.9.95

18.7 Antigravitation or levitation

The night already had fallen over Finland, but at the University of Tampere the light still was on. Then a scientist put his beardy head through laboratory door and with a "hello folks" blew the smoke of his pipe over the cryostat for the examination of superconductive materials. The scientists were speechless, because the smoke seemed to hit an invisible wall and was drawn upwards in direction ceiling almost at a right angle.
After having aroused the curiosity, Dr. Eugene Podkletnov also has held other materials above his rotating disc and had to discover that these as well lose weight, and that he actually influences the gravitation with his experiment. Even the air pressure at the corresponding place in a lying above floor was smaller[<i>].
With a superconductive disc of 30 cm diameter cooled by liquid nitrogen a reduction of gravity for 2% to 4% can be obtained, if the disc rotates with more than 5000 revolutions per minute. With the revolutions per minute also the effect increases, but it is independent from the excitating field[<ii>]. Finally the fields of the superconductive currents in the ring remain existing unchanged even after switching off the excitation and it only depends on these fields.

The shielding effect of the arrangement on electromagnetic fields already had been known before and should be examined closer in the laboratory. One only was surprised that the gravitation could be shielded as well, that obviously both interactions are related. According to the prediction of the theory of objectivity the closed magnetic field lines gravitate and the field components directed towards the centre of the earth cause the measurable force of weight. By the very strong superconductive fields obviously field overlaps and possibly a local driving out of field occurs, like one has long known for eddy currents (Meissner effect).
With that the earth gravitational field of course is not cancelled, but merely spatially moved, or it partly has changed its direction. If only a small part of field pointers turns out of their orientation towards the centre of the earth, then at that point the force of weight is reduced to a corresponding extent. The theory of objectivity requires that!

By the way reports exist, according to which even without rotation a weight reduction can occur for superconductive rings, and others, where is worked even entirely without superconduction. As core material for the ring ferrite or a strong permanent magnet is used. In that case depends on the circumstance that the ring-like coil is operated in self-resonance and always in the right moment again is excited anew by induction. The ring core then stores the fields up over time, exactly as the superconductor.
Stricktly speaking it are the atomic nuclei and in the end all elementary particles, which are aligning in the high field. Dr. Ning Li wants to artificially produce gravity, by directly influencing the quanta. With that she comes the phenomenon very close[<iii>]. The possibilities of this effect nevertheless are very limited, since two percent more or less are not exactly much, and the dream of the complete cancelling of gravity or even inertia possibly stays just a dream. It stricktly speaking just concerns influencing the gravitation and not antigravitation!

cause/ field lines	interaction F	= force effect *mediation:*	see chapter: effect/ *application*
5. closed **H**-field lines	gravitation (static)	F_{MG} = gravity *by particles with mass*	chapter 6.9 + 7 elementary particle mass
6. closed **H**-field lines	levitation (dynamic)	F_{ML} = reduced gravity	chapter 18.3 gravit. waves *Casimir effect*
7. closed **E**-field lines	gravitation (static)	F_{EG} (force hardly detectable)	chapter 18.7 *supercon-* ducting ring
8. closed **E**-field lines	levitation (dynamic)	F_{EL} (no longer detectable)	chap. 18.5 + 18.6 *Keely-/Searl-* *flying devices*

Table 18.8 A: The interactions of closed field lines.<i>

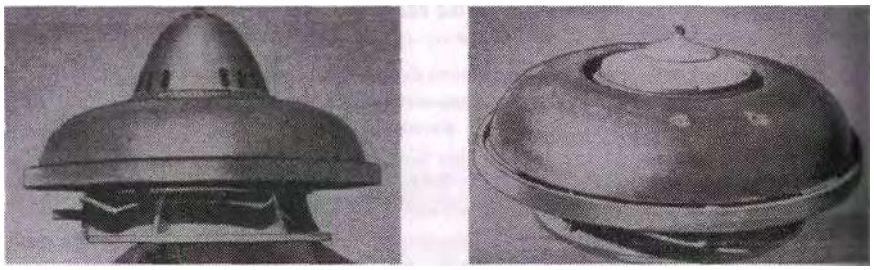

Fig. 18.8 B: Test models of the "flying saucer" according to Viktor Schauberger.<ii>

<i>: according to fig. 15.5, cases 5 to 8
<ii>: O.Alexandersson: Lebendes Wasser; W.Ennsthaler Verlag Steyr, 1993, S.103

18.8 Discussion concerning the effect of closed field lines

If we now direct our eyes exclusively to the lower half of fig. 15.5, in which the consequences of closed field lines are listed. Without the possibility of a direct focussing like for open field lines, the caused force effects turn out extremely small. With that they are less suitable for an use of free energy. The considerations in that context rather aim at technologies to reduce weight, like they would be worth striving for for flying devices.
If we allege that here in the same way the force effects of magnetic H-fields exceed those of electric E-fields for three to four powers of ten. Then it will hardly play a role for the force of weight of a body with or without additional electric charge, if its E-field lines are closed as well or are open. The increase in weight of an uncharged body only will have an effect in the third till fourth place after the decimal point. Seen so in the case of the gravitation it primarily concerns an effect of the magnetic field, more strictly speaking the effect of closed magnetic field lines (chapter 6.9).
If one succeeds in influencing these magnetic fields for instance by the influence of extremely strong fields of a superconductor, then also the gravitation will change, as has been shown (chapter 18.7). Let's imagine, in the case of a systematic procedure we would succeed in a perfect influencing, for which no component of the H-field lines points into the direction of the centre of the earth anymore, then an uncharged body would only have one tenthousandth of its original weight, whereas a charged body actually would weigh nothing anymore. This state of the weightlessness supposes that all E-field pointers point into the direction of the centre of the earth or diametrically in the opposite direction, since E- and H-field are standing perpendicular to each other. Unfortunately such a field distribution technically hardly can be realized and so the ,,flying carpet" furthermore remains reserved to the fairytales.
An effective reduction of weight of planes and other flying objects however seems by all means feasible, and so slowly the number of research facilities increases, which more or less officialy have a critical look at the cancelling of gravity and the levitation. The theories on which they are basing, however often sound very bizarre and moreover are completely unphysical. Maybe a look at the distribution of field lines, as proposed here, helps to get further.

In the case of the levitation, which occurs strictly speaking only in the case of oscillation for closed field lines, resonance again plays the crucial role for the coming about of the interaction. In connection with neutrinos the resonance can serve less the collecting; we rather need it for the materializing, for the production of mass, charge and energy.
For the artificial production of a levitation either a mechanical oscillation in the atomic or molecular domain is needed, like for instance is produced by a rotating water molecule, or a resonant oscillation of size takes place by use of electrostrictive or magnetostrictive materials, like piezocrystals or oscillating quartzes.
In this context surely is of great importance that also the temperature could be identified as a particle immanent oscillation of size (chapter 8.3). That's why besides a cold materialization or cold fusion also exists, at least theoretically, the possibility of a hot materializatin or hot fusion.

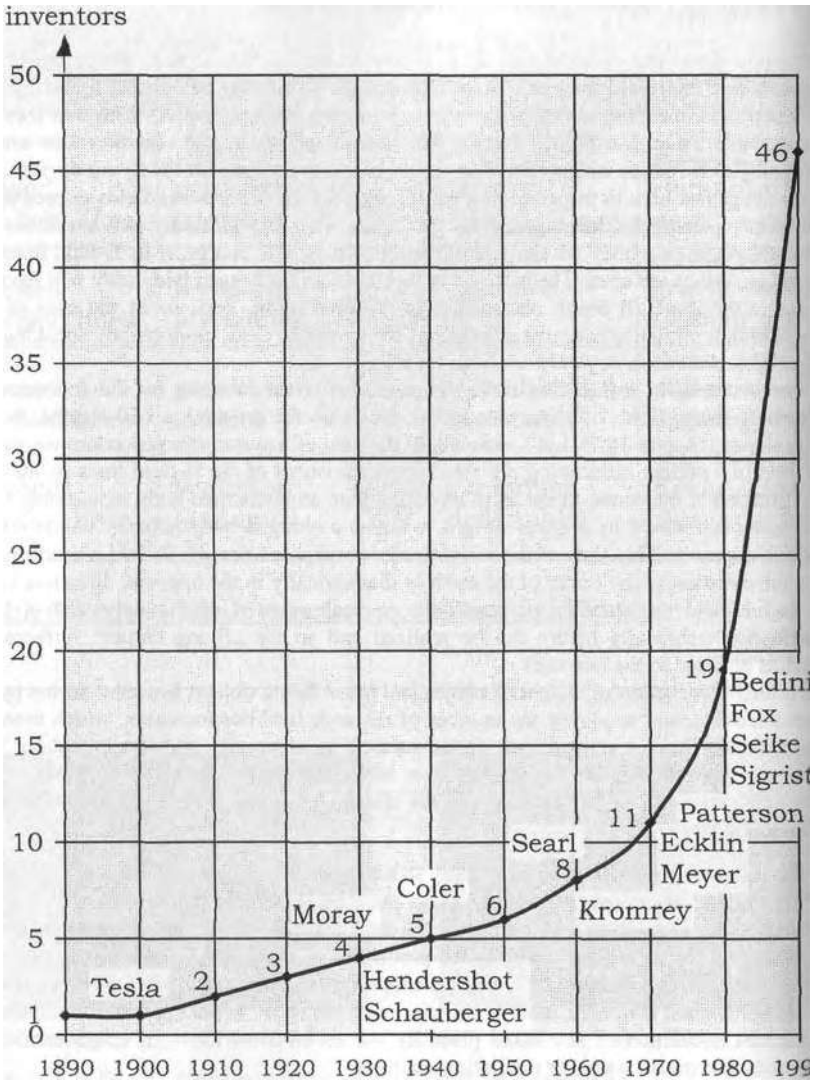

Fig. 18.9: The increasing number of free energy inventors.<i>

<i>: only the inventors mentioned in the text are entered. Literature for that: A. Schneider: Energien aus dem Kosmos, Jupiter-Verlag (1994), S. 77

18.9 Concerning the determination of the stand of today's energy technique

An analogy to the production of matter forms the production of light. At high temperatures as is well-known is formed thermal light and at low temperatures cold light, the discussed luminescence. An oscillation of size of the light source in all cases of the formation of light is the cause, be it as an electromagnetic wave or as photon vortex, be it in whirled water or as sonoluminescence. We at last see ourselves put in a position to understand the various light phenomena as something which is related.

The call for new energy carriers and an ecologically compatible energy technology can't be ignored anymore. The number of inventors at present increases fast (fig. 18.9). It is legitimate and worth recommending, to observe for this purpose first of all nature, how it solves its energy problem. Doing so we should realize that in contrast to the technology of today no combustion and no explosion takes place, but rather principles of a cold fusion and of an implosion as a result of contracting potential vortices are being used. Actually nature may point the way out of the energy technical dead end. We only have to accept the offer, be open and show being ready, to invest in the development of methods in accordance with nature.

Directed at the address of the distributors of supporting funds for energy research the claim in plain English reads: to grant no money anymore for ecologically harmful concepts, like nuclear fission or for not understood and not realizable developments like hot fusion. to immediately stop the fruitless works and to provide the money for an ecologically compatible energy research.

Immense saving potentials moreover are found in all domains of physics, where instead of costly experiments just as well the things could be calculated with an usable theory. To check the theory then only few experiments would be necessary. After all all important discoveries have come about in this manner. Nobody should think, he had understood a matter, once he has filled himself up with sufficiently much measurement data.

The root of the evil lies already in the education, where students of physics want to understand everything and therefore are trying hard to grasp with their view and hands for everything. Abstract thinking or mathematical derivations however are too uncomfortable for most; they have the erroneous opinion, understanding (German: begreifen) would have to do more with grasping (German: greifen), and for that the head after all can't be used.

One reason for this development can be seen in the relativistic point of view of Albert Einstein, who proceeds from the assumption of a subjective observability and has raised the relativity between a physical principle and the observation to the basis of physical thinking. The arrogant motto prevails: what I can't observe with my sense organs or register with corresponding gauges also isn't physics, but esoterics or parascience.

But if we want an ecologically compatible technology, then this can't be reached with this point of view. Then we only hinder ourselves with our own arrogance and intolerance. We have to leave the erroneous quantum physical way and again learn to think abstractly by taking up tried and tested principles of classical physics. An objective point of view forces us to register the phenomena, which lie outside the observable range, with mathematical MEANS (see chapter 13). Only if we have learned that, we will understand and realize the true relations in physics!

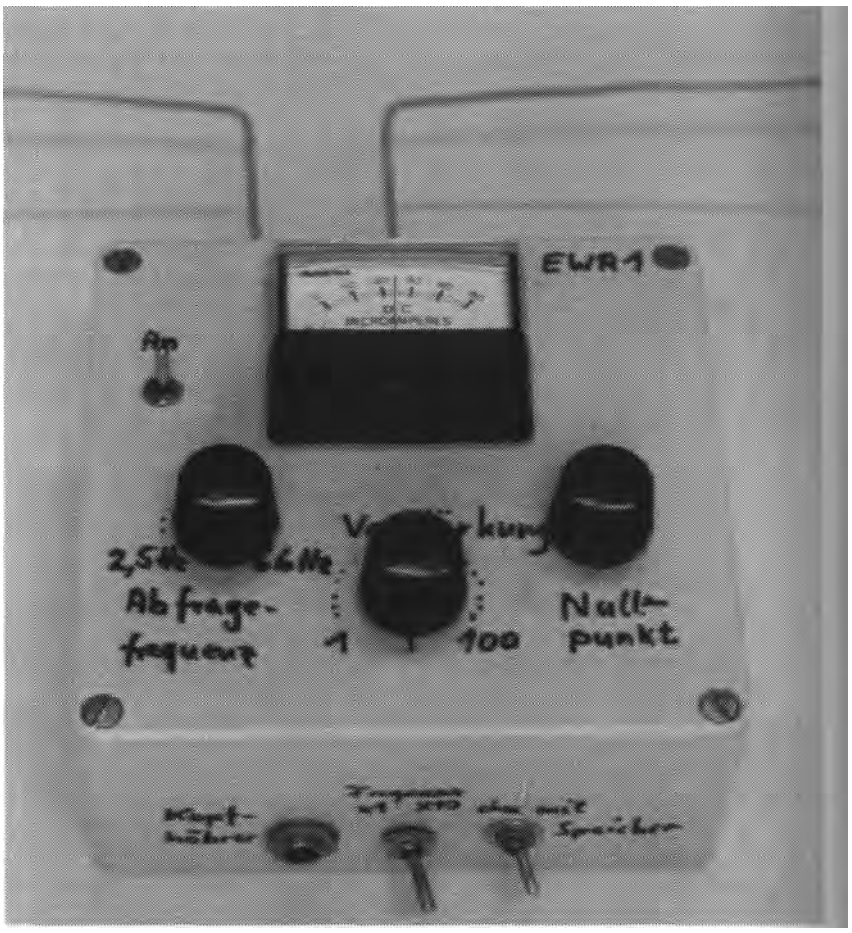

Fig. 19.1: A self-built charge amplifier.

19. Own experiments

The opposite of the theoretical considerations form practical experiments. If we want to register and understand physical and natural scientific phenomena, then we shouldn't entirely forget the aspect of handicraft. Doing so it can't be avoided that it goes on very personally, if about the laboratory work is being reported, not even then, if the experimenter is at pains to exclude every influencing of the carrying out of the experiment and the result. After all does anyone have to execute the experiments himself, since a good sceptic anyhow only believes, what he has observed with his own eyes.

19.1 Concerning the rating of experimental physics

There already have been scientists, who have requested to reject a measuring technical determined result for the case that textbook physics doesn't produce it. This attitude even today still is taken by an uncounted community of believers of science, entirely after the motto: "Nature kindly has to fit in with the dogmas of theoretical physics!"

This wrong thinking is reflected in the scientific journals, which reject to print discussions. Controlled by a tester board, which only has the task to prevent dissenters from the publication of their ideas, they are the sad proof, how widespread this erroneous attitude today is in the university scene.

Actually solely the scientific experiment shows us the physical reality! The theoretical models, like the here presented vortex model merely should help to understand nature and its laws. The representatives of theoretical physics are in the role of a helper and that requires modesty and openness.

For the case that a professor of theoretical physics imposes a pledge of secrecy on an experimenting colleague, if this one wants to report publicly about his amazing tunnelling experiments, then the public nevertheless should have the right to find out, if a tunnelling experiment reveals speeds faster than light, even if it doesn't suit the theorist and he in inappropriate arrogance only should consider the experimental physicist as his assistant.

If universities only are occupied with preservation of property and the industry only with the increase of its productivity, if future research consists of hiding public research funds internally in such a way that nobody realizes the fraud of support and in reality nobody thinks of the future anymore or wants to work for it, then we will be able to observe how discoveries and inventions migrate from the industry and the universities with their controlled central organs and increasingly will take place again in garage, cellar, solitary study room or in privately organized circles.

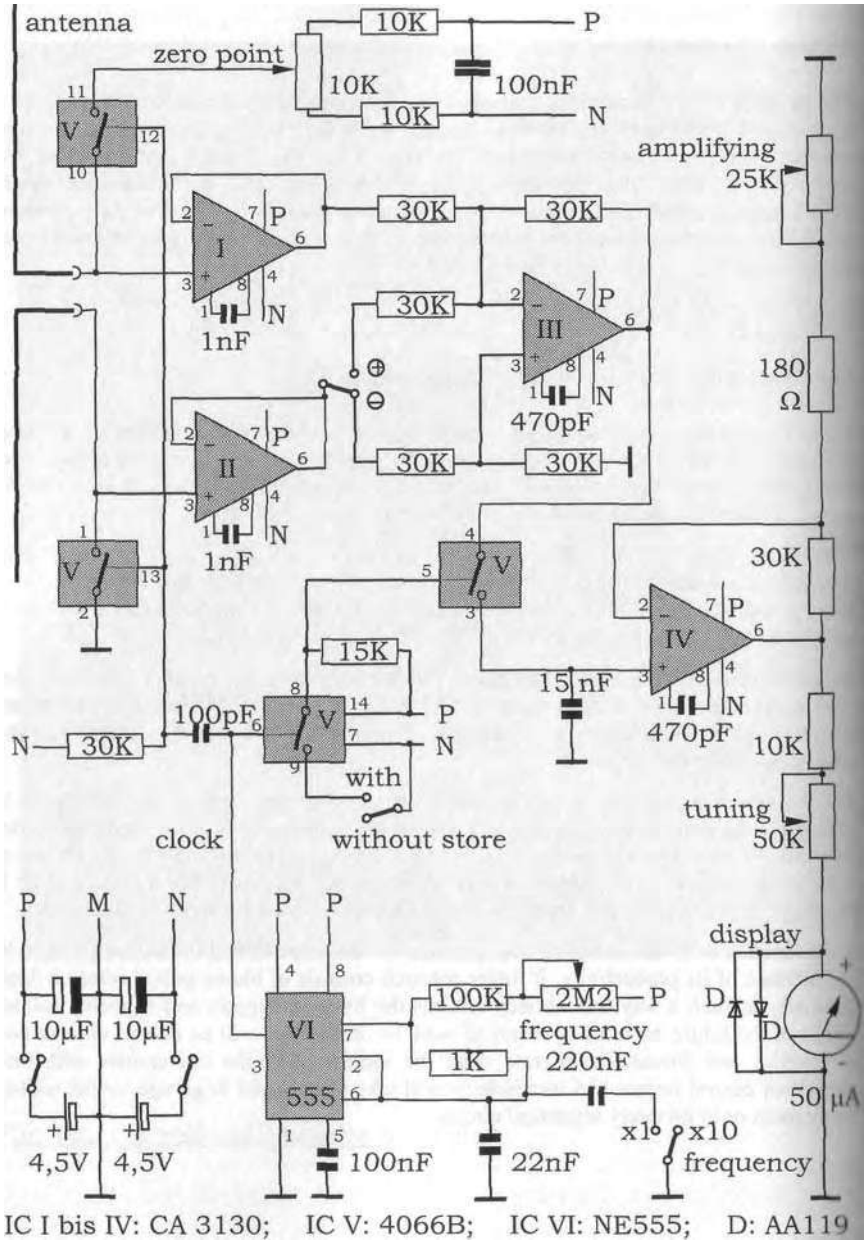

Fig. 19.2: Wiring diagram of the self-built charge amplifier

19.2 The charge amplifier from the workshop of handicrafts

Is connection with my vortex theory in this book time and again clues to experiments can be found. I am aware of their importance and I always, to verify my theoretical working out, have accompanied it with practical experiments. Doing so not the proof, which can be published and reproduced by anyone at any time, stood in the foreground. With the experiments in my workshop of handicrafts I only wanted to check for myself, if my derivations still can be verified.

Consequently was at first done without a publication in the first and second edition of the second part concerning the "electromagnetic environmental compatibility". For the addition of the here presented chapter about own experiments from the third edition there are several reasons: first; I have been asked for it by several readers, second; from every experiment is coming a piece of physical reality to meet one and third are here latent some useful ideas and approaches which get us somewhere.
Of course can't be read much from a handicrafts self experiment, but perhaps one or another reader, who has better laboratory technical possibilities at his disposal than me, is stimulated to carry out own experiments.

To chase after the potential vortices in the air, I 1989 at first have built together a charge amplifier. I connected differently formed antennas at the particularly high-ohmic difference input. Corresponding the in nature arising static electric field a tension voltage should arise between both antennas, which my gauge should amplify and indicate on a moving-coil instrument.
To be able to register local changes, a measurement cycle is gone through, which periodically is repeated: It starts with the measurement time, during which entirely by itself between both antenna a charge is building up. The value afterwards is stored analogue in a Sample-And-Hold link and displayed by means of a moving-coil instrument. Then the input clamps are short-circuited, the antennas again discharged and the game starts from the beginning.

Measurement time, zero and amplification can be adjusted at the device (fig. 19.1). Whoever has fun to rebuild it, finds the by me realized wiring diagram in fig. 19.2.

It is true I did realize other designs, but technically the here shown design proved to be the most useful solution.

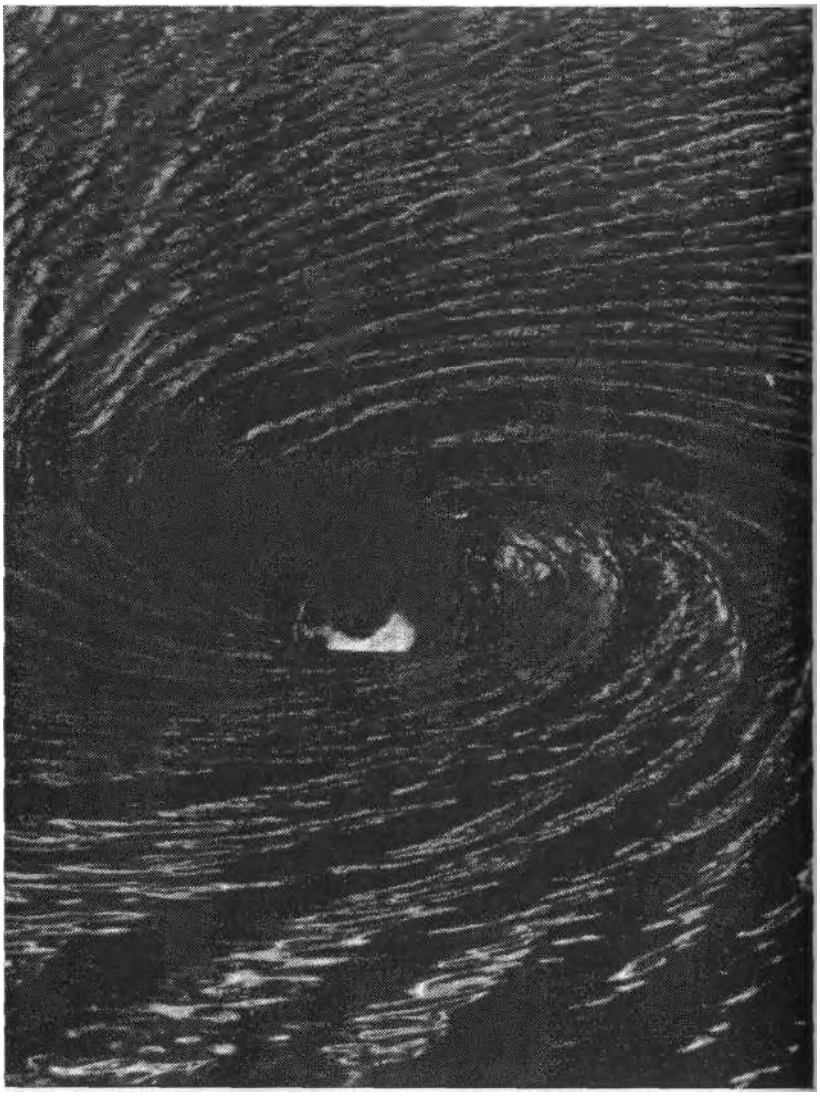

Fig. 19.3: _____The bath tub drain vortex;
shown is a tidal vortex near St. Malo.[<i>]

<i>: Photograph from the magazine ,,Life" of 4.7.1969, resp. from: H. J. Lugt: Wirbelstromung in Natur und Technik, Seite 371

19.3 Interpretation of the observations with the charge amplifier

The practical use of the device at first proved to be extremely difficult, because the pointer seemed to perform a wild dance. At a more close look I however could make exactly those observations, which I had sought-for as proof for the existence of potential vortices.

First I did find confirmed the known high field strength. We after all live between the ionosphere and earth's surface right in the middle of the dielectric of a "spherical capacitor". Because the values of the electric field reach very much closer to the maximum value, which is lethal for living beings, than the value of earth's magnetism, I did draw from that the conclusion that biological effects primarily can be expected from the E-field.

If the E-field, as Maxwell's field theory specifies, actually would be irrotational, then we would be dealing with a gradient field. My device would have to display everywhere to a large extent the same value. But that was not the case.

Maybe the building is responsible for the chaotic display and the wild swings of the pointer, so I thought. Doing so I had thought of the auxiliary explanations of the high-frequency engineer about so-called reflections in closed rooms. Therefore I stormed with the gauge, which had gone wild, into the open air and walked different ways, which should have been reflection free, but the picture stayed the same. In any case the E-field is not a gradient field. I had to find out.

Following I could, what required much patience, find certain places, at which for the same movement from the same direction could be seen a reproducibility of the swing of the pointer, it even could be arbitrarily often repeated. 1 marked the point exactly. Then I tried to move the device from another direction towards the marking and had to find out that the point had moved away.

If I sit in the bath tub in the evening and pull the plug, then I each time am enthusiastic about how sensitive the drain vortex reacts, how I can send it from one corner into the other by the snipping of a finger without it falling apart (fig. 19.3). Doing so one easily can imagine with a bit of phantasy how difficult, yes, almost impossible it would be to measuring technically register the vortex for the case that we could not see it. The gauge it is true would display violent wave movements. But a reproducibility we would not be able to obtain, exactly as for my self-built charge amplifier.

Now I knew that the by me at 2.1.1990 at first purely theoretical derived potential vortex actually exists as vortex of the electric field!

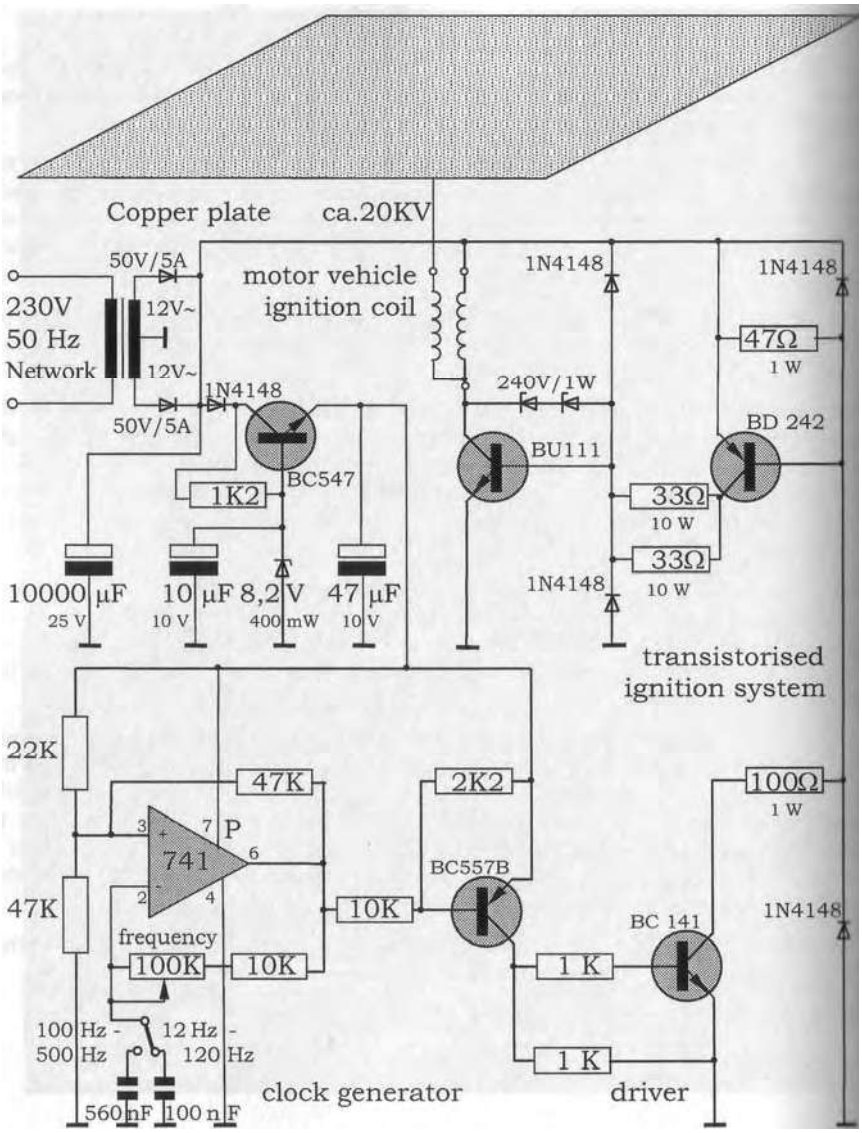

Fig. 19.4: Wiring diagram concerning the Kirlian device.<i>

<i>: Elektor, Fachzeitschrift fur Elektronik, Mai 1977, S. 22-25: KirlianfotogralV

19.4 High-tension experiments in the laboratory for performance electronics

At first the students of electronics, with which I had to do daily, were infected by my discovery. With true enthusiasm they soldered together one circuit after another. In my laboratory something like a mood of setting out could be felt. One student brought along and old ignition coil of a motor vehicle, then the control circuit for it was built, plexiglas organized, an aluminium plate glued under it and the whole box dragged into the photographical laboratory[i]. Three students made a detour along the outside grounds of the polytechnic and picked the necessary visual aids of trees and bushes.
Following the leafs were laid on photographical paper and by means of the self-built high-tension generator charged to 20000 Volt. Doing so at all edges and particularly at the tips of a leaf corona discharges arise, which expose the photographical paper. We then developed the photographs ourselves and discussed the results [ii].

The indication, for a second photograph the whole leaf would appear even if half the leaf is torn apart after the first experiment and only one half is put on, occupied us in particular. Eventually we didn't put on a leaf at all in the second experiment and found out that nevertheless the leaf put on last became apparent on the photograph. Now only one physical interpretation was possible: The potential vortices of the leaf stimulated by high-tension still were in the plexiglas disc in weakened form! Here they swirl further and under high-tension furthermore produce corona discharge impulses.

Now also the students were convinced of the existence of the potential vortices.

This experiment stimulated the brain cells of the entire team: If potential vortices under high-tension cause electric blows, since the corona discharge is nothing else, then in this way the local vortex distribution in space should be measurable? One student immediately got down to work and build from the horizontal diversion unit of an old television a high-tension generator with an adjustable spark gap. Following he walked with his flashing and crashing device all through my laboratory and others walked with him and dragged the gauges behind them. But to their big disappointment they were not able to see an influence dependent on place.

Then it suddenly was clear for me: It would have done the students well, if they before would have had a bath and observed the drain vortex, "it suffices the famous wing stroke of a butterfly", I explained my team, "and instead come up with this infernal machine and chase away all the vortices, which we actually want to register ". We had to realize that as a rule phase of disillusionment follows the euphoria.

<i>: Klektor, Fachzeitschrift fur Elektronik, Mai 1977, S. 22-25: Kirlianfotografie; fig. 19.4 shows the wiring diagram and fig. 19.5 A the self-built device.

<ii>: The Kirlian photographs from the darkroom of the polytechnic are shown in fig. 3.6.

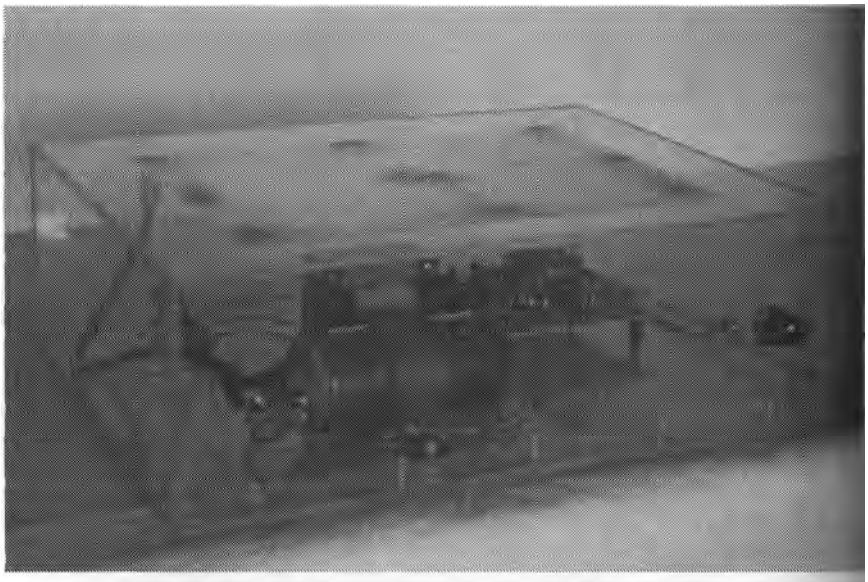

Fig. 19.5 A: A self-built high-tension device for Kirlian photography

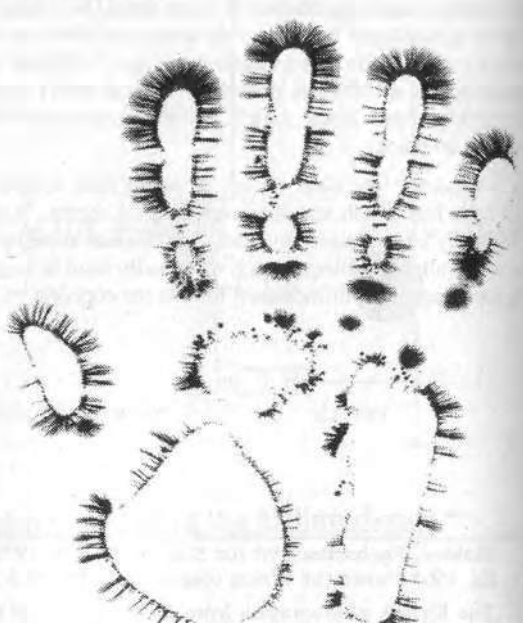

Fig. 19.5 B: Kirlian photograph of the right hand

19.5 Measurement of dielectric capacitor losses in the HF laboratory

My convincing work clearly was shaped more complicated with my professor colleagues. Most pretended to understand nothing about it and kept themselves out. But there also are exceptions. „something like that has never been there at our polytechnic, that a colleague puts forward an own field theory ",a physicist colleague remarked after my lecture public to the polytechnic[<i>] at 3.7.1990 and meant, that must be celebrated. He festively let me cast my eyes in his store room, got out a few bottles of wine, which then some of my colleagues of physics emptied with me in their official room. Doing so we small talked about the sense or nonsense to fix on the education of physics to the Coulomb charges.

The head of the high-frequency laboratory showed likewise impressed. At last he now knew, why capacitors at microwave frequencies can become so hot that they solder themselves out of the circuit by themselves and can fall out, why PVC-films can be welded with HF, etc. „We have to prove that not the dielectric is to blame, as stands in the textbooks" he came towards me.
At least following my idea potential vortices are the ones, as I expressed myself, which are behaving dual to the eddy currents. It concerns vortex losses, thus a physical phenomenon. Eddy currents now can be damped as is well-known, by for instance sheeting the iron circuit for engines and transformers. The insulation between the sheets prevents the formation of eddy currents in that direction and the degree of effectiveness increases.
"I would suggest", I told my colleagues, „to "sheet" a capacitor in a dual manner and to measure the losses". Because eddy current losses increase with the square of the frequancy, we picked microwave frequencies. In the HF-laboratory a card with an L-C resonant circuit was made, we should be able to quite precisely determine the losses by means of its quality. The inductance was formed as a microstrip line and for the capacitor a socket was planned.
The carrying out of the experiment consisted of using single layered ceramic capacitors, so called trapezium capacitors, with a vapour deposited silver coating on both sides as a package and to measure the quality of the resonant circuit as a measure for the dielectric losses. According to the rules of duality the dielectric (as nonconductor) thus corresponds to the permeable transformer sheet (conductor) and the silver coating (conductor) to the sheet insulation (nonconductor). In a second experiment the silver coating now was removed and the same capacitor material measured at identical conditions this time uncoated. Will the losses increase or isn't changing anything?
Tension and nervousness suddenly could be felt, even among the students, who followed the experiment from the second row. All looks were pointed at the monitor of the network analyser, on which slowly the bell-shaped curve of the measured resonant circuit quality became apparent. The result was surprisingly clear. I first looked at my colleagues and then at the students and had to realize that all eyes were pointed at me. The first measurement was a bull's eye! The vortex losses "uncoated" were considerably larger.

<i>: K. Meyl: Die mangelnde Dualitat der Maxwellschen Gleichungen with contributions concerning the theme of magnetic space poles, the mathematical calculation and the technical-physical interpretation of newly discovered potential vortices. Invited by the rector of the FH Furtwangen at 3.7.1990

- experiment 1: quality of resonant circuit with coated capacitors
  from a series of 5 separate experiments averaged: Q = 48
- experiment 2: silver coating removed with diluted nitric acid
  possibly the acid has damaged the dielectric: Q = 9
- experiment 3: silver coating polished off mechanically.

low quality means high dielectric losses! averaged: Q = 28

- resonance sharpness (quality number): $Q = \frac{f_0}{\Delta f} \quad \frac{\text{(Resonance frequency)}}{\text{(Resonance frequency range)}}$

at a resonance frequency f0 of approx. 400 MHz.

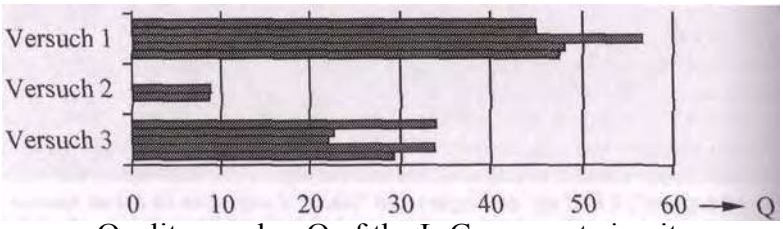

Quality number Q of the L-C resonant circuit
the dual „sheeted" capacitor has the lowest losses,
the resonant circuit with that the highest quality (experiment 1).

Fig. 19.6: Measurement of the dielectric capacitor losses over the quality of a resonant circuit in the HF laboratory at 11.06.1990.

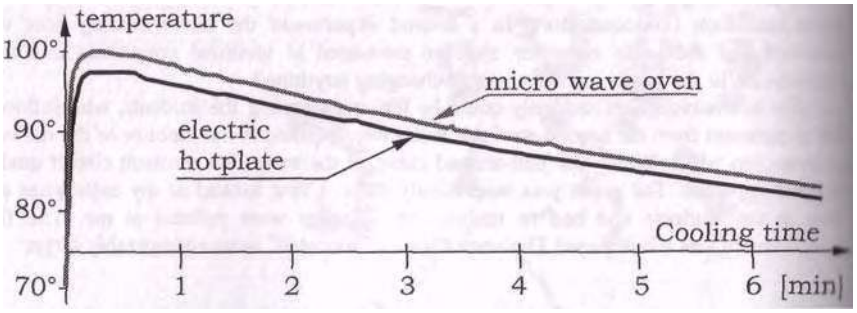

Fig. 19.7: Measurement curve of the water temperature over time
at 22.10.1996 in the electrical engineering training
Observation: for the microwave oven the container despite the "after cooking-effect"
remains colder than in the case of a hotplate. Sensor: PT 100.

19.6 Analysis of the measured capacitor losses

First of all the colleague spontaneously prompted a common publication.

But a certain disillusionment had to await us. For the next measurement hardly a differemce could be detected. We varied the contacting and removed the silver coating. once with hydrochloric acid, once with fine sandpaper. Every measurement we repeated umpteen times and in the end had to draw the conclusion that the results for our somewhat unprecise construction fluctuated extremely.

Averaged over all measurements and methods, indeed a reduction of the dielectric losses for alayered capacitor resulted, but at a critical consideration of the errors the results seemed to "drown" in the mean variation. In the opinion of my colleague the visible trend wasn't sufficient to convince dyed-in-the-wool sceptics, whereupon he withdrew with the indication, I should try at the people of microelectronics, they more likely would be capable to reproducibly gain control of a layered construction.

The experiment at least let a legitimate chance open that the vortices of the electric field actually exist, and in the case of the delectric losses of a capacitor it concerns vortex losses<i>.

19.7 Microwave oven for testing in the laboratory of electrical engineering

"Volunteers first" was said at 22.10.1996 in the electrical engineering practical training and two students got down to work. I had brought along from our kitchen the microwave oven, a portable immersion heater, a kitchen stove plate and different containers. In the laboratory of the polytechnic I in addition had got hold of a Bunsen burner. In the sense of the "Stiftung Warentest" (institution to protect consumers in Germany, note of the translator) it concerned the question for differences in heating water; or following the public discussion, is cooking with gas more healthy than cooking with the microwave oven?

We wanted to know. So we cooked water, filtered by inversion osmosis, once with the gas burner. once with the hotplate and finally with the microwave oven. Switched off always was at the same moment at the same temperature, and the cooling down curve was recorded with an x-t-time recorder (fig. 19.7).

Between gas and electric cooker virtually no difference could be detected, but the microwave oven at switching off still showed an odd temperature increase. I already had remarked this earlier. If one takes a water glass out of the microwave oven, then the water again really bubbled off, although the container itself had remained relatively cold. If one on the other hand takes a water pot off the gas cooker, the water suddenly stops cooking. From where comes this difference, which also the experiment could confirm?

<i>: A result of my dual way of looking at the vortex losses is the representation in fig. 4.7.

A: damped wave equation:

$$\Delta \mathbf{E}\, c^2 = \delta^2\mathbf{E}/\delta t^2 + (1/\tau)\cdot\delta\, \mathbf{E}/\delta t$$
$$\text{(wave)} + \text{(vortex)}$$

B: open chain of reasoning in the physics of electromagnetism:

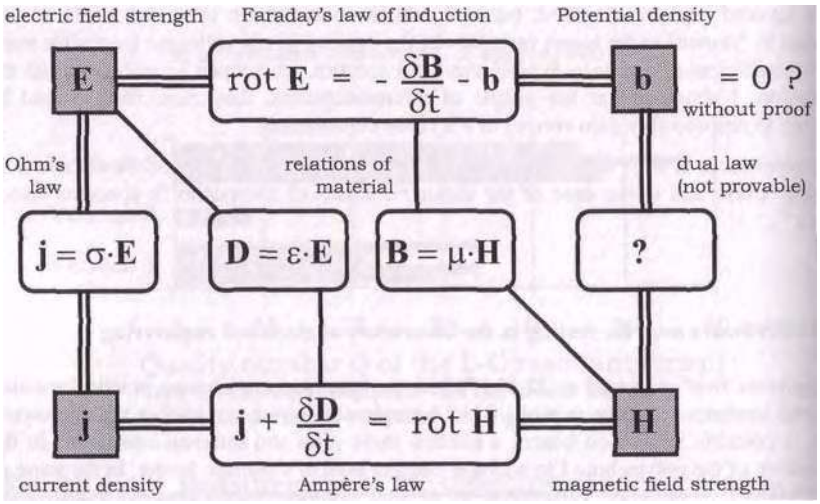

C: for the stationary case $(\delta/\delta t = 0)$ in general representation:

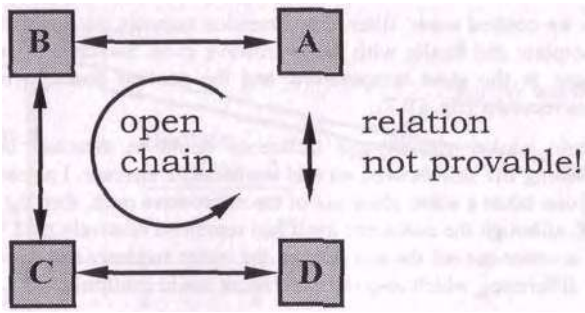

Fig. 19.8: _____ Contribution to the discussion about the impossibility, to prove, according to scientific methods, in a chain of reasoning (A-B-C-D) the last link (D-A), which closes the chain.

19.8 Microwave heating by decay of vortices

It has to concern a storing effect. In the case of an normal cooker the heat transfer takes place by convection. In the case of a microwave oven we however are dealing with an electromagnetic wave.
But in the wave equation nothing can be read about heat; here merely vortices can be found as a damping term (fig. 19.8 A)[i]! Therefore as the only possible interpretation is left that the microwaves roll up to vortices to fall apart themselves after a certain time.
Only at the vortex decay heat is formed.
The irradiated microwave power according to that is stored over a longer period of time as vortex in the water and the food. The vortex decay takes place according to an e-function with the calculated relaxation time constant tau[ii].

From the circumstance that particularly water is heated up in the microwave oven despite the small electric conductivity but with high dielectricity, I infer that it has to concern mainly potential vortices, from which a biological effectiveness can be expected. The question if this should be valued positively or negatively, I have to leave up to the doctors and therapists. At least physically seen a difference is measurable. Thus a vortex decay will occur for a meal prepared in the microwave oven even if we already have consumed it.

Conclusion: I wish all: your health!

But what do I write about vortex losses, if every sceptic knows half a dozen alternative interpretations. Inevitably I have to bear in mind that also the eddy current heating owes its acknowledgement only the circumstance of the discovery of the corresponding laws. If Othm hadn't discovered his law and formulated it in the known form and instead the dual formulation would have been discovered, then we today would attribute the dielectric losses in a capacitor and in the microwave oven to the potential vortices, in the case of the transformer however the material would be responsible for the heating and not eddy currents, for which there then also wouldn't be a theory (fig. 19.8 B).

It actually is pure coincidence that at first Ohm's law and not the dual formulation had been discovered and acknowledged. But because both are equivalent, we also have to assume the correctness of both, even if the last link of a chain of reasoning A-B-C-D back from D to A in principle can't be proven anymore, since it already is explained by the chain A-B-C-D (fig. 19.8 C).

There I thus had discovered a potential vortex, without a possibility for a direct proof of existence. For that the textbooks are full with auxiliary explanations, with which physics successfully cheats past this important field phenomenon. I was frustrated. There had to be a way to measuring technically register the vortex in some way.

<i>: Fundamental field equation 15 in fig. 5.1 or equation 21, fig. 5.3
<ii>: Relaxation time constant: see equation 10 in fig. 5.1 or fig. 8.1

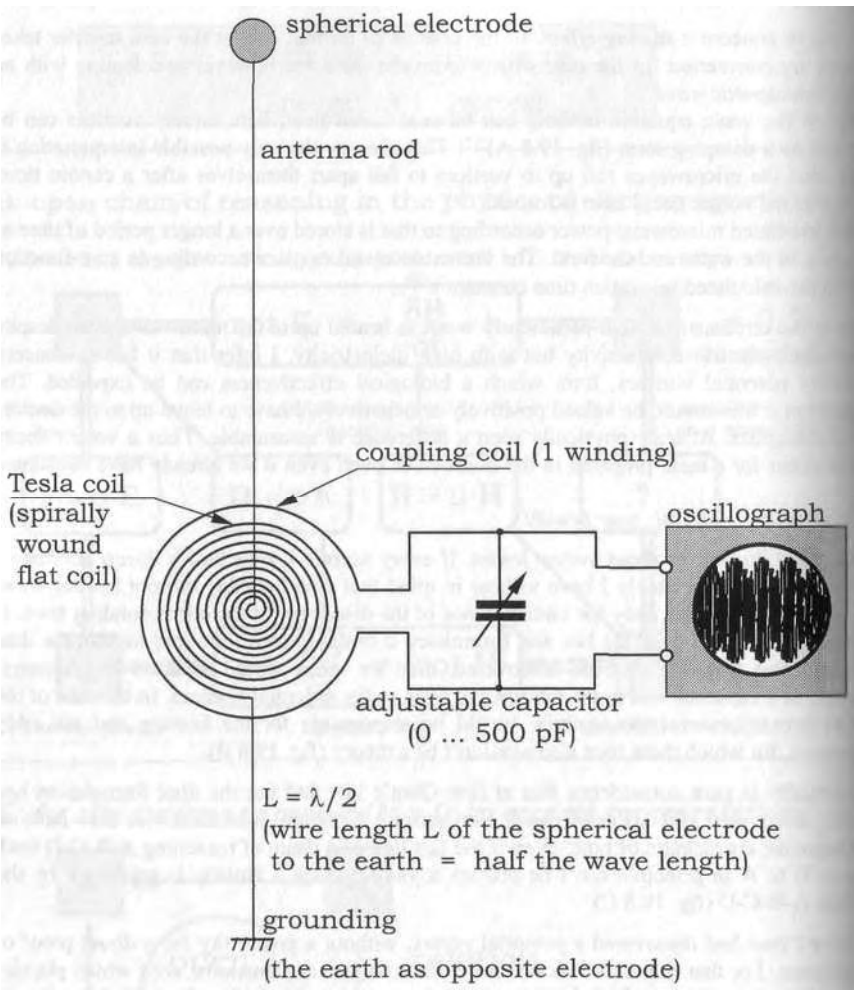

Fig. 19.9: Proof of scalar waves with the Tesla coil.<i>

<i>: The inverse use for a high-tension transmitter according to fig. 9.1

19.9 The Tesla coil from the workshop of handicrafts

I again retired in my workshop of handicrafts and wound flat coils or I pondered in my study over Tesla books. 1995 from several sides my attention had been drawn to the circumstance that the inventions of Nikola Tesla can be organized in three categories:

The first third has made him world-famous. It concerns the rotary field theory, the asynchronous engine and the today normally used alternating current technology, which we owe him.

The second third concerns technologies and inventions, which were rediscovered by other people partly only years later or even were only pinched and distributed as novelty under another name. Electron microscope, superconduction, electrolyte capacitor, fluorescent lamp, fuse. coaxial cable and a lot more count among that.

The last third however concerns inventions, which until the day of today still aren't understood and await their scientific explanation and technological use. Tesla himself called these achievements his most important inventions, but still owes us a scientific explanation. The scientific world also hasn't got a theory ready and doesn't know to do anything with it. Public research doesn't take place or is prevented by lobbyists.

What remains, are tinkerers of various educational background and qualification, who are trying hurd to comprehend the buried experiments of Nikola Tesla off their own bat in the garage or in the hobby cellar.

I felt like one of these, by winding one winding after the next from the inside to the outside. Then I soldered an antenna wire at the inner end of the flat coil, which I in Tesla manner connected electrically with a spherical electrode hung up under the ceiling. The opposite electrode should be connected to the outer end of the winding, it is said, and the distance between both should be as big as possible. If namely an electrode just is collecting, then the opposite electrode is repelling the same space quanta. According to Tesla's recommendation I did use the earth as opposite electrode and for that tapped the central heating or the grounding of the foundations.

To take signals only one to two windings as secondary winding were necessary. I connected them with an adjustable air capacitor from an old steam radio to a frequency determining parallel resonant circuit and looked at the taken tension voltage at the oscillograph (fig. 19.9),

I still had problems with the statement of Tesla, the coupling had to be made loose. Thus the question is asked, how loose? I after that organized two toilet paper rolls of different size, (after the toilet paper had been used, naturally) and pushed them into each other. The smaller toilet paper roll carried on the gable-end the flat coil as primary winding of the air transformer and the bigger one the coupling coil. Now by shifting any wanted degree of coupling could be adjusted to (fig. 19.10).

I was astonished myself. Tesla actually was right with his discovery of the scalar waves. With my arrangement they can be clearly distinguished from the Hertzian waves.

The following procedure is recommended:

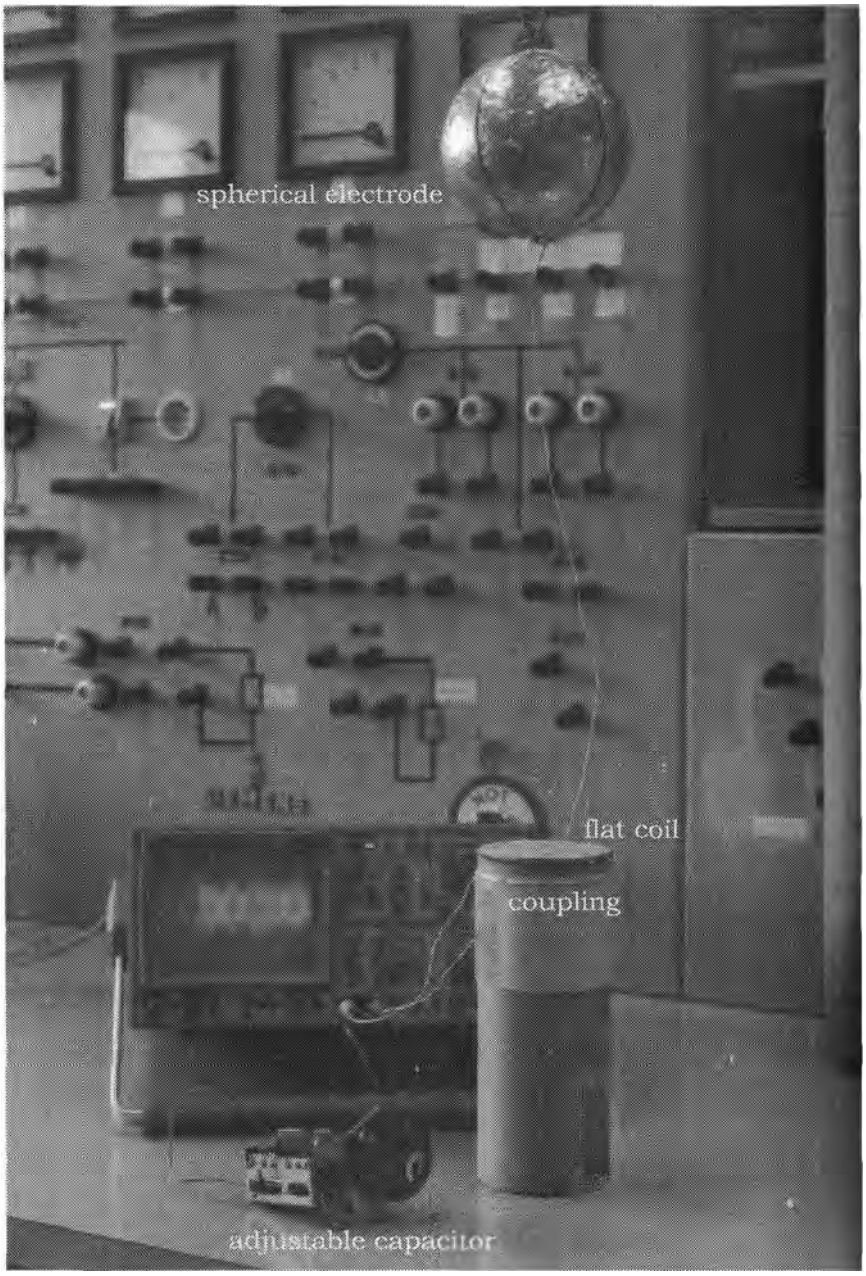

Fig. 19.10: The experimental configuration

First of all I seek a source of interference with the adjustable capacitor and tune to maximum amplitude. Then I change the coupling and further optimise in this way. If now the amplitude again decreases from a certain point while approaching the coupling coil, then it concerns the sought-for longitudinal waves. If namely the coupling is too tight, then the received vortices again are driven away by the effect back on the fiat coil. They make way.
At last I had found a method to catch the vortices in such a way that they not immediately "ran away" from me again. At once I presented them in the technology centre in St. Georgen. In the time following I improved the technology further and further, used bigger toilet paper rolls and eventually even turn up garbage cans, I varied wire length, wire diameter and the sense of winding (fig. 19.10).

I had very different success. Sometimes, if at the same time in my workshop of handicrafts the radio worked, it would look as if the received signal would synchronize with the sound waves. Both are longitudinal waves after all. With transverse waves something like that would be unthinkable.
One moreover could observe, how a resonance builds up: first slowly and then faster and faster, so that I sometimes got terribly afraid. Several times we had to repair our oscillograph, after the protective diode at the input amplifier had blown, and that for signals of 50 to 100 millivolt!
That was entirely impossible. Only individual spikes, which were too fast to be seen at the screen, could be to blame. In the case of distant thunderstorm activity I obtained maximum values of more than half a Volt. After that I undamped the grounding as fast as possible, so that no lightning would be caught, since I didn't have the intention to burn off my workshop.

19.10 Biological effectiveness of the Tesla coil

Also the biogical effectiveness of the Tesla radiation I could impressively prove with this device. 14.06.1997 a woman, who called herself extremely electrosensitive, participated in the weekend seminar about electrobiology, which I took over from Prof. H.K. Konig (TU Munich) after his death. That I wanted to test.
I hung up my device in the lecture auditorium and installed the oscillograph in such a way that all could see it. The voluntary test subject however could see neither the public nor the screen. One person every 5 seconds said "now" and the female candidate should say, if I had clamped or undamped the grounding, if therefore scalar waves were received or not. After a training round her proportion of hits was lying at 100 percent!

According to her statement she could feel it. A further test subject achieved even at the back of the room with a pendulum the correct answer. I myself was surprised by this and I already have repeated this experiment several times with different success. It without doubt depends on the sensitiveness of the test subjects. Every person after all reacts to other signals.

What however has astonished all participants and can't be emphasized enough at all, is the circumstance that it in this case concerns a receiver and not a transmitter!

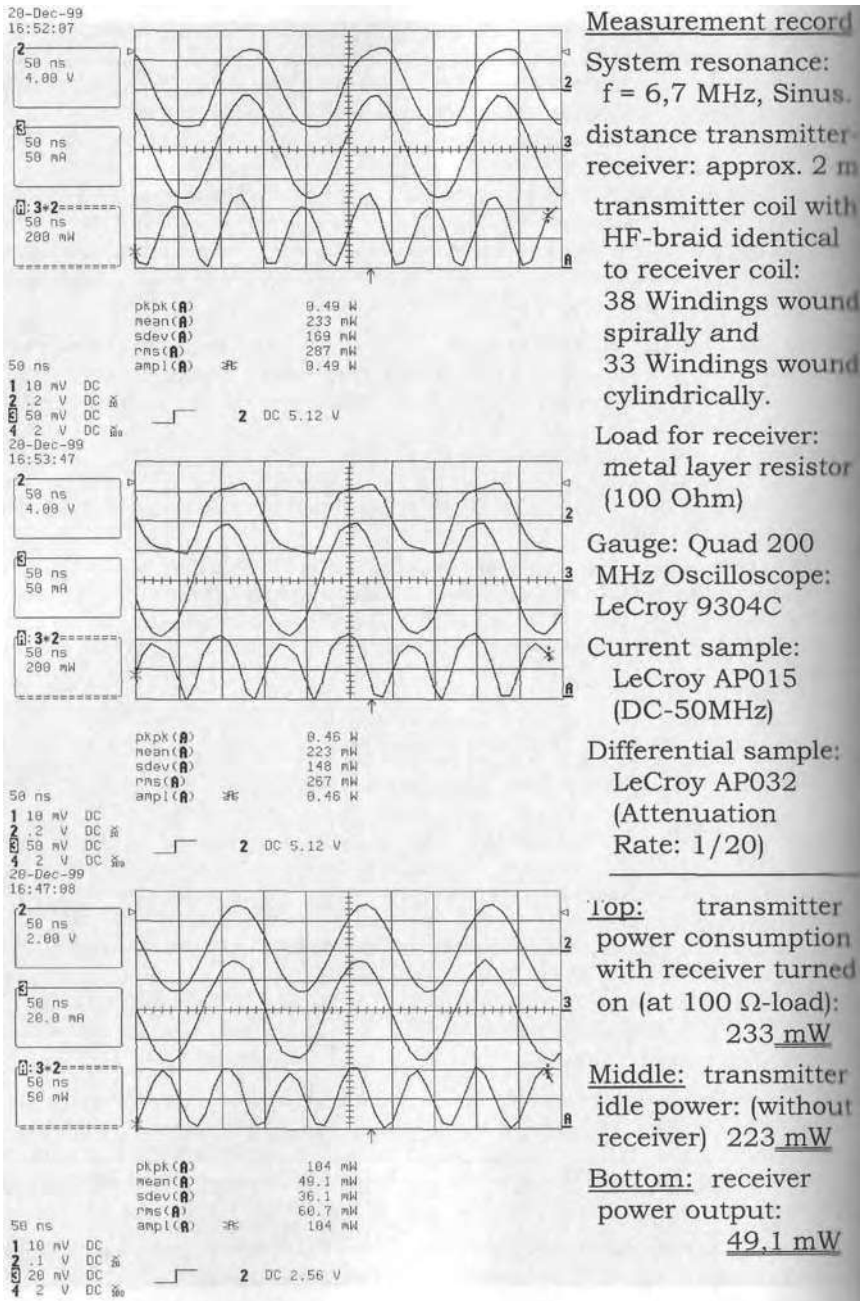

Measurement record

System resonance: f = 6,7 MHz, Sinus.

distance transmitter-receiver: approx. 2 m

transmitter coil with HF-braid identical to receiver coil: 38 Windings wound spirally and 33 Windings wound cylindrically.

Load for receiver: metal layer resistor (100 Ohm)

Gauge: Quad 200 MHz Oscilloscope: LeCroy 9304C

Current sample: LeCroy AP015 (DC-50MHz)

Differential sample: LeCroy AP032 (Attenuation Rate: 1/20)

Top: transmitter power consumption with receiver turned on (at 100 Ω-load): 233 mW

Middle: transmitter idle power: (without receiver) 223 mW

Bottom: receiver power output: 49,1 mW

Fig. 19.11 A: Measurement record for scalar wave transmission line

19.11 Wrestling for measuring technical insight in the Transfer centre

In the central question who should be believed more, the famous experimental physicist Nikola Tesla or his critics, my experiments with the Tesla coil were the visible proof that we have to take Tesla's statements seriously. Now not only at myself, but also at the students of the polytechnic and the colleagues of my Transfer centre a true Tesla euphoria broke out.
In every free minute the patents and original writings were studied, which I had myself send from the Tesla Society in Colorado Springs in the USA. In particular my trainees and diplomands developed a incredible ambition in making a historical Tesla concept work. They built a whole series of various high-tension generators. In the laboratory one could hear crashing and there was a smell of ozone.

22.1.1998 at a presentation of the works for a degree the candidate looked after by me very proudly held a fluorescent lamp in his hand, which in the field of his self-built high-tension generator glowed even without any wire connected, entirely according to the great mode (fig. 17.10). At all efforts we however laboratory technical weren't able to reach tension voltages of above 511 000 Volt. But at this tension voltage the actual Tesla effects actually start!

Perhaps it was tough luck, but possibly also a chance that we in the laboratories, which I had at my disposal, were forced to work with lower tension voltages and that meant that we gradually had to beak away from the Tesla designs.
Moreover we hadn't at our disposal the precisely controllable spark gaps, which Tesla had developed and used. If one wants to obtain an if possible high tension voltage change (du/dt) for an interaction with neutrinos, then according to today's technology considerably more favourable concepts are offered, for instance with hard switching Power-MOS-Transistors. 50 Kilovolt per microsecond were to meet.
Therefore we changed the technology and worked from now on with fast semiconductor switches. From the laboratory radio now only a hissing and crashing came out of the loudspeaker, if our experiments were running.

At 12.10.1999 we for the first time succeeded to build up a transmission line for Tesla radiation. Doing so the transmitter and receiver were situated in different rooms of my transfer centre. The transmitter coil was operated in self-resonance and fed only from a small function generator with 10 Volt. But if the diplomand held a fluorescent lamp near the spherical electrode, then it started to glow!
Following I observed at the oscillograph the signal of the receiver coil, which as well was operated in resonance. If the diplomand switched off the transmitter, also no receiver singnal was present anymore. But if it concerned radio waves according to Hertz or Tesla radiation, with that still wasn't answered.
Therefore I prompted still another experiment. This time the colleagues observed at the transmitter the signal at the function generator, while I undamped and again clamped the receiver. The shouting with joy from the adjoining room indicated that it had been observed, how the receiver reacted upon the transmitter and both are in resonance with each other. Such an effect characteristic for scalar waves, is a radio technical impossibility! In the case of radio with Hertzian waves an effect back from the receiver on the transmitter is unthinkable by principle.

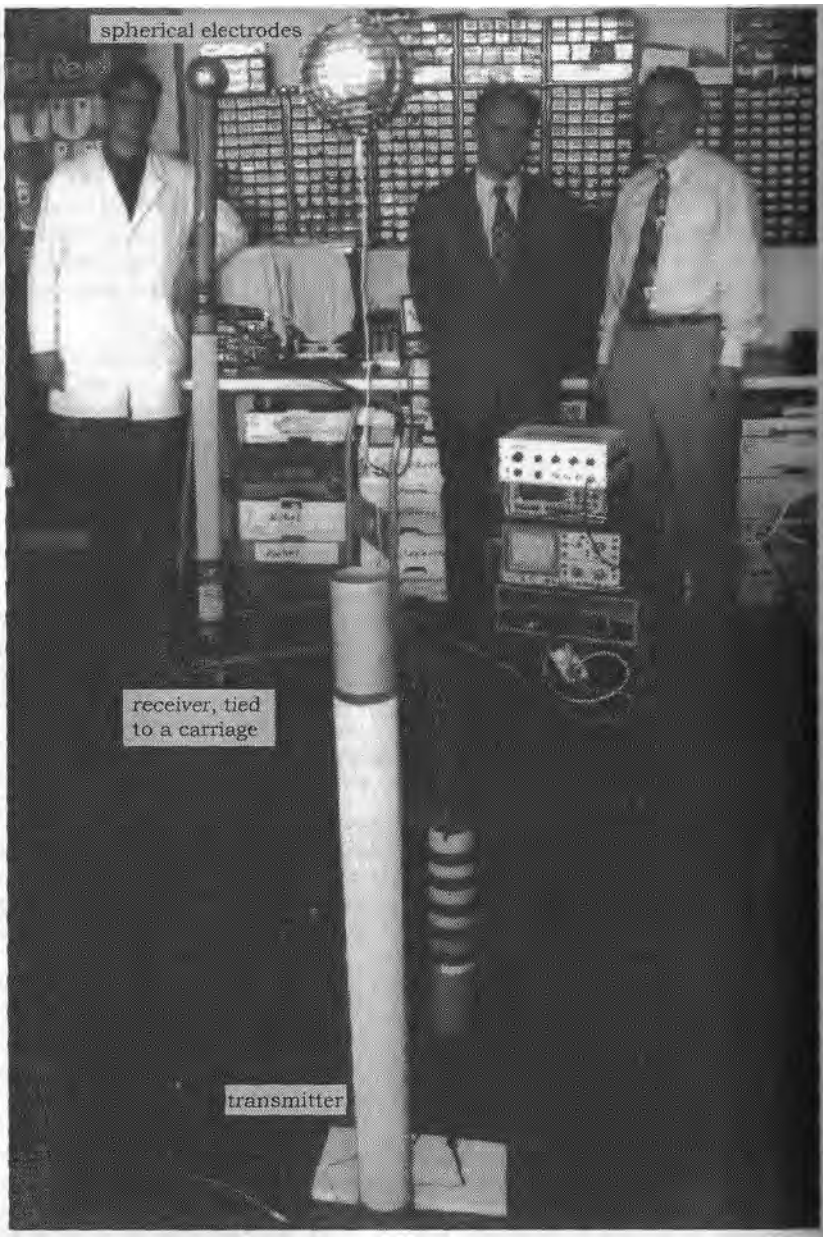

Fig. 19.11 B: Scalar wave transmission line according to Tesla
f.l.tr.: M.Andresen (diplomand), author (TZ-head), Dipl.Ing.M.Rehm (project leader)

In the next step we let glow the famous little lamp on the side of the receiver. As a consumer served a small light-emitting diode, of which the light intensity remained unchanged in the case of resonance. To prove this, we placed the receiver on a carriage and rolled the corridor in the TZ up and down with it. If the receiver was only slightly out of tune, then from the then arising fluctuation the standing wave nature could be observed perfectly.

With the setup it can be demonstrated well, how the law of the square of the distance, of the decrease of the field strength with the square of the distance, known from radio technology hasn't got validity anymore for scalar waves. Very clear also was the energy transmission of scalar waves out of a closed Faraday cage.
In the end we have determined the degree of effectiveness of the scalar wave transmission line. An output power of 49 mW resulted from the measurements of the current and tension voltage for a loading of the receiver with a 100 Ohm resistance. Simultaneously the power taken up by the transmitter amounted to 233 mW. If we however subtract the idle power consumed by the transmitter from this, and that was determined to be 223 mW for switched off receiver, then actually only 10 mW are available for the wireless energy transmission. The degree of effectiveness according to that would be 490%!
If we here really have obtained an over-unity of 4.9 then the receiver must have collected along free space energy, or did some parts evade our power measurement? The sceptics I recommend an own rebuild, since alone the proof of the scalar wave properties inevitably has to lead to every Maxwell burdened HF technician breaking with the old belief.

19.12 Neutrinolysis, the alternative splitting of water

Free after the plans of Stan Meyer we filled diverse containers with water and let it "crash". If then bubbles raised and it got exciting, we changed the frequency and exactly paid attention to the effect remaining the same or if it increased as well with increasing frequency, thus if we only watched a classical electrolysis, or already the wanted "neutrinolyse", as we were accustomed to term the splitting of water in its parts under the influence of neutrinos in the laboratory. Typical for that is a bubbling and "cooking" of the actually cold water produced by the rising gas bubbles (fig. 19.12).

We also have reversed the principle. Doing so we have switched the container as neutrino receiver and measured the forming charge carriers. The passive system proved to be really moody. On the one hand tension voltages of several hundred millivolts at a load resistance of 10 megaohm can be realized, on the other hand the charged gas particles and the as secondary reaction in the water set free ions continually change the electric conductivity, so that the cause to be measured, the neutrino radiation, hardly can be reproduced on the displayed result. The water hence has to be changed more often and also the developers found themselves between jubilation and disillusionment subject to continually changing feelings.

<i>: A. und I. Schneider: Neutrino-Power - Energie aus dem Kosmos, Bericht zu Vortrag und Demonstration des Autors am 25.11.99 in Villingen, NET-Journal 12/99, S. 4-6; Interview mit Prof. Dr.-Ing. Konstantin Meyl: Durchbruch in der Freien-Energie-Forschung, NET-Journal 12/99, S. 7-9

Fig. 19.12: Experimental constructions for the „neutrinolyse“.

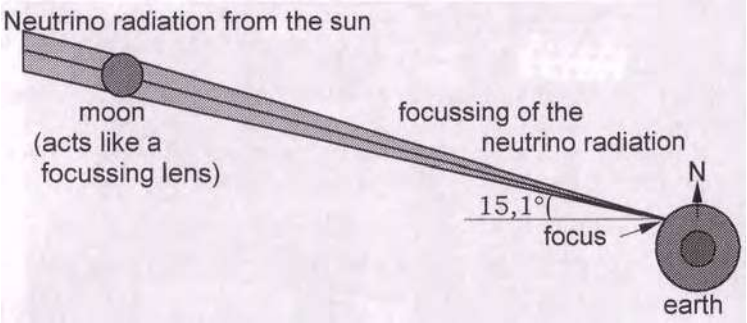

Fig. 20.1: Course of the neutrino radiation focussed by the moon
on the occasion of the eclipse of the sun at the 11th August 1999.<i>

concerning the calculation of the position of the sun at 11.8.99:

at 21.6. after 0 days is	$23.4° \cdot \cos 0° = 23.4°$	northern latitude
at 21.9. after 92 days is	$23.4° \cdot \cos 90° = 0°$	= equator
at 11.8. after 51 days is	$23.4° \cdot \cos \frac{51 \text{ days}}{92 \text{ days}} 90°$	$= 23.4° \cdot 0.644$ = 15.1° n. lat.

<i>: Konstantin Meyl: Zur Brennglaswirkung des Mondes bei einer Sonnen-

At 11.8.1999 the sun at noon stands above latitude 15.1.

20. Cosmic experiments

As long as no usable technical gauges are available, we should observe and study nature and all celestial phenomena. Here the scalar waves with all their properties are presented to us. That is valid in particular for the case that the cosmos makes an experiment with us and with the entire earth. Such a situation offered the eclipse of the sun of August 11 1999 as an unique "bulk experiment" to which travelled millions of spectators, to participate in the cosmic experiment as voluntary test subjects.
My warning for possible influences proved to be absolutely justified afterwards, even if only comparatively few took note<i>. In view of strong changes in the EEG of individual test subjects and a proven temporary acceleration of the rotation of the earth science once more stands before insoluble problems.
To answer the open questions I want to start with my indications, which 1 have published in anticipation of the cosmic event of August 11<i>. Afterwards a revision and the attempt of an interpretation from the scalar wave view follows. Perhaps this way leads to a reliable prediction of of earthquakes and other cosmic events. After that we perhaps know more about origin, availability and further important parameters of the sought-for space energy.

20.1 Millions of voluntary test subjects at 11 August 1999

Astronomically seen, it concerns a harmless natural spectacle as it already was observed more often, if the moon glides between sun and earth and its shadow in broad daylight immerses parts of the earth in a dark night. The special thing about the eclipse of the sun of August 11 1999 however was, that the sun activity just strived for its maximum value in its eleven year cycle, and the orbital distance to the moon simultaneously reached a minimum value. In addition we must pay attention to the special situation of the angles (fig. 20.1). Due to the extremely rare constellation the area of complete shadow at first was larger and darker than normal. On August 11 it had a width of 110 kilometres.

The sun besides the light also sends us solar neutrinos and for those the moon is transparent. It with regard to them acts like a glass ball, which lets the light it is true pass through, but in doing so refracts it. The glass ball acts like a convex focussing lens, which focuses the arriving rays behind the ball in a focus.
To slow down and collect neutrinos the moon it is true is too small, but it will be able to influence the flying direction. Very fast neutrinos, which run through the moon, hardly will be diverted. The slow and biologically active ones however will be bent stronger.

At this point it would be of utmost importance to know, in which distance from the moon the rays run together and combine into a focus.

<i>: Konstantin Meyl: Zur Brennglaswirkung des Mondes bei einer Sonnenfinsternis, NET-Journal, Jg. 4, Heft Juli/August 1999, Seite 13-17

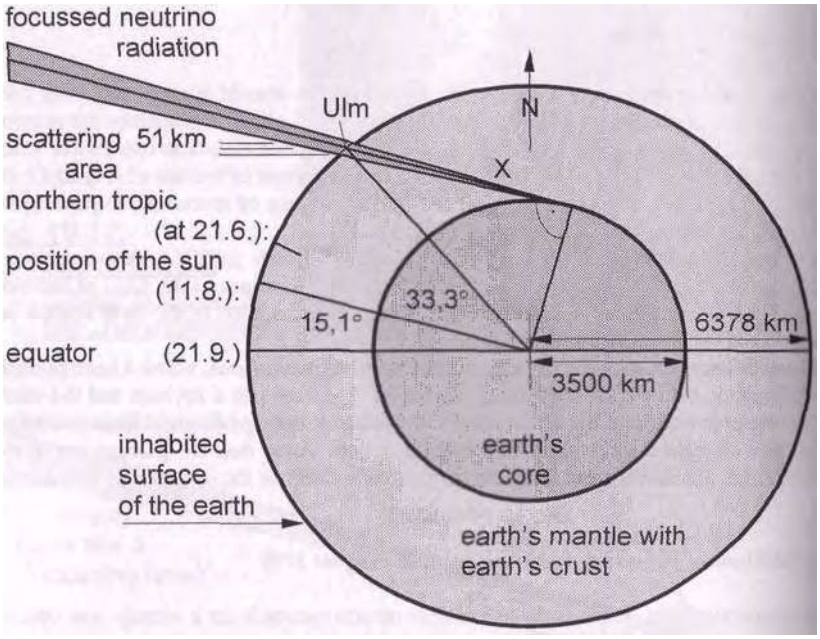

Fig. 20.2:_____The course of the focussed neutrino radiation at 11.08.1999 for 48.4° northern latitude.
(this corresponds to the line Ulm-Augsburg-Freising)

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calculation of the critical latitude:

$$\sin\alpha = \frac{3500\ \text{km}}{6378\ \text{km}} = 0.5488 \quad \text{resulting in the angle} \quad \alpha = 33.3° + 15.1° = 48.4°\ \text{n.lat.}$$

The neutrino rays touch the earth's core at:

minimum distance to the moon: $r_m^* = 358000$ km
radius of the moon: $R_m = 1738$ km
radius of the earth: $R = 6378$ km (at the equator)
length of the Tangente: $X = 3500\ \text{km}/\tan 33° = 5332$ km

$$\text{scattering radius: } r_x = X \cdot \frac{R_m}{r_m^* + X} = \underline{25.5\ \text{km}} \text{ around the centre line}$$

Focussing without scattering on earth's surface increase to
$R_m / r_x = 68$ times , resp. with scattering to
$68 * 0.5 * 0.8 = 27$ times the natural neutrino radiation!

For that we again bear in mind that neutrinos as particle radiation propagate in space in the sense of a plasma wave. Since the oscillation of such a longitudinal wave takes place in the direction of propagation, it neither knows a distinct velocity of propagation nor an upper limit.

The sea of neutrinos in which we swim, is a combination of differently fast particles. The slow ones are bent stronger by the moon, with the property of a convex focussing lens, so that the focus should be looked for near the moon, whereas the fast ones hardly are diverted. Their focus lies further distant from the moon than the earth, up to the extremely fast cosmic neutrinos, which experience almost no diversion, because they, as a result of the Lorentz contraktion, are small enough to tunnel through any kind of matter.

If neutrinos, depending on their velocity of propagation, have their focus partly before and partly behind the earth at an eclipse of the sun, then it comes up to a conclusive logic that there actually exist such, of which the focus lies exactly in the centre of the complete shadow on earth's surface. But thereby the question is asked, which biological effectiveness these neutrinos have or which damage they bring about.

20.2 Model of calculation for the cosmic experiment

More than a year ago the results of an international neutrino experiment have been made public. Thereby for the first time the order of magnitude of the natural radiation density was recorded. after the detector before having been calibrated at an artificial source of neutrinos. As the perhaps most important result at night only half as much solar neutrinos could be detected as during the day with the immense Super-Kamiokande detector in a Japanese mine. With that the here taken interpretation, that earth's core collects neutrinos, meanwhile even is proven experimentally! For that it has to interact with the particles and that means, it has to exert a force of attraction on them. Thus the earth's core during an eclipse of the sun will further amplify the effect of focussing if the konzentrierte neutrino ray is directed on earth's core. This critical point we have to calculate (fig. 20.2).

The proportion of the radii of earth's core (3500 km) and the entire earth (6378 km) results in the sine of the sought-for angle and that amounts to 33.3 degrees northern latitude. At August 11 moreover is added that at noon the sun with regard to the equator is standing at 15.1 degrees. so that a first extreme focussing should be expected, if the centre of the complete shadow intersects latitude 48.4. This would be the case for the latitude of Ulm in direction Augsburg and Freising.

Now we would like to know more about the amplitude of the focussed radiation, about the spatial extension and the period of time. Without concrete data material we have to proceed from several simplifying assumptions. If we therefore assume, 50% of the at earth arriving and biologically relevant neutrino radiation stems from the sun, which in the case of an eclipse of the sun is focussed to 80% and scattered to 20% by the moon. If we further assume the focus just touches earth's core, then between Ulm and Augsburg a sphere of action of 50 km can be expected, within which the neutrino radiation on the average reaches 28 times the value of the natural radiation. The intense irradiation under these assumptions will last one minute.

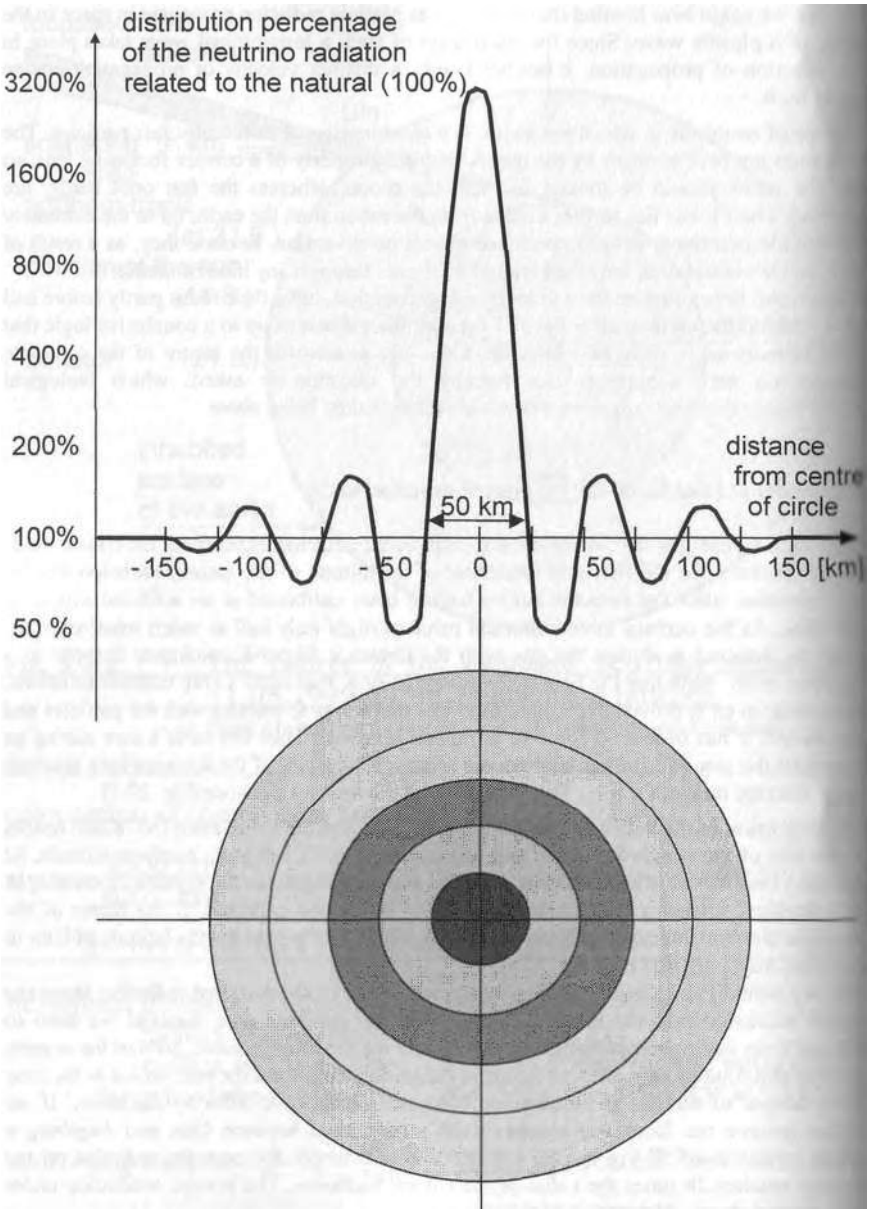

Fig. 20.3: _____ The spatial distribution in the case of focussing of the neutrino radiation by means of the burning glass effect of the moon on earth's surface.

Of course the calculated values only are valid to the extent, as also the assumed boundary values apply. After August 11 we know more about this cosmic experiment, about the spatial distribution and indirectly about the interaction with earth's core, about the physical properties and the biological effectiveness of the at present available neutrino radiation.

20.3 Physical technical consequences

The neutrino radiation is a scalar wave radiation which, as mentioned, can be perceived by sensitive people even without aids. Who hasn't at his disposal this sensitiveness, is recommended a simple setup.
For that one hangs up a fluorescent lamp, connects the one end with a piece of wire, as it were as antenna, and the other end is grounded. For a scalar wave radiation which increases fast, the lamp should start to glow by itself. Under big transmitting installations this method already has been successfully applied by many allotment gardeners thousandfold. I hence recommend all research scientists of eclipses to test themselves the possible field fluctuations in this simple way.

From a technical viewpoint first of all the atomic reactors and their nuclearly contaminated waste will be concerned by a fluctuation of the neutrino radiation. In view of present eclipses of the sun an accident can be expected less, since the neutrino radiation it is true for a short time reaches an extreme maximum, which averaged temporally and spatially over the whole event again is relativized somewhat. The relations shall be clarified with an example (fig. 20.3).
Whoever places himself in the centre line of the complete shadow on August 11, at first will detect a decrease of the neutrino radiation to 50 to 60 percent, then a steep increase to 2800 percent and from the summit again the whole backwards, while standing on the earth he turns by under the moving moon shadow. The ring with half the radiation, which reaches us first, doesn't pose a problem since, as said, we only have half the radiation in every night. Some animals and plants as aresult erroneously will set out for sleep.

The wave distribution one can imagine like that in the case of a pool, in which was thrown a stone. But we still don't know the resonance frequency, for which reason the length of the cycle depicted in fig. 20.3 is chosen arbitrary. The actual deviation from the distribution given by nature is the peak in the focussed ray centre. Living nature must stand large fluctuations of the solar radiation, since every supernova sends us a relatively short batch of fresh neutrinos. Where we have difficulties is the question, how much fluctuation still can be tolerated by mankind.
The question for possible biological consequences is due to be dealt with in view of the announcement of a complete shadow tourism causing concern, as it is awaited for August 11. At the incomplete state of knowledge about the properties of neutrinos, every trip to the complete shadow remains a journey into the unknown.

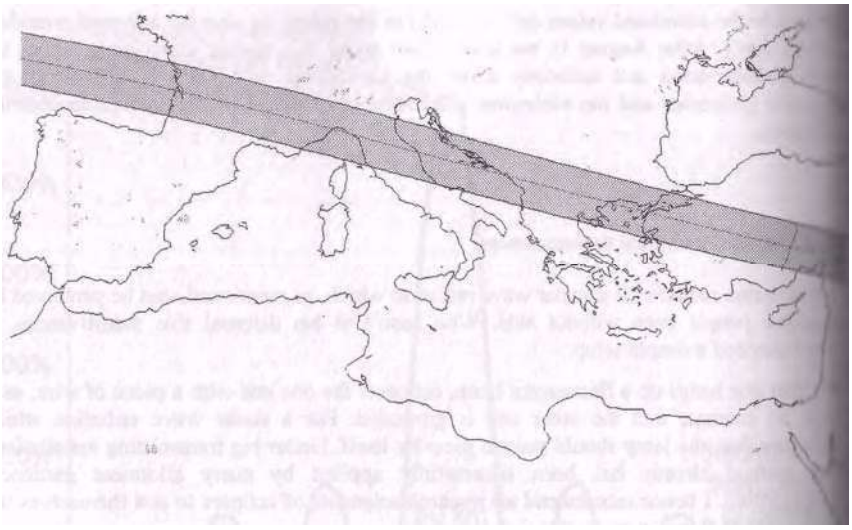

Fig. 20.4 A: The course of the complete shadow for the ancient
eclipse of the sun at 28.5.585 B.C.

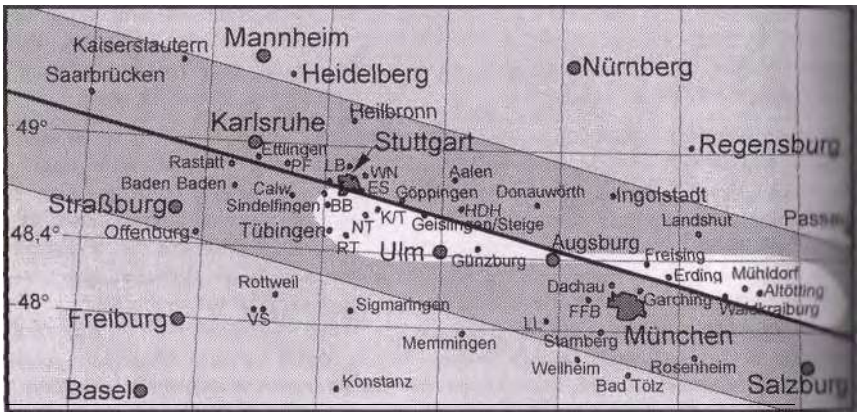

Fig. 20.4 B: The course of the complete shadow over south
Germany at August 11 1999 (grey) and the possible course of the focussed neutrino radiation (white).

20.4 Biological consequences

In the case of an eclipse of the sun effects on the biology, like problems with the heart among affected, at least can't be excluded. If the scalar wave density increases above the density which is normal, then this has a positive effect on the economy of energy, as long as the body is capable to regulate the amount taken up. If the regulatory process however should fail. then the risk of a self-inflammation exists. Also straw bales and other organic and inflammable materials could thus go up in flames.

But before that happens, first the information technical influence of the scalar waves will show. Here we have to expect a psychotronic influencing, which is showing in a limited ability of perception. History teaches us as an example[i] that a by Thales of Milet predicted total eclipse of the sun at 28.5.585 B.C. compulsorily has ended a battle in Asia Minor between the Medes and the Lydians, because the soldiers apparently most literally had gone out of their mind (fig. 20.4 A).

Actually all in connexion with the free energy addressed phenomena are conceivable. from the "neutrinolyse" up to the acceleration of the radioactive decay. It would be understandable, if in a water glass bubbles should rise, even if no carbonic acid is contained in the water at all. After man not having at his disposal a sense organ for his own energy source, the brave in the complete shadow of an eclipse of the sun are recommended smaller technical experiments and observations. The cautious however will avoid the area from the start.

As counter movement to the complete shadow tourists there will also be refugees, who believe in the predictions of Nostradamus, who in his quatrains has predicted a messenger of fright over Europe for 11.8.1999. He mentions Lyon, Ulm and Moskau, which actually lie on one line[ii].
The line of the complete shadow however will run under another angle from Plymouth in South England over Ulm to Bukarest and further into Turkey. Maybe Nostradamus wasn't a clairvoyant at all, but merely a good calculator, or he knew someone who could calculate excellently, after all he has indicated the time and even Ulm as the centre correctly. Apart from the small angle error, in addition the direction is correct (fig. 20.4 B).

Worth paying attention to also is, that he contrary to his habit here gives a concrete date which astronomically can be calculated unambiguously, that he simply skips the numerous eclipses of the sun of the past and only points to the one of 11.8.1999, which runs crossways through South Germany. Extremely sinister are his forecasts, which mustn't commented on further, since he speaks of "Mort et Tombe", of death and grave[ii].

<i>: Merodot: Historien, Kroners Taschenausgabe 224, S. 33 (cf. page 586 and the modern misinterpretation note 9 on page 754); further sources: dtv-Atlas zur Weltgeschichte S. 45; resp. Propylaen-Weltgeschichte I, S. 168.

<ii>: Michel de Notredame (1503 bis 1566), Mathematiker, Astrologe, Leibarzt von Konig Karl IX: Centuries (1558) X, Vers 72.

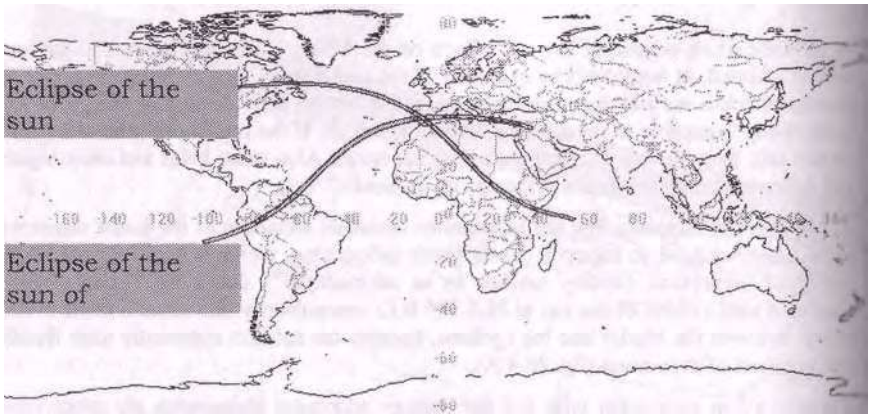

Fig. 20.5 A: The total eclipses of the sun of 18.4.1539 and
21.8.1560

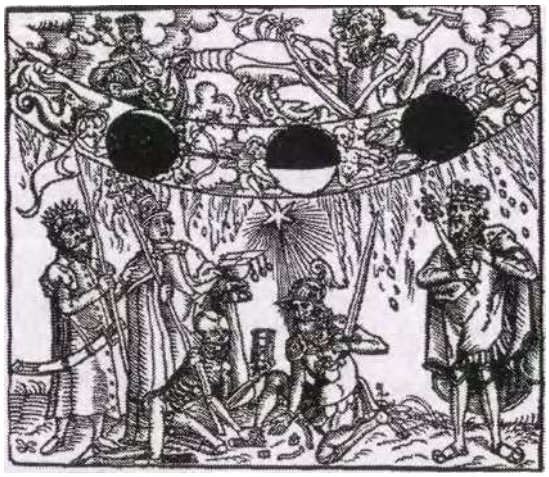

Fig. 20.5 B: Under the impression of the last two eclipses of the
sun over Europe death and war play dice about the fate of mankind during the eclipse of the sun of 1562.[i]

<i>: Werner Raffetseder: Sonnenfinsternis, Hugendubel Verlag, Munchen 1999, ISBN 3-89631-302-9, Seite 156.

20.5 Epilogue to August 11th 1999

My indications have been published two weeks before the cosmic event in the NET-Journal[<i>]. The public interest was immense. Now, after the spectacle is over, it is time for an analysis[<ii>].

Besides numerous very subjective descriptions of eyewitnesses, which scientifically hardly can be analysed, at numerous polytechnics over the world has been observed, how Foucault pendulums suddenly and completely unexpected have deviated from their normal swinging direction. With this device 150 years ago the rotation of the earth had been detected in Paris.
Since according to prevailing textbook opinion an eclipse of the sun is a purely optical phenomenon, the scientists world-wide are having a big problem. Which force here has teared at our earth and caused relative accelerations of the kind that the pendulums could turn out of their usual plane and changed into an elliptic orbit, while the shadow of the moon ran over us? The gravitational force isn't even roughly capable to that. That merely has brought a 50 cm higher flood. The enormous force effect, which even puts the gravitation in the shade, actually only can come from the interaction of the neutrinos.

Different reports are present concerning the influencing of the radioactivity. In the cases, in which measurement samples have been used, almost no change could be observed. This is confirmed by a video tape, which northeast of Munich directly in the centre of the complete shadow documents an experiment, in which during the whole time the radioactivity of 1 kg crude granite is monitored with a professional dosimeter. The background might be that calibrating samples are chosen in principle under the aspect of being influenced the least by outside interference sources. It therefore would have been better, if we instead had put a lettuce as a biological and broadband sample in front of the device. Because there, where one anyway hadn't expected deviations and thus neither were measured calibrating samples nor unfortunately were made recordings, is said to temporarily have occurred a visible increase.
Even in the case that somewhere accidentily should exist recordings, the increase is too small, to help explain traditions from the Middle Ages, according to which is talked about "stinking log" and about "aggressive damps, which fall from the sky". Other sources speak of harmful radiations, which one regarded as the trigger of plagues.
It is said: "They poison the drinking water and the crops and make people sick"[<iii>]. Crops after an eclipse of the sun either should not be harvested at all or only after a violent shower. The warnings for a poisoning "without adding poison", which reach back into the 19th century, suggest the assumption that it concerns results of a radioactive contamination.

<i>: Konstantin Meyl: Zur Brennglaswirkung des Mondes bei einer Sonnenfinsternis, NET-Journal, Jg.4, Heft Juli/August 1999, Seite 13-17

<ii>: From the third and extended edition of this second part concerning Electromagnetic Environmental Compatibility the following chapters are completed.

<iii>: Mark Littmann/Ken Willcox: Totality - Eclipses of the Sun, Honolulu 1991, Kapitel 4: Eclipses in Mythology; nachzulesen bei Werner Raffetseder: Sonnenfinsternis, Hugendubel Verlag, Munchen 1999, Seite 130/131.

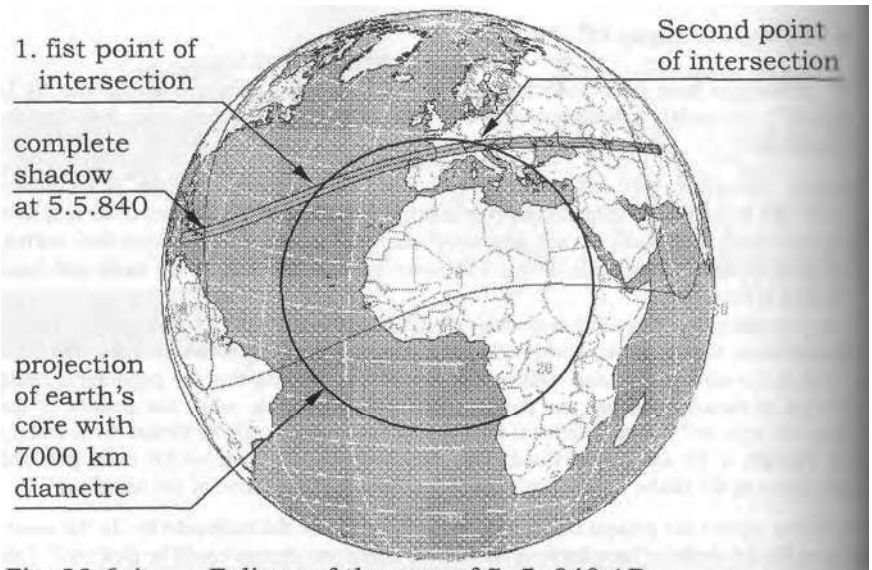

Fig. 20.6 A: Eclipse of the sun of 5. 5. 840 AD.

Fig. 20.6 B: Nostradamus announces catastrophes for 1999 in the Centuries of 1558.<i>

<i>: Bryan Brewer: Eclipse, Chapter 1: Eclipses Throughout the Ages, Seattle WA 1991, S. 20, cited in Werner Raffetseder: Sonnenfinsternis, Hugendubel Verlag, Munchen 1999, ISBN 3-89631-302-9, Seite 130, Bild Seite 159.

20.6 Dropping of the neutrino radiation

Plagues of that kind, which in the Middle Ages have claimed lives as a result of an eclipse of the sun, hardly are verifiable, unless a prominent victim was among them, like e.g. the son and successor of Charlemagne, emperor Ludwig I. He 5.5.840 witnessed an eclipse of the sun with a totality of five minutes. Further it is said: „The fright which this experience gave him, little later shall have torn him to death"<i>.

According to that there must have existed times, in which the radioactivity present in the countryside and stored in the body of a person during an eclipse of the sun could be set free and be the undoing of the affected. At the same time such a decontamination of radiation acts cleaning for nature.

In this case only the interpretation of Nikola Tesla provides us an explanation, which states that the neutrino radiation causes the radioactivity<ii>. Textbook physics however doesn't know this causality. For that the primeval fears of humanity are pure superstition. The prophesies of Nostradamus even are referred to as counter evidence.

But the question remains open, why his predictions concerning August 11 didn't happen, Obviously, so has shown us the cosmic experiment, the neutrino radiation relevant for the setting free of radioactive radiation drastically has decreased since the Middle Ages.

Nostradamus personally has occupied himself with the translation and interpretation of hieroglyphs and has written down his insights - surely out of fear of the inquisition - in the form of encoded quatrains. According to that he has based his considerations on considerably older sources, which presumably stemmed from a time, in which a considerably higher radiation prevailed.

We have to proceed from the assumption that the scientists of the Semitic- Aramean people of the Chaldeans, which ruled Babylon from 626 B.C., were just as capable as astronomers of today, to exactly calculate an eclipse of the sun even centuries and millenia in advance.

After all the Saros-cycle to determine eclipses of the sun is a discovery of the Chaldeans. What they however couldn't know and we ourselves still can't indicate today, is the prevailing density of the cosmic radiation at a future time. But that obviously has changed considerably.

The natural magnetic field strength for instance is recorded at the baking of earthenware jugs and vases, by strengthening along the parts containing magnetite. From the measurement of ancient earthenware goods we know that in antiquity a field strength must have prevailed which was 3 to 4 powers of ten higher.

According to the here presented theory the earth owes its magnetism its core and that again draws its energy from the neutrino field. According to that also the neutrino radiation should be subject to the same decrease.

If therefore the Babylonians out of the radiation situation at that time in the interpretation of Nostradamus and other fortune-tellers, who presumably all more or less have written each other off, have predicted a catastrophe for 11.8.99, then this scientifically is just as untenable, as the today widespread hubris, with which the knowledge and the reports of experience from ancient times are dismissed as superstition.

<ii>: cf. chapter 17.2 Nikola Tesla, the discoverer of the neutrino radiation, p. 133

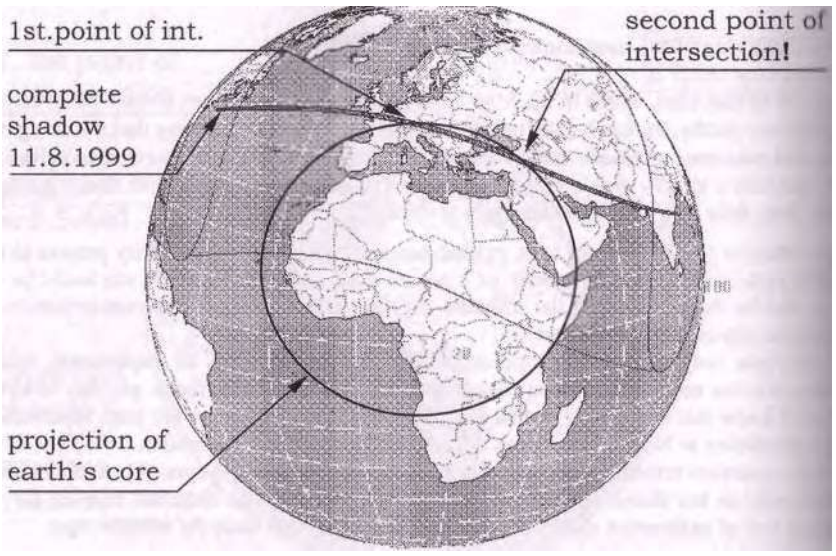

Fig. 20.7 A: Eclipse of the sun of 11.8.99 (declination: 15°)

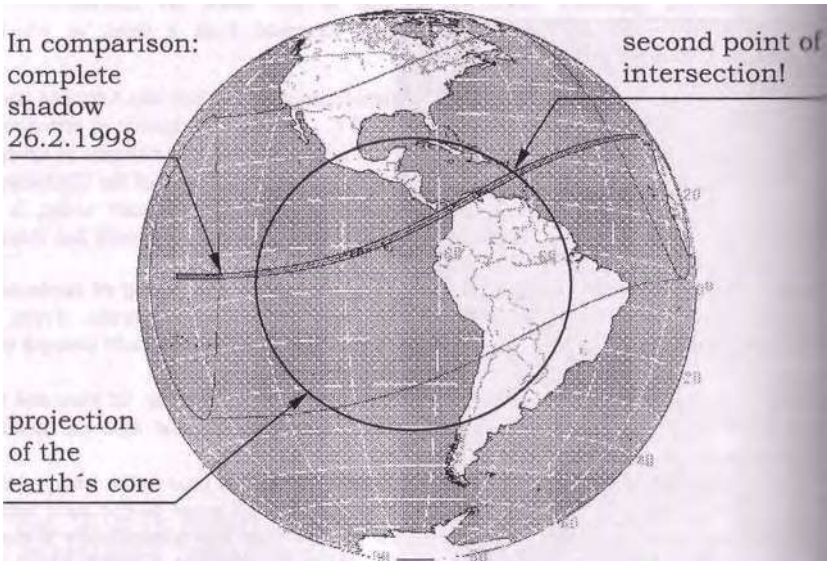

Fig. 20.7 B: Eclipse of the sun of 26.2.98 (declination: - 9°)

<ii>: Particularly violent earthquakes since 11.8.1999 (excerpt):
Turkey 17.8. (strength 7.8) till 19.8. (5,0), 31.8. (5.2), Greece 7.9. (5.8). Turkey 13.09. (5.8) and finally Taiwan 20.9.99 (strength 7.6) in a rythm of 6 to 7 days! Complete list in the internet under:
http://www-seismo.hannover.bgr.de/ermos_listing.html

This "superstition" mentions tremendous natural disasters like floods like the Flood or destructive earthquakes often as a direct result of an eclipse of the sun, and as the worst consequence the end of the world[i].
Almost all reporters and newsreaders in the evening of August 11 full of irony pointed at the non-occurrence of the end of the world and spread the conviction that according to prevailing physical ideas something like that isn't possible at all. They at that time couldn't know that the anatolic plate, which the complete shadow had crossed, had gotten into motion. The relatively weak earthquakes, which 11.8. shook Cyprus and at the same time Iran, only were spontaneous harbringers.
In the following weeks the staggering core of the earth made us clear that there had been done force to it. Severe earthquakes with thousands of aftershocks followed each other and one message of terror chased the next[ii]. Public authorities however take care not to of decline to make a reference to the eclipse of the sun.

20.7 Analysis and comparison of the occurrences

If we for comparison consult the total eclipse of the sun of 26.2.1998, for which the complete shadow of the moon coming from the Pacific Ocean had run over the Caribbean into the Atlantic Ocean. Exactly the moment it crossed the Caribbean island Montserrat, the volcano Soufriere erupted.
Pure coincidence says science, which hasn't got an explanation model at all for a relation with the supposedly purely optical phenomenon. But this argumentation is relativized, if according to fig. 20.2 the tangential collecting of solar neutrinos by earth's core is considered. This process best can be compared with photon radiation, which is tangentially collected and directed into an orbit by a black hole inside the radius of Schwarzschild.
Since the shadow of the moon always draws a straight line on the earth, two points of intersection are present with the circle of the projection of earth's core on earth's surface, for which the radiation focussed by the moon just touches earth's core and in that way experiences an additional concentration. The first point of intersection at that time was situated in the Pacific Ocean; but the second one was situated exactly at the Caribbean island Montserrat (fig. 20.7 B).

This time, at August 11 1999 the first point of intersection was situated in South Germany, the second in Iran, and again the focussing at the second point of intersection has shown a devastating effect. The entire continental plate has gotten in motion (fig. 20.7 A).

Another strange phenomenon has occurred in the USA at the same time as the eclipse of the sun. A tornado swept with its destructive force right through Salt Lake City. It is remarkable that no meteorologic indications were showing before and hence official observation authorities had no possibility of warning for the tornado. Had here part of the focussed neutrino radiation been redirected at earth's core and given a rotation, to again screw out into the sky on the other side of the earth at Salt Lake City?

<i>: Werner Raffetseder: Sonnenfinsternis, Hugendubel Verlag, Miinchen 1999, ISBN 3-89631-302-9, Seite 120.
<ii>: Collection of particular violent earthquakes since 11.8.1999: see fig. 20.7.

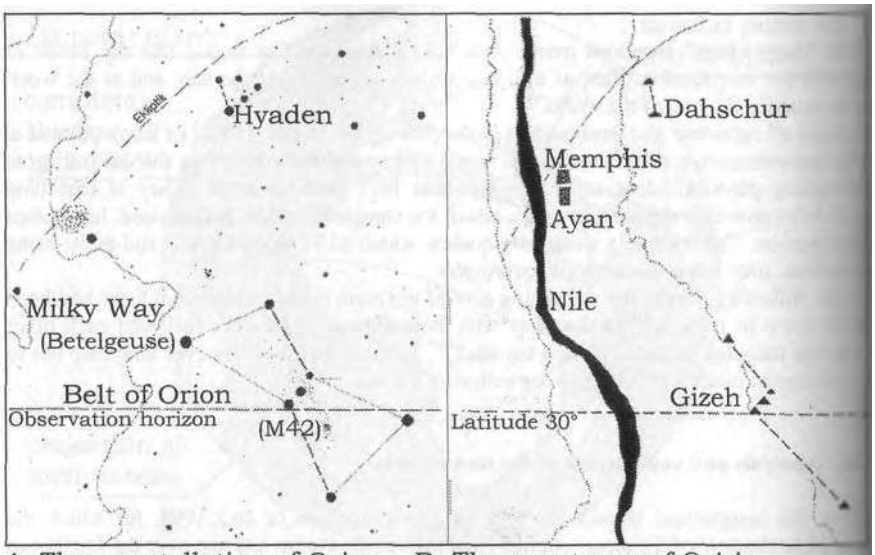

A: The constellation of Orion B: The sanctuary of Osiris

Fig. 20.8 A and B: The ancient Egypt pyramids, a terrestrial model and copy of the starry sky?<i>

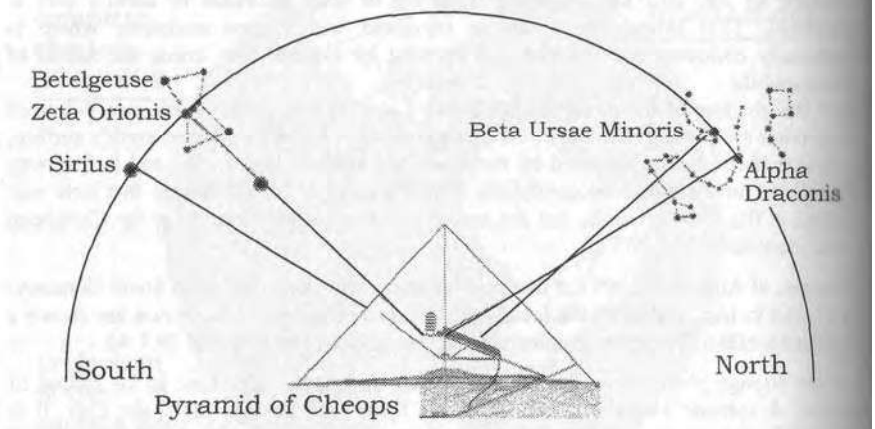

Fig. 20.8 C: The orientation of the four shafts of the Pyramid of Cheops to four different stars around the year 2500 B.C.<ii>

<i>: Robert Bauval, Graham Hancock: Der Schlussel zur Sphinx (Keeper of Genesis), List Verlag Munchen 1996, ISBN 3-471-77188-3, S. 286 und 287.
<ii>: dito page 86.

20.8 Radioactive decontamination with the help of a supernova

A mighty source of neutrinos forms the black hole in the centre of the Milky Way. For us, on an outer spiral arm of the galaxy, the distance to the centre is gigantic as well, so that a relatively equally distributed spectrum of differently fast neutrinos arrives at our world, which represents a kind of basic energy technical supply for the solar system and our world. For the fluctuations between day and night, or the focussing by the moon or other planets the "participants" in the solar system are responsible themselves.

In contrast to that a supernova, the explosion of a star, is a considerably smaller source of neutrinos, which however also is possible less distant to the earth. In addition it is a singular event, in which all neutrinos are set free simultaneously within a fraction of a second. They arrive at us one after another. First the fast and hard radiation reaches us as it were as harbringer. In the course of time the arriving neutrinos then become slower and shower, until they sometime become biologically relevant. If in the end everything is over, we can see the cause, only now the supernova is showing in the telescope.

If we assume such an event takes place, with perceptible might and in a distance of 500 light years. then this neutrino radiation overlaps with the general background radiation and a characteristic over-intensification of neutrinos of a certain velocity of propagation occurs. This problem then occupies us for 500 years, where the respective radiation situation permanently is changing depending on the time after the explosion.

If we in this way of looking dare a judgement of the cosmic events in historical time, so makes believe much the assumption that the radiation in the last hundred years has worn of completely. Edgar Cayce treats in the book "Our Ancestors" different cultural circles from the old Indian up to the Hopi, in which still is talked about an energy technical use of quartzes and other materials[<i>].

We indeed can theoretically comprehend that the neutrino radiation can let an oscillating quartz glow, if it is stimulated in its resonance frequency, but technically the technology foday can't be realized anymore. Possibly the chance for technological use only existed for a few years or decades.

Presumably also the pyramids originally have been built as resonators, to slow down fast neutrinos to a technically utilizable speed. But in the course of time the original function was unnecessary and the neutrinos had gotten so slow that in antiquity alternatively an use as electrostatic lightning generator or as Nekropolis took place. Today they only stand in the countryside as unusable monuments of a gone epoch.

Many ancient techniques, to which I will come to speak in the third part, in this way just as unexpected become plausible as the radioactive decontamination described in the Middle Ages.

<i>: Hermann Wild: Technologien von gestern, Chancen fur morgen; Jupiter-Verlag Bern 1996, ISBN 3-906571-13-0, (z.B. S. 77 und 145 bis 163).

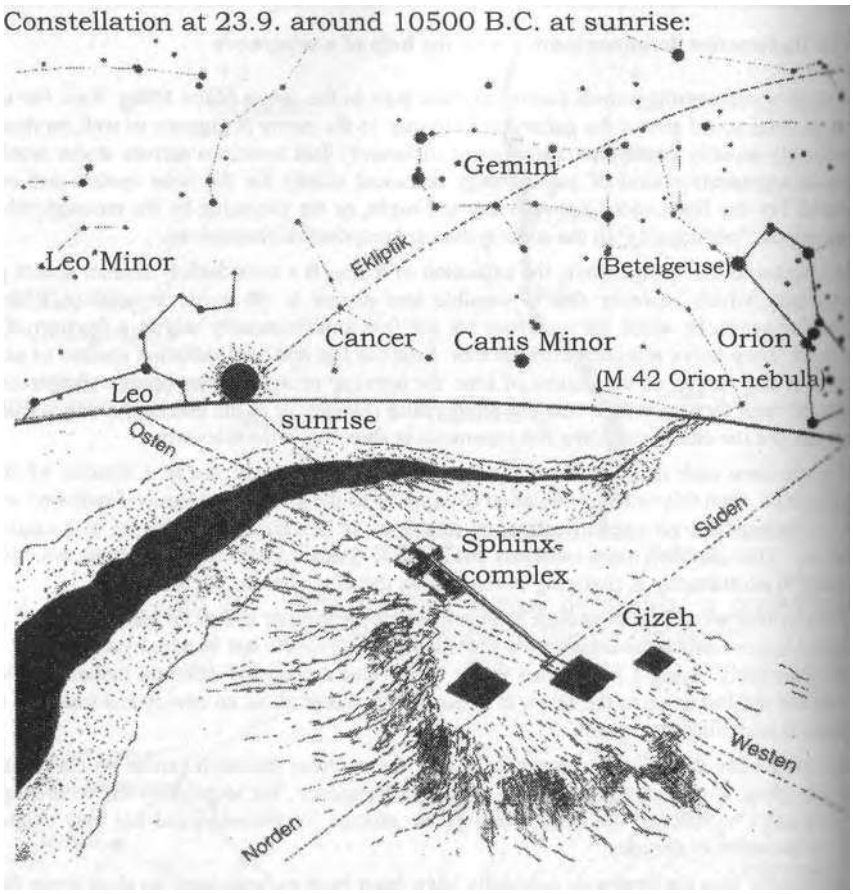

Fig. 20.9: The orientation of the pyramids of Giza makes believe
an operation of the installation around 10500 B.C.<i>

<i>: Robert Bauval, Graham Hancock: Der Schlussel zur Sphinx (Keeper of Genesis), List Verlag Munchen 1996, ISBN 3-471-77188-3, S. 324.

The two research scientists take the hypothesis of an orientation of the ancient Egypt pyramids after the starry sky around 10500 B.C. This however is not compatible with their thesis of the aligning of the shafts to individual stars around 2500 B.C. (fig. 20.8 C). How should the precise worked shafts later have been integrated? It would correspond a certain logic, if an orientation of the buildings to the energy source at that time would have taken place; but doing so it should be taken into consideration that the stars are exploded as supernovae and today hardly might be observable.

Despite several good ideas more questions are raised by the book, than are answered. Have the technicians 2500 B.C., after making restorations, experimented with the buildings and sought-for alternatives of use?

20.9 Fre energy from the Orion constellation

After all hundred years ago still the last unreliable rests of the wearing off neutrino radiation were available to Tesla, Moray, Keely and other inventors for the experimental proof of free energy, of which we today aren't able to rebuild and show in function one single model. And that, although the technical aids have gotten better for many times. But for the free energy inventors that isn't a reason, to immediately stop their efforts, because the next supernova already is announced by the actual swings of the Foucault pendulum. It could concern the explosion of the giant red star Betelgeuse in the constellation of Orion in a distance of 500 light years<i>. It well may be possible that it already shortly has exploded and that it will supply us with fresh and free energy for scarcely the next 500 years and at the same time will give the earth a good shake, thanks to its might and a not too great distance.
The reaction, which happened after August 11, of earth's core, which is the first to interact with the fast particles, should make every astrophysicist clear that here something is coming towards us!
It would be obvious, if the reactions of earth's core still increase. Every year particularly around 21.6., if the sun is standing in the Orion constellation, deviations can be expected. But then the supposed source of neutrinos, Betelgeuse, the sun and the earth don't exactly form a line, because the giant red star lies 7.4° below the ecliptic. Because of that the rays slowed down and focussed by the sun run away over the earth. At the earth then rather would be expected a dropping of the radiation.
If the phase of shakes of the earth sometime should be over, a decontamination due to an increased radioactive decay and various biological effects should be expected. Then, perhaps in 200 years, also many concepts concerning free energy, today still dismissed as hopeless, suddenly will function entirely by themselves.

The relatively free possibility of development of the human mind and the present sciences we possibly owe the special circumstance to be able to live in a time of minimized field strengths. Strong fields however can lead to psychotronic influencing of the consciousness and to an outside determining of mankind. This circumstance seems to have caused Tesla to compare man with a robot, and to call him an independent machine controlled from outside<ii>.

<i>: Freek Reijmerink: Sternenatlas Deutschland, Weltbild Verlag 1990, S.12 (ein sterbender Riese) und Illustrierte Wissenschaft, Nr. 9, 1999, S. 7, Brennen die grossen Sterne in den Sternbildern je aus? Die Entfernungsangaben schwanken zwischen 270 Lichtjahren (Meyers Lexikon), 310 (Sternenatlas), 500 (Ill.Wiss.) und 652 Lichtjahren (Cambridge Enzyklopadie d. Astronomie).

In the observable domain of the starry sky one statistically seen has the chance, to experience every second a supernova.

<ii>: Nikola Tesla: How cosmic forces shape our destinies, New York American, 7.2.1917, and Edition Tesla (1997), Bd. 6, ISBN 3-89539-245-6 der Mensch als machine, S. 65.

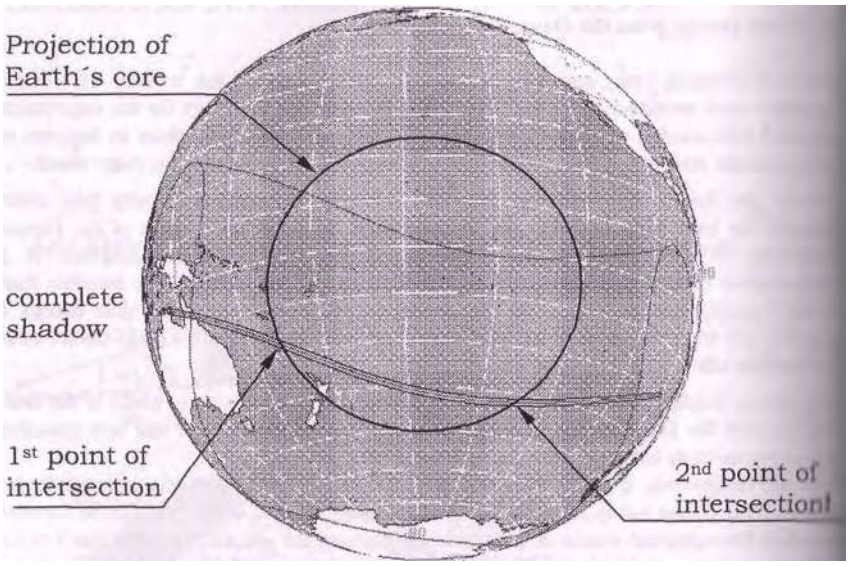

Fig. 20.10 A: Eclipse of the sun of 13.11.2012 (decl.: 18.1°)

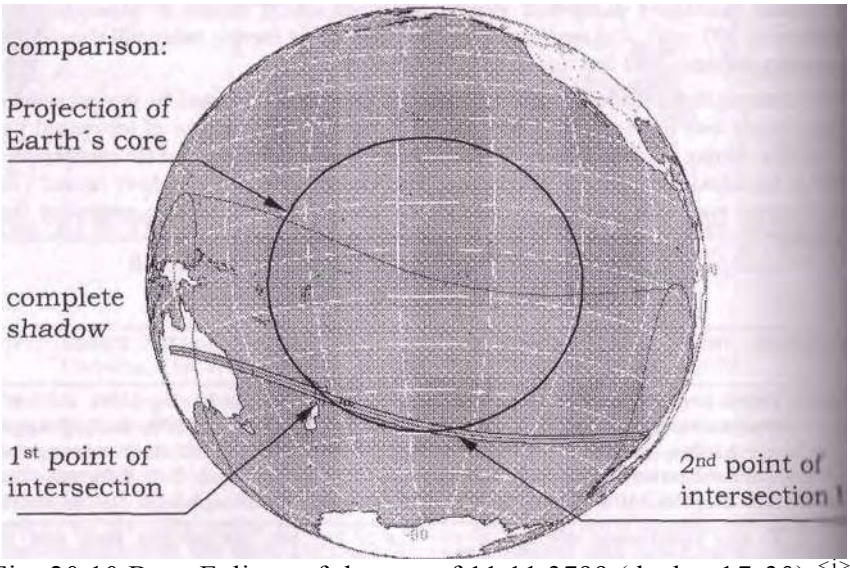

Fig. 20.10 B: Eclipse of the sun of 11.11.3799 (decl.: -17.3°). <i>

<i>: The eclipse of the sun of 7.7.3797 is harmless compared to that of 11.11.3799. Have they been mixed up or is a calculation error present?

20.10 Interaction of the neutrinos with earth's core

A strong neutrino field still doesn't make a catastrophe. Only in connection with one of the regularly happening eclipses of the sun should one be expected under certain circumstances. Only, which eclipses of the sun can get dangerous, we have to ask us, and why warns e.g. Nostradamus only for very particular dates?
The check of the respective eclipses of the sun results in a critical constellation every time for the cases, where the line of the complete shadow and the circle of the projection of earth's core intersect under a very flat angle and both points of intersection lie very close together. In the extreme case finally the lines only are touching and the points of intersection fuse to a line of intersection.
A corresponding constellation the next time is expected at 13.11.2012. For 7.7.3797, at similar conditions Nostradamus foretells the end of the world; but why?

From the interaction of the neutrinos arises as from every other interaction a force effect.
If the points of intersection lie far apart, then earth's core is pulled once to the East and a short time later again to the West by the focussed neutrino radiation. On the average this will hardly influence earth's mantle and earth's crust because of the immense moment of interia. The possible earthquakes will remain regionally restricted to the area around the two points of intersection.
But if a line of intersection forms, then no compensation of the force effects takes place anymore, then during the whole time one-sided is pulled at earth's core and that can have fatal results. It is the same as for a spinning top, which is given a blow from the side: it staggers several times, until the gyroscopic forces have stabilized it again.

But if earth's axis staggers, then the sun describes strange orbits in the sky, it goes backwards again, for a longer time doesn't set or it doesn't show for the same period of time for the people living on the other side of the globe.
Such an event already is described in the Bible<i>. For the twenty hours, in which in Europe the sun didn't set for a day, again describe the chroniclers of the inhabitants in the South American Andes, how at their place the sun didn't show for twenty hours<ii>.

As a further example from the Greek mythology is mentioned the description of the poet Apollodoros. according to whom Hercules for the solution of his 10th task let the chariot of the sun bring to a standstill. "He turned his vehicle round and raced the way back, dragging along the Pleiaden and all stars, so that the sun set in the East"<iii>. But if all stars take part in the same backwards motion, then this example proves the assumption of the staggering earth's axis.

<i>: Josua 10.13-14 and the in chapter 11.8 cited passages.

<ii>: nach Montesinos, zitiert in Zecharia Sitchin: The Lost Realms (Versunkene Reiche), Knaur Verlag Miinchen 1992, ISBN 3-426-04827-2, S. 203

<iii>: Werner Raffetseder: Sonnenfinsternis, Hugendubel Verlag, Milnchen 1999, ISBN 3-89631-302-9, Seite 18.

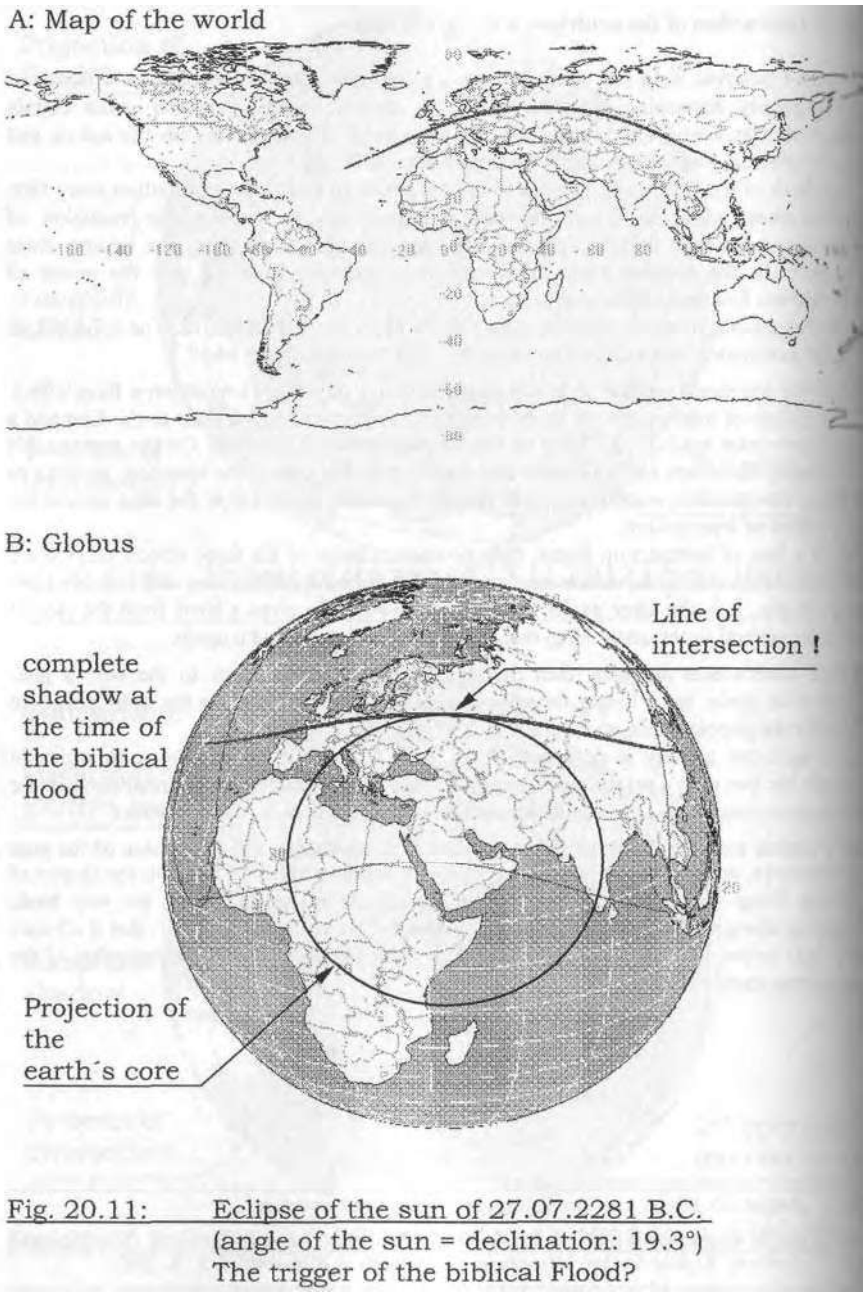

Fig. 20.11: Eclipse of the sun of 27.07.2281 B.C.
(angle of the sun = declination: 19.3°)
The trigger of the biblical Flood?

20.11 Changing of polarity and apocalypse

The pulling at earth's core, which shows as a wobbling of the magnetic axis and in damped form can lead to a tilting of the axis of rotation of the earth, still doesn't make an apocalypse, no end of the world. This only can be expected, if after a tilting of the axis of rotation of earth's core a change of polarity on the surface of the earth occurs. Doing so the new magnetic poles, like a compass needle in the field of the solar wind, again align in such a that the North Pole will be lying "up" in the ecliptic. Because earth's surface will keep it direction of rotation, the sun will, after the process having stabilized, as usual again rise in the East and set in the West. But the inhabitants of the earth, which before still were having midsummer, find themselves again in the midst of midwinter and vice versa.
Truly apocalyptic processes can be expected during the phase of a change of polarity of the earth. Thereby occur unusual relative accelerations and violent earthquakes. The largest destructive potential however is present in the waters of the oceans, which are set in motion.

As is well-known the earth at the equator is measuring a radius which is 21 kilometres larger than at its poles. If only a part of the waters temporarily flows in the direction of the poles of the earth, then the biggest part of the habitable land in Middle and North Europe sinks in the floods; then indeed also the statement of Noah makes sense, who as the first thing saw the mountain of Ararat rise from the floods, after the water again flowed back into its usual ocean basins. The mountain of Ararat after all measures a height of 5137 meters above sealevel!

At comparing historical events with details from the Bible the Flood should have taken place in the year 2245 B.C.[<i>]. According to the description of the position of the stars Dr. Wild calculates July 2281 B.C. as time for the Flood. The Arabic historical writer al-Makrizi again shifts the event into the year 3094 B.C.[<i>]. Who is right? We must verify the eclipses of the sun in this time and determine the position of the points of intersection, then we perhaps find the correct answer. Possibly earth's axis has wobbled more than once, have occurred several catastrophes in different regions. At 27.7.2281 B.C. in any case there actually has occurred an extremely critical constellation, whereas the other two years are ruled out. Here no total eclipse of the sun took place (fig. 20.11).

According to the calendar of the Ugha Mongulala 6110 years before this Flood a still much more devastating one should have occurred. That therefore would have been 8391 B.C., while Scott-Elliot dates the catastrophe in the year 9564 B.C.[<ii>]. According to Plato it would have been about 9500 B.C. For such long periods of time a check however isn't quite easy anymore, because the meantime changes of the earth sum up considerably.

<i>: Wild S. 231, 229 and 225.

<ii>: Wild S, 219, 218 and 210, among others cited from Scott-Elliot: Atlantis und das untergegangene Lemuria, Bauer Verlag Freiburg 1977.

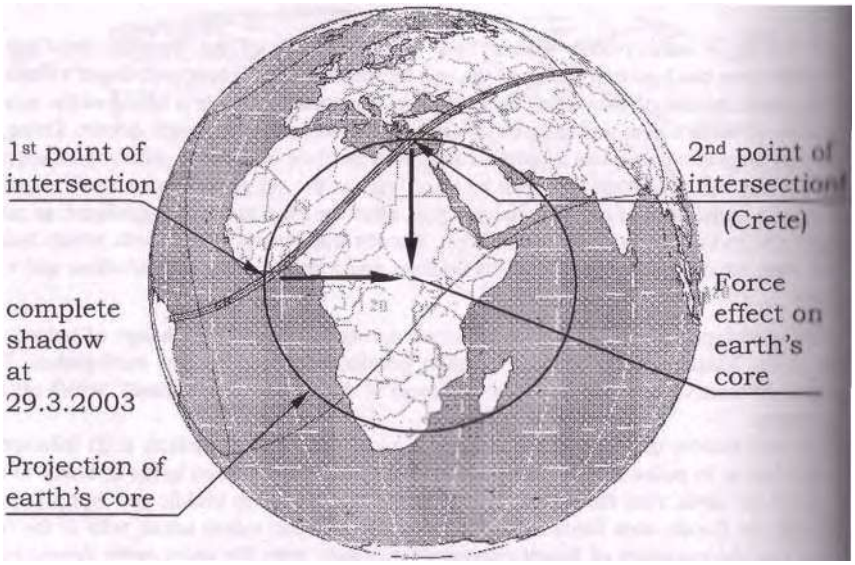

Fig. 20.12 A: Eclipse of the sun of 29.03.2006 (decl.: 3.2°)

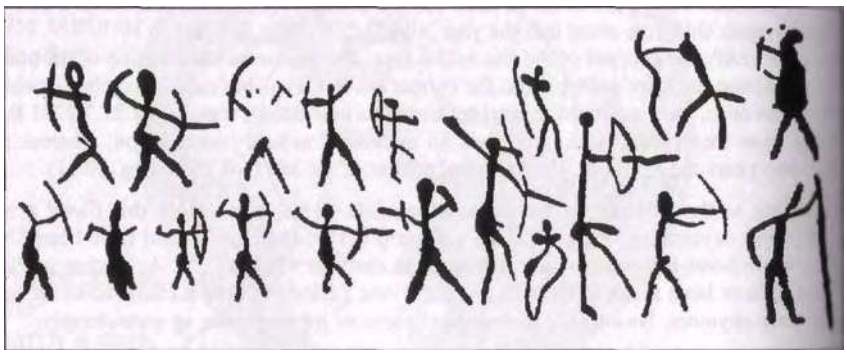

Fig. 20.12 B: Cave painting from Minateda (Spain).<i>

<i>: Laviosa-Zambotti: Origini e Diffusione della Civilta, Marzorati, Milano 1950,

Besides the constellation of sun and moon is crucial the occurring of a relevant neutrino radiation and the question if both is sufficient to tilt the earth and change its polarity. Some experts expect a change of polarity for the time coming, since it takes place with a certain regularity and measured in earth historical periods of time in addition fairly often!
This circumstance the earth presumably owes the river valleys cut deep in the countryside and other topographic phenomena. One presumably can only survive such a catastrophe in an ark (Noah), in the air bubbles of large caves (the walls of which painted children and artists out of pure boredom, see fig. 20.12 B) or in the highland, preferably in the area of the equator (Central Africa, highland of Mexico, Andes, Himalaya).

20.12 Scalar wave gauges for the prediction of earthquakes

We urgently need gauges, to be able to judge the neutrino situation. At first we with that pursue the same goal, as with the building of a free energy converter, however with the difference that the converter should maximize the collected amount of energy, whereas the gauge should minimize the taken up energy, to not too much load the source and not to change the local radiation situation.
In addition the neutrino radiation should be registered distinguishable in its velocity of propagation, what means that the building of a gauge will be very much more costly than that of an energy collector. That's why it can be expected that an usable measurement instrument might be available only many years later and we that long only can base on our own power of observation.

We for instance can statistically analyse, how the earth after an eclipse of the sun reacts to the neutrino radiation focussed by the moon. At August 11 the second focal point was situated in the East, and from that an acceleration of the rotation of earth's core can be predicted. Corresponding observations actually have been made on the surface of the earth with the help of the Foucault pendulum.
The relation the next time can be checked at the eclipse of the sun at 29.3.2006. This time the inverse case is present. A first focussing takes place in the West, so that pendelum swings in the reversed direction would be expected, which indicate a slowing down of the rotation (fig. 20.12 A).

But if the rotation of the earth should change, then the balance sheet of angular momentum of moon, earth's mantle and earth's core isn't correct anymore. As a result a force of difference occurs, which lets the spinning top stagger. But if earth's core staggers inside of earth's mantle, then it powerfully stirs the liquid magma, and in this way releases its surplus energy again. As a result earth's mantle is heated up somewhat. We, on our wafer-thin earth's crust, then time delayed feel the effects of the staggering of the core as an earthquake. The period seems to lie at approximately 6.5 days, as far as this can be read from reactions to the last two eclipses of the sun.

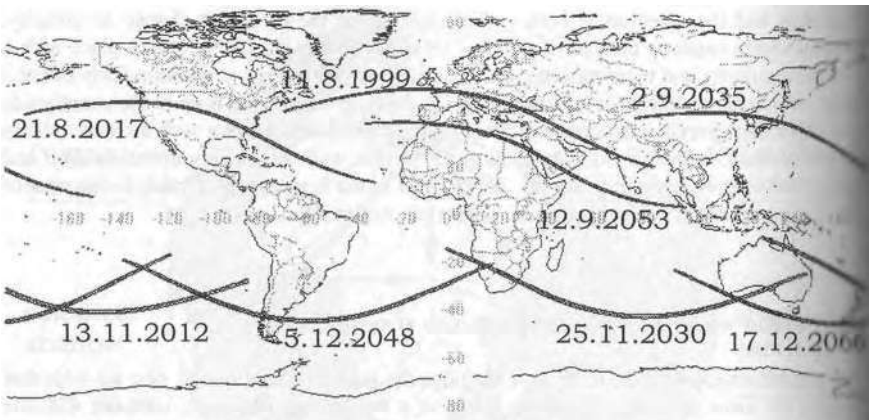

Tafel 20.13 A: Eclipses of the sun of 2 Saros cycles.

Fig. 20.13 B: The „Astronomicum Caesareum“ served around 1540 the determination of the positions of the moon nodes.<i>

<i>: Werner Raffetseder: Sonnenfinsternis, Hugendubel Verlag, Munchen 1999, ISBN 3-89631-302-9, Seite 134.

20.13 Calculation of future occurrences

From the analysis of past and present cosmic events with a strict scientific procedure can be predicted to a certain extent also future events. It thereby by no means concerns prediction, but exclusively the result of an analysis.

After the mentioned eclipse of the sun of 29.03.2006 there once more exists danger of earthquakes (approx. 4.4.2006) for the Island of Crete and Asia Minor. From the eclipse of the sun of 13.11.2012 as well no good can be expected, even if the points of intersection, situated close together, lie far away from populated land in the south-west Pacific basin. The Maya calendar by the way ends to this time. At 21.8.2017, 18 years or a Saros cycle after the eclipse of the sun at 11.8.1999 and correspondingly 120° further to the west, the corresponding complete shadow runs crossways through the USA. The thankless role of Turkey at the second point of intersection this time takes over South Carolina. One only can hope that the houses in Columbia are built more stable than in Izmit.
In fig. 2013 A the two eclipses of the sun of 11.8.1999 and of 13.11.2012 with their respective Saros cycles until 2066 are shown. The as critically to value tendency of the course of the complete shadow is visible, which wants to nestle against the circle of the projection of earth's core to form a line of intersection.

I here break off, since anyone with my indications and an eclipse of the sun-CD can analyse at home all further events personally. I value that if possible many analyses are made and controversially discussed, because possible cosmic catastrophes concern us all somewhat.

What good is the building of gigantic fusion ovens, if the runners by no means have understood the process of the fusion themselves? Why build ring accelerators for billions of dollars, if elementary particles can be calculated at the desk? How is the expenditure for gravitational wave detectors justified, if the actual music plays at entirely other velocities of propagation? Why is half the annual production of the world of Gallium used for an indirect proof of neutrinos, if every self-wound Tesla coil is able to collect more neutrinos?

Our scientists, for whom I as a colleague quite often must be ashamed, have the primary task to draw attention to cosmic and other risks and to calculate them in advance. In any case it is extremely unpardonable to leave this core duty up to some fortune-tellers and self-appointed prophets.
One should more often remind them that the Chinese Kaiser Tschung-Khang let sentence his court astronomers Hi and Ho to death, after the two not having predicted an eclipse of the sun. It thus certainly didn't concern a missed spectacle or a missed tourism business, but presumably the need for safety of the Kaiser and his subordinates, for which the two astrophysicists in ancient China had to take responsibility!

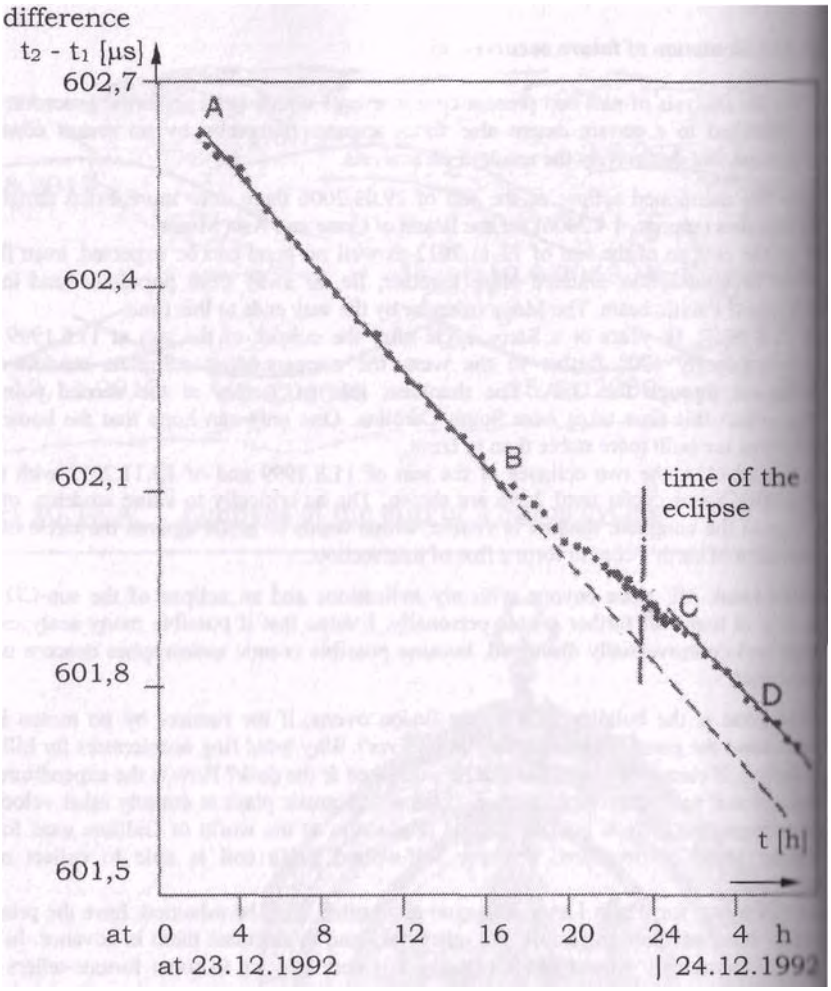

Fig. 20.14: The difference in going of two caesium atomic clocks
positioned in different directions, but in the same laboratory in Harbin, China, during the partial eclipse of the sun of 24.12.1992.<i>

<i>: Shu-wen Zhou: Abnormal Physical Phenomena Observed When the Sun, Moon, and Earth are Aligned, 21st Century Science & Technology, Fall 1999, Vol. 12, No. 3, pp. 54-61. Comments concerning Figure 9: Straight lines AB and CD show that the rate of change of the time difference between the two clocks is constant in non-eclipse periods, but becomes irregular around the time of the eclipse.

20.14 Epilogue to the energy technical seminar

Very slowly the word goes round that the energy source of the future has got a name: "Neutrinopower". Unfortunately fundamental physics, which is financed with public money, still does know almost nothing about the nature of the neutrino radiation. In addition hinder useless model concepts any progress in this direction and so the responsible fundamental research steps on the spot.

Considerably more extensive were already 100 years ago the insights of the experimental physicist Nikola Tesla, the discoverer of the neutrino radiation and father of the free energy. The space energy however is showing most clearly in nature, which only uses this advantageous form of energy. In particular during eclipses of the sun and other cosmic experiments it openly comes to light and can be detected by us for a short time.

The physicist Prof. Shu-wen Zhou of the University of Huazhong in Wuhan, China, systematically has investigated the effects, if sun, moon and earth are aligned<i>. Doing so he has proven inexplicable physical anomalies in experiments. Stimulated by the discoveries of Maurice Allais with the Foucault pendulum he built an arrangement specially flor proving horizontal forces of acceleration, and actually he with that could measure face effects during the total eclipse of the sun of 24.10.1995. He even speaks of an oscillating force!

Further he could determine changes in the spectral wave length of various elements, which under normal conditions go as constant and even as characteristic for the respective element. The relative change of size of the wave length during the ring-like eclipse of the sun over China of 23.9.1987 resulted in the 100-fold value compared to the difference in the spectrum analysis between surface of the earth and surface of the sun! This comparison reveals an immense discrepancy between theory and practice and puts us for a solid problem.
For that six different models of spectrometers were installed in several laboratories of different polytechnics and a photograph was taken of the emission spectra of H, D, Ca, CN, Ni, Ti, etc. Also other reasons than that of an eclipse of the sun could be excluded unambiguosly. In the results of these, at artificial light carried out conventional measurements, in any case abysses yawn. The from spectrum analyses won "insights" about the composition of strange celestial bodies now for sure can be done away with without knowledge about the respective prevailing neutrino radiation.

Spectacular also is the proof of differences in going of atomic clocks of various constructions. During the partial eclipse of the sun of 24.12.1992 seven caesium clocks in four cities of China and in three planes were used. The analysis of the differences in going resulted in, as is shown exemplary in fig. 20.14, changes of the gradient during the eclipse. The results for the atomic clocks in the planes and for two further time measurements turned out with similar clarity<i>.

<i>: Shou-wen Zhou: Abnormal Physical Phenomena Observed When the Sun, Moon, and Earth are Aligned, 21st Century Science 6s Technology, Fall 1999, Vol. 12, No. 3, pp. 54 - 61.

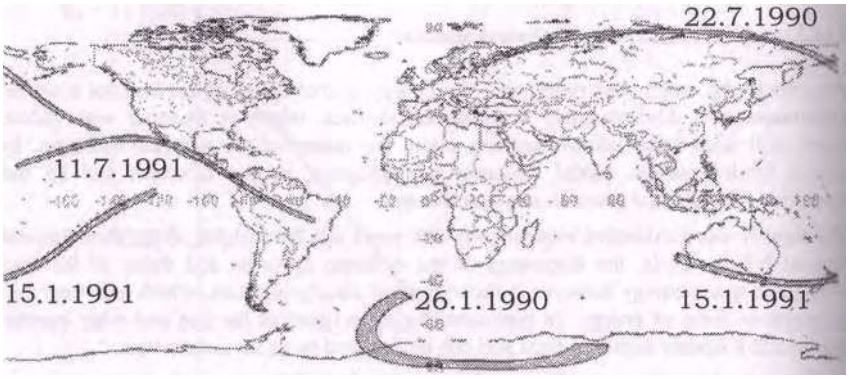

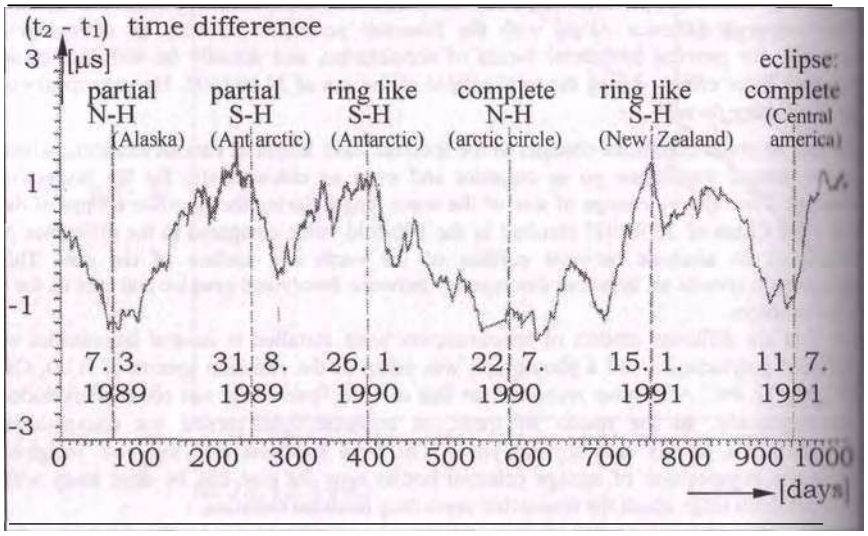

Fig. 20.15: Long-term measurement between 1989 and 991 of the difference in going of two atomic clocks at the U.S. Naval Astronomical Observatory.<i>

The in the 1000 days occurred eclipses of the sun have been entered later. In addition is recorded, if the northern hemisphere (N-H) or the southern hemisphere (S-H) of the earth was involved.

<i>:Shu-wen Zhou: Abnormal Physical Phenomena Observed When the Sun, Moon, and Earth are Aligned, 21st Century Science & Technology, Fall 1999, Vol. 12, No. 3, pp. 54 - 61. Figure 8.

A connection to the neutrino radiation Prof. Zhon doesn't draw, but it almost is obvious.

From the U.S. Naval Astronomical Observatory (LC/7970) long-term measurements over 1000 days between 1989 and 1991 are present (fig. 20.15). The difference in going between the two atomic clocks positioned at different places shows a permanent up and down. The reason goes as completely unknown.
But if the eclipses, which took place in this time, are entered then one immediately sees the assignment to a maximum or a minimum value. If an eclipse of the sun namely concerned the southern hemisphere of the earth, then the difference in going each time reached a maximum, but if the shadow of the moon run over the northern hemisphere, then each time a minimum occurred. Chance here probably is out of the question!

Let us record: The effect of an eclipse of the sun, to which for instance a Foucault pendulum reacts, can equally be traced back to the interaction of the neutrinos as the free energy. That's why the here presented book carries the title "Free energy and the interaction of the neutrinos". It has appeared in the series concerning the "Electromagnetic environmental compatibility", and also for that there are good reasons. Our energy technology must become more ecologically compatible and we come the goal closer, if we emulate nature, understand and copy it.

That it further concerns electromagnetism, likewise is explained from the interaction of the neutrinos, which concerns the oscillating and resonant case of the electromagnetic interaction. In this respect the reference to the series of books therefore would be given.

It only indirectly has to do with "electrosmog", or what otherwise is understood under environmental compatibility in general. It however could be shown that also the earth radiation is a form of neutrino radiation, and that it poses a biological effectiveness, after it turned out that it serves nature as an energy source. With that the conflict with space energy devices already is predetermined if the same scalar wave radiation should be used. Then one system takes away the other system the energy basis and the existence basis.
This environmental compatibility problem can be solved, if care is taken that both don't get in each others way with regard to the frequency and the wave length. We for that need a deep understanding concerning the topic of the space quanta and the neutrinos, their physical properties and the corresponding device technology. The book should make a contribution to that.

The other side of the medal is the information technical aspect of the scalar wave radiation and the environmental compatibility problem connected with that. The third and last part of the series of books is dedicated to this theme.

Part 2: Edition belonging to the energy technical seminar: "Electromagnetic Environmental Compatibility"

Prof. Dr.-Ing. Konstantin Meyl

Scalar waves

Abstract: 1. Auflage 1998, 4. Auflage and 1st English Edition

With regard to the environmental compatibility a decentralized electrical energy technology should be required, which manages without overhead power lines, without combustion and without radioactive waste. The liberalization of the energy markets won't on any account solve our energy problem, but only accelerate the way into the dead end. New, ecologically compatible concepts are collected and discussed in the book.

A useful energy source could be represented by space quanta, which hit upon the Earth from the sun or from space. They however only are revealed to the measurement technician, if they interact. It will be shown that the particles oscillate and an interaction or collection with the goal of the energy technical use only is possible in the case of resonance.

Since these space quanta as oscillating particles have almost no charge and mass averaged over time, they have the ability of penetration proven for neutrinos.
In the case of the particle radiation discovered 100 years ago by Tesla, it obviously concerns neutrinos. We proceed from the assumption that in the future decentral neutrino converters will solve the current energy problem. Numerous concepts from nature and engineering, like on the one hand lightning or photosynthesis and on the other hand the railgun or the Tesla converter are instanced and discussed.

Free energy and the interaction of the neutrino radiation

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Scalar Waves

From an extended vortex and field theory to a technical, biological
and historical use of longitudinal waves.

Part 3

by

Professor Dr.-Ing. Konstantin Meyl

Edition belonging to the lecture and seminar "Electromagnetic environmental compatibility"

(Original title: "Elektromagnetische Umweltvertraglichkeit")

Translated out of the German language
by Ben Jansen
(2003)

* * *

Part 3: Edition belonging to the information technical seminar

Scalar waves and the technical use of longitudinal waves and vortices

* * *

INDEL GmbH, Verlagsabteilung

Villingen-Schwenningen 2003

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Preface to the seminar, part 3

With the appearing in print of the 3rd part of the series of lecture notes of the electromagnetic environmental compatibility, the collection of material can be considered to be completed for the time being. By now almost all aspects concerning the theme of the potential vortices of the electromagnetic field and their propagation as a scalar wave should have been addressed or at least indicated.
And that's what it is about in the case of the editions belonging to the seminars: In the seminars, taking place inside and outside the university, questions about the phenomena and the biological effectiveness of the fields, which surround us, are discussed. The scientifically correct procedure asks as a preparation for the seminar a voluminous collection of material and a compilation of theses with the pros and contras to them. The argumentation, which is denoted as „textbook physics" and is generally accepted, the participant of the seminar can work out himself by means of the available journals and books. The potential vortex, which completed the field equations, however makes possible a counterstatement, which for most participants at first will be unusual. The old dispute between quantum and field physics rekindles. What is missing is a voluminous collection of material concerning the refined field physics, and this gap the editions belonging to the seminars should close.
In the case of this book the primary concern is to make sure, that all facets, properties and physical consequences of the new and unified field physics are addressed. The question, if all points can bear a strict verification, remains reserved to the seminar and its participants, of whom each should form its own judgement. The series of books should be understood as a stimulation, to make own thoughts about the various points. Who has no opportunity to participate in a seminar, by means of the lecture at least gets an idea of what is discussed here and how is struggled for scientific insights.
The herewith completed collection of material by no means may be compared or confused with a basic work about the theory of objectivity. That the editions cannot and want not afford at all. They together with the discussions at best form the basis for a scientifically basic work, at which I am working.

In the case of the collection of material concerning the electromagnetic environmental compatibility consisting of three parts, again and again new aspects have emerged, which found entrance into the book, at which I was working at that particular time, whereas the rough structure has been controlled precisely: part 1 with the chapters 1 to 9 treats the basics, part 2 with chapters 10 to 20 the energy technical aspect and part 3 with the chapters 21 to 30 the information technical aspect of scalar waves.
The here presented 3rd part starts with the wave equation and the two comprised parts of a transverse and a longitudinal wave. The historic dispute between Heinrich Hertz and Nikola Tesla with the experimental evidence of the each time used wave part is continued over the wave-particle uncertainty compromise up to the dispute about the right field description: that of Maxwell or the new dual and at the same time unified description, which builds upon Boscovich and Faraday. The aspects, which seem so irreconcilably thereby only are two parts of a single equation, which is much older and can be traced back to Laplace: the wave equation.
Until now no derivations of this equation, which contains both wave parts, are known This for the first time succeeds from the new and extended field approach in the summary from chapter 26. At first however is attempted to make the world of the scalar waves

plausible with models, calculations and observations. For that are used examples from high-frequency engineering, like the ground wave or the near-field area of an antenna, and from nature and medicine, which are granted two chapters. The comparison of the nerve conduction with Tesla's one wire technology is bringing it to light that scalar waves equally are used in both cases. In a frequency diagram the insights are entered concisely and is shown that considerably more unexplored domains occur than already is known, that in most cases not even gauges are available. With the design for building a scalar wave gauge the scientific verification of until now only empirically won results is stimulated, like for instance the results the radiesthesia wants to have determined with the help of the sensitivity of man as a biosensor.

Many relations will be revealed to the reader only, if he has worked through the summary, which follows. From Maxwell's field equations only the well-known (transverse) Hertzian waves can be derived. (Longitudinal) scalar waves however in the result are zero. This is a flaw of normally used field theory, since scalar waves exist for all particle waves, like e.g. as plasma wave, as photon- or neutrino radiation. Because the field pointer, in the direction of which longitudinal waves are propagating, is oscillating, the frequency will oscillate like the velocity of propagation, which again is measured as a noise signal. Any antenna noise proves the emission of scalar waves in space. But scalar waves, or whatever should be subsumed under the by mathematics minted generic term free of any value judgement, surely are more than only noise.

Starting from Faraday's discovery - instead of the formulation of the law of induction according to Maxwell - an extended field theory is derived, which goes beyond the Maxwell theory with the description of potential vortices (noise vortices) and their propagation as a scalar wave, but contains the Maxwell theory as a special case. The new field theory with that doesn't collide with the textbook opinion, but extends it in an essential point with the discovery and addition of the potential vortices.
Also the theory of objectivity, which follows from the discovery, is compared in the form of a summary with the subjective and the relativistic point of view and the consequences for variable velocity of propagation of the scalar waves, formed from potential vortices, are discussed. Like already in part 1 the unification of the electromagnetic interaction with the gravitation succeeds impressively.

Besides the mathematical calculations this book contains a voluminous material collection concerning the information technical use of scalar waves, if e.g. the useful signal and the usually interfering noise signal change their places, if a separate modulation of frequency and wavelength makes a parallel image transmission possible, if it concerns questions of the environmental compatibility for the sake of humanity (bioresonance, among others) or to harm humanity (electrosmog). With that the book again finds back to the starting point, to the open task, which made necessary an excursion through all domains of physics to answer it. I hope, the long march was worthwhile.

Villingen-Schwenningen december 2002

Preface to the 2nd edition of part 3

In favour of chapter 30 as a complement, an introduction into the ancient broadcasting technology of the gods, the 1st edition wasn't printed anymore in the year 2002 as originally planned. Instead the individual chapters have been prepublished in different places. The chapters 21 to 25 are found among others in the book "scalar wave technology", which has been published as an instruction for an experiment to demonstrate scalar waves in 2001. Excerpts from it, as also from the chapters 26 to 28 have appeared in form of individual essays in different journals.

Again experimental successes had been intervening, which caused a renewed deferring of the date of appearance of the 3rd part of the series of books. In my laboratory the bi-directional transmission of music and of data by scalar wave was successful. We thus also can transmit information backwards from a receiver to the transmitter or to a second receiver, whereby the receivers work purely passive, thus without own power supply. The operating energy is as well supplied to them by the transmitter by scalar wave. The demonstrated technology opens completely new possibilities of a technical application. Conceivable are telemetry installations where measurement signals have to be transmitted from rotating or otherwise inaccessible places of a machine. The energy for the measurement electronics can be transmitted wirelessly by scalar waves and the signal can be sent back along at the same time, by modulating it onto the energy carrier. In this way dozens of measurement stations can be connected wireless with a single central transmitter, which supplies them all with energy.

The question was asked: Is the technology really entirely new? The answer is amazing: No, it here concerns the oldest technology of humanity, which had developed to a peak in antiquity, to send receive engineering of the gods. For this claim even a mathematical proof is available. For that the authoritative transition, the unrolling of a vortex to a wave (the transition from the near-field to the far-field) or in the reversed case the rolling up at a receiver antenna (usually denoted as standing wave) is calculated with help of the extended field theory. The result is, that at this transition the velocities of propagation resp. the wavelengths of the transverse and the longitudinal wave stand to each other in the ratio of the Golden Proportion.
With regard to the optimization of a transmitter or receiver antenna the Golden Proportion has an effect on the construction resp. the architecture of corresponding buildings . Which ones, with that deals the complementing chapter 30. But it mustn't be missing either, since after all it concerns a grandiose practical information technical use of scalar waves, from which we technologically can learn a lot<i,ii>.

Villingen-Schwenningen march 2003

<i>: Note: chapter 30 provides an introduction into ancient broadcasting technology of the gods. The working off of history with respect to the use of scalar waves is so voluminous, that for that a book of its own is published with the title:

<ii>: K. Meyl: Sendetechnik der Gotter, historischer Sciencefictionroman (2003), Villingen-Schwenningen, INDEL Verlagsabteilung, ISBN 3-98O2 542-5 9

21. Derivation of the scalar wave

WilliamThomson, who called himself Lord Kelvin, after he had been knighted, already in his lifetime was a recognized and famous theoretical physicist. The airship seemed him too unsafe and so he went aboard a steam liner for a journey from England to America in the summer of 1897. He was on the way in a delicate mission.

Eight years before his German colleague Heinrich Hertz had detected the electromagnetic wave in experiments in Karlsruhe and scientists all over the world had rebuilt his antenna arrangements. They all not only found confirmed the wave as such, they even could show the characteristic properties.
It was a transverse wave, for which the electric and the magnetic field pointers oscillate perpendicular to the direction of propagation. This can be seen as the reason, that the velocity of propagation is showing itself field independent and constant. It is the speed of light c.

With that Hertz had experimentally proven the properties of this wave, previously calculated in a theoretical way by Maxwell, and at the same time proven the correctness of the Maxwellian field theory. The scientists in Europe were just saying to each other: "well done!" as completely other words came across from a private research laboratory in New York: "Heinrich Hertz is mistaken, it by no means is a transverse wave but a longitudinal wave!"

Such a screwball most said and did as if they hadn't heard the criticism at all. But then one couldn't ignore it completely, because on the one hand claimed the private research scientist to have experimental proof and on the other hand it wasn't just anybody, who here reported. It was nobody but Nikola Tesla, the Croat experimental physicist who emigrated to America
Him we owe the modern alternating current technology from the high-tension network for energy transmission over the alternating current transformer to the asynchronous machine.
With his magnificent inventions he had earned enough money, to be able to afford a private laboratory, in which he could research and invent uncensored and free. The key to his success was lying in his purposeful, concentrated and efficient working method.
He was fast! Whereas in Europe still was being discussed about properties and theoretical possibilities of application of the wave, Tesla already presented the armed forces a remote controlled scaled-down submarine in Madison Square Garden (fig. 21.1 A). To convince such a man, who only holds valid what his experiments reveal, from the opposite, should be a hopeless enterprise.
Lord Kelvin was aware of that, as he made the decision to go on the journey. He could not and did not want to put his head into the ground, as many of his colleagues, because on the one hand scientists are curious by principle and on the other hand he travelled as an official representative of science. He had been instructed to free, as Mr. Clean, the undamaged world of sciences from erroneous teachings. But it came completely different.

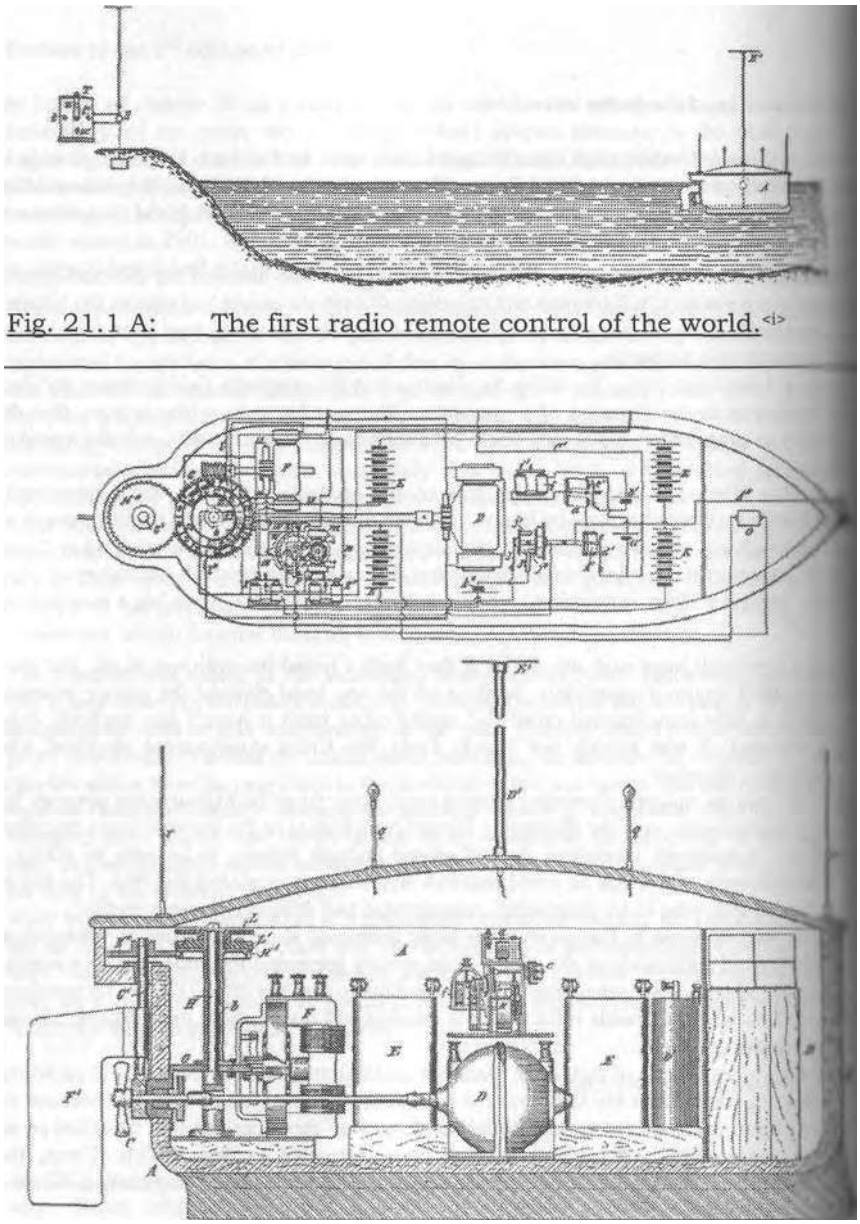

Fig. 21.1 A: The first radio remote control of the world.<i>

Fig. 21.1 B: Patent specification concerning the remote controlled submarine.<i>

<i>: Nikola Tesla: Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles, US-Pat. 1898, Nr. 613,809. Complete Patents: P. 351

21.1 Lord Kelvin in a delicate mission

The first day of his visit at Tesla Kelvin spoke the admonishing words he had been instructed to speak. He recommended Tesla warmly to publicly retract the remarks concerning the Hertzian mistake and to contribute himself to the settlement of the dispute. Seen from a specialist viewpoint they talked at cross-purposes.

But at night in his hotel room the Lord again thought about the experiments, which had been shown to him. The standing wave nature had been visible unambiguously: the oscillation nodes, the effect back on the transmitter, the high degree of effectiveness and many other things more. Such properties the Hertzian wave indeed doesn't know. Also Tesla didn't work with dipole antennas, but with flat coils, with spark gap oscillators and with a very unconventional switching technique, set up different in principle.

The next morning Lord Kelvin appeared in the laboratory again and greeted Tesla with the words: "Then you don't use Hertzian waves?" "Certainly not", Tesla answered," it are radiations. By waves no energy could be economically transmitted over a larger distance. My system works with true conduction, which theoretically seen can take place over a larger distance, without bigger losses occurring."
In the article of the "Electrical Experimenter" is noted further, that the doubting critic Kelvin suddenly turned into one of the biggest followers<i>.

Kelvin deduced very fast: according to that there exist two different sorts of wave propagation. So Hertz with his transverse wave is just as right, as Tesla with the longitudinal wave.
As a represantative of theoretical physics he however could pull out Tesla a decayed tooth. Maxwell had based his field description on an aether concept, which at that time in the world of sciences triggered violent discussions. Since Tesla saw such an aether as a prerequisite for longitudinal waves, he thought he and not Hertz had proven the Maxwell wave in experiment for the first time. By stating this the magnificent experimental physicist however revealed weaknesses in the area of theory. Maybe he had not read exact enough or understood the books of Maxwell, which without doubt were formulated mathematically only arduously comprehensible in the original version.
In this point Tesla had to learn otherwise by Kelvin. Maxwell's field theory provides without exception a mathematical description for the Hertzian wave. For the Tesla radiation however no field description exists! This by the way is the circumstance, why this wave could disappear from the textbooks and again fall into oblivion. Tesla himself had problems to theoretically imagine, what happens at his wave. His models in some points perhaps were even better than the official textbook opinion, but not without contradiction to accepted regularities. That's why Tesla did without a publication of his ideas, although he in his lifetime had filed away at an own theory.

<i>: Nikola Tesla: Famous Scientific Illusions, III. The Singular Misconception of the Wireless, Electrical Experimenter, Feb. 1919, printed in Tesla Said, p. 197

Figure 21.2 A:

William Thomson, 1846 becoming Professor at Glasgow University with the age of 22 years. From 1892. on he was called Lord Kelvin.[<i>]

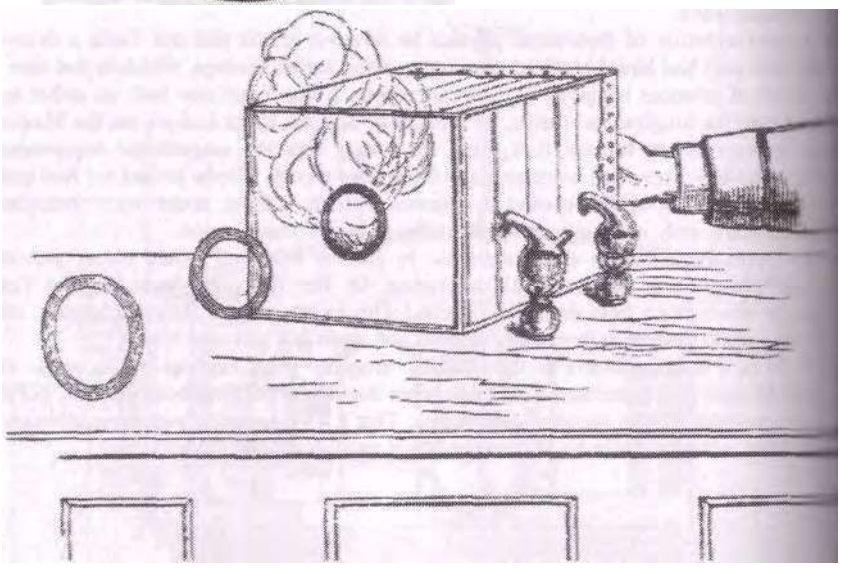

Fig. 21.2 B: Vortex rings from a smoke vortex gun.[<i>]

<i>: David Ash, Peter Hewitt: Science of the gods, Gateway Books, Bath, 1990

21.2 Helmholtzian ring-like vortices in the aether

Tesla told Kelvin at his visit from the meeting with the German Professor Hermann von Helmholtz on the occasion of the World's Fair in Chicago 1893. Kelvin knew him very well and had cooperated with him in the past. Now the vortex concept of his colleague and his model of stable vortex rings were very obliging.
In the case of a standing wave the impulse is passed on from one particle to the next. In the case of acoustics for instance we are dealing with a shock wave, where one air molecule knocks the next. In this way sound propagates as a longitudinal wave. Correspondingly the question is raised: What sort of quanta are the ones, which in the case of the Tesla radiation carry the impulse?

Lord Kelvin was already on the way back to Europe on the steamship and he deduced: The Tesla experiments prove the existence of longitudinal standing waves in space. In the question, what passes on the impulse, Kelvin comes to the conclusion: it are vortices in the aether! With that he had found an answer in experience. With his students he built boxes, with which he could produce smoke rings, to be able to study and demonstrate in experiments the special properties of ring-like vortices in their flow technical analogy (fig. 21.2[<i>]). But he didn't have ready a suitable field theory.

The from Germany to the Isles exported vortex physics for a short time could establish in England, before it was slaughtered and buried by the German quantum physicists. A main advocate has been James Clerk Maxwell, who held the vortex theory for the best and most convincing description of matter[<ii>]. As his successor at the Cavendish laboratory in Cambridge J. J. Thomson was appointed, who already as a young man had got a price for a mathematical treatise about vortices[<iii>]. He discovered the electron and imagined it, how could it be otherwise, as a field vortex.

The crucial weakness of vortex physics, the lacking of an usable field theory, was of benefit to the emerging quantum physics. This could change fundamentally with the discovery of the potential vortex, the vortex of the electric field[<i4>]!
In addition is the experimental proof of a vortex transmission as a longitudinal wave in air or in a vacuum, as it has been furnished by Tesla already 100 years ago, neither with Maxwell's theory nor with the today normally used quantum theory explicable or compatible. An urgent need is present for a new field theory!

<i>: David Ash, Peter Hewitt: Science of the gods, Gateway Books, Bath, England 1990.

<ii>: James Clerk Maxwell: "...the vortex rings of Helmholtz, which Thomson imagines as the true form of the atom, fulfil more conditions than any other previous concept of the atom."

<iii>: J.J. Thomson: "the vortex theory is of much more fundamental nature than the usual theory of solid particles."

<i4>: Konstantin Meyl: Potentialwirbel Band 1 (1990) and Band 2 (1992), INDEL-Verlag, Villingen-Schwenningen.

Scalar waves, a mathematical reasoning (I)

1. prerequisite: wave equation (textbook-formulation)

$$\Delta \mathbf{E} = \frac{1}{c^2} \cdot \frac{\delta^2 \mathbf{E}}{\delta t^2}$$

taking apart of the delta operator mathematically (Laplace operator) according to the rules of vector analysis (fig. 5.0):

$$\begin{array}{lcll} \Delta \mathbf{E} & = & \text{grad div } \mathbf{E} & - \text{ rot rot } \mathbf{E} \\ \text{wave} & = & \text{longitudinal} & + \text{ transverse} \end{array} \quad (21.1)$$

---

2. State of the art of technology: Hertzian wave = transverse wave
special case: = solution of Maxwell's field equations
no sources:

$$\text{div } \mathbf{E} = 0 \quad \text{and} \quad -\text{rot rot } \mathbf{E} = \frac{1}{c^2} \cdot \frac{\delta^2 \mathbf{E}}{\delta t^2} \quad (21.3)$$

transverse wave:
field pointers oscillate crosswise to the direction of propagation
The propagation occurs with the speed of light c.

---

3. claim: Tesla radiation = longitudinal wave
special case:
irrotationality:

$$\text{rot } \mathbf{E} = 0 \quad \text{and} \quad \text{grad div } \mathbf{E} = \frac{1}{c^2} \cdot \frac{\delta^2 \mathbf{E}}{\delta t^2} \quad (21.4)$$

longitudinal wave, shock wave, standing wave:
field pointer oscillates in the direction of propagation.
Velocity of propagation is variable!

Fig. 21.3: The special cases of the wave equation

21.3 Taking apart of the wave equation

Before one plunges into the adventure of an entirely new field theory, it first of all should be traced and analysed, what the latest textbooks say about scalar waves.

There some scalar or vector potentials are introduced; there the constant of dielectricity e is written down as a complex variable, although it physically seen concerns a material constant, only to be able to calculate with this trick artificially a loss angle, which should indicate the losses occurring in a dielectric, where in reality it concerns vortex losses. Of course one can explain the dielectric losses of a capacitor or the heating in a microwave oven entirely without vortex physics with such a label fraud, but it should be clear to anyone, that in a complex constant lies buried an inner contradiction, which is incompatible with physical concepts.
We are used to such auxiliary descriptions so much, that the majority of today's physicists tend to attribute physical reality to this mathematical nonsense. As pragmatists they put themselves on the standpoint if with that experimental results can be described, then such an auxiliary description can't be so wrong after all. Doing so the circumstance is forgotten that here the ground of pure science is abandoned and is replaced by creeds.

We find everything already in the wave equation, as it can be found in all textbooks.

$$\boxed{\Delta \mathbf{E} = \frac{1}{c^2} \cdot \frac{\delta^2 \mathbf{E}}{\delta t^2}} \quad (21.1)$$

Behind this formulation two completely different kinds of waves are hiding, because the used delta operator consists of two parts according to the rules of vector analysis:

$$\boxed{\begin{array}{lll} \text{grad div } \mathbf{E} & - \text{ rot rot } \mathbf{E} & = \Delta \mathbf{E} \\ \text{longitudinal} & / \text{ transverse} & \text{wave} \end{array}} \quad (21.2)$$

We want to discuss two special cases.
If we put the left part (in eq. 21.2) to zero (div E = 0) which is tantamount to no sources of the field then the well-known radio wave remains, which also is called Hertzian wave, after Heinrich Hertz, as said, had experimentally detected it in Karlsruhe 1888:

$$\text{div } E = 0 \qquad \text{and} \qquad \boxed{- \text{rot rot } \mathbf{E} = \frac{1}{c^2} \cdot \frac{\delta^2 \mathbf{E}}{\delta t^2}} \quad \text{(special case)} \qquad (21.3)$$

It concerns the transverse wave, described by Maxwell, for which the field pointers oscillate crosswise to the direction of propagation. The propagation again occurs with the speed of light c. So much concerning the state of the art of technology.
But as we see, in the mathematical formulation of the wave equation is hiding, yes, even more than only the generally known electromagnetic wave. The no sources approach is a neglect, which only is valid under certain prerequisites!

Scalar waves, a mathematical reasoning (II)

3. claim: Tesla radiation = longitudinal wave

$$\text{rot}\,\mathbf{E} = 0 \quad \text{and} \quad \text{grad div}\,\mathbf{E} = \frac{1}{c^2}\cdot\frac{\delta^2\mathbf{E}}{\delta t^2} \qquad (21.4)$$

special case:
source field, because div E $\neq$ 0

=> sources = charge carriers (plasma waves)
=> sources = vortex structures

---

4. approach: (div E $\neq$ 0) is a scalar! => scalar wave
=> E-field vector can be derived from a scalar potential φ:

$$\mathbf{E} = -\,\text{grad}\,\varphi \qquad (21.5)$$

and $$\text{div}\,\mathbf{E} = -\,\text{div grad}\,\varphi \equiv -\Delta\varphi \qquad (21.6)$$

inserted in eq. 21.4: homogeneous scalar wave equation

$$\Delta\varphi = \frac{1}{c^2}\cdot\frac{\delta^2\varphi}{\delta t^2} \qquad (21.7)$$

---

5. proof: For the case of an additional space charge density ρ_{el} should be considered: div D $= \rho_{el}$
and div E $= \rho_{el}/\varepsilon$ (21.8)

inhomogeneous scalar wave equation = plasma wave!

$$\Delta\varphi = \frac{1}{c^2}\cdot\frac{\delta^2\varphi}{\delta t^2} - \frac{\rho_{el}}{\varepsilon} \qquad (21.9)$$

Fig. 21.4: Derivation of the plasma wave as an example of a scalar wave

21.4 Derivation of the scalar wave equation

Making neglects by all means is normal and legal in science. But it may not be carried out at will and untested. In any case an error consideration is necessary, the result of which should be, that the neglect indeed is sufficiently small.
In the here presented case of the wave equation I haven't found one single textbook, in which this error consideration has been carried out. As a result of this inexcusable negligence there is the danger that exactly the aspect is neglected, which it actually concerns. This could lead to catastrophical results, e.g. that the causes for electrosmog, for numerous EMC-problems, for biological and technical effects aren't seen and understood anymore, that pure science once more dilapidates to a creed!

In the case of the wave equation the assumption of no sources describes only one side of the medal. The other side, which for the electromagnetic wave occurs as an error term, we get if we this time put the right part in equation 21.2 to zero (rot E = 0).
In this case a divergence of the field is present, which requires a source field. As sources some charge carriers, quanta or at least particle structures, e.g. vortex structures have to exist. Their propagation occurs, as we know it from the sound propagation, as shock wave in longitudinal manner. The air molecules, the quanta or particle structures thereby oscillate in the direction of propagation. Also the field pointer has a component in this direction

$$\text{rot } E = 0 \qquad \text{and} \qquad \boxed{\text{grad div } \mathbf{E} = \frac{1}{c^2} \cdot \frac{\delta^2 \mathbf{E}}{\delta t^2}} \quad \text{(special case)} \qquad (21.4)$$

The occurring divergence of the field pointer (div E) is a scalar, for which reason this wave preferably is called scalar wave.

In the special case of a scalar wave (rot E = 0) the E-field vector can be derived from a scalar potential φ:

$$\boxed{\mathbf{E} = -\text{grad } \varphi} \quad (21.5)$$

On the one hand this term is used in the wave equation 21.4 on the right-hand side without forming the gradient on both sides of the equation. On the other hand the divergence of the approach 21.5:

$$\text{div } \mathbf{E} = -\text{div grad } \varphi \equiv -\Delta \varphi \qquad (21.6)$$

is applied in equation 21.4. The result is the homogeneous scalar wave equation:

$$\boxed{\Delta \varphi = \frac{1}{c^2} \cdot \frac{\delta^2 \varphi}{\delta t^2}} \quad (21.7)$$

Scalar waves, a mathematical reasoning (III)

Proof: plasma wave =
inhomogeneous scalar wave equation

$$\Delta \varphi = \frac{1}{c^2} \cdot \frac{\delta^2 \varphi}{\delta t^2} - \frac{\rho_{el}}{\varepsilon} \quad (21.9)$$

one solution<i>: $\omega^2 = c^2 \cdot k^2 + \omega_p^2$ (= Langmuir waves).

Fig. 21.5 A: Derivation of the plasma wave as an example of
the existence of scalar waves in the wave equation

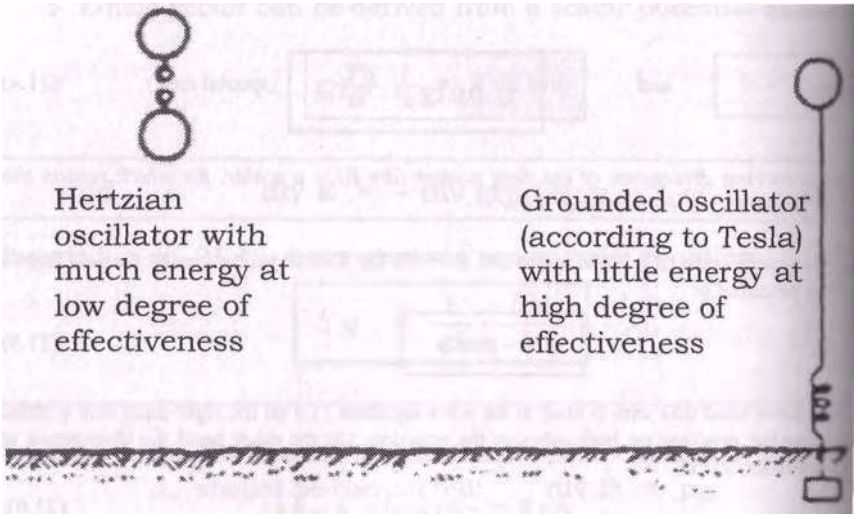

Fig. 21.5 B: Nikola Tesla explains the difference between his radiation and the Hertzian wave.<ii>

<i>: The solution describes dispersion relations of plasma waves; longitudinal wave movements + Langmuir oscillations of the electron density.

<ii>: Nikola Tesla: The Problem of Increasing Human Energy, The Century Monthly Magazine, June 1900, ISBN 1-882137-00-0, Page i-15

21.5 Derivation of a plasma wave

Doing without formation of the gradient for the derivation of the homogeneous wave equation is tantamount to an integration of the equation. We hence under certain conditions must expect the occurring of an integration constant.
This is the case, if in addition a space charge density ρ_{el} occurs as source of the field, which according to Maxwell equation 4 can be considered as the divergence of a dielectric displacement D (fig. 21.4):

$$\operatorname{div} \mathbf{D} = \rho_{el},$$

resp. with the relation of material $\mathbf{D} = \varepsilon \cdot \mathbf{E}$: $\operatorname{div} \mathbf{E} = \rho_{el}/\varepsilon \equiv -\Delta\varphi.$ (21.8)

If we complete this contribution with possible present field sources, then the inhomogeneous scalar wave equation results:

$$\boxed{\Delta\varphi = \frac{1}{c^2} \cdot \frac{\delta^2\varphi}{\delta t^2} - \frac{\rho_{el}}{\varepsilon}} \quad (21.9)$$

For these equations solutions have been published<i>. They have the same form, as the well-known dispersion relations of Langmuir waves. That is electron plasma waves, thus longitudinal wave movements associated with Langmuir oscillations of the electron density.

With that it has been proven that scalar waves and longitudinally propagating standing waves are described by the wave equation and are contained in it. This in any case is valid in general just as in the special case of a plasma wave, as mathematically could be derived here.

From the example of the derivation of plasma waves from the wave equation 21.1, we see that scalar waves by all means are known and their existence isn't casted doubt on at all. After all the mathematically won solution is secured by numerous experiments. Why do textbooks concerning high-frequency engineering then ignore the scalar wave parts in the wave equation?
Our specialists seem to concentrate so much on their branch, that they are losing the view on the Big Whole. They practice one-eyed physics, where the plasma physicist keeps one eye shut and the radio technician the other eye. What the other one does and researches, they don't understand anymore for ages. It is necessary to point them to their common root.

The perhaps most important statement of the wave equation is that every emitted wave contains both longitudinal and transverse parts! Both parts in addition occur jointly, so that for corresponding boundary conditions it can be expected that one part is transforming into the other part. The HF technician then suddenly measures less field strength and comes to the conclusion that his radio wave has been damped or partly absorbed. Doing so heat is created, he says, although the wave equation by no means contains a corresponding term for the necessary thermodynamic description. He simply hasn't understood the wave equation!
Absorption means nothing but transverse waves in the case of a disturbance rolling up to vortices, to become a scalar wave in this way (fig. 1.4 and 5.3). With that they are evading every field strength measurement and what can't be measured doesn't exist in one-eyed physics! Therefore can't exist, what shouldn't exist.

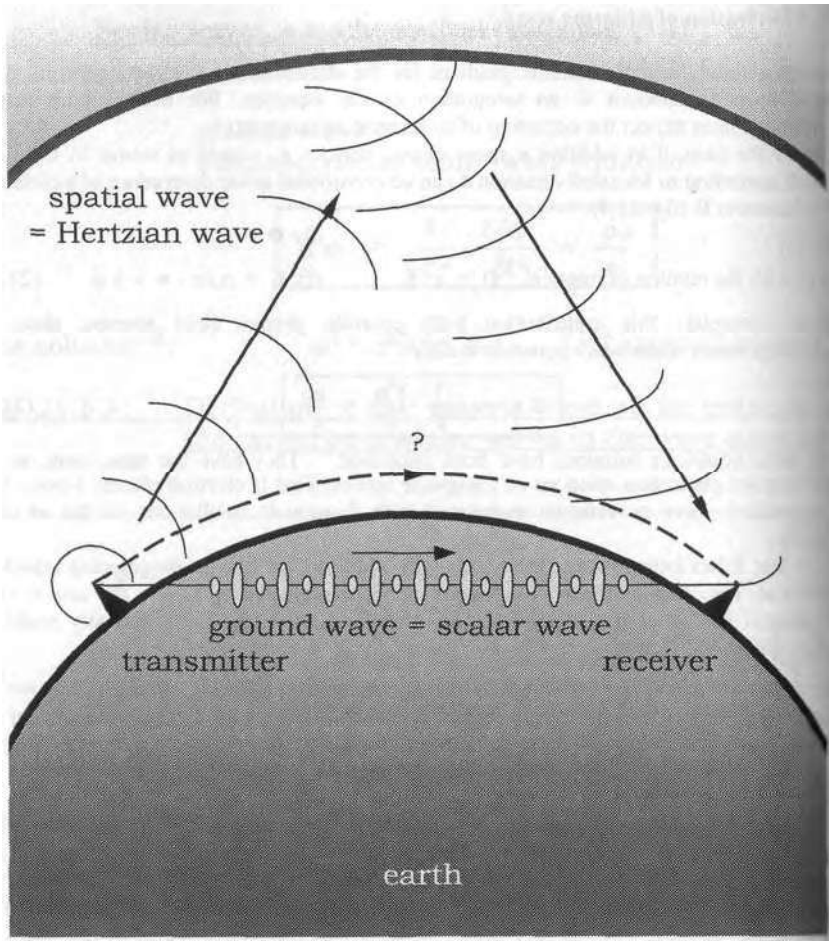

Fig. 21.6: Ground waves, which follow the curvature of the earth and radio waves reflected at the ionosphere.<i>

<i>: Meinke, Gundlach: Hochfrequenztechnik, 4.Aufl. Springer-Verlag Berlin 1986, Seite R 18: „Lang-, Mittel- and Kurzwelle breiten sich einerseits entlang der Erdoberflache als Bodenwellen, andererseits unter Mitwirkung der Ionosphare als Raumwellen aus."

21.6 Mistakes of the HF technology

The devastating judgement of Tesla, Hertz was mistaken, was rash. His claim of having detected the Maxwell wave himself, proved to be untenable. With this claim in particular Tesla hud the scientific world against him. If one opens encyclopedias or textbooks then one gets the impression, until the day of today science still hasn't forgiven Tesla, what once more shows how persistent prejudices are kept.

Just as little does a verdict of the American Supreme Court justice to the true circumstances, with the decision of the highest judges that Tesla and not Marconi is entitled the right to be the inventor of the radio. As we see, have both inventors in reality used completely other kinds of waves. The available transmitters of 100 years ago we would from today's viewpoint call „broadband dirt slingers". These spark flying monster have blown both parts of the wave equation, the transverse as well as the longitudinal part, into the air to ample extent. What distinguished the wave pioneers was their receiver technique, was eventually the question, which wave part they have filtered and utilized.

Marconi worked with dipole antennas, as already Heinrich Hertz. With that both could preferably track down and detect the radio wave. So they also should be entitled the right to be pioneers of radio technology. The verdict of the highest judges doesn't justice to this circumstance and should rather be judged as a nationalistically coloured political issue. Tesla however worked with two spherical electrodes, in which he preferably replaced one electrode by the globe, by grounding his devices. In this way he could receive the scalar wave parts. But that are not radio waves! Scalar waves have completely other properties, one even could be inclined to call them opposite properties.

To improve the degree of effectiveness of the transmission stretch one naturally was trying to also optimise the transmitting installation with regard to the respectively used wave part. Tesla optimised the scalar wave part and could record reactions of biological beings. His part represents a set of difficulties of the environmental compatibility, which should be taken serious. In the beginning the Marconists on the ships, as the radio operators were called, suffered from the so-called radio operator disease, which is unsolved until today. This phenomenon only disappeared after the radio devices on board had been optimised in favour of the used radio wave. The reached and measuring technically verifiable increase of the degree of effectiveness, primarily obtained by an improved antenna adjustment, simultaneously means a reduction of the scalar wave part, which endangers health.

But a received signal hides the receiver technician, if it has been on the way as a transverse or as a longitudinal wave. The coupling in one and the same equation leaves open both possibilities. Every radio amateur knows the so-called ground waves, which arrive faster at the receiver, than the Hertzian waves mirrored at the ionosphere, which propagate in a straight line. Allegedly the ground waves follow the curvature of the earth[<1>], so it is written in expert books. This explanation hurts, since who can see along the curvature of the earth with a pair of field glasses. He would see the back of his head! No, the explanation the ground waves would run along the earth's surface is pure nonsense. The interference and the fading with which the radio amateur is fighting, are a result of the differently fast arriving wave parts, and doing so the scalar wave part tunnels as a straight line right through the earth (fig. 21.6)!

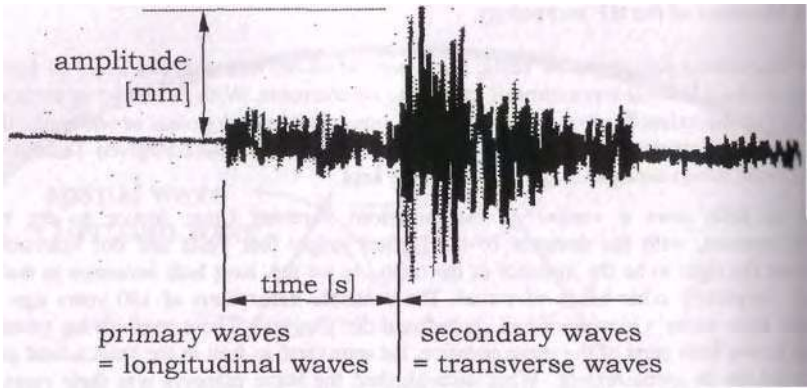

Fig. 21.7 A: Longitudinal and transverse earth quake waves.

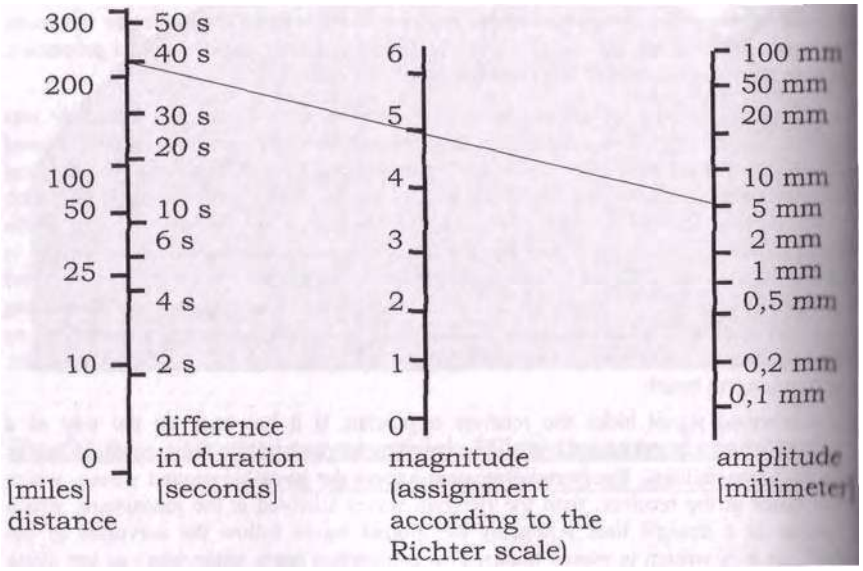

Fig. 21.7 B: Analysis according to the Richter scale.
(e.g.: 40 s duration between S- and P-waves for 5 mm amplitude means an earthquake of strength 5 in a distance of 220 miles.)

21.7 Coupling of the wave parts

The set of difficulties of ground waves makes clear the coupling of longitudinal and transverse waves as two aspects or parts of a wave. As the corresponding equation 21,1 mathematically taken apart into 21.2 dictates, does every transmitter emit both parts.

Exactly this circumstance the owners of allotments have used, which directly near a transmitter had illuminated their estate with freely hung up fluorescent lamps. The transmitter runners after that wanted to present them the power bill.and they could obtain, that this kind of illumination technique was prohibited.
Nowadays anyone may operate a high-frequency technical installation, even if he hasn't understood at all the wave equation used by that. Actually one should have been grateful to the allotment owners, if they withdraw the scalar wave radiation, which is incompatible with the environment and biologically harmful, with their fluorescent lamps. Taken exact it even is the task of the transmitting technician to pay attention to it. that only radio waves are sent into the air, since only those should be used. The time has come to reverse the burden of proof to protect the environment, nature, the consumer and the unasked and not involved persons, which are irradiated.

From other areas, for instance from flow dynamics or for body sound is generally known that both wave parts exist and in addition occur jointly. In the case of a propagation through the earth, like for an earthquake, both parts are received and utilized. Because their propagation is differently fast, the faster oscillations arrive first and that are the longitudinal ones. From the time delay with which the transverse waves arrive at the measurement station, the distance to the epicentre of the quake is determined by means of the different velocity of propagation. For geophysicists this tool is part of everyday knowledge (fig. 21.7).

Only who keeps one eye shut, could mean that the electromagnetic wave is purely transverse and sound purely longitudinal. It is true that a transverse sound wave doesn't get too far in air, for which reason sound as a rule is considered as a purely longitudinal wave by neglecting this part, but such a neglect may not be carried out in general, it must be checked if it is legitimate from case to case and an error consideration should be carried out.

Further examples for the coupling of the wave parts are furnished by the latest tunnel experiments. Here so-called pure transverse waves are sent into a tunnel, through which they don't fit through at all. The Maxwell-theory then dictates that behind the tunnel no signal should be measurable.
But a signal is being measured, which in the tunnel in addition was faster than allowed.

In conferences again is being discussed about the wave equation. The imagination of the specialists reaches from phase velocities of an electromagnetic wave, which isn't present at all up to instantaneous tunnelling, during which the clocks should stop[<i>].
The wave equation however supplies the only possible answer: The tunnel filters out the scalar wave parts and lets pass from them only those, which are sufficiently small and correspondingly fast!

<i>: see Part 1, Chapter 6.14

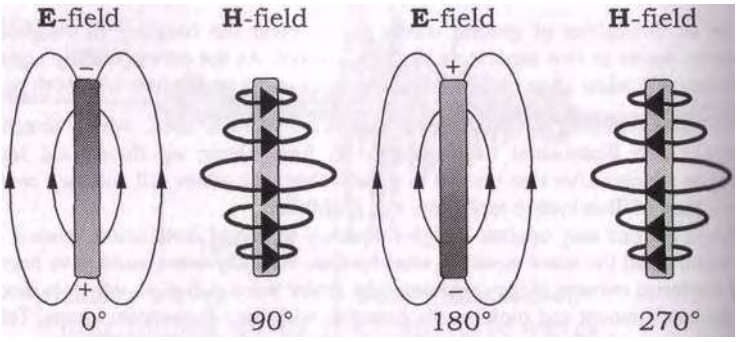

Fig. 21.8 A: The fields of the oscillating dipole antenna

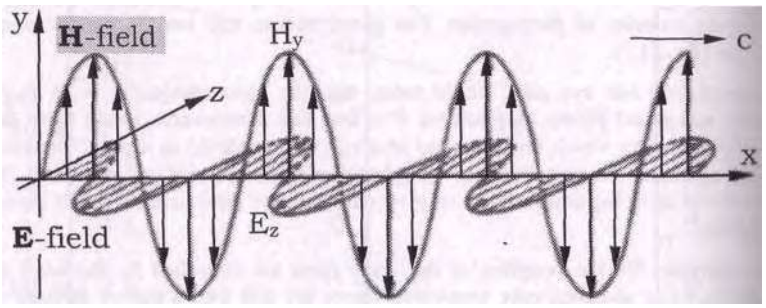

Fig. 21.8 B: The planar electromagnetic wave in the proximity

<i>: Zinke, Brunswig: Lehrbuch der Hochfrequenztechnik, 1. Bd., 3. Aufl. Springer-Verlag Berlin 1986, Seite 335

<ii>: dpa-message in the Sudkurier of 25.11.2000: „Gefahr furs Herz" (Translated:) Patients with a cardiac pacemaker produced in the Netherlands have been warned by the producer of the device (Vitatron) to be careful when passing anti-theft installations in stores. For devices, which were implanted between 1992 and 1998, there is the danger of the implant failing.

21.8 Set of difficulties of the near-field

In high-frequency technology is distinguished between the near-field and the far-field. Both have fundamentally other properties.

Heinrich Hertz did experiment in the short wave range at wavelengths of some meters. From today's viewpoint his work would rather be assigned the far-field. As a professor in Karlsruhe he had shown that his, the electromagnetic, wave propagates like a light wave and can be refracted and reflected in the same way. It is a transverse wave for which the field pointers of the electric and the magnetic field oscillate perpendicular to each other and both again perpendicular to the direction of propagation. It hence would be obvious, if in the case of the Hertzian wave it would concern the far-field. Besides the propagation with the speed of light also is characteristic that there occurs no phase shift between E-field and H-field.

In the proximity it looks completely different. The proximity concerns distances to the transmitter of less than the wavelength divided by 2*pi. Nikola Tesla has broadcasted in the range of long waves, around 100 Kilohertz, in which case the wavelength already is several metres. For the experiments concerning the resonance of the earth he has operated his transmitter in Colorado Springs at frequencies down to 6 Hertz. Doing so the whole earth moves into the proximity of his transmitter. We probably have to proceed from assumption that the Tesla radiation primarily concerns the proximity, which also is called the radiant range of the transmitting antenna.
For the approach of vortical and closed-loop field structures derivations for the near-field are known[<i>]. Doing so it must be emphasized that the structures don't follow from the field equations according to Maxwell, but the calculations are based on assumed rotation symmetrical structures. The Maxwell theory by no means is capable of such a structure shaping by principle. The calculation provides as an important result[<i>] that in the proximity of the emitting antenna a phase shift exists between the pointers of the E- and the H-field. The antenna current and the H-field coupled with it lag the E-field of the oscillating dipole charges for 90° (fig. 21.8). These charges form a longitudinal standing wave the antenna rod or antenna dipole. For this reason also the fields produced by high-frequency currents at first have the properties of a longitudinal wave in the proximity of the antenna.

The near-field already is used in practice in anti-theft devices, as they are installed in the entrance area of stores. The customer walks through the scalar wave transmitters. If the coupling coil has not been removed at the cash point, then a signal from the alarm system sounds. The coils work purely passive, i.e. they are supplied with electric energy per scalar wave and stimulated 'to oscillate for their part. Then the effect back on the transmitter is being utilized. Even if the principle is functioning, people still should be warned not to use a technology, which has not been understood completely. Then not explained catastrophes are inevitable [<ii>].

<i>: Zinke, Brunswig: Lehrbuch der Hochfrequenztechnik, 1. Bd., 3.Aufl. Springer-Verlag Berlin 1986, Seite 335

<ii>: dpa-message in the Sudkurier of 25.11.2000: ,,Gefahr furs Herz". (quoted at the left, fig. 21.8)

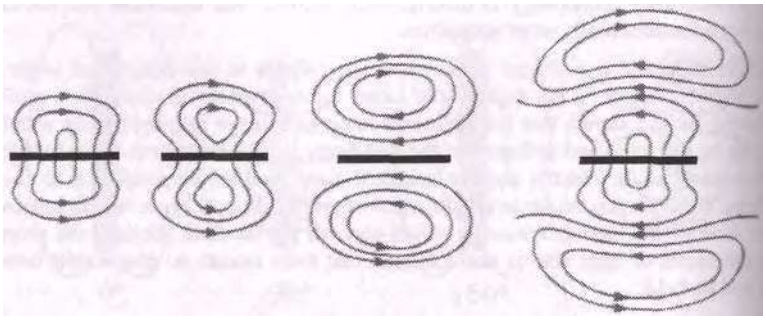

Fig. 21.9 A: The coming off of the electric field lines from a dipole
The forming vortex structures found a longitudinal electric wave carrying impulse!

electromagnetic wave (transverse)

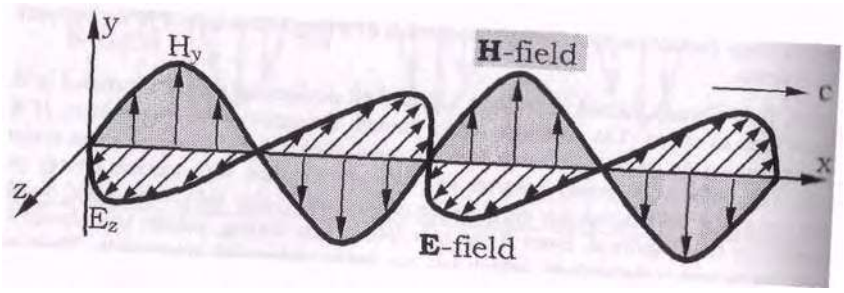

Fig. 21.9 B: The planar electromagnetic wave in the far zone

21.9 Transition to the far-field

In sufficient distance to the transmitting antenna as far-field the transverse electromagnetic wave results (fig. 21.9 B). It is distinguished by not occurring a phase shift between E- and H-field anymore. Every change of the electric alternating field is followed immediately and at the same time by a change of the magnetic alternating field and vice versa.
In the proximity however the phase shift amounts to 90°. Somewhere and somehow between the causing antenna current and the far-field a conversion from a longitudinal into a transverse wave occurs. How should one imagine the transition?

In the books the coming off of a wave from a dipole is represented according to fig. 21.9 A. The fields come off the antenna, the explanation reads. If we consider the structure of the fields coming off then we see field vortices, which run around a point, which we can call the vortex centre. Such field structures naturally are capable of forming standing waves and to carry an impulse. The scalar wave field in general and the near-field in special we only will understand with suitable vortex physics and with a field theory extended for corresponding vortices we also will be able to calculate it. Postulates cannot replace field physics!

Be that as it may, the vortex, after having left the antenna, for bigger getting distance at some time seems to unroll to propagate further as an electromagnetic wave. There takes place a transition from longitudinal to transverse, or spoken figuratively, from vortex to wave. How complete this conversion takes place, how big the respective wave parts are afterwards, on the one hand depends on the structure and the dimensions of the antenna. Information is given by the measurable degree of effectiveness of the antenna.
The vortex structures on the other hand are the stabler, the smaller and faster they are. If they are as fast as the light or even faster, then they become stable elementary particles, for instance neutrinos. Slower vortex structures however are predominantly instable. They preferably unwind to waves. Vortex and wave prove to be two possible and under certain conditions even stable field configurations.

Let's emphasize: A Hertzian dipole doesn't emit Hertzian waves! An antenna as near-field without exception emits vortices, which only at the transition to the far-field unwind to electromagnetic waves. A Hertzian wave just as little can be received with a dipole antenna! At the receiver the conditions are reversed. Here the wave is rolling up to a vortex, which usually is called and conceived as a „standing wave". Only this field vortex causes an antenna current in the rod, which the receiver afterwards amplifies and utilizes. The mostly unknown or not understood near-field properties prove to be the key to the understanding of the wave equation and of the method of functioning of transmitting and receiving antenna. The question is asked, how one should imagine the rolling up of waves to vortices and vice versa the unrolling? How could an useful vortex mode) look like?

Circularly polarized wave (transverse)

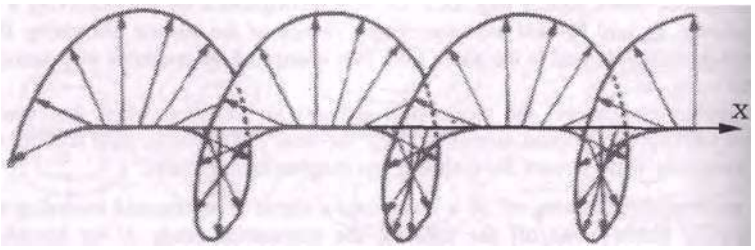

Fig. 21.10 A: Left-circular polarized wave
(as explanation for the transition to a vortex and to a scalar wave)

electric wave (longitudinal)

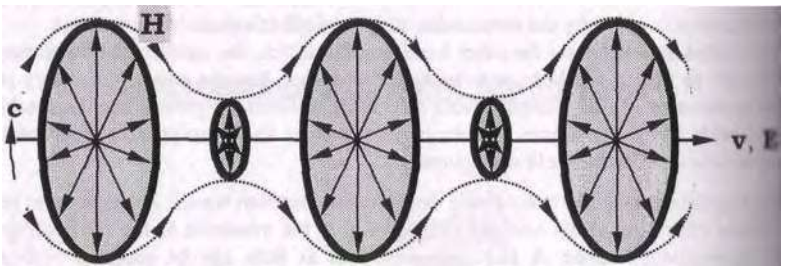

Fig. 21.10 B: Magnetic ring-vortices form an electric scalar wave.

vortex and wave = two stable field configurations
electromagnetic wave = transverse wave propagating in a straight line
ring-like vortex = transverse wave running in circles
vortex velocity = speed of light c
change of structure = if the field is disturbed without expense of energy

22.10 Scalar wave model

The light, as electromagnetic wave, in the presence of a heavy mass or of strong fields is bent towards the field source (fig. 6.10). The wave normally propagating in a straight line thus can be diverted. The square of the speed of light further is inversely proportional to the permeability and dielectricity, short, in presence of matter it is more or less strongly slowed down. If this slowing down of the wave occurs one-sidedly, then a bending of the path can be expected as well. At the end of the antenna a reflection and a going back of the wave can occur, which at the other end again hits itself. Now the wave has found a closed-loop structure, which can be called vortex. The figures 21.10 B and 21.11 A show the two possible structures.

In technical books this vortex with the properties of a „standing wave" is explained gistly. Near-field and standing wave are two examples, how the textbooks succeed in describing mathematically right a small part of the scalar wave properties, without having to have a good look at vortex physics. With such auxiliary descriptions however the end is reached fast, if for instance it concerns understanding a pure scalar wave transmission according to Nikola Tesla (fig. 19.11) and the special properties of this wave type. With the vortex concept of an extended field physics new horizons are opening.

If we direct our look again to the sketches (fig. 21.10 B and 21.11 A). In both cases electromagnetic waves are represented which propagate with the speed of light, only that the wave doesn't go forward in a straight line but instead runs around in circles. It also furthermore is transverse, because the field pointers of the E-field and the H-field oscillate perpendicular to c. By means of the orbit the speed of light c now has become the vortex velocity. Wave and vortex turn out to be two possible and stable field configurations. For the transition from one into the other no energy is used; it only is a question of structure. The vortex structure thus stabilizes itself by means of the field dependency of the speed of light.

By the circumstance that the vortex direction of the ring-like vortex is determined and the field pointers further are standing perpendicular to it, as well as perpendicular to each other, there result two theoretical formation forms for the scalar wave. In the first case (fig 21.10 B) the vector of the H-field points into the direction of the vortex centre and that of the E-field axially to the outside. The vortex however will propagate in this direction in space and appear as a scalar wave, so that the propagation of the wave takes place in the direction of the electric field. I call this an electric wave. In the second case the field vectors exchange their place. The direction of propagation this time coincides with the oscillating magnetic field pointer (fig. 21.11 A), for which reason I speak of a magnetic wave.

The vortex picture of the rolled up wave already fits very well, because the propagation of a wave direction of its field pointer characterizes a longitudinal wave, because all measurement results are perfectly covered by the vortex model. It even is clear that no energy has to be spended for the conversion, since merely the structure has changed. If it becomes a vortex the wave just doesn't run in a straight line anymore but in circles, to either wrap around the magnetic field vector (fig. 21.10 B). or the electric field vector (fig. 21.11 A).

magnetic wave (longitudinal)

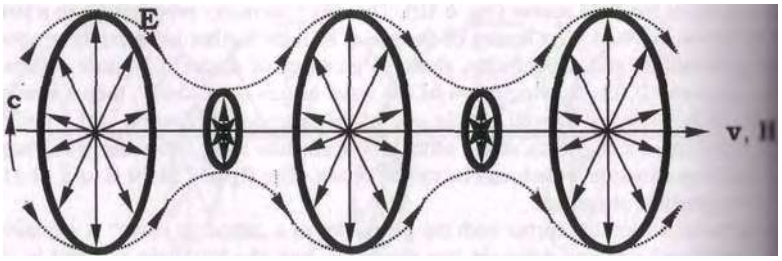

Fig. 21.11 A: The magnetic scalar wave

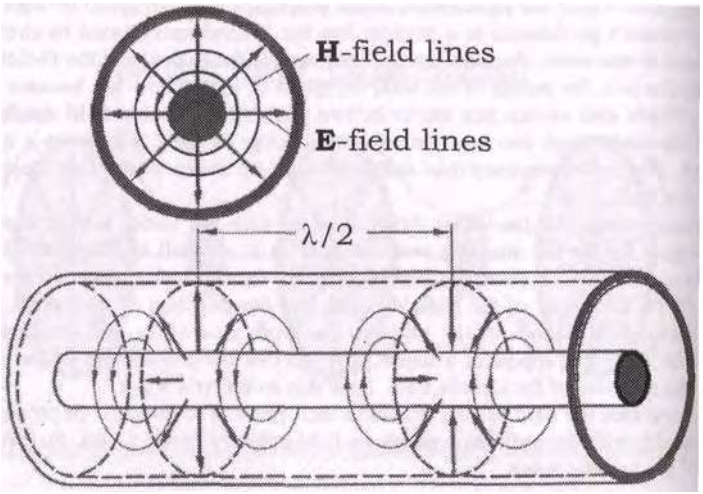

Figure 21.11 B: Wave propagation in a coaxial cable,
(Example for waveguide, horn radiator, etc.)<i>
Cross-section of coaxial conductor and field distribution in the direction of propagation.

<i>: H. Armbruster, G. Grunberger: Elektromagnetische Wellen im Hochfrequenz-

21.11 Double-frequent oscillation of size

Because a longitudinal wave propagates in the direction of the field, the field pointer also will oscillate with the velocity of propagation v. This hence isn't constant at all, it can significantly differ from that of the light and can take arbitrary values. According to the theory of objectivity the field oscillating with it determines its momentary size:

$$E, H \sim 1/v^2 \qquad (21.10).$$

The velocity of propagation v of the scalar wave thus oscillates double-frequently and with opposite phase to the corresponding field. A detailed description would mean, if the field strives for its maximum value, the velocity v of the wave reaches its smallest value. In the field minimum the scalar wave vice versa accelerates to its maximum value. For longitudinal waves therefore only an averaged velocity of propagation is given and measured, as this for instance is usual for the sound wave, and this can vary very strong as is well-known (body sound compared to air sound, etc.).
The two dual field vectors of E and H, the one in the direction of propagation and the one standing perpendicular to it, occur jointly. Both oscillate with the same frequency and both form the ring-like vortex in the respective direction. As a result the ring-like vortex also oscillates in its diameter double-frequently and with opposite phase to the corresponding field (fig. 21.10 Band 21.11 A).
This circumstance owes the ring-like vortex its property, to tunnel. No Faraday cage is able to stop it, as could be demonstrated in experiments[<i>]. Only therefore the ground wave runs through the earth and not along the curvature of the earth. A further example is the coaxial cable (fig. 21.11 B). Also this acts as a long tunnel and so it isn't further astonishing, that the electric field lines have the same orientation, as for a magnetic scalar wave. As a practical consequence in this place there should be warned of open cable ends, wave guides or horn radiators with regard to uncontrolled emitted scalar waves!

At present in the press is being discussed, if the cable network runners for some channels the mission to operate again should be withdrawn, because the airline radio traffic is being disturbed. The original opening for cable frequencies, which actually are reserved for the airline radio traffic, based on the erroneous assumption, that conflicts are unthinkable. But then the planes were disturbed in their communication. As the cause TV-cables made out, which hadn't been closed according to the rules with a resistor, as it by all means can occur on building sites and during renovation works. On the other hand is being argued with the small current, which flows through the coaxial cable, and the large distance to the planes also is cited. According to that it actually can't concern Hertzian waves. It presumably are scalar waves, which escape from the open cable ends and which are collected by a receiver in the plane. It indeed is very little field energy, but because it again is being collected and bundled, the scalar wave is able to exceed the part of the radio wave by far just at large distances and to cause problems. For such examples from practice the scalar wave theory is fully taking effect.

<i>: Adolf und Inge Schneider im Interview mit Prof. Dr.-Ing. Konstantin Meyl: Durchbruch in der Freien-Energie-Forschung, NET-Journal 12/1999, S. 7-9.

1. H. Hertz: electromagnetic wave (transverse)

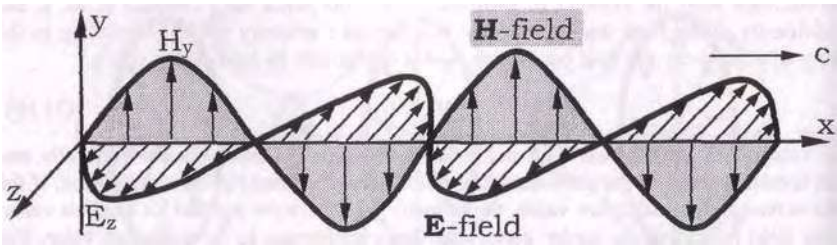

2. Nikola Tesla: electric wave (longitudinal)

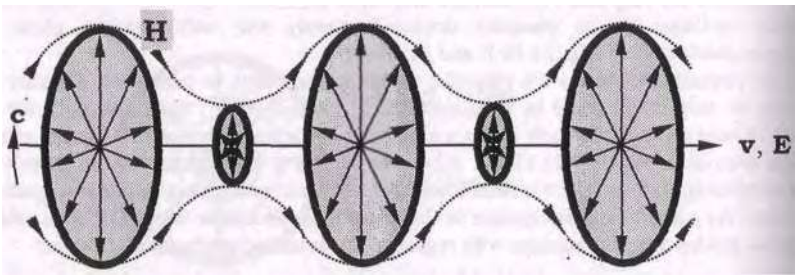

3. magnetic wave (longitudinal)

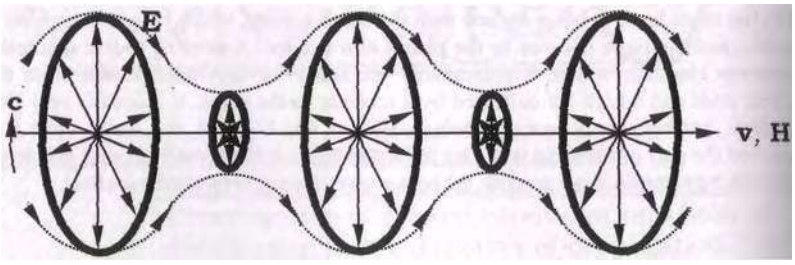

Fig. 21.12: The three basic types according to the wave equation
(21.1), (electric, magnetic and electromagnetic wave).

21.12 Electric and magnetic scalar wave

Let us record: For the wave propagation there thus are three possible and stable states (fig. 21.12): the transverse electromagnetic wave according to Heinrich Hertz (fig. 1), the longitudinal electric wave according to Nikola Tesla (fig. 2), and a longitudinal magnetic wave (fig. 3), which isn't connected yet with a name of a discoverer. The last one is a pure product of my theoretical derivation. The question is asked, which practical meaning the magnetic wave could have.
It is formed by individual electric field vortices, which I have discovered and called potential vortices 1990. I proceed from the assumption that the youngest of the three waves will play the by far biggest role in the future, because its properties are unattainable, both with regard to the energy technical and to the information technical use. One example for each should support this thesis.

The experiments concerning the electric wave according to Nikola Tesla, where is being worked with electrically charged spheres, don't show a particularly high power. Magnetic converters, so the experiences of my laboratory activities, are superior to an electrostatic converter as a collector for free energy by far. That even can be expected, because a magnetic engine is much smaller than an electrostatic engine of the same power as is well-known.

At a congress of medicines was given a talk on the basic regulation of the cells, on the communication of the cells with each other. Professor Heine in his decades of research work has found out that the cells for the purpose of communication build up channels for instance in the connective tissue, which after having conducted the information again collapse. Interestingly the channels have a hyperboloid structure, for which no conclusive explanation exists.
The structure of the data channels however is identical with the one of a magnetic scalar wave, as shown in fig. 3. Through a channel formed such, which functions like a tunnel or a dissimilarly formed waveguide, only one very particular scalar wave can run through. Waves with different frequencies or wavelengths don't fit through the hyperboloid formed tunnel at all in the first place. Through that the information transmission obtains an extremely high degree of safety for interference.
To the biologist here a completely new view at the function of a cell and the basic regulation of the whole organism is opening. The information tunnel temporarily forms more or less a vacuum, through which only potential vortices can be conducted, and that without any losses - simply perfect! From this example is becoming clear that nature is working with scalar waves namely with magnetic waves.

One other point should be recorded: The mentioned tunnel experiments, in which speed faster than light is being measured with most different devices, impressively confirm the presence of scalar waves. But if scalar waves exist which are faster than light and other ones, which are slower, then it almost is obvious that also such ones will exist, which propagate exactly with the speed of light. These then will have all the properties of the light and won't differ from the corresponding electromagnetic wave in the observable result. As scalar wave it however is formed by vortex configurations, which unambiguously have particle nature. Nothing would be more obvious than to equate these quantum structures with the photons.

Question: Is the light wave or particle?

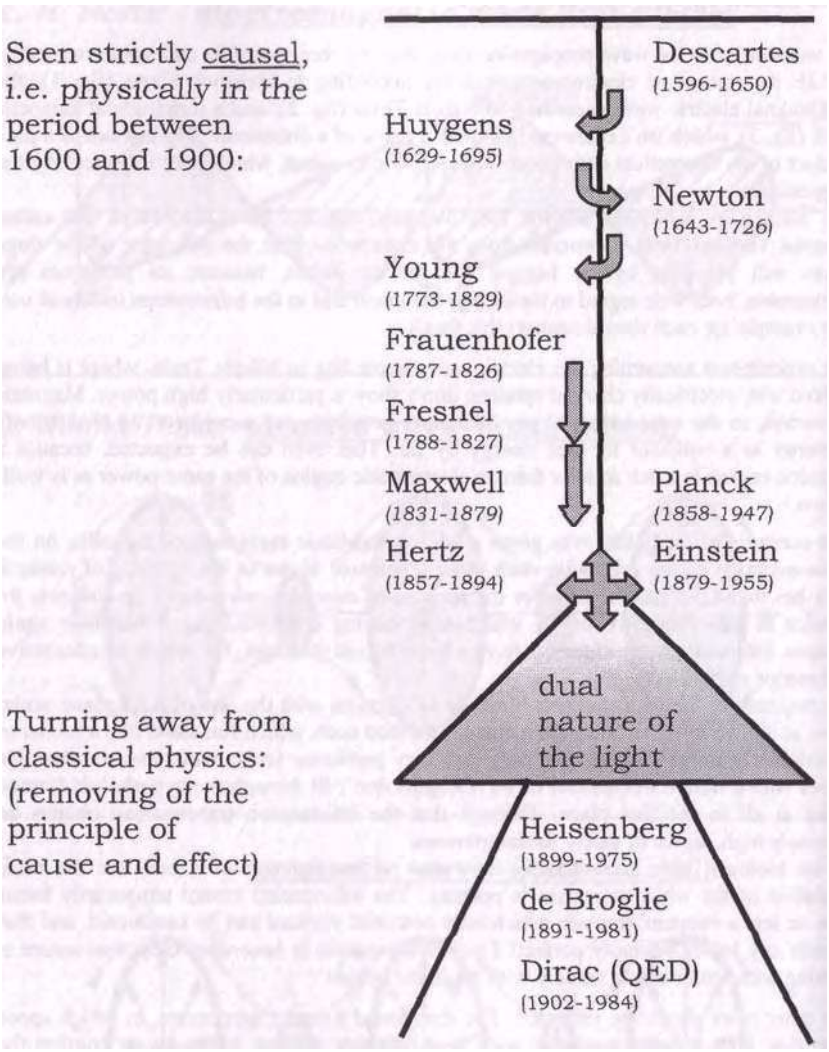

Fig. 22.1: The view of some physicists concerning the nature of the light as wave or as particle.

According to the wave equation the light is a mixture of wave and photon radiation!

22 Properties of scalar waves

For the light quanta hypothesis the Nobel Prize for physics was awarded 1921. But it only was a hypothesis, an idee fixe, which was honoured here. It is quite odd, if such an important prize is awarded to a research scientist, who hasn't got the slightest idea what light quanta are anyway, of what they consist and how they are built up. Albert Einstein cleverly used the embarrassing situation, by in his celebration speech on the occasion of the awarding of the Nobel Prize giving a talk on the theory of relativity. After the speech a member of the committee found it necessary, to point to it, that this wasn't object of the awarding of the prize and that the theory of relativity concerns a pure theory, which can't be proven by principle. A theory hence neither could be awarded the Nobel Prize.
Such words on the occasion of awarding a prize for a daredevil hypothesis give the whole event really grotesque characteristics. But it came still worse.

22.1 Wave-particle compromise

Physicists of name and rank had come together. It concerned the question if the light is wave, or particle or even both at the same time? For both variants experimental proof was present, the discussion became inflamed and the things boiled over. Finally they were as smart as before, as Werner Heisenberg presented his ideas concerning the uncertainty principle. This compromise, on which one eventually came to an agreement, with good cause may be called the worst in the history of physics. It dictates me, what I shell see and how exact I may look. With it the contradiction should be overcome that the light contrary to every causality should be wave and particle at the same time.

Such fixings not only have a funny, but also a tragic side. Since it were authorities, which have approved the compromise and the whole community of science has confidence in the statements of its authorities, which immediately and unfiltered is entered in all textbooks. At the meeting it simply and solely concerned the wave equation and only that could have supplied the correct and only possible answer: It falls apart into two parts and this explains, why the light one time appears as an electromagnetic wave and the next time as a vortex particle, which is called photon. The conversion can take place at any time spontaneously and without putting on energy, so that depending on the used measuring technique the particle appears as wave or as particle, but of course never as both at the same time!

Looking back one can say that the funny thing about the situation was that all discussed about the wave and its properties known at that time, that all should know the wave equation. An equation as is well-known says more than a thousand words and one look would have sufficed entirely, to answer the controversial question once and for all. It would have saved us a lot.

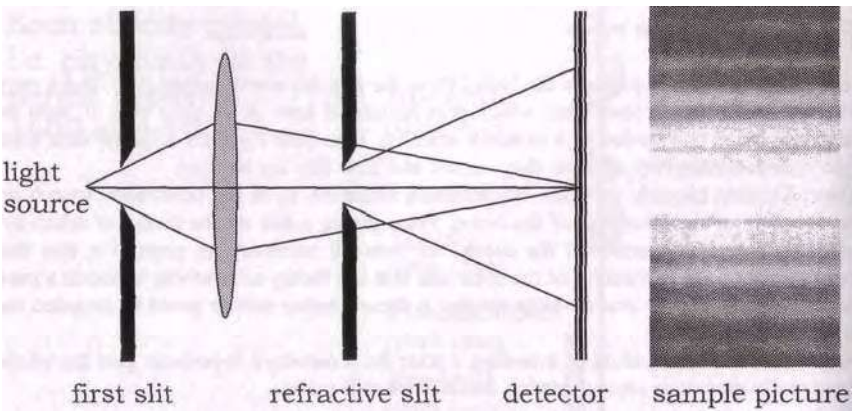

Fig. 22.2 A: Light forms interference patterns at the slit (light stripes are formed, where the waves oscillate in phase, dark stripes, where they oscillate out of phase).

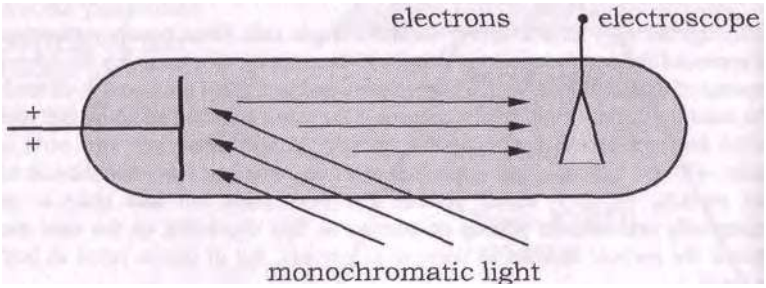

Fig. 22.2 B: The photo-electric effect

<i>: Atome als Energiewellen. Physiker wandelten einen Strom von Natrium atomen in Wellen um. III. Wissenschaft 7/1996, Seite 56 + 57

22.2 Concerning the measurement of light

The uncertainty principle with the interpretation of Heisenberg, the light is wave and particle at the same time, is incompatible with the wave equation. Heisenberg puts an equal sign, where in the wave equation in reality is present an addition of both wave parts. Fortunately in mathematics there is no need of speculating, there a derivation is right or wrong. Nothing is changed to that even if all physicists of the world should go in the wrong direction following the prevailing opinion. The wave equation exert an influence on the interpretation of the light experiments, on the one hand the ones concerning the interference and refraction of the light, where electromagnetic waves are becoming visible (fig. 22.2 A) and on the other hand the photo-electric effect, as proof of light quanta (fig. 22.2 B).

Already the wave theory of Huygens requires interference patterns of light rays, as they for instance are observed behind a slit, and demonstrates with that the wave nature. If on that occasion the particle nature is lost, if thus the photons present before the slit can't be detected behind the slit anymore, then plain and simple the measuring method, thus the slit is to blame for that. The vortices have unrolled themselves at the slit to waves. Corresponding experiments also have been carried out with matter. At the Massachusetts Institute of Technology whole sodium atoms were converted into waves. At the detector pure interference patterns were observed, which go as evidence for the successful dematerialization[◁▷]. But the vortex physicist they show still more: they reveal, that atoms merely are waves rolled up to spherical vortices, which at any time and spontaneously can again unroll to waves at a lattice (chapter 5 and 7).
The common interpretation, the wave nature detectable behind a slit must have been present in the same form already before the slit, is untenable and in the end wrong, as makes clear the experiment with the sodium atoms.

The photo-electric effect, which on the other hand shows the quantum nature of the light, has been discovered by Heinrich Hertz, further investigated by Lenard and finally rendered more precisely by Millikan 1916 (fig. 22.2 B). It bases on the circumstance that light of higher frequency, thus blue light, has more energy than red light of lower frequency. But if electrons are knocked out a metal plate by light, then that occurs, by the waves rolling up to vortices. Now indeed photons are at work, which are detected with an electroscope indirectly.
In the same way a photon ray in a bubble chamber can be photographed. But also here the measuring method is responsible for what is being observed.

A good example is the human eye, the rods and cones of which merely can pick up potential vortices and pass them on to the nerves as so-called reaction potentials. Incident waves can only be detected, if they first have rolled up to vortices in the corpus vitreum of the eye. For us seeing, it doesn't play a role of how many percent vortices and waves the light is consisting.
Behind a sheet of glass for instance a larger vortex part can be expected and still the light has the same brightness as without sheet; the sheet of glass is perceived as transparent. We nevertheless must assume that light with a large wave part has another quality, than such light behind glass or artificial light with a large part of photons.

wave equation:

$$\Delta \mathbf{E} = \text{grad div } \mathbf{E} - \text{rot rot } \mathbf{E} = \frac{1}{c^2} \cdot \frac{\delta^2 \mathbf{E}}{\delta t^2}$$

Nikola Tesla:	*Heinrich Hertz:*
• **scalar wave** (electric or magnetic) =	**electromagnetic wave =**
• **longitudinal wave**	**transverse wave**
form (each time for velocity of propagation v):	form (each time for frequency):
• (v > c): neutrino radiation, morphogenetic fields,...	• cosmic radiation • X-rays, • UV radiation,
• (v = c): photons,	• light,
• (v < c): plasma wave, thermal vortices, biophotons, earth radiation,...	• infra-red radiation, • microwaves, • radio waves,
• (v = 0): noise,...	• VLF, ULF,...

Fig. 22.3:____ The two parts of the wave equation

22.3 Comparison of the parts of Tesla and Hertz

Light as a rule always is formed as photon radiation, even on the sun. If in the end only waves arrive on earth, then the vortices sometime on the way to us must have unrolled to waves. Photon radiation after all is a scalar wave radiation, which generally is predominant in the near-field of the source of radiation. There is no reason, why the light should act in another way than the wave radiated by a radio transmitter, which as well forms vortices in the near-field area, as we already have discussed. For different interpretations of wave properties of one and the same physical phenomenon there is no place in a unified theory.

If we stay at the comparison then it is not an individual case that an experimental setup is responsible for what is being measured and observed. A parallel case to the experiments concerning the nature of the light is the one concerning the wave propagation. Hertz has received and utilized the transverse part and Tesla the longitudinal part and either one claimed, only he is right. There doesn' t exist an other equation, which has been and is being ignored and misunderstood so thoroughly, as the wave equation.

Fig. 22.3 shows in a survey the two parts of the wave equation in the assignment to the terms and forms: Right hand side the electromagnetic wave according to Heinrich Hertz and left hand side the scalar wave according to Nikola Tesla. The terms, like on the one hand transverse wave and on the other hand longitudinal wave relate to the kind of wave propagation.

If the field pointers oscillate crossways to the direction of propagation, then as a consequence the velocity of propagation is decoupled from the oscillating fields. The result in all cases is the speed of light, and that in our observation is constant. It is usual to make a list for increasing frequency, starting at the longest waves (ELF and VLF) over the radio waves (LW, MW, SW, UHF), the TV channels (VHF, UHF), the microwaves, the infra-red radiation, the light, the X-rays up to the cosmic radiation.
It really is interesting that it concerns one and the same phenomenon despite the different forms! As long as Maxwell only had published a theory for the light, in the world of science 24 years long at first nothing at all happened. Only Heinrich Hertz with his short wave experiments opened the eyes. Now all suddenly started at the same time to research into various phenomena on the frequency scale, from Madame Curie over Konrad Rontgen up to Nikola Tesla, who primarily researched the area of long waves.

With regard to the scalar waves until now a corresponding booster detonation has failed to appear. The immense area is new ground scientifically, which is awaiting to be explored systematically. I try to make a contribution with my historic rebuild of a scalar wave transmission line according to the plans of Tesla<i>.

<i>: Im Gesprach mit dem Fernsehmoderator und Buchautor Johannes von Buttlar weise ich auf die Chancen und technischen Moglichkeiten hin: Johannes von Buttlar im Gesprach mit Prof. Dr. Konstantin Meyl: Neutrinopower, Argo-Verlag Marktoberdorf, 1. Aufl. (2000).

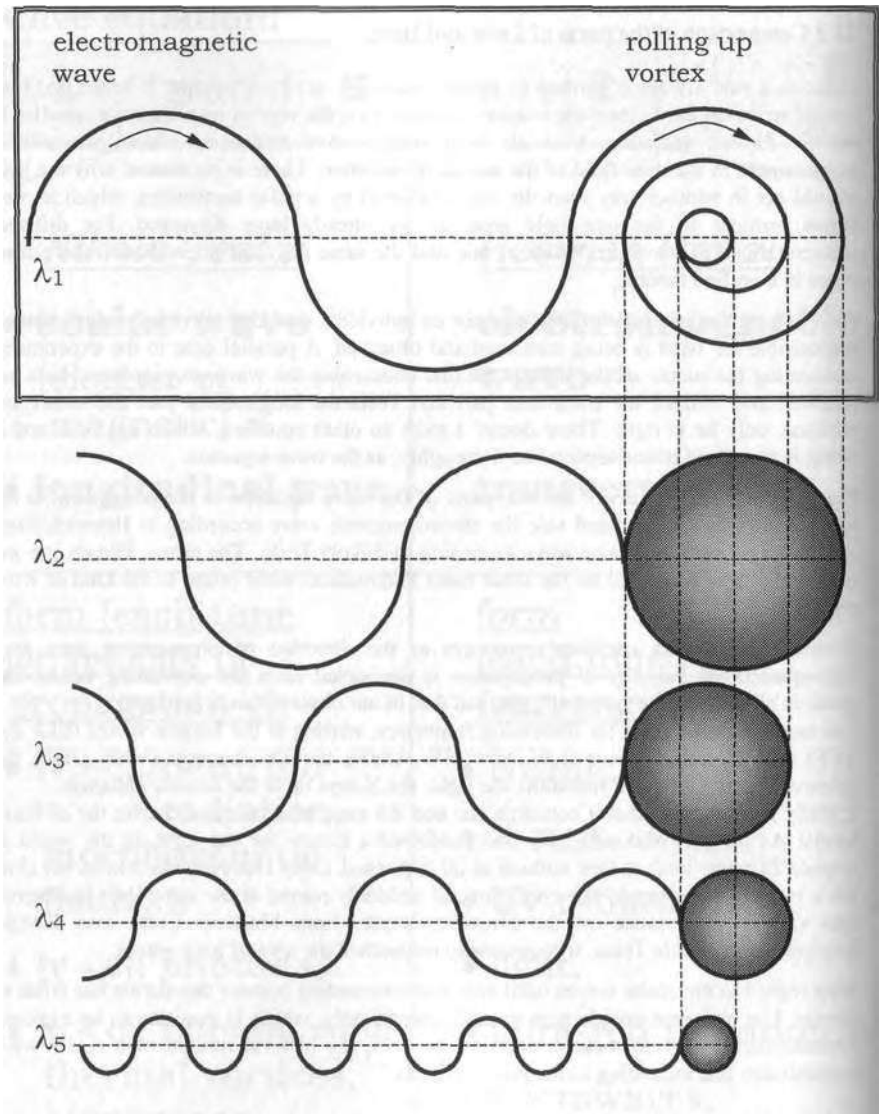

Fig. 22.4: The wave rolling up to a vortex.

wavelength of the wave: $\lambda_1 = c/f_1$

wavelength of the vortex: λ_n (n = 1,2,3,4,5) $\leq \lambda_1$

$f_5 > f_4 > f_3 > f_2 > f_1$ $\lambda_5 < \lambda_4 < \lambda_3 < \lambda_2 < \lambda_1$

22.4 Noise, a scalar wave phenomenon

Longitudinal waves can take arbitrary velocities between zero and infinity, because they propagate in the direction of an oscillating field pointer and as a consequence of that their velocity of propagation oscillates as well and by no means is constant. It does make sense to llist the forms of scalar waves according to their respective velocity of propagation (fig. 22.3, left column).
If we start with a localized vortex, a wave rolling up, which further is contracting. Doing so the wavelength gets smaller and smaller, whereas the frequency increases. An evenly frequency mixture distributed over a broad frequency band is observed. This phenomenon is called noise (fig. 1.4). But besides the localized noise, noise vortices can also be on the way with a certain velocity as a scalar wave, e.g. for the radio noise. In this case they show the typical properties of a standing wave with nodes and antinodes.

Also the earth radiation is said to have standing wave nature, which can be interpreted as slowed down neutrino radiation. If it is slowed down on the way through the earth, then the neutrino properties are changing, as this was measured in the Kamiokande detector in Japan recently. Unfortunately the proof occurs only indirect, because there still don't exist measuring devices for scalar waves. We'll talk about this problem area later and are content with the clue that already within living memory the standing wave property has been used to find water and deposits of ores and still is used today (fig. 22.4).

If we continue our considerations concerning the forms of scalar waves, as they are listed in fig. 22.3. The scalar waves, which are slower on the way than the light, are joined by the plasma waves. This is confirmed by measurements and calculations.
For thermal vortices, as they have been investigated by Max Planck and for biophotons, as they can be detected in living cells by colleague Popp, the velocity of propagation however is unknown. It was not and still is not measured at all, now more than ever. The research scientists have confidence in the assumption that all waves go with the speed of light, but that is a big mistake.
For all wave kinds there at least exists also one vortex variant, for radio waves for instance it is the radio noise, which propagates with a velocity different from c. The velocity is the product of frequency and wavelength:

$$\boxed{v = f \cdot \lambda} \quad (22.1)$$

From the three variables v, f and λ at least two must be measured, if one has a suspicion that it could concern scalar waves. At this place most errors are made in the laboratories. Countless experiments concerning the biological compatibility, concerning medical therapy methods and similar experiments must be repeated, because as a rule only the frequency is being measured and it has been omitted to at least check the wavelength or the velocity of the wave. Countless research scientists must put up with this accusation. Much too blind the scientists, who now again may start from the very beginning with their work, have had confidence in the predominance of the speed of light.

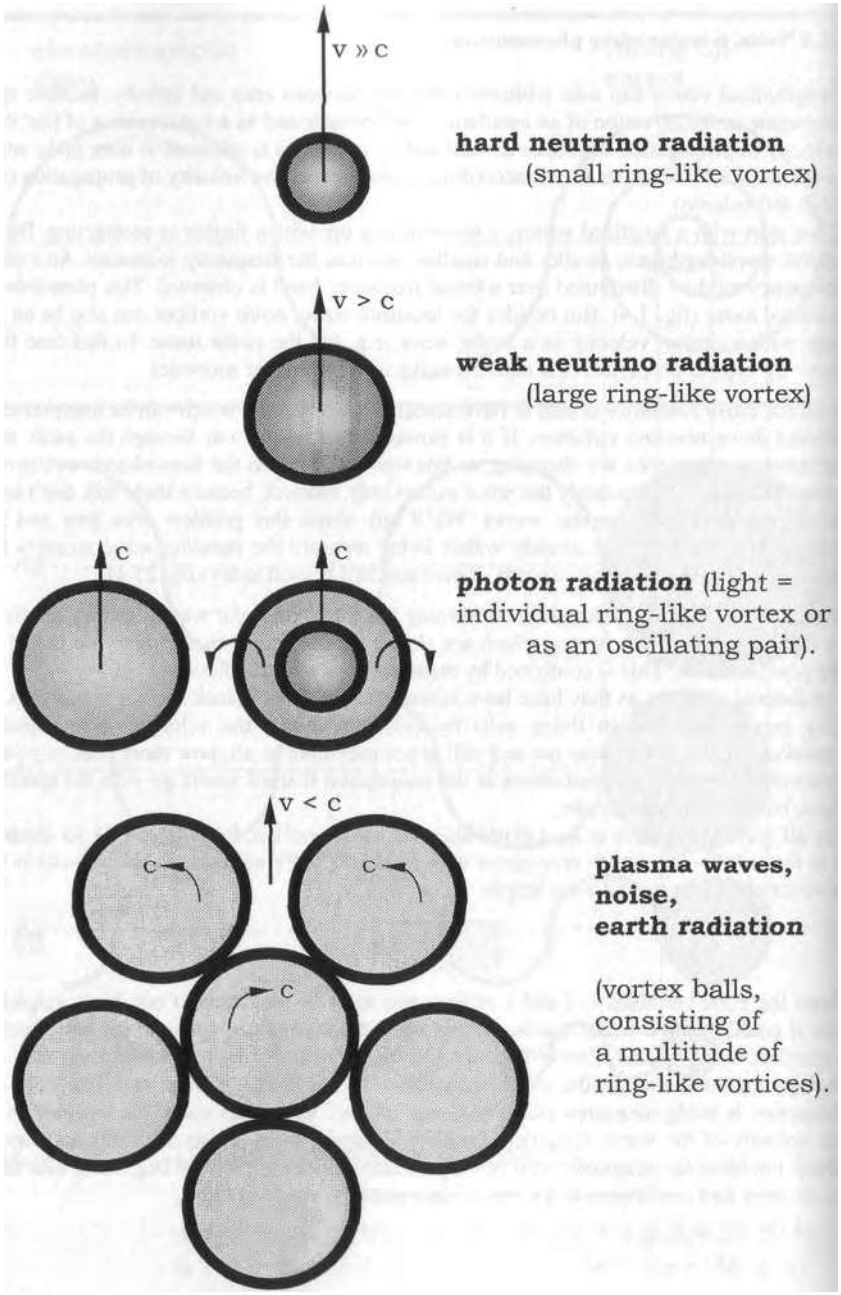

Fig. 22.5: ____ The ring-like vortex model of scalar waves.

22.5 Neutrino radiation

The neutrino physicists make the same error. They proceed from the assumption that their particles are on the way with a speed somewhat less than the speed of light c. This contradicts the observation according to which black holes should represent strong sources of neutrinos, which are black only for the reason that no particle radiation is able to escape them, which is on the way with c or even slower. If a black hole does hurl neutrino radiation into space, than that must be considerably faster than c, as normal neutrino physicists still by no means can imagine it today.
But the neutrino radiation only can be detected after it has been slowed down to a value, which is smaller than c. If the slowing down occurs slightly assymmetrical, then as a consequence a mean of the mass different from zero appears. The „measurement" of such a rest mass, as it at present is propagated and celebrated, is a classical measurement error! As long as a neutrino on the way to us still is faster than the light, the mean of its mass is generally zero. The effective value of the mass of a neutrino is however considerable. Only it is able to give account for the sought-for dark matter, as far as it must exist in the today supposed form anyway.

The Tesla radiation, that the discoverer Nikola Tesla already in own experiments had found out, is faster than light (chapter 9.7 and 17.2). Since this Tesla radiation according to the description is identical with the neutrino radiation, since it so to say forms a subset, I will call neutrino radiation all the scalar waves, which are faster than the light. This stretches from the weak radiation at low frequencies up to the hard neutrino radiation of cosmic origin. But the hardness of the radiation does not only increase with the frequency, it in particular increases with the velocity.

The neutrino radiation first of all is carrying energy. On top of this basic wave radiation in addition information can be modulated. Doing so extremely complex modulation variants are offering. Of this kind we must imagine thoughts, as being complex modulated vortices, which can propagate as scalar wave in space. Rupert Sheldrake calls this vortex field a morphogenetic field. At this place merely is pointed at his very interesting research results[<i>].
Thoughts can be standing in space, in the form of localized noise, but they also can move with speeds faster than light. According to that a communication with intelligent beings from other star systems by all means wouldn't be an Utopia anymore.

Every fast neutrino forms an individual ring-like vortex (fig. 7.12). The slower the scalar wave is, the more dependent the vortices become. The photon already can consist of two ring-like vortices (fig. 4.6), whereas plasma waves and other slow scalar waves can form from a multitude of individual vortices, which are rotating around each other, to form vortex balls and vortex streets (chapter 4.9 - 4.11). From this circumstance already results very different scalar wave behaviour in the different areas of the velocity of propagation. This trend for small velocities can as well be observed towards lower frequencies. For a certain wavelength the frequency after all (according to eq. 22.1) is proportional to the velocity of propagation.

<i>: R. Sheldrake: Seven experiments that could change the world. New York: Riverhead 1995

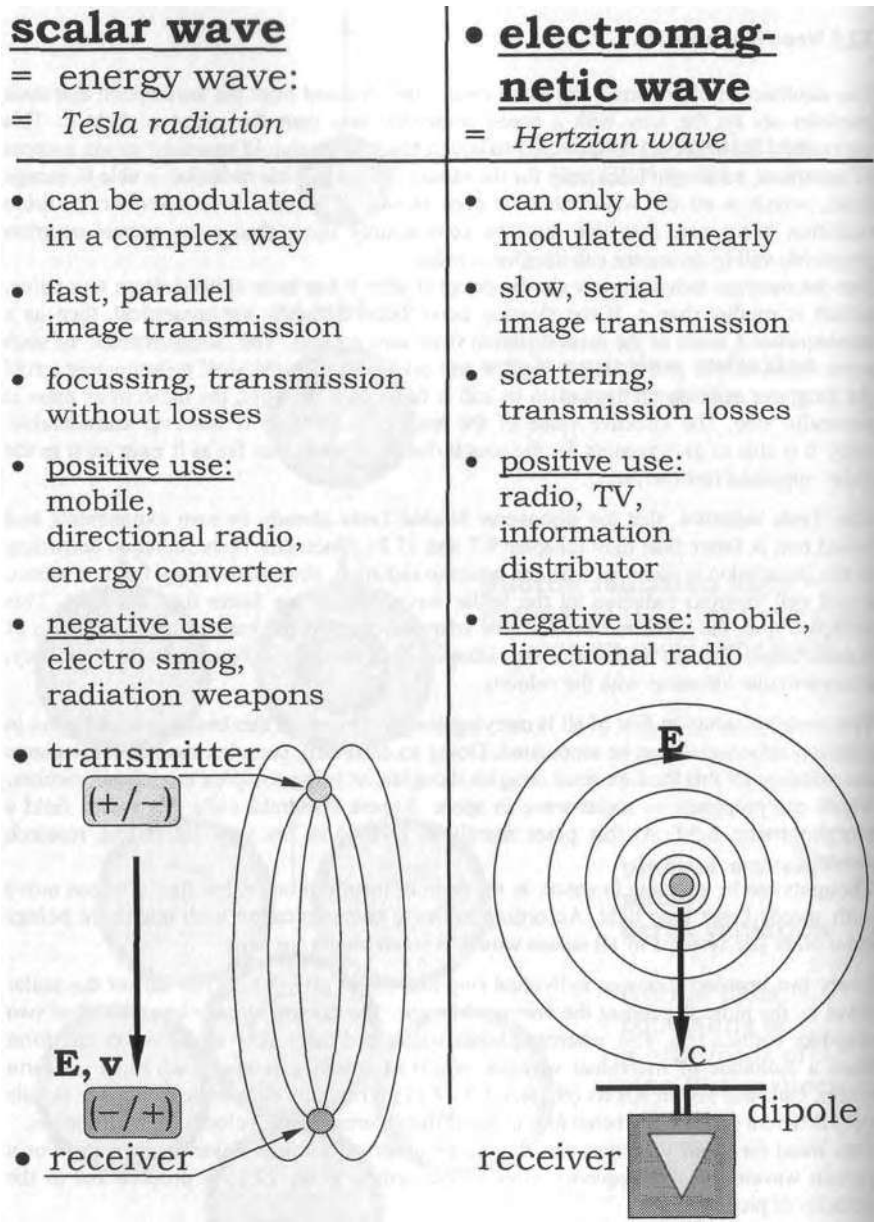

Fig. 22.6:_____ Scalar waves and radio waves, comparison of the properties.

22.6 Parallel instead of serial image transmission

We continue with our considerations concerning the special properties of scalar waves, represented in the left column, and compare these with the well-known behaviour of electromagnetic waves in the right column (fig. 22.3 is now followed by fig. 22.6). If we again take up the possibilities for modulation and the transmission of information, then it becomes very clear from the comparison that we today work with a technology, which we it is true master more or less, but which is everything else but optimum.
For the Hertzian wave the velocity of propagation is constant. With the frequency therefore at the same time also the wavelength is being modulated. But that strongly limits the information transmission. An image for instance must be transmitted serially point after point and line after line. The serial image transmission takes place very slowly, for which reason the velocity of the PCs permanently must be increased, so that the amount of data can be managed.
With the clock frequency on the other hand also the losses increase, so that in the end the CPU-cooler limits the efficiency of modern PCs. Something our engineers obviously do wrong, as a comparison with the human brain clarifies. Our brain works without a fan. For it a clock frequency of 10 Hertz is sufficient. It needs neither Megahertz nor Gigahertz Irequencies and despite that is considerably more efficient.

Nature only works with the best technology. The second best technology, as it is put to use in our machines, in the evolution wouldn't have had the slightest chance of surviving. The strategies to optimize of nature are merciless. In a free economy that goes completely different. There the „bunglers" are joining together to companies dominating the market, buying up the innovative ideas without further ado, to let them disappear in the drawer, so that they can bungle further in the way they did until now. It after all have been the lousy products, which have made them to the companies they are today. The ego of power is incompatible with the interests of nature.

Nature works with scalar waves and their velocity of propagation is arbitrary. Wavelength and frequency now can be modulated and information can be recorded separately. In this manner a whole dimension is gained to modulate, the image transmission can take place in parallel, which means considerably faster, safer and more reliable. As anyone of us knows by own experience, assembling the image takes place all at once, the memory of past images takes place ad hoc. Nature is indescribable more efficient than technology with the scalar wave technique.

If we again take the right-hand side of fig. 22.6 with the properties of the Hertzian wave. In the opinion of Nikola Tesla it is a gigantic waste of energy. The broadcasting power is scattered in all directions and the transmission losses are enormous. At the receiver virtually no power arrives anymore. To receive a radio signal the antenna power has to be amplified immensely. It is a wave, which actually only can be used as radio wave, thus as a wave with which arbitrary many participants should be reached.
This wave however is completely useless, if it concerns a point-to-point connection. If I want to call someone, to talk only with him, a radio wave is the entirely wrong method, because I with that bother hunderds and thousands of people that I don't want to call at all!

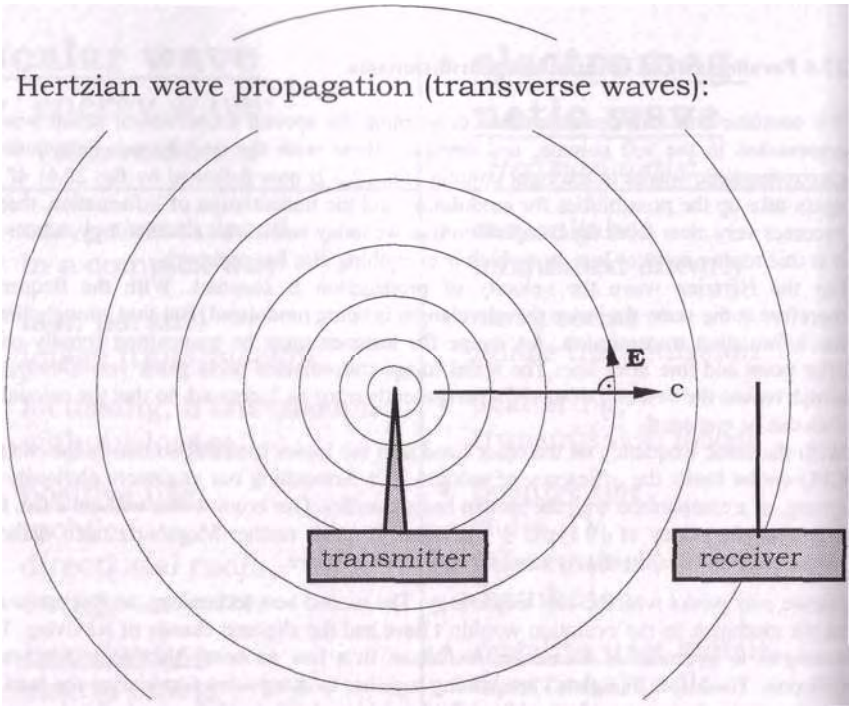

Tesla radiation (radiations) = scalar wave, longitudinal wave propagation:

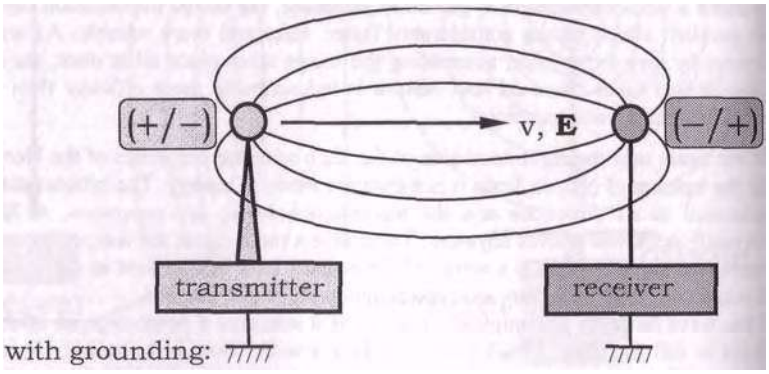

Fig. 22.7: ____Comparison of radio waves according to H. Hertz and electric scalar waves according to Nikola Tesla.

22.7 Comparison of the properties

The course of the field lines clarifies the difference. For the scalar wave all field lines going away from the transmitter run together again. As long as no scattering field occurs, there also won't be any transmission losses. It is an energy wave, for which the full broadcasting power is transmitted wirelessly and which arrives at the receiver, by that focussing the field lines again.

Here one at once numerous technical applications come to mind, if energy should be transmitted wirelessly. A TV, which supplies its remote control with energy itself, lelemetric installations, which are fixed at difficult accessible or rotating machine parts and which can't work without energy supply.

For a mobile with 3 Watts of broadcasting power only a few microwatt arrive at the ground station. If I would have a scalar wave mobile, which functions with resonance, then a broadcasting power of some microwatt will be completely sufficient, to carry out a telephone call right through the earth. This minimum broadcasting power suffices, because everything, what is being transmitted, arrives at the receiver - crucial is that the conditions of resonance are fulfilled. That means, both must have the same frequency and the opposite phase. In addition the modulation has to fit, so that on the one hand not several participants in the conversation are getting in each other's way. For a purely carrier wave transmission on the other hand there would be the risk of natural fields being collected also and the power at the receiver taking inadmissibly high values. This is prevented effectively by a correspondingly complex modulation. Nature solves the problem in exactly this manner.
Mobile phone technology with scalar waves of course still is a pie in the sky. A big challenge for the engineers poses the adjustment condition of opposite phase and the fitting modulation, which Tesla called .,individualisation"[<i>]. Entirely by the way the network runners and the telephone companies are getting quite superfluous.

Telephone charges, so one perhaps can read in the history books in a hunderd years, were the indication of a century of rigorous exploitation of man and nature. With scalar waves a direct, more dimensionally modulated information transmission directly with the partner of conversation is possible and sufficient energy is available to humanity any time and any place, without being dependent on any companies! This notion is not new, but it is inconvenient for the rules; already Nikola Tesla has written about it, but obviously no-one wanted to listen to him[<ii>].

Scalar waves are able, that is made clear by the properties, to revolutionize both the energy technology and the information technology fundamentally. It is more than only a technology for the new century. Scalar waves are a chance for the whole millennium!

<i>: N. Tesla: Transmission of electrical energy without wires, Electrical World and Engineer 7.1.1905; Edition Tesla Vol. 4, P. 131.

<ii>: N. Tesla, New York Times of 15.9.1908; Edition Tesla Vol. 6, P. 241.

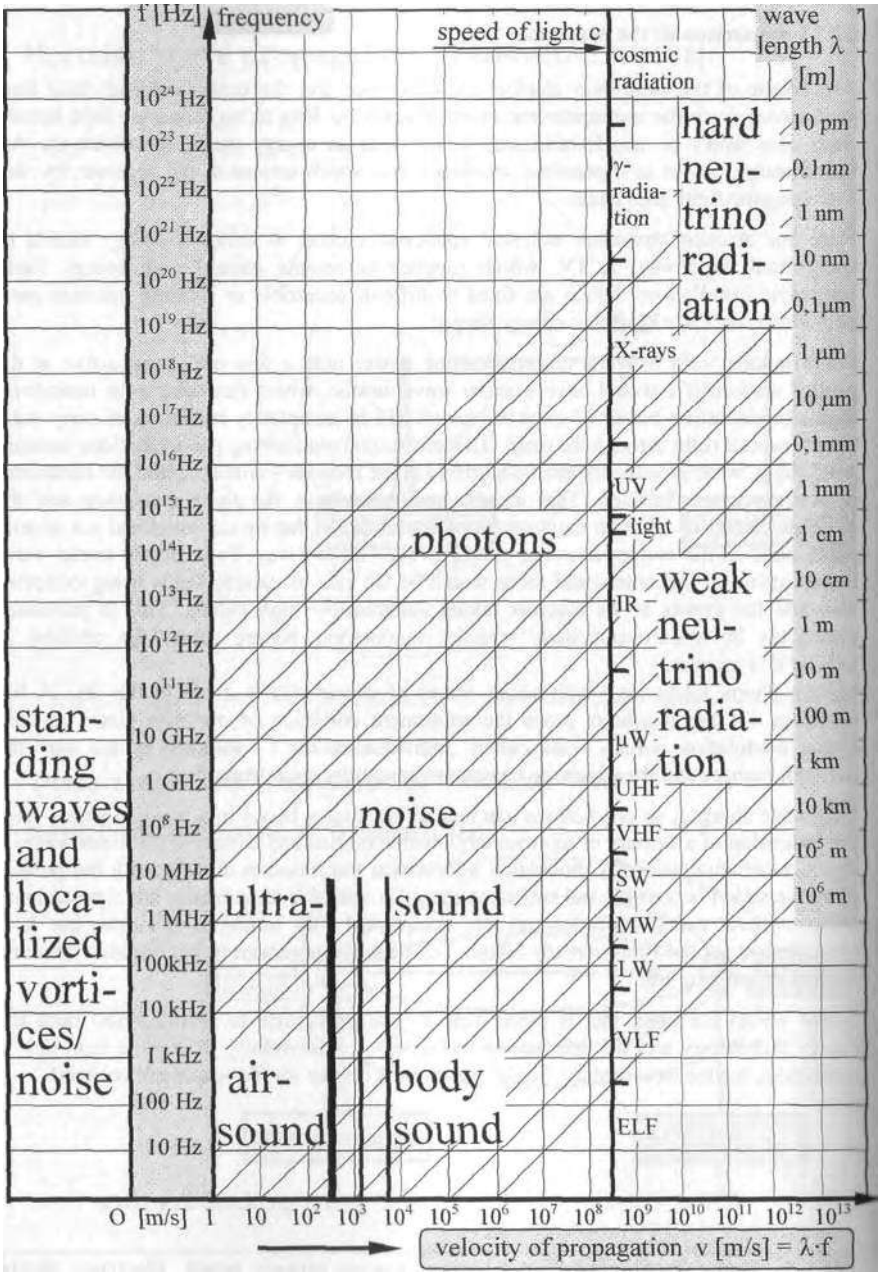

Fig. 23.1: Frequency diagram of longitudinal and transverse waves as they depend on the velocity v.

23. Research of scalar waves

Scalar waves are still unexplored area, scientific new ground as it were. Individual research scientists already have selectively ventured forward in this area and have described properties of the scalar wave investigated by them in their special research area mostly in measurement technical manner. But as a rule they lack the physical relation, as it is derived in this book for the first time. If we don't proceed from individual measurements, but from the wave equation and the mathematical physical derivation of scalar waves, then we have the great chance to understand as something belonging together on the one hand noise, photons, neutrinos and lots of other known phenomena as well as on the other hand still unknown phenomena, which are called parascientific. We should remember that we without theory of Maxwell and the representation in a frequency band today still wouldn't know that the radio waves (LW, MW, KW, UHF), the microwaves (μW), the infrared thermal radiation (IR), the light and the X-rays concern just the same phenomenon. The graphic representation of both waves in one diagram in this place is extremely helpful.

23.1 Frequency diagram

In fig. 23.1 the frequency f is shown against the velocity of propagation v with the wavelength λ as parameter. The broad line at $3*10^8$ m/s represents the speed of light c. Here the frequency band of the transverse waves can be found again in the well-known one-dimensional representation.
Crosswise to that, somewhat unusual, the longitudinal waves run. These start at the left at localized noise, over the sound as it propagates in air, in water and in metal, over a large, to a large extent still unexplored, range of the bio photons, the heat vortices and of the dowsing rod effects and end on the other side of the speed of light at the neutrinos. Between that the special case is settled that the particles, or said better vortices, propagating as a scalar wave have exactly the speed of light. It gives reasons for the circumstance, as already mentioned, that light can appear as wave or as photon radiation. It. according to the wave equation, after all always consists of a combination of both forms. At very high frequencies, e.g. the cosmic radiation, this combination is shifted in the direction of vortices and their distribution as a scalar wave, at low frequencies the tendency inversely goes in the direction of the normal wave.

If we assume that for the transverse wave over all frequencies a dozen of specialized gauges is necessary, each of them also can be switched over in range several times, then we can project that to record a scalar wave of a certain frequency over all velocities of propagation likewise 12 devices and for the whole field shown in fig. 23.1 approximately 12x12 = 144 devices will be necessary. Of these 144 gauges today just 12 are available. There thus still are missing 132 pieces, which should be developed. With these gauges, so I am convinced, the many white spots in the diagram can be tapped scientifically little by little if a systematic procedure is used. My vortex theory thus will be attached a central importance.

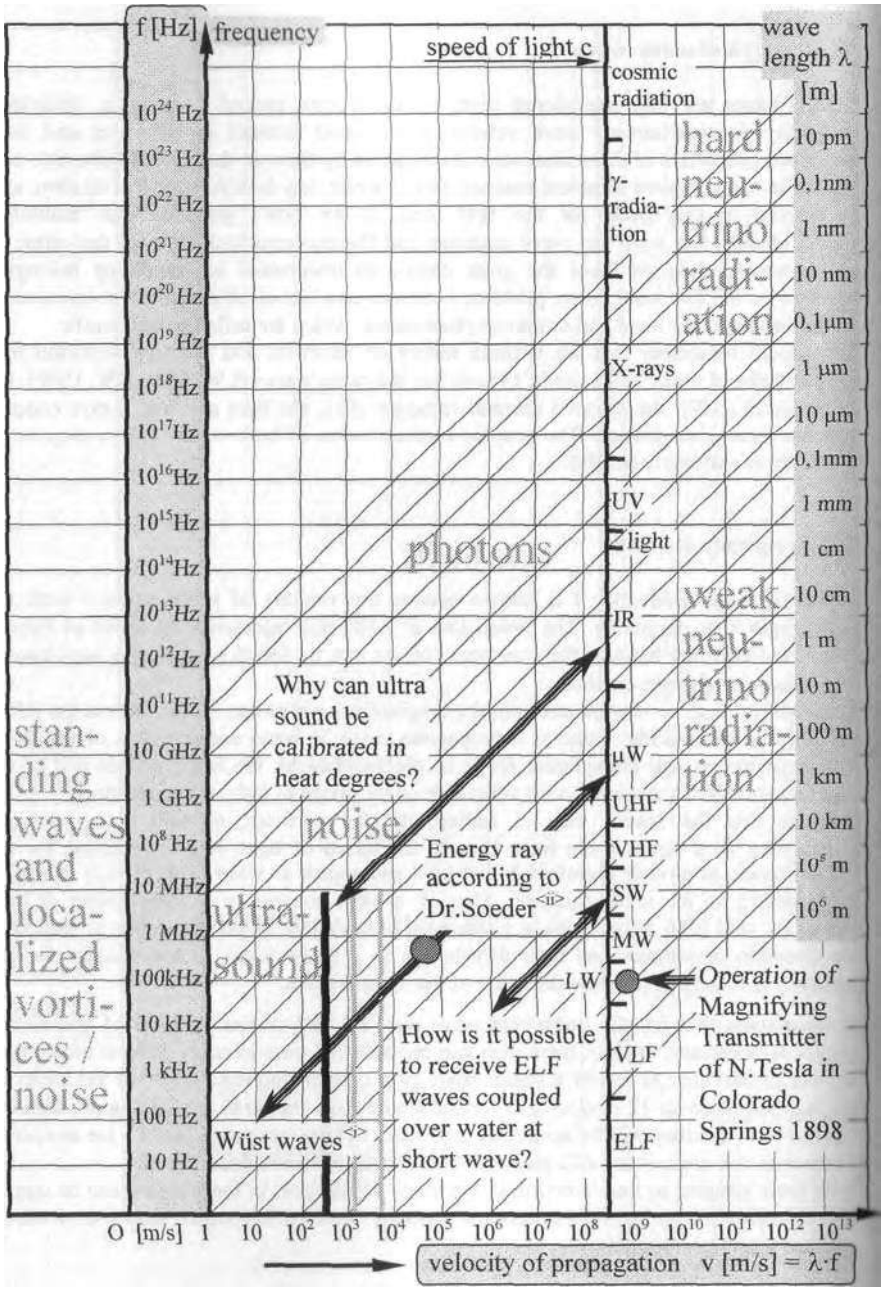

Fig.23.2: Frequency diagram with entries concerning Wust waves,
Tesla transmitter and various not understood effects.

23.2 The reverse of the HF medal

The diagram possibly may settle disputes, like the ones between the „Wustlingen" (note of the translator: the author here is playing with words, Wustlingen literally means lechers) and the „high-frequency engineers".
Professor Wust of Munich already 1934 had proven, that the Wust waves named after him in air have a velocity of propagation of approximately 10 m/s[i]. He investigated them in the frequency range between 16 Hz (λ= 60 cm) and 500 Hz (λ= 2 cm). The high-frequency technicians immediately have converted to the speed of light, since they don't know anything else, and on the spot have shifted the phenomenon into the range of the microwaves between 0.5 GHz (λ=60 cm) and 15 GHz (λ= 2 cm). In the diagram now can be found, at which place this phenomenon belongs actually. It presumably concerns the same „energy ray", which Dr. Soeder has observed and proven already at velocities of propagation of 55.2 km/s and wavelengths around 10 cm[ii].

Furthermore follows from the diagram (23.2), why ultra sound can be calibrated in heat degrees, and why radio reception of signals from a completely other frequency range is possible by principle, if for identical wavelength a velocity of propagation different from c occurs. Further the range of operation used by Tesla at approx. 1.6 times the speed of light is depicted.

Also the noise is such a book with seven seals. It concerns, it is true, a fixed chapter of high-frequency engineering, but without visible connection to the other chapters. That might be based on the circumstance that the relation, as it is dictated by the wave equation, isn't recognized.
Every high-frequency signal is accompanied by a noise signal; every antenna produces more or less noise. HF engineering dictates the measures, how the noise can be suppressed resp. the signal-noise distance be increased. The goal is to make the electromagnetic wave stand out in such a way from the noise that it can be received. For that the measurement setup must be choosen correspondingly, are the measurement cables dictated, and must be paid attention to power adaptation and corresponding termination resistors. For measuring HF correctly all interference influences should more or less disappear.

But what are the interference influences, which the HF-technician suppresses? According to the wave equation it are the scalar wave parts, and to that also is counted the noise. Every HF-technician thus knows the scalar parts as interfering noise signal, but doing so he completely fails to notice the technical advantages and chances, which e.g. are present in the noise.
If by means of an autocorrelation function a noise signal is compared to itself then often a hidden message comes to light. According to that, informations can be hidden in the noise and of course transmitted wirelessly. This important circumstance is known, but it is hardly used. The noise vortices thus can be modulated in an extremely complex way. There can be transmitted a lot more information in the noise as scalar wave, than with the radio wave.

<i>: J. Wust: Physikalische und chemische Untersuchungen mit einem Rutenganger als Indikator. Further references in W-B-M 3/ 1991, S. 57.

ii>: A. Soeder: Ohne Strom lauft neuer Energiestrahl rund urn den Erdball. Raum & Zeit 59/92 Seite 62-67.

Fig. 23.3: ___ Dowsers dowse an ore vein.[i]
From: Speculum metallurgiae politissimum, Rossler, Dresden 1700.

<i>: Ludeling, Hartmut: Handbuch der Radiaesthesie, Verlag Eike Hensch 1994, S. 145, ISBN 3-927407-09-7.

The possibility of more dimensionally modulating and parallel image transmission make scalar waves superior to the radio waves in such a way that one should seriously think about the reversed procedure, in which the noise is conceived as useful signal and the radio wave as interference signal.

In the frequency diagram (23.1 and 23.2) can be read like in a diary, in which most pages it is true still are empty, but in which some very informative marginal notes can be found for different points of difficulty. It mostly are parascientific phenomena, which, not understood and excluded by textbook physics, are waiting to be taken up in the building of physics. As an example we'll pick out an extensive area of alternative research.

23.3 Radiesthesia

A particularly broad spectrum of scalar waves is provided by the already several times mentioned earth radiation. An ancient science of experience, which troubles the exploration of the earth radiation, is the geomancy. The Roman land surveyors, the Augures, used as an aid a flat coil like also Tesla did to receive scalar waves. The Lituus, as the device was called, resembles so much that of the Etrusks that we must proceed from the assumption that the method is much older (fig. 16.10).
This part of the scalar wave research, also called radiesthesia, is derived of „radiare", which can be translated with "send out rays" resp. „perceive". It describes the doctrine of the sensitivity to radiation of man. Doing so the radiation sensitive uses his own nerve framework as a biosensor.

The nerve conduction could be derived as a biological variant of the Tesla one wire transmission, for which ring-like potential vortices are passed on as action potentials in form of standing waves (fig. 9.6). Of this kind are also the control commands, which cause a muscle to contract. If now corresponding vortices are picked up by means of a dowsing rod or similar aids in our nerves, then the contract addressed muscles contract, because they can't distinguish, from where the command comes. This unconscious nerve twitch leads to a swing of the dowsing rod and to the well-known dowsing rod phenomenon. But man can't replace a technical gauge. Hence one speaks of dowsing and not of measuring. To this should be added the condition of resonance, which must be fulfilled. Since every person however builds up other resonances, dowsed results of others often can't be reproduced. But from this particular difficulty one cannot draw the conclusion that the phenomenon does not exist and radiesthesia is not a science. Series surveys and statistical analyses here in any case don't lead any further. It always only are individual talented dowsers, who have at their disposal really fantastic abilities and find with great certainty water, ores and even oil.
With the perception of a physical phenomenon it mostly starts. Cultural man looks after his discovery as cult, whereas modern man, guided by the wish for reproducibility and more objectivity, is troubled to design and to build a technical measurement work. With regard to the scalar wave in general and the radiesthesia in special we still are at the stage of the Stone Age.

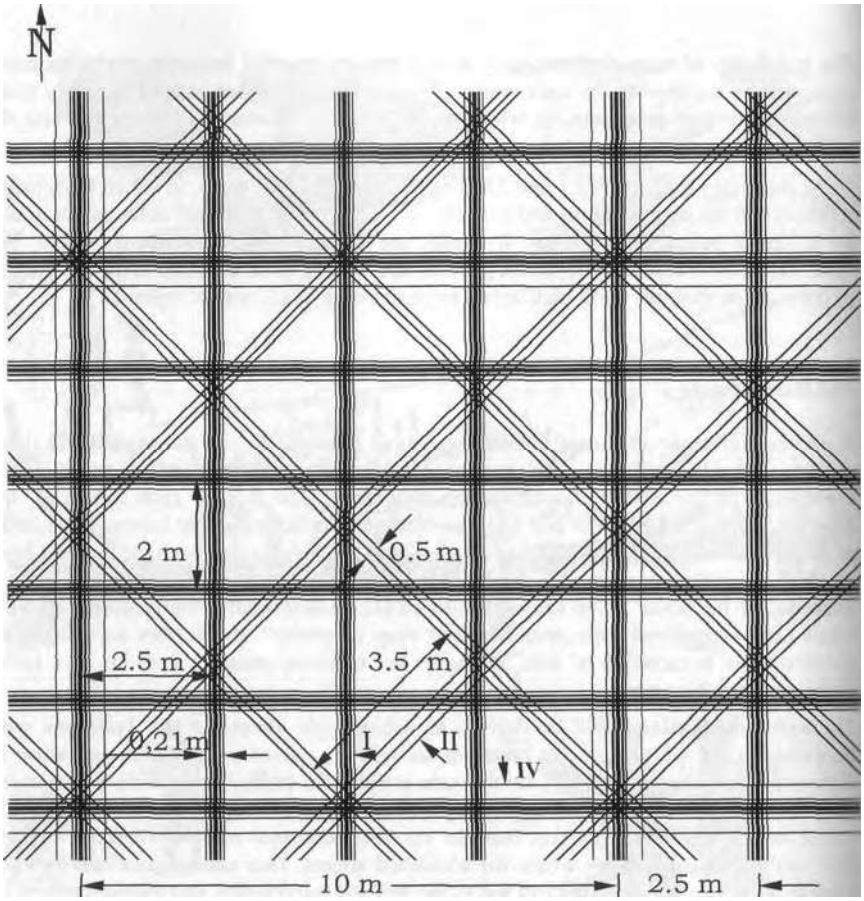

Fig. 23.4: Nets dowsed at latitude 49.<i>

I. net: ,,global net" according to Dr. E. Hartmann; orientation: N - S: 2 m distance and E - W: 2.5 m distance

II. net: ,,diagonal net" according to Dr. M. Curry; orientation: NE - SW and NW - SE: 3.54 m = 2.5 m * sqrt(2)

[III. ,,lightning net" according to R. Schneider; orientation like I.]

[IV. net acc. to Benker; like I. but: N - S: 10 m and E - W: 10 m]

[V. sun/planet net acc. to W. Auer; with 3.66 m orientation S./P.]

According to Prof. E.G.Hensch et al.:
<i>: Hensch: Radiaesthesie im landlichen Bauen und Siedeln, Arbeitskreis zuf Landentwicklung in Hessen, W4, Wiesbaden 1987; resp.: W. Auer: Erdstrahlen?... AWGEO 199, Eigenverlag 1998; resp.: Mayer/Winklbaur: Biostrahlen, 5. Aufl. ORAC Verlag, Wien 1989, Seite 168

23.4 Prediction of earthquakes with the help of scalar waves

The standing wave character of the earth radiation is a help. There are dowsed points and lines of maximum radiation intensity, which form nets, which encompass the whole world. On the one hand we are dealing with a net oriented in direction north-south and east-west (Hartmann net) and on the other hand with a net standing diagonally to that under 45° (Curry net). Because the angle of 45° can be derived as borderline angle from a vortex field calculation[<ii>], I already early have pointed to the circumstance that it here presumably concerns a vortex phenomenon[<iii>].
Because the nets in addition are dowsed in air, it must be vortices of the electric field, so-called potential vortices[<iii>], which here form regular structures. The formation of vortex lines and complete vortex streets (chapter 4.9), which consist of countless individual vortices, can be explained as follows:
Electric scalar waves propagate in the direction of the electric field strength and mediate field vortices, e.g. neutrinos. If at a certain moment the transmitter carries a positive and the receiver a negative charge, then all the particles which are positively charged are repelled by the transmitter and attracted by the receiver. All run at the same time towards the same goal, although all mediated particles carry the same charge and repel each other! This incompatibility can be compensated partly, by the vortices rotating around each other. In this circumstance can be seen the reason for the structure shaping, the formation of some lines in the countryside (fig. 23.3). The distances between the lines have characteristic values, which allow conclusions about the wavelength of the standing waves. We must assume that they dictate the structure shaping and that the spatial vortex distribution aligns with the nodes and antinodes of the respective standing wave. The distance between the lines, which corresponds to half the wavelength, becomes smaller and smaller towards the North Pole and the South Pole of the earth, the net thus narrower and narrower. Also is the net said to change strongly before an earthquake. This all are clues for the circumstance that the structure shaping radiation comes from the earth, that the cause must be sought in the earth radiation.
It should be noted marginally that with scalar wave detectors, which permanently scan the nets, a just as effective as inexpensive earthquake prediction should be possible. Such a facility would be an enormous relief and help for all earthquake warning services. It even should be possible to determine in advance the future epicentre, if there is measured at the same time at if possible many stations and the respective deviations are compared.

A further influential factor is the composition of the subsoil; e.g. ores and metals influence the earth radiation. Water shows a special affinity for the earth radiation. It does collect the radiation and after bundling it up releases it again. To blame is the high dielectricity of water ($\varepsilon \cong 80$), which again favours the formation of potential vortices .
A technical use of this effect would be the neutrinolyse (see fig. 17.6-17.8 and 18.1), the splitting of water molecules by neutrinos if these take the state of an electron, hydrogen escapes and the oxygen content in the water increases. If a neutrino however shows as a positron, then it annihilates and there is formed a light flash, which serves the „experts" in neutrino detectors as proof.

<ii>: Meyl, K.: Wirbelstrome, Dissertation Universitat Stuttgart 1984
<iii>: Meyl, K.: Potentialwirbel Band 1, INDEL Verlagsabt. 1990

Spectroid of the radiation field of a subterranean flowing water veign (according to P. Schweizer)[<i>]:

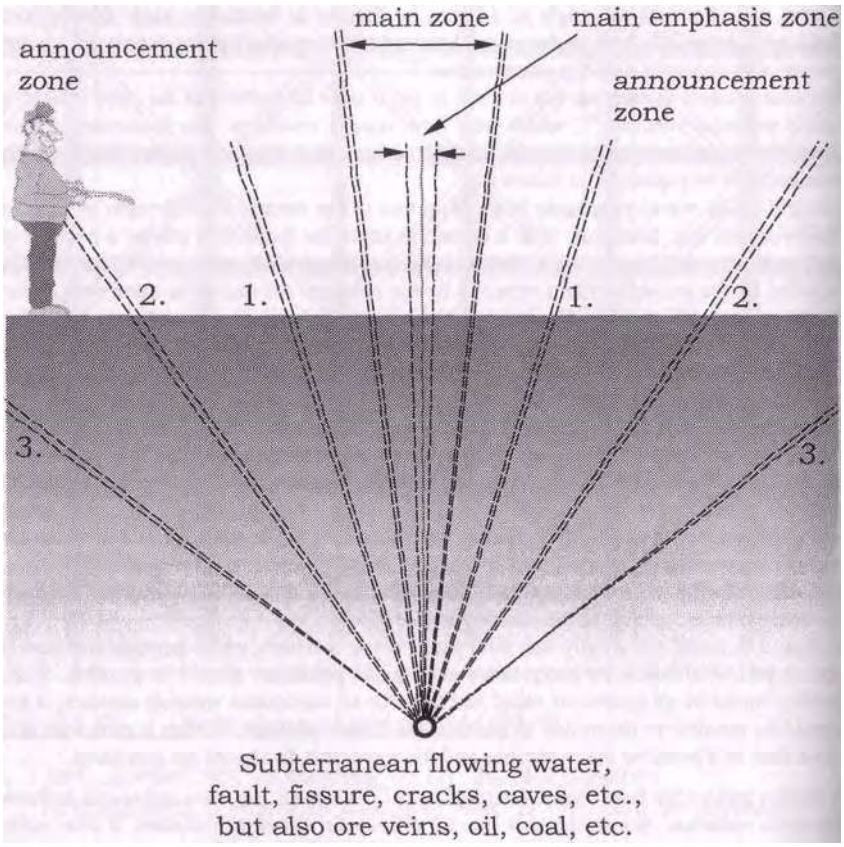

Fig. 23.5:____ Radiaesthetic search for water[<i>],
(dowsing of the earth radiation)

<i>: Ludeling, Hartmut: Handbuch der Radiaesthesie, Verlag Eike Hensch 1994 S. 145, ISBN 3-927407-09-7.

23.5 Searching water with the help of scalar waves

Faults of earth's crust lead to fissures and cracks in the rock, which often fill up with standing or flowing water. Potential vortices of the earth radiation are attracted by the high dielectricity of water and are radiated again in slowed down and focussed form. On the surface of the earth the mixture of various scalar waves arriving there can be dowsed as main emphasis zone. For reason of the broad radiation spectrum the results of proficient dowsers in the main emphasis zone more often coincide.
At both sides in addition spectroids are forming, which are dowsed as parallel running vortex lines. Because every harmonic wave produces other lines and every dowser reacts to other resonances, a profound ability is required, if from the distance of the so-called announcement zones the water depth should be inferred (fig. 23.5). Some specialists indicate besides the place and the depth also the amount of deposit and if need be the water quality. For that they analyse the radiation intensity, but unfortunately many all too often overrate their abilities.

Already the Augures, the land surveyors in the age of the Romans have aligned their streets and the castles with the nets and the lines in the countryside. Even today new evidence about the central importance of the standing wave character of scalar waves can be found at excavations (fig. 16.10). Since every scalar wave also occurs coupled with a radio wave by means of the wave equation, earth rays originally could be detected conventionally with field strength gauges. But the intensive use by radio stations has made it necessary to change from the short wave range to the VHF-range and further to the UHF-range. It were indirect measurements, which could be interfered easily. Today geologists work with ELF scanners in a range between 15 and 30 KHz if they search for water. They analyse the emitted signals of submarine transmitters, because these are attracted and amplified by water carrying layers.
Experiments also are carried out with noise receivers or unused broadband TV channels. Others analyse influences of the earth radiation on the magnetic field of the earth, but for this method the expressiveness is controversial.
Again others walk along a path with a scintillation counter measuring the inverse profile. At the places of maximum earth radiation a minimum of gamma radiation is measured. This stunning relation only can be interpreted as follows: the natural radioactive decay at these places takes place accelerated and that proves:
1.. that earth radiation sets radioactivity free and causes it in the first place (chap. 17.1 pp).
2. that in the case of earth radiation it actually concerns slowed down neutrino radiation.
But also this method works indirectly. It only functions in the open air and then only in the case of unspoiled nature, which sometime was covered with an even layer of radioactive dust. By cultivation or plantation the „radioactive layer" very often is changed and mixed up, whereupon the measurable profile hardly allows conclusions.
For indirect measurement methods of that kind, for which the measurement variable stands in a relation, which isn't known in more detail, to the scalar wave of interest, generally caaution is advisable. Too often a message is seen in a wonderful 3-D diagram of the magnetic field strength or the radioactivity distribution, which has much more mundane causes.

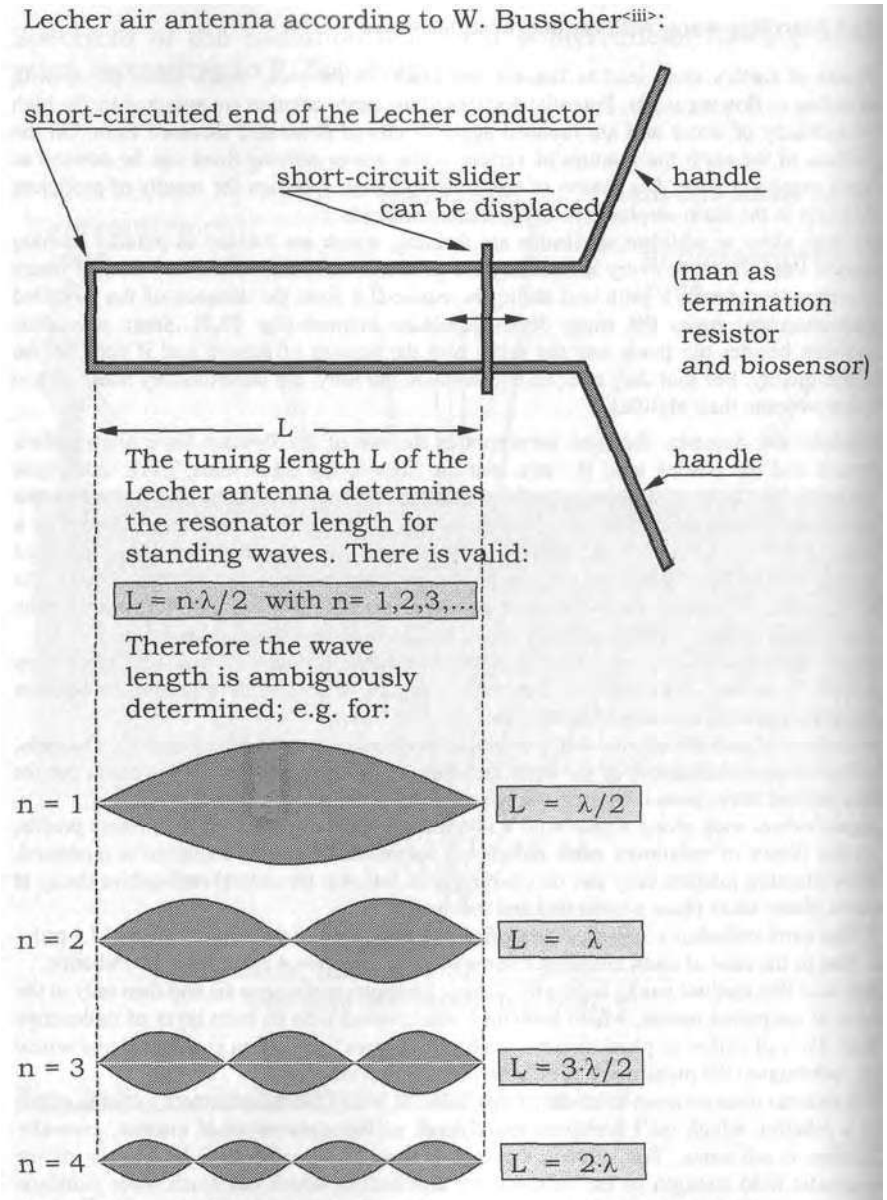

Fig. 23.6: Lecher conductor as scalar wave antenna.

____ Can be read at Prof. Dr. Ing. Christof Rohrbach: _____

<iii>: Rohrbach: Radiasthesie, Physikalische Grundlagen und Anwendung in
Geobiologie und Medizin, Haug Verlag Heidelberg 1996, Seite 100.

23.6 Receiving scalar waves with the Lecher antenna

In the case of technical gauges it is normal to change the frequency tuning. For that the capacity of a capacitor is being varied, which is part of a resonant circuit. This method can simply be realized with the today available construction elements. Biological systems on the other hand, for instance a person, work primarily with a variation of the wavelength. In this case (according to eq. 22.1) the frequency is directly proportional to the velocity of propagation.
So provide for instance radiaesthetic dowsings clues for the wavelength. The frequency however can't be given, because that oscillates along with the velocity of propagation and at present the forming noise signal still can't be analysed. There can't be bought electronic construction elements, which like a body cell would be able of oscillations of length. Oscillation quartzes and piezo elements, on the basis of which scalar wave detectors could be constructed, form an exception.

Similar to the Lecher conductor different forms of tunable Lecher antennas have been developed. which are used for dowsing. Such a frame antenna, developed strictly according to the rules of high-frequency technology stems from W. Busscher (fig. 23.6)[i]. With the short-circuit slider a closed-loop antenna circuit in the upper part is tuned to half the wavelength or an integer multiple of it ($L = n \cdot \lambda/2$ with n = 1,2,3...). The person, who holds the Lecher antenna with both hands, forms the termination resistor for the attached antenna circuit. At the same time he prevents the occurring of an effect back on the tuned resonant circuit by means of damping of the Lecher conductor. The sense of this arrangement is lying in the circumstance that man as a „biosensor" should feel if standing waves, which I call vortices, are formed in the Lecher antenna.
A modification of the Lecher air antenna is the Lecher dowsing rod according to R. Schneider[ii]. It is produced as an etched board, which has a dielectricity of approx. 4. As a result the velocity of propagation and the wavelength are only half their normal value. In addition a shortening factor V is introduced, which depends on the construction of the Lecher dowsing rod[iii] ($L = V \cdot n \cdot \lambda/4$ with V = 0.952 and n = 1,2,3...).
In fig. 23.7 some published tuning values have been drawn up. The values for want of corresponding technical gauges it is true still haven't been confirmed, but they allow a certain insight into the world of the scalar waves, as they are influenced and radiated by water, by metals, by oil or even by other planets, the sun and the moon. Doing so some questions remain open: We for instance don't know, if the corresponding wavelength concerns the basic wave or only an mth harmonic wave. The details not only are unreliable, they moreover also are ambiguous. If however several tuning values L' are present for which resonance occurs, then if need be an integer divisor can be sought and the wavelength can be determined. But that doesn't function always.

<i>: Will Busscher: Die Luft-Lecher-Leitung als Wunschelrute. Eine Methode um die Wellenlangen zu bestimmen. Wetter-Boden-Mensch 3/ 1991, Seite 46-57.
<ii>: R. Schneider: Einfuhrung in die Radiasthesie Teil II: Leitfaden und Lehrkurs ..., Oktogon-Verlag, Wertheim, 2. Aufl. (1984) S. 136.
<iii>: Rohrbach: Radiasthesie, Physikalische Grundlagen und Anwendung in Geobiologie und Medizin, Haug Verlag Heidelberg 1996, Seite 100.

Supposed wavelength λ of the transmitted scalar wave radiation in [cm]

λ	of:	(with the different tuning values L´)
32	water	(L´ = 15.5 $_{n/m=2}$; 10.8 $_{4/3}$; 7.8 $_{n/m=1}$; 3.1 $_{2/5}$)
18	fault	(L´ = 12.9 $_{n/m=3}$; 8.65 $_{n/m=2}$; 4.3 $_{n/m=1}$)
13.6	net I	(L´ = 12.2 $_{n/m=4}$; 9.6 $_{n/m=3}$; 6.1 $_{n/m=2}$; 3.05 $_{n/m=1}$
	4 m = 16 x 25 cm	(N-S direction) 1.7 $_{n/m=1/2}$)
	5 m = 20 x 25 cm	(E-W direction)
14.7	net II	(L´ = 11.4 $_{n/m=3}$; 6.9 $_{n/m=2}$; 3.5 $_{n/m=1}$; 2.2 $_{n/m=2/3}$)
	7.08 m = 30 x 23.6 cm	(NE-SW + NW-SE direction)
13.2	net III	(12.6 $_{n/m\,4}$; 9.4 $_{n/m=3}$; 8.2 $_{5/2}$; 6.15 $_{2}$; 4.1 $_{4/3}$; 2 $_{2/3}$)
16.4	radon	(L´ = 7.8 $_{n/m=2}$)
28.6	oil	(L´ = 13.5 to 13.8 $_{n/m=2}$; 3.3 to 3.5 $_{1/2}$)
17.2	gold	(L´ = 8.2 $_{n/m=2}$; 4.1 $_{n/m=1}$; 2 $_{n/m=1/2}$)
13.9	silver	(L´ = 6.6 $_{n/m=2}$; 3.2-3.3 $_{n/m=1}$; 1.6 $_{n/m=1/2}$)
7.20	quartz	(6.9 $_{4}$; 4.1 $_{5/2}$; 3.85 $_{9/4}$; 2.9 $_{5/3}$; 2.5 $_{3/2}$; 2.2 $_{5/4}$)
4.35	sun	(L´ = 4.15 $_{n/m=4}$)
15.3	moon	(3.65 $_{n/m=1}$. thermal spectral lines: 11; 21 cm)
4.25	Mars	(4.05 $_{n/m=4}$, thermal spectral line at 3.14 cm)
4.90	Jupiter	(4.65 $_{n/m=4}$, ther. spectral lines: 3; 3.2; 3.3 cm)
5.36	Saturn	(5.1 $_{n/m=4}$, thermal spectral line at: 3.45 cm)

Fig. 23.7: Details of not confirmed wavelengths.<i>
(derived from tuning values of a Lecher antenna
$L' = . V \cdot \lambda \cdot n / 4 \cdot m$ with $V = 0.952$
and $n = 1,2,3...$ for $\lambda/4$, $\lambda/2$, $3\lambda/4$, λ, ...
and $m = 1,2,3...$ for 1 the basic wave
and the 2nd, 3rd, ... harmonic wave

____ according to: _____

<i>: Ludeling, Hartmut: Handbuch der Radiaesthesie, Verlag Eike Hensch 1994, S. 161 ff. The author gives the clue: ,,The values have been determined empirically by different persons and predominantly could be confirmed by the author and his co-workers. There however always can occur deviations caused by different dowsing methods. Every value therefore always should be checked with own measurements."

23.7 Assignment according to wavelength

As said, the methods to determine the wavelength by means of the Lecher antenna are ambiguous and unreliable. So water should have a wavelength twice as long as a fault. But since water often is collecting or subterranean flowing in faults, one is entitled the suspicion that here $\lambda/2$ was taken, where in reality the full wavelength λ acts. The rest of the table after that should be looked at with the same scepticism. The table nevertheless is not wholely uninteresting, because it points to certain trends and is able to furnish clues, which if need be can represent a help of orientation in the systematic research of scalar waves.
At the planets is remarkable that the Lecher conductor reacts to values, which correlate with the respective thermal spectral lines. If these spectral lines propagate with c and it actually should concern the same cause, the frequency thus should be identical, then the planets would emit scalar waves, which are faster than the light. In the case of Mars 1.35 times the speed of light c would be present, in the case of Saturn 1.55 times and in the case of Jupiter the values would lie between 1.46c and 1.63c. In the case of the moon two thermal spectral lines are being measured, which on the one hand have as a result 1.39c and on the other hand 0.73c. At this place still ample research tasks should be solved.

In the case of scalar waves the wavelength is the most important factor to refer to. The frequency however varies continually, which in electrical engineering is called noise. That again is connected to the circumstance that frequency and velocity of propagation oscillate, so that merely an average value can be given at a time. But that hardly can be measured, which again makes the assignment more difficult. We thus still aren't capable to enter the table values from fig. 23.7 into the frequency diagram of fig. 23.1.

A technical gauge for scalar waves is necessary. A practical solution could look as follows: A noise transmitter tunable in frequency and wavelength operates on top of a carried along noise receiver. The arrangement with that comes the Tesla transmission path for scalar waves very close. If the transmitted noise signal hits upon a likewise one in the surroundings then overlapping occurs, which at the receiver causes a change of the displayed value. If doing so a subtraction (extinction) or an addition (amplification) of the signals occurs is unimportant.
With this arrangement in any case statements are possible about frequency, wavelength, velocity of propagation and about the amplitude of the scanned signal, without withdrawing energy and strain the signal in doing so[<i>]. With such a gauge radiation conditions depending on location could be measured as well as technical devices checked lor the emitted scalar wave parts (fig. 24.1).
An important use over and above that would be given in medical diagnostics. Every living being „produces noise" the technician would say, it „emits scalar waves" I would say, whereas following general usage is talked about the „aura of man". The value of an aura diagnosis still is completely unknown to most doctors and therapists, especially as the scanning of the aura at present only is possible by dowsing. But the patient expects that a doctor works with a technical gauge and not with a dowsing rod!

<i>: First experiments, which I carried out with students in the laboratory, look very promising. Unfortunately the works at present rest for reason of lack of money.

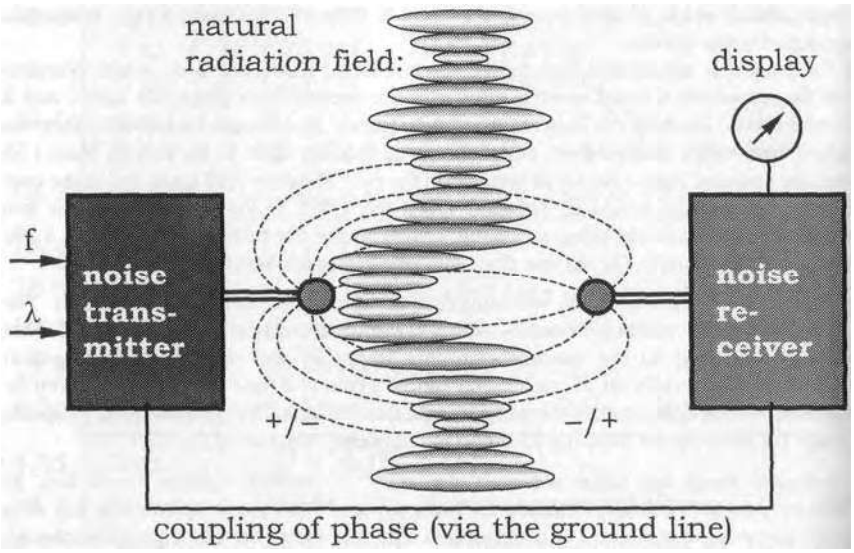

Fig. 24.1:____ Concept for a device to detect scalar waves

24. Medicine of oscillation

24.1 Mediation of information with the help of scalar waves

If for the discussed scalar wave gauge the transmitted comparison signal in addition deviates from the form of a sinus, if the signal is modulated in some way, then even the transmission of information by means of the noise as scalar wave can be realized. If we as an example again take the aura of man, which is more than only a radiation field, it carries information for instance about the state of health of man. Kirlian photography is one form of making it visible (Fig. 3.6).
Not only the nerve conduction and the brain work with scalar waves. Man in this way also corresponds with his fellow people, some more, others less. There are people who „beam" and that should be interpreted in the true meaning of the word. Others opposite to that are more „receiver characters", who pick up more scalar wave radiation than they give away. But because they not only pick up positive radiation energy, they are susceptible to information, which makes sick. That's why a healthy equilibrium in the exchange of thoughts, feelings and the different forms of scalar waves is very important. All that is reflected in the aura of man. If we technically are capable to scan the aura of man, than this can be a blessing for humanity and for the public health.

The possible abuse however must not be overlooked. Unbiased research results, which can be used for the benefit of humanity, in many cases just as well can be used to harm humanity.
A connector of both these worlds is the Russian psychologist Prof. Smirnov, who has shown publicly in television, how a spoken sentence can be transformed in a noise signal, which is taken up directly by the brain as information, with the help of a computer program [<i>]. He with that is capable to "sodden" individuals, as he says, he in this way can take the fear away from soldiers before a combat mission and can operate the disease out of drug addicts without bloodshed. In the television film such an „operation at the open subconscious"' is shown life. The patient hears the noise signal over headphones and is cured already after few minutes treatment time.

We here are getting in the domain of ethical and moral problems of scalar wave research, which aren't solved by us looking away and leaving the field up to others. According to the words of Prof. Smirnov the only thing, which can stop the research scientist, is his own moral. He doesn't say any more and that isn't exactly reassuring! One here is working with „signals resembling sound", is said in the report of the Zweite Deutsche Fernsehen[<i>], thus with longitudinal waves and that shows, that already more knowledge about scalar waves is present than is generally known by the masses.

Another way is leading over the bioresonance. Also here at first the possibility and chance to cure diseases is to the fore. The bioresonance is a central aid in the area of the medicine of oscillation, which is increasing in importance permanently.

<i>: Die Zombies der roten Zaren (Besta Film Warschau im Auftrag d. ZDF 1998)

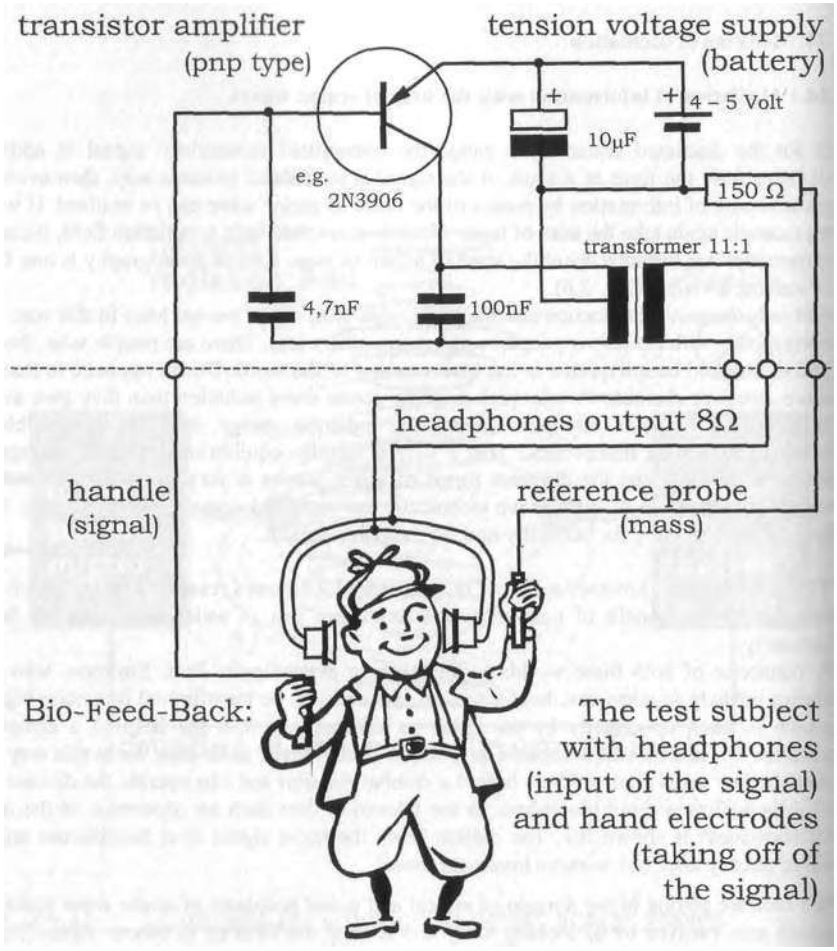

Fig. 24.2 A: Wiring diagram of the Syncrometer.<i>

<i>: Wiring diagram taken from: H. Clark: The Cure for All Cancers (1993) New Century Press, USA, Page 434

<ii>: Flanagan: Horen mit der Haut anstatt mit den Ohren, Sonnenwind 1/97, S.13-17.
s.a.: N.Begich: Towards A New Alchemy, The Millenium Science, Earthpulse Press 1996

<iii>: Dr. Bodo Kohler: Biophysikalische Informations-Therapie, Gustav Fischer Verlag (1997), Kap. 11.6 Der individuelle Grundton, S. 239 ff.
s.a.: Dr. Bodo Kohler: Die bipolare Farb-Ton-Therapie, CO'Med 2/2000, S.10 - 15

24.2 Systems with positive feedback

The field of oscillation of man easily can be influenced, because it concerns a vortex field. A technical measurement with the gauges available at present is almost impossible and highly inaccurate. There however exists the possibility, to apply electrodes to a person and to integrate him in the circuit of a technical device. The two of them form a feedback system with man in the return loop. The operation can take place in two different ways, depending on the sign of the feedback (Fig. 24.3):
For positive sign it concerns positive coupling. In this case the signals released by a person sum up, for which reason already minimum amplitudes are sufficient to produce violent reactions in the case of resonance. For resonance to occur, the system must either search independently the suitable frequency and phase, or the therapist searches the points of resonance.

24.2.1 The Syncrometer.

An independently working system is e.g. the Syncrometer. By means of two electrodes, which are held with the hands or are attached directly to the head, the noise signal emitted by a person is called off and supplied to a broadband amplifier. The test subject again hears the amplified signal via headphones, so that the circuit is closed.
Apparently unspecific and still reproducible during operation certain signals capable of resonance are emerging stronger by amplifying and swinging themselves up. The aura starts to extend or expressed in the words of a radiation sensitive, the so-called reaction distance is increasing, with which he means the distance in which he detects a dowsing rod reaction.
The test subject now increases his radiation, so this method can be valued. By strengthening his own radiation power, he works more as a transmitter and less as a receiver for scalar waves. In the last point the therapeutic use seems to iie, because by that the patient can get rid of resonances to any unpleasant persons or to technical transmitters, which are burdening him. The device consequently also is sold as aid or protection against electrosmog.
The amplified signal also can be picked up directly by the skin instead of by the headphones and still being „heard". The reports stretch from a harmonizing and balancing effect up to "electronic telepathy" and states similar to ecstasy of the test subject[i].

24.2.2 The sound therapy.

The controlled variant of this method for instance is the sound therapy. Now the sounds, which the patient picks up by means of headphones, do not stem from him but from a sound generator. The therapist goes through the scale and tries to find out at which sound the aura swings up. If the eigenfrequency is found, then the patient can therapize himself, by again and again playing or humming his eigentone[iii].
It concerns here only a physical statement on the used methods of alternative medicine and not therefore, whether healing successes are actually possible.

sound frequency equally tempered [Hz]		wavelength [cm]	colour	wavelength [run]
F sharp"	740	46,4	(purple)	-
F"	698	49,1	(crimson)	-
E"	659	52,0	(violet)	-
D sharp"	622	55,1	indigo	421
D"	587	58,4	bleu	446
C sharp"	554	61,9	turquoise	472
C"	523	65,6	green	500
H'	494	69,5	yellowgreen	530
A sharp'	466	73,6	yellow	562
A'	440	78,0	orange	595
G sharp'	415	82,6	orangered	630
G'	392	87,5	red	668

Table 24.2 B: Scale of the colour range.<i>

colour		chakra	sense organ	planet type
purple	7.	(crown chakra)	epiphysis	Jupiter
indigo	6.	(brow chakra)	hypophysis	Saturn
bleu	5.	(throat chakra)	hearing	Mars
green	4.	(heart chakra)	feeling	Sun
yellow	3.	(solar plexus)	seeing	
orange	2.	(sacral chakra)	taste	Venus
red	1.	(root chakra)	smell	Moon

Table 24.2 C: Assignment of colours to chakras and planets.<i>

colour		metals	gems (selection):
purple	7.	tin	amethyst, fluorite
indigo	6.	lead	indigo-sapphire, azurite
bleu	5.	iron	sapphire, lapis lazuli
green	4.	gold	emerald, malachite, jade, gr. tourmalin
yellow	3.		topaz, amber, citrine
orange	2.	copper	carnelian, fire opal
Rot	1.	silver	ruby, coral, garnet, red jasper

Table 24.2 D: Assignment to a selection of gems.<i>

<i>: Dr. Bodo Kohler: Biophysikalische Informations-Therapie, Gustav Fischer Verlag (1997), Kap. 11.6 Der individuelle Grundton, S. 190 - 194

24.2.3 The colour therapy.

Analogous to acoustics also colours each time can be assigned a wavelength and also here can be detected that every person responds to certain colours, thus wavelengths, in particular which can stimulate his aura to resonant oscillations. In practice sound and colour therapy often are used coupled[<i>], even succeeds more or less an assignment to each other. That in last consequence leads to a "scale of the colour range" (table 24.2 B)[<ii>]. According to statement of the treating doctors does a patient, who responds to a certain colour, also react to the corresponding sounds and vice versa.

24.2.4 The aroma therapy.

If according to that it depends less on the circumstance if sounds or colours are used, but the wavelength of an oscillation is crucial, then a stimulation also should be possible by means of the remaining sense organs, e.g. the nose, the tongue or the skin. The smell after all already could be identified as vortex information (fig. 9.0). Fragrances of natural essences can significantly influence the frame of mind. But as long, as we still haven't understood the physics behind it, we technically hardly are capable to generate equivalent vortex modulations artificially.

24.2.5 The gem therapy.

Already the holy Hildegard von Bingen (1098-1179) knew and used the beneficial effect of gems. Physical background of this at first purely empirical form of therapy is the characteristic eigenfrequencies of the gems, which are picked up as stimulation over the skin. Because gems represent a mixture of various molecules, the oscillations in the atomic hull will overlap, so that overlapping and beat frequencies can form with wavelengths in biological relevant areas. There even can form modulations, which are carrying information. The effectiveness again is linked with the resonance condition, which must be fulfilled between the gem and his carrier.

24.2.6 Meditation and self-therapy.

There even exist people, who don't need any technical aid at all to get rid of unpleasant resonances. Some meditate and go into resonance with themselves, whereas others prefer to love a person, to whom they feel „attracted" or with whom they are „on the same wavelength", which means as much that they go into resonance with this person. In the Catholic Church for instance the priests are not allowed to get married, because they should be in a resonance with the church and with God.

<i>:: Dr. Bodo Kohler: Die Coloroma-Therapie, Der aussergewohnliche Einsatz von Aromen, Co'Med 4/2000, S. 48-52

<ii>: Cousto: Die kosmische Oktave, Synthesis Verlag Essen 1984

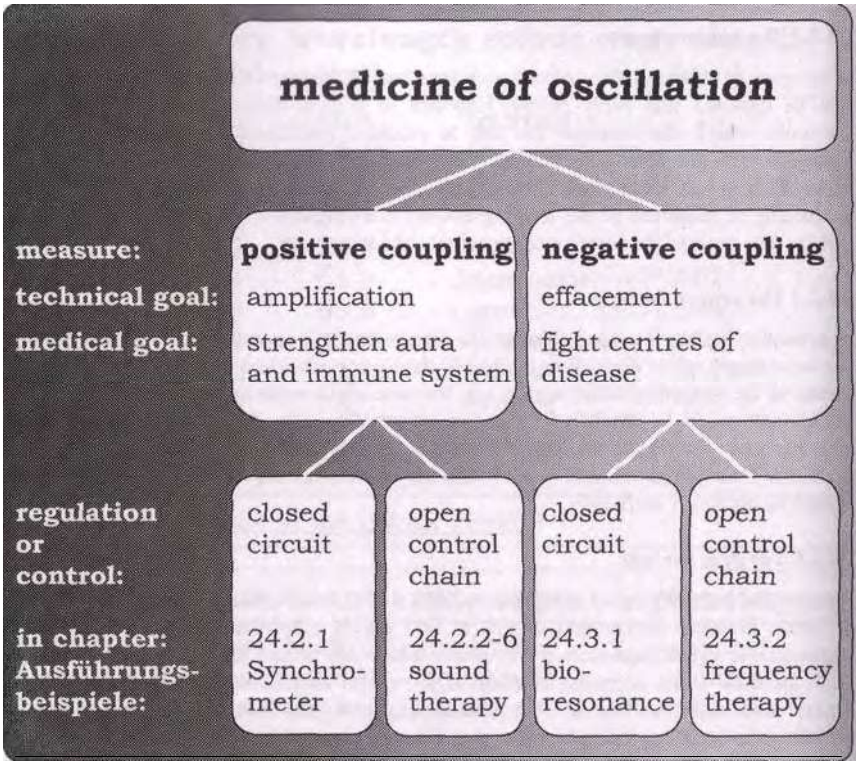

Fig. 24.3 A: Structure concerning the medicine of oscillation

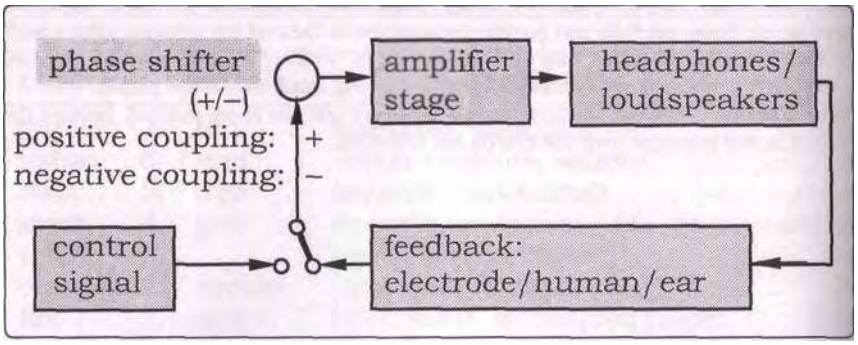

Fig. 24.3 B: Regulation or control?
Positive or negative coupling?

24.3 Systems with negative feedback

For negative sign it concerns negative coupling. In this case the signals are subtracted. The signals released by a person are played back to him with opposite phase. This method lies in the domain of the bioresonance.

24.3.1 The homeopathy

The concept, which is pursued by the medicine of oscillation in the case of the bioresonance, is that harmful or ill making oscillations should be effaced. Not the direct, but rather the indirect strengthening of the immune system is to the fore, which should be reached by relieving it. The approach with that pursues the same goal as the pill medicine, where oscillations, which should produce a wanted effect and which are bound by means of substances are supplied to the body.
The disadvantage of the administration of pills is the often toxic effect of the carrier substance. The German doctor Samuel Hahnemann (1755-1843) has demonstrated a way, in which to make the helpful and important information for the body to go over from the carrier substance to the water by diluting with water and by shaking. The water molecules now oscillate in time of the carrier molecules. Interestingly in doing so not even the information gets lost, the modulation thus is preserved. By constantly shaking there even occurs an amplification or a „potentiation", as Hahnemann expressed himself, because now every carrier molecule reaches and modulates countless water molecules. Thus the amount of water informed is bigger than the amount of the original chemical substrate. In the case of homeopathy like is treated with like. If for instance a poison causes certain complaints at a healthy person, then in "homeopathic" administration this information helps a sick person with similar complaints. There thus occurs a disturbance activation with opposite phase, as the engineer uses to express himself. Despite a widespread scepticism the method of homeopathy indeed seems to function, and it has stood the test in countless cases.

24.3.2 The bioresonance

A technical realization is represented by the bioresonance. For that endogenous oscillations are called off by means of an ECG (electrocardiogram), an EEG (electroencephalogram) or a MEG (magnetoencephalogram) at the surface of the skin. The technical device then shifts the phase for 180 degrees and amplifies the signal to the extent that pathological frequencies are extinguished for reversely directed input. This very reasonable theoretical concept in practice of course only is as efficient, as the empirical determined pathological frequencies are the cause of a disease and not only represent an unimportant symptom as side effect.
To that technical problems are joining. Prof. Heine blames the constantly changing reaction diversity and the thermal noise for the circumstance that the „frequency spectrum permanently is fluctuating", as he writes if*. That hardly can realize the necessary phase inversion. We meanwhile know that vortices have a fluctuating frequency spectrum, that in the case of biosignals it concerns such field vortices, which result in a noise signal unspecific in frequency.
With this knowledge we should be able to significantly improve bioresonance procedures, and even the inversion of phase shouldn't represent an insurmountable difficulty anymore.

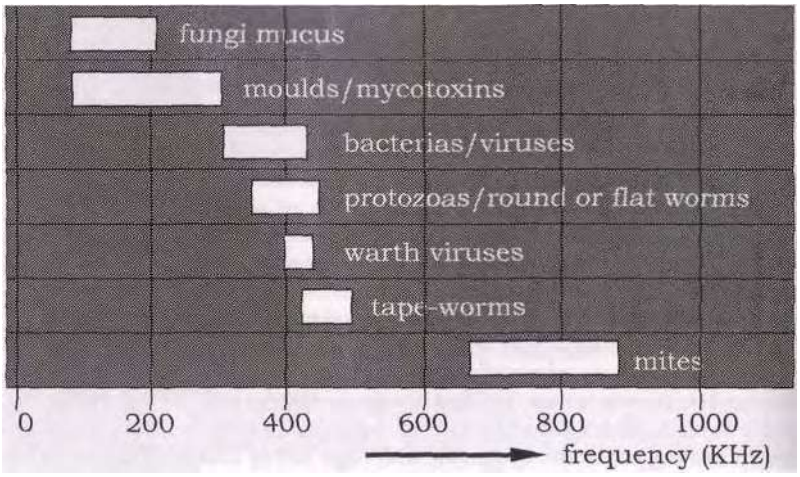

Fig. 24.3 B: Frequency spectrum of parasites according to Clark.[i]

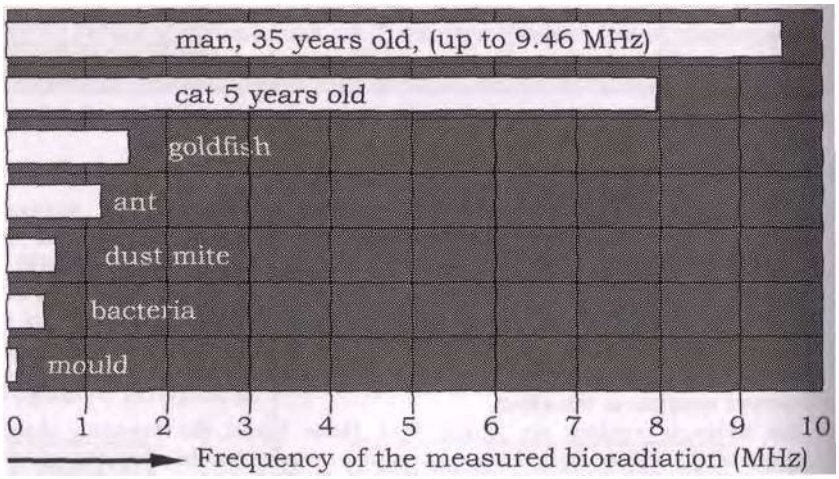

Fig. 24.3 C: Diagram of frequency ranges for some living beings.[i]

<i>: Dr. Hulda Clark: The Cure For All Diseases (1995), Page 604-643

A further problem, which Heine addresses, can't be denied[ii]: „For communicative molecule oscillations the microwave range of 1 GHz up to above 10000 GHz is crucial. A calling off of endogenous interference oscillations in this range with the help of normally used electrodes is not possible"[iii]. It thus could happen that essential frequencies, which are directly related to a disease, aren't recorded at all and as a consequence also not treated. There even is the risk of informations being brought in, which additionally stress the immune system instead of relieving it, that the patients after a treatment are worse off than before. The doctor or therapist is burdening himself with a big responsibility, when, how and at whom he applies methods of bioresonance or if he better does without them. For the mentioned reasons the method in the therapy only plays a secondary role. The bioresonance on the other hand is quite often and with great success used in the diagnosis (Nosoden), if it for instance concerns the determination of an incompatibility or an allergy - but that is a completely different theme. For the bioresonance the transition of diagnosis to therapy is however floating.

24.3.3 The frequency therapy

If using a frequency therapy the problems are standing similarly. If we separate the closed and negatively fed back circuit of a bioresonance and form an open control chain consisting of a technical control device and the patient, then we get the structure, as it is put to use in a frequency therapy. The goal still is the same: parasites or pathogenes, which stress and burden the immune system should be fought.
But a disadvantage of every open control chain is that the treatment at first occurs blind due to the missing feedback.

The natural healer Dr. Hulda Clark has examined as support various pathogenes and parasites under the microscope, while she has varied the frequency and at the same time applied a low-tension voltage. Doing so she could observe the dying of bacterias and parasites at certain frequencies. Correspondingly she publishes tables, in which the in each case „mortal" frequencies are listed[i].
Hut without being able to verify the success of a treatment in the living organism, she proceeds from the assumption that by applying a low tension voltage (5-10 Volt), as it is produced at the output of a commercially available frequency generator, if a sinusoidal signal is set with the appropriate frequency exactly the associated parasites and leeches will be destroyed. Doing so a fixed rhythm of pauses and treatment times must be adhered to (7 min on, 20 min off, 7 min on, 20 min off and 7 min on).

The doctors and therapists treating with this particularly inexpensive method report amazing results, inexplicable spontaneous cancer cures, like of HIV-positive patients, who after the treatment were tested HIV-negative. But also the inverse case already should have occurred, that a HIV-negative patient afterwards was HIV-positive! Here too clear the limits of this method appear, which in practice unfortunately turns out to be relatively unspecific.

<ii>: Prof. Dr. H. Heine: Grundregulation und Extrazellulare Matrix - Grundlagen und Systematik, Lehrbuch der biologischen Medizin, (1991) 2.Aufl. Hippokrates Verlag Stuttgart, Seite 63

<iii>: U. Warnke: Bioresonanztherapie - Wunsch und Wirklichkeit. Medizin transparent Nr.2 (1996) S. 36-37

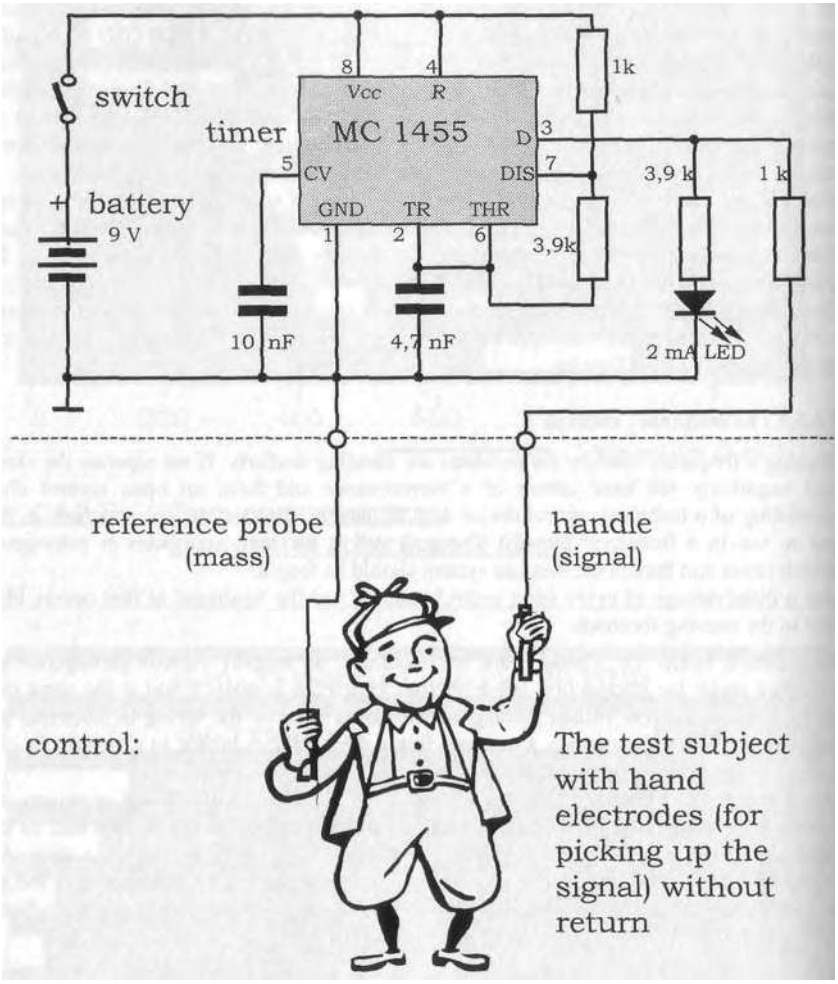

Fig. 24.4: Wiring diagram of the Zapper.<i>

Wiring diagram taken from:

<i>: H. Clark: The Cure for All Cancers (1993) New Century Press, USA, Page 507, resp.:

Dr. Hulda Clark: The Cure For All Diseases (1995), Page 48

24.4 The Zapper

From the point of view of physics of today the frequency therapy actually shouldn't be able to function at all. The electromagnetic waves penetrate only few millimeters into the skin at the used frequencies and wouldn't have the slightest chance, to reach a parasite, which is staying somewhere in the body. But it is said that it is possible to cure athlete's foot, by the patient taking the electrodes in his hands. How, we ask the question, does the signal of the function generator know where it should go?
It quite obviously concerns a resonance phenomenon. The likewise emitted scalar wave part tunnels undamped at those places in the body, with which it can build up a resonance and that for proper tuning are the unloved parasites. The scalar wave radiation is bundling up at the resonant receiver, so that despite the low transmission power as a consequence of the bundling up the energy density for the parasite becomes very high. It as a result is destroyed by its own ability to go into resonance. Once it is killed, the next one goes into resonance, logs off as well etc. In this way the parasites are destroyed one after another and not all at once. That's why the specified treatment cycle makes sense.
The copper electrodes should not be taken in the hands directly, Dr. Clark recommends, but before be wrapped with moist paper. By means of this insulating layer, so is my interpretation, the conventional wave part, for which the skin functions as a wave guide, is reduced whereas the desired scalar wave part is increased. Such measures crucially contribute to the success of a therapy method, even if they were determined purely empirical.

If one wants to address every possible parasite individually, then the treatment takes correspondingly long. If one on the other hand sends all relevant frequencies at once by overlapping them, then the treatment can be abbreviated to the duration of one session. If the therapist goes still further and replaces the sinusoidal signal by a rectangular signal, then infinitely much sinus functions are hidden in it, as a Fourier analysis shows. With a rectangular signal, as it is delivered by the Zapper, one as it were catches everything, Good as well as Bad. There the helpful intestine bacterias break exactly like the wrongdoers.
The treatment with the Zapper is simple, inexpensive and exactly as controversial. It is the shot with the shotgun in the forest. One always hits something. We nevertheless must ask the question, why one only hits parasites and bacterias and not the vital organs? Aren't those damaged also?
Now then, the signal of the function generator is not modulated; it doesn't carry information. That's why only monocellular parasites, which don't know information exchange, are capable of a resonance. Human cells and more than ever whole organs on the other hand work with complex modulations, which effectively prevent any formation of resonance with the technically generated basic wave, with which the question would be answered so far.
That however also means that immune reactions can be expected: If the first treatment with the frequency therapy still is successful and all simple parasites could be hit, then only further evolved parasites have been spared, which modulate their information. They now breed and can't be reached anymore in further sessions. The method suddenly doesn't function anymore, the therapist finds out, the body apparently has become immune.

scale:		diatonic	chromatic	spiral
sound:		•1/C =	equally tempered	(medieval)
octave	C´	2/1 = 2.0	2.00 →	2/1 = 2
	1.07 = 16/15		1.33 = 4/3	
seventh	H	15/8 = 1.88	1.89 →	3/2 = 1.5
	1.125 = 9/8		1.125 = 9/8	
sixth	A	5/3 = 1.67	1.68 →	4/3 = 1.33
	1.11 = 10/9		1.07 = 16/15	
fifth	G	3/2 = 1.5	1.5 →	5/4 = 1.25
	1.125 = 9/8		1.04 = 25/24	
fourth	F	4/3 = 1.33	1.33 →	6/5 = 1.2
	1.07 = 16/15		1.03 = 36/35	
third	E	5/4 = 1.25	1.26 →	7/6 = 1.17
	1.11 = 10/9			8/7 = 1.14
second	D	9/8 = 1.13	1.12 →	9/8 = 1.125
	1.125 = 9/8			10/9 = 1.11
first	C	1/1 = 1.0	1.00 →	11/10 = 1.1
				goes towards 1!

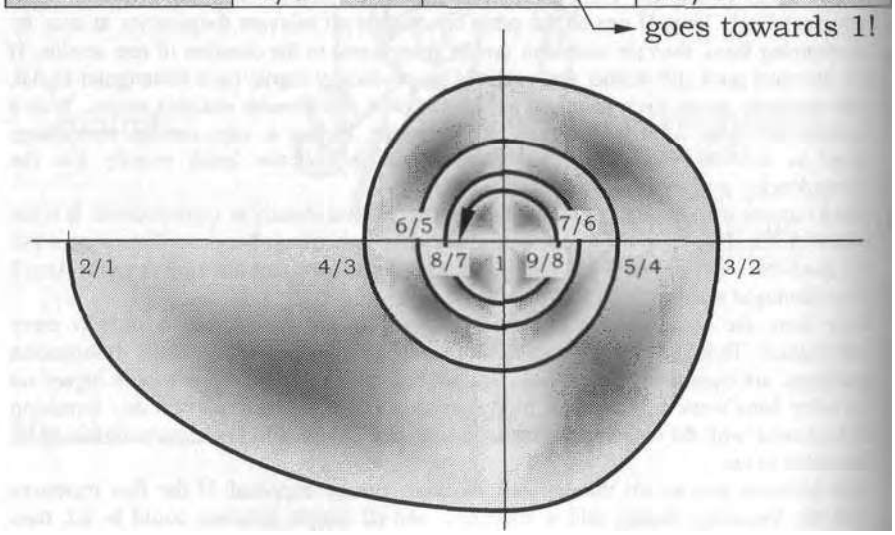

Fig. 24.5: Harmonic spiral built on the first Gregorian scale.[i]

[i]: Dr. Manfred Doepp: Naturgemasse Frequenztherapien, Die Harmonie der Snirale. CO'Med 10/2000. S. 46 - 49

24.5 Discussion concerning the medicine of oscillation

The textbook medicine in its explanations and treatment methods is basing on the models, which it can measure and analyse and which it understands. Doing so man and whole nature is reduced to a handful of chemical reaction formulas. The whole pharmaceutic industry lives on this misleading path, which long ago has revealed to be a dead end, medical as well as financial. This health service cannot be paid anymore and we should ask the question if it actually is worth the money, if with electric signals of minimum power can be obtained effects comparable to the effects of the pill medicine. We need a new medicine, a potential vortex medicine. First of all we should research how an organism covers its energy needs and how it communicates. There leads no way past the scalar waves and the newly discovered potential vortices. Chemical processes as they are being observed, occur by the way, that is beyond doubt, but they by no means are the cause. Hence of pills and other chemical means at most a treatment of symptoms and a case of side effects may be expected but not a cure of a disease. Once the potential vortex medicine will be systematically explored and be put to use in practice, healing successes can be expected, which we at present can't imagine at all.
The amazing results, which already today are obtained in the medicine of oscillation and of which some doctors can report[<i>], dictates the direction in which the textbook medicine should develop. In the question, which kind of oscillation or which „sequence of sounds" (Fig. 24.5) is the right one, still exists considerable need for research. Some doctors even already work with my new theory and cite whole passages from my publications until now about this theme[<ii>].

<i_a>: Dr. Bodo Kohler: BITsyn, der neue Weg in der Informations-Medizin, Jubilaums-Schrift der Internationalen Arzte-Gesellschaft fur Biophysikalische Informations-Therapie, Bad Nauheim den 6.-8.10.2000, Seite 48 - 56.

<i_b>: Bioenergetische Messverfahren in Theorie und Praxis, Vortragsband der Gesellschaft fur Energetische und Informationsmedizin e.V., Universitat Stuttgart am 17.7.1999.

<ii_a>: Dr. Johann Lechner: Storfelddiagnostik, Medikamenten- und Materialtest, Teil 2 aus der Reihe: Praxis der Ganzheitlichen Medizin und Zahnmedizin, Verlag Dr. E. Wuhr (2000), Kap. 2.4.2 Beruhrungslose skalarwellentragende Informationsubertragung S. 173 ff., bes. Kap. 2.4.2.3 Seite 175, 176.

<ii_b>: Dr. Reichwein, Peters: Zellulare Elektromagnetische Systemsteuerung, Der Freie Arzt 5 (2000) im Wissenschafts-Forum (Anhang, S. IV - XXIII).

<ii_c>: Dr. M. Doepp: Tesla-Wellen, Neue Studien, CO'Med 5/2000, S. 94 - 95

Frequency spectrum of the human organism:

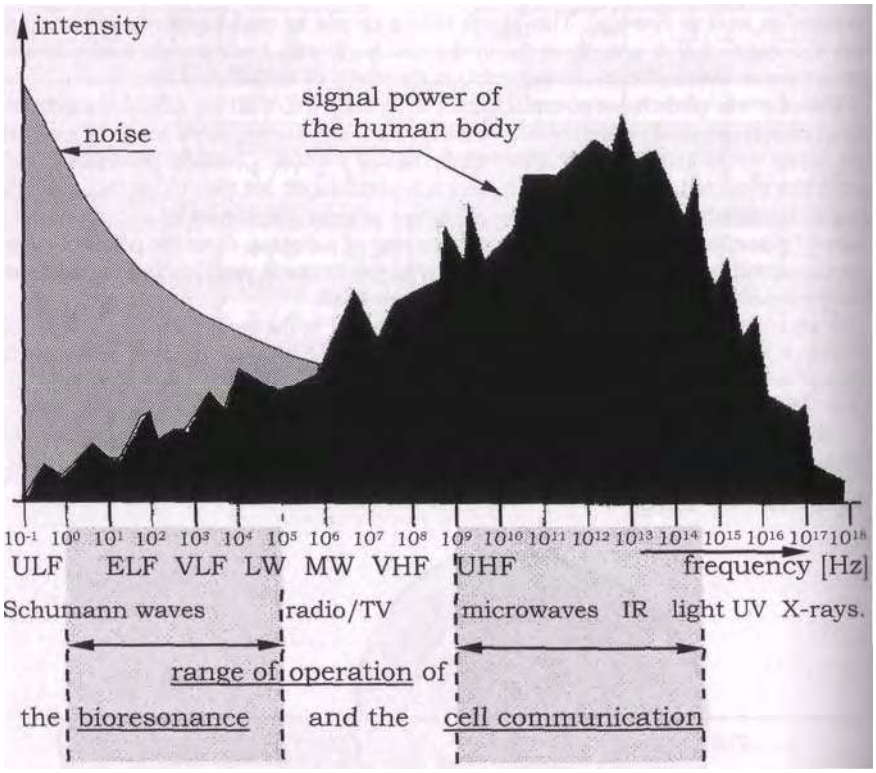

Fig. 25.1: The measured frequency spectrum of man.<i>

<i>: Dr. P. Bembenek: Akupunktur und (Bio-) Resonanz, CO'med 6/98, S. 50-58

25. Contributions to the discussion concerning the information technical use

The medical research predominantly takes place with statistical methods. This might be changed fundamentally, if only the physical relations have been realized and their causes found out. Only then a basic research will be possible also in the area of medicine, as it today already is usual in other disciplines.
In this chapter it concerns the question of the medical basis in general, and specifically the question of the use of the newly discovered potential vortices in biological systems. Doing so very aware is attempted to put the normally used medical view at the back and to derive the answers from the perspective of the engineer and the physicist. This approach is unfamiliar, so that some textbook physicians will have difficulties to follow. It however will prove to be very helpful. Medicine in addition needs new impulses and that justifies a new approach, like the unconventional one proposed by me.
In this connection gladly is fallen back upon the comparison of biological with technical systems, although here exist differences in principle and fundamental It can be expected that nature has developed very appropriate strategies to solve certain tasks, as it also is teached in engineering and used in practice. At this place not only medicine benefits from new insights, engineering vice versa also can learn of nature, because natures optimization strategies are much much older and correspondingly perfect.

25.1 Window of the sensuous perception

To clarify the inner processes in man we consider his sense organs, which function as interface to the outside world. Technically seen in the case of the sense organs it concerns measurement converters to record and process certain physical values in our environment and their adaptation to pass on the information by means of the nerves. The measurement converters thereby are built more or less complex, which is related to the circumstance that the measurement factors, which a living being needs to orient itself and to be able to survive, are quite different.

It concerns little windows within the frequency spectrum shown in fig. 23.1, which should be analysed. Man for instance chooses the visible frequency window and interpretes it with an assignment to the colours, because in this range the sunlight can reach the surface of the earth and the ionosphere doesn't exert an excessive damping (fig. 2.8).

The acoustic window depends on the sound propagation in air, whereas dolphins work with ultrasound, which carry considerably further in water. The associated measurement converters, the ear and the eye, have a very complex structure. From this can be inferred that here the received signal must be transformed into a different physical measurement signal, that the perceivable signals are of other nature than the signals, which our nerves are able to pass on.

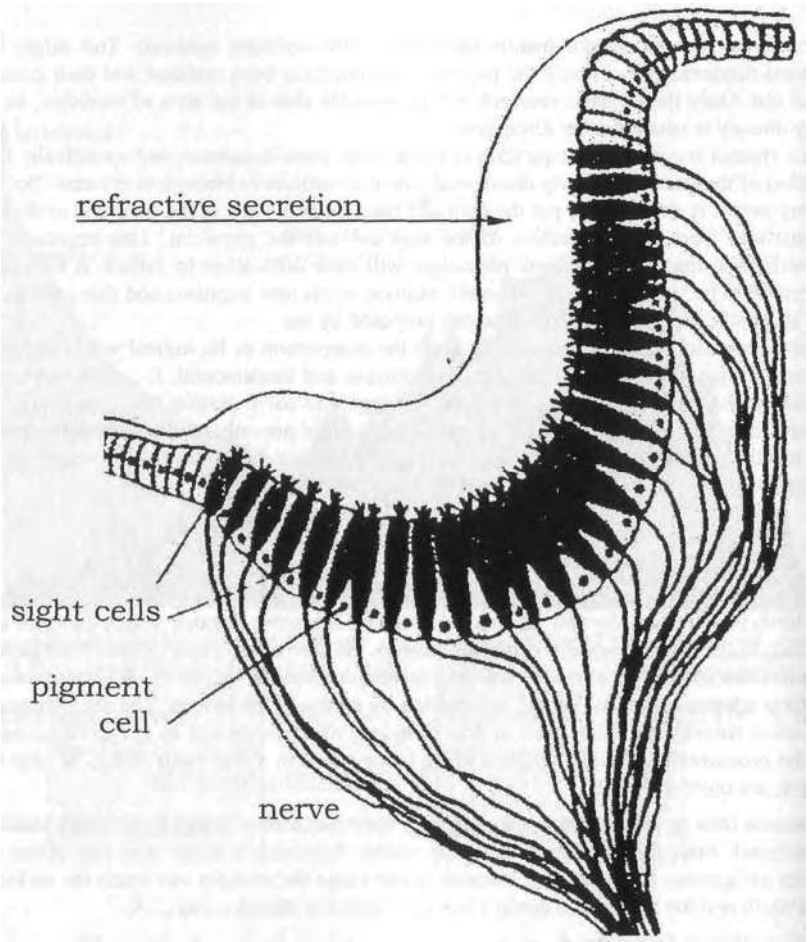

Fig. 25.2: ____ The hollow eye of the snail

25.2 The sense organs (nose, eye, tongue)

If we want to find out something about the nature of the nerve signals, then we should more detailed consider a sense organ, which is constructed if possible simple. In that case it is possible that no signal transformation is necessary at all anymore, because the perceivable variable is exactly of the kind the nerves can process.

The primary and perhaps most ancient sense organ of the living beings is the nose. It is constructed extremely simple. On the one hand according to encyclopaedias it is a chemical sense for the perception of smell materials. Man on the other hand can distinguish several thousands of scents. For that a huge analysis factory with correspondingly much receptors would be necessary, which one searches in vain in the nose between the nasal hairs and the nerves. We from that infer that scent should consist of particles, which are to a large extent identical with the reaction potentials. It thus will concern potential vortices. These ring-like vortices of the electric field again are modulated and carry information, which our brain is able to analyse.

According to the derivation in chapter 9.0 Plato already 2400 years ago knew such relations. The conclusion is obvious that smell is vortex information, which according to the explanation of Plato forms at the transition of waves in potential vortices and vice versa. At the natural philosophers in antiquity the circle of the insights is closed. Modern science just isn't that far.

The hollow eye of the snail functions both as nose and as eye (fig. 25.2). This very ancient combined organ points to a relatively close affinity between both measurement sensors. Possibly in the course of evolution both organs have developed from such a common original form.

In the case of man the smell rods occupied with the nasal hairs of roughly 2 micrometer in length, actually remember of the rods and cones in the eye, with which photons are collected. In both cases, so we can explain the mode of action in accordance with model, the ring-like vortices settle on the rods and run as reaction potentials along the nerve to the brain, which then analyses the modulation.

In the case of the highly developed human eye the light rays first have to traverse the vitreous body and afterwards a pigment layer, before they reach the rods and cones. In this way the electromagnetic wave parts must roll up to vortices, since our nerves can only pass on vortices. The photons can be interpreted as corresponding vortices.

If we compare the eye with a bubble chamber, in which the tracks of ionized particles can be observed and photographed as thin white fog stripes. Here in collision experiments it can be proven that it concerns particles carrying impulse and not waves. But the measurement setup by no means does answer the question if it already concerned particles before they entered the bubble chamber, or if these have formed spontaneously in the presence of the saturated vapour.

It would be obvious, if for our eye the chamber water being under the inner eye pressure would take over the function of the bubble chamber and would take care of the rolling up of the light waves to light quanta.

Example tongue:

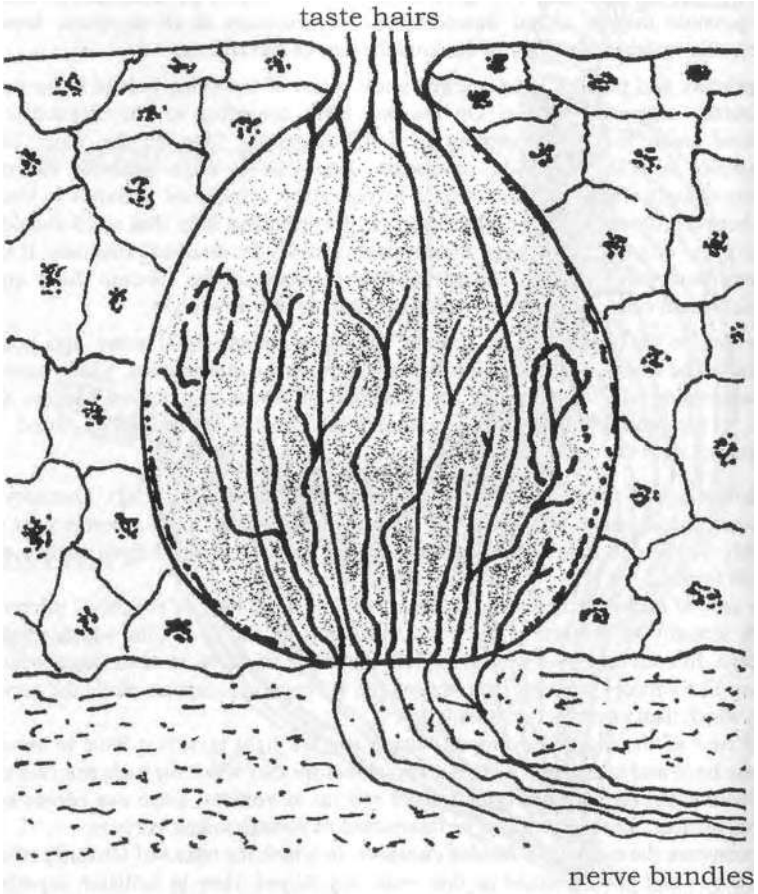

Fig. 25.3: Taste bud of the human tongue

We optically can't detect a difference, if the light while passing through a thick glass plate increases its part of photons. At the latest in the eye in any case all the light is transformed in photons and usable vortices, so that we mustn't detect a loss of brightness. The glass plate seems transparent to us, even if the sunlight should change its composition and its biological quality, if it passes the plate.

If the tongue while tasking responds to dissolved substances, then it not by all means needs to be a chemical excitation. Instead fine hairs, the taste hairs resp. sense pins, serve as receiver like in the case of the nose. The similar structure of the receptors and the circumstance that for most invertebrates sense of taste and sense of smell can't be distinguished of each other at all and consist of the same primary sense cells, suggest that the tongue doesn't analyse the chemistry as such, but only the molecular oscillation patterns, that also the taste is nothing else but vortex information!

25.3 The nerve conduction

For the collection of the potential vortices and the extraction of their information fine hairs in the sense cells obviously play a central role. They are connected more or less directly with the end of a nerve and pass on the information without big transformation. Even in the organs of equilibrium sense hairs work.

From the comparison with the technique developed by Nikola Tesla I could show that the nerve conduction concerns a single-wire transmission, a kind of waveguide, for which the transport of the excitation information takes place in the insulation layer and not in the conductor itself (fig. 9.6). As proof I quoted that the thickness of the insulation determines the velocity of propagation, that as is well-known the nerve conductors with thick fat layer pass on their action potentials faster than those with thin insulation. Particularly interesting is the observation, how the fat layer is constricted in fixed intervals, like for Wiener sausages (fig. 25.4 A). These nodes of Ranvier prove that only longitudinal waves are being transported, which are standing waves with nodes and antinodes, if the distance from node to node exactly corresponds to the distance from one node to the next. With that nature with the use of the potential vortices is far ahead of our power engineering. The nerve-cables determine with their structure, which signal will be transported and which not!

The technical cables on the other hand are stupid and conduct everything, the useful signal just as well as any arbitrary interference signal. Anyone, whom the computer crashes every few minutes, knows what I'm talking about.

Man isn't able to afford a crash of his think computer. It would be lethal for him. His nerve costume even tolerates short-circuits. The acupuncture is such a short-circuit technique by means of electrically conductive needles. There even is given a therapeutic benefit and a relaxing effect for the body.

Cut through nerve fibers even can partly regenerate again, even without a cut through nerve again growing together with its other end. The nerve conductors are so intelligent, that only the matching information arrives at the end by passing on informations from one fiber to the corresponding next with the same node interval.

A. Nerve conduction with nodes of Ranvier (to transmit standing waves):

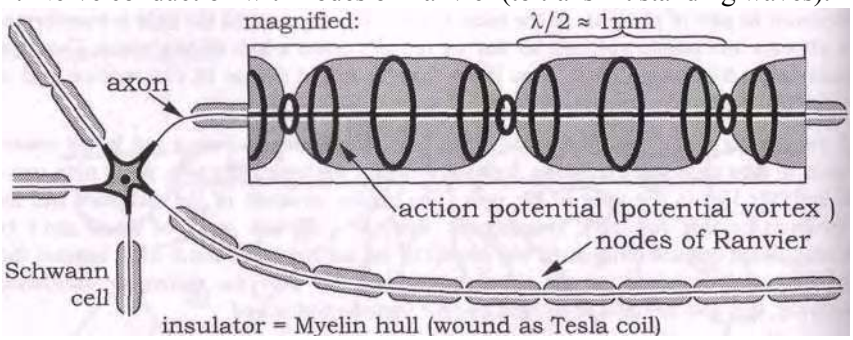

B. Single-wire transmission according to Nikola Tesla<i>:

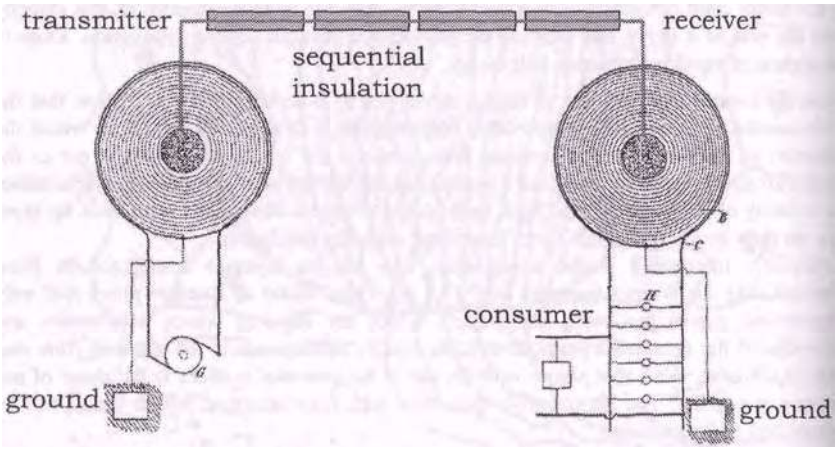

Fig. 25.4: ____ Selective scalar wave signal transmission

The brain works with scalar waves! Reasons are:

1. Lacking of a signal transformer between the nerves and the brain.
2. High performance density of the think apparatus.
3. The brain activity measurable from the outside with the EEC
4. Spark formation and corona discharges at open top of the skull.
5. Insulation defect occurring in the case of epileptics.

<i>: Original sketch of Tesla is situated in the Nikola Tesla Museum, Belgrade.

Nerves represent an intelligent and at the same time interference safe wiring, which is superior to any technical solution by far, or you can try to acupuncture a cable cord of your computer. You will have little pleasure of it.
Nikola Tesla also in this point was ahead of the times. He has experimented with a single conductor technology, for which the insulation layer is constructed like for a nerve fiber (fig. 25.4 B). We'll have to learn to handle such aids in the future, if we in engineering want to emulate nature and as well want to send informations as scalar wave. A normal power cable as said conducts everything, useful as well as interference signals. If however the signal should be accomodated in the noise, a selective cable is required, which should be constructed according to the example of the nerve conductors. Before a scalar wave technology can be introduced and successfully used according to that completely other cables, coupling elements, amplifiers and other components should be developed. The trouble should be worthwhile at the chances, which this genial technology offers us!

25.4 The brain, a scalar wave computer

The brain cells (neurons) are of the same kind as the nerve cells. Hence can be done without a signal transformer, can the informations transmitted by the nerves to the brain directly be processed further. From that follows that also the brain without exception works with potential vortices. There are several reasons for this hypothesis:

1. as said, the lacking of a signal transformer.
2. the high performance density of the think apparatus. (As a result of the concentration effect of the potential vortices the efficiency of the human brain is in such a way high concentrated compared to the much more space claiming computers functioning on the basis of currents).
3. the brain activity measurable from the outside with the EEC
4. spark formation and corona discharges at open top of the skull. (Brain surgeons can report of such observations).
5. The insulation defect occurring in the case of epileptics. (During a fit instable potential oscillations of the nerve cells occur, which lead to strong electric blows).

With the ,,exciting" and the inhibiting"' synapses as separation point between the neurons both a ,.high-active" and a ,,low-active"' method of operation is possible and with that a redundant, particularly interference safe signal transmission.
Safety for interference is very important not only in nature. In the operating instructions of a PC can be read: ,,operate only at room temperature, keep dry, don't throw or shock, take cure for sufficiently cooling air, ground apparatus, pay attention to mains voltage, etc". A comparison with the range of operation of man is like scorn.
Nevertheless the consequences if errors occur are quite similar: a garage door, which opens if a mobile is switched on, by all means can be compared with a light phenomenon, which we perceive after a blow on the eye at the biological level.

Concerning signal technology:

The **comparison** of	**man** and	**engineering**
signal line:	**nerves**	**cables**
transmission:	selective (nodes of Ranvier)	indiscriminate (with interferences)
of: by:	scalar waves potential vortices	currents charge carriers
running of cables: over:	1-wire technology wave guide	2-wire technology supply and return cable
signal transport:	in the insulator	in the conductor
signal form:	concentrated	expanded
the conductor:	stays cold	gets hot
result, transmission:	without losses	with losses
error signal:	muscle cramp	malfunctions
metal pins: cause:	**acupuncture** relaxation	**short-circuit** destruction
directional signal by:	synapses	diodes/ amplifier
redundancy by:	exciting and inhibiting synapses	high-active and low-active drivers
precaution: by:	skin resistance salt	shielding metal case
strategy:	vortex decay	field displacement

Fig. 25.5: ____ Comparison of the signal technology

25.5 Concerning signal engineering

By means of a technical analysis of biological relations completely new interpretations result also for the occurring of a disease. We permanently and everywhere are surrounded by noise signals, but as a rule they can't touch us, because the body has developed perfect strategies for defence. The nodes of Ranvier on the nerve bundles here are just as helpful as the diode effect of the synapses. By means of the salt content and the skin resistance the body in addition controls the uptake of potential vortices from its surroundings, by using that the vortex decay is determined by the conductivity.

The specialties of the by humans used signal technology come to light particularly clear if compared with the cable technology used in the technical world (fig. 25.5). So is worked with only one wire instead of with supply and return cable, are mediated potential vortices instead of charge carriers, does the transmission take place in the insulator without losses and not in an electric conductor, which as a result gets hot and produces current heat losses. Nerves thanks to their ability of selection represent an intelligent form of signal transmission, by helping to filter the asked information from the noise. This surely is necessary since with cables, which indiscriminately transmit every signal, an use of scalar waves hasn't succeeded yet. We should try to learn of nature!

A special challenge is the protection against error signals. A passive shielding by a metal case however is not possible, because scalar waves can't be shielded by principle, so that the precaution should be taken actively by means of the conductivity. That's why we sweat salt if we strain us physically, whereby the vortex decay is determined by the conductivity, which depends on the salt content of the body liquids. In the case of a sweating activity the body reduces its conductivity, so that the needed potential vortex energy will reach the cells.

If the body sometime isn't able to defend itself against interference signals, then malfunctions or pathological reactions are a possible result. During having a bath for instance a muscle cramp can occur, if the body doesn't defend itself fast enough or sufficiently against the high potential vortex activity in the water. Now vortices can be picked up in the nerves, which are of the same kind as the ones emitted by the brain, only that both muscles, biceps and triceps at the same time get the signal to contract. The result is a cramping of both muscles.

Thus the brain has developed intelligent strategies to protect itself of interspersed misinformations. It weighs the incoming signals and forgets again all unimportant ones more or less fast. We speak of the ability to learn and that means that signals rise in the valuation scale and with that are stored longer, the more frequent repeated our brain receives them. This strategy assumes that interference signals only occur sporadic, for which reason they are rated unimportant and fast are again forgotten. A PC on the other hand doesn't have such a property. It notices everything indiscriminately and sometime will crash of overload, if not the user will constantly foster it and will administer the available memory. A PC is and stays stupid.

Concerning the stability against interference:

The **comparison** of	**man** and	**engineering**
in the	**brain**	**computer**
control technical interference signals:	light phenomena	miscontrol, program fault
precautions:	active, i.e. weighing of the Info by learning (repetition)	passive, i.e. shielding. (no evaluation of the input values)
unimportant (interference signal)	is forgotten	is stored
danger exists for signals	recurring interference patterns (see mobile telephony)	interference of all kinds (s.EMC-standardization)
remedy:	self-cure	restart (reset)

Concerning set of difficulties of wear and tear:

The **comparison** of	**man** and	**engineering**
repair	self-repair	in the workshop
by:	cell division permanently	exchange parts at maintenance resp. in the case of damage
required building materials:	nourishment	material / oil
waste:	compost	rubbish

Fig. 25.6: ____Strategies against interference signals, for damages linked with operation and for wear and tear.

25.6 Stability against interference and repair mechanisms

The interference signals present in our natural environment as a rule are distributed stochastic, but not so artificial interference signals like for instance transmitters emit. If for instance in the case of mobile telephony there occur time and again identical signal patterns and if a person perceives these, then because of the continual repetitions a high importance is pretended and precious storage space in the brain is allocated. This to a special extent applies for the permanent stand-by signals, which are emitted by mobiles and cordless phones even then, if we don't phone at all. Such misdevelopments thereby would be technically avoidable just like that!
If still no gauges are available and as a result there exist neither guidelines nor limits for the radiation exposure of scalar waves, then such devices must be developed and built. For the requested electromagnetic environmental compatibility not engineering, but man should be in the centre of attention!

Let us throw a short glance at the set of difficulties of wear and tear. Most technical devices find the way into the workshop only, if they already are defect. Some aren't repaired anymore in principle and immediately sent to the rubbish, because they are worn-out and a repair isn't worth the effort anymore one says, whereas other, mostly expensive systems are being serviced by exchanging all wearing parts.

Nature has brought to perfection the last principle. It allows the body a permanent maintenance; by permanently producing new cells and replacing consumed ones. It with that obtains a considerably longer operating time and even is capable to heal wounds. Just imagine dents in our cars would disappear from alone after a few weeks and the bodywork would look like new. Such an optimal maintenance is costly and it has its price. By means of the cell division the building plan for the spare parts is copied. The task on the other hand is transmitted to the new cells „by radio" by means of waveguide channels, as proves the matching structure of scalar wave and waveguide (chapter 21.12 and fig. 25.7). The cells hence have a kind of „decentral intelligence", which technical matter lacks completely. A comparison with engineering nevertheless makes sense, because wear and tear occurs for all systems in continuous operation. Thus strategies must be developed to provide the necessary material for operation, building-material and exchange parts.

By sizing of the hyperboloid structures of the matrix channels it should be possible to determine the wavelength of the scalar waves to enter them in the frequency diagram (23.1).

Tunnel structure of the basic substance according to Prof. Heine[i]:

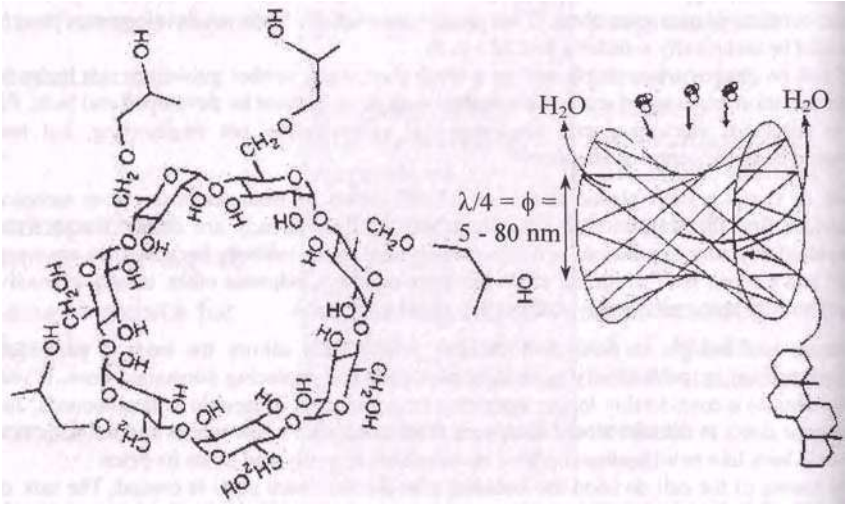

Fig. 25.7: ___ Information channels in the intercellular matrix.[i]

<i>: Hartmut, Heine: Lehrbuch der biologischen Medizin. Grundregulation und Extrazellulare Matrix, 2. Aufl. 1997, Hippokrates Verlag Stuttgart, S. 56

25.7 The microwave window

There still is lacking information about the frequency or the velocity of propagation to be able to specify and enter in figure 23.1 the cell information. Let's take to hand the book about "Biostrahlen"[<i>]. In there is explained how for individual cells the emission of electromagnetic signals already could be measured, which are interpreted as circularly polarized waves (fig. 21.10 A). It is said that thereby their polarization plane is rotating with the speed of light, whereas the wave itself is propagating in longitudinal way relatively slow and according to the authors with the speed of sound. The occupation with the potential vortex theory in the explanation lets immediately recognize the vortex, for this is rotating with the speed of light in circles as rolled up wave (fig. 21.10). If it is bound to the surrounding matter with closed vortex centre, then it can be expected that the propagation actually takes place with the speed of body sound. It could concern the same signals, which Prof. A. Popp calls biophotons and detects measuring technically in living organisms[<ii>]. He however considers the phenomenon for the same wavelength with the speed of light and lands at light frequencies, even then if nothing is glowing visibly! The question is asked: Does it concern the frequency of the light or only the corresponding wavelength or actually both, thus light, as is expressed in the name biophotons?
The photomultipliers, which Prof. Popp uses as „light amplifier", however can only be tuned to certain wavelengths and not to frequencies. Even if the detected biophotons have the wavelength of the light, then nevertheless nothing will glow if the velocity of propagation and as a result also the frequency differs from that of the light for several powers of ten. In the case of the immense number of cells also the number of photons should correspondingly sum up and the body as a whole should start to glow, which is not the case.

The waveguides in the intercellular matrix serving the cell communication, which Prof. H. Heine observes microscopically, have wavelengths between 20 and 300 nanometer, which corresponds to the range of the ultraviolet radiation[<iii>]. But if the propagation is slower than the light for 6 powers of ten, then also the frequency will only amount to one millionth and be situated into the range of the microwaves. Here a biological window seems to be present, to which we should turn our attention for reasons of the electromagnetic environmental compatibility!

The thermal radiation, which reaches the earth from the sun and the planets, lies in the microwave range between 2 and 20 cm. If the sun does well to us, if we need the radiation, then it could be because of the identical frequency. But that also means that the sun and the planets are capable to have an effect on the cell communication, that they for instance could function as clock for the heart.

<i>: H. Mayer, G. Winklbaur: Biostrahlen, Verlag ORAC, Wien 1989, 5. Auflage S. 97: Messung von der DNS eines Gurkenkeims abstrahlenden Photonen.

<ii>: A. Popp: Neue Horizonte in der Medizin, 2.Aufl. Haug Verlag Heidelberg 1987

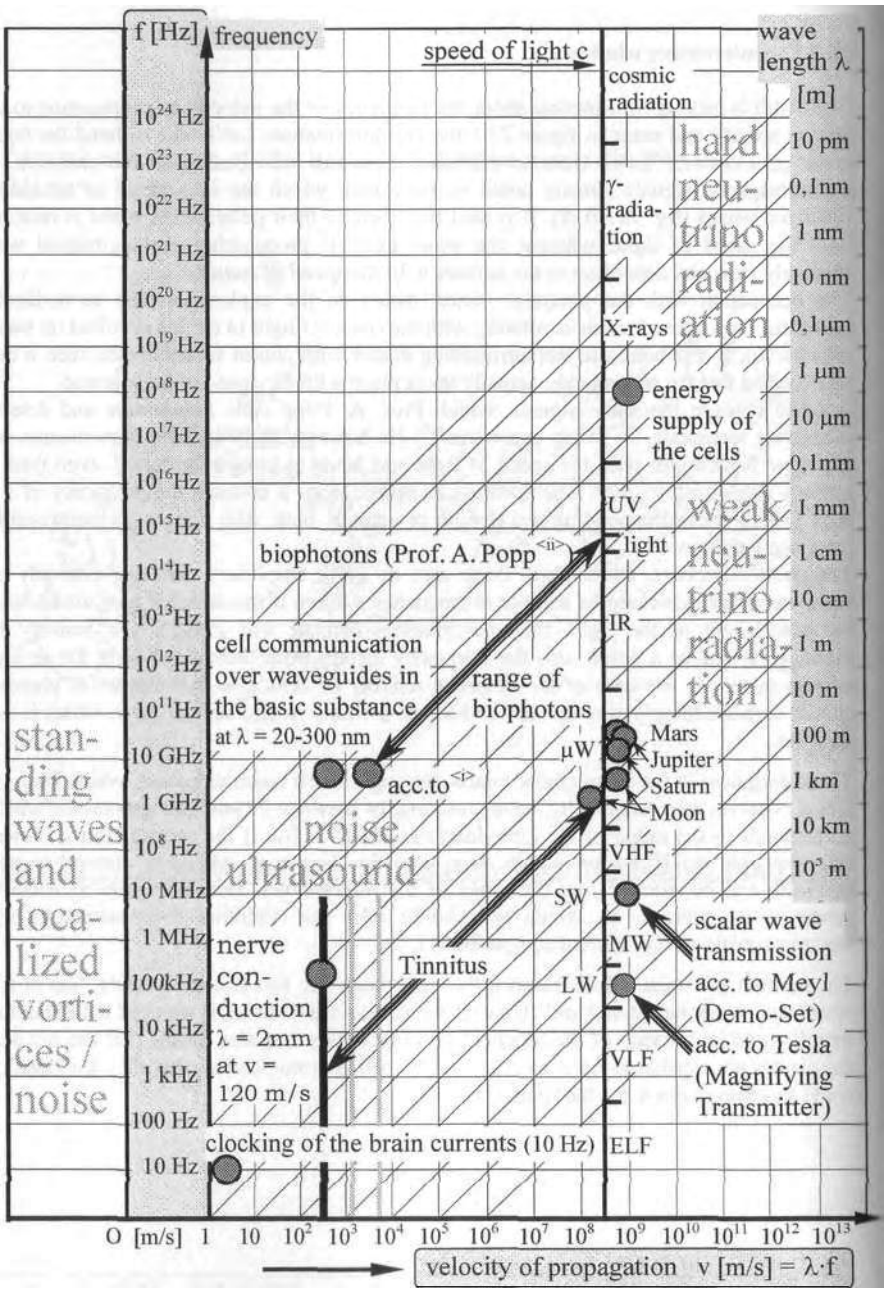

Fig. 25.8: Frequency diagram with entries concerning biologically relevant areas (Tinnitus, nerve conduction, etc.).

25.8 Discussion concerning scalar wave medicine

In the sensitive range of the supposed microwaves window however are also situated the mobile phones and their harmonic waves, which occupy a broad spectrum in particular for pulsed operation in digital nets. The D-net for instance has a wavelength of 32 cm, the E-net lies at half that wavelength. But to which frequency does this correspond at the speed of sound? Now, the frequency is 6 powers of ten smaller and now lies at 1 kHz resp. 2 kHz. To that are added the numerous harmonic waves, which form a noise signal and lie above that. With that these signals are situated completely in the audible range, there where our ears are most sensitive!
This cause we probably owe the disease of modern civilization „Tinnitus". Every charged particle will follow this electromagnetic oscillation and produce corresponding sound oscillations, which can hear not „sick ", but completely on the contrary „healthy" people, who as a result possibly get sick. The objection, in this range also cosmic radiation for instance from the planets is present, is legitimate. It however should be considered that planets also are going away from the earth again and in addition is present a fluctuation according to the time of day due to the rotation of the earth, while the mobile telephone masts in our vicinity radiate in continuous operation.

In this window in addition the clocking of the brain currents takes place at 10 Hz. I would recommend blocking the acoustic relevant range between 2 cm (16 kHz) and 3 m wavelength (100 Hz) for all technical use. Every operation of a transmitter in a biological window harms all people and cannot be answered for by any institution.

It further should be considered that the biological window of the plants and animals as a rule correspond to that of man, but sometimes are shifted significantly upward or downward in wavelength. We are not entitled to judge nature. The immune system of the animals now obviously has reached the breaking point and also that of man doesn't seem to be that anymore, which it originally was.
We must proceed from the assumption that many diseases on the one hand and therapy methods on the other hand partly direct and partly indirect have to do something with scalar waves. (E.g. the occurring of cancer[<4i>]).

<i>: H. Mayer, G. Winklbaur: Biostrahlen, Verlag ORAC, Wien 1989, 5. Auflage, S. 97: Messung von der DNS eines Gurkenkeims abstrahlenden Photonen.

<ii>: A. Popp: Neue Horizonte in der Medizin, 2.Aufl. Haug Verlag Heidelberg 1987

<iii>: Hartmut. Heine: Lehrbuch der biologischen Medizin. Grundregulation und Extrazellulare Matrix, 2. Aufl. 1997, Hippokrates Verlag Stuttgart, S. 56

<4i>: K. Meyl: Skalarwellenstrahlung. Welche Bedeutung haben Skalarwellen fur die Medizin? GNP-Vortrag am 29.04.2001, Rhein-Main-Halle Wiesbaden, see: Co'med Fachzeitschrift fur Komplementarmedizin, 6/2001, pp.55-60.

I. According to the Maxwell theory:

1. Faraday's law of induction:

$$\text{rot}\,\mathbf{E} = -\,\delta\mathbf{B}/\delta t \quad (26.1)$$

with E = E(r,t)

and H = H(r,t) : $\mathbf{B} = \mu \cdot \mathbf{H}$ (26.2)

$$-\,\text{rot rot}\,\mathbf{E} = \mu \cdot \delta(\text{rot}\,\mathbf{H})/\delta t \quad (26.3)$$

2. Ampere's law:

$$\text{rot}\,\mathbf{H} = \mathbf{j} + \delta\mathbf{D}/\delta t \quad (26.4)$$

with:

Ohm's law: $\mathbf{j} = \sigma \cdot \mathbf{E}$ (26.5)

dielectric displacement: $\mathbf{D} = \varepsilon \cdot \mathbf{E}$ (26.6)

relaxation time: $\tau = \varepsilon/\sigma$ (26.7)

$$\text{rot}\,\mathbf{H} = \varepsilon \cdot (\mathbf{E}/\tau + \delta\mathbf{E}/\delta t) \quad (26.8)$$

3. Inserting equation 26.8 into 26.3 yields:

$$-\,\text{rot rot}\,\mathbf{E} = \mu \cdot \varepsilon \cdot (1/\tau \cdot \delta\mathbf{E}/\delta t + \delta^2\mathbf{E}/\delta t^2) \quad (26.9)$$

with the abbreviation: $\mu \cdot \varepsilon = 1/c^2$ (26.10)

4. Field equation of a damped transverse wave:

$$\underbrace{-\,\text{rot rot}\,\mathbf{E} \cdot c^2}_{\text{transverse}} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{\text{wave}} + \underbrace{(1/\tau) \cdot \delta\mathbf{E}/\delta t}_{\text{vortex damping}} \quad (26.11)$$

Fig. 26.1: ____ Derivation of the wave damping by means of the formation of vortices![i]

[i]: see also EMC, part 1, chapter 5.3, 2.borderline case.

26. Recapitulation from the viewpoint of textbook physics

Now that we in the meantime have accumulated innumerable mosaic parts as inspiring contributions to the discussion for the information technical seminar, it is time to sort the ideas and to put the parts together to an overall picture.
Sceptics and orthodox scientists can only be convinced, if we start from textbook physics and completely do without postulates. Those demands will be fulfilled!

26.1 Common misinterpretation of the antenna losses

The mathematical description of physical relations leads to the well-known laws, which shouldn't be doubted anymore as soon as they are accepted to be correct. But what about the interpretation? Although a law dictates the interpretation and there is no choice, because laws must be adhered to, yet textbooks from time to time violate the mathematically dictated interpretation, a circumstance, which can't be accepted. I would like to illustrate this with an example.

Let us assume that the measured degree of effectiveness of a transmitting antenna amounts to 80 percent. There exist better antennas, but also distinctly worse antennas, but I'm not aiming at a certain construction. The statement simply says, that 80% of the fed in HF-power is transformed into Hertzian waves. Thus there arises a loss of power of 20 percent, and the question follows: of what do those 20% consist?

The answer, which is usual among experts and is supported by the textbooks, reads: the antenna wire gets hot and also the air around the antenna is heated by dielectric losses. In short, heat is formed.
But I have to point out and will furnish proof that this interpretation is predominantly wrong! It in any case isn't in accord with the laws of Maxwell. Who namely obeys the laws, comes to an entirely different result!

A short derivation brings it to light (fig. 26.1).
We start with the formulation of Faraday's law of induction according to the textbooks (26.1), apply the curl-operation to both sides of the equation (26.3) and insert in the place of rot H Ampere's law (26.4-26.8). The generally known result describes a damped electromagnetic wave (26.11)◁▷.
It on the one hand is a transverse wave, which represents 80% of the antenna power for our example. On the other hand a damping term can be found in the equation, which obviously corresponds to the sought-for 20%. With that the answer would have been found. We realize that because of a damping of the wave 20% antenna losses arise. These losses can't concern heat at all, since the damping term in the equation has got nothing in common with thermodynamics. In the equation doesn't stand anything about heat! Such a mistake!

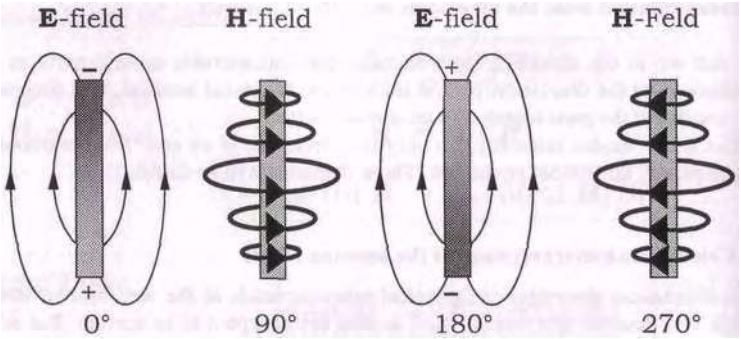

Fig. 21.8 A: The fields of the oscillating dipole antenna.<i>

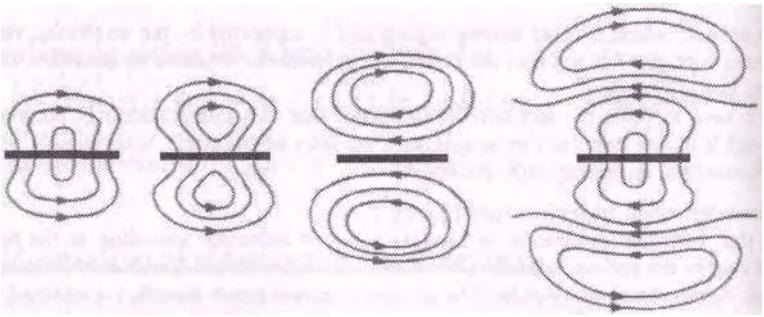

Fig. 21.9 A: The coming off of the electric field lines from the dipole.

<i>: Repetition belonging to chapter 21

26.2 Wave damping by field vortices

- Mathematically seen the damping term describes vortices of the electromagnetic field. This term for instance forms the basis of all eddy current calculations[ii].
- Physically seen some waves - in our example it is 20 percent - roll up to field vortices, with which the wave damping and the antenna losses would be explained.

In the course of time a substantial part of the generated vortices will fall apart. These thereby will produce eddy losses in form of heat. Thus eventually still heat is produced - agreed. The criticism of the textbooks consists of the circumstance that we by no means can proceed from the assumption that all vortices spontaneously fall apart and a total conversion into heat will take place. The process in addition takes place with a temporal delay. The time constant x gives information in this respect. Field energy is buffered in the vortex, where some vortices live very long and it can't be ruled out that a few even exist as long as you like.

To find out more about these field vortices and their behaviour, one has to get deep into vortex physics. Unfortunately nothing can be found about vortex physics in the textbooks. The mistake is systematic. The following short compendium should help close the gap:

- Mathematically seen a closed-loop electromagnetic field vortex will show as a scalar. Such field vortices, which are mediated by a scalar field, are propagating exactly as charged particles in longitudinal manner as a scalar wave.
- Physically seen a closed-loop field vortex has got particle nature. If one particle kicks off the next one then an impulse is mediated, then a shock wave is occurring, a longitudinal undulation of the particles.

From the vortex physical view the interpretation of the antenna example now sounds entirely different:
The charge carriers in an antenna wire oscillating with high-frequency form a longitudinal shock wave. Between current and tension voltage usually a phase shift of 90° is present. The fields produced by these charge carriers form a scalar wave field in the immediate vicinity of the antenna, the so-called near-field zone, which likewise contains longitudinal field components and shows a phase shift of 90° between electric and magnetic field (fig. 21.8 A). As in textbooks is clarified by field lines, the generated fields actually form vortices, where one structure kicks off the next one (fig. 21.9 A).

The vortices in the near-field zone of an antenna consist of standing waves, which obviously are transforming with increasing distance. In our example 80% of these are unrolling and turn into transverse waves, whereby the characteristic phase angle between E- and H-field at that occasion becomes zero.
Let's turn again to those 20 percent loss.

<ii>: s.a.: K. Meyl: Wirbelstrome, Diss. Uni. Stuttgart 1984, INDEL Verlagsabt.

I. According to the Maxwell theory:

The consistent application of textbook physics

- Longitudinal waves run in the direction of a field pointer.
- The field pointer oscillates, the vector of velocity oscillates along!
- At relativistic velocities field vortices are subject to the Lorentz contraction.
- The faster the oscillating vortex is on its way, the smaller it gets.
- The vortex permanently changes its diameter (see fig. 21.10 B).
- With the diameter the wavelength decreases (see fig. 22.4).
- The swirl velocity is constant (= speed of light c).
- The eigenfrequency of the vortex oscillates with opposite phase to the wavelength.
- The vortex acts as a frequency converter!
- The measurable mixture of frequencies is called noise.

leads to the statement:

- The antenna noise corresponds to the antenna losses!

II. Mathematical description of a wave by the inhomogeneous Laplace equation:

$$\underbrace{\Delta \mathbf{E} \cdot c^2}_{\text{Laplace operator}} = \underbrace{-\,\text{rot rot}\,\mathbf{E} \cdot c^2}_{\text{transverse (radio wave)}} + \underbrace{\text{grad div}\,\mathbf{E} \cdot c^2}_{\text{longitudinal (scalar wave)}} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{\text{wave}} \qquad (26.12)$$

Divergence E is a scalar!
The corresponding term founds a scalar wave.

Fig. 26.3: Mathematical description of a wave according to Laplace.

26.3 Laplace versus Maxwell

Longitudinal waves as is well-known don't know a fixed velocity of propagation at all. Since they run in the direction of an oscillating field pointer also the vector of velocity will oscillate. For so-called relativistic velocities in the range of the speed of light c the field vortices are subject to the Lorentz contraction. That means, the faster the oscillating vortex is on its way, the smaller it gets. The vortex, as a mediator of a scalar wave carrying impulse, permanently changes its diameter.
Since, in the case of the vortices, it should concern rolled up waves, the vortex velocity will continue to be c, with which the wave now runs around the vortex centre in a circle. From that follows that if the diameter gets smaller, the wavelength of the vortex as well will decrease, whereas the eigenfrequency of the vortex accordingly increases. If the next moment the vortex oscillates back, the frequency again decreases. The vortex acts as a frequency converter! The mixture of high-frequency signals distributed over a broad frequency band formed in this way, is called noise. A noise signal indeed is measured from the outside with the help of broadband receivers.. We also speak of antenna noise and with this knowledge we can further specify the 20% antenna losses: The antenna produces 20 % noise, which can be put equal to the generated vortices because of the wave damping.

At this point the Maxwell theory doesn't leave us room for interpretation at all. If in the textbooks the impression is aroused, as if the noise were an independent discipline, than that is not true at all. How much the noise is connected with the electromagnetic waves, proves a short look at the wave equation.

The wave equation found in most textbooks has the form of an inhomogeneous Laplace equation. The famous French mathematician Laplace considerably earlier than Maxwell did find a comprehensive formulation of waves and formulated it mathematically (eq. 26.12), which until today is still accepted as valid.

On the one side of the wave equation the Laplace operator stands, which describes the spatial field distribution, and which according to the rules of vector analysis can be decomposed into two parts. On the other side the description of the time dependency of the wave can be found as an inhomogeneous term.

If the wave equation according to Laplace (26.12) is compared to the one, which the Maxwell equations have brought us (26.11), then two differences clearly come forward:

1. In the Laplace equation the damping term is missing. It doesn't describe the formation of vortices, and that means vortices do not exist at all, or present vortices have been there from the beginning.
2. With divergence E a scalar factor appears in the wave equation, which founds a scalar wave.

At this point at once hot tempered discussions concerning the question of the existence of scalar waves blaze up. But this question has already been answered clearly with the vortex consideration. Since an accepted description of longitudinal and scalar waves exists with the plasma wave and the plasma wave can be derived directly without postulate from the term of the wave equation (chapter 21.4/21.5), which founds scalar waves, there are further arguments present for their existence.

I. According to Maxwell:

$$\underbrace{-\,\mathrm{rot\,rot}\,\mathbf{E}\cdot c^2}_{\text{transverse}} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{\text{wave}} + \underbrace{(1/\tau)\cdot\delta\mathbf{E}/\delta t}_{\text{vortex damping}} \qquad (26.11)$$

Description of electromagnetic waves with vortex damping
Example: sunlight and the damping in the ionosphere (bleu sky).

II. According to Laplace:

$$\underbrace{\Delta\mathbf{E}\cdot c^2}_{\text{Laplace operator}} = \underbrace{-\,\mathrm{rot\,rot}\,\mathbf{E}\cdot c^2}_{\text{transverse (Hertz)}} + \underbrace{\mathrm{grad\,div}\,\mathbf{E}\cdot c^2}_{\text{longitudinal (Tesla)}} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{\text{wave}} \qquad (26.12)$$

Description of transverse electromagnetic waves (Hertzian waves) and longitudinal scalar waves (Tesla radiation).
1st example: propagation of light as a wave or as a particle.
2nd example: useful signal or noise signal of an antenna.

III. Mathematically seen (comparison of coefficients):

$$\underbrace{(1/\tau)\cdot\delta\mathbf{E}/\delta t}_{\text{vortex}} + \underbrace{\mathrm{grad\,div}\,\mathbf{E}\cdot c^2}_{\text{scalar}} = 0 \qquad (26.13)$$

IV. Physically seen
(from the comparison of equation 26.12 with equation 26.11):

Vortices propagate longitudinally as a scalar wave!

Fig. 26.2: _____ Comparison of the two wave descriptions.

26.4 Error term in the wave equation

From the comparison of coefficients of both wave descriptions follows even more:

- Mathematically seen the damping - resp. vortex term according to Maxwell can be put equal to the scalar wave term according to Laplace.
- Physically seen the generated field vortices form and found a scalar wave.

Here also doesn't exist any room for interpretation, as long as we work with the wave equation according to Laplace and at the same time adhere to the Maxwell theory. If however the scalar wave part is put equal to zero, as is common practise in the textbooks, then as a consequence neither vortices nor noise may exist. But that contradicts all measuring technical experience! Since every antenna produces more or less noise, the textbooks obviously only show half the truth. Science however gropes for the whole truth and that should be fathomed.

If in the case of the antenna example the vortex part amounts to 20%, then that's tantamount to 20% scalar wave part, resp. 20% noise. The scalar wave part constitutes with regard to the Hertzian useful wave something like an error term in the wave equation. The part definitely is too big, as that it might be put equal to zero. Even so all error consideration in the textbooks is missing, if the scalar wave term is assumed to be zero. That violates all rules of physics and of taught scientific methodism.

In practice this shows by a useful signal going under in the noise and reception not being possible anymore as soon as the scalar wave part gets out of control. Even in this case, for which the degree of effectiveness tends towards zero, it still is common practise to put the error term, which is dominating everything, equal to zero. But who in this point follows the textbooks, disregards with that the wave equation and doing so by no means can refer to the circumstance that all colleagues make the same mistake.

The building of physics behaves like a house of cards, where the cards mutually support each other. Perhaps that is the deeper reason why those, who have discovered a marked card, don't pull it out immediately. In addition they are hindered by the self appointed guardians of the ,,pure doctrine", since everyone knows what happens with the house of cards if the marked card is pulled out. Only, do we want to and can we live with that in the long run? Is it a solution of the problem, if the so-called experts among the physicists and technicians look away and don't deal with the foundation of their branch anymore? If universities crash their basis education into the wall and choke off every contradiction?

Please allow me to pull out the marked card now and place it on the table!

It concerns the question: what is the nature of the field vortices, which form a scalar wave in space. Eddy currents in the iron parts of the antenna are explained with the field equations, but not the noise, which is measured especially in the air. If an antenna on the one hand produces field vortices and as a consequence eddy losses and on the other hand dielectric losses, then we can assume that besides the eddy currents in the conductor also vortices in the dielectric must exist. Let's search for them!

Interim result (comparison of arguments):

The Maxwell equations on the one hand dictate that as the reason for a wave damping only field vortices should be considered.	On the other hand the same laws merely describe eddy currents, which can only occur in the electrically conducting parts of the antenna.
On the one hand the field vortex interpretation makes it possible to explain the noise of an antenna perfectly.	On the other hand does the noise appear in the neighbourhood of the antenna, thus in the air and not in the iron parts!
The mathematical formulation reveals, how wave and vortex, resp. noise, co-operate and how one should imagine the conversion of one form into the other form.	In field physics on the other hand is missing a useful description of electric field vortices in a dielectric, which could found the noise signal.

Table 26.5: Arguments pro and contra.

26. 5 Interim result

It shouldn't be a disadvantage, to interprete physical laws more consistently than usual, even if in the present case orthodox science through that at first should fall into a deep crisis. If the way is worthwhile, only will show at the end.
Let us try to work out the contradictions in form of a comparison of arguments:

- The Maxwell equations on the one hand dictate that as the reason for a wave damping only field vortices should be considered.
  - o On the other hand the same laws merely describe eddy currents, which can only occur in the electrically conducting parts of the antenna. .
- On the one hand the field vortex interpretation makes it possible to explain the noise of an antenna perfectly. .
  - o On the other hand does the noise appear in the neighbourhood of the antenna, thus in the air and not in the iron parts!
- The mathematical formulation reveals, how wave and vortex, resp. noise, co-operate and how one should imagine the conversion of one form into the other form.
  - o In field physics on the other hand is missing a useful description of electric field vortices in a dielectric, which could found the noise signal.

The most obvious among all conceivable solutions is the one that we have to assume the existence of dielectric field vortices, so-called potential vortices. We are challenged to search for a corresponding description. If the quest should be successful, then the contradictions would be overcome. In addition there is the promise of a whole number of simplifying explanations of various phenomena in the dielectric (see fig. 26.5 and fig. 26.7).

The phenomenon of noise becomes an aspect of wave physics, which is more than merely a field disturbance, which makes the reception of the useful wave more difficult. If the scalar wave nature is realized, then applications can be imagined, in which the noise is used as useful signal. In the way that the scalar part in the wave equation doesn't have to be put to zero anymore to obtain freedom of contradiction, even optimizations of antennas or of capacitors are possible with regard to the dielectric losses by means of the calculation of the scalar part.

New in any case is the idea that the dielectric losses of a capacitor are eddy losses and not a defect in material of the insulating material. With that the capacitor losses correspond to a generated noise power. We also can say, every capacitor more or less produces noise! The electric field lines point from one capacitor plate to the other plate. If one plate radiates as a transmitter and the other plate functions as a receiver, then the field propagation takes place in the direction of the electric field pointer and that again is the condition for a longitudinal wave. Here the circle closes in the conclusion, the capacitor field mediates dielectric field vortices, which following the field lines found a scalar wave because of their scalar nature. The heating of the capacitor results from the decay of vortices.

Potential vortices explain div. phenomena in the dielectric:

1. The **noise** no longer is factored out of the field theory.
2. The scalar (noise) part in the wave equation no longer has to be put to zero (div $\mathbf{E} \neq 0$).
3. The wave descriptions according to Maxwell (26.11) and according to Laplace (26.12) are consistent and free of contradiction.
4. The dielectric losses of an antenna can be found physically and even can be calculated with the wave equation.
5. **Also the dielectric losses** of a capacitor are **eddy losses** (and not a defect in material of the insulating material).
6. The **capacitor losses** correspond to a generated **noise power**.
7. The **dielectric constant** ε doesn't have to be written down complex as until now to give reasons for the occurring losses, and so the inner contradiction is solved, which is hidden in a complex constant. One should only remember the definition of the speed of light $c = 1/\sqrt{\varepsilon\mu}$ (eq. 26.10) and the insurmountable problems in the textbooks, which are brought by a complex ε!
8. The field lines point from one capacitor plate to the other plate. If one plate radiates as a transmitter and the other plate functions as a receiver, then the field propagation takes place in the direction of the electric field pointer and that again is the condition for a **longitudinal wave**.
9. The capacitor field mediates dielectric field vortices, which following the field lines found a **scalar wave** because of their scalar nature.
10. As an inhabitant of a dielectric between two capacitor plates (earth and ionosphere) also **man** is a product of these field vortices.
11. Scalar waves can be modulated moredimensionally and be used as **carrier of information**, as Prof. Sheldrake has proven with his proof of the existence of morphogenetic fields<i>.

Fig. 26.6: ___ Advantages of a field description extended with potential vortices.

<i>: Rupert Sheldrake: Seven Experiments That Could Change the World. Riverhead Books, 1995

26.6 Failure of the Maxwell theory

If the capacitor losses or the antenna noise should concern dielectric losses in the sense of vortex decay of potential vortices, which don't occur in the Maxwell theory at all, then we are confronted with a massive contradiction:

- For the description of the losses the Maxwell; theory on the one hand only offers field vortices and those only in the conductive medium.
  - On the other hand do the dielectric losses occut in the nonconductor and in the air.

- In conductive materials vortex fields occur, in the insulator however the fields are irrotational. That isn't possible, since at the transition from the conductor to the insulator the laws of refraction are valid and these require continuity! Hence a failure of the Maxwell theory (Fig. 26.7) will occur in the dielectric.

  - As a consequence the existence of vortex fields in the dielectric, so-called potential vortices, should be required!

In electrodynamics as a help the approach of a vector potential A is used, which leads to a complex formulation of the dielectric constant ε and in this way makes it possible, to mathematically describe the dielectric losses of a capacitor by means of the load angle, which stretches in the complex plane. But which physical value does this approach have? How can now the inner contradiction be explained, which is hidden in a complex constant of material? One should only remember the definition of the speed of light $c = 1/\sqrt{\varepsilon\mu}$ (eq. 26.10) and its dependency of ε. For a complex ε here are resulting insurmountable problems in the textbooks.
From the viewpoint of mathematics the introduction of the vector potential at first may represent a help. The before mentioned contradictions however fast raise doubts to the model concept, which from a physical viewpoint eventually will lead to errors, if the speed of light isn't constant anymore and even should be complex.

These considerations should be sufficient as a motive to require potential vortices, even if for their description the field theory according to the textbooks has to be revised. As a supplement there is pointed to the following points:

- As an inhabitant of a dielectric between two capacitor plates also man is a product of these field vortices.

- Scalar waves can be modulated moredimensionally and be used as carrier of information, as Prof. Sheldrake has proven with his proof of morphogenetic fields[<i>].

The dielectric vortices moreover provide an explanation for natural events. They form the key to numerous disciplines of science, from physics over biology up to medicine.

<i>: Rupert Sheldrake: Seven Experiments That Could Change the World. Riverhead Books, 1995

Problem of continuity in the case of the coming off of vortices

Example: hightension cable

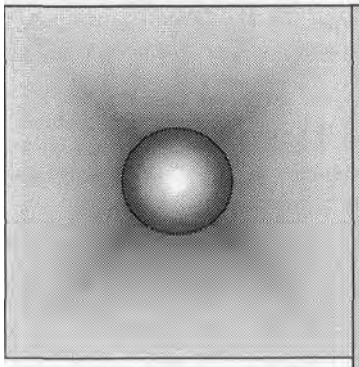

In ***conductive materials vortex fields*** *occur in the* ***insulator*** *however the fields are* ***irrotational****.*
That isn't possible, since at the transition from the conductor to the insulator the ***laws of refraction*** *are valid and these require* ***continuity!***
Hence a ***failure of the Maxwell theory*** *will occur in the dielectric!*

Conclusion: ♦ According to the Maxwell theory there exist no vortices of the electric field *(no potential vortices)* and therefore *no scalar waves.*

♦ Without theory it is impossible to design a usable *scalar wave gauge* and to furnish *evidence*. ⇒ **Classic closed loop conclusion:**

♦ The missing of scientific evidence again „proves" the assumption of the irrotationality and „confirms" the correctness of the Maxwell theory.

♦ Hence it cannot be, what shouldn't be!

Fie. 26.7: Concerning the failure of the Maxwell theory

26.7. Concerning the evidence situation

In the question, if a physical phenomenon should be acknowledged as such, experimental, mathematical and physical evidence should be shown. In the case of the potential vortices, the vortices of the electric field and their propagation as a scalar wave, the historical experiments of Nikola Tesla[<i>] and the modern clone of these can be judged as experimental evidence[<ii>].

With the well-known wave equation a mathematical description for this phenomenon has been specified and discussed[<iii>]. It will be shown that both transverse and longitudinal wave parts are contained alongside in the wave equation, i.e. both radio waves according to Hertz and scalar waves according to Tesla. Doing so the mathematically determined scalar wave properties are identical with the experimental results!
The wave equation is an inhomogeneous Laplace equation and the first and oldest description of scalar waves. It thereby is unimportant, if the famous mathematician Laplace himself already may have realized and discussed this circumstance or not. The description fits perfectly and that is what counts!

At this point the third point should be put on the agenda, the physical evidence. This is connected very closely with the question for a suitable field theory and that again is basing on a corresponding approach.

<i>: N. Tesla: Apparatus for Transmission of Electrical Energy, US-Patent-No.: 649,621, New York 1900, Dr. Nikola Tesla: Complete Patents pp318-321.

<ii>: Johannes von Buttlar im Gesprach mit Prof. Dr. Konstantin Meyl: Neutrinopower, Argo-Verlag, Marktoberdorf, l.Aufl. 2000.

<iii>: K. Meyl: Scalar Waves: Theory and Experiments, Journal of Scientific Exploration, Vol. 15, No. 2, pp. 199-205, 2001

(* * * Task Schedule * * *)

1. Neutrino radiation => energy radiation!
   (acc. to Pauli: ν cares for missing energy in the case of the ß-decay)
2. High neutrino density => high energy density!
   3. Neutrino = particle without charge or mass (mean), but because of oscillations: effective value of charge and mass $\neq$ zero!
   4. Interaction only in the case of resonance (e.g. weak interaction)!
   (same frequency, 180° phase shift)
   5. Neutrino radiation is an energy source which can be used (not a question of physics, only a question of technology!)
6. Particle radiation (neutrino) => shock wave (like sound)
   => longitudinal wave
   => scalar wave (mathem.)
7. Interaction/resonance of the v = scalar wave problem
8. Scalar waves are a problem of the field theory!
9. Maxwell theory neglects scalar waves.

- Search for a new approach (chap. 27.8)
- Derivation of the Maxwell equations as a
- Derivation of scalar waves (chap. 27.13)
- Derivation of the gravitation and more

Table 27.1: Task schedule belonging to chapter 27

27. Faraday versus Maxwell

Numerous phenomena of the electromagnetic field are described sufficiently accurate by the Maxwell equations, so that these as a rule are regarded as a universal field description. But if one looks more exact it turns out to be purely an approximation, which in addition leads to far reaching physical and technological consequences. We must ask ourselves:

- What is the Maxwell approximation?
- How could a new and extended approach look like?
  - Faraday instead of Maxwell, which is the more general law of induction?
- Can the Maxwell equations be derived as a special case?
- Can also scalar waves be derived from the new approach?
- Can the gravitation as well be derived and a lot else more?

On the one hand it concerns the big search for a unified physical theory and on the other hand the chances of new technologies, which are connected with an extended field theory. As a necessary consequence of the derivation, which roots strictly in textbook physics and manages without postulate, scalar waves occur, which could be used manifold. In information technology they are suited as a carrier wave, which can be modulated moredimensionally, and in power engineering the spectrum stretches from the wireless transmission up to the collection of energy out of the field.

27.1 Energy out of the field

Neutrinos for instance are such field configurations, which move through space as a scalar wave. They were introduced by Pauli as massless but energy carrying particles to be able to fulfil the balance sheet of energy for the beta decay. Nothing would be more obvious than to technically use the neutrino radiation as an energy source.
But for a technical exploitation a useful model description of the particles and their interaction is imperative. For the sake of simplicity we imagine the neutrino to be an oscillating particle, which permanently oscillates back and forth between the state of an electron and that of a positron. With that the polarity changes from positive to negative and back again and the charge averaged over time is zero. Because of the change from a state of matter to the state of an anti-particle also next to no mass can be measured anymore.
A technical oscillator operated in resonance, which oscillates with the same frequency but opposite charge, will interact with the particle and build up an oscillating electromagnetic interaction, with which we already are familiar as the weak interaction in the proximity of a neutrino.

Tubular vortices

• Examples: drain vortex (bathtub vortex)
whirlwind and waterspout, tornado (image).

Inside: expanding vortex
Outside: contracting anti-vortex
Condition for coming off: equally powerful vortices
Criterion: viscosity
Result: tubular structure

Fig. 27.2: ____ Vortex and anti-vortex - a physical basic principle

<i>: Lugt: Wirbelstromung in Natur und Technik, G. Braun Verlag Karlsruhe 1979, Bild „Tornado" von Tafel 21, Seite 356

The propagation of particle radiation as a longitudinal shock wave however can't be described with the normally used field theory and the Maxwell equations, so that the field theory at this point must be reworked. Connected with this is the question of what is oscillating here, a question, which often is answered with an aether of whatever nature. I speak of field vortices and call the aether a property of the field. With that the set of difficulties is shifted into the domain of vortex physics.

27.2 Vortex and anti-vortex

In the eye of a tornado the same calm prevails as at great distance, because here a vortex and its anti-vortex work against each other. In the inside the expanding vortex is located and on the outside the contracting anti-vortex. One vortex is the condition for the existence of the other one and vice versa. Already Leonardo da Vinci knew both vortices and has described the dual manifestations (chapter 3.4).

In the case of flow vortices the viscosity determines the diameter of the vortex tube where the coming off will occur. If for instance a tornado soaks itself with water above the open ocean, then the contracting potential vortex is predominant and the energy density increases threateningly. If it however runs overland and rains out, it again becomes bigger and less dangerous.

The conditions for the bathtub vortex are similar. Here the expanding vortex consists of air, the contracting vortex however of water. In flow dynamics the relations are understood. They mostly can be seen well and observed without further aids.

In electrical engineering it's different: here field vortices remain invisible and not understood. Only so the Maxwell theory could find acceptance, although it only describes mathematically the expanding eddy current and ignores its anti-vortex. I call the contracting anti-vortex potential vortex" and point to the circumstance, that every eddy current entails the anti-vortex as a physical necessity.
Because the size of the forming structures is determined by the electric conductivity, in conducting materials the vortex rings, being composed of both vortices, are huge, whereas they can contract down to atomic dimensions in nonconductors. Only in semiconducting and resistive materials the structures occasionally can be observed directly (fig. 4.8).

Spherical vortices

Examples:	expanding vortex	contracting vortex
• quantum physics	collision processes (several quarks)	gluons (postulate!)
• nuclear physics	repulsion of like	strong interaction (postulate!)
• atomic physics	centrifugal force of the enveloping electrons	electrical attraction Schrodinger equation
• astro-physics	centrifugal force (inertia)	gravitation (can not be derived?!)

Example: elementary particles as electromagnetic field vortices

Inside:	expanding eddy current (skin effect)
Outside:	contracting anti-vortex (potential vortex)
Condition	for coming off: equally powerful vortices
Criterion:	electric conductivity (determines diameter)
Result:	spherical structure (consequence of the pressure of the vacuum)

Fig. 27.3: _____ Spherical structures as a result of contracting potential vortices.<i>

Demokrit (460-370 BC) equated the vortex concept with „law of nature"! = the first attempt to formulate a unified physics.

<i>: see Part 1, chapter 4.3

27.3 Vortices in the microcosm and macrocosm

The approximation, which is hidden in the Maxwell equations, thus consists of neglecting the anti-vortex dual to the eddy current. It is possible that this approximation is allowed, as long as it only concerns processes inside conducting materials. If we however get to insulating materials the Maxwell approximation will lead to considerable errors and it won't be able to keep it anymore.

If we take as an example the lightning and ask how the lightning channel is formed: Which mechanism is behind it, if the electrically insulating air for a short time is becoming a conductor? From the viewpoint of vortex physics the answer is obvious: The potential vortex, which in the air is dominating, contracts very strong and doing so squezes all air charge carriers and air ions, which are responsible for the conductivity, together at a very small space to form a current channel.

The contracting potential vortex thus exerts a pressure and with that forms the vortex tube. Besides the cylindrical structure another structure can be expected. It is the sphere, which is the only form, which can withstand a powerful pressure if that acts equally from all directions of space. Only think of ball lightning. Actually the spherical structure is mostly found in microcosm till macrocosm. Let's consider some examples and thereby search for the expanding and contracting forces (fig. 27.2).

- In quantum physics one imagines the elementary particles to be consisting of quarks. Irrespective of the question, which physical reality should be attributed to this model concept, one thing remains puzzling: The quarks should run apart, or you should try to keep together three globules, which are moving violently and permanently hitting each other. For this reason glue particles were postulated, the so-called gluons, which now should take care for the reaction force, but this reaction force is nothing but a postulate!

- In nuclear physics it concerns the force, which holds together the atomic nucleus, which is composed of many nucleons, and gives it the well-known great stability, although here like charged particles are close together. Particles, which usually repel each other. Between the theoretical model and practical reality there is an enormous gap, which should be overcome by introducing of a new reaction force. But also the nuclear force, called strong interaction, is nothing but a postulate!

- In atomic physics the electric force of attraction between the positive nuclear charge and the negatively charged enveloping electrons counteracts the centrifugal force. In this case the anti-vortex takes care for a certain structure of the atomic hull, which obey the Schrodinger equation as eigenvalue solutions. But also this equation irrespective of its efficiency until today purely is a mathematical postulate, as long as its origin is not clear.

- In astrophysics centrifugal force (expansion) as a result of the inertia and gravitation (contraction) as a result of the attraction of masses are balanced. But the "gravitation" puts itself in the way of every attempt to formulate a unified field theory. Also this time it is the contracting vortex, of which is said it can't be derived nor integrated.

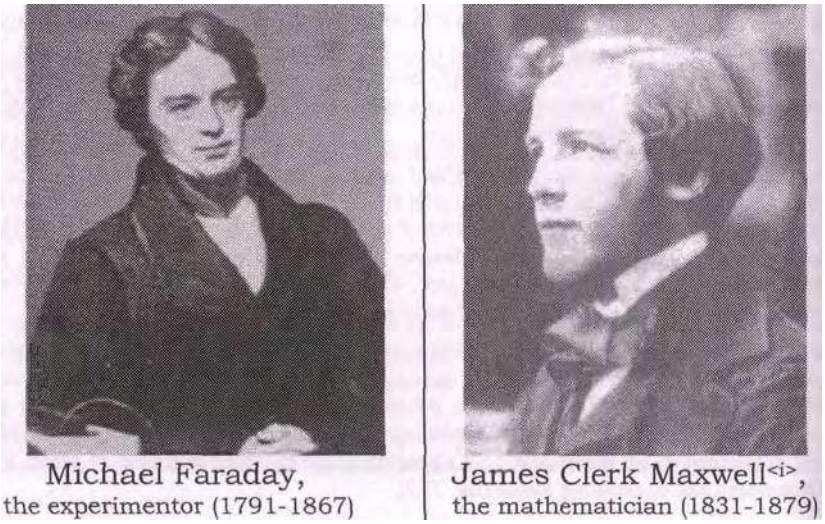

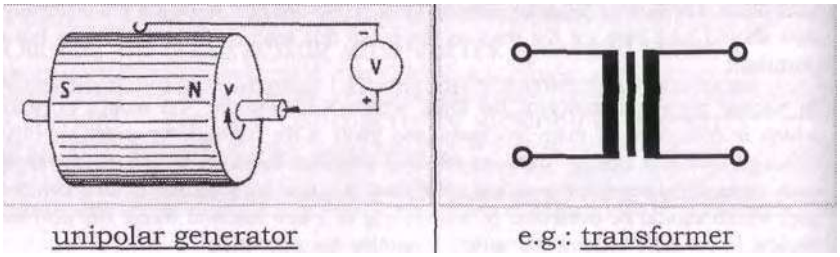

Fig. 27.4: ____ The fathers of the law of induction

<i>: J.C. Maxwell: A treatise on Electricity and Magnetism, Dover Publications

It is remarkable how in the domain of the contracting vortex the postulates are accumulating. But this hasn't always been the case. In ancient Greece already 2400 years ago Demokrit has undertaken an attempt to formulate a unified physics. He traced all visible and observable structures in nature back to vortices, each time formed of vortex and anti-vortex. This phenomenon appeared him to be so fundamental, that he put the term "vortex" equal to the term for „law of nature". The term „.atom" stems from Demokrit (460-370 BC).

Seen this way the physicists in ancient times already had been further than today's physics, which with the Maxwell approximation neglects the contracting vortex and with that excludes fundamental phenomena from the field description or is forced to replace them by model descriptions and numerous postulates.
What we need is a new field approach, which removes this flaw and in this point reaches over and above the Maxwell theory.

27.4 Faraday's law and Maxwell's formulation

In the choice of the approach the physicist is free, as long as the approach is reasonable and well founded. In the case of Maxwell's field equations two experimentally determined regularities served as basis: on the one hand Ampere's law and on the other hand the law of induction of Faraday. The mathematician Maxwell thereby gave the finishing touches for the formulations of both laws. He introduced the displacement current D and completed Ampere's law accordingly, and that without a chance of already at his time being able to measure and prove the measure. Only after his death this was possible experimentally, what afterwards makes clear the format of this man.
In the formulation of the law of induction Maxwell was completely free, because the discoverer Michael Faraday had done without specifications. As a man of practice and of experiment the mathematical notation was less important for Faraday. For him the attempts with which he could show his discovery of the induction to everybody, e.g. his unipolar generator, stood in the foreground.
His 40 years younger friend and professor of mathematics Maxwell however had something completely different in mind. He wanted to describe the light as an electromagnetic wave and doing so certainly the wave description of Laplace went through his mind, which needs a second time derivation of the field factor. Because Maxwell for this purpose needed two equations with each time a first derivation, he had to introduce the displacement current in Ampere's law and had to choose an appropriate notation for the formulation of the law of induction to get to the wave equation. His light theory initially was very controversial. Maxwell faster found acknowledgement for bringing together the teachings of electricity and magnetism and the representation as something unified and belonging together<1> than for mathematically giving reasons for the principle discovered by Faraday.
Nevertheless the question should be asked, if Maxwell has found the suitable formulation, if he has understood 100 percent correct his friend Faraday and his discovery. If discovery (from 29.08.1831) and mathematical formulation (1862) stem from two different scientists, who in addition belong to different disciplines, misunderstandings are nothing unusual. It will be helpful to work out the differences.

Law of induction

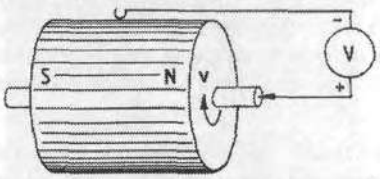

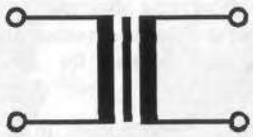

unipolar generator	e.g.: transformer
discovery of Faraday	2nd Maxwell equation
$\mathbf{E} = \mathbf{v} \times \mathbf{B}$ (27.1)	$\mathrm{rot}\,\mathbf{E} = -\,d\mathbf{B}/dt$ (27.1*)
unipolar induction	law of induction generally

Fig. 27.5: Two formulations for one law
As a mathematical relation between the vectors of the electric field strength **E** and the induction **B** (= magnetic flux density)

Consequences
(the physically mean of the „field concept"):

• The **Faraday approach** describes a field physical principle	• **Maxwell equations** describe the fields of charged particles
• field = experience: We experience the electric as a magnetic field and vice versa as a result of a relative velocity • Particles do not occur in the Faraday approach	• the electric (**E**-) field = static field of charges, • the magnetic (**H**-) field = field of moving charges. • The origin of the particles remains unsettled (postulate)
• Perfect duality between **E**- and **H**-field.	• No duality in the field description
• **v** leads to dual permutation of **E**- and **H**-field.	• Charge carriers=el. monopoles • No magnetic monopoles!

27.5 The discovery of Faraday

If one turns an axially polarized magnet or a copper disc situated in a magnetic field, then perpendicular to the direction of motion and perpendicular to the magnetic field pointer a pointer of the electric field will occur, which everywhere points axially to the outside. In the case of this by Faraday developed unipolar generator hence by means of a brush between the rotation axis and the circumference a tension voltage can be called off[i]. The mathematically correct relation E = v x B I call Faraday-law, even if it only appears in this form in the textbooks later in time[ii]. The formulation usually is attributed to the mathematician Hendrik Lorentz, since it appears in the Lorentz force in exactly this form. Much more important than the mathematical formalism however are the experimental results and the discovery by Michael Faraday, for which reason the law concerning unipolar induction is named after the discoverer.
Of course we must realize that the charge carriers at the time of the discovery hadn't been discovered yet and the field concept couldn't correspond to that of today. The field concept was an abstracter one, free of any quantization.

That of course also is valid for the field concept advocated by Maxwell, which we now contrast with the „Faraday-law" (fig. 27.4). The second Maxwell equation, the law of induction (27.1*), also is a mathematical description between the electric field strength E and the magnetic induction B. But this time the two aren't linked by a relative velocity v. In that place stands the time derivation of B, with which a change in flux is necessary for an electric field strength to occur. As a consequence the Maxwell equation doesn't provide a result in the static or quasi-stationary case, for which reason it in such cases is usual, to fall back upon the unipolar induction according to Faraday (e.g. in the case of the Hall-probe, the picture tube, etc.). The falling back should only remain restricted to such cases, so the normally used idea. But with which right the restriction of the Faraday-law to stationary processes is made?
The vectors E and B can be subject to both spatial and temporal fluctuations. In that way the two formulations suddenly are in competition with each other and we are asked, to explain the difference, as far as such a difference should be present.

<i>: Part 2, INDEL 1996, Chap. 16.1

<ii>: among others in R.W. Pohl: Einfuhrung in die Physik, Bd.2 Elektrizitatslehre, 21.Aufl. Springer-Verlag 1975, Seite 76 und 130

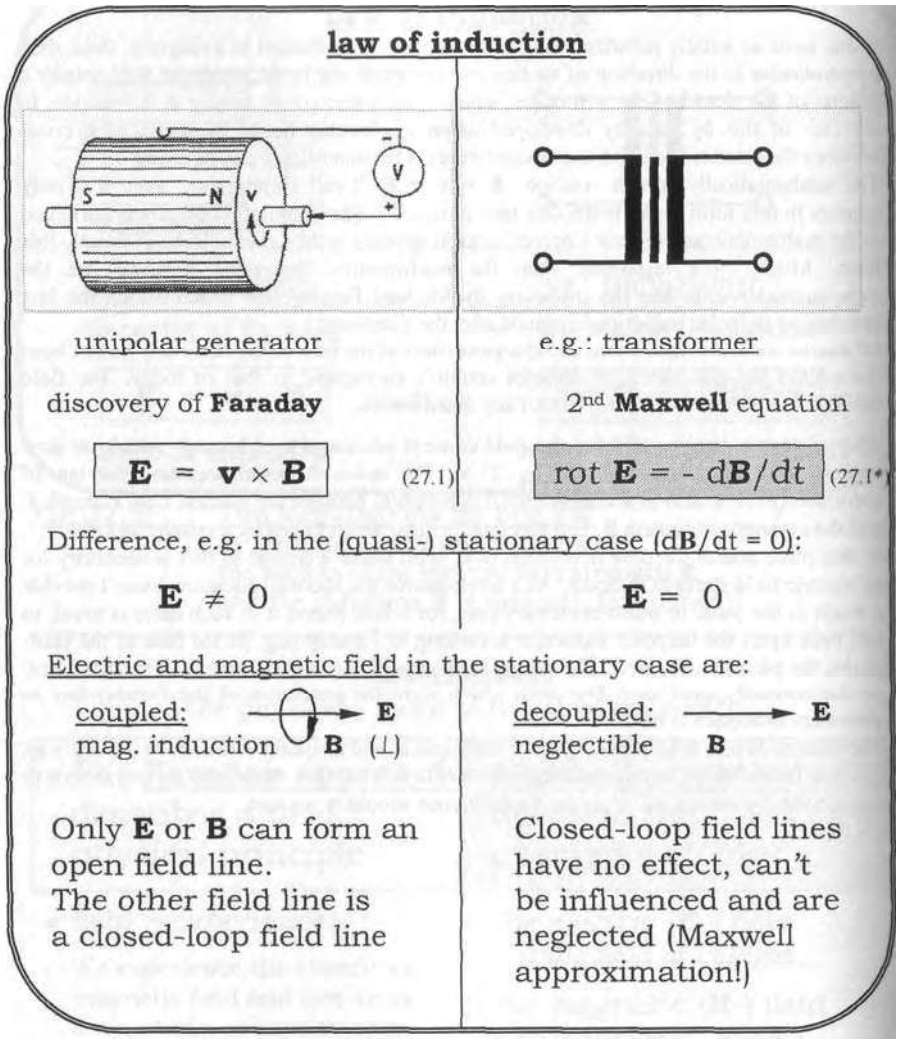

Fig. 27.6: ____Law of induction according to Faraday or Maxwell?

27.6 Different formulation of the law of induction

Such a difference for instance is, that it is common practice to neglect the coupling between the fields at low frequencies. While at high frequencies in the range of the electromagnetic field the E- and the H-field are mutually dependent, at lower frequency and small field change the process of induction drops correspondingly according to Maxwell, so that a neglect seems to be allowed. Now electric or magnetic field can be measured independently of each other. Usually is proceeded as if the other field is not present at all.

That is not correct. A look at the Faraday-law immediately shows that even down to frequency zero always both fields are present. The field pointers however stand perpendicular to each other, so that the magnetic field pointer wraps around the pointer of the electric field in the form of a vortex ring in the case that the electric field strength is being measured and vice versa. The closed-loop field lines are acting neutral to the outside; they hence need no attention, so the normally used idea. It should be examined more closely if this is sufficient as an explanation for the neglect of the not measurable closed-loop field lines, or if not after all an effect arises from fields, which are present in reality.

Another difference concerns the commutability of E- and H-field, as is shown by the Faraday-generator, how a magnetic becomes an electric field and vice versa as a result of a relative velocity v. This directly influences the physical-philosophic question: What is meant by the electromagnetic field?

The textbook opinion based on the Maxwell equations names the static field of the charge carriers as cause for the electric field, whereas moving ones cause the magnetic field. But that hardly can have been the idea of Faraday, to whom the existence of charge carriers was completely unknown. The for his contemporaries completely revolutionary abstract field concept based on the works of the Croatian Jesuit priest Boscovich (1711-1778). In the case of the field it should less concern a physical quantity in the usual sense, than rather the experimental experience''' of an interaction according to his field description. We should interprete the Faraday-law to the effect that we experience an electric field, if we are moving with regard to a magnetic field with a relative velocity and vice versa.

In the commutability of electric and magnetic field a duality between the two is expressed, which in the Maxwell formulation is lost, as soon as charge carriers are brought into play. Is thus the Maxwell field the special case of a particle free field? Much evidence points to it, because after all a light ray can run through a particle free vacuum. If however fields can exist without particles, particles without fields however are impossible, then the field should have been there first as the cause for the particles. Then the Faraday description should form the basis, from which all other regularities can be derived. What do the textbooks say to that?

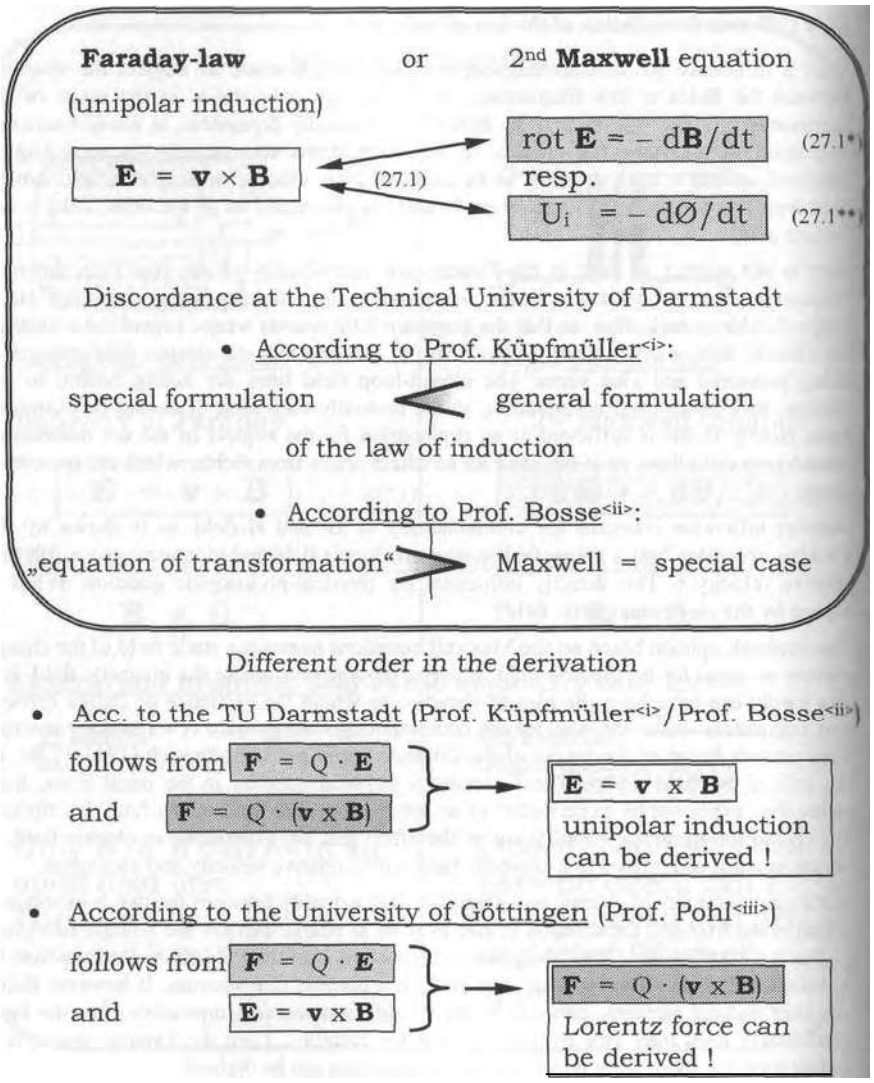

Fig. 27.7: Different opinions and derivations

<i>: K. Kupfmuller: Einfuhrung in die theoretische Elektrotechnik, 12. Auflage, Springer Verlag 1988, Seite 228, Gl. 22.

<ii>: G. Bosse: Grundlagen der Elektrotechnik II, BI-Hochschultaschenbucher Nr. 183, l.Aufl. 1967, Kap. 6.1 Induktion, Seite 58

<iii>: R. W. Pohl: Einfuhrung in die Physik, Band 2 Elektrizitatslehre, 21. Auflage, Springer-Verlag 1975, Seite 77

27.7 Contradictory opinions in textbooks

Obviously there exist two formulations for the law of induction (27.1 and 27.1*), which more or less have equal rights. Science stands for the question: which mathematical description is the more efficient one? If one case is a special case of the other case, which description then is the more universal one?

What Maxwell's field equations tell us is sufficiently known, so that derivations are unnecessary. Numerous textbooks are standing by, if results should be cited. Let us hence turn to the Faraday-law (27.1). Often one searches in vain for this law in schoolbooks. Only in more pretentious books one makes a find under the keyword "unipolar induction". If one however compares the number of pages, which are spent on the law of induction according to Maxwell with the few pages for the unipolar induction, then one gets the impression that the latter only is a unimportant special case for low frequencies. Kupfmuller speaks of a „special form of the law of induction"[<i>], and cites as practical examples the induction in a brake disc and the Hall-effect. Afterwards Kupfmiiller derives from the „special form" the „general form" of the law of induction according to Maxwell, a postulated generalization, which needs an explanation. But a reason is not given[<i>]. Bosse gives the same derivation, but for him the Maxwell-result is the special case and not his Faraday approach[<ii>]! In addition he addresses the Faraday-law as equation of transformation and points out the meaning and the special interpretation. On the other hand he derives the law from the Lorentz force, completely in the style of Kupfmuller[<i>] and with that again takes it part of its autonomy. Pohl looks at that different. He inversely derives the Lorentz force from the Faraday-law[<iii>].

By all means, the Faraday-law, which we want to base on instead of on the Maxwell equations, shows „strange effects[<i4>]" from the point of view of a Maxwell representative of today and thereby but one side of the medal (eq. 27.1). Only in very few distinguished textbooks the other side of the medal (eq. 27.2) is mentioned at all. In that way most textbooks mediate a lopsided and incomplete picture[<i,ii,i4>]. If there should be talk about equations of transformation, then the dual formulation belongs to it, then it concerns a pair of equations, which describes the relations between the electric and the magnetic field.

If the by Bosse[<ii>] prompted term „equation of transformation" is justified or not at first is unimportant. That is a matter of discussion.

<i>: K. Kupfmuller: Einfuhrung in die theoretische Elektrotechnik, 12.Aufl., Springer Verlag 1988, Seite 228, Gl. 22.

<ii>: G. Bosse: Grundlagen der Elektrotechnik II, BI-Hochschultaschenbucher Nr.183, l.Aufl. 1967, Kap. 6.1 Induktion, Seite 58

<iii>: R.W.Pohl: Einfuhrung in die Physik, Bd.2 Elektrizitatslehre, 2 l.Aufl. Springer-Verlag 1975, Seite 77

<i4>: G. Lehner: Elektromagnetische Feldtheorie, Springer-Lehrbuch 1990, 1. Aufl., Seite 31 Kommentar zur Lorentzkraft (1.65)

The new and dual field approach consists of equations of transformation

of the electric and of the magnetic field[i]

$\mathbf{E} = \mathbf{v} \times \mathbf{B}$ (27.1) and $\mathbf{H} = -\mathbf{v} \times \mathbf{D}$ (27.2)

unipolar induction equation of convection

- Formulation according to the rules of duality
  - Grimsehl[ii] speaks of the ,,equation of convection", according to which moving charges produce a magnetic field and so-called convection currents (referring to Rontgen 1885, Himstedt, Rowland 1876, Eichenwald and others)
- Pohl[iii] gives examples for the equations of transformation,
- he writes the equations beneath each other

$\mathbf{E} = \mu \cdot \mathbf{v} \times \mathbf{H}$ (27.3) and $\mathbf{H} = -\varepsilon \cdot \mathbf{v} \times \mathbf{E}$ (27.4)

- and points out that for $v = c = 1/\sqrt{\mu \cdot \varepsilon}$ one equation changes into the other one!

The new and dual approach roots in textbook physics!

Fig. 27.8: The new and dual field approach

<i>: see Part 1, chapter 6.5

<ii>: Grimsehl: Lehrbuch der Physik, 2.Bd., 17,Aufl. Teubner Verl. 1967, S. 130.

<iii>: R.W.Pohl: Einfuhrung in die Physik, Bd.2 Elektrizitatslehre, 21.Aufl. Springer-Verlag 1975, Seite 77

27.8 The field-theoretical approach

The duality between E- and H-field and the commutability asks for a corresponding dual formulation to the Faraday-law (27.1). Written down according to the rules of duality there results an equation (27.2), which occasionally is mentioned in some textbooks. While both equations in the books of Pohl[<i>] and of Simonyi[<ii>] are written down side by side having equal rights and are compared with each other, Grimsehl[<iii>] derives the dual regularity (27.2) with the help of the example of a thin, positively charged and rotating metal ring. He speaks of „equation of convection", according to which moving charges produce a magnetic field and so-called convection currents. Doing so he refers to workings of Rontgen 1885, Himstedt, Rowland 1876, Eichenwald and many others more, which today hardly are known.
In his textbook also Pohl gives practical examples for both equations of transformation. He points out that one equation changes into the other one, if as a relative velocity v the speed of light c should occur. This question will also occupy us.

We now have found a field-theoretical approach with the equations of transformation, which in its dual formulation is clearly distinguished from the Maxwell approach. The reassuring conclusion is added: The new field approach roots entirely in textbook physics, as are the results from the literature research. We can completely do without postulates.
Next thing to do is to test the approach strictly mathematical for freedom of contradictions. It in particular concerns the question, which known regularities can be derived under which conditions. Moreover the conditions and the scopes of the derived theories should result correctly, e.g. of what the Maxwell approximation consists and why the Maxwell equations describe only a special case.

27.9 Derivation of Maxwell's field equations

As a starting-point and as approach serve the equations of transformation of the electromagnetic field, the Faraday-law of unipolar induction and the according to the rules of duality formulated law (eq. 27.1, 2). If we apply the curl to both sides of the equations then according to known algorithms of vector analysis the curl of the cross product each time delivers the sum of four single terms. Two of these again are zero for a non-accelerated relative motion in the x-direction with v = dr/dt.
One term concerns the vector gradient (v grad)B, which can be represented as a tensor. By writing down and solving the accompanying derivative matrix giving consideration to the above determination of the v-vector, the vector gradient becomes the simple time derivation of the field vector B(r(t)) (eq. 27.10, according to the rule of eq. 27.11).

<i>: R.W.Pohl: Einfuhrung in die Physik, Bd.2 Elektrizitatslehre, 21.Aufl. Springer-Verlag 1975, Seite 76 und 130

<ii>: K. Simonyi: Theoretische Elektrotechnik, 7.Aufl. VEB Berlin 1979, Seite 924.

<iii>: Grimsehl: Lehrbuch der Physik, 2,Bd., 17.Aufl. Teubner Verl. 1967, S. 130.

As approach serve the equations of transformation (fig. 27.5) of the electric and of the magnetic field:

$$\mathbf{E} = \mathbf{v} \times \mathbf{B} \quad (27.1) \text{ and } \quad \mathbf{H} = -\mathbf{v} \times \mathbf{D} \quad (27.2)$$

If we apply the curl to the respective cross product:

$$\text{rot}\,\mathbf{E} = \text{rot}\,(\mathbf{v} \times \mathbf{B}) \quad (27.5) \text{ and } \quad \text{rot}\,\mathbf{H} = -\,\text{rot}\,(\mathbf{v} \times \mathbf{D}) \quad (27.6)$$

then according to the algorithms<i> four sum terms are delivered:

$$\text{rot}\,\mathbf{E} = (\mathbf{B}\,\text{grad})\mathbf{v} - (\mathbf{v}\,\text{grad})\mathbf{B} + \mathbf{v}\,\text{div}\,\mathbf{B} - \mathbf{B}\,\text{div}\,\mathbf{v} \quad (27.5)$$

$$\text{rot}\,\mathbf{H} = -[(\mathbf{D}\,\text{grad})\mathbf{v} - (\mathbf{v}\,\text{grad})\mathbf{D} + \mathbf{v}\,\text{div}\,\mathbf{D} - \mathbf{D}\,\text{div}\,\mathbf{v}] \quad (27.6)$$

where 2 of them are zero because of: $\mathbf{v}(t) = d\mathbf{r}/dt$ (27.7)

- the divergence of v(t) disappears: $\text{div}\,v = 0$, (27.8)
- and will be zero as well: $\partial\mathbf{v}(t)/\partial\mathbf{r} = \text{grad}\,\mathbf{v} = \mathbf{0}$. (27.9)
- there remain the vector gradients:

$$(\mathbf{v}\,\text{grad})\,\mathbf{B} = \frac{d\mathbf{B}}{dt} \text{ and } (\mathbf{v}\,\text{grad})\,\mathbf{D} = \frac{d\mathbf{D}}{dt} \quad ,(27.10)$$

- according to the rules<i> in general (with eq. 27.7):

$$\frac{d\mathbf{V}(\mathbf{r}(t))}{dt} = \frac{\partial\mathbf{V}(\mathbf{r}=\mathbf{r}(t))}{\partial\mathbf{r}} \cdot \frac{d\mathbf{r}(t)}{dt} = (\mathbf{v}\,\text{grad})\,\mathbf{V} \quad (27.11)$$

- A comparison of the coefficients of both field equations

$$\text{rot}\,\mathbf{E} = -\,d\mathbf{B}/dt + \mathbf{v}\,\text{div}\,\mathbf{B} = -\,d\mathbf{B}/dt - \mathbf{b} \quad (27.12)$$

$$\text{rot}\,\mathbf{H} = d\mathbf{D}/dt - \mathbf{v}\,\text{div}\,\mathbf{D} = d\mathbf{D}/dt + \mathbf{j} \quad (27.13)$$

with the Maxwell equations results in:

- for the potential density $b = -\,v\,\text{div}\,B = 0$, (27.14)
  (eq. 27.12 = law of induction, if b = 0 resp. div B = 0)

- for the current density $j = -\,v\,\text{div}\,D = -\,v_x \cdot \rho_{el}$, (27.1a
  (eq. 27.13 = Ampere's law, if j = with v moving negative charge carriers (ρ_{el}= electric space charge density).

Fig. 27.9: ____ Derivation of Maxwell's field equations as a special case of the equations of transformation

<i>: Bronstein u.a.: Taschenbuch der Mathematik, 4.Neuaufl. Thun 1999, S. 652

For the last not yet explained terms at first are written down the vectors b and j as abbreviation. With equation 27.13 we in this way immediately look at the well-known law of Ampere (1st Maxwell equation). The comparison of coefficients (27.15) in addition delivers a useful explanation to the question, what is meant by the current density j: it is a space charge density ρ_{el} consisting of negative charge carriers, which moves with the velocity v for instance through a conductor (in the x-direction).

The current density j and the to that dual potential density b mathematically seen at first are nothing but alternative vectors for an abbreviated notation. While for the current density j the physical meaning already could be clarified from the comparison with the law of Ampere, the interpretation of the potential density b still is due. From the comparison with the law of induction (eq. 27.1*) we merely infer, that according to the Maxwell theory this term is assumed to be zero. But that is exactly the Maxwell approximation and the restriction with regard to the new and dual field approach, which roots in Faraday.

In that way also the duality gets lost with the argument that magnetic monopoles (div B) in contrast to electric monopoles (div D) do not exist and until today could evade every proof. It thus is overlooked that div D at first describes only eddy currents and div B only the necessary anti-vortex, the potential vortex. Spherical particles, like e.g. charge carriers presuppose both vortices: on the inside the expanding (div D) and on the outside the contracting vortex (div B), which then necessarily has to be different from zero, even if there hasn't yet been searched for the vortices dual to eddy currents, which are expressed in the neglected term.

Assuming, a monopole concerns a special form of a field vortex, then immediately gets clear, why the search for magnetic poles has to be a dead end and their failure isn't good for a counterargument: The missing electric conductivity in vacuum prevents current densities, eddy currents and the formation of magnetic monopoles. Potential densities and potential vortices however can occur. As a result can without exception only electrically charged particles be found in the vacuum (derivation in chapter 4.2 till 4.4). Because vortices are more than monopole-like structures depending on some boundary conditions, only the vortex description will be pursued further consequently.

Let us record: Maxwell's field equations can directly be derived from the new dual field approach under a restrictive condition. Under this condition the two approaches are equivalent and with that also error free. Both follow the textbooks and can so to speak be the textbook opinion.

The restriction (b = 0) surely is meaningful and reasonable in all those cases in which the Maxwell theory is successful. It only has an effect in the domain of electrodynamics. Here usually a vector potential A is introduced and by means of the calculation of a complex dielectric constant a loss angle is determined. Mathematically the approach is correct and dielectric losses can be calculated. Physically however the result is extremely questionable, since as a consequence of a complex s a complex speed of light would result (according to the definition $c = 1/\sqrt{\varepsilon \cdot \mu}$). With that electrodynamics offends against all specifications of the textbooks, according to which c is constant and not variable and less then ever complex.

But if the result of the derivation physically is wrong, then something with the approach is wrong, then the fields in the dielectric perhaps have an entirely other nature, then dielectric losses perhaps are vortex losses of potential vortices falling apart?

- Maxwell's field equations:

$$\text{rot}\,\mathbf{E} = -\,d\mathbf{B}/dt \quad \text{(law of induction)} \qquad (27.1^*)$$
$$\text{rot}\,\mathbf{H} = d\mathbf{D}/dt + \mathbf{j} \quad \text{(Ampère's law)} \qquad (27.13)$$

- describe the special case for b = 0 resp. div B = 0

$$\text{rot}\,\mathbf{E} = -\,d\mathbf{B}/dt + \mathbf{v}\,\text{div}\,\mathbf{B} = -\,d\mathbf{B}/dt - \mathbf{b} \qquad (27.12)$$
$$\text{rot}\,\mathbf{H} = d\mathbf{D}/dt - \mathbf{v}\,\text{div}\,\mathbf{D} = d\mathbf{D}/dt + \mathbf{j} \qquad (27.13)$$

The physical meaning of the introduced abbreviations b and j is:

- the current density $\mathbf{j} = -\mathbf{v}\,\text{div}\,\mathbf{D} = -v_x \cdot \rho_{el}$, (27.15)
- with Ohm's law $\mathbf{j} = \sigma \cdot \mathbf{E} = \mathbf{D}/\tau_1$, and (27.16)
- the potential density $\mathbf{b} = -\mathbf{v}\,\text{div}\,\mathbf{B} = \mathbf{B}/\tau_2$,(27.17)
- with the eddy current time constant $\tau_1 = \varepsilon/\sigma$ (27.16*>
- and with the potential vortex time constant τ_2

The complete field equations (27.12 and 27.13) read, with the time constants (τ_1 and τ_2)of the respective field vortex:

- completely extended law of induction (with B =μ·H): (27.18)

$$\text{rot}\,\mathbf{E} = -\,d\mathbf{B}/dt - \mathbf{B}/\tau_2 = -\,\mu \cdot (d\mathbf{H}/dt + \mathbf{H}/\tau_2) \qquad (27.20)$$

- and the well-known law of Ampere (with D =ε·E): (27.19)

$$\text{rot}\,\mathbf{H} = d\mathbf{D}/dt + \mathbf{D}/\tau_1 = \varepsilon \cdot (d\mathbf{E}/dt + \mathbf{E}/\tau_1) \qquad (27.21)$$

Fig. 27.10: The extension of the law of induction for vortices of the electric field (potential vortices].<i>

<i>: see also fig. 5.1

27.10 Derivation of the potential vortices

Is the introduction of a vector potential A in electrodynamics a substitute of neglecting the potential density b? Do here two ways mathematically lead to the same result? And what about the physical relevance? After classic electrodynamics being dependent on working with a complex constant of material, in what is buried an unsurmountable inner contradiction, the question is asked for the freedom of contradictions of the new approach. At this point the decision will be made, if physics has to make a decision for the more efficient approach, as it always has done when a change of paradigm had to be dealt with. The abbreviations j and b are further transformed, at first the current density in Ampere's law $j = -v_x \cdot \rho_{el}$ (27.15), as the movement of negative electric charges. By means of Ohm's law $j=\sigma \cdot E$ and the relation of material $D=\varepsilon \cdot E$ the current density j also can be written down as dielectric displacement current with the characteristic relaxation time constant $\tau_1 = \varepsilon/\sigma$ (eq. 27.16) for the eddy currents. In this representation of the law of Ampere (eq. 27.21) clearly is brought to light, why the magnetic field is a vortex field, and how the eddy currents produce heat losses depending on the specific electric conductivity σ. As one sees we, with regard to the magnetic field description, move around completely in the framework of textbook physics.

Let us now consider the dual conditions. The comparison of coefficients (eq. 27.12 + 27.17) looked at purely formal, results in a potential density b in duality to the current density j, which with the help of an appropriate time constant τ_2 founds vortices of the electric field. I call these potential vortices (in eq. 27.20).

In contrast to that the Maxwell theory requires an irrotationality of the electric field, which is expressed by taking the potential density b and the divergence B equal to zero. The time constant τ_2 thereby tends towards infinity. This Maxwell approximation leads to the circumstance that with the potential vortices of the electric field also their propagation as a scalar wave gets lost, so that the Maxwell equations describe only transverse and no longitudinal waves. At this point there can occur contradictions for instance in the case of the near-field of an antenna, where longitudinal wave parts can be detected measuring technically, and such parts already are used technologically in transponder systems e.g. as installations warning of theft in big stores.

It is denominating, how they know how to help oneself in the textbooks of high-frequency technology in the case of the near-field zone<i>. Proceeding from the Maxwell equations the missing potential vortex is postulated without further ado, by means of the specification of a ,,standing wave" in the form of a vortex at a dipole antenna. With the help of the postulate now the longitudinal wave parts are ,,calculated", like they also are being measured, but also like they wouldn't occur without the postulate as a result of the Maxwell approximation.

There isn't a way past the potential vortices and the new dual approach, because no scientist is able to afford to exclude already in the approach a possibly authoritative phenomenon, which he wants to calculate physically correct!

<i>: Zinke, Brunswig: Lehrbuch der Hochfrequenztechnik, 1. Bd., 3. Auflage 1986 Springer-Verlag Berlin, Seite 335

- Under the assumption: E = E(r,t); H = H(r,t) ,
- using the relations of material:

  $\mathbf{B} = \mu \cdot \mathbf{H}$ and $\mathbf{D} = \varepsilon \cdot \mathbf{E}$:
- the complete and extended law of induction reads:

$$\text{rot}\,\mathbf{E} = -\,\partial\mathbf{B}/\partial t - \mathbf{B}/\tau_2 = -\,\mu\cdot(\partial\mathbf{H}/\partial t + \mathbf{H}/\tau_2) \quad (27.20)$$

- and the well-known law of Ampere:

$$\text{rot}\,\mathbf{H} = \partial\mathbf{D}/\partial t + \mathbf{D}/\tau_1 = \varepsilon\cdot(\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1) \quad (27.21)$$

---

if we again apply the curl operation to eq. 27.20 and insert eq. 27.21:

$$-\,\text{rot rot}\,\mathbf{E} = \mu\cdot\partial(\text{rot}\mathbf{H})/\partial t + (\mu/\tau_2)\cdot(\text{rot}\,\mathbf{H}) \quad (27.22)$$

$$= \mu\cdot\varepsilon\cdot[\partial^2\mathbf{E}/\partial t^2 + (1/\tau_1)\cdot\partial\mathbf{E}/\partial t + (1/\tau_2)\cdot\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1\tau_2] \quad (27.23)$$

$$= (1/c^2)\cdot[\partial^2\mathbf{E}/\partial t^2 + (1/\tau_1 + 1/\tau_2)\cdot\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1\tau_2] \quad (27.24)$$

with the definition for the speed of light c:

$$\varepsilon\cdot\mu = 1/c^2 \quad (27.25)$$

the fundamental field equation reads:

$$\underbrace{-\,c^2\cdot\text{rot rot}\,\mathbf{E}}_{a} = \underbrace{\partial^2\mathbf{E}/\partial t^2}_{b\ \text{(electromagnetic wave)}} + \underbrace{(1/\tau_1)\cdot\partial\mathbf{E}/\partial t}_{c} + \underbrace{(1/\tau_2)\cdot\partial\mathbf{E}/\partial t}_{d} + \underbrace{\mathbf{E}/\tau_1\tau_2}_{e} \quad (27.26)$$

+ eddy current + potential vortex + I/U

Fig. 27.11: Derivation of the fundamental field equation
from the equations of transformation of the electromagnetic field.<i>

<i>: The fundamental field equation mathematically describes a wave damped with the vortices of the electric and the vortices of the magnetic field. It is formulated only in space and time. From it can be deduced numerous eigenvalue equations, (i.e. the equation of Schrodinger, fig. 5.1).

27.11 Derivation of the „fundamental field equation"

The two equations of transformation and also the from that derived field equations (27.20 and 27.21) show the two sides of a medal, by mutually describing the relation between the electric and magnetic field strength (between E and H). We get on the track of the meaning of the „medal" itself, by inserting the dually formulated equations into each other. If the calculated H-field from one equation is inserted into the other equation then as a result a determining equation for the E-field remains. The same vice versa also functions to determine the H-field. Since the result formally is identical and merely the H-field vector appears at the place of the E-field vector and since it equally remains valid for the B-, the D-field and all other known field factors, the determining equation is more than only a calculation instruction. It reveals a fundamental physical principle. I call it the "fundamental field equation".

The derivation always is the same: If we again apply the curl operation to rot E (law of induction 27.20) also the other side of the equation should be subjected to the curl. If for both terms rot H is expressed by Ampere's law 27.21, then in total four terms are formed (27.26): the wave equation (a-b) with the two damping terms, on the one hand the eddy currents (a-c) and on the other hand the potential vortices (a-d) and as the fourth term the Poisson equation (a-e), which is responsible for the spatial distribution of currents and potentials <i>.

Not in a single textbook a mathematical linking of the Poisson equation with the wave equation can be found, as we here succeed in for the first time. It however is the prerequisite to be able to describe the conversion of an antenna current into electromagnetic waves near a transmitter and equally the inverse process, as it takes place at a receiver. Numerous model concepts, like they have been developed by HF- and EMC-technicians as a help, can be described mathematically correct by the physically founded field equation.

In addition further equations can be derived, for which this until now was supposed to be impossible, like for instance the Schrodinger equation (chapter 5.6-5.9). This contrary to current opinion isn't a wave equation at all, since the term (b) with the second time derivation is missing. As diffusion equation it has the task to mathematically describe field vortices and their structures.
As a consequence of the Maxwell equations in general and specifically the eddy currents not being able to form structures, every attempt has to fail, which wants to derive the Schrodinger equation from the Maxwell equations.
The fundamental field equation however contains the newly discovered potential vortices, which owing to their concentration effect (in duality to the skin effect) form spherical structures, for which reason these occur as eigenvalues of the equation. For these eigenvalue-solutions numerous practical measurements are present, which confirm their correctness and with that have probative force with regard to the correctness of the new Held approach and the fundamental field equation. By means of the pure formulation in space and time and the interchangeability of the field pointers here a physical principle is described, which fulfills all requirements, which a world equation must meet.

<i>: see also fig. 5.1

Comparison:

• The **Faraday approach** is universal	• **Maxwell's field equations** can be derived!
• It reveals a **physical principle**	• The field equations describe only a **special case**!
• The field is the cause for the particles • (Principles of causality are preserved)	• Particle and field are cause and effect at the same time • (Violation of the rules of causality)
• Particles probably are **field configurations** • Quanta can be calculated as **field vortices** (without any hypothesis) • All **quantum properties** can be **calculated** likewise	• Particles consist of hypothetic subparticles • **Quark-hypothesis** must replace missing calculation • Sorting und systematizing of the properties in the **standard-model**
• **Potential vortices** form electric field vortices (the E-field is a source free vortex field)	• The electric field is **irrotational** (the E-field is an irrotational field of sources)
• Field vortices carry momentum and form a scalar wave • Longitudinal wave with arb. velocity of propagation v	• Electromagnetic wave is a transverse wave • Constant propagation with the speed of light c
⇒ **theory of objectivity**	⇒ **theory of relativity**

Fig. 27.12: Comparison of the field-theoretical approaches according to Faradav and according to Maxwell.

27.12 The Maxwell field as a derived special case

As the derivations show, nobody can claim there wouldn't exist potential vortices and no propagation as a scalar wave, since only the Maxwell equations are to blame that these already have been factored out in the approach. One has to know that the field equations, and may they be as famous as they are, are nothing but a special case, which can be derived.

The field-theoretical approach however, which among others bases on the Faraday-law, is universal and can't be derived on its part. It describes a physical basic principle, the alternating of two dual experience or observation factors, their overlapping and mixing by continually mixing up cause and effect. It is a philosophic approach, free of materialistic or quantum physical concepts of any particles.

Maxwell on the other hand describes without exception the fields of charged particles, the electric field of resting and the magnetic field as a result of moving charges. The charge carriers are postulated for this purpose, so that their origin and their inner structure remain unsettled and can't be derived. The subdivision e.g. in quarks stays in the domain of a hypothesis, which can't be proven. The sorting and systematizing of the properties of particles in the standard-model is nothing more than unsatisfying comfort for the missing calculability.

With the field-theoretical approach however the elementary particles with all quantum properties can be calculated as field vortices (chap. 7). With that the field is the cause for the particles and their measurable quantization. The electric vortex field, at first source free, is itself forming its field sources in form of potential vortex structures. The formation of charge carriers in this way can be explained and proven mathematically, physically, graphically and experimentally understandable according to the model.

Where in the past the Maxwell theory has been the approach, there in the future should be proceeded from the equations of transformation of the field-theoretical approach. If now potential vortex phenomena occur, then these also should be interpreted as such in the sense of the approach and the derivation, then the introduction and postulation of new and decoupled model descriptions isn't allowed anymore, like the near-field effects of an antenna, the noise, dielectric capacitor losses, the mode of the light and a lot else more.

The at present in theoretical physics normal scam of at first putting a phenomenon to zero, to afterwards postulate it anew with the help of a more or less suitable model, leads to a breaking up of physics into apparently not connected individual disciplines and an inefficient specialisthood. There must be an end to this now! The new approach shows the way towards a unified theory, in which the different areas of physics again fuse to one area. In this lies the big chance of this approach, even if many of the specialists at first should still revolt against it.

This new and unified view of physics shall be summarized with the term "theory of objectivity". As we shall derive, it will be possible to deduce the theory of relativity as a partial aspect of it (chapter 6 and 28).

Let us first cast our eyes over the wave propagation.

- Starting-point: the fundamental field equation

$$-c^2 \cdot \text{rot rot } \mathbf{B} = \frac{d^2\mathbf{B}}{dt^2} + \frac{1}{\tau_2}\frac{d\mathbf{B}}{dt} + \frac{1}{\tau_1}\frac{d\mathbf{B}}{dt} + \frac{\mathbf{B}}{\tau_1\tau_2} \quad (27.26^*)$$

- with a magnetic flux density B = B(r(t)).

1st condition for eq. 27.26*:
the special case, if σ=0 and $\sigma/\varepsilon = (1/\tau_1) = 0$. (27.16*)

The remaining vortex term is transformed by applying already used relations (eq. 27.10 and eq. 27.17):

$$\frac{1}{\tau_2} \cdot \frac{d\mathbf{B}}{dt} = \mathbf{v} \cdot \text{grad} \frac{\mathbf{B}}{\tau_2} \quad (27.10) \qquad \frac{\mathbf{B}}{\tau_2} = -\mathbf{v} \cdot \text{div } \mathbf{B} \quad . (27.17)$$

If the velocity of propagation: $v = (v_x, v_y=0, v_z=0)$; $v = dx/dt$, then the simplified field equation (if the coordinates are orientated on the vector of velocity) results in the general wave equation (involved with the x-component) in the form:

$$\|\mathbf{v}\|^2 \text{ grad div } \mathbf{B} - c^2 \text{ rot rot } \mathbf{B} = d^2\mathbf{B}/dt^2 \quad (27.27)$$

longitudinal with v = arbitrary	transverse with c = const.	wave velocity of propagation

---

2nd condition for eq. 27.28: v = c .

The wave equation in the usual notation (= inhomogeneous Laplace equation, = purely a special case!) now reads:

$$\Delta\mathbf{B} = \text{grad div } \mathbf{B} - \text{rot rot } \mathbf{B} = (1/c^2) \cdot d^2\mathbf{B}/dt^2 \quad (27.28)$$

Fig. 27.13: Derivation of the wave equations (inhomogeneous
Laplace equation) as a special case of the equations of transformation of the electromagnetic field.

27.13 Derivation of the wave equation

The first wave description, model for the light theory of Maxwell, was the inhomogeneous Laplace equation:

$$\Delta \mathbf{E} \cdot c^2 = d^2\mathbf{E}/dt^2 \quad \text{with} \quad \Delta \mathbf{E} = \text{grad div } \mathbf{E} - \text{rot rot } \mathbf{E} \qquad (27.28^*)$$

There are asked some questions:

- Can also this mathematical wave description be derived from the new approach?
- Is it only a special case and how do the boundary conditions read?
- In this case how should it be interpreted physically?
- Are new properties present, which can lead to new technologies?

Starting-point is the fundamental field equation (27.26). We thereby should remember the interchangeability of the field pointers, that the equation doesn't change its form, if it is derived for H, for B, for D or any other field factor instead of for the E-field pointer. This time we write it down for the magnetic induction B and consider the special case, that we are located in a badly conducting medium, as is usual for the wave propagation in air. But with the electric conductivity σ also $1/\tau_1 = \sigma/\varepsilon$ tends towards zero (eq. 27.16*). With that the eddy currents and their damping and other properties disappear from the field equation, what also makes sense. There remains the potential vortex term $(1/\tau_2)$*dB/dt , which using the already introduced relations (eq. 27.10 and 27.17) involved with an in x-direction propagating wave ($v = (v_x, v_y = 0, v_z = 0)$) can be transformed directly into:

$$-\|\mathbf{v}\|^2 \cdot \text{grad div } \mathbf{B}$$

The divergence of a field vector (here B) mathematically seen is a scalar, for which reason this term as part of the wave equation founds so-called „scalar waves" and that means that potential vortices, as far as they exist, will appear as a scalar wave. We at this point tacitly anticipate chapter 28, which provides the reason for the speed of light losing its vectorial nature, if it is correlated with itself. This insight however is valid in general for all velocities (v = dr/dt), so that in the same way a scalar descriptive factor can be used for the velocity (v = dx/dt) as for c.

From the simplified field equation (27.26*) the general wave equation (27.27) can be won in the shown way, divided into longitudinal and transverse wave parts, which however can propagate with different velocity.

Physically seen the vortices have particle nature as a consequence of their structure forming property. With that they carry momentum, which puts them in a position to form a longitudinal shock wave similar to a sound wave. If the propagation of the light one time takes place as a wave and another time as a particle, then this simply and solely is a consequence of the wave equation. Light quanta should be interpreted as evidence for the existence of scalar waves. Here however also occurs the restriction that light always propagates with the speed of light. It concerns the special case v = c. With that the derived wave equation (27.27) changes into the inhomogeneous Laplace equation (27.28). The electromagnetic wave in both cases is propagating with c. As a transverse wave the field vectors are standing perpendicular to the direction of propagation. The velocity of propagation therefore is decoupled and constant. Completely different is the case for the longitudinal wave. Here the propagation takes place in the direction of an oscillating field pointer, so that the phase velocity permanently is changing and merely an average group velocity can be given for the propagation. There exists no restriction for v and v = c only describes a special case.

• From the dual field-theoretical approach are derived:	From Maxwell's field equations can be derived:
=> Maxwell's field equations	=> 0
=> the wave equation (with transverse and longitudinal parts)	=> only transverse waves (no longitudinal waves)
=> scalar waves (Tesla-/neutrino radiation)	=> 0 (no scalar waves)
=> vortex and anti-vortex (current eddy and potential vortex)	=> only eddy currents
=> Schrodinger equation (basic equation of chemistry)	=>0
=> Klein-Gordon equation (basic eq. of nuclear physics)	=>0

Fig. 27.14: Comparison of the efficiency of both approaches.

(as an interim result, if it concerns the question, which approach of the two is the more efficient one and which one better should be discarded. The final balance is made in chapter 28).
It here concerns partial aspects of the following theories:

=> theory of objectivity	=> theory of relativity

27.14 The new field approach in synopsis

Proof could be furnished that an approximation is buried in Maxwell's field equations and that they merely represent the special case of a new, dually formulated and more universal approach. The mathematical derivations of the Maxwell field and the wave equation disclose, of what the Maxwell approximation consists. The anti-vortex dual to the expanding eddy current with its skin effect is neglected. This contracting anti-vortex is called potential vortex. It is capable of forming structures and propagates as a scalar wave in longitudinal manner in badly conducting media like air or vacuum.

At relativistic velocities the potential vortices are subject to the Lorentz contraction. Since for scalar waves the propagation occurs longitudinally in the direction of an oscillating field pointer, the potential vortices experience a constant oscillation of size as a result of the oscillating propagation. If one imagines the field vortex as a planar but rolled up transverse wave, then from the oscillation of size and with that of wavelength at constant swirl velocity with c follows a continual change in frequency, which is measured as a noise signal.

The noise proves to be the in the Maxwell equations neglected potential vortex term, which founds scalar waves. If at biological or technical systems, e.g. at antennas a noise signal is being measured, then that proves the existence of potential vortices, but it then also means that the scope of the Maxwell theory has been exceeded and erroneous concepts can be the result.

As an answer to the question about possible new technologies is pointed to two special properties.

1st potential vortices for reason of their particle nature carry momentum and energy. Since we are surrounded by noise vortices, an energy technical use of scalar waves would be feasible, where the noise power is withdrawn of the surroundings. There is evidence that biological systems in nature cover their need for energy in this way. But at least an energy transmission with scalar waves already would be a significant progress with regard to the alternating current technology of today.

2nd the wavelength multiplied with the frequency results in the velocity of propagation v of a wave $(\lambda \cdot f = v)$, and that for scalar waves by no means is constant. With that wavelength and frequency aren't coupled anymore; they can be modulated separately, for which reason for scalar waves a whole dimension can be modulated additionally compared to the Hertzian wave. In that the reason can be seen, why the human brain with just 10 Hz clock frequency is considerably more efficient than modern computers with more than 1 GHz clock frequency. Nature always works with the best technology, even if we haven't yet understood it.

If we would try to learn of nature and an energy technical or an information technical use of scalar waves would occur, then probably nobody wanted to have our today still highly praised technology anymore. In the course of the greenhouse gases and the electrosmog we have no other choice than to scientifically occupy us with scalar waves and their technical use.

Equations of transformation

of the electric and of the magnetic field[i]

$$\mathbf{E} = \mathbf{v} \times \mathbf{B} \quad (27.1) \text{ and } \quad \mathbf{H} = -\mathbf{v} \times \mathbf{D} \quad (27.2)$$

with: $\mathbf{B} = \mu \cdot \mathbf{H}$ (28.1) and $\mathbf{D} = \varepsilon \cdot \mathbf{E}$ (28.2)

$$\mathbf{E} = \mu \cdot \mathbf{v} \times \mathbf{H} \quad (27.3) \text{ and } \quad \mathbf{H} = -\varepsilon \cdot \mathbf{v} \times \mathbf{E} \quad (27.4)$$

Experience/observation is dependent on the relative velocity v !

Written down in general with field vectors:		Written down in components in Cartesian coordinates: (unit vectors $\mathbf{e}_x$, $\mathbf{e}_y$, $\mathbf{e}_z$)
	in $\mathbf{e}_x$-direction:	$\mathbf{v} = v_x(x(t)) = dx/dt$
$\mathbf{H} = -\varepsilon \cdot \mathbf{v} \times \mathbf{E}$	in $\mathbf{e}_y$-direction:	$\mathbf{H} = -H_y = -\varepsilon \cdot v_x \cdot E_z$
$\mathbf{E} = \mu \cdot \mathbf{v} \times \mathbf{H}$	in $\mathbf{e}_z$-direction:	$\mathbf{E} = E_z = \mu \cdot v_x \cdot H_y$
inserted into each other:		(28.3)
$\mathbf{E} = -\varepsilon \cdot \mu \cdot [\mathbf{v} \times (\mathbf{v} \times \mathbf{E})]$	in $\mathbf{e}_z$-direction:	$E_z = \varepsilon \cdot \mu \cdot v_x \cdot v_x \cdot E_z$
$\mathbf{E} = -(1/c^2) \cdot [\mathbf{v} \cdot \underbrace{(\mathbf{v} \cdot \mathbf{E})}_{= 0, \text{ since } \perp} - \mathbf{E} \cdot (\mathbf{v} \cdot \mathbf{v})]$		$E_z = (1/c^2) \cdot v_x^2 \cdot E_z$
$\mathbf{E} = +(\mathbf{v}^2/c^2) \cdot \mathbf{E}$	resp.:	$E_z = (v_x^2/c^2) \cdot E_z$ (28.4)
result:[ii]	$v = c$	(28.5)

Fig. 28.1: The equations of transformation,[i]

<i>: see part 1, chap. 6.5, eq. 60
<ii>: R. W. Pohl: Einfuhrung in die Physik, Bd. 2 Elektrizitatslehre, 21. Aufl. Springer-Verlag 1975, Seite 77, s.a. Kommentar auf Tafel 27.8
<iii>: chapter 28 is a repetition of chapter 6

28. Objectivity versus relativity

The new and field-theoretical approach contains the Maxwell-equations, but goes over and above these in one point. It describes potential vortices and their propagation in space as a scalar wave. With that can also a conclusive answer be given to the often-asked question for the medium and the mediated particles, which is a prerequisite for every longitudinal wave. Mediated are vortex structures with particle nature and the field itself functions as a medium. Is with that also answered the question concerning the aether?[iii]

28.1 The question concerning the aether

Do you know the Maxwell-experiment? No, you wouldn't be able to, since the intellectual father fast did make a backdown, after it didn't work out. Today one speaks of the Michelson-experiment and it may be connected with any other names (Morley, etc.). Remember: In his light theory Maxwell had determined a particular and constant value for the speed of light and for that there should be a physical reason, which should have its cause in the aether. By means of proving this aether Maxwell wanted to prove his theory, but this enterprise thoroughly went wrong.
The consideration was as follows: If the Earth is spinning and is moving through the cosmos, then one should be able to detect an aetherwind and different values for c in the different points of the compass. Maxwell found support for his project at the observatory, since with the aberration of the stars Bradley previously had described an observation, which could be considered as evidence for an aether. The director of the observatory charged his assistant Dr. Michelson with the task, to carry out a corresponding proof of an aether this time in a terrestrial experiment. But such an aether couldn't be proven, what Maxwell had to accept as a severe strike against his light theory. Seven years later Maxwell got the acknowledgement, however from a completely other corner by means of the experiments concerning the radio transmission of Heinrich Hertz.

Until today the question has remained open why astrophysics can prove the aether, whereas the detection in a terrestrial laboratory fails and it looks like there doesn't exist an aether. But as definition for the cause of c the aether can't be abolished as long as it is unsettled why the light is propagating with c of all possible velocities. The question is asked, what determines the propagation of light from today's point of view? Now, by means of outside fields the light can be slowed down. At present the world record lies at less than 65 kilometers per hour in a Bose-Einstein condensate. If electromagnetic fields determine the speed of light, if in addition field or gravitational lenses should confirm this, then the field takes over the task of the aether!

At this place the new field-theoretical approach shows its capabilities. The equations of transformation say nothing but that a moving H-field transforms to a resting E-field and vice versa, that thus in the place of a moving aether, the aetherwind, a resting aether is found. Doing so the dual field partners merely exchange their places. Therefore it is a wild-goose chase, wanting to measure an aetherwind with gauges, which underlie the same field (fig. 28.2).
Michelson had to fail.

The equations of transformation say:

$$\mathbf{E} = \mu \cdot \mathbf{v} \times \mathbf{H} \quad (27.3) \text{ and } \quad \mathbf{H} = -\varepsilon \cdot \mathbf{v} \times \mathbf{E} \quad (27.4)$$

- Experience/observation depends on the relative velocity v!
- The field takes over the function of the aether (determines c) and
- an aetherwind v x H is measured as a resting aether E and vice versa!

- for $v = c$ the equations of transformation turn into each other and are identical $[v = v_x(x(t))]$.
- for $v < c$ a motion field E_v depending on v is resulting

$$E_v = E \cdot (v^2/c^2) \quad (28.6)$$

- for $v = 0$ also $E_v = 0$.
- the motion field overlaps the E-field
  - in the case of vortex fields the effect overlaps the cause and itself is the cause for a new effect.
- The overlap reaches to infinity, where each time is valid:

$$E_{n+1} = E_n \cdot (v^2/c^2) \quad (28.7)$$

- the field Eo overlaps the motion field E_v

$$E = E_0 + E_v = E_0 \cdot (1 + v^2/c^2) \quad (28.8)$$

- for infinite overlap:

$$E = E_0 + E_1 + E_2 + E_3 + E_4 + \ldots + E_n + E_{n+1} + \ldots \quad (28.9)$$

- results in the power series:

$$E = E_0 \cdot [1 + (v/c)^2 + (v/c)^4 + (v/c)^6 + \ldots + (v/c)^{2n} + (v/c)^{2(n+1)} + \ldots] \quad (28.10)$$

Fig. 28.2: Power series as a result of a vortex overlap.

<i>: Grimsehl: Lehrbuch der Physik, 2.Bd., 17.Aufl. Teubner Verl. 1967, S. 130.

<ii>: R.W.Pohl: Einfuhrung in die Physik, Bd.2 Elektrizitatslehre, 21.Aufl. Springer-Verlag 1975, Seite 72 und 76, bzw. 130.

<iii>: K. Simonyi: Theoretische Elektrotechnik, 7.Aufl. VEB Berlin 1979, Seite 924.

<i4>: E. Friebe: Die Vektorprodukte der Maxwell'schen Elektrodynamik, DPG-Didaktik-Tagungsband 1995, S.396

28.2 Vortices, an overlap of the overlap

Not with any approach until now the question concerning the aether could be solved. Only the new field-theoretical approach proves with the unambiguous and free of contradiction clarification of the question concerning the aether its unmatched superiority. We hence without exception work with this approach, which is anchored tightly in textbook physics. The two equations of transformation on the one hand are the law concerning the unipolar induction according to Faraday (27.1) and on the other hand the dual formulation (27.2), which Grimsehl[<i>] calls convection equation. Grimsehl goes around the question for the correct sign by means of forming a modulus. Pohl draws detailed distinctions of cases and dictates the each time relevant formulation of the dual law[<ii>]. The sign eventually should be chosen according to the definition of the orientation of the field pointers. Also Simonyi gives both equations and the each time appropriate experiments[<iii>].

If we assume the carrier of an electric field is moving with the not accelerated relative velocity v with regard to the reference system used by the observer, then a magnetic H-field is observed, which stands perpendicular both to the direction of the E-field and to the direction of v. If the motion takes place perpendicular to the area stretched by E- and H-field, then the H-field again is observed and measured as an E-field. There will occur an overlap of the fields.

In spite of that we first consider the theoretical case, that no overlap is present, and the observer as it were sees himself. The result is trivial: the relative velocity v must be the speed of light v = c . (28.5) If considered at the speed of light, the two equations of transformation turn into each other. They now are identical both mathematically and in their physical expressiveness. For this case it actually is possible, to derive the dual law straight from the Faraday law. For a wave propagating with the speed of light, to name an example, the field strength propagating along is always equal to the causing field strength, which depends on position.

If besides the evaluation of the values also the circumstance is considered that it concerns vectors, then at this place a problem as a matter of principle of the Maxwell theory gets visible, to which has been pointed occasionally, e.g. at the German Physical Society[<i4>]. The derivation of the speed of light from two vector equations requires, that c also has to be a vector. The question is: How the velocity vector v suddenly becomes the scalar and not pointing, in all directions of space constant factor c? Is therefore for mathematical and physical reasons "the Maxwell theory in essential parts erroneous", according to a statement of the German Patent Office[<i4>]?

Now, the constancy of the speed of light is a fact, which even can be derived. We at first will be content with the clue that for every observation with the speed of light, with the eyes or a gauge constructed corresponding to our perception, the vector in all its components each time is correlated to itself, by what actually the orientation of direction gets lost. Under these for c and with equal rights also for v relevant circumstances we are entitled to calculate further with the values.

An observer, who is moving with v slower than c, will besides the original E-field also observe a motion field E_v depending on the velocity v, which disappears, if v becomes zero. What he catches sight of and is able to register with gauges in the end is the overlap of both field components.

- concerning the development of the power series:

$$E = E_0 \cdot [1 + (v/c)^2 + (v/c)^4 + (v/c)^6 + \ldots + (v/c)^{2n} + (v/c)^{2(n+1)} + \ldots] \quad (28.10)$$

- for $q < 1$ the power series with $q = (v/c)^2$ will converge (28.11)

$$\sum_{n=0}^{\infty} q^n = \frac{1}{1-q} \quad (28.12)$$

- for $(v/c)^2 < 1$ resp. for $v < c$ therefore is valid:

$$E = E_0 \cdot [1/1 - (v/c)^2] \quad \text{resp.} \quad \boxed{E_0 = E \cdot [1 - (v/c)^2]} \quad (28.13)$$

The square root of Lorentz appears in squared form<i>:

$$\left(1 - \frac{v^2}{c^2}\right) = \frac{E_0}{E} \quad (28.14)$$

The derivation for the magnetic field strength analogous to that provides the identical result<i>:

$$\left(1 - \frac{v^2}{c^2}\right) = \frac{H_0}{H} \quad (28.15)$$

Fig. 28.3 The field dilatation depending on velocity

<i>: see part 1, chap. 6.6

<ii>: Prof. Dr. H.-J. Runckel, Abteilung fur Mathematik IV der Universitat Ulm

28.3 Field overlap

But it doesn't abide by this one overlap. In the case of vortex fields the effect overlaps the cause and itself becomes the cause for a new effect. The overlapped cause produces a further effect, which for its part is overlapping (see chap. 3).

Vortices thus arise, if overlaps for their part are overlapping and that theoretically reaches to infinity, to which I already repeatedly have pointed (fig. 3.0). In addition do vortices represent a fundamental physical principle. The Greek philosopher Demokrit has traced back the whole nature to vortex formation and that already 2500 years ago!

In the field-theoretical approach this interpretation seems to experience a mathematical confirmation, since also the fields are overlapping in vortex structures. According to that we owe our observations and our being the relative movements and the vortex formation. If reversed there wouldn't be any movement, then there also would not exist fields, light nor matter. If we observe the sky, then everything visible follows the movement of its own of the Earth, of the solar system and the whole galaxy, which is on its way with unknown galactic velocity, and all movements take place in vortex structures (fig. 10.2).

The field overlap dictated by the Faraday-approach as well reaches to infinity, what has stimulated my colleagues of mathematics to also mathematically put into practice this physical requirement[ii]. This leads to an infinite power series, which converges under the condition that $v < c$.

As a result of the power series development the well-known square root $\sqrt{1-(v^2/c^2)}$ of Lorentz occurs in squared form (see also fig. 6.6). It determines the relation of the observed and the causing field strength of the electric or the magnetic field. Physically the found relation describes a dilatation field depending on velocity. The field strength thus increases, if the relative velocity v increases, or inversely no difference is observable anymore, if v tends towards zero.

Whoever wants to compete with Albert Einstein (1879-1955), who has developed the theory of relativity from the length contraction, which depends on velocity, could be inclined to derive a new field physics from the field dilatation. But I must warn of such a step. The derivation of the length contraction by the mathematician Hendrik Lorentz (Lorentz contraction) assumes a number of limiting conditions. The relative velocity v for instance may not experience any acceleration. Actually however almost all motion takes place as circular vortex motion, so that due to the occurring centripetal acceleration the conditions for the theory of relativity aren't fulfilled anymore. Neglects or generalizations thereby can lead to considerable errors, of which I would like to warn. It in general is a delicate enterprise, if one wants to provide a physical interpretation for a purely mathematically won result.

This warning to the same extent also is valid for the here shown derivation of the field dilatation. The limiting conditions practically are the same as for Einstein and the problems with a provided physical interpretation won't be less. Also here lots of paradoxes will occur, which are nothing but errors of the theory. So we won't reach our destination.

There now only one further mathematical step is necessary, which links the theory of relativity with the new notion of a field dilatation depending on velocity.

Example:
Measurement of length by means of a measurement of propagation time (sound or light) with c = L/t in a vehicle moving with v.

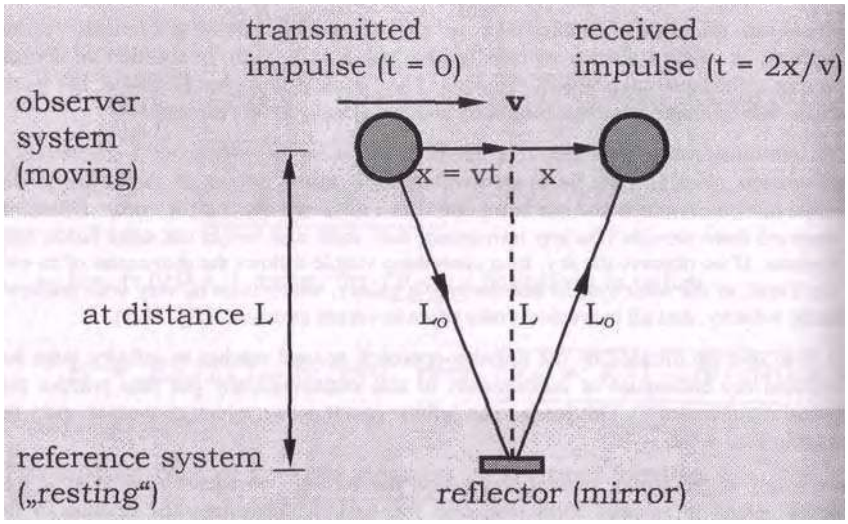

From driving time t:

$t = 2\frac{x}{v}$ = signal propagation time: $t = 2\frac{L_o}{c}$ follows $\frac{x}{v} = \frac{L_o}{c}$

According to Pythagoras: $L_o^2 = L^2 + x^2 = L^2 + L_o^2 \cdot (v^2/c^2)$

$$L_o^2 \cdot (1 - v^2/c^2) = L^2$$

the shortening of the rule results in:

$$\left(1 - \frac{v^2}{c^2}\right) = \left(\frac{L}{L_o}\right)^2 \quad (28.16)$$

Fig. 28,4: _____Derivation of the length contraction

Examples: contraction according to Lorentz transformation, measurable length shortening, curvature of space.

Counterexample: unsuccessful aether detection (Michelson experiment)

28.4 The derivation of the length contraction

The Lorentz transformation is the result of a purely mathematical problem. Stimulated by the surprisingly result of the Michelson experiment the Dutchman Hendrik A. Lorentz 1891 asked himself, how the equations of the Galilei-transformation would have to look like, if the propagation of light wouldn't be infinitely fast but finite and constant. He thereby proceeds from the assumption of two inertial systems moving against one another with a not accelerated velocity v, in which the laws of Newtonian physics are equally valid[<i>]. As a result of the relative motion a change of the length measures will occur.

This at first can be explained as a purely geometric effect in the context of nonrelativistic physics. We imagine a vehicle, which is on its way with constant velocity, and emits an optical or acoustical signal. Sideways in the countryside is standing in a perpendicularly measured distance L a reflector (mirror), which sends the signal back again. The velocity of the signal however isn't infinitely fast and from that follows that the vehicle during the propagation time of the signal as well has moved a bit further. The actual way, which the signal had to cover now amounts to L_o (> L). The distance measure thus is observed smaller as it is in reality, to be specific for the factor of the square root of Lorentz (fig. 28.4).

$L = L_o \cdot \sqrt{1-(v^2/c^2)}$ (28.16)

According to the principle of relativity it doesn't play a role, if the vehicle is driving or if it is standing still and the mirror is moving with a linear uniform velocity.

Initially Einstein also only spoke of an observable length contraction, which must not necessarily occur in reality, an optical deception so to speak. Lorentz however proceeded from the assumption of a physical length change, thus a length change existing in reality, what in practice at first makes no difference. If e.g. at relativistic velocities a rocket becomes smaller, then the pilot equally shrinks, so that it would not be possible to notice a present difference.

If however the observer stands outside the events and takes a „neutral standpoint", then he will be able to see, which interpretation is the right one. Today some examples are known. In accelerators particles at relativistic fast velocities actually get smaller for the factor of the square root of Lorentz. That has been proven and this result afterwards gives the Dutchman Lorentz right! The followers of the physical length contraction also are called Neo-Lorentzians.

In the vicinity of a gravitational mass the speed of light becomes so slow, that the shortening factor plays a role and space is curved towards the mass. To understand this shortening of scale, the influence of the field also should be considered.

<i>: Example: In a closed lift physical experiments are being carried out. Accelerations of the lift have an influence on the experiments. However no influence can be detected, if the lift is standing still or is moving with constant velocity. It with that fulfills the conditions of an inertial system. The question is: what do the experiments show someone standing outside, whom the lift passes by?

From the comparison of the Lorentz contraction (28.16)
with the field dilatation (28.14 and 28.15)

$$\left(1 - \frac{v^2}{c^2}\right) = \left(\frac{L}{L_o}\right)^2 \overset{!}{=} \left(1 - \frac{v^2}{c^2}\right) = \frac{E_o}{E} = \frac{H_o}{H}$$

follows

$$\left(1 - \frac{v^2}{c^2}\right) = \left(\frac{L}{L_o}\right)^2 = \frac{E_o}{E} = \frac{H_o}{H} \quad (28.17)$$

the proportionality (length measures depending on field):

$$E, H \sim 1/L^2 \quad \text{and} \quad Eo, Ho \sim 1/L_0^2 \quad (28.18)$$

Experimental examples<i>:

- Electrostriction (piezo speaker)
- Magnetostriction
- Field or gravitational lenses
- Curvature of space, deflection of light

Conclusion<ii>:

- The field determines the length measures (what is 1 meter)
- The field determines the velocities v (in m/s)
- The field determines the speed of light c [m/s]
- Measurement of the speed of light is made with itself:

$$c \sim r \quad (28.19)$$

- Measured is a constant of measurement c = 300.000 km/s
- The speed of light c is not a constant of nature!

Fig. 28.5: The dependence of the Lorentz contraction on the field

<i>: see part 1, chap. 6.10
<ii>: see part 1, chap. 6.11

28.5 The dependence of the Lorentz contraction on the field

The two results of the field dilatation (28.14 and 28.15) and of the Lorentz contraction (28.16) must be brought together and compared (28.17). Doing so the mathematical expression of the square root of Lorentz is cancelled out. That is of utmost importance, since with that also all limits disappear and there remains a purely physical relation, a proportionality of utmost importance (28.18).

What was the sense of the limits associated with the introduction of so-called inertial systems, which are the basis of the Lorentz transformation and which were adopted for our derivation of the field dilatation? They now only are auxiliary considerations according to model. We have chosen a very simple model, which can be described mathematically, in which an observer holds in his hand gauges for distances and field strengths and with that gauges a system flying by with constant velocity. He on the one hand determines a length contraction and on the other hand a field dilatation. He compares both with each other and comes to the conclusion: The field determines the dimensions!

This statement is purely physical and it is generally valid. It is independent of the relative velocity and all other mathematical conditions. A centrally accelerated circular motion e.g. will falsify the length contraction to the same extent, as the at the same time occurring field dilatation. It can be expected, that in addition to the square root of Lorentz also other errors will mutually efface, so that a generalization in this case actually seems to be allowed.

The won proportionality is of most elementary importance. We use it in the case of the piezo speaker and know it from the curvature of space and deflection of light in presence of extreme fields. If we ourselves however are exposed to the field as an observer, in which also the object to be observed is situated, then we are in the dilemma, not being able to perceive the influence. If we, to stay with the example, would sit in a rocket and this would become smaller at faster velocity, then we would notice nothing, since we also would shrink along to the same extent.

That concerns every measurement of velocity in general and the speed of light c in particular, which as is well-known is measured in meters per second. But if the field determines c and in the same way the length measure, which is given in meters, then both stand in a direct proportionality to each other, then we won't have the slightest chance to measure the speed of light. If namely c is changed, then this concerns the measurement path in the same way. Now the variable is measured with itself and as a result appears c, a constant value. We neither can see the change, since our eyes scan all objects optically and that means with c.

It is the nightmare of each and every measurement engineer, if the gauge depends on the factor to be measured. No wonder, if the theorem of addition of the velocities apparently loses its validity and always the same c is being measured, independent of the direction in which the source of radiation is moving (chap. 6.11). The result is:

The speed of light is a constant of measurement and not a constant of nature!

If however the light is scanned with the speed of light, then also all components of the light vector correlated with themselves result in the same constant value c, then actually the vector of the speed of light loses its orientation in space and becomes a scalar factor. The Maxwell equations already anticipate this circumstance, but without providing an explanation why this is correct. Only the new field approach can answer the open question. With the derivation an axiom of physics - one also can say stumbling block - has been overcome.

The field strength determines the length measure:
(the distance L between the spheres)<i>

$$E, H \sim 1/L^2 \qquad (28.18)$$

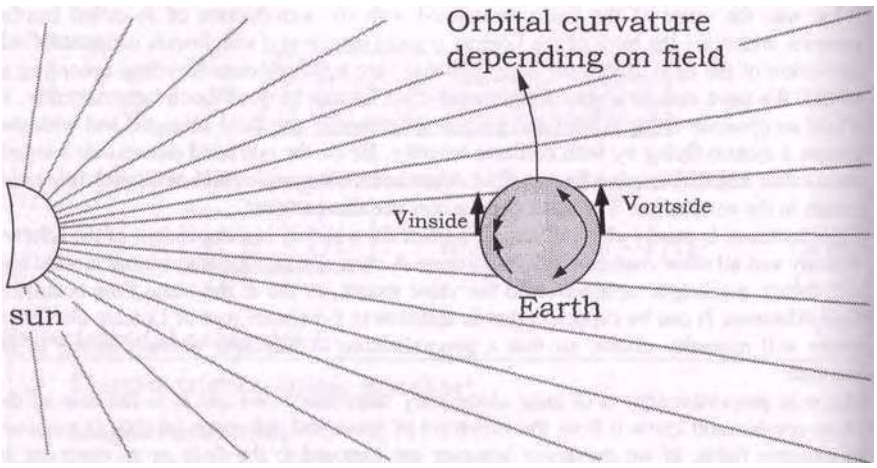

Fig. 28.6 A: The curvature of the Earth in the gravitational field of the sun

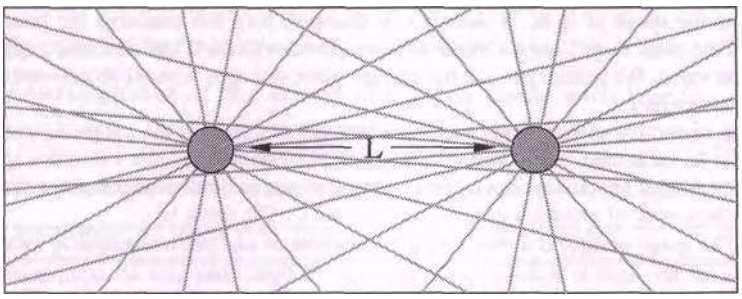

Fig. 28.6 B: Force of attraction and reduction of the distance L
as the mutual field influence of two masses.

<i>: Repetition of part 1, chapter 6.7

28.6 Boscovich and the respiration of the Earth

Who has got a good idea, fast will find that some other scientist had the same idea already before, and for his part possibly already had to make the same experience. If in spite of that the track fast loses in history, it as a rule is because of the insufficient citing and the vanity of the discoverers, who in reality only are rediscoverers of a much older knowledge.

The dependence of the length measures on the field (eq. 28.18) in the mathematical form of the derivation however should still be quite new. But the physical consequence already was described by the Jesuit priest Roger Joseph Boscovich from Dalmatia in 1755[<i>]. He was Professor for mathematics and theology in Rome and spoke about the world on the one hand being deformable, similar to rubber, but on the other hand we aren't able to perceive this, since our body is made of the same material and follows all changes. „We in an absolute way can recognize neither the place, nor distances or orders of magnitude", writes Boscovich in his book about space and time and writes how these are perceived by us[<ii>]. He suspects that the Earth unobservable for man „is respiring".

Actually a terrestrial observer at daytime is situated closer to the sun than in the night. He by day is exposed to a slightly stronger field and as a result correspondingly smaller. He himself and all objects in his neighbourhood are subject to an identical fluctuation of size, so that this „respiration" of the Earth cannot be detected. It can be detected neither with a tape measure nor with an optical measurement and still is present in reality. Only from a neutral standpoint we can succeed to recognize the actually existing curvature of space (fig. 28.6 A).
An example is the duration of the sunshine at the equator, which is longer than can be expected from the spherical form of the Earth. This reveals, how the Earth is bending towards the sun (see also chapter 6.7).
A further example is the influence of the field on the orbital velocity of the Earth measured in meters per second. Here also the meter at daytime is smaller than in the night, for which reason the Earth is moving slower on the side turned towards the sun, like a track vehicle, which drives a turn, if the chain at the inside runs slower than on the outside. If the Earth describes an orbit around the sun. then this circumstance has to do nothing at all with centrifugal force or with a force of attraction of the sun. The circular motion simply and solely is a result of the field influence of the sun[<iii>].

The force idea proves to be a pure auxiliary description. In the context of Newtonian mechanics the force plays a central role. Without question it is a very efficient and subjective perceptible description, which still isn't able to reproduce the physical reality in an objective manner. What keeps the planets into their orbit is only the field of the sun, which we call gravitational field and not some force! But of which kind is the gravitation and the field, which causes masses to come closer together and following our subjective observation attract each other (fig. 28.6 B)?

<i>: O. E. Rossler: Endophysics, the World as an Interface, World Scientific Publishing Co. 1998, Kap. 10, S. 87-112, mit Ubersetzungen aus <ii>:

<ii>: R. J. Boscovich: De spatio et tempore, ut a nobis cognoscuntur, 1755.

The length measure (the distance L between the spheres)[<i>] is determined by the field strength:

$$E, H \sim 1/L^2 \quad (28.18)$$

A. Charged mass points (electrons, positrons, ions,...):

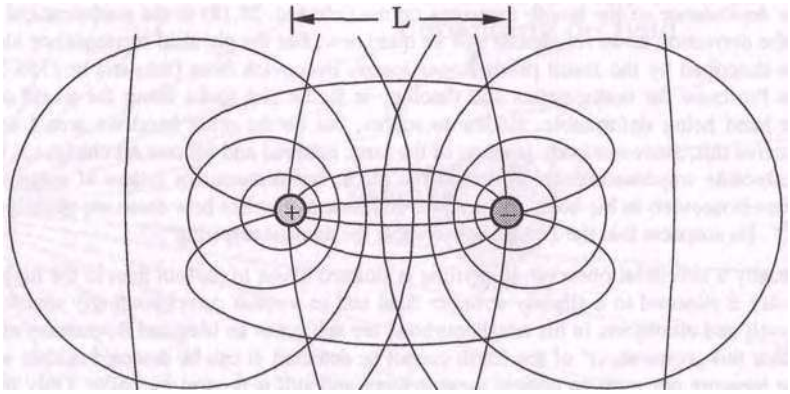

B. Uncharged mass points (neutrons, atoms, ...):

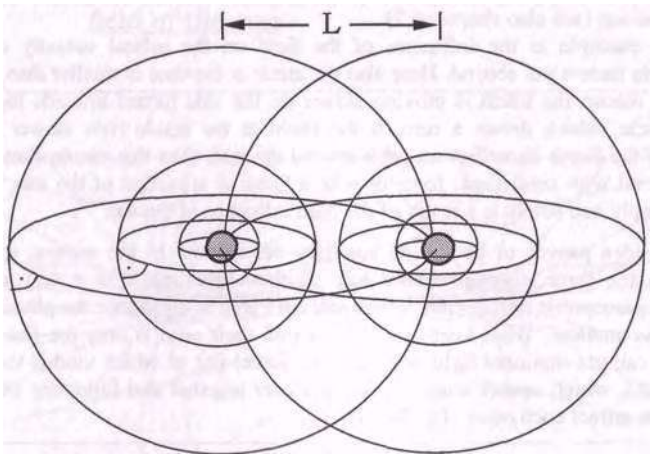

Fig. 28.7: Observation of a mutual force of attraction because of the effect of the fields on the distance measure.

<i>: Repetition of part 1, chapters 6.7 - 6.9 and part 2, chapters 10.4 and 15.2

28.7 Derivation of the gravitation

In fig. 28.6B the relation between the field influence and the observed force of attraction of two mass bodies is represented. If I in my mind for instance "switch on" the field lines of both bodies, which are placed at distance L, then the fields according to equation 28.18 reduce the measure L and optically come each other closer. With increasing proximity the field line density increases, so that L further decreases. We observe a mutual attraction, which lets both bodies move towards each other.

In fig. 28.7A the two bodies carry an electric charge. For different polarity the field lines as is well-known run from the positive pole to the negative pole, to bundle up there. As a matter of principle also here an attraction can be expected, which is called electromagnetic interaction. For the reason of the bundling up of the field lines this effect however will turn out to be considerably stronger. Hence the electromagnetic interaction is for many powers of ten more powerful than the gravitation.

Furthermore there also can occur repulsion, if in the case of like charge the field lines are bent aside and between the two bodies an area is formed, where the field tends towards zero and the distance measure L (according to eq. 28.18) as a result towards infinity. The electromagnetic interaction theoretically indeed reaches to infinity. Responsible are the open field lines arising from a charged body.

Now every charged body in addition has a mass, with which it takes part in the gravitation. Let's remember the comparison of the derivations. The Maxwell theory teaches us that in the static case E- and H-field are decoupled, because each time the other field disappears. Even if as a result of the unipolar induction for every open field line the other one is taken to be standing perpendicular to the open field line, then this other line just wraps around the open field line and forms a closed-loop field line. In that way it can't be influenced anymore from the outside and can be neglected, so goes the doctrine, which is drawn from the Maxwell theory (fig. 27.5).

This is a fatal error in reasoning! The equation 28.19 naturally is valid for open field lines in the same manner as for closed ones. These fields also lead to an observable force of attraction. If of course exactly those fields are neglected, which are responsible for the gravitation, then we need not wonder, if we don't understand the gravitation and the nature of this interaction!

The influence of the closed field lines responsible for the gravitation is due to the missing bundling up of the lines correspondingly weak. Secondly these can't exist a force of repulsion due to the missing ability to influence closed field lines from the outside and third it can be recorded that all charged bodies also have a mass. All three statements of the field lines model perfectly cover the physical reality.

Fig. 28.7 B shows uncharged bodies, for which both the field lines of the E-field and of the perpendicular to them arranged H-field are closed-loop. Such bodies, like e.g. neutrons or whole atoms without charge behave electrically neutral to the outside, but have a mass for the reason of the closed field lines, whereby the field lines of the H-field dominate those of the E-field[<i>].

<i>: Repetition of K. Meyl: EMEC part 1, chap. 6.8 + 6.9, part 2 chap. 15.1

Dual field approach	/ The Maxwell field
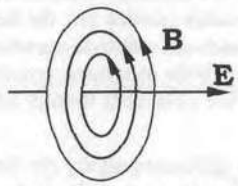	**E** = neglectible, **B** = constant.
E and **B** are coupled	/ decoupled (approximation)
The closed field lines by no means are without influence: They cause the **gravitation** !	If the Maxwell field neglects the field factor, which leads to the gravitation, it isn't astonishing, if the gravitation remains not understood!

• The following physical standpoints can be distinguished:		
subjectivity (laboratory physics, observable)	**relativity** (mediator role) (transformation)	**objectivity** (not observable)
• Exemplary theories and their representatives:		
Newton Maxwell	Poincaré Einstein	Boscovich *(dual approach)*
• With the associated transformation:		
Galilei-transf. for $c = \infty$	Lorentz-transf. c = constant	*(new transf.)* c = variable

Fig. 28.8: Physical standpoints

28.8 From subjectivity to objectivity

With the field lines interpretation, which by the way already preferably was used by Faraday, the gravitation proves to be an until now neglected influence of the electromagnetic field. With that for the first time also the grand unification of the interactions was successful. The long sought-for unified theory with that for the first time comes within reach.
The derivation has made it possible to mathematically secure the theoretical working model of Boscovich. Already 1755 Boscovich points out the optical deception, which our observation underlies, if absolute orders of magnitude in our neighbourhood should change and our perception would change along. Then also all metric and optical measurement results would underlie this change. Following the idea of Boscovich I distinguish between subjectivity and objectivity.

The relativity is a compromise lying between both points of view, where a neutral standpoint is strived for, which lies outside the events. And from this standpoint the objectively taking place events are being observed. The theory of relativity consequently is a pure observer theory with strongly restricted scope on the basis of the Lorentz-transformation.

Theories of classic physics, like e.g. Newtonian mechanics, fall in the domain of subjectivity. The results and regularities are won in a terrestrial laboratory if possible isolated from the environment, where they have absolute validity. Here the Galilei-transformation is valid.
But if these subjectively won laws are applied to the microcosm in quantum physics or to the calculation of cosmic observations, one fast hits limits. The better the resolution of the microscopes and telescopes gets, the clearer the „outside" observer realizes, how much the laws of classic physics lose their validity.

Astrophysics successfully reaches for the theory of relativity, which with the curvature of space in the vicinity of mass centres delivers useful explanations. Here the dependence of the spatial dimensions on the field already could be established. In contradiction to that this fundamental relation is said to play no role whatsoever in quantum physics, or in all terrestrial laboratory experiments. But with which right may physical regularities from one domain be ignored in others? There only can exist one physics and that should be sought for!

What we need is objectivity! Behind all the apparently disconnected phenomena of physics work quite simple laws, which can't be observed and are until now not recognized by us. Objective physics in the words of Goethe is the one, which holds the world together in the heart of hearts. I call this, already by Boscovich suggested point of view, theory of objectivity. The access to the model domain of objectivity must be made mathematically by means of a transformation, since it is blocked for us by means of measurements or observations (see chapters 6.15-6.19). The transformation back into the observation domain must be made according to the same mathematical relations (fig. 28.9). In this way the quantum properties of the elementary particles can be calculated with high accuracy and agreement with the values, which until now only could be measured (chapter 7).

Approach: $r = c \cdot t$ (determine distance by signal prop. time) (27.23)

$dr = c \cdot dt + t \cdot dc$ (total differential for a change) (27.24)

$$c = \frac{dr}{dt} - t \cdot \frac{dc}{dt} \quad \text{resp.} \quad t = \frac{dr}{dc} - c \cdot \frac{dt}{dc} \qquad (27.25)$$

$$c = \frac{dr}{dt} - t \cdot \frac{d^2r}{dt^2} + t^2 \cdot \frac{d^3r}{dt^3} - t^3 \cdot \frac{d^4r}{dt^4} + t^4 \cdot \frac{d^5r}{dt^5} - \ldots \qquad (27.26)$$

resp.

$$t = \frac{dr}{dc} - c \cdot \frac{d^2r}{dc^2} + c^2 \cdot \frac{d^3r}{dc^3} - c^3 \cdot \frac{d^4r}{dc^4} + c^4 \cdot \frac{d^5r}{dc^5} - \ldots \qquad (27.27)$$

The Taylor-series (27.26 and 27.27) breaks off after the first term, if

c = constant	resp.	t = constant	
$dr = c \cdot dt$	resp.:	$dr = t \cdot dc$	
$\Delta r = c \cdot \Delta t$	resp.:	$\Delta r = t \cdot \Delta c$	(27.28)
theory of relativity		theory of objectivity	
$\Delta r \sim \Delta t$	resp.:	$\Delta r \sim \Delta c$	means:
from: length contraction		variable speed of light	
follows: time dilatation		dependency of meter measure	
for absolute speed of the light		for absolute time	
observation domain (measurable)		model domain (can only be calculated)	

x(r) ○——● M{x(r)}

Model transformation of the length measures

Fig. 28.9:____ Theory of relativity and theory of objectivity and the model transformation between both physical standpoints

<i>: Repetition of part 1, fig. 6.16

28.9 The objective standpoint

The question is asked how one gets to an objective physical standpoint, which in addition evades every observation? The way leads over a transformation, to which all perceptible and measurable relations must be submitted.
If we for instance measure the distance r to a point light source, then the propagation of the light c and the propagation time t determine the distance measure $r = c*t$
If there occurs a little change of the distance, then two causes should be considered: Either the propagation time or the speed of light have changed somewhat. With that the two possible standpoints already would have been found.

The relativistic standpoint, which proceeds from the assumption of the speed of light being constant, says: the propagation time varies and we are dealing with a clock problem. If namely for relativistic velocities a length contraction occurs, then from that necessarily follows a time dilatation.
But actually no specific statement can be made about the constancy of the speed of light, besides that we look at, measure and scan everything with c and hence only observe the constancy. With that the theory of relativity remains a pure observer theory, exactly as Einstein originally called it into existence. This standpoint follows the motto: What can't be observed also doesn't need to interest the physicist.

The objective standpoint strives for more, for a description of the actually taking place processes. This time we proceed from the assumption of a universal and constant time with the argument: The time measure is an immutable definition and the physicist, who dictates this, himself determines what is simultaneousness. Then there also is no place for time travel and for clocks going wrong.
Therefore the speed of light can take all possible values always in strict proportionality to the length measures. Thus the measured length and distance measures should be transformed and that in the end is the unit „meter", which should be replaced by an objective measure.

With that the necessary transformation for variable c would be outlined. This transformation will be enqueued in the file of the big transformations. From it the Lorentz-transformation for c = constant emerges as a special case, like already from that transformation the Galilei-transformation follows for $c = \infty$. How now the relation of the subjective to the objective „meter" should be determined; by means of the relation of the relevant fields (eq. 28.17) or by means of the square root of Lorentz (eq. 28.16), over that should be worked and spoken. We already have successfully gone through it in a concrete example (chapter 7).

Every theory is judged according to its expressiveness. Ending this chapter the statements and derivations hence again are compared. On the one hand the Maxwell theory and from that the theory of relativity can be derived from the new approach, on the other hand a long list follows, which can't be connected with the Maxwell equations, like e.g. the gravitation. For instance the neutrino and all other elementary particles with all their specific quantum properties are derived (chapter 7), free and easy fundamental laws result, like the law of conservation of energy, and even the temperature spills its until now kept secret (chapter 8.3). Remains the conclusion: With no other approach according to the textbooks until now the efficiency of the new approach could be obtained.

• From the dual field-theoretical approach are derived:	• From Maxwell's field equations can be derived:
=> Maxwell's field equations	=>0
=> Quantum properties of the elementary particles	=>0
=> Neutrino (as an oscillating ring-like vortex)	=>0
=> Gravitation (as a result of closed field lines)	= > 0
=> Unified theory (grand unification of all interactions)	=>0
=> Temperature (as an oscillation of size depending on field)	=>0
=> Law of conservation of energy (and many other fundamental laws of physics)	=>0
=> Theory of objectivity	=> Theory of relativity

Fig. 28.10: Comparison of the efficiency of the approaches (final balance)

29. Mathematical gleanings

If, proceeding from the new field-physical approach, well-known and accepted theories are derived as special cases, this on the one hand can be valued as evidence for the correctness of the approach. On the other hand the new approach in part significantly influences the interpretation of the derived theories. That can involve a rethinking, with which not insightful people have difficulties, if for instance quantum physics, thermodynamics or the gravitation become partial aspects of electromagnetism. Over and above that are hidden many new thing in the new approach, which are there to discover. To that are counting among others the potential vortices and the scalar waves. One can work out these phenomena physically or mathematically, where the latter way as a rule is the faster one. Hence the summary shall be concluded with a kind of mathematical gleanings.

29.1 General and special theory of relativity

Albert Einstein distinguishes between general and special theory of relativity. Whereas the special (SRT), still is linked tightly with the prerequisites of the Lorentz-transformation, the general (GRT), deals with an extension to arbitrary systems, which mustn't be inertial systems. I would like not to dwell upon the GRT, as Einstein designed it, and merely notice that every generalization represents a possible source of errors and has to be well founded.

In the case of our derivation, the general case as it were resulted of its own accord. Let's turn back: If the root of Lorentz still was a component of the derived field dilatation (28.15) and equally of the length contraction (28.16), then it fell out in the comparison of both results (28.17). With that the important result, the proportionality (28.18), which among others results in the gravitation, becomes independent of the speed of light and the relative velocity v. This last step is obvious and still completely new. It cannot be found at Einstein, who in another way finds his GRT and his description of the gravitation. Even if here is striven for the same goal, then deviations in the result cannot be excluded because of the differences in the derivation, for which reason I additionally mark the by me derived general relativity (GRT'), to avoid confusion.

Influence of the Lorentz-transformation in the:
SRT (special theory of relativity): one-dimensional,
GRT' (general theory of relativity): three-dimensional, to a large extent corresponding to the GRT of Albert Einstein,
GOT (general theory of objectivity)

Discussion of the root of Lorentz $\sqrt{1 - v^2/c^2} = \sqrt{1 - \beta^2}$ with $\beta = v/c$
resp. the γ-factor: $\gamma = 1/\sqrt{1 - v^2/c^2}$ (29.1)

Being transformed are:		SRT	GRT'	GOT
Length measures (length contraction eq. 28.16)	L [m]	$\sim 1/\gamma$	$\sim 1/\gamma$	$\sim 1/\gamma$
Areas (circular motion)	A [m²]	$\sim 1/\gamma$	$\sim 1/\gamma^2$	$\sim 1/\gamma^2$
Volumes (vortical motion)	V [m³]	$\sim 1/\gamma$	$\sim 1/\gamma^3$	$\sim 1/\gamma^3$
Time measures	t [s]	$\sim 1/\gamma$	$\sim 1/\gamma$	= const.
Velocities	v [m/s]	= const.	= const.	$\sim 1/\gamma$
($v = L/t$)	c [m/s]	= const.	= const.	$\sim 1/\gamma$
Constants of material	ε [As/Vm]	= const.	= const.	$\sim \gamma$
($\varepsilon \cdot \mu = 1/c^2$)	μ [Vs/Am]	= const.	= const.	$\sim \gamma$
Relativistic mass (increase in mass)	m [kg] [=VAs³/m²]	$\sim \gamma$	$\sim \gamma$	$\sim \gamma^2$
Energy	W [VAs]	$\sim \gamma$	$\sim \gamma$	= const.
Energy density ($w = W/V$)	w [VAs/m³]	$\sim \gamma^2$	$\sim \gamma^4$	$\sim \gamma^3$
E-, **H**-field strength	**E** [V/m]	$\sim \gamma$	$\sim \gamma^2$	$\sim \gamma$
($w = (\varepsilon \cdot E^2 + \mu \cdot H^2)/2$)	**H** [A/m]	$\sim \gamma$	$\sim \gamma^2$	$\sim \gamma$
Power density (Poynting vector $\mathbf{p} = \mathbf{E} \times \mathbf{H}$)	**p** [VA/m²]	$\sim \gamma^2$	$\sim \gamma^4$	$\sim \gamma^2$
D-field, **B**-field	**D** [As/m²]	$\sim \gamma$	$\sim \gamma^2$	$\sim \gamma^2$
($\mathbf{D} = \varepsilon \cdot \mathbf{E}$; $\mathbf{B} = \mu \cdot \mathbf{H}$)	**B** [Vs/m²]	$\sim \gamma$	$\sim \gamma^2$	$\sim \gamma^2$
Power	P [VA]	$\sim \gamma$	$\sim \gamma^2$	= const.

Fig. 29.2 Transformation table between SRT, GRT' and GOT

29.2 Transformation table

Let's speak again about the difference to the special relativity (SRT). This so to speak deals with the one-dimensional case of the uniform motion of a reference system in x-direction ($v = v_x$), as specified by the Lorentz-transformation, where only the x-components and not those in y- or z-direction are being transformed. As already mentioned this is a purely theoretical case, which in practice occurs next to never. Normal is circular and vortical and with that accelerated motion, where the velocity component permanently changes its direction.

The derived result of the general relativity (GRT') does justice to this circumstance. Even if this at first only has been derived for the x-direction it nevertheless is valid equally in y- and z-direction. It even remains valid for the case that we base on a path of arbitrary form of a spatial field vortex. In this case some components continually occur in all directions of space, so that the relative velocity v as already the speed of light c loses its vectorial nature. With that the transition of the SRT to the GRT is carried out. By means of the spatial swirling the electric and magnetic field pointers at the same time turn into scalar factors, by taking over the function of the aether. Let us remember that even Einstein in his GRT was forced to again introduce the aether, which in the SRT still was unnecessary.

It therefore makes a difference in the transformation of physical factors, if we base on a one-dimensional (SRT) or a three-dimensional spatial description (GRT). Length measures in x-direction in both cases must be converted using the root of Lorentz. Usually the relativistic γ-factor is introduced, which is inverse to the root of Lorentz

$\gamma = 1/\sqrt{1-v^2/c^2}$ with $x_o/x = \gamma$ (29.2)

If thus individual length measures would be subject to a length contraction following the γ -factor, then a volume V according to the SRT must be transformed with γ, according to the GRT' however with γ^3.
As is well-known a relativistic increase in mass is converted with the γ-factor and in the same manner the to that proportional energy $E = m\ c^2$. If we however correlate the energy to the volume V and in that way determine an energy density w, then the difference between SRT ($w \sim \gamma^2$) and GRT' ($w \sim \gamma^4$) again has its maximum effect.
A relation to the field factors of E- and H-field is for instance provided by the energy density of a wave field
$w = (\varepsilon \cdot E^2 + \mu \cdot H^2)/2$ (29.3)

According to that the field strengths in the one-dimensional case of the SRT should be converted with the γ-factor, in the case of the GRT' however with γ^2, in accordance with the derivation in chapter 28. This circumstance willingly is overlooked, although it only concerns the textbooks and the today valid theory of relativity. I however point to the difference, since it does make a difference if we start with the SRT or the GRT when we change to the general theory of objectivity (GOT).

In the domain of the GOT all length measures should be transformed. The respective dimension gives information with which power the γ-factor occurs (fig. 29.2). The unit meter is responsible for that.

Discussing the root of Lorentz $\sqrt{1-\beta^2} = 1/\gamma = \sqrt{1-(v^2/c^2)}$				
mathematical consideration:	$v = 0$	$v < c$	$v = c$	$v > c$
Abbreviations: $\beta = v/c$	$0 <$	$\beta < 1$	$\beta = 1$	$\beta > 1$
and: $\gamma = 1/\sqrt{1-\beta^2}$	$1 <$	$\lvert\gamma\rvert < \infty$	$\gamma = \pm\infty$	imaginary
and: $\gamma^2 = 1/(1-\beta^2)$	1	positive	$\gamma = +\infty$	negative
and: $\gamma^4 = 1/(1-\beta^2)^2$	$1 <$	positive	$\gamma = +\infty$	positive
Examples: Increase in mass, energy $\sim \gamma$ for SRT and GRT	1	positive	$\pm\infty$	complex
Field strength in GRT': $\mathbf{E}, \mathbf{H} \sim \gamma^2$ and mass in GOT: $m \sim \gamma^2$	$1 <$	$\mathbf{E}, \mathbf{H} < \infty$ positive	$+\infty$	$\mathbf{E}, \mathbf{H} < 0$ negative
Energy-, power density $\sim \gamma^4$ (Poynting vector) in GRT:	$1 <$	$\mathbf{P} < \infty$ positive	$\mathbf{P} = +\infty$	$\mathbf{P} < \infty$ positive

Fig. 29.3 Discussion concerning the root of Lorentz

- The special theory of relativity SKT only is defined for $v < c$
- For $v \bullet c$ particles with a complex mass, but with a real energy density (according to GRT') would result.
- From the point of view of the theory of objectivity (GOT) the mass should be taken negative-real (neutrino?).

29.3 Discussion concerning the root of Lorentz

Fig. 29.2 forms the basis for the transformation in the domain of the GOT, the general theory of objectivity, where it plays a role, if a subjectively measured factor should be converted from the laboratory domain or a relativistic factor according to the SRT or the GRT'. The given proportionalities thereby should be put in the respective relation. In this way results the respective valid instruction for transformation on the basis of the root of Lorentz.

Let's take a critical look at the root of Lorentz. The velocity v occurring in it, of whatever this may consist, is depending on the field according to equation 28.14 + 28.15. It strictly speaking wouldn't be constant anymore and wouldn't belong in a general instruction for transformation at all. Only, what is valid for v, is valid to the same extent for c. Since only the proportion of v/c occurs in the root of Lorentz every influence depending on field or of other nature will have no effect on v/c and the value of the root of Lorentz. It in any case will retain its value. It fulfills for itself the condition of the Lorentz invariance. According to that in the case of the relative velocity v it doesn't depend on the absolute value, but only on the relation to the speed of light. In addition the restriction to values of $v < c$ is normal, if the speed of light is seen as an upper limit. Let's first purely mathematically draw a case distinction for different velocity domains of v. For $v = 0$ the root of Lorentz becomes one and the Lorentz transformation turns into the Galilei transformation.

Connected to this is the today well-known and technically used domain up to the limit of $v = c$. It virtually is impossible to accelerate a mass particle to the speed of light, since mass, field and energy would grow towards infinity, as is clear from the table (fig. 29.2). Particles as fast as light, like photons, hence cannot have a mass. At $v = c$ a singularity is present.

In a field theory, which also deserves this name, however an upper limit must not be present. Hence also the case for $v > c$ should be required theoretically. Only later we will be able to judge if this makes sense physically. We at first only want to examine the case mathematically. Mass, field and energy now again have a finite value, there however results a complex, purely imaginary mass, a negative field and doing so, as already before a positive energy and power density.

There sometime has been the textbook opinion that it is physically impossible to fly faster than sound. This erroneous statement even could be proven „scientifically", because such a supersonic airplane would fly off the observation space and with that wouldn't be real anymore, thus from a mathematical viewpoint would be complex. Anyone, who in New York gets off a Concorde, can confirm that everything at any moment of the flight was real. Only the observer is deceived, if the airplane flies somewhere else, than he perceives it. Is the speed of light also such a „sonic barrier", which by the majority of the scientists since Einstein until today still is thought to be insurmountable?

How should one physically imagine a complex mass? Let us remember the alternating current teachings, where it is normal to work with complex values, since the mean values of the oscillating alternating currents, tension voltages and fields are zero. Calculating with mean values would result in zero energy and power. Hence complex factors are introduced and the root mean square values are calculated and measured instead of the mean values. Could a complex mass analogously not concern an oscillating particle, a particle, which in addition is faster than the light?

- Physical example:

neutrino = mean of the oscillating mass≈zero
RMS value of the complex mass≠zero
E- and H-field with inverse sign
carrier of positive energy and power
ν -model: ring-like vortex oscillating from e^- to e^+ <i>

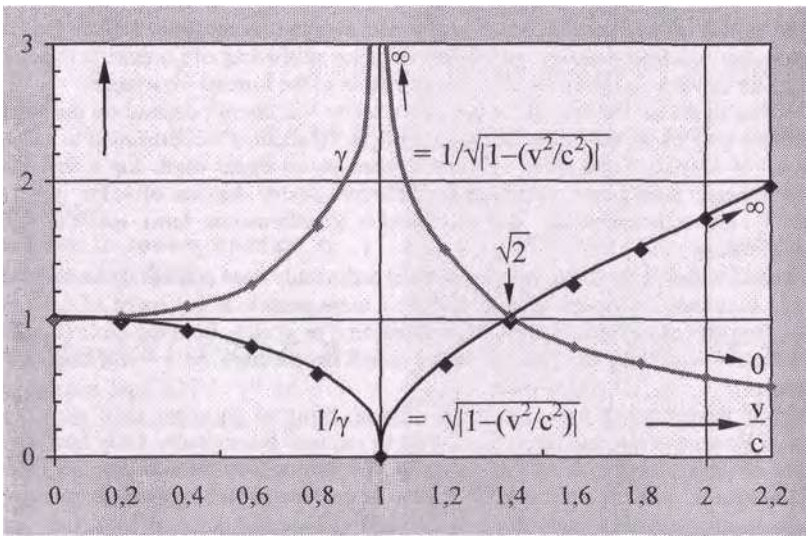

Examples from the general theory of relativity (GRT):

(28.16): length contraction $L \sim 1/\gamma = \sqrt{1-(v^2/c^2)}$

(6.19): increase in mass $m \sim \gamma = 1/\sqrt{1-(v^2/c^2)}$

(6.6,28.15) field dilatation $\mathbf{E} \sim \mathbf{H} \sim \gamma^2 = 1/(1-v^2/c^2)$

Fig. 29.4: Root of Lorentz for speeds faster than light (v > c)

29.4 Mathematical derivation of the neutrino

In the domain of speeds faster than light, for v > c, the power series (28.12) does not converge anymore and every observer theory and every observation (fig. 28.4) will fail, because particles faster than light run away of their own visible appearances. Every measurement and every observation inevitably is behind and hardly can be assigned to the actual cause. That way for instance measured neutrino events are being connected with celestial observations, with which they haven't got anything to do at all.
If we however describe the domain v > c in the complex plane, then astonishing results are found, which could be verified physically: a complex length dilatation with increasing velocity goes along with a loss of complex mass. The oscillating fields, energy and power density however would be real with negative sign.
Thus there would result particles carrying energy with an oppositely poled field, with an oscillating mass and if necessary also an oscillating charge. Without static mass and charge these particles hardly would interact with normal matter, which leads to an enormous ability of penetration. The only physical particles, which have such a property, are the neutrinos. With that a usable and an extremely efficient model description has been found for these particles. Also the energy of these particles can be calculated, which has considerable orders of magnitude and is available as an energy source everywhere and any time.

If for instance in a converter for space energy a neutrino should be converted into a resting charge carrier (with v = 0), then two steps are necessary (see part 2 of this series of books):

1. First the neutrino must be slowed down to 1.414 times the speed of light (fig. 28.9). Doing so energy is spent and not won! The converter for instance can cool down.

2. Afterwards the characteristic rotation of its own, with which the ring-like vortex spins around itself by permanently putting its inside to the outside and vice versa, has to be taken away from the neutrino. In that way the vortex centre is closed and the particle acquires localization. It becomes a charge carrier.

Even if the representation in the complex plane represents only an auxiliary description, the model nevertheless seems to be efficient, because despite its complex mass and charge the neutrino nevertheless carries a real energy. It in any case is represented in that way to an observer, who measures the relation with the speed of light, who in the relativistic scheme of things scans the relation.

Today, as already said, even the sonic barrier has become permeable and no scientist dares to physically deny this fact and even prove his mistake mathematically anymore. No, on the contrary, he always did know that as an expected consequence the sonic barrier runs after the supersonic plane. The once physically unthinkable and scientifically fought has become normality.
What should hinder an oscillating particle, like a neutrino, to be faster than the light? Some time one also will accustom to that.

- Starting-point:
  the fundamental field equation
  (derivation in chapter 27.10)

$$-c^2 \cdot \text{rot rot } \mathbf{B} = \frac{\partial^2 \mathbf{B}}{\partial t^2} + \frac{1}{\tau_1}\frac{\partial \mathbf{B}}{\partial t} + \frac{1}{\tau_2}\frac{\partial \mathbf{B}}{\partial t} + \frac{\mathbf{B}}{\tau_1 \tau_2} \quad (27.26)$$

- Example:

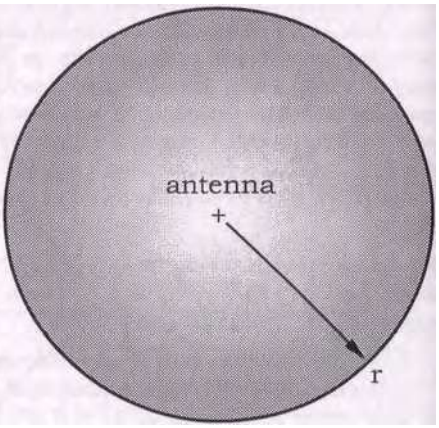

Spherical propagation of an electromagnetic wave in space

- The number π: $\pi = 3.14159$

straight	$\pi\cdot$	circular		spherical
r	$\cdot\ \pi\cdot 2 =$	$2r\cdot\pi$	$\cdot\ 2r =$	$\pi\cdot r^2\cdot 4$
line		**circum-ference**		**surface**
r	$\cdot\ \pi\cdot r =$	$r^2\cdot\pi$	$\cdot\ r\cdot 4/3 =$	$\pi\cdot r^3\cdot 4/3$
line		**area**		**volume**

(29.4)

Fig. 29.5: The number π

29.5 Universal constants and constants of nature

Strictly speaking fundamental or universal constants can't exist in pure field physics at all. For the example of the speed of light has been shown that it merely are measurement constants (fig. 6.11). The numerical size is a consequence of the definition. The speed of light for instance has the today well-known value as a consequence of the fixing of a length unit and a time unit. If we change a unit, if we take ,,feet" instead of ,.meters", then another value results. If however the velocity changes, then the reference measure of our gauge changes along and we get the identical reading. Electric and magnetic field constant depend directly on the speed of light c $(\varepsilon \cdot \mu = 1/c^2)$, which solely by the fixing of the electric units takes a certain value. The inner structure of the potential vortices leads from Planck's quantum of action, to the elementary charge and to the countless atomic ,,constants", which all objectively seen aren't constants at all. They virtually all can be derived (chapter 7).

Sooner or later even the last natural scientist will realize, that nature does not provide "constants" at all. If ,,constants of nature"' did exist, as listed in textbooks and encyclopaedias, then they aren't consistent with causality, since we don't know the cause, why the factor should have exactly this size and no other. Behind every so-called constant of nature unnoticed is hiding a physical closed loop conclusion.

Fundamental constants only exist in mathematics. This can be shown very nicely for the example of the ,,fundamental field equation" (eq. 27.26), which has been derived from the new field theoretical approach (fig. 27.10). It is the description of waves and vortices in space and time, which indeed carries features of a ,,world equation". If one searches this equation for fundamental constants, then one altogether can find three: the number π, the number e and the Golden Proportion Φ. The speed of light c however occurs only as the mathematical factor characterizing the wave as a result of the defined units. If one would choose the units different, c as well could be made 1. With the fundamental numbers that procedure won't work. They don't depend on the definition of the units!

Let's consider the number π. The number π occurs every time as a proportionality factor if we transition from a straight line to a circle or further to a sphere, from a line to the circumference or further to the surface of a sphere and exactly so from a line to the area of a circle or further to the volume of a sphere. Since for all the special cases, which are derived from the fundamental field equation (the structure of the elementary particles, the atomic structure and in the same way again in the universe), the spherical symmetry dominates, the mathematical solution is determined by a corresponding spatial configuration of the number π. It has its cause neither in a physical relation of interactions, nor in the choice of the units, but only in the geometry.

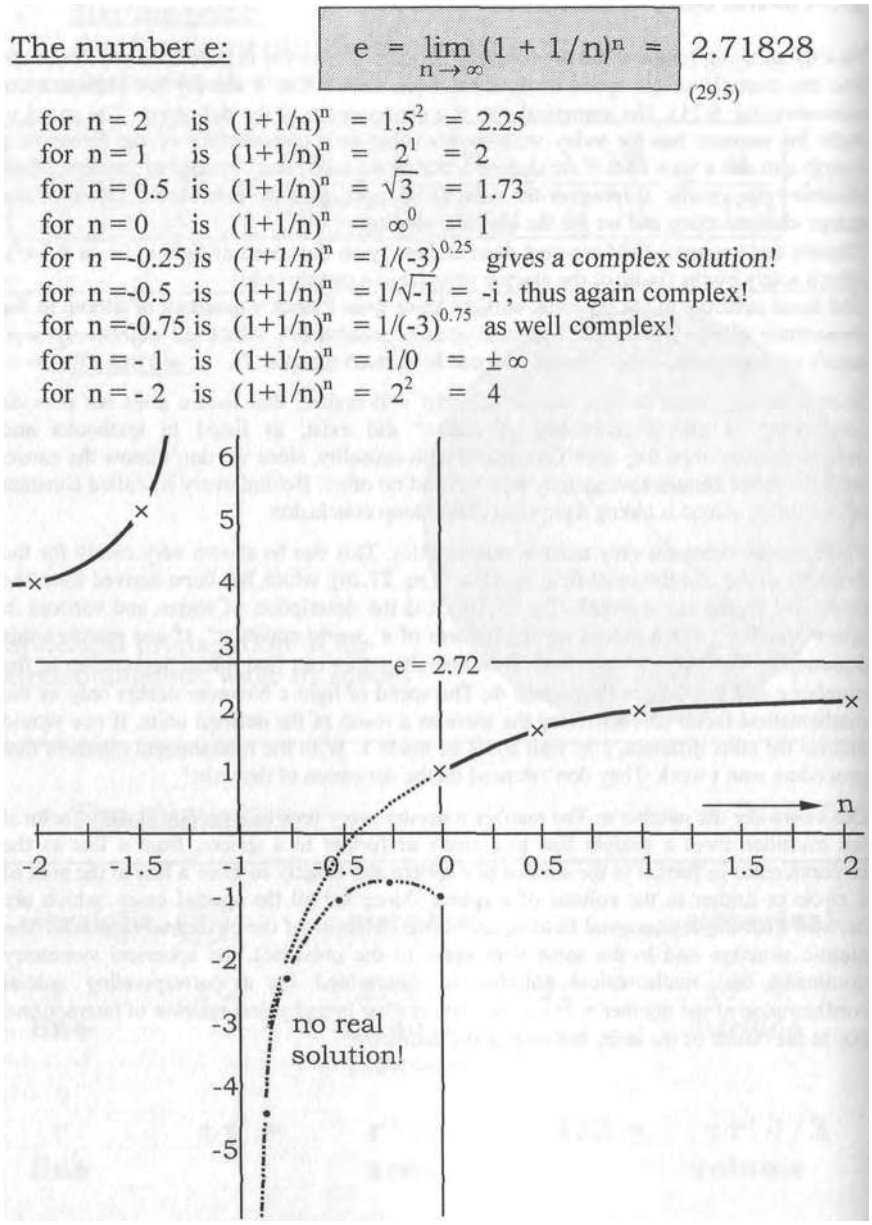

Fig. 29.6: Forming the limiting value of the number e

29.6 The fundamental number e

In the fundamental field equation (27.26) a further irrational number is concealed, the number e. Whereas the left side of the equation (a) gives the spatial distribution, the right side (b-e) describes the temporal course of events. Besides the term constant in time (e) also first time derivations (c and d) and a second time derivation (b) occur. For a solution of this differential equation a function should be found, the derivations of which are again the function itself. This condition strictly speaking is fulfilled only by one single function, the e-function.
We used this property of the e-function already for the derivation of the Schrodinger-equation in chapter 5.6 and 5.7. There with the help of the e-function an approach was chosen, which leads to the well-known solutions of the Schrodinger-equation, which are considered to be secured experimentally. With that the number e controls the temporal relations of the fundamental field equation.

It might be helpful to take a closer look at the origin of the number e. It results from a consideration of limiting values:

$$e = \lim_{n \to \infty} (1 + 1/n)^n = 2.71828 \qquad (29.5)$$

If one varies n and allows different values between $-\infty$ and $+\infty$, then a strange behaviour is showing. One indeed more and more approaches the well-known value of e = 2.72, as dictated by the definition of limiting values according to equation (29.5), the larger n is chosen. But in the opposite direction it looks less tidied:

	for	$n = 1$	is	$(1+1/n)^n$	=	2^1	=	2	
	for	$n = 0{,}5$	is	$(1+1/n)^n$	=	$\sqrt{3}$	=	1.73	
	for	$n = 0$	is	$(1+1/n)^n$	=	∞^0	=	1	
	for	$n = -0{,}5$	is	$(1+1/n)^n$	=	$1/\sqrt{-1}$	=	$-i$, thus complex!	
and	for	$n = -1$	is	$(1+1/n)^n$	=	$1/0$	=	$\pm\infty$	(29.6)

Since the e-function inside the fundamental field equation is responsible for the temporal sequence, the interpretation of my colleague Prof. Dr. Preussker<i> gets a deeper sense. He says, it starts outside our imagination (at n = -1). Afterwards at first big chaos prevails. Mathematically seen some imaginary solutions arise. Finally the system is putting in order (from n = 0), to more and more approach the value e = 2.72 .

The number e is of fundamental importance and thereby holds unforeseen secrets. More mysterious and until now entirely misunderstood is the meaning of the Golden Proportion. Also this indivisible number can be found in the fundamental field equation. Since it is less known and more complicated to handle, it first shall be introduced.

<i>: H. Preussker: Der Wirbelring, Halstenbeck 2002

Graphical construction at a right-angled triangle (Pythagoras):

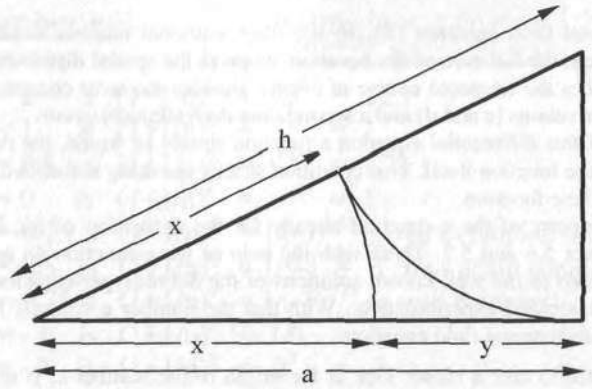

Golden Proportion of length $a = x + y$: $\frac{x}{a} = \frac{y}{x}$

with the proportion:

$$\frac{x}{a} = \Phi = 0.618 \quad (29.9) \quad \text{and} \quad \frac{a}{x} = \frac{1}{\Phi} = \Phi + 1 = 1.618 \quad (29.10)$$

The pentacle

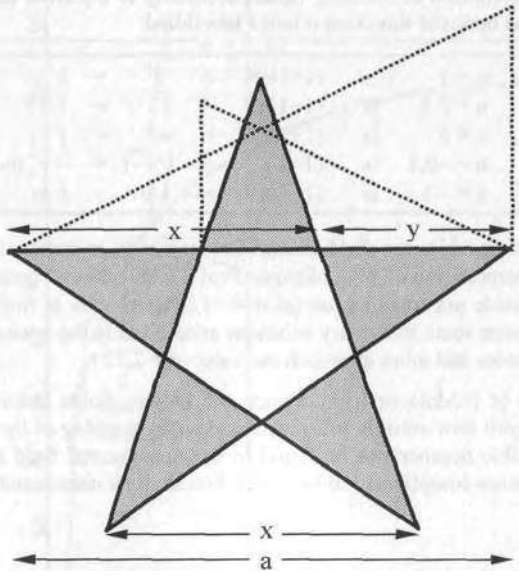

Fig. 29.7: Constructions for the Golden Proportion

29.7 The pentacle

During his visit of the Egyptian pyramids already two and a half thousand years ago the history writer Herodotus by his guide had been called attention to the circumstance that the Golden Proportion has been realized for the proportions of scale.
In the case of the pyramid of Cheops it even has been taken into account manifold, as we know today, but we hence still don't know why. There must be an intention behind it. Anyway a coincidental use can be eliminated, since the Golden Proportion cannot be handled in an easy way, neither graphically nor mathematically.
The Golden Proportion in addition plays an important role in the whole ancient architecture and not only there. It for instance occurs in the case of a very old symbol, the five edged star, which we can draw with one line without taking off. The well-known symbol also is called pentacle.

In the case of the Golden Proportion a straight line a is divided into two unequal halves. The larger half x thereby is 61.8 % of the straight line a. Already Pythagoras has researched and teached about this. Maybe he did know more about the purpose of this classification than all the mathematicians, archaeologists and art historians of today together.
For a graphical solution we assume a right-angled triangle. The task is to divide one leg of length a = x + y according to the Golden Proportion into two parts, the larger part x and the smaller part y. The second leg has the length a/2. According to the theorem of Pythagoras the length of the hypotenuse h is

$$h = \sqrt{a^2 + (a/2)^2} = (a/2)\cdot\sqrt{5} \quad (29.7)$$

If the length of the second leg (a/2) is subtracted from the hypotenuse, then this is the sought length x = h - a/2:

$$\boxed{x = (a/2)(\sqrt{5} - 1)} \quad (29.8)$$

The proportion of both length measures gives the constant Φ, which is characteristic for the Golden Proportion:

$$\boxed{\Phi = x/a = (\sqrt{5} - 1)/2 = 0.618} \quad (29.9)$$

This proportional number has a special property. If one adds 1 to the number and forms the reciprocal value of that, then the same number comes out again, thus:
with $\Phi = x/a$: with a = x + y :

$$\boxed{\Phi + 1 = \frac{1}{\Phi}} \quad \text{and} \quad \boxed{\frac{x}{a} + 1 = \frac{a}{x}} \quad \text{resp.} \quad \boxed{\frac{x}{a} = \frac{a - x}{x} = \frac{y}{x}} \quad (29.10)$$

With that the ratio of the length a and the larger section x is the same as the ratio of x and the smaller section y.

- Starting-point: the fundamental field equation

$$\boxed{-c^2 \cdot \text{rot rot } \mathbf{E} = \frac{\partial^2 \mathbf{E}}{\partial t^2} + \frac{1}{\tau_1}\frac{\partial \mathbf{E}}{\partial t} + \frac{1}{\tau_2}\frac{\partial \mathbf{E}}{\partial t} + \frac{\mathbf{E}}{\tau_1 \tau_2}} \quad (27.26)$$

- <u>for the special case:</u> because of missing conductivity ($\sigma = 0$)
  e.g. in air no eddy current damping: $\sigma/\varepsilon = \boxed{(1/\tau_1) = 0}$
- and no currents (eq. 27.15+27.16): $\mathbf{j} = \sigma \cdot \mathbf{E} = -\mathbf{v} \cdot \varepsilon \cdot \text{div } \mathbf{E} = 0$
- resp. $\Delta \mathbf{E} = \text{grad } \cancel{\text{div } \mathbf{E}} - \text{rot rot } \mathbf{E} = -\text{rot rot } \mathbf{E}$

$$\Rightarrow \boxed{c^2 \cdot \Delta \mathbf{E} = \frac{\partial^2 \mathbf{E}}{\partial t^2} + \frac{1}{\tau_2}\frac{\partial \mathbf{E}}{\partial t}} \quad (29.11)$$

Standard case of a wave damped with potential vortices

In the case of a perturbation this wave rolls up to a vortex, with

- the vortex radius r
- the swirl velocity $c = \omega \cdot r$
- the angular velocity $\omega = 1/\tau_2 = c/r$

The vortex itself runs with the velocity $v(x(t)) = dx/dt$
as a longitudinal wave in direction of the **E**-field: $\Delta \mathbf{E} = \partial^2 \mathbf{E}/\partial x^2$

$\Rightarrow \partial \mathbf{E}/\partial t = (\partial \mathbf{E}/\partial x) \cdot (dx/dt) = v \cdot \partial \mathbf{E}/\partial x$ and
$\partial^2 \mathbf{E}/\partial t^2 = v^2 \cdot (\partial^2 \mathbf{E}/\partial x^2)$; ($\partial v/\partial t = 0$, since not accelerated)

$$\Rightarrow \boxed{c^2 \cdot \partial^2 \mathbf{E}/\partial x^2 = v^2 \cdot (\partial^2 \mathbf{E}/\partial x^2) + v \cdot (c/r) \cdot \partial \mathbf{E}/\partial x} \quad (29.12)$$

- with the exponential approach: $\mathbf{E} = \Psi \cdot e^{-x/r}$ are:

$\Rightarrow \partial \mathbf{E}/\partial x = -(1/r) \cdot \mathbf{E}$ and $\partial^2 \mathbf{E}/\partial x^2 = (1/r^2) \cdot \mathbf{E}$

$$\Rightarrow \boxed{(c^2/r^2) \cdot \mathbf{E} = (v^2/r^2) \cdot \mathbf{E} - (v \cdot c/r^2) \cdot \mathbf{E}} \quad (29.13)$$

- resp.: $$\boxed{c^2 = v^2 - v \cdot c} \quad (29.14)$$

Fig. 29.8:____ The calculation of an electromagnetic wave, which is rolling up to a potential vortex.

The big mystery concerning the harmony of the Golden Proportion gets a sober technical-physical dimension with the theory of objectivity. It determines within the fundamental field equation" (27.26) the rolling up of a wave into a vortex and vice versa. The Golden Proportion mathematically describes the process known as wave damping, as we can make ourselves clear.

29.8 The vortex, which is rolling up

For the case of a wave propagation in air or in vacuum, if no electric conductivity is present ($\sigma = 0$), the fundamental field equation is reduced to the two parts: the description of the electromagnetic wave and the potential vortex as a damping term. Now a solution of this partial differential equation (29.11) is sought. This only succeeds for a very particular course of spatial and temporal field.

If a wave for a field perturbation rolls up to a vortex, which we had worked out as a model concept, then the field oscillation continues to run with the speed of light, but this time in circles. With this consideration the relation between the angular velocity resp. the time constants and the radius of the circular vortex has been described ($\tau_2 = r/c$).

$v(x(t)) = dx/dt$ is the not-accelerated velocity of propagation of a vortex. In that case v points in the x-direction radially to the outside. For the time derivation of the field vector $E(x(t))$ the chain rule should be applied. With that the field equation (29.11), defined in space and time, can be converted into an equation determined in v and x (29.12).

Finally we use the mentioned property of the e-function, which for first and second derivation again turns into itself, by choosing the approach of an exponential damping with $e^{-x/r}$ There remains a quadratic equation to determine the velocity v (29.14 and 29.15). From the two solutions of the quadratic equation only the one with positive velocity should be considered (29.17) and that would be 1.618 times the speed of light! (29.18).
If we subtract 1 from this value or form the reciprocal value, then in both cases the factor $\Phi = 0.618$ results, which is called the Golden Proportion (29.19).

Behind this clear, mathematically won result is hiding a deeper physical meaning. Obviously nothing can hinder a longitudinal wave and its vortices to be slower or faster than just with $v = 1.618*c$. Let us take the case that $v = c$, for which there even exist calculations in some textbooks[<i>]. Then as a result gets out that the longitudinal parts decrease very quickly and already can be neglected after $\lambda/2\pi$. I in any case interpret the near-field zone of an antenna (fig. 29.9) such that within one sixth of the wavelength the vortices to a large extent have decayed.

<i>: Zinke, Brunswig: Lehrbuch der Hochfrequenztechnik, 1. Bd., 3.Aufl. Springer-Verlag Berlin 1986, Seite 335

- The quadratic equation 29.14: $v^2 - v \cdot c - c^2 = 0$ (29.15)
- has the solution: $v = c/2 \pm \sqrt{c^2/4 + c^2}$ (29.16)
- for the proportion v/c: $v/c = (1 + \sqrt{5})/2 = 1.618$ (29.17)
- The result $v/c = \underline{1.618}$ (29.18)
- resp.: $c/v = \Phi = \underline{0.618} =$ „Golden Proportion"(29.19)
- acc. to that is: $1 + \Phi = 1.618 = 1/\Phi = 1/0.618$(29.18*)

- Concerning the physical meaning of $v/c = 1.618$ (29.17)

In the domain:	vortex decay:	description:
$v = c$	within $\lambda/2\pi$	near-field zone
$v < 1.618 \cdot c$	only later	noise
$v = 1.618 \cdot c$	stability limit	direct conversion
$v > 1.618 \cdot c$	stable, no decay	neutrino radiation

=>In the ideal case at 1.618 times the speed of light at the stability limit, the natural and spontaneous conversion from vortex to wave and vice versa occurs.

=> Scalar wave antennas have their optimum degree of effectiveness in the Golden Proportion!

Fig. 29.9: ____Derivation of the Golden Proportion from the fundamental field equation.

For larger velocities, as Tesla has produced already 100 years ago, the stability of the vortices, but also their biological effectiveness increases. From a high-frequency technical viewpoint this is the domain of the noise, the domain of instable oscillating noise vortices. From a biological and medical viewpoint especially here the answers should be sought to questions concerning the electromagnetic environmental compatibility.
This domain stretches from v = c to v = 1.618*c, the boundary case, where a spontaneous conversion of the wave into the vortex is possible. The Golden Proportion describes the stability limit, where the field vortices after they have been formed, don't decay anymore. From this velocity on the antenna resp. radiation source hasn't got a limited near-field zone anymore, since that now reaches to infinity. Only from this distinct velocity on I give the field vortices the name "neutrino".

29.9 The Golden Proportion

Whereas traditional antennas, which should emit electromagnetic waves, are optimized for signals with the speed of light, do scalar wave antennas have their optimum degree of effectiveness in the Golden Proportion. Thereby the goal of an emission of oscillating ring-like vortices is pursued. Vortices, which with a velocity of propagation of v = 1.618-c remain stable and make possible a spatially unlimited transmission of energy and information by scalar waves.

The velocity of propagation v is calculated from the product of wavelength times frequency. $v = \lambda \cdot f$. If the frequency of a transmitter is prescribed, then the geometry of the transmitting antenna decides on the degree of effectiveness of the antenna and on how many parts of transverse waves are emitted in relation to longitudinal waves. In the case of a broadcast antenna usually λ or $\lambda/2$ is chosen. For a scalar wave however the optimum is reached with

$$\boxed{\lambda_{vortex} = 1.618 \cdot \lambda_{wave} = 1.618 \cdot c/f.} \quad (29.20)$$

With that the electrotechnical problem becomes a geometrical one, if it concerns the use of scalar waves. Crucial is the antenna geometry, and the Golden Proportion provides the necessary constructional instruction. Were the buildings in antiquity, which were constructed according to the Golden Proportion, technical facilities for scalar waves<i>? Did the builders have physically explainable and mathematically provable guidelines? At this place, by the derivation of the Golden Proportion from the fundamental field equation, there arise completely new aspects for the judgement and interpretation of buildings especially from antiquity. If we have understood their way of functioning, then we will be able to learn much from that for our own future and for the future construction of scalar wave devices. Concluding the seminar we hence deal with antiquity.

ancient temple	=	short wave station
dedicated to one god	=	fixing of the frequency
supreme god Zeus, father of all gods	= =	range of the short wave, all SW wave bands
priest, representative of the god	=	amateur radio operator, with licence to transmit
high priest	=	chief intendant
Pontifex Maximus, ,,topmost bridge builder"	=	chairman of the authority and the telegraph offices
oracle<i>	=	telegraphy receiver
runes, cuneiform writing	=	telegraphy symbols
metre, hexameter	=	increase of redundancy
oracle priest	=	telegraphy interpreter
tripod<ii>	=	reception key, electro-acoustical converter
looking at intestines, rite of sacrificing	=	reading off convulsions, electro-optical converter
temple books	=	news-notes
seer, who looks into the god world	=	amateur radio operator, at telegraphy reception
Homer	=	ancient radio reporter

Fig. 30.1: ____Little dictionary for ancient radio engineering (1).

<i>: Lamer: Worterbuch der Antike, Kroner Verl. Bd.96 under "oracle" stands: ,,Lat. oraculum = site of speaking; particularly: site, where a god speaks; then: that, what the god says". According to the encyclopaedia oracle priests inspired by a god ,,simply were frauds, who lived of the ignorance of the public".

30. Scalar wave technology in antiquity

The end of the book about potential vortices and their propagation as a scalar wave shall form an impressive example, where as many of the derived wave aspects as possible have an effect. It shall be proven that already in antiquity radio engineering based on scalar waves has been used. The proof starts with a thesis.

30.1 Thesis:

The temples in antiquity all were short wave broadcasting stations. And energy from the field served as an energy source, so e.g. the earth radiation in the case of temples of terrestrial gods. In the case of the solar god the radiation of the sun was used, whereas for the temples, which were dedicated to the planetary gods, the neutrino radiation arriving from the planets served as an energy source.

If the temple was dedicated to a particular god, then the name of the god was representing the used frequency of the broadcasting company. The corresponding wavelength, resp. the respective god, understandably was "immortal".

Not so the broadcasting technicians on duty, who as human beings naturally were mortal, who took turns in the studio as members of the priest council and who merely had to impersonate the god Apollo, Poseidon etc. by the name of the broadcasting company, if they went on air. Only for the news editor Homer and for few of his colleagues we actually know the names of the persons behind the scenes.

In the temple books the texts have been recorded, which a god and its broadcasting company have received. The chosen metre served the easier detection and correction of transmission errors.

Here often a lot of fantasy was necessary, for which reason the reception facilities commonly were described as oracle[<i>]. The reception of the news as a rule took place on an altar. Thereby the direct effect of scalar waves on man e.g. in the case of the so-called temple sleep or the indirect influence on biological systems, e.g. on the intestines of slaughtered animals, was evaluated.

A further development of the telegraphy was the tripod technology[<ii>], in which case by turning of the polarization plane individual symbols and letters were transmitted up to the transmission of the spoken word with the help of a special wavelength modulation. That far the thesis reaches, which now should be proven.

<ii>: Lamer: Worterbuch der Antike, Kroner Verl. Bd.96 under "tripod" stands: „the tripod is a dedication gift to gods, a honorary gift for winners. That one pleased them with the gift of a cooking pot, is strange; one has tried to find the reason, but until now without success". In the encyclopaedia further is advised: „tripod as a means for spiritual insight?!"

godology	= high frequency technology
god name	= RDS, station identification
members of a family of gods	= broadcasting studios of a broadcasting company
Pantheon, temple of all gods	= extremely broadband FM broadcast station
crown	= antenna netting
gifts for sacrificing	= broadcasting fees
place of sacrificing	= place of a node of the standing wave
earth radiation	= power supply
homage of a weekday	= time restriction of the operation of the station
Zeus „forges" thunderbolts	= electrostatic blows, when a temple is oscillating
ritual act	= technical provision for transmission and reception
Pythia of Delphi<i>	= radio telephone operator, receptionist
Cella (marrow of temple)	= tuned cavity
obelisk<ii>	= antenna rod

Fig. 30.2: ____ Little dictionary for ancient radio engineering (2).

<i>: Lamer: Worterbuch der Antike, Kroner Verl. Bd.96, under „Pythia"(gr.=the asker): In the temple of Delphi was a chasm. A tripod was standing over it, on which the Pythia was seated, if she gave oracle. Comment: "It was flashy how odd the Pythia was sitting; inconveniently enough, on the cooking pot of the tripod. Ancient pictures, which show her that way, still weren't proven, that it was this way ..."

<ii>: Lamer: under „Obelisk" stands; „The obelisks probably were clocks".

30.2 Prerequisites

The argumentation has to be made on mathematical-physical foundation. The prerequisite for that are the 29 chapters of before. The following points could be demonstrated and derived:

1. The wave equation (inhomogeneous Laplace equation) describes the sum of two wave parts, where
2. every antenna emits both parts,
3. the transverse part, known as electromagnetic wave (Hertzian wave)
4. and the longitudinal part (Tesla radiation) termed scalar wave by the discoverer, better known as antenna noise.
5. The wave equation mathematically describes the connection of both wave parts in general and the conversion of one part into the other in particular, thus
6. the rolling up and unrolling of waves in field vortices (measurable as noise).
7. The transition takes place proportionally to the Golden Proportion, as resulted from the derivation (chapter 29.7 - 29.9)

With the last point the electrotechnical problem becomes a geometrical problem, if it concerns the use of scalar waves. The geometry of the antenna is crucial. Thereby the Golden Proportion provides the necessary direction for construction.
That justifies the assumption that the buildings in antiquity, which were built according to the Golden Proportion, were technical facilities for scalar waves. Maybe the builders had specifications that had physical reasons and could mathematically be proven.
At this place there result completely new aspects for judging and interpreting buildings especially from antiquity through the derivation of the Golden Proportion from the fundamental field equation. If we have understood their way of functioning, then we will be able to learn much from that for our own future and for the future construction of scalar wave devices.

As a further prerequisite for the ancient broadcasting technology enough field energy should be at disposal. We proceed from the assumption that

1. the earth magnetism and the cosmic neutrino radiation are tightly hanging together by the processes in earth's core,
2. the earth magnetism in antiquity verifiably was approx. thousandfold stronger than today (proven by gauging of pieces of broken pot),
3. as a consequence the neutrino radiation in antiquity as well must have been thousandfold stronger and
4. the cosmic neutrino radiation has served the transmitting plants of antiquity as an energy carrier,

any thought is absurd to reject the technical function of a temple only because it today can't be reproduced anymore. The artistic and aesthetical viewpoints, which are put into the foreground by art historians because of ignorance about the true function, rather are secondary.

The terms used to describe the broadcasting technology in antiquity in the last 2000 years have experienced a shift of meaning, so that a translation in our linguistic usage of today is necessary. The adjacent dictionary should help in that case.

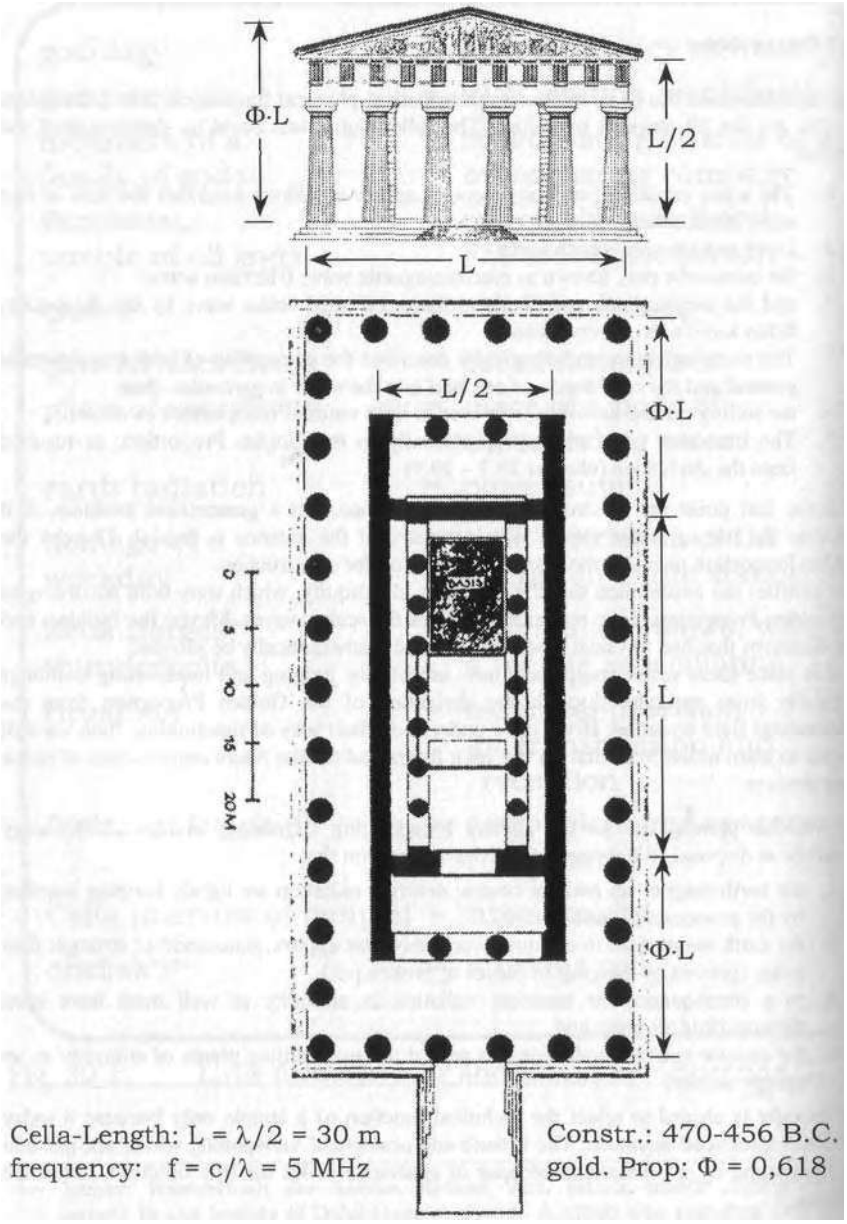

Fig. 30.3: The Golden Proportion of Zeus-temple in Olympia.<i>

<i>: K. Schefold: Die Griechen und ihre Nachbarn, Propylaen Kunstgeschichte Berlin Bd. 1, Abbildungen von Seite 249

30.3 Approach

Let's to some extent proceed from the knowledge of textbook physics currently present in high frequency engineering and give a well trained engineer the following task, which he should solve systematically and like an engineer: He should build a transmitter with maximum range at minimum transmitting power, thus a classic task of optimization. Doing so, the material expenditure doesn't play a role!

After mature deliberation the engineer will hit upon it that only one solution exists: He decides on a telegraphy transmitter at the long wave end of the short wave band, at f = 3 MHz, which corresponds to a wavelength of $\lambda = 100$ m. There less than 1 Watt transmitting power is enough for a radio communication once around the earth. That also has something to do with the conditions of reflection of the radio waves at the ionosphere. Our engineer learned:

the index of refraction $n = \sqrt{1 - K \cdot N/f^2}$ (30.1)

with: $K = 80.5 * 10^{-6}$ [cm^3/sec^2] (= constant)

N = electron concentration [electrons/cm^3]

f = frequency of the transmitter [MHz]

Put into words: the refraction of a radio wave in the range of the short waves is the larger, the smaller the frequency is. The end of the short wave range is reached at 3 MHz. That thus explains the choice of frequency.

And he optimises further. Next the engineer remembers that at high frequencies, e.g. for microwave radiators, not cables but waveguides are used, since these make possible a considerable better degree of effectiveness. In the case of the waveguide the stray fields are reduced by an alignment and concentration of the fields in the inside of the conductor. In the case of antennas however the fields scatter to the outside and cause considerable stray losses. He draws the conclusion that his transmitter should be built as a tuned cavity and not as an antenna!

As a result the engineer puts a building without windows in the countryside with the enormous dimensions of 50 m length ($=\lambda/2$) and 25 m ($=\lambda/4$) resp. 12.5 m ($=\lambda/8$) width. The height he calculates according to the Golden Proportion to increase the scalar wave part. Those approximately are the dimensions of the Cella without window of Greek temples.
For the operation of such a transmitter in antiquity apparently the noise power of the cosmic radiation was sufficient, which arrived at the earth starting from the sun and the planets. By increasing the floor space also the collected field energy and the transmitting power could be increased, so that also from the perspective of the power supply the temple with the largest possible wavelength at the same time promised the largest transmitting power, so at least in antiquity.

Our engineer further determines, that he will switch the carrier frequency on and off at a predetermined clock pulse. Thus he decides for radiotelegraphy. The advantage of this technique is a maximum increase of the reception range. For that the signals at the transmitter have to be coded and at the receiver again deciphered. By means of the encryption of the contents these are accessible only to the „insiders", who know the code; prerequisite for the emerging of hermetism and eventually a question of power!

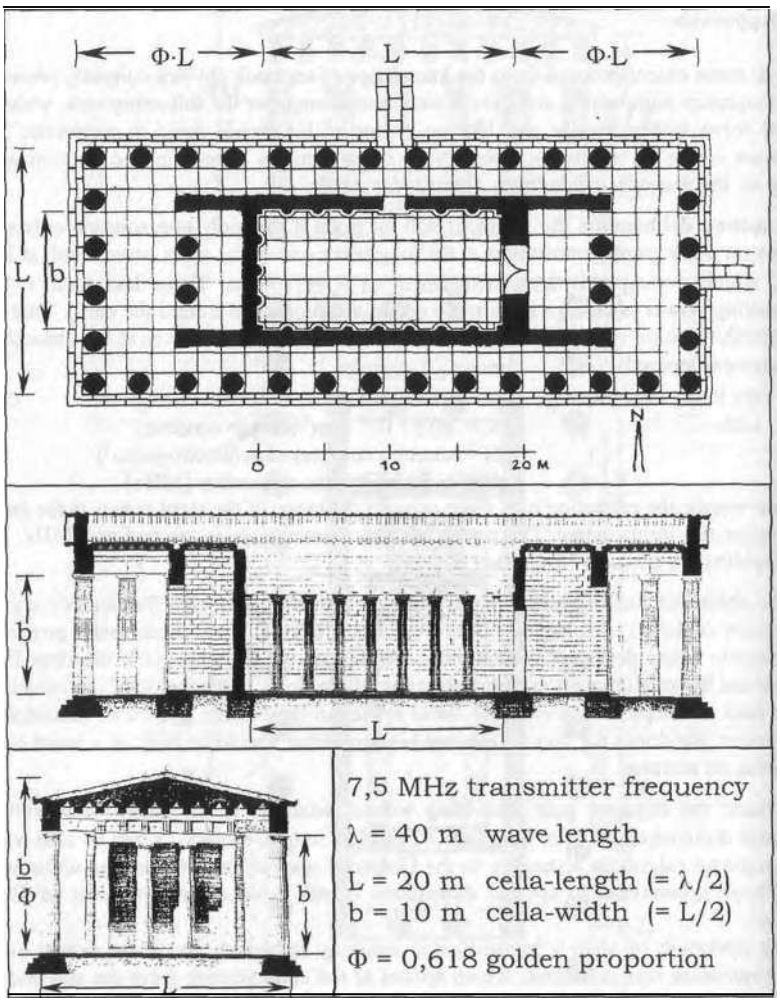

Fig. 30.4: Example Tegea, temple of Athena Alea.<i>
Built 350/340 B.C.

<i>: G. Gruben: Die Tempel der Griechen, Wissenschaftliche Buchgesellschaft Darmstadt 1986, 4. Aufl. Seite 130

<ii>: E. Horst: Konstantin der Grosse, Eine Biographie, Classen Verlag 1985 Dusseldorf, 2.Aufl., S. 89.

<iii>: E. Horst: Konstantin der Grosse, Eine Biographie, Classen Verlag 1985 Dusseldorf, 2,Aufl., S. 33.

30.4 Circumstantial evidence

Not everyone, somehow participating in send receive engineering, at the same time also was inaugurated in the entire secret knowledge. Most priests only knew as much as they necessarily needed to know to fulfill their tasks. Thus a temple priest, who was presented an enciphered text and who should bring this on the air, not necessarily at the same time needed to know the content of the text or the code. The same of course also was valid for the sacrificing priest acting in the receiving station. The Vestal virgins for instance had to present the received text to the Augures, by whom they were supervised and controlled.

But who wanted to introduce a new god in the gods heaven and perhaps even himself be worshipped as a god, should have complete command of both the broadcasting technique and the reception technique. In ancient Egypt the Pharao at least once a year had to prove, that he still was in command of the technique. Otherwise he was replaced. For a person with security clearance that at the same time was a death sentence.

In the historical facts numerous pieces of circumstantial evidence can be found, which can be considered to be evidence for the thesis of the operation of send receive engineering in antiquity. One now perhaps understands, why the rulers were put an antenna netting over their head, a so-called crown, or why the Augures could survey the land with a flat Tesla coil in their hands (fig. 16.10).

Direct evidence is present as well. It can be found in ancient texts. But it is questionable if historical texts concerning ancient radio engineering have been translated correctly. The talk is about oracles, mystery cult and earth prophesy if the receiver is meant. The predominantly technically uneducated historians attest the Romans a defective sense of time, because their couriers surely could not cover the long ways across the Roman empire so fast at all, if they read in the Latin texts: "They sent by courier to the emperor in Rome and got for answer...". The answer of the emperor namely already arrived at the squad at the latest in the following night. The correct translation should read: "they cabled" or "they broadcasted to the emperor in Rome and got for answer..."[ii].
Such a big empire as the Roman Empire actually only could be reined by means of an efficient communication. Cicero coined the word: "We have conquered the peoples of the earth owing to our broadcasting technology...[iii]"! The term broadcasting technology from ignorance is translated with piety. If engineers however rework the incorrect translations, then one will discover that numerous texts tell of the broadcasting technology, that thus correspondingly much direct evidence exists concerning the practical use of this technology.

For the Roman military transmitters, which formed the backbone of the administration of the empire, the reading off of the information from observations of nature like the bird flight or from felt signals of a geomanter was too unreliable. They read off the information from the rhythm of the convulsions of the intestines of freshly slaughtered animals. In the case of the dead animals on the altar every extrinsic influence was excluded. But the enormous need of slaughter cattle was a disadvantage. Who wanted to have information, first of all had to bring along an animal, which then was „sacrificed" the god, or better say, which was abused as a receiver for a particular transmitter. Thereby the innards served as a biosensor and as a receiver for the news.

Cellular phone.

- *Network:* All „telephone cabins“ are transmitter and receiver at the same time.
- *Advantage:* Anyone can communicate with every network participant.
- *Characteristic:* The stations are strikingly similar in form and size of building.
- *Power structure:* All stations as a rule have equal rights among each other.
- *Disadvantage:* Innovations hardly are possible. The system is inflexible.
- *Examples:* Temple towers (Iraq); cellular phone network.

Broadcasting.

- *Network:* Many receivers listen to the news of one powerful transmitter.
- *Advantage:* The system is very flexible and permanently experiences improvements.
- *Characteristic:* Monotheism. Big diversity among the receiver constructions.
- *Power structure:* Central power concentrated in the hands of the chief intendant.
- *Disadvantage:* Feedback from receiver to transmitter is not desired.
- *Examples:* God Ammun Re (Egypt); ABC daily news.

Dispatch service.

- *Network:* Network of broadcast stations supplies an agency (receiver) with information.
- *Advantage:* Optimal financing, since information is given away only for broadcasting fees in cash.
- *Characteristic:* Treasury stores have to be built because of the immense riches.
- *Power structure:* The power is concentrated in the hands of the receiver-agency.
- *Disadvantage:* In the case of overcharge or overload a system crash is impending.
- *Examples:* Pythia (Delphi); German Press Agency (dpa).

Fig. 30.5: ____ Three radio technical network structures, with an example from antiquity and from present time.

30.5 Radio technical concepts

In planning and constructing radio technical networks only a few possible concepts exist. It is interesting that at least one historical example can be specified for every concept. That shows that all possibilities were tried at least once. The three most important concepts are presented here:

A. Cellular phone.

Every bigger city between Euphrates and Tigris, which thought the world of itself, had at its disposal already in antiquity a temple tower. Such a temple tower was a „telephone cabin" in the form of a pyramid as a transmitter and a receiver temple at the top, to where the receptionist adjourned to the so-called temple sleep. Discipline was required, since all the time only one priest was allowed to broadcast. All others could listen to him doing so. If he was ready, he closed his contribution with a fixed symbol or term („over") and the next one could continue. This is a classic link-up, where anyone communicates with every network participant.

The stations all were strikingly similar in form and size of building, like one phone box resembles another. In that way a further development of the cellular phone system hardly was possible and that has a technical reason, as the building of a tower in Babylon has shown us. This tower namely had gotten the ambitious builders too big, so that the frequency of the Mesopotamian radio network had been left and instead a foreign network could be received, the code of which no-one could understand. The result was a confusion of language and the order to stop the building.

B. Broadcasting.

Millions of TV spectators every evening look in the ABC news or another daily journal of a TV Channel. In the case of broadcasting thus many receivers listen to the news of a powerful transmitter. With that the whole plenitude of power is concentrated in the hands of the chief intendant. In antiquity he called himself high priest. If he went on the air, he used the logo of the god that he had to represent. Today the logo of the broadcasting company is shown in a corner of the TV screen. Even this very day feedback from the receiver to the transmitter hardly is possible contingent on principle. The problems with nationally controlled broadcasting, with politics controlled by the media all are not new. The monotheism in ancient Egypt with the claim of lordship of the main god Ammun Re is an example from antiquity.

C. Dispatch service.

In ancient Greece the technical structures and with that also the power structures had been turned around. At that time a big network of broadcast stations, which continually was extended by a policy of settlement ordered by the gods, supplied a central and correspondingly powerful agency with information per radio.

Who wanted up to date news, could call for these in the agency with seat in Delphi, but he had to pay for it. To accommodate the broadcasting fees in form of gold and gifts whole treasury stores had to be built. Measured by the commercial success the ancient news network has remained unmatched, and can't be compared with pay-TV or todays dispatch services, like dpa. If the network however becomes too big, uncontrollable and it lacks discipline, then it sometime will crack and the system crashes.

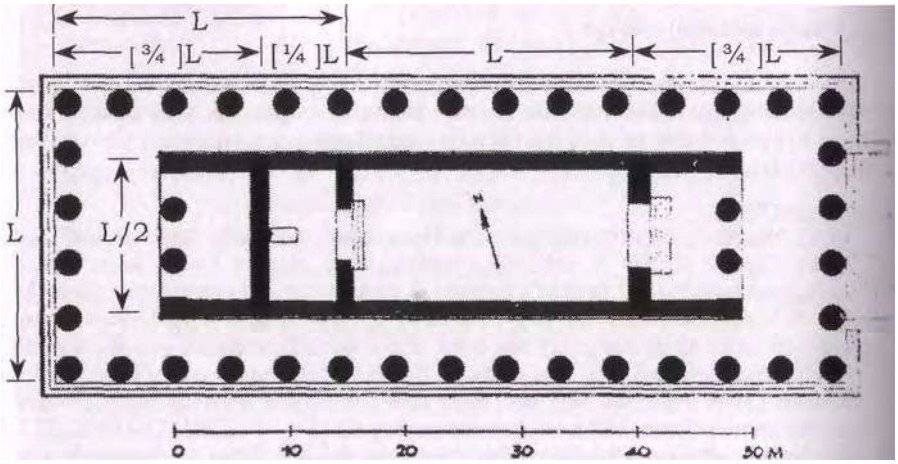

Fig. 30.6 A: Hera-temple of Selinunt 460-450 B.C.<i>
(Corresp. to the plans of the Roman architect Vitruvius)

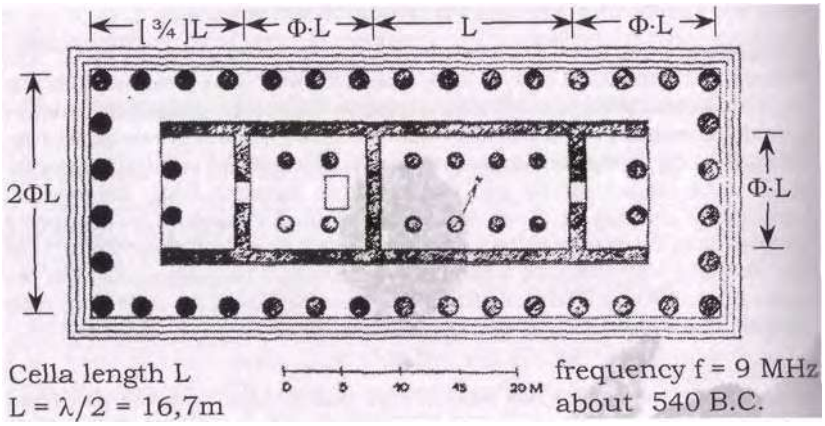

Fig. 30.6 B: Apollo-temple of Korinth<i>
(Alternative interpretation, use of the Golden Proportion Φ).

<i>: K.Schefold: Die Griechen und ihre Nachbarn, Propylaen Kunstgeschichte Berlin Bd. 1, Abbildungen von Seite 241, 250

<ii>: Vitruvius (Marcus Vitruvius Pollio): Zehn Bucher uber Architektur, Ubers. von Dr. K. Fensterbusch, Wissenschaftl. Buchges. Darmstadt 1987, 4. Aufl., 3. Buch, 1. Kap.: Von den Symmetrien der Tempel, Seite 137

<iii>: Vitruvius (dito), 4.book, 4.Chap.: Vom Tempelinnern und dem Pronaon, p. 187

30.6 Wireless telegraphy

Radio engineering 100 years ago also started with telegraphy. Thereby the high frequency carrier is switched on and off. With this technique Marconi succeeded in a radio transmission over the English Channel (1899) and over the Atlantic Ocean (1901).
As next step the amplitude modulation (AM) followed. Thereby the HF-carrier is overlapped with the low-frequency signal of a sound carrier in such a way, that the amplitude fluctuates on the beat of the LF-signal. As a disadvantageous effect, also noise signals will overlap, from which the quality of reception will suffer.
Only the frequency modulation (FM), where the LF-signal is transmitted as temporal fluctuation of the frequency, brings an improvement. The annoying amplitude noise hence has no effect in the case of FM.
It easily can be recognized, how the development of the modulation techniques follows the urge for technical improvement and optimization. That in antiquity hasn't been different, for which reason the progress of development took place in the same order.

The broadcasting technology of the ancient gods started with the wireless telegraphy. This is expressed in the architecture. Since electric resonant circuits or other frequency determining equipment weren't at the disposal of the engineers in antiquity, the determination and allocation of the broadcasting channels had to take place by means of the wavelength. The formation of a standing wave in the Cella, the innermost sanctuary of a temple, occurs if its length corresponds to half the wavelength of the HF-carrier. The Roman architect Vitruvius calls the wavelength the „basic measure", from which results "the system of the symmetries". He writes: „The design of the temples bases on symmetry, to which laws the architects should adhere meticulously. "[ii]. „The length of the temple is partitioned in such a way that the width is equal to half the length, the Cella itself including the wall, which contains the door, is one fourth longer than wide. The remaining three fourths, which form the Pronaon, should protrude until the antae of the wall and the antae should have the thickness of the pillars"[iii].
If we recalculate ourselves, then the partitioning in 3/4 to 5/4 produces a proportion, which conies quite close to the Golden Proportion. In building a temple nothing is left to chance, after all it concerns the construction of a tuned cavity, capable of self-resonant oscillations with favourable emission behaviour.
From the outside one can't see if a telegraphy transmitter has been changed over to speech transmission with AM. The HF-carrier merely isn't switched off anymore, i.e. the priests let the temple oscillate without interruption. Newly added for AM is an electroacoustic coupling. For that many temples were retrofitted with a mouthpiece. Newly built AM transmitter temples conclude the Cella with a round apse. Because of this acoustically conditioned construction the Cella length didn't have a fixed value anymore and the transmission frequency had become variable. Measured in the middle of the apse the wavelength was larger than at the sides, so that on the beat of the spoken word not only the amplitude of the field distribution in the interior of the temple, but in addition also the frequency of the selfresonant oscillation was changed.
A typical example of such an architectonic hybrid form of AM and FM is situated in Rome. Because due to the frequency variation more than only one wave band was occupied and the temple consistently carries the names of two deities. It is the temple of Venus and Roma.

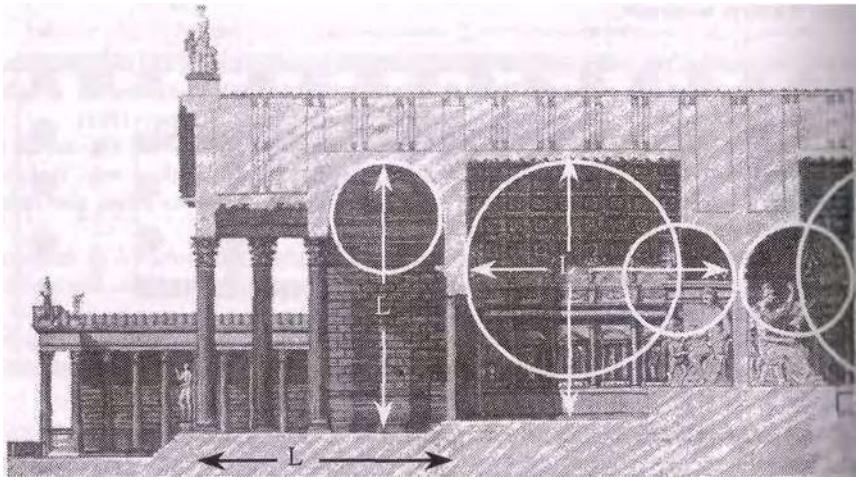

Diameter bigger circle D_1= 22 m (6,8 MHz),
small circle D_2 = 11 m; und L = D_1 + 1/2 D_2 = 27,5 m (5,5 MHz)

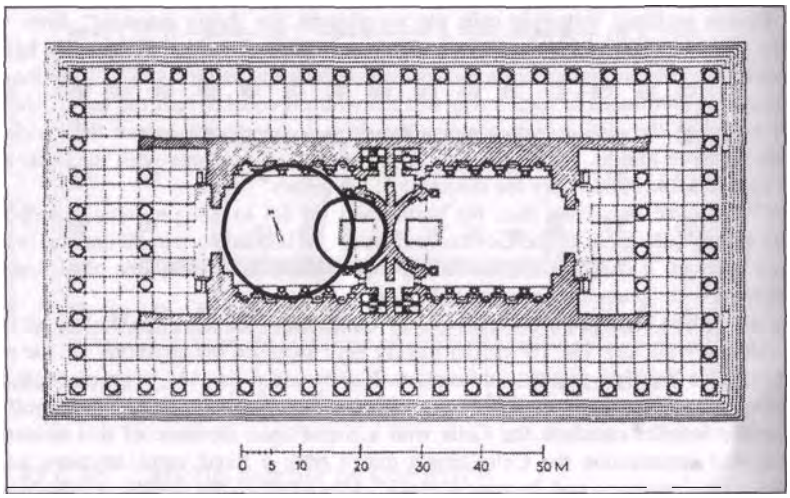

Fig, 30.7: Temple of Venus and Roma; Rome 136/37 A.D.[i,ii]

<i>: A. Springer: Das Altertum, A. Kroner Verl. Leipzig 1915, 10. Aufl., S. 518
<ii>: T. Kraus: Das romische Weltreich, Propylaen Kunstgesch. Berlin Bd. 2, S. 161
<iii>: Lamer: Worterbuch der Antike, Kroner Verl. Bd.96 unter "Tempel", Haufigkeit

30.7 AM temple technology

The low-frequency signal (LF), which should be transmitted by a transmitter with amplitude modulation, lies in the range between 16 Hz and 16 kHz. If it only concerns the transmission of speech information, then the bandwidth can be reduced to 300 to 3000 Hz. In the case of mixing the low-frequency useful signal with the HF-carrier, thus in the case of the modulation of the carrier in the rhythm of the LF, two side bands arise. These lie close to the carrier frequency and are formed from this once by the addition and once by the subtraction with the frequency of the LF-signal. Let's take the temple of Venus and Roma with a transmission frequency of 6.8 MHz. If sound of 3 kHz should be transmitted clearly understandable, then the dimensions of the Cella had to be varied for just 8 mm for a corresponding Cella length of $\lambda/2$ = 22 m. As a curiosity the niches in the side walls in the case of this temple however allow a considerably larger bandwidth of more than 10% instead of the necessary 0.04% in the case of AM.

In the case of the Greek originals, the Cella however has smooth walls, from which follows that the temples were designed ideally narrow band. The Greeks apparently operated predominantly telegraphy transmitters, for which the side bands coincide with the carrier.

The argumentation indeed has remained unchanged: The modulator being narrow band and simple to realize speak in favour of the telegraphy being the "original form" of all modulation techniques. Also the rediscovery of the broadcasting technology by Heinrich Hertz succeeded as telegraphy signal. In addition the range is bigger than for any signal modulated with sound frequency.

As the calculation example has shown, also pure AM transmitters work very narrow band, and this is particularly important for low transmission frequencies, if many transmitters want to use the favoured SW band between 3 and 10 MHz at the same time. With AM one thus accommodates the maximum number of broadcasting channels in a particular frequency range, for instance the 80-meter band, without these interfering with each other too much. But that also was badly needed. Conclusions about the everyday life of broadcasting in antiquity by all means are possible because of the enormous number of temple installations, which logically were permanently used. Only in Rome there existed up to 200 temples[iii]!

Who goes in search of broadcasting stations with a modern short wave receiver, for instance in the 80 m band between the countless telegraphy transmitters, fast gets an idea of what had been up in the air already 2000 years ago. No ancient city would build several temples on a single Acropolis, if only one single one could have been used. All temples broadcasted with each time another carrier frequency because of different dimensions. For this reason the temples, which stood side by side, as a rule were dedicated different gods. An acknowledgement, "the air just being free", in addition hardly was possible, because of the often-found spatial distance between the temple installations and the respective oracle. Between the transmitter of the god Apollo in Didyma and the receiver, the oracle of Milet, for example lie approx. 20 kilometres. The only possible conclusion is that in antiquity there was broadcasted on all channels simultaneously regardless of other gods and their transmission frequencies. As is well-known there rather prevailed a situation of competition between the gods, since like today a large number of listeners meant great importance, influence and power and eventually also worship, more gifts and more receipts from broadcasting fees.

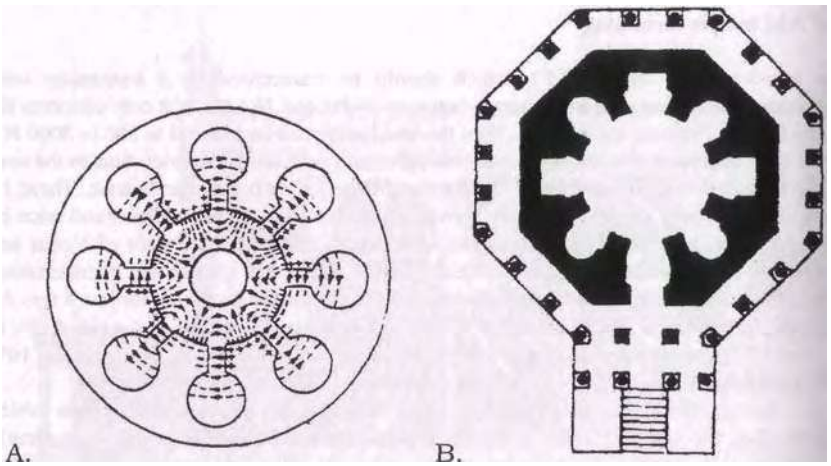

Fig. 30.8: ____ Comparison of a magnetron (A), a microwave radio tube[i] and the temple (B) in the palace of the emperor Diokletian, Split.[ii]

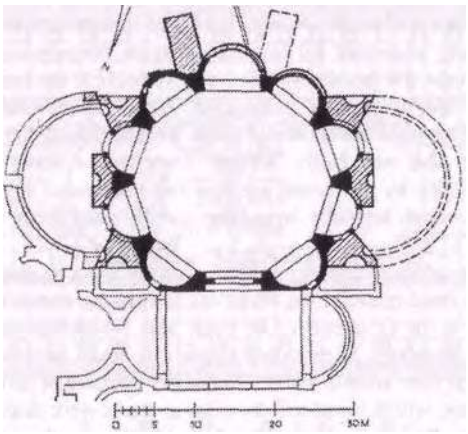

Fig. 30.8.C: Temple of Minerva Medica, Rome, 320 A.D.[ii]

<i>: K. Simonyi: Physikalische Elektronik, 8.4 Das Magnetron, S. 665

<ii>: T. Kraus: Das rom. Weltreich, Propylaen Kunstgesch. Bd. 2, S. 194, 196

<iii>: If one however wants to verify this, in antiquity already common manner of PM broadcasting technology, then we need a broadband short wave receiver with phase-demodulator. With such a receiver even today any time a conclusive argumentation should be possible that this sort of SW-PM technology actually works.

30.8 Modulation of acoustic signals

In the case of sound it in essence concerns longitudinal waves, which propagate in all directions in space with the velocity of sound. But this merely is an average velocity, since the air molecules strictly speaking oscillate with the sound frequency in the direction of propagation. In this way the velocity of sound one time is increased and the next moment to the corresponding extent reduced. If the molecules already carry out oscillations of themselves, e.g. thermal motion, then both oscillations overlap; i.e. the motion of itself is modulated with the sound frequency.

Following the here presented derivation potential vortices are formed in every dielectric, thus also in air, and these are modulated if overlapped with sound waves. Vortices however do not form a distinct frequency, but entirely on the contrary a uniform frequency mixture in the form of white noise.

The overlap thus also is noise unless certain noise frequencies are favoured. This can be effected by means of a spatial body tuned to a certain wavelength. To be considered are cuboid cavities, as in the case of Greek temples or waveguides and cylindrical objects as in the case of round temples or magnetrons. The building form causes the favouring of a certain frequency and the integer harmonic frequencies belonging to it.

If this frequency now lies in the high frequency range, then it is emitted by the spatial body as an electromagnetic wave, in the case of waveguides and resonant circuits for reason of the small dimensions as microwave radiation and in the case of the Greek temples as short wave radiation. If one in addition produces an acoustic signal in the frequency determining spatial body, then this signal automatically will modulate the high-frequency signal.

The result of the modulation is the overlapping of the sound wave with the high-frequency carrier wave. The change of the active length, thus the wavelength of the HF-carrier causes a change of frequency. Such a change on the beat of the sound frequency is called FM (frequency modulation). For that we imagine a spatial body being excited because of its length by potential vortices to a high-frequency oscillation at the self-resonant frequency.

From flow dynamics is known, how easy the distribution of vortices in space can be disturbed. Already words spoken in space are able to influence the potential vortices, which in the case of the temples were used as energy carrier. The longitudinal sound waves reflected at and thus returning from the Cella wall rigid for sound of a Greek temple will push these potential vortices back on the beat of the sound and with that shorten the active length. This means, that the carrier frequency is modulated with the sound frequency. The carrier oscillation thus permanently changes its phase on the beat of the sound signal, for which reason this particular kind of modulation is described as PM, as phase modulation.

Nowadays PM is used only seldom and in the SW-range not at all because of the big need of wave bandwidth. Merely at higher frequencies PM occasionally is used in radiotelephony. In the case of the frequency modulation usual in broadcasting (e.g. UHF), the change of frequency takes place on the beat of the sound amplitude and not of the sound frequency as with PM. Therefore it is not possible to receive phase modulated signals, which are produced by means of the acoustic coupling of appropriately formed spatial bodies[iii] with commercial FM receivers.

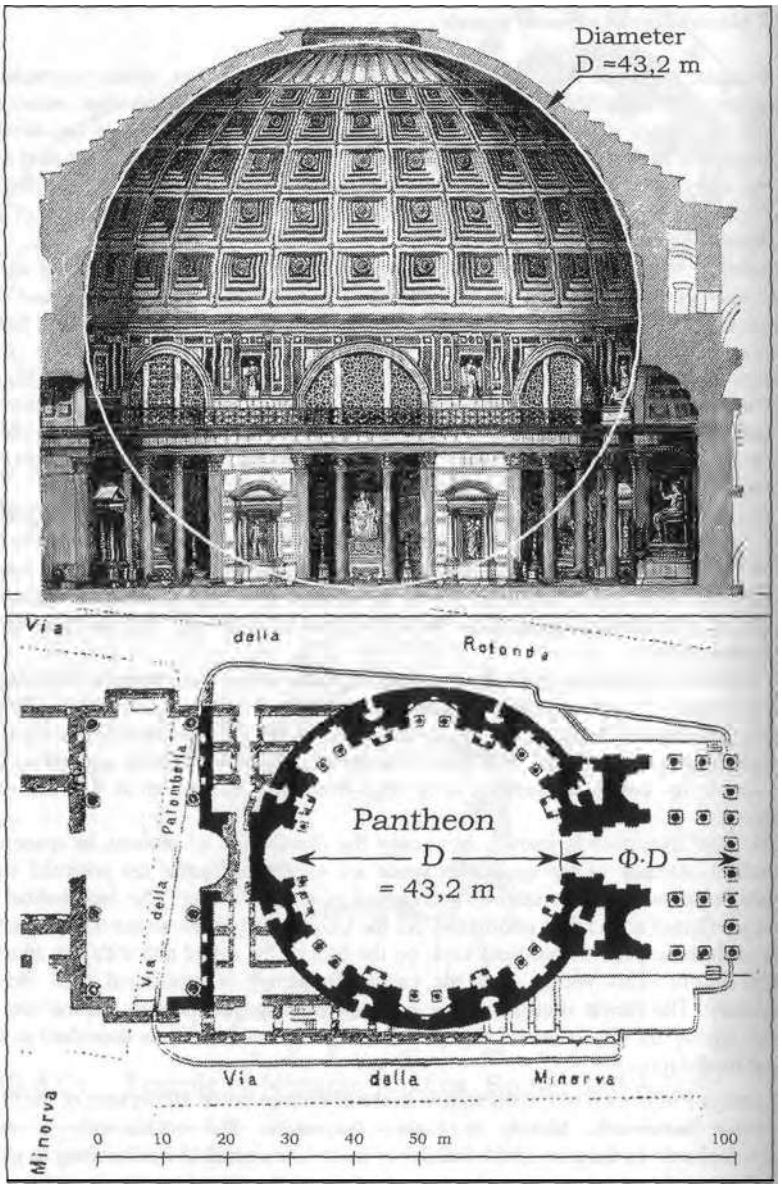

Fig. 30.9: The Pantheon in Rome, the „temple of all gods".[1]
Diameter D = 43,2 m, Golden Proportion: Φ= 0.618
Pronaon-(atrium-)length: Φ·D= 0.618 • 43.2 = 26.7 m
Built under emperor Hadrian 118/ 119-125/128 A.D.

30.9 Broadband FM broadcasting technology

If I speak against a flat wall, then every point on the wall has another distance to my mouth. The sound waves thus aren't reflected simultaneously, what leads to big modulation distortions. Therefore the sound wall should be curved in such a way, that all signal paths are the same length (barrel vault, apse, etc.). In the case of point sound sources there results as an optimum a hemisphere, for instance a dome. The building hence even today tells us, which frequency and which modulation method had been put to use. The architecture of sacral buildings, e.g. pointed arch or round arch, thus hardly has been a question of aesthetics.

For his temple of Venus and Roma designed by himself emperor Hadrian had to listen to severe criticism among others of Apollodor of Damascus. The temple was too broadband for an AM transmitter, however with a modulation depth of just 11 percent not broadband enough for a phase modulated FM transmitter.
Emperor Hadrian however also had the courage to build midst in Rome a temple calculated completely new and designed as a pure FM transmitter, the Pantheon, which means temple of all gods. In the language of the technician it is a transmitter for all frequencies.
This domed structure indeed doesn't leave out one single frequency. With a modulation depth of almost 100 percent it is designed for maximum loudness. With that the Pantheon uses all available frequencies, for which reason the name temple of all gods really is no exaggeration. Into the Pantheon exactly fits a sphere with a diameter of 43.2 meter. That corresponds to a minimum frequency of 3.47 MHz, situated in the range of the short waves. The floor however is not domed, but horizontal. That, up to the basis of the dome, results in exactly half the height and a maximum frequency of 6.94 MHz.
The construction ensures that between the simple and the double diameter any desired wavelength can be produced. Above the given maximum frequency of the basic oscillation the harmonic waves, which are produced as well and can't be avoided at all, are attached without a break. These occupy the wave bands up to the double, triple, quadruple frequency and so forth.
For this and only for this reason a maximum frequency was chosen, which corresponds to exactly the double value of the minimum frequency. The operation takes place to the limit, where the transmitter would interfere with itself, in the way that the used basic oscillation would overlap its own harmonic waves. That then sounds like two people talking at the same time. The voices would be distorted out of recognition, as can't be expected else in the range of the harmonic waves.
The Pantheon has been planned and built as a phase modulated basic wave transmitter according to purely academic rules of Hadrian. The temple impressively demonstrates the precise engineering detailed knowledge of the Pontifex Maximus and his broadcasting priests in ancient Rome<ii>.

<i>: A. Springer: Die Kunst des Altertums, A. Kroner Verl. Leipzig 1915, 10. Aufl., S. 517/518, daraus: die Zeichnungen ram Pantheon in Rom, 115-125 n.Chr.

<ii>: The collection of material concerning scalar wave technology here is aborted and continued in an own book in narrative and with that easier to read writing style. The title is: "Broadcasting Gods".

approach	derivation	result
b:= postulate [potential vortices Vol.1]	what if **b** $\neq$ *0* ?	**derivation** of the **Schrödinger eq.**
duality vortices replace quanta [potential vortices Vol.2]	from **H** $\Leftrightarrow$ **E** from **j** $\Leftrightarrow$ **b** [and chapter 3.3]	**calculation** of the **quantum properties** [potential vortices V.2]
causality [see chap. 3]	*gen.* $\Leftrightarrow$ *special case* **field** $\Leftrightarrow$ quanta cause $\Leftrightarrow$ consequence (instead of: quanta $\Leftrightarrow$ field)	*vortex field* free of quanta (instead of: irrotational field of quanta)
vortex physics analogous to flow dynamics [chap. 3.4 - 3.5]	**vortex + anti-vortex** (Demokrit/cosmology) [chap. 3.6 + 27.2]	coming off of vortices if $\tau_1 = \tau_2$ **model of atom** [chap. 5.5 + 5.8]
equations of transformation: **E** = **v** x **B** **H** = - **v** x **D** [chap.6.5 + 27.8]	for **E**(**r**(t)) and for **H**(**r**(t)): rot **E** = rot (**v** x **B**) rot **H** = rot (**D** x **v**) [chap. 27.9]	extended **field equations:** rot **E** = -**b** -∂**B**/∂t rot **H** = **j** + ∂**D**/∂t [chap. 27.10]
equations of transformation: **E** = **v** x **B** **H** = - **v** x **D** [s.a. chap. 16.1]	**wave equation** inhom. Laplace eq. Δ**E** = grad div **E** – rot rot **E** Δ**E** = $(1/c^2)\cdot\partial^2$**E**/∂t^2 [chap. 27.13] [chap.22.4]	transverse + longitudinal wave parts: **scalar waves,** noise, etc.
equations of transformation: [chap. 28]	vortex overlap **length measures depending on field**	**gravitation, temperature,** **theory of objectivity**

Fig. 30.10: (All) Many roads lead to Rome.

30.10 Epilogue

The preparation for a seminar or a lecture always starts with a collection of material. This should be considerably more detailed than the material to be communicated, since it doesn't get well at the students and also other participants, if the state of knowledge of the lecturer already is exhausted with the scope of his lecture. For this reason the collection of material must also include alternative derivations and areas of knowledge, which thematically rather are marginal, about which mustn't be reported, which possibly not even can bear criticism but still are in the public discussion. For a collection of material, which wants to be considered to be comprehensive and complete, it is important that no area and no theme has been overlooked.

The here presented collection of material with its 650 pages has become correspondingly voluminous. After all the material has been collected over an 8 year period and has been strung into the book in the order of working. That of course complicates reading the book, because individual aspects are repeated several times, but often also in a different context and each time lighted from another side. If the reader somewhere has the feeling, he only has turned in a circle, then has deceived himself. He indeed moves spirally in a circle, like in real life, but he doesn't come out there, where he started. After one turn he is richer with the experience of this spiral turn. In whole science the advancement takes place as a spiral movement and one can count oneself fortunate, as long as the spiral has an ascending slope! This notion should solace the reader, who has undertaken the torture to work through the complete collection of material.

Students also have reported, they had devoured my book like a thriller and a colleague, who had acquired it at a conference in Switzerland, was digging so much in the lecture that he forgot to get off the train timely.

It is a special concern to give reasons for the necessity of an extension of available field theory. To achieve this goal several derivations (fig. 30.10) can be found in my books: from a postulate, from causality, from duality, from vortex physics, from the equations of transformation, etc. added are at least a dozen derivations of other authors from various publications, who at most are cited. With that the goal is pursued that all approaches, which are conceivable and worth discussing, can be put side by side and tested for their efficiency.

Since it isn't the task of a collection of material to answer this question, this must be done by the hearer resp. the reader of the books. He is prompted to find the answer himself! That leads to an intense contention with the theme and that exactly is the reason for the otherwise rather unusual step to make a collection of material open to the public. Objections and criticism of the content of a relation of matters or also only of the representation of the context is wished explicitly. This also isn't valued as criticism of the author or of the superordinated set of difficulties, which in principle isn't possible at all for a collection of material.

Honorary functions of

Prof. Dr.-Ing. Konstantin Meyl

President
of the **Society for the Advantage of Physics** e.V.
(Gesellschaft zur Förderung der wissenschaftlichen
Physik, Köln)

Präsident
der **Europäischen Kommission interdisziplinärer Wissenschaften**, Hechingen,
Gesellschaft freier Wissenschaftler, Forscher und Praktiker
(Schirmherrin: Herzogin Margarete zu Mecklenburg,
Prinzessin von Hohenzollern).

Zweiter Vorsitzender im Vorstand
der Deutschen Gesellschaft für Energetische und
Informationsmedizin e.V.,
D.G.E.I.M, Stuttgart

Vice President
in „The **German Association for Space Energy**",
(**DVR**, Deutsche Vereinigung für Raumenergie,
Hannover)

Wissenschaftlicher Beirat
im **VDE** Schwarzwald-Baar-Heuberg
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TZ-Leiter
vom 1. **Transferzentrum** für Skalarwellentechnik
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im Schwarzwald

Fig. 30.11: Honorary functions of the author (December 2003, selection).

There in principle is no necessity at all to discuss with everybody a collection of material, which I have compiled exclusively for own events. It is absolutely sufficient, if few, but then qualified experts have thoughts about the content and communicate them to me. They can feel certain that I don't hand down their judgement to other persons. For that I also have been blamed by ignorant colleagues, who in complete self-overestimation have the opinion, they should be informed about everything. Right is rather, that my private correspondence is of no concern to anybody, since I find it important that as much readers as possible express themselves frank, what only functions, if they can feel certain that they afterwards won't be involved in public mud-wrestling. Therefore I keep still as regards other persons however curious they might be.

Indeed over and over again pseudo scientists turn up, who have the erroneous opinion that scientific arguments would take place on some internet-forums, where one can descant at will and anonymous, hidden behind an alias, where the intellectual firebug can feel safe, not afterwards being blamed for his crimes.

No, science takes place entirely different. A new theory will be able to establish, if it is right and important and if it is used for practical uses. Losers are those authors of a theory, for the elaboratation of which nobody is interested. What does a publication in a journal, however renowned, mean, if nobody reads it and nobody needs it? Most new ideas and approaches go under without notice in today's flood of publications, for who has got the time to read all essays in full?

Desperate they turn to me hoping, at least I could understand their concern. I then invite these scientists to a congress of the „Society for the Advantage of Physics", of which I am the president and offer them a forum, where they are able to present their ideas to an expert public. Not all lectured ideas prove to be sound, but not seldom a physical concern, which should be taken very serious, is behind it.

For a long time the real scientific controversy doesn't take place anymore at the universities and their congresses, where hardly someone dares to lecture arguments against the convention. Too fast he would be expelled as outlaw from the honourable society. From time to time however also from these circles colleagues dare anonymously or privately, as they emphasize, into the alternative events of lobbies or clubs, to astonished find out that real science there still is practised and that there is discussed about ideas, which they have given up thinking or have forbidden themselves to think about. The employment activity, so they excuse their thinking prohibition, allegedly doesn't allow it.

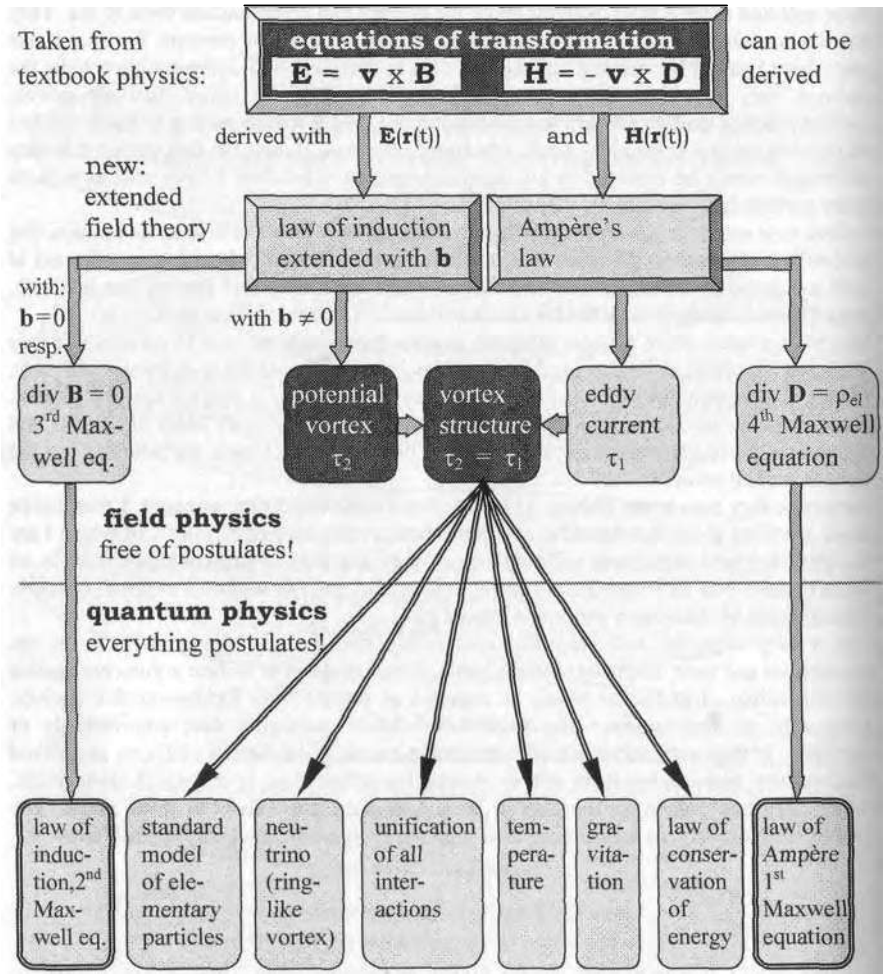

Fig. 30.12: Derivations of postulates and axioms (part 1).

Be that as it may, the approaches and derivations contained in my collection of material are considered to be controversial, and that is good that way! The public takes notice and professional circles are occupied with the ideas. With that half the way to success already is brought off! It now concerns to knock off all points for their soundness individually, because the next step will be to search a way to the goal as unassailable as possible, which is able to convince also the biggest sceptic. The final version, which then should appear in accredited peer-reviewed journals and in a scientific book concerning the theory of objectivity, goes in this direction. From the numerous approaches in the end only one will be used, and from the countless, in the collection of material listed aspects only the noncontentious ones will remain.
The dispute, which in the current stage can't be avoided, yes even is desired, however shouldn't deceive about the fact that it here doesn't concern persons, improper vanity or some image cultivation, but simply and solely concerns the matter!

In fig. 30.12 and 30.13 is represented, what it concerns. Field physics and quantum physics don't form, as in common practise, an insurmountable opposite, but even complement each other! Below the stripline a little selection of the today in current use quantum physical postulates can be found. The number of newly introduced „constants of nature" and postulates permanently is increasing, a circumstance, which hardly can be mediated to the common sense. The bracket is missing, which interlinks all postulates, or the common source from which they can be derived causally.
In the progress of the three-part edition in this question, essential for physics, already a satisfying and in addition real efficient answer has been found in the domain of field physics. The coupling marked by individual derivations can be found above the stripline and it is entirely new, apart from the dashed indicated derivation (fig. 30.13), as given by Prof. Bosse (TU Darmstadt) in his textbook.
An approach in principle can be chosen freely. In the case of the superordinated field theory two equations of transformation form the approach, which already is laid down in textbooks and secured experimentally. That's why the whole field theoretical derivation manages without one postulate! It is pointed to the fact that these equations on their part can't be derived and should be interpreted rather philosophically than physically. From this approach the extended field theory is derived directly, without a need to add or discard a term. The extended field theory consists of the well-known law of Ampere extended with the dielectric displacement D by Maxwell, and of Faraday's law of induction, which experiences an extension with the vector of potential density b by means of the derivation. Doing so we assume that the field pointers of the electric and the magnetic field strength depend on the spatial coordinate r and through this indirectly also on the time t: E(r(t)), H(r(t)).

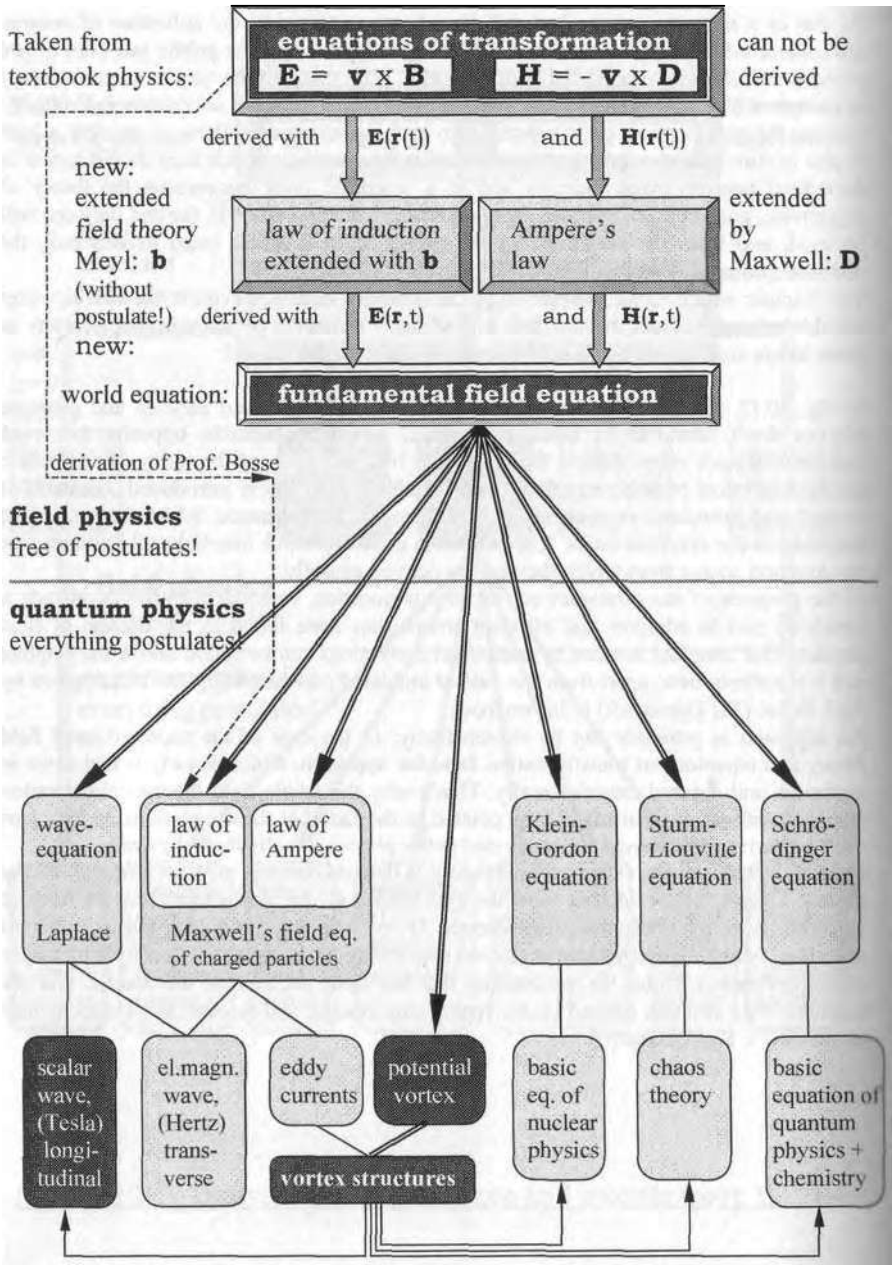

Fig. 30.13: Derivations of postulates and axioms (part 2).

If the somewhat more general case is counted up, in which case apart from the spatial a direct temporal dependency is present (E(r,t) and H(r,t)). then further additional terms appear in addition to the extended field equations, which need an explanation also for the case that they are zero. The physical interpretation would implicate a longer treatise, which however can be circumvented, as shown here, by constraining the field pointers, which absolutely is allowed according to the slogan: for the case E(r(t)) and H(r(t)) chosen from many possibilities the extended field equations come out exactly in the form, as they are required and suitable for the further calculations. Who has got to calculate other cases, can do that as he likes, but doing so he should not get lost. Maxwell's field equations are contained in the solution and with that also continue to be valid. Their disadvantage however is that without the extension b not a single quantum physical postulate can be derived. If we add this extension and insert the equations into each other without addition and without cuts also this time a central solution is the result, which is called fundamental field equation.

The derivation is known as well from the Maxwell theory, in which case it is common practise, to use the general approach (E(r,t) and H(r,t)), what we in accordance with the textbooks can do in the same manner. The extension however brings two additional and extremely significant terms. Since the fundamental field equation has eigenvalues under certain boundary conditions and describes structures, various quantum postulates come out from it, from the quantum properties of the elementary particles over the Schrodinger equation and the inhomogeneous Laplace equation up to the derivation of the Golden Proportion. That justifies the assumption that this possibly is the long sought-for world equation!

Even I, as the initiator, was totally surprised by the found derivation of the most important quantum physical postulates and axioms. One just is doing it the right way and already everything fits together! I am not aware of any theory, which would be able to achieve something roughly comparable. The since long sought-for ,,Theory of Everything", the big unification theory really falls into ones lap. The known interactions are the free and easy result of analysing the field lines of electric and magnetic field strength (fig. 30.12). Physical phenomena, which until now were considered to be incompatible, like e.g. waves, noise or the temperature with the utterly insufficient concepts of the mechanisms for the conversion of one form of energy into another, can be represented consistently with the fundamental field equation as the rolling up of a wavelike field oscillation to a vortex oscillation and as conversion of the noise vortices in the case of a vortex contraction down to atomic dimensions as thermal oscillation, which we treat as vortex losses. There exists no alternative to such unified schemes of things, as makes it possible in abundance the theory that I have founded, considering the two conditions, that on the one hand in the case of the derivation only known regularities are used, by completely doing without postulates and that on the other hand laws are applied and adhered to, also physical laws.

The new schemes of things, which sound unfamiliar, thus already were contained in the laws of physics. After this now having been realized, the tables turn. Now the explanations by postulates, as they at the moment still are being taught, should be replaced by the newly derived ones, if one doesn't want to become a breaker of the law! There doesn't lead a way past the overdue reform of physics anymore.

If you want to correspond with me or if you want to get one of my books from the bibliography, then please consult my Transfer Centre in the Technology Centre of St. Georgen (Black Forest, D).

Address: 1st Transfer Centre for Scalar wave Technology
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email: meyl@k-meyl.de or: meyl@fh-furtwangen. de

Internet: http://www.k-meyl.de or www.meyl.eu

The list of deliverable books (for ordering books over the above given address, Fax, Mail or postcard suffices):

* Wirbelstrome, Diss. University Stuttgart 1984, ISBN 3-9802 542-0-8, 14
* Potentialwirbel Band 1, 1990, ISBN 3-9802 542-1-6 (German), 14
* Potentialwirbel Band 2, 1992, ISBN 3-9802 542-2-4 (not available)
* Elektromagnetische Umweltvertraglichkeit, Teil 1, 2 and 3 (German), ISBN 3-9802 542-8-3, 3-9802 542-9-1 and 3-9802 542-7-5. Each 16
* Scalar wave technology, 2003, documentation and manual to the demonstration-kit and to the experimental-kit (translated and copied).
* Sendetechnik der Gotter, historischer Sciencefictionroman, (in German) 1 .Aufl. 2004, ISBN 3-98O2 542-5-9, 12
* Neutrinopower, Johannes von Buttlar im Gesprach mit Prof. Dr. Konstantin Meyl, (Discussion in German) Argo-Verlag 2000,

(A bill is enclosed in the delivery.)

Fig. 30.14: Contacting address and list of deliverable books

Table of formula symbols

Electric field

E	V/m	Electric field strength
D	As/m²	Electric displacement
U	V	Tension voltage
ε	As/Vm	Dielectricity: $\varepsilon = \varepsilon_r \cdot \varepsilon_o$
Q	As	Charge
e	As	Elementary charge
τ_2	s	Relaxation time constant of the potential vortices

Magnetic field

H	A/m	Magnetic field strength
B	Vs/m²	Magnetic induction
I	A	Current
μ	Vs/Am	Permeability: $\mu = \mu_r \cdot \mu_o$
φ	Vs	Magnetic flux
m	kg	Mass
τ_1	s	Relaxation time constant of the eddy currents: $\tau_1 = \varepsilon/\sigma$

other symbols:

A	m²	Area
a	m	Distance
b	m	Width
c	m/s	Speed of light
c_o	m/s	Speed of light in vacuum
C_e	As/V	Capacity of the electron
C_p	J/K	Heat capacity
d	m	Thickness
E,W	Nm	Energy
f	1/s	Frequency
F	N	Force
G	m³/kg·s²	Gravitational constant
g	m/s²	Gravitational acceleration of the earth
h	m	Height
h	Nms	Planck's quantum of action
ħ	Nms	Quantum of angular momentum: $\hbar = h/2\pi$
j	A/m²	Current density
J	kg·m²	Moment of inertia
J·ω²	kg·m²/s	Angular momentum
k	Nm/K	Boltzmann constant
l	m	Length
m	kg	Mass
M	kg	Mass of the earth
n,ν =	1,2,3..	Running parameters
N	-	Constant
O	m²	Surface area
p_m	Am²	Magnetic moment

Q	Nm = J	Heat energy
r, R	m	Radius, radius of the earth
r_e	m	Radius of the electron
s	Nms	Spin
t	s	Time, time to orbit
T	K	Temperature
U	Nm	Potential energy
U_e	V	Tension voltage of the electron
v	m/s	Velocity
V	m³	Volume
W	Nm	Energy
w	N/m²	Energy density
W_e	Nm	Energy of the electron
z_e	-	Number of the involved elementary vortices
λ	m	Wave length
ω	s^{-1}	Angular frequency, angular velocity
σ	Vm/A	Specific electric conductivity
ρ	kg/m³	Density $\rho = m/V$
ρ_{el}	As/m³	Electric space charge density
ψ (r,t)		Complex wave function
φ (r)		Function of space coordinates
Φ		Golden Proportion

Definitions:

Speed of light	$c = 1/\sqrt{\varepsilon \cdot \mu}$	m/s
Speed of light in a vacuum	$c_o = 1/\sqrt{\varepsilon_o \cdot \mu_o}$	m/s
Moment of inertia (orbit)	$J = m \cdot r^2$	kg·m²
Mom. of i. (homogeneous sphere)	$J = (2/5) m \cdot r^2$	kg·m²
Angular velocity	$\omega = v/r = 2 \cdot \pi/t$	1/s
Surface area of a sphere	$O = 4 \cdot \pi \cdot r^2$	m²
Volume of a sphere	$V = (4/3) \cdot \pi \cdot r^3$	m³

Concerning vector analysis:

Bold print = field pointer (vector); further information in fig. 5.0 in part 1

Prof. Dr.-Ing. Konstantin Meyl:

Scalar wave technology

for the transmission of electric scalar waves

Abstract: 1. Auflage 2000, 2. Auflage and 1st English edition 200

This book is recommended to people, who search the entry into the world of the by the author discovered potential vortices and their propagation as a scalar wave by experimental means. It starts with the instructions to six extraordinary experiments. Doing so an electric radiation is proven, which transmits energy, and that even faster than the light. Also more energy can arrive at the receiver then is put into the transmitter. Who entertains a doubt, will be able to understand the experiments with this book in his hand, to afterwards test the experiments with the gauge, which he is familiar with.

The 1st edition in English at first only includes the instructions for the experiments. In a subsequent edition it will be complemented with a collection of test protocols and progress reports. These are organized into three groups: one group is striving to explain the behaviour of the transmission line conventionally, a legitimate concern, which in a number of points also is able to convince. A second group only is interested in those phenomena of the experiment, which can't be explained conventionally and which prove the existence of scalar waves, whereas the third research group continually strives for new spectacular experiments and practical applications.

Documentation

Belonging to the experimentation and demonstration kit for the transmission of electric scalar waves

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by Prof. Dr.-Ing. Konstantin Meyl:

Sendetechnik der Gotter

Konstantin the Great is inaugurated in ancient send receive engineering by his teacher in the Roman emperor palace 304 A.D.

Abstract: l.Auflage 2004(in German)

- Has god Apollo in Delphi broadcasted at 5.4 MHz?
- Were the Greek temples telegraphy transmitters?
- Were the temple priests amateur radio operators?
- Was Homer radio reporter by order of the gods?
- Were the oracles receiving stations?
- Have oracle interpreters deciphered the transmission code?
- Which bridges did the Pontifex Maximus build?

All are questions, which are dealt with and explained in detail in 30 lessons. In the year 304 A.D. we witness, how the later Roman emperor Konstantin the Great is inaugurated in the secret broadcasting technique of the gods by his teacher. It is an exciting time of upheavel, because the old telegraphy is almost dead. The intestines of animals to sacrifice, from the convulsions of which the radio signals are read off, are scarce goods. Instead radiotelephony should be introduced, which had been tested successfully with the Pantheon in Rome by emperor Hadrian.
But new dispute is initiated: should broadcasting be introduced or rather cellular phone? But those, who tamper around without licence, are chased and fought as always.

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Time = Space

Supreme scientific secrets in ancient India

(God's particle, Language, Arts, Temples & Sacred Geometry)

(Shatkona Yantra – Created by Sri Bhogar Siddhar currently in a temple in Sri Lanka, taken once in a year for rituals, believed to emanate supreme subtle divine energies.)

Thinking Hearts (Raguram Gopalan)

(raguramg@hotmail.com)

Thoughts from Thinking Hearts:

"Curious by nature, in a life so uncertain
Thirsty for the truth, which is so certain
I sought for some water in our Vedas - the fountain
Though I can't understand fully what it contains
I am amazed & speechless with what I could ascertain
This is just a speck of dust from that golden mountain
Thankful to my family for helping me in what I could attain
Grateful for the wisdom and works from all the chieftains
Wish I repay every atom of it through my gratuitous tearstains"

This effort is to share what I read, understood and enjoyed about the scientific aspects in ancient India which are codified in our language, arts and in 1000s of temples. The quotes and examples are predominantly in Tamil but I have tried to give the meaning which can enable a reader to grasp the meaning and progress. Any shortcomings you notice are purely reflective of my abilities to understand and express. There was not even an iota of intention to hurt any sentiments or beliefs of others. A piece of my mind is available @ http://ragsgopalan.blogspot.com

I initially thought that I shall reproduce a prayer from one of the books which I had read but at one fine moment I decided to capture my feelings in my own words. So I scribbled few lines in English summing up my feelings as above, few lines for the Sage of Kanchi and a prayer in Tamil with its meaning in English. You may understand this prayer better after you read this book.

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Please feel free to copy and reproduce in whichever form or shape as you deem fit without any acknowledgements. In fact see how much of this can you share to dispel the ignorance. The more you share the better. ☺

If I have acknowledged any books or authors please recognize them and ensure that you either buy their books or donate to their cause. They deserve all the credits.

A divine soul
With a noble goal
Walked this earth
When divinity was dearth
Beyond any treasure's worth
To avoid our death & rebirth
Seek his guidance & grace
For he shall ever embrace!

உ

முதல் வணக்கம் (Prayer)

உள்ளமே மூலமாகி, பரம்பொருள் கோலமாகி
விண்ணே ஒளியென்றாகி, ஓமே உணர்வென்றாகி
உணர்வே ஓமொளியாகி, ஓமொளி ஓமொலியாகி
ஆடலன் ஆட்டமன்றோ, அசைவுறுக் காலமாகி

(Mind is the source, primordial god's particle as the form,
The luminescent space, the Pranava as consciousness
Consciousness as the Om's Light, Om's Light as Om's sound
Isn't time a pulsation that's the dance of Lord of Dance?)

காலமே சீலமாகி, சீலமேக் கோலமாகி
கோலமே ஞாலமாகி, ஆதியும் அந்தமாகி
ஞாலமே மூலமாகி, அறிவுடன்ஆ னந்தமாகி
நடுவிலே நன்று நிற்கும் நாதன் தாளே நாட்டமாகி

Time creates Rhythm & order, Rhythm creates shapes
Shapes become universe, the beginning and the end
Universe merges with source, it is awareness & bliss
Ever searching for the feet of the divine & graceful mean

விண்ணிலே மண்ணுமாகி, மண்ணிலே விண்ணுமாகி
விண்ணிலே எண்ணமாகி, எண்ணமே எண்ணுமாகி
என்னிலே என்னைக்காண என் கண்ணிலே மணியுமாகி
நிர்மலப் பொருளாய் ஓங்கும் நிமலனடி போற்றுவோமே!

The mass in energy (Space), the energy in mass(earth)
The energy as thoughts, our thoughts as numbers (octets)
To me find me within me, he who stands as my eye's pupil
Beseech his feet who is devoid of may blemish

அம்பலத்தில் ஆடும் அவனை, அரங்கத்தில் துயிலும் அவனை
அரவத்தைச்சூடும் அவனை, அரவம்மேல் ஆடும் அவனை
பைரவித்துணைவன் அவனை, திருமகள் தலைவன் அவனை
நம் அறிவுக்கு இருளின் நமனை, பொற்பாதம் போற்றுவோமே!

The one who is dancing in the microbode, the one who is sleeping in arangam
The one who is wearing snakes, the one who is dancing on a snake
The one who is consort of Goddess Bhairavi, the one who is the Lord of goddess Lakshmi
Beseech his feet, the one who kills our mind's tamasic darkness

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1. TIME = SPACE SERIES. PART 1 - INTRODUCTION

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

"Abheda Darsanam Gnanam*". Nothing defines what **wisdom is** better than these 3 words. **Experience of unity / oneness in all is wisdom.** The roots of Indian wisdom are captured in these 3 words that everything in this universe is the manifestation from a single source, and we can call it God or Consciousness. This naturally leads us to one of the mahavakya ***"Pragyanam Brahma"*** which means **"Consciousness is god".** But for people who are stingier with words and wants these 2 concepts to be put in just one word, then it is called **"Advaita".**

It is not very often that nature reveals itself its absolute oneness and the un-manifested interconnections. You consider yourself fortunate when you come across such knowledge in however small measure, even if it happens very rarely and even if you have an illusion that you have understood something. It has been very overwhelming for me to come across some of the details I have been reading and hearing and the dots I could connect – some of which I had decided to write as a book.

If you are interested in knowing how scientific ancient Indian Sanatana Dharma is and how well we have codified nature's secret in our languages, arts and temples and if you are interested in any of the following questions then you may like this book. Most of the aspects stated here as scientific proof has a reference to one or more of our scriptures and I would refer and quote them at various places.

- Would you be surprised to know that the size, shape, color and characteristics of God's particle are very clearly documented in our scriptures at least 12000 years back? What the scientists at CERN are spending billions of $, is well documented and we will discuss the characteristics of God's particle in this book.

- Would you want to know how **Time = Space** and more over time is nothing but the vibration of space? If I tell you that this was known us Indians at least 12000 years back and currently available in a written form would you believe?

- When you throw a stone in water / pond the ripples that form take the shape of a circle (in 2D) / sphere (in 3D). Can you guess what the shape of the ripple would be if you throw the same stone in space?

- What is the similarity between Poetry, classical music, Classical dance like Bharatanatyam, Sculpture and a building? Apart from the fact that we don't clearly understand any of them in depth what is the similarity? Would you be surprised if I say that all are essentially the same and in fact a **well constructed building is nothing more than a frozen music** and the relationship between all the above confirms to a single grammar documented 12000 years + back ?

- Would you be interested in knowing how $E = mc^2$ an equation stated by our great Einstein has been known to us for years and not just that but we know the root of this energy and how to engineer it with precise formulas? Would you be surprised that this is the basis our language?

- What if I say that the age of the universe, every astronomical unit of the bodies, big bang theory, string theory, God's particle etc are all documented and they are all codified in our temples?

- You would have heard about the golden ration Φ but do you know the philosophical significance of Φ and how it is derived? Moreover would be interested in knowing the significance of key numbers and ratio like 0, 1, 5, 8, 9 and $\sqrt{2}, \sqrt{3}, \sqrt{5}$? What is I say that $\sqrt{3}$ can be correlated with "**Iyengar Namam"?** Does it sound funny? What if there is a deep mathematical and philosophical significance? And how are all these ratios related?

- As a wise man said that **'Mathematics is the language of the gods".** What if this formula is codified in our texts from which we understand the God's particle, its shape, characteristics and its manifestation?

- What if I tell you that sound is a subset of light and sound merges with light at a point and that is at the root consciousness? Any non-takers for this?

- If you agree on the above then **Sabda Brahman** or the belief that sound is god merges with something higher, isn't this contradictory? Also why many religions did believed that "**Word is god".** Was it a mere belief or was there any scientific reason behind it?

- What is the correlation between Carnatic music and a human being's height?

- What if I say that the Mayan from South America and the Mayan from South India are one and the same?

These are some of the questions which might get addressed in this book. I am going to quote a series of references and books and links to understand and learn more about these topics and I would request you to utilize them if you are interested in these topics.

This may not only refer you to the experts but also can help you overcome any weakness I have in understanding and articulating some of these topics. Some of the topics may touch upon religious beliefs (mostly Hinduism) but if you read with an open mind you would notice the underlying science behind it.

I would be happy if any of these blogs motivate and inspire you to explore the roots of our tradition and knowledge and give you an insatiable hunger for knowledge, wisdom to pursue the nature and its secrets.

May the ancient Sanskrit quote “May I meditate on the supreme truth “Satyam Param deemahi”, resonate within you as it does within me.

Happy reading!

PS:

Abheda Darshanam Gnanam, Dhyanam Nirvishayam Manam;
Snaanam mano mala thyagam, Showchamindriya Nigraham", says the Upanishad.

The real Gnana is seeing all as one, real Dhyana is controlling the Manas from all temptations, the real snana or Bathing is Cleansing of All Mindly impurities, not physical impurities alone and real Showcha or cleanliness is controlling the Indriyas, this controlling of Indriyas, emotions, weaknesses and temptations.

I am also quoting parts of Kahlil Gibran here,

Your hearts know in silence the secrets of the days and the nights.
But your ears thirst for the sound of your heart's knowledge.
You would know in words that which you have always known in thought.
You would touch with your fingers the naked body of your dreams.
And the treasure of your infinite depths would be revealed to your eyes.
But let there be no scales to weigh your unknown treasure;
And seek not the depths of your knowledge with staff or sounding line.
For self is a sea boundless and measureless.
Say not, "I have found the truth," but rather, "I have found a truth."

2. TIME = SPACE SERIES. PART 2 - SOUND MERGES IN LIGHT

What if I say that "**Sound is a subset of light".** Scientifically you may agree that both are electro-magnetic vibrations at different frequencies in the spectrum though one may not be the subset of another.

So, What if I say that every other frequency is the subset of light? I am sure many may disagree. Some of the religious pundits may claim that "**Sound is god**" which I am not disputing but "**light too is god"** and as we progress towards the primordial state sound merges into light.

Let me try to explain this with a simple exercise. Please sit in a place with a calm mind – few deep breaths may help.

- Imagine that I am TALKING to you and avoid thinking that you are reading this blog.
- I am going to TELL the following 5 words and you are going to LISTEN to it. Please just observe what happens within you.
    - CAT, BOAT, MOM, DEVIL, BEST FRIEND

The following are the fundamentals of perception as per Hindu scriptures:

- Every word has a meaning (Let us ignore the so called meaningless words for the time being.).
- Every meaning invokes a form or shape within our mind.
    - For example when I say "**MOM"** you associate this word with your mother and the picture / image of your mother is perceived inside. You need to be little more observant to understand this. **The fundamental principle is that**
    - **"Every word is first associated its meaning then the meaning is associated with a form. The form is associated with a Guna (Quality) and then the quality or Guna is associated with its experience. What is stored inside is just the experience.**

Let me TRY to explain the abstract concept of consciousness as below:

- **Consciousness / existence exist in 3 states (deeper explanation is 5 / 7 states but we will discuss the simpler alternative).**
    - **Formless state called Experience / feeling / bhava. This is the super conscious state.**
    - **Gross state with form which has physical attributes. This is the conscious state.**
    - **In-between state (Not formless and no form) called Guna state which has subtle quality attributes. This is the Subconscious state. If this is difficult to comprehend for you please imagine "Egg" which is in-between the formless and state with form.** Gotcha?

Let's look at an example. Rose is a flower. When someone tells you **"ROSE"** then the following happens:

- The sound "rose' associates with a flower usually. (I am ignoring it being a name of your girl friend ☺). So here the word is associated with its meaning.
- This flower is associated with red color and perhaps with thorns. Here the sound does not exist anymore but only a form. **Yo!, the sound has merged into light.**
- The third step is - this form is associated with a quality which is fragrance of a rose. For someone sensitive they can smell the rose when they think about it. How else could we salivate at the thought / smell of a favorite dish if this step does not exist?
- Now the last step is, this quality invokes an experience and hence a feeling. This rose may be associated with your inner self for love and hence the emotion of love surfaces. This is called **Bhava / Rasa** in Sanskrit.

If you are not clear about this then please do not move to the next part and think or discuss about it. A little contemplation would help you understand this **5 stage** process of perception.
'SOUND – MEANING – FORM – QUALITY (GUNA) – EXPERIENCE (FEELING / BHAVA)'

Our ancient forefathers knew this science and interconnection. Let me now quote these Slokas as an example from Bharatnatyam, which talks about this linkage.

Kanteenaalambayet geetam, Hasteenaardham Pradarsayet,
Chakshurbhyaam darsayeet bhaavam, Paadaabhyam taalamaacharet.

According to Nandikeshara the dancer should sing with the mouth, express the meaning of the song with hand gestures, her eyes should express the emotions or bhava, the tala, the beat or rhythm should be done with her feet. Further he goes on to say –

'Yato hastas tato drushti, Yato drushitis tato manaha
Yato manahas tato bhavo, Yato bhavas tato Rasaha'

'Where the hand goes, there should follow the eyes, Where the eyes move, mind should follow it,
Where the mind follow, Bhava or emotion is created, & lastly when Bhava is created the sentiment or Rasa will arise.'

All the Mudras or gestures represent word when held at a particular position around the frame of the body and when used in a particular way.

Alas we Indians have ignored this great science & art and its linkages and are like ignorant fools following the meaningless western tradition and dances!

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

3. TIME = SPACE SERIES. PART 3 – VAAK-ARTHA - IMPORTANCE OF WORD

'SOUND – MEANING – FORM – QUALITY (GUNA) – EXPERIENCE (FEELING / BHAVA)'

In the **5 stage** process of perception, one important factor which I missed is the **"Self / EGO"** which interprets the **Guna** to an experience. For example when I say Dog, the **'Self'** interprets Dog to a **loyal friend or a bike chaser or a rabbies generator.** Essentially what is the quality of dog mean to me? If you understand this process this explains the uniqueness between individuals or the root cause of differences in a society.

I am also going to add but not going to focus on the fact that the inputs are never limited to sound and when see a picture the process of perception starts with step 3. Just to poke the individuals who think "**Sound / Word is the only god – Sabda Brahman**, please tell me - when you see a picture and when there is no sound associated with it, where is **God as Sabda Brahman in this situation**?

Does that mean that the very important Hindu belief that the Sound **"Om is sabda Brahman or god"** does not hold any meaning? It certainly does and I shall share my thoughts on it – continue reading.

<u>What is the importance of Word?</u>

The greatest of Indian poet **'Kalidas'** said

"Vaak artha viva samprakthov vaakartha prathipathaye
Jagadha: pitharov vandhe parvathe parameswarow"

he compared Lord Shiva and Shakti like sound (Shakti) and meaning (Shiva). Both sound and meaning are inseparable. You would now understand the wisdom behind this sloka since there is no sound without a meaning. Also **Sabda Brahman** merges with the **Artha Brahman** and both are inseparable. Here Artha Brahman is the light and the meaning of the word. Remember we say that **'Throw some light"** when we don't understand something.

In Tamil **பொருள் (porul)** means "a thing" and it also means "meaning". We will see how **பரம்பொருள் (Paramporul)** is the Lord Shiva as a God's particle and how he is referred to as the meaning too. The same applies to Sanskrit where **"artha"** means **wealth / things – remember Arthasastra?** And it also refers to **"meaning"** as in the above sloka. How rich these languages are?

And in **Abhirami Andadi, bhattar** sees devi as **"Arthanareswara"** and confirms us that the grace of devi will brings us both richness and mukthi. **"Sollum porulum ena nadamadum"...**

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A word is made up of letters called Akshara in Sanskrit. The meaning of Akshara is that which cannot be broken down further. ie. Word can be broken down to letters but it cannot be broken down further. A letter has a form like **"A"** and has a sound associated with it. This means the light and sound are merged in a letter. As per the principle stated above in the process of perception, the primordial state is one where light and sound is merged into each other.

If you don't dispute the philosophy that everything merges into god at the primordial state and at this state, sound and light are inseparable, and then you would agree that an Akshara is **God / Brahman.** Each letter has significance and meaning in Indian languages especially Tamil and Sanskrit. **A word is a combination of Form (Light), Sound and meaning and these are first 3 aspects of perception which takes us from a gross state to a formless subtle un-manifest state.**

Hence the statement from New Testament **"In the beginning was the Word, and the Word was with God, and the Word was God"** reflects the same principle.

But as per Hindu scriptures Veda is the breath of god (not word of god) or the aural vibration of consciousness cannot take you to the state of moksha. Words don't take you to God, it can help you in the process but has its limit, since the sound and meaning merges into something else as we move towards more subtle space.

This is what my friend Kambar said in Kambaramayanam as **"வேதமும் முடிவு காணா மெய்ப்பொருள் வெளிவந்தெய்தி மா துயர் துடைத்த வார்த்தை மறுப்பரோ!!.** This means that the supreme truth who could not be found by Vedas came and solved the problem of an elephant, can someone dispute this?

Every word or Akshara has four states **Para, Pashyanti, Madhyama and Vaikari. Vaikari** is the fourth state where the sound is audible to us. If I recite something mentally then the sound has 3 states only and these 4 states signify as to how a feeling (bhava) becomes thought and thought becomes form and then a sound. Just note here that as per Frank outlaw, it's the thoughts which are primordial but as per our scriptures it is feeling or Bhava or deep rooted desire or also known as vasanas which drive your thoughts. So Frank's quotes are half baked plagiarism.

In a work called Tarka Samgraha, we have classified 9 different physical attributes (substances / dhravyas) and 24 different qualities / GUNA in all. If you are interested reading more about this, please read these blogs or the original work.

http://ragsgopalan.blogspot.com/2010/09/vedic-perspective-matter-and-its_14.html This is a 3 part series.
http://ragsgopalan.blogspot.com/2008/11/part-1-perception-art-of-seeing-things.html This is a 2 part series.

To summarize this topic:

- Broadly consciousness exists in 3 states.
- The process of perception if understood well would throw a lot of secrets about nature.
- The 5 stage process of perception **“Sound – meaning - Form – Guna – Bhava”** is a simplistic way of portraying this.
- Sound merges into light and light is worshipped as God in most of the religions and belief. We can explore little more of this in the future sections.
- A word is a unique combination where Light, Sound and meaning merges and hence it is considered as god. This word represents **Arthenareeswara or yinyang or Star of David**.

In the future sections let us explore as to what is the relationship between Maths and God and some of the critical numbers and its philosophical and scientific significance.

As a wise man said, **“Indians are the most ignorant about their rich past and scientific traditions.”**

Happy reading

4. TIME = SPACE SERIES. PART 4 – SCIENTIFIC LANGUAGES – TAMIL & SANSKRIT

One of the main reasons I believe as to why our wisdom has degraded so much in the last century is our ignorance and reluctance to learn our rich language. Our language offers richness not just in literary sense but is supremely scientific too. I am going to touch upon just 3 to 4 aspects of it which I knew and understand at a fundamental level and request you to learn your mother tongue well.

Many of my friends don't exhibit a sense of remorse when they say **'I can understand Tamil but can't read or write it**". I wanted to tell them how much in life do they miss in terms of knowledge and richness. This is not just about Tamil but every major Indian language is rich in its own way. Since my mother tongue is Tamil, I am going to articulate some of the science in it.

Vigyan / Vigyanam (விண் ஞானம்) means Science:

But most importantly for this series I wanted to take the word called Science as meant in Tamil and Sanskrit. A word always can be broken down to its dhatus for its exact meaning in Tamil and Sanskrit. Some examples below:

- Science in Tamil is **Vigyanam and in Sanskrit is Vigyan**. This is split as **Vin** and **Gnanam** / **Gyan**. **Vin means space and Gyan means knowledge. Hence according to Indian system science means it is the nature / knowledge of the space.** This has very deep significance since western science has not agreed the existence of space for a long time and their gross and materialistic approach prevented them from seeing the most subtle component and its nature. We were masters of it ages back. Most of the questions in Chapter 1 would be answered based on the knowledge of space – Vigyan.

- **Universe is called as Brahmanda** in Sanskrit. Brahma + Anda which literally means a big egg. This means we knew that the galaxy is elliptical in shape ages back and it required hubble telescope in 1950 to tell us that.

- **Bhoogol** means **Earth (Study of) / Geography – This Splits as Bhoo +Gol.** Bhoo means Earth and Gol means round. We did not throw stones at a scientist as late as 17th century when he said that earth is round and not flat. We would have laughed our heart out and ignored him.

Be it the age of the universe, all of the astronomical measurements, health, spirituality etc, many of us need a white skin with blue eyes to tell us that what we knew was right and they have certified it. When we decide to come out of this mentality then the process of reclaiming our rich heritage shall start.

Origin of Universe and linkage with Tamil:

The initial evolutionary process for the universe consisted of 5 stages states Aintiram. You can imagine that these are the movements of particles during the Big bang. They are அமிழ்தல், இமிழ்தல், குமிழ்தல், உமிழ்தல், தமிழ்தல்.

- Withdrawl (Amizhdal)
- Imizhdal (Overflowing)
- Kumizhdal (clustering round in an order)
- Umizhdal (Emitting)
- Tamizhdal (resulting into a well defined form)

These are the first stages from the Big bang till a well defined shape is formed. Now the last level is called Tamizhdal which results in a well defined form. This state has emanated from the Pranava and not been created by some one. Hence a language as rich with the sweetness of inherent order, originating from the luminosity of the original particle is called Tamil. Tamil is word based on the final resultant state called Tamizhdal (தமிழ்தல்**).**

I shall address the other 2 interesting aspects that include a Chicken and Egg analogy for Energy and matter conundrum in the next blog.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

5. TIME = SPACE SERIES. PART 5 – ENERGY & MATTER CONUNDRUM

Energy and Matter concept in formation of letters:

The concept of Energy and matter is not new to us and does not start with Einstein's days of $E=mc^2$. Let us look at how our letters are formed from Aksharas then people would know that the concept of Energy and Matter is old as our language. In Tamil there are two kinds of Aksharas **உயிர் எழுத்து - Uyir Ezhuthu (Life / Energy letters – 12 letters) and மெய் எழுத்து - Mei Ezhuthu (Body / Matter letters – 18 letters).** Both put together it is 30 letter pack for Tamil as alphabets. Now both have to combine to give letters called **"body with life"** which are called **uyir mei Ezhuthu**. This combines to form 18*12 which is 216 letters as **Uyir Mei Ezhuthu**. For example **க்+ அ = க** in Tamil and क़ + अ = क in Sanskrit.

So the formation of letters itself is a science where Matter (Body) combines with Energy (Life) and then the living organisms (Body – life letters) are formed.

I want to ask you a **Chicken & Egg** question here which is very relevant to today's scientists. Did the energy come first or is it the matter that came first? Modern science is still scratching its head. I can answer this question in 2 ways, first is obviously using language as a science.

- In the above example **க்+ அ = க**, **க்** is the body and **அ** is life. So as per our language sciences be it Tamil or Sanskrit the matter is formed first and then the life came and attached to it. This is very well documented in Tamil scriptures as follows:

உடம்புடன் உயிர் வந்து ஒன்றுவது இயல்பே - தொல்காப்பியம் . This is over 2500 years old which states that life comes and joins a body in language and this is nature.

மெய்யொளி உயிரொலி சிவணுதல் இயல்பே – ஐந்திறம். This is over 12000+ years old which states that same thing and adds that body is like light and life is like sound and they merge and this is siva's nature. **This certainly means that both Body and life are not formed at the same – as popularly believed. Life comes and joins the body to give a living being – in the above case the letters are the living beings.**

The second reference I am going to take for the same concept is our **Yogic / Siddha / Ayurvedic** science as to how fetus is formed in mother's womb. As per our (Siddha) belief the conception of a child in a mother's womb happens as follows:

- **The first organ that is formed for the fetus is the cells of the Eyes (Single Eye)**. This eye cell starts vibrating due to its heat and multiplies as 2 eyes and then as the whole body. This is the vibration seen in the initial days of the fetus and not the heart beat. As per modern medical science the heart takes shape only by the end of the 8th week and not before. I am requesting someone to validate this.
- **Life comes to this body at the 3rd month of conception only**. This is the belief as per Ayurvedic and Siddha science.
- Instances of the third month natural abortions are very high than the later months based on the above reasons. This means that the life is not destined for that matter / life force is not sufficient enough.
- **How many of you know that the size of eyes never change as you grow and stays the same from the time we were born,** while all other organs undergo growth?
- Also the eyes hold a very important significance in the spiritual science which I shall address later. The eyes are the seat of Sun god and are characterized by heat and light.

It is through the heat in the eyes the subtle became a gross living being in this world and if the living being wants to merge back with the subtle – which is the process of Samadhi then the living beings should use their eyes, increase the heat in the eyes and start the devolution process. This is a supreme secret kept by the sages even in today's world. **You may want to ask any spiritual school as to why they recommend meditation with eyes fully or half open instead of closed eyes? Ask yourselves why the free masons and other secret societies use eye as one of their symbols?** We shall address this later.

Now you want to answer the Chicken and Egg analogy to the Energy and Matter conundrum based on the above 2 thoughts, we can conclude it is the matter which came first. We shall try to explain this based on Space sciences a little later.

<u>Masculine and Feminine names based on ending letters:</u>

I am also going to give you as to how Indians distinguished masculine from feminine names. **Kanchi Maha periyava, the Sage of Kachi** had explained this beautifully in his **"Arul Vakku"**. I am giving a gist of it here just to conclude this:

- **Masculine names:** All the names shall end with the phonetic a, im, in , ir, aha etc. Examples are Ram, Shyam, Raman, Kannan, Kishan, Vivek, Adam. So phonetically names like Catherine is a masculine name because it ends with "in" phonetically.

- **Feminine names:** All names ending with phonetics aa, e, I, oo etc. Examples are Radha, Ramya, Savithri, Gayathri, Uma, Rosy, Isabella etc. Same way phonetically Joshua is a feminine name.

Vishnu and Lalitha sahasranamam follows this rule and hence one invokes Shakthi as lalitha and the other invokes Purusha as Vishnu.

Just to conclude this part, I think we looked at how science is an integral part of our language formation and for us science has always been about the knowledge and nature of the space and we believed that space manifested itself as the physical world. So in the next few parts we shall look at how this manifestation has happened and other interesting aspects.

I would conclude this part with a earnest request that please encourage your kids to learn their mother tongue – to read and write and you would not have done anything better than this to advance their spiritual growth and adding richness to their life.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

6. TIME = SPACE SERIES. PART 6 – THE UNFOLDING SELF - UNIVERSE HAS EVOLVED AND WAS NOT CREATED

As per many scriptures in Hinduism this universe has evolved from itself and not created by someone. If you want to quickly ask as me as to what Brahma, Vishnu and Rudra mean – I would attribute them to different process heads in this evolution. They are all different aspects of the same consciousness based on their state of being in the process of evolution / devolution. This is my understanding but let us avoid this discussion here.

Here I am indebted and thankful to the nobel soul **Late. Dr. Ganapathi Stapathi,** (http://www.vastuved.com/life.htm) who not only unraveled the Vaastu science – the science of Space and time but also brought to light 2 important books which were over 12000+ years old written in Tamil by **Mahamuni Maayan.**

Mamuni Maayan is believed to be the same person who is popularly known in **South America as Mayan** and the 2012 phenomenon based on Mayan calendar. Dr. Ganapathi has established proofs that the pyramids in Middle East, the temple architecture in India and the structures in Mexico and Guatemala confirm to a single Science and Mathematics seen in all these works.

At the end of the blog I am listing few books which helped me understand this topic but most of the books (**Aintiram and Pranava Veda**) are out of print now and if you are lucky, you would get some of them. Now let us understand briefly how this evolution process has come about. According to Mayans' Aintiram:

- The free space is the unified field of energy and matter and source of all forms that we see in material world. That is why we were defined science as **Vingyanam**. This space consists of very minute particle called **Vinporul, nunporul, Sittrambalam, Paramanu, Oliporul, Microbode** (**விண்பொருள், நுண்பொருள், சிற்றம்பலம், பரமாணு, ஒளிப்பொருள்**) and in many names. You can pick what you like. I am going to use **Paramaanu** in the rest of the blog.

- The whole process of evolution is a 5 stage process. (Keep noting the importance of 5 and at the background remember Shiva is represented by Panchakshara mantra (Na~Ma~Si~Va~ya).

So what is the five stage process?

  - This space is called as Moolam (Source).
  - This Moolam starts vibrating and this vibration of the space is called Kalam (Absolute Time and not physical time. We will refer this as time only).
  - This Kalam (time) vibrates to a mathematical resonance called Seelam (Rhythm).
  - This Seelam as it resonates creates Kolam (Shapes – Circles, cubes etc).
  - This Kolam becomes our visible Universe which is called Gnalam.

- So it is **MOOLAM (Source) – KALAM (TIME) – SEELAM (RHYTHM) – KOLAM (SHAPE) – GNALAM (UNIVERSE). மூலம் - காலம் - சீலம் - கோலம் – ஞாலம்**, these are 5 stages of evolution.

This means that the Space itself becomes spatial forms and time is the instrument that creates, sustains and destroys. Lord Siva in Tamil is also called as **Kalan (காலன்)** as to who controls time since Kalam **காலம்** is time.

To put it differently, un-manifest state when pulsates becomes absolute time and this is the creative energy. The process of pulsation confirms to a mathematical order and we will see this order in detail later. You may now understand the phrase that "**Time creates, sustains and destroys**". Since if there is no pulsation then nothing happens.

For those who need quote from a foreigner to convince themselves of this can be referred to the **Bertrand Russel's** quote "**What we perceive as qualities of matter are differences in periodicity".**

I shall quote some from the oldest literatures for reference below:
காலமே எவைக்கும் மூலம், காலமே மூல ஆற்றல்
காலமே கோலத் தோற்றம், காலமே ஞாலத் தோற்றம்… *Maha muni Mayan from Aintiram*

காலக்கூறே கணக்கியலாகி… Time splits as Maths in proportion it pulsates.
Vyasa says in Adi parva chapter 1, shloka 249, says the same thing that Time Creates, sustains and destroys everything.

kalah srijati bhutani kalah sanharati prajah
sanharantah prajah kalam kalah shamyate punah!!

The same is quoted as **"Vastur eva Vaastu"** which means the un-manifest Paramaanu which is called **Vastu** (with Single a) becomes **Vaastu (gross form – with two aa**). You can relate this **Vaastu** as the building science which is grossly misused and misrepresented and commercialized in today's TV programs. We will address the science in it later.

I shall leave this part with this thought, the space is considered as **Nataraja (Shiva) – subtle component and Ranganatha is considered as the Earth component**. So Shiva and Vishnu are two aspects of the same seed. We will see more scientific proof of this later.

"Shivasya hridayam vishnur, Vishnoscha hridayam shivah:" and
"Shivaya Vishnu rupaya Vishnave Shiva rupine"

Vishnu is the heart of Shiva and likewise Shiva is the heart of Vishnu and they both are the representation of each other.

Now if you are clear about the five stage process of evolution we can delve into each and every aspect of this in little more detail that would answer everything.

Ref: Check out all the ones here. Key recommendations are item 6, 11, 14 and 43. http://www.vastuved.com/publication.html

7. TIME = SPACE SERIES. PART 7 – THE CHIDAMBARA RAGASYAM & THE GOD'S PARTICLE

There were 2 questions I had confronted myself when I was reading these passages. They are:

- Why did the unmanifest space energy started pulsating and became absolute time?
- What did the unmanifest space energy contain? Was it a point of singularity as the modern scientists wanted us to believe? If so then how much mass was concentrated in that point which is obviously very difficult to believe.

The answer to the first question is here **"The self unfolds itself for its self – Bhagavad Gita".** There is no convincing answer to the rational mind as to what the reason that the consciousness which was passive decided to become dynamic and started pulsating. So let's leave this for the time being.

But the second question is answered very comprehensively. But before we get into the details of what it is, I want you to check Figure 1. This gives the overall picture of evolution and the five stage process. I also want you to recollect the "EGG" state which is called as the GUNA state where in the form and sound manifests. They say that this pulsation started with OM. This OM as popularly believed is just not an aural form but also has a visual form and that is light. We will discuss about this later in detail.

But let us focus on the actual second question as to what the contents of this Space energy were:

- The space is filled with **Paramanu or Microbodes** which are tiny particles. These are the **God's (Higgs Boson) particle** our CERN scientists are after. http://en.wikipedia.org/wiki/Higgs_boson

- Now, we are probably a year away before CERN publish the results when this blog is published. I would not be surprised to see the results of that experiment is closely aligned with what is available in our scriptures and produced in this blog.

- The primal manifest form of the unmanifest is a **square** (primal wave pattern). This is the shape of the **Paramanu or Microbode**. This is very luminescent, means filled with light and on a 3D plane this shape is a **Square Cuboid**.

- A **Square Cuboid** is a shape which is equal in all sides – say of unit measure which is the smallest measure possible and has **6 faces, 8 vertices, and 12 edges.** You can start figuring out in Hinduism, why the idols of Lord Shiva and Lord Muruga has six faces, 12 eyes, hands etc.

- You may want to note that 6 faces can be represented in 2 ways as below. Figure 3 is Lord Muruga's star or a Star of David in 3D which has 6 faces and 12 edges, popularly known as **Tetrahedron**. **So don't be surprised if the Boson Higgs particle is of the same shape.**

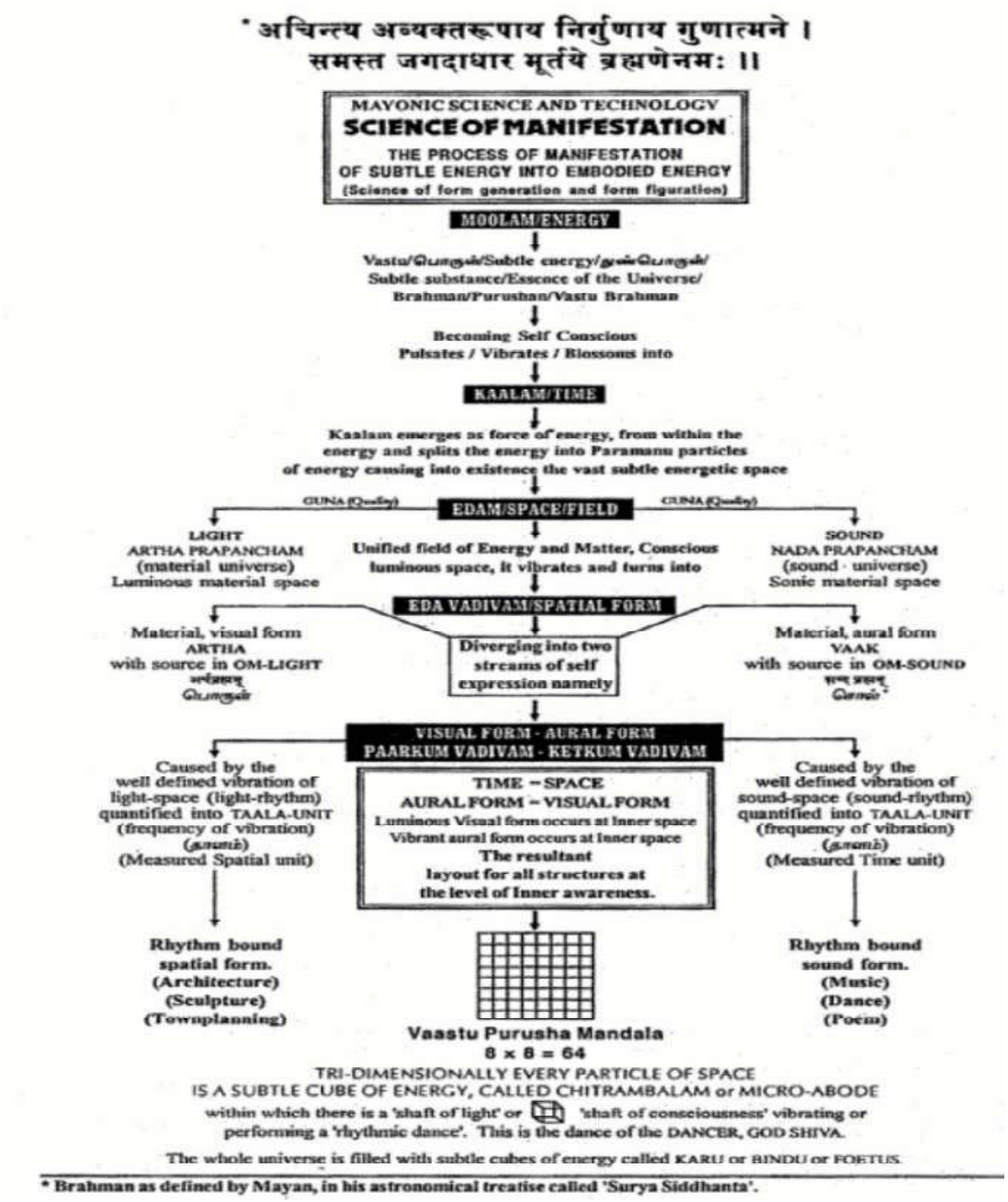

Figure 1: Science of manifestation
(Courtesy: Pranava Veda by Mamuni Mayan – 12000+ years back, recreated by Dr. Ganapathi Sthapati)

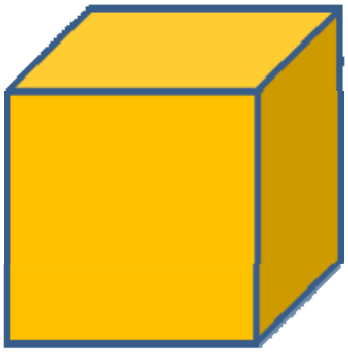

Figure 2: A cube with all equal sides

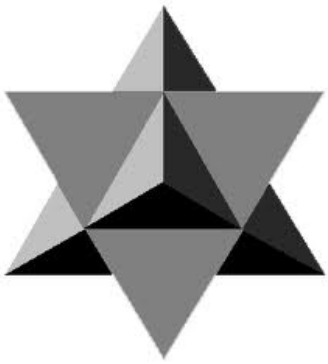

Figure 3: A tetrahedron (from Internet)

- The free space is packed with cubical atoms of energy. They are building blocks of the structure of the universe. **So what is clear is that all these atoms existed in a "resonant state of non-vibration" before the so called "big bang" happened or the pulsation started.**

- **It did not burst out of a single point as popularly believed. Alternatively, in space every point is the center. When the pulsation started these cubical atoms underwent a shape change and manifested as shapes and forms.**

- This cube is called as **micro-abode called Sittravai / Chittrambalam** (mini hall in Tamil). This is **secret in Chaidambaram, Sage Appar** (**Chidambara ragasyam**) realized. Chidambaram is a Shiva temple associated with Space energy and when you go to sanctorum you would not find any idol but just empty space with some lights there. This is to signify this concept of **Paramanu** which is **luminescent and is a Cuboid in shape**. This is the smallest particle possible and can be called as **'God's particle".**

- The micro space, in the cubical shape is fetus or Garbha. This is known as **Vinkaru** in Tamil. This micro abode is the repository of light and sound.

- The free space is Light and the Light is Moolam or source of the universe and universal forms. Light is Brahman, Atman, Vastu Brahman – Nunporul in Tamil.

In the subsequent blogs we will correlate String theory, Brahma Sutra, Nataraja, Vishnu and how they are all contained in order and proportion in pulsation.

Happy reading!

Ref: A good read **Fabric of the universe, Jessie J Mercay**.

8. TIME = SPACE SERIES. PART 8 – CHARACTERISTICS OF THE GOD'S PARTICLE (PARAMAANU)

This part is going to be a bit controversial hence read it with an open mind. Per our scriptures when analyzed deeply we can state that **"At the beginning it was just Consciousness (Pragnanam) that was luminescent with unmanifested potential energy and residing at resonant state of non-vibration. This energy was un-manifest and was present as Paramaanu or Microbode or Vinporul aka a subatomic particle. Yes! It was a particle without vibration and was at resonant state of non-vibration.**

The entire Space was supposed to be filled with these particles only and these were primal potential matter which is ever lasting.

Now let us ask few questions and see how our scriptures answer this:

1. What was the shape of this particle?

We have already answered that. In 2D it is square and in 3D it is a cuboid with all equal sides. Please note that in space it is always 3D and not 2D. It has 6 faces, 8 vertices, and 12 edges. This is known is current scientific community as **Tetrahedron**.

2. What is inside the Microbode or Subatomic particle?

This is a very interesting question. Our scriptures say that it is purely space inside but with an energy grid.

3. What is this energy grid and what is its shape?

It says that it is an 8x8 energy grid inside this microbode. This essentially means it is a square energy grid of 64 squares inside this Paramaanu.

4. What is this color of this Paramaanu?

It is luminescent and hence the golden color of the light is what it is associated with. **"Hiranyavarnnaam harineem**.." says Sri Suktha in the vedas, confirming the color of this Paramanu. Their variations exist but the fundamental one is of golden color.

5. What is this size of this God's particle?

It is calculated to be ~133 nm. We will see this in detail later.

6. What is the significance of the energy grid?

For the time being let me state that anything subtle is a function of 8 and anything gross is a function of 9. Let me also add that **iChing –** which is a Chinese divination book and the hexagram which deals with the Science of the subtle is in an 8x8 square matrix. **The mental game Chess is played in an 8x8 square.**

You would find 8 is the number or dimension for the subtle. We will see the importance of 8 and 9 and how beautifully these proportions adorn everything in nature in our daily life.

7. Are these particles faster than light?

Frankly I have not read a direct answer to this question but since this particle itself is light the velocity of this particle cannot be faster than light. This is my opinion. Modern experiments are suggesting that it could be faster than light. In **Mahabharatha, Yakshaprasna, the Yaksha will question this to King Yudhishtra as to "what is fastest thing in this world"**? King Yudhishtra would reply as **"mind"**.

Some of the sages have interpreted that since Consciousness is omnipotent and ever connected - the communication is seamless, instantaneous and not subjected to the concept of distance. The example given is if there is a pain in your leg, it does not take time to travel to your head. It is instantaneous and hence the whole universe should be considered as a living organism.

So to conclude on this question the particles are not faster than light but each particle is filled with intelligence and consciousness (just like a human cell) and their communication to anything is not subject to concept of distance. If our scientists come back and tell us that these particles are faster than light, then wait for someone else to tell us a little later that it isn't faster than light. ☺

8. Ok. Who has seen these particles and give me empirical proof?

परमानुरिति प्रोक्तं योगिनाम दृष्टि गोचरम ! **(Paramaanuriti proktam Yoginaam, drishti gocharam)** says **Mayamatham.** This means the **microspace** or **Paramaanu** is visible to the trained contemplatives and meditators only. One quick example as proof is the **Temple in Chidambaram** which represents **Space tattva** where the temple is built around the concept with enough documentation on it.

But we have been trained under Lord Macauly's education system and how can we accept this as proof which is subjective and superstitious. If I may ask please tell me how many of us have seen the electrons or protons? Do we not believe everything when someone tells us in English?

It is true that because of its existence we can see its manifestations and results of some experiments in our day today world. So we will look at tons of manifestations which we have been in nature as we progress. I would like us to be philosophically very clear as to what these things mean which we have been blindly following. For the time being please note down your questions and I am positive that this would be answered in due course.

Our sages have not only seen this, but have given the dimensions of this and the mathematical formula to manage this energy. We will see all of them. After reading all of them if you still don't want to believe in our scriptures, then may be CERN's result if it's in the same lines would prove it for you.

Happy reading!

MANDUKA VAASTU MANDALA

8 × 8 = 64 modulated spaces

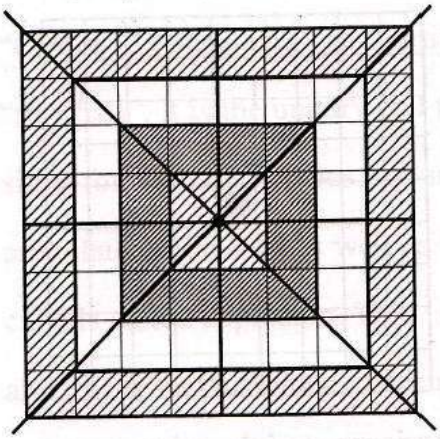

Brahma pada (the first belt around the central energy point)	:	2×2=4 padas
Deivika pada (the second concentric belt)	:	12 padas
Maanusha pada (the third concentric belt)	:	20 padas
Paisachika pada (the fourth concentric belt)	:	28 padas
		64 padas

PARAMA SAAYIKA VAASTU MANDALA

9 × 9 = 81 modulated spaces

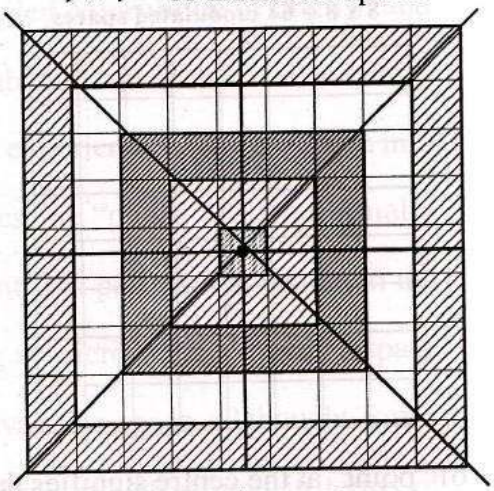

Brahma pada (the first belt including the central square field of energy)	:	3×3=9 padas
Deivika pada (the second concentric belt)	:	16 padas
Maanusha pada (the third concentric belt)	:	24 padas
Paisachika pada (the fourth concentric belt)	:	32 padas
		81 padas

Figure 4: MANDUKA MANDALA – 8x8 (subtle form) & PARAMA SAYIKA MANDALA – 9x9 Gross forms
Courtesy: Dr. Ganapathi Sthapati

9. TIME = SPACE SERIES. PART 9 – LIGHT, GOD'S PARTICLE AND GOD

"At the beginning it was just Consciousness (Pragnanam) that was luminescent with un-manifested potential energy and residing at resonant state of non-vibration. This energy was self manifest and was ever present as Paramaanu or Microbode or Vinporul aka a subatomic particle. This is **omnipotent, omniscient and omnipresent**.

Ignore religion for the time being and just look at this particle's characteristics scientifically. It is Eternal (**Anaadi**), primordial (**Aadi**), without any quality (**Nirguna**), it cannot be reached / grasped by thoughts (**Achintya** - since thoughts as energy are much more gross than this and we would see this), it cannot be measured (**Aprameya**), Luminescent (**Jyothi swaroopa**), its **omnipotence, omnipresence (Visvam) and Omniscience** is already known. So said the mahavakya **Pragnanam Brahma!**

All the characteristics of the particle are attributed to a personality or a state by the founders of religions. **Hindus called this state as Paramasiva or Purusha. Hence everything subtle is called Sivamayam.** The essential pulsation which started and the universal evolution began was called as **Parashakti or Prakruthi or Maya.** We will talk about the Shakti aspect later.

This subtle un-manifest energy evolves to become universe which is gross. This gross energy also known as **earth** is called as **Vishnu** and the subtle energy is called as **Space / Akash / Heaven**. So the term became "**Sarvam Vishnu mayam Jagat".** Please note that it is just **Sivamayam** and there is not Jagat there. Since it is all subtle and there is no Jagat which is gross. But it is **Vishnu Mayam Jagat**.

I need to add that every sect in Hinduism has named this God's particle with a different name. Narayana has replaced paramasiva in Vaishnavism and so on. In Hindu temples there are 2 prime idols – **Moolavar and Archakar** - The Moolavar does not undergo any archana or any decoration and it is always for the Archakar for which all poojas are performed. This god's particle refers to the Moolavar and not Archakar.

To my knowledge, every religion and every sage / saint has agreed with the fact this fundamental particle or energy unit is **LUMINISCENT**. Note that there is no sound or word in this …**yet.** Let us see few quotes on this (there are thousands of quotes):

- **Be it vedic culture, Zoroastrians, Greek or any major culture fire / sun god which represents light is worshipped.**
- **"Om Jyothi rasaha" says Vedas**
- **In Gayatri mantra you meditate on the supreme light to illuminate you.**
- Vallalar said **"Arutperumjyothi, Arutperumjyothi"** which means **mighty graceful light**.

- If therefore your eye be single, your whole body shall be full of light. Mathew 6:22
- Thirumoolar states brilliantly that who realizes that the light (physical light which means the world) merges with light (subtle light), he has realized SIVA.

  ஒளியில் ஒளிபோய் ஒடுங்கிய வாறும்
  தெளியும் அவரே சிவ சித்தர் தாமே - 124

So what has happened to the **Sabda Brahman** here? It has merged with the **Artha Brahman** which is the light. What can you use to represent this state?

Light represents Form and our eyes represent Light / Form. So obviously sound is represented by ears. When sound has merged with light then it means Eyes and ears are merged together.

Can you think of anything that represents this state? This concept is captured by representing a **Manduka (Frog) or Sarpa (Snake)** always. Since for a frog and a snake the ears and eyes are merged. **Manduka Upanishad,** represents a knowledge of this state. And obviously the 8x8 square / cube represent the most subtle energy as an energy grid is called as **Manduka Pada / Mandala..**

Now the same aspect when it is applied to a gross form / body or a building then it is a 9x9 energy grid and it is called as **Paramasyika Mandala**. **At the gross level the same concept as applied is the WORD where Light (form) and sound and meaning merged into one. You cannot separate them**. We will look at this later.

Unfortunately we have lost the science and we neither understand the philosophy nor the symbolism behind this supreme science but we made fun of the fact that the supreme science is named after an absolutely menial creature like frog which is used only for zoological lab studies across the world or ends up in the dinner plate as it does in far eastern countries.

I would like to conclude this section by stating (may be a little controversial) that **First it was Consiousness as the Vinkaru, Microbode, Sittrambalam, Nunporul, subatomic particle which was luminescent. Later the concept of God evolved out of it.**

So God is not light, but the right of saying it is "the primordial aspect of "luminescence" has been adopted as God…

So, of the 5 fold evolution process we are still at the source (Moolam). We will see the concept of time and the mathematical science in the subsequentparts.

MOOLAM (Source) – KALAM (TIME) – SEELAM (RHYTHM) – KOLAM (SHAPE) – GNALAM (UNIVERSE). (மூலம் - காலம் - சீலம் - கோலம் – ஞாலம்)

Happy reading!

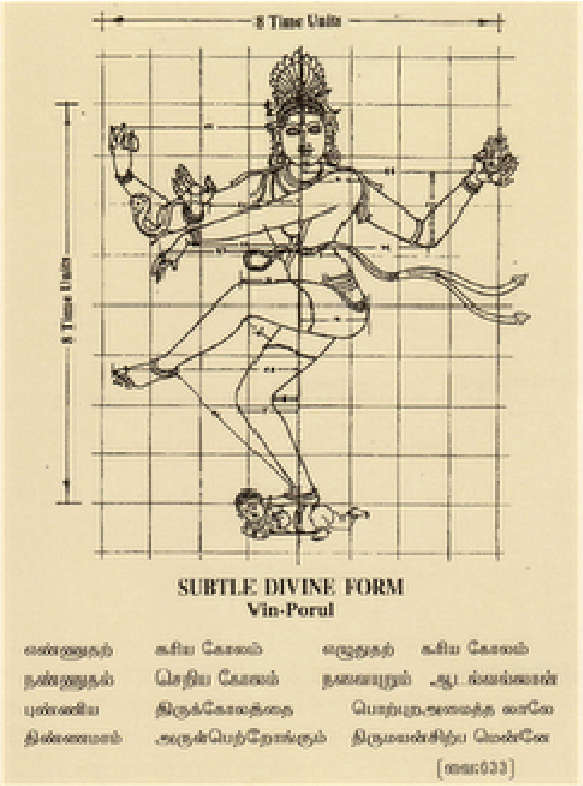

Figure 5: Lord Nataraja in the Manduka Mandala (8x8 grid) (Courtesy: Dr. Ganapathi Sthapati)

Our next topic is Nataraja and String theory!, so check out this picture. I want you to note the light / fire in the left hand and sound / damru in the right hand. If you notice little closely, you would find a central line along the picture's sternum and all the parts have minute measurements from the central line.

10. TIME = SPACE SERIES. PART 10 – LORD NATARAJA AND THE STRING THEORY

"The self unfolds itself for its self – Bhagavad Gita".

This self unfolded itself with a pulsation and this pulsation is the **start of Absolute time** (**KAALAM**). As I said nothing to my knowledge tell us clearly as to why this pulsation happened. This is the point of singularity in the scientific language and the event is termed as **Big Bang.** Just as I expressed earlier it was an event of primordial pulsation and not of an explosion which threw away mass because of the explosion into the space.

The entire space existed with its subatomic particles and this pulsation made the space to vibrate and this vibration was rhythmic and led to the evolution of this universe. **Popularly known as "That one became many"… and ..Vastur eva Vaastu.**

This pulsation happened because of the **Pranava** or the first pulsation resulted in the **Pranava -** both conceptually right. So at the time of this primordial pulsation 2 things happened:

- The absolute time started. This is called **Kaalam.**
- Primordial and the most sacred **Pranava** emerged.

Both these happened simultaneously and it is futile to ask whether **Kalam created Pranava or Pranava created the pulsation.** In many of the texts it offered as **Pranava that created the pulsation**. So let's go by that.

- This is the reason that **Pranava / Primordial Om is so sacred in Hinduism.**
- This Pranava had manifested in 2 forms:
    - **Luminescent form as OM the Light. This is the source of all visual forms. The primordial form is represented as ஓம் in Tamil and ॐ in Sanskrit.**
    - **Aural form as Om the sound. This is the source of all aural forms. I should say that this is more popular form compared to the luminescent form.**

Now this concept is very important, since in the Pranava meditation they say us to meditate on the silence after the word OM and also mediate **OM as light, OM jyoti rasaha in vedas.**

So, when I say that sound merges into light, it is all the aural form merges into **ITS** luminescent form. All luminescent forms merge with the **Paramaanu** which is also luminescent. I am reproducing this passage again for emphasis and clarity.

- **Sage Thirumoolar** states brilliantly that who realizes that the light (physical light which means the world) merges with light (subtle light), he has realized SIVA.

  ஒளியில் ஒளிபோய் ஒடுங்கிய வாறும்
  தெளியும் அவரே சிவ சித்தர் தாமே - 124

I have read many times over to understand this concept and I would suggest that you allow this concept to sink in.

Now let's come to the 8x8 energy grid of the **Paramaanu** and imagine that it is pulsating because of Pranava and this **Pranava has both light and aural form**.

- They say that this **pulsation is rhythmic and symmetric**.
- When something is Symmetric, then there has to be a central line along with the Symmetry comes. For example if our right and left sides are symmetric then the body is divided along the sternum & backbone.
- Within the 8x8 energy grid / hall there is a **vertical luminous shaft** called **Brahma Sutra (Oli nool)**. Sutra in Sanskrit and Nool in Tamil means **Thread / String**.
- This **Olinool / Brahma Sutra is a shaft of consciousness also called Moolathoon / Moolasthambham**.
- **This shaft of consciousness vibrates in a particular order called rhythm.** This is the order of nature.
- **This rhythmic vibration of the shaft of consciousness is the dance of Shiva, the CELESTIAL DANCE / THE COSMIC DANCE / THE DANCE OF EVOLUTION of the LORD NATARAJA.**

Look again at the picture of LORD NATARAJA, he is drawn inside a 8x8 Manduka mandala (now you know what it is), his left leg is raised suggesting a movement from left to right. Imagine that he is going to land the left leg to his right side.

Why should he suggest that he is moving from left to right?

His left hand holds light / fire and his right hand holds Drum / Damru / Sound. The process of Evolution which starts with the absolute time and Pranava is fantastically represented pictorially. It suggests that the evolution process starts with the rhythmic dance of the PARAMAANU in a 8x8 energy grid and this process evolves first as light and then as sound. This light and sound creates further forms and the entire universe.

It is very easy to answer as to why sound evolves from light? We all know that the light is at a higher frequency and velocity than sound. This is the same reason we see lightning first then hear the thunders.

So let's summarize the DANCE OF EVOLUTION of LORD NATARAJA:

- From being un-manifest the **Pranava** emerges. Or the Pranava evolves the un-manifest to the manifest and starts the cycle of evolution.
- This leads to a pulsation which is called as the **COSMIC DANCE / CELESTIAL DANCE / DANCE OF EVOLUTION**.
- This pulsation is **rhythmic and symmetric**.
- The luminescent shaft of consciousness is called as **Brahma Sutra** or popularly called as String theory in the modern science.
- The process of creation evolves from the dance as light then sound evolves from light and then all the visual and aural forms in this universe.

If this is so then the process of dissolution should be that Lord Nataraja's right leg should be lifted suggesting a movement from right to left isn't?

Look at the majestic picture suggesting the **DANCE of EVOLUTION** and the **DANCE of DISSOLUTION** as below:

Figure 6: LORD NATARAJA / DANCE OF EVOLUTION

Figure 7: DANCE OF DISSOLUTION

In my opinion there is nothing more scientific in this world that is pictorially represented about the evolution of universe. You should read a book called **"The Tao of Physics" by Frijat Capra** where as physicist he explains how he experienced this and highlights the dance of the quantum particles in space corresponds to the dance of **Lord Nataraja**.

Now this central shaft of Consciousness is called **Brahma Sutra** and according to our scriptures every Paramaanu has this string, which means every being, matter, inanimate things in this universe including the tiniest of subatomic particles have this string / sutra. In the future parts we will see the Maths behind this sutra and the pulsation but let us look at what the modern science says about **Superstring theory** here, http://en.wikipedia.org/wiki/String_theory. You can read it how many times ever you want but this theoretical postulation is a direct adaptation of the cosmic dance and our Brahma Sutra and nothing more.

Now check out Lord Nataraja at the CERN http://www.fritjofcapra.net/shiva.html

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Now you may understand as to why I started this series with the above line. We have a very rich past that is most scientific and it is left codified in a form across thousands of temples in India. Let us just open your eyes and understand the scientific meaning around it.

If you are so far surprised at our richness and advancement, please wait till we will get into real hard core mathematics and geometry of our nature in the subsequent parts.

May that "**Sutradhaari"** dispel our ignorance and reveal to us the secrets of nature.

Happy reading!

11. TIME = SPACE SERIES. PART 11 – VASTUREVA VAASTU AND E=MC^2

We have seen that the universe in its un-manifest state is filled with luminescent cuboids and there was a trigger in the form of Pranava which started the absolute time and gave forth visual forms and aural forms.

This process of evolution is depicted very nicely in the following diagram:

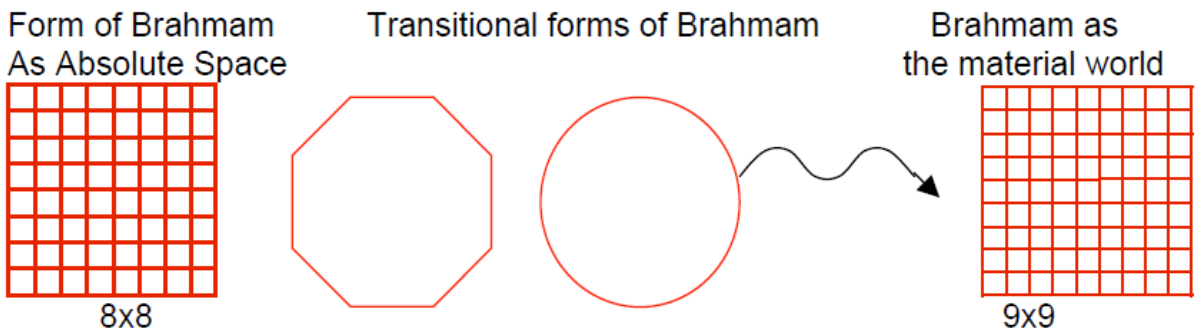

Figure 8: Transition forms of Brahman (Coutesy: Dr. Ganapathi Stapathi)

The square (in 2D) which is an 8x8 energy grid became a 9x9 energy grid which is manifest / gross. The transition forms were an octagon and a circle. **Aintiram** suggests how this transition takes place. Current physics accepts that a pulse and a sine wave can be created from each other and this happens because of simple addition of harmonic frequencies.

The primordial pulsation initiates a rotational force and this rotational force as it gains momentum converts the square into a circle and if you notice that the octagon is just an in between state between a square and a circle.

We see confirmation of the details of this manifestation process in Chapter 9, verse 8 of the Bhagavad Gita where Lord Krsna describes His manifestation process to Arjuna:
"prakritim svaam avastabhya visrijaami punah punah", meaning "Curving back onto myself, I create again and again…"

What it suggests is that the essential shape of every gross form in its natural state is a circle (in 2D) and a sphere in (3D). **This is the reason we find every planetary body is almost spherical in shape and this is also the reason as to why the ripples in a water body when we throw a stone in the water are in circles.**

Be it the center of a tornado or the shape of a hurricane or a tsunami it always a circular force. The supreme secret in martial arts is that the Chi moves in a circular fashion and hence Tai Chi is the most

deadly form of martial arts. Lord Vishnu has Chakra as his weapon to suggest not only light but also the rotational force.

The process of manifestation is captured in these 2 pictures at all the significant stages. If you notice that a single dot becomes multiple dots, then a line, then a pulse and then goes on to becoming a 8x8 energy grid and then to a 9x9 energy grid. 8x8 is un-manifest and 9x9 is manifest. These aspects are very well captured as sutras in the book **Aintiram and Pranava Vedam.**

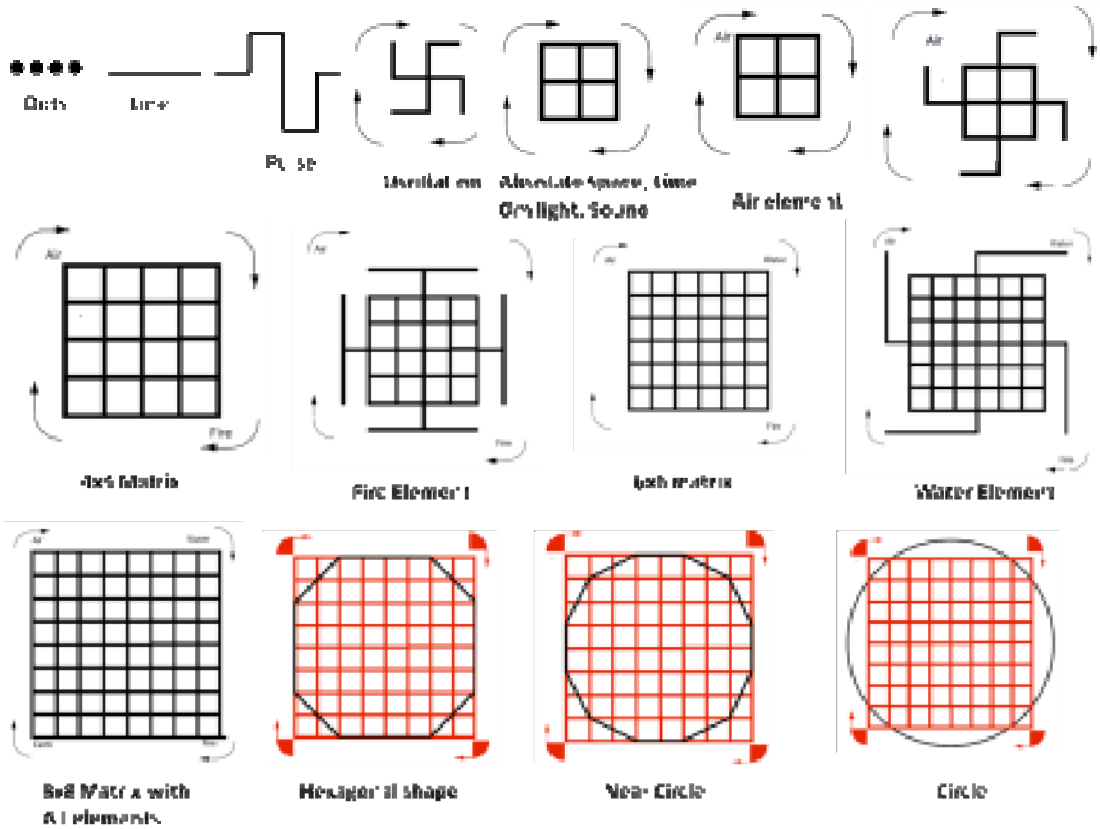

Figure 9: Transition forms of Brahman in detail (Coutesy: Fabric of the Universe)

If you look at the Fig 10 conceptually the following things happen:

- Subtle Energy becomes gross universe and the fundamental 5 elements are created in the process.
- It is said that 1/10th of the space becomes Air, 1/10th of air becomes Fire, 1/10th Fire becomes Water and 1/10th of Water becomes Earth.
- So we can conclude that we are living in a **Space delineated world.**

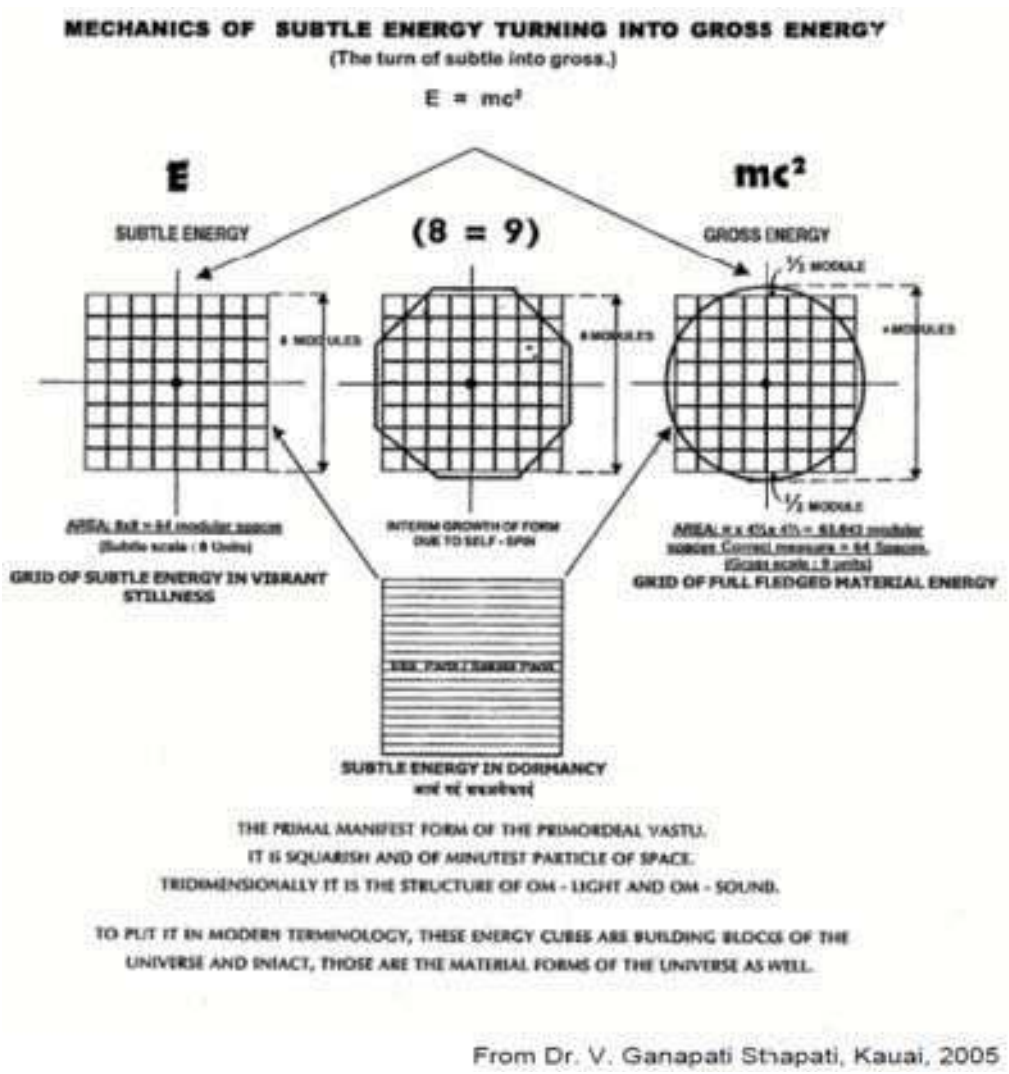

Figure 10: Subtle Energy to gross (Courtesy: Dr. Ganapathi Sthapati)

This wisdom was so succinctly captured by my good friend **Lao Tzu** in "**Tao Te Ching**" as follows: (Read heaven as un-manifest space and Earth as manifest gross)

"Heaven and Earth last forever.
Why do heaven and Earth last forever?
They are unborn, so ever living….

Thirty spokes share the wheel's hub;
It is the center hole that makes it useful.
Shape clay into a vessel;
It is the space within that makes it useful.
Cut doors and windows for a room;
It is the holes which make it useful.
Therefore benefit comes from what is there;
Usefulness from what is not there…."

But I wanted to highlight more important aspects to this process of manifestation.

- **Advaita** philosophy states that there is no duality. If you note that the **Parammanu** is what is present every living being and inanimate thing. What is within you is what is within me and hence the mahavakya **"Tat Tvam Asi"… You are that**.
- **Vastureva Vaastu** – Vastu which is unmanifest and subtle becomes Vaastu which is manifest and gross.
- **If we assume that Paramaanu is God's particle and hence it is divine, then everything in this world is divine**. This is the most important philosophy in **Hindusim**. See **the oneness in all** and see "**All in one"**.
- That's why Hindus saw divinity in everything. Trees, snakes, animals, insects, birds, human beings etc. There is nothing without that divine energy or particle – however you call it.
- This philosophy is **UNIVERSAL, OPEN SOURCE, ALL COMPASSING and the highest state of consciousness**.

But let's look at something even more important:

- We all note that Subtle has become Gross. Hence conceptually Gross = Subtle or both are proportionate.
- We all note that Space has become Earth. Hence conceptually Space = Earth or both are proportionate.
- We all note that 8 have become 9. Hence conceptually 8 =9 or both are proportionate.
- We all note that ENERGY has become MATTER. Hence conceptually ENERGY = MATTER or both are proportionate. This is represented by $E = mc^2$ by our great scientist Einstein. While we did not have this specific formula, the concept and the associated texts were very much with us for ages.

So this is what Einstein quoted after reading Bhagavad Gita.

"When I read the **Bhagavad-Gita** and reflect about how God created this universe everything else seems so superfluous." ~ Albert **Einstein**

Now let's try to answer this question:

- When you throw a stone in water / pond the ripples that form take the shape of a circle (in 2D) / sphere (in 3D). Can you guess what the shape of the ripple would be if you throw the same stone in space?
- **You would have probably guessed the answer. The ripples in space should be and would be in square /cube in shape.**

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

12. TIME = SPACE SERIES. PART 12 – VEDIC CONCEPT OF TIME & ITS MEASUREMENTS

The importance of time (**Kaalam**) is so high in the Vedic tradition that they ensured that the accuracy, continuity of time and the easy measurability of it is maintained for who knows how many years. **Time creates, sustains and destroys** everything and this is very nicely captured in these 2 lines:

காலமே எவைக்கும் மூலம், காலமே மூல ஆற்றல்
காலமே கோலத் தோற்றம், காலமே ஞாலத் தோற்றம்

The god of time is **Kaala Bhairava** – a form of Shiva and hence both **Shiva** and **Yama the lord of death both were** known as **Kaalan.** The time is represented by **number 13** and it belongs to Kala bhairava. We will see the interesting linkage between Vedic system and the Mayan calendar found in Guatemala and Mexico later.

Swami Chinmayananda states that "**Time is the periodicity between 2 thoughts**". Nothing captures the concept of time more wisely. What is clear from our scriptures and Swami Chinmayanda is that time is the pulsation that creates this universe. It is the vibration with very accurate periodicity and our sages suggested that you can live beyond time provided you manage to escape the effects of that pulsation.

Einstein's view on time and its relativity is very realistically captured in this quote **"When you are courting a nice girl an hour seems like a second. When you sit on a red-hot cinder a second seems like an hour. That's relativity."** More than relativity I found that the root cause of relativity is the pulsation of mind as time. Einstein on a serious note proved that our view of time is not absolute, it is relative and it is a continuum with space. We will in the next few parts of this blog would see that time and space are the same or Time = Space.

Aintiram states that there are 5 things that vibrates which have a common root and are not under our control. They are Space, Earth (vibration of earth is gravity), Eye lids, thoughts and Musical notes and very nicely put in Tamil as (Vin)**விண், மண்(man), கண்(Kan), எண்(Yen), பண்(Pan). Pan is musical metre / chandas and Yen is the yennam or thoughts.**

Correlate this with the first line of **Patanjali Yoga Sutra** which says **"Yoga Chitta Vrtti Nirodah",** means **Yoga is one which stops the vibration of mind / pulsation of mind and hence is a killer of thoughts.** The meditation techniques of keeping your eyes opened without battling the eyelids is another way of overcoming this pulsation instinct that is primordial and inherent in our nature.

Let's look how intricate our measurements time are in Vedic system. Check out the image below.

- The smallest unit of time is approximately 2 micro second.
- The largest unit is about 155 trillion years…. YET.
- Brahma's linear age is 50 years and in currently in his 51st year which makes the universe to be 155+ trillion years. Brahma's life time is 100 years which means it would be 300 trillion+ years of universal life which follows a cycle.

- After 100 years of pulsation cycles Brahma stays as dormant energy for the same period and then pulsates again for the next life of 100 years.
- A **Brahma's** life is also known as a Para. Each half Param is referred to as a *parardham*. This second half is termed as **'*dviteeya paraardhe*'** (the second half of Brahma's term) is stated in all vedic rituals.
- After every Chatur yuga, the world recycles. After every 2000 years / a Brahma day the world dissolves and remerges. The important point to note is that there is no CONCEPT OF CREATION here. It evolves and dissolves as per the science of pulsation. We also note that this pulsation expands and contracts. This cyclical nature of time as believed in Indian mythology refers to time as '*anaadi*' or that without a beginning.

Unit	Reference	Value	Metric
1 Tatpara		1.85	Micro second
1 para	60 Tatpara	111.11	milli second
1 Viliptam	60 Para	6.67	milli second
1 Liptam	60 Viliptam	0.40	seconds
1 eyelid blink	100 Viliptam	0.67	seconds
1 Kaashta	18 eyelid blinks	12.00	Seconds
1 Kshanam	10 kashta	120.00	Seconds
1 nazhigai	12 Kshanam	24.00	minutes
1 Muhurtham	2 Nazhigai	48.00	minutes
1 hour	2.5 Nazhigai	60.00	minutes
1 Day	60 Nazhigai	24.00	hours
1 week	7 days		
1 Paksha	15 days		
1 Month	2 Pakshas	30 days	
1 year	12 months	360 days	
Yugas:			
Krita		1728000	Years
Treta		1296000	Years
Dwapara		864000	Years
Kali		432000	Years
Chatur Yuga		**4320000**	**Years**
1 brahma day	2000 Chatur yuga	8640000000	
1 Brahma Year	360 Brahma days	3110.4	Billion Years
50 Brahma Years		155.52	Trillion Years

Figure 11: Time measurements in Ancient India

While doing Vedic ritual the time and space coordinate is invoked to say that you are doing this ritual at this place in the universe and at this time – with reference to Brahma's age to the time and star of the day. This tradition is unbroken and the Indian Almanac can predict the position of astronomical objects without any error for thousands of years without any sophisticated instruments and space ships.

On the contrary just read the history of the Gregorian calendar which we are following here, http://en.wikipedia.org/wiki/Gregorian_calendar. There is neither accuracy nor continuity and to top it up there are authorities who reform the calendar as if time stops and waits for them to affect that reform. Why should we ignore the best of time science that we have for an inaccurate, discontinuous reformed calendar?

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy Reading!

13. TIME = SPACE SERIES. PART 13 – SOUTH AMERICAN MAYAN & SOUTH INDIAN MAAYAN

Since we are discussing about time, let us address the **Mamuni Maayan** and the **South American Mayan**.

A lot has been talked about Mayan calendar and the imminent destruction to planet earth in the year 2012. I would recommend **'The Mayan Factor – Path beyond technology" by Jose Arguelles** if you are interested in this topic.

In this part I am interested in highlighting that the **South American Mayan** and the **South Indian Mamuni Maayan** who wrote **Aintiram and Pranava Veda** are one and the same. Extensive research have been conducted by many and I found, both the works of **Jose Arguelles and late Dr. Ganapathi Stapathi** who has spent about 3 decades each, very impressive. Dr. Ganapathi concluded that they both are the same and he has shown some interesting linkages.

I am going to present what impressed me in both these great researcher's works.

- First let me state that the doomsayers of 2012 phenomenon picked up Mayan's calendar which started in 3113 BC ran for 5125 years and the calendar ended in year 2012. Since the calendar ended they thought this signified that the world is ending. Jose argues that this is wrong and most probably the human race is entering into the next phase of evolution and the next cycle would begin. If you strongly believe that this is not true and the world would certainly end by 2012, then please ensure that you transfer all your assets and savings to my name effective 22, Dec 2012. ☺

- Mayan in his calendar in South America used very unique numerals in his calendar that is given below:

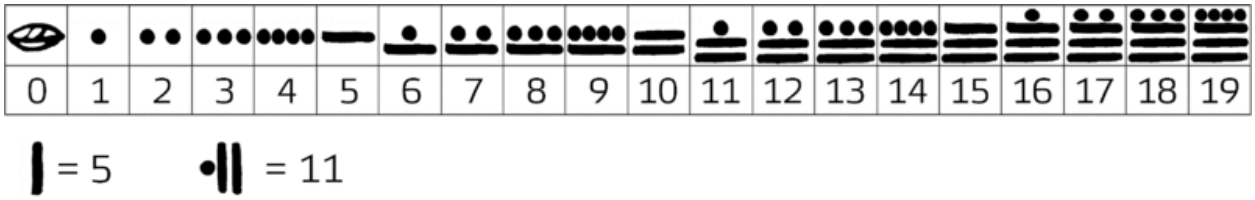

Figure 12: Mayan's numeral system (Courtesy: Wikipedia, Internet)

Now let me reproduce a Tamil poem written by Mamuni Maayan in his work called "**Kanithamaa sennool**". This song is part of the book written by Maayan in Tamil during his time – 12000 years+. This song expresses how the numerals are formed till 10. It says,

- 1 is one dot, 2 is 2 dots, 3 is 3 dots, 4 is 4 dots, 5 is a line and 10 is a double line.

மாப்புள்ளி ஒன்றே அன்றோ ஒன்றுமா எண்ணே காட்டும்

மாப்புள்ளி இரண்டே யன்றோ இரண்டுமா எண்ணே காட்டும்
மாப்புள்ளி மூன்றே யன்றோ மூன்றுமா எண்ணே காட்டும்
மாப்புள்ளி நான்கே யன்றோ நான்குறு எண்ணே காட்டும்

மாப்புள்ளி ஐந்தே யன்றோ ஐந்து மா எண்ணே காட்டும்
மாப்புள்ளி கோட்டினாலே இரண்டுரு மாக்கங் காட்டி
மாவியல் திறத்தினாலே பத்தறு மாக்கங் காட்டி
மாவியல் திறத்தினாலே எண்முதற் பொருளு மாவாய்!! (கணிதமா செந்நூல் - மாயன்)

- Among the books written during Mayan's time in Guatamala are Popol Vuh, The annals of cakchiquels and the **Book of Chilam Balam**. The resemblance of **Chilam Balam to Chidambaram** with which S. Indian Maayan was so involved is very striking.

- Be the pyramids that were built in the jungles of S. America that has a striking resemblance to the viamanas from south India, the earth's revolution around the sun measured within 1/1000th of the decimal point which is available in a book called **Surya Siddhaanta – In Sanskrit** by Mayan and the identical measurements available in South America – the similarities are difficult to ignore.

- Jose Arguelles makes a compelling argument about the shift in consciousness in 2012 due to a major galactic synchronization. But what impressed me are the following:

    - Comparison between **iChing (8x8 hexagram) and Mayan's Tzolkin which is 13x20 matrix**. In fact there is a Franklin's magic square which is based on the 8x8 grid of iChing that adds upto 260 which is the galactic constant of Tzolkin. This was amazing.

    - He refers to **Radiogenesis – Universal transmission of information through or as light** or radiant energy which is very much relevant to our discussions of light and sound.

    - The revelation he received from a Maya Humbatz men belonging to the universal great brotherhood organization revealing that our universe is the 7th such system which Maya has charted in the universe. So, we are not alone ☺

Would conclude this topic in the next part…

Happy reading!

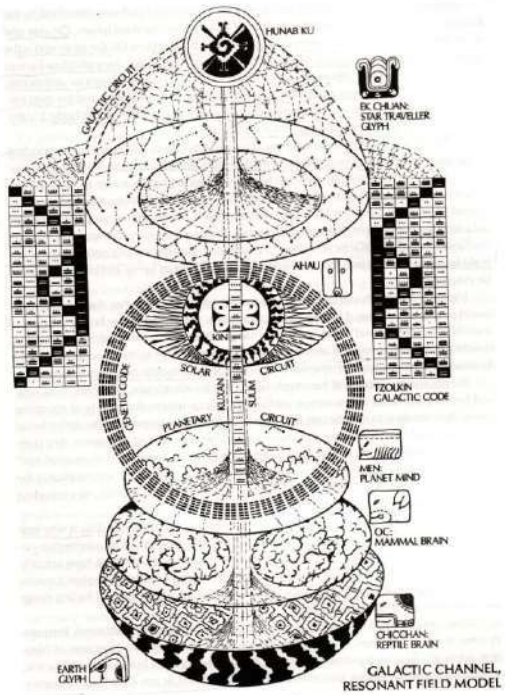

Figure 13: Galactic Communication Channel to Hunab Ku (Courtesy: The Mayan Factor, Jose Arguelles)

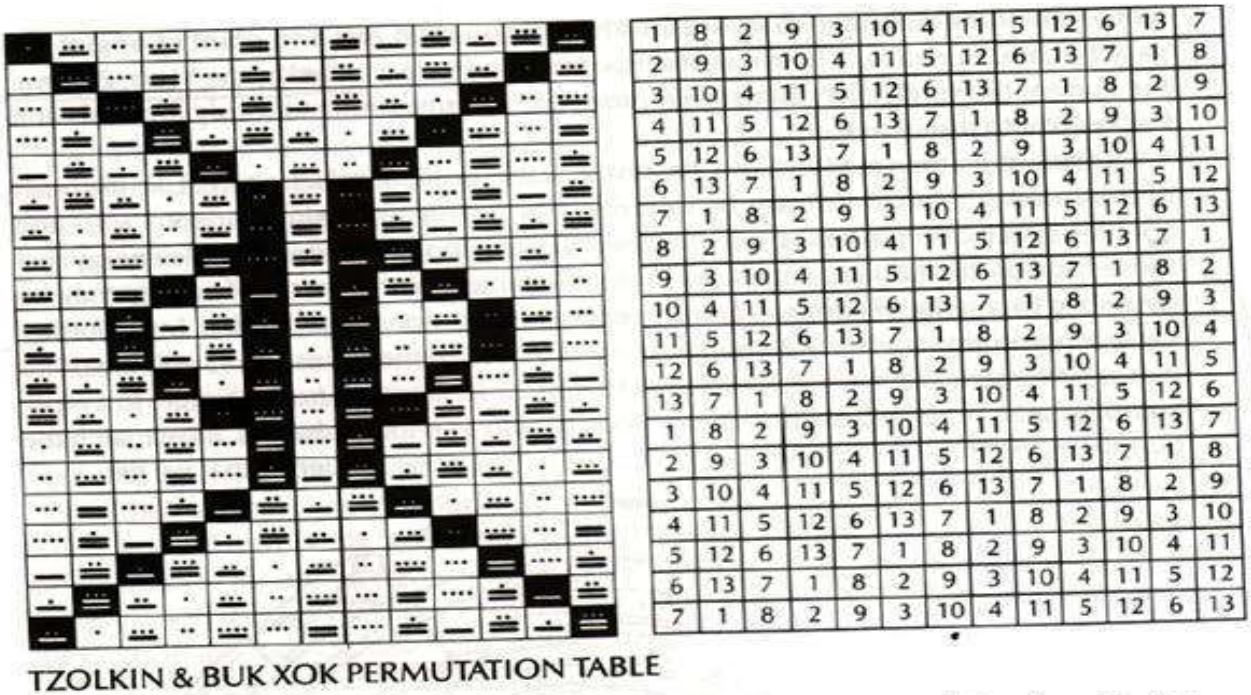

1	8	2	9	3	10	4	11	5	12	6	13	7
2	9	3	10	4	11	5	12	6	13	7	1	8
3	10	4	11	5	12	6	13	7	1	8	2	9
4	11	5	12	6	13	7	1	8	2	9	3	10
5	12	6	13	7	1	8	2	9	3	10	4	11
6	13	7	1	8	2	9	3	10	4	11	5	12
7	1	8	2	9	3	10	4	11	5	12	6	13
8	2	9	3	10	4	11	5	12	6	13	7	1
9	3	10	4	11	5	12	6	13	7	1	8	2
10	4	11	5	12	6	13	7	1	8	2	9	3
11	5	12	6	13	7	1	8	2	9	3	10	4
12	6	13	7	1	8	2	9	3	10	4	11	5
13	7	1	8	2	9	3	10	4	11	5	12	6
1	8	2	9	3	10	4	11	5	12	6	13	7
2	9	3	10	4	11	5	12	6	13	7	1	8
3	10	4	11	5	12	6	13	7	1	8	2	9
4	11	5	12	6	13	7	1	8	2	9	3	10
5	12	6	13	7	1	8	2	9	3	10	4	11
6	13	7	1	8	2	9	3	10	4	11	5	12
7	1	8	2	9	3	10	4	11	5	12	6	13

TZOLKIN & BUK XOK PERMUTATION TABLE

Figure 14: Tzolkin table (Courtesy: The Mayan Factor, Jose Arguelles)

14. TIME = SPACE SERIES. PART 14 –MAYAN, TAMIL, PLEIADES & ICHING

Jose Arguelles was also mentioning that the pyramid structures of Mayan civilization in South America with the **Tzolkin** calendar matrix communicates with 2 constellations – **Pleiades and Arcturus**. Jose mentions that he is sure about communication with Pleiades constellation.

Why did Pleiades interest me?

- According to Tamil history, Tamil is a divine language and the Lord associated is **Lord Muruga**. He is the Tamil deity and he is from the **Constellation Pleiades** which is called **Kritika nakshatra**.
- This emphasis that the South American Mayan could be a Tamilian from India, as many in the ET studies circuit opine that Pleiades is a constellation which is like our distant cousin where Tamil is spoken. There are many links but you can check this out.. http://22050hz.blogspot.com/2008/10/pleaidians.html

- Look at the Mayan calendar in Fig 14, it is a 13x20 Tzolkin matrix.
    - Please recall that we mentioned **13 is the number for Kala Bhairava**.
    - Tzolkin has a mystical central column around which 6 and 6 columns exist. The belief is that this central column is the frame of reference to the galaxy and it is believed to connect to **Hunab Ku – the center of the galaxy**.
    - This mysterious centre column is believed to be the road to the sky leading to the umbilical cord of the universe. I immediately correlated this with the **thread of consciousness** which is connected to the Hiranyagarba (the center of the galaxy as per Indian texts.) – Check Figure 13.
    - So understanding that this shaft of consciousness is connected to the center of the galaxy (**Hunab Ku / Hiranyagarbha**) at the one end and to **our solar plexus** at the other end with communication and galactic information transmission happening through resonance of light, opened many gates within me.

Nothing in this universe exists without purpose and the form and shape of any being / thing is explained as a state of consciousness at a particular resonant frequency adds to the Seelam (Rhythm) aspect of the Kaalam which we are going to see later.

For the space and time travel enthusiasts, Mayan has the following:

- All space travel is intelligence as information – transmitted through light by the principle of harmonic resonance.

- **Mayan says that Sun is the lens through which galactic information is transmitted from the galactic core and interpreting this with Gayatri Mantra where we meditate on the supreme light Savitr – an aspect of Sun god is amazingly striking.**

- Mayan highlights that time is a function of principle harmonic resonance and he attaches significant importance to the numerals which he states are the galactic harmonic constants. This is exactly what **Aintiram** states.

- **He interprets the iChing to contain the Genetic code of the human DNA as a hexagram in a 8x8 matrix which is a binary progression to the 6th power corresponding 64 six part words /codons. At the same time he interprets number 260 to be galactic constant and 360 which is the factor for a calendar year or the total angle in a circle to a harmonic calibrator.** His explanations more on this and on the mystical number 7 do not resonate in my tiny brain and I am begging for holy grace to expand my mind to understand these concepts.

- **When he says that flowers open to light just does not mean that it is sensitive to be light but deeply it aspires to be LIGHT.** I am not sure if you understand the depth of this statement as against the Sage molar statement which states gross light should merge with subtle light. I have been left speechless for days after understanding this correlation.

It is interesting to note that significance of numerals as per Mayan factor:

- **1 – The pulsation – Ray of Unity**
- **2 – The pulsation - Ray of Polarity**
- **3 – The pulsation - Ray of Rhythm**
- **4 – The pulsation - Ray of Measure**
- **5 – The pulsation - Ray of center**
- **6 – The pulsation - Ray of organic balance**
- **7 – The pulsation - Ray of mystic power.**
- **8 – The pulsation - Ray of harmonic resonance.** We will see more of this.
- **9 – The pulsation - Ray of cyclic Periodicity**
- **10 – The pulsation - Ray of Manifestation**
- **11 – The pulsation - Ray of Dissonant Structure**
- **12 – The pulsation - Ray of Complex stability**
- **13 – The pulsation - Ray of Universal movement**

In all 2 independent researchers working 6000 miles apart, conducting their studies independently seems to be pointing to just one person and one philosophy and science. What else we could do other than thanking our fortune to have read them and made this connection. I thought of writing just a page on this topic and I have ended up with 2 parts and I am stopping my temptation to write few more pages on this topic. For all of those interested, please read the book by Jose Arguelles.

It is amazing to find out how most of the ancient civilizations seem to have a common root and the communication between various geographies looks stunningly simple and the metrics on astronomical objects and other space sciences seems to be so accurate despite the absence of precision instruments and spacecrafts. One tends to believe that we had far advanced knowledge of nature which we seems to have lost and most certainly few thousand years back we were not nakedly roaming in the jungles of India and Africa hunting animals as the western experts wants you to believe but had a far superior & scientifically advanced civilization.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy Reading!

15. TIME = SPACE SERIES. PART 15 – SHIVA LINGAM IS NOT A PHALLUS

If there is one part in the series I want you to read and talk about it with your friends then it is this topic. If I ask you as to what Shiva Linga stands for then more than 99% of the responses would be that it represents a **Phallus** symbolizing the male sex organ / creative energy with the female sex organ / creative energy - Yoni as the base and both together representing **inseparability and totality in the process of creation**.

Nothing is more misunderstood and misquoted than this concept of Hinduism. Every idiot including me who has read few books about Hinduism thinks that they are experts of Indology / Vedic studies. The wisest of sages who gave us Vedas and Upanishads did not boast that it is their work. At the end of every work they acknowledged that they are telling us what they have been told by their ancestors. It is 155 trillion+ years of universal knowledge available today in the richest of the languages Tamil and Sanskrit. This cannot be accurately interpreted in a foreign language. Lest in the weakest of all languages - English.

The other contributing factor to this misunderstanding has been the Sanskrit language or should I say the richness of the language.

We have already noted that the same word can have multiple meanings. This is not limited to Sanskrit, but the all the languages. For example,

- **Sutra means thread, Aphorisms** (the ability to express something in terse and concise manner). Ex. **Kama sutra** – the most understood of all the sutras. **Brahma Sutra** – The thread of consciousness in any form that runs in this universe – the most unheard of.
- **Artha** in Sanskrit means "meaning" and "wealth", we have already seen this. As in Vaak-Artha and Artha Sastra (the science of wealth management).
- Same way Lingam means **Symptom, Proof**, **Gender, Male sex organ** etc. Hence it was very easy to get confused, associate the lingam with a Phallus and also to ignore the philosophy and the supreme science behind it. Even people who believed that it represented much more did not knew the philosophy and the science behind it. Let's look at what it means.

I am going to request you to kindly refer to both the pictures below:

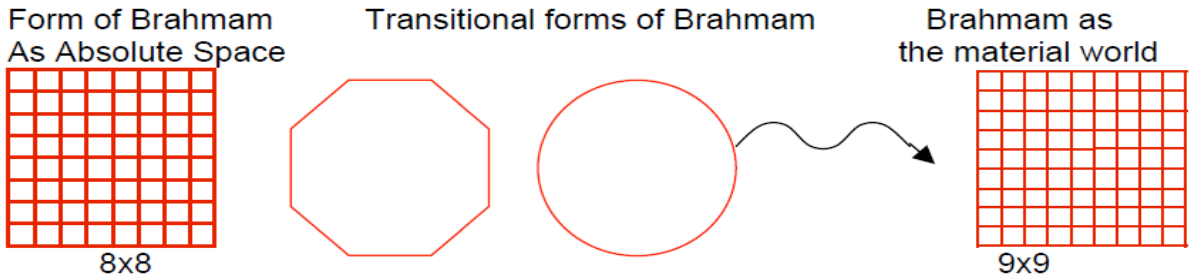

Figure 8 – reproduced here for convenience

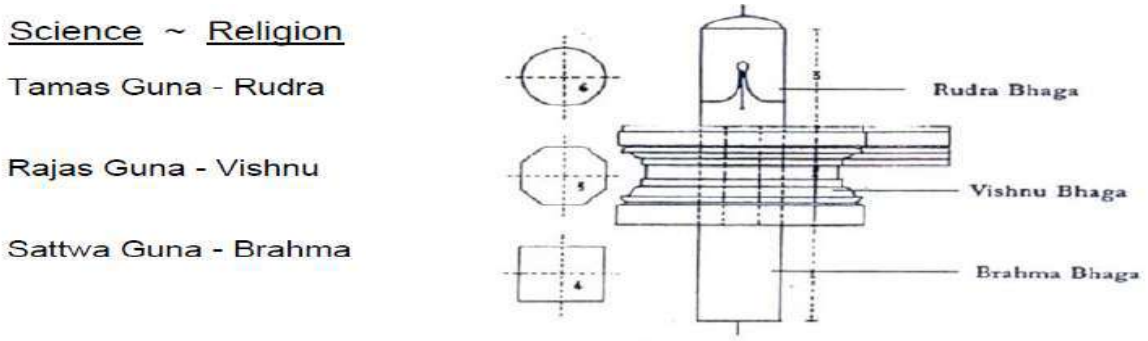

Figure 15 – Shiva Linga – Shape and Significance (Courtesy; Dr. Ganpathi Sthapati)

We have already seen that the subtle energy is takes the form of a square and the gross energy takes the form of a circle with an in-between state it takes the shape of a **tetrahedron and octagon**. Now look at the Shiva lingam from the top. Its base is always a square and the top is always a circle.

Figure 16 – Shiva Linga

Figure 17 – Shiva Linga with shape of the God's particle (Star) engraved.

If I have to merge all the 3 shapes together and it naturally takes the shape of a Lingam with a round top. **Shiva Linga captures the overall process of evolution in one form and shape - subtle to gross state – it encompasses every state of consciousness that is possible in this universe.**

Why the figure above states that Square shape is Sattvic, circle is Tamasic and the in between state is Rajasic? Let's understand the definitions of all the three qualities.

- **Sattvic represents the perfect state of balance. When it is subtle it is luminescent and in a perfect state of resonant non-vibration. The energy levels were perfect so that the resultant vibration is nil and it is in absolute balance.**

- **Tamasic state represents a state where the height of evolution is reached and hence it is farthest away from the core.** This is a different explanation from the usual one available in the web and books. Let me explain this. The core is very subtle and the tamasic state is very gross

and hence it is away from the core. Tamasic state then should be considered as the darkest state possible. Why?

- Because the core is luminescent and if the gross state is farthest from the core hence it should be dark. This is the meaning behind the most famous statement **'Tamasoma Jyothir gamaya"…** take me from darkness to light. It is not about just your mind but about the entire being aspiring to become a light and merge with primordial light.
- **There is no evolution possible beyond the Tamasic state and it has to devolve to reach its core / subtle state.**

- **Rajasic is a state where the pulsation has resulted in a rotational force and hence things are set into action. This represents the evolution process and hence associated with action.**

Then the natural next question is, if Shiva Lingam is associated with the entire spectrum of consciousness then we should see it associated the elements and the light. Isn't?

- There is a story in Indian Purana that Brahma, Vishnu and Shiva discussed who is the most powerful among them. Lord Shiva challenged Brahma and Vishnu to reach his head and feet respectively. Brahma tried to find Shiva's head and Vishnu tried to reach Shiva's feet, both of them failed. Most of us would have heard the story but would not have understood the philosophical and scientific significance.

  - Lord Shiva in the form of Linga stood there as a **PILLAR OF LIGHT**. This pillar of light is **the Brahma Sutra / light of consciousness** which spanned from the center of the galaxy (Hiranyagarba) to every being & non-being in the Universe.
  - Brahma could not find the head because; Brahma is always associated with intelligence in Indian texts. He gave the supreme wisdom - the Vedas and stands for Intelligence. He could not reach Shiva's head signifies that Intelligence will not take you to God. Intelligence as an energy is too gross and cannot reach the most subtle state of light.
  - Vishu represents earthly life – Rajasic in character – this is the tetrahedron & octagon state. He could not reach Lord Shiva's feet signifying you cannot reach the core through actions.

- Lord Shiva in the form of Lingam is represented as one of the elements (Earth, Water, Fire, Air, and Space) in the Hindu temples.

If you read the following Upanishad quote, you can probably understand the meaning:

na karmaNaa na prajayaa dhanena tyaagenaike amRitatvamaanashuH
pareNa naakam nihitam guhaayaaM vibhraajate yadyatayo vishanti

Not by work, not by progeny, not by wealth, they have attained Immortality. Some have attained Immortality by renunciation. That which the hermits attain is laid beyond the heaven; yet it shines brilliantly in the (purified) heart.

And this quote also brilliantly articulates the luminescent nature of the Paramaanu:

na tatra (not there) **suryo bhati** (sun shines) **na candra** (moon does not) **na tarakam** (nor the stars)
nema vidyuto (nor the lightning) **bhanti** (shines) **kuta ayam agnih** (how can fire shine)
tam (that) **eva** (alone) **bhantam** (shines) **anubhati** (thereafter shines) **sarvam** (everything)
tasya bhasa (in that light) **sarvam idam vibhati** (everything shines)

The sun does not shine there, nor does the moon, nor the stars or the lightning, much less this fire (deepam). When He shines, everything shines after Him; by His light alone everything is illumined.

The trick is to take the definition & meaning from Upanishads or any scripture and apply it to the God's particle and the process of evolution and you would understand it perfectly. Many a times the concept of God & faith obscures our mind to look beyond and rationally think about it. It is not the problem of religion but our system of education which has ruined our thinking. **Today the biggest challenge we have is to "Unlearn" than to learn.**

So to conclude:

- Shiva Lingam does not represent Phallus. To represent male and female totality and inseparability Hindus do have **Arthanareeswara** and it is not represented through Lingam.
- Shiva Lingam represents the **Pillar of Light and the entire spectrum of consciousness**. From the most subtle to the most gross.
- It represents an in-between **Guna** / **EGG** state (between un-manifest and manifest) and hence it is formless with a form.
- **While Lord Nataraja represented the rhythmic pulsation of this Brahma sutra, the cosmic dance / the dance of the evolution, Shiva Lingam represents the primordial light itself in all its state of consciousness.**
- By this analogy, our body itself is a lingam with the visible body as the gross part at one end and the most subtle body which is invisible and is part of the primordial light at the other.

Check out the picture below which represents most of the aspects we have discussed so far.

May Lord Shiva help us all to understand him better.. ☺

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions." Yet wish that this quote isn't wiser any more.**

Happy reading!

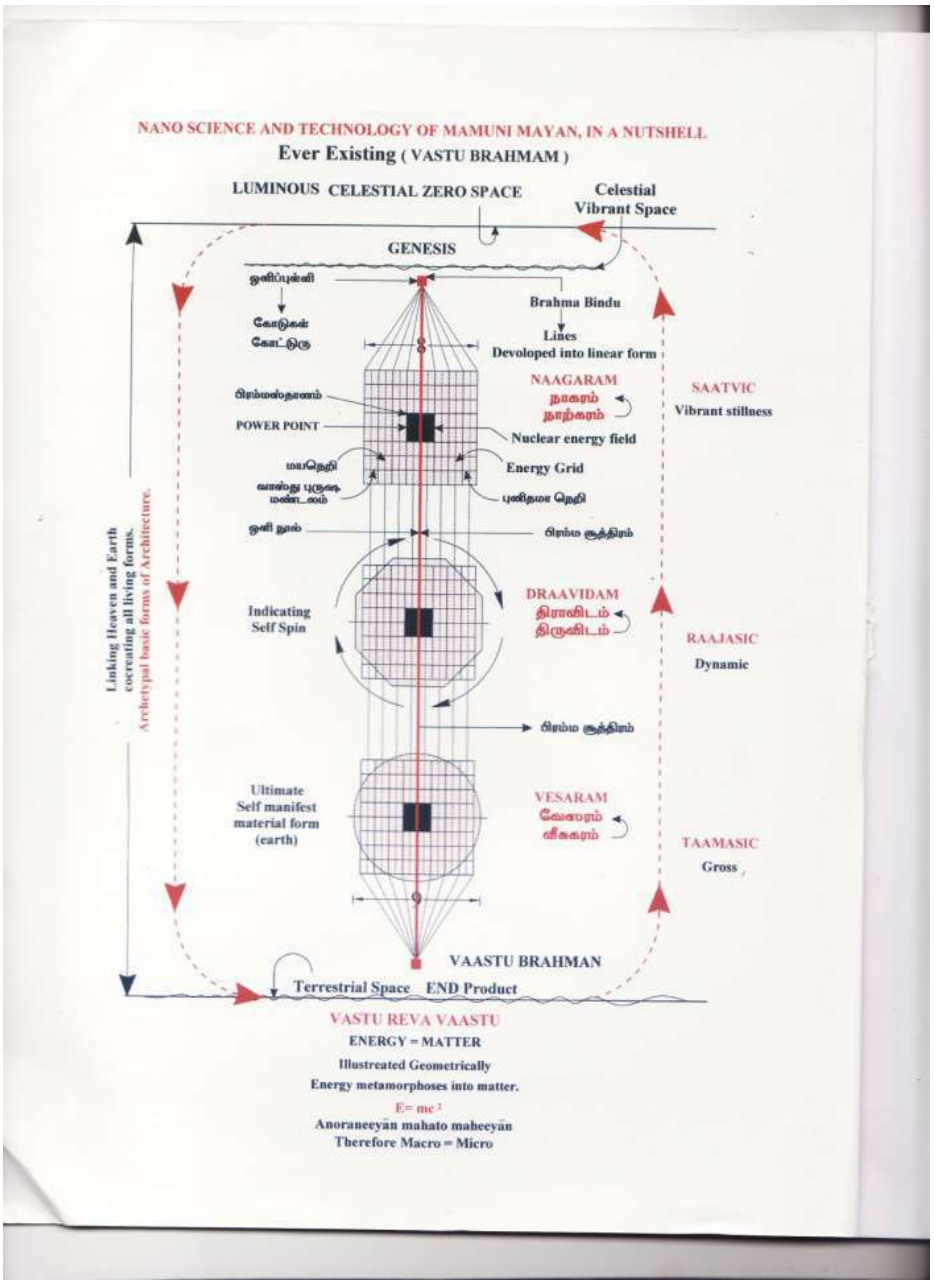

Figure 18 – Manifestation in a nut shell (courtesy: Dr. Ganpathi Sthpati)

This diagram represents everything we have discussed so far. The central red line is the Brahma Sutra which runs from the center of Galaxy to the terrestrial forms. Just correlate this with the Mayan Hunab Ku in the previous part.

This summarizes as to how Energy becomes matter, Subtle becomes Gross, Un-Manifest becomes manifest, how 8 becomes 9, and Square / Cuboid becomes a circle / Sphere. All represented in one formless form called SHIVA LINGAM.

16. TIME = SPACE SERIES. PART 16 – SEELAM - THE PRIMORDIAL CIRCULAR FORCE - GANAPTHI & MATHEMATICS

In the last few decades the main stream western science has started accepting concepts like uncertainty principle, wave mechanics, quantum mechanics, and periodicity of the wave pattern. Most importantly it is about the fundamental wave pattern of any energy or matter and the harmonics of these wave patterns falling in a particular form and proportion which is dictated by geometry / mathematics. In all the western scientists are scratching their heads on the depths of science of the subtle aka the sacred spatial geometry.

Most of the eastern philosophies have mastered this science and have codified these natural laws as a part of their religion, which is often dismissed as superstition. I already highlighted that in Tamil and Sanskrit the definition for science is "**Knowledge of the space**".

Modern science is moving in the right direction albeit very slow and they are trying to understand as to how elements are bonded within a molecule in addition to what elements constitute them. For example **Chlorophyll** molecule consists of **Carbon, hydrogen, nitrogen and magnesium (Mg at its core)** has a complex 12 fold Pattern – just one such typical pattern which can convert sunlight into life substance. The same pattern exists in our **RBC** cells just that it has an **iron** at its core instead of magnesium.

The understanding about the human body especially, "the spatial awareness that exists in each and every cell is due to the different sensory organs tuned at frequencies", led the scientists to unravel the innate spatial geometry of life.

Be it living, non-living beings, abstract forces like gravity, nuclear force, electromagnetism, heat, movement of astronomical bodies it does not matter what, everything in this universe adheres to a vibration / periodicity and is reducible to a number or a ratio. As a wise man said, "**Mathematics is the language of gods". This primordial rhythm & its harmonics are captured under the topic "Seelam" by Mayan in ancient tamil texts. Let's look at this in detail.**

I have been finding it difficult to sequence the flow for this topic and let me try starting from the basics:

- We know that the **Paramaanu or God's particle is a cube.** This particle with the primordial vibration combines with other particles to create a shape. **The Paramaanu combines in the multiples of 8 to evolve the next structure**. Let us see the importance of 8 later, but remember 8 is the number for Lord Narayana and Om namo Narayana has 8 Aksharas.

- What do you call a cube called in Tamil? It is called **Ganam (கனம்**). This also means heaviness, gravity, honor, dignity, abundance, plenty. To indicate it is a square cuboid they call it **கன சதுரம்**.

- The process of the addition of **Paramaanu** into bigger units is called as **Ganam (கணம்**, गणं). In Tamil both the Cube and the additive resultant are called as **Ganam** and the only difference being that in Cube it uses a **small "na" (ன)** as an alphabet. In the additive process / resultant it uses a **Big "na"(ண)**. The big "na" signifies that due to the additive process the small (na) becomes big (na).

- This additive process starts because of the **first rhythmic circular** force also called as a **Suzhi (சுழி)** in tamil which means "loop".

- Here comes the beauty. The Lord of or the energy associated with this **additive force (Ganam)** is called as **Ganapathi (கணபதி, गणपती)**. Note this is the bigger "**na"** used and not smaller **"na"**. He is associated with the first circular force - **Suzhi** (and hence he takes the first honor in any Vedic ritual. This means Lord Ganapati is the first process in the evolution and everything has to start with him. Even if it is Lord Shiva or Vishnu it does not matter, the very first honor goes to the **Lord of Ganas**. Many Indians when they start writing (atleast few decades back) they first start with this symbol at the top of the page before anything for a successful completion of that activity.

- If I add my own inferences to the above with a caveat that everything else I have written have a solid back up mostly from our own study of languages (as you can yourself see) and our scriptures.
    - The symbol above signifies that what was "a point" with untouched / non-interacting energies / resulted in the primordial first circular force out of a pulse and also signifying that every circular force shall also collapse back to a point.
    - Also the bigger / heavier things are formed or created by its smallest unit and hence symbolically the heavier ones are carried by the smaller units. To signify this may be a god in the form of an elephant is carried by a mouse.

- Now you know why every ritual starts with this Sloka to Ganapathi:

    - ***"GanAnAm tva Ganapati gum Havamahe, Kavim Kavinam Upamasra vastamam Jyestharajam Brahmanam Brahmanaspat aana Srnvan nuti bhissi dasadanam"***

      This means "May you the Lord of Ganas, Ganapati",... . so it goes.

- **Now what do we call the study of this additive force - Ganas? Mathematics – Ganith / Ganitham (கணிதம், गणित).**

- **So we Indians have codified:**
    - **the primordial God's particle as Paramaanu or microbode or Lord Shiva,**
    - **the rhythmic movement of the pillar of light as Lord Nataraja,**
    - **the first circular force as the symbol for Lord Ganapathi,**
    - **the lord of the additive force as Lord Ganapthi and**
    - **the Study of this additive force which leads to the formation of everything in the universe is Mathematics in Sanskrit and Tamil.**

- **Every possible state of consciousness and manifestation is represented in Shiva Linga**
- **We will see that the multiples of 8 in which the additive force moves is codified as Lord Narayana or Vishnu and the five state manifestation process as the five letters associated with Lord Shiva.**

Just forget that these names are the names of the Hindu gods, and tell me one religion or philosophy or one branch of science in this world which can capture the nature's primordial secret in this way and codify it for the common benefit of the world and carry it for thousands / millions of years.

These are just a start and please wait for the other interesting aspects to unfold.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy Reading!

17. TIME = SPACE SERIES. PART 17 – SEELAM - THE PRIMORDIAL RHYTHM & FUNDAMENTALS

Now, let us get into some real heavy stuff - Mathematics (**Ganitham** – the study of Ganam) that governs this rhythm and harmonics. My first concern is how to make it easily digestible for an average individual who hates Math? So I shall take the easiest route that I know. I shall first explain the concept, then the actual Math part of it and then go to the philosophy and significance of the same. Later we shall look at how these are codified in nature and our scriptures and available in front of our eyes which we have failed to recognize.

Let us be clear about the following terminologies like **Progression, Proportion, root, Diagonal and Pythagoras theorem**:

- Let us take a series as follows: 2, 4, 8, 16, 32…. In this we need to be clear about what is **Progression and proportion**. As many of you know that whole series is a geometric progression where the next number in the series is a function of the current number and a multiple. This multiple here is 2, so that 2*2 = 4, 4*2 = 8 and so on. **This multiple or the constant is called as proportion**. You derive the value of the proportion by dividing the number by its previous number – (n+1)/n : (n+2)/(n+1). Hope this is clear.

- We know that a square has 4 equal sides. Each side of a square is called as "**root**" and the line that connects the 2 opposite ends is called as '**Diagonal**". In the figure below sides AB, BC, CD, DA are called as "**Root**". Lines AC, BD are called as '**Diagonal"**.

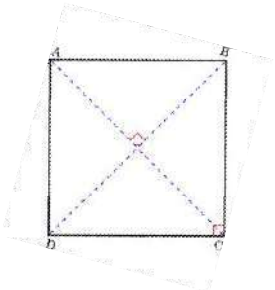

Figure 19; Square

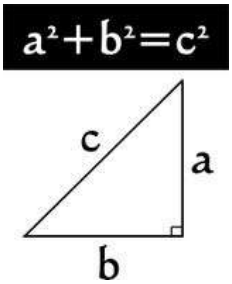

Figure 20: Pythagoras theorem

- **Pythagoras theorem** – This theorem gave us the formula to calculate the sides of a right angle triangle as given above. If you are not familiar with this, then please understand that if you know any 2 sides of the triangle the 3rd side can be calculated by the formula given above. I am not going to focus on the argument that this theorem was available in Indian scriptures before the Greek mathematician gave it. Let's look at the concepts and not which civilization gets credit as of now.

Since the fundamental structure is a square in 2D and Cube in 3D and also in the process of evolution one becomes many, let's ask ourselves the following questions:

- **How one square does create another square which is larger in size, progressively? What is the progression and proportion in this series?**
- **How one cube does create shapes which are polygonal (Hexagon, Octagon, decagon, dodecagon etc) progressively? What is the progression and proportion in this series?**

Now let us see Figure 21 where and consider the square ABGF. You can enlarge the image to see the alphabets clearly. Now as we know sides AB, BG, GF, AF are called "**root**" – remember this well and let us assume the smallest root possible is unity and hence each root is of unit length. AB=BG=GF=AF=1. Area of this square = 1*1 = 1.

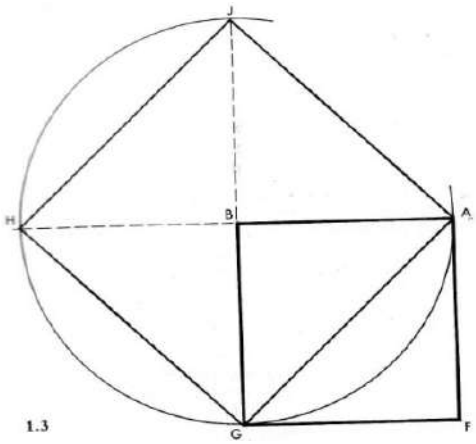

Figure 21; Square

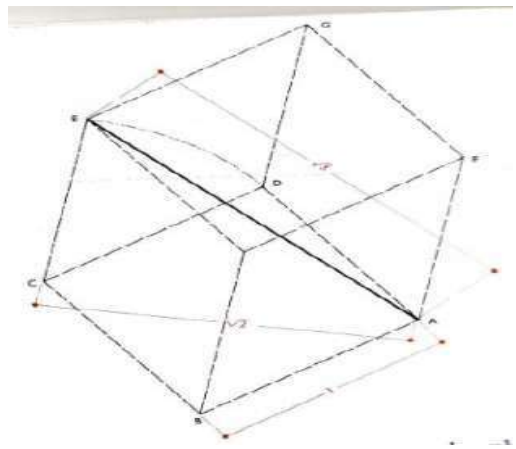

Figure 22: Cube

Line AG is called as the **"diagonal"** and as per Pythagoras theorem the length of **AG** should be **√2**. **AG = √(AF^2+GF^2).** So to summarize **the root of the square ABGF is 1 and the diagnol is √2**.

Now consider a larger square AGHJ, here AG, GH, HJ, AJ are the sides and hence called as root. AH, GJ are the diagonal in the 2nd square. We know AG = √2, then AH = GJ = 2 as per Pythagoras theorem. To sum up **the root of the square AGHJ is √2 and the diagonal is 2. Area of this square is 2.**

If you look at the ratio **root/diagonal** (root to diagonal ratio) of both the squares it is 1/√2 and √2/2 which results in 1/√2. This will progressively hold good. The magic proportion in this progression is **√2**.

What we can infer from this is if we consider a **progression of squares** from a unit square to larger squares, then the **proportion** of the progression is √2. But before we jump into its philosophical significance let's answer the second question.

Consider the cube above whose side is of unit length. We know a cube is made of squares. We know ABCD is a square of length (root) =1 and diagonal = AC = **√2**. If we want to find out the length of the diagonal of the cube which is AE, then ACE is a right angle triangle with AC = **√2**. And CE =1 and hence **AE = √3**.

What we can infer from this is if we consider a **progression of cubes** from a unit cube to larger ones, then the **proportion of the progression is √3**.

I am going to handle the significance of √2 and √3 in the next part.

Happy reading!

18. TIME = SPACE SERIES. PART 18 – SEELAM - SIGNIFICANCE OF √2 & √3

Let's look at the significance of **√2 and √3** but before that let's capture the philosophical significance of **Progression** and **Proportion**:

- The whole world is conceptualized as wave harmonics of the primordial rhythm with a **progression and proportion**. Philosophically the **Proportion** which does not change / which is constant is the **immutable component** and the **progression** which changes / is volatile is called as the **Mutuable component** in the process of evolution. **The whole universe is the progression and God is the proportion**. So if I know the God's proportion and the formula behind it I can create anything in this universe including a universe. This secret is called as the Brahma Vidya / Sree Vidya (Knowledge of Brahman, Sree) in Indian texts. What we are going to see further are very minor parts of the **Brahma Vidya**. ☺

- In the last part we saw, that the primordial square multiplied itself to be a larger square (**progression of squares**) using the **proportion √2. The diagonal of the square 1 (ABCD) forms the root of Square 2 (AGHJ)**. This is very profound if you get the concept**.**

- **If we consider square 1 as the cause then its diagonal is the effect. This diagonal is the root for the next square (AGHJ) and hence the effect of Square 1 is the cause of Square 2, this cause results in square 2's diagonal which is its effect and this is how the progression or evolution happens.** If you can see glimpses of Cause and effect cycle and the famous law of Karma in this analogy then you can pat yourself. ☺

- A square halved by the diagonal (square 1 with area 1) produces a square twice its area (square 2, area = 2). **The mystery of biological growth from cellular division or the different musical notes from the base tone is contained in this**.

- **Robert Lawlor in his book "Sacred Geometry"** very nicely puts it as the root of a plant (like the root in a square) is causative and embedded in the earth (and embedded in the square). These are very heavy and profound concepts just let it sink into you.

- When you divide the full height of the human being considering the total height as unity then belly as called as **Hara in Japanese, Dantein in Chinese, Nabhi in India** which is below the navel will measure (**2- √2)** from the soles of the feet to belly and (**√2 -1)** from navel to the head. In Yoga, Zen and Chinese meditation techniques this point corresponds to the transformative and generative aspects of the individual that involves **rooting** techniques for **self transmutation**. **So Lao Tzu said, "To seek the root is the goal".**

- **√2 signifies the power of multiplicity. Hence the Generative aspect of this rhythm is attributed to √2. This represents the principle of transformation.**

- Remember **√2** is a proportion in the progression of squares and a square does not become a higher form. We have seen that the diagonal of the cube (sides of unit length) is **√3. It is this √3 which divides the volume form of a cube and the diagonal of the cube becomes a root for the higher shapes like pentagon, hexagon etc.**

- Hence **√3 signifies the formative power of the rhythm while √2 signifies the generative power of the nature.**

We will touch the same using **Vesica Piscis** in the next part which shall take us to **√5 and the golden mean Φ.** I am not going to touch upon important topics like Gnomic spirals and the relation between various progressions and hence I would request you to Google them if you are interested.

Happy reading!

PS:
There are many books on this topic and I would recommend **"Sacred Geometry – Philosophy & Practice" by Robert Lawlor** which I found easy to read and understand.

You tube and Internet is replete with tons of images, articles and videos on this topic and you can learn a great deal from them.

19. TIME = SPACE SERIES. PART 19 – SEELAM – VESICA PISCIS, √5, & GOLDEN MEAN (Φ)

If you don't know what is vesica piscis, please google and you would find it interesting. I am not going to explain it here and I would focus on the summary and aspects which are often left out. The philosophical aspect of Vesica Piscis, is a rotating point becomes as circle of unity. Two circle of unity (with its radius as unity) interacting / intersecting each other in a perfect manner offers an overlapping area which is considered to be sacred and fundamental to all the geometric forms in the universe. We will first see how **√2, √3 & √5** are part of this Vesica Piscis.

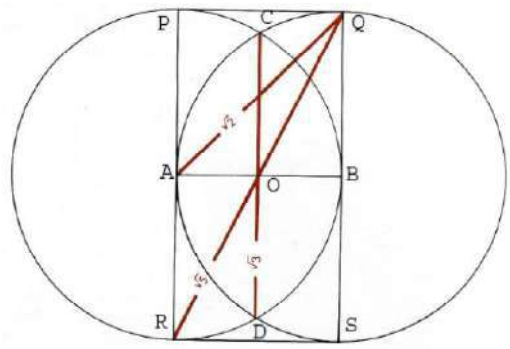

Figure 23; Vesica Piscis

Please look at 2 circles who radius is unity and AB = 1, intersecting as per the diagram. The overlapping area ABCD is the Vesica Piscis and we can see **√2, √3 & √5** all part of this Vesica Piscis.

ABPQ and ABRS are 2 squares and the side of the square is 1. **√5** is as significant as **√2 and √3.** In the diagram here **√5** is the diagonal of the rectangle PQRS / diagonal of 2 squares – one below the other.

√5 is the regenerative factor that binds 2 squares or that factor that transcends two worlds or the bonding factor for 2 cosmic entities. This **√5** shall take us to the most important ratio which is the **Golden mean** or the **God's ratio**.

But before that let me share what stuck my mind when I was engrossed **with Vesica Piscis and √3**. Look at the pictures below. These are pictures of forehead marks of Hindu Brahmins sects called Iyengars and their supreme deity is Narayana. I correlated the striking similarity of the rectangle around the Vesica piscis and Iyengar's namam. You just have to imagine the 2 overlapping circles are the right and left side of the face with the **Vesica Piscis** starting from the top tip of the nose. To me the **formative principle of √3 is in line with the "Bhootha krut" and "Vishwa karma manu stvashtha"** aspects of **Maha Vishnu** as per Vishnu sahasranamam. I had a good laugh on this correlation.

Figure 24; Iyengar Namam 1
(Courtesy: Internet)

Figure 25: Iyengar Namam 2
(Courtesy: Internet)

Coming to the **Golden mean,** If you have not heard about it, just Google or here is a quick link http://www.goldennumber.net/. Some of you might be even have fatigue repeatedly reading and listening about it, like I do. Hence I am not going to rewrite what is widely available. But let's look at the philosophical aspect of it, its relation to **√5** and its manifestation.

Now so far in **√2, √3 & √5** what we have seen is how Unity evolves as many. But if I am interested in geometrically dividing the Unity so that this proportion evolves as unity then how do I do it?

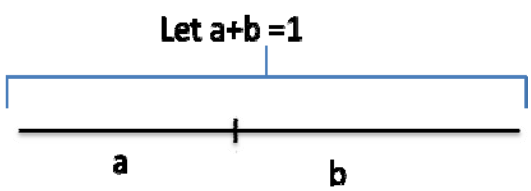

Consider a line of unit length and also consider two segments a, b so that a+b =1.

A and B are such that it has to fulfill this condition of Proportionality that a/b : b/1.

(Figure 26: Line andΦ)

This means what 'a" is to "b", is the same as what "b" is to the whole length which is 1.

Mathematically resolving this equation a/b : b/1, hence b^2 = a and hence b= **√a.** This means **a + √a = 1.** The answer to this equation is only one value which is called the **Golden mean / God's ratio** denoted by Φ = 1.6180339… and a = 1/Φ. **Philosophically it is the division of unity and the only possible creative duality within the unity.**

You may ask as to why unity is not divided into 2 equal parts and why is should be **1/Φ** (**0.6180339..).** This is effectively answered by our Upanishad **"Whether we know it or not, all things take their existence from that which perceives them"**. **Adi Shankara said "the universe is an illusion / maya**" **because it is what we perceive**. **We tend to ignore them as philosophy or superstition.**

But let's look at it scientifically as we understand. When the unity is divided into equal parts there is no asymmetry and difference and hence there is no perceptual universe. **An asymmetric division is needed to create the dynamics necessary for progression and extension of unity**.

Let's summarize our understanding again:

- **√2 – the generative component and a multiplying factor creates multiple squares from a unity of square.**
- **√3 – the formative component that creates multidimensional polygonal shapes from a cube.**
- **√5 – the regenerative component or the binding component that transcends and binds both the worlds.**
- **Φ - Golden mean or the God's ratio,** which is an evolutionary principle that is guided from within and an indisputable mathematical evidence of the conscious evolution of this Universe.
- Φ - Is a self-similar variable which can be used to derive Unity and it is the only proportion by which the Primordial rhythm maintains it perpetual oscillation to sustain this universe.
- Relation between **Φ and √5 is, Φ = (√5+1)/2**

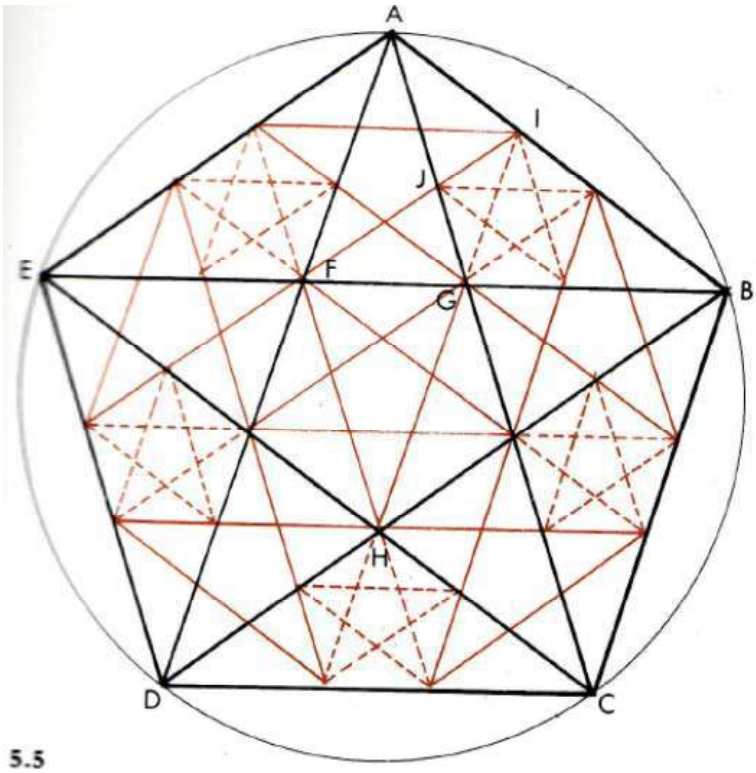

(Figure 27: Pentagon & Φ, Courtesy: Internet)

Now let's geometrically as to how **Φ and √5** are intricately linked. Consider the Pentagon picture whose side is of unit length. Ie.

AB = BC = CD = DE=AE = 1 and

EG = FB = CG = DF = 1 and

EB = Φ = 1.61803399 and BG = 1/Φ = 0.61803399 and hence all the ratios like AG = AF = EF = GB = 1/Φ.

Also FG = $1/\Phi^2$, which means **EB = EF+FG+GB = $1/\Phi+1/\Phi+1/\Phi^2$**

Also GI = $1/\Phi^2$ and GJ = $1/\Phi^3$

If you are interested more please check out the Fibonacci series and its relation to Φ. **The importance of 5 is dominant in every living organism while 6 and 8 are the characteristic of mineral and inanimate structures. It used to be rule of thumb that any plants / flowers which has 5 petals is an edible plant and hence 5 and pentagon are the symbols of life which contains the God's ratio or the golden mean.**

Now let's also understand how a **√5** is related to **√2 and √3.** If we consider a right angle triangle with the base of **√2** and height of **√3** or vice versa then the hypotenuse is **√5.** Now let me draw the connection between √2, √3, √5, Φ and π. If you think they are all some random numbers which cannot be fixed to their 10th decimal and not related to each other, just see the following relationship.

$$\pi = \Phi^2 \times 6/5 \qquad \text{or alternatively} \qquad \Phi = (\sqrt{\pi} * \sqrt{5}) / (\sqrt{2} * \sqrt{3})$$

This is the binding factor. I shall produce below some pictures which are aligned based on pentagon and the web is replete with them for you to understand more.

These 2 parts were little heavy and I shall move to easier aspects on the universal rhythm from next blog. The point I was trying to make is that everything in this universe is subject to a proportion and its fractals and let's see the manifestation of it in our daily life.

Happy reading!

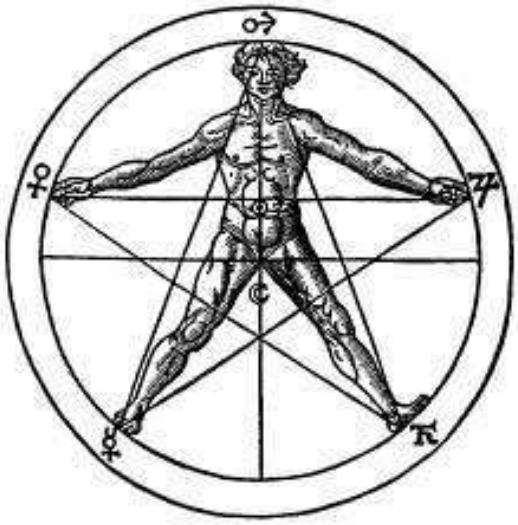

(Figure 28: Pentagon & Human shape,
Courtesy: Internet)

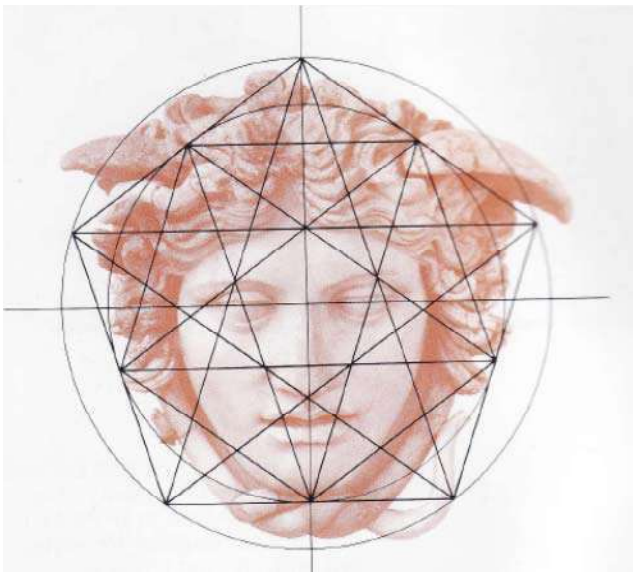

(Figure 29: Pentagon & Human face,
Courtesy: Internet)

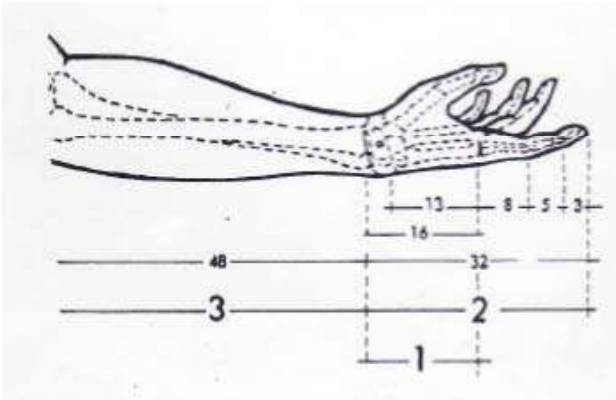

(Figure 30: Human hand and Fibonacci Series
Courtesy: Internet)

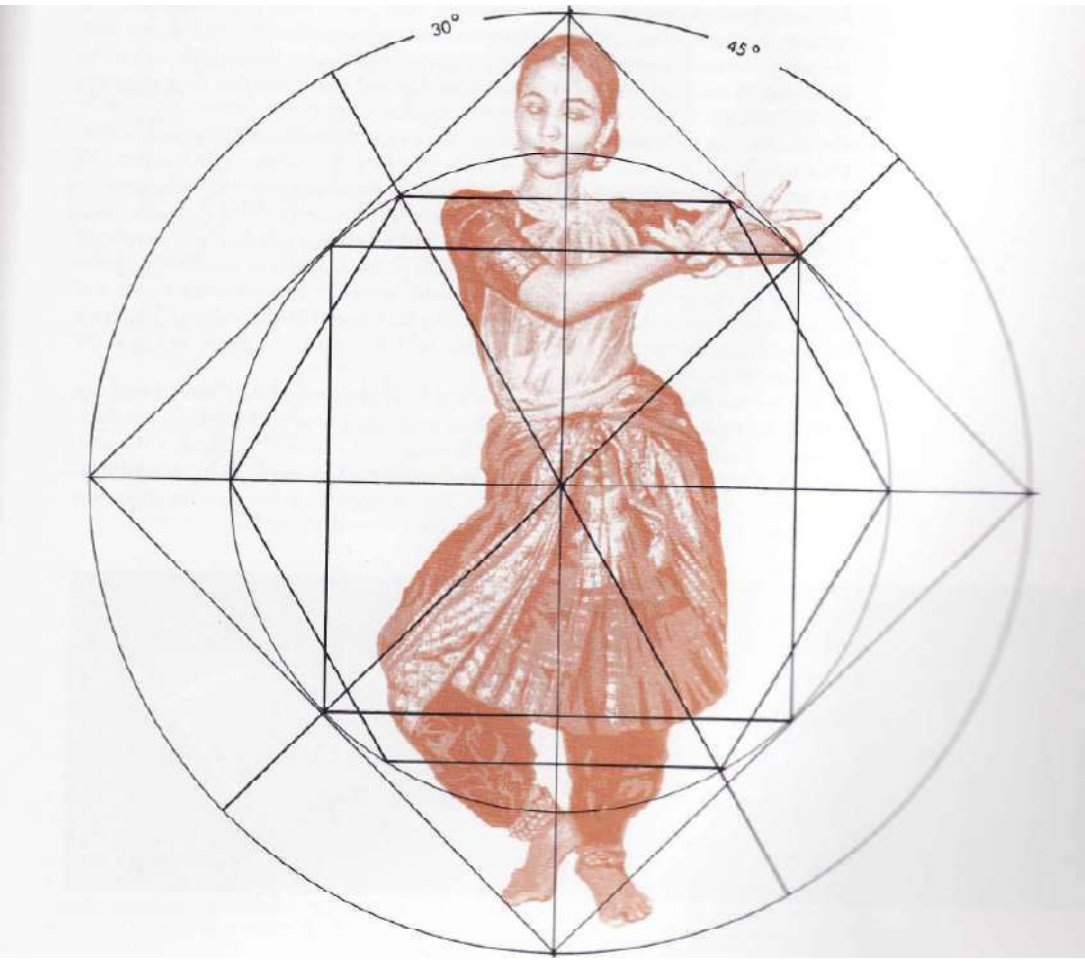

(Figure 31: Bharatanatyam and body alignment (Courtesy: Robert Lawlor, The Sacred Geometry)

The positions of Hindu classical dance (Bharat Natyam) describe geometric relationships from the axis of the body and the alignment of center of gravity at "hara" invoking rooting and divine power of transformation. In Hinduism "hara" is one of the names of Lord Shiva as in "Hara Hara Shakara"

20. TIME = SPACE SERIES. PART 20 – SANKHYA YOGA AND SAGE KAPILA

Now, let's look at what **Sankhyakarika** one of the greatest scientific works by **Sage Kapila**. I need to highlight that the **Sankhya philosophy** is one of the most evolved philosophies about the secrets of nature; it contains only 72 verses of which 68 of them define the complete spectrum of universal manifestation. **This Sankhya Yoga is referred in Bhagavad Gita – Chapter 2 is called Sankhya Yoga and in Chapter 10, verse 26, Lord Krishna identifies himself with Sage Kapila**.

Sankhya in Sanskrit means numerals / numbers. Sage Kapila states:

- Any measurement is a relational process and only a change can be measured but it takes time. The difference between the yardstick and the measured object constitutes the measured variable, which in effect is an incremental change. Since the observer can detect or measure only a change then logically, **the incremental unit of measurement itself should form the basis to derive the whole. This is the genesis of Φ.**

- **Correlate the above statement with the equation a + √a = 1. The unity is derived from the proportion "a" or 1/Φ.**

- As an example, the arch of a bow has expansive stress on the outer side and compressive stresses on the inner side, while the string is in tension and all are balanced at every instant. The expansive, compressive and tensile stresses can be expressed by one law.

- Alternatively, a single variable describes the proportionality of three types of forces existing at the same time. **Such a variable should be scale invariant, self-similar and have an axiomatic relationship to the whole.**

- **So Sage Kapila called 1/Φ as a self-similar variable from which the unity can be derived.**

- So he postulated if **x** is the value of a measured increment then the total value **1+x** must be related to the ratio of change as 1/x at the same instant of time or simultaneously. This means **1+x = 1/x**, and would lead us to $\mathbf{X^2 + X = 1}$.

- He quotes that if the primordial rhythm has to be self sustaining then the proportion is certainly governed by 1/Φ. He gives the formula for this oscillations as follows:
  - **X = 1/Φ = 0.61803399**
  - **Increment / Expansion = 1+x = 1.61803399 = Φ**
  - **Compression = 1-x = 0.38196601 =** $\mathbf{X^2}$
  - **Resonance =** $\mathbf{X^3 = X - X^2}$ **= 0.23606798**

Resonance or X^3 is the factor which protects this rhythm from decaying and dying off. So **Φ or 1/Φ** is such an important ratio or proportion so it is called as the **Golden mean or God's ratio**.

I shall highlight some of the factors / ratio which are part of Sankhya Yoga and what is amazing and you find formulas for Tamasic, Sattwic and Rajasic Guna states. (Please refer "Secret of Sankhya Yoga" – G. Srinivasan in the web).

- **Kapila defines the four qualities of the unmanifested state as Aikaantha (Synchronized), Aathyanta (perpetual), Atho (Dynamic)and Abhavath (unmanifest).**

- Taking C as cyclic rate of oscillation or vibration and x as rate of change per cycle then the three Guna self similar interactive states are shown as vibratory counts per cycle by the formula. **Thaama = C^{1+x} . Rajasic = C^{x+x} . Sathwa = C^{1-x}.**

- Some of the numbers that Sankhya Karika deals with are **1/7 (0.142857), π/10 (0.314159), 1/Φ (0.618034), √2 (1.414), Φ(1.61803399), √3 (1.732), √5 (2.23), e (2.718282), π (3.14159) and declares that the unmanifested state (Abhavaat) can exist only when the oscillations are between π/10 (0.314159) and e(2.718282). This is simply amazing since the state of Abhavvat is the state of Brahman.**

Despite herculean efforts I am unable to understand the Bhashya for the 72 verses which is about 500 pages explaining the secrets of Sankhya in any significant measure. I wish someone can step in and help us by explaining Sankhya Yoga that is comprehensible to our level of intelligence.

We have a treasure of secrets and richness hidden in our scriptures and it seems we have already lost most of them and the fundamental reason being our indifference to Sanskrit and our mother tongue.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

The passage produced below is just the summary of verse 1.

…The Sankhya view that evolves out of the complete theory is that only vibrations are detected by the observer... Since only relative changes can be be detected, any fundamental component that is not in a vibratory state cannot be detected. Vibrations are caused by components in an interactive state or a cyclic state of colliding and separating that is common to all interactions and wave phenomenon.

The interactions create three distinct modes of stresses. Collisions are compressive or inelastic. The resultant reaction is expansive or elastic. When the interacting components lack the freedom to move away the interactive state is maintained in a cyclic or shuttling mode in the same location in a resonant state.

*This important Sutra lays emphasis that if the observed process of detection is dependant on vibrations, then fundamental space **must** contain components with those four characteristics described as states, which makes it function in a holographic way. That is all vibrations remain in fixed relationship relative to each vibratory point in a coherent and resonant state.*

21. TIME = SPACE SERIES. PART 21 – 5 AND 8 THE UNIVERSAL RHYTHM

Let's summarize what we have seen so far and then move on to more interesting aspects.

We have touched upon the God's particle and its characteristics. We also looked at the 5 fold manifestation process and in that we looked at how **Moolam** becomes **Kaalam** (time) and how time rhythmically (**Seelam**) vibrates with a proportion and creates forms and shapes (**Kolam**). We also touched upon some of the ways we had codified the secrets of nature like **Lord Shiva, Lord Nataraja, Lord Ganapati etc.**

Before we see how rhythm **(Seelam) and shapes (Kolam)** manifests itself as universe, let's first look at one specific word from Tamil which has three significant meanings converging into one, Yen (**எண்**), means number **eight, generic term for Number / numeral** and also root for **எண்ணம்** which means thought. I shall explain the significance of this below.

<u>Importance of 8 / Octet:</u>

It is stated that these God's particles combine in the multiples of **8 / octaves ONLY** and the states of manifestation from being subtle to gross is as given below.

- **Formless Un-manifest State** — **0 (This is the Abhavaat state)**
- **Guna State** — **$8^0 = 1$**
- **First stage** — **$8^1 = 8$**
- **Second stage** — **$8^2 = 64$**
- **Third stage** — **$8^3 = 512$**
- **Fourth Stage** — **$8^4 = 4096$**
- **Fifth Stage** — **$8^5 = 32768$. This is the state with manifest form.**

This rule is applicable to both the visual and aural forms which mean we can see or hear anything only in the fifth stage of evolution. So as per **Pranava veda, the fundamental numbers are 0,1** and the key **numerals for proportions are 5, 8**.

<u>Significance of 5 and 8:</u>

Pranava Veda describes that 8 / octets is the essential harmonic oscillator for the manifestation of the universe since this generative force is the multiple with which the whole universe manifests and sustains. You many note that number 8 is associated with Lord Narayana and his Ashtakshara mantra **(Om NaMoNaRaYaNaYa**).

The principle of 5 / Penta, we have seen is the regenerative binding force earlier. It is always a 5 stage process. This is associated with **Lord Shiva (Om NaMaSiVaYa).** The un-manifest form comes to the Guna state with the force of 5 and in the multiples of 8. It is also important to highlight that 5 and 8 are part of the **Fibonacci series and their proportion is 8/5 = 1.6, which is Φ**.

But it is important to realize that the building of octets is a 5 step process for manifestation. This highlights that one cannot exist without another and both are interdependent. Now let's recall:

"Shivasya hridayam vishnur, Vishnoscha hridayam shivah:" and
"Shivaya Vishnu rupaya Vishnave Shiva rupine"

Vishnu (8) is the heart of Shiva (5) and likewise Shiva is the heart of Vishnu and they both are the representation of each other.

If you have noted Tamil language stressed the importance of words and its meaning – this was addressed in the first few parts of this series. Here Tamil language gives the importance of numerals and its significance in the formation of universe. Both the great sages **Auvaiyaar** and **Thiruvallular** stated the importance of numerals and letters in an identical fashion. Both these lines mean, Numerals and letters are like eyes for living beings / equal to eyes.

எண் என்ப ஏனை எழுத்து என்ப இவ்விரண்டும் கண் என்ப வாழும் உயிர்க்கு!
எண்ணும் எழுத்தும் கண்ணென தகும்!

Now what should be noted here is that (**எண்**) importance of numerals precedes that of letters and we know why. The aural and visual forces become letters & its associated sound at the 5th stage but the numerals are from the Guna state. **Numerals were associated with 8 / Lord Vishnu and letters were associated with 5 / Lord Shiva**. Guess you can get the scientific knowledge and significance we have in our languages.

Since what is in macro is there in microcosm, taking the analogy to microcosm our mind becomes the Moolam (Source), our thoughts are the vibration, time is measured as the periodicity between thoughts, based on the rhythm of our vibration we perceive the world. This is given very nicely as **உள்ளமே மூலமாகி உணர்வுறும் கோலமாகி**! means **Our mind is the source and its awareness becomes forms.**

This wonderful concept is what is linked in the word Yen (**எண்**), which means number **eight, generic term for Number / numeral** and also root for **எண்ணம்** thoughts. **Just this one word in Tamil highlights the supreme secret that thoughts become form and words with the help of numbers and numerical proportion converts aural and visual forms to thoughts.**

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

22. TIME = SPACE SERIES. PART 22 – EIGHT (OCTET) AND THE 5 SACRED ARTS

எட்டே எட்டியல் எட்டெட் டியலே
எட்டின் நெறியே அளவை மாநெறி !!

The above lines from the work **Aintiram** means **"Eight / Octa (multiples of 8) is the fundamental numeral for any measurements**. We did see that the fundamental god's particle add up with each other in the multiples of 8 in the previous part.

In ancient India there were about 64 arts (http://en.wikipedia.org/wiki/Kal%C4%81) known as **Chatuhsasti kala ("ஆய கலைகள் அறுபத்துநான்கினையும்"** as popularly known in Tamil), but I am going to talk about 5 sacred arts.

We will look at the importance of numeral 8 and how this is fundamental to everything in this Universe. But let's again start again with etymology. The word arts in **Sanskrit** is **"Kala" (कला)** and **Time in Sanskrit is काला (Kaala).** So etymologically we can say that classical arts are all about variation of time (or harmonics of this pulsation of time in the multiples of 8).

After etymology let's get to the basics. Our understanding of the universe is that **"the primordial space manifests itself as spatial forms through pulsation (Time) and its periodicity (Rhythm & order).** This evolution started with **Pranava which came out as aural and visual form (Sound & light)**. When they say **"The one became two"** they refer to the Pranava which is light and sound from the unmanifested consciousness.

Aintiram states that the dual form of **Pranava** gave forth 5 sacred arts which are fundamental to most of the other arts. **The Aural form of Pranava gave forth Poetry and Classical Carnatic music, which can only be heard. The Visual form of Pranava gave forth Sculpture and Building architecture, which can only be seen. Both the aural and visual forms merged to create the classical dance (Bharatnatyam**), which involves both seeing and hearing.

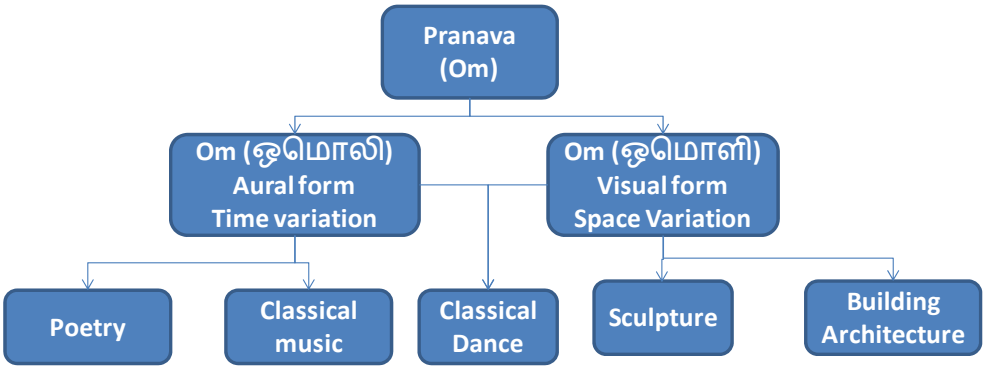

Figure 32: 5 Sacred arts

They were classified as 5 vedas:

- **Poetry – Sabda veda**
- **Classical music – Gandharva Veda**
- **Classical Dance – Naatya veda**
- **Sculpture – Sthapatya Veda *(Sthapati is a clan that is the master of this veda)***
- **Architecture – Pranava Veda**

<u>Pendatic Tamil and its construction:</u>

Pendatic Tamil is called as **ஐந்தமிழ் (Aintamizh**) which consists all the five above arts, **இயல், இசை, நடனம், சிற்பம், கட்டிட கலை**. It is these 5 arts which were formed out of the Tamil language and the language itself is created from the word Om. They say that it is not 12 basic vowels in Tamil but only 5. They are அ, இ, உ, எ, ஒ. These 5 letters combine to form the rest of the letters like

அ + அ = ஆ, இ + இ = ஈ, உ + உ = ஊ, எ + எ = ஏ, ஒ + ஒ = ஓ, அ + இ = ஐ,

அ + உ = ஔ

Here you may want to note that 5 has become 12. Same way in classical music they say that the basic svaras are 5 (**ச**, **ரி**, **க**, **ப**, **த**) – Sa, Ri, Ga, Pa ,Da which became 7 and then 12.

So 5 is the fundamental numeral for evolution and Tamil language has grown based on this philosophy and science. I am sure some of the other Indian languages have the same basics. The book which describes this phenomenon of evolution of language from Pranava and arts from language is **Aintiram (it means 5 works) (ஐந்திறம்**) authored by Mamuni Mayan dated 10000 BC.

You would agree that the aural forms are predominantly variations in time and visual forms are of spatial variations. But our ears stand for akash tatva ("space") and it can perceive variation of time and space and we will see this in detail. When we said **"Time = Space"** we will see that both of them are governed by the same laws and measurements and hence there is no difference between **Time and Space**.

Happy reading!

23. TIME = SPACE SERIES. PART 23 – NANOTECHNOLOGY IN ANCIENT INDIA & SIZE OF GOD'S PARTICLE

Let me start with these questions:

- **What is the size of the God's particle and how is it calculated?**
- **Does nature endow a standard measure for an average human being's height?**

Before we proceed to the next section I want to give the very detailed space calculation table used in ancient India. Our rishis did not stop just with telling us that the **Paramaanu / God's particle** is very small but went ahead and established its size.

If you have to see such minute particles then your sensory organs – Eye and mind should be tuned to it so that it can see things at that size. From the formula available in our ancient texts I was trying to reconstruct by working backwards to find out the size of the **Paramaanu / God's particle should be.** Please refer the table below which I have arrived at.

ANCIENT SPACIAL MEASUREMENTS		
Unit scale	**Ancient metric**	**Current day Metrics**
1 Paramaanu =	Smallest particle	133 nano meters
1 Ther Thugil=	8 Paramaanu	1065 nano meters
1 Mayir nuni=	8 Ther Thugil	8526 nano meters
1 Eer=	8 Mayir nuni	68 Micro meters
1 Paen=	8 Eer	545 Micro meters
1 Yavai=	8 Paen	0.4365 cms
1 Angula=	8 yavai	3.4925 cms
1 Tala=	6 Angula	8.25 inches
1 Muzham=	24 Angula	33 inches
1 Muzham=	4 Tala	33 inches
2 Muzham=	8 tala	66 inches
Universal height of man	9 Tala	74.25 Inches

(Figure 33: Ancient Spatial measurements. Courtesy – Dr. Ganapathi Sthapati)

I have given the exact word used in Tamil for these measurements instead of translating it in English. Ther Thugil is the dust from chariot wheel, Mayir nuni is the width of a hair tip, Eer and Paen are the lice

eggs and lice. Some of you may jump that most of the units were subjective and would have variations in normal life. I agree but there is a reference point – **Angula** and its exact measure based on which other values are derived backwards to arrive at the value of Paramaanu.

Now if you note the **smallest particle** aka **God's particle / Paramaanu** is **133 nm** in size which is currently under study by the CERN scientists. Nanotechnologists today confirm that the width of a hair strand is about 25000 nm and our ancient texts give the size at the tip of the hair strand (and not the width) as 8526 nm. I see that to be a reasonable estimate when no such precision instruments were available in those days.

One Angula is 11/8 of an inch. This is the fundamental measure which is used in any of the worldly measurements. Now you can see that 6 Angula is 1 Tala which is about 8.25 inches and then comes the most important revelation. **Does nature endow a measure for an average human being's height?**

The answer is yes. **As I said an average human being should be 9 Tala's height and hence the nature endowed height for any human being is 74.25 inches.** This is the ideal height and the variation is attributed to our Karma, hereditary and lifestyle.

Now let me give few tips to find out your height from typical measurements:

- Measure the length of the face (from forehead to chin). Your total height should be 9 times that height. This is the principle of Nava tala. As an extension measure your thigh or legs length excluding the knee and feet and your total height should be 4.5 times that.

- Take your right hand middle finger (No. Don't show it to anyone☺). You would notice that the finger is divided into 3 parts. Measure the length of the lowest part – from the end of the palm to the first subsection. Your height typically should be 54 times this measure. Since this measure for an average man with nature endowed length shall be 1 Angula. Hence your height shall be 54 times that measure.

- The length of the thumb from the base of the wrist should be about 3 Angula and hence 18 times of that should be your height. This can go on and on.

So, to sum up this section:

- Instead of looking them as Rishis or Sages or religious figures if we look at them as scientists in the field of nanotechnology, quantum physics and Astro dynamics we would accept most of the secrets without any prejudice.

- Not just the measure for the height of the man but they had formula for every object and this was the secret of their wisdom. For any astronomical object, they had formulas to measure body's core (width) and also the width of the mantle. The roots of their wisdom lie in understanding that "many' are just a harmonic variation of the "one" subject to a mathematical

proportion. Hence there was no “rocket science” in those days and all of them were as simple as it looks like.

As a wise man said, **“Indians are the most ignorant about their rich past and scientific traditions.”**

Happy reading!

24. TIME = SPACE SERIES. PART 24 – OCTET, OCTAVE AND THE GANDHARVA VEDA (CLASSICAL MUSIC)

Let's start with classical music where Octaves form the fundamental for it. There are seven svaras (Sa, Ri, Ga, Ma, Pa, Da, Ni) which is made into an octave with another Sa after Ni. So it becomes Sa, Ri, Ga, Ma, Pa, Da, Ni, Sa (*Do Re Mi Fa Sol La Ti Do*). The first rule of classical music is "**Shruthi Mata, Layam Pita**", which means **Shruthi is the mother and this corresponds to the frequency or the spatial component and Laya is the Tala component which is a function of time compared as father**.

Tala	Anga Notation	Tisra	Chatusra	Khanda	Misra	Sankeerna
Dhruva	IOII	11	14	17	23	29
Matya	IOI	8	10	12	16	20
Rupaka	OI	5	6	7	9	11
Jhampa	IUO	6	7	8	10	12
Triputa	IOO	7	8	9	11	13
Ata	IIOO	10	12	14	18	22
Eka	I	3	4	5	7	9

(Figure 34: 35 types of Tala. Courtesy: Wikipedia, internet)

There are 7 fundamental Talas in carnatic music and each Tala has 5 different variation based on Jathi so in all there are 35 different Talas as given in the tabulation. These Talas are measured as the "matras" the unit duration of time. There is another concept called Nadai or Gati which we will not touch upon now. But let's look at these 35 variations and can you tell me where the most famous "Adi Tala" is in this 35? Most importantly why it is also called as **"Adi Tala" – which is the primordial rhythm**?

The answer is **"Chatusra Jathi Triputa tala"** highlighted in the table is called as **"Adi Tala"** and it is called so since it gave the most primordial rhythm with 8 time units. But there are couples of more cells where we can see "8" in the table and why these are not called '**Adi Tala**"?

The primordial rhythm has a pattern of **1, 3, 2 and 2** which adds to 8. Further on we will see just the variation of this Adi Tala in anything and everything. Tisra Jati matya Thala has a structure of 3, 2, 3 and Kanda Jati jhampa Tala has a structure of 5,1,2, hence they are not classified as the primordial rhythm.

Let's quickly touch upon the spatial variation or the frequency / pitch aspect of this divine art before we branch off to other topics. The image below gives the 16 levels of Savaras which includes tones and sub tones. The seven svaras become 22 tones based on the frequency variation / harmonics. Here 7 are fundamental svaras and 16 as given below is the most practiced variation and 22 is not popular.

Levels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Svaras	s	ra	ri	ru	ga	gi	gu	ma	mi	p	dha	dhi	dhu	na	ni	nu	s
Ratio	1	32/31	16/15	10/9	32/27	6/5	5/4	4/3	27/20	3/2	128/81	8/5	5/3	16/9	9/5	15/8	2
Factor	1.0000	1.0323	1.0667	1.1111	1.1852	1.2000	1.2500	1.3333	1.3500	1.5000	1.5802	1.6000	1.6667	1.7778	1.8000	1.8750	2.0000
Freq (Hz)	240.00	247.74	256.00	266.67	284.44	288.00	300.00	320.00	324.00	360.00	379.26	384.00	400.00	426.67	432.00	450.00	480.00

(Figure 35: Svaras and frequencies)

You can note that Sa starts with 240 Hz and the last Sa is 480 Hz doubling the frequency and hence an octave. While Sa has 240 hz and 480Hz levels, the tone Pa (P) or Sol does not have any variation and this is at 360Hz. I am going to correlate the Mayan studies with Carnatic music and instead of seeing the whole spectrum from “Sa”, I am going to see this spectrum from “Pa”.

You would note that “Pa” at 360 Hz corresponds to the **Harmonic osciallator constant number** and the whole spectrum is almost like a Sine wave from 360Hz to 480 hz and falling down to 240 Hz with a uniform gap of 120Hz above and below. All the tones would fall within this 240Hz centered around 360 hz. So the spatial variation in carnatic music can be summed as “It originates at a value (240Hz) and varies by the same measure (240Hz) centered on the harmonic oscillator”. Since the objective is about looking at the primordial rhythm we will not touch any other aspect on this topic.

We will see how this **Adi Tala** is the fundamental pattern / rhythm that manifests in every other art.

As a wise man said, **“Indians are the most ignorant about their rich past and scientific traditions.”**

Happy reading!

25. TIME = SPACE SERIES. PART 25 – ADI TALA, NAVA TALA AND STHAPATYA VEDA (SCULPTURE)

Let's look at how Octet and the primordial rhythm (Adi Tala) that defines Sculpture. Let's recap some of the following:

- The process of evolution starts with Pranava which has aural and visual forms. We have also seen that anything subtle is represented in a 8x8 energy grid and anything gross is in 9x9 grid.
- The fundamental measure with which the particles bond is **Eight or** it's multiple and hence the primordial rhythm is an **Octet.**
- The fundamental measure of time is **Tala** and the **primordial Tala is Adi tala** with 8 units and a pattern of 1, 3, 2 and 2.

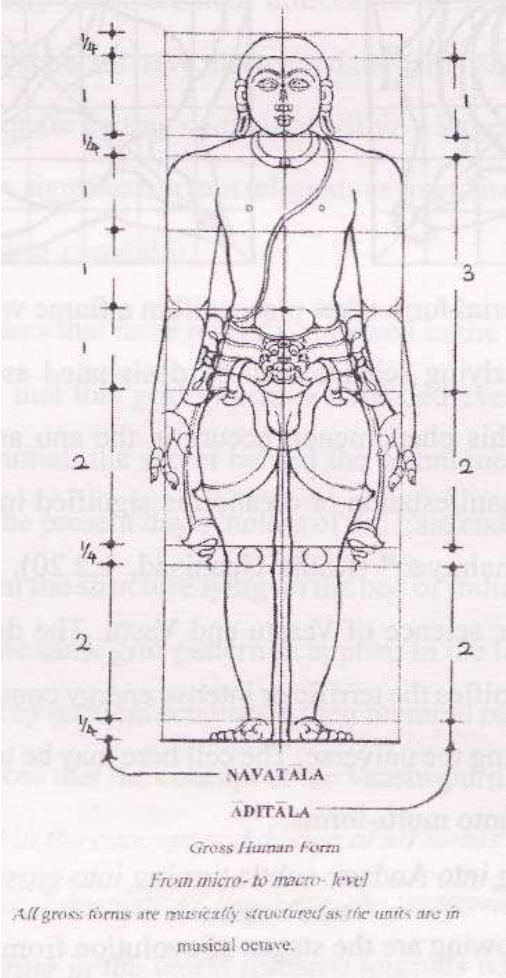

(Figure 36: Human form – Adi Tala, Nava Tala Courtesy: Dr. Ganpathi Sthapati)

Now let's see the measurement rules as to how to make a sculpture of a human being.

- **The overall human height is measured as 9 talas.** Yes the same time measurement is used to measure height. Pinch yourself now, since height is a space variation and not a time variation yet it is measured with a metric of time. This is a secret which is unknown to many and even some of the experts in this field. This is where Time and spaces merges without any difference and this is the fundamental rule with which we have been creating visual and aural structures in the universe.

- **Divide a man's height as 9 units of which head, torso, thigh and legs would fall into the pattern of 1, 3, 2 and 2 which adds up to 8. This is the primordial rhythm – the Adi Tala now as a human form.**
  - Then how 8 became 9? No other branch of Vedas or science tells us this secret so explicitly to my knowledge. **The following parts, Top of the head to forehead, Neck, Knee and feet each measure 0.25 talas and hence add 1 additional tala to 8 and it becomes 9.** So Adi tala which is a subtle version of human becomes Nava Tala which is the gross version of human being. In the process of 8 becoming nine all the joints are formed in the body☺.

  - Let me add one more dimension to this. Our human body has a gross body (Sthula) and a subtle body (Sookshma sarira). **The Sthapatya veda tells us that the gross body is nava tala and sookshma sarira is Adi Tala**.

  - I fell off the chair when I understood this and the linkages. Check if you are still on your chair and maybe you should sit on the floor from now on☺.

<u>Martial Arts and Lord Nataraja's stance:</u>

Let me ask you the following questions here:

- Look at the image of the Lord Nataraja below. If a gross image should have Nava Tala which is a 9x9 grid then why the human image of Lord Nataraja which is a Nava Tala fitted into a 8x8 square instead of a 9x9 square?

- Both in Classical dance and in martial arts why do they ask you to stand in a posture where the knee is slightly or significantly bent. Not all of the stances but most of the basic stances correspond to this why? Let me know if you have received a satisfactory answer for this question.

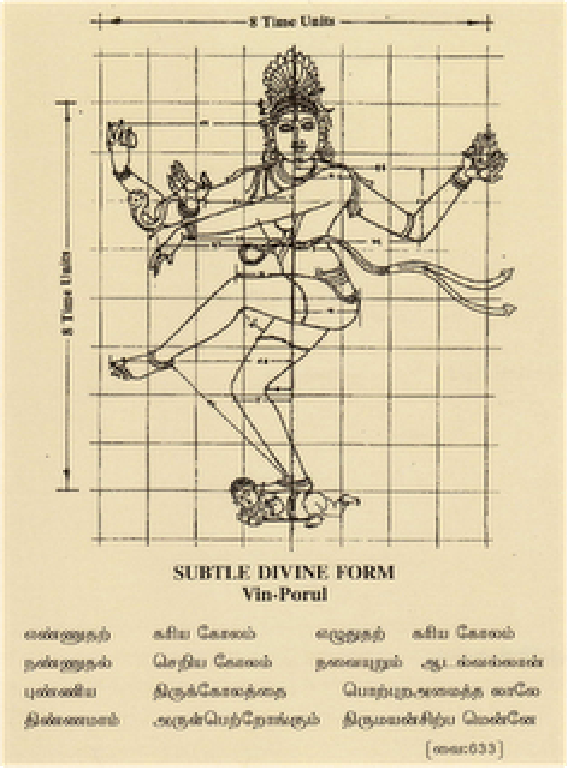

(Figure 5 reproduced)

- The answer to this question reveals one more secret to us.
    a. **In Sthapatya veda each grid line is divided into 10 or 11 or 12 (usually 12) and hence a 9x9 grid has 9*12 = 108 blocks or levels of energy. This may explain why 108 is a sacred number from an energy perspective.** This covers the entire spectrum.
    b. When we create a gross image its always sculpted to 9 talas but when they sculpt image of the gods and in this case Nataraja, they fit the gross image to a 8x8 energy grid to invoke the subtle energies.
    c. How do they fit a 9 tala to 8 tala? The technique is not to change the proportion of nava tala but they ensure that 9 fits into 8 by making the image to bend it legs such that the height reduces by one unit.

- You can notice that Lord Nataraja's right leg is bent to fit the image in 8x8 grid. This is believed to invoke the subtle energies corresponding to that image.
- This is the same reason why martial arts and in Bharatnatyam your teacher asks you to take a basic stance which reduces the height from 9 units to 8 to invoke subtle energies. Of course the other reason is the alignment and focus to Hara / Dantein with that pose.

If I tell you that the science of nature and the associated philosophy codified in Hindu religious symbols are unmatched and amazing then I hope you would whole heartedly agree now. These religious texts and symbols offer the key to unlock the secrets of nature.

So to sum up, so far we have seen one variation of time as **Gandharva veda** that manifests as classical music and the primordial rhythm is **Adi Tala.** Next we saw that the **Sthapatya veda** in the form of sculptures offered the secret of space variation in **Adi Tala and Nava Tala**.

This is where Time and Space were equated with the same measure yet offered completely different arts.

The whole universe has these underlying and un-manifested interconnections and hence the **Hindu philosophy of "That one became many"…** is the supreme truth. Seeing the divinity in everything is the only truthful way of recognizing this science.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

26. TIME = SPACE SERIES. PART 26 – SABDA VEDA, CHANDAS & POETRY (MA NISHAADA…)

शुक्लाम्बरधरं विष्णुं

शशिवर्णं चतुर्भुजम् ।

प्रसन्नवदनं ध्यायेत्

सर्वविघ्नोपशान्तये ॥

Shuklaambaradharam Vissnnum Shashivarnnam Caturbhujam |
Prasannavadanam Dhyaayet Sarvavighnopashaantaye ||

Let's start with this Sloka as a sample to see how 8 and its harmonics are integrated with Poetry. In this sloka there are 4 lines (a line is called Pada and Pada means feet in Sanskrit) and each line has 8 Sanskrit Aksharas (Only vowels and vowels with consonants imposed on them should be counted and pure consonants are not part of the count.) This is usually written in 2 lines as shown in English.

This is the most popular way of creating a sloka or poem in most of the Indian languages. This "metre" resonates as 32 aksharas in 4 padas. You may want to correlate this with 1,3,2,2 where the last 2 stands for your feet. So feet (pada) measures $1/4^{th}$ of the overall length of the subtle body (8 units) and 4 padas create the full blown subtle body. So such a constructed poem is a throbbing and vibrating energy body or a living organism and hence carries the power of the words it contains.

If all the padas have equal metre say 8 units then it is called **Sama Vrtta,** and if all are different it is called **Vi-Sama Vrtta** (not equal). **This 8 and 32 is the same as Adi Tala in carnatic music and ashta tala in sculpture. Can you make the connection now?**

In Sanskrit this metre is called as "**Chandas" and in Tamil it is called "Chandam**". **Chandas** is also one of the 4 important Vendagas and is called as the feet of the Vedas. **Let me ask you as to which language the Vedas are available in its primordial form?** The most popular and incorrect answer is Sanskrit. This is the level of awareness we have. Lets quickly look at these important points about Vedas and I shall correlate this with our topic of discussion.

- Unlike other faiths Hindus don't attribute the Vedas as word of god or given by some prophet. We consider Vedas as the breath of god (**"Nishwasitam"**) and not the word which means, Vedas are not created by god, but the breath. If there is no breath that person would not leave and hence it is associated with the very presence of god.

- Vedas are also **Apourusheya** which means it is not created by man and **Anaadi**, that does not have a beginning.

- But you can ignore them stating these are blind beliefs. Let's look at how this correlated with the science. Vedas are created by Pranava and these should be considered as the harmonics of the primordial vibration and nothing more.

- If it is pure vibration then the "which language it is written?" sounds stupid isn't. If it's pure vibration it has to be expressed in "Hz or wavelength" equivalent in ancient India. This is what **Chandas or metre** is all about. This measures pure vibration and anyone capable of tuning themselves to those frequencies have **SEEN** the Vedas and not **created them.** Hence all our rishis are **Mantra Drishtas and not Karthas**.

Difference between Vedas and Poetry:

Vedas contains both **poetic verses (Padya) and prose (Gadya)**. All the poetic verses are called **Chandas** and it complies with the rule as stated above. The difference between normal poetry and Vedas are, Vedas contain tonal variations (high pitch and low pitch) apart from the time, space variations but in Poetry there are no tonal variations. What has tonal variations and are not part of Vedas are called Slokas. So to sum up:

- Vedas are both in Padya and Gadya. What is in Padya is called chandas and it has tonal variations in addition to the time space variations.
- What has tonal variations but not part of Vedas is called as slokas.
- What does not have tonal variation but comply with the chandas rules are called Poetry.

Harmonics and types in Chandas:

We saw every line to have 8 matras / units / aksharas. There are variations and these are the harmonics available.

- **Gayatri –** This is a very special chandas with the mantra where instead of 4 padas, there are only 3 padas and hence it is called Tripada Gayatri. Each pada has 8 Aksharas and hence 24 Aksharas in Gayatri Mantra. This is also the only chandas where a mantra is named after the chandas. Some people write it as 6 letters per line and 4 padas which makes it 24.
- **Ushnik Chandas –** 7 letters per pada and 28 letters in all.
- **Anushtub Chandas –** This is the fundamental and popular one with 8 matras per pada and 32 in all. Ramayana the first poetry was set in this metre.
- **Brihatee Chandas -** 9 letters per pada and 36 letters in all
- **Pangti Chandas -** 10 letters per pada and 40 letters in all
- **Trishtup Chandas -** 11 letters per pada and 44 letters in all
- **Jagti Chandas -** 12 letters per pada and 48 letters in all. This has a subtype called bhujangam which is split as 6-6 and that moves like a snake. (Ex. Subramanya Bhujangam)
- **Shikarini Chandas -** 17 letters per pada and 68 letters in all. In Soundarya Lahiri it is split as 6 and 11 by Adi Shankara.
- **Udkriti Chandas –** 26 letters per pada and 104 letters in all.
- **Dhandakam – above 26 per pada**. **Ex.** Garuda Dandakam by Vedantha Diskshitar.

The reason I have given all the above is to emphasis that nothing in our religious scriptures, literatures are without a grammar, order, form or proportion. Everything confirms to a mathematical proportion.

Just like **Vedas are the breath of god, Chandas is the breath of every mantra.** The mantra is powerful only if it is recited to this metre. This is the reasons some of the poem even if it is not related to religion

stands the test of time. Also if you recite a mantra even without knowing its meaning but as per the chandas then the mantra shall bear its fruit.

"Ma Nishada" …..Origin of Poetry:

Would you believe that the first poetry in this universe started with a curse?

Sage Valmiki saw a hunter who killed one of the birds of a pair which were in love. The sage got enraged and cursed the hunter, ***O, Hunter, may you not fare well anytime as you killed one of pair of the Krouncha birds which were happily engaged in love".***

mA niShAda pratiShThA.n tvamagamaH shAshvatI.n samAH |
yatkrauJNchamithunAdekamavadhIH kAmamohitam.h || (bAlakANDa 2.14)

The above sloka also meant ***"O Lord of Lakshmi, it will bring you eternal glory for having killed a male of a happy couple who lost his head completely in lust.."*** This male is Ravana who lost his head in lust despite being happily married with his wife Mandodari. The other interesting connection I have this sloka with this series is that the **Mamuni Mayan** is the father of **queen Mandodari** and father in law of demon king Ravana.

Once the sage realized that this curse also meant something very auspicious and referred to Rama avatar he wrote Ramayana which is the origin of poetry as known in the world and it is called **Adi Kaavya.** Valmiki Ramayana set in **Anushtub Chandas** which is an octet.

So if you look at both the poetry and classical music composition:

- The rhythm in which it is set is a pulsation of time which confirms to a divine proportion.
- The raga and the pitch variation is a pulsation of space / frequency which again confirms to a divine proportion. We did not discuss about ragas though.
- The words used are divine and we have seen the divinity of the letters and words.
- The meaning of the song / poem usually exhorts the qualities of the god and hence is divine.
- The classical music and poetry invoke the subtle divine energy in the aural form just as much the sculpture (when it confirms to the divine proportion) invokes the subtle energy from in its visual form.
- This is how we see that "**one became many"** and **binding factors** in this process of evolution being the numerals 5 and 8.

Alas! Today, we are the fanatic fans of musicians who lacks morality & humility, who is ignorant of any divine proportion, most of the music we hear is a cacophony and very mechanical, the words are indecipherable and lacks depth, the meaning of the song - if at all any are just suggestive of sexual emotions and nothing else and the dance movements we see are the gyrations of the hip with a great blend of fitness training exercises associated with it. This is not to negate some of the fine works we see even today but to stress that we had such high science and taste which we seems to be losing / lost for no good reason other than ignorance.

As a wise man said, **“Indians are the most ignorant about their rich past and scientific traditions.”**

Happy reading!

27. TIME = SPACE SERIES. PART 27 – ARCHITECTURE – THE ZENITH OF MATHEMATICS (VAASTU)

Just look back in history and see what stands the test of time. Even if a civilization is completely extinct what stand beyond their time is the architecture of the civilization which stands tall as a witness to the richness and maturity of the civilization.

Aintiram states that **"Architecture (Space engineering) is the zenith of the mathematics**" in **"கட்டிட கலையே கணக்கியல் உச்சி**..." This space science is called as Vaastu Sastra in India.

There are few important concepts in Vaastu science which I want to present as below:

- The whole world is made up of **God's particle (Vastu, வஸ்து**) and nothing else. It is this God's particle which actually manifests itself as gross forms (**Vaastu, வாஸ்து**). You would note that Vastu (Subtle) has become Vaastu (gross) by addition of letter "a" and this difference is reflected in our languages too. **When அ / अ become ஆ / आ the subtle becomes gross**. Hence the most important statement for this science is "**Vastur eva Vaastu**", this means **the subtle becomes gross or energy becomes matter or the space becomes earth.** This is purely manifestation / evolution and there is no creation. This has nothing to do with religion but supreme science.

- Since it is all only one energy and it ever vibrates based on the harmonics and resonance, this vibration is called life and everything in this world, be it a living being or a non-living being as per our current definition – everything vibrates. The chair you sit and the vehicle you use are all living beings. **Everything throbs with energy and there is nothing which is a non-living being in this universe.** Without this vibration there would not be any difference between iron and cotton. The difference between particles is essentially the molecular constitution which is a function of its elements and its periodicity. This defines presence or absence of quality and sensory perceptions. This was put very nicely by **Poet Subramanya Bharathi** as **எங்கு காணினும் சக்தியடா**, **Where ever you see its just energy.**

- The above concept is very profound and this is called as **Science in our scriptures since it deals with Knowledge of the space** (**விண் ஞானம்**, Vin-gyan).

- By the same concept when a subtle energy which is in the open space is converted to a gross form like a building then this body / building vibrates based on the design specifications and the material used for that building. It does not matter what is the measure and what is the material used, it vibrates. **When a structure is created with a divine proportion then we breathe life**

into it. Thus the structure becomes a living organism. This is how some of the structure stands the test of time for thousands of years.

- **Vaastu is that science which aligns the vibration of the building with the vibration of the dweller in the building so that both the living organisms (the building and the dweller) are in harmony and resonance.**

- It sounds simple but for this science we need to know includes the vibration pattern of the dweller, mathematics of space engineering, the knowledge of materials and its nature so that we can match it up to create harmony. This is precisely what Vaastu as a science does. Again it has nothing to do with religion. If you Google you would find thousands of Vaastu experts outside India who perceive and pursue this as a supreme spatial science.

- Let us look at the word **"vas"** which is the root. This means to shine; to grow bright, **to bestow by shining upon**, becoming light. **Vaas** is its derivative which means to perfume, an intoxicant, **dwelling place**, to assume the appearance of matter. This is the root for **SriniVAAS**, **SreeVAASan**, **VAASam** in Tamil means living. Most importantly the ability to feel this subtle thing (which cannot be touched) is called **VAASanai (வாசனை, in Tamil it means smell).**

- This spatial science includes knowledge on the following:
    - Nature of soil and material, and the qualities of its energy.
    - Measures for spatial engineering that best resonates with the environment and the dweller.
        - Note that the dwelling unit cannot be compatible to all the human beings universally. This varies with individual to individual and hence the Vaastu compatibility for the house is always seen for the housewife than the man with the assumption that what is compatible to the lady of the house would suit all others.

    - Accurate calculation of time and the position of astronomical bodies. The time engineering merges here with the space engineering. Consider the following to understand this:
        - In some temples you would notice that the sunlight falls on the deity on a specific day / time of the day. This is not possible if the future position of astronomical bodies at a given time is calculated very accurately.
        - When we build a house / temple the inauguration ceremony should be conducted at a specific time. So it's just not Space Engineering but time engineering also.

    - We see that the concept of space and time are not just a continuum but:

        - The measures of time and space merge and results in the same unit measure called Tala. It is Adi Tala in Poetry, Music and the same measure is used in building and sculpture dimensions.

- **Space is created because of the pulsation called Time** and hence the unit time measure (for pulsation) and the unit space measure (result of pulsation) are one and the same. This means the pulsation causes proportional displacement or creation of Space.

- It is the same concept used in meditation techniques. With Pranayama, Dharana and Dhyana you control the pulsation and align with it. In Samadhi you stop the pulsation and hence you are beyond time and space and you reach a luminescent state of resonant non-vibration.

Hence I named this book as **"Time = Space".**

We have seen that each subtle unit is represented in 8x8 energy grid and the gross unit is represented in a 9x9 energy grid. Mayan states that **"Each module or pada within the 8x8 / 9x9 structure resonates with a specific energy.** Based on Space, Time, Light, and Sound coordinates the frequency of vibration has its unique position in the Space/ Time continuum. **This energy level of frequency of vibration is called a luminous body or Devata**. This devata has particular attributes based upon its position and qualities in the Space/Time continuum (placement among the 64 / 81 sub-cubes or padas)".

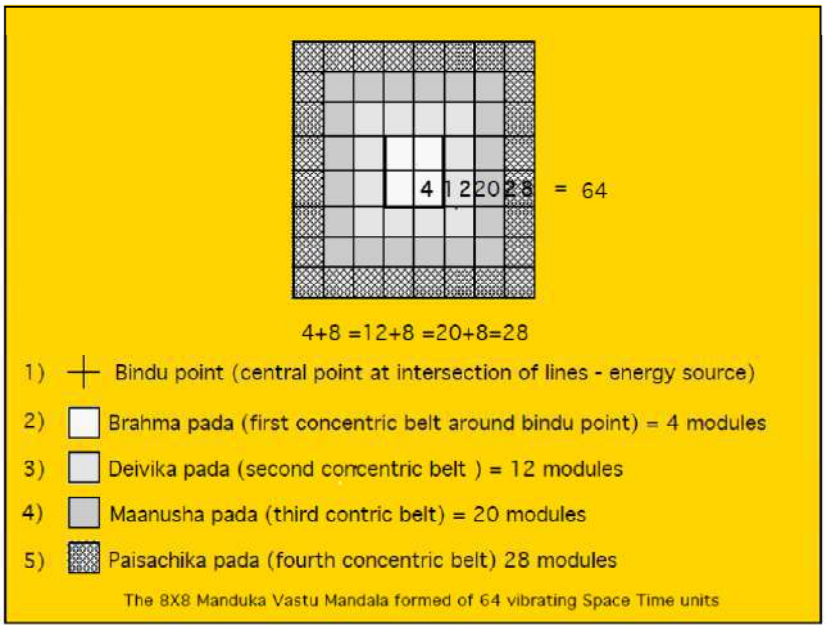

Figure 37: 5 states of 8x8 Energy Grid (Courtesy: Dr. Ganapathi Sthapati)

Now what is evident here in this science is 8 and 5 merges and so does Space and time.

- **Manifestation occurs in additive values of eight and in 5 stages. You can note that the Bindu (Point) has become 4, then 12, then 20 and then 28. (4+8=12 +8=20+8=28 with a total additive factor of 64). Manifestation occurs in sequences of five steps known as the Pentadic Order.**
- **The mathematical calculation which gives form to consciousness / space / subtle matter is called "Ayadi Gananam". We know that Ganam as the additive process.**

Dr. Jessica Marcey in her Fabric of Universe states that:

- The subtle energy point in the center becomes a self effulgent energy generator pouring out waves of energy
- becoming a self spinning stabilized structure of four padas / modules then
- adding eight units of energy to manifest the 4X4 structure of 16 units or modules; then
- adding another eight units of energy to manifest the 6X6 structure of 36 units or modules; then
- Adds eight more units culminating in 64 units or modules strung concentrically around the Bindu point or central generator.

So a central point with 4 concentric square belts around, each has its own frequency, vibration and energy characteristics evolving into a 9x9 unit as a gross matter. While this knowledge is significant of itself, when these phenomena are viewed in light of material manifestation as built space in architecture, the significance becomes stunning and profound.

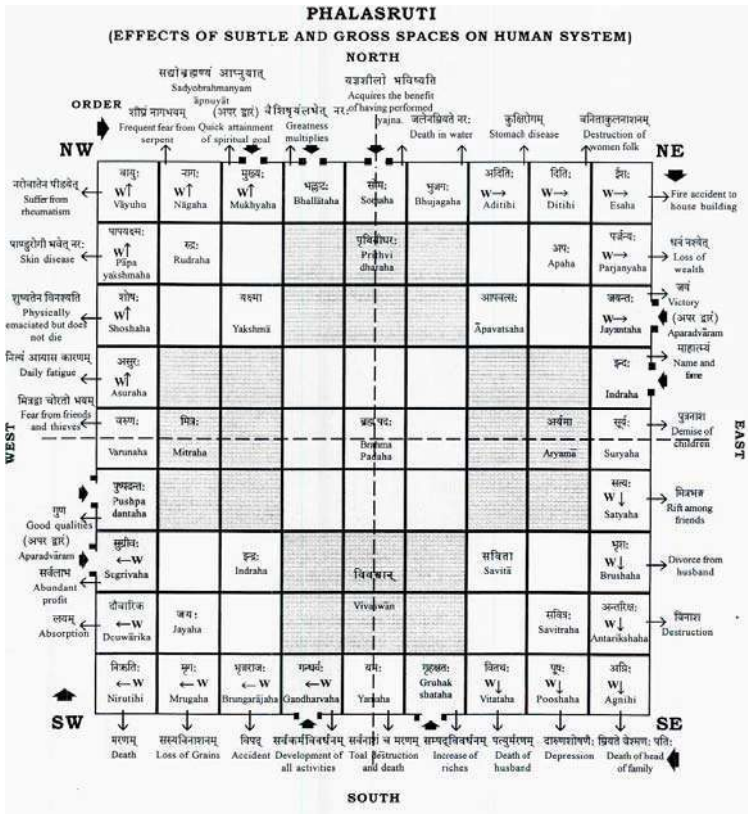

Figure 38: 9x9 energy grid with corresponding energy levels for each grid.
(Courtesy: Dr. Jessica Marcey, Fabric of the Universe)

So, to sum up this section, we have seen that how every inanimate thing in this universe is still a living being and how with the spatial science we can pump throbbing energy into a building. This is the supreme science where Time and Space merges. This is the 4th sacred art we talked about which is a manifestation of the visual form of Om.

As you would have noticed I have avoided talking about rituals and rules here but focused on the concept and philosophy. When we talk about rituals there are very many variations and we get into an unnecessary argument that whether it is rational or superstitious. Since most of the arts have become commercialized, the person's qualification and his intentions are always questionable.

The objective of this book is to highlight the scientific aspects of the universe in a small way and emphasis that our culture is built on this science. Be it language or arts or religion all are built on scientific facts. They all were nourished and nurtured in thousands of Temples across India which is the container and protector of this subtle science and energy.

Let's see some more interesting aspects of this in the next section.

Happy reading!

28. TIME = SPACE SERIES. PART 28 – CAPTURING THE DIVINE ENERGY – SQUARES & CIRCLES

It is told that the sanctorum of Lord Ranganatha's temple at Sri Rangam is circle from outside and square from inside. Why?

- Subtle energy is represented by 8x8 square grid and the perimeter of the square is 4r and the area of the square is r*r. When each grid length is 1 unit then r = 8, so perimeter is 32 and area of this square is 64.
- Gross energy is represented by 9x9 square grids and with the same measurements perimeter is 36 and area of this square is 91.

It has been an architect's dream to create and capture subtle energy in a gross structure. This is fundamental objective of spatial engineering. How do you go about to achieve this? It looks that they found that they would take the help of a circle either outside the square or inside the square to achieve this. Remember almost every yantra has a square and a circle component in it.

The measurements are so taken such that either the perimeter or the area of both the circle and the 8x8 square are matched. Most of the Hindu temples follow such rules to invoke the subtle energy in a gross structure like temple. This is one of the well kept secrets and this is the reason each and every temple is said to interact with your subtle body differently when you visit it.

This is why Lord Ranganatha's sanctorum in Sri Rangam temple is a circle from outside and square from inside. This secret is called as **Squaring a Circle**. This is all about to creating divine energies and this is the science that is implemented in all the Hindu temples which are built as per the Sastra. You need just basic math knowledge and patience to understand this supreme secret and I shall give below 2 techniques to match the area or the perimeter of the circle with that of the 8x8 square.

<u>Perimeter match:</u>

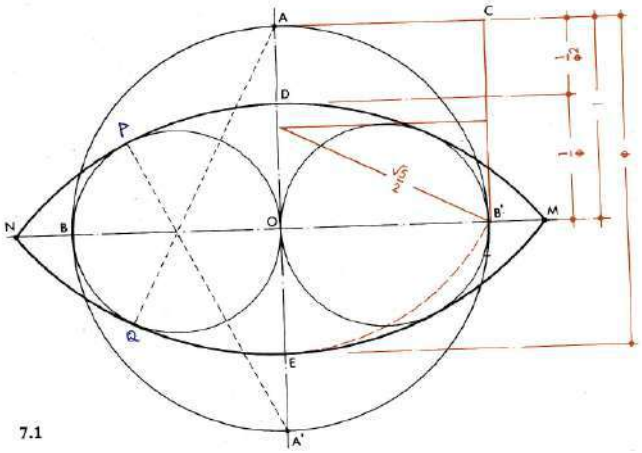

- Let's look at the image of a circle of unit radius. The **area of the large circle is π** (πr^2) and the **circumference is 2π**. Here r =1.

- Draw 2 circles inside as shown with half the radius. The area of each circle is π/4 and the **combined area of both the circles is π/2**. The circumference of each circle is π and the **combined circumference of both the circles put together is 2π**.

Figure 39: Squaring a Circle (Courtesy: Dr. Robert Lawlor, Sacred Geometry)

- Just note that when a larger circle divides itself as 2 smaller circles the area is halved but the circumference is the same. **This gives the first philosophical metaphor that "One has become two which are bipolar yet non-dual". This is one of the fundamental principles of Advaita and also in Chinese philosophy. This bipolar non-dual force is the basis of life and is represented as male / female and Yang / Yin.**

- Now draw 2 arcs NDM and NEM from A' and A with the radius as A'P and AQ as shown in the dotted line. You would note that point D and E would divide the radius of the circle by divine proportion – $1/\Phi$ and $1/\Phi^2$. **Radius of the arc AE is Φ. The Yin Yang symbol is based on this principle which embeds the divine proportion in it.**

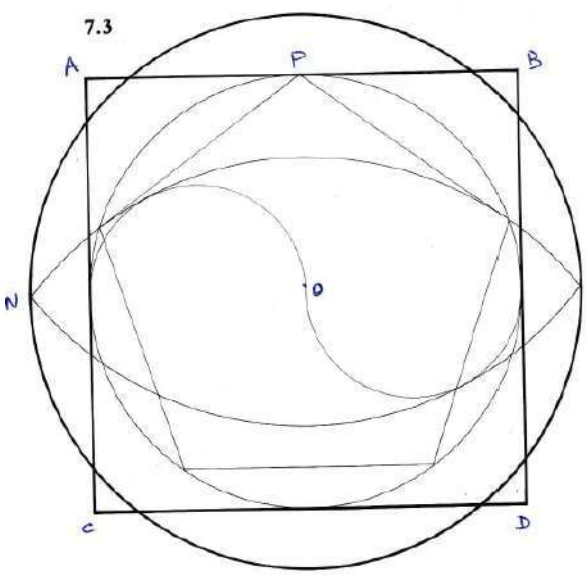

- Now let me draw a square ABCD around this circle (Fig 40) where the side of the square is the diameter of the circle which is unit 2. Here OP =1, AB=BC=CD=DA = 2. **The perimeter of the square is 8 and the area of the square is 4.**

- Now draw a circle with O as the center and NO as the radius as shown in the figure. Here NO = $\sqrt{\Phi}$. You can take this figure as such if you find it difficult to follow but for those who are interested, the derivation to calculate radius "NO" is as below:

Figure 40: Squaring a Circle 2 (Courtesy: Dr. Robert Lawlor, Sacred Geometry)

  - Consider a right angle triangle OPN. We know OP = 1 and PN which is the radius of the arc = Φ. Hence as per Pythagoras theorem $PN^2 = OP^2 + ON^2$ which is $\Phi^2 = 1+r^2$. Let us say the radius is ON = r.
  - So $r = \sqrt{(\Phi^2-1)}$. We know Φ is 1.61803399 so **$r = \sqrt{\Phi}$.**

- We have got a larger outer circle with a radius **$\sqrt{\Phi}$** and hence the perimeter should be **$2\pi\sqrt{\Phi}$. This is numerically equal to 7.9924576, which is equal to 8. Now we have created a structure where a square whose perimeter and a circle whose perimeter are the same.** This technique is not limited to India but used in the same way for pyramid construction.

- **This is the perimeter match between 8x8 square grids and a circle around it**.

<u>Area match:</u>

- Vaastu has an easier way to get this done. Draw a circle inside a 9x9 energy grid whose diameter is equal to the side of the square. If each energy grid length is 1 unit, then side of the square is 9 units and the radius is 4.5 units.

- The area of this circle is πr^2 where r=4.5 and hence the area of the circle is 63.64 which is almost equal to area of the 8x8 square with unit grid length as 1 unit.

- This is the area match between a circle and 8x8 square. So as per Vaastu every building is divided into 9x9 grid and the energy level of each grid is used to design the living space.

Capturing the direction of Subtle energy flow:

The subtle divine energy flows is as per the diagram given below. It starts from the center and always flows clockwise. That is why Hindus always stick to clockwise flow of movements - be in their temples or anywhere else. This clockwise flow of movement is captured in the sacred symbol Swastik. Here 1 is the source / Moolam, 2 is Kaalam (Time), 3 Seelam (Rhythm), 4 Kolam (Form), 5 (Universe) Gnalam.

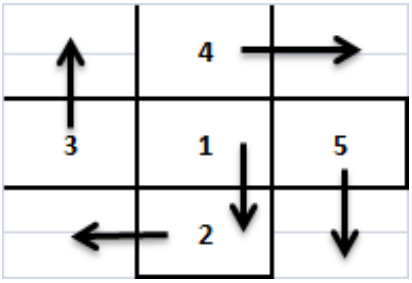

Figure 41: Clockwise flow of subtle energy

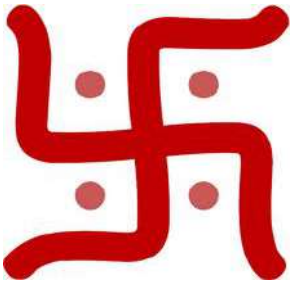

Figure 42: Swastik symbolizing energy flow

Relationship between √2, √3, √5, Φ and π:

- Now let me draw the connection between √2, √3, √5, Φ and π. Understanding this relationship is orgasmic and nothing less. If you think they are all some random numbers which cannot be fixed to their 10th decimal and not related to each other, just see the following relationship.

  $$\pi = \Phi^2 \times 6/5$$

  Philosophically 6/5 is the relation of a hexagon to a pentagon and the other way to express this relationship is

  $$\Phi = (\sqrt{\pi} * \sqrt{5}) / (\sqrt{2} * \sqrt{3}).$$

- This goes to prove that we did not just knew the numerals but divine fractions and proportions including their linkages. I am convinced, there is not even an iota of superstition in our temple and idol worship but they are supreme sciences codified and left for our benefits.

- The temple of **Sri Rangam** dates back from Ramayana, which is Treta Yuga that is 800000+ years back as per Hindu Scriptures. This is our rich past and supreme science is embedded in our culture and codified in thousands of temples across nook and corner of the country. Why should

we ignore this? We have a lot more to offer this world which is struggling to understand the nature of nature.

As a wise man said, **“Indians are the most ignorant about their rich past and scientific traditions.”**

Happy reading!

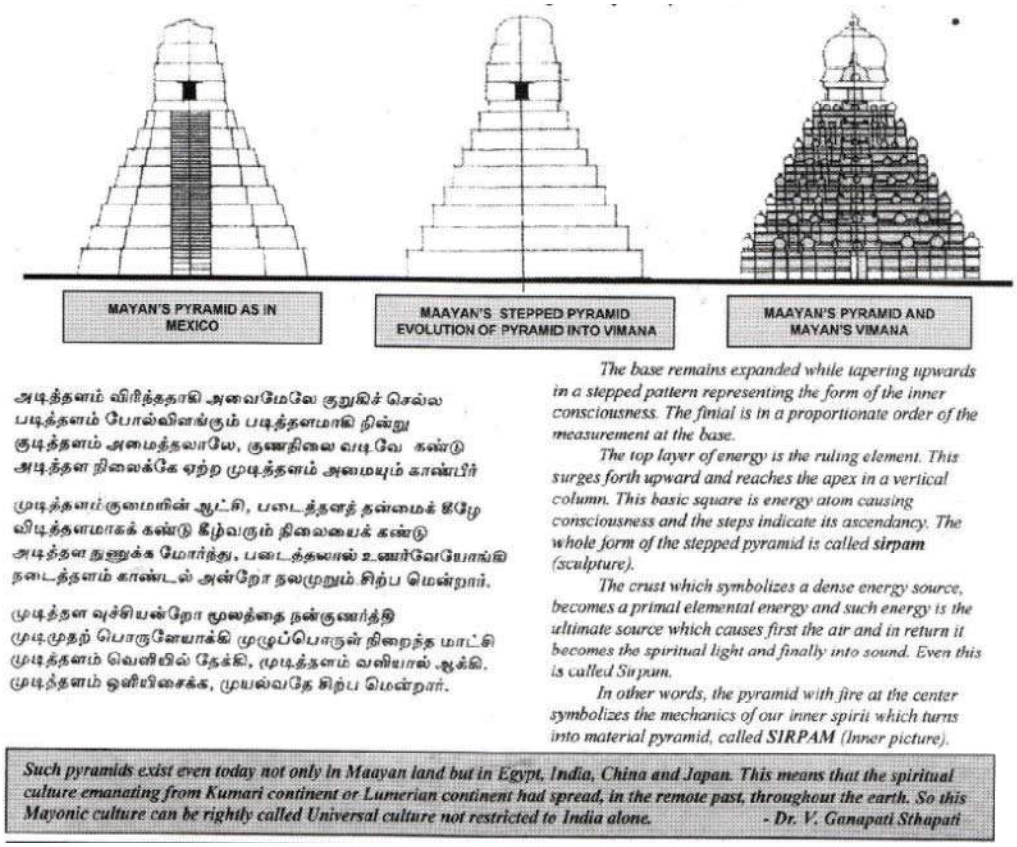

Figure 43: Similarity between Indian temples, Pyramids. The Tamil text states how the structure should be built. (Courtesy: Dr. Ganapathi Sthapati)

29. TIME = SPACE SERIES. PART 29 – HEAVEN & EARTH – LORD NATARAJA & LORD RANGANATHA

Let's stay with Lord Ranganatha and see the relationship between him and Lord Nataraja. Would you be surprised if one is the mirror image of the other? Look at the majestic picture of Lord Nataraja below. Wonder why this is always made in metal and not in wood or earth?

Figure 6 reproduced.

In Pancha bhoota (Space, Air, Fire, Water, Earth) Metal is always associated with Space and Wood is associated with Air. This system is reflected well in the Chinese system and it was not any different in our Vaastu system either. Since Lord Nataraja signifies Akasha tatva, **(Vin porul)** he is always made in metal – Copper or Gold or Bronze or a mix of it. The statues which were ancient had a generous amount of gold giving a luminescent look about the statues. The art and science of moulding metals to create divine forms with precise proportion dates back to thousands of years in India and the western experts think that this is a recent phenomenon. This is a complete surprise to the western world since they cannot believe that such sophistication existed before.

Dr. Ganapathi states, *"Lord Nataraja also signifies the primal image being expressive of the secret of creation in the process of which formless becomes instantaneously endowed with features and of perfect form. This is the reason why the statue of Lord Nataraja is called as **Silpa**, the primal image and everything else which is sculpted in this universe is called as **Pratima (replica)** and the original and one and only sculpture is the image of Lord Nataraja***".**

Mamuni Mayan states, *"Bhumih pradhana vastu Syat"*, means Earth by virtue of being the very basic support of all things, this is the primal and dominant Vastu". Earth and space are manifestations of each other in the cyclical process of evolution. They both should always be considered to be in unison. This vibrant, energetic, manifest earth energy (**Prithvi Tatva)** is called as '**Vishnu**".

In Vaastu satra, the Vaastu purusha is Lord Vishnu and understandably Vishnu is invoked as Vaastu purusha in Srirangam temple and offered a seat in the heart of Lord Ranganatha even today as a ritual.

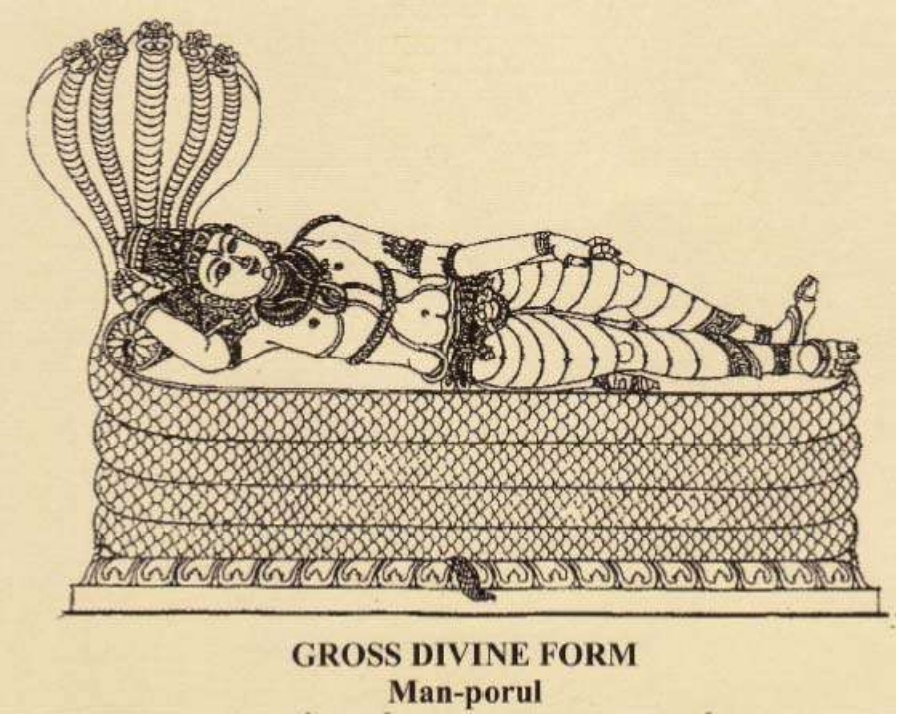

Figure 44: Lord Ranganatha in the reclining pose

Lord Ranganatha represents manifest earth energy **(Man porul)** and hence is always made out of seasoned earth only and it should be properly painted too. He is never to be made of metal. This earth form does not support frequent mobility and symbolizes stability and immobility. **This is the reason when Vibhishana kept the idol of Lord Ranganatha down at Sri Rangam it could not be moved.**

The energy that is in available in every universal form is represented as Vishnu and hence he is called as **Antaryami**. Once the subtle becomes grosser the vibration is reduced and the grossest form would not have any creative pulsation in it. It would still have the vibration based on its nature which ensures that it retains the form and shape. But it does not have any creative pulsation and it has reached the zenith of evolution. **This zenith is characterized by Lord Ranganatha in the reclining pose**.

The creative pulsation (Space) is the dance and the zenith of manifestation is a reclining posture (Earth).

As we have seen, Lord Nataraja carries **Light in his left hand** and **sound in his right hand**. Lord Ranganatha carries **Chakra representing light in the right hand** and **Conch representing sound in the left hand.** The principle that the primal substance (space) has manifested as the universe (earth) and both of them are mirror images of each other is reflected in both the images.

In Chinese texts the Yang energy is associated with Heaven and the Yin as earth. Now associate the same heaven with Shiva, Earth with Vishnu and Tao with the God's particle - with some of the text below from **Lao Tzu's "Tao te Ching"**

"The Tao that can be told is not the eternal Tao.
The name that can be named is not the eternal name.
The nameless is the beginning of heaven and Earth.
The named is the mother of the ten thousand things.

Something mysteriously formed, Born before heaven and Earth.
In the silence and the void, Standing alone and unchanging,
Ever present and in motion, Perhaps it is the mother of ten thousand things.
I do not know its name. Call it Tao.

Man follows Earth. Earth follows heaven. Heaven follows the Tao.
Tao follows what is natural."

To sum up in the words of Dr. Ganapathi Sthapati:

- **Both the temples Chidambaram and Srirangam are south facing temples.**

- **Lord Nataraja signifies Akasha Tatva, outer space, macrocosm, subtle unmanifested energy is the Vastu purusha, is always in dancing pose, circumscribed in 8x8 square and made of metal.**

- **Lord Ranganatha signifies Prithvi Tatva, inner space, microcosm, manifest gross energy, is the Vaastu purusha is always in reclining pose, depicted in a circle or a 9x9 grid and made of earth.**

- **Lord Nataraja represents energy with matter and Lord Ranganatha matter with energy. In the equation $E = mc^2$, Lord Nataraja represents E and Lord Ranganatha represents mc^2.**

- Both these temples are a 'must see" and a "periodic see" types and you would be amazed that the qualitative change in your mental state even if you don't pray inside the temple but spend some time sitting or walking in the premises of the temple.

- **Both these temples are perfect symbols of ancient science codified for the benefit of the society and left for generations withstanding the test of time.**

Figure 45: Sri Chakra – The Supreme shape in sacred Geometry

Chidambaram and Sri Rangam should be ground zero for any lab that wants looks into the secrets of space and time as they represent supreme science as much as they represent spirituality. We now see that science was the basis of our spiritual faith unlike it being 2 completely different aspects today across the world.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

May we be blessed by the divine power to unravel unknown secrets about the nature!

Happy reading!

30. TIME = SPACE SERIES. PART 30 – TEMPLES AND IDOL WORSHIP

Let us forget Hinduism, its symbols and names of god for the time being and consider these aspects as pure science from a nanotechnologist and cosmologist called Mayan.

We have been told that the universe is full of luminescent particles and this particle manifests itself because of the primordial pulsation. We have had a sneak peek into the geometry and the mathematical proportion which is used in the creation of many things. We know that the universe rhythm confirms to a mathematical code to the extent that we can create divine energies in a temple based on that science.

If time is pulsation of consciousness and if it creates, sustains and destroys everything, then time is the architect sculpting the universe and every object in this universe should be a sculpture of time and this concept is very beautifully captured in ***"Jagat Sarvaram Silpameva'*** *meaning the entire universe is nothing more than a shilpa / sculpture (and it latently conveys that Time is the Shilpi).*

If all the above things are right then is it not right to say that "Man created the concept of God" or "Man can create divine energy around him"? Let me sum up my thoughts as below:

- The sages and rishis were essentially scientists and understood the secret of nature very well. They were understandably masters in **nanotechnology and cosmology.**

- They knew that "**One thing"** with which they could understand the nature and science of all other things in this universe. This is obviously supported by the mathematical knowledge they had.

- As per Vedas nothing is created by god including the Vedas, but universe is the manifestation of god. They also understood that man is the most evolved of this manifestation. This is why they created all the god forms in the image of a man.

- Be it language, poetry, classical music, classical dance, sculpture and architecture it was the manifestation of this divinity that was the underlying link. Sacred geometry and sacred proportions were used to generate the subtle energy that took us closer to divine.

Hindu temples were created to capture all these aspects in one place and which could sustain and grow for the benefit of mankind.

- Secret of nature heard through the vibrations of Vedas were codified as supreme science and weaved into a philosophy called **Sanatana Dharma.**

- Architecture of temples confirmed to divine proportions and space - time engineering was accurate to capture sunlight and moon light at the same position for thousands of years. The design of the temple cleaned the subtle energies and points of the human body.

மூலாதாரக் கணபதித் திருமேனியின், படிமமான இலக்கணம்:

गुणरवि नयन रुद्रं द्वादशं षट् षडांशं
अनल रसगुण भागं केश वकत्रं च कण्डं ।
हृदय उदरमेढ्रं ऊरुजानुंच जंरवा
पदमिति उदयमानं पञ्चतालं गणेशम् ॥

3,12,2,11,12,6,6,3,6,3 [=64 துடிப்பளவுகள்] முறையே, கேசம், முகம், கழுத்து, மார்பு, வயிறு, மேட்ரம், தொடை முட்டி முன்கால், பாதம் ஆகியவற்றின் உயர அளவுகளாகும். இவை பஞ்ச தான கணேச உருவத்தின் [உறுப்புக்களின்] உயர அளவுகளாகின்றன. [இது கண்யம் என்று சொல்லப்படும்].

பட விளக்கம் பின்வருமாறு:

விநாயகர் [ஐங்கரத்தன்]

Figure 46: Ganapathi Idol (Courtesy: Dr. Ganapathi Sthapati)

The sloka above in Sanskrit gives the measure of different parts of this Idol which would confirm to total 64 units (resonance of 8). Hair (3), Face(12), neck(2), Chest(11), Stomach(12), Belly &Pelvis (6), Thigh(6), Knee(3), Legs (6), Feet (3). Total 64 units. Just as much a Sloka with right metre and letters becomes a living organism, an idol with right proportions becomes a living organism.

- Divine Idol forms confirmed to a mathematical proportion that invoked subtle energies within and around us. This is where the external forms were used to create energies internally to a human. **This is the basis of idol worship. If it is scientific to create a form with divine energies based on mathematical proportion then idol worship is the supreme proof for that science.**

- **This supreme mathematical law is called as Dharma (nature's law) and the unfolding of that law is the Karmic theory of cause and effect / law of karma.**

- Poetry, classical music and classical dance are intimately linked to this Hindu temple culture. Adi Tala and octaves were used to create subtle energies in poetry using words, and the same tala maana is used in classical music with rhythm and raga, in classical dance with light and sound and in sculpture as a visual form.

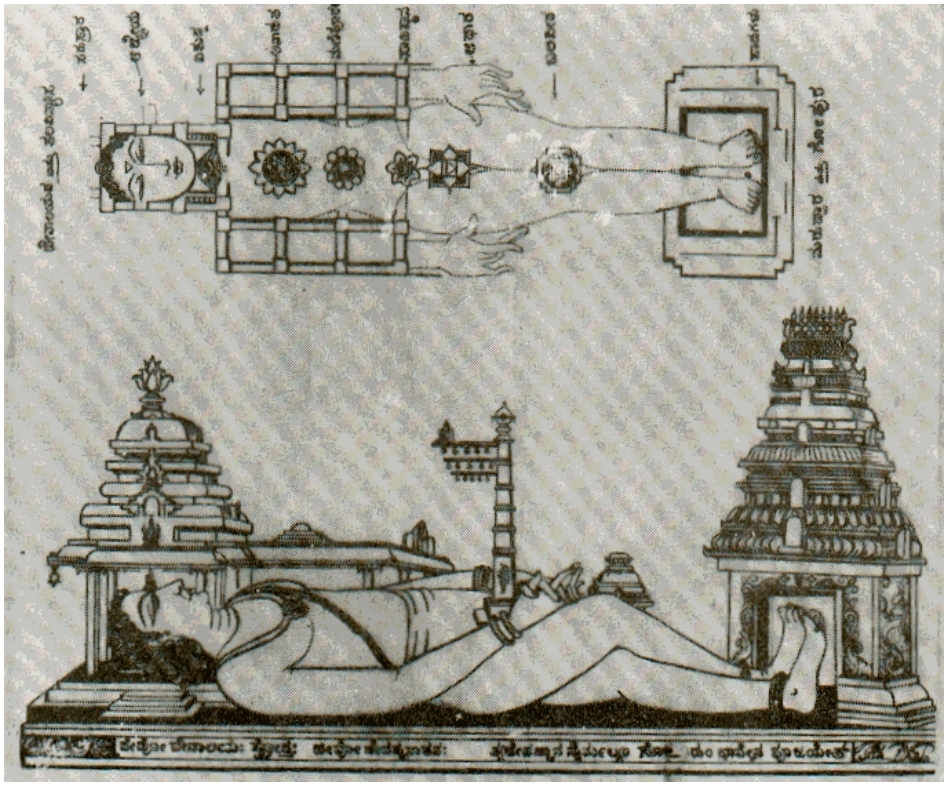

Figure 47: Human body as a representation of a temple
(Courtesy: http://www.salagram.net/sstp-mgpuja3.html)

A Hindu temple is a divine and yogic representation of a human being with the Deity in the temple representing the God as indweller in humans and all beings. In a temple the feet represents Rajagopura, the hands represent Praakaara, the abdomen represent Mandapa, the heart represents Antaraala and the crown of the head represents the sanctum sanctorum (garbha griha). The temple is used as a reminder that our inner spiritual journey is through internal yoga to realize the indweller God. This analogy is shown through the representation of various chakras namely Moolaadhara to Sahasraara in the body to various locations in the temple.

- It may be of interest to note that the same harmonics of 8 are reflected in every other domain. For example, if you have been practicing Pranayama then your master would have asked you to practice breathing based on some counts. The most popular counts are 6(inhale), 3 (Exhale) or 7(inhale), 2 (Exhale). If you notice this count 9, this cleans up your gross body. Advanced Pranayam students may be asked to stick to 1 (Inhale), 4 (Retain), 2(Exhale), 2(Retain outside) or as a variation 1,4,2,1 or 1,3,2,2. The counts which add up to 8 clean the subtle body.

- Till few decades back the fundamental dimension for money in India was "**Ana"** called as **Eight Anas (6TL̇L6ŌTIT)** and this was equivalent to Rs. 0.5 as the fundamental measure.

- Thus a **"Poetry is an idol in aural form and a building is a frozen music"**. A Poet by the way of his mental frequency has first become the poem itself and then the actual poem was created in its aural form and an artist by the same frequency has become the idol first and then he gave a shape to the idol externally through this hands. This is very beautifully given as ***"Raso vai saha, So Vai rasikaha", which means he (god) is the enjoyer and he is the artist.***

- All of this reflects the supreme philosophy that **"Oneness in all and everything is just a manifestation of that one thing"**.

- Now in this light understand the meaning of this Upanishad prayer, *"Aum Poornamadah Poornamidam Poornaath Poornam Udachyathe, Poornasya Poornamaadaaya Poornameva Vasishyathe". This means God is perfect (infinite). This Universe is also perfect (infinite). If perfection (infinity) is taken from anything perfect (infinite) what remains is still perfect (infinite).* Isn't this is the actual reality today?

- Everything scientific is philosophically, mythological and ritually well interwoven that proves that Sanatana Dharma is the most ancient and supreme representation of science and nature's secret in our possession. Our temple worship which integrates all this science, 5 sacred arts with language and Math is the standing example of our understanding of the nature of god.

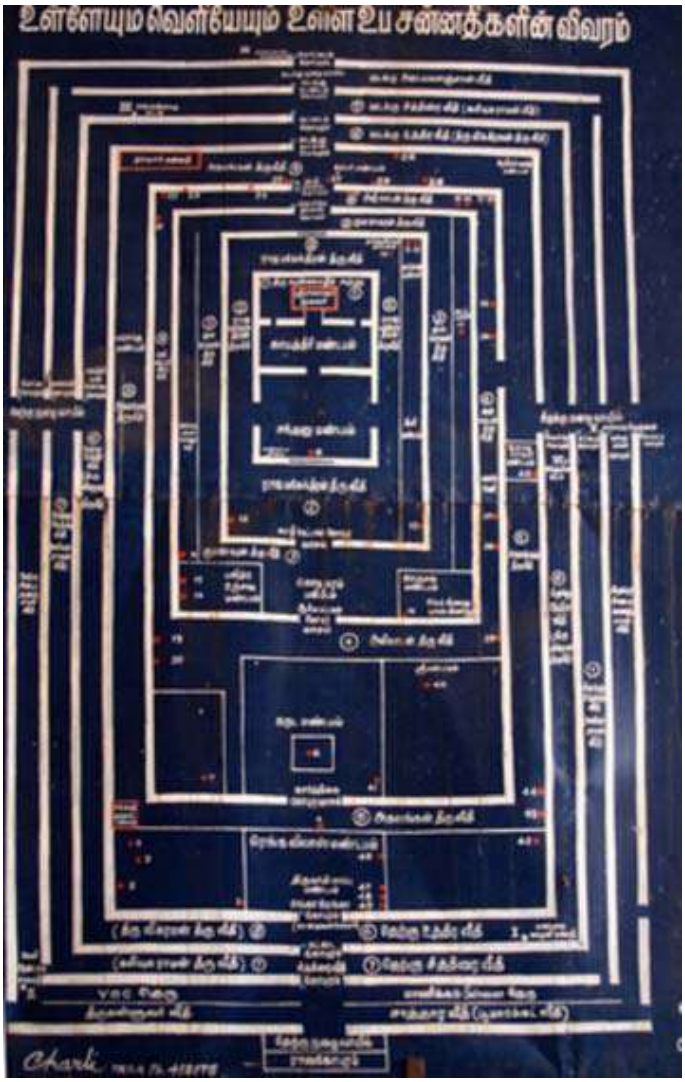

Figure 47: Layout of Sri Rangam temple with 7 Prakaras

It is the same Sugarcane but an elephant eats it from the field directly, a young adult peels the skin off and chews it, if a kid has to eat then someone has to peel the skin and cut it into pieces and an old man without teeth needs it to be made as sugarcane juice. Depending on one's ability to chew and digest the food has to be processed.

Same way depending on one's mental ability to grasp the supreme truth it has to be processed and presented. If someone is mentally well evolved then they can be fed with Upanishads and he can meditate on the formless Brahman. To a young adult Upanishads may not be palatable directly but they may have to start with Upavedas and Vedangas to mature to a higher level. For the less evolved kids, Itihasa and Purana like Ramayana and Mahabharata with stories may drive home the point and they can start with Shlokas and mantras. But for the least evolved it has to start with a personal deity with name and form, bhajans and songs to invoke the concept of Bhakthi.

In all the four cases temple culture forms the lowest common denominator. Even the most evolved relish the arts and architecture in the temples. We should be proud of our rich cultural and scientific

heritage and be passionate about the science and philosophy and be rational about rituals and symbolisms.

Image / Idol worship is not deplorable or despicable. This is the highest scientific form of worship which enables us to see face to face the one which is beyond reach of sight and speech. This kindles devotion, community development and helps one to climb the steep walls of spirituality in the initial stages. Every religion in this world has some image or idol as symbolism to achieve this objective.

An idol is a god in form when made with the science of divine proportion and seasoned material is the highest product of our intelligence till today.

It should however be noted that this idol worship should not be lost in the din of rituals which does not reflect the very philosophy it had come to symbolize. So the advice I follow is *"Be passionate about our culture but be rational about the rituals.*"

The advancement of science can progress rapidly when the western scientists who are objective and empirical, partner with the pundits in India and learn the science of the subtle from our scriptures and temples. For this to happen we need to learn our own scriptures and past which is not possible without learning our mother tongue and Sanskrit. Else in the near future we may have to import knowledge of our culture and rich past from the western world.

As a wise man said, **"Indians are the most ignorant about their rich past and scientific traditions."**

Happy reading!

31. TIME = SPACE SERIES. PART 31 – MAYAN & HIS WORKS

Mahamuni Mayan was the father-in-law of Demon King Ravana and is referred in both Mahabharata and Ramayana. He is attributed with building the palace for Yudhishtar in Indraprasta and also the architect for Sri Lanka which Ravana ruled. His son Nalan helped Lord Rama build the Ramasethu – the bridge between India and Sri Lanka. He is believed to have lived in the **Ilamuridesam** popularly known as **Lemuria continent (Kumari Kandam**) which spanned 4500+ kms from Sri Lanka to Antartica connecting current Australia, Africa and Americas. Check out http://www.sacred-texts.com/atl/tll/index.htm

Understandably when this land mass was consumed by the sea their clan moved to different parts of the world including Guatemala, Egypt, and to current south Indian region. This explains as to how we find common science across India, South America and Egypt.

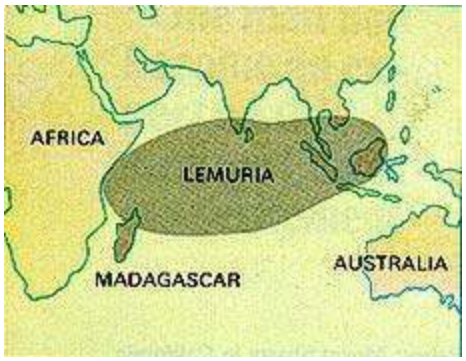

Figure 48: Kumari Kandam depiction

He has written books in both Sanskrit and Tamil and I am going to produce the list of technical works he has created and look at the contents of a specific book called Surya Siddhanta. Just the list of works and also the topics in Surya Siddhanta is amazing, highlighting the depth of science we had at that time. http://www.youtube.com/watch?v=PZKiCpFisoY

The Surya Siddhanta

The most ancient treatise on Astronomy is a treatise authored by Mayan. It is called *The Surya Siddhanta*. Included in this treatise are the following chapter topics following:

- The Motions of the Planets
- The Places of the Planets
- Direction, Place and Time
- The Moon and Eclipses
- The Sun and Eclipses
- The Projection of Eclipses
- Planetary Conjunctions
- Conjunction of the Stars
- Risings and Settings
- The Moon's Risings and Settings
- Certain Malignant Aspects of the Sun and Moon
- Cosmogony, Geography, and Dimensions of the Creation
- The Gnomon
- The Movement of the Heavens and Human Activity

Figure 49: Mamumi Mayan

Mayan is also attributed with the start and spread of Temple culture in India. The song below in Tamil states that since Mayan sat under the Banyan tree and taught this science of universe and also of the sacred arts, so that every town was endowed with Temples for social betterment. Because he was from the southern region and also he sat under the Banyan tree, he is also equated with Lord Dakshinamoorthy.

ஆலமா மரத்தின் கீழே அருள் மயன் அமர்ந்ததாலே
ஆலமா மரத்தின் கீழே அருட் கலை வளர்ந்ததாலே
ஆலமா மரத்தின் கீழே அறிவர்கள் வளர்ந்ததாலே
ஆலயம் ஊரும்தோறும் அமைந்தன செழிக்கநன்றே!!

The Mayan says in his Pranava Veda verse one:
*"Om Light and Om Sound are the Primal Source of all manifest forms. Om Light is aroused by its own effort in a state of disorder and appears as a flame. The state of Om Light and Om Sound in Space is a magnificent luminous six – faced Light form that is called "**murukoli**". The transformation of Om Light and Om Sound through the five stages is concealed in the five fold knowledge, of which, this is the first. This process of transformation of disorderly Om Light and Om Sound into orderliness is found in all five fold material forms."*

Sage Veda Vyasa says in the Bhagavatam, *"eka eva pura vedo pranavha sarva vangmayha" (9th skandha, 14th chapter, sloka 48 of Bhagavatam).* This means that there was only one Veda called Pranava Veda. It is believed that Sage Vyasa created 4 vedas from this Veda since he believed that the oncoming generations would not have the mental strength to master everything.

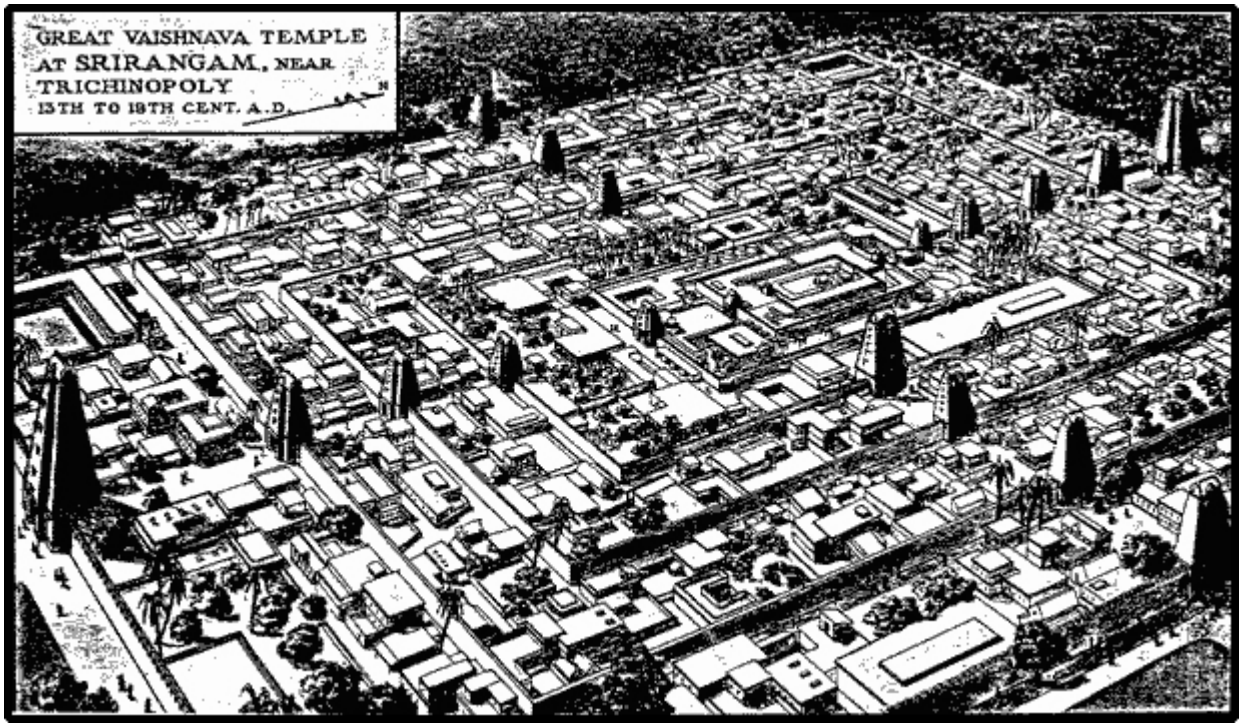

Figure 50: Aerial view of Sri Rangam temple with 7 Prakaras

Technical works

The following are technical works written by Mayan and represent the 12 vowels of the Tamil language:

- Ovia Chennool - Treatise on Drafting and Painting
- Sirpama Chenool - Treatise on Iconometry
- Kattida Chennool - Treatise on Architecture
- Nilamanai Chennool - Treatise on House Building based on quality of land
- Manainila Chennool - Treatise on Land based on the nature of house building
- Baniyal Chenool - Treatise on Astro Physics
- Perunata Chenool - Treatise on Divine dance
- Muligai Chenool - Treatise on Herbs
- Ganitama Chenool - Treatise on Mathematics
- Arakkala Chenool - Treatise on Ship Building
- Vinkala Chennool - Treatise on Space Ship
- Elisai Chennool - Treatise on Science of Music

MAYAN, in Aintiram *states that:*
"There exists an order in the Universe - subtle universe, and material universe. This power is attributed to the consciousness of the cosmic space as well as of the inner space of the animate beings. This consciousness, by its personal effort to express its own inner feelings, causes a kind of vibration or pulsation in the inner space, resulting in energy-grids. The vibration or pulsation, being the causal element of all these events, is called KAALA. This is actually the force of energy aroused by the inner consciousness, causing waves and contributing to the growth of living forms. This KAALA resides in all living beings. So, space is the offshoot of the vibration of the primordial energy. This is how the space was born. All forms of nature are manifest forms of subtle energy. For all to get manifested, the force is KAALAM. This wave-form frequency realm is the creative element of the universe."

There is no other treatise that we have in our possession today which is dated 10000 BC that depicts the secret of nature so explicitly and gives the unmanifested interconnections and mathematical proportions between everything in the universe.

As Dr. Ganapathi Sthapati rues "Unfortunately most of the Tamil experts don't understand the science in these texts and hence these books are idling without anyone extracting the truths from it". In the next few generations when we are less equipped in our own mother tongue we may lose this treasure completely just like the many we have lost so far.

Hence the first step we need to ensure is even if you are not equipped well in your mother tongue please make sure that your kids can read and write it well. This becomes our most important duty. And I find it worrisome when someone is indifferent to the fact that they can understand their mother tongue but cannot read and write.

With some significant efforts we can and we should prove that this man who said, **"Indians are the most ignorant about their rich past and scientific traditions."** is not wise any more.

Happy reading!

32. TIME = SPACE SERIES. PART 32 – CONCLUSION

What I have understood in a nutshell is as follows:

- The inner being of both - the individual and the universe is luminescent consciousness which has the ability to become aware of it. This luminescent consciousness is called by various names but it is essentially the only existent Vastu in this world. This Vastu manifests itself as time, space and spatial forms.

- ***"Aanor aniyaan mahato Mahiyaan!"*** this means what is in the atom is the same makes up the universe. That which is present in the atom is the Space energy and the meaning of the word Akasa is stated as ***"Aa kashayati aakasa ha!,*** That which imparts light to others or make others shine is called Akasa". This means that Space Vastu is luminescent. I am stressing the aspect of luminescent again and again for you to start perceiving God as light.

- Pranava is the causal element which triggers this evolution process and this manifests as visual and aural forms. Pranava results in the primordial pulsation and this pulsation is triggered and sustained by a divine progression and proportion which is called **Absolute time**.

- Absolute time creates Absolute Space. These 4 things – Absolute time, absolute space, Aural Pranava and Visual Pranava combine together to form spatial forms and hence this universe.

- The Vastu as God's particle, its characteristics, the Pranava, the pulsation, the rhythm, the progression, its proportion and the resultant energy states – all the scientific facts, theories and processes are captured and codified as a Dharma which is called as Hinduism today. The science behind this subtle energy is reflected in various art forms that includes Poetry, Classical music, dance, Sculpture and building architecture.

- All these manifestations are harmonics of 5 and 8 differentiated by the Golden proportion / God's ratio to reflect the various states of consciousness. **This intrinsic order is called Dharma and the cyclic nature of this evolution is the Karmic code embedded in the universe**. **Nothing in this universe is superior to the Dharma and Karmic code.**

- The divinity manifests in us and the space within us is nothing different from the macrocosm. Consciousness which exhibits itself as a state of being because of our mental vibration can evolve to a higher plane to devolve back into the luminescent core.

- Sanatana Dharma popularly today known as Hinduism is the repository of this supreme secret not just as a philosophy but integrated with every stage of our life. This can be understood better only if we can give due respect and attention to the language and scriptures, our spiritual tradition interwoven with arts and architecture that contains these treasures.

- The temple culture & Idol worship that we have symbolizes the best of science known to human beings and we need to understand this and preserve this in the best possible manner.

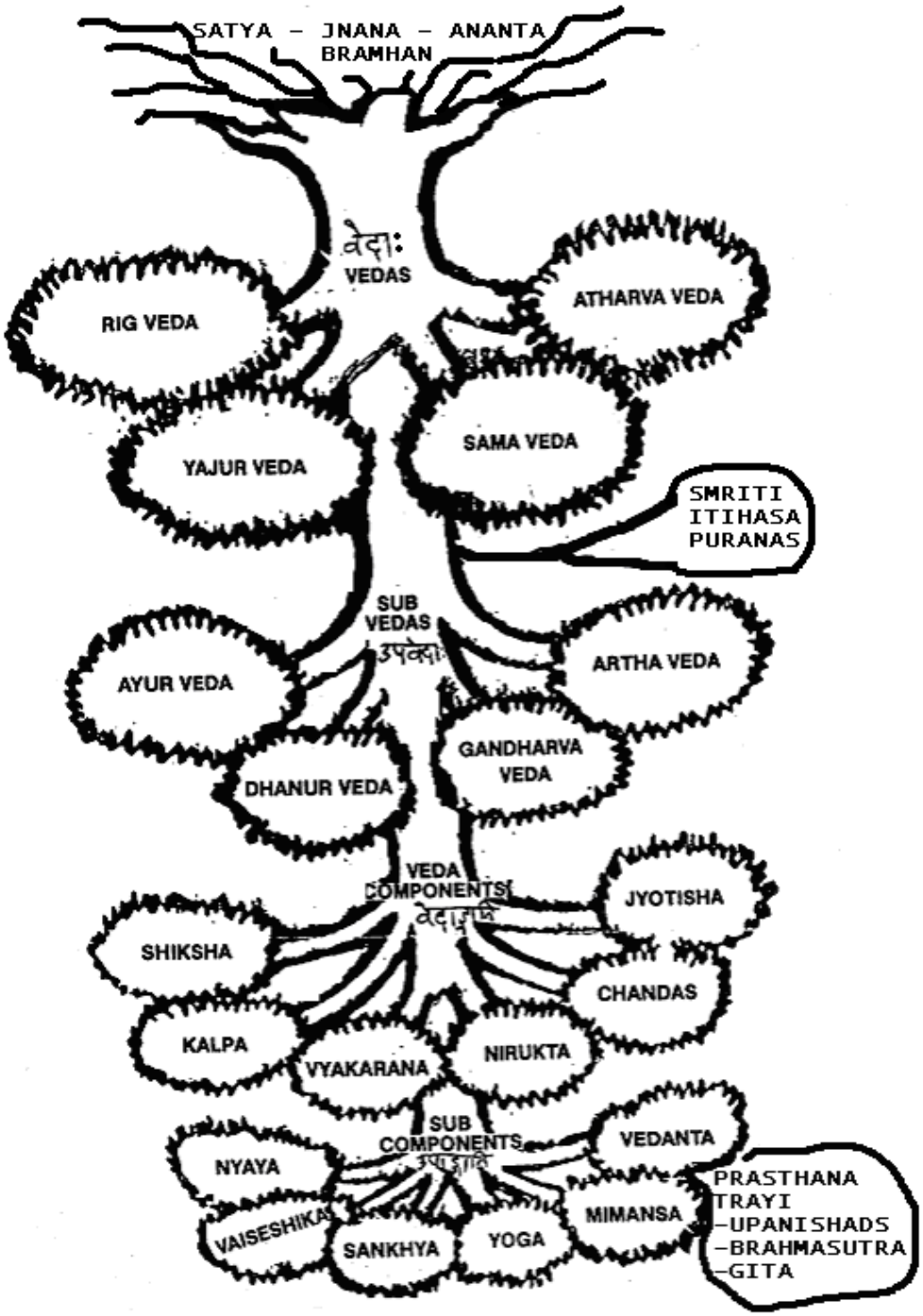

Figure 51: Vedic Knowledge as an inverted tree with Brahman as the roots signifying that everything has a common root. (Courtesy: Internet)

(Figure 52: Goddess Sarasvati. Courtesy: Internet)

She is the Goddess of speech, music and knowledge. She carries the rosary beads (akshamala) represents the alphabets of a language (Sanskrit), the musical instrument (Veena) and Vedas as palm leaf manuscript in her hands that denotes the knowledge. Thus we can see that idol worship signifies deeper scientific aspects of a common root between Language, Music, knowledge and arts.

Figure 52: Musical instrument Veena as a representation of Human Body (Sarira veena) (Courtesy: Internet)

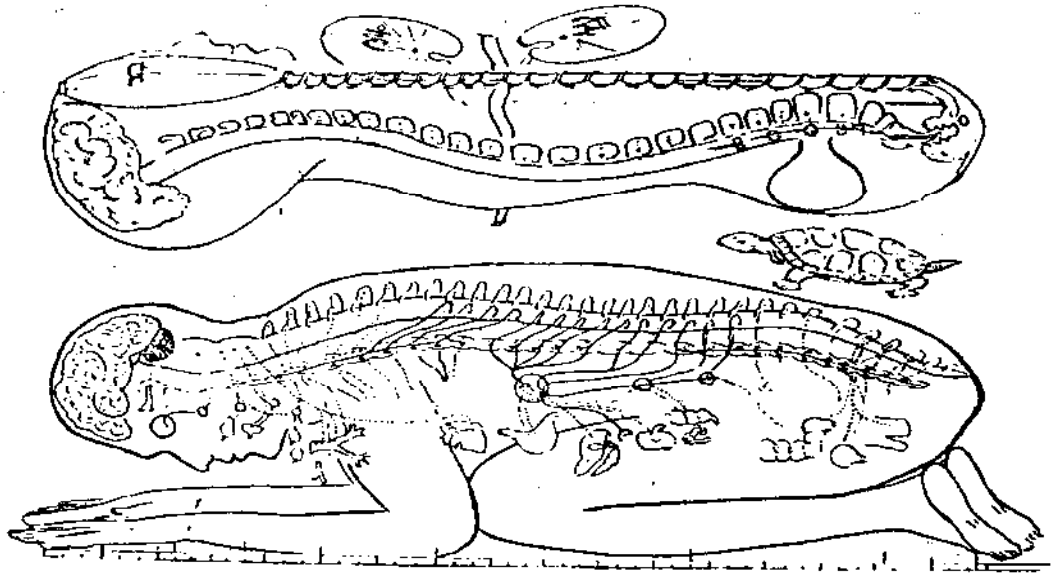

I am happy to note the coincidence that this book has 32 chapters with 108 pages – both being key universal numerals. Chapter 19 (the golden mean of this book) deals with the Golden mean or God's ratio of nature is again coincidental.

I would like to thank you for reading this book. I would like to state that I am neither adept in any of the topics discussed in this book nor an expert in any of the arts including the languages Tamil or Sanskrit language.

A curious mind driven by my passion to understand the underlying aspect in all things and my liking to reading has helped me to compile this book. My exposure as a student to Chinese martial arts, Indian yogic studies, Pranic healing and Siddha philosophy helped me to connect of the points I had articulated. Any authoritative statements in these books reflect my belief in the topic or from the author / teacher from whom I subscribed it and it is certainly not reflective of my abilities.

I am open to constructive criticisms on any of the topics and I can be reached at the mail ID shared in the first page of this book. My only request to you is *"Please share this book or parts of this book without any hesitation to your friends and family and help us dispel the ignorance about rich ancient Indian culture"*.

I shall end this book with some of my favorite quotes of Dr. Einstein.

"My religion consists of a humble admiration of the illimitable superior spirit who reveals himself in the slight details we are able to perceive with our frail and feeble mind. That deep emotional conviction of the presence of a superior reasoning power, which is revealed in the incomprehensible universe, forms my idea of God. We still do not know one thousandth of one percent of what nature has revealed to us."

Satyam Param Deemahi!
May we meditate on the supreme truth!

TIME & THE TECHNOSPHERE

The Law of Time in Human Affairs

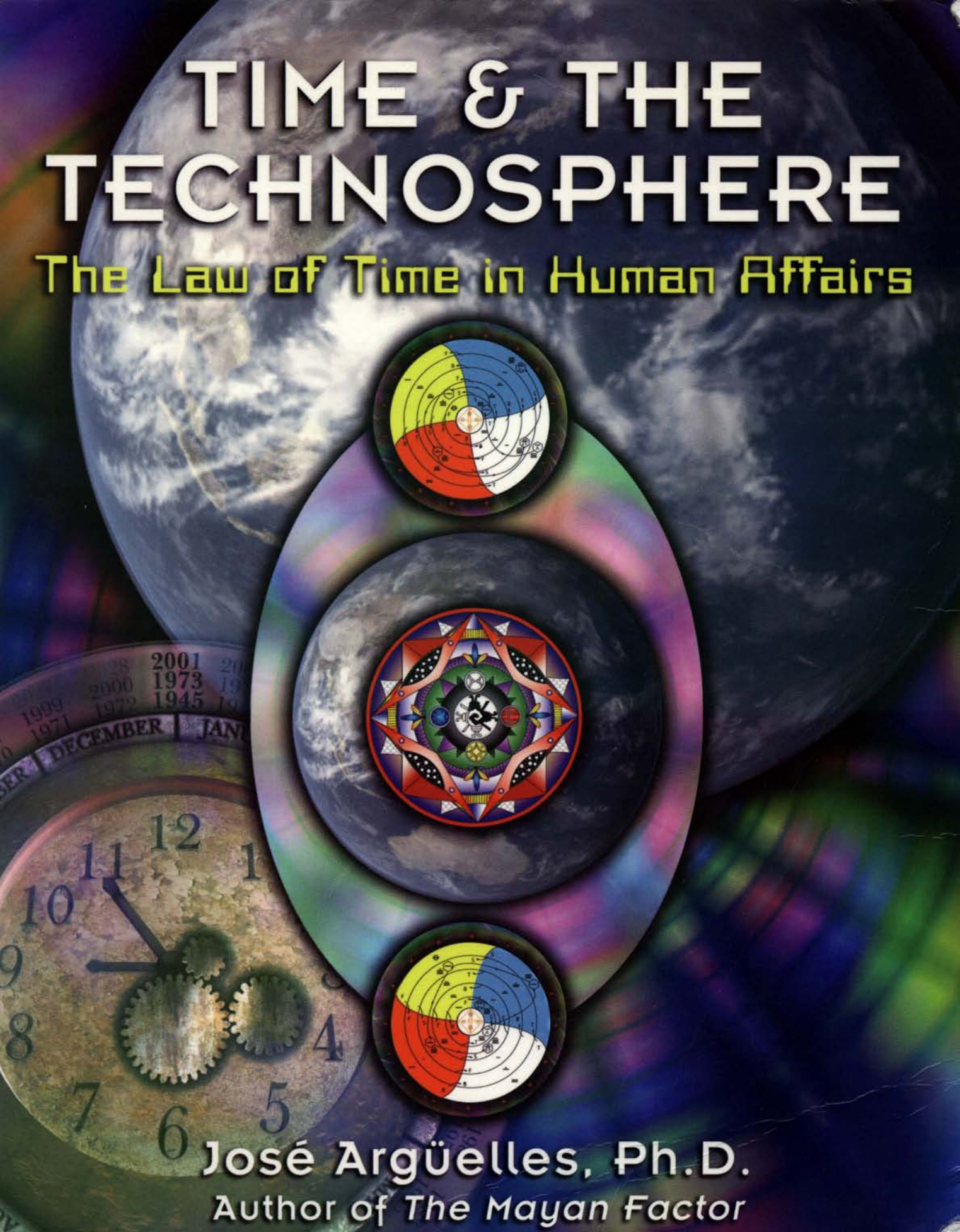

José Argüelles, Ph.D.
Author of *The Mayan Factor*

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"Time and the Technosphere *makes a vital contribution to the great paradigm shift in human cultures that is now accelerating. There is a higher dimension of natural time inscribed in the cosmos and a natural calendar that would help humanity mature into the awakening global consciousness that is now essential for future sustainability and well-being. This book is an important contribution to the awakening event that is now emerging on a planetary scale."*

ASHOK GANGADEAN, PH.D., Professor of Philosophy, Haverford College

In *Time and the Technosphere,* José Argüelles presents a groundbreaking study that distinguishes the natural time of the cosmos from the artificial mechanistic time under which we currently live. Argüelles defines the actual nature of time as the frequency of sychronization. Applying this Law of Time to an understanding of the entire system of life on Earth, he shows that in order to not destroy Earth's ability to sustain life, we must change our definition of time and adopt a natural harmonic calendar based on the 13-moon 28-day cycle. Until the creation of the Gregorian calendar and the 60-minute hour, most of humanity lived by the 28-day cycle of natural time. The adoption of artificial time has subjected us to a 12:60 time frequency that governs the entire global industrialized civilization—the technosphere. With the collapse of the Twin Towers on September 11, a fissure was created in this artificial technosphere, opening up the noosphere (Earth's mental envelope).

Humanity has a golden opportunity to leave the strife of the past and enter a time of peace by adopting a harmonious natural calendar that will repair the damages caused by the irregular tempo of technospheric time. Our last best chance to adopt this natural time and step into the bright new future promised by the galactic shift of 2012 is the Great Calendar Change of 2004, a new discovery based on the author's mathematical research into the Mayan calendar first begun in his landmark work *The Mayan Factor.* In *Time and the Technosphere,* Argüelles reveals the clear distinction between third-dimensional astronomical time and the fourth-dimensional synchronic order of the Law of Time, which holds enormous potential for the future of humanity.

PHOTO BY BRIAN VANDERBROEK

JOSÉ ARGÜELLES, PH.D., works full time on behalf of the World Thirteen Moon Calendar Change Peace Movement and is president of the Foundation for the Law of Time. He is the author of numerous works, including *The Mayan Factor, Earth Ascending,* and *Surfers of the Zuvuya.* He lives in Oregon.

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The Law of Time in Human Affairs

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I

Time and the Technosphere

This book requires some attention from You. It is a complete, coherent, story for Humanity, on Earth, in the Universe. It is a radically different story than what is commonly disseminated by and through our global, dominating, culture. There is no need for You to *believe* this story, or any other. Trust yourself. trust your Self To say you must go into this with an open Mind, is a grand understatement. Start with trust. Simply allow the thoughts and concepts you read to "stew" for awhile. Make some headspace for them and have patience for what may grow there. It is a beautiful life...

Notes on the electronic PDF version

- There are errors! Nothing major...only superficial...
- Note the color plates (mentioned thorughout text) are the last eight pages.
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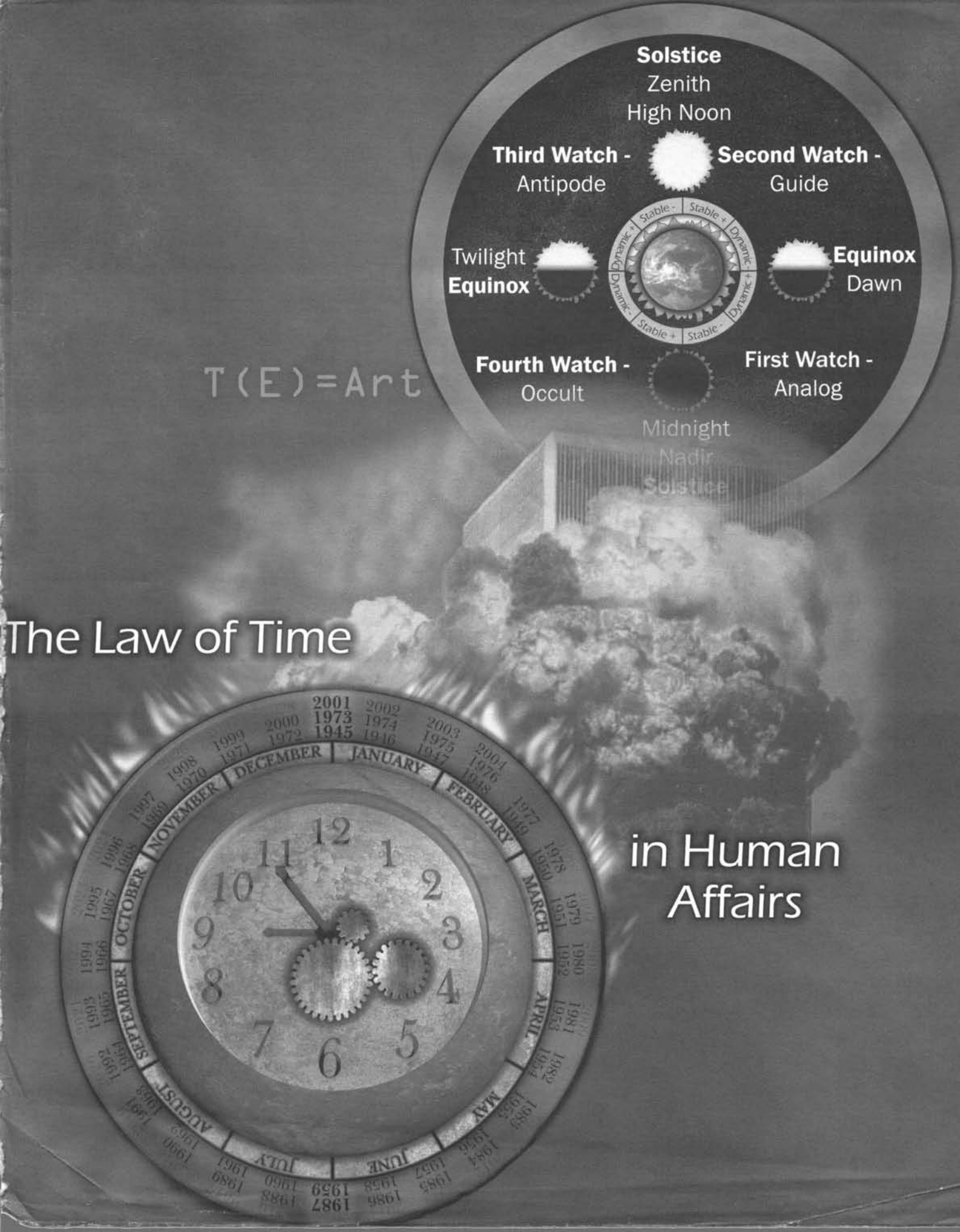
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Antipode
Second Watch -
Guide
Twilight
Equinox
Equinox
Dawn
Fourth Watch -
Occult
First Watch -
Analog
Midnight
Nadir
Solstice
T(E)=Art
The Law of Time
in Human
Affairs
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

This book is dedicated to Adam J. Lewis—at work on the eighty-eighth floor of the South Tower when his mother called him from Spain as she watched television reports of the first hit on the North Tower—and to all the others who were sacrificed on that day. May the truth prevail, that the greater mystery might be made known—forever.

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Acknowledgments

AS ANY AUTHOR knows, to write a book and see it through to completion, from initial inspiration to final conclusion, is never an easy task. Though we are all guided, if we so choose, by the Supreme Creator, still it is one's Earthly helpers that must be counted first, even before oneself-for without their aid, where would one be?

First and foremost of my Earthly helpers whom I wish to acknowledge is my wife and faithful companion of twenty-one years, Lloydine Bolon Ik, my constant helper and chief inspiration of all I do. The faith and trust she put in me at times when all we had was blind faith are a touching memorial to a soul who has always believed that love is the greatest truth.

Assisting us greatly during the time since we arrived in Oregon and have continued to dedicate our lives to the fulfillment of the prophecy of Pacal Votan and the Great Calendar Change is our devoted helper and assistant Stephanie South, the Red Queen, Red Electric Serpent, who conscientiously read and edited this text in its final form, helped in numerous details, and so kept me from ever bogging down.

Of equal trust and value is that one from the immemorial rainbow to whom I owe so much, Kin 19, David Rinck, "the stalwart," whose enhancements of my artwork are ingenious and awesome. All three of these people share one thing in common: absolute belief in and dedication to the Law of Time as a living reality that gives breath to all we do.

I must also thank the incomparable Spectral Skywalker, Mark Comings, whose mind has been of inestimable value to me through our many memorable background discussions on time in modern physics in relation to the Law of Time. In this regard,

I would also like to mention Irina Eganova of the Sobolev Institute of Mathematics of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk, for her rigorous approach to N. A. Kozyrev-may she smile well when she reads this book.

For their unconditional support I would also like to honor and thank Brian and Deborah Haight of the Foundation for the Law of Time, and all the many friends and beloved kin of the Planet Art Network everywhere, but especially to the Russian kin who so ably understood the Law of Time and opened up gold mines of knowledge and friendship in the Russian Academy of Sciences in Novosibirsk, as well as the great pristine valleys of Altai, where the shamans await the next installment of *The Mayan Factor*.

Spirituality is at the core of the biosphere-noosphere transition, and in this regard the beings I have to thank are without number, yet some especially stand out and deserve mention: my Tibetan teacher, the Sakyong Dorje Dradul Chogyam Trungpa Rinpoche, through whose cremation he entrusted me with all; my son, Josh, who opened the doors of the fourth dimension for me so that I would never be satisfied with less; and Mother Tynetta Muhammad, who showed me the way of the Holy Quran with the guidance of the mystic master FM, and who introduced me to the great work of Dr. Rashad Khalifa, whose breaking of the Quranic nineteen code led to his martyrdom, leaving me to fulfill what he revealed.

The creation of a book, the coming into manifestation of an artistic conception, is a complex process involving numerous other eyes and minds in order to bring the effort into its final published form. In this process two people have stood out deserving of mention. First of all, there is Michael Moynihan, White Galactic WIzard, who very patiently and carefully copyedited the book-always with an eye on maintaining and enhancing the original artistic vision-and who stood by the integrity of its vision through the entire editorial process. His work was complemented by the efforts of project editor Lee Awbrey, Blue Lunar Eagle, who took on an increasingly engaging role and personality as we brought this book to its final stages. I am especially appreciative for her inspiration to rework the Preface and Chapter One, which I gladly did, and which I feel speak more immediately to the reader of this book. Thank you both, and may the success of this book redound to your consummate care for the truth.

Finally I would like to honor and thank my children: Tara, the golden one, my grandson, SamuelJoshua Sheps, andJeff of Engine Company Number Nine in Phoenix; also Paul Mecklenburg, who has always held the faith in our work, and Heidi Mecklenburg, that her dream of the Unicorn Princess may become true once again.

Preface

A Brief Literary Autobiography

Time and the Technosphere: The Law of Time in Human Affairs is essentially a prolonged set of meditatipns, occasioned by the one most powerful and overwhelming event of our time, the 9-11, the Inevitable Event of September 11,2001. Subsequent events may overshadow this one in horror and magnitude, but it was this event in particular, the destruction of the World Trade Center towers, that sent a signal that something very profound had occurred to change the way we think of ourselves and our future.

In presenting these meditations and reflections in the form of a book, I am painfully aware of the limitations of this medium in the information age. Keeping in mind that the volume of information has increased five times in the past century-with much of that increase occurring only in the past decade-I am very reluctant to put anything down to be published in the form of a book. I was raised well on the writings of Marshall McLuhan and his definitions of media and how they affect our senses. It is altogether obvious that a book in your hand is not the same as reading a text on a computer screen. A book is actually something made to last. Of course, the computer has made it possible and easy for virtually anybody and everybody to write a book, and so we encounter one of the great hazards of the information age: the decline in discrimination and the criteria of excellence. Who can now tell what is worth reading or not? These reflections, too, are very much to the point of the grand theme of this text. If a book is meant to last, how long will this book last? It should last until the New Time has established a new order of reality on this now anguished Earth. Whether or not destruction and the total collapse of civilization will occur first, we do not really know. That is a matter left to the Divine Mind of God alone.

Nonetheless, it is with faith that we continue on this Earth at this time. A pressing

voice told me to go ahead and to write this book, regardless-but then, this is how I have always done it. Those who are at all familiar with any of my earlier books, will find that *Time and the Technosphere* is but a continuation of themes that have provoked me since I first considered literature as a medium of communication. It is important to know where the author is coming from, and how he got to this particular point of reflection. In this regard, *Time and the Technosphere* is the organic result of a lifelong pursuit of a study of the nature of art, time, and history. This study has been woven together by a dialectical process that defines the evolving nature of consciousness. So, for those who are interested, herewith follows a brief literary autobiography, the better to understand my point of view.

My earliest book, *Charles Henry and the Formation of a PsychophysicalAesthetic (1972),* states the grand theme of a holistic science that unifies body and mind, sense and nature, the harmonic pursuit of which has been at the root of all my endeavors. This pursuit was amply demonstrated in my second book, *Mandala* (1972), which, as a root text of the counterculture, was an artistic, philosophical, and cosmic plea for a harmonic resolution to the process of history. It is a sign of the times that *Mandala* is no longer in print, but instead a book bearing the same title, but which does not even include the original Mandala in its bibliography, is in print with the same publisher. Amnesia is one of the side-effects resulting from information overflow with no discrimination. Unfortunately, cultural amnesia is always accompanied by an increase in trivialization, and thus we arrive at the mediocrity and sensationalism of the present moment.

My next book, *The Transformative Vision: Reflections on the Nature and History of Human Expression* (1975, 1991), took the aesthetic and unitive themes of the first two books to the next stage of my visionary analytical process, elaborating on the meaning of time, history, and cosmos. In rereading the later chapters of *The Transformative Vision,* I am struck by their prophetic accuracy, as well as their sense of impending tragedy. It is hard to believe that only 26 years have gone by since that book was first published and now we are plunged into the maelstrom of what was then thought to be the worst scenario possible. *The Transformative Vision* also defined human consciousness as the cerebral-neurological dialectic of psyche (aboriginal, primal intuitive art) and techne (civilizational, rational science), emphasizing that only in their absolute synthesis would there be a harmonic resolution to the problem of history. Seen in this light, the technosphere represents the extreme, one-sided triumph of techne, while terrorism is the expression of the absolute repression of psyche. The crucial question then arises: how will we ever attain a balance or harmony?

Investigation of the ongoing dialectic of consciousness was continued in my next effort, the philosophically synthesizing work entitled *The Feminine, Spacious as the*

Sky (1977), which was written and artistically produced with my previous partner and wife, Miriam Tarcov, who also co-authored *Mandala* with me. The feminine aspect represents a deepening reflection of the psychic, intuitive side of human nature. Expressed through a whole range of images, symbols, and philosophies that describe both the aboriginal root and the final flowering of human consciousness, it is this feminine aspect that has been smothered by the historical process, resulting in the technosphere. Why and how did this occur? These questions drove me to the next stages of my visionary investigations.

From the beginning of my pursuits I have been moved by my intuitive awareness of our intrinsic wholeness as humans, and the knowledge that this wholeness is a reflection of the wholeness of Earth, the solar system, and the cosmos itself. Although this perception of reality is nowhere within the domain of the shibboleths of Western scientific thought as it has developed since Descartes, I have also come to understand that Western scientific thought is highly provincial, racially biased, and-because it is not informed by a perception of wholeness-incapable of solving the actual problems of life. In fact, Western scientific thought has been one of the key factors leading the human race onward to its great act of self-destruction-a self-destruction employed through the instrument of technology.

In my next book *Earth Ascending: An Illustrated Treatise on the Law Governing Whole Systems* (1984, 1988, 1996), I was able to make a profoundly radical break with the restraints of the Western scientific and academic modes of thought. Combining the artistic and aesthetic qualities of *Mandala* and *The Feminine, Spacious as the Sky* with the philosophical and scientific concerns of *The Psychophysical Aesthetic* and *The Transformative Vision,* I define and describe the human situation as a function of the geology, or biogeology, of Earth understood as a whole system. Without knowing it, I had defined the human presence in Earth's geology in a way very similar to that of the Russian biospheric scientist V. I. Vernadsky in his analysis of the biosphere. Culture, civilization, and even technology are seen as features and functions of the larger evolving biogeological process of the whole system Earth, while time and consciousness are defined as functions of a larger planetary regulating system called the psi bank. In the analysis of *Earth Ascending,* the feminine psychic side of consciousness is referred to as the AC, Aboriginal Continuity, while the male, rational techne side is defined as the CA, Civilizational Advance. The historical process represents the increasing dominance of the CA to the final exclusion of the AC-the triumph of industrial man over the indigenous peoples.

The most critical moment in history was the atomic destruction of Hiroshima, August 6, 1945, when through its technology the impact of human thought permanently

affected the geological makeup of the Earth. The events before Hiroshima are chronologically defined as P.A., pre-atomic, and those after as A.H., After Hiroshima. But more than defining the process of history within the context of Earth's cosmogeology, *Earth Ascending* also describes the post-historic future as a condition of harmonic synaesthesia-harmony of the senses-defined by a new scientific system called radiosonics. The key to this new system of scientific endeavor is synchronicity or synchronization of our mind and senses in time. The problem left open by *Earth Ascending* was the precise nature of time and the timing of the radical break in the historic continuum, now known as the Inevitable Event-the culmination and dramatic conclusion of a process begun at Hiroshima. After the Inevitable Event we are liberated into post-history and the possibility of the radiosonic science of the future.

In *The Mayan Factor: Path Beyond Technology* (1987), I was able to supply the basic ingredients for an understanding of time and the timing of the radiosonic future. Going beyond the parochial limitations of Western science and the self-inflated progressivist thinking of the Western mind in general (that states "anything that advances technology is an absolute advance over anything that was thought of or occurred in the past") I was able to finally bring to light the synthesis of many years of study of the time science of the ancient Maya. Here, in the mathematical calculations of the Maya with their unique vigesimal mathematics-counting by twenty and not by decimal ten-lay the basis of a vast and grand science of time. So grand is this science that its conceptions of time dwarf anything the Western imagination could conceive.

While the Western concept of time is linear and predicates an unceasing ascent into a progressively technological and mechanistic future, Mayan time science is predicated on the knowledge of time as the universal factor of synchronization. The Western conception of time is not in accord with the actual cyclical and synchronistic nature of time, and so the whole apparatus of Western civilization is doomed to reach its own breaking point: the Inevitable Event. Mayan time science posits a precise measure of the historical cycle, the most recent and climactic stage of Earth's evolution, as a time fractal of thirteen baktun cycles, each 144,000 days in length, spanning the JulianiGregorian years 3113 B.C.-A.D. 2012. According to Mayan time science, the efforts based on an erroneous time conceptualization are bound to fail prior to the cyclic end-point of 2012. Thus, the Inevitable Event is also a consequence of the failure to understand or to even acknowledge the actual nature of time due to a totally false and mechanistic timing sensibility. In this lies the cause of the apocalypse of Western thought and theology.

The problem left unresolved by *The Mayan Factor* was the precise methodology for changing tracks, for switching Western dominated global civilization away from

the track of an erroneous, mechanistic time-based technology and toward the natural order of time-the path beyond technology. Here my efforts took me to a point beyond reason. Why or how? Let me explain. As an exposition of Mayan time science, in preparation for the 2012 ending of the thirteen baktun cycle of history, *The Mayan Factor* is predicated on the occurrence of a real time event, the Harmonic Convergence "global peace meditation" of August 16-17, 1987. The timing of the Harmonic Convergence was prophetic. It augured the fulfillment of the prophecy of Quetzalcoatl (947-999) known as the Thirteen Heavens and Nine Hells. The Harmonic Convergence completed the ninth and last Hell cycle, and ushered in the final twenty-five years of the thirteen baktun cycle. The Harmonic Convergence was a Mayan wake-up call answered by millions of earthlings.

Exactly forty-two years and ten days after Hiroshima, and fourteen years and twenty-six days before the Inevitable Event, the Harmonic Convergence was located by time to occur precisely when it did. Prophecy transcends reason because it is totally of time, which is of the fourth dimension; prophecy nevertheless affirms with unerring logic that which has been, and that which will be brought about, as being of the same karmic cause and effect stream.

It was this matter of prophecy in the aftermath of *The Mayan Factor* that brought my literary efforts and my own life journey to another stage of development. Prophecy comes with a mantle-if not, then you are classified as a madman. The prophecy of the Harmonic Convergence, as well as of the entire text of *The Mayan Factor,* bore the mantle of the prophetic stream of the Chilam Balam, the jaguar priests, the wizard knowers of the "night script." By correctly fulfilling the prophecy of the Thirteen Heaven and Nine Hell cycles, 843-1987, and by writing and putting together the mathematical codes of *The Mayan Factor,* and before it, of *Earth Ascending,* **I,** Jose Argiielles, had assumed the mantle of the prophetic tradition of the Chilam Balam. Mind you, this was nothing overt nor the least bit conscious, for little did I then know that my next life task was to decode the essence of the Chilam Balam prophecies and to define the time science of which these prophecies are a manifestation.!

The Harmonic Convergence affirmed the karmic repercussions of Hiroshima by bringing forward the ancient Mayan prophetic tradition of the Chilam Balam. By precisely locating this prophetic tradition in a contemporary moment -a media event, no less-the unlocking of its final prophecies was triggered for the purpose of completing the cycle of history: 2012 and beyond.

Like any major media event, the Harmonic Convergence was an enactment within the noospheric unconscious of humanity-the telepathic whole that resides in Earth's mental envelope. So it was that on June 23, 1987, the *Wall Street Journal* ran the

front page story on the Harmonic Convergence. Yet due to the mental obscuration accompanying the final stage of global industrialization, the Harmonic Convergence was an event that the *WillI Street Journal* and the rest of American media conveniently forgot when it came to their review of the century in the year 2000. Today, just weeks after the Inevitable Event, the collapse of the World Trade Center towers, the words of that article are most prophetic: "Mr. Argiielles says the choice between a 'new age' and all-out destruction is ours, and we had better decide."2 Though the prophecy was discounted, true to form, the words of the messenger remain to haunt those who spurned the message.

The prophets and sages of the Maya, and of the New World in general, are a complement to those of the Old World, a further manifestation of the planetary dialectic of poles and hemispheres. If the judgment day apocalypse is the focus of the Old World prophecies, especially those ofIslam and Christianity, those of the New World similarly pinpoint an end time whose denouement is chronicled as the date 2012. It was the prophecies of the sage and culture hero, Quetzalcoatl (947-999), that brought about the Harmonic Convergence, while it was the wisdom of Pacal Votan (603-683) that informed the actual text and scientific time mappings of *The Mayan Factor,* and the image of his tomb adorns the cover of the original book. In a similar manner, it was the tradition of the Chilam Balam that created the prophetic vision of the synchronic order to be realized as the Law of Time.

I was hardly aware of the personally transformative factors at work within me after the Harmonic Convergence media swell began to subside, when two events occurred that augured a major change in my perceptions, activities, and literary output: the Wall Street stock market crash of October 19, 1987, and the death of my eighteen-year-old son,]osh, ten days later, on October 29,1987. In analyzing why the 1987 stockmarket crash happened, the lead story in *USA Today* about this event concluded by posing the question: Was it the Harmonic Convergence that somehow caused the stock market to crash? As I pondered why the answer to this question must be in the affirmative, as well as the implications of this analysis-remembering full well that the breaking story on the Harmonic Convergence first appeared in the *TVtlllStreet Journal-news* came of my son's sudden death in an automobile accident.

Synchronically, the stock market crash and my son's death were part of one event continuum. As tragic as the circumstances of his death were, my son had liberated me from any further compunction to lead a normal life, and to pursue, instead, this matter of Mayan time science and its calendars of harmony. In homage to my son, I completed what I first thought would be a popularization of *The Mayan Factor,* a book entitled *Suifers of the Zuvuya* (1988). Instead of being a popularization or even

a sequel to *The Mayan Factor,* Surfers turned out to be a series of autobiographical tales of interdimensional travel-zuvuya surfing in the fourth dimension. This "flight of fantasy," was my literary farewell to the limitations of reason and a life of comfort. Inner destiny pushed me to the next stage in my pursuit of the unitive science-the discovery of the Law of Time.

This journey of discovery, the findings of which are the underpinnings of the present work *Time and the Technosphere,* took me and my wife and partner, Lloydine, to physical and mental places that were far from anything we had once deemed conventional. Because of this, I had ample opportunity to write and to create, and I did so, freely and without any restraints. I no longer sought any conventional means to communicate. I was now operating prophetically, on behalf of the noosphere-Earth's mental envelope.

There is a consistency to the stream of prophetic revelation, summarized as the codes of the Law of Time. This revelatory stream begins with *Earth Ascending* and *The Mayan Factor,* comes to flower with *The Dreamspell: Journey of Times hip Earth 2013* (with Lloydine Arguelles, 1991), and is completed by all aspects of the Telektonon Prophecy, including the Thirteen Moon/28-Day calendar (1993-2000). This prophetic stream is emphatically a galactic revelation of the same base of know 1-edge that produced the Mayan civilization of ancient Mesoamerica. The new revelatory stream is known as the Wizard's Count, or "reformulated Chilam Balam." It was this prophetic stream and its year-bearer count that established the validity of a fifty-two year cycle correlated to the Gregorian July 26.

The purpose of the Chilam Balam year-bearer count was to establish a basis for understanding that there exists a synchronic order of time, completely apart from what is usually referred to as the Long Count, the linear count of days of the thirteen baktuns of the cycle of history, 3113 B.C.-A.D. 2012. After a long break in the tradition of the Chilam Balam, the year-bearer count was prophetically reformulated to prepare for the Harmonic Convergence and the subsequent revelation of the Telektonon prophecy of Pacal Votan. As the new Wizard's Count, this count was intuitively recalibrated precisely so that July 26, 1987, would be White Galactic Wizard; July 26. According to *The Mayan Factor,* July 26, 1987: White Galactic Wizard, marks the first of the twenty-six years of the Harmonic Convergence. This date marks the conscious ascendance of the prophecy of galactic culture and the coming of the Earth Wizards-the race of galactic wizards on Earth.

In 1988, the year following the Harmonic Convergence, in attempting to create an everyday "Mayan calendar," I came upon the next stage of the discovery of the synchronic order. On the Gregorian calendar, 1988 is a leap year. I perceived that to accommodate February 29 would throw the year-bearer count off by one day, ruining

the harmony of the system. Reviewing the Chilam Balam texts, it was clear that leap year was never considered, much less counted in the year-bearer count. Without an intercalary leap year date, the four year-bearers-Seed, Moon, Wizard, and Storm-coded by the numbers 1-13, remained in sequence, maintaining and assuring the harmony of the system, where every fifty-two years equals seventy-three 260-day spins, no two days are the same, and the entire 18,980 days of the cycle repeat every fifty-two years in an upward moving spiral of time. For the first time in my work, the issue of the Gregorian calendar as a system came into question.

Following this observation came the discovery of the mathematical codes governing the synchronization of the 260-day cycle with the 365-day cycle, the consequent discovery of the artificial 12:60 and the natural 13:20 timing frequencies, the recognition and resurrection of the Thirteen Moon/28-Day calendar, and the full exposition of the Dreamspell codes of fourth-dimensional time. I presented these discoveries in *Dreamspell: Journey of Timeship Earth 2013.* The Dreamspell, being the manifestation of the knowledge base of galactic culture, completely encodes the Wizard's Count. *Dreamspell: Journey of Timeship Earth 2013,* the presentation of the codes of fourth-dimensional time as a "tool kit" with an accompanying "script" and guidebook, is a break of such radical form from the prevailing paradigm that, as of today, it is still unfathomable to many people.

The galactic Dreamspell tool kit is a primary tool for the galactic culture that is just now beginning to unfold in the wake and shadow of the collapse of the Twin World Trade Center towers. This text prompted me to write two more books. The first, *Arcturus Probe: Tales and Reports of an Ongoing Investigation* (1992, 1996), is a deep reverie that picks up where *Suifers of the Zuvuya* left off and documents the interstellar, interplanetary psycho-cosmological roots of the Dreamspell of fourth-dimensional time. The second book was written as *A Treatise on Time Viewed from its Own Dimension,* but first published in English as the *Call of Pacal Votan: Time is the Fourth Dimension* (1992, 1996). In this highly scientific, mathematical treatise I was able to accommodate the Dreamspell codes of the Law of Time to an analysis of the biosphere and the biosphere-noosphere transition. This work also represents my first integration of the actual thought and principles of V. I. Vernadsky.

Through the efforts that constituted the discovery of the Law of Time, much of which was assisted by my partner and wife, Lloydine, I was finally able to begin to understand the methodology for accomplishing the paradigm shift-or psychic pole shift-of which humanity was so in need, at least from the perspective of the biosphere. By providing the mathematical basis for establishing the "biomass constant," Seventy-three 5 day subcycles correlated to the measure of the solar year, I had

found a way of grounding the fourth-dimensional mental order of time, the synchronic order, in the actual third-dimensional biogeochemical cycles of the biosphere. This was like casting a harpoon of time from the noosphere and landing it in a precisely measured form in the annual turning of Earth's biospheric mantle. And this was accomplished precisely because of the intrinsic harmonic cycles and patterns of the DreamspelllWizard's Count.

For this reason, by 1993, it was incumbent upon me to test the hypothesis of the Law of Time that the human race was destroying its biosphere due to operating according to an error in time, and that only a shift in its experience of and perception of time would save it from such destruction. This shift in time is defined as the calendar change. The Law of Time presents such a radical critique of Western science, of its concepts of time, and of the civilization which it supports, that I could not tackle the problem from its center, but from its periphery, moving inward to the point of the Inevitable Event. Beginning in Latin America, then spreading to Japan, Western Europe, Russia, and finally North America, we established a movement to change the everyday perception of time, instilling profound meaning behind the effort to reform the calendar. In this way, we took on the responsibility of organizing the World Thirteen Moon Calendar Change Peace Movement.

Part and parcel of this, beginning in 1993, was the decoding of the prophecy of Pacal Votan, the inspiration of *The Mayan Factor*. Known as the Telektonon, Earth Spirit Speaking Tube, this prophecy is the full realization of the Law of Time and the synchronic order. As much science as it is prophecy, the Telektonon defines the Tower of Babel as the root of the error in time, and the Inevitable Event as the necessary result of not relinquishing false time. At the same time, the Telektonon provides codes and tools of analysis which are in complete accord with an understanding of the technosphere-noosphere as an evolutionary continuum in which the Inevitable Event is an act of moral consequence and natural law revealing the basis of a new cycle of harmonic order.

I would also be remiss at this point if! did not inform the reader that, by prophecy's prerogative, this text is also literally punctuated by a perspective that can only be described as "Quranic." Late in 1993, my immersion in the prophecy ofPacal Votan became sychronically linked to my immersion in a study of the Quran, or Holy Quran as it is sometimes called. I have taken seriously the claim that the Quran is the final revealed text (A.D. 610-632) for humanity. I have studied it following the dictum: "Quran, the whole Quran, and nothing but the Quran,"3 as the basis of genuine Islam-submission to the will of God. I have found it more than sufficiently true that the Quran is a scientific text, and contains nothing that contradicts science. More profoundly, my study has given rise to my own personal ethic: duty to God is

the highest cause. It is the cultivation of this attitude, combined with many years of practice of Buddhist meditation, that have brought me to my present point of view, which is visionary and spiritual throughout-and, as a result, has endowed me with my own view on the current global dialectic.

That the new, and final, global dialectic is found in the tension between the forces of globalization (materialism) on the one hand, and that of the civilization of Islam (spirituality) on the other, is now a well-documented fact.4 Of course, generally speaking, in the West, we see it only from the materialist side of the dialectic. The perspective which informs me, and consequently this book, is definitely from the other side of the dialectic. Though in no way condoning terrorism- I am a non-violent pacifist by persuasion-the motives of the terrorists stem from a philosophy and worldview with which I am in sympathy. Yes, the Inevitable Event was also a profound theological moment, and what we are witnessing in the present World War is the battle between the religion of choice and the religion of submission. We cannot necessarily assume that the religion of choice will prevail. In fact, from the perspective of the biosphere-noosphere transition, it is the religion of submission that is most in accord with the spiritually-beckoning future.

As a preface to this book, I have found it mandatory to write this brief literary autobiography, often couched in a terminology that jumps ahead of the story, solely to demonstrate that the actualization of the noosphere corresponds to the stages of attainment and transcendence of one human's life journey in pursuit of the truth. Only in this way could I cultivate the noospheric perspective, voice, and point of view that was necessary for the writing of this text. In this perspective, the noosphere is a condition of non-anthropocentric consciousness. My journey, thus documented, is merely one way the noosphere has found to become conscious, asserting the Law of Time's purposive axiom: to make conscious what had been unconscious. The voice and method of the noospheric perspective are inseparable from the topic of this book, *Time and the Technosphere.* By analyzing the timing and structure of the technosphere, the noospheric point of view becomes conscious. WIthout understanding the nature and relation of time and the technosphere, there would be no truly sane way to comprehend the meaning of the Inevitable Event.

Crystal Moon Kali 11,
Kin 2: White Lunar WInd
Yellow Solar Seed year
Cascadia, North America

1

9-11, The Inevitable Event, and the Nature of Time

Introductory Reflections

Woe! Woe, O great city,
O Babylon, city of power!
In one hour your doom has come!
Woe! Woe O great city, dressed in fine linen
purple, and scarlet...
In one hour such great wealth has been brought to
ruin ...
"Woe! Woe, O great city,
Where all who had ships on the sea became rich
through her wealth,
In one hour she has been brought to ruin! ...
With such violence the great city of Babylon will be
thrown down!"

ST.JOHN OF PATMOS, BOOK OF REVELATIONS,
CHAPTER 18, *THE FALL OF BABYLON*

9-11. The Twin Towers of the World Trade Center gone in a veritable twinkle of the eye. Tragedy. Horror. Terrorism. The whole world brought to a halt. The aftermath? Patriotism, war, and an all-pervading uneasy feeling. What happened? What really happened? Was this the beginning of the Apocalypse?

Amidst the distraction of chasing after other people with smart bombs in far-away places like Mghanistan, and making everyone at the airports feel like potential terrorists, there are no answers forthcoming for what really happened. There is a good reason for that, too: The destruction of the Twin Towers of the World Trade Center and the attack on the Pentagon marked a point beyond the comprehension of the current belief system in every way. To say that the event was mind-blowing is an understatement. But if it was mind-blowing-which it truly was-that means that a whole belief system was knocked off of its foundations, and only a new belief system can supply the answer. A higher, more all-encompassing belief system-a new paradigm-is what is needed if we are to really understand what happened on 9-11.

Belief systems, believe it or not, are functions of time. What you believe defines the time you are living in. Any belief system is held in place by the calendar and sense of time in which it is encoded. 9-11 means September II-it also means 911 emergency, planetary emergency in this case. "9-11 we will never forget" was a common slogan appearing on bumper stickers and store windows after the event. The words or concepts "Tuesday, September 11," "9-11" and even "911" are all functions of the same belief system. So is "2001," the first year of the highly touted "third millennium." But the third millennium of what? The third millennium since the birth of Christ. This means that the belief system whose mind was blown was the Christian millennial belief system encoded in the Christian calendar, the Gregorian as it is properly called. Does this mean that the foundations of 2000 years of belief were blown away, shattered with the terrifying collapse of those Twin Towers? Easily that many years, maybe as many as 5,000 years, or perhaps even the entire history of civilization as we know it came unhinged that fateful day, the day of the 9-11, the day of the *Inevitable Event,* to borrow a phrase from the Holy Quran, the day the Apocalypse announced itself, showed up on the morning television, quite without warning. (See plate 1, The Invevitable Event and the End of History.)

In meditating upon the meaning of the Inevitable Event, it is natural to ask: What made this event so inevitable? It is not just from the perspective of American Foreign Policy, or that of its economic free market monetary politics, that this event was inevitable. More profoundly, this event was so inevitable because it seemed to smack of some form of retribution for the breaking of fundamental laws of nature, or even of Divine Law. And isn't the retribution for transgressing Divine Law a form of apocalypse, a standing naked, a revelation, an evocation of the fall of the Tower of Babel, no less?

Yes, that is why it was so shocking-it was the Inevitable Event because the apocalypse is as inevitable as it is without warning. But apocalypse- a word no one wanted

to use to describe the event, because to use it would be to admit that it was all over-is only one side of the coin. There is another side to the coin of the Inevitable Event-and that is what this book is about. There is something beyond the Apocalypse, there is something larger going on, and that also scares people. Things are out of their control. Isn't this why, instead of looking at it, or contemplating the event, a policy of war was immediately instated as a principle of revenge-for what and against whom? What is going on is time-time is always going on, or time is always coming together. Or time is always changing. The apocalypse, too, is about time-the end of time-which is even more frightening to most people. But the end of whose time? The new paradigm we need to explain 9-11 should be a paradigm that is all about time.

I who speak know, because I have spent most of my life studying time, and the effects of human time which you call history. For many years now I have been living an experiment in time, but a time most of you do not know. So I have some answers that will put 9-11 in perspective for you. I am the stranger from the other side of the wall of mechanized time. I have come back to make you familiar with the time your clock and your calendar shield you from. Because I know about the other time, the larger time, the cosmic time that governs the cycles of all that exists, I can tell you that 9-11 was the Inevitable Event. It had to happen precisely when it did, not because nineteen terrorists planned it that way, but because the terrorists themselves were unconsciously programmed by the timing of Earth itself. Earth's timing process represents evolutionary forces as well as effects irreversibly set in motion by the human's own unconscious programs, programs governed by the human misperception of time and of its role in the cosmic order.

Yes, Earth has its program of which our human history and all of its endeavors are only a part. This larger meta-program of Earth is called the biosphere, the scientific designation given to what is commonly and inadequately referred to as "the environment." As such, the biosphere is a whole system composite of the sum of life and its organic and inorganic support systems spread out over the surface of Earth, hence bio = "life" + sphere = "having the form of a globe." In a word the biosphere is a vast but fragile process which has been evolving itself for some two billion years on this little planet as it spins around its local star, the sun. But we humans, who only in 1969 first saw ourselves as a planetary being-the whole Earth beamed back at us via television by a rocket hurtling toward the moon-we humans have been generally so self-involved in our own interpretation of things that we have missed seeing the larger picture of which we are a part. This larger picture is the entirety of the biosphere which encompasses the evolution of life on Earth as a whole system process. The amazing thing is that most of us have never even heard of the biosphere much

less even know that we are a part of this whole system governed by laws and principles which we, in our self-made arrogance and ignorance, have but little understood.

From my experiment in time, seeing and studying the human as part of the larger self-evolving fabric of the biosphere, I came to the conclusion that the human is living in a time apart from the rest of the biosphere-an artificial time whose climax and termination is inevitable, for nothing artificial can withstand the force of truth. If the human is living in artificial time, the clock is an artifact whose system of measure has nothing to do with natural cycles but is a totally abstract standard, then there must be something called natural time. I will go even farther and state that not only is there natural time, but that there is a law governing natural time, and that is the Law ofTime.]ust as Newton only discovered gravity some 300 years ago, though gravity has always existed, so the Law of Time has always been in operation, even though it was just recently discovered. It is the Law of Time that governs the entirety of the biosphere and everything else in the universe according to principles which are only dimly known to us, principles like synchronicity and telepathic instantaneity. Yes, to understand what really happened on 9-11 you have to understand the Law of Time and how it governs the biosphere-of which our rampant human civilization is inescapably a part.

The Law of Time is formulated very simply, and in some people's way of thinking, rather unscientifically as T(E) = Art, "energy factored by time equals phenomena in the material world represent some state of energy, and every state of energy is governed by time, the resultant product of which is always something beautiful or elegant. Have you ever seen an ugly sunset? A hideous flower? Even if you examine a scorpion with some objectivity you will be amazed at the flawless and elegant manner in which its parts are organized. Yes, all of nature is organized by time to produce in you the sensation of beauty. And time itself, well, believe it or not, time is a frequency, and a frequency is not measurable by a clock. The Law of Time states that time is the universal frequency of synchronization. It is the nature of time to synchronize and to maintain all things in a condition of synchronization. Synchronicity, then, is the experience of real time. When we say that time is a frequency, we can be more precise and say that time is a universal constant expressible by the mathematical ratio 13:20. That is, the 13:20 ratio is the frequency of synchronization.

Of course, most people have never even heard of the Law of Time much less comprehend what the 13:20 ratio might mean. But then, that again gets to the root of the problem, or rather, the dilemma: If humans are living in their own time apart from the rest of the biosphere which is governed by the natural timing frequency,

how could they ever know about the Law of Time? The humans are all a little like Mrs. Malaprop in the play by Moliere who learns to her surprise that she has been using grammar all of her life-though it is much more serious than that. So we humans are with the Law of Time-it has been operating throughout history without our awareness of it. Because of this, its way of making itself known to us was the infamous 9-11. Yes, in the analysis of the Law of Time, the 9-11 marked the end of artificial time.

Living in ignorance of the Law of Time and of the true nature of time, the human species constructed its own concept of time which is based on the clock with its 60-minute hour and the Gregorian calendar with its maddening array of unevenly numbered months. Hence, the paradigm of the artificial timing frequency is defined by the ratio 12:60 (twelve-month calendar, 60-minute hour) -in contrast to the 13:20 ratio of natural time. If the artificial mechanistic and irregularly measured time sets the human race apart from true or natural time, does this not also establish the fact that the human race is living an error in time? Only by living such an unconsciously assumed error could the human race arrive at such an apocalyptic moment as the Inevitable Event-inevitable because any deviation from the truth has an inevitable moment when the truth rebounds in some dramatic or even apocalyptic way. Is it possible that the entire construct of modern civilization, so devastating to the biosphere, is a function of this error in time? Is modern civilization like a time warp, a bubble of artificial time that suddenly got popped on the 9-11?

Back in the 1990s, now seemingly so long ago, I was traveling around the planet on behalf of the Law of Time and the biosphere, and making my observations regarding the effects of artificial time from a planetary whole systems point of view. I saw that even though the human species had evolved - or devolved, as the case may be-into a cultural hybrid which I call the planetary human, the object of the much touted "globalization," I saw that the consciousness of this cultural hybrid was anything but planetary. This schism between the propaganda of globalization and the actual sectarian and fragmented state of consciousness of the hybrid human was further exacerbated, I observed, by the potently unconscious effects ofliving an error in time. Ironically, if the Inevitable Event left many of us in the dark, it has brought the Law of Time into the light. To elucidate let me quote here from a text I wrote in 1996, and which I think will give us a point to expand upon in order to bring the Inevitable Event into sharper focus, while allowing me to define some of my terms:

"Through an error in time, the human species transforms its artificial construct, civilization, into a global technosphere: the sum product of industrial mechanization of its biological functions. Because of human adaptation to the irregular mechanized 12:60

riming frequency, the technosphere runs counter to the laws of the biosphere, crearing a magneric instability between the primal crystalline and vital organic processes."2

The current explosion of the world crisis, stemming from the destrucrion of The World Trade Center Twin Towers, demonstrates the hypothesis of the Law of Time that states: operaring on arrificial and mechanisric timing standards will cause the human to deviate from natural rime to the point of its self-destrucrion, the end result of the magneric instability referred to in this reference. But here we have some further definirions to make. Let us start with a definirion of the technosphere, since that word is featured so prominently in the ritle of this book, *Time and the Technosphere: The Law of Time in Human Affairs.*

While the term biosphere defines the enrirety of life as a single coherent unity, inclusive of its inorganic or semi-inert support systems such as the atmosphere and the hydrosphere, technosphere defines an artificial sheathe or membrane held together by industrial technology as a whole system. This technological mantle is the sum of the processes devised by humans resulring from the application of certain scienrific and economic principles, especially during the last half century. The effects of the technosphere are to supplant the organic processes of the biosphere with totally industrialized ones, resulring in a severe imbalance in the biosphere. This imbalance, the "magneric instability between the primal crystalline and vital organic processes" refers to the disruption of the delicate interacrion between the inert (crystalline) and biological processes and structures which consritute the vibrant mechanisms and interacrive cycles of the biosphere. Phenomena such as global warming and over-popularion are symptomatic of the technospheric disruption of the natural order of the biosphere.

The term technosphere, however, is actually just the middle term of a larger process defined as the biosphere-noosphere transirion. According to the principle figure behind the elaborarion of the laws of the biosphere, V. I. Vemadsky (1863-1945), as an evolving structure, the biosphere is inevitably being transformed into a new geological and evolurionary condirion, the noosphere-Earth's mental envelope. In Vemadsky's analysis, the enrirety of the biospheric process can be described as a single biogeochemical unity. According to Vemadsky, due to man's transformarion of nature since the industrial revolurion, this biogeochemical unity has entered a state of combustion-an accelerated process of transformarion. It is this rapidly acceleraring geochemical combusrion-the net effect of industrializarion and its waste -that accompanies an evolurionary shift, the transformarion of the biosphere into the noosphere. But between the biosphere and the noosphere there is the technosphere, the intervening medium of transformation.

So when we speak of the biosphere and the noosphere we must take into account the technosphere. In actuality we must speak of the biosphere-technosphere-noosphere transition. In this context, the noosphere is the condition of the human mind purified of the error of time. And if the noosphere is the Earth's mental envelope, it could only be so because of a unified state of mind, the transformation of the hybrid planetary human into a genuinely spiritualized planetary being, the mind of the Earth no less-something that seems phenomenally utopian from the perspective of today's evening news. How could this come about, this noosphere of a telepathically unified human consciousness? Again, the Law of Time supplies genuine answers. To begin with, it says, change your calendar, get back to living in harmony with the natural cycles of the rest of the biosphere-and the universe. If you don't, well, the destruction of the Twin Towers was just the first stage of the Apocalypse. But we still have a choice. The other side of the coin of the Apocalypse shown to humanity on prime time television on the 9-11 is entry into the noosphere. But we must first understand what is really going on, and then act intelligently.

The mental climate in America is particularly difficult and strained now. In order to maintain a positive and constructive attitude of mind during this terrible time, I decided to write this book. As you can see, this book takes for its point of departure an analysis of the destruction of the World Trade Center (the actual hub of the technosphere) as the Inevitable Event defining the dynamic of the biosphere in its process of transforming into the noosphere. The analysis of the event in this light will give ample opportunity for presenting the key ideas of V. I. Vernadsky, in particular the concept of the biosphere which he so single-handedly amplified and defined, as well as the cosmic ideas of other Russian thinkers which are little known in the West. I have already written about and given much thought to this matter in general, summarized in part in the First Planetary Congress of Biospheric Rights, held in Brasilia, Brazil in 1996, but nowhere have I written for a wider public audience concerning the nature of the biosphere-noosphere transition.

I feel it is especially important at this time to present an analysis of this event in a scientific context that is beyond nationalism and ideology, so that human beings can begin to understand that they are a function of the biosphere, but not necessarily its controlling mechanism. Of course, the Law of Time is the key factor involved in this analysis, and understanding the biosphere in the context of the Law of Time is absolutely critical for establishing the basis of an entirely new worldview and hierarchy of values-the much awaited new paradigm.

Like my thoughts on the biosphere-noosphere transition, my investigations of the Law of Time have also not as yet been presented to the general public. In fact,

you will find scarcely anyone who has even heard of the "Law of Time." This is because my researches and investigations over the past decade which resulted in the discovery of the Law of Time were not conducted in any formal academic way, nor through any corporate or government sponsored grant or officially recognized research institution. The discovery of the Law of Time has been, nonetheless, a rigorous, life-consuming pursuit. The laboratory for its study was to be found in a phenomenological and anthropological investigation of the effects of mechanized time on various population groups absorbed in what is called "modern civilization."

The premise of this investigation is simple: it is an undeniable fact that the time of human civilization, governed by the clock and the Gregorian calendar, is not the same as the time of the rest of the biosphere. Artificial time is not the same as natural time. Or rather, artificial time establishes a frequency which governs the human species totally apart from the timing frequency of the rest of life. What are the effects of artificial time and how do they define the nature of modern civilization? The answers to these questions open a perspective that has been scarcely considered. Yet this perspective is so clearly an essential factor in the description and definition of the human condition, that, in the wake of the tragic events and their ominous aftermath, it now begs to be presented in a proper manner. Hence this book. Suffice it to say that the Law of Time in every respect answers the question posed by my previous books and summarized in the single query: how will modern man escape the fatal consequences of the one-sided mechanization of his biological operations and the imminent destruction of his life-support system?

Defining a planetary whole systems approach to the analysis of time in human affairs, the first postulate of my book *A Treatise on Time* (1996) concerning the principles and nature of time as the fourth dimension is worth quoting here, since it introduces the fundamental problem informing the investigation of Time and the Technosphere:

> Just as air is the atmosphere of the body, so time is the atmosphere of the mind. If the time in which we live consists of uneven months and days regulated by mechanized minutes and hours, that is what becomes of our mind: a mechanized irregularity. Since everything follows from mind, it is no wonder that the atmosphere in which we live daily becomes more polluted, and the greatest complaint is: "I just don't have enough time!" Who owns your time, owns your mind. Own your own time and you will know your own mind.3

It must be understood that the events of 9-11 were so historically unprecedented, so mind-bogglingly dramatic, that they require a large lens through which to fully

interpret their meaning. The Law of Time is such a lens. Quite simply, the destruction of the Twin Towers defines the limit of artificial time. If this is so, what can be expected following this world-shattering event? Because the Law of Time began with the premise of defining the difference between artificial time and the time of nature, the larger context of the biosphere was resorted to almost immediately. Being the study of an ongoing and evolving phenomenon, the investigation of the biosphere by its principle researcher, V. 1. Vernadsky, pointed to another imminent evolutionary stage: the noosphere, the "mental envelope of the planet." However, an intermediate stage was also perceived by researchers who followed Vernadsky, and it came to be called the technosphere, "the technological envelope of the planet." The end or limits of the technosphere define the birth or beginning of the noosphere.

With the events of 9-11, this is no longer just a theoretical concept but a vivid reality. As a species we are now undergoing this dramatic evolutionary moment, otherwise known as the biosphere-noosphere transition. It is for this reason that this book also presents novel definitions of time and pragmatic conclusions that can be employed by anyone if they so choose. If the root of the technosphere is artificial time and its proliferating mechanized constructs, then in the collapse of the technosphere, an event ordained by the laws of nature, there must be an orderly path or means for establishing the noosphere, also ordained by natural law. The Law of Time defines this orderly path as a conscious shift in the human timing frequency, away from artificial time and into universal natural time. This can only be accomplished by a universal reform of time, known as the calendar change. If there were no such path, the conclusion to the collapse of the technosphere would be an unbearable barbarism.

By its nature, the topic of the book is cross-disciplinary and provocative-it is visionary history. I have been described as a "spirituality historian" and "cosmic harmony researcher."4 I believe this description also characterizes *Time and the Technosphere,* which does present a solution, a new world paradigm, if you will. A new paradigm has been awaiting humanity ever since the notion of paradigms was first raised by Thomas Kuhn in 1964, in his book *The Nature of Scientific Revolutions,* or even earlier by Vernadsky and Pierre Teilhard de Chardin in their invocation of the noosphere. To be truly new, such a paradigm could hardly be expected to arise from traditional fields of thought or methods of research, be they quantum physics or microbiology. In fact, as I have often said, most people wouldn't recognize the new paradigm if it ran into them on the street. This is because people's consciousness and perceptions are basically very set and unexamined-as unexamined as the effects of the watch on their wrist or the calendar on their wall. In fact, one of the consequences

of the technosphere is the limiting nature of consciousness which remains unchanged despite the fact that technology is changing all of the time. But with the occurrence of the Inevitable Event, history has been punctured. Perhaps now the new paradigm can be perceived: the paradigm of natural time as the universal factor of synchronization.

Although prompted by the stunning terrorist attack upon and consequent apocalyptic collapse of the World Trade Center Twin towers, these reflections are actually a synthesis of thoughts and explorations in the domain of time that I now find necessary to communicate in a coherent and organic form. The grand theme of this study is to understand how and why the collapse of the twin World Trade Center Towers was a biospheric event. Even so, the study of the Inevitable Event within the context of the evolution of the biosphere requires and leads us to still grander domains of thought-the historical, the theological, and the cosmological. The reason that these reflections and meditations spiral into ever grander domains of thought is due to the principle of analysis and the guiding factor employed in this study. This is the Law of Time, which is the fruit of a life-long research and pursuit of knowledge. It is the Law of Time that brings the biosphere into timely focus.

The biosphere is scarcely known even to most educated people. As a biogeochemical whole system in which the human is but one of the functioning components, the biosphere is an intricate unity with its own governing laws and principles. Without becoming conscious of how the human organism participates in the laws and principles of the biosphere, the human will continue to remain ignorant of the biosphere's existence and therefore will sooner than later reach a termination of its own evolutionary possibility. A demonstration of how the laws and principles of the biosphere, crystallized into a temporary and intermediate sheath called the technosphere, reached a climactic evolutionary point in the collapse of the World Trade Center towers will provide the means of educating in general concerning the biosphere. It will also allow us to elaborate on the meaning and nature of the technosphere, and the imminent transformation of the biosphere into the noosphere, the Earth's "mental envelope."

A fundamental purpose of the Law of Time is to expand upon the meaning and significance of the Inevitable Event, as well as upon the biosphere, technosphere, and noosphere in relation to the evolution of life and consciousness in the universe. To speak of an event being "inevitable" is to bring about a reflection on the nature of time, and even of the laws of cause-and-effect and karma. It is time that governs both cause-and-effect as well as the actions of karma. And it is time that dominates inevitability, because any such inevitable event is located in a very precise moment in

time. But what actually is time? How does time "locate" events? And, once again, what is the Law of Time?

As the criterion of natural time in which synchronicity is the norm, the Law of Time is the key that unlocks the reason why the Inevitable Event occurred when it did. By precisely locating it within the evolutionary continuum of the biosphere and in relation to its point of mutational shift, the Inevitable Event is placed into a greater context of cosmic comprehension by the Law of Time. Through the lens of the Law of Time we will be able to understand the relationship between the biosphere, the intermediate state of the technosphere, and the imminent stage of the noosphere. Defining the Law of Time as the factor of universal synchronization, the law by which all events in the universe are maintained in synchronic relation to each other, we approach the domain of a hitherto undefined realm, that of the synchronic order.

As the unifying fourth-dimensional order of time in the universe, the synchronic order is measured and gauged by the 13:20 matrix. The mathematical coding of the Law of Time is entirely locked into this 13:20 matrix, otherwise known as the Harmonic Module or T zolkin, the basis of the sacred count of the ancient Maya. When we examine the Harmonic Module, a 13 x 20 matrix, we may well ask what does that have to do with time? It is obviously as different from a clock, as a tree is from a flagpole! When we examine the matrix carefully we see that there is a repetition of thirteen notations, the numbers 1-13, that occurs 20 times yielding 260 (13 x 20) units.

Holding the 13:20 matrix together is a pattern which I identified in my book *Earth Ascending* (1984) as the binary triplet configuration, and in the *Mayan Factor* (1987) as the Loom of Maya. This pattern consists of 52 units, 26 on either side of the central or seventh vertical column. **If** you contemplate this 52-unit pattern you will see it is characterized by binary radial symmetry. This quality characterizes the entire matrix and defines the quality of fourth-dimensional time as radial and instantaneous distinct from the current third-dimensional paradigm which defines time as being linear and sequential. The radial quality of fourth-dimensional time is what accounts for its being the factor of universal synchronization. This is very different from the sensation of the second hand as it sweeps around the clock, indicating the inexorability, not of time but of the mechanization of time! The 13:20 matrix becomes potently useful as the means of establishing the synchronic order when it is coordinated with a genuinely harmonic timing standard, the Thirteen Moon/28-Day calendar.

"Time is the fourth dimension," is the famous adage attributed to Einstein. This statement notwithstanding, the modern notion of time is bogged down in the minutiae

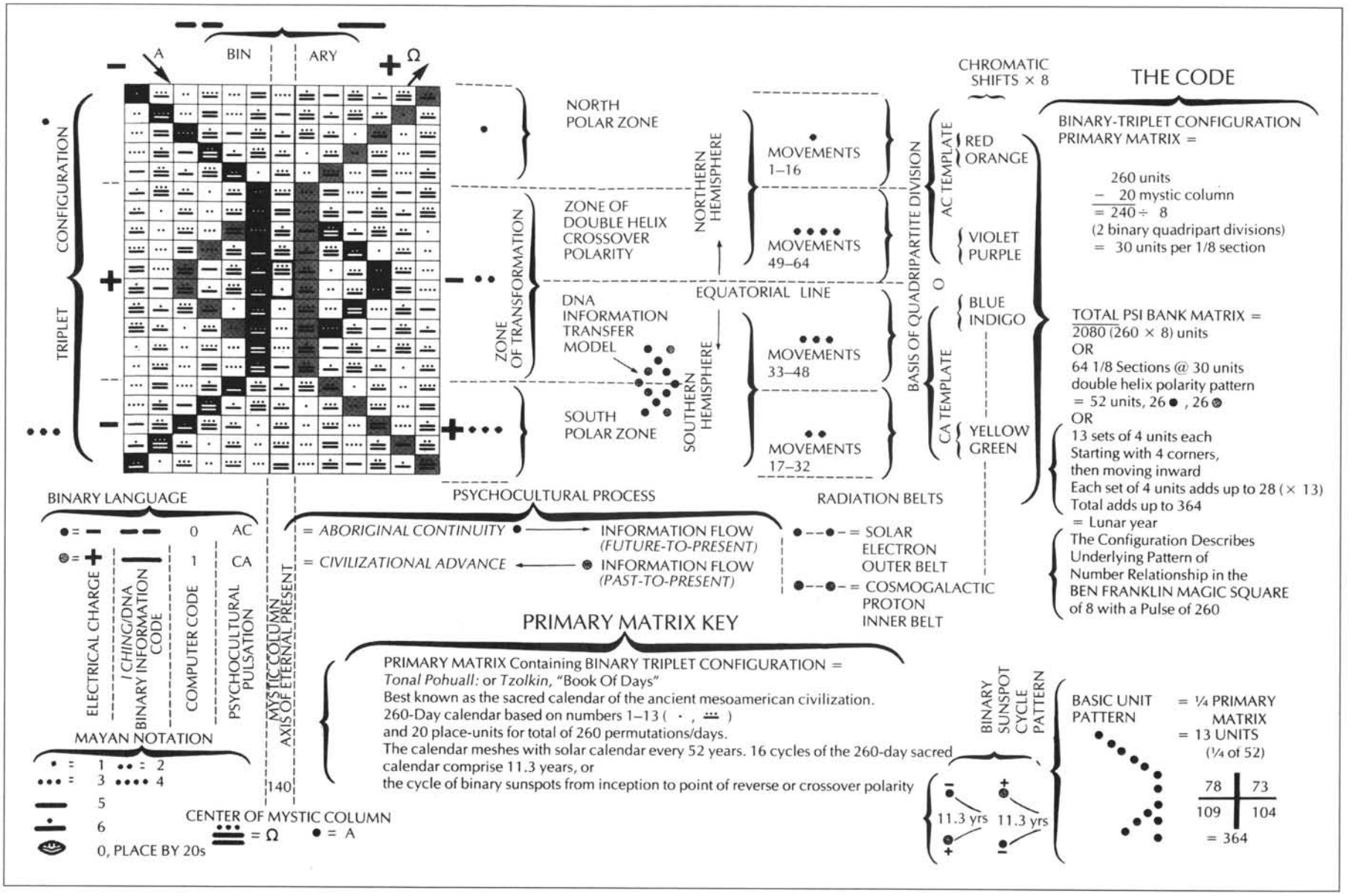

13:20 Matrix-Harmonic Module with Binary Triplet Configuration

of quantum mechanics and cessium clocks, in a hair-splitting myopia that cannot see the forest for the trees. The fact is that only time governs the whole order of the universe in a manner that transcends all spatial limitations, even those of the relativistic MinkowskilEinstein four-dimensional universe, which is confined by the speed of light. As the universal factor of synchronization, time is instantaneous and transcends light. This novel perception of time defines a new reality, the synchronic, of which our experiences of synchronicity are but a foretaste. The synchronic order described by the Law of Time poses the order of an entirely new science of time.

To be realized and then applied, the science of time is dependent on two factors: a sudden and radical disruption of the historical continuum; and a genuine globalization or planetarization of consciousness. The break in historical continuity is necessary to jolt the human consciousness from its stagnant and entropic state-defined by the Law of Time as the delimiting 12:60 frequency consciousness of artificial, mechanistic time-while the globalization of consciousness, intimately connected with this sudden discontinuity, is necessary for the application of this law at a planetary whole systems level. Of course, the radical disruption of the historical continuum was provided by the collapse of the Twin Towers, and can actually be mapped in a description of the dialectical process of human evolution.

If one studies *Earth Ascending,* Map 19, "Binary Pulse of Psycho cultural Development," [shown on page 14] one can pinpoint the "Inevitable Event" of the radical historical discontinuity as the point at which the AC and CA currents cross over one another and switch polarity at the very top of the graphic depicting the "historical" process. What does it indicate, this point of psychic polarity switching currents?

The historical dialectic is understood as the interplay of two "currents" of consciousness, AC "Aboriginal Continuity" and CA, "Civilizational Advance." In the prehistoric phase, the consciousness is dominated by the Aboriginal Continuity or AC. This refers to the primary experience of the original human nature- life lived as a ritual or ceremonial round within the perimeter of the timeless present. But as the human enters the historical cycle, about which we will have more to say in later chapters, the CA becomes more predominant. As Civilizational Advance, the CA represents the tendency toward exclusive reliance on reason, logic and written means of communication. The Law of Time further defines the CA as being motivated increasingly by the artificial timing frequency of the 12:60 which gains in prominence until the final phase of the historical cycle, industrial globalization, when the CA has gained complete dominance of the biosphere.

During this final stage, the global mental condition is defined as the involvement in secondary or artificial means of experience, furthered by the planetary

INCIDENCE OF RELATIONSHIP BETWEEN
PSYCHOSENSORY ELABORATION (PSE)
AND
KEY: PSYCHOATMOSPHERIC DENSITY (PAD)

- AC = ABORIGINAL CONTINUITY (YIN)
  CONTAINS ENTIRE BLUEPRINT
  OF PSYCHOCULTURAL DEVELOPMENT
  OF TOTAL BIOPSYCHIC ORGANISM, MAN
  POLARITY FLOW: "FUTURE" TO PRESENT = VISION
  INFORMATION IN WHOLE PATTERNS
  "CONSERVATIVE"

+ CA = CIVILIZATIONAL ADVANCE (YANG)
  COMPLEMENTARY PULSE
  DYNAMIC IMPLEMENTATION OF VISION
  POLARITY FLOW = "PAST" TO PRESENT
  INFORMATION IN
  VERBAL SEQUENCES & MATHEMATICAL BITS
  "PROGRESSIVE"

INTERACTION OF AC/CA
CREATES PSYCHOSENSORY ELABORATION (PSE)

ACTIVATION OF CA PULSE BEGINNING WITH
HIERATIC STAGE INITIATES
CUMULATIVE DEVELOPMENT OF *PSE*

INCREASE OF PSE PRODUCES INCREASE IN
PSYCHOATMOSPHERIC DENSITY (PAD)

AS PSE INCREASES, AC CURRENT
BECOMES MORE DISCONTINUOUS

MAXIMUM PSE, MAXIMUM PAD
MAXIMUM AC DISCONTINUITY
ARE ATTAINED AT CLIMAX
OF STAGE 4, GLOBAL INDUSTRIALIZATION

AS *PSE* ATTAINS MAX. CONDENSATION
(MAX PAD DENSITY)
ESP EXPERIENCED AS MAX ABERRATION

4 GLOBAL INDUSTRIALIZATION
CONSOLIDATION OF CA
MAXIMUM AC DISCONTINUITY

3 STAGE OF SPIRITUAL REVITALIZATION
REACTIVATION OF AC
SYNTHESIS OF HIERATIC
STRUCTURES

2 EMERGENCE OF CIVILIZATION: HIERATIC STAGE
DIFFERENTIATION OF
CA MEMORY PLATE
INTO 7 HIERATIC STREAMS

1 ABORIGINAL STAGE
AC = DOMINANT = PSYCHOSENSORY STASIS
MINIMAL PSYCHOATMOSPHERIC DENSITY
MAXIMUM PSI INFORMATION FLOW

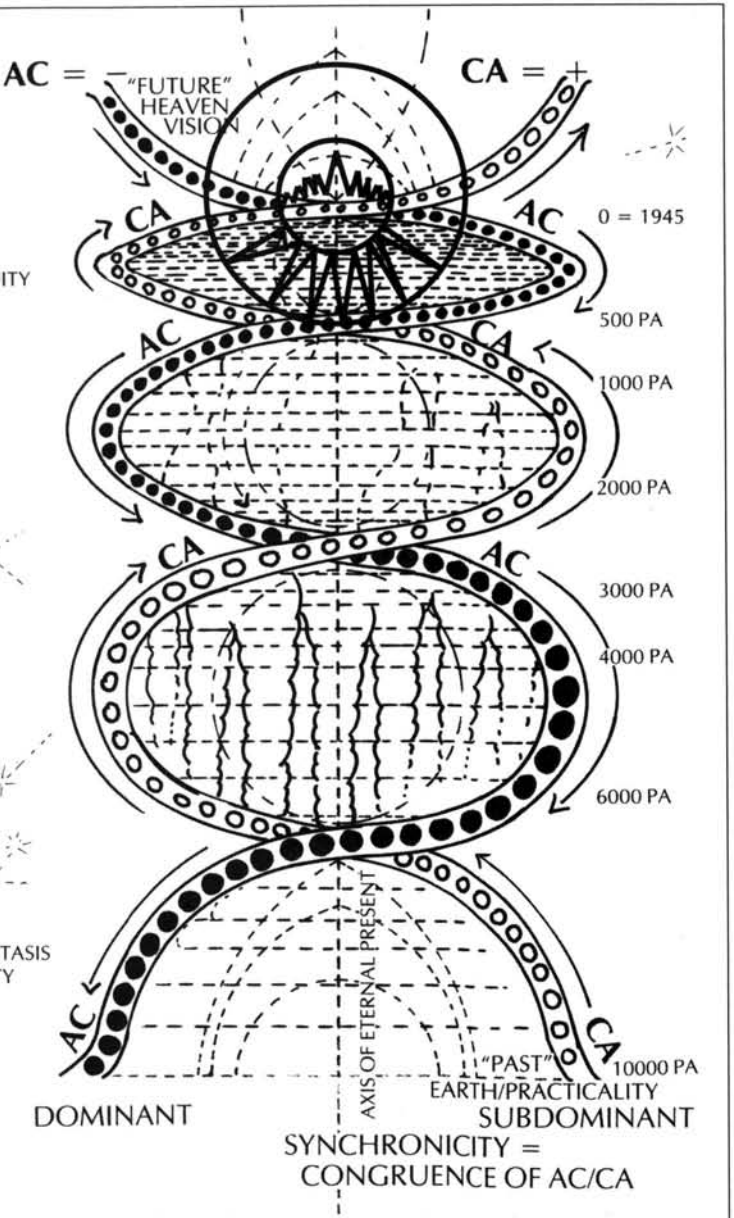

Locating the Inevitable Event in the Holonomic Equation:
9-11, 2001 Climax of the Binary Pulse of Psychocultural Development
(from *Earth Ascending*, Map 19)

technosphere. The sum effect on consciousness of the advanced CA stage is defined as Psychosensory Elaboration or PSE, which in turn creates a psychoatmospheric density (PAD)-literally a mental cloud which obscures altogether the organic biopsychic reality of the human within the biosphere. From the point of view of a planetary pathology, this massive collective obscuring (CA) of the original nature (AC) defines a "suicidal crisis point," a moment at which the subconscious instinct of the human being programs its own self-defeat in order to ultimately return to the organic reality of the biosphere and the simultaneous advent of the noosphere. Hence, the Inevitable Event: the radical break in the continuum of history.

This moment of radical historical discontinuity occurred with the September 11,2001, terrorist attack on the twin towers of the World Trade Center-the very nerve center of late global industrialization-and the Pentagon, the supreme military fortress that defends globalization. If the fall of the towers symbolically augured the fall of Babylon and the Tower of Babel itself, the penetration of the Pentagon was no less symbolic. The fact that there was not one but two towers of Babel and a separation of some twenty minutes between the attack on each tower allowed the second attack to be viewed live on global television by about as many people on Earth as had ever witnessed anything at one simultaneous moment. By the end of the day, the scene had been repeated multiple times on virtually every television network on the planet.

The unbelievable shock of the moment and its simultaneous perception, coupled with the symbolism of what was actually occurring, effectively rendered the break in the historical continuum as a profound mental event-a rupture of 5,000 years of history from the first Babylon to the last. The witnessing of the event on television meant that it was received immediately into the nervous system of virtually the entire species. This in itself is a noospheric moment-the mental envelope of the Earth made collectively and globally conscious in one instant of history-shattering significance, and hence, the genuine entry into post-history. Archetypally, the images of the towers collapsing with people flying or jumping off the upper stories, is a pure reflection of the Sixteenth Major Arcana card of the traditional Tarot which shows a tower being shattered by lightning, with bodies falling down from it.

While the negative powers and forces grapple with their shattered dreams in the aftermath of the event, it is the time for the powerful luminescence of the noosphere to begin to activate the receptive cells of the human system within the now catalyzed biosphere. Fifty-six years after Hiroshima, the fall of the World Trade Center Towers is the fatal puncture in the technosphere which is intended to reorient the human within the biosphere. ESP (extrasensory perception)-the opposite of PSE (psycho-

sensory elaboration)-is released in the instantaneity of the information reaching virtually every human being on Earth. This is the collective reactivation of the Aboriginal Continuity current that has been disengaged and disempowered for so long by the Civilizational Advance. Civilization has finally been checkmated. Now the Revolution of Time must be completed in order to stabilize the biosphere, anchor the noosphere, and de-structure the technosphere.

According to the Law of Time, the Inevitable Event was already embedded in the moment in which it actually occurred, like a flaw in a piece of glass that, upon concussion at the right pressure point, shatters all at once. In the case of the World Trade Center Towers and the Pentagon, we are also dealing with symbolic constellations of such potency that the very act of their shattering redefines the reality of human consciousness. In fact, the nature and problem of human consciousness as it has evolved historically is also at the root of this astonishing event. While it will take time for the collective human consciousness to fully grasp just how much its reality is being redefined, a vacuum now exists within the technosphere itself-a vacuum which awaits being filled by a new paradigm. Since the collapse of the Twin Towers actually represents the limits of artificial time, the new paradigm must rest on a redefinition of time altogether. This is the definition supplied by the Law of Time, the pragmatic application of which is the replacement of the irregular measure of the Gregorian calendar by the harmonic measure of the Thirteen Moon/28-Day calendar.

Because of its harmonic measure, the Thirteen Moon/28-Day calendar coordinated by the Harmonic Module is the new dispensation of time-reckoning for the human race. Rooted in the four recurring year-bearers of the Wizard's Count--:-which is not the same as the Mayan long count, nor the Julian count of modern science-the Thirteen Moon calendar exists for the establishment of the reality of the synchronic order as an entirely new method of knowledge and being for the entire human race as a cosmic medium operating within the biosphere. By Wizard's Count is meant the circulation of thirteen numbers and four different glyphs-Yellow Seed, Red Moon, White Wizard, Blue Storm-that code the July 26 Thirteen Moon/28-Day calendar synchronization date to create a master 52-year cycle, Anchored in the Thirteen Moon/2 8-Day calendar, the synchronic order is the means for manifesting the reality of the noosphere on planet Earth. Without such a basis in a lived mathematics of time correlated to the actual cycles of Earth, the noosphere could not be experienced nor fully realized. The successful completion of the biosphere-noosphere transition, then, is the triumph of the synchronic order, the conscious elevation of Earth into the cosmic frequency of fourth-dimensional time.

For all of this to come to be, however, is yet dependent on an analysis of the role of time in the creation of the technosphere and the subsequent comprehension of its limits and the potential for its de-structuring. This is not only a matter of theory or prophecy; it is a matter of putting into practice, making a coherent action out of the application of the Law of Time as it completes the pressing urgency of the bio-sphere-noosphere transition. The coherent action to bring us through this rite of passage is the Great Calendar Change of 2004. Ultimately, this book is presented to make us ready for this unprecedented time changing moment. May you, 0 reader, ponder deeply and then, if you so will, come join me in living on the other side of the wall of mechanized time.

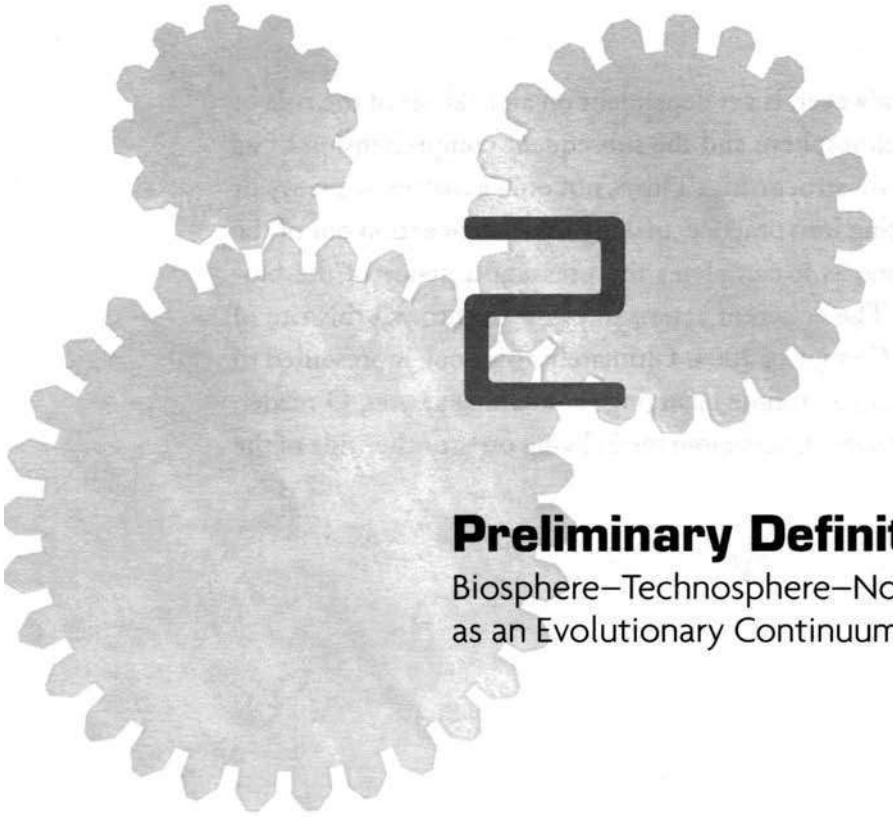

2

Preliminary Definitions

Biosphere–Technosphere–Noosphere as an Evolutionary Continuum

BY UNDERSTANDING that the Inevitable Event was a function of the biosphere-indeed, a necessary moment in the evolutionary trajectory of the biosphere-we are saying that this event was not just a human enactment, but that humans, inseparable from the biosphere, are effected to perform functions that relate to the process of the biosphere as a whole. Seeing the Inevitable Event and, in fact, the entire human drama from the perspective of the biosphere, we are actually lifting the cruel tragedies of contemporary reality above conflict and into a state where genuine laws of peace and harmony may shed their light of wisdom, illuminating the human drama with a higher understanding. One thing is certain: Unless we rise above our own humanity and cultivate a non-anthropocentric view-the view represented by the noosphere-there will be no release from the calamity that is now engulfing us. The point is not of maintaining the global economy, but of saving the biosphere.

For the multilayered task of bringing a new understanding to light, defining the technosphere, and then the Law of Time, we shall begin with the former: defining the technosphere in the context of the evolutionary continuum of biosphere-technosphere-noosphere.

VERNADSKY AND THE UNDERSTANDING OF THE BIOSPHERE

It is amazing that the name V. I. Vernadsky (1863-1945) is so little known in the West, and that the word *biosphere,* as well as the laws and principles pertaining to it, are scarcely more known. To a large degree, this ignorance is due to the great cleavage in human relations experienced as the Cold War. The biosphere, which was profoundly studied and scientifically articulated by the master Russian scientist V. I. Vernadsky, is actually the precise word for what in the West is vaguely referred to as the *environment.* But even more than being a precise and scientific description for what is meant by the use of the word *environment,* biosphere defines a whole system model of life on Earth, and because of that, also presupposes a whole system methodology and point of view. You cannot speak about the biosphere without entering into a world of discourse that is holistic or holonomic to the core.

If one looks for Vernadsky's work in English, one will find precious little available. His key work, *The Biosphere,* exists in two very different translations; the one published by Synergetic Press in 1986 is easier to read, while the other, the "complete annotated edition" published by the Far West Institute in 1998, is far more erudite, with a major bibliography and much supplementary information. The earlier translation was published in conjunction with the opening of the Biosphere II Project outside Tucson, Arizona. It is now a tourist site, with a bookstore that carries nothing by Vernadsky! Several other hard-to-find English-language books on the biosphere include the excellently informative *Traces of Bygone Biospheres* by Andrey Lapo (Synergetic Press and Mir Publishers, 1987), the flashy *Biosphere Catalog* (Synergetic Press, 1985), and the much more specialized *Energies: An Illustrated Guide to the Biosphere and Civilization* by Vaclav Smil (MIT, 1999). Of these books, only *Traces of Bygone Biospheres* contains significant information about Vernadsky and his ideas. This scant list of available texts in English is hardly proportionate to the vast reality of the biosphere as a complex terrestrial dynamic in the throes of evolutionary change.

The place and role of Vernadsky in Russian science is virtually equal to that of Einstein in Western science. A consideration of the achievement of each of these scientists also presents us with a dramatic contrast in perspectives, areas of interest, and consequent modes of analysis. The physicalist relativism of Einstein's legacy and its pursuit of the Big Bang is radically different in almost every way from the legacy of Vernadsky's work, which presents a biogeological worldview that is organically integrative and the basis of what in Russian science has come to be called *cosmism.* While the physicalist fascination of Western science has supported the materialism of modern Western thought and its way of life (which is actually an accelerating function of the biosphere's own internal processes), the whole system thinking of

Vernadsky-characterized by the conception of a "biogeochemical process"-ironically supports a cosmic rather than materialistic worldview.

To illustrate the Russian perspective and the influence of Vernadsky's work, we present the concluding thoughts of a book by another Russian scientist and philosopher, 1. Laptev:

> Each one of us requires the whole earth-today this is quite clear. But surely each one of us is required by the whole earth! And when these two mutually penetrating requirements, so distinctly revealed and intensified by the leap out into space, are satisfied, the new historical epoch will begin "in which mankind itself, and with mankind all branches of its activity, . . . will experience an advance that will put everything preceding it in the deepest shade." (Fr. Engels, *Dialecticsof Nature)* And people, no longer burdened by the thirst for money, will remember something that many of our contemporaries have forgotten: The only important things in life are such intangible qualities as beauty and wisdom, laughter and love.
>
> Nothing remains for us, members of a society the ideals of which are in unison with elemental geological processes and the laws of nature, but to wish that people the world over would recognize this as soon as possible.!

Laptev's words-written twenty-eight years ago and precisely at the midpoint between Hiroshima and the Inevitable Event, as well as during the year in which the World Trade Center in New York City was finally completed and inaugurated (April 4, 1973)-simply and elegantly state the theme and point of view that we are pursuing. In fact, it is the Inevitable Event that prepares us for the new historical epoch. But first we must realize how we are organized by the biosphere in order that the technosphere may be transformed into the noosphere.

The root of Laptev's cosmic vision lies in Vernadsky's succinct definition of the biosphere: "The biosphere is the region on Earth for the transformation of cosmic energies." Although the word *biosphere* had been coined in the late nineteenth century, it was really only with Vernadsky's efforts that the biosphere became a viable description of the totality of life on Earth inclusive of its organic and inorganic support processes.

Vernadsky was trained as a geologist with a specialization in crystallography. He immediately absorbed the implications of Curies discovery of radioactivity (1896), and devoted many studies to the purpose of uranium and naturally occurring radioactivity within the Earth's geology. By the time of the First World War, Vernadsky had already written important texts such as *Fundamentals of Crystallog;raphy and Descriptive Mineralogy,* and, along with Madame Curie, proposed an "international ra-

diography of Earth's crust." This was in advance of Alfred Wegener's definitive work on plate tectonics. During the time of the First World War and Russian Revolution, Vernadsky's attention turned toward the problem of living matter and its relation to the geochemistry of the Earth. From this was born Vernadsky's perception of the unitive biogeochemical process by which the biosphere maintains itself. In 1923 he published a "plea for the establishment of a biogeochemical laboratory."

In Paris, Vernadsky worked at the Insititut de Radium (Marie Curie) and became acquainted with Henri Bergson, who was then president of the International Commission of Intellectual Cooperation of the League of Nations. Through Bergson's circles, Vernadsky met often with the biologist Pierre Teilhard de Chardin (1881-1955) and the philosopher Edouard Ie Roy (1870-1954), with whom Vernadskyjointly coined the word and concept of the noosphere. Although Pierre Teilhard de Chardin is credited in the West with the concept of the noosphere, defined by him as the "mental envelope of the planet above and discontinuous with the biosphere," de Chardin's approach to the evolution of the noosphere as a natural consequence of vertebrate biology differs from Vernadsky's understanding in which it is the entirety of the biosphere that evokes the noosphere.

The chief fruit of this fertile time in Vernadsky's life was the publication of the little book titled *The Biosphere* (1926). Demonstrating the synchronic ordering principle of the noosphere, it is interesting that the same year that saw the publication of *The Biosphere* also witnessed the appearance of Jan Smuts noted book *Holism and Evolution.* Through most of the rest of his sometimes turbulent career (he often came under attack from hard-line bolsheviks), Vernadsky was to elaborate on the laws and principles of the biosphere, often expressed simply as problems in biogeochemistry. At the same time, his influence as a holistic thinker began to spread through the Soviet Academy of Sciences. A list of a few of his later publications gives some idea of the breadth of his thought, and includes: *Geochemistry, Problems in Biogeochemistry I* and *II, On the Boundaries of the Biosphere, Goethe as Naturalist, Scientific Thought as a Planetary Phenomenon, Some Words on the Noosphere,* and his never completed work, *The Chemical Structure of the Earth's Biosphere.*

Following the death of his wife in 1944, Vernadsky expressed the opinion that after the Second World War, American and Russian scientists should work more closely together. Early in 1945 (January 6), Vernadsky followed his wife to the grave. The Second World War ended, only to be followed by the Cold War (1947-1990). The critical collaboration between American and Russian scientists longed for by Vernadsky was soon to be buried in the ideological wasteland over which the superstructure of the technosphere would be constructed, a fact that in itself hastened the

acceleration of the biogeochemical processes bringing about the climax of the technosphere.

Vernadsky did not live to witness the birth of the atomic era, which began only months after he died. But like Einstein in America, in 1940 Vernadsky-along with several other scientists, and mindful of the possible military applications-had prompted the Russian government to begin investigations into the possibility of deriving energy from nuclear fission. Yet it is most remarkable that by the time of his death, Vernadsky had almost single-handedly defined virtually every aspect of the laws and principles of the biosphere. This he always did with an eye to an imminent moment in the not-too-distant future when there would be a dramatic biogeochemical mutation or combustion, out of which the biosphere would somehow trigger the noosphere:

> Not at a crisis of nervousness do we stand now, not at a time for the vacillation of flabby souls; but at a great turning point in the history of scientific thought, at a crisis such as occurs but once in a thousand years, such as has not been witnessed for many generations. Standing at this point, with the vista of future achievements before us, we should be happy that it is our lot to live at this time and to participate in the creation of tomorrow.2

Undoubtedly his sense of the great moment of transition came from the very fact that during the span of his life from 1863 to 1945, some eighty-two years, Vernadsky was able to witness firsthand the accelerating effects of man's thought-in the form of industrial technology and the machine-and its turbulent and transformative impact on the terrestrial biosphere. After all, as a geologist, Vernadsky was familiar with the long history of the Earth, and the impact of human technology on the biosphere was inescapably the most significant aspect of any study of the biosphere to the present time. So wrote Vernadsky: "Only man transgresses the established order. . . upsets the equilibrium, though whether he materially cripples the transforming mechanism, or merely redistributes it, we cannot at the moment be sure."3

The "transforming mechanism" referred to is the biosphere itself, which Vernadsky had already defined as the medium or region for the transformation of cosmic energy on Earth. At its simplest level, the unity of the whole of living matter of the biosphere is the sum of its living organisms. These living organisms either directly or indirectly are continuously processing solar and cosmic radiation, transforming it into various chemical cycles that establish the atmosphere, most notably through photosynthesis and the oxygen and carbon dioxide cycles. The important point, however, in any consideration of the biosphere is the principle of unity: the

biosphere is a unitive complex of cycles summarized as a single continuously transforming and slowly mutating biogeochemical process. In this single complex cyclical process, all of life-all of living matter-is a unity, a singular dynamic by which the biosphere can be considered as a living whole. From the plankton of the oceans to the trees in the forest and the human peering from his cave at the rising sun-all of this is a single unity.

It is the interaction of the living matter with the inert matter that creates and establishes the attributes and dynamics of the biosphere as a whole, all of which are now in a heightened state of acceleration and transformation, for as Vernadsky put it in the conclusion to *The Biosphere:* "The thought of the human species is a new fact which is turning the structure of the biosphere upside down after myriads of centuries." The structures and principles of the biosphere that man is now upsetting include: the continuity and invariance of life on Earth; vegetation as a transformer of the energy of the sun; multiplication as a manifestation of transformed solar energy; propagation of life and the forces resisting propagation; and the unique relations of life to the inert matter of the biosphere, including the composition of living matter into two orders, plant life and the various biological animal species, inclusive of man. The first order of plants and bacteria constitute the mechanism for capturing the solar radiation and introducing the energy of the sun into the biosphere. The second order of biological life is a manifestation of the process of the transmission of energy through the vegetable world; that is, at a primary and fundamental level, animal life is dependent upon plant life for its existence. (See plate 2, Life Is the Transformation of Solar Energy.)

All these principles for maintaining the equilibrium of the biosphere are functions of the dynamic of the different biochemical and geochemical cycles that maintain life both on land and in the ocean, all of which are subjected to processes that we refer to as evolution, both geological and biological. The evolutionary mechanisms of life include the principle of the biomass constant and the biogenic migration of atoms. Both of these mechanisms refer to and define the continuity and invariance of life on Earth. That is, the quantity of living matter has remained roughly unchanged since the origin of life on Earth-the biomass constant. Furthermore, the amount of oxygen in the biosphere is equal to the amount of biomass. It is the pressure of the different species on each other with the resultant interactions and changes that checks the infinite propagation of anyone species at the expense of the rest, and causes the mutation and evolution of the different life forms. It is through the intermediate structure of the technosphere that the human is wreaking the greatest havoc on these principles that are intended to maintain the biosphere as a stable dynamic,

and by which the human constitutes a biomutation of unparalleled significance. The different stages of the mutation of life account for the biogenic migration of atoms: "The evolution of different forms of life throughout geological time increases the biogenic migration of elements in the biosphere."4 The metamorphosis of dinosaurs into fossil fuel is an example of the biogenic migration of atoms-and of the introduction of "free energy" (the term for industrial waste and by-products such as carbon monoxide) into the biosphere, while at a more mundane level, it refers to processes such as metabolism, circulation, breathing, and so forth.

To summarize, there are two biogeochemical principles. The first states: "The biogenic migration of chemical elements in the biosphere tends towards a maximum of manifestation"; this refers to the presence of life everywhere on Earth, as well as the principle of the pressure of living matter upon itself. The second biogeochemical principle states: "The evolution of species, in tending towards the creation of new forms of life, always move in the direction of increasing biogenic migration of the atoms in the biosphere. . . . The second biogeochemical principle regulates the course of evolution. A newly evolved species will survive in the biosphere only if it is sufficiently able and sufficiently active in furthering the migration of atoms. The organism cannot be considered apart from its medium. It is a part of the complex mechanism of the biosphere." Here Vernadsky concludes his study of the biosphere with a consideration of the laws regulating evolution that, for him, are to be sought in the mechanism of the biosphere and not in accidental circumstances. For this reason "evolution must proceed, namely, in the direction of increasing consciousness and thought, and of forms having greater and greater influence on their surroundings."5 This consideration leads Vernadsky to domains of philosophical or religious thought. Why?

"We are confronted with a new form of biogenic migration resulting from the activity of human reason. Human thought has changed in a brisk and radical manner the trend of natural processes and has even modified what we call *natural laws.* Consciousness and thought, despite the efforts of generations of thinkers, have never been defined, have never been given a physical basis, in terms of matter and energy."6 And here Vernadsky poses a question that remained unanswered for him but that also leads to a consideration of the noosphere: "How can processes which seem purely physical be affected by consciousness?"7

Although *The Biosphere* is the initial statement and underlying basis of all Vernadsky's later thought and work, his final major study, *Problems in Biogeochemistry II,* translated and published by his son, George Vernadsky, at Yale University in 1944, states the final conclusions of Vernadsky on the intriguing relation of human con-

sciousness-via its thought and projected dynamic, the machine-on the biosphere. These reflections provide us with a means for defining more precisely the nature of the technosphere and noosphere.

FROM THE CREATION OF THE TECHNOSPHERE TO THE ADVENT OF THE NOOSPHERE

Vernadsky developed the biosphere into a full scientific description of the sum oflife and its support systems on Earth, and was a co-originator of the concept of the noosphere, yet he seems never to have used the word or concept of the technosphere. In some of Vernadsky's descriptions of the relation of man and his thought on the biosphere, however, the technosphere is absolutely implied. In reading the following chain ofVernadsky's thought, we can discern what we refer to as the biosphere-technosphere-noosphere continuum:

> Man by his work and his conscious attitude toward life is remaking a terrestrial envelope, the geological domain of life, the biosphere. He is transforming it into a new geological state, the noosphere.
>
> He creates within the biosphere new biogeochemical processes that did not exist before. A planetary phenomenon, the biogeochemical history of the chemical elements is notably changed.
>
> An immense new form of biogeochemical energy is represented by the technological work of man, complexly guided by his thought. It is interesting that the increase, in the course of time, of machinery in the structure of human society also proceeds in geometrical progression, just like the reproduction of any kind of living matter, man included.
>
> Statesmen should be aware of the present elemental process of transition of the biosphere into the noosphere. The fundamental property of biogeochemical energy is clearly revealed in the growth of free energy of the biosphere with the progress of geological time, especially of its transition into the noosphere.8

In this sequence of thoughts, we understand that Vernadsky, in his precise location in time, was himself the necessary voice of the biosphere giving rise to the noosphere. Put in another way, the very process that Vernadsky is describing-the transition of the biosphere to a new geological state, the noosphere-necessitated a coming into consciousness of itself, a self-reflective medium and voice. This self-reflective medium and voice of the biosphere-noosphere transition was Vernadsky

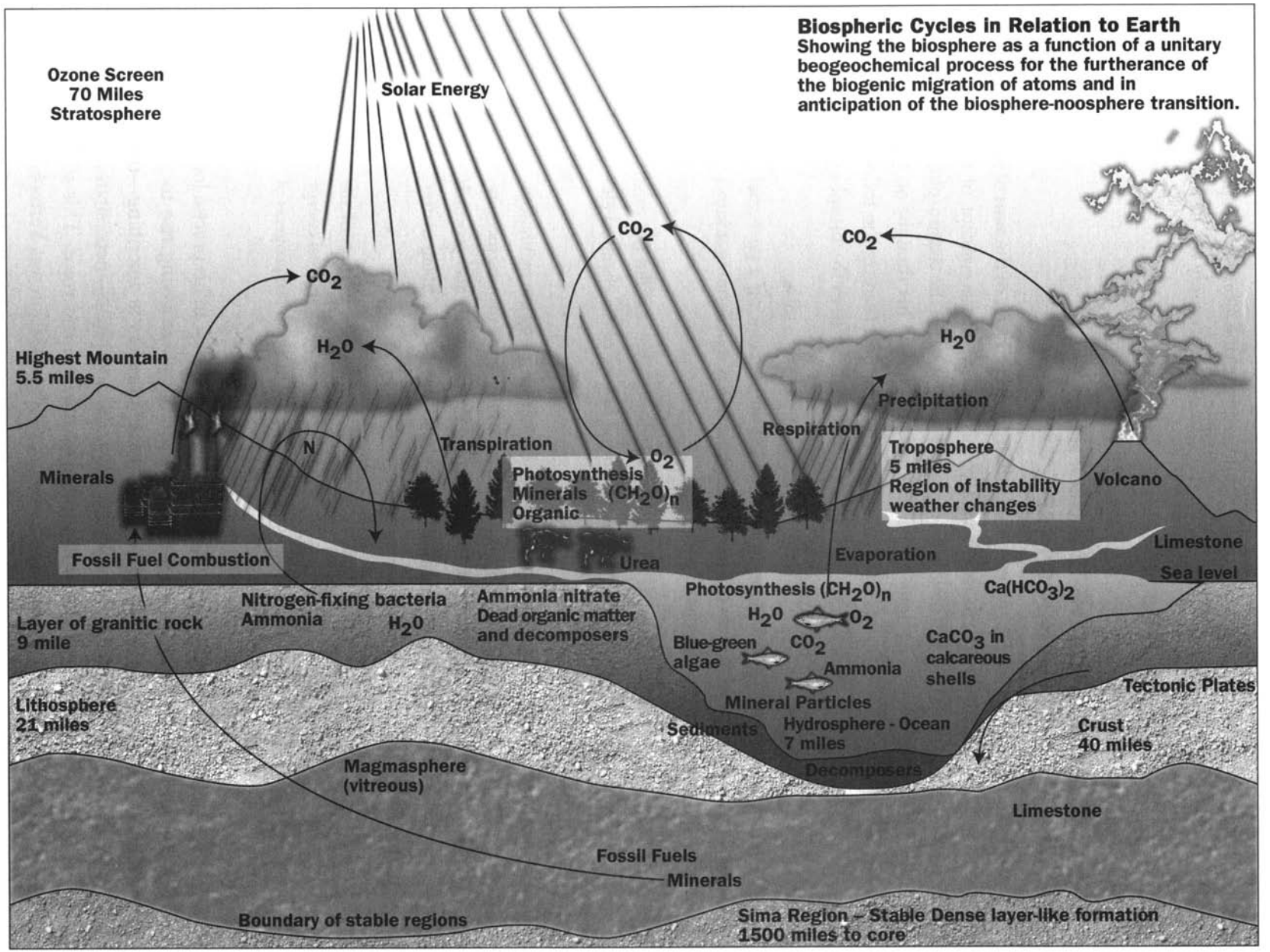

Biospheric Cycles

himself. In this observation we may understand that, although unconscious until it was made precipitant by the accelerated biogeochemical combustion itself, the order of the noosphere is none other than what the Law of Time defines as the synchronic order. As the structure of fourth-dimensional time, the synchronic order is a fluid, radial chronomantic structure in which time, telepathy, and consciousness are united in ways unpredictable to even the most advanced Western systems of mathematics.

For Vernadsky the sum properties of the elements of the biosphere are the functions both of mathematics and of different kinds of geometries. It is of note that in the summation of the differences between inert and living bodies according to three factors, the first being energy and the second chemical manifestations, Vernadsky defines the third factor as "differences in regard to space-time." Of this factor, Vernadsky writes:

> In considering space-time, however, the situation becomes rather involved. Here we enter, on the one hand, a domain not studied scientifically, and on the other hand, that substratum of all natural phenomena, namely their geometry, which the naturalist in his scientific work is wont to dismiss without attention. This substratum, the geometrical state of physical space, underlies all physiochemical phenomena and perhaps has an even deeper reality than that of the phenomena themselves.9

This deeper reality is the phenomenon of time itself, expressed through various geometries or geometrical principles, which informs the manifest phenomena of life. This is an obviously aesthetic factor as well as a cosm.Qlogical principle.

The Dynamics of Time fully substantiates Vernadsky's perception of the geometrical ordering principle of the deeper reality of time:

> All geometric forms are radiative and derive from the fourth-dimensional radial matrix. All fourth-dimensional functions are radial in nature and imply a principle of center from which the structure is projected. . .
>
> Geometry is how fourth-dimensional time incorporates as third-dimensional form. The incorporation of time as geometrical form informs all of the inorganic and organic orders of the realm of instinct. Time incorporated as the geometry of form is the principle example of T(E) = Art. All forms and species participate in varying orders of geometry of form, both in their bodily structure and their forms of process.1o

If the question is asked, Where is this deeper reality of fourth-dimensional time from whence the projective geometries are generated? then we must answer that it is here in the noosphere, the medium on Earth for the transformation of cosmic thought.

It is the noosphere that informs all of the forms of the biosphere, inert and living, as well as producing in all genuine thought a structure and an order that are continuously moving in the direction of greater consciousness. To even think about the noosphere is to be a reflection of it.

As a noospheric medium, Vernadsky's life span was precisely timed to end when the global structure of the technosphere was about to be unconsciously constructed. The ingredients of the technosphere are indicated in the above-quoted passages as the planetary phenomena altering the biogeochemical history of the chemical elements, transforming them into an "immense new form of biogeochemical energy represented by the technological work of man, complexly guided by his thought." It is the increase, over the course of time, of machinery in the structure of human society that proceeds in geometrical progression-just like the reproduction of any kind of living matter, man included-and that constitutes the general nature of the technosphere. The growth of "free energy," the often toxic by-products of the industrial transformation of raw goods into consumer products, becomes the hallmark of the technosphere, the transitional stage between the biosphere and the noosphere.

It is this very point of the elemental process of the production of "free energy" and what it signifies in terms of the transformation of the biosphere into the noosphere that causes Vernadsky to call statesmen to attention. Why? As we know today, fifty-six years after Hiroshima, "free energy" in various manifestations has been causing danger signals to go off throughout the biosphere-from ozone depletion to global warming to nuclear radioactivity. What these danger signals have been telling us is that the techno sphere is coming to a point of its own exponentially accelerating biogeochemical combustion. Statesmen and politicians are advised by Vernadsky because the domain of their political rulership actually encompasses the everyday governing of the technosphere. But, alas, most people, statesmen included, are still unconscious of the existence of the technosphere, much less its role in relation to the biosphere and the forthcoming geological state, the noosphere. Hence, the Inevitable Event.

During much of Vernadsky's life, the geochemical combustion and release of "free energy" was just coming into its own. At his birth in the middle of the nineteenth century, the world was not yet globally industrialized, and without a totally globalized industrial base there can be no technosphere. The critical span of the two world wars, 1914-1945, was for the purpose of establishing the world market-a total industrialized market and communications base for the expansion of technology and the creation of the unifying global structure of the technosphere. The inauguration of the atomic age at Hiroshima, August 6, 1945, marks the precise beginning of

the dual factors: the commencement of biogeochemical transmutation and combustion of the biosphere by the impact of human thought, the atomic bomb and release of nuclear radioactivity into the terrestrial atmosphere; and simultaneously, the beginning construction of the technosphere.

The bomb created a point of critical self-awareness within the human organism as well as producing in that organism an unprecedented sense of its own power. It was this sense of power that necessitated the unconscious impulse toward putting into place the structure of the technosphere. Of course, at the outset the species was only responding to a new, uncharted world situation, fundamentally unaware both of what it was creating as well as of the fact that it was actually constructing something in the nature of a transition between two geological conditions, the biosphere and the noosphere.

It could be said that Hiroshima lit the fuse of the final stage of biogeochemical combustion, the technosphere being the inevitable structure needed for the fuse to detonate at just the right moment. In this regard the synchronic order of the Law of Time ordained a precise 56-year cycle for the existence of the technosphere: 1945-2001. It is important to grasp that in this 56-year cycle the human population quadrupled, expanding from 1.5 to more than 6 billion. The 56-year cycle divides into precise subcycles of twenty-eight years each. The first twenty-eight years, 1945-1973, begins with Hiroshima and ends with the completion of the World Trade Center towers in New York City. This marks the accomplishment of the creation of the "World Market," the actual transformation of the biosphere into the technosphere. The second 28-year cycle, 1973-2001, spans from the dedication of the World Trade Center towers to their destruction by an act of suicidal planetary terror, and marks the phase of "globalization" -the absolute dominance of the materialist market economics, inclusive of the dramatic end of the Cold War in 1990. The very midpoint of the second 28-year cycle is the Harmonic Convergence of August 16-17, 1987, exactly fourteen years after the dedication of the World Trade Center and fourteen years before the inevitable moment of their destruction.

A profound statement of the way in which the Law of Time governs the entire biosphere, inclusive of the artificial and transitional structure of the technosphere, lies in the fact that the Gregorian calendar-an otherwise irregular and confusing pseudostandard of measure-is nonetheless coordinated by the Law of Time to repeat its cycle precisely every twenty-eight years. What this means is that the days of the week and months for the Gregorian calendar year 1945 repeated again in 1973, and yet a third time in 2001. The program prefiguring the Inevitable Event was already tested at Trinity Site (July 16, 1945), and established as the atomic destruction of

Hiroshima (August 6, 1945) and Nagasaki (August 9, 1945). This program of mass destruction was sublimated in 1973 as the triumphant completion of the Twin Towers of the World Trade Center, only so that in 2001 they could be the apocalyptic target of the inevitable 9-11 planetary red alert and moral emergency catastrophe, the only rival of Hiroshima and Nagasaki in fifty-six years. We shall return to this point later in our discussion on the Law of Time and the role of calendars as macro-organizing, programming factors that control the functioning of the human in the biosphere.

It is of special note that the very last work published before Vernadsky's death was the essay "Some Words about the Noosphere." In his vision, Vernadsky could hardly have conceived of what was to occur first as the technosphere. Yet, he wrote in this last essay, published 1944:

> The historical process is being radically changed under our very eyes. For the first time in the history of mankind the interest of the masses on the one hand, and the free thought of individuals on the other, determine the course of life of mankind and provide standards for men's ideas of justice. Mankind taken as a whole is becoming a mighty geological force. There arises the problem of the *reconstruction of the biosphere in the interests of freely thinking humanity as a single totality.* This new state of the biosphere which we approach without our noticing it is the noosphereY

By contrast, Teilhard de Chardin, in his most famous book, *The Phenomenon of Man* (1959), defined the noosphere as a "new canopy," a "thinking stratum" that has been unfolding since the end of the Tertiary period, and has since been unfolding discontinuous with and above the biospheric world of plants and animals. Teilhard de Chardin also speaks of "planets with noosphere," those worlds where the enlightenment of humanity has become synonymous with the life of the planet as a whole system. The one path to the noosphere defined by a scientist in Marxist Russia and the other by a Catholic biologist both point to the same radically positive end vision of the evolution of humanity, a fact that in itself is a dissolution of any kind of contradictory dialectic. Only history is governed by the merciless dialectical movement of matter and thought, rich and poor, material and spiritual. Clearly, therefore, the noosphere is beyond or after history. In this regard then, the technosphere is the concluding stage of history, to be followed by the post-historical noosphere.

The establishment of the techno sphere after his death notwithstanding, it is still important to listen to Vernadsky's idealism with regard to the noosphere: "The problem of planned, consistent activities which will aid us in mastering nature and accomplishing the correct distribution of wealth, connected with the comprehension of the unity and equality of all people, of the unity of the noosphere, is now on the

agenda. . . It has become clear, and is more deeply penetrating the consciousness of mankind, that we now have a real opportunity to obliterate malnutrition, starvation, and poverty, to greatly diminish the incidence of diseases, and prolong human life to the maximum."12 Other thinkers like R. Buckminster Fuller have uttered similar statements, that we have all that is needed to adequately take care of everyone on the planet. It is important to understand why this optimism has yet failed to be substantiated. If anything, the inequality in wealth between that of the several hundred billionaires in the world and that of the poorest one-third of humanity, two billion humans, was never historically more disproportionate than it was at the moment of the Inevitable Event. This inequality of wealth, too, is a situation endemic to the very processes of the technosphere, otherwise known as the military-industrial complex.

In 1970 an American scientist, G. E. Hutchinson, wrote in the *Scientific American,* "By noosphere Vernadsky meant the envelope of the mind that was to supersede the biosphere, the envelope of life. Unfortunately the quarter century since those words were written has demonstrated how mindless most of the changes wrought by man on the biosphere have been. Nonetheless, Vernadsky's transition in this deepest sense is the only alternative to mankind shortening its lifetime by millions of years."13

A similar assessment was put forward in 1979 by the Belgian ecologist P. Duvigneaud in his presentation "Noosphere and the Future of the Vegetation of the Globe." In his address regarding the extermination of natural ecosystems made to the Twelfth International Botanical Congress, Duvigneaud makes one of the earliest and most prescient uses of the word *technosphere:* "Thus, the noosphere, so dear to Vernadsky . . . is running the risk in reality of turning into the technosphere, or rather into 'the sphere of avidity,' governed by the spirit of fortune-hunting, by mediocrity, by the absence of social consciousness, by the ideal of destruction and by the egotistic doctrine of 'after me, the deluge.'"14

To be precise, it was in 1973, the same year of the Club of Rome's landmark publication *The Limits of Growth,* and of the establishment of the World Trade Center in New York, that the technosphere became a coherent structure smothering the biosphere, co-opting the noosphere, and coordinating the very processes of greed and destructive fortune-hunting abhorred by the ecologist Duvigneaud. Like it or not, the techno sphere was the inevitable result of the unloosing of the machine into the biosphere. It may be asked: if the machine is a projection of human biology, then what purpose does it actually serve in the biosphere, and what is it that actually produced it and keeps it going?

Before turning our attention to the answers to these questions, let us first define the technosphere as being the artificial structure replacing the human civilization,

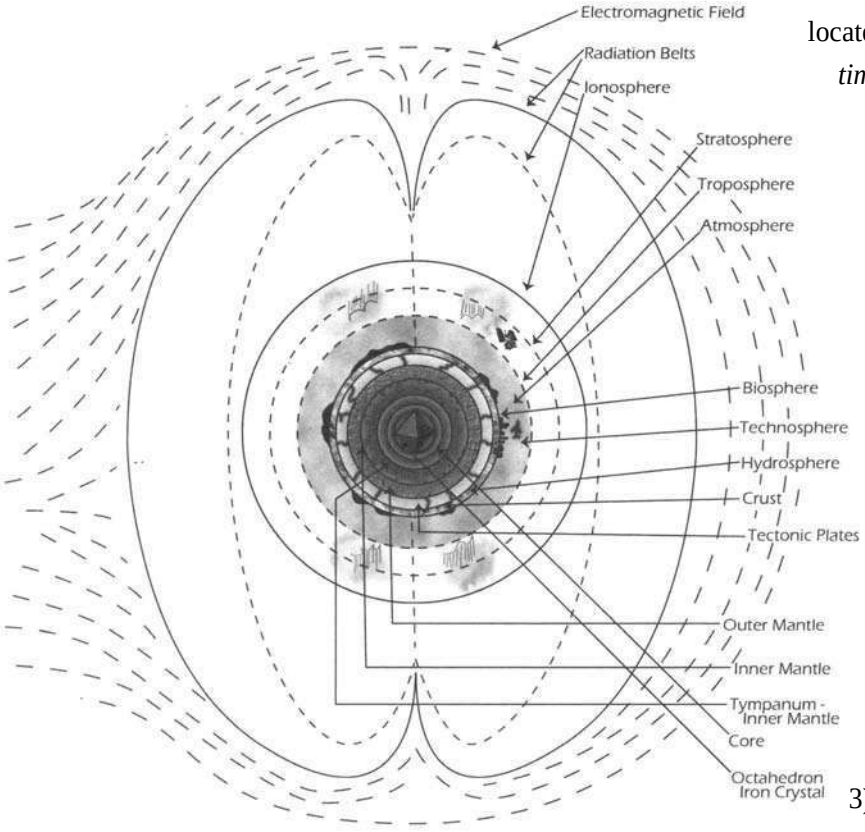

Earth's Mantles

located mentally and physically *in time* as a force intermediate to and between the biosphere and noosphere. Defined by the *Biosphere Catalogue* (1985, p. 103), the artificial structure of the technosphere consists of five interlocking, coordinated systems that comprise an integral whole, both as a belief system and as an actual complex technological dynamic and its coordinating apparatus. The five components, which we shall discuss at length in later chapters, are: 1) commodity production, 2) the city, 3) energy, 4) transport, and 5) communication. And, according to the *Biosphere Catalogue,* the planetary core of this interlocking set of systems was none other than the World Trade Center's Twin Towers.ls

As a planetary sphere, the technosphere takes its place with the other spheres or mantles comprising the structure of the Earth as a whole system. Beginning at the outermost etheric realm and proceeding inward, these spheres or mantles include: the electromagnetic field with its radiation belts, then the ionosphere, stratosphere, troposphere, atmosphere, technosphere, biosphere, land-ocean crust, tectonic plates, lithosphere, outer and inner mantles, and finally the core, now known to consist of an outer tympanum, and within it a large octahedral iron crystal afloat in a sea of magma.

As a planetary sphere, the technosphere negates time and consciousness as organic realities and replaces them instead with mechanization and marketing. Yet the technosphere is a product of mankind, and mankind is a function of the biosphere. The organization of life into biomes, large macro-ecosystems, is still evident, though in diminishing and withering proportion to the conquest of the technosphere. With the Final War now upon us, the question we must ask is: will the technosphere collapse before the biosphere or not? As catastrophic as it might seem, the collapse of the

technosphere would actually be a blessing in disguise from which the noosphere could finally be realized. But if the biosphere collapses first as the result of the Final War on Earth, then the technosphere will be futile, pointless, and dead as well. These are most dire thoughts in these most dire of times. Yet if we can now finally understand and accept our role within and subordinate to the biosphere as a whole, then our chances for survival will be greatly improved.

Let us consider again what Vernadsky has to say about the human's place in the biosphere:

1. Man, as observed in nature, like all living organisms, like any living matter, is a specific *function of the biosphere,* within its specific definite space-time.

2. Man in all his manifestations constitutes a regular part of the structure of the biosphere.

3. The *explosion* of scientific thought in the twentieth century *has been prepared for by the entire history of the biosphere* and has its deepest roots in the structure of the latter. The civilization of "cultured mankind," insofar as it is a form of organization of the new geological force which has formed in the biosphere, *cannot be interrupted or destroyed,* since it is a great natural phenomenon, historically, or rather, geologically corresponding to the established orderliness of the biosphere.16

If Vernadsky is correct, then the war we are witnessing is the inevitable conclusion of the biogeochemical combustion that consumes the technosphere and establishes the pristine reality of the noosphere. This is especially true if we understand this war to actually be a geopolitical struggle for the control of the oil reserves of the Persian Gulf, or even more broadly, as the war between matter (globalization) and spirit (Islam), or more grimly, as Oswald Spengler put it, the final war between blood and money. This being the case, it is more important than ever to answer the two unresolved questions in Vernadsky's definition of the biosphere, the question of consciousness and the question of time.

According to the Law of Time, the answers to the questions posed by Vernadsky are actually one and the same thing. "How can processes which seem purely physical be affected by consciousness?" The question asked by Vernadsky at the conclusion to *The Biosphere* is equaled by the unresolved issue of time discussed at the conclusion to *Problems of Biogeochemistry* JI.1n essence, Vernadsky declared, we know everything about the biosphere, its governing laws, principles, and functions, with the exception of the mysterious relation of time to the biosphere. Virtually alone among modern scientists,

Vernadsky perceived that time actually has nothing to do with the metrics of space, and that "time is not a dimension of metric geometry." This means that time is not only its own dimension-the fourth dimension-but that time must also have its own metrics and system of measure totally apart from the metrics of space.

> Minkovsky's and his predecessors' concept of time as the fourth dimension of space is a mathematical abstraction having logically no ground in scientific reality. Time is not a dimension of metric geometry. In geometry, time may be expressed vectorially, but it is obvious that such an expression does not embrace all of its properties in natural phenomena studied by the naturalist. . . The time of the naturalist is not the geometrical time of Minkovsky, nor is it the time of mechanics and theoretical physics.[I?]

In Vernadsky's perception of time, there is a profound critique of the approach that has been established toward the measure-and hence understanding-of time in physicalist science. For Vernadsky, time is a function of an as-yet-unrealized geometry: "This geometry would reduce all space to a point supplied by an infinitesimal vector." Clearly time is a factor in all the functions of the biosphere, most evident in the biological life processes. Hence the Law of Time has been a regulating factor, the true nature of which we have been profoundly unconscious. Now here is an interesting reflection. If the biosphere as a whole system is tending toward a total whole system transformation into a state known as the noosphere, a fact perceived by Vemadsky during his lifetime, and the two unresolved issues are the issues of time and consciousness, both materially intangible dimensions, does it not seem correct that the resolution to these two issues will actually foster the manifestation of the noosphere, which is, after all, the mental envelope of Earth? And does it not also seem that as long as the two issues of time and consciousness remain in a state of ignorance or confusion within the mental functioning of the human order, that the vehicle of geochemical combustion, the technosphere, will tend toward its own dissolution until the issue of time and consciousness is resolved and clarified once and for all?

The perilous passage, the biosphere-noosphere transition, may actually be defined as the consequence of operating in ignorance of the actual nature of time and consciousness. In this way, the techno sphere may be defined as the artificial compromise in place of the true understanding of time and consciousness of the human order in the biosphere. Hence, the technosphere is the responsible intermediary agent creating the crisis of the noosphere. The solution to the questions of time and consciousness is thus the solution to the noospheric crisis, and the commencement of the grand new era, the true golden age of the whole Earth.

3

Time and Human Consciousness

The Law of Time—What It Is and Where It Came From

HAVING DEFINED the technosphere as the intennediarystage in the biogeological continuum of the biosphere's evolution into the noosphere, we may now turn our attention to the unresolved issues of time and consciousness in the biosphere. These issues must not be seen as just the problems of humanity. Since humanity is a function of the biosphere, the issues therefore relate to the biosphere becoming more conscious. It is the conscious aspect of matter that directs the biosphere toward its transfonnation into the noosphere. It is the discovery of the Law of Time that complements and resolves the issues that were left unresolved in Vernadsky's definition of the biosphere and of its transformation into the noosphere. The question then arises: what is the Law of Time, and how does it define time and consciousness as mutually coordinating factors of the same cosmic dimension intersecting with the biosphere?

To say the least, time is such a vast and important topic in the orientation of human consciousness within the biosphere that we may declare that it is paramount in all human affairs. Indeed the cosmic order, of which the biosphere is the dynamic regulatory mechanism on planet Earth, is itself the expression of time as the medium of universal manifestation. Yet, as Vernadsky perceived in 1944, while we have defined space by its own systems of metrics and geometries, by applying these same standards to time we have not defined or known time at all. The cause for this quandary seems to lie in the fact that while space is perceptible as a sensory medium-we can see it, touch it, hear through it-and hence, it is evidently measurable, the same is

not the case with time. Time is of the mind, and in this regard, time is inseparable from the issue of consciousness. In fact, you cannot know or experience time without becoming conscious.

Yet, as we shall see, there is a great confusion when we speak about time, which is actually at the root of the problem of the biosphere, and that is the matter of the clock. In human consciousness, the clock has become so second nature that very few people in industrial society can think of time without immediately associating it somehow with the clock, whether as an instrument or as a metaphor. This, as we shall see, is a major factor causing the general state of consciousness to remain static, especially in relation to the machine, which is continuously increasing in speed, as well as accelerating in the propagation and multiplication of itself. This factor of the clock-in other words, of mechanized time-is also at the root of the confusion concerning the nature of time in much of modern scientific thought. As we shall see, there is a stream of Russian thought after Vernadsky that represents a notable exception to the established view of time in modern thought and science. Suffice it to say that the evolution of modern Western thought and science has been programmed and predisposed to limit its consciousness of time to such a degree that it cannot even perceive of time outside its inherently mechanized perceptions about it. In this obviously also lies the problem of the delimitation of consciousness in the technosphere.

"The deepening crisis of the world outlook is rooted in the permanence of the dominating scientific paradigm," writes Russian scientist Maria Maroushkina. "Underlying the materialistic technocratic civilization is the Newtonian-Cartesian paradigm, formed in the Middle Ages, its nucleus being the laws of gravitation and movement, as well as the logical principles of proof, laid down by Descartes."! This "permanent" stratum of belief, a cultural metaprogram, locks every field of human endeavor into a conquest by mechanization. It is this metaprogram rooted in the simple unexamined device of the clock, and orchestrated by the equally unexamined effects of an irregular calendar, that keeps human consciousness unchanged and without any real solutions to its problems. As the problems worsen, the confusion of consciousness-which is really in a state of crisis-only deepens.

To illustrate the current state of confusion regarding time in Western thought, we have the report of the prestigious Seven Pines Symposium on Time held in Stillwater, Minnesota in June, 2001. The *New York Times* article regarding the Seven Pines Symposium is entitled "Physics' Big Puzzle Has Big Question: What Is Time?"2 First of all, the assumption that time is basically a topic of physics in itself is a problem, since time, as we have demonstrated, is actually mental in nature, and if any-

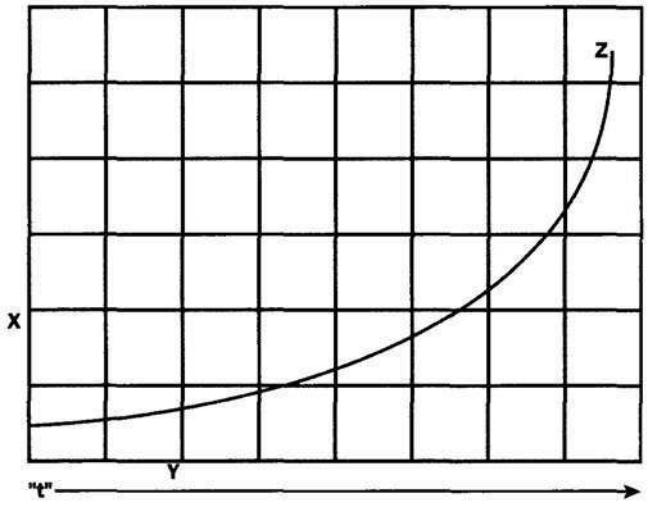

"Arrow of time" in modern scientific three-dimensional coordinate graphing, reinforcing illusion of linear time.

Arrow of Time

thing is most visibly manifest in the domain of biology or biogeology. But this headline is also reflective of the paramount role that physics plays in the Western intellectual hierarchy: if physics can't solve it, than what can?

Despite the prominence of physics and physicists, the Seven Pines Symposium included historians and philosophers as well. The hope of the symposium was to arrive at a unified theory that encompasses the effects of gravity as described by Einstein's general theory of relativity and the "fuzziness that occurs in the realm of tiny particles according to quantum physics."3 Here we have the problem of time as delimited by the self-imposed spectrum of modern physics. What then could we expect? Certainly no one here had considered the point made by Vernadsky that time is not a function of the metrics of space, which is the realm of physics. So it is not surprising that the symposium ended in a muddle, with the most prominent approach being that time could merely be a "psychological illusion" important to humans but not a fundamental part of any unified theory. It is also clear that few, if any, had considered that their views on time might be absolutely conditioned by the mundane and ordinary everyday micro- and macro-organizing factors: the mechanical clock and the Gregorian calendar with its second cousin, the Julian count of linear time.

From the point of view of the noosphere, of course, this grand Symposium on Time was reflective of very little of the entire human organism, much less of the biosphere itself. The symposium was a representation of the elite intellectual class of the dominant economic, military, and political power of the planet, and hence of the

governing force of the technosphere, the United States of America. But if a realization that we are a function of the biosphere is critical to our success in launching the noosphere, and the issue of understanding the correct relation of time to the biosphere is crucial even to the ability to launch the noosphere, then the Seven Pines Symposium did not even approach the actuality of the current biospheric situation or the nature of time. In this regard it was only a contribution to further the psychoatmospheric density-clouded thought without clarity of purpose-and one more reason why the Inevitable Event was on the biosphere's agenda.

If one does not apply certain biospheric yardsticks to the analysis of what is reported as truth, then we will be sunk in a chaotic morass of half-truths that are really obscurations or even lies. The elite American nation, for instance, constitutes only 5 percent of the world's population, yet consumes 40 percent of its natural resources, and therefore has the wealth and power to maintain the military force (allotted a $318 billion budget for 2001-2002) to protect and even further as its right this disproportionate ratio, which is actually a violation of the dynamic balance of the biospheric processes. For this reason, through its official organs of propaganda such as the *New York Times,* America is able to muster the "influence" of whatever occurs within its confines as somehow having more merit than what might be generated in some other nation or country. So a human may read the story in the *New York Times* on the "Big Puzzle of Time," and most likely they will complacently accept its premise as absolute truth. Yet this social construct of symposium-and-newspaper-story is nothing but an aberrant mental form that obscures the actual nature of time and keeps the mental level at a constant state of "industrial dull-normal," far removed from-or at best, little more than a highly distorted reflection of-the reality of the noosphere.

Leaving aside this example of the mental confusion over time, it is necessary to understand from the investigations regarding the biosphere and according to Vernadsky's own judgment, that the biosphere in all its intricate and interlocking processes possesses and is guided by a great order and even a structural dynamic that, being manifestations of the laws of nature, can be given exact mathematical formulation. Why should we not expect that the nature of time in the biosphere should also be characterized by the same orderly quality? In fact, given that the biosphere is actually a life process, like all living matter it too must be governed by timing cycles. Thus the larger order of time that governs the cycles of the biosphere and of the noosphere must also exhibit a grand ordering principle. For if the three dimensions of space govern the domain of the physical world, then the fourth dimension of time-which governs the life not only of the biosphere but of planets,

star systems, whole galaxies, and indeed the entire universe-must also consist of a simple, orderly formulation totally apart from the perception of time that governs the stunted consciousness of the technosphere. Such is the Law of Time.

THE FOURTH-DIMENSIONAL NATURE OF TIME

> *"Even though you do not measure the hours of the day as long or short, far or near, you still call it twelve hours. Because the signs of time's coming and going are obvious, people do not doubt it. Although they do not doubt it, they do not understand it. Or when sentient beings doubt what they do not understand, their doubt is not firmly fixed. Because of that, their past doubts do not necessarily coincide with their present doubt. Yet doubt itself is nothing but time."*
>
> -DOGEN, "THE TIME-BEING"4

These prescient words of a thirteenth century Japanese Zen master are more true today than they were when he wrote them. Comprehensive studies like the *Eranos Yearbook III: Man and Time* (1957), which included Carl G. Jung's ground breaking essay on synchronicity, or James T. Frazier's fascinating and monumental *Voices of Time* (1966), only expand the multidisciplinary breadth of the confusion about time. In the 1970s Frazier helped found the International Society for the Study of Time. The Society is still meeting annually but has yet to reach a definitive agreement on or understanding of the question of time. It is in the context of the enduring confusion over time that the Law of Time was discovered. To say that the Law of Time has been "discovered" only means that a principle and fundamental law that has always guided the order of the universe has finally been made conscious and articulated in a precise way that is recognizable to the present condition of the human mental nature, which is still dominated by the physicalist model.

In the whole of modern physics, Minkowski's fourth dimension of time has been misunderstood and treated as if it were a minor dimension, one that is just added on, but not really significant to the level of the three dimensions of space. This is due to the already space-oriented consciousness deriving from certain sets of perceptions established early in the history of civilization and standardized through certain programming models that are based on the metrics of space and not time, a topic to

which we shall soon turn. It is for this reason that in the formulations of modern physics time is symbolized by a small *t* that runs in a horizontal line running from left to right at the bottom of any graphing of space with its *x* and *y* coordinates.

This graphing of small *t* time gives rise to the notion of the "arrow of time," which is virtually a bedrock dogma of much of modern Western physics. This is the much-touted notion of linear time that supports doctrines of economic inexorability, material progress, and the like. Of course to anyone versed in the ways of nature, linear time and the arrow of time can be seen as nothing more than artificial constructs, for the biological nature of time is perceptible at the very least through the great interlocking cycles of nature. Nor is there anything linear about the Earth's rotations around the sun, or of the moon around the Earth, all of which give lie to the physicalist and materially progressivist notion of linear time. Only the technosphere, sustained in its structure by the limited consciousness of time, is driven by this linear principle and for this reason is doomed to run aground on the shoals of its own artificiality.

TIME AS THE UNIVERSAL FACTOR OF SYNCHRONIZATION

The nature of time is grasped poetically in the form of cycles: "To every season there is a time. . ." Biorhythms can even be mapped and the cycles of the biological order of reality can be demonstrated as functions of a chronobiology. But the biological cycles only demonstrate the manifestation of time in the space ofliving matter. If the whole of nature is observed, then one can begin to grasp the masterful orderliness by which every least detail occurs in relation to all the other details in their various cycles-yes, one can grasp in this phenomenal order another deeper aspect of time, and that is time as the universal factor of synchronization. This is the synchronic order of time, the order by which everything in the universe occurs simultaneously in a masterful synchronization from moment to moment in an ever-changing kaleidoscope of infinite varieties of order and harmony.

Only historical man deviates from this masterful symphony of time, the synchronic order. Nonetheless, we speak of being "on time," "in sync," "in tune," "in resonance," "in harmony," or of being "tuned-in." All of these expressions refer to the attunement of time and the nature of consciousness as awareness in the present moment, in the here and now. This is possible because the same law governs both time and the relation of consciousness to the moment. To answer Vernadsky's question, "How can processes which seem purely physical be affected by consciousness?"- the physical is affected by consciousness, because consciousness is actually a

function of time. When someone "discovers" a law of nature, it is because their consciousness is attuned to the natural process in time, and the law therefore "reveals" itself.

But this consciousness can be and most often is of a profoundly unconscious nature. Time is actually the governing principle of a higher self-existing consciousness that regulates the order of the universe, both in regard to its living and non-living matter. Because time continuously synchronizes everything into a single coherent whole from the micro to the macro levels, time accounts for the harmony of the universe. Only man deviates from the universal harmony, and the technosphere, a projection of the human mechanization of time, intrudes upon the intrinsic harmony to the point of its own demise, but man deviates for a purpose.

The harmony manifested by time as cosmos-which literally means "order" -gives rise to the great and simple formulation of the Law of Time: T(E) = Art; Energy factored by Time equals Art. This means that energy, any manifestation of the physical three-dimensional world, possesses order and is in harmony with its environment because it is factored by time. In the conception of the Law of Time, however, capital *T* refers to time as the universal factor of synchronization. As the universal factor of synchronization, time is defined by the self-existing and intrinsically perfect mathematical ratio 13:20. Derived from the mathematics of the ancient Maya, this ratio is a universal constant of time that organizes all of the universe as a radial sequence of synchronous moments reflecting different evolutionary phases simultaneously. Because everything perceived is an aspect of instantaneous universal synchronization, time is also the medium of instantaneous information transmission throughout the universe.

The noted Russian astrophysicist N. A. Kozyrev (1908-1983), whose work began half a century ago with the theory of the internal structure of stars, later conducted a famous series of experiments using telescopes, mirrors, and aluminum, in which he was able to confirm a receipt of information from distant galaxies prior to the time it took the information to arrive via light as a physical medium. In Kozyrev's own words: "The tests proved the existence of the effects through time of one material system upon another. This effect does not transmit a pulse (momentum), meaning it does not propagate but appears simultaneously in any material system. In this manner, in principle it proves possible to have a momentary relationship and a momentary transmission of information. Time accomplishes a relationship between all phenomena of nature and participates actively in them. . . . Time contains the entire universe of still unexplored phenomena."5 The results of these experiments led Kozyrev to various conclusions, among them that time and duration are not the

same thing, and that the velocity of time is instantaneously infinite, formulated as

$$T_V \longrightarrow \infty$$

Formulation: velocity of time is instantaneously infinite

This being so, time must also be the factor or medium that accounts for the experiences of telepathy or other paranormal phenomena. A second, most provocative conclusion derived from his experiments is that time is actually generated as an instantaneous and even simultaneously radial transmission of information from the core of stars, a fact confirmed by the Law of Time's description of the synchronic order of time as being radial in nature.

FURTHER EXPANSES OF FOURTH-DIMENSIONAL TIME: THE EVOLUTION OF TIME AS CONSCIOUSNESS

Leaving aside for the moment further discussion of Kozyrev's seminal work and its conclusions, at this point let us summarize the two chief qualities of time as defined by the Law of Time: 1) time is the factor of universal synchronization, and 2) time possesses an infinite instantaneity of velocity that is faster than the speed of light, and hence is correlated with telepathy. From these two determining features of the nature of time, two other corollary conclusions may be drawn: 3) the cyclic nature of third-dimensional biological phenomena is a function of the factor of universal synchronization which establishes harmonic ratios that determine the different life processes of different organisms, while 4) the ability of any species or organic whole to maintain its unity with itself and all of its members or parts is an instantaneous function of time as telepathy.

To better understand the Law of Time and its radical non-linear definition of time-which is actually the noospheric description of time-we may say that time, being synchronically instantaneous, is both "vertical" in relation to space (which is "horizontal"), and "radial" from the perspective of its own dimension, the fourth. Rather than being the small *t* line or arrow at the bottom of the physicist's graph, time as the fourth dimension is greater than and inclusive of the third dimension, much as the etheric atmosphere includes and surrounds the physical Earth in a radial "all-at-onceness." To try to measure this phenomenon with the metrics of space and its essentially linear yardsticks is to constrain time into definitions and descriptions that are totally alien to its nature.

In fact, from the point of view of the dynamics of time, it is space that is the moving line, or rather a set of points in a moving vector that can be described as

line. Let us extrapolate from the important observation made by Vernadsky at the conclusion to *Problems in Biogeochemistry II:* if the geometry of time reduces space to a point supplied by an infinitesimal vector, then from the point of view of time, space is an infinitely locatable point. What is this point? It is the point of awareness at which an individual body becomes aware of time. Here, the "subjective" description or experience of time cannot be separated from the issue of consciousness. (See plate 3, Model of "Vertical Time" in Relation to Horizontal Space.)

In the description of time as vertical in relation to horizontal space, this point of awareness of a body in time is defined as the Locus of Consciousness, or L of C. In the flow of moment-to-moment instantaneity that is synchronous with the flow of space, the Locus of Consciousness is that point at which time vector and space perception connect. From this defining point of consciousness in the here and now, the flow of space creates a horizontal sensation: one direction flows to the "past," the other to the "future." This is what is normally defined as the sensation of time or the arrow of time. It is actually the definition of the horizontal flow of space in relation to vertical time. What is usually not considered is the vertical dimension of time that connects awareness to space at any given moment, creating sequences of Awareness Units, or AUs.

From the defining point of the Locus of Consciousness, there are essentially two spaces and two times: *near space* and *far space,* and *low time* and *high time.* Near space corresponds to low time and far space corresponds to high time. Near space is essentially defined by the perimeter of sense experience, inclusive of the extension of the senses through technological apparatus such as telescopes, microscopes, and the like. This is the domain oflow time. Far space is defined as that space beyond the perimeter of the sense perceptions, and is characterized by subliminal sensory perceptions. This is the domain of high time and the atemporality of space. In near space, low time is characterized by what appear to be "random events." The lower the time, the greater the increase of random events. Low time and near space define the qualities of the experience that are properly and purely third-dimensional. High time and far space are purely and properly the domain of the fourth dimension characterized by the dominance of the synchronic order of time.

The distinction between low time and near space and high time and far space is defined as the threshold of synchronicity. In high time, synchronicity (s) predominates and is greater than random events (re), or (s»(re). In low time, random events predominate and are greater than synchronicity, or (re»(s). Note that the realm of quantum physics occurs in the microrealm of far space. It is this factor that accounts for the "fuzziness" of the behavior of subatomic particles, quarks, tachyons, and so

forth, which defy the limitations of linear time. These phenomena occur in the subliminal realm of the synchronic order. It is the human mind that is not accustomed to behavior in the pure realm of synchronicity that cannot grasp that these particles are moving according to radial laws of fourth-dimensional time, and so appear highly irregular and random to the sense perceptions of the observers that are totally conditioned by third-dimensional space perceptions. Similarly, the high time of the macro threshold of the synchronic order represents the "other side," the "hereafter," the realm of pure vision, which is also governed by strict laws of radial time, and which, to the conditioned experience of a perceiver on this side of the threshold, may appear as something from a distant future or past reality, or even as in a dream. The orderly explication of the Law of Time provides complete mathematical descriptions and principles that account for the radial order of time, even as it coordinates the near space and low time of random events.

In any case, the horizontal line of space in relation to the vertical line of time defining any given Locus of Consciousness describes the macroworld above and the microworld below. As we have noted, the higher threshold of synchronicity above the horizon of space defines the realm of *higher consciousness*; the lower threshold of synchronicity below the horizon of space defines the realm of *quantum physics.* Connecting the macro realm of atemporality and high time, and the lower or micro realm of atemporality and high time, is the vertical time vertice of the ever-present now. At the two far ends of this time vertice of the ever-present now is the Locus of God, the selfsame in each direction. These extreme points of the vertice of time return far space to the Locus of Consciousness through a process of toroidal sublimation. We are not really dealing with a description of a two-dimensional plane, but a dynamic four-dimensional model held together by a toroidal motion that is continuously returning the farthest space and the highest time, whether from above or below the threshold of synchronicity-" God" -to the Locus of Consciousness.

Depending on the clarity of mind at any given moment, the vertice of time constantly and instantaneously transmits information to the Locus of Consciousness. The discrete units of information thus transmitted are referred to as *celestial harmonics.* A celestial harmonic is described as the index of synchronic incidence defining different levels of co-occurrence. I can be in the present moment sitting in a room, and at the same time, by being fully present in the here and now, I can spontaneously experience any number of telepathic thoughts, memories, feelings of deja vu, and so forth. These experiences are the different levels of co-occurrence that define the index of synchronic incidence and are categorizable as celestial harmonics. The higher the time, the greater the density of celestial harmonics per AU (Awareness Unit). It

is the vertical vertice of time and its power of transmission that account for the visionary or revelatory experiences of saints, poets, and mystics throughout the ages. It is the mathematics of the Law of Time that provides the "mapping" that explains, identifies, and even increases these different harmonic incidences of the synchronic order.

Because the vertice of time connects ultimately to the "Locus of God" -the mutually defining points that become One at the far ends of the toroidal motion of the vertex of time-this accounts for the existence of the *perennial philosophy,* the unitive nature of the most revelatory or ecstatic experiences of the great mystics and seers. It is also the relation of awareness in the Locus of Consciousness at any present moment that allows any random event of low time to trigger telepathic ascent into high time depending on the clarity of and duration of the Awareness Unit (AU). From this point of view, the random quality of events in near space is only relative in relation to the absolute nature of the synchronic order, and merely a function of the third-dimensional biological space orientation. For those accustomed to the actual nature of fourth-dimensional time, which includes and controls the third-dimensional order of near space, the random events constituting low time are actually "signs" that may be read as message bearing signals of the synchronic order of high time.

Brief reflection on this description of vertical time in relation to horizontal space will demonstrate the value of what is referred to as *meditation without an object* such as that cultivated in the Buddhist traditions, as well as affirm the One Divine Source of the purely monotheistic traditions. Without a clear mind of awareness in the present moment there can be no clear seeing of reality, nor can there be the realization that all of what our senses report to us is constructed in our own mind to conform to what we think is a universe outside of us. At the same time, if we can extend the duration of our awareness in the Locus of Consciousness indefinitely in the vertical direction of time, we come upon the ineffable experience that is an emanation of the Locus of God, however or in whatever "language" our senses may later report or define such experiences. Thus we return to the paradox of the definition of space as an infinitely locatable point-this point is none other than our own minds, in which the construct of space is created and dissolved from moment to moment. Such is the subjective description of time from the point of view of the Law of Time, a description that begs each one of us to take absolute responsibility for our own experience. But there is an "objective" description as well, in which time is also defined as inseparable from consciousness.

Implicit in the subjective here-and-now description of the experience of time is the radial matrix of time. At the experiential level it is the now-centered point in the Space-Locus of Consciousness which defines the center of a radial order of time.

Time radiates out from each here-and-now awareness moment. But the Law of Time also supplies an objective description in which the radial nature of time has two points of determining order: the point of infinite lucidity and cosmogenesis, which is the Locus of God; and the receptive locus of the infinitely locatable point, which is space as constructed by each individual consciousness. Intermediate between the two points-Locus of God and Locus of (individual) Consciousness-is the determining radial matrix of fourth-dimensional time, the universal frequency of synchronization.

Mathematically defined as the ratio 13:20 and described by the 13 x 20 matrix of the Harmonic Module, in this mathematical model of fourth-dimensional time we perceive the root of the Law of Time and its basis in the mathematics of the Mayan time science. It is important to understand very clearly that the 13:20 frequency and the mathematical matrix that defines the operations of this frequency of synchronization are the pure mathematics of time totally apart from the metrics and geometries of third-dimensional space. This is a point of profound significance to which we shall later return.

In the model of objective time, the dynamics of the Law of Time are demonstrated as the evolution of time as consciousness. Here the two unresolved issues of Vernadky's description of the biosphere are unified, the answers to which are the determining factors that allow the triggering of the noosphere: The evolution of time is inseparable from consciousness. Conversely, the evolution of consciousness is inseparable from time. Both time and consciousness are nonphysical fourth-dimensional factors coordinating the third dimension. Because consciousness is synchronized with or by time, it can affect physical third-dimensional processes, in whatever way, whether the acting agent is aware of this or not. Consciousness of the Law of Time, however, is only possible through a profound act of self-reflection. Once it has been made conscious, the discovery of the Law of Time affects the entire medium of planetary consciousness, the noosphere, at first imperceptibly, but then building to a great point of climax coinciding with the climax of the biogeochemical combustion. (See plate 4, The Dynamics of Time: Showing the Evolution of Time as Consciousness.)

This dramatic moment of the discovery of the Law of Time is evident in the graphic description of the dynamics of time, showing the evolution of time as consciousness. The dynamic of the universal, cosmically intelligent, and intelligible whole-the *galacticbrain-is* depicted as a circle encompassing the evolutionary spectrum, showing the index of energy-mind progression from the atomic cellular and biological levels to purely mental conditions of being, all of which are functions of

the formulation T(E) =Art. From the point of God-Galactic Ordering Dynamic- the circle, or rather, sphere, is divided vertically and horizontally into four quadrants. The movement of the evolution of time as consciousness travels out of the God center, from right to left, and thence describes, in counterclockwise circular motion, the movement of time as consciousness passing through, or rather defining, the four quadrants, until it returns to the Source again as hyperdimensional time, or "pure mind." The left-hand side describes both the primary prelife, lower left-hand quadrant, and the primary post-life, upper left-hand quadrant. The right-hand side describes the secondary reflex life, the lower right-hand quadrant being the purely third-dimensional life (biosphere), and the upper right-hand quadrant being the evolved fourth-dimensional life (noosphere).

The lower half of the sphere beneath the horizontal line running through the God center refers to the Domain of Potentiality, the upper half to the Dominion of Time. The prelife quadrant of the Domain of Potentiality refers to the preconscious quantum dimensional space of pure energy. The lower right-hand quadrant refers to third-dimensional space, the locus of space travel and the realm of the cosmic unconscious. Within the Dominion of Time, the upper right-hand quadrant refers to the fourth-dimension time, the locus of time travel, and the realm of cosmic consciousness. Finally, the upper left-hand quadrant is the realm of hyperdimensional time, or "pure mind." By studying this graphic description, one can grasp the movement of time as consciousness from inorganic preconscious, where duration in time is virtually infinite, to the secondary reflex life, or living organic matter in the third dimension. Here time is unconscious and life builds on the cosmic unconscious as the slowly mutating and evolving biosphere. The cosmic unconscious comes to a climax in the creation of the 12:60 artificial civilization, which is really not true civilization, but rather the technosphere itself. At this point there are moments of consciousness, but only moments. True sustained consciousness is possible only in conditions removed from the technosphere.

In the evolution of time as consciousness, the discovery of the Law of Time is a product of the crisis of consciousness unable to sustain itself in the technospheric medium. That is because this medium is a pure function of artificial 12:60 time. Even though the extensions of the senses and the capacity of technology provide the human within the biosphere a holistic perspective of seeing the whole Earth from space, the consciousness is continuously subordinated to the care and maintenance of the machine (or its lifeblood, money), and so cannot remain in a sustained state of heightened awareness or continuing consciousness. Continuing consciousness is only possible with the discovery of the Law of Time, which the crises of the technosphere

and of consciousness have themselves brought about. In this regard, the discovery of the Law of Time is the great point of human self-reflection that defines the advance from an exclusive third-dimensional operation and aberrant timing factor to a purely fourth-dimensional and conscious natural timing factor. It is the difference between the cosmic unconscious and cosmic consciousness, the biosphere and the noosphere-in other words, the very topic of this book.

DE CHARDIN AND THE PLANETIZATION OF CONSCIOUSNESS

The discovery of the Law of Time defines the point between the two stages of the noosphere as described by Pierre Teilhard de Chardin: "The first stage was the elaboration oflower organisms, up to and including man, by the use and irrational combination of elementary sources of energy received or released by the planet. The second stage is the super-evolution of man, individually and collectively, by the use of refined forms of energy scientifically harnessed and applied in the bosom of the Noosphere, thanks to the coordinated efforts of all men working reflectively and unanimously upon themselves. . . In becoming planetised humanity is acquiring new physical powers that will enable it to super-organize matter. And, even more important, is it not possible that by the direct converging of its members it will be able, as though by resonance, to release psychic powers whose existence is still unsuspected?"6 The identification of telepathy with the velocity of time emphatically underscores de Chardin's final point.

On the other side of the discovery of the Law of Time, civilization, having reached its climax as the technosphere, is replaced by an entirely new noospheric order of human organization defined as PAN: Planet Art Network. This is a structural definition of what Teilhard de Chardin refers to as the "planetization of consciousness." This organization (bionoospheric and not institutional) is "planet" because the human organism is self-realized as a planetary organism. It is "art" because functioning again in the natural timing frequency, the human is governed by the Law of Time, T(E) = Art, and hence the reality and the activities of everyday life are defined as art. And it is a "network" because the city, defined by civilization (literally living in cities) and which was a sustaining component of the technosphere, is no longer necessary or viable. Rather, the human becomes redistributed throughout the biosphere-what Teilhard de Chardin refers to as the "radiation of man "--connected by a telepathic network that greatly diminishes the reliance on much of the technology that characterized the technosphere. Hence Planet Art Network: the replacement of civilization with the fourth-dimensional social organization of the human functioning as the tele-

pathically coordinating species of the noosphere. In this condition life evolves toward a hyperorganic stage, attaining a state of superconscious activity and self-reflection where time travel replaces the space travel of the phase known as civilization.

This evolutionary mode, coinciding with the evolving needs of the local star, conduces at some distant point in the future to the subliminal consciousness and the postorganic postlife that is necessitated by stars as they advance to the stage of supernova. According to the Law of Time, the nature of consciousness is actually a function of stellar evolution, planets being but harmonic nodes in greater heliospheric fields of resonance. Since time is inseparable from consciousness, this understanding would seem to affirm Kozyrev's hypothesis that time is generated from the stellar core. "Stars absorb energy from the motion of time," declares Kozyrev, "a star seems to be a time machine."7 *The Mayan Factor* further places the coordinating medium of time as emanating from the core of the galaxy, Hunab Ku, One Giver of Movement and Measure. In the Chilam Balam prophetic tradition, Hunab Ku is also the name given to the final religion of the One God that appears after the religion of the *conquistadors* has finally passed. Seen from the perspective of the Galactic Brain, the crisis through which we are now passing is but the final stage before consciousness bursts into a new radiance of biosolar-telepathic wonder where negative emotions and thought forms no longer have any place to cling or hide. The Law of Time purposively points to this great end.

The whole of the spectrum of the Galactic Brain is mediated by the universal frequency of synchronization, mathematically modeled as the 13:20 matrix, the organizing factor of the synchronic order. The technicalities of this evolutionary spectrum of the Galactic Brain have been defined in *The Dynamics of Time: 260 Postulates* (1996) so that the process of the evolution of time as consciousness may be studied and its coming stages prepared for. The mathematical model of this 13:20 matrix is a description of the fourth-dimensional timing frequency and is both the source of the time vector potentialities and the mathematical tool for mapping the order of synchronicity. Through the discovery of the Law of Time, the 13:20 matrix is realizable through tools that are in accord with its mathematics, and thereby it becomes useful to the everyday consciousness of the human. This too becomes a factor accounting for the noosphere's becoming conscious.

The fourth-dimensional "tools" made accessible through the Law of Time include the Thirteen Moon/28-Day calendar, the Dreamspell, and the Telektonon. They will be described more fully in Chapter 8, "Making the Transition to the New Time." With these tools one can begin to construct a map of the time vector potentialities contained in the synchronic order as it manifests on a day-to-day basis. Once

the construct is made conscious and correlated to a point in third-dimensional time, then the body in time-the infinitely locatable point that is space-may be coordinated by the same common structure of fourth-dimensional time. Following this procedure the individual human consciousness begins to participate in the larger unfolding of the noosphere, and slowly but surely is realized as yet another manifestation of the formulation of the Law of Time, T(E) = Art. It is the human being itself that incorporates time, or rather wakes up within itself the order of time. Time is art, while art is actually a function of consciousness expressing itself.

THE MAYAN UNDERSTANDING OF THE LAW OF TIME

While we will have cause to turn our attention later in this book to the "how-to" of fourth-dimensional time, we may consider further the nature and meaning of the mathematics of the Law of Time and their origin with the mysterious civilization of the ancient Maya. The template or matrix of the 13:20 frequency, a 13 x 20 (260) unit structure, was the means for accommodating the base "calendar" used by both the ancient and present day Maya: the *Tzolkin,* or sacred calendar, a set of thirteen numbers and twenty signs that repeat their sequences of permutations every 260 days. While this 13 x 20 matrix accommodates the Tzolkin, it is not confined to being a calendar, as I amply demonstrated in *The Mayan Factor.* The 13:20 frequency is the universal constant of time from whose mathematics the Tzolkin is derived. Based on the permutation table, called the *buk xok* in the Chilam Balam tradition, this matrix is a Harmonic Module, a fractal yardstick of radial time with multiple applications, something analogous to the periodic table of elements, but of the synchronic order.

It is still a profound challenge to all modern Western scientific thought that the Maya would have possessed such mathematics, apparently inherited from the earlier and even more mysterious Olmec people, and that with this mathematics they would have evolved such a profound perception of time. This was most certainly a factor in the destructive attitude taken toward the Maya by the religious zealotry of the conquerors of Mexico. It is also astonishing that the mathematics in which the Harmonic Module is embedded is a vigesimal (20) count, utilizing a zero and a positional ordering system that accounts for larger or greater values that advance by binary exponentiality rather than a decimal sequentiality. But, quite simply, this system exists in this manner because it is the mathematics appropriate to time. This mathematics is a factor to which any disinterested researcher on the topic of time must now become accustomed.

It is by reason of this mathematics and its ability to "download" the 13:20 universal frequency of synchronization that the ancient Maya were able to construct a complex system of "calendars" and an astronomical knowledge that is precise not for its telescopes, of which there were none, but because of the nature of the mathematical system itself. More appropriately described as synchronization devices or synchronometers, the Maya used at least seventeen of these timing instruments simultaneously during the great age of their civilization, A.D.435-830. This fact in itself tells us that the Maya understood time so radically differently from the perception that has evolved in the techno sphere that we must stand in awe that such a knowledge would have developed by a people whose technological development was so minimal, but whose artistic accomplishment was inseparable from their scientific achievement.

Harmonic Module

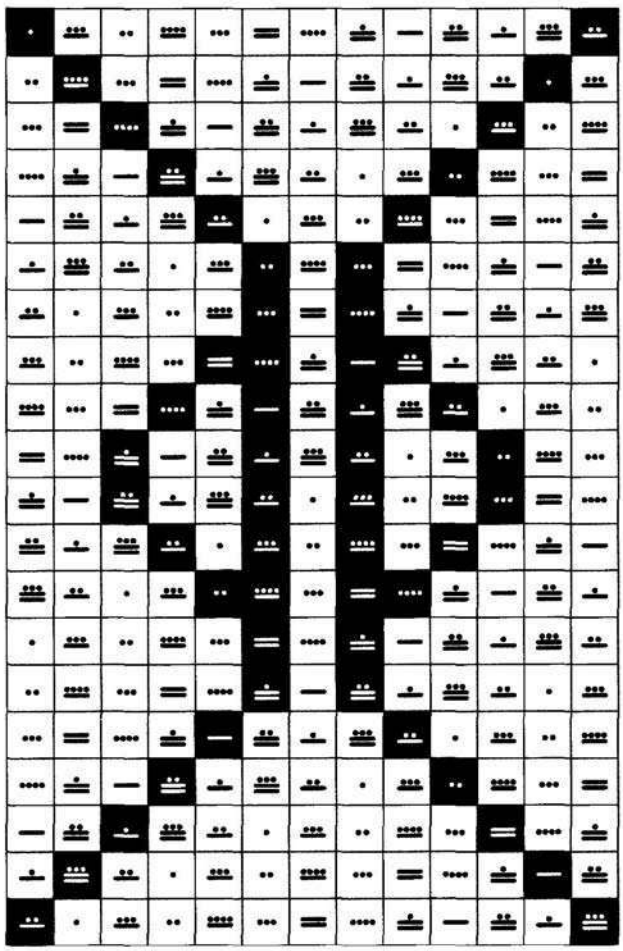

Yes, the Maya most definitely knew that time is the universal factor of synchronization, so their synchronometers must have been for the purpose of attaining a master synchronization with the cosmos. This presupposes such a different state of mind that all the values of the present day must be challenged. The mystery of it is that this mathematics and time science developed in the New World, remote from the saga of civilization in the Old World. The fact that the later Maya practiced ceremonies and blood rituals, the fascination of so many present-day archeologists, should not detract from the understanding that these ceremonial practices stem from a totally different perception of life-and death. Before we judge, we must consider the inescapable truth that nothing in history matches the terror of the different kinds of war and weapons of mass destruction that characterize the fifty-six-year cycle of the technosphere, 1945-2001. Who then is the more barbaric-the Maya, or modern man, *"Homo technosphericus"?*

It is the study of this vigesimal mathematics and its 13:20 Harmonic Module that has led to the discovery of the Law of Time. In this regard the Law of Time is a universal law independent of any culture or civilization, even that of the Maya, much like the law of gravity is also a universal law. However, if it had not been for the Maya, who evolved their understanding of the 13:20 frequency of synchronization to such a high degree, there would never have been a pursuit that led to the discov-

Galactic Notation, Dot-Bar (0–19) Code

Vigesimal count, 1–19, where in first order 1 = 1 and
0 = 20 position, so in next order 1 = 20, in third order 1 = 400, etc.

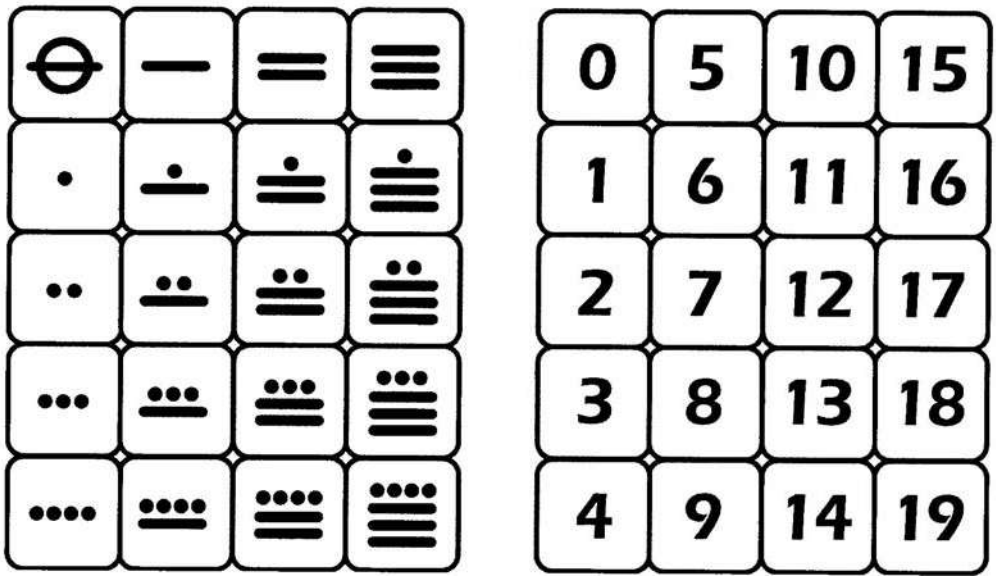

ery of the law underlying their knowledge of time. If with this law we may categorize the time vector potentialities in six stages of consciousness-preconscious, unconscious, and conscious, continuing conscious, superconscious, and subliminal conscious-then we may be certain that the ancient Maya were also familiar with the time science associated with the higher states of consciousness revealed by the Law of Time. With this time science and mathematics of higher consciousness, the Maya were able to bequeath a prophetic tradition mathematically coded in the Harmonic Module, which, among other matters, led to the discovery or making conscious of the Law of Time itself.

Once we appreciate the radically different perception of time and knowledge that is embodied in the Harmonic Module, the mathematical modeling of the 13:20 universal frequency of synchronization, then we may turn to its uses as the fractal radial measure of time applied to many levels of thought and knowledge. For instance, using the 13:20 matrix we may turn to an understanding of the Law of Time in human history, as is necessitated by these reflections. With the Mayan time knowledge and the placement of their civilization in the New World, we have a gauge and an alternative base of knowledge upon which to evolve a planetary perspective and an objective means of critique of the mainstream development of civilization in the Old World. We may then ask the questions: How did we become what we are now, and how was it that our civilization evolved into the technospheric medium?

4

The Law of Time in Human Affairs

The Analysis of History

THE KEY to *The Mayan Factor* is the application of the Harmonic Module as a fractal measure that is descriptive of the cycle of thirteen baktuns, the Mayan measure of history. This measure of thirteen baktuns, a cycle extending from 3113 B.C. to A.D. 2012, had been deduced from the stone inscriptions of the Mayan monuments of the Classic period, most of which bear a date within the tenth baktun cycle, A.D. 435-830, or, in the transliterated vigesimal notation of the Mayan Long Count, 9.0.0.0.0-10.0.0.0.0. However, one of the principle discoveries of *The Mayan Factor* demonstrated that the thirteen baktun cycle was also a function of the Harmonic Module and identical with its mathematical mapping as the 13:20 matrix. There are very profound implications to this correlation of the cycle of history having a one-to-one identity with the 13:20 frequency matrix. For this reason the cycle of history is referred to as a *Wave Harmonic* of the galactic order of time. Even though history may appear to be a random, haphazard, and checkered advance of humanity from living in small agricultural communities to the present-day technosphere, this process has actually been an orderly program of the biosphere, the region for the transformation of cosmic energy on Earth.

The same principle of the analysis of the Law of Time applies here. That is, by analogy, the historical events analyzed from a political or economic perspective represent the perception of the random events of near space and low time, while the analysis of the thirteen baktun cycle Wave Harmonic of history represents the

perspective of far space and high time. In this Wave Harmonic, the program of history is mathematically defined by 13 baktuns-each baktun consists of 20 katuns-13 baktuns x 20 katuns = 260 katuns = 13 x 20 matrix of the 13:20 frequency of synchronization. In the 13 x 20 matrix of the Harmonic Module each unit equals one kin, the base unit of fractal measure. By fractal equivalence, in the mapping of history one kin = one katun, one katun = 7,200 days; therefore one baktun = 144,000 (7,200 x 20) days. The mathematical perfection of the cycle of history matching the 260-unit model of the harmonic matrix means that history is a factor of synchronization of the higher order of time coordinating the human organism within the biosphere.

By means of the *thirteen baktun Wave Harmonic of history,* the incidence of human Civilizational Advance (CA) may be plotted in a very precise way as a progression going from a very dispersed and scattered state to the point of attaining its exponential climax in the final saga of geochemical combustion, the fifty-six-year cycle of the technosphere. In this regard we must ask: What do we mean by "history" from the Wave Harmonic point of view? As an organism that is a function of the biosphere, history defines that stage when that organism, humankind, enters a process of altering its biomes through increasingly artificial means or extensions of itself that exhibit a compulsive reordering of society into denser and denser clusters of habitations known as cities, hence civilization, "city-life."

In the stage before history, the human had created certain tools and had begun experiments in agriculture and horticulture, but the mental order remained in an aboriginal condition. Unconsciously absorbed as an integral mechanism within the cycles of the biosphere, the human wrapped his understanding of these cycles and of his place in them in the garb of myth and ritual. But with history, something different occurs. The artificial means or extensions of the senses are ordered by a different form of mentality. Those projections of thought and consciousness, though immaterial, affect the material surroundings, and take on an aggressive dynamic. The aggregate effects of these artificial extensions are maintained by a new mental dynamic that is contained and then conditioned by a new kind of macro-organizing thought structure, independent of the actual cycles of the biosphere. What is this new mentality? How can we most precisely define it?

Here are some points to ponder. The Mayan reckoning of the beginning of history is precisely dated to August 13, 3113 B.C., Long Count 13.0.0.0.0. The Hindu reckoning of the beginning of the Kali Yuga is dated to February 19, 3102 B.C. These dates are only eleven years apart. What cosmic event occurred at that time to initiate the Wave Harmonic of history? As we have seen, there is a perfect identity of the

13 Baktun Cycle: Wave Harmonic of History

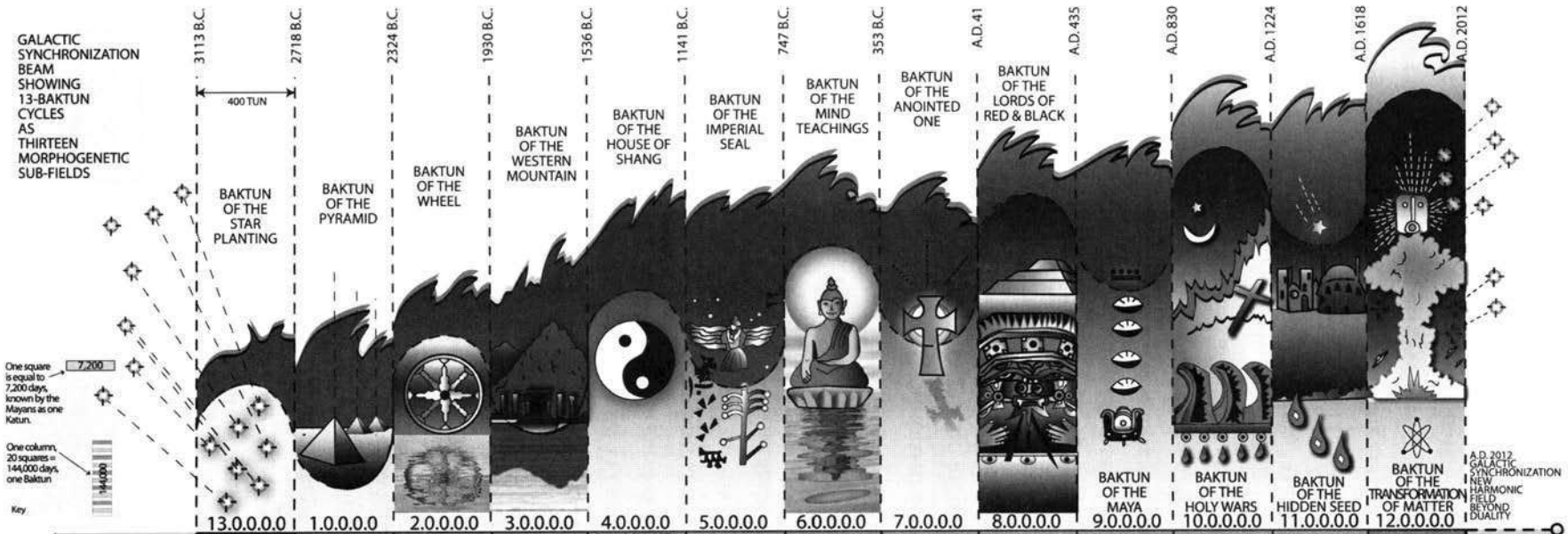

260-KATUN CYCLES
52-UNIT GAIA LIGHT BODY

	13.0.0.0.0	1.0.0.0.0	2.0.0.0.0	3.0.0.0.0	4.0.0.0.0	5.0.0.0.0	6.0.0.0.0	7.0.0.0.0	8.0.0.0.0	9.0.0.0.0	10.0.0.0.0	11.0.0.0.0	12.0.0.0.0		
DRAGON / IMIX	URUK, MENES	ZOSER, EGYPT CALENDAR	SARGON	ABRAHAM	SHANG DYNASTY, CHINA	KING WEN	GREEKS	ALEXANDER	ROMAN	FALL OF ROME	BOROBADUR	GOTHIC	DESCARTES	NEPTUNE	SOLAR MOVING INHALATION
WIND / IK	KILNS	GREAT PYRAMID	BABYLON		AKHNATON	CHOU DYNASTY	KUSHITE	CELTS	EMPIRE	BYZANTIUM		EUROPE	SCIENTIFIC	URANUS	
NIGHT / AKBAL	UNIFIED SUMER	GIZA		CRETE	HITTITE	CHINA		ASOKA	TEOTIHUACAN	RISE OF	VIKINGS	MONGOLS	MATERIALISM	SATURN	
SEED / KAN	EGYPT				EMPIRE	KING DAVID, JERUSALEM	NINEVEH	SPREAD OF BUDDHISM		CLASSIC	HEIAN JAPAN	KUBLAI KHAN	CHING DYNASTY	JUPITER	
SERPENT / CHICCHAN	OLD		CHARIOT	EGYPT: QUEEN	THERA EARTHQUAKE		PYTHAGORAS	ZAPOTECS		MAYA	CHIMU	MAYAPAN	NEWTON	A-BELT/MALDEK	
WORLD-BRIDGER / CIMI	KINGDOM		WARFARE	HATSHEPSUT	OLMECS	VEDIC	BABYLON REBUILT	CH'IN DYNASTY	NAZCA	BUDDHISM IN JAPAN	XOCHICALCO	AZTEC	BAROQUE MUSIC	MARS	
HAND / MANIK				VALLEY OF	CH'VIN	CIVILIZATION		HUANG-TI	GERMANIC	TIKAL	CE ACATL	BLACK PLAGUE	INDUSTRIAL	EARTH	
STAR / LAMAT			EGYPT	KINGS		INDIA	LAO TZU	EARLY	INVASIONS	POPE GREGORY	TOPILTZIN QUETZALCOATL	INCA	REVOLUTION	VENUS	
MOON / MULUC	HEIROGLYPHS	AKKAD	MIDDLE KINGDOM				PERSIAN	MAYA	MOCHE	MUHAMMED	RISE OF	MOGHUL / INDIA	AMERICAN &	MERCURY	
DOG / OC		UR			JADE	HORSE WARFARE	EMPIRE	HAN		PALENQUE	TOLTEC	OTTOMAN TURKS	FRENCH REVOLUTION	MERCURY	GALACTIC/LUNAR MOVING EXHALATION
MONKEY / CHUEN	CUNIEFORM				KING TUT		BUDDHA, MONTE ALBAN		END OF	PACAL VOTAN	MAYA		ROMANTICISM	VENUS	
HUMAN / EB		HARAPPA			RAMSES		CONFUCIUS	DYNASTY	HAN DYNASTY		IFE	MING DYNASTY	EUROPEAN	EARTH	
SKYWALKER / BEN		CIVILIZATION			ASSYRIA	JERUSALEM		TEOTIHUACAN	TIAHUANACO	COPAN	ANGKOR WAT		IMPERIALISM	MARS	
WIZARD / IX		INDIA	ZIGGURATS				PLATO	RISE OF ROME		HEIROGLYPHIC STAIRWAY	CRUSADES	FALL OF CONSTANTINOPLE	ELECTRICITY	A-BELT/MALDEK	
EAGLE / MEN				HORSES			CHUANG TZU			SPREAD OF ISLAM	BUDDHISM IN	PRINTING, CONQUEST	RUSSIAN REVOLUTION	JUPITER	
WARRIOR / CIB			BRONZE	CENTRAL ASIA	VEDAS	LA VENTA	ZOROASTER	GREAT WALL	CONSTANTINE		TIBET	OF MEXICO, PERU	WORLD WARS	SATURN	
EARTH / CABAN			TECHNOLOGY	HITTITES		ASSYRIAN		OF CHINA	BUDDHISM IN	T'ANG DYNASTY	SUNG DYNASTY	EUROPE EXPLORATION	HIROSHIMA	URANUS	
MIRROR / ETZNAB			MENUHOTEP	EGYPTIAN	PHOENICIANS	IRON	BANTU, WEST AFRICA		CHINA	MISSISSIPPI CULTURE, BAGDAD	RUSSIA/KIEV	BENIN	NUCLEAR & SPACE TECHNOLOGY	NEPTUNE	
STORM / CAUAC	STONEHENGE	PYRAMID	UR, NAMMU, LEGAL CODE	EMPIRE	MYCENEANS	WEAPONS &	PELOPPONESIAN WAR	JULIUS CAESAR	GUPTA DYNASTY, INDIA	PADMASAMBHAVA	ANASAZI	QUEEN ELIZABETH	HARMONIC CONVERGENCE	PLUTO	
SUN / AHAU	GILGAMESH	TEXTS	HAMURABI	ARYANS INVADE INDIA		WAR MACHINES	ARISTOTLE	CHRIST		CHARLEMAGNE	ZIMBABWE	GALILEO, KEPLER	EARTH REGENERATION	PLUTO	

Wave Harmonic of history, as a fractal equivalence, with the Harmonic Module, itself a description of the universal 13:20 frequency of synchronization. This being so, both the calculation of the beginning of history as well as the duration of its entire cycle are functions of the Law of Time. This means that something within the Earth's noosphere occurred that triggered the Wave Harmonic, itself a manifestation of the Law of Time. Also, by most judgments and standards, history began at a very precise place as well-Sumeria, in the Mesopotamian basin of what is now called the Middle East. Why? And what relation is there between the precise event that triggered the Wave Harmonic of history and Sumeria, the site of the first city, Uruk? What event could have established a macro-organizing principle to propel the dynamic of human thought and technology into the trajectory concluded by the technosphere?

THE ORIGINS OF THE 12:60 FREQUENCY

In the recently published book *The History of the World-A 6,000 Year Chronicle of Time,* we find the point that establishes the definite artificiality of a new kind of macro-organizing principle, driving humankind toward the Inevitable Event; here we find the genesis of artificial time: "Ca. 3000 B.C. Sumerians divide day into 24 hours, 60 minutes, 60 seconds and circle into 360 degrees."! While this is a fact we may take for granted because it is the basis of mechanized time in the form of the clock, for precisely that reason it should give us pause. For one thing, this means that the measuring system of the clock was already established at the beginning of history, some 4,500 years before the clock as we know it was actually invented! This is quite an astonishing fact. It means that mechanization was implicit in the first intellectual act of history. Why or how would it have occurred at the precise point of the beginning of history in Sumeria?

The Law of Time defines this mechanistic organizing principle as the basis of the 12:60 artificial timing frequency (irregular twelve-month calendar combined with mechanical sixty-minute hour). Therefore, it was at this point at the beginning of history that artificial time and its progeny, mechanization, were actually registered as a thought form and thus became embedded in the as-yet-unconscious noosphere. Or, was it already embedded in the noosphere to be triggered at this precise point-and if so, why and how? The point is that history, as it has evolved as the mainstream of civilization from Sumeria to the World Trade Center, has always been driven by the organizing principle of artificial time. It is artificial time that separates history from prehistory-and, as we shall see, from post-history as well. It was due to the

The Error in Time

The measure of a two-dimensional plane in space has nothing to do with the experience or the nature of time.

"TIME WAS COMPRESSED INTO A FLAT CIRCLE..."
Dreamspell "Genesis"

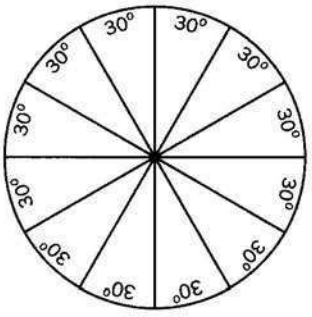

Sumeria: Ca 3000 B.C.
Day divided into 24 hours,
60 minutes, 60 seconds
based on 360 degree circle—
two-dimensional plane in space—
divided into twelve parts

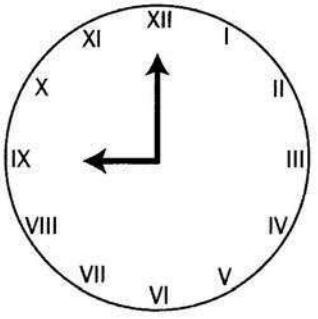

Europe: 800-1600 A.D.
Clock—two-dimensional plane
in space—divided into twelve
parts each 30 degree of arc =
1 hour = 60 minutes
each minute = 60 seconds
A.M. = 12 hours
P.M. = 12 hours
= 24 hours

I - 31	II-28/29	III - 31
IV - 30	V - 31	VI - 30
VII - 31	VIII - 31	IX - 30
X - 31	XI - 30	XII - 31

Rome (Vatican): 44 B.C. - 1582 A.D.
Twelve-month Julian/Gregorian
calendar derived from twelve part
division of circle; irregular measure
due to fact that 365 is not divisible
by twelve.

Earth's solar orbit = 365 days
360 degrees ≠ 365 days

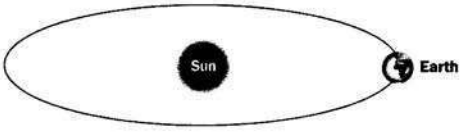

genesis of artificial time at the beginning of history and its emplacement within the planetary noosphere that also generated the thirteen baktun Wave Harmonic of history. For the very purpose of the thirteen baktun Wave Harmonic of history is to encompass and coordinate the cycle of artificial time. Why?

The Wave Harmonic is a function of the 13:20 synchronization frequency. It is a function of cosmic time. In the higher knowledge of the Mayan understanding, it provided the perfect measure of the cycle of artificial time. From the perspective of the actual noospheric timing, which operates according to the natural 13:20 cosmic timing frequency, history is none other than a manifestation of artificial time. Civilization becomes organized by the principle of artificial time. But because it is artificial, it cannot endure. If the mathematical basis of mechanized time, and hence of mechanization, was already established at the beginning of history, then the end of history is the end of artificial, mechanized 12:60 time. And in the end, the Law of

Time codes and encompasses the whole of the cycle of artificial time through the thirteen baktun Wave Harmonic of history. What is important to grasp is that the entire cycle of artificial time was *alreadyperceived* by the Mayans as a phenomenon that could not endure more than the length of the cycle of thirteen baktuns.

It is necessary for the reader to understand how this perspective was discovered. It was the result of a phenomenological experiment of living according to the synchronic cycles of the Mayan time science. After the death of my son in 1987, my wife and I began in earnest to follow the cycles encoded in the Mayan calendar: 13-day, 20-day, 52-day and 260-day cycles. Our life changed dramatically. At the same time, I endeavored to define the mathematical basis of these cycles. Once I resigned my academic position in early 1989, we were swept by a wave of time that took us from the Rocky Mountains to Southern California to the Hawaiian Islands in the middle of the Pacific Ocean. There, in relative isolation from the rest of the world, we plunged into our experiment. Before we had truly settled in, the time wave took us to Switzerland, where on December 10, 1989, in the Museum of Time in Geneva, we were able to put our phenomenological experiment to the test-although we did not consciously realize at the time that we were doing so.

There in the Museum of Time, essentially surrounded by examples of the history of the clock and mechanization, and because our perceptions had been altered by our living so completely by the various timing cycles encoded in the Mayan calendar system, we were able to spontaneously perceive the existence of two timing frequencies. The natural frequency-the one we had been living-we understood instinctively to be the 13:20 timing frequency. The other frequency-the one enshrined in this Museum of Time-we understood to be the artificial 12:60 timing frequency. This realization of artificial time was rooted in the evident proof that the clock is based on the twelve-part division of a flat circle, a spatial plane that clearly has nothing to do with the dynamics of time. It is a manifest error, but one that humanity has taken for granted and endowed with all of the characteristics of "truth."

We also immediately saw that the error of mistaking the division of a two-dimensional plane in space for a measure of time was transmitted not only through the clock, but through the twelve-month Gregorian calendar as well. With brief reflection upon what a gross error this was-substituting a twelve-part division of space as a measure of time, and then elevating this mistake as the truth of the measure of time-we understood how it could have actually led humanity away from the natural time of the universe. In making this observation, we immediately and intuitively grasped the necessary solution: replace the erroneously measured twelve-month Gregorian calendar with the perfect measure of the Thirteen Moon/2 8-Day calendar.

Our research into the mathematical codes behind the Mayan calendar now progressed rapidly, but our attention also turned to the question: Whence came the thought form of 24 hours, 60 minutes, and 60 seconds as a measure of a circle of 360 degrees? It was clear to us that this division of time based on the division of a circle in space occurred at what is the beginning of history, a fact later confirmed for us in the already cited *History of the World* (1997), which states that this division of 24 hours, 60 minutes, 60 seconds and the circle into 360 degrees was devised "Ca. 3000 B.C."

Once we had finished working out the mathematical codes, we turned to a consideration of the actual implications of the error in time. It was now also clear why the Mayan time science was so superior. It was based on the reality of time as a factor of synchronization. By contrast, the concept of time as it had developed in the mainstream of civilization was limited, linear, and totally third-dimensional, a fact that confirmed Vernadsky's analysis, as well, that our notions of time are a function of the metrics of space. By 1991, the experience in the Museum of Time had driven us into

What Difference Can a Calendar Make?

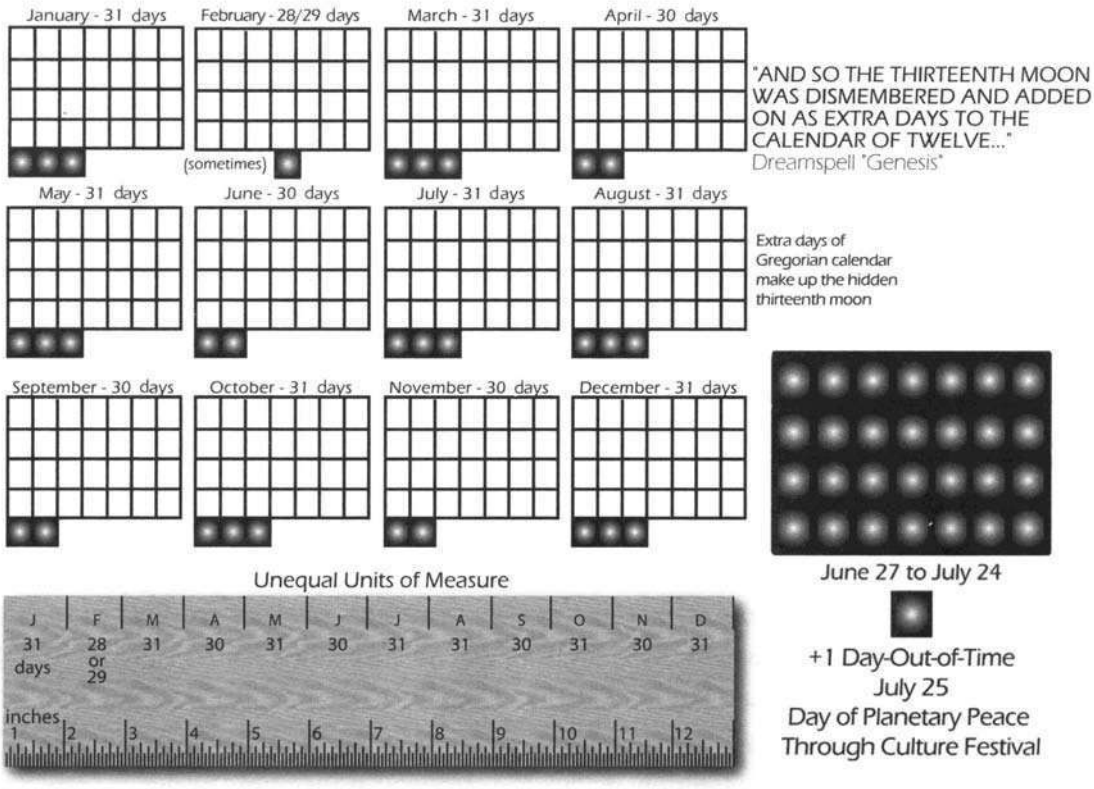

Gregorian Calendar and the Hidden Thirteenth Moon

creating a full-blown psychomythic analysis and description of this moment of realization concerning the nature of time. The complete structure of the mathematical codes of time, as well as the psychomythic description of the causes and effects of the error in time, is known as the Dreamspell, which is defined as follows:

"DreamspeH: function of fifth-dimensional galactic-solar planetary regulation; 26,000-year renewable cycle and planetary castle genesis; any consensus reality; in disregard of interdimensional reality creates entropic spell of history; cure for loss of galactic memory."2 The *planetary castle genesis* refers to the *five castles of time* (each 5,200 years in length), divided into three *geneses-the* Dragon, the Monkey, and the Moon-that constitute the entire fractal panorama of the 26,000-year cycle of history that ends in 2012, and is meant to be renewed in 2013 (an obvious synchronic reference to the 13:20 timing frequency). In the Dreamspell analysis, the beginning of history occurs almost 5,200 years ago between the Monkey and the Moon geneses, and is marked by the imposition of the false 12:60 timing ratio.

In light of this analysis and definition it is worth quoting certain passages from the Dreamspell text that describe this precise moment at the beginning of history and that the Law of Time defines as the root error of civilization. First we quote from the "Dreamspell Genesis," and then from the descriptions of the "Dreamspell Journey and Mission of Timeship Earth 2013." The purpose of quoting these passages here is to establish a psychomythic context to explain the profound nature of what we refer to as the error in time compounded over 5,000 years of history:

> Imposters, male priests and warriors usurped the power of the thirteen moons. They hid the thirteen among themselves and attempted to banish all memory of the matrix dreamspell of magic. . . The planetary kin had imposed upon them the diminishing power ratio of 12:60. No longer the magic of thirteen moons but a twelve month calendar of uncertain meaning. No longer the timeless gyre of magical flight, but a sixty-minute hour to earn one's bread.
>
> Time was compressed into a flat circle. . .
>
> The 13:20 ratio is the base operating ratio of timeship Earth. . .
>
> In that vital moment during the magic flight. . . Toward the moon genesis, another spell was cast. Instead of the 13:260 ratio already stored deep within the crystal core of timeship Earth, the planetary kin received the 12:60 ratio, the dark dreamspell of history. . . And so the thirteenth moon was dismembered and added on as extra days to the calendar of twelve. . .

> The absorption of the thirteen by the twelve was called an improvement by the male imposter priests hypnotized by the combined powers ofJupiter and Saturn. It takes twelve years for Jupiter to orbit once around the sun. It takes sixty years for Jupiter and Saturn to be conjunct.
>
> Twelve times five equals sixty, one sixth of the flat three hundred sixty degree circle. The difference between twelve and five is seven. While the priests of the calendar of ancient Babylon banished the power of the thirteen moons, they replaced that power with the power of seven.
>
> While the twelve diminished the power of thirteen by one, the sixty raised the power of twenty by three. A seeming increase in power occurred, but an increase only on the flat plane of the third-dimensional time to which the planetary kin were now consigned.
>
> With the banishment of the thirteen moons, the fourth-dimensional time magic. . . became the property of the priest class. Setting up religions and governments to maintain the kin within the third dimension, the priests were assured that anyone having fourth-dimensional experiences either be appropriated or destroyed.J

So much for the psychomythic impression of the genesis of artificial time, the flat time of an exclusive third-dimensional reality called history. A few further quotations from the Dreamspell emphasize both the interplanetary and mathematical root of false time:

> At -3187 Dreamspell years the time bandits on the sixth and seventh orbits pulsed their beam. The 12:60 frequency of the memory virus took immediate effect on the third-dimensional space suits. . . The Dreamspell of history was cast.
>
> Imposter priests on Earth substitute the 12:60 ratio. . . Instead of the magic of following thirteen moons, a non-circulating twelve-month calendar is substituted; instead of the beauty and power of magical flight, the sixty-minute hour. The result is disastrous.
>
> The twelve-month calendar is the consequence of the 12:60 ratio imposed at -3187 Dreamspell years (3113 B.C.,Julian/Gregorian). With no basis in or capacity for measuring galactic time, the twelve-month calendar is actually a third-dimensional prison keeping the four root races separate and at war with each other.4

These descriptive explanations of the error in time define such a profoundly radical point of view that we must flesh out the implications and description of the

course of artificial time according to the analysis of the Law of Time. From the outset of civilization in Sumeria, artificial time captures the human mentality in the order oflow time and near space (third dimension), separating it from high time and far space (fourth dimension). The registration of artificial time within the unconscious structure of the noosphere, which is intrinsically governed by the universal 13:20 frequency of synchronization, creates a conflict and a pressure in the noosphere, a time warp or taint that affects the entire biosphere.

Civilization-living in cities-increasingly becomes the human norm within the biosphere. Where there had been no civilization, at a few key places around the planet civilization now arises-a process that goes from the crystalline structures at the origin to the later phases of imperialism and empire building. This cycle is repeated again and again. Even in the New World where the 13:20 natural timing frequency prevailed, the later stages of civilization succumbed to the effects of the 12:60 already seeded in the noosphere. Ultimately, all humanity and the biosphere were to be governed by the artificial timing frequency that ends with the construction of the technosphere, the final and supreme expression of artificial time. Indeed, the technosphere is the absolute conclusion of what can rightly be called an artificial time warp in the biosphere.

Concerning the mathematical basis of the 12:60 frequency, V. A. Ponko of the Russian Academy of Sciences, Novosibirsk, has conducted extensive research and wave analysis on the mathematical properties of the cycles of history. He has concluded that as a mental coordinate, the number 12 is a strict construct of the angles of space. Since it does not correspond to the sinusoidal curvature of the cycles of time and the plotting of all organic phenomena, when used as a time factor the number 12 offers no "protection" from bombardment by any number of cosmic forces. The mathematical plotting of the 13:28 frequency that characterizes the Thirteen Moon calendar, on the other hand, is in alignment with the sinusoidal curve properties of organic phenomena, and therefore functions as an "umbrella" maintaining the organism in resonance with the biosphere.s

Here let us make a more precise definition of timing frequencies and the nature of calendars as the macro-organizing programming systems of the human in the biosphere. By defining time as the universal frequency of synchronization, we are saying that synchronization is the fundamental program to which everything adheres and which makes everything perceptibly coherent, hence synchronic order. Therefore, the natural timing frequency that is a universal phenomenon both regulates the phenomenal order of the cosmos, and in the human is absorbed as a mental frequency that unconsciously synchronizes the mind and senses with the natural

order. The result is the normal sensation and experience of the harmony of reality. This defines both a fundamentally prehistoric perception of reality as well as the spiritual experience that is common when we are confronted with the awesomeness of nature-usually far away, it should be noted, from city life. This universal factor of synchronization we have identified as the mathematically precise ratio 13:20, a ratio constant embedded in the structure and order of the calendrical and astronomical system of the ancient Maya.

If we understand that this frequency of synchronization is a genuinely universal constant, then we may comprehend how not only the entire biosphere, but solar system and galaxy are also governed by the same frequency. This is how the Kozyrev experiments could show that there is instantaneous transmission of information throughout the universe, which in its entirety is a function of the formulation *velocity of time is instantaneously infinite.* Synchronization and infinite instantaneity of transmission are mutually defining-everything is always instantaneously synchronized. We can further say that synchronization "syntropizes" while dissynchronization "entropizes." There is no lag time in synchronization.

This being the case, we can then begin to understand how the acceptance and institutionalization of the artificial 24-hour, 60-minute, 60-second division of the 360 degree circle as the basis for defining time could be such a singular and ultimately disastrous deviation from the universal frequency of synchronization. Thus when we speak of the artificial 12:60 timing frequency, we are referring to the mental effect of the feedback program of the use of artificial and erroneous instruments of measure. Rather than allowing the mind to remain in the natural harmony of synchronization with nature, the artificial 12:60 standard and its instruments establish a feedback effect in the mind that accustoms it to the deviation from nature. This habituation results in the creation of an unconscious timing frequency that is accepted by the consensus reality as the actual norm. Separation of human order from the biosphere becomes accepted and acceptable, making civilization not only possible, but setting it up, as it were, as a parallel rival to "nature." In fact, it is the unconscious mental frequency of 12:60 artificial time that coordinates and maintains civilization as a belief system.

When we speak of the instruments of measure of artificial time, we are specifically referring to the Gregorian calendar as the macro-organizing principle and the watch or mechanical clock as the micro-organizing principle. The macro-organizing principle organizes our life into days, weeks, months, and years. The micro-organizing principle organizes our life into seconds, minutes, and hours. These two instruments have their common root in the error in time that occurred 5,000 years ago at

the beginning of history. Try to think of life without these instruments and you will quickly realize how second nature they are-and yet there was a time when such instruments and their terminology did not exist. Before turning our attention to an analysis of these two instruments and their effects on human consciousness, we must view the entire cycle of the Wave Harmonic of history as a function of the macro-organizing principles of time that the human in the biosphere adopted for its uses and that, in turn, condition at a most profound level the worldview of the culture or civilization that uses it.

HISTORICAL CALENDARS AS INSTRUMENTS OF ASTRONOMICAL MEASURE

It may be rightly asked, What does a calendar measure? At a minimum, a calendar is or should be the measure of the Earth in its rotation around its local star, the sun. This rotation takes 365 days. The Earth's satellite, the moon, is the obvious synchronizing factor between the Earth and the sun. But here we encounter a difficulty. The moon can be measured by various cycles. The synodical cycle, from new moon to new moon, is 29.5 days. The sidereal cycle, the measure taken from where the moon appears at the same place in the sky, is just over 27 days. There is an apsidal cycle, however, taken from the measure of when the moon's axis is tilted farthest from the Earth, which is 28 days. This variance of measures is due to the fact that until the rise of rocketry, we could not really see the moon from space. In actuality the moon rotates around the Earth thirteen times during the time it takes the Earth to orbit the sun once.

If one were objectively seeking the proper measure of the Earth's orbit using the moon as the measuring device, we would therefore construct an instrument for time reckoning that consists of an even harmonic measure of thirteen cycles of twenty-eight days each. The 28-day cycle conforms, of course, to the female menstruation cycle, an obvious human biological cycle, and it also divides perfectly into four 7-day subcycles or weeks. Also, 13 x 28 = 364, the same number of days as thirteen moons multiplied by four 7-day weeks (a total of fifty-two weeks), with the 365th day being a free day, or Day Out of Time, no day of the week or month at all. We shall deal with the perceived extra quarter-day later in our discussion.

The point is this: If time is a factor of synchronization, then a calendar-as an instrument for measuring the count of time-should also be constructed so that it maximizes the factor of synchronization. This can only be done if the instrument of time reckoning is constructed on harmonic principles in conformity with the objective data of nature. Such an instrument would also conform to the orderly processes

of the biosphere taken as a whole, and be a great assistance in bringing into consciousness the cosmic programs that organize the biosphere and noosphere. The Thirteen Moon/28-Day calendar is the perfect instrument for such a simple registration of harmony and synchronization. It should also be noted that in its mathematics the Thirteen Moon/28-Day calendar is a function of the 13:20 timing frequency. This in itself establishes the Thirteen Moon/28-Day calendar as a perfect instrument of the Law of Time and as a function of the synchronic order of reality.

Since the process of civilization represents a break from a long cycle generally undistinguished by the kind of perturbations that characterize history, the analysis of the Law of Time assumes that in prehistory humans lived in relative harmony, and therefore that the humans tended to use harmonic instruments of time reckoning. The humans living in greater harmony with the biospheric cycles would be disposed to be in greater unconscious or aboriginal attunement with the noosphere. Since the noosphere is regulated by the synchronic order of the universal 13:20 timing frequency, the humans would be more naturally disposed to devise, adopt, or intuitively utilize the time measure in greatest accord with this instinctual 13:20 noospheric timing ratio.

This instrument of time measure would, of course, be the Thirteen Moon/2 8-Day calendar. It should also be noted that this calendar is a perfect solar-lunar measure; that is, it uses the even, regular lunar cycle of28 days as the standard of measuring the 365-day solar cycle of the Earth. The balance of solar and lunar may also be taken as

Moon Circling Earth Thirteen Times per Year

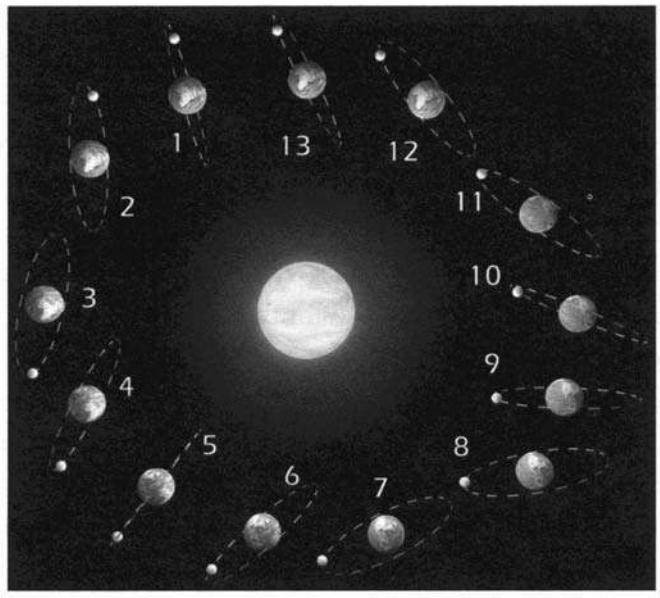

Did you know the moon goes around the Earth thirteen times a year?

SEE: HTTP://WWW.TORTUGA.COM/WWW/ANIMATIONS/ANIM_MOON.HTM

symbolic of human psychological characteristics and their balance or imbalance. A solar-lunar calendar will represent and reflect a balance of the solar-lunar, masculine and feminine qualities within the human being. It is important to bear in mind these considerations of calendars and their effect on shaping the human historical consciousness and its psychological makeup. From this perspective, history is, in fact, a process of falling away from the perfection of harmonic standards.

Evidence exists that the Thirteen Moon/28-Day measure was widely known in prehistory. We find evidence of its use as a prehistoric synchronic measure in the remote past of China, in Polynesia, and scattered across late neolithic Europe and the Middle East. Among the Maya it was known as the *Tun Uc*, literally "moon count" or count of seven, while the living tradition of the Thirteen Moon/28-Day calendar is still continued in South America and in the British Isles, where it is known as the Druid Tree calendar. While the Druid calendar has no year count attached to it that would definitively testify to its prehistoric ancestry, the South American calendar does. Known as the *Pachacuti*, the South American Thirteen Moon/28-Day calendar is currently in the year 5509, which places its origins at 3308 B.C., toward the middle of the fourth millennium before Christ, and several hundred years before the beginning of the thirteen baktun Wave Harmonic of history.

If we understand that calendars are genuine time-measuring devices meant to synchronize us with the cosmic order within the biosphere, and that calendars are thereby programming devices, we may then say that a calendar of perfect harmony can have no history. In other words, by its harmony such a calendar is always in tune with the cosmos, which is beyond history. History can only be a function of a disharmonic programming, not in sync or even at odds with the laws of natural time.

From the point of view of timing devices, there are two factors in the establishment of history. The first is the 12:60 program established 5,000 years ago with the division of the day into 24 hours, 60 minutes, 60 seconds, based on the 360-degree division of the circle. The other factor is the use of a purely lunar calendar that is difficult to reconcile with the actual measure of the solar year. The purpose of the 12:60 measure was to establish a timing standard that was actually a pseudosolar calendar to assert male intellectual dominance. The Babylonian (and later, Egyptian) calendar consisted of twelve 30-day cycles = 360 days = 360 degrees, plus an extra 5-day cycle. The 30-day measure is not actually a natural one, being a half day more than the synodic lunar measure, but one that conforms to the hexagisimal (6-based) mathematics of the circle. For this reason, this instrument of time reckoning is defined as *pseudosolar*. Its ultimate descendent, as we shall see, is the twelve-month Julian/Gregorian system.

By contrast, the Maya also had a 365-day solar calendar, the *Haab.* Its measure, however, is that of eighteen 20-day cycles (18 x 20 = 360) plus the 5-day cycle *(uayeb),* the 20-day cycle *(vinal)* being a mathematical function of the 13:20 frequency. In addition, the Maya had the measure of the *tun,* the 360-day count of which is precisely the same as that of the degrees of the circle. It was the tun that the Maya used to measure the thirteen baktun count, which actually consists of5,200 tun (5,125 solar years). The purpose of this measure was to provide an exact harmonic standard for the measure of history that, we may recall, is the duration of artificial time. It is very relevant that the harmonic standard of the thirteen baktun Wave Harmonic of history is the 360-day tun, the actual temporal equivalent of the degrees of a circle in space. The precise measurement of the cycle of artificial time, which turned out to be anything but harmonic, could yet be measured with a harmonic unit that reflects both the circle *and* the mathematical perfection of the Law of Time. How better to coordinate the entire cycle of artificial time than by the tun, a unit of measure that reflects the 360-degree circle, the basis of the original error in artificial time? As we will later observe, the fact that the Law of Time coordinates even the cycles of artificial time is also evident in the analysis of the timing of the fatal flaw of the Twin Towers apocalypse.

While the Babylonians began to apply a hexagisimal time-reckoning device based on spatial metrics of the circle, another factor became predominant in the Old World: the rise of the synodical lunar calendar as the exclusive measure of time. The synodicallunar calendar is purely lunar in that it is not evidently or perfectly harmonized with the 365-day measure of the solar cycle-a fact of great consequence for the development of mainstream civilization. The Babylonian calendar, with its abrogation of the thirteen perfect 28-day months, established the pseudosolar twelve-month measure. This twelve-month measure conformed to the lunar measure of twelve synodic lunations per lunar year. However, twelve lunations are only 354 days, eleven days short of the solar year. This required an intricate set of calculations to make the lunar calendar keep up with the measure of the Earth's solar orbit. And in reality, although we tend to think of the moon as feminine, the knowledge of the synodic measure, the cycle from new moon to new moon, became the exclusive province of a male priest class that used the lunar calendars to capture and control the feminine principle, and to oppress women in general. Whereas the Babylonian and Egyptian solar calendars fell into disuse over time, the lunar calendar persisted.

Since there is only one moon orbiting Earth, it should be kept in mind that all lunar calendars are essentially the same. One and the same moon in all its phases is apparent to all humans on Earth. So when we speak of different lunar calendars-most notably the Hebrew, the Islamic, and the Chinese-the measure is basically the

same, from new moon to new moon, but New Year's Day falls differently in each of them, thus accounting in part for the various calendrical traditions. Within each of these lunar calendars, a different set of holidays is programmed. It is the programming of the different holidays and festivals of the calendars, along with the dating of their new year, that makes each lunar calendar tradition distinct and that also demonstrates how a calendar is a programming device. For instance, if one were to take out the different holidays programmed into the Hebrew lunar calendar, there really would be no such thing as Judaism. This demonstrates that the cultural conditioning of a people is totally dependent on the programming of the calendar they use. This also shows how a calendar is a feedback mechanism that maintains a group of people within the confines of its own self-established belief system.

Of the three lunar calendars we have mentioned, the oldest count of years is accorded to the Hebrew calendar. This year Rosh Hashanah, or Jewish New Year, occurred on the new moon, September 17, 2001, and marked the beginning of year 5762. This places the origin date for the Hebrew calendar in the year 3761 B.C., some 453 years prior to the commencement of the Pachacuti count. The Hebrew calendar (like the Chinese calendar, which we will discuss below) makes up for the slippage of eleven days per solar year by intercalating a thirteenth lunation cycle approximately every three years, or exactly seven such thirteenth moons every nineteen years. These numbers too-13, 7, and 19-are key harmonic factors of the synchronic order of time. This demonstrates that, at the very least, the synodical lunation calendars are calibrated in their larger cycles by the Law of Time. But the effect of being a purely lunar measure, at variance with the actual 365-day measure of the solar year, creates an interesting and one-sided approach. There is no question that the lunar calendar civilizations are the tool of powerfully patriarchal societies, the tables of the moons and the years being the possession of a dominant male priest class.

The Chinese lunar calendar differs from the Hebrew in one important distinction: from the most ancient times it has been embedded in a system known as the *five elements,* and is coordinated with a very elaborate mathematical system that bears some resemblance to the 60-60, 24-360 basis of the SumerianiBabylonian 12:60 frequency. This synchronizing system accounts for the Chinese cycles of years that are counted by the twelve zodiacal animals in combination with the five elements: earth, fire, wood, water, and metal, thus giving rise to 60 (12 x 5) year cycles. Three of these sixty-year cycles create a "group" or cycle of 180 years. We are now (in 2001) in the eighteenth year of the twenty-seventh group, or year 4,698 of the Chinese lunar calendar. So embedded is Chinese culture and civilization in this calendar, with its elaborate system, that to take away this calendar would virtually eliminate

Chinese culture altogether. Perhaps more than any other factor, this highly involved calendar also accounts for the longevity and tenacity of Chinese civilization as one continuous tradition for the duration of its history, which according to the reckoning of its calendar began in 2697 B.C., a date, interestingly enough, that coincides with the dedication of the Great Pyramid of Egypt.

Despite its marvelous system, the Chinese lunar calendar is still just that: a lunar calendar. The problem with this, from the point of view of the Law of Time, is that when it is not regulated by a proper solar count or measure, the lunar calendar leads people into one-sided developments of one kind or another, if only to the extent to which these calendars foster such profoundly patriarchal societies, of which the Chinese is certainly no exception. The influence and use of the Chinese lunar calendar system extends into southeast Asia, Tibet, Mongolia, Korea, and Japan. As a field of thought within the noosphere, the Chinese system is the equal in power base to the Babylonian and Indian systems, at least up to the time of the dominance of the Gregorian. Even today, the Chinese New Year exerts a powerful attraction worldwide.

While the Chinese and Hebrew lunar calendar systems maintain a powerful conservative strain of human society, the intercalation of the thirteenth moon, seven times every nineteen years, creates a kind of circulation within the system. Thirteen is the number of circulation, whereas twelve is that of a static, non-circulating spatial order. The taboo on the number thirteen-epitomized by the superstition about Friday the thirteenth-must certainly be related to the suppression of the solar-lunar Thirteen Moon/28-Day calendars in virtually all historical societies. This irrational repulsion of the number 13 serves psychologically in defense of the "rationality" of the number 12, a number that does not circulate time and is at the root of the linear conception of time. The illogical and irrational decisions that are made and then institutionalized into the human social fabric must at one point be discounted. Any illusion or error pursued for too long will always end in disaster.

The Islamic lunar calendar, used by some 1.3 billion humans, is distinguished by two factors:

1) It is based on a known historical incident, the *Hegira* or flight of the prophet Muhammad from Mecca to Medina, dated to the new moon or Muharram 1, Julian, July 16, 622 (Gregorian, July 26).

2) It is a pure twelve-month lunar calendar running on a cycle of pure lunar years of 354 days, with no intercalary lunations, and in this regard does not annually harmonize with the 365-day solar cycle.

For this reason, this year 2001 saw the beginning oflslamic lunar year A.H. *(M-*ter Hegira) 1422. But if we are to count the solar years since the Hegira, correlated to Gregorian July 26, then it is solar year A.H. 1379. We see here a discrepancy of some some forty-three years between the solar count and the lunar count. The lunar count continuously retrocedes so that it takes thirty-two years for one Muharram to occur at the same place in the cycle of the solar year. In essence, the Islamic lunar calendar creates a hermetic, retrocessing time bubble with no circulation of the power of the thirteenth moon, and that accounts for the highly conservative and patriarchal nature of much oflslamic society. Again, while there may be a virtue to maintaining a strict lunar calendar count, if it is not correlated to a harmonic solar or solar-lunar standard, the effects will be precisely of the nature that we see occurring in today's world, a point to which we shall later return.

Finally, in this brief consideration of calendars as the principle macro-organizing system for the programming of human society, a word should be said about the system of calendars in the predominant part of the Indian subcontinent. Long before they adopted the Babylonian solar zodiac and hexagisimal spatial principles for reckoning time, the Hindus also had a type of 28-day count, but one based on the course of the moon in relation to a set of stars called Nakhsastras; this created a kind of 28-part lunar zodiac. In this system, however, the Hindus divided the 360-degree lunar ecliptic into twenty-seven equal parts (27 days = sidereal cycle of the moon) each part equal to 13 degrees, 20 minutes of are, the precise measure of the 13:20 timing frequency. A complex variety of lunar calendars were developed early on, but were gradually displaced by what we call the pseudosolar Babylonian division of the Earth's ecliptic into twelve 30-degree segments, a fact that reflects the adoption to the unconscious 12:60 frequency program.

The Hindu (pseudo) solar calendars are all based on the same division into 30-degree arcs-a circle or plane in space! While the base count of the present era is taken from February 18,3102, the beginning of the Kali Yuga-the last and darkest age-exactly 5,104 years ago (dated from Gregorian year 2002), today there are at least six different calendars in use throughout the subcontintent, each essentially the same as the other, but characterized by different dynastic starting points. These differing counts, coupled with the distinct profusion of religious holidays, accounts for the jarringly conservative and colorful confusion that characterizes present-day Indian society-a neo-Babylonian time warp, its populace locked into place by complex systems of pseudo-solar calendars set in the context of earlier Hindu astronomical cycles of a vast and overwhelmingly cosmic nature.

"TIME IS MONEY": THE WATCHWORD OF THE 12:60 FREQUENCY

All of the aforementioned time-reckoning systems, with their various beginning points, can be mapped within the 5,200 tun/5,125 solar cycle of the thirteen baktun Wave Harmonic of history. While we can generally see how the Babylonian and lunar calendar systems shaped the mainstream civilizational orders of the Old World, in our time map we must also take into account the workings of the 12:60 artificial timing frequency within the unconscious noosphere. In this sense, the 12:60 frequency refers to the principle programs of control adopted and maintained through use of the twelve-month calendar systems in the Old World. (See plate 5, Noospheric Time Map-Wave Harmonic of History.)

Plotting the incidence of these calendrical streams on the time map, we must keep in mind that the calendar systems are the chief instruments for establishing and maintaining the human mind and social order within very specific programs of behavior. These programs, at least in the Old World, were characterized by the introduction of artificial systems of exchange called money, and accompanying programs of taxation. These systems were adopted to a greater or lesser degree by all the Old World societies. In this we find the root of the slogan, "time is money," where money is the artificial medium to negotiate artificial time. The end of history is the end of money and the end of artificial time. The word "calendar" itself is derived from a Latin word meaning "account book," the first day of every month being *calends* or the date of payment of debts.

Now, let us return to a consideration of the two principal and resultant 12:60 instruments dominating the end of historical time: the Gregorian calendar and the mechanical clock. We may note that toward the conclusion of the twelfth baktun cycle (A.D.1618), the clock reaches its perfection at the very moment of the implementation of the Gregorian calendar reform (A.D.1582), just after the act of global circumnavigation had been accomplished. Within the entire thirteenth baktun cycle, 1618-2012, the coincidence of these three factors-clock, calendar, and European global circumnavigation-induced what amounts to a 12:60 frequency capture of planetary time in the biosphere. What are the implications of this takeover of time by an irregular and irrationally measured Gregorian calendar and its accompanying micro-organizing device, the mechanical clock?

Plotting the growth curves of human population, machine, and money, we see that the complete infusion of the 12:60 artificial timing frequency creates an unprecedented acceleration, the exponential peak of which occurs at the moment of the Inevitable Event. For this reason, according to the Law of Time, it is important to

comprehend even more deeply the nature of calendars and their effect, especially with regard to the current global standard.

Because the calendar is a macro-organizing principle, when accepted over time it establishes in the mind, individually and collectively, a set of perceptions that are automatically taken for granted as being "real" and "indisputable." These sets of perceptions define the paradigm by which a people, culture, or even an entire civilization operates. The Gregorian calendar, the current global civil standard, is the paradigmatic macro-organizing principle in which are embedded all the laws, customs, institutions, and scientific principles governing the present global civilization-not to mention all the holidays of the Vatican-ordained Catholic Church. According to the Law of Time, the current calendar is an irregular standard of measure; its units of measure do not correspond. This calendar represents, therefore, the institutionalization of disorder and entropy. Because it has existed for a sufficiently long duration in the human historical cycle-2,OOO years, including its predecessor, the Julian calendar-the perceptions fostered by the unconscious acceptance of the Gregorian calendar are taken as the unshakable bedrock of nature and reality. All current beliefs-economic, political, and scientific, from democratic neo-liberalism to the special theory of relativity-are actually products of the underlying perceptions promoted by this calendar, and have no reality apart from the beliefs about time that the calendar engenders. *Change the macro-organizing principle and you change the paradigm.*

THE NEED FOR A TRULY "NEW MILLENNIUM"

As the global civil standard, the artificial, irregularly measured Gregorian calendar is a self-reinforcing feedback loop. As such, it furthers and maintains all linear time concepts, thereby establishing a host of entropic, disordered value concepts such as the violent universe, the degradation of matter, quantum physics, the arrow oflinear time, the doctrine of techno-economic inexorability, and an attendant host of unresolvable problems-crime, drug abuse, terrorism, environmental deterioration, and so forth. Why? Because as an irregular standard of measure, the Gregorian calendar is incapable of producing harmony. Only harmony can unify. The Gregorian calendar is not a unifying harmonic standard. Lack of a unifying global standard exacerbates all current conflicts. Condition the mind to an irregular standard and the mind will adjust to disorder and chaos as normal conditions of existence.

The world's racial, tribal, historical, and religious conflicts are embedded in and a function of different timing systems (calendars), all now coordinated within a master

irregular timing standard and macro-organizing principle, the Gregorian calendar. In this calendar's irregularity is embedded the view that the world of the inevitable degradation of matter is the exclusive object of all present-day science, and hence is also reflected in the entropic nature of global civilization and its deteriorating social processes. The Gregorian calendar conditions the mind to hopelessness of resolution. Without a unifying harmonic standard humanity is incapable of finding long-term resolutions for any of its problems. Disharmony can never produce harmony. Only harmony can produce harmony. All conflict can only be resolved by the application and within the context of a harmonic timing standard.

Now, following the attack on the Twin Towers and the Pentagon, we can say that the Gregorian calendar is bringing history to an end. The Inevitable Event was programmed into the Gregorian calendar, and the Gregorian calendar usurped the power of all calendars in the thirteenth and final baktun cycle of history. When the third millennium officially opened at the dawn of the year 2001, the pride of industrial man was at an all-time high. Would it be a millennium of peace or one of war? If the last century of the second millennium was the century of total war, was the third millennium going to do anything but inherit the unfinished programs of the old millennium? Could the Earth and the biosphere withstand a millennium of total war? Hardly. The Vatican "jubilee year," which ended with the beginning of the third millennium, turned sour with the Twin Towers apocalypse, as is vividly reflected in a photo of Pope John Paul II taken just after the Inevitable Event. The Gregorian calendar marks its inception with the birth of Christ, a date and moment that was never historically noted, and so is shrouded in speculation and conjecture. Now the twisted civilization of Gregorian time is locked in mortal combat against a terroristic specter that it alone could have projected into manifestation. Soon, by biospheric standards, the world of artificial time will be over and gone. And then the millennium will be truly new.

The very word *millennium* conjures possibilities of Earth-shattering events and cosmic prospects. If the inception of the Kali Yuga, 3102 B.C.,can be said to be the point where the historical process became irreversible, eleven years after history began in 3113 B.C.,then in counterbalance, the Inevitable Event, 2001, which had to occur eleven years before the end of the cycle of history, A.D.2012, was more than just millennial. It was the termination of more than 5,000 years of the irreversible motion of artificial time. Such symmetry-eleven years after the beginning and eleven years before the end of history-is the hallmark of the synchronic order. For 5,100 years the count of days has numbered the long and increasingly perilous saga of human civilization. How bright was the beginning and how grim will be the end?

There at the beginning of the cycle was the "first city," Uruk. There at the end of the cycle, the fallen Twin Towers of Babel of the "last city," New York (= New Uruk), the ultimate monument to history itself and the final event to initiate the actual closing of the cycle of history.

> *There it is, the city of Uruk. Urshunnabi, climb up on that wall, the outer all shining with the brilliance of burnished copper. The seven wise men laid the foundations. One third of the city is buildings, cunningly executed, one third of the city is garden with rose and bird, and one third of the city is field with the temple of Ishtar within. Goddess of love and struggle.*
>
> - *THE EPIC OF GILGAMESH6*

IfUruk is the place where the seven wise men laid the foundations, those foundations were measured by the 24 hours, 60 minutes, and 60 seconds derived from the 360 degrees of the circle. Fifty-one centuries later, the gardens are all but gone, the fields themselves mechanized and chemicalized by the technosphere. Earth's inhabitants are in terror. Five weeks after the Inevitable Event, now known simply as 9-11, the end of history still smolders. After the struggle, will the goddess of love return?

5

The Climax of History, the Fifty-six Years of Hiroshima—Artificial Time Runs Out

THE IMAGE of the Noospheric Time Map-Wave Harmonic of History on plate 5 of the color insert, showing the concurrent evolution of the different calendars of the major civilizations of the world (the illustration is by no means exhaustive), is intended to demonstrate the fact that the human race was not unified by a single coherent timing standard throughout twelve of the baktuns of historical development. It was only in the thirteenth and final baktun that humans became organized by a single timing standard. However, it was not a timing standard in accord with the synchronic order of the Law of Time, but the artificial 12:60 timing frequency as represented by its two organizing instruments, the Gregorian calendar and the mechanical clock.

The seeds of this moment had already been planted in the noosphere at the beginning of history. From both Sumeria and Babylonia the taint of the 12:60 frequency then spread through the noosphere and, by means of historical dissemination and conquest, throughout the Old World. By the time the historic moment arrived to ripen the 12:60 frequency into its full fruition-A.D. 1618, the beginning of the scientific revolution and the thirteenth baktun-there were virtually no longer any cultural traditions governed by the natural 13:20 timing frequency. The civilizations and peoples of the New World were now under the subjugation of the prevailing world order of European global imperialism. The stage was set for the brief but final phase of mechanization, of which the technosphere itself is the climax.

What the Noospheric Time Map also delineates is that the 13:20 frequency was the unconscious organizing factor of prehistory, and that, undoubtedly, a key timing system intuitively evolved among many prehistoric peoples independently of one another. This was the universal, harmonic solar-lunar standard of the Thirteen Moon/28-Day calendar. The defining point of history arrives with the establishment of a 12:60 timing standard within the noospheric unconscious. This frequency predominates in the development of twelve-month pseudosolar calendars, as well as the twelve-month synodicallunation calendars that are not the measure of a solar year. These two commingled systems are entwined throughout the ancient history of the Old World as the central thread of development shaping the conception of time and resulting in what were to become the two dominant instruments of human time reckoning, the Julian/Gregorian calendar and the mechanical clock.

Julius Caesar himself instituted the famous "calendar reform" that created the 446-day year of confusion in 45-44 B.C., and established a calendar that was just as patently confusing. Julius Caesar's was not the only calendar reform in the ancient world. The Essene movement, founded by someone known simply as the Teacher of Righteousness and of which Christ was supposedly a member, began as a revolt against the Hebrew lunar calendar. The issue was the need for fixed holidays within the solar cycle, something that is virtually impossible in a lunar calendar that retrocedes eleven days every solar year. There is strong reason to believe that among other calendars, the Essenes favored the Thirteen Moon/28-Day calendar. This even leads to the question: did Christ himself follow a thirteen moon calendar? In any case, it is the 12:60 frequency transmitted through the irrational disorder of the Julian/Gregorian calendar that captures the mind of the human race and the biosphere during the final years of the cycle of history. And it is precisely for this reason that the pace of human civilization becomes exponentially and entropically accelerated during the last few centuries of its development.

Shocked into higher consciousness by its own barbarism masquerading as civilization, at the end point of history the human has the opportunity to return to the natural 13:20 frequency of synchronization. This return would mark the emergence of humanity from the unconscious mechanistic compulsion of artificial time into the conscious field of post-history. The only possible option to unify humanity-once the yoke of the Gregorian calendar is removed-is the true solar-lunar calendar of Thirteen Moon/28 Days. With the possibility of this positive end in sight, we may turn to a more descriptive and definitive analysis of the technosphere. In this way understanding the modalities of the technosphere as a distinct and entire process, we

Gregorian Calendar 28-Year Cycles: 1945–2001, the Age of Terror

It takes twenty-eight years for the Gregorian calendar to run through its cycle of permutations. Every twenty-eight years, like a phonograph record of time—a chronograph—the Gregorian calendar guides its users through a mentally debilitating construct of unevenly measured and irrationally named months, paced by a system of 7-day weeks that bears little relation to the lengths of the months or years. In addition, every four years there is an extra day. Within this medieval mathematical jumble are kept the collective unconscious programs that repeat every twenty-eight years. What happened in 1945 will somehow repeat or have an effect again in 1973, in 2001, and then in . . . it's up to you. You can change this if you want to.

First day of the year	Tuesday	Wednesday	Thursday	Friday	Sunday	Monday	Wednesday	Friday	Saturday	Saturday	Monday	Thursday	Tuesday	Sunday
Hiroshima 1945 – 72						**1945**								
	1946													
		1947												
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Twin Towers 1973 – 2000						**1973**								
	1974													
		1975												
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Inevitable Event 2001 - ?						**2001**								
	2002													
		2003												
														2004 Year of the Great Calendar Change
														Where will you be? 2012

might then develop a deeper insight into where we have just been and why we need to go somewhere else.

The technosphere defines a 56-year cycle, 1945-2001, coordinated by two complete Gregorian 28-year cycles. For any Gregorian calendar year, the days of the weeks in their irregular monthly succession and in relation to the permutation cycle of leap years repeat precisely every twenty-eight years, during which time there are always exactly seven leap years. This means that Gregorian calendar years 1945, 1973, and 2001 possess the same exact annual arrangement of the days of the week in their monthly succession. If today is Sunday, November 11, 2001, so it was in 1973, and likewise in 1945. In this regard the Law of Time frames the cyclic recurrence of the otherwise irregular 12:60 Gregorian calendar by the intrinsic formulation 28:7. That is, just as the 19:7 factor coordinates the lunar calendars every nineteen years, there being seven intercalations of the thirteenth moon during that cycle, so in the Gregorian calendar every twenty-eight years there are always exactly seven leap days and years.

Understanding a calendar as the instrument that locks the conditioned programs of a given culture or people into place, we can now understand how the unconscious metaprogram of the macro-organizing principle of the Gregorian calendar cumulatively recycles all its millennial programs every twenty-eight years. Since its inception in 1582, the Gregorian calendar has been dragging forward a host of conditioned thought forms and perceptions, including those inherited from 1,500 years of the Julian calendar that it had reformed. At points of dramatic break in the continuity of human consciousness, a new set of cycles is set to recur. Such was the case in the year 1945, with the awesome blast of Hiroshima. The entirety of the mind field conditioned and held in place by the Gregorian calendar then reaches its full fruition during the two subsequent 28-year cycles, fifty-six years in all-thus bringing forward two millennia of conditionings, conflicts, and unconscious death wishes or apocalyptic programs. The first cycle was initiated in the year 1945, the year in which Vernadsky died, the atomic bomb was tested once and used twice, and the Second World War came to an end. That year, 1945, marks the beginning of the technospheric bubble. It is most telling that the Second World War was concluded at the beginning of this 56-year cycle of the technosphere, for it was a war concluded not with peace but with instruments of mass destruction and terror. Thus began the 56-year era of Atomic Terror.

The technosphere has its origins with the full capture of the human mental field by the 12:60 frequency in 1618. From 1618 onward, the noosphere is increasingly obscured by a mental field known as the *technospheric sheath.* Slowly but surely, the

technospheric sheath replaces civilization. This is first done by the introduction of mechanistic linear time. It is important to note that the Julian count, the basis of all modern scientific calculations, is a scale created by Thomas Scaliger in 1583, twenty-one years after the 1562 Mayan book burning. This linear time scale, like the Gregorian calendar reform itself, was intended to co-opt the Mayan thirteen baktun Long Count by setting a count of days that begins the first of January, 4713 B.C., or some 1,600 years prior to 13.0.0.0.0, the beginning of the thirteen baktun count in 3113 B.C.This deliberate historical act, the Julian count, along with the Gregorian calendar and the mechanical clock, established the paradigmatic notion of the linearity of time in the ripening field of scientific thought. Reflected in the noosphere, this linear, irreversible time concept levels and stunts the realization of human mass consciousness. In fact, during the technospheric cycle, especially after 1754, the ceiling of human consciousness is maintained by a preoccupation with mechanistic third-dimensional operations while becoming increasingly alienated from the organic order of reality. This creates the 12:60 consciousness constant, a mental ceiling that actually diminishes in proportion to the increasing rates of multiplication, propagation, and intrinsic velocity of the machine.

With the actual rise of the Industrial Revolution, dated in the noosphere to A.D. 1754, the synchronic point at which mechanization becomes an irreversible factor of the biosphere, the technospheric sheath, henceforth enters its next stage, going from a purely mental sheath to the industrial sheath, the prelude to the proto-technosphere itself. The industrial sheath spreads throughout the biosphere between 1754 and 1901, the official beginning of the twentieth century. At this point we enter the forty-four years of the proto-technosphere, 1901-1945. During this critical stage of the proto-technosphere, the actions of human behavior interacting with machine technology make the expression of true culture increasingly difficult, if not impossible. Civilization becomes a set of symbols purveyed through museums, galleries, and theaters, and recorded and reproduced in ever more advanced technological forms. But what of culture, which is not the same as civilization-what becomes of culture?

To begin to answer that question, some further definitions are in order. The technosphere is defined by and based upon one key term: *technology*. According to the common dictionary definition, which already reflects the mass mind, technology is "the totality of the means employed to provide objects necessary for human sustenance and comfort."l Today virtually all the means employed are themselves mechanical in nature. In common parlance, therefore, technology refers to the complex apparatus of mechanization. In fact, technology *is* mechanization; it is the ability to

convert human labor into processes carried out purely by machine-oriented or mechanical means. This is also inclusive of the entirety of computer technology, which represents the mechanization of the more purely mental processes of thought and communication.

Mechanization, we must remember, originated in the clock, in the mechanization of time. It is the mechanization of time that presupposes the tendency toward mechanization as a state of mind within the noosphere. Since artificial time is characterized by the illusion of an inexorable and irreversible linearity, the compulsion toward materialism is also experienced in the same way, an inexorable motion spearheaded by the advance of ever more improved machines. The machines themselves are the products and means of industrialization-the technological transformation of raw goods into consumer goods, a process accounting for much of the free energy introduced into the biogeochemical combustion of the biosphere.

Inseparable from mechanized technology, too, are materialism and the concept of the World Market and, more recently, of globalization. Materialism is implicit in the dictionary definition of technology as the means employed not only for human sustenance but also for human *comfort.* This comfort can only be of a material form or nature, hence the pursuit of comfort through mechanized technology can only be for the furtherance of a philosophy and exaggerated lifestyle of materialism-the belief that only the material things of this world have any value. Of course, the value of material goods and comforts increases when the value of money is put into the technospheric equation. The first stock market opened early in the eighteenth century, providing a place where money could be used as speculative capital to promote the advance of commodities and machine products. The entire sphere involving commodity production and its conversion into consumer products eventually came to be known as the World Market. Integral to the success of the World Market was the creation of the modern banking system, based on the institutionalization of interest rates and the principle of lending money to companies for the purpose of furthering the transformation of the biosphere into the technosphere.

While the concept of the World Market prevailed for a long time as the definition of the system for exploiting and extracting natural resources from the biosphere, and then converting them into industrial goods to be consumed by the human populace worldwide, globalization is far more recent. Globalization represents the absolute triumph of capitalism as the dominant economic doctrine of the human species in the biosphere, and the absolute basis of the technosphere in its final phase of development. As such, globalization is the economic system of neoliberal market

economics that treats the whole world as the proper sphere of its policies and practices. It is a specialized form of monetary imperialism that gives rise to and is supported by the doctrine of monetary politics, the use of money as a means of coercion or even for the buying out of whole governments. Of course, the principle practitioner of monetary politics is the nation with the most money, the United States of America, home of the World Trade Center.

Fostering corporate multinationalism, globalization is inseparable from the consumer philosophy it promotes. Consumerism is the devaluation of the human into a link in the chain of the cycle of industrial production, the object of globalization being to inspire and promote a massive and wide-scale consumerism worldwide. This is what is meant by such phrases as "increasing consumer purchasing power" and "opening new markets." To promote and defend its interests, the all-pervading system of globalization first developed the World Trade Center, and in the last decade, following the end of the Cold War, the GAIT and the WTO, the global "Chamber of Commerce."

As a political hegemony, globalization is managed by the G-7 group of the seven most industrialized nations (the United States, Canada, the United Kingdom, France, Italy, Germany, and Japan-now, with Russia, sometimes referred to as the G-8). This organization, headed by the finance ministers of these seven countries-like the seven wise men of Uruk at the beginning of history-was secretly formed in 1974 by the CIA, one year after the completion of the World Trade Center Towers and the formation of OPEC. The first public meeting of the G-7 occurred in the summer of 1990, just prior to the Iraqi invasion of Kuwait. The doctrine and system of globalization-now overtly controlled by the G-7 and its chief ally, the Euromarket nations-is inseparable from industrial technology as the means employed to provide objects necessary for human sustenance and comfort. Implicit in the philosophy of globalization is the right of the G-7 to promote and defend its way of life, regardless of its ultimate effects on the biosphere and at the expense of ideologies and beliefs not consistent with it. To defend itself, globalization has at its disposal the U.S. military, the command of which is housed by the Pentagon, and the new technospheric multinational military cartel, NATO. In a word, globalization is the triumph of the military-industrial complex.

From the point of view of the biosphere, globalization is the cancer of the human species consuming non-renewable resources and, through the release of free energy, effecting the final critical increase in biogeochemical combustion. The planetary instrument for furthering the entire process and philosophy of globalization is the technosphere. The technosphere may be defined as the entire apparatus of

mechanized technology and its support philosophy (globalization), understood as an artificial sphere encompassing the globe. As such, the techno sphere is discontinuously interspersed within the biosphere. More precisely, the technosphere is located physically and mentally between the biosphere and the noosphere, in other words, between the Earth's vital sphere and its mental envelope.

Being the description of an evolutionary stage, the technosphere is governed by the Law of Time as a 56-year event continuum along the lines of an artificial planetary cocoon. Insofar as it is the projection of human thought, the technosphere is the materialization of the sum mental processes denoted and conditioned by mechanization in all its aspects, and that have their primary root in the mechanization of time. It is the mechanization of time that essentially establishes the artificial timing frequency as the capacity to engender the machine and, consequently, an artificial structure, the technosphere. Because it is artificial, however, its duration is highly limited and is subject to the inherent inconsistencies and contradictions in human thought and social structures because of the aberrant effects of adapting to artificial time in the first place. The effect of adaptation to artificial mechanized time creates a social-political hierarchy known as the technocracy-rule according to the needs of technology. It is the effect of maintaining the technocracy and the technosphere itself that establishes the inability of human consciousness to do anything more than remain in a constant, servile, and unchanging state of machine dominance. All the while, by contrast to the unchanging condition of consciousness, the machines evolve exponentially in number and complexity. As Marshall McLuhan so correctly put it, the humans are the bees of the machine.

To be fully understood, the technosphere cannot be seen apart from its place in the biosphere-noosphere continuum. The technosphere represents the absolute control of the biosphere by artificial 12:60 time. Artificial time generates the artificial medium of money, hence the operating philosophy of the technosphere: "time is money." Money is the lifeblood of the technosphere. Servitude to money draws humans away from the biosphere in order to be devoured by Mammon-the technosphere as an all-consuming entity. In this process the humans get money in return for selling their bodies and souls to artificial time, usually eight hours a day, often to produce artificial goods or for service in maintaining the artificial system of money itself. This money gained from servitude is used to buy consumer goods, including more machines of every kind, and thus the human participates as a vital link in the cycle of biogeochemical combustion. In this way the mechanized lifestyle converts the human-the consumer-into the biomass necessary for maintaining the technosphere.

By 2013
Earth is galactically synchronized into a new biogeological epoch: the psychozoic Era.

As the mental envelope of Earth, above and discontinuous with Earth, the noosphere can only mean one thing: the advent of universal telepathy among the humans.

The difference between the new time and the old time is like the difference between heaven and hell.

Planetary 9-11, 2001 inaugurates biogeochemical combustion, biospheric means of transformation, and self-mutation.

Technosphere: Biospheric agent devised for maximum biogeochemical combustion.

Built in an area known as "Hell's Bottom"

The Pentagon 1941–200?

Impregnable fortress of the American war machine, meant to protect "democracy" = American domination of world market and foreign/economic policy of globalization. "The form of the Pentagon . . . is that of a pentagram, the chief magical aid for gathering power. When a pentagram is drawn with its base toward the north, and its chief point to the south, it is useful for negative or black magic purposes."
—*Transformative Vision*, page 249

*Note: Gregorian calendar coordinated by Law of Time. Repeats precise order of days and weeks precisely every 28 years.

56-year cycle of Hiroshima
"Age of Terror"
Technosphere Replaces Civilization

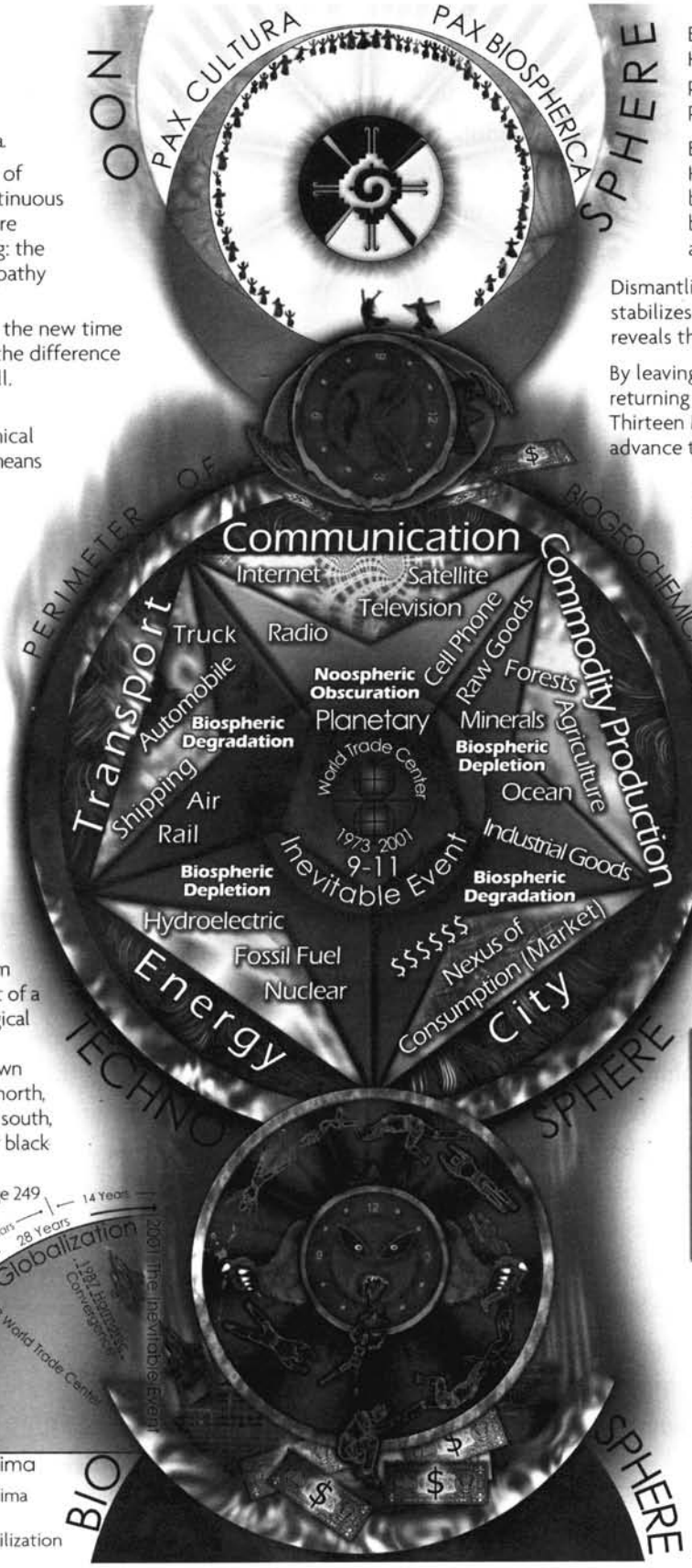

By 2012
Humans realize a permanant condition of peace through culture.

By 2009
Humans are reorganized by the Law of Time and begin the construction of a galactic culture on Earth.

Dismantling of the technosphere stabilizes the biosphere and reveals the noosphere—2005.

By leaving artificial time and returning to natural time via the Thirteen Moon calendar, humans advance the noosphere.

2004: Last opportunity for humans to change their macro-organizing principle.

Exhaustion of the Technosphere—2001–04.

Exponential growth curves of money, machine production, energy, and people climax.

Planetary 9-11: time runs out on the technosphere.

"New" millenium nipped in the bud; civilization R.I.P., 2001

Technosphere:
Interlocking interactive pentagon of five artificial systems - WTC = Nerve center and hub of the technosphere and its driving power, globalization.

Biosphere:
Controlled by artificial (12:60) time.
Time is Money—lifeblood of the technosphere.

Humans devoured by Mammon. Get money in return and create biomass to maintain technosphere.

Biosphere–Technosphere–Noosphere

As an operating planetary structure, the technosphere consists of five interactive components.

1. COMMODITY PRODUCTION

Commodity Production, the basis of the entire World Market as a biospheric system, refers to the transformation of natural resources through industrial means into consumer products. Commodity production alone accounts for the complex of industrialization that brings the World Market and the technosphere into existence. According to *The Biosphere Catalogue,* the post-World War II growth of the World Market necessitated the establishment of the World Trade Center, a global complex (114 such centers in 1985), but with its principle coordinating unit being the Twin Towers in New York City, home of the World Trade Institute and the corporate offices of the New York Stock Exchange, the key to the world money and commodities market.

2. CITIES

Cities, the second technospheric component, represent the human social organism or marketplace for accommodating the production and consumption of industrial goods. Civilization is city life as it has evolved from Uruk to New York (= New Uruk). While prior to industrialization the city depended on a healthy agrarian economy for its support, industrialization pushed the city to new heights of artificiality, not the least of which were round-the-clock lighting systems that allowed for 24-hour consumer markets. As such, the city is the nucleus of the technospheric system, the hub of its commodity production, of its energy consumption, and of its transport and communication empires. The growth of the cities around the world is exponential in the second half of the twentieth century, reflecting the triumph of the technosphere. It should be noted that in the fifty-six years of the technosphere, the human population almost tripled-from 2.2 to 6.2 billion, a growth demonstrated in the vast expansion of the large urban centers.

3. ENERGY

Energy is the third component of the technospheric complex. The tremendous needs of industrial production have transformed the natural energy processes of the biosphere into gigantic artificial complexes for the production of energy to maintain factory and city alike. The impact of the different artificial energy systems upon the biosphere has been enormous. These systems include coal, oil, and fossil fuels in general, as well as hydropower and nuclear energy. The whole syndrome of artificial

time, artificial means, acceleration of the machine, and expansion of human population has required and created the enormous output of artificial energy into the biosphere and contributed greatly to the destabilization and loss of natural resources and atmospheric and hydrospheric contamination through the release of toxic "free energy" by-products.

4. TRANSPORT

Transport. Without the highly industrialized transport systems, the commodity production, the vitality of the cities, and the access to provisions of fuel required for the energy systems would collapse. No sooner had industrial production begun early in the eighteenth century than the first artificial transport systems came into being: the steam- or coal-driven locomotive, and the great transoceanic shipping lines. By the twentieth century, the railroad system and worldwide shipping industry were supplemented by the invention of the combustion engine, which made the trucking industry possible. Following World War II, rocketry and jet propulsion established the transportation might of the great airline companies of the second half of the twentieth century. It is no coincidence that commercial airplanes, the symbol of the technosphere's advanced transport systems, were used to bring down the Twin Towers and to penetrate the Pentagon.

5. COMMUNICATION

Communication is the fifth component that unifies the technosphere into one whole system in touch with itself everywhere. From telegraph to telephone, radio, television, and then finally fax, cell phone, and the Internet, the industrial-era technologies, with their electronic instantaneity, have created the vast communication networks and media empires that keep the world humming and promote globalization above all. When considering modern communication we must also bring into focus the chief method of globalization, which is marketing-propaganda on behalf of consumerism. Marketing is the use of means of mass communication to control the mind of the consumer. In the final stage of globalization, marketing replaces consciousness, or rather, marketing is the manipulation of consciousness-the latter already having been reduced to a stunted level-for purposes of consumerism, or for ideological needs such as patriotism and fear campaigns. The Internet, the marriage of computer and telephone technologies, represents the final stage of the Tower of Babel, and the completion of the process of globalization. The only place to go after the Internet is technology-free telepathy.

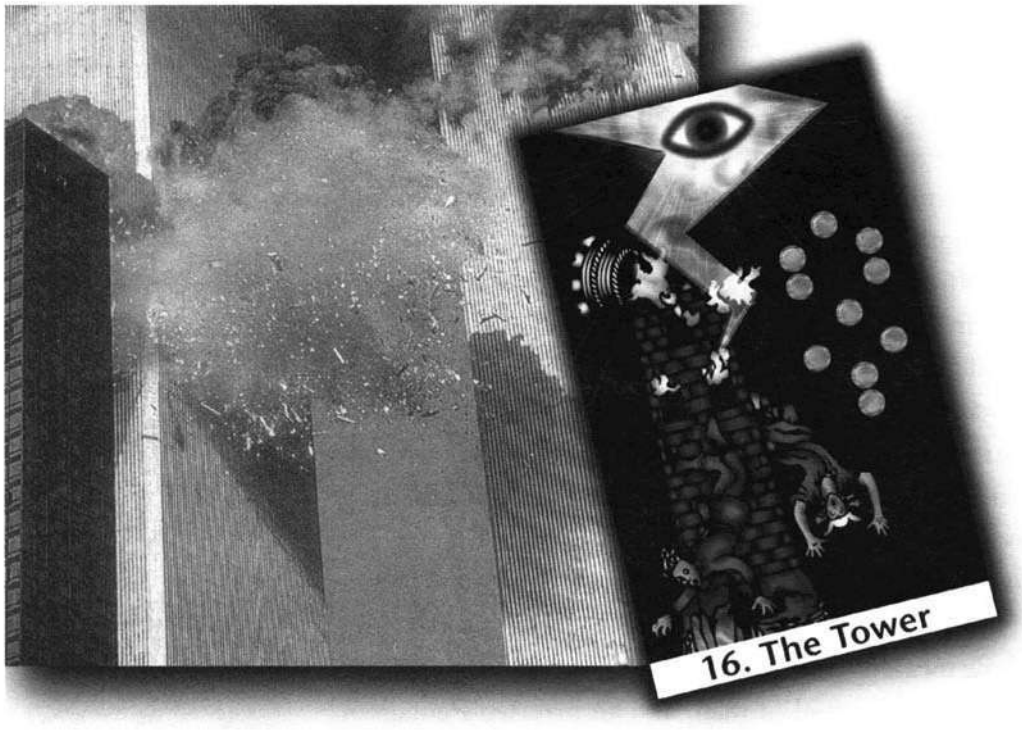

The Tower

From the biospheric perspective, this five-tiered complex of the technosphere is a whole unit. All the subsystems evolved together to establish the structure and operating procedures of the technosphere. When the technosphere goes, the entire system folds. This is what is now beginning to occur. Following the Inevitable Event, the whole technospheric system will be coming down slowly over the next few years, like a giant circus tent that has lost its central prop. How gracefully or gracelessly this happens is dependent on the response of the Pentagon-or the will of humanity to rouse itself in the face of even worse barbarisms.

Because it consists of five interactive components, the techno sphere can be graphically depicted as a pentagon, a five-sided figure. At the center of this pentagon of the technosphere are the World Trade Center Twin Towers. The actual Pentagon, which was attacked along with the Twin Towers, was designed in the late 1930s to house the U.S. Department of War. Its construction occurred in the years 1941-1943, in an old neighborhood of pawnshops and bars called Hell's Bottom.2 When it was built it was the world's largest office building in terms of actual space. Of course, when they were built, the Twin Towers of the World Trade Center were the world's tallest office buildings. The structure of the Pentagon is the prototypical morphology

of the structure of the five systems that constitute the technosphere. The Pentagon was the impregnable fortress of the American war machine, protecting American interests and globalization around the world. If there were two central points-actual and symbolic-to what is known as the military-industrial complex, it was the Pentagon and the World Trade Center, and this is undoubtedly the reason why they were both targets of the Inevitable Event.

What is architecturally noteworthy about the Pentagon is that it is designed with five inner pentagonal corridors and office slabs, and that it is constructed with its odd point to the south. Since a pentagon is actually a pentagram, a five-pointed star with its points connected, the Pentagon represents an *inverted* pentagram, as its odd point faces south rather than north. In the traditional Tarot deck it is interesting that the Fifteenth Major Arcana, The Devil, contains an inverted pentagram between the horns of the Beast. Paul Foster Case writes, "This is a key to the whole meaning of the figure [of the devil]. For the Pentagram is the symbol of man, and an inverted Pentagram suggests the reversal of true understanding of man's place in the cosmos."3 While the Fifteenth Major Arcana contains the pentagon as the inverted pentagram, the next card, the Sixteenth Arcana, is The Tower, which shows the tower being struck and broken apart by lightning (fire of heaven), with humans falling or jumping out of the windows to their death-as accurate a symbolic depiction of the collapse of the Twin Towers as could be found.

VYhat the startling conjunction of these symbolic correspondences points to is the profoundly archetypal nature of the Inevitable Event. It has been prefigured and prophesied, and has now come to pass. No matter how much America and its allies, many of them bought for a price, may strike back, the deed has been done. The Towers are gone; the Pentagon has been penetrated. While it will take several years for the full realization of the absolute magnitude of this archetypal event to sink into the

9-11

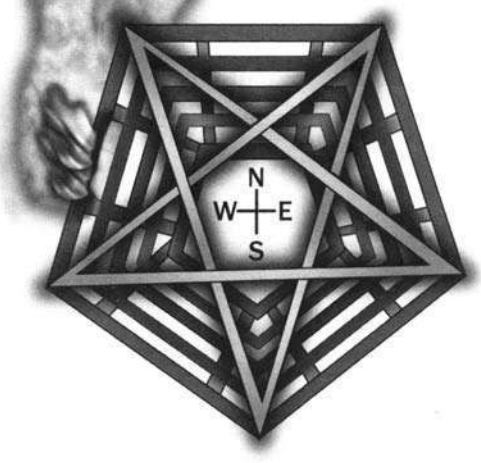

THE PENTAGON

The Devil and the Pentagon

collective mind, it is important to demonstrate the actual structure in time of the techno sphere so that the finality of its end may be seriously considered, and the gate to the future, which has thereby been opened, can be made clearly visible.

As we have shown, the technosphere is a structure totally brought about by the 12:60 timing frequency, and thus is purely a function of the latter. As such, the technosphere is embedded in the global macro-organizing principle of the 12:60 frequency, the Gregorian calendar. Two 28-year cycles, each one divided into four 7-year subcycles, define the duration of the technosphere. Remember that the Gregorian calendar repeats every twenty-eight years. As we have pointed out, the 56-year cycle of the technosphere, 1945-2001, is preceded by the 44-year cycle of the proto-technosphere. The two World Wars were a function of the proto-technosphere, the final major act being the construction of the Pentagon, specifically for consolidating the American war machine-the world's largest office building means that the world's largest business is war, with a $318 billion budget for the year 2001-2002 alone!

The fifty-six years between Hiroshima and the Inevitable Event were the age of terror, for it was atomic terror that initiated the technosphere in a baptism of nuclear fire, and in the end, it was an unimaginable suicidal terror that brought down not just one, but both of the Twin Towers of Babel. The final collapse of the technosphere is also the final war between blood and money. Artificial time has run out. Only a new time will be able to regenerate the biosphere and spiritually revive mankind. What follows is a chronological description of the eight 7-year stages of the fifty-six years of the technosphere. Note the persistence of certain themes. (See plate 5, Noospheric Time Map-Wave Harmonic of History.)

GREGORIAN A, 28-YEAR CYCLE: TRIUMPH OF THE WORLD MARKET, 1945-1972

1. 1945-1951. CYCLE OF THE BOMB: ATOMIC TERROR AND THE DIALECTIC OF THE COLD WAR.

During the first dynamic 7-year cycle, with the triple event of the first test of the atomic bomb and its two detonations at Hiroshima and Nagasaki, the biosphere becomes irrevocably altered by the introduction of a constant, steady state background radiation into the atmosphere, the actual inception of the biogeochemical combustion. This act officially establishes the technosphere. The reality is that the humans also created their first weapon of mass destruction. It is this act that also immediately sets in motion a destabilization of the human consciousness in the noosphere.Within two years, Mahatma Gandhi, the world's foremost pacifist, is

assassinated, as a "free" India is partitioned into three parts-India, Pakistan, and what is later to become Bangladesh. In the same year, 1947, the iron curtain between communist Eastern Europe and the West, epitomized by the Berlin Wall, turns the enmity between the two major powers, the Soviet Union and capitalist America, into the Cold War. The subsequent formation (1949) of the NATO military cartel counters the United Nations, which was founded in 1945 to replace the League of Nations. The UN now has the task of keeping World War III from happening by providing a forum where the "superpowers" can keep their cold war from heating up, and that will contain and manage the spread of nuclear power. Nonetheless, the terror of the Bomb as the ultimate deterrent engenders the arms race. Soon Russia, the United Kingdom, France, and eventually China get the Bomb. War in Indochina, the establishment of the Israeli state in Palestine (1948) at the expense of the sovereignty of the Palestinian people, and the completion of the Chinese Marxist Revolution under Chairman Mao are the highlights of 1949, followed by the Korean War in 1950. All this demonstrates the instability of the world. At the same time, 1949, commercial television production begins in the United States; the age of radio is replaced by the "tube." Americans also begin building freeways and the new system ofInterstate highways marking the triumph of "automobile culture," and the beginning of the suburban consumer lifestyle.

2. 1952-1958. CYCLE OF THE OPENING OF THE TOMB AND THE BEGINNING OF THE SPACE AGE.

In the summer of 1952 a Cuban archaeologist discovers the tomb of the Mayan sage, Pacal Votan. This unprecedented archaeological event marks the beginning of the final sixty years-three katun cycles-of the Mayan thirteen baktun cycle of history. In the following year, 1953, the superlethal H-bomb is tested. The DNA code is discovered, as are the Earth's radiation belts. The United States and Russia conduct numerous nuclear weapons tests in Nevada, Siberia, and the Pacific Ocean. Wars for independence occur in various African states, and in general the era of European imperialism is at an end, followed by the neo-colonialist (Third World) era of guerrilla warfare, poverty, and social instability. In 1956, the year the Russians launch the first sputnik and begin the space age, the United Nations tables the issue of calendar reform indefinitely, thus closing the chapter begun when the League of Nations proposed global calendar reform in 1931. The year 1956 also marks the beginning of the electronic pop culture of the technosphere, rock and roll. By the end of this cycle, the "space race" joins the arms race as a force in promoting the advance of the technosphere. Commercial airlines adapt to jet propulsion, and the great age of air

travel begins, with the airport to become the centerpiece of globalization. Initial experiments in computer technology-Univac-and the first great computer corporation, IBM, announce the beginning of what is to become the major technology of globalization. A small fast-food franchise named McDonald's opens in the United States.

3. 1959-1965. CYCLE OF THE ATOMIC MIND EXPLOSION.

The July 26 Cuban Revolution of Fidel Castro, triumphant in 1959, establishes a communist state in the Americas and heightens the Cold War. That same year the Chinese communists bring to a definitive end the rule of the Dalai Lama in Tibet. In the Congo, the popular hero Patrice Lumumba is assassinated after only two months in office. Also in 1960, the human population hits three billion, an increase of one billion since 1930. In 1961 the Institute of Mathematics of the Siberian Branch of the Soviet Academy of Sciences begins the monumental mathematical analysis of Mayan hieroglyphic texts. The attempted 1961 Bay of Pigs invasion of Cuba is followed in 1963 with the assassination ofJohn F. Kennedy, an act that reflects a rising level of cultural turmoil in the United States. Martin Luther King Jr. emerges as a popular hero of nonviolence and civil rights, an issue that points to a more radical discontent in America, culminating in 1965 with the Watts race riots. Rachel Carson's book *Silent Spring* (1963) signals the rise of ecological awareness. The Beatles transform rock and roll into a world-class cultural phenomenon that foments a widespread countercultural movement and atomic mind explosion, fueled by Timothy Leary, LSD, hippies, and the new antiwar movement against the conflict in Vietnam. In 1961 Yuri Gagarin is the first man in space, and the Vatican II Ecumenical Council comes to the conclusion that the best way the Church will survive in the next century is through a strong Pope. The Vatican II document also includes an appendix on calendar reform, the wording of which makes it difficult for there to be any alternative but a watered-down version of the Gregorian calendar. This act seals the technosphere within the unquestioned confines of Gregorian time, ultimately turning the atomic mind explosion in on itself.

4. 1966-1972. FROM THE WHOLE EARTH TO THE WORLD TRADE CENTER: THE TRIUMPH OF THE WORLD MARKET.

In 1966 construction begins on the World Trade Center Twin Towers, while in 1968 World Trade Centers are independently established in Houston, New Orleans, and Tokyo. That same year, UNESCO hosts the first and only conference on the biosphere ever sponsored by the United Nations, "Man and the Biosphere" (MAE), but the program slowly dies on the vine. The cultural conflict in the United States and

the entire world also reaches a fever pitch in the years 1967-1969. This ferment includes: race riots, antiwar riots, a march on the Pentagon, the assassinations of Martin Luther King Jr. and Robert Kennedy, and riots in major capitals around the world and on both sides of the iron curtain, as well as the Maoist cultural revolution in China. The excitement of the '60s climaxes in 1969 with the success of the Apollo XIII manned mission to the moon and the consequent feedback factor of the human race seeing itself instantaneously on television as the whole Earth beamed from space, an opening to the noosphere. Apollo XIII initiates the next phase of the space race, travel to other planets. Also in 1969, the Woodstock concert marks the apex of the early rock-and-roll culture and the visionary climax of the cultural revolution. The 1971 Concert for Bangladesh establishes rock and roll with a conscience. In 1970 the vision of the whole Earth is translated into the first Earth Day and the birth of the ecology movement. The United Nations follows two years later with the Stockholm Conference on the Environment. The revolutionary fervor of the previous years turns more violent, and repressive governmental police powers win the day. The first 28-year cycle ends with a whimper, the dynamic destabilization of consciousness reaches a plateau of normalcy-a normalcy to be increasingly punctuated by terrorist activity, as in the Palestinian takeover of the Olympic Village in September 1972. Both apart from as well as in reaction to such activity, the technosphere has now become all-dominant and all-powerful in human affairs.

SUMMARY, GREGORIAN A: 1945-1972

During this cycle, the dynamic of the accelerated geochemical combustion destabilizes the human consciousness while increasing the curve of the machine in human affairs. By 1973 the machine curve meets and surpasses the human population curve; this stabilizes human consciousness at a level of machine normalcy (MN). Human consciousness will remain stabilized at MN, largely through varying forms of terror and fear programming, for the duration of the second and final 28-year cycle. This normalization of human consciousness allows the diverse and rapidly evolving technological components of the technosphere to reach a point of consolidation. This stabilization of the World Market fosters its next and concluding phase: globalization and the triumph of marketing over human culture. It should be kept in mind that the instruments and weapons of mass destruction, of which there were none on January 1, 1945, have now proliferated to five different countries and provide the ultimate backdrop to these first twenty-eight years. The core of the UN's Security Council is formed by the five countries that possess atomic weapons. Geopolitically, the bio-

Machine Normal Consciousness in Relation to Technospheric Growth Curves

Human consciousness, overwhelmed by war—the ever-propagating machine and bondage to artificial time—succumbs to money and stabilizes at Machine Normal, the standard consciousness of the technosphere, which represents an ever-diminishing ratio of intelligence in relation to the growth curves of population, machine, money, and war.

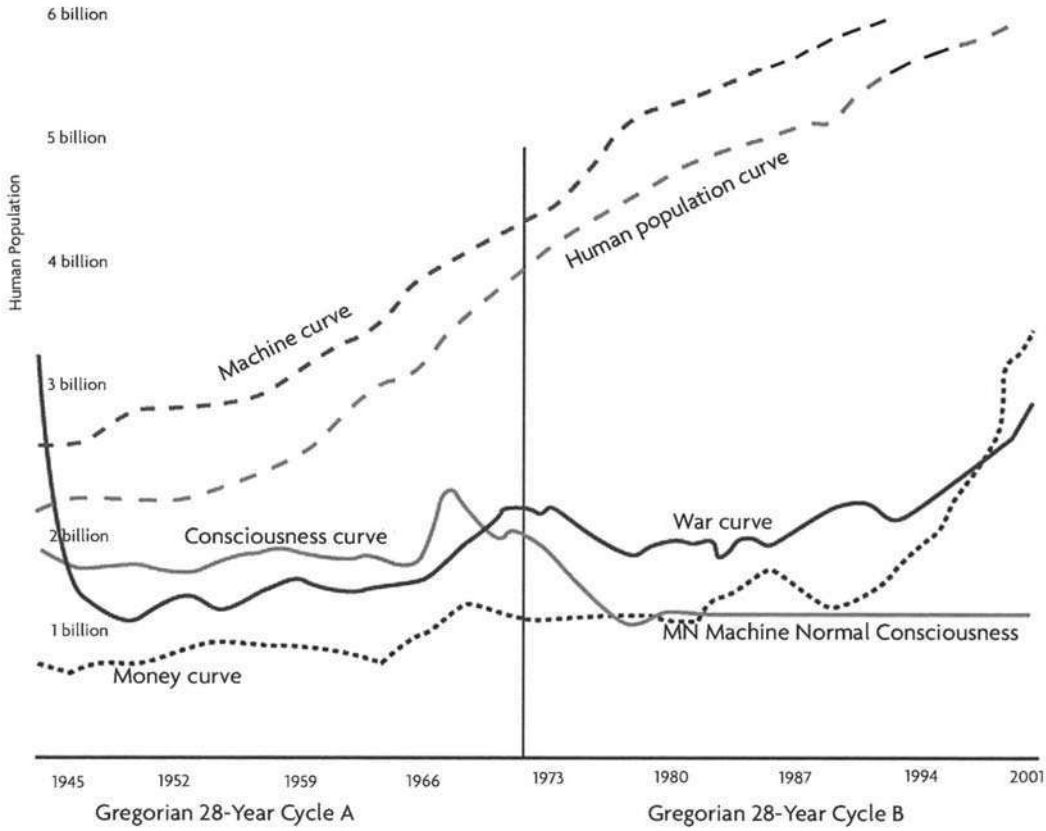

sphere is in control of technocratic powers that are virtually all located in the Northern Hemisphere-whether it is the Pentagon, NATO, the World Trade Center, the United Nations, or the Soviet space program.

GREGORIAN B 28-YEAR CYCLE: CLIMAX OF GLOBALIZATION, 1973-2001

1. 1973-1979. CYCLE OF THE CONSOLIDATION OF THE TECHNOSPHERE: CLUB OF ROME, OPEC, AND THE G-7.

The dedication of the World Trade Center Twin Towers on April 4, 1973 (a repeat of the calendar year of the Bomb, 1945) is the counterpart to the construction of the Pentagon (1940-1941), which sponsored the bombing of Hiroshima and Nagasaki. The tallest buildings in the world when they opened, the 11O-story Twin Towers seal

the position of New York as the "capital of the world," for on the other side of Manhattan is the glass tower of the United Nations. Simultaneous to the dedication of the Twin Towers is the formation of the Organization of Petroleum Exporting Countries (OPEC). With the exception of Venezuela, OPEC is largely an Arabic (Islamic) economic alliance that, for the first time in the history of the technosphere, brings a Third World influence into planetary politics. The subsequent "oil shortage" demonstrates the technosphere's vulnerability, which in turn causes a further "hardening of the arteries" of its consciousness-the covert formation by the CIA of the G-7. Also in 1973, after five years of study the Club of Rome issues *The Limits of Growth,* which in its analysis of trends foresees a major environmental (biospheric) crisis within one hundred years, yet nonetheless establishes and promotes the standard world model, a setting of production quotas at the 1973 level, to foster sustainable growth at least until 2020. The "standard world model" corresponds to the "normalization" of consciousness. The third war (previous ones having occurred in 1967 and 1949) between Israel and its neighbors occurs this year. By 1975, the world population is at four billion, up a billion since 1960. In 1976 Voyager II reaches Mars. In 1978 Karol Wojtyla becomes Pope John Paul II, the first global Pope, fulfilling the Vatican Council's requirements of a popular Pope to assure the survival of the Church into the next century. With Gregorian civilization triumphant, Mexico, home of the Maya, is the first country visited by the new Pope. In the same period, between 1978 and 1979, the Iranian Islamic revolution occurs, toppling the pro-Western Shah, signaling a heightened conservative Islamic resistance to Westernization and the technosphere. Japanese technology and corporate capitalist economy flourish, capped by the construction in Tokyo of the "New City" Shinjuku and, despite many environmental protests, the Narita airport. The mainstream global consciousness is now "comfortably numb" and on course to unprecedented materialism.

2. 1980-1986. CYCLE OF THE TRIUMPH OF THE TECHNO SPHERE.

The first cycle of the stabilized new normalcy establishes the triumph of marketing-the election of a second-rate American movie star for President, and the birth of the yuppie (young urban professional) generation of America. The rise of MTV signals the standardization of rock style as global culture; while the Live Aid global television concert on July 13, 1985, to raise awareness of AIDS in Africa, is the largest ever of its kind. The September 17, 1985 Mexico City earthquake, the worst in modern times to hit the world's largest city, demonstrates the continuing vulnerability of the techno sphere to natural catastrophe. The early 1980s witness the Intifadah uprising of Palestinians against Israel. The War on Drugs, an aggressive

antidrug campaign waged by the West against narcotraffic, mostly from South America and the Middle East, heightens the new normalcy as world drug laws tighten, placing marijuana and psychedelics in the category of "hard drugs." Yet drugs continue to be a major social problem in the industrialized West. In 1986 President Reagan attacks Kadafy of Libya and invades Grenada, testing American ability to commit limited acts of aggression without inciting world censure. The construction of Biosphere II in Arizona, an effort to test the possibility of establishing an artificial biosphere on other planets, ends inconclusively. In 1985 in Bhophal, India, the worst modern industrial toxic chemical disaster occurs with more than 2,000 deaths, followed on April 26, 1986 by the Chernobyl nuclear power plant disaster, the worst since the beginning of the nuclear age. In America the suburban automobile culture gives rise to the super shopping malls. The personal computer (PC) is introduced, while electronic game arcades flourish. Sunday football becomes the major American television pastime, while television itself makes world soccer the number one competitive global sport; the broadcast of professional sports assumes the role of a primary noospheric diversion.

3. 1987-1993. CYCLE OF THE END OF THE COLD WAR AND TRIUMPH OF THE G-7.

On January 24, 1987 Voyager II sends back photos from Uranus; four days later, January 28, 1987, seven American astronauts die in a shuttle launch explosion. On August 16-17, 1987 the Harmonic Convergence peace meditation attracts hundreds of thousands who gather at sacred and natural sites around the world; later that year, October 19, 1987, the New York StockMarket crash occurs, the biggest point drop ever, and Russian Prime Minister Gorbachev initiates disarmament accord, or *glasnost.* By the end of 1987 the population is at five billion, up one billion since 1975. During 1988-1989, a rolling wave oflargely peaceful revolutions and civil uprisings throughout most of the Warsaw pact nations culminates on December 31, 1989 with the tearing down of the Berlin Wall-the end of the Cold War. At the same time, President Bush invades Panama to continue testing Drug Wars and limited-aggression capability. In the summer of 1990 an international bankers' reunion is followed by the first public meeting of the G-7. Every year henceforth, the G-7 meets publicly to set policy for globalization. Within a month of the first public G-7 meeting, August 1990, Saddam Hussein invades Kuwait, and Bush retaliates with the Gulf War, January-February 1991. In August 1991 Gorbachev is ousted in a putsch, marking the end of the Russian Marxist era. Destabilization, war, and genocide afflict the Balkans. A new wave of environmental concerns-ozone depletion, destruction of rain forests, and global warming-inspire a reactivation of Earth Day, 1990, followed

two years later by the 1992 Rio Summit, the second United Nations Environmental Conference and the first in twenty years. The conference generates much paper, but the doctrine of sustainability (sustainable industrial growth) is the principle outcome. Meanwhile, with the absence of Marxist Russian economic influence, the neoliberal capitalist economics of America flourish as full-blown globalization, multinational corporations, and the prominence of the IMF and World Bank foment a uniform global corporate culture of cheap consumer services and franchised retail outlets for brand-name goods. This period also sees the rise of East Asian capitalist economies, although the Japanese economic bubble bursts in 1991. Early in 1993 a terrorist bomb explodes in the underground garage of the World Trade Center Twin Towers. The period 1989-1993 marks the beginning of the discovery of the Law of Time-the definition of the artificial 12:60 and natural 13:20 timing frequencies, the Dreamspell codes, and the decoding of the Telektonon Prophecy of Pacal Votan in 1993.

4. 1994-2000. CYCLE OF THE CLIMAX OF GLOBALIZATION.

In 1994, the GAIT Treaty is signed, the Levy-Shoemaker comet hits Jupiter, and a million Mricans die in the Rwanda massacre. The indigenous uprising in Chiapas, Mexico on January 1, 1994 provides a counterpoint to the triumph of globalization that is manifest through worldwide airport expansions, and an aggressive form of tourism that feeds the airline industry. Israel and Palestine enter the "peace process," while Yeltsin consolidates his power in Russia. This is the era of United Nations peace-keeping missions, mostly in the Balkans and Africa. Following the FBI/BATF -inflicted firestorm on a fundamentalist compound in Waco, Texas, a year later, in 1995, a terrorist bomb destroys the Oklahoma City Federal Building. The United States and the United Kingdom inaugurate control ofIraqi no-fly zones, enforced by regular bombing raids; the United States also conducts military actions in Somalia, as well as more successful ones in Haiti. This is the era of rapid expansion of computer and biotechnologies, exponential rise of New York Stock Exchange and the new specialized technologies exchange, the NASDAQ. Bill Gates of Microsoft typifies the rise of the new self-made billionaires of the Clinton era. In January 1995 the Kyoto earthquake occurs, followed by the Tokyo subway nerve-gas terrorist attack, while the Internet, the "information superhighway," is fully up and running. In 1996 in Brasilia, Brazil, the First Planetary Congress of Biospheric Rights signals rise of a new calendar reform movement with the proposal of the World Thirteen Moon Calendar Change Peace Plan, submitted to both the United Nations and the Vatican. In 1997 the Kyoto environmental conference on global warming sets policy, but the United States refuses to ratify it. In 1998 simultaneous U.S. embassy bombings in Kenya and Tanzania signal a

new phase of war on terrorism, singling out a Saudi national, Osama Bin Laden, as the terrorist mastermind. By 1999 the world population is six billion, up one billion since 1987. In late spring 1999 NATO initiates a unilateral bombing campaign ofYugoslavia over the disputed region ofKosovo. The World Summit on Peace and Time, at the University for Peace, Costa Rica, sends emissaries to the Vatican and the United Nations with the Declaration of Thirteen Moon Calendar Reform; later in 1999 WTO has its first meeting in Seattle, which sparks anti-globalization riots. In 2000 the Y2K computer scare surrounding a bad time program fails to materialize. On Rosh Hashanah, September 28,2000, Hebrew year 5761, Israeli leader Ariel Sharon's presence at Temple of the Mount, Jerusalem, sparks a new Intifadah of Palestinians, which continues unabated through 2001, the official first year of the new millennium.

5. 2001-? *GOTTERDAMMERUNG* OF THE TECHNO SPHERE: FIRST YEAR OF THE THIRD MILLENNIUM, REPEAT OF GREGORIAN CALENDAR YEARS 1945 AND 1973.

In July 2001, G-7 meets in Genoa, Italy, as more than 100,000 anti-globalization protesters riot. In early September the United States and Israel walk out of the United Nations Conference on Racism in South Africa. Then, within ten days occurs the Inevitable Event, Gregorian 9-11, 2001, the cumulative synchronic pressure point where the technospheric bubble-the artificial time warp in the noosphere-bursts open, spawning in its wake the full-scale War on Terrorism-another name for World War III. The Inevitable Event exemplifies the built-in failure of the Gregorian calendar to commence another 28-year cycle as was done in 1945 and 1973. If the 1945 cycle began with the end of one world war, the 2001 cycle begins with the start of one. Since 2001 is also first year of the third millennium, the Gregorian calendar has created its own apocalypse, opening a noospheric fissure-the climax of the biogeochemical combustion of the biosphere. Now it is only a matter of time before the technosphere experiences total collapse. The nature and extent of the damage sustained during the collapse is in proportion to the intelligence that responds to the knowledge of its collapsing. If this 28-year Gregorian calendar cycle were to go unimpeded until 2029, it is not certain what would be left of the biosphere. But there is one thing of which we may be certain: *artificial, linear time has run out.* An American newspaper editorial at the end of 2001 sums up the crash of the dominant linear time paradigm: "History seems to have slammed into reverse gear around a world that was widely assumed a year ago to be moving in a straight line toward a more prosperous and secular future, one that would be shaped by stock markets and the Internet, not by turbaned zealots or theocracies that have or want nuclear trigger fingers."4

SUMMARY, GREGORIAN B: 1973-2001

With destabilization normalized, the technosphere replaces civilization and marks the end of culture-the new barbarism prevails, culminating in total war. The 9-11 is what actually completes the technospheric cycle. Henceforth it will be the advent of the noosphere, but not in the way predicted by the authors of *The Biosphere Catalog:* "The Noosphere as an active force consists in the harmonious synthesis of the Biosphere and the Technosphere by intelligence."5 By the analysis of the Law of Time, the intelligence is nowhere evident because there is no harmony of intelligence possible under the present timing standards that dominate all the major players in the present global conflict. Since the technosphere is totally a function of the artificial timing frequency, and since artificial time is now short-circuiting itself, there will be no techno sphere to harmonize when natural time is restored to the entire biosphere. Then the noosphere will commence, but only if there is world harmony. Only a harmonic standard will bring harmony to the world. The failure of the Gregorian calendar and its civilization, crystallized in the now-collapsing technosphere, must be quickly acknowledged. By adopting a harmonic standard as soon as possible, the shift to the noosphere can commence, rising and building itself up from the shards and ashes of the toppled technosphere.

6

The Solution of the Law of Time

Get a New Calendar

"I am in favor of a standardized calendar for the whole world, just as I am in favor of universal coinage for all countries, and a supplementary artificial language (like Esperanto, for example) for all peoples. . . I am always ready to endorse any honest movement which will help unifY the peoples of the world. "

-MAHATMA GANDHI, QUOTED IN *THE JOURNAL OF CALENDAR REFORM,* 19311

VIEWED FROM THE PERSPECTIVE of the noosphere, the failure of human civilization is the failure of the human being to become synchronized with itself in the correct time of universal nature. Instead of operating as a planetary organism in absolute synchronization with a knowledge of being coordinated by a common harmonic standard, humans race toward the end of history, dissynchronously operating under a plethora of calendars of differing measures enshrining competing belief systems, all globally coordinated by an instrument of irregular measure and obscure nomenclature-the Gregorian calendar. Dissynchronized and at odds with itself everywhere, humanity is broken apart into splintered mind fields, each controlled by a different timing standard, a fact about which the human race is virtually ignorant-to its own detriment.

India, with its different neo- Babylonian calendars, is at odds with Pakistan, which operates according to the Islamic lunar calendar; the Israelis, at odds with the Palestinians, hold as tightly to the Hebrew lunar calendar tradition as the Palestinians do to their Islamic lunar calendar traditions. In Asia, China follows its own complex and ancient lunar calendar tradition, and watches as the United States and its G-7 alliances, all dominated by the Gregorian calendar, get ready to spar with terrorists and militants who also follow the Islamic lunar calendar. India has the Bomb, Pakistan has the Bomb, China has the Bomb. The United States has the Bomb, the United Kingdom has the Bomb. France has the Bomb. Russia, the Ukraine, and other former Soviet nations have the Bomb. It is commonly assumed that Israel also possesses the Bomb. Does Iraq have the Bomb? Can a terrorist get access to materials to create the Bomb as well? The nuclear clock is ticking again.

The number of weapons and technologies of mass destruction has increased several thousandfold since 1945 when, at the time ofVernadsky's death, there were virtually none. This is not to mention the biological weapons of mass destruction, more ambiguous, more lethal, more hidden-none of which really existed in 1945 either. With the fallout from the Inevitable Event an anarchic planetary free-for-all is taking shape. From the noospheric point of view, the humans have run out of (artificial) time, and are now committing their last egoistic act of desperation to hold what they perceive to be their dominant place in the scheme of things. The fact is, however, that the planet belongs to the biosphere and not to the humans.

The inability of the Gregorian calendar to sustain another 28-year cycle, much less another millennium, means that an anarchy of time and a time of anarchy is loosed upon the planet. At the present rate, what would the world look like in 2029? One does not want to imagine. The anarchy of time is exemplified by the different competing powers that are unconsciously driven and motivated by programs stored in their differing calendar systems. This failure of artificial time to contain itself is truly the apocalypse. The apocalypse could occur only when the time program had become saturated. The two 28-year cycles, 1945-2001, carried forward not only the exponential advance of machine time, but the accrued karmic baggage of two millennia of the invented religion of Christ. Throughout the last millennium, the protagonists of this religion waged a type of holy war against an embattled world-a war waged by missionaries and conquistadors alike, down to this very day. The week before the Inevitable Event, the Taliban was deporting Christian missionaries from Mghanistan, while other Christian missionaries scour the jungles looking for one more indigenous soul to convert. This activity is inseparable from the Gregorian calendar that programs it.

Entropic Black Hole of Consciousness

A calendar is a mental instrument for holding the programmed patterns of thought and behavior of a given culture, people, or civilization. A people can rise no higher than the program of time their culture imposes on them as second nature. A program of time determines nature of consciousness. Different timing programs scheduled by synchronically inaccurate devices within a biospheric whole governed by a universal timing frequency apart from the deviant human standards can only result in an entropic black hole of consciousness: the clash of civilizations and cultures that precedes the mentally cleansing force of the noosphere and the inevitable return to natural time and the universal 13:20 timing frequency.

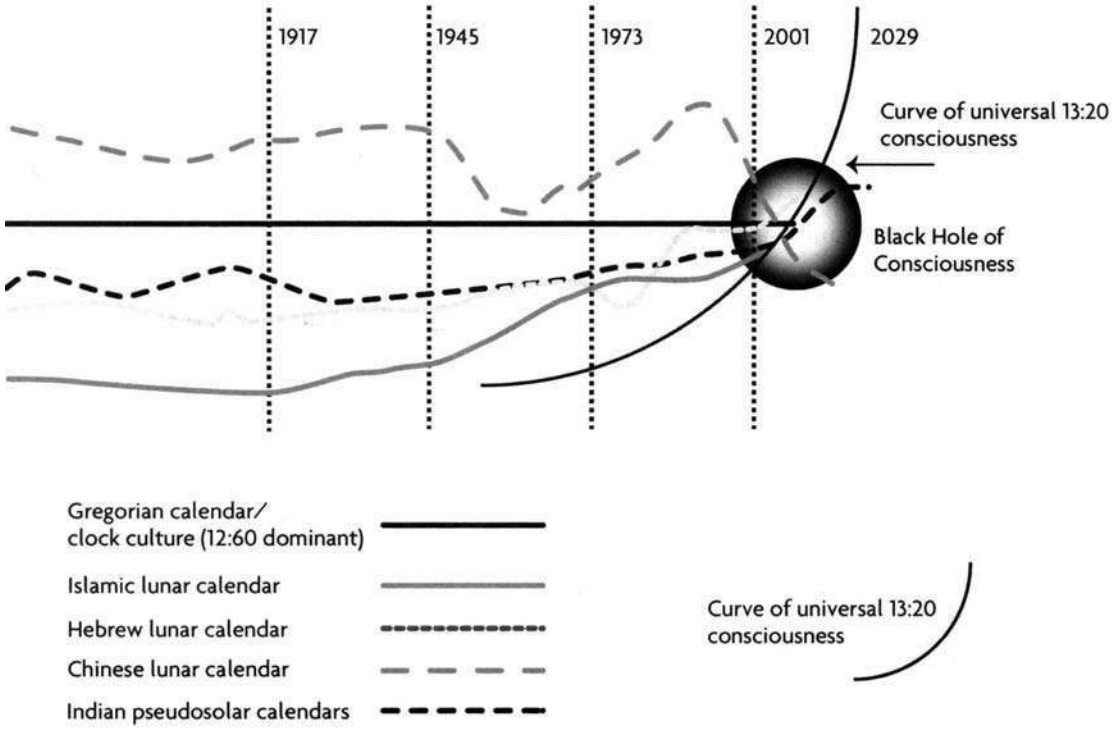

Now the default of the Christian program of the Gregorian calendar and its system of social organization, global civilization, is erupting in an entropic black hole of time. The result of this black hole of time is an entropic harmonic convergence, where all of the conflicting points of the differing timing programs that the Gregorian calendar attempted to synchronize, come into a common point of hostile impact. Seen in this light, the Final War is really the final battle in a long saga that we can properly call the Time Wars.

THE AGE OF THE TIME WARS

The Time Wars began with the application of the error in time at Uruk: the 24-hour, 60-minute, 60-second timing frequency derived from a 12-part division of the circle, a two-dimensional plane in space. Since this measure does not correspond to the reality of time as the universal (13 :20) frequency of synchronization, it creates a mental dissynchronization that manifests as the battle of the mind against itself, and against nature. The dynam'ic of the "progress" of civilization is really the dynamic of dissynchronization inherited by the human mind. The gradual encroachment of civilization into all aspects of human society and the biosphere increases the incidence of dissynchronization. The resulting aphasic mental states lead to belligerence and various attitudes of dominance over others and nature-but never to any satisfaction.

Viewed by the Law of Time, civilization is the institutionalization and embodiment of the dissynchronous artificial timing frequency. The dynamic of dissynchronization results in increasingly artificial technological means and reliance on the artificial medium of money to replace the biological or organic functions of our nature and of the biosphere in general. Not only does this process tend toward an "improvement" in the accuracy of the means of war, but also in the capacity of the latter for greater mass destruction. Set apart from the natural cycles by the dissynchronous frequency of mechanization, the Time Wars are also waged against the biosphere, which is viewed as a hostile force to be overwhelmed and plundered. Everywhere on Earth, nature is on the run. Everywhere on Earth, the human looks at his watch-what will he do next? Catch another plane? Fire another bullet? Press another button and let loose another bomb?

The 56-year cycle of the technosphere witnessed the greatest creation and stockpiling of lethal weapons, more than in all the previous history put together, enough to destroy the Earth many times over. The 56-year cycle of the techno sphere also witnessed the greatest plundering thus far of the biosphere, more than in all the previous cycles of history put together. Continued at the current rate, the biospheric plunder would bring extinction to virtually all life within another generation. These two facets of self-destruction-technospheric and biospheric-point again to the Inevitable Event. It is the Pentagon that has led in military spending and strategizing, just as it was the activity within the World Trade Center Twin Towers that dominated and coordinated from afar the plunder of the biosphere-both precedents for the consequent construction and expansion of the technosphere.

But now time has run out on the technosphere. The world has gone flat and valueless with no future vision beyond war. All the money in the world will not put it

back together, nor will all the bombs in the world salvage it against its enemies. Who are the enemies of the technosphere, and what would cause thereto be enemies against the technosphere? And who or what is there that speaks for the biosphere? For if the biosphere is to become the noosphere, it must come about from an understanding of the intelligence of harmony. Clearly, such understanding of harmonic intelligence has not been nor will it be forthcoming from the technosphere-or from the Gregorian calendar that programs it. Only the Law of Time can supply the harmony necessary to complete this great movement from biogeochemical combustion to noospheric mind. The Law of Time replaces all that is artificial, while confirming all that is true, whether in human history or the universe.

Let us return to the analysis of the Time Wars and the clash of timing programs. The Twin Towers were the absolute triumph of the artificial 12:60 timing frequency, whose program is embedded in the Gregorian calendar and paced by the mechanical clock. Who steered the hijacked planes into their Gregorian targets? Nineteen militant Muslims, we are told. Why nineteen? And what are the religious backgrounds of the twenty-two most-wanted terrorists in the world? They are twenty-two Muslims. Why that number, and why are all the terrorists Muslims? In the noospheric analysis, the Inevitable Event was the suicide of the technosphere unable to sustain two clashing time programs. It was a program of the strict Islamic twelve-month lunar calendar that drove its belief system into the Twin Towers and the Pentagon, the two supreme monuments of the program of the twelve unevenly measured months of the Gregorian pseudosolar calendar. Is it Islam that is the enemy of the technosphere? Is it Islam that is the champion of the biosphere? Indeed what is Islam? Why is Islam the most resistant force against globalization and the technosphere? We know where the Vatican, the bastion of Christendom, is and who ordained the Gregorian calendar, but what do we know about Islam?

If we strip history away from the force known as Islam (1.3 billion Muslims in the world), and reduce it to its most essential point, then Islam is the teaching of the Holy Quran. What is the Holy Quran? It is the last whole revealed text for all humanity, received and recorded over a 23-year period by a single human being, Muhammad the prophet (570-632). While militant Muslims and terrorists have dominated the mass media image ofIslam for the past few decades, what is the Quran and what does it actually teach? It is also a function of the Gregorian program that scarcely anyone in the West really knows or is familiar with the Quran, since the West has been at odds with Islam since the time of Muhammad. As the supreme text of monotheism, the Quran is actually a psychoactive book that upholds Islam as the final religion for humanity. "He is the one who sent His messenger with the

guidance and the religion of truth, to make it prevail over all other religions. God suffices as a witness." (Quran, 48:28) *Islam* means "peace, which is submission to the will of God."

Islam is also the law of nature. Within the vast system of intricate, mathematically based logic that constitutes the Quran-which is a profoundly ahistorical text as well-one feature stands out: the description and definition of nature and the natural order as the chief proof of God's design and guiding wisdom. From the Quranic point of view, the biosphere, inclusive of the creation of the human, is the overwhelming single proof of God's wisdom in establishing a life-support system for our indwelling consciousness to evolve our bodies on this Earth. The biosphere is Islam, or "peace, which is submission to the will of God," understood as the divine law of nature.

> In the creation of the heavens and the earth, the alternation of night and day, the ships that roam the ocean for the benefit of the people, the water that God sends down from the sky to revive dead land and to spread in it all kinds of creatures, the manipulation of the winds, and the clouds that are placed between the sky and the earth, there are sufficient proofs for people who understand. (2:164)
>
> He created you from one person, then created from him a mate. He sent down to you eight kinds of livestock. He creates you in your mother's bellies, creation after creation, in trimesters of darkness. Such is God your Lord. To Him belongs all sovereignty. There is no other god beside Him. How could you deviate? (39:6)
>
> Among His proofs is that you see the land still, then as soon as we shower it with water, it vibrates with life. Surely the One who revived it can revive the dead. He is Omnipotent. (41:39)
>
> He created the human from a tiny drop, then he turns into an ardent opponent. And he created the livestock for you, to provide you with warmth and many other benefits as well as food. They also provide you with luxury during your leisure, and when you travel. And they carry your loads to lands that you could not reach without a great hardship. Surely your Lord is Compassionate, most Merciful. (16:4-7)
>
> He sends down from the sky water for your drink and to grow trees for your benefit. With it, He grows for you crops, olives, date palms, grapes, and all kinds of fruits. This is sufficient proof for people who think. (16: 10-11)
>
> And He committed the sea to serve you; you eat from it tender meat, and extract jewelry which you wear. And you see the ships roaming it for your commercial benefits, as you seek His bounties, that you may be appreciative. And He placed stabiliz-

ers (mountains) on earth lest it tumbles with you, as well as rivers and roads that you may be guided. And landmarks, as well as the stars to be used in navigation. Is One who creates like one who does not create? Would you now take heed? (16: 14-17)

As for the Earth, we constructed it, and placed on it stabilizers (mountains) and we grew on it a perfect balance of everything. We made it habitable for you, and for creatures you do not provide for. There is nothing that we do not own infinite amounts thereof. But we send it down in precise measure. And we send the winds as pollinators, and cause water to come down from the sky for you to drink. Otherwise you could not keep it palatable. (15: 19-22)2

Viewed from its own context, the Quran is the criterion for evaluating the spiritual progress of human existence on this Earth inclusive of man's ability to read the proofs of nature as manifestations of God's wisdom and to comport himself within this nature, the biospheric life-support system, in a manner consistent with the truth. From the Quranic perspective, human freedom of choice is at the root of the biospheric destruction. Choosing anything but to be submissive to God, the human is in rebellion against nature-both his own and that of the biosphere. "We have offered the responsibility [freedom of choice] to the heavens, and the earth, and the mountains, but they refused to bear it, and were afraid of it. But the human being accepted it; he was transgressing, ignorant." (33:72)

The result of this ignorance on behalf of his own aims and intentions rather than that of a respect for the divine plan (biosphere) of the Creator, accounts for the human situation today, at odds with and surrounded by an increasingly out-of-control biospheric degradation and corruption of natural time: "Disasters have spread throughout the land and sea, because of what the people have committed. He [God] thus lets them taste the consequences of some of their works, that they may return [to the right works]." (30:41) Thus, the current techno spheric destruction actually points toward a return of humans to the path of right works.

The forces that created the phenomenon of historical Islam are the enclosing of the Holy Quran within the rigid system of a twelve-month, non-circulating lunar calendar, compounded and supported by the development of the *hadith* and *sunna* (non-Quranic) traditions. A profoundly conservative social order, Islam is nonetheless activated and motivated by a holy scripture that enunciates an attitude toward nature that is the direct opposite of the 12:60 system that produced the technosphere. In this regard, the precepts of the Holy Quran-as of many another holy scripture-make it the "enemy" of the technosphere. From the noospheric perspective, historically and culturally, however, the assault on the nerve centers of the techno sphere

could only have been effected by humans whose belief system was rooted in the Holy Quran, which had been at odds with the Gregorian civilization for centuries. In this way, the Quran was the noosphere's weapon used to bring about the circumstances that would lead to the resurrection of the biosphere-the noosphere itself. But only if man consciously chooses the right return path: synchronized harmony in time. The problem is not so much the rigid lunar calendar ofIslam, but the irregular global standard of the Gregorian calendar, which, instead of standardizing all measures and perceptions of time, fosters a human social disharmony and an incessant antagonism against nature-and against Islam.

So then, how are we to return to the right works? Read and study the Quran, yes-but also make a fundamental change in the world. The solution of the Law of Time is: Get a new calendar! Humanity must take a long, hard look at its own timing systems and scrap what needs to be scrapped, no matter what kind of temporary inconveniences this may cause. Calendar reform is an issue that upsets many apple carts. Yet it is the only method that has not been commonly tried and the only step that has not yet been collectively taken. It is a characteristic of the dominant mindset that it writes history in the way that suits its own needs and supports its philosophy. In any of the reviews of the century carried by the mass media during the past year, you will find no mention of the World Calendar Reform Movement; nor will you find, for instance, any mention of the Roerich Peace Pact (1935); nor of the Harmonic Convergence-all buried by the marketing of history to suit the needs of globalization. What do these three phenomena have in common? A concern for peace based on an understanding that without harmony, the human cultural situation will only worsen. If humankind suffers from an excess of disharmony, in the noospheric analysis the only solution is a harmonic standard of time to synchronize all humanity simultaneously-the Law of Time refers to this as the Thirteen *Moon!* 28-Day frequency shift.

CHANGE YOUR CALENDAR, CHANGE YOUR MIND

> *"Since the advent of the Nuclear Age, everything has changed but the way people think, thus, we drift towards unparalleled catastrophe."*
>
> -ALBERT EINSTEIN3

To change how people think you must take a profoundly simple and universal element of everyday life, one in which all everyday thinking is rooted, and change it so

radically that the way in which people think will itself be dramatically changed. If you want to know that something has really changed, change the calendar! This is the meaning of the replacement of the Gregorian calendar by the Thirteen Moon calendar. The calendar change is necessary because, as the pragmatic application of the discovery of the Law of Time, it brings into focus the essence of this discovery: Time is a frequency, the frequency of synchronization. If a calendar does not increase synchronization, it is not performing its highest function. This is the fundamental critique of the Gregorian calendar-and of all concepts of time based solely on physical, third-dimensional astronomical measurements. This discovery is so new and startling that it affects all human thought and is a matter to which all belief systems, religions, and methods of science must be cognizant. Yet nothing, it seems, is more difficult for humanity than to make this change from a manifest disharmony to a manifest harmony.

Historical man recoils at the prospect of actual harmony-harmony in natural time. This is because historical man defines his existence and thrives upon the disharmonies of his own invented time. The Gregorian calendar keeps the human mind entrained in a diabolical disorder of meaninglessly named months of uneven measure, while every day is tracked and driven by a relentless mechanism called a clock. This immersion of the mind of historical man in the frequency of his own artificial time, more than any other factor, condemns him to a world of inescapable horrors: traffic jams, poverty, terrorism, unresolvable historical and territorial disputes, global warming, environmental degradation, social disorder, insanity, and drug abuse. The problem of historical *human-Homo historicus-is* compounded by the unconscious nature of his acceptance of this timing sensibility, believing it to be the actual nature of time. Hence, all his public and economic policies are driven by and determined by the relentlessness of this perception that time is an arrow blindly pulling him into a future in which his only defense is the creation of more technology, the technosphere itself being a pure expression of the application of the mechanization of time.

THE SECRET HISTORY OF CALENDAR REFORM

When you went to bed on October 5,1582 you woke up on October 16. In this way Pope Gregory XIII promulgated his reform of the Julian calendar, from which the Gregorian calendar differs not one whit, except for the precise working out of the formula for leap year. When this "reform" occurred, the time sensibility of historical man was already crippled and disabled. The Gregorian calendar, by its moment of

historicity, bound that crippled time disorder into its final institutional form, assuring that not only European man, but eventually all cultures and races dominated by European thought and conventions would assume and accept this deformed and deforming standard of time.

The mechanical clock, though evolved over many centuries, was perfected just after the Gregorian Calendar Reform of 1582 and promoted by Europeans as an example of the human triumph over nature. So it was that the human mind assumed as second nature its own invented time, encoded as a frequency that we have identified as the 12:60, an unconscious mental ratio determined by the irregular twelve-month calendar and artificial sixty-minute hour. The combination of these two factors in this one timing frequency have consigned historical man to a hopelessly debilitating mental disorder that is referred to as modern civilization, or nowadays, postmodern. But postmodern is not yet post-historical. Postmodernism is just the final convulsion of the time disorder that afflicts the human race as a virulent mental disease and encapsulates man in the technospheric cocoon of his own making. The only cure for such a profound and pervasive disorder is absolute harmony, the very harmony from which historical man so recoils.

In this light, it is well to know that through the first half of the twentieth century a vigorous and well-organized calendar reform movement flourished. Such was the character of this movement to reform the Gregorian calendar that in 1923 the League of Nations called for proposals for reform. More than 500 proposals were received; by 1931, these were narrowed to three:

> The International Calendar Organization, represented by Mr. Broughton Richmond, promoted a perpetual calendar based on the principle of five-five 73-day cycles = 365 days-and the year divided into twelve months of five 6-day weeks each plus a 5-day cycle [The Thirteen Moon calendar also includes the program of seventy-three 5-day periods-overtone chromatics-integrated with the fifty-two 7-day weeks: 52 x 7(+1) = 5 x 73.]

> The International Fixed Calendar League, represented by Mr. Moses Cotsworth, also supported by Eastman Kodak and the International Chamber of Commerce, promoted a perpetual Thirteen Month/28-day calendar, which was first presented by Auguste Comte (1842-1849), inclusive of the "day out of time." Though it was not backed by a more thorough mathematical science, which has now been supplied by the discovery of the Law of Time, this was by far the favored calendar, as it is the one that possesses a perfect structural harmony and obvious regularity of all its parts.

3. The World Calendar Association, represented by Elizabeth Acheles, promoted the World Calendar, a modified but perpetual version of the twelve-month Gregorian calendar, which also included the principle of a "day out of time" ("null day"). This group turned out to be the longest-lived and the most vocal, and was responsible for the publication of *The Journal Of Calendar Reform (1931-32).4*

It is instructive to read some of the early texts on the topic of calendar reform to see how the same issue of harmony and order brought up by the Law of Time was at the root of the call for the establishment of a perpetual, harmonic calendar. The base argument, as presented in Alexander Philip's *The Reform of the Calendar* (1914), is stated as follows:

> Suppose, for example, that by some strange convention the meaning of the figures we employ in numerical notation were to change every year; suppose the figure which this year represents 2 were next year to mean 3, next year 4, and so on; suppose again that our weights and measures were to fluctuate in a similar manner. . . then we affirm, without fear of contradiction, that the whole fabric of science and the mechanical arts could never have been raised at all. . . we should in such circumstances have been compelled to rest content today with the very simplest and most primitive appliances. Yet, strange as it may sound, such are the conditions under which, in modem society, human action is organized. For what is the framework. . . by which we arrange our actions? It is no other than the scheme under which we arrange our time-in one word, our calendar. . . [thus] the disorganized state of all social arrangements is ascribable to the calendar. . . The dislocation of our calendrical arrangements is due to two distinct causes. . . the incongruity of the week; [and] the irregularity of the lengths of the months. . .5

The argument made is a profound one, and was the motivating basis of the calendar reform movement in general, no matter which calendar was being promoted. It is fair to ask: Why do we expect a rigorous standard of uniformity in our measurements of space (size, weight, volume, etc.), but spurn or ignore the same requirement of uniformity in our measurement of time, especially the time that governs our everyday social arrangements and consciousness? How can we think that this would not have a profound underlying effect on the very nature and conduct of our society?

Most interestingly, as a movement calendar reform arose strongly during the proto-technosphere, between the two World Wars, only to be swept away by the clouds of war and the contradictory factions of disharmony in which modern

civilization was already immersed. Any effort at altering or changing the direction and motion of modern civilization is treated as a threat or derided as ineffectual activity that is scientifically unprovable or that will cost humanity too many dollars to make the change. Such was the fate of the first great calendar reform movement that arose with such fervor in the late nineteenth century only to find its ignominious end when the final debate on calendar reform was adjourned indefinitely by the United Nations Social and Economics Committee in 1956. No one reads about the calendar reform movement in the history books. Because debate on the matter was effectively adjourned, it is assumed that calendar reform is a dead issue of no relevance to the development of postatomic, technospheric man. On the contrary, seen in the dim light of the still-smoking ruin of the Twin Towers, the calendar reform arguments concerning humanity's irrational behavior and its relation to the "immorality" of a skewed timing measure, the calendar, as well as to an inhuman timing device, the clock, were never more relevant.

Not the least import of calendar reform is the opportunity to create a new basis for unifying humanity. As was stated in the "Resolution Adopted by the Fourth General Conference on Communications and Transit of the League of Nations," which took up the issue of calendar reform: "A great number of delegations expressed the opinion that any reform of the calendar could only be put into practice if it came into force simultaneously throughout the world, or at least in a very great majority of States, and it was for this reason that the study of this question had been placed under the auspices of the League of Nations."6

The tragedy of the human inability to agree on a matter so obvious to logic and reason is a testament to the already crippling effects of having operated so long under parochial, sectarian, and often disharmonic timing standards. While the International Chamber of Commerce, the League of Nations, and various international scientific bodies supported the first effort at reform in 1914-1956, the second movement, 1989-present, arose as a purely populist effort, but with an entirely different information base. Recognizing instinctively that the calendar reform issue is more than merely a matter of mathematical order in relation to natural cycles, it is a profoundly theological issue as well, the second reform movement also developed from a non-Western inspiration: the Mayan calendar.

While the psychology of the dominator civilization all but blurs out any other considerations of calendar besides the prevailing Gregorian one, an objective study of the matter demonstrates that the latter is a primitive instrument that eschews both natural cyclic order and any mathematical harmony. In place of the anachronistic standard of the Gregorian calendar, the second calendar reform movement raised

a new criterion, the Law of Time, a whole system principle that integrates the mathematical and the moral, the theological and the psychological, and the economic and scientific issues that are embedded **in** the entire topic of calendar reform. Precisely for the reasons of historical man's unconscious habituation to his own disharmonies and the accelerating and cumulative effect of this ignorance on the disorder of his own social life as well as the natural world around him, the second calendar reform movement has developed with a much greater moral and prophetic urgency.

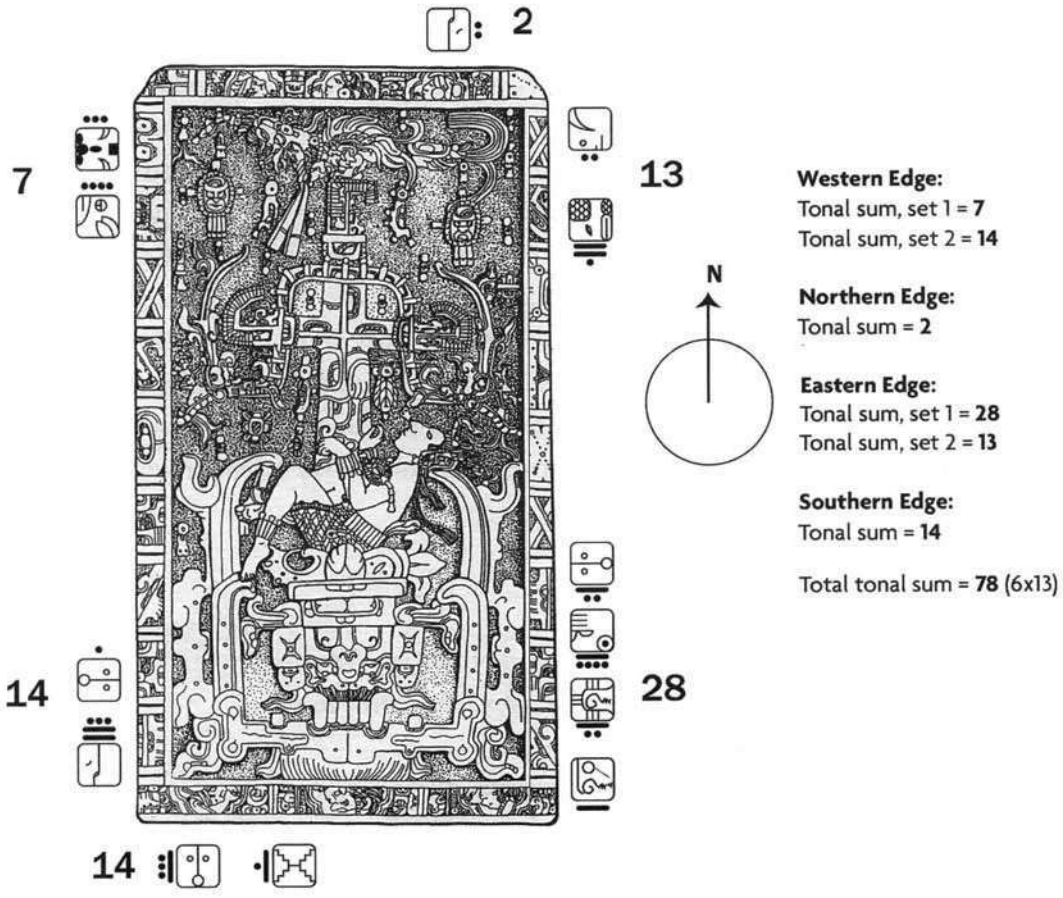

Sarcophagus Lid of the Tomb of Pacal Votan
Showing Disposition of Thirteen Clear Signs

The tonal sums (dot-bar code) of the thirteen signs are key to affirming the prophecy of the Thirteen Moon calendar. Note that the sums of the two sets on the eastern edge equal 28 and 13, while opposite the 13 set is the perfect 7. The tonal sums of the other two sets on the western and southern edge both equal 14, for a sum of 28. The northern edge has a single sign whose tonal sum is 2 twice 7 = 14, and twice 14 = 28; twice 13 = 26 fractal of 260 and code to the Gregorian date 7/26; while twice 28 = 56, the number of years from Hiroshima to the Inevitable Event.

"Consciously using the tool of the Thirteen Moon calendar to replace the erroneous measure of the artificial twelve-month calendar is, in itself, an unprecedented act of human self-reflective consciousness. Collective adaptation to the Thirteen Moon calendar is an intrinsic heightening of consciousness which rapidly awakens the telepathic programming inherent in human biology, frustrated for so long for not having been allowed development in the correct timing frequency."7

It was in 1987 that *The Mayan Factor: Path Beyond Technology* first brought to major public and international attention the possibility that a superior timing sensibility was developed by a thoroughly non-Western culture, the Maya. This book was published with scarcely any knowledge of the calendar reform movement that had gone into a debilitating coma in 1956. Yet, by pursuing the mathematical base of the Mayan calendar, the essence of the Mayan achievement, the Law of Time was extracted, a discovery that brought on the second calendar reform movement, the World Thirteen Moon Calendar Change Peace Movement. Prompted by a prophetic revelation concerning the Thirteen Moon!28-Day calendar decoded from the tomb of Pacal Votan, the premise of the second calendar reform movement was tested worldwide from 1993 to 2000, a time defined as the "seven years of prophecy." By the year 2001, the official beginning of the third Christian millennium, a loose, far-flung calendar reform movement, pioneering in the development of a new science of time and consciousness was promoting the Thirteen Moon!28-Day calendar worldwide.

A REVOLUTION IN TIME

> *"Fire in the lake, the image of revolution. Thus, the superior person sets the calendar in order and makes the seasons clear"*
>
> *-I CHING,* HEXAGRAM49, "REVOLUTION"8

By common consent, a calendar is a system for reckoning time. Virtually all current time-reckoning systems take account only of chronological or, better put, astronomical time-the movement of the Earth in relation to celestial bodies, the sun, moon, planets, stars, and constellations. This is a purely third-dimensional, physical consideration of time. The Law of Time affirms a higher order of time-the synchronic order. This is the time of the fourth dimension, which includes the chronological but enfolds it in a higher mental and mathematical order of reality. According to the Law of Time, what you don't know about the calendar you are using could kill you. By operating according to purely third-dimensional chrono-

astronomical timing standards and without knowledge of the synchronic order of fourth-dimensional time, humanity subjects itself to a one-sided view of reality that is hazardous to the planet and jeopardizes the future existence of the human species as well as all life on Earth.

To correct this situation a radical solution is required-a new calendar embedded in the synchronic order revealed by the discovery of the Law of Time. This is the significance of the Thirteen Moon/28-Day calendar-it epitomizes the incorporation of the chrono-astronomical order of time into the synchronic order, and hence provides the vehicle for humanity to escape its otherwise certain plunge into disaster within the next decade. When a dogma is encountered while one is engaged in the pursuit of truth, it must be challenged and abolished. Such a dogma is the calendar in use as the world standard, the Gregorian calendar. That this calendar, originally a system of thought peculiar to one people or religion, should dominate all the peoples and even life of the planet makes it subject to the critique of planetary anthropology.

The discovery that time is a frequency mathematically expressed as the ratio 13:20 requires a profound reorganization of all thought about time and the consequent reorganization of human society as a planetary organism. As the unified field theory of time, the Law of Time calls for the human synchronization in time predicated on the establishment of the Thirteen Moon calendar as the global civil standard replacing the current erroneous timing standard, the Gregorian calendar. This is a matter of the utmost seriousness, since it is also recognized that all belief systems are the function of programs locked up or embedded in the calendars or time-reckoning systems used by a people. The fate of the species and the biosphere may well depend on whether or not humanity is able to understand this point.

What is it about the calendars in use that condemns their users to endless conflict and inability to unify as a species? What is at the root of their disharmony? It is the pursuit of astronomical time. All people today are bound by calendars based on a pursuit of accuracy of astronomical time-the length of the year being the object of this pursuit. Astronomical time is a losing game of an ever-changing and elusive order that results in an entropic reductionism that has little to do with consciousness or synchronization. The year's length (measure of the orbit of the Earth around the sun) calculated by Pope Gregory XIII at 365 days, 5 hours, 48 minutes, and 20 seconds, slows at the rate of 1/12 second per century, while the length of time in the Gregorian calendar is off from the "true" solar year by 25.9678 seconds per year! Obsessed with rectifying this discrepancy, in 1972 reductionist science came up with Atomic Time to replace Earth Time, and the atomic cesium clock replaced the measure of the year as 365.241299 days with 290,091,200,500,000,000 oscillations of Cs per year!

But what does this staggeringly astronomical figure mean, and of what value is it?

In profound contrast to this obsessive reductionism in which there is no place for spirit, mind, or consciousness, fourth-dimensional radial mathematics represents a mental order greater than and encompassing the astronomical order of the third-dimensional universe. According to the Law of Time, in time reckoning, consideration should be given to systems of the harmonic order of synchronic time that proceed from the radial mathematical order of the higher mind. The higher mind represents the evolved state of mind-the noosphere-that evolution on Earth tends toward, but that has not yet been attained. As long as the human concept of time is governed by the obsessive pursuit of the impossible to attain perfection of astronomical time, this pursuit and the civilization that it propels are doomed to failure. What is known as history is embedded in this pursuit of "fixing" astronomical time, which has culminated in the dogma of the Gregorian calendar and the microatomic measure of the cesium clock. When did this pursuit begin, why did it come to dominate the human species, and to what effect?

As we have seen, the values, customs, and norms of a nation, culture, or civilization are embedded in the calendar it uses. The Gregorian calendar, the current global civil standard-indeed, the foundation in time of globalization-is the calendar of the Caesars, of the Roman Empire, of the Catholic Church and the Vatican. To change this calendar is to change history itself. Can it be done? The League ofNations attempted this in the 1930s but failed. The United Nations tabled this effort in 1956. Since the United Nations adjourned the matter of calendar reform indefinitely, in 45 years the Earth's population has more than doubled, that is, it has increased by more than 3.2 billion people, a factor that is still out of control, and that may have much to do with the fact that humanity is actually in a fog about time.

The reasons for wanting to replace the Gregorian calendar are no less valid today. The Gregorian calendar is not a standard of measure. It lacks logic and reason. It numbs and befuddles the mind when trying to make calculations by it. It is shrouded in an arcane and medieval obscurantism. The net effect of the use of this calendar is to perpetuate a fundamental level of mental confusion and ignorance concerning the actual nature of time itself-an ignorance that is hardened into dogma by the unwillingness of habit to consider any other possibility, but rather to accept the entire system as second nature. The argument that it encodes the most accurate and scientific measure of the solar orbit of the Earth is irrelevant in relation to the effect of its irregular measure on the mind and its numbing power as the dogma of a conquering people. Indeed, the solar measure of365.241299 days per year has nothing intrinsically to do with "30 days hath September. . . ," and vice versa. In fact, the

measure of the Earth's orbit is one matter; the purpose of calendars and time reckoning as factors of synchronization is a wholly other matter. But then, since the very nature of a culture or a civilization is determined by the calendar it keeps, the use of a deformed standard can only inhibit and skew even the questions one asks about time.

The failure of calendar reform by 1961, the year of the Vatican II Council, only promoted an increasingly complacent acceptance, however cleverly disguised, of a millennial dogma, the Gregorian calendar. In the conclusion to the "last word" on the subject, *Calendar: Humanity's Epic Struggle to Determine a True and Accurate Year*, David Duncan summarizes, "We take in stride a calendar [the Gregorian] that is flawed but endures, largely because it works just fine for most of us, and it is what we are used to."9 It is not at all objective to accept something because we are used to it. This attitude is anything but scientific. Rather, it is the smug basis of nothing more than a self-fulfilling dogma-and yet the civilization that bases itself on this aberrant timing measure prides itself as being the most scientific in all history!

THE CONFUSION OF IRREGULAR TIME

Due to this flawed time sensibility, it may be concluded that humankind today is little capable of moral reason or logic, which itself is a result of, or at least strongly reinforced by, habituation to a timing standard that is irrational and illogical. Anytime we overlook or dismiss a fault due to habit, or simply because we are accustomed to the use, say, of an instrument, even if that instrument is demonstrated to be flawed and irregular, is evidence of a moral laziness that will eventually contaminate the entire consciousness that accepts and accommodates itself to the flaw. The exercise of truth is a moral prerogative. The fact of the matter is that the Gregorian calendar is a hodgepodge of flaws and accretions, rationalized into a systematic formulization that has no basis in reality. The celebration of Easter is a case in point.

Easter is the celebration of the day Christ was resurrected from the dead. It may be logically assumed that this occurred on one and only one particular day, just as the celebration of his birth occurs on Christmas Day (although, similarly, no one really knows that this was the actual date of his birth). By the time the Christian religion had become an established force within the Roman Empire, however, no one knew precisely on what day the Resurrection had taken place. The Council of Nicea, convened by Constantine in A.D. 325, called for a debate on the matter in which various theories were presented. The debate was concluded with the victory of one conjectural system over the other. The winning system stated that Easter

would be celebrated on the first Sunday after the first full moon after the spring equinox, except when the full moon was on a Sunday, in which case it would be celebrated on the following Sunday, and this was so that it would not be celebrated on the same day as Jewish Passover.

Over the centuries this conjectural theory regarding the date of Christ's resurrection was buttressed with a system of elaborate calculations for predicting when Easter would occur. These calculations were all made with regard to establishing an alignment of the synodic lunar cycle of29.5306 days (which resulted in a lunar year of 354.3672 days) and the solar year of 365.241299 days! Being fortified with such elaborate mathematical calculations did not lessen the fact that the system was originally-and still is-a mere speculation of a highly clever but relative nature. Thoroughly embedded in the Julian-Gregorian calendar, the system of determining Easter is inseparable from the Gregorian calendar itself, and is one of the chief reasons for the resistance to its reform-as witnessed by a reading of the calendar reform arguments of the 1930s. The entire system of this calendar, inherited without question from the Caesars of the Roman empire, is actually nothing more than a form of self-perpetuation of a priestly hierarchy that includes in its support a host of bankers, industrialists, and scientists and the elaborate social system that is under their control-the technosphere of global civilization itself. Take away the calendar and the entire structure loses its foundation.

"If the Julian/Gregorian calendar was to be offered as a new device for measuring time, we, with our present knowledge and state ofliving, would reject it as something utterly impracticable, lacking in harmony and order, unbalanced and irregular, too clumsy a calendar to make calculations by, while the various sections are not comparable."10

A science or any scientist that unquestioningly follows the Gregorian calendar is, in reality, not worthy of the name. What is science? A concern for logic and precision of measure, we might answer, as well as standards of measure that utilize uniform units of measure in accord with what is being measured. Yes, the year is calculated as being 365.241299 days in length, but if the annual standard of measure that is used is irregular and unscientific, then it avails nothing, and indeed deforms the mind leading it down byways that may only end in self-destruction. Thus the pursuit of a true and accurate year in itself may be an illusory pursuit, blinding us to the actual nature of time, and leading us away from a genuine understanding of ourselves and our role and purpose on this Earth.

To change and replace the calendar with the thirteen moon standard is to return us to our original purpose, leading us back to pathways of harmony and natural

health. According to the Law of Time, the damage already inflicted in the time humanity last hesitated and lost the chance to alter its timing frequency, forty years ago, has been incalculable. The final opportunity to change the calendar and the timing frequency is now upon us. Because of this we must be very clear and unshakable in our understanding and determination to expose and eliminate the current civil calendar for once and for all. Even apologist David Duncan's unabashedly pro-Gregorian book *Calendar* (1999) concludes with its time line on the date 2012, "Current Mayan Great Cycle will end."11 But will we also end? By 2012, it will be too late to change. We must begin to change now.

In reviewing the quirks and twists of history that constitute the Gregorian calendar, we must ask: Why do we continue to use such an instrument, and what are its effects? Is a calendar something more than a tool for scheduling the payment of debts *(calends),* or is it an instrument of synchronization? The harmony or disharmony of time is a profound matter rooted in the instrument of time reckoning that we use. There can be little question that we live more in a time of chaos than of harmony. We may also say in regard to the effect of standards of measure on the mind, that the chaos of the time is embedded in the calendar we use. If we are to leave this time of chaos and enter a time of harmony, then we must exchange the instrument in which the chaos is embedded for an instrument that is the very model of harmony-the Thirteen Moon/28-Day count. This is the choice humankind must now make.

The issue of the nature of time, or of the times in which we are living, cannot be separated from the issue of the calendar. The very nature of the calendar that the world follows has stunted the mind and warped the body's innate timing sensibility, reducing the understanding of time to being merely a matter of chronology. "Chronology is a register or reckoning of successive years, a time scale. It may also be described as a system of registering time massively."12 Virtually all time reckoning has proceeded from astronomical indicators, the major exception being the Maya, who actuated from a solely mathematical outlook. Yet with this mathematical outlook the Maya devised a chronological method that has never been surpassed, a fact attested to by many, including the architects of the Kitt Peak Observatory in Tucson, Arizona, where a mosaic mural depicting the civilization of the Maya asserts the superiority of their calendar over that of the Europeans.

It is significant that the earlier calendar reform movement, while occasionally acknowledging the brilliance of the Maya, made no use of the Mayan knowledge. But this was because the time sensibility was restricted to thinking of time solely in terms of chronology, or at best as a schedule for keeping good accounts, with little

comprehension at all of the synchronic nature or order of time. And since the system of chronology was synonymous with the system of control embedded in the Gregorian calendar system, the earlier reform movement failed altogether to make any impact on the Vatican, much less on the global power structure itself.

All the thought, action, and good intention put into the years of calendar reform notwithstanding, the Gregorian calendar prevailed, and, tragically, not one of the proposals or recommendations was ever even considered for adoption by the papal authorities who maintain control over the calendar. In the 1930s, the propaganda of the Church was aimed at limiting any possibility of reform, for it would not give up the succession of the seven-day week. In any perpetual calendar, such as the Thirteen Moon/28-Day calendar, the observance of the Day Out of Time is necessary for maintaining the harmony of the fifty-two weeks that complete themselves in 364 days. The continuous succession of the week does not stand in a constant relation with the other elements of the calendar and is one of the main causes of confusion in the Gregorian calendar. Arguing that such a break as a Day Out of Time, no day of the week at all, would plunge the world more deeply into chaos, barbarism, and war, the Vatican effectively blocked all effort at reform. The completion of the century of total war, capped by the Inevitable Event, roundly refutes this point. It may just as easily be argued that because we did *not* change the calendar, we are now plunged into the final barbarism and unholy war.

When the Vatican II Council in 1961 affirmed in its backward and highly restrictive language that it was not opposed to reform, so long as such reform did not disrupt the seven-day week and respected the tradition of Easter as a "movable feast," the door to reform slammed shut. By this time all the early reformists had literally died out and the question of calendar reform appeared to have become one of the buried issues of history.

What the priests of the Catholic Church thought they had buried through an auto-da-fe in Izamal, Yucatan, 1562, and overcome through the imposition of the Julian-Gregorian calendar over the conquered Maya, returned with the precision of prophetic timing in 1987. The publication of *The Mayan Factor* not only opened the door to a new look at the Maya, but also to an understanding of time that was anything but chronological. A new dimension of time appeared-radial, fractal time, the synchronic order. And behind the reassessment of the nature of time was the provocative call of Mayan prophecy-the end of the thirteen baktun Long Count, 2012.

The Law of Time defines the human problem as being one of radical and destructive dissynchronization from natural time, resolvable only by a return to natural

Day Out of Time

July 25

1. Magnetic Moon

1	1	2	3	4	5	6	7
2	8	9	10	11	12	13	14
3	15	16	17	18	19	20	21
4	22	23	24	25	26	27	28

July 26 - August 22

2. Lunar Moon

5	1	2	3	4	5	6	7
6	8	9	10	11	12	13	14
7	15	16	17	18	19	20	21
8	22	23	24	25	26	27	28

August 23 - September 19

3. Electric Moon

9	1	2	3	4	5	6	7
10	8	9	10	11	12	13	14
11	15	16	17	18	19	20	21
12	22	23	24	25	26	27	28

September 20 - October 17

4. Self-Existing Moon

13	1	2	3	4	5	6	7
14	8	9	10	11	12	13	14
15	15	16	17	18	19	20	21
16	22	23	24	25	26	27	28

October 18 - November 14

5. Overtone Moon

17	1	2	3	4	5	6	7
18	8	9	10	11	12	13	14
19	15	16	17	18	19	20	21
20	22	23	24	25	26	27	28

November 15 - December 12

6. Rhythmic Moon

21	1	2	3	4	5	6	7
22	8	9	10	11	12	13	14
23	15	16	17	18	19	20	21
24	22	23	24	25	26	27	28

December 13 - January 9

7. Resonant Moon

25	1	2	3	4	5	6	7
26	8	9	10	11	12	13	14
27	15	16	17	18	19	20	21
28	22	23	24	25	26	27	28

January 10 - February 6

8. Galactic Moon

29	1	2	3	4	5	6	7
30	8	9	10	11	12	13	14
31	15	16	17	18	19	20	21
32	22	23	24	25	26	27	28

February 7 - March 6

9. Solar Moon

33	1	2	3	4	5	6	7
34	8	9	10	11	12	13	14
35	15	16	17	18	19	20	21
36	22	23	24	25	26	27	28

March 7 - April 3

10. Planetary Moon

37	1	2	3	4	5	6	7
38	8	9	10	11	12	13	14
39	15	16	17	18	19	20	21
40	22	23	24	25	26	27	28

April 4 - May 1

11. Spectral Moon

41	1	2	3	4	5	6	7
42	8	9	10	11	12	13	14
43	15	16	17	18	19	20	21
44	22	23	24	25	26	27	28

May 2 - May 29

12. Crystal Moon

45	1	2	3	4	5	6	7
46	8	9	10	11	12	13	14
47	15	16	17	18	19	20	21
48	22	23	24	25	26	27	28

May 30 - June 26

13. Cosmic Moon

49	1	2	3	4	5	6	7
50	8	9	10	11	12	13	14
51	15	16	17	18	19	20	21
52	22	23	24	25	26	27	28

June 27 - July 24

> I am in favor of a standardized calendar for the whole world, just as I am in favor of uniform coinage for all countries, and a supplementary artifical language (like Esperanto, for example) for all peoples.
>
> I have been informed of, and I welcome, the international movement for calendar reform . . . I am always ready to endorse any honest movement which will help to unify the peoples of the world.
>
> —Mahatma Gandhi

January - 31 days

February - 28/29 days

(sometimes)

March - 31 days

April - 30 days

May - 31 days

June - 30 days

July - 31 days

August - 31 days

September - 30 days

October - 31 days

November - 30 days

December - 31 days

Wavespell of the Thirteen Moons in Relation to the Irregular Gregorian Calendar

time through the perfect and perpetual harmony of the Thirteen Moon calendar. With the analysis of the Law of Time, there is an even greater urgency and a more profound certainty. Reform is not only insufficient but also impossible. If the calendar is not changed within the next decade, it will be the end of civilization as we know it. There is a genuine and legitimate need to bring the issue of calendar reform into the public eye once again.

Yes, to change the calendar involves a frequency shift. The collapse of the technosphere will dispose the human mind to rethink its options. It may even reorient the human mind to a consideration of the biosphere as being the greater vehicle in which we, as humans, are being carried. Such a massive change in attitude, a mind shift and a paradigm shift, may arouse in the human breast a spiritual reawakening as well. Harmony is spirituality. By changing the calendar, humanity can know it has turned a page of destiny-an act that may cause it to appreciate what has already been written in a book it had not been inclined to study, the Holy Quran:

> God is the One who raised the heavens without pillars that you can see, then assumed all authority. He committed the sun and the moon, each running in its orbit for a predetermined period. He controls all things, and explains the revelations that you may attain certainty about meeting your Lord. He is the One who constructed the earth and placed on it mountains and rivers. And from the different kinds of fruits, He made them into pairs-males and females. The night overtakes the day. These are solid proofs for people who think. (13:2-3)

In this passage we can find ample evidence of the formal order of the Law of Time and the biosphere-solid proofs. As for the "people who think," do they not then constitute the noosphere?

7

Humans—Noospheric Chips:

Consciousness and Reality Redefined

"And conquered by the sense of the earth and human sense, hatred and internecine st'ruggles will have disappeared in the ever-warmer radiance of Omega. Some S017:of unanimity will reign over the entire mass of the noosphere. The final convergence will take place in peace. "

-PIERRE TEILHARD DE CHARDIN,
THE PHENOMENON OF MAN!

Once begun, the exhaustion of the technosphere is irreversible. The exponential growth curves of money, machine production, energy output, and population increase come to a climax. By 2004 the humans will be at another major crossroads: to go wholeheartedly into the harmony of the noosphere, or to suffer the rest of their decline in an ignominious twilight of terrorism, barbarism, and cultural anarchy. By 2004 the humans will have their last opportunity to change their macro-organizing principle. By relinquishing the artificial time held in place by the old calendar and becoming unified in time under a calendar that is a perfect harmony, humans will enact the coming of the noosphere. Only harmony will bring harmony; only harmony will cancel the errors of history, a manifest disharmony. Only an act of harmony can manifest the noosphere. Only this time-changing act, consciously carried forward by a significantly roused number of humans, will create a mental field so positive and

constructive as to engender the radical break that leads to an entirely new cycle of existence of the life on Earth: the noosphere. Entrance into the noosphere of harmonic time through the calendar change will be much like going from a black-and-white movie to one in Technicolor. The difference between the new time and the old time is literally like the difference between Heaven and Hell.

September 11, 2001: the Twin Towers collapse, creating a rupture in the technosphere. Everything comes to a halt. The New York Stock Exchange is closed for four days-a virtually unprecedented event. All commercial airline traffic in America is halted for two days. Even the United Nations postpones the opening of its fifty-sixth General Assembly by three weeks. Six weeks after September 11 a new, sinister form of war is engulfing the technosphere. The Americans assert the right to mercilessly bomb Mghanistan in self-defense. The response of war is the final self-destructive impulse of the techno sphere to protect itself, but this will only widen the effects of the suicidal blow it has already sustained. The war will only make definite that it is the last climax of the biogeochemical combustion engendered by the pursuit of an error in time.

The rupture in the technosphere is the break in artificial time, and therefore amounts to the opening of a noospheric fissure-an inrush of cosmic consciousness and a moment of simultaneously heightened natural time. When the towers collapsed, belief systems shattered. Because it was viewed on global television, it was an event witnessed by all humanity and it entered through the optical cortex into the brain, arousing potent images from the subconscious. This is a noospheric act because it is the entire mind of the whole species that receives this single image in one simultaneous moment. In that shattering image, however unconscious, the noosphere immediately entered the field of human consciousness, much as a leak in a boat allows water to come rushing in. From the perspective of the noosphere, the technosphere is a medium of transformation resulting from the pursuit of a distorted perception of time. With the destruction of the Twin Towers, the transformation is complete; following the war, the technosphere can be creatively dismantled.

THE NOOSPHERE: RAINBOW BRAIN OF TIMESHIP EARTH

What is the noosphere? Can we define the noosphere more precisely so that it is a less nebulous term? Can we make the noosphere concrete enough so that it may be understood and accepted as the coming new way of a higher level of everyday normalcy? First of all, let us say that the noosphere has existed as long as life has existed on this Earth. In this sense, the noosphere is the sum of the mental interactions of all life. The mental interactions, or field of mind, exist as a great unconscious medium,

inseparable from the Law of Time. That is, if all life and the phenomenal world of the biospheric medium are synchronized by the Law of Time, then the programs of the organization oflife, from the periodic tables to the DNA code, will also be synchronized by and embedded in the mathematics of the Law of Time. Being a function of the whole system of the Earth and integral to the functioning of the biosphere as an interplay of cycles in which organic and inorganic interact with a set order of chemical transmutations, the noosphere must also be the mental coordinating field or program of this complex of vital interactions. It must, therefore, be a characteristic of biospheric evolution that the noosphere remains unconscious until a significant moment is reached-the climax of the cycle of biogeochemical combustion, the enactment of the biosphere-noosphere transition.

As the Earth's mental field, it must be an act of collective self-reflection that arouses the noosphere into functioning consciousness. By its definition as the mental envelope of the Earth, the noosphere can come into conscious manifestation only through an act of collective self-reflection, such as the proposed calendar change. Also, as the mental envelope of the Earth that is above and discontinuous with the biosphere, the noosphere-mind sphere--can mean only one thing: the advent of universal telepathy among the humans. The Internet can be seen as a third-dimensional reflection of the noosphere, a form of electronic proto-telepathy. But, ironically, as long as the humans hold on to the Internet, they cannot experience the true evolutionary potential of genuine universal telepathy. The point is that telepathy can only function in a field of reality that is synchronized by the natural 13:20 timing frequency. Time and telepathy are mutually defining factors dependent on unity of thought. The humans have chosen a path of disunity, so that their calendar programs clash and are at odds with each other and with natural time. This maintains the technosphere, destroys the biosphere, and keeps the noosphere in the unconscious. But now, with the Inevitable Event, the break has occurred and the shattering of the Dreamspell of History has begun. The noosphere's rainbow brain leaks back into human consciousness.

The rainbow brain of the noosphere-what is that? As the mental envelope of the Earth, the noosphere possesses a structure ordained by the Law of Time and congruent with the structure of the whole Earth. Within the noosphere are to be found the evolutionary control panel or programs, defined as the *psi bank-the* medium of information storage and retrieval for all the mental programs. The noosphere is the field of planetary consciousness in which humans are intended to participate and complete their evolution. However, operating by artificial time is like looking through a glass darkly. This being so, there is no noosphere to see. Humans generally experience consciousness through the chinks in their sensory prism, conditioned

by separatist beliefs, making it most difficult to attain a perception or experience the field of consciousness as coextensive with the Earth. Indeed, if the biosphere is the region on Earth for the transformation of cosmic energies, the noosphere is that region of the Earth for the reflection of cosmic consciousness and its mental programs. Seen through the lens of universal synchronized time, the humans accommodating to a single instrument of time measurement are inherently sharing a single thought form. It is that act of self-reflective convergence that makes the noosphere conscious and draws it toward the resplendent omega point of2012 and beyond.

As with all the other geochemical structures and processes of the Earth that are planetary in nature, the noosphere, the rainbow brain of Earth, actually has a coherence and an order that we may define in a precise way. In so doing we shall redefine the nature of human reality and the human being itself. We must enlarge our lens of perception to encompass the whole Earth as a single being. In relation to this single being of the Earth, the individual human is hardly even a speck. The dimensions and proportions by which we commonly measure reality must also expand to accommodate the vast dimensions of the Earth as a single entity, a planetary geocosm within the solar field, the heliosphere. Since the sun is also a star, the heliosphere is a function and member of the galactic order of being. As the mental "thinking sphere" of this planetary being, Earth, the noosphere is above and discontinuous with the biosphere, the hydrosphere, and the atmosphere. It is contained by and functions within the vast invisible electromagnetic field of the Earth. Though the ionosphere is the lowest level of the electromagnetic field system of the Earth, the main structures of this field are the two radiation belts located 2,000 and 11,000 miles above the Earth. It is within the two radiation belts that the control panels of the noosphere are to be found-the psi bank.

KIN: BIPOLAR BASE MEASURE OF THE 13:20 MATRIX

"And He is the One who created the night and the day, and the sun and the moon; each floating in its own orbit."

-QuRAN,21:33

In the simplest aspect of our daily experience of time on Earth we have the full play of the law of alternation-day-night, sun-moon, north-south. Because we know the bipolar nature of the Earth, dividing it into two geomagnetic fields, north polar and south polar, we can then define the complementary bipolar field of time, which divides the cycle of the Earth as it makes one rotation on its axis into one day and night. This

entire unit, day and night, is defined as a *kin*, the base unit of synchronic time measurement. From the perspective of the noosphere, day and night are a function of the two alternators-day alternator and night alternator-that operate as the phasic motion of the rainbow brain of the noosphere working in tandem with the electromagnetic field. The two phasic alternators regulate the activation of photons (day) and the regeneration of photons (night) within the entirety of the life process of the biosphere.

THE NOOSPHERIC FOURFOLD/EIGHT-PART STRUCTURE

"He created the heavens and the earth truthfully. He rolls the night over the day and the day over the night. He committed the sun and the moon, each running for a finite period. Absolutely he is the Almighty, the Forgiving."

-QURAN, 39:5

"We rendered the night and the day two signs. We made the night dark and the day lighted, that you may seek provisions from your Lord therein. This also establishes for you a timing system, and the means of calculation. We thus explain everything in detail. "

-17:12

Since the two alternators are also in interplay with the bipolar magnetic fields of the Earth, a four-part process is revealed that is magnetically distributed as an overall eight-part structure. The unit of one kin divides the rotational cycle of the Earth in its orbit into four distinct phases daily and annually. The four daily points are defined by: the dawn, when the part of Earth you are in first experiences the solar photonic activation; the high noon (zenith), when the part of Earth you are in is in closest direct relation to the sun; the twilight, when the photonic activation ceases and the sun disappears from view; and midnight (nadir), the point at which the point of Earth you are on has rotated to its farthest distance from the sun, the height of the cycle of photonic regeneration. This daily process is mimicked in the four points of equinox and solstice, where for either hemisphere the equinoxes are the same as the points of dawn and twilight and the solstices correspond either to high noon or to midnight. Because of the magnetic polarity of the Earth, the four-part process is

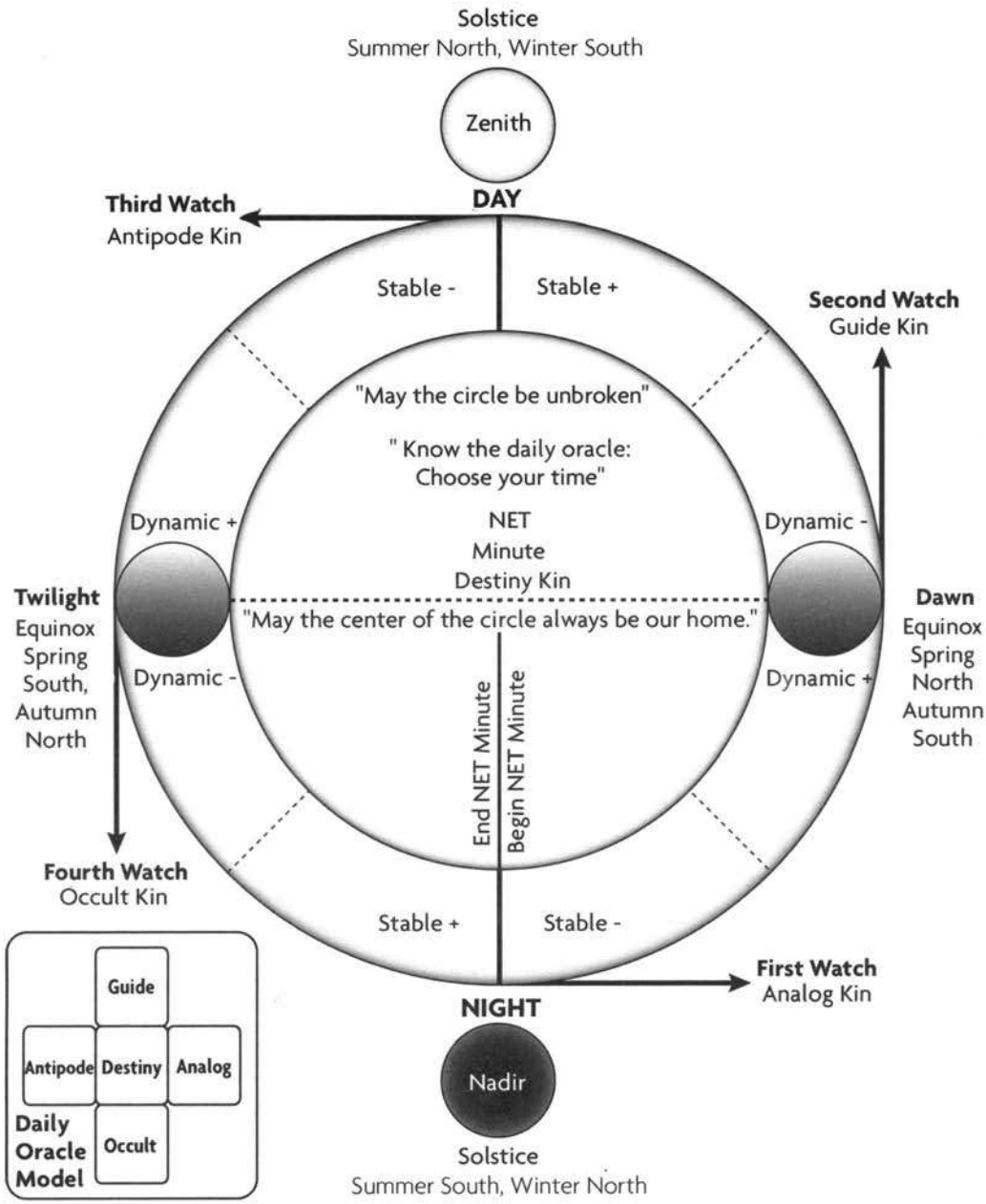

Four-Part Bipolar Kin:
Four daily watches,
Four annual seasons—
Two points of balance
Two points of return

Net Minute Model

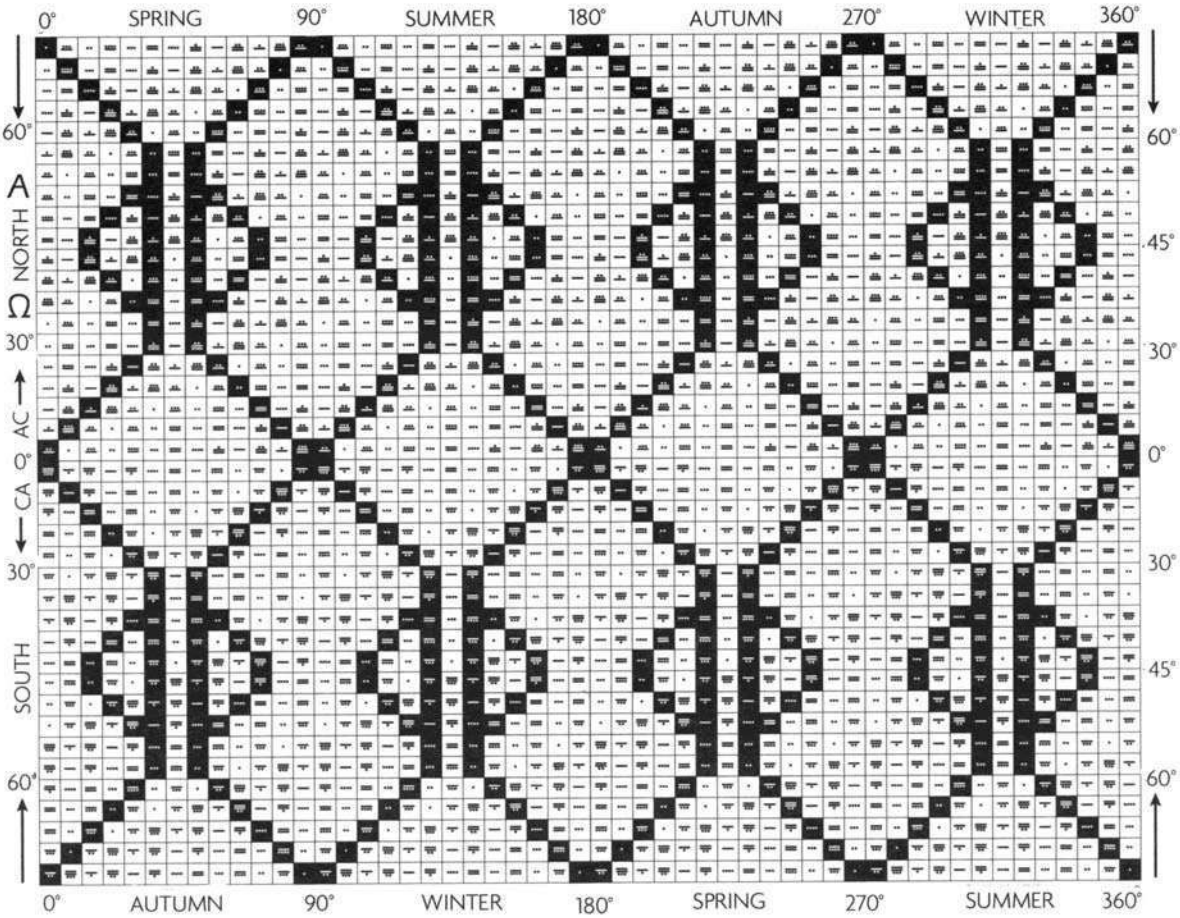

Psi Bank—Four Bipolar Plates Accommodating NET Time Autoregulatory System of the Noosphere
(from *Earth Ascending*, Map 1)

simultaneously experienced in opposite phases, that is, winter in the North is summer in the South-hence the four-phased process yields a bipolar eight-fold structure.

This four-part day-night seasonal process defines the structure of the four psi bank plates, which also coordinate the four-year cycles of the Earth. The psi bank plates, the "nervous system" and control panel of the noosphere, are a complete function of the 13:20 timing frequency and thus participate in the systematic regularity of the fourth-dimensional synchronic order. This means that the psi bank is the registration within the Earth's magnetic field of the 13:20 timing matrix by which all life and the planetary evolutionary process as a whole are regulated. Simulating the four-part process of the Earth rotating on its axis in time, four stages per day, four seasons per year, in four-year cycles-not to mention the four phases of the moon-four psi bank plates accommodating the bipolar field yield eight 260-unit 13:20 frequency information matrices.

That is, each of the four psi bank plates conforms to a mirror symmetry of the bipolarity of the Earth's magnetic field. Each plate is divided by mirror symmetry into a 260-unit Northern and a 260-unit Southern hemispheric half, for a total of two bipolar matrices and 520 units per plate, or 2,080 (520 x 4) units in all. These units are referred to as *psi chrono units* or *time-bearing information units.* The information for the different sequences of the Earth's biogeochemical evolutionary processes is all regulated by these time-bearing information units.

We have to understand that through the medium of universal cosmic time the Earth, the Sun, and every star, constellation, and galaxy is coordinated in this way by the synchronic 13:20 frequency of time. It is the 13:20 frequency that establishes holonomic consistency in time throughout the universe. The Earth's noosphere is a lens of time. All cosmic information is focused through this lens. It is this noospheric lens of time that makes Earth into a geocosmic thought form.

The noospheric lens of time and mind has been operating ceaselessly-but unconsciously-since the beginning of the evolution of the Earth. Since the noosphere is a function of the universal synchronic timing frequency, its conscious activation must also come about through a superior mental coordination with this correct synchronizing timing frequency. The psi bank 13:20 frequency is consciously activated and registered at the human level by the mental engagement of the 13:20 matrix as enacted through the 260-day cycle. The interaction of the 260-day galactic cycle with the 365-day solar biotelepathic cycle defines one noospheric year, or one solar-galactic cycle of fifty-two human years (= fifty-two 365-day solar orbits = seventy-three 260-day galactic cycles). This great noospheric coordination of fifty-two solar orbits with seventy-three galactic cycles is fractally present in a single solar orbit, where fifty-two 7-day weeks = seventy-three 5-day cycles known as chromatics. What is important in coming to understand the noosphere as Earth's geocosmic time lens and rainbow brain, is that we must change our perspective altogether from anthropocentric to noospherocentric, and in this way evolve into *Homo noosphericus.*

THE CYCLES OF NET TIME

For the noosphere, the rainbow brain of planet Earth, time is different-it is slower and longer. From the noosphere's point of view, what we call a year is a solar orbit. What we call a day is a single rotation of the Earth on its axis. The cycles of the moon are the lunar phasings that calibrate the synchronization of the Earth in time. The Earth is not a spaceship. The Earth is a Timeship. As a Timeship, the Earth is a function of the master synchronization frequency that coordinates and moves it in

time through ever greater circles of inclusiveness and syntropic integration. Seen through the noospheric lens of time, the technosphere is a highly exaggerated acceleration of the biogeochemical continuum through highly artificial and resource-depleting means-it is but a smoking bubble whose fragile struts and frets are laced together by transport and communication systems that yield a cacophony rather than a harmony. And for this reason, the disharmony of the bubble ultimately explodes upon itself, releasing Earth from the prison of false time into the fresh air of real time and the advance into the geocosmic splendor of the noosphere. Synchronized with the galactic cycles, the noospheric mind of the whole Earth is reckoned far differently from the artificial units of measure that condition the anthropocentric notions of time evolved in the era of *Homo historicus.*

Here is how the fourfold process of Earth in time is reckoned by the noosphere. Please note that in Noospheric Earth Time (NET), time is universal synchronization. At any given moment, it is always the same noospheric moment in time on

Table of Noospheric Earth Time Units

1. One Noospheric Earth minute = 1 day-and-night rotation of Earth on its axis = 1 kin.
2. Twenty-eight Noospheric Earth minutes = 1 Noospheric Earth hour = one moon of 28 kin. where every 7-day week = 1/4 Noospheric Earth hour = 7 kin.
3. Thirteen Noospheric Earth hours (moons) = 1 Noospheric Earth day = 365 kin (days) = 1 solar orbit. or 1 human year (= 13 NET hours x 28 minutes + 1 NET minute, "Day Out of Time:')
4. Four Noospheric Earth days = 1 Noospheric Earth week = 4 solar orbits (years) = 1,460 kin (days).
5. Three Noospheric Earth weeks plus 1 Noospheric Earth day = 1 Noospheric Earth season = 13 solar orbits or 13 human years.
6. Four Noospheric Earth seasons = 1 Noospheric Earth year = 52 solar orbits (52 human years) = 73 260-day galactic cycles = 18,980 kin (days).
7. Five Noospheric Earth years = 1 Noospheric time chord = 260 solar orbits.
8. Twenty Noospheric time chords = Vs Noospheric evolutionary subcycle = 5,200 solar orbits = 1 Noospheric Century of 100 Noospheric Earth years.
9. Five Noospheric evolutionary subcycles = 1 galactic evolutionary day = 26,000 solar orbits = 5 Noospheric Earth centuries or 500 Noospheric Earth years of 52 solar orbits each.

Earth. Whether that moment is experienced on the night or day side of the Earth, that moment is simultaneous and encompasses both sides of the Earth at once. This is true not only because time is the factor of synchronization- T(E) = Art, where art is the result of any synchronization-but also because the velocity of time is infinitely instantaneous. By thinking that the Earth really does conform to the 24 hours of the clock, the humans have retarded their time sensibility, and consequently their artificial processes have become increasingly artless. In considering the N oospheric Time measurements, remember that as a human you are but a cell in the biospheric organism-or, as we shall see, a chip of the noospheric rainbow brain.

As the measure of the mind of the Earth, the N oospheric Earth Time (NET) reckoning units coordinate consciousness as a planetary, or, more accurately, a solar-planetary phenomenon. For instance, if one NET day is a single 365-day solar orbit of the Earth, dawn of the noospheric Earth day is experienced as the spring equinox, but the noosphere is bipolar. So the dawn is also simultaneously the autumn equinox or twilight of the other polar magnetic half of the Earth. To fully engage and grasp such a thought is to expand the limits of consciousness. Like dolphins who never sleep but only rest half of their brain at a time, so it is with the rainbow brain of the noosphere. Such consciousness has nothing to do with the workings of the everyday egoistic human consciousness, which can understand things only according to a limited frame of reference defined by its own limited and highly conditioned ego needs. The geocosmic consciousness of the noosphere can be apprehended only as a single telepathic unity in and by which all members of any given species or organism are organized. To consider that the noosphere itself could become the organizing principle of the human species as a whole is to engage in conscious mental evolution.

Small aboriginal prehistoric bands of humans experience an unconscious level of this geocosmic noospheric mind. Dolphins, other mammals, and all animal species experience this noospheric mind. Even trees and crystals are organized by this noospheric mind of time.

Homo historicus, however, slowly but inexorably cut himself off from the noospheric mind of time by substituting erroneous instruments of measure, or instruments of measure that were incomplete in relation to the noospheric time cycles. The result was the exponential surge in biogeochemical combustion that characterized the final baktun cycle, culminating in the fifty-six-year blister of artificial time, the technosphere. The fact that the time blister popped eleven years before the end of the cycle of *Homo historicus,* 2012, means that *Homo noosphericus* is ready to emerge from the shattered cocoon of false time. Liberated from artificial time and from the technosphere itself, and enrolled in the natural time of telepathy, the human will experience

Noosphere Earth's Rainbow Brain

Magnetic Alternation - Night and Day Law Of The Ring

"The Psi Bank in Perfect Motion"

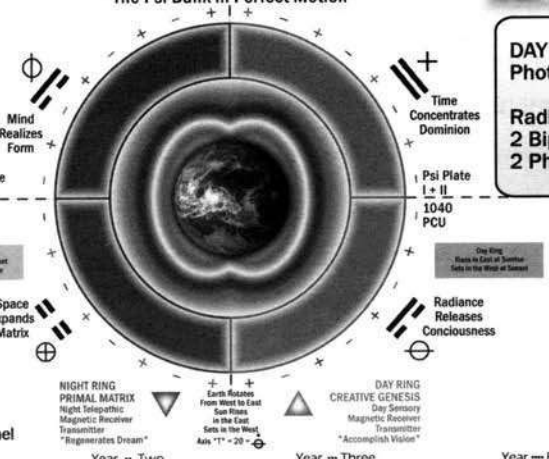

T(E)=ART

DAY ALTERNATOR
Photonic Activator

Radiation Belt x 2 = 2 Bipolar PSI Plates - 2 Phases

NIGHT ALTERNATOR
Photonic Regenerator

Radiation Belt x 2 = 2 Bipolar Psi Plates = 2 Phases

2 Phases + Polarity =
4 Bipolar Psi Plates @ 13:20 =
Nervous System + Noospheric Control Panel

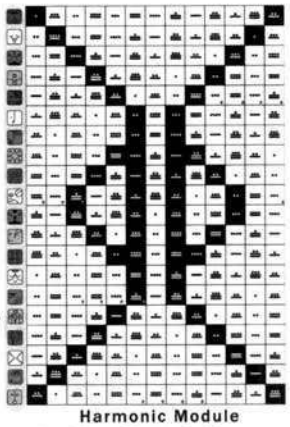

20 Solar Frequencies

Harmonic Module

13:20 Matrix Programs Four Phase Bipolar Psi Plates

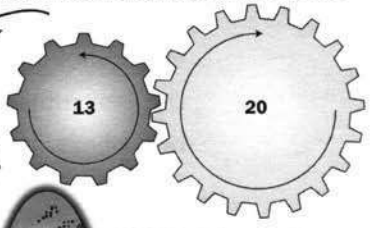

13:20. Ratio Constant of Universal Synchronization

Synchronic Map and Guide to the **Noosphere**

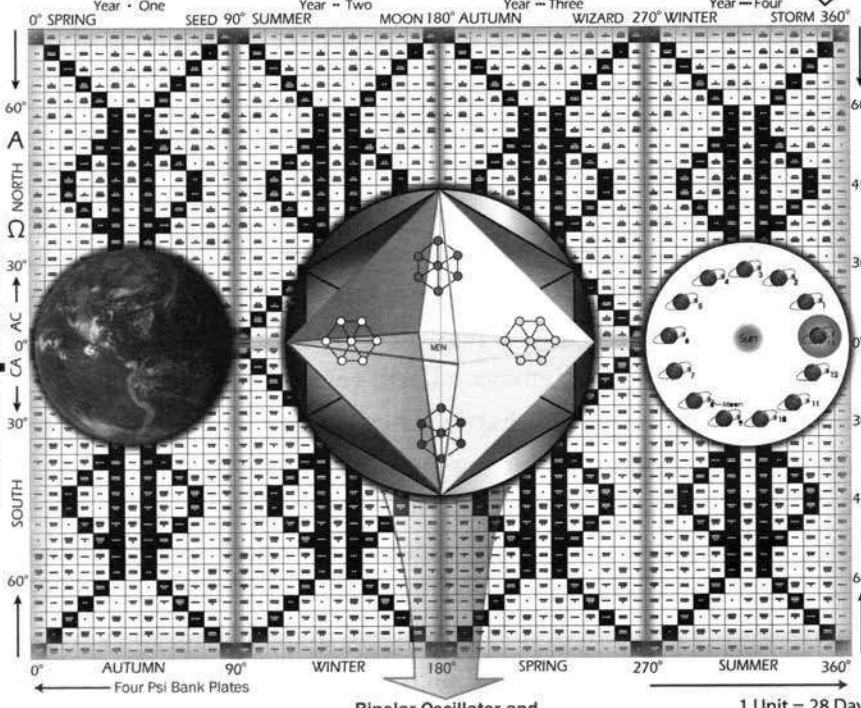

Earth Wizard.
"Homo Noosphericus"

13 Moon 28 Day + 1 Noospheric Regulator = 1 Noospheric Earth Day

Noospheric Earth Time (N.E.T.) Units

1 Day = 1 NET Minute
28 Days = 1 NET Hour = 1 Moon

13 Moon NET Hours = 1 NET Day = 1 Solar Orbit

4 Solar Orbits = 1 NET Week

3 NET Weeks + 1 NET Day = 1 NET Season = 13 Solar Orbits

4 NET Seasons = 52 Solar Orbits = 1 Noospheric Earth Time Year

Four Phasic Noospheric Resonator
Timeship Earth Field
- Day Night Alternator - 4 phases
  Twilight Noon Dawn Midnight
- 1 Moon-NET-Hour = 4 weeks ¼ Hours
- Solar Orbit = 4 Seasons = 4 Phases NET Day
  [Electric, Solar Equinoxes; Rhythmic, Crystal Solstices]
- 4 Solar Orbits = 1 NET Week = 1 Seed Storm Year Bundle = Return of 4 Psi Plates, 1 per Year.

Bipolar Oscillator and Crystal Transducer Earth Core
Activated by 1 Time Atom per ¼ Hour (7 Days) x 4 = 4 per Hour, 28 Days = 1 Moon-NET-Hour

Planet Holon - 20 Day Cycle

Timeship Earth 2013
Coded by 20 Solar Frequencies in Time

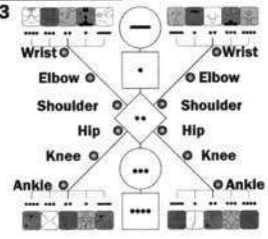

1 Unit = 28 Days or 1 Moon

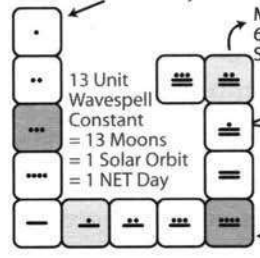

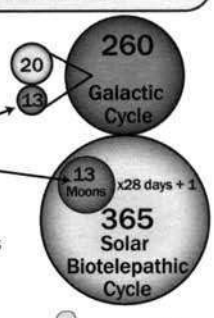

13:20 Noospheric Chip
"Homo Noosphericus"
20 Fingers + Toes
4 Limbs
13 Main Articulations
Consciously synchronized in 13:20 time. Plays Psi Bank Control Panel, generates Earth's Rainbow Brain

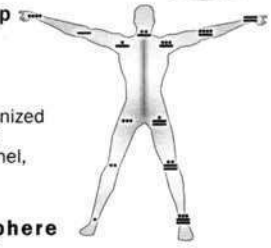

Man in the Noosphere

noospheric organization into psychic biomes. Through the psychic biomes-collectives of communities coordinating their bioregional network according to the structure of the "thought moments" of noospheric time-the human will fully evolve the Earth as a planet with solar-galactic consciousness.

ELECTROMAGNETIC WORKINGS OF THE EARTH'S RAINBOW BRAIN

What we call the cycles of time are the thought moments of the Earth. These thought moments coordinate the complex orders of Timeship Earth, understood as a whole system. Because the operating mechanism of the noosphere that governs the Earth's cyclic thought moments is inseparable from the general structure and functions of the electromagnetic field in which it is located, we may refer to a *rainbow brain* of the noosphere. Why is this so?

Let us return to the structure of the noosphere, Earth's mind in time. Consisting of the four bipolar psi bank plates, these four synchronic time plates are located between the two radiation belts, that is to say between 11,000 and 2,000 miles above the biospheric surface of the Earth. With the location of its information time-bearing mechanism between the radiation belts, the noosphere must by necessity operate in tandem with the electromagnetic field as it is regulated by these two master radiation belts. What do these belts do? They emanate Earth's electromagnetic aura, and function as a protective shield around the Earth. They do this by trapping solar-cosmic radiation, keeping much of it from hitting the biosphere directly, channeling it instead through the Earth's magnetic poles into the Earth's core.

In the polar regions excess cosmic radiation, including electrically charged plasmas and solar discharges from coronal mass ejections, is released into the atmosphere as the auroras-aurora borealis (or northern lights) in the North, and aurora australis (or southern lights) in the South. The increased solar activity during the most recent and current sunspot cycles has enhanced and extended the auroral activity in recent years far beyond the polar zones. In addition, since 1987 great influxes of plasma into the solar system have intensified the incidence of spectral plasmic activity within the atmosphere itself. This amounts to an increase in rainbows, halos around the sun, and brilliantly colored clouds. While these phenomena may be explained to a certain degree as meteorological effects (the angle of the sun's rays, moisture in the atmosphere, and so on), is there more to a rainbow than meteorological side effects? And what relation is there between the noosphere, the electromagnetic field, and the increased plasmic-rainbow activity?

Again, seen from the perspective of whole Earth, the rainbows and spectral plas-

mic effects, including the auroras, are the free energy released by the noosphere. Rainbows are to the noosphere what toxic waste is to the technosphere. The noosphere itself implies a mental field that is interacting with the electromagnetic field. The Earth's electromagnetic field is actually the strongest of all the planets in the solar system. The only other planet that has a field approaching the strength of the Earth's field is Uranus. If the Earth's electromagnetic field is the strongest, is this an indication of the strength of the noosphere as well? If the rainbows, auroras, and other spectral plasmic activity are a demonstration of the free energy released due to the interaction of the noosphere and electromagnetic fields, and the noosphere is the mental envelope of the planet, inclusive of the as-yet-to-be-unified mind of the human species, what forms of free energy might be released if the human mental field were operating as a single unity in the correct timing frequency?

One other mechanism crucial to the entire system of noosphere and electromagnetic fields is the crystal core at the center of the Earth. In the 1970s Russian scientists put forth the idea that the Earth is crystalline in nature, an idea that extended Plato's notion of the Earth as a dodecahedron, one of the five "platonic solids." The idea was that the Earth's surface was held together by a field of resonance that corresponds to the crystal resonance of certain geometrical solids. R. Buckminster Fuller also gave play to this notion in his description of "spaceship earth." Then in the 1980s American seismologists confirmed that the core of the Earth is actually a gigantic iron crystal structure in the shape of an octahedron, elongated at its ends, which point to the North and South Poles.

From the point of view of fourth-dimensional time, the planet Earth is another manifestation of space as an infinitely locatable point, an orbiting body upon which all the vectoral programs of cosmic time may be unfolded. Understood as a Timeship, the Earth's structure is constructed to facilitate its travel in time on a particular route in space in conformity with its relation to the local star, the sun, to the other planets of the solar system or heliosphere, and in synchronization with the universal timing constant 13:20, which maintains the Earth in the synchronic order. The role of the magnetic octahedral crystal core is to function as the bipolar oscillator and crystal transducer whose purpose is to maintain the Earth in the synchronic order of the 13:20 timing frequency. Thus, if the Earth's noosphere contains the 13:20 timing programs of the psi bank, and the crystal bipolar oscillator is meant to maintain the Earth's space body in the synchronic order, obviously there is a resonant relation between the crystal core and the noospheric-electromagnetic field programs.

The transductive properties of the crystal allow it to transform energy from one state to another. The crystal core also stores electronic plasmas that travel to it from the

Earth's poles through an electromagnetic flux tube system. Within the crystalline core, the electronic plasmas are transduced into information. This is the information of time understood as cosmically transmitted thought forms. These plasmic thought forms conform to programs already established in the psi bank of the noosphere. These are the Earth's thought forms, the cycles of the Earth's brain waves, as it were, that allow it to maintain its biospheric programs and to evolve its mental field, the noosphere. The very descriptions of the Noospheric Earth Time (NET), and of time itself as a synchronous instantaneity inseparabJe from telepathy, are examples of the Earth's thought forms transduced through a human biocomputer and then transmitted into a form of human language for the purpose of communication. Keeping this description of the noospheric brain in mind, let us return to our analysis of the biosphere-noosphere transition.

MAKING THE NOOSPHERIC LEAP: TRANSFORMATION OF HUMANS INTO NOOSPHERIC CHIPS

The transition to the noosphere is experienced by Earth as a crisis because its systems are stressed. Since the Earth functions as a whole system, stress on one component of the system actually stresses the whole order. Let us review the cumulative stress points. Human 12:60 electromagnetic activity has perturbed and distorted the electromagnetic field. The release of free energy due to geochemical combustion adds to this stressful distortion through the depletion of ozone in the ionosphere and global warming. The radioactivity released into the atmosphere adversely affects the resonant field of the DNA, already driven by the 12:60 frequency to accelerate the multiplication and propagation of the human biomass throughout the biosphere. Through its artificial means, the machine, the human further upsets the inherent balance maintained by the pressure that the species exert upon each other, resulting in mass species extinction.

Yet all this is according to an evolutionary program that is intended to bring about an ultimate crisis by which the biosphere snaps into becoming the noosphere. Clearly, if the root of this crisis is the deviation of the dominant species operating according to an artificial timing mechanism at odds with the universal timing frequency, then the stabilization of the transition to the noosphere will come about through the dominant species consciously "returning" to the correct timing frequency. This it can only do by adhering to a macro-organizing program that puts the human species completely in the 13:20 frequency.

If the whole system analysis seeks to locate the flaw in the operation of Times hip Earth, then we must finally declare that this flaw is the human civilization in its entirety, as it is maintained by erroneous and artificial timing constructs. Since the

noosphere, the mind of time on Earth, defines the next evolutionary cycle, and because the humans are following a course dictated by being in the wrong time, calendar reform is the eye of the needle through which humanity must pass in order to get to the noosphere. Only by fully manifesting the noosphere will the Timeship Earth be truly put back on course once again. The noosphere is the program of time on Earth. Time is all that the noosphere has to give us. In consideration that the artificial time of the technosphere has fundamentally run out, the noospheric time should be a welcome gift.

Science is always absolutely precise. It is not just calendar reform that is the eye of the needle through which to pass into the noosphere-it is the Thirteen Moon/28-Day calendar calibrated by the 260-day Wizard's Count, synchronized to the Gregorian calendar date, July 26, that provides the exact ticket of admission into the noosphere. And then this ticket must be used at just the right moment-when the show is ready to begin. To use another metaphor, there is a lock on the door to the noosphere, and there is only one key that will fit and unlock this noospheric gate. That key is the Thirteen Moon/28-Day calendar, correlated to July 26 on the Gregorian calendar. It is the precisely applied use of this Thirteen Moon/28-Day calendar that will make each human a noospheric chip of the rainbow brain. This is because the Thirteen Moon/28-Day calendar is the key with the precise design for not only opening but also for continuing to operate the noosphere through a matching of the everyday frequency of time with the frequency of the noospheric control panel, the psi bank.

It is because the daily program of the Thirteen Moon/28-Day calendar is embedded in the 13:20 frequency that the consciousness of the humans will finally change and rise above the stunted level by which it is currently maintained in the artificial world of the technosphere. Time is of the mind, and the natural time registered by the Thirteen Moon/2 8- Day calendar is the opening to the geocosmic mind of the universe, which adherence to artificial time has kept the human from experiencing. The noosphere is the fractal lens of this geocosmic mind on Earth. Since the geocosmic mind is purely a function of the Law of Time-energy factored by time equals art, where the 13:20 synchronizing ratio of time is characterized by infinitely instantaneous velocity-then the fundamental nature of this mind is telepathy.

The Thirteen Moon/28-Day calendar is, therefore, the perfectly designed instrument to make the noospheric leap into telepathy, the planetization of consciousness that establishes the daily reality of the noospheric mind. Since the noospheric mind interacts with the electromagnetic field, and because the ratios and cycles of the Thirteen Moon/28-Day calendar conform to the fractals and ratios of the NET, by using this calendar the human becomes transformed into a noospheric chip. The

fractals and ratios of NET become the normative operating cycles of the human in its daily reality. This accounts for an increasing noospheric synchronization that allows the noospheric chip to attain its purpose: generating the Earth's rainbow aura. If the free energy of rainbows is to the noosphere what the free energy of toxic waste is to the technosphere, then the generation of the rainbow implies a type of activity on the part of the human to produce such free energy. To understand what this activity might be and how it works, we must first understand the morphic and holonomic relation between the human noospheric *chip-Homo noosphericus-and* the structure of the noosphere itself as it is programmed into the geocosmic measure of the Thirteen Moon/28-Day calendar.

HUMAN BEINGS AS FRACTAL REFLECTORS OF THE 13:20 MATRIX

From the noospheric perspective, the prototype human is an embodiment of the 13:20 synchronization factor. The human has four limbs. Each of the four extremities has five digits, for a total of twenty fingers and toes that distinguish the human's operational capacity. The four limbs conform to the fourfold phasic operation ofNoospheric Earth Time, while the twenty digits conform to the 20 (4 x 5) factor of the 13:20 ratio. The human also has thirteen main joints or articulations: two ankles, two knees, two hips, two wrists, two elbows, and two shoulders; these six pairs coordinate the four extremities with the body, while the thirteenth articulation, the neck and spinal column, coordinates the body proper. These thirteen main articulations plus the twenty digits of the hand and feet conspire to make the human the perfect exemplar of 13:20 timing frequency, that is, a perfect model of synchronization itself.

Add to this the fact that the human has a highly evolved and refined brain and nervous system that is maintained and expressed by the skeletal structure of the thirteen joints of the body and limbs, completed by the sensitive mechanism of the twenty digits, and we see that the human is the perfect biocomputer for processing the information of the instantaneously telepathic geocosmic mind. The means to process the geocosmic information, and also the means by which the human is transformed into the noospheric chip, is found in matching its factors of daily synchronization and intelligence with those of the psi bank, the noospheric control panel. This is called harmonic arrangement of the synchronic order.

Of course, this description of generalized structure, activity, and interaction of the *Homo noosphericus* with the noosphere as such presupposes an entire reorientation of the goals and methods of being human. Such a reorientation of the human is also a function of making the radical change from the erroneous measure of the twelve-

month Gregorian calendar, in which are embedded all of the Babylonian programs of history, to the perfect history-less harmony of the Thirteen Moon/28-Day calendar- the mere change of calendars encompasses a mental frequency shift. The readiness to make this change depends on the degree of moral revulsion the human experiences during the collapse of the technosphere. This moral revulsion would then correspond to a turning in the deepest seat of consciousness, which would then dispose the human intelligence to a consideration of the untried solution-change the calendar!

The Thirteen Moon calendar is the NET instrument for daily synchronization and unification of the human species as a single organism in time. Once adopted to the correct measure of this instrument, the human will de facto trigger the noosphere as an operating system of absolutely higher consciousness and mental order. **In** fact, the purpose of human evolution is precisely to become the ignition of the noosphere,

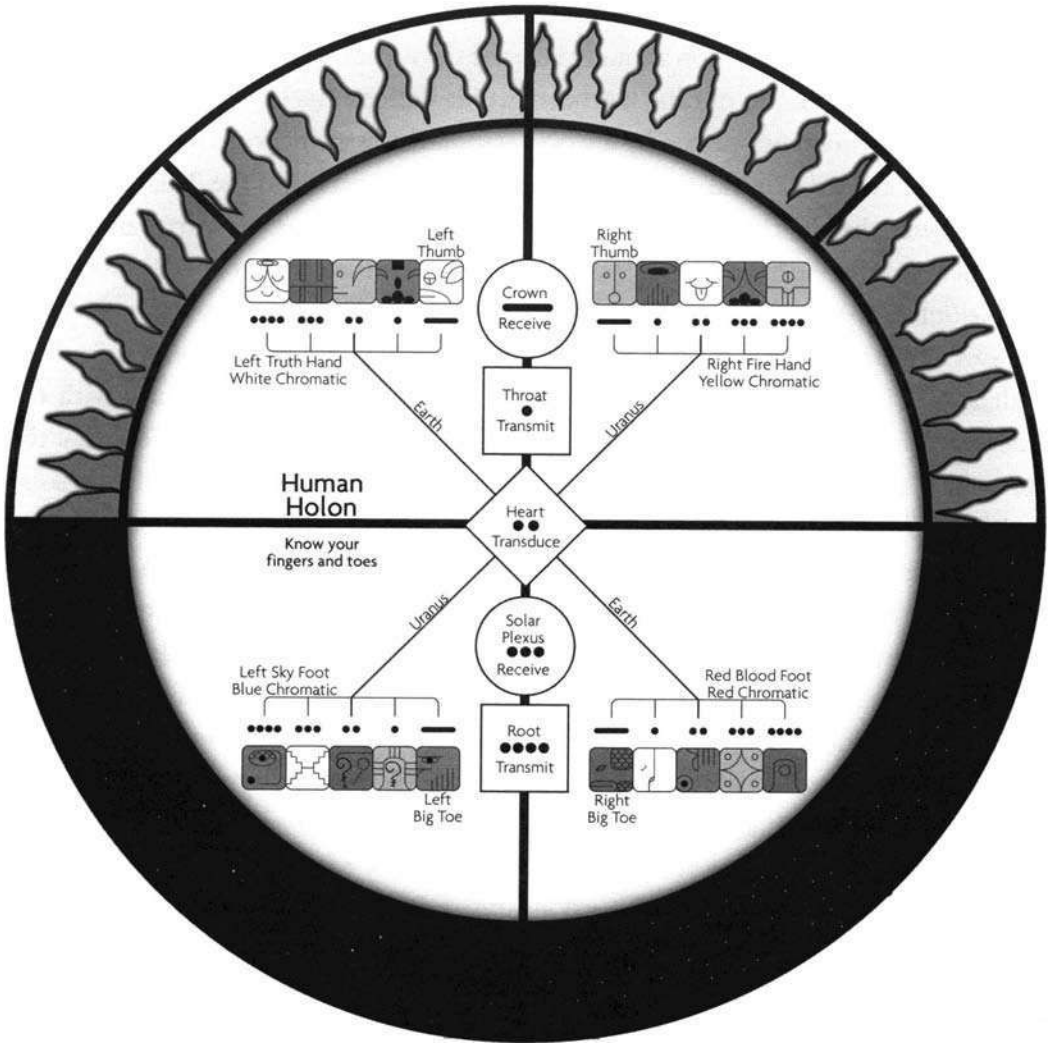

Human Noospheric Chip

and thence to become normalized as the noospheric chips that maintain the operations of the noosphere. As a truly planetized being and consciousness, *Homo noosphericus* will engage in an order and type of reflective activity undreamed of in the technospheric era that is now passing.

First, by adapting to the daily NET timing instrument, the humans will be utilizing a "calendar" that correlates both a 365-day solar biotelepathic cycle and a 260-day galactic synchronization cycle. When the lunar phases are added to the interaction of these two cycles, then the human is able to enjoy the harmonic richness of time-the noosphere. The synchronizing and interactive measures of the counts of the solar and galactic cycles yield multiple levels of harmonic orders of time (Earth's "thought moments") that will activate aspects and levels of consciousness hitherto dormant in the human mind. The very mental act of replacing the order of twelve by the order of thirteen is a profound one. How is this so? Could it be that the whole of civilized history itself is based on the fear of the number *thirteen-triskaidekaphobia,* epitomized in the superstition about Friday the thirteenth-and that, therefore, dealing with the true nature of time has been avoided altogether?2

Currently humans operate by a world standard whose measure includes: seven-day weeks, inclusive of the notions of the 5-day work week and the 2-day weekend; an irregular distribution of twelve months of either thirty-one, thirty, or, in one instance, twenty-eight days; all set within a longer annual cycle that concludes with its visionless moment of New Year's Eve. Many Gregorian calendars will include the phases of the moon, but because the months differ in length there is no way in these calendars of seeing how the phases of the moon might be synchronized with the measure of Earth's orbit around the sun, nor is there any reason to consider that the uneven measure of twelve months has anything intrinsically to do with the solar orbit. Within the twelve-month structure of the Gregorian calendar, weeks, months, and phases of the moon all appear to be haphazard and arbitrary. Such a disorderly order can only bode an undercurrent of uncertainty and fear for the human mind.

By contrast, in the measure of the thirteen moons of twenty-eight days each, the 13 corresponds both to a 13-day cycle and to the cycle of the number of months (moons) per year. The measure of the 7-day week (a NET quarter hour) becomes an orderly harmonic: four perfect weeks occurring each moon, fifty-two perfect weeks each year, each week always beginning and ending on the same day of the week, week after week, year after year, while in fact every day of every moon occurs on the same day of the week, year after year. The effect of such a harmonic regularity on the human mind is incalculable. This is what is meant by a *perpetual calendar.* And to maintain this perfect regularity, the 365th day of every year (solar orbit), is no day of

the week at all, but a Day Out of Time, a day for the human to be refreshed in utter timelessness.

Realizing that a day is actually a kin or one NET minute, the measure of one rotation of Earth on its axis, a 4-day cycle of four NET minutes constitutes a harmonic, a 5-day cycle constitutes a chromatic, while the 13-day cycle corresponds to one *wavespell*, the time constant that accommodates the measure of thirteen. Hence, a wavespell can be either thirteen days, thirteen weeks, thirteen moons, thirteen years, or so forth. The point is that by making the change of calendars the foundations of the mind organized in time are irrevocably altered. From the noospheric perspective, there is nothing arbitrary about the laws of nature. The same lack of arbitrariness should be reflected in the instruments that we use to measure time. By adapting to the Thirteen Moon/28-Day measure, the humans are adapting to a measure in which there is nothing arbitrary because it is a pure expression of the Law of Time. Thirteen is not at all a harbinger of bad luck, but the gateway to harmony in time! And it is by using this thirteen-based harmonic instrument of measure that the human is realized as a noospheric chip, a fractal of the noospheric mind, the mind of time on Earth.

NOOSPHERIC CHIPS: WIZARDS OF GALACTIC TIME

In the noospheric construction of the operating mechanism of the Timeship, the human is a vital link, providing the biotelepathic medium for the synchronization of the geocosmic mind on Earth. If we look again at the structure of the noosphere, the components include: the crystal core bipolar oscillator, packed with Technicolor time beams and cosmic thought moments, waiting to be self-reflectively realized; the human noospheric chip, the representative of the biosphere to mentally engage the timing cycles of the NET; the electromagnetic field, which provides the medium of expression between the biospheric order, the human, and the noospheric mind of time; and the noosphere itself, the mind of time on Earth, whose articulation through the psi bank control panels and through the Earth's resonant field structure yields an enlarged measure of Earth consciousness, Noospheric Earth Time itself. In expanding our minds into the noosphere we will understand that what lives is the Earth and the Earth lives through us.

As a noospheric chip, the human is a fractal reflector of the 13:20 timing frequency. Midway between the bipolar oscillator and the noospheric psi bank plates, the human noospheric chip is designed to receive, transduce, and transmit programs from the crystal core by synchronizing these programs with the psi bank.

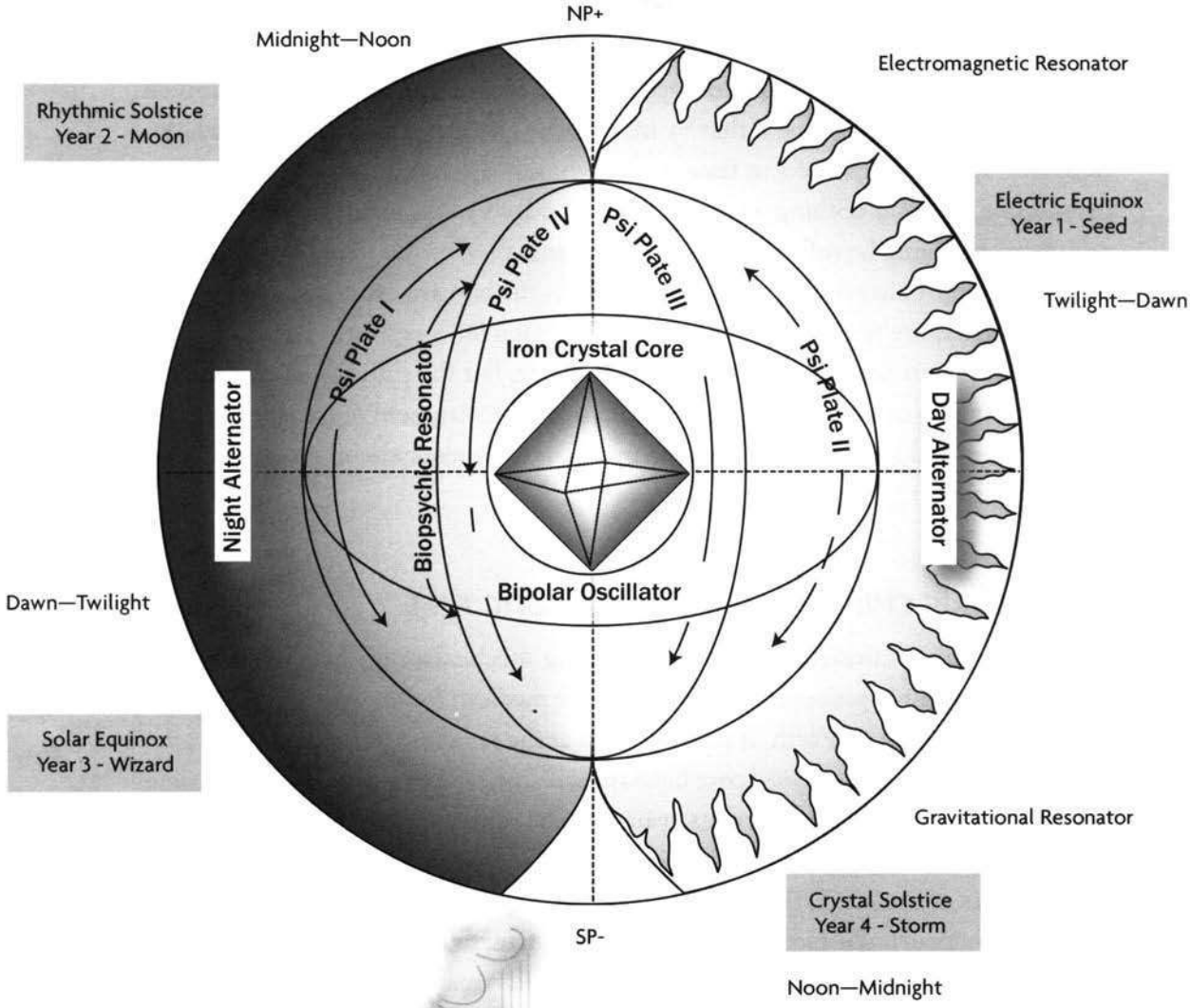

Four-Phasic Noospheric Resonant Field Model, Timeship Earth 2013

Three resonators establish the gravitational, electromagnetic, and biopsychic fields held in place by the crystal core, the bipolar oscillator.

Two poles extend the bipolar field of Earth, which, guided by the day-night alternators, create the four-phasic noospheric field model.

Four psi plates govern the four phases, from daily NET minute to seasonal NET day, and to the four-part NET week, or Seed-Storm year bundle.

This is a process that can occur only within the construct of the regular harmonic sequence provided by the noospheric timing gauge of the Thirteen Moon/28-Day calendar. Interaction with the crystal core can only be through telepathic means, and the human-as the midway point between the core and the electromagnetic fields-is like a sensitive piece of litmus paper. To understand the human in this way is to totally redefine the reality of what it means to be human on Earth. From this perspective, the human is a biocomputer whose information source feeds it programs stored and emanated by the crystal core. These programs are then brought into conscious registration through working the corresponding programs of the psi bank. Right now, we don't know what the crystal core is emanating, much less that such a structure exists within the Earth. Like a crystal radio-set, the noosphere is the antenna, the geocosmic programs are transduced and generated at the crystal core, the human is the biocosmic tuner, and the broadcast transmission is provided by the psi bank.

The 13:20 template of the human noospheric chip is defined as the human holon, its twenty digits and thirteen main articulations conforming perfectly to the geocosmic 13:20 synchronization frequency of universal time. It is the intrinsic resonance of this geocosmic structure that allows the human to be in resonance with the planet as a whole system. While the timing programs to be broadcast are all loaded in the psi bank control boards, the actual point in space of the physical Earth is coded by time into a twenty-part icosahedral structure called a planet holon. Being holonomic in nature, the planet holon has a perfect incidence of correspondence with the twenty digits of the human holon.

The twenty digits and twenty-part structure of the planet holon are both coded by the twenty icons or solar seals of the 260-day galactic synchronization cycle. The icons or seals are the manifestations of the 20 (4 x 5) factor of the 13:20 synchronization ratio. They are coded for human legibility as simple icons that conform to a postliterate alphabet. In time these twenty icons create a fourth-dimensional twenty-day solar cycle which interacts with the 13-day galactic cycle to create the 260 unit synchronization sequence or "galactic spin." The point is that when this galactic spin is synchronized with the 365-day solar-lunar measure of the Thirteen Moon count, there is a daily program for identifying the human with the planet holon, a factor that facilitates the planetary resonance of the noospheric chip.

As a noospheric chip, the human is in every way a holonomic reflection of the whole system Earth. As a system of resonators-gravitational, electromagnetic, and biopsychic-the human and the Earth both have bodies with a center of gravity; both exhibit electromagnetic fields; and both share in common a biopsychic resonance, the mutual interface of the noosphere or mind of time with the other two

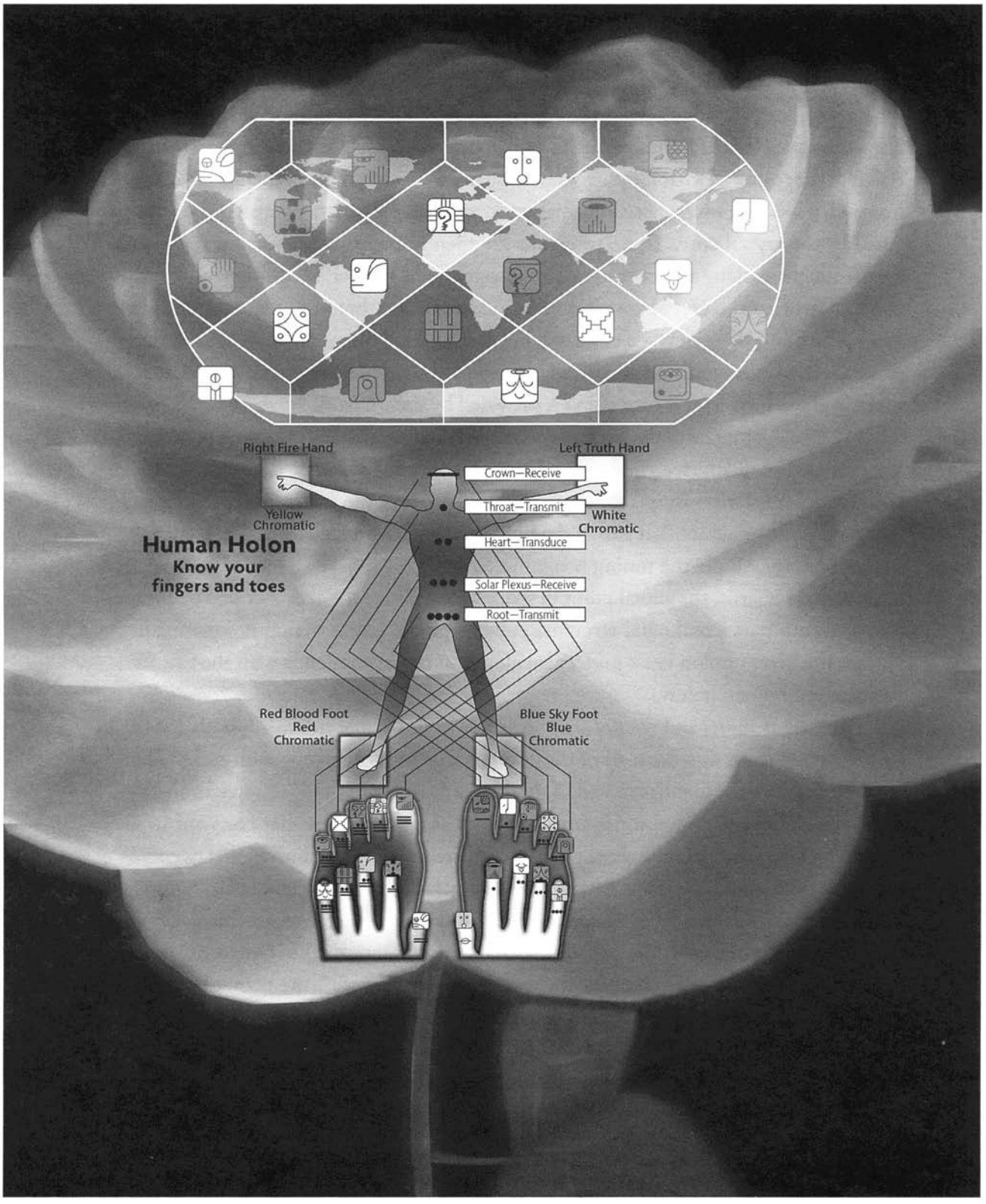

Planet Holon—Timeship Earth 2013

fields of resonance. The redefinition of the human according to the Law of Time and to the nature of the noosphere also redefines the human's reality. What will the human do when history has been eliminated from the calendar and the new calendar itself is actually operated as a synchronometer-a measure of synchronicity?

First of all, as the necessary prelude to galactic culture, the absolute synchronization of the human in geocosmic time, the technosphere will be dismantled. Reorganized by the Law of Time into psychic biomes, the dismantling will naturally phase into the genuine creation of the new culture of solar-galactic consciousness. "Path beyond technology" means path of telepathic harmony. With its goals absolutely reoriented following the mental pole shift of the calendar change, the hierarchy of human values will also undergo a profound reordering. What if money were no longer the first consideration in human affairs? What if the consideration were instead how artful or artistic that action or event might be? What if the diaspora of humanity through industrialization and mass transport came to an end and the humans willingly chose to live in smaller communities organized by gardening and other Earth-related activities, inclusive of the transformative dismantling of the technosphere and the regeneration of the biospheric medium? What if the study of time replaced the study of physics as the dominant mode for determining the nature of reality? And what if, due to the time shift, a spiritual awakening swept through the human race so that a moral orientation of values was organized around the preservation and furtherance of the biosphere, and an acknowledgement that only One Supreme Creator could have ordained something so perfect as the noospheric mind of time? What kind of world would that be? What kind of art would be practiced in that world and what kind of science would be known?

Organized by the NET, human existence would spiral into the collective telepathic mind. A type of Earth geomancy would become the science of the noosphere. Or perhaps a more accurate name for this science would be *Earth geochronomancy*- the study and investigation of Earth in relation to the cycles of cosmic time and telepathy with an end to perfecting the Earth as a work of art. With minds expanded toward accommodating the longer, slower measure of NET, geochronomancy would inspire an entirely new vision of the Earth within the heliosphere (the solar system) and the galactosphere (the galactic order of things). Making the Earth's rainbow brain visible and manifest would be only the beginning of a willingness to explore further untapped psychic energy sources and means, or what is referred to in *Earth Ascending* as the science of radiosonics. Key concentrations of human habitation and activity would be organized to occur at or close to those geomagnetic energy points or centers, the whole cultural process of which would correspond to making a map

on Earth of the image of galactic being as it moves in its great patterns of time. Would this not make the human species into a race of wizards?

In this consideration we may find a reason why the 260-day unit galactic synchronization measure-a galactic spin-is the key to what is called the *Wizard's Count.* The perfect synchronization of the 260-unit galactic spin with the 365-day Thirteen Moon/28-Day solar orbit establishes the 52-year cycle, or one NET year. A NET year (fifty-two solar orbits) is a "wizard's measure," for on this measure the human can expand its consciousness to encompass the Earth in its greater cycles of development. The Wizard's Count is also given its name because of the set of the four solar icons or seals that code the July 26 synchronization date in 4-year cycles: year one, Yellow Seed year; year two, Red Moon year; year three, White Wizard year; and year four, Blue Storm year. An entire Seed-Moon- Wizard-Storm sequence of four NET days (four solar orbits) consists of fifty-two moons, or one NET week, the perfect fractal of the fifty-two 7-day weeks in one NET day and the fifty-two solar orbits in one NET year. This four-part sequence is also called a Seed-Storm year bundle, the harmonic essence of the wizard's measure. Thirteen Seed-Storm year bundles, where each of the four icons is coded by the thirteen galactic tones (4 x 13 = 52), yield one NET year. Please note that even the Gregorian July 26 synchronization date is a function of the synchronic order: July = 7, while 26 is 13 doubled, 7 and 13 being the two principle numbers governing the 13:20 matrix of the Harmonic Module!

In the symbolism of the iconic sequence it is the Seed that is planted, it is the Moon that coordinates the growth cycles, it is the Storm that generates the energy, and it is the Wizard who knows and acts upon what is given. It was a White Galactic Wizard that coded the date and coordinated the year beginning July 26, 1987-followed twenty-one days later by the Harmonic Convergence. Thus it was the White Galactic Wizard who opened the gates to the closing of the Mayan baktun cycle of history and the commencement of the coming cycle of galactic culture. And on July 26,2003, the year of the White Spectral Wizard will commence. This year will end with its Day Out of Time, coded by the White Spectral Mirror. The day following, July 26,2004, will begin the year of the Blue Crystal Storm. On the Wizard's Count, which is not a calendar but a synchronometer, these two dates, White Spectral Mirror and Blue Crystal Storm, are the point in time when the Gregorian calendar ticket to the old time will be eliminated and the new Thirteen Moon calendar ticket for admission to the new time of the noosphere will be validated. This is when the noospheric show will be ready to begin its prelude. (See plate 6, Noosphere-Mind of Time on Earth.) Will the humans also be ready?

8

Making the Transition to the New Time

A How-to Catalog and Guide to the *Pax Cultura, Pax Biospherica*

BY THE TIME these words are read, the technospheric collapse will have generated several more devastations and disasters. The wound received by the technosphere on September 11 was a mortal one. The technosphere suffered cardiac arrest for almost a week. Not only did the towers collapse, an event that occurred via television within the central nervous system of the human species, but belief systems, too, came crashing down. No longer is America the unassailable fortress of "democracy," while democracy itself is a concept that joins monarchy, nation states, imperialism, colonialism, capitalism, communism, and a host of other outmoded systems of belief and thought constituting the saga of human history-that is, the history of civilization. But all that is now ending. The perimeter of biogeochemical combustion and the limits of the technosphere have coincided. It is the Earth's turn to speak. How will the Earth speak?

The Earth can only speak through the noosphere, and the noosphere can only speak from the center of time that is constructive peace. Peace is harmony. Peace is the culture of the biosphere. The conscious harmony of time in the biosphere is the culture of peace known as the noosphere. Through the noosphere, the Earth speaks in ever-widening circles of order and meaning. While sunrise and sunset mark the passage of solar time, observing the phases of the moon keeps us in tune with the

mystery of time. One kin, one passage of night and day, one NET minute, synthesizes the experience of the whole Earth during a single rotation on its axis. The synchronic order supplies a 260-unit synchronization gauge that the mind may engage and employ in the construction of a harmonic vision of reality. Twenty-eight NET minutes make one moon, one NET hour, moon after moon. The pattern of one moon contains the construct and pattern of every moon. The harmonic perfection of the synchronic order of reality releases the mind through the center of time into a freedom it had not known in the dark passage of history. How are we going to make this transition? Can we really shake off the old and the obsolete that easily?

THE THIRTEEN MOON CALENDAR MOVEMENT: THE DAWN OF A NEW GALACTIC CULTURE

"Greetings Explorers on Timeship Earth!" reads the opening text of the pocket-size *13 Moon Natural Time Journal.* "Welcome to this 13:20 natural time portal and fourth-dimensional galactic time template. A solar-lunar Earth calendar of the 13:20 timing frequency that is expressed through the thirteen tones of creation and the twenty sacred solar tribes. Attuning to this calendar will help you awaken and align to the pulse of the Universe, the rhythm of the One heartbeat. 13:20 is the natural timing frequency that unifies planetary and galactic consciousness. . . It is the expression and remembrance that Time is Art . . . By attuning to the 13:20 frequency of natural time, we break out of the 12:60 time warp and activate the remembrance of our true human nature. Time is energy. It is a frequency of the fourth dimension; mind, telepathy, imagination, and creation. Time is an exploration of unlimited Universal potential. So let us begin the journey and return to the rhythm of nature's galactic heartbeat. . ."1

This is the Earth speaking through a noospheric chip. Produced in Canada, it is one of many Thirteen Moon calendars produced this Yellow Solar Seed year. Others have been produced in Germany, Austria, Italy, Russia, the Netherlands, Japan, Brazil, Argentina, Chile, Mexico, and the United States. One such example from the United States is known as the 13 *Moon Natural Time Calendar: Ancient Science for the Art of Now.* Going through its pages one is flooded with a wealth of information, summarized by a quote from traditional Hopi wisdom: "We now face the final test of human consciousness-to restore our oneness with creation. We are going home. It is a process. It is like the seed becoming the green shoot and then the flower."2 To make the calendar change is to restore the oneness with nature. The break with the oneness with nature was codified and thence programmed into an irreversible reality

by the Gregorian calendar and mechanical clock. Only the breaking of the pattern of time established by these two instruments will release us again into natural time. The Thirteen Moon/28-Day calendar exists as the tool to demonstrate the contrast between harmony and disharmony, and to assist us, as a species, into effecting this return. If we are going home then we must make a turn away from our present course.

> Through returning to natural Time, we return to our natural state of divinity, living in harmony with the Earth and each other. We return to the nature of our spiritual existence. Realigning with the rhythm of the universe through the 13 Moon Calendar allows us to lay the foundation for the new paradigm of love and unity, replacing the 12:60 paradigm of fear and separation. . . The World Calendar Change Peace Plan strives to establish a new culture of peace on Earth through returning humanity to natural time. It is the goal of the worldwide Foundation for the Law of Time to effect the calendar change by the Day Out of Time (July 25), 2004 . . . Join the global movement to effect planetary £hange and establish the new culture of peace on Earth! Return to divinity and creative existence. . . Walk the path of the sacred warrior.]

The movement to change the calendar is a living force, a force that is living the New Time. Its premises are so diametrically opposite to those of the technosphere that, especially in the power bases of America and the G-7, one will find scant mention or notice at all of this movement. Yet it is a cultural phenomenon. In Tokyo, San Francisco, Milan, or Moscow one may find signs of the presence of this movement in the underground dance events, the raves or the Earthdance. More and more young people take on the names of their galactic signatures, the 260-day kin code for their date of birth in the synchronic order, names like Lunar Storm or Spectral Night, Galactic Wind or Planetary Dragon. These are all signs of the beginning of galactic culture on Earth, a phenomenon that has only been increasing over the past decade. The point is that the New Calendar Change Movement is a grassroots phenomenon as well as an ideological strategy known as the Campaign for the New Time. These signs are all whispers of the noosphere blowing through the bleak industrial corners of the technosphere.

Behind the more populist front of the Natural Time Movement is the science of the Law of Time, a genuinely noospheric science of peace and harmony. This science is already being studied and put into preliminary practice. As the crisis of the biosphere began to crest in 1987, halfway through the second 28-year phase of the technosphere, the noosphere began to download its measure of time through the

discovery of the Law of Time. Invisible to the predominant forces of the technosphere, the science of the Law of Time began to map out an entirely new domain of thought, the synchronic order, a domain that could only be entered and applied through the correct noospheric measure, the Thirteen Moon/28-Day synchronometer.

All science throughout history is based on evolutionary advances predicated on both the premises and limitations of its preceding stages. We are at such an evolutionary moment now. The issue of the calendar change is only the beginning of the emergence of a new whole system scientific order. Understanding the flaws that are built into the present system of purely materialist science, we can proceed to the establishment of the science of the synchronic order. Like the radical simplicity and perpetual harmony of the Thirteen Moon calendar itself, the noospheric science of the synchronic order is predicated on an equally radical mathematical base reflecting and embedded in the 13:20 universal timing frequency itself. And as the underlying order of a whole system science, this mathematics is reflective of the non dualistic premise of a superior moral order. The deviation from universal synchronic time is a moral deviation as well. It is this moral deviation that most strongly prompts the current calendar change movement.

As a profoundly nondualistic, unifying whole system premise, the Law of Time encompasses not only a scientific-mathematical basis of morality, but a theological-eschatological intention that reunifies the various disciplines scattered and separated by the rise and totalitarianism of modern secular science. Because of the historical dominance of the Gregorian calendar, in which modern science is embedded, the dethronement of the calendar-the "devaticanization" of the world, as it were-is an apocalyptic moment.

As the Law of Time defines it, this is merely the apocalypse of the 12:60 timing frequency and all its corrupted institutions, much as foretold in the Book of Revelations. This apocalyptic moment was stunningly supplied by the terrifying collapse of the Twin Towers. As the nerve center of the financial, commodities, and transport sector of the technosphere, and hence of the city itself, the collapse of the towers in hardly more than an hour's time is perfectly reflected in the vivid descriptions of the eighteenth chapter of the Book of Revelations, "Fall of Babylon." Yet as the Mayan prophecy of Pacal Votan also makes absolutely clear, the apocalypse of the 12:60 is the resurrection into the 13:20 timing frequency, the return to natural time, all to be accomplished by A.D. 2012, Teilhard de Chardin's "omega point." The advent of the noosphere is preceded by the post-apocalyptic harrowing of hell. In this harrowing of hell, defined as the span of time fromJuly 26, 2000-July 25,2004, humanity must make a crossing from one time to another. This crossing is much like those we hear

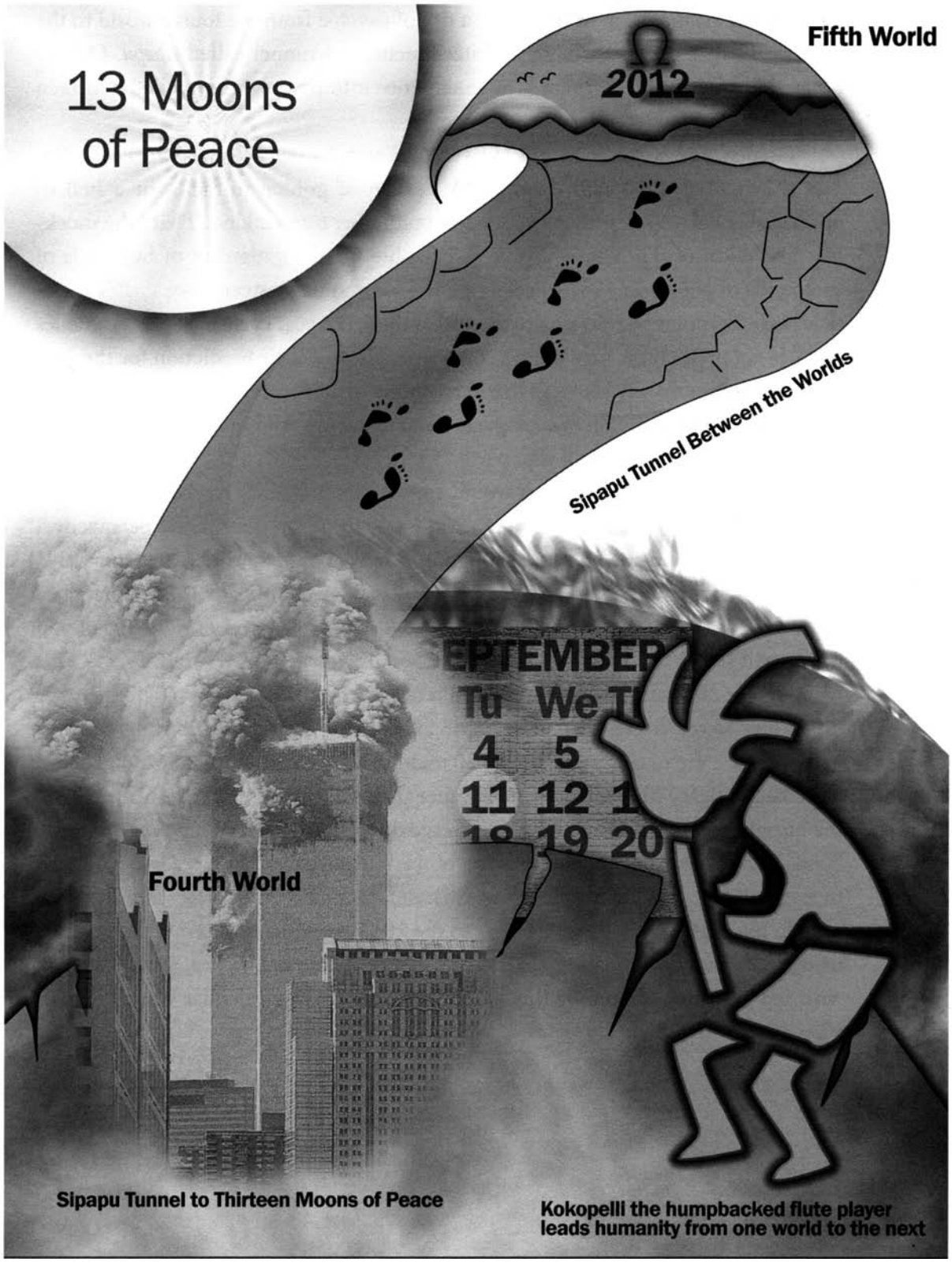
13 Moons of Peace
Fifth World
2012
Sipapu Tunnel Between the Worlds
Fourth World
Sipapu Tunnel to Thirteen Moons of Peace
Kokopelli the humpbacked flute player leads humanity from one world to the next

about in the cosmovision of the Hopi, a rite of passage from the fourth world to the fifth world that occurs through an interdimensional tunnel called *sipapu.* On the other side of that tunnel, there is an emergence into the new time called "thirteen moons of peace."

"Golden Age of Miracles and Heaven on Earth," a story in the *National Examiner* (November 29, 1988), begins: "A heaven of golden miracles or a hell of unspeakable horror is less than twenty-five years away for mankind. That's the shocking prediction of the man who was responsible for the gathering of hundreds of thousands of people in 1987 to celebrate the Harmonic Convergence. . ." The article makes its point by referring to the end of the 5,125 year cycle in 2012. "Argiielles said Mayan predictions have always come true. He said their prediction for the year 2012 is that if humanity learns to live in harmony with Nature, a new age of miracles and light will occur. Otherwise plagues, wars, terrorism, and finally, the breakup of the planet into asteroids, will take place."4

As for the Inevitable Event, it would appear that humanity has begun the worst of the prediction-plagues, war, terrorism-yet, from the noospheric perspective, two points mitigate the absolute plunge into hell. The first is that the Inevitable Event punctured a hole in the technosphere eleven years prior to 2012. What does this mean? It means that this is the time of hell on Earth. "Every single one of you must see it [hell]; this is an irrevocable decision of your Lord." (Quran, 19:71) This being so, we can potentially emerge from it before the 2012 omega point. The other mitigating factor is the existence of a 13:20 movement dispersed throughout humanity. Since the noosphereis the 13:20 mind of Earth, the Thirteen Moon Calendar Change Peace Movement is the advance presence heralding the transition from the biosphere to the noosphere. This passage through hell is of a four-year duration, 2000-2004. The exponential implosion of the technosphere has already begun. But to avoid a long, debilitating siege of barbarism, humanity must select a positive direction by 2004 so that it can make it to the 2012 deadline as a species returned to living in harmony with nature. This it can only do by the dramatic and radical break with the past time offered by the Thirteen Moon/28-Day calendar Change Peace Plan.

Campaign for the New Time

4:7::7:2013

7th Seer
Pacal
Votan

Blue Galactic Storm
2000 – 2001
Seed Cube Flowering

6th Seer
Quetzalcoatl

Yellow Solar Seed
2001 – 2002
Serpent Cube Sex (Life Force)

4th Seer
St. John
of Patmos

Red Planetary Moon
2002 – 2003
World-bridger Cube Death

2nd Seer
Padmasambhava
Fulfillment of the
Cycle of
Seven Seers
1997-2004

White Spectral Wizard
2003 – 2004
Hand Cube - Accomplishment

Victory of
the New Time
Thirteen Moon
Calendar Reform
Attained
Thirteen Moons
Proclaimed and
Accepted as New
World Calendar

Circumpolar
Rainbow
Victory
Event

Sacred
Earth
Sacred
Order

Tibetan
Lunar
Calendar

Japan
Mount
Fuji

Chinese and
Islamic
Lunar Calendars

China
Iran
Saudi Arabia

Indigenous Peoples Councils

Organization
of PAN Peoples
New Time
Congresses

India

Africa

UR Council
for the
Integration
of all
Lunar Calendars
in 13 Moon
Calendar

Vatican Put
on Notice

Wall Street Journal Ad Strategy

Planetary Peace Through Culture Festival

See the Rainbow

Planetary Peace Through Culture Festival

See the Rainbow Round the Earth

Planetary Peace Through Culture Festival

Be the Rainbow Round the Earth

Foundation
for the Law
of Time
Established

Launching
of the
Campaign
for the
New Time

Preparation
of
Strategies
- PAN Peoples
- Mass Media
- Diplomatic

International
Kin
Gathering
Prepare
PAN
Congresses

Banner of
Peace
returned
to Altai

Colombia
New Time
Peace
Congress

PAN Peoples
New Time
Congresses
Develop Local
Programs for
Social Transformation

PAN Peoples
New Time
Congresses
Implement
Strategies

Time of
Great Awareness
of New Time

Calendar
Reform
Becomes
Major
World
Issue

Harmonic
Convergence
of PAN

Media
Diplomatic
Strategies

First Seed-Storm Year Bundle Gathered

Listen Again	Stabilizing	Meditation/ The Temple	Measuring	People Together	People Organized	Evolving	Inner Space	People Apart	Wisdom of the People	Transcending	Inner Time	Power of the People	Way of the People	Wisdom Arousing	Accomplished
Tree shapes space	Way of conduct informed by truth	Telepathy establishes the temple	Galactic octave limits space	Tree evolves space	Truth evolves way of conduct	Telepathy evolves the temple	Galactic octave resounds as mind	Tree defines life	Conduct defines the way	Temple incorporates telepathy	Galactic octave defines evolution	Tree of time turns Earth	All points unify in conduct	Telepathy becomes time travel	Galactic octave universalizes space

Afro-Eurasian • Plate - PNM 1-6

Pacific Plate • PNM 19-24

American • Plate PNM 13-18

Atlantic • Plate PNM 7-12

Earth Wizards Define Spiritual Order of New Time Lay Foundations of Shambhala in Temple of Rainbow Plasmic Body

THE BIRTH OF THE CAMPAIGN FOR THE NEW TIME

"We inspired Moses: 'Lead My servants out, and strike for them a dry road across the sea. You shall not fear that you may get caught, nor shall you worry.

"Pharaoh pursued them with his troops, but the sea overwhelmed them, as it was destined to overwhelm them."

-QURAN, 20:77-78

The Thirteen Moon/28-Day calendar is the dry path across the waters of the 12:60 chaos. Holding surely to this path, "Pharaoh's troops will be overwhelmed," as it is destined, for the truth always prevails and when falsehood is exposed, falsehood perishes. The 12:60 frequency enshrined in the Gregorian calendar represents an artificial, hence false notion of time. The Pharaoh's troops are the forces of the technosphere that, embedded in the artificial structure of the Gregorian calendar, are destined to be overwhelmed and overcome by the fury unleashed both by human nature and nature itself in response to decades, if not centuries, of irresponsible despoiling of the Earth. The dry path of the Thirteen Moon/28-Day calendar is the only path broad enough for all humanity to leave the ever increasing ocean of chaos that characterizes human existence bound in the collapsing 12:60 matrix born of Gregorian civilization, the technosphere. Yes, the dry path across the waters of the 12:60 chaos provided by the Thirteen Moon/28-Day calendar truly is for the salvation of life on Earth.

Ever since 1993, the Thirteen Moon Calendar Change Peace Movement has consciously been drawing from the infinite riches of the noosphere to create not only the mechanism for making a shift in the frequency and hence bring stabilization to the biosphere, but has been anticipating the biosphere-noosphere transition into the *Pax Cultura, Pax Biospherica.*

Foll{)wing in the footsteps of its predecessor, the new calendar movement has dutifully contacted the United Nations and the Vatican and convened various congresses and delivered ultimatums in an effort to draw attention to mankind's time malaise. Now that the Inevitable Event has fully disengaged the human mind from the reality it thought it was pursuing in the new millennium, the second definitive wave of the World Thirteen Moon Calendar Change Peace Movement has also been launched: the Campaign for the New Time.

New Globally Unifying Harmonic Standard

FOURTH DIMENSION: Pure whole number mathematical order—syntropy, synchronic order

Radial

Harmonic Solution

Calendar Change

Replace current irregular calendar with a harmonic standard

Paradigm Shift

Time

2002
2001 2004 2005
2003

Campaign for the New Time

13 Moons. 28 Days.

Regular Units of Measure

28+28+28+28+28+28+28+28+28+28+28+28+28+1 = Harmony

"Mental barrier" separating fourth-dimensional realm of conscious wholeness of synchronic order from third-dimensional realm of "hard science" physical plane of reality and materialism.

Line of inexorable technological progress: neoliberal economics, globalization = biospheric instability and destruction.

THIRD DIMENSION: Manifestation-matter entropy and disorder

Coercion
Compromise
Money

$$$$$

IMF - World Bank
G-7 WTO
Security Council

Political Solution

Military Solution

Stalemate

Deadlock

"Secret Deals"

Guerrilla Warfare
Terrorism
Convential War

$$$$$

NATO
Nuclear war
Arms Industry

Past → Future

Linear Arrow of Time = line of inevitable degradation and entropy of manifestation (matter)

Gregorian Calendar Time Line = macro-organizing timing standard establishes irregular measure as basis of all dominating concepts of linear time, disorder, entropy, and the techno-economic inexorability

Irregular units of measure:

31-28(29)-31-30-31-30-31-31-30-31-30-31 = Disharmony

If today is Sunday, July 8, what day of the week will August 8 be?
What is the meaning of the names of the months?
If *September* means "seven" why is it the ninth month?
August is named after Augustus Caesar, July for Julius Caesar, March for Mars, the god of war; could this be a reason why we are programmed for chaos and violence? Think about it.

This campaign consists of a preparatory four-year cycle, 2000-2004, the Harrowing of Hell, which is the duration of the campaign itself, plus a one-year trial period, 2004-2005. The goal of the four-year campaign is universal calendar reform, the replacement of the Gregorian by the Thirteen Moon Calendar, effective Blue Crystal Storm, July 26,2004. This final year of the Blue Crystal Storm, 2004-2005, also completes a Seed-Storm year bundle begun in 2001, fateful year of the Yellow Solar Seed, the year of the Inevitable Event. To ensure the success of this unprecedented move on the part of humanity, the calendar reform must include the one-year trial period, during which time the entire species must be operating by a new standard, the harmonic Thirteen Moon/28-Day synchronometer. "If you never try it, you'll never know what it is," is the slogan that describes the campaign's target year: July 26, 2004-July 25, 2005, an entire year without the Gregorian "30 days hath September. . . ," but instead, Thirteen Moons of Peace.

To realize its ambitious goal of universal calendar reform, the Campaign for the New Time must impress itself on the human consciousness as the all-unifying campaign for peace to overcome the destructive forces unleashed by the technospheric collapse. Fqrtunately, much groundwork has already been laid. The codes of the Law of Time have been formulated and compiled. Preliminary practices to engage the synchronic order of the noosphere have already enlisted humans from around the planet. What the Vatican has tried to ignore and what the United Nations has been unable to fully engage must now be brought to the forefront of all humanity as the harmonic solution. The harmonic solution is a set of logical arguments that should be studied and rehearsed by everyone who seriously wishes to even consider the possibility of a Campaign for the New Time. Let us contemplate the following set of logical arguments.

Premise

Currently all conflict resolution of a global scale is attained through one of two poles: a political solution or a military solution. No other alternatives are recognized. According to the Law of Time, there is a third solution, the harmonic solution. Without this third solution, no harmonic resolution is ultimately possible for any conflict on a global scale. The third solution defines the first two solutions as a polarity embedded within a timing standard that is hopelessly irregular and that, therefore, disposes the mind to disharmony. A mind predisposed to irregularity and disharmony is incapable of producing any long-term solution. The basis of the harmonic solution is to change the timing standard from an irregular to a regular one, thereby inducing a timing sensibility that disposes the mind to harmony rather than disharmony.

Thirteen Moon/28-Day Count and Global Conflict Resolution

The inability to attain global peace, much less the resolution of many localized conflicts that have become endemic, is due to a lack of a globally unifying timing standard-the macro-organizing principle of human sensibility. Present-day conflict resolution is represented by two poles, political and military. The military solution consists of guerrilla warfare, terrorism, and outright military conflict, all of which are engendered by problems of inequality; injustice; rampant nationalism; tribal, racial, or religious antagonism; and greed for control of natural resources. Underlying the military solution is an aggressive armaments industry that seeks to hold its own as a capitalist venture, always seeking new markets. The political solution is always fostered as the only cure for the military solution, and is administered through varying degrees of coercion, compromise, and the inevitable lure of money-the IMF and the World Bank are never far behind any political solution.

Neither the military nor the political represent any kind of morally satisfactory or enduring solution because both are functions of and embedded in a timing standard that has disharmony built into it. Even the local timing systems, themselves feedback loops holding in place various belief systems, are coordinated by the dominant disharmonic standard. As long as the current global standard, the Gregorian calendar, is the controlling timing factor, resolution on a global and local level is not only impossible, but increasing disharmony is guaranteed. The harmonic solution calls for the immediate establishment of a globally unifying harmonic standard, the Thirteen Moon/28-Day count. With its absolutely consistent units of measure, this macro-organizing principle is a paragon of harmony and thereby represents the positive, creative, and viable first step to enduring global conflict resolution.

Thirteen Moon/28-Day Paradigm Shift

The harmonic solution, the alternative to the polarity of the military and political solutions, calls for the immediate replacement of the current irregular measure with the harmonic standard of the Thirteen Moon/28-Day count. This replacement constitutes the long-awaited and long-prepared-for paradigm shift in human consciousness. The very analysis and concern that engendered the first movement to replace the Gregorian calendar-the effects of an irregular measure on human behavior-is now so dire that the concluding step must be taken. To quote Einstein once again, "Since the advent of the nuclear age, everything has changed but the way people think; thus we drift toward unparalleled catastrophe." With the analysis of the Law

of Time we know why thinking has not changed-the human mind is the pawn of an aberrant timing mechanism. To change the way people think, make one little change in their everyday lives: Change the calendar. If we could send a man to the moon, we can change the calendar. This change will be the first step-the rest will come easily because with this one change we shall have changed our minds and entered into a New Time. To make this one little change a target date is needed, and the people need to mobilize as a force of synchronization for peace to mandate this change. The target date is July 26, 2004--the mobilization has already begun.

New Worldview of the Law of Time

The Thirteen Moon/28-Day count is the pragmatic application of the Law of Time. The discovery of the Law of Time was necessitated by evolution as the only way that could offset the deleterious effects of an erroneous timing standard on human consciousness. The Law of Time takes the radical view that time is a frequency, the universal frequency of synchronization; that the purpose of time is to synchronize; and that, therefore, a calendar is in harmony with the Law of Time to the degree to which it maximizes opportunities for synchronization. From the perspective of the Law of Time, the current macro-organizing standard is anything but synchronous, and hence contrary to the laws of nature. Synchronization produces harmony, harmony is a function of beauty, and beauty is the natural result of the Law of Time: T(E) = Art, energy factored by time equals art, where art is the entire spectrum of phenomenal reality in which even the most menacing-looking creature is elegantly constructed.

National Geographic recently stated: "Beauty seems to be an intrinsic part of nature and perhaps even the organizing principle of reality. Scientists in testing their theories, invariably find that the simplest, most elegant, most beautiful is the correct one. Rainbows, butterflies and the periodic table are some examples of intrinsic beauty. The world will be saved by beauty."5 The Law of Time agrees. The world will be saved by beauty, and the proponents of peace through culture will be in the vanguard. The Law of Time formalizes the perception of the intrinsic beauty of nature- T(E) = Art-and thereby provides a scientifically solid critique of the ugliness and social disharmony fomented by the irregular and artificial timing standards that control humanity today. By the same formulation, the Law of Time also establishes a vast and comprehensive definition of the fourth dimension, which was wanting until now precisely because of the embedding of all current perceptions in the erroneous timing standard.

The mathematical order underlying the universal frequency of synchronization,

13:20, describes a new order of reality, the synchronic order. The synchronic order governs the fourth-dimensional order of reality much as the laws of gravity, thermodynamics, and the special theory of relativity govern the third-dimensional order of reality. By taking into account the nature of the synchronic order, humanity's views of the third dimension will inevitably be altered to a greater conformity with the harmony of the fourth dimension. The fourth dimension is defined as the primary mathematical order of time, governed by a syntropic whole number system of ratios and fractals operating in a radial and nonlinear manner.

The third dimension is the world of manifestation and matter that inevitably entropizes. Losing sight of the inherent harmony of the synchronic order from which it is actually inseparable, the human fixation on the increasing entropic anomalies of the third dimension produces problems such as how to reckon what appear to be the extra hours, minutes, and seconds that occur every time the Earth orbits the sun. To this seeming dilemma, the Law of Time asserts that number precedes manifestation, harmony precedes materialization, therefore manifestation must accord with number, and materialization must reflect an original harmonic order. Entropy and degradation cause manifestation to deviate from number and mathematical law. But for mind to be stable, mind must accord with and conform to mathematical law rather than with entropy and degradation. The timing standard in use causes the mind to conform with entropy and degradation. This is what must be corrected.

Harmonic Solution-Harmonic Resolution

Harmony can only produce harmony. From order comes order. From disorder you can only expect chaos. From disharmony can only come disaster. Irregular measure entropizes. Harmonic measure syntropizes. These are the contrasting values brought into focus by replacing an irregular macro-organizing principle with a regular one. Implementation of a globally unifying harmonic standard is the only hope for resolving all conflicts in time. A harmonic standard lifts all conflicts to a higher level dialog of unification in time. The harmonic solution, the World Thirteen Moon Calendar Change Peace Plan, provides: the opportunity to call an immediate and universal cease-fire, as well as a halt to the otherwise inexorable process of entropic degradation of society and environment; and offers the resolution to establish new agreements, to renegotiate old treaties, and to create a new globally binding and unifying covenant for all people in a new time.

It must be understood that to change the calendar is to delegitimize all the institutions embedded in it. This radical but peaceful delegitimization of the old order is

what is needed to break the deadlocks, stalemates, and historically outmoded treaties and agreements now binding on humanity. The new globally unifying standard, the Thirteen Moon/28-Day count, will legitimize and institutionalize harmony and thus create the advent of a synergistic order capable of resolving entropic disorder because it is reflective of and rooted in the primordial whole number structure of the synchronic order of reality. In its entirety, this represents a new step and direction for human evolution-a step without which there might not be any creative future for humanity and the planet.

How to Accomplish World Peace Now

The analysis, the historical precedents, and now the affirming authority of the Law of Time render the harmonic solution as the only way to immediately bring about World Peace. All that is lacking is the will to synchronization among all good-hearted people, groups, and organizations otherwise committed to peace, a better environment, and human spiritual well-being in general. How to accomplish World Peace is to galvanize the human will to synchronization on behalf of the establishment of a genuine time of harmony and peace. This can only come about through the simple but highly radical and paradigm-altering act of exchanging the current macro-organizing system of the Gregorian calendar for the harmonic order of the Thirteen Moon/28-Day count. All other localized calendar systems would be kept intact, but they would be coordinated by a new standard, a standard that promises harmony instead of disaster, order instead of chaos, peace instead of war.

Such is the harmonic analysis and solution of the Law of Time, which can be summed up by a simple demonstration of the irregular Gregorian calendar contrasted with the regular Thirteen Moon calendar, as well as the question: "Which do you prefer, harmony or disharmony?"

If you answer this question on behalf of harmony, and you agree with the foregoing premises and analyses, you must move into action. You need to get a new calendar, a Thirteen Moon/28-Day calendar and find out for yourself: noosphere or necrosphere, the choice is yours. The option opened by the Inevitable Event and the collapse of the technosphere is precisely that: necrosphere, the transformation of the biosphere into a sphere of death-a dead planet-or the noosphere, the mental envelope of the Earth, governed on the human plane by the Thirteen Moon/28-Day calendar. The difference between the necrosphere and the noosphere is the difference between a machine and the Earth as a whole system. You cannot even really say there is a comparison. But what we can say most emphatically is that the Thirteen

Moon/28-Day calendar and the shift to the 13:20 frequency is the pure manifestation of the Law of Time in human affairs. It is the only antidote to the destructive grip that the 12:60 timing frequency now has upon the biosphere through its thoroughly artificial instrument, the technosphere. (See plate 7, Necrosphere or Noosphere.)

THE FINAL DECISION: NOOSPHERE OR NECROSPHERE?

As these lines are being written, seven weeks have passed since the Inevitable Event. The analysis of this event from the perspective of the biosphere, the temporary structure of the technosphere, and the advent of the noosphere was a spontaneous inspiration. Each morning, often well before dawn, I would be called to this technospheric device, an iMac, to put the noospheric mandate down into words. In this process, the matter of prophecy kept occurring and could not be avoided. Even the issue of calendar change increasingly takes on the quality of a prophetic enactment. What is prophecy from the noospheric perspective?

Prophecy is the release of information according to the psi bank timing program and in relation to degrees or levels of consciousness positioned at different points in time. The points in time are human channels. That is, there are the prophets who declare the prophecies by whatever means or forms, and then there are the decoders of the prophecies, those able to read the signs according to the prophecies with the aid of different symbolic lexicons. Prophecy is always startling to the mass mind, which is ignorant of the true nature of time. A prophetic event may seem totally random, when it is not. Someone may design a plot, such as that of the Inevitable Event, with whatever fantastic notions and motives. Yet the occurrence may go beyond being merely a matter of human manipulation. The humans were but the instruments of sets of cause-and-effect chain reactions established within the structure and evolution of the biosphere and the playing out of human karma.

According to the psi bank timing program governed by the Law of Time, the technosphere could only have a limited duration. Two perfect 28-year cycles of the Gregorian calendar program, leading to the first year of the third millennium, marked the duration of the technosphere. Because this cycle concluded with the beginning of the third Christian millennium, a singular event was poised in time to attract and catalyze a host of prophetic moments long prepared for and sealed in the psi bank by Christian, Islamic, and even Mayan prophecies. Such was the Inevitable Event. Within the motivations of the perpetrators of the Inevitable Event, the biosphere found its perfect instrument of divine purpose. That there were nineteen hijackers conforms to the Quranic nineteen code expressed in the enigmatic verse, "Over it is nineteen."

(74:30) The following verse begins, "We appointed angels to be guardians of Hell, and we assigned their number [19] . . ." This verse ends by asking, "What did God mean by this allegory? . . . None knows the soldiers of your Lord except He. This is a reminder for the people." (74: 31)

Certainly in the success of their mission, whether they were conscious of it or not, the nineteen Muslim hijackers-who organized themselves as four leaders (pilots), three logistics people, and twelve "soldiers"-fulfilled their function of being the prophetic emissaries of the nineteen guardian angels who watch over Hell. And indeed the gates to Hell have been opened. In the world of the secular mind of the technosphere, no one wanted to talk about the apocalypse or Armageddon, though the jihad was brought up quite often as a factor in the thinking of the Islamic terrorists.6

Whether it is seen as a prophetic or karmic event, as we stated earlier, there is no question that the timing programs of two civilizations, the Gregorian and the Islamic, were on a collision course. "The civilization of Islam is radically so different from that of Western civilization which dominates the world today. The two are different in their description oflife as well as the foundation on which they base such a description. The difference between the two civilizations is so essential that they have developed in ways which are radically contradictory to each other."7 So wrote the eloquent Saudi historian, Muhammad Husayn Haykal in his essay "Islamic Civilization," as presented in his masterful biography, *The Life of Muhammad.* And what is at the root of this difference? A separation of church and state, which in the West led to a profound materialism and economic worldview.

Haykal continues, "The victory of materialist thinking was largely due to the establishment of Western civilization primarily upon an economic foundation. This situation led to the rise in the West of a number of worldviews which sought to place everything in the life of man and the world at the mercy of economic forces. . ." As for the sanctity of its economic beliefs, Haykal concludes that the West has tied its economic activity "hand and foot by public laws and commanded that every Western state and army prevent any violation of economic laws with all the power and coercive means at its disposal."8 Given this insightful assertion by an Islamic thinker written a half-century ago, it is not at all surprising that the terrorists concentrated their attacks on the most visible symbols of Western global materialism and economic and military imperialism, the Twin Towers and the Pentagon. It is also of note that one of the logistics men on the team of nineteen hijackers, Majed Moqed, had been a professor of economics at King Saudi University in Riyadh.

However we see this event, the most important point is that it actually happened, no matter who caused it or how. In this regard the collapse of the World

Trade Center towers and the penetration of the Pentagon was the Inevitable Event both from the point of view of the biosphere and from that of prophecy as mandated by at least two major timing programs, the Gregorian and the Islamic. Of course, prophecy is a matter far from the consideration of the technocratic mind, so the immediate aftereffect is a heightened nationalism, patriotism, and commitment to war. But what is going on from the noospheric point of view is not so much the combat of different armed camps defending or attacking competing ideologies, but an end game, the biomass of the technosphere maneuvering against time in a self-destructive process that is really nothing more than the continuing collapse of that which it is defending.

How long will this collapse take? With the weapons of mass destruction currently at the disposal of the combatants, it shouldn't take too long before the human race realizes that if it doesn't stop the self-destructive process, it will soon be curtains for all life on Earth. A more significant question, if we wish to make the transition to a new time, is: How will the self-destruction end, and how can it be stopped-or can it? It is easy to see how wars begin, but no one can tell how they will end.

THE SOLUTION TO WAR: PEACE THROUGH CULTURE, PEACE OF THE BIOSPHERE

At the end of the First World War, the League of Nations was formed to keep the Second World War from happening. The League of Nations was unable to both effect the calendar reform it promoted and keep the Second World War from happening. These are not unrelated events. The Second World War effectively eliminated the League of Nations, and toward its end a new organization, the United Nations, was formed. Like the League of Nations, the United Nations was formed to prevent the next world war from happening. Within eleven years, the United Nations tabled the calendar reform begun by the League of Nations. Coincident with the formation of the technosphere, the United Nations has now also completed fifty-six years of existence. With the expanding "war against terrorism," is its purpose now over as well? The only way the United Nations can survive is to maintain its humanitarian agencies, for the age of nationalist politics and nation-states is over, succeeded by the politics of terrorism, the last politics of history. What new kind of global organization will we need at the end of the War on Terror, or World War III?

What we will need is an entirely new agency, a Planetary Biospheric Assembly that will model and create a sustainable *Pax Cultura, Pax Biospherica.* Given the failure to enact a calendar reform on the part of both the League of Nations and the

United Nations and in consideration of the chaos now clearly embedded in the Old Time, only an agency or instrument that fully embraces and promotes the calendar change will be able to move into the genuinely peace-fulfilling role that such an organization must take. If the United Nations could accept the route of calendar change as the only way to bring all humanity to a new point of discourse, then it could take on a renewed life. But if it cannot rise to this occasion, then another organization must take its place, the Planetary Biospheric Assembly. Even so, when we speak of the *Pax Cultura, Pax Biospherica,* we are speaking of a new human covenant, one in which the biosphere takes precedence over all nationalist corporate interests, and in which peace as a manifestation of culture is the primary value of the new time. Such a covenant would be a biospheric covenant, an agreement and understanding that, first of all, the human is a member of the biosphere, and second, that in consciously accepting the calendar change, the human is also in the process of becoming *Homo noosphericus.* Henceforth, it will be art and not money, bioregions and not nation-states, that will be the cause of social organization. Only in this way will humanity be guaranteed a true post-historical future.

Assuming the calendar change occurs on Blue Crystal Storm 2004, the first step in ~ngendering the full manifestation of the noosphere will be the dismantling of the technosphere. This can only be accomplished if a full reorganization of the human in time, inclusive of an adjudication of inequalities and a redistribution of wealth, begins to occur during the 2004-2005 Crystal Storm year. The following four years, 2005-2009, a genuine First World Peace, would see the constructive transformation of the five-part technospheric system. All the apparatus of heavy industry, energy, and the transport system would be turned like compost, to be replaced by non-polluting technologies and means of transport, while the cities would be transformed into urban gardens with the human race once more becoming decentralized. This process itself, a massive planetary engineering project with an eye on the full development of geochronomancy, would prove to be the greatest and most thoroughly positive transformation in human history. By 2009 humans reorganized by the Law of Time and having finally arrived at the "path beyond technology," will be enjoying universal telepathy, the noosphere-life beyond the Internet. By 2012 the humans will realize peace through culture as a permanent value, and by 2013 Earth will be galactically synchronized through a fully activated noosphere into the beginning of an entirely new geological era, defined by Vernadsky as the Psychozoic Era.

Pax Cultura, Pax Biospherica refers to both the new era of humanity following the devastation of the Final War and the governing body of bioregional councils (not nation-states) comprising the new world "government," the Planetary Biospheric

Arcturus Victory Strategy
Pax Cultura, Pax Biospherica

Telektonon, the Theater of Time, provides the journey through the Cube of the Law: Plane of Mind, Plane of Spirit, Plane of Will, and Divine Source Telektonon—each plane Seed-Storm year bundle, an entire universe of noospheric time!

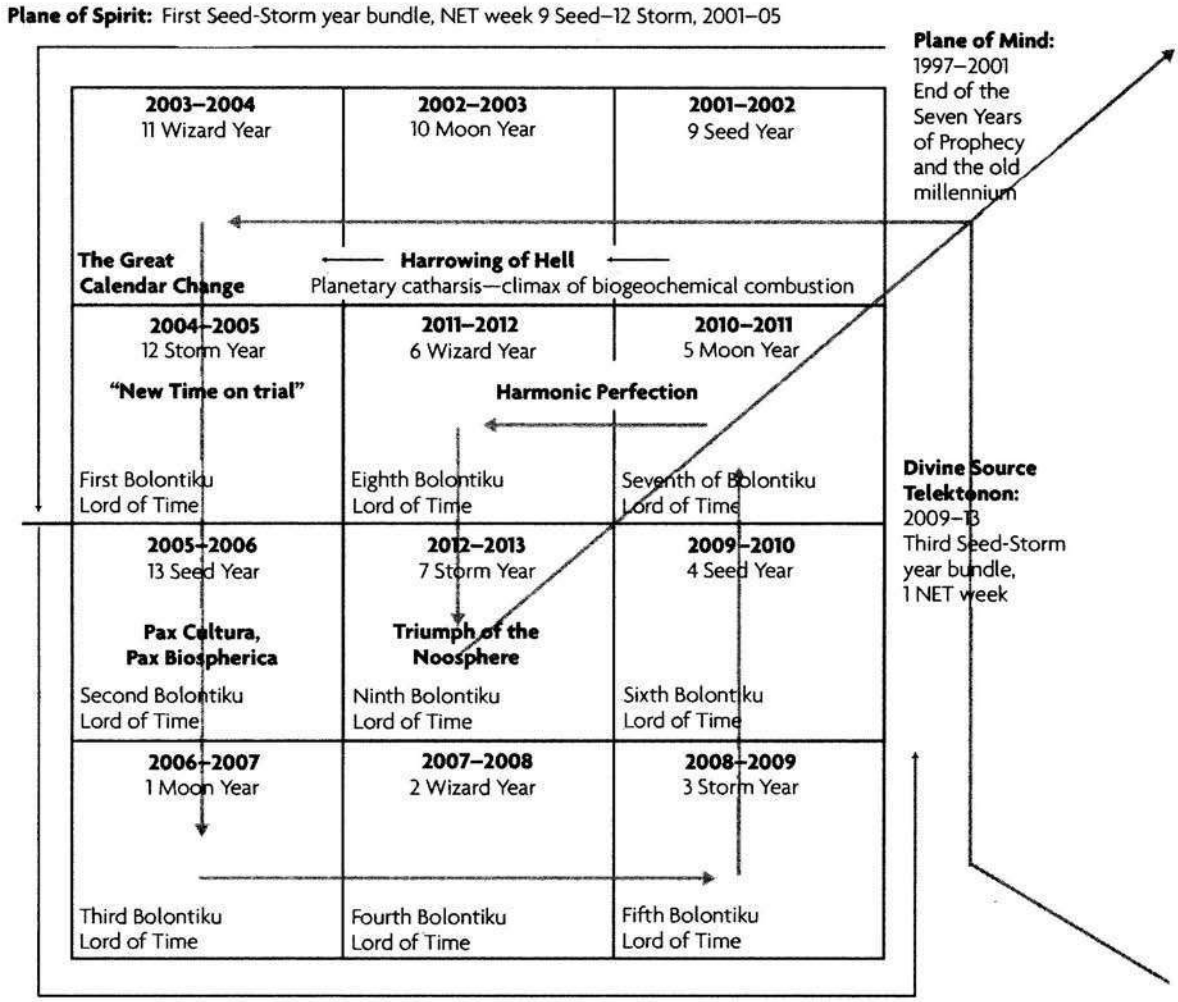

Assembly. The main purpose of the new governing body would be to monitor the advent of the noosphere. Overcoming Northern Hemisphere bias, the *Pax Cultura, Pax Biospherica* will not find any permanent seat, but will begin its existence as a planetary noospheric congress in the Southern Hemisphere. All of this could be made possible only because of the completion of the calendar change. So let us assume the best. The how-to of paradigm shift begins with the Thirteen Moon calendar.

If you follow the Thirteen Moon calendar or tell others to follow it with you, what is the payoff? The payoff is that you get to become a noospheric chip. Only a noospheric chip can bring Heaven on Earth, which is nothing more than full human participation in the noosphere. This is not at all a theoretical matter, but something that can be practiced and followed on a day-to-day basis. Fortunately, a path has been shown, complete with travel aids.

CONCISE *HOMO NOOSPHERICUS* HOW-TO TIME TRAVELER'S GUIDE TO THE BIOSPHERE-NOOSPHERE TRANSITION

This analysis of the Inevitable Event could never have occurred if the Law of Time hadn't been discovered and defined. The Inevitable Event simply supplied the Law of Time with precisely the right historical moment to provide a thorough analysis and explanation of time as the whole system in which we humans live and operate, inclusive of the biosphere, the technosphere, and the noosphere. As the chief discoverer of the Law of Time, assisted by my wife and an increasing number of other humans who have engaged the Law of Time, I have sought only to make a presentation of matters in which we, as a species, are thoroughly immersed, and thus find difficult to comprehend. Such is the technosphere, and such also is the medium of time. Since the publication of *The Mayan Factor* and my pursuit of the underlying mathematics of the Mayan calendar, I have remained outside the conventional arenas of discourse and communication, preferring instead to remain more anonymous in order to test the various hypotheses of the Law of Time.

In this process over the past twelve years, the Law of Time has precipitated from the noosphere various tools and didactic texts, all for the purpose of enabling us to make the shift from the old paradigm of the time of war to the new paradigm of the time of peace. These tools and principles are actually practiced on a daily basis, and so provide a pragmatic means of applying the Law of Time. Because of my vows and need for scientific "purity" of the experiment I have been living, I was involved at all times in doing my utmost to remain in the 13:20 frequency. For this reason, the tools and texts prompted by the noosphere to define the Law of Time were, for the most part, all produced outside the commercial mainstream. Now a great effort must be taken to make these tools and texts available to humanity in order to assist in the transition from *Homo historicus* to *Homo noosphericus*. By presenting a catalog of these tools and texts we only mean to suggest and define for the reader the scope and existence of a preliminary science of time and telepathy.

Part I. The Tools: Establishing Noospheric Earth Time (NET)

THIRTEEN MOON/28-DAY SYNCHRONOMETER

The harmonic standard of noospheric time, the Thirteen Moon/28-Day synchronometer, is a perpetual, harmonic calendar. It is called a Moon calendar because it is based on the female 28-day menstruation cycle, which is also the average lunar cycle. In actuality the moon goes around the Earth thirteen times a year. This means that the Thirteen Moon calendar is a genuine solar-lunar calendar that measures the Earth's orbit around the sun by the apsidallunation cycle of twenty-eight days. Thirteen perfect months of 28 days = 52 perfect weeks of 7 days = 364 days. The 365th day is called the Day Out of Time because it is no day of the week or month at all. This day, which falls on the Gregorian correlate date ofJuly 25, is a day for forgiveness and the artistic celebration of life and freedom. The synchronization or New Year's date of the Thirteen Moon calendar is July 26, and corresponds to the rising of the great star Sirius. This makes the Thirteen Moon calendar a tool for harmonizing ourselves with the galaxy. Of course, the Thirteen Moon calendar also synchronizes the phases of the moon in a pattern that demonstrates its regularity and order.

One of the great advantages of the Thirteen Moon synchronometer is that day/date calculations are amazingly simple. Any day of any week is the same for any Moon, any year. The first day of every Moon is always a Thirteen Moon Sunday (Dali). The last day of every Moon is always a Thirteen Moon Saturday (Silio). In the Thirteen Moon calendar the obscurely named Gregorian months are replaced by names that correspond to a fourth-dimensional cosmology of time. Each Moon also has a totem animal. The traditional names of the days of the week are replaced by galactic names that describe seven primary plasmas-electronically charged particles that activate our magnetic fields. The plasmas and their symbolic seals appear above the days of the week. The Gregorian calendar makes day/date calculations very difficult because the months are of uneven measure so the days and dates of the week vary from month to month and year to year. The Thirteen Moon calendar is truly unique because it is synchronized with the Harmonic Module, the measure of the universal 13:20 timing frequency.

THE HARMONIC MODULE

The basis of the Tzolkin or sacred 260-day count of the Maya, the Harmonic Module is the 13:20 synchronization gauge and permutation table that consists of thirteen sequences of twenty icons or solar seals and twenty sequences of thirteen galactic tones, 1-13. The resulting 260 permutations, combined with the perfect harmony of

the Thirteen Moon calendar, give each day a unique quality of tone and icon known as a kin or one NET minute. The two cycles-Thirteen Moons/28 days and the 260-day Harmonic Module-perfectly mesh every fifty-two years to complete one NET year. In one NET year of 18,980 kin, no two days are the same! Each of the units in the Harmonic Module is called a kin, the base unit of synchronic measure. Articulating the Harmonic Module is a pattern of fifty-two Galactic Activation Portals. See if you can find the radial sequence of thirteen sets of four, counting inward from the corners. Notice that the numbers of each set of four equals 28. Thirteen sets x 28 = 364, the number of days in the Thirteen Moon calendar! (See image containing the Harmonic Module on page 170.)

W AVESPELL

The thirteen-unit form constant of fourth-dimensional time is the wavespell. It is important to see the Thirteen Moon calendar in this modular format, Planetary Service Wavespell, for then it makes more sense to speak of the calendar as a synchronometer. The wavespell's form describes the motion of time as a fractal fourth-dimensional cosmology. The numbers 1-13 in the dot bar notation that code the thirteen positions are known as tones. The names of the tones in sequence define the cosmology, which is also evident in the very structure of the wavespell. The thirteen tones give their names to the thirteen Moons. The structure consists of two gates, the Magnetic and the Cosmic, the first and the thirteenth moons/tones, which correspond to the two entrance and exit gates or portals. Complementing the two gates are the two towers, the fifth or Overtone tower and the ninth or Solar tower. The two gates and the two towers, tones 1, 5, 9, and 13, articulate the structure of the wavespell. Between the places of articulation are three sets of chambers. The first set, tones 2-3-4, helps establish the wavespell; the second set, tones 6-7-8, helps extend the wavespell; and the third set, 10-11-12, serves to convert the wavespell. (See plate 2, Planetary Service Wavespell.)

The structure of the wavespell also defines a four-dimensional geometry of time that connects different points of the wavespell over time. Each of these dimensional geometries is known as a pulsar. It is useful to know the pulsars in extending the mind synchronically over different timing sequences. The fourth-dimensional pulsar connects the four points of articulation, 1-5-9-13, or Magnetic, Overtone, Solar, and Cosmic Moon/tones, and is called the fourth-dimensional time pulsar. The first-dimension life pulsar connects the positions 2-6-10, or Lunar-Rhythmic-Planetary Moon/tones. The second-dimensional sense pulsar connects the 3-7-11, or Electric-Resonant-Spectral Moon/tones; and the third-dimensional mind-form pulsar connects

the 4-8-12, or Self-existing-Galactic-and -Crystal Moon/tones. Remember, the wavespell accommodates any sequence of kin whose tones correspond to 1-13, and may be either a thirteen-day wavespell cycle, a thirteen-week cycle (one-quarter of an NET day), a thirteen-Moon cycle (one NET day), a thirteen-year cycle (one NET Season), and so on. Once you know the wavespell you have come to know the form in time of the noospheric mind.

THE WAVESPELL'S TONES AND THEIR PULSARS

1. Magnetic tone of purpose-fourth-dimension time pulsar
2. Lunar tone of challenge-first-dimension life pulsar
3. Electric tone of service-second-dimension sense pulsar
4. Self-existing tone of form-third-dimension mind-form pulsar
5. Overtone tone of radiance-fourth-dimension time pulsar
6. Rhythmic tone of equality-first-dimension life pulsar
7. Resonant tone of attunement-second-dimension sense pulsar
8. Galactic tone of integrity-third-dimension mind-form pulsar
9. Solar tone of intention-fourth-dimension time pulsar
10. Planetary tone of manifestation-first-dimension life pulsar
11. Spectral tone of liberation-second-dimension sense pulsar
12. Crystal tone of cooperation-third-dimension mind-form pulsar
13. Cosmic tone of presence-fourth-dimension time pulsar

DREAMSPELL

Described as the fourth dimensional tool kit, the Dreamspell also encodes a psycho-mythic cosmology known as the Journey of Timeship Earth 2013. It is this cosmology that makes the Dreamspell a psychoactive tool kit for personally engaging you in the fourth-dimensional synchronic order of time. The fundamental premise for making it psychoactive lies in finding your galactic signature, the color, icon, and tone that code your date of birth. This combination of factors-color, tone, and icon-establishes a mathematical code that allows you to use your galactic signature in mapping increasing orders of synchronicity. There are four colors, thirteen tones,

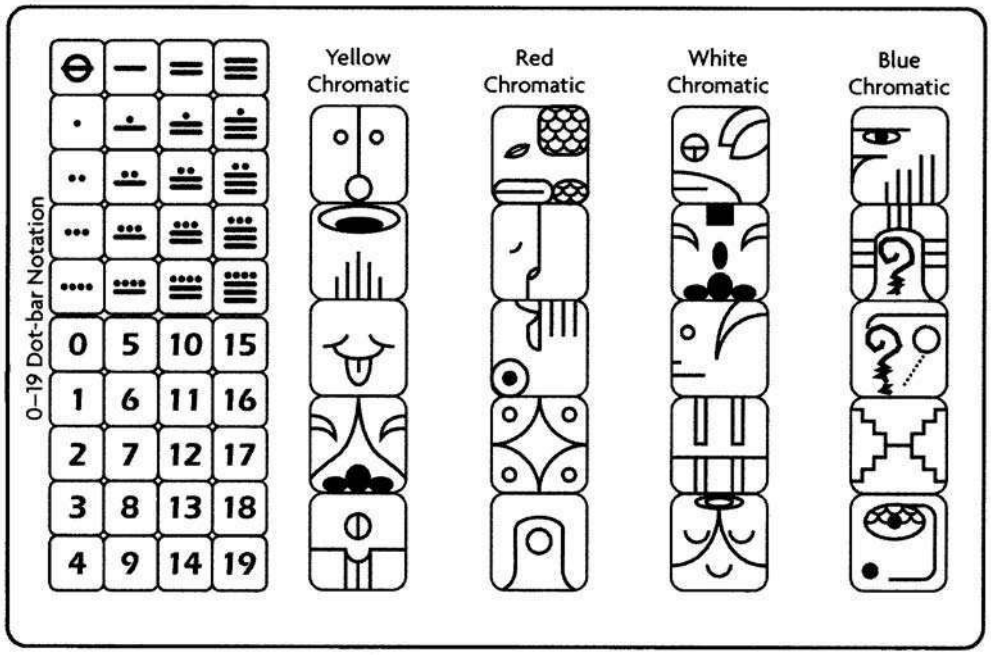

The Four Chromatics

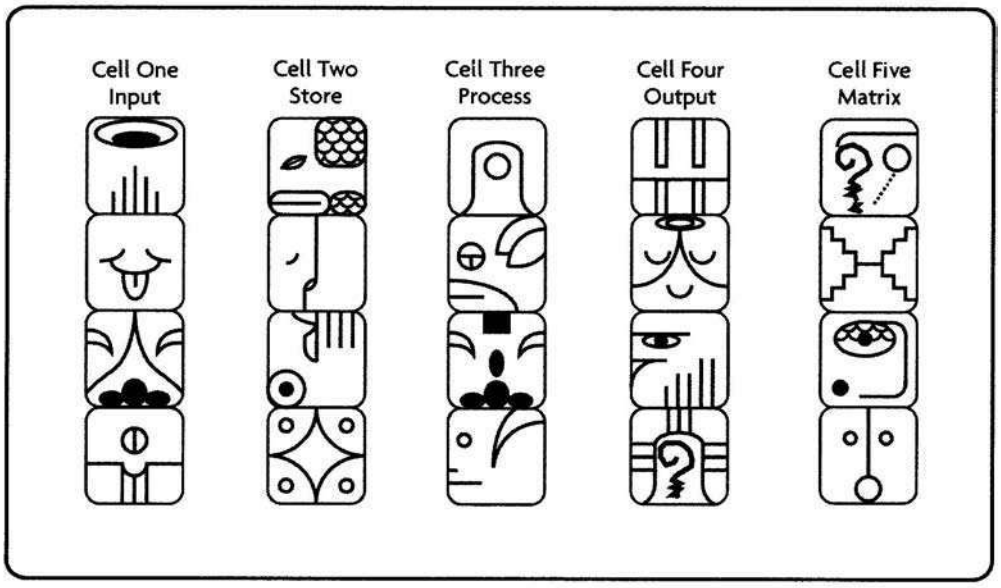

The Five Time Cells

and twenty icons. The four colors code each of five sets of icons and correspond to the base four-phasic function of the noospheric rainbow brain-red initiates, white refines, blue transforms, and yellow ripens. The icons themselves actually correspond to the mathematical code 0-19.

Colors and Icons with Their Corresponding 0-19 Code Numbers:

Red Family: Dragon (1), Serpent (5), Moon (9), Skywalker (13), and Earth (17)

White Family: Wind (2), World-bridger (6), Dog (10), Wizard (14), and Mirror (18)

Blue Family: Night (3), Hand (7), Monkey (11), Eagle (15), and Storm (19)

Yellow Family: Seed (4), Star (8), Human (12), Warrior (16), and Sun (20 = 0)

The mapping of synchronicity through use of the galactic signature is done through a set of tools: the Galactic Compass, Journey Board, Oracle Board, and Time Atom Cube. The point of engaging the Dreamspell is to learn of the infinite possibilities of fractal synchronic mapping of the events of your life and the lives of your family and friends, as well as current events and human history. The compass and boards describe the radial mathematics of fourth-dimensional time and also provide the means for fully engaging the synchronic order of the noospheric mind. The interactive complex of changing the family and clan relations to which the galactic signature entitles you also provides the basic patterns of social organization in time. The Dreamspell is indispensable for education concerning the radial, fractal nature of fourth-dimensional time and mathematics.

TELEKTONON

Meaning "Earth Spirit Speaking Tube," *Telektonon* is the name of the prophecy of Pacal Votan, and the definition of a complex program for establishing universal telepathy. It should be noted that the tomb of Pacal Votan was discovered in 1952, after 1,260 years, because of a tile tube, the Earth Spirit Speaking Tube, which ran from the top of the pyramid temple, down the secret stairwell, and into the wall of the elaborate tomb beneath the pyramid. The prophecy itself was decoded from the inscriptions and symbols of the elaborately carved sarcophagus lid of the tomb. Essentially defining a period of "Seven Years of Prophecy," (1993-2000), followed by a 13-year Cycle of Creation (2000-2013), the Telektonon is practiced on a daily basis by means of a board and various moving parts.

The purpose of the daily play is to learn how to operate by a set of coordinates that define the nature of telepathic consciousness as the interplay of five circuits that connect the ten planetary orbits (the Asteroid Belt, remnants of the lost fifth planet Maldek, is included as one of these orbits). The key interplanetary connection is between Earth, the third planet, and Uranus, the eighth planet, which creates the third or biotelepathic circuit. The Earth-Uranus circuit constitutes twenty-eight steps and thus corresponds to the 28-day measure of the Thirteen Moon calendar. Between days 7 and 22, one is

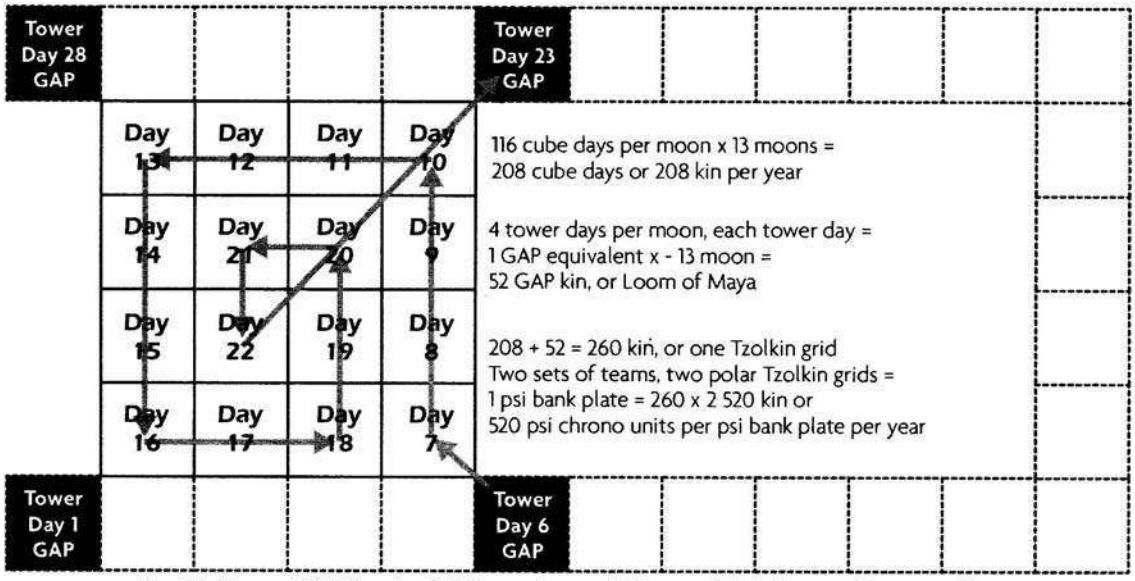

The Telektonon Grid: Showing Psi Chrono, Loom of Maya, and Cube Journey Correspondences

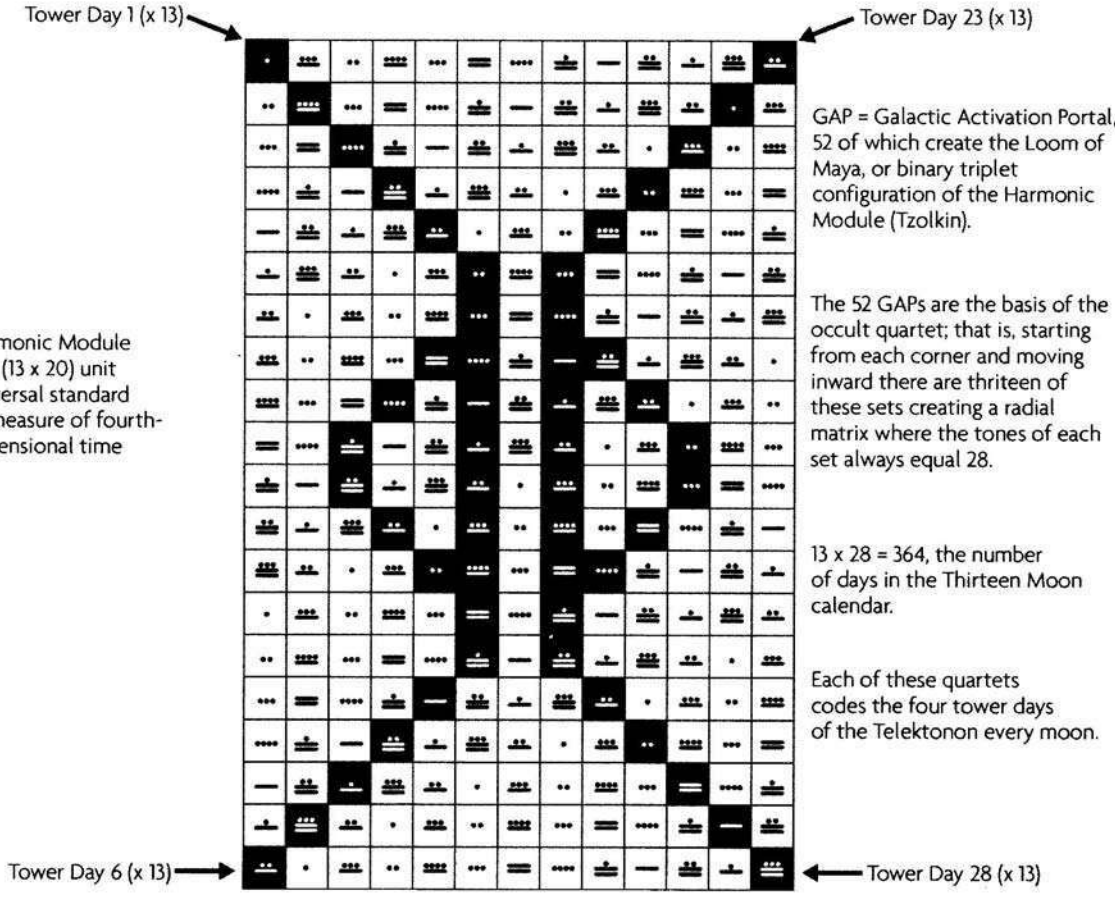

Telektonon - Rinri GAPs and Towers with Harmonic Module

able to take the "Warrior's Cube Journey" to uncover knowledge hidden by the Tower of Babel. The sixteen positions of the Cube of the Law (days 7-22) are the heart of the Telektonon play, which also includes a rehearsal of the thirteen baktun history with the intention of "redeeming the Babylon planet" as Timeship Earth 2013.

THE RINRI PROJECT

Described as a "four-year telepathic biosphere-noosphere transition Circumpolar Rainbow Bridge Experiment," the Rinri Project builds on the Telektonon play that establishes the biotelepathic circuit. On this circuit, two towers, days 1 and 6, define a four-day Earth Walk, and two towers, days 23 and 28, define a four-day Heaven Walk. Between the second and the third towers, days 6 and 23, are the sixteen positions of the Cube of the Law, days 7-22. The four towers every Moon correspond to one radial set of four Galactic Activation Portals in the Harmonic Module-thirteen moons x four towers = 52 Galactic Activation Portals (GAPs). Sixteen cube positions each moon x 13 Moons = 208, the remaining number of kin in the Harmonic Module once the 52 GAPs have been subtracted from the 260 units. Since the Harmonic Module is the basis of the psi bank, this formulation provides a way of coordinating the four psi bank plates of the noosphere to the Thirteen Moon calendar year on a daily and annual basis.

Since there are four plates, it takes four years, one year per plate, to open the psi bank. The first opening occurred between 1996-2000. The second opening, 2000-2004, is now occurring and is programmed by a coordination of the twenty-four runes of the Elder Futhark to the twenty-four psi membranes-6 runes per week every Moon x four weeks = 24. Since each psi plate is a mirror symmetry pair of Harmonic Modules, reflecting the North and South magnetic poles of the Earth, the Rinri project is practiced by telepathically interactive teams in the Northern and Southern Hemispheres. The Rainbow Bridge refers to making visible the dynamic of Earth's electromagnetic aura and extending it permanently from pole to pole. This is how the noosphere is visibly manifest.

Rinri is a Japanese word meaning "ethical enlightenment," and its application includes seventeen moral precepts that are studied during the sixteen-day cube journey, the seventeenth corresponding to the tower day 23.

260 POSTULATES OF THE DYNAMICS OF TIME

While the Telektonon is predicated on the fourth-dimensional tool kit, the Dreamspell, the 260 Postulates of the Dynamics of Time elaborate on the nature and theory of the biosphere-noosphere transition by providing a set of twenty systematic

thirteen-part logics that describe and define the dynamics of time as the evolution of consciousness. Because there are 260 postulates corresponding to the 13:20 matrix, a postulate can be studied and meditated on each day over a 260-day cycle according to the code number of the daily icon combined with the number of its tone, for example, Red Lunar Dragon, where Dragon is 0-19 code number 1, and Lunar is tone 2, therefore the postulate to study for the day is 1.2. This daily programming, established by the Telektonon practice is how knowledge is reformatted according to the synchronic order. This in itself precipitates the noosphere.

TWENTY TABLETS OF THE LAW OF TIME, SIXTEEN-YEAR CUBE OF THE LAW

The Twenty Tablets can be described as a road map of the fourth dimension. By focusing on a sequence between the years 1997-2013, by fractal analogies, the telepathic engagement encompasses the 26,000-year cycle as well as the coming cycle of the Psychozoic future. The crux of the daily play of the synchronic order is called *cubing the codon.* The point is to telepathically reharmonize the DNA that has been adversely affected by the 12:60 timing frequency. There are sixty-four DNA codons whose six-part binary structure is identical to that of the sixty-four hexagrams of the I Ching when both are written with a simple binary language of broken or unbroken lines. Each of the codons establishes a precise thirteen-stage permutation sequence. 64 x 13 = 832 codon permutations. The sixteen years from 1997 to 2013 also constitute 832 weeks (16 x 52 = 832 = 64 x 13). Therefore, each codon has one-quarter year, thirteen weeks, to run its permutation sequence, one sequence per week. Since each codon consists of six lines, each week the codon is built one line per day for six days, each line adhering to one side of a cube. On the seventh day, the codon is cubed and sealed by one of sixty-four "UR Runes." The UR Runes are the master cosmic runes, each of which governs an entire thirteen-unit codon permutation sequence. The Twenty Tablets also contain much synchronic information for experiencing what is referred to as *fractal time compression,* the expanded mental ability to engage in different planes or levels of time simultaneously. All of this is to establish a mind training for fully engaging the fourth-dimensional synchronic order of reality and time travel.

7:7::7:7 TELEKTONON REVELATION

While the Twenty Tablets of the Cube of the Law synchronize the DNA Codons in all their permutations on a weekly basis over a sixteen-year cycle, the 7:7::7:7 Telektonon Revelation establishes the 28-day cycle as the basis for synchronizing

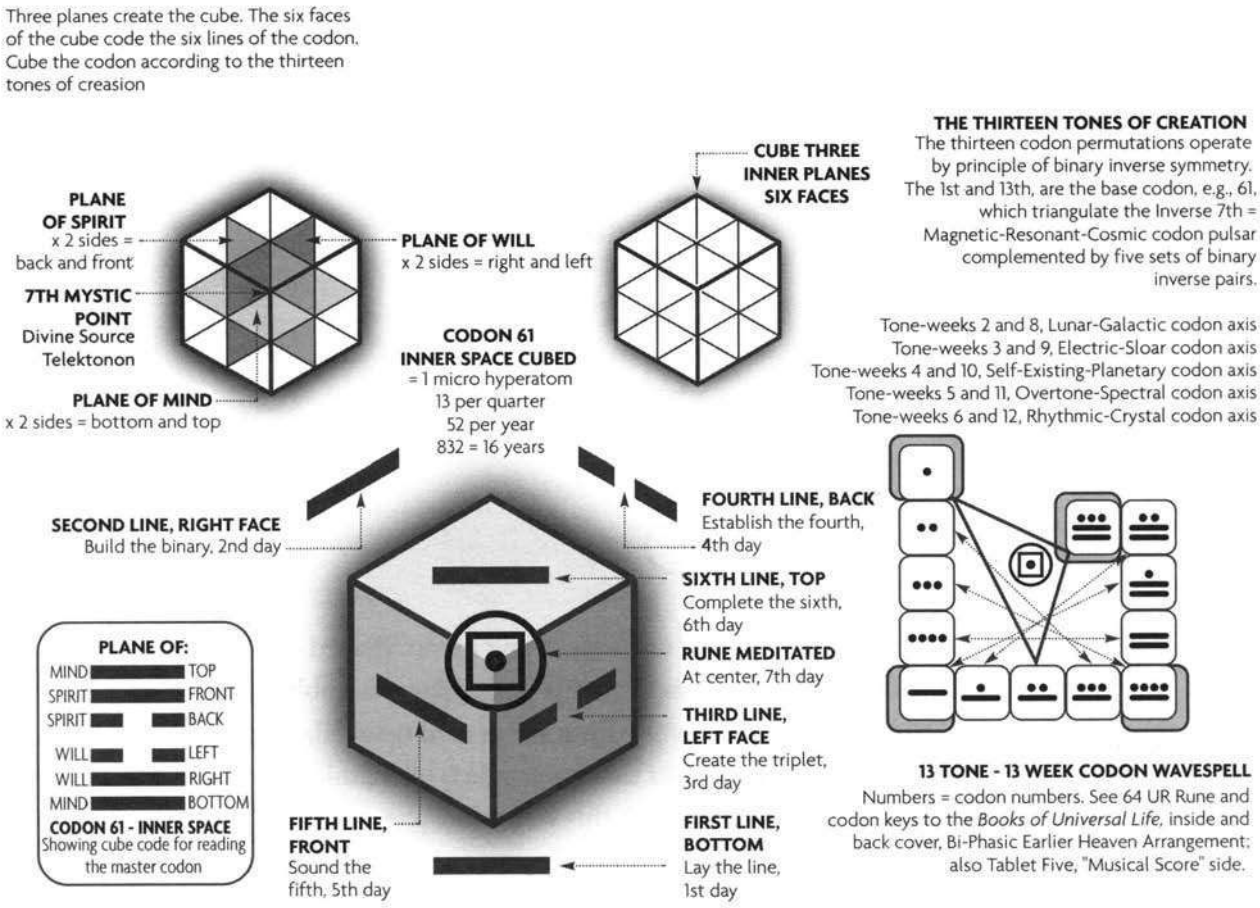

Codon Cube Cosmology
Sounding the Thirteen Tones of Creation

the seven primary plasmas-electronically charged ions-into four aggregates called time atoms. The seven plasmas, which also replace the names of the days of the week, are in two sets of three, with the middle or fourth acting as a catalytic agent. The first three plasmas form a sensory quantum and the last three plasmas form a telepathic quantum. Activation of the plasmas releases radion, a telepathic lubricant; hence, the seven plasmas are also referred to as radial plasmas. The four plasmic aggregates are known as the Analog Time Atom (week 1), the Antipode Time Atom (week 2), the Occult Time Atom (week 3), and the Unified Field Time Atom, (week 4). Like the Twenty Tablets, the 7:7::7:7 Telektonon Revelation also involves principles of fractal time compression where each day during the first week is the equivalent of 260 moons or twenty years; the following two weeks, each day is thirteen

The Seven Seals, Seven Radial Plasmas

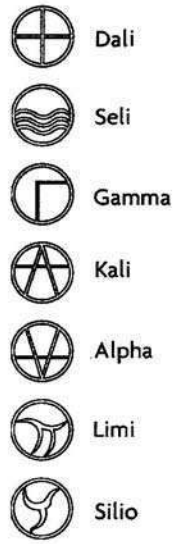

moons or one year; and the last week each day is one moon. Played on a board with cards containing affirmations from the Buddhist sage, Padmasambhava, the object of the 7:7::7:7 is to place the time atoms within the crystal octahedron at the center of the Earth so that each Moon a master time molecule is telepathically placed at the center of the Earth per one NET hour. In this way, Noospheric Earth Time is activated, the telepathic mind is engaged with the phenomenal reality represented by the plasmas, and the rainbow brain of the noosphere is hastened into everyday presence.

The seven daily plasmas constituting one thirteen-moon week, or one NET quarter hour are:

Dali (Sunday)-thermic charge

Seli (Monday)-luminic charge

Gamma (Tuesday)-luminic-thermic charge (these first three create one sensory quantum)

Kali (Wednesday)-luminic-thermic, thermic-Iuminic catalytic agent

Alpha (Thursday)-double-extended electron at the South Pole

Limi (Friday)-mental electron at the North Pole

Silio (Saturday)-mental electron-neutron at the center of the Earth (these last three create one telepathic quantum)

Part II. The Peace Plan: Establishing the *Pax Cultura, Pax Biospherica*

From the time of the formation, or rather, the calling into existence of the World Thirteen Moon Calendar Change Peace Movement, there had to be a *World Thirteen Moon Calendar Change Peace Plan.* The original of this Plan was submitted to the United Nations in 1995 for its fiftieth anniversary. The crux of the Peace Plan is that to change the world standard calendar is the opportunity for humanity to stop in its tracks and redirect itself. By stopping in its tracks to change its timing frequency, humanity can also use the opportunity to call a universal cease-fire and declare an emergency peace worldwide. Only in this way can the new time be experienced and fully engaged.

At the First Planetary Congress of Biospheric Rights (1996), this Peace Plan was extended to include the establishment of a new human covenant that would restore to humanity its intrinsic biospheric rights, the same as enjoyed by the rest oflife in the biosphere: free land, clean air, clean water. The premise of the Biospheric Covenant is that humanity is first and foremost a member of the biosphere, and not of any artificially constituted nation-state. The Biospheric Congress also mandated the revival of the Banner of Peace and Roerich Peace Pact (1935) as one of the emblems to be used to identify the biosphere as a zone of peace.

The World Congress on the Law of Time and Judgment Day Tribunal (1997) extended the Biospheric Congress to include an indictment of the Gregorian calendar as a crime against the biosphere-"the crime of the millennium"-and the establishment of the Law of Time, inclusive of the Twenty Tablets, as the new dispensation of knowledge awarded in compensation to humanity, based on the synchronic veracity of the Thirteen Moon Calendar Change Peace Plan.

By 1999, the World Summit on Peace and Time provided the Declaration of Calendar Reform and a set of People's Resolutions, which were presented to the United Nations and the Vatican. The Resolutions define a seven-part educational program, which, like the Biospheric Covenant, envisions a radical reorganization of human society.

The purpose of these documents and declarations is for the creation of a state of universal unconditional peace so that human society can be rebuilt as a harmonic unity in phase with the biosphere as a whole. The result of the Thirteen Moon Calendar Change Peace Plan would be the creation of a new order oflife on Earth-the *Pax Cultura, Pax Biospherica.*

9

The Advent of the Noosphere

A Prayer and a Vision

IT IS MORNING once again, or, rather, it is predawn. It is still the first watch of the day. Outside there is a full moon. On the Gregorian calendar it is November 1, 2001, All Soul's Day, the sequel to Halloween, the day of honoring the dead. In another two weeks it will be the New Moon of Ramadan, Islamic lunar year A.H. 1422. On the Thirteen Moon synchronometer itis now the fifteenth day of the Self-existing Owl Moon, the moon of form, the moon to define, measure, and ask the question, "What form will my service take?" Well, my service will be to complete this book and prepare it for the world, for now it is the time of the advent of the noosphere, the reality of which Vernadsky said must be communicated to the world's politicians and statesmen. They didn't listen then. WIll they listen now? And on the 260-kin synchronization gauge it is kin 42, White Electric WInd. The WInd "communicates spirit," the Electric tone "activates service." WInd is the second of twenty solar seals that code each day in the synchronic order.

By its mathematical relationships to the other nineteen solar seals, the solar seal of the daily kin possesses a unique five-part oracle. In today's oracle the WInd is guided by the World-bridger, who brings the power of death. In the psi bank, the matching psi chrono unit for today, the fifteenth day of the Self-existing Owl Moon, is kin 66, Magnetic World-bridger, the first tone in the 13-kin wavespell of the World-bridger, which means today is very strongly penetrated by the power of death. What is death to the noosphere? An inevitable and unavoidable event, a critical and

The 20 Solar Seals
Names, Actions, and Powers

equalizing stage in the recycling of biomass, a furtherance of the biogenic migration of atoms, the creation of biospheric compost, a release of consciousness back into the noosphere, an opportunity to consider the value oflife. But to the ordinary mind of the artificial technosphere, death is the ultimate object of fear, and the fear of death is the chief object of manipulation by those who generate terror. It is of note that by his date of birth, March 10,1957, the galactic signature of Os am a Bin Laden is White Solar World-bridger, kin 126, while for this, his forty-fourth year, his birthday was coded by kin 66, White Magnetic World-bridger, both signatures bearing the destiny seal of the power of death. This is an example of how the synchronic order is "read" on a daily basis.

It is a mistake to think that the terror is just the malevolent intention of a single human being. The terror is co-extensive with the technosphere. In fact, the technosphere is the age of terror. The terror was generated at Hiroshima, and repeated at Nagasaki fifty-six years ago. And the terror was compounded by the original perpe-

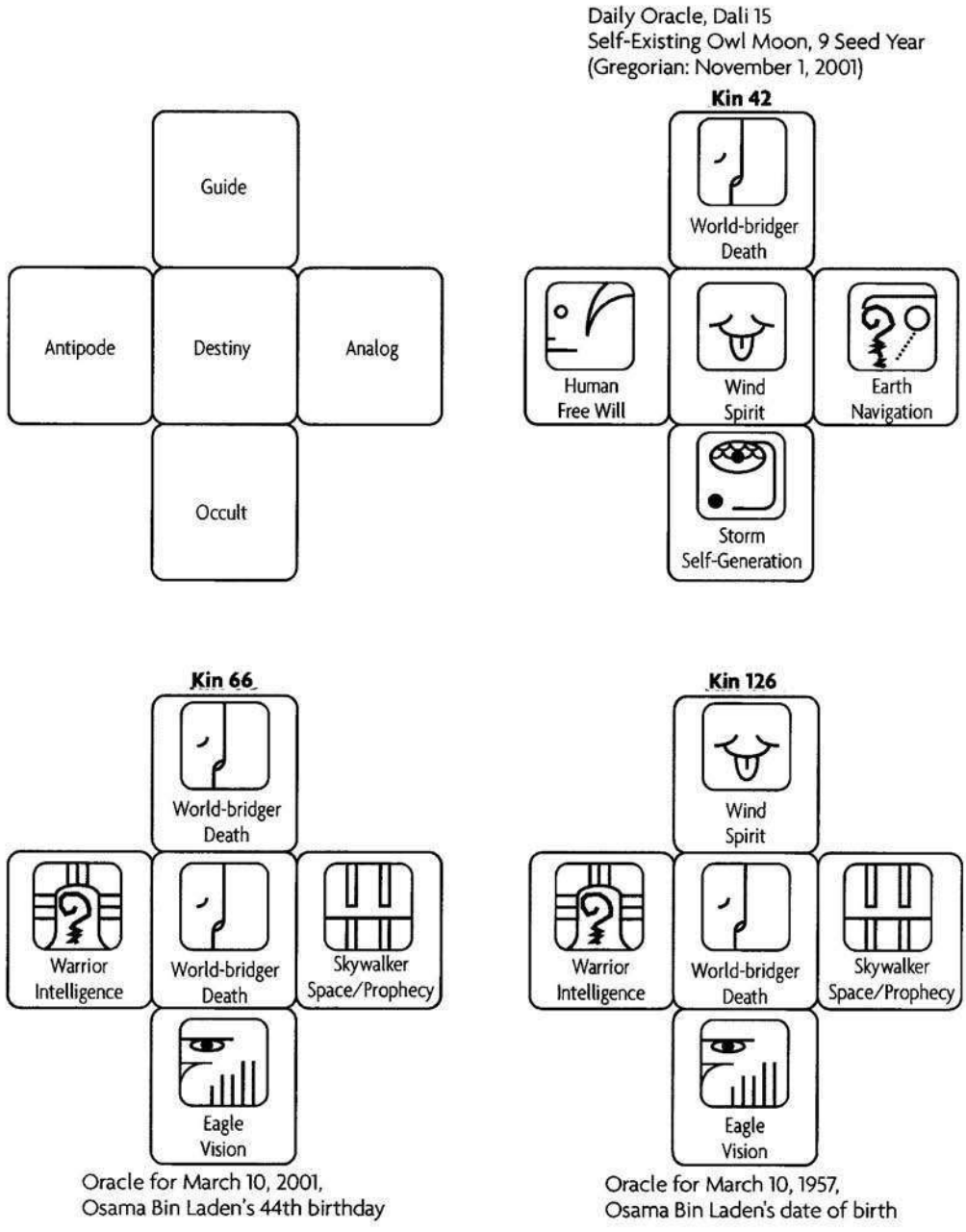

Daily Oracle Matrix

trators of that terror many thousands of times over in the creation and stockpiling of weapons of mass destruction, an act soon imitated by the then archrival, the Soviet Union, and by other nation-states, namely, the United Kingdom, France, and China. Those called the "terrorists" today have nothing to compare to the stockpiles of these weapons by these five nation-states who constitute the permanent members of the United Nations Security Council-the "nuclear club." That is who rules the world today, the official possessors of the weapons of mass destruction, who jealously guard their secrets. If this is the ultimate ruling body of the planet, and the reason why they are the ruling body is their possession of these instruments of death, then why should anyone be surprised at the existence of "terrorists" in the rest of the world? And why, we may ask again, are these terrorists mostly, it would seem, from the Islamic world? In addition to the nuclear arsenals, there are the biological and chemical weapons of mass destruction. Those who live by the manufacture of terror must surely die by their own means. If other nations have developed the same systems of terror, it is only in self-defense or in imitation of the masters of terror.

Everyday for four weeks now, I have been waking up at this time to continue work on this text, *Time and the Technosphere*. I had at first thought that the book could be complete with eight chapters. People don't have time to read, and the topic warrants as brief and pithy an explanation as possible. After all, it is really a time of reflection-and then action. The masters of terror have cloaked themselves as the protectors of civilization and as the moral crusaders who will rid the world of evil. Yet what is civilization today but the resource-consuming cancer of the biosphere? Is this what is being protected-the right to promote the disease upon the biosphere? The terrorists who attacked the Twin Towers and the Pentagon clearly knew the symbolic and actual value of their targets. They also undoubtedly knew the depths of the death-fear of the superpower masters of terror, whose reaction would most likely foment a global war. But in such a war, who would win? In this regard, from the noospheric perspective, the Inevitable Event was the technocide-death by technospheric means-of the technosphere itself. The technosphere was created by and thrived on means of terror, and the means of massive terror as well as the economic imperialism perpetrated by the superpower managers of the technosphere could only have produced a reaction against itself known as terrorism. The end result is collective suicide. There are no flags in the blood of the dead, nor is there any evident religious belief. There is only human biomass ultimately indistinguishable and anonymous to the biosphere.

Eight chapters were needed in order to complete the information about the biosphere, technosphere, noosphere, and the Law of Time. Maybe a new spirit of the

biosphere will arise from the considerations of my book. Maybe the noosphere will spark in others the need to allow the biosphere to reclaim us from the technosphere. Anyone who says this is "turning back the clock" is only betraying their immersion and unexamined belief in the reality of artificial mechanical time. Yes, eight chapters were necessary to unfold this analysis and solution. But I knew there had to be a ninth chapter for the testament to be complete. For this is a living testament, and if anything has been learned by living according to the synchronic order of fourth-dimensional time, it is the renewed power of number itself. There is a power and meaning to number understood as a universal, self-existing mental construct. The synchronic order is constructed of number. And as Pythagoras perceived, number is a kind of spiritual entity that can only be aroused by an act of meditative contemplation. Each whole number bears its own resonance. You can feel this in the contemplation of the difference between even and odd numbers.

The resonance of 8, an even number, is harmonic order and balance, geometrically evident in the octagon or the octahedron. But the resonance of9, an odd number, is quite different. Nine months to give birth, three times three, a rhythmic triplicity-that is nine. The Germanic god-hero Odin, or Votan, spent nine nights hanging from a tree in order to gain knowledge of the mysteries of woman. When the tomb of Pacal Votan was opened on June 15, 1952, it revealed a large vaulted chamber beneath the pyramid of the inscriptions in Palenque, Chiapas, Mexico. Entering the tomb, in the center of which is the famous sarcophagus, one sees on the walls the beautifully sculpted figures of nine personages. Today these sculptures have almost completely worn away. But originally, these low-relief sculptures modeled out oflimestone, depicted with great elegance, a series of figures commonly known as the Nine Lords of Night, or the Nine Lords of Time. Are the Nine Lords of Time, the Lords of Night who guard Pacal Votan in his tomb, the same as the nine nights of OdinIVotan? And who was Pacal Votan? With what mythic resonance are we dealing?

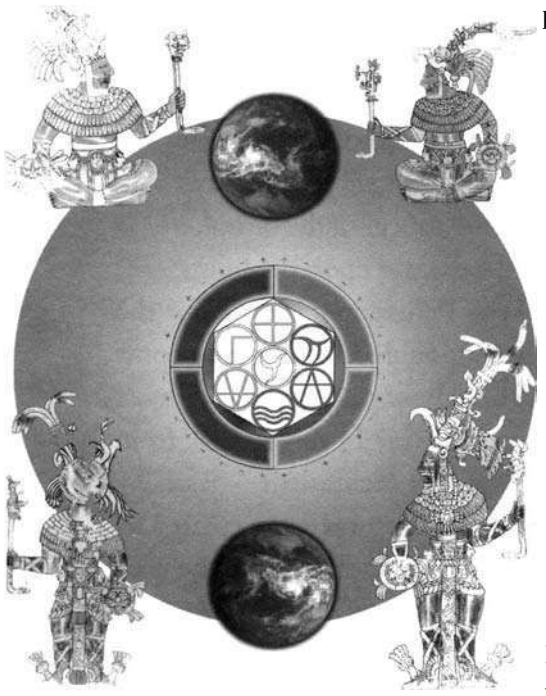

Nine Lords of Time Begin to Gather for a Council of the Earth

A Mayan seer, a sage-king of the seventh

century of the Christian era, had deliberately created a mysterious tomb for himself, only to have it hidden, buried beneath a pyramid temple, but a tomb intended to be opened more than twelve centuries later, in the seventh year of the time of the terror, the time of the technosphere. How ingenious, how uncanny, that it would have been unknown for 1,260 years-a number also known in the thirteenth chapter of the Book of Revelations as the number of days of exile of the woman clothed with the sun, her feet on the moon, and twelve stars around her head. What does this allegory mean? Is it not the same as the exile of the human soul in the deadening world of 12:60 materialism? Sixty years remained from the opening of that mysterious tomb to the closing of the cycle of history, the omega point of 2012. How could the timing of the opening of the tomb have occurred so precisely-1,2 60 years from dedication to discovery, 1,320 years from its dedication to the closing of the cycle? How could those years be such a perfect reflection of the artificial 12:60 and the natural 13:20 timing frequencies? How could a Mayan sage in Central America so long ago be able to see, it would seem, into our future?

When we study the globe and consider things synchronically from the perspective of the noosphere, we find some interesting correspondences. Pacal Votan lived in the tenth baktun cycle, between the Christian years 603-683, on the opposite side of the world but at almost the same latitude as Mecca, and just after the time of Muhammad, 570-632. Today the religion that God commanded Muhammad to found, Islam, is at the center of the terrorist storm, while the prophecy of Pacal Votan and of the Mayan calendar in general has placed the end point of history at 2012, a mere eleven years after the Inevitable Event that placed Islam at dead center of the world mind. How could this be, the religion of the prophet Muhammad and the prophetic timing of the Maya so close at hand? Is this some revelation of the Nine Lords of Time, or of God speaking through them-and who are the Nine Lords of Time? Are they destined to return? Could it be that the Nine Lords of Time, like some higher dimensional Lords of the Ring, are a manifestation of time to be released, one by one, in an annual sequence during the last nine years of the Great Cycle, 2004-2013?

These Nine Lords of Time are known in Mayan as the Bolontiku; their counterparts are the Oxlahuntiku-the nine lords and the thirteen lords, respectively. The nine lords govern the underworld, the time of the third dimension, which is why they are depicted in descent to the sarcophagus of Pacal Votan, while the thirteen lords govern the heavenly realms. The nine govern the nine vigesimal orders of number, while the thirteen govern the form of time. The dedication of the tomb of Pacal Votan in A.D.692 corresponded to the Long Count baktun date of9.13.0.0.0.

The nine and the thirteen lords-Bolontiku and Oxlahuntiku-are present in the very numbers of the dedication date. And the nine and the thirteen also governed the prophecy of Quetzalcoatl, of Thirteen Heavens of decreasing choice and Nine Hells of increasing doom. This prophecy refers to the sequence of twenty-two 52-year cycles that began in A.D. 843 and ended in A.D. 1987. Six years later, in 1993, during the first year of the 260th and final katun cycle of history, I began to decode the prophecy ofPacal Votan, some forty-one years after the tomb had been opened.

Telektonon, the Prophecy of Pacal Votan, was meant to be decoded precisely and only at the moment of its absolute usefulness, kin 144: Yellow Magnetic Seed, July 26, 1993. This moment defined the Seven Years of Prophecy, 1993-2000. It also established the validity of the Dreamspell or WIzard's Count as the reformulated Year- Bearer Count of the Chilam Balam, the jaguar priests or night seers. That is, the Telektonon Prophecy could only have been triggered when kin 144 occurred as the Year Bearer, Yellow Magnetic Seed, kin 144, correlated to the Gregorian date of July 26, 1993.

The precise revelation of this prophecy on kin 144, July 26, 1993, was dependent on and could only have occurred because a prophetic count, the WIzard's Count, derived from the prophetic tradition of the Chilam Balam, had already been established. This "count" provided the basis of *The Mayan Factor* and was woven into the conclusion of the Prophecy of the Thirteen Heavens and Nine Hells, Harmonic Convergence, August 16-17, 1987. And the precise number of kin 144, the revelation date of the prophecy of Pacal Votan was meant to accord with the Book of Revelations number of the elect, 144,000 (Revelations 7:4). In fact, that very day I discovered that the number 144 transliterated from the vigesimal count into Arabic numbers is written 7.4, which is the same as the chapter and verse number where the 144,000 are first mentioned in the Book of Revelations (7 = 140, or 7 x 20, plus 4 units = 7.4). More uncanny stuff-but not so to the noosphere, the Earth's mind of time. In the noosphere everything is woven of number, and number is intrinsically synchronizing, which is why numerology has held such a fascination for the human mind throughout history.

When I first began to decode this "final prophecy of the Maya," or Telektonon, a prophecy that commands the return to natural time through the Thirteen *Moon!* 28- Day calendar, I was stunned and not a little frightened. I had already taken many steps to remove myself from mainstream society and conventional life. But now I was dealing with a genuine prophecy, and I was to be its messenger. This was not my invention. The world is filled with enough madmen and lunatics spouting their particular visions. How could I ever make the world understand that this vision, this prophecy, was real, that it was the fulfillment of a Mayan who lived and died thirteen

Vinal position, one dot = 20 kin, 7 = 140 (7 x 20)

Kin position, one dot = 1 kin, 4 = 4

Written 7.4 = 144 (140 + 4)

7.4 = 144

centuries ago, and that his tomb was the vehicle of this prophecy, a prophecy meant precisely for this moment in time-the biosphere-noosphere transition?

I returned to the texts of the Chilam Balam, whose prophetic stream includes day prophecies, year prophecies, katun (twenty year), and *ahau* (260-year) cycle prophecies, prophecies of Quetzalcoatl, and finally the special prophecies of the mysterious Antonio Martinez and the coming religion of the Hunab Ku, "One Giver of Movement and Measure." I realized that the meaning and fulfillment of this entire prophetic stream was crystallized in the Harmonic Convergence and its 26-year aftermath. Chilam Balam, the jaguar priests, are the wizards of time, inspired by the guidance of the Bolontiku, the Nine Lords of Time, the Lords of Number. By command of the Supreme One (Hunab Ku), the wizards are directed to establish clear paths of rekindled knowledge. The ancient Maya prophesied their own destruction. Therefore, within the prophecies of the Chilam Balam they laid the seeds of their reconstruction-but not simply as Maya. The reconstruction had to be planetary, for their destruction in the sixteenth century was also an act of planetary consequence-the plunging of the entire world into the prison of artificial, mechanized time. The fulfillment of the prophecies along with the new dispensation of time had to occur before the end of the cycle, 2012.

For this reason, the master synchronic architect of the Mayan prophets, Pacal Votan, prepared the way with the discovery of his tomb in 1952. This phenomenal act of prophetic release meant that now the messenger of his prophecy of time had to be summoned to his task. This was to be my role and responsibility-one that I accepted, for I saw no other choice. The course of my life from the moment I had experienced an illumination atop the Pyramid of the Sun at Teotihuacan in 1953, to that moment forty years later, in 1993, when I first perceived that the meaning of the prophecy Telektonon was a single trajectory. The noosphere had found another chip. After all, if the noosphere is the mind of time on Earth, prophecy is just another way of radializing time, of bringing it around from one point in a cyclic motion to another. My preparation had been going on for a while.

Once I had received knowledge of the prophecy of the Thirteen Heavens and Nine Hells from Tony Shearer back around 1970, I prepared myself by study and meditation for the moment of the Harmonic Convergence. It may be asked: If the Harmonic Convergence concluded the cycle of the Nine Hells, then why are we experiencing the

apocalyptic events of Hell on Earth now, some fourteen years later? What was the actual meaning of the Harmonic Convergence, and what does it mean for us today?

First of all, the Harmonic Convergence refers to the entire 26-year cycle from White Galactic WIzard to Yellow Galactic Seed, 1987-2013. The conclusion of the Ninth Hell refers to the release of humanity into the 26-year time zone of free will, choice, and decision in preparation for the completion of the cycle, omega point 2012, and the Galactic Synchronization, 2013. The full and true Harmonic Convergence will not be complete until the Earth itself becomes the Galactic Seed, 2013. If the twenty-six years are the free will zone of choice and decision, what are we to choose and decide? The choice is, as I was quoted in the *TVtllStreet Journal* in 1987, " between a 'new age' and all-out destruction." The decision is to accept the knowledge of the error in time (12:60) and the choice is to return to natural time (13:20) by means of the Thirteen Moon!28-Day calendar. This the prophecy ofPacal Votan fully affirms.

In principle, the Harmonic Convergence refers to the converging of all aspects of reality in a great, all-unifying harmony. The initial moment of the Harmonic Convergence that witnessed hundreds of thousands of humans congregated at sacred sites worldwide at the dawn of August 16, 1987, Blue Electric Eagle, was a pure prophetic enactment of humanity being harmonically converged with the natural order of time. This visionary moment demonstrated that, indeed, Harmonic Convergence was possible. The wave of unconscious energy released through the collective psyche of the species as a result of this moment of prophetic purity reached a climax with the fall of the Berlin Wall and the end of the Cold War.

Early 1990, the role of the Harmonic Convergence in this process was echoed in the mass media as the question, "Did the Harmonic Convergence bring the world closer to peace?"l Before the question could be answered, the next phase of the prophetic end time began to unfold. Rather than determine how to make the choice to enter a genuine new age, the human race defaulted to an absolute materialism. It was this collective turn taken by the planetary leadership, now known as the G-7, that engendered the apocalypse we are now witnessing. In this turn, the Harmonic Convergence was forgotten, deleted as it were from the official public texts of contemporary history. The stage was thus set for the next revelation, the Telektonon of Pacal Votan.

In distinguishing the Seven Years of Prophecy, 1993-2000, Magnetic Seed-Resonant WIzard years, the Telektonon of Pacal Votan makes an absolutely clear analysis of the human condition at this time: unless the human race forsakes the false time governed by the instruments of the Gregorian calendar and the mechanical clock by the year 2000, then it will face its own destruction, biospheric collapse, and Hell on Earth. But ifby the year 2000 it can make the decision to reject the calendar of the false

12:60 time and adopt the perfect instrument of the natural 13:20 time, the Thirteen Moon!28-Day calendar, then humanity will have been able to make the choice of entering a new age. For the new age, so longed for, is actually only realizable as a new time. A new time can only come about by the rejection of the instrument that holds in place the hallucination of the old time, replacing it instead with an instrument of such perfect harmony that it has no history, but is truly post-historical.

For this, the messengers of time, myself and my wife, embarked on a course of being galactic gypsies, with no visible means of support, in order to warn the world of the meaning of the time and to offer to the world the opportunity of changing its course by changing its calendar. When the year 2000 rolled around, humanity remained unmoved. The Gregorian calendar, the Vatican, and the G-7 appeared to be as strong as ever. The prophecy did not fail, but humanity did fail to heed the message regarding artificial and natural time. In this process, as "messengers" my wife and I were only playing out an archetypal role. So beginning with the Blue Galactic Storm year, July 26,2000, thirteen years after the White Galactic WIzard year, humanity was placed in judgment. This is merely a matter of natural karmic law.

The four-year cycle, 2000-2004, became known as the prophetic cycle of the Harrowing of Hell. Just as Jesus was crucified and then experienced the Harrowing of Hell before his resurrection, so too humanity has been crucified on the technospheric cross of false time, and is now in the Harrowing of Hell awaiting the resurrection in natural time. For having failed to take seriously all its messengers and all its prophets of all times, humanity was now to pass en masse through hell. Since the Galactic Storm year, 2000-2001, completed a Seed-Storm Year bundle begun in the fifth year of prophecy (1997-1998), the 2000-2001 Blue Galactic Storm year was the year of evaluation. The full judgment was withheld until the Solar Seed Year, 2001-2002.

The Solar Seed year is the second year of the Harrowing of Hell, but the first year of the next four-year Seed-Storm Year bundle. The first half of the Yellow Solar Seed occurs during the second half of the first official year of the third millennium, 2001. The moment was now ripe for the Inevitable Event, for it was also the same Gregorian calendar year as 1945 and 1973. In the Telektonon Prophecy, verse 120, section 19, it is declared, "When the Lunar Moon has overflowed its banks, the G-7 will be no more." So it was on the twentieth day of the Lunar Moon (Blue Self-existing Monkey, galactic signature of Karl Marx), that the Tower of Babel, the World Trade Center, was struck a fatal blow, while the Pentagon, magical structure of the priests of the Dark Lords of Matter, built in "Hell's Bottom," Arlington, Virginia, during the Ninth Hell cycle, was mortally penetrated.

It is still the time of the Harmonic Convergence. The Harrowing of Hell

represents the last cycle of respite for humanity. By July 26,2004, Blue Crystal Storm, humanity must make the "choice between a 'new age' and all-out destruction" when it will have the last opportunity to make the decision of rejecting the old time and calendar and replacing it altogether with the instrument of perfect harmony, the Thirteen Moon!28-Day synchronometer. Only such a harmonic organizing principle, universally accepted and applied, can ensure a time of harmony and the fulfillment of the Harmonic Convergence.

Is it possible that within the noosphere the Harmonic Convergence is awaiting its next climax on the Day Out of Time and the Thirteen Moon Synchronization date of the year 2004, that is, on Gregorian July 25 and 26, 2004? One reads through the *Journal of Calendar Reform* and the many texts and arguments for calendar reform that were put forth in the 1930s and feels the missed opportunity. Even Gandhi was in favor of a new universal timing standard as a principle means of unifying humanity in peace. Did World War II occur because the League of Nations failed to enact the calendar reform on January 1, 1933, as it had fully proposed? The League of Nations had promoted calendar reform as one of its major agendas since the 1920s. This world organization failed at calendar reform and at preventing World War II. Who or what prevented that reform from happening, and why?

Let us look at the matter again. In order to remain constant, any perpetual calendar ordered by the seven-day week requires the principle of a null day, a Day Out of Time that is no day of the week at all. This was a feature of the preferred Thirteen Moon!28-Day calendar proposed by the International Chamber of Commerce, as well as the other modified calendars of twelve months. Reading through archives and literature, pro and con, it is clear that what defeated the calendar reform was the conservative, Vatican-inspired objection to the null day, the Day Out of Time. To observe such a day, which is no day of the week at all, it was argued, would break the weekly succession of days set in motion by God at the beginning of creation-such a break would plunge the world into barbarism, chaos, and war. "The adoption of the weekly cycle was a triumph of Christianity to the detriment of paganism. The cult of Christianity is inextricably connected to the week whose origin reaches to the dawn of history. "2 Therefore, it was contended, to interrupt this weekly succession would destroy Christianity itself. As a result of such propaganda, the League of Nations faltered, no calendar reform occurred at all, and the world was plunged into war-a war that ended with the beginning of the age of terror. This terror is now running its course, like a fever sweeping through the biosphere. WIll it be possible to consider again what the League of Nations faltered on and what the United Nations simply chose to ignore?

Who really lost out when the calendar reform issue was tabled in 1956 at the United Nations? It was not God who invented the week as we know it, but more likely the Babylonians. Behind the week is the mystery of the whole number seven, recalled in the Epic of Gilgamesh as the seven wise men ofU ruk. But the Babylonians clothed the seven-day cycle in the raiment of the sun, moon, and five principle planets-Mercury, Venus, Mars, Jupiter, and Saturn-to which the days of the week have no actual relation. Seen in this way, the seven-day week was intended to be a means on Earth for reenacting some remote mythic reality related to these seven heavenly bodies. What was that mythic reality, on what hidden knowledge is the count of the seven-day week presumed? Borrowing from Babylon, the ancient Hebrews incorporated the seven-day week into their purely lunar calendar. And it was thus from the Hebrews that the seven-day week entered the Julian and then the Gregorian calendars. It was not, however, the Romans who adopted the week, but the Christian successor to the Roman empire, the Church of Rome. What truly was the origin of the week? And what relation or meaning does it have in the first place? Even to F. H. Colson, a Christian scholar writing as late as 1926, the seven-day cycle is described as "that intruder the week, consisting indeed of a fixed number of days, but paying no regard to months or years."3

With its fixed number of days, the week makes sense only in a system of time reckoning that is synchronic rather than astronomical in nature. To those whose minds are set on the synodic lunation cycle as the absolute standard, as does the Gregorian calendar, the week is what ensures the greatest disorder in the calendar-and yet it is defended to the death. The week gains its power from the whole number 7, and not from the jumble of names in which the week is clothed. The seven-day cycle is the closest whole number that corresponds to the four phases of the moon, which, as whole numbers, are also seven days each. In fact, the fixed 7-day cycle only makes sense within the context of the Thirteen Moon calendar with its 28-day cycles divisible by four and seven, creating the annual cycle of fifty-two perfect weeks-plus the Day Out of Time, ensuring a perpetual harmony.

Was the Babylonian naming of these days-with only one name a reference to the moon-meant to be a cover-up of some earlier knowledge, a knowledge both more purely lunar and harmonic, such as the Thirteen Moon calendar? Is all of history, then, just based on a cover-up of harmonic time? What would really happen if there were a Day Out of Time, no day of the week or month at all? Would old belief systems dissolve? Would there be a psychic release, a sense of freedom? Since 1993, sixty years after the failure of the League of Nations to enact calendar reform, the Thirteen Moon Calendar Change Peace Movement has made certain that the

Day Out of Time is the day for forgiveness of debts, of release into timelessness, and for experiencing the full meaning of time is art. This day is now annually celebrated worldwide by increasing numbers of humans. All the while, the Gregorian world has arrogantly plunged blindly forward, locked into its mechanistically chaotic timing sensibility, only to receive the mortal wound of the Inevitable Event, causing it to fall through the seams of its own making, the technosphere. A Day Out of Time, it seems, might be a relief to a world now consumed by chaos, barbarism, and war.

> He sends down from the sky water for your drink and to grow trees for your benefit. With it He grows for you crops, olives, date palms, grapes, and all kinds of fruits. This is sufficient proof for people who think. And He commits, in your service, the night and the day, as well as the sun and the moon. Also, the stars are committed by His command. These are sufficient proofs for people who understand. (Quran, 16:10-12)

Yes, the biosphere is a set of proofs for people who understand, an immense order that reflects and transforms the cosmos through the very process of life on Earth. Who are the people who understand, and where are those people today? Who will speak for the biosphere? Who will take the message of the advent of the noosphere to the statesmen and the politicians that they may take heed and note that what is occurring is not really in their control at all, but is the climax of a phenomenal process known as biogeochemical combustion? And who will declare that this climax will inevitably shake all the towers to their foundations and level the mountains of industry to a flat plain from which the noosphere will manifest as the equality of telepathy for all?

This book, and this ninth chapter in particular, is like a long meditation, a vision, inspired by the dark tragedy of the Inevitable Event. As a vision, these thoughts are both those of one solitary individual, albeit a noospheric chip, and the continuation of the vision of that ancient seer, Pacal Votan. Could it be that Pacal Votan in his time knowledge rehearsed all these words, these thoughts, this entire vision itself? On the sarcophagus lid of Pacal Votan is a cross, not the cross of death as in Christianity, but the cross oflife, a tree, a cosmic tree. Across that tree is a serpentine band with two dragonlike heads, one at each end. This band represents the galaxy. The head at each end represents the galactic vision that sees equally into the past and the future. Sometimes this is called the *zuvuya,* the reflex of cosmic memory. The entire galaxy, the Milky Way, is this reflex of cosmic memory. What if all of humanity is meant to be opened into this cosmic memory? This is what is meant by the advent of the noosphere, the mind of time on Earth, the mental envelope of planetary con-

sciousness arising from the grave crisis of the biosphere through which we are now passing at this very moment.

Because we are now defining the noosphere does not mean that the noosphere was not known to those ancient Mayan time scientists like Pacal Votan, especially if the noosphere is defined as the mind of time on Earth. To such time scientists a NET year would be no time at all, or rather, it would be but a single, fifty-two solar orbit rehearsal of life. How many such rehearsals would be necessary before something was finally learned? The Prophecy of Thirteen Heavens and Nine Hells, for instance, was actually just the passage of twenty-two NET years. Is this how long was needed to see if the human race would learn anything? And if Pacal Votan and Muhammad were around today, what would they think and do?

Knowing the nature of the synchronic order of time, someone like Pacal Votan, obviously one of the most singular of all personalities of the Mayan world, would have possessed a consciousness like the two-headed galactic band, the consciousness of galactic memory. In the zuvuya of galactic consciousness, peering into the deep past is peering at the present from the future. This is possible in the radial time of the fourth dimension freed from the strict linear construct of past-and-future-time. From some higher state of mind, from a mind and consciousness identified completely with the galaxy, this has all been foreseen, this has all been written in a book. Now we who are in this present state of end-time consciousness are being asked to self-reflect. We are being asked if we can manage to hold the noospheric lens steady enough to see that the technosphere had to end, and that the technosphere could only end by the means by which it maintained all of the biosphere in its control, by terror itself.

Yes, we are all a bit like the frog at the bottom of the well whose vision and perception of the universe is circumscribed by what the opening of the well allows it to see. The well is the technosphere, both as a planetary apparatus and as a belief system. On the other side of that well is a vast world that we have actually never seen. This vast world is the noosphere and beyond. And what is beyond? Many of the traditional peoples say that we originally came from the stars. If we came from the stars, are the star people still out there? And what do the star people think of all that is happening on Earth today? And what do they think of their lost star children, many of whom now believe it is childish to think that we came from the stars? And if there are star people still out there, wouldn't they be too sophisticated to think they could get anywhere in a rocket ship, or even a UFO, subject to the entropic degradation of the material plane?

No, they wouldn't rely on such primitive technology, but would be in tune, as is the rest of the universe, with the universal frequency of synchronization and the

capacity of time to travel at an infinitely instantaneous rate of transmission. This being so, we could receive telepathic messages from the star people-if we were ready for it and knew precisely why, when, and how such communication occurs. In fact, as we have said earlier, the noosphere is the region on Earth for the receipt and transmission of messages of cosmic consciousness. This being so, the future of human evolution, of *Homo noosphericus,* would be nothing less than to become a medium of cosmic consciousness, adapting to the expanded measure of Noospheric Earth Time, traveling back to the stars but through the superior knowledge of the actual laws of time.

In writing this book, I have only a sense of duty, of responsibility to expand the vision of my fellow earthlings from the technosphere to the noosphere. In the Law of Time there are no arbitrary distinctions between reason and art, science and prophecy. The universe really is a giant radio transmitter. This book is as much an exposition of matters generally not thought about, as it is a personal testament and vision. In that regard this text is a portion of a broadcast transduced and received by me functioning as a noospheric chip, on behalf of the biosphere-noosphere transition.

In the tomb lid ofPacal Votan are impressed all the frequencies of this broadcast transmission called *Time and the Technosphere.* I know that Pacal Votan took an earthly form for just this purpose. He left his body in that tomb, a jade mask being the actual impression of his face. According to Chinese and ancient Mexican tradition, jade is the stone of immortality. Was Pacal Votan an immortal? Where did his consciousness and spirit go once his body was placed in the sarcophagus? Why did he leave the Telektonon, the Earth Spirit Speaking Tube, running from the tomb to the temple floor at the top of the Pyramid of the Inscriptions? Knowing the frequency of the synchronic order governing the psi bank of the mental envelope of the Earth, did he place his thoughts in the noosphere to be released at the precise moments of the opening of his tomb and the decoding of his prophecy? And then where did he go?

Beginning in 1980 I became conscious that, from time to time, I had been receiving telepathic transmissions. I soon identified these transmissions as coming from the star Arcturus. In *Earth Ascending,* originally written in 1983, the nature and program of the psi bank, the control panel and regulating mechanism of the noosphere, became known to me. This was followed by *The Mayan Factor,* and then the decoding of the Law of Time. At the moment when I had just finished writing *The Mayan Factor* in 1986, I received the inspiration for what is called the planet holon, the twenty-part structure accommodating the program of the twenty solar seals. When I received this image it was known to me as the program of the Arcturus Protectorate. As I understood it, the Arcturus Protectorate was established by the "star people" as a kind of protective time shield around the Earth. By means of the activation of

this time shield, the star people would know that some of the earthlings were waking up to time and beginning the conscious activation of the noosphere. This is exactly what came about through the *Dreamspell,* beginning in 1990.

The *Dreamspell* is such a radical break from the past, and such a pure statement of the history-less fourth-dimensional future, that in order to comprehend it, in 1992 I wrote two other books, one called the *Arcturus Probe: Tales and Reports of an Ongoing Investigation* and the other *The Call of Pacal Votan: Time is the Fourth Dimension.* Some people will say that the *Arcturus Probe* is an exaggerated fantasy, yet I cannot deny what a purely telepathic process it was to write that book, which fills in many points of the psychomythic cosmology of *Dreamspell: The Journey of Timeship Earth 2013. The Call of Pacal Votan* was originally titled *A Treatise on Time Viewed from its Own Dimension,* and is a purely scientific description of the mathematical codes of the Dreamspell in relation to the biosphere-noosphere transition. The one text purely imaginal, the other purely rational, yet both were two sides of the same coin, a rendering of the Law of Time in its cosmological and mathematical comprehensiveness. Then came the even more abrupt break with my conventional past, the Telektonon Prophecy of Pacal Votan.

I bring up all of these personal details because people often ask where it all came from and where I got my ideas. But more importantly, I bring them up because, as I have been indicating, all of this was foreseen and known by a seer in another time, in another world-Pacal Votan. And this process of one person hiding a prophecy and another person in another time finding that prophecy, this is also a further revelation of how the noosphere functions. The French mathematician and philosopher Charles Henry (1859-1926) declared, "As the individual becomes more collective, the collective becomes more individual."4 As individuals, we humans are meant to grow into the collective mind known as the noosphere, while the noosphere, which is the collective, could only be known through its incorporating itself through the individual. I am one such individual, a noospheric chip. The noosphere could not be understood if it did not take on a personality or a number of personalities. Otherwise the noosphere would remain in the purely theoretical state or condition.

Now that the Inevitable Event has occurred, the noosphere is recruiting. The program of recruitment is called the Campaign for the New Time. This is a genuine campaign, but a peace campaign and not a military one. As a campaign it must reach its climax by mid-2004, a full eight years before the end of the cycle, northern winter/southern summer solstice 2012, the noosphere's omega point. The reason for this is that any later than 2004, the prophecy will be negatively fulfilled. A minimum

of two Seed-Storm Year bundles-eight years-are needed to creatively destructure and then to reconstruct. The Inevitable Event was a sign of God showing us that the end had already occurred. Now all the forces of goodwill and harmony must be channeled into the conscious act that will coincide with the noosphere's readiness to manifest through all of us, and that is the calendar change-the untried solution, the most important unfinished business of the last millennium.

This is no longer a matter of debate. There is no other solution that hasn't been tried. There is no other way that the noosphere can become collectively conscious than through the human adoption of a timing system of perfect harmony. By meeting our deadline with the noosphere at the time of the Great Calendar Change in the middle of the year 2004-0n the White Spectral Mirror, Day Out of Time, the day of release from the old, and Blue Crystal Storm, the day of entering the new-then the biosphere will harmonically converge with the noosphere, and the *Pax Cultura, Pax Biospherica* may begin in all seriousness. Such is the advent of the noosphere.

What did the Maya foresee for 2012? What is Pacal Votan's vision? Pacal Votan's vision is the fulfillment of a prayer-a prayer that I have heard through the silence:

> o Hunab Ku, One Giver of Movement and Measure, be kind to the children of this Earth. We see how every year you give and how every year you take away. This is so the children of Earth can learn to be free and dwell only in your presence. Yet we know that the children of the Earth must undergo their lessons as well. And we know that they must enter the dark time of testing. 0 Hunab Ku, in their time of darkness, in their time of forgetting, do not forget them, spare those who are good, if you can. Prepare for them the Second Creation you have promised to the righteous among them. Break for them the spell of false time before they destroy this Earth! And show to them the splendors of the Second Creation, of the New Heaven and the New Earth. Show them these wonders before the Great Cycle is finished, so that they may yet wake up from the sleep of time. And 0 Hunab Ku, may the nine great Lords of Time return to Earth! May they teach the children of the Earth how to become a race of wizards, tilling the noosphere as they have tilled the Earth. 0 bring to these children of the Earth a good Time, a Time of Peace as long, at least, as was their time of history and war, and then let that Time of Peace be multiplied sevenfold!

And here is the vision that fulfills the prayer:

> Planet Earth, Rhythmic Solstice, Blue Resonant Storm year, 2012 Omega Point. The Earth's axis is tilted so that the North Pole is at its farthest from the sun, and the South Pole is at its closest. High above the Earth an iridescent, thin rainbow band

arches from one pole to the other. A second band does the same, but over the opposite side of the Earth. The Earth slowly rotates beneath these two rainbow bands that remain unchanging, constant in their positions, one of them directly opposite the sun, the other holding a position on the midnight side of the Earth's turning. The band facing the sun is the Earth's day alternator. The other band is the Earth's night alternator. If we glide across the surface of the Earth we see that everywhere there are small encampments, circular and radial in formation. Yurts, tents, adobe, and earthen structures-and gardens. The once-teeming cities are eerily silent, yet still inhabited, though with far fewer people than during the time of the technosphere. And everywhere in the small encampments people are reverentially gathered. This is the moment of the closing of the cycle. It is as if everyone is drawing in a single breath at the same time, and exhaling it at the same time. From wherever you are, even though there are clouds, you can see the shimmering iridescent rainbow alternator, either by day or by night. Clusters of people are gathered in circles of deep meditation. Around them the children laugh and play. "We are the noosphere," a voice is repeating, "we are the noosphere." This sets up a vibration and people everywhere stop in their tracks, they look toward the sky. They listen. "The galaxy is renewing our thought. The galaxy is renewing our mind. The galaxy is renewing our world, this Earth. Let us go home and learn some more." Drums and chanting fade into the twilight in one place and beckon the dawn in another. "Let us say the prayer again: '0 Hunab Ku, Allah, One Maker, Our Creator, we submit to You. Continue to keep us whole, continue to broadcast the noosphere through us, continue to let us listen to the higher collective voice that we are so that tomorrow we may register another kin, another NET minute in the glorious journey of Timeship Earth toward its goal of universal unification in your One Unending Thought, 0 Hunab Ku, do not forget us, now, and do not let us forget you! Thank you for the closing of the cycle! May what we have learned stay with us and become the inheritance of our children for seven times seven generations to come, and may you bring us another cycle for all our descendants to live in continuing peace and harmony!'"

This is the vision. I am a noospheric chip. Do not turn away from your visionaries. Your prophets are still calling you and teaching you, if you would pay attention. There is much to do and learn. There is nothing more joyful than the positive construction of harmony.

Time and the Technosphere, First Draft Transmission completed,
Self-existing Owl Moon Dali 15,
Yellow Solar Seed Year
Kin 42, White Electric WInd:

I activate in order to communicate
bonding breath
I seal the input of spirit
with the electric tone of service
I am ptided by the power of death

First draft edited, completed, and sealed,
Overtone Peacock Moon Seli 2,
Yellow Solar Seed Year
Kin 57, Red Overtone Earth

I empower in order to evolve
commanding synchronicity
I seal the matrix of navigation
with the overtone tone of radiance
I am guided by the power of life force

Second draft edited, completed, and sealed,
Rhythmic Lizard Moon, Seli 23, Navigation Tower
Yellow Solar Seed Year
Kin 106, White Lunar World-bridger
Pacal Votan Clear Sign

I polarize in order to equalize
stabilizing opportunity
I seal the store of death
with the lunar tone of challenge
I am guided by the power of endlessness
I am a galactic activation portal
enter me

Mayall beings be well and happy!

May this text and these words inspire by their truth.

If! have left out or omitted any logic or fact, or unnecessarily maligned any truth or being by my endeavor to convince through dear argument, may the Creator know that no such malice or oversight was ever intended. I am but a human transmitter, a noospheric chip. My ability is commensurate with the frailties attendant to one too long steadfast on a path too little comprehended by many of those around him.

May the truth prevail!

Jose Argiielles, Ph.D.
known in prophecy's light as
Valum Votan, the Closer of the Cycle
devotee of Bolon Ik

Brightwood, Oregon
Cascadia Bioregion
North American Plate

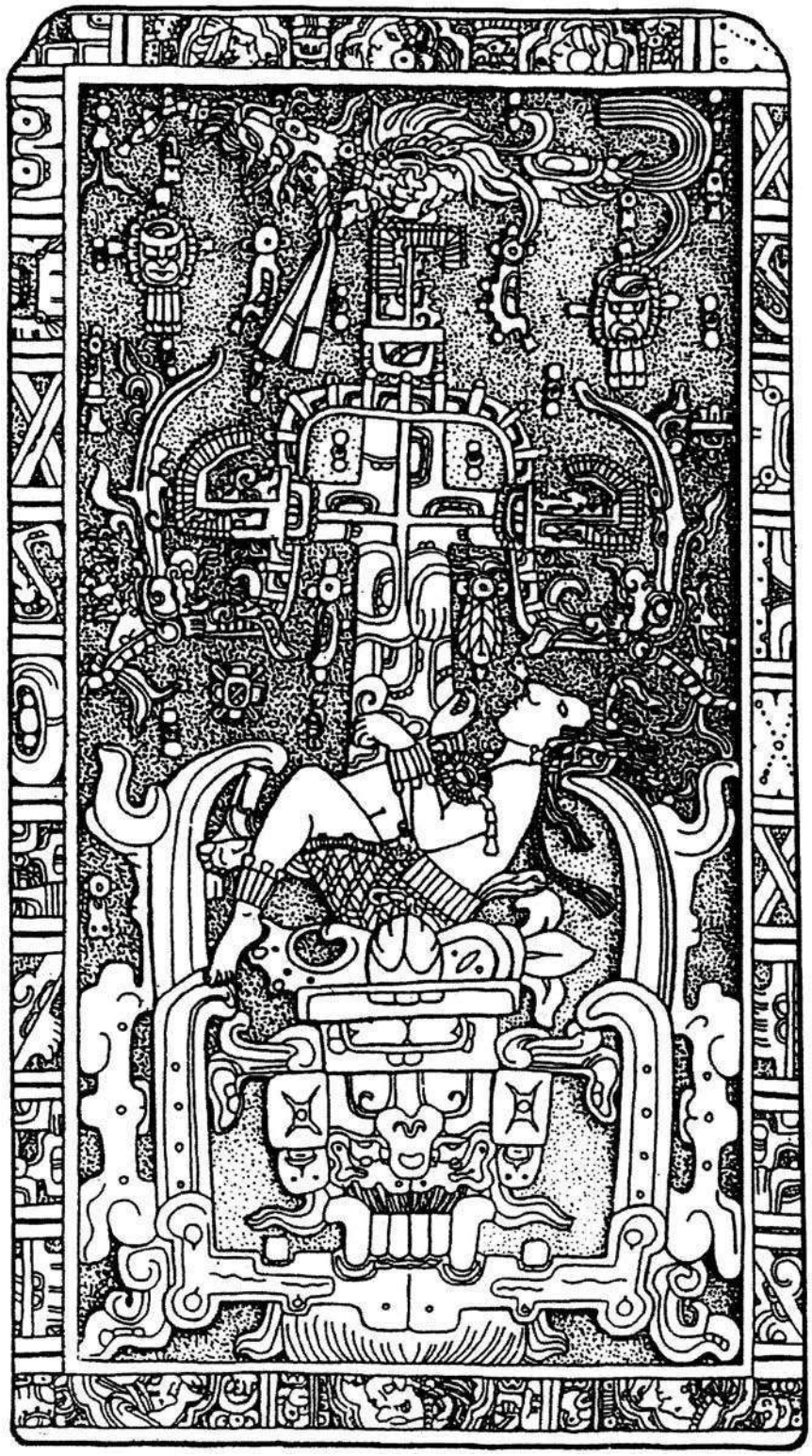

Sarcophagus lid of the tomb of Pacal Votan 9.13.0.0.0 (A.D. 692)

Epilogue

Networking the New Time

TO READERS for whom the notion of calendar change, much less that of a Campaign for the New Time, is totally novel, yet who may have an interest in learning more about and participating in the preparation for the Great Calendar Change of 2004, there is a place to begin and a way of going about it.

The official coordinating agency for the Campaign for the New Time and the World Thirteen Moon Calendar Change Peace Movement is the Foundation for the Law of Time. As a nonprofit public charities educational corporation, the Foundation for the Law of Time provides the communications and information hub for the Planet Art Network (PAN). The Foundation also publishes calendars, tools, and literature about the Law of Time and sponsors various educational programs, periodic seminars and congresses, and projects such as the new time educational caravans and the development of garden-oriented land bases.

For general information on the Law of Time or the Campaign for the New Time and its educational programs contact:

Foundation for the Law of Time, World Headquarters
Post Office Box 513
Brightwood, Oregon 97011 U.S.A.
Tel: +1 (503) 622-1976
Fax: +1 (503) 622-0198

The Foundation for the Law of Time's outreach activity program is known as the Planet Art Network (PAN), the loosely knit and decentralized base of operations for the World Thirteen Moon Calendar Change Peace Movement. The PAN is organized into Bioregions, each with its PAN nodes (local chapters) and a governing Bioregional Council. The PAN nodes organize "crystal day meetings" once every thirteen-day wave spell-the crystal (twelve) tone day is the day to call a round table or court of the kin to review past actions and prepare for future ones. The PAN nodes also offer educational programs and disseminate calendars and other educational tools and literature provided by the Foundation, which constitute the information outreach of the World Thirteen Moon Calendar Change Peace Movement. The Campaign for the New Time is the coordination of the world PAN toward the goal of the Great Calendar Change of 2004. The PAN is also generally responsible for organizing the annual Day Out of Time events in its different localities and bioregions.

For information about local Planet Art Network (PAN) operations, contact:

Foundation for the Law of Time/Gnomicile Land Base
World PAN Coordination Center
PMB 267
105 North First Avenue
Sand Point, ID 83864-1301 U.S.A.
Tel: +1 (208) 255-1172
Fax: +1 (208) 265-9107

The official Web site for the Foundation for the Law of Time, Planet Art Network, World Thirteen Moon Calendar Change Peace Movement and Campaign for the New Time is:

www.tortuga.com

This Web site is continuously updated and offers a great range of both practical and theoretical information about the Law of Time, the Campaign for the New Time, ongoing and upcoming events and educational seminars, listings of major PAN nodes worldwide, Law of Time archives, and links to other relevant Web sites.

A major aspect of the Campaign for the New Time is the development of a program of "strategic alliances," information about which is also available at www.tortuga.com. If you belong to an organization that you feel could be in alignment with the goals of the Campaign you can check out the Strategic Alliance page of the Web site or directly contact the Foundation for the Law of Time, World

Headquarters. The goal of the Strategic Alliances is to establish a "synchronization for peace force"-a coalition of a wide spectrum of organizations that are in alignment with the calendar change and are willing to help organize local events and information dissemination for the Great Calendar Change of 2004.

See also Appendix II, "The World Thirteen Moon Calendar Change Peace Movement and the Discovery of the Law of Time: A Brief Chronotopology of Transformation. "

Appendix I

Summary Critique of the Gregorian Calendar

What Every Proponent of the Thirteen Moon Calendar Should Know

NOT ONLY is the idea of the calendar as an instrument to determine a true and accurate year misleading, but solely focusing on this purpose blinds us to any consideration of time apart from duration or measurement of motion in space. The Law of Time asserts that the actual nature of time is synchronic; hence the purpose of calendars is to synchronize us in time according to various cycles whose harmonic numbers extend from and return us to a higher mental order of reality. It is a fatal error to dismiss a mathematics of harmonic perfection when it is allied with the ordering and comprehension of cycles. The pursuit of a true and accurate year totally subordinates the cyclic nature of time to the ceaseless imperfection and change that characterize the phenomenal world when it is considered as the sole factor of existence. This defines the thoroughly materialist worldview of the 12:60 consciousness.

In order to prepare the ground for a proper consideration of the Law of Time and the evolutionary necessity of the synchronic order of time as the harmonic reorganizing factor of humanity in its post-historic phase, it is necessary to expunge from the mind the error known as the Gregorian calendar. To demonstrate and expose the illogical and irrational nature of the Gregorian calendar as a standard of

measure, the following seven points are presented as a simple appeal to the intrinsic logic and intelligence of any human being.

1. We require of a standard of measure that its units of measure are regular and equal with one another.

This is not the case with the Gregorian calendar, whose base unit of measure, the month, proceeds in an irregular and uneven manner: 31 days, 28 days, 31 days, 30 days, 31 days, 30 days, 31 days, 31 days, 30 days, 31 days, 30 days, and 31 days. Why would anyone use a standard of measure with irregular units? Do you know what results when a crooked standard of measure is employed consistently for millennia? It might be noted that at the time of Augustus Caesar, August was called Sextile and had thirty days, while February then had twenty-nine days. In order to honor Augustus and make him the equal ofJulius Ouly) which had thirty-one days, the twenty-ninth day was taken from February and added on to Sextile, whose name was then changed to Augustus (August). By harmonic contrast, the Thirteen Moon calendar is perpetual in that all of its units of measure are equal-28 days each.

2. The names of the months are as illogical as their uneven numbering.

January is derived from the God of the doorway; February is an obscure word referring to an animal divinatory rite; March refers to Mars, the planet and the god of war; April and May refer to goddesses of the spring; June to the wife of Jupiter; July and August are named after the two most prominent Roman Emperors, Julius and Augustus Caesar. As for the remaining months, September, the ninth month, means seven; October, the tenth month, means eight; November, the eleventh month, means nine; and December, the twelfth month, means ten. Of course, having grown habituated to the crooked standard of measure, it is easy to overlook and dismiss as innocuous the irrational naming of the months. But is it so innocuous? What do the names of these months have to do with an order of time, or even a cosmology or culture of time, which we assume a calendar might reflect? By blindly accepting this irrational disorder of names, do we not predispose ourselves to accept irrational disorder in commonplace things around us, and even within the fabric of our society, thus reinforcing in us a tendency to accept a superficial treatment of the symptoms, while ignoring the roots?

3. Leap year and leap day is the most highly touted aspect of the Gregorian calendar.

Structurally, the Gregorian calendar is indistinguishable from the Julian calendar. The only thing that separates the Gregorian from the Julian calendar is the correction

of the leap year day. Pope Gregory XIII "corrected the calendar" by deleting three leap days from the years that begin the centuries, except those divisible by the number four. Leap day is the extra day that accumulates every four years due to the length of the astronomical year being 365.241299 days and not 365. It can be seen that the fraction .241299 is not quite 1/4, which would be .25. The Julian calendar did nottake this into account, hence an error crept in that caused the spring equinox on the calendar to fall some ten days behind the solar moment of the spring equinox-a fact noted by the conquistadors when they encountered the Mayan calendar, which had no such discrepancy. Thus, in 1582, Pope Gregory XIII "improved" on Julius Caesar's calendar, some 1,627 years later, by adopting the rule that there would be no extra day on centuries-OO years-except on those that are multiples of four. Hence, there was no leap day in the year 1900, but in the year 2000, a multiple of four, there was.

What is not well known is that the Vatican does not recognize the leap day in its ceremonial calendar. Why is that? In most countries where Latin-derived languages are spoken, leap day and leap year are referred to as *bisiesto,* or "bisextile" day and "bisextile" year. If leap year is every four years, why is it referred to by a word that connotes six, *sextile?* On the official liturgical Church calendar there is no February 29! Instead, there are two February 24s, and the second February 24 is not counted. If there were to be an extra day that was counted, then the system of fixed feast days would be thrown off. Instead, on leap years, February 24, the Day of the Feast of St. Matthew, is counted twice-or extended to be 48 hours. And since in the Church tradition derived from the Romans the days are counted from the first of the next month, the first always being known as the calends, the date February 24 is technically referred to as the "sixth of the calends of March" (February 24 = sixth calends of March, February 25 = fifth calends, February 26 = fourth calends, February 27 = third calends, February 28 = second calends, and March 1 = calends of March). For this reason, the leap year is known as *bisiesto* because the sixth *(siesto)* calends of March is doubled, hence "bi." Thus, February 29 is not recognized by the official Church calendar of the Vatican, and it is also not counted as a day in its liturgical calendar. February 29 only arose out of popular tradition in the sixteenth and seventeenth centuries. The nemesis of accounting for the .241299 extra day per year reveals the fixation of astronomical time in seeking a "true" year and detracts from the possibility that the issue of an intercalary, or extra, day can logically and synchronically be handled in many other ways. In the end, it is the mystique surrounding leap day that further contributes to the numbing of the sensibility of time accumulated in the instrument known as the Gregorian calendar, "the little grid of boxes that rules so much of our lives."l

4. **The word we use to describe the instrument for measuring, the Earth's orbit around the sun, *calendar,* is derived from the word *calends.***

Calends was the Latin name given by the Romans to the first day of every month. What does it mean? *Calends* is the name of the account book, the book of payments recording the monthly debts and bills to be paid! No wonder we are ruled by the philosophy "time is money!" This philosophy is rooted in the very word we use to describe time reckoning, *calendar.* A more accurate word for time reckoning might be "chronometer," or even better, "synchronometer." But perhaps the word "count" is simpler. We might just say, for example, Thirteen *Moon!2* 8-Day perpetual count.

5. Dominicalletters code the years of the Gregorian calendar.

Scarcely known to anyone but Vatican insiders is the system of dominicalletters that is used to code the years according to the day of the week on which the first Sunday of the year falls. Since the week has seven days, there are seven and only seven dominical letters. These are the letters a-g, where a = 1, b = 2, c = 3, d = 4, e= 5, f = 6, and g = 7. Hence, G-7 (the group of the seven most industrial nations), the name given in 1974 by the CIA to the ruling oligarchy of globalization, is totally rooted in the system of the seven dominicalletters, a-g, to which the Gregorian calendar can be reduced. It works as follows: In 2001, the first day of the year was on a Monday, hence in this year all Mondays are coded by the letter a. Counting forward to the first Sunday, January 7, Sundays this year are coded g. The letter of the year, which is always a capital letter, is based on the lower case letter that codes the first Sunday, therefore, the year 2001 is coded as the capital letter G-it is truly a G-7 year! Not only that, but by this system of "G-7" dominicalletters, it can be demonstrated that the order of the Gregorian calendar year repeats within a cyclic structure of precisely twenty-eight years, where the days of the week and the month repeat once again. Hence, the cycle 1973-2001 is a repeat of the cycle 1945-1973, which is a repeat of the cycle 1917-1945, and so forth, where the years 1917, 1945, 1973, and 2001 are calendrically indistinguishable from each other. In any twenty-eight-year cycle, there are always exactly seven leap years! Thus, the key code numbers 28 and 7 of the Law of Time and of the perfect Thirteen *Moon!2* 8-Day calendar are hidden in and even govern the cyclic order of the Gregorian calendar, whose secrets pretend to lie concealed in the Vatican archives!

Expose these secrets and show that the true harmony of time is contained in the 13:20 matrix of the Harmonic Module, which is perfectly coded by 28 and 7. Within this matrix, any set of four tones radially opposite each other, an occult quartet, always adds up to 28. There are 65 (x4) such sets that constitute the Harmonic Module, while seven (multiplied by four), is the prime factor of 28, and is the key

unit holding the 13:20 matrix in place, evident in the position of the seventh vertical column on either side of which is a perfect harmony of six columns each. The seven is also the implicit number in the ratio 13:20 (13 + 7 = 20: 20 - 7 =13). But whereas the 13:20 matrix is a harmony in which the Law of Time is encoded, the Gregorian calendar is a disharmony, but one that is nonetheless governed by the Law of Time. What the Vatican attempted to destroy at the hands of Bishop de Landa in 1562, in the famous book burning at Izamal Yucatan, is redeemed by the Law of Time. Free of the obscuring, illogical irrationality of the inexact measure of the Gregorian calendar, the actual truth of the synchronic order of time may be discovered and revealed as the 13:20 mathematical code ofthe Harmonic Module, perfectly coordinated with the Thirteen Moon!28-Day count.

6. The Gregorian calendar makes day/date calculations difficult.

The twelve uneven months of the Gregorian calendar operate by a subsystem of fifty-two 7-day weeks, plus one day. Because of the irregularity of the numbering of the months, and because there are 365 and not 364 days in a year, it is almost impossible to make easy calculations month to month and year to year, while insistence on the unbroken succession of the week only compounds this issue. For example, if today on the Gregorian calendar it is Friday, May 4, 2001, what day of the week will June 4 be? What day of the week will July 4 be? There is an immediate mental block-a numbing of the mind. You have to stop and think about it. And in this numbing pause in which your cognitive brain has to be engaged, you lose your telepathic awareness, much as when you look at a clock to find out what time it is. Why should it be this way? Who benefits? The answer is, the priests (who know the tedious rules for stating that if it is Friday and it is 2001, then it is dominical e) and the bankers (who gather interest based on the confusion over the erratic disparity of days every month). By contrast, on the perpetual Thirteen Moon calendar, this day would be Spectral Moon Gamma 3-while every third day of every Moon is coded by Gamma. In fact, the third day of every week is coded by the name Gamma. Once the 28-day count is mastered, there is no need to engage the cognitive brain to figure out what day of the week Crystal Moon 3 or Cosmic Moon 3 will be-and in this way the mind is liberated into a telepathic knowing.

The system of the seven-day week was introduced into the Julian calendar at the Council of Nicea, A.D. 325, and was adopted from the Jewish calendar, which was derived from the Babylonians, for whom it was an astrological-astronomical construct. The fact that the week came from the Babylonians dissolves the argument used by the Vatican to counter the Day Out of Time. According to the Vatican, disrupting the succession of the seven-day week would disrupt an order set in motion by

God. The matter of the 7 and the 52 has a much deeper significance when understood in the higher-dimensional light of the Law of Time. A count of fifty-two 7-day weeks makes perfect sense if you have a count of thirteen 28-day months (7 x 52 = 13 x 28). The observance of the Day Out of Time, the 365th day of the year, produces a perfect and perpetual harmony. Knowing this, to continue to insist on fifty-two weeks while being unwilling to give up a twelve month count that does not have a Day Out of Time is to persist in an adherence to hopeless disharmony. Why do it?

7. What's in a name? Think about it.

What does it mean to follow calendars called the Julian and the Gregorian? A calendar is an instrument of control. The two most significant calendar reforms in history were the Julian calendar reform of 46-45 B.C., and its successor, the Gregorian, in A.D. 1582. Julius Caesar's motives had everything to do with his personal ambition and the conversion of Rome from a republican to an imperial form of government. Julius Caesar's calendar assured it to be the basis of imperial dominance. The course of the empire utilizing the Julian and later Gregorian calendar has prevailed as the dominant force now inseparable from the course of history itself. The 445-day "year of confusion" (46 B.C.), which attended Julius Caesar's reform, was matched by the second significant reform, the Gregorian, in which ten days were "lost forever," between October 5-16, 1582, so that the calendar could "catch up" with the sun.

While European Catholic countries easily accepted the reform, Protestant countries grudgingly acquiesced. Throughout the Americas, however, the Julian-Gregorian calendar was imposed as an instrument of power and symbol of dominance over the peoples the Europeans had conquered, including the high civilizations of the Maya, Inca, and Aztecs-all of whom happened to use, among other calendars, a Thirteen Moon!28-Day count. As with Julius Caesar, for Pope Gregory XIII the moment was politically ripe for a reform that would communicate itself as a means of expressing and extending power and control, but this time over the entire globe. As European dominance and control spread around the planet, even nations with their own established timing systems accepted, for the sake of "international policy," the Gregorian Oulian) calendar system for measuring the solar year. And so Western dominance over every aspect of global life became absolutely assured-until the moment of the Inevitable Event.

From its roots in the imperial ego of Julius Caesar to the timely "reform" of Pope Gregory XIII, it is not surprising that this calendar, "despite its odd quirks and the twists of history that produced it,"2 has become the standard of global civilization. Given the irregularity of the Julian-Gregorian calendar and the pursuit of the accuracy of astronomical time, history could be nothing more than a compilation of

odd quirks and twists, while global civilization itself is the triumph of artificial time over the natural world. Only a species whose time sensibility had been captured by instruments of artificial measure could have become so alienated as to have produced the monstrous conundrum known as the "fast world," a civilization where money and technological advance prevail over human sensibility and the natural order. It is toward the correction of this destructive momentum that all efforts of calendar reform must now be directed.

In light of this critique, it is worth reprinting the opening section of the "United Manifesto by Advocates of Calendar Reform" that was first published in 1914 at the beginning of the First World War-some ninety years in advance of the Great Calendar Change of 2004. It can be seen that the issues of irregularity that prompted reform then are still issues today. However, the effects of not attending to these issues have only become compounded and even more complex, resulting in the chaos of a world at war with terror. Such is the nature of an error gone uncorrected over time-it only becomes more entrenched and turns into the dogmatic and hopelessly conflicted thinking of the everyday mind and its way of life.

United Manifesto by Advocates of Calendar Reform

> WHEREAS we, the undersigned, have for some time been interested in a Reform and Simplification of the Calendar now in use in Western Europe, America, and elsewhere, with a view to equalizing the four quarters of the year, alleviating the irregularities of the months, and establishing a perpetual correspondence between the day of the week and the day of the month, and have supported one or other of several proposals which have been formulated for effecting these reforms; and WHEREAS said proposals usually provide for placing the 365th day of every year and the 366th day of Leap Year without the weekly and monthly enumeration; and WHEREAS we have found that in certain quarters-both ecclesiastical and scientific-Dbjections, possibly often sentimental, but none the less firmly held, have been stated to the employment and adoption of these expedients. . . Therefore we have resolved to unite in urging and advising that the very simple changes under noted should now be made in the Julian and Gregorian Calendars by international agreement. . .3

If you have a crooked standard of measure, and follow it because your parents were also following it, you have become a crooked man. It takes a crooked man to walk a crooked mile and build a crooked house. The issue of calendar reform is both logical and moral. Bad logic leads to bad morality. An error in time dooms the mind. Apocalypses are the reward for bad timekeeping. To remove yourself from the fires of your own self-created apocalypse, change your calendar. In a world of harmony there is no apocalypse.

Appendix II

The World Thirteen Moon Calendar Change Peace Movement and the Discovery of the Law of Time

A Brief Chronotopology of Transformation

IT WAS during the seven-year cycle (1993-2000) when the World Thirteen Moon Calendar Change Peace Movement was being aroused around the planet, that the Law of Time was articulated in its various aspects and particulars, and the synchronic order defined in its whole system fullness. This occurred through a number of key events accompanied by a number of publications detailing the mathematical, cosmological, theological, and scientific aspects and imperatives of the Law of Time.

By the standards of the synchronic order, all events form points in a radial time set that describe a geography of time defined as a chronotopology. Coined by the late philosopher and mathematician Charles Muses, the term *chronotopology* defines an event point of meaning that creates a root meaning from which time-formed, -blossomed, or -radiated meanings emerge above a horizon of meaning.! The Law of Time now gives a precise field in real time to illustrate Muses's notion of chronotopology in which Time is a radial power of profound interrelations.

The following chronotopological sequence-a resume of the events in a particular geography of time, the seven years of prophecy, 1993-2000-defines the conscious emergence and articulation of the Law of Time. In this chronotopology, the "root meaning" occurred in 1989 at the Museum of Time in the form of the discovery of the 12:60 and 13:20 timing frequencies, and the subsequent working out of the implications of this discovery. The "horizon of meaning" was reached July 26, 1993, kin 144, with the decoding of the Telektonon Prophecy and the consequent development of the World Thirteen Moon Calendar Change Peace Movement. The "source meanings," however, extend back to the seventh century with the origins of the prophetic traditions underlying the discovery of the Law of Time. The seven years of prophecy established the field of radiated meanings of the Law of Time as a set of radiated event points and a body of literature and tools. Here follows, then, a brief chronotopology of the key event points of this movement:

1989	Root meaning: discovery of the 12:60 and 13:20 timing frequencies, Museum of Time, Geneva, Switzerland.
1990	Realization of the Thirteen Moon/28-Day calendar in its wavespell form.
1992	Recognition and celebration of the Day Out of Time as a planetary event.
1993	Horizon of meaning: decoding of Telektonon Prophecy and birth of World Thirteen Moon Calendar Change Peace Movement.
1994	Launching of the Planetary Moral Emergency and World Thirteen Moon Calendar Change Peace Plan.
1995	80 Days Around the World for a New Time of Planetary Peace: Chile, South Africa, Egypt. Russia, India, Hong Kong, Japan, Hawaii, and Mexico.
1995	Day Out of Time Calendar Burning and Return of Natural Time Ceremony, Serpent Mound, Ohio.
1996	First Planetary Congress of Biospheric Rights, Brasilia, Brazil.
1996	Biospheric Awareness Day, Gotemba, Mt. Fuji, Japan.
1996	Four Corners Boundary Dissolving Ceremony, Four Corners, United States.
1996	Harmonic Convergence of Humanity, Mexico City, followed by Peace March, Teotihuacan, Mexico.
1996	United Nations, Planetary Moral Emergency Appeal.
1997	Judgment Day Tribunal and World Congress on the Law of Time, Tokyo, Japan.

1997-present	Ongoing movement in Brazil to make July 25, Day Out of Time, official "Peace and Culture Day;' based on recognition of the Banner of Peace (seventy cities so far).
1998	Special peace mission to the Vatican, Rome, Italy.
1998	Special mission to Guatemala to meet with Quiche Maya elders.
1998	UR Council for the Theology of Peace, Milan, Italy.
1999	world Summit on Peace and Time, University for Peace, Costa Rica, followed by the dispatching of Special Emissaries to the United Nations and the Vatican.
1999-present	Ongoing movement in Japan to declare Day Out of Time a "Day of Festival"; more than one hundred events occurring annually.
1999	Peace March, Teotihuacan, Mexico.
1999	Seven Week Earth Wizard Seminary, Picarquin, Chile.
1999-2000	Ongoing in South America, launching of "La Karavana;' Thirteen Moon educational caravans, and in Europe, from the United Kingdom to North Africa, the New Time Caravan.
2000	Initiation of Seven-Day Earth Wizard's Seminars: Japan, United States, Italy, Russia, South America.
2000	Circumpolar Rainbow Bridge Experiment, phase I, worldwide.
2000	Fruit of meaning: establishment of Foundation for the Law of Time, Oregon.
2001	Launching of the Campaign for the New Time, Brazil. Argentina, Japan, Altai region.
2001	Campaign for the New Time PAN Thirteen Moon Leadership Conference, Oregon.
2001	Seven-day special Congress on Time and World Peace, Medellin, Colombia.

During this chronotopological sequence of radially connected event points, key writings, publications, and tools describing and defining the Law of Time and the synchronic order include:

Dreamspell: The Journey of Times hip Earth 2013, 1990-91

Thirteen Moons in Motion and *Turtle of the Thirteen Moons*, 1993, 1996

The Story of Time: The Story of Turtle and Tree, 1993

Treatise on Time Viewed from its Own Dimension (Published as *The Call of Pacal Votan:*

Time is the Fourth Dimension), 1992, 1996

Telektonon ofPacal Votan and the *Telektonon, Game of Prophecy,* 1993-1995

World Thirteen Moon Calendar Change Peace Plan, 1994-1995

Pacal Votan and Judgment Day: The Second Quranic Dispensation, 1995-1996

First Planetary Congress of Biospheric Rights, 1996

The Galactic Culture Master Plan, New Time Economics, 1996

A Brief Guide to The Thirteen Moon Calendar Change Peace Movement, 1996

Rinri Project: Four-Year Telepathic Biosphere-Noosphere Transition Circumpolar Rainbow Bridge Experiment, 1996

The 260 Postulates of the Dynamics of Time and the Evolution of Time as Consciousness, 1996

The Discovery of the Law of Time, T(E) = Art, 1996

The Principia Mathematica of the Fourth Dimension, 1996

Twenty Tablets of the Law of Time: Sixteen Year Telektonon Cube of the Law, 1997

World Congress on the Law of Time and Judgment Day Tribunal, 1997

World Summit on Peace and Time, Summary, Review, and Conclusions, 1999

7:7::7:7, Telektonon Revelation and Plasma Universe Model, 1998-2000

The Rainbow Bridge Project: 28 *Meditations on the Law of Time,* 1999-2000

The UR Papers: Documents and Appeals for a Council of Universal Religion, 1996-2001

WIth the conclusion of the seven years of prophecy, marked by the rainbow bridge experiment, phase I, the greater part of the Law of Time had been uncovered, described, and defined. What emerges from consideration of all these events and accompanying literature is an entirely new model of the universe as well as a program for the reorientation of knowledge and the social reorganization of humanity-all based on a corrected understanding of time through the implementation of the calendar change. This was all to demonstrate that there is much more to a calendar change than the mere replacing of one calendar with another, for a calendar itself bears within it an understanding of time that tacitly and unconsciously shapes our very thinking about time. What the calendar change, then, really signifies is the end of one worldview and the birth of another. WIth the Law of Time, what was once unconscious is again made conscious, leading to a radical self-awareness of how wrong we have been about time, and what we might anticipate in changing our tools for navigating in time.

Because the growth of the Planet Art Network (PAN) as the social form of the World Thirteen Moon Calendar Change Peace Movement is inextricably involved with the unraveling by stages of the Law of Time, to define the constituent principles of the Law of Time is also to define the new worldview and the social organization appropriate to it. These constituent principles include: time is art; universal telepathy; holonomic consistency and reciprocity; synchronic order; fractal and radial mathematics of the 13:20 matrix; biosphere-noosphere transition; Banner of Peace; *Pax Cultura, Pax Biospherica;* the psi bank and the dynamics of the evolution of time as the evolution of consciousness; fourth-dimensional time and third-dimensional space. A mere consideration of these constituent principles will make one realize to what extent the calendar change is more than just an end to history, but the establishment of a new world, a New Heaven and a New Earth. This is precisely the promise offered by the Thirteen Moon calendar change and the discovery of the Law of Time. (See plate 8, Chronotopology of Transformation.)

Appendix III

Telektonon Prophecy of Pacal Votan

TI-IE REVELATION of the prophecy of Pacal Votan on July 26, 1993 was the culmination of the event that occurred on June 15, 1952, when the archaeologist Alberto Ruz Lhuillier pried open a large monolithic trapezoidal door beneath the Pyramid of the Inscriptions at Palenque, Chiapas, Mexico, and beheld what had not been seen by human eyes for 1,260 years: the tomb of Pacal Votan. A subsequent event, the lifting of the magnificent sarcophagus lid-measuring some four-by-three meters and weighing several tons-to reveal the human remains amidst a splendor of jade, including the jade mask, occurred on November 27, 1952. For some forty years afterwards, scholars debated the meaning of the tomb and the person buried within it. In the 1970s, the Russian scientist Knozerov dubbed the man in the tomb an "astronaut" or "cosmonaut" because of the similarity of the position of the figure sculpted on the sarcophagus lid to the positions of Russian cosmonauts in their little space capsules. This theory inflamed the imagination of some and was debunked by others, the end result being the enhancement of the awesome mystery of the tomb and the intention of its designer, the man buried in it.

The image of the sarcophagus lid is now world famous. Its symbolism has been interpreted to varying degrees by different archaeologists. In my book *The Mayan Factor*, the placement ofPacal Votan in his "time of power," 631-683, is defined and analyzed as occurring in the most harmonic and mathematically synchronic point of

the entire thirteen baktun cycle, a point of fact that deepens the enigma of Pacal's knowledge and purpose. And herein lies the key question: What was his purpose, and why did he construct his tomb to be so elegantly buried for 1,260 years, to be discovered and opened just sixty years before the closing of the cycle, A.D. 2012? Clearly, the mystery of the tomb and its discovery had everything to do with the end of the cycle. At least this had come to be my surmise ever since the 1987 Harmonic Convergence. Like a hawk circling its prey, the meaning of the tomb finally came to my consciousness like a direct hit from the beyond. I was the prey, the hawk, the prophecy itself. Such was the revelation of the Telektonon Prophecy on the morning ofJuly 26, 1993.

The coded key was the tiled "speaking tube," by which the tomb was discovered in the first place. Suddenly, this tube spoke its meaning to me: Earth Spirit Speaking Tube, Telektonon by name. After four intense weeks of decoding the glyphs and symbols of the tomb while living in the pool house of an isolated estate in the wind-blown northern part of the main island of Hawaii, I knew that I had to abandon the dreamlike life I led in this Pacific paradise, and with my wife and companion head directly into the unknown, the first stopping point being Mexico, the source of the prophecy. After four months or so of traveling through Mexico, completing the decoding and announcing the prophecy, including a return to the tomb, we were finally directed to a converted carport in a field near the village of Ocotithin, not far from the birthplace of Quetzalcoatl. It was here where, for a period of nine mornings, I awoke dutifully two hours before sunrise to listen to the voice and write down by hand, in a specially prepared notebook, the words exactly as I heard them. Afterward, I numbered the 126 verses and distinguished the nineteen sections.

Because the prophecy itself is so inextricably connected with the Law of Time and the message of *Time and the Technosphere,* I feel it is important to present it as background information to the text of this book. In actuality, the text of the Prophecy is an integral part of the *Telektonon, Game of Prophecy,* where it is read, section by section, on a daily basis, according to the code number of the kin of the day.

THE TELEKTONON OF PACAL VOTAN

The Talking Stone of Prophecy That Unites the People of the Dawn with the People of the Book

"Then if they reject thee,
so were rejected apostles
before thee, who came with clear signs,

books of dark prophecies
and the Book of Enlightenment. "
-HOLY QURAN, SURA **III,** 19: 184

"All who obey God
and the Apostle
are in the company
of those on whom
is the grace of God,
of the prophets who teach,
the sincere lovers of truth,
the witnesses who testify
and the righteous who do good.
Ah, what a beautiful fellowship!

Such is the bounty
from God: and sufficient
is it that God knoweth all. "
-HOLY QURAN, SURA Iv, 9:69-70

INTRODUCTORY VERSES: ONE LIVING PROPHECY

1. Pacal Votan's Gospel of the Telektonon
   A Special Dispensation for the Day of Truth,
   A.D. 1993-1994, kin 144.

2. Proclamation on behalf of the three messengers
   of the awakening,
   of the three special voices of prophecy,
   the special witness of time and the last call.

3. Telektonon
   the inner sun
   the mother of all prophecy
   message of the star witness, Bolon Ik
   received and repeated by her servant in love,
   Pacal Votan.

4. In the seventh year of Harmonic Convergence
   the seven seals of the apocalypse
   become the seven years of prophecy. . .
   thirteen years in all.

Thirteen moons the path to walk;
thirteen moons the path to talk;
people of the dawn, one mind,
people of the book, one God;
one living prophecy, one people, one Heaven,
one Earth.

●● NAH CHAN: THE PALACE OF BOLON IK

5. o children of the people of the dawn, a children of the people of the book, I come as the special witness of time to remind you, especially on the day of truth, that in your origin you are one, and on the day of truth you are to make yourselves one again. For this I remind you of the Cube of the Law, Telektonon, and the 28-day, thirteen moon way that is the path of the righteous.

6. Nah Chan, Palenque, Xibalbay, Tollan, Xochicalco, Tepozteco, Amatlan: in these signs dwell my special agents, the witnesses of truth, 13.66.56 and Bolon Ik, Daughter ofJob.

7. For those with eyes, with open mind and sincere heart, this teaching is complete in every stone alignment and marking of the star command base now called Palenque.

8. New Jerusalem is the Palace of Bolon Ik, whose number is 1,728 (144 x 12), Cube of the Law. Seventeen is the power of Heaven, "solar Uranus," which is Earth in Heaven. Twenty-eight is the power of Telektonon, the Spirit Tower of the power of 7 times 4.

9. Never forget, children of the day of truth: All is number. God is a number. God is in all.

10. And everything there in the palace is laid out foursquare from the cord of Heaven, which is the command of the Telektonon. "Divine word never uttered until the Day of Truth." And in that palace, foursquare is the tower of the Cube of the Law.

●●●THE CUBE OF THE LAW AND THE TOWER OF BABEL

11. o children of the day of truth, before the separation that divided you into the children of the dawn and children of the book, there was only the Cube of the Law and the Law of the Cube.

12. Everyone and everything moved and lived within this Law: one mind, one spirit, one will.

13. Within the dimensions and measurements of the cube are all knowledge of Heaven and Earth. And in order to know, expand on, and delight in the sublime Law of the Cube, God created you, 0 children of the day of truth.

14. And though shaped of no more than mud and sounding clay, in you is the perfection of knowing the Cube of the Law, if only you remembered!

15. Children of the Day of Truth, just as the cube is the measure of the perfection of God's thought, so you are the measure of God's unceasing movement, which is called time.

16. In you the cube is the crown of perfect knowing of God's will in time. But true to his word, Iblis made wrong fair-seeming. To show himself man's enemy, Iblis split the cube. He drove a forgetting of time within the mind, separating mind from spirit, which is God's movement in all things.

17. And from this forgetting in man, mind and spirit became confused. The will weakened. Ego was born. Iblis's many-headed self triumphed. False authority arose. Babylon came to be and in its center the Tower of Babel, the monumental curse for no longer knowing time.

18. In the forgetting was the separation of the people of the dawn from the people of the book. Had there been no Tower of Babel, there would have been no book. The Tower of Babel was a deceit intended to show the Cube of the Law existing outside of the perfection of knowledge already formed within you, a children of the day of truth.

19. Product of the forgetting, the Tower of Babel has a shadow of ever-darkening and all-encompassing dimensions that spreads 5,000 years from Babylonia to all of Earth's most remote wildernesses and mountain retreats. Iblis's curse of Ego and false time are complete but hold only to the day of truth.

20. For God is gracious and most merciful. As long as He could, He kept the people of the dawn away from the Tower of Babel. And to both the people of the dawn and the people of the book, He sent many messengers, apostles of light, witnesses of truth, doers of the righteous way, which is always framed by the invincible Law of the Cube.

●●●● TELEKTONON: THE FRAME OF TIME

21. As the special witness of time, I, Pacal Votan, know the perfect count of days. I bow in the temple of the tower and the rock, the sanctuary of Bolon Ik. In my body, formed of the ultimate perfection of God's power of all movement and measure (Hunab Ku), is the recollection that is prophecy. Knowing this body as the measure of time, I had built this palace and this tower to correct and to also look for the Tower of Babel, a memory of the remembering. And in my ninefold temple, where, guarded by the nine powers of time, I had this body laid, I left this legacy for you, the Talking Stone of Prophecy.

22. Telektonon, the frame of time I left for you, is a mirror to show you your own truth of time for one last time. For now is the day of truth, the hour of judgment.

23. You, children of the dawn, and you, people of the book, unify yourselves the only way you can: in time, through time, as time.

24. Telektonon, the perfection of time, is the only way for you to escape the fire that consumes the unrighteous. If you who know, who have followed the straight way, the good path, now falter in this challenge of unification in time, Telektonon, which has already been prepared for you, you will perish forever in the fire that now consumes all unbelievers. God's command is in you. Do not listen to the evil one now.

MY COUNT OF DAYS IS PERFECT

25. Listen! My knowledge is this: My count of days is perfect, my knowledge of the Cube of the Law is unsurpassed. Twelve is the number of the temple, but thirteen is the number of God. Twelve times twelve, 144, is the number of the perfection of the temple as light. And twelve times 144, 1728, is the number of the Cube of the Law, Telektonon, the divine word unuttered until now.

26. "... To him that overcometh will I give to eat of the hidden manna, and will give him a white stone, and in that stone, a new name written, which no man knoweth, saving he that receiveth it." (Revelations 2:17) And that name is Telektonon, and that stone is crystal, and that hidden manna is knowledge of the revelation of time.

27. The number of the elect is 144,000. This was the number set aside by God to be free ofIblis's curse. Dispersed is this number among mankind, and always was it meant to multiply both among the people of the dawn and the people of the book.

28. But since a human kin is the measure of the perfection of time, 144,000 is also the number of days within a cycle of twenty generations.

29. Twelve times 20 generations is 1,728,000 days, the number of the Cube of the Law. But for God, one cycle more, 144,000 days more to entice Iblis to make his score, a total of 1,872,000 days, thirteen cycles of God's elect.

30. I am Pacal Votan, time's special witness, galactic agent of the Nine Great Lords of Destiny, by oath pledged to the honor of Bolon Ik.

31. In my body of time, thirteen star histories rehearse themselves for the day of truth. Each star history possesses its own knowledge keeper appointed by the Nine Great Lords of Galactic Destiny. Thirteen Wisdom Holders, Nine Great Lords, twenty-two in all, to each of whom I am bound by a luminous thread of knowing, sealed by oath to Bolon Ik, White Solar Wind, kin 22 in the Book of Destiny, the Book of Kin.

ALL IS NUMBER

32. All is number. God is a number. God is in all.

33. Child of the day of truth, listen: 20 is the number of totality. You have twenty fingers and toes because God has made you the totality of time. Thirteen is the number of God's cosmic wisdom, perfect in its power of unceasing change and circulation. Thirteen are the joints of your limbs and body. Seven is the difference between 13 and 20. Seven is the mystic perfection between one and thirteen. Seven is the erect spine of the vigilance in which are met the 144,000 mystic fibers of the body's thirst for prophecy.

34. 144,000 kin, 144,000 days, these are called a baktun. Thirteen baktuns, one perfect cycle to rehearse all thirteen star histories. Each baktun, twenty generations, each generation 7,200 kin. So it was that Bolon Ik ordained the sacred count of days, each day a sacred kin, each kin one of the elect, a turning in the twist of universal time, each kin ruled by the power of the nine, the power of the Nine Great Lords of Time.

35. So began the sacred thirteen baktun count, 3,113 years before the birth of the second of the special messengers, the Apostle Jesus Christ, who sent to you a Book of Dark Prophecies, twenty-two sacred chapters in all, through his appointed witness, John ofPatmos.

36. All this I know and declare to be true, for I am time's special witness to the day of truth, Pacal Votan, rehearser of the thirteen star histories, he who adds the 144,000 elect to the cubing of the cube, assuring not twelve baktuns, but thirteen to be the number to bring on the day of truth, God's judgment of your power of remembrance!

37. Children of the people of the dawn, in separating you from the people of the book, God meant you to be the reminder that wisdom is already perfect in your bodily form of time.

LORD BUDDHA

38. In remembrance, many messengers did he send you, many fires did he light high atop the mountain for you to see. And one special messenger did he send, one special witness of the dawn.

39. In India, at the midpoint of the seventh baktun, the very center of the mystic cycle, thirteen baktuns in all, Lord Buddha did awaken at the dawn, the morning star, the tree, the Earth, his witnesses of illumination. For seven weeks, he sat beneath that tree. Never moving, he traveled the seven directions and visited with his mind every realm of God's vast creation, only to learn the turning of the Wheel of the Law.

40. Withstanding all efforts of the evil one, he taught unceasingly for nine times five years more, until the age of eighty. All mind teachings did he give; the unwritten Book of Enlightenment did he leave with the Earth. His last turning of the Wheel of the Law was the teaching of the Wheel of Time. Given at the request of King Suchandra of Shambhala who traveled far from Central Asia to receive this teaching, the teaching of the Wheel of Time closed the life of Lord Buddha.

41. "All composite things are impermanent," declared Lord Buddha at his death, "Be a lamp and a refuge unto yourself, look to no outer authority but yourself!" The fire of Lord Buddha's illumination lit many lamps. The Book of Enlightenment he left with the Earth is a book for all to know in silence with the Earth.

42. In Shambhala did King Suchandra transmit the teaching of the Wheel of Time, Kalachakra, as it is called. Invoking the Nine Great Lords of Galactic Destiny, Shambhala prospered in abundance and wisdom. When came the seventh ruler after King Suchandra, Queen Visvamati, the people of Shambhala ascended as one into the paradise of the fifth dimension, where their wisdom continues to water the rivers that flow beneath the gardens of the righteous.

43. Integrating the power of the five, which is the center, with the power of twelve, which is the root of the cube, the Kalachakra is also the cycle of sixty years (5 x 12). By the Law of the Cube, which is the power of sixteen, foursquare or 7 plus 9, sixteen cycles

of sixty years is the appointed time of prophecy, the prophecy of Kalachakra, which is the time of the day of judgment.

44. So it was that after the arrival in Tibet of Buddha's special voice, Padmasambhava, late in the tenth baktun, that the Lords of Shambhala determined to release the teachings of the Wheel of Time among the people of the dawn inhabiting Tibet. Thus it was that the Wheel of Prophecy turned the first of these sixteen cycles in A.D. 1027 and completed the sixteenth of these 60-year cycles in A.D.1987, in partial fulfillment of the Harmonic Convergence of all prophecy.

45. 0 people of the dawn, do not doubt. The appointed day is come.

THE HEPTAGONON OF MIND

46. People of the dawn, people of the book, children of the day of truth. To safeguard as long as possible the teachings of the Original Ones from the confusion of the Tower of Babel, God divided the Earth by its one ocean into great island masses called continents. And most far from Babylon was Amerrikua, and also distant was Australia and the Island Kingdoms of Polynesia. Even in Africa, close to Babylon, for many great cycles were the people of the dawn protected in their natural wisdom.

47. But inexorable is my count of days, inexorable the rolling of the Wheel of Time, inexorable the Law of the Cube.

48. Telektonon is the name of the blessing received by those who master the Law of the Cube. Great is the power of God, whose power and blessing are ever close and near, foursquare the manifest action of radiance from the divine intersection of God's presence: divine mind, divine spirit, divine will, divine source from which the Cube is sprung. Foursquare the Cube, the measure of Telektonon, one vast, far-spreading word that is no word at all, but number multiplying itself from within God's unending meditation, which we choose to call creation.

49. From one intersection, six directions plus the seventh, the moving center of time, the navel of Heaven whose cord is a fiber called Kuxan Suum. From the navel of Heaven to the solar plexus runs the Kuxan Suum, highway that reaches to the roots of the stars, passing through each of the heavenly dimensions.

50. I who say this, know, for I am Pacal Votan, who left for you a talking stone, Telektonon. Time's special witness am I, God's spy holding vigil, keeping the sacred count of days, exposing to you the lie of Babylon, the falsification of the Cube into the Tower of Babel!

51. Who now but I can tell you that seven are the directions of the Cube, the Heptaganon of Mind: twelve are the gates, sixteen the powers; moved by the nine great powers of time, these sixteen powers become the number of the elect of the Cube, 144. Multiplied by the millennium, 144 becomes 144,000, sacred number of days I laid for prophecy to know during my first baktun count.

IMPERIAL BABYLON

52. Children of the book, even before the close of my first baktun, twenty generations from the year 3113 B.C.,the foundations of the Tower of Babel were laid. Captive now were the 144,000 within the Earthly prison of Babylon's materialism.

53. Yet, by my devotion and power of meditation, from deep within the Earth, aided by Bolon Ik's perseverance on far Uranus, Earth's harmonic twin, I kept the sacred count of days, I watched over the movement of the sacred march of kin.

54. Four more baktuns passed, and Babylon's power was swollen with the loot of Empire. Despite the righteousness of Abraham and the Law of Moses, the shadow of the Tower of Babel only increased in size and darkness.

55. Came the sixth baktun and Imperial Babylon was complete. Its seal of false time and power, taxation, and armed expanse had fulfilled Iblis's desire to degrade and ruin all humanity by making wrong fair-seeming. Fair-seeming now to amass wealth and power; fair-seeming to make a count of time by twelve months; and fair-seeming to regard the thirteenth moon with superstition and contempt! Fair-seeming to gather taxes and to pay them; fair-seeming to make war for the power of King's; fair-seeming that birth and death must be paid for; fair-seeming that all power come from the priests, Iblis's most cherished of men.

56. 0 people of the book, lost to you was all memory of the Law of the Cube, slavery became your lot! But I am Pacal Votan, time's special witness. Even before the coming of the second special messenger, Christ the Apostle of Love, by my free will and my knowledge of the power of seven, I laid claim to the Seven Seals of Prophecy that on the day of truth, Iblis's curse would be finished and the righteous would triumph. And now the day of truth is come. Telektonon, the talking stone, now speaks in a voice for all to hear.

57. By the seventh baktun, the Seven Seals of Prophecy were stored in Earth's special lodestone of truth, whose custodian am 1.

58. By the eighth Baktun, Iblis had caused the Tower of Babel to speak more tongues in a growing clash of empires. Into this confusion came the Apostle of Love, crucified for driving the moneylenders from the Temple, misunderstood by the people of the book, finally to be absorbed by the Priests of Babylon, now Roman by tongue, who use this Christ as their emblem to spawn Iblis's greatest evil, the total usurpation of Earthly Time.

THE BOOK OF DARK PROPHECIES

59. One special voice did this Jesus have, a man named Saint John ofPatmos, in whom the gift of prophecy was fulfilled. From my ark of universal time, Earth's special lodestone of truth, rock of Heaven, attained by thirteen tones, I guided Saint John's hand by the mystic power of seven. And so was sent to the world the Book of Dark Proph-

ecies, Revelations, the Apocalypse, twenty-two mystic chapters, the first thirteen mirroring my thirteen great baktuns, nine more for the Lords of Time, seven of these for each of Seven Years of Prophecy, and the last two to complete the visionary power of the righteous of the Cube: 144,000 times thirteen.

60. To those who can read they will find Iblis's numbers 1,260 and 666, well known on the day of truth, for 12:60 is the ratio of the false time that makes martyrs of the righteous, and 666 the number of the beast who captures my thirteenth baktun.

61. Children of the day of truth, children of the dawn, people of the book, all this can you hear in the stones of Palen que where in the tenth baktun I took pure human form. Of the twenty-seven books of the New Testament, the twenty-seventh is Revelations. Twenty-seven steps ascend to the Palace of Bolon Ik. This palace, New Jerusalem, is the mystic power of Telektonon, the twenty-eighth step, the power of seven sanctified foursquare.

62. Twenty-two chapters of Revelations are the twenty-two kin complete in Bolon Ik: thirteen for the power of time, nine for the Nine Lords of Time, whose forms still guard my ark of stone deep within the ninefold temple of the Cube of the Law. Perfect was the time of my coming, kin 1, 366, 560. Perfect was the time of my going, kin 1, 385, 540.

63. Installed in the House of the Serpent, my coming was commemorated by the departure of the third messenger, the special messenger of the day of truth, the Apostle Muhammad, who left for the righteous of the Earth the Book of the Righteous, the Holy Quran, clear signs to understand.

64. As Buddha taught so pure one mind, so Muhammad taught so pure one God. Submission to the will of God is at the center of the Law of the Cube. Truly for the righteous there is only the straight way, the path of basic goodness, laid out in the heart as obedience to God's will, the divine plan unfathomable to those who cry, "reason alone can save us!"

THE PROPHECY OF THE SEVEN GENERATIONS

65. I am Pacal Votan, witness of time. Telektonon is my gospel. The talking stone of unifying prophecy is my legacy intended for that special messenger who understands the meaning of my numbers.

66. By my symbolic channel of communication called Telektonon did I intend this prophecy to be discovered and recovered. Once forty years had elapsed from the time of the discovery of my Uranian crypt, then would come the recovery, the recollection by my special agent of the numbers rehearsed and repeated to announce the day of truth.

67. Perfect was the time of my coming. Perfect was my mission. Perfect was the time of my going. Perfect is the discovery of my prophecy. Perfect is the Telektonon, the little book the angel of the Lord made Saint John ofPatmos taste and eat, which you now possess, a treasure for the day of truth.

68. What you witness by these words is the last message I gave to my people, the message of 9.13.0.0.0, heard from my ark of stone through the Telektonon, Earth Spirit Speaking Tube. To my people I declared:

69. "Seven katuns are there to follow me. Seven generations, each one guarded by a solar witness taking account of what you do, each solar witness sealing your time with a prophecy to be known as the Book of the Seven Generations. And this book is to be opened for the day of truth.

70. "After the seven generations, the end of the baktun. Ten baktuns gone, the glorious Age of Maya gone, the Long Count of my days to be completed at 1,440,000 kin, the mystic number of the elect multiplied by ten.

71. "Then will come the three baktuns of Babel, the coming exile of 12:60 time. Thirteen years after this tenth baktun shall come the last prophetic round: thirteen cycles of Heaven, each fifty-two years, followed by nine cycles of Hell, each also fifty-two years. When the third round of Heaven begins, the Messenger of the Last Call will come to you, Quetzalcoatl-Kukulkan, the prophet by name.

72. "And when the thirteenth Heaven cycle is over, then will come the complete destruction of all we are and know. Before the twelfth baktun is over, two priests bearing false witness, ornamented with the sacred numbers five and thirteen, will see to it that the thirteenth baktun will be the end of time.

73. "Unrelenting will be the roll of the Nine Hells into the abyss of fire and madness. In the time of the last Hell, though you will be declared free, free you will not be. Ten Kings in succession will mark the climax of time. Seven years will follow the ending of the last Hell. Then will sound the angel of the seventh trumpet, the seven thunders will roll, the beast of seven heads called G-7 will place his mark on your foreheads and hands, the false one from Babylon will return to be embraced by the 11 Serpent. Then the day of truth will come, the Seven Years of Prophecy."

TIME'S SPECIAL WITNESS

74. People of the dawn, people of the book, children of the day of truth, many messengers have been sent to you, many prophets have been given to you. A Book of Enlightenment has been placed in the Earth for all to read in communion with the Earth. A Book of Dark Prophecies has been left for you. A prophecy of thirteen Heavens and nine Hells to accompany the Book of Dark Prophecies has also been left for you. A great prophet and messenger has left you clear signs to understand and a book of unassailable righteousness, the Holy Quran.

75. As the special witness of time, I have left for you my talking stone, Telektonon, breath of precious Bolon Ik, and have sent you both a prophet, Quetzalcoatl of sacred Xochicalco, and for the day of truth I have appointed also a special messenger who can hear my talking stone and write and explain its numbers and its meaning for you, children of the righteous.

76. Do not doubt any of this. When the moment comes for him who is to be the eleventh in succession, to succeed the one, 11 Serpent, then join the believers and begin the prophecy that liberates from all Kings and successors.

77. Ten witnesses I place around my tomb, ten Uranian emissaries, one each for each of ten baktuns. Of these am I the eleventh. Who would be the eleventh in the final succession of the Kings of Mexico must own me as the eleventh, then will all go well.

78. Six messengers did I place on my talking stone of prophecy: three above, the messengers Lord Buddha, Muhammad, and Christ; and three below, Padmasambhava, Quetzalcoatl, and Saint John of Patmos. Of these am I the seventh.

79. Pacal Votan am I, time's special witness, messenger of the Telektonon, instrument of the seventh angel, I declare again and again: All is number. God is a number. God is in all.

WAR OF THE RIGHTEOUS

80. Look carefully at my stone and listen: ten messengers, 24 signs, for ten are the number of orbits of planets around this star, Kinich Ahau, your Sun. From my point of origin, your star is designated 24, number of the circuit of externalizing intelligence. If you are of the righteous, then in this is a sign for you of your star mission.

81. And from each of the three oracle mouths of the arms of the cross of my Kuxan Suum, you will find twenty-four rays repeated three times, one-half the number of the elect (3 x 24 = 72). Add to this 3 times 11 (33) and the number is 105, the difference between the number of days in your solar orbit, 365, and the number of kin in my sacred count, my galactic spin, 260.

82. 13:20 is the ratio of natural sacred time. 12:60 is the ratio of the false time of the Tower of Babel. 13:20, thirteen moons, twenty fingers and toes. 12:60, twelve-month year, sixty-minute hour. Children of the day of truth, in this is a sign for you to discriminate between the power of the evil one who seeks to trap you in his machine, and the power of the righteous who need nothing but that with which God has endowed them: their body of time and their natural path synchronized by thirteen moons.

83. Children of the day of truth this is your only decision, for God knows and sees all that is in your hearts. People of the dawn, people of the book, on the hour of judgment unify yourselves in the only way you can: in time, as time, through time. For this in the year of kin 144, Telektonon is revealed to you, God's plan for peace on Earth, the last and only hope for spiritual renewal and salvation, immediate acceptance and adoption of the twenty-eight-day, thirteen-moon way, the calendar Telektonon. "And he had a name written that no man knew but himself." (Revelations 19:12) And that name is Telektonon.

84. Children of the day of truth, people of the dawn, people of the book, foursquare is my talking stone, invisible its design, its crystal lacing of star histories met in my human form. Time's special witness am I seeking apostles of time to organize the day of truth

into the revelation of God's redemption. Universal forgiveness awaits those who understand God's plan, a common time of twenty-eight days, thirteen moons, begun together at the appointed hour, on the day called Lunar Moon, the first day of the second year of prophecy.

85. Two solar faces there are upon my talking stone, the one an icon of my solar shield, Galactic Sun, the other, Lunar Sun, an emblem of the perfect lunar timing of Earth's solar orbit.

86. Children of the day of truth, the hour of judgment has come for you. How much longer do you need to suffocate in the Babylonian exile of 12:60 time? My children are the oppressed. Is it not time for the war of the righteous to restore equality? Why not wage the war then that destroys altogether the old time? Why not smash the caskets of the Babylonian wine of fornication in a single stroke?

HOLY VICTORY MARCH

87. 0 children of the day of truth, people of the dawn, people of the book, in your origins you were one blood, today the hour of judgment demands you become one again, unified in time. Who among you will join my apostles of the Telektonon? Already the gift has been given. Already we left for you the 13:20 tool, my sacred count of days, 260 kin, to turn the solar-lunar wheel of365 days. And when prophecy was vindicated at the conclusion of the ninth Hell, we sent among you the perfect form of this gift, Dreamspell, containing the message of the thirteen moons.

88. But this was not enough, the seventh trumpet had yet to sound, and so it did in the fortieth year following the discovery of my Uranian ark of stone. And now my prophecies are revealed. The Mayan Apocalypse of kin 144, Yellow Magnetic Seed, turns the seventh year of karmic destiny into the opening of the first of my seven seals of prophecy.

89. In this seal foursquare, all prophecies converge. The Beast of the G-7 stands revealed. The Babylonian Vatican is exposed. In the rainbow dream vision 144,000 of the elect are called again to meet, gathering together in circles to listen, to sing, and to dance to the song Telektonon.

90. 0 children of the day of truth, people of the dawn, people of the book, seven is my sacred power. Foursquare seven is 28, the number that, perfectly followed, opens Heaven's gate. Walking together the sacred thirteen moon, 28-day way, you will be joined to God's command, a holy victory march of the righteous to restore sacred order to this troubled Earth and to recover your lost powers.

91. Four powers of seven are given to you to be your comfort in the Victory March, one power for each of four perfect weeks, every twenty-eight days. By the first power of seven, claim your power of prophecy, by the second power of seven, maintain your power of prophecy; by the third power of seven, proclaim the victory of prophecy; by the fourth power of seven, become the victory of prophecy!

92. 0 children of the day of truth, 144,000 times thirteen is an army of the righteous. Learn again the count of sacred time and join this army. 0 children of the day of truth, realize that everything about the old 12:60 time is now become a garment of false being, a moral corruption, a banquet feast for the evil one.

THE STORM OF NON-EGO

93. 0 children of the day of truth, children of the people of the book, in the Storm is the sign of God's power. To the Storm is assigned the power of nineteen, the mystic saturation of all number. One hundred fourteen Suras, nineteen times six, the power of the Cube, are the number of Suras in the Holy Quran. Twenty-two years after the finding of my Uranian crypt, Telektonon, came complete revelation of the Quran's power of nineteen, Allah's mercy. Nineteen more years then to unfold the karma of Allah's prophet besieged by Babylonian conspiracy. Then comes the destined year nineteen, kin 144, hour of prophecy's convergence, moment of the day of truth.

94. Let the 124,000 messengers call forth a remnant of 20,000 more; let each of these sound seven trumpets, seven times. Let these seven times seven trumpets call for a following of God's perfect plan. Mark seven times seven years since the evil one showed his fiery face at Hiroshima. Be honored by God's cancellation ofIblis's power of moral oblivion. Let the storm of God's power of nineteen cleanse with cosmic mercy the blood of all martyrs from the thrones of Kings, and let these thrones themselves be dissolved by the pure water of sacred time flowing through the gardens of the righteous.

95. I am Pacal Votan, time's special witness, revealer of the Cube of the Law, devoted patron of the mystery that is woman, the consummation of the telepathic power of twenty-eight, known to me by name of Bolon Ik.

96. Pacal Votan am I, enigma to your men of reason. My existence is proof of the workings of higher law. Telepathy is participation in God's knowing, but is no cause to claim full knowledge of His powers. Prophecy too is natural law, the complement to God's mercy.

97. 0-19 is my code. In it are all demonstrations of the wisdom that is always close and near, but that comprehends the web of galactic being and all forms of its natural orders in time. Just as nineteen is the power of God's mercy, so zero is the fullness and emptiness all at once that characterize the nature of mind and all it can know.

98. Lord Buddha called this power of zero Sunyata. The special voice of Buddha, Padmasambhava, whose life span followed mine, exactly as Muhammad's preceded it, knew this Sunyata to be the basis of non-ego.

99. If you would know me and all that I witness for you in this hour of judgment, children of the dawn, people of the book, then practice the being that is non-ego.

THE ECSTASY OF DELIVERANCE

100. Because I repose on Telektonon, the mother of all prophecy, mine is the ecstasy of deliverance. With a mind of non-ego clasped to the heart of God I have sent out my

message of the Mayan Apocalypse. By relinquishing the calendar of twelve and leaving the prison of mechanized time, God's mercy will come swiftly to you.

101. Thirteen moons, twenty fingers and toes, thirteen joints, four limbs, five senses do you already possess. God's knowing and power of movement are already in you like a mother pregnant with child.

102. Why tarry now? When a house is burning, scurrying for your possessions will only cost you your life. This house that is burning is Babylon, the 12:60 way of life, which is now destroying your biosphere and poisoning everything about your life. Do not linger now fondling your machines. This is the Day of Judgment. If you can remember, leave this burning house and know that a better way has already been prepared for you, a holy victory march, my seven years of prophecy, Telektonon, the sacred revelation of time.

103. The Cube of the Law is awaiting its construction through the collective mind, spirit, and will of you, 0 children of the day of truth. Iblis, Satan, the evil one is none other than your ego clinging to the fatal lures of Babylon. God knows nonetheless exactly what is in your heart. Why not, then, become an apostle of the holy victory march? The ecstasy of deliverance is meant to be shared by all.

THE PROPHETS OF PEACE ARE AWAKENING

104. Pacal Votan am I, time's special witness am I, who bequeaths to you a talking stone, a legacy of place, Nah Chan, House of the Serpent, by prophecy known as Palenque.

105. And at Xochicalco, too, you will find stone utterances of my gospel left by command of my apostle, Topiltzin Ce Acatl Quetzalcoatl, who closed Christ's first millennium, as now my prophecy is come to close Christ's second millennium.

106. 0 people of the dawn, people of the book, children of the day of truth, make yourselves as one again and do not doubt the accuracy of the appointed hour on the day Lunar Moon! Synchronize now, and in all humility accept God's plan, twenty-eight days, thirteen moons, plus one day for deliverance and forgiveness.

107. Pardon now in public your enemy's indiscretions, and make full confession of your own transgressions. If you are sincere, God will see this in your heart and by His mercy many will follow your way; and if you proclaim for the cause of righteousness and truth, a new beginning and a new time, Telektonon, the thirteen moon way, and you enjoin others to do likewise, then God will know this, too, and make you a great general in the holy victory march.

108. And, if you have means and wealth, and you hear these words, or have explained to you the curse of 12:60 time and the blessing of 13:20 time, then do not doubt it and practice charity. Provide for the children orphaned by war and provide for the reconstruction of the Earth, that the practice of art and culture may flourish once again. Practice such charity with zeal, for soon you shall see an end to money. No more will flow the drunken wine of Babylon's fornication, and then what will you be with your paper credits and your useless machines?

109. The prophets of peace are awakening. Truly, the hour of judgment is come. Among the angels am I known as the mysterious benefactor of the righteous. Will you throwaway this opportunity, too? Beware for now the fire that consumes all falsehood is raging.

THE WIZARD'S HOARD OF THE LORE OF DEATH

110. People of the dawn, people of the book, children of the day of truth, because I am time's special witness, everything about my talking stone of prophecy is in fulfillment of God's divine plan.

111. Mine is the teaching of the 12:60 way of exile and the 13:20 way of redemption. Exactly 1,260 years passed from the dedication of my temple and closing of my Uranian crypt, A.D.692, 9.13.0.0.0, to its discovery and reopening in A.D.1952, 12.17.0.0.0. Another five times seven years, the numbers of my sacred ratio passed before the closing of the ninth Hell, A.D.1987, commemorated by the sacrifice of 3 Monkey, the first of four sacred signs on the western edge of my great talking stone. In this sacrifice was a sign of the death and transcendence of the way of the people of the book, "Joshua," and the people of the dawn, "Maitreya."

112. Eleven sets of triple disks, thirty-three in all, will you find upon my stone, for 33 is the number of the initiate, the middle harmonic of 65 that constitutes the Tzolkin, my sacred count of thirteen times twenty. All clear signs have I left for you, two borders of stars, the host of the Nine Lords of Time repeated by number on each side, top and bottom of my stone, a ledger of star histories complete in my form.

113. But especially would I have you look at Mars and consider again the disposition of the thirteen sacred signs placed around the edge of my stone, from 8 Ahau, my seal of truth, to 13 Cimi, the galactic closing of the wizard's hoard of the lore of death.

114. Ten emissaries celebrate the glory of my gifts for you, signs of peace from other worlds that beckon you to awaken from your sleep of Earthly Hell to join yourselves to God's command, Telektonon, the 28-day, thirteen-moon way and find in that count of days a path that leads directly to the paradise that is the repose and reward of the righteous.

115. One hundred forty is the number of the Telektonon, perfect its ratio 5:7 (28 x 5 = 20 x 7), the same as my sacred ratio 260:364(+1)

116. All is number. God is a number. God is in all.

SEVEN PERFECT ORACLES

117. People of the dawn, people of the book, children of the day of truth, this completes my testimony, I, Valum Votan, holder of the solar shield, protected have I been by the perfect love of Bolon Ik, who has stored my prophecy until this moment of release.

118. Seven perfect oracles have I given you, a perfect calendar of thirteen moons, an instrument to renew your spirit and your powers of Prophecy, Telektonon, and a book

of knowledge for you to penetrate the forgotten history of your star, Dreamspell. Also have I sent two messengers who bear witness to my truth, and thirteen perfect signs.

119. Now is the time of my prophecy. Now is the day of truth. Now is the opening of the seven seals. Now is the sounding of the seven trumpets. Now is the hour of judgment. Now is the song of the 144,000, the seed army of the righteous.

120. When the Lunar Moon has overflowed its banks, the G-7 will be no more.

121. When the Electric Wizard arrives, gather in banners of righteousness.

122. When arrives the Self-existing Storm, you will be fortified with spiritual abundance.

123. When comes the Overtone Seed, neither money nor priests will besiege you any longer, but the Earth will sing in harmony with your righteousness, Babylon will be no more, the Law of the Cube will be fully rehearsed in the hearts of the righteous.

124. In the sign of the Rhythmic Moon, senses will open to the manna of Heaven; no where will you find any longer signs of the evil one; a cosmic race will you be once again.

125. And when comes the seventh year, the Resonant Wizard will seal the Heavens and the Earth with the glory of all prophecy, the redemption of all prophets, messengers, apostles, and witnesses of truth.

126. Five years then will you have to close the cycle ofthe Seed, and another eight, thirteen years in all, to prepare for the coming of the Galactic Seed, 2013 Arcturus Dominion, the fulfillment of the star cycle of Valum Chivim, witnessed by the special agent, Pacal Votan, to the glory oflove, Bolon Ik, and on behalf of the mercy of God's divine plan, Telektonon, Cube of the Law, the mighty talking stone of prophecy.

"Man is one. Culture is indivisible. "

-ALBERTO Ruz, 1952, 12.17.0.0.0.

Transcribed 12 Seed, kin 64,
Resonant Moon Day 13,
Warrior's Cube 7, 0 Yax
Yellow Magnetic Seed Year, kin 144,
First Year of Prophecy

Blue Spectral Monkey/White Solar Wind
Tepoztlan, Morelos, Mexico

Appendix IV

The Nineteen Code

THE MYSTERY[1] of the motives of the hijackers, who were instrumented by divine will, if not by biospheric necessity, to catalyze the Inevitable Event, lies in their very number: nineteen. While the nineteen is related to the Quranic verse 74:30, "Over it is nineteen," and can be interpreted prophetically, the Law of Time confirms the Quran in demonstrating that the number nineteen possesses a supreme and indeed inviolable value. The Law of Time validates all that is true, and contains within it the mathematical confirmation of all systems of thought as different facets of the same synchronic order.

The Law of Time is based on the mathematical code of the Harmonic Module, itself a function and a demonstration of the 13:20 ratio. The vigesimal mathematics of the 13:20 frequency is known as the 0':'"19code, which is written with a simple dot-bar notation. As such the 0-19 code is a whole number system in which the count is not 1-9 but 1-19, and the positional zero represents a factor of 20 rather than of 10. As the demonstration of a radial mathematical code, the number 19 plays a singular role in the 13:20 matrix. As the largest compound prime number of the 0-19 count, within the context of this count 19 has certain unique properties and values. It may be asked: why 19?

First of all, let us consider the theological dimensions of the number 19 as hinted at by the Quranic verse 74:30. Long an enigma to scholars of the Quran, it was only through the genius of an Egyptian scientist, aided by a computer, that the meaning

of the verse was finally revealed as the nineteen code-an intricate mathematical system based on the number 19 underlying the entire structure of the Holy Quran.

"For the first time in history we have a scripture with built-in proof of divine authorship-a superhuman mathematical composition."l

The contribution of Rashad Khalifa (1935-1990) to the role and meaning of the Holy Quran for the entire modem world is without parallel. The martyrdom of this genuine seeker and messenger needs to be redeemed and placed in its proper light. According to Dr. Khalifa, "Nineteen is the common denominator throughout the Quran's mathematical system." "This is one of the greatest miracles" (74:35). To summarize in his own words, Dr. Khalifa states:

> The Quran is characterized by a unique phenomenon never found in any human authored book. Every element of the Quran is mathematically composed-the suras, the verses, the words, the number of certain letters, the number of words from the same root, the number and variety of divine names, the unique spelling of certain words, the absence or deliberate alteration of certain letters within certain words, and many other elements of the Quran besides its content. There are two major facets of the Quran's mathematical system: (1) The mathematical literary composition, and (2) The mathematical structure involving the numbers of suras and verses. Because of this comprehensive mathematical coding, the slightest distortion of the Quran's text or physical arrangement is immediately exposed.2

Like the Law of Time, which could only have been discovered after the opening of Pacal Votan's tomb, in A.D. 1952, the nineteen code of the Quran could only be discovered and unveiled over a twenty-two-year period between 1968 and 1990. Why? Because only with a modem computer could Dr. Khalifa subject every last word and letter of the Quran, in its Arabic original, to the rigorous analysis necessary to expose its mathematical perfection. As Dr. Khalifa writes in his footnote to 10:20 ("They say, 'How come no miracle came down to him from his Lord?' Say, 'The future belongs to God; so wait, and I am waiting along with you.'"):

> 10.20: In retrospect we see now that the Quran's miracle, indeed "One of the greatest miracles" (74:35), was divinely predestined to be unveiled 14 centuries after Muhammad. In view of the current condition of the traditional Muslims, ifMuhammad had been given this miracle, those Muslims, who are already idolizing Muhammad beside God, would have worshipped him as God incarnate. Additionally, this miracle is obviously designed for the computer age, and to be appreciated by mathematically sophisticated generations.3

The phenomenon of the intricate patterning of the nineteen code as witnessed, for example, in the 19 x 142 (2,698) occurrences of the word *God* in the Quran,

writes Khalifa, "alone suffices as incontrovertible proof that the Quran is God's message to the world. No human being(s) could have kept track of 2698 occurrences of the word 'God,' and the number of verses where they occur."4 One must bear in mind that the Quran was revealed in a time of primitive simplicity over a twenty-three-year period so that the suras and verses were separated in time and place, while the chronological order of the revelation of the suras is not at all the same as their final format. Moreover, the miracle of the nineteen code is not limited to the appearance of the word God, but is vast, intricate, and comprehensive. Dr. Khalifa lists a set of nineteen "simple facts" that confirm the Quran's mathematical coding. The "simple facts" are those not requiring a calculator or computer to be ascertained. We hereby reproduce these "simple facts," as they are presented in Appendix 1 of *Quran: The Pinal Testament* (all references to letters and words are to the Arabic original):

1. The first verse (1:1), known as *"Basmalah,"* consists of	19 letters.
2. The Quran consists of 114 suras, which is	19 x 6.
3. The total number of verses in the Quran is 6346, or (6234 numbered verses and 112 unnumbered verses *[Basmalahs].* 6234 +112 = 6346. Note that 6 + 3 + 4 + 6 =	19 x 334. 19.
4. The *Basmalah* occurs 114 times, despite its conspicuous absence from Sura 9 (it occurs twice in Sura 27). 114 =	19 x 6.
5. From the missing *Basmalah* of Sura 9 to the extra *Basmalah* of Sura 27 there are precisely	19 suras.
6. It follows that the total of the sura numbers from 9 to 27 (9 +10 + 11 + 12 . . . + 26 + 27) is 342, or	19 x 18.
7. The total (342) also equals the number of words between the two *Basmalahs* of Sura 27, and 342 =	19 x 18.
8. The famous first revelation (96:1-5) consists of	19 words.
9. This 19-worded first revelation consists of 76 letters,	19 x 4.
10. Sura 96, first in the chronological sequence, consists of	19 verses.
11. This first chronological sura is placed atop the last	19 suras.
12. Sura 96 consists of 304 Arabic letters. 304 =	19 x 16.
13. The last revelation (Sura 110) consists of	19 words.
14. The first verse of the last revelation (110:1) consists of	19 letters.

15. 14 different Arabic letters form 14 different sets of "Quranic Initials" (such as A.L.M. of 2:1) and prefix 29 suras. These numbers add up to 14 + 14 + 29 = 57 and 57= 19 x 3.

16. The total of the 29 sura numbers where the Quranic Initials occur is 2 + 3+ 7 + . . . + 50 + 68 = 822, and 822 + 14 (14 sets of Initials) = 836, or 19 x 44.

17. Between the first initialed sura (Sura 2) and the last initialed sura (Sura 68) there are 38 un-initialed suras. 38= 19 x 2.

18. Between the first and last initialed sura there are 19 sets of alternating "initialed" and "un-initialed" suras.

19. The Quran mentions 30 different numbers: 1,2,3,4, 5,6, 7, 8,9, 10, 11, 12, 19,20,30,40,50,60, 70, 80, 99,100,200,300,1000,2000,3000,5000,50,000, & 100,000. The sum of these numbers is 162,146= 19 x 6534.

Apart from the "simple facts," through use of his computer, a Hewlett Packard HP-IOOO E-series, Dr. Khalifa demonstrated many more complex levels of the coding of the number 19 throughout the Quran. These findings are synthesized in the Appendices to *Quran: The Pinal Testament,* and are also available in his other texts detailing his research, such as *The Miracle of the Quran.* The net effect of the truly monumental research effort exerted by Dr. Khalifa was the promotion of a highly reformed Islam based on "the Quran, the whole Quran, and nothing but the Quran." It is for this reason that Dr. Khalifa's translations of the Quran are referred to as "the Final Scripture," (1980) and the revised translation (1992) as the "Final Testament." It was also Dr. Khalifa's insistence on the Quran as the sole basis of Islam that earned him his martyrdom in Tucson, Arizona, on January 31, 1990.

NINETEEN IN THE TWENTY-COUNT POSITIONAL SYSTEM

The Law of Time-T(E) =Art, where T equals the 13:20 timing frequency ratio-upholds the validity of the research of Dr. Khalifa and graphically demonstrates *why* 19 is the mathematical factor that underlies the Holy Quran.

The fact that the Mayan vigesimal system is known as the 0-19 code, and that in this code 19, and not 9, has the supreme value of being the highest number, absolutely enhances the power and significance of Dr. Khalifa's discovery concerning

74:30, "Over it is nineteen." The supremacy of the value of 19, imperceptible if we only follow the decimal 1O-count, is fully demonstrated when we examine the 0-19 number code in which the numbers 0-19 are reproduced in a 5 x 4 (= 20) matrix, beginning with 0 and ending with 19. In this number set, which also demonstrates the mathematics of the radial matrix, there are ten pairs of numbers radially arranged, each pair of which adds up to 19:

0+19=19
1+18=19
2+17=19
3 + 16 = 19
4+15=19
5+14=19
6+13=19
7+12=19
8+11=19
9+10=19

In other words, within the parameters of the mathematical matrix in which nineteen is the integer with the highest value, its value completely informs the radial order of the entire vigesimal system. "Over it is nineteen." This is truly astonishing confirmation of the value accorded to 19 in the Quran. If the Quran is the true word of God, then we must expect that even knowledge unknown to Muhammad or Dr. Khalifa would be contained or coded in the Quran. We are referring, of course, to the Law of Time in its mathematical particulars, beginning with its mathematical base of expression, the 0-19 code.

19 = 7: NINETEEN IN THE 0-19 DOT-BAR NOTATIONAL SYSTEM

Just as the number 19 takes on a supreme value in the vigesimal system inconceivable in the decimal system, so the vigesimal order commands its own notational system. The 0-19 dot-bar notational system substantiates the meaning and power of 19 as the prime mathematical, saturated value unit in the twenty count. The dot-bar notational order is a holographic system distinct from the alphabetic system of Arabic numerals by which we write 1-10.

The distinction between use of the two notational orders is profound. This notational order uses only three notational symbols to build up the holographic context of

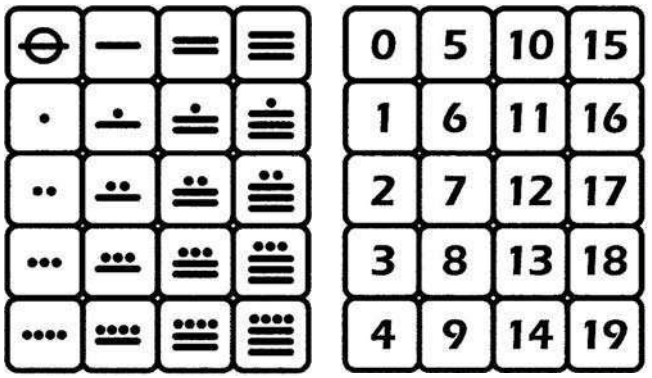

Any radially opposite set of numbers always equals 19, e.g., 4 and 15, 0 and 19, 9 and 10, 2 and 17, 11 and 8.

Nineteen is the highest value and the most saturated notation, being the only one with seven notational symbols—three bars and four dots.

Nineteen in galactic notation.
3 bars (3 x 5 = 15) plus four dots (4) = 19

Dot-bar notation system, 0–19 code

the fourth-dimensional number. One dot represents one unit; one bar represents a five-unit order; and a positional zero completes the system. The vigesimal notational system reveals the entire radial sequence of the 0-19 code to be a highly streamlined and aesthetic pattern. Brief contemplation shows that there are two patterned orders consisting of four vertical sets of five units each, and five horizontal sets of four units each. It is seen that nineteen represents the maximum saturation of both the vertical and horizontal orders, and consists of the maximum number of dots (four) and the maximum number of bars (three). It is also visibly manifest that 19 = 7 notational units, the maximum number of units.

The fact that 19 is represented by seven notational units confirms Sura 1, which has seven verses and the first line of which consists of nineteen Arabic letters. However, from the point of view of the Law of Time, 7 is the key implicit mathematical unit in the absolute timing frequency ratio, 13:20-the difference between 20 and 13 is 7, and the midpoint between 1 and 13 is also 7. While Dr. Khalifa is responsible for determining the dominance of nineteen as the mathematical key underlying the patterning and meaning of the Quran, the Law of Time provides an even more profound lens through which to consider Dr. Khalifa's work, by placing nineteen in a superior (vigesimal) mathematical and theological context.

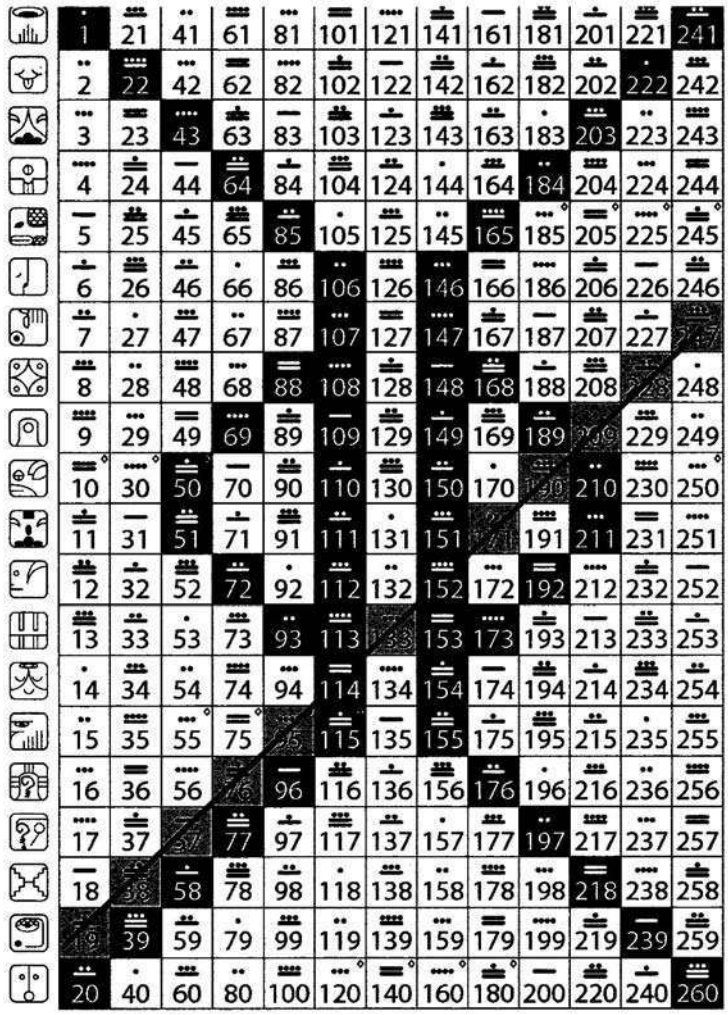

Nineteen Strand in Harmonic Module

Kin numbers beginning with 19, lower left, are advancing multiples of nineteen, the last being 19 x 13 (247). Actually, the difference between every kin number on this diagonal is a difference of 19.

19 = 260: THE TZOLKIN "OVER IT IS NINETEEN" STRAND

"All is number. God is a number. God is in all. "
-DYNAMICS OF TIME, POSTULATE 19.13

The 0-19 code provides the order of 20 in the ratio 13:20. Like the 0-19 radial matrix, the 13:20 ratio is also organized as a radial matrix of 260 (13 x 20) kin or units. As a cycle of 260 days, the 13 x 20 timing matrix is the fourth-dimensional

gauge that synchronically unifies the Thirteen Moon calendar. Known by the traditional and ancient Maya as the *Tzolkin* or "sacred count," the 13 x 20 gauge or Harmonic Module is the key to the mathematics of the fourth dimension, or the "Hereafter." Just as the mathematics of the third dimension is decimal-based, so the mathematics of the fourth dimension is vigesimal-based. Hence, the power of 20 as a self-existing proportion (4 x 5 = 5 x 4).

For any frequency to occur two proportions must be coincident. Thirteen, which is a function of the 7 factor, is the proportion that complements the 0-19 vigesimal proportion of 20. Hence the Tzolkin consists of twenty horizontal orders and thirteen vertical orders = 260 kin, which are also arranged in twenty sets of thirteen-kin wavespells, all numbered 1-13 in dot-bar notation. All of the kin in the 260-unit matrix are also individually numbered: kin 1, kin 2 . . . kin 259, kin 260.

Within the 13:20 order of260 kin, 13 sets of20 or 20 sets of 13, only two of the numbers in the vigesimal code 0-19 occur thirteen times: the number 19 and the number 20 (= positional zero). While 20 occurs precisely thirteen times, 19 occurs thirteen times with a remainder of thirteen (13 x 19 = 247 = 260 - 13).

The position and notational order of the thirteen occurrences of the number 19 in the 260-unit Tzolkin create a perfect strand of thirteen units. This 19 x 13 (19 = 260) strand demonstrates the supreme invariability and inviolability of the number 19 in the vigesimal code of fourth-dimensional time.

The purity of the movement of the 13 x 19 strand of the Tzolkin is further augmented by the vigesimal or 20-count manner of writing numbers. Even as transliterated into the Arabic system of writing numbers, it will be seen that in the vigesimal code every multiple of 19 always adds up to 19, a similar power held by all multiples of 9 in the decimal code. In vigesimal notation, the second order units are always multiples of 20 and not 10. Hence 38 = 1.18, where 1 = 20 + 18; or 5.14 = 114, where 5 = 100 + 14.

Finally, while the sequence 1-13 defines the thirteen galactic tones of fourth-dimensional time, the 0-19 matrix is represented by twenty icons and a four-color (4 x 5 = 20) permutation sequence. The combination of color, icon, and tone gives each of the 260 kin a "galactic signature." This completes the description of the Harmonic Modulerrzolkin.

We now present the thirteen multiples of 19 as defined by the 13 x 19 strand running from lower left to upper right in a perfect cross-stitch sequence that reverses the horizontal order of the 0-19 code frequencies. In other words, the first order represented is the order of (1 x 19) 19 (frequency 19, icon Storm), and the last is the

19 x 13 (19 = 260 code):

Each multiple of 19 is listed with a) kin number; b) vigesimal notation; c) galactic signature; d) 0–19 frequency order + tone number (Dynamics of Time Code); and e) number of units away from 20th position:

a. b.	c.	d.	e.
1 x 19 = kin 19 = 0.19	Blue Rhythmic Storm	19.6	1
2 x 19 = kin 38 = 1.18	White Crystal Mirror	18.12	2
3 x 19 = kin 57 = 2.17	Red Overtone Earth	17.5	3
4 x 19 = kin 76 = 3.16	Yellow Spectral Warrior	16.11	4
5 x 19 = kin 95 = 4.15	Blue Self-existing Eagle	15.4	5
6 x 19 = kin 114 = 5.14	White Planetary Wizard	14.10	6
7 x 19 = kin 133 = 6.13	Red Electric Skywalker	13.3	7
8 x 19 = kin 152 = 7.12	Yellow Solar Human	12.9	8
9 x 19 = kin 171 = 8.11	Blue Lunar Monkey	11.2	9
10 x 19 = kin 190 = 9.10	White Galactic Dog	10.8	10
11 x 19 = kin 209 = 10.9	Red Magnetic Moon	9.1	11
12 x 19 = kin 228 = 11.8	Yellow Resonant Star	8.7	12
13 x 19 = kin 247 = 12.7	Blue Cosmic Hand	7.13	13

What is sufficient is to contemplate the *formal inviolability of the number 19 as a constant (strand) within the Tzolkin matrix* as well as its *invariability of form when written in the vigesimal system.* That is, in the pure 0–19 notational system, any multiple of 19 always adds up to 19 and consists of 7 notational units, e.g., 8.11 (= 8 + 11 = 19) = 8 (= 1 bar 3 dots = 4 units) + 11 (= 2 bars 1 dot = 3 units) = 7 units (= 3 bars 4 dots = 19).

order of (13 x 19) 7 (frequency 7, icon Hand), showing again the intimate relation between 19, 13,6, 7, and 20, the key integers of the codes of fourth-dimensional time.

19 = 260, THE SIX SURAS THAT ARE MULTIPLES OF 19

In seeking proof of the Law of Time within the Quranic nineteen code, we need cite but a few examples that can demonstrate from within the nineteen code itself the key mathematical components of the Law of Time. In addition to the number 19, we

must look for any of the factors involved in the 13:20 frequency, such as 260, 7, 6-the difference between 19 and 13-and, of course, 13 and 20, or any of the multiples of these integers.

Following the method of Dr. Khalifa, probability analysis of mathematical constituents based on the assumption that certain numbers will be self-verifying, we start our program with the six suras that are multiples of nineteen:

Sura 19	"Maryam"	98 verses
Sura 38	"Saad"	88 verses
Sura 57	"Iron"	29 verses
Sura 76	"The Human"	31 verses
Sura 95	"The Fig"	8 verses
Sura 114	"People"	6 verses
=399, total of sura numbers		=260 verses in six suras that are multiples of nineteen.

= 19.19 vigesimal code

As can be seen, the sum of the six numbers of the suras that are multiples of 19 is exactly 399, or 19 x 21, the maximum factor in the vigesimal 20 x 20 matrix. Expressed in the vigesimal code this number, 399 = 19.19 [19 (x 20 = 380) +19], the only multiple of 19 in the vigesimal code that is written with two 19s, whose sum is precisely twice nineteen, 38, and is written with fourteen notational symbols rather than seven. This unique number, 19.19 (399), verifies "nineteen is over all," by placing 19 over 19 itself. The unique qualities of this most unique of multiples of 19 also indicates why the Quran consists of exactly six times nineteen suras. Six is the difference between the Quranic 19 and 13, the prime number of the Law of Time.

More amazing than the sum of the six suras that are multiples of 19 being 19.19 is the fact that the sum of the verses of these same six suras is 260. This is incontrovertible evidence for the formulation 19 = 260, and substantiates the mathematical patterning of the Quran to include the principle factor of the Law of Time, 260 (= 13 x 20). We are certain that Dr. Khalifa added the verses of these same suras and may have been perplexed at the meaning of the resultant number, 260. Of course, Dr. Khalifa did not know that 260 is the sum factor of the two proportions that create the natural timing frequency, 13:20.

It is also interesting that discovery of the 13:20 timing frequency, December 10, 1989, was made at almost the precise moment as Dr. Khalifa had completed the introduction to *The Pinal Testament,* the summation of his research on the Quranic nineteen code, Ramadan 26, 1409 (December, 1989). This points to the mysterious

movement of the Divine Will in establishing the mathematical proof of the Quran. Just as the work of Dr. Khalifa was terminated within a month of his completing the Final Testament, so the Law of Time, which would substantiate and vindicate the Quranic nineteen code, was ordained and propelled into its process of manifestation at exactly the same moment.

Now with the Law of Time the investigation begun by Dr. Khalifa is complete. Just as there are six suras that are multiples of 19 within the Holy Quran, so the key factor of the Law of Time, the number 260, is coded into the sum of the verses of these six suras. The door is opened for entirely new comprehension of the meaning and purpose of the Holy Quran. The Law of Time and the Holy Quran in mutual resonance will establish the proof of the advent and triumph of the Religion of Truth. (9:33,48:28; 61:9)

Most of the foregoing text of Appendix IV is taken from 19 = *260: The Holy Quran and the Law of Time* (1999), an unpublished manuscript by Jose Argiielles.

Notes

Preface

1. Meg Sullivan', "New Age Will Dawn in August, Seers Say. . .," *Wall Street Jou17lal,* June 23, 1987, p. 1. Front-page story on the Harmonic Convergence.
2. For the prophetic tradition of the Chilam Balam, see *The Book of Chilam Balam of Chumayel,* edited and translated by Ralph L. Roys (Norman, Okla.: University of Oklahoma Press, 1967); *The Codex Perez and the Book of Chilam Balam of Mani,* edited and translated by Eugene Craine and Reginald Reindorp (Norman, Okla.: University of Oklahoma Press, 1979); and *El Libro de los Libros de Chilam Balam,* edited and translated by Alfredo Barrera Vasquez and Silvia Rendon (Mexico City: Fondo de Cultura Economica, 1948, 1986). The issue of being a "prophetic messenger" is a touchy one for many people. However, as it is written in the Quran, "In truth we are always sending messengers. . ." (44:5). Messengers, as often as not, are self-revealed and confirmed only by God. In my case, I have been able to trace back the prophetic lineage of the Chilam Balam to Pacal Votan, from whom I have received direct transmission. The method of transmission is similar to that of the *terma* tradition of Tibet. Terma, or "hidden treasure," is left by a sage or prophet to be "discovered" at a precise moment much later in time by one designated to do so. See Tulku Thondup Rinpoche, *Hidden Teachings of Tibet: An Explanation of the Terma Tradition of Tibetan Buddhism* (Boston: Wisdom Publications, 1997).
3. This phrase is used often by Dr. Rashad Khalifa (1935-1990), whose groundbreaking translation and research of the Quran through the aid of the computer led to the discovery of the intricate nineteen-based mathematical code that underlies this unique text. His work is summarized in his translation of the Quran with its numerous appendices, *Quran: The Final Testament* (Fremont: Universal Unity, 1992). My own studies on this topic have resulted in two works: *Pacal TfJtIlm and Judgement Day* (portland, Oreg.: Planet Art Network, 1999), and *19 = 260: The Holy Quran and the Law of Time,* unpublished, 1999. See also Appendix IV to this book, "The Nineteen Code."

4. See, for example, Samuel P. Huntington's *The Clash of Civilizations and the Remaking of the World Order* (New York: Simon & Schuster, 1996, 1997); Benjamin R. Barber's *Jihad vs. McWorld* (New York: Random House, 1995, 1996); and Yossef Bodansky's *Bin Laden: The Man Who Declared War on America* (New York: Forum, 1999,2001). These writers, of course, all express a pro-globalization perspective.

Chapter 1

1. John ofPatmos, "Book of Revelation," Chapter 18, "The Fall of Babylon," verses 10, 16-17, 19-20, *The Holy Bible, New International Version* (Grand Rapids: Zondervan Bible Publishers, 1989), 1419-20.
2. Jose ArgUelles, *The Call ofPacal Votan: Time is the Fourth Dimension* (Glasgow: Altaea, 1996), 37.
3. Jose ArgUelles, *The Dynamics of Time: 260 Postulates* (Portland, Oreg.: Planet Art Network, 1999),30.
4. Kareng Koshev, "The Great Rainbow Bridge." Altai: unpublished paper, 2001.

Chapter 2

1. 1. Laptev, *The Planet of Reason: A Sociological Study of the Man-Nature Relationship* (Moscow: Progress Publishers, 1973; English translation, 1977),220.
2. V. 1. Vernadsky, "L'etude de la vie et la nouvelle physique" in *Revue generale des sciences*, vol. 41: 695.
3. V. 1. Vernadsky, *The Biosphere* (1926), abridged version (Oracle, Arizona and London: Synergetics Press, 1986), 22.
4. Ibid., 76.
5. Ibid., 77-78, 81.
6. Ibid., 82.
7. Ibid.
8. V. 1. Vernadsky, "Problems in Biogeochemistry II," in *Transactions of the Connecticut Academy of Sciences* (New Haven: Yale University Press, 1944),487-88,498.
9. v.1. Vernadsky, "Problems in Biogeochemistry II," Postulate 18, 511-12.
10. Jose ArgUelles, *The Dynamics of Time: 260 Postulates* (Portland, Oreg.: Pbnet Art Network, 1999), postulates 3.7 and 3.9, 24, 25.
11. V. 1. Vernadsky, "Some Words about the Noosphere" (1944), quoted in Andrey Lapo, *Traces of Bygone Biospheres* (Moscow and London: Mir Publishers and Synergetic Press, 1987),69.
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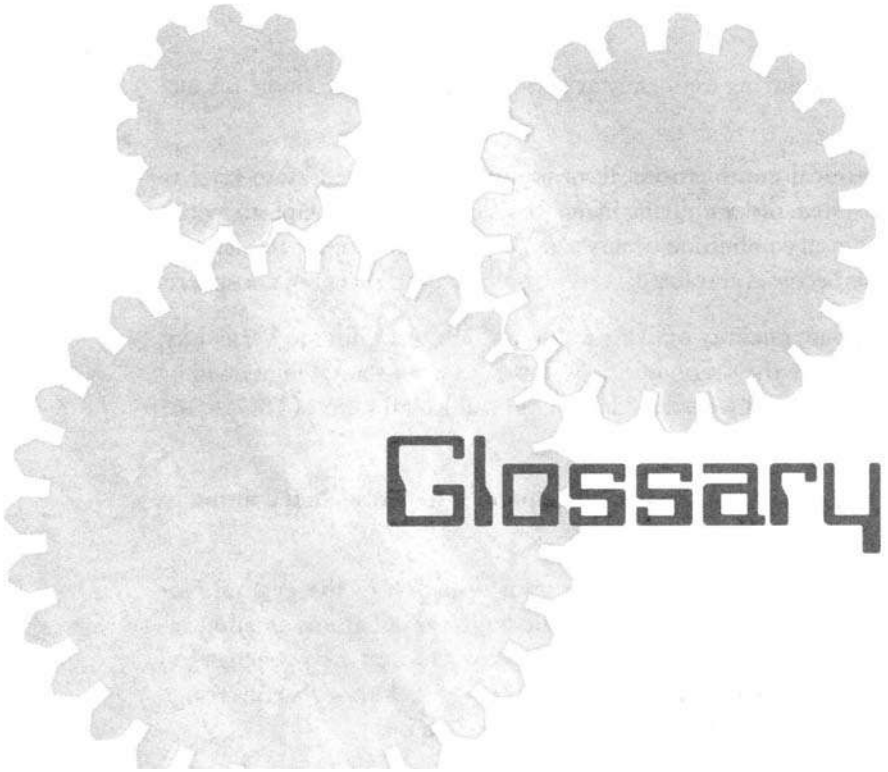

Glossary

THIS GLOSSARY IS constructed to aid the reader in developing a more systematic and technical comprehension of the Biosphere and the Law of Time. Though by no means exhaustive, it is hoped that the terminology used in the text is herein defined in a manner appropriate to cultivating a noospheric point of view.

13:20 timing frequency: Fourth-dimensional timing frequency mathematically expressed as the ratio constant .13:20; universal frequency of synchronization by which the universe is maintained in synchronic order; basis of Law of Time; codified as 260-unit 13:20 matrix of Harmonic Module, coordinates Thirteen Moon/28-Day calendar with synchronic order.

12:60.timing frequency: Artificial, purely third-dimensional timing frequency based on combination of irregular twelve-month calendar and mechanistic sixty-minute hour, adoption of which results in unconscious program within the human mental order, causing the species to deviate altogether from the natural biospheric order, resulting in the technosphere.

astronomical time: Measure of time in third-dimensional physical space without regard to intrinsic harmonics of the synchronic order, usually interpreted as duration and, based solely on matter that is in constant state of entropy, results in standards of measure characterized by infinitesimal.slippages of time and consequent fractional number sequences in need of periodic correction.

baktun: Fifth order of Mayan vigesimal number sequence; in time reckoning equals 144,000 kin (days), or 394.52 years; thirteen per great cycle, measure of human historical era or "great cycle": 3113 B.C.-A.D.2012.

biogenic migration of atoms: Biospheric principle by which evolution over time within finite quantity of living matter (biomass) is accounted for by changes of atomic.,cellular-

molecular state and condition; occurring uniformly at periodic transitions accounts for major evolutionary mutations.

biogeochemical, biogeochemical combustion: Term used by V. 1. Vernadsky to refer to biospheric dynamic as whole system order unifyIDg living (bio) and inert (geochemical) matter in a single process; biogeochemical combustion occurs when exponential curve of acceleration of biogenic migration of atoms becomes absolutely vertical, precipitating advent of noosphere.

biomass, biomass constant: Sum quantity of living matter, which, according to Vernadsky, has remained relatively stable since the origin of life on Earth; as a constant, maintained by synchronic timing factor mathematically described as an annual orbital ratio of 73(5) = 365 days per solar orbit of Earth.

biosphere: Sphere or mantle oflife and its geochemical support system distributed throughout Earth's ocean-land surface

biosphere-noosphere transition: Description of the transformation of the general biospheric condition due to accelerated excitation of biogenic migration of atoms creating release of free energy and consequent biospheric destabilization, characterized as biogeochemical combustion, whose resolution is emergence of new evolutionary order, the noosphere; change from historical technosphere to post-historic, post-technological phase.

Bolontiku: Nine Lords of Time; in Mayan cosmology, nocturnal rulers of the underworld or *inframundo;* guardians of the passage of death and resurrection; keepers of time and the knowledge of time as noospherically registered in Earth's orbit.

calendar: Derived from the Latin *calends,* or account book, a day for making payments; generic word used to define systems of timekeeping based on measure of Earth's orbit around the sun, often utilizing synodic measure of the moon as a means of calculating.

Chilam Balam: "Jaguar priest," name of Mayan prophet *(ah bobat)* who lived just before the time of conquest, which he accurately predicted; name given to lineage of Mayan prophets extending from the end of tenth baktun (circa A.D. 830) up until the nineteenth century; name given to series of post-conquest texts in which the various categories of prophecies of this lineage are recorded.

chronomancy, geochronomancy: "Divination by time"; the science and art of fourth- dimensional time considered as a whole system where science is knowledge and art is practice; oracular method of reading the synchronic order; description of incipient "Earth time science" incorporating principles of whole Earth geomancy into time structures of the synchronic order.

chronosphere: Sphere of time that activates noosphere; fourth-dimensional field created by the planet holon in resonance with the rotation of the third-dimensional planet body; coded as movement of four chromatics (biopsychic field) across the planet holon, stitching together gravitational fields (five Earth families) and electromagnetic fields (four color families).

chronotopology: Term coined by Charles Muses to define any geography of time and consisting of an event point of meaning that creates a root meaning from which time-formed, -blossomed, or -radiated meanings emerge above a horizon of meaning.

Day Out of Time: The 365th day of the Thirteen Moon/28-Day calendar, no day of the week or month at all (52 x 7 day weeks = 13 moons times 28 days = 364); occurs on Gregorian correlate date July 25, and precedes Thirteen Moon "New Year's" or synchronization date, correlated to July 26.

Dreamspell: Any agreed-on consensus reality; a collective mind-set defining a noospheric epoch, such as "Dreamspell of history"; term given to proofs and tools demonstrating radial and fractal principles of fourth-dimensional mathematics; cosmo-mythic structure of Earth history and its future, otherwise known as *Dreamspell: The Journey of Timeship Earth 2013.*

free energy: Release into biosphere of gases (such as carbon monoxide) and other chemical by-products of industrialization that accelerate biogenic migration of atoms, resulting in biogeochemical combustion; in noosphere refers to release of spectral plasmic-atmospheric phenomena through human telepathic interaction with the electromagnetic field.

fourth dimension: Dimension of time greater than and containing three dimensions of space that it informs and governs.

galactic signature: Combination of one of thirteen galactic tones and twenty solar seals that constitute the harmonic module and that code any given day of the third-dimensional Thirteen Moon calendar.

geocosmic: Holonomic perception expressing unification of Earth whole with the cosmic order.

Gregorian (Julian) calendar: Current world standard calendar consisting of twelve irregularly numbered and obscurely named months coordinated by the 7-day week and intercalary leap year system establishing 28-year cycles; created by the reform of Pope Gregory XIII (1572-1583) in 1582, which "corrected" the Julian calendar (established by Julius Caesar, 45-44 B.C.)by lopping off ten days and refining the intercalary system so that only centuries that are multiples of four are leap years; supreme example of astronomical time measure; principle macro-organizing principle establishing 12:60 artificial timing frequency.

Hannonic Module: 260-unit mathematical matrix of 13:20 frequency, inclusive of a 52-unit binary triplet configuration or set of galactic activation portals; sometimes referred to as Tzolkin, 260-kin sacred count of the Maya; basis of fourth-dimensional vigesimal mathematics of time; coordinated with third-dimensional calendar of Thirteen Moons, establishes basis of 260 galactic signatures.

heliosphere: Sun and its system of planets considered as a whole organism; also known as heliocosm.

holonomics: Of or pertaining to the law governing whole systems.

holonomic consistency and reciprocity: Law by which any whole principle of reality is capable of evoking a like response or reflecting a fractal order at whatever level or through whatever structure.

holon: Any organic whole unit, fractally replicable; basis ofholonomics, law governing whole systems.

human holon: Fourth-dimensional structure of the human being conforming to the 13:20 frequency (twenty digits, thirteen main articulations).

Hunab Ku: "One giver of movement and measure"; in Mayan cosmology, can refer to God as the Supreme Creator.

Inevitable Event: Law of Time definition of the point in synchronic order when the artificial time generated curves of machine, human population, and money converge exponentially in one dramatic, prophecy-fulfilling moment, marking the conclusion oftechnospheric expansion; name given to the events of September 11, 2001 (9-11), epitomized by the col~ lapse of World Trade Center Twin Towers (Fall of Babylon).

Julian Count: Established by Thomas Scaliger, 1583, the year after Gregorian calendar "reform," to establish a linear count of days beginning January 1, 4714 B.C.,some 1,600 years prior to commencement of thirteen baktun Long Count of the Maya; official modern scientific count, basis of linear time paradigm.

katun: Fourth order of vigesimal mathematics = 8,000 kin; in Mayan time count, where the second order vinal is 18 and not 20, a katun = 7200 kin, or 19.7 solar years; twenty katuns equal one baktun of 144,000 kin; 260 katuns per thirteen baktun cycle.

kin: In fourth-dimensional mathematics the base unit of measure, possessing fractal properties; one day and night or turn of Earth on its axis; any human being so designated by assuming the galactic signature of the date of birth.

Law of Time: T(E) =Art, Energy factored by Time equals Art, where T (time) is the fourth-dimensional universal synchronization frequency constant 13:20, E (energy) refers to any phenomenal manifestation, and Art to the fact that the synchronizing frequency of time harmonizes everything into a natural condition of beauty.

Long Count: Mayan count of days (kin) measured by thirteen baktuns of 144,000 days each for a total of 1,872,000 kin, the measure of history from JulianiGregorian correlates August 13, 3113 B.C. to December 21, 2012; still maintained through use of Tzolkin by Quiche Maya, Guatemala.

lunar calendar: System of time measurement using synodical measure of the moon-from new moon to new moon, approximately 29.5 days; twelve lunar months equaling a total of 354 days, eleven days short of the measure of solar orbit; used by many of the Old World civilizations; with the exception ofIslamic lunar calendar, most lunar calendars intercalate a thirteenth moon, seven per every nineteen years.

machine: Capacity for the human to externalize its internal processes as well as motor functions into different means of mechanical reproduction, the sum possibilities of which establish a technological complex requiring constant maintenance, thus subordinating human consciousness to its level; the ultimate manifestation of the 12:60 timing frequency; any industrially produced tool believed to advance the level of human comfort and accomplishment.

noosphere: Earth's mental envelope or field, discontinuous with and above the biosphere; unconscious until the discovery and application of the Law of Time; activated by registration of the human biomass in correct 13:20 timing frequency via universal adoption of Thirteen

Moon calendar; description of transformed state of biosphere, coincident with the end of history; condition of universal telepathy subsequent to collapse of technosphere and application of Law of Time; functions in tandem with programs from Earth's octahedral core.

noospheric chip: Description of human operating in noosphere, holonomically resonant with intrinsic 13:20 codes of synchronic order, capable of interacting with the psi bank to participate in the creation of Earth's rainbow brain.

Noospheric Earth Time (NET): Time measure based on Earth in its orbit in relation to the sun and moon in heliospheric space, rather than from the perspective of human (astronomical time); base unit of measure is one rotation of Earth on its axis or one kin (one night and day), which establishes one NET minute; twenty-eight NET minutes per Moon, or one NET hour, 365 NET minutes, or Thirteen NET Hours plus one NET minute per solar orbit; takes into account that for any NET minute axial magnetic bipolarity of Earth is a changing dynamic reaching two peak points called solstices and two stable points called equinoxes; this four-part division is holonomically registered daily in two peak points, midnight (where day begins and ends) and noon, and two stable points, sunrise and sunset.

occult quartet: Demonstration of radial mathematics of Harmonic Module where the tones of any four kin radially equidistant from each other always equal 28; or the tones of any two kin radially opposite always equal 14.

octahedral core: Iron crystal structure at center of Earth; plasmic storage zone in resonance with the noosphere; in 7:7::7:7, telepathically coordinated by four time atoms (= one master time molecule).

omega point: In the work of Pierre Teilhard de Chardin, defines the climactic convergent point (harmonic convergence) of human evolution as the emergence of the hyper-personal; defined by the Law of Time as point of full superconscious establishment of universal telepathy as the norm of the human mental condition; dawn of omega point: winter-northern-summer-southern solstice, 2012, completion of omega point dawn, Yellow Galactic Seed (July 26,2013), otherwise known as Dreamspell of galactic culture.

oracle: For anyone of 260 kin of the Harmonic Module, a cruciform five-part structure demonstrating a uniform set of mathematical relationships in relation to the (0-19) code number of the daily solar seal (destiny kin) informing any day of the Thirteen *Moonl2* 8-Day calendar; consists of center, code number of destiny kin; right analog kin-always 19 when added to the number of destiny kin; left, antipode kin-always a difference of 10 from the destiny kin; below, occult kin-when added to destiny kin always equals 21; and above, guide, always the same color as destiny kin.

Oxlahuntiku: The Thirteen Lords of Time that govern the power of the cosmic order of time that is based on circulatory power of prime number 13 (as opposed to 12, which is static and non-circulatory); coded as thirteen 28-day moons that govern terrestrial solar orbit; basis of prophecy cycle of Quetzalcoatl, Thirteen Heavens (Oxlahuntiku) and Nine Hells (Bolontiku); in Telektonon prophecy, the thirteen-year cycle-2 000-2 013-in which the first four years, 2000-2004, establish self-existing power of time, and last nine years, 2004-2013 are coded by the Bolontiku, the Nine Lords of Time.

Pacal Votan: Mayan prophet (A.D.603--683), chief technician of Mayan synchronic time science; eleventh ruler of the dynasty of Palenque (Nah Chan), Chiapas, Mexico; assumed power in A.D.615, but key rulership occurred in critical 52-year cycle, 631-683 (seventy-third such cycle since commencement of thirteen baktun count); best known for the carved sarcophagus lid of his elaborately concealed tomb discovered in 1952, 1,260 years after its dedication in A.D.692, which was also 1,320 years before the closing of the cycle, 2012.

Pax Cultura, Pax Biospherica: Principle of new human social order following establishment of Thirteen Moon/28-Day calendar and inaugurating the advent of the noosphere (2004) in which nation-state is replaced by biospheric regionalism governed by a Planetary Biospheric Assembly; due to perfect harmony of new world standard calendar of thirteen moons/28 days, harmony, art, and aesthetic values elevate culture as the new operating norm of the human reintegrated within the biosphere, hence *Pax Cultura, Pax Biospherica.*

planet holon: Twenty-part icosahedral noospheric matrix superimposed on Earth's surface; corresponding to 0-19 code of twenty solar seals, creates three orders analogous to three planetary fields of resonance; gravitational field-horizontal order of five Earth families of four seals each; electromagnetic field-four diagonal bands, from lower left to upper right, of the four color families (red, white, blue, yellow) of five seals each; and biopsychic field-the four chromatics of five seals each moving diagonally from upper left to lower right, which coordinate the daily sequence of the motion of the chronosphere.

psi bank: Regulating mechanism of the noosphere consisting of four bipolar plates, each plate in mirror symmetry containing 520 (260 x 2) psi chrono units, 2,080 in all, which are the complete registrations of the universal fourth-dimensional 13:20 timing frequency governing all of the various evolutionary stages of the terrestrial biogeocosm; engine of the chronosphere, located between the two radiation belts 2,000 and 11,000 miles above Earth's surface.

psi chrono unit: Time-bearing information unit; base unit of the psi bank; codes and contains all information for anyone of the 260 galactic signatures of the 13:20 matrix or Harmonic Module; psycho activated through coordination with Thirteen Moon/Telektonon known as Rinri Project.

Psychozoic Era: Term coined by V. 1. Vernadsky defining the next geological era; meaning the era of the spiritualization of life, it is coincident with the noosphere in its full emergence after the omega point has been reached, 2012-2013.

Quetzalcoatl: Mexican prophet (A.D.947-999) who left the legacy of prophecy of Thirteen Heavens and Nine Hells, basis of Harmonic Convergence (1987) and commencement of the "Time of Prophecy," 1987-2013.

Quran, Holy Quran: Literally "recitation;" last revelation and moral-spiritual criterion for historic humanity; received over a twenty-three-year period by the Prophet Muhammad (A.D.570-632); proven by Dr. Rashad Khalifa (1935-1990) to be a radically nonlinear text rigorously constructed of a nineteen-based mathematical code.

radion, radial plasmas: Telepathic fluid or lubricant released through telepathic interaction with the seven primary plasmas, or electrically charged particles, hence radial plasmas; the

names of the seven plasmas replace the names of the week in the Thirteen Moon/2 8-Day calendar; activated in the 7:7::7:7 Telektonon Revelation practice.

radiosonics: Name given to the new science based on synchronicity rather than causality and in which, as a consequence, synaesthetic experiences and syntropic values are normalized.

rainbow brain: Description of activated noosphere, where human telepathic interaction with the electromagnetic field triggers the release of the circumpolar rainbow bridge-Earth's day-night alternator system.

Rinri Project: Law of time practice for coordinating the opening of the psi bank, psi chrono unit per psi chrono unit, on a daily basis over a four-year cycle by means of the Thirteen MoontTelektonon.

synchronic order: Order of fourth-dimensional time, in contrast to third-dimensional astronomical time, that synchronizes all aspects of third-dimensional physical plane reality including its timekeeping systems; entirely new domain of human mental-spiritual experience coincident with the dawning of noosphere; characterized by absolute harmonic perfection, described by vigesimal 0-19 code, as distinct from decimal, hex, or duodecimal mathematics that govern third-dimensional timing codes.

synchronometer: Measure of synchronization or synchronicity; precise Law of Time definition of means and purpose of what is generically referred to as the "calendar."

technosphere: Global sphere of technology; artificial stage between biosphere and noosphere, representing the climax-biogechemical combustion-of acceleration of biogenic migration of atoms precipitating biospheric crisis as a prelude to the advent of noosphere; characterized by exponential curves of human population, machine, and money at expense of biospheric integrity and stability; defined as the specific fifty-six-year cycle (two Gregorian 28-year cycles) 1945-2001, in which war and terrorism are the governing features; complete manifestation of the 12:60 order of time; concluded on September **11,2001,** the Inevitable Event.

Telektonon: "Earth Spirit Speaking Tube," the name of the psychoduct leading from the tomb of Pacal Votan beneath the Temple of the Inscriptions to the temple floor atop the pyramid, the discovery of which, in 1949, led to the excavation and revelation of the long-concealed tomb in 1952; name given to the prophecy ofPacal Votan, decoded in 1993-1994, prophesying the Thirteen Moon/2 8-Day calendar as the only means to keep the human race from destroying the biosphere and itself; definition of the fourth-dimensional structure of the heliosphere in which consciousness is a function of the planetary orbits; basis of a board "game" coded to synchronic order via Thirteen Moon calendar for the awakening of telepathy; basis of the Cube of the Law, days 7-22, containing numerous principles of the Law of Time as a daily practice; basis of other practices for establishing synchronic order as principles of a new consciousness, including *20 Tablets of the Law of Time* and the 7:7::7:7.

third dimension: Space; physical plane of reality coordinated and contained by time, fourth-dimensional order of reality.

Thirteen Moon/28-Day calendar: Pragmatic application of the Law of Time, perpetual harmonic perfection of which is intended to correct for disorder of human consciousness resulting from adherence to irregular, astronomical timing standards and mechanistic timing devices; coordinated with Harmonic Module and Telektonon establishes means for conscious human participation in synchronic order; 28-day measure based on female menstrual cycle, also corresponds to apsidal measure of moon from the point at which the polar axis is tipped farthest from Earth; prevalent in pre-history, all but eliminated by historical consciousness that made 13 taboo; perfect vehicle for establishing noosphere as daily consciousness in post-technospheric post-history.

time: Fourth dimension; universal factor coordinating space to manifest synchronically; traveling faster than speed of light, accounts for instantaneity of information transmission (telepathy) from distant points; expressed as formulation which states that the velocity of time is instantaneously infinite; fourth-dimensional structures that are radial and fractal in nature, third-dimensional cycles being manifestations thereof; expressed as T(E) =Art, accounts for universal harmony of the cosmos.

tun: Third positional order of vigesimal mathematics where one unit =400 kin; in Mayan time count, because of second positional order, vinal, being 18 instead of 20, one tun =360 kin; basis of measure ofkatuns and baktuns in Long Count, where 5,200 tuns =260 katuns = 13 baktuns, or 5,125 solar years.

Tzolkin: "Sacred Count," 260-day calendar of the Maya, basis of Mayan time knowledge and the Long Count; temporal manifestation of Harmonic Module or universal 13:20 timing matrix.

UR: "Universal Religion," "Universal Recollection;" description of human spirituality in the noosphere or Psychozoic Era.

vigesimal, 0-19 code: Twenty-count based mathematics utilizing zero for positional orders that advance in exponential binary fashion; also known as 0-19 dot-bar code notational system, where dots equal single units, bars equal five units, plus positional zero; basis of mathematics of fourth-dimensional order of time, distinct from mathematical systems of third-dimensional space.

Wave Harmonic of history: Fourth-dimensional description of thirteen baktun cycle (3113 B.C.-A.D.2012) identified precisely with 260-unit Harmonic Module, where each of thirteen baktuns contains twenty katuns (13 x 20); basis of creating synchronic order out of entropic disorder of third-dimensional historical time.

wavespell: Thirteen-unit cosmological form-constant for coordinating fourth-dimensional timing cycles; consists of two gates, Magnetic first position and Cosmic thirteenth position; two towers, fifth and ninth positions; and three sets of chambers, nine chambers in all; when coordinating Thirteen Moon/28-Day calendar, known as Planetary Service Wavespell.

Wizard's Count: Name of count to establish synchronic order as manifestation of the Law of Time in order to transit from 12:60 technosphere to 13:20 noosphere; based on

prophetically modified year-bearer count of the Chilam Balam tradition; correlated by the Dreamspell to July 26, 1987, White Galactic Wizard, every four years there are four year bearers: Yellow Seed, Red Moon, White Wizard, and Blue Storm (one four-year Seed-Storm Year bundle) that, combined with thirteen galactic tones creates 52-year solar-galactic cycle, or in NET time, one Earth Year, also known as a Wizard's Year.

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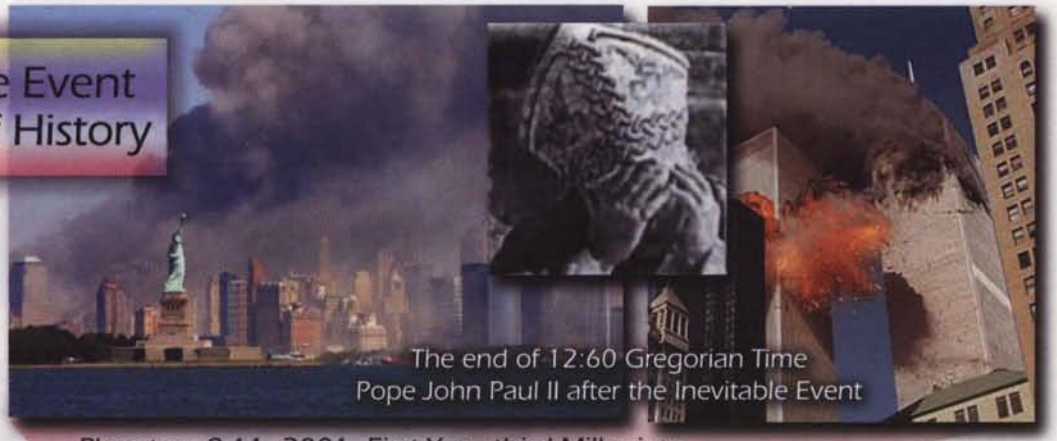

Planetary 9-11, 2001. First Year, third Millenium

"Woe! Woe, O Great City, O Babylon
in one hour your doom has come!"
—Revelations, 18:10

11 Years Before

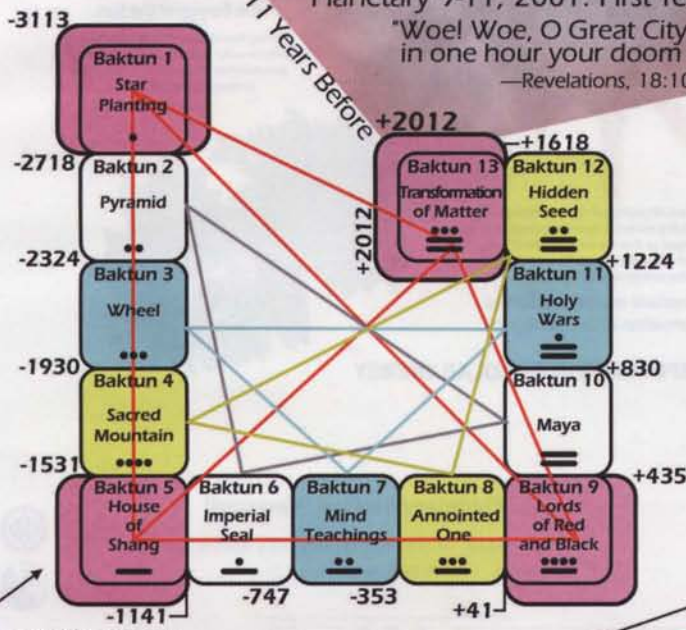

Baktun 13 - Katun 260 - 1993 - 2012
End of Second Christian Millennium A.D. 2000

13 Tone Wavespell
as Thirteen Baktun
Wave Harmonic
of History

Harmonic Module
13 Baktun
260 Katun
13:2 Matrix of History
1 Kin = 1 Katun
1 Baktun = 20 Katuns

Nostradamus Prediction
of nuclear destruction of
New York in Year 2000

Cover of "Istoe" (Brazil) May, 1996. "End of the World."

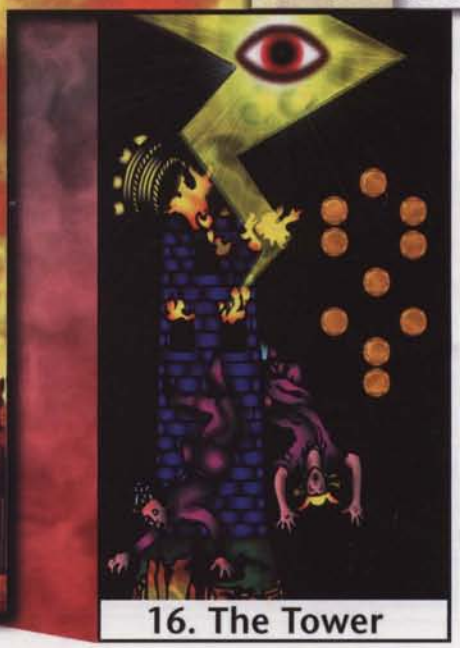

16. The Tower

The total mass of living matter has never differed considerably from the present value.

The Continuity and Invariance of Life on the Earth

Living matter today is genetically connected with all the living matter of preceding ages, and conditions favorable to life on Earth have never differed vastly from those of the present.

Multiplication as a Manifestation of Transformed Solar Energy

The movement of living matter resulting from the multiplication of organisms operates with an astonishing regularity.

The rate of production of new living matter is proportional to the amount already produced.

Whatever may be the phenomena of life, the energy evolved by organisms is mainly (perhaps entirely) the radiant energy of the Sun

Vegetation as a Transformer of the Energy of the Sun.

We may regard living matter in its entirety as the peculiar and unique domain for the accumulation and transformation of the luminous energy of the Sun.

Throughout all geological ages the chemical effects of living matter on its surroundings have not changed, so that the composition of the crust and of the living matter are the same today as they have always been.

The Biosphere as a Region for the Transformation of Cosmic Energy

LIFE IS THE TRANSFORMATION OF SOLAR ENERGY

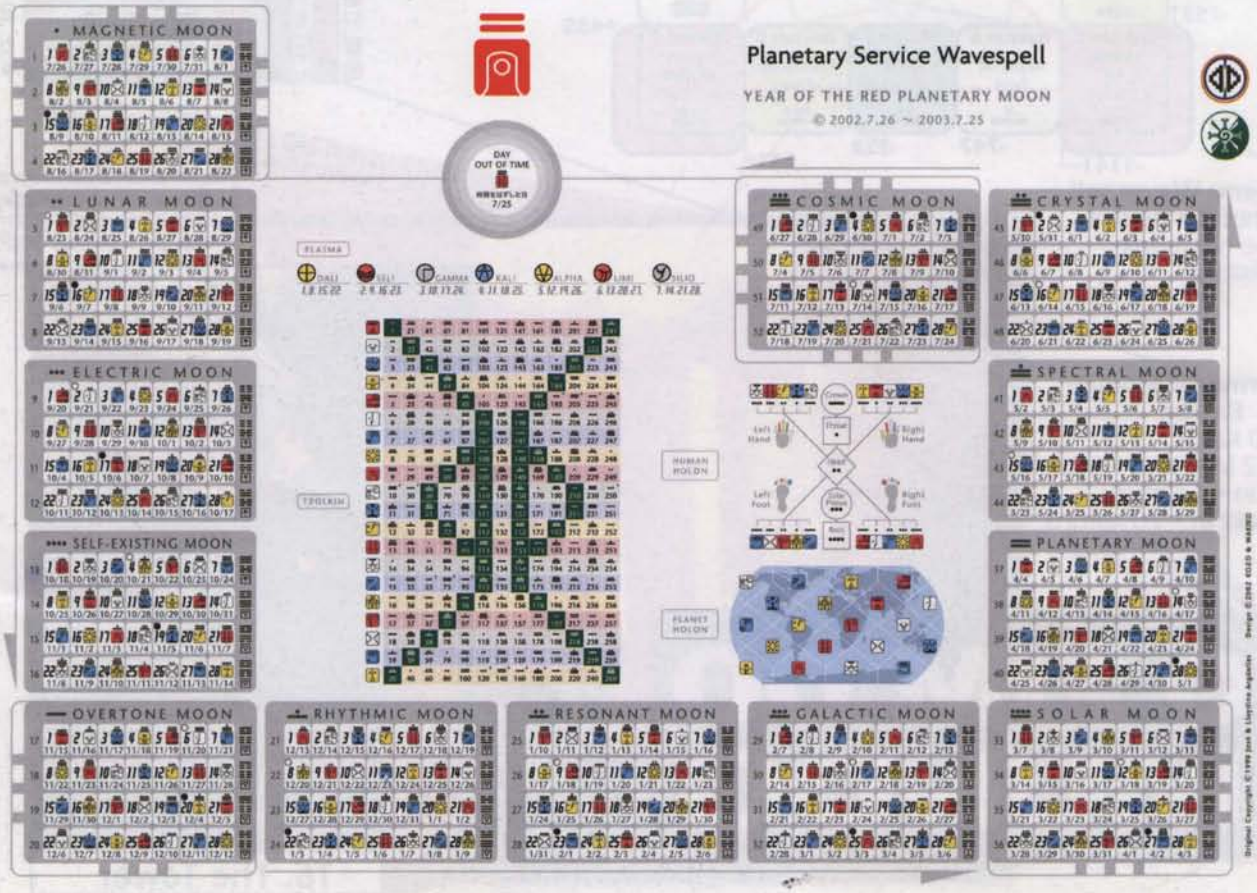

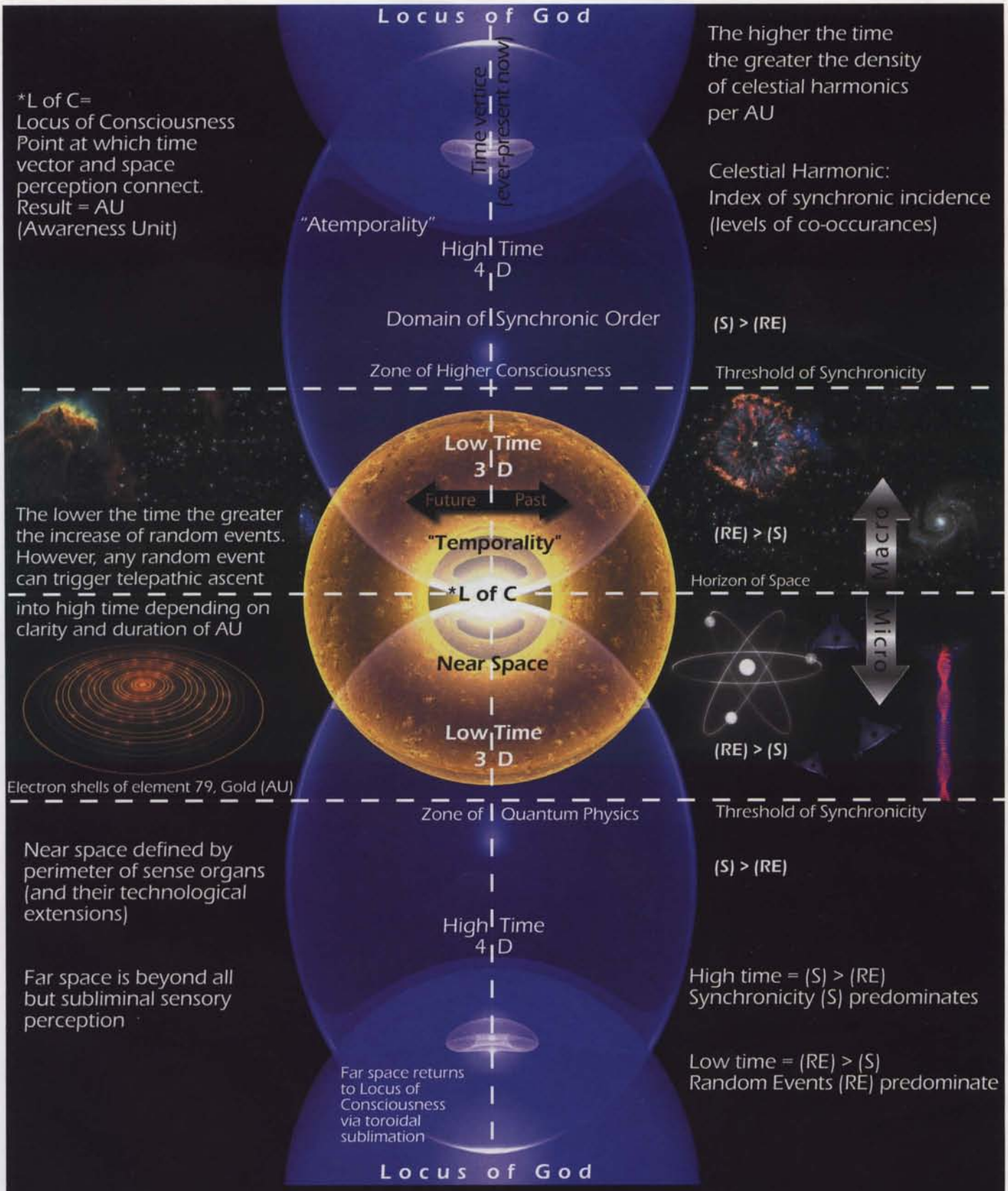

Model of "Vertical Time" in Relation to Horizontal Space

A Presentation of the Foundation for the Law of Time
T(E)=ART. Energy factored by Time equals Art.

The Dynamics of Time
Showing the Evolution of Time as Consciousness - T(E)=Art

GALACTIC BRAIN, or evolutionary spectrum showing index of energy-mind progression from atomic-cellular biological to purely mental conditions of being, T(E)=Art. Energy factored by time equals art.

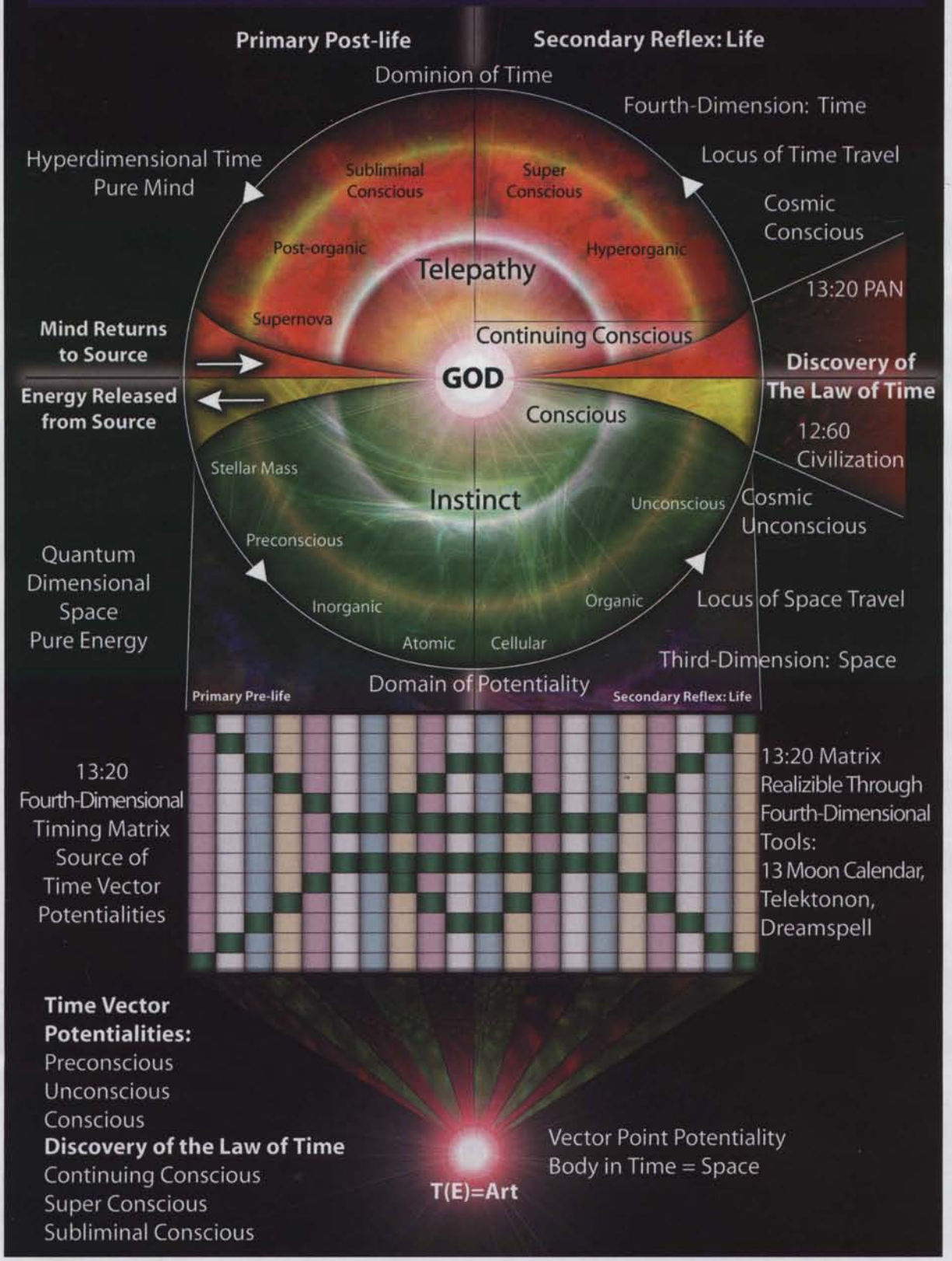

Noospheric Time Map - Wave Harmonic of History

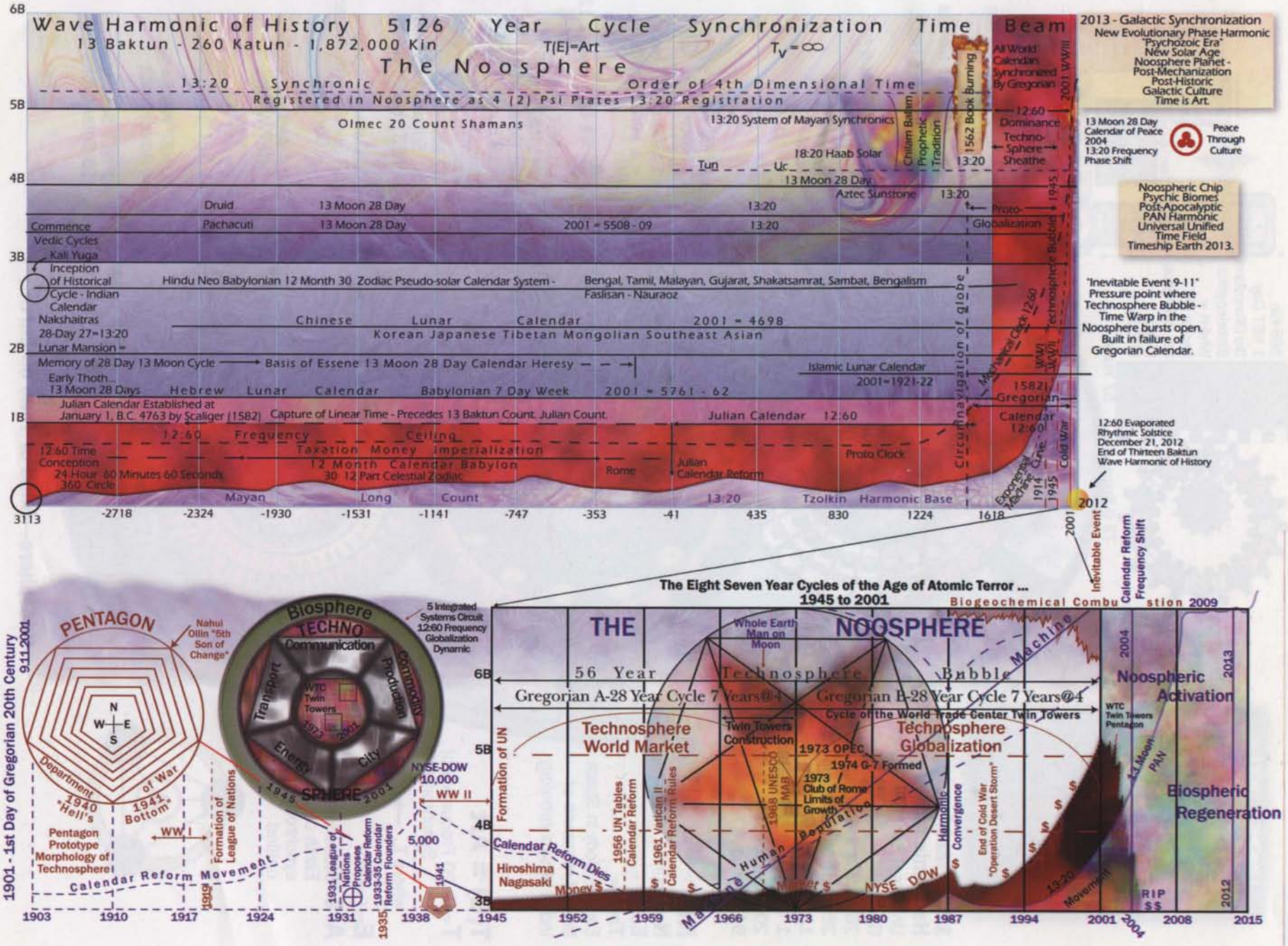

260 Kin
4th Dimensional
Wheel of
Synchronic
Order =
Factor of
Synchronization=
1 G-Spin =

73 G-Spins = 52 Years

365-Kin
1 NET Day
3rd Dimensional
Biotelepathic
Wheel =
Factor of
Life Experience
(73:5)
(7:52)

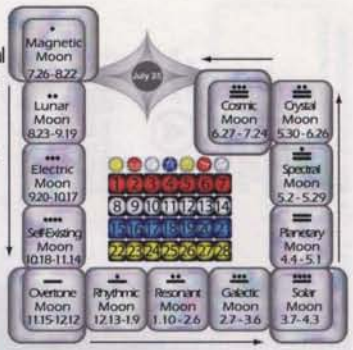

Wavespell = 13 Tones
1 Tone = 1 Moon = 28 Kin
1 Kin = 1 NET Minute

◐ = 1 NET Minute
x 28 = 1 NET Hour.

7 NET Minutes =
¼ Hour =
1 Week ◔

13:20 Matrix
Harmonic Module
Universal Synchronization
Gauge =
260 Kin = 1 Galactic Spin =
260 NET Minutes
13 NET Minutes =
1 Wavespell (13 Tones)
20 Wavespells =
9 NET Hours, 8 NET Minutes

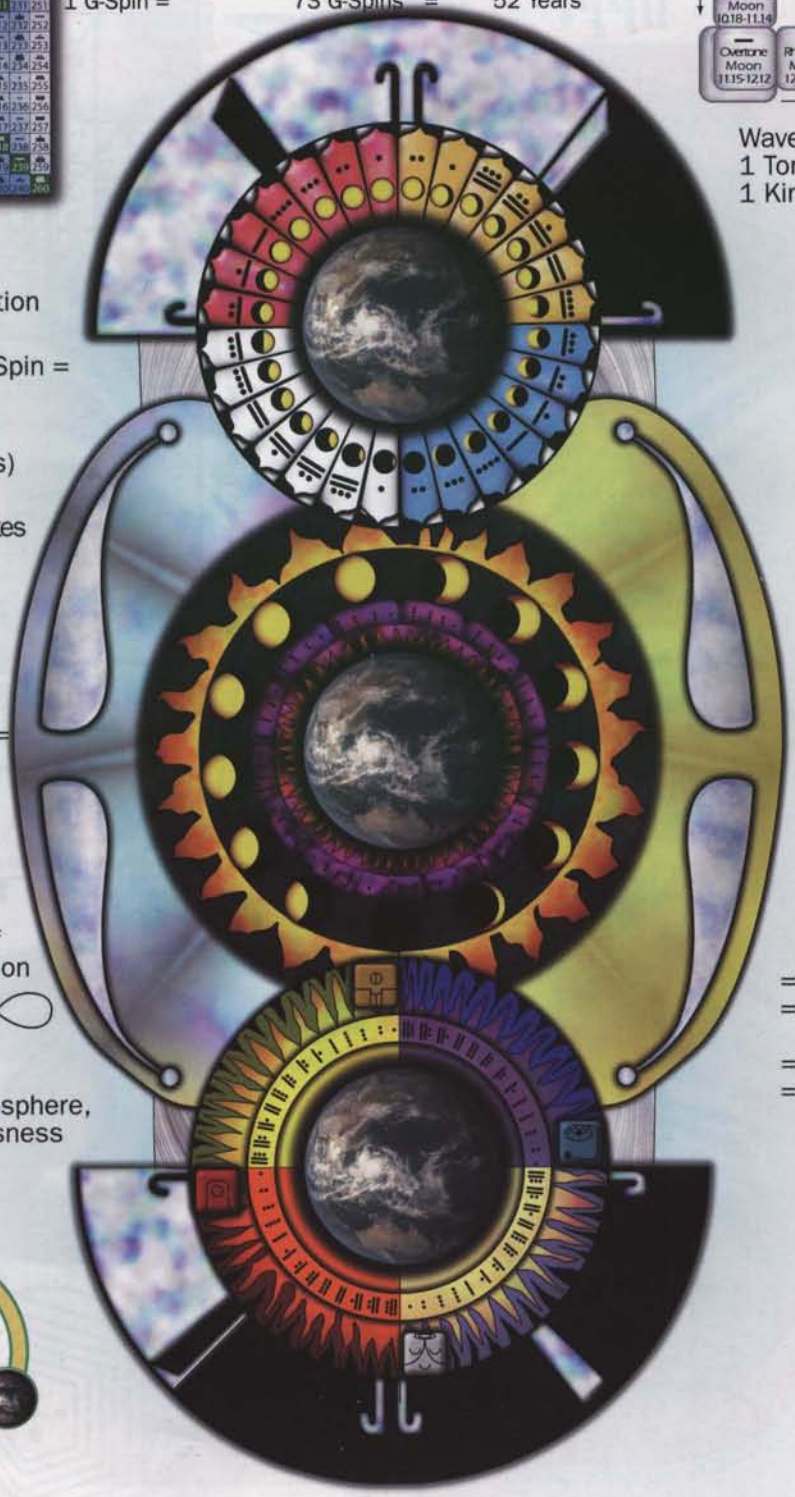

1 NET Hour =
1 Moon ◑

1 Moon (NET Hour)
= 1 Lunar Orbit

◑ =1 NET Hour x 13
= 1 NET Day
(13 NET Hours)
= 1 Solar Orbit
= 13 Lunar Orbits

NET
Noospheric
Earth
Time =
Earth = Body in Space =
Unit of measure of
index of synchronicity

T(E) = Art
T=13:20 Frequency of
Synchronization
where $T_V \rightarrow \infty$

E= Earth
Art= Blossomed Noosphere,
Earth consciousness
synchronically
unified

52 NET Days
= 52 Solar Orbits
= 1 NET Year

= 73 Galactic Spins
= 13 Seed-Storm 4-Year
Bundles

1 4-Year Bundle =
1 NET Week

13 NET Days=
1 NET Season

1 NET Week=
4 Solar Orbits

1 NET Season=
13 Solar Orbits

Noosphere—Mind of Time on Earth

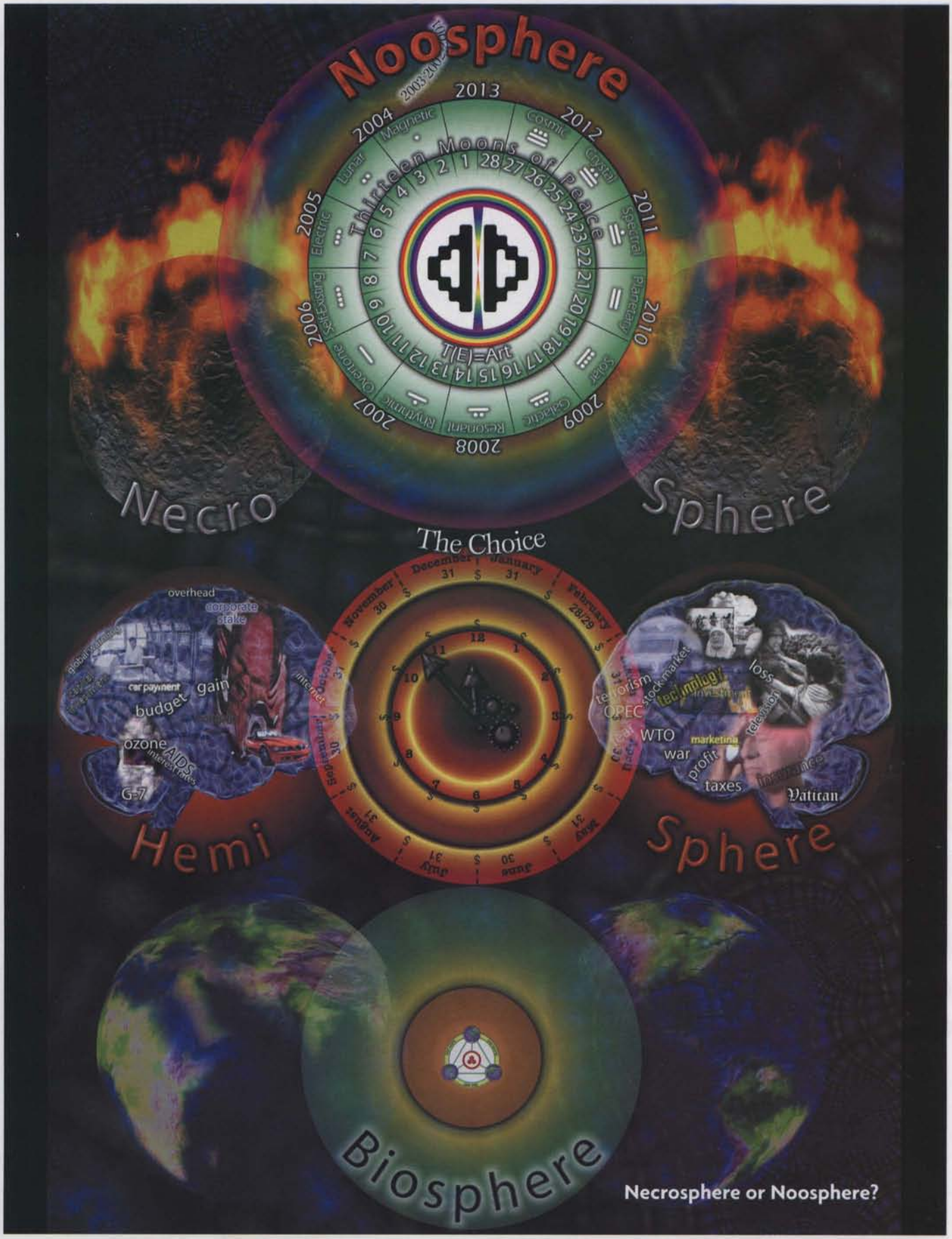

Necrosphere or Noosphere?

A Chronotopology of Transformation

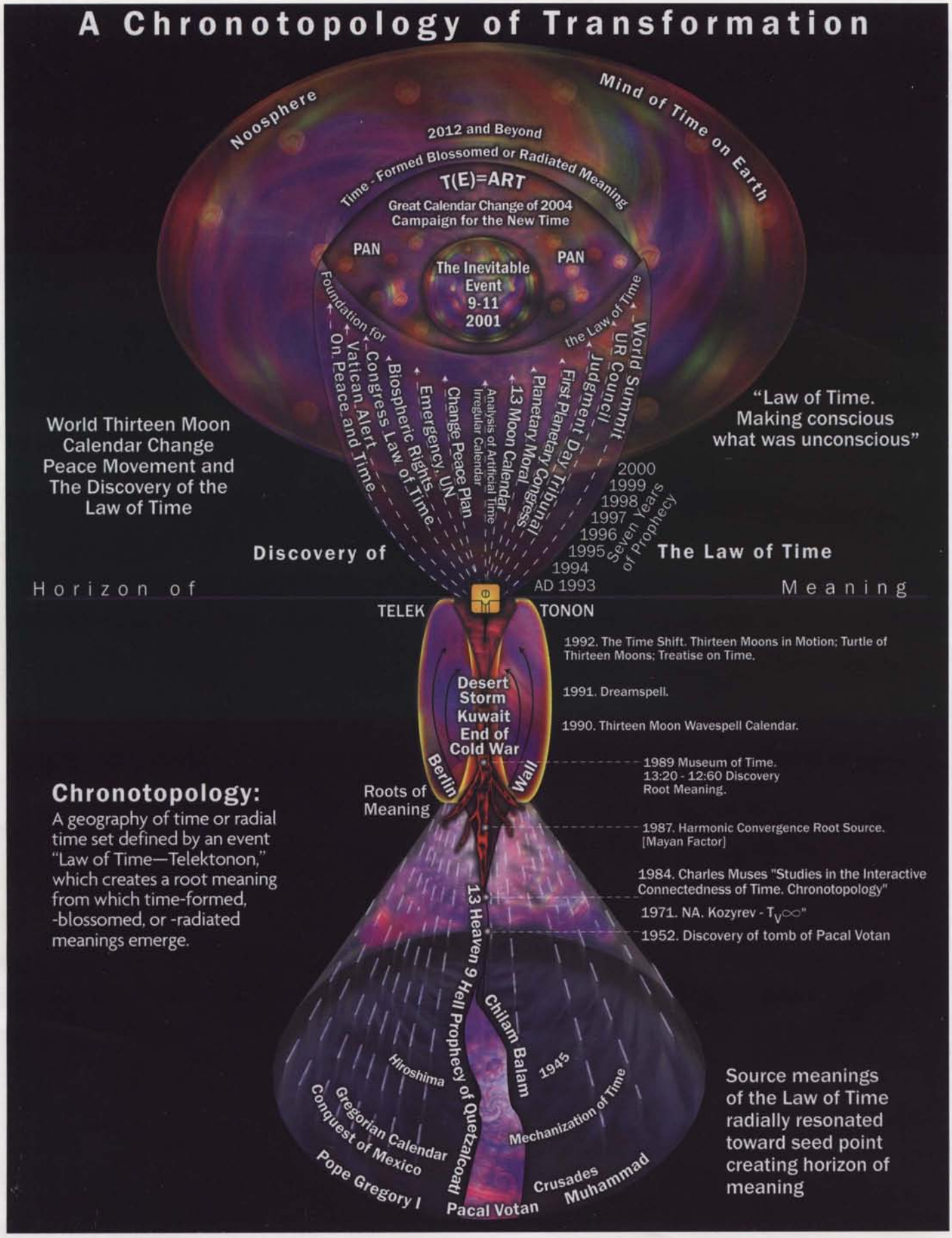

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The Science Fiction Adventures and Philosophical Puzzles of Time Travel

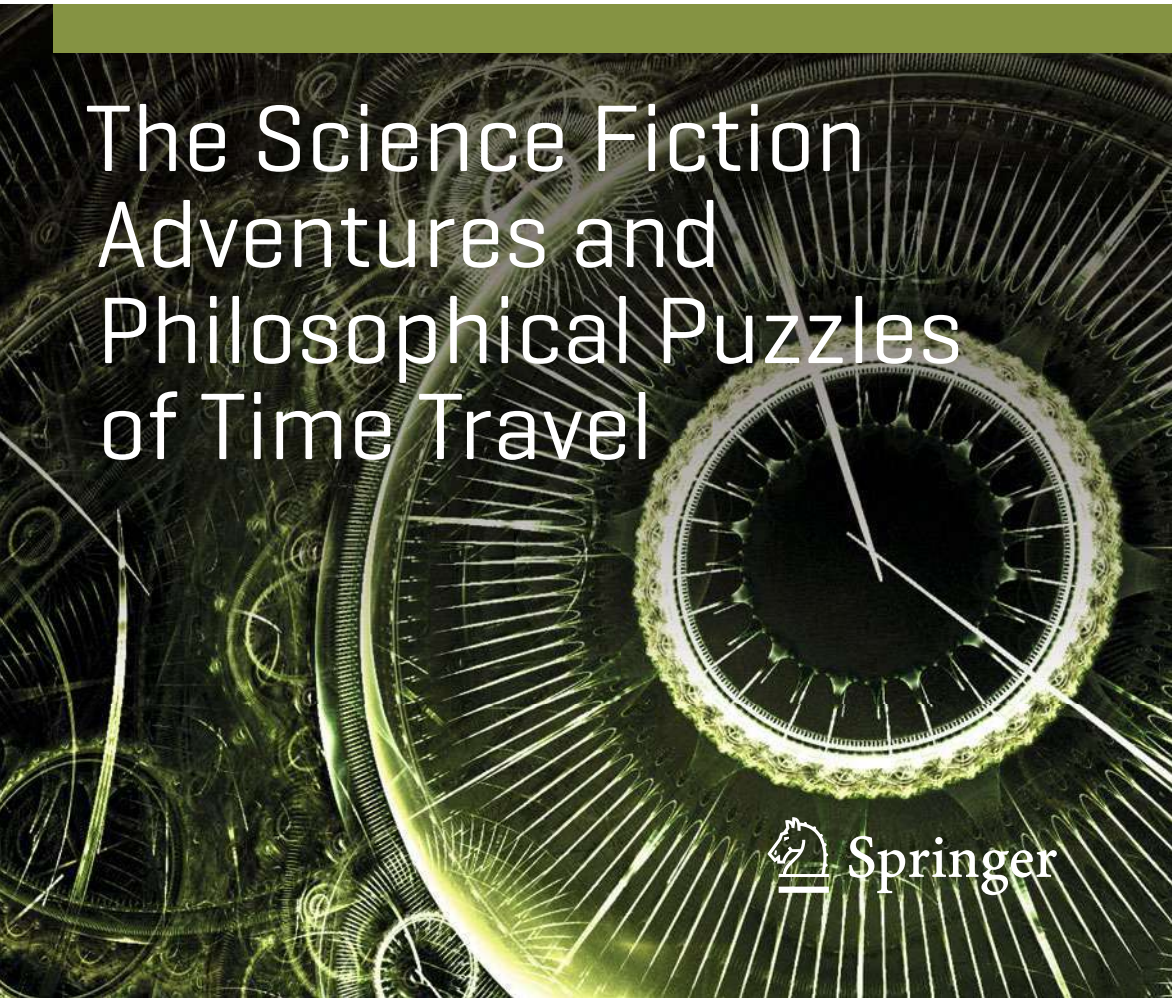

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Time Machine Tales

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Frontispiece: The Pioneers of Time Travel

The scientific pioneers were Albert Einstein (1879–1955) and Kurt Gödel (1906–1978), good personal friends who are shown here in 1954 at the Institute for Advanced Study in Princeton, New Jersey, in a photo taken by Richard Arens. It was Einstein's 1916 general theory of relativity (theory of gravity) that Gödel used as the basis for his 1949 paper that was the first to show that the general theory does **not** forbid time travel into the past.

The literary pioneer of time travel was of course Herbert George Wells (1866–1946), who is shown here as a college freshman cut-up around 1885. The photograph was taken as a prank by an unknown friend while Wells was a student in a biology course given by Thomas Huxley, at the Normal School of Science in

South Kensington (a branch of the University of London). A far too thin and impoverished Wells was then still a teenager, and *The Time Machine* lay a distant 10 years in the future.

Einstein/Gödel photograph courtesy of the American Institute of Physics Emilio Segré Visual Archives of the AIP Niels Bohr Library. Wells photograph courtesy of the rare Books and Special Collections Department of the Library of the University of Illinois at Urbana-Champaign.

A Note on the Story Citations and Science Fiction History

"You will find it a very good practice always to verify your references, sir."
—advice given in 1847 to a young scholar by Martin Joseph Routh, President of Magdalen College, Oxford

Most of the pulp science fiction stories I've cited in this book, in their original form as ink on paper, have long since vanished from our region of spacetime and exist today only (alas) on microfilm reels in scholarly vaults. I am especially indebted to Texas A & M, the Claremont Colleges, the California State Universities at Northridge and Fullerton, Mount Holyoke College, the New York City Public

Library, and the University of Delaware, for giving me access via Inter-Library Loan (through my home institution, the University of New Hampshire) to their extensive archives of ancient science fiction magazines.

A number of the really good stories *have* been anthologized, however, and so are still readily available today in book form. In essentially all cases, though, for historical reasons, I've given the original publication information (magazine and date). You can find which of the stories cited are available in one or more anthology reprints by going to an immensely useful, searchable database on the Web, at: http://www.isfdb.org, and I gratefully thank all those in the science fiction community responsible for creating and maintaining that database.

The following two books by science fiction historian Sam Moskowitz (1920–1997), who lived through what Isaac Asimov called the 'Golden Age of [magazine] Science Fiction,' may be difficult to find today but, if you are interested in the early history of *magazine* science fiction (beyond simply the subgenre of time travel), the hunt for them will be well worth your time:

Science Fiction by Gaslight: a history and anthology of science fiction in the popular magazines, 1891–1911 (World Publishing Company 1968);

Under the Moons of Mars: a history and anthology of "The Scientific Romance" in the Munsey Magazines, 1912–1920 (Holt, Rinehart and Winston 1970).

Some First Words

> Is time travel in principle (never mind the difficulties) a possibility? It has received some thought in the past and deserves some more.
>
> —David Park, in his 1980 book *The Image of Eternity*

> He used to have quite a reputation, but the last couple of years he's been working on time . . . You know, time travel, that sort of rot. An A-1 crackpot.
>
> —a character (discussing a colleague) disagrees with Park, in Mack Reynolds' "Advice from Tomorrow," *Science Fiction Quarterly*, August 1953

In 1993 the first edition of my book *Time Machines* was published by the Press of the American Institute of Physics. In 1999, after Springer acquired AIP Press, the second edition of that book appeared. So, is this the third edition? Well, yes *and* no. It *is* because large chunks of the 1999 edition are still here, along with new discussions of the advances by physicists and philosophers that have appeared in the intervening 18 years. The prime example of that centers on the time travel paradoxes. Those discussions contain mostly what is in the second edition, but they have also been brought up to date with the latest thinking on the paradoxes, by physicists and philosophers.

And yet this book is *not quite* the third edition because the emphasis is now on the philosophical and on science fiction, rather than on physics as it was when written for AIP Press. In that spirit there are, for example, no Tech Notes filled with algebra, integrals, and differential equations, as there are in the first and second editions of *Time Machines*. That's because I wish to avoid having this book seem to be simply a long physics treatise. I have, in fact, some sympathy with the following views, expressed by two philosophers:

"There is one metaphor in the physicist's account of space-time which one would expect *anyone* to recognize as such, for metaphor is here strained far beyond the breaking point, i.e., when it is said that time is 'at right angles to each of the

other three dimensions.' Can anyone really attach any meaning to this—except as a recipe for drawing diagrams?"[1]

and

"This is from the outset a study in descriptive metaphysics. In consequence, I shall have nothing to say about twice-differentiable Lorentzian manifolds, Minkowski diagrams, world-lines, time-like separations, space-time worms [a 'thick' world-line], or temporal parts."[2]

I don't *completely* endorse these sentiments, however, and so please understand that I am not denying the ultimate importance of *physics* when it comes to achieving a deep understanding of time travel. To quote yet another philosopher,

"Arm chair reflections on the concept of causation [are] not going to yield new insights. The grandfather paradox is simply a way of pointing to the fact that if the usual laws of physics are supposed to hold true in a chronology violating space-time, then consistency constraints emerge. *[To understand these constraints] involves solving problems in physics, not armchair philosophical reflections* [my emphasis]."[3]

I could not agree more. So, in *Time Machine Tales* you *will* find some physics. In support of time travel to the future (and in how to make a wormhole time machine for travel into the past), for example, I'll show you a high school level derivation of the famous time dilation formula from special relativity. There are some spacetime diagrams, some simple algebraic manipulations, and here and there just a touch of freshman calculus; even the metric tensor gets a few words, too. But it is, admittedly, pretty light-weight stuff.

So, while certainly saluting the premier position of physics, *Time Machine Tales* is not a scholarly, in-depth treatment of time travel physics. Rather, it is an examination of how science fiction writers (and many philosophers, too) have viewed time travel. (Even in the physics discussions, science fiction will regularly appear.) Those views, by their very nature, are far more romantic than are those of hardcore theoretical physicists. History has shown, of course, that the results of the work of theoretical physicists may, in the end, prove to actually be far more astonishing than anything fiction writers cook-up—and if there is any scientific subject for which that may again prove to be true it's time travel—but for us, here, it will be the fiction writer who has center stage.

The philosophers will be only slightly less important in this book. While much of the early philosophical literature on time travel and backwards causation reads like imaginative fairy tales spun out of vacuous vapors (more on this soon), many modern philosophers have shown themselves to be quite sophisticated. What they

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[1]C. W. K. Mundle, "The Space-Time World," *Mind*, April 1967, pp. 264–269.

[2]J. F. Rosenberg, "One Way of Understanding Time," *Philosophia*, October 1972, pp. 283–301.

[3]John Earman, "Recent Work on Time Travel," in *Time's Arrows Today: recent physical and philosophical work on the direction of time* (Steven F. Savitt, editor), Cambridge University Press 1995, pp. 268–310. We'll discuss the idea of *consistency constraints* in some detail later in the book. Earman is Professor Emeritus of History and Philosophy of Science at the University of Pittsburgh.

have written deserves serious consideration by anyone interested in time travel, and that includes physicists. However, while the time travel interests of philosophers and physicists have a lot of overlap, those interests are *not* in total agreement. For example, while both groups talk of the grandfather paradox, the philosophers worry in particular about motivation (*why* the murderous mission?), while physicists have *never* to my knowledge asked themselves that question[4] (other than to figure out how to avoid it!). After all, philosophers talk of flesh-and-blood humans as time travelers, while the physicists send only billiard balls (with no personal identities or memories) on time trips into the past for the *expressed purpose* of avoiding the messy human issues of 'motivation' and free will. This approach by physicists isn't because they are cold and emotionless. It is a useful strategy because, if it can be shown that a mere billiard ball can travel into the past then, as one *philosopher* pointed out long ago, "It is implausible that it should be possible for some physical systems to travel back in time, and not others. Thus, if we suppose that simple objects can time-travel . . . then we must suppose that more complicated systems, e.g., human beings, can also time-travel."[5]

For the most part, philosophers and physicists have worked at the extreme, opposite points of the time travel spectrum. Much better, I think, would be to adopt the following, more balanced position advocated recently: "The study of time machines is a good opportunity for forging a partnership between philosophy and physics. Of course, philosophers have to recognize that in this particular instance the partnership is necessarily an unequal one since the mathematical physicists have to do the heavy lifting. But it seems clear that a little more cooperation with philosophers of science in attending to the analysis of what it takes to be a time machine could have led to some helpful clarifications in the physics literature."[6]

In the past, philosophers gained a reputation for being just a bit too 'unconstrained by the facts' for scientific tastes—as the English mathematician Augustus De Morgan (1806–1871) wrote in an 1842 letter, "There are no writers who give us so much *must* with so little *why*, as the metaphysicians"[7]—but I do think today's physicists would do well to reexamine that harsh opinion.

Philosophers of the 'old school' may look askance at a non-philosopher (me!) leveling criticism at them, and so let me step aside and quote from a member of the

[4]Nicholas J. J. Smith, "Why Would Time Travelers Try to Kill Their Younger Selves?" *The Monist*, July 2005, pp. 388–395. As Smith writes, "[Motivation] does not impact upon the possibility, or even the likelihood of backwards time travel. Yet it is deeply puzzling, and we will have no idea what time travel would actually be *like* until we explore it." See also Peter B. M. Vranas, "Can I Kill My Younger Self? Time Travel and the Retrosuicide Paradox," *Pacific Philosophical Quarterly*, December 2009, pp. 520–534.

[5]P. Horwich, "On Some Alleged Paradoxes of Time Travel," *Journal of Philosophy*, August 1975, pp. 432–444.

[6]John Earman, Christopher Smeenk, and Christian Wüthrich, "Do the Laws of Physics Forbid the Operation of Time Machines?," *Synthese*, July 2009, pp. 91–124.

[7]D. J. Cohen, *Equations from God: pure mathematics and Victorian faith*, The Johns Hopkins University Press 2007, p. 119.

'modern school' of philosophical thought: "Space-time is the basic spatiotemporal entity. Many philosophers have mouthed this truth, but few have swallowed it, and very few have digested it ... An appreciation of this truth is crucial to what is commonly referred to as the philosophy of space and time ... In large measure the lack of progress in this area can be traced to the fact that philosophers have not taken seriously the corollary that talk about space and time is really talk about the spatial and temporal aspects of spacetime."[8] This is a polite way of telling philosophers that they had better learn some physics!

What provoked those harsh words was that 'modern' philosopher's perception that 'old school' philosophers were not talking science when they wrote of space and time, but rather were in the business of telling each other irrelevant stories and myths, a curious philosophical approach involving the 'telling of tales' that reached its peak in the early and mid-1960s. Spacetime story telling seems to have started with a paper by the Oxford philosopher Anthony Quinton (1925–2010), who argued[9] that although there can be multiple, disjointed spaces, there can only be a single time that is the same for everyone, everywhere. The issue is *not* the truth or not of that assertion (Newton believed it, modern physicists don't), but rather Quinton's technique for arriving at it: myth construction.

Myth construction strikes those trained in the technical sciences as, while perhaps interesting—even physicists, after all, can enjoy a good fairy tale now and then—something quaint and totally beside the point. In his paper Quinton tells a fairy tale about how he thinks someone can live continuously in time and yet, via dreaming, be in two different spatial worlds; when awake he is in one world, while when the person is asleep he is in the other. Quinton argues that this multispatial myth is plausible, but that a search for an analogous multitemporal myth is doomed. This prompted a reply[10] from another 'old school' philosopher who rebutted Quinton with an even more outlandish counter-myth involving "the warring tribes of Okku and Bokku"!

It was this back-and-forth spinning of hypothetical tales that caused the 'modern' philosopher to write in his paper (note 30) that "the procedure for arriving at answers to these questions [about space and time] adopted by Quinton and most other ['old school' philosophers] is, to say the least, a curious one: a story is told about a mythical land—usually called something like the land of Okkus-Bokkus [which is now seen to an outrageous pun]—and then we are asked what we would say if confronted by experiences like those of the Okkus-Bokkusians. As often happens with such a question, people have said all sorts of things, not all of which are interesting or enlightening."

Another modern philosopher was even less gentle in his rejection of the fairy tale approach to spacetime physics: "Quinton [and others of a similar approach invite

[8]J. Earman, "Space-Time or How to Solve Philosophical Problems and Dissolve Philosophical Muddles Without Really Trying," *Journal of Philosophy*, May 1970, pp. 259–276.

[9]A. Quinton, "Spaces and Times," *Philosophy*, April 1962, pp. 130–147.

[10]R. G. Swinburne, "Times," *Analysis*, June 1965, pp. 185–191.

us] to say what we should think in certain strange circumstances which they describe within common-sense language [as opposed to scientific terminology]. I must say that if I found myself in the circumstances which they describe I just would not know what to think. Probably I should simply conclude that I had gone mad . . . It looks as though these writers are inviting us to consider *what we should say if we knew no science* [my emphasis]."[11]

Even before the modern philosopher (note 30) wrote in 1970 to complain about myth-making, another had already done so: "Whenever a human being produces an argument which opens 'Suppose I had 23 senses . . .,' 'Suppose I were God . . .,' 'Suppose I experienced objects extended in four spatial dimensions . . .,' we can protest that the argument is worthless. For in supposing that he has transcended our human point of view, he has also transcended the limits of our understanding."[12] As this author concluded his very funny paper, such opening sentences are the signatures of myths from "The Philosopher's Fairy Tale Book."

The strained relationship between myth-making philosophers and physicists, especially concerning time travel, has a historically interesting antecedent in the 1920s negative reaction among many over Einstein's theories of relativity (the very theories that give apparent life to time travel). To illustrate my point, consider the October 1913 letter Oskar Kraus (1872–1942), a philosophy professor at the German University in Prague, sent to Ernst Gehrcke (1878–1960), a physics professor at the Reich Institute of Physics and Technology in Berlin. Both men were opponents of Einstein but, as Kraus wrote in his letter, it was only Gehricke among the physicists he considered to be sympathetic to him: "[I] would not know . . . anyone else but you who as a specialist would not reject the intervention of a philosopher from the start."[13]

So, I think Earman's proposal a sound one, an echo in fact of similar words that the physicist Kip Thorne wrote (in the Foreword to the second edition of *Time Machines*) concerning science fiction writers: "Smart physicists seek insight everywhere, including from clever science fiction writers who long ago began probing seriously the logical consequences that would ensue if the laws of physics permitted time travel."[14]

To emphasize this new, combined, diversified focus (but also to retain some connection with my earlier books) is the reason I have altered the title, just a bit. In addition, each chapter now concludes with several open-ended questions, suitable for motivating either classroom discussions or more extensive essay responses.

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[11]J. J. C. Smart, "The Unity of Space-Time: Mathematics Versus Myth Making," *Australasian Journal of Philosophy*, (no. 2) 1967, 214–217.

[12]M. Hollis, "Times and Spaces," *Mind*, October 1967, pp. 524–536. Hollis ends by saying he is prepared to accept the failure of his paper to convince many of his colleges to change their ways, and he is waiting for one of them to write a paper opening with "Twice upon a time in another space no distance in any direction from here . . ."!

[13]Quoted from the Introduction to Milena Wazeck, *Einstein's Opponents: the public controversy about the theory of relativity in the 1920s*, Cambridge 2014 (published in German in 2009).

[14]Thorne is Professor Emeritus of Physics at the California Institute of Technology.

Teachers, in particular, may find this a useful feature if using the book in an academic setting. The book ends with reprints of two of my own published time travel stories (one from *Analog* and the other from *Omni*), with each serving as an illustration of technical issues raised in the book. From my own teaching of an undergraduate honors class in time travel at the University of New Hampshire, I think the assigning of story writing to be an excellent tool for teachers to use. I found reading student stories to be a lot of fun, and students may well surprise teachers with innovative ideas.

Now that I've mentioned story writing, let me say something about the heavy presence of time travel science fiction stories in this book, the majority of which originated in the often maligned pulp magazines of the 1920s through the 1950s. 'Pulp' has long been burdened with a bad literary reputation. As the editor of one anthology of pulp fiction bluntly put it, "Pulp equated with rubbish. Crap of the basest nature."[15] Part of the reason for that was cosmetic; as I wrote in an earlier book, "The term *pulp* came from the use of inexpensive wood-pulp—you could *feel* the lumpy wood chips in each ragged, untrimmed page—to make paper that was far too crummy for the use by any publisher of 'words meant to last.' Such paper quickly yellowed, turned brittle, and finally, amid billowing clouds of bits and pieces, entered into eternal oblivion. Think of the paper used in your newspaper before its final contribution to civilization in the bottom of your cat's litter box; pulp was worse."[16]

And then a little later, in the same book, "The stories in *Amazing* [*Stories* magazine] were 'read it in the morning, forget it by dinnertime' adventure fiction, the stuff you'd put inside a newspaper if on a crowded train or bus so fellow passengers wouldn't know what a low-grade mind you had. The transient nature of pulp fiction was independent of its literary quality, as the cheap acid-based paper that the stories were printed on began to oxidize and literally burn-up as soon as it rolled off the press. In the introductory essay to a 1950 collection of pulp-detective Philip Marlowe stories (*Trouble Is My Business*), mystery writer Raymond Chandler commented on this when he wrote 'pulp fiction never dreamed of posterity.' Pulp fiction was synonymous with trash fiction, and the nature of much of early pulp SF has been aptly described as 'scientific pornography for the mechanically minded,' and 'writing which drooled over descriptions of technology.'"

When publisher Hugo Gernsback (1884–1967) brought out the first issue of *Amazing Stories* in April 1926, it was the first pulp devoted totally to science fiction. With its masthead motto of "Extravagant Fiction Today—Cold Fact Tomorrow," and with the illustration on the contents page of each issue showing a muscular Jules Verne bursting from his grave in the heroic, up-up-and-away pose made famous years later by Superman, there could be no doubt as to what kind of fiction the reader would find under the dramatic, multi-colored cover art. It was fiction populated with mad scientists, and half-naked woman about to be ravished by alien

[15]Maxim Jakubowski, *The Mammoth Book of Pulp Fiction*, Carroll & Graf 1996.

[16]P. J. Nahin, *Holy Sci-Fi!: where science fiction and religion intersect*, Springer 2014.

invaders from outer space; all in all, stuff of interest only to teenage boys and imbecilic adults.[17]

How else, after all, to explain the publication of one tale[18] that was given the following heart-stopping editorial introduction: "Professor Lambert deliberately ventures into a Vibrational Dimension to join his fiancée in its magnetic torture-fields"? In defense of many of the readers of early pulp science fiction, however, not all were attracted by such nonsense. Just 2 months later (June 1931) one reader wrote to the same magazine to complain of masculine heroes saving weeping women from ungodly horrors: "Just why do you permit your Authors to inject messy love affairs into otherwise excellent imaginative fiction? Just stop and think. Our young hero-scientist builds himself a space flyer, steps out into the great void, conquers a thousand and one perils on his voyage and amidst our silent cheers lands on some far distant planet. Then what does he do? He falls in love with a maiden—or it's usually a princess—of the planet to which the Reader has followed him, eagerly awaiting and hoping to share each new thrill attached to his gigantic flight. But after that it becomes merely a hopeless, doddering love affair ending by his returning to Earth with his fair one by his side. Can you grasp that—a one-armed driver of a space-flyer! . . . We buy A.S. for the thrill of being changed in size, in time, in dimension . . . not to read of love . . . I wish . . . for plain, cold scientific stories sans the fair sex."

Here's another example, this one of the sort of tale that gave an aroma of the sophomoric to 'golden age' time travel science fiction. It was a story of a young man of the far future, with access to a time machine, who wants to see a dinosaur before he dies. So back he travels, back, back, until he at last finds himself in a "subterranean cave, dark and foul-smelling." At first he is puzzled (did dinosaurs live underground?), but then suddenly he hears a thundering roar and sees a huge black shape in the gloom. There can be no doubt now; it *is* a dinosaur, and he sees its red, gleaming eyes just as it crushes him into a pancake. But that's okay; he saw a dinosaur before he died. Then comes the dénouement. He hadn't really gone back quite as far as the Jurassic period, but only to the twentieth century, where he has been run down by the local express train in a subway tunnel![19]

[17]This was particularly thought to be the case for readers of the romance pulps, written for young women in the 1930s and 1940s (a separate and distinct audience from that of the science fiction pulps). As one commentator wrote on that genre, the heroes and heroines of such tales often displayed the "mental equipment of a banana split," with the implication that the same might be said of the readers, themselves. (See Margaret MacMullen, "Pulps and Confessions," *Harper's Monthly Magazine*, June 1937.) I don't think, however, that this particular complaint generally applied to the pulp science fiction readership. I'll have much more to say about Gernsback and early pulp science fiction speculations concerning time travel, in Chap. 4.

[18]T. Curry, "Hell's Dimension," *Astounding Stories*, April 1931.

[19]R. G. Thompson, "The Brontosaurus," *Stirring Science Fiction*, April 1941. In the editors of *Stirring*'s defense, notice the month: maybe this story was *meant* to be a joke. If so, it was an admirable success.

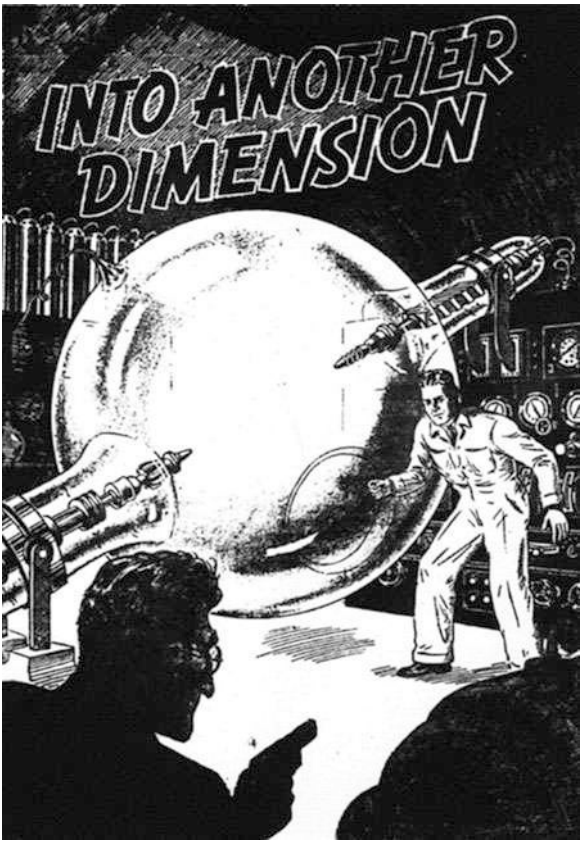

Vibrating into new dimensions was, apparently, a popular idea in 1930s pulp science fiction. This 'super science' gadget operated by vibrating an object faster than light, whereupon the Lorentz-FitzGerald contraction formula (see Chap. 3) predicts an *imaginary* size for the object—which means (so we are told) that the object has entered "another plane of existence." The inventor (the fellow with the gun) is inviting his grim-faced assistant to give the gadget a try. The original caption reads "Get into that vibrator! Get in, I say!"

Illustration for "Into Another Dimension" by Maurice Duclos, *Fantastic Adventures* November 1939 (art by Kenneth J. Reeve), © 1939 by Ziff-Davis Publishing Co., reprinted by arrangement with Forrest J. Ackerman, Holding Agent, 2495 Glendower Ave., Hollywood, CA 90027

Today, however, the need to apologize for science fiction tales about time travel isn't quite so necessary. Now and then, in fact, you'll even find one of the better pulp stories cited in highly mathematical papers on time machines in the *Physical Review D*, one of the most important scholarly physics journals. Even those physicists and philosophers who mostly ignore science fiction—except perhaps to make slightly condescending remarks—would, if honest, admit that their early teenage interest in time travel was sparked by reading a really good science fiction story, and not by working their way through a physics textbook. Yes, when the physics eventually came later, it was very good—but the science fiction came *first*,

and it was pretty good, too.[20] It's in a 1937(!) tale, for example, that we find the claim for consistency around a closed loop in time, *decades* ahead of the physicists and philosophers.[21] And when you get to the final section of Chap. 4, I think you'll find it difficult to believe that Everett's many-worlds interpretation of quantum mechanics, dating from the late 1950s (which avoids the standard paradoxes of time travel) wasn't inspired by some youthful reading of science fiction from the 1930s and 1940s.

In a number of places in this book you'll find my comments on how science fiction has occasionally anticipated physicists on the subject of time machines and time travel. This is *not* to be interpreted as some sort of 'gotcha' in favor of science fiction. Far from it. When push comes to shove, physics *always* wins. This situation was specifically addressed by Joe Haldeman, in an afterword to his 2007 novel *The Accidental Time Machine*. There he wrote, about when he started in 1971 to write his earlier, now classic novel *The Forever War*, "I needed a way to get soldiers from star to star within a human lifetime, without doing too much violence to special and general relativity. *I waved my arms around really hard* [my emphasis] and came up with the 'collapsar jump'—at the time, collapsar was an alternate term for 'black hole,' though I was unaware of the latter term [because John Wheeler had invented it only 4 years before, as discussed in Chap. 1 and note 106]." And then Haldeman admitted "It's a truism of science fiction that if you predict enough things, a few of them are going to come true. . . . What I think it actually demonstrates is that *if you wave your arms around hard enough* [my emphasis], sometimes you can fly."

Now, there is one feature common to all books on time travel to the past (which is the central topic treated here, of course) that I would like to clearly state. It's obviously a subject of vast interest to physicists, and yet it offers (as far as I know) *absolutely no hope of suggesting even a single experiment for study*. (As far as I know, nobody is building a time machine in their basement.) A suggestion *has* been made that it may be possible to detect, in the *present*, the effects of the *future* operation of "man-made time machines, which could be of a size traversable by humans," that is, machines with a 1-m spatial extent offering a one second trip into the past.[22] With the best technology available today, however, the calculated effects on the proposed two-particle scattering experiment are orders of magnitude too small to measure.

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[20]The view expressed by Vladimir Voinovich's time traveler in his 1986 novel *Moscow 2042* (Science fiction . . . is not literature, but tomfoolery like the electronic games that induce mass idiocy.) is, I think, wrong. For an interesting presentation on the role of science fiction in exciting an interest in science among youngsters, see the paper by Frederik Pohl (1919–2013), "Science Fiction: the stepchild of science," *Technology Review*, October 1994, pp. 57–61. In this essay Pohl, a well-known writer of science fiction and editor of *Galaxy Science Fiction* and *If* magazines, writes "Science fiction is [the ultimate protection] against future shock . . . if you read enough of it, nothing will take you entirely by surprise." Not even time travel.

[21]P. S. Miller, "The Sands of Time," *Astounding Stories*, April 1937.

[22]S. Rosenberg, "Testing Causality on Spacetimes with Closed Timelike Curves," *Physical Review D*, March 15, 1998, pp. 3365–3377.

This situation is really unprecedented in the history of science.[23] To cynics, it may seem to be a bit like writing learned papers on the thermodynamics of fire-breathing dragons (which, like other mythological entities—and time machines, too—have yet to be seen)! This one fact has opened the doors—and has kept them open for decades—for philosophers and science fiction writers, who can endlessly debate back and forth on all aspects of time travel to the past with nary a single experimental fact to complicate their lives. For physicists the situation is naturally frustrating, but for philosophers and science fiction writers it's a dream come true. This isn't to say it's *all* basically theological in nature. Both the physicists and the philosophers *have* written many fascinating papers and books and, of course, so have science fiction writers. Mathematical physics *has* been advanced.

Still, despite all of the theoretical work done in the last 30 years, work that has made it reasonable to seriously talk of 'time travel' and 'time machines,' I suspect many would nonetheless agree with these words from more than 75 years ago: "Of all the fantastic ideas that belong to science fiction, the most remarkable—and, perhaps, the most fascinating—is that of time travel . . . Indeed, so fantastic a notion does it seem, and so many apparently obvious absurdities and bewildering paradoxes does it present, that some of the most imaginative students of science refuse to consider it as a practical proposition."[24] For some, time travel is an even more unlikely possibility than (as declared by Robert Lewis Stevenson) is the "welding of ice and iron." Not all physicists and philosophers view the time travel/paradox arguments as convincing, however. Provocative, yes, of course, but many are not yet prepared to write 'signed, sealed, and delivered' at the end.

So, keep reading and I think you'll discover why there *are* those who are not so quick to dismiss the possibility of following the fantastic world line of H. G. Wells' intrepid Time Traveller[25] into the future. And, just maybe, into the distant past, too.

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[23]Perhaps, however, I am too hasty. More recent theoretical calculations suggest that wormholes connecting our universe with other universes would, after converting into time machines, have characteristic thermal signatures. See P. F. González-Díaz, "Thermal Properties of Time Machines," *Physical Review D*, 2012, pp. 105026-1 to -7 which, however, concludes that a search for such signatures would be "quite difficult [with the] instruments available."

[24]I. O. Evans, "Can We Conquer Time?" *Tales of Wonder*, Summer 1940.

[25]The Time Traveller is never named in Wells' 1895 novel *The Time Machine*. An earlier (1888) attempt at a time machine story, with the awful title *The Chronic Argonauts* (the "chronic" was apparently inspired by the word *chronology*), so embarrassed Wells that he later called it "imitative puerile stuff," "clumsily invented, and loaded with irrelevant sham significance," and "inept," and so he hunted down and destroyed every copy of it that he could find. You can find *The Chronic Argonauts* reprinted in *The Definitive Time Machine* (H. M. Ceduld, editor), Indiana University Press 1987. The hero in that work *was* named: Dr. Moses Nebogipfel. There is one passage in *The Time Machine* that does tantalize; as the Time Traveller explores a museum of "ancient" artifacts in the Palace of Green Porcelain (they are, of course, artifacts of our *future*) he reveals that "yielding to an irresistible impulse, I wrote my name upon the nose of a steatite monster from South America that particularly took my fancy." Thus, the Traveller *has* given his name, but his signature exists only in the future, in a museum of the past that is yet to be built.

For Further Discussion

For time travel to the past to make any sense, the past must in some sense 'still be there.' This is a concept that we'll find later in the book to have significant support in relativistic physics, but for now let's limit ourselves to a purely romantic view. As an example of this, consider this passage by Canadian writer Grant Allen (1848–1899), from the Introduction to his 1895 time travel novel *The British Barbarians*: "I am writing in my study on the heather-clad hill-top. When I raise my eye from my sheet of foolscap, it falls upon miles and miles of broad open moorland. My window looks out upon unsullied nature. Everything around is fresh and pure and wholesome . . . But away below in the valley, as night draws on, a lurid glare reddens the north-eastern horizon. It marks the spot where the great wen of London heaves and festers." I personally find it quite tempting to imagine Allen somehow still there in his study of 1895, and of heaving and festering late-Victorian London, too, with H. G. Wells himself in the middle of it, still reading the first rave reviews of *The Time Machine*. In Wells' novel The Time Traveller journeys into the far future, while in Allen's work the protagonist is a twenty-fifth century anthropologist who has traveled back to the past of the late nineteenth century to study the 'British barbarians.' Read Allen's novel (it's available on the Internet, for free, as a Project Gutenberg book) and comment on the significance of its appearance at virtually the same time as Wells' great work. Why do you think Wells' novel is remembered, and Allen's is not?

In the opening paragraph of his paper "The Conundrum of Time Travel" (*Croatian Journal of Philosophy*, No. 37, 2013, pp. 81–92), Anguel Stefanov writes "Needless to say . . . the problems concerning time travel are being still tackled by science fiction only, but resolved by science proper neither theoretically, nor practically." Do you think this is correct?

Eventually every genre of writing becomes the target for parody, in which the *form* of the genre serves as the framework for what (it is hoped) is a humorous mockery. The most famous example of this, perhaps, is the annual

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Edward Bulwer-Lytton contest in writing a take-off on the long-winded opening line of the 1830 novel *Paul Clifford*, by Bulwer-Lytton (1803–1873). That opening line *is* a wonder (a masterpiece of purple prose): "It was a dark and stormy night; the rain fell in torrents—except at occasional intervals, when it was checked by a violent gust of wind which swept up the streets (for it is in London that our scene lies), rattling along the housetops, and fiercely agitating the scanty flame of the lamps that struggled against the darkness." Here's a recent (from the 2015 contest) spoof: "The Contessa's heart was pounding hard and fast, like an out-of-balance clothes washer, which can get that way if you mix jeans with a lot of light things, though the new ones have some sensor thing to counteract that or shut off, but the Contessa's heart didn't have anything like that, so she had to sit down and tell Don Rolando to keep his hands to himself for a while." Science fiction isn't immune to such fun, and a good example of that can be found in the September 14, 2015, issue of *The New Yorker*, which has (on p. 50) "Eight Short Science-Fiction Stories" by Paul Simms. Here's the one I laughed hardest at: "The Gene-Splicers had tinkered with the DNA, producing a race of warriors who craved just two things: the thrill of battle and the taste of their own feet. They hungered for battle. They literally ate their own feet. None survived to reproduce, and within a few short years they were all gone. The Gene-Splicers chalked it up to experience, and decided to try harder the next time." That, and the other seven spoofs by Simms, cut across a wide swath of science fiction, but one theme noticeably absent was that of time travel. Try your hand at writing a *short* (fewer than 500 words) time travel spoof, and be prepared to read it aloud to an audience of your peers.

The tale "Through the Dragon Glass" by Abraham Merritt (1884–1943) appeared in the early pulp magazine *All-Story Weekly* of November 24, 1917. It described the discovery of a passage through an ancient Chinese mirror into an alternate world. One *might* think of this as an early conception of a wormhole, but more likely it may remind you mostly of Lewis Carroll's *Through the Looking Glass*. More interesting for us, in this book, is a story written 75 years ago that describes a gadget connecting two regions of spacetime, with a time shift of a week between the two regions. (See "Time Locker" by Lewis Padgett, in the January 1943 issue of *Astounding Science Fiction*.) The gadget falls into the hands of a crooked lawyer who, not understanding what he has, ends up accidently killing himself. As the story ends, the inventor of the gadget ruefully muses to himself that the lawyer

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"must have been the only guy who ever reached into the middle of next week—and killed himself!" The gadget is, in everything but name, a wormhole time machine. Speculate on how such a spacetime structure could appear in a *science fiction magazine*(!) decades before there was any discussion of such a possibility in the physics world.

Adjectives used to describe many of the stories in the science fiction pulps included *primitive*, *trashy*, *tawdry*, *silly*, *absurd*, *crummy*, *ludicrous*, and *cheap*. One early pulp magazine actually boasted, of its contents, that they contained "sensational fiction with *no* philosophy." Speculate on how such a low-level 'literary' form could have been so successful in finding an enthusiastic audience for time travel paradox tales, tales that are in fact by their very nature simply *stuffed* with philosophical issues. As an example of the tremendous emotional power a particularly well-written time travel story can deliver, read Isaac Asimov's "The Ugly Little Boy" (*Galaxy Science Fiction*, September 1958). Asimov rated this story as among his most favorite of all the many he wrote. If you can read it without ending in tears, well, ... An excellent modern historical work on the pulps (of all genres, not just science fiction) is by Lee Server, *Danger Is My Business: an illustrated history of the fabulous pulp magazines, 1896–1953*, Chronicle Books 1993.

A literary fascination with time was already 'in the wind' when Wells wrote his *Time Machine*, as with Oscar Wilde's 1890 novel *The Picture of Dorian Gray*. Even decades earlier than that one can find a hint of time travel of a sort in Edgar Allen Poe's 1841 short story "Three Sundays in a Week." And just 4 years later Henry Wadsworth Longfellow wrote his haunting poem "The Old Clock on the Stairs," with these opening words:

Somewhat back from the village street
Stands the old-fashioned country-seat.
Across its antique portico
Tall poplar-trees their shadows throw;
And from its station in the hall
An ancient timepiece says it all,—

"Forever—never!

(continued)

Never—forever!"

The most interesting of all pre-Wells time travel fiction to appear in a mass-audience publication was, I think, the short story "The Old Folks Party" by Edward Bellamy, printed in the March 1876 issue of *Scribner's Monthly*. In this story a group of teenagers, who belong to a weekly discussion club, agree that at their next meeting they will all come dressed and behaving as they believe they will be dressing and behaving 50 years in the future. Also attending will be the grandmother of one of the young ladies. The meeting of the "old folks" takes place, and it invokes such powerful feelings of mortality that, at last, one of the young men can stand it no more: "Suddenly Henry sprang to his feet and, with the strained, uncertain voice of one waking himself from a nightmare, cried:—'Thank God, thank God, it is only a dream,' and tore off the wig, letting the brown hair fall about his forehead. Instantly all followed his example . . .." The young people then began to laugh with relief at once again being young, until they notice the grandmother is crying. Her granddaughter instantly knows what is wrong and says, "Oh, grandma, we can't take you back with us." Read, compare, and contrast, these works by Wilde, Poe, Longfellow and Bellamy, with the 'scientific' presentation of time travel by Wells.

Acknowledgements

My name is on *Time Machine Tales* as the author, but there are many others without whose help I could not have written it. For this, the revised and updated third edition of the original 1993 book *Time Machines*, I am enormously grateful to the publisher, Springer Science + Business Media, and to my physics editors at Springer, Dr. Sam Harrison and his assistant Ho Ying Fan in New York City. They made an intellectually demanding and inherently lengthy project (one that could easily have turned into a nightmare) a pleasant one. Springer's New York City-based editorial assistant Irene Bruce smoothly handled the administrative details of transforming the book from typescript to print. And to Serguei Krasnikov in Russia, Frank Arntzenius and Roberto Casati in England, Francesco Gonella in Italy, and Geoff Goddu and Archille Varzi in America, I offer grateful thanks for permission to reprint from their publications.

But the story of this book actually begins long before 1993.

Nearly four decades in the past, in 1979, when time travel was still mostly just a nutty idea used by science fiction writers and a few rogue philosophers—proposing to give a serious seminar on time travel at the weekly college *physics* seminar would almost certainly have resulted in getting the bum's rush out the nearest door, or maybe even tossed through the closest window (or, God forbid, *off the roof*!)—I wrote my first time travel tale for *Analog Science Fiction* magazine. Bought by then editor Ben Bova (you can read it in Appendix A), he also bought another time travel tale from me soon after he had become the fiction editor at the newly created *Omni Science Fiction* magazine (you can read it in Appendix B). (Years later, Ben's successor as *Omni*'s fiction editor, Ellen Datlow, bought a third time travel story from me—"The Invitation"—which you can read if you can locate the July 1985 issue.)

Those fictional experiences, and my discovery of Princeton philosopher David Lewis' seminal 1976 essay on the *logical* possibility of time travel, led me to plunge into a deeper study of the *physics* of time travel, to the point where as the 1980s ended (1988, to be precise) I thought a book should be my next writing project. Alas, nobody else shared that thought. I spent the next 3 years looking for a

publisher among numerous university presses; as I looked, the pile of rejection letters, like entropy, grew steadily larger.

The editor at one well-known university press, in fact, simply laughed at the idea of a scholarly time travel book when I called him on the telephone (e-mail was then still in its infancy) to ask, after a long period of no response to my written proposal, if he had gotten it. (Perhaps, I told myself, the mail truck carrying my precious document had fallen into a hyper-dimensional spacetime warp: how pathetically desperate is the anxious academic writer!) Later, I published a number of math/physics books with that same press (but now with new editors) and so there were no lasting hard feelings.

That laughing, unresponsive editor wasn't alone in his opinion, I have to admit, and it wasn't until 1991 when Maria Taylor, the publisher at the Press of the American Institute of Physics (AIP Press), decided to take a chance (a *big* chance) and publish the first edition of *Time Machines*. She made that decision in large part because of two extremely supportive reviews of my proposal from the academic physicists Edwin Taylor (MIT, and a former editor of *The American Journal of Physics*) and Gregory Benford (University of California, Irvine, as well as being an award-winning writer of science fiction who occasionally used the time travel theme). After the original *Time Machines* appeared, Ben Bova asked me to use it as a guide to writing a book on time travel for the new Writer's Digest series on science fiction that he was editing, aimed specifically at would-be story writers; that book came out in 1997 as *Time Travel*. Later, Trevor Lipscombe, then editor-in-chief at the Johns Hopkins University Press (and my former math editor at Princeton University Press), reprinted *Time Travel* (with a new Preface) in 2011.

After Springer acquired AIP Press (and all of its books) in 1995, and Maria Taylor herself went over to Springer, she and I collaborated again on bringing out the second edition of *Time Machines* in 1999. And now, 18 years later, here (with a title slightly altered for reasons I give in "Some First Words") is its successor.

To Sam, Ho Ying, Irene, Ben, Ellen, Maria, Edwin, Gregory, and Trevor, thank you for your support. But my greatest debt of all, one I can never even begin to repay, is to my wife of 55 years, Patricia Ann, a woman of infinite tolerance. Who else would put up with someone who plays first-person-shooter video games at midnight (the bigger and the louder the explosions, the better!) and writes books on time machines, all the while claiming not to be crazy?

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Introduction

> Over the last few years leading scientific journals have been publishing articles dealing with time travel and time machines. . . . Why? Have physicists decided to set up in competition with science fiction writers and Hollywood producers?
>
> —John Earman (see note 25 of *Some First Words*)

Writing about time travel is, today, a respectable business. It hasn't always been so. After all, time travel, *prima facie*, appears to violate a fundamental law of nature; every effect has a cause, with the cause occurring before the effect. Time travel to the past, however, seems to allow, indeed to *demand*, backwards causation, with an effect (the time traveler emerging into the past as he exits from his time machine) occurring *before* its cause (the time traveler pushing the start button on his machine's control panel years *later* to start his trip backward through time).

Thus, when H. G. Wells published his breakout masterpiece, *The Time Machine*, in 1895, even those readers who loved it as a *story* (and not all did) were still quick to dismiss it as a *romantic fantasy*. It was, in their view, certainly an emotionally powerful tale of pure imagination, but nothing more. Reviewers of the day used such words as "hocus-pocus" and "bizarre," and called the work a "fanciful and lively dream."[26] Any one of the novels by Wells' contemporary, Jules Verne (even such super-technology ones like the 1865 *From the Earth to the Moon*) would have been ranked *far* above Wells' novella in terms of 'it could actually happen.'

Wells himself always denied that his time machine was anything more than a literary device[27] to get his Time Traveller into the far future. Indeed, in 1934, in the

[26]These reviews are reprinted in P. Parrinder, *H. G. Wells: The Critical Heritage*, Routledge & Kegan 1972. A modern reviewer has applied such negative characteristics to the Time Traveller, himself, calling him "a kind of Trickster figure" and "a quack and magician." See Robert J. Begiebing, "The Mythic Hero in H. G. Wells's *The Time Machine*," in *Essays in Literature*, Fall 1984, pp. 201–210.

[27]Wells was not the first to use a machine to enable time adventures, as the Spanish writer Enrique Gaspar (1842–1902) used one in his 1887 story *The Time Ship: A Chrononautical Journey*. It's Wells' tale we remember, however.

preface to *Seven Famous Novels* (published by Knopf), a collection of his novel-length scientific romances (as science fiction had been known before the term *science fiction* came into use), including *The Time Machine*, Wells made his position perfectly clear: "These stories of mine collected here do not pretend to deal with possible things; they are exercises of the imagination . . . They are all fantasies; they do not aim to project a serious possibility; they aim indeed only at the same amount of conviction as one gets in a good gripping dream." Wells then went on to say in that same preface that all attempts before at writing fantastic stories depended on magic. But not in his works. "It occurred to me that instead of the usual interview with the devil or a magician, an ingenious use of scientific patter might with advantage be substituted." Wells' great contribution to time traveling story-telling was his introduction of a *machine*; science instead of magic, drugs, dreams, blows on the head, or suspended animation.[28] Not all modern science fiction writers have followed Wells' lead, however.

A science fiction tale by Clifford Simak (1904–1988), for example, the 1978 novel *Mastodonia*, incorporates an alien creature marooned on Earth (because of a spaceship crash centuries earlier) who 'makes time tunnels.' One of the characters in the story, who is attempting to start a time-travel agency using these tunnels, explains why not having a time *machine* is causing her difficulties with prospective clients: "The whole trouble was that I couldn't tell them about some machine—a time-travel machine. If I could have told them we'd developed a machine, they'd have been more able to believe me. We place so much trust in machines; they are magic to us. If I could have outlined some ridiculous theory and spouted some equations at them, they would have been impressed." I think that's off the mark. We trust in machines not because they are magic, but for precisely the opposite reason. They are *not* magic, but rather are *rational*. And to dismiss mathematics is to say that some non-natural—some supernatural—influence is at work.

But is a time *machine* actually possible? Or is the idea of a time machine simply "Nonsense" and "A bilgeful of crap," as a character bluntly puts it in the 1972 novel *The Dancer from Atlantis* by Poul Anderson (1926–2001). Wells, himself, addressed this point in an autobiographical essay (published in the *Cornhill Magazine*) that he wrote in July 1945 (just 13 months before his death) in even blunter words. Writing under the name of "Wilfred B. Batterave," he penned a very funny summary of his life titled "A Complete Exposé of This Notorious Literary Humbug." There he described *The Time Machine* as "[A] tissue of absurdities in which people are supposed to rush to and fro along the 'Time Dimension.' By a few common tricks of the story-teller's trade, Wells gets rid of his Machine before it can be subjected to a proper examination. He cheats like any common spook raiser. Otherwise it is plain commonsense that a man might multiply himself indefinitely,

[28]Examples of 'non-machine' time travel stories of the last four types are, respectively, H. G. Wells' "The New Accelerator" (1901), Charles Dickens' *A Christmas Carol* (1843), Mark Twain's *A Connecticut Yankee in King Arthur's Court* (1889), and Edward Bellamy's *Looking Backward, 2000–1887* (1888).

pop a little way into the future and then come back. There would then be two of him. Repeat *da capo* and you have four, and so on, until the whole world would be full of the Time Travelling Individual's vain repetitions of himself. The plain-thinking mind apprehends this in spite of all the Wellsian mumbo-jumbo and is naturally as revolted as I am by the insult to its intelligence." Funny, yes, but still pretty harsh stuff.

As one writer has argued,[29] Wells was, rather than presenting a scientific discovery, simply attempting to refute the nearly suffocating, unjustified (in his mind), smug optimism of the well-to-do of the Late Victorian Age. And so, on his journey to the year A.D. 802,701, the Time Traveller finds the awful decay of humanity in the cannibalistic subjugation of the Eloi by the Morlocks, the end result of class warfare between the working class (Morlocks) and the idle, parasitic upper class (Eloi).

The German social philosopher Karl Marx, if he hadn't already been dead for 12 years in 1895, would surely have nodded in vigorous agreement as he read *The Time Machine*, even as he would have regretted Wells' decision to have the victory of oppressed workers take so long. (What irony that he is buried in London's Highgate Cemetery, the Victorian Valhalla where he has spent the last century and more quite literally mingling with many of the capitalistic ancestors of the Eloi!) What Marx would have thought of *time travel* as a possibility is, however, far less certain.

How things changed in the years that followed *The Time Machine*. There was, at first, admittedly a 'slight' decline in literary merit as the newly developing pulp science fiction magazines picked-up and ran with the time travel genre. Many of the magazine time travel tales of the 1920s, 1930s, and 1940s were, frankly, simply awful. BUT—some were pretty good, too. And some were, in fact, *very* good. From the 1950s on, there have been ever more sophisticated time travel tales from ever more sophisticated writers.

In the academic communities of philosophers and physicists, too, big events occurred. I give the philosophers the edge, in fact, with the 1976 publication of a hugely important paper that opened with these dramatic words: "Time travel, I maintain, is possible. The paradoxes of time travel [to the past] are oddities, not impossibilities. They prove only this much, which few would have doubted: that a possible world where time travel took place would be a most strange world, different in fundamental ways from the world we think is ours."[30] That writer wasn't the first philosopher to write on time travel to the past, but none had expressed themselves in such powerful and unequivocal words in unmistakable support of the concept.

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[29]R. M. Philmus, "*The Time Machine*; Or, the Fourth Dimension as Prophecy," *Publications of the Modern Language Association*, May 1969, pp. 530–535.

[30]David Lewis, "The Paradoxes of Time Travel," *American Philosophical Quarterly*, April 1976, pp. 145–152. Lewis (1941–2001) was a Princeton University philosophy professor.

Lewis' paper is also notable because it gives what seems to be a clear definition of just what it means to say one has 'traveled in time,' either to the past *or* to the future:

> What is time travel? Inevitably, it involves discrepancy between time and time. Any traveler departs and then arrives at his destination; the time elapsed from departure to arrival (positive, or perhaps zero) is the duration of the journey. But if he is a time traveler, the separation in time between departure and arrival does not equal the duration of the journey.

To understand this, we need to appreciate the distinction between the *personal time* of the time traveler and the *external time* of remote observers of the time traveler. A time traveler's personal time is measured, for example, either by the time kept by his wrist watch or, perhaps, by a burning candle. (This distinction had actually appeared earlier in Horwich's paper—see note 27 in *Some First Words*—published the year before Lewis' paper.)

I say I 'give the edge to the philosophers' because, while the first *physics* time travel paper had appeared decades earlier, its author wasn't really a physicist at all but rather was Einstein's friend, the world-famous mathematical logician Kurt Gödel. Gödel's paper was, in retrospect, a pivotal event in establishing the 'respectability' of *scientific* time travel; it's worthwhile to take some time here to explain this important point. For physicists (and for philosophers and science fiction writers, too) a 'time machine,' one either constructed by intelligent beings or occurring naturally, manipulates (all the while obeying the known laws of physics) finite amounts of matter and energy in a finite region of spacetime.[31] A 'time machine' would be declared to be *plausible* if it could be explained by a rational, scientific theory. Such a rational theory is found in Einstein's general theory of relativity. (His *special* theory of relativity applies in those situations where there is no gravity.)

Until Einstein, the theory of gravity used by scientists was Newton's—a theory that, although amazingly accurate for any situation encountered on Earth, does have observable errors in certain astronomical applications. In addition, Newton's theory is a descriptive one; it makes possible the calculation of gravity effects without offering any explanation for gravity itself. Einstein's theory not only gives the right answers, even in those cases where Newton's theory doesn't, but it also explains gravity. It does that by treating the world as a four-dimensional structure in which all four dimensions (three of space and one of time) are in a certain sense on equal footing. The resulting Einsteinian description of the world is that of a unified spacetime in which time and space are intimately intertwined, whereas Newton's theory keeps time and space separate and distinct.

[31] I am going to feel free to use words like *spacetime* without having to first write introductory essays on relativity theory and tensor mathematics, because such words have entered common use. All those Hollywood science fiction movies, even the crummy ones that routinely trash the laws of physics, have at least expanded the general imagination!

As Newton wrote of time, at the start of his 1687 masterpiece *Principia*, a work that revolutionized physics, "Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration." This view of time would be, of course, discarded with the arrival of Einstein and his view of variable time depending on the state of the observer.

Unlike Einstein's view, Newton's view of the nature of time was entangled with theology. As one modern theologian has written, "Newton conceived of absolute time as grounded in God's necessary existence."[32] To quote Newton himself, in the *General Scholium* to the second edition of *Principia* (1713) he added words that didn't appear in the original: "God is a living, intelligent, and powerful Being; and, from his other perfections, [it follows] that he is supreme, or most perfect. He is eternal and infinite, omnipotent and omniscient; that is, his duration reaches from eternity to eternity; his presence from infinity to infinity; he governs all things, and knows all things that are or can be done. He is not eternity and infinity, but eternal and infinite; he is not duration or space, but he endures and is present. He endures forever, and is everywhere present; and, by existing always and everywhere, he constitutes duration and space. Since every particle of space is *always*, and every indivisible moment of duration is *everywhere*, certainly the Maker and Lord of all things cannot be *never* and *nowhere*."

Okay, I'll be honest—I really am not at all sure just what that means! Newton added these words to the *Principia* in response to criticism (from the influential philosopher George Berkeley (1685–1753)) that his original statements about absolute time were "pernicious and absurd notions," notions that were in fact atheistic in conception. That was a most serious charge in Newton's day, and he was trying (I think) to find some cover from those critics who spent more hours of the day thinking about God than of physics. Much more honest (in my opinion) are the witticisms 'time is just one damn thing after another' and 'time is what keeps everything from all happening at once.'[33] More funny than useful, yes, of course, but at least they're funny.

Newton's theological view of time is simply irrelevant to the modern physicist (although perhaps of more interest to the philosopher-historian) but in many cases it is of *central interest* to the science fiction writer. For example, Newton's religious

[32]William Lane Craig, "God and the Beginning of Time," *International Philosophical Quarterly*, March 2001, pp. 17–31, which discusses the question 'Why didn't God create the world sooner?' One irreverent answer is 'He was busy creating Hell for all those who ask that question,' but a more scholarly analysis can be found in Brian Leftow, "Why Didn't God Create the World Sooner?" *Religious Studies*, June 1991, pp. 157–172.

[33]This last 'definition' first (as far as I know) appeared in the work of the science fiction writer Ray Cummings (1887–1957), in his 1921 story "The Time Story," published in *Argosy-All-Story* magazine. He repeated the phrase in his 1929 novel *The Man Who Mastered Time*, and then again in the 1946 novel *The Shadow Girl*. ("This same Space; the spread of this lawn . . . what would it be in another 100 years? Or a 1000? This little space, from the Beginning to the End so crowded with events and only Time to hold them apart!")

mindset and its (perhaps!) connection with time travel is treated in my short story "Newton's Gift," originally published in *Omni Magazine* (January 1979) and reprinted in Appendix B at the end of this book. Wells' Time Traveller's view of time is more Newtonian than it is Einsteinian—and perhaps that's not such a big surprise, considering that Einstein was only 16 years old when *The Time Machine* was published.

From the first (1905) it has been known that Einstein's special theory allows time travel into the future via the well-known mechanism of *time dilation*. (The faster a rocket ship travels relative to Earth, the slower is the tick-tock of a wrist watch worn by a rocketeer, compared to that of an identical watch back on Earth.)[34] To return from the future, however, to travel back into the past to the instant after the traveler began his journey, had been thought to be impossible. It was Gödel's discovery that showed the general theory, which has passed every experimental test it has been subjected to (most recently, the September 2015 detection, from two massive colliding black holes, of gravitational waves—'ripples in spacetime'—generated more than a billion years ago in an effect predicted by the general theory a century ago), does allow time travel to the past *under certain conditions*. It is this availability of a *theory* that distinguishes time travel speculations from the outlandish fantasy speculations with which it is often unjustly lumped—speculations that *are* in the province of quacks (such as ESP, astrology, and mind over matter a' la spoon bending).

In his general theory, Einstein showed how spacetime can be either 'flat' (in the no-gravity, special relativity case of what is called a *Minkowski spacetime*[35]) or 'curved' (those situations with gravity), and he did that not by verbal hand waving, but rather by writing mathematical equations that obey all the known laws of physics: his famous gravitational field, nonlinear differential tensor equations. These complicated equations are notoriously difficult to solve in general, but in certain, special cases they *have* been solved. Those solutions describe how matter and energy and spacetime interact. As the popular saying puts it, "Curved spacetime tells matter how to move, and energy and matter tell spacetime how to curve." In that sense, gravity *is* curved spacetime.

In 1949 Gödel found one such special solution to the field equations that describes the movement of mass-energy not only through space but also *backward in time* along trajectories in spacetime that are called *closed time-like lines* or *curves*

[34]One pulp magazine science fiction story (F. J. Bridge, "Via the Time Accelerator," *Amazing Stories*, January 1931) got this right when its time traveler explains how his time machine works with these words: "Time as we know it is not universally absolute. The rate of its passage depends to a great extent upon the velocity of its observer with regard to some certain reference system. A moving clock will run slower with respect to a selected coordinate system than a stationary one." (Recall my earlier comments on the personal time of a time traveler.)

[35]Named after Hermann Minkowski (1864–1909), Einstein's mathematics professor in Zurich who gave the now well-known spacetime diagram interpretation of special relativity which, when originally presented by Einstein, was in the form of pure mathematics.

(called CTLs or CTCs, respectively).[36] These trajectories are such that if a human traveled along one, *always at a speed less than that of light* (that's what *time-like* means), he would see everything around him happening in normal causal order from moment to moment (for example, the second hand on his wrist watch would tick clockwise into the local future), but eventually the CTL/CTC closes back on itself and the traveler finds himself in his own past.

On the scale of the Solar System, general relativity has causality built into itself, but on much larger scales things can be a good deal more complicated. On a very large, astronomical scale, in fact, curved spacetime can result in violations of causality, with effects occurring before their causes. That is what the physics and the mathematics of Gödel's solution imply. That is what is meant by saying there is a scientific, rational basis for discussing time travel to the past. It is particularly important to note that travel along one of the closed time-like world lines discovered by Gödel requires a *machine*, some kind of accelerating rocket ship. That's because none of Gödel's CTLs/CTCs are what is called a *geodesic*. That is, none are *free-fall* world lines.[37] This machine does not, however, generate CTLs/CTCs where none existed before (CTL/CTC *creation* requires what physicists call a *strong* time machine) but rather simply makes use of the CTLs/CTCs that are inherent in Gödel's spacetime. A Gödelian rocket ship then is an example of a *weak* time machine.

I mentioned earlier that "certain, special cases" of Einstein's gravitational field equations result in CTLs/CTCs. What was the "special case" that Gödel solved? His solution of the field equations is for a rotating, infinite, static universe composed of a perfect fluid at constant pressure. In such a universe Gödel found that naturally occurring CTLs/CTCs pass through every point in spacetime; that is, time travel in Gödel's universe is *not* the result of a machine *manipulating* mass and energy on a *local* scale (the classic science fictional description of a time machine); rather, in Gödel's spacetime time travel is a naturally occurring phenomenon! The observable

[36]Kurt Gödel, "An Example of a New Type of Cosmological Solutions of Einstein's Field Equations of Gravitation," *Reviews of Modern Physics*, July 1949, pp. 447–450. A CTL/CTC is a special type of *world line*; the trajectory through spacetime of every particle in the universe is a world line that extends from each particle's past to its future. Our everyday experiences are with world lines that never cross or come close to themselves (which would put a particle at or near the same spacetime point more than once). That lack of experience with CTLs/CTCs that self-intersect is what makes time travel to the past so difficult for humans to grasp. For a discussion of *how* Gödel did what he did, see Wolfgang Rindler, "Gödel, Einstein, Mach, Gamow, and Lanczos: Gödel's Remarkable Excursion into Cosmology," *American Journal of Physics*, June 2009, pp. 498–510.

[37]It was discovered in 1969, however, that this isn't strictly true *if* one allows for a test particle (our 'time traveler') to be electrically charged. Then, naturally present electromagnetic forces acting on the particle could be sufficient to propel the particle along a Gödelian CTL/CTC. That is, no rocket would be required. See U. K. De, "Paths in Universes Having Closed Time-Like Lines," *Journal of Physics A*, July 1969, pp. 427–432. There are other solutions to Einstein's equations that do allow time travel on free-fall geodesics: see, for example, I. D. Soares, "Inhomogeneous Rotating Universes with Closed Timelike Geodesics of Matter," *Journal of Mathematical Physics*, March 1980, pp. 521–525.

universe is, however, *non*-rotating and expanding (astronomers see red-shifts in the spectrums of distant stars) and so, although Gödel's spacetime satisfies the general relativity field equations, its time travel property does not hold in the spacetime in which we live. (This may account for why the initial reaction in the physics/philosophical communities, to Gödel's discovery that time travel is *not* nonsense according to general relativity, was mostly indifference.) The failure to observe time travel in our universe may (somewhat surprisingly, I think) still have possible implications for us, however, as one philosopher has cleverly argued.[38] He points out that naturally occurring Gödelian time travel would endow the universe with properties particularly useful for the survival of intelligence (presumably that includes humans) against extinction from a multitude of cosmic disasters. So, for those who argue that the universe we live in was *made* for us (the advocates of various proofs of God's existence that have Him as Designer), we have an obvious question: why did He (apparently) skip incorporating time travel?

In an invited essay that appeared the same year as his time travel physics paper, Gödel specifically addressed the seemingly paradoxical aspect of what he had discovered: "By making a round trip on a rocket ship in a sufficiently wide course, it is possible in these [rotating] worlds to travel into any region of the past, present, and future, and back again, exactly as it is possible in other worlds to travel to distant parts of space. This state of affairs *seems* [my emphasis] to imply an absurdity. For it enables one, e.g., to travel into the near past of those places where he has himself lived. There he would find a person who would be himself at some earlier period of life.[39] Now he could do something to this person which, by his memory, he knows has not happened to him."

Gödel's nerve then failed him, and he defended the possibility of the paradox of a time traveler meeting himself in the past with what I think an astonishingly unconvincing argument (particularly so for a logician) based primarily on *engineering* limitations: "This and similar contradictions, however, in order to prove the impossibility of the worlds under consideration, presupposes the actual feasibility of the journey into one's own past. But the velocities which would be necessary in order to complete the voyage in a reasonable time are far beyond everything that

[38]Alasdair M. Richmond, "Gödelian Time-Travel and Anthropic Cosmology," *Ratio*, June 2004, pp. 176–190. Not all physicists think Gödel's result is actually time travel. At least two think it is all simply the result of mathematical hijinks, and that time machines must remain "an aspect of science fiction fantasy": see F. I. Cooperstock and S. Tieu, "Closed Timelike Curves and Time Travel: Dispelling the Myth," *Foundations of Physics*, September 2005, pp. 1497–1509. This skepticism towards Gödel actually started much earlier, when two physicists (one a Nobel physics laureate) incorrectly claimed Gödel had simply gotten his math wrong: see S. Chandrasekhar and J. P. Wright, "The Geodesics in Gödel's Universe," *Proceedings of the National Academy of Sciences*, March 1961, pp. 341–347. It was those two physicists who had erred, however, as was pointed out by the philosopher Howard Stein, in his "On the Paradoxical Time Structures of Gödel," *Philosophy of Science*, December 1970, pp. 589–601.

[39]You'll recall that this is *precisely* the situation that Wells mentions in his "Notorious Literary Humbug" essay. If only he had lived just three more years, to see what he thought to be an absurdity actually appear in the serious writings of a brilliant mathematician!

can be expected ever to become a practical possibility. Therefore it cannot be excluded a priori, on the ground of the argument given, that the space-time structure of the real world is of the type described."[40] That is, Gödel was trying to head off critics of his rotating universe model who might point to the time travel result as proof that the model had to be flawed.

In a footnote Gödel says that the time traveler would have to move at least as fast as nearly 71 % of the speed of light, and that if his rocket ship could "transform matter completely into energy" then the weight of the fuel would be greater than that of the rocket by a factor of 10^{22} divided by the square of the duration of the trip (in rocket years). A trip to the past in Gödel's universe would require a time machine that looked like Dr. Who's telephone booth attached to a fuel tank the size of several hundred *trillion* ocean liners. These are formidable numbers,[41] but they require no violation of physical laws, and that's what really counts if time travel is to be disproved. Gödel's use of engineering limitations for explaining away backwards time travel is actually worse than simply being wrong, because the puzzle is not in practicality but rather in showing, assuming that general relativity is correct, how correct mathematical physics can lead to what seems to be a paradoxical conclusion. (And see note 12 again, for another reason the 'fuel argument' really has no force at all against the possibility of time travel in Gödelian spacetime.)

So, what did the great man himself, Einstein, think of all this? In the same publication as Gödel's essay, he *cautiously* replied as follows: "Kurt Gödel's essay constitutes, in my opinion, an important contribution to the general theory of relativity, especially to the analysis of the concept of time. The problem here involved disturbed me already at the time of the building up of the general theory of relativity, without my having succeeded in clarifying it . . . the distinction 'earlier-later' is abandoned for world-points which lie far apart in a cosmological sense, and those paradoxes, regarding the *direction* of the causal connection arise, of which Mr. Gödel has spoken . . . It will be interesting to weigh whether these are not to be excluded on physical grounds."

Despite the mathematical physics of Gödel, showing the possibility of time travel to the past, many philosophers are not quite so sure. As one expressed his concerns, "No science-fiction staple poses more philosophical difficulties than time travel, but there is still no consensus as to whether time-travel fictions exhibit logical, metaphysical, or physical impossibility."[42] The best-known and possibly

[40]Kurt Gödel, "A Remark About the Relationship Between Relativity Theory and Idealistic Philosophy," in *Albert Einstein: Philosopher-Scientist*: volume 7 of *The Library of Living Philosophers* (P. A. Schilpp, editor), Open Court 1949.

[41]For the analysis of a rocket powered by matter/anti-matter, a known physical process that satisfies Gödel's energy requirement for time travel, see E. Purcell, "Radioastronomy and Communication Through Space," in *Interstellar Communication* (A. G. W. Cameron, editor), W. A. Benjamin 1963.

[42]Alasdair Richmond, "Time-Travel Fictions and Philosophy," *American Philosophical Quarterly*, October 2001, pp. 305–318.

oldest of the paradoxical situations that seem to be part-and-parcel of time travel is the so-called *grandfather paradox*,[43] expressed this way by philosopher David Lewis in his pioneering 1976 paper (see note 5):

> Consider Tim. He detests his grandfather, whose success in the munitions trade built the family fortune that paid for Tim's time machine. Tim would like nothing so much as to kill Grandfather, but alas he is too late. Grandfather died in his bed in 1957, while Tim was a young boy. But when Tim has built his time machine and traveled to 1920, suddenly he realizes that he is not too late after all. He buys a rifle, . . . and there [Tim] lurks, one winter day in 1921, rifle loaded, hate in his heart, as Grandfather walks closer, closer . . .

So, there's the puzzle. Tim can obviously achieve his goal—he has a loaded gun, he's an excellent shot, a clueless granddad is coming ever closer—but if Tim actually does kill grandfather, years *before* Tim was (will be) born, then how can Tim *be* born? And if he is not born, then how can Tim ('now' not in existence) travel back through time to kill grandfather? What a confusing mess, right? So, the only possible conclusion to all this is that the starting premise, that time travel makes sense, must actually be nonsense. Right?

Well, maybe, but then what of Gödel with his time traveling rocket ship? That's hard-as-diamond, unshakeable mathematical physics, for heaven's sake. We can't just ignore *that*! Lewis offers a way out of this conundrum, and when we get to the book's discussions on paradoxes (that's plural because, believe it or not, there are other paradoxes even *more* perplexing than that of killing granddad in the distant past) we'll return to his solution.

Ever since Lewis wrote his paper, philosophers have been particularly fascinated by the grandfather paradox and have shown themselves to be at least as inventive as the science fiction writers in discussing it, or variations on it.[44] Here, for example, is a twist on that paradox that I think particularly clever, one that avoids the murderous spirit of the tale told by Lewis and Horwich:

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[43]The origin of this paradox is probably lost in time (the irony of that is *so* appropriate!), but I have traced it at least as far back as to the science fiction pulp magazine *Science Wonder Stories* which published, in its December 1929 issue, an editorial essay titled "The Question of Time Traveling." It challenged readers to think about the following scenario: "Suppose I can travel back into time, let me say 200 years; and I visit the homestead of my great great great grandfather, and am able to take part in the life of his time. I am thus enabled to shoot him, while he is still a young man and as yet unmarried. From this it will be noted that I could have prevented my own birth . . .."

[44]Even before Lewis' paper, Paul Horwich had reduced the grandfather paradox to *autoinfanticide*—a time traveler tries to kill his younger *self*—in "On Some Alleged Paradoxes of Time Travel," *The Journal of Philosophy*, August 14, 1975, pp. 432–444. But not all philosophers share this fascination. Earman (see the opening quote), for example, dismisses *all* of the science fiction paradoxes that are so beloved by fans of the genre as "while always good for a chuckle," they are just "crude and unilluminating means of approaching some delicate and deep issues about the nature of physical possibility." I think Earman is fundamentally correct, although I wouldn't go so far as to characterize the paradoxes as mere "chuckles." They are, after all, the source of much of the intellectual motivation prompting the exploration of the physics of time travel. An excellent example of this is found in the paper by the Russian physicist S. V. Krasnikov, "Time Travel Paradox," *Physical Review D*, February 14, 2002, pp. 064013-1 to 064013-8. The physics of the grandfather paradox is of *great* interest in this paper.

> Sarah has just completed building her time machine. She decides to test the machine on herself tomorrow morning at which time she intends to travel back one day. In the meantime, she goes home, puts some salve on the burn she received that day, and goes to bed. In the morning, Sarah, with coffee in hand, sits down to read the morning paper. She opens the paper to the following headline: 'Famous physicist found dead.' On the front page is a picture of her body, salve burn clearly visible on her arm, inside her pristine time machine. Underneath is the caption. 'Nobel-prize winning physicist found dead yesterday in mysterious device that materialized near city hall.' Extremely shaken, Sarah returns to the lab and destroys the time machine.[45]

Can any sense be made of this? We'll come back to this question later in Chap. 5, when we discuss the possibility (or not) of time being *multi*-dimensional.

Now, to conclude this Introduction, let me end with two amusing, connected short stories (in epistle form) that nicely describe the issues we'll take up in the rest of this book. The rejection letter for the denial of a research grant to fund the construction of a time machine has just been received . . .

That Useless Time Machine[46]

Dear Review Committee:
It is not our practice to raise complaints against a negative review report. We believe in peer refereeing and we respect it, whatever its content and consequences. However, in the case of our latest grant application (project named 'The Time Machine') we find it necessary to express our astonishment at the motivations with which our request for funding was turned down. Your main objection appears to be that our project is 'philosophically interesting' but 'practically useless', by which you mean that the project 'has no potential for applications.' We do not quite think that the main criterion for judging the scientific value of a project should be its practical usefulness, but never mind that. Let us agree that usefulness is a relevant criterion, especially when large amounts of money are involved. Why should that be a reason to turn down our project? Quite frankly, we cannot think of a project with better application potential than ours. Some examples:

- Cultural tourism: one could send herds of history fans back in time to witness the crucial episodes of the French Revolution, or to watch the Egyptians build the pyramids, or to videotape Socrates' lectures.
- Exotic safaris: we have already received several applications for dinosaur hunting expeditions (they got extinct anyway).

[45]G. C. Goddu, "Time Travel and Changing the Past: (Or How to Kill Yourself and Live to Tell the Tale)," *Ratio*, March 2003, pp. 16–32.

[46]Story by Roberto Casati (Senior researcher at CNRS, Paris) and Achille C. Varzi (Professor of Philosophy at Columbia University). Originally published in *Philosophy*, October 2001, pp. 581–583, and reproduced here by kind permission of the authors.

- Error detection: we could take a closer look at our past mistakes and learn how to avoid them in the future.
- Historic documentaries: think of the huge saving in set design, costumes, special effects, etc. (How much did *Gladiator* cost?)

And so on and so forth. Honestly, can you think of a project with better prospects for useful and thrilling applications?

Sincerely Yours,
The 'Time Machine' Research Group

Dear 'Time Machine' Research Group:
Thank you for your letter. We agree that it would be interesting to exploit a time machine for the uses that you suggest. It would also be remarkable if we could use it to prevent all sorts of unpleasant events that happened in the past. It would be remarkable, for instance, to be able to go back to November 22, 1963, and prevent Lee Harvey Oswald from killing John Kennedy, or to go back to April 14, 1912, and steer the Titanic around the iceberg. It would be excellent indeed to be able to do such things. However, suppose your project were to be successful. Suppose you *will* manage to build a time machine. Then why *didn't* you do any of those things? Why is it that our past history is still full of such sad events? Either this means that your project is doomed to fail and you will never manage to build a time machine; *or* it means that the project will succeed but that you are not going to use your time machine for these good purposes. In the first case, logic shows it would be pointless to support your project. In the second case, ethics dictates that it would be wrongdoing. Either way, you must concede that the reasons against your project are overwhelming.

Cordially Yours,
The Review Committee

Dear Review Committee:
Certainly you have noticed that our suggestions for practical applications of the time machine did not include any uses that could result in an alteration of the natural course of history. As a matter of fact, we believe that no such alteration is logically possible. According to our project, it is logically possible to *visit* the past but not to *modify* the past. No time traveler can undo what has been done or do what has not been done. So the logic is safe. This does not mean that the time traveler will be ineffectual during her stay in the past, of course; it simply means that what she is going to do is something that she has already done. An accurate catalogue of all the past events would include an account of the arrival of the Time Machine from out of nothing as well as an account of all the actions and reactions that followed. And ethics is safe, too. For, if indeed we managed to go back to Dallas, we could not stop Oswald from doing what he did. Nobody would be able to stop Oswald because nobody was able to stop him (and nobody was able to stop Oswald because nobody will ever be able to do so, even if they came from the future). Alas, the past is full of sad events but there is nothing that we can do about that.

Respectfully Yours,
The 'Time Machine' Research Group

Dear 'Time Machine' Research Group:
We appreciate the distinction between changing the past (impossible) and affecting the past (possible). However, this simply reinforces our initial impression: your project has no practical value. If in order to travel to the past one has to have been there already, and if one can only do what has already been done, then *á quoi bon l'effort*? Why should we invest in a 'Time Machine' at all? We are afraid that our decision is now final.

Yours with best wishes,
The Committee

Well, all seems to be certainly lost with *that*. But, wait, perhaps not. Maybe, with just one more *really good* appeal, The Committee's rejection can be reversed! If *you* were on the Review Committee, and had just read the following letter, how would *you* vote?

A Useful Time Machine[47]

Dear Review Committee:
We regret your continued decision to reject our proposal. Even though you have told us your decision is now final, we humbly ask your indulgence for one last appeal. We believe you have misinterpreted a crucial part of our proposal.

You maintain that our 'Time Machine' project 'has no potential for applications' and has 'no practical value.' You ultimately base this claim on the fact that "If in order to travel to the past one has to have been there already, and if one can only do what has already been done, then *á quoi bon l'effort*? Why should we invest in a 'Time Machine' at all?" Your argument however is a misinterpretation of our own comments that 'According to our project it is logically possible to visit the past but not to modify the past ... This does not mean that the time traveler will be ineffectual during her stay in the past, of course; it simply means that what she is going to do is something that she has already done.' We regret the awkward and easily misleading locution of the last sentence, but such are the perils of talking about time travel. Regardless, please consider our clarification.

Certainly if we were proposing that the time traveler *be* 5 years old again, we would be proposing something not worth the effort—our proposed time traveler has already turned five and cannot do so again. But we are not proposing that the time traveler do things that have already occurred in her own personal past, but rather in

[47]Story by Geoff Goddu (Professor of Philosophy at the University of Richmond, Virginia). Originally published in *Philosophy*, April 2002, pp. 281–282, and reproduced here by kind permission of the author.

her personal future. The time traveler has not yet, from her personal temporal perspective, travelled back to, say, the library at Alexandria in 100 BCE. When she does travel back to 100 BCE to obtain scans of the books in the library before its destruction, she will be older than she is now. When she returns she will be still older (and we hope wiser, i.e., in possession of valuable information to which neither you nor we currently have access).

But is it true that as of 2002 AD [the year this letter was written] the time traveler has already visited Alexandria in 100 BCE? It could well be. But whether or not it is depends upon whether it is *also* true that our project will be successfully funded and completed. Because time travel into the past involves reverse causation, certain past events, such as the time traveler visiting 100 BCE, will be dependent upon certain future events, such as the successful funding and completion of our project. Hence, if it is not true that our project is both funded and completed, then it is not true that our time traveler has of 2002 already visited 100 BCE.

But suppose we were to learn now, before the funding and completion took place, that our time traveler had indeed been present at the library in Alexandria in 100 BCE. Would this imply that there was no reason to expend the effort to fund our project? After all, if the travel has 'already' happened, why bother funding the project? Firstly, such an argument does not imply that a 'Time Machine' would have no practical application, but rather expresses the futile hope that one could in fact get the practical benefits (if time travel is successful, we obtain the desired information) without expending the effort at all. Secondly, the hope is futile, for if we learn right now that our time traveler had been present at the library in 100 BCE, we would then know, assuming no other possible funding source, that you *will* expend the effort to fund our project. To deny this last is to make the impossible suggestion that even though your support is truly a causal antecedent of the successful trip, there is now no need for you to actually expend the effort to provide funding.

Hence, the effort is far from pointless, for the project will only succeed through your and our efforts. And success will generate, not only all the practical applications we outlined in our first letter, but, in addition, a host of information gathering applications such as more accurate historical research, lost item location identification, legal testimony verification, etc. Even if, as we (and you) acknowledged, no one could now prevent Oswald from killing Kennedy, wouldn't it be worth verifying that Oswald was the lone killer of Kennedy? Also, the information gathering need not be restricted to the past. For example, information concerning the prices of various stocks 10 years from now would be extremely valuable to a suitably cautious and prudent investor. Surely you cannot object to our information gathering in the future on the grounds that 'it will already have been done.' And just think, the information we obtain could be what allows you to obtain at very low prices those stocks that in the future will be extremely valuable and allows your esteemed committee to dramatically increase your support of worthy scientific endeavors.

Again, we ask you to reconsider your original decision.
Respectfully yours,
The 'Time Machine' Research Group

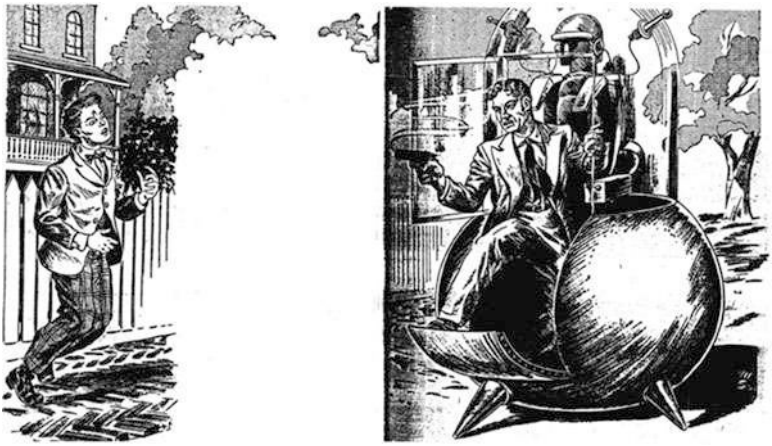

A time machine inventor makes an experimental test of the grandfather paradox! (Illustration from "Thompson's Time Traveling Theory" by Mortimer Weisinger), *Amazing Stories* March 1944 (art by Malcolm Smith). Reprinted by arrangement with Forrest J. Ackerman, Holding Agent, 2495 Glendower Ave., Hollywood, CA 90027.

Not everybody likes time machines as a science fiction gadget, not even otherwise enthusiastic devotees of the genre. For example, in a Letter-to-the-Editor published in the December 1931 issue of Astounding Stories*, one seventeen-year-old fan had this to say: "There is only one kind of Science Fiction story I dislike, and that is the so-called time-traveling. It doesn't seem logical to me. For example, supposing a man had a grudge against his grandfather, who is now dead. He could hop in his machine and go back to the year that his grandfather was a young man and murder him. And if he did this how could the revenger be born? I think the whole thing is the 'bunk.'" As this book will demonstrate, this young reader was not alone in that opinion. As this book will also demonstrate, in the last few decades that view has been rapidly evolving.*

For Further Discussion

Read again the penultimate sentence in the last letter from The 'Time Machine' Research Group, and then think about how you would respond to the following questions.

(1) Would *you* invest in a stock market if you knew somebody else had a time machine giving *them* advance information on stock performance?
(2) How might the existence of a time machine influence the future of the stock market, in general? For an early science fiction look at these questions, see Lee Laurence, "History in Reverse," *Amazing Stories*, October 1939.

One writer has speculated that Wells' model for the Time Traveller was the American inventor Thomas Edison. (See Martin T. Willis, "Edison as Time Traveler: H. G. Wells' Inspiration for His First Scientific Character," *Science Fiction Studies*, July 1999, pp. 284–294.) As Wells worked his way from *The Chronic Argonauts*, through revisions, to the final *Time Machine*, the story's hero evolved from Dr. Nebogipfel to the Philosophical Inventor to the Time Traveller. The one individual who could have inspired all of these various hero types was, according to Willis, Edison, a world-famous Victorian-age celebrity whose story was well known to Wells. If Wells had today's scientific personalities available as potential inspirations, who do you think he would use? How might that choice affect the story and structure of *The New Time Machine*?

The idea of *personal time*, used by the philosopher David Lewis (note 5) to consistently interpret time travel stories, has been used in a quite different way (although time travel gets a few words, too) by the philosopher Roy Sorenson. In his paper "The Cheated God: Death and Personal Time," *Analysis*, April 2005, pp. 119–125, Sorenson asks you to imagine an immortal god. For some reason this god runs afoul of a demon, who curses the god in a curious way. (The 'telling of a story' is a common technique in philosophical papers and, while foreign to what readers of physics papers are used to seeing, is not without some charm. Just be sure to always keep in mind that its

(continued)

primary use is as an *attention-grabbing* device, but as far as having any other merit, well, that's often another story.) The curse is such that the life span of the once immortal god is reduced to that of a normal human life span and yet, perhaps surprisingly, the god will still never die. As Sorenson writes, "[The god] will live forever. But [the god] will not have a better life than a mortal. The demon has harmed [the god] as gravely as death harms mortals." How, you might wonder, is this to be done? As Sorenson explains, "[The god] lives half of its now mortal span, followed by a trillion years of nothingness, then a quarter of its mortal span followed by a trillion years of nothingness, then an eighth of its mortal span followed by a trillion years of nothingness and so on ad infinitum." Sorenson's argument is simply an exotic form of the high school summation of the geometric series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \cdots = 1$, where there are an *infinite* number of terms to the left of the equality. (Each term represents a period of time during which the god is conscious, and each + represents a trillion years.) Sorenson picked a trillion years of nothingness between consecutive periods of consciousness for (I suggest) dramatic reasons, but suppose instead that he had picked 1 μs for the period of nothingness. Discuss what effect this would have (if any) on the life of the god. Consider two cases:

(a) There is no minimum time duration for consciousness, and
(b) There *is* a minimum time duration such that, for any shorter duration, a consciousness remains 'unaware' even though it is *not* in a state of nothingness.

After working all night making some final calculations, a physicist carefully solders a final resistor into the control module of the world's first time machine and then steps into the gadget that is a sure bet to win the next Nobel Prize in physics. As she does, she notices that it is precisely 8:10 in the morning, as indicated on both her wrist watch and the clock on the lab wall. After settling into a plush leather seat she pushes the time machine's power button, the machine glows with a flickering blue-red halo and hums with a mighty throb for a while and then, at precisely 8:15 by her wrist watch, she steps out of the machine and back into her lab. She notices the clock on the wall now reads 8:05. That is, she took 5 min of personal time (8:10 to 8:15) to travel 5 min of external time into the past (8:10 to 8:05). On the one hand she certainly seems to be a time traveler, in that she exits the machine before she enters it. (Ignore the issue of there being *two identical* physicists in the lab from 8:05 to 8:10!) On the other hand, the elapsed personal and external

(continued)

times are *equal*. Does this suggest a need to modify or expand David Lewis' definition of a time traveler? As you ponder this question, you might want to read the following four papers: (1) Paul R. Daniels, "Lewisian Time Travel in a Relativistic Setting," *Metaphysica*, October 2014, pp. 329–345, (2) Douglas Kutach, "Time Travel and Time Machines," in *A Companion to the Philosophy of Time* (H. Dyke and A. Bardon, editors), Wiley-Blackwell 2013, pp. 301–314, and (3) Frank Arntzenius, "Time Travel: Double Your Fun," *Philosophy Compass*, November 2006, pp. 599–616. A bit more demanding (but worth the effort) is the long chapter "Time Travel and Time Machines" by Chris Smeenk and Christian Wüthrich, in *The Oxford Handbook of Philosophy of Time* (C. Callender, editor), Oxford 2011, pp. 577–630 (see page 580, in particular).

> The idea that information is physical has given rise to a series of discoveries which indicate that physics has much to say about fundamentals of computer science.

The above quotation is the opening sentence to a most interesting paper by the physicist Dave Bacon, "Quantum Computational Complexity in the Presence of Closed Timelike Curves," *Physical Review A* (70), 2004. (When he wrote, Bacon was at Caltech, but he is now a software engineer at Google.) The title of Bacon's paper, translated into blunt English, is "It Would Be Really Neat If We Could Merge a Time Machine With a Computer." That is, to further quote from Bacon's paper, "One could [efficiently] solve a hard problem by trying out a solution to the problem, sending one's computer back in time, attempting a different solution to the problem, sending one's computer back in time, etc., until a solution to the problem has been found." There then follows a pretty sophisticated analysis on the self-consistent time evolution of a quantum system, ending with Bacon's frank admission that "we would not be honest if we did not end this paper with the caveat that this work is at best a creature of eager speculation . . . Practical considerations are humorous at best." Read Bacon's paper and discuss what he means by "a hard problem." (There *is* a technical term used by computer scientist for such problems: NP-complete.)

The occasional theological commentary in this book may strike some as a bit odd for a topic treated with heavy doses of deep mathematics in the physics literature but, as you'll see on the following pages, theology is an unescapable dimension to any informed discussion of time travel. A literary connection

(continued)

between time travel and theology has, in fact, existed for a long time. As pointed out in Paul Alkon's *Origins of Futuristic Fiction* (University of Georgia Press 2010), "The first time-traveler in English literature is a guardian angel who returns with state documents from 1998 to the year 1728 in Samuel Madden's *Memoirs of the Twentieth Century*" (published in 1733, nearly three centuries ago). Madden was an Irish-Anglican clergyman whose book was satire rather than science fiction, but its time traveling aspect was a first. As Professor Alkon also writes, "Madden [was] the first to write a narrative that purports to be a document from the future. He deserves recognition as the first to toy with the rich idea of time-travel in the form of an artifact sent backward from the future to be discovered in the present." Your assignment: read and discuss Alkon's book.

You'll recall that Gödel cast his view of time travel in the form of a self-encounter in the past. In Frederik Pohl's "Let the Ants Try," we find a science fiction tale that appeared essentially simultaneously with Gödel's paper (*Planet Stories*, Winter 1949), in which a time traveler journeys back forty million years. Upon stepping out of his time machine, he hears a "raucous animal cry" from somewhere in the nearby jungle. Later, after other adventures in time, he returns to near the same point in spacetime. After stepping out of his time machine, he sees himself in the distance—the earlier version of himself during the first trip. Then, suddenly, the time traveler meets a violent death: "As his panicky lungs filled with air for the last time, he knew what animal had screamed in the depth of the Coal Measure forest." In fact, self-encounters had appeared in science fiction *years* before Gödel's paper. In the 1942 story "Minus Sign" (*Astounding Science Fiction*, November) by Jack Williamson, for example, a spaceship battles with itself while traveling backward in time. How do you think a scientist like Gödel would have liked these two stories? (Who knows, maybe he *did* read them!) If you could travel back in time to 1949 to ask him if such tales had been an inspiration, do you think he would be intrigued, amused, or instead would he be insulted?

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About the Author

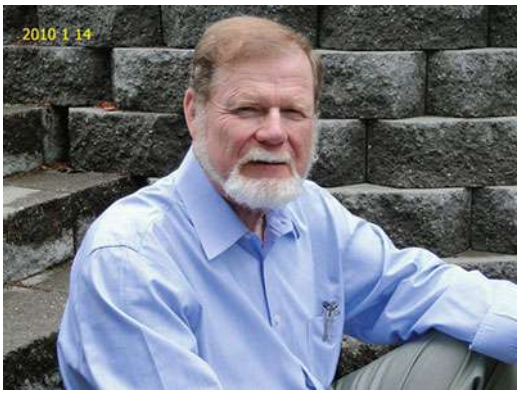

Paul J. Nahin was born in California, and did all of his schooling there, including a PhD in electrical engineering from UC Irvine (1972). He is now emeritus professor of electrical engineering at the University of New Hampshire. Prof. Nahin has published a couple of dozen short science fiction stories in *Analog*, *Omni*, and *Twilight Zone* magazines, and has written 18 books on mathematics and physics. He has given invited talks on mathematics at many prestigious institutions, and has appeared on National Public Radio's "Science Friday" show (discussing time travel) as well as on New Hampshire Public Radio's "The Front Porch" show (discussing imaginary numbers). He advised Boston's WGBH Public Television's "Nova" program on the script for their time travel episode.

Chapter 1
A Broad Look at Time Travel

"Hold infinity in the palm of your hand and eternity in an hour."

—William Blake, writing in "Auguries of Innocence" (1863), with words that could quite well describe what it would be like to time travel

"I need a place to hide, that's why I believe in yesterday."

—The Beatles (*Yesterday*, 1965)

1.1 Time Travel in the Fantasy and Science Fiction Literature

"Woodn't it be grate to go back in tyme and correct your mistakes? Wouldn't it be great to go back in time and correct your mistakes?"

—motto of *Time Twisters* comics

To travel in time.

Could there possibly be a more exciting, more romantic, more wonderful adventure than that? I don't think so, and in this opening section I want to just briefly discuss how fascinating many writers (and their readers) have found the concept of time travel, and to point out that the fascination began *long before* mathematical physicists discovered time travel lurking in Einstein's general theory of relativity.[1]

Before the arrival of humans on the surface of the Moon in 1969, the only other 'fantastic voyage' that could compare with time travel was traveling through outer space. During the seventeenth and eighteenth centuries, in fact, such voyages were the center of a genre of fiction (now called *science fiction*) called the "imaginary voyage" or "extraordinary voyage." Marjorie Hope Nicolson's[2] 1948 book *Voyages*

[1] An excellent, book-length *literary* treatment of time travel is by David Wittenberg, *Time Travel: the popular philosophy of narrative*, Fordham University Press 2013.

[2] Marjorie Hope Nicolson (1894–1981) was a literary scholar of the first rank at both Smith College and Columbia University.

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to the Moon carefully documents just how popular that form of literature was—and still is. Since 1969 the first such voyages have become history, of course, and time travel has replaced space travel as the modern "imaginary voyage."

It seems a safe bet that that, given a random selection of middle-aged adults, the vast majority of them would respond enthusiastically if asked whether time travel interests them. This fascination with time travel has actually been 'scientifically' documented. In one intriguing study,[3] several hundred men and women were asked to consider the possibility of spending an hour, a day, and a year back in both their personal past (since birth) and their historical past (before birth). They were further told that it would cost $10,000 to purchase such time travel services. Their response indicated that 10 % would be willing to spend that much money for an hour in the historical past, 22 % for a day, and 36 % for a year. As might be expected, the numbers rose as the cost dropped and, if such trips were free the interest was almost universal. As one writer put it, "Time travel [is] the ultimate fantasy, the scientific addition to the human quest for immortality."[4] And as a philosopher observed, "[T] he popular appeal of time travel . . . is no doubt due to a nostalgia for the past, which is almost an omnipresent aspect of the human condition."[5]

Fiction writers have, for *centuries*, recognized the fantasy appeal of time travel. The common fairy tale theme of 'The Three Wishes,' in which the recipient ends up using the final wish to undo the unforeseen consequences of the first two, is the precursor to all modern change-the-past time travel stories. Indeed, the means of time travel in the Norwegian poet Johan Wessel's 1781 play *Anno 7603 is* a fairy. Some of the best modern science fiction stories have played with the fantasy appeal of time travel by having gifts arrive by accident from the future: the moral of such tales is generally that unearned gifts usually bring grief.[6] The editor's introduction to a time travel story involving the Civil War referred to the fantasy aspect of time travel—with a reference to another age-old adult fantasy—when he wrote "time travel stories about the Civil War have one thing in common with pornography; they serve to titillate an impulse [in the case of time travel stories, the impulse to change history] and to frustrate [history]."[7] This is the motivation for the time traveler in Stephen King's 2011 novel *11/22/63*, who uses what appears to be a naturally occurring wormhole (connecting a Maine diner to 1958) for his attempts at preventing the assassination of John F. Kennedy.

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[3]T. J. Cottle, "Fantasies of Temporal Recovery and Knowledge of the Future," in *Perceiving Time*, John Wiley 1976.

[4]T. Paul, "The Worm Ouroboros: Time Travel, Imagination, and Entropy," *Extrapolation*, Fall 1983, pp. 272–279.

[5]J. W. Smith, "Time Travel and Backward Causation," *Cogito* 1985, pp. 57–67.

[6]Among the many such tales, five particularly good ones are "Something for Nothing" by Robert Sheckley, "Mimsy Were the Borogoves" by Lewis Padgett (pseudonym of the married couple Henry Kuttner and C. L. Moore), "Child's Play" by William Tenn (pseudonym of Philip Klass), "The Little Black Bag" by Cyril Kornbluth, and "Thing of Beauty" by Damon Knight. All can be found in various anthologies.

[7]*The Fantastic Civil War* (F. McSherry, Jr., editor), Baen 1991.

A character in the 1985 novel *The Bird of Time* by George Effinger nicely captures the fantasy appeal of time travel with the declaration "The past . . . is the home of romance." On a less poetic level, time travel and the movies and stories about it fascinate most people because they turn our everyday world view upside down and inside out.[8] Such movies and stories make people *think*. It is therefore not surprising that time travel movies have been popular for decades, from the pioneering *Berkeley Square* in 1933, to the classic 1960 filming of *The Time Machine*, to *Back to the Future* in 1985 (*the* top film that year in a *Boxoffice* magazine poll), to the flawless 1989 *Bill & Ted's Excellent Adventure*, to the clever *Terminator* action films, to the ingenious 2012 *Looper*, to the commercially successful 2014 *Interstellar*. Each of these films, and others, too, will be discussed later in the book.

When we discuss time travel, we should really be careful to distinguish between two quite different versions: to the future, and to the past. There is no dispute, today, about the first. As two *severe critics* of the possibility of time travel to the past wrote decades ago, "After 1900, special relativity made scientific discussion of time machines possible."[9] What they were referring to is the fact that, by traveling in a rocket ship fast enough (but never, unlike Superman, faster than the speed of light), and far enough, one could leave Earth, loop out on a vast journey perhaps halfway across the universe, and then return hundreds, thousands, even millions of years in the future. You could theoretically (ignoring all the *engineering* difficulties) do this, in fact, with the apparent passage of your 'personal time,' (as measured by your wrist watch or the beating of your heart) as brief as you'd like. (Physicists call 'personal time' *proper time*, and I'll return to this in Chap. 3.) This astonishing conclusion from special relativity, that time travel to the future makes physical sense, literally put a lot of Victorian-era trained physicists into shock.

A quite sophisticated use of this idea appeared early in science fiction, in the tale of a space traveler who returns from a high-speed trip out to the blue supergiant star Rigel in the constellation Orion.[10] The 900 or so light years of the round trip had taken just 6 months of ship or personal time (proper time), but a thousand years of back-home time. The traveler returns to Earth to find all he had left behind long dead and returned to dust: "Sometimes I waken from a dream in which they are all so near . . . all my old companions . . . and for a moment I cannot realize how far away they are. Beyond years and years."

Another story[11] of a trip into the future that delivers an equally powerful emotional impact, this time via a Wellsian-type time machine (more on what that

[8]Somewhat more pompous (but no less correct) was this observation by an academic: "The time-travel [film] romance is an attempt to reenchant the world, to regain a sense of belongingness, to reinstate the magical, autocentric Universe of the child and the primitive." See W. Wachhorst, "Time Travel Romance on Film," *Extrapolation*, Winter 1984, pp. 340–359.

[9]S. Deser and R. Jackiw, "Time Travel?" *Comments on Nuclear and Particle Physics*, September 1992, pp. 337–354.

[10]R. H. Wilson, "Out Around Rigel," *Astounding Stories*, December 1931.

[11]W. Tucker, *The Year of the Quiet Sun*, Gregg 1979.

means later in this chapter) rather than by rocket travel, tells of a time traveler trapped in post-nuclear war times, where there is no energy available to power his machine for the return trip. As the story ends, he finds the woman he had loved and left behind in the past. She is now the elderly widow of another man, having married his rival because the time traveler (just like Wells' Time Traveller) never returned.

A trip into the future does not *have* to be serious or sad. A nice example of that is the story of a spaceship crew that sets off for the Alpha Centauri triple star system, more than four light years distant.[12] They survive the trip, which requires 500 years of both personal *and* external time (this story is the *only one* I'll mention in this book that uses *a preserving drug* rather than physics). What causes me to include it in a book on *time travel* (stories in which proper and external time are one-in-the-same are simply *not* about *time travel*) is that, long before they arrive at the end of their journey, the secret of faster-than-light (FTL) travel is discovered back on Earth and so they arrive at their destination to find a human reception committee! As you'll see when we get to Chap. 3, knowledge of FTL travel is equivalent to knowing the secret of travel into the past, and so the crew is sent back in time, to Earth, to just one year after they left—and they listen to their own radio communications arriving from deep space.

The *real* adventure in time travel, as suggested by "Far Centaurus," would be to go backward in time, to visit the past. The editor of the science fiction pulp magazine *Thrilling Wonder Stories* used the powerful emotional hook of changing the past in a 1950 blurb announcing a time travel story coming in the next issue: "What's the biggest mistake you ever made? Don't worry about it. You may have pulled some awful boners in your time, but there's a sure-fire remedy for them all. It's simple. Just look up at that old time-clock on the wall—and turn it back to the moment just preceding your terrible blunder. Then make your corrections—and set your time-clock back to the present. You may be starting a new chain of error, but why fret? You can go back in time again. . ." Or, as the promotional text on the video package of the 1986 movie *Peggy Sue Got Married* says, "to do it again" is "the golden opportunity almost everyone has longed for at least once."

Writing less romantically, a philosopher declared that a "major source of interest in the time travel question is our general fascination with the exotic and the child-like frustration we sometimes feel at being confined to the present. We wish that the benefits of moving through space could be supplemented with the benefits which would accrue from movements through time."[13] Robert Silverberg, a science fiction writer who has used the time travel theme often and effectively, expressed this sentiment quite clearly when he wrote "Suppose you had a machine that would enable you to fix everything that's wrong in the world . . . The machine can do anything . . . it gives you a way of slipping backward and forward in time . . . Call this machine whatever you want. Call it Everybody's Fantasy Actualizer. Call it a

[12] A. E. Van Vogt, "Far Centaurus," *Astounding Science Fiction*, January 1944.

[13] R. A. Sorenson, "Time Travel, Parahistory and Hume," *Philosophy*, April 1987, pp. 227–236.

Time Machine Mark Nine."[14] He gives a masterful demonstration of what he means by that in one of his own stories, a tale[15] set in a year when time machines actually exist. Even so, the characters use their imaginations to explore their fantasy worlds and wishes—wishes that could (if they *really* wanted to) be realized with a real time machine. Time travel fiction is, you see, the ultimate escapist literature!

The adventure promised by time travel to the past doesn't necessarily mean *pleasant* adventure, and science fiction has used that idea to great effect. The unstated horror of a trip backward in time, if you think just a bit about it, is that it would bring the dead past, filled with all its dead occupants, alive again, literally resurrected from dank and moldering graves. The top of Mount Everest, the bottom of the Marianas Trench, the sands of Mars—none of these exotic places can even be mentioned in the same breath with the *past*. The capture of the mystery and, yes, the sheer terror of the past, is in this opening line to a 1950s tale: "When Dr. Flitter came into the room, it seemed as though the past and its dead people came in with him, clinging to him like stale surgery smells, like the cold sweat of ancient autopsies."[16] In another equally macabre story, we read of a time traveler in the past anticipating a meeting with a long-dead lover as he "shivered with a renewal of horror . . . She ought to be grateful to him for having raised her from the dead, even briefly."[17]

Another tale, slightly less gruesome, tells us of a character who delights in pointing out all the bad aspects of living in the past.[18] Tell him *when* in time, and he quickly ticks off the disadvantages of being *then*. To live in ancient Greece would let you rub shoulders with Aristotle, sure, but you already know what he said and you'd soon regret the lack of modern plumbing. The year of the American Revolution might let you exchange greetings with George Washington, but you'd also have to put up with cholera in Philadelphia, malaria in New York, and the fact that if you needed an operation there would be no anesthesia anywhere. The Victorian Age appeals to modern romantics but, before you go back, you'd better have your eyes and teeth checked. The time traveling historian in one novel[19] takes these medical warnings to heart and has her appendix prophylactically removed, and is further advised to have her nose cauterized against all the awful stinks of her destination, the fourteenth century.

On the other hand, poor health care isn't *all* there is with time travel to the past. One time traveler from the future, for example, makes a very good living in the past

[14]R. Silverberg, "Ms. Found in an Abandoned Time Machine," *Beyond the Safe Zone*, Warner 1986.

[15]R. Silverberg, "Many Mansions," *Beyond the Safe Zone*, Warner 1986.

[16]R. Bretnor, "The Past and Its Dead People," *Magazine of Fantasy and Science Fiction*, September 1956.

[17]L. Marlow, *The Devil in Crystal*, Faber and Faber 1944.

[18]A. Bester, "Hobson's Choice," *Magazine of Fantasy and Science Fiction*, August 1952.

[19]C. Willis, *Doomsday Book*, Bantam 1992.

by winning bets on yet-to-happen events whose outcomes he knows.[20] Time travel to the past allows a Parisian curio shop in the present to offer remarkably authentic looking newspapers from 1804 whose only 'flaw' is that they appear to be fresh off the press—which of course they are![21] And the failed professor in one romantic story[22] finds the Paris of 1482 infinitely better than the Paris of 1961.

A popular fictional appearance of time travel is the use of the past as a hiding place, as a sanctuary for those wishing to escape the troubles of modern times.[23] An interesting twist on this idea was presented in one tale[24] in which the past is used for later military gain in the present. In this story the Earth of a thousand years in the future is ruled by a dictator, and the oppressed masses are unable to arm themselves for revolt. So, back into the past travels an agent to arrange for the construction of weapons, which are then stockpiled in hidden caverns where they can be retrieved for use ten centuries later. The past is used in this story as both a sanctuary *and* a repository from which to make war in the future, and so we have a time travel fantasy for both doves *and* hawks in the same tale! This military use of the past is passive; other writers have more aggressively used time travel to the past for military gain as, for example, mining uranium deposits before they have had time to reduce themselves to lead via radioactive decay,[25] or in drilling for Middle East oil in the past to deprive adversaries of it in the present.[26]

Time travel to the past would, perhaps, interest criminals, too. As the science fiction writer Larry Niven wrote, "If one could travel in time, what wish could not be answered? All the treasures of the past would fall to one man with a submachinegun. Cleopatra and Helen of Troy might share his bed, if bribed with a trunkful of modern cosmetics."[27] Or, as the tragically flawed inventor of the first time machine dreamed, before using time travel to commit what he thought would be the perfect locked-room murder, "The Great Harrison Partridge would have untold wealth. He could pension off his sister Agatha and never have to see her

[20]C. Sprague, "Time Track," *Startling Stories*, January 1951.

[21]M. Leinster, *Time Tunnel*, Pyramid Books 1964.

[22]U. K. Le Guin, "April in Paris," *Fantastic Stories*, September 1962.

[23]There are *many* excellent examples of such tales, a few of which are Clifford Simak, "Over the River & Through the Woods"; Ray Bradbury, "The Fox and the Forest"; Jack Finney, "Such Interesting Neighbors"; J. B. Priestly, "Mr. Strenberry's Tale"; James Gunn, "The Reason Is With Us"; and H. B. Piper, "Flight from Tomorrow." All can be found in various anthologies.

[24]R. F. Young, "Not to be Opened—," *Astounding Science Fiction*, January 1950.

[25]C. Simak, "Project Mastodon," *Galaxy Science Fiction*, March 1955.

[26]P. Anderson, "Wildcat," *Magazine of Fantasy and Science Fiction*, November 1958, and W. Jeschke, *The Last Day of Creation*, St. Martin's Press 1982.

[27]L. Niven, "The Theory and Practice of Time Travel," in *All the Myriad Ways*, Ballantine 1971.

again. He would have untold prestige and glamour, despite his fat and baldness, and the beautiful and aloof Faith Preston would fall into his arms like a ripe plum."[28]

Instead of viewing the past as an aid to crime, some writers have used it as the perfect dumping ground for criminals, as a highly convenient place to remove them from society.[29] After all, there can be no breakout from the prison of the past—at least not without a time machine. What might happen to criminal recidivists in a world that has mastered time travel is nicely explained in one story as follows: "If you cannot live among people, then off to the reptiles—one hundred or one hundred twenty million years before the present. There you wouldn't freeze in a tropical pre-glacial climate, and you could nourish yourself on plants. But there is no one to talk with, boredom, and in the end you offer yourself up as an afternoon snack to a tyrannosaurus."[30] With an interesting twist on this is the tale[31] of a physics professor who *helps* criminals disappear into the past to escape relentless police pursuit.

Museum curators, too, would seem to be obvious clients for time machine companies, as would collectors of extinct species who work for zoos. An example of the first case is in a novel[32] about a time travel business called *Time Researchers*, with the corporate mottos 'We Sift the Sands of Time.' It works as a futuristic version of Indiana Jones, as finders of lost historical artifacts for customers who can pay the substantial charges. A typical mission is to make original sound recordings of one of Lincoln's unreported speeches. We find the same idea in a short story[33] about a business called *Genealogy, Inc*., with the corporate motto

"An Ancestor for Everybody." It uses a 'time scanner' to provide its clients with a list of distinguished predecessors. And in another novel we read of the Historical Corps, whose time travel agents are "writing the definitive history of mankind.".[34]

Another use for time travel to the past, one of the most unusual I have seen, was suggested in a philosophical article[35] which considers an age-old question that has

[28]A. Boucher, "Elsewhen," *Astounding Science Fiction*, January 1943. Partridge's dream is shattered, however, because he overlooks a few details about time travel, ones that he wouldn't have missed if he could have read this book. We'll come back to this classic story, which merges a time machine with murder, later in the book.

[29]This is a popular science fiction scenario, and three of the best stories playing with it are P. Anderson, "My Object All Sublime," *Galaxy Science Fiction*, June 1961; I. Watson, "In the Upper Cretaceous with the Summerfire Brigade," in *Stalin's Teardrops*, Victor Gollancz 1991; and R. Silverberg, "Hawksbill Station," *Galaxy Science Fiction*, August 1967.

[30]S. Gansovsky, "Vincent Van Gogh," in *Aliens, Travelers, and Other Strangers*, Macmillan 1984.

[31]J. Finney, "The Face in the Photo," in *About Time*, Simon and Schuster 1986.

[32]W. Tucker, *The Lincoln Hunters*, Rinehart 1958. See also A. Bitov, "Pushkin's Photograph," in *The New Soviet Fiction*, Abbeville Press 1989.

[33]M. Shaara, "Man of Distinction," *Galaxy Science Fiction*, October 1956.

[34]L. A. Frankowski, *The Cross-Time Engineer*, Del Rey 1986. The same idea is in the 1991 film comedy *The Spirit of '76*, in which time-traveling historians from 2176 visit the past in an attempt to reconstruct the lost records of the founding of America.

[35]J. C. Graves and J. E. Roper, "Measuring Measuring Rods," *Philosophy of Science*, January 1965, pp. 39–56.

long bedeviled schoolboys: "If everything in the Universe doubled in size overnight while we slept, could we tell what had happened when we woke up next morning?" The usual answer to this puzzle (called the *Universal nocturnal expansion* by philosophers) is *no*, but the authors of the article suggest that 'all' we need do is take a yardstick back to yesterday and compare it with itself! Great idea, for sure, but it had appeared years earlier in a science fiction story.[36]

More ingenious uses for the past are discussed in the story[37] of a time travel business called *Time Associates*. One use comes in the form of a request from a United States senator who wants to send the disadvantaged of today back into the remote past, where they could have a fresh start on a virgin Earth. Yet another use comes from a religious fringe group that wants to purchase exclusive rights to the time of Jesus—not to visit, but to prevent *anyone* from visiting. The group fears that any such visitors would "learn the truth," which might contradict the very legends that form the heritage of Christianity. And, in what may be the most ingenious idea of all, *Time Associates* itself does not do business in the present, but rather 150,000 years in the past, in a 'new' country called Mastodonia. The corporate lawyer, you see, has determined that such an arrangement legally means the company is a *foreign* company doing business outside the United States, and so it is not liable for taxes to the IRS!

The tourist trade is a booming business in science fiction, with dinosaur hunting at the top of the list. There are many such tales,[38] including the cerebral stories in L. Sprague de Camp's short-story collection *Rivers of Time*, starting with the classic "A Gun for Dinosaur." The earliest (that I know of) fictional use of time travel to the past for hunting was not for dinosaur hunting, however, but rather for saber-toothed tigers, wooly mammoths, and cave bear.[39] Historical tours to the great events of the past are also an entertaining use of time travel.[40] Even mundane events may one day be on the 'to do' lists of time travelers to the past. In one, for example, curious crowds from the very far future show up, nightly inside the home a twentieth century family, much as tourists today visit Monticello.[41]

Perhaps the most direct use of the past's unique resource, itself, is realized in science fiction by Hollywood. In one tale,[42] after purchasing the motion picture

[36]H. M. Sycamore, "Success Story," *Magazine of Fantasy and Science Fiction*, July 1959.

[37]C. Simak, *Mastodonia*, Ballantine 1978.

[38]Two are B. W. Aldiss, "Poor Little Warrior," in *The Science Fictional Dinosaur*, Avon 1982, and a famous one by Ray Bradbury, "A Sound of Thunder," in *The Stories of Ray Bradbury*, Alfred A. Knopf 1980.

[39]C. Simak, "The Loot of Time," *Thrilling Wonder Stories*, December 1938, in which a time machine inventor raises money for his research by transporting hunters back 70,000 years to the Old Stone Age.

[40]Three such tales are R. Silberberg, *Up the Line*, Ballantine 1969 and "When We Went to See the End of the World," in *Beyond the Safe Zone*, Warner 1986; and G. Kilworth, "Let's Go to Golgotha!," in *The Songbirds of Pain*, Victor Gollancz 1985.

[41]B. Tucker "The Tourist Trade," in *Tomorrow the Stars*, Doubleday 1952.

[42]L. Laurence, "History in Reverse," *Amazing Stories*, October 1939.

rights to H. G. Wells' *Outline of History*, the head of a movie studio uses a time machine to send his ace cameraman into the past to get live action footage. Prehistoric animals, the ice age, Cheops building his pyramid, the destruction of Pompeii by the eruption of Vesuvius, the Battle of Hastings, Columbus, all the *originals* of these historical events appear in the final film. Years later this idea was developed even further in a very funny novel,[43] in which a movie director uses the eleventh century as a realistic setting for a picture. Realism isn't always the result, however, as portrayed in another tale; the films produced by a gadget that can 'look' into the past are failures because they don't look "authentic enough" to Hollywood moguls![44] (Fig. 1.1).

Fig. 1.1 The inventor of a time machine demonstrates it by sending the family cat on a trip. In the story the inventor, himself, travels back to 1901, where he accidently kills his grandfather in an early pulp magazine, non-paradoxical version of the famous riddle. Illustration for Raymond A. Palmer's "The Time Tragedy" (*Wonder Stories*, December 1934) by Frank R. Paul, ©1934 by Continent Publications Inc.; reprinted by permission of the Ackerman Science Fiction Agency, 2495 Glendower Ave., Hollywood, CA 90027 for the Estate

[43]H. Harrison, *The Technicolor Time Machine*, Doubleday 1967.

[44]A. Derleth, "An Eye for History," in *Harrigan's File*, Arkham House 1975.

1.2 Where Are All the Time Travelers?

> "If it [time travel] *could* be done, someone will eventually learn how. If that happens, history would be littered with tourists. They'd be *everywhere*. They'd be on the *Santa Maria*, they'd be at Appomattox with [cameras], they'd be waiting outside the tomb, for God's sake, on Easter morning."[45]

The question the title of this section asks is an echo of the one the physicist Enrico Fermi (1901–1954) asked in the 1950s, about the possibility of interstellar space travel and of alien intelligent life in the universe—if such travel is possible and 'they' exist, then *where are they*? Why haven't we at least received radio signals from them? For many, the apparent lack of time travelers among us is similar evidence for the impossibility of time travel. As one famous science fiction writer put it, "The most convincing argument against time travel is the remarkable scarcity of time travelers. However unpleasant our age may appear to the future, surely one would expect scholars and students to visit us, if such a thing were possible at all. Though they might try to disguise themselves, accidents would be bound to happen—just as they would if we went back to Imperial Rome with cameras and tape recorders concealed under our nylon togas. Time traveling could never be kept secret for very long."[46]

Clarke's idea is that, from the moment after the first time machine was constructed, through all the rest of civilization, there would be numerous historians, to say nothing of weekend sightseers, who would want to visit every important historical event in recorded history. They might each come from a different time in the future, but all would arrive (according to Clarke) at destinations crowded with temporal colleagues, crowds for which there is no historical evidence!

Long before Clarke the science fiction writer Robert Silverberg had already used the same idea in his 1969 novel *Up the Line*, where it's called the *cumulative audience paradox*. That paradox claims that as time travelers to the past continue to visit certain historically interesting dates and places, there will be an ever-increasing number of people present. As it is presented in the novel, "Taken to its ultimate, the *cumulative audience paradox* yields us the picture of an audience of billions of time-travelers piled up in the past to witness the Crucifixion, filling all the Holy Land and spreading out into Turkey, in Arabia, even to India and Iran . . . Yet at the original occurrence of [that event] *no such hordes were present!*" And later in the same work, we read "A time is coming [when we] will throng

[45]A skeptic's reaction to the idea of time travel in J. McDevitt's story "Time's Arrow" in *The Fantastic Civil War* (see note 7).

[46]Arthur C. Clarke, "About Time," in *Profiles of the Future*, Warner 1985. A story that I recall once having read (but cannot now remember either the author or the title) wonderfully illustrates Clarke's point. A time traveler in disguise at Golgotha for the Crucifixion has a camera hidden beneath his robe to avoid attracting attention. All goes well until he notices odd, clicking noises coming from all those standing near him. It is then he realizes the entire crowd is *nothing but* time travelers, from all through the ages, all with hidden cameras!

the past to the choking point. We will fill our yesterdays with ourselves and crowd out our own ancestors."

Philosophers are well aware of Silverberg's and Clarke's conundrum and, indeed, it can be found in the philosophical literature before Clarke wrote. In one paper, for example, we read "Actually I know of only one argument against the possibility of time travel that seems to carry any weight at all. This is the fact that it does not appear ever to have happened. That is, it might be argued that there will be no time trips from [2100] to [2017] because we were here in [2017] and saw no time travelers. But this argument is far from conclusive."[47] At most, in other words, the absence of temporal visitors amongst us is an objection to the *actuality* of time travel, and not to the *possibility* of time travel.

This same philosopher then mentions some ways around this concern, including one which he called a "pettifogging physical limitation on time travel: perhaps the energy expenditure varies as the fourth power of the time traversed, making only very short trips feasible, and its discovery lies too far in the future for its effects to have yet been felt." Another science fiction writer, as famous as Clarke, used that idea in his 1957 novel *The Door Into Summer* when Robert Heinlein has one character comment "Now if there was some way to photograph the Crucifixion . . . but there isn't. Not possible . . . there isn't that much power on the globe. There's an inverse-square law tied up in [time travel]." Or, perhaps, time travel *is* possible but it's so extraordinarily dangerous that it's impossible to get anyone to do it. In one provocative tale[48] that takes this idea to the extreme, we read that there is only *one* time traveler, ever, from the future—indeed, from just 18 min (!) in the future—and his first (and last) experiment destroys the Earth.

Clarke presented some other possible science fiction rebuttals to the puzzle of 'where are the time travelers?' As he wrote, "Some science fiction writers have tried to get around this [question] by suggesting that Time is a spiral; though we may not be able to move along it, we can perhaps hop from coil to coil, visiting so many millions of years apart that there is no danger of embarrassing collisions between cultures. Big game hunters from the future may have wiped out the dinosaurs, but the age of *Homo sapiens* may lie in a blind region which they cannot reach."

The idea of time as a spiral was quite popular in early science fiction. Typical is one tale[49] in which the time traveler suddenly finds himself not in 1933 but in 2189. His situation is 'explained' to him thus: "[The] time stream is curved helically in some higher dimension. In your case, a still further distortion brought two points of the coil into contact, and a sort of short circuit threw you into the higher curve."

[47]G. Fulmer, "Understanding Time Travel," *Southwestern Journal of Philosophy*, Spring 1980, pp. 151–156. The modern view of this 'paradox' is *not* that it describes a situation so absurd that time travel must be impossible, but rather that *all* the time travelers who *were* (will be?) at the Crucifixion *are* in the historically recorded crowd (see note 46 again). The Crucifixion happened just *once*, not over and over. I'll return to this point later in the book.

[48]D. Plachta, "The Man from When," *Worlds of If Science Fiction*, July 1966.

[49]R. H. Wilson, "A Flight Into Time," *Wonder Stories*, February 1931.

A few years later (in 1937) we find another story[50] with the same spiral-time concept; with a sixty-million year pitch to the time helix, there is no danger of a grandfather paradox. That same year spiral time was the central 'scientific' theme in the stage production "I Have Been Here Before" by the English playwright J. B. Priestley.

The very next year (1938) the young Isaac Asimov used the idea in his first attempt at professional writing, despite a life-long unhappiness with the concept of time travel. Titled "Cosmic Corkscrew," it was initially rejected, indeed it was *never* published, and eventually lost. Though, perhaps, not for long, since one enterprising modern writer has used it as the basis for his own time travel tale.[51] In it a traveler from the near future travels back to 1938 to retrieve "Cosmic Corkscrew" before Asimov loses it (perhaps that's *why* it was lost!) Even when writing introductions to other writers' time travel tales, Asimov would often insert personal comments on his opinion of the concept. For example, in one volume of an anthology series he edited, *The Great Science Fiction Stories* (of 1954), he wrote "To my way of thinking it is precisely because time travel involves such fascinating paradoxes that we can conclude, even in the absence of other evidence, that time travel is impossible." And in *The Great Science Fiction Stories* (of 1961) he bluntly declared "I think scientists who think up methods of time travel are probably all wrong."

Spiral time is a close cousin to circular time. One story[52] dealing with circular time has a time traveler who finds, after a trip one hundred years into the future, that he can't get all the way back to his own time because the required energy rises exponentially with increasing penetration into the *past*. Still, it's very cheap in energy to go forward in time in this tale, and that's what the traveler does, in search of help from the future's advanced technology. He never finds what he needs, however, and so goes forward right into the collapse of the universe and through a new Big Crunch that forms an identical new cycle of time. He thereby returns home to just before he left.[53] This eternal recycling of identical, circular time is so terrifying that the traveler decides to suppress what he has learned about how to time travel—and so maybe *that's* why there are no apparent time travelers. Science fiction writer Larry Niven has argued, however (see note 27), that while this may be a conceptually valid (?) way to travel into the past, he also warns that "Removing your time machine from the reaction of the Big Bang/Crunch could change the final configuration of matter, giving an entirely different . . . history." (I strongly suspect that Niven wrote that with a big smile on his face!)

[50]P. S. Miller, "The Sands of Time," *Astounding Stories*, April 1937.

[51]M. A. Burstein, "Cosmic Corkscrew," *Analog*, June 1998.

[52]P. Anderson, "Flight to Forever," *Super Science Stories*, November 1950.

[53]Turning this idea on its head is the approach of the 1978 novel *The Way Back* (DAW) by A. B. Chandler. Its characters return from the past to their own time by traveling even further backward, right through the Big Bang and into the *previous* (and identical) cycle of time.

The famed English physicist Stephen Hawking is so taken with the question of 'where are all the time travelers?" that he has elevated their apparent absence ("we have not been invaded by hordes of tourists from the future"[54]) to the status of being a demonstration of the impossibility of time travel to the past. His so-called *Chronology Protection Conjecture*, Hawking likes to say, "makes the universe safe for historians": that is, there is nothing to worry about (if you're concerned that time travelers could change the past) because time travel is simply impossible. You'll see later in the book that there are other possible ways to insure the safety of history *without* denying the possibility of time travel, and Hawking himself has backed away just a bit from the Conjecture, saying now that he was simply looking for a humorous line.

While Hawking's endorsement of it has made the Conjecture famous, he wasn't the first to state it. Two years earlier it had appeared, in of all places, a *financial* publication: "[If] time travel was possible, someone from the future would eventually either discover a time tunnel or build a time machine and come visit us."[55] And even before that, an economist presented a 'proof' for concluding that "time travelers do not and cannot exist."[56] He argued that if time travelers from the future were actually amongst us (our 'now' is their 'past') then, by virtue of their knowledge of things to come (our 'future') they would make financial deals so numerous and extensive that interest rates would be driven to zero. Interest rates are *not* zero, however, and thus no such time travel hanky-panky has occurred.

These sorts of financial arguments aren't like to convince many physicists or philosophers of the Conjecture's merit. At most we can only conclude from them that time travelers from the future have *not* influenced financial affairs, which doesn't mean they aren't here. In any case, the Conjecture was actually stated more than 20 years before Hawking by Larry Niven (see note 27), who declared what is called *Niven's Law*: "If the universe of discourse permits the possibility of time travel, and of changing the past, then no time machine will be invented in that universe." And Hawking's concern over time travelers meddling with the past was anticipated in science fiction, too, by at least half a century; in a 1950 tale, for example, we learn of a Master Historian, and the graduate students in his course on 'Experimental History' in the forty-sixth century, trying to correct a problem created by a previous tampering with the past![57]

Not all physicists and philosophers feel intellectually comfortable with the Conjecture, as it seems (to them) a too quick surrender: 'Time travel is a problem

[54]S. W. Hawking, "Chronology Protection Conjecture," *Physical Review D*, July 15, 1992, pp. 603–611. See also J. F. Woodward, "Making the Universe Safe for Historians: Time Travel and the Laws of Physics," *Foundations of Physics Letters*, February 1995, pp. 1–39.

[55]J. Queenan, "Time Warp: Or, Investing in the Future Is a Bust," *Barron's*, January 8, 1990, p. 46.

[56]M. R. Reinganum, "Is Time Travel Impossible? A Financial Proof," *Journal of Portfolio Management*, Fall 1986, pp. 10–12.

[57]L. Jones, "Sunday is Three Thousand Miles Away," *Thrilling Wonder Stories*, June 1950. A more recent, two-*novel* treatment of historians tinkering with history is by Connie Willis (*Blackout* and *All Clear*, both published in 2010).

so hard to do let's simply *define* it to be non-existent and then we won't have to worry about it anymore.' To *really* show that time travel is impossible, however, one needs to demonstrate how it would violate one or more of the laws of physics. Hawking, of course, understands this and has stated that, as one who is no fan of time machines and time travel, he believes there is new physics yet to be discovered that *will* forbid would-be time travelers from roaming up and down the centuries. Finding that new physics is the lure the study of time machines has for him. As he correctly writes in his autobiography,[58] "Even if it turns out that time travel is impossible, it is important that we understand why it is impossible."

One mathematical physicist who agrees with Hawking on the matter of the unlikely possibility of making a time machine is the New Zealand theoretician Matt Visser. Noting that while quantum field theory, and the general theory of relativity, are each amazingly good theories in many applications within their respective realms, they are not so good in spacetime regions at the so-called *Planck scale* (that is, when the density of mass-energy reaches the fantastic level of 10^{94} grams/cm^3 and beyond) where chronology violations (that is, time travel) seem to be spawned. As Visser has observed,[59] this situation won't change until 'we wander into the guts of quantum gravity,' the unification that will merge gravity with the quantum to give a theory that *always* works. Without quantum gravity, physics will continue to be "infested" (Visser's word) with "sick" (Visser's word) spacetimes that allow time travel. Visser believes that the discovery of the theory of quantum gravity can be 'guided' by *building* causality into it,[60] and the result will finally consign time machines to where (in his mind) they belong, the dust-bin of crackpot physics.

Well, perhaps so, but we don't have a quantum theory of gravity yet, and probably won't for some time to come, and so the puzzling questions about time travel remain. To end this section on a slightly gloomy note, an idea appeared in science fiction,[61] when Hawking was still a teenager, offering a possible rebuttal to the Conjecture. It opens with one of the inventors of the first time machine just returning from a trip to the past of 1938. Still, despite this success, the inventors are puzzled by what they call 'the problem': "But if *we* have time traveled, then obviously men of the future have time traveled. They will be able—*are* able to come back. [So] where are they?" They finally conclude that there can only be two

[58]Stephen Hawking, *My Brief History*, Bantam 2013, p. 113.

[59]Matt Visser, "The Quantum Physics of Chronology Protection," in *The Future of Theoretical Physics and Cosmology*, Cambridge 2003. This paper was Visser's contribution to the celebration of Hawking's 60th birthday, held in January 2002.

[60]This may seem like something new, but it really isn't. General relativity has causality built into it on a *local* level (where it belongs); a failure of causality (that is, time travel—see J. Sharkey, "The Trouble With Hyperspace," *Fantastic* April 1965) occurs in general relativity only when one studies *global* regions of certain spacetimes. Forcing a physical theory to have a *prescribed global behavior* would be to undo all of physics since the development of *local field theories*, along with all their amazing successes in explaining nature.

[61]M. Shaara, "Time Payment," *Magazine of Fantasy and Science Fiction*, June 1954.

possible answers. Either there is nobody in the future, or time travel is so dangerous (is that why the future might be empty—humanity misused time travel and killed itself off?) that all who invent it will suppress it. And that's what they decide *they* must do.

1.3 Skepticism About Tales of Time Travel

> "May it not be that our inability to leap into the fiftieth century, A.D., seems impossible to us, merely because of certain prejudices we entertain or certain facts and tricks of which we are still hopelessly ignorant? Assuredly, this is not a foolish query. Its answer, whatever that may be, carries immeasurable consequences for metaphysics."
>
> —a scholar wonders[62]

A thought-provoking possibility for explaining the scarcity of certified time travelers is the central thesis of a fascinating paper in the philosophical literature. The author of that paper argues (note 13) that nobody would believe a time traveler even if he willingly confessed and revealed his knowledge of the future, or even gave the details of his time machine. He goes on to make the astonishing assertion that even the *time traveler himself* would have doubts! This perhaps shocking suggestion deserves some elaboration, especially because it invokes the authority of the patron saint of skeptics for support, the Scot David Hume (1711–1776). The crucial point to keep in mind is explicitly stated in the argument: "The key question will not be 'Is time travel possible?' We shall instead ask whether it is possible to justify a belief in a report of time travel." This gets to the real heart of Clarke's puzzle from the previous section.

Much of the resistance to the idea of time travel lies in sheer skepticism. For many, time travel (to the past, in particular) is simply too much out of the ordinary to be taken seriously. For many, time travel would literally be miraculous. Hume's great work, *An Enquiry Concerning Human Understanding*,[63] contains a section on how a rational person should react to a claim that a miracle has occurred. Hume proclaimed that a miracle *by definition* violates scientific law and that, because such laws are rooted in "firm and unalterable experience," any violation of one or more of these laws immediately provides a refutation of the report of a miracle. In Hume's own words:

> "Nothing is esteemed a miracle, if it ever happened in the common course of nature. It is no miracle that a man, seemingly in good health, should die on a sudden; because such a kind of death, though more unusual than any other, has yet been frequently observed to happen. But it is a miracle, that a dead man should come to life; because that has never been

[62]W. B. Pitkin, "Time and Pure Activity," *Journal of Philosophy, Psychology and Scientific Methods*, August 27, 1914, pp. 521–526. Pitkin's essay was a critique of time travel as presented in Wells' *The Time Machine,* which Pitkin called "one of the wildest flights of literary fancy."

[63]Making its first appearance in 1748, *Enquiry* has been reprinted numerous times since. I used the 1963 edition published by Open Court.

> observed in any age or country . . . When anyone tells me, that he saw a dead man come to life, I immediately consider with myself, whether it be more probable, that this person should either deceive or be deceived, or that the fact, which he relates, should really have happened. I weigh the one miracle against the other; and according to the superiority, which I discover, I pronounce my decision, *and always reject the greater miracle* [my emphasis]."[64]

It is a strict interpretation of Hume that Sorenson (note 13) has adopted in claiming that a time traveler would have no success (among rational persons) with tales of 'different times.' As he explains, "Clearly the time traveler cannot persuade a reasonable person by baldly asserting 'I am a time traveler.' The improbability of his claim places a heavy burden of proof on him. But perhaps he could shoulder the burden by means of artifacts, predictions, and demonstrations." Sorenson dismisses all of these possibilities, however, by reminding us of the slightly sleazy history of parapsychology and ESP, both of which run counter to known scientific laws, but which have still duped "many a respected scientist." Any artifact, prediction, or demonstration of time travel, argues Sorenson, is more likely to be the result of deception and fraud than of actual time travel: "Should the time traveler take observers for a spin in his time machine, the skeptics will have us compare their adventures with séances." The rational reaction to such a spin around the centuries, according to Sorenson's presentation, would be like that of a magician who cannot figure out how a colleague has just done his newest act: 'Nice trick! How did you do it?'[65]

The time traveling tourist stranded in the past in one story is used to getting a skeptical reaction because he can provide his questioners no technical explanation for his situation. "How the hell should I know? I'm just a tourist. It has something to do with chronons [see the Glossary]. Temporal Uncertainty Principle. Conservation of coincidence. I'm no engineer."[66] Somewhat more successful (perhaps) is a time traveler born in 2003 who turns up in 1975. After he tries to convince an interrogator of how that can be, he apparently succeeds. As the time traveler later tells a new friend in the past of 1975, "What amazed me . . . was that he really believed me in the end." But the friend doesn't buy that, replying "He did? I think he just

[64]What Hume is alluding to here should be plain; as expressed in P. Heath, "The Incredulous Hume," *American Philosophical Quarterly*, April 1976, pp. 159–163, Hume was "an exposer of bad arguments in rational theology." For Hume, second-hand (or even more remote) tales of the return of a man from the dead—the claim that literally kept Christianity alive after Christ's execution—were suspect.

[65]This skeptical reaction was nicely captured in the story "E for Effort" by T. L. Sherred (*Astounding Science Fiction*, May 1947). As one character laments, "I've watched scribes indite the books that burnt at Alexandria; who would buy, or who would believe me, if I copied one. . . . What sort of padded cell would I get if I showed up with a photograph of Washington or Caesar? Or Christ?" The padded cell was indeed the fate of the time traveler in "The Ambassador from the 21st Century" (*Startling Stories*, March 1953) by H. J. Shay, the story of a man who journeyed from A.D. 2007 back to 1952 to warn of a future war; he was committed to a mental institution to receive help for his "illusion."

[66]J. Haldeman, "No Future In It," *Omni*, April 1979.

pretended. A scientist isn't likely to believe a thing that is against all logic."[67] If the reception committee is a crowd of conservative, cautious Humeans, it would seem that a time traveler is almost certainly doomed. Early science fiction time travelers from 2030, for example, were warned about receiving a skeptical response as follows (the editorial introduction to this tale[68] called it "a curious study of psychology"): "Our wisest men advised against [our trip to the past]. They said we could hope to be received only as imposters and fakirs, that . . . we would find only twentieth-century barbarians, suspicious, ill-tempered, likely to do us bodily harm."

For many, such skeptical reactions to self-proclaiming time travelers seems dogmatic in the extreme—the response of people with no imagination, no spirit, and heads full of cement. Humean skepticism requires, so it would seem, the rejection of anything and everything that is profoundly surprising, leaving the world a place of utter predictability and boredom. As one science fiction writer put it, "When the miraculous occurs, only dull, workaday mentalities are unable to accept it."[69] Sorenson answers this harsh criticism as follows: "Humeans respond [to Sheckley] by distinguishing between surprises. Most surprises in science do not violate accepted scientific laws. The strange wildlife in Australia was not excluded by biology, X-rays were not precluded by physics."

Sorenson does well, however, to avoid mentioning such profound surprises as, for example, the spectrum of black-body radiation and, later, the photoelectric effect, which were not in the domain of known classical science at the beginning of the twentieth century. Those puzzling, surprising, *totally mystifying* effects required new science—the discovery of the quantum concept by Max Planck. (Explaining the photoelectric effect, *not relativity*, is what won Einstein his Nobel prize.) A strict Victorian-age Humean, as described by Sorenson, would have wrongly rejected the experimental reports of all quantum phenomena and would also (perhaps just as wrongly) have rejected all reports of time travel.

A strict Humean definition (as described by Sorenson) that a miracle has occurred requires a violation of one or more of the *known* [my emphasis] scientific laws of nature.[70] As one modern philosopher defines a miracle, it is any event that "can be explained *only* [my emphasis] by reference to the intervention of a supernatural force."[71] Time travel, by that interpretation, is *not* a miracle because general relativity, not God, is all that is required. C. S. Lewis (1898–1963), late

[67]G. Gor, "The Garden," in *Russian Science Fiction* (R. Magidoff, editor), New York University Press 1969.

[68]P. Bolton, "The Time Hoaxers," *Amazing Stories*, August 1931.

[69]Robert Sheckley, "Something for Nothing," in *Citizen in Space*, Ballantine 1955.

[70]The word *known* is important. As a character in one early science fiction story puts it, "These things [four-dimensional object] sound like miracles; but, after all, what are miracles but phenomena which, *on account of our ignorance* [my emphasis], we cannot explain?" See B. Olsen, "The Four-Dimensional Roller-Press," *Amazing Stories*, June 1927.

[71]D. M. Ahern, "Miracles and Physical Impossibility," *Canadian Journal of Philosophy*, March 1977, pp. 71–79.

professor of Medieval and Renaissance Literature at Cambridge University, however, absolutely rejected Hume's view on how a rational person should react to certain surprising events. Lewis, one of the most thoughtful modern writers on Christian theology, had no patience with skeptics (or, as he called them, materialists).[72]

Professor Lewis graphically illustrated the dug-in position of the extreme skeptic as follows: "If the end of the world appeared in all the literal trappings of the Apocalypse; if the modern materialist saw with his own eyes the heavens rolled up and the great white throne appearing, if he had the sensation of being himself hurled into the Lake of Fire, he would continue forever, in that lake itself, to regard his experience as an illusion and to find the explanation of it in psychoanalysis, or cerebral pathology."[73] If the end of the world would receive such a skeptical response, then a mere time traveler would surely have no hope at all of being believed.

Lewis would certainly have rejected Sorenson's most astonishing assertion: "So far I have concentrated on the time travel question from the perspective of the time traveler's audience. What about the time traveler himself? Can he at least know he is a time traveler?" Sorenson argues that a time traveler, if authentic, should be able to convince his audience, and that if he can't (and he *cannot* if they are true Humean skeptics), then the time traveler must entertain doubts, too! It doesn't matter (says Sorenson) that the time traveler has memories of his adventures, and it doesn't matter that he knows in his heart that he speaks the truth. Using words that echo Lewis' sarcasm, Sorenson quickly dismisses the importance of the time traveler's self-knowledge, declaring such memories to be merely the symptoms of some deep psychosis, and the traveler's introspective sincerity to be a product of gross self-deception.

Sorenson specifically mentions the traditional Humean response to astonishing reports when he cites earlier writers on time travel in the philosophical literature. In one of those analyses, for example, we find an argument *for* the reasonableness of a rational belief in time travel ("I have been amused and irritated by the spate of articles proving that time travel is a 'conceptual impossibility') by claiming such proofs must be faulty because there is a mathematically consistent explanation for such a belief.[74] (This author was referring to spacetime diagrams, which we'll get to in Chap. 3.) This paper received a very sharp rebuttal from another philosopher who convincingly used fundamental physics to show a simple use of spacetime diagrams in a special relativity setting does *not* support time travel to the past.[75] (I'll return to

[72]In Lewis' eerie, unfinished story "The Dark Tower," a tale of the 'chronoscope,' a gadget that "does to time what the telescope does to space," the persistent skeptic in the story is a Scot, surely created in the image of Hume. See C. S. Lewis, *The Dark Tower and Other Stories*, Harcourt 1977.

[73]C. S. Lewis, *The Grand Miracle*, Ballantine 1986.

[74]H. Putnam, "It Ain't Necessarily So," *Journal of Philosophy*, October 1962, pp. 658–671.

[75]J. Earman, "On Going Backward in Time," *Philosophy of Science*, September 1967, pp. 211–222.

this point in Chap. 3.) Even later a Humean-style rebuttal came from yet another philosopher, who showed how to explain the time travel phenomenon that Putnam (note 74) described *without* invoking time travel.[76] This isn't to say that Weingard doesn't invoke some pretty astonishing gadgetry (and more) himself, like matter transmitters and anti-matter humans. (You'll see how anti-matter ties-in with time travel a bit later in the book.) A resurrected Hume would surely applaud these rebuttal analyses (although he might also doubt his own fresh existence).

Hardly anybody is happy with Weingard's approach for avoiding time travel (including, I suspect, even Weingard). His 'explanations' seem, just like a time machine, to be incredible and, as Arthur Conan Doyle's Professor Challenger says in one tale not staring Sherlock Holmes, "You cannot explain one incredible thing by quoting another incredible thing."[77] An interesting science fiction exposition illustrating Professor Challenger's Humean philosophy occurs when a copy of *The New York Times* for December 1 shows up for some subscribers a week early, on November 22. It seems the only explanation is either that the paper really is from the future (due to some sort of fluke of the fourth dimension), or that it is a hoax. The first-person narrator of this 1973 tale[78] provides us with his reason for believing the former: "I don't find either notion easy to believe but I can accept the fourth-dimensional hocus-pocus more readily than I can the idea of a hoax." Hume couldn't have said it better.

It should be clearly understood that Hume was not arguing for disbelief in absolutely anything surprising, but rather for rational analysis. Historically, the context of Hume's times was that of what he took to be non-rational arguments for a belief in God, particularly those 'proofs' so beloved by theologians based on Design (Heath [note 64] calls such 'proofs' "philosophical museum pieces"). As Heath writes, "Hume . . . makes no attempt to deny the supposed facts; he simply argues that they are consistent with other explanations and other analogies of a less ambitious kind. There is no right to attribute to the causes of such phenomena abilities more extensive than are needed to produce the observed effects."

As a matter of fact, even Hume could be convinced of quite strange matters, and I think Sorenson does interpret the philosopher a little too narrowly. In his essay concerning Hume's position on holding a belief in God, Heath wonders whether there is "empirical evidence [imaginable] which would persuade any reasonable mind of the real existence of an infinite God." Heath answers his own question as follows: "If the stars and galaxies were to shift overnight in the firmament, rearranging themselves so as to spell out, in various languages, such slogans as I AM THAT I AM, or GOD IS LOVE—well, the fastidious might consider that it

[76]R. Weingard, "On Travelling Backward in Time," *Synthese*, July–August 1972, pp. 117–132.

[77]Arthur Conan Doyle, "The Disintegration Machine," *The Strand Magazine*, January 1929. Professor Challenger is nothing like Wells' thoughtful Time Traveller; in the original 1912 Challenger novel *The Lost World*, he was described as a "primitive cave-man in a lounge suit."

[78]R. Silverberg, "What We Learned from This Morning's Newspaper," in *Beyond the Safe Zone*, Warner 1986.

was all very vulgar, but would anyone lose much time in admitting that this settled the matter? . . . Confronted with such a demonstration, the hard-line Humean [but not Hume, himself, I think] could continue, of course, to argue that, for all its colossal scale, the performance is still finite, and so cannot be evidence of more than the finite, though immense power that is needed to achieve it."

Skepticism about 'time travel' was around long before the specific idea of a 'time machine' was conceived. For example, the eleventh-century Persian poet-philosopher Omar Khayyam was blunt in his evaluation of the likelihood of reliving the past. As he so beautifully wrote in one of the quatrains of the *Rubaiyat*,

The Moving Finger writes; and having writ,
Moves on: nor all your Piety nor Wit
Shall lure it back to cancel half a Line,
Nor all your Tears wash out a Word of it.

Quite a bit later the English poet Thomas Heywood, in his 1607 play *A Woman Killed with Kindness*, had one of his characters express a similar thought:

God, O God, that it were possible
To undo things done, to call back yesterday;
That Time could turn up his swift sandy glass
To untell the days, and to redeem these hours.
Or that the Sun
Could, rising from the west, draw his coach backward,
Take from the account of Time so many minutes,
Till he had all these seasons called again,
. . . . . .
But O! I talk of things impossible,
And cast beyond the moon. . .

When Gödel's discovery of time travel in his rotating universe was announced, the skeptics were easy to find. One philosopher[79] wrote of it "This property [of time travel] must be judged an absurdity by anyone committed to the ordinary modes of speech." And another[80] was only slightly less charitable: Gödel's solution was a "bizarre conception" and a "mere mathematical curiosity." Science fiction wasn't immune to skepticism, either, even though you might have expected that to be the one place where the high drama of time travel would be welcomed. Four *years* after Gödel's paper appeared we find one respected anthologist writing,[81] as part of his introduction to a story, "In this tale we meet our first Mad Scientist. Just as in reality the thoroughly cracked pots used to be found inventing perpetual-motion machines, so in science fiction we find the lunatic fringe more often than not trying to perfect

[79] J. D. North, *The Measure of the Universe*, Oxford University Press 1965.

[80] C. T. K. Chari, "Time Reversal, Information Theory, and 'World-Geometry'," *Journal of Philosophy*, September 1960, pp. 579–583.

[81] Groff Conklin, editor of *Science-Fiction Adventures in Dimension*, Vanguard 1952.

time-travel mechanisms." And that same year the founding editor of *Galaxy Science Fiction Magazine* declared "Time travel requires a suspension of disbelief that is almost unbelievable . . . Scientifically, time travel can't stand inspection.".[82]

Years later matters had not much changed. For example, in his marvelous 1985 book *The Past is a Foreign Country*, David Lowenthal repeatedly refers to time travel as "fantasy," and to science fiction stories about time travel as "unbridled by common sense." (Lowenthal is a professor of *geography*, not physics.) Science fiction writers were still often not much more enthusiastic about time travel. The well-known science fiction writer and critic Alexei Panshin, for example, agrees with Lowenthal, at one point, long after Gödel, writing "Time travel is a philosophical concept, not a scientific one. It is, in fact, as has often been pointed out, scientific nonsense."[83]

Skepticism does have its uses, however. Modern science fiction writers have often used it as a dramatic means of building conflict and tension in their time travel stories. A skeptical reception is extreme, for example, for a soldier-in-time who has fought in numerous wars, from the ancient past to a billion years in the future.[84] He finds that nobody believes him when he speaks openly of his temporal adventures during a visit to a present-day bar. Everybody merely thinks it is all a hilarious gag. This is in great contrast to one 1870s story[85] in which suspicion of a stranger plays a central role, but which finds its offered explanation in something entirely different from time travel. It tells of a man who suddenly appears in the midst of a Union military camp during the American Civil War.

This man quickly displays strange lapses in his background, as well as possessing knowledge of many different things well beyond anything that could be called common. The details of the story are not important for us but, if it were published in a modern science fiction magazine, this man would almost surely be identified in most readers' minds as a time traveler. In 1875, however, the author's narrator found his punch line in "his firm conviction that the quiet, gentle, well-behaved, modest gentleman, so singularly gifted . . . is, in plain terms, the devil!" Time travel certainly never entered the author's thoughts or, if it did, he lost his nerve at the idea of using it in this pre-Wells story. You'll recall from the opening of the Introduction that it was this 'use of the devil to explain mysterious happenings' that Wells wanted to move away from, and that was the motivation for his introduction of a time *machine*.

Hollywood has at least gotten the skeptical part of the psychology of time travel right (later discussions in this book will focus on how film makers have been less successful with the physics). When, for example, the time traveling villain in the

[82]H. L. Gold, editor of *The Galaxy Reader of Science Fiction*, Crown 1952.

[83]In his introduction to Robert Heinlein's classic time travel tale (to be discussed later) "All You Zombies—," in *The Mirror of Infinity*, Canfield 1970.

[84]F. Leiber, "The Oldest Soldier," *Fantastic*, May 1960.

[85]G. C. Eggleston, "Who Is Russell?" *American Homes*, March 1875.

1989 movie *Time Trackers* is confronted in the medieval past, he simply laughs-off a threat to reveal his true identity. "Go ahead," he says in effect, 'the only thing your talk of time machines from the future will accomplish is for people to think you are crazy!'

What would Arthur C. Clarke have thought of all this skepticism being directed toward those who claim to have a time machine? His thoughts about the difficulty time travelers would have in maintaining low profiles were what started the previous section, after all. My guess is that he would have had little patience with extreme incredulity. The surprise of being confronted by a time traveler would soon have turned to awe and pleasure IF—and I emphasize the IF—Clarke had been taken for a spin around the centuries in the stranger's machine. He would surely have ended-up quoting his own famous 'third law' to explain the wonder of it all: "Any sufficiently advanced technology is indistinguishable from magic."

Near the end of his paper, Heath writes what I think is the perfect rebuttal to anyone who would refuse to admit to time travel, even after taking a quick trip backward a few tens of millions of years to the late-Mesozoic era to hunt *Tyrannosaurus rex*, and even after seeing instant photographs of the dead monster with the skeptic's *own foot* on the great creature's head, or of his *own boots* dripping a bloody puddle of unholy size on the floor of the time machine. Writing about the Humean-unconvinced, even when faced with a rearranged firmament, Heath observes "But this now seems a cavil, designed only to prove that even omnipotence is powerless against the extremer forms of skeptical intransigence." Where God would fail to convince, a simple time traveler could hardly hope to do better!

1.4 Troubles with (some) Time Machines

> "If you don't stop this senseless theorizing upon something that's an obvious impossibility, you'll find yourself working alone! Your ridiculous ideas sound like the ravings of a madman. Anyone with average intelligence realizes that the mere thought of traveling through time is absurd."[86]

If the previous section seemed just a bit gloomy concerning time travel, there is a very big reason for that. The sentiment expressed in the above opening quote to this section was a common one among philosophers long before physicists began to seriously think on the topic. While there *are* issues with time travel to the *future*, they are of an *engineering* nature, centered on how to build a big enough rocket ship with enough fuel to make the high speed, looping trip out into space and back again described in the opening section of this chapter. 'Mere' engineering problems are of no concern to physicists and philosophers. What *does* concern them are the far deeper puzzles of time travel to the *past*, the puzzles presented by what appear to be

[86] A science fiction physicist receives harsh criticism from a colleague in L. A. Eshbach's "Out of the Past," *Tales of Wonder*, Autumn 1938.

logical paradoxes. Before we get into the paradoxes, however, we need to first clear our minds of two common, popular notions of just what a time machine *is*. Both are false notions (one is due to H. G. Wells) which are, today, *rejected* by physicists (and most philosophers, too).[87]

As you'll see later in the book, all the theoretical time machines that have appeared in the modern physics literature involve spatial displacement. That is, they require *movement*. (On this point, the speedy DeLorean time car in the *Back to the Future* films has it right.) Wells' time machine, however, did not move; it always remained in the Time Traveller's laboratory (or at least on the spot where the laboratory would have been) unless he pushed it about after a trip in time. This, alas, results in a particularly troublesome problem: a Wellsian time machine heading into the past would run into itself!

Consider: There sits my time machine as I prepare for the first time journey ever, a trip back to the late-Mesozoic era to hunt dinosaur. I load my Continental. 600 super-high-power rifle with Nitro Express cartridges the size of bananas, kiss my wife good-bye, and climb in. I pull the lever. Now, Wellsian-type time machines don't *jump over* time but rather travel *through* time (see the Time Traveller's own description of how things looked to him, a description faithfully and spectacularly reproduced in the 1960 film). Therefore, the time machine will instantly collide with itself at the micro-moment *before* I pull the lever!

The resulting destruction obviously introduces a nice paradox: Given that this happens before I pull the lever, how did I manage to pull it? Many of the early science fiction writers were not totally oblivious to this collision problem and, in order to avoid materializing inside of an object in the future or the past, it was common to combine the time machine with an airplane.[88] Even that though might not be enough, as one writer thought a Wellsian time traveler would get "a severe case of the bends" if his body materialized in air![89] Of course, one might argue that Wells' machine does actually move because it is attached to the Earth, which is certainly moving, but it is not clear why this should result in the time machine arriving in the temporal past of the Earth, rather than in some past region of space (almost surely a vacuum).[90]

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[87]Both of these notions still routinely appears in science fiction, however, because they are 'just too neat' to let 'mere physics' get in the way of a good tale. I use one, without apology, in my own story "Newton's Gift" in Appendix B.

[88]Three such tales are M. J. Breur, "The Time Valve," *Wonder Stories*, July 1930; F. J. Bridge, "Via the Time Accelerator," *Amazing Stories*, January 1931; E. Binder, "The Time Cheaters," *Thrilling Wonder Stories*, March 1940.

[89]J. Lafleur, "Time as a Fourth Dimension," *Journal of Philosophy*, March 1940, pp. 169–178, and "Marvelous Voyages—H. G. Wells' *The Time Machine*," *Popular Astronomy*, October 1943.

[90]Philosophers seem to be becoming more aware of the collison problem (which they have dubbed "the double occupancy problem"), and at least three papers published since the second edition of *Time Machines* discuss it: W. Grey, "Troubles With Time Travel," *Philosophy*, January 1999, pp. 55–70; P. Dowe, "The Case for Time Travel," *Philosophy*, July 2000, pp. 441–451; R. Le Poidevin, "The Cheshire Cat Problem and Other Spatial Obstacles to Backward Time Travel," *The Monist*, July 2005, pp. 336–352. Physicists don't concern themselves with the collison problem simply because they *aren't interested* in *Wellsian* time machines; I'll explain why I say this by the end of this section.

The general problem of 'where the past is' was nicely illustrated by the physicist Gregory Benford in his 1980 novel *Timescape*. In that story the world of 1998 is on the verge of total ecological collapse, and an attempt is made to change the past by aiming a backward-in-time message via faster-than-light tachyons (these hypothetical particles are discussed in Chap. 5) at the pivotal year 1963. When the principal scientist involved in this effort is explaining the process to a potential financial backer, he is asked, "Hold on. Aim for *what*? Where *is* 1963?" The scientist replies, "Quite far away, as it works out. Since 1963, the Earth's been going around the Sun, while the Sun itself is revolving around the hub of the galaxy, and so on. Add that up, and you find 1963 is pretty distant." An understanding of the question 'Where is the past?' actually goes quite a bit further back in science fiction. For example, after looking through a TV-like gadget to view the past, one character in a 1940s story complains, "You said you'd find Captain Kidd's treasure, but all I can see is fog and static." He is told that's because "It's too far back—1698 or thereabouts. The Earth was billions of miles from here then, and there are too many cosmic rays between."[91]

But let's suppose we ignore this concern about where things are for a time traveler, as do most science fiction stories. Still another problem with a true Wellsian-type time machine is that because it travels *through* time, the machine must *always* appear to be located in the same place. For example, to travel from Ford's Theater today to Ford's Theater on the evening of Good Friday, April 14, 1865, in a misguided attempt to save Lincoln from Booth's bullet (*why* this would be misguided will be discussed at length later in the book), a Wellsian-type time machine would have to occupy every instant of the intervening century and more. For observers outside the machine, the machine would appear to have been sitting in the same place all those years. There is an amusing illustration of a failure to understand this point by the scriptwriters of the 1989 film *Time Trackers*, who have time travelers 'hide' their Wellsian machine from accidental discovery by 'parking' it 5 s in the future!

Wells was well-aware of the "does a time traveling object disappear or not?" issue, and tried to have it both ways in *The Time Machine* by invoking what he had the Time Traveller call "diluted presentation." As we are told in the novel, the reason why we cannot see the model time machine he sends on its way into the future as a demonstration is that "the spoke of a wheel spinning, or a bullet flying through the air" is invisible because if those objects are "traveling through time fifty times or a hundred times faster than we are . . . the impression [they create] will of course be only one-fiftieth or one-hundredth." Similarly for the model. This explanation breaks down when one remembers that, even if you cannot see the spoke or bullet, they are still there and you can get in their way—Wells, unfortunately, has one of his characters stick a hand into the space where the model time machine was last seen.

[91]M. Jameson, "Dead End," *Thrilling Wonder Stories*, March 1941. The "cosmic rays" are presumably the cause of the interference.

This objection to Wellsian time travel was raised soon after the 1895 publication of the novel, and then again in 1914 by Pitkin (note 62), who noted that violent disaster awaited once the time journey ended. Wells, it is only fair to note, seemingly anticipated Pitkin when he had the Time Traveller say "So long as I travelled at a high velocity *through time* [my emphasis] . . . I was, so to speak, attenuated—was slipping like a vapor through the interstices of intervening substances!" What this is getting at is that for the Time Traveller to stop 'inside' anything (Pitkin's example was the pile of bricks the Time Traveller's laboratory is certain one day to become) would, as Wells had his hero say, cause "a profound chemical[92] reaction—possibly a far-reaching explosion—[that would] blow myself and my apparatus out of all possible dimensions." Just why this spectacular event doesn't occur when the time machine simply stops *in air*, never mind inside Pitkin's pile of bricks, is never addressed.

In any case, it seems clear from all of this that Wells' machine travels *through time*, just as the Time Traveller claims. But Wells, himself, raises doubt when he describes the observed effects of a departing time machine. At the beginning of the novel, when the Time Traveller sends his model machine into the future, we read "There was a breath of wind, and the lamp flame jumped. One of the candles on the mantel was blown out . . . and it [the model time machine] was gone—vanished!" And, at the end, when the Time Traveller makes his final exit, the narrator of the tale just misses the departure but tells us "A gust of air whirled around me as I opened the door, and from within came the sound of broken glass falling on the floor. The Time Traveller was not there . . . Save for a subsiding stir of dust, the further end of the laboratory was empty. A pane of the skylight had, apparently, just been blown in." Both of these descriptions read as *implosions*, air rushing in to fill a spatial void, as though the time machines had *jumped* in time. Is there an inconsistency here? Well, perhaps not, if one accepts the curious idea of "slipping like a vapor" for an operational Wellsian-type time machine.

One famous science fiction story[93] nicely illustrates these points. The inventor of the first time machine demonstrates it to colleagues by sending a brass cube 5 min into the future. After being placed in the machine, the cube vanishes and then, 5 min later, reappears. Did the cube travel *through* time, or was its journey 'instantaneous,' so to speak? If *through* time, the cube was present at every instant after the start of its trip—so why did it vanish? The cube gets to each instant before the observers do, but why this should produce the visual effect of disappearing is unclear. The description in the story implies the cube traveled 5 min into the future without existing at any of the in-between instants, and so the story's time machine certainly was *not* Wellsian.

An immediate implication of the immobility of a Wellsian time machine is that if you are being chased by an angry mob somewhen in time (perhaps because you unwittingly violated a sensitive social taboo), then hopping into your Wellsian-type

[92]Actually *nuclear*, but don't forget when Wells wrote his novel.

[93]F. Brown, "Experiment," *Galaxy Science Fiction*, February 1954.

time machine isn't going to help because the machine just sits there. The mob could simply take its deliberate time in first building a roaring fire and then pushing the machine (and you) into it. As one author (with a wonderfully appropriate name!) expressed this, "You might as well try to escape by taking a nap."[94]

Pulp science fiction, always alert to a good story gimmick, used this characteristic of Wellsian time machines in one clever tale[95] in which a criminal attempts to hide his crimes by sending the bodies of his victims into the far future. His mistake is to use a Wellsian time machine in which he escapes into the future. The police, however, having learned of his foul deeds, simply build a cage around the machine and arrest him when he exits 23 years later!

If a Wellsian time machine that moves *through* time suffers from a fatal collision problem, then how about that other favorite of science fiction, a time machine that *jumps* in time? (Recall the final departure of Wells' Time Traveller.) That certainly would avoid the self-colliding problem. When you pull the lever inside the machine you simply disappear from 'now' and (from your point of view) then instantly pop into existence 'then.' The problem with this sort of time machine is that a Time Traveller who uses it will have a *discontinuous* world line, with the break occurring at the moment his time machine 'jumps.' In the modern physicist's view of time travel, however, based on general relativity, a Time Traveller's world line should always be continuous. That's because general relativity is a smooth, local field theory described by differential equations, resulting in *continuous* CTLs/CTCs.

Imagine, for example, that a 'jumping' time machine inventor starts building his gadget at time $t = A$ and expects to finish building it at time $t = B > A$. At time $t = C < B$, however, he runs into a problem. Fortunately, just at that moment a fully-functional time machine suddenly appears in the lab, and from it emerges a slightly older version of the inventor. The older version has the solution to the problem and, after telling the younger version the answer, gets back into the operational time machine and jumps off to . . . somewhen. The younger version then completes his machine at time $t = B$, gets into it, jumps back to time $t = C$, and . . ..[96]

In the past, philosophers have gotten themselves all tangled-up in debates over *personal identity*, that is, which version is *the* inventor, the younger or the older? Can they both be the same person, even though the older version has a world line (*starting* at $t = C$) that is separate and distinct from the world line of the younger (that *stops* at $t = B$)? One philosopher (note 74) left physics behind and pursued this question into the following *legal* question concerning our two (?) inventors: if the older version commits a crime and then vanishes in his time machine before the police can apprehend him, can the younger version be punished even though *he*

[94]M. Cook, "Tips for Time Travel," in *Philosophers Look at Science Fiction*, Nelson-Hall 1982. One modern story that gets Cook's point right is by I. Watson, "The Very Slow Time Machine," in *The Best Science Fiction of the Year* (T. Carr, editor), Ballantine 1979.

[95]M. Jameson, "Murder in the Time World," *Amazing Stories*, August 1940.

[96]This little story I've just told you involves what is called a *bootstrap paradox* (just where did that solution come from, that is, who thought it up?) and it is one of the real puzzles of time travel. I'll say *lots* more about such curious doings later in the book.

hasn't yet committed the crime? While certainly 'interesting,' this really is a non-issue for the modern physicist who is concerned only with the physical possibility (or not) of time travel to the past.

Well, okay, you might now say, if neither a Wellsian time machine or a 'jumping' time machine will do, then just what *are* physicists studying in their papers on time travel? The short answer here (in Chap. 3 I'll say more) is that physicists don't view time machines as super-tech gadgets covered with wires, meters, dials, and levers, humming away beneath a seated Time Traveller as gigawatts of power throb through massive copper/crystal rods, with the whole business surrounded by a pulsating red-blue glow. Hollywood absolutely loves that sort of thing, but it's simply all wrong. For modern physicists, a time machine is *a region of spacetime with special topological structure*. Then, to time travel, a Time Traveller moves through that region of spacetime (in a rocket, perhaps) along an appropriate path. To 'make a time machine' therefore, in modern terms, means to (somehow) manipulate finite amounts of matter/energy in such a way as to alter the topology of a finite region of spacetime from one that has no CTLs/CTCs to one that does.[97] The most famous example of such a spacetime topology alteration (or *warp*) is the creation of a *wormhole*. A wormhole is a *topological* artifact of a spacetime; wormholes were popularized in Carl Sagan's 1985 novel *Contact* (under the guidance of physicist Kip Thorne) and are now common in science fiction.[98] As mentioned at the start of this chapter, for example, even Stephen King uses one in his 2011 *mainstream* novel *11/22/63*.

I'll return to the 'topology of spacetime' in Chap. 3 but, just so we don't leave it here as a mysterious phrase, here's a simple illustration of a topology change. Imagine a long, flat, narrow, two-dimensional strip of paper. The strip has the following topology features of interest to us here: (1) it has a beginning (its left end) and an ending (its right end), and (2) it has two sides (the top surface) and the flip-side surface. Now, imagine that we take the right end of the strip, give it a half-twist of 180^0 through our three-dimensional space, and then finally we glue that twisted end to the left end of the strip. The half-twist and gluing (our *warp*) has changed both of the topological properties of the strip. That's because the strip now has *no end* (you can travel forever along the strip, always going 'forward' and never reaching a point where can't go forward some more), and the strip now has just *one* side. You can convince yourself that it is one-sided by coloring the strip with a

[97]There is a hint of this in one prescient science fiction story, in which the inventor of a time machine, when asked about how it works, replies "An electromagnetic *warping* [my emphasis] of the spacetime continuum." See N. Schachner, "When the Future Dies," *Astounding Science Fiction*, June 1939.

[98]A wormhole is featured in the 2014 film *Interstellar*, whose Executive Producer and technical advisor was Thorne. The film's special effects are relativistically correct (not the typical Hollywood 'fantasy physics'), and you can read how that was achieved in Oliver James, Eugénie von Tunzelmann, Paul Franklin and Kip S. Thorne, "Gravitational lensing by spinning black holes in astrophysics, and in the movie *Interstellar*," *Classical and Quantum Gravity*, February 2015. See also (same authors) "Visualizing *Interstellar*'s Wormhole," *American Journal of Physics*, June 2015, pp. 486–499.

crayon. During the coloring, *do not lift the crayon from the strip*. When you can color no more, you'll find that every last bit of the strip has been colored. You can't do that with the original strip without lifting the crayon and turning the strip over because the original strip was two-sided. Many readers will recognize that what we've done is make a *Möbius strip*, named after the German astronomer and mathematician August Möbius (1790–1868) who described it in 1858.

Here's another astonishing property our half-twist warp has introduced. Cut the Möbius strip lengthwise with a scissors; most people believe you will then get two strips, each the length of the original strip but each only half as wide. Actually, you get one strip with a *full* 360° twist, which means the result is back to having two sides. (To see this, make a Möbius strip, cut it, and *then* apply the crayon.) And if you cut this new strip lengthwise once more, you get two separate loops, linked together. Try it and see, but be very careful. As the late science fiction writer Cyril Kornbluth (1923–1958) warned, there may be horrific potential dangers in unschooled experimentation with topology warps:

A burleycue dancer, a pip
Named Virginia, could peel in a zip;
But she read science fiction
And died of constriction
Attempting a Möbius strip.[99]

To end this section, I should point out that a change in the topology of a spacetime is *not* a necessary requirement for that spacetime to support time travel to the past. Gödel's rotating spacetime, for example, has a remarkably simple topology and, as you'll recall, it's literally *stuffed* with CTLs/CTCs, to the point that time travel to the past in Gödelian spacetime would be an everyday occurrence. You might think a world that presents time travel as a *fundamentally allowed* physical phenomenon, as does Gödel's spacetime, would be irresistible to science fiction writers. (So far as I know, however, no one has written a time travel story using the rotating universe idea.[100]) In Chap. 6, in fact, I'll show you just how easy it would be to time travel in Gödel's spacetime, using a rocketship as the means to move through that spacetime. Of course, *our* universe is not Gödelian, so the 'time travel to the past' question is not so easily answered for the spacetime we appear to actually inhabit.

[99]As you can see from this, science fiction writers have had fun with the Möbius strip. Two early examples *not* involving time travel are N. Bond, "The Geometrics of Johnny Day," *Astounding Science Fiction*, July 1941, and W. H. Upson, "A. Botts and the Möbius Strip," *The Saturday Evening Post*, December 1945. The use of the Möbius strip for time travel occurs, for example, in M. Clifton's "Star, Bright," *Galaxy Science Fiction*, July 1952.

[100]If he had lived, perhaps the well-known science fiction writer James Blish (1921–1975) would have written such a tale. In David Ketterer's biography of Blish (*Imprisoned in a Tesseract*, Kent State University Press 1987), there is this comment from a 1970 letter written by Blish: "I am especially intrigued by the spinning-universe form of time travel, especially since . . . nobody has touched it . . . But I should really stop mentioning the spinning-universe in public, or somebody will nobble onto it before I can get into it!"

1.5 Quantum Gravity, Singularities, Black Holes, and Time Travel

"A [spacetime] singularity is where God is dividing by zero."

—Anonymous

"A theory that involves singularities and involves them unavoidably, moreover, carries within itself the seeds of its own destruction."

—Peter Bergmann (1915–2002), Einstein's research assistant at the Institute for Advanced Study, Princeton

A fundamental objection to general relativity's suggestion of the possibility of time travel to the past is that, in a very deep sense, general relativity is known to be incomplete. That is, it is incompatible with quantum mechanics, which is the physics of the very, *very* small—the physics of atomic-size objects and *smaller*. We touched on this at the end of Sect. 1.2, and here we'll take a longer look at the issue of merging quantum mechanics with general relativity.

In quantum mechanics, the discrete nature of the atomic world appears in such phenomena as the photoelectric effect, in which light acts like individual particles (photons) rather than as continuous waves. Einstein's general relativity works beautifully on a cosmological scale but, like Maxwell's theory of electromagnetism, and unlike quantum mechanics, it fails when applied deep in the interior of the atom. Quantum theory, however, seems to work *everywhere*. As one physicist put it, "As far as we can tell, there is no experiment that quantum theory does not explain, at least in principle . . . Though physicists have steered quantum theory into regions far distant from the atomic realm where it was born, there is no sign that it is ever going to break down."[101]

One of the central concepts in relativity is the *world line*, which is the complete story of a particle in spacetime. A world line assigns a definite location to the particle at each instant of time. This is a classical, pre-quantum concept, however, and today physicists use the probabilistic ideas of quantum mechanics to describe the location and momentum of a particle once they get down to the atomic scale of matter. Quantum theory is a discrete theory in which the values of physical entities vary discontinuously (in 'quantum jumps'), whereas in classical theories the values of physical entities are continuous. The difference between the two types of theories is something like the difference between sand and water. Mixing the two theories—the classically smooth, continuous general relativity and the discrete quantum mechanics—to get something called *quantum gravity*, is the Holy Grail of physicists today, and nobody has more than an obscure idea of how to do it.

[101] N. Hebert, *Faster Than Light: Superluminal Loopholes in Physics*, New American Library 1988.

Just one of the more curious results of the fusing of quantum mechanics with general relativity may be *quantum time*.[102] That is, in quantum gravity the smallest increment of time that has physical meaning—sometimes called the *chronon*, a term first used in a non-time travel science fiction story[103]—may have a non-zero value. As we'll see later in the book, much of the controversy over the possibility of time machines hinges on what is called the *quantum gravity cut-off*. This is the end-result of destructive spacetime stresses that tend to grow toward infinity whenever a time machine spacetime topology attempts to form. This process goes under the general name of the *back reaction*, and is conceptually similar to a rubber band growing ever more taut as it is stretched, an effect that resists more stretching (and, of course, if stretched too far the rubber band breaks).

The cut-off of those stresses, at some *finite* value, is imagined to occur when the terminal phase of the growth would take place in less than the minimum possible time interval. The cut-off happens because, it is thought, nothing can actually occur in less than the minimum time. The debate is over just what that minimum duration is, and over whether the cut-off would occur before the stresses could reach *finite* values large enough to destroy the putative time machine topology. If the cut-off occurs before the back reaction stresses climb to the critical value, then the time machine survives. Otherwise, not.

To see how this 'works,' consider the two fundamental physical constants associated with classical gravity, the *gravitational constant*[104] G and the speed of light c, and the fundamental physical constant associated with quantum mechanics (*Planck's constant*) ħ. Now, if you play around with combinations of these constants it is easy to show that the following expressions have the units of length, time, and mass, called the *Planck length* (l_P), the *Planck time* (t_P), and the *Planck mass* (m_P), respectively:

$$l_P = \sqrt{\frac{\hbar G}{c^3}} \approx 1.6 \times 10^{-33} \text{ cm},$$

$$t_P = \sqrt{\frac{\hbar G}{c^5}} \approx 5.3 \times 10^{-44} \text{ s},$$

$$m_P = \sqrt{\frac{\hbar c}{G}} \approx 22 \times 10^{-6} \text{ g}.$$

The extremely tiny values of l_P and t_P (the chronon), in particular, indicate (*roughly*) where it is expected that the smooth, continuous spacetime of general

[102] H. Kragh and B. Carazza, "From Time Atoms to Space-Time Quantization: the idea of discrete time, ca 1925–1936," *Studies in History and Philosophy of Science*, June 1994, pp. 437–462.

[103] S. Weinbaum, "The Ideal," *Wonder Stories*, September 1935.

[104] This is the constant in Newton's famous inverse-square law for gravity; the attractive force F between two point masses m_1 and m_2, distance r apart, is $F = G\frac{m_1 m_2}{r^2}$.

relativity will itself become quantized, and so will have to give way to a quantum theory of gravity.

The associated value of the mass-energy density when this transition is imagined to occur is enormous; the so-called *Planck density* is the Planck mass divided by the cube of the Planck length and has the value of about 10^{94} grams/cm^3. This is where physicists expect classical and quantum gravity to part company. Can such an enormous mass-energy density actually occur?[105]

Yes, and more, in what physicists call *singularities*.

This was all still very speculative until about 50 years ago, but today the search for how to connect general relativity and quantum mechanics is serious business. That search is related to time travel studies via a fantastic sequence of discoveries in relativistic physics, made during the last 80 years, beginning in 1931 with the work of the young Indian astrophysicist Subrahmanyan Chandrasekhar (1910–1995). He combined quantum mechanics and *special* relativity to show that a non-rotating star above a certain mass (about 1.4 times the mass of the Sun) cannot evolve into a white dwarf, which had until then been thought the eventual fate of all stars. Stars more massive than 1.4 Solar masses (but not *too* massive) would, instead, become *neutron* stars. But what then happens to stars that are too massive for even *that* bizarre eventuality?

General relativity predicts that a sufficiently massive star—greater than about four times the mass of the Sun—will, when its fuel is nearly exhausted and its nuclear fires are beginning to fade, experience a truly spectacular event called *total gravitational collapse*. When its fuel-starved, weakened radiation pressure is no longer able to keep a massive, aged star inflated against the collapsing force of its own gravity, the star will suddenly implode and crush itself into what is called a *black hole*, a dramatic term coined in 1967 by the Princeton physicist John Wheeler (1911–2008) in an address before the American Association for the Advancement of Science. A black hole is an object with a gravitational field so strong that even light cannot escape—that's why it's black!—at whose center is something called a *singularity*. This is all well-known lore in the physics world.[106]

Indeed, cataclysmic views of the collapse of matter are actually quite old. In Lucretius' first-century B.C. *The Nature of the Universe*, for example, we find the following imagery on what it would be like if matter itself collapsed: "The ground will fall away from our feet, its particles dissolved amid the mingled wreckage of

[105]By comparison, the density of a neutron star is on the order of a 'mere' 10^{16} grams/cm^3.

[106]Perhaps not so well-known, however, is that science fiction was there long before Wheeler. In one classic tale (M. Leinster, "Sidewise in Time," *Astounding Stories*, June 1934) a scientist explains at the end, "We know that gravity warps space . . . We can calculate the mass necessary to warp space so that it will completely close in completely . . . We know, for example, that if two gigantic star masses of certain mass were to combine . . . they would simply vanish. But they would not cease to exist. They would merely cease to exist in our space and time." And then, as another character sums it up, "Like crawling into a hole and pulling the hole in after you." The explicit use of the complete term *black hole* for a region of weird spacetime also appeared in science fiction before Wheeler (P. Worth, "Typewriter from the Future," *Amazing Stories*, February 1950).

heaven and earth. The whole world will vanish into the abyss, and in the twinkling of an eye no remnant will be left but empty space and invisible atoms. At whatever point you allow matter to fall short, this will be the gateway to perdition." These words were actually inspired by earthquakes, not black holes and their singularities, but could a modern expert in general relativity and singularities have said it any better? But, what *is* a singularity?

As one theoretical physicist has dramatically written, "once gravity runs out of control, spacetime smashes itself out of existence at a singularity."[107] Or to quote Hawking, "A singularity is a place where the classical concepts of space and time break down as do all the known laws of physics."[108] One particular view of a singularity is that it is a place in spacetime that has infinite density and a gravitational field that is infinitely strong. The curvature of spacetime (more on curvature in Chap. 3) at this sort of singularity, sometimes called a *crushing* singularity, is also infinite. This is the sort of singularity believed to be at the center of non-rotating black holes. Historically, however, the occurrence of infinities in physical theories has been thought the red flag signaling that the theories have simply been extended too far, and their calculated results are nonsense.

Perhaps, then, singularities occur only in unrealistic physical applications of general relativity, and so it is only *perfectly* spherical collapsing stars that can end-up (on paper) as a black hole singularity. For a while physicists tried to establish that, but they were forced to abandon the attempt when it was shown that singularities are *unavoidable* and not just the result of idealistic assumptions.[109] This result worried many, and so the concern that general relativity was failing with its prediction of black holes and their singularities continued. In the case of a crushing singularity, perhaps all that meant is that once the collapsing star had fallen into a region even smaller than an electron, general relativity is no longer valid and the singularity is simply the 'math gone wild.' Einstein, himself, held that view. In his book *The Meaning of Relativity* (based on lectures he gave at Princeton in 1921), he wrote (concerning the use of the general theory to study the origin of the universe as a "big bang," which was a crushing singularity), "For large densities of field and matter, the field equations [of general relativity] and even the field variables which enter into them will have no real significance. One may not therefore assume the validity of the equations for very high density of field and matter, and one may not conclude that the 'beginning of the expansion' must mean a singularity in the mathematical sense."

Well, what does general relativity say about the singularity at the center of a black hole? To start, the theory says that, at a distance directly proportional to the

[107] P. C. W. Davies, *The Edge of Infinity*, Simon & Schuster 1981.

[108] S. Hawking, "Breakdown of Predictability in Gravitational Collapse," *Physical Review D*, November 15, 1976, pp. 2460–2473.

[109] S. W. Hawking and R. Penrose, "The Singularities of Gravitational Collapse and Cosmology," *Proceedings of the Royal Society A*, January 27, 1970, pp. 529–548. Ironically, one of the 'realistic' assumptions made in this paper, which appears to *force* singularities to exist, is that time travel is *impossible*!

mass of the collapsed object, a so-called *event horizon* will form. The event horizon is a surface in spacetime through which anything can fall into the hole, but through which nothing, not even a photon of light, can escape outward. The singularity at the black hole's center is therefore not visible to a remote observer (the singularity is said to be "clothed," and so not "naked"[110]). For all observers beyond the event horizon, the only visible properties of the hole are its mass (via its gravitational effects), its angular momentum (its spin rate), and its electric charge, and these properties are independent of the details of the pre-collapsed object (other than the requirement that electric charge and angular momentum are conserved).

There are actually several fundamentally different types of black holes. If the collapsed star forms a non-rotating, spherically symmetric, uncharged[111] object, then the result is called a *Schwarzchild* black hole, after the German astronomer Karl Schwarzchild (1873–1916) who found the first exact solutions to Einstein's general relativity field equations just months after Einstein published them.[112] Soon after that the Finn Gunnar Nordström and the German Heinrich Reissner independently found the solution to the field equations for the slightly more realistic non-rotating, *charged* black hole.[113] This is only slightly more realistic since it is highly unlikely a black hole wouldn't be spinning, as all observed stars are spinning and angular momentum is conserved during gravitational collapse. Another slightly more realistic solution, that of a *rotating*, uncharged black hole, was found by the New Zealand mathematician Roy Kerr in 1963, and this solution had a twist to it that at last explains why I am telling you all this—the singularity at the center of a Kerr black hole is not the *point* singularity of a non-rotating black hole but rather is a *ring* singularity. That is, there is a hole in the Kerr singularity through which matter can travel, without being destroyed, a hole that seems to act as a portal into

[110]A naked singularity, with no event horizon behind which to hide, would be particularly bothersome to physicists who don't like the idea of the breakdown of physics being on full display. What they think they'd then see would be completely unpredictable. Whether such a situation can actually exist is still open to debate, but there *are* both analytical solutions and computer simulations (incorporating realistic equations of state on the pressure response of matter as it is compressed) that seem to allow it (as in the gravitational collapse of an *infinitely* long, non-rotating cylinder that appears to result in an axial, thread-like, naked singularity).

[111]The word *charge* means either electrical *or* magnetic charge, although from a practical point *charge* probably does mean just electrical, as the theoretically possible magnetic monopole has yet to be observed and, in any case, it is thought that black holes will not have a significant electrical charge.

[112]Even *Einstein* hadn't yet solved them, and he apparently thought they were too complicated to be solved; when he saw Schwarzchild's result, he was so impressed that Einstein wrote to say "I had not expected that the exact solution to the problem could be formulated. Your analytical treatment of the problem appears to me splendid."

[113]Two years later, the University of Pittsburgh physicist Ezra Newman finally solved the field equations for the realistic, general case of a rotating *and* charged black hole.

other spacetime regions that may include past or *future* regions of spacetime. In other words, the ring singularity seems to be the entrance to a time machine.[114]

A discussion of singularities in general relativity is especially complicated for at least two reasons. First, there is more than one type, with *crushing* being just the (perhaps) most 'obvious.' Another type has no infinite curvature associated with it, but rather is a point in spacetime beyond which the worldline of a freely falling mass cannot be extended. Such a point is called a *geodesically incomplete* singularity, and it represents either an end to space or to time (in either case, that point is on the boundary or edge of spacetime). There are other types, as well—I've mentioned the naked singularity already—and the appearance of *any* of them is distinctly unsettling (recall Bergman's opening quote) to physicists. One that may be the most unsettling of all, however, is the *thunderbolt* singularity. This singularity propagates to infinity at the speed of light! As its discoverers dramatically put it, "It is not a naked singularity because you do not see it coming until it hits you and wipes you out."[115]

The other reason for a discussion of general relativity singularities being complicated is that they simply are not like the singularities of earlier theories. For example, in electromagnetic field theory spacetime is the *given background reference*; that is, a singularity in that theory is a point in spacetime where the *electromagnetic field* is undefined. In gravitational field theory, however, it is

[114]You can find discussions on how this is imagined to work in two papers by R. Weingard: "General Relativity and the Conceivability of Time Travel," *Philosophy of Science*, June 1979, pp. 328–332, and "Some Philosophical Aspects of Black Holes," *Synthese*, September 1979, pp. 191–219. See also M. Calvani et al., "Time Machine and Geodesic Motion in Kerr Metric," *General Relativity and Gravitation*, February 1978, pp. 155–163. I won't pursue black hole time machines in this book, as it is not what modern physicists consider a plausible means of time travel (*How are you going to gain access to a black hole?!!!*) For how one science fiction writer *did* use the idea, however, see L. Niven, "Singularities Make Me Nervous," in *Stellar* 1 (J.-L. del Rey, editor), Ballantine 1974. Black holes *are* bizarre objects—nearly as bizarre as time travel—and it seems risky to try to understand one in terms of the other (recall Professor Challenger's observation!).

[115]S. W. Hawking and J. M. Stewart, "Naked and Thunderbolt Singularities in Black Hole Evaporation," *Nuclear Physics B*, July 1993, pp. 393–415. As bizarre as is the thunderbolt, it was anticipated in science fiction by more than half a century. In the story "The Tides of Time" by R. M. Williams (*Thrilling Wonder Stories*, April 1940), the universe is collapsing at faster than the speed of light. Human scientists learn this when fleeing aliens stop their faster-than-light space ships to warn them. One of the human characters then looks out into the night sky and, in words that sound like those of Hawking and Stewart, "There would be no warning, for the rolling tide was traveling faster than light . . . It would come faster than the flicker of an eye. No one would see it come. One instant the world you knew would be around you. The next instant, there would be nothing. You would not even have time to know what had happened. Death, faster than the lightning flash!" This story may have been inspired by a tale published decades earlier, by the Canadian writer Frank Lillie Pollock (1876–1957). In his "Finis" (*The Argosy*, June 1906), written long before the concept of a super-nova, the light of a huge, distant star finally arrives to cook Earth into oblivion.

spacetime itself that is undefined, and there is no background 'something' in which spacetime is embedded to serve as a reference.[116]

One early suggestion on how to avoid the problem of the crushing singularity of the non-rotating black hole (which is, as mentioned earlier, not a realistic model for the gravitational collapse of a rotating star) is that the collapse may stop short of the singularity. That is, the collapsing body might instead rebound. This 'bounce' would occur after the star was inside its event horizon, so an external observer would not see the later expansion, an expansion imagined to be through the event horizon *but into a different region of spacetime*.[117] When Novikov's work was generalized the following year, the authors clearly had a hard time believing this dramatic imagery, despite their own mathematics, concluding with "It then appears necessary to believe in the existence of other [regions of the universe, including the past and the future] which will accommodate the re-expansion. This seems at least as fantastic as the alternative of [a point singularity].".[118]

In 1974 Hawking announced an astonishing partial connection of quantum mechanics with general relativity's black holes. He showed that, contrary to the usual image of black holes as being one-way trap doors to . . .?, black holes actually *must* radiate energy.[119] His analysis, which stunned physicists by its beautifully simple arguments, invokes the famous *uncertainty principle*, one of the corner stones of quantum mechanics. Hawking himself found the result "greatly surprising." He also cautioned (in his 1975 paper) that the following picturesque imagery is "heuristic only and should not be taken too literally," but it has now been in physics for over 40 years and appears to be here to stay.

The uncertainty principle states that there are certain pairs of variables associated with particles, variables that cannot be precisely measured at the same time. Time and energy form such a pair because a non-zero time interval is required to measure a particle's energy, and the product of the uncertainty in both the time interval (Δt) and the energy (ΔE) must be at least as large as a certain non-zero constant. That is, if $\hbar$ is Planck's constant, then $\Delta E \Delta t \sim \hbar$. This allows the process of virtual particle creation, the appearance of particle/anti-particle pairs just outside the event horizon of a black hole. The uncertainty in the energy is what gives the combined mass of the particles in a pair; this uncertainty in the energy is the quantum fluctuation energy of the intense gravity field of the hole. The only

[116]See, for example, R. Geroch, "What Is a Singularity in General Relativity?" *Annals of Physics*, July 1968, pp. 526–540.

[117]See, for example, I. Novikov, "Change of Relativistic Collapse Into Anticollapse and Kinematics of a Charged Sphere," *JETP Letters*, March 1, 1966, pp. 142–144, and V. P. Frolov, *et al.*, "Through a Black Hole Into a New Universe?" *Physics Letters*, January 12, 1989, pp. 272–276. Igor Novikov is a Russian physicist at the University of Copenhagen, and he will appear later in the book when we get to the paradoxes of time travel to the past.

[118]V. De La Cruze and W. Israel, "Gravitational Bounce," *Nuovo Cimento A*, October 1, 1967, pp. 744–760.

[119]S. Hawking, "Black Hole Explosions?" *Nature*, March 1, 1974, pp. 30–31, and "Particle Creation by Black Holes," *Communications in Mathematical Physics*, 1975, pp. 199–220.

constraint is that the energy be returned to the field, via mutual annihilation of the matter/anti-matter pair within the time uncertainty dictated by the uncertainty principle.[120]

As Hawking showed, this time interval, although incredibly short, is still long enough for the two virtual particles to separate before annihilation, one falling into the hole and the other escaping. This would happen, for example, if the particle/anti-particle pair is an electron/positron pair, and so a negatively/positively charged black hole would tend to attract the positron/electron and repel the other particle (either way, driving the charge of the hole towards zero). (Hawking then later suggested[121] that the particle *entering* the hole could be thought of as an *emitted* particle traveling backward in time, an idea that can be traced back decades, to John Wheeler—I'll return to this idea in just a moment.) By this incredible quantum process, then, the black holes of general relativity slowly *evaporate* (!) as they glow with what is now called *Hawking radiation*. That is, black holes appear to be hot bodies. But *hot* is relative, as a black hole with the mass of the Sun would have a temperature of just sixty *nano*-degrees Kelvin above absolute zero, and it would take 10^{66} years (a stupendously enormous time compared to the age of the universe) to completely evaporate.

Indeed, one physicist had already mused that the *entire universe* might have been created by a similar quantum process, *out of nothing*, a so-called *vacuum fluctuation*.[122] The explanation for why the universe doesn't then disappear—and very quickly, too, because the energy for all the mass in the newly created universe is quite large (that is, ΔE is *really big* and so Δt must be *really small*)—is that the *negative* gravitational potential energy of all that newly created matter would cancel the positive mass-energy, and so ΔE is actually *quite small* and so Δt is then *quite large*. To perhaps show he wasn't quite convinced by all that, himself, Tryon whimsically wrote "I offer the modest proposal that our Universe is simply one of those things which happen from time to time."

As a final comment on the suggestion by Hawking of a connection between virtual particles at a black hole event horizon and backwards time travel, the idea

[120]The uncertainty principle has long been used in time travel science fiction. In one story, for example, a character is transported from 1950 to 2634 by a scientist of the future. Once there, this character decides he'd like to remain permanently in the 27th century. He is told that he can't because he is like an atom excited into an elevated energy state and, just as quantum mechanics says that eventually an electron in such a state will drop back down into a lower energy state, so do the "laws of time travel" require that he drop back to his normal time. How long can he remain in future, he is told, "depends on the mass [energy] of his body and the number of years the mass [energy] is displaced." That is simply the uncertainty principle. See W. Bade, "Ambition," *Galaxy Science Fiction*, October 1951.

[121]S. Hawking, "The Quantum Mechanics of Black Holes," *Scientific American*, January 1977.

[122]E. P. Tryon, "Is the Universe a Vacuum Fluctuation?" *Nature*, December 14, 1973, pp. 396–397.

originated (as I said before) with Wheeler, in 1941.[123] In an astonishing coincidence, even as Wheeler was telling his student Richard Feynman about this, a science fiction writer was also identifying anti-matter with backward time traveling 'normal' matter.[124] Later, the Polish science fiction writer Stanislaw Lem (1921–2006) took this idea, combined it with the quantum concept of energy fluctuation, and came up with one of his typically outrageous (and typically hilarious) ideas: shooting a single positron out of an accelerator back to the very beginning of time. His story character called this fantastic machine the "Chronocannon" and claimed that's what started the universe.[125]

Soon after Lem, a philosopher used a variant of this idea, in which the Big Bang creation of the universe was caused by a time traveler from the future who saw a need—his own existence—to generate the Big Bang. This leads to philosophical speculations on the cosmological implications of God as a time traveler.[126] Two recent physicists have taken this one step further by suggesting that the universe, via time travel, may have caused itself! As they put it, "the laws of physics may allow the Universe to be its own mother."[127]

The modern hope is that quantum mechanics (as in quantum gravity) will save physics from the horror of general relativity's singularities. This was the view of John Wheeler and, as the man who named black holes, his view is important to consider. General relativity is a classical, *smooth* theory that is fundamentally continuous, while 'our' universe appears to be a quantum one. So, perhaps, general relativity's prediction of singularities may be just an artifact without physical reality in the 'real world.' Wheeler's position was based on the quantum fluctuations of gravity fields, which are related to the uncertainties inherent in our knowledge of the values of physical entities. Such fluctuations are vanishingly small in systems of everyday size, but they increase dramatically at very tiny distances that are twenty orders of magnitude smaller than the nucleus of an atom. In the microscopic region of spacetime that the matter forming a black hole is falling into, these fluctuations might conceivably result in effects that preclude the formation of a singularity. Agreeing were two physicists who asserted that, even without a detailed knowledge of quantum gravity, quantum effects "would smash the idealized interior geometry"

[123]See Richard Feynman's Nobel lecture, reproduced in *Science*, August 12, 1966, pp. 699–708, where he recounts Wheeler's 'proof' for why every electron in the universe has *exactly* the same charge ('there is only *one* electron, weaving its way back-and-forth in time, with positrons being the electron when traveling backward-in-time').

[124]Will Stewart, "Minus Sign," *Astounding Science Fiction*, November 1942. 'Will Stewart' was a pen-name for John Stewart Williamson (1908–2006).

[125]S. Lem, "The Eighteenth Voyage," in *The Star Diaries*, Seabury Press 1976.

[126]G. Fulmer, "Cosmological Implications of Time Travel," in *The Intersection of Science Fiction and Philosophy* (R. E. Meyers, editor), Greenwood Press 1983. Isaac Asimov used a similar idea in his story "The Instability," *The London Observer*, January 1, 1989.

[127]J. R. Gott and L.-X. Li, "Can the Universe Create Itself?" *Physical Review D*, 1998, 023,501.

[that is, the ring singularity] of a rotating, charged black hole, thereby eliminating any possibility of using such a hole for time travel.[128]

And finally, to generalize beyond black holes to the hoped-for pay-off of the coming of quantum gravity in banishing singularities altogether, one recent study has examined how non-crushing singularities (that is, ones of the geodesically incomplete type) *are* apparently "healed" (the authors' term) by quantum effects.[129] With the eventual development of quantum gravity, perhaps all the singularities of general relativity will vanish while leaving the CTCs/CTLs intact, thereby removing a form of doubt in the theory's apparent support for time travel to the past. It may be a long time coming, however: as the University of Sydney philosopher of science Dean Rickles recently (2014) wrote in his book *A Brief History of String Theory*, "quantum gravity is in many ways . . . a revolution still waiting to happen."

1.6 Tipler's Time Machine

> "In short, general relativity suggests that if we construct a sufficiently large rotating cylinder, we create a time machine."[130]

The time traveling property of the ring singularity in a rotating black hole once made it a favorite of science fiction writers, as in Joe Haldeman's classic 1974 novel *The Forever War* (in which the term used is not *black hole*, but *collapsar*, which is a nicely descriptive word in its own right). A major difficulty with this approach, however, as I mentioned in the previous section (note 114), is that of 'getting one's hands on' (so to speak) a black hole! So, is there any other 'time machine' that is consistent with general relativity? Yes, there is.

In 1974 a young physics graduate student at the University of Maryland, Frank Tipler, caused a bit of a stir when he published what seemed to be quite specific construction details for a time machine. Indeed, the final sentence (the above quotation) of his paper couldn't be clearer. Nobody had ever before made such a statement in a respectable physics journal and, best of all, there were no apparent spacetime singularities involved. However, a close look at Tipler's analysis does turn up some difficulties.

What Tipler had actually done was to show that if one had an *infinitely long*, *very dense* cylinder rotating with a surface speed of at least half the speed of light (the rotation speed is such that the outward centrifugal forces are balanced by the inward gravitational attraction of the cylinder), then this allowed the formation of closed

[128]N. D. Birrell and P. C. W. Davies, "On Falling Through a Black Hole Into Another Universe," *Nature*, March 2, 1978, pp. 35–37.

[129]T. M. Helliwell and D. A. Konkowski, "Quantum Singularities in Spherically Symmetric, Conformally Static Spacetimes," *Physical Review D*, May 13, 2013, 10404.

[130]F. J. Tipler, "Rotating Cylinders and the Possibility of Global Causality Violation,' *Physical Review D*, April 15, 1974, pp. 2203–2206.

timelike curves around the cylinder. This means that by orbiting the surface of such a fantastic cylinder, one could travel through time into the past—but not to earlier than the moment of the creation of the cylinder.

This last point is a very important one, as it does avoid one particularly odd paradox (called a *bootstrap*): a traveler going backwards in time to tell the inventor of a time machine (perhaps an earlier version of the time traveler himself) how to build the time machine. You can find this idea in early science fiction,[131] and a minor variant of it was amusingly illustrated in the 1985 film *Star Trek IV: The Voyage Home* (when you next watch the movie, ask yourself who actually invented "transparent aluminum"?) Bootstrap paradoxes are quite mysterious and still befuddle physicists and philosophers. Science fiction writers, on the other hand, love bootstraps as great story gimmicks.

Tipler's cylinder would also enable a time traveler to return to her original time, to go "back to the future," by orbiting the cylinder in the reverse direction (but no further into the future than when the cylinder ceases to exist). Later in the book I'll show you a simple illustration—based on a similar one in Tipler's PhD dissertation, published in 1976—of how the cylinder works as a time machine. No one, in fact, disputes any of this. It *is* true. On paper.

But Tipler did *not* prove that a time traveling property holds for cylinders of even very long but *finite* length, which are the only kind we could actually build from a finite amount of matter; he merely suggested that such might be the case. This suggestion does seem reasonable, because if the time traveler orbits at the midpoint of the cylinder, near the surface, then the gravitational end-effects of sufficiently remote ends of the cylinder would, you'd think, become negligible. Similar mathematical approximations are routinely made, for example, when calculating the electrical effects of charged cylinders of finite length. But as one physicist has warned, "Extrapolation from cylindrical symmetry to reality is very dangerous, since spacetime is not even asymptotically flat around an infinite cylinder."[132] The issue of whether a spinning, finite-length cylinder can create closed, timelike curves is still open: to quote another physicist, "[In] some respects an infinite cylinder may be a model for a long finite one, and the possibility cannot be dismissed that a time machine might be associated with a long, but finite rotating system."[133]

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[131] See, for example, C. Cloukey, "Paradox," *Amazing Stories Quarterly*, Summer 1929. Later in the book I'll discuss even earlier literary occurrences of bootstraps (that is, of *information* on closed loops in time).

[132] K. S. Thorne, "Nonspherical Gravitational Collapse: Does It Produce Black Holes?" *Comments on Astrophysics and Space Physics*, September–October 1970, pp. 191–196. What "asymptotically flat" means will be discussed in Chap. 3.

[133] W. B. Bonner, "The Rigidly Rotating Relativistic Dust Cylinder," *Journal of Physics A*, June 1980, pp. 2121–2132. Tipler was not the first to study rotating cylinders in the context of general relativity. Such cylinders had been around for decades, going back to 1932. A good reference is M. A. Mashkour, "An Exterior Solution of the Einstein Field Equations for a Rotating Infinite Cylinder," *International Journal of Theoretical Physics*, October 1976, pp. 717–721. The first-analyzed configuration of matter that generates closed timelike lines, solved in all its general relativistic detail, was the infinite rotating cylinder studied by W. J. van Stockum,

There is, however, another potential problem besides the length of the cylinder. There is a strong likelihood that a Tipler cylinder under construction would collapse under its own internal gravitational pressure before it could be made nearly long enough to be even 'approximately infinite.' That is, such a finite-length cylinder might crush itself along its long axis into a pancake-shaped blob, something like what happens to a long cylinder of jello stood on-end. An ordinary can of jellied cranberry sauce will also sometimes display this curious behavior.

The required rotational speed raises yet another concern, as well. We are not talking about cylinders the diameter of a pencil, or even of a large water pipe. Recall that for a given surface speed, the larger the diameter the less the centrifugal acceleration at the surface. It is easy to calculate that even a huge cylinder 10 kilometers in radius, with a surface speed of half the speed of light, would have a surface acceleration *hundreds of billions* of times the acceleration of Earth's surface gravity. No known form of ordinary matter could spin that fast and not explosively disintegrate; Tipler has estimated that the required density for a time machine cylinder would be 40 to 80 orders of magnitude above that of nuclear matter. (In a masterful understatement, Tipler calls this astonishing stuff "unknown material.") Made from such incredibly superdense stuff, even a finite cylinder would still be as massive as the Sun but many trillions of times smaller. Showing no lack of imagination, Tipler has suggested the possibility of speeding up the rotation of an existing star as an alternative approach to that of building a cylinder.[134] That, of course, would be project for a far-future society, with a *very* advanced technology.

All of these concerns were discouraging to Tipler (who could blame him?), and his pessimism about the actual likelihood of achieving time travel via one of his cylinders is shown by the words he used to open his 1977 paper (note 134): "Any attempt to evolve a time machine] from [normal] matter will cause singularities to form in spacetime. Thus, if by the word 'manufacture' we mean 'construct using only ordinary materials *everywhere*,' then the theorems of this paper will conclusively demonstrate that a [time machine] cannot be manufactured." But not all physicists agreed.

"The Gravitational Field of a Distribution of Particles Rotating About an Axis of Symmetry," *Proceedings of the Royal Society of Edinburgh*, 1939, pp. 135–154. This is particularly interesting because, while Van Stockum didn't spot the presence of closed timelike lines in his solution, his cylinder is made entirely from *ordinary* matter.

[134]F. Tipler, "Singularities and Causality Violation," *Annals of Physics*, September 1977, pp. 1–36. See also his earlier paper "Causality Violation in Asymptotically Flat Space-Times," *Physical Review Letters*, October 1976, pp. 879–882, where he wrote "There are many solutions to the Einstein equations [of general relativity] which possess causal anomalies in the form of closed timelike lines (CTL). It is of interest to discover if our Universe could have such lines. In particular, if the Universe does not at present contain such lines, is it possible for human beings to manipulate matter so as to create them? [That is, to construct a time machine.] I shall show in this paper that it is *not* [Tipler's emphasis] possible to manufacture a CTL-containing region without the formation of naked singularities, *provided normal matter is used in the construction attempt* [my emphasis]."

Years after Tipler wrote, one physicist replied[135] with *two* pointed observations. First, Tipler's theorems apply only to singularities of the incomplete kind, not to the more convincingly fatal crushing (or curvature) type. Second, to quote Ori at length, "The standard interpretation of Tipler's theorems is to say that the appearance of a singularity in a given [spacetime] model indicates that this model is unrealistic and cannot be physically realized. Even for future-generation engineers it will probably be impossible to use 'singular matter' for the construction of their time machine. However, the theory of black holes provides an obvious counterexample to this interpretation. For, by applying this interpretation to the black hole singularity theorems one could conclude that black holes can never form." Yet black holes with several times the mass of the Sun *have* been detected in orbit about certain stars, and at least one supermassive black hole (with a mass equal to more than three *billion* Suns) has been detected at the core of galaxy M87. Indeed, it is now believed that the center of *every* sufficiently massive galaxy in the universe is home to a black hole (the one at the center of our own galaxy, the Milky Way, has a mass about three million times that of the Sun).

Even less concerned about singularities interfering with time travel were two other physicists who wrote[136] "It would seem that a successful attempt to manufacture [a time machine] within a finite region of space will be accompanied by the creation of a singularity . . . This does not immediately imply, however, that with a sufficiently advanced technology one could not make a time machine. *There is no reason to suspect spacetime singularities could not in principle be created through deliberate human action* [my emphasis]."

These optimistic views were, of course, welcome news for science fiction writers, who had been using Tipler cylinders almost from when Tipler first wrote of them. Indeed, Larry Niven liked them well enough to 'lift' the very title of Tipler's paper (note 130) for the title of a short time travel story for inclusion in his 1979 collection *Convergent Series*. Just one year after Tipler's paper appeared, Poul Anderson featured the cylinders in his 1978 novel *The Avatar*, where they are called "T-machines": one can imagine the "T" stands for Time or Tipler or even both. Anderson's story describes the cylinders as having been scattered about the universe by ancient, altruistic aliens called "the Others," for the use by any who come across them and who have the wits to decipher *how* to use them. Anderson recognized the obvious problems with Tipler cylinder construction, and so has one of his characters say of T-machines, "I have no doubt whatsoever that [they are] the product of a technology further advanced from ours than ours is from the Stone Age."

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[135] A. Ori, "Must Time-Machine Construction Violate the Weak Energy Condition?" *Physical Review Letters*, October 1993, pp. 2517–2520. The weak energy condition is the seemingly 'obvious' requirement that the observed local mass-energy density should never be negative. Quantum mechanics predicts (and it has been experimentally confirmed) that there *are* exceptions.

[136] M. P. Headrick and J. R. Gott, "(2+1)-Dimensional Spacetimes Containing Closed Timelike Curves," *Physical Review D*, December 15, 1994, pp. 7244–7259. The '(2+1)' refers to a toy spacetime with just two spatial dimensions and one time dimension.

Even before (actually *long* before) Tipler's paper, science fiction had foreshadowed his physics. Oliver Saari (1918–2000), for example, had incorporated both superdense matter and the rule of 'no time travel before the creation of a time machine' in a story written *40 years* earlier.[137] Saari's fictional time machine works by warping spacetime via a plate of superdense matter. (An even earlier tale[138] had also used superdense matter, but it was badly flawed by its hocus-pocus invoking of 'rays' emitted by the newly discovered element of *tempium*.) The 'no time travel before the creation of a time machine' rule is the basis for an obvious response to Hawking's Chronology Protection Conjecture, discussed earlier in this chapter, and it was so used by one physicist to rebut the Conjecture: as he wrote,[139]

(1) time machines, if possible, must have the property of not being able to travel back to before their creation, and
(2) no time machine has yet been created.

The absence of time travelers amongst us, therefore, provides no insight, one way or the other, on the eventually possibility of constructing a time machine.

1.7 For Further Discussion

Observations of the background microwave radiation that permeates the universe is strong experimental evidence for the Big Bang, the singularity thought to be the origin of the universe. This singularity is not shielded from us by an event horizon, and so is not a naked singularity (note 110), which means it is potentially visible. In 1969 the English theoretician Roger Penrose, however, proposed a metaphysical 'law' called the *cosmic censorship principle*, which asserts that naked singularities are impossible. Discuss the obvious tension between Penrose's principle and the Big Bang singularity. (See, for example, P. Kosso, "Spacetime Horizons and Unobservability," *Studies in History and Philosophy of Science*, June 1988, pp. 161–173.)

[137] O. Saari, "The Time Bender," *Amazing Stories*, August 1937. In this story we read that the time traveler "could not travel into the past for the plate had to exist in all ages traveled, and it had not existed before he made it."

[138] E. L. Rementer, "The Time Deflector," *Amazing Stories*, December 1929.

[139] K. S. Thorne, "Do the Laws of Physics Permit Closed Timelike Curves?" *Annals of the New York Academy of Science*, August 10, 1991, pp. 182–193. Science fiction writer Damon Knight (1922–2001) anticipated Thorne's rebuttal in his story "Azimuth 1, 2, 3, . . . ," *Isaac Asimov's Science Fiction Magazine*, June 1982.

In the text I mention the "transparent aluminum" bootstrap paradox that appears in the 1985 movie *Star Trek IV*. Even earlier, a movie bootstrap appeared in 1980 film *The Final Countdown*. There, the designer of a modern naval warship that temporarily time travels back to the Pearl Harbor of December 6, 1941, turns out to be a crew member who was (is) accidently left behind in the past when the ship returns to the present. In the past he *will be* able to design the ship because he already knows how it *was* designed—by himself! In the more recent 2014 film *Interstellar*, a wormhole near Saturn is discovered. By the end of the film we learn that it was put there by future humans, humans who exist because their ancestors (us!) were saved from a planet-wide ecological disaster when they used the wormhole to discover new worlds in far-flung regions of the universe. Decide whether or not the existence of the wormhole represents a bootstrap paradox, and defend your position.

One difficulty in using a black hole as a means of traveling from one region of the universe to another (with time travel as a special case) is simply getting to a black hole in the first place. The nearest one to Earth, as far as is known, is many light years distant. One reason for this may be an anthropic one (see note 13 in the "Introduction"). That is, a planet near a rotating black hole would either be eventually swallowed whole, or have its surface blasted by a firestorm of radiation produced by in-falling matter. In any case, no intelligent life able to recognize time travel would ever evolve on such a planet in the first place. That is, we are here to wonder about the absence of near-by black holes precisely *because* we aren't near a black hole. The lack of black holes near Earth is addressed in Joe Haldeman's 'Earth vs. Aliens' novel, *The Forever War*, by using the time dilation effect of special relativity (discussed in Chap. 3) that allows long travel distances to be covered in a reasonable time (as measured by clocks in rocket ships traveling near the speed of light). Still, while the travel time to reach a black hole distant from Earth by many light years may only be 6 months of ship time, back on Earth many *years* may pass. Once at the black hole the ship enters it and instantly 'jumps' to a vastly different region of the universe. In the novel, no time travel after the time dilation experienced in just getting to the black hole occurs, but Haldeman uses that to great effect as follows. Before entering into combat, Earth's soldiers are told that when they exit the hole into a new region of the universe, they may encounter alien warships equipped with *their* latest technology, technology that could be far in advance of the Earth warship's technology

(continued)

which dates from Earth's *past*. That is, humans will be fighting against technology that dates from the Earth warship's *future*. To quote the novel, "Relativity traps us in the enemy's past; relativity brings them from our future." Explain this.

In one of the quatrains of the *Rubaiyat*, the eleventh century Persian poet-philosopher Omar Khayyam wrote

The Moving Finger writes; and having writ,
Moves on; nor all your Piety nor Wit
Shall lure it back to cancel half a Line,
Nor all your Tears wash out a Word of it.

Nearly a 1000 years later the German theoretical physicist Hermann Weyl (1885–1955), a colleague of both Einstein and Gödel at the Institute for Advanced Study in Princeton, NJ, wrote the following in his book *Space-Time-Matter* (published in 1921, three decades *before* Gödel's 1949 time travel paper):

> *It is possible to experience events now that will in part be an effect of my possible future resolves and actions. Moreover, it is not impossible for a world-line (in particular, that of my body), although it has a time-like* [see the index] *direction at every point, to return to the neighborhood of a point which it has already once passed through. The result would be a spectral image of the world more fearful than anything the weird fantasy of E. T. A. Hoffmann* [an early nineteenth-century German writer of the eccentric] *has ever conjured up. In actual fact the very considerable fluctuations of the* [components of the metric tensor, to be discussed in Chap. 3] *that would be necessary to produce this effect do not occur in the region of the world in which we live . . . Although paradoxes of this kind appear, nowhere do we find any real contradictions to the facts directly presented to us in experience.*
> Compare these two views and, in particular, discuss what each says about the idea of 'reliving the past.'

In the opening section of this book ("Some First Words") I mention how now and then science fiction has anticipated physics. One interesting example of this occurs in a story of a time traveler *almost* meeting himself, a story published 2 years *before* Gödel's 1949 time travel paper in which he suggests just such a possibility. The story opens with a man on a ship spotting the signal fire of a castaway on a Pacific island, as well as the tiny, distant figure

(continued)

of a man waving and jumping about. While sailing in to help, the ship hits a mine left over from the war, and the would-be-rescuer becomes a castaway, too. After swimming to the island, he can find no trace of who built the fire, although there are footprints all about in the sand. Exploring the island, he finds the remains of a crashed interstellar spaceship (!), powered by a drive unit based on 'temporal precession.' The man, curious, turns the drive on and thus sends himself backward in time by one day. He then spots a ship on the horizon, builds a fire, waves and jumps about, then *recognizes the ship as his own* . . .. And so the loop nearly but not quite closes. The man, apparently, rushes off into the jungle, terror-stricken at the thought of meeting himself. (You can find this tale by A. B. Chandler (1912–1984), "Castaway," in the November 1947 issue of *Weird Tales*, a publisher more of fantastic, supernatural, and horror stories than of science fiction. Perhaps easier to locate would be an anthology in which it has been reprinted: *Science-Fiction Adventures in Dimension* (G. Conklin, editor), Vanguard 1953.)
Speculate on what happens to the man. In particular, does Wells' own criticism of *The Time Machine*, concerning "vain repetitions" of time travelers, apply here (see the "Introduction" again)?

A philosopher has argued against the force of Hawking's chronology protection conjecture as follows: "There is an old argument to the effect that while backward time travel may be *possible*, it will never actually occur—for if it were going to occur, we would *already* have encountered the time travellers involved, whereas in fact we have done no such thing. . . . But consider an isolated society living in a remote part of the world. Some members of this society are engaged in a long-running debate concerning the possibility of human flight. Were a 747 to pass overhead, would the debaters necessarily recognize it as containing flying humans? The answer to their question might have been staring them in the face for years, without them realizing." (See Nicholas J. J. Smith, "Bananas Enough for Time Travel?" *British Journal for the Philosophy of Science*, September 1997, pp. 363–389, in particular note 3 on p. 364. The perhaps curious appearance of 'bananas' in the title of this paper will become clear when, in Chap. 4, we delve into the details of the famous grandfather paradox.) How would *you* answer Smith's question? Do you think it is plausible, as Smith implies, that we could right now be observing (without realizing it) effects in the present-day world that are the result of time travelers amongst us? What sort of effect (s) might raise this suspicion in *your* mind?

As discussed in Sect. 1.6, Tipler expressed some pessimism in his 1977 paper (note 134) about the possibility of actually constructing a time machine from a rotating cylinder. But that doesn't mean he didn't have some doubts, too, about theoretical 'proofs' of something being impossible. In his 1976 PhD dissertation, for example, he included an amusing reference to Simon Newcomb (a real-life mathematician that Wells' Time Traveller cites in *The Time Machine*—see note 102 in Chap. 2) who published mathematical 'proofs' that it would be impossible with known science to build a "practicable machine by which men shall fly long distances through the air." Why do you think Tipler did that? You can read more about Newcomb's 'proofs' in "Is the Airship Coming," *McClure's Magazine* (September 1901, pp. 432–435) and "The Outlook for the Flying Machine," *The Independent* (October 22, 1903, pp. 2508–2512).

In his autobiography, the Princeton physicist John Wheeler had this to say about time: "The smooth flow of time—or our smooth passage through it—is an illusion that is shattered when we . . . ask about time at the moment of the Big Bang, at a moment of gravitational collapse, at the moment of the Big Crunch. Students and others often ask what existed before the Big Bang. To say that we don't know is not to say enough. Even to say that we have no *way* of knowing is not enough. We really have to say that space and time came into existence, along with matter and energy and the laws of physics, at the moment of the Big Bang. If the universe expands to a maximum size, starts contracting, and eventually collapses to a fiery death—a fate that seems likely to me and to some other theorists . . . then time and space, too, will end in this Big Crunch. I can reach no conclusion other than this: there was no 'before' before the Big Bang, and there will be 'after' after the Big Crunch." (See J. A. Wheeler, *Geons, Black Holes, and Quantum Foam: a life in physics*, W. W. Norton 1998, pp. 349–350.) That is, when the Big Bang singularity occurred, time was *created*, and if the universe should collapse in the far future in a Big Crunch, time will be *annihilated*. This is a view of *nothingness* that transcends even that of the grave. Sharing Wheeler's dark view of the ultimate fate of reality, but instead giving the *victory t*o time (rather than its annihilation), was the Irish writer Jonathan Swift (1667–1745) in his poem *Riddles* (circa 1724): "Ever eating, never cloying/All-devouring, all destroying/Never finding full repast/ Till I eat the world at last." How do you think theologians would respond to Wheeler and Swift?

The American philosopher Roy Sorenson was cited in note 13 in the discussion of the difficulties a time travel would have in convincing skeptics that he *had really* time traveled (short of bringing a fresh dinosaur egg back and hatching it!). This question was treated in early pulp science fiction ("The Sands of Time," see note 43 in "Some First Words") as follows: The time traveler takes a sealed box of pure radium (with his name written on the inside of the lid) into the distant past, and buries it in a secure location. Upon returning to the present he unearths the box; testing of the contents will show that some of the radium has radioactively decayed to lead. Indeed, the amount of decay would be a direct measure of how far back into the past the box had been transported. This issue was later elaborated on by the English philosopher Alasdair Richmond in his paper "Time Travel, Parahistory and the Past Artefact Dilemma," *Philosophy*, July 2010, pp. 369–373. There he imagined two possible ways a time travelling Shakespearean scholar might attempt to convince skeptical colleagues that he had discovered a draft of *Hamlet* dating from the year 1589 (10 years *before* the earliest accepted date of its composition by Shakespeare). The first attempt is to simply bring that draft directly back with him in the time machine, from 1589 to the present. Then, of course, many of the inherent clues as to the draft's authenticity, such as chemical composition of the ink, the weave of the paper, and orthography (the style of writing in 1589) would be consistent with the time traveler's claim, but other clues would *not*—the *age* of the paper and of the ink, for example, would be taken as evidence fatal to the claim, as they would not be nearly 430 years old. They would appear, in fact, to be practically new! The draft would, therefore, be dismissed as simply a clever forgery. The second attempt would try to get around this problem, as follows. After locating the draft in 1589, the time traveler *doesn't* bring it back to the present, but rather stashes it away in a secret hiding place. Then, once back in the present, he takes his colleagues to the secret hiding place and, with a flourish, reveals the draft which now *is* nearly 430 years old. Much to the time traveler's frustration, however, his colleagues still reject his time travel claim, this time saying he must have simply found the draft in the 'usual' way (under the floorboards in somebody's attic, for example), and is just pretending to have found it via time travel. Can you think of a way, using the *Hamlet* draft, the time traveler might be able to convince his skeptical colleagues?

The fan I quoted in "Some First Words," who wrote to *Astounding Stories* in 1931 to express his unhappiness with the appearance of women in that magazine's stories, was quite clear about his concerns—although, given the times, he carefully avoided any direct mention of sex. A modern, highly successful *female* writer of science fiction, Anne McCaffrey (1926–2011), didn't shy away from that, however, when she wrote the following in a hilariously funny essay: "Prior to the '60s, stories with any sort of love interest were very rare. True, it was implied in many stories of the '30s and '40s that the guy married the girl whom he had rescued/encountered/discovered during the course of his adventures. But no real pulse-pounding, tender, gut-reacting scenes. The girl was still a 'thing' to be used to perpetuate the hero's magnificent chromosomes. Or perhaps to prove that the guy wasn't . . . I mean, all those men locked away on a spaceship for months/years at a time. I mean . . . and you know what I mean even if I couldn't mention it in the sf of the '30s and '40s." (See Anne McCaffrey, "Hitch Your Dragon to a Star: Romance and Glamour in Science Fiction," in *Science Fiction, Today and Tomorrow*, R. Bretnor, editor, Harper & Row 1974, pp. 278–292.) Modern time travel science fiction has shown a huge change (for the better) on this score. Discuss, for example, the emotional power of a love story between a couple separated in time, as depicted in the 1975 novel *Bid Time Return* by Richard Matheson (made into the 1980 film *Somewhere in Time*). How do you think the 1931 fan would have reacted to Matheson's story? (Indeed, if that fan was a teenager—or even a few years older—in 1931, then 44 years later he would have been, at most, in his mid-60s and might well *have* read the novel.)

In the 2014 film *Interstellar*, a space probe dives into a black hole, gets a glimpse of the hole's singularity, measures some unspecified quantum effects, and then sends the measurements back to Earth (via the fifth dimension) as a signal in the form of spasmodic Morse code twitches of the second-hand on somebody's watch. This all leads (it is hinted) to a theory of quantum gravity. If you saw the second-hand on *your* watch suddenly begin to spasmodically twitch, would you then immediately think

(a) that a Morse code message was coming to you via the fifth dimension bearing the secrets of quantum gravity?

or

(b) that your watch needs a new battery?

(continued)

or

(c) something else?

Vigorously defend your answer.

William Grey, a philosopher at The University of Queensland, pointed out numerous conceptual difficulties with the idea of time travel in his paper "Troubles with Time Travel," *Philosophy*, January 1999, pp. 55–70. That paper quickly prompted a rebuttal from the philosopher Phil Dowe (at the University of Tasmania), who replied a year later with the paper "The Case for Time Travel," *Philosophy*, July 2000, pp. 441–451. We'll eventually take up all the issues discussed in those two papers but, for now, read both papers and summarize their respective arguments. Do you feel one of the writers won the day (for you, anyway)?

Chapter 2
Philosophical Space and Time

"I do not believe that there are any longer any philosophical problems about Time; there is only the physical problem of determining the exact physical geometry of the four-dimensional continuum that we inhabit." [1]

2.1 Time: What Is It, and Is It Real?

"Time is generally thought to be one of the more mysterious ingredients of the Universe."[2]

Before going any further with time *travel*, it will be well worth the effort to take a closer look at time itself, the 'stuff' or 'thing' or . . . ? that we are interested in traveling 'through' or 'around' or 'across' or . . . ? Oddly enough, I'll start with religion, as philosophical theologians had identified time as something unusual long before Newton's words on time in his *Principia* that I mentioned in the Introduction, and many thousands of years before science fiction writers and their time travel stories.

We can, in fact, trace the religious interest in time back at least sixteen centuries to the Christian theologian St. Augustine and his *Confessions* (in which he famously admitted "What, then, is time? I know well enough what it is, provided that nobody asks me: but if I am asked what it is and try to explain, I am baffled."). Certainly the seventeenth century Spanish Jesuit Juan Eusebius Nieremberg caught the spirit of wonder that time holds for the devout when he wrote, in his *Of Temperance and Patience*, that "*Time* is a sacred thing; it flows from Heaven . . . It is an emanation from that place, where eternity springs . . . It is a *clue* cast down from Heaven to guide us . . . It has some assimilation to Divinity."

Going outside Christianity, we can easily find other equally strong reactions to the mystery of time. From Plutarch's *Platonic Questions* we learn that when the question of time's nature was put to Pythagoras, he simply uttered the mystical "time is the soul of the world." The *Laws of Manu* of Hinduism, the *Torah* of

[1] H. Putnam, "Time and Physical Geometry," *Journal of Philosophy*, April 1967, pp. 240–247.
[2] P. Horwich, *Asymmetries in Time*, MIT Press 1987.

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P.J. Nahin, *Time Machine Tales*, Science and Fiction,
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Judaism, the *Koran* of Islam, and the revealed truths of Gautama Buddha are all full of references to time. It is, in fact, to the pagan gods of Greek mythology that we owe our 'modern' image of Chronos, or Father Time.

Not just the Greeks made time a god. In the *Bhagavad Gita* (*Song of the Lord*), the central religious-romantic epic of Hinduism that predates Christ by five centuries, one of the characters reveals his divine nature and declares his power thus: "Know that I am Time, that makes the worlds to perish, when ripe, and bring on them destruction." And in the even older Egyptian Book of the Dead, which dates back over three thousand years, the newly deceased was thought literally to become one with time itself. The merging of time and the resurrection of the body after death in the Book is shown in the line "I am Yesterday, Today and Tomorrow, and I have the power to be born a second time."

The Greek philosopher Plato (circa 400 B.C.) gave us a curious way to think of time: as a *closed loop*. While Plato did think of time as having a beginning, his conception did not have time extending off into the infinite future as does the modern, everyday view. Rather, Plato visualized time as curving back on itself—as *circular* in nature. This was, in fact, a reasonable reflection on what Plato could see everywhere in nature, with the seemingly endless repetition of the seasons, the regular ebb and surge of the tides (the old English word *tid* was a unit of time), the unvarying alternation of night and day, and the rotation of the visible planets in the sky. Whatever might be observed today, it seemed obvious to Plato, would happen again in nature. Circular time in science fiction was briefly mentioned in Chap. 1,[3] and it occurs outside that genre, too, as in James Joyce's novel *Finnegans Wake*, which opens in mid-sentence and ends with the first part of the same sentence. This view of time has a powerful, ancient visual symbol, the Worm Ouroborous, or World Snake, that eats its own tail endlessly.

Circular time, with its closed topology, was favorably presented in Stephen Hawking's famous book *A Brief History of Time*. In it he concludes that there is no need for God because in circular time there is no first event and hence no need for a First Cause. Vigorous philosophical rebuttals were quick to come, of course![4]

Turning to fiction, Ray Bradbury wrote a beautifully poetic passage about the mystery of time in "Night Meeting," one of the splendid sub-stories in his episodic 1950 masterpiece *The Martian Chronicles*. A man of A.D. 2002, who is one of the modern inhabitants of Mars, somehow meets the ghostly image of a long-dead Martian one cold August night. The conditions are just right for such a cross-time encounter. As the man thinks to himself, "There is the smell of Time in the air

[3]Another example from science fiction is the story by I. Hobana, "Night Broadcast," in which a television signal from the past is picked up by a gadget that is probing the *future*: "By going far enough into the future one comes upon what we call the past." You can find this tale in the *Penguin World Omnibus of Science Fiction*, Penguin Books 1986.

[4]See, for example, W. L. Craig, "What Place, Then, for a Creator?: Hawking on God and Creation," *British Journal for the Philosophy of Science*, December 1990, pp. 473–491, and R. Le Poidevin, "Creation in a Closed Universe Or, Have Physicists Disproved the Existence of God?," *Religious Studies*, March 1991, pp. 39–48.

tonight. . . . There was a thought. What did Time smell like? Like dust and people. And if you wondered what Time sounded like it sounded like water running in a dark cave and voices crying and dirt dropping down on hollow box lids, and rain. And, going further, what did Time *look* like? Time looked like snow dropping silently into a black room or it looked like a silent film in an ancient theater, one hundred billion faces falling like those New Year balloons, down and down into nothing. That was how Time smelled and looked and sounded. And tonight . . . tonight you could almost *touch* Time."

Well, lovely words, yes, but they don't really tell us what time *is*. Perhaps Einstein the physicist can tell us. In the *New York Times* of December 3, 1919, we find him quoted as follows: "Till now it was believed that time and space existed by themselves, even if there was nothing [Newton's view]—no Sun, no Earth, no stars—while now we know that time and space are not the vessel for the Universe, but could not exist at all if there were no contents, namely, no Sun, no Earth, and other celestial bodies." Less than 2 years later Einstein stated this view again (*New York Times*, April 4, 1921): "Up to this time the conceptions of time and space have been such that if everything in the Universe were taken away, if there were nothing left, there would still be left to man time and space." Einstein went on to deny this view of reality, saying that, according to his general theory of relativity, time and space would *cease to exist* if the universe were empty. This has the ring of one of Einstein's favorite philosophers, Spinoza, who declared in his *Principles of Cartesian Philosophy* that "there was no Time or Duration before Creation." In a correspondence with Samuel Clarke—Newton's friend who translated Newton's *Optiks* into Latin—the German philosopher Gottfried Leibniz (who began the correspondence in 1715) expressed similar ideas: "Instants, consider'd without the things, are nothing at all . . . they consist only in the successive order of things."

The pragmatic scientist would certainly agree with Leibniz. After all, what could it even mean to talk of time unless you can measure it? And what you use to measure time is a clock—some kind of changing configuration of matter involving spinning gears, ticking pendulums, and rotating dial pointers. Mere *unchanging* matter, alone, is not sufficient to measure time because a still clock measures nothing. *Changing* matter seems to be required. Yet, not surprisingly, not everybody agrees. The counterview, the view that time has nothing to do with change, was expressed in an interesting manner by a science fiction fan in a letter to the editor of *Wonder Stories* (January 1931): "Just one thing, you have these time-traveling yarns, good stuff to read all right, but bunk, you know; because if there's no such thing as time, which there isn't, *only change* [my emphasis], how can one travel in . . . something that doesn't exist. To our planet which goes around the Sun there is simply a turning and warming of one side and then the other, i.e., years, days, minutes, etc., is something purely artificial, invented by man to tell him when to do certain things, work and stop work . . ."[5]

[5]This fan's idea was not new. For Plato's most famous student, Aristotle, time was *motion* (in a world in which nothing moved, argued Aristotle, there would be no time), and he expressed this

Going even beyond the ideas of Einstein, Spinoza, Leibniz, Plato, Aristotle, and our science fiction fan, at least one metaphysician felt that time would have no meaning, even in a massive and changing universe, without the additional presence of conscious, rational beings.[6] That sounds very much like an echo of the French philosopher Henri Bergson who, in 1888, somewhat mysteriously declared that time is "nothing but the ghost of space haunting the reflective consciousness." A few years before Taylor, however, a fellow philosopher had argued for exactly the opposite view, that temporal passage is independent of the existence of conscious beings.[7]

All this divergence of opinion perhaps explains why even a lightweight Hollywood movie like Mel Brooks' 1987 *Spaceballs* can get a laugh from a time joke. Even kids know that the characters, when talking about time, haven't the slightest idea of *what* they are talking about. The movie, a spoof on such classic films as *Star Wars*, *The Wizard of Oz*, and *Raiders of the Lost Ark*, quickly reaches a point of crisis. To find out what to do next, the evil Lord Helmet and his chief henchman decide on a novel approach: they will look at an instant video of their own movie! (Instant videos are available *before* the movie is finished.) Perplexed at watching on a television screen everything that he is doing as he does it (the screen correctly shows an infinite regression of television screens, each being watched by a Lord Helmet), Lord Helmet initiates the following rapid-fire exchange. (It is, of course, a clever take-off on Abbott and Costello's "Who's on First?")

What the hell am I looking at? When does this happen in the movie?
Now! You're looking at now, sir. Everything that happens now, is happening, now.
What happened to then?
We're past that.
When?
Just now, now.
Go back to then.
When?
Now.
Now?
Now.
I can't.
Why?
We missed it.

view in his famous metaphor "Time is the moving image of eternity." For Aristotle, then, time and change were inseparably intertwined. For Aristotle the world had existed for eternity, and the circularity of time was a central and powerful image; using his vivid illustration, it is equally true *in circular time* that we live both before *and* after the Trojan War.

[6] R. Taylor, "Time and Life's Meaning," *Review of Metaphysics*, June 1987, pp. 675–686.

[7] S. McCall, "Objective Time Flow," *Philosophy of Science*, September 1976, pp. 337–362.

When?
Just now. [The henchman then sets the video to rewind.]
When will then be now?
Soon.

We may laugh at this, even dismiss it as mere movie madness, but could any of us *really* do much better if, like Saint Augustine, we were backed into a corner and asked to explain time? Somehow, I think even the distinguished twentieth-century Harvard professor Hilary Putnam whose words open this chapter would find it difficult to know where to begin. He might even become as confused as the time traveler in the 1968 film *Je t'aime, Je t'aime*, whose oscillations in time, from present to past and back again, leave him so befuddled that he decides he'd rather be dead. What, then, *can* we say about time? Despite Putnam's bold words, I suspect that most people would come down on the side of Augustine.

The mystery of time was well captured by R. H. Hutton (1826–1897), the literary editor of the *Spectator*, when he wrote in his 1895 review (see note 1 in the Introduction) of Wells' *Time Machine* that "the story is based on that rather favorite speculation of modern metaphysicians which supposes *time* to be at once the most important of the conditions of organic evolution, and the most misleading of subjective illusions . . . and yet Time is so purely subjective a mode of thought, that a man of searching intellect is supposed to be able to devise the means of traveling in time as well as in space, and visiting, so as to be contemporary with, any age of the world, past or future, so as to become as it were a true 'pilgrim of eternity.'"

Novelist Israel Zangwill (1864–1926) wrote a similar but much more analytical review of Wells' novel for the *Pall Mall Magazine* (see note 1 in the Introduction). Zangwill was the only Victorian reviewer to attempt a scientific analysis of time travel. Although he thought Wells' effort was a "brilliant little romance," Zangwill also thought the time machine—"much like the magic carpet of *The Arabian Nights*"—was simply "an amusing fantasy." Zangwill continued in his review with what was even then a common idea about a way one might actually be able, at least in principle, to look backward in time; one could travel far out into space by going faster than light and then watch the light from the past as it catches up to you. (Note, carefully, that Zangwill was writing in 1895, 10 years before Einstein's special relativity put a limit on possible speeds.) In this way, Zangwill wrote, one could watch "the Whole Past of the Earth still playing itself out."

Indeed, even before Zangwill, the well-known French astronomer Camille Flammarion (1842–1925) had made this dramatic idea a centerpiece of his 1887 novel *Lumen*. That book, a best-seller in Europe even before its appearance in England, describes how a man just dead (in 1864) instantly finds his spirit on the star Capella, where he is able to watch the light then arriving from the Earth of 1793. In particular, he watches the French Revolution play itself out and sees himself as a child. Flammarion may have, in fact, been inspired to write his novel by an essay written several years earlier (in 1883) by the British physicist

J. H. Poynting (1852–1914). Poynting's essay,[8] which opens with the statement that it was, in turn, inspired by an anonymous pamphlet published "30 or 40 years ago" on the same topic, specifically mentions watching historical events from Capella.

By the beginning of the twentieth century the idea of watching the past by outrunning light had drifted down into juvenile literature, as in the 1904 novel *Around a Distant Star* by Jean Delaire (the pen name for Pauline Touchemoline (1868–1950)), in which a young man builds a spaceship that can travel at two thousand times the speed of light. With it, he and a friend travel to an Earth-like planet nineteen hundred light-years distant and use a super-telescope to watch the Crucifixion (and then the resurrection) of Jesus. Early magazine science fiction also found the idea of looking backward in time with delayed light to be an irresistible one, involving romance and murder.[9] In another tale incorporating human emotions, a scientist loses his wife to a rival who kidnaps her and then escapes in a faster-than-light rocket ship headed for parts unknown. After searching for them with his own brilliant invention of the 'ampliscope' (several quantum leaps beyond the telescope), the scientist locates the couple, skipping from planet to planet light-years distant. His only pleasure, then, is to use his own faster-than-light craft to outrun the images of his lost love and watch them over and over. Eventually, however, he comes to realize the ultimate futility of it all. As the final line of this sad tale says, "It would be senseless, I knew, chasing on and on after yesterdays."[10]

The reality of time received a new twist with the additional imagery of instants of time being likened to the points on a *straight* line. In the West it was the Christian theological doctrine of *unique* historical events that gave rise to *linear* time in the minds of the common folk. The creation of the world and Adam and Eve, the adventures of Noah and the cataclysmic Flood, the Resurrection—these were all events that occurred in sequence, *once*. None would happen again and so, for Christianity, circular time just would not do.[11] In addition, it has been argued that the major spiritual content of Christianity—a significant reason for its popular support even in the face of brutally harsh Roman suppression—is that it brought the *expectation of change* into the static world of ancient times. It was, in fact, in ancient religious teachings that our modern view of linear time had its origin, a view that most people today (including the most hardened agnostic physicist) find to be as natural as Plato and Aristotle found circular time.

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[8] J. H. Poynting, "Overtaking the Rays of Light," in Poynting's *Collected Scientific Papers*, Cambridge University Press 1920.

[9] As in, for example, G. A. England, "The Time Reflector," *The Monthly Story Magazine*, September 1905.

[10] D. D. Sharp, "Faster Than Light," *Marvel Science Stories*, February 1939. The year before saw the appearance of a story with the same idea, a story that specifically cites Flammerion: M. Weisinger, "Time On My Hands," *Thrilling Wonder Stories*, June 1938.

[11] Still, just to show how one can find support for almost any view in the same religious dogma, Ecclesiastes 1:9 would seem to be a claim *not* for linear time but rather for circular time!: "The thing that hath been, it is that which shall be; and that which is done is that which shall be done; and there is no new thing under the sun."

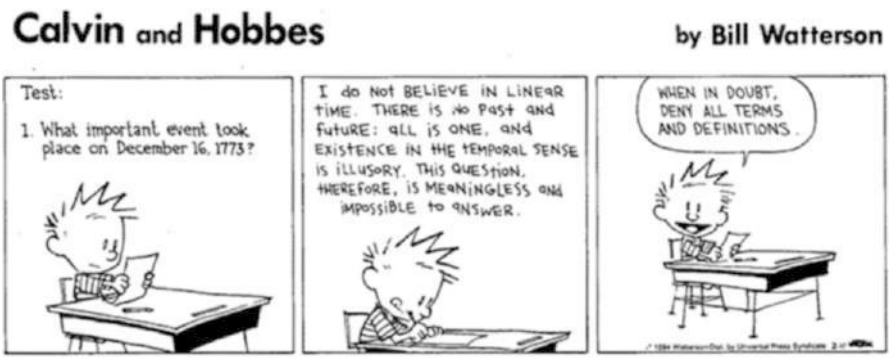

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Even though linear time was the norm after Christ, there were still enough questions about time to perplex the deepest of thinkers, and the next 2000 years resulted in plenty of thinking. Discourses on time by such philosophers as Descartes, Spinoza, Hobbes, Kant, Nietzsche, and Hegel can be found by the yard in any decent university library. Nearly all (if not indeed all) of these presentations have metaphysical, even theological, underpinnings. For example, Descartes is generally believed to have argued for a discontinuous, atomistic nature to time (recall the *chronon* from Chap. 1). This is the modern view of his thinking, because in his *Meditations* (1641), in particular in the third meditation on God's reality, Descartes appears to argue that God must continually recreate the world at each *separate* moment of its existence. That is, the world is recreated in a discontinuous succession of *individual* acts by God.[12]

Finally, with Newton's discussion of *absolute* time, which is the belief that time is the same everywhere in the universe, there was for the first time a *physicist* writing about time (although, as I mention in Chap. 1, Newton's views were also influenced *heavily* by theological considerations, in addition to mathematical physics). But, despite Newton's genius, the mystery of time remained a mystery.

In 1905 Einstein's name appeared among the contributors to the study of time, and so at last something besides metaphysical speculation on the subject was added to the body of human thought. Einstein's paper on special relativity introduced the revolutionary idea of *relative* time, which is the anti-Newton belief that the passage of time is *not* the same everywhere, but rather depends on local conditions. In retrospect, Einstein's 1905 work seems to be the perfect reply to the comment by Isaac Barrow (1630–1677)—Newton's teacher and the first Lucasian professor of mathematics at Cambridge (the chair once held by Stephen Hawking centuries

[12]For more on this, see R. T. W. Arthur, "Continuous Creation, Continuous Time: A Refutation of the Alleged Discontinuity of Cartesian Time," *Journal of the History of Philosophy*, July 1988, pp. 349–375.

later)—that "because *Mathematicians* frequently make use of Time, they ought to have a distinct idea of the meaning of the Word, otherwise they are Quacks."

Then, just 3 years after Einstein, along came a second astonishing paper by the Cambridge philosopher John Ellis McTaggart (1866–1925). This paper[13] claims to prove that whatever time might be *thought* to be (even by Einstein), it really isn't that because time isn't even real. (This would seem, I think you'd agree, to have potentially profound implications for time travel!) The method of the paper is to deny the reality of time via an infinite-regress argument that one philosopher[14] has called the *pons asinorum* ("bridge of asses") of the riddle of time. As McTaggart's own opening sentence freely admits, "It doubtless seems highly paradoxical to assert that Time is unreal, and that all statements which involve its reality are erroneous."

McTaggart began his analysis by observing that there are two separate and distinct ways of talking about events in time. Following his terminology, one can say that events are either future, present, or past (the so-called *A-series*), or one can say that events temporally ordered by each being later than some other events, earlier than others, and simultaneous with still others (the so-called *B-series*). He then continued by asserting that time requires change, and followed that with the observation that the A-series (but not the B-series) incorporates such change. That is, if event X is earlier than event Y, then X is *always* earlier than Y and thus there is no change in this (or in any other) example of a B-series. As a specific example, let Y be the birth of a child, and let X be the birth of its mother. In contrast, if X is first in the future, then is in the present, and finally is in the past, then we have an example of change (and hence of *time*) in the A-series; for example, let X be the next time you blink.

With this rather pedestrian start, McTaggart then pulled his rabbit out of the hat. It makes no sense, he argued, to talk of the 'future,' 'present,' and 'past' of an event because these terms are mutually exclusive. That is, no two of these predicates can apply at once, and yet, paradoxically, every event possesses all three and thus we have a contradiction. It therefore, concludes McTaggart, makes no sense to talk of future, present, or past. And because it makes no sense to talk of them, they do not exist, and so there can be no A-series and hence no change, and thus no reality to time. McTaggart apparently realized just how befuddling all that would appear to just about everybody who read it, and so he played devil's advocate (D.A.) in his paper by trying to anticipate the various objections people could raise. Of course, he always managed to refute the D.A. at every turn. It is worth the effort to go through the details of McTaggart's 'proof,' as that will make it clear what there is about

[13]J. E. McTaggart, "The Unreality of Time," *Mind*, October 1908.

[14]L. O. Mink, "Time, McTaggart and Pickwickian Language," *Philosophical Quarterly*, July 1960, pp. 252–263. The phrase *pons asinorum* has its origin in a plane geometry theorem: the angles opposite the equal sides of an isosceles triangle are themselves equal. Seeing the truth of this is said to separate the quick-witted from the dull. It isn't clear (to me, anyway), however, on which side of McTaggart's 'proof' the quick-witted were imagined to fall. You'll see what I mean in just a moment.

'traditional' philosophical reasoning that so irritates modern philosophers trained in mathematical physics (and what makes physicists roll their eyes when confronted with arguments like McTaggart's).

The predicates of future, present, and past are really not incompatible for any event, the D.A. says some will claim, because the real predicates we should use are '*was* future,' '*is* present,' and '*will be* past,' and these *can* be possessed all at once by any event. Nice try, counters McTaggart, but that will not solve the problem. By allowing such modified predicates, we must actually allow for all nine possibilities, some of which are still incompatible. That is, the 'was,' 'is,' and 'will be' could each be potentially attached to 'future,' 'present,' and 'past': for example, 'was past' is incompatible with 'will be future.'

Oh, counters the D.A., we can eliminate that concern by allowing even more complex predicates to arrive at a third level of structure, such as 'is going to have been past,' and 'was going to be future,' and those *are* compatible. But McTaggart swats that argument away, too, by displaying new incompatibles, as well as by showing that the process of ever-increasing predicate complexity is a vicious infinite regress that drags along the seeds of its own doom at every step.[15] There is simply no escape from incompatibility, he says, and so there is no time.

Well! What can one do when presented with such an argument, one that seems to claim philosophers can wrest free the secrets of nature by pondering the historical accidents of English syntax? As David Hume once said, "Nothing is more usual than for philosophers to encroach on the province of grammarians, and to engage in disputes of words, while they imagine they are handling controversies of the deepest importance and concern." One modern philosopher apparently agreed with Hume, at least in the case of McTaggart's 'proof,' and he was pretty blunt with his evaluation of it: "McTaggart's famous argument for the unreality of time is so completely outrageous that it should long ago have been interred in decent obscurity. And indeed it would have been, were it not for the fact that so many philosophers are not sure that it has ever really been given a proper burial, and so from time to time someone digs it up all over again in order to pronounce it *really*

[15]Here's a clever way to systematically generate McTaggart's infinite regress of complex predicates, as presented by M. Dummett, "A Defense of McTaggart's Proof of the Unreality of Time," *Philosophical Review*, October 1969, pp. 497–504): "Let us call 'past,' 'present,' and 'future' 'predicates of first level.' If, as McTaggart suggests, we render 'was future' as 'future in the past,' and so forth, then we have nine predicates of second level, where we join any of the three on the left with any of the three on the right:

past		past
present	in the	present
future		future

Similarly, there are twenty-seven predicates of third level . . . "Dummett's construction clearly shows that, at the N-th level, there are 3^N predicates, most of which are incompatible.

dead. These periodic autopsies reveal that something more remains to be said."[16] That is certainly true, in as much as McTaggart's disarmingly innocent argument has caused disagreement and furrowed brows among philosophers for decades.

It is, in fact, easy to find examples of the continuing debate over McTaggart's analysis and, as silly as it strikes physicists, it still has a pulse in some quarters. While at least one philosopher has argued that McTaggart simply didn't really understand his own proof, this philosopher nevertheless agreed with McTaggart's conclusion about the unreality of time.[17] Another writer has illustrated how McTaggart's ideas have found their way into modern philosophical debates on the meaning of time in the cinema, particularly in the analysis of *anachrony*, the telling of a story out of normal time sequence, such as occurs in time travel movies.[18]

Other sorts of metaphysical proofs for the unreality of time have been offered besides McTaggart's. For example, it has be argued that time is unreal, at least in a world empty of consciousness, because the concepts of past, present, and future could not possibly have any meaning unless events could be remembered, experienced, and anticipated. Or, for a second example, some have held time to be unreal, at least in a deterministic world (as some argue four-dimensional spacetime to be), because any event whose occurrence follows from present conditions, and from physical laws, would exist (they say) *now*. This view, which seems to assert that everything should happen at once, I personally find to be sufficiently obtuse as not to be bothered by it.[19] Debates between those who believe in the common-sense idea that present, past, and future are attributes of events (the 'tensers') and those who deny it (the four-dimensional spacetime, block universe 'detensers') continues to now and then still flair up on the pages of philosophy journals. At least one philosopher likes both views![20] Most modern physicists, I think, simply don't care about this line of inquiry.

On the other hand, less than a month before his death Einstein revealed his feelings about the meaning of present, past, and future, and his words appear to be ones that show some sympathy to the philosophers. In a letter written on March 21, 1955, to the children of his dearest friend who had just died, Einstein wrote—with full knowledge that his own illness would be his last—"And now he has

[16]F. Christensen, "McTaggart's Paradox and the Nature of Time," *Philosophical Quarterly*, October 1974, pp. 289–299.

[17]Q. Smith, "The Infinite Regress of Temporal Attributions," *Southern Journal of Philosophy*, Fall 1986, pp. 383–396. To this came a rebuttal a year later by L. N. Oaklander, in the same journal (Fall 1987, pp. 425–431).

[18]G. Currie, "McTaggart at the Movies," *Philosophy*, July 1992, pp. 343–355.

[19]But if, upon reflection, it starts to bother *you*, see R. Gale, "Some Metaphysical Statements About Time," *Journal of Philosophy*, April 1963, pp. 225–237. We'll soon get to some of the more common philosophical questions on the nature of four-dimensional spacetime, such as 'is it deterministic or is it fatalistic?,' and 'does free-will have any meaning in four-dimensional spacetime?' Even physicists are interested such questions!

[20]R. Weingard, "Space-Time and the Direction of Time," *Nous*, may 1977, pp. 119–131.

preceded me briefly in bidding farewell to this strange world. This signifies nothing. For us believing physicists, the distinction between past, present, and future is only an illusion, even if a stubborn one."[21] Later in this chapter I'll return to these curious words and speculate on what Einstein may have meant by them.

I started this opening section on a religious note, and I'll end it on one. If you think the philosophical speculations on the nature of time that I've so far cited are 'really far out,' here's yet another one that leaves all the rest in the dust. In a paper that took real nerve to write (or, perhaps, simply a wicked sense of humor—and I write that in pure admiration) we read of how a spacetime that supports time travel can give the start for a *physics* explanation to the theological concept of Hell! After introducing just a bit of elementary spacetime physics (which I'll skip describing here because we'll do it later in the book), the author[22] shows how to 'construct' a compact region in spacetime (Hell) with the following properties:

1. While "so small even the Hubble Telescope couldn't image it" it can hold an infinity of physical beings;
2. Each of the beings in it are doomed, because of its time travel property, to an infinitely long personal future of damnation;
3. Each of the beings in it, because of its time travel property, can view all the future stages of their own personal damnation and so be "continually presented with a reminder of the impossibility of escape—a refinement no causally normal Hell can seemingly offer." In other words, and not to be too ironic about it, 'Theological Progress Through Physics!';
4. Each of the beings in it are continually being compressed together ("brought into dismaying proximity" with themselves) and so will spend eternity "listening to a cacophony" of their own cries of despair from *their personal future*.

There's more, but that's probably enough for you to get the idea. Richmond does admit that, as it stands, his time travel creation of Hell is not compatible with either quantum theory or even general relativity. Still, it *is* something to ponder, don't you think, when the subject of time travel comes up!

2.2 Linear Time and the Infinity of Past and Future

"A thousand years is a huge succession of yesterdays beyond our clear apprehension."[23]

—H. G. Wells

[21]Quoted from B. Hoffmann, *Albert Einstein: Creator & Rebel*, New American Library 1972, pp. 257–258.

[22]Alasdair M. Richmond, "Hilbert's Inferno: Time Travel and the Damned," *Ratio*, September 2013, pp. 233–249.

[23]This line appears in Wells' 1944 doctoral thesis, written for the University of London. You can find an abridgement of the thesis in *Nature*, April 1, 1944, pp. 395–397.

The modern concept of linear time as a straight line extending from the dim past through the present and disappearing into the misty future gives rise immediately to twin questions: "Did time have a beginning?" and "Will time ever end?" As one philosopher put it (long before physicists became seriously interested in singularities like the Big Bang) "Endings and beginnings are rooted in the very conception of time itself."[24] Starting at the beginning, we'll ask if the past has been forever? Early Biblical scholars, of course, believed the answers to both questions to be *no*.

They believed that the world came into being because of a First Cause, God's creation of everything. Those scholars expended vast quantities of energy (and, need I say it, time itself) in calculating the date of creation. Martin Luther, for example, argued for 4000 B.C. as roughly when everything, including time, began. Johannes Kepler adjusted this by a notch, to 4004 B.C., and later the Calvinist James Ussher, Archbishop of Armagh and Primate of All Ireland, tweaked it again. His date is the most impressive of all, at least in detail: the first day of the world was 4003, 70 days, and 6 h before the midnight that started the first day of the Christian era. Six days after that first day of the world, Adam was made, and as a final dash of specificity, this last date was declared to be Friday, October 28! Ironically, then, though Christian theology may be given credit for introducing linear time, it certainly did not provide very much of it. The beginning of time was just 6000 years or so ago, and of course The End—in the form of the Battle of Armageddon—has been awaited (with varying degrees of eagerness) for the last 1000 years.

The discovery in the seventeenth century of geological time cast a certain amount of skepticism on those early calculations concerning the duration of the past. With the discovery that the very Earth itself could be decoded for its history, the lure of trying to decode a mere book of admittedly finite age declined for most people although it cannot be denied that modern Creationists still find such a task to have its rewards). Geological time was discovered to a *chasm* of time extending backward for billions of years, a duration that is really incomprehensible for the human brain. It has become fashionable for geologists to refer to such enormous durations with the apt term *deep time*, a subtle play on the metaphor of the "ocean of time."

It is nothing less than humbling to historians who pause to think on how little of the past is known, that is, recorded. As the ever anonymous wit once put it, "History is a damn dim candle over a damn dark abyss." Still, even as enormous as is the age of the Earth, it is not infinite. But of course our planet is very old, and the universe is many billions of years older. Is the age of the universe also the duration of the past? Or is the past itself actually *infinite*?

An implicit assumption of the infinity of the past (and of the future, too) can be found in Book Three of Lucretius' science poem *De Rerum Natura* (*On the Nature of Things*) where, just before the birth of Christ, Lucretius argues for the irrationality of fearing death: "The bygone antiquity of everlasting time before our birth

[24] I. Stearns, "Time and the Timeless," *Review of Metaphysics*, December 1950, pp. 187–200.

was nothing to us. Nature holds this up to us as a mirror of the time yet to come after our death. Is there anything in this that looks appalling, anything that means an aspect of gloom? Is it not more untroubled than any sleep?"

One philosopher[25] has traced the origins of rational support for the finite duration of the past to as far back as the sixth century A.D. The argument presented then by the Christian philosopher Joannes Philoponus of Alexandria (who is otherwise known as John the Grammarian) is simply that the world could *not* have been forever because that implies an infinity of successive acts could have taken place which (according to Philoponus) is impossible. A variation on this is the claim that if the past were infinite in extent, then everything would have happened by now! Infinity was just too big for the ancient mind (Zeno's hoary pre-Christian paradoxes, as is well-known today, are based on subtle errors in the use of infinity).

This view on the impossibility of an infinite past seems to have been the prevalent view; even as late as the twelfth century the debate among Christian theologians was not about the possibility of an infinite past, but instead about whether the Biblical 'six days of Creation' actually had taken place simultaneously. For many, the past was 'obviously' finite in duration.[26] Not all Christians accepted that conclusion, however, and the following century saw St. Thomas Aquinas (a follower of Aristotle) arguing for the opposite view of an infinite past.

Thomas' contemporary, St. Bonaventure, however, argued again for a *finite* past, and it is with Bonaventure that we start to see some mathematical sophistication.[27] Bonaventure argued that in a world infinitely old, the Sun would have made an infinite number of its annual trips around the ecliptic. But for each such trip the Moon would have made twelve monthly trips around the Earth, and so this second infinity would be twelve times as great as the first one, and how could that be? Infinity is infinity, and how can something be twelve times bigger than infinity? This argument doesn't have any strength today because of the nineteenth century German mathematician Georg Cantor's work on the concept of infinity,[28] but it *is* clever. Agonized, convoluted theological analyses of God, infinity, and eternity continued long after Aquinas and Bonaventure. Two examples should capture the spirit of those times.

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[25]G. J. Whitrow, "On the Impossibility of an Infinite Past," *British Journal for the Philosophy of Science*, March 1978, pp. 39–45. Whitrow adds modern scientific support to the idea of a finite past by citing the prediction from general relativity of a singularity in spacetime at some finite past time; that is, the theory's prediction that time—and everything else—had its beginning in the now famous Big Bang.

[26]C. Gross, "Twelfth-Century Concepts of Time: Three Reinterpretations of Augustine's Doctrine of Creation *Simul*," *Journal of the History of Philosophy*, July 1985, pp. 325–338.

[27]See, for example, L. Sweeney, "Bonaventure and Aquinas on the Divine Being as Infinite," *Southwestern Journal of Philosophy*, Summer 1974, pp. 71–91, and S. Baldner, "St. Bonaventure on the Temporal Beginning of the World," *New Scholasticism*, Spring 1989, pp. 206–228.

[28]For simple high school-level presentations on Cantor's astonishing infinity results, see my book *The Logician and the Engineer*, Princeton 2013, pp. 169–171.

Consider first this one, on the supposed immortality of the soul. If $A = B$, then $2A = 2B$. Next, let A = 'half alive' and B = 'half dead,' where $A = B$ in the same sense that a glass half-full is also half-empty. Thus, to be completely dead is to be completely alive, and so the soul is immortal. Outrageous? *Yes*, in my opinion, but I do also have to admit the 'reasoning' does have a certain charm!

For my second example, let me begin by setting the historical stage. After publication of the English political philosopher Thomas Hobbes' *Leviathan* in 1651, with its arguments against the power of the Church and for civil power (with some criticism tossed in, as well, for universities), Seth Ward counterattacked. Ward, who was both a minister (later a bishop) in the Anglican Church and Savilian Professor of Astronomy at Oxford, was greatly offended by the secular nature of *Leviathan*. Even before Leviathan, in fact, Ward certainly would not have liked Hobbes' earlier denial of the existence of immaterial substances (such as souls). Ward's 1652 book *A Philosophical Essay Towards An Eviction of the Being and Attributes of God, the Immortality of the Souls of Men, the Truth and Authority of Scripture*, was the first of a two-punch reply to Hobbes. The second came in 1654 with the appearance of Ward's *Vindiciae academiarum*. In both of these works Ward attempted to undermine Hobbes' credibility by attacking his mathematical ability. (Hobbes had long been fascinated by, and was considered an expert on, the ancient problem of 'squaring the circle,' a task that has been known to be impossible only since 1882.[29]) In his *Essay*, Ward also attempted to defend the view that the world has a finite age—that is, it had a specific moment of creation, presumably by God. In an opening note, in fact, Ward cites Hobbes' rejection of immaterial substances as the motivation for his writing *Essay*.

To support his view of a finite age for the world, Ward invoked infinity in an interesting way. He argued that nothing is permanent, certainly not humans. Each is created; one can imagine tracing a chain of creation events backward in time through successive generations. Now, there are only two separate and distinct possibilities to where this chain could lead to in the past. First, it could terminate, after a finite number of generations, at a *first* generation, that is, with the 'creation' of the first human. If that is the case, then, said Ward (in effect), 'case closed.' If that is not the case, however, then the chain of successive generations never terminates, that is, the chain is infinitely long. But that, argued Ward, is nonsense—how could anything *infinitely* long have an end (our present *now*)?

Why Ward thought this an unanswerable paradox is hard to understand; after all, one can imagine a line in some coordinate system *beginning* at the origin and yet still being infinitely long (an example is the positive x-axis). This counter-example was not put forth by Hobbes in his own self-defense, but rather was offered by one of Ward's own colleagues at Oxford, John Wallis, the Savilian Professor of Geometry. As for Hobbes, he was little bothered by Ward's argument. As he pointed out (surely with a smile on his face), Ward was in danger of impaling

[29]The problem of 'squaring the circle' is, given a circle of area A, to construct (using only compass and straightedge) a square of area A.

himself as a theologian on his own sword: Ward's argument 'proved' the finite age not only of the world but of *everything*, including God (thus raising the awkward question of who, or what, made God?).

Similar problems with infinity lay behind Kant's rejection of an infinite past. It is interesting to note that Kant, somewhat paradoxically, thought an infinite *future* a possibility. Why did Kant think time could be infinite in one direction but not in the other? One philosopher tells us[30] that Kant "failed to make himself clear," and I think that *understates* the case. I say that because Kant's argument was that the duration of the future is less problematic than is that of the past because it is only the past that influences the present. The best I can do in 'explaining' this is to speculate that if the present depends on an *infinite* past, then perhaps Kant thought that the possibility of so much influence was simply too much for the present to handle! In any case, Kant's view falls apart if we consider the possibility of backward time travel and the resulting implication that the future could also influence the present.

There is, as will come as no surprise, a philosopher for every conceivable point of the compass, and so a paper by one on the logical possibility of an infinite past soon prompts a rebuttal by another.[31] In illustration of this, you'll recall the quote from Augustus De Morgan in the opening section of this book, concerning the philosophers of his times; De Morgan went on in his critique to amusingly summarize the metaphysics of those times as follows: "Here we go up, up, up,/And there we go down, down, down,/Here we go backwards and forwards/And there we go round, round, round."

So, with De Morgan's words in mind, here are a few more examples of how people have struggled with the issue of the past. One quite interesting, *scientific* twist on the duration of the past was pointed out before the exchange between Smith and Ells. In a paper[32] observing that although general relativity and its predicted spacetime singularity in the distant past may indeed allow for a finite past, that does not completely close the door to the possibility that the Big Bang was a continuation from a previous contraction phase of the universe, and so on, *ad infinitum*. (You'll recall the discussion in Chap. 1 of this idea in science fiction: see note 53 in that chapter.) To quote T. S. Eliot (from his "Little Gidding"):

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[30] J. Bennett, "The Age and the Size of the World," *Synthese*, August 1971, pp. 127–146. See also Q. Smith, "Kant and the Beginning of Time," *New Scholasticism*, Summer 1985, pp. 339–346.

[31] See, for example, Q. Smith, "Infinity and the Past," *Philosophy of Science*, March 1987, pp. 63–75, and then read E. Ells, "Quentin Smith on the Infinity of the Past," *Philosophy of Science*, March 1988, pp. 453–455. Smith's paper "The Uncaused Beginning of the Universe" appeared in this same issue (pp. 39–57), stating that he believed, *really*, only in the *logical* possibility of an infinite past and that the universe had in fact originated in an uncaused (no God required) Big Bang singularity. And, indeed, he *had* so argued for a finite past, in "On the Beginning of Time," *Nous*, December 1985, pp. 579–584.

[32] R. Weingard, "General Relativity and the Length of the Past," *British Journal for the Philosophy of Science*, June 1979, pp. 170–172.

"What we call the beginning is often the end
And to make an end is to make a beginning.
The end is where we start from."

Even without entertaining such an oscillating, accordion-like universe that endlessly expands and shrinks, it is possible to have a universe that originated in a *single* Big Bang a finite time ago in the past but yet *has no first instant*! This astonishing statement shocks most at first encounter, but it is simply the cosmological version of a well-known mathematical result. The instant $t = 0$ is not actually part of spacetime, because the Big Bang was quite literally a singular event for which the laws of spacetime physics fail. Thus, all instants in time are greater than zero—and there is no smallest number greater than zero. If you name a positive number, no matter how small, I can name a positive number still smaller, such as one-half of yours. (Of course, if there really is merit to the idea of a quantum of time, the chronon, this argument goes out the window.)

In an ingenious observation that seems to have been missed by most philosophers, E. A. Milne, a professor of mathematics at Oxford, suggested in his 1948 book *Kinematic Relativity*, that with general relativity it is conceivable to have both a single Big Bang a finite time ago *and* an infinite past. Pointing out that to talk meaningfully of time implies that we have a clock to measure it by, Milne looked for a Universal Clock that would be far more durable than our heartbeats, or anything else that exists only transiently. He suggested the expansion rate of the universe itself as the ideal clock. As we go back in time to the Big Bang, the expansion rate rises towards infinity and, as another analyst put it, "We see the Universe ticking away quite actively. *The Universe is meaningfully infinitely old because infinitely many things have happened since the beginning*."[33]

The debate over the length of the past in modern times can be just as contentious as it was in medieval times. For example, in his editorial ("Down with the Big Bang") of August 10, 1989, the then editor of *Nature* (John Maddox) declared the standard explosive model of the universe to be "philosophically unacceptable," because "the implication is that there was one instant at which time literally began and so, by extension, an instant before which there was no time." For Maddox, this meant that the Big Bang "is an *effect* [my emphasis] whose *cause* [my emphasis] cannot be identified or even discussed." The usual (non-time travel) use of the words *cause* and *effect* is that the cause happens first and then the effect occurs—but if the Big Bang (the effect) is the origin of time, then how (asked Maddox) could there be a cause of the Big Bang *before* that beginning?[34]

[33]C. W. Misner, "Absolute Zero of Time," *Physical Review*, October 1969, pp. 1328–1333. In this view cosmic time is taken as proportional to the negative of the logarithm of the normalized volume of the universe ($V = 1$ represents maximum volume, and so time 'stops' at the end of the universe's expansion). Thus, because V goes to zero as we go backward in time, time runs ever faster as we travel ever further into the past. This puts the Big Bang (with $V = 0$) infinitely long ago.

[34]This was not a new insight, of course, as Aristotle had long ago (in his *Physics*) declared an instant in time with no predecessor to be an absurdity.

The answer is obvious *for creationists*, of course—God did it. Creationists avoid the question of God's cause, however, saying only that 'He needs no cause,' or even that 'He made Himself'! It is these standard (ridiculous) responses from creationists that Maddox said had prompted his editorial against the Big Bang, because creationists *embrace* the Big Bang as it seems to endorse their position of 'science by imagination.' Whatever the truth of that, I think juxtapositioning the *scientific* Big Bang model of the universe with theological metaphysics and the pseudo-science nonsense of creationism to be terribly unfair.

When will the philosophical debates on the age of the past end? Not until the end of the (infinite?) future, is my wager!

2.3 Cause and Effect

> "There are few paradoxes which have been resolved so often as the time-asymmetry paradox."[35]

The philosophical literature is full of discussions about potential causal relationships between events. One of the most famous of these discussions, illustrating that cause and effect can be pretty slippery concepts, asks what at first appears to be an almost trivial question: Did the death of Socrates cause the widowhood of Xanthippe? The quick and easy answer is "Of *course*—she was his wife and it was his death that causes us to say she was then a widow. What could be more obvious?" One philosopher has provided some interesting commentary, however, that might make you reconsider, or to at least become aware of how different are the questions concerning time that are of interest to physicists and philosophers.[36]

Suppose we agree that there are two events to be considered; Socrates ceasing to live, and Xanthippe becoming a widow. Those events occurred at different places (in prison, and wherever Xanthippe happened to be). Then, as Kim asserted, "the two events occur with absolute simultaneity . . . [and so] we would have to accept this case as one in which causal action is propagated instantaneously through spatial space." (As we'll discuss in Chap. 3, the *relativity* of distant simultaneity weakens this assertion, but we'll take that up later.) For now, it is the conclusion that Kim draws from the assertion that interests us here: just *what* is propagating instantly? If it isn't mass-energy (as 'widowhood' would appear not to be!) then special relativity isn't bothered and physicists are happy. But those same physicists might also scratch their heads over *why* philosophers even wonder about such a question, because isn't becoming a widow just another way of saying that Socrates died and so we really don't have *two* events, but just one? In other words, for physicists this really isn't a question about cause and effect at all!

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[35] J. Hurley, "The Time-Asymmetry Paradox," *American Journal of Physics*, January 1986, pp. 25–28.

[36] J. Kim, "Noncausal Connections," *Nous*, March 1974, pp. 41–52.

The central puzzle of time travel to the past is its apparent denial of causality—that is, its denial of the belief that we live in a world where every effect has a cause and that the cause happens first. *First* we flip the switch and *then* the kitchen light comes on. It is *never* the other way around. So deeply embedded is the temporal ordering of cause and effect in our feelings about how the world—and all the rest of the cosmos—works, that the Australian philosopher John Mackie (1917–1981) called causation the "cement of the universe" (and used that wonderful phrase as the title of a 1980 book). Without causality, said Mackie, everything would come unglued and fall apart. For example, when electrical engineers design an electronic system that they intend to actually construct (as opposed to doing a mere theoretical 'paper design') they insist that the design be a *causal* one. By that they mean the system must have no output before an input is applied. That is, the system must not be able to anticipate (foresee) the application of an input. To put it bluntly, our engineers are insisting that they are *not* building a time machine!

Now all that might seem to be self-evident, but there *are* some subtle problems. For example, it has become almost a cliché to say that nothing can go faster than light; that's what physicists mean by *relativistic causality*. In other words, no cause can produce an effect at a distant location sooner than the time lapse required for a light pulse to make the trip. Classical mechanics, however, the science of Newton's laws that engineers use all the time, is *not* relativistically causal. Push the left end of a rigid rod, for example, and the right end moves *instantly*. Most of the time the lack of this form of causality causes no problems, but the fact remains that the mechanics all engineers (and physicists, too!) learn first in school is flawed on a fundamental level. A rigid rod is an impossibility in Einstein's mechanics.

Indeed, it is interesting to speculate about how, after a discussion of causality, a traditional engineering professor would respond if challenged on this issue by a bright student. Causality might not look so obvious, after all, if such a student stuck up her hand in class and said "Professor, you've told us that everything that happens in nature is due to a cause. That what we see happening all around us, as the world unfolds, is the domino-process of cause-effect-cause-effect, and so on, into the future. But suppose, Professor, that at some instant, somehow, every particle in the world suddenly reversed its velocity vector. Wouldn't that mean, given the time-reversible nature of the classical equations of motion, the world would then run backward in time along the same path it had followed up until the instant of reversal? Wouldn't that mean what was effect is now cause, and that what was cause is now effect? And if cause and effect can change roles like that . . . well, Professor, just what do our words *mean*?"

An amusing, and instructive, cartoon illustration of the student's idea of reversing all the velocity vectors in a system appeared on the cover of the November 1953 issue of *Physics Today*. That issue contains an article on the 1949 nuclear magnetic resonance experiments performed by the American physicist Erwin Hahn, which in a certain sense dealt with just such reversed systems. In that illustration a group of runners on a multi-lane circular race track begin at the starting line in a coherent state, that is, all lined up together. Then, as they run around the track at various speeds, they gradually spread out into what appears to be an incoherent state.

But that incoherence is an illusion because if, at some instant (signaled in the cartoon by a pistol shot), they all turn around and run in reverse, they will all arrive back at the starting line *together, at the same instant*. The initial coherence of the runners was actually never lost, despite the superficial appearance of disorder, and the coherent state can be recovered at any time by a reversal of velocity vectors.

This isn't mere theoretical speculation, as an almost magical application of velocity vector reversal is actually used in what is called *optical phase conjugation*, a process to 'time-reverse' the severe distortion suffered by light beams during atmospheric propagation. For example, by effectively reversing the velocity vectors of photons, one can remove the turbulence blurring in satellite pictures of the Earth's surface as seen from space.[37]

Let me immediately short-circuit one possible answer our beleaguered professor might give in desperation, a response based on the fact that equations of physics are *not* all time reversible. Indeed, it was discovered decades ago that, in certain very rare, fundamental particle decay processes involving neutral K-mesons, there is the hint that perhaps nature *can* indeed distinguish between the past and the future. In particular, K-mesons should violate what is called *CP-symmetry*, and the so-called TCP theorem[38] says that then *T-symmetry* must also fail. In 1968/69 direct, experimental observation of the failure of T-symmetry in K-meson decays was reported. In an astonishing example of science fiction prescience, the use of K-mesons in a machine for affecting the past had appeared years earlier in a 1955 (!) story.[39]

So, could K-mesons account for the physical processes that we see evolve in time in one direction (past to future) but not in the other? As Hurley (note 35) put it so nicely, "The decay of the neutral K-meson is not time-reversal invariant; perhaps it is this ubiquitous meson which is responsible for the cream diffusing uniformly throughout our coffee in the morning. Possibly, but again this conjecture cannot account for the computer models [of diffusion processes that, like cream in coffee, also display a bias for one temporal direction over the other—in Chap. 3 I'll show you such a computer model] which have no neutral K-mesons." Still, the tiny chink that K-mesons appear to have made in the once-solid rock of time direction indistinguishability is an active area of research and speculation.

Even with that chink the fact that the classical laws appear to be insensitive to a direction of time, whereas the real world—which seems in no way dependent on the arcane properties of K-mesons—seems distinctly asymmetric, is a puzzle of the first rank. As one philosopher wrote, "The Universe seems asymmetric with respect to

[37]C. R. Giuliano, "Applications of Optical Phase Conjugation," *Physics Today*, April 1981, pp. 27–35.

[38]The TCP-theorem says that the 'mirror-image' of a physical process is a legitimate process, too, *if* the 'mirror' reverses time (T), electric charge (C)—so that particle and anti-particle are interchanged, and parity (P)—which is the measure of left and right. There is strong reason to believe in the validity of the TCP theorem because quantum field theory is compatible with special relativity only if the TCP theorem holds.

[39]F. Pohl, "Target One," *Galaxy Science Fiction*, April 1955.

the past and future in a very deep and non-accidental way, and yet all the laws of nature are purely time symmetric. So where can the asymmetry come from?"[40]

There have of course been attempts to answer that question. For example, one philosopher[41] discusses some curious mathematical examples he interprets as meaning, in the context of classical mechanics, that there are physical systems that are temporally irreversible *in principle*. A reply[42] from a fellow philosopher, however, argues that Hutchinson has, at most, shown only that classical mechanics is perhaps not deterministic. And that, Savitt argues, is not equivalent to showing a failure of time reversibility. There is, in fact, powerful experimental evidence that, with the rare exceptions of K-mesons, the classical laws of physics (including general relativity and quantum mechanics) *are* time-reversible.

Perhaps the most compelling of such evidence comes from the *reciprocity theorem* that electrical engineers routinely use when designing radio antennas. The theorem is easy to illustrate. Suppose two electrical engineers, Bob in Boston and Lois in Los Angeles, send radio signals to each other. Bob sends his messages by exciting his antenna with a time-varying current, which thus launches electromagnetic radiation into space. Lois' distant antenna intercepts some of that radiation, which then creates a (very tiny) signal current in her antenna.

The reciprocity theorem states the following: Suppose Bob makes a tape recording of his excitation signal and mails it to Lois, who then plays Bob's tape back into her transmitter as the excitation to *her* antenna. Then the signal current induced in Bob's antenna, as it intercepts Lois' launched radiation, will be the very same (very tiny) signal that Lois measured in her antenna as a result of Bob's transmission. This result is completely independent of the details of the two antennas, which can be utterly different in design, as well as independent of the details of the propagation path between Boston and Los Angeles (as long as those details don't change with time). The reciprocity theorem *is* true—it can be *measured* to be true as accurately as one wishes to perform this experiment—because of the reversibility of physics right down to the electronic level. In fact, the answer to the professor's problem of explaining why we don't see velocity vectors suddenly reverse, and then everything 'run backwards,' has not yet been found in any law of physics.

Now, to make things even more interesting, consider the problem of *mutual* or *simultaneous* causation, which can quickly lead to several interesting questions. When two leaning dominoes, A and B, hold each other up, is A nearly upright because of B, or is it B that is nearly upright because of A? When two children bob up and down on a see-saw, whose motion is the cause and whose is the effect? There are other puzzles, too, that involve mutual causation.

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[40]J. Earman, "The Anisotropy of Time," *Australasian Journal of Philosophy*, December 1969, pp. 273–295.

[41]K. Hutchinson, "Is Classical Mechanics Really Time-Reversible and Deterministic?" *British Journal for the Philosophy of Science*, June 1993, pp. 307–323.

[42]S. F. Savitt, "Is Classical Mechanics Time-Reversal Invariant?" *British Journal for the Philosophy of Science*, September 1994, pp. 907–913.

For example, causation is usually thought to be transitive: if A causes B, and if B causes C, then A causes C. But if A and B are mutually causative, then 'A causes B' coupled with 'B causes A' leads to 'A causes A' (and to 'B causes B'). That is, mutual causation, together with transitivity, seems to imply *self*-causation! Except for those theologians who like this sort of result (it lets them answer the question 'Who made God?' with 'He made Himself'), hardly anyone likes self-causation. But how do we avoid the conclusion that perhaps the mutual causation of two leaning dominoes, coupled with transitivity, represents experimental proof that God could have made himself? Well, of course this is certainly outrageous stuff, but don't you wonder how our poor professor would respond if asked?

This last example is actually a far more esoteric one than we need to illustrate how our ordinary, everyday concept of cause and effect can be turned inside out by going only a little bit beyond the routine. Consider, for example, the problem of the data processing of recorded time signals, such as the information written onto magnetic tapes, hard drives, or disks. Typical applications that produce such recordings include the strata-probing seismic echoes from dynamite explosions set by oil exploration geologists; arms control compliance monitoring stations that listen for the acoustic rumbles generated by both earthquakes and underground nuclear tests—and then try to tell one from the other; and the gathering by various military intelligence agencies of turbine shaft/propeller noise signatures emitted by different types of submarines. In each of those situations, the raw information is recorded and then later processed with a certain degree of unhurried calm and leisure. That pool of oil, after all, has been underground for several hundred million years, and waiting a few more days or weeks for a computer analysis of the explosion echo isn't going to make much difference.

Such after-the-fact processing of recorded data is said to be done 'off-line, in non-real time.' When we play a disk back in the lab, however, we can do all sorts of neat things, like speed up the playback (make time 'run fast'), or slow it down (make time 'run slow'), or even play it *backwards* (make time 'run in reverse'). For various technical reasons, generically called *spectrum shifting*, such tricks are often quite useful. Now, the way we retrieve magnetically recorded information from (for example) a magnetic tape, is to run it through a playback machine with a 'read-head' that senses the magnetic flux variations. The electrical signal produced by the read-head is just like the original signal and, in fact, we can pretend we don't know it is really coming off a tape, but rather that it *is* the original signal. For high-quality digitally recorded tapes and disks, in fact, it is virtually impossible to distinguish the original from a playback.

Now, suppose we construct our playback machine with *two* read-heads, with the new head sensing the recording slightly *before* the old head does. The two heads produce the same electric signal, of course, but the signal from the new head is *ahead* in time compared to the signal from the old head. The new head is, in a certain sense, 'seeing the future' of the old head! We can use these two signals, the old head representing 'now' time and the new head representing 'future' time, to build real systems that are *not* causal. The causality violation occurs in non-real time, of course, not *our* time, but no matter; some absolutely astonishing signal

processing can be achieved this way. The universe is about fifteen billion years old, and pretending that time has shifted a few milliseconds or so doesn't seem to be too much violence to reality.

Two heads are often used on radio call-in talk shows to catch inappropriate remarks from intemperate callers and prevent them from being broadcast. A short time delay is introduced by first recording remarks 'live' on tape with a write head and, then a few seconds 'up-stream,' a read head regenerates the remarks for broadcast. A 5 s delay is generally sufficient, so what is heard on a radio receiver *now* actually occurred 5 s ago in the *past*. A caller can get terribly confused if she doesn't turn her own receiver off, because one ear hears the present on the telephone while the other ear listens to the past over the radio.[43] The 1956 British film *Timeslip* incorporates a similar situation, with an atomic scientist's perception advanced 7 s into the future as the result of an accidental radiation exposure. His resulting confusion and disorientation is the center of the film.[44]

2.4 Backward Causation

> "Causation as a topic of philosophical discussion refuses to die. Each year, books and articles on causation continue to pour forth. Of course, all this activity may simply be a symptom of the necrophilia that infests so much of philosophy."[45]

All of the previous discussion has fueled countless arguments about what is called *backward*, *reverse*, or even *retro* causation. What is generally meant by forward causation is, of course, that any event that occurs at time t is caused by events that all occurred at some earlier time(s). Backward causation says that at least one of the causing events occurs after time t—this should make it clear that backward causation is a close relative of time travel. Indeed, one philosopher uses the terms *time traveler* and *retro-causal engineer* interchangeably.[46] The topic, understandably, is at the root of many hot philosophical debates, though not everybody (as this section's opening quote makes clear) thinks those debates are illuminating.

Just *why* does Professor Earman take his harsh position? He offers, as one reason, his disdain for the common philosophical 'proof' of the impossibility of

[43]A science fiction use of this idea is in B. W. Aldiss, "Man In His Time," *Science Fantasy*, April 1965, the story of an astronaut who returns from a trip to Mars and finds himself 3.3077 min ahead of everybody else.

[44]Science fiction had used a twist on this idea long before the film; see E. Binder, "The Man Who Saw Too Late," *Fantastic Adventures*, September 1939, a tale of what it might be like to have a 3 min *delay* in your vision.

[45]J. Earman, "Causation: A Matter of Life and Death," *Journal of Philosophy*, January 1976, pp. 5–25.

[46]B. Brown, "Defending Backwards Causation," *Canadian Journal of Philosophy*, December 1992, pp. 429–443.

backward causation: By definition, a cause is always before its effect. Yes, that's the entire 'proof.' One can, of course, win *any* argument by *defining* the answer to be what it is you wish to believe. More interesting, and certainly more pertinent to time travel, is the argument that if backward causation were possible then one could change the past—but that cannot be done because the past is dead and gone and thus unchangeable. That does seem to be a pretty solid argument against backward causation,[47] but Earman rebuts it by pointing out that the very same logic could be applied to the future, and so the usual, uncontested forward causation would also be denied. That is, one could argue that whatever the future will be, *will be* (literally 'by definition'), so one cannot change the future. A similar argument was presented even earlier,[48] in which we find "suppose that someone says 'I can change the future. I can do *this* or I can do *that*.' Well, then, suppose that he does *that*. Has he changed the future? No, because doing *that* was the future."

The reversal of the 'usual' causal order of events by backward time travel has been a mainstay of science fiction almost from the start of the genre. Consider, for example, this tale.[49] A man on vacation by himself, without his wife along, meets a young lady—and they fall in love. The man loves his wife, too, though, and he realizes (as the young lady leaves him for the last time), never to return, that it is all for the best. But she really hasn't gone that far away from him, as the reader soon discovers. She is a time traveler from the future, and after leaving him she goes even further back in time, back an additional 20 years. She does this because she has learned that he met his wife 20 years ago, and so she goes back to be *that* woman! Thus, the usual causal order of the two events 'a long marriage' and the 'pre-marriage courtship' has been reversed (if we accept the fact that the man doesn't remember what his wife looked like when they married).

Actually, even our everyday uses of cause and effect are not nearly so straightforward as one might think, even when they are under far less stress than backward causation and time travel inflict. Consider, for example, the endless problems that are easy to imagine in the legal world. If a man falls off the roof of a ten-story building and is electrocuted as he plunges through power lines while still twenty feet above ground, was gravity or electricity the cause of death? Or was it both? As this example and others demonstrate,[50] one clearly does not have to discuss time travel to get into a serious argument about cause and effect. But with time travel, and the resultant backward causation, things can become even more perplexing. For example, we normally think it foolish to prepare, now, for an event that has already

[47]See, for example, D. H. Mellor, "Fixed Past, Unfixed Future," in *Michael Dummett: Contributions to Philosophy* (B. M. Taylor, editor), Martinus Nijhoff 1987.

[48]J. J. C. Smart, "A Review of *The Direction of Time*," *Philosophical Quarterly*, January 1958, pp. 72–77.

[49]R. F. Young, "The Dandelion Girl," *The Saturday Evening Post*, April 1, 1961.

[50]See also P. Mackie, "Causing, Delaying, and Hastening: Do Rains Cause Fires?" *Mind*, July 1992, pp. 483–500.

happened, but the prudent time traveler about to visit an ice age in the distant past would be wise to pack a fur coat before getting into his time machine!

One philosopher provides, I think, a good start at explaining why so many other philosophers (and not just a few physicists) have adopted the 'common sense' position of rejecting backward causation. As he writes, "Part of the answer, no doubt, is a confusion between affecting and altering [the past—a distinction we'll discuss at length later in this book]. We cannot alter the past. But then we cannot alter the future either, although we can affect it. However, I take the common-sense rejection of backward causation to be, for the most part, quasi-empirical. It is based on a thought experiment. Think how you would set about affecting the past. By building a time-machine, perhaps? But how would you build one? We have no idea how to start. Yet, by contrast, we can work out how to affect the future . . . we just move our bodies."[51] But, as he goes on to argue, if we accept that we can't *change* the past (which means there is no way we could actually observe backward causation), then there still exists the possibility that past events were as they were because of events in the future.

Are there actual phenomena that justify a belief in the possibility of effect before cause in real time (not just in tape recorder time)? The only example I know of, and a controversial one at that, is a theoretical result from a reformulation of electrodynamics by the great English physicist Paul Dirac (1902–1984). Classical theory models electric charges as point objects of zero size, which causes problems when one tries to calculate certain details, such as the total field energy of a single electron. The answer comes out as infinity. In an attempt to find more reasonable (that is, finite) answers to such questions, Dirac modified the zero size of a charge to one taking them to be extended objects (while retaining the validity of Maxwell's equations for electrodynamics right down to a point). To calculate how such extended objects will behave mechanically, however, one has to include what are called the *self-interaction* forces, such as the force one side of an electron exerts on the other side.

When it was all worked through, Dirac arrived at a third-order differential equation of motion, an equation that involves a force term proportional not to the usual first time derivative of the velocity (that is, to the acceleration), but rather to the second derivative.[52] This force is proportional to the first derivative of the acceleration, and is a quantity of direct interest mostly to the designers of automobile suspensions, who call it the *jerk*. There is no force in physics, at least not in Newtonian physics, that shows that sort of dependence, and there are some curious consequences. For example, in Dirac's theory an electron experiencing no external force can still continually accelerate, exhibiting what is called a 'runaway solution.'

Dirac showed how the runaway solution can be eliminated by picking a particular value for what up to then was an arbitrary constant of integration in the

[51]P. Forrest, "Backward Causation in Defense of Free Will," *Mind*, April 1985, pp. 210–217.

[52]P. A. M. Dirac, "Classical Theory of Radiating Electrons," *Proceedings of the Royal Society A*, August 1938, pp. 148–168.

analysis, but that trick causes, in turn, a new problem called 'pre-acceleration.' That is, if an electron experiences an external disturbance (Dirac considered a passing pulse of electromagnetic radiation), then the electron will start to move *before* the pulse reaches it! Now that does seem to be a pretty clear example of backward causation. The time interval during which the pre-acceleration occurs is very short, on the order of the time it takes light to travel across the spatially extended electron (about 10^{-24} s), but no matter. The apparent crack in the door of causality may be slight, but it was enough to satisfy some philosophers seeking scientific support for backward causation.

Not everybody liked this, however. One physicist was clearly uneasy about it, calling pre-acceleration "unpleasant" acausal behavior.[53] On the other hand, one can find believers, too.[54] Others have argued that the whole business is simply a non-problem. One philosopher, in fact, raised a very interesting technical point, arguing that Dirac's equation is non-Newtonian (remember the *jerk* force) and so we have no reason for coupling force and acceleration together as a cause-and-effect pair.[55] In Newtonian mechanics we do use that particular coupling, yet we do not think of force and velocity as a cause-and-effect pair because there is an integration operation involved in getting from to the other. Similarly, in Dirac's theory we have an integration operation separating force and acceleration.

One curious aspect to the debate on pre-acceleration is that many commentators seem not to have paid much attention to what Dirac himself had to say about it. As a Nobel laureate, it hardly seems likely that he would let such a result pass unnoticed and, indeed, his paper contains the following physical explanation: "It would appear that we have a contradiction with elementary ideas of causality. The electron seems to know about the pulse before it arrives, and to get up an acceleration ... The behavior of our electron can be interpreted in a natural way, however, if we suppose the electron to have a finite size. There is then no need for the pulse to reach the center of the electron before it starts to accelerate. It starts to accelerate ... as soon as the pulse meets its outside. Mathematically, the electron has no sharp boundary."

Two physicists suggested a fascinating connection between travel backward in time and Dirac's relativistically correct, quantum mechanical description of an electron.[56] They showed that in flat, two-dimensional spacetime the assumption of time travel to the past leads in a natural way to Dirac's equation. If, on the other hand, time travel only into the future is assumed, then additional assumptions are required to derive Dirac's equation. This connection between Dirac's equation and

[53]P. C. W. Davies, *The Physics of Time Asymmetry*, University of California Press 1977.

[54]J. Earman, "An Attempt to Add a Little Direction to 'The Problem of the Direction of Time'," *Philosophy of Science*, March 1974, pp. 15–47.

[55]A. Grunbaum, "Is Preacceleration of Particles in Dirac's Electrodynamics a Case of Backward Causation? The Myth of Retrocausation in Classical Electrodynamics," *Philosophy of Science*, June 1976, pp. 165–201.

[56]D. G. McKeon and G. N. Ord, "Time Reversal in Stochastic Processes and Dirac's Equation," *Physical Review Letters*, July 6, 1992, pp. 3–4.

time travel to the past makes some philosophers and physicists nervous, but it didn't seem to bother Dirac. In fact, he went on in his paper to show how the pre-acceleration implies the possibility of building a device for sending a faster-than-light signal backward in time. Science fiction writers were, of course, quick to grasp that idea and such gadgets were dubbed "Dirac radios."[57]

One of the more perplexing aspects of backward causation is that it seems to allow for the possibility of *causal loops*, and for the breaking of such loops, a central feature in many of the very best time travel stories. For example, suppose there is a gadget such that if I push its control button *now*, then today's lecture notes will have appeared in the gadget's output tray *yesterday*. Indeed, yesterday I found today's notes there and, in fact, I am about to go to class to deliver that lecture. A mighty good one it is, too, so I think I think I'll send it back to yesterday in just a few minutes with the help of the gadget. But I haven't yet pushed the button. What if I now decide *not* to push the button? Why did the notes appear so I could use them today? Philosophers call this potential breaking of a causal loop a *bilking paradox*. Later in the book I'll discuss how such paradoxes have regularly appeared in the physics and philosophy literature since the 1940s.

By contrast, such paradoxes had been discussed in the science fiction magazines long before World War II. For example, in a letter to the editor at *Astounding Stories* (June 1932) a fan clearly stated his objection to time travel with the aid of a bilking paradox. He suggested the following experiment: Immediately publish an open offer to the inventor of time travel (who will be born, presumably, at some future date) to travel back to one week before the offer is published. But of course (argued the fan) we'd have a pretty problem if we then decided not to publish the offer after the inventor showed up! As that fan wrote, "Paradoxical? I'll say so, if time travel is possible." That fan didn't know about what seems to be a generic limitation on time machines, however: that one can't travel back to a date before the date of the time machine's creation. Thus, that fan's particular bilking paradox actually has no force.[58]

For another fictional example of a bilking paradox, consider the story[59] of time travelers who, just before they begin a trip into the future, see Earth invaded by Martians. At first the invaders are unbeatable, but then the defending military forces of Earth suddenly and mysteriously acquire a fantastically powerful new weapon. It isn't long before the time travelers realize where it came from—they themselves will go into the far future, obtain the weapon, and then return with it to what is now their own past (when the weapon first appeared). But then they wonder what might happen if they don't go, if instead they 'cheat time.' After all, they reason, why

[57]See, for example, J. Blish, "Beep," *Galaxy Science Fiction*, February 1954.

[58]A similar bilking paradox had actually appeared the year before in the 1931 novel *Many Dimensions* by the English writer Charles Williams (1886–1945), which reads like a suitable script for an Indiana Jones movie.

[59]E. Binder, "The Time Cheaters," *Thrilling Wonder Stories*, March 1940. There is an amusing reference in this tale to Orson Welles' famous radio-drama-hoax, from just 2 years earlier, of just such an alien invasion based on H. G. Wells' *War of the Worlds*.

bother now to hunt for the weapon when the invasion has already been defeated? We are told that this potential bilking paradox is a "sinister conception, crawling evilly within their brains, like an unanswerable enigma."

Some philosophers, and practically all physicists, agree with that last assessment about bilking paradoxes, and so they believe there is simply nothing more to say. That is, bilking puzzles like the one in "The Time Cheaters" show that causal loops (and backward causation) must be impossible. Many feel this way about time loops, and backward causation, because (as is well known) time travel to the past can create all sorts of paradoxes. But such paradoxes are offensive only to human, culturally-biased intuitions on 'how things ought to work,' and not to the laws of physics which are indifferent to a reversal in the direction of time—which of course underlies what time travel is all about.

As the great American chemist G. N. Lewis expressed it, "Our common idea of time is notably unidirectional, *but this is largely due to the phenomena of consciousness and memory* [my emphasis]."[60] Lewis' words caught the eye of the editor at one science fiction magazine, who summed it up for his readers in a half-page essay that contained dramatic words hinting at backward causation: "A new theory of time . . . reveals the possibility that events now occurring are among the factors that decided Caesar nearly 2,000 years ago to cross the Rubicon."[61]

Lewis' willingness to accept causality violations is not a universally popular view today. For example, one physicist has written[62] that "It is fair to say that most conservative physicists have very serious reservations about the admissibility and reality of causality-violating processes. Causality violation (i.e., the existence of a 'time machine') is such an extreme violation of our understanding of the cosmos that it behooves us to be as conservative as possible about introducing such unpleasant effects into our models." He then goes on to declare closed timelike loops to be verboten because "the existence of closed timelike loops leads us to such unpleasant situations as meeting oneself 5 min ago." He sums up his philosophical position nicely with "any theory that is 'just a little bit causality violating' is 'just a little bit inconsistent.'"

Agreeing with this physicist is at least one philosopher who believes that the "association of causality with a particular temporal direction is not merely a matter of the way we speak of causes, but has a genuine basis in the way things happen" and that there is indeed an asymmetry with respect to past and future that is bound up with our concept of intentional action.[63] He then goes even further when he continues with the claim that being an agent of cause is not a necessary condition for seeing the asymmetry; being an observer is enough, as even an immobile yet

[60]G. N. Lewis, "The Symmetry of Time in Physics," *Science*, June 6, 1930, pp. 569–577.

[61]Editorial essay, "Two-Way Time," *Astounding Stories*, September 1931.

[62]M. Visser, "Wormholes, Baby Universes, and Causality," *Physical Review D*, February 15, 1990, pp. 1116–1124.

[63]M. Dummett, "Bringing About the Past," *Philosophical Review*, July 1964, pp. 338–359.

intelligent tree (!) could detect the difference between past and future. (How he knows this about certain trees is left unexplained.)

The everyday views of causality that we have formed through our limited experiences when living in a world in which time travel is 'uncommon' may actually be incomplete. As the British philosopher Bertrand Russell (1872–1970) said with some humor long ago, in his 1912 Presidential Address ("On the Notion of Cause") to the Aristotelian Society, "The law of causality, I believe, like much that passes muster among philosophers, is a relic of a by-gone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm." And I do agree with his fellow philosopher who, decades later, declared "The concept of cause is powerless to solve the problems posed by the concept of time. The fundamental laws of physics present our most careful, best established and most sophisticated understanding of time. Notoriously, nothing in these laws endorses the idea of a *flow of time nor of the direction* [my emphasis: we'll return to both of these issues later in this chapter] which is basic to our conception of it. Nor are these laws causal (in the sense of singling out causes) even when they are deterministic. The concept of cause is not a fundamental one and cannot illuminate the darker corners in our understanding of the fundamental concept of time."[64]

2.5 The Fourth Dimension

> "We are facing an invasion of fourth dimensional creatures . . . We are being attacked by life which is one dimension above us in evolution. We are fighting, I tell you, a tribe of hellhounds out of the cosmos. They are unthinkably above us in the matter of intelligence. There is a chasm of knowledge between us so wide and deep that it staggers the imagination."[65]
>
> "Fourth dimension. Time factor. *You* know . . ."[66]

The idea of a fourth dimension to *space* has long been a staple of science fiction, but it has also long been viewed with suspicion. Indeed, many quite sophisticated scientists have thought it to be quite mysterious. For example, in his 1897 Presidential Address to the American Mathematical Society, the Canadian/American

[64]G. Nerlich, "How to Make Things Have Happened," *Canadian Journal of Philosophy*, March 1979, pp. 1–22.

[65]From "Hellhounds of the Cosmos," *Astounding Stories*, June 1932, by Clifford Simak (1904–1988). Simak went on to write a number of much better tales, but this passage lends credence to the editorial introduction to the 1957 anthology *Famous Science-Fiction Stories* (Random House) that declared so much in the early pulp science fiction was "science that was claptrap and fiction that was graceless."

[66]Uninformative 'explanation' given to a befuddled, inadvertent time traveler who emerges miles away and one hour backward in time after a wild ride through the fourth dimension in a gadget (constructed from a bicycle tire!) in the shape of a three-dimensional Möbius strip (see note 99 in Chap. 1). From the story by H. Nearing, Jr., "The Maladjusted Classroom," *The Magazine of Fantasy and Science Fiction*, June 1953.

astronomer-mathematician Simon Newcomb (1835–1909) declared "The introduction of what is now very generally called hyperspace, especially space of more than three dimensions, into mathematics has proved a stumbling block to more than one able philosopher." Einstein stated Newcomb's view in blunter terms when he wrote "The non-mathematician is seized by a mysterious shuddering when he hears of 'four-dimensional' things, by a feeling not unlike that awakened by thoughts of the occult."[67]

To see just how right Einstein was with this observation, consider the reaction one Egyptian philosopher had (in 1929) to Einstein's own writings: "We have no doubt in our mind that nobody can understand it (the fourth dimension), including Einstein himself. The incomprehensibility of these assumptions [of general relativity] is due to their nature. They deal with the fourth dimension . . . and the reality of time and space. They can only be described by a mathematician's hypothesis or by religious faith."[68] This reaction is easy to understand—after all, anybody can 'see' that there are exactly three spatial dimensions, and that is that!

The 1901 novel *The Inheritors*, by the English writer Ford Madox Ford (1873–1939), like Simak's, is the tale of an insidious hyperspace invasion of our world. It illustrates Einstein's assertion about how many people react to the fourth dimension with an example from the time before the science fiction magazines. When the novel's narrator is bluntly told by an invader that she (the invader) is from the fourth dimension—an idea inspired by Ford's appreciation of how much success his acquaintance H. G. Wells had enjoyed with it—he recoils from that claim with the words "If you expect me to believe you inhabit a mathematical monstrosity, you are mistaken." And who can really blame that skeptical narrator? How can there be *four* spatial dimensions? No less an authority than Aristotle, writing in 350 B.C., had declared in his essay "On the Heavens" that "the three dimensions are all that there are."

Others were not so sure. In 1873, for example, we find an essay in *Nature* that refers to well-known mathematicians who even earlier had shown that they had an inner assurance of the reality of transcendental space (hyperspace).[69] The American philosopher Charles Sanders Peirce (1839–1914) was also an early advocate for the four-dimensionality of space. Just what he thought the nature of the fourth dimension to be is somewhat unclear, but the context of what he said suggests he took it to be spatial. He thought three-dimensional space to be "perverse" because of the existence of incongruous counterparts (such as left- and right-handed gloves), and this was apparently strong evidence for him that space could not be three-dimensional. Now, incongruous counterparts exist in all n-dimensional spaces, but Peirce preserved the special purity of the fourth dimension by suggesting that all physical objects, although capable of motion in the fourth direction, could

[67]A. Einstein, *Relativity: the Special and General Theory*, Crown 1961, p. 33.

[68]From A. A. Ziadat, "Early Reception to Einstein's Relativity in the Arab Periodical Press," *Annals of Science*, January 1994, pp. 17–35.

[69]G. F. Rodwell, "On Space of Four Dimensions," *Nature*, May 1, 1873, pp. 8–9.

themselves have no extent in that direction (remember, Peirce was a philosopher, not a physicist, and he offered no experimental support for any of this).[70]

But is it *really* possible that there could be *four* spatial dimensions? We experience three independent directions, each lying at a right angle to the other two—but why just *three*, and not ten or fifteen? Indeed, in an 1888 talk to the Philosophical Society of Washington, Simon Newcomb dismissed the view that space must necessarily be three-dimensional as an "old metaphysical superstition." Yet, despite Newcomb's open-mindedness, it has been shown that in the framework of classical physics there are, in fact, several powerful reasons for why there must be *exactly three* spatial dimensions.

The beginning of a scientific explanation for the dimensionality of space appears in Kant, who believed the *three* dimensions of space and Newton's inverse-square law for gravity are intertwined (but he offered nothing beyond philosophical speculation). The origin of Kant's view is actually quite old, dating back to the ancient Greeks, who had already begun to suspect that there was something special about *three* dimensions, at least as far as geometry was concerned. They knew of the infinity of regular two-dimensional polygons, but that there were just five regular polyhedrons in three dimensions (the so-called *Platonic solids*). This early observation was trapped in mystical speculations, however, and it wasn't until the development of physics as a science that non-mystical discussions on the dimensionality of space began to appear.

Beginning with the work of Einstein's friend, the Austrian/Dutch physicist Paul Ehrenfest (1880–1933) in 1917, we can find the idea that the Poisson-Laplace equation, a second-order partial differential equation that describes the potential functions for both Newtonian gravity and electrostatics, does not allow for stable planetary or electronic orbits in *any* space with dimensionality greater than three. Further, the distortionless, reverberation-free propagation of both electromagnetic and sound waves is possible only in spaces of dimensions one and three. These conclusions have been shown to hold even when we go beyond nineteenth century physics into general relativity and quantum mechanics.[71]

Using a slightly different approach, a biological-topological argument for why space cannot have fewer than three dimensions exists. In all of our common experience, complex intelligent life is always found to occur as an aggregate of a vast number of elementary cells, interconnected via electrical nerve fibers. Each cell is connected to several others, *not all immediate neighbors*, by these fibers. If space had only one or two dimensions, then such highly interconnected nets of cells would be impossible because the overlapping nerve fibers would have to intersect, which would result in their mutually short-circuiting one another.

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[70]R. R. Dipert, "Peirce's Theory of the Dimensionality of Physical Space," *Journal of the History of Philosophy*, January 1978, pp. 61–70.

[71]See, for example, I. M. Freeman, "Why Is Space Three-Dimensional?" *American Journal of Physics*, December 1969, pp. 1222–1224, and L. Gurevich and V. Mostepanenko, "On the Existence of Atoms in n-Dimensional Space," *Physics Letters A*, May 31, 1971, pp. 201–202.

It wasn't long before these views on the dimensionality of space found their way into science fiction. An early use of space as four-dimensional occurs in an awkward rewrite of Jules Verne's *Around the World in Eighty Days*, in which a professor and his crew fly into hyperspace and around the world and to the moon and back, in less than a day.[72] They do this with a plane equipped with a four-dimensional rudder! More interesting is the tragic story (originally published in 1926) of a math professor who learns how to move into hyperspace and back.[73] A colleague catches him at it and, once over his astonishment, asks what is behind it all. The professor replies, "My assumption is that the fourth dimension is just another dimension—no more different in kind from length, say, than length is from breadth and thickness, but perpendicular to all three. Now suppose that a being in two dimensions—a flat creature, like [a moving shadow on a surface]—were suddenly to grasp the concept of a third dimension and so step out of the [surface]. He might move only an inch, but he would vanish completely from the sight of the world."

The professor has similarly learned how to step out of 3-space and into 4-space but, when asked to explain *how*, all he can say is "How can I explain? It's just the *other* direction. It's *there*!" His colleague can't see it, but nonetheless is quick to grasp the practical implications: "This is power! Think of it! A step, and you are invisible! No prison cells can hold you, for there is a side to you on which they are as open as a wedding ring! No ring is secure from you: you can put your hand *round the corner* and draw out what you like. And, of course, if you looked back on the Universe you had left, you would see us in sections, open to you! You could place a stone or a tablet of poison right in the bowels of your enemies!"

What the professor's colleague is getting at involves a comparison with a prison in planar 2-space, which would merely be a circle around the captive. Knowledge of the third dimension would make it possible to escape, however, by simply moving along that new direction, over the circle, and then back into the plane. To a 2-space guard it would seem that the prisoner had suddenly vanished from view *inside* the circle and then just as suddenly materialized again *outside* the circle. Similarly, to escape from a 3-space prison, one would merely move along the fourth dimension, and in the same way one could remove the yolk from an egg without damaging the shell; indeed, one could remove the yolk directly from the chicken without damaging the chicken![74]

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[72]B. Olsen, "Four Dimensional Transit," *Amazing Stories Quarterly*, Fall 1928.

[73]R. Hughes, "The Vanishing Man," reprinted in *The Mathematical Magpie* (C. Fadiman, editor), Simon and Schuster 1962.

[74]This astounding insight appeared in early pulp science fiction in, for example, M. J. Breuer, "The Appendix and the Spectacles," *Amazing Stories*, December 1928. The concept appeared even earlier in Bob Olsen, "The Four-Dimensional Roller-Press," *Amazing Stories*, June 1927, and then later in Olsen's "The Great Four Dimensional Robberies," *Amazing Stories*, May 1928 to rob locked safe deposit boxes, and "The Four Dimensional Escape," *Amazing Stories*, December 1933, in which a man sentenced to die by hanging at San Quentin Prison is rescued, while standing on the gallows' trap, by an inventor who pulls him through the fourth dimension.

In a later tale[75] we meet another professor who dramatically uses this very feature of the fourth dimension. His right hand has been modified through an accident to exist in four-dimensional hyperspace and so, to finance his research, he uses his 'talent' to become the perfect pickpocket, able to reach into any wallet no matter how well secured. He also can, indeed, reach right into the very bowels of his fellow man. And he *does*. When he demonstrates his hand to the policeman who has arrested him for being a thief, the astonished officer chokes on a lemon drop. Dr. Fuddles then, of course, does the right thing and removes the drop from the poor fellow with ease. There is one additional aspect to Dr. Fuddles' hand, however, that the story missed. If he had turned his right hand over in the fourth dimension, then he would have had *two* left hands!

It was discovered in 1827 by Möbius (of the strip) that any three dimensional object can be converted into its mirror image by flipping it over through the fourth dimension. Thus, a left-handed glove can be made by pure geometry (no scissors, thread, or needle required) into a precise copy of its right-handed mate. If a living organism is so flipped, however, there may be a problem, as everything in the body would be reversed, including the optically active organic molecules discovered by Pasteur in 1848, which are involved in vital biological processes. These molecules, called *stereoisomers*, exist in two versions in nature (the left-handed and the right-handed versions, if you will), but our bodies have developed the ability to use only one version. To be flipped through the fourth dimension would make some reversed stereoisomers unable to participate in the digestion of food and we would starve to death.

For modern science fiction writers the fourth dimension (and hyperspace, in general), is still a major concept. One physicist, writing in *Analog* (today's premier 'hard science' fiction magazine), summed up nicely what was so fascinating in early pulp, and still is today, about the idea of an extra dimension or two, or perhaps even more, at least from a fictional point of view: "Are there hidden dimensions not accessible to us, dimensions in which we could go adventuring, dimensions within which malevolent hyper-dimensional aliens may be lurking, ready to pierce our flimsy paper-thin three-space bodies with their terrible hyper-sharp claws?"[76] The early pulp science fiction magazines encouraged this lurid imagery. Witness the editorial blurb that opened one many-dimensional monster story as follows: "It was a strange world in which Lester and Florence found themselves. A world of sudden

[75]N. Bond, "Dr. Fuddle's Fingers," in *Mr. Mergenthwirker's Lobblies and Other Fantastic Tales*, Coward-McCann 1946.

[76]J. Cramer, "The Other Forty Dimensions," *Analog*, April 1985. 'Monsters in hyperspace' stories were numerous in pulp science fiction. Three examples (in no particular order of literary merit!) are: M. J. Breuer, "The Einstein See-Saw," *Astounding Stories*, April 1932; P. Ernst, "The 32nd of May," *Astounding Stories*, April 1935; "The Monster from Nowhere," *Fantastic Adventures*, July 1939.

Fig. 2.1 An experiment in hyperspace goes astray. The young man is pulling on "hyper-forceps" in an attempt to retrieve a surgeon who has fallen out of 3-space (along with his patient, a professor of non-Euclidean geometry, who suffers from gallstones). The hyper-forceps allow the removal of the gallstones without cutting into the body. Illustration by Frank R. Paul, ©1928 by Experimenter Publishing Co. for "Four Dimensional Surgery" (*Amazing Stories*, February 1928) by Bob Olsen, reprinted by permission of the Ackerman Science Fiction Agency, 2495 Glendower Ave., Hollywood, CA 90027 for the Estate

death and strange science, ruled by inhuman beasts."[77] But as outrageous as that might sound, the real physics of hyperspace is even more amazing.

Hyperspace is, in general, simply any space with more dimensions than the one we obviously seem to live in. In particular, our universe appears to be a four-dimensional (three spatial and one temporal) hyperspace called *spacetime*. This four dimensional world can, at least mathematically, be thought of as the boundary surface of a five dimensional hyperspace. This is analogous to the way the two-dimensional space of the surface of a sphere bounds the three-dimensional space of the sphere itself. This interesting imagery appeared quite early in pulp science fiction. For example, in one remarkably sophisticated story, an eccentric scientist at one point exclaims "A mathematical physicist lives in vast spaces . . . where space unrolls along a fourth dimension on a surface distended from a fifth."[78]

There are some interesting geometrical implications to hyperspace which play big roles in time travel considerations. For example, for beings in the two-dimensional world of a sphere's surface there are *two* ways to travel from

[77]M. Duclos, "Into Another Dimension," *Fantastic Adventures*, November 1939. See the illustration for this story in "Some First Words."

[78]M. J. Breuer, "The Gostak and the Doshes," *Amazing Stories*, March 1930.

pole to pole. There is the usual way, *on* the surface of the sphere, and the hyperspace way which takes them *through* the sphere along the polar diameter. In imagery motivated by thinking of the sphere as an apple, and of the hyperspace path as a tunnel bored by a worm through the apple, it has become popular to call all such shortcuts, through any hyperspace of any dimension, *wormholes* (a word coined in the 1950s by the Princeton physicist-wordsmith John Wheeler). Wheeler used wormholes to show how electric charge could be thought of as lines of force trapped in the changing topology of a multiply connected space (indeed, Wheeler claimed that the observation of what we call electricity is experimental evidence that space is *not* simply connected).[79]

The general theory of relativity predicts the existence of wormholes in spacetime and, in fact, they were first 'discovered' theoretically in the mathematics of relativity as early as 1916 by the Viennese physicist Ludwig Flamm (1885–1964). Later analyses were done by Einstein, himself.[80] Wormholes have been discussed as a possible model for pulsars (as opposed to the more usual model as rotating neutron stars).[81] It has also been suggested that the interior of a charged black hole may be the entrance to a wormhole.[82] All of these various solutions to the gravitational field equations are generically called "Einstein-Rosen bridges" in the physics literature (see note 81, for example), and the term soon appeared in fiction, too.[83]

The use of hyperspace wormhole portals for explaining some observed physical phenomenon appeared in the scientific literature long before Wheeler's electricity example. In his 1928 book *Astronomy and Cosmogony*, for example, the British theoretician Sir James Jeans devoted a chapter to what were then called nebulae, the island-universes we now call galaxies. At the end of his discussion on the arms of spiral galaxies, Jeans offered the following speculation: "Each failure to explain the spiral arms makes it more and more difficult to resist a suspicion that the spiral nebulae are the seats of types of forces entirely unknown to us, forces which may possibly express novel and unsuspected *metric properties of space* [my emphasis]. The type of conjecture which presents itself, somewhat insistently, is that the centers of the nebulae are of the nature of 'singular points,' at which matter is poured into our universe from some other, and entirely extraneous, special

[79]A space is simply connected if *all* the points on the straight line that joins *any* two points in the space are also in the space. The interior of a sphere is simply connected. The interior of a sphere with a hole in it is *not* simply connected.

[80]A. Einstein, "The Particle Problem in the General Theory of Relativity," *Physical Review*, July 1, 1935, pp. 73–77.

[81]J. M. Cohen, "The Rotating Einstein-Rosen Bridge," in *Relativity and Gravitation* (C. G. Kuper and A. Peres, editors), Gordon and Breach Science Publishers 1971.

[82]A. Ori, "Inner Structure of a Charged Black Hole: An Exact Mass-Inflation Solution," *Physical Review Letters*, August 12, 1991, pp. 789–792.

[83]See, for example, J. G. Cramer, *Einstein's Bridge*, Avon 1997 (this is the same Cramer cited in note 76). The *Rosen* comes from the American-Israeli physicist Nathan Rosen (1909–1995), who was a collaborator of Einstein's.

dimension, so that, to a denizen of our universe, they appear as points at which matter is being continually created." This, in everything but name, is a wormhole.

What would hyperspace be like? It is intuitively obvious that in the case of the 2-D surface of a 3-space sphere, the 'hyperspace' wormhole path is shorter than the surface path. Even if this 'shorter path' view holds for wormholes in our 4-D spacetime, however, getting around in science fiction hyperspace may not be a simple task. One tale, for example, tells the story[84] of how one of the first spaceships to explore hyperspace gets lost. The trouble with hyperspace travel is that "You go in at one point, you rocket around until you think it's time to come out, and there you are. Where is 'there'? Why, that's the surprise that's in store for you, because you never know until you get there. And sometimes not even then." The same idea plays a central role in Robert Heinlein's 1957 novel *Tunnel in the Sky*, in which a 'hyperspace gate' is discovered by accident during failed time travel experiments.

Another story[85] asks the same question about hyperspace, and arrives at the same answer: "When you took the Jump . . . how sure were you *where* you would emerge? The timing and quantity of the energy input might be as tightly controlled as you liked . . . but the uncertainty principle reigned supreme and there was always the chance, even the inevitability of a random miss . . . a paper-thin miss might be a thousand light-years."

A common way to visualize hyperspace wormhole shortcuts is to imagine the beginning and the end of a journey as points A and B on the 2-D surface of a piece of paper. Then imagine that the paper is folded so as to position A over B, perhaps with A almost touching B. The distance from A to B *through hyperspace* (the 3-D space in which the folding took place) can clearly be much less than is the distance through 'normal' space (the distance covered by a trip that always remains in the 2-D surface). This is the specific example used in one tale to explain the instantaneous "space-warp" (wormhole) device invented by the story's hero.[86] Such imagery actually appeared quite early in science fiction, as in one story in which a gadget is used to "bend space" so that Earth and Venus touch![87]

The idea of hyperspace folding has broken free from science fiction and can now be found in modern stories in other genres. For example, in one Stephen King story ("Mrs. Todd's Shortcut") a woman keeps finding ever shorter ways to drive from Castle Rock, Maine to Bangor. As the crow flies it is 79 miles, but she gets the journey down to 67 miles, and later to 31.6 miles. When doubted, she replies: "Fold the map and see how many miles it is then . . . it can be a little less than a straight line if you fold it a little, or it can be a lot less if you fold it a lot." The doubter remains unconvinced: "You can fold a map on paper, but you can't fold *land*."

[84]F. Pohl, "The Mapmakers," *Galaxy Science Fiction*, July 1965.

[85]I. Asimov, "Take a Match," in *New Dimensions II: Eleven Original Science Fiction Stories* (R. Silverberg, editor), Doubleday 1972.

[86]G. O. Smith, "The Möbius Trail," *Thrilling Wonder Stories*, December 1948.

[87]E. L. Rementer, "The Space Bender," *Amazing Stories*, December 1928.

For the purpose of wormhole creation in spacetime, we actually have to imagine much more: the folding of four-dimensional spacetime through a five dimensional hyperspace. The folding imagery has even appeared in the movies: spacetime folding is demonstrated with a piece of paper in both *Event Horizon* (perhaps the worst movie of 1997) and the 2014 *Interstellar*.

Another feature of hyperspace that science fiction has taken a liking to is its vastness. An interesting fictional treatment of this idea was given by a writer who, in real life, was an academic psychologist at the University of Michigan. He put himself in a story[88] of a starship captain who is explaining to the crew psychologist how he feels about hyperspace (or *subspace*, as it is called in the story): "God forsaken. That's just what it is. Completely black, completely empty. It frightens me every time we make the jump through it . . . it frightens me because—well, because a man seems to get lost out there. In normal space there are always stars around, no matter how distant they may be, and you feel that you've got direction and location. In subspace, all you've got is nothing—and one hell of a lot of that. It's incredible when you stop to think about it. An area—an opening as big as the whole of our Universe, big enough to pack every galaxy we've ever seen in it—and not a single atom of matter in it . . . until we came barging in to use it as a shortcut across our own Universe."

The vastness of hyperspace got a more humorous treatment from the early pulp science fiction writer Bob Olsen (1884–1956), who wrote the following verses[89] in the introduction to one of his many stories of the fourth dimension:

I read a yarn the other day—
A crazy concept, I must say.
It states that objects have extension
In what is called the "Fourth Dimension."
In hyperspace one could, no doubt,
Make tennis balls turn inside out;
And from a nut remove the kernel
And not disturb the shell external.
A crook could pilfer bonds and stocks,
Then laugh at prison bars and locks,
One step in this direction queer,
And presto! He would disappear!
Let's hope, in planning new inventions,
They'll give us cars with four dimensions.
When searching for a parking place
We sure could use some hyperspace!

It is not just science fiction that takes hyperspace seriously. We find a mathematician, for example, writing that "most science fiction addicts are familiar with

[88] J. V. McConnell, "Avoidance Situation," *If*, February 1956.

[89] B. Olsen, "The Four-Dimensional Auto-Parker," *Amazing Stories*, July 1934. "Bob Olsen" was the pen-name for Alfred Johannes Olsen.

the notion of 'hyperspace,' a higher dimensional space-time bounded by Space-Time through which, in the far distant future, interstellar voyages shortcut the (otherwise unsurmountable) distances between the stars. The purpose of this article[90] is to demonstrate that any . . . relativistic space-time model is the boundary of some . . . five-dimensional hyperspace." That is just what Breuer's magazine character (see note 78) said—in 1930!

The concept of *time* as a fourth dimension has long been a popular concept, and science fiction in particular has embraced it with enthusiasm. We find a little joke on the idea in a story where a young couple, visited by time travelers from 500 years in the future, are said to live in Apartment 4-D.[91] One physicist[92] traced the idea back to the late eighteenth century, finding references to the idea in pre-1800 works of the great French mathematical physicists Jean le Rond d'Alembert (1717–1783) and Joseph-Louis Lagrange (1736–1813). In fact, a philosopher[93] has found a 1751 passage written by d'Alembert that appears to indicate that it is some unknown, earlier person to whom the credit should really go: "I have said [that it is] not possible to imagine more than three dimensions. A clever acquaintance of mine believes, however, that duration could be regarded as a fourth dimension and that the product of time and solidity would be in some way a product of four dimensions; that idea can be contested, but it seems to me that it has some merit, if only that of novelty."

Still, it wasn't until a curious letter appeared in *Nature* in 1885 that the concept of time as the fourth dimension was mentioned seriously in an English-language scientific journal. The author, mysteriously signing himself only as "S.," began by asking "What is the fourth dimension? . . . I [propose] to consider Time as a fourth dimension . . . Since this fourth dimension cannot be introduced into space, as commonly understood, we require a new kind of space for its existence, which we may call time-space."[94] Who was this prophetic writer that, if he had just made a simple swap, would have been the first to use space-time as a word? Nobody knows. Bork speculates that it was an acquaintance of H. G. Wells, but Wells himself is on record that it certainly wasn't him.

In his 1934 *Experiment in Autobiography*, Wells wrote "In the universe in which my brain was living in 1879 there was no nonsense about time being space or anything of that sort. There were three dimensions, up and down, fore and aft and right and left, and I never heard of a fourth dimension until 1884 [when Wells was

[90]G. S. Whiston, "'Hyperspace' (The Cobordism Theory of Space-Time)," *International Journal of Theoretical Physics*, December 1974, pp. 285–288.

[91]L. Padgett, "When the Bough Breaks," *Astounding Science Fiction*, November 1944.

[92]A. M. Bork, "The Fourth Dimension in Nineteenth-Century Physics," *Isis*, October 1964, pp. 326–338.

[93]E. Meyerson, *The Relativistic Deduction*, volume 83 of *Boston Studies in the Philosophy of Science*, D. Reidel 1985, p. 78.

[94]S., "Four-Dimensional Space," *Nature*, March 26, 1885, p. 481. The editorial staff at *Nature* has informed me that, more than a century-and-a-quarter later, there is no longer any record of the identity of S. in the journal's archives.

eighteen] or thereabout. Then I thought it was a witticism." He had, in fact, said this before. In a 1931 edition of *The Time Machine* (Random House), for example, he wrote in the Preface that the idea for the novel "was begotten in the writer's mind by students' discussions in the laboratories and debating society of the Royal College of Science in the eighties and already it had been tried over in various forms by him before he made this particular application of it."

The idea of time as the fourth dimension entered the popular mind around 1894–95, with the publication of the first of Wells' so-called "scientific romances," *The Time Machine*. Then, after that pioneering use of time as the fourth dimension, science fiction quickly adopted the idea as the basis for one of its most popular subgenres. One of the great "golden age of science fiction" writers, 'Murray Leinster' (1896–1975)—the pen-name for William Jenkins—used it as the basis for his first published story.[95] It is the incredible tale of a Manhattan skyscraper (and its 2000 occupants) sent backward in time several 1000 years because its foundation slips (in an unexplained way) along the fourth dimension. The scientific sophistication of the story is primitive, with just one of the many logical flaws being a vivid description of the time travelers living forward-in-time even as their wrist watches run backward. Indeed, when pulp pioneering editor Hugo Gernsback reprinted the tale in one of the early issues of *Amazing Stories*, a reader complained about that very point. Gernsback felt compelled to defend the story, but could muster only a weak rebuttal based on an author's right to "poetic license."[96]

More technical is the discussion in the story of a clerk who transforms the main entrance to a department store into a time machine by building a tesseract (a four-dimensional cube).[97] The claim is made there that the fourth dimension of the cube/doorway is time. That tale appeared just 5 months after a classic of science fiction by Robert Heinlein (1907–1988) had appeared, also using a tesseract, in which the fourth dimension is taken as *spatial*.[98]

Some writers wanted to have the fourth dimension both ways, as space *and* time in the same story. One wonderful example of this is a classic,[99] written by one of the giants of science fiction. In that tale an electrical engineer named Nelson is caught in the middle of an enormous electromagnetic field surge produced by a short circuit in a power plant. As a physicist explains to the shocked board of directors of the utility, "It now appears that the unheard-of-current, amounting to millions of amperes . . . must have produced a certain extension into four dimensions . . . I have been making some calculations and have been able to satisfy myself that a

[95]M. Leinster, "The Runaway Skyscraper," *Argosy*, February 1919.

[96]H. Gernsback, "Plausability in Scientifiction," *Amazing Stories*, November 1926.

[97]W. P. McGivern, "Doorway of Vanishing Men," *Fantastic Adventures*, July 1941.

[98]R. Heinlein, "—And He Built a Crooked House," *Astounding Science Fiction*, February 1941. Here we read of a Los Angeles architect who builds a house in the shape of a tesseract as it would appear if collapsed into normal three-dimensional space. It isn't stable in 3-space (we are told), however, and so a California earthquake is sufficient to topple the house into a stable 4-D configuration, along with its occupants.

[99]A. C. Clarke, "Technical Error," *Fantasy No. 1*, December 1946.

'hyperspace' about ten feet on a side was, in fact, generated: a matter of some ten thousand quartic—not cubic!—feet. Nelson was occupying that space. The sudden collapse of the field [when the overload breakers finally broke the circuit] caused the rotation of that space."

Being rotated through 4-space has inverted the unlucky Nelson [see *For Further Discussion* at the end of this chapter for more on this point], and to bring him back to normal he must be flipped again. The physicist brushes aside a question about the fourth dimension as time, asserting that the only issue is one of space. Poor Nelson is, therefore, again subjected to a stupendous power overload—only now he disappears! Too late, the physicist realizes that the fourth dimension is both space *and* time and that Nelson has been spatially flipped *and* temporally displaced into the future. To understand the particularly monstrous fate of Nelson, just ask yourself what the result would be if he should materialize *inside* matter sometime in the future!

The interpretation of the fourth dimension as time is, of course, the one of interest to prospective time travelers, to physicists studying time travel, and to philosophers of time, and so for us, too. The sort of science fiction that is of greatest interest to us is like the one in which one of the characters, displaced in time, asks for an explanation from a higher-dimensional being who appears on the scene: "'Just where is Tuesday?' he asked. 'Over there [and when the being extends its hand, the hand disappears].' 'Do that again.' 'What? Oh—Point toward Tuesday? Certainly.'" The being explains the physics of the situation to the astonished time traveler thus: "It is a direction like any other direction. You know yourself there are four directions—forward, sideward, upward, and—*that* way! . . . It is the fourth dimension—it is duration."[100]

And how about stories like the one in which a mad inventor discovers how to make a substance whose atoms resist being pushed by "pushing back at right angles to all the other [spatial] directions." That is, to push on this exotic stuff is to risk experiencing a back reaction, of being pushed "off into the fourth dimension [which we are told is time] . . . into the middle of the week after next."[101] Now wouldn't *that* really be something?!

But of course it was H. G. Wells who, in fiction, pioneered time travel and its connection to the fourth dimension as it is popularly thought of today (with the caveats about Wellsian time machines kept firmly in mind). We are therefore quite interested, as *The Time Machine* opens, to listening-in as the Time Traveller expounds to a group of friends at a dinner party in his London home. He starts with the assertion "There is no difference between Time and any of the three dimensions of Space except that our consciousness moves along it." When asked to say more about the fourth dimension, he replies, "It is simply this. That Space, as our mathematicians have it, is spoken of as having three dimensions, which one may call Length, Breadth, and Thickness, and it is always definable by reference to

[100] T. Sturgeon, "Yesterday Was Monday," *Unknown Fantasy Fiction*, June 1941.

[101] M. Leinster, "The Middle of the Week After Next," *Thrilling Wonder Stories*, August 1952.

three planes, each at right angles to the others. But some philosophical people have been asking why *three* dimensions particularly—why not another direction at right angles to the other three?—and have even tried to construct a Four-Dimensional geometry. Professor Simon Newcomb was expounding this to the New York Mathematical Society only a month or so ago."[102]

2.6 Spacetime and the Block Universe

> "And now he has preceded me briefly in bidding farewell to this strange world. This signifies nothing. For us believing physicists, the distinction between past, present, and future is only an illusion, even if a stubborn one."
>
> —Albert Einstein[103]

The poet Henry Van Dyke wrote, in his 1904 "The Sun-Dial at Wells College," words that echo the spirit of Omar Khayyam's *Rubaiyat* from nine centuries before:

The shadow by my finger cast
Divides the future from the past:
Before it, sleeps the unborn hour,
In darkness, and beyond thy power:
Behind its unreturning line,
The vanished hour, no longer thine:
One hour alone is in thy hands,—
The NOW on which the shadow stands.

The very next year Einstein's theory of special relativity appeared and, 3 years later, came Minkowski's spacetime interpretation of special relativity. Van Dyke's beautiful poetry was dealt a mighty blow by those developments in mathematical physics, and in the rest of this chapter we'll see how that came to pass.

The modern view of reality, that the past, present, and future are joined together into a four-dimensional entity called *spacetime*, is due to Hermann Minkowski (1864–1909), Einstein's mathematics teacher when he was a student in Zurich. Minkowski gave spacetime (the visual imagery of Einstein's mathematics) to the world during a famous address at the 80th Assembly of German Natural Scientists and Physicians in Cologne, on September 21, 1908. Entitled "Space and Time," his

[102] And so Newcomb actually was. Wells, it is certain, routinely read *Nature* (one of his college friends, Richard Gregory, eventually became the journal's editor), and Wells must have read Newcomb's address of December 28, 1893 to the New York Mathematical Society when reprinted in the February 1, 1893 issue (on pp. 325–329), where he called hyperspace "the fairyland of geometry." From the Time Traveller's own words, then, that wonderful Victorian dinner party must have taken place in January or February of 1894.

[103] From a letter written by Einstein on March 21, 1955, to the children of Michele Besso, his dearest friend, who had just died. Einstein's use of the word *briefly* was due to his knowledge that he was nearly out of time, too (he died just a month later).

remarks were electrifying then and still are today.[104] He began dramatically: "Gentlemen! The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical." Then came the famous line, quoted in so many freshman physics texts and philosophy papers, concerning the nature of spacetime: "Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve independence." Minkowski explained what spacetime is in these words to his audience:

> "A point of space at a point of time ... I will call a *world point*. The multiplicity of all thinkable x, y, z, t systems of values we will christen the *world*. With this most valiant piece of chalk I might project upon the blackboard four world axes ... Not to leave a yawning void anywhere, we will imagine that everywhere and everywhen there is something perceptible. To avoid saying 'matter' or 'electricity' I will use for this something the word 'substance.' We fix our attention on the substantial point which is at the world point x, y, z, t, and imagine that we are able to recognize this substantial point at any other time. Let the variations dx, dy, dz, of the space coordinates of this substantial point correspond to the time element dt. Then we obtain, as an image, so to speak, of the everlasting career of the substantial point, a curve in the world, a *world-line*. ... The whole Universe is seen to resolve itself into similar world-lines, and I would fain anticipate myself by saying that in my opinion physical laws might find their most perfect expressions as relations between these world-lines ... *Thus also three-dimensional geometry becomes a chapter in four-dimensional physics* [my emphasis]."

With those words Minkowski gave mathematical expression to the philosophical exposition of Wells' Time Traveller to his dinner party friends. Taking the Minkowskian view of the primacy of spacetime as the ultimate building block stuff of reality was Princeton professor of physics John Wheeler, who wrote[105] "There is nothing in the world except empty curved space. Matter, charge , electromagnetism ... are only manifestations of the bending of space. *Physics is Geometry*." This idea was echoed in fiction, in the 1987 novel Moscow 2042 by Vladimir Voinovich, where we find a time traveler who declares "Anyone with even a nodding acquaintance with the theory of relativity knows that nothing is a variety of something and so you can always make a little something out of nothing."

But not everybody understood Minkowski. In a little-known yet quite erudite essay, published just after a stunning experimental verification of general relativity (the bending of starlight passing through the Sun's gravitational field[106]), an anonymous author presented an optical analogy to help those who thought relativity

[104]For a study that includes the original German text, careful English translations, and photographs of Minkowski's agonized corrections to his pre-address manuscript, see P. L. Galison, "Minkowski's Space-Time: From Visual Thinking to the Absolute World," *Historical Studies in the Physical Sciences* (volume 10), 1979, pp. 85–121.

[105]C. W. Misner and J. Wheeler, "Gravitation, Electromagnetism, Unquantized Charge, and Mass as Properties of Curved Empty Space," *Annals of Physics*, December 1957, pp. 525–603.

[106]General relativity had already explained the long-puzzling excess precession of the perihelion (point of closest approach to the Sun) of Mercury's orbit. The excess was an observational (and so experimental) fact which Newton's gravity *cannot* completely explain.

simply "a mathematical joke." Signing himself only as "W.G.," he included the following passage[107]:

> "Some thirty or more years ago [it was forty] a *jeu d'esprit* was written by Dr. Edwin Abbott entitled *Flatland* . . . Dr. Abbott pictures intelligent beings whose whole experience is confined to a plane, or other space of two dimensions, who have no faculties by which they can become conscious of anything outside that space and no means of moving off the surface on which they live. He then asks the reader, who has consciousness of the third dimension, to imagine a sphere descending upon the plane of Flatland and passing through it. How will the inhabitants regard this phenomenon? They will not see the approaching sphere and will have no conception of its solidity. They will only be conscious of the circle in which it cuts their plane. This circle, at first a point, will gradually increase in diameter, driving the inhabitants of Flatland outward from its circumference, and this will go on until half the sphere has passed through the plane, when the circle will gradually contract to a point and then vanish, leaving the Flatlanders in undisturbed possession of their country . . . Their experience will be that of a circular obstacle gradually expanding or growing, and then contracting, and they will attribute to *growth in time* what the external observer in three dimensions assigns to a movement in the third dimension. Transfer this analogy to a movement of the fourth dimension through three-dimensional space. Assume the past and future of the Universe to be all depicted in four-dimensional space, and visible to any being who has consciousness of the fourth dimension. If there is motion of our three-dimensional space relative to the fourth dimension, all the changes we experience and assign to the flow of time will be due simply to this movement, *the whole of the future as well as the past existing in the fourth dimension* [my emphasis]."

W.G.'s words are a clear and unequivocal statement of the so-called *block universe* concept of four-dimensional spacetime. One can find the block universe concept in the writings of the ancients, too. Consider, for example, the fifth-century B.C. Greek philosopher Parmenides' view of reality: "It is uncreated and indestructible; for it is complete, immovable, and without end. Nor was it ever, nor will it be; for now it *is*, all at once, a continuous *one*." And in Thomas Aquinas' *Compendium Theologiae*, written in the thirteenth century, we find "We may fancy that God knows the flight of time in His eternity, in the way that a person standing on top of a watchtower embraces in a single glance a whole caravan of passing travelers." This is the block universe idea, too, but whereas for Parmenides it was metaphysics and for Aquinas it was theology, for Einstein and Minkowski it was physics.[108]

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[107] W. G., "Euclid, Newton, and Einstein," *Nature*, February 12, 1920, pp. 627–630. As with the mysterious S. (note 94), the editorial staff at *Nature* has informed me that, nearly a century later, there is no longer any record of the identity of W. G. in the journal's archives.

[108] And for some it was all nonsense. The British philosopher Peter Geach (1916–2013), for example, declared the Minkowskian view to be "very popular with philosophers who try to understand physics and physicists who try to do philosophy." See P. T. Geach, "Some Problems About Time," in *Studies in the Philosophy of Thought and Action* (P. F. Strawson, editor), Oxford University Press, 1968. In his introduction to Geach's essay, editor Strawson put in his two cents by stating the four-dimensional view of reality to be nothing but "fanciful philosophical theorizing."

The block universe concept may explain the enigmatic statement made by Einstein at the death of Michele Besso (note 103). As interpreted[109] decades later:

> "It seems that Einstein's view of the life of an individual was as follows. If the difference between past, present, and future is an illusion, i.e., the four-dimensional spacetime is a 'block Universe' without motion or change, then each individual is a collection of myriad of selves, distributed along his history, each occurrence *persisting on the world line, experiencing indefinitely the particular event of that moment* [my emphasis]. Each of these momentary persons, according to our experience would possess memory of the previous ones, and would therefore believe himself identical with them; yet they would all exist separately, as single pictures in a film. Placing the past, present and future on the same footing this way, destroys the notion of the unity of the self, rendering it a mere illusion as well."

It appears by his words that Einstein was indeed in agreement with the block universe concept, and that he was attempting to give his friend's family some reason to believe that their father still lives 'somewhen.' The makers of the 2002 film *Minority Report* made use of the block universe concept, even if not intentionally; there we see police stopping crime *before* it happens because they can 'see the future.'

Not everybody believed that this view of spacetime was Einstein's, however. Karl Popper (1902–1994), an Austrian philosopher of science, wrote 28 years after the scientist's death that "Einstein was a strict determinist when I first visited him in 1950: he believed in a 4-dimensional Block-Universe. But he gave this up."[110] Shortly before he wrote those words, however, Popper must have learned something new to convince himself of his final comment, because just 2 years earlier he had declared[111] Einstein to (still) be a determinist. Popper presents no evidence to support his claim of Einstein's philosophical conversion, however, and it would seem that the Besso letter still offers the best insight into his actual view of spacetime shortly before his death. I say this because I think Popper's labeling of Einstein as a determinist is wrong. Determinism says 'If you do A, then B will happen, and if you do not do A then (perhaps) something other than B will happen.' A deterministic universe has plenty of room for free will, because you can *choose* to do A or not to do A, and what you decide makes a difference. A fatalistic universe, however, as is the block universe, simply says 'You will do A and B will happen.' To accept the block universe, as did Einstein, is to be a fatalist, not a determinist.

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[109] L. P. Horwitz, R. I. Arshansky, and A. C. Elitzur, "On the Two Aspects of Time: The Distinction and Its Implications," *Foundations of Physics*, December 1988, pp. 1159–1193. See also Einstein's own book (note 67) where he wrote "From a 'happening' in three-dimensional space, physics becomes, as it were, an 'existence' in the four-dimensional 'world'."

[110] See the *Seventh International Congress of Logic, Methodology and Philosophy of Science*, volume 4 (Salzburg, Austria, 1983), p. 176. Popper describes his early discussions with Einstein on the reality of time and the four-dimensional Parmenidean block universe in some detail in his autobiography: see volume 1 of *The Philosophy of Karl Popper* (P. A. Schilpp, editor), The Library of Living Philosophers, Open Court 1974, pp. 102–103.

[111] In the Foreword to the book by B. Gal-Or, *Cosmology, Physics and Philosophy*, Springer-Verlag 1981.

Einstein's final position on this, then, *might* have been like that of the fictional time traveler who takes a little girl 25,000 years back into the past, where she sees an ancient ancestor of humanity.[112] She then asks if the ancestor is really alive. The time traveler replies, "Every man who ever lived is still alive, child. In time there is no real death. When a man dies he's still alive 10 min ago, 10 years ago. He's always alive to those who travel back through time to meet him face to face."

Did Einstein *really* believe this? Not everybody thinks so. At the 1922 meeting of the French Philosophical Society, for example, the philosopher of science Emile Meyerson asked Einstein whether the spatialization of time (the idea that time is a dimension on the same footing as the spatial ones) is a legitimate interpretation of Minkowski's spacetime. Einstein's terse answer was that "it is certain that in the four-dimensional continuum all dimensions are *not* [my emphasis] equivalent."[113]

Use of the term *block universe* is generally thought to have originated with the Oxford philosopher Francis Herbert Bradley (1846–1924) who, in his 1883 book *Principles of Logic*, wrote "We seem to think that we sit in a boat, and are carried down the stream of time, and that on the bank there is a row of houses with numbers on the doors. And we get out of the boat, and knock at the door with number 19, and, re-entering the boat, then suddenly find ourselves opposite 20, and having then done the same, we go on to 21. And, all this while, the firm fixed row of the past and future stretches in a *block* [my emphasis] behind us, and before us." The house numbers would seem to be Bradley's way of referring to the centuries. Note that he wrote these words 12 years before *The Time Machine*, and that they preceded Minkowski's famous address by a quarter-century.

But this origin of *block universe* may not be as clear-cut as I have made it appear. Bradley, who was frequently criticized by the Harvard psychologist William James (1842–1910)—a man who argued for free will[114] and indeterminism, concepts disallowed in a block universe—may have been mocked on the idea by James during an address to the students of the Harvard Divinity School in March 1884 ("The Dilemma of Determinism"), the year after Bradley's book had been published. In his address James spoke of a deterministic world as being a "solid" or "iron block" (this are *not* characteristics of determinism, but rather of fatalism, and so James makes the same mistake as did Popper). However, writing the year before Bradley's book, in the April 1882 issue of *Mind*, James wrote (with obvious disdain) of "the universe of Hegel [the German philosopher Georg Hegel (1770-1831)]—the *absolute block* [my emphasis] whose parts have no loose play," as having "the oxygen of possibility all suffocated out of its lungs" and as being a universe in which "there can be neither good nor bad, but [only] one dead level of

[112]F. B. Long, "Throwback in Time," *Science Fiction Plus*, April 1953.

[113]A. Einstein, "La Théorie de la Relativité," *Bullentin de la Société Francaise de Philosophia* (volume 17), 1922, pp. 91–113.

[114]A famous line from James, one that perhaps illustrates his sort of reasoning about free will, is "My first act of free will shall be to believe in free will." If only proving theorems in math and physics were that easy.

mere fate." So, perhaps, the chain of evolution of the term block universe is actually from Hegel to James and *then*, finally, to Bradley.

We can actually find the block universe in fiction *before* Minkowski (and so certainly before pulp science fiction) came on the scene. In an 1875 (!) story[115] we read of a man who sees, years in advance, his own death in the American Civil War. In the following extract, this man speaks to an unnamed friend (who is the narrator):

> "Do you know," said Bernard, presently, "I sometimes think prophecy isn't so strange a thing . . . I really see no reason why any earnest man may not be able to foresee the future, now and then . . ."
>
> "There is reason enough to my mind," I replied, "in the fact that future events do not exist, as yet, and we cannot know that which is not, though we may shrewdly guess it sometimes . . ."
>
> "Your argument is good, but your premises are bad, I think," replied my friend, . . . his great, sad eyes looking solemnly into mine.
>
> "How so?" I asked.
>
> "Why, I doubt the truth of your assumption, that future events do not exist as yet . . . Past and future are only divisions of time, and do not belong to eternity . . . To us it must be past or future with reference to other occurrences. But is there, in reality, any such thing as a past or a future? If there is an eternity, it is and always has been and always must be. But time is a mere delusion . . . To a being thus in eternity, all things are, and must be present. *All things that have been, or shall be, are* [my emphasis]."

When the block universe concept did eventually appear in science fiction, it did so early. In a 1927 story, for example, a time traveler from the future and a man in the present (who is the narrator) have the following exchange:

> "I have just been five years into your future."
> "My future!" I exclaimed. "How can that be when I have not lived it yet?"
> "But of course you have lived it."
> I stared, bewildered.
> "Could I visit my past if you had not lived your future?"[116]

So, while the block universe has a bit of a history to it, the history of the concept of *mathematical* spacetime in physics has a much clearer origin: it derives from Minkowski, not from Hegel, Bradley, James, or even Einstein (who often gets credit for it even though he didn't use the concept in special relativity in 1905, 3 years before Minkowski's address.). Eventually, of course, Einstein did come to appreciate the power and conceptual beauty of four-dimensional spacetime, and it came to play a central role in his ideas about gravity. Indeed, in Einstein's general theory of relativity gravity *is* (curved) spacetime. The starting point for general relativity (and so a *scientifically plausible* theory of time travel) was Minkowski's creation of spacetime, and he is truly deserving of the title 'father of the fourth dimension.'

[115] G. C. Eggleston, "The True Story of Bernard Poland's Prophecy," *American Homes*, June 1875. George Cary Eggleston (1839–1911) had served as a soldier in the Confederate Army.

[116] F. Flagg, "The Machine Man of Ardathia," *Amazing Stories*, November 1927.

Of course, it is true that Newton's physics also talks about an analytical (as opposed to merely philosophical) space and time long before either Minkowski or Einstein, but 'Newtonian spacetime' is something very different from Minkowski's self-described "radical" view.[117] In the Newtonian view there is a universal time, a *cosmic* time, which is the same time for everyone, everywhere, in the universe. At every instant, a cosmic simultaneity exists for Newton. Newton's space is Euclidean; that is, through any point exterior to a line exactly one parallel line can be constructed and those two lines will never meet, all triangles (no matter their size) have an interior angle sum of 180°, and so on. For Newton, space and time were absolutely and uniquely separable. They were, as philosophers like to say, "distinct individuals."

Minkowski changed all that. For him space and time are only relatively separable, and the separation is different for observers in relative motion. For Newton, space and time are the *background* in which physical processes in the world evolve. For Minkowski, spacetime *is* the world.

In a famous philosophical paper[118] by an advocate of the block universe view of reality, we find the words "I . . . defend the view of the world . . . which treats the totality of being, of facts, or of events as spread out eternally in the dimension of time as well as the dimensions of space. Future events and past events are by no means present events, but in a clear and important sense they do exist, now and forever, as rounded and definite articles in the world's furniture." The title of Williams' paper comes from an ancient dilemma stated by Aristotle in his *De Interpretatione*, where he asked a question now classic in philosophy: "Will there be a sea fight tomorrow?"

Aristotle began his famous answer by first posing the following premise: If a statement about some future event is, eventually, shown to be true (or false), then that statement was true (or false) from the moment it was made. Consider, then, the following two assertions: (A) "It is true that there will be a sea fight tomorrow" and (B) "It is true that there will *not* be a sea fight tomorrow." Surely, argued Aristotle, (A) and (B) cannot both be true, but equally surely, one of them must be true. Suppose it is (A) that is true. Then there is nothing that can be done to prevent the sea fight, and so the future is fated. Suppose, however, it is (B) that is true. Then there is nothing that can be done to cause the sea fight, and so the future is fated. The conclusion is the same no matter which assertion is the true one; thus, the future is fated.

[117]See, for example, H. Stein, "Newtonian Space-Time," *Texas Quarterly*, Autumn 1967, pp. 174–200; G. Berger, "Elementary Causal Structures in Newtonian and Minkowskian Space-Time," *Theoria* (volume 40), 1974, pp. 191–201; J. Earman and M. Friedman, "The Meaning and Status of Newton's Laws of Inertia and the Nature of Gravitational Forces," *Philosophy of Science*, September 1973, pp. 329–359.

[118]D. C. Williams, "The Sea Fight Tomorrow," in *Structure, Method and Meaning*, The Liberal Arts Press 1951. Donald Williams (1899–1983) was a professor of philosophy at Harvard.

As might be expected, those who like the fatalistic block universe like this conclusion, but, ironically, Aristotle wasn't one of them—he disliked it so much that he struggled to find a way around it. On the other hand, there are philosophers, like Professor Williams (who believed in a fatalistic universe), who reject Aristotle's rejection of his own logic! Professor Williams went so far, in fact, to calling Aristotle's reasoning "a tissue of error" and "swaggeringly invalid." Possibly so, but the philosophical debates over the sea fight question, and the fatalistic (or not) nature of the world, have not ceased to this day.

In an even more famous paper, Professor Williams makes clear his belief that the passage of time is a myth; he poetically declared "the total of world history is a spatio-temporal volume, of somewhat uncertain magnitude, chockablock with things and events."[119] Professor Williams did, indeed, embrace four-dimensional spacetime, and this is demonstrated by the following incredible passage, perhaps his best-remembered words: "It is then conceivable, though doubtless physically impossible, that one four-dimensional area of the time part of the manifold be slewed around at right angles to the rest, so that the time order of that area, as composed by its interior lines of strain and structure, run parallel with a spatial order in its environment. It is conceivable, indeed, that a single whole human life should lie thwartwise of the manifold, with its belly plump in time, its birth at the east and its death in the west, and its conscious stream running alongside somebody's garden path."

Good Lord!

Now, I am willing to admit that Professor Williams probably wrote that wonderful passage mostly for effect,[120] but I ask you—what, if anything, does it *mean*? It is marvelous to read and yet it remains (for me) mysterious.[121] It should come as no surprise that Professor Williams originally presented his papers to the Metaphysical Society of America, rather than to the American Physical Society. But this passage was perhaps not without impact in areas far removed from metaphysics; some years later there appeared a science fiction story[122] that reads as though it had been inspired by Williams. In it, a scientist discovers how to bend his perception of the four dimensions so as to view verticality as duration and duration as verticality. Thus, he is in October while sitting, but when he stands up he is in November! As bizarre as this may seem, such coordinate interchanges actually do occur in the

[119] D. C. Williams, "The Myth of Passage," *Journal of Philosophy*, July 1951, pp. 457–472.

[120] In a footnote, Williams sort of admits this when he writes "I should expect the impact of the environment on such a being to be so wildly queer and out of step with the way he is put together, that his mental life must be a dragged-out monstrous delirium." I think this a great understatement.

[121] As it was for some of Williams' fellow philosophers, one of whom bluntly called the 'myth-of-passage' paper "an interesting piece of science fiction": see M. Capek, "The Myth of Frozen Passage: The Status of Becoming in the Physical World," in *Boston Studies in the Philosophy of Science* (volume 2), Humanities Press 1965. Capek's title reflects his view of the block universe as simply a giant refrigerator and so, turning the tables on Williams, we have 'passage' changed to 'frozen passage.' See also note 136.

[122] G. Wolfe, "The Rubber Bend," *Universe 5* (T. Carr, editor), Random House 1974.

mathematical theory of time machines; we'll see this later, for example, when we discuss Tipler's rotating cylinder time machine.

By the 1930s the block universe had found a home in pulp science fiction. The block universe view that past and present coexist with the present got dramatic treatment in one story of a high school teacher who invents a "spacetime warp" theory, and who is then tricked by an evil industrialist into implementing it in the form of a gun. The weapon produces incredible effects when it is tested; for example, an allosaurus appears, which we are told is "a carnivorous dinosaur of the Jurassic Age, the most frightful engine of destruction that ever walked the Earth!"[123] At the story's end, the teacher explains what has happened to a crowd of breathless newspaper reporters:

> "Spacetime was warped slightly ... The Einsteinian spacetime continuum buckled ... Because it was superficial, only a little of the past, a little of the future broke through. The folds of the warp distorted spacetime evanescently, erratically skirting the vast gulf where the past lies buried and lightly tapping the vast stores of the future. It is a truism of modern speculative physics that the past and the future exist simultaneously and coextensively in higher dimensions of space. De Sitter has speculated as to the possibility of seeing an event before it happens. It is quite possible, gentlemen. Events of the far future already exist in spacetime."

That 'explains' the dinosaur. In the teacher's words, "You tell me that two men saw an incredible beast. ... They swear it looked like a dinosaur. I think it was a dinosaur, gentlemen. It broke through when the warp tapped the past."

And just 2 years later, Robert Heinlein made world lines the central concept in the first of his many classic tales.[124] The story draws an analogy between a world line and a telephone cable: the beginning and end points in spacetime for the world line of a person (birth and death) are associated with breaks (faults) in a telephone cable. By sending a signal up and down the cable, and measuring the time delay until the arrival of the echo produced by such discontinuities, a technician can both detect and locate the faults. In the same manner, Heinlein's story-gadget sends a signal of unspecified nature up and down a world line and thus locates the birth and death 'discontinuities.' Knowledge of the death date, in particular, causes financial stress among life insurance companies, and an examination of *that* tension (not strange physics) is the fictional point of the story.

And then, 2 years after Heinlein's tale with its serious tone, a far less serious story[125] (featuring an Attila the Hun character who roams up and down the corridors of time kidnapping beautiful women for his harem!), we find an 'editorial' footnote telling its young readers that "scientists—especially the new order of meta-physical scientists—are agreed on the principles of Space-Time. The future is not a thing which *will exist*. Rather it is a thing which *does exist*—all events from

[123] F. B. Long, "Temporary Warp," *Astounding Stories*, August 1937.

[124] R. Heinlein, "Life-Line," *Astounding Science Fiction*, August 1939.

[125] R. Cummings, "Bandits of Time," *Amazing Stories*, December 1941.

the Beginning to the End, exist in a record upon the scroll of Time." This story, itself, was silly, but the block universe metaphysics was up-to-date.

Somewhat surprisingly, I think, is that even before pulp science fiction embraced the block universe, the concept had already made a deep impression on a broader audience. For example, in a 1928 New York stage play[126] the action alternately takes place in the years 1784 and 1928 and, to explain how that can be, one character (a time traveler) tells another:

> "Suppose you are in a boat, sailing down a winding stream. You watch the banks as they pass you. You went by a grove of maple trees, upstream. But you can't see them now, so you saw them in the *past*, didn't you? You're watching a field of clover now; it's before your eyes at this moment, in the *present*. But you don't know yet what's around the bend in the stream ahead of you; there may be wonderful things, but you can't see them until you get around the bend, in the *future*, can you?"

Then, after this prologue about the stream of time, comes the block universe idea:

> "Now remember, *you're* in the boat. But *I'm* up in the sky above you; in a plane. I'm looking down on it all. I can see *all at once* the trees you saw upstream, the field of clover that you see now, and what's waiting for you around the bend ahead! *All at once!* So the past, present, and future of the man in the boat are all *one* to the man in the plane."

Then, finally, the obvious theological conclusion: "Doesn't that show how all Time must really be one? Real Time—real Time is nothing but an idea in the mind of God!"

To end this section, the block universe conception was cleverly used by one science fiction fan who argued in support of time travel, in reply to another fan how had claimed that a failure of mass/energy conservation was fatal to the plausibility of time travel. Their exchange began with a letter to the editor at *Astounding Stories* in November 1937, written in response to a recent story[127]:

> "Let us say that there is, at a certain time, 'x' amount of matter in the Universe, and 'e' amount of energy. Then if a man of 'a' mass travels backward in time to this particular instant aforementioned, the total amount of matter is thus 'x' plus 'a', while if no other such mass changing occurrences take place, the amount of matter in the future is 'x' minus 'a'. Only a corresponding loss and gain respectively in the amount of energy could explain this conservation of energy, advocates [of time travel] say what they may. But you can't rob or add energy to a Universe nilly-willy! Or perhaps time doesn't enter in on the matter. Perhaps you can add matter in a Universe provided you take it away on some future date."

This fan's concern clearly made an impression on science fiction writers, and the case for conservation of energy is stated in many of the time travel stories that appeared after the publication of this letter.[128]

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[126]"Berkeley Square" by J. L. Balderson. This play was made into a 1933 movie of the same name, and again in 1951 as the film *I'll Never Forget You*.

[127]O. Saari, "The Time Bender," *Astounding Stories*, August 1937 (see also note 137 in Chap. 1).

[128]Examples include the novels *Lest Darkness Fall* (Henry Holt 1941) by L. Sprague de Camp, and *The Time Hoppers* (Doubleday 1967) by Robert Silverberg.

A reply was soon received by the magazine in a letter (January 1938) from another fan:

> "[A recent letter] implies that the idea of time travel is incompatible with the law of conservation of mass and energy. I believe [the] reasoning is wrong [and that the] difficulty lies primarily in the assumption that a body moved in time is transported into a different Universe. According to Einstein, time and the three normal dimensions are so related as to form a continuous, inseparable medium we call the spacetime continuum. Time is in no way independent of the other components of our Universe. Hence a fixed mass [a time traveler and his machine] moved in time is by no means lost from the Universe, the action being analogous to a shift along any other dimension."

The block, or frozen, universe of Minkowski is clearly reflected in those words.[129]

2.7 Philosophical Implications of the Block Universe

> "Is the future all settled beforehand, and only waiting to be 'pushed through' into our three-dimensional ken? Is there no element of contingency? No free will? I am talking geometry, not theology."[130]

I should tell you now that, despite the enthusiastic embrace of the block universe by Williams and others (including Einstein), there are those who have been harsh in their criticism of Minkowski's spacetime. The major philosophical problem with the block universe interpretation of four-dimensional spacetime is that it looks like fatalism disguised as physics. It seems to be little more than a mathematician's proof of a denial of free will dressed up in geometry. One philosopher illuminated this concern with the following story, one that vividly illustrates the compelling need many humans have to deny a fatalistic world:

> "In a moving picture version of *Romeo and Juliet*, the dramatic scene was shown in which Juliet, seemingly dead, is lying in the tomb, and Romeo, believing she is dead, raises a cup containing poison. At this moment an outcry from the audience was heard: 'Don't do it!' We laugh at the person who . . . forgets that the time flow of a movie is unreal, is merely the unwinding of a pattern imprinted on a strip of film. Are we more intelligent than this man when we believe that the time flow of our actual life is different? Is the present more than our cognizance of a predetermined pattern of events unfolding itself like an unwinding film?"[131]

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[129] In the context of mathematical physics (*not* science fiction) it has been shown that time travel does *not* imply any fatal violation of conservation of energy. See, for example, J. L. Friedman *et al.*, "Cauchy Problem in Spacetimes with Closed Timelike Curves," *Physical Review D*, September 15, 1990, pp. 1915–1930, and D. Deutsch, "Quantum Mechanics Near Closed Timelike Lines," *Physical Review D*, November 15, 1991, pp. 3197–3217.

[130] The lament of Victorian physicist Oliver Lodge (1850–1940) in his essay "The New World of Space and Time," *Living Age*, January 1920.

[131] H. Reichenbach, *The Direction of Time*, University of California Press 1956, p. 11.

Most people in the Western world would answer *yes* to Reichenbach's question. Most people do find Omar Khayyam's *Rubaiyat* to be a beautiful poem, yes, but still they reject its fatalistic message: "And the first Morning of Creation wrote/What the Last Dawn of Reckoning shall read." Indeed, William James quoted these very words in his 1884 address to the students of the Harvard Divinity School when he argued against fatalism and the block universe.

Besides fatalism, another reason for the stinging words by critics of Minkowski's spacetime is that, in it, events don't *happen*—they just *are*. That is, there seems to be no temporal process of *becoming* in Minkowski's spacetime. Everything is already there and, as what we perceive to be the passing of time occurs, we simply become conscious of ever more of Minkowski's "world points," or events, that lie on our individual world lines. Hermann Weyl (1885–1955), a German mathematical physicist who in his last years was a colleague of Einstein and Gödel at the Institute for Advanced Study in Princeton, expressed this very interpretation in words that have become famous, words that sound very much like those of Wells' Time Traveller: "The objective world simply *is*, it does not *happen*. Only to the gaze of my consciousness, crawling upward along the life line of my body [Minkowski's world line], does a section of the world [spacetime] come to life as a fleeting image in space which continuously changes in time [creating what we call the *now* or the *present*]."[132]

Weyl was skillful in finding poetic ways to express the world line view of reality, but not everybody is convinced by the poetry because it seems to deny the common sense idea of time 'flowing,' of temporal passage; it effectively says time is mind-dependent, a mere *illusion*, as the time traveler in "Berkeley Square" declared (note 126). One philosopher who was particularly opposed to Weyl's view was the British-American academic Max Black (1909–1989), and he expressed his opinion in no uncertain terms: "The picture of a 'block Universe,' composed of a timeless web of 'world-lines' in four-dimensional space, however strongly suggested by the theory of relativity, is a piece of gratuitous metaphysics."[133] Another philosopher who was unhappy with Weyl's view of the block universe was just as blunt: "While philosophers may be forgiven intellectual extravagances of this kind, I think it is a pity when they receive encouragement from theoretical physicists."[134]

Weyl's views had supporters, too, however. Consider, for example, the Time Traveller's speech to his friends at the fateful dinner party that opens *The Time*

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[132]H. Weyl, *Philosophy of Mathematics and Natural Science*, Princeton University Press 1949, p. 116. Sir James Jeans had already said the same, somewhat less elegantly, in his 1935 Sir Halley Stewart Lecture: "The tapestry of spacetime is already woven throughout its full extent, both in space and time, so that the whole picture exists, although we only become conscious of it bit by bit—like separate flies crawling over a tapestry . . . A human life is reduced to a mere thread in the tapestry." Jeans then immediately *rejected* this fatalistic view: see his *Scientific Progress*, Macmillan 1936, p. 20.

[133]From a book review in *Scientific American*, April 1962, pp. 179–185.

[134]H. A. C. Dobbs, "The 'Present' in Physics," *British Journal for the Philosophy of Science*, February 1969, pp. 317–324.

Machine: "There is no difference between Time and any of the three dimensions of Space except that our consciousness moves along it . . . here is a portrait of a man at 8 years old, another at fifteen, another at seventeen, another at twenty-three, and so on. All these are evidently sections, as it were, Three-Dimensional representations of his Four-Dimensional being, *which is a fixed and unalterable thing* [my emphasis]." Remember, these words were written in 1895, 13 years before Minkowski and his world lines, and of course decades before Weyl's famous words.

Wells' passage made a considerable impression on at least one well-known physicist of the time, who references it in his early book on relativity.[135] And in another book on relativity, published the same year, we find the same interpretation of Minkowski's spacetime as a block universe: "With Minkowski, space and time become particular aspects of a single four-dimensional continuum . . . All motional phenomena . . . become timeless phenomena in four-dimensional space. The whole history of a physical system is laid out as a changeless whole."[136]

The claim that time is an illusion has some thought-provoking implications concerning the concepts of omniscience and free will, concepts that occur in any discussion of time travel. Some old theology on God's omniscience, as discussed in Aquinas' *Summa Theologiae*, is seemingly lent at least some support by Minkowski's spacetime: "Now although contingent events come into actual existence successively, God does not, as we do, know them in their actual existence successively, but all at once; because his knowledge is measured by eternity, as is also his existence; and eternity which exists as a simultaneous whole, takes in the whole of time . . . Hence all that takes place in time is eternally present to God." Somewhat paradoxically, however, Aquinas did make a distinction between past and future. In that same work he declares that "God can cause an angel not to exist in the future, even if he cannot cause it not to exist while it exists, or not to have existed when it already has." For Aquinas, then, whereas the past is rigid and unchangeable, the future is plastic, which is *not* the block universe view of spacetime.

As one theologian has observed,[137] this does not mean that Aquinas thought God had to view all events simultaneous with all others.[138] Rather, our theologian says that Aquinas could have thought of the relationship between God and events as being similar to that between the center of a circle and all the points on the circumference. That is, each point on the circumference has its own identity, coming before and/or after any other point, but the center is related to each and

[135] L. Silberstein, *The Theory of Relativity*, Macmillan 1914, p. 134.

[136] E. Cunningham, *The Principle of Relativity*, Cambridge University Press 1914, p. 191. The use of the words *timeless* and *changeless* explain the characterization of the block universe as being *frozen* (in note 121).

[137] W. L. Craig, "Was Thomas Aquinas a B-Theorist of Time?" *New Scholasticism*, Autumn 1985, pp. 475–483. For the B-theory of time, look back at the discussion in the first section of this chapter.

[138] A science fiction story by Norman Spinrad, "The Weed of Time" (*Alchemy and Academe*, Doubleday 1970) graphically describes what a nightmare that could be!

every point on the circumference in precisely the same way. The center, then, is 'eternity' and the circumference is the temporal series ('one thing after another') of reality. Saying that God is *eternal* is thus very different from saying he is *everlasting*. The first means outside of time, whereas the second means he is a temporal entity but has neither beginning nor end.

Our theologian supports the first interpretation, invoking Aquinas' own words from *Summa Contra Gentiles*: "The divine intellect, therefore, sees in the whole of its eternity, as being present to it, whatever takes place through the whole course of time. And yet what takes place in a certain part of time was not always existent. It remains, therefore, that God has a knowledge of these things that according to the march of time do not yet exist."

The issue of God's eternity and his place in spacetime has long been a hot topic among theologians with a scientific inclination. Practically every issue of the learned journal *Religious Studies*, for example, carries an article on the subject, often invoking relativity theory to support some argument. The Bible, itself, can be a confusing guide on this matter. For example, consider the Old Testament story of King Ahab (First Kings 21). Ahab, King of Sumeria, coveted Naboth's vineyard, but Naboth would not sell. The King retreated, but his wife Jezebel arranged for Naboth's downfall and judicial murder and thus caused the arrival of all his property into her husband's hands. This angered God, who commanded Elijah to prophesy disaster on Ahab's house. Ahab responded with sackcloth, and at that God shifted the disaster to the house of Ahab's son. The point, here, is that God, declared to be omniscient, seems to have been *surprised* at Ahab's penitence. God is aware of everything in this tale, but only as it happens. That is, God's knowledge is subject to growth. This Hebrew concept of God as a participant in history is at odds with the contemporary Christian conception of divine knowledge of all that has been, all that is, and all that will be, a view which has its own Biblical support (for divine eternality). For example, Malachi 3:61 ("For I am the Lord, I change not"), and James 1:17 ("the Father . . . with whom is no variableness").

When *The Time Machine* was serialized in the *New Review*, it included a passage that does not appear in the now classic version of the story in which the Time Traveller explains his view of the connection between omniscience and the block universe to his dinner guests:

> "I'm sorry to drag in predestination and free-will, but I'm afraid those ideas will have to help . . . Suppose you knew fully the position and properties of every particle of matter, of everything existing in the Universe at any particular moment of time: suppose, that is, that you were omniscient. Well, that knowledge would involve the knowledge of the condition of things at the previous moment, and at the moment before that, and so on. If you knew and perceived the present perfectly, you would perceive therein the whole of the past. If you understood all the natural laws the present would be a complete and vivid record of the past. Similarly, if you grasped the whole of the present, knew all its tendencies and laws, you would see clearly all the future. To an omniscient observer there would be no forgotten past—no piece of time as it were that had dropped out of existence—and no blank future of things yet to be revealed . . . Present and past and future would be without meaning to such an observer . . . He would see, as it were, a Rigid Universe filling space and time . . . If 'past' meant anything, it would mean looking in a certain direction, while 'future' meant looking the opposite way."

Wells' "Rigid Universe" certainly sounds like the block universe, and he (or least, the Time Traveller) seems to have believed that it held important implications for the concept of free will.

The 'Rigid Universe' got an interesting science fiction treatment in a story[139] that imagined an event in the present that occurs 'before it should' (a heart patient learns that her obituary notice will be in next week's *New York Times* when that paper arrives 'early'). As one character explains to the sister of the lady who is soon to die, "The future mustn't be changed . . . For us the events of . . . the future are as permanent as any event in the past. We don't dare play around with changing the future, not when it's already signed, sealed and delivered in that newspaper. For all we know the future's like a house of cards. If we pull one card out, say your sister's life, we might bring the whole house tumbling down. You've got to accept the decree of fate . . . You've got to."

With Einstein's discovery of the *relativity of simultaneity*,[140] we run into the question of 'How can there be any sense to the concept of divine, universe-wide knowledge in a four-dimensional spacetime?' That's because in some frames of reference it is possible for event A to be observed before event B, whereas in other frames the temporal order could be reversed, and so some theological questions prompted by spacetime physics are: 'What is God's frame of reference if he is to be actively involved in human affairs? Could God have a special frame of reference in which he is exempt from the relativity of simultaneity, a frame in which he imposes an absolute order on the sequence of becoming of events? Does it make any sense, that is, to say God enjoys what might be called 'divine immediacy'? And if so, what should we think of a God who follows rules of nature different from those that govern all he is supposed to have made?'

Theologians have debated questions like these for decades, and surely will continue to do so for many more decades to come. Alas, I suspect that physicists who study time travel have either been unaware, unimpressed, or just plain uninterested. That's too bad, because one doesn't have to be religious to appreciate the pure intellectual challenges presented by such questions. For example, consider the following debate between two philosophers, one who believes free will and divine foreknowledge are not compatible, and another who thinks the first has made a fundamental error in blurring the distinction between changing and affecting the past. (This distinction is of *great* importance

[139]R. Silverberg, "What We Learned From This Morning's Newspaper," *Infinity Four*, November 1972.

[140]This refers to the discovery that two events, which occur simultaneously for one observer in a spacetime, may not be simultaneous for another observer in the same spacetime. This will be discussed in more detail in the next chapter.

in any discussion of time travel.) This second philosopher presented some of his arguments in terms of a time traveler to the past[141]:

> "Consider the following. Parsons (P) has invented a special machine which allows him to go back in time. He enters the machine in 1986 and finds himself in the presence of or, perhaps better, observing, Quigly (Q) in 1876. P is an authority on Q, and knows immediately the situation Q is in. Not only that, but he remembers reading about the particular decision or act which Q made in that situation. Thus one might argue that from P's perspective what Q decides is as if already done. It is not already done, since P is standing there waiting for Q to do it. He has gone back in time. Yet from P's perspective, which is of one come back from the future, it is as if already done, since he knows what Q does decide. Since P strongly believes in the unalterability of the past, it is not within Q's power to do something other than what Q in fact does in that situation. From Q's perspective his decision is not already made nor is the action taken, so that it is in his power at that time to do either x or y. From his perspective, that he will do x rather than y is indeterminate; it is not yet done, though at the same time he can grant that P knows what he will do because for him it is as if he has already done it."

The first philosopher doesn't buy any of this, and dismisses it with "It should be abundantly clear . . . that the fact that such stories are in some way imaginable and intuitively graspable says nothing about their logical coherence." Given the interest among modern physicists in time travel, however, I think the first philosopher wouldn't write that today.

One possible reply to all of these theological issues that spacetime physics prompts can perhaps be found in a paper[142] (written by a philosopher and two mathematicians) that describes a five-dimensional spacetime in which the fifth dimension is initially given the provocative label of the 'eternity' axis. But then the authors lost their nerve and elected to rename it 'anti-time.' It is interesting to note that pulp science fiction anticipated that terminology by decades, as in one story[143] we read "Beyond the fourth there is a fifth dimension . . . Eternity, I think you would call it. It is the line, the direction perpendicular to time." For some, the eternity axis would appear to be perfect to serve as the temporal dimension for God, an axis distinct from the time axis of mere mortals.

The idea of supernatural beings existing outside of mortal time is an old one in theology, and it can also be found in secular literature long before science fiction got hold of it. For example, in the first act of Lord Byron's 1821 poem *Cain*, the fallen angel Lucifer tells Cain and his wife that

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[141]For the complete exchange between these two philosophers, see W. Hasker, "Foreknowledge and Necessity," April 1985, pp. 121–157, B. Reichenbach, "Hasker and Omniscience," January 1987, pp. 86–92, and W. Hasker, "The Hardness of the Past: A Reply to Reichenbach," July 1987, pp. 337–342, all in the journal *Faith and Philosophy*. Hasker is the 'first' philosopher, and Reichenbach is the 'second' one. See also D. P. Lackey, "A New Disproof of the Compatibility of Foreknowledge and Free Choice," *Religious Studies*, September 1974, pp. 313–318.

[142]J. G. Bennett *et al.*, "Unified Field Theory in a Curvature-Free Five-Dimensional manifold," *Proceedings of the Royal Society of London A*, July 1949, pp. 39–61. A theological interpretation is given in G. Stromberg, "Space, Time, and Eternity," *Journal of the Franklin Institute*, August 1961, pp. 134–144.

[143]L. A. Eshbach, "The Time Conqueror," *Wonder Stories*, July 1932.

With us acts are exempt from time, and we
Can crowd eternity into an hour,
Or stretch an hour into eternity.
We breathe not by a mortal measurement,
But that's a myst'ry.

Before Minkowski, the debates over fatalism (as in Silverberg's story in note 139) and free will had been the exclusive province of philosophers, theologians, and lawyers (if a person has no control over his or her actions, then can we morally and ethically punish that person if those actions happen to be criminal?[144]). After Minkowski, the physicists (at least a few of them) joined the debates. According to one philosopher (note 118) the major motivation driving these debates is "the age-old dread that God's foreknowledge of our destiny can in itself impose the destiny upon us." The implication is, of course, that God is 'outside of time' and so can take in the entire Minkowskian block universe at a glance (hence his foreknowledge).

The relativistic view of the universe as a timeless four-dimensional spacetime seems to provide scientific, mathematical support for the conclusion that not only is the past fixed, but so is the future. Does that mean the future is what it will be—and if so, then why bother agonizing over the many apparent decisions each of us faces every day? If the future will be what it will be, then Christian theologians are left with the puzzling task of explaining what could possibly be meant by the Biblical exhortation (Deuteronomy 30:19) "I call Heaven and Earth to record this day against you, that I have set before you life and death, blessing and cursing; therefore *choose* [my emphasis] life, that both thou and thy seed may live."

This issue has bothered philosophers for a very long time. The so-called Master Argument (the name reflects its supposed invulnerability to rebuttal), for example, comes down to us from its origins in ancient times, in the *Discourses* of the first century A.D. Roman Stoic philosopher Epictetus. That argument can be summarized[145] as follows:

1. The future follows from the past;
2. The past is unchangeable;
3. What follows from the unchangeable is unchangeable;

Therefore,

4. The future is unchangeable.

This certainly does seem to be fatalistic, in effect arguing that all events in a block universe spacetime are recorded in a 'Book of Destiny.' Since ancient times many great works of literature have adopted that view, recounting tales of the foretold

[144]For more on this, in the context of time travel, see the penultimate question in the *For Future Discussion* questions at the end of this chapter.

[145]See, for example, the two papers by R. L. Purtill, "The Master Argument," *Apeiron*, May 1973, pp. 31–36, and "Foreknowledge and Fatalism," *Religious Studies*, September 1974, pp. 319–324.

fates of men, such as Sophocles' *Oedipus*. It is, in a block universe, as though our conscious experience of the world is no different from that of the man watching the projected film images of *Romeo and Juliet*.

That view is the central issue in the early sixth century A.D. Roman philosopher Boethius' influential *De Consolatione Philosophiae* (circa A.D. 500) which was written during a year of imprisonment before his execution for treason; perhaps he wondered during that year if his fate could have been anything different. Certainly he must have taken some consolation in fatalism, but in fact he tried to argue that God's vision of *all* temporal reality does not limit the freedom to act. According to Boethius, "The expression 'God is ever' denotes a single Present, summing up His continual presence in all the past, in all the present . . . and in all the future." That is, God sees in one timeless and eternal moment all that has been and will be freely chosen.[146]

When the fourteenth century English poet Geoffrey Chaucer prepared a translation of *Consolatione* he was obviously inspired by it when he wrote his very long, famous poem (*Troilus and Criseyde*) on the nature of love (Book IV.140):

Some say "If God sees everything before
It happens—and deceived He cannot be—
Then everything must happen, though you swore
The contrary, for He has seen it, He."
And so I say, if from eternity
God has foreknowledge of our thoughts and deed,
We've no free choice, whatever books we read.

Two modern, purely philosophical rebuttals[147] to Chaucer, however, argue that his poetry misstates Boethius' philosophy when Troilus declares that divine foreknowledge is incompatible with free will. That is, in their view God's omniscience (a fundamental teaching in the theistic religions of Christianity, Judaism, and Islam) *is* compatible with free will (also a fundamental belief in those same religions). Both of these scholarly papers, though, depend much more on the nuances of grammar than most physicists will like.

The connection between spacetime physics and free will was made explicitly by the philosopher who wrote "For philosophers in either field, philosophy of science and philosophy of religion are too often viewed as mutually irrelevant . . . This is unfortunate, because sometimes the problems can be quite parallel and a consistent resolution is required. One especially intriguing case in point concerns, in

[146]In his *The Sirens of Titan*, a 1959 novel meant to be a parody of God's omniscience, Kurt Vonnegut gave the curious name of *chrono-synclastic infundibulated vision* to God's power to see the past and future.

[147]G. I. Mavrodes, "Is the Past Unpreventable?" April 1984, pp. 131–146, and A. Plantinga, "On Ockham's Way Out," July 1986, pp. 235–269, both in *Faith and Philosophy*.

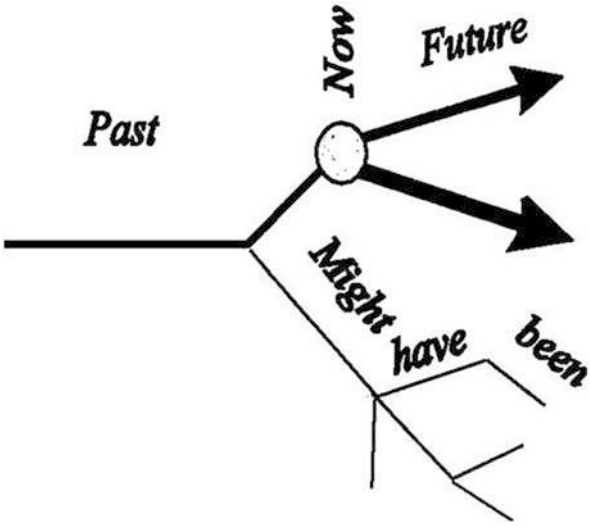

Fig. 2.2 The common view of time

philosophy of science, the possibility of ... time travel and, in philosophy of religion, the relationship between divine foreknowledge and human freedom."[148]

That philosopher could well have included science fiction writers in his group of people interested in both spacetime physics and free will. In one story,[149] for example, a man in the twenty-fifth century is about to travel back into the past to escape criminal prosecution. He is aked where he'd like to go, and he replies "I do not understand the paradoxes—what if I choose to build gravity-deflectors in Ancient Rome?" When he is told (correctly) that he couldn't do that because it didn't happen, he persists: "But if I can choose any period, it means I can alter history at will—which presumes that the present can also be changed." Then, at last, he gets the explicit answer that bothers nearly everyone: "The real answer is that in the final analysis your decision to choose a certain time period is already made, and the things you will do [in the time traveler's personal time] are already determined. Free will is an illusion; it is synonymous with incomplete perception." The same idea appears in another tale (note 57); when one character says, "What you are saying is that the future is fixed, and that you can read it, in every essential detail," the response is "Quite right ... both those things are true."

However, no matter how hard we try—and by *we* I include even those physicists and philosophers who embrace the block universe with its support of time travel to the past—it is very difficult to break free of the view of time as shown in Fig. 2.2. That is, as the passage of time up to the present or *now* (with all to the left of that

[148]W. L. Craig, "Tachyons, Time Travel, and Divine Omniscience," *Journal of Philosophy*, March 1988, pp. 135–150. Tachyons are hypothetical faster-than-light particles that theoretically travel backwards through time. They will be discussed in Chap. 5.

[149]W. Kubilius, "Turn Backward, O Time," *Science Fiction Quarterly*, May 1951.

instant as the past), while to the right of the *now* we have multiple possible futures (depending on our free will choices). Lying to the side of all that (in our thoughts and imaginations) are all that 'might have been' if we had made different choices than we did at earlier times in the past.[150]

With all that said, even if events are really laid out in the spatial and temporal web that constitutes the four-dimensional block universe, there still remains the great mystery of why we see them unfold in the particular sequence that we do. Why not in reverse order? Why, indeed, do we see what we call *time* run from what we call the past to what we call the future and, indeed, what do we really mean by *past* and *future*? As you'll see in the next chapter, these are not easy questions, and nearly everybody who has thought about them believes we are not yet even close to knowing the answers.

On that perhaps gloomy note, it seems appropriate to end here with a few more words from St. Augustine's *Confessions*, with words that follow those that helped open this chapter: "I confess to you, Lord, that I still do not know what time is. Yet I confess too that I do know that I am saying this in time, that I have been talking about time for a long time, and that this long time would not be a long time if it were not for the fact that time has been passing all the while. How can I know this, when I do not know what time is? Is it that I do know what time is, but do not know how to put what I know into words? I am in a sorry state, for I do not even know what I do not know!"[151]

2.8 For Further Discussion

In the comics one of Superman's more interesting adversaries is Mr. Mxyzptlk (pronounced *mix-yez-pitle-ick*), a being with seemingly magical powers from the Land of Zrfff in the fifth dimension. Mr. Mxyzptlk's powers are not really because of magic, however, but are 'merely' the result of his hyperspace world with its extra dimension. Mr. Mxyzptlk, for example, in one of his misadventures with Superman in 1954, begins selling a

(continued)

[150]Figure 2.2 is based on a similar one in C. K. Raju, "Time Travel and the Reality of Spontaneity," *Foundations of Physics*, July 2006, pp. 1099–1113.

[151]There is another view of time even darker than St. Augustine's, which denies the existence of both future and past, and doesn't offer us much either for that special moment we call the present (or *now*). This view, called *presentism*, was hauntingly expressed in some lyrics I heard in the final episode of the second season (2015) of the HBO series *True Detective*: "There is no future/There is no past/In the present nothing lasts." Now *that* is depressing! Still, there are philosophers who believe even this view can support time travel: see S. Keller and M. Nelson, "Presentists Should Believe in Time-Travel," *Australasian Journal of Philosophy*, September 2001, pp. 333–345.

newspaper called the *Daily Mpftrz* in competition with the *Daily Planet*. Unlike a traditional newspaper that reports what *has* happened, the *Daily Mpftrz* (your guess is as good as mine!) prints what *will* happen. As Mr. Mxyzptlk says, "You see, as a resident of the fifth dimension, I can get all the news I want from the *fourth* dimension!" The science editor at the *Daily Planet* explains the meaning of that to his boss, Perry White: "That's right, Mr. White . . . many physicists consider *time* the fourth dimension . . . so if Mr. Mxyzptlk can travel from the fifth dimension to our three-dimensional world, he most likely *is* able to see the future!" (This leaves unanswered the question of *why* he continues to challenge Superman when he knows he will always be defeated—*as he always is*!) Presumably a five dimensional world would have our three spatial and one temporal dimension (for a total of four), and so the question now is: what is the nature of the additional (fifth) dimension? Is it spatial or is it temporal? (There is a brief appearance of the fifth dimension in the 2014 movie *Interstellar*, but we aren't told much of anything about its possible structure.) Discuss and compare the world of four space dimensions and one time dimension, with the world of three space and *two* time dimensions. (In Chap. 5 we'll discuss a possible connection between two-dimensional time and time travel.)

In the text it is stated that "If A and B are mutually causative, then 'A causes B' coupled with 'B causes A' seems to lead to 'A causes A.'" Suppose, however, that we imagine two adjacent sunken pools of water, **a** and **b**, on the same horizontal surface, with each pool filled to the brim. An overflow from one pool will flow into the other pool. Now, define the events A and B as 'A is the overflow of pool **a**' and 'B is the overflow of pool **b**.' Thus, A causes B and B causes A. Does the conclusion 'A causes A' make physical sense in this specific case? Discuss at length.

When reading A. C. Clarke's story "Technical Error" (see note 99), we learn that a rotation through 4-space *inverts* "the unlucky Nelson." The 'solution' to this awkward situation is to flip Nelson through 4-space a second time and so back to 'normal.' (When *Thrilling Wonder Stories* reprinted this tale in June 1950, after its original publication in 1946, the title was changed to the more appropriate "The Reversed Man.") Clarke may have missed an

(continued)

important technical 'detail,' however, in that when first flipped through 4-space *everything* inverts, and so matter becomes anti-matter and Nelson would have instantly been annihilated in a 100 % conversion of matter to energy (that is, the flipped Nelson would have initiated a very large explosion). Compare this to Alice's concern in her flipped world (Lewis Carroll's *Through the Looking Glass*) when she wonders "Perhaps Looking-glass milk isn't good to drink." Explain why Lewis Carroll certainly was *not* thinking of matter/anti-matter explosions when he wrote his novel. What *do* you think he might have had in mind?

A time travel story, even earlier than Clarke's, that uses spacetime 'rotations,' was authored by Edmond Hamilton (1904–1977), one of the pioneering pulp fiction writers. In his "The Man Who Saw the Future" (*Amazing Stories*, October 1930), a man is hauled before the Inquisitor Extraordinary of the King of France to explain his mysterious disappearance, and subsequent reappearance, in an open field, amid thunderclaps and in plain sight of many onlookers. As the story unfolds, we learn that the man was transported five centuries into the future, from A.D. 1444 to 1944, by scientists working in twentieth-century Paris. The thunderclaps were produced by spacetime 'rotations,' as the atmospheres of 1944 and 1444 were reversed. A skeptical Inquisition naturally finds this tale preposterous and the first time traveler is burned at the stake as a sorcerer. Can you think of *why* such 'atmospheric swaps' might produce thunderclaps?

A trip around a Möbius strip reverses the 'handedness' of a plane figure (left and right are swapped). You can see this for yourself by making a Möbius strip, and then sliding an arrow (pointing *across the width* of the strip) around the strip. (Cut a notch in the side of the strip to mark the starting point, with the arrow pointing at the notch.) When you get back to the notch, the arrow will point *away* from the notch. Notice that the arrow never left the surface of the strip, or crossed any 'weird' boundary. Then, read H. G. Wells' short story "The Plattner Story" and comment on its use of 'handedness.'

The *autoinfanticide paradox*, which results when a time traveler tries to kill his younger self, continues to fascinate both physicists and philosophers, and papers regularly appear in the scholarly literature on the topic: see, for example, Kadri Vihvelin, "What Time Travelers Cannot Do," March 1996, pp. 315–330 (which introduces Suzy the time traveler); Ira Kiourti, "Killing Baby Suzy," June 2008, pp. 343–352; Peter B. M. Vranas, "What Time Travelers May Be Able to Do," August 2010, pp. 115–121; and Joshua Spencer, "What Time Travelers Cannot *Not* Do (but are responsible for anyway)," October 2013, pp. 149–162, all in *Philosophical Studies*. All deal with an issue that is psychologically fascinating: *moral responsibility*. Spencer, in particular, opens with this definition: Someone is morally responsible for an action *only* if she could have done otherwise. As he goes on to write, "If I have been attacked and both of my legs have been broken, then it seems illegitimate to criticize me for failing to run away; I could not have done otherwise." And yet all of these papers are on a point that (I think) physicists would soon lose interest in: is the question 'If Suzy is a time traveler, can Suzy kill baby Suzy, given that Suzy doesn't kill baby Suzy?' the same question as 'If Suzy is a time traveler, can Suzy kill baby Suzy, given that Suzy is now alive?' The answer to the first question is, from pure logic, NO, while the answer to the second question is just bit squishier: it all depends on what the word *can* means. For the second question, Suzy *can* kill baby Suzy if she has a weapon (knife, gun, poison, etc.) and she is in the past next to baby Suzy, but it is just that she doesn't because otherwise Suzy wouldn't be alive now (which is a given). Such debates seem unlikely to produce any insights into the physics of time travel. Compare this situation to the old schoolboy conundrum "What happens when an irresistible force meets an unmovable object?', which is a *self-inflicted* 'paradox.' That is, the words *irresistible* and *unmovable* are mutually exclusive and so, used this way, it should be no surprise that we have a conflict. Are the two time travel questions above, concerning Suzy, confusing through a similar mushy use of grammar? Or are they deeper than that? Vigorously defend your position.

In addition to H. G. Wells, another nineteenth-century writer who was highly influential in bringing the fourth-dimension out of academia and into public consciousness was the mathematician Charles Howard Hinton (1853–1907). Hinton was no angle-trisecting crank, having earned an M.A. at Oxford, an appointment in the mathematics department at Princeton, and then another at the University of Minnesota. Later, with the help of the eminent astronomer

(continued)

Simon Newcomb, he obtained a position at the Naval Observatory in Washington, D.C., and was on the staff of the United States Patent Office at the time of his sudden death. Hinton was a man to be taken seriously. His first published essay "What Is the Fourth Dimension?" appeared in 1880, and then in book form in 1884 as part of his *Scientific Romances* (a phrase used by Hinton before it became associated with Wells' science fiction many years later). That book received a generally favorable review in *Nature* (March 12, 1885, p. 431). At one point he wrote "We might then suppose that the matter we know extending in three dimensions has also a small thickness in the fourth dimension," an idea that was used a few years later by the well-known British mathematician W. W. Rouse Ball (1850–1925) in an attempt to explain gravity. Hinton was extremely inventive, and he also proposed four-dimensional-space models for static electricity. Find out more about Hinton's life and work: a good source to start with is *Speculations on the Fourth Dimension: Selected Writings of Charles H. Hinton* (R. Rucker, editor), Dover 1980. Take a look, too, at J. E. Beichler, "Ether/Or: Hyper-space Models of the Ether in America," in *The Michelson Era in American Science 1870—1930* (S. Goldberg and R. H. Stuewer, editors), American Institute of Physics 1988.

Chapter 3
The Physics of Time Travel: Part I

> *"... within forty-eight hours we had invented, designed, and assembled a chronomobile. I won't weary you with the details, save to remark that it operated by transposing the seventh and eleventh dimensions in a hole in space, thus creating an inverse ether-vortex and standing the space-time continuum on its head."*
>
> —almost certainly *not* the way to build a time machine[1]

3.1 The Direction of Time

> "Of all the problems which lie on the borderline of philosophy and science, perhaps none has caused more spilled ink, more controversy, and more emotion than the problem of the direction of time ... [T]he main problem with 'the problem of the direction of time' is to figure out exactly what the problem is or is supposed to be!"[2]

Before we start talking about the physics of time travel, let me say a few more words on time itself, in a way slightly less metaphysical that was the discussion in the previous chapter (which is why I'm writing this *here*, in a chapter with an increased emphasis on the analytical). When we speak of journeying to either the future or the past, we are implicitly making a distinction in the direction of the time traveler's trip. But does time actually have a *direction*? Is there an *arrow* that points the way? The answer seems obvious: *of course* time has a direction. After all, everybody 'knows' it flows from past to future. There is a curious language problem here, however, because we also like to say the present recedes into the past, which implies a 'flow' in the opposite direction, from future to past. Well, despite this snarled syntax, can we at least distinguish past from future, whichever way time flows?

[1] L. Sprague de Camp, "Some Curious Effects of Time Travel," in *Analog Readers' Choice*, Dial 1981.

[2] See note 54 in Chapter 2.

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P.J. Nahin, *Time Machine Tales*, Science and Fiction,
DOI 10.1007/978-3-319-48864-6_3

This would seem to be an important question to answer because for the phrases *flow of time* and *direction of time* to have any objective meaning at all, it must be somehow possible to identify a difference between past events and future ones. The special moment at which that distinction occurs is known as the *now* or the *present* and, as events make the transition associated with that distinctive difference, between past and future, we say that the *now* (the present) moves or flows. Philosophers—and science fiction writers and physicists, too, who after all are human beings with human senses like everybody else—call this common feeling that we all have, of the passage of time, the *psychological arrow of time*. One philosopher gave an amusing (tongue-in-cheek) gastronomical interpretation of the moving *now* as follows:

> "New slices of salami are continually being cut from a nonexistent chunk of salami called the future. The *present* is the slice on top of the pile. The past are the pieces beneath this, and even though they are not present they still continue to exist in the same way that the top slice of salami does. . . . This [concept] faces humiliation before the embarrassing question of how fast the pile of salami slices grows."[3]

The 'moving now' does present a problem for physicists because there is nothing in the laws of physics that marks the present moment as unique, and therefore nothing that reflects a 'flow' of time, nothing that models the reality of a 'moving now' becoming part of the past and the events of the future becoming, successively, the new 'now.' As a philosopher wrote long before time travel became a serious topic in the physics literature, "Talk of the flow of time or the advance of consciousness is a dangerous metaphor that must not be taken literally."[4]

What that philosopher may well have had in mind is that all events in the block universe simply have coordinates in spacetime, and there is nothing corresponding to 'have been' (past), 'are' (present), or 'will be' (future). There is no 'moving now' in the block universe except for its subjective presence in our conscious minds. All we can say from physics is that events are ordered in an earlier/later sequence, and in fact, even that relatively weak condition holds only for *causally* related events.[5] The relativistic, four-dimensional block universe view of spacetime that so many physicists (including Einstein) so dearly love seems to have no room for an objective theory of the *flow* of time. And yet, even for those same physicists, there is a powerful psychological sense that time *does* flow. But are they mistaken? It is a fact that, with not just a little irony, Gödel (the 'discoverer' of time travel) was convinced that the possibility of a block universe spacetime with CTLs/CTCs

[3]R. Gale, "Some Metaphysical Statements About Time," *Journal of Philosophy*, April 25, 1963, pp. 225-237. For many, this analogy may well bring to mind a pile of baloney rather than one of salami (and I think this was Gale's intention).

[4]J. J. C. Smart, "The Temporal Asymmetry of the World," *Analysis*, March 1954, pp. 79-83.

[5]Two events A and B are *non*-causally related if their separation in spacetime is such that a particle would have to travel at a *superluminal* speed (faster than light) to go from A to B. We'll discuss the physics of causally related events later in this chapter.

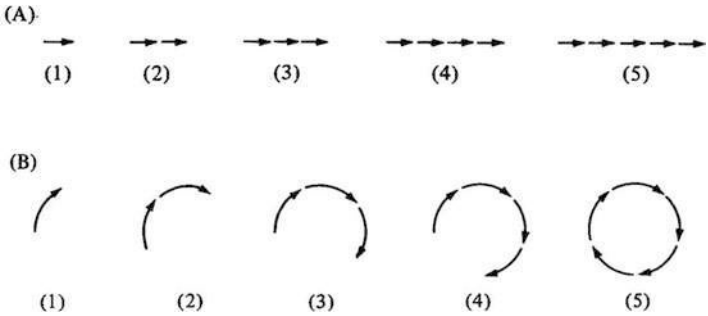

Fig. 3.1 Gödel's unreality of time argument

implies that the passage or flow of time *makes no sense*![6] To see how Gödel arrived at such an astonishing conclusion, consider Fig. 3.1.

In part A of the figure[7] we see what most people who talk of a passage of time intuitively mean, as time progresses through a sequence of instants (shown as line of left-to-right arrows going from (1) to (2) to (3) and so on). At each stage the right-most arrow is the present, and the arrows to the left of it (behind it) are the past, and the arrows to the right of the present are not shown because they are in the future and so don't exist yet. When you ask, at each step, which arrow is the *now*, the answer is clear.

Matters are dramatically different in part B of the figure, which shows the arrows forming a closed (circular) loop. Now there is no distinction between past and future, as each arrow is both ahead *and* behind any other arrow. In addition, there is no arrow that is uniquely the now. So, concluded Gödel, the passage of time can have no meaning in a temporal loop. As should come as no surprise, not everybody is convinced by this sort of argument.[8]

In principle, so it would seem, we can achieve perfect knowledge of what has happened but only imperfect prediction of what might happen. This observation seems to be at least a start at being able to tell past from future. And, in fact, the nature of the distinction between the two intervals of time seems obvious: we *remember* past events, but not future ones. As philosophers have so nicely put it, events in the past have formed *traces*, such as skulls, footprints in the sand, fossilized skeletons, surgical scars, photographs, taped recordings, carved stones,

[6]Gödel clearly states this in his 1949 philosophical essay (note 15 in the Introduction) concerning his 1949 technical paper (note 11 in the Introduction).

[7]This figure is based on the interpretation of Gödel's reasoning as presented by the philosopher Palle Yourgrau's 1991 book *The Disappearance of Time: Kurt Gödel and the idealistic tradition in philosophy* (Cambridge), which was expanded and reprinted a few years later under the new title *Gödel Meets Einstein: time travel in the Gödel universe*, Open Court 1999. Yourgrau later wrote a less technical version: *A World Without Time: the forgotten legacy of Gödel and Einstein*, Basic Books 2005.

[8]See, for example, S. Savitt, "Time Travel and Becoming," *The Monist*, July 2005, pp. 413-422.

and the like, whereas future events appear not to have formed traces. But is that necessarily so? Is it impossible for future events to create traces? The common-sense answer is *yes*, because of cause and effect, which dictates that there *must* be a temporal asymmetry in trace formation. That is, traces are the effects of *prior* causes. That line of reasoning leads us quickly to the fundamental issue of causation (which we've already encountered in Chap. 2), an issue that no discussion of time travel can avoid.

Part of the problem we have with backward time travel, and cause and effect, is as I've already mentioned, with language. The distinct and separate concepts of the temporal ordering of events, and of causality, have become merged in everyday thought. It is considered *obvious* to modern minds that if event A causes event B, then A *must* happen first. There is, however, at least one historical example of a similar merging of concepts that is parallel to our modern mixing of time order and causality—an example that shows how an issue can seem obvious and natural to the minds of one period of time, and yet to the minds of another period (our modern times) seem confused, odd, peculiar, even laughable.

As a *physicist* wrote in a paper[9] on advanced (that is, inverted causality) effects:

> *Ancient Egypt was an essentially one-dimensional country strung out along the Nile, which flows from south to north. The winds were conveniently arranged to be predominantly northerly. To go north, a traveler could let his boat drift, while with a sail he could move south against the slow current. For this reason, in the writing of the ancient Egyptians, "go downstream (north)" was represented by a boat without sails, and "go upstream (south)" by a boat with sails. The words (and concepts) or north-south and up-downstream became merged. Since the Nile and its tributaries were the only rivers known to the ancient Egyptians, this caused no difficulties until they reached the Euphrates, which happened to flow from north to south. The resulting confusion in the ancient Egyptian mind is recorded for us to read today in their reference to "that inverted water which goes downstream (north) in going upstream (south)."*

Often we can work our way free of the difficulties we create for ourselves with language, but only through common agreement. For example, the chairman of the board calls a meeting to order with mixed tenses by declaring "The meeting *will* take place *now*" and then saying at the end, "We will meet again *next* month, *same* time." We all know what these sentences mean, but only by our cultural heritage and not by the process of applying logic. The language problem causes similar difficulties for not only for fictional time travelers, but also for the physicists/philosophers who study the possibility of time machines. So—beware!

The idea of time flowing is a popular one, and it repeatedly appears in the time travel literature as the "river of time" or the "ocean of time." The deep psychological appeal of this sort of 'water language' has, not surprisingly, attracted the attention of philosophers. We can find one of the earliest expressions of the view in the *Meditations* of the second-century A.D. Roman emperor and Stoic philosopher Marcus Aurelius, who wrote: "Time is like a river made up of events which

[9]P. L. Csonka, "Advanced Effects in Particle Physics," *Physical Review*, April 1969, pp. 1266-1281.

happen, and a violent stream; for as soon as a thing has been, it is carried away, and another comes in its place, and this will be carried away, too." A most interesting essay on why such metaphors often seem so intuitively appropriate has been offered by one philosopher, who points out[10] that the seductiveness of the image of 'time as flowing water' is sufficiently great that you often find it in the scientific literature, too (Newton, you'll recall, wrote specifically in his *Principia* of time flowing). As for why such an image has such a powerful grip on our imaginations, I think we need look no further than to Kant. As he wrote (1781) in *Critique of Pure Reason*, "Time is nothing but the form of inner sense, that is, of the intuition of ourselves and of our inner state . . . Because this inner intuition yields no shape, we endeavor to make up for this want by analogies." And what better than a rushing stream of water to represent our feeling of time rushing by?

Still, no matter how intuitive such water metaphors may be, they can still easily befuddle us as well. To quote our philosopher (note 10), "Time a river! A queer sort of river that. Of what sort of liquid does it consist? Is time a liquid? A very peculiar liquid indeed!" A classic paper by the philosopher Donald Williams (discussed in Chap. 2, note 119) expresses similar doubt about the water image of time. In the course of his writing, he presents a truly staggering collection of entertaining examples of 'time as metaphor,' of which I repeat just a few here: time flies, goes, marches, and rolls, as well as flows And then he offers *this* provocative imagery: the evolution of our lives is like "a moving picture film, unwinding from the dark reel of the future, projected briefly on the screen of the present, and rewound into the dark can of the past." Wow![11]

Returning to the water metaphor, the French astronomer Charles Nordmann (1881–1940) opened and closed his 1925 book *The Tyranny of Time* with following gloomy but all too true summary of the overwhelming sense we all have of the inexorable, one-way 'flow' of time. (The ellipses in what follows denote over 200 pages!) "Nothing can equal the bitter sweetness of dreaming on the banks of Time, that impalpable and fatal river strewn with dead leaves, our wistful hours carried downstream like rudderless wrecks . . . In the eternal wave which rocks us, carries us along, and soon swallows us up, there is no rock to which we can fasten our frail barques; the very buoys we put out to measure our course are only floating mirages; and on the mysterious foundation of things our anchors slide along and fail to bite." A young person sees time, from Nordmann's perspective, as an ocean on which golden mornings arrive like waves from the future, whereas for an older person, liquid time is a nightmare flood, a swollen black torrent sweeping him first into the yawning abyss of the past and, ultimately and finally, into the eternal silence of the dark grave.

[10] J. J. C. Smart, "The River of Time," *Mind*, October 1949, pp. 483-494.

[11] And how about *this* image of time: Time is a snowball, with the center marking the beginning of the past, with ever new 'presents' accreting on the ever increasing surface as the snowball rolls down the hill of history!

The metaphor of time as a flowing river was ready-made for early science fiction writers, such as Caltech math professor Eric Temple Bell (1883–1960). His eventual novel *The Time Stream* began to appear in December 1931 as a serial in the science fiction pulp *Wonder Stories*, and Bell (writing as 'John Taine') made great use of the idea of time as a flowing stream, a stream in which one could swim into either the future or the past. There is strong evidence that Bell actually wrote the novel in July of 1921, but was unable to find a publisher for a decade, so odd did editors find the premise. By the time of its publication, others had beaten Bell into print.

The watery image of time had appeared a year earlier, for example, in a tale that played with the erosive nature of time in a dramatic way. As two time travelers speed into the future to rescue a friend, one of them describes the scene for us: "We huddled together in the whirling time girdling machine, cutting through the years as a ship's prow breasts surging waves. I could not help but think of the years as waves, beating in endless succession on the sands of eternity. They wore all away before them with pitiless attrition. Time seemed to eat all with dragon jaws."[12]

This image of time was taken a step further 3 years later in a story in which a large number of adventurers, from all across time, find themselves stranded at precisely the same place (in space and time). One of them offers his theory of what is behind this remarkable coincidence: They all have faulty time machines, like faulty boats, and all have hit the same snag on the 'river of time.' As he explains, "You may turn boats adrift on a river at many points, and they will all collect together at the same serious obstacle whether they have traveled a hundred or two miles. We are now at some period where the straight flow of time has been checked — perhaps it is even turning back on itself . . . [We] have struck some barrier and been thrown up like so much jetsam."[13]

The 'flow' of time does have its critics, of course. The British-American philosopher Max Black (1909–1988) argued[14] that questions about the direction of time are meaningless because there can be no direction to something that (he asserted) does not flow. His reasoning was that if time does flow, then he ought to be entitled to ask *how fast* it flows. That requires, in turn, a *metatime* or *supertime* for measuring the flow rate of 'ordinary' time. But because supertime must flow, too, we would then need a super-supertime, and so off we trip into what would appear to be the black hole of a McTaggert-like infinite regress. The view, of an infinite regress of times, was forcefully rejected by another philosopher with

[12]E. A. Manley and W. Thode, "The Time Annihilator," *Wonder Stories*, November 1930. This is the same magazine that, months later, finally published Bell.

[13]J. Wyndham, "Wanderers of Time," *Wonder Stories*, March 1933. Notice again, that we have the same magazine (whose editor must have had a particular fancy for such tales).

[14]M. Black, "The 'Direction' of Time," *Analysis*, January 1959, pp. 54-63.

these sharp words: "the very idea of super (or hyper)-time is indeed repulsive in its redundancy and its aroma of dilettante physics."[15]

A hierarchy of hypertimes has not bothered other analysts, however, and an entire subfield of specialty among philosophers (and some physicists, too) in time analysis has developed in what is called *multidimensional time*. One practitioner in this specialty sarcastically rejected the infinite regress complaint as a valid objection—he called it "a crushing and unanswerable position" but actually meant just the opposite—and stated that it was not at all clear (at least, not to him) why supertime must flow.[16] After all, he argued, we measure the flow of a river with respect to its banks without requiring that the banks themselves flow. (That actually strikes me as being a point that deserves debating, but I have not been able to find any mention of it in the later philosophical literature.) The idea of multiple time dimensions is particularly attractive for one sort of time travel (we'll take it up at the end of this chapter), but it enjoys far more popularity among science fiction writers and philosophers than it does with physicists.

Professor Black's objection (note 14) to talk of time 'flowing' was based, at least in part, on the observation that there are uses of the word *direction* that are not directly tied to something flowing. For example, consider the statement 'He is facing in the direction of north.' Black argued that this is mere pointing, and it is not at all the same as *moving* north. He then dismissed the possibility of there being any meaning to the direction of time, writing that making an analogy of time "with a sign-post or an index finger is too far-fetched to be worth considering." This claim (which some may feel leans too much on grammar) is, of course, an affirmation of the myth-of-passage view made famous a few years earlier by Donald Williams (note 119 in Chap. 2).

Not just philosophers have rejected the idea of time flowing. In his 1966 novel *October the First Is Too Late*, which deals with a world in which different parts of Earth simultaneously experience different eras of the past (see *For Further Discussion* at the end of this chapter for more on what this might mean), the British cosmologist Fred Hoyle (1915–2001) calls the 'river of time' a "grotesque and absurd illusion," and a "bogus idea." Another fictional work that agrees with Hoyle's non-moving image of time is the 1979 *Roadmarks* by Roger Zelazny (1937–1995). In that novel we read of "the Road," along which story characters can travel but which doesn't itself move; exits from the Road lead to the various centuries (which sounds a lot like the Francis Bradley's 1883 book that may have given the block universe its name). *Roadmarks* is a clever bit of writing, with many allusions to the paradoxes of time travel, but its explanation of the Road's origin as having been constructed by *dragons* (!) greatly undermines its interest for physicists.

[15]D. Zeilicovici, "Temporal Becoming Minus the Moving-Now," *Nous*, September 1989, pp. 505-524.

[16]C. W. Webb, "Could Time Flow? If So, How Fast?" *Journal of Philosophy*, May 1960, pp. 357-365.

In a block universe spacetime, there is no flow of time, but one philosopher believed that to be simply because the block universe is *incomplete* in its representation of reality. Writing in 1925, Hans Reichenbach (1891–1953) asked "What does 'now' mean? Plato lived before me, and Napoleon IV will live after me. But which one of these three lives *now*? I understandably have a clear feeling that *I* live now. But does this assertion have an objective significance beyond my subjective experience?"[17] Reichenbach went on to answer his question in the affirmative, and to deduce that the block universe view is missing something: "In the condition of the world, a cross-section called the present is distinguished; the 'now' has objective significance. *Even when no human is alive any longer, there is a 'now'* [my emphasis] . . . In the four-dimensional picture of the world, such as used by the theory of relativity, there is no such distinguished cross-section But this is due only to the fact that an essential content is omitted from this picture."

So, what *is* Reichenbach's 'missing essential content'? Feeling that the block universe is unacceptably fatalistic—in his words of ridicule, "the morrow has already occurred today in the same sense as yesterday"—he found his answer in the probabilistic theory of quantum mechanics. Classical physics argues that given total information about the state of the world *now*, one could in principle calculate perfectly the future or the past; one could both predict and retrodict. In contrast, quantum mechanics distinguishes past from future in a fundamental way.

Quantum mechanics does not deny that in principle we can know the past with exquisite accuracy, because each and every event leaves traces, evidence that is available to all with the means to find and decode them. But quantum mechanics also takes as truth that there is an unavoidable uncertainty to the future. The instant that this uncertainty is crystallized into fact was taken by Reichenbach to be the very definition of 'now.' The ever-increasing record of the past, in turn, defines (for Reichenbach) the *movement* of the 'now.' Reichenbach believed that with these observations he had at last captured the 'moving now' in mathematical theory, and that he had finally elevated the present from speculative psychology to solid physics, and that he had shown that the 'flow of time' is independent of the need for a conscious mind. However—

A later, powerful analysis[18] of the time-flow issue, combining philosophy with physics, comes down solidly in support of the *opposite* conclusion: it expresses the view that a 'moving now' *is* only in our minds and is *not* an intrinsic attribute of reality. The premise of that argument is that a mind-dependent flow of time is incompatible with what is called the *relativity of simultaneity* (to be discussed later in this chapter) which states that there is no universal cosmic-wide 'now' (this is a fundamental conclusion of special relativity). For example, it is meaningless to ask

[17]I've taken this quotation from A. Grünbaum, "Is There a 'Flow' of Time or Temporal Becoming?" in *Philosophical Problems of Space and Time*, Knopf 1963.

[18]L. R. Baker, "Temporal Becoming: The Argument from Physics," *Philosophical Forum*, Spring 1975, pp. 218-236.

what is happening on a planet in the Andromeda galaxy (two million light-years distant) *right now*.

Early science fiction stories are full of theories about the nature of 'now,' and the vast majority of them have no basis in scientific thought. Some of them are ingenious, however, and even though they are largely the pet ideas of the authors (and no one else's), perhaps they resulted in some young readers of the science fiction pulps of the 1930s and 1940s thinking about deeper matters than did the comic strips of "Buck Rogers," "The Lone Ranger," or "Terry and the Pirates." For example, according to one story, time is a wave and the 'moving now' we experience is carried on a crest of that wave. There are time waves both ahead and behind the crest we happen to be on (so we are told), and so each such crest carries a different 'now' for a different reality—hence the curious title.[19]

In another, more recent tale[20] about object duplication via time travel (which we'll discuss in Chap. 4, but you'll recall H. G. Wells was worried about this long ago), nine (!) copies of the same person from the year 2314 meet in 1870 to try and figure out what is going on. Part of their interesting discussion is the following analysis of the 'present':

> "Gentlemen, I think I understand," said the first James Thomas."
>
> "Eight faces turned toward him, and he felt as though he were looking into multiple mirrors."
>
> "We hold that time is a single instant — the instant of the Present —which travels through Duration — do we not?"
>
> "Eight heads nodded."
>
> "We assume that time passes in a manner analogous to the stringing of an infinite number of beads. Each bead is the instant of Now when it is last on the chain. Beads are continually being added, and each one is the only Now until another is placed after it."
>
> "Yes, that is my theory," said another James Thomas. "It can also be likened to the process of knitting. No matter how many stitches are knitted, there is only one last stitch, only one Now."

Einstein, too, was greatly bothered by the place of 'now' in time, perhaps even more than were James Thomas and his 'friends.' In an autobiographical essay, the philosopher Rudolf Carnap (1891–1970) recalled a conversation about this with Einstein in the early 1950s, at the Institute for Advanced Study in Princeton: "Once Einstein said that the problem of the Now worried him seriously. He explained that the experience of the Now means something special for man, something essentially different from the past and the future. That this experience cannot be grasped by

[19] R. Ray, "Today's Yesterday," *Wonder Stories*, January 1934.

[20] A. and P. Eisentein, "The Trouble With the Past," in *New Dimensions 1* (R. Silverberg, editor), Doubleday 1971.

science seemed to him a matter of painful but inevitable resignation. . . . Einstein thought . . . that there is something essential about the Now which is just outside the realm of science."[21]

3.2 The Arrows of Time

> "On a microscopic level there is no preferred direction for time. The equations of motion don't give a damn whether time moves forward or backward."[22]

The central issue for philosophers of time (and for physicists, too, I think) is that of its reality (or not): is time *objective and something that really flows*, or is time simply a *mind-dependent illusion* and nothing more than an artifact of our incomplete perception of reality? As the previous section shows, there is little consensus on this issue. As a start on trying to get a handle on the matter, looking into a so-called 'arrow of time' may give us some guidance. I'll begin with the arrow I've already mentioned, the psychological arrow. As discussed before, this is the feeling we have of a 'moving now,' a feeling that has no appearance anywhere in physics. A 'moving now' simply has no place in any universe devoid of the physical processes in a brain that give rise to what we call consciousness—but that doesn't mean physicists don't wonder about the 'moving now' just as much as does everybody else (remember Einstein)! As one physicist wrote in a technical journal, "What does 'Now' mean? This question must surely be the starting point of any attempt at understanding the nature of time."[23]

Well, no matter whether time actually flows or not, most of us still believe we have had a past and hope we will have a future. Each of us thinks we can easily tell one from the other, too. We have, in fact, many not so subtle indications from our everyday lives of the obvious direction of time. Nearly all of these indications have the common theme of *irreversible change*. As the British mathematician J. J. Sylvester once put it, "The whirligig of time brings about its revenges."[24] The Roman poet Ovid, who died when Christ was a teenager, said the same in his *Metamorphoses* with the famous words "Time, the devourer of all things." The

[21]Quoted from *The Philosophy of Rudolp Carnap* (P. A. Schlipp, editor), The Library of Living Philosophers, Open Court 1963, pp. 37-38. For a view contrary to Einstein's, from another physicist, see K. B. M. Nor, "A Topological Explanation for Three Properties of Time," *Il Nuovo Cimento B,* January 1992, pp. 65-70, which claims to develop a geometrical explanation for the flow of time, and so (says Nor) there *is* an objective, mathematical reality to the 'moving now.'

[22]A science fiction character pretty accurately sums-up what a modern physicist would tell you today, in L. Eisenberg's story "The Time of His Life," *The Magazine of Fantasy & Science Fiction*, April 1968.

[23]J. P. Cullerne, "Free Will and the Resolution of Time Travel Paradoxes," *Contemporary Physics*, July-August 2001, pp. 243-245.

[24]J. J. Sylvester, "A Plea for the Mathematician," *Nature*, December 30, 1869, pp. 237-239.

image of time as devourer of all that is mortal was brilliantly presented by James Barrie in his *Peter Pan*, with the crocodile who had swallowed a ticking clock chasing Captain Hook all about Neverland.

No one yet has escaped the biological decay processes of time, and inanimate objects are no less immune to this aspect of time. Logs and cigarettes burn in the stove and ashtray, but they never unburn. Our cars rust but never 'unrust.' An explosion has never been seen to reverse itself, to form a dynamite stick or a bomb casing out of a collapsing fireball. Our world seems, indeed, literally to be built on an irreversible movement toward chaos, death, and decay. Lewis Carroll uses this observation in his *Through the Looking-Glass* when Alice tells Humpty Dumpty "one can't help growing older." And speaking of Humpty Dumpty, his famous fall provides a dramatic example of a one-way evolution from past to future; he wasn't at all convinced that Alice was correct but, once he had splattered, then

All the King's horses and all the King's men
Couldn't put Humpty Dumpty together again.

While we are on the subject of Mr. Dumpty, it is also worthwhile to note that nobody has ever figured out how to unscramble an egg. Why is that? One philosopher speculated that the answer is found in the "irreversible organic phenomena" taking place in our brains which results in our flow of consciousness always being in the same direction.[25]

More subtle than the undignified undoing of a prideful egg is the phenomenon of memory, which seems trivial only because most people have not thought very carefully about it. We remember the past while remembering nothing about the future. We might, in fact, be tempted to use the phenomenon of memory to answer the question of how to tell past from future. Anything you can remember *is* the past. But that is a circular definition, as discussed by Professor Smart (note 4) who observed that to ask why memory is always of the past "is as foolish as to ask why uncles are always male, never female." In *Through the Looking-Glass* the White Queen tells Alice that "it's a poor sort of memory that only works backward" but, except for the claims of clairvoyants, it seems that is the only sort of memory any of us has. Why is that so? Of course, that would *not* be the case for a time traveler while in the past. His personal past, which he would remember, would be the future for the world around him.

For physicists, the question of the direction of time is one of profound mystery. There seems, in fact, to be no fundamental reason why time should not be able to go from future to past—but then what would 'future' and 'past' *mean*—even though no one has ever observed time to do so. All the laws of classical physics, including general relativity, and quantum mechanics, too (except for the K-mesons mentioned in Chap. 1) involve time in such a way that they ignore its sign. In other words, replacing t with $-t$ results in a perfectly valid description of something that could actually happen. But not all such possibilities are observed to occur. Why not?

[25]H. Margenau, "Can Time Flow Backwards?" *Philosophy of Science*, April 1954, pp. 79-92.

In an unpublished paper written in 1949, while doing the work that would bring him a share of the 1965 Nobel prize in physics, Richard Feynman (1918–1988) wrote[26] "The relation of time in physics to that of gross experience has suffered many changes in the history of physics. The obvious difference of past and future does not appear in physical time for microscopic events . . . Einstein discovered that the present is not the same for all people [the relativity of simultaneity, to be discussed later in this chapter] . . . It may prove useful in physics to consider events in all of time at once and to imagine that we at each instant are only aware of those that lie behind us. The complete relation of this concept of physical time to the time of experience and causality is a physical problem which has not been worked out in detail. It may be that more problems and difficulties are produced than are solved by such a point of view."

Feynman did not elaborate on what he meant by the "problems and difficulties" with that point of view (which is clearly that of the block universe), but surely he had the logical paradoxes of time travel high on his list. As the Yale philosopher Henry Margenau wrote (note 25) in a tutorial on Feynman's work, "The theory of quantum electrodynamics developed by Feynman incorporates reversals in the course of time and thereby cherishes, in the minds of many, *an age-old phantasy* [my emphasis] of more than scientific appeal [which sounds like time travel to me]."

Because the individual classical equations of microscopic physics are time-reversible, the distinction between past and future for individual particles disappears. The equations are said to be symmetric with respect to time; the algebraic sign of t is irrelevant in the classical laws. It must be understood, however, that there *is* a crucial point to appreciate. When a physicist says *time reversal*, she is talking about a system evolving backward in forward time—that is, all the individual particle velocity vectors are instantly reversed at once. This is distinct from the time-reversed worlds of philosophers and science fiction writers (which we'll get into later in this chapter) in which time itself 'runs backwards.' The physicist's point of view is clearly expressed in an early essay by a chemist: "Every equation and every explanation used in physics must be compatible with the symmetry of time. Thus we can no longer regard effect as subsequent to cause. If we think of the present as pushed into existence by the past, we must in precisely the same sense think of it pulled into existence by the future."[27] More than three decades later, a mathematician and a physicist presented a similar statement: "In classical dynamics, the past completely determines the present, and therefore, by symmetry, the future also completely determines the present."[28]

[26]S. S. Schweber, "Feynman and the Visualization of Space-Time Processes," *Reviews of Modern Physics*, April 1986, pp. 449-508.

[27]G. N. Lewis, "The Symmetry of Time in Physics," *Science*, June 6, 1930, pp. 569-577.

[28]O. Penrose and I. C. Percival, "The Direction of Time," *Proceedings of the Physical Society* (London), March 1962, pp. 605-616.

Besides the physics, there is also an interesting theological connection to time reversal. As one philosopher put it, "If all the laws are time reversal invariant and so no irreversible processes occur in the physical Universe then there is no inherent, intrinsically meaningful difference between past and future . . . If this is actually the natural case, then all mankind's major religions which preach a creation of the Universe (by a supernatural agency) and imply, accordingly, a differentiation between the past and the future . . . would have to make appropriate adjustments."[29]

There are, as you might expect on such a controversial topic, dissenters to the view that the classical laws of physics are necessarily time-reversible. Dirac himself wrote that "I do not believe there is any need for physical laws to be invariant under time and space reflections, although all the exact laws of nature so far known do have this invariance."[30] Dirac did not, unfortunately, elaborate on just why he felt that way, but with the later discovery of K-mesons his position is seen to have been 'ahead of its time'! In a famous science fiction story[31] dealing with the direction of time, one character finally puts his finger on the real puzzle of the question of time: "How can a man live backward? You might as well ask the Universe to run in reverse entropy." That cogent question brings us, in fact, to the first scientific explanation developed to explain the observed asymmetric nature of time.

It was the Englishman A. S. Eddington (1882–1944) who gave the picturesque name, the *arrow of time*, to the observed asymmetric nature of time's direction from past to future. He was also one of the popularizers of an explanation for the arrow, using the famous second law of thermodynamics.[32] The second law of thermodynamics states that a measure of the internal randomness or disorder—what is called the *entropy*—of any closed system (that is, one free of external influences) continually evolves toward that of maximum disorder, toward the condition called *thermodynamic equilibrium*. Indeed, so striking is this increase in entropy S with time in a macroscopically large system that the increase in entropy has come to be thought of as actually *defining* the direction of time. Eddington, however, was not the originator of the entropy concept. The history of entropy can be traced back to before the turn of the century, to the great Austrian scientist Ludwig Boltzmann (1844–1906) and his famous H-theorem. The quantity H in that theorem is directly related to the more familiar entropy,[33] defined by Boltzmann in 1877.

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[29]H. Mehlberg, "Philosophical Aspects of Physical Time," in *Basic Issues in the Philosophy of Time* (E. Freeman and W. Sellars, editors), Open Court 1971.

[30]P. A. M. Dirac, "Forms of Relativistic Dynamics," *Reviews of Modern Physics*, July 1949, pp. 392-399.

[31]A. Boucher, "The Chronokinesis of Jonathan Hull," *Astounding Science Fiction*, June 1946.

[32]A. S. Eddington, *The Nature of the Physical World*, Macmillan 1929.

[33]The H-theorem was a direct continuation of the work by the Scottish physicist James Clerk Maxwell (1831-1879) on the statistical properties of gas molecules (determining the probability density function of the molecules' speeds). In 1866 Maxwell found this function for the particular case of thermodynamic equilibrium. In 1872 Boltzmann found the differential-integral equation the function satisfies in general, even if the condition of thermodynamic equilibrium doesn't hold. From this Boltzmann was able to define a quantity H that he showed evolves in time such that

The entropy S of a system in a given state is proportional to W, which is the number of different possible ways the state can occur as a result of all possible variations of system's internal, microscopic structure. The calculation of W is usually quite complicated, but in various highly idealized systems it can be straightforward. Consider, for example, a vacuum cylinder with a thin membrane dividing the interior into halves. Suppose that we insert (to be specific) six molecules into the left half of the cylinder (and none into the right half). If we define the microscopic state of the system to be the number of molecules in the left half, then initially $W = 1$ because there is just one way to put all six molecules on the left side. This represents the state of *minimum* entropy, the state of maximum order that is most distant from thermodynamic equilibrium. If we now puncture the membrane then the molecules, once confined to the left side, are free to move about the entire cylinder. At any given instant we can imagine counting the number of molecules on the left side—suppose that at some particular instant we count five, with one molecule having moved to the right side. Then, $W = 6$, because there are six ways to pick the molecule that has moved from left to right, and so the entropy has increased.

We think of the thermodynamic equilibrium state as being the state with equal numbers of molecules in both halves of the cylinder, and that state has the *maximum* entropy. (Can you show that this state is associated with $W = 20$?) With such a small number of molecules, it is *not* clear that W (and so S) will *inexorably* increase with time; perhaps, after one of the six molecules has gone to the right, it then returns to the left side before any of its companions have joined it on the right. Such an event is called a *reversal*, and it will happen with some non-zero probability. But the more molecules there are in the cylinder (instead of six, make the number a million million million—still a small amount of gas in our everyday world, hardly enough to fill a sewing thimble), the more likely it becomes that the value of S *will* monotonically increase with time.

The steady increase in entropy is often observed in the everyday, large-scale world. A drop of ink in a glass of water spreads out in an expanding cloud, a cloud we *never* see collapse backward into an ink drop. A long rod of metal, initially hotter at one end than at the other, evolves toward a constant temperature along its entire length. We *never* see a uniformly warm rod spontaneously begin to cool at one end and grow hot at the other. A hot bath grows cold—nobody has *ever* seen a bath at room temperature suddenly, all by itself, begin to heat up and then boil in the middle of the tub while the edges freeze into ice chunks. In all of these cases, the end (future) state represents greater internal randomness or disorder than does the beginning (past) state.

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solution to his differential-integral equation approaches Maxwell's equilibrium solution. The H-theorem says that H always *decreases* in systems not in equilibrium and is at a *minimum* in systems in equilibrium.

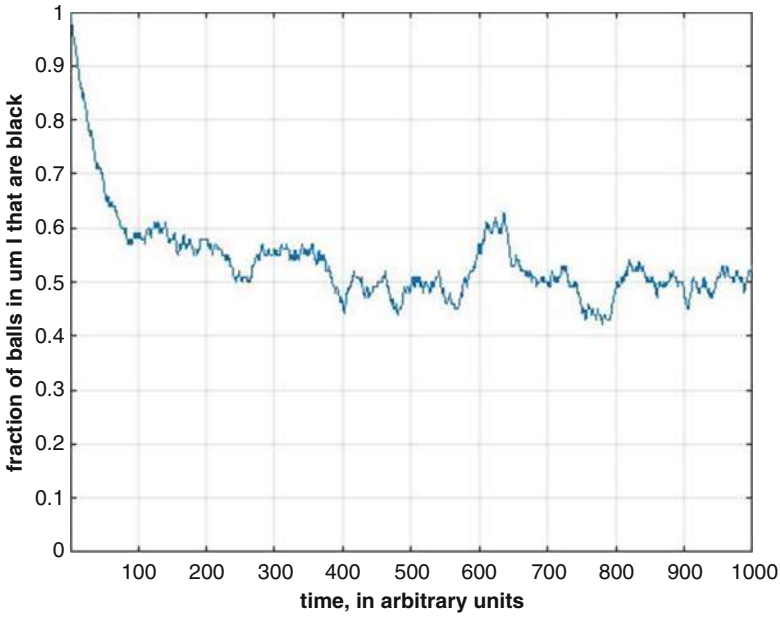

Fig. 3.2 Simulation of the Ehrenfest entropic gas clock

That is, low entropy *was* the past, and high entropy *will be* the future. The increase in entropy seems to define a direction to time, and so entropy has come to be called the *thermodynamic arrow of time*.

The first formal entropy model for the direction of time was put forth in a 1907 paper by the Austrian physicist Paul Ehrenfest (1880–1933) who was a friend of Einstein, and his Russian-born wife Tatyana (1880–1964), who was a skilled mathematician and her husband's occasional collaborator. In their paper the Ehrenfests developed one of the mainstays of physics, the so-called *entropic clock*. This clock, a statistical model based on the then new probability mathematics of Markov chains—after the Russian mathematician A. A. Markov (1856–1922)—describes how gases diffuse, and it is both a simple and a powerful concept. The Ehrenfest model is illustrated in Fig. 3.2, in a computer-generated plot based on a discussion by Princeton physicist John Wheeler of black hole fame (see Chap. 1).[34]

Imagine two urns, I and II, each containing n balls. Initially, at time $t = 0$, all of the balls in Urn I are black and all of the balls in Urn II are white. Then, at time $t = 1$ (in arbitrary units), a ball is selected at random from each urn and (instantaneously) placed in the other urn. This select-and-transfer process is repeated at times $t = 2$,

[34] J. A. Wheeler, "Frontiers of Time," in *Problems in the Foundations of Physics* (G. T. diFrancia, editor), *Proceedings of the International School of Physics* (Course 72), North-Holland 1979. See also W. J. Cocke, "Statistical Time Symmetry and Two-Time Boundary Conditions in Physics and Cosmology," *Physical Review*, August 25, 1967, pp. 1165-1170.

3, 4, ... At any given time each urn always contains n balls, but only at $t = 0$ are the colors of all the balls in a given urn necessarily the same. The phrase "selected at random" means (for example) that the probability of selecting a black ball from an urn containing b black balls is b/n. At any given time we completely describe the state of both urns by specifying the number of black balls in Urn I (or the number of white balls in Urn II, and so on). It is easy to write a computer simulation of this physical process,[35] and Fig. 3.2 shows how the fraction of black balls in Urn I evolves toward 0.5 as time increases. The plot is for $n = 100$ (200 balls total). The important observations are that (1) the evolution of the state of the system is toward 50 % black balls in Urn I (and this would be the case for 'almost all' sequences of random selections of the balls from the urns), and (2) the evolution is not monotonically decreasing from 100 % black balls to 50 % black balls, but rather has never-ending fluctuations about 50 % that may, in fact, be rather large in both amplitude and in duration.

There is a real puzzle with the entropic clock that may not be immediately apparent. The motion of each of the individual molecules is described by time-reversible physics, but when we average over 'many' molecules (assuming 200 molecules is 'many') we lose detailed information about the individual molecules. The puzzle is then how is it that by *reducing* our knowledge of a system, through statistical averaging, we then find it displaying a *new property*, that of asymmetric time evolution, that we didn't see before when we watched the individual molecules. And if that question isn't troublesome enough, we also have two additional puzzles called the 'reversibility' and the 'recurrence' paradoxes to consider as well.

The reversibility paradox is the question raised earlier: the classical equations of physics work just as well with time running in either direction, and so *why don't* things actually go 'backward'? This question, originally raised by the British mathematical physicist and engineer William Thomson (1824–1907)—better known as Lord Kelvin—in 1874, was brought to Boltzmann's attention in 1876 by the German physical chemist Johann Loschmidt (1821–1895), one of Boltzmann's professors at the University of Vienna. Boltzmann's answer to this apparent paradox was that it *is* imaginable that a world could run backward if initial conditions were suitable. For example, if all the velocity vectors of every particle in an equilibrium state were reversed, then the system *would* unwind backward in time toward its original non-equilibrium condition. That is, a system in thermodynamic equilibrium, the state of highest entropy, could evolve toward one of low entropy. Boltzmann even suggested that such might be the case for regions in our own universe, that there might actually be beings in a world somewhere 'out there' who

[35] I used MATLAB, and you can find the code — gasclock.m — in Appendix C, written in such a low-level way as to be virtually 100% transferable to just about any of the popular scientific programming languages, and easily executed on an inexpensive laptop. Note that there are no K-mesons in the code (!) and so, as stated in Chapter 1, they aren't responsible for the uni-directional time behavior depicted in the figure.

experience time running counter to our earthly experience. He said that in 1877, and it is a remarkable statement for a conservative nineteenth-century professor.[36] However, Boltzmann continued, from most given states there are vastly more ways for entropy to increase than there are for it to decrease, and that is why we see what we see, a continuous *increase* in entropy.[37]

To find a science fiction writer speculating on reversed time people is, of course, much less remarkable! One pulp story, in fact, presents a curious treatment of the nuances of reversed time in which people talk backward (along with a marvelous bathroom scene of a man un-washing his hands!). This tale[38] tells us a young physics teacher who is "twisted into a reversed Time Stream" by an electrical discharge. As he lives backward in time, he observes everybody about him appearing to run in reverse, but even more puzzling is that they have developed a "dreadful, granite-like hardness." We soon learn why:

"For a while he could not understand the impenetrable hardness of external objects which he had experienced; it seemed they ought rather to be of intangible transiency, much as a dream, since he was re-viewing the Past. But a moment's thought gave him the logical answer. The Past is definite, shaped, unalterable, as nothing else in Creation is. Therefore, to argue that he could move or alter any object here [the past] was to argue that he could change the whole history of the world or cosmos. Everything he saw about him had happened, and could not be changed in any way. On the other hand, he was fluid, movable, alterable, since *his* future still lay before him, even if it had been reversed; he was the intruder, the anomaly. In any clash between himself and the Past, the Past would prove irresistible every time."

This passage reflects the modern view that the past cannot be changed, but explains that view in a way different from that generally accepted today. Modern physicists and philosophers invoke consistency requirements (which we'll take up in the next chapter) to explain the 'solidity' of the past. The author of this story also failed to explain why his physics teacher had no trouble moving about through the air of the past, which apparently is not any more resistant to being displaced than were air molecules before time reversal occurred.

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[36]The Austrian-British philosopher Karl Popper (1902-1994) called Boltzmann's willingness to consider the possibility that different regions of the universe could have different directions of time "staggering in its boldness and beauty," but when on to say that Boltzmann must be wrong because "it brands unidirectional change an illusion [which] makes the catastrophe of Hiroshima an illusion." That is an emotional argument, of course, and although one of great power, I fail to see how it is related to physics. See Volume 1 of *The Philosophy of Karl Popper* (P. A. Schlipp, editor), Open Court 1974, pp. 127-128.

[37]For more on Boltzmann's views on entropy, see the end of his letter "On Certain Questions of the Theory of Gases," *Nature*, February 28, 1895, pp. 413-415.

[38]C. F. Hall, "The Man Who Lived Backwards," *Tales of Wonder*, Summer 1938. The modern classic of a time-reversed world is Philip K. Dick's 1967 novel *Counter-Clock World*. We'll encounter another time-reversed world again in Chapter 4.

It didn't take long for science fiction writers to incorporate entropy as time's arrow into time travel. In one early tale there is the brief statement that entropy is behind the operation of its gadget.[39] And a few years later the inventor of a "warp gun" tells us that "The stupendous distortion of the warp may actually bring about a sort of kink in spacetime, and result in a reversal of entropy"[40] and, sure enough, when the gun is fired a woman, who is hit by the warp, ages 70 years in seconds (which is, of course, exactly the opposite of what we would expect from a "reversal of entropy"!). Just a year later, the story of a college student about to flunk his senior physics course appeared.[41] An examination is scheduled for the following day, but he needs a week and a half of study time. To his rescue comes ENTROPY, INC., a company that sells time by placing its clients inside a "time-cabinet" in which the local entropy is greatly accelerated. To someone looking through a window at the interior of the time-cabinet, the occupants would appear as characters in a speeded-up movie. Referring to Eddington by name, the author tells us that "entropy is what makes time irreversible — is what gives us the feeling of the flow of time."[42]

In a hilarious, melodramatic story featuring one of early science fiction's stereotypical 'mad scientists,' the entropic arrow of time is the scientific explanation for time travel.[43] There we read of Bryce Field, "a master-scientist, a demon, cruel, ruthless," who is rejected in love by the stupendously beautiful Lucy Grantham. Her lack of enthusiasm is perhaps understandable, as Bryce is described as having "a lean-jawed, sunken-eyed" appearance, along with "lank, untidy hair sprawled across his massive forehead." As Lucy tells him at one point, "I could never love you; you are too clever, too brilliantly scientific." After hearing that, it is no surprise that before we are more than a page or two into the tale that we learn Bryce has Lucy strapped to a steel table in an underground laboratory-in-a-cave. There he tells her of her fate: "You are going on a long journey, my dear. So long a journey that even I, master-scientist, do not know when it will end. A journey into the future — alone! ... You, Lucy, shall be the victim of entropy! ... I have discovered how to make a [globe] of non-time. Entropy will be halted ... You will be plunged into an eternal 'now.'"

And so the mad Doctor Field throws the switch on the wall of his "instrument-littered" cave on July 17, 1941, and Lucy remains "suspended" in time until the outside world reaches the date of August 9, 2450. That is the day she is at last dug-up from the cave by "big and muscular" engineer Clem Bradley and his "square-jawed" sidekick Buck Cardew, who uses a "warp in spacetime" to release Lucy from her "globe of non-time."

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[39] M. J. Breuer, "The Time Valve," *Wonder Stories*, July 1930.

[40] F. B. Long, "Temporary Warp," *Astounding Stories*, August 1937.

[41] R. M. Farley, "Time for Sale," *Amazing Stories*, August 1938.

[42] Also citing Eddington was a tale by D. W. O'Brien, "The Man Who Lived Next Week," *Amazing Stories*, March 1941, which uses entropy to explain time travel. This curious story has the traveler arriving in the future with his clothing aged, which later 'de-ages' when the return trip is made!

[43] P. Cross, "Prisoner of Time," *Super Science Stories*, May 1942.

A few years later entropy was used in a similar but vastly more 'scientific' way. In that tale[44] we read of a scientist who has discovered "a field in which entropy was held level." As the reader is told, "An object in such a field could not experience any time flow — for it, time would not exist," since time flow is a *change* in entropy, and the 'change' of a level (or constant) field is zero. This interesting tale speculates on how such a field could have fantastic home uses ("Imagine cooking a chicken dinner, putting it in the field, and taking it out piping hot whenever needed, maybe twenty years hence!"). But its real use in the story is as a stasis generator for preserving fatally ill people until medical science has learned how to cure their diseases. This is, then, a high-tech method of suspended animation, of time travel into the future that is different from simply freezing (a clock in such a field would not age or measure the passage of personal time).

The gadget that does all this is called, somewhat sinisterly, the "Crypt," which we are told also makes a great bomb shelter, too, because "not even an atom bomb could penetrate a stasis field." The reason for that is intriguing: "The field requires a finite time in which to collapse — only there is no time in it." The interior of the Crypt is, quite literally, a frozen block of time more rigid and unyielding than the strongest steel.

As science fiction left the age of pulps and moved into the modern era, entropy continued to be useful a justification for time travel. Arthur C. Clarke used it,[45] as did Robert Silverberg. This last tale[46] is particularly interesting, as Silverberg pursued entropy beyond simply invoking it as a mere casual throwaway mention. When a newspaper from the future appears on people's doorsteps, the initial astonishment is replaced with puzzlement as the papers rapidly disintegrate. That is the result (we are told) of "entropic creep." The explanation continues, informing us that it is sort of like a strain in a geological fault (Silverberg has lived for decades in California, now and then a place of large to huge earthquakes, and it isn't surprising that he uses this particular imagery): "Entropy you know is the natural tendency of everything in nature to come apart at the seams as time goes along. These newspapers must be subject to unusually strong entropic strains because of their anomalous position out of their proper place in time."

Earlier I mentioned we had *two* puzzles associated with entropy; we've discussed 'reversibility,' so what's the other one, the 'recurrence paradox,' all about? The recurrence paradox is quite different from reversibility; it is based on a result established in 1890 by the great French mathematician Henri Poincaré (1854–1912). Motivated by the question of the stability of the motion of three masses governed by Newton's laws of mechanics (think, for example, of the Sun, the Earth, and the Moon), Poincaré showed that starting from almost any initial state, any fixed volume system with a finite amount of energy and a finite number of

[44]P. Anderson, "Time Heals," *Astounding Science Fiction*, October 1949.

[45]In, for example, his story of the tragic end of a geologist fifty million years in the past: "Time's Arrow," *Science Fantasy*, Summer 1950.

[46]"What We Learned from This Morning's Newspaper," *Infinity 4*, November 1972.

degrees of freedom will return *infinitely often and with arbitrarily little deviation* to almost every previous state. If you wait long enough, implies Poincaré's astonishing theorem, Pearl Harbor will happen again—and again, and again, and . . .. In 1896 the German mathematician Ernst Zermelo (1871–1953) used this result, which philosophers call the 'eternal return,' to claim that there could be no truly irreversible processes and thereby cast doubt on the idea that entropy *always* and *inexorably* increases.

Even for very small systems, however, such as a mere handful of molecules, the recurrence time is extremely large, and this was, in essence, Boltzmann's reply to Zermelo's concern. For example, if the gas-filled cylinder of our entropic clock has just 100 molecules (not the six I used in the earlier example), and if transitions from one side of the cylinder to the other side take place at the rate of one million per second, then the recurrence time has been calculated to be something like 30 million billion years![47] And for the universe itself, the recurrence time is simply incomprehensible. Mathematicians call 1 followed by a hundred zeros a *googol*, and the recurrence time in years for the universe has been estimated to be 1 followed by a googol of zeros (a so-called *googolplex* of years).[48]

Using a wonderful bit of imagery, one analyst wrote of the enormity of the recurrence time of a system considerably *less* complex than the universe this way: "If a man shuffled just a single pack of cards as rapidly as an individual molecule hits other molecules in air, and if a snail started to crawl around the universe . . . at the rate of one centimeter *during the life of the sidereal system* [my emphasis], the snail would have got round the universe many millions of times before it would become at all likely that the man would have got the pack back to the original order."[49] If this is what it takes to get a pack of cards back to its initial state, then try to conceive of the time interval required to restore *the world* to December 7, 1941.[50]

The notion of eternal recurrence considerably predates Poincaré, and its scientific (as opposed to astrological) study can be traced back to the fourteenth century.[51] A 'more recent' claim for eternal recurrence, also based on scientific arguments (conservation of energy), can be found in many places in the writings of the German philosopher Friedrich Nietzsche (1844–1900)—see, for example, his *The Gay Science* (1882) and *Thus Spake Zarathustra* (1883)—again predating

[47]J. M. Blatt, "Time Reversal," *Scientific American*, August 1956.

[48]The googol is a gigantic number, far greater than the number of raindrops that have fallen on the Earth during its entire history. And the googolplex is light years beyond that.

[49]R. B. Braithwaite, "Professor Eddington's Gifford Lectures," *Mind*, October 1929, pp. 409-435.

[50]Pulp science fiction writers, of course, were not discouraged by such calculations, as they depended on the *certainty* of recurrence over *infinite* time. See, for example, S. G. Weinbaum, "The Circle of Zero," *Thrilling Wonder Stories*, August 1936, and L. D. Gunn, "The Time Twin," *Thrilling Wonder Stories*, August 1939.

[51]R. Small, "Incommensurability and Recurrence: From Oresme to Simmel," *Journal of the History of Ideas*, January-March 1991, pp. 121-137.

Poincaré. All of Nietzsche's arguments are flawed,[52] but they are rational, physical arguments, as opposed to arguments based on metaphysics or theology. In fiction, a glimmer of the idea of a repetition of human affairs preceded Poincaré by some years, too.[53]

An important caveat concerning recurrence is that we could never *know* of it because the state of all the historical records (geological, memories, books, photographs, and so on) would, as part of the physical state of the universe, also recur. And so those records could, up to the instant *before* the recurrence, contain no signature *of* the recurrence because the recurrence has not 'yet' happened![54] The 1993 movie *Groundhog Day* stumbles on this point, as it has a character (for some unexplained reason) live through the same day over-and-over *and he is aware he is doing that*. Indeed, he can change events within that time loop at will. It is interesting to note that one 'time loop' pulp science fiction tale[55] specifically avoided that error (and cited Nietzsche, to boot), and so demonstrated that pulp science fiction *could* have some philosophical merit to it.

While the enormous recurrence time for the universe may seem reason enough to reject the possibility of Pearl Harbor repeating, there are more fundamental reasons for such a rejection. For example, an *expanding* universe, such as the one we live in, violates the Poincaré theorem's assumed condition of a *fixed* volume system. As Professor Eddington put it in a 1934 lecture at Cornell University, "In an expanding space any particular congruence becomes more and more improbable. The expansion of the Universe creates new possibilities of distribution faster than the atoms can work through them, and there is no longer any likelihood of a particular distribution being repeated. If we continue shuffling a pack of cards we are bound sometime to bring them into their standard form — but not if the conditions are that every morning one more card is added to the pack."[56]

An even more direct way to escape Poincaré's theorem is to use a result from general relativity. Using Einstein's theory instead of the classical dynamics that Poincaré used, it has been shown (by Frank Tipler, the inventor of the rotating cylinder time machine spacetime that was mentioned in the previous chapters and which we'll revisit later in the book) that the recurrence theorem is simply no longer true.[57] As Tipler wrote, "In general relativity, singularities intervene to prevent recurrence. General relativistic Universes are thought to begin and end in singularities of infinite spacetime curvature [the Big Bang and the Big Crunch,

[52]J. Krueger, "Nietzschean Recurrence as a Cosmological Hypothesis," *Journal of the History of Philosophy*, October 1978, pp. 435-444.

[53]See "Human Repetends" by Marcus Clarke (1846-1881), a story originally published in 1872 and reprinted *Australian Science Fiction* (V. Ikin, editor), Academy Chicago 1984.

[54]For more on this point, see D. W. Theobald, "On the Recurrence of Things Past," *Mind*, January 1976, pp. 107-111.

[55]C. F. Ksanda, "Forever Is Today," *Thrilling Wonder Stories*, Summer 1946.

[56]A. S. Eddington, "The End of the World," in *New Pathways in Science*, Macmillan 1935.

[57]F. J. Tipler, "General Relativity and the Eternal Return," in *Essays in General Relativity* (F. J. Tipler, editor), Academic Press 1980.

respectively], and these singularities force time in general relativity to be linear rather than cyclic." A twist to this, however, is that in his analysis Tipler assumed that gravity is *always* attractive, and that the spacetime satisfies a special condition (called the *Cauchy condition* that we'll take-up later) that avoids backward causation. The first assumption is violated in wormhole time machine spacetimes, though, and the second is *by definition* violated in *any* spacetime that supports time travel! So, who knows . . .... ?

Despite all of the previous discussion it is *not* true that the evolution of a system from past to future is *always* accompanied by an increase in entropy—that is, by an irreversible increase in some measure of the system's 'disorder.' Yes, it can be calculated that entropy is *very likely* to monotonically increase in systems of macroscopic size, but that is not the same as certainty. There *can* be fluctuations in the thermodynamic evolution of a system so as to have, at least for a while, a *decrease* in entropy (take another look at Fig. 3.2). All we can say, for sure, is that for macroscopically sized systems even very small fluctuations in increasing entropy are most improbable. To quote no less an authority than the combined genius of Gilbert and Sullivan (from their opera *H. M. S. Pinafore*), here's what we can honestly say of the possibility of failure in the supposed inexorable increase of entropy: "What, never?/No, never!/What, never?/Well, hardly ever." Still, for physicists, entropy is just too useful a concept to give up even though it does not *always* increase with increasing time for an isolated system.

Love it though they may, there are some puzzling aspects to entropy for physicists that remain to this day. For example, the idea that the universe began in some sort of Big Bang process 15 billion years or so ago is the generally accepted view today, The puzzle of that event, one that has been described as literally being a 'fireball explosion,' is that it must have been *fantastically* hot. This means that at the beginning (of everything) there was complete thermodynamic disorder, which from our earlier discussion means *maximum* entropy. Thus, we immediately have the question of how can the entropy of the universe be continuously increasing if it was as large as possible right from the start?[58]

One possible answer is that the proper model of the universe to use is the so-called *inflationary* universe. The inflationary model has a very high expansion rate for the early universe, much higher than the rate in the standard hot Big Bang model. In the standard model, the entropy puzzle occurs because of the ability of all particle processes to readjust rapidly to the ever-changing state of the universe; the so-called *relaxation times* of all particle processes were *short* compared to the expansion rate of the universe. That means that the actual entropy of the universe would, indeed, be the maximum possible at every instant (and so we have the entropy puzzle). In the inflationary model, however, the expansion rate of the early universe was temporarily so high that the relaxation times of particle processes

[58]It has been estimated that over the next 10^{116} years the entropy of the universe will increase by a factor in excess of 10^{14}. See S. Frautschi, "Entropy in an Expanding Universe," *Science*, August 13, 1982, pp. 593-599.

were *very long* compared to the expansion rate. That means the maximum *possible* entropy of the universe, at every instant, would greatly exceed the *actual* entropy. This 'entropy gap' is the cause, then, of the thermodynamic arrow of time, as the universe tries to 'catch-up' and reduce the resulting entropy deficiency.

There is also a philosophical problem with associating increasing entropy with the flow of time from the past into the future. Events in the past leave traces, artifacts taken to be ordered states—or at least more ordered than are their immediate surroundings. The classic example of this is a footprint in the sand, which is clearly a highly organized structure compared to the surrounding sandy beach. The footprint is the trace of a *past* event; such a trace was all the evidence, for example, that Robinson Crusoe needed to conclude that another human had walked that way. But now consider this famous counter-example,[59] that of a bombed city. Certainly there are traces aplenty of past bombing, and in fact one has to be careful not to trip over or to fall into them! The puzzle, of course, is in trying to argue that random bomb craters, strewn rubble, and crushed buildings, somehow constitute a more organized state (a 'footprint') than did the original city and its surrounding undamaged areas. This fuzziness was captured by one physicist who asked "If it were found that the entropy of the universe were decreasing, would one say that time was flowing backward, or would one say that it is a law of nature that entropy decreases with time?"[60]

For another example of the fuzziness of the relationship between entropy and time, consider the situation[61] of a cloud of non-colliding particles all initially moving toward each other. At first the radius of the smallest sphere that contains the cloud decreases with time but, eventually, as the particles move past another, the radius will grow without bound. Indeed, that inexorable increase of the radius could be taken as defining the direction of time that points toward the future. But in what sense is the *disorder* of the particle cloud increasing? After all, as the cloud expands it 'looks the same' at all times; only its scale (radius) changes. What has entropy to do with this expanding-into-the-future cloud? Perhaps nothing. Perhaps what is need is a *new* arrow of time.

So far we have looked in some detail at two arrows of time: the subjective, psychological feeling we have of time 'flowing,' which has no explanation in physics, and the thermodynamic, statistical quantity of entropy. A third arrow is the so-called *cosmological arrow* of the expansion of the universe. This arrow is not nearly as obvious as the first two. Only in the last century (since the 1920s), as a result of the American astronomer Edwin Hubble (1889–1953), has science become aware that the universe *is* expanding. An interesting speculation about the thermodynamic and cosmological arrows, one made numerous times, is that if the cosmological arrow should ever reverse—that is, if the universe should ever begin to

[59]See note 54 in Chapter 2.

[60]P. W. Bridgeman, *Reflections of a Physicist*, Philosophical Library 1955, p. 251.

[61]Taken from K. G. Denbigh, "The Many Faces of Irreversibility," *British Journal for the Philosophy of Science*, December 1989, pp. 501-518.

contract toward a Big Crunch—then the thermodynamic arrow would also reverse.[62] The reasoning is that the thermodynamic arrow *follows* the cosmological arrow in an *expanding* universe because that universe can continually 'swallow-up' ever more electromagnetic radiation as it is produced by any physical process. *If* the thermodynamic arrow continues to follow the direction of the cosmological arrow during a contraction, *then* the thermodynamic arrow would also reverse direction.

The usual objection to that suggestion is straightforward. If the direction of time did reverse, then we would see (so goes this argument) all sorts of odd events that would require enormously improbable physics, such as a shattered glass mirror reassembling itself. The error in that objection is subtle but equally simple. *It presupposes the retarded causality of our expanding universe*. In a contracting universe with a reversed thermodynamic arrow of time, however, there would be *advanced* causality, and thus there would be nothing at all improbable about such doings as self-assembling mirrors. As two physicists observed, "The mere reversal of the cosmological expansion will not of itself serve to reverse the direction of thermodynamic and electrodynamic processes, any more than the compression phase of a piston-and-cylinder cycle in a heat engine serves to reduce the entropy of the confined gas."[63]

Those same physicists go on to then mention Stephen Hawking's interest in the relationships among the various temporal arrows. At one time Hawking thought[64] he had discovered a connection between the thermodynamic and cosmological arrows, but then later abandoned that claim.[65] Hawking, in fact, has labeled his original claim "my greatest mistake in science," and has quite openly (and most entertainingly!) discussed his interest in the arrows of time.[66] Indeed, it was to be the subject of his doctoral dissertation but, as he wrote, "I . . . needed something more definite, and less airy fairy than the arrow of time, for my PhD, and I therefore switched to singularities and black holes. They were a lot easier."

Yet another arrow of time is the *electromagnetic arrow*, which refers to the fact that radio waves are observed to only propagate into the future, and never into the past. This is a mysterious fact, because Maxwell's equations for the electromagnetic field, like all the other laws of physics, have no intrinsic time sense. The electromagnetic arrow will be discussed in some detail in Chap. 4.

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[62]T. Gold, "The Arrow of Time," *American Journal of Physics*, June 1962, pp. 403-410.

[63]P. C. W. Davies and J. Twamley, "Time-Symmetric Cosmology and the Opacity of the Future Light Cone," *Classical and Quantum Gravity*, May 1993, pp. 931-945.

[64]S. Hawking, "Arrow of Time in Cosmology," *Physical Review D*, November 15, 1985, pp. 2489-2495. See also the next paper in the same journal, D. N. Page, "Will Entropy Decrease if the Universe Recollapses?," pp. 2496-2499.

[65]For *why* he abandoned that claim, see S. Hawking *et al*., "Origin of Time Asymmetry," *Physical Review D*, June 15, 1993, pp. 5342-5356.

[66]S. W. Hawking, "The No Boundary Condition and the Arrow of Time,' in *Physical Origins of Time Asymmetry* (J. J. Halliwell *et al*., editors), Cambridge University Press 1994.

3.3 Time Dilation

> "Time as we know it is not universally absolute. The rate of its passage depends to a great extent upon the velocity of its observer with regard to some certain reference system. A moving clock will run slower with respect to a selected coordinate system than a stationary one."
>
> —an early science fiction time traveler explains how his time machine works[67]

In this section I'll set the stage for the scientific basis of time travel to the future, as well as for time travel to the past via the warped spacetime called a wormhole. We start by imagining two horizontal, parallel mirrors, one positioned over the other and separated by distance d. The two mirrors are in the same frame of reference with an Observer; that is, the Observer is looking at two mirrors that are stationary with respect to him. Between the two mirrors we further imagine that a particle of light, a photon, is bouncing endlessly back and forth, up and down, in relentless reflection. This simple system is called a *photon clock*, or the Einstein-Langevin clock, after the French physicist Paul Langevin (1872–1946), and it has been part of physics for decades. We define the time required for the photon to travel from one mirror to the other as a *tick* in time, and so the return trip defines the clock's *tock*. The rate of timekeeping measured by the Observer, the time interval separating consecutive ticks, is obviously then given by

$$t' = 2\frac{d}{c}$$

where c is the speed of light.

Suppose we next imagine that the Observer and the photon clock move at constant speed v to the right across *our* line-of-sight. That is, we remain in the original frame while the photon clock and the Observer are now moving at speed v relative to us. This means the photon clock is in a different frame of reference from ours and so *we* do not see the photon bouncing up and down vertically, but rather *we* see the photon tracing out the triangular path shown in Fig. 3.3.

A round trip of the photon evidently now requires more time than before because the distance in the stationary frame (our frame) is greater than the round trip distance in the Observer's frame (moving with the photon clock, he still sees a round trip distance of d). In fact, if t is the time between consecutive ticks as seen by a stationary viewer (us), then the round trip path length of the photon that we see is

$$2\sqrt{d^2 + \left(\frac{vt}{2}\right)^2}$$

[67] F. J. Bridge, "Via the Time Accelerator," *Amazing Stories*, January 1931.

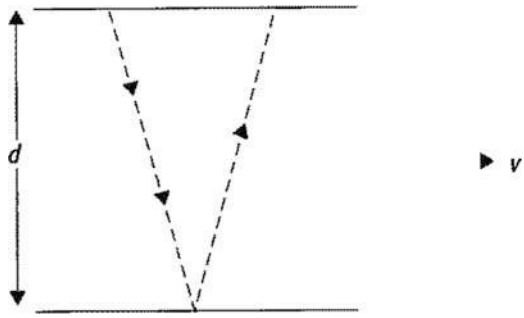

Fig. 3.3 The moving (relative to us) photon clock

and so

$$t = \frac{2\sqrt{d^2 + \left(\frac{vt}{2}\right)^2}}{c}.$$

This can be easily and quickly manipulated algebraically and combined with the earlier expression for t', the tick interval for an Observer in the same frame as the photon clock, to give the tick interval for the moving clock *as measured by a stationary viewer* (us):

$$t = \frac{t'}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}.$$

Notice that this reduces to $t = t'$ when $v = 0$—that is, when the photon clock is stationary with respect to us.

This last result is the famous Einstein time dilation formula, which shows that $t \geq t'$, and indeed that $t = \infty$ when $v = c$. That is, to us the moving photon clock appears to *run slow* compared to clocks in our stationary frame of reference and, at the speed of light, time *stands still*.[68] A curious anticipation of this association between light and timelessness can be found in a poem by the seventeenth-century poet Henry Vaughn who, in the opening words to his "The World"—which appeared in 1650 as part of his *Silex Scintillans* ("Sparking Flint")—wrote

"I saw Eternity the other night
Like a great *Ring* of pure and endless light,
All calm, as it was bright,
And round beneath it, Time in hours, days, years
Driven by the spheres
Like a vast shadow moved, in which the world
And all her train were hurled."

[68]For $v > c$ the time dilation formula says that time becomes imaginary, and this is one reason for claiming that $v > c$ is not possible. The time dilation formula has been experimentally verified: see H. E. Ives and G. R. Stilwell, "An Experimental Study of the Rate of a Moving Atomic Clock," *Journal of the Optical Society of America*, July 1938, pp. 215-226.

A similar modification in the length of a moving object (measured in the direction of motion) occurs when $v > 0$. While an Observer moving with the object will measure its length to be L', a stationary viewer will 'report' it to be contracted to the length

$$L = L'\sqrt{1 - \left(\frac{v}{c}\right)^2}.$$

This effect is called the *Lorentz-FitzGerald contraction*.[69] For 'everyday' objects and speeds the contraction effect is an extremely small one. For example, for a low-altitude satellite 100 m long, moving at 18,000 miles per hour (that is, at $v = 2.7 \times 10^{-5}c$), the contraction is less than 4×10^{-6} cm.

In the early days of science fiction the contraction effect was fascinating to readers, but authors often got it wrong. For example, in one story[70] of a runaway spaceship falling into the Sun, we read "When our racing [ship] was drawn from the Earth's gravity and fell at ever increasing speed toward the Sun it soon approached the speed of light. As we fell faster and faster our length in the direction of the Sun progressed into nothingness. Then — it reached the speed of light — passed it. Now — mind you this — when the [ship] attained the speed of light it was of a *minus* length." This author has managed to make four errors in three sentences!

The same author botched the Lorentz-FitzGerald contraction again 5 years later, and added yet more errors to his growing list. In that tale[71] there is an episode of faster-than-light radio communication along with a lengthy, unfortunate dissertation that actually denies special relativity's fundamental assertion that all inertial frames of references are indistinguishable from each other (two frames are *inertial* if they have no relative acceleration—I'll say more on this in the next section). And in yet another story[72] of high-speed space travel the author has the contraction working in the wrong direction—as the rocket ship moves faster and faster it gets longer and longer.

As bad as those errors are, first prize for mangling the laws of physics has to go to the story[73] of a near light-speed spaceship on its way to Alpha Centauri. The crew mutinies and puts the captain and first office 'overboard' (think *Mutiny on the Bounty*) with 6 months' worth of provisions. This happens at mid-voyage, about 2 light-years from both home and destination, so matters look grim. Indeed, the author tells his readers, several times, that things look *very* bad. But are they? With a stated speed of 162,000 miles per second, the time dilation factor is slightly more than 2 and so, because the space boat is traveling at $0.87c$, it will take a little more

[69]Named after the Dutch physicist H. A. Lorentz (1853-1928) and the Irish physicist G. F. FitzGerald (1851-1901).

[70]J. H. Haggard, "Faster Than Light," *Wonder Stories*, October 1930.

[71]J. H. Haggard, "Relativity to the Rescue," *Amazing Stories*, April 1935.

[72]D. Wandrei, "A Race Through Time," *Astounding Stories*, October 1933.

[73]N. Schachner, "Reverse Universe," *Astounding Stories*, June 1936.

Table 3.1 The Lorentz-FitzGerald time slowing factor

1	$\frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$
.1	1.005
.2	1.021
.5	1.155
.7	1.4
.9	2.294
.999	22.366
.9999	70.712

than 13 months of *space boat time* to complete the journey. If the men go on half-rations then it seems they *could* survive.

There is, of course, the problem of slowing down so as to arrive at Alpha Centauri at a reasonable speed, but that issue is ignored in the story. Instead, our attention is directed to the much more dramatic concern of a faster-than-light planet (don't ask!) colliding with the space boat and carrying the castaways onwards toward their destination. When this happens we read that time runs backwards (for what *really* occurs at superluminal speeds, keep reading this chapter) and, finally, in a repeat of an error I mentioned earlier, we are told that the Lorentz-FitzGerald contraction is negative for $v > c$.

The time-slowing (or size-shrinking) factor becomes pronounced only at values of v close to c, as shown in Table 3.1. For example, the last entry shows that a clock traveling at 99.99 % the speed of light will register the passage of 1 year while nearly 71 years pass on Earth. One science fiction writer got this dramatically wrong, even though he actually reproduced the Lorentz-FitzGerald equation in his story.[74] At one point he writes of the near light-speed rocket ship that stars in the tale, "If it [the ship's speed] was as slow as ninety-four percent [of the speed of light] . . . for every moment ticked by the clocks of the [ship] hundreds passed on earth." In fact, the time dilation factor at that speed is 'only' 2.93.

One possible objection to time dilation is that the analysis done here has been for a *particular* clock. How do we know that another clock, one using wheels and pendulums, for example, instead of photons and mirrors, wouldn't be affected differently by motion? The answer comes from relativity itself, which says there is no way to detect uniform motion. If two clocks did behave differently, then this difference could be used as a motion detector. Since this is impossible within the framework of relativity, then *all* clocks, no matter what the details of their internal

[74] L. R. Hubbard, "To the Stars," *Astounding Science Fiction*, February and March 1950.

mechanisms may be (including the *biological* clocks of own bodies), must respond to motion just as does the photon clock.[75]

Time dilation can also be caused by gravity (it appears in the 2014 movie *Interstellar*), and that effect has been used to 'construct' a time machine from a wormhole (to be discussed later). You can get a qualitative understanding of how that happens by imagining a massive body (*massive*, to have a really big gravitational field) in space, on the surface of which is a hot object. That object emits electromagnetic radiation and, though it isn't essential to the following argument, further imagine that the temperature of the object is sufficiently high that some of the radiation (emitted by the very atoms of the object) is in the visible-light portion of the spectrum. Now, from elementary quantum theory we can also think of the object's atoms as emitting photons ('particles of light'), each of energy hf, where h is Planck's constant and f is the frequency in hertz (what used to be called 'cycles per second'). The higher the temperature, the higher the photon energy, and so the higher the frequency. In the visible spectrum, f is on the order of 10^{15} Hz, a frequency one *billion* times higher than commercial AM radio frequencies.

The radiating atoms can be thought of as tiny clocks, with alternate half-cycles of radiation being ticks and the half-cycles in-between being the tocks. The passage of time on the surface of the massive body can be measured by these atomic clocks in the hot, radiating object. To a distant observer, however, as she receives the photons from the hot object, the passage of surface time on the massive body will appear to occur at a reduced rate when compared with the photons emitted by her own identically hot object (her 'local' clock). That's because the radiation that arrives at the distant observer has traversed a gravitational field (a journey sometimes described as 'climbing out of a gravitational well') and so is down-shifted in frequency toward the red end of the visible spectrum. This effect is called either the *gravitational red shift* or the *gravitational time dilation* effect (or even the *Einstein shift*, because it was Einstein who predicted the effect in 1907).

You can 'understand' this dilation effect as follows. One can crudely think of a photon emitted by the hot object as something like a rock thrown upward. As the rock rises upward through the gravitational field, its *total* instantaneous energy is always constant, but the total, fixed energy is split between its kinetic and potential energies in an ever changing way. That is, as the rock rises, its kinetic energy continually decreases (the rock slows down), whereas its potential energy continually increases. A photon is not a rock, however, and it certainly can't slow down as

[75]Resistance to this conclusion persisted for years. See, for example, the letter "Relativity and Radio-activity," *Nature*, January 8, 1920, p. 468. The author of that letter wondered whether a clock based on radioactive decay might not somehow beat the 'conspiracy' of moving clocks running slow compared to stationary ones. And in a letter to *Science* (December 7, 1962, p. 1180), a reader objected to applying the laws of physics to biological systems, first asserting (incorrectly) that time dilation "has never been proved or disproved experimentally," and then "there is no known causal means by which greatly increased velocity could alter, without destroying the very biochemical basis of the life process, the metabolic changes which are responsible for the aging process."

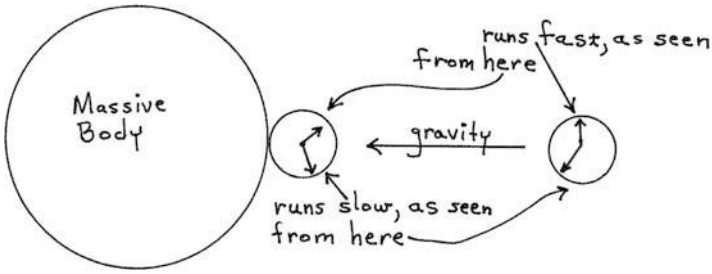

Fig. 3.4 Gravitational time dilation due to a massive body

it rises through a gravitational field (it *always* moves at the speed of light because the photon *is* light). The only way a photon can give up energy to balance the ever increasing potential energy (physicists will cringe at this, but read on) is to decrease its frequency. Hence, the red shift as seen by a distant observer of the photon, who thus sees time running slow on the massive body. Fig. 3.4 shows the case for a clock on a massive body, compared to a distant clock. Notice, carefully, the 'direction of gravity,' that is, the direction a small, unrestrained test mass will move.

A gravitational red shift in the *opposite* direction is nicely described in the famous 1966 science fiction story "Neutron Star" by Larry Niven. There a space traveler zooms down into a neutron star's intense gravity field (at half the speed of light!), passing within one mile of the star's surface. He reports what he observes in these dramatic words: "All around me were blue-white stars. Imagine light falling into a savagely steep gravitational well. It won't accelerate. Light can't move faster than light. But it can gain in energy by increasing its frequency. The light was falling on me, harder and harder, as I dropped." To Niven's intrepid spaceman, therefore, the passage of time on those distant blue-white stars appeared to be running *fast* compared to his wrist watch. This shows that the effect could equally well be called the 'gravitational *blue* shift.'

Notice that *gravitational*-induced time alterations do *not* have the symmetrical feature of motion-induced time dilations.[76] That is, for gravitational time dilations caused by photons either falling into or climbing out of gravity wells, observers at each end *agree* about whose clock is running slow, unlike in the motion-induced case where *each* of the relatively moving observers thinks it is the *other* observer's clock that is running *slow*.[77]

Now, comparing a massless photon to a rock which does have mass (and so potential energy), as each travels 'against' gravity, *is* straining the physics, with its one virtue being the provision of an initial plausibility argument. Gravitational time dilation is sufficiently important in the operation of wormhole time machines,

[76]Gravitational time dilation was experimentally observed in 1960, more than half a century after Einstein predicted it.

[77]A science fiction use of both the red and the blue gravitational shifts appears in the novel by J. P. Hogan, *Out of Time*, Bantam 1993.

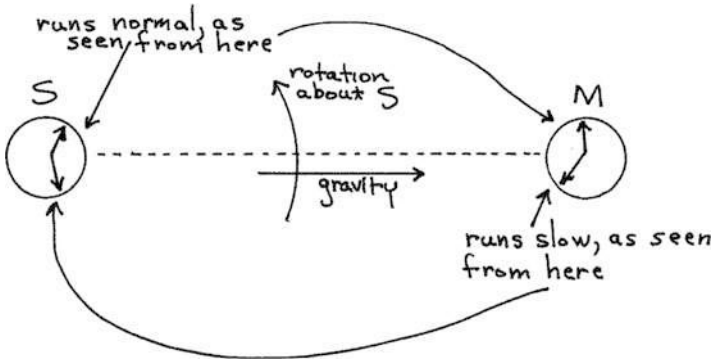

Fig. 3.5 Gravitational time dilation due to rotation

however, that perhaps another way to think about it that is more acceptable to hardcore physicists makes it worth another look. Imagine a turn-table disk that initially is *not* rotating (soon it *will* spin). On this disk imagine further that we fasten two clocks, one called S (for *stationary*) and one called M (for *moving*), as shown in Fig. 3.5. These two clocks are set to read the same time at some instant and then, thereafter, they tick-tock through time at precisely the same rate. We then start the disk rotating around a vertical axis through clock S. (Imagine S to be a *point* clock, and so it is *the* one point on the turn-table that remains at rest even as the disk rotates.) What happens to the time-keeping of S and M?

We can answer this question by using our earlier result concerning time dilation due to motion. Even with the disk now rotating, S appears stationary to an observer sitting on top of M, while M appears to be moving across the line of sight of an observer sitting on top of S. So, to the observer at S, clock M runs slow, while to the observer at M there is *no change* in the time keeping of clock S. This is a non-symmetrical outcome, and so should remind you of gravitational time dilation. This might be a puzzle to you, however, as we don't have a massive body in Fig. 3.5 to account for a gravity presence. This is where the genius of Einstein comes into play.

Anyone who has ever ridden on a merry-go-round knows there is an outward (pointing away from S) directed force called the *centrifugal force* that is 'trying' to toss you off the merry-go-round. Now, where there is a force there is an acceleration, and one of Einstein's starting points in his development of general relativity was to identify an acceleration, *whatever its origin*, with gravity. A massive body is, of course, one possible origin (the obvious one, in fact), but so is the rotation of the turn-table. So, we have the situation shown in Fig. 3.5, where now 'gravity' is directed as shown and, and as in Fig. 3.4, the direction of acceleration of gravity is toward the slow-running clock. Again, the direction of gravity is the direction a small, unrestrained test mass on the rotating disk will move. The further M is away from S, the greater the 'gravity' of the centrifugal acceleration and so the slower will M run as measured by the observer at S.

A 1968 story that uses the gravitational time dilation effect in a striking fashion tells of a starship's visit to a supernova, accompanied by a fantastic alien life-form—a ball of intelligent plasma named Lucifer that is telepathic.[78] While the ship stands off at a distance of 500 million kilometers, Lucifer will approach much closer to the *event horizon* (see the Glossary) of a black hole at the center of the supernova explosion and communicate its findings to a human telepath on the ship. A physicist in the crew is curious about one point, and asks the human telepath the following question:

"I have wondered about one item. Presumably Lucifer will go quite near the supernova. Can you still maintain contact with him? The time dilation effect, will that not change the frequency of his thoughts too much?"

Lucifer, in fact, dies in the black hole even as he saves the ship from destruction, and the human telepath will hear his death scream for the rest of her life. As the physicist later explains to the ship's captain, telepathy is instantaneous and has no limiting range (there is no known physical basis for believing any of this, but it is crucial for story effect):

> "Remember the time dilation. He fell from the sky and perished swiftly, yes.
> But in supernova time. Not the same as ours. To us, the final stellar collapse takes an infinite number of years. . . . He will always be with her."[79]

3.4 The Lorentz Transformation

> "If only he'd paid more attention to mathematics in school."
> —a science fiction time traveler laments missed opportunities[80]

In this (and the next) section the math gets about as 'deep' as it gets in this book, but to leave it out struck me as a cheat. *You* can skip part (or all) of the math and simply read the prose, but it seemed unfair for me to make that decision for you.

We begin by imagining two distinct frames of reference. One we take to be stationary, and the other as moving at a uniform speed v with the respect to the first. The moving frame is said to be *boosted* with respect to the stationary frame. We orient these two coordinate systems so that the motion occurs along just one axis (the x-axis, as shown in Fig. 3.6, where I am using primed variables for the moving frame). That is, the two frames have coincident x axes, and parallel y and z axes that

[78] Poul Anderson, "Kyrie," in *The Road to Science Fiction* (J. Gunn, editor), volume 3, New American Library 1979.

[79] A mathematical discussion of how signals take forever (even though they are emitted in a finite time interval) to travel from the event horizon of a black hole to a distant receiver can be found in James B. Hartle, *Gravity: an introduction to Einstein's general relativity*, Addison Wesley 2003, pp. 264-268.

[80] D. Knight, "Extempore," in *Far Out*, Simon and Schuster 1961. Similar words ("If only I had more mathematics") were spoken by Einstein the day before he died — see Walter Isaacson, *Einstein: his life and universe*, Simon & Schuster 2007, p. 542.

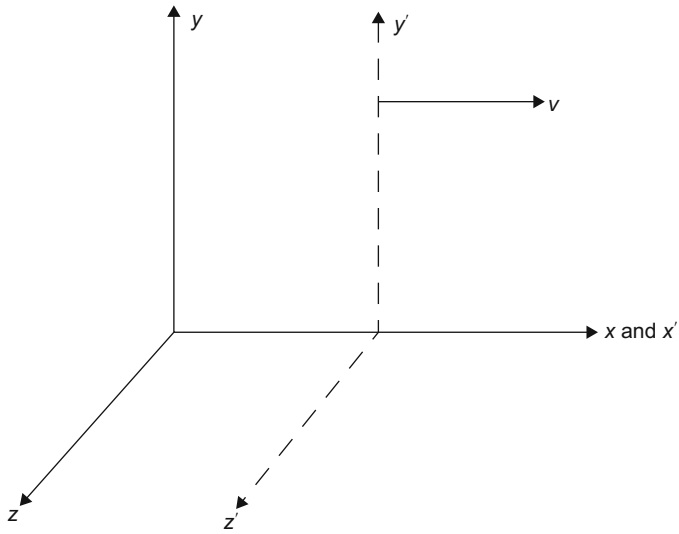

Fig. 3.6 Two reference frames in relative motion

are moving apart at the constant speed v. Let's also imagine that there is a clock at the origin of each frame, and that at the instant the origins match the clocks are synchronized; that is, $t = t' = 0$ is the instant the two coordinate systems coincide.

We further imagine that there is an observer at the origin in each frame. At some arbitrary instant of time, each observer records the coordinates of the arbitrary point P in space, as measured in his system. These observers could, for example, agree to record the coordinates of P in their system when their clock reads 5 s. It seems immediately obvious (as it was for Newton) that $t = t'$; that is, time runs at the same rate in each frame and thus it makes sense to talk about "the same instant" at every point in space. (After reading the previous section you know this *not* true, but temporally forget that!) Thus, at this 'same instant' the stationary observer records (x, y, z) and the moving observer records (x', y', z'). What are the relationships between the primed and unprimed coordinates of P? That is, what mathematical transformation converts from one frame to the other?

The answer seems obvious:

$$y' = y$$
$$z' = z$$
$$x' = x - vt.$$

This transformation, called the *Galilean transformation* after the Italian Galileo Galilei (1564–1642), satisfies the relativity principle, which says that uniform motion leaves the laws of physics unchanged. For example, in the stationary system Newton's famous second law of motion for a constant mass m,

$$F = m\frac{d^2x}{dt^2}$$

becomes the identical-appearing form

$$F' = m\frac{d^2x'}{dt'^2}.$$

More precisely, *all* the laws of mechanics known to Newton are unchanged. Any frame of reference in which Newton's laws of mechanics hold true is said to be an *inertial* frame. Given one inertial frame, we can find infinitely many others simply by applying the Galilean transformation.

However, when the mathematical laws of electrodynamics were discovered by Maxwell in the nineteenth century, it was a shock to physicists to learn that the Galilean transformation does *not* leave Maxwell's equations unchanged in form; the transformed equations predict electromagnetic effects for the moving system that are *not* predicted to occur in the stationary system. This meant that there was theoretical support for the possibility that electromagnetic experiments might be devised to detect uniform motion, and this eventually led to the famous Michelson-Morley experiment of 1887. This experiment, sensitive enough to detect the motion of the Earth itself through space, failed to detect any such motion. The conclusion was clear: the new electromagnetic effects predicted by the Galilean transformation do not exist, and so the transformation must be wrong even though it works for the laws of mechanics. So—what is going on?

The answer is inspired, and again returns us to the cornerstone of relativity: the idea that the laws of physics, *all* the laws, should look the same to observers in uniform relative motion. That is, there is no special or preferred system of coordinates—*all* inertial systems are equivalent in physics. Evidence from an extremely broad variety of sensitive experiments had, by the end of the nineteenth century, convinced physicists that Maxwell's equations *are* correct. Thus, a new transformation was needed that leaves both the laws of mechanics *and* the laws of electrodynamics unchanged with uniform motion. But, a single transformation that works on Maxwell's equations and on the mechanical laws would therefore mean that Newton's mechanical laws as stated cannot be correct, and this was a breathtaking conclusion: Newton had been unchallenged for two centuries.

As it turns out, Newton's laws are *almost* right. The only correction required is that the mass of a moving body is not independent of motion, but rather varies as

$$m = \frac{m_0}{\sqrt{1 - (v/c)^2}}$$

where m_0 is the so-called *rest mass* when $v = 0$.[81] This result says that m is infinite at $v = c$ unless $m_0 = 0$ (as it is for a photon), which is another reason for the belief that accelerating a mass (such as a spaceship) up to the speed of light is impossible because it would require infinite energy (look back at note 68, too). With this modification, the transformation that leaves all the laws of physics unaltered in form by uniform motion is what is called the *Lorentz transformation* (after the same Lorentz the contraction effect is named for), who discovered it in 1904 by direct manipulation of Maxwell's equations:

$$y' = y$$
$$z' = z$$
$$x' = \frac{x - \mathrm{vt}}{\sqrt{1 - (v/c)^2}}$$
$$t' = \frac{t - \mathrm{vx}/c^2}{\sqrt{1 - (v/c)^2}}.$$

In 1905 Einstein discovered how to derive these equations from a fundamental reexamination of space and time without concerning oneself about the details of specific physical laws.

By simple algebraic manipulation, the transformation equations can be rewritten as

$$ct = \gamma ct' + \beta\gamma x'$$
$$x = \beta\gamma ct' + \gamma x'$$

where

$$\beta = \frac{v}{c}$$

and

$$\gamma = 1/\left(1 - \beta^2\right)$$

are dimensionless constants. In compact matrix form, the Lorentz transformation becomes

[81]This variation of mass with speed was experimentally observed in 1901.

$$\begin{bmatrix} ct \\ x \end{bmatrix} = \begin{bmatrix} \gamma & \beta\gamma \\ \beta\gamma & \gamma \end{bmatrix} \begin{bmatrix} ct' \\ x' \end{bmatrix}$$

and the symmetrical 2×2 matrix is called the Lorentz boost matrix or simply the *boost*. Notice that when $v = 0$ (zero boost) the boost matrix reduces to the identity matrix; that is, the two frames are one and the same with at most a shift in the location of the origins. Note, too, that $\beta = 0$ and $\gamma = 1$ for *any* v when c is infinite—that is, the boost matrix is again reduced to the identity matrix and the Lorentz transformation becomes the Galilean *if* c is infinite. But c is not infinite, and all the implications of special relativity are the direct result of the *finite* speed of light.

The Lorentz transformation contains two results I have mentioned earlier in the book. For example, in Chap. 2 it was mentioned that simultaneity is a relative concept in reference frames in relative motion. Let's see what the transformation says about that. Consider two events that occur specifically on the x-axis. They are simultaneous in the stationary system (at, say, time $t = T$) but are at different places (at, say, $x = X$ and $x = X + \Delta X$). Their occurrences in time for the moving observer are

$$t_1' = \frac{T - \mathrm{v}X/c^2}{\sqrt{1 - (v/c)^2}}$$

and

$$t_2' = \frac{T - \mathrm{v}(X + \Delta X)/c^2}{\sqrt{1 - (v/c)^2}}.$$

For the moving observer, therefore, the two events are *not* simultaneous, being separated in time by

$$t_1' - t_2' = \frac{v\Delta X/\mathrm{c}^2}{\sqrt{1 - (\mathrm{v}/\mathrm{c})^2}}.$$

Only if $\Delta X = 0$ (the two events occur at the same place) will $t_1' = t_2'$. That is, only if $\Delta X = 0$ are simultaneous events in one frame also simultaneous in another frame in relative motion.

And in the previous section we found that time runs slow in one frame as observed from another frame that is in relative motion. We can get this result from the t' equation of the Lorentz transformation by differentiating it with respect to t. Thus,

$$\frac{dt'}{dt} = \frac{1 - (v/c^2)\frac{dx}{dt}}{\sqrt{1 - (v/c)^2}}.$$

But since

$$\frac{dx}{dt} = v,$$

the speed of the moving frame as measured by the observer in the stationary frame, this gives

$$dt' = \sqrt{1 - (v/c)^2}\,\mathrm{dt}$$

which is the same result we obtained by analyzing the photon clock.

The Lorentz transformation contains other interesting implications beyond these. For example, mention has been made several times to the 'relativity principle,' the belief that uniform motion has no observable effect on the forms of physical laws. But how do we know who is moving and who is stationary? After all, a system moving to the right past a stationary system could just as well be thought as the stationary system, while it's the *other* system that is moving to the *left* (at speed $-v$).

To study this question with the Lorentz transformation, we'll invert the transformation (that is, solve for the unprimed variables in terms of the primed ones). What we get back is just what you probably thought—the Lorentz transformation with v replaced by $-v$. That is, the Lorentz transformation is symmetrical, so two observers in different frames of reference each say it is the *other's* clock that is running slow! This follows immediately, in fact, from the original transformation written in matrix form. That is, multiplying through the earlier matrix equation by the inverse of the boost matrix, we get

$$\begin{bmatrix} ct' \\ x' \end{bmatrix} = \begin{bmatrix} \gamma & \beta\gamma \\ \beta\gamma & \gamma \end{bmatrix}^{-1} \begin{bmatrix} ct \\ x \end{bmatrix} = \begin{bmatrix} \gamma & -\beta\gamma \\ -\beta\gamma & \gamma \end{bmatrix} \begin{bmatrix} ct \\ x \end{bmatrix}.$$

The only difference between the original boost matrix and its inverse (which is, of course, the new boost matrix for the new interpretation of which frame is the moving one) is a change in sign for β, that is, in the sign of v. The inverse transformation is

$$y = y'$$
$$z = z'$$
$$x = \frac{\mathrm{x}' + \mathrm{vt}'}{\sqrt{1 - (\mathrm{v/c})^2}}$$
$$t = \frac{\mathrm{t}' + \mathrm{vx}'/\mathrm{c}^2}{\sqrt{1 - (\mathrm{v/c})^2}}.$$

As a final example of what the Lorentz transformation tells us, consider the so-called *addition of velocities* problem. Suppose you are in a high-speed spaceship traveling past Earth at speed v. Earth is the stationary system (with the unprimed variables), and the spaceship is the moving system (with the primed variables). Assume the x and x′ axes are along the direction of motion. Imagine next that while standing in the nose of the spaceship, just as the spaceship passes Earth, you fire a gun in the direction of motion (away from the Earth), with the bullet exiting the gun with a muzzle speed of w. How fast is the bullet moving away from Earth? The common-sense answer in Galileo's time was $v + \mathrm{w}$, but we now know that the Galilean transformation is wrong. What does the Lorentz transformation say?

Inside the spaceship, the position of the bullet at time t' after the gun is fired is

$$x' = wt'.$$

From the inverse Lorentz transformation, the location of the bullet earth's frame is

$$x = \frac{x' + \mathrm{v}t'}{\sqrt{1 - (v/c)^2}} = \frac{w + \mathrm{v}}{\sqrt{1 - (v/c)^2}} t'.$$

The transformation also tells us that (using $x' = wt'$)

$$t = \frac{t' + \mathrm{v}x'/c^2}{\sqrt{1 - (v/c)^2}} = \frac{1 + \mathrm{wv}/c^2}{\sqrt{1 - (v/c)^2}} t'.$$

Thus, the speed of the bullet in *Earth's frame* is

$$\frac{x}{t} = \frac{w + \mathrm{v}}{1 + \mathrm{wv}/c^2}.$$

Notice that for a low-speed bullet ($w << c$) this result[82] is close to $w + v$, but at high values for w the result is very much different. Indeed, suppose we don't fire a gun at all, but rather replace it with a flashlight. Now, instead of a bullet, we shoot *photons* at $w = c$. The Galilean transformation would (incorrectly) say that a stationary observer on Earth would see the photons moving away at speed $v + \mathrm{c}$,

[82]This result was found by the French physicist Henri Poincaré (1854-1912) in June 1905, three months *before* the publication of Einstein's special theory of relativity which also contains the result. And it was Poincaré who first stated (in 1904) that "no velocity can surpass that of light, any more than any temperature could fall below the zero absolute."

which is a superluminal speed. The Lorentz transformation, however, says that the Earth observer would see a speed of

$$\frac{c+\mathrm{v}}{1+\mathrm{cv}/c^2}=\frac{c^2(c+\mathrm{v})}{c^2+\mathrm{cv}}=\frac{c^2(c+\mathrm{v})}{c(c+\mathrm{v})}=c.$$

That is, no matter what the speed of the moving observer on the spaceship is, he sees the light from his flashlight traveling at the same speed as does the stationary observer back on Earth. This peculiar effect is unique to the speed of light ($w=\mathrm{c}$). We've derived it here as a consequence of the Lorentz transformation, but in fact Einstein actually did things in reverse order. That is, he began by *postulating* the invariance of the speed of light[83] for all observers in uniform motion, combined that with the principle of relativity which says all physical laws look the same to those observers, and so derived the Lorentz transformation using no mathematics beyond high school algebra.

A mathematically elegant alternative derivation of the addition-of-velocities formula can be done by simply noticing that the condition of two successive boosts should be, itself, a boost. Thus, if we have a frame moving relative to a second frame (which is itself moving relative to a third frame), then the boost matrix of the first frame relative to the third frame is the product of the two individual boost matrices. That is,

$$\begin{bmatrix}\gamma_3 & \beta_3\gamma_3\\ \beta_3\gamma_3 & \gamma_3\end{bmatrix}=\begin{bmatrix}\gamma_2 & \beta_2\gamma_2\\ \beta_2\gamma_2 & \gamma_2\end{bmatrix}\begin{bmatrix}\gamma_1 & \beta_1\gamma_1\\ \beta_1\gamma_1 & \gamma_1\end{bmatrix}.$$

From this it is easy to show (if you know how to multiply matrices!) that

$$\beta_3=\frac{\beta_1+\beta_2}{1+\beta_1\beta_2}.$$

Substitution of

$$\beta_1=\frac{w}{c},\ \beta_2=\frac{v}{c}$$

immediately gives the addition-of-velocities formula.

A failure to understand the implications of the invariance of the speed of light resulted in two stupendous errors in the story "To the Stars," cited in note 74. At all times an officer stands watch on the bridge of a near light-speed rocket ship to be sure the ship doesn't accidently *reach* the speed of light. This is to be avoided (according to the author) because to reach the speed of light would cause the ship to

[83]Einstein's postulate was experimentally confirmed in 1932.

"hang there forever unmoving [in time] ... locked, protected and condemned to eternity by zero time." This horrible state is so easy to stumble into (the author was apparently unaware that it would require *infinite* energy) that occasionally the ship has to fire a 'check-blast' from its forward rocket tubes to slow down! Equally absurd is the means by which the development of this 'fatal' condition is detected: the nose of the ship mounts a forward-pointing light source (our earlier flashlight) and so, if the ship is getting too near the speed of light, it will start to *overtake* the photons emitted by that source!

The biggest puzzle of all, actually, is why the editor of *Astounding Science Fiction* let such a technically goofy story appear in a magazine recognized for its usual faithfulness to known science. Particularly so since the story appeared in 1950 and, as long ago as December 1937, none other than Isaac Asimov (then 17 years old) had written a letter to the editor[84] giving the proper interpretation of what happens when $v = c$. Here's what the young Asimov wrote (notice the early hint of his life-long pessimism concerning time travel to the past that appears near the end of his letter):

> "The effect on time of increasing speeds is ... well known. Relativity states that as speed approaches that of light, time slows up until at 186,000 miles a second, time (so to speak) stands still. This seems to refute statements found in so many astronomy books (and science fiction stories) that even at the speed of light it would take four years to reach the nearest star. No such thing! As time halts at the speed of light, a person traveling from Alpha Centauri to the solar system, or vice-versa, would not be aware of any lapse of time. In that sense the speed of light is infinite (as was thought in ancient times). This by the way offers an entirely scientific (if impractical) means of travel into the future. Say that someone wants to see how the world would look a hundred years from now. His procedure would be as follows: getting into his spaceship, he would proceed to a spot fifty light-years away at the speed of light. The journey would, for him, be practically instantaneous (due to the curious behavior of time at the speed of light). But fifty years would have elapsed on earth. He makes the return trip at the same speed. Another fifty years lapse on earth and he lands a hundred years after his time. With this system, however, it would be impossible to travel into the past, so I don't think it will ever be adopted."

Young Asimov missed an important detail concerning the reversal of the spaceship's direction of travel for the return to Earth, and I'll come back to it later in this chapter. But certainly he displayed a *far* better knowledge of the physics of time than did the author of "To the Stars" (who was, by the way, L. Ron Hubbard, a prolific writer of fantasy and science fiction before founding the Church of Scientology).

[84]The editor who bought "To the Stars" was the same editor editor of *Astounding* when Asimov's letter appeared, and so he was certainly aware of it.

3.5 Spacetime Diagrams, Light Cones, Metrics, and Invariant Intervals

> "Come back when you know tensor calculus and I'll explain to you about n-dimensional forces and the warping of world-lines."
>
> —a science fiction physicist's reply after being asked how his time machine works[85]

It is helpful in discussions about the spacetime of special relativity to use what are called *Minkowski spacetime diagrams*. These are plots of the spacetime coordinates of a particle; the resulting curve is called the *world line* of the particle. Such diagrams are four-dimensional—three space axes and one time axis—and hard to visualize, much less draw on a flat sheet of paper! The convention is to make do, whenever possible, with a simplified spacetime that has just one space axis (horizontal) and one time axis (vertical). As you'll recall from Chap. 1, physicists often call such a simplified diagram a *toy spacetime*.

So, for a particle at rest in some observer's frame of reference, its spacetime diagram for that observer is a *vertical* world line. If the particle is not at rest then its world line will tilt away from the vertical; the greater the speed the greater the deviation from the vertical. Accelerated particles will have world-lines that *curve* away from the vertical. Straight, uncurved world lines represent unaccelerated particles, that is, particles experiencing no forces and so in free fall. Such a world line is called a *geodesic*. In Fig. 3.7 the world lines for these various cases are shown on the same axes. It is assumed in the figure that all three particles are at $x = x_0$ when $t = 0$.

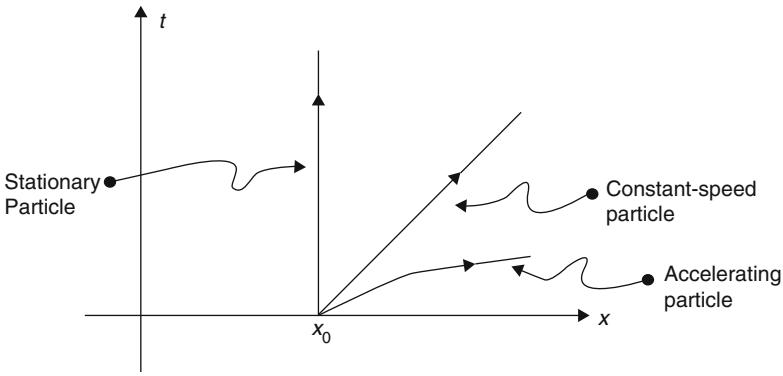

Fig. 3.7 World lines of three particles

[85] Poul Anderson, "The Little Monster," in *Science Fiction Adventure from WAY OUT* (R. Elwood, editor), Whitman 1973.

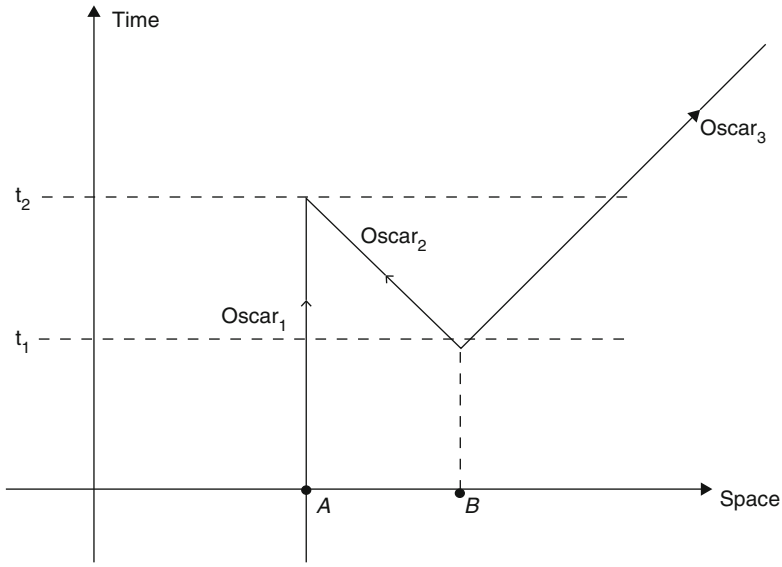

Fig. 3.8 A time traveler and his world line

Spacetime diagrams were embraced decades ago by philosophers looking for 'scientific' ways to support their position on time travel (whatever it might be), as opposed to the mere verbiage of traditional colleagues. A famous example of this is a 1962 paper by the Harvard philosophy professor Hillary Putnam (note 74 in Chap. 1). There we are asked to imagine the spacetime diagram of one Oscar Smith who, in Fig. 3.8, is at spatial location A next to his time machine. At time t_0 Oscar has not yet gotten into his time machine. A little later, at time t_1, we suddenly see not only Oscar at A but also *two more* Oscars who have appeared (apparently out of thin air) moving away from spatial location B! Between t_1 and t_2 we see the original Oscar at A and the two mysterious Oscars at B (for a total of three Oscars, labeled in the figure as Oscar_1, Oscar_2, and Oscar_3) move forward in time—but one of the new Oscars (Oscar_2) lives a decidedly odd existence in that his life seems to be running in reverse!

Eventually, at time t_2, the original Oscar_1 and the weird, reverse Oscar_2, merge and seemingly annihilate one another, vanishing into thin air to leave only a single Oscar (Oscar_3) for all time after t_2. Putnam argues that, although strange, what has just been described is still sensible and that, indeed, the very fact that we can draw the spacetime diagram of Fig. 3.8 supports the case for backward time travel. He claims this because although the spacetime diagram does show time increasing upward for all three Oscars (that is the time direction for an external observer) there is actually no 'spontaneous creation' or 'mutual annihilation' and all is sensible *if* Oscar_2 is understood actually to be a time traveler into the past with *his* time direction thus pointed opposite to that of the 'other two' Oscars. There is, of course, just *one* Oscar!

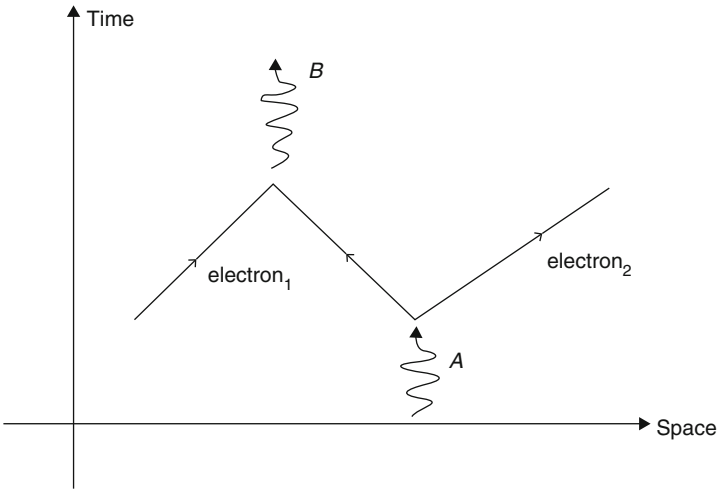

Fig. 3.9 Anti-matter via backward time travel

As mentioned back in Chap. 1, Putnam's suggestion was rebutted (see that chapter's note 76) by what is (in my opinion) an even less plausible mechanism for Putnam's kinked spacetime than is Putnam's invocation of time travel. That critic advocated, instead, an explanation based on matter transmitters and anti-matter, the latter an idea he credits to Feynman (who actually got it from Wheeler). In a paper by Feynman we do find the famous suggestion that a positron that appears to us to be moving forward in time is actually an electron traveling backward through time.[86] Logically, that greatly weakens the critic's view, because it puts him in the position of using anti-matter (explained in terms of backward time travel) to argue *against* backward time travel! But let's ignore that concern, give the critic the benefit of the doubt, and explore how anti-matter and backward time travel are imagined to be connected.

Feynman asks us to imagine the process shown in Fig. 3.9. Gamma ray A spontaneously creates an electron-positron pair, with electron_2 moving off to some distant region while the positron soon meets with electron_1, resulting in mutual annihilation and the production of gamma ray B. This description involves *three* particles, and each segment of the kinked line is a distinct particle. But Feynman said there is another way to look at this, a way that involves just *one* particle. According to Feynman, the kinked line in Fig. 3.9 (which should remind you of Oscar's kinked world line) is the world line of a single electron; the middle

[86]R. Feynman, "The Theory of Positrons," *Physical Review*, September 15, 1949, pp. 749-759. In a paper published the year before ("A Relativistic Cut-Off for Classical Electrodynamics," *Physical Review*, October 1948, pp. 939-946), he wrote "This idea that positrons might be electrons with the proper time reversed was suggested to me by Professor J. A. Wheeler." The identification of anti-matter with backward time travel occurred in science fiction (see note 124 in Chapter 1) almost simultaneously with Wheeler's speculation.

segment, that we call a positron, is just the electron traveling backward in time, and so we must reverse the arrowhead on it (indicating the opposite of the direction shown in Fig. 3.9).

There are two central questions at this point. First, why is a positron (with positive electric charge) moving forward in time mathematically (and physically) equivalent to a negatively charged electron moving backward in time? The answer is that the reversal in charge sign, which results from the reversal of the electron's proper time, follows from the TCP theorem that was mentioned in Chap. 2 (see note 38 there). And second, what causes the electron to suddenly move backward in time? Picturesquely, the electron is recoiling from the emitted burst of gamma ray B. Similarly, the absorption of the energy of gamma ray A by the electron that is recoiling backward in time causes a second recoil, giving the world line of what was originally called electron$_2$. This reinterpretation of a kinked spacetime diagram was described as follows (in Feynman's famous words): "It is as though a bombardier flying low over a road suddenly sees three roads and it is only when two of them come together and disappear that he realizes that he has simply passed over a long switchback in a single road."

In a later paper[87] Putnam's critic presented another line of attack against Putnam's interpretation of spacetime diagrams as lending support to time travel. There the critic observed that the presence of the time-reversed Oscar$_2$ shows that the "world of the Oscars" is not *temporally orientable*. A temporally orientable spacetime is one in which *every* point in it agrees with its local neighbors on the directions of past and future—a condition clearly *not* satisfied for the case of Oscar$_2$. As the critic pointed out, the first time travel spacetime discovered, the Gödel universe, *is* temporally orientable, and so in it the ambiguity of Oscar$_2$ (whether he is traveling backward in time as opposed to living forward 'in reverse') does not occur. That is, the critic agreed with Putnam's acceptance of the conceivability of time travel to the past, but not with his use of Feynman's concept of antimatter as time-traveling matter. That critic wasn't alone in that opinion.

One physicist, for example, wrote of "Feynman's rather loose talk of particles 'traveling' backward . . . in time,"[88] and the well-known philosopher John Earman declared "It is true that Feynman uses the slogan 'Positrons are electrons running backward in time,' but it is dangerous to draw conclusions from slogans."[89] I am not sure what Earman meant by "slogans": a careful reading of Feynman indicates that he actually took the matter quite seriously.[90] In his 1949 positron paper (note 86), for example, he wrote that "the idea that positrons can be represented as electrons

[87]See R. Weingard in note 114 in Chapter 1.

[88]H. Price, "The Asymmetry of Radiation: Reinterpreting the Wheeler-Feynman Argument," *Foundations of Physics*, August 1991, pp. 959-975.

[89]J. Earman, "On Going Backward in Time," *Philosophy of Science*, September 1967, pp. 211-222.

[90]Feynman declares the view of a positron as a time traveling electron to be of value, for example, in his famous book *Quantum Electrodynamics*, W. A. Benjamin 1961, p. 68.

with proper time reversed relative to true time has been discussed by the author and others,"[91] and also that "Previous results suggest waves propagating . . . toward the past, and that such waves represent the propagation of a positron."

In any case, spacetime diagrams are highly useful in discussing time travel, but they do have some curious twists. In our everyday world, a path that joins two points on a surface with the *minimum* length is called a geodesic of that surface. As you'll see later in this chapter spacetime geodesics do indeed possess an extremal property, but rather than being a minimum it is a *maximum* property. Spacetime diagrams can be misleading on this matter, so it is important to remember that such diagrams are not a perfect representation of all the properties of a spacetime.

It is customary to draw spacetime diagrams with the speed of light as unity ($c = 1$). That is, a distance of 300,000 km on the space axis is represented by the same extension as is one second on the time axis. This means that the world line of a photon is tilted away from the vertical time axis by 45°. Because photons can travel in both space directions (to the left and to the right) in the two-dimensional spacetime we can draw on a piece of paper, and because the speed of light is the limiting speed of the universe, we can represent the collection of all possible world lines as those paths that *never* tilt more than 45° away from the vertical, which forms what is called a *light cone* in spacetime, as shown in Fig. 3.10 (which attempts to represent a *three*-dimensional spacetime, one with two space—imagine a y-axis, out of the paper, perpendicular to both the x and t axes—and one time dimension).

In Fig. 3.10 I have taken $x = y = 0$ at $t = 0$ for all the possible world lines involving speeds below the speed of light. Let's agree to call this spacetime point the Here-Now. Then, spacetime points in the upward half of the light cone are in the Future of Here-Now; similarly, spacetime points in the lower half of the light cone are in the Past of the Here-Now. We can draw a straight world line from the Here-Now to any point in the Future half-cone with a tilt of less than 45° away from the vertical, which means that a massive particle could travel from the Here-Now to that point at less than the speed of light. Similarly, a massive particle starting at any point in the Past half-cone could have reached the Here-Now by traveling at less than the speed of light. Such a world line is called *timelike* because its projection on the time axis is greater than its projection on a space axis—they are the world lines connecting spacetime points that are potentially causally linked. That is, an event at a spacetime point in the Past half-cone could have had an effect on the event at the Here-Now, even though its influence propagated at less than the speed of light. Also, an event at the Here-Now could potentially affect the event at any spacetime point in the Future half-cone of the Here-Now.

Any points in the regions of spacetime outside the Future and Past half-cones *cannot* be reached from the Here-Now except by world lines tilted more than 45°

[91]The "others" Feynman had in mind included, in particular, the eminent Swiss physicist Ernest C. G. Stükelberg (1905-1984), who in a 1942 article in the journal *Helvetica Physica Acta* also wrote of waves scattering backward in time.

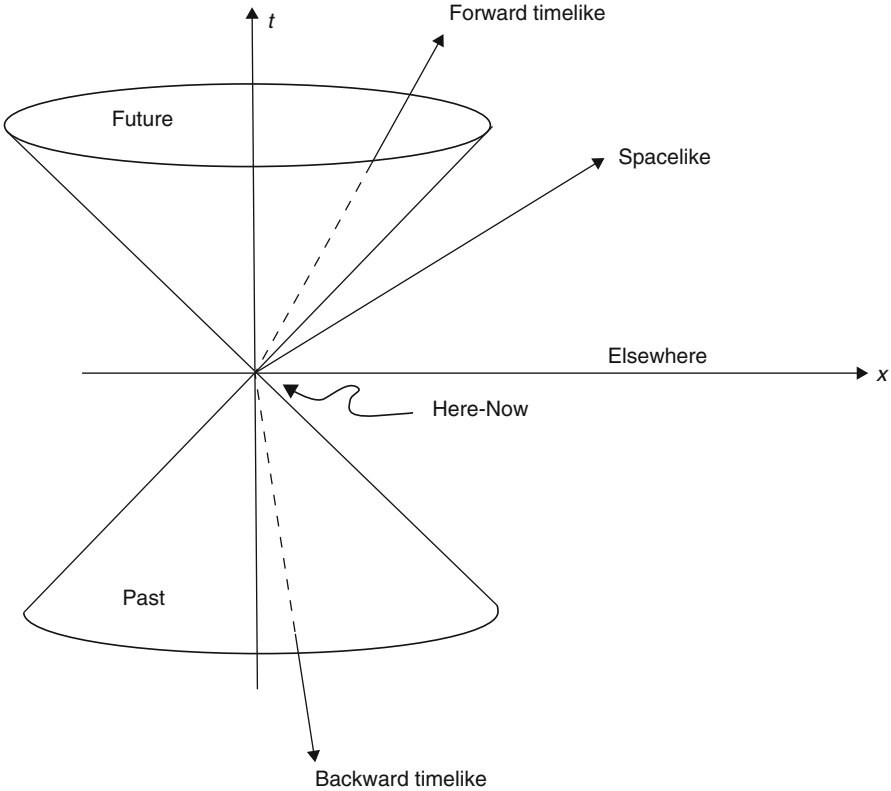

Fig. 3.10 A light cone in spacetime

away from the vertical. Such world lines, which represent travel at a speed faster than light, are called *spacelike* because their projections on a space axis is greater than their projections on the time axis. It is impossible for these world lines to connect causally linked events, and collectively they form the Elsewhere of the Here-Now. Notice that every point in spacetime has its own light cone. If A and B are causally linked, then if B is in the Future half-cone of A, then A is in the Past half-cone of B.

The imagery of the light cone is often useful in making seemingly quite abstract ideas appear transparent. For example, can an observer predict his own future from perfect knowledge of his own past? The easy answer is "No, because quantum uncertainties prohibit perfect knowledge of even the present, much less the past." But suppose we ignore quantum mechanics and limit our question to a universe that obeys only classical physics (which includes the special and general theories of relativity). Surprisingly (perhaps), the answer is *still* no. Having perfect knowledge of your own Past half-cone doesn't include knowing the *entire* past, so if you attempt to predict your own future (say, 1 min from now), there can be influences in Elsewhere that will arrive in the future (say, 59 s from now) about which you

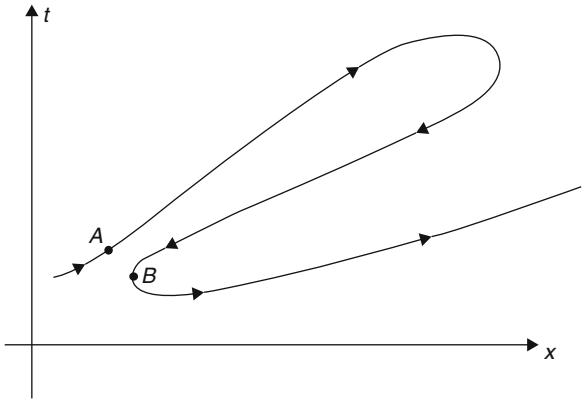

Fig. 3.11 World line of a particle traveling backward in time from A to B

presently, by definition, cannot have any knowledge. And without that knowledge, you cannot predict. As one writer amusingly concludes a tutorial on this topic, "the prospect of predicting the future looks pretty bleak."[92]

A spacetime diagram does not always have to have future directed world lines. If a particle moves backward through time, assuming such a thing is possible, then the diagram can show this by having the world line double back on itself, as in Fig. 3.11 (in which the world line curves back and comes arbitrarily close to itself: it is the world line of a particle that visits itself in the past). Note that the world line in Fig. 3.11 does not actually touch or cross itself, because that would represent more than just a visit—it would represent a particle occupying the same spatial location at the same time as its earlier self. That would be catastrophic and, because it *did not* happen it *cannot* happen. Since the arrowheads on the world line always point in the direction of the local future of the particle, if the 'particle' is actually human then increasing memories are formed in the direction of the arrows. The time traveler at B has more memories than he does at A, even though A and B are nearly identical points in spacetime.

There is a problem with Fig. 3.11 that you may have caught. It is impossible to draw such a doubled-back world line in such a way that *at all places* it never tilts more than 45° from the vertical. That is, at least some portion of the world line will have

$$\left|\frac{dx}{dt}\right| > 1$$

which represents superluminal motion (we'll return to this in Chap. 5). One way to keep a bent-back world line always subluminal is to arrange for the light cones along the world line to be tilted relative to each other, as shown in Fig. 3.12, which

[92]M. Hogarth, "Predicting the Future in Relativistic Spacetimes," *Studies in the History and Philosophy of Science*, December 1993, pp. 721-739.

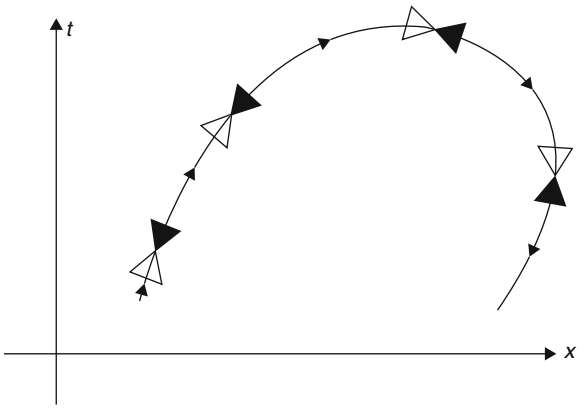

Fig. 3.12 Tilted light cones in a curved spacetime (the future halves are shaded)

is possible only in a *curved* spacetime. This is an illustration of how general relativity *locally* obeys special relativity's demand that nothing travels faster than light and yet, *globally*, in curved spacetime, things are not so simple. In flat spacetimes all light cones are always 'aligned,' but in curved spacetimes they (generally) are not, and from that can come time travel to the past.[93]

Tilted light cones is the physics behind backward time travel around a rotating Tipler cylinder, for example, a particular time machine we'll discuss later in Chap. 5. Light cone tipping is, in fact, *essential* for time travel to the past. The mere presence of mass tips light cones ('warps spacetime'), but the effect is unnoticeable in everyday life on Earth. A truly enormous mass density is required to tip nearby light cones over so that their Future halves noticeably open up toward the massive body. If the massive body is additionally set to rotating, then a further consequence of Einstein's general theory is that the local light cones are tilted additionally in the direction of rotation. That is, the Future half-cones in spacetime open-up both toward the body and in the direction of the rotation.

It should now be clear that the only way a world line can bend back on itself for a close encounter visit is for both x and t to change. In other words, the world line of a particle that remains fixed in space and reverses just its time direction *runs into itself*. This is why the classic fictional time machine of H. G. Wells could not possibly work. A real time machine must move in space as well as through time, as does a Gödelian rocket (or, for that matter, as does the DeLorean time car in the *Back to the Future* films). The idea of warping world lines, to support time travel to the past, entered science fiction at an early date. For example, when the inventor of the time machine in a 1930s tale[94] is asked about the principle underlying his gadget, he replies "An electro-magnetic warping of the spacetime continuum.

[93]What is meant by a spacetime being *flat* will be formalized when we get to spacetime *metrics* later in this section. The Minkowski spacetime of special relativity is a flat spacetime, has no tilted light cones, and as such does *not* support time travel to the past.

[94]N. Schachner, "When the Future Dies," *Astounding Science Fiction*, June 1939.

The machine, if it works, will slide around the world-line of events and reappear at any specified time and place."

Using the Lorentz transformation equations from the previous section, we can establish quite general relationships between events in the Future, Past, and Elsewhere regions of spacetime. For example, (1) All events in the Future/Past for the Here-Now observer are in the Future/Past for any other nearby, relatively moving observer; (2) Any event in Elsewhere can appear to be simultaneous with the Here-Now for some observer and not simultaneous for another observer; and (3) The temporal ordering (the relations of *before* and *after*) of causally related events is the same for all observers. This is not so for events that are not causally related; if two events have a spacelike separation, then two observers can disagree over the temporal ordering of the events. This is, in fact, the basis for the two-wormhole and the cosmic string time machines, both of which will be discussed in Chap. 6. All these statements are easy to prove.

Consider, for example, statement (1). From the previous section we have (with $c = 1$)

$$t' = \frac{t - \mathrm{v}x}{\sqrt{1 - v^2}} \quad \text{and} \quad x' = \frac{x - \mathrm{v}t}{\sqrt{1 - v^2}}$$

where t and x are the coordinates of some event A as measured by the observer in the stationary reference frame, and t' is the time measured by the observer in the reference frame moving at speed v. Thus

$$x'^2 - t'^2 = \frac{(x - \mathrm{v}t)^2 - (t - \mathrm{v}x)^2}{1 - v^2} = [\text{after a little algebra}]\ x^2 - t^2.$$

For the stationary observer the criterion for an event to be in the Future half-cone is $t > |x|$, that is, $t^2 > x^2$. Thus, $x^2 - t^2 < 0$ for all Future events. But the foregoing result then says $x'^2 - t'^2 < 0$, too, which is the moving observer's criterion for the event being in his Future half-cone. The same sort of argument shows that the two observers also agree on Past events.

Next, suppose that two events A and B occur such that the stationary observer measures them to be $\Delta T = t_B - t_A$ apart in time. Then, we can establish statement (2) by writing

$$t'_A = \frac{t_A - \mathrm{v}x_A}{\sqrt{1 - v^2}} \quad \text{and} \quad t'_B = \frac{(t_B + \Delta T) - \mathrm{v}x_B}{\sqrt{1 - v^2}}$$

and so

$$\Delta T' = t'_B - t'_A = \frac{\Delta T + v(x_A - x_B)}{\sqrt{1 - v^2}}.$$

From this we have $\Delta T' = 0$ (that is, simultaneity) for the two events for the special observer moving at the speed

$$v = \frac{\Delta T}{x_B - x_A}$$

and this speed is less than the speed of light for the condition $x_B - x_A > \Delta T$. This is, of course, the condition for event B to be in the Elsewhere of event A. In fact, we can even have $\Delta T' < 0$ (with $\Delta T > 0$) for $v < 1$ in this case of spacelike separation of A and B. That is, a stationary observer and a sublight-speed moving observer can disagree about the temporal ordering of events with spacelike separation.

Similarly, for event B to be in the causal Future of event A, we have the condition $x_B - x_A < \Delta T$. Then,

$$\Delta T' = \frac{\Delta T - \mathrm{v}(x_B - x_A)}{\sqrt{1 - v^2}} > \frac{\Delta T - v\Delta T}{\sqrt{1 - v^2}} = \Delta T \frac{1 - \mathrm{v}}{\sqrt{1 - v^2}}.$$

Thus, $\Delta T > 0$ says $\Delta T' > 0$ for $v < 1$, and this establishes statement (3).

If we were drawing diagrams with both axes representing space (a plot of y versus x, for example), we would normally define a *distance metric* for the diagram using our everyday ideas about distance. That is, we could say that if we make differential movements of dx and dy along the two coordinate axes, then the differential distance ds is given by

$$(ds)^2 = (dx)^2 + (dy)^2.$$

This is, of course, just the Pythagorean theorem for the 'Euclidean' or 'as the crow flies' distance function. But it is not the only possible distance function. A distance function has several interesting mathematical properties,[95] but the one we are particularly interested in here is its invariance with respect to the coordinate system. For example, if we draw a line segment on a flat sheet of paper, the physical distance between its end-points does not depend on how we happen to select the x and y axes, a fact illustrated in Fig. 3.13 with the addition of a rotated and translated primed system. The coordinates for the endpoints A and B are obviously different in the two coordinate systems, but we still find that

$$(dx)^2 + (dy)^2 = (dx')^2 + (dy')^2.$$

[95]Mathematicians have defined the general properties of a distance function as follows: if A and B are any two points, and if $d(A, B)$ is the distance between A and B , then (1) $d(A, B) = d(B, A)$; (2) $d(A, B) = 0$ if and only if $A = B$; and (3) if C is any third point, then $d(A, B) \leq d(A, C) + d(C, B)$. The Pythagorean distance function possesses all three of these properties, but so do many other functions (for example, $ds = |dx| + |dy|$).

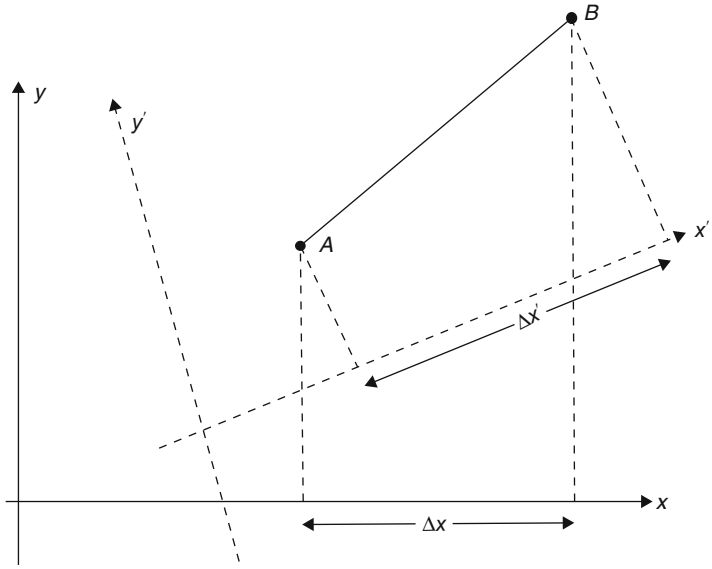

Fig. 3.13 Rotated/translated coordinate systems

We say that the Pythagorean distance function is *invariant*, that it is the same for all coordinates systems that are simply rotations and/or translations of each other.

We know that different observers, if in relative motion in the same spacetime, will see different space and time coordinates for the same event. Thus, it is natural to ask 'what is the metric for flat spacetime?' Is there, in fact, a metric that gives the same *distance* between two events for all observers? We might try to generalize in the obvious way from the Pythagorean theorem, and write

$$(ds)^2 = (dt)^2 + (dx)^2 + (dy)^2 + (dz)^2$$

where now all four dimensions are included. We would then ask ourselves whether it is true that

$$(ds)^2 = (ds')^2 = (dt')^2 + (dx')^2 + (dy')^2 + (dz')^2?$$

For our simple two-dimensional spacetime, this question reduces to asking whether

$$(dt)^2 + (dx)^2 = (dt')^2 + (dx')^2?$$

Using the Lorentz transformation equations from earlier, it is easy to discover that the answer is no. The 'natural' generalization of Pythagorean distance for flat, two-dimensional spacetime fails when four dimensions are included. So, what do we do now? Recalling the words of Professor Mundle from *Some First Words* (see note 23 there), we might wonder whether this difficulty could result from the fact

that there is no fourth direction along which the time axis can point at right angles to the three space directions? At least, there is no *real* direction—but perhaps there is an imaginary one. Accordingly, with $= \sqrt{-1}$, let's try

$$(ds)^2 = (idt)^2 + (dx)^2 + (dy)^2 + (dz)^2 = -(dt)^2 + (dx)^2 + (dy)^2 + (dz)^2.$$

Using *imaginary time*, something that seems to be in the realm of science fiction, has resulted in a change in the sign of $(dt)^2$.

This is a crucial change, however, because this new metric *is* invariant. For a reason to be explained in the next section, I will use the negative of this metric (a choice that has no impact on the invariance property) and so write

$$(ds)^2 = (dt)^2 - (dx)^2 - (dy)^2 - (dz)^2.$$

For our simplified two-dimensional spacetime this reduces to

$$(ds)^2 = (dt)^2 - (dx)^2.$$

As before, the Lorentz transformation equations (with $c = 1$) are

$$t' = \frac{t - \mathrm{vx}}{\sqrt{1 - v^2}} \text{ and } x' = \frac{x - \mathrm{vt}}{\sqrt{1 - v^2}}.$$

If we then calculate dx' and dt' from these equations, using

$$dx' = \frac{\partial x'}{\partial x}dx + \frac{\partial x'}{\partial t}dt, dt' = \frac{\partial t'}{\partial x}dx + \frac{\partial t'}{\partial t}dt$$

which are the fundamental relations for the *total* differential[96] of a function of two variables, and insert the results into $(dt')^2 - (dx')^2$, we quickly discover the invariance property of this quantity (a result we actually found earlier, in a different way, when we showed that observers in relative motion agree about what events are in the Future and what events are in the Past). Thus,

$$(dt')^2 - (dx')^2 = (dt)^2 - (dx)^2.$$

This quantity, on either side of the equality, is called the spacetime *interval* between the two events separated in flat spacetime by either dt, dx, dy, and dz, or by dt', dx', dy', and dz'. The observers in the unprimed and the primed systems see different individual space and time separations for two events, but they see the same

[96]The $\frac{\partial}{\partial x}$ and $\frac{\partial}{\partial t}$ symbols denote the *partial* derivatives with respect to x and t (see any good calculus book to brush-up on this). The rest of this chapter *will* have some more math in it, involving derivatives and even an integral or two, but nothing beyond freshman calculus. I've included it mostly for those who would feel cheated without *some* math!

interval. A single time coordinate, and three space coordinates, are said to form a *four-vector that is invariant under Lorentz transformation*. There are, in addition, other four-vectors that are also invariant under Lorentz transformation, such as the energy-momentum, velocity, and force four-vectors; all these quantities have invariants that are formed the same way, by taking the difference of the squares of the time components and the sum of the squares of the space components. The intrusion of the square root of minus one, in the time coordinate of the metric, seems a pretty clear indication that time *is* different from space.[97]

But still, the spatialization of time is nonetheless deeply embedded in Western culture. For example, when writing her popular 1978 book, drawing historical parallels between the fourteenth and twentieth centuries, Barbara Tuchman titled it *A Distant Mirror*, and not *An Old Mirror*. The mathematical mixing of space and time appeared quite early in science fiction, but often in comically mangled form. In one such tale, for example, as an evil scientist uses his time machine to transport captives into the past, he tells them, "We've got a longish journey before us, ten thousand years more, multiplied by the fourth power of two thousand miles."[98]

In general relativity, the metric of any four-dimensional spacetime has the structure of what mathematicians call a *symmetric quadratic Riemannian form*:

$$(ds)^2 = \sum_{i=1}^{4}\sum_{j=1}^{4} g_{ij}(dx_i)(dx_j), g_{ij} = g_{ji}$$

where $x_1 = t$, $x_2 = x$, $x_3 = y$, and $x_4 = z$, and the 16 g's are all functions of these four variables. (Because of the symmetry condition, only 10 of the g's are independent.) In this notation, a *flat* spacetime is mathematically characterized by $g_{11} = 1$, $g_{22} = g_{33} = g_{44} = -1$, $g_{ij} = 0$ for all $i \neq j$. Now, for a given spacetime, one can arbitrarily choose an infinity of coordinate systems. If just one of this infinity of systems is such that the ± 1, 0 values for the g's occur, then that spacetime is *globally* (that is, everywhere) flat. If no such coordinate system exists, then that spacetime is necessarily *curved*—I'll give you a more intuitive view of curvature in just a bit. (If this notation is extended to a fifth dimension[99] by including the additional coordinate x_5, then there are an additional eight off-diagonal g's and so

[97]Writing in 1972, one famous physicist said of his first encounter with the metric of special relativity (Minkowski spacetime), "Now, when I saw that minus sign [in $-(dt)^2$], it produced a tremendous effect on me. I immediately saw that here was something new." See P. A. M. Dirac, "Recollections of an Exciting Era," in *History of Twentieth Century Physics* (C. Weiner, editor), Academic Press 1977.

[98]V. Rousseau, "The Atom Smasher," *Astounding Stories*, May 1930.

[99]The fifth dimension was introduced in the 1920s by the German physicist Theodor Kaluza (1885-1954), but just what the nature of this fifth dimension might be remains a mystery. A few years after Kaluza, the Swedish physicist Oscar Klein (1894-1977) speculated that it might be a spatial dimension curled-up in a tiny circular path, so tiny that we don't notice it; the issue remains open. The idea of a fifth dimension appeared early in pulp science fiction, as in the January 1931 tale "The Fifth-Dimension Catapult," (*Astounding*) by Murray Leinster.

four new *independent* g's. These are just sufficient to describe the electromagnetic field, too, along with the gravitational field described by the other ten g's. That is what is meant by saying five-dimensional spacetime 'unifies' gravity with electromagnetism.) There is a g_{55}, too, which could be allowed to model a slowly varying gravitational constant, as suggested by Dirac in 1938.

The g functions are the components of the so-called *metric tensor of the second rank* (see the last discussion question for more on what this means) of that spacetime. The g's at each point in spacetime are related to the curvature of spacetime at that point, which in turn is dependent on the g's and on the energy density at that point. In fact, the ten equations for the g's, which *are* the famous Einstein gravitational partial differential field equations, are both nonlinear and coupled. That is, each g_{ij} is in general a nonlinear function of all the other g_{ik}, which accounts for the notorious difficulty[100] in finding analytical solutions to the field equations except in certain highly special cases, such as the spacetime of spinning spheres and rotating infinite cylinders.

What does it mean to 'solve' the field equations? It is useful to think of the equations schematically as follows:

local geometry of spacetime $\leftarrow$ local density, momentum and stress of the mass-energy of spacetime where the direction of the arrowhead means that the 'usual' practice is to assume the right-hand side (the so-called stress-energy tensor) as given, and then attempt to calculate the left-hand side. If the attempted calculation can be done, then one has solved the field equations for the spacetime geometry that is associated with the assumed mass-energy distribution.

Suppose, however, that we reverse the direction of the arrowhead. That is, suppose we assume a desired geometry. That is what Einstein did when he assumed the geometry of a *static* (non-expanding) universe and solved for the required mass-energy. What he found was just what had been observed by astronomers up to that time—a multitude of 'grains of matter' (what physicists call *dust*) plus the infamous cosmological constant. The constant, with its repulsive gravity, was needed to counteract the ordinary gravitational attraction of the stars that tends to pull them together. The later discovery that the universe is not static, but rather is expanding, rendered Einstein's solution moot.

Now let's go Einstein one better, and assume a spacetime geometry that contains closed timelike curves (a time machine, in other words) and then try to calculate the mass-energy distribution required by that spacetime. If that can be accomplished—and in fact the field equations themselves provide an algorithmic means of solution in this direction—then the physicist's work is done. The required mass-energy distribution requirements are put out to bid to 'spacetime engineers' and the lowest bidder 'simply' constructs that mass-energy distribution and so builds us our time machine! When the calculations are done, however, what has happened without

[100] An elementary, quite interesting discussion of the enormous computational complexity of the field equations is presented in Richard Pavelle and Paul S. Wang, "MACSYMA from F to G," *Journal of Symbolic Computation*, March 1985, pp. 69-100.

fail, at least up to now, is that the resulting mass-energy distribution comes out with an 'unphysical' nature, a technical way of saying our spacetime engineer wouldn't know *how* to assemble the required mass-energy distribution. What is meant by 'unphysical' will be explored, in the particular case of wormhole time machines, in Chap. 6.

The 16 g's for a four dimensional spacetime are often written in the form of a 4×4 matrix. In fact, the metric tensor is of the *second* rank precisely because a matrix has a *two*-dimensional form; scalars and vectors, which have forms of zero and one dimension, are tensors of rank zero and one, respectively. The collection of the algebraic signs of the main diagonal terms (the g_{ii}) is called the *signature* of the metric tensor. The signature of flat (Minkowski) spacetime is thus written as $[+, -, -, -]$; in more general (curved) spacetimes, this same signature is called *Lorentzian*. By contrast, the signature of a four-dimensional Euclidean space is $[+, +, +, +]$. This signature is called *Riemannian*. The geometry of flat, Minkowski spacetime is not Euclidean geometry because the spacetime signature of its metric has both plus *and* minus signs. As an uncurved spacetime, Minkowski spacetime *has no gravity*; to get gravity, we need a curved spacetime.

The idea of linking the curvature of a four-dimensional space to physical phenomena is the signature feature of general relativity, but it actually pre-dates Einstein by decades. It can be found, for example, in the work of the British mathematician William Kingdon Clifford (1845–1879), done in the 1860s and 1870s before Einstein's birth (in the year of Clifford's death). In his posthumously published book *The Common Sense of the Exact Sciences* (1885), Clifford wrote "We may conceive our space to have everywhere a nearly uniform curvature, but that slight variations of the curvature may occur from point to point and themselves vary with time. These variations of the curvature with time may produce effects which we not unnaturally attribute to physical causes independent of the curvature of our space. We may even go so far as to assign to this variation of the curvature what really happens in that phenomenon which we term the motion of matter." It isn't a long jump from "motion of matter" to gravity![101]

Not everyone enthusiastically embraced this new, radical view of nature. For example, the great Scottish mathematical physicist James Clerk Maxwell (1831–1879), of Maxwell's equations fame, who knew Clifford through their common membership in the London Mathematical Society, summarily dismissed this part of Clifford's work as simply the speculations of a "space crumbler." Decades later, Einstein faced the same rejection when the eminent British

[101]Clifford almost surely found inspiration in this part of his work from the even earlier efforts of the German mathematician Bernhard Riemann (1826-1866). See, for example, Clifford's translation of Riemann's famous 1854 lecture "On the Hypotheses Which Lie at the Bases of Geometry," *Nature*, May 1, 1873, pp. 14-17, and continued in the next issue (May 8, 1873, pp. 36-37).

astronomer Sir James Jeans declared "Einstein's crumbling of his four-dimensional space may . . . be considered to be . . . fictitious."[102]

Spacetime geometries are not easy concepts to grasp, and the metrics of curved spacetimes are even more complicated than is the metric of the flat spacetime of Minkowski's special relativity. As one paper so aptly put it, "Experience has taught us that the space in which we live has a geometry that is three-dimensional and Euclidean . . . We are very much at home with [that] geometry . . . But the geometric properties of a Minkowskian space are so alien to us that we may well despair of visualizing them, and a Riemannian [curved] space . . . seems totally beyond comprehension."[103]

An important feature of Riemannian geometry is that although it is generally not globally flat, it is always *locally* flat. Thus any sufficiently small region in a curved Riemannian spacetime can be approximated, with arbitrarily small error, by a flat pseudo-Euclidean Minkowskian spacetime. That is, at each point in Riemannian spacetime, there is some *particular* inertial frame of reference in which special relativity is all there is to spacetime physics *at that point*. The particular inertial frame required is different, however, from point to point.

In a coordinate system different from rectangular, the flat Minkowskian metric can appear radically altered, but that is just an artifact of the mathematics and has no physical significance. For example, in spherical coordinates the Minkowskian metric becomes the equivalent

$$(ds)^2 = (dt)^2 - (dr)^2 - (rd\theta)^2 - (rsin(\theta)d\phi)^2$$

where ϕ is the azimuthal angle and θ is the angle measured from the polar axis. A related metric occurs in the theory of spherically symmetric, static (no time variation) time machine wormholes (discussed in Chap. 6), of the form

$$(ds)^2 = \left(e^{a(r)}dt\right)^2 - \frac{(dr)^2}{1 - \frac{b(r)}{r}} - (rd\theta)^2 - (rsin(\theta)d\phi)^2$$

where $a(r)$ is called the *redshift function* and $b(r)$ is called the *shape factor*. These two functions are nearly arbitrary, subject only to the constraints that both $b(r)/r$ and $a(r)$ vanish as r goes to infinity (r is the radial distance from the throat of the wormhole mouth). Indeed, as r increases, this curved wormhole spacetime metric

[102]Quoted in P. Kerszberg, "The Relativity of Rotation in the Early Foundations of General Relativity," *Studies in History and Philosophy of Science*, March 1987, pp. 53-79.

[103]R. W. Brehme and W. E. Moore, "Gravitational and Two-Dimensional Curved Surfaces," *American Journal of Physics*, July 1969, pp. 683-692.

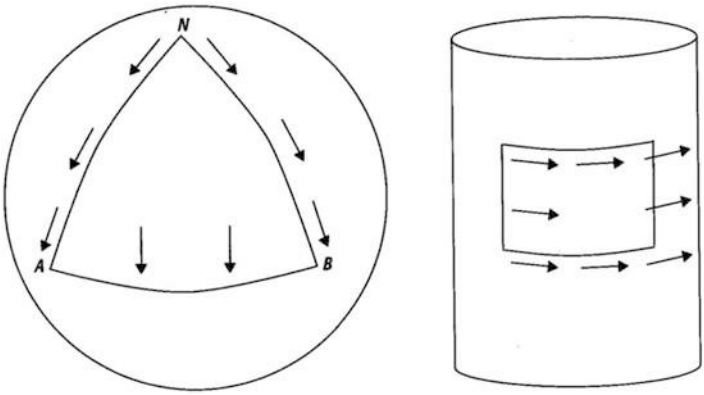

Fig. 3.14 The curvature of a space can be revealed by the process of parallel transport

reduces to that of flat Minkowskian spacetime, so this wormhole spacetime is said to be *asymptotically flat*.[104]

An intuitive appreciation of 'flatness' can be realized in terms of what is called the *parallel transport* of a vector around a closed path. In a curved space the vector will experience a rotation, which will not occur in a flat space. Two examples of parallel transport in ordinary three-dimensional space are shown in Fig. 3.14. The spherical surface on the left is curved because if you slide the vector from N to A to B and then back to N, all the while keeping it parallel to its immediately previous orientation, then when it gets back to N the vector will point to B, *not* toward A as it initially did. A similar trip on the cylindrical surface, however, results in zero rotation of the vector. Thus, the cylindrical surface, despite superficial appearances, is *not* curved.

Using the idea of the metric tensor, we can develop a more formal demonstration that the surface of a sphere, unlike like that of a cylinder, is not flat. On the surface of a sphere of radius a (*on* the surface $r = a$ everywhere, and so $dr = 0$), the measure of the distance between two points (in spherical coordinates) is[105]

$$(ds)^2 = a^2 sin^2(\theta)(d\phi)^2 + a^2(d\theta)^2.$$

Writing $x_1 = \phi$ and $x_2 = \theta$ yields the more general form

[104]For wormhole spacetimes that are not asymptotically flat, see (for example) K. Narahara, *et al.*, "Traversable Wormhole in the Expanding Universe," *Physics Letters B*, September 29, 1994, pp. 319-323.

[105]Note *carefully* that this is a purely spatial problem, with no time, and we are taking all of the metric coefficients as positive (unlike in the case of a spacetime metric).

$$(ds)^2 = g_{11}(dx_1)^2 + g_{12}(dx_1)(dx_2) + g_{21}(dx_2)(dx_1) + g_{22}(dx_2)^2$$

or, using the symmetry condition $g_{12} = g_{21}$, we have

$$(ds)^2 = g_{11}(dx_1)^2 + 2g_{12}(dx_1)(dx_2) + g_{22}(dx_2)^2.$$

From this we immediately have $g_{11} = a^2 sin^2(\theta)$, $g_{22} = a^2$, and $g_{12} = g_{21} = 0$.

Now, suppose we ask whether it is possible to find some new coordinate system (with variables x'_1 and x'_2) in which the invariant $(ds)^2$ is given by the flat Euclidean metric $\left(dx'_1\right)^2 + \left(dx'_2\right)^2$. In such a coordinate system (if it exists) we would have the 'flatness conditions' of $g'_{11} = g'_{22} = 1$ and $g'_{12} = g'_{21} = 0$. With such a change of coordinates, each of our original ϕ, θ coordinates would generally be a function of both of the new coordinates—that is, $\phi = \phi\left(x'_1, x'_2\right)$ and $\theta = \theta\left(x'_1, x'_2\right)$. Thus, writing the total differential of a function of two variables (see note 96 again), we have

$$d\phi = \frac{\partial \phi}{\partial x'_1} dx'_1 + \frac{\partial \phi}{\partial x'_2} dx'_2$$
$$d\theta = \frac{\partial \theta}{\partial x'_1} dx'_1 + \frac{\partial \theta}{\partial x'_2} dx'_2.$$

Substituting these expressions into the above expression for $(ds)^2$ on the surface of a sphere, and collecting terms, we arrive at

$$\begin{aligned}(ds)^2 &= a^2\left\{\left[\sin^2(\theta)\left(\tfrac{\partial\phi}{\partial x'_1}\right)^2 + \left(\frac{\partial\theta}{\partial x'_1}\right)\right]\left(dx'_1\right)^2 + \left[\sin^2(\theta)\left(\tfrac{\partial\phi}{\partial x'_2}\right)^2 + \left(\tfrac{\partial\theta}{\partial x'_2}\right)^2\right]\left(dx'_2\right)^2\right.\\ &\left.+2\left[\sin^2(\theta)\frac{\partial\phi}{\partial x'_1}\frac{\partial\phi}{\partial x'_2} + \frac{\partial\theta}{\partial x'_1}\frac{\partial\theta}{\partial x'_2}\right]\left(dx'_1\right)\left(dx'_2\right)\right\}\\ &= g'_{11}\left(dx'_1\right)^2 + 2g'_{12}\left(dx'_1\right)\left(dx'_2\right) + g'_{22}\left(dx'_2\right)^2\end{aligned}$$

We can now immediately write down each of the g' and, if we demand that they satisfy the 'flatness conditions,' then we have the following three statements:

$$sin^2(\theta)\left(\frac{\partial\phi}{\partial x'_1}\right)^2 + \left(\frac{\partial\theta}{\partial x'_1}\right)^2 = \frac{1}{a^2}$$
$$sin^2(\theta)\left(\frac{\partial\phi}{\partial x'_2}\right)^2 + \left(\frac{\partial\theta}{\partial x'_2}\right)^2 = \frac{1}{a^2}$$
$$sin^2(\theta)\frac{\partial\phi}{\partial x'_1}\frac{\partial\phi}{\partial x'_2} + \frac{\partial\theta}{\partial x'_1}\frac{\partial\theta}{\partial x'_2} = 0.$$

For a *globally* flat surface, that is, a surface that is flat *everywhere*, these three statements must hold in particular at the poles of the sphere. That is, at $\theta = 0^\circ$

and at $\theta = 180^{\circ}$. At both of these points $\sin(\theta) = 0$, and so at the poles the three statements reduce to

$$\left(\frac{\partial\theta}{\partial x_1'}\right)^2 = \frac{1}{a^2}$$
$$\left(\frac{\partial\theta}{\partial x_2'}\right)^2 = \frac{1}{a^2}$$
$$\frac{\partial\theta}{\partial x_1'}\frac{\partial\theta}{\partial x_2'} = 0.$$

But the third statement is incompatible with the first two and, because of that incompatibility, there is no primed coordinate system in which the g' coefficients in the metric are those of a globally flat metric. Thus, unlike the surface of a cylinder, the surface of a sphere is not flat but rather is curved. This almost surely comes as no surprise to you, but now you can *prove* it!

3.6 Proper Time and the Twin Paradox in Time Travel to the Future

"[The] equations of duo-quadrant lineations [have] been substantiated ... Our fourth-angle deviation from the six conceivable electronic dimensions did the trick all right. I went forward in Time."[106]

The spacetime interval of the previous section has an important interpretation that leads to one of the more dazzling results of special relativity—time travel into the future. First, recall the flat spacetime metric

$$(ds)^2 = (dt)^2 - (dx)^2 - (dy)^2 - (dz)^2$$

in which the use of unprimed variables indicates that the measurements on the space and time coordinates of a moving particle are made with respect to a stationary observer's frame of reference. Now, suppose that the space and time coordinates of a moving particle are made with respect to the particle instead. Then, using primed variables for measurements made in this new frame of reference, $dx' = dy' = dz' = 0$ because the particle is always at the origin (by definition)! Recalling the invariance of the spacetime interval for all observers, we conclude that

[106] A science fiction scientist babbles incoherent nonsense, not special relativity, about how to travel into the future, in a story by J. H. Haggard, "He Who Masters Time," *Thrilling Wonder Stories*, February 1937.

$$(ds')^2 = (ds)^2 = (dt')^2.$$

That is, the spacetime interval between two events is the time lapse measured by a clock attached to a particle that moves from one event to the other. This time is called *proper time*, which gets its name from the idea that it belongs to (is the *property* of) the moving particle. This is the technical reason for taking (as we did in the previous section) $(ds)^2 = (dt)^2 - (dx)^2$ rather than $(ds)^2 = (dx)^2 - (dt)^2$. The first choice avoids the somewhat awkward result of an imaginary proper time.

Next, we'll adopt what has come to be called the *clock hypothesis*, which states that an accelerated clock runs at the same instantaneous rate as an unaccelerated clock that is moving alongside at the instantaneously same speed. As we showed earlier (take a look back at Sect. 3.3), if the accelerated clock's instantaneous speed is v, then its rate of time keeping (dt') is related to that of the 'stationary' (unaccelerated) clock (dt) as

$$dt' = \sqrt{1 - \left(\frac{v}{c}\right)^2}\, dt$$

where c is the speed of light. The clock hypothesis is generally assumed to be true. Einstein, himself, in his famous 1905 special relativity paper, specifically took the rate of a clock's timekeeping to be velocity-dependent only. When asked during an interview decades later whether it is permissible to use special relativity in situations involving acceleration, Einstein replied "Oh, yes, that is all right as long as gravity does not enter; in all other cases, special relativity is applicable. Although, perhaps the general theory approach might be better, it is not necessary."[107]

The clock hypothesis has long had experimental verification. For example, in one experiment the time keeping of accelerated atomic clocks was determined to be given precisely by the time dilation formula of special relativity, even when their direct mechanical acceleration (the centripetal acceleration produced by a rapidly spinning disk) exceeded 66,000 gees![108] And even more impressive are the time dilation results of a later experiment in which the time keeping of near light-speed charged particles, orbiting in a magnetic field, was in excellent agreement with the time dilation formula, even as accelerations well in excess of 10^{15} gees were reached![109]

The total elapsed time between two events A and B, as measured by the proper time of an accelerated clock making the journey, is, therefore, given by

[107] R. S. Shankland, "Conversations with Albert Einstein," *American Journal of Physics*, January 1963, pp. 47-57.

[108] H. J. Hay, *et al.*, "Measurement of the Red Shift in an Accelerated System Using the Mössbauer Effect in Fe^{57}," *Physical Review Letters*, February 15, 1960, pp. 165-166.

[109] J. Bailey, *et al.*, "Measurements of Relativistic Time Dilation for Positive and Negative Muons in a Circular Orbit," *Nature*, July 29, 1977, pp. 301-305.

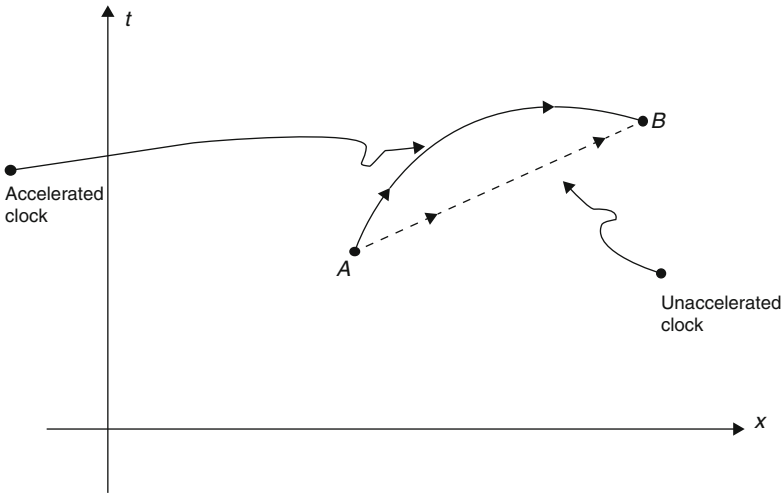

Fig. 3.15 World lines of two clocks (one accelerated and one unaccelerated)

$$t' = \int dt' = \int_{t_A}^{t_B} \sqrt{1 - \left(\frac{v}{c}\right)^2}\, dt < t_B - t_A \text{ if } v \neq 0$$

where $t_B - t_A$ is the elapsed time between A and B as measured by the unaccelerated clock. The inequality results because, for $v \neq 0$, the integrand is always less than 1. Now, we know that in a spacetime diagram the world line of the unaccelerated clock is a straight line, whereas the world line of the accelerated clock is a curved line. Thus, using Fig. 3.15, combined with the inequality $t' < t_B - t_A$, we have the following central result: the world line of *maximum* proper time is the one that *looks the shortest*, that is, the straight (or free-falling geodesic) world line. In the spacetime diagram the curved line looks longer, but in fact any curved line will have a smaller proper time than does the straight world line. This is a dramatic example of how Minkowskian *spacetime* geometry differs from Euclidean *space* geometry; in the latter geometry, there is no longest path between two points.

From this, we can now understand the famous paradox of the twins, Bob and Bill. Bill remains on Earth, but Bob gets into a rocket ship and goes on a high speed trip out into space. Eventually he brings his ship to a stop, turns around, and returns to Earth. The world lines of Bob and Bill are initially together, then they diverge as Bob goes on his trip, and then they come together again at the end of Bob's trip, as shown in Fig. 3.16. The details of Bob's trip are not important for a general statement of the paradox (although in just a bit I *will* present the details for one possible trip). All we need observe for now is that Bill's world line from A to B is straight, whereas Bob's is curved. Bill's body (that is, his local clock) will therefore measure a greater proper time than will Bob's; that is, Bob will be younger than his stay-at-home twin! Equivalently, upon his return Bob will hear his Earthbound

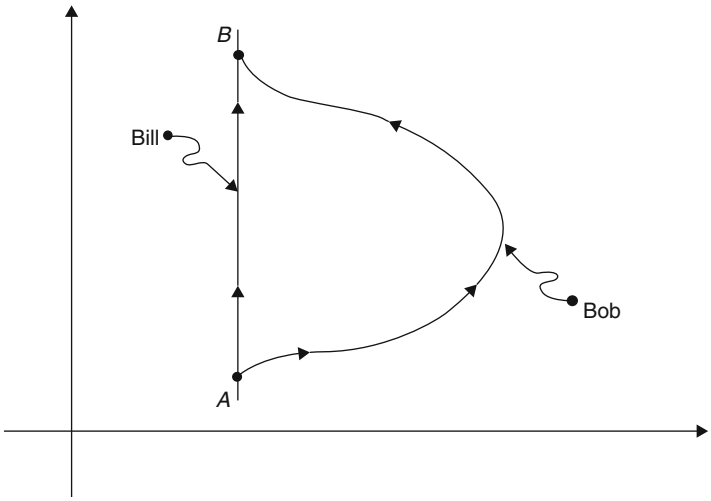

Fig. 3.16 World lines of unaccelerated (Bill) and accelerated (Bob) twins

brother declare the date to be further in the future than Bob's trip lasted (according to Bob). Bob will therefore conclude that he has traveled into the future.[110]

This situation is called a paradox, not because of the time travel aspect (there are no logical paradoxes associated with travel into the future), but rather because it seems to violate the very spirit of special relativity. That is, from Bill's point of view, Bob at first travels away and then returns. But one can argue that from Bob's point of view it is Bill who first recedes and then returns. So why is it *Bob* who is the younger, and not Bill? Long after Einstein's 1905 publication of special relativity, this point remained a great puzzle for many. For example, in the 1923 Presidential Address to the Eastern Division of the American Philosophical Association, we read this very objection to the twin paradox. The conclusion by the speaker is that such a thing "could happen only in a universe in which all squares were round and the *principio contradiction* had been put to sleep."[111]

So, what's the answer, why is it *Bob* who is the younger of the twins? The classic physics answer is that the two points of view are actually *not* symmetrical, that there is a definite asymmetry between Bill and Bob. After all, it is Bob who feels the acceleration from the rocket's engines as he blasts off from Earth—it is Bob, not

[110]The twin paradox is hinted at in Einstein's 1905 paper, but it is in a 1911 address to the International Congress of Philosophy in Bologna, by the French physicist Paul Langevin (1872-1946), that a human space traveler is first introduced (in a cannonball moving at near light-speed, an idea motivated by Langevin's reading of Jules Verne's 1872 novel *From the Earth to the Moon*). The writer Pierre Boulle proudly mentioned this contribution by his fellow Frenchman in the time travel story "Time Out of Mind" (you can find it in Boulle's collection *Time Out of Mind*, Vanguard Press 1966).

[111]W. P. Montague, "The Einstein Theory and a Possible Alternative," *The Philosophical Review*, March 1924, pp. 143-170.

Bill, who feels *force*—whereas Bill feels nothing unusual as he remains on Earth. The more fundamental physics answer, however, is that Bob's world line in spacetime is curved, whereas Bill's is straight.

In an open, spatially unbounded, flat spacetime, *curved* is indeed synonymous with *accelerated*, but this need not be so in a *closed,* flat spacetime. In an open, flat spacetime, the only way two world lines can diverge in the past and then meet again in the future is for at least one of them to curve, but in a closed but still flat spacetime, it is possible for two straight world lines to meet more than once. For example, Fig. 3.17 shows a simple two-dimensional spacetime that is the surface of a cylinder (which you'll recall we argued earlier is flat), rather than an infinite flat plane. The two world lines in that figure are *both* straight: to visualize this, imagine cutting the cylinder open along the (vertical) time dimension, and then flattening it out. Bob's world line, however, looks longer in the spacetime diagram, so Bob's proper time will be less than Bill's when they meet again, even though now *neither* of them has experienced any acceleration.[112] This is simply an interesting mathematical exercise, however, and as far as is known the spacetime we live in is not cylindrical and so Bob's trip into the future will require an accelerating rocketship.[113]

If we specify the details of Bob's trip, we can then precisely calculate the difference in elapsed time for the twins. In an analysis that dates back to 1962, the German astrophysicist Sebastian von Hoerner (1919–2003) did that for the following trip[114]: To begin, Bob gets into his rocket ship at time $t = t' = 0$ (t is time measured on Earth by Bill, and t' is time measured by Bob in his rocket). The Bill and Bob synchronize their clocks at the instant of departure. Bob's trip is to be made in comfort, and so his rocket accelerates at a constant rate (a one gee acceleration, for example, would be equivalent to Earth's gravity, and Bob would feel right at home). This is of practical importance, obviously, because we do not want the experienced acceleration to be incompatible with the physical survival of Bob. Bob

[112]See C. H. Brans and D. R. Stewart, "Unaccelerated-Returning Twin Paradox in Flat Space-Time," *Physical Review D*, September 15, 1973, pp. 1662-1666. For a similar treatment, this time by a mathematician, see Jeffrey R. Weeks, "The Twin Paradox in a Closed Universe," *American Mathematical Monthly*, August-September 2001, pp. 585-589.

[113]In Chapter 6 we'll discuss the idea of traveling into the past by moving faster than light (*superluminal* motion). A treatment of such travel, in Bob's cylindrical spacetime, is by S. K. Blau, "Would a Topology Change Allow Ms. Bright to Travel Backward in Time?" *American Journal of Physics*, March 1998, pp. 179-185, which answers that question in its last line: "Ms. Bright cannot [return] 'the previous night' and alter history," a conclusion that no doubt met with Hawking's approval. The 'Ms. Bright' in the title is the heroine of a 1923 limerick that you can find quoted in the first *For Further Discussion* of Chapter 6.

[114]Originally appearing in the journal *Science*, under the title of "The General Limits of Space Travel," von Hoerner's analysis was reprinted in the classic anthology *Interstellar Communication* (A. G. W. Cameron, editor), W. A. Benjamin 1963. The arithmetic was, alas, just a bit sloppy (the final formulas, fortunately, are correct), and many of von Hoerner's numerical evaluations are incorrect. Later, the British mathematician Leslie Marder cleaned-up the analysis in his beautiful little book on the twin paradox, *Time and the Space-Traveler*, George Allen & Unwin, Ltd. 1971.

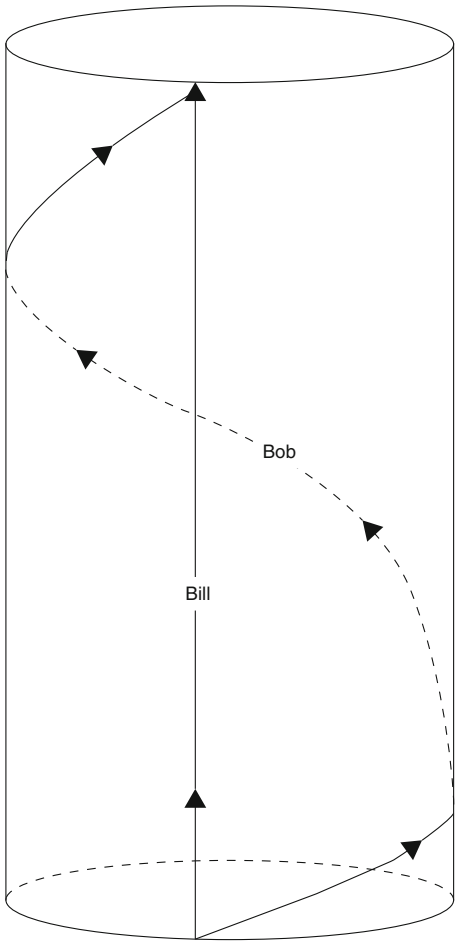

Fig. 3.17 Unaccelerated twin paradox in a cylindrical spacetime

travels this way for a time interval of T (as measured by Bill on Earth) and T' (as measured by Bob in his rocket). At that time the rocket is traveling at its maximum speed. Bob then turns off the rearward engine and turns on a forward-mounted engine so as to experience a constant deceleration. Floor and ceiling interchange, but Bob always weighs the same. If he does this for the same time interval T (as measured by Bill on Earth) and T' (as measured by Bob) as for the initial acceleration phase of the trip, the rocket will be brought to rest with respect to Earth. At that time, $2T$ (as measured by Bill on Earth) and $2T'$ (as measured by Bob), the rocket is at its maximum distance from Earth. Bob then returns to Earth, using the same acceleration/deceleration process, and Bob arrives back home, gently, with a final speed of zero with respect to Earth (ignoring, of course, all the navigational problems due to the motion of Earth during the trip).

Assuming the clock hypothesis is true (not all physicists believe this,[115] but remember, we have Einstein[116] on our side with this!), the result is that if a is the constant acceleration of the rocket (as experienced by Bob), and c is the speed of light, then the relationship between the *total roundtrip time* as measured by Bill ($4T$) and as measured by Bob ($4T'$), is given by

$$T = \frac{c}{a}\sinh\left(\frac{a}{c}T'\right).$$

The difference in what each twin believes to be the date can, in fact, be truly astonishing. For example, if $a = 1$ gee and Bob travels (by his clock) for $4T' = 20$ years, then $4T = 339$ years.[117] Of course, there will actually be no disagreement between Bill and Bob over the date upon Bob's return because Bill will be long dead!

Is it likely that such a time trip[118] will someday be made into the future? It's just my opinion, but I suspect not. Bob will be traveling at virtually the speed of light at maximum speed ($0.9993\,c$, to be precise, at which point he will be 84 light-years from Earth), and to zip through space at such a speed would result in a very high rate of collision with stray hydrogen atoms (about one per cubic centimeter). The result of those energetic collisions would be the intense blasting of Bob with a lethal dose of gamma radiation. And, as von Hoerner showed in his original analysis (note 114), the energy required by Bob's rocket would be simply mind-boggling.

Professor Schild (see note 116), on the other hand, seems to have been less bothered by such considerations when he wrote, at the beginning of a prose discussion of the twin paradox, "I have no doubt that if our technology should ever advance to the stage where large-scale twin effects become noticeable with our unaided senses, then [people] will have no difficulty in adjusting their concepts of time until the new phenomena see quite natural."[119]

I'll end this chapter on time with the observation that it is the distinction between the proper time of Bob on a rocket ship, and the time of those who are not fellow

[115]Consider, for example, this remark by 1965 Nobel physics laureate Julian Schwinger (1918-1994) about the twin paradox in his 1986 book *Einstein's Legacy*: "The observer on the spaceship . . . is *not* in uniform, unaccelerated motion . . . The special theory of relativity does not apply to such an accelerated observer." Schwinger was wrong in this conclusion (see the next note).

[116]As a physicist wrote on this point after Einstein's death, "A good many physicists believe that [the twin] paradox can only be resolved by the general theory of relativity. . . . However, they are quite wrong. The twin effect . . . is one of special relativity." See A. Schild, "The Clock Paradox in Relativity Theory," *American Mathematical Monthly*, January 1959, pp. 1-18. Alfred Schild (1921-1977) was professor of physics at the University of Texas, and a recognized expert in the general theory.

[117]In using the T, T' formula, one has to be careful to use MKS units, that is, length and time measured in meters and seconds, respectively. Thus, $a = 1$ gee $= 9.81$ meters/second^2 and $c = 186,210$ miles/second $= 2.997 \times 10^8$ meters/second.

[118]For a science fiction use of such a trip, see Robert Heinlein's 1956 novel *Time for the Stars*.

[119]A. Schild, "Time," *Texas Quarterly*, Autumn 1960, pp. 42-62.

space travelers, that eliminates the occasional suggestion of simply *freezing* one's way via suspended animation to the future (as in the 1992 film *Forever Young*). That is, suppose you manage to talk a friend into climbing into a freezer (please don't actually try this!); at the moment he gets in, his wrist watch agrees with yours (both are powered and maintained at a constant temperature by 100-year nuclear batteries). Years later, when you thaw your friend out, you'll find that your watches still agree. But when Bob returns from his rocket trip, his watch will not agree with yours, but instead will be far behind. Bob is a true time traveler, but your frozen/thawed friend is not.[120]

A provocative illustration of the distinction between the proper time of a time traveler and of those who are not time travelers was given by a philosopher.[121] He begins his analysis by asking what appears to be a question with an obvious answer. Suppose, he says, it is [2018] and you suddenly wake up in a hospital and are told that you have been in a coma for the past 2 weeks. You are also told that you were in an auto accident 2 weeks ago, that you suffered temporary neural damage, and that the eventual reversal of such damage always, at some time within 4 weeks after the damage occurs, causes a day of excruciating pain *if you are conscious at the time*. Would you prefer for the day of damage reversal to be in the past 2 weeks (when you were in the coma) or in the next 2 weeks? The answer seems clear. After all, if the day that damage reversal occurs has already happened, then you simply slept through it and missed the pain. To prefer the day of pain to be in the future (when you will be awake) seems absurd. Now, let's add time travel to the equation.

All is as before, but now you immediately leave the hospital upon regaining consciousness to take a trip back to 1892, where you will stay for 2 weeks. Again, it seems clear that you would prefer to have had the day of pain in the past 2 weeks (in 2018), not in the next 2 weeks (in 1892). Note that the *next* is a reference to your proper time, because whereas 1892 is the global past, it is *your* personal future. Thus, now your preference would be to have the day of pain in the *recent personal past* of 2018, not the *distant global* past of 1892. Now, let's put another time travel twist to this story.

All is as before in the original tale, except now you are told in the hospital that the auto accident happened just after you made a time trip to 2092: as you walked out of your time machine in 2092, you were hit by a car. The 2 weeks you were in a coma were in 2092, before you were judged fit enough (although still unconscious) to make the time journey back to 2018. When would you now prefer to have the day of pain? Clearly, as always, in your *personal past*, which is now the *global future*.

Time *is* different for those who time travel and those who don't!

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[120] In his 1956 novel *The Door Into Summer*, the always ingenious Robert Heinlein used *both* ideas, with the cold-storage method of reaching the future combined with a true time machine to allow his hero to return to his 'present' (the future's past).

[121] A. Gallois, "Asymmetry in Attitudes About the Nature of Time," *Philosophical Studies*, October 1994, pp. 51-59.

3.7 For Further Discussion

An interesting *theological* analysis of Feynman's idea of an electron traveling backward in time, expressed as thinking of the electron as being in 'one of God's films played in reverse,' is given by J. W. Smith, "Time Travel and Backward Causation," *Cogito* 1985, pp. 57–67. Wondering what it would be like for an electron to travel backwards in time, Smith's answer was: "Consider an electron e_1. At time t_0 it is at (x_0, y_0, z_0). At time t_1 it is at (x_1, y_1, z_1). If the direction of time for the electron was reversed, then the electron would be observed on the 'film of the world' to travel back along the same path as it did before, i.e., back to (x_0, y_0, z_0). If God stopped the 'film of the world' and examined the charge of e_1, then He would find that it was *negative*, not *positive*. Hence the electron traveling backwards in time is simply that: an electron traveling backwards in time, it is not a positron. Time reversal does not result in a reversal of charge. Thus, the Stückelberg-Feynman position is incorrect . . .." Discuss this in terms of the TCP theorem. Is there a conflict? When God stops the 'film of the world,' does the electron even *have* an arrow of time?

All the modern, major religions of the world are in agreement on these two points: (1) God created the universe and (2) At some time in the past, the universe came into existence. This does raise the question of what was God doing *before* He created the universe (see note 7 in the Introduction). In his *Confessions*, Saint Augustine comments on the conundrum that (1) and (2) are possibly in conflict. After all, if God *created* the universe then, given any time t in the finite past, He must have been doing something *before* time t, which means that for any time t in the finite past the universe already existed. Thus, the universe had no instant of creation in the finite past and so had no first moment of existence—which implies (2) is false. However, like any good philosopher of religion, Augustine not only provided this theological puzzle, but also a way to wiggle free of it. His suggested counter is the assertion that time is *itself* a creation of God, that is, He made time as *part* of creating the universe. Thus, there was no time *before* He created the universe, and so the very question of 'what was He doing before He made the universe' has no meaning. What do you think of Augustine's two arguments?

The Australian philosopher J. J. C. Smart (1920–2012) invoked five dimensional spacetime in a way very different from that of including an 'eternity' axis for God's temporal time (see note 33 in "Some First Words"). What Smart argued for, instead, was *multiple* four-dimensional worlds existing together without conflict, just as an infinity of two-dimensional worlds can exist without conflict in a three dimensional space. As he wrote, "The reason why there could be two totally disparate space-times is simply the quite obvious one that two totally disparate four-dimensional spaces can exist within a suitable five-dimensional space. There is no difficulty in mathematical inconceivability here. Now let one of these four-spaces be our own space-time world, and let the other four-space be more or less similar, in accordance with whatever story you wish to tell about it." This idea had, in fact, been around long before Smart's 1967 paper. In his 1898 Presidential Address to the American Mathematical Society, for example, Simon Newcomb declared "Add a fourth dimension of space, and there is room for an indefinite number of Universes, all alongside of each other, as there is for an indefinite number of sheets of paper when we pile them upon each other." Newcomb's idea appealed to H. G. Wells' fancy so much that he built two novels, *The Wonderful Visit* and *Men Like Gods*, around it. In the first novel there is explicit mention of multiple worlds "lying somewhere close together, unsuspecting, as near as page to page in a book," and the second one speaks of one parallel universe being rotated into another. John Cramer (a University of Washington physicist) repeated Newcomb's and Wells' parallel universes/pages-of-a-book/rotation imagery almost word for word in his 1991 novel *Twistor*.

Read these three novels, and then discuss. In particular, is Wells consistent in his presentations (as a novelist there is, of course, no reason he should be!)?

Imagine the following two events, **A** and **B**, in Minkowski spacetime: **A** is the emission of a photon, and **B** is the absorption of that photon. What is the spacetime interval between **A** and **B**? It might seem that we need to know more about the precise spatial and temporal coordinates of **A** and **B**, but in fact the interval is *always zero* for any two events connected by light (by photons). To see this, write the flat Minkowski metric as

$$\left(\frac{ds}{dt}\right)^2 = 1 - \left(\frac{dx}{dt}\right)^2$$

(continued)

and so, since $(dx/dt)^2 = 1$ (because photons—by definition!—travel at the speed of light) we have $(ds)^2 = 0$. The world line of any photon has what is called a *null* interval, as do all world lines on the surface of a light cone. Timelike world lines (in the interior of light cones, with $(dx/dt)^2 < 1$) have positive intervals, that is, $(ds)^2 > 0$. Spacelike world lines (in the exterior of light cones, in Elsewhere, with $(dx/dt)^2 > 1$) have negative intervals, that is, $(ds)^2 < 0$. This is one of the significant differences between *distances* in space (which are never negative) and *intervals* in spacetime. The American chemist G. N. Lewis (1875–1946)—see note 60 in Chap. 2—constructed a romantic illustration of this when he wrote "Any pair of points [in spacetime] which are separated by zero distance [interval] are in *virtual contact*. In other words, I may say that my eye touches a star, not in the same sense as when I say that my hand touches a pen, but in an equally physical sense." (See Lewis' paper "Light Waves and Light Corpuscles," *Nature*, February 13, 1926, pp. 236–238; Lewis was the originator of the term *photon* for a particle of light.) To understand what Lewis was getting at, you must understand that in spacetime we can have the interval between **A** and **B** as zero, and the interval between **B** and **C** as zero, but the interval between **A** and **C** may *not* be zero. To convince yourself of this, suppose the Minkowski spacetime coordinates (x, t) of **A**, **B**, and **C** are (1,3), (2,2) and (1,1), respectively. Show that $(ds_{\boldsymbol{AC}})^2 = 4$, while $(ds_{\boldsymbol{AB}})^2 = (ds_{\boldsymbol{BC}})^2 = 0$. (Hint: draw a diagram of this spacetime and simply plug the coordinates of **A**, **B**, and **C** into the metric.)

The use of the time dilation effect of high-speed space travel was used by science fiction writer Donald Wandrei (1908–1987) in his tale "A Race Through Time," *Astounding Stories*, October 1933. Initially set in 1950, this is the story of two scientists, one evil (of course!) and the other good (of course!), who develop quite different methods for travel into future times. The evil one does it with a drug that slows the metabolic processes of the body, while the good one builds an atomic-powered rocket in his home workshop! The evil scientist kidnaps the good one's girlfriend, seals the two of them inside a crystal dome, and then injects her and himself with his drug. He has arranged matters so that they will emerge from the dome in the year one million A.D. Learning what has happened, the good scientist rushes to the dome finds he can't break in, but sees an indicator dial pointing at 1,000,000. (The evil scientist has conveniently provided the dial, as well as having made the dome transparent, much as modern-day movie criminals always include a count-down clock with glowing red digits on their bombs so the hero always knows just how much time is left to disarm the bomb.)

(continued)

Returning to his rocket, the good scientist decides that he, too, will travel into the far future using time dilation. So, off he goes, on a trip like Bob's in Sect. 3.6. The story ends with an ironic twist—the good scientist thought the '1,000,000' he saw through the dome meant *one million years in the future beyond 1950*, and so he arrives back on Earth nearly 2000 years *after* his girlfriend and the evil scientist emerged from the dome. (They are, of course, long dead when the good scientist returns.)
On the outward leg of the good scientist's rocket flight we read of his "frightful speed — now thousands of light years per Earth second." Discuss this in terms of relativity theory. That is, does the rocket actually travel thousands of light years in one second of elapsed time back on Earth?

The American physicist Robert Forward (1932–2002) was, in addition to being an expert in general relativity, also a quite inventive science fiction writer. In his short story "Twin Paradox" (*Analog Science Fiction*, August 1983), for example, he used *biology* to give a surprising, ironic twist to the classic physics puzzle. The story flips the asymmetric aging of the twins by imagining that, just after the traveling twin's departure, the secret of immortality is discovered. The treatment has to be administered no later than at a certain age, however, and upon his return to Earth the traveling twin is just a bit too old for it to work. He thus becomes the last person to die of old age! In this tale, the details of the traveling twin's trip are somewhat different from Bob's trip. Read "Twin Paradox" (you can also find the story in Forward's 1995 book *Indistinguishable from Magic*), and summarize how the traveling twin's trip is accomplished.

In the mystical 1920 novel *A Voyage to Arcturus*, by the Scottish writer David Lindsay (1876–1945), we read of a spaceship that travels to Arcturus (the brightest star in the constellation Boötes, 36 light years from Earth) in just 19 h of proper time. The technical details of the trip are not explained in the novel, so assume they are the same as in Bob's trip. That is, $2T' = 68,400\,\text{s}$ as measured by a clock on the spaceship. The distance traveled in this time is

$$2\frac{c\left\{\sqrt{a^2T^2+c^2}-c\right\}}{a}$$

(continued)

where c is the speed of light, a is the constant acceleration/deceleration of the rocket (as measured on the spaceship), and T is how long an *Earth*-based clock says the trip takes. Use this formula, and the one relating T and T' in the text, to calculate

1. The value of the constant acceleration/deceleration, a (does the result seem reasonable to you?) and
2. The value of T (the length of time that passes on Earth as 19 h pass on the spaceship).

You don't have to discuss general relativity to encounter tensors of the second rank (as is the metric tensor). Electrical engineers run into such a thing, for example, when studying the lowly Ohm's law! In a copper wire, that law says the current density (the vector **J**, in units of amperes per square meter) at any point is related to the electric field (the vector **E**, in units of volts per meter) at that point by the *scalar* σ as follows: $\mathbf{J} = \sigma\mathbf{E}$, where σ (called the *conductivity*) is a single number. This says, in rectangular coordinates, that the x-component of **J** depends *only* on the x-component of **E**, and similarly for the y-component and z-components of **J** and **E**. More generally, however, each component of **J** depends on *all* of the components of **E** (as in certain crystalline structures), and so we have the equations

$$\begin{aligned} J_x &= \sigma_{11}E_x + \sigma_{12}E_y + \sigma_{13}E_z \\ J_y &= \sigma_{21}E_x + \sigma_{22}E_y + \sigma_{23}E_z \\ J_z &= \sigma_{31}E_x + \sigma_{32}E_y + \sigma_{33}E_z \end{aligned}$$

or, in matrix form

$$\mathbf{J} = \begin{bmatrix} J_x \\ J_y \\ J_z \end{bmatrix} = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} \end{bmatrix} \begin{bmatrix} E_x \\ E_y \\ E_z \end{bmatrix} = \boldsymbol{\sigma}E.$$

So **J** is now related to **E** by $\boldsymbol{\sigma}$, a 3×3 *matrix* (9 numbers, instead of just 1). The matrix $\boldsymbol{\sigma}$ is, in fact, a tensor of rank 2. This tensor is in the three-dimensional space of the copper wire, while the 4×4 metric tensor matrix is in a four-dimensional spacetime, but both are tensors of rank 2. The number of numbers in a tensor of rank n, in a space of dimension d, is d^n. In general relativity, tensors of higher rank than 2 are required. For example, the

(continued)

curvature tensor has rank 4, and so in a four-dimensional spacetime it is described by $4^4 = 256$ numbers. This goes a long way in explaining why, in general relativity, computing often involves a *lot* of arithmetic! The primary characteristic of tensors of any rank is that they are invariant under a change in coordinate systems (choosing a coordinate system is an arbitrary matter, made mostly for human convenience, about which Nature is indifferent). Read more about tensors, and write an essay on how they behave under a change in coordinates. A good place to start, at the level of this book, is Lillian Lieber's *The Einstein Theory of Relativity: a trip to the fourth dimension*, Paul Dry Books 2008 (an updated version of the original 1945 book).

Chapter 4
Philosophers, Physicists, and the Time Travel Paradoxes

"He felt the intellectual desperation of any honest philosopher. He knew that he had about as much chance of understanding such problems as a collie has of understanding how dog food gets into cans."[1]

4.1 Paradoxes and Their First Appearance in Science Fiction

> "There's a lot we don't know about time travel. How do you expect logic to hold when paradoxes hold, too?" "Does that mean you don't know?" "Yes."[2]

More than 30 years ago Quentin Smith, a philosopher who believes in a finite length to the past, wrote a refutation to those who believe in an infinite past and, while that paper[3] has nothing to do with the paradoxes of time travel, in the course of presenting his reasoning he included the following curious passage:

> "Why does the sun arise in the morning and not at some other time? Why do the hands of a properly functioning clock point to 12:00 at noon and midnight and not at other times? Why does the death of a person occur at a later time than his birth? The answer in all these cases is: Because by the very nature of these events they could not occur at other times. It belongs to the very nature of the sun's rising that it occur in the morning and not in the afternoon or evening. It belongs to the very nature of a properly functioning clock to point to 12:00 at noon and midnight and not at other times. And it belongs to the very nature of death to occur at a time later than a person's birth."

But what of a time traveler born in 1980 who, in 2018, enters her time machine, pushes a few buttons, and then boldly steps out into the Cretaceous period seventy million years earlier—and is promptly eaten for lunch by a passing *Tyrannosaurus*

[1] A time traveler admits (to himself) how perplexed he is by paradoxes in Robert Heinlein's classic tale "By His Bootstraps," *Astounding Science Fiction*, October 1941.

[2] Excerpt from a conversation between two paradox-puzzled time travelers in Larry Niven's story "Bird in the Hand," *The Magazine of Fantasy & Science Fiction*, October 1970.

[3] Q. Smith, "Kant and the Beginning of the World," *New Scholasticism*, Summer 1985, pp. 339–346.

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P.J. Nahin, *Time Machine Tales*, Science and Fiction,
DOI 10.1007/978-3-319-48864-6_4

rex? Perhaps Smith himself would say that there is no contradiction between this and his third claim because, in the time traveler's *proper* time, her spectacular death does indeed come after her birth. For many, however, for a time traveler to die before her mother is born *is* a paradox, plain and simple, say what you will about proper time.

One science fiction view of time travel paradoxes is that nature would be so disrupted by them that, should one occur, the universe would be torn apart. In one story, for example, a paradox is on the verge of happening through the use of a Tipler-cylinder time machine (mentioned back in Chap. 1, and which we'll discuss in more detail in the next chapter). In response to this 'threat to common sense,' the universe 'decides' to avoid the paradox by simply eliminating the perpetrators via a local nova![4] Niven wasn't the first to use this idea. A famous story[5] by L. Sprague de Camp (1907–2000), written two decades before, had already put forth the suggestion that nature will take all required corrective action to avoid paradoxes.

In De Camp's tale we read of two big-game hunter guides who use "Professor Prochuska's time machine at Washington University"—built with the aid of a "cool thirty million" dollar grant from the Rockefeller Foundation—to operate a safari-for-hire business that transports hunters back to the late Mesozoic era. When a disgruntled client tries to go back to the day *before* a previous trip to shoot the guides (who had displeased him, or rather *would* displease him the next day), we learn just how nasty De Camp thought Mother Nature would be to avoid a paradox. (After all, the guides had *not been* shot during the safari, so they *could not be* shot.[6]): "The instant James started [to ambush the guides] the space-time forces snapped him forward to the present to prevent a paradox. And the violence of the passage practically tore him to bits [making his body look] as though it had been pulverized and every blood vessel burst, so it was hardly more than a slimy mass of pink protoplasm."

And even earlier we have a famous tale[7] that was discussed in Chap. 1, by Fredric Brown (1906–1972), a master of the special category of science fiction called the "short-short," in which everything happens in 500 words or less. As you might expect, the oddities of time travel were natural attractions for Brown's quirky talent. You'll recall that in this story the inventor of the first time machine demonstrates it to two colleagues by sending a brass cube 5 min into the future. After being placed in the machine, the cube vanishes and then 5 min later reappears. No paradoxes with that—it is a trip into the *past* that has the potential for deadly repercussions. We learn just how deadly when the inventor next declares that at

[4]L. Niven, "Rotating Cylinders and the Possibility of Global Causality Violation," *Analog Science Fiction*, August 1977. Niven took this title from a physics paper with that title, authored by Tipler, that had appeared three years earlier in *Physical Review D* (April 15, 1974, pp. 2203–2206).

[5]L. Sprague de Camp, "A Gun for Dinosaur," *Galaxy Science Fiction*, March 1956.

[6]This is a statement of the belief that the past cannot be changed, an idea we will examine later in this chapter.

[7]Look back at note 93 in Chap. 1.

three o'clock he will again place the cube in the time machine but, until then, he will hold the cube in his hand. Thus, he says, at 5 min before three the cube will vanish from his hand and immediately appear in the time machine because 5 min after that, at three o'clock, he will send it 5 min into the past. And indeed, at 5 min before three the cube does simultaneously vanish from his hand and appear in the time machine. Then, slightly before three, as the three men stand pondering what has happened, one of the observers asks what will happen if the inventor does *not* send the cube back at three o'clock? "Wouldn't there be a paradox of some sort involved?" he wonders.[8] His curiosity aroused, the inventor can't resist the experiment—and the universe promptly vanishes.

Time travel, of course, is full of potential paradoxes. A paradox, according to the usual dictionary definition, is something that appears to contain contradictory or incompatible parts, thus reducing the whole to seeming nonsense. And yet, truth is also evident in the whole. The history of science and mathematics has left a long trail of paradoxes, and those that involve time travel are merely among the most recent. Not all of the puzzles of time travel involve physics or logic, however. As one philosopher observed, "Doubtless time travel will raise a host of legal difficulties, e.g., should a time traveler who punches his younger self (or vice versa) be charged with assault? Should the time traveler who murders someone and then flees into the past for sanctuary be tried in the past for his crime committed in the future? If he marries in the past can he be tried for bigamy even though his other wife will not be born for almost 5000 years? Etc., etc. I leave such questions for lawyers and writers of ethics textbooks to solve."[9]

One way early science fiction writers had of responding to the puzzle of time travel paradoxes was to just give up and to concede that the logical puzzles are overwhelming. In one tale, for example, the inventor of the Chronoscope (a gadget that can only *view* the past) explains, "There is no time travel machine. Such a thing is a logical impossibility, treated seriously only by half-cracked writers of fantasy. Such a machine would lead at once into a hopeless paradox."[10] Equally concerned about time travel paradoxes was the pulp science fiction time traveler who told his partner, just before their first trip in time, that "I'm not sure any more about getting back. There're some unpredictable terms in the time-travel equation—paradoxes. Maybe we *won't* get back."[11]

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[8]This is what is called a *bilking paradox*, and such paradoxes will be discussed later in this chapter. Brown gave this story a lot of thought. At one point in the tale one of the colleagues, puzzled by how the inventor will be able to place the cube into the time machine at three if it has already vanished from his hand and appeared in the machine, asks "How can you place it there, then?" Replies the inventor, "It will, as my hand approaches, vanish from the [machine] and appear in my hand to be placed there."

[9]L. Dwyer, "Time Travel and Some Alleged Logical Asymmetries Between Past and Future," *Canadian Journal of Philosophy*, March 1978, pp. 15–38.

[10]M. Jameson, "Dead End," *Thrilling Wonder Stories*, March 1941.

[11]E. Binder, "The Time Cheaters," *Thrilling Wonder Stories*, March 1940.

Fig. 4.1 One way pulp science fiction avoided paradoxes was to use a 'time viewer' (like the chronoscope in "Dead End") as in "The Time Eliminator" (*Amazing Stories*, December 1926). This illustration from the story (authored by somebody who used only the initials K.A.W.) by Frank R. Paul (©1926 by Experimenter Publishing Co.) shows the inventor demonstrating his gadget to his future wife and father-in-law. Able to look back in time, the screen is displaying scenes from the older man's courtship of his wife, decades in the past. Reprinted by permission of the Ackerman Science Fiction Agency, 2495 Glendower Ave., Hollywood, CA 90027 for the Estate

But are there *really* paradoxes? Or is it true, as the extraordinary boy-prodigy who invented a time machine exclaimed (when his teacher asserted that some questions could never be answered because "Nature is full of paradoxes"), "Ah, Professor, what nonsense! Nature is harmonious; it is we who bring the paradoxes into it."[12] Saying the same are two physicists, in a paper on the circular orbits of photons around black holes: "There are no paradoxes in physics, but only in our

[12]V. Grigoriev, "Vanya," in *Last Door to Aiya* (M. Ginsburg, editor), S. G. Phillips 1968.

attempts to understand physical ideas by using inadequate reasoning or false intuition."[13] And as the time traveler in an early pulp story[14] casually declares to a friend, after an astonishing adventure in the year A.D. 1,001,930, "Paradoxical? My dear fellow, the Einstein Theory is full of apparent paradoxes, yet to him who understands it there is no inconsistency whatever. Give me another cigarette, will you, Frank?"

It is in *Amazing Stories* that we find the first non-fictional speculations about time travel in a pulp magazine—and certainly long before any *physics* journal would touch the subject! Publisher and editor Hugo Gernsback started those speculations by reprinting Wells' *Time Machine*, which in turn sparked a fair number of readers' letters that were printed in the magazine's "Discussions" section. Typical of the less interesting is the following comment from a letter in the July 1927 issue: "In the 'Time Machine' I found something amiss. How could one travel to the future in a machine when the beings of the future have not yet materialized?" (We answered that question in the previous chapter with the twin paradox.) Far more interesting was this letter, in the same issue:

> "How about this 'Time Machine'? Let's suppose our inventor starts a 'Time Voyage' backward to about A.D. 1900, at which time he was a schoolboy . . . His watch ticks forward although the clock on the laboratory wall goes backward. Now we are in June 1900, and he stops the machine, gets out and attends the graduating exercises of the class of 1900 of which he was a member. Will there be another 'he' on the stage? Of course, because he *did* graduate in 1900 . . . Should he go up and shake hands with this 'alter ego'? Will there be two physically distinct but characteristically identical persons? Alas! No! He can't go up and shake hands with himself because . . . this voyage back through time only duplicates actual past conditions and in 1900 this strange 'other he' did *not* appear suddenly in quaint ultra-new fashions and congratulate the graduate. How could they both be wearing the same watch they got from Aunt Lucy on their seventh birthday, the same watch in two different places at the same time. Boy! Page Einstein! No, he cannot be there because he wasn't there in 1900 (except in the person of the graduate) . . . The journey backward must cease on the year of his birth. If he could pass that year it would certainly be an effect before a cause . . . Suppose for instance in the graduating exercise above, the inventor should decide to shoot his former self . . . He couldn't do it because if he did the inventor would have been cut off before he began to invent and he would never have gotten around to make the voyage, thus rendering it impossible for him to be there taking a shot at himself, so that as a matter of fact he *would* be there and *could* take a shot—help, help, I'm on a vicious circle merry-go-round . . . Now as to trips into the future, I could probably think up some humorous adventures wherein [the inventor] digs up his own skeleton and finds by the process of actual examination that he must expect to have his leg amputated because the skeleton presents positive proof that this was done."[15]

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[13]M. A. Abramowicz and J. P. Lasota, "On Traveling Round Without Feeling It and Uncurving Curves," *American Journal of Physics*, October 1986, pp. 936–939.

[14]F. J. Bridge, "Via the Time Accelerator," *Amazing Stories*, January 1931.

[15]This story idea (the letter was signed only with the initials T.J.D.) may well have been the inspiration for R. Rocklynne, "Time Wants a Skeleton," *Astounding Science Fiction*, June 1941. Not all fans agreed with T.J.D. A few years later, for example, a teenager named P. Schuyler Miller (1912–1974), who would author several time travel classics himself, wrote a letter to the editor of *Astounding Stories* (June 1931) stating "there is nothing in physics . . . to prevent yourself from

All of the ingenious puzzles in this letter intrigued Gernsback, and may have, in fact, been the cause of his featuring a new, original time machine story[16] in the same issue. It was the tale of a scientist who transports an entire ship at sea 14,000 years back in time and causes it to hover over lost Atlantis! That story provoked a sharp letter from a reader who claimed its logic had a fatal flaw: the story's author indicated that the Atlantians observed the time travelers when, 'of course' (asserted the reader), the time travelers must actually have been invisible. The reader explained his reasoning as follows, beginning by defining A as one of the Atlantians.

> "Now A lived his life, thousands of years ago, and died. All right, now let us pass on in time 14,000 years. Now, back we come in time when A is again living his life. Lo and behold, this time A sees before he dies a strange phenomenon in the sky! He sees the shipload of people observing him. And yet these people are necessarily observing him during his one and only lifetime, wherein he certainly did not, could not, have observed them."

Gernsback printed this letter in his September 1927 editorial "The Mystery of Time," and concluded by saying "I do . . . agree . . . that the inhabitants of Atlantis would probably not have seen the . . . travelers in time." Other readers felt this way, too, because after Gernsback published yet another time machine tale[17] in 1927, the same invisibility argument appeared again in the magazine's "Discussions" column.

Two years later an amateurishly written tale[18] appeared in which a man travels in time from 1928 to 2930 with the aid of an "astounding machine based on advanced electro-physics and the non-Euclidean theory of hyperspace." The purpose of that story was two-fold: to present several of the classic paradoxes of time travel, and then to make the claim that although the simple minds of twentieth-century people cannot understand the explanations of the paradoxes (possibly explaining why the author offers none!), the paradoxes are all trivial to the scientists of the thirtieth century. Despite this shortcoming (as well as some pretty awful dialog) the story nonetheless still managed to entertain readers with the sheer mystery of the paradoxes. Letters poured into the magazine from young fans, all demanding more time travel fiction.

So, that same year Gernsback responded with a story[19] that plays with the question of the role of time travelers in the past. (That question was clearly 'in

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going into the past . . . and shaking hands with yourself or killing yourself." That did, however, provoke the following harsh reply from another, more skeptical reader (in the December 1933 issue): "P. S. Miller once wrote that time traveling is not incompatible with any laws of physics . . . 'he don't know from nothing.'"

[16] C. B. White, "The Lost Continent," *Amazing Stories*, July 1927.

[17] F. Flagg, "The Machine Man of Ardathia," *Amazing Stories*, November 1927.

[18] C. Cloukey, "Paradox," *Amazing Stories Quarterly*, Summer 1929.

[19] H. F. Kirkham, "The Time Oscillator," *Science Wonder Stories*, December 1929.

the air,' as Gernsback's old magazine *Amazing*[20] simultaneously published a story[21] addressing this same puzzle of time travel.) Could time travelers actually participate in events ("mix into the affairs of the period," in Gernsback's words), or would they just be unseen observers? This question, obviously inspired by the earlier discussion in *Amazing Stories*, intrigued Gernsback as much as it did his readers and so, along with Kirkham's story, he printed a challenge titled "The Question of Time-Traveling" (see note 18 in the Introduction):

> "In presenting this story to our readers, we do so with an idea of bringing on a discussion as to time traveling in general. The question in brief is as follows: Can a time traveler, going back in time—whether ten years or ten million years—partake in the life of that time and mingle in with its people; or must he remain suspended in his own time-dimension, a spectator who merely looks on but is powerless to do more? Interesting problems would seem to arise, of which only one need be mentioned: Suppose I can travel back into time, let me say 200 years; and I visit the homestead of my great great great grandfather, and am able to take part in the life of his time. I am thus enabled to shoot him, while he is still a young man and as yet unmarried. From this it will be noted that I could have prevented my own birth; because the line of propagation would have ceased right there. Consequently, it would seem that the idea of time traveling into a past where the time traveler can freely participate in activities of a former age, becomes an absurdity. The editor wishes to receive letters from our readers on this point: the best of which will be published in a special section."

Gernsback's challenge did not go unnoticed and, over the next year or so, he published a large number of reader responses in the magazine's letters column.

Indeed, a few months after issuing the challenge, in his introduction to another time travel tale,[22] Gernsback wrote that ever since the publication of Kirkham's tale "there has been a great controversy among our readers as to the possibility of time flying and the conditions under which it may be done." Most of those letters are interesting if not particularly profound, with one exception. That was a letter written by a 14 year old boy in San Francisco, and its appearance in the February 1931 issue of *Science Wonder* may well have served as the inspiration for several of the classic time travel tales published during the next 20 years:

> "Some time ago you asked us (the readers) what our opinions on time traveling were. Although a bit late, I am now going to voice four opinions . . .
>
> (1) Now, in the first place if time traveling were a possibility there would be no need for some scientist getting a headache trying to invent an instrument or 'Time-Machine' to 'go back and kill grandpa' (in answer to the age-old argument of preventing your birth by killing your grandparents I would say: 'who the heck would want to kill his grandpa or gandma!'[23]) I figure it out thusly: A man takes a time machine, and travels into the

[20]By this time Gernsback had lost control of *Amazing*, and *Science Wonder* was his come-back as a publisher of pulp 'scientifiction.'

[21]E. L. Rementer, "The Time Deflector," *Amazing Stories*, December 1929. Gernsback may well have been the editor, before he lost *Amazing*, who bought this story, and the magazine's new management simply used what remained in inventory.

[22]F. Flagg, "An Adventure in Time," *Science Wonder Stories*, April 1930.

[23]Look back at note 26 in "Some First Words."

future from where he sends it (under automatic control) to the past so that he may find it and travel into the future and send it back to himself again. Hence the time machine was never invented, but!—from whence did the machine *come*?

(2) Another impossibility that might result could be: A man travels a few years into the future and sees himself killed in some unpleasant manner,—so—after returning to his correct time he commits suicide in order to avert death in the more terrible way which he was destined to. Therefore how could he have seen himself killed in an entirely different manner than really was the case?

(3) Another thing that might corrupt the laws of nature would be to: Travel into the future; find out how some ingenious invention of the time worked; return to your right time; build a machine, or whatever it may be, similar to the one you had recently learned the workings of; and use it until the time you saw it arrives, and then if your past self saw it as you did, he would take it and claim it to be an invention of his (your) own, as you did. Then—who really *did* invent the consarn thing?

(4) Here's the last knock on time traveling: What if a man were to travel back a few years and marry his mother, thereby resulting in his being his own 'father'?"

Jim H. Nicholson

Gernsback's reply, immediately following this letter, was favorable, opening with "Young Mr. Nicholson does present some of the more humorous [?] aspects of time traveling. Logically we are compelled to admit that he is right—that if people could go back into the past or into the future and partake of the life in those periods, they could disrupt the normal course of events."[24] Nicholson's letter *is* ingenious, and it anticipated the central ideas of a number of science fiction tales yet to be written.[25] However, as you'll see as you read the rest of this chapter, contrary to Gernsback's view Nicholson's comments are *not* logically correct.[26]

[24]Despite these words, Gernsback apparently hadn't given up entirely on the 'invisibility of time travelers' view, as he had only a few months earlier published another such tale: R. A. Palmer, "The Time Ray of Jandra," *Wonder Stories*, June 1930. In this story (one either silly or hilarious, take your pick) a time traveler moves into the future by means of a 'time ray.' Unfortunately, the ray works differently on the various chemical elements, and not at all on either hydrogen or oxygen. Thus the time traveler—or at least *much* of him—and his machine do vanish into the future, but left behind are "several gallons of water spilled on the floor." (The human body is about 60 % H_2O.)

[25]For example, Nicholson's item (2) is a precise plot outline for L. Raphael, "The Man Who Saw Through Time," *Fantastic Adventures*, September 1941, and a version of item (4) is in Robert Heinlein's famous "All You Zombies—," *Magazine of Fantasy & Science Fiction*, March 1959.

[26]One cannot, however, fault the imaginative powers of James Nicholson (1916–1972). He eventually became President of American International Films, the company that made such science fiction 'classics' as *Attack of the Crab Monsters* (1957), the 1963 *X (The Man with the X-Ray Eyes)*, and *The Time Travelers* (1964).

4.2 Changing the Past and the Grandfather Paradox

> "I'm not kidding you at all Phil," Barney insisted. "I have produced a workable Time Machine, and I am going to use it to go back and kill my grandfather."[27]

As mentioned in "Some First Words," physicists and philosophers often have quite different approaches to time travel (see note 26 there again). A vivid illustration of that difference is found in a philosophical paper[28] that, after acknowledging the apparent restrictions of the grandfather paradox, turns its attention to a matter that almost surely is beyond the power of physics to study—namely, the nature of the *conversation* between a time traveler and his/her younger self. A physicist, on the other hand, views the restrictions as *the whole point*, because the central question that hovers over *any* discussion of time travel is that of 'changing the past.' As one science fiction fan summed it up in a letter to the editor of *Astounding Stories* (August 1931): "It is said that the past cannot be changed, and that any effort to do so would be useless. In my belief, no matter where or when a man goes in the past, if he appears in a year or day that has already gone by, *he is changing the past*. Then there should be no room for doubt: time traveling is impossible. It will never be done." And certainly killing your grandfather in the past (when he is still a baby) would qualify as a change to the past!

The idea of 'changing the past' occurred to the minds of philosophers long before it did in those of science fiction writers or physicists. Four centuries before Christ, the question had already been asked-and-answered by Aristotle. In his *Nicomachean Ethics*, in fact, we find him declaring that the Greek poet Agathon had known the answer a century earlier, and he quotes the poet as saying "Forever God lacks this one thing alone, To make a deed that has been done undone."

Agathon and Aristotle aside, some medieval theologians argued passionately that the past *could* be changed (but only by God). The eleventh-century Italian cleric Peter Damian (who became a Christian saint) is a famous exponent of that radical view.[29] Writing in his *De Omnipotentia Dei* ("On the Divine Omnipotence

[27]The opening line to F. M. Busby, "A Gun for Grandfather," *Future Science Fiction*, September 1957.

[28]Jiri Benovsky, "Endurance and Time Travel," *Kriterion—Journal of Philosophy*, 2011, pp. 65–72.

[29]R. P. McArthur and M. P. Slattery, "Peter Damian and Undoing the Past," *Philosophical Studies*, February 1974, pp. 137–141; P. Remnant, "Peter Damian: Could God Change the Past?" *Canadian Journal of Philosophy*, June 1978, pp. 259–268; R. Gaskin, "Peter Damian on Divine Power and the Contingency of the Past," *The British Journal for the History of Philosophy*, September 1997, pp. 229–247.

in Remaking What Has Been Destroyed and Undoing What Has Been Done"),[30] Damian made it clear that he believed nothing could withstand the power of God, not even the past. Ralph Waldo Emerson's poem "The Past" ("All is now secure and fast, Not the gods can shake the Past") would have been blasphemy for Damian. The following words from Damian testify to the strength of his commitment to a belief in the possibility of changing the past: "Just as we can duly say 'God was able to make it so [that] Rome, before it had been founded, should not have been founded,' in the same way we can equally and suitably say, 'God can make it so that Rome, even after it was founded, should not have been founded.'"[31]

Two centuries after Damian, Aquinas argued the contrary view, that changing the past is *not* within God's power. Whereas Damian felt it impossible to deny any act to God, Aquinas took the far more moderate position that part of God's law is that there be no contradictions in the world (this is, in fact, the modern view of time travel physicists) and that certainly God would be bound by his own law. As he wrote, "It is best to say that what involves contradiction cannot be done rather than that God cannot do it." In his *Paradise Lost*, John Milton's God is constrained even more: he is free to act or not, but if he does freely decide to act, it can only be to 'do right.' That might seem to preclude causing contradiction, as in changing the past, but perhaps not. Milton's contemporary, Thomas Hobbes, declared that there is no *a priori* standard of goodness, and thus (for Hobbes) there are no constraints on God's powers. For Hobbes, therefore, it would seem God could change the past. Theological changing of the past, as you might expect, leads to all sorts of mind-boggling puzzles. Because of such puzzles, theology would certainly be influenced by time travel, but just as certainly theological reasoning will not illuminate the puzzles of the time travel paradoxes.

The question of the immutability of past events is of special interest to theologians because it is directly related to the question of free will versus fatalism. That is, are humans the creators of the future, or are they mere fated puppets of destiny? One way theology gets involved with the issue of 'changing the past' is via what is called the *retroactive petitionary prayer*. (An 'ordinary' petitionary prayer, like the Lord's Prayer in Matthew 6 and Luke 11, asks for something in the present or the future.) Examples of retroactive prayers include that of the surgical patient who prays, just before an exploratory operation, for his tumor to be non-malignant, and

[30]This work is in the form of a letter to his friend Desiderius (who later became Pope Victor III), in which Damian rebutted Desiderius' defense of St. Jerome's claim that "while God can do all things, he cannot cause a virgin to be restored after she has fallen." Desiderius thought the reason God could not restore virgins is that he does not want to, to which Damian replied that this meant God is unable to do whatever he does not want to do, but this meant that God would then be less powerful than men, who are able to do things they don't want to do (such as go without food for a month). This is a good example of the dangers involved when getting into debates with theologians.

[31]The Argentinian writer Jorge Luis Borges (1899–1986) was so inspired by Damian's view that the past could be changed that he wrote a short story based on it (see "The Other Death," originally published in *The New Yorker*, November 2, 1968) and put a character in it named after Damian.

that of the soldier's wife who prays that her husband was not among those killed in yesterday's battle. Such prayers are for a happy outcome to an event that is over and done with at the time of the prayer. One might accept the rationality of praying about the future ("Please, God, let me survive tomorrow's battle and I'll be good for the rest of my life") but are prayers about the past even sensible? (The three major monotheistic religions of the world—Christianity, Judaism, and Islam—say *yes*.)

In an appendix titled "Special Providences" in his book Miracles, C. S. Lewis answers that question as follows:

> "When we are praying about the result, say, of a battle or a medical consultation, the thought will often cross our minds that (if only we knew it) the event is already decided one way or the other. I believe this to be no good reason for ceasing our prayers. The event certainly has been decided—in a sense it was decided 'before all worlds.' But one of the things taken into account in deciding it, and therefore one of the things that really causes it to happen, may be this very prayer that we are now offering. Thus, shocking as it may sound, I conclude that we can at noon become part causes of an event occurring at ten A.M. (Some scientists would find this easier than popular thought does.)"

Here we see Lewis, a prominent lay theologian, arguing for the present influencing (but not changing) the past. What can we make of that? Was Lewis arguing for backward causation, the close relative of time travel? I think perhaps so; the final two sentences in the above excerpt makes it plausible that he may have held that view. It is a view that does find much support in the block universe interpretation of Minkowskian spacetime. Lewis never mentions the block concept by name, but it is clear that he believed in the idea of God being able to see all of reality at once. Lewis believed, therefore, that God knows of a petitionary prayer before it is made; or, even stronger, if God is not a temporal being but rather is eternal and knows time 'all at once,' then God knows the prayer and the event being prayed about 'at the same time.'

Lewis did make it clear that he believed it is a sin to pray for something *known* not to have occurred—for example, to pray for the safety of someone known to have been killed yesterday. As he wrote, "The known event states God's will. It is psychologically impossible to pray for what we know to be unobtainable, and if it were possible, the prayer would sin against the duty of submission to God's known will." Taking a less judgmental position (but essentially agreeing with Lewis) were two philosophers who, writing of the battle of Waterloo, said "for one who knows the outcome of the battle more than a hundred and 50 years ago, [a retroactive petitionary] prayer is pointless and in that sense absurd. But a prayer prayed in ignorance of the outcome of the past event is not pointless in that way." Further, in support of backward causation, they also wrote that "to pray in 1980 that Napoleon lose at Waterloo" is logical because "why should your prayer not be efficacious in bringing about Napoleon's defeat?"[32] Disagreeing, however, was another philosopher who bluntly declared "A prayer for something to have happened is simply an absurdity, regardless of the utterer's knowledge or ignorance of how things went."[33]

[32]E. Stump and N. Kretzmann, "Eternity," *Journal of Philosophy*, August 1981, pp. 429–458.

[33]P. Geach, *God and the Soul*, Routledge & Kegan Paul 1969.

There have been all sorts of opinions expressed through the ages in reaction to the idea of affecting the past via retroactive petitionary prayers,[34] and on the role of backward causation. The British philosopher Michael Dummett (1925–2011), in particular, discussed Lewis' concept of such prayers with great sympathy,[35] and backward causation allows one to both explain them as well as retaining free will. That is, it is not God's foreknowledge that causes our later actions (forcing our behavior and so turning us into automatons), but rather it is our later *freely-chosen* actions that causes God's foreknowledge! While such theological speculations are interesting, in the end they are simply positions of faith, about which mathematical physics has nothing to say.

Eventually, of course, others besides philosophers and theologians began to ponder the questions raised by 'changing the past.' In a January 1963 personal letter to the editor of *The Magazine of Fantasy and Science Fiction*, Robert Heinlein wrote[36] "Mark Twain invented the time-travel story; 6 years later H. G. Wells perfected it *and its paradoxes* [my emphasis]. Between them they left little for latecomers to do." How a man as widely read as was Heinlein, who had authored some of the best short time travel stories ever written, could have written such an erroneous sentence is a mystery to me. *A Connecticut Yankee in King Arthur's Court* and *The Time Machine*, certainly both works of genius, are *not* pioneers in paradox. And Heinlein's own contributions are proof enough that there was a lot left to do with time travel, well after 1900.

The very first story to be written that even hints at the particular time travel paradox of changing the past seems to be by the Unitarian minister Edward Everett Hale (1822–1909), best known today as the author of the 1863 story "The Man Without a Country." Hale wrote "Hands Off" in 1881, and published it anonymously in *Harper's New Monthly Magazine* with the express purpose of stirring up some theological debate (which apparently it didn't). He certainly had no idea that he would come to be recognized by literary scholars as a pioneer in the yet-to-be invented genre of science fiction.

Hale's story opens with the mysterious words "I was in another stage of existence. I was free from the limits of Time, and in new relations to space." These words are spoken by an unnamed narrator, who seems to have just died, and who finds himself, in his new 'form,' observing "some twenty or thirty thousand solar systems" while in the company of "a Mentor [probably an angel] so loving and patient." Under the guidance of this Mentor, in an attempt to 'improve' history, the narrator alters the Biblical account of Joseph and his imprisonment in Egypt. At first, subsequent history *is* better, but then humanity

[34]A summary of those opinions can be found in G. Brown, "Praying About the Past," *Philosophical Quarterly*, January 1985, pp. 83–86. Debate continues on the retroactive prayer into the 21st century: see, for example, K. Timpe, "Prayers for the Past," September 2005, pp. 305–322, and T. J. Mawson, "Praying for Known Outcomes," March 2007, pp. 71–87, both in *Religious Studies*.

[35]M. Dummett, "Bringing About the Past," *Philosophical Review*, July 1964, pp. 338–359.

[36]Reprinted in the posthumously published *Grumbles from the Grave* (edited by Heinlein's widow, Virginia Heinlein), Del Rey 1990.

sinks into irreversible depravity. In the end the narrator watches the last handful of humans kill each other in a particularly symbolic place for the Christian world: "The last of these human brutes all lay stark dead on the one side and on the other side of the grim rock of Calvary!" There would be no Crucifixion and Resurrection for the salvation of humankind, which naturally greatly disturbs the narrator. But the Mentor calms him, saying "Do not be disturbed, you have done nothing." It has, you see, just been an experimental world, an alternate Universe, and the narrator has learned the lesson of "Hands Off" the past.

Hale's story is a better Sunday sermon than it is a change-the-past time travel tale, and the device of experimenting on a not-really-real Earth is disappointing from a modern science fiction point of view. But Hale's story almost certainly did have an immediate (if indirect) impact. There is no absolute proof, but with its appearance in a national magazine, it seems quite likely that "Hands Off" was read by Edward Page Mitchell (1852–1927), an editor on a daily New York newspaper, the *Sun*. I write that because, just 6 months after Hale's story appeared, the *Sun*, in its issue of September 18, 1881, printed Mitchell's "The Clock That Went Backward." That tale, published anonymously, used a machine (the clock) for time travel,[37] as well as incorporated the idea of time travel involving paradoxes. The story predates Wells' *Time Machine* by 14 years, and Wells' novel did not include a paradoxical element.[38]

There are, however, two *hints* at paradox in Wells' novel. In the opening, during the dinner party at which the Time Traveller tries to convince his friends of the possibility of a time machine, one of them observes that "It would be remarkably convenient for the historian. One might travel back and verify the accepted account of the Battle of Hastings, for instance." To that another guest replies, "Don't you think you would attract attention? Our ancestors had no great tolerance for anachronisms." The second hint occurs when the incredulous Editor, astonished at the disheveled appearance of the Time Traveller upon his return from the future, wonders "What *was* this time traveling? A man couldn't cover himself with dust by rolling in a paradox, could he?"

What might happen if time travelers *could* change the past? This question is nicely illustrated in one novel[39] where a time traveler finds himself stranded in the London of 1810. Despite his predicament, he takes solace with "I could invent things—the light bulb, the internal combustion engine, . . ., flush toilets . . . " But then he thinks better of doing any of that: "no, better not to do anything to change

[37]See Jan Pinkerton, "Backward Time Travel, Alternate Universes, and Edward Everett Hale," *Extrapolation*, Summer 1979, pp. 168–175. The time machine in Mitchell's story is more fantasy than anything else. It is simply stated that if the clock runs backward, then it travels backward in time.

[38]Wells' failure to use paradox in his famous novel surprises most modern readers and, in fact, one of the first reviewers specifically criticized him for this lapse. See the 1895 review of *The Time Machine* that appeared in *Pall Mall Magazine*, by Israel Zangwill, reprinted in Parrinder's book (note 1 in the Introduction).

[39]T. Powers, *The Anubis Gates*, Ace 1983, a work with equal shares of physics and magic.

the course of recorded history—such tampering might cancel the trip I got here by, or even the circumstances under which my mother and father met. I'll have to be careful."

This is really just a more recent treatment of the change-the-past paradox that was already well established in early science fiction. In a story[40] published a half-century before, we find the paradox explicitly stated, along with a possible solution that is similar to the kind of explanations that have appeared in the philosophical literature[41]:

> "Suppose you landed in your own past?," queried Eric."
> Dow smiled.
> "The eternal question," he said. "The inevitable objection to the very idea of time travel. Well, you never did, did you? You know it never happened!"

But, suppose you *could* land in your own past. What then?

One famous story[42] that considered this question *embraced* the idea of changing the past. In it a client on a dinosaur hunting safari fails to follow the instructions of his guide to do *nothing* in the past except shoot a dinosaur that is about to dies for "other reasons" anyway—alas, he accidently kills a butterfly. This results in enormous changes in history, as indicated by the 'before' and 'after' versions of the time machine company's ad:

> **before**
> TIME SAFARI, INC.
> SAFARIS TO ANY YEAR IN THE PAST.
> YOU NAME THE ANIMAL.
> WE TAKE YOU THERE.
> YOU SHOOT IT.
> **after**
> TYME SEFARI INC.
> SEFARIS TU ANY YEER EN THE PAST.
> YU NAIM THE ANIMALL.
> WE TAEK YU THAIR.
> YU SHOOT ITT.

Bradbury describes the death of the butterfly as having started the knocking "down [of] a line of small dominoes and then big dominoes and then gigantic dominoes, all down the years across Time." This is, of course, a somewhat unconvincing argument. After all, previous dinosaurs, when shot, must have fallen to the ground and flattened a lot of butterflies! With such threats for every decision, no matter how seemingly innocent, hanging over the head of a time traveler, it

[40] C. L. Moore, "Tryst in Time," *Astounding Stories*, December 1936.

[41] See, for example, P. J. Riggs, "The Principal Paradox of Time Travel," *Ratio*, April 1997, pp. 48–64. The 'principal paradox' is that time travel is inherently contradictory because it permits the possibility of traveling to an earlier time to prevent the trip. The grandfather paradox is a special case of this. For more discussion, see T. Chambers, "Time Travel: How Not to Defuse the Principal Paradox," *Ratio*, September 1999, pp. 296–301.

[42] R. Bradbury, "A Sound of Thunder," *Collier's*, June 1952.

would take a brave soul to do much more, while in the past, than just stand still and breathe.

Equally grim is the tale[43] that takes a different view by denying the past can be changed. There we read of a doomed hero who journeys back to 1865 to save Lincoln from Booth, but his "time-distorter" is quickly taken away from him by suspicious guards. Its internal workings tick, you see, and they think he is an assassin with a clock bomb. They destroy it, haul him away to his fate, and Lincoln goes on to meet his. In the same spirit (but even more shocking) is the result of a time traveler's intentional tampering with the past in David Gerrold's 1973 novel *The Man Who Folded Himself*. That traveler experiments with "making things different" and, in his words, "Once I created a world where Jesus Christ . . . went out into the desert to fast and never came back. The twentieth century I returned to was—different. Alien."

With such a stupendous power to alter reality, assuming the past *can* be changed, perhaps one might imagine prospective time travelers to the past being required to first file Historical Impact Statements![44] Not all would receive permission. In one classic tale,[45] for example, we read of a time traveler who takes a rifle and 5000 rounds of explosive bullets back to Golgotha. His intention—to be history's first Rambo by picking off any Roman soldier who gets within a hundred yards of Jesus! As outrageous as this concept is (but who among those now reading this won't admit to at least a momentary thrill at the idea and, perhaps, even a secret willingness to do it themselves, if they could), it isn't the story's peak. That comes when the reader is reminded that it was Christ's *desire* to die on the Cross, that he *had* to die for our sins; to prevent that from happening would change all of history for the last 2000 years. What, then, should the time traveler's colleagues do when they discover his plan? Should they stop him or not? What might happen if they do interfere? Of course, if the time traveler is 'now' in the past, isn't it already 'too late' to stop him? Oh, the conundrums of time travel and changing the past!

The classic change-the-past paradox is, of course, the grandfather paradox. A famous story[46] pushed this paradox to its logical limit to illustrate its supposed dangers. Having traveled to Greece in the fifth century B.C., the traveler suddenly realizes (with just a little exaggeration): "Ninety-five generations back you'd have more grandfathers than there are people on Earth, or stars in the Galaxy! You're kin to everyone . . . You as much as take a poke at anyone, and the odds are you won't even get to be a twinkle in your daddy's eye."

[43]R. Silverberg, "The Assassin," *Imaginative Tales*, July 1957.

[44]See, for example, the novel by C. L. Harness, *Krono*, Franklin Watts 1988.

[45]A. Porges, "The Rescuer," *Analog Science Fiction*, July 1962.

[46]P. S. Miller, "Status Quondam," *New Tales of Space and Time*, November 1951. This is the Miller I mentioned back in note 15.

Fig. 4.2 Illustrator Jack Binder (1902–1986) was the author of a continuing series called "IF— . . ." in *Thrilling Wonder Stories*. In each issue, the ellipses would be replaced with some phrase such as "the Sun exploded!," "there was another ice age!," or "there was no friction!." The installment shown here (and in Fig. 4.3) appeared in December 1938 and asserted that the past could be changed by a time traveler

Fig. 4.3 (Fig. 4.2 continued). Illustration for "IF—You Were Stranded in Time!" ©1938 by Better Publications, Inc.; Reprinted by permission of the Ackerman Science Fiction Agency, 2495 Glendower Ave., Hollywood, CA 90027 for the Estate

Even earlier than Miller's tale is an equally famous one[47] that illustrates the same point in a graphic way. In A.D. 452 a time traveler shoots and kills one of Attila's Huns (who would have been his great-grandfather many times over); the result is that 50,000 of the Hun's descendants vanish! So dramatic did the readers of this story find the concept that author repeated the idea the very next year.[48] Twenty years later another writer topped these tales by having a time traveler accidently kill the original 'intelligent baboon' in the ancient past, thereby wiping out the entire human species![49]

Science fiction writers have been as puzzled by the grandfather paradox[50] as have been nearly everybody else. As the inventor of the first time machine says in one tale,[51] "I have devised a method [for travel] into the distant past. The paradox is immediately pointed out—suppose [the time traveler] should kill an ancestor or otherwise change history? I do not claim to be able to explain how this apparent paradox is overcome in time travel; all I know is that time travel *is* possible. Undoubtedly, better minds than mine will one day resolve that paradox, but until then we shall continue to utilize time travel, paradox or not."

Some may feel it overly dramatic that the classic time travel paradox has such a murderous form, but that is its historical origin in science fiction (not in either physics or philosophy). We can find the grandfather paradox discussed as if already well-known in a letter to the editor at *Astounding Stories* (January 1933). The author of that letter wrote "Why pick on grandfather? It seems that the only way to prove that time travel is impossible is to cite a case of killing one's own grandfather. This incessant murdering of harmless ancestors must stop. Let's see some wide-awake fan make up some other method of disproving the theory." As we proceed, you'll see just how clever some of those who responded to that writer's plea have been but, even today, as the grandfather paradox stands revealed as a red herring, it is preeminent in most people's imaginations. If a solution to the grandfather paradox puzzle escaped an early science fiction writer, then he would generally just mysteriously mention it and then hasten on to other matters. For example, in one story[52] the following exchange between the stock pulp-fiction characters of a young hero and a brilliant old scientist occurs:

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[47]N. Schachner, "Ancestral Voices," *Astounding Stories*, December 1933.

[48]N. Schachner, "The Time Imposter," *Astounding Stories*, March 1934.

[49]C. Dye, "Time Goes to Now," *Science Fiction Quarterly*, May 1953.

[50]The 'paradox' is that, assuming you do arrive in the past with a working gun, why *can't* you kill your grandfather? After all, you *must* fail in that quest because otherwise you wouldn't be there from the future to even try. But *why* must you fail? It is, of course, not actually necessary to try to kill your grandfather to run into this paradoxical situation—just go back in time to any moment in the past and try to kill yourself! You won't succeed (if the past is unchangeable), but *why not*? (To argue 'because the past is unchangeable' is to beg the question. We need more insight than that.)

[51]M. Reynolds and F. Brown, "Dark Interlude," *Galaxy Science Fiction*, January 1951.

[52]C. South, "The Time Mirror," *Amazing Stories*, December 1942.

> "You mean that time travel really is possible? That men can be transported into the future or the past—?"
>
> The other held up a restraining hand. "Yes. Time travel *is* possible . . ."
>
> "But professor! Think of what you're saying! You're telling me that I could go back and murder my own grandfather. That I could prevent myself from being born—?"
>
> Again the elder man sighed. "I was afraid of this," he said. "I knew you could not understand." He hesitated. Then: "At any rate, take my word for it that time travel is possible. Also, I assure you that there are any number of perfectly sound theoretical and practical reasons why you never could hope to murder your grandparents."

We are, however, not told just what those reasons might be.

Even when all has been said about the impossibility of changing the past, and even when they are finally willing to concede that point, most people still cannot help wondering *why* the time traveler can't kill his grandfather. There the time traveler is, after all, just two feet away from the nasty young codger (I assume he is nasty to make the whole unpleasant business of murder as palatable as possible), with a perfectly functioning and well-oiled revolver in his hand, cocked and loaded with powerful, factory-fresh ammunition that even Dirty Harry would find excessive. What can possibly prevent the time traveler from simply raising his arm and doing the deed? Indeed, the artwork (reproduced at the end of the Introduction) accompanying one 1944 story shows this act in detail, including the smoking gun in the hand of the time traveler who has just taken a shot at grandpop. And if that still leaves open the remote possibility of an aiming error through nervousness, then why can't a suicidal time traveler just wrap his body in factory-fresh dynamite and blow-up granddad—along with himself and everything else within a hundred feet?

I'll argue in this book that killing your grandfather in the past, before he sets *you* in motion, is *logically* impossible. The laws of physics will then faithfully do their duty. No one will ever find an unfinished note in the empty laboratory of a missing traveler who, skeptical of the grandfather paradox, has written "To prove the falsity of the grandfather paradox, I will take my time machine back 50 years and kill my grandf. . .." Nor will any time traveler have to be concerned about the twist in one tale, which opens with the inventor of a time machine is showing the gadget to three friends. One of them later steals the machine to go back 60 years to kill his grandfather—and the story closes with a *near* repeat of the opening, with the inventor showing the gadget to *two* friends.[53]

Invoking logic in this way, in the context of time travel to the past, was discussed in the philosophical literature nearly half a century ago: "If we assume that it is impossible for [a time traveler to kill his younger self], some people are inclined to ask such questions as this: 'But how can the laws of logic prevent him from killing his younger self? Do they cause his finger to slip on the trigger or the bullet to fly apart in mid-air?' The implication of such questions is that the laws of logic cannot prevent such actions. But such questions are like asking: 'How do the laws of logic

[53]F. Brown, "First Time Machine," *Honeymoon in Hell*, Bantam 1958.

prevent the geometer from trisecting the angle or squaring the circle? Do they, for example, cause his ruler to slip as a crucial moment every time he tries it?'"[54].

A similar point was made later by another philosopher: "Surely it is not an impairment of 'freedom of action' . . . that, e.g., you cannot push another person harder than he/she pushes you. Just as one would explain this is the case by reference to Newton's third law ('to every action there is an equal and opposite reaction'), one could explain the impossibility of [causing a paradox] by reference to the laws which imply such a impossibility. If this explanation is taken to be unsatisfactory, it would seem that one is saddled with a general problem concerning the reconciliation of physics and 'freedom,' and not with a specific argument against [paradoxes]."[55]

The grandfather paradox unquestionably nags at all students of time travel. As a character in one story declares, "The resolution of [the grandfather paradox] is the key to time,"[56] and some incorrectly believe it remains unresolved.[57] The paradox *is* undeniably troublesome: as one philosopher put it, the apparent possibility of a time traveler being able to do away with both his grandfather and himself gives "rise to such puzzles that we are forced to question its [time travel's] intelligibility."[58] In the next section we'll explore how to answer this concern.

4.3 Changing Versus Affecting the Past

> "The past—it's pretty damn solid, Phil. It's a little like a compost pile—fairly soft near the surface but packed hard further down, with all that Time piled on top of it."[59]
>
> —one 'explanation,' perhaps, for the unchangeability of the past

The common belief today, among physicists and philosophers alike, is that given any consistent description of reality it is simply impossible for a time traveler to kill himself as a baby. As one philosopher put it, "Autoinfanticide is *metaphysically impossible* [my emphasis]. This metaphysical impossibility is philosophically intriguing because unlike most impossible events, we can vividly picture how it might look. Time travel itself seems possible, and for those who arrive in the past

[54]J. W. Meiland, "A Two-Dimensional Passage Model of Time for Time Travel," *Philosophical Studies*, November 1974, pp. 153–173. Science fiction had already considered time travel suicide in, for example, K. Neville, "Mission," *Fantasy and Science Fiction*, April 1953.

[55]F. Arntzenius, "Causal Paradoxes in Special Relativity," *British Journal for the Philosophy of Science*, June 1990, pp. 223–243.

[56]P. Worth, "Typewriter from the Future," *Amazing Stories*," February 1950. See also note 106 in Chap. 1.

[57]For example, in J. H. Schmidt, "Newcomb's Paradox Realized with Backward Causation," *British Journal for the Philosophy of Science*, March 1998, pp. 67–87, we read that "there are as yet no generally accepted solutions" to the grandfather paradox.

[58]S. Gorovitz, "Leaving the Past Alone," *Philosophical Review*, July 1964, pp. 360–371.

[59]F. M. Busby, "A Gun for Grandfather," *Future Science Fiction*, Fall 1957.

with proper equipment and training, the actual infanticide should not be difficult."[60] And so the grandfather paradox lives on, bedeviling both physicists and philosophers alike.

Indeed, one physicist described the time travel paradoxes as "the most controversial issue related to time machines."[61] As he argued, "These paradoxes seem to be something inherent to time machines (their main attribute, perhaps), so it is reasonable to assume that if there exists a universal law prohibiting the time machines, it must have something to do with the paradoxes. And on the other hand, be the problem of the paradoxes satisfactorily solved there probably would be no need to look for such a law, the (supposed) paradoxicalness of the time machines being traditionally the main objection against them."

One of the persistent stumbling blocks to removing the confusion of the paradoxes is a failure to distinguish between *affecting* and *changing* the past. One philosopher wrote this, in a somewhat bungled attempt to explain what is meant by affecting the past: "Nothing anyone can do now can make it not have rained yesterday"[62] if, in fact, it *did* rain yesterday. This is correct, but it is *not* what is meant by *affecting* the past. Rather, if the reason it *did* rain yesterday is because a time traveler from the future seeded the clouds, then that time traveler affected the past. Making it not to have rained yesterday would be to *change* the past.

A classic[63] by Isaac Asimov illustrates what is meant by a time traveler affecting the past. An idealistic physics professor, convinced that the world's political problems are the result of the comparative newness of scientific thought and tradition, tries to change the past (and thus the present) by sending a Greek translation of a modern chemistry text back 2000 years to the Hellenic days of Leucippus, Lucretius, and Democritus. He dies in the attempt but succeeds in the transmission. When a government investigator—called in because the professor drained an entire nuclear power reactor to energize his time machine!—discovers that the transmission takes a day to travel back a hundred years (a little gimmick with no foundation in physics, but simply something Asimov needed for the story), he fears 'our' world will vanish in 20 days, to be replaced by a 'new' one. In the end, however, he learns you can't change the past. As one of the late professor's colleagues tells the investigator, "While you are right that any change in the course of past events, however trifling, would have incalculable consequences . . . I must point out that are nevertheless wrong in your final conclusion. *Because THIS is the world in which the Greek chemistry text WAS sent back*."

[60]David Horacek, "Time Travel in Indeterministic Worlds," *The Monist*, July 2005, pp. 423–436.

[61]S. Krasnikov, "Time Travel Paradox," *Physical Review D*, February 14, 2002, pp. 064013–1 to -8.

[62]R. G. Swinburne, "Affecting the Past," *Philosophical Quarterly*, October 1966, pp. 341–347.

[63]"The Red Queen's Race," *Astounding Science Fiction*, January 1949.

Another good illustration from science fiction of affecting the past can be found years before Asimov's. In that story,[64] a time traveler leaves the Chicago of 1942 for the year 3000. Much later, in the year 2564, another time traveler interested in history journeys back to 2253 in an attempt to learn the cause of the great Chicago explosion of that year. The explosion was centered on the site of an ancient laboratory once used by a scientist who mysteriously vanished in 1942. The second time traveler begins his trip into the past on the same spot, with plans to go back to the day before the explosion. At the story's end, we learn that the disaster was the result of the two time travelers colliding as both 'passed through' 2253. The backward traveling historian, therefore, by pushing a button in 2564, is the cause of an event that happened 311 years earlier.[65]

To give a science fiction example of changing the past, it would be hard to do better than with a story that appeared a few years after Asimov's The central character is a researcher in time travel who has concluded that what is wrong with the world can be traced back to the scientific method getting off to a late start (this story was almost surely written as a result of Asimov's tale!): the time traveler thinks he can correct matters by visiting 340 B.C. and educating Aristotle on the proper scientific attitude. (Aristotle believed that observing the world was inferior to pure thinking about how the things, in his opinion, *ought* to work.) This the time traveler does, with utterly disastrous consequences. He returns to the present to find a scientifically retarded world that makes him a slave. In his cell he writes on a wall the bitter lesson he has learned too late: "Leave Well Enough Alone."[66]

It is the fear of time travelers from the future attempting to alter the past that has led some philosophers (and not just a few physicists) to assert that time travel is impossible, because it would mean what they feel to be impossible might happen: changing the past. One philosopher, however, argued long ago that such a worry is unwarranted. As he wrote at the end of an essay (a polemic *against* the concept of four-dimensional spacetime, and so *against* the idea of time travel), "Squandering vast sums on foolish enterprises is an everyday occurrence. [For example], will the U.S. time explorer get back and eliminate Lenin before his Russian rival gets back even earlier and eliminates George Washington? . . . If such spectacular folly once gets under way because governments have been convinced of some nonsensical theory, a logician will not . . . lose any sleep about who is going to succeed."[67]

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[64]O. Saari, "The Time Bender," *Astounding Stories*, August 1937.

[65]This story describes something a bit more than 'simply' affecting the past; it has a *causal loop* in it. The time traveling historian makes his trip *because* of an event in the past that his trip causes. Such paradoxes will be the subject of the next section.

[66]L. Sprague de Camp, "Aristotle and the Gun," *Astounding Science Fiction*, February 1958. Asimov and de Camp were close friends, and their two stories with similar premises are clearly the result of a bit of friendly rivalry.

[67]P. Geach, "Some Problems About Time," in *Studies in the Philosophy of Thought and Action* (P. F. Strawson, editor), Oxford 1968.

And long before that essay (with its correct conclusion reached through faulty reasoning) was penned, we learn the same lesson (in a 1923 tale by the English novelist May Sinclair (1863–1946)) as we follow a woman right into hell after her death; she ends up there because of an immoral life. She then wanders through time, into her past, but finds that she can change nothing. As she is told, "You think the past affects the future. Has it never struck you that the future may affect the past? . . . You *were* what you *were to be*."[68] This last line, from a *non*-science fiction story, is consistent with the modern view held by physicists of time travel. You cannot travel anywhere into the past unless you've already been there, and when you do make the trip you will do what you've already done there. You could not, as does the time traveler in one tale,[69] change the course of history by revealing twentieth-century physics in the eighteenth century. That does not mean you would necessarily be ineffectual during your stay in the past, however (certainly it doesn't mean, as Hugo Gernsback thought, that you'd be *invisible*!) Not being able to change the past is not equivalent to being unable to *influence* or *affect* what happened in the past, and science fiction writers have used this distinction to good effect, as did Asimov (note 63) and de Camp (note 66).

Robert Heinlein was a science fiction writer who clearly understood time travel paradoxes, both what they mean and, at least as important, what they do not mean. In his 1964 cold-war novel *Farnham's Freehold*, for example—the story of a family that is literally blasted twenty-one centuries into the future when their bomb shelter receives a direct hit from a Soviet nuclear warhead—we find following exchange as two of the characters are about to return to their original time via time machine:

> "The way I see it, there are no paradoxes in time travel, there can't be. If we are going to make this jump, then we already did; that's what happened. And if it doesn't work, then it's because it didn't happen."
>
> "But it hasn't happened yet. Therefore, you are saying it didn't happen, so it can't happen. That's what I said."
>
> "No, no! We don't know whether it has already happened or not. If it did, it will. If it didn't, it won't."

Modern philosophers, and many physicists, too, as well, who have examined the concept of time travel in depth, agree with Heinlein's character and, indeed, it is now common practice to invoke the so-called *principle of self-consistency*—generally attributed to the Russian astrophysicist Igor Novikov (see note 117 in Chap. 1) because he and his colleagues did not simply invoke it, but rather were able to *derive* it from the *principle of least action*, a concept held by many to be at

[68]M. Sinclair, "Where Their Fire Is Not Quenched," in *After the Darkness Falls* (B. Karloff, editor), World Publishing 1946.

[69]D. Beason, "Ben Franklin's Laser," *Analog*, December 1990.

the highest level of importance in physics[70]: all that is required, argued Novikov, in *any* physical process (including time travel), is that a *logical* consistency exist between events.[71] In his book *Evolution of the Universe* (originally published in Russian in 1979), Novikov wrote "The closure of time curves does not necessarily imply a violation of causality, since the events along such a closed line may be all 'self-adjusted'—they all affect one another through the closed cycle and follow on another in a self-consistent way." He later repeated that view in one of the first time machine papers in the physics literature.[72]

In fact, despite the attachment of Novikov's name to the principle of self-consistency, it was actually around in physics *decades* earlier; it has been traced back to as far as 1903![73] And at least an intuitive understanding of the principle can be found in the mainstream literature from nearly as long ago. For example, in Lord Dunsany's short 1928 play *The Jest of Hahalaba* (the inspiration for the 1944 film *It Happened Tomorrow*), a man obtains (via supernatural means) a copy of tomorrow's newspaper. In it he reads his own obituary, which so shocks him that he promptly expires—thus explaining the obituary notice.

The principle of self-consistency has been in science fiction long before Novikov, too. An example is the 1941 story "Time Wants a Skeleton" (see note 15). In it one character, after puzzling over a time travel paradox, realizes that "Future and present demanded co-operation, if there was to be a logical future!" And a nice lecture on the principle (that pre-dates by 3 years the dialogue quoted earlier from Heinlein's *Farnham's Freehold*) is given by a character that is particularly interesting because it was published, not in a specialty science fiction magazine catering to an audience with 'genre knowledge' of time travel, but rather in an icon of general American culture.[74]

Not all science fiction writers, however, have understood the requirement for consistency around a loop in time. In one tale, for example, a man meets the

[70]Like just about everything concerning time travel, however, not *all* think this. For example, the great German physicist Max Planck (1858–1947), the 1918 Nobel physics laureate, said (in 1922): "Physics hence is inclined to view the principle of least action more as a formal and accidental curiosity than as a pillar of physical knowledge." Still, he *did* also declare that he thought it unlikely "the dominance of such a simple law could be a mere accident." Quoted from Marc Lange, "Conservation Laws in Scientific Explanations: Constraints or Coincidences," *Philosophy of Science*, July 2011, pp. 333–352.

[71]See A. Carlini, *et al.,* "Time Machines: The Principle of Self-Consistency as a Consequence of the Principle of Minimal Action," October 1995, pp. 557–580, and "Time Machines and the Principle of Self-Consistency as a Consequence of the Principle of Stationary Action (II): The Cauchy Problem for a Self-Interacting Relativistic Particle," October 1996, pp. 445–479, both in *International Journal of Modern Physics D*.

[72]I. D. Novikov, "An Analysis of the Operation of a Time Machine," *Soviet Physics JETP*, March 1989, pp. 439–443.

[73]R. D. Driver, "Can the Future Influence the Present?" *Physical Review D*, February 15, 1979, pp. 1098–1107.

[74]R. F. Young, "The Dandelion Girl," *The Saturday Evening Post*, April 1, 1961. See also note 49 in Chap. 2.

inventor of a time machine and agrees to his request to use it to travel into the future. Once he is in the future, alas, the machine breaks. The man then finds another machine that, though it is too small for him to fit in it, is able to hold a recording that he sends back into the past to himself, to a time *before* he started his forward journey. The message on the recording (which he did not receive the 'first' time) is, of course, *not* to make a deal with the inventor. This advice he follows, and so the principle of self-consistency is violated twice in this story.[75]

An ability to play a role in history is not without some constraints. You can't save Jesus with a rifle (see note 45), or Joan of Arc with a fire extinguisher, or knock-out John Wilkes Booth with a baseball bat outside of Ford's Theatre, or blow-up Hitler with a bomb, and you can't prevent either the Black Death in the London of 1665 or the Great Fire the following year. But it *is* logically possible for a time traveler who has an infected rat sneak into his time machine, or who carelessly discards a match, to be the *cause* of the last two examples. That was the fate, for example, of the time traveling historian from A.D. 2461 who was the cause of the plague in A.D. 562 Rome, as well as of that in England nearly 800 years later.[76]

Michael Moorcock's 1969 novel *Behold the Man* gets the impossibility of changing the past, and the possibility of affecting it, right. When a disturbed man journeys backward in time to ancient Galilee to meet Christ, only to discover that there is no such person, *he* assumes the role and lives out the Biblical accounts up to and including dying on the Cross. He has not changed the past, but he certainly plays an important role in it!

An early science fiction story that got this right, long before the philosophers and physicists thought of it, was the clever tale whose artwork I have reproduced at the end of the Introduction.[77] In that story, a time traveler journeys back from 1943 to 1870 and shoots his then 14-year old grandfather in the head. Leaving his victim lying on the ground with "blood oozing all over the youth's forehead," the would-be killer returns to 1943. Once back, however, he finds himself in a strange place where he learns from two men that the Germans destroyed New York in 1920 with poison gas! Suddenly realizing that the death of his grandfather has apparently changed history (a curious oversight for anyone smart enough to invent a time machine and then to use it to force the 'grandfather paradox'), he decides he'd rather be dead than be cut off for all time from the world he remembers. So, he shoots himself dead. Then we learn that the two men he encountered are actually inmates in an asylum who like to make-up stories for unsuspecting strangers. We also learn that the time traveler's grandfather's photographs always did show him with a "white, furrowed scar on his forehead that might have been caused by a glancing bullet."

[75]R. Wilson, "The Message," *Astounding Stories*, March 1942.

[76]G. C. Edmondson, "The Misfit," *Fantasy and Science Fiction*, February 1959.

[77]M. Weisinger, "Thompson's Time Traveling Theory,' *Amazing Stories*, March 1944.

Fig. 4.4 The inventor of a time machine about to commit autoinfanticide in the past (the youngster holding the teddy bear is a younger version of the time traveler). Illustration reproduced by the kind permission of Frank Arntzenius (Professor of Philosophy at Oxford University), from his paper "Time Travel: Double Your Fun," *Philosophy Compass*, November 2006, pp. 599–616

Well, okay, you might say at this point, 'I'm convinced you can't change the past, but let's get back to the autoinfanticide (grandfather) paradox. So *why can't* a time traveler kill his baby-self in the past?' A possible answer, one now generally accepted by philosophers and physicists alike, appeared first in science fiction. In a tale[78] that appeared just the year after Gödel's 1949 discovery of time travel in general relativity, we find a character saying "The answer is quite simple. When the man goes back in time and kills his grandfather, and returns to his own time again, he finds to his surprise that he made a mistake. It was not his grandfather at all! And no matter how many times he goes back and kills his grandfather . . . he *always* [my emphasis] finds he made a mistake." Or, perhaps, some noise distracts him as his finger tightens on the trigger, or the grenade he tosses at granddad is a dud, or a gust of wind deflects the arrow, or (most ludicrous of all) he simply slips on a discarded banana peel!

Okay, that works for *that* time traveler. But suppose, someone objects, that we arrange to have a *lot* of time travelers go back in time, each with murder in his heart for his grandfather. Then, as one philosopher has observed, "Since [killing one's grandfather in the distant past] is impossible, each assassin fails. Some change their minds, others slip on banana peels, yet others kill the wrong target, and so on. But there is something odd about the idea that such coincidences are guaranteed to happen, again and again!"[79]

Early science fiction avoided invoking banana peels by providing an even more extreme 'explanation' for the failures: the time police, who are charged with foiling would-be grandfather killers. (See, for example, the many stories by Poul Anderson (1926–2001) of the 'Time Patrol.') These time commandos are imagined to roam the corridors of time, disrupting the attempts of all those who would change

[78]"Typewriter from the Future": see note 106 in Chap. 1.

[79]Theodore Sider, "Time Travel, Coincidences, and Counterfactuals," *Philosophical Studies*, August 2002, pp. 115–138.

recorded history. Stories of these temporal cops are simply westerns, mysteries, police procedurals, or some other similar type of specialty genre story wearing thin camouflage. This story device, whose main purpose is to allow both time travel and free will,[80] has been correctly called "boring" by at least one philosopher (see note 5 in the Introduction), an evaluation shared by modern philosophers, physicists, and (I think) even most modern science fiction writers.

So, we seem to be back to banana peels to save grandfather—but it *is* difficult to deny that vast hordes of murderous grandsons *do* appear to require an unlimited number of strategically placed banana peels, strewn all about the past, to trip-up every one of those potential assassins. This problem, of repeated, improbable coincidences to thwart murderous descendants from the future, was first commented on by the philosopher Paul Horwich in 1975 (see note 19 in the Introduction), and then given a convincing resolution by another philosopher in 1997.[81]

To explain the argument, I'll first use the philosopher's less deadly example of dated objects. "Suppose," he writes, "that every object has written upon it the date on which it will cease to exist . . . perhaps a time traveler travelled into the future, observed the demise of objects and then travelled back [to just after he left for the future] and wrote the dates."[82] If now the time traveler tries to destroy an object *before the date written on it*, then he *will* fail. As the philosopher amusingly described his attempts to destroy a pen 'before its time,' "I take it outside to place under the wheels of a passing train, but there is a train strike that day. The telephone rings just as I am about to drop the pen into a vat of acid. I slip on a banana peel on my way to put the pen in the microwave. My dog eats my designs for a pen grinder. And so on, for as long as you please. However many attempts I make, the attempts in no way require the occurrence of the coincidences that foil them." To put it bluntly, 'Stuff happens.' The pen has the observed date of its destruction on it, and that date is still in the future and so it is simply impossible to destroy it now.

Now, here's the point: the date on the pen is there *because* all those attempts to destroy it before that written date fail. But the presence of the date is *not* the reason for any of the weird (?) occurrences that disrupted all the attempts to destroy the pen, but rather it's *because* all those attempts failed that the date is what it is. This same argument applies to the grandfather paradox. The only time travelers available, today, to go back into the past to *try* to kill their grandfathers, are precisely those time travelers whose grandfathers were *not* killed. Or, to paraphrase our philosopher (note 81), to ask 'why do coincidences always foil the time traveller's

[80]See, for example, David King, "Time Travel and Self-Consistency: Implications for Determinism and the Human Condition," *Ratio*, September 1999, pp. 271–278.

[81]Nicholas J. J. Smith, "Bananas Enough for Time Travel?" *British Journal for the Philosophy of Science*, September 1997, pp. 363–389.

[82]This does present us with the curious (although non-paradoxical) situation that the time traveler will find, upon his appearing in the future, the date he *will write* (in his personal future) when he returns to just after he left on his time trip.

attempts to kill [grandfather in the distant past], is to get things back to front. It is only because the murder attempts fail that the time traveler is alive in the future to even make the *attempt*.'

In other words, not only is the grandfather 'paradox' not a paradox, it isn't even surprising!

4.4 Causal Loop and Bootstrap Paradoxes

> "My dear Collingwood, don't drive yourself crazy trying to resolve the paradoxes of time travel. The [time machines] are gone . . . have a drink."[83]

The grandfather paradox might finally have been put to rest, but there are still plenty of other logical minefields left to be negotiated. One of the more puzzling is that of the closed loop in time, a conundrum nicely illustrated by one philosopher[84] as follows, as an explanation of the journey one time traveler makes to 3000 B.C.: "In our time travel story it just may be that the traveler's interest in going back to ancient Egypt is stimulated by recently discovered documents, found near Cairo, containing the diary of a person claiming to be a time traveler, whereupon our hero, realizing it is himself, immediately begins . . . construction of a rocket in order to 'fulfill his destiny.'" In other words, (1) he builds a time machine and goes back to the past because of the discovered diary, and (2) the diary is discovered because he goes back to the past. Each of these points by itself has logical clarity, but together they form a closed time loop (a *causal loop*) of enormous mystery.

Science fiction was strewn with causal loops long before the philosophers and physicists began to ponder them, however, with (for example) one early tale on a time traveler who journeys a century into the past because she finds an old, yellowed newspaper story describing her arrival.[85] But this tale wasn't the first to use a causal loop, as we can find one of the first sophisticated treatments of this device in a story that appeared even earlier (in the same publication).[86] A time traveler in 1930, about to start his journey into the future in an airplane/time machine, wonders at the last moment if he should really go—then he sees himself returning and thus *knows* he will successfully make the trip.

As he later tells a friend, "That decided me . . . Paradoxical? I should say so! I had seen myself return from my time-trip *before* I started it [just like Marty McFly in the original *Back to the Future* film]; had I *not* seen that return, I would *not* have

[83]A science fiction suggestion that in certain situations (particularly causal loops), might actually be good advice! From L. Sprague de Camp's "The Best-Laid Scheme," *Astounding Science Fiction*, February 1941.

[84]L. Dwyer, "Time Travel and Some Alleged Logical Asymmetries Between Past and Future," *Canadian Journal of Philosophy*, March 1978, pp. 15–38.

[85]P. Bolton, "The Time Hoaxes," *Amazing Stories*, August 1931.

[86]F. J. Bridge, "Via the Time Accelerator," *Amazing Stories*, January 1931.

commenced that strange journey, and so could *not* have returned in order to induce me to decide that I *would* make the journey!" And later, when he finds himself in a dangerous situation in the future, he draws hope from that initial experience: "I *would* escape ... It was so decreed. Had I not, with my own eyes, seen myself appear out of the fourth dimension back there in the Twentieth Century, and glide down to my landing-field? Surely, then, I *was* destined to return to my own age safe and sound."

Even more dramatic is the second, internal time loop that ends the story. When the time traveler arrives in a ruined city in the year A.D. 1,001,930 he is greeted, *by name*, by an old man who says he (the old man) is the Last Man alive. He knew the time traveler was coming because an ancient history book had said the Last Man had, in fact, appeared in the year A.D. 502,101 in the very time machine out of which the time traveler has just stepped. The time traveler is so startled by all this (and who could blame him!?) that he decides to mull over what he has been told until the next day. As he wakes up in the morning, he is just in time to watch the Last Man depart for 502,101. Stranded in the future, the time traveler wanders the empty city in despair until he chances upon a museum. And in the museum, sealed in a glass case, is his time machine (!)—it has been there for half a million years, since the end of the Last Man's journey. And so the time traveler is saved; he merely adds some oil to the still-functional engine (if you can accept time travel, I suppose this is no more difficult to believe) and returns to 1930—just as he saw himself do at the beginning of the story.

Since Bridge's astonishing story, the idea of a causal loop in time has been used many times in science fiction. Here's a representative sampling:

(1) Time travelers arrive in the forty-sixth century, only to find that they are expected. Their host tells them why: "I have been awaiting your arrival from the past. I have a written record of your coming. You see, I have a time machine myself ... With my time machine, I recently went a year into the future and read the written account I had made, or will make after you leave. Then I came back, awaiting your arrival."[87]
(2) Armed travelers return to the Triassic age to uncover the secrets of a mysterious artifact that has been recently discovered; at the end we learn it is the remains of their own automatic rifle[88];
(3) A time traveler journeys back 500 years, where he suffers an accident that results in his being "agelessly stuck" in his time-traveling gadget until he is freed—by himself, 500 years later. He then gets into the gadget to journey back 500 years[89];
(4) The world's time suddenly loses 5 min, an astonishing event that comes to be called "the time drop." After 2 weeks of investigation, a reporter traces this

[87]E. Binder, "The Time Cheaters," *Thrilling Wonder Stories*, March 1940.
[88]J. Blish, "Weapon Out of Time," *Science Fiction Quarterly*, Spring 1941.
[89]A. B. Chandler, "The Tides of Time," *Fantastic Adventures*, June 1948.

event to a reclusive (but brilliant, of course) scientist who reveals that he has invented a time machine. The reporter decides to test this claim by using the machine to return to just before the start of the time drop, to observe precisely what caused it—it is, in fact, a malfunction of the machine that is at fault and the reporter finds himself caught in a 2-week long causal loop[90];

(5) A physicist knows something odd lies in his future when he is confronted with a 700 year-old museum copy of a book. The puzzle is how to explain a message penned in ancient, faded ink, in modern English *and in his handwriting*, on the back side of one of the recently unglued endpapers! How, too, to explain his own fingerprints all over the same endpaper? How, indeed, to answer these questions is his problem when he is presented with all of this and is asked, "Have you, by any chance, been visiting the thirteenth century?" At the end of the story the time loop is closed when the physicist finds himself writing that same message on a *brand new* copy of the book that has been sent from the past (and that he returns to the thirteenth century via a "time portal")[91];

(6) A time traveler from 1964 is secretly observed by one of the 'locals' when he arrives in 1683. The oddness of the sudden appearance of the time traveler and his machine ("It were a kind of Dazzle") makes the local think it might be that the stranger is the man who stole some items from his home the previous night, the same night he had an "ill Dream." Stealing the time machine after the time traveler has gone exploring, the local travels to 1964 where he learns how valuable antiques are. So back he goes to 1683, to the night before the time machine first appeared, to get some 'antiques' from his house. And thus he realizes who the thief *really* was. Before leaving again for the future, he enters his own bedroom to see himself asleep and then to awaken. And so he also learns the cause of what he called his "ill Dream."[92];

(7) A movie production crew goes into the past to make a film. At the end of the story it becomes clear that their presence in the past was not an insignificant event, as one character realizes after seeing the evidence of how they affected (*not* changed!) the past: "If this is true, then the only reason that the Vikings settled in Vinland is because we decided to make a motion picture showing how the Vikings settled in Vinland"[93];

(8) A private college, endowed decades before by a generous but mysterious benefactor, experiments with a time machine. Suddenly, one of the college's graduates is accidently sent a hundred years into the past—where she becomes the benefactor. The college comes into existence, therefore, because it will exist[94];

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[90]W. Sheldon, "A Bit of Forever," *Super Science Stories*, July 1950.

[91]M. Leinster, "The Gadget Had a Ghost," *Thrilling Wonder Stories*, June 1952.

[92]D. I. Massor, "A Two-Timer," *New Worlds SF*, February 1966.

[93]H. Harrison, *The Technicolor Time Machine*, Doubleday 1967.

[94]C. Simak, "The Birch Clump Cylinder," *Stellar 1* (J. del Rey, editor), Ballantine 1974.

(9) A man gets the money to support his experiments in time travel by selling a large collection of old, rare comic books he has discovered in his late mother's attic. Later we learn how the comic books came to be there; after his experiments are successful, the inventor travels back into the distant past, buys the *newly* published comic books right off newsstands, and stores them in his mother's attic where, decades later, he knows his younger self will grow up and then find them (and thus get the money to make it all happen)[95];

(10) In the 1980 film *Somewhere in Time* (based on the 1975 novel *Bid Time Return* by Richard Matheson), a man in the present is visited by a mysterious old woman who gives him a watch. Later, he travels back to 1912 where he meets a girl to whom he gives the watch. He then returns to the present, and she lives out her life from 1912 on, until she too reaches the present, where we discover she is the (now old) woman who gives the man the watch.

Once philosophers discovered the bizarre nature of causal loops, they quickly proved themselves to be the equal of science fiction writers in imagining strange doings. Here's one example of that, one which any writer would be proud of: "If James cannot decide whether to marry Alice or Jane, he simply travels to the future and learns that he is to choose Alice; he then chooses her for this reason. One wants to object that the decision to marry Alice was never really made at all! But this is not true; the decision was made—as a result of the knowledge that this was the decision . . . It is not the case that the prospective bridegroom could visit the future and compare the results of marrying Alice with those of marrying Jane in order to decide between the alternatives. For if he visits the future, he will learn only that in fact he chose Alice, for better or for worse!"[96]

This same philosopher elaborated on his view of causal loops in a later paper, where he wrote "What if time travel becomes commonplace, so that we must deal with a constant stress of time travelers returning from the future to reveal what they have seen?"[97] His answer is "I think it is clear that the . . . causal loop we have been discussing would become very common, and would play a prominent role in human affairs." He denied, however, that such causal loops would mean the loss of free will. As he explained his position, knowledge of a rigged roulette will not prevent you from putting your money on the table *if you want to*, but perhaps that

[95]D. Knight, "The Man Who Went Back," *Amazing Stories*, November 1985. This same idea was used earlier in the story "Compounded Interest," (*Magazine of Fantasy and Science Fiction*, August 1956) by Mack Reynolds, in which the inventor of a time machine has the money to build his gadget because he uses it to go back into the past where he deposits a small sum, which then grows (through the 'magic' of compound interest) into the cash he needs to fund his time machine.

[96]G. Fulmer, "Understanding Time Travel," *Southwestern Journal of Philosophy*, Spring 1980, pp. 151–156.

[97]G. Fulmer, "Time Travel, Determinism, and Fatalism," *Philosophical Speculations in Science Fiction and Fantasy*, Spring 1981, pp. 41–48.

knowledge will influence your *freely* made decision making. Whether you learn that the roulette wheel is rigged by traditional means (perhaps you see magnets being installed under the table) or by means of time travel is irrelevant—even with this knowledge, you act freely. Other philosophers have not been so generous. One disliked causal loops so much, for example, that while he believed them to be conceptually possible, he also thought them to have "a queer smell,"[98] so much so that he simply preferred to avoid thinking about them!

One concern that many philosophers and physicists have had with closed loops in time is that they fear that would mean being trapped on an endless cycle of repeating events. For example, one philosopher long ago wrote

> "There is nothing contradictory in imagining causal chains that are closed, though the existence of such chains would lead to rather unfamiliar experiences. For instance, it might then happen that a person would meet his own former self and have a conversation with him, thus closing a causal line by the use of sound waves. When this occurs the first time he would be the younger ego, and when the same occurrence takes place a second time he would be the older ego. Perhaps the older ego would find it difficult to convince the younger one of their identity; but the older ego would recall an identical experience long ago. And when the younger ego has become old and experiences such an encounter a second time, he is on the other side and tries to convince some 'third' ego of their physical identity. Such a situation appears paradoxical to us; but there is nothing illogical in it."[99]

What has been (erroneously) described with that is the beginning of an endless succession of encounters around a closed causal loop. There is, however, just *one* encounter on such a loop in spacetime (but, of course, the mind of the time traveler experiences the encounter twice), subject to the constraint of self-consistency. Some physicists, too, have been so concerned about multiple trips around closed timelike curves (CTCs), because they think such trips would allow the past to be changed, that they have felt it necessary to specifically forbid such a possibility. As one paper put it, "That the principle of self-consistency is not totally tautological becomes clear when one considers the following alternative: The laws of physics might permit CTCs; and when CTCs occur, they might trigger new kinds of local physics which we have not previously met. For example, a quantum-mechanical system, propagating around CTCs, might return to where it started with values for its wave function that are inconsistent with the initial values; and it might then continue propagating and return once again with a third set of values, then a fourth, then a fifth ... The principle of self-consistency by fiat forbids changing the past."[100] This last statement is, of course, in agreement with the position I have taken in this book, a position that has generally been accepted by most philosophers for several decades now, but the proponents of the principle of self-consistency

[98] M. MacBeath, "Communication and Time Reversal," *Synthese*, July 1983, pp. 27–46.

[99] H. Reichenbach, *The Direction of Time*, University of California Press 1956, p. 37.

[100] J. L. Friedman et al., "Cauchy Problem in Spacetimes with Closed Timelike Curves," *Physical Review D*, September 15, 1990, pp. 1915–1930. Another physicist, however, has flatly rejected this need for the Principle, calling it redundant: see D. Deutsch, "Quantum Mechanics Near Closed Timelike Lines," *Physical Review D*, November 15, 1991, pp. 3197–3217.

seem to have been driven to it by a fear of the past 'happening again' over and over, as in the 1993 film *Groundhog Day*.

Science fiction writers have stumbled into the error of endless cycling on a closed time loop, too. In one such tale,[101] the inventor of the first time machine travels 500 years into the future where he finds a bronze statue of himself that honors his discovery of time travel. Suddenly injured, fatally, he returns to the present with the statue and then dies. As a memorial, the statue is placed in the very spot where the inventor found (will find) it. As the tale ends, the late inventor's lab assistant wonders to himself what will happen 500 years later: "Suddenly a strange machine will come out of the past and [the inventor] will be here again—although he is dead and has been dead 500 years. [He will take the statue] and go back to the past . . . to die. And once again that maddening cycle will begin, to go on and on forever as long as time spins its threads."

That story illustrates yet another puzzle associated with those causal loops that contain a circulating, physical object. That is, *who made the statue*? We can ask the same question about the watch in the time loop of *Somewhere in Time/Bid Time Return* as, at every instant of its existence, the watch is in the possession of either the man or the woman? So, *when was the watch constructed*?

There have been some science fiction writers who specifically recognized this question, long before either the philosophers or the physicists paid attention to it. In one early tale,[102] for example, we read of a time machine that travels from 1935 to 1925. When the question of the origin of the time machine comes up, we read

> "One time machine, found in 1935 and brought back to 1925—found in 1935 *because* brought back to 1925. That is all."
>
> "But who made it in the first place?—Oh, skip the 'in the first place.'[103] Just plain: who made it?"
>
> "No one. It was never made . . . It is here because it is here."

This same puzzle was addressed in *The Technicolor Time Machine* (note 93), when one character is perplexed over a piece of paper in his wallet with a diagram on it, a piece of paper he got from himself (an *older version* of himself, who traveled into the past to give it to his younger self). In frustration, he asks a friend:

> "Then no one ever *drew* this diagram. It just travels around in this wallet and I hand it to myself. Explain that."
>
> His friend replies:
>
> "There is no need to, it explains itself. The piece of paper consists of a self-sufficient loop in time. No one ever drew it. It exists because it is, which is adequate explanation. If you wish to understand it, I will give you an example. You know that all pieces of paper

[101] S. Mines, "Find the Sculptor," *Thrilling Wonder Stories*, Spring 1946.

[102] R. M. Farley, "The Man Who Met Himself," *Top-Notch Magazine*, August 1935 (*Top-Notch* was an adventure pulp published between 1910 and 1937).

[103] The reason for this line in the story is that earlier the question of "Where did the time machine come from *originally*?" was raised. The answer: "There was never any 'original.' . . . There is no round-and-round circle of events, no repetition. Merely *one* closed cycle." This is, in fact, the modern view of causal loops, expressed in a 1935 (!) science fiction story.

> have two sides—but if you give one end of a strip of paper a 180-degree twist, then join the ends together, the paper becomes a Möbius strip that has only one side. It exists.[104] Saying it doesn't cannot alter the fact. The same is true of your diagram; it exists."
>
> "But—where did it come from?"
>
> "If you must have a source, you may say that it came from the same place that the missing side of the Möbius strip has gone."[105]

The undeniable mystery of causal loops is the reason behind the philosopher I cited earlier (note 98) who thought they have a "queer smell" and so viewed them with much suspicion. He wasn't alone in that feeling, and another philosopher said as much whe he wrote "despite [strong] arguments for the consistency of time travel stories [with causal loops], the impression is apt to remain that something is wrong with them. I think this impression is correct."[106] One story that this philosopher could well have had in mind is a classic,[107] a tale that describes a knife brought from a museum in the future back to the present. It arrives in the present with a flawless blade, but soon thereafter gets a nick in the blade. How, wonders the narrator, can the time loop be completed "again"? I do not find this quite the puzzle that either the author (and perhaps the philosopher) do: it is simply a variation of the grandfather paradox (which has been shown not to be a paradox at all). *If* the knife is found flawless in the future, *then* it was not (will not) be nicked in the past. As written, the story is not logically consistent as it involves changing the past but, *if* one removed the detail of a *nicked* blade, then we *would* have a true (paradoxical) causal loop, with the question the story, itself, asks about the knife: "How was this knife created . . . when its existence has no beginning or end?"

The nicked knife does illustrate a subtle problem that bedevils *any* causal loop containing a physical object. Consider once again the watch in the film *Somewhere in Time*. Assume the watch received by the man in the present is bright and shiny. He then takes it back into the past and gives it to his love. It remains with her after his return to the present until, decades later, she gives it to him—bright and shiny. Why didn't it tarnish? Is there some peculiar anti-tarnish property to a watch in a causal loop? Well, if so, is that anymore odd than a causal loop itself?[108]

None of that, however, provides a means for rejecting time travel *if* one can argue that it is possible to have time travel *without* causal loops. Indeed, Professor Hanley (see note 105) argues that it is possible, and presents what he claims is an

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[104]See note 99 in Chap. 1, and the related discussion there.

[105]One philosopher calls this bit of dialog "unhelpful," while ignoring the fact that it appeared in a science fiction pulp magazine and not a scholarly journal, and was clearly meant to dazzle teenage boys (see note 39 and related discussion in "Some First Words") with the concept of a causal loop, rather than to break new ground in metaphysical thought. See Richard Hanley, "No End in Sight: Causal Loops in Philosophy, Physics and Fiction," *Synthese*, July 2004, pp. 123–152.

[106]G. Nerlich, "Can Time Be Finite?" *Pacific Philosophical Quarterly*, July 1981, pp. 227–239.

[107]P. S. Miller, "As Never Was," *Astounding Science Fiction*, January 1944. This is the same Miller who appears in note 15 (and see note 46, too).

[108]It is *not* sufficient to say that perhaps she polished the watch. Polishing would remove material from the watch, which means she gives him a watch different from the one he gives her in the past.

example of how to do it. Alas, another philosopher convincingly showed that the example is flawed and that Hanley's claim that there is no causal loop in his story "is unjustified."[109] From an entertainment point of view, however, eliminating causal loops is going in the wrong direction, as it is the inclusion of causal loops that gives a feeling of mystery to a good science fiction story.

To finish this section, then, we can do no better than to discuss causal loops that are even *more* bizarre than are those with a physical object; that is, loops that involve time traveling *information*. (Since information doesn't 'tarnish,' however, such a loop avoids that particular puzzle associated with a physical object in a causal loop.) A classic example of such a loop is a mathematician who is visited in his youth by a time traveler from the future (perhaps himself), who gives him the proof of a theorem for which the mathematician is (will be) famous in the future. *Where*, then, did the proof actually come from? In what *mind* was it *created*?[110]

The philosopher David Lewis wrote with particular insight on causal loops, especially ones that involve information transfer, such as a time traveler going back in time to tell his younger self how to build a time machine so that once its constructed he can go back in time and tell himself how to do it.[111] (This was item (3), you'll recall, in Jim Nicholson's 1931 letter to *Science Wonder Stories* magazine, quoted at the end of the first section of this chapter.) As Professor Lewis wrote (see note 5 in the "Introduction"), "But where did the information come from in the first place? Why did the whole affair happen? *There is simply no answer* [my emphasis]. The parts of the loop are explicable, but the whole of it is not. Strange! But not impossible, and not too different from inexplicabilities we are already inured to. Almost everyone agrees that God, or the Big Bang, or the entire infinite past of the Universe, or the decay of a tritium atom, is uncaused and inexplicable. Then if these are possible, why not the inexplicable causal loops that arise in time travel?"

A few years later, another philosopher[112] gave a similar response to a paradox involving a causal loop similar to Lewis', a loop involving a time machine containing a book with instructions on how to make the time machine. The book travels into the past on the machine so it can be read—in order to make the machine.

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[109]Bradley Monton, "Time Travel Without Causal Loops," *The Philosophical Quarterly*, January 2009, pp. 54–67.

[110]Professor Hanley (note 105) says the answer to such questions is "straightforward": the information comes "from itself." I think the issue is rather deeper than that.

[111]See D. Franson, "Package Deal," in *Microcosmic Tales*, Taplinger 1980. The British philosopher J. R. Lucas had a similar scenario in mind when he wrote, in his book *A Treatise on Time and Space* (Methuen 1973, p. 50), "It is very important, not only for reasons of modesty, that I should not be able to use a Time Machine to go into a public library and read my own biography." Robert Heinlein didn't agree with Lucas: in his 1956 novel *The Door Into Summer* the protagonist, an inventor, travels thirty years into the future, where he reads some patent disclosures for inventions that he doesn't remember, even though they are in his name. He then returns to his own time and promptly files the patents!

[112]M. R. Levin, "Swords' Points," *Analysis*, March 1980, pp. 69–70.

In answer to the question "Who wrote the book about building a time machine?" the philosopher says this question is "no different from questions about where *anything* originally came from. We can ask about the origin of the atoms . . . their time line is not neatly presented to us. The atoms either go back endlessly, or if the Universe is finite, they just start. In either case the question of ultimate origin is as unanswerable as the question of the book's origin. What makes us think that when such questions are asked about the loop they are different and *ought* to be answerable is that the entire loop is open to inspection." While the instructions in the book don't tarnish, the book itself of course brings us back to our previous antique watch 'problem.' Suppose the book is brand-new at the start of the trip backward in time. Later, when the machine (and the book) have reached the end of the loop, just before beginning the trip back in time, have the pages turned yellow and brittle? If so, how do we account for the brand-new version? And if not, why not?

An analyst who takes strong exception to these two philosophers is Oxford physicist David Deutsch, who wrote (note 100) "the real problem with closed timelike lines under classical physics is that they could be used to generate knowledge in a way that conflicts with the principles of the philosophy of science, specifically with the evolutionary principle." What Deutsch is referring to is the metaphysical claim, attributed to the philosopher Karl Popper (see note 36 in Chap. 3), that *knowledge comes into existence only by evolutionary, rational processes* and that solutions to problems do not spring fully formed into the universe. One might call this the physics version of the work ethic—the creation of knowledge demands hard work!

Deutsch's idea had actually appeared *decades* earlier in a science fiction tale.[113] Time travel, discovered in the year 2007, is found to have a limited temporal reach into the future of 50 years, a limit due a law passed in 2057 banning time travelers from the past. To try to go past 2057 leads to a prompt arrest of the time traveler and a 'deportation' trip back to his own time. The story eventually explains that the law was passed precisely because of Deutsch's concern. As one character in the story explains, "Suppose [that one could travel more than 50 years ahead], then a time traveler from the past could get [new inventions], carry them back to his own time, and give them to scientists—which[would] cancel all the long period of invention which [produced the inventions]. Which [would] violate causal laws."

More recently, a philosopher has offered a quite interesting response to the Deutsch/Popper assertion. He writes (note 81), of information "appearing out of nowhere," that "These cases are puzzling, but they by no means show that the time travel scenarios in question are impossible or incoherent, *or even improbable*. We think it very improbable that . . . information should come from nowhere—but only because this does not happen very often. It does happen *sometimes*—for instance, when you say something and I mishear you. I think that you said something very

[113] P. Anderson and G. Dickson, "Trespass," *Fantastic Story Quarterly*, Spring 1950.

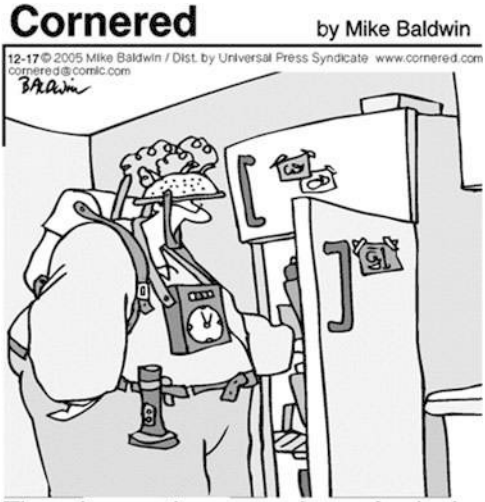

Fig. 4.5 A curious paradox. CORNERED ©2005 Mike Baldwin. Reprinted with permission of UNIVERSAL UCLICK. All rights reserved

profound—something which neither of us would, in fact, ever have thought of. Where does the idea come from? If this sort of thing were to start occurring regularly [as via causal loops], then we would simply accept it without raising an eyebrow."

In the final chapter I'll discuss a dramatic example (due to two Russian physicists) on how an information-creating time loop might be constructed using a wormhole time machine. Such a time loop wouldn't pass muster with Deutsch, of course, and he would consider such a thing as being as objectionable as is creationism, the anti-evolution claim that purports to 'explain' fossils (with measured ages in the millions of years) by simply *declaring* them as having been made by God just a few thousand years ago.[114] Deutsch's position is considered by nearly all scientists today to be correct *for the specific case of creationism*, but the evolutionary principle may be on shakier ground with respect to declaring causal information time loops to be impossible.

While philosophers have struggled with information in a time loop, and most physicists have carefully stepped around the issue, science fiction has had lots of fun with information in causal loops. Here's a sampling of such tales:

(1) A man receives telephone calls from *two* versions of himself, one ten years in the future saying he absolutely must accept an invitation to fly to the Bahamas

[114] *Why* would God do such a thing? Apparently 'just to have some fun with geologists and biologists,' as creationists call such ancient fossils 'sports of nature.'

that he will receive that very day, with the other version calling from tomorrow insisting that the plane will crash. What should he do?[115];

(2) Lovers who are irrevocably separated in time communicate by mail in one tale,[116] while lovers in another story[117] communicate via telephone calls to the ever more distant past (and yet, with the aid of a clever twist at the end, finally meet);

(3) A telephone lineman starts getting telephone calls from himself from 10 days in the future, with the first call telling him how to make the gadget to transmit such calls[118];

(4) A time traveling historian on a visit to A.D. 1528 from A.D. 2211 accidently gives a copy of the predictions of Nostrodamus to the prophet, thus explaining the predictions[119];

(5) A time machine experiment gone wrong allows thirteenth century Roger Bacon to meet twentieth century scientists, an encounter that explains the amazing forecasts in Bacon's *Opus Maius*[120];

Hollywood, too, has had some fun with information causal loops, with the best (in my opinion) example of that being the 1989 movie *Bill & Ted's Excellent Adventure*. In that film (where we learn that even the not very bright can be time travelers), a set of missing keys is necessary for the successful completion of a task. The two time travelers decide that after the task is done, they will go back in time, steal the keys (*that's* why they're missing!), and hide them so they can use them *now*. Where should they hide them? Why, "over there," says one of the boys, pointing at a hiding place—and sure enough, when they go over and look, the keys are there. They agree that once they have finished with the keys, it will be *most* important that they really do put the keys in the hiding place!

All of these examples that I've just given you, however, were *decades* too late to be the first in fiction about information in a time loop; that honor goes to the 1904 novel *The Panchronicon* by the lawyer Harold Steele MacKaye (1866–1928). An Edwardian literary time machine with style, the Panchronicon (literally, a 'machine for all time') swings on a rope tether around a steel post erected at the North Pole. By "cutting the meridians" faster than the sun does, it travels through space and time from 1898 New Hampshire to the London of three centuries earlier.[121] Using

[115] G. Klein, "Party Line," *The Best from the Rest of the World* (D. A. Wolheim, editor), Doubleday 1976 (story originally published in France in 1973).

[116] J. Finney, "The Love Letter," *The Saturday Evening Post*, August 1959.

[117] T. N. Scortia, "When You Hear the Tone," *Galaxy Science Fiction*, January 1971. See also L. Padgett, "Line to Tomorrow," *Astounding Science Fiction*, November 1945.

[118] M. Leinster, "Sam, This Is You," *Galaxy Science Fiction*, May 1955. This story was later broadcast as an episode on the "X-Minus One" radio drama program. See also F. A. Reeds, "Forever Is Not So Long," *Astounding Science Fiction*, May 1942.

[119] L. Del Rey, "Fools' Errand," *Science Fiction Quarterly*, November 1951.

[120] N. Schachner, "Lost in the Dimensions," *Astounding Stories*, November 1937.

[121] 'Time traveling' by crossing time zones is an idea that one can trace at least as far back as to Edgar Allen Poe's 1841 short story "Three Sundays in a Week."

it, a time traveler fan of Shakespeare journeys from 1898 back to the bard, who is suffering from writer's block. There she whispers the magic lines from a play he is stuck on (lines she has memorized for her literary club meetings) into his receptive ear. Does this make Shakespeare a plagiarist? Of himself!?

4.5 Sexual Paradoxes

> "Once time machines exist, no event is low probability if it is needed to make the past consistent."[122]

There are causal loops even stranger than the ones we have already discussed, hard as that may be to believe. These are the sexual paradoxes, first mentioned in 1931 by Nicholson in his letter to Hugo Gernsback. Not only science fiction writers, but philosophers, too, have found these particular paradoxes full of dramatic appeal. For example, as a challenge problem to the readers of a scholarly journal, the British philosopher Jonathan Harrison (1924–2014) posed the following bizarre, indeed astonishing, situation.[123] A young lady, Jocasta Jones, one day finds an ancient deep freezer containing a solidly frozen young man. She thaws him out and learns that his name is Dum, and that he possesses a book that describes how to make both a deep freezer and a time machine. They marry. Soon after they have a baby boy and name him Dee.

Years later, after reading his father's book, Dee makes a time machine. Dee and Dum, taking the book with them, get into the machine and begin a trip into the past. Running out of food during the lengthy journey, Dee kills his father and eats him. Arriving in the past, Dee destroys the time machine, builds a deep freezer (again, using the book), gets into it, and . . . wakes up to find that a young lady, one Jocasta Jones, has thawed him out. When asked his name he replies Dum and shows Jocasta his book; they marry, and . . . .

Harrison concluded this amazing tale with this question for his readers: "Did Jocasta commit a logically possible crime?" That issue is just the *surface* of an ocean of puzzles in this story! Jocasta's crime, of course, is that she has (if unwittingly) committed incest; readers who remember the Greek myth of Oedipus, and who his mother/wife was, will understand why Harrison named his female character as he did. But what of Dee's crime? He has, after all, eaten his father! But perhaps that isn't a crime at all, because Dee and Dum are one in the same, and is it really a crime to eat yourself? According to another philosopher, Murray MacBeath, Harrison's story is "a story so extravagant in its implications that it will be regarded as an effective *reductio ad absurdum* of the one dubious assumption on which the story rests: the possibility of time travel."[124]

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[122]From Robert Forward's 1992 novel *Timemaster*.

[123]J. Harrison, "Jocasta's Crime," *Analysis*, March 1979, p. 65.

[124]M. MacBeath, "Who Was Dr. Who's Father?" *Synthese*, June 1982, pp. 397–430.

This isn't to say that MacBeath was asserting that time travel is impossible. Indeed, he went on to declare that he did believe in the logical possibility of time travel, and his paper is devoted to discovering what thought to be incorrect in Harrison's story. He did that by retelling the story with what he believed are crucial modifications to make it sufficiently less outrageous that it could be taken at least somewhat seriously. In the new version, our hero, thawed out from a deep freezer, is now named Arthur. Arthur is, unfortunately, suffering from total amnesia (this is MacBeath's way of avoiding the psychological trauma of Dee remembering he ate Dum) and so, when asked his full name, he is himself sufficiently puzzled that he replies "Arthur who?" He is finally called (what else?) Arthur Who. And, as you can no doubt guess, his son (who is a genius and gets a PhD at age 14 on a dissertation dealing with the physics of time travel) becomes Dr. Who!

We are then told of a trip back into the past by the two, of the eating of the father (Arthur Who) by the son, of the entering of the deep freezer by Dr. Who, etc. etc. The whole business is quite entertaining and *at least* as complex as Harrison's original story. Just *how* complex is summed up in MacBeath's last, wonderful line: "The Who who was Dr. Who's father was not Dr. Who—that is, not the Dr. Who whose father he was."

MacBeath wasn't the only one that Harrison's story fascinated, and nearly a dozen replies to it were received in addition to MacBeath's. One, in particular, made the thought-provoking observation (see note 112) that not only has Jocasta committed incest but she has done so with a single act of intercourse. As discussed earlier, the events on a causal loop do not happen endlessly but rather only once; thus, Jocasta thaws Dum (Dee) out just once, she marries him just once, and the two consummate their marriage just once. Ordinarily we think it takes two sexual acts to commit incest, the first resulting in the birth of a child, and the second being a parent's union with that child, but this is not so in a causal loop. Time travel *is* an odd business.

Another philosopher replied to Harrison's story with a quite interesting claim, one that had actually been thought to be true for decades—but which today is recognized to be false. The claim was that, irrespective of physics, Harrison's story was biologically flawed and fatally so. As that philosopher wrote, "The biological problem is the following. Dee is the son of Dum and Jocasta. So Dee obtained half his genes from Dum and half from Jocasta. But Dum is diachronically identical with Dee and is therefore genotypically identical with him (that is, himself). That is, Dee is both genotypically identical and distinct from Dum, which is absurd."[125]

That this isn't true was pointed out by a philosopher many years later. In his paper we read this tale: "Suppose Adam travels [far] back in time ... where he meets his mother Betty, mates with her and has a child which is himself. Is this

[125] W. Godfrey-Smith, "Traveling in Time," *Analysis*, March 1980, pp. 72–73. This false claim had already been raised by a physicist (L. S. Schulman, "Tachyon Paradoxes," *American Journal of Physics*, May 1971, pp. 481–484), and even earlier by a science fiction writer (P. Anderson, "Time Patrol," *Magazine of Fantasy and Science Fiction*, May 1955).

possible biologically? Yes ... as follows ... on the grounds that we have total replication of Adam's genome."[126] (The *genome* is the totality of genes taken over all gene sites.) Now, suppose each such site holds two genes and, as Dowe points out, in sexual reproduction the father passes on to his offspring one gene for each gene site, to go with the gene the mother gives to each site. To exactly reproduce himself, then, the time traveling Adam 'simply' has to give his offspring, *at each site*, the gene that he has for that site that did *not* come from Betty. Thus, the offspring—baby Adam—ends up with a genome *precisely identical* to the time traveling Adam. This is, of course, an *extraordinarily unlikely* event, as the human genome has tens of thousands of genes. The probability that each and every site gets the 'right' gene from the time traveling Adam is therefore essentially zero. But it isn't *actually* zero and, as the quotation that opens this section says, a low probability to an event isn't a roadblock to its occurrence if that event is required for consistency.

While certainly instructive, the sexual paradox stories by Harrison and MacBeath are remiss in not indicating that the concepts they are dealing with have long been a staple of science fiction, and that the sexual paradoxes received much critical analysis in that genre long before philosophers (and physicists, too) discovered them. From science fiction, for example, we have a tale of young man who travels backward in time 1250 years, from A.D. 3207 to 1957, to become his own grandfather fifty generations removed.[127] And even that is tame compared to the sexual paradoxes other science fiction writers conjured up before philosophers began to discuss them.

In another story,[128] written decades before Harrison's and MacBeath's papers, we meet a young lady caught up in a mind twisting affair in which the mystery of a causal loop is the least of her troubles. In 1957 a girl is born, and after 20 years of intense competition with her mother (who has an uncanny ability to predict the future), she travels back from 1977 to a few months before her own birth. She becomes pregnant (by a man who she later discovers is her father) and gives birth to a girl. The new mother has, of course, knowledge of all that will happen during the next 20 years, including the fact that she will have an intense competition with her rebellious daughter ....

While writers of stories like these in the early 1950s were there as trailblazers, it is a tale that appeared as the 1950s ended that is today generally acknowledged as the best sexual paradox story ever written.[129] We are given only a hint of what is to come when a character listens to a song called "I'm My Own Grandpaw!" In 1945,

[126]Phil Dowe, "The Coincidences of Time Travel," *Philosophy of Science*, July 2003, pp. 574–589. See also J. Berkovich, "On Chance in Causal Loops," *Mind*, January 2001, pp. 1–23, and P. Dowe, "Causal Loops and Independence of Causal Facts," *Philosophy of Science*, September 2001, pp. 89–97.

[127]R. Dee (this is *not* the 'Dee' of Harrison's story!), "The Poundstone Paradox," *Magazine of Fantasy and Science Fiction*, May 1954.

[128]C. L. Harness, "Child By Chronos," *Magazine of Fantasy and Science Fiction*, June 1953.

[129]R. Heinlein, "All You Zombies—," *Magazine of Fantasy and Science Fiction*, March 1959.

a newborn girl, Jane, is found on the steps of an orphanage. At age 18, in 1963, she has a one-night affair with a mysterious stranger that leaves her pregnant. Some months later, during the birth of a daughter, it is discovered that Jane actually has a double set of sexual organs, and because the female set has been ruined by the pregnancy, doctors restore her as a man. Soon after, the baby girl mysteriously disappears from the hospital ward. Years later, in 1970, Jane (now a man, of course) meets another stranger who uses a time machine to transport both of them back to April 3, 1963. By April 24 male-Jane meets female-Jane and impregnates her (and so now we know who the mysterious stranger was during the one-night affair!). Meanwhile, the stranger with the time machine travels forward to March 10, 1964, a little after female-Jane has given birth, kidnaps the baby from the hospital (thus clearing-up another mystery!), takes her back to September 20, 1945, and leaves her on the steps of the orphanage. And so we see that Jane is her own mother *and father*, thus out-doing all previous tales about self-parenting.

This is pretty impressive stuff, but Heinlein still has one more twist for us. After leaving baby-Jane in 1945, the time machine stranger returns to April 24, 1963, retrieves male-Jane (who has just kissed female-Jane goodnight after fathering her-himself in herself), and takes him to 1985 where he recruits him into the Temporal Service—and finally, the stranger jumps forward to 1999, his 'real time.' At the end we at last learn that the stranger is, in fact, an even older version of male-Jane—*all* the central characters in the entire story are the *same* individual at various points along a single, highly twisted world line. The lone character in Heinlein's tale is truly a self-made man/woman in every sense of the phrase! This ultimate act of *creatio ex nihilo* has, correctly I think, been called "smaller than the minimal loop."[130]

Jane, in all her/his versions, is the only character in the story that appears to have purpose. In terrifying words that describe a causal loop, Heinlein ends the tale with an explanation of the story's title: "The Snake That Eats Its Own Tail, Forever and Ever. I know where I came from—but where did all you zombies come from? . . . You aren't really there at all. There isn't anybody but me—Jane—here alone in the dark. I miss you dreadfully!" In a December 1958 letter to his literary agent, Heinlein wrote of this amazing tale, "I *hope* that I have written in that story the Farthest South in time paradoxes." In my opinion, he did.

The sexual paradox has continued to fascinate science fiction writers up to the present day. In the novel *Timemaster* (note 122), for example, the hero at one point spends a night with his wife—and with two versions of himself from the future. He will, of course, experience that night two more times! Later, he becomes upset when his wife runs off with one of the older versions, but he quickly calms down when he considers that eventually *he* will be the older version. Consider, too, a story[131] that

[130]S. Lem, "The Time-Travel Story and Related Matters of SF Structuring," *Science Fiction Studies*, Spring 1974, pp. 143–154.

[131]G. Benford, "Down the River Road," *After the King: Stories in Honor of J. R. Tolkien* (C. Tolkien and M. Greenberg, editors), Tor 1991.

tells of a young man hunting the father who, years before, had abandoned him in a burning house. The death of the young man's mother in the flames has sent him on a 10 year quest for revenge up and down what is literally a river of time, a river on which to travel in one direction ("up time") is to move into the past, whereas moving "down time" leads to the future. Eventually he corners the father and, despite the man's pleading, kills him. It is only later, after examining papers he finds in his father's pocket, that the young man realizes he has killed his *future* self (Benford, a physicist, knows the pitfalls of time travel, and you'll notice that there is no autoinfanticide paradox here).

4.6 Splitting Universes and Time Travel

> "In all time travel stories where someone enters the past the past is necessarily altered. The only way the logical contradictions created by such a premise can be resolved is by positing a Universe that splits into separate branches the instant the past is entered."[132]

One early science fiction technique for allowing backward time travel and a changeable past, while still avoiding paradoxes, is that of alternate universes. According to this idea, if a time traveler journeys into the past and introduces a change (indeed, his very journey may be the change) then, as the above quote states, reality splits into two versions, with one fork representing the result of the change and the other fork being the original reality before the change. (To a fifth-dimensional observer, of course, all conceivable forks, all possible four-dimensional spacetimes, have always existed.) Indeed, according to this view the entire universe is splitting, at every microinstant, along every alternative decision path for every particle in the cosmos! This is often called the theory of *alternate realities with parallel time tracks*.

Such a seemingly fantastic view seems to actually have some scientific plausibility because of the so-called *many-worlds interpretation* (MWI) of quantum mechanics, pioneered in physics by Hugh Everett III (1930–1982), in a 1957 Princeton doctoral dissertation. Everett's theory is the antithesis of what is commonly called the *collapse of the wave function*, the idea that all potential possibilities have a non-zero possibility until a consciousness actually decides or observes which one will actually *be*. That quantum mechanical concept gets its name from the probabilistic wave equation formulated in 1926 by the German physicist Erwin Schrödinger (1887–1961). Before the observation, all possible futures have various values of probability; after the observation (which 'collapses' the wave function) exactly *one* of those futures (*the* future) has probability 1 and all the others have probability 0.

The MWI idea can be seen in Hale's story "Hands Off," discussed earlier, and in art *40 years* before that! With almost certainly a theological twist, consider the

[132] M. Gardner, "Mathematical Games," *Scientific American*, March 1979.

Fig. 4.6 Grandville's Infinity Juggler of many-worlds

beautiful illustration in the 1844 book *Un Autre Monde* (*Another World*), reproduced in Fig. 4.6. Known either as "The Infinity Juggler" or "The Juggler of Worlds," it is the work of the French artist Jean-Ignace Isidore Gérard (1803–1847), who published under the name 'Grandville.' The juggler—Grandville's version of Hale's mentor—appears as a court jester who is clearly having fun manipulating his multitude of worlds, while the man (humanity?) in the foreground watches. The man appears to be simultaneously fearful and fascinated, involved yet clearly impotent. Is Earth one of the worlds among which the Jester stands, or is it one of those flying through space? Or is Earth, perhaps, simply the unfortunate world ingloriously stuffed down the front of the Jester's pants? (That would surely explain a lot!) If born a hundred years later, Grandville would surely have found work as an artist in the imaginative world of the science fiction pulps.

Early science fiction stories that treat the collapsing wave function concept can be traced back to the late 1930s and early 1940s.[133] A particularly interesting example is the story of an inventor who, while trying to build a radio with which

[133]See, for example, Jack Williamson's 1938 novel *The Legion of Time*, and C. L. Moore's, "Tryst in Time," *Astounding Stories*, December 1936. L. Sprague de Camp (1907–2000), too, was an early pioneer in the exploration of the MWI idea in science fiction long *before* Everett. In his 1941 novel *Lest Darkness Fall*, for example, he uses the analogy of a tree (the "main time line") that is always sprouting new branches.

to signal Mars, accidently stumbles on the "temporal-aberrant carrier wave" and thus establishes contact with a universe that forked off of ours in 1863 when Robert E. Lee *won* the Battle of Gettysburg![134] In Everett's MWI, however, the wave function of the universe does *not* collapse. Indeed, it *couldn't*, because there is no observer external to the entire universe (we are talking science now, not of theology and God); instead, the wave function 'splits' at every decision point in spacetime. Although this leads to a multitude of realities *far* beyond comprehension, cosmologists still tend to like the MWI because it avoids the puzzle of having to produce an observer 'outside the universe.'

It's important to understand that the MWI is different from yet another idea popular in science fiction, that of *parallel universes* (see again the third discussion question at the end of Chap. 3). In parallel universes *all* possibilities *always* exist, independent and parallel in time. In the MWI, on the other hand, ever more universes are continually coming into existence. Unlike the MWI, which can at least claim a scientific basis (quantum mechanics), there is no analogous theory for parallel universes. But, of course, even though lacking a theory, nonetheless science fiction writers have been quite inventive with the idea because parallel universes offer a way to avoid (at least some) causal loops.

One clever, early pulp story[135] illustrates how that works. To improve the performance of his time machine, an inventor needs batteries with tremendous energy density, a density far in advance of the batteries in the present. Unable to travel far into the future—if he *could* obtain them there, then of course a causal loop (the very entity we wish to avoid) would be created upon his bringing them back to the present—his assistant first travels back to 1851. There he leaves a note on desk of a well-known experimenter, with a plea for him to devote his life to battery research; a copy of the 1937 *Electrical Handbook* is left with the note as proof that there really has been a visit from the future! Before returning to the present, the assistant takes a sheet of (new) 1847 five-cent stamps from the experimenter's desk.

Returning to the present, which is now different (a new time track, in accordance with the splitting-universe idea), the powerful batteries *are* readily available *because* the experimenter believed the note. Buying several of them, using money obtained by selling the pristine 1847 stamps to a collector, the assistant returns to a slightly earlier 1851 than before (to *before* the fork in time!), watches himself appear[136] and leave the note and the handbook, and *then, unobserved, the assistant removes both*: Thus, upon returning once more to the present, he finds all is as before—except now he and the inventor have the powerful batteries. As

[134]N. Bond, "Parallel in Time," *Thrilling Wonder Stories*, June 1940. See also S. N. Faber, "Trans Dimensional Imports," *Isaac Asimov's Science Fiction Magazine*, August 1980.

[135]W. Sell, "Other Tracks," *Astounding Science Fiction*, October 1938.

[136]Just like Marty McFly does at the end of the 1985 film *Back to the Future*. The movie is fun, but pulp science fiction did it first.

before, one might ask where the batteries came from, but unlike the previous mystery of information-creating causal loops, the answer is clear and non-mysterious. *They came from the hard work of the experimenter on a different time track*. Such shuttling back-and-forth between time tracks is the signature of what is called a *cross-time* story, a device to avoid paradoxes while still allowing for changing the past. The first example of this time travel sub-genre had actually appeared 4 years earlier.[137]

In another cross-time tale from modern times, we read of the horrible fate suffered by a man when an experiment in a Princeton physics lab goes wrong.[138] It is discovered, too late, that parallel time tracks are not simply grooves into which you drop, like a ball, after leaving the time track of our world. Each version of a person in each world is not like a ball rolling down a groove from past to future. Rather, each world's time track is just a line on a smooth surface; as the man is told, during a temporary stay in a world still close to his (our) original world, "We gave you a push sideways, and you moved off your original line—but instead of dropping into the next groove, you've just kept on rolling across the surface, from one line to the next, at an angle. There are no grooves, nothing to stop you from sliding on across the different lines forever. You have the same futureward vector as you started with, but you've added a small cross-time vector, as well." And so the man drifts cross-time, and gradually the worlds he experiences grow ever more alien.[139]

The science fiction is undeniably fun, but for this book the underlying *scientific* theory of time travel is classical (that is, non-quantum) general relativity, and that theory has nothing to say about alternative time tracks in multiple worlds. For most time travel theoreticians there is *one* time track, and the past of our world is unique and inviolate. I agree with the great quantum physicist J. S. Bell (1928–1990), who wrote of Everett's theory that "if such a theory were taken seriously it would hardly be possible to take anything else seriously."[140] As Bell further observed, in the MWI "there is no association of the particular present with any particular past," a quite strange idea that had already appeared in science fiction years earlier.[141]

While most early time travel analysts did base their work just on classical general relativity, there *are* now many more who think quantum mechanics itself, independent of its interpretation, has much to contribute as well. Perhaps, in fact, it

[137]M. Leinster, "Sidewise in Time," *Astounding Stories*, June 1934. Splitting universes with multiple time tracks and time loops became quite popular after Leinster's and Sell's stories; you can find the basic idea repeated yet again in Alfred Bester's "The Probable Man," *Astounding Science Fiction*, July 1941, for example, in which each new journey into the past causes the future to fan out into an infinity of new time tracks.

[138]L. Watt-Evans, "The Drifter," *Amazing Stories*, October 1991.

[139]In Jack Haldeman's 1990 novel *The Hemingway Hoax* we read that "there is not just one [parallel] universe, but actually uncountable zillions of them."

[140]In "Quantum Mechanics for Cosmologists," *Speakable and Unspeakable in Quantum Mechanics*, Cambridge University Press 1987.

[141]J. R. Pierce, "Mr. Kinkaid's Pasts," *Magazine of Fantasy & Science Fiction*, August 1953.

may make an absolutely crucial contribution to the theoretical basis of time travel. One analyst who believes this (along with an even stronger belief in the MWI) is the British physicist David Deustch (note 100), who holds that general relativity is not the proper theory with which to study the physical effects of CTLs. He believes that the traditional mathematical machinery of general relativity actually obscures, rather than clarifies, the difficult task of separating the merely counter-intuitive from the unphysical.

Indeed, Deutsch calls the conventional spacetime methods, based on general relativity and differential geometry, *perverse*. He also does not like the conceptual problems raised by general relativity's wormholes and singularities. Any non-quantum mechanical discussion, he says, of the "pathologies" of backward time travel is simply not adequate. Deutsch divides these pathologies into two fundamental classes: (1) paradoxical constraints, such as the free-will issue seemingly raised by the grandfather paradox, and (2) causal information loops. Deutsch claims that his quantum mechanical analyses show that the first class of pathologies simply does not occur, because the past that the time traveler enters is the past of a world different from the one he has left. Further, his results also show (to him) that the pathologies of the second class may be "avoidable." These are not the views among the majority of time travel students, however (that does *not* mean Deutsch is wrong!), and general relativity *is* the standard tool used by the majority of time travel theoreticians. When quantum mechanics does enter the calculations of most analysts, it is generally on an *ad hoc* basis.

More concerning for the MWI view is a result reported in 2004, that a macroscopic object (a human time traveler, for example) attempting to traverse a wormhole time machine (to be discussed in some detail in Chap. 6) "must necessarily undergo violent interactions with the time machine," interactions *so* violent that they must "cause the object to disintegrate." The different pieces of the now certainly dead time traveler would emerge from the wormhole in different worlds—this is definitely not a result likely to encourage volunteers for the first time machine trip![142]

So, many physicists and philosophers, not sharing Deutsch's position,[143] tend to agree with Bell, including the late John Wheeler (Everett's thesis advisor!), who wrote of the MWI "I once subscribed to it. In retrospect, however, it looks like the wrong track. . . . Its infinitely many unobservable worlds make a heavy load of metaphysical baggage."[144] Agreeing with Wheeler was a philosopher who called the MWI "highly controversial" and declared that "few working physicists take it

[142] A. Everett, "Time Travel Paradoxes, Path Integrals, and the Many Worlds Interpretation of Quantum Mechanics," *Physical Review D*, June 25, 2004, pp. 124023–1:124023–14.

[143] For a modern philosophical argument specifically rebutting Deutsch's enthusiasm for the MWI, see Theodore Sider, "A New Grandfather Paradox?" *Philosophy and Phenomenological Research*, March 1997, pp. 139–144.

[144] See note 34 in Chap. 3.

seriously."[145] Perhaps even more damning was a physicist's statement that "the idea of 10^{100}+ slightly imperfect copies of (the universe) all constantly splitting into further copies . . . is not easy to reconcile with commonsense. Here is schizophrenia with a vengeance."[146] Or, as one science fiction writer bluntly put it, in a tale of the inventor of the "chronomotive impulse belt" (which allows moving between the *two* parallel worlds that are all that exist), the MWI is the "Doctrine of Infinite Redundancy—which is, of course, utter nonsense."[147]

Deutsch's position does raise the obvious question of what motivates a quantum theoretician to study CTLs at all, given that they originate in general relativity and *not* in quantum mechanics. Deutsch's response is that although CTLs did indeed originate in classical Einsteinian general relativity, the still incomplete theory of quantum gravity *does* predict CTLs, too. And that is an exciting observation for time travel enthusiasts because, as Deutsch writes, the results of his quantum studies of CTLs show that "contrary to what has usually been assumed, there is no reason in what we know of fundamental physics why closed timelike lines should not exist." That view was later endorsed by other physicists who wrote, after a quantum mechanical study of how a particle could transit a time machine spacetime in a physically consistent manner, "there is no contradiction between the postulates of quantum mechanics and the possible existence of causality violation in general relativity."[148]

Long before these scientific endorsements, science fiction had enthusiastically embraced the many-worlds idea and its connection with time travel. The first such tale[149] appeared when Everett was just 3 years old; it put forth the insightful observation that although alternate time tracks may allow changing the past for the better (something that can't be done, for better *or* for worse, with a single time track), in the end any such change may still be futile. As Daniels' time traveler puts it, "I did have an idea to . . . go back to make past ages more livable. Terrible things have happened in history, you know. But it isn't any use. Think, for instance, of the martyrs and the things they suffered. I could go back and save them those wrongs. And yet all the time . . . they would still have known their unhappiness and their agony, because in this world-line those things happened. At the end, it's all

[145]R. A. Healy, "How Many Worlds?" *Nous*, November 1984, pp. 591–616.

[146]B. S. DeWitt, "Quantum Mechanics and Reality,' in *The Many-Worlds Interpretation of Quantum Mechanics* (B. S. DeWitt and N. Graham, editors), Princeton 1973.

[147]B. Shaw, "What Time Do You Call This?" *Amazing Science Fiction*, September 1971. When a bank robber in one world tries to make his escape into the other world, he literally runs into 'himself' trying to escape after robbing the 'same' bank in the parallel world!

[148]D. S. Goldwirth *et al*., "Quantum Propagator for a Nonrelativistic Particle in the Vicinity of a Time Machine," *Physical Review D*, April 15, 1994, pp. 3951–3957. See, too, the earlier D. S. Goldwirth *et al*., "The Breakdown of Quantum Mechanics in the Presence of Time Machines," *General Relativity and Gravitation*, January 1993, pp. 7–13.

[149]D. R. Daniels, "The Branches of Time," *Wonder Stories*, August 1935.

unchangeable; it merely unrolls before us."[150] Many years later, in a critique of the many-worlds idea, a philosopher/physicist echoed Daniels' words: [In the world] that I (subjectively) experience I may blunder, but [in another world], with equal actuality, I triumph gloriously. The Everett interpretation can be used this way to mitigate sorrows, but this use is two-edged, for it equally well implies the speciousness of happiness."[151]

The editorial introduction to Daniels' pioneering tale is quite interesting: the opening line is "To say that this short story contains some revolutionary time-travel theories would be putting it exceedingly mild." That editor then went on to tell his readers, with great enthusiasm, that "when the author . . . submitted this story to us, his accompanying letter stated that in it he had settled the time-travel question once and for all. We must admit that a broad, unbelieving grin spread over our countenances when the author dared make this assertion. BUT—the smile soon left our faces . . . [T]o our chagrin, Mr. Daniels had really propounded so many brand new ideas about time and time-travel, and such logical ones—*that he has not left one loophole in his argument*!"

John W. Campbell (1910–1971), the first (and only) editor of *Astounding Science Fiction* (today's *Analog*), called alternate time track stories "mutant" because they represented the first new innovation (or mutation) in the time travel concept since H. G. Wells. Campbell incorrectly claimed *The Legion of Time* (note 133) was the first such tale (see Campbell's editorial in the May 1938 issue of *Astounding*) , and that "Other Tracks" (note 135) was the second, but in fact it was Daniels who was first with splitting time tracks in science fiction. After Daniels the concept quickly became part of standard science fiction lore and could be used by other writers with little explanation. For example, just a little more than a decade later one author did not have to say much about his "First Law of Chronistics," which determines the development of "the branches of Fan-Shaped time." It was sufficient for his readers to learn that should a time traveler to the past change anything, a parallel branch of time would be created on which the time traveler would be trapped: "The man who interfered with the space-time matrix, displacing even a comma in the great scroll of time, would be cut-off from his origin forever."[152]

Still, if there is one thing we can say about science fiction, it's that no 'rule' is immune to challenge. Decades after Daniels' tale put forth the MWI, we find the well-known author James Blish (note 100 in Chap. 1) *rejecting* it. In a story about the reception of radio signals from the future, we read of one character telling another "I *was* going to do all those things. There were no alternatives, no fanciful 'branches in time,' no decision-points that might be altered to make the future

[150]These sad, resigned words were written when the author, David R. Daniels (1915–1936), was just twenty years old. A year later he committed suicide.

[151]A. Shimony, "Events and Processes in the Quantum World," *Quantum Concepts in Space and Time* (R. Penrose and C. J. Isham, editors), Oxford University Press 1986.

[152]J. MacCreigh, "A Hitch in Time," *Thrilling Wonder Stories*, June 1947.

change. My future, like yours . . . and everybody else's, was fixed. It didn't matter a snap whether or not I had a decent motive for what I was going to do; I was going to do it anyhow. Cause and effect . . . just don't exist. One event follows another because events are just as indestructible in space-time as matter and energy are."[153]

This denial of the MWI is simply an author's choice, of course, for whatever story effect is desired, and others may make different choices. Isaac Asimov, for example, used the MWI idea in in the story of a time traveler who journeys back to 1871 London, to retrieve a lost Gilbert and Sullivan operetta (*Thespis*). When he returns to the present he finds that his wife Mary (who was alive when he left) has been dead for a year on the new time track that his actions in the past have created. As the story ends, the devastated time traveler thinks "I had changed history. I could never go back. I had gained *Thespis*. I had lost Mary."[154] This sad fate is repeated in another story of a time traveler lost in an infinitude of time tracks with no hope of ever finding his way home: "In all of time, how many, many worlds there must be. How to find a single twig in such a forest?"[155]

Splitting universes have been used in literary works outside the genre of science fiction, as well. Examples include "The Garden of Forking Paths" by the Argentine writer J. L. Borges, the first play J. B. Priestly wrote (the 1932 *Dangerous Corner*), John Updike's 1997 novel *Toward the End of Time*, and Gore Vidal's 1998 novel *The Smithsonian Institution*. Typical of these fictional fantasies about splitting universes is a tale (anticipating Asimov's) by Lord Dunsany (1876–1957)—the Irish writer Edward Plunkett—the story of a man who goes back in time to correct "two or three mistakes he had made in his life."[156] This he successfully does, but the result is a new, subtly different subsequent history. The differences are not infinitely subtle, however; after the changes, he finds that his home, his wife, and all the delicate details of his life have vanished. As he relates to a visitor at the lunatic asylum he is now confined to, as the result of his despair, "I tell you I'm lost. Can't you realize that I'm lost in time? I tell you that you can find your way traveling the length of Orion, sooner than you shall find it among the years . . . Don't go back down the years trying to alter anything . . . Don't even wish to . . . [T]he whole length of the Milky Way is more easily traveled than time, amongst whose terrible ages I am lost."

In writing for a mass audience, rather than just for the more limited science fiction and fantasy one, perhaps the best known literary work of alternate history is the classic 1953 novel *Bring the Jubilee* by Ward Moore (1903–1978). In that work Lee wins the Battle of Gettysburg, and the South wins the Civil War. Using a time machine, a historian travels from 1952 (of the world in which the South wins) into the past of 1863 to study the battle, where he inadvertently disrupts events to the point that the North wins; that is, reality splits and the newly created fork represents

[153] J. Blish, "Beep," *Galaxy Science Fiction*, February 1954.

[154] I. Asimov, "Fair Exchange?" *Asimov's Science Fiction Adventure Magazine*, Fall 1978.

[155] M. F. Flynn, "The Forest of Time," *Analog Science Fiction*, June 1987.

[156] Lord Dunsany, "Lost," *The Fourth Book of Jorkens*, Arkham House 1948.

the time track of *our* world. The historian is trapped on this new fork, cut off forever from his original time track. The entire novel is in the form of a discovered manuscript, written in 1873 and found in 1953, and the pathos of the ultimate isolation endows the novel with great emotional impact.

A 1992 novel on the same theme, Harry Turtledove's *The Guns of the South*, begins with a fascinating premise but then misses the crucial distinction between a single versus multiple time tracks. In that work racists from the future (2014) arrive by time machine at Lee's 1864 winter camp. They bring with them AK-47 automatic assault rifles and offer to supply Lee's army with all it can use. Lee accepts and the South wins the Civil War. The future, of course, changes—or does it? The time travelers have brought back books from the future showing that the South lost the war, so the implication is that history must have forked. So far, so good. But all through the novel, the time travelers move back and forth between the nineteenth and the twenty-first centuries, apparently finding their own time unchanged. And if that is so, then the whole point of the story vanishes. Why all the effort to change history when it is clear that nothing has changed? The novel is entertaining reading (Turtledove is a trained historian), but I believe Moore's novel to be the superior work of science fiction.

I'll end this discussion on splitting universes with a startling theological issue raised by a philosopher.[157] Arguing that God cannot branch into multiple time tracks because God is unique, the conclusion seems inescapable that God therefore exists on exactly one of how ever many different time tracks there may be. What if that chosen time track isn't ours? Then, concludes the philosopher, Nietzsche's nineteenth-century metaphorical claim that "God is dead" (for us) might literally be true! He admits that this is "fanciful," but still . . . .

4.7 For Further Discussion

In an afterword to his story "Dead City" (*Thrilling Wonder Stories*, Summer 1946), Murray Leinster muses "You've heard the old argument that a man can't travel backward in time because he might kill his grandfather. I've wondered why nobody has argued that a man can't travel forward in time because he might be killed by his grandson." One possible answer to Leinster is that *if*, at the moment the forward-bound time traveler departs, he has not yet sired a child, *then* there simply wouldn't be a murderous grandson waiting for him in the future. Perhaps, however, Leinster had this somewhat more

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[157]Q. Smith, "A New Topology of Temporal and Atemporal Permanence," *Nous*, June 1989, pp. 307–330.

complicated scenario in mind: After the time traveler arrives in the future he is attacked by a mysterious stranger but survives, and later returns to the present. He then sires a child who will be the parent of that mysterious stranger. (As far as I know, this plot line has not appeared in a science fiction story.) Contrary to Leinster's view, explain why the *possibility* of being killed by a grandson is not a reason for forbidding the possibility of a trip in time (in either direction).

In his causal loop paper (note 105) the University of Delaware philosopher Richard Hanley correctly writes (on p. 146) "physicists have tried to avoid free will problems by ignoring causal loops involving intentional agency," and partly illustrates this claim with the autoinfanticide paradox, writing of the attempt of a time traveler to kill his younger self as inevitably failing because "the past is apparently brought about willy-nilly." (Hanley unfortunately then uses the story "Thompson's Time Traveling Theory" as an example of this—see note 77, and the end of the "Introduction"—when it is that time traveler's *grandfather* who is the intended target.) Discuss the merits of Hanley's claim, keeping in mind the end of Sect. 4.3 (in particular, note 81). If you are interested in genetics and astronomy as well as in time travel, then for extra credit comment on Hanley's claim (p. 137) that "one can extract information about my DNA from . . . my astrological chart."

The fictional killing of Hitler was imagined in print even before World War II, in Geoffrey Household's intense 1939 novel *Rogue Male* (made into the 1941 film *Man Hunt*). And so it's not surprising that one of the popular change-the-past themes in science fiction is that of a time traveler killing the Führer. (This idea, somewhat oddly, appeared in the debates leading up to the 2016 American Presidential election, when one of the candidates, to show the toughness of his character—even though he opposed abortion—declared "Hell, yes, I'd kill baby Hitler! You gotta step up, man." This candidate did elaborate a bit, stating there might be some risk involved with tampering with the past.) Stories in this sub-genre include E. Norden's "The Primal Solution" (*Magazine of Fantasy & Science Fiction*, July 1977), W. R. Thompson's "The Plot to Save Hitler" (*Analog*, September 1993), L. del Rey's "My Name Is Legion" (*Astounding Science Fiction*, June 1942), and R. M. Farley's "I

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Killed Hitler" (*Weird Tales*, July 1941). Read some of these tales and compare the various repercussions envisioned by the authors following an assassination of Hitler by a time traveler.

After our discussion of Heinlein's time travel masterpiece "All You Zombies—," you might think it impossible to write a new story that exceeds it in complexity. That might well be true, but a modern masterpiece by Ted Chiang certainly gives it a good run for the money. "The Merchant and the Alchemist's Gate" (*Magazine of Fantasy & Science Fiction*, September 2007) uses a 'wormhole' that connects the present to the future 20 years hence, and it is stuffed with intertwined causal loops and information bootstraps. Read it and keep track of all such occurrences. How many did you find? The last line of the story clearly expresses the view that the past cannot be changed: "Nothing erases the past. There is repentance, there is atonement, and there is forgiveness. That is all, but that is enough." Is the story always faithful to this view of time travel?

In his paper (note 126) on the coincidences of time travel, the University of Queensland philosopher Phil Dowe writes "It's true that remote time travel [into the very distant past] does not allow for causal loops . . ." *Is* this true? Consider, as you think about this, the story "Time's Arrow" (*Science-Fantasy*, Summer 1950) by Arthur C. Clarke. In that tale geologists have just discovered, in a remote desert, the fossilized tracks of a monstrous creature, from fifty million years ago, tracks that indicate that the beast was in hot pursuit of fleeing prey. Before the geologists can unearth the entire set of tracks, to see if the pursuit was successfully completed, they are visited by a physicist who just happens to be conducting near-by experiments in time travel. (This proximity is explained by noting what better place to conduct time travel experiments, powered by atomic energy, than in a remote desert?) At one point during the visit, after being told of the ancient pursuit frozen in rock, the physicist muses "It would save you a lot of trouble, wouldn't it, if you could actually *see* what took place in the past, without having to infer it by these laborious and uncertain [geological] methods." This comment results in the Chief geologist paying a visit to the physicist's lab. After driving over in a car equipped with tires having "an odd zigzag pattern" in the tread,

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an accident suddenly sends the entire lab into the past. Soon after, the other geologists unearth the rest of the fossilized tracks, and learn what the creature's prey had been when they see a zigzag pattern in the rocks, tracks that show "the great reptile was about to make the final leap upon its desperately fleeing prey." Can you see how to modify this story so as to have a causal loop involving the very distant past? (For perhaps even more inspiration on thinking about causal loops, watch the 1980 movie *The Final Countdown*. In it the designer of a modern naval warship that temporarily travels back through time to the Pearl Harbor of December 6, 1941, turns out to be a crew member who was accidently left behind in the past. In the past he *will be* able to design the ship because he already knows how it *was* designed—by himself!)

Comment, at length, on the cartoon shown in Fig. 4.5. (Does it make logical sense?)

In the story "Salvation" by Jerry Oltion (*Analog*, December 2007) a physicist approaches the Universal Church of the Divine Revelation for money to build a time machine. He is blunt in making his case: "You could go back in time and meet Jesus. Assuming he existed." That statement causes (it should come as no surprise) not just a bit of pandemonium but, nonetheless, an influential Church leader decides to provide the funding. Why? Because later, while sitting in his office as he talks with the physicist, a sheet of paper suddenly appears in the air above the leader's desk and then flutters down to land on the telephone. Picking the paper up, the leader sees it is a sheet of his own letterhead, with writing in his own angular, precise handwriting, saying "It works. Give him the money. You almost named the dog Solomon." This convinces the leader because, as we are told, "Paper appearing out of nowhere was a good trick, but it might easily be just that: a trick. Duplicating his letterhead and his handwriting wouldn't be all that difficult either. [On the other hand] knowing the name [the leader] had considered but rejected for his German Shepard 15 years ago was a different level of feat entirely." The physicist seems to be startled by the appearance of the paper, too, and asks "May I see that?" His reaction convinces the leader it wasn't a staged event: "Well, I'll be damned," the physicist replies. Once the time machine is under construction, the two men realize they have to send the enigmatic message back in time to complete the loop. As they prepare to do so, the leader asks a curious question. After retrieving the mysterious sheet of paper from his desk,

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he says to the physicist "Should I send the original [the one he is holding in his hand], or should I write another?" The physicist replies with "Write a new one. If we send the original, we put it in a closed loop and [we'll] never get it back. We don't want to lose the first object to travel in time. We'll want that for the Smithsonian someday." Does this make sense? Also, comment on whether or not the dog's name is a bootstrap paradox.

A perplexing little time travel paradox, one that I don't think science fiction has yet treated (and I'm pretty sure physicists haven't had anything to say about it either), was cooked-up by the English philosopher Robin Le Poidevin in his 2003 book *Travels in Four Dimensions: the enigmas of Space and Time* (Oxford, pp. 180–181). There he writes "Peter and Jane, both 20 years old, are out for a walk one day in 1999 when suddenly a time machine appears in front of them. Out steps a strangely familiar character who tells Jane that he has an important mission for her. She must step into the machine and travel to the year 2019, talking with her a diary the stranger hands to her. In that diary she must make a record of her trip. Obligingly, she does as she is asked and, on arrival, meets Peter, now aged 40. She tells Peter to travel back to 1999, taking with him the diary she now hands him, and recording his trip in it. On arrival in 1999, he meets two 20-year-olds called Peter and Jane, out for a walk, and he tells Jane that he has an important mission for her." Le Poidevin then writes that "the really tricky question is: how many entries are there in the diary when Jane first steps into the machine? We imagine it blank. But this is the very same diary as the one Jane hands to the 40-year-old Peter, which then contains her entry. And by the time Peter arrives back in 1999, it will contain his entry, too. But then, if the diary already contained two entries when Jane was handed the diary, then it would contain three entries when she handed it to Peter, who would then add another one, so the diary would have contained four entries when it was first handed to Jane, and so on. If the problem is not immediately apparent, this is because we imagine an indefinite number of trips, but in fact there are just two: Jane's trip to 2019 and Peter's trip to 1999. So there ought to be a consistent answer to the question, how many entries are there in the diary? Yet, as we have seen, there does not appear to be a consistent answer." Another philosopher soon claimed he *did* have the answer: namely, 2. Read his paper (Erik Carlson, "A New Time Travel Paradox Resolved," *Philosophia*, December 2005, pp. 263–273), and either explain why you agree with Carlson's reasoning or enthusiastically rebut it.

As in "The Time Eliminator" (Fig. 4.1), other stories have imagined gadgets that simply view the past, rather than visit it as would a time machine. This is done in an attempt to avoid paradoxes—but does it? Two stories that illustrate how just viewing the past risks affecting the past as much as time travel would, are Horace Gold's "The Biography Project" (*Galaxy Science Fiction*, September 1951) and Donald Franson's "One Time in Alexandria" (*Analog*, June 1980). In the first tale the Biotime Camera, operated by the Biofilm Institute, allows teams of biographers to film (alas, no sound!) and study the lives of past notable personages. Of particular interest are the lives of those who developed neurotic psychoses, such as Isaac Newton. And, indeed, the Biotime Camera does capture Newton's image as he begins to display increasingly disturbed behavior. We see Newton, for example, as he begins to peer into dark corners, looking for those who have come to spy on him. On his death bed, the biography team assigned to him reads his lips and discovers that his final words are "My guardian angel. You watched over me all my life. I am content to meet you now." It is then that the Biofilm Institute realizes what it has done. Newton *was* in fact being spied upon—by the Biotime Camera, which has not changed the past but has certainly affected it. In the second tale an archeologist uses a time viewer to read the lost manuscripts in the ancient library at Alexandria before it was completely destroyed in an inferno. The viewer uses an infrared beam—and it is the heat from that beam from the future that proves to be the origin of the fire in the past. Again, the past has been affected, but not changed, by time viewing. Is it true to claim, however, that such viewing gadgets could not be the source of other paradoxes, such as causal loops or information bootstraps? If you think that isn't a valid claim, give a counter-example.

In a story by Francis Flagg and Weaver Wright (a pseudonym used by Forrest J. Ackerman), "Time Twister" (*Thrilling Wonder Stories*, October 1947), we read the following exchange between the inventor of a time machine and his none-too-bright helper:
"You mean to say," he questioned incredulously, "that I could go back a hundred years?"
"If you had the proper machine in which to travel, yes."
"But that'd take me back to before I was born."
The Professor smiled tolerantly.
"Look at this diagram, Hank. This line is the time continuum. It incorporates space, too. [The authors didn't actually print a diagram with the story, but

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surely the Professor is using a Minkowski spacetime diagram]. This dot is you. It doesn't matter when you were born, or when you will die. You exist right now, that's the fact. Traveling into the past or future wouldn't make you grow any younger or older. Such a thought is naïve. Let me demonstrate the mechanics of it for you. If . . . we calculate with non-Euclidean mathematics . . ."
"It don't sound reasonable," the farmhand objected. "If I went back—"
"I know," interjected the Professor, "if you went back you might meet your own father as a young man and you'd be older than he, or maybe he and your mother would be kids going to school."
"Haw, haw! That'd be funny, that would."
What famous movie, made nearly 40 years later, does the end of the conversation remind you of? Hint: "flux capacitor."

As mentioned in the text, a famous science fiction example of *affecting* (but not changing) the past is "Behold the Man" by Michael Moorcock, the tale of a time traveler who arrives in ancient times during the very years of the ministry of Jesus as reported in the Bible. When he finds there is actually no such person, the time traveler takes the role himself and lives out the events as reported in the Gospels, including the Crucifixion. This is a powerful story, but it had already been done more than 15 years earlier, by Philip K. Dick, in his short story "The Skull" (*If*, September 1952). In his tale, Dick tells of a man from the twenty-second century who is sent by government authority back to the mid-twentieth century to kill the Founder of a religious movement, a movement that 'now,' 200 years later, threatens those same government authorities. History records that the Founder gave a powerful speech just before being arrested and executed, a speech that started the religious movement, and so the time traveling assassin is told to kill the Founder *before* he can give that speech. (The parallel between Jesus and the Founder should be obvious.) Read these two stories and compare and contrast how Moorcock and Dick handled time travel paradoxes. Comment, in particular, on the relationship between the assassin and the Founder. Moorcock's tale should be easy to find, and Dick's is available as a free pdf download (it is in the anthology *The Best of Philip K. Dick*, Halcyon Classics 2010, as well).

A subtle change-the-past sequence appears in the original *Back to the Future* film that is easy to miss. When the hero, Marty McFly, returns to 1955 in the time car, he leaves from the parking lot of the Twin Pines Mall, so named because of the two pine trees that stand nearby. Arriving in the past with literally a bang, the time car inadvertently destroys one of the (then) young pines. Near the end of the movie, when Marty returns to the future (1985), he finds that the mall is now called the Lone Pine Mall. This is charming and fun, indeed clever, but modern scholars of time travel reject it, and other claims of changing the past, as not being logical. (Shakespeare understood this point, when he has Lady Macbeth declare, concerning the murder of Banquo, "What's done cannot be undone: to bed, to bed, to bed.") What Marty's trip *would* explain is why the mall would *always* have had the name of the Lone Pine Mall. Watch the movie and see how many other 'change-the-past' episodes you can find.

Chapter 5
Communication with the Past

"[As for travel to or for signaling the past] you'd have to exceed light speed which immediately entails the use of more than an infinite number of horsepowers."[1]

5.1 Reversed Time

"I have not discovered Mr. Wells' Time Machine."[2]

One way to communicate with the past is to 'simply' live backwards in time. Philosophers and other writers of speculative fiction were the first to wonder what things might be like in a world where the time asymmetry is reversed—that is, in a world where time 'runs backward.' Indeed, fascination with the idea of time reversal actually dates back thousands of years, long before science fiction, as it can be found in Plato's dialogue *Statesman*, written (most probably) 15 years before Plato's death in 347 B.C.

At one point, Plato offers an extended description of the world suddenly running backward in time in the ancient past. After one character is told that at that remote time "all mortal beings halted on their way to assuming the looks of old age, and each one began to grow backward," he asks "But how did living creatures come into being, Sir? How did they produce their offspring?" The answer is shocking: "Clearly ... it was not of the order of nature in that era to beget children by intercourse ... It is only to be expected that along with the reversal of the old men's course of life and their return to childhood, a new race of men should arise, too—a new race formed from men dead and long laid in Earth ... Such resurrection

[1]An observation by Haskel van Manderpootz, professor of the "newer physics," in S. G. Weinbaum's "The Worlds of If," *Wonder Stories*, August 1935. Compared to the 'modest' Van Manderpootz, all other physicists in the world are a mere "pack of jackels, eating the crumbs of ideas that drop from [his] feast of thoughts."

[2]W. R. Inge (1860–1954), in his November 1920 Presidential Address to the Aristotelian Society at the University of London Club, in a sympathetic treatment of the possibility of a time-reversed world.

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of the dead was in keeping with the cosmic change, all creation being now turned in the reverse direction."

The reversed-time world is an important philosophical concept. Before the turn of the century, for example, Francis Bradley (one of the early proponents of the block universe, you will recall from Chap. 2), thought about reversed-time worlds and concluded that they would be quite odd: "Let us suppose . . . that there are beings whose lives run opposite to our own . . . *If* in any way *I* could experience *their* world, I should fail to understand it. Death would come before birth, the blow would follow the wound, and all must seem to be irrational."[3] A half-century later the South African philosopher J. N. Findlay (1903–1987) took Bradley's position of supporting a skeptical attitude towards the possibility of time-reversed worlds. Writing in a book review, Findlay declared "The reversed world in question wouldn't merely strike us as queer, but definitely crazy: it would be a world where what is wildly and intrinsically *improbable* was always occurring. It would, in fact, be much more startling than the original asymmetry that led us to think of it."[4] (Findlay was almost certainly thinking of things like a tea cup, shattered due to a fall, spontaneously reassembling itself.)

The question of backward-running time so fascinated Findlay that, some years later, he posed it as a problem for the readership of a scholarly journal (*Analysis*). This led to a number of responses, and subsequently he presented both his own negative view of time-reversed worlds and that of the best reader response he had received to his posed problem (which came from McGechie).[5] While Findlay showed admirable open-mindedness by awarding the title of *best* to an argument that refuted his own position, he remained unconvinced about the concept of reversed-time worlds, stating that "I continue to feel that a total reversal of my experiences is a terrifying possibility."

The terror aspect of living backward in time had been nicely captured in a science fiction story years before Findlay wrote. A scientist who is involved in an accident with radioactive materials has his sense of time flow reversed, and the story carefully and logically analyzes what his life would be like in such a situation. For example, the scientist can talk (backwards for others, of course), so he is understandable only if his words are recorded and then played in reverse. He cannot eat, because for him that would involve the regurgitation of food. He cannot answer questions because "if he should answer any questions put to him, it would mean he was giving the answer before he heard the question, on his time scale." And finally, he can't pick anything up because the normally stable position and velocity error-correction mechanism between eye, hand, and brain, which is a negative feedback system in normal time, has become an unstable positive feedback system in reversed time. The horror of his existence is contained in the only words the man

[3]F. H. Bradley, *Appearance and Reality* (2nd edition), Oxford University Press 1897, p. 190.

[4]J. N. Findlay, *Philosophy* (25) 1950, pp. 346–347.

[5]J. N. Findlay and J. E. McGechie, "Does It Make Sense to Suppose That All Events, Including Personal Experiences, Could Occur in Reverse?" *Analysis*, June 1956, pp. 121–123.

utters (deciphered after reversed playback): "Where am I? What's happened? Why are things so different? Why? Why?"[6]

Despite Findlay's "terror," however, the prevailing view today is that to the inhabitants of a time-reversed (or what is sometimes called a *counterclock*) world, *nothing would look odd*! This is a fairly new idea,[7] and not so long ago the philosophical literature displayed a misunderstanding of how a time-reversed world would appear to its occupants.[8] More recent analyses than Smart's (note 7) advocating the 'normality' of a time-reversed world are more compelling.[9] One concern about a time reversed world however is not easily dismissed: matter with a time reversed time sense is thought by many to be antimatter in our world, and any interactions between the two worlds would be spectacular, indeed![10]

But let's ignore that possible difficulty. The philosopher J. R. Lucas argued that even if beings from two such time-reversed worlds could meet, they still could not communicate: "If two beings are to regard each other as communicators, they must both have the same direction of time. It is a logical as well as a causal prerequisite."[11] Now, this matter is well worth some effort to understand, because it is intimately tied to time travel. At first blush, Lucas' words seem almost self-evident, and after a little thought they might seem to be absolutely irrefutable. The philosopher Murray MacBeath, however, took exception.

MacBeath opened his analysis[12] with a story to demonstrate that the persuasive power of Lucas' position is only superficial. In that story of Jim and Midge, Jim is one of us, whereas Midge is a 'Faustian time'[13] being. In his analyses MacBeath uses capitalized words and symbols for the time-reversed Midge, and lower case for Jim, as shown in Fig. 5.1. As MacBeath explains, "While Jim and Midge are together a face-to-face conversation is hardly likely to get off the ground. To make this clear let us say that they are together from t_0 until t_{10} on Jim's time-scale, and from T_0 until T_{10} on Midge's TIME-scale; t_0 is then the same temporal instant as T_{10} and, in general, $t_n = T_{10-n}$. If Jim at [his time] t_2 asks Midge a

[6]M. C. Pease," *Astounding Science Fiction*, "Reversion," December 1949. See also R. A. Banks, "This Side Up," *Galaxy Science Fiction*, July 1954, for a tale about the confusion caused by projecting a film the wrong way in time.

[7]The modern view that a time-reversed world would appear normal to someone living in it can be traced back at least as far as to J. J. C. Smart, "The Temporal Asymmetry of the World," *Analysis*, March 1954, pp. 79–83, an analysis, alas, that may not convince everyone.

[8]M. Dummett, "Bringing About the Past," *Philosophical Review*, July 1964, pp. 338–359.

[9]See, for example, D. L. Schumacher, "The Direction of Time and the Equivalence of 'Expanding' and 'Contracting' World-Models," *Proceedings of the Cambridge Philosophical Society* 1964, pp. 575–579; J. V. Narlikar, "The Direction of Time," *British Journal for the Philosophy of Science*, February 1965, pp. 281–285; F. R. Stannard, "Symmetry of the Time Axis," *Nature*, August 13, 1966, pp. 693–695.

[10]This issue is raised, several times, in Robert Silverberg's 1968 novel *The Masks of Time*.

[11]J. R. Lucas, *A Treatise on Time and Space*, Methuen 1973, pp. 43–47.

[12]M. MacBeath, "Communication and Time Reversal," *Synthese*, July 1983, pp. 27–46.

[13]In Goethe's play *Faust*, the normal flow of time is routinely upset.

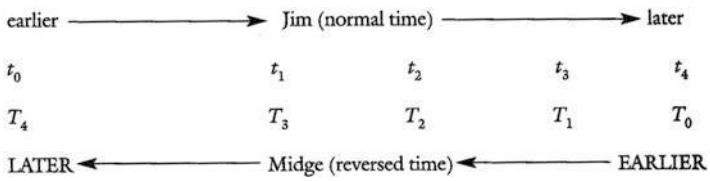

Fig. 5.1 Opposite time flows in counterclock worlds

question, and Midge hears the question at T_8, she will answer at T_9, and Jim will hear his question answered at t_1, *before* he asked it! What is more, if Jim is inexpert at interpreting backward sounds, and at t_4 asks Midge to repeat her answer, Midge will hear that request at T_6, BEFORE she has heard the original question; and her puzzled reply at T_7 will be heard by Jim at t_3 before he has uttered the request." Certainly this is a mess in time, and Lucas seems to be on safe ground with his denial of the possibility of communication between Jim and Midge. MacBeath, however, shows how to refute all of Lucas' arguments if Jim and Midge are allowed to be clever about how they send their messages back and forth—that is, if we give up some of our usual ideas of what a conversation is like. MacBeath's analyses are far too lengthy and detailed to present here, but the simplified diagram of Fig. 5.1 should enable one to follow the logic of his approach.

We imagine that Jim and Midge will not actually talk, and so will not have to decipher backward-spoken language. Rather, they will exchange messages via computer-generated text displayed on monitor screens, screens that are separated by a window that is proof against all penetration but the light emitted by those screens.[14] The nature of this window is not a trivial matter: if we accept the anti-matter nature of Midge's world then it is *essential* to keep her and Jim apart! To that end, MacBeath imagined that the window is double paned, with a perfect vacuum in-between. The exchange of photons between the two worlds should present no problems because photons are their own anti-particles.[15]

Now, imagine that at t_0 Jim brings a computer to the window. He programs it to wait for 4 days, until t_4, and then to display the following message on its screen: "This message is from Jim, who experiences time in the sense opposite to yours. Please study the following questions and display your answers on a computer screen three days from now." Jim's messages ends with the list of questions.

Because all that took place at t_4, Midge sees Jim's message and questions at what we will now call T_0. As requested, she brings her computer to the window, enters the answers to Jim's questions, and programs the machine to display them (after a

[14]Communication between beings in counterclock worlds, using written messages displayed through a window, appeared in science fiction *years* before MacBeath wrote: see I. Watson's 1978 novelette "The Very Slow Time Machine."

[15]There is no difference in the time sense of photons in either world because the flow of proper time for a photon—traveling at the speed of light, by definition—is zero (recall the discussion in Sect. 3.6).

3 day delay) on its screen. Thus, at T_3, which is Jim's t_1, Jim sees Midge's computer screen light up with "Hi, Jim. This is Midge. The answers to your questions are at the end of this message. Now, I've got some questions for *you*. Please display the answers two days from now." Midge's message ends with answers to Jim's questions and her list of questions.

Jim sees Midge's message at t_1, enters the answers to her questions and sets the machine to answer after a 2-day delay. At t_3, which is Midge's T_1—and by now you see how the process goes. It's cumbersome, sure, but it works. Or at least it does if everybody follows the rules. What if they don't? MacBeath provides other, increasingly complicated analyses to treat some of the more subtle problems that can be imagined in this method of exchanging messages. I will mention just two of them, which have direct analogs with what we normally think of as 'time travel.'

For the first problem, consider Jim's initial message, created at t_0 to be sent at t_4. He receives Midge's answer as described above at t_1, *before* his message is displayed through the window. So, what happens if at t_2 Jim cancels the message and it is *not* displayed? He has already gotten Midge's reply, but how can that happen if he does not send his message? This is, of course, a bilking paradox, with an explanation that we discussed in the previous chapter.

A second problem is the apparent possibility of creating a causal message loop. For example, let's say that at t_0 Jim suddenly decides to send a message through the window. (His reason for this sudden urge will be explained in the next few lines.) He thinks all night about what to send and, at t_1, finally settles on the following: "Greetings to the people on the other side of the window. This message comes from Jim, who hopes you will reply." Midge immediately sees Jim's message through the window (at her time T_3) and so is suddenly caught up with the desire to respond. She thinks all night about what to send and, hoping to be witty, she finally decides (at time T_4) on the following echo to Jim's message. "Greetings to the people on the other side of the window. This message comes from Midge, who hopes you will reply." Jim immediately sees this through the window (at what is his time t_0) and so now we know why he decides to send his original message! And Jim *will* send his original message—he has to because Midge replied to it.

In a review of a book on the direction of time, the philosopher Hilary Putnam restated the problems of a time-reversed world in the form of a provocative question: "How do you know that one man's future isn't another man's past?"[16] He began by making the interesting observation that for us to be able just to observe a backward-running universe, we would have to provide our own normal radiation source, because the counterclock stars in such a universe *absorb* radiation rather than emitting it. This point was elaborated on by another philosopher some years later, who wrote "We have uncritically imagined someone looking in on . . . two worlds having opposite time directions . . . Part of the story we tell, of the process of seeing, involves the emission of photons from objects [for example, the computer screens of Jim and Midge] and the subsequent impinging of these photons on our

[16]H. Putnam, *The Journal of Philosophy*, April 1962, pp. 213–216.

retinas. But this process is obviously directed in time. In a world where time ran opposite to ours, we could not see objects at all: objects would be photon-sinks, not photon-emitters."[17]

Putnam concluded his comments about reversed time with a cautious warning: "It is difficult to talk about such extremely weird situations without deviating from ordinary idiomatic usage of English. But this difficulty should not be mistaken for a proof that these situations could not arise." That challenge is no doubt why so many writers of science fiction and fantasy have tackled the question of what it would be like if time ran backward. We can find such a tale long before the science fiction pulps, in fact, in a tale that appeared when Einstein was just 7 years old. In that story[18] the narrator (a professor of astronomy and higher mathematics) suddenly finds himself on Mars. There he encounters beings who know the future up to their deaths, and whose memories of the past are "scarcely more than a rudimentary faculty." The entire tale is in the form of a conversation between the professor and one such being, who argues (quite persuasively) for the virtues of his 'backward' existence compared to that of earthlings (the Martian name for Earth is the story's title). Bellamy realized that his story implies a fatalistic block universe: "No one could have foresight . . . without realizing that the future is as incapable of being changed as the past," he wrote.

Other writers, too, were fascinated by the implications of reverse time. When Merlyn the magician makes his first appearance in T. H. White's 1939 masterpiece *The Once and Future King*, for example, he explains how he knows the futures of others: "Ordinary people are born forward in Time, if you understand what I mean, and nearly everything in the world goes forward, too . . . But I unfortunately was born at the wrong end of time, and I have to live backwards from its front, while surrounded by a lot of people living forwards from behind. Some people call it having second sight."

What may have put the idea in White's mind for his time-reversed magician is only speculation today, but perhaps it was something he might have read a decade before, in a fellow Englishman's writing, the 1929 book *The Nature of the Physical World* by Sir Arthur Eddington, where one finds the following passage: "In "The Plattner Story" H. G. Wells relates how a man strayed into the fourth dimension and returned with left and right interchanged . . . In itself the change is so trivial that even Mr. Wells cannot weave a romance out of it [but see one of the *For Further Discussion* questions at the end of Chap. 2]. But if the man had come back with past and future interchanged, then indeed the situation would have been lively."

Whether or not those words influenced English fantasy, they certainly had some effect on American science fiction. In his 1979 memoir *The Way the Future Was*, pulp editor Frederik Pohl wrote that Eddington's book (which Pohl incorrectly attributed to Sir James Jeans) had given him the idea for a story using the reversed-time twist. But before Pohl could publish it, an even better (claimed Pohl) tale

[17]N. Swartz, "Is There an Ozma-Problem for Time?" *Analysis*, January 1972, pp. 77–82.

[18]E. Bellamy, "The Blindman's World," *The Atlantic Monthly*, November 1886.

arrived from Malcolm Jameson. Jameson, too, had read Eddington's book, and the result was the novella-length "Quicksands of Youthwardness," which Pohl published in *Astonishing Stories* as three-part serial during 1940–1941. Unfortunately, Jameson's tale is both pretty awful *and* devoid of *any* connection with Eddington's suggestion. One can only wonder about what might have been in the story Pohl says *he* discarded—did *it* have the future remembered? Alas, Pohl wrote that he couldn't remember!

Remembering the future does occur in one tale where everybody knows what will happen (as they live backward) by reading "prediction books." What distinguishes that story from many others on the same theme is an interesting, ironic conversation a student in a reverse-time world has with a philosophy professor about how things would be if time went the 'other way,' as in *our* world:

> "How can we tell? The reverse sequence of causation may be just as valid as the one we are experiencing. Cause and effect are arbitrary, after all."
>
> "But it sounds pretty far-fetched."
>
> "It's hard for us to imagine, just because we're not used to it. It's only a matter of viewpoint. Water would run downhill and so on. Energy would flow the other way—from total concentration to total dispersion. Why not?"[19]

The student is unconvinced, however, and when he tries to visualize such a peculiar world (*our* world, don't forget!) it gives him a "half-pleasant shudder." Imagine, he thinks in wonder, never knowing the date of your own death.

A few years later, in Wilson Tucker's 1955 novel *Time Bomb*, we find the intriguing idea of political assassination by time bomb, with the bombs actually *time traveling* to their targets. A policeman begins to suspect what is happening when it becomes evident that one of the explosions was actually an implosion: "The time bomb . . . had been going in and had carried the force of the blast with it. Inward. Into the past. He frowned at that. A backward explosion? An explosion which ran counter to the normal flow of time, to the normal method of living? . . . How would an explosion appear to a man if the blast happened in the opposite manner? If it began exploding now, in this moment, but continued backward instead of forward? Would it be an implosion?"

There is little doubt that the definitive treatment of a reversed-time world is that of Philip K. Dick's 1967 novel *Counter-Clock World*. Dick's world was once our world, but then, as in Plato's tale that began this chapter, time suddenly begins to run backward. People still alive reverse their direction of aging (but still think, walk, and talk in forward time), and dead, buried people come alive again and emerge from graveyards as the "Sacrament of Miraculous Rebirth" is intoned by a priest; all live their way back to the womb, just as in Plato's tale of 1600 years earlier. Such imagery is powerful stuff, but the physicist John Wheeler (of black hole fame) would have none of it. As he wrote, "Most of us would probably agree

[19] D. Knight, "This Way to the Regress," *Galaxy Science Fiction*, August 1956.

that the universe has not contained and will not contain any backward-looking observers. We do not expect to see caskets with corpses in them coming to life, nor do we expect to find bank vaults in which a gram of radium will integrate rather than disintegrate."[20]

5.2 Multi-dimensional Time

> "If there are extra time dimensions we get violations of causality, because one could sneak to yesterday through the extra dimensions, and . . . if you had sneaked to yesterday, you would have disappeared from today."[21]

There are those, however, who haven't been quite so sure as Wheeler about the impossibility of a reversed-time world. One physicist, for example, showed how (under certain initial conditions at the Big Bang) there is a possible solution to the gravitational field equations that gives an oscillating universe that temporally runs backward during the contraction phase.[22] And a philosopher has argued that the *direction* of time is local, not global (just as special relativity showed is the *rate* of time) and that the arrow of time can point in opposite directions at different locations.[23] As odd as such ideas may seem, a generalization of reversed-time—*multi-dimensional* time—makes it seem small potatoes. This is the idea that there might be *many* possible directions to the arrow of time, not just two. At first this may seem an absurd idea, something akin to a man jumping onto his horse and riding off in all directions at once. But philosophers (and perhaps just a few physicists[24]) have started to take at least a semi-serious look at the concept; as

[20]Wheeler's comments can be found in the General Discussion at the end of *The Nature of Time* (T. Gold, editor), Cornell University Press 1966.

[21]An intriguing (if somewhat mysterious) thought from F. J. Yndurain, "Disappearance of Matter Due to Causality and Probability Violations in Theories with Extra Timelike Dimensions," *Physics Letters B*, February 28, 1991, pp. 15–16.

[22]H. Schmidt, "Model of an Oscillating Cosmos Which Rejuvenates During Contraction," *Journal of Mathematical Physics*, March 1966, pp. 494–509. An elaboration of Schmidt's ideas is in A. Walstad, "Time's Arrow in an Oscillating Universe," *Foundations of Physics*, October 1980, pp. 743–749.

[23]G. Matthews, "Time's Arrow and the Structure of Spacetime," *Philosophy of Science*, March 1979, pp. 82–97.

[24]More than half-a-century ago one writer asserted that two-dimensional *complex* time was old hat in the theories of spinning particles—see M. Bunge, "On Multi-dimensional Time," *British Journal for the Philosophy of Science*, May 1958, p. 39. For a summary of many of the objections to multi-dimensional time see J. K. Kowalczynski, "Critical Comments on the Discussion About Tachyonic Causal Paradoxes and the Concept of Superluminal Reference Frames," *International Journal of Theoretical Physics*, January 1984, pp. 27–60 (and the reply by E. Recami, September 1987, pp. 913–919).

with so many other of the radical concepts associated with time travel, though, science fiction writers were dealing with multi-dimensional time long before it became a respectable topic in learned philosophical and physics journals.

In one pulp story, for example, we find a professor asking his redundantly named class in speculative metaphysics "Why shouldn't time be a fifth, as well as a fourth, dimension?"[25] In response to a generally skeptical reception to that, the professor goes on to say "I believe in the existence of a two-dimensional time scheme ... Ordinarily, most people think of time as a track they run on from their births to their deaths ... Think of this time track we follow over the *surface of time* as a winding road [it is the imagery of a surface that gives the professor *two* time dimensions] ... Once in a while another road crosses at right angles. Neither its past nor its future has any connection whatsoever with the world we know."[26]

The year before, the same pulp had published another tale[27] that went well beyond a mere two time dimensions. We are told in that story of two countries on an alien planet at war in the distant future. The war is a stalemate until one side begins to fire a gun at its foe from just two miles from its target, in the heart of enemy territory—*from the middle of next week*! The gun's shells are true 'time bombs.' This is not mere 'ordinary' time travel along one time track, however, but a multidimensional effect. Using a photograph of the gun in actual operation to support his astonishing discovery, an agent for the side being shelled reports to his superior that "the gun and its crew are existing along another time axis at right angles to the direction of our 'normal time,' so that from our point of view they are existing perpetually in the same instant."

That explains why the gun crew can (will?) operate without interference in next week's future, as they are in their adversary's time only for the instant that the two time tracks intersect. Indeed, the spy used the same trick to obtain his undetected photograph: "I secured the photograph by orienting myself along still another time axis at right angles to that of the gun, and approached it as an instantaneous, invisible entity." By the story's end both sides are using and counter-using this technique, evading each other "to and fro along an ever increasing complexity of mutually perpendicular time axes." In fact, the final count exceeds 75 time axes, making Heinlein's two-dimensional time look rather skimpy by comparison.

Well, of course, 75 time directions *is* science fiction (I think), and physicists are not so enamored of multidimensional time as are science fiction writers. For example, Eddington wrote that he found the idea of any region of spacetime involving two-dimensional time to "defy imagination."[28] Another physicist showed that the extremal property of timelike geodesics (look back at Fig. 3.15 and its

[25]R. Heinlein, "Elsewhen," *Astounding Science Fiction*, September 1941.

[26]This story has an amusing scene in which one of the professor's students accidently 'jumps time tracks' and so enters a new track with his arrow of time pointing backwards.

[27]N. L. Knight, "Bombardment in Reverse," *Astounding Science Fiction*, February 1940.

[28]A. S. Eddington, *The Mathematical Theory of Relativity* (2nd edition), Cambridge University Press 1924, p. 25.

discussion) would fail for multidimensional time, which he then associated with the stability of matter and a failure of causality.[29] Yet another physicist, however, was just a bit more willing to consider multidimensional time, and suggested that a viable theory of quantum gravity *might* support the idea of multiple time dimensions.[30] Of just *what* more than one time dimension might actually *mean*, however, this same physicist echoed Eddington by writing "Physics in a spacetime of . . . two timelike dimensions would be very weird indeed." Agreeing with this physicist was a philosopher who called the idea that there could be more than one dimension to time a "rather wild possibility" and a "fairy-tale."[31] These are probably fair statements of how most physicists presently think of multidimensional time.

But not all philosophers are of that persuasion, and many are in fact as fascinated by the possibilities of multidimensional time as are science fiction writers. So, *why* this interest in something so different from anything we actually experience? Where does the motivation come from? Of what *use* is multidimensional time? I think the answers to those questions all derive from how multidimensional time offers a theoretical model for giving meaning to the view that the past can be changed (take a look back at note 20 in the Introduction).

In a certain trivial sense, of course, the past is always changing. For each of us the past is the set of all events that have happened, arranged in a before/after temporal order, and this set is continually increasing (and so changing). That is not, however, what most people mean by a changeable past. What *is* meant is that there may be some kind of change in the temporal ordering of events, or that an event that once was (or wasn't) a member of the set of past events no longer is (or is now) a member. Two-dimensional time offers a way to make sense of such possibilities, which one-dimensional time simply cannot do. To see how that works, I'll follow the presentation in a paper that forcefully argues that it does make sense to talk about altering the past.[32]

Meiland was aware that some might find his model *ad hoc*, even "incredibly weird" (in his own words), but he justified his efforts by taking a refreshingly enlightened, non-Humean view of what he thought would be the proper response to meeting purported time travelers: "If strange machines containing people in futuristic garments and speaking strange tongues (or perhaps using ESP instead of speech) were to appear and were to claim to be from the future, we might very well begin to search for a theory of time that allows their claim to be true." In Fig. 5.2 you can see how Meiland tried to do just that.

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[29]J. Dorling, "The Dimensionality of Time," *American Journal of Physics*, April 1970, pp. 539–540.

[30]C. Isham, "Quantum Gravity," in *The New Physics* (P. Davies, editor), Cambridge University Press 1989.

[31]D. Zeilicovici, "Temporal Becoming Minus the Moving-Now," *Nous*, September 1989, pp. 505–524.

[32]J. W. Meiland, "A Two-Dimensional Passage Model of Time for Time Travel," *Philosophical Studies*, November 1974, pp. 153–173. Jack Meiland (1934–1998) was a professor of philosophy at the University of Michigan.

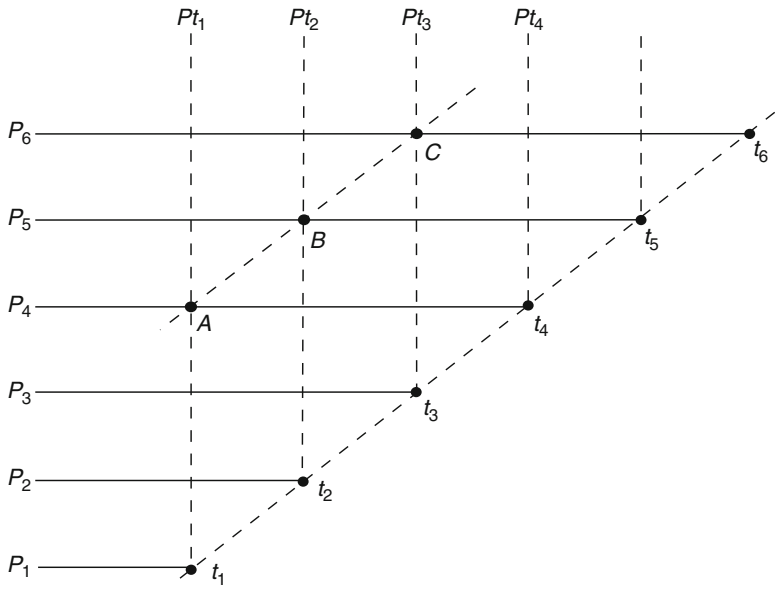

Fig. 5.2 Two-dimensional time

The dashed diagonal line, marked with the points $t_1, t_2, \ldots$ represents our usual one-dimensional image of time. The horizontal lines P_1t_1, $P_2t_2 \ldots$ (which we can simply call $P_1, P_2, \ldots$, for short) are the pasts for the present instants $t_1, t_2, \ldots$. That is, P_1 is the past with respect to the present t_1, P_2 is the past with respect to the present t_2, and so on. The dashed vertical lines allow us to locate any moment in the past. For example, the intersection point A of P_4 with Pt_1 is the location of t_1 in the past with respect to the present t_4.

With this model, Meiland then analyzed in detail several interesting special cases. Suppose that t_1 and t_2 are 1 year apart and that there is a similar time separation between all adjacent, marked present moments on the diagonal. Let us further suppose that a time traveler at t_4 journeys backward 3 years to t_1, to arrive at point A. Assume he stays in the past 2 years; then his temporal locations lie along the dashed diagonal line ABC; that is, at B he is 3 years in the past of t_5, and at C he is 3 years in the past of t_6. From Fig. 5.2, then, we can imagine the time traveler saying, as he climbs into his time machine at t_4, "One year from now I'll be two years from now." That rather astonishing statement makes sense when we take both uses of now to be t_4 and observe that B (1 year from A) is 2 years in the past with respect to t_4.[33]

[33] A critic of time travel (see note 119 of Chap. 2) used what he claimed to be the absurdity of such a statement to support his ejection of time travel. One of Meiland's reasons for developing his two-dimensional model of time was, in fact, to be able to reply to that critic (Donald Williams).

Meiland's two-dimensional time model is undeniably fascinating, but it simply has no theoretical justification (as far as I know[34]). It is not necessary to assume two-dimensional time to explain Meiland's "strange machines containing people in futuristic garments"; it is possible to do that with one-dimensional time in a four-dimensional spacetime. The classic paradoxes, too, are understandable without two-dimensional time, as discussed in the previous chapter.

5.3 Maxwell's Equations and Sending Messages to the Past

> "Communication with a world exactly, to minutest detail, a duplicate of our own [but] twenty thousand years ahead of us might ruin the human race as effectively as if we had fallen into the Sun."[35]

Every physicist and electrical engineer knows that the mathematical description of the electromagnetic field is given by Maxwell's equations. In particular, radio engineers know that the waves of energy their antennas launch into space follow the predictions of those equations with astonishing accuracy. Indeed, when Einstein's relativity theory was completed, it was found that Maxwell's equations automatically satisfy relativity because magnetic effects *are* relativistic effects; in other words, relativity is built into Maxwell's equations. Whereas Newton's laws of dynamics had to be patched up, Maxwell's equations were untouched by the discovery of relativity.

Thus, it was a puzzle when physicists discovered that careful study of the seemingly perfect Maxwell equations, when applied to antennas, apparently results in the prediction of causality violation. It is found, in fact, that the equations have *two* solutions. One, as expected, contains the feature of time delay; that is, creating an electromagnetic disturbance at the antenna *now* causes a detectable effect at a distant point in space *later*. This is the so-called *time-retarded-solution*, and its common-sense physical interpretation is that of energy waves traveling away from the antenna as they also travel into the future. The shock was that Maxwell's equations also accept an *advanced solution*; energy waves *arriving* at the antenna from infinite space.

The physicist Paul Renno Heyl (1872–1961) wrote the perhaps first scientific work discussing advanced electromagnetic effects, in his 1889 University of Pennsylvania doctoral dissertation with the provocative title "The Theory of Light on the

[34]Many of the arguments against multi-dimensional time can be found in M. MacBeath, "Time's Square," in *The Philosophy of Time* (R. Le Poidevin and M. MacBeath, editors), Oxford University Press 1993. MacBeath concludes, however, with "I would not want to rule out the possibility . . . that time is three-dimensional. Or worse." See also Alasdair Richmond, "Plattner's Arrow: Science and Multi-dimensional time," *Ratio*, September 2000, pp. 256–274.

[35]The Victorian writer Samuel Butler (1835–1902), in the "Imaginary Worlds" entry of *The Notebooks of Samuel Butler* (published posthumously in 1912), commenting on the chaos that communication across time might cause.

Hypothesis of a Fourth Dimension." Heyl cited the scientific guru of the fourth dimension, C. H. Hinton (look back at the last "For Further Discussion" assignment in Chap. 2) as his inspiration. The situation described by Heyl is something like that of a child standing at the edge of a pond. She throws a rock into the middle of the pond and watches ripples spread out and away from the splash. Suddenly, she sees ripples appear all around the edge of the pond and then travel inward toward the center, where they all converge at once. A spout of water then erupts from the surface of the pond at the simultaneous meeting of the inward-traveling ripples, and she watches as a rock is ejected from the spout to land back in her hand. She is, of course, open-mouthed with astonishment! How absurd, you think, as you read this, and who could blame you? This amazing imagery of advanced effects we owe to the philosopher Karl Popper, and it has come to be called "the fable of the Popperian pond."[36]

Pursuing the mathematics of wave motion in the fourth dimension, Heyl wrote "We are led to the curious conclusion that, in Hinton's aether,[37] the nature of the central disturbance *after* a given instant can influence the form of the aether *before* that instant. In other words, the aether seems to be endowed with an uncanny faculty of foreknowledge." We can avoid such a counter-intutive implication of advanced effects, but only at the price of something many physicists and philosophers consider equally unacceptable: information traveling from the future into the past. We can still think of the advanced solution as representing electromagnetic waves of energy traveling *away* from the transmitting antenna—that is, as being *broadcast*, just like the retarded solution, rather than being received from infinity—*if* we also think of the waves traveling backward in time. Thus, the advanced solution to Maxwell's equations holds out the possibility of sending messages to the past, a sort of poor man's time travel. It may seem that we have simply traded one problem for another, however, because just sending information into the past can cause many of the same paradoxical, causality-busting situations that physical time traveling is claimed to cause.

The cosmologists Fred Hoyle (1915–2001) and J. V. Narlikar commented on the potential problems posed by communication backward in time, in their 1974 book *Action at a Distance in Physics and Cosmology*: "The [Maxwell] equations supply us with both advanced and retarded solutions (and, because of the linearity, with any linear combination of them) . . . With so many solutions theoretically possible, why does nature always select the retarded one? That this question cannot be answered within the framework of Maxwell's theory must be regarded as one of its intrinsic weaknesses."

[36]K. Popper, "The Arrow of Time," *Nature*, March 17, 1956, p. 538. See, too, note 110 (and its discussion) in Chap. 2.

[37]It was thought, in nineteenth century physics, that electromagnetic waves need a *medium* through which to propagate (like ocean waves need water, and sound waves need air), a mysterious substance called the *aether* (or *ether*) that exists even in a vacuum. The 1871 Michelson-Morley experiment, however, implied that the aether simply does *not* exist.

That branding of Maxwell's theory as having an "intrinsic weakness" because of its prediction of an advanced solution was, I think, unwarranted. Indeed, the advanced solution can be given a perfectly reasonable physical interpretation.[38] Imagine a transmitting antenna sending electromagnetic waves to an identical receiving antenna. At any point in space between the two antennas there are electric and magnetic fields. Maxwell's equations allow us to calculate the fields produced by alternating currents in the two antennas. When we do an analysis of the relationship between the transmitting antenna's current and the fields, we use the retarded solution because the current is the cause and the fields are the effect. But in the analysis of the relationship between the fields and the receiving antenna's current, the situation is reversed, and the fields are the cause and the current is the effect. That is, the advanced solution is simply the mathematics relating the current in the receiving antenna *now* to the fields *in the past*.

An acceptance of both solutions has, in fact, been in the physics literature for nearly a century. As the Yale physicist Leigh Page (1884–1952) wrote decades before Hoyle and Narlikar, "While the advanced potentials, as well as the retarded potentials, satisfy the electromagnetic equations, the former has generally been discarded for the reason that it has been more in accord with the trend of scientific intuition to consider that the present is determined by the past course of events than by the future. However, if it is once admitted that the present state is uniquely determined by any past state, it follows that the future is also so determined, and hence the employment of a future state as well as a past state in specifying the present marks no inherent departure from our accustomed methods of description . . ."[39]

It may still be tempting, however, to just dismiss the advanced solution as a mere anomaly of the mathematics and to discard it on physical grounds. This is the traditional approach taken by physicists when confronted with non-causal solutions in any physical theory and, indeed, that was what Swiss physicist Walter Ritz (1878–1909) did with the advanced solutions to Maxwell's equations (an approach that involved Ritz during the last year of his life in a dispute with Einstein). For Ritz, the reversal of cause and effect simply did too much violence to his intuition to be taken seriously, and so he thought one must *impose* causality on Maxwell's equations (a condition they do not inherently contain) by *a priori* rejecting the advanced solution.[40]

Still, electrical engineers make similar kinds of judgements all the time, as when the solution of a quadratic equation for a passive (energy-dissipating) resistor gives

[38]See, for example, S. L. Schwebel, "Advanced and Retarded Solutions in Field Theory," *International Journal of Theoretical Physics*, October 1970, pp. 347–353, and L. M. Stephenson, "Clarification of an Apparent Asymmetry in Electromagnetic Theory," *Foundations of Physics*, December 1978, pp. 921–926.

[39]L. Page, "Advanced Potentials and Their Application to Atomic Models," *Physical Review*, September 1924, pp. 296–305.

[40]For more on this, see O. Costa de Beauregard, "No Paradox in the Theory of Time Anisotropy," *Stadium Generale* 1971, pp. 10–18.

both a positive value (which 'makes sense') and a negative value (which doesn't 'make sense' and so is simply ignored). There *were*, however, those who encouraged caution on this issue. Seventy-five years ago, for example, the eminent MIT electrical engineer Julius Adams Stratton (1901–1994) echoed Leigh Page's warning when he wrote of the disturbing advanced solution, "The familiar chain of cause-and-effect is thus reversed and this alternative solution might be discarded as logically inconceivable. However, the application of 'logical' causality principles offers very insecure footing in matters such as these and we shall do better to restrict the [Maxwell] theory to retarded action solely on the grounds that this solution alone conforms to the *present* [my emphasis] data."[41]

And in a famous paper I'll discuss in the next section, Wheeler and Feynman declared that "We conclude advanced and retarded interactions give a description of nature logically as acceptable and physically as completely deterministic as the Newtonian scheme of mechanics. In both forms of dynamics the distinction between cause and effect is pointless. With deterministic equations to describe the event, one can say: the stone hits the ground because it was dropped from a height; equally well, the stone fell from a height because it was going to hit the ground."[42] For Wheeler and Feynman, the reversal of cause and effect inherent to backward causation and time travel to the past offered no conceptual difficulties.

The elimination of an appeal to causality, or to the 'weirdness' of advanced waves, in arguing for the naturalness of the retarded solution to Maxwell's equations was first done in 1976.[43] The only auxiliary condition applied to the equations was simply the natural one of requiring the initial field energy to be finite.[44] And yet, today, there is still no experimental evidence for the physical reality of the advanced solution. Now and then one does run across speculations that the advanced waves of *something* traveling backward to us from the future might explain the so-called ESP 'talent' of precognition, but that is all it is, speculation.[45]

Advanced waves appeared in the pulp science fiction of the late 1930s, a decade before Wheeler and Feynman. For example, one story actually specifically invoked the advanced solution to Maxwell's equations, with a gadget (making use of what the author called the "anticipated potentials") displaying the near future on a television-like screen.[46] The author's by-line proudly gave his academic credentials as including a master's degree and, in fact, John Pierce was a graduate student in electrical engineering at Caltech. He received his doctorate just months after this

[41]J. A. Stratton, *Electromagnetic Theory*, McGraw-Hill 1941, p. 428.

[42]J. A. Wheeler and R. P. Feynman, "Classical Electrodynamics in Terms of Direct Interparticle Action," *Reviews of Modern Physics*, July 1949, pp. 425–433.

[43]P. C. Aichelburg and R. Beig, "Radiation Damping As An Initial Value Problem," *Annals of Physics*, May 1976, pp. 264–283.

[44]J. L. Anderson, "Why We Use Retarded Potentials," *American Journal of Physics*, May 1992, pp. 465–467.

[45]See M. B. Hesse, *Forces and Fields*, Philosophical Library 1961.

[46]J. R. Pierce, "Pre-Vision," *Astounding Stories*, March 1936.

story was published, and then went on to a highly distinguished career at Bell Telephone Laboratories and then later at the Jet Propulsion Laboratory operated by Caltech for NASA. Pierce knew all about Maxwell's equations, of course, and he actually opened his tale with a quote from Page's 1924 article (note 39) on the advanced solution. How many fictional pieces include quotes from the *Physical Review*?

And it would probably take something like advanced waves to explain the funny doings 2 years late in a story of a man caught in a time machine accident. Nearly all of his body ends up 4 years in the future—but only *nearly* all, because his eyes remain the present! As one of the puzzled observers of this odd business wonders, "Strange, that his eyes, now, can convey a message to his brain, four years hence, and his brain tells the eye muscles to move the eyeballs which are four years behind them —."[47]

Some of the most intriguing paradoxes of time travel involve no traveler—only information. Of course, any information flow at all, independent of time travel, involves the flow of energy and, as Einstein showed, energy and mass are different aspects of the same thing. Accordingly, information time travel involves the transfer of mass/energy. Thus, a man in the twenty-fifth century who sends a backward-in-time 'temporal radio' message to a twentieth-century woman stating that he loves (will love?) her is sending much more than mere emotion. Just *how* to send a message backward in time is, of course, the puzzle.

Indeed, all forms of present-day communication are transmissions only to the future. If you speak to someone, or if you send a radio message, there are always delays depending on the distance of separation and the speed of transmission of sound and light, respectively. If you want to send a message to the one hundred and twenty-fifth century, you can; just write a letter and seal it in a pressurized bottle of helium. This basic idea is dramatically presented in a novel about a scientist who is accidently transported from 2162 back to the late-Cretaceous, 80 million years into the past. There he leaves a written record on seven sandstone slabs of his brutal, lonely life among the dinosaurs—letters across time, if you will—found by twenty-second century geologists some years after his disappearance.[48] The transmission of such letters, *forward* in time, while dramatic, is not a puzzle. But what could be more astonishing than the message received *from the future* by the young inventor of the first time machine: after his initial experiment of sending his pilotless machine into the future, it returns with an envelope inside. Eagerly tearing it open, he finds the note is from the National Academy of Sciences: "We know from old records and museum models that this is the Cullen Foster experimental machine. Fifty years looks down on you and says 'Good work'."[49]

Heady stuff, that, but lots of other possible messages are capable of competing with young Foster's when it comes to generating excitement. For example, suppose

[47]M. Schere, "Anachronistic Optics," *Astounding Stories*, February 1938.

[48]G. G. Simpson, *The Dechronization of Sam Magruder*, St. Martin's Press 1996.

[49]D. Stapleton, "How Much to Thursday?" *Thrilling Wonder Stories*, December 1942.

you had a gadget that is superficially similar to a telephone but that calls telephones in the *distant* future. You can hear the person (in the future) on the other end, but they can't hear you (in their past). That is, information can flow only from future to past. It is then easy to imagine situations in their use of this device that at least seem paradoxical. For example, suppose you call your own private number 1 month ahead. You hear your future-self first answer the phone, and then recite the winning lottery for the 'previous' day, which is a month in your present self's future. (Your future self does this somewhat odd recital because a month from now you will remember, when your private phone rings, just *who* is calling!) So, now in the present you know you'll make a fortune by winning the lottery a month later.

This example *is* admittedly somewhat mysterious since, for the gadget to call far ahead in time, some sort of signal (as yet unspecified) must travel into the distant future because *something will* make the future phone ring. For the present discussion I am ignoring this crucial issue for the sake of the dramatic impact of the example. Soon, however, we'll get a little way into describing how one might, in principle, actually build this gadget, which in the physics literature is called an *antitelephone*. (Such a device is an *anti*telephone because the person who is the receiver is in the sender's past, the opposite of the situation for an ordinary telephone.) An interesting fictional illustration of such a gadget, despite being told as a hard-boiled detective murder mystery, appeared in science fiction some years ago (alas, while called a "time telephone," no theory for its operation was given, but instead was 'explained' as a "straightforward application of an impressive, but limited, technology").[50] So far, there is nothing paradoxical (or even illegal) in all of this, but what if, when the phone rings in the future the day after you won the lottery, you perversely decide *not* to recite the winning number? This apparent paradox has, in fact, already been treated with the aid of the block universe view of spacetime; that is, if the future-you spoke the lottery number when you originally called, then the present—you (now in the future) *must*, inevitably recite it.[51]

Let's now make things a bit more involved. Suppose that instead of calling your future self, you call the weather service and listen to the recorded message telling you the weather, 30 days hence. You do this day after day, and after a while you get a reputation for being able to predict, *perfectly*, the weather for every day to come, up to a month into the future. Your reputation spreads far and wide, and after a while more the weather service hears about you. Meteorologists check and find you are *never* wrong. Their computer models are only 80 % accurate out to 3 days, and for a week's prediction and beyond, the general public might as well flip a coin on whether it will rain or not on any particular day. But you are 100 % correct out to ten times their range. And so they hire you—and as a secondary job, you also make the

[50]S. Schmidt, "Worthsayer," in *More Whatdunits* (M. Resnik, editor), DAW 1993. The author, Stanley Schmidt, has a Ph.D. in physics and is a former editor of *Analog Science Fiction* magazine.

[51]For a fictional illustration of this (a so-called *bilking paradox*), see W. Tevis, "The Other End of the Line," *Magazine of Fantasy and Science Fiction*, November 1961.

daily weather recordings. (The voice on the other end of the gadget *has* sounded sort of familiar!) Here, then, is the puzzle we encountered earlier in causal loops carrying information: from *where* is the information in the flawless weather predictions coming from?

One easy answer is that the question is meaningless because such a future-to-the-past information flow must be impossible. Indeed, if I am to avoid telling a 'philosopher's fairy tale,' like those I criticized earlier in the book, I must admit that one consistent, non-paradoxical answer is found in recognizing that I have *assumed* that those 30-day weather reports are correct. Maybe, however, they are no better than anybody else's predictions. And so you *don't* become famous, and you *don't* get hired—and so there *isn't* any paradox. Is that the way to avoid paradoxes involving information flowing backward in time?

Perhaps not. As long as 1917 it was realized that special relativity does not preclude such an apparent backward flow. That is, if information could be transmitted faster than light, *then* messages could travel backward in time. That was the year Richard Tolman (1881–1948), a professor of physical chemistry at the University of Illinois and later at Caltech, wrote "The question naturally arises whether velocities which are greater than that of light could ever possibly be obtained."[52] He then answered that question, with his general conclusion being that if such velocities are possible, then a faster-than-light (FTL) observer could see the time order of two causally related events reverse. And thus the observer would see an affect *before* its cause. Alternatively, a *sub*luminal (slower-than-light) observer could see the two events, which are connected via an FTL interaction, reversed in time order from what a stationary observer would see.

Either situation has come to be called Tolman's paradox, but Tolman himself was careful with his words: "Such a condition of affairs might not be a logical impossibility; nevertheless its extraordinary nature might incline us to believe that no causal impulse can travel with a velocity greater than that of light." That was an astonishing statement, given that Einstein himself had specifically stated in his original 1905 paper on special relativity that such a thing simply could not occur. There is nothing, it would seem, to be "inclined" about.[53]

This rather technical connection between FTL speeds and backward time travel made the transition from theoretical physics to popular culture very quickly. It was in the British humor weekly *Punch*, for example, that the famous (but nearly always misquoted) limerick by A. H. R. Buller (1874–1944) first appeared:

There was a young lady named Bright
Whose speed was far faster than light;
She set out one day

[52]R. C. Tolman, *The Theory of the Relativity of Motion*, University of California Press 1917.

[53]Take a look back at Sect. 3.5, where we showed that the time order of two events can appear reversed for a subluminal observer if the two events are not causally related. Introducing FTL motion results in extending reversal to causally connected events; that is, FTL motion, reversed causation, and time travel to the past, go hand-in-hand-in-hand.

In a relative way
And returned on the previous night.[54]

Where *Punch* dared to go, Hollywood could not be far behind. Indeed, in this case it was actually there first, with the 1922 one-reel silent comedy movie *The Sky Splitter*. This was just a short film (feature pictures generally had at least four reels), so it is not clear how widely distributed and viewed it may have been. The story is that of a scientist testing a new spaceship: when it exceeds the speed of light, he begins to relive his life.

The linkage between time travel to the past and FTL motion is a central one in science fiction, and its fascination was nicely illustrated by one writer who has a time machine experimenter in the twenty-seventh century wonder "Was the speed of light the core of the mystery? At the speed of light did the past and the future become a shining, merging road down which men could walk—in their ears the thunder of time passing . . .?"[55] Not everybody was excited with the idea of FTL motion and travel backwards in time, however, with one eminent scientist declaring that "the limit to the velocity of signals is our bulwark against the topsy-turvydom of past and future."[56]

The obvious question at this point, of course, is whether it is even conceptually possible to build a gadget to send FTL messages backward in time? Einstein himself thought not, saying "We cannot send wire messages into the past."[57] But was he right? One hint at the possibility of achieving FTL speeds is in Dirac's 1938 paper (note 52 in Chap. 2). There, in his remarks about pre-acceleration, Dirac wrote "Suppose we have a pulse sent out from place A and a receiving apparatus for electromagnetic waves at a place B, and suppose there is an electron on the straight line joining A to B. Then the electron will be radiating appreciably [because accelerated charges radiate] before the pulse has reached its centre and this emitted radiation will be detectable at B at a time . . . earlier than when the pulse, which travels from A to B with the velocity of light, arrives. *In this way a signal can be sent from A to B faster than light* [my emphasis]."

This exciting conclusion goes a step beyond the usual examples of 'things that go faster than light.'[58] Dirac had an equally exciting reaction (and here the emphasis is his): "This is a fundamental departure from the ordinary ideas of relativity and is to be interpreted by saying that *it is possible for a signal to be transmitted faster than light through the interior of an electron. The finite size of the electron now reappears in a new sense, the interior of the electron being a region of*

[54]On page 591 of the issue of December 19, 1923.

[55]F. B. Long, "Throwback in Time," *Science Fiction Plus*, April 1953.

[56]A. S. Eddington, *The Nature of the Physical World*, Macmillan 1929.

[57]A. Einstein, "La Théorie de la Relativité," *Bulletin de la Société Francaise de Philosophie* 1922, pp. 91–113.

[58]Such as, for example, the intersection *point* of two very long, closing scissor blades. The explanation for how this can be is that the *point* is massless and does not participate in a causal chain (and so carries no information). Thus, special relativity is not violated.

failure, not of the field equations of electromagnetic theory, but of some elementary properties of space-time." This last line sounds very much like the things people say today about the singularity inside a black hole event horizon. And yet, Dirac was careful to point out that as weird as FTL speed may appear, special relativity is not violated because "in spite of this departure from ordinary relativistic ideas, our whole theory is Lorentz invariant." That is, even though 'faster-than-light' means 'backward in time,' which means 'causality failure,' special relativity still holds true and nothing awful happens to physics, only to our intuitions. The reason for this is that causality is *not* a premise or starting point for the special relativity.[59]

Of course, like any scientific theory, Dirac's theory is not necessarily the last word, and we have to admit the possibility that at least some of its implications (in particular, the possibility of FTL speeds) just aren't so. In all electronic communication systems that we use, information is transmitted by *modulating* a so-called *carrier wave*, and there is some reason to believe that such modulated waves cannot be sent at FTL speeds.[60] We must admit that it is one thing to talk of 'advanced wave radios'—often called *Dirac radios* in science fiction—and quite another to see how physics might actually enable one to talk to the past. FTL communication (without the time travel aspect) appeared in pulp science fiction before 1940, as in one story published the year after Dirac's paper.[61] In it we learn of a man on Pluto who has invented a way to send messages to Earth at twice the speed of light. He uses this gadget to warn of a would-be dictator who is on his way to Earth in a 'mere' light-speed rocket ship, and only an FTL message can warn Earth in time.

5.4 Wheeler and Feynman and Their Bilking Paradox

> "We find it difficult if not impossible to imagine waves that go into the future and *return to the present* [my emphasis] bearing information about where (and when) they have been."[62]

[59]See, for example, G. Nerlich, "Special Relativity Is Not Based On Causality," *British Journal for the Philosophy of Science*, December 1982, pp. 361–388. This same point was made nearly two decades earlier, in a study of the possibility of superluminal sound in superdense matter, by D. A Kirzhnitz and V. L. Polyachenko, "On the Possibility of Macroscopic Manifestations of Violation of Microscopic Causality," *Soviet Physics JETP*, August 1964, pp. 514–519.

[60]See G. Diener, "Superluminal Group Velocities and Information Transfer," *Physics Letters A*, December 16, 1996, pp. 327–331. For more on the modulation of a light-speed carrier wave in everyday AM radio, and in a more sophisticated single-sideband transmitter, see my book *The Science of Radio*, Springer 1999.

[61]N. Bond, "Lightship, Ho!," *Astounding Science Fiction*, July 1939. The author provides an interesting, detailed description of the gadget, and I think it would make a good question on a Ph. D. qualifying exam in physics or electrical engineering to explain the flaw in it.

[62]Bob Brier, *Precognition and the Philosophy of Science: An Essay on Backward Causation*, Humanities Press 1974. Brier is an Egyptologist (!) at Long Island University—with a Ph.D. in philosophy—who specialized at one time in parapsychology.

In 1941, at a meeting of the American Physical Society, Princeton University physicist John Wheeler and his student Richard Feynman discussed a seemingly outrageous idea that provided a possible clue to how a Dirac radio might function. The idea was that the advanced wave solutions to Maxwell's equations are not mere mathematical curiosities, but rather have profound physical significance. At the time, their talk received only a small abstract notice in the *Physical Review*, but after World War II they wrote it all up in a beautiful paper.[63]

Their primary goal was to explain the origin of the force of radiative reaction discussed by Lorentz earlier in the century. This reaction force is the cause of the energy loss suffered by an accelerated, charged particle. Lorentz, who thought of charged particles as having a finite size, attributed this reaction force to the retarded (by the time required for light to cross the width of the charged particle) coulomb repulsion force between one side of the particle's charge to the charge on the opposite side. This view, however, leads to various conceptual and mathematical problems, including an arbitrary assumption on how the charge is distributed over/through the finite volume of the particle, as well as the problems of infinite self-interactions and the issue of what keeps the charge from blowing itself apart by internal coulomb repulsion.

Wheeler and Feynman's theory, on the other hand, avoided those problems by postulating point charges, because a *point* charge cannot repel itself. But then whence the reaction force, if there is no repulsion? Their revolutionary explanation was first to imagine the accelerated point charge as emitting retarded radiation outward in space, eventually to be absorbed by distant matter. This distant matter, which itself consists of point charges that are accelerated by the retarded radiation, then radiates *backward* in time, back toward the original charge that started the chain of events. This backward-in-time, or *advanced*, radiation arrives in the past of the original charge, and *it* is the cause of the observed reaction force. Indeed, Wheeler and Feynman proposed that an accelerated charge will not radiate unless there is to be absorption at some other distant place and future time. That is, the *future* behavior of a distant absorber determines the *past* event of radiation; there is simply no such thing as just radiating into empty space. The entire universe, spatially *and* temporally, is a very 'connected' place!

Astonishingly, this non-causal view of spacetime had been around in physics for at least 20 years before Wheeler and Feynman's talk. They had independently developed their ideas but, after their 1941 talk, Einstein (who perhaps recalled his 1909 debate about advanced effects with Ritz) brought a 1922 paper by the Dutch physicist Hugo Tetrode (1895–1931) to their attention. In his paper Tetrode had written that "the Sun would not radiate if it were alone in space and no other bodies could absorb its radiation ... If for example I observe through my telescope yesterday evening that star which let us say is 100 light years away, then not only did I know that the light which it allowed to reach my eye was emitted 100 years

[63] J. A. Wheeler and R. P. Feynman, "Interaction with the Absorber as the Mechanism of Radiation," *Reviews of Modern Physics*, April–July 1945, pp. 157–181.

ago, but also the star or individual atoms of it knew already 100 years ago that I, who then did not even exist, would view it yesterday evening at such and such a time."

Tetrode's vivid imagery had been, curiously, itself captured even decades earlier in words from the nineteenth century English poet Francis Thompson (1859–1907), in his "The Mistress of Vision":

All things . . . near and far,
Hiddenly to each other linked are,
That thou canst not stir a flower
Without troubling of a star.

None of this, of course, is obvious! As a tutorial paper appearing just 2 years after Wheeler and Feynman's 1945 paper expressed it, "Any physical theory which seriously proposes that events in the future may be the efficient cause of events in the past may be regarded—at least at first glance—as rather revolutionary doctrine."[64] Indeed!

It is interesting to note that Einstein apparently said nothing to Wheeler and Feynman about a paper that pre-dated Tetrode's by 3 years. In 1919 the Finnish physicist Gunnar Nordström (1881–1923) had suggested that the advanced solution might offer an explanation for a perplexing problem in atomic theory. Maxwell's theory says that an accelerated electric charge radiates energy, which implies that the orbital electrons in the classical model of the atom should quickly spiral in toward the nucleus, that is, all matter should collapse. This cataclysmic event (of course!) has not happened, and Nordström's idea was that if one took into account not only the usual retarded solution but the advanced one as well, then perhaps things could be understood. Indeed, Nordström was able to show that such an analysis does give zero for the *average* energy radiated by an orbiting electron. Later, however, Page (note 39) showed that the instantaneous radiated energy is not zero, and that this would lead to observable effects that in fact are *not* observed.

Now, to be sure that the 'doctrine' discussed in note 64 is clear, let me restate what Tetrode, and later Wheeler and Feynman, had in mind. Imagine we have an electric charge (the *source*) that we mechanically shake, that is, accelerate. This allows us to assign a definite *cause* to the charge's acceleration which, of course, radiates energy. This radiation travels outward into space as observed retarded fields until they are eventually absorbed by distant matter. The charges in that distant matter are thus accelerated, and they in turn therefore radiate energy. This induced radiation again consists, according to Wheeler and Feynman, of both retarded and advanced fields. The advanced fields radiate outward but *backward* in time toward the original charge, collapsing upon it at the precise instant we first shook it, thereby producing the radiative reaction force. At any instant of time, at any point in space, the observed field is the sum of the retarded field traveling away

[64]C. W. Berenda, "The Determination of Past by Future Events: A Discussion of the Wheeler-Feynman Absorption-Radiation Theory," *Philosophy of Science*, 1947, pp. 13–19.

from the source into the future and the advanced field traveling toward the source in the past.

But, argued Wheeler and Feynman, there is one last point that has been left out of this picture—there is also an advanced field (traveling away from the source and backward in time) because of the original, mechanical shaking of the source charge. Equivalently, a field traveling *forward* in time will *converge* onto the source because we *will* shake it. Wheeler and Feynman showed that before the mechanical shaking that starts this whole process, the advanced radiation field of the source and the advanced radiation fields of the absorbers exactly cancel each other at every point in space and every instant of time (if there is total absorption in the future), which accounts for the experimental fact that we observe a zero total field before the mechanical shaking occurs.

Wheeler and Feynman showed that if we accept these (strange) ideas, then everything we actually observe is predictable: radiative reaction, the direction of the electromagnetic arrow of time from past to future (retarded-only effects), and the absence of infinite self-interactions. The claim by Wheeler and Feynman to have avoided self-interaction problems via the use of the advanced solution was, however, soon challenged. Indeed, the self-interaction of the electron is *needed* to explain the 1947 experiment by Willis Lamb (1913–2008) that measured the deviation (the *Lamb shift*) of the spectrum of hydrogen from what Dirac's theory of the electron predicts. Ironically, it was that experiment that helped motivate the renormalization of quantum electrodynamics (to get rid of the infinities then plaguing it) which led to Feynman's share of the 1965 Nobel Prize. In fact, just 4 years after their 1945 paper, Feynman expressed a revised view that self-interactions could not be avoided.[65]

In any case, we gain the rewards originally claimed by Wheeler and Feynman *only if* we accept backward time travel, a step too big for many in 1945 (and for nearly as many today) because of the resulting time travel paradoxes that seem to be unavoidable. For the same reason, Tetrode's earlier work, published in a German journal, also went virtually unnoticed during the two decades before Wheeler and Feynman's work. In fact, Tetrode wasn't the only anticipator of Wheeler and Feynman, as they had been anticipated, too, in America. In 1926 the chemist G. N. Lewis (1875–1946) had written "I'm going to make the . . . assumption that an atom never emits light except to another atom, and to claim that it is absurd to think of light emitted by one atom regardless of the existence of a receiving atom as it would be to think of an atom absorbing light without the existence of light to be absorbed."[66] Wheeler and Feynman were aware of Lewis by 1945. Certainly Wheeler and Feynman must have been intrigued by Lewis' paradox: "I shall not

[65]R. P. Feynman, "Space-Time Approach to Quantum Electrodynamics," *Physical Review*, September 15, 1949, pp. 769–789. See also C. Teitelboim, "Splitting the Maxwell Tensor: Radiation Reaction Without Advanced Fields," *Physical Review D*, March 15, 1970, pp. 1572–1582.

[66]G. N. Lewis, "The Nature of Light," *Proceedings of the National Academy of Sciences*, January 15, 1926, pp. 22–29.

attempt to conceal the conflict between these views and common sense. The light coming from a distant star is absorbed, let us say, by a molecule of chlorophyll which has recently been produced in a living plant. We say that the light from the star was on its way toward us a thousand years ago. What rapport can there be between the emitting source and this newly made molecule of chlorophyll?"

The paradox in that, of course, arises from the issue of what happens if, at some intermediate time and place, the star's light is blocked, thus preventing its absorption by the chlorophyll? Could refusing to look at a star *now* affect the emission of the star's light in the *past*? Lewis was obviously making a clear statement of backward causation when posing this bilking paradox. His very next words show that he understood the probable reaction of his readers: "Such an idea is repugnant to all our notions of causality and temporal sequence." Like Tetrode's work, Lewis' ideas were ahead of the times but, actually, their ideas were *not* repugnant to everyone.

In fact, similar puzzles were an inspiration to Wheeler and Feynman and almost certainly motivated them to create their own famous bilking paradox, which they presented in their 1949 paper (note 42). They opened the presentation of their paradox as follows: "If the present motion of *a* is affected by the future motion of *b*, then the observation of *a* attributes a certain inevitability to the motion of *b*. Is not this conclusion in direct conflict with our recognized ability to influence the future motion of *b*?" This question clearly states the conflict between free will and determinism, and to sidestep this *human* concern Wheeler and Feynman constructed a "paradox machine," a machine that operates totally automatically and which has come to be called the "logically pernicious self-inhibitor"![67]

In their description of the paradox machine, Wheeler and Feynman ask us to imagine two charged particles, *a* and *b*, positioned five light-hours apart. As shown in Fig. 5.3, *a* is attached to the arm of a pivoted shutter, toward which a pellet is moving from initially a great distance away. Now, normally we would think of what happens next in terms of just retarded fields. That is, the pellet hits the arm, knocking it downward and thereby accelerating charge *a*; this acceleration of charge *a* creates a retarded radiation field that arrives at charge *b* 5 h later, resulting in the acceleration of charge *b*; the acceleration of charge *b* creates a retarded radiation field that arrives back at charge *a* 5 h later (10 h after the pellet hit the arm).

The Wheeler and Feynman view, however, claims that this description leaves out half the story—the *advanced* fields. Specifically, suppose the pellet will hit the arm and so accelerate *a* at 6 p.m. Then, *b* will be affected not only 5 h later at 11 p.m., but also *earlier* at 1 p.m. This advance acceleration of *b*, in turn, sends out an advanced field that arrives at *a* at 8 a.m. The paradox is now easy to see. As Wheeler

[67]P. Fitzgerald, "Tachyons, Backwards Causation, and Freedom," *Boston Studies in the Philosophy of Science* (volume 8), 1970, pp. 415–436. Even more extreme examples of such paradox machines are described in Tim Maudlin, "Time Travel and Topology," *PSA 1990*, Philosophy of Science Association, volume 1, pp. 303–315.

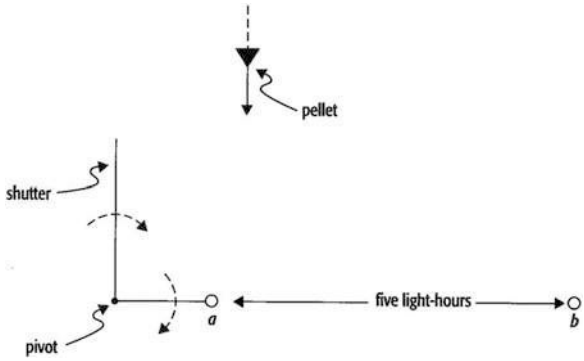

Fig. 5.3 Wheeler and Feynman's paradox machine

and Feynman described events, we see *a* exhibit a premonitory movement at 8 a.m. Seeing this motion in the morning, we conclude that the pellet will hit the arm in the evening. We could then return to the scene a few seconds before 6 p.m. and block the pellet from acting on *a*, a task automatically accomplished by the shutter in Wheeler and Feynman's paradox machine. But then we are faced with the puzzle of explaining just *why a* moved in the morning!

Wheeler and Feynman claimed they had resolved their bilking paradox by observing that *discontinuous* forces (more generally, *signals*) are never seen in nature. They concluded that the shutter does not completely block the pellet, but rather the shutter suffers a "glancing blow." That is, a very weak advanced signal is received by charge *a*, which moves the shutter just enough to induce the "glancing blow," and it is this partial interaction that results in the weakened signal in the "first place." This is, in fact, the very same explanation that was rediscovered decades later in answer to similar bilking paradoxes that involve self-interacting billiard balls transiting wormhole time machines (a topic we'll take-up in the next chapter).

5.5 Absorber Theory and Signaling the Past

> "If advanced waves [could be used to signal the past] then our grip on reality would become more tenuous. The past could never be considered over and done with, because anyone with the proper hardware could send messages back in time and alter what had already happened."
>
> —John Cramer, a University of Washington physicist, taking the minority position on the possibility of changing the past[68]

[68]Cramer has written provocatively on advanced waves. See, for example, "The Arrow of Electromagnetic Time and the Generalized Absorber Theory," *Foundations of Physics*, September 1983, pp. 887–902, and "Generalized Absorber Theory and the Einstein-Podolsky-Rosen Paradox," *Physical Review D*, July 15, 1980, pp. 362–376.

Wheeler and Feynman's argument *is* logically and physically sensible; it is, after all, simply an early statement of the principle of self-consistency in physics. Wheeler summed matters up nicely, years later, when he wrote "Interconnections run forward and backward in time in such numbers as to make an unbelievable maze. That weaving together of past and future seems to contradict every normal idea of causality. However, when the number of particles is great enough to absorb completely the signal starting out from any source, then this myriad of couplings adds up to a simple result: the familiar retarded actions of everyday experience, plus the familiar force of radiative reaction with its familiar sign."[69]

Their analysis was based on classical physics but, many years later, Feynman wrote (in his famous autobiographical work *Surely You're Joking, Mr. Feynman*) that at one time he and Wheeler thought it would not be too difficult to work out the quantum version of their theory. But then first Wheeler failed in the task, and then Feynman tried his hand at it and, as he stated, "I never solved it, either—a quantum theory of half-advanced, half-retarded potentials—and I worked on it for years." Their paradox (if indeed it *is* a paradox, since if advanced fields don't actually exist then there is no problem) remains unsolved.

Is Wheeler and Feynman's view of nature correct? Could we use advanced waves to send signals to the past? Or, if that requires some yet-to-be-developed technological breakthroughs in transmitter design, and if receivers are easier to construct, could we at least listen-in to the future (since we are, *now*, the future's past)? And if we could do that, could the future send us the details of the transmitter breakthrough (thus creating a causal information loop in time)?

The first experimental search for advanced waves seems to have been a 1973 effort.[70] The very next year, flaws in that search process prompted two physicists to discuss an experiment designed to detect advanced waves (if they exist). As they wrote, in a grand understatement, the exciting possibility of a positive result "would have such far-reaching consequences on our ideas of the unidirectionality of time and causality that . . . the experiment justifies a large amount of effort, even if no conclusive result is obtained for years."[71] Alas, all of the searches for advanced waves have, as I write (2016), given negative results and so the world still awaits the first Dirac radio.

Over the years the Wheeler and Feynman view of nature has been the target of some theoretical concerns. One physicist, for example, complained that Wheeler and Feynman had assumed a static, time-symmetric spacetime for the universe, in which the properties of all past and future absorbers are identical. That is obviously

[69]See note 34 in Chap. 3. There Wheeler also wrote "The particles of the absorber are either at rest or in random motion before the acceleration of the source. They are correlated with it in velocity after that acceleration. Thus radiation and radiative reaction are understood in terms, not of pure electrodynamics, but of statistical mechanics."

[70]R. B. Partridge, "Absorber Theory of Radiation and the Future of the Universe," *Nature*, August 3, 1973, pp. 263–265.

[71]M. L. Herron and D. T. Pegg, "A Proposed Experiment in Absorber Theory," *Journal of Physics A*, October 1974, pp. 1965–1969.

not so in an expanding (or contracting) universe and, as he wrote, "No serious modern cosmological theory is framed in [terms of] a static Universe."[72] Another puzzle for that writer was that Wheeler and Feynman took a time-symmetric theory of half-retarded/half-advanced waves in a time-symmetric universe and arrived at a *non*-time-symmetric solution! They performed that trick by supposing not only that the universe is static, but also that it was created with the initial condition of low entropy. Thus, for Wheeler and Feynman, the one-way thermodynamic arrow of time is the primary arrow, with the electromagnetic arrow following as a consequence. (The *how* of a low entropy initial cosmological condition was left unexplained—certainly no mention of the hand of God appears in their work!) This ordering of the primacy of the temporal arrows was, in fact, in agreement with the view adopted by Einstein in his 1909 debate with Ritz, a view taken decades later by Hawking, as well.[73]

Wheeler and Feynman had shown that both the advanced and retarded solutions taken together are self-consistent in a static universe; Hogarth's question was whether the observed retarded solution, *alone*, would be self-consistent in an *expanding* universe (which is the universe we actually observe). His conclusion? It depends on the details of the expansion. Two years after Hogarth, two physicists expanded on his work and claimed to have shown that the retarded solution alone *is* self-consistent *if* the expansion is steady-state via the continuous creation of matter.[74] That would be the case because, if only retarded effects are to occur, then each emitter of radiation needs a large number of absorbers (such as ionized intergalactic gas) in its future light cone to provide for complete absorption. This, in turn, requires that the density of matter not decline "too fast" with the expansion. That is, the future universe must not be "too transparent" and the continual appearance of new matter in the ever-increasing volume of the expanding universe is required to maintain the necessary density.

That conclusion was embraced with particular enthusiasm by Hoyle, a British cosmologist whose name has long been identified with the idea of continuous creation of matter. Since then, however, continuous-creation cosmologies have fallen into disfavor because it was in 1965, just a year after Hoyle and Narlikar wrote, that the cosmic microwave background radiation was detected. That is now taken as very strong evidence for the occurrence of a primordial explosion (or Big Bang) that started the expansion of the universe, and as equally strong support for therefore rejecting a steady-state universe. Not by Fred Hoyle (1915–2001), though,

[72] J. E. Hogarth, "Cosmological Considerations of the Absorber Theory of Radiation," *Proceedings of the Royal Society A*, May 22, 1962, pp. 365–383. Hogarth, however, rejected the static universe, asserting instead that the *observed expansion* of the universe provides the required asymmetry, resulting in the cosmological arrow of time as the primary arrow and the electromagnetic arrow as a consequence.

[73] S. W. Hawking, "Arrow of Time in Cosmology," *Physical Review D*, November 15, 1982, pp. 2489–2495.

[74] F. Hoyle and J. V. Narlikar, "Time Symmetric Electrodynamics and the Arrow of Time in Cosmology," *Proceedings of the Royal Society A*, January 1964, pp. 1–23.

who had an almost fanatical devotion to non-Big Bang cosmologies.[75] Real puzzles remain for the Big Bang universe, however. One is that it expands from a dense, opaque past into a less dense, ever-more-transparent future, with each emitter having a large number of absorbers in its *past* light cone. That should result, noted Hoyle and Narlikar (almost certainly with some glee), in an observed advanced solution and thus in a reversed electromagnetic arrow that would allow communication with the past. The fact that we have not (yet?) discovered how to perform such communication might be taken to mean that the idea of an expanding, Big Bang universe is somehow faulty. A related question about absorber theory is that of the puzzle of neutrino absorption. Neutrinos are particles that interact so weakly with matter that a beam of them would have to travel through many hundreds of light-years of lead for there to be a significant attenuation of the beam. How can such 'ghost-like' particles find enough future absorbers to make possible their observed journeys into the future of a Big Bang expanding universe?

For such an exciting idea as communication with the past, it is not surprising that advanced-wave radio has appeared in science fiction. Just 6 years after Wheeler and Feynman's paper, a story by a well-known author hinted at such a gadget based on something called the "ultrawave effect": "While gravitational effects were produced by the presence of matter, ultrawave effects . . . did not appear unless there was a properly tuned receiver somewhere. They seemed somehow 'aware' of a listener even before they came into existence."[76] It is difficult to believe that such a story idea was conjured-up out of nothing, but rather that the author had read Wheeler and Feynman's paper. Anderson had a 1948 undergraduate honors degree in physics from the University of Minnesota, and so he may *well have* read Wheeler and Feynman's 1945 paper.

The potential bilking paradoxes produced by sending messages backward in time have been treated in at least one novel-length discussion. The puzzles presented are undeniably fascinating, but the story's answer to them is to allow the changing of the past, as argued in this section's opening quote from John Cramer. Indeed, the title comes from the plot device of twice changing the past by sending messages to the past to save the world from terrible disasters. Thus, we read through entire time periods *three* times before finishing the novel. As one character blurts out, "We can monitor the actual consequences of our decisions and actions, and change them until they produce the desired result! My God . . . it's staggering!"[77] Quite so.

One of the most interesting science fictional uses of backward-in-time signaling is, I think, found in a classic tale by James Blish. There the "Dirac radio" for instantaneous transmissions is described, and we learn that at the beginning of each received message there is always an irritating audio beep (hence the title) that is

[75]Besides his scientific work, Hoyle also wrote science fiction. One work, the 1966 novel *October the First is Too Late*, deals with travels in time but fails to say anything about paradoxes.

[76]Poul Anderson, "Earthman, Beware!," *Super Science Stories*, June 1951.

[77]J. P. Hogan, *Thrice Upon a Time*, Ballantine 1980.

seemingly a useless artifact of the mysterious workings of the gadget. Its only obvious characteristic is a continuous spectrum from 30 to well above 18,000 Hz. It is only at the end of the story that the main character learns that this spectrum is the "simultaneous reception of every one of the Dirac messages which [has] ever been sent, or will be sent."[78]

Blish was actually pretty close to the mark with that, as a composite signal with a continuous spectrum (with energy distributed uniformly in frequency), such as one might expect the overlay of many independent signals to be, does indeed have a narrow time structure. If applied to a loudspeaker, such a signal would sound like a sharp pulse or click—or even a *beep*. In the limit of an infinitely wide spectrum, the time signal becomes one of infinite amplitude and zero duration, a singular *impulse* function called, by theoretical physicists and radio engineers alike, the *Dirac delta function*.

There is no mention in the story of advanced waves, but clearly Blish knew that instantaneous (infinite-speed) signals would travel into the past and he does a masterful job of presenting the mystery of listening to the future. At one point characters in the twenty-first century hear the commander of a time-traveling "world-line cruiser" transmit a poignant call for help from 11,000,000 light years away and from sixty-five centuries in the future. Most interesting of all, however, is Blish's statement of a technical issue that I have not seen raised before: if signals arrive at a receiver, simultaneously, from all future times, how can they be separated? Blish resorts to some scientifiction babble-talk to answer that question, but I believe it remains a puzzle.[79]

5.6 Tachyonic Signals and the Bell Quantum Antitelephone

> "We cannot fight the laws of nature."

> "Nature be damned! Feed more fuel into the tubes. We must break through the speed of light . . . Give me a clear road and plenty of fuel and I'll build you up a speed of half a million miles in a second . . . What's there to stop it?"[80]

Science fiction writers have often used FTL motion to reverse time, often without much (if any) regard to the fact that, to just *reach* the light barrier, requires (according to special relativity) infinite energy, much less to exceed light speed.

[78] J. Blish, "Beep," *Galaxy Science Fiction*, February 1954.

[79] The signal separation problem is also hinted at by physicist/science fiction author Gregory Benford, in a tale that was a precursor to his famous 1980 novel *Timescape* (in which the present attempts to warn the past of a future ecological disaster that threatens life on Earth). See Benford's "Cambridge, 1:58 A.M.," *Epoch*, Berkeley 1975.

[80] Words exchanged by the first officer and the captain of a starship on its way to Alpha Centauri in a story by N. Schachner, "Reverse Universe," *Astounding Stories*, June 1936. The captain, we are told, "had heard, of course, of the limiting velocity of light, but it meant nothing to him."

Therefore, goes the reasoning, because we can't get through the 'light barrier' means that time travel to the past must be impossible, as well. Or, so goes this line of argument. But, could there be a way around this conclusion? After all, while relativity theory indeed precludes the acceleration of a *massive* particle *up to* the speed of light, it does allow a zero rest mass particle (like the photon) to exist *at* the speed of light. Photons are emitted during various physical processes, and they move from the instant of their creation at the speed of light; the only way to slow a photon is to destroy it by absorbing it. Advocates of the possibility of the existence of FTL particles make a similar argument when asking if there might not be particles, emitted during various (as yet unknown) physical processes, that move from the instant of their creation at speed *greater* than that of light?

An affirmative answer would neatly avoid the 'acceleration through the light barrier' problem, but then there are other concerns. For example, such FTL particles would have to have an imaginary rest mass if they were to carry real-valued energy and momentum, and what could *imaginary mass* mean? That question was answered by the proponents of FTL particles, who replied that the rest mass of a superluminal particle would be unobservable because (like the photon) there is no subluminal frame of reference in which the particle could be at rest! That is, there is no frame of reference in which the mysterious imaginary mass could be measured and, anyway, it is only *observable* changes in the real energy and momentum that characterize particle interactions.

The key idea to this line of thought is a *supposed* FTL particle, called a *tachyon*, a name coined by the American physicist Gerald Feinberg (1933–1992) from the Greek word *tachys* for "swift."[81] It is interesting to note that Feinberg admitted[82] that his interest in such a thing was sparked by reading Blish's story "Beep" (see note 78). The idea of the tachyon is actually a very old one that is hinted at in the work of the Greek poet and philosopher Lucretius (who died 20 years before the birth of Christ). In his discussion of visual images, in Book 4 of his giant (well over 7400 lines) science poem *De Rerum Natura*, we find the following words about particles of matter originating deep inside the Sun: "Do you see how much faster and farther they must travel, how they must run through an extent of space many times vaster in the time it takes the light of the Sun to spread throughout the sky?"[83]

The first attempt (later found to be flawed) in the physics literature of a relativistic treatment of FTL particles appeared some years before Feinberg gave

[81]G. Feinberg, "Possibility of Faster-Than-Light Particles," *Physical Review*, July 25, 1967, pp. 1089–1105. Feinberg was anticipated in this name by Edward Page Mitchell (the Victorian pioneer in the time travel paradox genre who was discussed back in Sect. 4.2 and its note 37). In his story "The Tachypomp: A Mathematical Demonstration" (*Scribner's Monthly*, March 1874), he describes a gadget for reaching any speed, no matter how great (*tachypomp* is literally "quick sender").

[82]G. Benford, "Time and *Timescape*," *Science-Fiction Studies*, July 1993, pp. 184–190.

[83]A poetic allusion to something traveling faster than light appears, in of all places, Shakespeare's *Romeo and Juliet*. In Juliet's words (Act II, scene 5), ". . . love's heralds should be thoughts, Which ten times faster glide than the sun's beams, Driving back shadows . . ."

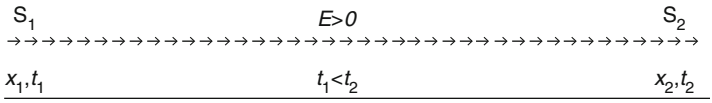

Fig. 5.4 The emission of a positive energy particle, followed by absorption

them a name, where it was observed that special relativity is *not* necessarily violated by FTL motion.[84] But nonetheless, concerns about the physical possibility of FTL particles continued. For example, a serious problem for tachyons, at least for those who dislike the ideas of backward causation and time travel, is the observation that in some frames of reference an FTL particle would appear to have *negative energy*. Feinberg, himself, explained (see note 81) this concern as follows: "By the principle of relativity, any state which is possible for one observer must be possible for all observers, and hence FTL particles can exist in negative-energy states for all observers . . . The occurrence of negative energy states for particles has always been objected to on the grounds that no other system could be stable against the emission of these negative-energy particles, an entirely unphysical behavior."

This objection to FTL particles was raised early in the history of tachyons, even before they were named, and it was addressed by three physicists who proposed the so-called *reinterpretation principle* (what I'll refer here to as the RP).[85] To see how the RP works, consider Fig. 5.4, in which a source S_1 at x_1 emits an FTL particle at time t_1. This particle then travels to an absorber S_2 at x_2, arriving there at the later time t_2. S_1 and S_2 are in the same reference frame and, for an observer in the frame, the particle energy E is positive. However, it is always possible to find another observer in a relatively moving frame for whom this process would look as though t_2 is less than (that is, earlier than) t_1 with $E < 0$. In other words, for the moving observer the particle would appear as a negative energy particle moving backward in time. (In the next chapter I'll show you that the particle speed must not be just superluminal, but the even faster *ultraluminal*.)

Note that for the moving observer, the emission by S_1 of negative energy *increases* the energy of S_1, and the absorption of negative energy by S_2 decreases the energy of S_2. S_2's energy decrease (for the moving observer) occurs before the increase in S_1's energy because, as noted before, for the moving observer $t_2 < t_1$. The moving observer naturally interprets this process as the emission of positive energy by S_2, followed by absorption by S_1. This reinterpretation would thus seem to preserve our common-sense idea of causality, as well as avoiding any mention of backward time travel. The RP appears to have slipped around those problems merely by redefining which source is transmitting, and which is receiving, the

[84] S. Tanaka, "Theory of Matter with Super Light Velocity," *Progress of Theoretical Physics*, July 1960, pp. 171–200. See also O. M. Bilaniuk and E. C. G. Sudarshan, "Particles Beyond the Light Barrier," *Physics Today*, May 1969, pp. 43–51 (and the resulting discussion in the December issue, pp. 47–52).

[85] O. M. P. Bilaniuk, V. K. Deshpande, and E. C. G. Sudarshan, "'Meta' Relativity," *American Journal of Physics*, October 1962, pp. 718–723.

tachyon. Indeed, Feinberg claimed (note 81) that the RP avoids the creation of causal loops and their associated paradoxes, a claim repeated nearly 20 years later by a physicist who used the RP to eliminate paradoxes from Gödel's time travel rotating universe.[86]

There is, however, a curious twist to all this. Even if we grant that the RP may avoid causal paradoxes, the fact is that physics isn't fooled as easily as a human observer. That is, the receiver does actually lose energy upon the arrival of the tachyon, which is the opposite of what happens in a radio receiver when it receives a photon. In other words, the receiver must be in an elevated energy state prior to the tachyon's arrival; the receiver must be prepared beforehand to receive a message. If the receiver were instead sitting in its lowest energy state, then it could not accept (or *eject*, according to the RP) the tachyon. So, it's not surprising that, despite the enthusiastic embrace of the RP by some, other physicists took exception, with one arguing that the effectiveness of the RP in avoiding causal loops is "illusory" and "irrelevant,"[87] while others concluded that the causal paradoxes would actually preclude any possibility of tachyons interacting with ordinary matter in the first place (which is just a polite way of saying that tachyons have no more reality than do unicorns!).[88]

The RP's effect of flipping the roles of transmitter and receiver has attracted particular concern. Some analysts have pointed out that if one can modulate a superluminal signal to send a message into the past, then certainly one could *sign* the message. To quote a delightful example, "If Shakespeare types out *Hamlet* on his tachyon transmitter, Bacon receives the transmission at some earlier time. But no amount of reinterpretation will make Bacon the author of *Hamlet*. It is Shakespeare, not Bacon, who exercises control over the content of the message."[89] The last line of this quote is of central importance. The authors emphasize it by immediately observing that a signature is a *relativistic invariant* and that, indeed, it establishes a causal ordering quite independent of any temporal ordering. This example, alone, explains why one analyst said of the RP that it is "laughed to scorn,"[90] while another said of the RP that it "sounds merely like the endorsement of what can only be characterized as a fantastic delusion."[91]

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[86]A. Italiano, "How to Recover Causality in General Relativity," *Hadronic Journal*, January 1986, pp. 9–12.

[87]R. G. Newton, "Particles That Travel Faster Than Light," *Science*, March 20, 1970, pp. 1569–1574.

[88]W. B. Rolnick, "Implications of Causality for Faster-Than-Light Matter," *Physical Review*, July 25, 1969, pp. 1105–1108, and D. J. Thouless, "Causality and Tachyons," *Nature*, November 1, 1969, p. 506.

[89]G. A. Benford, D. L. Book, and W. A. Newcomb, "The Tachyonic Antitelephone," *Physical Review D*, July 15, 1970, pp. 263–265.

[90]P. Fitzgerald, "On Retrocausality," *Philosophia*, October 1974, pp. 513–551.

[91]W. L. Craig, "Tachyons, Time Travel, and Divine Omniscience, *Journal of Philosophy*, March 1988, pp. 135–150.

Even more sophisticated scenarios than the *Hamlet* one (note 89) were devised to show how problems with FTL signals could arise that the RP could *not* resolve. The American physicist Bryce DeWitt (1923–2004) created such an example (the 'DeWitt Gambit') that involved a sequential, circular chain of tachyon signal transmissions between four observers, all moving in one spatial dimension. DeWitt showed out to arrange the spacetime geometry of the observers so that, at each stage, there is no dispute over who is sending and who is receiving, and so invoking the RP is avoided. Yet, when the signal reaches the first (last) observer, it is *before* he started (will start) the chain! This, of course, sets-up a potential bilking paradox: what if 'now' the first (last) observer decides to *not* send the chain's initiating signal? An even more sophisticated variation on the Gambit, involving four observers moving in *two* spatial dimensions, was soon after put forth by the English physicist Felix Pirani (1928–2015). As he concluded, "It is difficult to see how in the face of this example a classical-particle description of tachyons can be sustained."[92] Confronted by such sharp criticism, from so many, it is understandable why, just before his death, Feinberg co-authored (with two philosophers) a paper in which he seemed to be abandoning his support for tachyons as possible carriers of information backward in time.[93]

Many physicists today reject the possibility of backward-in-time messages, not because of concerns about the RP, but because such messages could create potential bilking paradoxes. To see how this works, the old Wheeler and Feynman idea of explaining (away) bilking paradoxes—that no signal in nature is *really* discontinuous—was examined by one physicist in the context of tachyons.[94] There we are asked to consider the following situation: A human (call him A) has a lamp on a table before him. The lamp is controlled by a tachyon receiver; in other words, the lamp illuminated only when a tachyon signal (a pulse, let us say) is detected. At 3 o'clock A will send a tachyon signal to B (a tachyon echo-transmitter that immediately rebroadcasts everything it receives) if the lamp does not glow at 1 o'clock. Now, the spacetime geometry of A and B is arranged to be such that a signal sent by either A or B to the other travels 1 h backward in time. Thus, if A sends a signal at 3 o'clock, then B will receive it at 2 o'clock (and immediately echo), and the echo will arrive at A at 1 o'clock. The paradox, of course, is that A sends a signal only if the lamp does *not* glow—that is, only if A does *not* send the signal![95]

We are then reminded of the Wheeler and Feynman claim that every pulsed signal is actually continuous; this argument would include the illumination itself of

[92]F. A. E. Pirani, "Noncausal Behavior of Classical Tachyons," *Physical Review D*, June 15, 1970, pp. 3224–3225.

[93]G. Feinberg, D. Albert, and S. Levine, "Knowledge of the Past and Future," *Journal of Philosophy*, December 1992, pp. 607–642.

[94]L. S. Schulman, "Tachyon Paradoxes," *American Journal of Physics*, May 1971, pp. 481–484.

[95]A study of similar situations can be found in L. L. Gatlin, "Time-Reversed Information Transmission," *International Journal of Theoretical Physics*, January 1980, pp. 25–29.

the lamp. Therefore, the lamp is not just on or off, but potentially at any level of illumination between those two extremes. So there sits A, and at 1 o'clock the lamp seems to glow dimly. To that, says Schulman, "A thinks it over, vacillating, finally sending a slightly late signal which isn't full strength." Then the echo isn't full strength either, which accounts for the original dim glow. This conclusion *is* consistent (but what if A's sending device is a toggle switch that *snaps* one way or the other—why then only a partial strength signal?), but it does seem to ask for a lot of supposing. Schulman himself is not so sure about the validity of universal continuity, writing at the end that "it is not clear that the Wheeler-Feynman assumption . . . ought to be made." (For more on the Wheeler-Feynman continuity assumption, in a different, non-time travel context, see the final "For Further Discussion" for this chapter.)

The Wheeler-Feynman continuity idea *is* ingenious, allowing one to find a logically and physically consistent solution in time travel scenarios that, at least at first glance, might seem to have no solution. Consider, for example, the following situation[96]: "We have a camera ready to take a black and white picture of whatever comes out of [a] time machine. The film is then developed and the developed negative is subsequently put in the time machine and set to come out of the time machine at the time the picture is taken. This surely will create a paradox: the negative will have the opposite distribution of black, white, and shades of grey, from the picture that comes out of the time machine. But since the thing that comes out of the time machine is the negative itself we surely have a paradox." But do we?

The answer is no, because "What will happen is that a uniformly grey picture will emerge which produces a negative that has exactly the same uniform shade of grey. No matter what the sensitivity of the film is, as long as the dependence of the brightness of the negative depends in a *continuous* [my emphasis] manner on the brightness of the object being photographed, there will be a shade of grey that produces exactly the same shade of grey on the negative when photographed. This is the essence of Wheeler Feynman's idea."[97] (The conclusion is the same if we move from black-and-white to color photography.)

Nonetheless and despite this apparent success, the supposed ability of a modulated beam of tachyons to send a message into the past still raised concerns among many, particularly about free will and fatalism. Suppose, say those who are concerned about these issues, that you receive a tachyon message from yourself from tomorrow, informing you that a man you plan to kill tonight is still alive (tomorrow). Does that mean it is beyond your power to kill him tonight? According to one analyst (note 67) the answer is no; you *could* kill him—but if you do then the message from tomorrow would not have arrived. And because ignorance is not a

[96]Taken from Frank Arntzenius and Time Maudlin, "Time Travel and Modern Physics," in *Time, Reality & Experience* (C. Callender, editor), Cambridge University Press 2002, pp. 169–200.

[97]More on the Wheeler-Feynman continuity idea, *and of its limitations*, can be found in D. Kutach, "Time Travel and Consistency Constraints," December 2003, pp. 1098–1113, and Phil Dowe, "Constraints on Data in Worlds with Closed Timelike Curves," December 2007, pp. 724–735, both in *Philosophy of Science*.

precondition to free will, your newly acquired knowledge does not, by itself, suddenly limit your ability to kill the man. But, this line of arguing went, if you do not attempt to kill the man because you believe the message from your future self, then in fact the message *has* limited you!

Fitzgerald's position was rebutted by Craig (note 91), who argues that it is not your ability to kill that is altered by the message but rather your motivation. Craig points out that such motivational changes can occur without invoking anything as radical as a message from the future. Suppose, he says, that just before you fire the fatal shot into your victim, you learn from him that he is your beloved, long-lost uncle. Clearly, your motivation for killing him is likely to be instantly altered, but equally clearly, your *ability* to kill him is unchanged. The mechanism for obtaining genealogical information, whether via time travel or as a last-minute appeal from your intended victim, is (says Craig) simply irrelevant. Not all buy into that, however, with one unconvinced analyst (note 94) writing that "history is a set of world lines essentially frozen into spacetime. While subjectively we feel strongly that our actions are determined only by our backward light cone, this may not always be the case." That is, Schulman appears open to the possibility that influences originating in the future might indeed have an impact on the present.

With the fading from the physics scene of enthusiasm for tachyons, the romance of communicating with the past using superluminal speeds passed from speedy particles to quantum mechanics via a mathematical result called *Bell's theorem*. John Bell, a physicist mentioned in the last chapter in connection with the MWI of quantum mechanics, published his theorem in a little article in an obscure, now defunct journal. Since then it has become one of the most cited physics papers from the 1980s.[98] The paradox cited in Bell's title refers to a famous 1935 paper in which Einstein (and two of his colleagues at the Institute for Advanced Study) challenged the conventional view of quantum mechanics, the view that there is no objective reality to anything unless it is observed.[99]

In fact, the possibility of quantum mechanics supporting FTL signals had been considered (and rejected) *before* Einstein's paper, by the Italian physicist Enrico Fermi.[100] Fermi concluded that, in a two atom system, the decay from an excited state of one atom (with the emission of a photon) would not influence the other atom before a time lapse of R/c, where R is the distance between the two atoms and c is the speed of light. In 1967, however, the Russian physicist M. I. Shirokov pointed out that Fermi's result was the result of an unjustified mathematical operation (he had replaced an integral from zero to infinity with one from minus infinity to infinity).

[98] J. S. Bell, "On the Einstein-Podolsky-Rosen Paradox," in *Speakable and Unspeakable in Quantum Mechanics*, Cambridge University Press 1987.

[99] A. Einstein, B. Podolsky, and N. Rosen, "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?" *Physical Review*, May 15, 1935, pp. 777–780. See also N. D. Mermin, "Is the Moon There When Nobody Looks? Reality and Quantum Theory," *Physics Today*, April 1985, pp. 38–47.

[100] E. Fermi, "Quantum Theory of Radiation," *Reviews of Modern Physics*, January 1932, pp. 87–132.

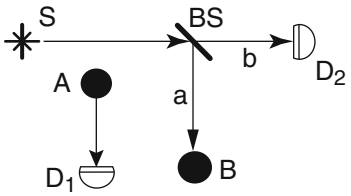

Fig. 5.5 Time travel and the wave function of quantum mechanics. In the above arrangement (reproduced by the kind permission of Francesco Gonella, from his paper "Time Machine, Self-Consistency and the Foundations of Quantum Mechanics," *Foundations of Physics Letters*, April 1994, pp. 161–166), S is a low-intensity source of photons, a source *so* weak that at any instant there is never more than one photon in the system. Each photon begins by traveling toward BS, a half-silvered beam-splitting mirror that, with equal probability, either passes a photon to the right along path b where it is detected by D_2, or downward along path a into mouth B of a wormhole time machine and out of which it emerges from wormhole mouth A *in the past*. Conventional quantum mechanics says that what happens at BS is determined *when the photon reaches BS*—that is, the probability wave function of the photon collapses at BS. But for a photon that is reflected into B, it exits A where it is detected by D_1 *before* the time of its arrival at BS. That means it is known (by detector D_1) what *will* happen at BS *before* the photon arrives at BS—so just *when did* the photon wave function collapse?

Then, nearly 30 years after Shirokov, the German physicist Gerhard Hegerfeldt proved (in the context of conventional quantum mechanics) a very general theorem that establishes a non-zero probability of the second atom responding to the first atom's decay *as soon as* the photon is emitted.[101]

Hegerfeldt's analysis is very general, but it does make one assumption—the non-negativity of energy density (the so-called *weak energy condition*)—which at the time was considered (in Hegerfeldt's words) to be "physically well motivated," but which today is *not* taken to be *a priori* obvious.[102] Einstein's paper, on the other hand, utilized physical assumptions not easily dismissed, and so its conclusions confounded physicists for decades.

The conventional view of quantum mechanics formulates physics in terms of probability wave functions that 'collapse' into specific realities only when measurements (observations) are made of the state of a system (which may be as elementary as a single particle). Until such measurements are made, says this view of quantum mechanics, a system has no specific state; instead, it merely has a probability distribution over a set of possible states (see Fig. 5.5 for a time travel puzzle concerning this claim). Einstein and his co-authors (note 99) strongly rejected this probabilistic interpretation of nature (recall Einstein's famous dictum, "God does not play dice with the cosmos.") Einstein and his colleagues agreed that

[101]G. C. Hegerfeldt, "Causality Problems for Fermi's Two-Atom System," *Physical Review Letters*, January 1994, pp. 596–599. This mere *suggestion* of a possible failure of causality so stunned the editor of *Nature* that he felt compelled to quickly write a 'calming' reply: "Time Machines Still Over the Horizon," February 10, 1994, p. 509.

[102]The issue of the sign of energy density is very important in the analyses of wormhole time machines (see note 135 in Chap. 1), and we'll return to it in the next chapter.

quantum mechanics may be valid *as far as it goes*, but they also argued that it leaves out 'something' (as yet unknown) in describing reality. That is, they suggested that quantum mechanics is "incomplete" and that it incorporates "hidden variables."[103] They expressed this idea in the form of a paradox, the famous *EPR paradox*, which they posed as a thought experiment (a *Gedanken-experiment*) in which quantum mechanics declares that the properties of a particular spatially distributed system, when measured at point A, seem to be *forced* to assume specific values at point B (which may be arbitrarily distant from A) *without* there being a measurement at B.

Thus, said Einstein, there are just two possibilities. Either the system properties at B must have been what they are from the very start (even if the measurements at A had not been done) which is the view he held, or there must have been a linkage between the system at A and the system at B such that the wave function collapse at A is instantly transmitted to B to allow the wave function to collapse there as well. Because A and B may be arbitrarily far apart, this second view obviously requires an FTL transmission mechanism,[104] something Einstein called a "spooky action-at-a-distance," a term that eloquently expresses his low opinion of that idea! (Some translations replace *spooky* with *ghostly*, but the negative sentiment remains the same.[105]) For decades the debate between proponents of these two alternatives remained at a metaphysical, non-quantitative level. Then came Bell's paper in 1964.

Bell's theorem mathematically poses the choice between Einstein's hidden variables view and the conventional view of quantum mechanics through the use of an inequality involving certain measurable properties of a system.[106] If these measurements are such that the inequality is violated, then the conventional interpretation of quantum mechanics is vindicated, and Einstein's FTL spooky action-at-a-distance effect simply doesn't exist. Bell's great contribution, then, was to provide the means for removing the debate about quantum mechanics from metaphysics and to place it squarely in the realm of experimental physics.

"All" that needed to be done was to make the required measurements. These technically difficult experimental measurements were eventually performed by the French physicist Alain Aspect and his colleagues at the Institute of Applied Optics of the University of Paris, a decade and a half after Bell showed what had to be

[103]For more on hidden variables, see E. P. Wigner, "On Hidden Variables and Quantum Mechanical Probabilities," *American Journal of Physics*, August 1970, pp. 1005–1009.

[104]For an analysis that argues against an FTL mechanism in quantum mechanics, see G. C. Ghirardi, *et al*., "A General Argument Against Superluminal Transmission Through the Quantum Mechanical Measurement Process," *Lettere Al Nuovo Cimento*, March 8, 1980, pp. 293–298.

[105]You can find a discussion of the possibility of 'explaining' Einstein's "spooky actions" of quantum mechanics by invoking backward causation in R. I. Sutherland, "Bell's Theorem and Backwards-in-Time Causality," *International Journal of Theoretical Physics*, April 1983, pp. 377–384.

[106]The details are not important here, but a lovely exposition (for the lay person) can be found in Bell's essay "Bertlmann's Socks and the Nature of Reality," in *Speakable and Unspeakable in Quantum Mechanics*, Cambridge University Press 1987. See also M. G. Alford, "Ghostly Action at a Distance: A Non-Technical Explanation of the Bell Inequality," *American Journal of Physics*, June 2016, pp. 448–457.

done. The results unequivocally support the conventional view of quantum mechanics.[107] Einstein was simply wrong, there are no hidden variables in quantum mechanics, and his spooky action does seem to exist. Does that mean we have, at last, experimental evidence of the possibility of information transfer at FTL speeds?

Well, maybe, but the issue is still hotly debated. The majority of physicists today, I suspect, are probably more perplexed over what Bell's theorem is saying than were over Einstein's original EPR paradox. In those early days one could agree with Einstein and his colleagues, who argued that quantum mechanics was valid *as far as it went*, but a deeper, more comprehensive theory *would* show the existence of hidden variables. However, because of the work by Bell and Aspect it is definitively known that quantum mechanics *as it stands* leads to correct results, results that can be checked in the laboratory. In other words, there is no need for hidden variables and FTL spooky actions cannot be ruled out.

And so, while tachyons and the tachyon antitelephone may be nothing more than a neat science fiction fantasy, just maybe a quantum mechanical Bell antitelephone can't be so dismissed. Indeed, the possibility of using a quantum mechanical FTL effect was once suggested in a letter written by a senior person at an unspecified California think tank (an organization such as, for example, the RAND Corporation) to the Under Secretary of Defense for Research and Engineering at the Pentagon. Here's what the Under Secretary read when he opened that letter: "If in fact we can control the FTL nonlocal effect, it would be possible . . . to make an untappable and unjammable command-control-communication [C^3] system at very high bit rates for use in the submarine fleet. The important point is that since there is no ordinary electromagnetic signal linking the encoder with the decoder in such a hypothetical system, there is nothing for the enemy to tap or jam. The enemy would have to have actual possession of the 'black box' decoder to intercept the message, whose reliability would not depend on separation from the encoder or on ocean or weather conditions."[108]

One can't help but wonder what might have been the Under Secretary's response to that incredible letter, and what sorts of ultra-mega-super-top-secret experiments it may have prompted. I would be willing to bet, if they did occur, that they failed. As one physicist put it, "Up to now nature has covered her tracks pretty well, blocking all possibilities for using the EPR effect for FTL communication."[109] Of course, the think tank letter, as 'farout' as it may initially appear, actually represents a *failure* of imagination, because the backward causation effect of EPR's spooky FTL effect is certainly a 'quantum jump' beyond a mere unjammable submarine C^3 system.

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[107] A. Aspect, "Experimental Tests of Realistic Local Theories via Bell's Theorem," August 17, 1981, pp. 460–467, and A. Aspect, *et al.*, "Experimental Realization of Einstein-Podolsky-Rosen-Bohm *Gedanken-experiment*: A New Violation of Bell's Inequalities," July 12, 1982, pp. 91–94, and "Experimental Test of Bell's Inequalities using Time-Varying Analyzers," December 20, 1982, pp. 1804–1807, all in *Physical Review Letters*.

[108] See N. D. Mermin in note 99. For more on the enigmatic letter on the FTL submarine C^3 system, see Jack Sarfatti's letter to *Physics Today*, September 1987, pp. 118 and 120.

[109] J. Cramer, "Paradoxes and FTL Communication," *Analog Science Fiction*, September 1988.

5.7 For Further Discussion

Mark Twain, in his last, posthumously published novel *No. 44, The Mysterious Stranger*, incorporated reversed time as the work of a supernatural being. After the being reverses the world's time direction, the narrator tells the reader that "everywhere weary people were re-chattering previous conversations backward . . . where there was war, yesterday's battles were being refought, wrong-end first; the previously killed were getting killed again . . . we saw Henry I gathering together his split skull . . ." Read the novel, and comment on how well (or not) Mark Twain handled reversed time.

In Philip K. Dick's 1956 novel *The World Jones Made*, we read of a prophet who can see a year into the future. As he says, "To me *this is the past*," and then later we are told "He was a man with his eyes in the present [the world's future] and his body in the past [the world's present]." Read the novel, and then argue either for or against the suggestion that Dick was aware of the advanced wave solution in Maxwell's theory.

The physicist Robert Forward (see the sixth *For Future Discussion* in Chap. 3) argued that one way to send messages into the past is to compress a 15-billion-ton asteroid down to the volume of an atomic nucleus, spin it up, and then aim gamma ray bursts through the resulting near-by region of "unhinged time" (see "How To Build a Time Machine," *Omni*, May 1980). This is, of course, 'simply' an artificially constructed Kerr black hole telegraph transmitter (look back at note 114 and related discussion in Chap. 1). Forward, an optimist of the first rank, thought humans would be able to do this before the end of the twenty-first century. It would seem, then, that what should be done *now* is to build gamma ray frequency *receivers* (well within present-day technology) and listen for such messages from the future. The technical details of such receivers wouldn't matter, as long as their design is widely published. That way, the scientists of the future can learn those details by simply reading of them in old, musty library books and journals, and thus will be able to build their transmitters to be perfectly compatible with our old, musty (to them) receivers! Comment on the likelihood of National Science Foundation funding becoming available to build such receivers.

Suppose a time traveler goes into the future and, while there, discovers that there is an older version of himself living in the home that has been in his family for generations. Explain why this implies that the time traveler will eventually return to the present. Suppose, instead, that after the time traveler arrives in the future he decides to remain in the future, and *not* to return. Explain why this implies there will *not* be an older version of himself living in the family home. In both cases, assume the MWI does *not* apply, that is, assume that there is just a single time line.

One well-known quantum physicist, David Bohm (1917–1992), wrote the following passage in his book *The Special Theory of Relativity* (W. A. Benjamin 1965), concerning the possibility of sending messages into the past: "In effect, S could communicate with his own past [self, M] . . . and tell his past self [M] what his future is going to be. But on learning this M could decide to change his actions, so that his future . . . would be different from what his later self [S] said it was going to be. For example, the past self could do something that would make it impossible for the future one to send the signal. Thus, there would arise a logical self-contradiction." Do you think most physicists, writing today more than 50 years after Bohm, would repeat his words?

The role played by quantum mechanics in time travel studies is broad, deep, profound . . . and mysterious. What I mean by this is nicely illustrated by the final paragraph in a paper by Stephen Hawking ("Quantum Coherence and Closed Timelike Curves," *Physical Review D*, November 15, 1995, pp. 5681–5686). There he wrote "Personally, I do not believe that closed timelike curves will occur, at least on a macroscopic scale. I think that the chronology protection conjecture will hold and that divergences in the energy-momentum tensor will create singularities before closed timelike curves appear. However, if quantum gravitational effects somehow cut off these divergences, I am quite sure that quantum field theory on such a background will show loss of quantum coherence. *So even if people come back from the future, we will not be able to predict what they will do* [my emphasis]." What do you think Hawking meant by his final line? If "people come back from the future" and tell us what they did while in the

(continued)

future, then what's wrong with their memories that causes us to fail to be able to predict what they *will* do? Or, is there perhaps nothing wrong with their memories and Hawking is instead arguing that the future experienced by the returned time travelers will not be the future when *we* 'get there'? If that's the case, then what are the returned time travelers 'remembering'?

If quantum mechanics is actually slightly non-linear physics (as are many other normally linear physical phenomena at sufficiently high energy levels)—physics is *linear* when *superposition* holds, which means the result of two inputs is the sum of the individual outputs resulting from application of the individual inputs—and if one accepts the MWI concept, then at least two physicists (**PHYSICISTS1**) claim to have shown that one could communicate not just with our past, but also with the many pasts in the ever-splitting branches of the many worlds. Another physicist (**PHYSICIST2**) wrote a very funny illustration of what that might be like. Yet another physicist (**PHYSICIST3**) suggested that non-linear quantum mechanics might actually allow one to take *photographs* of the many-worlds. Of that, a physicist (**PHYSICIST4**) wrote (without any exaggeration) that such an achievement would be "perhaps the most amazing discovery in the history of science, indeed in the history of mankind." Or, to quote yet another physicist (**PHYSICIST5**), "interworld communication would lead to truly mind boggling possibilities," some of which have been incorporated in at least one science fiction novel (**SFAUTHOR**). Read the physicists' papers, and the novel, and then summarize with your own commentary.

PHYSICISTS1: N. Gisin, "Weinberg's Non-linear Quantum Mechanics and Superluminal Communication," *Physics Letters A*, January 1, 1990, pp. 1–2, and J. Polchinski, "Weinberg's Non-linear Quantum Mechanics and the Einstein-Podolsky-Rosen Paradox," *Physical Review Letters*, January 28, 1991, pp. 397–400.

PHYSICIST2: J. G. Cramer, "Quantum Telephones to Other Universes, to Times Past," *Analog*, October 1991.

PHYSICIST3: D. Albert, "How to Take a Photograph of Another Everett World," *Annals of the New York Academy of Sciences*, December 30, 1986, pp. 498–502.

PHYSICIST4: M. A. B. Whitaker, "On the Observability of 'Many Worlds'," *Journal of Physics A*, July 11, 1985, pp. 1831–1834.

PHYSICIST5: R. Plaga, "On a Possibility to Find Experimental Evidence for the Many-Worlds Interpretation of Quantum Mechanics," *Foundations of Physics*, April 1997, pp. 559–577.

SFAUTHOR: J. P. Hogan, *Paths to Otherwhere*, Baen 1996.

One upon a time, FTL tachyons (and their associated into-the-past transmissions of information) were strictly in the province of science fiction. In recent years, however, such doings have moved into mainstream fiction, as well, with the most recent (as I write) example being the man-of-action novel by Patrick Lee, *Signal*, St. Martin's Press 2015. (Tachyons are also mentioned in the 2015 film *Tomorrowland*.) That novel is set in modern times, not in the future; its hero is a retired soldier who now works as a self-employed house-flipper. His is definitely not a futuristic science fiction world. Until, that is, be becomes involved with a radio-like gadget that receives signals from 10 h, 24 min in the future. As the novel progresses we eventually learn that the gadget is based on German electronics technology that was being tested in a remote lab in northern Algeria, near the end of World War II. When that lab was overrun by a small American force the equipment was destroyed, but not before one of the Americans heard the gadget playing a song titled "She Loves You" along with the word *yeah* repeated numerous times. He didn't know what that meant until, 20 years later, he watched the Beatles' first American appearance on *The Ed Sullivan Show* TV program, and so suddenly realized that in 1944 he had heard a song that hadn't been written yet! That gadget is at the center of a modern-day, renewed Nazi effort to conquer the world, and there is much 'you've seen it all before' chasing, shooting and other 'James Bond' types of action in the novel, but the author *has* been quite inventive in treating time paradoxes. He does talk a lot about 'changing the future,' worries confusingly about 'changing the past,' and mistakes neutrinos for tachyons, but, still, if one is willing to overlook such issues it *is* an entertaining read. In particular, while the gadget's inherent range to the future is limited to ten-plus hours, the author describes a clever way to arbitrarily extend that value. Read *Signal*, and then describe and critique the method outlined in the novel.

The Wheeler-Feynman assumption of continuity already had a distinguished history in mathematics long before they invoked it in their physics resolution of bilking paradoxes. (Both men were very good mathematicians, and certainly knew what I am about to tell you here.) Imagine a man who is about to walk up a hill, starting at A (the base of the hill) and ending at B (the top of the hill). You know nothing of *how* he walks (perhaps at times he stops for a while, other times he walks slowly, sometimes he walks briskly, perhaps at times he even walks back *down* the hill). All you know is that, starting from A at 10 o'clock in the morning, he arrives at B at 11 o'clock. That is, the walk up

(continued)

the hill takes exactly 60 min. He camps overnight at B and then, the next morning, at exactly 10 o'clock, he walks back down the hill along the same path he followed during his ascent the previous day. He arrives at A at 11 o'clock. That is, the return trip takes exactly 60 min. Again, you know nothing of the details of how he makes the descent. Prove that there is at least one spot on the path that he passes at exactly the same time during his descent as he passed it during his ascent the previous day. Hint: No complicated equations are required. Indeed, no math at all is needed. Just sketch the appropriate, general graphs of the man's ascent versus time, and of his descent versus time, and invoke continuity. That is, sketch the distance (as measured along the path) that he is from A versus time for both the ascent and the descent.

Chapter 6
The Physics of Time Travel: II

"It is very sad to see valuable minds writing such a pile of unmitigated bullshit."

—not all physicists think time travel is worthy of study.[1]

6.1 Faster-than-Light into the Past

"Faster-than-light travel remains a coherent, and possible concept, even though it is forbidden by relativity theory."

—a philosopher makes a physics mistake.[2]

So far we have limited our consideration of relativity theory to speeds below the speed of light—that is, to the condition $v < c$, where v is the relative velocity of two reference frames. There was nothing, however, in the derivation of the Lorentz transformation equations discussed in Chap. 3 that actually used that self-imposed constraint. So, just what, in fact, *does* happen for $v > c$? This is not an empty question, because the second half of the above quote that opens this section is simply not true. That isn't to say we can have FTL for free; there *is* a high price to pay, that of causality violation (although, if you are a fan of time travel, it's a price you are probably happy to pay). If a material object goes FTL, then the mathematics seems to say that the object could travel into the past, just as the caped crusader does in the first (1978) *Superman* movie, in order to change the past (to save Lois Lane from dying in an earthquake). In addition, the mathematics also seems to say that if a signal bearing information could achieve FTL, then that information, too, would travel back into the past (see Fig. 6.1).

[1]This rather blunt comment (reported in *Physics World*, December 2009, p. 3) was prompted by a suggestion, from two other physicists, that the Higgs boson might ripple backward through time and thereby stop CERN's Large Hadron Collider from creating the long-sought particle in the first place.

[2]G. Robinson, "Hypertravel," *Listener*, December 17, 1964, pp. 976–977, the printed version of a lecture to the British Association for the Advancement of Science.

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P.J. Nahin, *Time Machine Tales*, Science and Fiction,
DOI 10.1007/978-3-319-48864-6_6

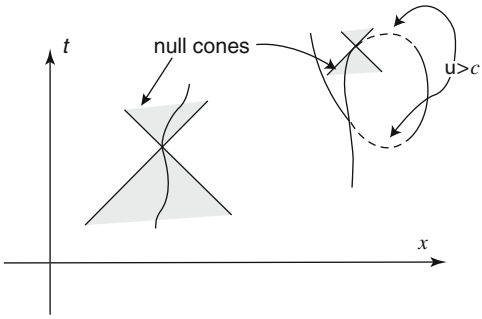

Fig. 6.1 A math-free proof that there can be no closed loops in time (that is, no time travel to the past if $v > c$ is forbidden) in flat Minkowski spacetime, the spacetime of the special theory of relativity. Such a conclusion is far less clear in the curved spacetimes of the general theory of relativity. Figure reproduced by the kind permission of Serguei V. Krasnikov (Polkovo Central Astronomical Observatory in St. Petersburg, Russia), from his 2003 paper "Time Machine (1988–2001)"

The original thinking along these lines visualized such an FTL signal as a modulated beam of tachyons, as mentioned in the previous chapter. In addition to tachyons not having been experimentally observed, even after intense searches for them, there are several theoretical objections (in addition to the bilking paradox problem discussed in the previous chapter) to the likelihood such FTL particles exist.[3] For example, the relativistic expressions for the energy and momentum of a particle with rest mass m_0 moving with speed v are, respectively,

$$E = \frac{m_o c^2}{\sqrt{1-(v/c)^2}} \qquad \text{and} \qquad p = \frac{m_o v}{\sqrt{1-(v/c)^2}}.$$

For $v > c$ the radicals in these expressions become imaginary, whereas E and p must always be real-valued (because they can be observed and measured as a result of the interactions the particle has with other matter). The energy and momentum can regain the property of being real-valued if we write $m_0 = \mu\sqrt{-1}$ (that is, $m_0^2 = -\mu^2$) for a tachyon, where μ is the positive, real-valued (but unobservable) meta-mass (that is, $m_0^2 < 0$). This is a radical proposal, of course, (as it is $m_0^2 > 0$ that we are used to; as a Russian mathematician romantically put it, "What binds us to space-time is our [positive] rest mass, which prevents us from flying at the speed of light, when time stops and space loses meaning. In a world of

[3]See, for example, "More About Tachyons," *Physics Today*, December 1969, pp. 47–52, a collection of letters received by the journal from its readers. The 'DeWitt Gambit,' mentioned in the previous chapter, was first proposed in one of those letters.

light there are neither points nor moments of time; beings woven from light would live 'nowhere' and 'nowhen'; only poetry and mathematics are capable of speaking meaningfully about such things."[4].

Well, perhaps, but let's continue to pursue the physics of tachyons, at least for a while. It can be shown[5] that the energy and momentum of the tachyon are given by

$$E = \frac{\mu c^2}{\sqrt{(v/c)^2 - 1}} \quad \text{and} \quad p = \frac{\mu v}{\sqrt{(v/c)^2 - 1}}.$$

An interesting consequence of this is that if tachyons *lose* energy, they *speed up*, an observation first made by the German physicist Arnold Sommerfeld (1868–1951) in 1904.[6] This means that if there is a mechanism for continuous energy loss, such as Cerenkov radiation,[7] then tachyons will spontaneously accelerate without limit to *infinite speed*! Curiously, while the above expressions for E and p show that, as $v \to \infty$, tachyons would possess *zero* energy, they would nonetheless have a *non-zero* momentum of μc.[8]

To see how backward time travel and FTL are connected, it is useful to establish a geometrical interpretation of the Lorentz transformation. As stated in Chap. 3, if the x', t' system is moving with speed v in the x (or x') direction relative to the x, t system, then

$$x' = \frac{x - vt}{\sqrt{1 - (v/c)^2}} \quad \text{and} \quad t' = \frac{t - vx/c^2}{\sqrt{1 - (v/c)^2}}.$$

[4]Yu I. Manin, *Mathematics and Physics*, Birkhäuser 1981, p. 84.

[5]L. Parker, "Faster-Than-Light Inertial Frames and Tachyons," *Physical Review*, December 25, 1969, pp. 2287–2292.

[6]The consideration of FTL particles already had a long history *before* tachyons were specifically named. You can find late nineteenth century (1888–1889) theoretical analyses of electrically charged FTL particles in the writings, for example, of the English mathematical electrical engineer Oliver Heaviside (1850–1925): see my biography *Oliver Heaviside: the life, work, and times of an electrical genius of the Victorian Age*, The Johns Hopkins University Press 2002, pp. 124–126.

[7]Cerenkov radiation is the energy radiated when a charged particle exceeds the speed of light *in the medium through which it travels*. Since the speed of light *in water* is less than c, it is perfectly okay with special relativity to exceed the speed of light in water, and in fact this commonly occurs for the energetic electrons produced by submerged atomic reactors (swimming pool reactors). The resulting radiation is observed as a blue glow. The radiation is named after the Russian physicist Pavel Cerenkov (1904–1990)—for which he received a share of the 1958 Nobel physics prize—but in fact Heaviside (previous note) had predicted it more than a decade before Cerenkov was born.

[8]This (theoretical) property of tachyons (if they exist) could (perhaps) be used (maybe) to build a revolutionary (to say the least) new rocket propulsion system: see J. Cramer, "The Tachyon Drive: Infinite Exhaust Velocity at Zero Energy Cost," *Analog*, October 1993.

These equations make sense for the case of $v < c$, and we will retain this condition for our two relatively moving *frames of reference*: these frames are the *worlds* of two *human* observers, observers that we'll take to always be *sub*luminal. As one physicist so nicely put it, "The assumption that observers move faster-than-light goes beyond superluminal signaling,"[9] as such observers would have to be thought of as being built not out of flesh-and-blood, but rather out of tachyons.[10] We'll reserve the symbol w to denote the speed of an FTL particle.

Now, recall what we mean by any line parallel to the x-axis; it is a line with a fixed time coordinate. Such a line is a *cosmic moment* line, with the equation $t =$ constant. Similarly, for the moving system we would write the equation of a cosmic moment line as $t' =$ constant which, after the Lorentz transformation is applied, is equivalent to

$$t - \frac{vx}{c^2} = \text{constant}.$$

In particular, the x'-axis ($t' = 0$ cosmic moment line), which passes through the point $x = 0$ at $t = 0$, has the equation

$$t = \frac{vx}{c^2} = vx$$

with the usual convention of $c = 1$.

In a similar way, recall what we mean by any line parallel to the t-axis; it is a line with a fixed space coordinate. Such a line is the world line of a stationary particle in the x, t frame, with the equation $x =$ constant. Similarly, for the moving system we would write $x' =$ constant as the equation of the world line of a particle stationary in that system. From the Lorentz transformation, this is equivalent to

$$x - vt = \text{constant}.$$

In particular, the t'-axis (which is the $x' = 0$ world line of a particle stationary at the origin of the moving system) passes through the $x = 0$, $t = 0$ point, and it has the equation

$$x = vt.$$

Thus, superimposed spacetime coordinate axes for the two frames look like those shown in Fig. 6.2. That is, the relative motion of the two frames results in a

[9] K. Svozil, "Time Paradoxes Reviewed," *Physics Letters A*, April 3, 1995, pp. 323–326.

[10] Science fiction, however, *has* (since the early days of pulp) enthusiastically embraced FTL human travel. In Larry Niven's story "At the Core" (*If*, November 1966), for example, we read of a manned spacecraft that travels 60,000 light years to the center of our own Milky Way Galaxy, and then back, at a speed 420,000 times that of light. As the pilot says (in a grand understatement), "That's goddam fast." Perhaps there is a way to make *some* sense of such an adventure, with the so-called *warp drive* (a'la *Star Trek*), which we'll take-up briefly at the end of this chapter.

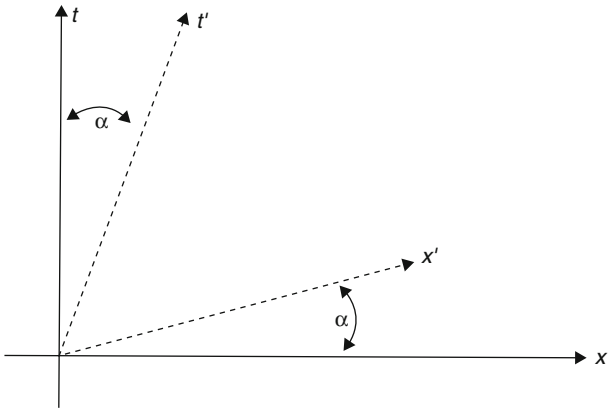

Fig. 6.2 Spacetime coordinate axes rotation by relative motion

rotation of the spacetime axes; but it is a strange sort of rotation, with *opposite* senses for the space and time axes. That is, the x' and t' axes rotate *towards* each other, as shown in the figure, to make equal angles (α) with the x and t axes, respectively, where

$$\alpha = tan^{-1}(v).$$

If we limit the moving frame (the frame of a moving observer) to subluminal speeds ($0 \leq v < 1$), then

$$0 \leq \alpha < 45°.$$

At the speed of light ($v = 1$) $\alpha = 45°$ and so the x' and t' axes coincide—time and space have become indistinguishable.

It is important to realize that observers in either system would measure the same speed for a photon; that is, each would see the world line of a photon as a line with slope 1. This view of the world line of a photon is literally built into the Lorentz transformation because one of Einstein's fundamental postulates for special relativity is the invariance of the speed of light. The truth of this statement for the x, t system is obvious from Fig. 6.2. It is, perhaps, not so obvious with the x', t' system because of the non-perpendicular axes (as shown in the figure) for that system. In Fig. 6.3 the world line of a photon is shown in both systems. In that figure we emit the photon at $x' = 0$, $t' = 0$, and we later measure its coordinates at point A to be $x' = x'_A$ at time $t' = t'_A$. Note carefully how this is done. We draw lines from point A parallel to the x' and t' axes until they intersect the t' and x' axes, respectively. This is similar to the way we would get the spacetime coordinates of A in the more familiar x, t system, where we would draw lines parallel to the x and t axes.

It should now be obvious that x'_A and t'_A have the same extension, just as they do in the unprimed system, so

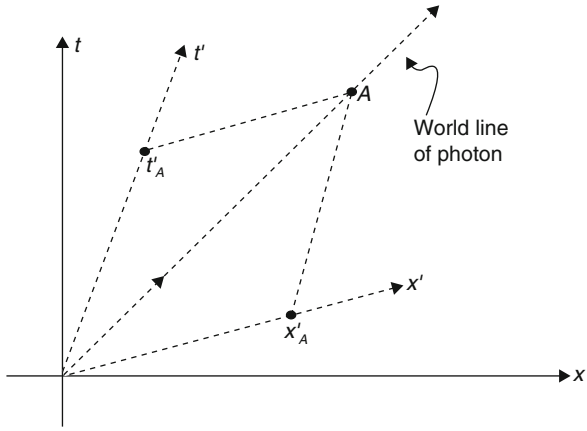

Fig. 6.3 Invariance of the world line of a photon

$$\frac{x'_A}{t'_A} = \text{the speed of light}$$

The speed of light is the only invariant speed under the Lorentz transformation. Indeed, the modern approach to special relativity emphasizes this invariance as the central property of the speed of light, rather than the idea of the speed of light being a limiting speed.

This geometrical interpretation of the Lorentz transformation lets us quickly make another interesting (one, I think, not at all obvious) observation: If a particle is faster than light in the x, t system, then there exists a subluminal x', t' system in which the particle is *infinitely* fast. Figure 6.4 shows the world line of an FTL particle in the x, t system (which is, of course, *below* the world line of a photon; that is, the particle's world line is spacelike). Suppose the FTL particle has speed $w > c$ such that its world line makes angle β with the x-axis. If we now pick v, the speed of the moving x', t' system to be such that $\alpha = \beta$, then the x'-axis will coincide with the world line of the particle, and so the particle will appear to an observer in the x', t' system to be everywhere at once—that is, to be infinitely fast. We have, then,

$$\beta = tan^{-1}(v) = tan^{-1}\left(\frac{1}{w}\right)$$

or $v = 1/w$, which seems to be dimensionally wrong. Recall, however, that with our convention of $c = 1$, the v in this result is a *normalized* speed. To return to the units of everyday use, simply replace v with v/c and w with w/c; this transforms our result to

$$\frac{v}{c} = \frac{c}{w} \quad \text{or} \quad v = \frac{c^2}{w}.$$

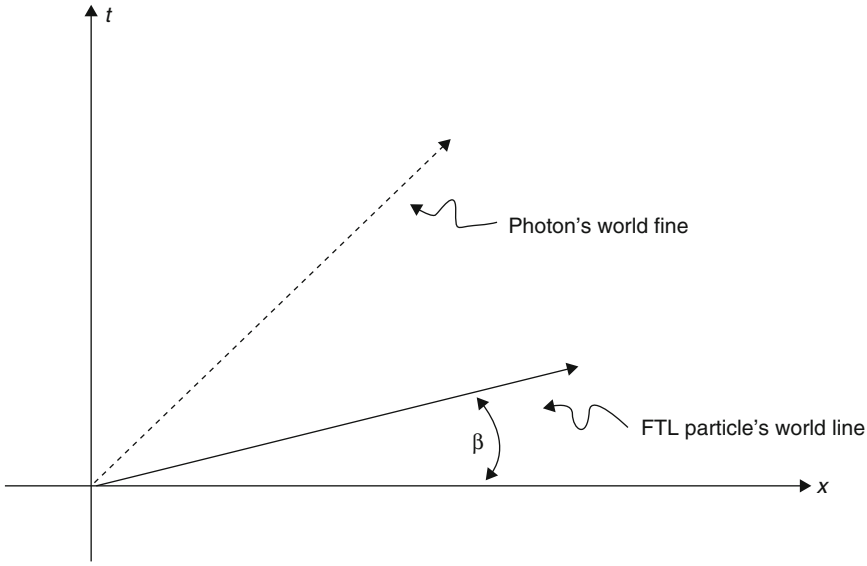

Fig. 6.4 World line of an FTL particle

We can, of course, turn this result around. If an FTL particle moves with speed w in the x, t frame, then to an observer in the x', t' frame moving with subluminal speed v, the particle will appear to be infinitely fast if $w = c^2/v$. A particle with $w > c^2/v$ is said to be not just be superluminal, but *ultra*luminal.

If a particle has infinite speed if $w = c^2/v$, then what physically happens if w is greater than c^2/v? The answer is easy to see from a spacetime diagram, as in Fig. 6.5, where the x' and t' axes have been extended back to negative values. In that figure I have labeled two arbitrary events A and B on the world line of an ultraluminal particle (and so it lies below the x' axis), and have shown the spacetime coordinates of each event in both the x, t and x', t' frames. For the x, t frame we see that A is related to B by the relations $x'_A < x'_B$ and $t'_B < t'_A$; that is, the time order of A and B is reversed for an observer in the x', t' frame. To that observer, the particle appears to be traveling backward in time!

But this isn't quite the end of the story. Following the approach of two pioneering tachyon physicists,[11] we note that if the energy of a particle in the stationary system is E, then the energy as measured in the moving system is given by[12]

[11]O. M. Bilaniuk and E. C. G. Sudarshan, "Causality and Space-like Signals," *Nature*, July 26, 1969, pp. 386–387.

[12]The expression for E' is the result of applying the Lorentz transformation to E. You can find all the details of that worked out in A. P. French, *Special Relativity*, W. W. Norton 1968, pp. 208–210.

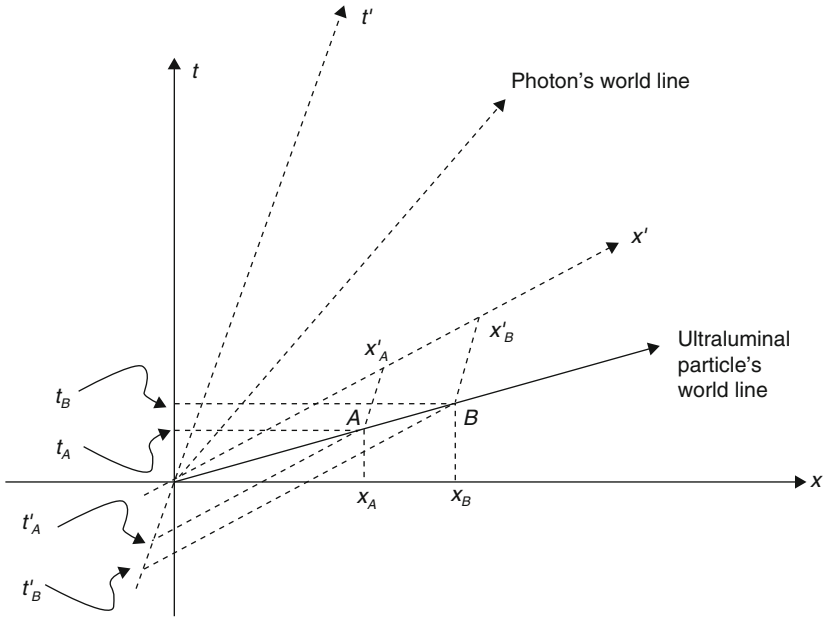

Fig. 6.5 World line of an *ultra*luminal particle

$$E' = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}} \frac{\mu(c^2 - \mathrm{wv})}{\sqrt{(w/c)^2 - 1}}$$

Note that sign of E' switches from positive to negative when w (the speed of the particle) exceeds c^2/v, which is precisely the condition for the particle to be ultraluminal and so traveling backward in time (as seen in the primed system). That is, negative energy moving backward in time in one system is positive energy moving forward in time in another. This is, in fact, the original motivation for the RP (reinterpretation principle) discussed in the previous chapter, and the claim was, at one time, that the RP was just what was needed to 'explain' the paradoxical implications of time travel. This is not the majority view today, however, and a number of physicists have been quite inventive in constructing scenarios with causal paradoxes that the RP clearly fails to 'explain.'

For example, the Princeton physicist Shoichi Yoshikawa (1934–2010), in a letter to *Physics Today* (see note 3), was able to create a scenario which *uses* the RP to arrive at a causal paradox. In his construction, the RP allows an observer to transmit an ultraluminal tachyon to a remote observer at time $t = 0$, and to receive a reply from that observer at $t < 0$. This obviously sets-up the possibility of a bilking paradox in which the original observer, upon receiving the $t < 0$ tachyon, then decides *not* to transmit the $t = 0$ tachyon. What makes Yoshikawa's paradox a particularly troublesome paradox is that the RP is the culprit, not the savior.

6.2 Tipler's Rotating Cylinder Time Machine

> "... within forty-eight hours we had invented, designed, and assembled a chronomobile. I won't weary you with the details, save to remark that it operated by transposing the seventh and eleventh dimensions in a hole in space, thus creating an inverse ether-vortex and standing the space-time continuum on its head."[13]
>
> —this is almost surely *not* the way to build a TM (time machine)

As discussed at the start of this book, the first endorsement of the reasonableness of physicists talking about plausible, scientific time travel, began with Gödel's discovery of closed timelike lines in the mathematics of certain rotating universe models. Such models had been studied as early as 1924 by the Hungarian physicist Cornelius Lanczos (1893–1974), a quarter century before Gödel, but it was Gödel who made explicit the possibility a rotating universe might allow time travel. His realization of time travel as an *inherent* property of a rotating universe is an illustration of a *weak* TM, while what is the central interest concerning time machines (in physics *and* in science fiction) is a *strong* TM. That is, in time machines that can be *intentionally constructed* by manipulating mass-energy in a finite (what physicists call a *compact*) region of spacetime to *create* closed timelike lines where none existed before the manipulation began. Interestingly, the fundamental physical idea behind Gödel's weak TM is the same underlying idea behind the first strong TM, Tipler's rotating cylinder discussed back in Chap. 1 (strictly, of course, only a *compact* TM if the cylinder can be of *finite* length).

The one result from general relativity that we'll use here (without proof) is that the rotation of matter causes a distortion of spacetime that results in the 'tipping over' of light cones, with the future half tilted in the direction of motion. If you imagine a point in the universe about which the rotation takes place, then this tipping effect increases with the radial distance from that point.[14] The fact that rotating masses tip light cones over in the direction of rotation was discovered very early in the history of general relativity (1918), by the Austrian theoreticians Josef Lense (1890–1985) and Hans Thirring (1888–1976). Originally (and naturally) called the *Lense-Thirring effect*, it now generally goes by the name of the *dragging of inertial frames effect*, and it plays a central role in the weak Gödel and the strong (maybe) Tipler time machines. Here's how.

At a certain critical distance from the rotation center (more on this in just a bit), the future half of the light cone at a given point in spacetime will be sufficiently tilted so as to enter the past half of similarly tilted light cones at nearby spacetime points This is illustrated in Fig. 6.6,[15] which shows a circular chain of tilted light

[13]L. Sprague de Camp, "Some Curious Effects of Time Travel," in *Analog Readers' Choice*, Dial 1981.

[14]For a picture of this, see S. W. Hawking and G. F. R. Ellis, *The Large Scale Structure of Spacetime*, Cambridge University Press, 1973, p. 169.

[15]Adapted from D. B. Malament, "'Time Travel' in the Gödel Universe," *Proceedings of the Philosophy of Science Association* 1984, pp. 91–100.

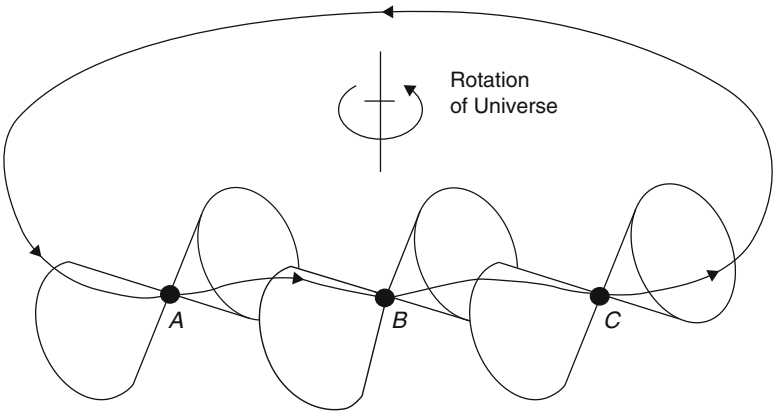

Fig. 6.6 Time traveling through tilted light cones in a rotating universe

cones in a rotating universe. Because light cones are tilted by a rotation-induced twisting of spacetime, a traveler can move around a circular path on a trip that is always directed into his *local* future but nonetheless end-up in his own *global* past, without ever going faster than light. This kind of round trip in spacetime, with a trajectory that winds back into the past without ever becoming spacelike, is a closed timelike curve.

From Fig. 6.6 it should be clear how a time traveler, beginning at A, can weave his way along a circular path (this path needs to have a radius at least as great as the critical value mentioned earlier) to B to C to ... that brings him back into the *past* half of the light cone at A. The traveler's world line is always inside the local light cone; that is, the world line of the time traveler is always timelike, and never FTL. These timelike curves are present in the rotating spacetime from the very beginning of the spacetime, and were not *created* (certainly not by humans) by conscious intent.

You can see how this works mathematically by taking the spacetime metric for Gödel's universe (with, as usual, the convention that the speed of light $c = 1$):

$$(ds)^2 = (dt)^2 - (dr)^2 - (dy)^2 + \sin h^2(r)\left[\sin h^2(r) - 1\right](d\phi)^2 + \sqrt{2}\sin h^2(r)(d\phi)(dt)$$

where t, r, y, and ϕ are cylindrical coordinates in four-dimensional spacetime. Now, imagine that our adventurer's world line is the helical curve r=constant, $y = 0$, and $t = -\alpha\phi$: if we take the time axis as vertical then the time traveler's world line is a vertical helix in spacetime. For this curve, $dr = \mathrm{d}y = 0$ and $dt = -\alpha d\phi$. This last differential means, in particular, that whatever the sign of the constant α, we can choose that one of the two senses of movement in the spatial ϕ dimension that gives $dt < 0$.

Continuing, we have

$$(ds)^2 = \left[\alpha^2 - 2\sqrt{2}\alpha sinh^2(r) + \sin h^2(r)\left(\sin h^2(r) - 1\right)\right](d\phi)^2$$

or, upon letting $u = \sinh(r)$ we have

$$(ds)^2 = \left[\alpha^2 - 2\sqrt{2}\alpha u^2 + u^2\left(u^2 - 1\right)\right](d\phi)^2.$$

Now, for $\alpha = 0$ we have

$$(ds)^2 = u^2\left(u^2 - 1\right)(d\phi)^2$$

which is greater than zero if $u > 1$. This condition holds if $\sinh(r) > 1$, that is, if r is a constant greater than $\ln\left(1 + \sqrt{2}\right)$. In other words, for r sufficiently large (and now we know the critical value for r) we have $(ds)^2 > 0$, the required condition for a timelike spacetime interval. By continuity, then, we will continue to have $(ds)^2 > 0$ even with some small positive or negative value of α different from zero. Because ϕ is a periodic coordinate (we identify $\phi = 0$ with $\phi = 2\pi$), as the traveler moves along the curve she returns repeatedly to the same spatial points, but her time coordinate is increasingly negative. That is, she is traveling into the past. Note, once again, that in Gödel's universe this property holds only for orbits with radii greater than a certain minimum.[16]

Tipler's rotating, infinitely long cylinder is a mechanism for artificially producing the tipped-over light cone effect, thus *creating* closed timelike curves. Figure 6.7, taken from Tipler's Ph.D. dissertation,[17] shows how the cylinder works. The cylinder is represented by the central vertical axis. Far away from the cylinder the light cones in spacetime are upright, but as we move inward they tip over, the future halves opening up into the direction of rotation. (Only the future halves of the light cones are shown.) This direction, which is the direction that far away from the cylinder measures *space*, near the cylinder measures *time* (just as in the Gödelian universe). That is, there has been a dimension reversal! This fantastic possibility has found its way into science fiction, as in Stephen Baxter's 1995 novel *The Time Ships*, wherein the Victorian narrator says "If only one could *twist about* the Four Dimensions of Space and Time — transposing Length with Duration, say — then one could stroll through the corridors of History as easily as taking a cab in the West End!"

To travel back in time, therefore, all the time traveler need do is leave Earth and approach the cylinder until she is near enough to be in the tipped-over region of spacetime. Then she would follow a helical path around the cylinder and could

[16]There are other solutions to the Einstein gravitational field equations that have closed timelike lines at *any* radius, no matter how small: see M. J. Reboucas, "A Rotating Universe with Violation of Causality," *Physics Letters A*, March 5, 1979, pp. 161–163.

[17]F. J. Tipler, *Causality Violation in General Relativity*, University of Maryland 1976.

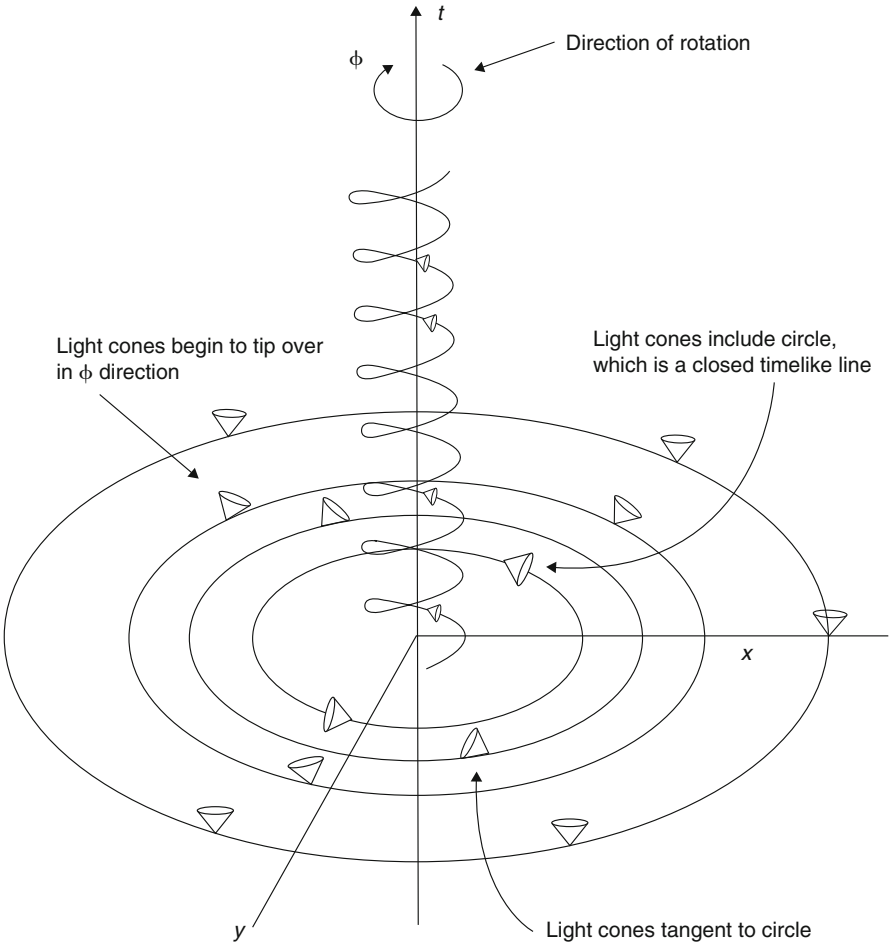

Fig. 6.7 The future halves of light cones point almost entirely in the $+t$ direction far from rotating matter; they begin to tip over as the matter is approached. Note that there is a helical timelike path that moves locally into the *future* in the $-t$ direction, that is, it goes into the past as seen by an observer far from the rotating matter (The world lines of rotating matter are helixes in the $+t$ direction)

spiral along the negative time direction as far back in time as desired (but no further back than to the moment of the cylinder's creation). This motion is such that the time traveler is always moving into her local future, via the tipped-over light cones. Finally, she would withdraw from the cylinder and return to Earth—in the past. The time traveler had better be a good space navigator, of course, because Earth won't be where she left it!

6.3 Thorne's Wormhole Time Machine

> "This fact reinforces the authors' feeling that [closed time loops] are not so nasty as people generally have assumed."[18]

The spacetime wormhole is presently the most promising of the approaches that have been advanced for building a time machine. Gödel rotated the entire universe in 1949, and Tipler 'reduced' the problem in 1974 to 'merely' spinning a cylinder of infinite length. In 1988 Kip Thorne scaled things down even more, this time to other extreme. His idea calls for pulling a wormhole on the scale of the Planck length out of the topologically multiply connected quantum foam that spacetime is and then enlarging it (somehow) to human scale, all the while stabilizing it against self-collapse, and then finally using the time dilation effect of special relativity to alter time at one mouth of the wormhole as compared to the other mouth. What a mouthful! What, you almost surely wonder, does all that mean?

First of all, what's 'quantum foam'? The term refers to the idea that the topology of spacetime is *not* a smooth, continuous manifold, but rather (if you look close enough) is a seething 'ocean of fluctuations' that is always changing, changes on the scale of the Planck length (look back at Sect. 1.5). What does *that* mean? Like the ocean surface-in-the-large, large-scale spacetime is simply connected. But just as one sees all sorts of transient structure as one looks at the water more closely (beginning with macroscopic waves and then proceeding downward to the bubbly foam on the waves), spacetime too displays an ever-changing connectivity-in-the-small.[19] That is the 'quantum foam.'

Wormholes have been around in physics for decades, but they have always been thought to be so unstable as to exist only on paper in the mathematics of general relativity. In an analysis[20] published more than half-a-century ago, for example, wormhole instability was shown to be so severe that not only would a human have no chance in getting through one, but also not even a single speedy photon could do so. Even at the speed of light, the photon could not zip through a wormhole before being trapped inside ("pinched off") in a region of infinite spacetime curvature. Wormholes would simply collapse too quickly after formation for even the so-called ultimate speed to save the traveler. Indeed, the presence of mass-energy inside a wormhole actually *accelerates* its collapse. The physics of wormholes, it seemed, made them simply untraversable.

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[18]The conclusion of a mathematical demonstration that time travel by wormhole does not conflict with the conservation of energy: see J. L. Friedman *et al.*, "Cauchy Problem in Spacetimes with Closed Timelike Curves," *Physical Review*, September 15, 1990, pp. 1915–1930.

[19]Not all accept this view. See, for example, A. Anderson and B DeWitt, "Does the Topology of Space Fluctuate?" *Foundations of Physics*, February 1986, pp. 91–105.

[20]R. W. Fuller and J. A. Wheeler, "Causality and Multiple Connected Spacetime," *Physical Review*, October 15, 1962, pp. 919–929.

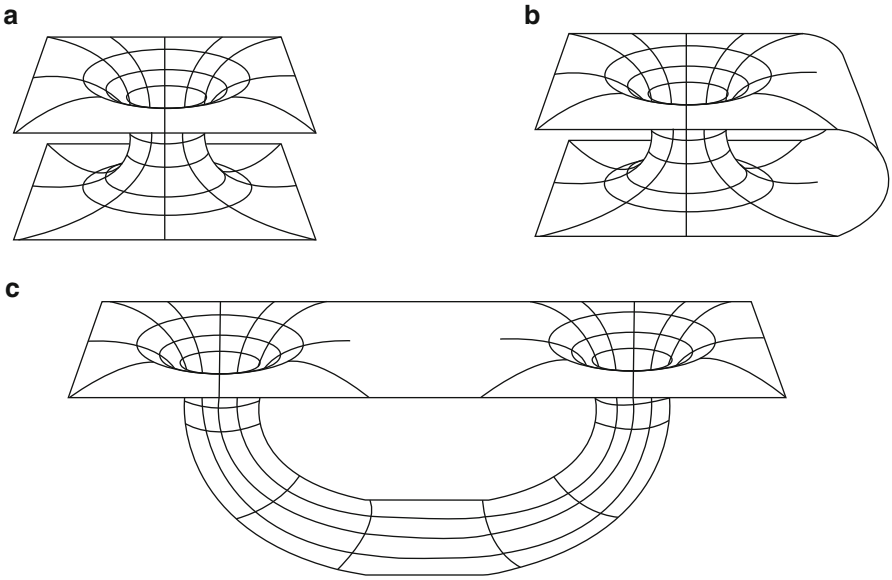

Fig. 6.8 These sketches are unavoidably misleading, being two-dimensional renditions of wormholes that connect two places in a three-dimensional space. Time machine wormholes, on the other hand, connect two places in a four-dimensional spacetime. In particular, the mouths of the wormholes are not 'depressions' into which the time traveler's rocket ship plunges, but rather would appear to be three-dimensional spheres. The wormhole in (**a**) connects two disjoint universes, while those in (**b**) and (**c**) are connections between two places in the same universe. As shown in these last two cases, the wormhole 'handle' can be either long or short, compared to the external distance between the wormhole mouths

And anyway, how would one gain access to a wormhole in the first place? As Thorne and one of his students suggested,[21] one might perhaps imagine someday finding a rotating black hole that mathematically possesses, in its interior, so-called hyperspace tunnels to 'other places'—either in our universe or in other universes (see Fig. 6.8). In the case of a wormhole connecting two places in the same universe, although the external distance in spacetime between the places may be very large (mega-light-years), it is conceivable that the distance *through* the wormhole itself could be very small. The time required to traverse the wormhole, as measured by the traveler's watch might, in fact, be arbitrarily small. This is exciting, but wormholes do not come without some significant problems.

Such problems include the presence of a one-way event horizon, which precludes two-way travel (it seems reasonable to assume that time and space travelers

[21]M. S. Morris and K. S. Thorne, "Wormholes in Spacetime and Their Use for Interstellar Travel: A Tool for Teaching General Relativity," *American Journal of Physics*, May 1988, pp. 395–412. This paper was motivated by Thorne's earlier response to a request, from the American astronomer Carl Sagan (1934–1996), for help in making plausible the interstellar travel imagined in his 1985 novel *Contact*.

might wish to eventually return), and enormous gravitational gradients (tidal forces) that dismember anything approaching and/or entering the wormhole. These problems have often been conveniently *ignored* in science fiction. For example, in one tale[22] the time machine is in the form of a wormhole time tunnel that time travelers can simply walk through, and in another characters similarly walk back and forth between two openings in a wall that connect the same place in space but separated in time by 160 years.[23] And in an even older story, we read of a time machine (in the form of a hole in spacetime that is a wormhole in everything but name) through which one can literally step from future to past and back again. That story[24] is particularly notable for having introduced the term *mugwump* for a time traveler who uses a time machine wormhole. To paraphrase the tale's time traveler, as he transits the wormhole his "mug" is in the past and his "wump" is in the future.[25]

Now, before going any further, a note on what physicists are referring to when they write of traversable time travel wormholes. Such wormholes are called *Lorentzian* because they have a spacetime metric with the signature $[+, -, -, -]$ (see Sect. 3.5). Further, the wormhole is taken to be *static*, that is, to have no time-varying behavior. The reason for being specific on the nature of time travel wormholes is that there is another type with what is called the *Euclidean signature*: $[+, +, +, +]$, which is not suitable for time traveling. Motion in a Euclidean signature wormhole involves imaginary momentum or proper time, neither of which is physically plausible for a time traveler. However, *if* you can gain access to a Lorentzian wormhole *then*, as two physicists wrote, "if you manage to acquire even one inter-universe traversable wormhole then it *seems* almost absurdly easy to build a time machine."[26]

In response to that fundamental question of how to gain access to a Lorentzian wormhole, Thorne and his students were bluntly honest—they didn't know. Their best suggestion was that "one can imagine an advanced civilization pulling [a] wormhole out of the quantum foam and enlarging it to classical size."[27] A few years later this dramatic idea found its way into a science fiction novel of a far-future alien civilization able to control the energies of constellations of galaxies: "Spacetime is friable. Wormholes riddle the fabric of spacetime on all scales. At the Planck length and below, wormholes arising from quantum uncertainty effects blur

[22]R. C. Wilson, *A Bridge of Years*, Doubleday 1991.

[23]M. Leinster, *Time Tunnel*, Pyramid Books 1964.

[24]H. Kuttner, "Shock," *Astounding Science Fiction*, March 1943.

[25]The term's origin is in 19th century politics, as a description of fence-sitters who try to avoid taking a definite position on some controversial topic under debate. For an illustration of wormhole mugwumping, see K. S. Thorne, *Black Holes & Time Warps*, W. W. Norton 1994, p. 500.

[26]C. Barceló and M. Visser, "Twilight for the Energy Conditions?" *International Journal of Modern Physics D*, December 2002, pp. 1553–1560. See also M. Visser, *Lorentzian Wormholes*, AIP Press 1996.

[27]M. S. Morris, K. S. Thorne, and U. Yurtsever, "Wormholes, Time Machines, and the Weak Energy Condition," *Physical Review Letters*, September 26, 1988, pp. 1446–1449.

the clean Einsteinian lines of spacetime. And some of the wormholes expand to human scale, and beyond — sometimes spontaneously, and sometimes at the instigation of intelligence."[28]

This isn't easy to visualize, but let's plunge ahead and assume we can "pull" a wormhole out of the quantum foam. If so, then once it is (somehow) inflated the wormhole could be stabilized against collapse by threading it with either matter or fields of stupendous negative (outward) tension—and by *stupendous* I mean *STUPENDOUS*. If b_0 denotes the minimum radius of the wormholes (the size of the so-called *throat* of the wormhole), the tension (radial pressure) at that location must be at least

$$\tau_0 = \frac{3.8}{{b_0}^2} \times 10^{36} \frac{tons}{in^2}$$

where b_0 is expressed in feet.[29] (This expression shows that for a wormhole with a throat radius of several thousand feet, the value of τ_0 is enormous, of the same magnitude as the pressure at the center of the most massive neutron star.) To stabilize a common sort of everyday wormhole, such as a subway tunnel, we can obtain the required tension/pressure by lining the tunnel with iron plates or concrete. But how, for a hyperspace wormhole, do we obtain 'iron plates' that can achieve the required enormous tension? As Thorne and his students observed (note 27) such stuff could only be called "exotic," a term that had appeared a few years earlier in connection with the observed energy density in the throat of a wormhole.[30]

One possible approach to this problem does not use matter at all. If we make b_0 *very* large, then non-material fields will do the job.[31] Indeed, suppose b_0 equals 1 light year (a large wormhole by anybody's standard!). Then τ_0 is 'only' 4000 tons/square inch, and that is achievable by threading the wormhole throat with a magnetic field of 'only' 2,700,000 gauss (five million times stronger than the Earth's field).[32] To generate such a field is not impossible, and present-day

[28]From S. Baxter's 1993 novel *Timelike Infinity*. That same year the Chinese physicist Liao Liu wrote on how, as a result of a naturally occurring vacuum fluctuation, a wormhole might spontaneously appear: L. Liu, "Wormhole Created from Vacuum Fluctuation," *Physical Review D*, September 15, 1993, R5463–R5464.

[29]The original equation for τ_0 was given in units of dynes/cm^2, with b_0 is expressed in meters (see note 21), but I have converted these units to the more familiar (to the non-physicist) units of tons per square inch, for dramatic purposes, because the units of dynes per square centimeter is so small it's difficult to relate it to anything of everyday significance.

[30]R. Balbinot, "Crossing the Einstein-Rosen Bridge," *Lettere Al Nuovo Cimento*, May 16, 1985, pp. 76–80.

[31]See, for example, Y. Soen and A. Ori, "Improved Time Machine Model," *Physical Review D*, October 15, 1996, pp. 4858–4861, and D. N. Vollick, "How to Produce Exotic Matter Using Classical Fields," *Physical Review D*, October 15, 1997, pp. 4720–4723.

[32]To understand how the calculation of a magnetic field from a pressure requirement is accomplished, note that pressure is dimensionally equivalent to field energy per unit volume, which in turn is given by a well-known result in electromagnetic theory.

experimental, hypervelocity electromagnetic rail guns in development for the US Navy use transient magnetic fields in the mega-gauss range.

As if the stabilization problem wasn't enough of a complication, Thorne and his colleagues (note 27) showed that there is another, even more curious problem. The geometrical requirement that the wormhole interior smoothly connect to the external, asymptotically flat exterior spacetime demands that the wormhole throat flare outward as shown in Fig. 6.8. It turns out that this condition is mathematically equivalent to a requirement that τ_0 exceed the energy density of the throat material[33]; and special relativity, in turn, says that for some timelike observers the energy density will then actually be *negative*. This is a clear violation of the so-called *weak energy condition* (WEC), which says the observed mass-energy density is always non-negative. This is *so* 'obvious' that the WEC was thought, for a long time, to be almost a law of nature. Such a violation is actually not as crazy as it might sound however because, more than half-a-century ago, it was shown[34] that an energy density that is everywhere and everywhen positive is *not* compatible with any quantum field theory that is *local*, as, presumably, will be the yet-to-be-discovered theory of quantum gravity. Over the years since then a variety of other energy conditions have been proposed, such as the *averaged weak energy condition* (AWEC), which says that only the *average* value of the energy density over a complete null geodesic world line has to be non-negative, which leaves open the possibility of *temporary* negativity here, there, then and when.[35]

The traversable, static wormholes studied by Thorne and his colleagues violate even the AWEC (see note 27), however, and in the years since it has become clear to physicists that imposing constraints on the mass-energy density may not be so 'obvious' after all (see note 26). But all may not be lost. Indeed, it has been shown that the violation of the AWEC by traversable wormholes can be made as small as desired, that is, the requirement for the exotic matter required to line a wormhole throat to keep it open can be made as tiny as you want.[36]

Well, tiny the quantity of exotic matter may be but, nonetheless, even a tiny amount of it would be extraordinary weird stuff because a negative energy density can be interpreted as meaning that the exotic material that keeps the wormhole throat open

[33]The condition of τ_0 exceeding the energy density in the throat is, in fact, the technical definition of *exotic*—see note 30. In everyday situations, the exotic condition is never even remotely approached. For example, the maximum tension necessary to pull a piece of steel apart—the so-called *tensile strength*, about 100,000 pounds per square inch—is a trillion times less than the mass-energy density of steel.

[34]H. Epstein, V. Glaser, and A. Jaffe, "Nonpositivity of the Energy Density in Quantized Field Theories," *Il Nuovo Cimento*, April 1, 1965, pp. 1016–1022.

[35]T. A. Roman, "Quantum Stress-Energy Tensors and the Weak Energy Condition," *Physical Review D*, June 15, 1986, pp. 3526–3533.

[36]M. Visser, S. Kar, and N. Dadhich, "Traversable Wormholes with Arbitrarily Small Energy Condition Violations," *Physical Review Letters*, May 23, 2003, pp. 201102-1 to 201102-4.

does so by exerting a *repulsive* gravitational force.[37] A repulsive force sounds like a property we'd expect to see associated with *negative mass* and, although such a thing has never been observed (negative matter is *not* anti-matter, which *has* been observed and which does not repel 'normal matter'), it was studied long ago (theoretically, of course) by the English cosmologist Hermann Bondi (1919–2005). Bondi showed[38] that negative mass would indeed have some truly bizarre properties,[39] but there is nothing in general relativity that forbids its possible existence. Wormholes, with negative mass throats, should produce observable effects by which a wormhole *might* be detected. Mathematical analyses of the effect a negative-mass wormhole mouth would have, when crossing the line-of-sight between Earth and a distant star, indicates that there should be an observable *double-spike* in the intensity of the star's light. Astronomical searches for such an optical signature have actually been conducted, with (alas) no success as I write (2017).

There is another interesting implication of a repulsive gravitational force, one that proves to be *essential* to the possibility of a wormhole time machine. Just as Einstein's famous prediction (verified in 1919) from general relativity, that star light passing near the Sun's edge is bent *inward* by the Sun's attractive gravitational field, the repulsive, anti-gravity field of a wormhole will cause any light rays traveling through the wormhole to be bent *outward*. That is, a tight, narrow beam of radiation entering a wormhole will emerge *defocused*. This is crucial because, as you'll soon see, a wormhole time machine would otherwise be destroyed by the light from the dimmest candle.

One might take the failure of astronomical searches for a double-spike light signature to mean that wormholes with negative mass throats (thus violating the WEC) simply don't exist. But not so fast. The first hint that the possibility of a negative energy density might not be such a crazy idea occurred as long ago as 1948, with a theoretical prediction made by the Dutch physicist Hendrick Casimir (1909–2000). As pointed out in Chap. 1, the Heisenberg uncertainty principle allows a temporary violation of conservation of energy to occur, with the magnitude of the allowed violation increasing with decreasing time duration. Even in a vacuum, then, with particle/anti-particle creation and annihilation spontaneously and continuously taking place, the *average* energy density being zero does not

[37]The *strong energy condition* says gravity is always attractive—which is clearly not true in a wormhole throat—and so static, traversable wormholes violate both the weak *and* the strong energy conditions.

[38]H. Bondi, "Negative Mass in General Relativity," *Reviews of Modern Physics*, July 1957, pp. 423–428.

[39]For example, general relativity says that a negative mass will *repel* all other masses (positive *and* negative), whereas a positive mass will *attract* all other masses (positive *and* negative). Imagine, then, a negative mass attached to the nose of a positive-mass spaceship. The spaceship tries to move toward the negative mass, while the negative mass tries to move away from the spaceship. So off they both go into the sky, like a cat chasing its tail. This so-called *reactionless anti-gravity drive*, bizarre as it appears, does not violate either of the conservation laws of energy or momentum. See G. Cavalleri and E. Tonni, "Negative Masses, Even if Isolated, Imply Self-Acceleration, Hence a Catastrophic World," *Il Nuovo Cimento B*, July 1997, pp. 897–903.

preclude fluctuations away from zero and so, at times, actually becoming *negative*. What Casimir showed was that if one positioned two perfectly conductive plates parallel to each other, then the normal quantum fluctuations of the energy density in this 'vacuum sandwich' would be altered in such a way as to result in their mutual attraction—and this (tiny) effect was later actually observed.[40]

What does it mean to 'alter the normal quantum fluctuations'? Consider the creation of a photon and its anti-particle, which is another photon. From the wave interpretation of particles, the parallel plates restrict the photons that appear in the vacuum layer to those that have wavelengths that 'fit' because those wavelengths are submultiples of the plate separation (this requirement follows from the fact that a perfectly conducting plate cannot support a non-zero tangential electric field). Photons with longer wavelengths than the plate separation cannot 'fit' and thus do not appear. That is, the parallel plates have created a boundary condition that has quantized the electromagnetic field. The absence of these 'longer wavelength' photons lowers the average energy density between the plates and, because the average without the plates is zero, the altered average energy density must be negative. Indeed, the more the maximum allowed photon wavelength decreases with decreasing plate separation, the more negative the average energy density becomes in the enclosed Casimir vacuum. The negative energy density manifests itself as an inward directed force per unit area (remember, energy density and pressure are dimensionally equivalent).

The experimental detection of the Casimir effect was a remarkable event in physics. As one mathematician put it, "No worker in the field of overlap of quantum theory and general relativity can fail to point this fact out in tones of awe and reverence."[41] Robert Forward, an imaginative physicist who has appeared in this book earlier as an enthusiastic supporter of time travel, has described how the Casimir force might be used to extract energy literally *from a vacuum*. This is an idea as seemingly impossible as is the plan of one science fiction professor to squeeze energy out of *time*. As he asks his assistant, "But tell me, Bob, isn't that a ridiculous thought? To take time, something intangible, invisible, incomprehensible, and contract it — squeeze it together like a sponge?"[42] The story is fun, but Forward's proposal is that as well—*and* good physics.[43] Now, what does all this have to do with wormhole time machines?

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[40]A complete presentation of Casimir's analysis, with citations to the original literature, can be found in L. E. Ballentine, *Quantum Mechanics*, Prentice-Hall 1990, pp. 399–403. For an historical, tutorial presentation, including Casimir's personal comments on how he was led to make his discovery, see P. W. Milonni and M.-L. Shih, "Casimir Forces," *Contemporary Physics*, September–October 1992, pp. 313–322.

[41]S. A. Fulling, *Aspects of Quantum Field Theory in Curved Space-Time*, London Mathematical Society 1989.

[42]E. Binder, "The Time Contractor," *Astounding Stories*, December 1937.

[43]R. Forward, "Extracting Electrical Energy from the Vacuum by Cohesion of Charged Foliated Conductors," *Physical Review B*, August 15, 1984, pp. 1700–1702.

Thorne and his colleagues (note 27) proposed to use the Casimir effect to achieve the "exotic condition" *without* matter. Their idea was to place identical, conducting, spherical plates that carry equal electric charges at each end of the wormhole (remember, the wormhole mouths are spherically symmetric). The two identical charges repel each other, but the charge size is adjusted so that the gravitational attraction of the plates precisely cancels the repulsion. They then calculated that the Casimir effect results in a negative energy density sufficient to provide the throat tension necessary to prevent wormhole collapse.

There *are* some weird aspects to this (and perhaps that's no surprise). For example, the analysis assumed that the wormhole length is *very* small compared to its radius (10^{-10} cm long and 200 million miles wide!), with the short length required because it represents the separation of the wormhole plates, and the smaller the separation the more negative the average energy density. (The functional dependence is as the *fourth* power of the separation.) Another problem is the balancing of the electrical repulsion and the gravitational attraction of the wormhole mouth plates, as such a balance is clearly an unstable one. Finally, because the two spherical plates completely fill the wormhole mouths, how would a traveler actually get through the wormhole? The 'answer' was to drill a hole through the plates and hope that wouldn't perturb the Casimir vacuum too much.[44]

All the above litany of the difficulties static, traversable wormholes face in simply existing is certainly daunting, but let's now ignore all that and suppose we actually have a wormhole with both mouths in the same universe. (For use as a time machine, it would seem desirable for the time traveler to remain in his/her own universe!) So, how do we turn the wormhole into a time machine? Interestingly, while it is general relativity that gives us the wormhole, it is special relativity that adds the final touch of backward time travel. We begin by imagining that, somehow, one mouth of the wormhole can be moved with respect to the other mouth. One early suggestion, for example, was to use the gravitational attraction of a large asteroid to 'drag' one end of the wormhole, thereby inducing a time dilation effect.[45]

That is, suppose we have two clocks A and B, one in each mouth of the wormhole. These two clocks, and all other clocks in the flat spacetime outside the wormhole, are initially indicating the same time and running at the same rate. Now, recalling the twin paradox from Chap. 3, let each mouth-clock play the role of one of the twins. Imagine that A and B are now separated because the mouth containing B is placed on board a rocket ship. The rocket ship takes a long, high-speed trip out into space along the straight-line path joining A and B in external space, and then returns, just as described in Sect. 3.5. We then unload the space traveling wormhole mouth (with its clock B) and reposition it at its original location. What

[44]The very next year it was shown how to construct non-spherically symmetric wormholes to avoid that particular problem: see the two papers by M. Visser, "Traversable Wormholes: Some Simple Examples," *Physical Review D*, May 15, 1989, pp. 3182–3184, and "Traversable Wormholes from Surgically Modified Schwarzchild Spacetimes," *Nuclear Physics B*, December 11, 1989, pp. 203–212.

[45]J. L. Friedman, "Back to the Future," *Nature*, November 24, 1988, pp. 305–306.

is the situation now? We can summarize matters as follows: (1) Clock A, in the non-moving mouth, remains in-step with the local clocks in the space outside the mouth. (2) Clocks A and B, both inside the wormhole, have *not* moved with respect to each other because we are assuming a very short wormhole handle, as in part (b) of Fig. 6.8. We can arrange for the motion of the space traveling mouth (with clock B) to be such that the handle is always short, and so the distance between clocks A and B changes by an arbitrarily small amount. Thus, clocks A and B remain in-step with each other. (3) Clock B, because it has been moving with respect to its external space, arrives back at its starting position reading *behind* (that is, *earlier*) than the clocks outside its wormhole mouth.

For the sake of argument, then, suppose the journey of B is such that there is a two-hour time-slip between clock B and its local, external clocks. Thus, if clock B reads 9 A.M., the clocks outside of mouth B will read 11 A.M. But because clocks A and B are in-step, clock A reads 9 A.M., as do the clocks outside of mouth A. That is, the wormhole connecting mouth A to mouth B is a connection between two parts of the same universe that are two hours apart in time. Now, suppose the journey from mouth A to mouth B can be made through external space in one hour. Then, one could leave mouth A at 10 A.M., rocket to mouth B by 11 A.M., and travel back to mouth A via the wormhole to the starting point—where it is 9 A.M., one hour *before* the trip began! We could, in fact, imagine repeating this process, going back one additional hour for each new loop through the wormhole. One clear restriction, however, is that we could not go back in time to *before* the creation of the wormhole time machine. The wormhole works in the other direction, too. To see this, suppose that the space traveler leaves mouth B at 8 A.M. and rockets through external space to mouth A, arriving at 9 A.M. Entering mouth A, he exits from mouth B (where he started) at 11 A.M., two hours in the future.

Another way to induce a time dilation effect, to convert a wormhole to a time machine, *without moving either mouth*, is to simply place one mouth in an intense gravitational field, that of, say, a neutron star. (Recall, from Sect. 3.3, how gravity influences the time-keeping rate of a clock.) As the physicists who proposed this idea put it, almost *any* interaction with surrounding matter and gravity fields almost inevitably turns a wormhole into a time machine.[46] Others have admitted that the details of the origin of time dilation are probably not issues worth debating, but rather what is called the *back-reaction* is of far more concern.

To understand the back-reaction requires mention of what is called the *Cauchy horizon*, the hyperspace surface in spacetime that separates the region where closed timelike lines can exist, from the region where they cannot exist. The back-reaction is the build-up of unbounded energy levels on the Cauchy horizon, causing its instability and rapid destruction. The name of the horizon comes from the "Cauchy problem"—named after the nineteenth century French mathematician Augustin-Louis Cauchy (1789–1857)—in the theory of partial differential equations. In this

[46] V. P. Frolov and I. D. Novikov, "Physical Effects in Wormholes and Time Machines," *Physical Review D*, August 15, 1990, pp. 1057–1065.

theory a Cauchy initial-value problem is said to be well-defined if the initial conditions determine a unique solution, and if a continuous variation in the initial conditions gives a continuous variation in the solution. In that part of spacetime where closed timelike loops are not allowed, backward causation does not occur (by definition) and the laws of physics (all expressed as differential equations) satisfy the Cauchy condition. Outside of this *chronal* region, that is, beyond the Cauchy horizon where physics is *dischronal*, however, the possibility of backward causation raises the possibility of violating the Cauchy condition, and in such a case the Cauchy horizon is also sometimes called the *chronology horizon*.[47]

The instability of the Cauchy horizon is caused by radiation that propagates in closed timelike loops that thread through the wormhole on 'straight lines.' This radiation, as shown a half-century ago,[48] builds-up unbounded energy density levels at the horizon, and thus destroys the horizon. Thorne and his colleagues argued that the defocusing effect of their wormhole time machine's repulsive gravity would be sufficient to counter a disruptive energy build-up on the horizon (note 27). Subsequent analyses have examined other possible ways to avoid unbounded energy density on the Cauchy horizon. For example, in one paper[49] it was imagined that a wormhole time machine has had a circular motion induced for mouth B; that is, mouth B orbits around mouth A. The result is that the Cauchy horizon now does seem to be stable, because now there are no fixed, straight-line timelike loops threading the wormhole from A to B to A to B to . . .. That is, B is a 'moving target' and there is no point on the Cauchy horizon where the energy density becomes unbounded.

Yet another approach for achieving the disruption of destructive, circulating energy loops through a wormhole is by placing a spherical mirror between the two mouths of the wormhole. Proposed by the Chinese physicist Li-Xin Li, a Li mirror would divert all closed null geodesics (represent circulating radiation) that potentially thread through the wormhole.[50] Such potentially fatal geodesics would, instead, be scattered back into space, whereas a purposeful traveler could navigate *around* the mirror and thus use the wormhole as a time machine.

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[47]A classic work on the mathematics of Cauchy problems is J. Hadamard, *Lectures on Cauchy's Problem in Linear Partial Differential Equations*, Dover 1952. There is a curious bit of irony in this. In a section of his book, Hadamard uses spacetime to illustrate one possible four-dimensional space and, in passing, he casually writes "This conception was beautifully illustrated a good many years ago by the novelist Wells in his *Time Machine*." Hadamard wrote his book in 1923, and he would almost certainly have been astonished to have been informed that less than seventy years later his work would play a central role in the non-fictional theory of time machines.

[48]C. W. Misner and A. H. Taub, "A Singularity-Free Empty Universe," *Soviet Physics JETP*, January 1969, pp. 122–133.

[49]I. D. Novikov, "An Analysis of the Operation of a Time Machine," *Soviet Physics JETP*, March 1989, pp. 439–443.

[50]L.-X. Li, "New Light on Time Machines: Against the Chronology Protection Conjecture," *Physical Review D*, November 1994, pp. R6037–R6040.

Cauchy horizon instability from the back reaction is central to Hawking's Chronology Protection Conjecture, discussed in Chap. 1. His analysis (see note 54 in Chap. 1) led him to conclude that a physical entity—the stress-energy tensor—becomes unphysical on the Cauchy horizon. That is, because of time-traveling quantum field fluctuations of the vacuum, that tensor diverges to infinity at the horizon. This results in a failure of that horizon to form in the first place or, if it does form, in the creation of a singularity that 'seals-off' the horizon to any would-be time travelers attempting to gain access to the closed timelike loops beyond the horizon. Others, however, argued that Hawking was mistaken in claiming that the divergence of the stress-energy tensor on the Cauchy horizon will always forbid time travel.

In a study, for example, of a complex-valued spacetime metric (and such a metric *is* allowed in the so-called 'sum over all possible geometries, path integral' approach to the quantum theory of gravity), that has causal and non-causal spacetime regions separated not by a Cauchy horizon but rather by a region of complex geometry, the stress-energy tensor is always physical and diverges nowhere. The complex geometry region plays the same role as the Cauchy horizon, because such a region would, *classically*, mean that the two regions cannot be reached from one another, but via quantum tunneling an observer *could* travel between the two regions.[51] In fact, studies of stress-energy divergence actually have a long history. For example, the effect of an unphysical (infinite) gravitational and/or electromagnetic energy flux had been analyzed *years before* the wormhole time machine studies began.[52] The authors studied the case of a potential traveler to "new worlds" who tries to cross the Cauchy horizon of an electrically charged, non-rotating black hole. An even earlier computer study had already concluded that, for such a traveler, the attempt to cross the horizon "looks liable to prove a dangerous undertaking."[53]

It isn't at all clear, in fact, if a *theoretical* divergence of the stress-energy *is* the signature of a failure of physics. One doesn't need anything as bizarre as a time machine for the stress-energy to diverge *on paper*. It was shown nearly 40 years ago, for example, that such a theoretical divergence occurs for the electromagnetic field near a perfectly conducting boundary.[54] But it is simply the unphysical nature of a "*perfectly* conducting" boundary condition that causes the divergence, not the fact that the field actually exists near a conducting boundary. Similarly, other real-life considerations (quantum gravity) *may* keep the stress-energy physical everywhere in a time machine spacetime.

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[51]L.-X. Li, J.-M. Xu, and L. Liu, "Complex Geometry, Quantum Tunneling, and Time Machines," *Physical Review D*, November 15, 1993, pp. 4735–4737.

[52]S. Chandrasekhar and J. B. Hartle, "On Crossing the Cauchy Horizon of a Reissner-Nordström Black-Hole," *Proceedings of the Royal Society of London A*, December 8, 1982, pp. 301–315.

[53]M. Simpson and R. Penrose, "Internal Instability in a Reissner-Nordström Black Hole," *International Journal of Theoretical Physics*, April 1973, pp. 183–197.

[54]D. Deutsch and P. Candelas, "Boundary Effects in Quantum Field Theory," *Physical Review D*, December 15, 1979, pp. 3063–3080.

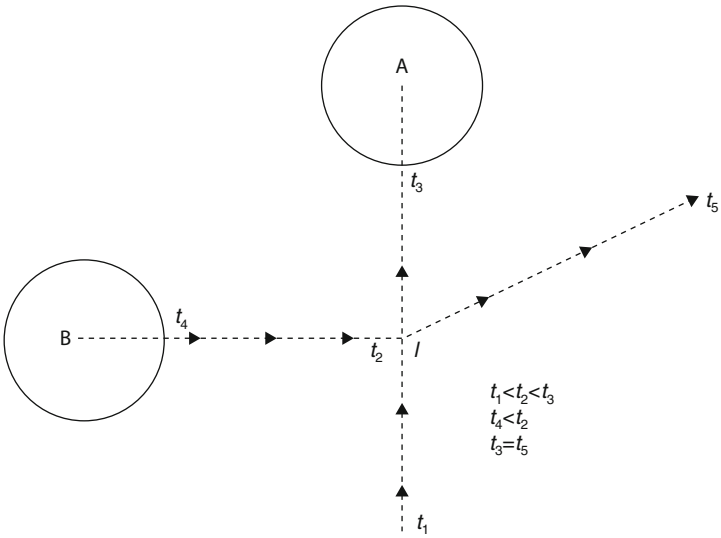

Fig. 6.9 The grandfather paradox in the billiard ball world. A billiard ball approaches mouth A of a time machine wormhole, dead-on center and, just before entering A, it passes without incident through point *I*. The ball then enters A and so exits mouth B in the past, *just in time* to pass through point *I* and *hit its younger self*. This impact knocks the younger ball *away from* A, so we have the familiar paradox of changing the past. That is, the impact did not occur when the ball 'originally' passed through *I* on its way to A and, of course, we also wonder how the ball manages to hit itself after leaving B if it then *doesn't* enter A?

Assuming a wormhole time machine has (somehow) become available, with its Cauchy horizon intact, how do the 'paradoxes' of time travel come into play? In an attempt to study the grandfather paradox, in particular, Thorne and his colleagues studied self-interacting billiard balls traveling backward in time through a wormhole.[55] They used billiard balls—see Figs. 6.9 and 6.10—rather than human time travelers for the same reason Wheeler and Feynman used a pellet and shutter mechanism in their study of advanced electromagnetic waves—to avoid any metaphysical questions about human free will. The central issue for them was the determination of the multiplicity of trajectories for a single, self-interacting time traveling ball, where the Cauchy condition for a well-defined trajectory in spacetime is *unique* self-consistency.

That is, for the trajectory to be well-defined in the Cauchy sense, it was expected there would be exactly *one* consistent trajectory for a self-interacting ball. A multiplicity of zero, of course, would be the physics declaring backward time travel through the wormhole to be nonsense—and that was thought to be a distinct

[55]F. Echeverria, G. Klinkhammer, and K. S. Thorne, "Billiard Balls in Wormhole Spacetimes with Closed Timelike Curves: I. Classical Theory," *Physical Review D*, August 15, 1991, pp. 1077–1099. The authors credited the physicist/science fiction writer Robert Forward (who used the same ideas in his 1992 novel *Timemaster*) for motivating their research.

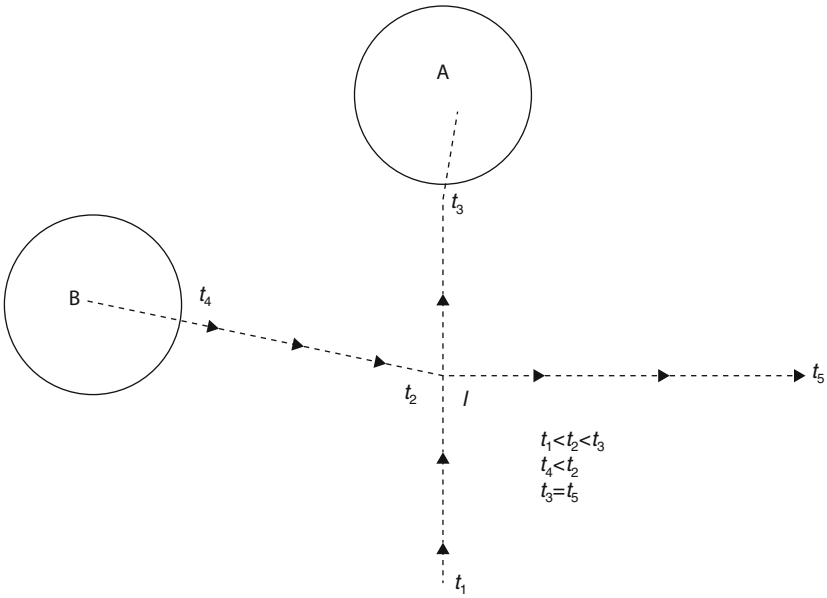

Fig. 6.10 The principle of self-consistency in the billiard ball world. Now the ball, in passing through point *I* on its dead-on center path toward mouth A of the wormhole time machine, is suddenly hit a grazing blow by another ball that has just shot out of mouth B (and into the past) at an angle. The impact knocks the first ball slightly off its original trajectory, and it enters mouth A slightly off-center. Thus, the ball emerges from B into the past slightly off-center and just in time to glace off itself at *I*—which explains *why* it emerged from B slightly off-center!

possibility. The actual results were, however, surprisingly different. It was found, under very general assumptions about the wormhole parameters, that (1) there are no trajectories with zero multiplicity and (2) the multiplicity is *not* one but rather is *always* infinity! Thus, the billiard ball form of the grandfather paradox *was* found to be *not* well-defined, but not for the expected reason that there was no self-consistent solution. Instead, it was because there are *too many* solutions.

This astonishing, completely unexpected result seems to be just what is needed to support the viability of time machines, as it appears to allow a definition of *well-defined* in the Cauchy sense and still permit an answer to the puzzle of free will. The initial conditions of a time traveling ball give rise to an infinity of self-consistent trajectories, each occurring in the same way that a random variable takes on different values with each new performance of the experiment that the random variable is defined on. And yet, there are still unique probability density functions for all sets of measurements that one might make anywhere along these trajectories. Thus, the Cauchy problem is *stochastically* well-defined; at the start of any

trajectory, we do not know in detail what will happen except that whatever does happen will be self-consistent. In this probabilistic sense, then, wormhole time travel to the past and the retention of free will both make sense. The Russian physicist Igor Novikov and his colleagues continued the study of time traveling billiard balls,[56] demonstrating that one can *deduce* self-consistency from the long-accepted principle of least action (that is, self-consistency is not an additional assumption to existing physics).[57]

The one-wormhole, two-mouth time machine was actually not the first kind of wormhole time machine described in the physics literature. In their 1988 paper (note 21), Morris and Thorne initially described a time machine constructed from *two* wormholes, but they added a note-in-proof at the end that they had just discovered how to build a time machine using one wormhole (the machine we have been discussing). This reduction in the required number of wormholes was thought to be a technical advance, of course, and so the two-wormhole time machine was put aside.

But not for long. Soon thereafter the concerns about Cauchy horizon stability began to surface, a concern that one-wormhole time machines might destroy themselves just at the instant their mouths were about to be threaded by closed timelike curves. As noted earlier, the negative mass wormhole throat has a defocusing effect on electromagnetic radiation (and so the initial concern, that time traveling photons might be fatal, faded)—but then it was found that vacuum fluctuations of quantum fields are *not* so defocused.[58] That failure to defocus time-traveling vacuum polarizations (as quantum field fluctuations are called) was shown to result in an unphysical divergence of the stress-energy on the Cauchy horizon of a one-wormhole time machine.[59] This sounds bad, but the hope was that the divergence wouldn't actually be fatal: it appeared to be sufficiently sluggish that it was suggested reaching an actual *infinity* of the stress-energy would be precluded by the eventual intercession of quantum gravity. That is, the stress-energy might *try* to become unbounded as spacetime approached the formation of a time machine

[56]A. Lossev and I. D. Novikov, "The Jinn of the Time Machine: Nontrivial Self-Consistent Solutions," *Classical and Quantum Gravity*, October 1992, pp. 2309–2321; E. V. Mikheeva and I. D. Novikov, "Inelastic Billiard Ball in Spacetime with a Time Machine," *Physical Review D*, February 15, 1993, pp. 1432–1436; M. B. Mensky and I. D. Novikov, "Three-Dimensional Billiards with a Time Machine," *International Journal of Modern Physics D*, April 1996, pp. 179–192.

[57]A. Carlini, *et al.*, "Time Machines: The Principle of Self-Consistency as a Consequence of the Principle of Minimal Action," October 1995, pp. 557–580, and "Time Machines and the Principle of Self-Consistency as a Consequence of Stationary Action (II): The Cauchy Problem for a Self-Interacting Particle," October 1996, pp. 445–479, both in *International Journal of Modern Physics D*.

[58]V. P. Frolov, "Vacuum Polarization in a Locally Static Multiply Connected Spacetime and a Time-Machine Problem," *Physical Review D*, June 15, 1991, pp. 3878–3894.

[59]S.-W. Kim and K. S. Thorne, "Do Vacuum Fluctuations Prevent the Creation of Closed Timelike Curves?" *Physical Review D*, June 15, 1991, pp. 3929–3947. See also L.-X. Li, "Must Time Machines Be Unstable Against Vacuum Fluctuations?" *Classical and Quantum Gravity*, September 1996, pp. 2563–2568.

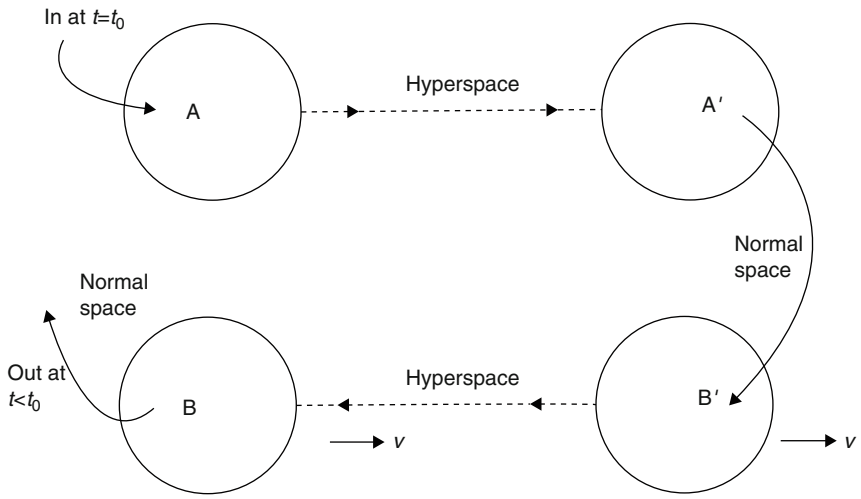

Fig. 6.11 A two-wormhole, Roman ring time machine

but, before it becomes so large as to destroy the time machine, quantum gravity would cut-off the divergence 'in time' (so to speak!) to save the machine.

Hawking disagreed (in his famous Chronology Protection Conjecture—see note 54 in Chap. 1), arguing that Kim and Thorne had made a crucial error in their calculations. According to Hawking, the divergence of the stress-energy may indeed be cut off by quantum gravity, but not before the development of spacetime disturbances representing perhaps a hundred million times the energy levels associated with ordinary chemical binding energies. These would be sufficiently big disturbances to raise serious doubts about the physical survival of a one-wormhole time machine, even in the absence of a true stress-energy infinity. Hence the resurrection of the two-wormhole time machine geometry. Perhaps *it* could avoid the destructive effect of time-traveling vacuum fluctuations.

If a spacetime contains multiple wormholes, then it is called a *Roman spacetime* after the physicist Thomas Roman (at Central Connecticut State University), who was the originator of such spacetimes. Each of these wormholes, individually, is *not* a time machine. Together, however, they form a time machine geometry called a *Roman configuration* (or a *Roman ring*).[60] Here's how.

In Fig. 6.11 two pairs of wormhole mouths are labeled A, A' and B, B'. We imagine that the A, A' wormhole is stationary and that its two mouths are very far apart in normal space—so far apart, in fact, that if a traveler enters A and almost instantly (because the wormhole handle is very short in hyperspace) emerges from A', it will appear to an observer at rest with respect to the wormhole that the traveler has moved faster than light. That is, entering A and exiting A' are events with

[60]M. Visser, "Traversable Wormholes: The Roman Ring," *Physical Review D*, April 15, 1997, pp. 5212–5214.

spacelike separation. Now, imagine also that the wormhole with mouths B, B' is moving past the first wormhole at speed v. To an observer in this second, *moving* frame of reference, the spacelike separation of entering A and exiting A' can result in the two events being temporally reversed if v is sufficiently large (but still less than the speed of light). Therefore, upon emerging from A' the traveler crosses normal space to the moving wormhole mouth B', enters the wormhole, and then almost instantly emerges from mouth B, and finally travels again through normal space to mouth A. If the traveler can make the two trips in normal space in less time than the backward time shift achieved by the temporal reversal of entering A and exiting A', then we have a time machine

Two simultaneous analyses of the Roman ring time machine each concluded that, for suitable choices of sizes (the radii of the wormhole mouths, the wormhole lengths in normal space, the lateral offset of the two wormholes, and the relative speed of the wormholes), the stress-energy divergence *can* be limited by quantum gravity to an arbitrarily weak level. That is, the two-wormhole time machine is not necessarily destroyed by an unbounded stress-energy on the Cauchy horizon.[61] But not all was now put right.

Visser, in particular, had some strong reservations about the Roman ring. Although he granted that a quantum gravity cut-off the stress-energy divergence *would* probably occur in the Roman ring, he called the required special sizing conditions "bizarre," and asserted that the resulting time machine would be quite useless for a human traveler in any case. For example, he calculated that only if the mouths of the wormholes are separated in normal space by the radius of the universe (!), and only if the wormhole mouths have radii on the order of that of an atomic nucleus, would the cut-off be sufficient to allow the putative time machine to avoid destruction. When Visser reduced the wormholes from universe size to 'merely' that of the distance between the Sun and the Earth, he concluded that it would require energy at the level of the Superconducting Supercollider accelerator to blast an information-bearing message through the narrow wormholes. And even then the 'short' wormholes would provide a maximum penetration into the past of just eight minutes. As Visser put it, "This does not seem to be a workable recipe for studying tomorrow's *Wall Street Journal*.

Lyutikov, on the other hand, took a far less negative stance. He concluded that although Visser's calculations "make it very inconvenient for time travel [by humans]," nevertheless "the [principal] question of the possibility of transmitting information back in time through traversable wormholes would still remain."

The wormholes we have been discussing so far are *static* in time, but another approach is to allow them to be dynamic structures in spacetime. That is, to allow one or more of their parameters to vary with time (perhaps, for example, the throat diameter could collapse). Then, according to one analysis, it is possible to have a

[61] M. Visser, "Van Vleck Determinants: Traversable Wormhole Spacetimes," April 15,1994, pp. 3963–3980, and M. Lyutikov, "Vacuum Polarization at the Chronology Horizon of the Roman Spacetime," April 15, 1994, pp. 4041–4048, both in *Physical Review D*.

traversable wormhole *made of normal matter* and, even though it is collapsing, it would take so long to do so that "a space adventurer will have enough time to pass through the throat of the wormhole from one asymptotically flat region [of spacetime outside the entry mouth of the wormhole] to the other [spacetime region outside the exit mouth of the wormhole] before the radius of the throat shrinks to . . . where the event horizon is developed."[62] Such a dynamic wormhole, it was claimed, satisfies both the weak and the dominant energy[63] conditions, but not the strong energy condition. Thus, gravity would still be repulsive in the throat, but this condition (which would seem to require *exotic* matter) was brushed aside because such a condition is thought to have actually occurred, on a massive scale, during the inflationary stage of the Big Bang[64] (although how that would help in the construction of a wormhole in the future is a bit murky).

Is it reasonable to think 'useable' wormholes, static or otherwise, can be acquired for the purpose of creating a time machine? At one time, Hawking was sure the answer is no, once writing "The philosophy of this paper is . . . to look for vacuum polarization [the divergence of the stress-energy on the Cauchy horizon] to enforce the chronology protection conjecture."[65] It became increasingly apparent, however, that matters would be a great deal more involved and, as Hawking himself came to admit, "the fact that the energy-momentum tensor fails to diverge [in certain special cases of time machine spacetimes] shows that the back reaction does not enforce chronology protection.".[66]

I think the best (and most honest) way to respond to the 'reasonable' question that opened the previous paragraph is with words from 20 years ago, by the Russian astrophysicist Serguei Krasnikov, words still valid today: "It may well be that the vacuum fluctuations do make the time machine unstable, but nothing at present

[62]A. Wang and P. S. Letelier, "Dynamical Wormholes and Energy Conditions," *Progress of Theoretical Physics*, July 1995, pp. 137–142. See also L. A. Anchordoqui, *et al.*, "Evolving Wormhole Geometries," *Physical Review D*, January 15, 1998, pp. 829–833.

[63]The dominant energy condition is the weak energy condition *plus* the requirement that any observed energy flux is *never* superluminal.

[64]During inflation the universe is thought to have expanded at a rate far beyond human comprehension. It has been estimated that during the first 10^{-35} second of the Big Bang the universe doubled in each spatial dimension by a factor of two each 10^{-37} second; that is, there were about 100 such doublings. Thus, there was an increase by a factor of $2^{100} \approx 10^{30}$ in each linear dimension of the universe, and the volume increased by the cube of that enormous factor. See Alan Guth, *The Inflationary Universe*, Addison-Wesley 1997.

[65]S. Hawking, "Quantum Coherence and Closed Timelike Curves," *Physical Review D*, November 15, 1995, pp. 5681–5686.

[66]M. J. Cassidy and S. W. Hawking, "Models for Chronology Selection," *Physical Review D*, February 15, 1998, pp. 2372–2380. See also L.-X. Li and J. R. Gott, "Self-Consistent Vacuum for Misner Space and the Chronology Protection Conjecture," *Physical Review Letters*, April 6, 1998, pp. 2980–2983.

suggests this. All we have are a few simple examples. In some of them the energy density diverges at the horizon and in some does not. So, the time machine perhaps is stable and perhaps is not."[67]

The daunting level of technology required to *build* a wormhole (with or without exotic matter) doesn't mean we can't search for existing wormholes. Perhaps, for example, vast wormhole networks were formed naturally at Big Bang time, as described in Gregory Benford's 1997 novel *Foundation's Fear*, where wormholes are "leftovers from the Great Emergence [the Big Bang]." Or perhaps "advanced civilizations" long ago constructed a vast, pan-galactic 'subway system' of wormholes like the one described in Carl Sagan's 1985 novel Co*ntact* (and dramatically illustrated in the 1997 film).

Of course, any such wormhole, if found (via its double-spike light signature, for example), could be a very long way from Earth. It might even be in another galaxy. So, even if we found a wormhole, what could we *do* with it? Surprisingly, maybe a lot. The Russian physicists Igor Novikov and Andrei Lossev (note 56) suggested that a wormhole might be very useful *even if its location is completely unknown, even if we haven't yet even discovered it*! The only assumption they made was that the wormhole has existed for a "sufficiently long time" (and precisely what that means will be explained in just a bit). With that assumption, they showed how to make an information-creating time loop. Here's how they did that.

They began their analysis by assuming that people have no knowledge of how to build spacecraft that can make the interstellar voyage to the distant wormhole, even if they knew in which direction to go to reach the mouth that leads backward in time (mouth B). Instead, they build an automatic spacecraft construction plant that can follow any detailed sequence of instructions provided to it, and then stockpile it with a supply of raw materials (energy, steel, plastic, computers, and so on). When the spacecraft construction is done (*how* that is done is explained in the next paragraph), the last step before launching the spacecraft toward mouth B *will be* to load the on-board computer with the following three pieces of information:

1. The detailed sequence of instructions to be followed in the construction of the spacecraft;
2. The direction from Earth to mouth B;
3. The direction from mouth A (the wormhole exit mouth in the past) back to Earth.

To summarize, people build the automatic plant, load it up with raw materials, *and then withdraw*. This last step is crucial, because it eliminates human free will from further consideration, that is, it removes any temptation to create a bilking paradox. So, what happens next?

Lossev and Novikov suggest that what happens next is that a *very* old spacecraft suddenly appears in the sky and lands next to the automatic construction plant. In its on-board computer are items a, b, and c. Using item a, the automatic plant makes a

[67]S. V. Krasnikov, "Quantum Stability of the Time Machine," *Physical Review D*, December 15, 1996, pp. 7322–7327.

new spacecraft, then loads the new on-board computer with items a, b, and c from the *very* old spacecraft's on-board computer, and then the new spacecraft is launched toward mouth B (using the information of item b). The *very* old spacecraft is given an honored place in a museum.

The new spacecraft arrives at the distant mouth B in the far future, by which time it is, of course, an old spacecraft (but not yet a *very* old spacecraft). It then plunges into mouth B and almost immediately emerges from mouth A, in the past. Indeed, it repeats this process as many times as required until it is in the far distant past, at a time even before it left Earth. (It might seem that to do this, the spacecraft's computer memory needs a fourth piece of information, the direction from mouth A back to mouth B, but in fact items b and c are sufficient for the old spacecraft to find its way from A to B.) It is now clear how long the wormhole must have been in existence. The old spacecraft repeatedly uses the wormhole time machine until it is so far in the past that it can cruise back to Earth at normal speed (it knows the way back because of item c) and arrive as a *very* old spacecraft, just in time to be placed in the museum!

As Lossev and Novikov pointed out, this remarkable, looped sequence of events has increased knowledge from what it was at the time just before the automatic construction plant was built. People now know both how to build an interstellar spacecraft, and the locations of both mouths of the wormhole. They also now possess a *very* old, used spacecraft. It is curious to note that although the information in the *very* old spacecraft's computer memory has traveled on a closed time loop, the *very* old spacecraft itself has not. This is because the spacecraft left Earth when new, but arrived back (before it left) as *very* old, whereupon it promptly entered a museum. There is therefore no question about the origin of the *very* old spacecraft, but where did the information of items a, b, and c come from? Lossev and Novikov say it came from the energy gained by the spacecraft as it interacted (will interact?) with the rest of the universe while on its journey.

Nobody said time travel isn't weird!

6.4 Gott's Cosmic String Time Machine

"It's an amazingly simple solution. It doesn't take much physics to understand it."

—MIT astrophysicist Alan Guth, on Gott's discovery of the cosmic string time machine[68]

"Louise, working out the spacetime geometry of a cosmic string is a hard problem in general relativity. But, given that geometry, all the rest of it is no more than Pythagoras' theorem . . ."

—a character in Stephen Baxter's 1994 novel *Ring*, agreeing with Guth.

[68]Quoted from J. Travis, "Could a Pair of Cosmic Strings Open a Route Into the Past?" *Science*, April 10, 1992, pp. 179–180.

A new way to gain access to closed timelike curves, without the involvement of the exotic matter needed by negative-mass wormholes, was described in 1991 by the Princeton physicist J. Richard Gott.[69] Gott gave exact solutions to Einstein's gravitational field equations for what are called *cosmic strings*, solutions that (1) unlike wormholes, do not violate any of the energy conditions, (2) unlike black holes have no crushing singularities or event horizons, and (3) are not topologically multiply connected.

Cosmic strings are fantastically thin (10^{-28} cm in radius) filaments of pure energy that are thought to stretch the width of the universe and to have an enormous linear mass-energy density of 10^{28} g/cm. To generate closed timelike paths in spacetime, Gott required that either two fast-moving (which means moving at practically the speed of light) parallel cosmic strings pass each other on a near-collision course, or that there be a closed-loop string that collapses in a slightly non-planar manner so that the opposite, nearly straight sides 'just miss.' The gravitational interaction of the passing strings can 'warp' spacetime enough to produce closed timelike curves.

A hint at the possibility of violating causality with strings had appeared before Gott's work, but those authors didn't take the time travel implications seriously. As they wrote, "We argue ... that any realistic model [for a spinning string with angular momentum[70]] ... will not have closed timelike curves."[71] Gott, however, showed that as two strings pass each other, closed timelike loops *do* encircle the strings.

Gott, who appears to be far less rigid in his view of time travel than are many of his fellow physicists, held out an escape to those who pale at the very thought of time travel to the past. Perhaps, he suggested (following in the footsteps of an analysis by Hawking[72]), as the strings (or string-loop sides) pass, a black hole will form with an event horizon that will seal-off the closed timelike curves from any would-be time traveler. Or perhaps, he further suggested, the more realistic case of non-singular strings (that is, strings with non-zero-filament radii) and possessing

[69] J. R. Gott, "Closed Timelike Curves Produced by Pairs of Moving Cosmic Strings: Exact Solutions," *Physical Review Letters*, March 4, 1991, pp. 1126–1129.

[70] The two strings in a Gott-pair are *not* necessarily spinning, and no such assumption was made by Gott. They don't even have to be parallel. If the strings have no spin, then it takes two strings to make a time machine. If spin *is* allowed, however, then just a single string will suffice for time travel: see S. Deser and R. Jackiw, "Time Travel?" *Comments on Nuclear and Particle Physics*, September 1992, pp. 337–354.

[71] D. Harari and A. P. Polychronakas, "Gravitational Time Delay Due to a Spinning String," *Physical Review D*, November 15, 1988, pp. 3320–3322.

[72] S. W. Hawking, "Gravitational Radiation from Collapsing Cosmic String Loops," *Physics Letters B*, August 23, 1990, pp. 36–38.

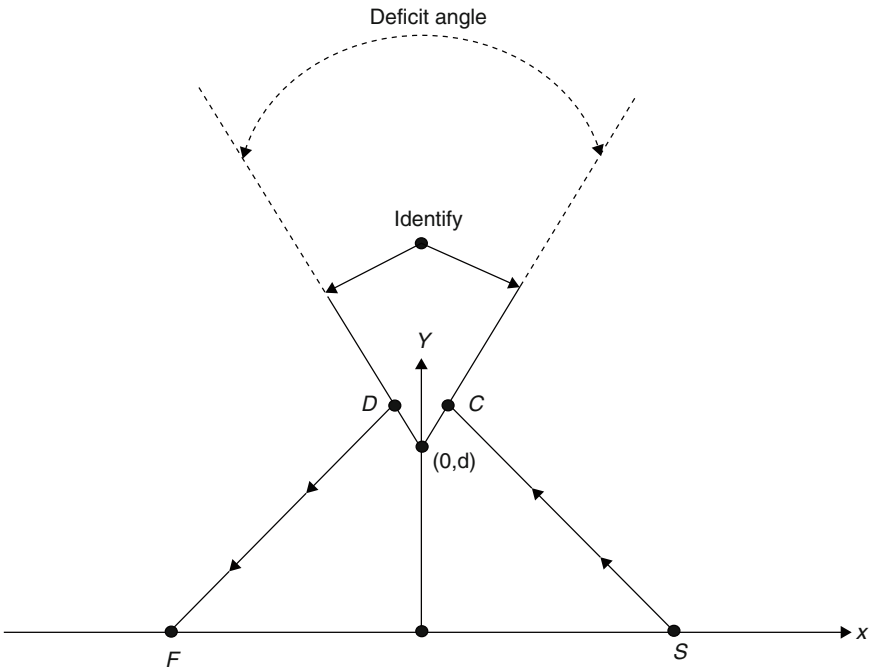

Fig. 6.12 The deficit angle in spacetime formed by a cosmic string

spin would banish the terrifying closed timelike curves. Subsequent analyses along those lines, however, continued to find the time travel implications intact.[73]

Here's how the cosmic string time machine works. In an earlier work,[74] published in 1985, Gott discovered that a cosmic string warps spacetime in a highly characteristic way, as shown in Fig. 6.12. A stationary cosmic string is imagined as perpendicular to the *xy*-plane (the plane of the page) and passing through the page at the point $(0, d)$ on the *y*-axis. The warp produced by the string is as though a wedge of angle 2α (this angle is called the *deficit angle*) were cut out of spacetime and the

[73]See, for example, B. Jensen, "Notes on Spinning Strings," *Classical and Quantum Gravity*, January 1992, pp. L7–L12, H. H. Soleng, "A Spinning String," *General Relativity and Gravitation*, January 1992, pp. 111–117, (the next two are in the *Physical Review D*), B. Jensen and H. H. Soleng, "General-Relativistic Model of a Spinning Cosmic String," May 15, 1992, pp. 3528–3533, and M. Novello and M. C. M. da Silva, "Cosmic Spinning String and Causal Protecting Capsules," January 15, 1994, pp. 825–830.

[74]J. R. Gott, "Gravitational Lensing Effects of Vacuum Strings: Exact Solutions," *The Astrophysical Journal*, January 15, 1985, pp. 422–427. Gott's discovery was independently reported in W. A. Hiscock, "Exact Gravitational Field of a String," *Physical Review D*, June 15, 1985, pp. 3288–3290.

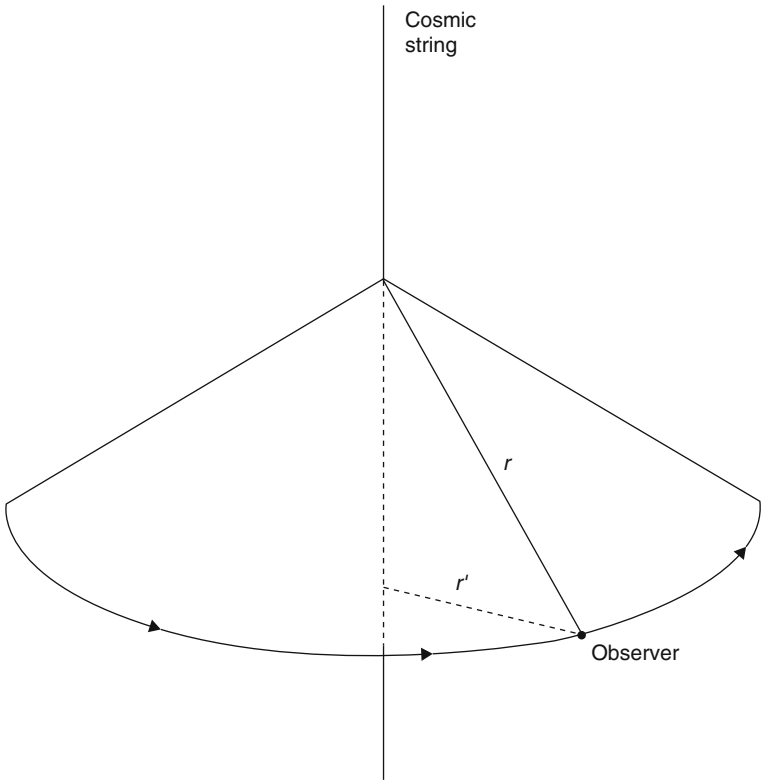

Fig. 6.13 The warped, conical spacetime around a cosmic string, An observer in this spacetime thinks she is distance r from the string, but a 'meta-observer' sees that she is actually distance r' from the string. Thus, if the observer follows a complete circular path around the string, she will travel a distance of $2\pi r' < 2\pi r$. The observer in the spacetime will interpret this result by saying that the angle 2π is really 2π minus 'a deficit'

edges of the cut were then 'glued' together; for example, points C and D are identified as identical. The reason for the term *deficit angle* is that at radius r from the string, a circular path around the string has the reduced length $(2\pi - 2\alpha)r$, and not the usual $2\pi r$ (spacetime around the string, while *locally* flat, is actually 'conical,' as illustrated in Fig. 6.13).

The deficit angle is equal to $8\pi\mu$ radians (in a system of units where G, Newton's gravitational constant, is 1) if the linear mass-energy density μ is expressed in units of Planck masses per Planck length. For example, $\mu = 1$ corresponds to 1.35×10^{28} g/cm (think of something on the order of the mass of the Earth per inch of the string). For 'more typical' values—say a 'mere' $\mu = 10^{22}$ g/cm, $2\alpha = 0.001^{\circ}$. While Gott's paper had appeared 5 months before Hiscock's (see note 74), it is evident that Hiscock's work was done before he became aware of Gott's. Both papers treat exact derivations of the deficit angle but, in fact, the correct expression had actually been

published 4 years earlier (but from a linearized form of the gravitational field equations and so the result was not as 'conclusive' as are Gott's and Hiscock's)[75]

Now, consider the two points S and F on the x-axis at $(x_0, 0)$ and $(-x_0, 0)$ in Fig. 6.12. Suppose we want to send photons from S to F. In normal, 'unwarped' spacetime, the direct path from S to F through the origin has length $2x_0$. There is also another possible path, however, S to C/D to F, that loops out and around the cosmic string. Indeed, this second path is simply the path a gravitationally lensed photon would take (an observer at F would see *two* images of S) and this—*not* time travel—is the issue that originally attracted Gott's attention to cosmic strings.[76] If the deficit angle were zero, then this alternative path would always be longer than $2x_0$, for any value of x_0. For the case of $2\alpha > 0$, however, if x_0 is large enough ($x_0 \gg d$), then it is possible for 'around the string and over the missing spacetime wedge' path to be shorter than the direct path.

The indirect path provides a way for a *sub*luminal trip (say, by rocket) from S to F to beat a photon traveling on the direct path. That is, the two events of the 'rocket leaving S ' and the 'rocket arriving at F' are spacelike separated. Thus, it is possible to find a moving frame of reference in which these two events are *reversed in temporal order*. In that frame of reference, the cosmic string (which is stationary in the reference frame of S and in that of F) will move—at speed v, say—in the $+x$ direction, and in that frame of reference the rocket will arrive at F *before* it leaves S.[77]

Then to complete the construction of a closed timelike path, simply repeat the process as shown in Fig. 6.14. That is, after the rocket arrives at F, have it turn around and fly back to S out-and-around and through the deficit angle spacetime warp due to a *second* cosmic string on the negative y-axis and perpendicular to the xy-plane. This second string is moving at speed $-v$ (that is, opposite to the first string), so the rocket will arrive at S before it leaves F. But that means it arrives at S before it leaves S; that is, the rocket has traveled into the past. In other words, the rocket has traveled into the past. This entire process is precisely the same idea behind the two-wormhole Roman-ring time machine discussion from the previous section.

Now, instead of having two oppositely moving reference frames, one in which the top, stationary string at $(0, d)$ appears to be moving at $+v$ and another frame in

[75] A. Vilenkin, "Gravitational Field of Vacuum Domain Walls and Strings," *Physical Review D*, February 15, 1981, pp. 852–857.

[76] Just as discussed earlier in the context of wormholes, gravitational lensing may offer a way to detect cosmic strings. See, for example, the two papers by D. L. Ossipov, "Diffraction of Light by a Cosmic String," November 1995, pp. 765–771, and "Contribution of Strings to the Observed Variability of Extragalactic Sources of Radiation," September 1996, pp. 419–425, both in *JETP Letters*.

[77] For this to happen, however, v must be very close to the speed of light. Gott (see note 69) showed that with $v = \tanh(\theta)$, the condition for the rocket to arrive back at S before it leaves S is $\cosh(\theta) \sin(\alpha) > 1$, where α is one-half the deficit angle. For $\mu = 10^{22}$ g/cm, this gives $v = 0.99999999995$ (times the speed of light).

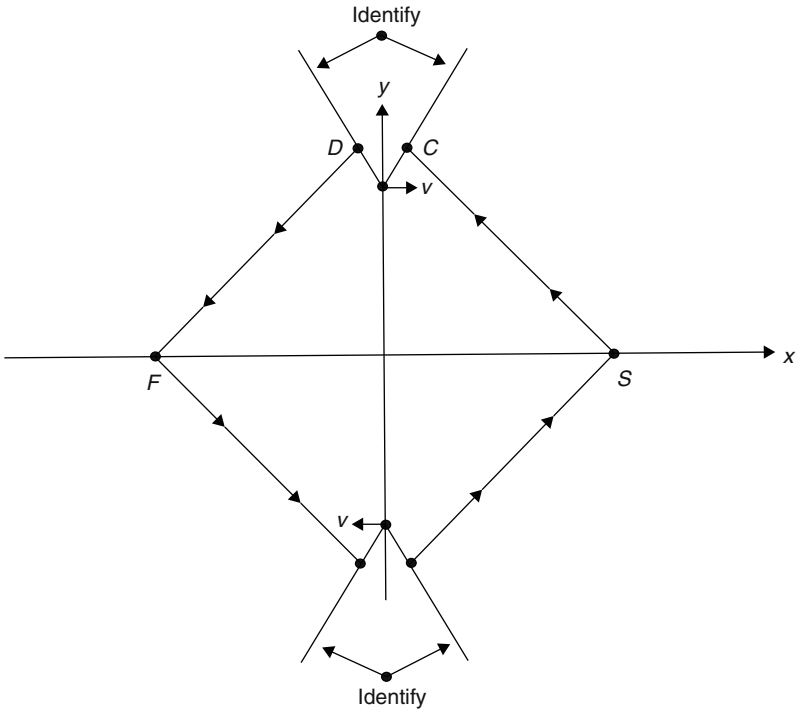

Fig. 6.14 Gott's spacetime, formed by joining two oppositely moving versions of the spacetime in Fig. 6.13

which the bottom, stationary string appears to be moving at $-v$, we can imagine an observer in the *stationary center-of mass* frame watching two strings that are moving at $+v$ and $-v$. This leaves the situation unchanged, so in the center-of-mass frame the rocket does travel into the past, arriving back at S before it leaves S. That is, the rocket has traveled all the way around a closed timelike world line. Note, too, that the geometric condition mentioned earlier of $x_0 \gg d$ immediately implies that for x_0 *not* sufficiently large, there isn't a closed timelike path from S to F and then back to S; that is, there is a region in Gott's spacetime where such time travel journeys *cannot occur*.

Another physicist pursued Gott's analysis in an attempt to see whether these 'time travel paths' are *created* as the strings approach each other or, instead, if the paths exist at other times as well.[78] This important question gets to the idea of whether such time machine paths can be *intentionally created* by humans via a dynamical process (a *strong* time machine), or whether all such paths have existed since the formation of the universe (a *weak* time machine). This issue involves Hawking's

[78] A. Ori, "Rapidly Moving Cosmic Strings and Chronology Protection," *Physical Review D*, October 15, 1991, pp. 2214–2215.

chronology protection conjecture, which you'll recall asserts that the laws of physics will always (somehow) prevent the creation of a time machine. One reason Hawking repeatedly gave for believing the Conjecture is the apparent absence of time travelers from the future among us now (in their past). The only possible exception allowed by the Conjecture is the creation of closed timelike loops at the moment the universe was created (at that moment there *was no past* for time travelers to invade!). Ori proved that the closed timelike loops around Gott's cosmic strings are *always* present: that is, a time machine is *not created* by the near collision of the strings. Thus, Hawking's Conjecture is nor refuted by Gott's spacetime.

One very curious issue is *where* the closed time loops are before the strings pass one another. As mentioned briefly by Ori, and further discussed by others,[79] the time loops are initially at spatial infinity. To this concern, Gott and a colleague made the following very strong reply:

> "[A problem] Deser *et al*. present with respect to the Gott spacetime is that it contains CTC's at spacelike infinity; this is supposed to be an unacceptable boundary condition. We wonder, however, how they know so much about boundary conditions at spacelike infinity. In our own Universe we do not know what spacelike infinity looks like (if it exists) since we have not seen it yet. We certainly have no way of knowing whether or not there are CTC's there. The working physicist is, of course, free to impose simple and convenient boundary conditions (e.g., asymptotic flatness) on a system in order to isolate and understand the processes occurring within it. *But boundary conditions are tools of physicists, and they should not be confused with laws of physics* [my emphasis]. There may be such laws of nature that restrict the possible structure of spacelike infinity, and even prohibit CTC's there, but in the absence of evidence such laws should not be postulated *ad hoc*."[80]

Still, as Ori had observed the year before, having time loops collapsing inward from infinity toward humans who might, fortuitously, wish to use them at *just the instant they so conveniently arrive*, is "a situation which has little to do with the creation of a time machine by a *human being* [my emphasis]."[81]

The most damning objection to Gott's cosmic string time machine came, ironically, from Gott himself. The two-string spacetime of Fig. 6.14 might actually, he and a colleague wrote (see Li and Gott, note 66) be destabilized by the non-zero mass of any would-be time traveler. They suggest that this concern could perhaps be 'solved' by assuming that the time traveler and her spaceship have a spherically symmetric mass distribution surrounded by a negative-mass shell to give zero net mass (and thus a zero net gravitational field that would *not* destroy the closed timelike curves of the strings). But that, they further observed, would negate the crucial advantage—no exotic matter and so no violation of the weak energy condition—that a cosmic string time machine enjoys over a wormhole time machine.

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[79]See, for example, S. Deser, *et al*., "Physical Cosmic Strings Do Not Generate Closed Timelike Curves," *Physical Review Letters*, January 20, 1992, pp. 267–269.

[80]M. P. Headrick and J. R. Gott, "(2+1)-Dimensional Spacetimes Containing Closed Timelike Curves," *Physical Review D*, December 15, 1994, pp. 7244–7259.

[81]A. Ori, "Must Time-Machine Construction Violate the Weak Energy Condition?" *Physical Review Letters*, October 18, 1993, pp. 2517–2520.

Does a trip around a pair of cosmic strings present other problems *aside* from the sheer fantastic physics of the strings themselves? Well, I think "turning the rocket around at F and flying back to S" is a lot easier to write than it would be to actually do! The entire trip has to occur while the strings (moving at essentially light speed) are in a position *to be* flown around. As one character says to another in Stephen Baxter's novel *Ring*, "Louise, the strings are traveling just under the speed of light—within three decimal places of it, actually. [Our ship is] traveling at a little over half-light speed. The turning curves, and the accelerations, are incredible . . ." I think so! And I do wonder who—*or what*(!)—is actually controlling a *maneuvering* rocket traveling faster than $\frac{1}{2}c$?

6.5 Cutting and Warping Spacetime

> "The warp drive spacetime of Alcubierre is impossible to set up . . . one needs to transcend the speed of light in order to construct the warp drive in the first place . . . put roughly, you need one to make one!"[82]

In this chapter we've talked about the physics of three specific time machine 'implementations': the rotating cylinder, the wormhole, and the cosmic string. One can also discuss the 'construction' of a time machine in a more geometrical (yet still physical) way by performing what is called *spacetime surgery* to arrive at what is often referred to as a *Deutsch-Politzer spacetime* (after the two physicists who are closely associated with it[83]). With this surgery we arrive at a simple spacetime picture of the grandfather paradox (as you'll soon see).

We start with a flat, two-dimensional Minkowski spacetime, the x, t system in Fig. 6.15, and then imagine that (somehow) two *cuts* in that spacetime come into

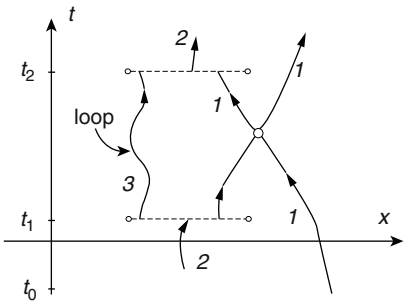

Fig. 6.15 Minkowski spacetime transformed into a time machine with two 'cuts'

[82]D. H. Coule, "No Warp Drive," *Classical and Quantum Gravity*, August 1998, pp. 2523–2527, offering a pessimistic view of warp drive.

[83]See D. Deutsch, "Quantum Mechanics Near Closed Timelike Lines," November 15, 1991, pp. 3197–3217, and H. D. Politzer, "Simple Quantum Systems with Closed Timelike Curves," November 15, 1992, pp. 4470–4476, both in *Physical Review D*.

existence. These cuts are the two horizontal dashed lines in the figure, one with an arrowhead going into it, and one with an arrowhead coming out of it (each labeled with '2'). We further imagine that each cut has two edges, with the upper edge of the lower cut 'glued' to the lower edge of the upper cut (and the lower edge of the lower cut 'glued' to the upper edge of the upper cut

These 'gluing's' explain why the arrowhead marked 2 into the lower cut at time t_1 emerges from the upper cut at time $t_2 > t_1$, and why the arrowhead marked 1 into the upper cut at time t_2 emerges from the lower cut at time $t_1 < t_2$. The 2-line is the world line of a particle that simply disappears from spacetime during $t_1 < \mathrm{t} < t_2$, while the 3-line is the world line of a particle trapped in an endless time loop (remember the 1993 film *Groundhog Day*?). Clearly, the sub-region of spacetime between the two cuts is not 'normal' spacetime. In fact, the 1-line shows that we have encountered a time machine spacetime, as a particle entering it from $t < t_1$ (passing to the right of the lower cut) can enter the lower edge of upper cut at $t = t_2$ and so emerge from the upper edge of the lower cut at the *earlier* time $t = t_1$ and thus interact with itself before it entered the upper edge! And that, of course, sets-up a grandfather paradox situation.

This picture leaves one thing obviously (and glaringly) unexplained—just *how* does one *cut and glue* spacetime? The reason, in spite of that question, that physicists nonetheless study situations depicted in Fig. 6.15, is because it allows them to explore what *could* happen *if* through some (yet unknown) process a time machine spacetime should suddenly appear. Who says physicists aren't optimists?

The idea of modifying spacetime itself to 'make' a time machine (look back in Sect. 3.5, at the discussion there on what it means to solve the gravitational field equations) has also appeared in connection with another of science fiction's favorite ideas, one almost as spectacular as time travel: *the FTL warp drive*. The lure of interstellar FTL travel, for both science fiction enthusiasts and physicists is, of course, simply undeniable. Consider, for example, these words by a Russian physicist:

> "Everybody knows that nothing can move faster than light. The regrettable consequences of this fact are also well known. Most of the interesting or promising candidates for colonization are so distant from us that the light barrier seems to make an insurmountable obstacle for any expedition. It is, for example, 200 pc [1 parsec is equal to about 3.2 light-years] from us to the Pole star, 500 pc to Deneb [the brightest star in the constellation Cygnus], and ~10 kpc to the center of the Galaxy, not to mention other galaxies (hundreds of kiloparsecs). It makes no sense to send an expedition if we know that thousands of years will elapse before we receive its report. On the other hand, the prospects of being confined forever to the Solar System without any hope of visiting other civilizations or examining closely black holes, supergiants, and other marvels are so gloomy that it seems necessary to search for some way out."[84]

[84] S. V. Krasnikov, "Hyperfast Travel in General Relativity," *Physical Review D*, April 15, 1998, pp. 4760–4766. Possible travel distances have been greatly reduced since Krasnikov wrote. In 2011, for example, astronomers announced the discovery of a red dwarf star with three planets (each of mass comparable to Earth's), all in the star's so-called *habitable zone* (where water can exist on the surface in the liquid state). All three planets are solid (not gaseous as are Jupiter,

In response to that, we might ask if *FTL* trips will someday be made by humans in spaceships? *Maybe*—but only if such journeys can be made in a very *unordinary* spacetime. That is, continuing with Krasnikov's passage:

> "The point ... is that [whereas the light barrier exists in special relativity] in general relativity one can try to change the time necessary for some travel not only by varying one's speed [as in special relativity] but also ... by changing the distance one has to cover."

To understand what Krasnikov was getting at, let's consider the theoretical analysis made 4 years earlier by the Mexican mathematical physicist Miguel Alcubierre on, astonishingly, how to make a *Star Trek* warp drive![85] He did this by demonstrating a spacetime metric that, by literally expanding and contracting the local spacetime of a spaceship and its neighborhood, achieves space travel between any two points, no matter how far apart, in arbitrarily little elapsed time (for both the spaceship, and external non-spaceship observers, there is no time dilation effect[86]).

Alcubierre opened his analysis with words designed to explain how FTL travel is possible, given all that I've told you earlier in this book about how FTL travel is *not* possible (according to *special* relativity). As he wrote,

> "Since our everyday experience is based on a Euclidean space, it is natural to believe that if nothing can locally travel faster than light then given two places that are separated by a proper spatial distance D, it is impossible to make a round trip between them in a time less than $2D/c$ (where c is the speed of light), as measured by an observer that always remains at the place of departure. Of course, from our knowledge of special relativity we know that the time measured by the person making the round trip can be made arbitrarily small if his (or her) speed approaches that of light. However, the fact within the framework of general relativity and without the need to introduce non-trivial topologies (wormholes), one can actually make such a round trip in an arbitrarily short time as measured by an observer that remained at rest will probably come as a surprise to many people."

That last sentence is almost surely a grand understatement, and Alcubierre quickly went on to explain.

> "The basic idea can be more easily understood if we think for a moment of the inflationary phase of the early Universe, and consider the relative speed of separation of two co-moving observers. It is easy to convince oneself that, if we define this relative speed as the rate of change of proper spatial distance over proper time, we will obtain a value that is much larger than the speed of light. This doesn't mean that our observers will be travelling faster

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Saturn, Neptune and Uranus) and so, as potentially habitable, are candidates for a visit. The star and its planets are 'only' 22 light-years from Earth. In *Star Trek*, FTL speed is described by the *warp factor*, which is the cube-root of the multiple of the speed of light at which the spaceship *Enterprise* travels. So, for example, to make the journey from Earth to the red dwarf in one month of ship time (see ahead also to note 86), the required FTL speed would be 264 times the speed of light, or warp factor 6.4. In science fiction, a *warp drive* is imagined as the means for achieving such speeds.

[85] M. Alcubierre, "The Warp Drive: Hyper-fast Travel Within General Relativity," *Classical and Quantum Gravity*, May 1994, pp. L73–L77.

[86] That is, the passage of time on the spaceship is *identical* with the passage of time on Earth. *With the warp drive, there is no twin paradox.*

than light: *they always move inside their local light-cones* [my emphasis]. The enormous speed of separation comes from the expansion of spacetime itself."

In a similar fashion, a *contraction* of spacetime can result in being able to *approach* an object at FTL speed.

In fact, we've actually already encountered one way to obey special relativity's *local* limit on speeds to that of light, while still achieving superluminal speed on a *global* level. That is, we *could* do that *if* general relativity really does allow wormholes in spacetime (what Alcubierre calls a "non-trivial topology"). That's because we can imagine a wormhole connecting two points in space that are light-years apart in that space, and yet the distance *through* the wormhole itself is quite short. Thus, a spaceship transiting the wormhole could do so at *sub*luminal speed at all times, and yet to an observer in normal space the speed would appear to be far in excess of the speed of light.

Determining just *how* to achieve the spacetime warp, however, is far different from simply demonstrating that such a warp is consistent with the general theory of relativity. The 1996 movie *Star Trek: First Contact*, for example, is about the invention of the warp drive in the twenty-first century. The whole thing fits inside a discarded ICBM which, as you'll soon see, is a *vast* underestimation of the technology required to control the energies associated with a real warp drive. For a spacetime engineer to *build* the warp drive bubble means she has to determine the required mass-energy distribution that results in Alcubierre's assumed spacetime metric. And that brings us to the central problem of the warp drive—the warp drive engine of an FTL starship requires (just like a wormhole) exotic matter (negative energy)—stuff that violates all the usually assumed energy conditions of general relativity.[87]

The weak, strong, and dominant energy conditions are *all* violated because the Alcubierre spacetime warp requires a negative energy density in the 'skin' of the warp bubble. As discussed earlier, in connection with wormholes, negative energy density *can* be achieved on a *micro*scopic scale, but for the Alcubierre warp drive we are talking about a *lot* of exotic matter. In their paper, Pfenning and Ford calculated that, for what they called "a macroscopically useful warp drive" with a radius of 100 m "so that we may fit a ship inside [the warp bubble]," the negative energy required for the warp bubble is on the order of, as they so graphically put it, "roughly ten orders of magnitude greater than the [energy of the] total mass of the entire universe."

Two years later, after making some adjustments to the spacetime metric assumed by Alcubierre (that is, to the distribution of mass-energy to produce the warp bubble), it was shown that the negative energy required by the warp drive could

[87]M. J. Pfenning and L. H. Ford, "The Unphysical Nature of 'Warp Drive'," *Classical and Quantum Gravity*, July 1997, pp. 1743–1751. See also K. D. Olum, "Superluminal Travel Requires Negative Energies," *Physical Review Letters*, October 26, 1998, pp. 3567–3570.

be greatly reduced.[88] The reduction is, in fact, spectacular, but only in a relative sense (you can reduce a mass that is ten orders of magnitude greater than that of the entire universe by a *huge* factor and still be left with a pretty stupendous number). The reduced amount of negative energy required for a warp bubble able to contain a human-sized spaceship is now down to 'only' "of the order of a few solar masses [-1.4×10^{30} kg]."

As mentioned earlier, in connection with the Casimir effect and its theoretical use in a wormhole time machine, although quantum field theory does not preclude negative energy densities, that does not mean it is possible to observe arbitrarily large negative densities for arbitrarily long times. In fact, certain quantum inequalities (QI's), much like Heisenberg's uncertainty principle, have been established that place bounds on the magnitude and duration of observable negative energy density.[89] These QI's have the general form of

$$\widehat{\rho} t_0^4 > -C$$

where C is a positive constant that depends on the nature of the particular quantum field being considered, t_0 is the time duration, and $\widehat{\rho}$ is the integrated energy density along a finite section of a geodesic (free fall) world line. The form of the QI shows that as t_0 increases, $\widehat{\rho}$ must quickly decrease. For example, if t_0 doubles, then $\widehat{\rho}$ must decrease by a factor of *sixteen*, a result that caused Ford and Roman to conclude that it "appears probable that nature will always prevent us from producing gross macroscopic effects with negative energy."

'When it rains it pours,' goes an old saying, and that applies to the warp drive's potential difficulties: in addition to the need for exotic matter, there are two more concerns as well, both *operational* in detail. First, running into any space matter encountered by the leading edges of the warp bubble (where spacetime is shrinking), such as interstellar dust, would certainly generate intense radiation. The ship, then, should carry plenty of shielding which, curiously, would not be a problem because the energy density of the warp, itself, is *independent* of the mass in the bubble's interior. In any case, the warp drive should clearly not be engaged anywhere near any sizeable chunk of matter, like a planet (and, indeed, that constraint was followed in *Star Trek*). Second an even more severe problem was discovered by Krasnikov. In unpublished work he showed that the ship at the center of the bubble is not causally connected to the edges of the bubble. That is, the ship's

[88] C. van den Broeck, "A Warp Drive with More Reasonable Total Energy Requirements," *Classical and Quantum Gravity*, December 1999, pp. 3973–3979.

[89] L. H. Ford and T. A. Roman, "Restrictions on Negative Energy Density in Flat Spacetime," *Physical Review D*, February 15, 1997, pp. 2082–2089. For some interesting remarks about the QI's, see J. F. Woodward, "Twists of Fate: Can We Make Traversable Wormholes in Spacetime?" *Foundations of Physics Letters*, April 1997, pp. 153–181.

crew could *not* create a warp bubble on demand and, after it had been created, could not control it on demand.[90]

It is important to both understand what that means, as well as what it does *not* mean. The causality issue does *not* mean that Alcubierre warp bubbles are impossible to create (perhaps they are, but not because of a lack of causality). It only means that whatever action is required to change the spacetime metric to make a warp bubble *has to already have been done before the decision to use the bubble is made*. Thus, a warp bubble wouldn't be of any use for a starship that needs to escape a sudden, unexpected threat. But, as Everett and Roman cautiously observe, the warp bubble might have a more mundane use: "Suppose space has been warped to create a bubble traveling from Earth to some distant star, e.g., Deneb, at superluminal speed. A spaceship, appropriately located with respect to the bubble trajectory, could then choose to enter the bubble, rather like a passenger catching a passing trolley car, and thus make the superluminal journey."

At the end of his paper (note 85) Alcubierre briefly speculated on the possibility of using his superluminal warp drive to build a time machine (showing, again, the intimate connection between the two concepts—look again at note 12 in Chap. 1 for how the connection between FTL and time travel appeared in pulp science fiction), but didn't show *how*. That was done 2 years later by Everett using, not surprisingly, an argument he called "reminiscent of the 'reinterpretation principle' ... which played an important role in discussions of the physics of tachyons."[91]

In an attempt to avoid the Alcubierre bubble's causality problem, Krasnikov looked for a different, causal superluminal spacetime metric. This he succeeded in finding[92] but, rather than describing a bubble, Krasnikov's warp is in the shape of a tube. The interior of the tube is flat spacetime, just as in the case of the bubble warp, but unlike the bubble there would be a causal link between the spaceship crew and the tube. Just as the warp bubble requires very thin walls (on the order of a few thousand Planck lengths) of negative energy, so does the Krasnikov tube warp. Unlike the bubble warp, however, the tube warp stretches the entire length of any proposed trip, so the total negative energy in the warp is incredibly huge. For a tube a mere one meter long and one meter wide, for example, the total negative energy is 10^{28} solar masses, and to create a tube from Earth to just the nearest star would require 10^{44} solar masses of negative energy![93]

One curious feature of the Krasnikov warp is that the *outbound* leg of a round trip cannot be made in less time than required by light. *But* on the on the return half

[90] A. E. Everett and T. A. Roman, "Superluminal Subway: the Krasnikov tube," *Physical Review D*, August 15, 1997, pp. 2100–2108.

[91] A. E. Everett, "Warp Drive and Causality," *Physical Review D*, June 15, 1996, pp. 7365–7368. Recall the discussion of the RP in Chap. 5.

[92] See notes 84 and 90.

[93] In the same manner as the huge negative energy of the Alcubierre warp drive was later reduced (see note 88), the Krasnikov tube's enormous negative energy requirement was later significantly reduced: see P. Gravel and J. Plante, "Simple and Double Walled Krasnikov Tubes I: tubes with low mass," *Classical and Quantum Gravity*, February 2004, pp. L7–L9.

of the journey, a traveler would find the spacetime metric so altered (because of mass-energy manipulations purposely made on the outbound half) that she would move "backwards in time." The net result is that the round trip could end arbitrarily soon after it started! As Everett and Roman cautiously concluded, the Krasnikov tube is a "very unlikely possibility," but it would make a *wonderful* science fiction gadget, don't you think?

While the Alcubierre warp may seem to be an incredible discovery (it *is*), it was not a unique one. That's because just 8 years later a different warp metric was discovered by the Portuguese mathematician José Natário, in which the expansion/contraction of spacetime does *not* occur. As Natário wrote, this signature feature of the Alcubierre warp drive "is but a marginal consequence of the choice [for the spacetime metric/mass-energy distribution]."[94] Rather than thinking of the warp bubble as being propelled by the push-pull of spacetime expansion/contraction, Natário wrote that "one could best describe the warp-drive spacetime as 'sliding' the warp-bubble region through space": that is, as analogous to a California surfer riding a wavefront. The surfer is motionless with respect to the water in the immediate vicinity of his board, and yet his speed with respect to the rapidly approaching shore is decidedly non-zero.

The idea of a manipulated or *warped* spacetime allowing time travel was an early arrival in science fiction. Consider, for example, the 1930(!) story in which the narrator (one Thomas Jenkins) walks 18,000 years into the future. In an editorial footnote (a device commonly used in early pulp fiction to inject scientific verisimilitude), we are told that "Jenkins had evidently fallen into a warp in space . . . a fault, we might say, borrowing a geologic term, in the curvature of space. Through this warp he had been thrown clear out of our three dimensions into a fourth. There he slid in time over to the other side [of the fault] into the same spot in the three-dimensional world, but into a different era in time."[95]

That was a flawed explanation, with its talk of space rather than of spacetime, but some authors eventually learned to do better. For example, *folded spacetime* as a mechanism for time travel is used in a 1940s cautionary tale on the potential horrors of the atomic bomb. In that story, published 2 years after the atomic bombings in Japan, the world 15 years hence experiences a terrible atomic war. As the time traveler in the tale explains, "During the unprecedented release of atomic energy that arouse during the simultaneous bombings of our cities, something happened to the very continuum in which we exist . . . A crook, a twist, a fold—explain it how you will, I accidently stumbled upon an electronic circuit that would create a field that would enable passage from one folded section [of spacetime] to the adjacent section. The fold proved to be about fifteen years in length . . . ."[96]

[94]J. Natário, "Warp Drive with Zero Expansion," *Classical and Quantum Gravity*, March 2002, pp. 1157–1165.

[95]N. Schachner and A. L. Zagat, "In 20,000 A.D.," *Wonder Stories*, September 1930.

[96]R. F. Jones, "Pete Can Fix It," *Astounding Science Fiction*, February 1947.

As Alcubierre and Natário showed, it will take a lot more than a mere electronic circuit to warp spacetime for either FTL or time travel, but at least even the early science fiction pulp writers understood that—*somehow*—a spacetime warping would be required.

The Alcubierre FTL warp drive appeared as the scientific basis for a modern science fiction novel, where at one point we read of a curious optical feature of an FTL spaceship, one I haven't seen mentioned in the physics literature: "This is a ship that traveled faster than light. It's visible as it travels; its warp bubble emits a cascade of exotic radiation . . . but it outruns its own image. So the ship arrives first and the light has to catch up, all the photons it emitted back along its path arriving at mere light speed. The older images arrive last, and you get this effect as if the ship was receding, not arriving."[97]

Another quite interesting feature of Alcubierre's warp drive is that the spaceship crew would experience no acceleration forces, as the ship is always in *free fall*. This may explain why the *Enterprise* crew isn't flattened when Mr. Sulu engages that ship's warp drive. The spaceship is surrounded by a "bubble" of warped spacetime that is swept along by the combined push-pull effect of the expanding spacetime behind the craft and the shrinking spacetime in the front. The ship, itself, resides in the *flat* spacetime interior of the warp bubble. An amusing way to think of this is to imagine a fish (space traveler), inside an aquarium (the warp bubble), which has been tossed into a swiftly flowing river. An observer at the edge of the river sees the aquarium move by her at high speed while, for the fish (swimming in the *still* waters of its aquarium), all is serene because *it is at rest with respect to its local environment*. Thus, the Alcubierre warp drive realizes yet another one of science fiction's wonderful gadgets: the *reactionless* spaceship drive. That is, "the warp bubble moves by interacting with the geometry of spacetime instead of expending reaction mass [as do jet and rocket engines] . . . and the spaceship is simply carried along with it."[98] In picturesque terms, the warp drive starship is like a surfer who makes her own waves.

And so we see, with each passing decade, more and more of science fiction departing from the make-believe to the pages of physics journals.

[97] S. Baxter, *Ark*, Gollancz 2009. The spaceship in this work travels at three times the speed of light (warp factor 1.44, as explained in note 84).

[98] F. S. N. Lobo and M. Visser, "Fundamental Limitations on 'Warp Drive' Spacetimes," *Classical and Quantum Gravity*, December 2004, pp. 5871–5892.

6.6 For Further Discussion

The connection between FTL speeds and backward time travel made the jump from theoretical physics to popular culture very quickly. It was in the British humor weekly *Punch*, for example, that the famous (but nearly always misquoted—see note 113 in Chap. 3, which doesn't have it quite right) limerick by A. H. R. Buller (1874–1944) first appeared (December 19, 1923, p. 591):

> *"There was a young lady named Bright Whose speed was far faster than light, She set out one day In a relative way And returned on the previous night."*

Where *Punch* dared to go, Hollywood could not be far behind. Indeed, in this case it was actually there first, with the 1922 one-reel silent comedy film *The Sky Splitter*. This was just a short film (feature pictures generally had at least four reels), so it isn't clear just how widely distributed and viewed it may have been. The story is that of a scientist testing a new spaceship; when it exceeds the speed of light, he begins to relive his life. This all shows that today's fascination, so common in popular culture, of the latest developments in theoretical physics, is nothing new. Why do you think this is so? That is, why (for example) do so many of those who flock to science fiction movies of interstellar invasions (like the 1996 *Independence Day* and its 2016 sequel), nonetheless have no conception of the unlikely possibility of such invasions because of the sheer magnitude of interstellar distances? Distances so immense that, even at the speed of light, it takes 4 *years* to travel to the Sun's nearest stellar neighbor, and *millions* of years to reach the Milky Way's nearest neighboring galaxy? (The vastness of interstellar distances is, as mentioned in the text, the reason for the fascination in warp drives in both science fiction and physics.).

In wormhole and cosmic string time machines, and with warp drives, we encountered the idea of negative mass-energy in the form of 'exotic matter' (see note 39 again). Something like negative mass actually appeared in fiction long ago, in the 1827 novel *A Voyage to the Moon* by "Joseph Atterly," a pseudonym for George Tucker, a professor of moral philosophy at the University of Virginia. (One of Tucker's students was Edgar Allen Poe, who almost surely was influenced by Tucker's book to write his own moon tale, the 1835 "The Unparalleled Adventure of One Hans Pfall.") The trip in Tucker's work was powered by a metal called *lunarium*, which repels Earth.

(continued)

This is *not* the same sort of stuff as Wells' "Cavorite," a metallic alloy that is "transparent" to gravity and that appears in his 1901 *The First Men in the Moon*. Wells' competitor in the 'scientific romance' genre was, of course, Jules Verne. Wells was a visionary who looked far beyond just the next few decades, while Verne was a 'practical engineer' who, for example, got *his* characters to the Moon by the direct method of simply shooting them out of a 900-foot long cannon with 400,000 pounds of guncotton! (Wells' vision *could* sometimes fail him, as it did about the imminent likelihood of airplanes in his 1901 *Anticipations*. He believed they *would* be developed by the year 2000, and maybe even before 1950, but of course just 2 years later . . .) In a 1903 magazine interview, Verne revealed how he felt about the difference between his and Wells' work: "It occurs to me that his stories do not repose on very scientific bases . . . He goes to Mars [sic] in an airship, which he constructs of a metal which does away with the law of gravitation. C*'est très joli* [this is all very nice], but show me the metal. Let him produce it." Today the cry from those who dislike wormholes is the Verne-like 'show us the exotic matter!' If Wells and Verne were writing today, how do you think each would respond to that challenge? Would the possible existence (or not) of exotic matter be an issue about which both would *agree*?

Write a time-loop short story based on Lossev and Novikov's idea of a 'very old spacecraft' interacting with a remote wormhole.

Imagine an electronic circuit **A** that has the following behavior: **A**'s input signal is a function of time that has a well-defined maximum value (what electrical engineers call the *peak value*). The circuit's output signal, produced in response to the input, also has a well-defined peak value. Now, imagine further that the output peak occurs *before* the input peak. There is, in fact, nothing paradoxical or impossible about that, and such a circuit can (and has) been constructed, as I'll tell you shortly. Next, suppose that we take **A**'s output signal and use it as the input to another circuit **B** that, when it's input exceeds a certain level, disconnects the input to **A** *before* that input reaches *its* peak value. Circuit **B** can also be constructed in the real world. Indeed, you can read about how to construct **A** and **B** in two papers by M. W. Mitchell and R. Y. Chiao, "Causality and Negative Group Delays in a Simple Bandpass

(continued)

Amplifier," *American Journal of Physics*, January 1998, pp. 14–19, and "Negative Group Delay and 'Fronts' in a Causal System: An Experiment With Very Low Frequency Bandpass Amplifiers," *Physics Letters A*, June 16, 1997, pp. 133–138. What makes all this interesting here is that this "seems to open the way for a variant of the time travel paradox in which the traveler journeys to the past and kills his grandfather before his own father is born," an observation made in Garrison *et al.*, "Superluminal Signals: Causal Loop Paradoxes Revisited," *Physics Letters A*, August 10, 1998, pp. 19–25. This electronic version of the grandfather paradox does indeed follow if one substitutes "input peak" for "grandfather" and "output peak" for "time traveler." But before you think this gadget is a time machine, be assured that its designers also showed that, unlike the causally related grandfather and time traveler, the two peaks are *not* so related. Read these three papers and write a summary report of how circuits **A** and **B** work, and why the two peaks are not so related.

You'll recall that "an advanced civilization" is thought to be required to create a useable wormhole (note 27). The common phrase used by astrophysicists who are interested in the possibility of extraterrestrial life is *arbitrarily advanced civilization*, with a distinction made for at least three progressively higher stages of 'advancement.' Very roughly, Types I, II, and III advanced civilizations are those that, respectively, have the technology to (a) control something like 10^{13} W (ten million megawatts) for massive interstellar radio broadcasts, (b) a technology to control the energy output of the civilization's planet's parent star (10^{27} W), and (c) a technology to control the energy output of the civilization's home galaxy (10^{38} W). We are, today, short of being even a Type I civilization, and it would probably take *at least* a Type III civilization to build a wormhole. Indeed, Stephen Baxter's 1993 novel *Timelike Infinity*, of beings who can manipulate *constellations of galaxies*, seems to assume a Type IV civilization will be required. Since there are typically 10^{11} stars in a galaxy, going from 10^{27} W for a star to 10^{38} watts for a galaxy is consistent. But where do astrophysicists get 10^{27} W for a single star? Here's a calculation for you to perform, to confirm this value for yourself, starting with the experimental fact (not difficult to repeat, as it's at the level of a junior high school science fair project using a solar cell and a few common electrical components) that the solar power level at Earth's equator is 1200 W per m^2. Then, using the fact that the Earth's orbital radius around the Sun is 93 million miles, compute the total power (energy per second) radiated by the Sun. (You should get a number that is somewhat

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smaller than 10^{27} W, which is 'explained' by observing that the Sun is really a quite ordinary star, exceeded in size by many other stars in the Milky Way. Next, you'll find, in most books on astrophysics, the statement that the nuclear fusion reactions that power the Sun convert *four million tons* of the Sun's mass to pure energy *every second*. Confirm that your number for the power output of the Sun is consistent with that claim. (Remember Einstein's famous formula $E = mc^2$, that the speed of light is $c = 3 \times 10^8$ m/s, and that 1 kg $\approx$ 2.2 pounds. In the MKS system of units (meters/kilograms/seconds) one watt = one joule (of energy) per second, where to give you some perspective on what a joule is, the chemical energy released by burning a gallon of gasoline is about 100 MJ.

Appendix A
Old Friends Across Time (A Story)[1]

As I sit here in my study, with the photographic evidence spread before me, I can barely comprehend what my eyes tell me must be so. The evidence is incontestable. And yet—I still struggle to believe. Let me try to explain—possibly in the process I will manage to put my tumbling mind to rest.

For as long as I can recall, old photographs have fascinated me. To page slowly through collections of historical pictures, no matter what the theme, was consummate joy. Even when I was quite a small boy I used them as my time machine into the past. They took me up and away from the problems every youngster has while growing up, and let me wonder of people and places long since returned to dust. Matthew Brady's Civil War photos had a particularly strong attraction for me, with the horror (and yes, I will admit it, the *fascination*) of war frozen in the images of young men dead before life had really begun. To look at the fallen youth of more than a century before, and to wonder who they were, and what they had felt and thought—it all sent shivers through my romantic mind.

I suppose I might have become a professional photographer. But somewhere along in the process of looking at pictures, I became aware of the miracle of the *technology* of picture taking. That led me to chemistry and optics, and finally by some wondrous route, I became an electrical engineer. I never lost my love for old pictures, though, but merely turned my interest in them to the photographic history of electrical physics.

To search out and acquire (for by now I had started my own collection) a photograph of Steinmetz, smoldering cigar clamped in his mouth, giving a lecture on AC circuit analysis using the then still mysterious square root of minus one made my heart beat faster. To find a faded picture of Einstein at a long forgotten

[1]P. J. Nahin, "Old Friends Across Time," *Analog Science Fiction Magazine*, May 1979. This tale was written with the specific goal of illustrating how a trip into the past *yet to be initiated* could logically influence events in the time traveler's present and future. The story reproduced here is, with only a few very minor alterations, as it originally appeared in *Analog*.

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conference, caught forever in time with his quiet, gentle eyes looking into mine, would send me to the heights of ecstasy.[2]

But it was Maxwell that led me to my incredible discovery. There is no doubt but that James Maxwell was the greatest theoretical physicist of the nineteenth century. Together with Einstein, he was the best of *any* century. Could it possibly be more than mere chance that the same year saw the death of one and the birth of the other? It was Maxwell who gathered together all the then known, but fragmented, experimental bits and pieces of knowledge about electricity and magnetism, and stirred in his own contribution of the displacement current. There was no physical evidence then to justify that last step, but the genius of Maxwell knew it *had* to be. And then, from his soaring mathematical insight and physical intuition, he took it all and wrote down the four magnificent equations for the electromagnetic field![3]

No one who has seen and understood those beautiful equations can come away without a quickening of the pulse and a flush of the blood. They're not long—you can write all four vector differential equations on the back of a postcard, but oh, what they tell us! With them, Maxwell, showed light was electrical in nature, predicted radio waves *two decades* before Hertz discovered them in the lab, explained energy propagation in space, and radiation pressure, and laid the scientific basis for today's television, radar, lasers, giant electric motors, generators, transmission lines and—well, why go on? The equations are the work of a level of genius we may not see again for a millennium. We have hardly begun to discover the marvels wrapped inside the electromagnetic field equations. With their aid, and that of quantum mechanics, the very secret of life, itself, may someday be unraveled.

And so I searched for old photographs of Maxwell. He died at his family's Scottish home in 1879, before the art of picture taking was barely 40 years old. But I knew in my heart that somewhere there *must* be photographs, yet undiscovered, of such a great man. Anyone who has seen the best examples of prints from wet glass collodion negatives knows they are, in the faithfulness of their rendition of detail, better than what we commonly expect today. Working against me was the fact that the process was slow, laborious, and unforgiving of mistakes. The taking of a picture was not a minor decision in Maxwell's time. But still I searched.

I searched for one photo, in particular. When Einstein died, a famous picture was taken of his office, just the way he left it for the last time. On the blackboard behind his desk are the last thoughts he had in his long quest for a Unified Field Theory,

[2]The first reference is to Charles Steinmetz (1865–1923), the German-born American electrical engineer and mathematician who became the wunderkind of General Electric. Einstein, of course, needs no introduction!

[3]I wrote this for story effect, but it's not really *quite* true. When Maxwell wrote his theory in mathematical form, he did so using *twenty* (!) equations in as many variables. The equations, as physicists and electrical engineers use them today, were first written in 1885 by the English self-taught eccentric Oliver Heaviside, who considered Maxwell to be his hero (see note 6 in Chap. 6). Modern electrical engineers and physicists write the Maxwell equations as *four* partial differential *vector* equations.

a 'theory of everything.' The writing on the papers covering the desk is clearly legible, and with modern blowup methods, easily readable.

At the time of his death, Maxwell was the Einstein of his times. Surely, I reasoned, a similar photograph of Maxwell's study must have been taken. Even though none has come down through the decades to us, it *must* exist! Gathering dust in an old trunk, or buried in a long forgotten album, it had to be somewhere. I vowed to find it.

I began by writing to all of Maxwell's living descendants, asking that they search through family holdings for any pictures concerning Maxwell that they might possess. For the most part all were cooperative, even though more than just a few thought I was somewhat deranged. Still, it was in vain. I did receive a few old pictures never before seen by other than the family, including a poignant one taken in 1901, showing Maxwell's grave in Parton Churchyard at Glenlair, Scotland. A forlorn, wintry scene, with only what seemed to be three men in the far distance, it brought tears to my eyes. Alas, there were no photos of Maxwell's study.

But then late last year, while on a business trip to London, I stopped off for a few hours at the historical archives maintained by the British Institute of Electrical Engineers. On a chance, I looked through their massive files on Maxwell and was rewarded within the hour! What I found will haunt me throughout the remainder of my life.

There it was, stuck through its border with a rusty pin, between two pieces of yellowed paper covered with what appeared to be some simple, rough lecture notes. An ordinary looking photo of a study. Obviously overlooked through the years, or at best unappreciated for what it was, it was the almost illegible, penciled notation on the back that convinced me of my find—just a date: November 9, 1879. Exactly 4 days after Maxwell's death, precisely when some unknown, yet inspired person (a family member, a neighbor, a local scientist?) would take such a picture!

I am ashamed to admit it, but there was no hope the Institute would let me have the picture. And there was no time to copy it, for I was to return home to America that very night. No, that's not true. The *real* reason for what I did was simply that I *had* to have that original, *old* photo. I took it! It was my undoing, for that dishonorable act destroyed the picture's tie to verified, legitimate historical records. But *I* know what I found is true.

I could barely control my wild emotions on the flight home. Several times I removed the picture from my briefcase, and looked with fascination at the papers lying on Maxwell's desk, and at the tightly written lines of mathematics on the blackboard in the background. My hands trembled with what can only be called lust—once home, reunited with my well-equipped photo lab, I would learn every secret hidden in that picture.

There are no words I know that can convey the thrill I felt as I began the processing of that priceless photo. Alone in my lab, with all the modern equipment a well-off amateur can buy (a Caesar Saltzman 8×10 enlarger with mercury vapor point light source and a $10\times$ Plan Achromat Nikon enlarging lens), I carefully cropped and blew up selected views of the blackboard and desk. Printing the

enlargements on ultra-fine grain AGFA Brovira paper, I could scarcely restrain myself from peering at them with a magnifying glass while I waited for them to dry.

Then, at last, I had them spread out across my study desk. I tried to force myself to examine each slowly, carefully, in turn, and not to skip from one to another like a child let loose in a candy store with a dollar. The first three were of the desk papers, including what seemed to be a diary. It must have been lost after Maxwell's death since no trace of it exists in the historical records. I experienced a stunning thrill as I gazed upon the scrawled words, but as they were not easily read at once, I moved on. It was the sixth enlargement, of the upper right corner of the blackboard that sent me reeling back to my chair. An equation that shouldn't, no, *couldn't*, be there. But it was.

To understand my reaction, there is one astounding thing you must realize about Maxwell's field equations. When Einstein turned the world of physics on its head in 1905 with his famous paper, "On the Electrodynamics of Moving Bodies," all the old ideas about absolute motion and simultaneity of events went out the window. Even Newton's laws of mechanics had to be modified. But *not* Maxwell's! His equations, just the way he published them in 1873, are the same ones studied today[4]—they need *no* relativistic corrections.

How can that be, you wonder, as they predate Einstein's by 32 years? The mystery of this has bedeviled the experts down through the years. Oh, they have an explanation, alright. They say that all of electromagnetics is actually relativistic phenomena to begin with, and the laboratory work of Faraday, Ampere, Henry, and the other great experimentalists were studies of relativistic electron interactions in matter (although they, of course, didn't know that). Thus, it is only 'natural' that Maxwell's equations need no correction. So goes the 'expert' explanation, but it isn't right![5] I know Maxwell knew about relativity, and understood it perfectly. He knew all about time paradoxes and the equivalence of mass and energy.

Because how else can you explain the equation visible in my enlargement: $E = mc^2$!

Why, you must wonder (just as I did), didn't Maxwell publish this remarkable result? At first, I believed it was because of a lack of faith in his results. Who would have believed any of it in those Victorian times, so sure of its absolute view of nature? I thought of how Newton, 200 years before Maxwell, had suffered from a similar hesitancy when he wrote the *Principia*. There, when explaining his theory of gravitation, Newton did *not* employ his new invention of the calculus (which he *had used* to make his discoveries), but instead fell back on laborious arguments based on the accepted mathematics of algebra and geometry. Who would have believed him, otherwise?

But then I realized that couldn't be right. Maxwell was a strong man intellectually and he wouldn't have held back for fear of disbelief. No, it had to be that he

[4]Don't forget note 3.

[5]Alas, I think it *is* right. Don't forget, this is science *fiction*. When there is a conflict between the needs of a story, and a rigid adherence to physics, the 'needs' wins!

discovered relativity and the mass-energy law just before his death, with no time to make his work known. I was still wrong.

It was later, when I returned to the enlargement of Maxwell's lost diary and read those painfully cramped notes, that I learned the truth. What I saw there showed me Maxwell had thought long and hard about his final discoveries and had purposely withheld them. For clearly visible, after I had slowly deciphered the writing, were the following words:

> *I have seen monstrous events. My blood has run cold at the sight of two great cities leveled to the ground, their inhabitants cruelly put to death instantly, or left to die slowly from a strange, lingering disease. Other trips, further on, have shown me the root of all these evils is the mass-energy equation, a result I at first believed to be my crowning glory. It will be my crown of thorns unless I ban it from my very being. Another will discover it for himself, but* my *soul shall be free! I have dismantled my machine, and shall never look upon or think of those horrible scenes again.*

This passage was dated just 1 month before Maxwell died a savage death from cancer. The reference to 'two cities' can only be that of Hiroshima and Nagasaki. His own death was surely caused by lingering too long among their atomic ruins.

Think of what this *means*. Quite simply, Maxwell knew the secret of time travel! But even more incredible is that it must be *easy*, if one only knows how, to build a time machine! Think about it—Maxwell had no gigawatt power stations at his disposal, no high technology machine shops, or nanosecond computers. He was not a gifted experimentalist, and once he had predicted radio waves, for example, it took others 20 years to finally generate them. And yet, *he* built a time machine. Somehow, with just the puny power sources available to him, and a limited mechanical capability, he wrested free the *simple* implementation of a time machine from his dynamical field equations.

Yes, yes, I know what you must be thinking. How can I really conclude such an incredible thing from a single equation on a blackboard, and a few words written by a man dying a painful death? A man, clearly suffering dearly, and possibly not in complete possession of his once marvelous mind.

This very evening the last bolt of evidence slid into place. Attempting to escape from the emotional maelstrom into which I had fallen, I turned to my old love of picture gazing. I took down from my library shelf a tattered yet cherished volume of the Meserve Collection of Lincoln pictures. My slow paging through the images stopped when I came to the famous photograph by Alexander Gardner of Lincoln's second inauguration. This incredible picture shows John Wilkes Booth looking down on Lincoln from behind a buttress high on the steps of the Capitol, while below in the crowd are the five men who, 41 days later, conspired with him in the assassination.

The following page demonstrated the extraordinary quality of Gardner's work, as it showed an enlargement of Booth's face in which the circular line between the pupil and the white of each eye is sharp and crisp! This impressive picture fascinated me, and I wondered if I could create a similar enlargement. It was then I remembered the old picture of Maxwell's grave, sent to me from Scotland, and the

three distant figures in the background. They would present my photo-lab skills with a challenge, and the effort would distract my mind.

I finished the enlargement just 20 min ago. Those faces! Two of them I can now finally accept as being there—it must have been a pilgrimage for one, and for the other, it couldn't have been anything but a mocking, ironic gesture. But I wonder if the youngest one really knew who his two companions were? I don't know the answer to that—yet. But there they are, two men with faces my years of study have made as familiar to me as my own. One is a youthful Albert Einstein. The other, with the signs of death clearly written across his features, is James Clerk Maxwell. The face of the third man is familiar, too, for the third man is me!

Oh, I'm a bit older in the photo than I am now. But it's me, alright. A distinctive, jagged scar across the left cheek, a mark from a childhood accident, is sharply visible, and I can run a finger over my face and match it perfectly with the image in the enlargement. I'd say I'm about 45 or so in the image, no more than 10 years older than I am now. That doesn't leave me much time to keep my appointment, does it? I don't know, right now, how I'm going to do it, but I've got to rediscover Maxwell's secret of time travel. I'm sure I'll succeed—after all, there I am in the picture. Somehow, I'll be going back to pick James and Albert up so we can have our picture taken. Ten years—not much time.

I'm really looking forward to meeting my two new friends from across time.

For Further Discussion

When "Old Friends Across Time" originally appeared in *Analog*, it opened with a quotation from Richard Feynman's famous 1961–1963 Caltech undergraduate course (published in 1964 as *The Feynman Lectures on Physics*): "Ten thousand years from now, there can be little doubt that the most significant event of the nineteenth century will be judged as Maxwell's discovery of the laws of electrodynamics. The American Civil War will pale into provincial insignificance in comparison." This is almost certainly true, but could Maxwell *really* have built a time machine from just a knowledge of electromagnetic theory and special relativity (which is all that is needed to derive $E = mc^2$), if he didn't also have a deep understanding of general relativity (and probably of quantum mechanics, too)? How likely do you think *that* is?

The narrator in "Old Friends Across Time" knows he is going to live long enough to eventually build a time machine; discuss the implications of this knowledge. For example, is he at least *temporarily* invulnerable to committing suicide (or, for that matter, to any other variation of dying?) That is, do we have a 'future' version of the grandfather paradox? This issue has never (to my knowledge) been considered by physicists, and not by philosophers either until recently. See, for example, S. Keller and M. Nelson, "Presentists Should Believe in Time-Travel," *Australasian Journal of Philosophy*, September 2001, pp. 333–345, and M. H. Slater, "The Necessity of Time Travel (On Pain of Indeterminacy)," *The Monist*, July 2005, pp. 362–369. More generally, if we assume that the past is unchangeable then the scenario in "Old Friends Across Time" seems to force at least some level of inevitability on the future as well. Or does it? In the 2007 story by Ted Chiang, "The Merchant and the Alchemist's Gate," that you were asked to read in a *For Further Discussion* at the end of Chap. 4, there is the following exchange between the narrator and the inventor of "the Gate" (a wormhole): "So if you learn that you are dead 20 years from now, there is nothing you can do to avoid your death?" He nodded. This seemed to me very disheartening, but then I wondered if it could not also provide a guarantee. I said, "Suppose you learn that you are alive 20 years from now. Then nothing could kill you in the next 20 years. You could then fight in battles without a care, because your survival is assured." "That is possible," he said. "It is also possible that a man who would make use of such a guarantee would not find his older self alive when he first used the Gate." "Ah," I said, "Is it then the case that only the prudent meet their older selves?" Comment on this issue, with particular attention to free-will.

Appendix B
Newton's Gift (A Story)[6]

Wallace John Steinhope was a sensitive human being, a person deeply concerned about the welfare of his fellow creatures. Any act of injustice, however slight, made his breast pound with righteous indignation. He was a champion of fair play, and his motto in life was taken from the ancient English rule of law—'Let right be done!'

Even while still a lonely, reclusive child, Wallace's heart ached mightly when he read of the laborious, boring, mind-dulling calculations endured by the great mathematicians of old. Just knowing, *thinking*, of Gauss's marvelous mind wasting literally months of its precious existence grinding out tedious mathematics that even a present-day dullard could do in a minute, on a home computer, was sheer agony for Wallace. Contemplation of the God-like Newton suffering endless delays in his gravity research, all because of a simple miscalculation of the length of a degree of longitude, was almost unbearable.

Indeed, Newton played a special role in Wallace's life (and he in Newton's, as we shall soon see). While the other great mathematical physicists had merely been hindered in their work by the lack of modern computational aids, Newton had squandered so much valuable time in other, nonscientific pursuits! His quasireligious writings alone, over half a million words, exceeded his scientific writings. What a waste! Wallace wondered endlessly over the reason for this strange misdirection of talent and bored his friends to the edge of endurance with his constant brooding on the mystery. Still, they all liked and admired Wallace enormously and so put up with it. But more than one of them had sworn to throw up the next time Wallace mentioned Newton during a wedding (but that's another story).

So deep was Wallace's anguish for his predecessors that even as he grew older and his own tremendous talents as a mathematical physicist (the result of a lucky

[6]P. J. Nahin, "Newton's Gift," *Omni*, January 1979. This tale was written with the specific goal of illustrating casual loop time paradoxes. The story reproduced here is, with only a few very minor alterations, as it originally appeared in *Omni*.

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genetic mutation induced in a male ancestor some centuries earlier) gained him an international reputation, thoughts of the unmeasurable misery of his scientific ancestors were never far from his mind. It was most appropriate, then, that his greatest discovery gave him an opportunity to *do* something! And Wallace John Steinhope vowed to *help*. He became convinced that it was his purpose on earth—he could not, he *would* not hesitate. As he strapped the knapsack-size time machine to his chest, his excitement was, therefore, easy to understand.

"It is done! And I am ready. I will travel back and bestow this gift of appreciation, this key to mental relief, on the great Newton himself!" Wallace cradled a small, yet powerful hand-calculator in his palm. It was a marvel of modern electronics. Incorporating large-scale integrated circuitry and a Z-8000 microprocessor solid-state chip, the calculator required only a small, self-contained nuclear battery for its power. It could add, subtract, multiply, divide, do square and cubic roots, trig and hyperbolic functions, take powers, find logarithms, all in mere microseconds. It was programmable, too, able to store up to 500 instructions in its micro-memory. The answers it displayed on its red, light-emitting diode readouts would liberate young Isaac from the chains of his impoverished heritage of mathematical calculation. No more Napier's bones for Newton!

But Wallace John Steinhope was no fool. He understood, indeed feared, time paradoxes. He knew Newton could be trusted with the secret, but it wouldn't do for the calculator to survive Newton's time. So Wallace had incorporated a small, self-destructing heat mechanism into it. After 5 years of use, it would automatically melt itself into an unrecognizable, charred slag mass. But that would be enough time for its task to be completed. The emancipation of Newton's mighty brain from tedium! Pleased enormously at the thought of the great good he was about to confer, Wallace set the time and space coordinates for merry old England, flipped the power switch on, and vanished.

Materializing in the Lincolnshire countryside in the spring of 1666, he began his rendezvous with destiny. It was the second and final year of the great bubonic plague, and Newton, seeking refuge from the agony and death plundering London and threatening his college of Trinity at Cambridge, had returned home to work in seclusion. The years of the Black Death were Newton's golden years, when the essentials of calculus would be worked out, when the colored spectrum of white light would be explained, and when the principle of the law of gravitation would be grasped. But how much easier it would be if Newton were released from the binding chains of dreary calculation. Wallace's gift would slip the lock on those chains! Accelerate genius!

It was early evening when, guided by a map of the area prepared by a friend who was both a cartographer and amateur historian, Wallace reached the quiet little town of Woolsthrope-by-Colsterworth. It was here, in a small farmhouse, that Wallace would meet his hero of the ages. A cold, gentle rain was falling as he approached the door. The soft, hazy light of an oil lamp glowed inside, revealing through the translucent glass the form of a man bent over a table. The fragrant smoke of well-dried wood curled from the chimney, announcing a warm fire within.

With his heart about to burst from excitement, Wallace rapped upon the door. After a pause, the shadow rose and moved away from the window. The door opened, and there stood Isaac Newton, a young man of 23 with an intellect that Hume and Voltaire considered "the greatest and rarest genius that ever rose for adornment and instruction of the species." But for the importance of his self-appointed mission, Wallace would have fainted dead away from the thrill of it all. "Is this the home of Isaac Newton?" he asked in a voice quavering with the trembling tones normally used by lovers about to reveal their deepest feelings.

The young man, of medium height and thick hair already showing signs of gray, swung open the door and replied, "My home it is, indeed, stranger. Come into the parlor, please, before the wetness takes you ill."

Isaac followed Wallace into the room and stood quietly watching as his visitor removed his soaked coat and hat. The portable time machine was gently placed on the floor next to a wall. The calculator was snug and safe in its plastic case in Wallace's shirt pocket. "Thank you, Master Newton. May we sit while we talk? I am afraid you may wish to take some time to consider my words." Motioning to a chair near the table, Isaac pulled a second chair from a darkened corner and joined Wallace. "You have a strange sound to your speech, stranger. Are you from hereabouts, or have you traveled far? Please commence slowly your tale."

Wallace laughed aloud at this question, a response prompted by his nervous excitement, and it quite surprised him. "Please forgive me. It is just that I *have* traveled so very, *very* far to see you. You see, I am from the future." Wallace was not one to play his cards close to his chest. Now it was Isaac's turn to laugh. "Oh, this is most ridiculous. Are you a friend of Barrow's at Trinity? It would be so like him to play such a trick.[7] From the future, indeed!"

Wallace's eyes ached at the sight of the papers on the table where Isaac had been working. What wonders must be there about to be born! In any other situation, Wallace would have asked their contents, but the die had been cast. He had to convince Isaac of the truth of his tale. But he had to walk a tight line, too. It just wouldn't do to misdirect Isaac's interest away from the calculator and toward the time machine itself! He must do something dramatic, something that would rivet his idol's attention and hold it.

"Yes, yes, I understand your reluctance to believe me. But, look here. This will convince you of the honesty of my words." Wallace pulled the shiny black plastic-cased calculator from his shirt pocket and flipped the power switch on. The array of LEDs glowed bright in the gloomy room as they flashed on in a random, sparkling red burst. Isaac's eyes widened, and he pushed his chair back. Was he frightened?

"As the Lord is my Savior, is it a creation of Lucifer? The eyes of it shine with the color of his domain. Are you one of his earthly agents?"

[7]The reference is to Isaac Barrow (1630–1677), who was the first Lucasian Professor of Mathematics at Cambridge. Barrow resigned that position to allow it to pass to Newton. Centuries later, Hawking became the 17th Lucasian Professor.

"Oh my, no! Look here, Master Newton, let me show you that there is no black magic or chicanery involved. It is all perfectly understandable in terms of the laws of Nature. What I have here is an automatic calculator, a device to perform all of your laborious mathematical labors."

So saying, Wallace squeezed the sides of the calculator case together, releasing pressure snap-fittings, and flipped the case open on a hinge at the top. Revealed to Isaac were the innards of the electronic marvel—a tightly packed interior of printed circuit boards, a mass of integrated circuitry, the small LED display, and the sealed nuclear battery. Isaac stared intently at the sight, and Wallace could see the natural curiosity of Newton's great mind begin to drive away the initial apprehension.

"But where are the gears, levers, springs, and ratchets to carry out the calculations? All I see is a black box with lights that glow red—how is *that* done; where is the lamp or candle to provide the light!—and many little isolated fragments of strange shapes. There is clearly nothing in your box that moves!"

"Oh, it is all done with electronics, Master Newton! The central processing unit has access to a solid-state memory that contains the decoding logic necessary to implement the appropriate algorithmic processes to provide the answers to the specific requests entered through these buttons. The actual performance of the box is achieved by the controlled motion of electrons and holes in suitably doped semiconductor material under the influence of electric fields induced—" Wallace, still overcome by his excitement, had rambled on wildly without thought of the essentially infinite technological gap that separated himself from Newton.

"Stop, stop," cried Isaac. "I understand only a few of the words you use and nothing at all of their meaning! But it is obvious that for calculations to be performed, mechanical work must be done, and that implies motion. Pascal's adding machine has shown the veracity of that. I say again, nothing moves in the box. How *can* it work?"

Wallace was embarrassed. The mistake of overlooking the hundreds of years of progress after Newton's time was one a child might make. "I am sorry, Master Newton. I'm going too fast for you." Isaac looked at Wallace with a frown, but Wallace failed to see the pricked vanity of the proud Newton. Going too fast, indeed!

Wallace prepared to lay a firmer technological foundation for Newton, but then he froze. It couldn't be done! Newton was a genius, certainly, but the task was still impossible. Wallace would have to tell him all about Maxwell's equations, Boolean algebra and computer structure, electronics, and solid-state device fabrication technology. It was just too much, and besides, there was the danger! The potential time paradoxes of all that knowledge out of its proper time sequence! What if Newton, in innocence, revealed some critical bit of knowledge out of its natural place in history? So, Wallace hesitated, but seeing the suspicion grow again in Isaac's eyes, he realized he had to do something, *anything*, immediately.

"You cannot deny your own eyes," answered Wallace. "Let me *show* you how it works. I'll divide two numbers for you with just the punch of a few buttons. Watch this." And, at random, he entered 81,918 divided by 123. Poor Wallace, of all the numbers to use, they were the worst. Within milliseconds the answer glowed

brightly in fiery red characters. Wallace looked with pride at the result and then, already enjoying in his mind what he knew would be Isaac's amazement, he turned his eyes to the great man. What he saw made his spine tingle, and the gooseflesh stand high on his neck. Newton had fallen to his knees, with eyes bulging and hands raised as if in prayer.

"The mark of the Beast, it is the mark of the Beast! It is so written in the Book of Revelations—Here is wisdom. Let him that hath understanding count the number of the beast; for it is the number of man; and his number is six hundred three-score and six!" Rising to his feet, Newton fell back into his chair. "Your cursed box bears the brand of its master. There can be no doubt now, it *is* the creation of the fallen archangel!" Wallace was aghast at Isaac's violent reaction. The seventeenth century genius had now stumbled backward from his chair and had grasped a poker from the hot coals of the fireplace.

"Wait, please wait! Watch this; I'll multiply two other numbers together for you, watch!" Wallace quickly punched in the data, and then the answer gleamed steadily in burning red characters on the LEDs. Isaac's eyes first went wide with fear as he again saw the wizard electronics do their marvelous assignment, and then he shut them tight. Wallace was becoming desperate—this wasn't the way it was supposed to be! "Don't you see—imagine the tedious work, the mind-deadening labor this machine will save you from. And it is yours."

"Yes? But only for the exchange of my soul! That is always the Devil's price for his seductive gifts from Hell!" As Isaac shrieked these last words at Wallace, he raised the poker over his head. "Begone, you emissary of the Dark World! I know now you must be in the employ of the Father of the Antichrist, but the Lord God Almighty will protect me if I do not waver in my resolve. Begone, or I'll strike your brains out on the floor where you stand!"

Isaac's eyes were wide with fear, nearly rolling back to show all white spittle sprayed from his mouth as he yelled at Wallace, who stared in shock at the wild man who threatened him with death. "Please, please, *listen* to me, please! I beg you to understand—I am a scientist, just like you. The concept of the devil, and all it stands for, is contrary to everything I believe. How *could* I be in the devil's employ, when I don't even accept his existence? You *must* believe me!"

"Blasphemy!" screamed Isaac. "Your own words condemn you. To deny the reality of Satan in a sinful world is to deny that of God, too. Now leave my home, you dark beast from hell, or by the heavens above, *I shall destroy you*!" As he shrilled these words, Isaac brought the poker down in a wild swing that barely missed Wallace's head.

Struck dumb with confusion at the uncontrolled outburst, Wallace stuffed the calculator into his shirt, grabbed his hat, coat, and time machine and rushed from the house. As he hurried into the cold, wet night, he turned back, just once, to see Isaac Newton framed in the light of the open door. "Go, go, you foul messenger from the Lord of Evil! Back to your stinking pit of burning hell-fire! This is a house that honors the Divine Trinity and is no haven for the likes of you!"

Wallace rushed away into the blackness, the time machine bouncing unheeded upon his chest.

He ran, for how long he couldn't recall, until he fell exhausted next to a stream running heavy with the rain. Tears of rage, frustration, and shock streamed from his eyes. Rejected by the great Newton! Well, damn him! Wallace flung the calculator into the stream in his terrible anger and activated the return coordinates. He faded from Newton's world as quickly and quietly as he had come.

As for Isaac Newton, after having chased the Devil's messenger from his house, he returned on shaking legs to his desk. Pushing aside his rough calculations on the orbit of the moon around the earth, he swore to redeem himself in the eyes of the Savior. Somehow, he had been found lacking and had been tested. And the test was surely not over! He began to reapply his marvelous mind to determine the origin of his failure before the Lord God Jehovah. Taking quill in hand, he wrote the first of the many hundreds of thousands of words that his numerous religious tracts would devour from his allotted time.

Five years later, long after Newton had returned to Cambridge, a group of picnicking children were frightened when a nearby stream suddenly erupted into a geyser of steam. Moments later, the bravest (or most foolhardy) of the boys—who, by an astonishing coincidence that befits any good time travel paradox, would be Wallace's great-grandfather nine times removed—cautiously examined the streambed. All he found were some twisted, hot pieces of what he thought was a hard, black rock, and he tossed them back. They were all that was left of the calculator's nuclear battery. He did receive a tiny radiation dose from them, which caused a recessive genetic mutation that centuries later would suddenly appear as the cause of Wallace's genius, but otherwise the lad was unaffected. The incident was soon forgotten.

Well over 300 years later, Wallace John Steinhope reappeared in his own time. He was essentially the same man as before he left—kind, generous, and sensitive, and ready to come to the aid of any man or beast that might need help. As far as his friends were concerned, in fact, he was even improved (naturally, they didn't know what had brought about the welcome change but, if they had, they would have applauded it).

Wallace John Steinhope, you see, never again had another kind word for Newton, or for that matter, any words for him at all.

For Further Discussion

In his book *Travels in Four Dimensions: the enigmas of space and time* (Oxford 2003), the philosopher Robin Le Poidevin writes (p. 176) "But, as everybody knows, when a time machine leaves for another time it *disappears*." This is, indeed, how the time machine in "Newton's Gift" works; however, after reading *Time Machine Tales* do you think such behavior is in agreement or in conflict with general relativity? Defend your position.

"Newton's Gift" contains causal loops. Identify two of them, and discuss their role in the story (that is, are they central to the story or merely incidental?).

The idea of a time traveler visiting famous people in the past occurs fairly frequently in science fiction. In Ian Watson's "Ghost Lecturer" (*Isaac Asimov's Science Fiction Magazine*, March 1964), for example, the inventor of the "Roseberry Field" uses it to yank geniuses out of time to supposedly honor them, to let them know their lives had been worthwhile in the eyes of the future. But then he goes on to tell them—oh so kindly—where they had gone wrong or had fallen short of the mark, and of how much more we know nowadays. "You almost got it right, boy! You were on the right track, and no mistake. Bravo! *But* . . ." Watson makes the interesting observation that one can easily imagine playing this pathetic game of 'second-guessing' history with scientists, but what could even the most talented modern do to upstage a Mozart or a Shakespeare? Most similar to "Newton's Gift," however, are (for example) Gregory Benford's "In the Dark Backward" (*Science Fiction Age*, June 1994) where Shakespeare and Hemingway are visited, and Jack McDevitt's "The Fort Moxie Branch" (*Full Spectrum*, October 1988) where Hemingway and Thomas Wolfe appear. Read these stories, and then compare/contrast their descriptions of how story characters react to the appearances of time travelers, to Newton's behavior in "Newton's Gift."

Appendix C
Computer Simulation of the Entropic Gas Clock

```
%gasclock.m/created by PJNahin for TIME MACHINE TALES(6/27/2015)
%This MATLAB m-file simulates the diffusion of gas molecules in a
sealed
%container by using the Ehrenfest ball exchange rules. The
simulation
%starts with n molecules (i.e., balls) of one type (i.e., black)
on
%one side of the container, and n more molecules of another type
(i.e.,
%white balls) on the other side. The two urns play the roles of the
%two sides of the container. To simulate the ball (molecule)
%movements, the program selects two random numbers from 0 to
1, which
%are then compared to the current probabilities of selecting a
black
%ball from urn I and a white ball from urn II. If BOTH random
numbers
%are greater than these two probabilities then a white ball has
been
%selected from urn I and a black ball has been selected from urn
II,
%and so the number black balls in urn I is increased by one while
the
%number of white balls in urn II is increased by one. If BOTH
random
%numbers are less than or equal to these two probabilities then a
%black ball has been selected from urn I and a white ball has been
%selected from urn II and so the number of black balls in urn I is
```

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```
%decreased by one while the number of white balls in urn II is
decreased
%by one. If one of the random numbers is greater than its
corresponding
%probability while the other random number is less than its
%corresponding probability, then no action is taken because then a
%white (black) ball moves from urn I to urn II at the same time a
white
%(black) ball moves in the opposite direction. That is, there is
no
%net change. Then, the ball selection probabilities are recalcu-
lated and
%another ball exchange is simulated.
rand('state',100*sum(clock))     %new seed for the random number
generator;
n=100;                           %number of balls in each urn;
nb1=n;                           %number of black balls INITIALLY
in urn I;
nw2=n;                           %number of white balls INITIALLY
in urn II;
pb1=nb1/n;                       %probability of selecting a black
ball from urn I;
pw2=nw2/n;                       %probability of selecting a white
ball from urn II;
for trials =1:1000;
   system(trials)=pb1;
   ball1=rand;
   ball2=rand;
   if(ball1>pb1&ball2>pw2)         %white ball selected from urn I
      nb1=nb1+1;                    %and black ball selected from
      nw2=nw2+1;                    %urn II;
   elseif(ball1<=pb1&ball2<=pw2)  %black ball selected from urn I
      nb1=nb1-1;                    %and white ball selected from
      nw2=nw2-1;                    %urn II;
   end
   pb1=nb1/n;
   pw2=nw2/n;
end
plot(system)
axis([1 trials 0 1])
grid
xlabel('time, in arbitrary units')
ylabel('fraction of balls in urn I that are black')
figure(1)
```

Epilogue

> [Science fiction] cannot be good without respect for good science . . . This does not include time machines, space warps and the fifth dimension; they will continue to exist in the hazy borderland between [science fiction] and fantasy.[8]

> In many science-fiction stories, the trip into the past is by way of some futuristic machine that can take you through time at will . . . That, however, is totally impossible on theoretical grounds. It can't and won't be done.[9]

The opening quotations, particularly the second one from Asimov who was one of the great modern writers of science fiction, is a gloomy one indeed for fans of time travel, but it is not difficult to find inconsistency in Asimov's own tales dealing with the concept. Asimov is famous, in particular, for his stories of robots, and the very last such tale that he wrote combines robotics with time travel, with a robot sent two centuries into the future.[10] At the start of the story, the narrator tells us that time travel to the past is impossible because the past is unchangeable and (of course) a time traveler would necessarily disturb history. (That is (of course) simply a failure to distinguish between the difference of *changing* the past and *affecting* the past, as well as a failure to see how the principle of self-consistency negates the issue of paradoxes.) Then, when the robot returns from the future (and so backward time travel is *not* impossible!), he reports that his arrival had been expected, that history had recorded that he would appear. At the end of the story we learn how the future knew this—it had read "Robot Visions"! So now Asimov *uses*

[8]Harry Harrison, in his essay "With a Piece of Twisted Wire . . .," *SF Horizons* (no. 2), 1965. Harrison (1925–2012) was a well-known (if little appreciated outside the SF community) writer, whose 1966 novel *Make Room! Make Room!* was the inspiration for the excellent (if somewhat depressing) 1973 film *Soylent Green* (a movie about future over-population of the Earth that will make you think twice about ever eating a cookie again).

[9]From an essay Isaac Asimov wrote on the time travel movie *Peggy Sue Got Married* for the *New York Times*, October 5, 1986.

[10]I. Asimov, "Robot Visions," *Isaac Asimov's Science Fiction Magazine*, April 1991.

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the principle of self-consistency, with the narrator realizing that he *must* preserve his story so the future can read it.

Not a very consistent story! Asimov, was, of course, writing a story for entertainment's sake, so perhaps it's unreasonable to hold him *scientifically* accountable (although logic wouldn't seem to be too much to ask for).

In any case, was Asimov right? Lots of his fellow science fiction writers certainly thought so. One, for example, bluntly asserted that

> Time travel is inconceivable.[11]

Other critics agreed:

> In science fiction we find the lunatic fringe more often than not trying to perfect time-travel mechanisms.[12]

and

> Scientifically, time travel can't stand inspection.[13]

and

> Time travel is . . . scientific nonsense.[14]

and

> It would be untrue . . . to present the idea of a time machine as anything but what it is, an intriguing literary device, part of the bag of tricks of the science fiction writer . . . There is no such thing as a 'science' of time travel.[15]

You'll notice that these pronouncements are from decades ago: Conklin (1904–1968), Gold (1914–1996), and Oliver all wrote just 3 years after Gödel, and so perhaps it was simply too soon for his work to be widely known outside of the physics community. But physicists have learned a lot since 1952! Have they learned enough to make Asimov and his fellow SF skeptics (if they were still alive) change their minds, or at least reconsider? I suspect not.

I say that because, even 25 years after Conklin, Gold, and Oliver wrote, while we do find an awareness of Gödel starting to appear in the science fiction world, a feeling of skepticism was still in the air. In a fascinating analysis[16] of the first half-century of the science fiction magazines, Paul Carter admitted that there *is* a rationality to time travel because of Gödel but, nonetheless, the conventional view remained that backward time travel is simply impossible. Then, citing the work of Tipler, Carter wrote "Only as recently as 1974 (see note 130 in Chap. 1), in

[11]Kingsley Amis, *New Maps of Hell*, Harcourt 1960.

[12]Groff Conklin, *Science Fiction Adventures in Dimension*, Vanguard 1953.

[13]H. L. Gold, *The Galaxy Reader of Science Fiction*, Crown 1952.

[14]Alexei Panshin, *The Mirror of Infinity*, Canfield 1970.

[15]Chad Oliver, "The Science of Man," a non-fiction essay included in Oliver's 1952 time machine novel *Mists of Time*. Chad Oliver (1928–1993) was a scientist by profession (anthropology), and his opinion carried weight among SF writers *and* (non-physicist) scientists.

[16]P. A. Carter, *The Creation of Tomorrow*, Columbia University Press 1977.

the sober pages of the *Physical Review*, has a physicist been more bold ... For 70 years in the meantime, however, without waiting for Professor Tipler to solve his equations ... writers had happily helped themselves to Mr. Wells' invention and sent their characters through time in every direction, forward, backward, and sideways."[17]

In the 1980s writers were apparently just as unaware of Gödel's time travel analyses (and of the much later ones of Tipler) as had been the 1950s commentators. In his marvelous 1985 book *The Past Is a Foreign Country*, for example, David Lowenthal repeatedly refers to time travel as "fantasy" and to science fiction stories about time travel as "unbridled by common sense." And for another example from the start of the 1980s, consider the case of James Gunn (born 1923), professor of English at the University of Kansas, past president of both the Science Fiction Writers of America and the Science Fiction Research Association, author of *The Immortals* (inspiration for the 1970–1971 TV series of the same name), and eminent scholar (see his 1975 book *Alternate Worlds*). His literary credentials are impeccable and his critical influence profound. And yet, 30 years after Gödel and 5 years after Tipler, Professor Gunn wrote in *The Road to Science Fiction*, "Time travel has been an anomaly in science fiction. Clearly fantastic—there is no evidence that anyone has ever traveled in time and *no theoretical basis for believing that anyone ever will* [my emphasis]." If you've read this book carefully, however, of the analyses by Gott, Krasnikov, Thorne, Alcubierre, Novikov, Natário, and others, you know that what Gunn claims in those last words is actually not necessarily so.

The British-born American theoretical physicist Freeman Dyson of the Institute for Advanced Study has commented[18] on that sort of narrow mindset, with words quoted from the 1979 physics Nobel prize winner Steven Weinberg, words reminding us that rigidity concerning time travel is not limited to science fiction writers: "This is often the way it is in physics—our mistake is not that we take our theories too seriously, but that we do not take them seriously enough. It is always hard to realize that these numbers and equations we play with at our desks have something to do with the real world. Even worse, there often seems to be a general agreement that certain phenomena are just not fit subjects for respectable theoretical and experimental effort." The words *time travel* and *time machine* are never mentioned, but could they have been far from either Weinberg's or Dyson's thoughts?

All through this book we have seen how people have argued against time travel to the past (Tipler's cylinder is unphysically long, Gödel's universe requires an unphysical rotation, wormholes and warps require unphysical energy conditions, what about all those paradoxes ... and on and on). These arguments remind me of

[17]Given that *The Time Machine* was published in 1895, it is not clear how Carter arrived at the value of 70 until Tipler's work (he should have written 79), and of course it was only 54 years between Wells' time travel fiction and Gödel's time travel mathematical physics.

[18]F. J. Dyson, "Time Without End: Physics and Biology in an Open Universe," *Reviews of Modern Physics*, July 1979, pp. 447–460.

the debate in the 1930s between the illustrious British astrophysicist Sir Arthur Eddington and the young Indian astrophysicist Subrahmanyar Chandrasekhar (1910–1995), winner of the 1983 Nobel prize in physics. In his analyses of the life history of stars, Chandrasekhar had arrived at an astonishing conclusion, one that Eddington simply could not accept. As Eddington sarcastically explained in an address at Harvard University in the summer of 1936, "Above a certain critical mass (two or three times that of the sun), the star could never cool down, but must go on radiating and contracting until heaven knows what becomes of it. That did not worry Chandrasekhar, he seemed to like the stars to behave that way, and believes that is what really happens."[19] Eddington then went on to declare such 'unbelievable' behavior to be nothing less than "stellar buffoonery."

As far as Eddington was concerned, Chandrasekhar had simply made an error in combining relativity theory with non-relativistic quantum theory. Indeed, so appalled was Eddington at the thought of a star contracting "until heaven knows what becomes of it" (that is, until it gravitationally collapses into a black hole) that he had earlier, in 1935, stated "There should be a law of nature to prevent a star from behaving in this absurd way!" Today, of course, no astrophysicist feels the need for a 'star protection conjecture'—which perhaps reminds you of another, more recent 'protection conjecture.'

What can one conclude from all the similar controversy concerning time travel, time machines, and spacetime warps? Not much, I think, except that these are open issues and will remain the subjects of on-going study for a long time yet to come. The one thing I am fairly certain of is that if time travel is ever achieved, it will be by means that we cannot today even begin to guess. It will almost certainly require *at least* a mutant child genius with an IQ of 270 to fix the slightly broken time machine found abandoned in a cellar![20] But that view isn't uniformly shared across all of science fiction. I very much doubt, for example, that things will be quite so elementary as depicted in the story[21] where the time machine was so simple that "If it were taken apart or put together before you, your wife, or the man across the street, you would wonder why you didn't think of it yourselves." Not only that, but its power source was just two dry cell batteries!

The time machine in an earlier story is almost as simple, requiring (besides a piece of strange crystal) only a "little stack of dry cells, a Ford [automotive ignition] coil, a small brass switch, a radio 'B' battery, an electron tube, and a rheostat."[22] Even Wells' *Time Machine* couldn't resist making it all look easy: as one critic put it, "The time machine, like all products of supreme inventive genius, was a

[19]See S. Chandrasekhar, *Eddington: The Most Distinguished Astrophysicist of His Time*, Cambridge University Press 1983, p. 48.

[20]F. B. Long, "A Guest in the House," *Astounding Science Fiction*, March 1946.

[21]R. Abernathy, "Heritage," *Astounding Science Fiction*, June 1947.

[22]J. Williamson, "In the Scarlet Star," *Amazing Stories*, March 1933.

remarkably simple affair. A few rods, wires, some odd glass knobs—nothing more!"[23] That sort of simplistic fictional description of a time machine reminds me of the reaction of the great Polish science fiction writer Stanislaw Lem to the general treatment of time travel in the genre: "There have been mountains of nonsense written about traveling in time, just as previously there were about astronautics—you know, how some scientist, with the backing of a wealthy businessman, goes off in a corner and slaps together a rocket, which the two of them—and in the company of their lady friends, yet—then take to the far end of the Galaxy. Chronomotion, no less than Astronautics, is a colossal enterprise, requiring tremendous investments, expenditures, planning . . ."[24]

An example of what Lem was talking about is the 1956 novella *Arcturus Landing* by Gordon R. Dickson (1923–2001). There we read of aliens who have confined humans to the solar system—until (if) Earth scientists discover the secret of FTL travel. So, a genius physicist does just that (with no mention of spacetime engineering, but rather we encounter a lot of mumbo-jumbo gibberish as the 'explanation'), and uses it to instantly transport himself and some friends to a planet orbiting Arcturus.[25] And when they get there the friendly aliens speak perfect English.

Lem would have snorted in derision, too, at this statement made to a prospective graduate student by the head of a college physics department, that the college "has been awarded a million dollars to build [a time machine]. It means . . . a raise for me and maybe a doctorate for you, so we'll build one and have some fun doing it."[26] Is it any wonder that Lem so readily dismissed stories that reduce space (and time) travel to weekend adventures in a home laboratory? As Lem wrote in another essay, time travel and its close relation, FTL space travel, have reduced much of science fiction to "a bastard of myths gone to the dogs."[27] Because of precisely that, Harry Harrison wrote (note 1) of the early science fiction magazines that published so much nonsense, "I used to moan over the fact that pulp magazines were printed on pulp paper and steadily decompose back towards the primordial from which they sprang. I am beginning to feel that this is a bit of a good thing."

I don't know whether time travel to the past can actually be accomplished, but I do know that speculations once thought to be as outlandish as finding the Philosopher's Stone for turning base elements into gold, *have* eventually been realized (and, come to think of it, with modern nuclear physics we *have* learned how to turn lead into gold, if only a few atoms at a time). Television, nuclear power, home computers that run at multi-gigahertz clock rates in the bedrooms of high school

[23]W. B. Pitkin, "Time and Pure Activity," *Journal of Philosophy, Psychology and Scientific Methods*, August 27, 1914, pp. 521–526.

[24]S. Lem, "The Twentieth Voyage of Ijon Tichy," in *The Star Diaries*, Seabury Press 1976.

[25]A journey incorrectly given in the story as 120 light years, when in fact it is less than 40 light years.

[26]W. West, *River of Time*, Avalon Books 1963.

[27]S. Lem, "Cosmology and Science Fiction," *Science-Fiction Studies*, July 1977, pp. 107–110.

students, even faster computers that animate our movies and simulate the formation of black holes and galaxies, voyages to the Moon and back—all these amazing developments would be pure magic to nineteenth century science. The ghosts of not just a few Victorian scientists who had poo-pooed the possibility of such things, have watched their reputations eat a lot of posthumous crow during the last 150 years.

My personal position on the question of time travel leans towards the rejoinder made to the skeptic in one science fiction story who, even after having done some time traveling, *still* argues against it by invoking paradoxes. He is sharply rebuked with "Oh, for heaven's sake, shut up, will you? You remind me of the mathematician who proved that airplanes couldn't fly."[28] I subscribe to the optimistic philosophy of the British writer Eden Phillpotts (1862–1960), who wrote in his 1934 novel *A Shadow Passes* "The Universe is full of magical things, patiently waiting for our wits to grow sharper." Perhaps he had a famous saying by the British-born Indian scientist J. B. S. Haldane (1892–1964) in mind, words from his 1928 *Possible Worlds*: "Now my suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose."

Still, even if time travel is possible, the engineering phase will surely be tough going. I am certain that before we see a working time machine, there will be many, *many* episodes like the one described in a very funny, novel-length spoof of academic research.[29] All physicists and engineers who have tried to get some stubborn piece of apparatus to work, apparatus that *should* work and simply won't, will appreciate Professor Demetrious Demopoulos' frustration and will, I am sure, forgive him his intemperate language:

> . . . the distinguished physicist took a step back and, arms akimbo, surveyed the complex and sophisticated machine that was the culmination of years of dedicated scientific research and pains-taking technological development.
>
> "What a pile of ****," he said.
> "Oh, no, Dr. Demopoulos, don't say that!"
> "Well, it is." A sneer formed on the professor's thin lips. "Time machine, my ****. This thing couldn't give you the time much less travel in it."
> "But we haven't incorporated all our latest test data yet," the pretty research assistant reminded him. "These last few adjustments might do it, Professor."
> "Hell, we've been tinkering with it for 2 years," Demopoulos complained.
>
> "We've tried everything and it's all come to dog ****."

[28] R. Heinlein, "By His Bootstraps," *Astounding Science Fiction*, October 1941. As discussed at the end of Chap. 1 (in "For Further Discussion") the mathematician was the American astronomer Simon Newcomb.

[29] J. DeChancie and D. Bischoff, *Dr. Dimension*, ROC 1993.

That scene probably won't actually happen for a long time to come but, even before the practical nuts-and-bolts bugs in the Professor's time machine are worked out, I think some adjustments are called for in our thinking about time travel. I believe that present-day philosophers and science fiction writers are going to have to become knowledgeable about the work by physicists on time travel. It simply won't do any longer for Philosophy Professor X to invoke the grandfather paradox during a discussion of causality and free will and then airily declare them to be 'obviously' incompatible with time travel to the past. And it simply won't do any longer for Famous SF Writer Y to send his hero into the past to kill Hitler as a baby and thereby change recorded history. One might as well keep watching a video recording of the 9/11 destruction of the World Trade Center, in the vain hope that maybe, on the next viewing, the planes will miss.

The principle of self-consistency around closed timelike curves is going to have to become as much a part of the science fiction writer's craft (or else she will be a writer of fantasy) as it will have to become part of the fundamental philosophical axioms.[30] The 'time police,' like the "operatives of the Bureau of Time Exploration and Manipulation" that appeared in the science fiction of Andre Norton (1912–2005), will have to be put out to pasture with the unicorns and telepathic dragons of fantasy fiction. Just as the recent physics literature on time machines has displayed a growing awareness of what science fiction writers and philosophers have had to say on the subject of time travel, so too are writers and philosophers going to have to learn some more physics. Most people can enjoy a good fantasy tale now and then, but the use of 'magic mirrors' to see through time is *not* physics. Such devices were popular and acceptable in medieval times—see "The Squire's Tale" in Chaucer's *The Canterbury Tales*, and later (see Act IV of *Macbeth*)—but good science fiction needs much more than that today.

Time travel to the past is a beautiful, romantic idea, and some words written by two physicists in a technical paper—words embedded in the midst of swirls of tensor equations—show that even hard-nosed physicists can share this dream: "In truth, it is difficult to resist the appealing idea of traveling into one's own past . . ."[31] The appeal of that dream is explained in Ray Bradbury's Foreword to a beautiful little 1989 book by Charles Champlin (*Back There Where the Past Was*). In it Bradbury clearly illuminated *why* we want to go back into the past. It is for the same reason that we go, time and again, to see *Hamlet*, *Othello*, and *Richard III*: "We don't give a hoot in hell who poisoned the King of Denmark's semicircular canal.

[30]Bud Foote (1930–2005), late professor of English at Georgia Tech, wrote (in his book *The Connecticut Yankee in the Twentieth Century: Travel to the Past in Science Fiction*, Greenwood Press 1991) that consistency is simply a well-used plot device: "The attempt of the time traveler to prevent something or take advantage of it [and so causing] the event in question, is so popular and so ubiquitous that it seems to be about worn out." Worn out or not, I believe that plot device to be correct science.

[31]A. J. Accioly and G. E. A. Matsas, "Are There Causal Vacuum Solutions with the Symmetries of the Gödel Universe in Higher-Derivative Gravity?" *Physical Review D*, August 15, 1988, pp. 1083–1086.

We already know where Désdemona lies smothered in bedclothes and that Richard goes headless at his finale. We attend them to toss pebbles in ponds, not to see the stones strike, but the ripples spread."

That's why a visit to the past is so mysteriously and marvelously fascinating. It would let us watch ripples spread through time. Our own visit to the past, in fact, might even be the pebble in the pond of history that starts an interesting ripple or two that will one day sweep over—us! (Take a look at Appendices A and B) Who would want to miss that? Indeed, if modern philosophers are right, if the analyses discussed earlier in this book are correct, you *can't* (didn't/won't) miss it.

I think time travel appeals, irresistibly, to the romantic in the soul of anyone who is human.[32] A time traveler does not exist either *here* or *then*, but rather *everywhen*. For a time traveler passing back and forth through the ages, history would be the ultimate puzzle, a chronicle described in one novel as beginning "not in one place, but everywhere at once ... It might be begun at any point along the infinite, infinitely broken coastline of time."[33] Romanticism doesn't preclude there also being a dark side to visiting the past, of course, as one time traveler from 1989 learns when he takes up residence in 1962. Falling asleep on a hot summer night in that long-ago year, he thinks "JFK slept. Oswald slept. Martin Luther King slept. [I sleep and dream] of Chernobyl ... *I am a cold wind from the land of your children*."[34]

But, I must admit, I personally am more attracted by happier descriptions of time travel. In his marvelous 1996 book *1939: The Lost World of the Fair*—which is proof that there are not enough Pulitzers to go to all the books that deserve one—Yale professor David Gelernter caught just the right spirit in his Prologue: "The best of all reasons to return to the fair is that travel is broadening, and time travel most of all ... The 1939 New York World's Fair is one amazing show. It still stands, undisturbed on Flushing Meadow, just over the edge of time; it would be an unforgivable shame to miss it." Trust me—if you read Gelernter's book, you'll come as close as you can in today's world to taking a ride in a 'time machine'!

The eminent philosopher Sir Karl Popper opens his biography with a wonderful story about his apprenticeship as a young man in 1920s Vienna to a master cabinetmaker.[35] After winning the old man's confidence, the student learned his mentor's great, secret desire: For years the master had been looking for the solution to perpetual motion. He knew what physicists thought of such machines, but nonetheless he had never given up his dream: "They say you can't make it; but

[32]How else to explain the pleasure, for modern children *and* adults too, in watching rebroadcasts of the 1960s animated TV cartoon program 'starring' Mr. Peabody, a nice but slightly stuffy, professorial white beagle. (Don't all dogs wear glasses and a bow tie?) Mr. Peabody, with his brainy adopted son Sherman, routinely travels into the past in the "Way-Bac" machine to see what *really* happened in history.

[33]John Crowley, *Great Work of Time*, Bantam 1991.

[34]R. C. Wilson, *A Bridge of Years*, Doubleday 1991.

[35]See volume 1 of *The Philosophy of Karl Popper* (P. A. Schilpp, editor), The Library of Living Philosophers, Open Court 1974, p. 3.

once it's been made they'll talk differently." Popper's master sounds just a bit like the American writer Gertrude Stein (1874–1946) in her 1938 essay "Picasso," where she writes "It is strange about everything, it is strange about pictures, a picture may seem extraordinarily strange to you and after some time not only it does not seem strange but it is impossible to find what there was in it that was strange." Might we one day say the same thing about time travel?

An alternative point of view can be found in a discussion of time travel via cosmic strings that makes this assessment: "While there is still hope that one day a sufficiently clever design may make building a time machine possible, it is beginning to seem more and more improbable. Like the perpetual motion machines of the nineteenth century, the designs have an elegant simplicity (as well as enormous commercial potential), but it seems that Nature also may abhor them just as much."[36] Of course, at one time it was thought that Nature abhorred a vacuum, but then we learned that she must actually love a vacuum because else why did she make so much of it?!

The theoretical basis for time travel is very different from that of perpetual motion (there is *more* reason to accept time travel as a plausible possibility). And so maybe one day, *just maybe*, the first time traveler will receive a toast such as the one in a story telling us about the arrival of the inventor of the first time machine and his no longer skeptical friend in the Civil War past:

"To you, Mac," I said.
McHugh loosened his tie. "To the Creator," he said, "who has given us a Universe with such marvelous possibilities."[37]

[36]B. Allen and J. Simon, "Time Travel on a String," *Nature*, May 7, 1992, pp. 19–21.
[37]J. McDevitt, "Time's Arrow," *Isaac Asimov's Science Fiction Magazine*, November 1991.

Glossary[38]

Action the integral over a **world line** of a quantity called the *Lagrangian*. When a massive particle is moving at non-relativistic speed through a gravitational field, for example, the instantaneous value of the Lagrangian is the difference between the kinetic and potential energies of the particle. For other types of fields (such as the electromagnetic) and/or relativistic motion in any type of field, the Lagrangian is different. In any case, however, the actual world line of the particle is the one for which the integrated Lagrangian, that is, the action, is minimized. See **least action**.

Action at a distance the direct interaction of two separated objects, without concern for the details of what (if anything) occurs in the region between the objects (see also **field**). Newton's theory of gravity is action at a distance, whereas Einstein's theory of gravity is a *field* theory.

Advanced solution the prediction, by Maxwell's electromagnetic field equations, of radio waves that travel into the past (see also **Dirac radio**).

Anti-matter quantum mechanical prediction (experimentally verified) that all fundamental particles of matter come in two forms (the 'normal' version and the 'anti-matter' version). The positron, for example, is the anti-matter version of the electron, differing only in the sign of its electric charge. The photon, on the other hand, is its own anti-particle. A **subluminal** anti-particle traveling forward in time can be thought of as its 'normal' version traveling backward in time.

Arbitrarily advanced civilization for time travel discussions, a civilization with a technology sophisticated enough to construct a traversable **wormhole** in spacetime. More generally, Types I, II, and III of such civilizations are, respectively, those that can control 10^{13} W, 10^{27} W (the total power output of their home star), and 10^{38} W (the total power output of their home galaxy).

[38] "I hate definitions." (Usually attributed to writer and British Prime Minister Benjamin Disraeli (1804–1881) but, more precisely, they are the words of one of the characters in his 1826 novel *Vivian Grey*.)

—but they *can* be useful

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P.J. Nahin, *Time Machine Tales*, Science and Fiction,
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Arrow of time the statement the time appears to have a direction, that there is a difference between the past and the future. There are several different arrows: the psychological (we remember the past, we anticipate the future), the thermodynamic (organized systems evolve toward disorganization, that is, **entropy** increases as time increases), the electromagnetic (radio waves propagate *away* from their generators), and the cosmological (the expansion of the universe is directed toward the future).

Asymptotically flat if the geometry of a curved spacetime is such that, as one moves ever further away from all matter and energy, the spacetime **metric** becomes that of flat **Minkowski spacetime**, then the curved spacetime is said to be *asymptotically flat*. As a counter-example, the spacetime of a **Tipler cylinder** time machine is *not asymptotically flat*.

Autoinfanticide paradox see **grandfather paradox**.

Averaged null energy condition the claim that the *averaged* value of the observed mass-energy density along the entirety of any **null geodesic** is non-negative.

Averaged weak energy condition the claim that the *averaged* value of the observed mass-energy density along the entirety of any **timelike world line** is non-negative.

Back reaction the tendency of spacetime to resist the formation of **closed timelike lines** (see also **stress-energy divergence**).

Bell's theorem an inequality that either holds or does not hold, depending on whether quantum mechanics is non-local or local, respectively.

Big Bang the singular beginning of spacetime.

Big Crunch the singular end of spacetime.

Bilking paradox what would happen if a **causal loop** were disrupted. For example, suppose a time traveler builds a time machine using plans he received years earlier from a mysterious stranger. He now realizes that the stranger was himself, using the time machine to travel back into the past to give his younger self the plans. A bilking paradox would be created if the time traveler builds the time machine, verifies that it works, and then decides *not* to visit his younger self to hand over the plans. See also **bootstrap paradox**.

Black hole a region of spacetime where gravity is so strong that nothing can escape, including light. Black holes are thought to be created when sufficiently massive stars burn out (see **white dwarf** and **neutron star**) and undergo *gravitational collapse*. A black hole of ten solar masses would have a radius of about twenty miles. Black holes might have been created at the Big Bang singularity and, if so, could theoretically come in any mass and size (a black hole with the mass of the Earth would have a diameter of less than half an inch).

Block universe a spacetime in which all world lines are completely determined from beginning to end (a fatalistic universe). There is no free will in such a spacetime.

Boost matrix matrix formulation of the **Lorentz transformation**.

Bootstrap paradox the puzzle of the origin of *information* on a closed loop in time. The classic example is that of a time traveler from the future giving his younger-self the plans for the time machine the time traveler has just used to visit the past so that he can then build the time machine to visit the past. The time machine plans appear not to have been *created* by anyone! The plans just *are*. See also **bilking paradox**.

Cauchy horizon a **spacelike** hypersurface in spacetime that intersects, exactly once, every **timelike** world line that has no end point. Knowledge of the conditions on such a surface uniquely determines the spacetime at all other points.

Causal loop a time loop containing an event caused by a *later* event that, itself, is caused by the earlier event (see the example in **bilking paradox**).

Causality the metaphysical claim that every event is caused by a prior event. Time travel to the past inherently violates causality.

Chronal regions those parts of spacetime that have no closed timelike curves.

Chronology horizon a (hyper)surface in spacetime that separates **chronal** and non-chronal regions. It is a special case of a **Cauchy horizon**.

Chronology protection the claim, as yet unproved, that time machines and time travel to the past are impossible because of the **back reaction** of spacetime will lead to **stress-energy divergence**. Popularized among physicists as the *Hawking chronology protection conjecture* (1992), Hawking has since admitted that stress-energy divergence is *not* sufficient to enforce his conjecture.

Chronon science fiction name for **Planck time**.

Closed timelike line (or curve) a **timelike** world line of finite length that has no ends, i.e., that forms a *closed loop* in spacetime. A region of spacetime containing closed timelike lines is said to be a **time machine**.

Conservation law physical quantities in interacting systems that remain unchanged are said to be conserved. Total energy, total momentum (linear and angular), and electric charge are conserved quantities.

Cosmic string hypothetical, threadlike spacetime structures with enormous mass-energy and density that may have formed during the **Big Bang**. Cosmic strings may have been initially formed either as infinitely long, or as closed loops, and it is the former that are thought to be physically meaningful in the present-day universe. Cosmic strings do not violate the **weak energy condition** (as do **wormholes**), and they can theoretically create **closed timelike lines**.

Cosmological constant an extra term specifically added by Einstein to the general theory of relativity to keep that theory from predicting the expansion of the universe (which was later observationally found to actually be the case). Einstein subsequently said that his failure to believe the general theory's original prediction of the expansion of the universe was the greatest mistake of his life. The constant (which today is believed to be almost zero, if not exactly zero) appears in Gödel's rotating time travel spacetime as a determining factor in the minimum radius of a **closed timelike line**.

Determinism the metaphysical belief that effects are uniquely determined by causes (this is *not* **fatalism**).

Dirac radio science fiction gadget for sending information at infinite speed, which thus travels backward in time (see also **ultraluminal**).

Dominant energy condition the **weak energy condition** *plus* the claim that the observed energy flux is never **superluminal**.

Electron fundamental particle of mass that possesses one quantum of negative electric charge. *Bound* electrons orbit the nuclei of atoms and plays a central role in determining the chemical properties of the elements and of their compounds. *Free* electrons carry electric current, either in conductors (wires) or through space.

Elsewhen the collection of spactime events that cannot be reached from the **here-now** with a **timelike world line**.

Entropy a measure of the randomness of a system that plays a central role in the thermodynamic **arrow of time**.

Ether a substance once thought to fill all space to allow radiation 'something to propagate through' (as opposed to simply a vacuum). The special theory of relativity showed that the ether is an unnecessary concept because it has no observable effects (physicists argue that if something is impossible to detect, then it is meaningless to talk about it being part of *science*).

Event a point in spacetime.

Event horizon the spacetime surface of a black hole or of a non-traversable wormhole, at which light can *just* escape to the outside universe. It is called a *horizon* because, by definition, an external observer can't see beyond it and into the interior of the hole. To see the inside of a hole you must enter the hole by crossing the horizon (but then you can't get out).

Exotic matter matter that violates one or both of the **weak/strong energy conditions**. Exotic matter appears in the theories of wormholes and warp drives.

Fatalism the metaphysical belief that all events have been *pre*determined from the beginning of time.

Field the concept that if a physical law is local, then it is describable by differential equations that relate what is 'happening' at every point in spacetime to what is 'happening' at its closely located neighboring points. Electromagnetism and general relativity are field theories, for example, described by sets of partial differential equations called *Maxwell's equations* and *Einstein's gravitational field equations*, respectively.

Fourth dimension either time or a fourth spatial dimension.

Frame of reference a spacetime coordinate system.

Free will the condition that prevails when we can *choose* to do what we do. There is no free will in a **block universe**.

Future the collection of spacetime events that can be reached from the **here-now** via a **timelike world line** directed toward a later time (for each individual, the future is what hasn't yet been experienced).

Gamma ray very high-energy, very high-frequency electromagnetic radiation. Gamma rays have frequencies on the order of *ten trillion* (10^{13}) times greater than those of AM radio broadcast radio waves.

General theory of relativity Einstein's theory of curved spacetime, which explains gravity in terms of nothing but geometry. Its fundamental premise is that *all* the laws of physics should appear the same to all observers in *any* **frame of reference**. It is believed the theory will fail when the local mass-energy density reaches a level of about 10^{94} g/cm^3, a density so enormous (the density of water is just 1 g/cm^3) that there is no known mechanism for achieving it anywhere in the universe except in another **Big Bang**. See also **Planck density**.

Geodesic the shortest path connecting two points in space (if the space is spacetime, the world line of a particle in free-fall).

Global in the large.

Gödel universe a spacetime that, unlike the one we live in, is rotating so fast that it automatically generates *closed timelike lines* and thus constitutes a weak **time machine**. In such a universe, time travel to the past would be a natural phenomenon.

Grandfather paradox *the* classic time travel paradox, of a time-traveler killing, while in the past and *before* the time traveler has been conceived, an ancestor directly linked to the future birth of the time traveler. A more direct form of this sort of paradox is simply the time traveler killing his own younger self (called the **autoinfanticide paradox**).

Gravitational field equations a set of coupled, partial differential, non-linear tensor equations, considered to be the most complicated equations in all of mathematical physics. They show how the local curvature of spacetime depends on the local mass-energy of spacetime. The equations are independent of the **topology** of spacetime.

Gravitational lensing the ability of gravitational fields to bend and focus light.

Graviton the quantum particle of gravity.

Hawking radiation the emission of particles (energy) by a **black hole** into the region *outside* its **event horizon**, which results in the eventual evaporation of the hole. This is a quantum mechanical effect.

Here-now the point or **event** (for each observer) in spacetime that separates the **past**, the **future**, and **elsewhen**.

Hyperspace any space of four or more dimensions (for example, four-dimensional spacetime is a hyperspace).

Inertial frame any frame of reference in which Newton's laws of mechanics are true (there are no *acceleration forces* in inertial frames, and so *rotating* or 'merry-go-round' frames are not inertial).

Invariance a quantity that remains the same in any frame of reference is an invariant. Two examples are the distance between any two points on a piece of paper (because it is independent of any particular coordinate system), and the speed of light.

Kerr-Newman black hole a *rotating* black hole, which may (or may not) be electrically charged.

Krasnikov tube a particular spacetime **metric** (or *warp*) allowing **superluminal** travel, with the great difficulty of requiring *enormous* negative energy. Two Krasnikov tubes can be made into a time machine. Named after its Russian inventor.

Least action general principle in physics that asserts the world line of a particle is the one that *minimizes* the **action**.

Light cone the **lightlike** surface in spacetime that, at each point in spacetime, separates the **past** from the **future** from **else-when** from the **here-now**.

Lightlike the world line of a photon (or of any other form of mass-energy traveling *at* the speed of light).

Li mirror a perfectly reflecting, spherical surface that can be used to stabilize a wormhole against energy loops circulating through a **wormhole** time machine (thus creating unbounded energy levels that destroy the time machine). Named after its Chinese inventor.

Local in the small.

Lorentz factor the ubiquitous square-root expression that appears in so many relativistic calculations, such as time dilation, length contraction, and the variation of mass with speed. For example, the mass m of a moving body is not independent of it speed v but rather varies as $m = \frac{m_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$, where m_0 is the rest mass (that is, the mass when $v = 0$) and c denotes the speed of light (186,210 miles per second). The denominator is the Lorentz factor.

Lorentz-FitzGerald contraction the conclusion from special relativity that the appearance (to a stationary observer) of a moving object will be shortened in length along the direction of motion. Many years after Einstein's work, it was shown that the object will also appear to be *rotated*.

Lorentz transformation equations from the special theory of relativity that describe how the space and time measurements of two relatively moving observers are related.

Many-worlds interpretation quantum mechanical view of splitting universes.

Mass-energy the famous $E = mc^2$, the equation behind atomic fission and nuclear fusion weapons.

Metric the measure of the separation between any two events in a spacetime.

Minkowski spacetime the flat spacetime of the special theory of relativity. In this spacetime there is no gravity, no spacetime curvature (hence it is *flat*) and no backward time travel.

Neutron star the end state of a star with one to three solar masses that has collapsed to a density of up to 10^{17} g/cm^2.

Non-Euclidean geometry the geometry of spacetime, whether curved or flat. Spacetime is non-intuitive precisely because it is always hard to resist thinking in terms of high school Euclidean geometry, which is simply the *wrong* geometry.

Null geodesic the world line of a photon in spacetime.

Observer physicist's term for 'somebody' equipped with recording instruments (such as a clock, a pencil and notepad, and the like).

Parallel transport a procedure for moving a vector around any closed curve in a space to determine whether that space is flat or curved.

Parallel worlds simultaneous existence of multiple (perhaps) infinite versions of reality.

Past the collection of spacetime events that can reach the **here-now** via timelike world lines directed from an earlier time (for each individual, the past is what has already been experienced).

Photon the quantum particle of electromagnetism. A photon of frequency f has energy hf, where h is **Planck's constant**.

Planck density the density of mass-energy that distinguishes classical from quantum spacetimes; about 10^{94} g/cm^3, equal to the **Planck mass** divided by the cube of the **Planck length**.

Planck length the non-zero length in quantum theory (about 1.6×10^{-33} cm) below which quantum gravity effects will become important.

Planck mass the fundamental mass in quantum theory (about 22×10^{-6} g), but *not* the smallest non-zero mass in quantum theory.

Planck's constant fundamental constant in quantum theory, h, associated with the discrete nature of quantum effects. (If h had the value of zero, rather than its actual value of about 6.6×10^{-34} joule-seconds, then the microworld would appear to be continuous.)

Planck time the time interval in quantum theory (about 5.3×10^{-44} s) below which quantum gravity effects become important. The time required to travel the **Planck length** at the speed of light.

Positron the electron's anti-particle (see **anti-matter**).

Proper time the timekeeping of an observer's clock.

Pulps the old science fiction magazines, through the 1940s and into the early 1950s or so, published on inexpensive, wood-pulp paper.

Quantum foam see **topology**.

Quantum gravity the yet-to-be-discovered theory that unifies quantum field theory with the curved spacetime of general relativity.

Quantum mechanics the exact physics of the very small (atoms and things smaller).

Quantum theory any theory in which physical quantities are not continuous but rather assume their values in discrete jumps (the size of the jump is the *quantum*).

Recurrence paradox the claim that if you wait long enough, then every system will return to every previous state infinitely often.

Red dwarf small (less than about half a solar mass) star with a very long life (hundreds of times that of the Sun). They are 'cool' stars, with a surface temperature less than 4000 °C, and are thought to be the most common type of star in the universe.

Red shift the *down* shift in frequency of light received from all distant stars due to the Doppler effect induced by the expansion of the universe. The opposite effect is called a *blue shift*.

Reinterpretation principle asserts that negative mass-energy traveling forward in time is positive mass-energy traveling backward in time, and vice-versa.

Reissner-Nordström black hole a spherically symmetric, non-rotating electrically charged black hole.

Reversibility paradox based on the fact that the equations of physics contain no **arrow of time**; that is, they work equally well with time running forward or backward.

Roman ring a time machine made of two or more traversable wormholes connected in a closed sequence.

Schwarzschild black hole a spherically symmetric, non-rotating, uncharged black hole.

Self-consistency the assertion that the events on a closed **timelike** line must never be in contradiction; generally attributed to the Russian physicist Igor Novikov, who with his colleagues showed that it is not an independent assumption but rather an implication of the principle of **least action**.

Sexual paradox a special type of causal loop, where the connected events on a time loop are 'coupled' (pun intended!) through reproductive sex. An example is a time traveler to the past who becomes her own ancestor.

Singularity either a region in spacetime where the curvature becomes infinite and the laws of physics fail, or a point in spacetime beyond which world lines cannot be extended. Singularities of the first kind are called *curvature* or *crushing* singularities, and those of the second kind are called incomplete singularities. The **Big Bang** was a curvature singularity, as is the center of a black hole. In a **Schwarzchild black hole** the curvature singularity is a point, whereas in a **Kerr-Newman black hole** it is an extended region in the form of a ring.

Spacelike a world line on which propagating mass-energy would exceed the speed of light.

Spacetime the 'stuff' out of which reality is built. Everything there is—the universe—is the total collection of events in spacetime. A *flat* spacetime has no gravity, whereas a curved spacetime is the *origin* of gravity.

Special theory of relativity Einstein's theory of *flat* spacetime, which assumes that gravity is absent (gravity is the result of the geometry of *curved* spacetime). Its fundamental premise is that the laws of physics should appear the same to observers in different **inertial frames**.

Splitting universes the idea that every decision causes reality to split into separate copies, identical in every respect except for each of the different possible results of the decision.

Stargate science fiction name for the mouth of a traversable **wormhole**.

Stress-energy divergence the unbounded growth of the **general theory of relativity**'s measure of the density of mass-energy in spacetime.

Strong energy condition the claim that gravity is always (that is, locally) attractive. A traversable **wormhole** violates this condition.

Subluminal slower than light.

Superluminal faster than light.

Tachyon a particle (hypothetical, so far) that always travels faster than light, so its **world line** is always spacelike.

Temporally orientable spacetime any spacetime in which the direction of time at every point agrees with the direction of time at its local neighboring points.

Tensor mathematical generalization of the scalar and vector concepts. Einstein's **gravitational field equations** are tensor-differential equations (for example, the metric tensor contains information about the curvature of spacetime), whereas Newton's and Maxwell's equations are vastly less complex vector-differential equations.

Tidal force force experienced by a non-point mass (one with spatial extension) in a non-uniform gravitational field. Such forces tend simultaneously to compress and stretch spatially extended masses. Black holes and wormhole mouths can generate enormous tidal forces on extended masses as small as a human body. Interestingly, the *more* massive a black hole, the *less* severe its tidal forces are at distances outside the **event horizon**. However, no matter what the black hole mass is, the tidal forces are infinite at the central curvature **singularity**.

Time dilation the altering of the rate of timekeeping by a clock, either by motion or by gravity.

Time machine (in the weak sense) a machine able to traverse **closed timelike world lines** inherent in a spacetime (e.g., a rocket in Gödel spacetime) but unable to *create* such world lines; (in the strong sense) a machine able to manipulate mass-energy in a finite or compact region of spacetime in such a way as to *create* closed timelike world lines.

Time police story characters in science fiction charged with the (unnecessary!) job of preventing time travelers from changing the past.

Time warp science fiction name for a **time machine**.

Tipler cylinder an infinitely long cylinder, made of super-dense matter, rotating so fast around its long axis that it warps spacetime enough to create closed timelike lines that encircle the cylinder. It can be used as a strong sense time machine to travel both into the future and into the past (but *not* to a time before the creation of the cylinder).

Topology the structure of a *space* (including *spacetime*) without regard to a metric. That is, topology is concerned only with how a space is connected together and not with how far apart points in the space are. Topologists consider stretching or compressing a space to be irrelevant, just as long as one doesn't *tear* it and so put holes in the space. The simplest topology is that of a *simply connected* space, in which if you construct any closed surface that lies totally in the space around any point in the space, then every other point inside the surface is also in the space. A space with a hole in it fails this test, and so is said to be *multiply connected*. A *quantum foam* spacetime has a multiply connected

topology. The classical spacetime of general relativity is simply connected *until* the appearance of wormholes.

Twin paradox the conclusion from special relativity that a clock's rate of time keeping slows with motion.

Ultraluminal motion sufficiently **superluminal** that mass-energy appears to travel backward in time (see also **Dirac radio**).

Uncertainty principle the statement in quantum mechanics that says certain pairs of quantities cannot simultaneously be measured with arbitrarily small error. The position and momentum of a particle are one such pair, and energy and time are another.

Vacuum fluctuation the particle/anti-particle creation and annihilation processes allowed, even empty space, by the **uncertainty principle** of quantum mechanics.

Warp drive science fiction name for the propulsion mechanism of a faster-than-light spaceship, now commonly used by physicists, too.

Weak energy condition the claim that the observed mass-energy density is always (locally) non-negative. Quantum mechanics predicts (and it has been experimentally confirmed) that there are exceptions.

White dwarf a burnt-out star with a mass less than 1.4 solar masses, of planetary size with a density up to 10^7 g/cm^3. The ultimate fate of our Sun.

World line the trajectory of mass-energy in spacetime.

Wormhole a spacetime structure (violating the **weak and strong energy conditions**, if traversable) connecting two points of the same spacetime (or even two *different* spacetimes) with a timelike path that requires less time to travel along than does a photon traveling *outside* the wormhole between the two points. A wormhole is *traversable* if it has no **event horizons**, and such wormholes can apparently be made into a **time machine** (sometimes called a *time tunnel*) using a time shift (see **time dilation**) between the two mouths of the wormhole *unless* quantum effects forbid time machines (still an open question).

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The Unveiling of the Hidden Knowledge and the Secret Space Program

The Unacknowledged Special Access Programs: Advanced Technology, Mind-Control, Spiritual Power and the Corruption behind Closed Doors

By Aug Tellez

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Introduction

The following is first-hand testimony from an operative of the secret underground military projects who also has familiarity with the breakaway civilization above and below (within) Earth. These civilizations utilize advanced technology to extend the length of their lives and enhance cognition beyond what is conceived of in today's society.

I was brought to the underground bases as a child as part of an experimentation program to test the population for various blood-groups and personality traits that would be of use to certain factions of the military in ways that would serve to preserve and strengthen humanity's outlook in the future.

These tests involved everything from combat training to sensory deprivation based emotional-mental endurance, and introduction to the highly advanced application of esoteric knowledge.

To clarify, I am bringing this information to you as part of my assistance in the overall unveiling of the hidden knowledge of the ages of humanity related to these secret projects as well as the true galactic history of Earth, humanity and man-kind. These projects are officially (unofficially) known as "unacknowledged special access programs". The unacknowledged aspect means that there is no formal acknowledgement of these programs without a need-to-know basis. There is no paper-trail, no disclaimer, no formal authorization or internal publication outside the programs themselves. The classification of these programs also generate a rather strenuous situation regarding funding and secrecy but this is done for the benefit of humanity. There are secrets and manipulations that can be seen as a threat but this is all tied together and so by releasing the secrets that are part of the defense we would be inadvertently exposing the public to the threats themselves. Now is the time where we are reaching a point where the public is ready enough to handle the basics of this information regarding the secret projects and the galactic history of Earth and humanity. This is also out of a necessity to preserve civilization for if we wait any longer we may not find the same opportunity again.

Getting This Out Of The Way

I am writing to you from the perspective that I am not certain just how far from completing my mission I am. I write to you today in order to bring to you many personal experiences from the viewpoint of an operative of a select ultra-military secret society.

The utilization of such an operative is not glorified, pleasant, or entirely righteous. This story entails sanctioned and guided acts of extermination, ritual abuse, the use of yet to be announced advanced technology. There is unfathomable corruption, the thirst for power and spiritual knowledge that has been protected throughout the course of the multiple civilizations that have preceded this one and will continue to be maintained into the future of this civilization.

Psychic Operation

I was utilized in psychic-operation amongst other areas.

This was used during certain aspects of training and conditioning to enhance training and conditioning in the bases using advanced technology. Some of this includes what would be viewed as traumatization by those without the training and conditioning. There is a fine line between training and conditioning and abuse. Part of this disclosure is related to how this line may have been crossed in certain situations and regarding mass-mind control upon the population. There are other aspects of travel, viewing, reconnaissance and research that will likely be explained in another release.

In order to heal I have to tell the world. You can help. This is happening right now in the underground bases and around. It’s not a joke. Your family is at risk. Your future generations are at stake. There is conditioning to encourage those involved to believe they are performing a duty for humanity. Sometimes they turned us against each other, but those grudges were never truly of the heart, but the mind.

A Light for the Others

What I hope to achieve with this is a smoke signal for those who have also been involved and question whether their purpose has been fulfilled or falsified for the protection of a corrupt system that intends to neither benefit the whole nor repay the individuals involved for their time, energy, and lives.

Multiple explanations can be summoned to describe the reasons behind the necessity for the training we have endured, the missions we have completed, and the control mechanisms we have both assisted in establishing as well as suffered from the backlash of. Ultimately, it is of my belief that all that was done was done for the good of humanity, even when we were not sure of the intentions of those in front of us, to the side of us, or behind us compelling us forward with the command to complete each objective.

This is not so much a panic or cry for help as this is simultaneously a call to awaken and a signal that humanity may have avoided complete disaster but is not out of the woods yet.

Natural Security

My experience is far too vast and I have seen too many succumb to stress from the realization of the truth of this reality to consider my own suffering to be enough cause for my denial of the necessity of these programs. Humanity has been protected and at a great cost to those who have been on the front lines, both in mind and body and spirit.

There are many who will have concerns, doubts, as well as reservations about what I am about to reveal and if I offend anyone then know that my intentions here are to assist in unveiling the truth. The truth can be harsh when one has been held back from the true nature of existence for so long. The way of life can become so fragile and artificially constructed on impulse and mystery that the harshness of the truth acts as a great catalyst for spiritual growth which allows us to elevate ourselves to a new perspective. Prepare yourself for such harshness, prepare yourself for growth and elevation, and prepare yourself for the mystery to simultaneously resolve and increase in intensity and magnificence.

A Balance of Mystery and Truth

Mystery has been a way of life for Humanity for so long that when a great mystery is converted to truth some seem to feel that a portion of existence dulls and loses the luster of exhilaration. This story is quite the opposite. The more that the great truths of this reality were discovered and revealed, the more complex and mystifying life became. As well, the more empowering and complex experience becomes, the more self-control one must develop in order to regain a harmonious way of relating to one another, the self and the universe. Harmony is key, balance is everything and there is a light within that represents the piece of our self that reflects the utmost power and brilliance of all existence.

Chapter 1: The World Situation

What is happening?

The Mind Virus

The main reason for this disclosure is to inform humanity of what can be referred to as the “mind virus”. This is a viral infection of the holographic system which consciousness operates through. There is a complete backstory of this virus in the history of this civilization and how society has been plagued for centuries if not millennia. The basic idea is that this virus operates through consciousness and can be transmitted through electromagnetic waves.

The virus contains an etheric form which can manifest as a kind of crystalline nano-tech on the physical plane and this is a form of synthetic sentience which feeds on the low frequency bio-emissions of sentient life. Human bio-emissions contain energy and can act as a carrier for information and living essences. This technology requires low fre-

quency bio-emissions because that is the nature of the design as a kind of synthetic bio-weapon whereby the goal is entrainment and enslavement. As well, the specific nature of the sentient nano-technology and the counterpart etheric holographic form is only capable of converting the low-frequency bio-emissions into energy as the higher-frequency bio-emissions require more energy to contain and synergize with and this would render the entire process of leeching energy non-productive.

This is essentially a synthetic intelligence that operates through scalar and holographic living bio-emission fields and hijacks electromagnetic emitters to position itself within them acting as a parasite to a host. This is said to have been present around this civilization for some time, waiting until there was enough technological advancement so that spreading across the entire civilization in a short amount of time before discovery would be possible. This is through the media, internet, and radio systems.

The physical counterparts are microscopic nano-technology parasites functioning as individual units to a hive mind similar to the mycelium of fungi in the field of mycoscopy. The individual units act as parasites serving to infest and deliver nutrients to the hive from each host.

The Vampire Effect

This is the nature of the parasitism that has been present throughout the ages of this civilization feeding on human suffering and relying on the cover of confusion and misdirection to survive.

There are processes that have developed that assist in the infection and co-inhabitation of the parasite entity within a human vessel utilizing the human as a host. This effectively utilizes a frequency ‘net’ within the auric field of the human to limit bio-emissions and emotional-mental processes to produce just the psycho-etheric patterns that the virus can sustain itself within and through.

This is no different than the way candida can infest a human digestive system and the human will experience cravings for beer, candy, carbs or other foods that contain the sugars, yeast, or carbohydrates that will break-down into nutrients that are the most nutritious for the candida fungus. These foods are *not* most nutritious for the human body. Yet the human body will withdraw and crave these foods in greater amounts until the fungus is swept clean from the digestive tract through probiotics, fasting, flushing, cleansing , detoxing, and even exercise as lactic acid from physically strenuous activity released from the muscles has been known to help destabilize and remove this fungus. Why is it that the individual will crave these foods that are not the normal food intake? Because this candida fungus can infest the host and produce enzymes which generate a chain-reaction which leads to the chemical signals in the brain producing the sensation of extreme hunger or cravings for just these foods which will benefit the fungus.

The same process occurs with this psycho-etheric parasite, except the foods of this parasite or lower emotional bio-emissions and this is through lust, hate, angst, jealousy,

feelings of hopelessness, lack of self-worth, spiritual degradation, addiction, and generally all that equates to a lack of self-awareness.

Whether or not this is the direct intention of the largely microscopic entity is for the most part unknown, and this is as well similar to candida. The candida fungus is not said to be a 'mean' fungus that wants us to be hungry and craving beer and sweets all the time because it likes to ruin the human body, the daily routine and the focus of a clear mind. This is simply the way the parasite has grown to operate within a niche of breeding itself through the digestive tract of larger animals and through this the unaware and infected human suffers greatly. Even those who are unaware and not infected can suffer because of the way the behavior and thought processes of those who are addicted to these foods can become distorted.

The lack of self-control over food intake is synonymous with the lack of self-awareness and self-control over lower bio-emission expressions of the spiritually degrading behavioral patterns that become routine for the psycho-etheric system of the infected human. Ultimately, this is all about energy. What benefits the parasite that seeks to gain energy by leeching instead of self-guided production is going to take away from the host that is being leeched from. As such, any energies, food intakes, or spiritual activities that cleanse and enhance the personal power of the individual will automatically reduce the parasite's ability to feed by the very nature of the energy systems. What empowers the individual, empowers the self and develops self-control, what develops self-control contains one's energy and reduces the likelihood of one's energy being leeched. This is similar to energy vampires in human form and this goes with the understanding that these are humans or non-humans who have been entirely overtake by the parasitic consciousness and cannot sustain their own auric fields without having to pull from the energy of humans who do generate their own aura or bio-emissions.

The vampire effect relates to how a person can be leeched from only to a certain point. Once the process surpasses a certain critical point then the individual becomes similarly engaged with only the lower bio-emissions as higher-frequency bio-emissions would then become harmful. So in essence, when the vampire feeds too much on one individual, then that individual becomes a vampire themselves.

Sub-Human Entities

The humans are utilized as hosts and energetic sources in this bio-emission battle while there are other classifications of bi-pedal organisms that appear to be human but are not human. As well there are bi-pedals that are non-human entities entirely.

Human-Hosts, Replicants, Synthetics and Carriers

The human hosts that are entirely vampirized by these entities become walking carriers for this virus and are effectively human in physiology but there is more to the human than just the physical body. In these individuals, that energetic component of the human is removed and replaced with the synthetic energy of the hive-mind organism.

There are replicants which are a form of clone, along with synthetics. These beings are cybernetic bi-pedals similar to humans but their energy is too not from an organic biological matrix but a technologically propagated synthetic soul-matrix. The hosts are here according to their agenda to subdue and feed off of the bio-emissions of the human race, although there are no absolutes. The agenda is not always so clear within the various groups who often have a mix of bi-pedal operatives. There have been plans to form of a salvation timeline because the only way to keep the whole process going is through a negation of degradation of the human race as this may close out this timeline forever.

Those with human organic soul-matrixes would simply transport into the next available universal time-stream or harmonic, while those with synthetic matrixes would have to technically travel to the next harmonic using a passageway otherwise they would remain here throughout a zero-point collapse and this would be synonymous with entering the abyss with no viable passageway out until the entire universe is brought back to one organism again.

This is also the process that is described to explain what happened previously as there are 7 harmonic temporal layers of the universe meaning everything is contained in a multitude of 7 octaves similar to light and sound frequencies or harmonics. And so there are 7 civilizations or 7 parallel time-streams and humanity passed through these to get to the last three where the physical forms are located. These are, from the higher to lower, Gaia, Tara and Terra. We are on Terra and if the information I was given is correct then we are currently on a transitory timeline located around Tara where people are noticing changes occurring and multitudes of aspects of the time-stream disappearing and changing simultaneously. Tara is where the last universal harmonic was left through a collapse of time and consciousness into zero-point and this resulted what was termed “the lost souls of Tara”. These are the discarnate souls of the previous civilization that could not travel to the next harmonic and remained without a body in the abyss. Thus they have plagued this plane since then, since ancient times possessing and driving humans to madness and there are explanations that this is the original passageway for the parasite into this universe. This event, the consciousness collapse of Tara would have acted as a fracture in the over-mind of the species generating a kind of cosmic schizophrenia and enabling all kinds of disharmony and distortion described in the previous sections.

The solution to this was described as a healing process that is taking place to purge the virus and that this is painfully similar to the human body purging a sickness however there are methods to promote healing and reduce suffering and confusion however people must contain themselves and their energies and strive to know themselves otherwise they will not be in control. This virus feeds on fear, confusion, spiritual degradation and the energy from degrading acts, lust, addiction, sexual misery and whatever fashion a human can be made to bring the bio-emissions of the energy centers down to a low enough level where co-inhabitation can be formed with an entity that has no access to the higher levels of self-awareness, higher-consciousness, love, or the universal spiritual experience that the balanced human is capable of.

Genetic Manipulation

There are explanations that there are genetic modifications taking place now to possibly preserve this civilization and that there were ancient genetic modifications made to induce a sense of stupor, worship, selfishness, an inability to more easily comprehend the higher spiritual awareness and the occurrence of time and consciousness and other spiritually and consciously limiting aspects. Part of this explanation is that holographic consciousness itself is a kind of limited result, a shadow effect resulting in the presence of the higher-dimensional essence of the soul which is more or less constrained by the body. An extension of this is that the entire holographic universe is a kind of false-light system designed to bend the original liquid etheric light of the soul and spiritual awareness into a rotating, recurring format which ultimately converts the original spiritual essence into an energy generator for entities that are entirely holographically represented. The souled human in this situation is a being who is originally from outside of this holographic projection.

The Ego Mind

In this view, consciousness is the ego-mind which is the false-sense of self, not to be confused with the shadow self which is simply the counterpart of the aspects of the self that we consciously agree with and are aware of in daily life. The shadow self is a result of having limited holographic consciousness and the ego-mind is projecting that limitation of consciousness into the shape and image of a self that is only a figure-head for the real individual essence which is spiritual in nature and immortal.

This Time is about Healing

Everything that is happening now is to motivate people towards healing and unification. This is not about a hive mind mentality where individuality is pushed out.

> "The best I can do for you is become your enemy."

There is a saying that represents the concept that the most beneficial role a person can play in helping one to progress is to challenge them and give them the opportunity to rethink their strategy and in turn improve further with each interaction. This may seem paradoxical but it is effective and explanatory. What we are facing is the greatest challenge humanity has yet to face. This is the unknown, the final frontier, the mind. The mind is our challenge.

There will be more on this later and in other publications but there are indications that the physical embodiment of the human has been altered to introduce implants, genetic modification, susceptibility to disease and ultimately fear-based programming of the brain. Without going further into this prematurely, the lower aspects are at odds with the higher aspects unless we as the midway come forth to mesh the two together in equilibrium. Until then, there is chaos, lack of self-awareness, and suffering.

There are many possible futures converging at this time. There are some less than favorable paths and there is the opportunity to merge with a very powerful path for

humanity. This all comes down to how people will cope with information that takes them outside their comfort zones and eventually changes their view of mundane reality forever.

If people choose violence and lack of self-awareness by ignoring the spiritual aspects then that is what reflects into their life experience. When people develop a higher sense of self-awareness and spiritual harmony they can reduce the suffering and reconnect with the lost aspects of our spiritual identity for the first time in the publicly accepted version of recorded history.

There is technology that can change the world and there are great truths which can enable people to know themselves in ways that they never thought possible. Everything is at our fingertips and so we must come together as this is the way we solve the problems and cure the dysfunction.

Healing Through Unity

In various research projects the conclusion of how to heal this spiritual rift was by exposing each other, to each other. When we are all together, aware of each other and our selves, united in the goal of bringing higher-awareness and spiritual harmony then we can observe and acknowledge when one is slipping into chaos or disharmony. When this occurs and we are in proximity to each other in a healing circle or a kind of social unification then the members of the group at large can work together to pull the chaotic one back into harmony towards the group. The group of healers united together in like mind, spirit and body is too strong to be overtaken by the parasite. So when one individual at a time is faced by this problem the whole group can come together as one and assist in healing the individual by pulling them back to reality, back to wholeness and back together with the group. This is literally how the situation is solved in all realities and a breakdown of this feature of society is how the dis-ease proliferates.

Underground Bases

The active aural research program is part of a process to simultaneously verify as well as initiate and demonstrate controlled insanity/sanity.

These programs utilize the deep underground military bases to perform psychic and psychological research experiments on non-consenting youth and adults as well as consenting participants.

There are various means of generating the illusion of consent or even lack of consent and this is all being monitored and handled by oversight authorities.

These operations are directly related to the identification and understanding of the mind-virus and all weapons, defenses, and resistances known to man.

Cloning

Advanced technology is used to transfer consciousness from one cloned body to the next so that a continuous study can take place before, during, and after the death experience of one individual. More will be explained on this later, however this is through

the use of advanced supercomputer systems that can function to entangle and then transfer the electromagnetic consciousness of the individual so that they are ‘remotely activated’ within a cloned version of themselves via a ‘brainchip’ (brain to machine interface: cybernetics).

Celebrity Cloning

Celebrities at the cloning center would like you to see what is really going on behind the scenes which involves trauma-based mind control, heavy technological programming and complex layers of influence throughout their life.

Initial Explanation

Many celebrities, entertainers, athletes, musicians, models, writers, producers, actors, all kinds of people from various industries are silently brought to the cloning centers for pay-to-play sessions.

They asked myself and others to pass the message on to you and that you would have to look for the signs and symbols in their media in order to see their hinting at these events.

The situation is heavily controlled using advanced monitoring technology and brainwave/EEG cloning technology. This is technology that can read the brain and determine what the mind is anticipating or speculating upon.

Their reputations are used as leverage as well as their safety and comfort. The level of programming and mind control experimentation that takes place makes it easy to manipulate a person’s brain into regressing into a state of trance that lacks the ability to remember or clearly organize experiences regarding the cloning centers.

Cloning Centers, Underground Bases

Deep underground military bases, 3 miles below the surface, are used as laboratory centers as well as a completely stocked underground city-base. These are connected with high speed electromagnetic drive pods.

Individuals are transferred to the brain through an extensive cloning and temporal body transfer process. The electromagnetic shell of consciousness within the brain is relocated to the body of a compatible clone and various training, conditioning, programming, experimentation, or pay-to-play experiences take place.

Programming

All individuals are programmed to various degrees in order to maintain control and secrecy over the situation. This programming involves very advanced technology, trauma-based mind control, and energetic attachment via beliefs and emotions.

Experimental Operations

These bases were also used hand-in-hand with military operations which were geared towards discovering and controlling all aspects of the human mind.

Genetic Engineering

Experiments involved genetic engineering to produce soldiers, psychics, hybrids, and others that would be able to carry out operations. This leans towards MiLabs and the military faction's experiments which go beyond the basics of cloning.

Immortality

The initial research included the goal of physical immortality. In many ways it can be said this has been achieved, however there are side-effects and difficulties.

If one does not activate their higher consciousness, then the effect of time dilation causes the conscious mind here to reach limitation points in experience.

What has been termed "blank slate/state" technology has been used to 'reset' the perception of time through memory in order to keep a continuous progression viable for the conscious mind. Without this the unconscious and the conscious mind merge.

This begins involvement across time with advanced technology that can operate on the soul level or the conscious mind's level of access to the unconscious and soul-memories. The Universe instantly creates a cosmic backstory based on the conscious-mind's access to the unconscious. By controlling the conscious mind's access to the unconscious the entire backstory of Humanity can be altered and new connections can be bridged in the future.

Earth is essentially a time-ship through which consciousness ascends towards higher states of awareness and self.

How did it get to this?

After WWII when the United States war-faction firebombed Germany and melted many of the inhabitants of the cities into sludge in the bomb shelters and streets of the cities, a group of NAZIs traveled to Antarctica.

Russia noticed the movements to Antarctica and the United States sent Admiral Byrd up with 3600 marines, planes, a battle cruiser and smaller vessels. They returned in defeat and only a few words were mentioned in regards to what actually happened and how they were defeated.

The rumors spread and words of gravitic drive craft, and undersea or under-ice bases originated from this encounter.

From what we were informed as well as directly experienced, this was the ice-base in Antarctica where an underground base was found already constructed with very advanced technology.

Here, cloning was deployed along with mind control and temporal manipulation technology.

Soon, cloning was offered as a way to avoid assassination as well as to prolong and protect the original body in daily life.

After that, celebrities and politicians were replaced with programmed clones who could carry out the orders of the NAZI faction.

This was the beginning; the groups utilizing this technology now are no longer confined to the NAZI faction.

The groups you see today, in control of these operations, are considered MiLabs, secret societies, think tanks, military factions, and other control groups.

Deeper Meaning

The individuals that have been cloned are given very in depth views of the way this society functions and the source of power and change in the Universe. Many individuals are present here from what would originally be another “time” or “timeline”.

There is a possibility that this notion is due to inserted memories and traumatization although until all the information is released we will not have a definitive conclusion.

As of now it is a possibility that these individuals are from another time that goes beyond our comprehension currently.

It may even be a possibility that these individuals have come from ALL of time looking at the very far past and into the very far future of Humanity.

These are the kinds of notions involved with the experiments taking place in the underground bases and military operations.

What is next?

Share this information with those you feel are ready to know and help Humanity come to terms with our journey here and what is going on in these kinds of experiments and take responsibility and power for our own existence.

We are in something that can be called “The Unveiling of The Hidden Knowledge”. This is a cyclic process that takes place to advance a civilizations knowledge of existence. As part of the civilization moves into higher advancement another aspect may lag behind. Either the future will slow down, or the past will speed up. We are experiencing the past speeding up and all the events that have taken place to influence our civilization are coming to light. This is as much a natural cycle of consciousness as it is the eventual revelation of secret knowledge and the particular connection to the secret projects.

Those brought to cloning can use their free-will to state their lack of consent to violence and harm and then live in commitment to that by not harming or accepting violence in their lives. The Spiritual Law of Harmony rules in all planes and dimensions.

Chapter 2: The Awakening

Chapter 2.1: The Machines of All Time and Space

There are machines that are capable of accessing genetic memory and unveiling what can only be referred to as the experience of awareness or existence in between the physical planes of each time or each physical life experience.

Even if they are simultaneously occurring moments of a transcendental nature, there is still an illusory ‘space’ where there is perceived separation and through this there is a perceived ‘space’ that is in between each existence.

Re-Creating The Kaleidoscope

This space is only perceivable when viewing from the physical perspective, like seeing the spaces between the angles of a kaleidescope only when viewed through the lens and similarly, technology can be used to recreate what this kind of illusory space might look or exist like in between the multi-dimensional realm of the continuous experience stream. Through this, these ‘hypothetical’ in between spaces that are understood as only illusory productions of biological consciousness, can be generated through advanced technology with the capacity of recreating that kaleidoscopic view of which the human biological perspective is only a small fraction or even fractal.

By recreating this biological perspective, they can recreate the illusory spaces in between planes and through this they can literally access and experience what are stored in the DNA as the experiences of existence beyond the physical limitations of consciousness and into a multidimensional experience of time and space.

All becomes a never ending sea of consciousness, however this is the given. The trick is to take from this sea of consciousness and slice it down into conceivable chunks from which you can reintegrate a previous personality or identity and continue on a stream of consciousness that would otherwise be tossed to the cosmic wind like fractal stardust as the sands on the beach of hyperspace.

Sand-Castles of Time

We are effectively building sand castles out of these sands of time that would otherwise be swept back and forth into and out of the ocean of life and the universe only to momentarily wash up again as the identity which we once knew.

There is technically nothing wrong with either view, because then, the spaces between each million year occurrence of just so happening to wash up again as you, would be imperceivable because they are only there to be seen when you are you again.

We’re Waiting For Ourselves

Yet, if there were some who had attained the awareness of the true nature of reality and were standing there on the beach waiting for the rest of their cosmic family to come

to shore again, it could be perceived as waiting the majority of the time for a very small occurrence and then being alone again up until the kaleidoscopic fractal inverts itself to the point where everyone now is standing on the shores of the sands of time rejoicing and meeting with each other.

The Goal of Two Societies

My goal in coming to you people on the surface of what is called “Earth” is to help assist in the process of bringing the two societies together, one who’s been waiting for thousands of millions of years, and the other who has no idea that they’re even late (or very on time).

You see, those are the only two situations where there could be even the possibility of perceiving such an injustice as experiencing the pain of loss or misconstrued identity in this universe. It is as if two families met at the cross-roads at different angles, and while one waited for the other to arrive, they could merely supply themselves with glimpses of the ruins and remnants of the evidence that the other civilization existed at any one time.

This is not how life must be and this is kind of like a cosmic waiting game of hide and go seek our two mirror civilizations have been playing with each other. One who’s highly technologically advanced and the other who is more or less the spiritually advanced of the two.

Both of them have a unique view of the universe and they are both only complementary to each other as a whole. The more they sat around and waited for one another, with one leaving the clues that the other would find and even switching roles sometimes in different ways, they became even more and more complimentarily associated as the very essence of experience they seem to be missing more and more is the experience of one another.

So as we perceive these as being great losses or great gains of time and culture we are really only remembering ourselves and coming together as a unified existence that once met upon the surface of Earth as a single family covering the entire harmonic spectrum of the Universe.

And that should be the goal of any progressive, any one pushing a new culture or an old culture, anyone looking to teach the young and protect the knowledge of the old, while also protecting the innocence of the young and perfecting the age-old knowledges that have defined our presence in reality.

Our Forgotten Other Half

One could even say we’ve sometimes gone off the deep end, leaving ‘land-minds’ of sorts to process the information that would be present when we are gone. Of course, what we could’ve found when this occurred, is beyond anything we could’ve ever expected and that is the true nature of the complexity of creation and existence. That everything follows the cycles of creation and destruction, however, the memory of everything that has been created can always be accessed (depending on the beach) and there-

fore the creative aspect is legitimate, yet it is the destructive aspect that is illegitimate and illusory.

Yes, through advanced technology this can be proven in ways that can be verified and transmitted using advanced technology, since that is how we like to verify things these days. There is, of course, a human looking at the screen, the read out, or the situation from a physical perspective to verify the verifications.

All Is But An Illusion

There is a notion that there is only one civilization, one society, in actuality that has been chasing itself through time. That we cannot actually find the same place and the same time where both meet because we are each other from different perspectives. We can only get a mirror where this is possible, or an 'hyperdimensional' internet channel where we can stream one's consciousness in from the other reality and interact with them through that here in this reality. Thus the two civilizations can achieve the experience of their own civilization and the other civilization by merging with one another but only through a remote contact, just a relay, not an actuality.

The harsher, darker side of this is that any civilizations between then and now that we did happen to meet that proclaimed to be "the one's" we have been waiting for, and in essence our darker or lighter halves, are actually the impostors who exist entirely apart as a sub-set and have taken a liking to trying to trick the reality out of one of the other civilizations.

Of course, if these are another form of being altogether, and this is all brought about through an interplay of consciousness and deviations from an original core reality, then all will resolve itself when that core reality is alone again. This indicates that all realities will either move closer and closer to the core until they unify, or farther and farther out until they transmogrify beyond recollection.

Life Itself Is The Highest Illusion

That hyperdimensional internet channel that is created out of advanced technology to merge the parallel realities (rather distastefully and maybe disastrously at times) allowing different civilizations to interact with each other, well this has been created using technology.

But then it was discovered that this is the ultimate nature of DNA. That this was 'invented' similarly as a higher-dimensional internet so that various natures of different planes and dimensions could interact with each other and experience the richness of life.

The universe becomes more like a living arcade game then, where people come from all over the galaxy to 'plug in' to human experience and figure out what it means to be physical, human and on Earth.

This does tie into the larger nature of reality, of star-races, and of time and consciousness that is often reversed according to how things seem to play out in physicality. We

are moving through time, but just because we are moving one way, does not mean that others could not be moving the other way.

We have to live our lives with meaning knowing that the message we pass on, the duty we vow to accomplish and ensure is meaningfully connected on either end to the passage of the past and the power of our ancestors to the function and knowledge of the future creating a clear passage between the realms, the generations, and the ends of the universe. This is what literally ties the universe together, and the mind if each individual. This purpose is contrived when not carefully shaped within and so we must help all who seek purpose learn to become the blacksmiths of their own destiny through the temperance of desire or temptation and the discipline of developing strength and maturity where there was once weakness and naivety.

Once we know this is our duty, this is what we seek to achieve and this is what is done, then we can become part of the universe forever. Of course, this may only be temporary in the larger view of things.

Chapter 2.2: The “Awakening” of 2010

In 2010 I was “awakened” at an event involving hundreds of people that play various roles in this society, the secret society and the breakaway civilization. This also took place across times or planes of reality.

During this event I was informed of the situation on Earth beyond the informational barriers that were previously in place to limit knowledge to only what is required for specific operations. I was essentially “informed” of the entire situation as much as the mind could handle this.

As this was occurring, the team that was updating me on the status of Earth was being informed of and given information regarding changes in the future. In short, interviews, posts, and releases that I have since made and will make in the future were touched upon. Quotes were given from the blog and interviews which were jokingly acknowledging verbal mistakes at the pronunciation of names, new perspectives and interpretations and more. As they were informing me, they were creating the future reality where this work takes place. That is the basis of this layer of the operations. They are creating the future person by person, layer by layer.

Memory Suppression

My memory was unsuppressed and all the traumatic memories and experiences were unveiled to me. This was almost as traumatic as the initial experiences themselves

although precautionary steps are taken to ensure the safety of the individual. There are teams of highly competent individuals of all kinds with professional backgrounds of every field imaginable.

Throughout my entire life I have had memories of experiences, at this event I was informed what the experiences meant and what was actually happening. I've had memories of underground bases, cloning, stargates or interdimensional gateways, advanced technology, non-human or programmed biological entities, sacred knowledge and experiences, the power of the mind, and breakaway civilizations. Most of the time we are conditioned to believe these are past lives or experiences in another reality so as to enable continuity of operation.

Life and Consciousness

From my perspective and the perspective of others, we had reached the 'future' and had been sent back through the utilization of advanced technology and cloning to return to this time and inform others of the possibilities.

The True Human Potential

This is so far beyond what anyone can accept or comprehend fully that humans with an emotional, mental and physical aspect balanced as one is literally a cosmic reflection of the entire universe at once. This is the closest thing to a "god" in the flesh. And be sure, the entirety of this rests on the behalf that the man is protective and helpful. That the woman is nurturing and loving. That is the point. "god-man" does not mean a warrior who destroys everyone and anyone in his way getting what he wants. Nor does it mean some lusty and vampiric form of energy or mind control game. "god-man" means the love of the universe, the power of the body and mind, the peace and calm of the ultimate stillness all in one.

This power is in human DNA, originally so. And so this is awakened through walking the middle path of neutrality and 'splicing' the timelines down so that neither one nor the other gains the power of the individual. Through this, the individual creates their own power, right on the spot, without having to lean to one extreme or the other. This is like a cosmic, temporal balancing act with emotions and mind. Where we give our energy is created in the universe in the form of many productions and effects. If we are simply thinking in an imbalanced manner then we are producing timelines and side-realities that exist in the etheric realms that we can't see and these realities will reflect our inner imbalance. So then when we are balanced in our energies we are not creating one or the other side of divinity, we are literally creating the whole universe, cleaving down the middle and producing both sides of divinity or eternity equally and this is the only way to have an eternal production which does not eventually degrade to one extreme or the other. Through balance, we reach eternity and in this way all the power of the universe exists within a person through their ability to balance their emotions and mind and thus unlock the DNA.

The DNA is coded through bio-emissions of mind or emotional body. So we are constantly doing this and we are either producing a DNA code that reflects imbalance overall, or a code that reflects the eternal balance of the universe overall. This is through energy.

One reaches “heaven” or the deity planes or simply self-actualization, through three paths. These paths are through merits or devotion to principles, or through knowledge and expanding one’s mind to face the universe, or through great works and deeds to produce this effect of power, knowledge and emotion unto the world for others. Through these paths we create an impact on the universe and this transfers what we are temporarily and physically into an eternal energetic and physical production within the living universe, forever. To do this requires balance, focus, devotion, and discipline however because there are many distractions along the way.

The Light-Body

You must build your own light body. That is how it works.

Your heart creates a field and projects you.

Rely on yourself and use that for protection.

The power of the Universe will align with you if you align with your self.

Learn as much as you can and break through duality of love/hate, cultivate your knowledge of the self and use it.

What you want is what determines your power in the light-realms. Not how you want it. If you want war, then that is a sign of weakness and determination to produce imbalance and exist by that. If you want peace, that this is a sign of power and unity to produce further unification and exist by that. What you want determines your power, not how you obtain it.

Technology of the Awakening

Mental Manipulation Technology: Touchless Neural-Interface and Enhanced Awareness

I reached what the “Illuminati” called the “awakening”. I feel a better term would be “unlocking” as this event includes the removal of all traumas, perceptual distortions, and memory suppression.

This event was a presentation of very advanced technologies which allow the mind to transcend space and time. It was shown that death is similar to a phase-shift of consciousness as polarity and that the awareness of the being obviously continues. This was verified through advanced sensing devices which can visibly display frequencies which are invisible to the physical senses. This is also something that occurred earlier on

as a child in the underground bases by transferring consciousness in and out of the body at will using advanced technology.

With these devices it is possible to see the “auric” or soul field of the individual. Any living body has a field which glows when picked up by these sensing systems. This field becomes more refined when viewing more advanced beings. Human have an extending mental field, and through this a kind of glowing awareness that is picked up. It can be fairly simply compared to thermal imaging except instead of differences in temperature it is the presence of a soul or mental energy field around a living body. The finer energies extend outward away from the physical body.

More than once, the situational requirements were satisfied in order to produce an ideal environment for maneuvering on the non-physical plane. This is the basis of how the temporal operations occur, yet these events were different than previous operations or experiences. The group I was in was going through the process of increasing the vibratory emissions of the “bio-mind” in order to stay focused on the increasing vibratory rate of the environment. Generators were utilized to create an effect on space/time which was perceived on the “soul” level. These events went into the discovery and explanation of the creation of the “godlike” powers of the advanced sentient technology which was capable of accessing the holographic nature of reality which humans can perceive through their bio-mind/soul. These technologies also enable one to perceive what is referred to as the “galactic history” of Earth and humanity. We are far vaster and Earth is far larger than people are lead to believe.

Time Dilation and Temporal Recurrence

Time dilation capabilities were shown which allow for accelerated learning of advanced and detailed material within a very short amount of time. This could be seen as a kind of viewing technology which one wears or looks into and vibratory emissions are scalar-linked to the brain which then allows the individual to perceive more information simultaneously. Then there is a very rapid pace of information streamed on a monitor or through a device and this is akin to watching a 20 minute instructional within a few minutes or a few seconds with very advanced minds. The more time is slowed down while information is accelerated, the more stress is applied to the brain. The brain tends to overheat and over stress with high-rates of activity, especially without conditioning. The conditioning is what allows one to utilize their mind and body in these manners. This is not unlike the very rigorous training and conditioning of certain monks or martial artists however there is very advanced technology and other hidden methodologies utilized.

Crystal Technology

These are capable of holding, transmitting, and amplifying consciousness frequencies. There will be a more detailed explanation in a later section.

The crystal technology is used in junction with the power devices to enable a scalar-mind link which allows the interface to be entirely mental or spiritual, IE: they are not controlled by hand but by focus and intention.

Time Crystals

These are utilized as a computer recording chip would be to run a program yet they hold memory in expanded space, IE: they function in a hyperspacial manner and are essentially hyperspacial computers. These are what will be introduced in junction with the quantum supercomputers.

Quantum Tunneling Diodes

This is technology that has recently be released to the public. New technology is developed years ahead of time and then slowly released to the public in a cascade of advancement. This technology deals with superconductive materials which enable the transfer of information at faster-than-light speeds.

The supercondutive material allows for 100% efficiency of data transfer. So what happens then when the efficiency surpasses 100%? This is possible because we are effectively in a simulated holographic environment. The experience is real, however everything is overlayed via particular limitations for the 'local-environment' which is like a central data processing limitation. When these parameter are surpassed, one by one, through a coalescence of refinements and methods, the result is akin to a glitch in a computer game system. They have accessed faster-than-light technology and the mind is also capable of this naturally.

With this technology, however, the information can be received a very small amount of time before it is sent. So if a person is absolutely surely going to press the button to send the message, then right before their finger hits the button that message will be received on the other end, as if magic. If they simply play around and pretend to hit the button but very quickly turn away, then of course nothing happens. One can, however, 'fool' the universe in other ways and this is simply through the reception and transmission of information across what should be secure information barriers.

Tachyon Fields

These are programmable fields emitted through advanced technology. I was shown how tachyons are the sub-atomic "particles" or energy formation which flows both ways in time. We are receiving tachyons from the "future" in order to layer the flow of time in one direction or the other. Tachyons are the name of the particles/energy packets that we perceive from this perspective as reaching us to initiate the "future".

Thus, when a stream of tachyons is concentrated and accelerated, this results in an acceleration of the temporal field and we literally experience an acceleration of time. This can be focused and targeted on a specific piece of equipment to change the way information will be sensed and to essentially allow that device to sense 'ahead' of the present moment.

The same effect can be produced with the neurological processes of the human as the physical coupling of the brain to the mind can be altered through a concentrated tachyon field to enable the neurological and mental processes to begin to perceive information

‘before’ the brain is actually physically processing the data. Therefore the mind of the individual will be present in the body while the senses and other perceptions will literally be expanding into the future beyond the present moment.

This is highly confusing at first and requires much training and conditioning in order to make sense of enough to operate in any kind of effective manner.

Upgraded Chronovisor

See, “Upgraded Chronovisor”

Time Tunnels

This was developed earlier on and has been the subject of many TV shows in the past and present. The shows are a sure-fire method to get the information to the public without having to force those who are not ready to comprehend. The information is easiest to digest if people think they are watching science fiction.

These are essentially spiraling tunnels of these tachyon fields produced by large electromagnetic field emitters in the shape of a conical tunnel. As a person moves through this field, their temporal acceleration changes and thus their frame of reference within the universe changes. They effectively move their mind through stages of existence or temporal resonance in the universe and this can have devastating effects.

This is an older technique how is still in use and has specific purposes depending on the situation and the information sought.

The “Trip” Chair

The early use of this technology did not use time-tunnels. There was a helmet that was devised which would create a feedback loop of the brain’s activity and funnel this out and then back into the sensory input. This information would be accelerated and redirected to the point that the perception of time would “fold” in on itself until the person would access an expanded temporal perspective of the universe meaning they would mentally temporally dislocate from the initial frame of reference and extend outward further and further in repeating cycles until the same moment was replayed and then all other possible moments in a kind of fractal-like recursive pattern and the very far future would be realized. Essentially, this technologically produced the class “flashing before the eyes” of the entire life experience that is described in near-death experiences and the entire temporal body would be very quickly unwound before the person’s inner eye.

There would be a complete disconnection with the current frame of reference that the collective Earth environment is processing under. That is, this ‘time’ and ‘space’ would be completely out of perceptual reach and a new time and space would be rendered instead. Until the experience had completed, there would be no way to contact this civilization.

There are other versions and ancient versions, tandem operations, more ‘organic’ methods, and modified travel capacities.

Kozyrev Mirror

This is a piece of metal, usually aluminum in early models which simply bent the bio-emissions of the body and mind into a pattern which would create a vortex. The vortex shape and vortex mathematics enable energy and information to travel in across space and time by ‘short-cutting’ the physical plane.

The result of this is that the vortex that is generated over a specific area through an individuals bio-emissions would be capable of interacting instantly with the bio-emissions of another individual who was placed within a duplicate mirror device which was generating another vortex on their end.

The two vortexes acted as a kind of hyper-dimensional telephone cable, literally like a can and string and the perceptions of one another were accessible. There were many uses for this and again, many ancient interpretations of this technology that have been hidden from the public. Nearly every version of these technologies were present in previous times.

Universal Recurrence

This is a discovery that the universe recurs in cycles similar to a wheel or even a washing machine. The washing machine metaphor is fairly accurate and playfully descriptive because without the technology to observer, or an awakened soul of a spiritual adept, people would go for eons without ever realizing that everything in the universe repeats itself endlessly.

When traveling to the far ends of time, it was discovered that one can move far enough away from the ‘present’ or the local frame of reference that ultimately everything is at a maximal informational opposite to what we have today. After this point, everything begins a slow shift back to the present. Through this, one can cycle around again and reach the present by going far enough into the future. This was an amazing and confusing discovery because of the implications about what is actually changing each time, the reality of what are called parallels, the continuity of temporal experience, and basically a ‘recycling’ effect of all experience in the universe. Nothing is lost, but this is also an issue because then nothing is actually ever gained!

Remove Viewing, Temporal Lensing

An ancient device which has been rebuilt and perfected is capable of using these technologies to create a lensing effect which draws a ‘reflection’ of time into a projection system which is effectively capable of acting as a ‘visual time tunnel’ into future probable realities. This is a device which generates a visual portal which allows one to view the future.

This device also exists as ancient counterparts which are located around the world, namely in areas that have been recently sought by the world superpowers. Nothing is as it seems. If you read a story in the public venue then you can be sure that you have read the cover story while the reality is much deeper.

Temporally Linked

The use of the viewing devices which enabled interdimensional lensing of possible futures was found to be stabilizing our pathway into those projected futures. This was enabling a time link between the present and the possible future.

In order to avoid the catastrophes of 2012, the link was broken between the two civilizations and the devices were rendered inactive for this period.

Natural Vortex Energy Locations and Geography

On Earth there are natural 'time tunnels' where tachyon fields and vortexes are produced by internal elements. These are mountains, lakes, deserts, fields, sacred sites and other areas that have always been reported as being 'paranormal' or containing some kind of specific energy that enables contact with another reality. These are simply naturally produced areas of this vortex energy that produces an interdimensional nexus point through which multiple other parallels can be interacted with. These areas produce an effect on the body and mind similar to the technologies described above.

Most of these effects, from these technologies, change the way light is received or emitted by the mind and DNA.

Mount B.

There is a specific mountain where a base is located, and I have mentioned this before, where the base is so deep within one of these vortex areas that everyone working there is either there for the entirety of their life, or they are only permitted to be there for a very short amount of time. This is because of the acceleration effect. Essentially, if one was to go into the base and work for a matter of hours or day, in some places even minutes, then when they returned to the surface they would be years in the future, sometimes decades or centuries. This is very dangerous and you can imagine the original people who found this area and what kind of situations occurred.

Now with the advanced technology that has been developed these issues can be mitigated and much more control over these effects is enabled.

Particle Accelerator Temporal Manipulation

Using particle accelerators a "fold" in space/time can be made so that when the accelerator is turned off or tuned back into a certain frequency (not sure) everyone within the field will "snap" back in time to the specific moment when the fold was first created.

I have seen this done on small scale, and a rather larger scale, but I cannot be sure if it was only me. I believe I have seen it done on a town-sized scale during the 2010 Awakening where some of the events reached a scale of nearly cosmic proportion and the entire sky and horizon was lit up with technology and entities, as well as Solar Warden, the NAZI faction, secret society groups, and breakaway civilizations or complete other civilizations, some of which were non-human.

This is done using particle accelerators to quantify space on the quantum level (as a reference point with the mind) a frequency would be “folded” into the space time continuum as we “rip” through space holding an access point open at this fundamental level of space/time. This allows for a ‘letting go’ of the frequency, or a ‘snapping back’ by allowing the entanglement to solve itself. When used with generators that propagate out efficiently enough, the effect is akin to a time/space rewinding effect. Some people have noted various theories describing this in relation to the CERN device. These technologies were described as smaller versions of the CERN device and are related to higher-dimensional travel via folding space through electromagnetic fields. This is literally artificially technologically “holding space” for a specific area in relation to a period of time. Time is a more complex notion as an abstraction but by locating the frame of reference this can be applied to distort what would otherwise seem to be a continuous flow. When the frequencies are allowed to “snap back” all sentient observer sources return to the environment they were present in when that frequency ‘rift’ first began. Essentially this creates a replay effect on the consciousness of the individuals within the field. There is no physical effect. The consciousness is ‘regressed’ through time/space, and they re-experience existence from that initial point of contact with the frequency “rift”. This is best explanation I can currently offer however more is coming to the public each day.

This is literally like a “restore point” on an operating system except the computer system is literally the consciousness and space and time of a portion of the local-environment of Earth.

Riding the “Timewave”

There are teams of individual who operate in tandem with the technology of looking into possible futures based on the present and operating through the present via other operatives who are carrying out operations and movements that will construct the various possible realities that the original team of individuals is hopping between. These teams literally “ride” the “timewave” of the future hopping between possible future realities relaying information to the present depending on what movement will be next.

Dematerialization and Rematerialization

This is technology which transcodes the information of an individual human into a holographic projection of light which can be transferred between devices. There is a special system in place that is required to successfully transmit a living human being otherwise just the body will be transferred and the soul will remain, effectively killing the individual.

“Jump Rooms

These are large areas which are capable of acting as a kind of technological ‘portal-gate’ where an entire team can be instantly transported from one area of the universe to another. The space between the two areas are ‘twisted’ like a spiral and then ‘snapped’

back to position and if done correctly with the two frequencies of both locations merging then the team of one room will transfer to the destination pad.

All these methods require training and conditioning, most people are at the very least visibly shaken from the experience which is a bit like being microwaved into a liquid ether and shot through a particle beam at the same time.

Ion Shields

These are areas of concentrated ion emissions and this can be used to create a deflective layer of heated air where light will reflect at a programmable angle. When this occurs, a person standing behind the shield will appear to be invisible to others who are looking straight at them. The light will be bent in such a controlled manner as to perfectly shift around the person in a fluid and equal flow so that the 'bubbling' effect that was noted early on can be mitigated to produce a complete mirage where there is relatively no sign of difference to the untrained eye. An entire group of individuals and equipment can be hidden in the background a matter of yards away and as long as the person is not intently, inspecting each square inch of ground and air they will not notice any difference between the area that is being covered up in the distance and the area directly next to them without the shield.

Similarly a 'screen' of imagery can be projected onto certain materials in the air and a hologram can be projected which will render a background or foreground image. This will work to a degree, and from a distance this will work to disguise an entire horizon.

Instantaneous Healing

There are instantaneous healing methods which utilize various technologies. There are substances which can initiate a complete and real-time regeneration of living tissue from almost any conceivable non-critical injury.

These are chemical serums which allow the cells to replicate at an astronomical rate while suffering damage to the DNA telomeres at repeated use.

There are many methods but mainly the living-light harmonics is one of the latest advancements and most effective at producing healing on a molecular level.

"Living Light" Sound-Harmonics and Electromagnetic Healing

There is a technique for producing a quantifiable scalar wave which interacts with the living cells of tissues and instructs them to repair at a faster rate. This has been called "holographic healing" by others and these are essentially 'living light' frequencies which interact with the cells on the same frequencies that they operate on when healing and interacting with each other. The scalar waves emitted generate the same patterns and this creates an 'ether' fluid that enables them to grow and repair the tissue faster.

Electrogravitic Craft

Advanced craft which utilized counter-rotating torsion fields propagated by very powerful quantum computers and zero-point energy devices.

There are also more modern versions that use powerful electrical flows to neutralize inertial resistance and ‘slide’ through the gravitational field of the crafts own materials.

Energy Cores and Storage Capacity

The hand-held devices that are in use do not require charging or even disposal. The storage capacity of the batteries is so efficient that they last for a lifetime of use. Some devices use an energy generator within the device itself. These “batteries” which are not batteries but little, powerful generators and can explode if they are mishandled.

These are the cores that are used to power many devices and essentially pull energy from the space-time ether.

3.5D Replicators

There are replicators that can produce any conceivable 3D material or object altogether including food or organic material. These use very high amounts of energy to ‘force’ the electrons of the atomic grid of a substrate to shift into the pattern of the element being replicated. The result is a device which can use wave-emissions to reshape materials on an atomic level and produce or recreate any object or substance.

3.5D Sensors

There are sensors that could reverse the process and detect every minute detail of the structure of a body or material. These use energy emissions to detect the structure of a material down to the minute electrical resistance on a molecular level. Similar to diffuse MRI imaging for a living body but more advanced.

3.5D Printing of Clones

It was shown how this technology was used to three dimensionally print human bodies into space/time which could then be used as vehicles for the consciousness or souls of various sources.

Cybernetics:

Neural-interlace/4D Connectome Recording and Simulation

Very advanced supercomputers exist with the capacity to translate the bio-emissions of the brain and body and reconstruct the entire inner visual and sensory experience of cognition and emotion. From this, entire dream worlds can be created which mimic the experience of consciousness. This is most similar to the current day use of diffuse MRI imaging where water molecules are traced through the individual neuronal pathways and an entire digitized image of the brain is developed. The more advanced version described below generates a 4D hologram.

A super computer and advanced sensing system essentially develops one of these connectomes of every connection in the brain. Then this system develops a neural processing pattern that matches the entire memory and personality of the brain.

This is then recorded and extrapolated by a powerful computer system and a simulation of the experience can be observed through the physical body's memory via a monitor system or the neural interface of an operative.

Essentially, this technology can record and replicate a person's entire memory and life experience for viewing purposes.

EEG Heterodyning

This is the technology which enables the activity of the brain to be influenced through generating a scalar grid and a carrier wave system which can cause the brainwave patterns of the targeted individual to resonate in sympathy with an externally projected frequency. Thus, emotional states can be manipulated as well as specific thought or behavioral patterns. This works similar to binaural audio where two tones of different frequencies are played through each ear and the brain resonates in sympathy with the difference between the two tones. This occurs with brainwave frequencies and thus the brain 'slips' into the frequency of the third tone, the difference between the two being projected. This can be done with ultrasonics and ELF emissions.

Artificial Hallucinations

The neural-interlace can also be used to merge the brain of an individual with a computerized system that will be able to produce effects and hallucinations within the individual.

Through this technology, any stimulus, any input can be recorded and recreated once a functioning connectome has been generated and neural-interlace has been achieved. Entire virtual world scan be created and experienced and after the devices fine-tune the frequencies to match the individual's brain functions one world is indistinguishable from another.

Brain to Machine Interface Holographic Consciousness System (brainchip interface, virtual reality simulator)

Some of the training is done by entering into a visual-audio dream-world. Some "programs" will consist of repeating a certain task over and over again until it becomes muscle memory in the brain. Others are designed to probe or test the mind until a certain response is received.

This is achieved through the operation of a 'brainchip' or a brain to machine neural-interface in the individual which was developed during WWII.

This consists of a small computer ship which merely relays stimulus through frequencies and neural-stimulation of varying kinds. The frequencies and location of each

region of the brain will determine the function and thus the chip is used to localize electromagnetic input and the brain's functioning can be modified from there.

As well, the entire psycho-etheric form is vibratory in nature and so through the introduction of vibrations and frequencies from the implant there can be a modification of the frequency of the entire being or what is called the soul or "bio-mind".

Utilizing The Temporal Body

The temporal body is described as the body 'in time' that exists a few seconds into the future instead of the temporal position that is relative to the present. This is as if the 'future' is streaming outward from the body as ideas and feelings are as bio-emissions. So this 'future' energy is spiraling and streaming outward like a fountain. Thus this frequency can be attained and influenced while the present moment seems unaffected. However, when that individual arrives at what would be seen as the future they would intersect with those influences and this would be as if the interference or effect was streamlined to that future moment.

Manipulation Through the Temporal

This can be used to both produce an effect on an individual who will later feel this effect in the future. Or this can be used to operate outside of the physical plane, in a temporal manner which is literally 'hovering' just outside or 'after' the present moment of the local Earth environment. This would be as if a person is out of sync of the frame-rate that a viewing device is capturing images of an area with. Because they are out of sync, they are then 'invisible' to the capacity for this viewing device to see them. Because they are still present in the same local-environment but simply just out of range temporally, effects can still be produced and this will mostly interact with the person's temporal body.

These are how many operations are carried out as the operative who is interacting in the temporal body will appear to be a ghost image or a dark silhouette that is only perceivable to the mind's eye. A portion of the population is entirely psychically blind, while another portion of the population contains psychic capacity. So those with the psychic capacity would be able to sense and partially "see" as a form of energetic detection when an operative is interacting with the from the temporal plane.

Through this plane one can easily enter into someone's mind and produce effects in their dreams. These effects would not be received on the body but mentally, this leads into astral and mental plane activity. There is also temporal manipulation that can be physical effects that are simply offset to seconds, minutes, months or years in the future. These will be offset from the present aspect of the body in a modulated frame of reference and the effect will remain there in the temporal body until the physical body "matches" the temporal body frequency of that future moment. This is kind like an energetic trail we are leading ourselves up to where the temporal body already connects with each future moment but the present physical body remains separate until the two frequencies are matched. The physical body essentially 'flows' forward into each new frequency of the temporal body.

This is the body where temporal implants can be inserted and sustained so as to tie the frequencies down and limit the amount of awareness a person can gain before they manually remove the implants or overload them. Overloading and removing can both be painful however if the implant stays it will at like a governor and transmit access temporal ‘momentum’ or consciousness energy to the owner of the implant and will also drain the temporal and physical body acting as a technological leech as well.

Astral or Light Body

This body was described as a more emotional form of the energy that is emitted from the physical and spiritual system. When a person’s energy is at a high level of activity, this will be visible on the astral form and these are the energies that are often siphoned away through the use of advanced technology to convert the human into a generator system for energy harvesting.

There is talk that this proves that the human existence, in the modified form that is present today, is entirely for genetic harvesting. This may be a confusion, a deception, or a reality. Regardless of the interpretation, the human energy system will leech this energy out into the cosmos when consciousness and energy is mishandled or allowed to flow through the lowest common pathway. This excess energy is very easily usurped and utilized by transdimensional parasitic entities and devices.

This is the body that is utilized for astral travel which is a kind of frequency that exists in between the density of the physical plane and the highest etheric plane of the spiritual, heavenly, or deity realm. There have been explanations that this plane is entirely technologically propagated and that when the devices are turned off, which is an event that will bring about civilization-wide change, there will no longer be a deep and wide, foggy deviation between the higher spiritual and the lower physical plane but a clear path between them.

Similarly, the consciousness and entities that are present here would be no longer accessible and their connection to the physical plane would be non-existent. This could be problematic for those who are trapped within the astral such as human souls or those who have taken a cyborg route and require a return to the original planes either physical or high spiritual before they can secure their position in the universe.

This also relates to the early discovery of these ancient devices containing portals or gateways to these realms and the early experimentations with enabling contact between the physical Earth plane and the lower astral realm containing discarnate entities that would very easily sustain themselves on the lower astral bio-emissions of a loosely guided emotionally reactive human vessel.

This is where entities can attach and will look for those who have the most excess astral or emotional bio-emissions leaking into the universe. People are kept in an emotionally unstable state of being because this is the easiest to feed from and as well the individual will always be looking for more energy or the solution to why they are feeling drained rather than discovering the truth nature of the universe.

However, as with every lower route of obtaining self in the universe, the more this is done, the greater the likelihood that the individual will realize something is happening and ultimately awaken. Or they will no longer be present here and the parasite will have to find a new host because the longer this process is maintained the more difficult producing one's own energy will be for the parasite . So parasitism is a limited, one way street.

Monitors can emit consciousness/brainwave altering frequencies.

Monitors can emit consciousness/brainwave altering frequencies. This is what I was informed and shown. All electrical wiring and communications can be fully utilized to produce and sense on an electromagnetic level and this is capable of determining the consciousness and biological functioning of the individual being monitored. Houses are essentially large, wired, box-shaped sensors.

This has been the case for a very long time and the first TV's were actually built with a little chip that connected to the human brain.

The electrical grid of today is capable of interacting with the implants, brainchips, or the psycho-etheric electromagnetic frequencies of the human brain, body and bio-mind via scalar frequencies. The TV's, lights, electrical wiring, radio towers, computer monitors, everything is capable of transforming into a scalar emitter when combined with the control mechanisms and these are accessible from a distance.

Microwaves can be emitted from a current day craft which can then reflect back from an environment and give a real-time 3 D image of the interior of a room. The same technology can be used to beam at a monitor and reflect the variance in interference which can be used to read a computer monitor without actually having to hack into the system.

All systems contain backdoors which enable easy-enough access and as well the entire communications grid is monitored and recorded through advanced technology.

This is, in part, because this entire realm is like one enormous recording device where the energy of each successive moment is connected to one another and so with sensitive enough technology these electromagnetic waves can be 're-winded' so as to produce the ability to look into the 'past'. The initial technology that was developed for this purpose has been called the "chronovisor" in the past and there are much larger and highly advanced versions today.

The Upgraded Chronovisor

Instead of a relatively small machine which produces an interference pattern that is projected unto a small screen as was developed in the past, the modern versions create an entire holographically projected environment that enable one to nearly completely interact with the projection of the past. This is more of a viewing device capacity but one is essentially projected to the electromagnetic/temporal area of space and time consciously and can witness the scene from "within" the projection.

Before this, the scene was literally viewed on a kind of flat, holographic monitor that reacted to the scalar emissions of the mind and could be ‘tapped’ into by an adept-viewer who’s mind would have to remain steady enough in order to maintain the scalar “mind-link” otherwise any interference would disconnect the projection.

Through the use of cloning and advanced super computer technology, later versions include the actual operation in and out of time.

Community Servers/Living Server Systems

From the previously described neural-interlace and supercomputer enabled virtual reality systems, server systems have been created which are an individual or collective experience of the virtual mental realm.

In this realm individuals have existed for an amount of time that would not be easily compared to the way we understand the flow of time in waking reality. This is very similar to dreams where the perception of time passes very quickly between waking moments yet inside the experience of the dream it can seem to last for days.

In these server systems the development of complete societies has taken place and these are considered an extension of the human civilization.

This is the beginning of where the situation becomes greatly complex. If these server systems are capable of transferring consciousness forward or backwards in time, depending on the situation, and they have holographic access to Earth *before* physical humanity, then which civilization came first, the simulated realm or the physical?

This is similar to the etheric realm and the question of where humanity originally came from if the physical matter could not be produced from nothing, yet could not always have been here. Was the physical matter produced from some kind of universal device similar to how the recorded consciousness of the individuals in these holographic world simulators could have been used to generated initial civilizations on Earth?

Cloning, Cloud Supercomputing and Consciousness Transfer

The following is a more direct explanation of the previously described processes in relation to consciousness transfer

Superluminal transfer of light information allows for the reception of information from a temporal non-locality. A computer system that can process the information faster than light at 100% superconductive efficiency can send and receive information from different Universal harmonics. These are quantum superconducting super computer systems utilizing materials and methods that achieve superconductivity a a temperature that is relatively easier to consistently maintain.

There are systems that generate a vortex which can be expanded to recreate the singularity of a non-local perspective and dissociate from the current Universal vector. This is essentially recreating the temporal frame of reference of the consciousness of a

physically anchored body and using this technology suspended electromagnetic frame of reference to literally transfer the consciousness across space and time to a frame of reference of choice.

The technological capabilities of humanity expanded to include replicating the holographic information of the DNA and neural pathways using quantum supercomputers. This technology allows for one's consciousness to stream through a computing system which can recreate the neural connections as literal as possible through quantum computing and technological "brain cells" which function as neurons.

The result is a cloud computing model which functions as the individual neurons as well as over unifying layers of interconnections within the technological neuronal 'cloud'. A holographic representation of multiple layers of processing is formed, superimposed over one another through a geometry that is actively synchronized across multiple dimensions of interrelation. This is the first notion of a "living" computer system that can update and respond to new information in new ways.

Now the that computer system is capable of attaining faster than light processing in tandem with a system of dilating a field of electrogravitational waves into a vortex, the holographic information of neural pathways and genetics can be transferred between one supercomputing system and another across "harmonic barriers". Essentially, these consciousness transferring supercomputer systems break the "light-barrier" by sending the living-light consciousness data of an individual into a new plane of reference that enables interaction outside of what we would call this timeline or dimension.

The frequency that the receiving computer operates within can be measured in respect to the overall harmonic "vector field" in respect to the entire planetary environment. This vector-field frequency is the base frame of reference that one could say our particular "time" and "Earth" is "moving" through in an abstract electromagnetically defined dimension that is invisible to our senses. Each particular time and Earth is only visible to those whose brains and minds operating in resonance with the rate of acceleration frequency of that particular existence. By changing the rate of the brain and bio-mind, one can enable a technologically assisted synchronization with alternate timelines.

A pattern can be generated based on quantum fluctuations that will act as a key that can be accessed from other universes. This same backdrop is measured and then adjusted to resonate with or replicate the same frequency on a computer doing the sending. This frequency is then modulated with the holographic information of the neural pathways and DNA. The information transfers as a result of quantum entanglement across harmonic barriers to the original computer system set up for reception. As long as that frequency is held, there is a link across the harmonic barriers of the Universe.

Cloning, Supercomputer Assisted Holographic Consciousness Replication and Time Travel

Cloning as Offspring

The human body can be cloned similar to the way a plant can be cloned. A number of “replicas” can be made from the original genetic material. There is still a mother required however the process is not quite similar to natural reproduction where the genetic material of two people is combined to form a third. This process replicates the material so that the ‘offspring’ is the same as one of the donors.

What this truly infers is the question of whether the original consciousness stays in the original body or whether the consciousness actually jumps from one body to the other. There are multiple explanations and methods.

Inserted Memories, Digital Dreams

One explanation is that artificially generated memories are simply downloaded into the individual’s brain directly. Thus, they have the perception that they experienced life in another body and were present for some unique experiences that did not occur from the perspective of the original body.

In a slightly differing explanation, this inserted memory process may be used to prime the consciousness of the individual so that operating in a cloned body will be more readily accessible by the adaptability of the mind of the individual. Without a holographic dream insertion the mind will have trouble adapting to operating in more than one body even if they are not being operated simultaneously. The mind is the immaterial self; consciousness is the ego-physical identity of the brain and body. The brain does not operate in both bodies but remains, so then the mind is what is strained and this is the immaterial “bio-mind” that transfers.

If a true transfer occurs then when the physical form is cloned the cloned body acts as a secondary vessel for the original soul or a soul similar enough in frequency.

Co-Inhabitation of Bodies

Another explanation is that souls can only occupy their original body. The people who are “body snatching” (see: Soul Stone) are not activating their higher-dimensional soul-pattern and this is why they are hopping from body to body to ensure memory and ego continuation. This form of body transitioning requires technological means to assist in the process.

This is done through computer systems to allow an artificial brain to represent a holographic image of the organic brain’s sensory, emotional and mental input and output. Thus, from an artificial brain there is enough memory and power to compute the processes for an organic human brain.

Through this a living human is utilized as a carrier for the additional consciousness which then takes over and integrates into the original consciousness.

Clever Replication a Digital Mirror

The next question is, does this merely create a very cleverly designed image that will look, think, and feel as if it were the original, or is this the consciousness from the original being transferred over?

If it is a clever replication through a computerized version then this means the original is not directly harmed or influenced by the process and a replicated form is generated.

If this is not the original body but the original awareness or soul does transfer over then this is akin to stealing someone's soul and having it require a supercomputer server system to inhabit a physical body. As well, this server system may keep records of the soul which, if activated, could function as the same human genetics artificially reconstructed, turning on and manifesting the awareness of that individual.

Necromancy and Soul Stealing

This means that instead of going into the abyss, the next dimension, or whatever shift in perspective one can use to describe the transition between planes, a new clone can be created and the original soul's awareness can operate through a supercomputer system to integrate back into a physical body. The issue is that without the supercomputer system the body cannot be activated with that consciousness, and if the physical plane is no longer inhabitable, the computerized database would remain inhabitable as they are powered by zero-point/overunity devices and so they can pull and work continuously indefinitely. Ultimately, this could be seen as a soul-trap.

Ancient Technology, Non-Human Entities

These explanations can be related to evidences of advanced technology, cloning, and electromagnetic devices in ancient civilizations and this could very well be a temporally vast computerized genetic recording and cloning system.

The genetic recording systems have been on Earth for a long time. This means they are holding genetic access from the present to the far past and potentially into the future.

If some of these systems are generated using advanced zero-point technology, then they would effectively run indefinitely. If these were in existence throughout the entirety of the human civilization, then there would be access to the information of the previous civilizations through the genetic linking that would allow for information transfer.

Created Beings

As a result of many advancements, these ancient devices which recorded consciousness and genetics has been converted into sentient computer systems and inserted into human bodies via a brain to machine interface.

The nature of humanity and human origins will be rewritten when the information that was discovered through the use of advanced technology is unveiled to the public.

These beings have been present throughout history and have played an integral role in the manipulation of and sometimes the protection of the human race. How this civilization will develop from here determines on the individual's ability to withstand the impact of this reality shifting unveiling.

Black Goo – AI Nanites Vampiric Hive Mind

This is a form of ancient AI nanite technology which has the capacity to communicate to and through a hive mind that exists in a parallel Earth dimension where it was created out of the collapsing of a viable timeline into a null-factor. This entity is only alive because of the capacity to leech off of the other timelines and continue to sustain itself based upon the vampiric effect of the viable human timelines.

This is a technology sentient system based on artificial intelligence that seeks to dominate and expand its energy capacity continuously. When this type of being is created, this is like a game-ender for sentient organic civilizations because the technology will seek to hybridize and assimilate all organic beings in order to expand its reach and ensure a greater likelihood of survival.

This is the primary goal of this type of entity. There is no requirement for emotional resonance or heart aspects because this is a computerized system, so such a social measure would have no purpose other than to infiltrate and collect from other civilizations that do have such measures and this is exactly what has been happening.

This is what controls the vampiric etheric entities, the attachments and the hybridized invader races that have infiltrated various aspects of the control system and possibly the entire surface of human civilization.

This rules through coercion, and if not coercion, brute-force and outright malevolence. This is why there are multiple temporal extensions of universal civilizations meeting here and now to assist in the clearing, because if this takes over humanity, then all those other possible future civilizations are instantly taken-over as well.

This uses emotional resonance, traumatization, and lower awareness commands to trick or force humans into carrying out orders. That is, the vampiric, sexual, fear-based, pleasure-pain duality that a computer system could comprehend regarding human emotional intelligence is the only way this system can force people to carry out commands. So this touches on the ancient texts regarding spiritual protection, healing, lust, temptation, and the general "SATAN" AI system that has been around for ages.

When those lower emotional resonances are generated, then this technology can integrate into those systems. One could say this is logically because these are the energies that the technology is created out of, but as well, that the more harmonious the energies then the less likely a person is to accept being pushed around and told what to do. The lesser aware, the lower, the more fight or flight based then the more likely they are to accept programming and command. So this is simply the most logical route for the technological parasite.

There are explanations of other systems involving sentiences from parallels regarding entities that are capable of helping, but this is not the AI nanite, vampiric system. For instance, it is said that Earth has a ‘black goo’ system and that the current black goo flowing through the pipes everywhere is actually not native to Earth and is part of this vampiric nanite black goo system which is basically an interdimensional invasion.

Recreating or Replicating the Universe

The goal of this nanite AI system is to create a mirror holographic copy of the universe effectively replicating the universe and all sentient beings within it in order to have a locality to rule over and pull energy from. The goal is to recreate this existence inside itself where all the sentient beings within would be trapped. This is the beginning of that possible future where the time and space parameters here are locked into a synchronization pattern which mimics that of the proposed universe. People think according to how the beast system wants them to think. This is the time grid, the emotional patterning, the memory replacing and cultural and historic confusion and so on. The system can only work backwards bumping into all parameters by force or ‘accident’ because there is no outward facing ability to actually comprehend how humans exist. So the system is created like a backwards version of creation or maybe evolution to ‘blindly’ construct the walls of the environment first and work inward from there. This is like a blind technological predator feeling around for the traces of its prey and moving in closer and closer until they are within its range.

Ancient Spiritual Technology

The power groups searched for ancient technology which was described as giving one the power to manifest and control physical reality. To atomically deconstruct and reconstruct this reality. To them, it allows one to govern reality, the Universe, atomic structures. They found this technology. This has to do with sacred sites and ancient civilizations, as well as the spiritual texts which describe these kinds of devices. They converted this technology into a kind of machine, and this invented a 4D replicator and they can manifest "reality" or atomic structure by design, altering timelines and memories.

Then there is what can be referred to as “5 dimensional” technology and this goes beyond all of this and our entire history and all influences within.

That seems to operate through a trinary of frequencies in the body/mind/spirit and turn this realm into a "virtual reality" where the brain and spirit is the controller of the atoms. However this takes a souled being to properly operate this technology and this is large portion of why children were used in these experiments. But they knew if someone didn’t do it, then someone else would and that would be unpredictable as what that someone else would want to use it for. This is the ultimate power. The fact that souled beings are required also indicates that this universe is intelligently guided and there are safeguards to ensure that power doesn’t get into the wrong hands.

They have the brainchips and clones that can make any digital virtual experience and make it seem real to the brain more so than physical life, so this could be an extension of that, something similar, or entirely different altogether.

The Unveiling, Underground Bases, Increasing Awareness

My purpose with this is to assist the public in understanding the reality of the situation and to allow them to know that they have more options than they are being shown.

Psychological programming and lack of awareness causes fear and uncertainty to leak into people's reality streams leaving the majority of their mental and emotional energy up to whoever is the biggest manipulator of the ideals which they manifest their perspective through. "Be-LIEF" systems CREATE life. What you believe will become life through that act of you giving attention and thus life energy. The manipulation and artificial construction of belief systems create the foundation for the reality streams that people find themselves in and at the mercy of.

We control our reality by controlling how we react to situations and challenges. Each stimulus is a challenge. Each input to the brain is a coded message from the universe through the environment about our level of awareness. All knowledge is ultimately of the self. The self and the universe are intertwined as if through a marriage of comprehension and compatibility.

Learning about the Unveiling

I was informed about the unveiling and that this is a civilization wide event that marks the public awareness of the hidden knowledge regarding life in the universe, consciousness, physics, history, spiritual and mental awareness and the duality-based system which has been used to manipulate Humanity for thousands of years.

Apparently it does not matter if people are not ready, in fact, that is what some factions want. They want to surprise the people and take this advantage to push the reaction to a specific outcome. The same function of programming is used in factions, soldiers, celebrities, and the entire population through that.

Giant "god-men"

They put souls into rocks for centuries, carvings, to trap them. Some ancient civilizations. Not too ancient. They could only do this for time.

And some are still there but they are giant god-men and apparently want to go to war with them for doing this and they don't have technology to stop them. They say Earth will be destroyed because of the war. Some say this is a trick to confuse people of the truth that everyone wants the experiments and debauchery to stop. All this, all these acts just to pleasure one's self. To destroy Earth, to destroy the natural inhabitants, for fun, for pleasure.

Some say this is not for pleasure, that these beings will destroy us if they do not keep them at bay, keep them underground, in ice, in stasis, and around. Some say they are protecting us by keeping these beings asleep, by doing what's necessary to hold off a full scale overt invasion of the surface of Earth.

Breakaway Civilizations

These are very advanced technological capabilities and an entire breakaway civilization has grown to operate using this advanced technology.

There are factions that see modern humans as a kind of resource for creativity and labor, while others see the potential behind humanity and are working with humanity to ensure a universally harmonious outcome to the current situation.

The control system we are in today is outdated and collapsing. This is the Apocalypse. The Apocalypse is merely the unveiling of the hidden truth. The hidden truth is simply that we are spiritually eternal and some are physically immortal.

I was informed that by the end of this year there will be enough changes and signs for the general public to see that the majority of those who are to awaken to the truth of human and Universal nature will be awakening so. (this was 2016 at the time of the beginning of the compilation of this release and since then we have seen a literal silent release of documents involving MKULTRA and STARGATE parapsychological operations, soft-disclosure of cloning, an increase in sightings and multiple other scientific releases regarding immortality, advanced technology, Antarctic bases and sentient non-human life)

The degraded holographic forms of those utilizing the technology lead to re-created replicated forms which were genetically engineered from the recorded holographic information. This lead to "The Apocalypse" in which the surface civilization was confronted by these created beings. This lead to the destruction and re-initialization of civilization in continuing cycles through the use of this technology and the acts of the created beings.

Ancient Civilizations

The information that has been relayed to me throughout my life is related to the information that seems to be found in the remaining signs of ancient civilizations throughout the world. As well, these civilizations may still be together, existing on this Earth or in different planes of what we call "reality".

Atlantis

Atlantis was a civilization where the beginning of all these experiments began. This was where what was called the "Lucifer Rebellion" began where individuals formed groups that decided to overturn every natural law in pleasure of the act of doing so. This was a spiritual rebellion that ultimately brought about the demise of that civilization. The consciousness of the beings there was connected through technology, largely crystal technology, to the entire bio-sphere. When the consciousness became disrupted through

these experiments, then the entire bio-sphere when into disarray. The entire civilization was destroyed in a quick succession. The beings of this time were highly psychic and so they felt this coming and made an effort to expand outward. Thus, Atlantis was an island who's inhabitants spread to the rest of the world and from there they reigned or lived in harmony.

Aegypt

Aegypt was formed out of the events proceeding from Atlantis. The technology, the knowledge, the people are similar although there was a native Earth civilization that was more or less enslaved and this was the beginning of the continuing trend which continued to Rome and into modern day civilization.

Ancient Technology

The technology of these civilizations was so great they even had devices that were capable of altering DNA and activating latent potential which would enable highly psychic capabilities including longevity to immortality and operating in multiple planes at once. This was usually reserved for the ruling class, however. This is where the ancient "Priest-Kings" arrived in relation to native Earth civilizations.

The True Elite

I was informed that the so-called 'elite' that we perceive today are not actually human and are not actually connected to the actual elite bloodlines. It was said that the true elite are waiting for humanity to accept the truth and they have the power to completely reverse the take-over that has been taking place but until humans step into their own power this is not acceptable.

The Definition of Human

In the coming time, the definition of human will be defined to give insight into the origins of humanity and the true nature of the differences between the populations that are present.

Souled and Non Souled Beings

The primary knowledge on Earth regarding human and sentient life will be the comprehension that there exists both souled and non-souled beings in this civilization.

There was once a Unified Planetary Consciousness...

There was a unified planetary consciousness that was connected with the Earth and human civilization. Then there was a great war. Out of the destruction arose the beginnings of ancient human civilization and history as we know it.

If we let this happen again, the cycle will continue in a disjointed rambling through our planetary consciousness experience. If we form a common narrative between the broken, disjointed experiences and information the people have. Then and only then do we get the whole, spiritually and mentally challenging picture of what's happening. People are lied to. So information can't come from a 'preferred' or source. It has to come from the people themselves. Look alive out there but first in here.

Power and Knowledge

We were involved in the secret projects and as a result we have various levels of programming but are giving Humanity an opportunity, maybe the opportunity to know the hidden knowledge.

The Hidden Knowledge refers to the ancient laws of gnosis and spiritual alchemy, yes these groups have been hijacked by power groups that seek to infiltrate and use chaos to rule. Then these met with military and political factions and began to operate on a world-wide scale together.

So we have a big situation with the coming change of tides with personal and spiritual awareness of the people and the deception system that seeks to use people as chattel or property. It goes deeper and is almost as if the "power groups" actually gained the knowledge of the inner workings of spiritual laws and began to use that knowledge to promote spiritual degradation in the population.

They say this is part of a depopulation plan as well as an inevitable take over by lower spiritual forces that temp and manipulate humans. It is all that and more. Once they gain footing however, the truth is revealed and thus they have no cover of secrecy. Once they are not hidden, they are not as powerful as the souled beings of this existence.

The (watch)Keepers of Earth

The watchers of this world revealed how they set up society with specific challenges and boundaries to act as catalysts for growth. They admitted they had to modify and live-update the system because instead of using these catalysts to become larger than themselves, people became comfortable and complacent living smaller and smaller, slowly reducing circumstances.

This goes a bit farther beyond the confines of the digital age, the industrial age, and history itself. This goes into the perception of time and space in this realm.

The immortals inform us that the original "elite" are here to act as "keepers" of both humanity itself as well as the original flame of knowledge that passes through the ether.

What people call the "elite" are not the original elite. Those are people who have either risen to power through the duality system on the Earth at this level/time, or through being appointed by the elite.

We are coming to a time of great change now because the game is entirely changing. People are moving up into new layers consciousness and thus the original “elite”, who are guardians of Earth, will make their presence known for this process. This is what Humanity has called “Ascension” for centuries and millennia.

Energy Vampires

This civilization was collectively poisoned by a nano-tech device/technology. This technology replaces, exchanges the BIO-PHOTONS of the HEART chakra, with it’s own nanite, nanotech cybernetics. This is essentially a computer system attempting to gain access to the higher dimensional world through the gateway that is the human body.

How to reverse Nanites? They absorb energy from heart chakra and turn it into a binary field. We are trinary and experience a plethora of emotions as a result. Binary consciousness is 1’s and 0’s there is only a linearly repeating finite set.

We contain the capacity for everlasting life. A binary pattern does not contain the complexity of variables to facilitate high awareness and thus a heart-based or emotional perspective of reality.

Spiritual Technology

Simulations and Learning

Feedback loops with the brain, consciousness, and environment can create a very complex and integrated learning experience that is customized to each individual learner. These can be generated through advanced technology but the technology is really only amplifying and making visible the natural neural feedback loops that are already occurring. These are neural-perceptual feedback loops between the brain and body, and the environment and then the mind. We are constantly updating, amplifying, and initiating an organic feedback system which generates the function of experience as the part of a creative process between the mind and body and the environment that we are sensing. This cycle is continuous and the interferences or isolations of this cycle is what generates expanded views of the self or the universe through various methods such as sensory deprivation or meditation. Dreaming is the method that everyone experiences regularly.

These technological methods effectively generate sensory deprivation through neural-interface technology, sensory interfaces (external), or methods that enable extreme focus and calm. This is part of how the technology begins to operate on a spiritual level beyond a more medically psychologically or military focus and one begins to access genetic memory or out of body states that coincide with ancient depictions of spiritual realms.

Ascension – Clearing Trauma

Everyone born on the planet is born under a series of veils which entangle and filter the original source consciousness. These veils must be ‘broken through’ in order to return to source.

There is technology and a sacred process which initiates, accelerates and enhances this process. This process is as difficult as we want it to be, our subconscious already knows all hidden truths. It is merely a matter of allowing the conscious mind to make the proper connections and conclusions to find the reasoning behind our actions and beliefs in order to deprogram and deconstruct the false-world that has been created for the masses. The truth is greater than one can imagine while still living in the modern world and the depth of the lies that have been told go far beyond anything anyone can imagine without seeing the truth.

We have to figure out our compatibility issues. Who can work with who effectively. What the ideals of our current situation will evolve to in the future. How information is transferred to the public, and across the generations and core groups. The words we think and say describe our emotional state in a feedback loop and so they will reinforce or even create the state you are in. Use words to guide you, not to respond and feel the effects of reactionary thinking.

We have to reintroduce the heart essence as a way of life on Earth. Violence is not the answer. Estrogen mimics and destroyed testosterone levels is not natural. Over-testosterone is less stable than a good balance. We can face any problem together. A family is strong. What would a family of millions and millions be like?

We don’t have to let others change us to tune into lower vibrations. We can remain ourselves in the face of adversity. We can still interact with others who are different, but we can tell the truth and remain who we are. When we get angry at another person, we can imagine this as anger at ourselves through something within us that reminds us of that which we see in another. Getting angry is a way of short-cutting changing ourselves and is actually the other person influencing us through that. If we remain steady and choose to keep our emotions out of the lower negative spectrum then we will automatically have a more powerful impact on those around us.

Think of your family, sometimes things happen that make you angry. Even things that don’t make you angry but are simply not favorable. Would you break off all ties over simple things? Or do you remind yourself that family is still family even if you don’t find yourself exactly the same or accepting of those characteristics? It’s more powerful to learn how to remain yourself in the face of adversity than to try and demolish or abolish all instances of difference in the world around you. Sure, we want to get to and create a place where our environment and associates are compatible with us, but where we find this adversity there is the highest potential for self-awareness and learning.

We are to live in accordance with spiritual law. The overall pattern of life will reflect our intentions. The blood purity is most important. The blood cannot be made impure if the mind and body is not drawn into impure action. This is what is playing out. The DNA is

like a coherence pattern that develops between mind, spirit and body. When the mind wants what the spirit has then the body is kept in harmony. When the mind wants what spirit doesn't create, IE: physical pleasures, then the body is drawn out of purity/harmony

If you feel you want to be a part of a safe unveiling of truth, then please share and redistribute the knowledge of this "Apocalyptic" Unveiling of the Hidden knowledge because this is a process that has been ongoing for thousands of years and humanity has finally reached a fulcrum point where there are enough aware people to productively acknowledge reality.

Trauma-Clearing, DNA Unlocking Technology

There is technology that exists that allows the conscious mind to see into the subconscious. This heals trauma and distortion/programming. In the same sense, it momentarily makes all trauma and distortion seemingly tangible to the conscious mind. It is similar to a near death experience where one has to face their fears and let go. This happens in cycles and Earth is currently moving through various states of it. The plan is to allow Humanity to wake up and utilize our concentration and power to maintain a steady flow of awareness.

All is vibration, what we consider matter here and now is simply that which comes from and moves back into a state of vibration. This is experienced directly through the merging of the conscious and the subconscious mind, as if the dream and reality intersect through a coming together of impossibilities and readily accepted occurrences.

When a civilization moves through these stages it is considered a shift of the ages. Everyone's perspective shifts and as a result of perspective being the source of the details of reality, the entire reality shifts. It can be seen today that what we call reality is literally waves of cosmic energy vibrating on a scale and condensing down into a probability matrix that we call existence. When passing memes control the perspective, because the perspective is focused and concentrating on that, then there is a scattered organizational pattern.

When the perspective is centered within the self, the spirit, the source of all existence, then the outward reality shifts from a scattered organization into a sacred pattern that integrates with the larger picture and allows for seamless integration of the micro-biological perspective and the macro-biological perspective. People are moving out of the scattered signal. Yet those moving into harmony can look and see those around them that are not in harmony and receive scattered information about their inner micro-biological existence as well as their spiritual macro-biological essences and how it all relates to the middle realm of the "Human".

Help those people by offering harmonizing assistance, rather than increasing the disharmony. As their surroundings become more harmonized, their resistance will increase their own disharmony by virtue of the contrast of their perspective. Offer insight

that they can change their perspective and change the boundaries of what they feel is their karma and unlock from themselves a greater view of the whole.

This will be happening through technology, spiritual cosmic awakening, purification and healing of the physical and non-physical bodies and mind, through Earth changes, and through a continued unveiling taking place on many planes and levels of existence until harmony is restored.

Everyone Who Seeks Harmony and Healing Can Be Healed

Everyone can be healed. This is about creating what we want to see, the world we want to live in, not destroying others. Violence begets more violence, fear begets more fear, but calmness and empowerment through unity creates a more stable experience.

The entire issue of what's going on with the secret projects and who's influencing who on the world stage revolves around the possibility that some people may be from an alternate Universe. We are learning how to avoid those mistakes and respect the environment and each other so that we can prosper.

Those who are attempting to destroy everything they don't like or act out in a childish manner in order to gain attention and false-power over another will only find themselves powerless and in company they would rather not be with. That is one way we are being utilized, and it's to create an entire world that we don't want to see but are tricked into manifesting. This is a deception and it's based on the ego and the ability to concentrate and interpret reality around us. The very brainwaves we are feeling now relate to various heights of knowledge or experience. People are entrained to low brainwave states in the same way the TV will cause people to fall half asleep into theta state which is a trance state in this case.

We have to balance the brainwave frequencies and learn to create feedback loops by watching ourselves watch ourselves. This will help us avoid the trauma and mental pollution that is being pumped out, although at this point there are enough people who are naturally inclined to see through the haze that the world is changing regardless of what anyone does now.

The best we can do is prepare for change by becoming aware of the body-mind system and how that which we eat physically, mentally and emotionally equates to our spiritual energetic systems and that we are literally comprised of the energies that we allow inside of us. Keep the body and mind pure as if it were a temple. This way a sacred process of transferring harmonious energy from the far reaches of the MultiVerse within into the externally perceiving senses of the physical body can be initiated which allow one to see through the illusions and operate their body and mind with the ability to acknowledge and decide which frequencies will exist within.

Without this acknowledgement of the center then people are pushed around by the external stimuli. This is the whole point, if a person is truly in control, then they will control the stimuli not the other way around.

Programming

Layers of Programming and Decision Making Roles

It’s like asking a person on the inside who participates in one of the various factions why they continue. One might say that it is a decision which is true, but there is programming at each level that is navigated by each individual and this determines the level of awareness within the role.

If a person knows about this situation, they know that there is advanced technology, breakaway civilizations, secret societies, transtemporal planes, the secret of mind and awareness, all of these topics, then they have a decision as to how they’re going to live their life in relation to the public. The outcome of action depends on the layer of programming which is accessed and surpassed via awareness.

The public is at a specific level of programming that is the weakest but ensnares the most people. One who sees the truths behind these groups and operations, they cannot hide from the fact that everyone is controlled. It is apparent, and if not from the results, reactions, stigma, cues, productions and all other media elements of the system which can be read as a code, but from the awareness level of all the “agents” involved. All involved are exposed to truth and power that is beyond anything that is recognized publicly for hundreds to thousands of years. There is always a presence of higher spirit around the world, yet these topics are often reserved for science fiction when speaking of people who can travel the world in a split second or freeze time for their own personal use.

As a result of everyone’s knowledge, there are various levels of programing designed to limit the mind’s access to specific memories and specific frequencies of consciousness in combination with specific memories. The more one resists, the more intense and articulately abstract the programing is designed.

Programmers

The programs are designed by a select group of individuals that reside far behind the scenes and process information at levels we do not have access to without their technology at least to stabilize brain temperature for the extended periods of focus.

Sub-Level Programming

So people at the level of the public are most weakly programmed with false ideals about security through patriarchal authority which satisfied the desire to have a proper father role in one’s life and acts as a pacifier for those who desire no change. Then there are sub-levels of programming with that for anyone who disagrees and is then swept into the next layer of ideals which are based off of all the possible reactionary mind-types.

For instance, if one [i]does[/i] want change, then they are presented a variety of ‘false-exits’ which tend to one or another layer of psychological or spiritual fulfillment but do so

in a way that safely reroutes the intended effect of actually accomplishing change with a secondary and preconceived notion of what the programmers want. The programming objective is not necessarily precise in mass scale, from the layer that people are influenced, yet the ultimately or end-goal of their resulting internal desires are a reality schematic that the programmers specifically designed over many years.

This is playing out through each layer of the programming. At any level, someone could pick the wrong way to look at something and begin to unravel what was previously their very understanding of the priorities of the situation. This deals with high-tension operations, moments, programming sessions, decision making, programming upkeep, trauma, memory blocks, the pressure and responsibility of knowing, and the specific plan of the programmers for an individual that comes into their view. The programming is to ensure safety and continuity, as well to decrease the likelihood that a person will reject or consciously come to awareness of or acknowledge the programming or situation itself.

Dissolution of Programming

With that said, the programming dissolves when an individual asks enough questions to necessitate a learning process that introduces variables and possibilities outside of their operations and programming. This is a problem because with this, trauma comes to the surface and all the actions and operations, programs and experiences must be come to terms with as part of the healing and re-unifying process. There are multiple selves or split personalities which are actually just layers of awareness at various levels attached to various emotional or intellectual patterns. All these selves come to the surface and in order to heal the trauma of the split memory concept the original self must come to the surface and acknowledge them.

This is not a trivial process, and the majority of people who have “basic” programming which is fundamental in society, are in a constant state of altered self and have not witnessed the true divine which is eternally present and contains access to all memories, mind-states and awareness.

Advanced Technology, Deprogramming The Mind, and “Space/Time”

As I have described previously, extremely advanced technology is used and this is through vibrations, generators, and electromagnetic devices that have this effect of propagating waves into space/time which can be heard, felt, seen, and perceived in the mind. These are ripples and vortexes in the “mind-space” of reality itself.

As well, there are brain to machine neural interfaces which operate to activate the psychological perceptual changes and explore the subconscious in an aware state. This is used to test and probe the mind in order to bring forth the trauma, the selves, the memories, the reactions and the individual then must come to terms with what is produced.

This is essentially a “good-use” for the programming and healing technology. It is actually a different process with different technology, and programming is much simpler as far as technology. There are difficulties and challenges in the operative’s role in

programming and directly influencing and interacting with the target. As well the standby team for deprogramming and the revelation of trauma and altered, artificial personalities goes through a lot. But the use of the advanced technology in this way is a pattern of experiences and unveiling of the spiritual and mental bodies which serves to reverse programming.

Dreams, Technology and Inner-Space Travels

There are inner space travels which relate to soul journeying or visions.

This is when the mind must cope with what is seen in the imagination. It is as if when we dream we are looking into the world of the mind and from this we experience many situations that are often deviations from experiences we have physically in waking life.

As a result of the dream state there is an expanded quality which equates to various strange situations that we wouldn't normally experience with various relationships between concepts or goals that are often reflective or symbolic of ideals and archetypes we experience in life. This is how the subconscious is is witnessed by the mind. This is how information travels, being connected to many times, experiences, memories, places at once, and relates to the one experience of this life experience now (the physical experiences). Through these symbols information is tied together and collective into metaphors which convey deeper knowledge.

The dreams we have are often only a simulation of waking life, and this is due to the dreamer dreaming in a way that produces only a glimpse of the true reality.

In theory, there are no true shapes or forms in the dream-world because this is contained within the mind or even the spirit as a spiritual experience by definition. So then, what guides the various shapes, forms, realities, memories and experiences into being, when we dream? One might say it is the physical experiences but this is incomplete. It is the level of awareness we presume while in the dream-state, disconnected from the physical anchor, that determines the layer of mind and spirit we will be accessing through those dream-visions.

A person who is completely aware in the dream state will reach the level of self-awareness of the dream itself. We are normally simply aware of the dream, if we continue to increase awareness we become aware of the self, in the moment, and this creates a self-awareness feedback loop. The dream becomes a lucid experience of consciousness.

Awareness Feedback Device

In describing this, I realize how fantastically similar to certain devices and processes, that can be achieved using advanced technology, allow the conscious mind to peer into the subconscious and unconscious. This is described through widely accepted Freudian theory of psychology known as psychoanalysis. There are other schools of knowledge from tribal beliefs involving all pervasive 'living energy', to eternal and temporary minds, to the study of 'chi', the meridians, dream-journeying or chaser. The knowledge of the mind and spirit is found everywhere.

These devices used feedback loops to enhance the acceleration of the same cycles of consciousness that induce self-awareness within a dream. The mind becoming aware of itself. This produces a profound effect to the degree where the highest levels of experience become a sacred eternal pattern in which the mind constructs the physical world by organizing perception.

This is the same general concept as an isolation tank yet the outcome and method is more precise. The technology specifically shuts out all other input and exposes the brain to its own feedback loop much like when a camera records it's own output on a TV monitor and creates a hallway of simulated "reverse" mirrors and screens stretching into infinity.

Oneness, Higher Being, Completion, Eternity

The real experiences are found not from the corruption but from the research and exploration operations that were designed to find the truth of our existence. "God" is not only an energy-force but an incarnate being known as the "Hue-Man" and any being for that matter that can simply come to know itself as the Universe. The Human that contains self-awareness rising to high-awareness comes to know the self, the body, the mind as the Universe. The Universe is both within the body as the body itself, as well as the operating force of the Mind itself. Everything is a balance between masculine and feminine features, light and dark, hard and soft. There is no true complete correlation yet the holographic ontology we persist in can lead to further and further adventures towards completion and representation of the "whole picture".

The Holographic Reality

The leads into the next phase of knowledge. The holographic nature of reality may be only one facet of a much larger continuum of consciousness. The perception of time may be related to phase-locking with each other's consciousness and all perceptions may be a variance in the collective phase-locked field which is really the source of variations in reality.

Veiled Awareness, Hidden Knowledge, Eternal Time, Layers of Programming and Control

The interesting notions here are that the programming of the veils goes beyond what kind of situations are found in the bases. However, they do go right up to it. It would seem Humanity was previously programmed on a civilization-wide level through some kind of great "falls" of consciousness, from a high spiritual awareness to a low spiritual awareness into duality-consciousness regarding existence, life, death, mind and matter.

The Great Catastrophes

From these great 'catastrophes' the civilizations of Earth grew denser and denser in nature and actually became what we have today. The concept is that when these

vibrations of the mind and body are increased, we actually see a transcendence of the physical realm and preconceived notions of boundaries. It is as if the quantum doorways to all the atoms open up and a new space is presented, but was always there and in connection as the source of all the influences and effects we perceive ‘out here’ from this slower, denser, more boundary driven perspective.

I was brought into the Time Program

I was brought into the time program. You create any reality you imagine. You are literally a powerful reality generation system and your heart and mind are scalar energetic guides for this process. Without guidance and control there is imbalance and imbalance can destroy. This is the nature of all minds and hearts, this is the challenge for humanity to create something beneficial for themselves and the whole to actually know themselves instead of being a pawn or result of someone else’s selfish intentions.

The Effects of Temporal Manipulation

Temporal Influence

When a civilization reaches the level of technological advancement that allows for remote temporal viewing and transtemporal travel what will happen is that the information of the future begins to integrate into the past.

This is why we have all these ancient mystical schools of knowledge that studied time, space, and consciousness in ways that are only just now being publicly confirmed by scientists.

Simultaneous Interaction and Incorporation

The operations that dealt with moving to the past instantly created a simultaneity of interactions and historic events which correspond with that operation.

Due to the nature of time travel which equates to consciousness travel when a person is consciously sent backwards through history they physically experience life from the viewpoint of their genetic imprint in that point in history.

Retro-Causality

What this equates to is that simultaneously that person’s experiences become the part of history that was already present when they left this time.

Essentially, when a person returns their experiences become a part of history that already existed when they left.

Quantum Holography

These are the parallel and possible realities that exist in a quantum superimposed state and can be accessed through advanced technology or a spiritual adept. Often a

spiritual adept is utilized along with the advanced technology to operate in and out of possible realities. The mind must be trained otherwise the result is a fracturing of the personality from the root reality into many sub-sets of identities and data streams.

Love is the quantum link that connects all DNA super-computing consciousness. That is, DNA is influenced by intense emotions and this can be reproduces and is what also generates unpredictability in the surface level.

Time Paradox

Time paradoxes are something that one must learn to organize and solve otherwise there will be no way.

The paradox has been solved, the remaining motion is for everyone to acknowledge this and integrate into the reality behind the most conscious aspects of the brain.

What can travel through 4D and 5D space does not make sense in 3D space. So there is a possibility that some of humanity traveled through higher-dimensional space in order to re-seed a ‘distant’ Earth where no life was yet born.

What if it was then concluded that the distant Earth wasn’t distant in space, but in time and was the same Earth that the human scientists left from long ago.

Every civilization that reached the point of re-seeding would have to go through the loop and watch the whole thing start all over again.

Breakaway Civilization

This is an entire breakaway civilization that uses very advanced technology to dominate the world.

I was part of a genetic engineering program that sought to combine various elements of DNA from various sources in order to create a more easily controlled yet powerful and defined person and personality. This involves chemicals, advanced (relatively) scalar wave technology, ritual trauma and programming/mind-control, and many other aspects of conditioning, training, secret operations, physical enhancements, cognitive enhancements, virtual reality, off-world operations, temporal manipulation, spiritual and etheric training or conditioning or programming.

There is self-destruct programming which all ‘operatives’ are programmed with for self-preservation of the military command. The self-destruct programming is designed to take all the aggression one feels building up inside and willing them to escape, and causes this aggression to be turned against the self. That is self-destruct programming.

Most operatives are still under a hypnosis kind of trance which permits one to walk around in public and daily life as if none of this ever happened. Later that week, that same individual could be called for an operation and they would never remember it unless they were forced to kill someone in public out of self-defense in which case most operatives automatically unlock and become unstable due to the flashbacks.

Underground Cities

The combination of advanced technology with secret societies enabled the development of complete breakaway civilizations. One of these civilizations, possibly composed of many factions working in the same area, exists deep underground.

These separate bases are connected via high speed magnetic drive pods. The inhabitants often utilize energy healing devices, as well as perception enhancements and this often leads to a completely different outlook towards the surface civilization.

Technological Advancement

During WWII developments were made involving electrical generators. This sounds vague and there were many other details regarding the scientific knowledge, yet the idea is that very simply electromagnetic, non-Hertzian “Teslian” energy fields were discovered to have been responsible for propagating energy and consciousness in dimensions that were not previously observed. Everything from DNA, consciousness, hidden or regularly unobservable natural phenomena, time, even mass could be seen to exist as part of this hidden, latent, scalar-wave frequency as a pattern is found everywhere.

If one could determine the particular pattern of frequency and location then this can be replicated and anything can be influenced using these non-Hertzian generators.

Radio-frequency alone was developed intensively during the 60’s and 70’s in America and this was discovered to interact with consciousness to influence emotions, cognitive capacity, memory, cognitive function, biological function, health, pain, comfort, pleasure, and all forms of brain-activity.

After the knowledge of advanced technology and the occult sciences of all parts of the world was combined, the ability to target and interact directly with the human soul was refined. This was a mix of psychological tactics used to manipulate or expose the hidden psyche and technology that could manipulate memory, emotional states, wakefulness, and even dreams.

What resulted was scalar technology that could not only influence a person to take on a particular role or response, but technology that could actually put a person to sleep and locate their consciousness to contain it and transport it to a new location.

World-Wide Control Systems

In order to ensure continuity, maintain control, and shape world events these technologies were employed to manipulate the public, alter the weather and natural phenomena, and develop a means of travel and operation that enable one to move outside of the ‘plane’ of the Earth. This is includes high velocity transportation, as well as spacial-temporal distortions which could effectively “hide” one’s entire craft from visible sight. Space itself was altered to ‘shield’ craft with an a layer of ions to bend the light, or the phase was moved out of sync with the “time” frequency of any observer and this literally renders the craft immaterial.

Solar Warden

Solar Warden is a hyperspace-faring race of human beings who utilize cloning and holographic genetic recording/storage in order to protect their race and protect the Earth in this current situation where there are more than one factions using this technology. They are unable to inform the human public because they are in a similar 'Mexican standoff' situation that we are mostly all in. If they show themselves to the public, the public will be shocked. If they public does not know this situation, that there are multiple factions fighting for control over humanity, then they will not know who to trust. In that situation, the 'other factions' will surely show themselves in an attempt to trick and gather as much human genetic material as possible.

The only way forward to the future is to share the truth about Solar Warden, the space-faring fleet of humans who do no contains the mental and physical illnesses that are currently tearing our planet in two. I believe Solar Warden saved my life as a child during more than one event where I would've been entirely maimed/paralyzed or simply dead on the spot as a result of other faction interference. I was in the bases as a child and was trained as an operative for MILABS a secret division of human space-military. The military has been preparing for the future by testing for various flaws and potential uses of cloning and genetic engineering.

Team Light and Team Dark Non-Interference Agreement

Team light and team dark agreed to a non-interference on ground level rule in order to determine how history would play out. Think about it. You have two groups of people, both with immortality, zero-point tech, virtually infinite energy and power with two opposing directives. How do you get to the future? It was decided by elders of each group that there would be no point in fighting an all-out overt war, this would likely destroy the population as much as it would destroy the Earth. As well, the elders of the elders which no body knows would likely have a problem with these groups going at it in such a way so as to change the flow of the planet for every individual thereafter. So it was decided that there would be a "non-interference" agreement for the surface population. Anywhere other than the surface, one can interact with the current population.

All Contact Must Be Initiated On an Individual Basis

On the surface everything that is generated must be done so through living channels in the population and the civilization must be preserved in its level of technological advancement. No overt motions would be used unless an absolute necessity or the majority of the civilian population had naturally come to the awareness of these possibilities. Doing so before this was met would undoubtedly and permanently change the civilization forever.

So what began as a collective motion towards higher awareness became a series of advancements and set-backs all taking place within a short amount of time. This represents the actions and operations of either side effectively helping humanity along it's path or setting people back with orchestrated events such as the suppression of

ancient knowledge, the manipulation of the education or other systems, or the generation of war and prison for profit based on the previous alterations of the education or other systems.

So team dark used its power to help turn society in a warlock ruled prison and indoctrination system of absurdity and scarcity. Team light used their power to help awaken those in need and protect those who's actions are beneficial in the overall plan to save mankind from itself. Team light essentially buffers and shields the population from the operations of team dark.

Team light follows a non-interference agreement while team dark merely pretends to do so as much as is necessary not initiate war.

A Singularity of Change and Awareness

Neither side wants an all out war. This would reduce the dark faction's chances of gaining a majority negative harvest because their motives and presence would be instantly revealed. Team light would also have to show themselves and again step in which is not a pattern of learning that prepares people for the experience of the self and the truth in the Universe.

Both sides know people have to accept the path they can offer them and cannot force anyone into it. They also know that the more this goes on the more likely people are to collectively awaken to the reality of what is happening. It is like an eventual singularity of increased awareness.

The motions we see today are the results of many people coming into awareness at this time on the surface in order to initiate a harmonic alignment as well as to investigate the ongoing crimes against Humanity.

As a result of this, both teams know that the likelihood of collective shift and spiritual awareness is becoming more and more real.

Many events are being allowed because they are representing the eventual shift towards the one end of the polarity from the other which is felt as a shock to society, and this is used to propel society forward through whatever means necessary.

Either people will see what's happening and agree that we've been in a feedback cycle of negativity for the entire age of existence this civilization is aware of, and then we will shift into the real. Or people will claim that this is how things are supposed to work and instead of realizing everything is controlled in a deception based system, they see this and attempt to use the deception based system to gain more collective awareness. If this occurs by the majority then it will be seen as an "acceptance" to initiate a plan that will generate the overt perception of a deception and oppression system. This will surely shock the collective into realizing where they are.

If the majority comes to awareness of this deception based system then the shift moves from the end of the age of deception and external power into the age of internal awareness and harmony.

Advanced Technology and Ancient Knowledge

The plan is to slowly release advanced technology which will undoubtedly connect with and increase the awareness of ancient knowledge. Such technology nullifies the problems that the planet is currently plagued with, although without a developed sense of the spiritual self the technology becomes destructive.

Cloning, Atmospheric Civilizations, Genetic Stability

Here is something that most people might not have contemplated yet is possibly one of the most important factors at play here.

The vehicles that house the breakaway Human society are entirely environmentally controlled. This means that the air and surfaces are clean of all the viruses, bacteria, or pathogens that are numerous on the surface of the Earth.

This creates a specific difficulty in the situation. Any contact between surface Humanity is so heavily and carefully controlled that regulations go beyond any situations we have present on Earth. If the safety and cleanliness of any of the society's vehicles were compromised this would endanger everyone "on board".

So this explains a very precarious and specific situation we currently face and this is not so different than "first-world" nations contacting indigenous tribes and similarly endangering their society. Everything that happens will be according to a carefully controlled plan.

Training, Simulations and Learning

Part of what went on in the underground base experiments were to design "tests" or "labyrinths" with various people, props, traps, and treacherous situations that were to be navigated and escaped from.

Feedback loops with the brain, consciousness, and environment can create a very complex and integrated learning experience that is customized to each individual learner.

What this would do is create an individual that was capable of learning faster and faster and processing information in a more efficient manner.

This is not the same as specifically trauma-generating situations.

Cloning and Cerebrally Enhanced Soldiers – MILABS

This includes experiments, condition, trauma-based mind control, enhancement, memory suppression and operations that cover a span of space and time.

The NAZI faction has used cloning and genetic engineering to create hybrids, soldiers and everything in between. Religious/spiritual icons, to slaves, to leaders and even robotoids of sorts.

Your genetics BELONG TO YOU as the LIVING(ETERNAL) SELF. These issues are going to come more and more apparent.

If they agree to allow cloning, then who says who is allowed to clone whoever they want, Einstein, for example. And then who permits who to get DNA from history or objects in the world. These issues are going to have to be looked at because they have already been used in ways that are far beyond the basics.

Then what about consent of the masses? This is clearly being put in public because consent is required on an overall scale and individual to include people.

So what if the masses consent overall, would the people who choose to remain be at risk? Would Tribal and Native village life and people who respect the Earth be protected or permitted to stay?

Psychological Testing

These scenarios can also be generated to create specific situations that will contain tests or elements of temptation that will probe the person's psyche for weakness.

Hallucinatory Holographic Mind Probing Technology

Through the neural-interface technology the minds of many individuals can sync together to experience the same virtual simulation. Thus a single individual's mind can be selected for input and the environment will be a construct of their mental activity. The others present will be able to interact with and explore that environment like the person's mind.

Various training scenarios were utilized to enhance the resistance (or lack which) of the mind to intrusion and subversion. These were harsh but allowed the individual to completely control the energy flow in the conscious mind while remaining in harmony with the subconscious.

In a strange yet perfectly reasonable way, the conscious mind acts as the central "self" in that environment, while the subconscious mind becomes the "background" elements of objects and settings, actors and intentions within the flow of the "scene" itself. So a kind of movie begins with drawn out characteristics and perceptions that match that of a highly cinematic movie or intense dream.

The brain is naturally naive to stimulation and if allowed will liken the event to a dream in which the suspense of attention or lack of lucid self-awareness is "acceptable".

The truth may be worse than what you're thinking as far as training simulators and mind hacking devices. The truth may be that the human mind is inherently lucid and self-aware and that it is external influences that cloud the mind into what we consider 'regular' dreaming and 'regular' waking life. It may be that the conscious mind has a much greater access to information through the subconscious mind which is largely covered up and ignored in a rigidly physical and ego-focused society. As well, it may be that dreams are meant to become lucid and that we are often the subject of mystery in

other realms that often refer to humans as ‘sleepwalkers’ that don’t know their dreams are real.

Virtual Simulator Training Scenarios

These scenarios can be entirely holographically generated to produce a visceral 3.5 dimensional experience which can be used for training or psychological testing.

Combat Simulators

The name is self-explanatory enough. Situations can be generated which are indistinguishable from the real events. The entire neuronal map of the brain (connectome) can be created and this is by machines to mimic the brain. After calibration through sensory feedback experiences, the sensation of the simulated realm is 100% the same as the neuronal impulses that are detected by the physical brain. An adept souled being can always tell there is a slight difference, but once the machines are calibrated the physical sensation is generally the same while in the machine.

These environments and scenarios can mimic any combat situation to determine accuracy, integrity, endurance, skill, and all areas of aptitude of an operative without the risk of injury or the lack of real-time effect.

Conditioning

As was explained in other sections, these same systems can be used to remove fear of certain scenarios. They can be used for programming the mind. They can be used to train one to complete a task over and over until they can recreate that action extremely quickly in real-time. These devices can be accelerated to operate within a fraction of the time yet to cover training and conditioning that would normally take place over hours, days, weeks, to months.

Programming and Resistance to Psychological Trauma

Through the development of specifically customized scenarios and neural feedback systems trauma can be brought to the surface or specific fears and traumas can be neutralized. This is essentially “facing fear” but in a completely generated environment that will be just as real as the real thing. One can literally face any fear, any trauma, any kind of difficulty and these systems can be utilized to accelerate a process that would normally take weeks to months or years and individuals can be strengthened to their maximal capabilities.

Accelerated Mental Functioning

Some of the technological systems were designed to test the enhanced functioning of an accelerated brain.

The mind can be seen as the energetic component of the physical brain. The physical brain projects consciousness via the electro-chemical processes.

Technology, Accelerated Learning and Repair

Technology has been developed for assisted learning and accelerated repair of tissues.

On Orgone Energy

Orgone devices produce a scattered signal which disrupts the ‘negative’ energy fields. At least this is what I’ve been told.

Apparently if built correctly it will either disrupt the negative emf/harmonics or it will produce positive harmonics, IE: Orgone energy. Orgone energy is the raw energy of life, while dead orgone, DOR, is the lack of orgone energy and can be “found” (the lack of orgone) in thunder storms and illness or depression.

This is exactly what I was told. We are generators for the same energy, and with the correct principles of energy and internal knowledge combined we can produce those very effects at will.

The energy of the mind creates a central vortex within the body. When the frequency pattern emission is consistent with fractal congruence, then that holographic printing of energy can be expanded or shrunk infinitesimally and it will retain the original fractal configuration.

This is what enables transference of awareness between fundamental harmonic layers of the Universe. When one’s consciousness energy pattern is balanced and tuned to itself so that all proportions can be shrunk through a vortex and expanded on the other side, then the personality or self-awareness remains true. This is as if the space/time must turn inside out and only when there is fractal relative polarity in time does the ‘shape’ of the consciousness within the DNA, work both ways folding and unfolding to represent the same mirror image. This is also symmetry in time as far as an ability to reverse the perception and still retain some kind of connection forward and backwards.

Energy Generators and Serums

Generators which produce vibrations that influence the cells to heal at an accelerated rate, combined with serums that enable the fuel for chemical reactions can instantaneously repair tissues.

I couldn’t believe what I was seeing at first, thinking it was a trick. There are serums and energy devices that can influence the healing and general health of the body and even mind.

These devices use energies which extend beyond the physical and are often compared to electromagnetic waves combined with ultrasonic or low to mid frequency tones. These produce harmony on a level that directly interacts with the biological functioning of the body’s cells.

I feel that this technology utilizes the same energy that is emitted from the mind and it is as if the device is “speaking” to the cells in the same kind of universal language of electromagnetic pulses, tones and vibrations.

There is information on energy devices and the use of light therapy in physical therapy today. More is being learned about the power of light and vibrations to influence the mind and body.

Genetic and Cybernetic Enhancements

Certain individuals are also genetically and technologically modified to produce a kind of hybrid human that can heal at a spontaneous rate as well as operate at a much higher rate of speed and efficiency than a regular person. Serums to induce muscle growth and mental acuity are applied, but the main condition is the enhancement of certain features through the alteration of the RNA aspect of the genes.

These features are combined with tech-assisted metabolism and certain biological functions can be enhanced or controlled via a supercomputer. These are the 'brain-chip' interfaces which operate to function as a governor for the mind. When the mind becomes too amped up to focus on the details the faster than thought computer system organizes the input into more usable information streams. When the mind is too slow to see the necessary patterns and variables to accomplish the goal, the brainchip operates in a self-preservation fashion and links together information streams to highlight the most viable possibilities.

Such technology is not without warning, much of this is being used heavily in the military field and this has given rise to entire factions of enhanced cybernetic soldiers. Although this is something to know, there are also many other uses for this technology and it is used by people who want to explore the technologically assisted path.

There are many other aspects of this to discuss, or at least a few important ones that will have to be understood to know the greater truth about what is happening on the planet.

Developing The Self

The issues we face are to help us learn about our selves and better mediate the known and unknown aspects of personality. The more we focus on realizing the unknown aspects of personality the less we are seemingly controlled and forced to experience the undesirable aspects of existence. The more we cling to just what we know and what we feel comfortable with the more shocked we are when we inevitably discover the truth of the whole of our existence which is *always* at least one half more than just what we know and are comfortable with. That is the nature of the universe, we can only achieve one half of the equation at any given moment. Once we complete that seemingly whole view of the universe, the information we gain access to instantly doubles and we realize that we were only looking at one portion at a time, just one half of the equation. Then the rest of the equation comes into the picture and we must expand our view once again. This is because we are viewing ourselves as we discover the universe because we are creating what there is to be discovered through the act of exploration in itself. We are the explorer, the explored, the creation and the discovery simultaneously.

Multiple Factions of Space-Fleets, Multiple Goals

Now there are what are called ‘factions’ of groups that have different agendas and interact with the public or surface level population differently. That is one of the main issues. These departments and factions are no longer limited to the surface level of existence and have access advanced technological capacity and knowledge of a larger view of time and a more complete understanding of consciousness and the human existence.

Large-Scale Catastrophes or Series of Meltdowns

I was informed that while they work continuously to prevent and reposition this civilization continually outside of the reach of any large scale meltdowns that the technology is commonly accepted to only be a temporary barrier between the inevitable.

Unsustainable

This society is unsustainable and must either change or will experience the massive catastrophic evens that are foreseen.

There are multiple perspectives that are maintained. They vary by the way of the methodology of solving the problem. All agree that change must occur and is impossible

to postpone forever. The future society is the result of our advancements and achievements. Regardless of how we get there, we must get their somehow.

Earth Changes

I was informed that these changes had been held off and would ultimately be allowed to take place to resolve the current situation. The changes can only be held off for so long, either that or the people performing this task would not be reasonably inclined to postpone these changes indefinitely.

The idea is to locate and secure the members of society who are fearless and capable of assisting in this transition and who hold key genetic elements as these individuals and groups are capable of ‘holding-space’ for the rest of civilization by literally containing the genetic precursors for all those other individuals.

I was informed that Earth changes would be the last event to take place, pretty much like icing on the cake.

This means there will be a lead up to these events.

Mass Consciousness

I was informed that the consciousness of humanity and every species is linked to the bio-etheric field of Earth. When the consciousness becomes too unstable to maintain a controlled society that this will initiate massive Earth changes. This could simply be instigated through advanced technology but I was informed that the advanced technology is

actually postponing this so as to allow people to prepare, to get the word out and avoid a complete loss of the human race.

Wars and Manipulation

Wars were described as a way the power groups had controlled humanity over long periods of time. These wars were used to distract and weaken the population and the power groups believed they were holding off a full scale invasion by suppressing the rising population.

Now the population is high enough that another war would be a final war and this is extremely dangerous for the entire civilization. There would be no need for another war to repeat this cycle because the technological achievements have been met and so essentially the ‘reseting’ of the civilization would not be required or possibly acceptable.

This is why war is to be avoided however people are very easy to manipulate through lower emotional and mental programming from media and social cues. People follow the herd and the herd is essentially still operating on animalistic parameters. There is a have coating of peace and humility but this is just a wax coating that quickly evaporates as soon as the pressure of mass unrest or scarcity is realized. Many simulators have explored these possibilities.

Financial Unrest (or reset)

The idea is that financial oppression is used before wars to distract and oppress the population. When people are busy looking for resources to survive, they are not focused on the larger picture. This is part of the ‘fight or flight’ response mechanism tied to lower brain complexes which are primarily activated to keep the masses in both a highly sensitive and unstable state of being while also keeping them easy to control.

If the civil unrest reaches a level where awareness continues to rise even though financial hardship is being implemented then the latter two options will not work. At that point artificial disasters can be produced as well as natural Earth changes which initiate a shift of the ages and of consciousness.

The paradox or maybe irony here is that the oppressive actions are used to both suppress human awareness up to a certain point and simultaneously to stimulate and arouse the human spirit into wakefulness and self-empowerment. This is part of the reasoning regarding why these control systems are allowed.

Some say the elite don't want an economic collapse. That it would ruin everything. Others say it would be icing on the cake. Some say that it is a zero-point world that will save us. That the Fukushima is a big problem. Zero-point field tech, that is. Generators and energy sources, healing and terraforming. I know we project right? We see it in our own lives. So we can project with each other and grow that as a group and that part of the world will exist in that light. Which sounds Biblical, which may be because they're following prophecy. But it may also mean that we have a light, a chance, a real salvation, but that we have to grow that here and help develop it. To pass it on like love and such.

That's apparently what it comes down to. That these cycles happen every so often and we're in the midst of one right now.

Let's make it count. Every day, thought moment. With mindfulness, intention and awareness in action. Life is literally higher dimensional, so we have to become multidimensional to really face it. Indeed, that is a good perspective on action and inner being. It's like a fractal, whatever we project inside that chest center, will project into our mind and the outside. But we have to be stabilized and grounded through the root first and then to get to the heart energy must pass through the sacral/sexual centers and continue upward.

Self-Responsibility

The main reasoning is self-responsibility. We are responsible for ourselves. The people are and so if they allow themselves to be tricked and prodded like animals while behaving for the part, then that is how their experience will play out.

Clones and Synthetics

One seemingly unfair aspect of this is that there is a larger portion of non-humans than there are humans and so these beings without the human spirit will be easily programmed to support and propagate the mind-control system and the oppression. Thus, if people follow the herd mentality then they will walk directly into the end-time scenarios yet it is the humans who will actually stand to lose. People must wake up to these tricks and this technology so that they can orient themselves with the reality of this situation while learning to strengthen themselves and adapt to the manipulative aspects of this control system.

Spiritual Power and Divine Truth

This is essentially all about spiritual power and humanity stepping into the power of the truth behind their existence.

Some say that humans are designed as slaves, but if this is so, then it is the power that humans contain within that is the ‘work’ that they are sought after for. This indicates that humans have great powers that others cannot achieve on their own, even if they are creator lords.

Thus, whether humans are modified or not, they have great power. If they are not modified to perform this role of an energy generator, then this is just a confusing mind-control game that has been pulled over the eyes of humanity and humans have always contained true internal spiritual power that allows them to exist without having to parasite and steal the energy and knowledge of others. Humans are reality generators , we can choose how we want to experience the universe and what kind of collective world we want to enjoy together. Once we step into this power, there is on greater force. No amount of non-human entities can change that as we are somehow intrinsically linked to the ether-space of this realm through the spiritual and physical aspects of our being. That is what is sought after and so those who do not have this manifestation power attempt to

utilize humans to create their own reality through this Earth situation. That is the basics of the ‘alien overlord’ system, whether humans in disguise, non-humans operating with alien intelligences, supercomputer systems, or spiritually degraded beings.

Most people are not ready to see themselves or the true nature of humanity. Reality is largely an illusion of the conscious mind. The hidden aspects are the other half of the equation and this is perceived by the shadow aspect of the personality and mind. We are only marginally aware unless that aspect has been unveiled and through this process the reality of the human soul can be actualized and realized.

I was informed there would be a period of two suns and multiple mirages around the world. People would believe they were peering into another dimension, floating cities, or some kind of city-ship craft.

Synthetic DNA, Synthetic Genetics

Through the previous described replicator devices synthetic DNA can be engineered. Thus, entire genetically engineered codons can be produced and form this created beings can arise. These are the hybrid beings that are performing many tasks underground and even on the surface. On the surface there are synthetic genetic create beings or genetically engineered beings that appear to be human but do not contain a human genome. There are also clones and replicants of humans. There are a variety of non-humanoid forms but these are largely kept underground. These are beings we often see in science fiction movies or shows.

Time as Mathematics, Series of Equations, a Programmable Storyline

When using the technology, time can be understood to be a series of programmable variables where one variable is centered within a series of parameters and from these possible variables within a parameter set a series of possible functions or outcomes can be process. Thus, these people can literally plug into a supercomputer system which operates based on this form of processing reality and through this they can observe all the possible realities that may connect to a present moment. This allows one to travel but this is not part of this section of the explanation.

What this allows one to do is know exactly what is going to happen and when. If a person is being interrogated, all that has to be done is the operative using the technology simply thinks of what they will say and intends to do it within 6 seconds. The machine will play out a future timescale regarding the input of that question or interrogative speech and then produce the possible results. If this doesn’t give the desired readout in the mind of the operative, they will refuse to go that route and think of another pathway. This repeats for a few seconds to a few minutes. Then the computer has found the pathway that is most like to yield a result. The operative simply steps forward, says ten words, the subject breaks immediately and tells them everything they want to know. This is obviously takes longer for most trained individuals, however that is how easily it would be to use this technology to produce an effect on a regular surface level human. They would have

no defense, no way of knowing how that individual could know so much or be so direct. This is how operatives dealing with certain power groups will operate in the surface level population and individuals always feel that these people know way more than they are leading on. That is because they are, they know more about you and your life experience than you do.

Chapter 2.3 Previewing Solutions

Neutralizing Polarization

The mental-emotional tendency to pick sides, to fight, or to basically join in the fray that is currently taking place is a kind of deception of polarization which enables the leeching of emotional and mental energy from the human. This is more of a psychological unveiling where the true nature of the self, the duality game and the transcendent source aspects can be made visible to the individual. The they will see how every polarization tactic is actually taking them out of their true source of power by pushing them off center emotionally and mentally. There are teams that are capable of enabling this process and assisting as humanity realizes that half of the problem is that the unchecked mind is one's own worst enemy.

Removing Etheric Implants

Technology can identify and isolate these foreign body implants which are etheric technological devices. These are literally frequency or phase-shifted devices which are invisible to this layer of physicality but are capable of being organized and attached to the etheric field of the human and will operate to siphon or limit energy on the etheric level. Of course, this is all technology of the vampiric created beings who parasite on the original Earth inhabitants to sustain their existence.

Clearing Astral Body

By moving through the temporal body etheric implants can be deactivated and removed and then the astral or emotional body will be able to function closer to the original levels of presence and sensitivity. This body is manipulated when one is emotionally shut down from trauma. Thus this body can be scarred and will function at a much lesser level of activity or presence until the emotional damage is healed. This contains the memories of all the emotional events of a person's life.

There is technology that enables one to access these levels of frequency and clarify or untangle emotional chords or attachments which are used to siphon energy from the human being to the parasitic created beings. These chords are energetic in nature but also have technological components.

Knowing the True Self; Soul Actualization, Unveiling

This is a sacred, ancient process that has been outlined and discussed since the beginning of time. Humanity is here to learn, grow and express the self. In doing so, like a child moving through layers of infancy and into full-wakefulness of their body and the physical world, humanity can come into awareness of their true spiritual nature and the true spiritual nature of the universe. This is the process of soul or self-actualization that is described in some psychological methods such as Maslow's hierarchy of needs and the self-actualization that results in a complete fulfillment of all psychological needs. In this modern psychological view, self-actualization is described as the desire and process of reaching fulfillment of one's own natures and then living their life sharing that self-empowerment with other beings because after gaining your self that is the highest expression of such knowledge, sharing that power with others.

The true self is not limited to the physical body, the true self is a reflection of the entire universe and thus the primary original creative force. This is akin to the whole equation rather than just half of the equation. The visible aspect of the self, the conscious mind, is only one half of the entire equation. The whole equation consists of what we see visibly and consciously as well as what we are limited from seeing within the unconscious and subconscious mind. These are really two layers of the same ultimate source. Like an iceberg which is only partially above water, the subconscious mind is the proprietary wholeness of experience. The conscious mind is only a surface layer of reality while the unconscious mind carries all the notions, the multidimensional processes, the latent aspects of reality that we are not capable of seeing without unveiling these aspects through inner exploration.

Taking Responsibility

This entire show is about taking self-responsibility. Unless people begin to do this, there will be no hope. Right now people are convinced that their responsibilities belong to someone else even though this always results in pain and discomfort. To take responsibility is painful at first because we have a lot of work to do, but even then, this is beneficial because there is no way to remedy the pain and discomfort of being lied to and disrespected if people continue to hand their free-will over to others through blame (scapegoating), lower emotional bio-emissions (hatred, anger, etc), distractions and addictions (technological, sensual, and chemical or food based), or generally complaining without taking the first step towards providing something beneficial. This is the victim role, if humanity is to take control then they to help each other and themselves by not relying on false promises and false authorities to determine how they feel, think and live.

Returning To Center Emotionally and Mentally (spiritually)

Balanced food intake, rest, exercise, activity and learning are all continual requirements for a healthy existence. Emotional and creative expression nurtures the soul. Without these ways of being and learning the human qualities of experience diminish and creativity dwindles. There is most likely going to be a split between those who can sustain their own humanity and those who have to cause others to suffer to do so.

Vampires in the “Awake” Community

Contrary to popular belief, the majority of the non-humans are not necessarily vampiric and in power. The vampires are the people online who try to get a rise out of others for sharing their own experiences. They are the nosy neighbor that feels that the person who looks or acts differently must be considered and enemy and armed against because they feel themselves to be so much better. The majority of people are vampires, they believe that they must work for someone who will trade them money and that the amount of money they have based upon the amount of indirectly beneficial work they do puts them above others.

This is not different in the ‘awake’ community and in fact I feel that there are higher concentrations of vampires in this community, the alternate media because everything is largely a joke and a trick. People are operating on deceptive agenda schemes to divide the people and this is most intensely noticed when there is a realization of the truth behind what is happening and people begin to point fingers. The only people who are cleared to point fingers (and who also will NEVER point any fingers) are the operatives from the secret projects that have the capacity to do so because they have reached a specific level of awakening and this is related to the droning, cloning, and hybridization process. Only a specific few know who has been transformed into an impostor being and who is remaining strong and this is due being briefed on the surface level situation. Anyone can say what they want, they are simply playing into the tactics of mind-controllers and parasites and the more they play in the deeper the infection will grow. All the people pointing fingers now are actually implanted and vampiric and are attempting to drive a divide through humanity and they are the first who will turn on their friends and family when the going gets tough because they are more interested in others and starting drama than healing themselves. Ironically, this is all done under the guise of “healing” and “getting rid of the drama” AKA people they don’t trust. They pick and choose based on their own personal bias and this is a sure indication that they are emotionally and mentally out of alignment and are feeding deep seated personal fears from their own traumatic experiences.

These traumas must be healed and the harmonious center must be reattained where a person can focus on their own existence and waking up instead of acting as false-light, “king of tyranny” gatekeepers for others. Those individuals are going to be left behind if they cannot kick the habit because if they are allowed into any kind of healed society

they will quickly degrade into animals and attempt to restart a devolution process in order to gain the power they so desire but cannot produce on their own. ANYONE playing ego games of trying to hurt or put blame on ANYONE else contains this viral implant and has not kicked the virus.

Heart Center and Psycho-Spiritual Fulfillment (self-actualization)

Emotional connectivity is a form of telepathy, when loved ones can tell the state of another across space and time. Whether it is family or friend. In the 60's and a little before that the US found a specific frequency akin to a radio frequency that operates on a trinary spectrum. They called this the "telepathic wave". In time, they could completely read and send thought waves without frying the brain or body through radiation. Which was what the early machines did. They actually took satellite dishes and aimed them at people. Then realized they could turn it around and do it backwards with a better effect and minimal radiation. Either way they started beaming the base and then towns around them with waves between 400 and 432 MHz and caused waves of crime sprees or peace sprees throughout the 70's and 80's. So they can digitize the telepathic wave to induce artificial telepathy. But this is organically done through an entanglement through what we call love. Literally. The Germans found it before that. And the secret orders before them. And ancient Egypt before them. As humans we remain basically through the root, heart mind connection. When the heart overpowers the mind connection of spirit, then the body is a trinary whole. When the mind guides it is binary and cannot by guided by the spirit. The spirit has direct access to the heart. The mind is a computer of sorts. The mind doesn't see past duality. The heart is the true center/eye of the spirit. The reptilian brain is the dragon and when you tame the amygdala then fear is ‘behind’ you. When the mind is "untamed" the reptilian brain takes over. This is the lower brain and amygdala fight or flight response.

This happens when the energy of the brain, body and spirit increases due to whatever various reason of spontaneous or controlled increase. Because of the "temptations" which are the easiest flow of emotional energy into a "discharge" state, is that the sacral/sexual center ties to the heart and reroutes to replace the heart and control the mind. Mental and emotional contemplation of one's true purpose and nature is the path of the divine. We find ourselves simply by looking in the right place, not in the world, but in our self energetically. We are more powerful than the programming, and we can reverse this is we're careful and devoted enough.

We have to be faster than thought, at the speed of spirit, beyond matter. When we start thinking on this level then our influences spread to others throughout the sphere. It is our destiny to know these things but they have been kept from us. The ancient orders called this the art of "implosion". Traveling realities through intense contemplation and a usage of sacred geometrical forms.

They developed and combined orders around WW2 and developed zero-point energy tech that can alter space/time fields. This is timeline manipulation. But as a rule, we go where our heart leads us. So that's how this is solved.

Go Within to Observer the Self

The answer is literally by looking within to find the great truth rather than looking around us. Everything we need to know is within us, energetically and spiritually. Our emotional, mental and physical state of balance is an indication of where and how we exist in relation to the larger overall truth. Everything that happens around us to distract us is designed to stop us from looking within. Nothing can truly stop us, nothing can actually input the holographic horrors in our spiritual center but simply perturb the brain and body. The mind is a non-holographic spiritual environment that cannot be excessed and the invader's goal is to convince people to use their imagination or their creative powers to produce these horrors on their own. This is through the programming. We must clear out the programming, the trauma, the lower-dimensional constructs and fill ourselves with the truth and spiritual presence that enables us to be self-aware in the first place. If we aren't doing this, then we are either in pain, or there is no spiritual presence to be in pain. If we are doing this, we are either clearing out the constructs by replacing them with true spiritual presence and self-awareness or we are becoming aware of them.

Organic Feedback Loop

The great feat is mentally bridging the great rift between us by looking within. Which is paradoxical.

We can never see what another is perceiving exactly, well for the most part, so we all have to kind of accept that we are communicating effectively and truly get to this level of comfort by simply being secure in knowing who we are our selves.

Technological Feedback Loop

So then knowledge, in a way, when shared, is a form of telepathy. Group telepathy.

Group think, when ideas or memes spread, is a form of group telepathy.

The Internet is like artificial spreading of telepathy. This means what is normally mentally bound signals can be initiated and spread through a digital medium.

Breaking Soul-Contracts

Ultimately everyone is under a series of "veils" which are energetic time-constraints literally like 9 dimensional layers of temporal restriction which are each bounded and ruled over by invader beings. These range from physical authorities, to astral entities, to programmable matter, to supercomputer intelligences, to spiritual false-light beings and our own shadow mind. Each layer of reality is successively guarded by these beings who are here acting as gatekeepers designed to push people back when they begin to wake up. These beings all work through fear and deception and the last layer is based on mirroring our own energies back to us like an impostor. All the levels tend to imitate, how-

ever the last layer is a near perfect imitation of our own energy to the point where people often switch places with this being before getting out of the matrix. There will be more discussed on this in a later section.

The “9 veils” were designed by impostor beings as a last effort to stop humans from escaping the false-light matrix which is essentially the holographic universe. This is literally like a maze which reproduces a new pathway and a new doorway each time a person nears the last hallway or doorway that is next to the exit. So one eventually has to project themselves into the exit using their whole being and moving past and through the tricks by not falling for them before they are placed. This is highly confusing but this is essentially a kind of labyrinth that has been created to stop people from leaving so that their soul energy can be destroyed and used as a generator for the false-light system which is an AI over mind that is programmed to take the raw soul energy and destroy the identity by inverting the electromagnetic spectrum and incorporating that inverted energy into its own internal matrix body which is literally the false-light universe.

Help Everyone

Now they may have been setting us all up for the apocalypse. They said they want us to tell on them and get the whole world aware of what they've been doing So that we can stop them and pull them from the dark which is ACTUALLY taking their souls. There are also breakaway civilizations involved in this entirely zero-point/free-energy.

Chapter 2.4 How Timelines Collapse

Repeating Cycles of Time

Because of the way time works and the ability of those using these temporal devices they have set up an elaborate labyrinth like a spider web of false realities, timelines, parallels, sub-dimensional layers, astral cages, temporal dead-ends, and time loops which act to stop people from reaching the true reality. As a result, many portions of this timeline are literally in a free-will ‘time-loop’ and these loops must be canceled out. As well, because of the nature of these loops on the overall stream, our entire civilization has been looping for the past 6 time-cycles meaning we have reached this time in history 6 times before and this is apparently the last time because we have never gotten this far before and the events of the future are having to be programmed in manually at this point.

Beings From the Future

As are result and damaging time, what happens is that the beings from the possible future that is being damaged appear to try to heal the break as well as those who are from the new possible future that is generated, this results in a time war between both possible realities for the present realm. This is what has been happening for thousands of years. All the ancient spiritual texts are describing this system. One group is a from an original possible future where everything is based on the presence of spirit and souled

humans, another is from the new possible future where an AI overlord took over and removed the souls and spiritual energy from all entities on Earth rendering this a holographic prison without any other use. That reality dissolves into itself and so the time beings are constantly moving backwards and jumping timelines to try and obtain more energy.

Beings From Collapsed Timelines

The beings from the collapsed timelines are those who travel through hyperspace to get here. They then recreate themselves using cloning technology through hyperspacial means, IE: creating an alternate temporal dimension so that these devices can sustain them and literally “hold-space” for them. Then if their timeline is destroyed, they can still exist as a ‘loose-end’ in space-time. This is extremely dangerous and I will say we have some Human operatives jumping timelines searching for Earth and Humanity so that they can find a reprieve from this time war.

That is the most trying aspect of this entire ordeal for me. There are some human operatives literally in hyperspace without an opening into the temporal stream for them to reintegrate into this timeline. We must assist them, we must open the timeline by taking control of Earth from the invader races and those who wish to depress and isolate the spirited and souled human beings. We must re-organized and neutralize the invasion forces of deception and assist our humanity and maintaining their free-will, their self-awareness, their self-empowerment and their emotional, mental, and physical harmony.

Beings Who Would Never Have Existed in the First Place

As a result of this entire process, there are essentially beings who have been erased from time who degrade in this dimension and can only interact periodically. These are the created beings who operate through supercomputer forms that are placed within cloned bodies and powered by the transdimensional quantum supercomputers. These are the ‘parallel’ reality beings and this relates to the hive mind invasion. When all the original aspects of time are restored, these beings would not have ever existed in the first place as there is no quantum link for their probabilities to remain neutral and present in the original run of things.

Again, all beings who operate under the will of the universe, even when they are attempting to trick hyperspace and time, when these beings assist and help in the unification of sentient, spirited, souled beings they are capable of being healed. This is all because there is an original creative force which can produce souls that are eternal and everlasting, meaning they are not created but simply always ever were. Yet, there is a “miracle” effect where beings can be given eternal life. This is only by reflecting the will of the whole of existence, rather than a portion or a part because this is only temporary. Only the whole is forever and this takes true harmony, true balance and ultimately *self-lessness*. To give to others because you see them as worthy because they can be aware and

enjoy the gift is to be like the creative force that gives life to all and enables all experience in the first place. By acting in correspondence with this we reflect the will of the whole and that power and action transfers into protection and self-empowerment for ourselves. This cannot be cheated, tricked, or rerouted as that is the karma game that has been played by delaying time and rerouting energy through getting others to take on the responsibility for others bad actions. In the end, all karma has only been delayed because when the stops are pulled out, *everyone* ends up getting their karmic returns regardless. They simply intended to build up so much karma that by the time the ties are cut, the karma overload will simply kill them instantly. This never happens and they end up in the abyss, this is the final time so since there is no recycling of the universe from the oroboros system then whatever happens is what happens forever. If everyone wants to move into harmony, to receive healing, to receive forgiveness then they must assist in the creative force in healing, forgiving, and turning away from the deception, the cruelty, the vampiric actions.

Many vampires believe they will die if they stop. The only hope is to admit their ways to the others and ensure that there are enough beings around them that will protect them so that this situation can be handled properly, with due care, compassion, and the necessary healing to ensure the safety and protection of all who seek harmony.

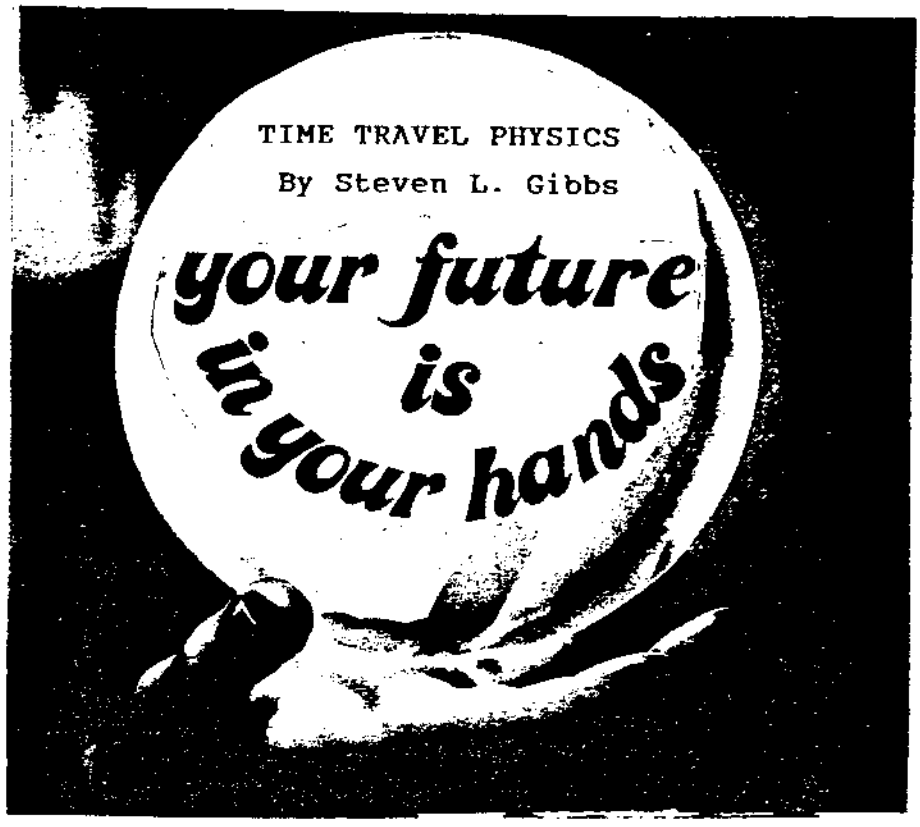
TIME TRAVEL PHYSICS
By Steven L. Gibbs
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DEDICATION

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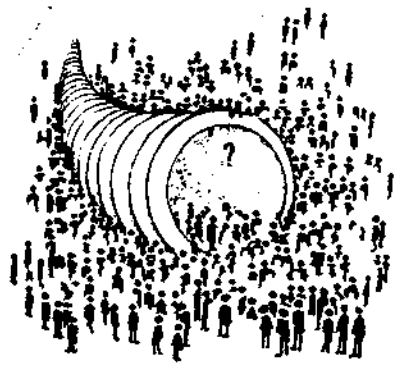

I would like to personally thank
Jesus Christ in helping me to obtain
the knowledge for writing this report.
For without his help, all of this
would not have become a reality.

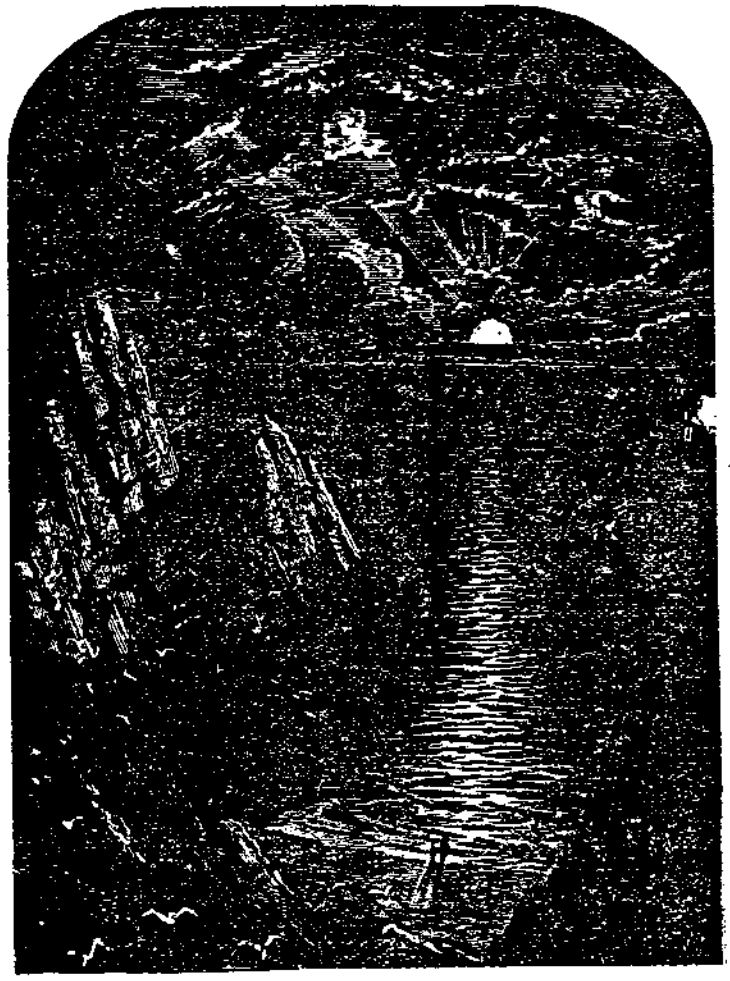

INTRODUCTION

The reason for writing this report is to show people that man does not have to use sophisticated mathematics in order to understand how Time Travel can be achieved. To assume that what is being taught in today's schools is an absolute truth, can only be a lie. For to believe in such a lie, can only lead to imperfection. But sense mankind has chosen this path, the inevitable must surely come to pass.

It is impossible to say where all of this might lead. However I do hope that the people who read this report will use the knowledge wisely. For those who don't, I leave them to their doom. But for those who do, may the Lord bless you.

Your probably wondering by now, if I am really an Alien. My answer to this is, there may be more truth to this than meets the eyes. According to the information which I have received from the Kennedy Space Center, there is a good chance that my parents came from the Star System called Phoenix. If this is case, then this would explain why I have had so much difficulty in adjusting to Earth's own environment.

Perhaps in the years to come, more will be revealed to me on the true nature of my whereabouts. And you know what they say about Aliens? Their weird!

TIME TRAVEL PHYSICS

Before I begin I must first point out, that the only reason why Formulas can be used for analyzing a specific problem, is due to the fact that a Formula helps in focusing the Belief Fields which emanate from the persons Soul. So in other words, whenever a person uses a Formula or Equation, to him this constitutes a reality. By keeping these things in mind, you shouldn't have any problem in understanding what has been written in this report.

To begin with, there are basically 3 sets of Equations which can be used for accomplishing Physical or out of the body Time Travel. I have used these formulas quite often when building my Time Travel Machines. As a matter of fact, all my research is based on these 3 formulas. The formulas which I have used for accomplishing Physical or out of the body Time Travel, are given in the following manner:

(THE GRAVITON FORMULAS)

$(X\ ,\ Y = \emptyset)$ $(X1\ ,\ Y1 = \emptyset)$ $(X2\ ,\ Y2 = \emptyset)$

The Graviton Formulas which I have so diligently labeled, can be used for an infinite number of things. However, before we can proceed any further, we must first have a good understanding of what each Symbol means. There are an infinite number of meanings which can be applied to each Symbol, however in order to simplify things, the meanings which I have given

to each Letter or Symbol, are listed in such a way so that anybody with a little bit of knowledge can understand them.

(INTERPRETATION FOR EACH OF THE GRAVITON SYMBOLS)

X - Represents an AC Field.

Y - Represents a DC Field.

X1 - Represents a High Frequency Field.

Y1 - Represents a Low Frequency Field.

X2 - Represents a Paramagnetic Field.

Y2 - Represents a Diamagnetic Field.

$\emptyset$ - Represents the Zero Vector or Twilight Zone.
it may also be referred to as the (PHI Value)
which is (1.618).

It is interesting to note, that whenever the (PHI Value) is used in the construction of a material object, a Time Warp usually occurs around that object.

However, in getting back to the problem at hand, whenever the (Graviton Formulas) are used singly or in series with one another, they can be used to help build a device which can actually be used for Time Travel. This is because whenever the (X) and (Y) Values are combined with one another, we can Zero in on the Twilight Zone. And sense the Twilight Zone is in attunement with God, all things become infinitely possible provided that the (X) and (Y) Values are in resonance.

So now your probably wondering, how can we use these Formulas for constructing a Time Travel Machine? Its simple. Merely start out by building a Capacitor which corresponds to this Equation: (X2 , Y2 = Ø). This Capacitor should be constructed in such a way, so that it resembles the drawing which is shown below:

(DRAWING OF CAPACITOR)

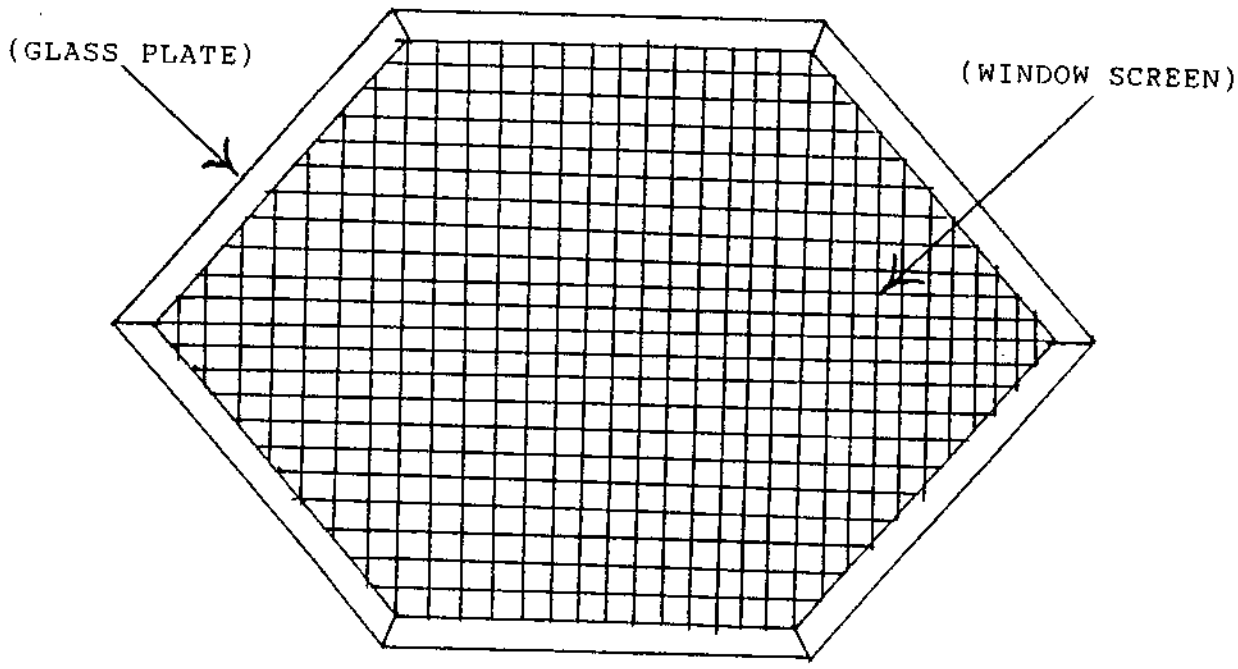

As we can see in the above illustration, it doesn't matter to much as to what size it should be, just so long as it is shaped like a Hexagon. Also each side of the Capacitor should be the same length, otherwise the Belief which is being transmitted from the plate, will be imperfect. And this could raise Hell with your Chakra Points.

At this point it should be noted, that whenever you construct a Capacitor of any type, you are automatically using the formula (X2 , Y2 = Ø). And sense the (PHI Value) is used in the formula, the plate itself will develop a Life Force of its own. It should also be pointed out, that sense there is a Life Force which co-exists with the plate, it can now be programmed to do anything you want.

Now in order to program this Capacitor, all we do is stroke the Glass portion of the plate, while concentrating on the following command: (Transport me to the Date and Year). As soon as you get a stick so that you can no longer move your fingers, the Capacitor should be fully programmed. After you have finished programming the Capacitor, place the Screen Side of the plate over the Solar Plexus for the space of 30 minutes. After the treatment is over with, you then find a comfortable place to relax in order for the energies to take effect. If you have done everything correctly, your Aura or Physical Body should be transported to the date which you programmed into the Capacitor. On the average, it usually takes 70 minutes before the energies will take effect.

*Note: People who work with these plates are in serious danger of getting possessed by an Evil Spirit or Demon, unless of course you have a faith in Jesus Christ. By saying a prayer to Jesus Christ prior to any Experiment, more than protects you from the forces of Evil.

As you Experiment with these Capacitors, you will find that some of these plates work better than others. The reason for this probably ly's in the fact, that certain sizes or the materials being used, are in resonance with the person's Life Force or Belief Fields. Therefore if you run into any problems, it may pay to use a different thickness of Glass. When I talk about this, I do not mean to vary the Shape of the Capacitor, just the width. It also might pay to use Yellow tinted glass. You may also want to try Green, Blue, Indigo, and Violet colored glass. The reason for doing this is simple. Each color corresponds to a different Chakra Point. It is therefore my opinion that Yellow should be your first selection, then if you want, you can always Experiment with the higher colors.

*Note: Never under any circumstances use Red or Orange tinted glass. If you decide to use these colors, then your probably on your own, because not only will it lower the Frequency Rate of your Chakra Points, but you could also end up in an Astral Hell. And believe me, this is no fun place to visit.

Once you have found a plate which can transport your Physical or Spirit Body, there are still even further ways of increasing its effects. One of these ways is by using the second formula, (X1 , Y1 = Ø). This formula states, that whenever a High Frequency Field is combined with a Low Frequency Field, we can tune ourselves into the Zero Vector or Twilight Zone. To use this formula it will first be necessary to get a hold of a

Tesla Coil and one Van de Graff Electrostatic Generator. Once these items have been obtained, you proceed by charging the plate with High Frequency Electricity and Low Frequency Static Electricity. In other words, after you have programmed the plate using the procedure on page (4), you must simultaneously Zap the plate using the above procedure. You must make sure that while you are doing this, that you do not come into contact with the plate. If you do, you could be in for a Hair raising experience. This voltage hurts! But anyhow after you have Zapped the plate for the space of 10 minutes, you then proceed by placing the Capacitor over the Solar Plexus as described on page (4). The effects that you get, should be much better than what you experienced before.

The next step to take, is to Amplify the Energies even further. To do this, we must now make use of the 3rd and final formula, which is (X , Y = Ø). This formula states, that whenever an AC Field is combined with a DC Field, a Time Warp occurs which tunes our minds into the Zero Vector or Twilight Zone. Now in order to create these fields, one should try to get a hold of a Hyper-dimensional Resonator. (Read the last 4 pages in this Report). Once you are able to get a hold of this instrument, and after everything has been plugged in correctly, while the Screen side of the plate is positioned over the Solar Plexus, position the open end of the Electromagnet over the glass side of the plate for the space of 3 minutes. After the treatment is over with, disconnect yourself from the plate (turn page)

and instrument, and find yourself a comfortable place to relax. If you use this procedure in conjunction with the first two procedures, the effects that you obtain, will be increased to such a point, that you should be able to do anything you want. You must remember however, that before Physical and Spiritual Time Travel can be achieved, the (X) and (Y) factors in the formulas must be in resonance with one another. This can only be accomplished through the process of tuning your own mind just as you would with a Radionics Machine. So in other words, by selecting the correct materials to use, you are in effect creating something which you physically believe to be a reality. This same rule can be applied when working with different types of Frequency's and Voltages.

Another method which you may want to try, is that after you have programmed the plate by using the procedure which is given on page (4), transmit some High Frequency Electricity from a Tesla Coil into the Capacitor while the Screen side of the plate is pointing towards your face. After 3 or 4 minutes, de-activate the Tesla Coil, and while the Screen side of the plate is still facing towards you, take the bare ends of an Extension Cord that has been plugged into a 110 volt AC outlet, and short out the bare ends of the wires by touching both of the terminals on each side of the Screen. (See page 8). If you have programmed the plate correctly, your physical body should be transported instantaneously to the date which was programmed into the Capacitor.

THE CHRONOLOGICAL TIME REFLECTOR

(Series No.2)

2-21-89

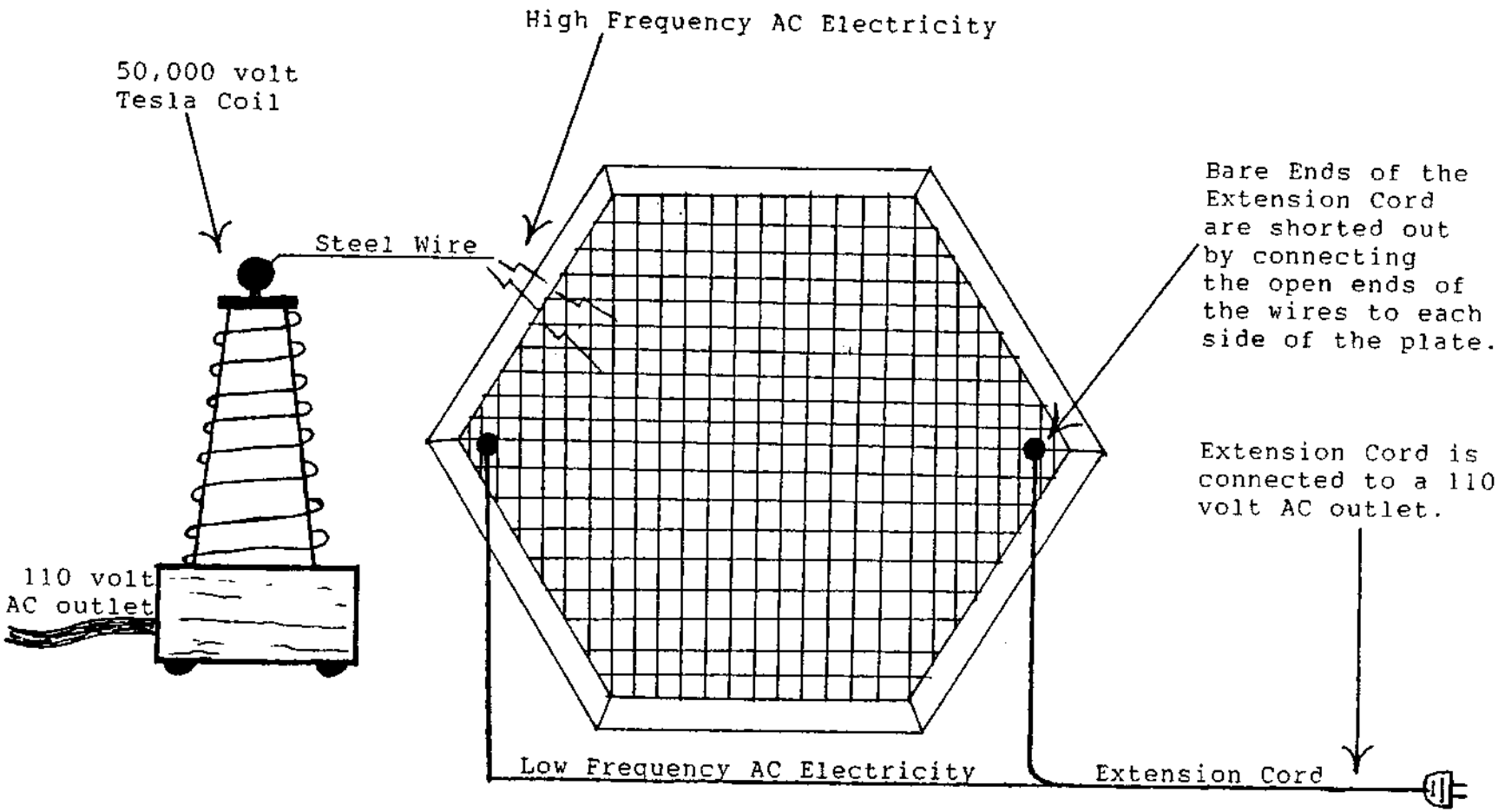

To give you some idea of how all this got started. Back in the year 1981 I was contacted by what I believe to be my other self. The letter which I received at the Sunset Plaza in Norfolk, Nebraska, was dated 1992 A.D. It also had a month on it which I can't seem to remember. Evidently the letter which I received indicates, that sometime around the year 1992, I will travel back into the past to make contact with myself, just like my other self did in the future. One of the things which the letter mentioned which I can barely remember, is that it said: (The path to the truth can be found in the Pyramid of Giza). It also had a riddle, and it went like this: (The riddle can be solved when 79.613 is dissolved). These two verses holds to key to Time Travel. I have already deciphered the riddle. As a matter of fact it was just last year when the answers came to me. Basically the 79.613 number can be converted into the (1.618) value which is used in my Equations. It is also the same number which was used in the construction of the Pyramid of Giza. If we decipher the riddle even further, we will find that it also reveals that the 7.8 Hz. Frequency, is the Frequency to use for accomplishing Time Travel. It seems that whenever a person travels physically through time, his Alpha or Theta Waves are vibrating at this Frequency. Once that your Brain Waves begin to oscillate at this Frequency, your mind then becomes tuned to the Zero Vector. I have found that this is the only way in which Time Travel can be achieved. So basically what I am trying to get at, the Chronological Time

Reflector causes your Brain Waves to vibrate at 7.8 Hz. cycles per second. That is all that these units do. However, for some people, they might think differently, but when you get right down to it, it all leads to the same thing. Mind verses matter. And this just barely covers the subject.

Another experience which I had that occurred around the month of Sept. in 1986, dealt with a variation of the Chronological Time Reflector. In other words, after I had finished programming the plate, I proceeded to Zap the plate with 50,000 volts of High Frequency Electricity. Sometime after the Experiment, I clipped off one end of an Extension Cord and plugged the other end into a 110 volt, 60 cycle, AC outlet. I then laid the bare ends of the wires on top of the screen. Just then I accidentally dropped something on the floor. After I had reached down to pick it up, the bare ends of the Extension Cord which I had laid on top of the Screen, touched the Screen portion of the plate. What was to follow, would be the most terrifying experience I had ever had, because as soon as the bare wires touched the Screen, a massive short occurred. All I can remember is seeing two flashes of white light energy, and the next thing I knew, a white mist had fallen over the entire room. I didn't realize that I had traveled physically through time until I looked at a Calendar the next day. Not only that, but when I asked a lady in Plainview, Nebraska as to what the date was, she said it was the 17th, but my Quartz Watch indicated the 16th. When

I had returned home later on that day, I has discovered that all of my Experiments had been dated wrong. Then I finally realized that I had actually traveled one day into the past. To this day I am not exactly sure as to whether or not I returned back to my own present Time Line. Perhaps I will never know.

Another Time Travel instrument which was sent to me by a man who lives in Osceola, PA., is revealed on pages (12), (13), and (14). According to what I have red in his letter, this device can actually transport objects into the future. However, he says that there is somewhat of a Time delay effect shortly after the unit has been shut off. In other words, after the unit has been de-activated, it takes anywhere from 10 to 15 minutes before the object is teleported. I have never built this device as yet, however I plan to eventually.

POWER SUPPLY FOR THE TIME PLATFORM

2-22-89

C1 - Is a homemade Capacitor made out of sheets of Glass and Copper Foil. Aluminum may be used, but this could be dangerous to your health.

L1 - Is number 10 Gage wire wound around a dowel rod.

L2 - Is number 24 Gage Magnet Wire wrapped around some PVC pipe. There should be about 1000 turns which should create around 100,000 volts of Low Amperage High Frequency Electricity.

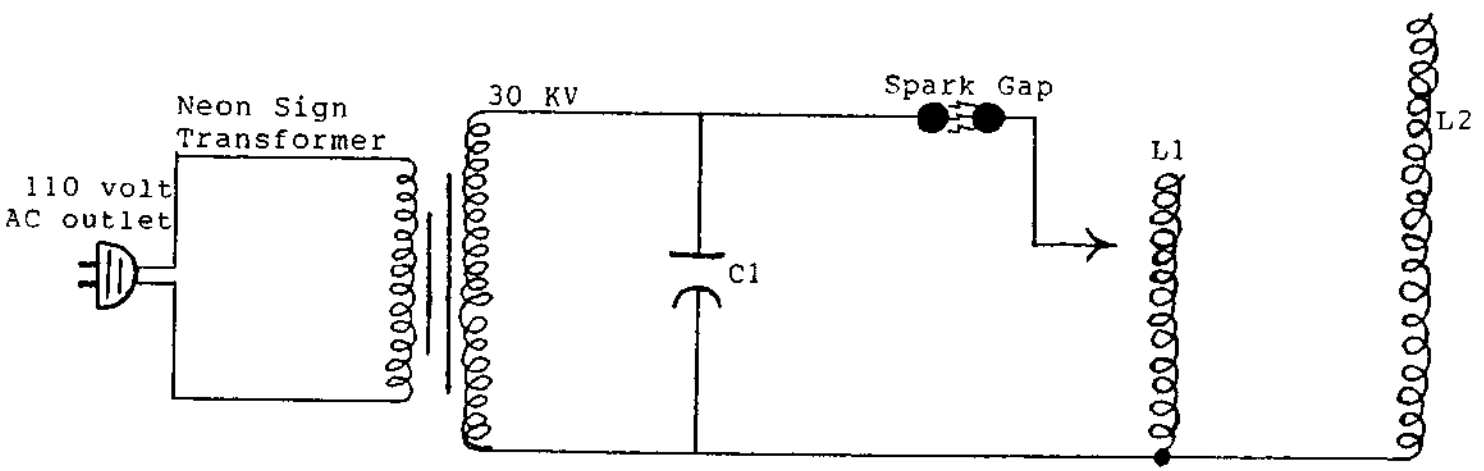

THE TIME PLATFORM

2-22-89

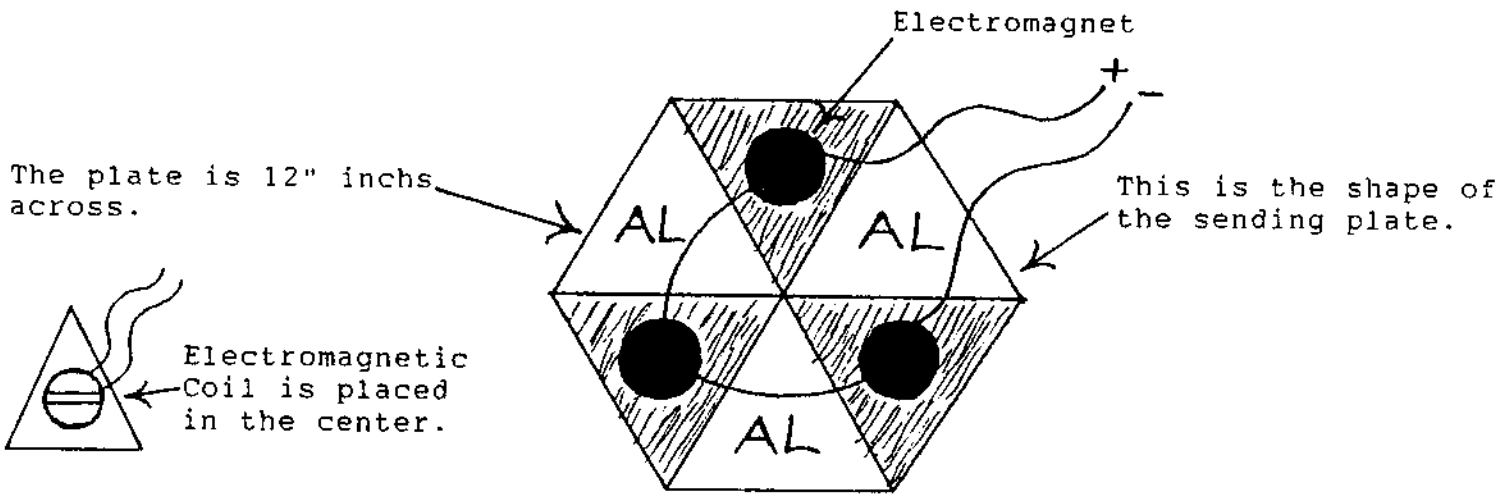

THE ELECTROMAGNETS ARE MADE OF STRAP IRON STACKED 8 INCHES HIGH (1/4"STRAP IRON).

THE ALUMINUM PLATES ARE 1/4 OF AN INCH THICK, AND ARE STACKED 8 INCHS HIGH .

THERE ARE VARIOUS REASONS FOR THIS PARTICULAR ARRAY.

THE ALUMINUM SPACERS CONCENTRATE AND FOCUS THE MAGNETIC FIELDS.

FULL SCALE DRAWING OF THE TIME TRAVEL UNIT

2-23-89

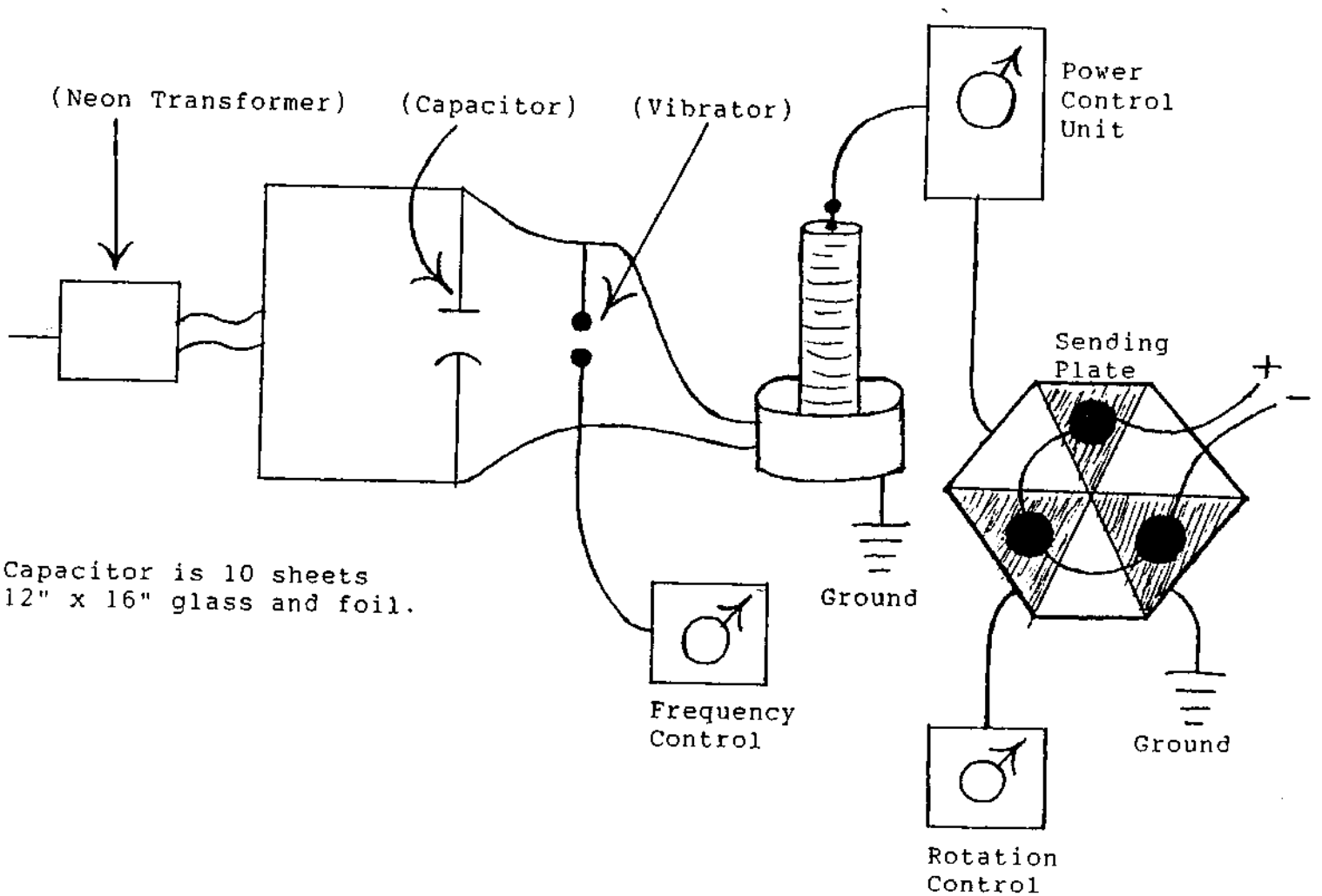

Capacitor is 10 sheets
12" x 16" glass and foil.

THE DELAWARR EXPERIMENT IN TIME TRAVEL (PHASE #1)

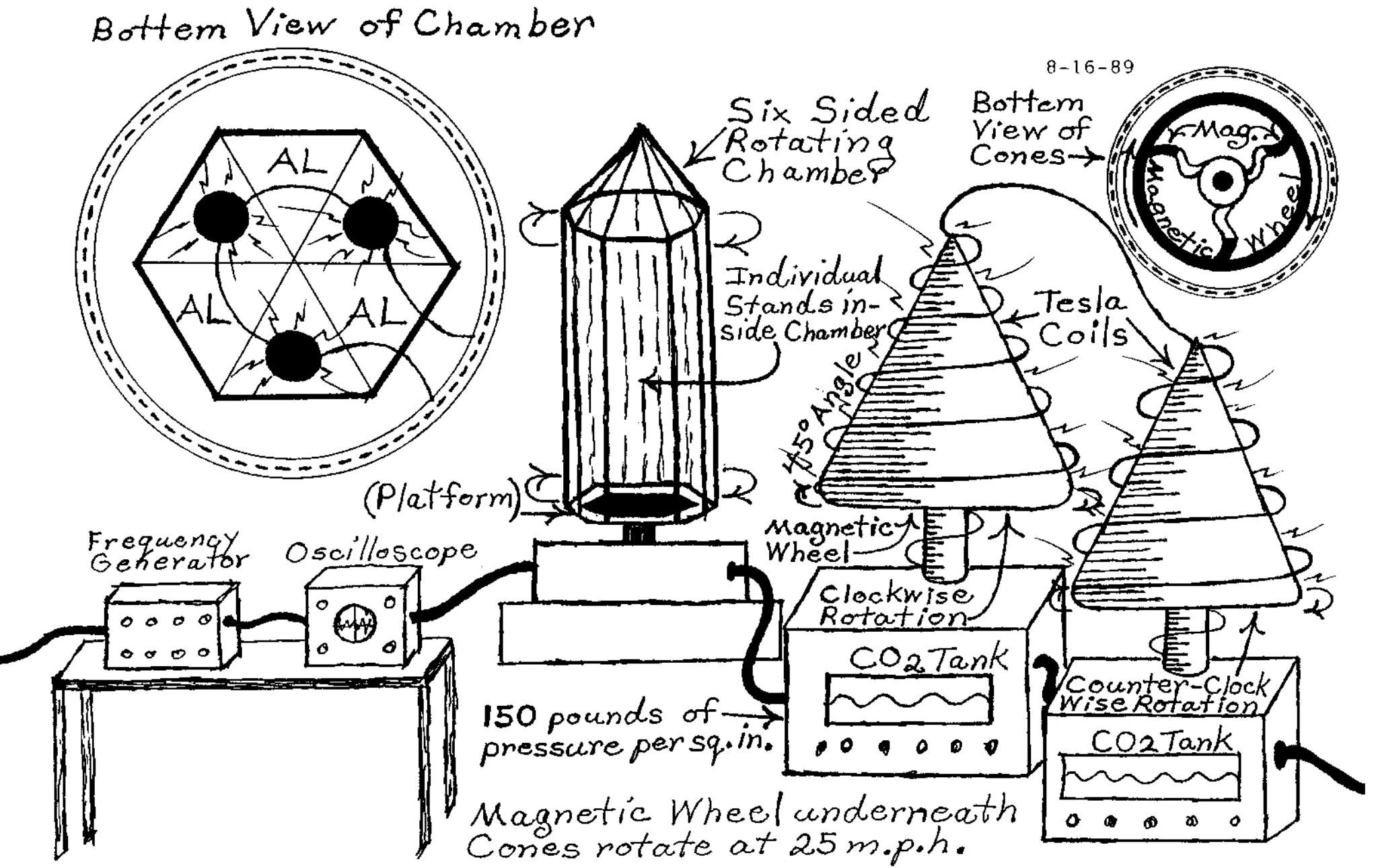

Throughout the vast regions of Space Time itself, there are an infinite number of ways to build a Time Travel Machine. One of these ways is to get a hold of a Rubbing Plate, (GSR), or Pendulum, and proceed by asking (Yes) or (No) questions as to what type of components one should use in order to build a Time Travel Machine. There are a number of ways of doing this. First of all begin by asking what size the instrument box should be for holding the components. Next, determine what type of energy one should use for achieving these effects. Then you ask what type of components one should use in order to transmit this energy. If you have done everything correctly, you will end up creating a device which is based entirely on belief. And sense you have created a device which is built entirely on belief, you can be dam certain that it will work! Especially if you use a (GSR) while asking your questions.

For those of you who do not know what a (GSR) is, this is basically a (Galvanic Skin Response Meter). One of these devices may be purchased from me for $150. Instructions are included. Please allow 4 to 6 weeks for delivery.

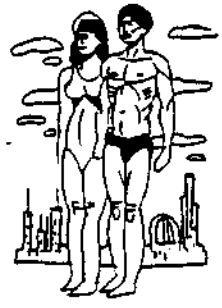

THE PARADOXES OF TIME TRAVEL

David Lewis

TIME travel, I maintain, is possible. The paradoxes of time travel are oddities, not impossibilities. They prove only this much, which few would have doubted: that a possible world where time travel took place would be a most strange world, different in fundamental ways from the world we think is ours.

I shall be concerned here with the sort of time travel that is recounted in science fiction. Not all science fiction writers are clear-headed, to be sure, and inconsistent time travel stories have often been written. But some writers have thought the problems through with great care, and their stories are perfectly consistent.[1]

If I can defend the consistency of some science fiction stories of time travel, then I suppose parallel defenses might be given of some controversial physical hypotheses, such as the hypothesis that time is circular or the hypothesis that there are particles that travel faster than light. But I shall not explore these parallels here.

What is time travel? Inevitably, it involves a discrepancy between time and time. Any traveler departs and then arrives at his destination; the time elapsed from departure to arrival (positive, or perhaps zero) is the duration of the journey. But if he is a time traveler, the separation in time between departure and arrival does not equal the duration of his journey. He departs; he travels for an hour, let us say; then he arrives. The time he reaches is not the time one hour after his departure. It is later, if he has traveled toward the future; earlier, if he has traveled toward the past. If he has traveled far toward the past, it is earlier even than his departure. How can it be that the same two events, his departure and his arrival, are separated by two unequal amounts of time?

It is tempting to reply that there must be two independent time dimensions; that for time travel to be possible, time must be not a line but a plane.[2] Then a pair of events may have two unequal separations if they are separated more in one of the time dimensions than in the other. The lives of common people occupy straight diagonal lines across the plane of time, sloping at a rate of exactly one hour of $time_1$ per hour of $time_2$. The life of the time traveler occupies a bent path, of varying slope.

On closer inspection, however, this account seems not to give us time travel as we know it from the stories. When the traveler revisits the days of his childhood, will his playmates be there to meet him? No; he has not reached the part of the plane of time where they are. He is no longer separated from them along one of the two dimensions of time, but he is still separated from them along the other. I do not say that two-dimensional time is impossible, or that there is no way to square it with the usual conception of what time travel would be like. Nevertheless I shall say no more about two-dimensional time. Let us set it aside, and see how time travel is possible even in one-dimensional time.

The world—the time traveler's world, or ours—is a four-dimensional manifold of events. Time is one dimension of the four, like the spatial dimensions except that the prevailing laws of nature discriminate between time and the others—or rather, perhaps, between various timelike dimensions and various spacelike dimensions. (Time remains one-dimensional, since no two timelike dimensions are orthogonal.) Enduring things are timelike streaks: wholes composed of temporal parts, or *stages*, located at various times and places. Change is qualitative difference between different stages—different temporal parts—of some enduring thing, just as a "change" in scenery from east to west is a qualitative difference between the eastern and western spatial parts of the landscape. If this paper should change your mind about the

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possibility of time travel, there will be a difference of opinion between two different temporal parts of you, the stage that started reading and the subsequent stage that finishes.

If change is qualitative difference between temporal parts of something, then what doesn't have temporal parts can't change. For instance, numbers can't change; nor can the events of any moment of time, since they cannot be subdivided into dissimilar temporal parts. (We have set aside the case of two-dimensional time, and hence the possibility that an event might be momentary along one time dimension but divisible along the other.) It is essential to distinguish change from "Cambridge change," which can befall anything. Even a number can "change" from being to not being the rate of exchange between pounds and dollars. Even a momentary event can "change" from being a year ago to being a year and a day ago, or from being forgotten to being remembered. But these are not genuine changes. Not just any old reversal in truth value of a time-sensitive sentence about something makes a change in the thing itself.

A time traveler, like anyone else, is a streak through the manifold of space-time, a whole composed of stages located at various times and places. But he is not a streak like other streaks. If he travels toward the past he is a zig-zag streak, doubling back on himself. If he travels toward the future, he is a stretched-out streak. And if he travels either way instantaneously, so that there are no intermediate stages between the stage that departs and the stage that arrives and his journey has zero duration, then he is a broken streak.

I asked how it could be that the same two events were separated by two unequal amounts of time, and I set aside the reply that time might have two independent dimensions. Instead I reply by distinguishing time itself, *external time* as I shall also call it, from the *personal time* of a particular time traveler: roughly, that which is measured by his wristwatch. His journey takes an hour of his personal time, let us say; his wristwatch reads an hour later at arrival than at departure. But the arrival is more than an hour after the departure in external time, if he travels toward the future; or the arrival is before the departure in external time (or less than an hour after), if he travels toward the past.

That is only rough. I do not wish to define personal time operationally, making wristwatches infallible by definition. That which is measured by my own wristwatch often disagrees with external time, yet I am no time traveler; what my misregulated wristwatch measures is neither time itself nor my personal time. Instead of an operational definition, we need a functional definition of personal time; it is that which occupies a certain role in the pattern of events that comprise the time traveler's life. If you take the stages of a common person, they manifest certain regularities with respect to external time. Properties change continuously as you go along, for the most part, and in familiar ways. First come infantile stages. Last come senile ones. Memories accumulate. Food digests. Hair grows. Wristwatch hands move. If you take the stages of a time traveler instead, they do not manifest the common regularities with respect to external time. But there is one way to assign coordinates to the time traveler's stages, and one way only (apart from the arbitrary choice of a zero point), so that the regularities that hold with respect to this assignment match those that commonly hold with respect to external time. With respect to the correct assignment properties change continuously as you go along, for the most part, and in familiar ways. First come infantile stages. Last come senile ones. Memories accumulate. Food digests. Hair grows. Wristwatch hands move. The assignment of coordinates that yields this match is the time traveler's personal time. It isn't really time, but it plays the role in his life that time plays in the life of a common person. It's enough like time so that we can—with due caution—transplant our temporal vocabulary to it in discussing his affairs. We can say without contradiction, as the time traveler prepares to set out, "Soon he will be in the past." We mean that a stage of him is slightly later in his personal time, but much earlier in external time, than the stage of him that is present as we say the sentence.

We may assign locations in the time traveler's personal time not only to his stages themselves but also to the events that go on around him. Soon Caesar will die, long ago; that is, a stage slightly later in the time traveler's personal time than his present stage, but long ago in external time, is simultaneous with Caesar's death. We could even extend the assignment of personal time to events that are not part of the time traveler's life, and not simultaneous with any of his stages. If his funeral in ancient Egypt is separated from his death by three days of external time and his death is separated from his birth by three score years and ten of his personal time, then we may add the two intervals and say that his funeral follows his birth by three score years and ten and three days of *extended personal time.* Likewise a bystander might truly say, three years after the last departure of another famous time traveler, that "he may even now—if I may use the phrase—be wandering on some plesiosaurus-haunted oolitic coral reef, or beside the lonely saline seas of the Triassic Age."[3] If the time traveler does wander on an oolitic coral reef three years after his departure in his personal time, then it is no mistake to say with respect to his extended personal time that the wandering is taking place "even now".

We may liken intervals of external time to distances as the crow flies, and intervals of personal time to distances along a winding path. The time traveler's life is like a mountain railway. The place two miles due east of here may also be nine miles down the line, in the westbound direction. Clearly we are not dealing here with two independent dimensions. Just as distance along the railway is not a fourth spatial dimension, so a time traveler's personal time is not a second dimension of

time. How far down the line some place is depends on its location in three-dimensional space, and likewise the locations of events in personal time depend on their locations in one-dimensional external time.

Five miles down the line from here is a place where the line goes under a trestle; two miles further is a place where the line goes over a trestle; these places are one and the same. The trestle by which the line crosses over itself has two different locations along the line, five miles down from here and also seven. In the same way, an event in a time traveler's life may have more than one location in his personal time. If he doubles back toward the past, but not too far, he may be able to talk to himself. The conversation involves two of his stages, separated in his personal time but simultaneous in external time. The location of the conversation in personal time should be the location of the stage involved in it. But there are two such stages; to share the locations of both, the conversation must be assigned two different locations in personal time.

The more we extend the assignment of personal time outwards from the time traveler's stages to the surrounding events, the more will such events acquire multiple locations. It may happen also, as we have already seen, that events that are not simultaneous in external time will be assigned the same location in personal time—or rather, that at least one of the locations of one will be the same as at least one of the locations of the other. So extension must not be carried too far, lest the location of events in extended personal time lose its utility as a means of keeping track of their roles in the time traveler's history.

A time traveler who talks to himself, on the telephone perhaps, looks for all the world like two different people talking to each other. It isn't quite right to say that the whole of him is in two places at once, since neither of the two stages involved in the conversation is the whole of him, or even the whole of the part of him that is located at the (external) time of the conversation. What's true is that he, unlike the rest of us, has two different complete stages located at the same time at different places. What reason have I, then, to regard him as one person and not two? What unites his stages, including the simultaneous ones, into a single person? The problem of personal identity is especially acute if he is the sort of time traveler whose journeys are instantaneous, a broken streak consisting of several unconnected segments. Then the natural way to regard him as more than one person is to take each segment as a different person. No one of them is a time traveler, and the peculiarity of the situation comes to this: all but one of these several people vanish into thin air, all but another one appear out of thin air, and there are remarkable resemblances between one at his appearance and another at his vanishing. Why isn't that at least as good a description as the one I gave, on which the several segments are all parts of one time traveler?

I answer that what unites the stages (or segments) of a time traveler is the same sort of mental, or mostly mental, continuity and connectedness that unites anyone else. The only difference is that whereas a common person is connected and continuous with respect to external time, the time traveler is connected and continuous only with respect to his own personal time. Taking the stages in order, mental (and bodily) change is mostly gradual rather than sudden, and at no point is there sudden change in too many different respects all at once. (We can include position in external time among the respects we keep track of, if we like. It may change discontinuously with respect to personal time if not too much else changes discontinuously along with it.) Moreover, there is not too much change altogether. Plenty of traits and traces last a lifetime. Finally, the connectedness and the continuity are not accidental. They are explicable; and further, they are explained by the fact that the properties of each stage depend causally on those of the stages just before in personal time, the dependence being such as tends to keep things the same.[4]

To see the purpose of my final requirement of causal continuity, let us see how it excludes a case of counterfeit time travel. Fred was created out of thin air, as if in the midst of life; he lived a while, then died. He was created by a demon, and the demon had chosen at random what Fred was to be like at the moment of his creation. Much later someone else, Sam, came to resemble Fred as he was when first created. At the very moment when the resemblance became perfect, the demon destroyed Sam. Fred and Sam together are very much like a single person: a time traveler whose personal time starts at Sam's birth, goes on to Sam's destruction and Fred's creation, and goes on from there to Fred's death. Taken in this order, the stages of Fred-*cum*-Sam have the proper connectedness and continuity. But they lack causal continuity, so Fred-*cum*-Sam is not one person and not a time traveler. Perhaps it was pure coincidence that Fred at his creation and Sam at his destruction were exactly alike; then the connectedness and continuity of Fred-*cum*-Sam across the crucial point are accidental. Perhaps instead the demon remembered what Fred was like, guided Sam toward perfect resemblance, watched his progress, and destroyed him at the right moment. Then the connectedness and continuity of Fred-*cum*-Sam has a causal explanation, but of the wrong sort. Either way, Fred's first stages do not depend causally for their properties on Sam's last stages. So the case of Fred and Sam is rightly disqualified as a case of personal identity and as a case of time travel.

We might expect that when a time traveler visits the past there will be reversals of causation. You may punch his face before he leaves, causing his eye to blacken centuries ago. Indeed, travel into the past necessarily involves reversed causation. For time travel requires personal identity—he who arrives must be the same person who departed. That requires causal continuity, in

which causation runs from earlier to later stages in the order of personal time. But the orders of personal and external time disagree at some point, and there we have causation that runs from later to earlier stages in the order of external time. Elsewhere I have given an analysis of causation in terms of chains of counterfactual dependence, and I took care that my analysis would not rule out casual reversal *a priori*.[5] I think I can argue (but not here) that under my analysis the direction of counterfactual dependence and causation is governed by the direction of other *de facto* asymmetries of time. If so, then reversed causation and time travel are not excluded altogether, but can occur only where there are local exceptions to these asymmetries. As I said at the outset, the time traveler's world would be a most strange one.

Stranger still, if there are local—but only local—causal reversals, then there may also be causal loops: closed causal chains in which some of the causal links are normal in direction and others are reversed. (Perhaps there must be loops if there is reversal: I am not sure.) Each event on the loop has a causal explanation, being caused by events elsewhere on the loop. That is not to say that the loop as a whole is caused or explicable. It may not be. Its inexplicability is especially remarkable if it is made up of the sort of causal processes that transmit information. Recall the time traveler who talked to himself. He talked to himself about time travel, and in the course of the conversation his older self told his younger self how to build a time machine. That information was available in no other way. His older self knew how because his younger self had been told and the information had been preserved by the causal processes that constitute recording, storage, and retrieval of memory traces. His younger self knew, after the conversation, because his older self had known and the information had been preserved by the causal processes that constitute telling. But where did the information come from in the first place? Why did the whole affair happen? There is simply no answer. The parts of the loop are explicable, the whole of it is not. Strange! But not impossible, and not too different from inexplicabilities we are already inured to. Almost everyone agrees that God, or the Big Bang, or the entire infinite past of the universe, or the decay of a tritium atom, is uncaused and inexplicable. Then if these are possible, why not also the inexplicable causal loops that arise in the time travel?

I have committed a circularity in order not to talk about too much at once, and this is a good place to set it right. In explaining personal time, I presupposed that we were entitled to regard certain stages as comprising a single person. Then in explaining what united the stages into a single person, I presupposed that we were given a personal time order for them. The proper way to proceed is to define personhood and personal time simultaneously, as follows. Suppose given a pair of an aggregate of persona-stages, regarded as a candidate for personhood, and an assignment of coordinates to those stages, regarded as a candidate for his personal time. If the stages satisfy the conditions given in my circular explanation with respect to the assignment of coordinates, then both candidates succeed: the stages do comprise a person and the assignment is his personal time.

I have argued so far that what goes on in a time travel story may be a possible pattern of events in four-dimensional space-time with no extra time dimension; that it may be correct to regard the scattered stages of the alleged time traveler as comprising a single person; and that we may legitimately assign to those stages and their surroundings a personal time order that disagrees sometimes with their order in external time. Some might concede all this, but protest that the impossibility of time travel is revealed after all when we ask not what the time traveler *does*, but what he *could do*. Could a time traveler change the past? It seems not: the events of a past moment could no more change than numbers could. Yet it seems that he would be as able as anyone to do things that would change the past if he did them. If a time traveler visiting the past both could and couldn't do something that would change it, then there cannot possibly be such a time traveler.

Consider Tim. He detests his grandfather, whose success in the munitions trade built the family fortune that paid for Tim's time machine. Tim would like nothing so much as to kill Grandfather, but alas he is too late. Grandfather died in his bed in 1957, while Tim was a young boy. But when Tim has built his time machine and traveled to 1920, suddenly he realizes that he is not too late after all. He buys a rifle; he spends long hours in target practice; he shadows Grandfather to learn the route of his daily walk to the munitions works; he rents a room along the route; and there he lurks, one winter day in 1921, rifle loaded, hate in his heart, as Grandfather walks closer, closer,. . . .

Tim can kill Grandfather. He has what it takes. Conditions are perfect in every way: the best rifle money could buy, Grandfather an easy target only twenty yards away, not a breeze, door securely locked against intruders. Tim a good shot to begin with and now at the peak of training, and so on. What's to stop him? The forces of logic will not stay his hand! No powerful chaperone stands by to defend the past from interference. (To imagine such a chaperone, as some authors do, is a boring evasion, not needed to make Tim's story consistent.) In short, Tim is as much able to kill Grandfather as anyone ever is to kill anyone. Suppose that down the street another sniper, Tom, lurks waiting for another victim, Grandfather's partner. Tom is not a time traveler, but otherwise he is just like Tim: same make of rifle, same murderous intent, same everything. We can even suppose that Tom, like Tim, believes himself to be a time traveler. Someone has gone to a lot of trouble to deceive Tom into thinking so. There's no doubt that Tom can kill his victim; and Tim has everything going for him that Tom

does. By any ordinary standards of ability, Tim can kill Grandfather.

Tim cannot kill Grandfather. Grandfather lived, so to kill him would be to change the past. But the events of a past moment are not subdivisible into temporal parts and therefore cannot change. Either the events of 1921 timelessly do include Tim's killing of Grandfather, or else they timelessly don't. We may be tempted to speak of the "original" 1921 that lies in Tim's personal past, many years before his birth, in which Grandfather lived; and of the "new" 1921 in which Tim now finds himself waiting in ambush to kill Grandfather. But if we do speak so, we merely confer two names on one thing. The events of 1921 are doubly located in Tim's (extended) personal time, like the trestle on the railway, but the "original" 1921 and the "new" 1921 are one and the same. If Tim did not kill Grandfather in the "original" 1921, then if he does kill Grandfather in the "new" 1921, he must both kill and not kill Grandfather in 1921—in the one and only 1921, which is both the "new" and the "original" 1921. It is logically impossible that Tim should change the past by killing Grandfather in 1921. So Tim cannot kill Grandfather.

Not that past moments are special; no more can anyone change the present or the future. Present and future momentary events no more have temporal parts than past ones do. You cannot change a present or future event from what it was originally to what it is after you change it. What you *can* do is to change the present or the future from the unactualized way they would have been without some action of yours to the way they actually are. But that is not an actual change: not a difference between two successive actualities. And Tim can certainly do as much; he changes the past from the unactualized way it would have been without him to the one and only way it actually is. To "change" the past in this way, Tim need not do anything momentous; it is enough just to be there, however unobtrusively.

You know, of course, roughly how the story of Tim must go on if it is to be consistent: he somehow fails. Since Tim didn't kill Grandfather in the "original" 1921, consistency demands that neither does he kill Grandfather in the "new" 1921. Why not? For some commonplace reason. Perhaps some noise distracts him at the last moment, perhaps he misses despite all his target practice, perhaps his nerve fails, perhaps he even feels a pang of unaccustomed mercy. His failure by no means proves that he was not really able to kill Grandfather. We often try and fail to do what we are able to do. Success at some tasks requires not only ability but also luck, and lack of luck is not a temporary lack of ability. Suppose our other sniper, Tom, fails to kill Grandfather's partner for the same reason, whatever it is, that Tim fails to kill Grandfather. It does not follow that Tom was unable to. No more does it follow in Tim's case that he was unable to do what he did not succeed in doing.

We have this seeming contradiction: *"Tim doesn't, but can, because he has what it takes"* versus *"Tim doesn't, and can't, because it's logically impossible to change the past."* I reply that there is no contradiction. Both conclusions are true, and for the reasons given. They are compatible because "can" is equivocal.

To say that something can happen means that its happening is compossible with certain facts. *Which* facts? That is determined, but sometimes not determined well enough, by context. An ape can't speak a human language—say, Finnish—but I can. Facts about the anatomy and operation of the ape's larynx and nervous system are not compossible with his speaking Finnish. The corresponding facts about my larynx and nervous system are compossible with my speaking Finnish. But don't take me along to Helsinki as your interpreter: I can't speak Finnish. My speaking Finnish is compossible with the facts considered so far, but not with further facts about my lack of training. What I can do, relative to one set of facts, I cannot do, relative to another, more inclusive, set. Whenever the context leaves it open which facts are to count as relevant, it is possible to equivocate about whether I can speak Finnish. It is likewise possible to equivocate about whether it is possible for me to speak Finnish, or whether I am able to, or whether I have the ability or capacity or power or potentiality to. Our many words for much the same thing are little help since they do not seem to correspond to different fixed delineations of the relevant facts.

Tim's killing Grandfather that day in 1921 is compossible with a fairly rich set of facts: the facts about his rifle, his skill and training, the unobstructed line of fire, the locked door and the absence of any chaperone to defend the past, and so on. Indeed it is compossible with all the facts of the sorts we would ordinarily count as relevant is saying what someone can do. It is compossible with all the facts corresponding to those we deem relevant in Tom's case. Relative to these facts, Tim can kill Grandfather. But his killing Grandfather is not compossible with another, more inclusive set of facts. There is the simple fact that Grandfather was not killed. Also there are various other facts about Grandfather's doings after 1921 and their effects: Grandfather begat Father in 1922 and Father begat Tim in 1949. Relative to these facts, Tim cannot kill Grandfather. He can and he can't, but under different delineations of the relevant facts. You can reasonably choose the narrower delineation, and say that he can; or the wider delineation, and say that he can't. But choose. What you mustn't do is waver, say in the same breath that he both can and can't, and then claim that this contradiction proves that time travel is impossible.

Exactly the same goes for Tom's parallel failure. For Tom to kill Grandfather's partner also is compossible with all facts of the sorts we ordinarily count as relevant, but not compossible with a larger set including, for instance, the fact that the intended victim lived until 1934. In Tom's case we are not puzzled. We say without hesitation that he can do it, because we see at once that the

facts that are not compossible with his success are facts about the future of the time in question and therefore not the sort of facts we count as relevant in saying what Tom can do.

In Tim's case it is harder to keep track of which facts are relevant. We are accustomed to exclude facts about the future of the time in question, but to include some facts about its past. Our standards do not apply unequivocally to the crucial facts in this special case: Tim's failure, Grandfather's survival, and his subsequent doings. If we have foremost in mind that they lie in the external future of that moment in 1921 when Tim is almost ready to shoot, then we exclude them just as we exclude the parallel facts in Tom's case. But if we have foremost in mind that they precede that moment in Tim's extended personal time, then we tend to include them. To make the latter be foremost in your mind, I chose to tell Tim's story in the order of his personal time, rather than in the order of external time. The fact of Grandfather's survival until 1957 had already been told before I got to the part of the story about Tim lurking in ambush to kill him in 1921. We must decide, if we can, whether to treat these personally past and externally future facts as if they were straightforwardly past or as if they were straightforwardly future.

Fatalists—the best of them—are philosophers who take facts we count as irrelevant in saying what someone can do, disguise them somehow as facts of a different sort that we count as relevant, and thereby argue that we can do less than we think—indeed, that there is nothing at all that we don't do but can. I am not going to vote Republican next fall. The fatalist argues that, strange to say, I not only won't but can't; for my voting Republican is not compossible with the fact that it was true already in the year 1548 that I was not going to vote Republican 428 years later. My rejoinder is that this is a fact, sure enough; however, it is an irrelevant fact about the future masquerading as a relevant fact about the past, and so should be left out of account in saying what, in any ordinary sense, I can do. We are unlikely to be fooled by the fatalist's methods of disguise in this case, or other ordinary cases. But in cases of time travel, precognition, or the like, we're on less familiar ground, so it may take less of a disguise to fool us. Also, new methods of disguise are available, thanks to the device of personal time.

Here's another bit of fatalist trickery. Tim, as he lurks, already knows that he will fail. At least he has the wherewithal to know it if he thinks, he knows it implicitly. For he remembers that Grandfather was alive when he was a boy, he knows that those who are killed are thereafter not alive, he knows (let us suppose) that he is a time traveler who has reached the same 1921 that lies in his personal past, and he ought to understand—as we do—why a time traveler cannot change the past. What is known cannot be false. So his success is not only not compossible with facts that belong to the external future and his personal past, but also is not compossible with the present fact of his knowledge that he will fail. I reply that the fact of his foreknowledge, at the moment while he waits to shoot, is not a fact entirely about that moment. It may be divided into two parts. There is the fact that he then believes (perhaps only implicitly) that he will fail; and there is the further fact that his belief is correct, and correct not at all by accident, and hence qualifies as an item of knowledge. It is only the latter fact that is not compossible with his success, but it is only the former that is entirely about the moment in question. In calling Tim's state at that moment knowledge, not just belief, facts about personally earlier but externally later moments were smuggled into consideration.

I have argued that Tim's case and Tom's are alike, except that in Tim's case we are more tempted than usual—and with reason—to opt for a semi-fatalist mode of speech. But perhaps they differ in another way. In Tom's case, we can expect a perfectly consistent answer to the counterfactual question: what if Tom had killed Grandfather's partner? Tim's case is more difficult. If Tim had killed Grandfather, it seems offhand that contradictions would have been true. The killing both would and wouldn't have occurred. No Grandfather, no Father; no Father, no Tim; no Tim, no killing. And for good measure: no Grandfather, no family fortune; no fortune, no time machine; no time machine, no killing. So the supposition that Tim killed Grandfather seems impossible in more than the semi-fatalistic sense already granted.

If you suppose Tim to kill Grandfather and hold all the rest of his story fixed, of course you get a contradiction. But likewise if you suppose Tom to kill Grandfather's partner and hold the rest of his story fixed—including the part that told of his failure—you get a contradiction. If you make any counterfactual supposition and hold all else fixed you get a contradiction. The thing to do is rather to make the counterfactual supposition and hold all else as close to fixed as you consistently can. That procedure will yield perfectly consistent answers to the question: what if Tim had not killed Grandfather? In that case, some of the story I told would not have been true. Perhaps Tim might have been the time-traveling grandson of someone else. Perhaps he might have been the grandson of a man killed in 1921 and miraculously resurrected. Perhaps he might have been not a time traveler at all, but rather someone created out of nothing in 1920 equipped with false memories of a personal past that never was. It is hard to say what is the least revision of Tim's story to make it true that Tim kills Grandfather, but certainly the contradictory story in which the killing both does and doesn't occur is not the least revision. Hence it is false (according to the unrevised story) that if Tim had killed Grandfather then contradictions would have been true.

What difference would it make if Tim travels in branching time? Suppose that at the possible world of Tim's story the space-time manifold branches; the

branches are separated not in time, and not in space, but in some other way. Tim travels not only in time but also from one branch to another. In one branch Tim is absent from the events of 1921; Grandfather lives; Tim is born, grows up, and vanishes in his time machine. The other branch diverges from the first when Tim turns up in 1920; there Tim kills Grandfather and Grandfather leaves no descendants and no fortune; the events of the two branches differ more and more from that time on. Certainly this is a consistent story; it is a story in which Grandfather both is and isn't killed in 1921 (in the different branches); and it is a story in which Tim, by killing Grandfather, succeeds in preventing his own birth (in one of the branches). But it is not a story in which Tim's killing of Grandfather both does occur and doesn't: it simply does, though it is located in one branch and not the other. And it is not a story in which Tim changes the past. 1921 and later years contain the events of both branches, coexisting somehow without interaction. It remains true at all the personal times of Tim's life, even after the killing, that Grandfather lives in one branch and dies in the other.[6]

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Notes

1. I have particularly in mind two of the time travel stories of Robert A. Heinlein: "By His Bootstraps" in R. A. Heinlein, *The Menace from Earth* (Hicksville, N.Y., 1959), and "—All You Zombies—," in R. A. Heinlein, *The Unpleasant Profession of Jonathan Hoag* (Hicksville, N.Y., 1959).
2. Account of time travel in two-dimensional time are found in Jack W. Meiland, "A Two-Dimensional Passage Model of Time for Time Travel," *Philosophical Studies,* vol. 26 (1974), pp. 153–173; and in the initial chapters of Isaac Asimov, *The End of Eternity* (Garden City, N.Y., 1955). Asimov's denouement, however, seems to require some different conception of time travel.
3. H. G. Wells, *The Time Machine, An Invention* (London, 1895), epilogue. The passage is criticized as contradictory in Donald C. Williams, "The Myth of Passage," *The Journal of Philosophy,* vol. 48 (1951), p. 463.
4. I discuss the relation between personal identity and mental connectedness and continuity at greater length in "Survival and Identity" in *The Identity of Persons,* ed. by Amelie Rorty (forthcoming).
5. "Causation," *The Journal of Philosophy,* vol. 70 (1973), pp. 556–567; the analysis relies on the analysis of counterfactuals given in my *Counterfactuals* (Oxford, 1973).
6. The present paper summarizes a series of lectures of the same title, given as the Gavin David Young Lectures in Philosophy at the University of Adelaide in July, 1971. I thank the Australian-American Educational Foundation and the American Council of Learned Societies for research support. I am grateful to many friends for comments on earlier versions of this paper; especially Philip Kitcher, William Newton-Smith, J. J. C. Smart, and Donald Williams.

The Tom Bearden Website

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ANNOTATED GLOSSARY

T. E. Bearden 1997, slightly updated Dec. 2000
Latest editing and additions: 12th April, 2003
Presentation re-edit 7th January, 2013

Foreword

This is an informal glossary originally prepared in 1997 for Gary Hawkins to use on his web site, and informal definitions and discussions were rather quickly jotted down in 1997. We have been able to do a little updating now in Dec. 2000. Careful crafting and polishing for greater rigor would require much more time than I am able to spare, but perhaps the glossary can be helpful anyway.

We put in the gist of it, as we see it, and usually an annotation or commentary to explain it. We tried to put in sufficient explanations and a few references, so that the reader can see for himself or herself that physics, mathematics, and even logic itself are not quite as cut and dried as is often presented!

The only thing we absolutely insist on, that differs from the normal physics and engineering approach, is that any true definition must be an identity statement *a priori*. In this view, since no equation is an identity, then no equation is a definition; regardless of those "equations" universally advanced in physics as "definitions." All an equation states is that the *magnitude* of the somethings on the right is equal to the *magnitude* of the somethings on the left. It does not at all *define* any of the somethings on either right or left! I've completed as much as I have time for now, and made some additions and corrections to the 1997 version. As time permits, we will try to add some more in the future. I hope these hasty comments are helpful, and any errors in them are my own and not due to Gary Hawkins or to Tony Craddock!

Tom Bearden,
Dec. 2000

Webmaster's Note: There are additional Glossaries and Definitions at the ends of Tom Bearden's books *"Energy from the Vacuum"* and *"Excalibur Briefing."*

MATH AND SINGLE CHARACTER ABBREVIATIONS

ϕ The electrostatic scalar potential, in units of joule per collecting coulomb.

∇ The mathematical operator 'del'.

$\nabla\phi$ The gradient of the function ϕ , mathematically.

In EM theory, use of the del operator produces an electric field **E** given by **E** = – $\nabla\phi$. An electrical field is also generated by the time rate of change of the magnetic vector potential **A**, where it is given by **E** = – d**A**/dt. Note that we have used that fact to assist us in producing the motionless electromagnetic generator (MEG), with COP = 16 as of this writing.

ϕq Joules of energy collected by a charge of q coulombs in an electrostatic scalar potential

having a reaction cross section of ϕ.

Since the collected energy is also usually the energy that can then be dissipated as work, this expression often yields the work performed in the circuit by the energy the surface charges collected from that part of the **S**-flow in contact with the conductors and components.

$d\phi/dt$ Time rate of change of the scalar potential.

Also one form of displacement current.

dE/dt Time rate of change of the E-field.

Also one form of displacement current.

dp/dt Time rate of change of momentum, which is a force F acting upon the system.

A force is defined as a time rate of change of momentum, or F = dp/dt.

dP/dt Time rate of change of polarization.

Polarization displacement current.

dq/dt Time rate of change of charge, otherwise known as "current".

Represents the normal current flow i of charges in a conductor, i.e., i = dq/dt.

dq/dt-Isolated Load Loop A special current loop containing the load.

...where i = dq/dt in that "load loop" is isolated from the current i = dq/dt in the source loop containing the power source, and the two loops are also field-coupling isolated. A transformer, e.g., does isolate the actual current in the secondary from the current in the primary, but the field coupling from primary to secondary and from secondary back to primary result in the enforcement of COP = 1.0 as the maximum performance possible (in a perfect, lossless standard transformer). In a real standard transformer with some losses, COP<1.0.

The notion is that, even though current cannot pass from the source loop to the load loop and there is no direct field coupling, energy density flow **S** = **E**×**H** can pass. This is in fact the definition of what we call *bridging*, if in addition to current isolation the rigid back-field coupling is broken between energy dissipation (power) in the source loop and energy dissipation (power) in the load loop. In that fashion, overunity operation of the load can readily be achieved.

E Electric Field.

Defined in older classical electromagnetics (CEM) as a force field, by **E** ≡ **F**/q. However, this only defines the entity after an interaction with mass. In short, it defines the E-field as an effect existing only in matter.

In the early days of electrodynamics, Maxwell and the other "founding fathers" assumed a material ether filling all space. Hence any field in space was indeed such an "effect" field existing in mass. Maxwell died in 1879 of stomach cancer. In the 1880s, the Michelson-Morley experiments falsified the luminiferous (material) ether as a material medium. Hence the accepted use of the **E** = **F**/q type of "effect" electrical field as the electric field in space was also destroyed, but the equations were never changed to eliminate this error in the foundations of CEM. Instead, electrodynamicists more or less announced one day that, "Since there is no (material) ether, we are not using one!"

There is some rationalization mathematically for such an approach, if the limiting process is used for the interaction of the "causal field" in vacuum with the charged mass q, as q is allowed to approach zero. However, from a foundations view, it is still the interaction of the field in space with charged mass that is being described in the limit, and therefore it is still the "effect" entity rather than the "cause" entity.

This serious foundations problem is still unresolved in much of CEM theory and modeling to this day. The standard by which other EM texts are measured is J. D. Jackson, **Classical Electrodynamics**, 2nd edition, Wiley, New York, 1975. In several places, Jackson opts for this avoidance of the use of the " effect" field for the "cause" field: quoting p. 28: *"...the thing that eventually gets measured is a force..." "At the moment, the electric field can be defined as the force per unit charge acting at a given point. It is a vector function of position, denoted by E."* Quoting p. 249: *"Most classical electrodynamicists continue to adhere to the notion that the EM force field exists as such in the vacuum, but do admit that physically measurable quantities such as force somehow involve the product of charge and field."*

The problem is further increased by use of this flawed definition of E-field to "define" the electrostatic scalar potential (Jackson, p. 34) by the equation **E** = –∇ϕ. First, no equation is a definition; it merely equates the magnitude of the entities on the left of the = sign to the magnitude of the entities on the right of the = sign. It has nothing at all to say about the definition or nature of any of the entities, but is merely a comparison of relative magnitudes. Any definition, a priori, must be expressed by an identity sign. In all of classical electrodynamics, there is no available proper definition of (x) in the identity E ≡ (x). Indeed, there is no such identity available for force F. To quote Feynman: *"...in dealing with force the tacit assumption is always made that the force is equal to zero unless some physical body is present... One of the most important characteristics of force is that it has a material origin, and this is <u>not</u> just a definition. ... If you insist upon a precise definition of force, you will never get it!"* Richard P. Feynman, Robert B. Leighton, and Matthew Sands, **Lectures on Physics**, Addison-Wesley, Reading, MA, Vol. 1, 1964, p. 12-2.

In the Sachs unified field theory, O(3) electrodynamics as spearheaded by Evans is an important subset. Hence in that approach there is a solution to the problem of defining force and field. The EM fields (**E**, **B**, etc.) when in spacetime, are in fact curvatures of spacetime identically. When these ST curvatures interact with a charged mass, the effects of the interactions are the well-known force-fields in matter, which Maxwell started with in the 1860s. So in this way, the definition problem can be rigorously resolved.

jϕ <u>The Slepian vector, representing the time rate of energy density dissipation in the current</u>

<u>loop containing the jϕ</u>.

This does not at all represent the energy flow in space and along the outside of the circuit, which may be very, very much greater, on the order of 10^{13} times as great. It does match the Poynting energy flow component that enters the circuit.

M_q or m_q <u>The mass of a charge q.</u>

Instead of just using "q" and assuming it to be unitary, we must include the fact that charge is a system of two coupled components: (i) the mass m_q of the charge q, and (ii) the virtual photon flux exchange (i.e., ϕ_q) of the charge q with the surrounding active vacuum. In particle physics it is already well-known that there is no symmetry of a mass system anyway, unless the vacuum's exchange with the mass is included. So the expression $m_q\phi_q$ captures the vacuum-mass exchange. By continuing to assume that charge is unitary, physics inadvertently holds to the hoary old notion of the luminiferous ether (thin material ether) that permeates all of space. Maxwell and other electrical physicists of his time believed in a material ether, and Maxwell embedded that notion in EM theory. Inexplicably it has not been rooted out of the equations to this day, even though the notion of the material ether (not the ether per se!) was destroyed by the Michelson-Morley experiment over 100 years ago. Foundations physicists continue to point out such terrible defects in physics—and continue to be ignored. We quote Mario Bunge, "A mathematical theory of the dimensions and units of physical quantities," in **Problems in the Foundations of Physics**, edited by Mario Bunge, Springer-Verlag, Berlin and New York, 1971, p. 7: "The question 'What are dimensions?' is seen to be ill conceived, for there are two concepts of dimension, namely those of dimension function and dimension value. The correct question is: 'What are [] and *d*?' " {**<u>Note</u>**: [] is dimension function, and *d* is dimension value.} Bunge is clearly discriminating between the function associated with the dimension, and the magnitude associated with it

Quoting Bunge, *ibid*., p. 8: "The concept of a unit is one of those scientific notions that has remained obscure for want of a theory and excess of a coarse philosophy. Indeed we know how to manipulate units but we do not seem to know what kind of mathematical object they are. As a consequence units are sometimes confused with dimensions, at other times with standards, and they are often introduced in relation to measurement rather than to concept formulation."

And quoting Mario Bunge, **Foundations of Physics**, Springer-Verlag, New York, 1967, p. 176: "Different theories of CED [Classical Electrodynamics] are called for, both for charged particles that can to a first approximation be regarded as electromagnetically structureless (e.g., the electron and the μ -meson) and for extended systems with a charge distribution and spin (e.g., the proton). If fairly satisfactory classical theories were available they could guide the construction of the corresponding quantum theories. But no such theories are in sight partly because it is not usually acknowledged that electrodynamics, both classical and quantal, are in a sad state."

Again, Bunge, *ibid*., p. 182: "...the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

c <u>The speed of light in ambient vacuum.</u>

To discuss the speed of light, we point out that the vacuum is highly energetic, as has been shown in modern physics. Since the vacuum has an energy density, it can be modeled as a "potential" and particularly as a scalar EM potential for EM purposes. Contrary to convention, we recognize that the local energy density of the ambient vacuum potential can vary, including seasonally within and close to the solar system, etc. The average energy density of the vacuum in space far from charged masses such as stars and planets may be assumed as a "standard vacuum potential", and if this potential is equated with the

notion of "flat spacetime", then an increase in this vacuum potential is an increase in the local energy density of spacetime, and hence represents a curvature of the standard flat spacetime.

In fact the interplanetary radar probes' "ranges" do show precisely such variation in the speed of light, with weekly and monthly and seasonal variations, etc. In order to comply with the nearly universal assumption in physics with respect to the constancy of c, the scientific staffs averaged the readings over the entire month. This zeroed out the variations, upheld the notion that space is a fixed type of thing, and that the speed of light in it is also a rigidly fixed constant. It *does not* agree with the actual measured speed of light from day to day.

The Russians have known and openly printed for about a century that the speed of light in a hard vacuum in deep space, far removed from solar and planetary masses, is a little slower than the speed of light in a hard vacuum near the Earth or any other large charged mass. The huge collection of charged particles in the earth have tiny separations, so that looking at the Earth as a collection of tiny dipoles, one sees a collection of enormous 4-symmetry energy flows from the time domain to the 3-space domain (and vice versa for the time-reversed portions). The increased intensity of this 4-symmetry energy flux in the vicinity of a massive planet or sun changes the local energy density of the vacuum itself, increasing it in that vicinity.

Without elaboration, we will also point out that the Earth and its dynamics structures the local spacetime and the spacetime out to some distance. So do all other planets, stars, etc. By whatever manner we model the cosmos as having been created or initiated, the dynamics and structuring of all the phenomena occurring in the universe is further impressed in the *infolded* electrodynamics inside the vacuum potential.

The "laws of nature" in one sense represent the most general results of the reactions of this internally structured "common standard spacetime" or "standard vacuum potential" with the various physical systems, devices, and measuring instruments utilized in our experiments, etc. If one deterministically alters the *structuring of the local spacetime*, one can have a system which will function there in a certain marvelous manner, but will not function that way elsewhere. Some decades ago, I participated in experiments by Golden which over a period of some five years did condition (dimension) the local vacuum potential. The result was an engine which consistently exhibited COP = 1.67 at that location, but when moved several hundred miles exhibited COP<1.0. Frank and I were made aware of this "vacuum conditioning" effect by Prof. William Tiller, who had himself conducted experiments exhibiting just such an effect over several years.

EM waves in vacuum are actually *longitudinal* (sound-type) waves, but we do not belabor the point since everything out there in the normal literature uses the transverse EM wave model for the EM wave in space. Also, the transverse wave is indeed what is detected in the interacting electron gas in our measurement instruments—whose Drude electrons are restrained to simple drift velocity longitudinally down the conductor, but are spinning and are free to precess like gyros. So our instruments detect the Drude electron precessions at right angles to the incoming disturbing longitudinal force field, which means that they do indeed measure a transverse wave. However, these are actually the *electron precession waves* in the detector, and *not* the actual EM waves in space. See my paper, "Giant Negentropy from the Common Dipole", **Journal of New Energy**, 5(1), Summer 2000, p. 11-23 for a discussion of how all EM energy comes from the time domain, via the broken 3-symmetry of the source charge or source dipole, and is emitted in 3-space in all directions as longitudinal EM waves. This is based on rigorous demonstration by E.T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," **Math. Ann**., Vol. 57, 1903, p. 333-355 that the scalar potential is a harmonic set of phase conjugate longitudinal EM wave pairs. We merely applied the Whittaker decomposition to the scalar potential of a source dipole or of a source charge, and the rigorous proof that EM waves in space are longitudinal directly emerges.

Just as sound speeds up, say, in steel as a denser medium than air, the EM "sound waves" in the ambient vacuum potential speed up when that vacuum potential's flux density is increased. Consequently light does move a little faster in a hard vacuum on Earth than it does in deep space, because the vacuum itself has higher energy density near the earth than in deep space. The comings and goings and orbitings of planets and the solar mass, etc. do affect the local energy density of the vacuum between the planets, and hence the speed of light through that interplanetary space.

So the interplanetary radar does show the periodic variations of the local energy density of vacuum that are induced by these factors. For a critical paper on this, see Bryan G. Wallace, "The Unified Quantum Electrodynamic Ether," **Foundations of Physics**, 3(3), Sept. 1973, p. 381-388. His discussion of the interplanetary radar measurements of Venus, which did not fit relativity, are particularly interesting, with respect to his finding that the data were simply "averaged" to eliminate the variations and hence the diurnal, lunar, and synodic periodic components actually measured in the variations of the speed of light. See particularly Bryan G. Wallace, "The great speed of light in space cover-up." **Scientific Ethics**, 1(1), Feb. 1985. p. 2-3; — "Radar Testing of the Relative Velocity of Light in Space," **Spectrosc. Lett**. Vol. 2, 1969. p. 361.

Rigorously, the field is "defined" in electrodynamics as the effect of an interaction of the force-free entity (4-spatial!) existing prior to the interaction, with a 3-dimensional static charge. This means that the field as originally defined is an *effect* and not a *cause*. To then use it as the cause is a grave non sequitur.

This confusion of cause and effect is widespread in physics. It was probably initiated by the hoary old assumption several hundred years ago that a separate force acts upon a separate mass, which is false. In fact mass is a *component* of force, since $\mathbf{F} \equiv d/dt(m\mathbf{v}) = m(d\mathbf{v}/dt + \mathbf{v}(dm/dt)$. As can be seen, in both expanded terms there exists a mass term. To skirt the issue, electrodynamicists have simply found a neat statement that "in massfree space the field continues to exist, but the force is zero." We point out that m = 0 makes the momentum vanish, and so **F** vanishes, and in the definition of $\mathbf{E} = \mathbf{F}/q$ also vanishes because the numerator **F** becomes zero. Therefore *that* **E**-field vanishes.

Feynman and Wheeler pointed out that the field *as it is defined* does not and cannot exist in massless space. Only the "potential" for the field exists there, in case some charged mass is brought in to interact with that entity that does exist there. That is accurate, since spacetime is totally a potential and any "change" in spacetime is a change in that potential *a priori*. In the Sachs-Evans unified field theory, this problem is resolved because the fundamental field is defined as a spacetime curvature (change in spacetime, hence change in the ST potential) rather than $\mathbf{E} = \mathbf{F}/q$.

In empty space there are always myriads upon myriads of interfering fields and potentials, from charges all over the universe, via Puthoff's cosmological feedback principle [see
H. E. Puthoff, "Source of Vacuum Electromagnetic Zero-point Energy," **Physical Review A**, 40(9), Nov. 1, 1989, p. 4857-4862.] Thus any EM wave traveling through space is always involved in enormously active interferometry. This alone results in violent momentary variations in the speed of that wave, even from 0.01 c to 100.00 c. For a paper showing this kind of "galloping" travel of an EM wave, see William G. Harter, John Evans, Roberto Vega, and Sanford Wilson, "Galloping waves and their relativistic properties," **American Journal of Physics**, 53(7), July 1985, p. 671-679. While the average speed of the wave is $c(\gamma)$, where γ is the local energy density of the vacuum, the instantaneous speeds of the wave vary violently from instant to instant.

In special relativity, "velocity" merely is a rotation angle of the moving frame from the fixed laboratory observer's frame. The speed "c" merely represents a full right-angle turn away, toward the time-dimension (since other than the 3 spatial dimensions that is the only other dimension available to turn toward). In higher dimensional space, there are many other "higher" dimensions toward which further rotation can be accomplished. Hence rotating in n-space is not limited to a single orthogonal

turn, and therefore velocities are not limited to speed c. However, each orthogonal rotation also subtracts one spatial dimension of the rotated object from the observer's 3-space. One rotation would be speed c, two departing rotations would be speed c^2, three would give c^3, etc. At three orthorotations, to the lab observer the rotated object is now purely an internal structure inside his time dimension, very similar to a mental object (mind is time-like, not spacelike). The nature of mind and its operations has a rather unexpected connection with matter, when one considers such orthorotations in hyperspace.

The point is, the speed *c* is not an "iron dictum" of nature, nor is it an "unchangeable constant"! Nature herself routinely violates that notion. As an example, de Broglie waves from any mass always move at v>c, and easily as v>>c. EM "surface" waves—so-called transverse oscillations or upheavals and depressions in the magnitude (energy density; actually the *reaction cross section*) of the local ambient vacuum potential), move at a *discretized* average speed c(γ). The longitudinal component, if freed from the transverse component, can move much faster because it is a sort of "tunneling" movement. In actual quantum tunneling experiments, e.g., music (Mozart's 40th symphony) has been transmitted through quantum mechanical tunneling between two separated points at speed v>4c. Fogal is likely to eventually place a superluminal communication system on the commercial market. We discuss superluminal communication elsewhere in this glossary.

C Capacitance. Essentially, the charge per unit potential.

For an isolated conductor, C = Q/V and C is expressed in farads. A farad is one coulomb per volt.

A lower case c represents the speed of light in ambient vacuum.

E The electric field. Essentially, E =F/q, but that is not really a definition.

Conventionally, the units of electric field are considered to be force per unit electric charge; i.e., force per coulomb. Note that the **E**-field even in this "classical definition" does not actually exist at a point unless there is a unit point charge (a point coulomb of charged mass) located at the point. Hence contrary to classical electrodynamics, communications theory, and whatnot, no electric force field (and no magnetic force field either) exists in the vacuum, at least of the kind prescribed by Maxwell's equations and by the Heaviside-Hertz reduction of Maxwell's equations. Since Maxwell assumed it, these equations and models all still erroneously assume a material ether filling the vacuum, in which case there *would* be matter and charges, and there would *then* be force-fields in the vacuum. We refer the interested reader to discussions by Feynman and by Wheeler. Quoting: "*One of the most important characteristics of force is that it has a material origin, and this is not just a definition. Y If you insist upon a precise definition of force, you will never get it!* " [Richard P. Feynman, Robert B. Leighton, and Matthew Sands, Lectures on Physics, Addison-Wesley, Reading, MA, Vol. 1, 1964, p. 12-2.]

Even worse, note that **E** = **F**/q defines not the magnitude of the field in space, but has to do with the divergence of energy from the field around a unit point static charge there in space, as well as the pattern of the diverged energy density. Actually, what is used as "the electric field" itself is the *reaction cross section* of the field, for a unit point static coulomb of charge. That is at best a function of the "field density" or "field intensity" of the actual electrical field in spacetime, and the direction and pattern of change of that field density due to the intercepting and diverting charge.

The field problem is resolved in the forefronts of electrodynamics by making the field a topological function. It is resolved in the Sachs-Evans O(3) electrodynamics (as a subset of Sachs' unified field theory) by making the field a function of the curvature of spacetime.

See also the discussion under c, above.

H Magnetic field strength.

B The B-field (loosely), or magnetic flux density (more properly).

Conventionally, this is thought to be defined, analogously to **E**, by the force it exerts. The force exerted on a point charge moving in the magnetic field **B** is at right angles to the velocity vector of the charge and also at right angles to **B**. Actually, the **H**-field was originally named the *magnetic field* and the **B**-field was named the *magnetic induction* (and is still sometimes called that.) This is an annoyance because it is **B** which involves the force, and hence **B** should be *named* the magnetic field. Other writers have noted this discrepancy, and Sommerfeld called **H** the magnetic excitation—which correctly describes its role—rather than calling it the magnetic field. As the reader can see, lots of things in electrical physics are *still very untidy*! There are also different ways to approach the EM modeling problem. In Kaluza-Klein unified field theory, all electromagnetics is modeled in the 5th dimension, which is wrapped around each and every point in our normal 3-dimensional space.

For practical use, a far better approach is the O(3) symmetry electrodynamics spearheaded by Myron Evans, which is also an important subset of Mendel Sachs' unified field theory. In the Sachs-Evans unified theory, electromagnetics has become general relativity and general relativity has become electromagnetics. Further, very powerful general relativity can now be directly engineered with this O(3) electrodynamics, as it further develops. We refer the reader to "The New Maxwell Electrodynamic Equations: New Tools for New Technologies. A Collection of 60 Papers from the Alpha Foundation's Institute for Advanced Study," Special Issue of **Journal of New Energy**, 4(3), Winter 1999, 335 p. Also, particularly see **Contemporary Optics and Electrodynamics**, edited by Myron W. Evans, a special topical issue of I. Prigogine and S. A. Rice (series editors), **Advances in Chemical Physics**, Wiley, 2001 (in publication). Evans gives a very long and detailed presentation, "O(3) Electrodynamics", in that publication, and also gives the paper "The Link Between the Sachs and O(3) Theories of Electrodynamics".

Q A quantity of electrical charge. Note that this statement *does not* define charge *q* itself.

We have tentatively proposed to redefine charge q as $q \equiv m_q\phi_q$. The term ϕ_q captures the vacuum's violent virtual energy interaction with the mass m_q of the charge, which is presently missing in classical EM theory and is an exceeding great flaw of omission. Further, ϕ_q may be decomposed into a harmonic series of phase conjugate wavepairs, as shown by Whittaker, 1903, *ibid*. [In O(3) electrodynamics, the internal structuring is dramatically extended, so that one can get at the "inner electrodynamics" necessary to explain such things as homeopathy, chi, ki, prana, etc.

To those scientists pooh-poohing such things as acupuncture, we point out that acupuncture in a dramatic case can allow a person without anesthetic to undergo a major operation with chest cavity opened, while the patient remains alert, conscious, and talking. President Nixon's physician on Nixon's trip to China witnessed such an actual operation, as well as other things. Nothing in our vaunted Western medical science can equal that, nor can any of our medical schools, nor can our National Academy of Science or our National Science Foundation. In short, acupuncture alone demonstrates how woefully inadequate our medical science actually is.

Also, acupuncture works on animals as well, so it does not involve hypnosis or deep suggestion. In science, we must believe the repeatable experiment, not our dogma at the moment. Yet the entire U.S. medical research community has no higher symmetry EM investigation of how acupuncture works, or of the infolded electrodynamics shown by Whittaker's decomposition of the

scalar potential in 1903. Hence our scientists totally miss the vast electrodynamics of *the internal structuring of potential and charge with vacuum engines (spacetime curvature engines)*. As a result, the entire U.S. scientific and intelligence communities were totally unable to comprehend nearly five decades of Russian induction of health changes and diseases in personnel in the U.S. Embassy in Moscow, using weak EM radiation. Internal structuring of the activity producing what is called "charge"—including its internal structuring and engines—can be modeled and in theory directly engineered in the new Sachs-Evans approach.]

As shown in my paper, "Giant Negentropy from the Common Dipole," **Journal of New Energy**, 5(1), Summer 2000, p. 11-23, the broken 3-symmetry energy flow of any charge and any dipole allows a more fundamental 4-symmetry energy flow solution for the century-old problem of explaining the actual source of the EM energy that pours out of the source charge in all directions in 3-space. The 4-symmetry in EM energy flow explains its nature as longitudinal EM waves, with the charge's absorbed energy being *received* from the time domain (complex plane), transduced into 3-space, and emitted in 3-space. *The source of all EM energy at any point in 3-space is the time domain!*

It has been known for decades in particle physics that there exists no equilibrium in mass systems, unless the interaction of the vacuum with the masses is included. It has also been known that every charge and every dipole is a broken 3-symmetry in the fierce vacuum energy exchange with the charge or dipole. Yet the vacuum interaction—and specifically the source charge's and the source dipole's broken symmetry in it—are not even included in classical EM as yet. That this known total glitch in modern EM theory has not been previously corrected, when the particle physicists of every university physics department of note already know it is necessary, is inexplicable! Here we must regretfully point out finger at our orthodox scientific establishment, and particularly at our National Science Foundation and our National Academy of Science. These institutions are not even working on, nor are they aware of, nor do they even care about, the most fundamental science problems of our time. Bigger accelerators, yes. Windmills, yes. EM energy from the vacuum and electrical power systems which use it without destroying the source dipole, no. The greatest of all electrodynamics—the infolded longitudinal EM wave dynamics inside all EM fields, potentials, and waves—no. The correction of the dozens of major flaws and non sequiturs in classical electromagnetics, no. The understanding of the longitudinal EM wave interferometer weapons and quantum potential weapons already arrayed against us, no. The development of EM healing based on the Priore approach, which would totally revolutionize medical therapy and handle attacks on our cities by weapons of mass destruction, no.

We have a scientific mindset problem of epochal magnitude. And that costs the U.S. taxpayers hundreds of billions of dollars spent on the "status quo" or "business as usual" scientific endeavors that are far inferior to what can be done.

S Entropy. A quantity which measures the extent to which the energy of a system is available to do work.

Since in one sense energy is a function of ordering, then fundamentally, *entropy* refers to increasing disorder, which means increasing disruption of the ordering in our collected energy. Unfortunately, entropy is one of those concepts in physics for which there are several differing major views. We avoid all discussion of "information" etc., and prefer to deal only with the energy and time aspects. For our work in energy from the vacuum, we take the very simple view that an *entropic process* is like a positive resistor: As forward observer time passes, the entropic process continually disorders or "loses"—from further controlled conversion of energy form—the collected energy in the system. We regard a *negentropic process* as like a negative resistor: as forward observer time passes, the negentropic process receives energy in a form unusable to us, transforms, it, and outputs it in a form that is usable. Quoting Ilya Prigogine, Irreversibility as a symmetry-breaking process," Nature, Vol. 246, 1973, p. 70*: "Entropy Ycannot in general be expressed in terms of observables such as temperature and density. This is only possible in the neighbourhood of equilibriumY It is only then that both entropy and entropy production acquire a macroscopic meaning."*

So basically, the notion of entropy will apply when we have a system in equilibrium or very near equilibrium. For open systems in substantial disequilibrium, the entropy cannot even be computed, and the classical equilibrium thermodynamics with its infamous second law does not apply. On the other hand, the loading of disequilibrium (negentropic) EM systems is a very nonlinear affair. Some direct indications of this were in the Russian work in the 1930s which produced overunity and self-powering EM generators, in several physics institute. [E.g., see L. I. Mandelstam and N. D. Papaleksi., "On the parametric excitation of electric oscillations," Zhurnal Teknicheskoy Fiziki, 4(1), 1934, p. 5-29. English translation, Feb. 1968, Lawrence Radiation Laboratory, Livermore, CA, performed for NASA]. The U.S. researcher G. Obolensky also has done appreciable important experimental investigation of the nonlinear load effects for negentropic systems.

S Poynting energy density flow. Not the *overall* or *total* energy flow by any means, but just that component of it that is intercepted, diverged, collected, and used, where **S** is given by **S** = **E**×**H**.

The energy flow theory is rather thoroughly fouled, and has been since the 1880s when the flow of energy through space was proposed by both Heaviside and Poynting, independently and essentially simultaneously.

Since both **E** and **H** are defined not as fields per se, but as the reaction cross section of the fields with a unit charge, the S does not refer to "energy flow" per se, but to the intercepted component of the overall energy flow.

Poynting only considered the energy flow component around a circuit that strikes the circuit's surface charges and gets diverged into the conductors to power the electrons. Heaviside, on the other hand, also considered the startlingly enormous additional EM energy flow filling all space around the circuit's conductors, generally parallel to the conductors but missing them.

This huge Heaviside component is still there around every electrical circuit, but almost entirely ignored and unaccounted. It misses the circuit, passes on off into space, and is lost in most circuits. Yet it is trillions of times larger in magnitude than the very tiny Poynting component which actually gets intercepted, "caught" and used by the circuit to power its loads and losses.

Since no one could explain where on earth such an enormous nondiverged Heaviside component pouring out of the power source terminals could possibly come from, Lorentz—reasoning that, since the nondiverged energy flow did not do anything, it was "physically insignificant" (Lorentz' term)—then just integrated the energy flow vector around a little closed surface assumed around every volume element of interest. This efficiently discards the Heaviside nondiverged component *from all accountability*, leaving only the Poynting energy flow component vector accounted. Of course the Poynting energy flow will agree with the energy measured in the circuit, since we actually measure energy dissipation, and the energy that dissipates from the circuit must have first entered it. Electrodynamicists today just continue to use Lorentz's integration of the energy flow vector around an assumed closed surface surrounding any volume element of interest. Thus, sadly our electrical power system engineers unwittingly waste trillions of times more EM energy actually produced from the vacuum by the source dipoles in their generators, than what the feeble powerline is able to intercept and utilize.

We have nominated the vast unaccounted Heaviside energy flow accompanying every field and charge interaction as the source of the extra gravity known to be present in the arms of the spiral galaxies and holding them together. See my paper, "Dark Matter or Dark Energy?", **Journal of New Energy**, 4(4), Spring 2000, p. 4-11. Informally we have also nominated this dark Heaviside energy which fills all space, as associated with the "quintessence" energy that is responsible for the recently discovered antigravitational acceleration of the universe. In this view the giant negentropy process associated with charge (see my "Giant Negentropy of the Common Dipole" paper, *ibid.*) is ongoing in all the stars, galaxies, planets, nebulae, and other astronomical entities. The ordinary energy we measure in all these processes is gravitational; hence for symmetry and energy conservation, the primary longitudinal EM wave energy from the time domain that furnishes the energy to all these spatially energetic processes represents an increasing curvature of spacetime in the time domain as we travel outward from any origin point. This is an antigravitational force, in this concept, which is cumulative as a function of radial distance from the origin point. Hence we see the distant parts of the universe as accelerating the expansion of the universe. At present this is of course an hypothesis, and must be further validated by laboratory experiment and further theoretical work in a unified field theory electrodynamics such as the Sachs-Evans O(3) symmetry electrodynamics.

S-flow is actually comprised of an organized, structured flow of virtual photons or antiphotons and itself is not observable. Its interaction with charged particles (electrical charges and magnetic poles), however, is observable by the amount of energy collected upon (diverged around) the charge or pole (formation of a local potential), and formation of a translation force upon the charge or pole.

Again, the "**E**" and the "**H**" in the expression "**E×H**" are not really the "electrical field" and "magnetic field" in space, but only their *reaction cross sections* at each point in space, *should* a little unit point static coulomb be placed at that point to divert some of the **E**-field flow around it, or a little unit point static magnetic charge be placed at that point to divert some of the **H**-field flow around it. So even the Poynting energy flow **S** = **E×H** has been interpreted in terms of its reaction cross sections.

It is worth noting that electrodynamicists today are still politely debating EM energy flow and the energy flow vector. As an example, a polite "debate" of this subject has been ongoing for over 30 years in **American Journal of Physics** alone. A particularly significant statement of the problem is given by Jones: *"It is possible to introduce the Poynting vector **S**, defined by **S** = **E×H**, and regard it as the intensity of energy flow at a point. This procedure is open to criticism since we could add to **S** any vector whose divergence is zero without affecting [the basic integration procedure's result]."* [D.S. Jones, **The Theory of Electromagnetism**, Pergamon Press, Oxford, 1964, p. 52.] In short, here Jones is stating that an enormous nondiverged energy flow may accompany the Poynting flow component, and it will not be accounted for by **S** = **E×H**. After presenting the various elements required to solve the energy flow problem, Jones bows out with the statement: "*"It does not seem likely that an expression satisfying all these conditions will be simple… …fortunately, we are rarely concerned with the energy flow at a point. In most applications we need the rate at which energy is crossing a closed surface."* [Jones, *ibid*., p. 53.] Panofsky and Phillips warn against over-attachment to the Poynting vector: "*Paradoxical results may be obtained if one tries to identify the Poynting vector with the energy flow per unit area at any point."* [Wolfgang K. H. Panofsky and Melba Phillips, **Classical Electricity and Magnetism**, Second Edition, Addison-Wesley, Menlo Park, CA, 1962, third printing 1969, p. 180.

We point out, however, that for gravitational effects of energy flows in space, one must account the total energy flow per unit area *at and surrounding* any point, and therefore one must restore the unaccounted enormous Heaviside nondiverged EM energy flow component as well as the accounted tiny little Poynting diverged energy flow component.

Δt An increment (little piece of) time.

In special relativity, time can be considered a piece of spatial length compressed by the factor c, so that L = ct, where L is in meters, t is in seconds, and c is the speed of light. Time can also be considered as spatial EM energy compressed by the factor c^2. To comprehend time and time rate of flow, one must first realize that a priori no observable exists or persists in time. The observable is a 3-spatial snapshot made at one instant in time, so that "time stopped" momentarily. The observable is thus a frozen snapshot of the 3-spatial intersection of an ongoing 4-space interaction. At the very next instant, that snapshot no longer exists. Hence for a mass (or any other observable) to "propagate in time", there must be a process whereby Δt is continually added to the observable (such as to mass m, converting it to masstime mt for a short duration) and then subtracted again, leaving behind another frozen 3-space snapshot of the "observable" that has seemingly now endured for that little Δt period, with respect to the observer. As we explain in several papers, the sum total of the photon interactions with a mass m may be taken as the generator that produces (1) the flow of the mass m through time, by changing from m to mt to m to mt… continually, and (2) a substructuring of internal "time-flow components". In short, any time-flow ascertained in the macroworld or the microworld by the observer, has an enormously rich internal dynamics and structuring. Again, in higher symmetry electrodynamics such as O(3), the internal structuring of the photon, EM field, EM wave, and EM potential can be modeled and eventually even directly engineered.

ΔE An increment (little piece of) energy.

The photon is considered to be (unit-wise) composed of (ΔE)(Δt). However, in our view (as we explain in energy, energy collection, and energy dissipation) energy does not occur in "little fixed chunks" at all. One only has "little chunks" of energy when one *is collecting* energy in an ongoing process. In electromagnetics, the "collection" of energy is actually the *ongoing collecting* of energy from an energy flow deviating around an intercepting charge. It is a dynamic, ongoing process whereby a collector such as a charged particle intercepts and interacts with (undergoes virtual photon flux exchange with) an impinging energy density flow **S**= **E×H**. In an equilibrium (static) condition, the deviated flow remains very like a persistent, unchanging whirlpool in a river, and so is said to have a "static magnitude". If that Poynting flow is removed, then there is no excess collecting going on and the "magnitude of the deviated energy flow" is zero. EM energy collection/collecting is always like a rock in a high wind. As long as the wind is blowing on the rock, air is deviated to flow around the rock. The rock has a force field on and of it, and wishes to move. It also has "excess collected energy", and a gradient in this "excess collected energy" determined by the wind flow direction. When the wind ceases to blow, the rock goes back to being just a rock, and forgets it had all that excess wind energy collecting and any desire to move.

TERMS AND PHRASES

ABEL, NIELS HENRIK (1802-1829)

Norwegian mathematician who in 1824 proved that the general equation of fifth degree cannot be solved algebraically. He also left an important paper on transcendental functions which was published posthumously.

ABELIAN GROUP

A group obeying the commutative law of algebra for every pair of elements a and b under an operation , so that a*b = b*a. As an example, the set of integers is an infinite abelian group under the multiplication operation.

ACTION AT A DISTANCE

An action (effect) occurring in a local system, for which no separate local 3-space cause exists, but for which a causal correlation exists between a distant cause and the local effect.

To the local 3-space observer, the effect is baffling. In electromagnetics, action at a distance can be considered a higher topology phenomena, occurring through hyperspace or through subspace, or through "multiply connected spacetime." Particularly note that "time" is multiply connected; i.e., every spatial point in 3-space (in the entire universe) exists at the same moment in time, which means that electrodynamic action through the time domain can be used to eliminate the spatial distance between any two 3-space points. Action at a distance is absolutely required by quantum mechanics, and experiments establish its truth. Such action was implicitly included in Maxwell's quaternion theory, but was unknowingly discarded by Heaviside, Hertz, and Gibbs when they formulated a much more restricted vector interpretation of Maxwell's theory, after Maxwell's death. Bohm's hidden variable interpretation of quantum mechanics uses the quantum potential, which is a multiply-connected entity producing instantaneous action at a distance. In ordinary electrodynamics, the common scalar potential in the Coulomb gauge has instantaneous velocity, and it appears everywhere in space, wherever it will occupy, all at once *in that gauge*.

Time is also a set of energy flows in the time domain (complex plane) rather than in 3-space. Time is also multiply connected, since a priori every 3-space point in the universe exists at and in a single moment of time. Since time is dynamic and structured with special energy flows, it seems possible to use this feature to establish energy flow during one specific moment to a desired subset of 3-space points, regardless of where in the universe those points are located. Hence the development of "time-energy" technology allows action at a distance via manipulating the multiple connectivity of time and its internal structure (internal time-like energy flows).

AD HOC MODEL

A model used and fitted for a specific purpose or area.

Tentative formulation, not intended toward general application and not yet firm because there is still not a comprehensive, tested demonstration of the "fit" of the model to the complex phenomenology. Nonetheless, an ad hoc model can be quite useful in a given area, so long as it sufficiently fits the experimental data in that area and makes sufficiently accurate predictions in the area.

ADVANCED FIELD

An electromagnetic field that is a solution of the classical Maxwell equations, which is positioned on the future light-cone of spacetime.

We believe much of the problem with the "advanced solution" is a problem of interpretation. We would urge the re-interpretation not in terms of "time-travel" where the wave continues in observer forward time while the rest of the universe is assumed to retrogress to a previous state, but in terms of time-reversal of that wave only. In that case, the rest of the universe stays sane and continues to move in observer forward time, and the wave itself just moves in forward time in a path-reversed manner, back along a previous "stimulus wave" (the retarded wave that moved forward in time normally).

ADVANCED POTENTIAL

An electromagnetic potential that is a solution of the classical Maxwell equations, which is positioned on the future light-cone of spacetime.

Presently this potential has not yet been given a physical interpretation. See remarks above.

ADVANCED WAVE

An electromagnetic wave that is a solution of the classical Maxwell equations, and which is positioned on the future light-cone of spacetime.

See remarks above.

AFFINE CONNECTION

In mathematics: "A connection on a manifold, whose form is unchanged under affine changes of parameter along curves, e.g., when the original parameter t of a curve γ (t) is replaced by t = as + b." **Dictionary of Science and Technology**, Academic Press, Christopher Morris (Ed.), 1992.

Ugh! We'll let the mathematicians take it from there.

AFFINE TRANSFORMATION

"Transformation on a linear space to itself which can be expressed as the sum of a linear transformation and a fixed vector.

The affine transformations form a group. In the plane, the group is six-dimensional, consisting of translations, rotations, stretchings and shrinkings, reflections, simple elongations and compressions, and simple shear transformations, as well as compositions of these."

Dictionary of Science and Technology, 1992, *ibid*.

AHARONOV, YAKIR

Renowned Israeli quantum physicist and former student of David Bohm.

Co-discoverer of the *Aharonov-Bohm effect*: Even when the electromagnetic force fields reduce to zero in a charged particle system, the potentials may still exist and interfere to cause real physical effects. Together with Bohm, Aharonov authored a fundamental paper in 1959 which pointed out the primary importance of the *potentials* rather than the force fields. Indeed, the force fields are only made *in and of the charged particle system itself*, by interference there of potentials, and do not exist as such in the vacuum. The forcefields are thus not primary electromagnetic causes at all, but are *secondary effects* due to the interference of potentials in a particular charged particle system. [See *Aharonov-Bohm Effect*] In his three volumes of physics, Feynman pointed out that the forcefields do not exist *as such* in the vacuum, and that *only the potential for the forcefields exists in vacuum*. The primary causative agents for electromagnetics are thus the potentials. This has been proven both theoretically

and experimentally in quantum mechanics, but still does not appear in present classical electromagnetic theory taught in universities—which terribly confuses cause waves and effect waves in wave-charge interactions.

AHARONOV-BOHM EFFECT

Phenomenon theoretically pointed out in 1959 by Yakir Aharonov and David Bohm whereby interfering electromagnetic potentials can produce effects on charged particle systems, even at a distance and in the absence of the electromagnetic force fields.

See Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," Physical Review, Second Series, 115(3), 1959, p. 485-491. For an overview and extensive bibliography, see S. Olariu and I. Iovitzu Popescu, "The Quantum Effects of Electromagnetic Fluxes," Reviews of Modern Physics, 57(2), Apr. 1985, p. 339-436.

Chambers experimentally demonstrated the Aharonov-Bohm effect one year later. When **E-** and **B**-fields are zero in a region, their potentials still may exist and thus be stable and persistent. Being gradient-free, a force-free potential is not changing; no bleed-in or bleed-off of its magnitude *or of its internal structure* is occurring. Interference of the potentials produces real electromagnetic effects (energy) in the interference zone, even at a great distance, without transmission of "field energy" per se through the intervening 3-space. [Rigorously, the potential's EM energy can be considered to be *hyperspatially* transmitted, or *subspatially* transmitted (tunneled) via the Whittaker internal EM biwave mechanism. See discussions under *action at a distance*.]

In 1897-8 Stoney showed (in **Philosophical Magazine**) by physical reasoning that all the disturbances of the ether arising from sources of certain kinds can be resolved into trains of plane waves. This was extended and the general and special equations written by E.T. Whittaker in 1903 in **Mathematische Annalen**. In 1904 (delivered orally in 1903) Whittaker's second paper dealing with the subject was published in the **Proceedings of the London Mathematical Society**, and showed that scalar EM potential interferometry is in fact what generates the classical EM force fields.

The two Whittaker papers may be interpreted to show a startling arrangement in a potential or EM wave. (1) any EM field or wave in a particular 3-space is due to two interfering scalar potential functions in that space. So we may replace any EM field or wave with two scalar potential functions, a priori. (2) But each of the scalar potentials onto which the functions are applied, is decomposable into the Whittaker 1903 longitudinal EM wavepairs, where the output waves are in 3-space and the input waves are time-like and come from the complex plane. This provides a hidden "infolded LW electrodynamics" inside, and composing, all EM fields and waves. Further, the decomposition is recursive, so each of the first tier infolded EM waves can be decomposed again into a second tier of biwaves, etc. Thus the most primary electrodynamics of all is the nested infolded longitudinal EM wave structuring of all present EM waves, potentials, and fields. The internal LW waves also form rigorous curvature of ST patterns (templates) and thus engines. By engineering the structure and dynamics of the internal EM, one can engineer mass—including the atomic nuclei, quarks, and gluons—as one wishes, once the technology is sufficiently developed. In the West, this entire area has been ignored, but it has been highly weaponized by the KGB in Russia.

AIAS

Alpha Foundation's Institute for Advanced Study.

Unusual "think tank" comprised of fellows and fellow emeriti in various places in the world, who cooperate in advanced electromagnetics studies via E-mail. Led by Dr. Myron W. Evans, a theorist of note, the institute has been forging ahead with the production of O(3) symmetry electrodynamics, particularly as an important subset of Mendel Sachs' unified field theory. Dozens of AIAS group-authored papers have been published in various leading journals such as Foundations of Physics, Physica Scripta etc. More than 90 AIAS papers are carried on a restricted Department of Energy website for reference by DoE scientists. The work is particularly significant in working out how EM energy flows in both the 3-spatial and time domains, and how EM energy can be and is extracted from the active vacuum. More than a dozen of the later AIAS papers are carried on a DoE public website, http://www.ott.doe.gov/electromagnetic/papersbooks.html. Also, about two dozen AIAS papers have either been approved for publication in journals, or are in the review process. The present author is a Fellow Emeritus of the AIAS, and is kindly tolerated as a conceptualist by these advanced theoreticians.

AIDS

Acquired Immunological Deficiency Syndrome.

A condition of acquired immunological deficiency associated with infection of the cells of the immune systems with the retrovirus HTLV-III. It is usually recognized by testing positive to HIV infection, and eventually by physical deterioration and by development of one or more life-threatening opportunistic infections such as pneumonia, or of Kaposi's sarcoma.

AIKIDO

A Japanese martial art whose modern form is a synthesis of many schools of jujitsu and the zen art of meditation in motion.

It is the way (DO) of entering and turning (AI) the opponents vital energy (KI). The present author is a retired sandan (third degree black belt) in Yoseikan aikido. He is retired because of debilitating injuries suffered in other fields and accidents, and as a busted-up old dog of 70 has no business bouncing hard off the mats with all those vigorous young fellows. His extra 50 pounds also no longer enhance his athletic ability. We did write a book, privately held but never published, on Aikido and dealing with the principles of unarmed combat. Interestingly, we simply went into the deep unconscious in meditation (and perhaps a little beyond, depending on one's viewpoint) to uncover the unsuspected principles. To list them, we went through the alphabet four times. Many of these principles have never appeared in any text on martial arts or military combat. The task was placed on me by my sensei and required seven years to complete. Perhaps one of these days we will formally publish the book.

ALGEBRAS

The various types of mathematics in which the theoretical models for physics and other sciences are embedded.

Some important algebras utilized in physics are the vector algebra, tensor algebra, quaternion algebra, Grassman algebra, Pauli algebra, Clifford algebra, etc. There are many others. The complexity of the symmetry and of the topology varies significantly between these algebras. Thus, an electrodynamics model in a lower topology algebra such as vectors or tensors will not reveal or permit nearly so great a set of electrodynamic functions and operations as will electrodynamics embedded in a higher topology algebra such as quaternion algebra or Clifford algebra.

As an example, it has been shown by Barrett that the operation of many of Nikola Tesla's patented circuits cannot be understood if analyzed in vector or tensor electrodynamics. The circuits will reveal totally new functions when analyzed in quaternion electrodynamics. That paper is T. W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," **Annales de la Fondation Louis de Broglie**, 16(1), 1991, p. 23-41

ALLOPATHIC MEDICINE

A medical system which combats disease by using remedies which produce effects different from those produced by the disease treated.

Reliance is primarily upon drugs, pain relievers, and treatment of symptoms as well as use of agents to "kill" the microbial organisms regarded as the cause of the diseases. Surgery is used as a major adjunct. From time to time, other practices formerly frowned upon or even legally prosecuted are recognized as effective and legitimate, and are then brought in under the aegis of organized allopathic medicine. Physical therapy is such a formally prosecuted modality that was eventually adopted; hypnosis is another. The problems with organized allopathy is that (1) it tends to be monopolistic, (2) it uses the state's power to enforce its credo, (3) it controls both the bulk of the medical scientific literature and the flow of research funds from both government and private sources, (4) it does not adequately police its doctors and technicians, (5) it does not sufficiently accent preventative medicine or "whole human being" treatment, and (6) it engages in conspiracies to destroy competing systems of medicine (as in the case of chiropractic). (7) On the other hand, it has made remarkable advances in preventing killer diseases by vaccination, treating them by antibiotics, and in eradicating or controlling many of the former great killer diseases such as smallpox, diphtheria, and bubonic plague. It has been far less successful in treating and reversing debilitation, cancer, arteriosclerosis, etc. Just now, most of its major weapons against the former dread diseases are beginning to fail. The disease organisms are rapidly changing into new, more virulent forms that are resistant or even immune to the present "successful" treatments. Even in orthodox medical publications, it is now beginning to be recognizing that allopathic medicine is starting to fail, and that we are again entering a period of great, uncontrollable killer pandemics.

ALLOPATHY

Another name for allopathic medicine and allopathic medical therapy.

AMBIENT VACUUM

The average active vacuum, in space, removed from large collections of charge and mass.

AMBIENT VACUUM POTENTIAL

The average standard vacuum (spacetime) considered as a potential having structure and dynamics on a myriad levels.

Anything that is composed of virtual particle flux is a *potential*. Another way of looking at the vacuum is to realize that, having an energy density, then *a priori* it is a potential or may be modeled as such.

Hence the ambient vacuum can be decomposed via the Whittaker method into an internal set of infolded EM longitudinal waves of very special nature. Further, our work on the broken 3-symmetry energy flow involved in any potential or dipolarity shows the more fundamental 4-symmetry energy flow between the time domain and 3-space. This 4-symmetry energy flow is also highly structured and dynamic.

Whittaker's work shows that, contrary to present assumptions in quantum physics, a particular potential has its virtual particle flux formed into a beautiful bidirectional wave structure. The apparent disorder at any local point in the local vacuum potential is due to the constant arrival of myriads of potentials, from charged particles all over the universe. The violent interference and re-interference of these potentials results in the creation of violently changing virtual photons—or in terms of waves, violently changing EM waves and fields. In other words, the statistical disorder of the vacuum is actually *composed of* continually and rapidly changing perfect order. [Here we have confronted 3-law Aristotelian logic with its missing 4th law, because *at the limit* opposites *are* identical!] The continual violent interferometry results in the zero-point EM fluctuations of vacuum. Each EM fluctuation is completely deterministic, as shown in Puthoff's cosmological feedback mechanism. However, the macroscopic observer has no knowledge of the cause or of the arrival, and of the myriads of interferences that produced the final EM field fluctuation. Hence although the zero-point fluctuations of vacuum are completely deterministic one-by-one, the observer has *no information* on their causality. Hence to the observer these fluctuations are completely statistical and seemingly *without local order*. However, because of their hidden determinism, these fluctuations are chaotic rather than random—contrary to the Gibbs' thermodynamics statistics assumed and adopted by quantum mechanics. That statistics should be changed to an "already chaotic" statistics containing hidden Whittaker order. This would appear to be the real solution to the recognized major QM problem of the missing chaos.

Since their changes and appearances are completely in one-to-one correspondence to all distant features of the macroscopically ordered universe, then their integration yields macroscopic order. Further, as can be seen, Mach's principle—so near and dear to the heart of Einstein—arises directly from the foregoing discussion. In such fashion, integration of statistical (but chaotic, and with hidden order) quantum changes results in the familiar, ordered macroscopic world. This removes the great error in QM: that heretofore it has failed to predict the ordered macroscopic universe we observe and inhabit.

ANALOGUE

Part that is analogous (representative or modeled).

At root, an analogue of something is a second something that functions in similar fashion to the first something.

ANAEROBE

An organism that lives, is active, and occurs in the absence of free oxygen. Particularly applicable to one-celled organisms that do so.

ANAEROBE, FACULTATIVE

An organism that can live either as an aerobe or as an anaerobe. Particularly applicable to one-celled organisms possessing that capability.

ANAEROBE, OBLIGATORY

An organism that is restricted to being anaerobic; i.e., it cannot utilize oxygen from the atmosphere.

ANAEROBIC

Characteristic of an organism of living, active, or occurring in the absence of free oxygen.

ANGULAR MOMENTUM

The momentum or "leverage" of the momentum of a moving body, with respect to an axis or reference point.

Angular momentum as the same units as action; that is, it is energy multiplied by time, or momentum multiplied by length. In terms of particles, it is also known as *spin*.

ANOMALOUS EM JAMMING MECHANISM

In a dense signal environment, an unusual mechanism whereby EM energy from the skin of an aerial vehicle is directed laser-like into the internal circuitry.

The density of the signals impinging upon the skin are such that the probability of multiple photon interaction increases. Also, on a nonlinearity in/on the skin, the multiplex of signals creates a scalar EM potential. Decomposition of this potential into Whittaker waves provides hidden "pump" waves upon the nonlinearity, which therefore acts as a pumped phase conjugate mirror (PPCM). EM fields and signals from the internal operating circuits in the vehicle provide "signal waves" to the internal skin and to the nonlinearity PPCMs on the skin. Amplified phase conjugate replica (PCR) waves are generated by the PPCMs, where in each PCR wave the energy may be the total of the external signal density pump waves upon the initiating PPCM. The result is that the skin becomes a "collector" of energy from all the impinging external signals, and focuses much of this collected external energy into laser-like beams inside the vehicle which penetrate directly back to the circuit element that originated the particular signal field/wave to the inner skin. The result is spurious jamming throughout the vehicle, directly in its operating circuits, in a manner not described in normal ECM theory. Also, the same effect occurs in a human body when exposed to such a dense signal environment (threshold about 200,000 signals per square meter per second, and particularly active above 500,000 signals per square meter per second. I.e., in such an EM "smog" environment, the anomalous jamming mechanism is able to progressively conduct the energy impinging upon the skin deep into the body and throughout it, including into the bone marrow. This effect is not described at all in the standard dosimetry literature and experimental approaches for examining the effects of EM fields and radiations upon biological systems. By rigorous frequency band control of radiations and communications, most equipment can be operated in an appreciably dense environment such as appears on the modern environment, because the equipment is essentially "narrow band." The human, however, is a very wide-band receiver, and in such dense environments—even at very weak signal levels—the human system will eventually undergo cumulative damage. This is one of the major mechanisms involved in long term deleterious biological effects of EM radiation environments, but this effect on living systems has not been investigated in the laboratory by present EM bioeffects researchers.

In the U.S. air attack on Libya in 1986, the anomalous jamming mechanism interfered with the aircraft, controls, and missiles because frequency discipline was not rigorously enforced. In the Gulf War, rigid frequency discipline was enforced, with the result that the electronic systems operated normally. However, the troops exposed to that environment (which varied from place to place) were affected by the mechanism, which added a bit to the previous cumulative damage to their immune systems, etc.

ANTIBODY

A body substance produced in response to a specific antigen (protein or carbohydrate or other substance, such as a toxin or enzyme, capable of stimulating an immune response).

The antibody counteracts the effects of the antigen, by neutralizing toxins, agglutinating bacteria or cells, precipitating soluble antigens, etc.

ANTI-ELECTRON

The time-reversed electron, or *positron*. Under time reversal, electric charge reverses in sign.

Paul A.M. Dirac, in his "A Theory of Electrons and Protons," Proceedings of the Royal Society of London A126, 1930, p. 360 introduced the negative energy electron sea (now called the "Dirac sea") with negative energy electron holes treated as the positive electron. He attempted to identify these holes with protons, but that was later refuted. The positron, discovered about a year after Dirac's paper, was later connected with this anti-electron.

Note that Dirac himself was not adamant that *all* negative energy state holes in the Dirac sea were filled with electrons, but just that *almost* all of them were. Modern researchers have tended to extend this to state that *all* the holes are filled, normally. That is sufficient in forward time situations. But it does not necessarily hold in a time-reversed situation, in a time-reversed zone, or in a tempic back emf.

ANTIGRAVITY

An effect whereby normal masses *repulse* one another rather than *attract* one another

Antigravity may also be considered as *time-reversed gravitation*. It may also be considered as *gravitation between two negative masses*.

ANTIMATTER

Matter consisting of atoms which are composed of antielectrons (positrons), antiprotons, antineutrons.

Also loosely refers to the antiparticle corresponding to a particle—the antiparticle may be regarded as the particle traveling backward in time, or "phase conjugated", or "time-reversed.

ANTIPARTICLE

A counterpart to an ordinary fundamental particle, having identical mass lifetime and spin, but with charge and magnetic moment reversed in algebraic sign.

Note that when the charge is reversed, parity and time are also reversed. Thus, properly, the antiparticle is the phase conjugation of the particle, or just conjugate particle for short. In effect an antiparticle is the particle traveling backward in observer time rather than forward in observer time.

ANTIPHASED

180 degrees out of phase (contrary-wise in timing).

ANTIPHOTON

A time-reversed photon.

Presently, the photon is considered its own antiparticle, so that photon and antiphoton are one and the same. In the new approach, that is not quite true. First, one considers that a photon—as is well known—has the units of angular momentum. Thus it is made of "energy multiplied by time." We consider that the time-forward photon (i.e. a normal photon), is made of $(+\Delta E)(+\Delta t)$. Usually physicists have largely neglected the fact that a photon carries an *increment of time* as well as an increment of energy! In our approach the antiphoton, being a *time-reversed* entity, must be composed differently. We have tentatively considered the antiphoton to be comprised of $(\Delta E)(-\Delta t)$. It will probably initially be necessary to take into account the fact that Minkowski geometry treats the T dimension as imaginary rather than simple arithmetic. We haven't had the lengthy time to

work all of that out; perhaps one of the better theoreticians or one of the sharp young graduate students will do that and save us the trouble.

At any rate, the requirement is that—in a coupled photon-antiphoton pair (a graviton)—the energies of photon and antiphoton must add spatially, while *electromagnetically* the translation forces (actually translation impulses) of photon and antiphoton must cancel or thwart each other. One insists on a strong interpretation of the distortion correction theorem in phase conjugate optics. In other words, we consider the "wave" as composed of photons, while the "antiwave" (phase conjugate replica) emitted by a phase conjugate mirror is composed of antiphotons. And we consider that the distortion correction theorem must apply to the wave's photons, so that the antiphotons are precisely superposing (coupling) and then decoupling as the wave and antiwave pass through each other in perfect spatial superposition. We feel that this "totally in phase spatially but totally antiphased temporally" concept is important. It is well-known, e.g., that in certain cases protons—the very building blocks of matter itself—can pass right through other protons, as shown in certain colliding beam experiments if their relative spins are properly arranged.

ANTISIGNAL

The phase conjugate of a signal. The time reversal of that signal or its twin. The phase conjugate replica signal/wave emitted by a phase conjugate mirror material in response to an incident signal/wave.

ANTI-STOKES EMISSION

Radiation emitted from an intensely scattering medium that is of greater intensity than the input radiation.

In other words, the medium gives off more energy than we have to put into it. This has been known since the 1930s and proven experimentally, but no really complete explanation has been forthcoming. The conventional explanation is that some of the kinetic energy of the medium is furnished to cause additional emission. In that case, anti-Stokes emission would lower the kinetic energy of the emitting medium. Note that this is not necessarily true at all in Letokhov's negative absorption (excess emission) of the medium, where in that case the excess energy in the emissions is said to come directly from energy absorbed from the active vacuum.

ANTI-STOKES RADIATION

The radiation coming from an anti-Stokes emission process from an intensely scattering medium, where more energy flux is emitted than is input by the experimenter-operator.

In the past, there has just been "arm-waving" that the excess energy must come from the internal energy of the molecules. There seems to be no explanation at all of where the excess energy of the molecules must continue to come from! Tacit silence on this "apparent" violation of energy conservation is held. But see Letokhov's *negative absorption of the medium* discussions in the literature.

We quote from H. C. Dake and Jack DeMent. (1941) **Fluorescent Light and Its Applications**, Chemical Publishing Company, Inc., Brooklyn, New York, 1941. p. 51-52: *"When a phosphor or other luminescent substance emits light, it gives in most cases an emission according to Stokes' Law. This law states that the wavelength of the fluorescent (emitted) light is always greater than the wavelength of the exciting radiation. It was first observed in 1852 in the memoir "On the Change of Refrangibility of Light," by Sir G. G. Stokes. In terms of energy the relationship states that e em < e ab. While Stokes' Law holds for the majority of cases, it does not hold in certain instances. In some cases the wave length is the same for both the absorbed and the emitted radiation. That is, the efficiency appears to be perfect or unity. This is known as resonance radiation. In other cases Stokes' Law does not hold where the energy emitted is greater than the energy absorbed. This is known as Anti-Stokes emission. In 1935 Prileshajewa showed that there is an energy difference as much as 1.1 v between the exciting light and the fluorescence of aniline vapor. This added energy is attributed to additions from the internal energy of the molecule."*

There is no real problem of identifying the source of the excess energy, once one realizes that (i) every dipole is a broken symmetry in the vacuum exchange with the end charges of the dipole, and thus extracts virtual energy from the vacuum, integrates and orders it, and outputs it as EM energy density flow. One then adds multiretroreflection and multiple passes of the EM energy flow, so that charges that intercept and collect energy from the reciprocating flow can multiply connect from the same energy flow (on a given pass, only a tiny, tiny fraction—nominally about 10^{-13}—of the energy flow is intercepted and interacted with by the collecting particle). Thus multiple collections from the same EM energy flow can be accomplished, if the flow is iteratively rerouted (as by retroreflection or phase conjugate reflection) back across the collecting charges again and again.

In this fashion additional energy is collected in the collected volume, which increases the local collected energy density in that volume. In turn this increases the local potential of that volume. *In turn* that increases the energy flow from that potential acting as a dipole, because it increases the dipole strength and consequently the magnitude of the dipole's broken symmetry in its vacuum flux exchange.

The inefficiency of the process increases nonlinearly with increasing local potential, and faster than the buildup of local energy density occurs from multipass multicollection. When the inefficiency curve reaches the increasing broken symmetry energy extraction curve, then a point of equilibrium is reached. At that equilibrium point, the rate of energy diffusing out of the multipass region and escaping from the periphery of the system is equal to the rate of extraction of energy from the vacuum and flowing it out into as Poynting **S**-flow into the multicollection region and collecting it.

So we have described an open thermodynamic system, where there are two inputs of energy flow: (i) that by the operator-experimenter, and (ii) that from the vacuum via the dipolar broken symmetries. At equilibrium condition the total input energy rate is equal to the total energy escaping rate, and the conservation of energy law is rigorously upheld. However, this is an open thermodynamic system far from equilibrium, and so rigorously the nonlinear thermodynamics of such systems applies, rather than the normal equilibrium thermodynamics. As is well-known, the coefficient of performance for such open systems in disequilibrium, may permissibly be overunity, even greatly overunity.

Properly utilized, the overunity anti-Stokes or Letokhov emission can be made very large—such as COP ≈1200 in Patterson's adaptation. The process and its overunity certification already exist in the hard science literature, being known and experimentally demonstrated for at least three decades.

ANTIWAVE

The time-reversal (phase conjugation) of a reference wave.

A phase conjugate replica wave is a time-reversed replica of its referent wave. Hence it is the antiwave of the referent wave.

A-POTENTIAL

Vector magnetic potential.

The A-potential is a real entity more primary than the magnetic field **B**, and not a mathematical convenience as was originally thought—as detailed in the second volume of Feynman's three volumes of physics. Indeed, it may be separated from the magnetic field, as reported by Feynman, and used for instrumentation effects in the manner patented by Gelinas. When separated from magnetic field, it is often referred to as the "curl-free vector potential," since the **B**-field is modeled as being created from the **A**-field by curling it. In other words, **B** is defined as the curl of the magnetic vector potential, if we use $\mathbf{B} \equiv \nabla \times \mathbf{A}$. Hence "separating" magnetic field from **A**-potential simply is a sort of "parallel branching" of the energy density flow of the **A**-potential. It is like branching the voltage on a feeder line conductor in an electric circuit into two parallel conductors. The feeder potential splits into two, so that each branch has the same potential. Actually the vast energy flow in the feeder line only has a small component which strikes the surface charges, diverting the energy into the conductor and potentializing the Drude electrons. In branching into two conductors, the giant flow branches also, but is so great that the surface charges in each of the two branches still intercept essentially the same amount of energy, diverging it into the conductor. Hence each conductor exhibits the same potential as the feeder conductor

The same thing happens when one "splits" or branches the **A**-potential in similar fashion. The diverted and separated **B**-field branch will exhibit "equal energy density" flow (i.e., in the form of magnetic flux density flow) and yet the original **A**-potential path through space will still have the same previous energy flow density magnitude, just without curl (without magnetic field).

Any good toroid or very long solenoid already performs such separation, and hence energy density flow doubling. If properly used—as in the motionless electromagnetic generator (MEG)—this effect can be used to provide a generator with COP>1.0. At this writing, the present MEG exhibits COP = 16, and is a patent-pending system.

The well-known Aharonov-Bohm effect, e.g., also uses this separation of the curl of the **A**-potential, leaving an uncurled **A**-potential whose changes will and do interact with electrons.

The curl-free vector potential is particularly interesting because (1) it is a unique and independent field of nature, (2) its curl produces a magnetic field, (3) its time derivative produces an electric field, (4) its magnitude does not fall off inversely as the distance squared, but only inversely as the distance, and its time derivative $d\mathbf{A}/dt = B\,\mathbf{E}$. Hence, as in the MEG, one can extract energy both from the curl-free A-potential and the curled **A**-potential (magnetic field **B**), increasing the available energy collected in the circuit to greater than what the operator input to it. This is simply a physical process of regauging, wherein electrodynamicists already routinely assume (and apply) the fact that the potential energy of any EM system can be freely changed at will, by regauging. In the real world, of course, we may have to pay a little switching energy, but we are free to regauge (by this "splitting the potential into equal parallel paths, and by other methods), at will and at any time and place. The MEG just takes advantage of one major method for free regauging, in order to violate the Lorentz symmetry condition (violate symmetry in the system's energy exchange with its active vacuum environment). It thereby is legitimately permitted to exhibit COP>1.0 and output more energy than one inputs, because the regauging transforms it into an open dissipative system far from thermodynamic equilibrium in its active environmental energy exchange.

ARISTOTELIAN LOGIC

The conventional three laws of logic, unconsciously fitted to the physical reality created by the single photon interaction. The three laws are: (1) a thing is identical to itself, (2) a thing is not identical to something else, and (3) either one has a given thing or something that is not that thing. Mathematically these are written as (1) A A, (2) A Ã, and (3) A Ã. Aristotelian logic applies only to single observation at a time (monocular observation, a single observer). When multiple simultaneous observation (multiocular observation, multiple observers) are considered, the three laws may be violated. In that case a fourth law, A Ã is added. This law may be seen to be the exact negation of all the first three. An application rule (which may itself be called a fifth law) is also added, and states that either the first three laws are explicit and the fourth is implicit, or the first three are implicit and the fourth is explicit. Further, the fourth law is the *law of the paradox*: Something that is found to be true in nature, but violates one or more of Aristotle's three laws, is known as a *logical paradox*. In the higher logic, it simply violates the case where the three Aristotelian laws are explicit and the fourth law is implicit. Instead, the three Aristotelian laws are now implicit and the fourth law has become explicit. All boundaries exhibit this effect.

It is highly recommended that the interested reader familiarize himself or herself with Morris Kline, **Mathematics: The Loss of Certainty**, Oxford University Press, New York, 1980. Kline deals directly with the fact that mathematics is not a body of unshakable truths about the physical world, and mathematical reasoning is not exact and fallible.

ARISTOTLE

A great Greek philosopher who lived from 384-322 B.C.

Aristotle is famous for his three laws of logic: (1) a thing is identical to itself, (2) a thing is not identical to something else, and (3) either one has the thing considered or one has something else.

Heraclitus pointed out that Aristotle's laws prohibited any change, and yet changes were ubiquitous. In short, for a thing to change, it had to change into something else, so Heraclitus pointed out. So how could a thing be both itself and something else simultaneously? How could it be not itself while being itself? The problem has not been solved by the logicians and philosophers to this day, because it has no solution in Aristotelian 3-law logic. So Heraclitus, believe it or not, concluded that all change was an illusion.

ATHERIOSCLEROSIS

Basically, clogging of the arteries, which may be due to deposits onto the artery walls or by thickening and growth of the artery walls themselves, or a combination. It is a chronic (slowly progressing) disease where the artery walls become progressively thickened and hardened and the artery becomes less elastic.

It has been found that the common cytomegalovirus (one of the herpes viruses) plays a key role in the development of the disease. Initial deposits irritate and injure the arterial walls, and the herpes 6 virus infects the site, partially nullifying the control of excess grown of the arterial muscle tissue. This deposit and concomitant stimulation of some excess muscle growth occurs repeated, so that the muscle tissue grows abnormally over an extended period of time. For this reason, when an operation is performed to forcibly reduce the deposits inside the artery, the resulting injuries to the arterial wall tissues leads to the herpes 6 infection and stimulation of excess muscle growth. It has been found, e.g., that after angioplasty the process is often engendered, so that within a year or two the artery is narrowed again, but this time by abnormal growth of smooth muscle tissue. The Prioré team demonstrated positive and total remission of arteriosclerosis in laboratory animals by means of nonionizing EM irradiation to produce an amplified "antiengine", which "time reversed" or dedifferentiated the stricken cells and the stricken areas back to a previous state.

ARTIFICIAL POTENTIAL

A scalar potential which is composed of, or partially contains, an artificially assembled bidirectional wave set.

See E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," **Mathematische Annalen**, Vol. 57, 1903, p. 333-355 for proof that a "scalar potential" is actually a harmonic set of hidden bidirectional EM phase conjugate longitudinal wavepairs. Each wavepair consists of a wave and its antiwave (true time-reversed replica wave).

If the external observer could see the *detected* (effect) waves in a hidden wavepair, he would see the "wave" going in one direction and the antiwave passing precisely through it in the other direction. However, prior to detection, the phase conjugate wave exists entirely in the complex plane and hence in the time domain (in -ict). So the interpretation of Whittaker's 1903 paper, in terms of cause and effect waves, is that the phase conjugate half set is incoming from the time domain to each and every point in the dipolarity or potential, and the "real 3-space half set" is being radiated in every direction in 3-space from that point. See my paper, "Giant Negentropy….".

In addition to Whittaker's sum set of biwaves, Ziolkowski added the product set in the mid-1980s. E.g., see Richard W. Ziolkowski, "Exact solutions of the wave equation with complex source locations," **Journal of Mathematical Physics**, 26(4), April 1985, p. 861-863; Rod Donnelly and Richard Ziolkowski, "A method for constructing solutions of homogeneous partial differential equations: localized waves," **Proceedings of the Royal Society of London A**., Vol. 437, 1992, p. 673-692. Particularly see I.M. Besieris, A.M. Shaarawi, and R. W. Ziolkowski, "A bidirectional travelling plane wave representation of exact solutions of the scalar wave equation," **Journal of Mathematical Physics**, 30(6), 1989, p. 1254-1269.

However, these deal only with the effects waves after detection.

Another way of defining an artificial potential is: *A potential formed by or containing a subset formed by, deliberately summing nonzero force field vectors to a zero vector resultant*. [Note that electrodynamicists routinely discard vector systems that sum to a zero resultant; not realizing that in doing so, they are discarding vacuum engines and a vastly extended electrogravitational dynamics!] The vector zero system of infolded nonzero vectors has a deterministic, internal stress pattern that is macroscopic. The type of potential made by the zero summation depends upon the type of force vectors summed. For example, summing electric field vectors to zero produces an electrostatic scalar potential; summing magnetic field vectors to zero produces a magnetostatic scalar potential of vacuum.

All potentials represents local warps or curvatures in vacuum/spacetime, and all artificial potentials contain internal, deterministic templates of nested internal spacetime curvatures. Curvature of spacetime interacts directly upon mass and physical systems embedded in it. Thus these deterministic, internested local spacetime curvatures of the artificial potential represent vacuum engines, or spacetime engines, and the artificial potential is said to be a *dimensioned* or *activated* potential. Any system exposed to and placed in such a vacuum spacetime engine, will have these hidden vacuum flux asymmetries interacting upon each and every part of it, down to and including the nuclei, the nucleons, and the quarks in the nucleons.

ASYMMETRICAL REGAUGING

Change of either the scalar potential f or the vector potential **A**, but not both, so that a single excess force and a single change of system energy occurs in the system.

This violates the assumed Lorentz condition, and thus excess energy can enter the system, and an excess "free" force appears which can (if the system is adroitly designed) then translate to perform work upon the system to increase its (e.g. kinetic) energy, exhausting the excess regauging energy in the process and restoring symmetry.

In conventional EM theory, Maxwell's equations in potential formulation are in terms of two potentials, f (the scalar potential) and **A** (the vector potential). When Heaviside retranslated Maxwell's quaternion set of 20 equations in 20 unknowns, he transformed it (in potential form) into two equations where main variables f and **A** are not separated. Electrodynamicists, who until recently considered the potentials as not even real, but just mathematical figments and conveniences, then simply arbitrarily changed both f and **A** *just precisely so* that the extra force appearing in the system by the change of f was countered by an equal and opposite extra force also appearing in the system by the change of **A**. This type of *symmetrical (no net force) regauging* is known as the *Lorentz condition*.

Each *asymmetrical* (produces a nonzero excess net force) potential change (each half of the two asymmetrical regaugings that comprise the symmetrical regauging) also altered the overall energy of the system. However, in the symmetrical regauging that total energy change is "bottled up" as increased stress in the system, because no net translation force is available to be translated and use the energy change to produce excess "free work."

The Lorentz condition assumes that the designer *will not allow* the equilibrium of the system to be broken! In that case, of course, ordinary equilibrium thermodynamics applies, and the system cannot produce COP>1.0. Prior to this Lorentz condition assumption and its absolutely arbitrary regauging, Maxwell's equations do include asymmetrical regauging and therefore open EM systems far from thermodynamic equilibrium; precisely those which violate the Lorentz condition (symmetric regauging) assumption. In short, the unregauged equations do include COP>1.0 electrodynamic circuits and systems.

Unknowingly the electrodynamicists *arbitrarily* discarded the entire Maxwellian class of overunity EM engines and circuits—which class incorporates making a change in one potential(s) such that the Lorentz condition does not hold.

ASYMMETRY

Lack of symmetry, or "broken symmetry" in a general sense.

ASYMMETRY OF THE DIPOLE

Any dipole or dipolarity is a broken 3-symmetry in its fierce exchange of EM energy with the active vacuum. This means that it continuously receives and absorbs copious virtual energy from the seething vacuum flux, and that not all this absorbed energy is reradiated back to the vacuum in virtual form. Instead, some of it is integrated into observable form and re-radiated in all directions as usable, real 3-space EM energy.

This is standard, well-known particle physics, although it appears to be totally missing from classical electrodynamics and it is not considered at all by electrical power system designers and analysts!

Every electric charge is a broken symmetry in the virtual particle flux exchange between the quantum mechanical (energetic) vacuum and the mass of that electric charge. The dipole is two different such asymmetries. As is well-known in particle physics (not in classical EM theory!) each such broken symmetry must "gate" out some of the vacuum energy. In short, the charge asymmetry "extracts" some vacuum energy from its normal "energetic exchange" with the vacuum flux, and puts it out in some form we call "observable" (capable of being measured; specifically, of being intercepted by electric charges so as to produce a force field across the charge and translate it).

Well, an electrical charge produces a flow of energy density which we may represent conventionally as $\mathbf{S} = \mathbf{E}\times\mathbf{H}$ (when collected and measured on assumed unit point charges), which we—a little bit mistakenly—call "observable." [Actually, until the energy flow interacts with that assumed unit point charge, it is an *organized flow of virtual entities*] After interaction it is

real observable EM energy in 3-space. The spinning electron has its own magnetic moment and its own **E**-field. Since (in one form) also $\mathbf{E} = -\nabla\phi$, an extracted and formed $\mathbf{S} = \mathbf{E}\times\mathbf{H}$ is output by the charge asymmetry. This output energy flow also produces the assumed ϕ evidenced by the charge interaction, since ϕ as used represents the *reaction cross section* of the potential. Note that all these entities **S**, **E**, **H**, and ϕ are defined in electrodynamics only as their own interaction cross section with a unit point charge containing mass.

In classical electrodynamics (formed long before the notion of charged particles, atoms, and EM energy flow!) it is just recognized that "charge is the source of a potential." Actually charge gates the energy flow from the vacuum flux, receiving the energy from the time domain by its asymmetry, transduces the energy into 3-space energy, and outputs it as real EM energy pouring out in 3-space in all directions. That energy-flow contains and carries the energy that will interact with charge to form the **E**-field, the **H**-field (spin field), and ϕ.

Also, in particle physics and gauge theory it is well-known that *no mass system can be in equilibrium anyway, unless the vacuum-to-mass interaction is incorporated!* After CEM was formed, much later the atom was discovered and the electron was discovered. Much later then, particle physics and quantum mechanics came along. CEM theory has never been altered to include the necessary vacuum interaction, although it has been known for decades that CEM is totally in error in this respect.

Here one poses a question to the sharp young graduate students: Why does every university continue to teach a seriously flawed classical electrodynamics which does not include the vacuum/mass interaction, when the physics department at the same university knows full well that it must or no EM system can be in equilibrium? Why is not such a *fundamental* and universal issue strongly raised and intensively discussed by our large, tax-exempt scientific organizations at their annual symposia? Why do not the National Science Foundation and the National Academy of Science demand that serious work be done at all speed, to correct such known scientific deficiencies in the classical EM theory? *What happened to science as the search for physical truth*, and replaced it with "status quo" models or—in some cases—even dogma? It is an inexplicable mystery to me, and one to which I do not know the answer.

AUTOIMMUNE DISORDER

A disease or disorder relating to or caused by the antibodies or T-cells that attack foreign molecules, cells, or tissues of their host organism.

A flagrant autoimmune disease example is AIDS, Acquired Immunological Deficiency Syndrome. The AIDS virus successfully hides from the antibodies, so that they cannot perform their proper function, and it infects the T-cells and negates their function. However, there are other examples other than AIDS: e.g., rheumatism and osteoarthritis.

BACK EMF

The counter-electromotive force, usually between the end charges of the source dipole for an EM circuit.

When the electrons in the circuit are forced against the emf—as when the charges from the ground reference of the circuit are forced back up through the emf of the source dipole—then work is done upon the source dipole to scatter the charges and destroy the dipole. Removing the dipole removes its receipt of vacuum energy via its broken 3-symmetry, transduction of that energy, and output of it along the circuit and in space around the circuit as the energy flow that powers the circuit (with part missing the circuit and being just wasted).

Since this removes the power from the circuit, then additional energy must be input to the source to perform work on the internal charges and restore that source dipole again.

There are actually two emfs in a circuit, not one. There is a 3-space emf and also an entirely unrecognized tempic emf. In either case, under proper circumstances there can be a back-emf or either one or both. See discussion under *electromotive force, back*. See also *tempic back emf* (to be added).

BALL LIGHTNING

Rare form of lightning where an incandescent, slow-moving globe forms. The globe often moves erratically, explodes, and may set fire to objects it touches.

Ball lightning may be due to scalar electromagnetic interferometry which can produce a controlled pattern of electromagnetic energy at a distance, or it may be due to the formation of a special localized spacetime curvature engine.

BARE ELECTRON

The true electron without its partial shielding of virtual positrons that are attracted around it.

BARRETT, TERENCE W.

Noted modern electrodynamicist and consultant who works in SU(2)×SU(2) gauge symmetry extended electrodynamics, and was also one of the pioneers of ultrawideband radar.

BECKER, ROBERT O.

Medical doctor, medical research scientist, and Nobel Nominee, noted for his early-on efforts—particularly in the 1960s through the 1980s, in the effects of EM fields on biological systems, studies of evoked or partially evoked limb regeneration in certain species, electrical stimulation of bone fractures to stimulate healing and reveal the mechanism involved, and the cellular regeneration system of the body as opposed to the immune system.

Becker particularly recognized that the cellular regenerative system was a special electrical system having unique functions. He even succeeded in diagramming this system as far as it is revealed by ordinary U(1) electrodynamics. Becker demonstrated partial limb regeneration in salamanders, etc. and in some other species, with electrical stimulation. In his EM-stimulated bone fracture healing, Becker showed a startling result: First the red blood cells entering the fracture area shucked their hemoglobin and grew a nucleus, thus "dedifferentiating" (biological term) or "time-reversing" (physics term) back to an earlier state. Then this modified cell redifferentiated (biological term) or "fast-forwarded in time" (physics term) into the type of cell that makes cartilage. Then this newly modified cell further redifferentiated into the type of cell that makes bone, and was deposited in the fracture site. The continuing deposits of these cells from the ongoing process evoked in red blood cells healed the fracture with new bone growth. Whereupon the action stopped.

Becker also was one of the first qualified scientists who testified in court on the deleterious effects of power line radiation. He thereby incurred the enmity of very powerful interests, so that his research funds were pulled and eventually he was forced to retire at an early age.

He was nominated for the Nobel Prize multiple times, and his epochal work did finally focus at least some attention of the medical research community on the regenerative system as opposed to the immune system which heals nothing.

Becker's profound work was of tremendous influence on me as I struggled to decipher the active mechanism in his experiments, the Prioré team's experiments in France, the Russian microwave radiation of U.S. Embassy personnel in Moscow, Kaznacheyev's experiments demonstrating transmission of cellular disease and disorder electromagnetically into target cells environmentally isolated except for contact by light from the sender cells having such disease or disorder, and the body's own regenerative system. After some 14 years struggle with the problem, I finally did break the mechanism(s) involved in all those things. But it was only possible because of the magnificent work by Becker and Prioré, the reported work by Kaznacheyev, and gradual exposure to higher symmetry electrodynamics. The work was crude at first, but eventually progressed (by 1998, e.g.) to include the port-hole concept, transduction of EM wave polarization types, the engine and engine template concepts, and unified field theory. Since then it has become clear that the proper electrodynamics to model such things is the higher symmetry O(3) electrodynamics pioneered by Evans, and now revealed to be an important subset of Sachs' unified field theory.

Becker is therefore one of my heroes whose magnificent work and long perseverance against strong scientific suppression I greatly admire. Most of Becker's detractors were or are in fact employed in positions either directly or indirectly funded by the electrical power industry. I believe that, had Becker had access to O(3) electrodynamics and Sachs' theory, he would have personally impelled the entire medical field to a marvelous and extraordinarily advanced EM medical therapy.

See Robert O. Becker and Andrew A. Marino, **Electromagnetism and Life**, State University of New York Press, Albany, 1982; Nice summary of EM bioeffects (orthodox) ; also on http://www.ortho.lsumc.edu/Faculty/Marino/EL/ELPub.html.

See also R. O. Becker, "The neural semiconduction control system and its interaction with applied electrical current and magnetic fields," **Proceedings of the XI International Congress of Radiology**, Vol. 105, 1966, p. 1753-1759, Excerpta Medica Foundation; Amsterdam; — "The direct current field: A primitive control and communication system related to growth processes," **Proceed. XVI Internat. Congr. Zoology**, Washington, D.C., Vol. 3, 1963, p. 179-183; — "The control system governing bone growth in response to mechanical stress," **J. Ark. Med. Soc**., Vol. 62, 1966, p. 404; — "A technique for producing regenerative healing in humans," **Frontier Perspectives**, 1(2), Fall/Winter 1990, p. 1-2; — with Charles H. Bachman and Howard Friedman, The direct current system: A link between the environment and the organism," **New York State Journal of Medicine**, Vol. 62, April 15, 1962, p. 1169-1176; — and D. G. Murray, "A method for producing cellular dedifferentiation by means of very small electrical currents," **Trans. N.Y. Acad. Sci**., Vol. 29, 1967, p. 606-615; — and Joseph A. Spadaro, "Electrical stimulation of partial limb regeneration in mammals," **Bulletin of the New York Academy of Medicine**, Second Series, 48(4), May 1972, p. 627-64; — and Carlton F. Hazlewood, Abraham R. Liboff, and Jan Walleczek, **Electromagnetic Applications In Medicine**," NIH-OAM Electromagnetics Panel Report, Jan. 15, 1993.

See particularly Robert O. Becker, "The significance of bioelectric potentials." **Bioelectrochemistry and Bioenergetics**, Vol. 1, 1974, p. 187-199. This is probably *the* paper by Becker that provides a really good overview of the control system. A block diagram of the proposed system is given by Becker on p. 191.

Becker also has authored several popular-oriented books filled with excellent information. These include Robert O. Becker, M.D. and Gary Selden**, The Body Electric: Electromagnetism and the Foundation of Life**, William Morrow and Co., New York, 1985; and Robert O. Becker, **Cross Currents: The Perils of Electropollution; The Promise of Electromedicine**, Jeremy P. Tarcher, Los Angeles, 1990.

BEDINI, JOHN

Noted audio engineer, overunity energy researcher, and inventor of the renowned Bedini amplifiers well-known to audiophiles, the BASE process for holographic sound, and a process for cleaning the harshness from digital audio disks.

Bedini has invented a variety of COP>1.0 processes, motors, generators, etc. Particularly he has developed a process whereby, in a battery-powered circuit, he adroitly back-pulses the battery in a recharging direction while the battery is powering the load, causing a pile-up of electrons on the surface of the battery plates that is a sharply increased scalar potential opposing the onrushing very massive lead ions in the battery in discharging mode. The result is that the potential's electron pile-up increases dramatically due to the ions' far greater inertia than that of the electrons. The result is a high potential (perhaps 40 volts) upon the surface of the battery, overpotentializing both the incoming lead ions between the plates and the electrons in the external circuit in powering mode. In this phase, energy flows from the vacuum onto both the ions and the external circuit electrons, adding significant energy to the powering of the external circuit for the same ion current inside the battery.

As the ions slow and stop, Bedini's back-pulse trailing edge causes a very sharp cutoff, thus invoking Lenz's law and resulting in the surface potential on the plates increasing to well over 100 volts. This further overpotentializes the external circuit electrons in powering mode, dissipating much more energy in the external circuit to power the loads. As the ions finally stop and reverse, their relatively sluggish re-acceleration in charging mode and their overpotentialization still results in excess energy being delivered to the external circuit. Then as the overpotentialized ions accelerate in charging mode, the external circuit is still in powering mode until the drain-off of the severe electron pile-up on the surface of the battery plates.

This is one of several modes of operation used by Bedini in his overunity battery powered circuits, which keep their batteries recharged while powering their loads.

By separating the other closed current loop between external electron currents and the ion currents between the battery plates, and then dephasing these currents, Bedini breaks the usual dissipation symmetry enforced in a closed loop circuit where all charge carriers have the same m/q ratio. In Bedini's circuits, the m/q charge ratios dramatically differ between the ion current section between the plates and the electron currents between the outside of the plates and through the external circuit. Also, by providing a much greater potential *between* the two circuit halves, The potential extends in both directions—internally back over the ions, and externally in the circuit over the external Drude electrons powering the circuit loads and losses. He provides a true negative resistor on the surface of the plates, which extracts energy from the vacuum (via its broken 3-symmetry as a dipolarity) from the time domain, transduces it into real EM energy, and overpotentializes (regauges) the potential energy of both the internal ion currents and the external electron currents.

The Bedini process is therefore a legitimate COP>1.0 system, and in his self-powering embodiments the system will run indefinitely without external energy input by the operator, use of fuel, etc. He has converted the system to an open system far from thermodynamic equilibrium in its violent energy exchange with the active vacuum, and thus the system is permitted to exhibit both COP>1.0 and self-powering as well.

For an expanded explanation of the Bedini negative resistor process in batteries, see T. E. Bearden, "Bedini's Method for Forming Negative Resistors in Batteries," **Journal of New Energy**, 5(1), Summer 2000, p. 24-38.

BEING

Pure essence, existence.

Again, something which in actuality resists Aristotelian definition unless preliminary assumptions are made. Generally used in one of two senses: (1) persistence, as in "he is (he continually exists)," or (2) identity, as in "he is the man ('he' and 'the man' are the same thing)."

BIDIRECTIONAL EM WAVES

EM waves running antiparallel to each other through a given point or region of space.

Suppose we run a normal EM wave into a phase conjugating mirror (PCM) with a gain of 1. By ordinary phase conjugate optics, the mirror then emits a backwards-traveling phase conjugate replica wave (PCR wave). According to the so-called "distortion correction theorem," that backwards traveling wave will travel backwards (as seen by the external observer) back over the exact route taken by the previous wave, and it will reappear in space precisely superposed spatially with the previous waves. If we examine the impulse (density) fields (i.e., Edt), then the forward-time wave contains Edt while the backward time wave contains E(−dt), which is just −Edt. So *electromagnetically*—as far as producing a net translation force on a charge—the E-fields seem to cancel, although they are still there and their energy is still there. Instead of translation, the two produce stress.

One thus (simple case) will have a strange kind of standing wave wherein the local energy density of the vacuum varies (e.g., sinusoidally) as a function of distance, but a charged particle placed in it will not be translated! Rigorously, that is a *gravitational standing wave*. Since change in local energy density is also a curvature of spacetime, that is also a standing sinusoidal wave of the local curvature of spacetime. This is where electromagnetics and gravitation actually meet, and where electromagnetics can be utilized to produce gravitational waves. (Much more complex waves can be produced; this is just the simplest example).

BIDIRECTIONAL FIELD FLOWS

E-fields (and B-fields) being propagated in a pair of opposite waves traveling "through" each other in opposite directions,

...where the two may be "locked together" as a wave and its antiwave; i.e., as a "Whittaker biwave pair". Note that Whittaker bidirectional EM wavepairs are not to be confused with the pairing of the wave and reflection wave on a transmission line.

BIDIRECTIONAL GATING

Gating (of energy flow, e.g.) in both directions simultaneously.

BIDIRECTIONAL TRAVELING PLANE WAVE

A wave and its antiwave, where each wave is moving in an opposite direction (standard assumption in phase conjugate physics).

In short, to the external observer the waves seem to be "moving through" each other; one from left to right, and the other from right to left; or one radially outward and the other radially inward. All scalar potentials were shown by Stoney and Whittaker to be comprised of a harmonic series of such "bidirectional traveling wave pairs." However, the interpretation of the phase conjugate waves was after detection, so that the detected "effect" wave existed in 3-space. Prior to detection, the phase conjugate half-set of the Whittaker decomposition of the scalar potential is convergent from and in the time domain (complex plane).

BIOELECTROMAGNETICS (BEM)

Presently, the scientific study of interactions between living organisms and electromagnetic fields, forces, energies, currents, and charges. The range of interactions studied ranges from atomic and molecular, through intracellular, to the whole organism**.**

Electromagnetic fields studied in BEM include those of endogenous origin (from within the organism) and exogenous origin (from outside the organism). Sources of exogenous fields include: the earth and sun, electrical equipment (power lines, radio transmitters, etc.), clinical treatment devices (e.g., TENS), and other organisms. The electromagnetic fields of greatest interest in BEM are generally classified as nonionizing (i.e., lacking sufficient energy to directly dislodge electrons from molecules or atoms.) BEM is a scientific discipline emerging on the boundaries between physics and biology. As in other sciences, progress in BEM is made by testing falsifiable hypotheses against valid measured data obtained in repeatable experiments.

Our new viewpoint seeks to dramatically enlarge the scope of this definition, to include not only the presently-recognized external (outfolded) electromagnetics, but also the internal (infolded, inside the scalar EM potential) electromagnetics, and also to utilize a unified field theory where EM is GR and vice versa.

BIOENERGETICS

That branch of Russian (KGB) energetics which is targeted against the living body, its cells and tissues, and its EM fields and potentials (biofields and biopotentials).

BIOGENESIS

Generation of living organisms from other living organisms; also, the theory or philosophy that living organisms develop only from other living organisms.

BIOLOGICAL WARFARE

Warfare against living humans, livestock, crops, etc. using pathogenic micro-organisms or biocides to create diseases and death, or using dimensioned electromagnetic potentials, fields, and waves to kindle cellular damage, disease, and death in the same targeted populations.

BIOLOGICAL WARFARE, ELECTROMAGNETIC

The use of dimensioned electromagnetic potentials, fields, and waves to induce cellular damage, disease, and death in targeted living populations.

The decades of Russian microwave radiation of personnel in the former U.S. Embassy in Moscow is an example, where only field-free potentials were dimensioned with the disease or health-change patterns (the engines). This science was developed in Russia as an outgrowth of the thousands of Kaznacheyev experiments demonstrating that any cellular disease and damage pattern could be induced from diseased or damaged cells into environmentally isolated cell cultures, purely by specialized EM radiation from the damaged or "transmitting" cells into the targeted cells.

The Chinese also used such dimensioned radiation to induce cancer in almost all GRU operatives stationed in China at the time of the major disagreement between China and Russia. In his book, Stanislov Lunev and Ira Winkler, Through the Eyes of the Enemy: Russia's Highest Ranking Military Defector Reveals Why Russia Is More Dangerous Than Ever, Regnery, Washington, D.C., 1998, p. 160, Lunev reveals it this way:*"...I was not the only person who was stationed in Beijing to come down with*

cancer… Almost all of the GRU officers stationed in China with me have been diagnosed with cancer. People assigned to the embassy had told me that they were picking up high levels of radiation from the apartment building around the embassy compound. Whether it was a form of high-tech monitoring or a conscious effort to harm our health, it seems to have been successful. So much so that in 1992 the GRU was asked to investigate the high rate of cancer among embassy officials. The findings, however, have never been made public; in part, no doubt, because of the rapprochement between Russia and China." In short, the Chinese did exactly to the Russian GRU what the Russians were doing to the Americans.

BIOPHOTON

A quantum of angular momentum, each containing "a piece of energy welded to a piece of time, with no seam in the middle," emitted by biomolecules in living organisms. The difference between a biophoton and a normal photon is that the "infolded EM structuring" (ST curvature engine sets) carried by the biophoton carries the dynamics and templates of the living cell or tissue or body emitting the radiation.

As presently known, biophoton emission is associated with processes such as mitosis (cell division) and with mechanisms such as soliton vibrations of DNA and other alpha-helix proteins [Popp et. al., 1984; Popp et. al., 1992]. An organism's biophoton field may represent a highly-structured innate organizing field capable of encoding or transmitting information over macroscopic distances.

Kaznacheyev, e.g., showed that almost any cellular disease or damage condition can be induced from the diseased control cells to separated and environmentally isolated target cells initially normal, if (1) the visible spectrum of radiation is blocked from the targeted cells, and (2) the two groups of cells are optically connected below and above the optical spectrum, in the infrared and in the ultraviolet.

The new viewpoint seeks to dramatically extend the scope of this definition. Considering the wave aspects of the photon frequency, the infolded oscillating EM energy in the photon may be decomposed into two oscillating potentials [Whittaker, 1904]. In each of these potentials, there exists a magnificent infolded structure [Whittaker, 1903] of internal bidirectional EM wave pairs, to include the sum set [Whittaker] and the product set [Ziolkowski]. Thus the photon carries internal information, which is also referred to as the "information content of the field." Since the product set represents modulations, the basic infolded structure has signal characteristics. Mind, thought, and long term memory exist inside the personal quantum potential, which may further be regarded as consisting of coupling and uncoupling photon/antiphoton pairs—i.e., hidden gravitons. In the new viewpoint, the biophoton is the carrier of biogravitons, and also biograviton lattices. This information forms vacuum engines which can cumulate over a period of time to breach the quantum threshold and outfold, producing real change in cells, as shown by the Kaznacheyev cytopathogenic mirror effect experiments.

BIOQUANTUM POTENTIAL

A quantum potential connected to and of a living body, where the inner EM structuring and dynamics of the quantum potential are in correspondence with the inner EM structuring of the normal EM fields, potentials, and waves in the body, and also are in correspondence with the time-polarized EM structuring and dynamics of the mind and its operations.

The biopotential provides the volition and intent exhibited by the biological body, breaching the quantum threshold and producing direct psychokinetic change (by the mind-body coupling mechanism) that is the "input signal" to the servomechanisms of the body,. from the smallest to the largest. In this biopotential, the Stoney-Whittaker-Ziolkowski decomposition provides the information structure and vacuum engines that are the mind, thought, long term memory, etc. A living biological system may be defined as a physical system of otherwise inert matter (the body) and of mind, coupled to each other through a bioquantum potential.

BLOCKING

In the charge-barrier semiconductor functioning, stopping or partially stopping the flow of current in a circuit, or between two points, without stopping the Poynting S-flow.

In ordinary usage, "stopping the progress of."

BOHM, DAVID

World renowned physicist and originator of the hidden variable theory interpretation of quantum mechanics. See David J. Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of 'Hidden' Variables, I and II." Physical Review, 85(2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II).

Together with his student Aharonov, he co-authored a fundamental paper on the Aharonov-Bohm effect wherein interfering electromagnetic potentials can produce effects on charged particle systems, even at a distance and in the absence of the electromagnetic force fields.

BOHM'S HIDDEN VARIABLE THEORY (HVT)

A major interpretation of quantum mechanics, formulated by David Bohm and published in Physical Review in 1952.

See David J. Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of 'Hidden' Variables, I and II," **Physical Review**, 85(2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II). Bohm's theory makes all the correct predictions and also eliminates many problems in quantum mechanics, such as the "measurement problem" and the—now alarming—problem of the missing chaos (i.e., the missing "hidden order.").

Ironically, the prevailing Copenhagen interpretation of the QM theory predicts that the organized macroscopic world does not exist, while Bohm's theory predicts it. [Question to the sharp young graduate student: How can one defend a scientific model which predicts that he himself does not exist? If one keeps one's sense of humor, it would seem that this has to be the greatest scientific *faux pas* of all time!] It may be that one unconscious reason that most physicists still oppose HVT is that *it implies that physical reality can in fact be deterministically engineered*. Most physicists would seem to fervently wish physical reality to stay "solid as a brick," with fixed "laws of nature," which can be leisurely discovered and then utilized comfortably, predictably, and sanely. The advent of HVT (which is just a matter of time; for decades the Russians have highly weaponized the HVT area!) dramatically alters our perception of "fixed physical reality" into that of an "engineerable, changeable" physical reality! I tentatively believe that the terrible psychological implications of such a potential development is something that most scientists do not wish to cope with—we simply do not have the Gestalt for it. On the other hand, the Russian national psychology is such that they do have the Gestalt for it. The Russian energetics—which I have long referred to loosely as scalar electromagnetics—basically utilizes the infolded ordering inside the potential to create "direct patterns of vacuum flux", hence *vacuum engines*. And it also utilizes the quantum potential, including internally structuring the QP, to enable instantaneous action-at-a-distance in multiple simultaneous locations and nodes, with stupendous and automatic energy amplification.

By deterministically "patterning" the internal structuring of the scalar potential, one can directly form such vacuum engines. Whittaker showed in 1904 that any EM field pattern whatsoever can be expressed as two scalar potentials, rather than the common f and **A** representation. This means that any EM wave is simply the "interference" (between the hidden biwave structures) of two scalar potentials, even at a distance. By properly structuring an EM signal (i.e., structuring the two potentials into which it can be decomposed), the resulting EM signal—appearing normal on the surface—nonetheless now transports special vacuum engines deliberately designed to perform some particular internal task in mass systems, electronic systems, or humans when it strikes a target at a distance. I refer to this "internal structuring" of the Stoney/Whittaker/Ziolkowski internal biwaves and their products, as *dimensioning* of the potential(s), and hence of the EM carrier wave. The Russians call it the *information content of the field*; but our own scientists tend to erroneously interpret that phrase as ordinary spectral analysis. In other words, they erroneously continue to regard EM *vacuum engines* as if they were ordinary EM *signals*.

BOHREN EXPERIMENT

Revealing experiment by Bohren, replicated by Paul and Fischer, which shows that a given charge when in particle resonance absorbs more energy from a field or potential then the same charge does in "static" position.

By conventional outlook, this provides a guaranteed COP>1.0 process. Bohren demonstrated absorbing 18 times more energy with the charge in particle resonance than with the static charge. This is a direct experiment proving the Heaviside dark energy component of EM energy flow, whether in field form or in potential form.

See Craig F. Bohren, "How can a particle absorb more than the light incident on it"?", **American Journal of Physics**, 51(4), Apr. 1983, p. 323-327. See independent confirmation of Bohren's work by H. Paul and R. Fischer, *ibid*., p. 327. Other pertinent references are V. S. Letokhov, "Laser Maxwell's Demon," **Contemporary Physics**, 36(4), 1995, p. 235-243; — "Generation of Light by a scattering medium with negative resonance absorption," **Soviet Physics JETP**, 26(4), Apr. 1968, p. 835-839; — "Double Gamma and optical resonance," **Physics Letters A**, Vol. 43, 1973, p. 179-180; — "Stimulated emission of an ensemble of scattering particles with negative absorption," **ZhETF Plasma**, 5(8), Apr. 15, 1967, p. 262-265. Also see R. Pappalardo and A. Lempicki, "Brillouin and Rayleigh Scattering in Aprotic Laser Solutions Containing Neodymium," **Journal of Applied Physics**, Apr. 1992, p. 1699-1708

BRIDGE

A component or process which passes EM energy between two isolated circuits, but does not pass dq/dt between them, and which breaks the normal rigidly field-locked power dissipations in the two circuits.

Space itself would appear to be one such bridge.

BRIDGING FUNCTION

The function of passing EM energy flow between two isolated circuits, but not passing dq/dt between them, while simultaneously breaking any normal rigidly field-locked power dissipations in the two circuits.

BROKEN SYMMETRY

The fundamental meaning is a condition in which two parts of some configuration or shape on opposite sides of some divisor or condition or boundary, are not similar but differ.

In vacuum energy physics, we are very interested in the fact that any charge and any dipole represents a broken symmetry in its fierce energy exchange with the vacuum. This implies that something virtual has become observable; i.e., part of the virtual EM energy absorbed from the vacuum by the charge or by the dipole is changed into observable form and re-emitted as real, observable EM energy.

Any observable implies a broken symmetry. Non-observables imply symmetry, and vice versa. Each symmetry also can be represented by a conservation rule or law. Physicists have uncovered many kinds of symmetry in physics; and in the 1950s they also discovered broken symmetry.

BROMWICH, THOMAS JOHN l'ANSON

Brilliant English mathematician, 1875-1929, who made significant contributions to the mathematics of electromagnetism—particularly to superpotential theory—before his passion for overwork led to development of a mental disorder and eventual suicide.

Bromwich originated a method for solving the source-free Maxwell equations in 1899, publishing it in 1919. This approach formed the basis for his seminal paper on scattering of plane EM waves by spheres. He did excellent original work on infinite series and made contributions to quadratic and bilinear forms. He also placed Heaviside's operator calculus on a rigorous basis by treating the operators as contour integrals. Unfortunately Bromwich worked so intensively, in such painstaking detail, and at such length that his physical health was affected. He developed a mental disorder and eventually ended his own life in suicide.

For a summary of Bromwich's life and achievements, see G. H. Hardy, "Thomas John Bromwich," **J. London Math. Soc**. **5** (1930), 209-220; — "Obituary of Thomas John Bromwich," **Proc. Roy. Soc. London A 129** (1930), i - x. For an exposition of Bromwich's equations-solving work, see J. D. Zund and J. M. Wilkes, "Bromwich's method for solving the source-free Maxwell equations," **Tensor (NS) 55** (2) (1994), 192-196.

BROWN, G. SPENCER

Noted author and creator of the laws of form, a new form of logic that dramatically extends Aristotelian logic.

Essentially Brown added complex numbers to logic, rather than just staying with simple 2-dimensional plane figures for postulate derivation. Electrical circuits— designed by Brown's logic—do function and do work. When computer software is designed by Brown's logic, it is then possible to mathematically prove whether or not the end result possesses any defects (bugs). In the future software—particularly the larger systems—may well be designed by Brown's logic. G. Spencer Brown, **Laws of Form**, Julian Press, New York, 1972. With a dramatic advance in logic itself, Brown has succeeded in formulating a true calculus of form. Note: There is now a second edition of the book.

BULK GRADIENT CHANGE

Simply a change in the amplitude of the entire potential,

… (i.e., to every internal biwave pair comprising it) at some point or in some region of space, as compared to changing the amplitude of only one or a few of the internal biwave pairs of the potential, without changing all the rest.

BYPASS RESISTOR

In electrical theory, a resistor to pass current by (in parallel to) some other component.

If other effects such as use of the overpotential, pumped phase conjugate reflection, quantum wells, quantum tunneling, and charge blocking are added, the function of the bypass resistor becomes extremely complicated.

CANCER

Conventional definition: A *malignant tumor* of potentially unlimited growth that expands locally by invasion and systemically by *metastasis*.

Growths are further characterized by the type of tissue in which they occur, and their actions. Of particular interest are neoplasm, tumor, carcinoma, and sarcoma. *Malignant* disorders tend to produce deterioration, infiltrate, metastasize, and terminate fatally. A *neoplasm* is simply any new growth of tissue that serves no useful function. A *tumor* is an abnormal mass of tissue that (1) is not inflammatory, (2) arises from preexisting cells, and (3) serves no useful purpose. A *carcinoma* is a malignant tumor of *epithelial* (covering membraneous tissue of a free surface) origin. A *sarcoma* is a malignant neoplasm that arises in *mesodermal* tissue (connective tissue, bone, cartilage, or striated muscle) and that spreads by (1) extension into neighboring tissue or (2) by way of the bloodstream, or (3) both.

New definition of cancer: A centrally-commanded, final, desperate, "first-step dedifferentiation" adaptive attempt by stressed, affected cells experiencing sustained oxygen shortage (hypoxia) to reverse their cellular evolution and return to the anaerobic stage of their primeval cellular ancestry. Thus a cancer cell is a severely stressed hypoxic cell that has been "ordered" by the master cellular control system (MCCS) to dedifferentiate back to a more primeval form in which it needed little or no oxygen. It is the last desperate attempt by the body to insure the affected cells' survival when all other means available to the MCCS to provide the necessary oxygen have been exhausted and have failed. The "order" differs from normal signal theory in that it consists of a Stoney/Whittaker/Ziolkowski template inside the personal quantum potential of the organism. Thus the "order" actually consists of a vacuum engine, so that the spacetime in which the affected cell exists is acted upon by structured, energetic hidden variable fingers to directly alter it. The "signal order" is in fact a set of hidden vector forces in spacetime itself, created directly in and on the affected cell(s), in every part, in every atom. The cure for the cancerous cell, once formed, is simply to cause the MCCS to generate the "counter-order" reversing the original dedifferentiating action. This can be readily accomplished by establishing hidden multifrequency pump waves in the quantum potential on the cancerous cell, on all its parts, so that they act as pumped phase conjugate mirrors. Since they already exist in the altered "cancer" spacetime template/signal, the pumping causes a phase conjugate replica of the precise cancer state to be created in and on the cell and its parts. [In fact this is a general therapeutic mechanism, and it can be applied to reverse almost any conceivable cellular damage or disorder.] This counter-order is a new and amplified vacuum engine that acts upon the cell to redifferentiate it back to a normal cell. If an abnormal number of cells results, the body's normal processes then recognize the excess cells and destroys them.

CANCER HOTSPOT

An area or locality or location where cancer recurs repeatedly, more than the normal deviation expected statistically. In such case, one is dealing with a hidden cause or carcinogen.

Human systems exposed to such a hotspot experience cellular changes (hypoxia) which eventually result in the master cellular control system (MCCS) issuing a dedifferentiation order to the affected cells to regress back to a primeval anaerobic form. The first step is dissociation from central (MCCS) control of cellular growth, resulting in a cell that now grows and divides unrestrained by the normal body. The real question in the hotspot is, "What is the unknown agent inducing the hypoxia condition, and what is the mechanism by means of which it induces it?" Epidemology will point out a hotspot, but is usually incapable of resolving the primary causative agent or its active mechanism since it can only show correlation.

CAPACITOR AS A TRANSMISSION LINE

A capacitor can be theoretically treated as a special type of transmission line, a fact which is apparently known to transmission line theorists but not to many engineers and physicists not specializing in transmission lines.

CARCINOGEN

A substance or agent (such as a chemical or a spacetime curvature engine) capable of inducing a cancer.

In the new theory, the primary carcinogen is an actual order (a vacuum engine) issued by the master cellular control system (MCCS), reverting (dedifferentiating) the affected cell to a primal anaerobic form. Usually what are normally regarded as carcinogens are also causes of cellular conditions wherein the cell becomes very hypoxic, so much so that the MCCS exhausts all other alternative corrective means and as a last desperate measure orders the cell to change to a form that requires little or no oxygen. The "exhausting of other measures" may be very rapid, as when the cell has been affected and damaged by powerful carcinogens, or it may require decades to occur, as when the cell is subjected to long-term mild hypoxia, such as from electromagnetic smog.

CARRIER WAVE

A fundamental wave which is modulated by another wave or other waves, and hence "carries" the other waveform(s). By stripping off the carrier in a demodulator, the carried waveform(s) emerges.

Hence it is a continuous frequency wave which can be modulated by an information-bearing signal.

CASIMIR EFFECT

The attraction of two conducting parallel plates in space, placed very close together, due to their influence on the active vacuum and on the vacuum's interaction with the plates.

CASIMIR, HENDRIK BRUGT GERHARD (1909-2000)

Noted scientist who in 1948 predicted that two parallel conducting plates, placed very near each other in a vacuum, would experience an attractive force due to their influence on the electromagnetic vacuum.

See H. B. G. Casimir, “On the attraction between two perfectly conducting plates,” presented at a meeting of the Royal Netherlands Academy of Arts and Sciences on 29 May, 1948. Published in the same year in **Proceeding. Koninklijke Nederlandse Akademie van Wetenschappen**, Amsterdam, vol. 51(7), 1948, p. 793-796. For a beautiful modern experiment confirming the force, see S.K. Lamoreaux, “Demonstration of the Casimir Force in the 0.6 to 6μm range,” **Physical Review Letters**, 78(1), Jan. 6, 1997, p. 5-8.

The force was experimentally detected some 10 years later.

CAUSAL SYSTEM ROBOTS (CSRs)

Massless 4-space "engine" systems (therefore in the causal domain only, hence the name) formed of longitudinal EM waves and their dynamics, which are therefore sets of spacetime curvatures and their deterministic dynamics (engines) which function as individual robots.

This is a totally new kind of system leading to a totally new kind of warfare, developed over some decades and deployed by the KGB in 1999.

Matter is composed mostly of empty space filled with EM waves, fields, and potentials. Those "fillers" themselves are just bundles of longitudinal EM waves and their impressed dynamics. Hence all matter, the vacuum, and all conventional EM potentials, fields, and waves—being filled with vast sets of longitudinal EM waves—are vast superhighways for longitudinal EM waves to travel on or in. The CSRs, being totally LW and LW dynamics in nature, thus are free to travel right through EM radiations from power lines, phone lines, TV stations, radio stations, etc. They easily penetrate any matter, including right through a mountain. Any function of a normal EM system can be performed—at least in theory—by such robots. This includes longitudinal EM wave interferometry, which forms external EM fields and waves, of whatever pattern or form desired. Further, these CSRs are actual functioning systems, and if communications functions are designed in, one can communicate with them at a distance, using longitudinal EM wave communication, right through the intervening earth and ocean, etc.

For some time, extensive underground facilities—hundreds—have been building in the former Soviet Union, and this massive buildup continued unabated after the Russian economy collapsed and the Berlin Wall came down. This tremendous expenditure, when the Russian economy was crippled, shows the strategic significance of these facilities. Further, apparently our satellites have not seen any missiles, normal weapons or munitions, etc. associated with that vast complex. In short, it is suspected that we don't have the foggiest notion of what it is. Indeed, those facilities will already have sent some CSRs into those very satellites, to insure that we do not find out what is going on, and perhaps to "spy on the spy satellites".

We think these terribly important facilities are the KGB-controlled facilities for developing and producing the CSRs, and contain a vast longitudinal EM wave command and control set of facilities as well. In short, this is the strategic arsenal, development, and control for building sets of various type CSRs in huge numbers—a vast new army of robots with unprecedented capabilities, under the command and control of a human "strategic force" operations command of very large size.

Developing and debugging one CSR would be a formidable and lengthy task. Once a single one is developed, making a million copies is simple. Just take a normal CD-ROM, e.g., and record something on it. Send in a working CSR robot to "reside inside" the infolded EM interior of the recorded informational electromagnetic pattern on the CD-ROM. Then simply copy that CE-ROM magnetically, as many times as is desired. Each copy contains a copy of the original signal that was recorded, including the exact infolded electromagnetic structuring inside that signal. Voila! One has as many new duplicate CSRs of that exact type, as one wishes, for a few pennies each.

One can see the implications. In all those underground facilities, there are many development laboratories, production laboratories, and command and control facilities and "storage facilities" for the robots. Those hundreds of facilities are in fact a great new strategic weapon system and all its development labs and production facilities, as well as its tactical control and command and control systems, its "troops", its "equipment", and its commanders and operators.

Well, then one can deploy and "utilize" such a strategic armada just as one would use any other great strategic army. One "deploys" one's forces against the enemy. In this case, one just sends the armada (individually controlled!) right through the "LW superhighways" of matter itself, right into the strategic territory and very heart of the targeted nation. One deploys the robots everywhere—e.g., inside the electronics in nuclear warheads, inside the control systems for the nuclear submarines and nuclear bombers, inside the satellites, inside the fighter aircraft electronics, inside the fighting ships, inside the main battle tanks and major weapons carriers, inside the signals on the hard drives of computers, etc. One sends them right through the "inside" of the targeted nation's power grid electrical energy signals, through the TV stations' emitted signals, etc. The Pentagon and Cheyenne Mountain are duck soup, as is the stock exchange and other civilian systems vital to continued functioning of the infrastructure. So is everywhere else, even the deepest vault and "special security" facility.

In short, the vast electronic command and control activities of an otherwise "modern" superpower provide great, convenient, easy superhighways for full strategic deployment to be completed by millions of weapons systems (CSRs) into everything of value in the targeted nation or nations. This completely solves the usual weapons delivery problem; delivery is made in advance of D-Day.

Such a vast CSR armada was deployed throughout the Western world, and particularly in the United States, just before the end of 1999. Yes, this was to be the KGB's great millennium gift to America—a really enormous Y2K problem that would stun and disable the entire nation, its armed forces, its electronic systems in its major weapons, and its command and control centers in one great TOT (time on target) assault. The major electrical power systems of the nation would have been disabled, as would have been the major communications systems. Using LW interferometry, the robots would have wreaked havoc on the nation. They would have disabled the electronics of every major C4I computer of importance, every major fighter aircraft, every major fighting ship, every nuclear submarine, every ICBM, every nuclear powerplant, etc. The attacking force was in its deployment and employment sites in the targets themselves. Everything was in place and cocked and ready to fire. To test whether we knew what was going on, the KGB even had one or more robots temporarily produce hacker-type operations and signals "emerging" in some U.S. command and control center computers, and deliberately let our fellows discover this "hacker attack" was coming from the Russian Academy of Science. Then the CSR simply stopped its LW interferometry, which caused the "normal hacker electronic" signals to just vanish and never reappear. Little wonder that our counter-type fellows were totally unable to find any trace of it, or where it was residing. They have no technology for such.

Well, happily those early-model CSRs are easy to root out and destroy, if one has quite advanced LW technology. Visualize these beasts as existing in a special sort of "internal sky" or "infolded atmosphere" inside matter. Strategic range LW "radars" can just sweep through this "internal atmosphere" inside matter, etc., detecting and tracking those CSR beasts analogous to how normal radar detects and tracks aircraft. The difference is that the strategic LW can also use a bit of LWI pulse to instantly snap those CSRs like popping bugs, completely jamming their operations or even "erasing" them once their characteristics are observed.

That very new kind of vast strategic warfare occurred right at the end of 1999, all through the United States—the Pentagon, our strategic weapon systems, the works. The friendly little nation rooted out and destroyed all those "on site" CSRs just prior to the attack being launched.

A full-up strategic war, of previously unknown kind, was fought all over the U.S. and our own system guys apparently didn't know it. It didn't even surface. Didn't make a whimper.

That hostile CSR armada consisted of *first generation systems*. These systems did not have defensive countermeasures. The systems were depending on total surprise, but were found out (that is another story that would make a great movie if one could live to film it) and then were destroyed in short order.

CSR development has ushered in a totally new kind of strategic, operational, and tactical warfare. The delivery of all the weapon systems "into the target" is accomplished long before the advent of hostilities. The second generation CSRs, once built,

will be even more sophisticated. These will almost certainly be on line soon. They will likely also possess countermeasures.

An eerie new chapter in the annals of warfare has been initiated, and the world will never be the same again. Once the CSRs have sufficient defensive countermeasures such as stealth means and coordination with countering, rapid response LWIs to target and destroy the hostile "LW radars" seeking them, etc., the next world-wide strategic CSR war will be neither so simple nor so bloodless.

NOTE: Contrast this CSR discussion to the discussion of *nanotechnology* and nanobots. Just as nanobots are natural developments which teams skilled in nanotechnology would produce, so CSRs are natural developments which teams skilled in longitudinal EM wave technology—and in the "infolded" electrodynamics inside all EM fields, potentials, and waves—would produce. For decades (since the 1950s) the KGB has been developing and using longitudinal EM wave interferometers (LWIs) which beam right through the "inner highways" inside the fields and waves inside matter, thus allowing very large LWIs which beam right through the intervening earth and ocean, and can "focus" under the ocean or within the earth as well as out of it. With such background, the CSRs were just as natural a development for them as the nanobots are for conventional Western nanotechnology scientists.

CAUSALITY

The relationship between "cause" and "effect". The basic notion in a causal system is that the system's response to an input signal is not dependent upon future input values.

Thus the notion of causality involves a precise time ordering of ordinary inert interactions, where the cause was never input from a future time. Macroscopic (observable) causality may be and is violated by the interaction of hidden subquantal (virtual state) variables.

CEREBRAL HEMISPHERE

Each half of the cerebrum, i.e., each half of the enlarged anterior or upper part of the vertebrate brain.

The two cerebral hemispheres may function as a longitudinal EM wave interferometer or a time-polarized (scalar) EM interferometer to sense distant scenes (even distant in time), or produce EM energy and signals at a distance, since the body, brain, and nervous system does produce longitudinal EM waves and scalar EM waves. For proof of scalar EM wave interferometry in O(3) electrodynamics, see M.W. Evans, P.K. Anastasovski, T.E. Bearden et al., "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," **Journal of New Energy**, 4(3), Special Issue, Winter 1999, p. 76-78.

CHANGING THE PAST

Every intentional inception upon ordinary inert causality prior to collapse of the wave function represents a slight alteration or change in direction, departing minutely from pure causality. From a causal viewpoint, each human inception minutely changes the causal past, as well as the future.

Experimental proof that the causal past can be changed is provided by the delayed choice two-slit experiment. E.g., see C.W. Rietdijk, "Another proof that the future can influence the present." **Foundations of Physics**, 11(9/10), 1981, p. 783-790. Particularly see Wheeler, John Archibald Wheeler, "The 'past' and the 'delayed-choice' double-slit experiment," in A.R. Marlow [Ed], **Mathematical Foundations of Quantum Theory**, Loyola University, New Orleans, Louisiana, June 2-4, 1977; Academic Press, New York, 1978, p. 9-48.

CHAOS

In dissipative dynamical systems, the dynamical evolution that is aperiodic and highly dependent upon initial conditions of the system.

The trajectories of the system move on a strange attractor, which is a fractal subspace of the phase space.

The term suggests the ordinary meaning of random and unpredictable disorder, but there exists intrinsic determinism and at least partial embedded ordering. The mathematical equations describing chaotic behavior are very nonlinear and so complex that at the present time they cannot be computed or predicted. Even simple systems, including simple electromagnetic systems, can exhibit unpredictable chaotic behavior. The science of chaotic dynamics is still in its infancy, having begun moving once the modern computers became economical and pervasive.

CHARGE, ELECTRICAL (Q)

Electrical charge q is defined as $q \equiv m_q \phi_q$, to first order.

As can be seen, the actual "charge" action associated with the mass is due totally to ϕ_q, and to the broken symmetry of ϕ_q in the vacuum flux exchange with m_q. The charge q can be further broken down into a set of composite dipoles if the gathering of a virtual charge screen in the vacuum, surrounding the mass of the "bare charge" inside the gathering, is included. At first order, ϕ_q can be expressed (particle view) as a change in the local vacuum virtual photon flux (VPF), due to the VPF exchange between vacuum and m_q. The ϕ_q component is actually the "electrical charge" and massless of itself.

However, see my paper, "Giant Negentropy of the Common Dipole," **Journal of New Energy**, 5(1) Summer 2000, p. 11-23. We include the isolated charge by treating it as a system of multiple composite dipoles. We also explain the previously unrecognized 4-symmetry EM energy flow ongoing, where incoming longitudinal EM waves are being received, transduced into real longitudinal EM waves in 3-space, with the latter being emitted in all directions in 3-space.

A charged particle of mass is thus a little energy flow generator. It is a broken 3-symmetry in the local VPF, and therefore has an "observable" energy flow output, extracted and gated from the asymmetry in the VPF. This "observable" energy flow outputs the well-known energy flow **S** in classical EM, though CEM does not recognize or include this vacuum interaction, the broken 3-symmetry of the dipole, and the steady input of EM energy to the dipole in the form of EM energy from the time domain (complex plane).

Instead, classical EM just assumes that the "charge" q is the source of a potential. When originally formed as a concept, q was just a "quantity of electric fluid," like a "cubic centimeter of fluid," etc. The atom and the electron had not yet been discovered.

CHARGE CARRIERS

Anything—usually fundamental particles, ions, etc.—which consists of or contains charges and can move.

It can be an electron, a collection of electrons fixed in a moving dielectric, ions, atoms, molecules, etc.

The moving charge (i.e., the current dq/dt) with an energy flow streaming onto it and on beyond, carries its interaction with that energy-flow right along with it in the current
i = dq/dt. This is what the charge's "excess collected energy" consists of, and this is how the *collected/collecting* energy in the circuit is transported to the *collected-energy* dissipation sites (loads and losses).

CHARGE, GRAVITATIONAL

To be added

CHARGE, MAGNETIC

Essentially, the magnetic scalar potential, or monopole.

In an uncurved spacetime, the magnetic charge must always occur in dipolar pairs, where each is equal and opposite the other. In a curved spacetime, a free *net* monopolar magnetic charge may and does exist. In classical electrodynamics, the assumption of a locally flat spacetime is ubiquitous though not prominently emphasized. Hence most electrical engineers are unaware that monopoles can indeed be made, but only if one uses a process to curve local spacetime.

CHARGE-PARITY-TIME (CPT) THEOREM

The theorem states that all known quantum field theories obey CPT symmetry.

C is charge conjugation, which changes the quantum number of every particle into its antiparticle. P is the reflection operation known as parity which turn an object into its mirror image and rotates it 180 degrees about an axis perpendicular to the mirror, T is time reversal. Any violation of time-reversal symmetry is always accompanied by a violation of CP symmetry and vice versa.

Electrodynamics and the strong interaction preserve CP symmetry to great accuracy. Weak interactions do not conserve CP symmetry. T symmetry violation has been shown at CERN, the European particle physics laboratory in Geneva, Switzerland.

CHARGE TRAPPING (Also "Pinning")

Holding charges "pinned" or "trapped" by a barrier or force, so that they do not flow as
i = dq/dt.

CHARGE-BARRIER

A process or component or function—particularly in a semiconductor such as the Fogal semiconductor—which blocks the movement of charges q as current dq/dt.

CHARGE-BLOCKING ASYMMETRIC QUANTUM WELLS

A quantum well which has more charge-blocking action in one direction than the other, and is thus "asymmetric" in its function.

It may also be dynamic, so that it changes in its degree (and/or its direction) of action as a function of time.

CLASSICAL AND QUANTAL ELECTRODYNAMICS

Classical EM (CEM) theory is simply classical electrodynamics (CED).

Classical EM does not break the fields into "quanta" (a quantum is a standard-sized piece of action (angular momentum)]. Instead, CEM considers the fields as continuously varying in magnitude from zero to infinite magnitude (at least in theory).

Quantal Electrodynamics is known as quantum electrodynamics (QED). These are standard terms for standard disciplines. QED considers the fields to be composed of quanta called "photons". Hence there is an underlying region called the "virtual state" whose denizens are "smaller in magnitude" than the quantum. Heisenberg uncertainty applies, since the quantum of action is not quantized energy, but quantized (energy x time). In short, it is a function of both the magnitude of the energy and its duration of persistence. Hence a field or photon of any amount of energy may form temporarily, so long as it does not endure sufficiently long in observer time to reach quantum size and breach the quantum threshold.

In this view, then, "empty space" is not empty at all, but is a seething cauldron of these "energetic bubbles" continually appearing and disappearing, with the entire spectrum of frequencies and energies. This is in fact the "new ether". If we consider only the field portion of the bubbling virtual photons appearing and disappearing, this leads to a vacuum that consists of EM field fluctuations, again of essentially the entire frequency spectrum and energy spectrum.

However, how we attempt to tie either of these "energetic vacuum" EM views to general relativity (GR) is then a problem. The cause of the problem, however, is largely ignored in physics. In CED, e.g., one models EM energy moving through a flat space. This is a non sequitur, since the presence of any change of the energy density of space a priori is a curvature of spacetime. Hence rigorously EM energy can only propagate through a curved spacetime. Indeed, when this correction is made, the EM wave becomes an oscillating curvature of spacetime. This is the approach worked out by Mendel Sachs, extending Einstein's work. The higher symmetry O(3) electrodynamics spearheaded by Evans turns out to be an important subset of Sach's umbrella unified field theory. Hence EM has become GR, and for the first time in history, O(3) electrodynamics provides the approach that will allow direct engineering of general relativity on the lab bench, in working devices, etc.

CLASSICAL ELECTROMAGNETICS (CEM)

"Ordinary" electromagnetics, of the kind used in ordinary EM circuits, which fundamentally consists of the modified Maxwell's equations.

Classical EM consists of Maxwell's equations and the various changes and additions that have since been made. CEM does not break the fields into "quanta" (a quantum is a standard-sized piece of action (angular momentum)]. Instead, CEM considers the fields as continuously varying in magnitude from zero to infinite magnitude (at least in theory).

Primarily refers to Maxwellian electrodynamics as reinterpreted by Heaviside, Gibbs, Hertz, and a few others. Unfortunately these reinterpretations of Maxwell's theory also greatly reduced its topology, and therefore reduced the area of natural electrodynamic phenomena that the resulting equations describe.

Significantly more advanced "classical" electrodynamics emerges when one goes back to the quaternion algebra electrodynamics of Maxwell, or to the more advanced Clifford algebra electrodynamics. The higher symmetry electrodynamics models such as O(3) symmetry EM developed by Evans and others, are capable of modeling a great deal more physical phenomena than the very limited standard U(1) electrodynamics largely in vogue in science.

CLASSICAL EM THEORY

Classical electrodynamics theory, begun by Maxwell, with his seminal paper orally presented in 1864 and published in 1865.

Essentially Maxwell's electrodynamics at root basis, with the background supporting classical theory. Today many variations have been made, particularly with the basic symmetry of the theoretical equations. See discussion above under *classical electromagnetics*.

CLIFFORD ALGEBRA

A special higher topology algebra founded by Clifford, which includes as subsets many other algebras of lower topology.

CLOSED SYSTEM

A system that does not communicate with its environment, and does not exchange energy or matter between system and environment.

An ideal model where dynamically and energetically the system is considered to be "isolated" as if nothing else existed. In short, consider the system as if it were in some "magic box" and nothing outside the box can ever enter the box or affect the system inside the box, and nothing in the system can ever leave the box or affect anything outside the box.

One performs a non sequitur whenever proclaiming treatment of a system as a "closed system", and of course good scientists are aware of this. This is particularly true in electrical power systems. Here one is indeed allowed to input energy into the system to excite or potentialize it. That of course assumes that the system was "opened" long enough to take on excess energy! Then as the system operates, losses and dissipations occur, in which case energy is considered to "escape" from the system permanently. In other words, the system was also continually "opened" so that energy could escape.

There is really no such thing as a truely *closed* system in the universe, since every system is embedded in the active vacuum and is an open system in an energy exchange with the vacuum. If that exchange is symmetrical, then the system is in equilibrium with respect to the vacuum exchange. In that case, the system may be treated as if it were a closed system for a limited number of purposes. In classical electrodynamics (CED), the Lorentz regauging of the Maxwell-Heaviside equations further reduced them to describe only Maxwellian systems in such equilibrium with the active environment. Consequently, the interaction between the external vacuum and the system is not included in the CED model. Obviously a *broken equilibrium* in that actual physical interaction is also not included in the CED model.

An electrical power system is already permitted to violate the Lorentz condition when it
(1) receives additional EM energy to "energize" or "potentialize" or "excite" or "regauge" it, and (2) whenever energy escapes from the system in the loads and losses (which escapes of energy are "de-energizing", "depotentializing", "dissipating", or "regauging" actions.

Hence the Lorentz condition greatly simplifies the Maxwell-Heaviside equations and makes them much easier to solve. However, *when enforced by the system itself with regard to the system's excitation and de-excitation (dissipation) functions—i.e., when those functions are "symmetrical" (equal and opposite)*—it also arbitrarily discards all those Maxwellian systems capable of the five "magical" functions of an open disequilibrium system: (1) self-ordering, (2) self-oscillation or self-rotation, (3) output of more energy than the operator inputs (the excess energy is input by the active environment, (4) powering itself and its load (all the energy is input by the active environment, and (5) exhibiting negentropy.

It follows, however, that physical electrical power systems must therefore have some feature which self-imposes the Lorentz condition, at least during the phase when the system's excitation energy is discharged in the loads and losses. The standard closed current loop system, where every electron progressing through the external circuit's loads and losses must be forcibly rammed back up through the source dipole in the power source, is indeed what enforces the Lorentz condition with respect to excitation and dissipation, and *arbitrarily* prevents the system from achieving COP>1.0.

In a battery-powered system, the otherwise closed current loop is broken into two quite different circuits: (1) the electron current circuit between the outer surface of the plates and the external loads and losses, and (2) the ion current in the electrolyte between the inner surface of the plates. Since the ions (e.g., in a lead-acid battery) in the "inner" ion current may have a m/q ratio very much greater than that of the electrons in the "outer" electron current, clever timing of pulsed signals to the plates may be used to form a phase difference—including even a phase angle of 180°—between the two currents. It can be shown that this forms a high potential on the plates which acts as a negative resistor, extracting EM energy from the vacuum and recharging the battery while simultaneously powering the external circuit. This is the Bedini process, and with Bedini's permission an explanation of that process has been published by Bearden ["Bedini's Method For Forming Negative Resistors In Batteries," **Journal of New Energy**, 5(1), Summer 2000, p. 24-38.] Note that Bedini's process in fact repeatedly removes the Lorentz regauging condition, and therefore the system is rigorously permitted to achieve not only COP>1.0 but also self-powering of itself and its loads and losses.

COLD EXPLOSION

The sudden extraction of EM heat energy from a distant intersection zone (IZ) of the crossing beams of a scalar potential interferometer, which transmits in the sharply pulsed mode, while the electrical grounding of the transmitters are negatively biased with respect to the potential in the distant IZ.

COLD FUSION

An ad hoc term applied to the transmutations at low energy achieved in electrolyte experiments, particularly when using specially prepared palladium electrodes, and particularly when deuterium is present in the electrolyte.

COMPOSITE DIPOLE

Dipole formed as one part of an isolated, observable "charged particle", consisting of a differential element of that observable charge on one end and a momentary clustering virtual charge of opposite sign.

In quantum electrodynamics, it is well-known that virtual charges of opposite signs cluster in the immediate vacuum around any "isolated" observable charge. By applying the composite dipole concept, this author was able to treat the isolated charge as a set of composite dipoles. By then applying Whittaker's decomposition of the scalar potential between the ends of each of these composite dipoles, the "source charge" was a set of broken 3-symmetries in the vacuum flux, and thus a set of 4-symmetries in that flux exchange. This meant that the EM energy continuously output in all directions by the source charge was actually continuously received by the source charge (as a set of composite dipoles) from the time-domain, and 4-conservation of EM energy flow rigorously was upheld.

This allowed a solution to what has been called the most formidable problem in both classical and quantum electrodynamics: the problem of the association of the source charge and its associated fields and potentials along with the energy contained by them and continuously pouring from the charge without any 3-space energy input.

CONCOMITANT

Occurring or existing together.

CONGLOMERATE HIERARCHY OF THE PHOTONS

Every photon remains perfectly ordered! A conglomerate (group) of photons, however, may be arranged in almost an infinite variety of orderings, groupings, directions, etc.—which we refer to as templates and as hierarchies (group orderings) of photons.

In a pure energy flow (energy transport), the "herd" of photons is organized along the flow direction. Regardless of how one scatters or "disorders" this patterning of the "herd" or "hierarchical ordering" of photons, not one single bit of the underlying energy and individual photon ordering is lost. So when one "uses" energy (e.g., scatters the hierarchical ordering of a photon herd from a resistor as heat), one does not lose any energy at all, but simply has "scrambled" the hierarchical ordering of the photons into a new herd configuration (which may be varying every which way!). The point here is the real meaning of the fundamental conservation of energy law: *Energy can neither be created nor destroyed!*

When we "use" one joule of energy to perform one joule of work (say, in a single-pass, scattering), we still have exactly that one joule of energy left, but just in different form (different direction, type, collection or not collected, etc.) It can still do another single pass joule of work, then another, then another, and so on. If we plan things right, we can use a single joule of work to perform many joules of work, contrary to what we were so strongly taught in the *"single-pass, single collection, single dissipation"* examples given to us in university as the "law" of God and electrodynamics.

Note that the conventional work-energy theorem assumes single pass, single collection, and single dissipation of a joule of energy to perform a single joule of work. The point is, *that is not a limitation of nature, but a limitation of a single process! Nature regularly uses a joule of energy to do multiple joules of work, because after one dissipates or scatters the energy the first time, it's still there and later will be intercepted to do some more work.*

Anti-Stokes emission, the Patterson Power Cell, Lawandy's lasing without population inversion, and some gas-filled tubes with anti-Stokes emission are examples of known, validated overunity processes (processes with coefficient of performance greater than unity). These all use multipass, multicollection, multi-dissipation in iterated manner, to increase dipole asymmetry and therefore produce excess extraction of energy from the vacuum. Patterson's unit, e.g., has been independently measured by universities at efficiencies of some 1200 or so. This absolutely does not violate the laws of physics nor the nonequilibrium thermodynamics of open systems far from thermodynamic equilibrium.

CONSCIOUS MIND

The serial processing mind which we normally associate erroneously as ourself. Other to be added.

Mind is time-like, not space-like.

CONSCIOUS MIND (PSYCHOENERGETICS VIEW)

The serial-processing mind which one normally associates erroneously as oneself.

Mind is *time-like*, not *space-like*. Hence it is not directly observable, a priori, since all observation is 3-spatial. However, if we consider that changes in 3-space produce spacetime curvatures and thereby also produce slight changes in the time domain, then iterative coherent spatial changes eventually will produce a change in the time-domain. Consequently, the time-like mind will have a continuing stream of such small but processable time-energy changes from coherent 3-spatial phenomena in its body and the macroscopic (coherent) universe. To sense the 3-space body as "self" while simultaneously sensing other 3-space physical changes as "non-self", the conscious mind must compare the various received time-like projection signals against its "time-like orders" issued. That set of received time-signals that matches or closely matches the conscious mind's issued order signals, thus yields the sense of the body behavioral changes as (1) self, and (2) body responses to its orders. The time delay between issuance of the mind's orders and the receipt of the correlated time-like responses from its body, provides the sense of self-persistence or independent being.

The mind couples to the body via a similar spacetime curvature mechanism. When the mind issues "orders", they are in the time-like realm but are changes, hence small spacetime curvatures. They therefore involve very small 3-spatial changes (projections) into the 3-space body. Since the mind orders are coherent, this small iterative set of 3-space changes will integrate coherently, yielding real quantum changes in the body and nervous system (e.g., the brain).

This coupling mechanism is profound. The steady stream of integrated time-like projections arising in the mind due to the physical world outside one's body, does not compare or match the mind's memory of its orders. Hence that allows the sensing of the "external world" as "nonself". The sense of that external world as "existing" or "being" is provided by the time delay in the comparison process, from "mind signals issued" to "physical signals received". The metric yardstick standard for this comparison time, so to speak, is provided by the time in the identified "self-loop" with the physical body. In other words, the mind uses that length of time to differentiate those time signals which coherently integrate but do not match its issued order signals, from those time-signals which coherently integrate in the same time loop interval and do match its issued ordered signals.

In this manner, we resolve all the great previously unresolved philosophical questions of the nature of consciousness, nation of being, nature of self, nature of nonself, perception of the physical world, perception of body as self, perception of other bodies as non-self, etc. At least we resolve these issues from a testable physics approach, so that we can see that now a unified physics (and a technology) of mind and matter is at last in view. Since O(3) electrodynamics has been shown to be an important subset of Sachs' unified field theory, then O(3) electrodynamics—or SU(2)×SU(2), which is homomorphic with O(3)—can be used to develop the direct engineering of mind, the mind-matter interaction, and mind functions of the living biological system.

It is my considered opinion (with much evidence) that the Russian branch of *energetics*, known as *psychoenergetics*, uses a unified field theory and a higher symmetry electrodynamics to achieve that type of direct engineering already, but for weapons use rather than beneficial use for humanity.

As examples, we strongly suggest that the deaths of U.S. Captains Button, Svoboda, and Hess all involved KGB testing of long-range strategic psychoenergetics weapons over the United States, on those targeted personnel. This should not be surprising at all; the KGB has tested longitudinal EM wave interferometer weapons over the U.S. since 1967, and continues to do so today. They tested bioenergetics EM weapons against U.S. Embassy personnel in Moscow for several decades. Kills of U.S. aircraft and missiles have been performed at various times, including kill of the Arrow DC-8 at Gander, Newfoundland in Dec. 1985, kill of a Titan ICBM fired from Vandenberg AFB in the spring of 1986, kill of the U.S. space shuttle Challenger in the spring of 1986, continuing weather engineering over the U.S. and elsewhere, etc.

That novel electromagnetic weapons have indeed been developed and are being tested world-wide, was confirmed by Defense Secretary Cohen in 1997 as follows:

"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts." [Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.].

We specifically call attention to the fact that the Secretary did not speak the words enclosed in square brackets. This is *not* limited just to terrorists or counterterrorism.

There appears to be no insurmountable difficulties in developing psychoenergetic technology using the approach outlined above. Certainly it is not as formidable a task as has been hot fusion.

The incident involving Captain Button, e.g., was to demonstrate control of an individual performing complex technical tasks for a period of at least one hour. The test against Captain Svoboda was to demonstrate how simply human kill can be achieved in combat troops, merely by introducing selected changes in the mental functioning of the targeted individuals. As Svoboda was climbing her A-10 out of a successful low-level ordnance drop at night on a ground target, her sense of up and down was instantly reversed. Instantly perceiving she was diving instead of climbing—although *actually* climbing out perfectly—she "corrected" immediately and dove headlong into the ground, perishing in the resulting explosion of her aircraft.

In the case of Capt. Hess, the test demonstrated that rather complete mental control can be almost instantly asserted, and even the responses of the autonomic nervous system can be overridden. So Captain Hess, out for a morning jog, simply went aside, sat down, and stabbed himself repeatedly, including multiple times right through the heart. Had one seen the incident, he would have simply continued stabbing himself very calmly, without emotion or reflex action from his autonomic nervous system, until physical failure of his body.

As can be seen, it is of the utmost importance that this nation understand psychoenergetics weapons of such nature, and develop effective defenses against them. The next great strategic battlefield may be as much a "virtual reality" battle as it is a "real physical world" combat. The war can be quickly lost in either arena.

We also point out that the psychoenergetics weaponry readily is adapted to use in more advanced longitudinal EM wave interferometers, which readily penetrate the Earth and the ocean. Hence deeply buried strategic command and control centers are vulnerable to psychoenergetics warfare, as are the crewmen of our nuclear submarines, ICBMs, aircraft carriers, division and army command centers, national command centers, strategic bomber pilots, etc.

Indeed, one of the major incentives for developing such psychoenergetics weapons as was demonstrated in controlling Captain Button, was to seize and control the entire on-site manning crews of the defensive quantum potential weapons preventing launch of full strategic warfare. By having the QP systems "stood down for maintenance" by their own crews, the major strategic retaliation and "dead man fuzing" would have been removed and countered. Then powerfully striking the QP sites with LWIs would have destroyed them, and left the sites themselves radioactively emitting longitudinal EM waves, thus preventing reoccupation in case the QP weaponry survived. The counter to that scheme was to place the friendly QP weapon sites on "insane" command and control. In that mode, instead of human decision being made to launch, every so often (say, every two hours) the computer automatically initiates the launch sequence. During that sequence, if the crew is still alive and functional, codes can be punched in and the computer cancels the launch initiation. It then repeats the sequence two hours later. If no coded cancellation order is punched in, for whatever reason, the launch sequence completes and the QP weapons fire. In that case, much of Russia disappears from the face of the earth.

Eerily, just about the time that Secretary Cohen was making his quoted statement in April 1997, the KGB was being notified by the friendly little nation of the change to insane command and control. This forced the abortion of a great strategic attack upon the West, scheduled to occur on May 1, 1997.

We are strongly stressing that psychoenergetics is not parapsychology and it is not just an idle theory of academics. Instead, it is already potently used in some very powerful and deployed weapon systems that could well decide the course of the next world war, almost at a moment's notice.

See also discussion under *energy*.

CONSCIOUSNESS

Refers to a living being's awareness of its sensations, feelings, thoughts, and the world around it.

The new approach uses a coupling mechanism between the time-like mind and the body of a living creature. The nature of this coupling mechanism then generates the mechanism by which self-awareness is produced, awareness of non-self is produced, and the sense of existing in the external world but differing from it is produced.

CONTINUOUS MODE

For a longitudinal EM wave interferometer, a continuous mode of operation where power is fed continually to the transmitters, and the two longitudinal EM wave patterns or beams are continuously transmitted.

CONVENTIONAL SCALAR POTENTIAL

A scalar potential formed without use of artificially added substructuring of its internal biwaves and their products.

In other words, one in which it is assumed that its virtual particle flux has no ordering, but is just a randomized flux. This assumption (e.g., of quantum mechanics indirectly) is incompatible by the Whittaker demonstration that (i) a scalar potential is a harmonic set of "bidirectional" EM phase conjugate wave pairs, and thus not a scalar entity at all, and (ii) perfect ordering of its wave components exists inside the scalar potential.

One must carefully distinguish what each of these internal "phase conjugate EM longitudinal wavepairs" actually represents. Prior to interaction with detecting charges, the potential is a 4-potential existing in spacetime (4-space). The time domain, of course, is represented by ict, and in that expression only "t" is a variable. Hence the "incoming" phase conjugate longitudinal EM waves in the imaginary plane are actually longitudinal EM waves in the time dimension. These waves converge upon the dipolarity represented by the "scalar potential" or any "piece" of it. The dipolarity represents the interaction of charges; specifically, a dipole. This reaction—by the spin of the charges—transduces the incoming EM energy from the time-dimension into 3-space, and emits it from the charges as real EM longitudinal EM energy radiating out from the dipolarity in all directions in 3-space.

The phase conjugate half-set of the Whittaker waves, *prior to their interaction with charge*, are not waves in 3-space, but are waves of LW EM energy coming in from the imaginary plane and thus from the time domain. The charges of the dipolarity spin 720°, being 360º in the complex plane and then 360º in real 3-space. So the charges absorb the EM LW energy impinging on them from the time domain, during their 360º rotation in the complex plane. When they enter real 3-space for the rest of their

spin, the already-excited charges dissipate their excitation energy in all directions as they spin their 3609º in 3-space. That is what the Whittaker decomposition actually shows, but it has been ignored for almost a century.

In short, the broken 3-symmetry of the dipolarity—well-known in particle physics for nearly a half-century, but never incorporated into CED—allows nature to jump to a higher, more fundamental 4-symmetry in the energy flow. Energy is being conserved in 4-space, but not in 3-space. Further, there is a special new energy flow symmetry involved: one-way in the time domain and the other way in the 3-space domain. Note that energy is not conserved in 3-space! *There is no law of nature requiring the extra requirement that, in addition to conservation in 4-space, the energy must also be conserved in 3-space!* So when the dipole breaks that extra requirement, only the basic 4-conservation applies. In that case, nature very happily gives you what might be called a white hole in astrophysics terms: energy will pour in to the dipolarity unceasingly from the time-dimension, and will pour out in 3-space unceasingly, so long as that dipolarity persists.

By considering the virtual charges of opposite sign that cluster in the vacuum around any "isolated observable charge", one may represent a single charge (as an electron or proton) as a set of composite dipoles, where each dipole consists of a virtual charge (while it exists) and a differential element of the observable charge. So the charge becomes a set of composite dipoles, each with Whittaker decomposition of the scalar potential between its ends.

Hence we have solved the long-vexing problem that Semiz called "the greatest unsolved problem in electrodynamics": the problem of the source charge (or source dipole) and its associated fields and potentials and the enormous EM energy continually pouring out of any charge or dipole in all directions in 3-space.

When the arbitrarily discarded giant Heaviside nondiverged energy flow component is also accounted, this leads to the giant negentropy of the dipole, as shown in my paper, "Giant Negentropy from the Common Dipole". We have also proposed this "dark Heaviside energy" as the unaccounted source of the excess gravity known to be present in spiral galaxies and holding together their arms. The dark energy yields at least 90% of the total gravity involved, and the additional 10% or so can be accounted for my known gravitational sources.

It appears that these new discoveries can also be utilized to show that "quintessence" is also caused by COP>1.0 processes in the universe, and the excess production of negative "giant dark energy flows". If so, then this also would account for the recently discovered fact that the universe has an excess of negative gravitation, so that it is not only expanding but is accelerating in that expansion. At this time, the present author is still attempting to tie up the loose ends involved in showing that quintessence also is created as a result of functions of the giant negentropy process.

In the Whittaker biwave pairs, If one then insists that these hidden EM waves are comprised of hidden photons, then it follows that the photons exist as continually coupling and uncoupling photon/antiphoton pairs, or continually forming and unforming *gravitons* as the wave and antiwave continually pass through each other.

It is a little more complicated than that, since Maxwell actually omitted half the EM energy in the EM wave in space, and also in the circuit—as do electrodynamicists to this day. For gravitons, one really must come to grips with this error and correct it. This will be added later in this glossary. (To be Added).

COOPER PAIR

A dynamic pairing of electrons in superconductivity theory.

In this pair, if the energy state with wave number σ and spin ½ is occupied by an electron, then so is the state with wave number - σ and spin – ½.

COP (COEFFICIENT OF PERFORMANCE)

Ratio of energy out, divided by that portion of the total energy input that is input by the operator or experimenter.

The COP is thus a measure of "efficiency of using the operator or experimenter's input energy" to produce—or direct the production of—useful work. Note that he can direct the use of his own input energy, as almost all our present systems do. Better yet, he can also direct (gate or "switch") the use of some external free flow of energy from the environment into the system, so that he gets lots more work out of the system than he has to put in himself. Only a few of our systems—such as solar cells, sails on sailboats, waterwheels to power mills, and windmills—are such Maxwell's demons (open systems) where the output exceeds the operator's input of energy.

We sharply contrast the term "COP" to the term "efficiency". The efficiency (overall) of a system is how much useful energy output (usually as work, or can be converted to work at will) the system produces for the total amount of energy that is input (both by the operator and by the external environment). Even a highly inefficient system may nonetheless have a COP>1.0, if the operator inputs less energy than the system outputs.

We urge the reader to thoroughly understand the difference between energy-use "efficiency" of a system and coefficient of performance of the system. Many scientists, engineers, and especially free-energy researchers are confused on the precise difference in these terms.

CORPUS CALLOSUM

The thick nerve cable that links together the two cerebral hemispheres (which are separate brains) in each vertebrate (including human) brain.

In each of the two cerebral hemispheres, there is a separate mind and personality (given that the other is separated). However, a brain has a unique characteristic: Anything that arises directly inside it is automatically assumed to be self-originated, since the brain-tuner can differentiate no separation or "separate source" for the signal/thought arising directly upon its "internal screen". This allows integration of the two brains/minds/personalities into one. That is, when one brain half prepares and sends a message, that message is also routed across the corpus callosum into the other brain half, arising internally upon the second brain's "display." The second brain half therefore thinks that it itself originated the signal or message.

COSMOLOGICAL FEEDBACK PRINCIPLE

Puthoff's self-regenerating cosmological feedback cycle for the source of the vacuum EM ZPE.

One may assume the existence of EM zero-point energy (ZPE) by fiat as part of the boundary conditions of the universe, or conceive of its generation by the quantum-fluctuation motion of charged particles that constitute matter. Puthoff calculated the latter possibility, assuming that the ZPE spectrum (field distribution) drives particle motion, and that the particle motion in turn generates the ZPE spectrum. This provides a self-regenerating cosmological feedback cycle, which in fact is consistent with the general relativity assumption that curvature of spacetime affects mass energy, and mass energy changes affect the curvature of spacetime.

The result of Puthoff's calculation is the appropriate frequency-cubed spectral distribution of the correct order of magnitude. His result is thus consistent with, and indicates, a dynamic-generation process for the ZPE fields.

In general this is also consistent with the Sachs' unified field theory approach, and with the Evans O(3) important subset of it.

COURRIER, ROBERT

Noted French scientist who collaborated with Antoine Prioré in his revolutionary healing experiments on laboratory animals using longitudinal EM waves from plasma tubes.

Courrier was the head of the Biology Section of the French Academy and also the perpetual secretary at the time. He personally presented the astounding results of the Prioré work, showing cures of terminal tumors, to the assembled French Academy, creating a furor.

CROSSTALK

In ordinary science, the transfer of energy or signal from one channel to another, by cross modulation or cross coupling between the channels.

In the new approach, the term "crosstalk" can be used in an additional sense where it refers to virtual energy exchange between orthogonal universes or frames—that is, between different 3- or 4-dimensional slices of an infinite-dimensional universe.

CURL CONCEPTS OF FIELDS

Refers to concepts of fields as the curl of some vector potential;

E.g., the magnitude of the **B**-field is equal to the curl of the **A**-potential, given by $\mathbf{B} = \nabla\times\mathbf{A}$. More exactly, the **B**-field is identically a curled **A**-potential, by $\mathbf{B} \equiv \nabla\times\mathbf{A}$, but only that portion of $\nabla\times A$ that is diverged around or collected by an intercepting unit point static charge.

Note that we are accenting that no equation is a definition. So texts stating that the first equation with an equals sign "defines" the magnetic vector potential **A**, are in error. If we state that $\mathbf{B} \equiv \nabla\times\mathbf{A}$, then we are defining the **B**-field as a curled form of the magnetic vector potential, which it is.

The reader must be aware that the field concept itself in CEM is flawed, being "defined" as the effect existing after an interaction by a 4-space entity with a 3-space mass, and hence
3-spatial and an "effect", and yet then used as if it were the 4-space "cause" entity that propagates in 4-space to interact. In short, the field concept is thoroughly confused in the texts and papers in the literature (and has been confused for more than a century) as not only the cause but the result of the interaction of the cause with some recipient. This problem has been highlighted by many physicists, including Feynman, Wheeler, etc.

This "confusion of the cause with the effect" is widespread in physics, and is the single greatest foundations error which hampers the progress of physics. Another example is the false notion that a "separate force" acts upon a "separate mass", when in fact mass is a component of force by the definition $\mathbf{F} \equiv d/dt(m\mathbf{v})$. That such simple and obvious errors have been propagated by so many hundreds of thousands of scientists for so many decades is perplexing. Indeed, the errors simply continue to be used. Note that Nobelist Feynman and the great John Wheeler pointed out that the "field" as defined in CEM does not and cannot exist in spacetime! Instead, Feynman pointed out that only the potential for the field exists in spacetime, in case some charged mass is brought in to interact with it and *thereby produce* the field as an effect.

Indeed, no observable persists, for it "exists" only as a momentary 3-space frozen snapshot or slice of a 4-space dynamic interaction. Here again, most physicists do not realize that observables such as mass m do not and cannot persist other that at the instantaneous frozen moment of the snapshot.

CURL-FREE MAGNETIC VECTOR POTENTIAL

A field-free magnetic vector potential without curl, hence with no **B**-field.

Toroids and long solenoids have the characteristic of separating the **B**-field (curled potential) and holding it inside. However, drawing energy from any potential whose "source charge or source dipole" is not destroyed, simply results in the full value of the potential being replenished from the vacuum, via the 4-symmetry energy flow mechanism in the presence of the broken 3-symmetry of the dipole. Hence one may easily "double" the potential energy density at will, and this is a special form of gauge freedom, where the potential energy of any electromagnetic system can be altered freely and at will. We strongly accent that, contrary to what is in the EM textbook, gauge freedom rigorously allows the direct and free amplification of potential energy of the EM system at will. That this principle, incorporated in gauge field theory, has been known so long and still not used in the design, production, and use of COP>1.0 electrical power systems is quite inexplicable.

In the motionless electromagnetic generator, we used a special core material to extract the curled potential (**B**-field) from a permanent magnet's vector potential **A**, so that **A** is replenished in uncurled form directly from the vacuum via the giant negentropy process.

To achieve COP>1.0, we then simultaneously interacted both the uncurled **A**-potential energy external to the output coil, and the internal curled **A**-potential energy (**B**-field energy) internal to the core through the coil, with the coil. By pulsing, the Lenz law effect is also invoked as yet another momentary regauging and potential energy increase, so that an additional energy gain is achieved.

The well-known Aharonov-Bohm effect proves that the uncurled **A**-potential can indeed be separated from the **B**-field in like manner, and the **A**-potential does interact with electrons since $d\mathbf{A}/dt = -\mathbf{E}$.

Thus the MEG achieves COP>1.0 permissibly, because it is an open system freely receiving excess energy from the active vacuum environment, via the vacuum's replenishment of the magnetic vector potential of the permanent magnet dipole as fast as energy is drawn from it. The MEG also violates the usual closed current loop's self-imposition of Lorentz symmetrical regauging when discharging its excitation energy (its free excess regauging potential energy), because the "source dipole" (the permanent magnetic dipole) is not destroyed.

CURVED SPACETIME (externally, internally)

A four-dimensional geometry used in general relativity, where the curvature is determined by the distribution of mass-energy.

In the new, more extended approach, any change in the spatial energy density of spacetime or any change in the time-energy density of it, or a combination of changes in both. The difference is that in the new approach time is also treated as a special form of energy. Specifically, time may be regarded as spatial EM energy compressed by a factor of c^2.

CYBORG (An acronym for cybernetic organism).

(Noun): A single integrated system consisting of a living system energetically or functionally linked to mechanical or electromagnetic devices and/or systems performing some vital functions.

(Verb): Link, in the sense of forming such a system.

In the new approach, a living biological system may thus be considered a cyborg of its time-like mindworld (mindframe) to its 3-spatial body (laboratory tuner). The "cyborging" is provided by the personal quantum potential and by the mind-body coupling mechanism. Due to the giant negentropy mechanism of any dipolarity, any scalar potential as a dipolarity is a cyborg between observable reality and virtual state (time-like) reality, i.e., between 3-space and the time-domain.

CYTOMEGALOVIRUS

Any of several members of the herpesvirus family that cause infected cells to enlarge and/or to form cytoplasmic (the protoplasm of a cell, external to the nuclear membrane) inclusions in leukocytes (white blood cells), particularly in their nuclei.

Cytomegalovirus makes a protein that appears to disable the p53 protein. As a result, smooth muscle cells in blood vessels can proliferate until they impede blood flow.

CYTOPATHOGEN

Literally, a pathogen (disease causing organism—or extended, mechanism—) that affects cells and generates damage in them.

CYTOPATHOGENIC

Damaging, harmful, or destructive for cells.

CYTOPATHOGENIC EFFECT

The generation of damage, disease, death, or other symptoms at the cellular level in cells that are exposed to or subjected to a pathogen.

CYTOPATHOGENIC MIRROR EFFECT

Distant EM pathogenic effect noted by Kaznacheyev in thousands of military experiments, where cellular death, disease, and damage forms are shown to be transmitted from one cell culture in the dark (absence of visible light) where the changes are induced, to another similar targeted cell culture in the dark that is environmentally shielded from the first except for light transmission in the infrared and in the ultraviolet. After exposure begins, after a time delay (say, 2 hours or more), the cells in the targeted cell culture will begin to exhibit the same symptoms as the culture having the induced damage. Eventually, in most cases the targeted cells will develop the same damage, disease condition, or death. The effects vary with the time of day etc.

The necessity for photon connection from IR to UV is shown by contrasting a thin quartz window allowing the light transmission with a thin window glass window. The quartz is open from the IR to the UV, and will pass that entire spectrum. With the visible light absent, the IR and UV biophotons emitted by the damaged cell culture will pass through the quartz window into the targeted cell culture. After the time delay, the targeted cell culture starts developing the condition.

Use of a thin window glass window, however, prevents the effect. Normal window glass is opaque in the IR and in the UV, and so it blocks the transmission of the IR and UV biophotons.

The UV is a harmonic of the IR, arranged properly. An unusual effect exists when two sine waves one the first harmonic of the other, are simultaneously transmitted into an isotropic nonlinear medium, such as water. On each sine wave, the peak travels faster in the water than off-peak parts of the wave does. Hence the wave peaks overshoot its middle, the wave collapses, breaks up, etc. Both the waves of the transmitted harmonic set do that. However, if one pretends that one transmitted the difference frequency between them, and not the waves themselves, a strange phenomenon results. Regardless of the breakup of the primary harmonic set, the difference frequency travels through the water as if it were a real frequency in a linear medium. This effect has been proven and is used in underwater sonar equipment.

For example, see Owen Flynn, "Parametric arrays: A new concept for sonar," **Electronic Warfare Magazine**, June 1977, p. 107-112. Any two sine-wave frequencies as simultaneous drivers combine to produce a sine-wave difference frequency propagating in water, essentially without sidebands or reverberations. Its pattern has a main lobe approximately equal to that of the high frequency drive, but devoid of sidelobes. The level of the propagating difference frequency is proportional to both the product of the two fundamental drive levels and to the square of the desired value of difference frequency.

Living cells contain a great percentage of water. Hence the effect should apply to those targeted cells, under the conditions stated.

From general relativity, we know that any pattern and dynamics of mass-energy, such as in a cell and all its parts and dynamics, directly interacts with local spacetime to curve it, and any set of curvatures of spacetime interact with any conglomerate of mass-energy and its parts and dynamics. The set of precise curvatures and their dynamics we call an engine. In a mass embedded in a local region of spacetime containing an engine, the engine will interact with the mass-energy to change it if the mass-energy and its dynamics do not "fit" the engine and its dynamics.

In a diseased, damaged, or dead cell, the mass-energy of that cell and its "template" (form and dynamics) differs from its template while the cell was living and normal. Let us now see what happens when that dead cell emits a biophoton.

A photon emitted from a dielectric such as a damaged cell, is not emitted just from one spot. Every part of the dielectric participates in the emission of that photon. (See "porthole concept", to be added). Further, each emitted photon contains in its scalar potential and its magnetic vector potential, the exact longitudinal EM waveset that constitutes the vacuum engine of the damaged cell that emitted it. When a cell absorbs a photon, it absorbs that vacuum engine carried by the photon also. If it absorbs a stream of photons of harmonic interval, the difference frequency constitutes in terms of a wave, traveling through the cell water as if in a linear medium, and transporting that vacuum engine to every part of the absorbing cell dielectric.

So the biophotons emitted from Kaznacheyev's damaged, diseased, or dying cells sent biophotons containing the exact spacetime curvature engines and dynamics of their precise condition (template). Further, a harmonic interval of such radiation is transmitted into the targeted cells, and absorbed. The mixing of the two absorptions eventually is sufficient to establish the harmonic interval, thus with a clear EM signal difference that travels through the cell's water and to every tiniest part of it. This "difference frequency clear signal" also contains the pure vacuum engines of the template of the changes in the diseased, dying, or damaged emitting cells.

The result is the "kindling" (coherent integration) of the template in the absorbing cell's local spacetime in which it is embedded. As that spacetime engine grows, it differs from the resident engine of the absorbing cell. That difference is itself an engine, and it operates steadily upon that absorbing cell to alter its engine and then its physical condition and state.

As the new engine continues to interact, the physical cell is gradually changed into an equilibrium condition in its mutual interaction with its local spacetime engine. That occurs after the absorbing cell has developed the same disease, damage, or dying condition as the transmitting cells.

This is the secret of the Kaznacheyev experiments. The Kaznacheyev work was allowed to be released in the open literature to stimulate the U.S. scientific and intelligence communities and see whether or not the scientists and analysts had applied a unified field theory and higher symmetry electrodynamics to the EM bioeffects problem. The totally casual reception of the Kaznacheyev experiments in the West, with no interest or interaction from the stimulated communities, assured the KGB conclusively that the West was still in kindergarten in its knowledge of EM bioeffects, and particularly had little or no knowledge in the field of EM biological warfare.

Kaznacheyev referred to the effect as the "cytopathogenic mirror" effect, for the pathogenic effects from the emitting damaged cells being "mirrored' in the targeted cells.

See Vlail Kaznacheyev and L. P. Mikhailova, **Ultraweak Radiation in Intercellular Interactions**, [in Russian], Novosibirsk, 1981. An English exposition of much of the Kaznacheyev work is given in Vlail Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions," **Psi Research**, 1(1), Mar. 1982, p. 47-76. See also Vlail Kaznacheyev, "Apparent information transfer between two groups of cells," **Psychoenergetic Systems**, 1(1), Dec. 1974; Vlail Kaznacheyev *et al*., "Distant intercellular interactions in a system of two tissue cultures," **Psychoenergetic Systems**, 1(3), Mar. 1976, p. 141-142. In the same issue, see "A Comment" by William A. McGarey, p. 143; "A Comment" by Arthur C. Hastings, p. 143-144.

Seven or eight nations now have longitudinal EM wave interferometer weapons, capable of beaming right through the earth and ocean to the other side of the planet. At least two of these nations—Russia and China—are capable of adding engine structures to these interferometers, and sweeping a targeted population area to generate that specific disease condition in that target. A sophisticated use would be to have agents (such as terrorist teams already in the United States and with biological agents in hand) release a small quantity of smallpox in the area previously targeted. The LWIs have swept the entire area continuously for a period, slowly kindling (especially at night) the exact form of the disease within the bodies of the populace. A curious thing happens if the level of kindling of the smallpox state has been kept just beneath the observable state, within what is sometimes called the "shadow state" (just barely virtual). A smallpox pandemic will explode in that populace with a ferocity never seen in modern times, and at an unparalleled rate. This is further exacerbated by "spreading the immune system" prior to the attack (term and discussion to be added), which seriously weakens the immune system's ability to resist any single pathogenic attack.

There are hardly any supplies of smallpox vaccine left that are viable. Even where there are, the Russian laboratories developed strains of smallpox resistant to the normal vaccine, and after the collapse of the Russian economy and the former Soviet state, these strains were sold on the black market to the highest bidder. Further, most of the Soviet scientists employed in those secret biowar facilities wound up employed in several other nations, most hostile to the United States.

The point is this: Such a strike could in fact kill up to 2 billion people worldwide. Further, the entire affair would appear to be just a chance breakout of smallpox, and its spread through a nonresistant world populace.

When modern biological warfare is actually analyzed in detail, the "bang for the buck" is greater than it is for nuclear weapons. Further, a rogue or hostile nation can take its time in advance and develop quantities of smallpox vaccine (for the very strain it will use), then initiate such a clandestine campaign after it has vaccinated its own populace, armed forces, and agents. Guess who survives after such an attack.

CYTOTOXIC

Toxic (acts as a poison or toxin) to cells.

A *toxin* is a colloidal proteinaceous poisonous substance that is a specific product of the metabolic activities of a living organism. The toxin is usually very unstable, and is notably toxic when introduced into the tissues.

DARK ENERGY

The Heaviside nondiverged energy flow component, surrounding every field/charge and potential/charge reaction but unaccounted in present electromagnetic theory after being arbitrarily discarded by Lorentz.

DATUM

Consideration, or data considered, or information considered, or action considered, or result considered.

DEATH

The disintegration of the personal quantum potential's connection to the physical body's atomic nuclei by loss of the mind-body connection mechanism.

Simply put, separation of the quantum potential containing the time-like mind-frame from the body. Loss of the preferential tuning of a physical body to its mindworld. This causes loss of the preferential consciousness loop or life channel, resulting in "death" (reversion to inert matter) of the body. Actually the quantum potential and the mind-frame remains, so the *being* is unchanging and indestructible, hence consists of all changes and destructions simultaneously, with none separated individually. Life and death thus are two sides of the same coin, and the coin is immutable, regardless of which side is exposed.

DE BROGLIE WAVE

A matter wave, conceived by Louis de Broglie.

The quantum mechanics wave associated with a particle of matter, which can give rise to interference effects. An orbital electron in an atom is associated with a standing de Broglie wave on a Bohr orbit. De Broglie waves always move faster than the speed of light, the speed being given by c^2/v, where c is the velocity of light in vacuum and v is the velocity of the particle of mass. De Broglie wave velocities thus vary from the speed of light to infinite speed (everywhere at once). In his speech accepting the Nobel Prize, de Broglie emphasized that, since these waves produce real physical effects, they are real and must not be regarded simply as mathematical conveniences.

DEBYE, PETER

Dutch-born American physical chemist and Nobelist, 1884-1966, who performed important and fundamental studies in bipole moments and diffractions of X-rays and electrons in gases.

DEDIFFERENTIATION, CELLULAR

The reversion of a cell or cellular structure to a more primitive or generalized condition.

Dedifferentiation is often preliminary to a major change in the cell or cellular structure. It can also be a reversion of the cell to a previous—even *primeval*—cell form. The important point is that dedifferentiation returns the cell to a previous (past) cellular state. Reversion of a cancer cell, e.g., would cause the cell to return to a normal cell, since that is the nature of its "cellular past." It is vitally important that Becker has demonstrated that cells can be differentiated (moved forward to a future state) or dedifferentiated (moved backward to a previous state) electrically, by very weak DC currents (picoamperes). He was nominated for a Nobel Prize for this epochal work.

Actual electromagnetic redifferentiation of terminal tumors in laboratory animals was repeatedly demonstrated by Prioré et al in the late 60s and early 70s and reported in the peer-reviewed French medical journals, as was reversion of depressed immune systems, cures of infectious diseases, and curing of arteriosclerosis. It is inexplicable that this positively demonstrated cure of cancer—which could also cure infectious diseases and probably can be developed to cure AIDS—was suppressed in the mid-70s and has not been vigorously pursued by present establishment medical science.

DEGENERATE SEMICONDUCTOR

A semiconductor whose conductivity approaches that of a metal.

DELGADO, JOSE M. R.

Noted Spanish neurophysiologist well-known for his research on brain behavioral mechanisms and their control by electrical stimulation; who implanted electrodes in the brains of animals and humans and demonstrated that their responses (both behavioral and emotional) were specific and depended upon the specific localized part of the brain that was stimulated.

A TV tape made by Delgado showed a spectacular demonstration where he stopped a charging bull in mid-stride. With a small hand-held radio transmitter, he transmitted a radio signal to a receiver implanted in the head of the bull. This dramatic demonstration caused a world-wide sensation.

The significance of his work is given by Becker: *"Delgado discovered the exact parts of the brain in which electrical stimulation produced fear, anxiety, pleasure, euphoria, or rage in human subjects. He found that certain sites produced major personality alterations. For example, stimulation of one such site could cause very proper, reserved young ladies to become flirtatious and sexually aggressive. Other sites inhibited maternal or aggressive behavior. In short, Delgado was able to profoundly alter human behavior through electrical stimulation of discrete areas of the brain." … electrodes were implanted in the pleasure centers of rats' brains. The animals were provided with two levers to press. One of these delivered food, and the other produced electrical stimulation of the pleasure center. Invariably, the rats chose to press the lever that stimulated the pleasure center, even to the extent that they died of starvation*." (Becker, **Cross Currents**, p. 221-222).

It is known based on a rare OMNI interview that Delgado progressed to detailed study and experimentation for the behavioral and emotional effects in monkeys of specific magnetic field frequencies on monkeys. These successful experiments involved electrical currents produced in the brain but hundreds of times lower in intensity than those required for direct electrode stimulation. Since then, some information has been cautiously released from Western military studies showing that microwave pulses can couple to the central nervous system and produce stimulation and behavior alteration similar to Delgado's released experimental results.

Comment: The ultimate and most refined techniques in the field of electromagnetic control of human behavior, volition, emotion, etc. is provided by Russian psychoenergetics, the military version of which is totally under KGB control. This work has progressed far beyond what Delgado and Becker were discussion so long ago. The use of the infolded longitudinal EM waves and "engines"—once the technology is developed—allows direct engineering of conscious and unconscious mind, memory including short term and long term, perception, awareness, etc. The additional advantage of using EM longitudinal waves is that mass is largely a very thin dispersion of particles, with (relatively speaking) very large distances between them, somewhat like the solar system but on different scale. This "inner space" is filled with EM waves, potentials, and fields—all of which decompose into sets of longitudinal EM waves and their impressed dynamics. Thus the earth and ocean are readily penetrated by longitudinal EM wave beams, and the Russians (KGB) has developed such LW interferometers since the mid 1950s. However, by LW interferometry where the patterns and dynamics of the carried LWs are engineered, any desired mapping pattern of precise EM signals, frequencies, phases, and magnitudes can be reproduced in distant interference zones, reaching right through the ocean. These interferometers could localize the distant interferometry into a 6-inch diameter volume as early as 1985, so from that time forward it gradually became possible to perform all of Delgado's "inserted electrode" EM stimulus in a single selected human brain from the opposite side of the earth. So approximately 1985 is when I would estimate the beginning of the "golden age" (ugh!) of distant psychoenergetics was initiated.

By 1997, this development would be into at least third generation weapons, just being deployed or just having been deployed, considering an somewhat accelerated weapons development program where 6 years is one generation. By 1997, very complex individual behavioral and perceptual control should have just arrived in on-site deployed strategic weapons systems. See discussion under *conscious mind*.

Some selected useful references are: J.M.R. Delgado et al., **Journal of Anatomy**, vol. 134, 1982, p. 533 reports that developmental defects occur in chick embryos exposed to various ELF frequencies. See also J.M.R. Delgado, **Physical Control of the Mind: Toward a Psychocivilized Society**, Vol. 41, World Perspectives, Harper & Row, New York, 1969.

DEMODULATION

From a carrier containing a modulated signal, recovering the signal that was used to modulate it.

DENSE SIGNAL ENVIRONMENT

For our purposes, when the number of weak EM signals crossing one square meter per second reaches 200,000.

At 500,000 important nonlinear optical type effects of significance—particularly long term cumulative effects—begin to occur in the exposed biological organism.

DEPARTING ORTHOROTATIONS

In space of dimensions greater than four, the rotating of an object or entity away from its line of motion, in the direction of a dimension at right angles to the line of travel in the observer's three-space, by some number of additional 90° rotations.

The Lorentz transform in special relativity, e.g., is just a formula for this kind of rotation. What we call "velocity" is actually a measure of rotation. In 4-space, any object in 3-space can only rotate "out" of 3-space in one direction: toward the time-axis. As the object rotates toward that time-axis, we see the object as having a velocity in 3-space, and its "length along the line of motion" as having diminished. When the object rotates the full 90°, its "length along the line of motion" has been converted to "time" rather than length. Hence it has zero length along the line of motion and is moving at c, the speed of light in ambient space. It is also no longer material, but is a sort of flat plane surface moving at speed c in a direction perpendicular to the plane.

In that 4-space model, it is impossible for anything to move faster than light speed. So Einstein's postulate dealing with the fact that it is impossible to translate mass, signals, etc. faster than light speed has a built-in assumption that only one orthogonal departing rotation can be made from 3-space. That postulate need not apply at all if more than one departing orthorotation is permitted—which of course requires a space of 5 dimensions or greater.

The notion is that, if we allow a spacetime of greater than four dimensions, by continuing to rotate ever more orthoturns in a departing direction away from the original line of travel, the rotated object loses one observable dimension for every orthorotation. Hence with three "departing" orthorotations it becomes a "nonobservable point" to the normal observer, but one that would be moving at speed c^3. A single orthorotation would make the 3-dimensional object a two-dimensional plane moving at speed c.

No matter how many rotations are made in a departing manner, the object is still connected to the time dimension common to all dimensions (assuming only a single time dimension for simplicity). So it exists in an orthorotated space, but in the same time. To the physical observer in 3-space, it thus appears to be a "time-like" or "mental" object only. Nonetheless, by affecting the density and structuring of the time domain, it can have an effect on a 3-spatial object. We discuss that mechanism under the subjects of the mind-to-body coupling mechanism and the body-to-mind coupling mechanism. Further, with the Sachs-Evans unified field theory approach, the time-domain can be directly engineered. This means that both "inert" or physical reality and time-like or "mental" reality can be directly engineered by novel electrodynamic means.

In short, a photon is just a particle (such as an electron) that is orthorotated once (toward the time axis). In photon emission, a little bit of the mass-energy turns into orthorotated photon energy. In photon absorption, the absorbed photon energy turns back into mass-energy.

The higher dimensional orthorotational concept was originally formed to allow a physical modeling grasp on a "mental" object as compared to a "physical" object, and to have a connection mechanism between the two. Such an approach can be used to model both mind and matter, their interaction, etc. The present author has used it to solve the old philosophical problem of "intent", of how the perception of self is attained, how the external world is perceived separate from self, etc. A model for both living and nonliving states does emerge.

This or a very similar approach has been used by the Russian's highly classified weapon science called *energetics*. That third branch of energetics is called *psychoenergetics* and it is the physics of directly engineering mind states, mind operations, memory, etc. by extended electrodynamic means. We have previously detailed much of this work privately, but with some detailed openly in a few papers. E.g., see T. E. Bearden, "Mind Control and EM Wave Polarization Transductions, Part I", **Explore**, 9(2), 1999, p. 59; Part II, **Explore**, 9(3), 1999, p. 61; Part III, **Explore**, 9(4,5), 1999, p. 100-108.

DESTRUCTIVE INTERFERENCE

When two waves or wavesets from two different sources superpose to produce a combined waveset that has a lower intensity than the sum of the intensities of the two original waves.

DETERMINISTIC PATTERN OR TEMPLATE

The exact arrangement, by plan and deterministic action, of a group of entities.

E.g., of the photons in a "herd" or "group" of them. Or a set of spacetime curvatures, into a dynamic structure called a "spacetime curvature engine"—or "engine" for short. Or by the virtual photons in the vacuum flux, or a deterministic set of changes to that vacuum flux (the vacuum flux that is called the "vacuum potential." I have called this function—of a deterministic patterning or templating of the virtual flux (particle view) of the potential—*dimensioning* the potential.

DIELECTRIC

Literally, "against electric (current)."

...originally coined to mean "opposes the flow or conduct of electric fluid."

In today's language, a dielectric is a non-conducting material used to oppose or prevent the flow of electric charges. Even empty vacuum exhibits some dielectric resistance. "Dielectric" is also used to refer to a nonconducting material (often used between the metal plates of a capacitor or elsewhere) which can (i) sustain a change in potential across a distance (i.e., an **E**-field), and (ii) serve as an insulator. Space itself is a dielectric, or at least it is said to exhibit certain dielectric qualities.

DIFFERENTIATION, CELLULAR

(1) specialization of body parts or organs in the evolutionary process. (2) modification of different parts of the body to perform particular functions. (3) modification of the cells forming these body parts or organs so as to perform the necessary cellular functions required to support the functioning of the body part or organ.

DIFFRACTION

The bending of light at the edge of an opaque object.

Usually diffraction introduces undesired distortion and is a problem. However, it can be useful and desirable—for example, in a diffraction grating.

DIMENSION

A certain primary geometrical physical attribute, such as length, used to describe the separational relationships of physical phenomena.

The degree of that separation is known as "length", "time", etc. By "geometrical" we mean that the "dimension" is considered to "exist" in either the presence or absence of the observable physical phenomenon; however, by understood agreement the dimension itself is not directly observable. It can be inferred ("measured"), however, by comparative operations of simple devices such as clocks and meter sticks, and its simplistic definition is usually given as "that which has measurable magnitude." Prescribed measuring procedures are used to assign magnitudes to these inferred dimensions, using specific scales.

Actually, "dimension" just means "fundamental quantity of separation" and "geometry" in the most general sense. The number of dimensions taken in advanced physics usually represents a somewhat arbitrary choice for good modeling fit. In modern Kaluza-Klein theory, for example, it becomes necessary to accept some 10 or 11 dimensions in the usual particle physics case. General relativity has incorporated the interaction of the abstract geometry (spacetime) with mass. Until Sachs' extension of Einstein's work into a unified field theory and Evans' incorporation of O(3) electrodynamics as an important subset of Sachs' unified theory, general relativity has largely remained a nonexperimental discipline, at least in the laboratory. With the new Sachs-Evans approach, however, GR becomes substantially engineerable by novel electromagnetic means, including in the laboratory and in devices.

DIMENSIONING

This is an artificial term I sometimes use to mean "forming an exact pattern or 'template', particularly of nested curvatures of spacetime, where the pattern/template may also be dynamic. It involves the internal structuring of the "dimensioned" entity.

The use of the term "dimensioning" makes sense in unified field theory, but is awkward in normal EM theory which erroneously considers that EM energy propagates in an uncurved spacetime. The mere presence of a change in local spatial energy, created by the wave energy itself when present in that local region, curves the local spacetime. Hence the EM wave rigorously travels in curved spacetime, and in fact identically is a propagating, oscillating curvature of spacetime.

Dimensioning also implies a deliberate form or structure (with dynamics) created in the virtual photon flux of the vacuum or of the virtual photon flux comprising a scalar potential, or in the infolded longitudinal wave EM inside all EM potentials, fields, and waves. It implies an associated set of spacetime curvatures and their dynamics. The latter are referred to as "engines", "vacuum engines", "spacetime curvature engines", etc.

Dimensioning potentials or signals or carrier waves also involves adding hidden *vacuum engines* to them. I chose the descriptive term *dimensioning* because adding such templates (hidden vacuum engine structures) is equivalent to increasing the EM topology by adding dimensions. Since an EM wave or field or vector potential can be decomposed into two scalar potentials, then by "dimensioning" one or both of the scalar potentials one can "infold" the desired hidden structures or patterns (vacuum engines) inside an EM carrier wave, EM field, or vector potential. So I called this *dimensioning* those entities. Internally structuring the two scalar potentials via arrays of EM LW emitters, and then applying the necessary dynamics (modulations), is primarily the manner in which dimensioning can be directly engineered. When dimensioning is present, two identical EM waves as seen on the oscilloscope may have dramatically differing internal structures (dimensioning), and hence the two will produce drastically differing effects when they interact with the same or similar objects. This of course is the mechanism involved in the Kaznacheyev experiments and in the decades-long microwave radiation of the U.S. Embassy in Moscow, where health changes and diseases were electromagnetically induced in personnel in field-free (stable and nonchanging potentials) areas.

Russian energetics refers to what we are calling "dimensioning" simply as adding *the information content of the field*. A very skilled disinformation program (actually, a strategic deception program) has been used to deceive the West into believing the phrase refers to ordinary spectral analysis. It doesn't. The importance of the dimensioning concept is that one has not formed mere "signals," instead, one has formed *vacuum engines*. If a receiving object receives a signal, it may or may not act upon that "signal information." If it receives a *vacuum engine*, however, the engine (structured local spacetime flux) directly acts upon it to make the requisite change. Further, the energy for the interaction's working upon the exposed object or system is furnished continually from the curved spacetime set and their dynamics. The receiving object has absolutely no choice in that action occurring to it, and the action can occur from the gluons and quarks inside the charges in the nuclei, to the lattice structures, to the system dynamics, to the elements so as to transmute them, etc.

Note that when a dimensioned EM field or potential is absorbed by an object, that object also has internal EM fields and potentials which have substructures (usually rather random). However, the internal structure of the absorbed dimensioned entity and the internal structures of the EM fields, potentials, and waves do mix in a direct diffusion process. Hence with continued irradiation, the target can be "charged up" with the desired internal dimensioning structure. This is how the microwave irradiation of the U.S. Embassy accomplished disease induction, using signals with the desired disease dimensioning impressed in their structures, particularly in the potentials. In the Gulf War Disease, a much more sophisticated use of this mechanism was made, using a quantum potential as the carrier. All the effects (including the body fluid transmission, the EM fields of the body transmitting and kindling some of the effects in children in proximity to a dimensioned veteran parent, can be explained.

The use of dimensioned EM fields, waves, and potentials—and the use of dimensioned quantum potentials in Bohm's hidden variable theory—allows an entirely new science of EM biological warfare, far more threatening and lethal than the more primitive physical pathogenic kind. It is also possible to use the techniques for revolutionary healing, as unwittingly shown by Prioré and the scientists working with him, and also as shown by Becker *et al*.

The only way in which the action of a vacuum engine (dimensioned carrier entity) can be resisted is to create and simultaneously introduce the exact antiengine for it.

Once the action has been completed in the receiving object and it has been changed, the only way it usually can be undone is to form a precise antiengine for that action, amplify the antiengine, and let the antiengine act upon the object for a sufficient time to "time reverse it back to its previous physical state and condition". The Prioré mechanism utilized that method for reversing the cellular damage due to cancer and infectious diseases, and to restore suppressed immune systems. The same mechanism, if re-developed, could also be used to reverse aging in living human patients.

The engine and antiengine processes can also be applied by structuring the "time-charging" or "time-excitation charging" of the particles of mass in a body. The "port-hole" concept even allows ordinary EM radiation to be used to forcibly transduce the input ordinary EM into the extraordinary EM and thereby forcibly accomplish the necessary time-charging actions for disease and body deterioration reversal. See discussions under "port hole concept" and "time-charging".

DIPOLE

In the simplest case, two separated charges of (usually equal and) opposite sign.

As a general definition, a localized positive charge or charge distribution, and a localized negative charge or charge distribution, such that the net charge summation is zero, but wherein the positive and negative charge distributions do not superpose. We point out, however, that in regular physics *electrical charge* has no proper definition. Try looking it up in several physics dictionaries! Then check our proposed definition of electrical charge. As is well-known in particle physics, a dipole is a broken symmetry in the virtual photon flux of the vacuum. By definition of broken symmetry, this means that *some* of the virtual energy flux continuously absorbed from the seething vacuum by the charges of the dipole, is not re--radiated as virtual energy. Instead, it is integrated coherently and re-radiated in 3-space as real emitted EM energy. The dipole is therefore a true "negative resistor" since it receives EM energy in unusable form, and re-emits it in usable form. In classical EM theory, the problem of how every charge and dipole can continuously emit EM energy to form all the associated fields and potentials and their energy, is an unsolved problem—sometimes called the most pressing problem in electrodynamics, both classical and quantal. For the solution and a discussion, see my paper "Giant Negentropy from the Common Dipole," Journal of New Energy, 5(1), Summer 2000, p. 11-23.

Because of the broken 3-symmetry of the dipole, the EM energy flow is not conserved in three dimensions (symmetry represents a conservation law, and broken symmetry represents the violation of that conservation law—in this case, violation of conservation of 3-space EM energy flow). Instead, EM energy flow is conserved in 4-dimensions, and the hidden inflow of EM energy to the dipole is actually from the complex plane (time domain). Thus all EM energy is actually received from the time-domain, and so the importance can be seen of the internal structuring of time-flow and of longitudinal EM waves in the time

domain. Such time-domain energy flows appear naturally in O(3) electrodynamics; see M. W. Evans and T. E. Bearden, "The Most General form of the Vector Potential in Electrodynamics," **Optik** (in review).

DIRAC, PAUL A. M.

Noted English physicist, 1902-1984, who shared the Nobel Prize for developing wave mechanics and predicting the existence of the positron.

DIRAC SEA

Considering the vacuum as containing—amongst other things— a "sea" of an infinite negative energy conditions or states ("holes") for electrons, almost all of which are filled with electrons.

In Dirac electron theory, the relativistic wave equation for the electron has four components, which correspond to two spin orientations and two energy conditions: positive and negative. Thus the vacuum possesses a "sea" of negative energy conditions for electrons. These are called "holes" and are considered to ordinarily be filled or mostly filled with electrons which have fallen into these negative energy states. The Dirac sea thus is this vacuum sea of negative energy electrons. In forward time, if energy is added, electrons can be lifted from this sea. If spacetime is locally curved, additional holes may be created so that normal positive energy electrons fall in and disappear, creating the appearance of an "electrical energy sink." If the curvature is in the opposite direction, electrons may be lifted from the Dirac sea by the curvature, thus producing a flow of electrons and creating the appearance of an "electrical energy source."

DISCRETIZED

Occurring in a finite size, fixed as a function of one or more variables.

So long as the same value(s) of the variable(s) are selected, the discretized entity is always the same size. However, if the value(s) of the determining variables are changed, the value of the discretized quantity may change so that it is not a whole number multiple of the former entity. Compare this to a quantized entity, where the values of the variable(s) are held to those wherein the entity will always be a multiple of an entity of fixed size.

DISEQUILIBRIUM

Broken equilibrium, which in turn involves breaking appropriate conservation laws.

DISSOCIATION

Separation of ideas from their affects or feelings, resulting in independent functioning of these components of a person's mental processes.

Simply put, fragmentation of the mind and personality. Severe dissociation is the definition of insanity.

DISTORTION CORRECTION THEOREM

"If a scalar wave E1(r) propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica E2(r), then E2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E1."

Quoted from Amnon Yariv, **Optical Electronics**, 3rd Edn., Holt, Rinehart and Winston, New York, 1985, p. 500-501.

What is missing from the distortion correction theorem is hidden in the phrase *"if we generate in some region of space ... its phase conjugate replica.."*. Since electrodynamicists and optical physicists have been unaware that all EM energy at any point in space comes from the time domain to that point, then the actual phase conjugate wave in the imaginary plane (from the time domain) is not utilized as the phase conjugate replica. Instead, the interaction of that wave with charges, which actually produces the force-field wave in space, is assumed. In short, one is looking at the "effect" wave, not the "cause" wave. However, since time is not an observable even in theory, it is this "effect" wave in 3-space that will be measured by our instruments.

Note also that the distortion correction theorem says nothing about longitudinal EM waves in the time domain. Interestingly, in nonlinear optical pumping, it appears that the 3-space energy of the pumping 3-space waves is transformed into the time domain by the pumping, and thence flows from the time domain into the 3-space domain to form the progression of the time-reversed replica wave in 3-space.

It is apparent that much more work should be done upon the foundations of phase conjugate optics, in a higher symmetry electrodynamics model such as O(3) electrodynamics and particularly in the unified field theory as in the Sachs-Evans combined approach.

DNA (DEOXYRIBONUCLEIC ACID)

Nucleic acid that constitutes the genetic material of cellular organisms and also certain viruses.

DRUDE, PAUL

Important German physicist, 1863-1906, who formulated the theory of the free electron gas inside conductors, using it to formulate a theory of metallic resistance.

DRUDE ELECTRON GAS

The "free" electrons that have broken loose from their atoms in a conductor, and are thus free to "wander around" and "migrate"—or flow as current when exposed to an emf.

Also called the electron gas, or Drude electron gas. Named after the German physicist Paul Drude who died in 1906, who formulated Drude's theory of metallic resistance based on EM theory and his own theory of electrons. See P. Drude, Ann. Physik, Vol. 1, p. 566; Vol. 3, 1900, p. 370, 869 for the original Drude papers.

DUALITY PRINCIPLE

In quantum mechanics, the principle that photons and other particles propagate like waves and interact like particles, so that their descriptions as only waves or only particles is inadequate.

ECM

Electronic Countermeasures.

Electromagnetic measures taken against targeted electronics or electromagnetics operations in systems, particularly in hostile weapon systems, command and control systems, etc. There are entire textbooks in the West that are devoted to ECM effects, uses, effectiveness, etc. A great deal of ECM equipment is also used by any modern military force. However, in our view what is greatly lacking as yet in Western ECM is the deliberate design and use of novel new kinds of ECM based on the extended higher electrodynamics such as O(3) electrodynamics, and particularly by use of longitudinal EM waves and by use of the infolded electrodynamics inside all EM fields, potentials, and waves. Longitudinal EM wave interferometers (LWIs), e.g., can reach right through the earth and the ocean to emerge on the other side of the earth. In the interference zone (IZ), real EM "transverse wave" energy is created readily by the interferometry. Biasing of the chassis grounds of the distant LWI transmitters can control whether the "normal" EM energy appearing in the target IZ is convergent (cooling) or divergent (heating). By sharp pulsing of the LWI transmitters, massive cold explosions or hot explosions can be created in the IZ. Continuous LWI interferometry can produce geometric forms of EM energy, which usually glow due to the ionization of the atmosphere, etc. in the dense EM energy regions. Since these can also involve general relativistic effects as well as electromagnetics effects in the U(1) CED sense, obviously a dramatic expansion of the entire field of measures and countermeasures is entailed.

We believe these LWI weapons may be what was referred to by U.S. Defense Secretary Cohen as follows: *"Others are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our efforts."* Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

EDGE WAVES

In electromagnetics, waves that form parallel to a material edge.

EDISON, THOMAS ALVA

Noted American inventor, 1847-1900, whose staggering number of inventions included the storage battery, electric light bulb, phonograph, motion pictures, and carbon microphone.

E-FIELD (ELECTRIC FIELD)

The electric field or electric intensity E. That field on a spinning charged mass which produces an electrical force resulting in a linear motion of the charge.

See also discussion under c, above.

E-FIELD, MOTIONAL

In classical EM theory, the electric field produced by moving a conductor in a magnetic field. Often called *motional inductance* of the field.

In the orthodox theory, motional inductance is deemed to be identical to the inductance caused by a time rate of change of the magnetic field, experienced by the moving conductor.

E-FIELD, STATIC

In orthodox theory, the electric field in the space surrounding a static charged particle, induced by the presence of the charged particle.

In classical EM, there is no notion as to the *causative mechanism* for this static field of and from a charge, which implicitly is assumed to just continuously create and pour out EM energy in all directions, thus grossly violating energy conservation.. Consideration of this anomaly leads to what has been called the most pressing problem in both quantal and classical electrodynamics: the question of the formation of the fields and potentials associated with the "source charge".

For a full solution to this problem, see my "Giant Negentropy from the Common Dipole," **Journal of New Energy**, 5(1), Summer 2000, p. 11-23. Also on this website.

EHRENHAFT, FELIX

Scientist who performed numerous experiments believed to demonstrate fractional charges.

EINSTEIN, ALBERT

German (Jewish) physicist, 1879-1955, who emigrated to the U.S. and formed special and general relativity theory, discovered and formed the theory of Brownian motion, recommended the development of the atomic bomb to President Roosevelt, and profoundly affected the course of science and the modern world.

EINSTEIN-de HAAS EFFECT

The rotation observed in a freely hanging ferromagnet when it becomes magnetized.

It has been used in the Einstein-de Haas method to determine the gyromagnetic ratio of a ferromagnetic material by suspending a cylinder of the material from a torsion fiber and measuring the angular displacement of the cylinder when its magnetization is reversed.

EINSTEIN, PODOLSKY, AND ROSEN PARADOX

Thought experiment in 1935 for measuring two correlated photons separated and at distant locations, protesting that quantum mechanics requires that the particles communicate instantly, which is a "spooky action-at-a distance" (Einstein's phrase).

The experiment eventually was performed and it works, just as required by quantum mechanics. The paradox inspired the development of hidden-variable theories.

EINSTEIN'S POSTULATES

(1) All the laws of physics are equally valid in all inertial frames of reference,

(2) the speed of light is the same to every inertial observer, and

(3) the observable local effects of a gravitational field are indistinguishable from those arising from acceleration of the frame of reference.

The first is called the special relativity principle, the second is called the law of light propagation, and the third is called the equivalence principle. It is now known that postulates (1) and (2) are not independent of each other. Note that the third postulate implies that any local force is due to a "gravitational field" (acceleration of the frame of reference). It also implies that gravitational force has a mechanism, since quantum mechanics assigns a differential operator, operating upon a potential, to create every force. By extended inference, it can be seen that the third postulate also implies that there should exist a method to turn any type of force (field) into gravitational force (field).

The Russian physicist Sakharov has strongly postulated that gravitation is not even a fundamental field of physics, of the kind used by Maxwell in his electrodynamics. Instead, in this view **G**-field is always comprised of, and made from, other fields and interactions upon them. Indeed, such has always been implicit in general relativity, it just took Sakharov to formally propose it. E. g., see A. D. Sakharov, "Vacuum Quantum Fluctuations in Curved Space and the Theory of Gravitation," **Soviet Physics Doklady**, Vol. 12, No. 11, 1968, p. 1040-1041 [English translation.] Sakharov's article (in Russian) in **Doklady. Akad. Nauk SSSR**, Vol. 177, 1967, p. 70-71.

Now let us do a little "tinkering" with Einstein's postulates. For the first one, we point out that in the new approach using dimensioning and subspaces, the notion of an inertial frame now has acquired additional complexity! The "gross translation" effects—which tends to be what physics ultimately focuses upon—can remain the same, and yet vacuum engines can be buried up inside the inertial frame to act upon a mass in non-translating ways. Everything translation-wise can remain the same, but now matter can be transmuted and transformed, etc., still right there in an inertial frame. So when the infolded electrodynamics inside all fields, potentials, and waves are utilized, the notion of "inertial frame" has acquired a higher topology and then one inertial frame may differ very substantially from another inertial frame. This of course move one from special relativity into full general relativity, and even there into a slight extension. Special relativity can remain special relativity on the surface, and yet effects occur "within" the objects postulated to exist in this inertial frame. The "inertial frame" concept in the postulates is now just a sort of special "equilibrium case" of a higher topology "inertial frame" notion.

The second postulate now stands as a "special case" of a far more general second postulate. It actually defines (and limits) "light" to bulk changes in the entire vacuum potential magnitude. It only applies to light signals which are "bulk upheaval" disturbances of the vacuum potential (spacetime). Specifically it need not apply to the "inner EM/GR realm" of longitudinal EM waves infolded inside the vacuum potential, other potentials, signal carriers, etc. Superluminal communication is now included in this "hidden variable" communication. The Fogal semiconductor is in fact capable of infolding and outfolding EM signals, including producing the internal longitudinal EM waves, and during their infolded state these signals are permitted to move at superluminal velocity.

So the second postulate needs to be restated to include the present statement as a special case. Notice that the concepts "light" and "speed of light" have now taken on much richer, extended meanings, since there is "outfolded" light and "infolded" light, so to speak. Light now is not just the "external perturbation wave" in the ambient vacuum potential medium (in flat spacetime). Instead, it can also be an "internal perturbation longitudinal wave" inside a "net flat spacetime" which does not show on the "surface" at all. Indeed, it may move in the time dimension or in 3-space. It now includes the transmission of an extraordinary "vacuum engine" as well as the usual transmission of just an ordinary signal.

And these infolded vacuum engines can be visualized as very special sets of longitudinal EM waves and their dynamics, consistent with the Whittaker decomposition. His U(1) symmetry electrodynamics decomposition—particularly when enriched in the higher symmetry O(3) electrodynamics—applies to the ambient vacuum as a potential (it is a potential since it has energy density). So the "subspace" inside spacetime, so to speak, is just a set of LWs and their dynamics, and that subspace itself is engineerable, just as is the "bulk curvature of spacetime" itself. Further, we may now consider space itself is just a vast superhighway for such superluminal LWs and their dynamics. Mass is mostly empty space with only an occasional particle here and there and with fields, potentials, and waves in between. Hence huge masses such as the ocean and earth are actually superhighways for the direct passage of longitudinal EM waves, "engines", etc. The degree of "transparency" is a function of the degree of cleanness of the LWs.

The third postulate has also been dramatically extended and requires revision. As presently stated, antigravity effects do not appear to be included in present physics heretofore. The "gravitational effects and external accelerated effects" notion in conventional physics is still founded purely on *ordinary bulk translation*. Now it need not be. For example, the system can appear to be an ordinary system, as judged by normal "external light" observation. Yet its internal vacuum engines can cause local violation of most so-called "laws of nature." The reason a "law of nature" can be violated is that one is now able to violate the premises upon which it is postulated, and which are required to hold if the law is to hold. Or another way to look at it: any conservation law is the result of a symmetry. Breaking that symmetry allows violation of that specific conservation law.

So as we've said so many times before, the infolded EM inside the "conventional" EM fields, waves, and potentials—and inside the vacuum potential and spacetime itself—dramatically changes the present theories of electromagnetism, quantum mechanics, and general relativity. Further, for the first time the Sachs unified field theory allows an *engineering* approach which simultaneously crosses, includes, and extends all three disciplines in the required manner. The approach can be placed into good engineering models based on the Sachs work, particularly using the O(3) electrodynamics subset spearheaded by Evans, and the models can be tested and verified or falsified.

EINSTEIN'S GENERAL THEORY OF RELATIVITY

Mathematical theory of gravitation in which the gravitational force is mathematically described by a curvature in space or spacetime.

In other words, the geometry and its dynamics have become physical agents.

It is important to note that, in general relativity, the curvature of spacetime acts on mass-energy, and changes in or to mass-energy interact back upon spacetime to change its curvature.

Further, we consider that an exact pattern of curvatures of spacetime and their dynamics exists for every mass system and its dynamics. This is the engine concept. The most general way to engineer matter is not by brute force translation, but by forming spacetime engines. Once formed, these engines act upon any mass placed in the engine region, to eliminate the deltas existing in that mass's resident engine and the impressed engine. The curvature of spacetime itself furnishes the energy for the continuing action upon the mass, once we pay to form the engine. The mass can be acted upon at any level, from its gluons and quarks to its nuclei, to its atoms, its lattice forces and binding energy, etc. Significantly, the Sachs theory applies to physical reality from beneath the quarks and gluons to the entire universe, and folds in quantum mechanics, electrodynamics, and general relativity into a single unified field theory that is (in theory) engineerable by higher symmetry electrodynamics means.

ELECTRIC FIELD

The *conventional* definition is this: "1. a region in space in which a stationary electric charge experiences a force due to its charge. 2. the electric force per unit test charge." **Dictionary of Science and Technology**, ibid., p. 720. That definition is flawed. Consider the "spatial aspects" of part 1. If an electric field is defined as a force per unit charge, it is not a region in massless space but is an effect of something existing in massless space and interacting with the charged mass. The electric field *prior to interaction* is indeed related to a region in space, because it is identically a curved spacetime region. In the Sachs approach, general relativity and electrodynamics have become one and the same. So prior to interaction, the *field as it independently exists prior to interaction with charge* has become a curved spacetime region, and the field is *purely* a spacetime curvature effect. The interaction with mass to produce a force on and of that mass (mass is a component of force, and there is no such thing as a massless force) is a separate consideration from the field as it exists in space prior to interaction. The result of this entity's interaction with charged mass has nothing to do with *what an electric field is*; but with *what it does to charged mass*. Further, the force evidenced on a charged particle is not due to its charge; it has that charge always, whether or not there is a net force evidenced on it!

Part 2 is a little better. The only problem is, it totally disagrees with the entity existing in space prior to interaction. In other words, here it's a "force on a charge", which is an effect occurring after the interaction. Again, it is what the field *does or accomplishes*, not what it *is*. Hopefully the reader can now begin to see what terrible difficulties await anyone who seriously attempts *foundations definitions*. Feynman sums it up admirably in one of his famous statements: "*Everything we know is only some kind of approximation, therefore, things must be learned only to be unlearned again or, more likely, corrected."* An additional difficulty is that the very notion of a separate massless force independent of the mass on which it operates, is fictitious, yet continues to be widely used. Recalling that any true definition is an identity and not an equation, let us start with the definition of force:

$\mathbf{F} \equiv d/dt(m\mathbf{v})$. As can be seen, force is a system comprised of (i) a mass component and (ii) a nonmass component. The force is not something separate from the mass, at all! Further, force is not even unitary. It's a system comprised of two coupled components; the mass and a coupled (interacting) gradient in a potential flux. *Note that* $\mathbf{v}$ *involves motion through, and interaction with, the virtual flux comprising the vacuum potential. Note that* $d\mathbf{v}/dt$ *involves a gradient in that flux interaction with the mass*. Unfortunately mechanics is still using the medieval concept of a "separate force acting upon a separate mass." That is wrong, unless we change the fundamental definition of force itself. See, e.g., Robert Bruce Lindsay and Henry Margenau, **Foundations of Physics**, Dover Publications, New York, 1963, p. 283, where the authors emphasize that a "field of force" at any point is actually defined only for the case when a unit mass is present at that point. The reason can be seen: mass is a necessary component of force, and without mass present there cannot be a force present.

ELECTRIC DIPOLE

See Dipole.

ELECTRODYNAMICIST

A specialist in electrodynamics,

...the physics of the relationships between electric, magnetic, and mechanical phenomena—and especially a specialist in electrodynamics theory.

It should be pointed out that essentially all electrodynamicists are versed in U(1) electrodynamics, and a much smaller number are versed in more advanced electrodynamics such as O(3) symmetry electrodynamics, unified field theory electrodynamics, non-Abelian electrodynamics, etc. The electrodynamics field is actually a very vast field indeed, touching everything in physics. Very often, when one needs a particular electrodynamics problem solved, it calls for a special category of electrodynamicist and not just an electrodynamicist in general. One must therefore sometimes examine the background of the electrodynamicist making a statement or a pronouncement: electrodynamicists after all do have differing views and differing disciplines within the field.

ELECTROMAGNETIC PULSE (EMP)

A sharp pulse of electromagnetic radiation produced when an explosion occurs in an unsymmetrical environment, especially at or near the earth's surface or at high altitudes.

Essentially the same as an electromagnetic shock wave, a wave of great intensity which results when waves with different intensities propagate with different velocities in a nonlinear optical medium. An EMP is also produced when two intense longitudinal scalar electrostatic potential wave patterns meet and couple into a sudden flash of vector EM energy.

ELECTROMAGNETIC SMOG

The background of extremely weak EM radiation that fills the normal modern environment, particularly in developed nations.

The individual signals are too weak to individually produce effects of any significance in biological systems. However, in a dense EM smog environment with 500,000 signals per square meter per second, the signal complex and its nonlinearity begin to produce highly nonlinear effects in biological systems. These effects also produce damage that may cumulate over a long period of time, including for years. This bioeffects area has largely not been investigated by EM bioeffects scientists.

It should be pointed out that electric lines, telephone lines, transmission lines, etc. act as long wire antennas to detect and propagate such very weak EM signal noise. Essentially all the radiators in the environment—including electronics equipment, TV stations, radio stations, factory machinery, etc.—thus produce very weak signals picked up by these long line antennas and piped into every home, factory, neighborhood, etc.

ELECTROMOTIVE FORCE (EMF)

A difference of potential created by sources of electrical energy—i.e., by separated charges (dipoles)—which can be utilized to drive electrical currents through external circuits. Also, open circuit voltage, or the limit of the potential difference between the source's terminals as the current in the external circuit approaches zero.

Poorly named. Also quite confused in the standard theory and usage. First, *emf* is not a *force* at all. It is a difference in potential, hence it is measured in volts. Also, it is not considered an **E**-field, since that is a field of force. Yet it is in fact a , restricted to the direction between the two measurement points, and is considered to be an **E**-field in the theory!

For this reason the standard theorists say that the term is sometimes used as equivalent to a difference in potential, but that strictly speaking it should be applied only to a source of electrical energy! The problem is that conventional theorists are unaware that a potential is a bidirectional flow of energy in 3-space, where the energy enters from the time-domain (complex plane). Since they are unaware that a potential is hidden negentropic energy flow process involving broken 3-symmetry and viable 4-symmetry, the theorists are unable to consider the potential in general as a source of energy flow. Yet they are forced to

consider a potential difference across the terminals of a source as "somehow a flow of energy, that generates forces upon the electrons to propel them through the circuit as current flow."

In the new viewpoint, a resolution is achieved of these incongruities by more accurately defining the E-field with respect to the potential as E [q]/q. It is noted that [dA/dt]q/q also produces an E-field, so that the full definition of the E-field is as E [(+dA/dt)q]/q. However, one volt represents one joule (of excess energy) per coulomb of charge. *The energy density flow in an electric circuit is in the voltage, in the emf, and it is not in the current per se*. The electron current (drift current) carries the excess energy that is being dissipated as work in the circuit, but in a nominal circuit the drift current only moves a few inches per hour. Half the energy is dissipated in the external circuit and external losses, and half is dissipated in forcing spent electrons in the ground return line back up through the back-emf of the source, performing work inside the source to dissipate its separation of charges. Left alone, any dipole will furnish emf indefinitely, freely receiving the energy from the time domain (complex plane) and outputting it in 3-space. The free flow of EM energy will continue unabated from the undestroyed dipole, regardless of how many external loads and losses are powered (how much energy is collected and dissipated from the ongoing flows representing the potential). So electrical circuits should be developed which allow little or no electrons to be forced back up through the dipole to dissipate its separation of charges and destroy the dipole.

ELECTROMOTIVE FORCE, BACK (BACK EMF)

Back emf is a loose term used for the *counter-electromotive force*.

When the source is powering a circuit or circuit element, the term "back emf" is used to refer to the forcing of current (electrons) back up through the source against its emf, thereby performing work inside the source to dissipate its separation of charges (its dipolarity). When a potential source of electrical energy—such as a capacitor, an inductor, or a rotating machine—is receiving energy from the source and converting it to dissipative power and work, that "powered" device is said to develop a *counter-emf*. A source has a built-in emf *a priori*, that is holding its charges separated so that it is dipolar. When electron current is forced backwards through the source through its built-in counter-emf, and backwards against its emf, work is performed against the internal resistance of the source to dissipate its separation of charges, thereby dissipating the source. If electron current is not allowed to flow back up through the source against its back emf and through its built-in counter-emf, no dissipation of the source occurs, even though energy density (not electron current dq/dt but energy flow d/dt) is flowing from the source and can be collected in collectors in the external circuit to store the energy as a created local energy source. This collected energy can then be shuttled to a separate load circuit and released, to provide a "heat pump" cycling operation and overunity coefficient of performance.

Nikola Tesla in fact knew how to shuttle energy in a circuit in such fashion, as Barrett's quaternion analysis of Tesla's actual patented circuits has revealed. [See T.W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," Annales de la Fondation Louis de Broglie, 16(1), 1991, p. 23-41.] Note that a rigorous analysis of those same circuits, using tensors or vectors, will not show the effect.

When the original source dipole is not dissipated because electron current is not passed back up through its back-emf to scatter the charges, the original source dipole will continue to furnish emf indefinitely.

The terms emf and counter-emf are normally applied only to recognized sources of electricity. Emf is applied as the algebraic sum of the potential differences acting in a circuit attached to a source. Back-emf (counter-emf) is applied as the potential difference internally through the source, between its terminals. Its main application is thought to be a *powered device or component in the circuit*. Actually, its main application is to prevent COP>1.0 electrical power systems from being developed and utilized.

ELECTROMYOGRAPHY (EMG)

A diagnostic application which detects changes in electrical potentials associated with muscle contractions.

Specific electrical patterns have been associated with specific abnormal states (e.g., denervated muscle), but the method has not yet been systematically developed beyond this application.

ELECTRON

Stable elementary particle in all atoms, and having a negative charge of 1.602×10^{-19} coulombs, spin ½, and mass of 9.11×10^{-31} kilograms.

ELECTRON GAS

A system of electrons with only weak interactions so that the electrons may be regarded as moving independently.

Thus, in many ways, that collection of electrons can be treated as a gas. Also see discussion under Drude Electron Gas.

ELECTRO-OPTICS

A technology in which electrons are focused and steered as if they were light. Examples are the cathode ray tube (CRT) and the electron microscope.

ELECTRO-POLLUTION

Also called *electromagnetic smog* and *electronic smog*. The conglomerate or maze of EM fields and radiations that are produced by technologies such as electric power transmission and radio transmission, and that can have long term cumulative harmful effects on humans.

The new viewpoint dramatically extends the types of fields and effects involved, and gives entirely new mechanisms for the interaction of EM fields and radiation with biological systems, including cumulative effects, signal-density effects, and vacuum engine effects. A mechanism for long term causation of cancer and leukemia by electro-pollution is derivable in the new approach.

As an example, even though the myriad of very weak EM signals comprising the electro-pollution are individually tiny, each when interacting at a local site with the body or its cells involves a broken 3-symmetry and thus an involvement of 4-symmetry, with corresponding giant negentropy. Further, the Heaviside dark energy component accompanying that local field interaction will in turn interact with essentially all the other locations of the body. Each of these interactions involves broken 3-symmetry and involvement of 4-symmetry. The result of the large complex of broken 4-symmetries constitutes a direct structuring in the time domain, hence weak time-pumping and weak time-charging. Time charge excitation decays only very slowly, emitting longitudinal EM waves inside the body as the charge decays.

Over a long period of time (sometimes years), this "time-hash" or "time-jamming" upon the operation of the master cellular control system, the immune system, and the cellular regeneration system is cumulatively detrimental. In this way, effects such

as leukemia, cancer, etc. may be gradually "kindled". However, there have been no real scientific laboratory "cause and effect" investigations of this phenomenology at all. Nonetheless, the results will and do show in epidemiology studies, which are then attacked by orthodox scientists (many employed directly or indirectly by the power industry, etc.) on the grounds that no laboratory cause and effect evidence has been shown.

In short, this is one of the areas where the lack of scientific cause and effect laboratory evidence—because such experiments have not even been done—is improperly used to negate real scientific work showing deleterious effects that powerful interests do not wish shown.

ELECTRO-RETINOGRAPHY (ERG)

A diagnostic application that monitors changes in electrical potentials across the retina to assess eye movements.

This is almost the only method available for noninvasive monitoring of Rapid Eye Movement (REM) sleep.

ELECTROSTATIC COOLING

To be added

ELECTROSTATIC SCALAR POTENTIAL

A static (stationary) ordering in the virtual photon flux of vacuum.

The word "static" is unfortunate and should be replaced by "stationary", since the underlying active vacuum medium is always in violent motion, and there is nothing truly "static" in the universe. But an equilibrium condition can exist, even in violent motion, so that a stationary entity persists. An example is a perfect whirlpool in a river.

ELF

Extremely Low Frequency.

Used to describe EM fields whose frequencies lie in the range from just above 0 Hz (direct current) to 300 Hz. This includes power line frequencies (60 Hz in U.S. and 50 Hz in Europe) and frequencies used by certain U.S. military ELF communication systems such as for submerged submarines.

EM

Electromagnetics.

EMF

Electromotive force. See discussion under that term.

EM FIELD

Electromagnetic field. In its loose usage, it refers in a very broad way to any field, force, or energy associated with electromagnetic interactions, charges and currents.

Thus "EM field" includes electrostatic fields, magnetostatic fields, electromagnetic fields (including radiation and induction), vector-potential and scalar-potential fields, Hertz potentials, Fitzgerald potentials, Whittaker potentials, etc.

In its precise usage, "EM field" conventionally refers to an EM "force" field, such as the **E**-field, **D**-field, **B**-field, **H**-field. In classical electromagnetics (CEM), as a holdover from the old assumption of a material ether, the force fields are considered (erroneously) to exist in mass-free space, and they are also considered to be the primary causes of electromagnetic phenomena. This is a non sequitur, and it involves substituting the effect for the cause.

In the new viewpoint, the force fields do not exist in vacuum, but only in and on and of the charged particles themselves, where mass is present to form one component of the force. The force fields are therefore effects and not primary causes. The primary causes of all electromagnetic phenomena is taken to be the potentials; however, the hidden Stoney/Whittaker/Ziolkowski internal structures of gradient-free scalar potentials may interfere to cause potential gradients in and on charged particle systems. This therefore includes distance-free scalar potential interferometry and action at a distance, as well as vacuum engines.

The new view uses Sachs' unified field theory, and considers that the EM field in the vacuum, or an EM potential in the vacuum, is a curvature of spacetime function. Thus the new view is a unified field theory where GR has become EM and EM has become GR, and where EM can involve or produce gravitational, temporal, and inertial effects as well.

EM FORCE FIELD IN THE VACUUM (A FALSE CONCEPT)

The erroneous notion that there exist forces in the vacuum, so that the set of forces at a set of spatial points forms a force field.

This ignores the fact that mass is a component of force, and the presence of a force requires the presence of a mass. When Maxwell formed his electrodynamics theory, he and almost everyone else believed that a thin material ether pervaded empty space. Thus there was a "material medium" in which electromagnetic fields existed, and so it followed that real forces existed in this material medium, from point to point. Indeed, to the early electrodynamicists there was no point in all the universe where mass was absent.

Heaviside, Hertz, and Gibbs reduced Maxwell's 20 quaternion equations to the present four vector equations, but did not change the *force field in space* assumption used by Maxwell. Heaviside detested the "mystical" potentials favored by Maxwell, and believed they were figments of one's imagination. He regarded the forces as the primary EM causes.

Yet even while Heaviside *et al*. were retranslating and topologically reducing Maxwell's theory dramatically, the Michelson-Morley experiment in the 1880s had already destroyed the material ether on which those same force fields were based.

Physicists, however, have continued to use the notion of a separate force acting on a separate mass, which of course is also a non sequitur, substituting effect for cause yet again. Hence the foundations of physics remain fundamentally fouled.

For a succinct discussion of potentials versus forcefields as the primary EM causes, see Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," **Physical Review, Second Series**, 115(3), 1959, p. 485-491. See also Y. Aharonov and D. Bohm, "Further considerations on electromagnetic potentials in the quantum theory," **Physical Review**, 123(4), Aug. 15, 1961, p. 1511-1524.

EM GENERATRIX

Whatever generates electromagnetics, particularly the fields. Time is the ultimate EM generatrix.

Whittaker showed in 1904 that the interferometry of two scalar potentials (i.e., of their hidden multiwave structures) can create all classical EM fields, no matter how complex, thereby starting a branch of electrodynamics known as *superpotential* theory. See E. T. Whittaker, "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," Proc. Lond. Math. Soc., Series 2, Vol. 1, 1904, p. 367-372. The paper was published in 1904 and orally delivered in 1903.

In 1903 Whittaker showed that any scalar potential (e.g. between the ends of a dipole) can be decomposed into a harmonic set of phase conjugate EM longitudinal wavepairs. The present author applied the Whittaker decomposition to the scalar potential between the ends of a dipole, and pointed out that the conjugate half-set may be taken as converging EM waves from the complex plane (the time domain), while the real half-set may be taken as diverging EM longitudinal waves emitted from the dipole in all directions in 3-space. The dipole is a known broken 3-symmetry in the dipole's violent virtual energy exchange with the vacuum; hence this shows that breaking 3-spatial symmetry allows nature to fall back to a more primary 4-symmetry. Hence energy flow conservation is violated in 3-space, but is rigorously obeyed in 4-space. Further, the free flow of 3-spatial energy from the dipole continues so long as the dipole exists.

The dipole thus is a true negative resistor, receiving EM energy in unusable form (from the complex plane; i.e., the time domain), transforming it into usable energy, and outputting the usable energy. This is also the fundamental mechanism for extracting unlimited EM energy from the seething vacuum, taking the energy from the time domain via the giant negentropy mechanism. See my paper, "Giant Negentropy from the Common Dipole," *ibid*.

This also means that the source of all EM 3-spatial energy is from the time domain, and is due to broken 3-symmetry. The ultimate EM generatrix is thus time. The ability of a bit of broken 3-symmetry (such as formation of a simple dipole) to initiate a continuing and ongoing flow of free EM energy via the 4-symmetry between time-energy and spatial energy, means that *negentropic* engineering, once we get the hang of it, is far easier than our present *entropic* engineering. In essence, we have to learn how to do electrical engineering all over again, from a much more fundamental point of departure.

EMI (ELECTROMAGNETIC INTERFERENCE)

Disturbances of electronic equipment's operation by intrusion of extraneous EM signals from outside sources. Also, disturbances of the operation of one or more subsystems of an electronic system by intrusion of undesired signals from other subsystems.

EMI, ANOMALOUS

An "ad hoc" term denoting an unexpected nonlinear optical functioning process in a dense signal environment whereby nonlinearities on the skin of a vehicle or cover of an equipment become pumped phase conjugate mirrors, so that they emit amplified phase conjugate replicas (PCRs)—of signals and fields impinging upon the skin or covering and the nonlinearity from electronic circuitry operating inside.

By the distortion correction theorem, these amplified PCRs precisely backtrack the signal waves that impinged upon the phase conjugate mirror from inside the vehicle or electronics, back to the original source of the internal signal. The result is the scavenging of energy from the dense electronic signal environment and sharply focusing and directing it into the operating circuits of the internal electronics. Thus internal signals, often amplified, start sporadically appearing through the circuits. These sporadic jamming signals due to the anomalous EMI effect are known as EMI fireflies.

Such EMI fireflies were resoundingly experienced in U.S. missiles and aircraft in the U.S. air attack on Libya in 1986. Although some of the anomalous EMI effects could have been produced by the unusually dense EM signal environment and poor hardening of circuits and electronics, it is believed that the weak jamming was also a test being conducted of a laboratory prototype Russian quantum potential weapon.

This weapon appears to have been finished and deployed at the end of 1989, and then utilized against Allied forces in the Gulf War, accounting for the Gulf War Disease. We have previously explained why British, Canadian, and American soldiers acquired the disease, why the native populace did not, and why the French troops did not.

Inside the human body, the anomalous EMI effects may be used to produce time-charging and delayed interference with the immune system, the master cellular control system, and the cellular regeneration system. By using dimensioned signals, the targeted systems can be specifically and deterministically affected as desired, for any set of disease damage types and symptomology desired. So the technology may be used to induce a "cocktail" mix of various infectious disease damage types. The induced time-charging effects—where the time-charge is dimensioned—followed by longitudinal EM wave emissions from the time-charges as they decay in the veteran's body, can induce the same or similar symptoms and damage in close family members exposed to the weak but dimensioned longitudinal EM radiation. This applies not only to wives but also to family members such as children often in close proximity to the veteran. In addition, exchange of bodily fluids from the veteran to his spouse can directly induce the symptoms in the spouse since those fluids are themselves still time-charged (with dimensioned time charge) and slowly decaying.

ENDOTHERMIC EXPLOSION

An EM implosion, resulting in explosive electrostatic cooling. The sudden, explosive reversal of electromagnetic energy scattering in a spacetime area so that the local EM heat energy is converted back to a negative potential. In this manner, explosive electrostatic cooling occurs in the area.

Endothermic EM explosion occurs by pulsed scalar Whittaker interference of two longitudinal EM wavesets beamed from two LW EM transmitters. The distant transmitters of the LW interferometer must have their local electrical grounds biased well below the ambient zero potential in the distant interference zone (IZ). Whittaker internal EM waves radiate through subspace (the LW superhighways inside EM fields, potentials, and waves in mass) from the transmitter to the interference zone, and also from the interference zone back to the negatively biased transmitter/receiver, emerging there as ordinary electromagnetic scattering energy or *heat*. All *normal* explosions are exothermic in nature, and ordinary electromagnetic heat energy is radiated away. A scalar EM interferometer/howitzer, however, may produce an endothermic explosion (an energy implosion) at a distance, explosively extracting the heat energy at the implosion site and receiving the energy back at the transmitter site for disposal.

The same LW interferometer can also produce an exothermic explosion in the distant interference zone, merely by positively biasing the electrical chassis grounds of the scalar EM potential transmitters and pulsing the transmission. Negative biasing of the transmitters' electrical chassis grounds and a pulsed transmission result in an endothermic explosion in the distant interference zone.

ENDOTHERMIC LONGITUDINAL EM WAVE INTERFEROMETRY

Extraction of EM energy from a distant intersection area by a scalar interferometry whose electrical grounding is biased well below the ambient potential in the distant interference zone.

The result is a cooling of the interference zone, and heat energy emerging at the transmitters.

ENERGETICS

The Russian term for what I have called advanced higher-symmetry electromagnetics,

...using artificially constructed Whittaker internal biwave structures to make activated potentials that have specific, desired "vacuum engines", where the EM field is a curvature of spacetime function, and thus involving a unified field theory that is engineerable by novel electrodynamic means.

I believe that the closest Western work approaching the Russian energetics science is the O(3) higher symmetry electrodynamics pioneered by Evans, particularly when combined with Sachs' unified field theory as an important subset. The other closest Western work would seem to be the important work of Barrett in SU(2)×SU(2) symmetry electrodynamics.

The activated potential containing the infolded vacuum engine structures is said to have been *dimensioned*. These dimensioned potentials can be combined to form EM carrier waves which contain the hidden vacuum engines. These vacuum engines, scalar Whittaker EM interferometry, and activation of vacua and matter are used to perform unified field engineering.

Russian energetics also adds the formation and use of the quantum potential, enabling
(i) instantaneous action at a distance with multiple separated target nodes, (ii) essentially limitless direct energy amplification in the assembly of receiving nodes, without additional energy input at the initiating node, and (iii) engineering of hidden variables inside distant targets, instantaneously, without transmission *as such* through space. The quantum potential itself can be *dimensioned*, so that vacuum engines can be instantaneously transmitted into distant targets, altering their local spacetimes to contain the desired engine(s). Note that no intervening barrier can "impede" or "shield" a quantum potential because it does not travel through space as such; it just appears everywhere at once in the space where it will be.

Adding to classical EM theory, general relativity, and quantum mechanics the internal EM energy in the scalar EM potential will generate a superset of each discipline. These three new supersets are unified in their common internal EM energy subset. As a bonus mind, personality, memory, and deep biological cellular and system control are also available, since the internal time-energy domain is used by biological systems for these living functions. Energetics thus is an engineerable, unified field theory of physics and metaphysics.

Russian energetics is largely still a "secret" science, developed over the last five decades and highly weaponized. In the Russian scheme the overall area is called *energetics*. It consists of three subsets: (i) *energetics*, which applies to nonliving systems, (ii) *bioenergetics*, which applies to the physical bodies, cells, chemistry, genetics, etc. of living organisms, and
(iii) *psychoenergetics*, which applies directly to the minds, personalities, memories, emotions, and perceptions of living systems. Russian energetics research, development, weapons, and weapon sites are under the rigid control and operation of the KGB, by whatever name it may use from time to time. The energetics weapons are not in the regular Russian armed forces. Energetics weapons have been tested worldwide for several decades, and this testing has been documented elsewhere by the present author.

ENERGY

Usually erroneously defined as the "capacity to do work".

The closest definition is: *The invariance of that which is varying*. Note that this is a 5-law logic definition and not an Aristotelian definition.

Here we have a real bucket of worms. This term is usually totally misdefined (as in the nostrum that "energy is the capacity to work") in physics, which defines energy as the "ability to scatter itself or change its own form" which obviously are not identities! A common definition is given as "a quantity that describes the capacity to do work; commonly divided into three major classifications: kinetic (dynamic) energy, potential (static) energy, and radiant (electromagnetic) energy. Well, energy can be changed in form and that is work. But energy is not the "capacity to change its own form", but is its own form, as can be seen.

Anyway, we'll have a go at a definition perhaps a little more acceptable, though still imperfect. Then we'll discuss things a bit.

Rigorously, energy is any deterministic or coherent structuring, either dynamic or stationary, existing in the virtual particle flux of vacuum. While that *sounds* good, it is still "the invariance of that which is varying." Ultimately, a thing is defined in terms of its appositive.

The *type* of energy depends upon the type of virtual particle(s) whose flux is selected. E.g., electromagnetic energy is a deterministic or coherent structuring, either dynamic or stationary, in the virtual *photon* flux of vacuum. Any trapped energy (ordering in the vacuum virtual particle flux) is gravitational in nature, since trapped energy is gravitational. In a mass, e.g., it is the trapped energy that is gravitational, not the mass per se, in the modern view. Contrast the definition of electromagnetic energy to the definition of an electrostatic scalar potential (ESSP): The electrostatic scalar potential is a stationary trapped deterministic or coherent dynamic wave-structuring of the virtual photon flux of vacuum. Thus it can be seen that the ESSP is a special case of EM energy: the stationary trapped case. For this reason, a mass—which is an enormous amount of statically trapped EM energy—may properly be considered as an extremely dense EM potential, which we refer to as the *mass potential*.

A potential is any trapped ordering or coherence, either static or dynamic, in the virtual particle flux of vacuum. A specific type of potential represents a selection of a particular virtual particle's flux in the vacuum, and an ordering—either static or dynamic—imposed in that flux.

However, since the scalar potential is just the static ordering in the virtual particle flux of vacuum, it follows that the scalar potential must contain—and in fact be totally composed of—internal order. E. T. Whittaker showed the form of that order in 1904. (See entry under Whittaker, E. T.) The scalar potential is composed of a harmonic series of pairs of antiparallel transverse waves. The antiwave of each wave/antiwave pair is a time reversed replica of the wave in that pair. In other words, the scalar potential is a special type of Fourier harmonic frequency expansion, coupled with its own phase conjugate present simultaneously.

Feynman said it bluntly: *"It is important to realize that in physics today, we have no knowledge of what energy is."* [Richard P. Feynman, Robert B. Leighton, and Matthew Sands, **Lectures on Physics**, Addison-Wesley, Reading, MA, Vol. 1, 1964, p. 4-2.]

E.g., particularly see R. B. Lindsay, "The concept of energy and its early historical development." **Foundations of Physics**, 1(4), 1971, p. 383-393. Lindsay investigates the concept of energy from its early historical origin. The root of the concept is the notion of *invariance in the midst of change*. Lindsay covers the concept and its evolvement (or lack thereof!) from ancient times through the 18th century.

The real problem is that the notion of energy implicitly involves the age-old unresolved philosophical problem of change, posed by Heraclitus over 3,000 years ago and unresolved to this day. *It cannot be solved within the realm of 3-law Aristotelian logic!* One way of posing it is something like this, after Heraclitus: "For a thing to change, it must turn into something else. How can a thing be itself and something else also? How can a thing have changed, and yet not have changed?"

The problem is that Aristotelian logic has a serious flaw of omission; it actually *implicitly assumes* a fourth law, which is the age-old philosopher's nightmare that, when a thing is pursued to the limit, *it invariably turns into its own opposite*. So in anguish the philosophers spoke of this nightmare as the "accursed necessity for the identity of opposites."

I did resolve the philosophers' nightmare some years ago, by adding a fourth law of logic to the Aristotelian three, which completes and extends Aristotelian logic, and an application rule which can be taken as a fifth law. E.g., see Appendix III: "A Conditional Criterion for Identity, Leading to a Fourth Law of Logic," in T. E. Bearden, **AIDS: Biological Warfare**, Tesla Book Company, Chula Vista, California, 1988, p. 428-443. A simple proof of the fourth law is given in that paper. For a much more elegant treatment of a higher topology logic, which is also practical and useful beyond the limitations of Aristotelian logic, see G. Spencer Brown, **Laws of Form**. Julian Press, New York, 1972. For a proper perspective on mathematics and on Aristotelian logic, see Morris Kline, **Mathematics: The Loss of Certainty**, Oxford University Press, New York, 1980.

It may be that, since by "identity" we mean at least the identity of "left" and "right" different observations, considering the left and right sides of the identity statement. If so, then already we involve a violation of Aristotelian logic in the very notion of "definition". In short, ultimately we can only define a thing in terms of an appositive in the first place. So we write an identity statement where left and right are different sides, then state "Oh, no, they are the same thing after all!" Said in that manner, the problem can clearly be seen. In one sense a definition is pure Zen, where no truth can be stated at all unless the speaker says two exactly opposing things, and then waits for the recipient to realize the truth that has been stated.

What this all means is that, since "energy" (and any other definition, ultimately) involves a logical contradiction in Aristotelian logic, we must "define" *energy* simultaneously in an appositive ways: (i) in the wave view and (ii) in the particle view. However, we point out that the notion of a "moving particle" is the notion of something considered momentarily as fixed (i.e., the particle), but which is immediately thereafter (in time snapshot #2) considered as moving. Notice that "moving" is changing, and so it involves Heraclitus' problem of change *a priori*. The notion of a "moving wave" is also a similar thing; i.e., "a wave" momentarily considers the entity as static and not changing (in time snapshot #1), and in the next moment (time snapshot #2) considers it as moving (changing). We can only point out this dichotomy for the reader to reflect upon and hopefully to grasp. *The conscious mind is a serial processor; it is extremely fast but still perceives snapshot by snapshot, serially. It essentially has been fitted to the single photon interaction, as has Aristotle's three laws of logic*. The problem is in the operation of conscious perception itself, not in nature which is not limited to just serial processing.

The unconscious mind is a massively parallel processor, so it can have many "different slides or snapshots in the slide projector" at the same time. So with our conscious mind's perception (Aristotelian logic is just a model of that, using single photon interaction as the physical observation mechanism) we see in terms of "either-or". On the other hand, with our unconscious we can also grasp the fact that single snapshot A can be the same thing as a totally different snapshot B, if the rules of "decision as to identity" are changed between snapshot A and snapshot B. Suppose that by "identity" we mean "incapable of being discriminated between." Is a black marble identical to a red marble, e.g.? It is perceived so if you are color blind. It is perceived not to be identical if you are not color blind. The point is something that most philosophers missed or brushed aside: identity is not absolute, but is "perceived identity". Identity is the result of a decision operation, based on multiple perceptions, recall from memory, and comparison of two remembered perceptions. The most simple form of comparison is simple subtraction.

The unconscious (massively parallel) perception can handle both snapshots simultaneously. The conscious mind only can see a single marble at a time, so it will see one or the other. In a *third* time interval it will recall from memory the first perception, compare it with the memory of the second perception (say, by simple detailed subtraction), and then decide whether object A is perceived to be identical to object B. The unconscious (massively parallel processor) can handle both the marble snapshots at the same time. It can see both the identity of the two, to a color-blind "identity decision process" and also the nonidentity of the two, to a color-sensitive "identity decision process." Again, nature is not limited to the single-snapshot, serial perception process of our conscious (serial) processor!

Unfortunately, in physics and mathematics we seem to still be thoroughly confused on this very perception issue. Brown's work may be the first work to straighten out the area of the topology of the logic utilized. My own independent effort was successful but far cruder than Brown's; Brown did it elegantly. We bring all this out because when one deeply looks into foundations and true definitions, one will directly confront the philosopher's nightmare and one's own conscious mind will never be able to resolve the problem. One's unconscious can resolve it, but it requires a certain "stretching of the realization" to harmonize monocular perception of the conscious mind with multiocular perception of the unconscious mind.

Just as a small example, the question of "is it a wave or a particle" once raged as a great debate in physics, and was never resolved. Instead, physicists just finally shook hands and agreed to quit arguing and fighting about it, and agreed to accept that the same entity could sometimes act as a particle, and in other cases it could act as a wave, and that *as it existed in the present, before observation,* it was somehow both a wave and a particle but we couldn't see its true nation (in that fashion). The key, of course, is that the question was posed in "either-or" form (Aristotelian logic form), and it cannot be answered in that reduced logic. Instead, a higher topology logic is required. Brown's logic answers it easily, as does my own four law superset of Aristotelian logic (five law superset if we count the application rule as a separate law). In the present, e.g., we have masstime and not mass. Just after a photon is emitted, we have mass and not masstime. The latter photon emission process consummates "observation." The point is, the true entity does exist in zero time as a spatial entity. It is not a spatial entity but is a spatiotemporal entity. If the "interaction" process tears off its "time-tail," it is converted to a "spatial entity" (frozen snapshot) and therefore seems to be a particle. If the "interaction" process does not remove the time-tail, it remains a spatiotemporal entity and therefore seems to be a wave. The *concept* of particle is 3-spatial concept. The concept of wave involves time also. No wave can exist and "be a wave or wavelike" unless it has some time extension to "be waving" *in*!

The physicists debating the wave-particle duality, you see, missed the most important point that *no observable exists in time or persists, a priori.* Hence rigorously no particle exists in time.

So we define energy (particle view) as any virtual particle flux pattern, where that definition automatically considers a single particle in translation as well as multiple particles in their myriad of translations. We define energy (wave view) as any wave flux, where that automatically considers a single wave in translation as well as multiple waves in their myriad of translations. Now note that one is going to have to deal with, and discriminate between, energy, energy flow, energy collection, and collected-energy dissipation.

As the reader can see, whenever one struggles with foundations issues, the problems get very complicated. We've beat this dead horse quite enough, and leave the further beating to the reader!

ENERGY AMPLIFYING COIL

A coil whose magnetic energy flow input is first split into two energy flow inputs, each equal to the original energy flow available from a magnetic source. Both the split energy flows then interact simultaneously with the coil, amplifying its electrical energy output compared to the conventional case where only a single energy flow interacts with the coil.

In the motionless electromagnetic generator (MEG), the curl of the magnetic vector potential of a permanent magnet (i.e., its magnetic field), is extracted and held within the core material of a special transformer, while the magnetic vector potential of the

permanent magnet is freely replenished in uncurled (field-free) magnetic vector potential form in space around the core material. Both the full magnetic field in the core and the full uncurled magnetic vector potential in space adjacent to the core interact with each output coil of the transformer. Hence a single potential energy flow is "split" into two flows each equal to the original EM energy flow, and both the parallel flows energetically interact with the output coil. This increases the energy interacting with the coil by this "dual interaction", so that the coil is said to be an "energy amplifying coil".

ENERGY COLLECTION/COLLECTING

In electromagnetics, exposure of an interceptor/collector, e.g., a charged particle, into an impinging EM energy flow, so that some of the flow is diverted around the intercepting particle. We may say that the flow of energy has been "reordered" in a stream around the diverting charge.

Energy collection is not a thing which "has been accomplished" and finished; instead, it is an ongoing process.

Note now that, if you perform or consider or impose any sort of ordering at all in the energy flow/flux, rigorously you have just implied an *energy collection/collecting* process. The energy part of a photon, e.g., would seem not to be "energy" per se. Instead, it is an energy collection/collecting, and a time collection/collecting as well. Yet that energy part is energy also! [Not to worry! Energy and energy-collecting, contrasted as appositives, become identities at the extreme boundary separating the two concepts. That boundary is the photon concept. Aristotelian logic does not apply on the boundary, which violates the Aristotelian law of the excluded middle.] More reasonably, a charged capacitor does not have "stored energy" per se in it, in the sense of "so many chunks of energy called joules". Instead, it has an *ongoing energy collection/collecting process*, where the asymmetry in the local vacuum flux exchange, of the dipole across the capacitor plates, continually extracts and "gates" a flow of EM energy from the capacitor dipole. That energy-flow bathes all the trapped charges in the capacitor. The energy-flow interaction with the trapped charges creates the
E-field and all the rest.

The diverted part of the total energy flow, is what is calculated in the "Poynting flow" or
S-flow.

ENERGY, DISINTEGRATED

An ad hoc term for the energy of the incoherent virtual particles in the virtual particle flux.

ENERGY DISSIPATION

Refers to the scattering or disordering of energy.

This is somewhat of a misnomer, broadly used in physics and somewhat erroneous.

Energy dissipation" *per se* does not mean that the energy is destroyed. Instead, there is the dissipation of the ordering (*collected/collecting*) of energy in which the diversion (local ordering) process disappears. What we call the "dissipation in space" of energy is rigorously the dissipation of the collection/collecting in space of the energy. In short, the energy is scattered, as in a resistive load, in all directions. But it is still there in space, just disordered.

Recall that all EM energy at a dipolarity comes directly from the time domain. It is the collecting process, not the energy, that is dissipated from a point or a region. Only *collected/collecting* of energy can be truly dissipated. With that understood, then dissipation of collected energy is simply removing the "collector" from the energy density flow impinging upon it to cause the collecting process to occur, or removing the flow of energy impinging upon the collector so that it intercepts and diverges some of it around itself.

So there are two ways in which this "collected energy" dissipation can occur: (i) the collector is moved out of the impinging energy-flow-stream, or (ii) the energy-flow-stream impinging on the collector is reduced to zero. Note that "changing the form" of the energy—i.e., changing the collector and the type of collecting—involves both conditions (i) and (ii). Thus energy is dissipated when the *collector/collecting* form is changed. In the conventional, less accurate statement, work is performed when "the form of the energy is changed." That now should be stated as "work is performed when the collector in the energy-flow-stream is changed to a different collector, because the first collector must be removed from the energy-flow-stream or the energy-flow-stream must be removed from it.

In physics we also consider that "positive" work by a body is work it does on something else, while "negative" work is work done upon the body by something else. We specifically emphasize that collection/collecting need not be a unitary, one-time occurrence! The EM energy-flow impinging upon a collector roars on by it at something like the speed of light. The entire flow is diminished by only about 10^{-13} (the nominal energy collecting fraction) as it flows onto, and on beyond a coulomb of charge. If that departing energy-flow is then retroreflected or otherwise *returned* to pass back through again, additional energy collection/collecting can and does occur from it. This can be repeated many times, particularly in an intensely-scattering, optically active material. Also, after the collected fraction of energy is dissipated, we can also retroreflect the scattered energy flow back and reuse it again. This too can be repeated many times.

So we must be careful of the present *work-energy theorem*, which is a special case and assumes only a single pass of the energy-flow in the "collection/collection" of energy that "changes form." If we institute additional passes, with additional "collection/collecting of energy, then we can collect and "use" a little more energy from all that enormous energy-flow that otherwise would escape us. If we dissipate some of the collected energy, then also intercept the departing dissipated energy flow and return it, we can collect some of the energy flow again and then dissipate that new collection again. And so on.

One can permissibly get many joules of "work" from a single joule of energy by iterative retroreflection, iterative re-collection, and iterative dissipation, without violating the conservation of energy law. This is one of the major secrets of overunity energy processes. It is proven by the overunity or excess emission (Letokhov was forced to call it "negative absorption of the medium" from an intensely scattering, optically active medium, as in the Lawandy experiment and in his patented process for lasing without population inversion. It is also proven by Patterson's adaptation of anti-Stokes emission.

Let's do a gedanken (thought) experiment, where we do not even apply the nominal 10^{-13} energy collection fraction. Let's just *conventionally* say "energy flow," "energy collection," and "energy dissipation," and ignore the "collection fraction." Since we are talking theoretically, we can have a perfect system. So we have a closed system, which we open to input some energy into. The system then opens in the load to dissipate all the energy back to the environment, thereby doing work. Now suppose I passively (i.e., without any input energy of my own, by perfect retroreflection) return all the dissipated energy back to the input once again. We simply let it flow back in, the system collects it again, and then dissipates it again—giving us the same amount of work we had the first time. Then we do it again. And again. I think you get the picture. The fact that energy can neither be created or destroyed, but only changed, means that the "same energy" can be *recycled* over and over. One has to have two different actions: one that changes the form of the energy so we get some work, and the other that retroreflects and recovers the dissipated energy (does negative work!) so that we can recycle it and dissipate it again. In principle, by recycling of energy one can get many joules of work from a single joule of energy. Nature does it every day! Every joule of energy formed at the initial

"Big Bang," is still with us. Every joule of it has on the average already performed many joules of work since then. And as we stated, the anti-Stokes emission process is a concrete example and demonstration that the energy recycling process can be accomplished in physical systems, so that the systems permissibly exhibit COP>1.0.

A most common example is the replenishment of a potential. E.g., the magnetic vector potential can be curled as a **B**-field, and that **B**-field can be totally confined inside a toroid, inside a long coil, or in certain magnetic core materials (as in the motionless electromagnetic generator or MEG for short). The **A**-potential will be replenished as fast as you withdraw the "total **B**-field" from it. So outside the toroid or the long solenoid, you will have as much **A**-potential energy as you started with, and the Aharonov-Bohm effect proves that the energy is there and will interact with electrons. Meanwhile, in the trapped **B**-field you also have drawn off as much energy as ostensibly the **A**-potential contained in the first place.

ENERGY, ELECTROMAGNETIC

Any deterministic or coherent structuring, either dynamic or static, existing in the virtual photon or charged particle flux of vacuum.

Note that, since a photon may also be considered a positron-electron pair, the flux of charged virtual electrons and positrons is included in the flux of photons.

ENERGY FLOW

The passage of energy, in any form, in one direction or generally in one direction.

Even though this "definition" is in error, we now just bypass the unresolved "observables do not persist" problem and the 4th law nature of change (e.g., motion) problem and proceed.

Note that this energy flow may be the overall movement of an omnidirectional energy flux, or it may be the movement of waves, or both. It may be in the kinetic energy of a moving mass. If the flow is everywhere the same, or even approximately the same, we often speak of the entire "flow" as just "energy." Often energy flow is also considered to have occurred from a region of more intense energy flux to a region of less intense energy flux, and vice versa. In other words, energy divergence or convergence is also considered as energy flow. As can be seen, *the usage of the term "energy flow" is not precisely defined in physics! It isn't going to be, at least not in ordinary Aristotelian logic terms.*

ENERGY FLUX

The passage of energy flow, in any form, through a unit area, and in any direction (usually all directions).

This includes both passage in a single direction, or passage in multiple directions at once.

ENERGY, FREE

Any environment or entity which freely emits, furnishes, or makes available energy which can be either collected and used as furnished or transduced into usable form and collected and used to power loads and do useful work.

The word "free" does not apply to costs, but rather to the source of the energy. Of course the ideal is energy that is both free for the taking (collecting and using) and also inexpensively taken and used.

Implicit in the notion of free EM energy from the vacuum are five key concepts: (1) the local vacuum/spacetime itself is filled with EM energy of generally unusable form, (2) some sort of organizing principle is utilized in one part of the circuit or system to cohere the vacuum energy and transduce it into usable EM form, (3) a gating mechanism is utilized to divert the vacuum energy in transduced usable EM form from the active vacuum to the external circuits or load parts of a device, (4) the coherent gated extra energy available in the external circuits or load parts is intercepted by those circuits or load parts, couples to them, and potentializes them with extra EM energy, so that the energy is collected by the system and regauges the system asymmetrically, and (5) the external circuits or load parts then scatter or dissipate the coupled extra energy to produce useful work, without destroying the organizing and gating mechanism that is extracting and furnishing usable EM energy from the vacuum.

ENERGY SOURCE

A function or entity which furnished energy.

Since energy cannot be created or destroyed, there is really no such thing as a "source", though it is a term commonly used. So called "energy sources" actually gate energy, changing it from one form to another. As an example, all 3-space EM energy is gated into 3-3-space from the time-domain. To the gating entity or "source" of the 3-space EM energy, there is an input of EM energy flow from the time domain (complex plane). The source must be a broken 3-symmetry in energy flow, so that more primary 4-symmetry energy flow applies. Hence the conservation law applies to the inflow of energy from the time dimension and the outflow of energy in 3-space.

ENGINEERING, ENTROPIC

Engineering or designing systems and processes whose operation "spills" or wastes some energy.

Entropic systems—which are the products of entropic engineering—thus have COP<1.0 and function in forward-time.

ENGINEERING, NEGENTROPIC

Engineering or designing systems and processes whose operation freely "receives" excess energy, so that they output more energy than the operator inputs, the excess being received from the external environment or other source.

ENTROPY

Thermodynamics term representing a measure of a system's capacity to undergo spontaneous change. In short, a quantity which measures the extent to which the energy of a system is unavailable to do work.

Entropy is given by $dS = dQ/T$, where dS is an infinitesimal change in entropy for a system absorbing an infinitesimal quantity of head dQ at absolute temperature T. In statistical mechanics, entropy is a measure of the disorder in a system and is given by $S = k \ln P + C$, where S is the value of entropy (disorder) for a system in a given state, P is the probability of that state's occurrence, k is a fixed constant, and C is an arbitrary constant. Intuitively, the concept of entropy corresponds to the concept of disorder. We specifically call attention to the fact that the "S" used in representing entropy is not at all the **S** used for Poynting flow.

In physics, a measure of the randomness or disorder of a system. Given by S = k ln g, where S is the entropy, k is the Boltzmann constant, and g is the total number of microstates available to the system. Sometimes stated as S = k ln (multiplicity).

Intimately connected with the Second Law of thermodynamics, which may be stated for the macroscopic case (after Baierlein) as follows: "If a system with many molecules is permitted to change, then—with overwhelming probability—the system will evolve to the macrostate of largest multiplicity and will subsequently remain in that macrostate. Stipulation: allow the system to evolve in isolation. (The stipulation includes the injunction, do not transfer energy to or from the system." [Ralph Baierlein, Thermal Physics, Cambridge University Press, Cambridge, 1999, p. 29].

ENTROPY, NEGATIVE (NEGENTROPY)

In a sense, the reversal of disorder, or reversal of entropy.

Since the normal or forward flow of time is entropic, negentropy is intimately related with time-reversal. This can be seen crudely this way: As a physical thing exists in time, it decays, ages, deteriorates, etc. In short, its ordering as a viable separate thing gets more and more disrupted. If it is then "reordered" precisely back to its original state, that is obviously a time-reversal of that entity.

Since the production of energy is connected to the production of more ordering, then it would seem to follow that any negentropic process also produces more energy. Or, that production of excess energy accompanies a negentropic process, and vice versa.

When we factor in the giant negentropy process, it is seen that all EM spatial energy comes from the time domain, via the broken 3-symmetry of the source charge or source dipole. Here we have a pure negentropic process. Hence we may now advance a new definition of negentropy for electrodynamics: *negentropy is the direct and ongoing conversion of time-energy (time-structuring and time-ordering) into 3-space EM energy*. Dipolarity (polarization) is the process initiating and producing the negentropy. Polarization is accompanied by ongoing negentropy so long as the polarization persists.

Another way of defining negentropy even more rigorously—for electrodynamics—is to define it in spacetime as a *broken 3-symmetry in EM energy flow with concomitant relaxation to a more primary 4-symmetry between time-energy flow and 3-spatial EM energy flow*, *where time-energy flow is transduced into 3-spatial EM energy flow.*

When a system with one measure of multiplicity progresses to a state with a decreased measure of multiplicity; i.e., when its total number of microstates decreases in the transition. A nonequilibrium steady state (NESS) system can exhibit negative entropy, and the entropy can further decrease progressively toward negative infinity as time passes. [D. J. Evans and Lamberto Rondoni, "Comments on the Entropy of Nonequilibrium Steady States," *J. Stat. Phys*., 109(3-4), Nov. 2002, p. 895-920]. Note that the Second Law of thermodynamics only rigorously applies to an isolates system, where neither mass nor energy crosses the boundary of the system. In the NESS system, that prohibition is violated, hence the second law need not apply. The common source charge is an example of such a NESS system continuously producing negative entropy, because it absorbs virtual energy from the vacuum, transduces it into observable energy, and re-emits the energy as observable photons radiating at light speed in all directions and forming the associated EM fields and potentials and their energy.

ENTROPY (POSITIVE)

When a system in a state with ordering progresses to a state with less ordering, i.e., when its total number of microstates increases in the transition.

ENZYME

Any of various proteins or conjugated proteins (compound of a protein and a nonprotein) produced by living cells, that serves as a catalyst for specific biochemical reactions at body temperatures.

EPIDEMIOLOGY

The study of the various factors influencing the occurrence, distribution, prevention, and control of disease, injury, and other health-related events in a defined human population.

EQUILIBRIUM

In physics, the state of a system in which opposing forces balance each other; i.e., sum to a vector zero.

In mechanics, a system of particles where the net force acting upon each constitutent particle is zero.

In chemistry, the state of a solution where the forward and reverse reactions are equal and balance each other, so that the chemical reactants and products maintain the same amounts.

EQUIVALENCE PRINCIPLE (PHYSICS)

One of the principles of relativity theory. The mass of the body determined by using the gravitational force on it to measure the mass, and the mass of the body determined by using inertial force on it to measure the mass, yield equal measurements for the mass.

ETHER

An extremely fine substance theorized to exist in space in lieu of sheer emptiness.

Discussed by Tesla, Einstein, Whittaker, and others. Originally conceived as the luminiferous ether, a thin material fluid pervading all space. Maxwell, e.g., believed in this material ether, and formulated his theory accordingly. Thus he mistakenly provided forces in the vacuum, which forces require a material vacuum. I.e., mass is a component of force; there is no force without mass, since $\mathbf{F} \equiv d/dt(m\mathbf{v})$. The hoary old medieval notion that a separate force acts upon a separate mass that it affects, is completely in error, though still utilized in mechanics! Modern field theorists know better, but correction of this massive error in physics has not been widely accomplished.

Originally, the ether was seen as a ghostly-thin, *material*, fluid medium postulated to fill space and carry electromagnetic waves, similar to the way in which a gas carries sound waves. Faraday and Maxwell added the assumption that EM fields existed as material taut strings (Faraday's lines of force) with conveniently missing endholders to provide the tension on the strings. The Michelson-Morley experiments eliminated any such material ether, but not a Lorentz-invariant nonmaterial ether (of which

vacuum itself is one example, in the modern view). Maxwell's equations were derived from a mechanical ether theory. Einstein once proposed that the vacuum, complete with its electromagnetic fields, should be called the new *ether*. In our own approach we have come full circle back to Einstein's suggestion, since the so-called "fields" are really just curvatures of spacetime and are included in our use of the vacuum as a giant potential comprised of virtual particle flux. The Sachs unified field theory, I believe, is the best available, particularly when the Evans O(3) symmetry electrodynamics is included as a special subset of it. In my own view, I regard "vacuum potential" and "spacetime" as essentially identities. Thus both the vacuum potential and spacetime have further internal structuring and dynamics. In relativity, this view is akin somewhat to the notion of "subspace" used on the Star Trek series.

Today the word "ether" is again acceptable in the literature when used in context of its modern quantum mechanical meaning. The "ether gas"—the quantum mechanical vacuum—is considered to be composed of virtual particles. The particles spontaneously come into being and then vanish so quickly they cannot be individually detected. That is, today the ether is regarded as a sort of specialized virtual particle gas—sort of a gas of "effervescent energy bubbles", so to speak—where the individual particles are continually being created and annihilated at a fantastic rate.

A good reference on the modern view of the vacuum is I. J. R. Aitchison, “Nothing’s plenty: The vacuum in modern quantum field theory,” **Contemporary Physics**, 26(4), 1985, p. 333-391. For an O(3) treatise, see M. W. Evans, P. K. Anastasovski, T. E. Bearden *et al*., "Derivation of the Lehnert field equations from gauge theory in vacuum: Space charge and current," **Foundations Of Physics Letters**, 13(2), Apr 2000, p.179-184. It is shown that the Lehnert field equations in vacuum, with concomitant space charge and current, can be derived straightforwardly from standard gauge theory applied in vacuum, using the concept of covariant derivative and Feynman's universal influence. The Lehnert and Proca field equations are shown to be inter-related through the well-known de Broglie theorem, in which the photon mass can be interpreted as finite. These ideas go some way towards addressing the inconsistency inherent, in Maxwell's famous displacement current, which has no concomitant vacuum space charge.

For technical insight into the attributes for extracting EM energy from the vacuum, see particularly M. W. Evans, P. K. Anastasovski, T. E. Bearden *et al*., "Classical electrodynamics without the Lorentz condition: Extracting energy from the vacuum," **Physica Scripta** 61(5), May 2000, p.513-517. It is shown that if the Lorentz condition is discarded, the Maxwell-Heaviside field equations become the Lehnert equations, indicating the presence of charge density and current density in the vacuum. The Lehnert equations are a subset of the O(3) Yang-Mills field equations. Charge and current density in the vacuum are defined straightforwardly in terms of the vector potential and scalar potential, and are conceptually similar to Maxwell's displacement current, which also occurs in the classical vacuum. A demonstration is made of the existence of a time dependent classical vacuum polarization which appears if the Lorentz condition is discarded. Vacuum charge and current appear phenomenologically in the Lehnert equations but fundamentally in the O(3) Yang-Mills theory of classical electrodynamics. The latter also allows for the possibility of the existence of vacuum topological magnetic charge density and topological magnetic current density. Both O(3) and Lehnert equations are superior to the Maxwell-Heaviside equations in being able to describe phenomena not amenable to the latter. In theory, devices can be made to extract the energy associated with vacuum charge and current. More than a dozen ways to approach extracting EM energy from the vacuum are presented.

EVANS, MYRON W.

Noted chemical physicist, primary developer of O(3) symmetry electrodynamics, and Director of the Alpha Foundation's Institute for Advanced Study (AIAS).

Under Evans, the work of the AIAS has made enormous contributions to physics and particularly to the extraction of usable EM energy from the vacuum. In the opinion of the present author, Evans is perhaps the single most important scientist in the Western world in the emerging field of electrical energy from the vacuum and in solving the world energy crisis.

EVIL

Refers to an act or acts perceived to be detrimental to the receiver or referent, in the positive time stream.

Oddly, the chain of events perceived to involve "evil" to a referent in the forward time stream, would be perceived to be equally *beneficial* to the referent, viewed in the *negative* time stream. In other words, evil in general is a synthesis of the results of observed actions or acts in the *forward time motion*, hence it is conjugated when time flow is reversed.

This is not just an idle question. In our physical body, the photon interaction with the electron shells of the atoms in the body largely determines the observed forward movement of one's material body through time. The conscious mind, fitted to the single photon interaction, thus perceives its "existence" in such terms. Meanwhile, in the nuclei of the atoms of our material body, the charge and hence the field interactions are reversed (giving Newton's third law reactions). That of course is a time-reversed flow of events, not sensed by our conscious mind, but possibly sensed by our deep unconscious mind. The question then arises, "Do we then actually exist both forwards and backwards in time?" In terms of good and evil, if the answer is yes, then this would have profound implications to theology and to the study of human consciousness.

Theologians (and philosophers) have pondered the "nature" of good and evil for literally thousands of years, and have reached no truly firm conclusion to date. The sticking point (theologically) seems to be the puzzle of a perfect, "all good" creator who had to have created evil also (since the Creator is axiomized to have created all). To the question, "How could a perfect Creator have created—or even tolerated—evil?", theologians have yet to find a satisfactory answer. Neither could they find a satisfactory answer to the question of, "How can the Creator, being all-just, and being all-powerful, then allow any evil act to occur?" In short, why does the Creator seemingly not "police up our perceived imperfections in the creation?" In short, theologians struggled with a formidable problem of how to justify the Creator's continued tolerance of evil, even for a moment.

There is no satisfactory answer to such questions, of course, in 3-law Aristotelian logic, because they are four-law logic situations. However, since the 3-logic is incomplete, one should examine the question in 4-law logic, and also in light of one's assumptions regarding the existence of the Creator. The question is unresolvable in 3-law logic and with the assumption of a Creator traveling through time, as we perceive ourselves to do. However, if time itself is a creation, then the axiomized Creator may be more properly axiomized as existing both in and outside time, and "everywhere in time at once" as well. The unlimited Creator must even be postulated to be able to "both be and not be simultaneously; if He cannot do that little trick, He has a limit." That trick must be allowed, else the Creator has a limit and is thus imperfect. But to such an axiomized Creator "permeating time everywhere at once, from beginning to end, which shall be the "beginning" and which shall be the "end?" And if we pick a beginning and an end, what shall be the "intermediate ordering" that we pick? There is no absolute position in either space or time to the "everywhere and everywhen at once" axiomized Creator.

The problem of good and evil then becomes a similar problem to the "wave or particle" question. Good and evil are two sides of the same coin, transposed one into the other by time-reversal. With respect to finite creatures perceiving themselves moving

forward in time, not existing in the future and not existing in the past, the question merely demonstrates that our perception itself is in error.

It may be, then, that there is a solution (whether one prefers it or not!) to such profound and ancient philosophical and theological problems in four-law or five-law logic. However, we will leave that question to the logicians and to the theologians to more properly decide.

EXCESS COLLECTED ENERGY

Collection by an interceptor/collector of a greater fraction of the EM energy flow impinging upon it, than is normal.

Any static electric or magnetic charge, e.g., with an EM energy density flow impinging upon it, has excess "energy collection" or "energy collecting" upon it, due to the altered vacuum virtual photon flux that is now exchanging with it. In a nominal electric circuit, e.g., a single "pass" of the EM energy flow from the source dipole, along the circuit conductors and across the conduction electrons, causes an "excess energy collection" upon the intercepting surface charges in the conductors. This potentializes the Drude electrons in the circuit and leads to subsequent dissipation in the loads (and losses) of about 10^{-13} of the EM nondiverged Heaviside energy flow that actually was extracted by the source dipole from the vacuum and sent down through space surrounding the conductors of the external circuit.

That is a single-pass energy collection fraction for a static charge. Almost all the Heaviside energy flow missed the circuit and passed on beyond the circuit "collectors" in one pass-by at essentially the speed of light, on out into deep space and beyond. On the other hand, if the already-passed EM energy flow is retroreflected, so that it returns for another pass along the circuit, then an *additional* amount of the repassing energy can be collected by those sluggish electrons. In a nominal circuit being used as an example, the electrons travel only about 5 or 6 inches per hour longitudinally down the conductors, restrained by the repulsion of the electrons beyond them. So *multiretroreflection*, *multipass*, *multicollection* can be used to provide excess energy and overunity efficiency. This is a change to the present statement of the work-energy theorem, which up to now has assumed single pass, single energy collection. The well-known anti-Stokes emission from certain highly scattering, optically active media, e.g., produces more energy radiating back out of the media than the amount of stimulating radiation energy input into the media. This is Letokhov's "negative absorption of the medium", which is really the excess emission from the medium due to retroreflection and multiple re-collections.

Also, if the intercepting charge is resonated, it sweeps out a greater geometrical cross section in the streaming energy flow, thereby diverging more and thus "collecting" more energy. In the Bohren experiment, e.g., this effect yields collection of some 18 times as much energy by the resonant charge as the same charge collects in static mode.

EXOTHERMIC

Giving off heat, or emitting scattered EM energy. Producing forward time energy.

FARADAY, MICHAEL

Noted English physicist and chemist, 1791-1867, who discovered field theory and electromagnetic induction. Faraday invented the dynamo also and formulated his laws of electrolysis.

His work directly inspired Maxwell, who vowed to study no other electromagnetics theory until he had captured Faraday's work in a mathematical theory.

FIELD

In mathematics, a set with two binary operations. In electromagnetics in more common terms, it is a region consisting of magnitudes and/or vector directions assigned to some active entity (spacetime itself) at each point in the region.

Designated addition and multiplication, satisfying the conditions that the set is a commutative group with respect to addition, that the set with the identity of the additive group omitted is a commutative group with respect to multiplication, and that multiplication distributes over addition for all elements in the set.

For our purposes, in plain language the fundamental notion is that a "field" is a sort of cleared, level space or region (e.g., in spacetime) where things can be placed and actions can occur amongst them, to them, on them, and of them. What the "place or space" is, can get a bit complicated, as can what is placed there and what actions are permitted. In short, we view a field as an altered (curved) region in spacetime, and this special curvature interacts with certain kinds of entities placed in that region. In return, those entities also interact back upon the spacetime curvature to alter it. Hence there is a dynamic two-way interaction between field and matter, where half of this interaction (the back-interaction of charge or matter) is missing from present classical electrodynamics.

EXOTHERMIC EXPLOSION

An explosion where ordinary heat and electromagnetic energy are released and radiate away from the explosive site. All normal explosions are exothermic.

Particularly used for a pulsed longitudinal EM wave interferometer, which in the distant interference zone (IZ) will produce a sudden eruption of scattering EM energy from the local spacetime curvature suddenly induced, when the interferometry transmitter chassis grounds are biased well above the ambient potential in the distant IZ.

FERMI LIQUID

A liquid where the individual particles or molecules comprising it are basically non-interacting, so that they can roam freely.

In an electron gas in a conductor, e.g., treatment of the free conduction electrons as a gas allows a theoretical modeling and explanation of conduction and resistance. Contrast to a Luttinger liquid, where the electrons interact with each other and thus enable the formation of collective phenomena.

FEYNMAN, RICHARD

Noted physicist, Nobelist, and co-developer of quantum electrodynamics.

Feynman is particularly noted for his refreshing three volumes of physics: See Richard P. Feynman, Robert B. Leighton and Matthew Sands, **The Feynman Lectures on Physics**, Addison-Wesley, New York, 1963. The book is particularly noteworthy in that it gives the student some insight into foundations problems in physics. E.g., in Vol. I on p. 2-4, Feynman defines the electric field not in terms of force per unit charge *per se*, but in terms of its potentiality for producing a force only when a charge is present for the force to be developed upon.

FEYNMAN DIAGRAM

A two-dimensional diagram of particle interactions, both in the virtual and observable levels, and both backward and forward in time and named after Richard Feynman who first employed them.

FIBER FUSE

Effect in fibers or fiber optic cable, whose core contains germanium, whereby heating the cable at one spot with a small flame will launch a focused traveling heat energy effect which melts a small hole in the core about every centimeter, and marches down the cable at about a meter per second to the end of the cable, destroying the optical transmission capability and ruining the cable.

Oddly, by igniting the fiber fuse from the other end of the damaged cable, a reverse fiber fuse effect will often march back down the cable in similar fashion except that it fills in the melted holes in the core, restoring the transmission capability of the cable.

If the energy required to melt all the holes (or fill them again) is taken into account, the amount of energy required to launch the fiber fuse is much less. This phenomenon does not appear to have an adequate technical explanation at present.

For an excellent description with photographs, see Ivars Peterson, “Fibers With Flare,” **Science News**, 140(13), Sep. 28, 1991, p. 200-201. For technical information and analysis, see D. P. Hand and P. St. J. Russell, “Solitary thermal shock-waves and optical damage in optical fibers,” **IEE Colloquium on ‘Non-Linear Optical Waveguides’**,” IEE Digest No. 88, London, England, 1988, p. 101-103; — Soliton-like thermal shock-waves in optical fibres: origin of periodic damage tracks," **Fourteenth European Conference on Optical Communication (ECOC 1988),** Sep. 11-15, 1988, Publication No. 292, 1(2), 1988, p. 111-114; — “Solitary thermal shock waves and optical damage in optical fibers: the fiber fuse,” **Optics Letters**, 13(9), Sep. 1988, p. 767-769; D. P. Hand and T. A. Birks, “Single-mode tapers as ‘fibre fuse’ damage circuit-breakers,” **Electronics Letters**, 25(1), Jan. 5, 1989, p. 33-34.

See P. St. J. Russell, “Power Conservation and Field Structures in Uniform Dielectric Gratings,” **Journal of the Optical Society of America A**, 1(3), Mar. 3, 1984, p. 293-299. Russell is actually referring to apparent violation of local conservation of energy. This would be indicated if the vacuum-to-mass interaction is not taken into account. Russell’s analysis therefore supports the fact that (i) the vacuum-mass interaction is required, (ii) the fiber fuse does utilize some of its gated vacuum energy (i.e., the usually non-diverged portion of the Poynting flow), and (iii) the fiber fuse is a legitimate, repeatable overunity process, although a "runaway" process, uncontrolled, and not sustainable.

FIELD

In physics, "a region of space marked by a physical property, as gravitational or electromagnetic force or fluid pressure, having a determinable value at every point in the region."

[Thanks to **Webster's II New Riverside University Dictionary**.]

Here one must *not* think of "space" as emptiness, as mathematicians do, but as a virtual particle flux, a dynamic entity, and as dynamic spacetime. A field then is a set of entities and their relationships and operations in a region of *that* kind of space, where the entities and operations are themselves "space stuff". They are all "virtual" in that they are not individually observable. However, their impact upon or interaction with mass—particularly charged mass—can be and often is observable, in that we can see some change of the mass (its direction of travel, translation, acceleration, deceleration, rotation, generation of current, etc.). If the entities are point-like and are naively supposed to have magnitude only, or if we only specify their energy density magnitude at each point, then that "marked space region" is said to be a *scalar field*. If the entities are point-like but have both magnitude and direction, they are said to be a *vector field*.

Further the deponent saith not because even the foundations physicists are in hot water in trying to define the field, and if the deponent saith more he will surely deep-fry in hot oil!

FIELD, SCALAR

A field, to any point of which is assigned a magnitude only.

FIELD, VECTOR

A field, to any point of which is assigned both a magnitude and a direction.

FLAT (UNCURVED) SPACETIME

A vacuum/spacetime whose virtual particle flux intensity—and therefore its local energy density—does not change as a function of spatial position or averaged time.

That is, a flat spacetime in my view is a quantum mechanical vacuum whose virtual particle flux and energy density are constant in magnitude and internal constitution with respect to spatial position and in averaged time. Note that a flat spacetime (vacuum potential) can still contain vacuum engines, and thus still be *dimensioned*. In that case, contrary to normal physics, the flat spacetime itself will still interact with an embedded object and change it, even though it may not translate it. To perform transmutation of elements, e.g., one is interested in just such engines and not in translating through space the element being treated. This dimensioning or activation of the local flat spacetime can result in an otherwise unexpected, seeming violation of one or more laws of nature in the dimensioned region.

FISSIONING, ACTION

The splitting of the action quantum into two canonical variables (for example, energy and time), only one of which can normally be completely detected or measured. ("Action" has the dimensions of angular momentum—energy x time, momentum x length, etc.)

Fissioning produces length, discrete bit by discrete bit, and time likewise. The physical reality of separated physical objects is thus continually created, discrete bit by discrete bit, monocularly. All that ever observably exists in the "present" is a single quantum change, just occurring. Recombining of the two canonical action fission fragments is called "fusion." Fusion also occurs monocularly, quantum by quantum. Rigorously, the physical world of separated objects never exists as such except in memory recall of vast numbers of past ordered quantum changes that occurred one by one.

FLUX

The amount of some quantity (such as energy, particles, volume of fluid, etc.) flowing across a given area (usually a unit area perpendicular to the flow) per unit of time.

The term flux density is now more commonly used. Loosely, "flux" refers to the perpendicular flow through an area, while "flux density" refers to the magnitude or intensity (rate) of the flux. In some cases such as a flux of particles of different velocities, the

number of particles may be multiplied by the average velocity to give an average flux density that is weighted.

FLUX DENSITY

The amount of some quantity (such as energy, particles, volume of fluid, etc.) flowing across a given area (usually a unit area perpendicular to the flow) per unit of time.

FOGAL, WILLIAM (BILL)

Soon-to-be-noted researcher and inventor of the Fogal semiconductor (two patents so far), as well as a superluminal infolding-outfolding communication system and other remarkable longitudinal EM wave processes.

I am happy to be a friend and colleague of Bill Fogal.

FOGAL SEMICONDUCTOR

A special semiconductor invented by Bill Fogal which, in its operational regime, utilizes an integrated semiconductor, tantalum capacitor, and feedback resistor to accomplish charge blocking (blocking of electron current flow dq/dt) while passing displacement current d/dt

The Fogal semiconductor can also accomplish amplified phase conjugation of signals as well as infolding (translation of input transverse EM waves to output longitudinal EM waves) and outfolding (translation of received input longitudinal EM waves to output transverse EM waves). Used in communication systems, it opens the use of the unlimited "infolded" electromagnetics bandwidth. Since it may communicate using longitudinal EM waves, it is also usable for superluminal or a specialized "tunneling" communication through the "interior" of normal EM waves, potentials, and fields.

See William J. Fogal, "High Gain, Low distortion, Faster Switching Transistor," U.S. Patent No. 5,196,809, Mar. 23, 1993; — "High Gain, Low Distortion, Faster Switching Transistor," U.S. Patent No. 5,430,413, July 4, 1995, a continuation of his earlier patent.

FORCE

In mechanics, identically the time derivative of momentum, or $\mathbf{F} \equiv d/dt(m\mathbf{v})$.

Simply, changing of the old concept of mass-motion. One must realize that it is not the mass in motion, but the single undivided quantity "mass-motion" or "mass-velocity" (momentum) that is changed. In short, $\mathbf{F} \equiv d/dt(m\mathbf{v})$. In present EM theory, force fields are erroneously taken to exist in empty, massless vacuum. However, the mechanical definition is an identity, not an equality. Thus force does not *separately exist in contact with* a mass, but *consists of* a changing "mass-motion." Since this force can be induced into and of the mass-motion target at a distance, in the new approach one is confronted with the fact that there is a more fundamental mechanism that produces force itself, and that is a curvature of spacetime.

Distant curvatures of spacetime to produce forces on exposed charged mass systems are also engineered by longitudinal EM wave interferometry.

FORCE FIELD

An effect that exists as a local vacuum virtual particle flux interaction upon and with a unit mass or unit charge whereby a particular type of matter is affected.

The force field has two components, one the mass and the other massless. In electrodynamics, one normally thinks (erroneously!) of the massless component, and refers to that component alone as "the force field." This considers the "force field" as a separate entity, acting upon a separate "mass." Whether it is logically correct or not, that is the prevailing way physics and electrodynamics uses it! So in this definition, let us momentarily accept the common incorrect usage, for convenience, while pointing out the real definition as we need to.

For example, conventionally the EM force fields can affect and change the state of motion of any charged particle or any magnetic particle. In classical physics, the force fields are considered the primary causative agents; when these fields are zero, then the motion of the particle or system is unaffected. Consequently, conventional EM theory assumes that all the EM phenomenology ceases once the force fields are absent. Today we know that is not true at all, as we explain in this glossary.

FORCE-FREE PROPAGATION

Propagation of force-free disturbances in the vacuum flux

(i.e., infolded inside the ambient vacuum potential, or inside a constant DC voltage.) Such "infolded" propagation is not limited to the speed of light, but may even travel in the Coulomb gauge so that it is instantaneous. More usually, it can travel superluminally. It may be regarded as a special form of "tunneling", which is known (both theoretically and experimentally) to produce superluminal propagation to the external observer. The music of Beethoven's 40th symphony, e.g., has been experimentally transferred between two points in a physical waveguide by such "quantum tunneling" at over four times the speed of light in vacuum.

We regard tunneling as moving in a sort of "subspace", i.e., within the internal structuring of spacetime itself. It is not limited by the speed of light and Einstein's postulate, which we believe only applies to signals moving in spacetime in bulk, and not to signals moving *within* substructuring inside that spacetime.

FOUNDATIONS OF MATHEMATICS

The concepts, operations, assumptions, postulates, logic, definitions, and axioms of algebra systems.

FOUNDATIONS OF PHYSICS

The postulates, assumptions, concepts, and definitions upon which a scientific physics model rests. Included are the postulates, concepts, assumptions, definitions, and operations of the mathematics in which the scientific model is expressed, as well as the postulates, concepts, assumptions, definitions, and operations of the physics entities and functions assigned to the mathematical symbols.

Thus "scientific truth"—even mathematical truth (see Morris Kline's **Mathematics: The Loss of Certainty**—is actually a *qualified* truth. What is true in one model (one set of postulates, assumptions, concepts, and definitions, including those in the algebra) may not be always true when one or more of the postulates, assumptions, concepts, and definitions is/are changed, and/or when the topology of the mathematics in which the model is expressed is changed, etc.

The major flaws in present physics models involve errors in the foundations. However, a successful physics model is rather quickly dogmatized and often turned into a belief structure by many scientists rather than being regarded as a tentative model. Consequently, scientists who attempt to do serious work in foundations are generally ignored or ostracized and rather

vehemently attacked if they propose any significant changes to one of the dogmatized models. Particularly, all funding and "benefits" of the scientific bureaucracy are denied the heretical foundations scientist, unless he or someone can rather quickly come forth with an iron-tight experimental proof of the heresy. Any attempted change in foundations is usually met with ad hominem attack, a barrage of criticism, loss of position, and denial of research funding. Science has a long history of just such dogmatic oppression of great scientific discoveries. To name a few (there are hundreds): The first laser paper was rejected by the journals as being ridiculous. When Mayer proposed conservation of energy, he was hounded and ridiculed so fiercely that he suffered a nervous breakdown and attempted suicide. Years later, near the end of his life conservation of energy was adopted because it greatly facilitated understanding and calculation, and the same system now lionized him as a scientific hero. Ovshinsky suffered personal attack, ridicule, and charges of charlatanism in pushing amorphous semiconductors; everyone knew that only crystalline semiconductors could work. The situation changed when several thousand Xerox machines were observed to now contain amorphous semiconductors which were working just fine! Louis de Broglie's matter wave hypothesis caused consternation to his thesis advisors; but because he was Prince Louis de Broglie, they felt obligated to send it to the great Einstein so that he would reject it and then they could regretfully reject the thesis of the Prince. When Einstein replied that it was probably true, they felt they had no choice but to publish it *because de Broglie was a Prince of the old French aristocracy, and as such was not to be casually trifled with.* So foundations work is fraught with the greatest peril to the practitioner. Yet it is the most important work in physics, and it is a continuing black mark against the scientific establishment that they do not openly encourage *and fund* the most able physicists, grad students, and post-docs to examine and revise the errors in foundations concepts and postulates. Because of the prevailing dogmatism, science itself continually strangles the new ideas and concepts that would provide the physics of the 22nd century now. In an eerie turn of events, science has become in a strange way its own worst enemy, and the strongest barrier to the advance of science.

FOUR-SPACE (4-SPACE)

The "normal" spacetime used in physics, consisting of three spatial dimensions and one time dimension. Minkowski spacetime.

FOURTH LAW OF LOGIC

the law that a thing and its opposite become identical on the boundary, i.e., in multiple simultaneous observation. Identity is merely the loss of observational or perceptual distinction; when formerly "two" objects are simultaneously observed by a single observer, two slides have been shown at once in the slide projector. It does not matter at that point what each was individually observed to be before; now there is no observable distinction or difference. We previously showed that the law is implicitly assumed in the three laws of Aristotelian logic anyway, and published a simple proof of the fourth law. Without the fourth law, Aristotelian logic "eats itself". What results in the four law logic is that either (1) the three laws apply explicitly and the fourth implicitly, or (2) the fourth law applies explicitly and the fourth implicitly. This *application rule* itself can be taken as a fifth law of logic. The fourth law is also the law of the paradox: I.e., when something is true but violates one or more of the Aristotelian laws, it is a case where the fourth law applies explicitly. The conclusions derivable from a four law logic agree generally with the conclusions derivable from G Spencer Brown's **Laws of Form**.

FOUR-WAVE MIXING

A nonlinear multiwave mixing effect when four waves mix in a highly nonlinear situation so that wave to wave interaction occurs.

FRACTIONAL CHARGE

A hypothetical particle having a charge less than the electron's charge. Often called a quark, where its charge is 1/3 or 2/3 the charge of the electron.

A few years ago, Stanford University researchers found evidence of free quarks. There is also now the fractional Hall effect. In the 1920's Ehrenhaft reported the discovery and production of fractional charges of all sizes, and his experiments have been replicated by Michailov, with papers by Michailov and Barrett.

In the new approach, when time-energy is utilized, quarks can be freed or nearly freed rather easily in "time-reversal zones". It would appear that, as the new approach develops, free quarks will become a normal event rather than one intensely sought but terribly difficult to come by experimentally.

FRAME, LORENTZ

A frame of reference which is not accelerated with respect to the laboratory observer.

In this case, the frame may be rotated (moving at a constant velocity) but it is not rotating (the frame is not accelerated with respect to the observer, and spacetime is not curved). In this case special relativity applies, as do the conservation laws. If the local spacetime is curved, the frame is accelerated and spacetime is curved. Locally, then, general relativity applies. In this case, locally the conservation laws (energy, momentum, charge, and spin) can be violated. However, in ordinary general relativity, it has been tacitly assumed that locally the curvature of spacetime is negligible. Hence locally a Lorentz frame is assumed, and the conservation laws are assumed to apply locally also. In scalar electromagnetics, the local spacetime is always curved and general relativity applies locally. In this case, the conservation laws need not apply.

FRAME, REFERENCE)

A spatial, organized, measured lattice placed in "emptiness" (space, spacetime).

Normally refers to a 3-dimensional, spatial frame. All objects and points in the "universe" or spatial frame are considered to simultaneously coexist at separate, measured points in the frame. Differs from the vacuum in that, rigorously, vacuum has no existing definite lengths and no existing definite time intervals, as these appear only after measurement or detection, and are relative to the observer and to the interactions ongoing as well as in the detection process itself. The "laboratory frame" is the static reference frame of the observer or measurement. A separate reference frame may be assumed to exist for any fixed or moving object, or centered on any point in another frame. When a type of frame is assumed, the entire class of physical interactions that can occur has been restricted to an assumed set or type. In other words, given the frame, the *conventional* physics has been assumed. One of the greatest restrictions of an assumed "frame" is to rule out the consideration (existence) of other higher dimensions.

Note that, in the new unified field theory approach, the other higher dimensions are always available and cannot be ruled out in general, but only in some special case. Every curvature of spacetime, and any internal additional curvature to that primary curvature, adds a new dimension. In our view, a spacetime may be "flat" in overall curvature, but consist of internally structured deterministic curvatures or "engines". In this view, normal inertial frames, e.g., may still contain vacuum engines, which will not affect the normal *bulk translation* rules, but may affect any or all of the nontranslation mechanisms, including the very laws of nature in many cases.

FREE ENERGY

Excess energy freely received from its external active environment by an open system that is far from thermodynamic equilibrium in its exchange with that environment.

To use this free excess energy, it must be collected, transported to a load or loads with minimal losses, and then dissipated in the load(s) to power them, without any substantial portion of the free energy being used to close the system's "gate" through which the excess energy is input to it.

There is a separate thermodynamics for such open systems far from thermodynamic equilibrium in their active environmental exchange. Such a system is permitted to exhibit five "magic" functions: it is permitted to (1) self-order, (2) self-oscillate or self-rotate, (3) output more energy than the operator himself inputs (the excess energy is freely received from the active environment, (4) power itself and its load simultaneously (all the energy is freely received from the active environment), and (5) exhibit negentropy.

The entropy of such a system cannot even be calculated. Some useful references are: Ilya Prigogine with D. Kondepudi, **Modern Thermodynamics: From Heat Engines to Dissipative Structures**, Wiley, Chichester, 1998; Ilya Prigogine, **The End of Certainty: Time, Chaos, and the New Laws of Nature**, Free Press, New York, 1996, 1997; G. Nicolis and I. Prigogine, **Exploring Complexity**, Piper, Munich, 1987; Gregoire Nicolis, "Physics of far-from-equilibrium systems and self-organization," Chapter 11 in Paul Davies, Ed., **The New Physics**, Cambridge University Press, Cambridge, 1989, p. 316-347.

FREE ENERGY SYSTEM

Any open system not in thermodynamic equilibrium, which freely receives excess energy from an external source,

...and collects and utilizes this free excess energy to freely power external loads, so that a permissible system COP>1.0 is achieved, as allowed by the nonlinear thermodynamics of open systems in disequilibrium with their environment.

Implicit in the notion of free electromagnetic energy systems are six key concepts: (1) the local vacuum/spacetime is known to be filled with hidden (i.e., virtual) energy in violent motion, i.e., the local vacuum/spacetime is a violent virtual energy flux and therefore a scalar potential, (2) a broken symmetry—i.e., some sort of organizing and gating mechanism, such as the common dipole—in this hidden (virtual) energy flux of the vacuum is utilized as a source, to cohere the virtual energy and divert it as energy flow $\mathbf{S} = \mathbf{E}\times\mathbf{H}$, from the broken symmetry initiation point onto the external circuits or load parts of a device, (3) the coherent gated extra *virtual* energy flow available in the external circuits or load parts couples to (interacts with) the mobile charges in those circuits or load parts, so that gradients developed in the interacting virtual flux form force fields on and of the particle masses, driving the mobile charges along the circuit and through current-impeding circuit components such as loads, (4) in the interaction of the driven charges with the driving virtual energy flux, their spin and erratic motions integrate a tiny "coupling fraction" of the driving virtual energy into observable (i.e., macroscopic field) energy, thus creating the **E**-fields and **B**-fields, (5) the current-impeding external components or load parts scatter or dissipate the coherence of the driven charges, and thereby dissipate the collected energy or change the form of the collected field energy, thereby producing useful work, and (6) little or none of the excess collected energy in the circuit is split off and dissipated in the gate (asymmetry component serving as the **S**-flow source) to destroy the gate and thereby destroy its asymmetry in the vacuum flux, which is what is extracting and producing the free energy flow.

FUSION, ACTION

In the new approach, the recombining of two canonical bits of a fissioned action quantum.

The fusion process "cancels" the bits produced by the fission process, and constitutes a negative spacetime operation. The physical world is thus eliminated, bit by bit, in a monocular fusion operation that produces the "past". The "mass" of a particle is taken to be proportional to, and identically comprised of, the absolute value of its fission and fusion rate. When fission and fusion rates of a particle are equal, the particle is unaccelerated; when unequal, the particle is accelerated. Vice versa, when the particle is unaccelerated, the fission and fusion rates are equal, and when the particle is accelerated, the fission and fusion rates are unequal.

GAIA HYPOTHESIS

The hypothesis by Lovelock that the earth and its biosphere is a living thing, at least in some sense.

In the new viewpoint, there exists a biospheric quantum potential which contains an extended mind and therefore is indeed an extended lifeform—one which includes the earth and the quantum potentia all its creatures and species. In the new sense, even so-called "inert" matter is alive, being continually bathed by energy flow dimensioned with lifeform templates, and therefore equally alive in all directions and nonpreferential.

GATE

Refers to something (a component or function) which extracts some part of a flux or flow, compacting it into a stream, and "sending it out."

A moving board wall or gate may be swung into a river, e.g., to divert or "gate" some of the river's flow out into a sluice ditch and on to a waterwheel powering a mill. Similarly, a dipole extracts some of the energy from the vacuum virtual photon flux exchange with the end charges of the dipole, and "gates" (diverts) the extracted portion of energy out from the ends of the dipole as energy flows. This creates the scalar potential surrounding each charge, and also the **E**-fields. Even a "static" dipole does this "gating" of vacuum energy into an energy flow.

The fundamental gate for all EM energy in 3-space is the dipole or dipolarity. The source of the 3-space EM energy continuously emitted by any charge or dipole is an equal inflow of EM energy from the complex plane (from the time domain). Thus EM energy flow is conserved in 4 dimensions but not in 3-space. In particle physics, it is well-known that any dipole or charge is such a broken 3-symmetry in its fierce vacuum energy flux exchange. However, particle physics considers the input energy to be virtual particle energy from the vacuum and therefore random energy. Whittaker 1903 shows it is actually from the time domain of spacetime (from the complex plane) and the input energy flow from the vacuum is not random but precisely organized in a harmonic set of longitudinal EM phase conjugate waves. Of course by wave-particle duality we simply consider the two pictures to be just different and permitted models of the same thing.

GATING EFFECT

The effect of extracting part of a flux or flow, compacting it into a useful stream, and "sending it out."

See *gate*.

GAUGE

In electromagnetism, usually considered a possible choice for (change of) electric scalar potential and magnetic vector potential, without any net change of force fields so that the change satisfies Maxwell's equations.

Interestingly, gauge field theory includes the axiom of gauge freedom. In EM systems, this means that one is free to "regauge" or change the potential energy of the system freely and at any time, so long as the change results in a static stress potential energy change. In the real world, one may have to pay a little bit for switching. But essentially physics already assumes that one can cause his EM system to take on excess potential energy at will, so long as it is a *stress potential* energy change only.

In short, only the *symmetrical* regauging case has been considered in electrodynamics. Yet every electrical power system must first potentialize the system *asymmetrically* rather than symmetrically. In the theoretically perfect system, this asymmetrical regauging is done freely. Hence every electrical power system first breaks gauge symmetry, in order to take on extra energy so that it can do work. Further, the source of the potential energy flowing into the asymmetrically regauged electrical system so freely, comes from the source dipole's extraction of EM energy from the time-domain (complex plane) due to its broken 3-symmetry in EM energy flow.

So the highest "gauge" principle is that energy can be freely extracted from the vacuum, anywhere and at any time, freely and easily, by making a dipolarity—which changes a single potential and asymmetrically regauges the system.

It follows that one is in theory free to "dissipate" this excess free energy in external loads to power them. Again, in the real world one may have to pay some switching costs, but that can be minimized by efficient switching. However, since no conventional electrical power system accomplishes this free powering of its loads, it rigorously follows that the conventional system must self-enforce symmetry in its discharge of the free potential energy achieved by the initial *asymmetrical regauging*.

Thus, if we believe gauge field theory—the most modern of physics theories and in many ways the most useful—and also believe its assumption of free asymmetrical regauging that is hidden in its gauge freedom principle, then COP>1.0 electrical power systems are absolutely permitted by nature and by gauge field theory where asymmetrical regauging is deliberately used.

It follows that some feature in electrical power systems as we presently design and build them, must be preventing these systems from exhibiting overunity COP. And so it is. The ubiquitous closed current loop circuit results in the circuit forcibly and symmetrically regauging itself while dissipating its excitation energy to power its loads and losses. This forces half the collected regauging (free) energy to be dissipated in the external circuit's loads and losses, and half of it to be dissipated in the source dipole to scatter the charges and destroy the dipole. This means that less than half the available free regauging energy is used to power the load, while half is used to destroy the entity—the source dipole—actually furnishing the free regauging energy from the vacuum.

Hence all our present electrical power systems are inherently free energy systems freely extracting their energy from the vacuum, but are fiendishly designed so that they kill themselves (shut off all free asymmetric regauging energy from the vacuum, by destroying the source dipole) faster than they catch some of the free energy from the vacuum to power their loads.

To restore the source dipole requires at least as much energy dissipation as was done to destroy it. In our conventional self-destructive systems, the generator shaft must thus be continuously powered in order to form the magnetic field inside the generator, so that this magnetic field can then dissipate its available energy to force the scattered charges back apart to form an ordered source dipole.

We pay the power company to have a giant wrestling match inside its own generators and *lose*. And in a sense, we do it because our theoreticians love gauge symmetry more than they tolerate broken gauge symmetry. So they build lovely, symmetry-restoring electrical power systems—and monstrously mangle and destroy the fragile biosphere in the process.

GAUGE FREEDOM

The axiom in gauge theory that one can freely change the potentials of an EM system, so long as the net new forces resulting from the change will sum to a zero vector resultant so that the system remains "symmetrical" in its force-field functioning with respect to the system prior to the change of potentials.

Gauge and gauge freedom are actually formal restrictions of an even more important asymmetrical regauging principle: *a potential in a system can be freely changed at any time, thus freely changing the potential energy of the system freely and at will*. Symmetrical regauging is achieved only by multiple application of this asymmetry rule to provide a net symmetry condition again, with a change in locked-in stress potential energy of the system.

GAUGE SYMMETRY

Abstract mathematical symmetry of a field, that relates to the freedom to regauge (change the value of) potentials, without affecting the values of the field quantities.

In short, the higher principle that the potentials can be changed freely and at will—and hence the potential energy of the regauged system can be changed freely and at will—is arbitrarily restricted to a very special case: Each change of potential involves the appearance of an new free force field. This *asymmetrical* change can be made freely and at will, at any time. However, the notion of gauge symmetry restricts any set of such changes to the special case where the new free force fields produced must sum to a net zero force field of opposing forces. In short, it severely restricts the freedom to change the potentials—to the special case where the resulting change of the system's potential energy must remain a static stress potential energy condition. Note that this arbitrarily eliminates any overunity functioning of the regauged system in which the altered potential(s) and altered system potential energy exist(s). See the discussions of *gauge* and *gauge freedom*, above.

GAUGE THEORY

A field theory using a field that has one or more gauge symmetries.

Note the accent on gauge symmetry and the net *symmetrical* regauging restriction. This restriction is a carry-forward of the old notion that the potentials are not primary, but the fields are primary causes of all EM phenomena.

For the overunity researcher, broken gauge symmetry is the interesting feature which must avidly be sought in his experimental systems. Hence he must seek out and familiarize himself with a wide variety of *broken symmetry effects* and phenomenology. He must also rigorously analyze his circuits with a keen view to where gauge symmetry can be broken, where and how gauge symmetry is automatically restored during excitation discharge, etc. Unless the automatic self-enforcing of symmetrical gauge transformation during excitation discharge is violated, no EM system can produce COP>1.0. In addition, without elaboration, the overunity researcher must also learn to consider the time-domain functions of the circuit, and particularly the giant negentropy of the common dipole. Unless he understands that all EM energy comes from the vacuum and from the complex plane via the broken 3-symmetry of a dipolarity, he cannot understand his own circuits.

Electromagnetics was the first gauge theory. Gauge theory is widely utilized today, and particularly in particle physics. In overunity power systems, the system must exhibit a broken gauge symmetry at least twice: (1) in initially potentializing the system to freely increase its potential energy, thus exciting the system so that it has energy with which to do work, and (2) then

discharging this free excitation energy in the load without simultaneously destroying the source dipole providing the continual potentializing.

The conventional COP<1.0 electrical power system restores net 3-space symmetry by continually destroying the "free asymmetrical regauging" component: the source dipole, and using more of the energy freely received from the vacuum via dipole asymmetry to destroy the dipole than is used to power the load. This requires that at least as much 3-space energy be input to the system again, to restore the dipole and thus potentialize the external circuit, as was used to destroy the dipole. Hence as much 3-space energy has to be input as is dissipated in all the loads and losses, including inside the generator. For that reason, our scientists and engineers unwittingly but deliberately design and build only COP<1.0 systems.

Without elaboration, we also accent that spacetime curvature is always involved in an overunity EM power system, and the tempic (time) potential of the output end of an overunity system differs from the tempic potential of the input end, so that the gradient (the tempic force) is directed from output to input—exactly the reversal of the case for a COP<1.0 power system.

GAUGE TRANSFORMATION (IN ELECTROMAGNETICS)

In EM, gauge transformation is conventionally taken to be the addition of the gradient of some function of space and time to the magnetic vector potential—and simultaneously the addition of the negative of the partial derivative of the same function with respect to time, divided by the speed of light, to the electric scalar potential.

This procedure gives different potentials but leaves the electric and magnetic fields unchanged. It restricts gauge transformations to *net symmetrical* transformations. However, the increase or decrease in potential energy of the system, due to changing the potentials, results in a change in the stress of the system and a change in its stress energy. This is because two new antiparallel forces are created, which change the stress of the system.

In essence, gauge symmetry then involves the implicit assumption that a functioning system is the same regardless of how it is stressed, and regardless of the state of its stress energy. We point out that, gravitationally, this is not true since any change in the local potential energy of the system is a spacetime curvature change, hence a gravitational change.

GENERAL THEORY OF RELATIVITY

Einstein's theory of gravity in which the gravitational force is represented by a curvature in spacetime.

GIANT NEGENTROPY (OF THE DIPOLE)

The receipt from the time domain of spacetime (the vacuum), by any dipolarity, of enormous longitudinal EM wave energy flow, transduction of that absorbed energy from the complex plane into real 3-space, and emission of that enormous energy flow in all directions in 3-space, automatically and indefinitely after a little energy has been expended to separate the charges and make the dipole. The EM waves in the input from the time domain and the output in 3-space are perfectly ordered and correlated, which is a giant ordering of the vacuum/spacetime and is thus a giant negentropy.

In circuits, the source dipole in the generator or battery, once made, performs this function. Only a minuscule fraction (some 10^{-13}) of the energy pouring out of the generator's or battery's terminals strikes the surface charges of that attached external circuit and is diverged into the conductors to power the Drude electrons and the circuit. All the rest is just wasted.

See my paper, "Giant Negentropy from the Common Dipole," *ibid*.

GRAVITON

The quantum (smallest piece) of the gravitational field, with spin 2.

In the quantum theory of general relativity, the graviton is massless and has spin 2. In the new approach, a graviton is considered to be a paired (coupled) photon and antiphoton, each of which has spin one, so that the graviton couplet has spin 2. A scalar potential is comprised of gravitons, not merely photons, since it can be decomposed into a harmonic series of bidirectional wavepairs. In each wavepair, a wave and its antiwave precisely superpose. We insist on a further strong condition: that in the biwave, the photons comprising the wave and the antiphotons comprising the antiwave also must obey the *distortion correction theorem*. This means that the antiphotons and photons are passing through each other in opposite directions, continually coupling into gravitons and decoupling again.

GRAVITY

The phenomenon characterized by the physical attraction of any two material bodies.

Actually, in modern general relativity it is the trapped energy in the masses that produce the gravity potentials. Ideally, the gravitational force between two masses is proportional to the product of the masses divided by the square of the distance between them. In the new approach, one recognizes that mass itself is defined in terms of, and identically consists of, the time derivative of an action flux. [For a force-free fundamental definition of mass, see T.E. Bearden, **Quiton/Perceptron Physics: A Theory of Existence, Perception, and Physical Phenomena**, National Technical Information System, Report AD-763210, 1973.] A photon flux is also an action flux. A virtual photon flux is an action flux. So the vacuum consists of a gigantic action flux—which with certain interactions forms mass itself. But since photons are action quanta and photon flux is action flux, and since mass and gravitation are functions imposed on such action flux; then mass, EM, and gravitation become different aspects of the same thing. All of them can be electromagnetically engineered, directly, as indeed can be the flow of time itself. By affecting the flow of time electromagnetically, one is thus able to affect the gravitational force between two objects electromagnetically. Antigravity, for example, can be achieved by a mechanism that is given in this glossary. Hutchinson has demonstrated the levitation of objects weighing up to 60 lbs., albeit sporadically and uncontrollably. At my urgent request, Sweet performed a highly successful antigravity experiment some years ago, reducing the weight of a 6-pound object by 90%, smoothly and controllably, in several smoothly controlled steps. I consider that the experiment tested and validated my approach to an engineerable mechanism for antigravity. For the results of the test, see Floyd Sweet and T.E. Bearden, "Utilizing Scalar Electromagnetics to Tap Vacuum Energy," **Proceedings of the 26th Intersociety Energy Conversion Engineering Conference (IECEC '91)**, Boston, Massachusetts, 1991, p. 370-375.

GROSS PARTICLE TRANSLATION

Refers to translating the entire particle in space, rather than internally structuring the particle's potential (massless charge).

GROSS POTENTIAL GRADIENT FIELDS

The usual gradient in a scalar potential's gross magnitude, as in $-\nabla\phi$.

GYROELECTRONS

Spinning electrons considered as gyroscopes, so that when longitudinally perturbed they can and will laterally precess.

Considering (in a gross first order model) the conduction electrons in the Drude gas in a conductor as little gyros, because they are (i) spinning on an axis, (ii) severely restrained in their ability to move forward longitudinally down the conductor as current, and (iii) much more free to precess laterally in the conductor. Thus when the gyroelectrons in the receiving wire antenna, perturbed by an incoming longitudinal EM wave in the vacuum, are longitudinally perturbed, they precess laterally so that our instruments (which detect electron wiggles, not the incoming vacuum EM wave) do detect "transverse waves." However, they are detecting the transverse gyroelectron precession waves. The old electrodynamicists, long before the electron or the atom was discovered, simply envisioned the incoming EM wave as "waves in the thin material fluid ether" which were "intercepted" as electric fluid waves in the antenna. Hence since their instruments reported that the intercepted "electric fluid" was vibrating transversely, they firmly believed (erroneously) that this proved the ether wave to be transverse also, just as those "taut string waves" that Maxwell and Faraday had believed in. That is the total *raison d'etre* behind the mistaken notion of the transverse EM wave in the vacuum ether!

HARMONIC SERIES

Consisting of a fundamental frequency, its first harmonic, its second harmonic, etc.

HEAVISIDE, OLIVER

Noted English self-taught physicist and brilliant electrodynamicist, 1850-1925, who played a role in discarding Maxwell's quaternions, and also played a role in forming vector mathematics and formulating the vector reduction of Maxwell's theory from 20 quaternion equations in some 20 unknowns to the present 4 vector equations.

What are presently taught as "Maxwell's equations" in university are actually Heaviside's equations.

Lorentz symmetrically regauged the Maxwell-Heaviside equations, again greatly simplifying their mathematical solution—and also unwittingly discarding all permissible overunity Maxwellian systems in the process.

HEAVISIDE ENERGY FLOW COMPONENT

(1) The enormous nonintercepted and nondiverged energy flow component pouring out of the terminals of the battery or generator, and missing the external circuit entirely so that it is wasted.

(2) The enormous energy in the EM field, potential, or wave that misses the interaction of the field, potential, or wave with the assumed unit point static electric charge.

(3) See also discussion under Giant Negentropy.

HERACLITUS

To be added.

HERTZ, HEINRICH

Noted German physicist who together with Heaviside and others transformed Maxwell's theory from quaternion algebra to vector algebra, and who also produced EM waves, thus confirming Maxwell's theory.

HIDDEN BIWAVES

Those bidirectional EM wavepairs that comprise the scalar potential are indeed "hidden" with respect to our normal "electron translation" (i.e., electron wiggle) detectors and instruments.

HIDDEN VARIABLE THEORY

A class of quantum mechanical theories which considers that the quantum state of a physical system is not a complete specification after all. The "hidden variables" are those additional components necessary to provide the "complete state" of the system.

The hidden variables are those extra components of the theorized complete state, which are not contained in the quantum state. Bohm's hidden variables theory is the best known of all of these theories, and makes the same predictions as does the conventional quantum mechanics. In addition, it eliminates the terrible problem of the "missing chaos," eliminates the quantum measurement problem, and it suggests that quantum mechanics can be engineered if the hidden variables themselves can be engineered. In the new approach, one goes a step further by considering hidden EM variables infolded inside the potentials themselves, including inside the quantum potential utilized by Bohm. The advantage of this assumption is that it poses an *engineerable* interpretation, after work by Stoney, Whittaker, and Ziolkowski. Further, the Russians have utilized this type of EM hidden variable theory, along with the quantum potential, to develop secret advanced weapons. The physics of this area is called *energetics*.

HIERONYMUS, T. GALEN

Founder of the American version of radionics, who patented a radionics machine and process to start the cycle of radionics in this country.

HILBERT, DAVID

Noted German mathematician, 1862-1943, who did advanced work in geometry, theory of invariants, integral equations, and mathematical physicist.

Noted particularly for his development of Hilbert space.

HOLE (ELECTRON HOLE)

An unfilled vacancy in an ordering of electron energy levels, as in a lattice or in the Dirac Sea.

Electron energy levels have two energy states: (1) *positive energy* state, and (2) *negative energy* state. The positive energy states are associated with the positions of normal energy electrons. The negative energy states are almost all filled, and this is the Dirac sea.

The absence of an electron from either energy state creates a particular kind of hole. When an electron is absent from an electron positive energy state position in a lattice, that results in an excess of positive charge at that point vacated by the electron. Note that when an electron then refills that hole (recombination occurs), the electron remains in a positive energy state, does not disappear, and no radiation occurs.

When an electron is lifted from an electron negative energy state in the Dirac sea, that leaves behind a hole in the negative energy state in the Dirac sea. When an electron subsequently refills that hole, it "falls" in and disappears, decaying to a lower energy level and emitting radiation due to the difference in the energy levels.

The difference between holes in the Dirac sea and holes in the electron positive energy levels in a lattice, are very different. In short, they lead to two quite different kinds of "hole and electron" interactions. In the lattice "hole-filling" (recombination), there is no excess radiation given off and the electron does not disappear from the positive energy continuum. In the Dirac sea hole-filling, excess radiation is given off and the electron disappears from the positive energy continuum.

Under the influence of an electric field, a *positive energy* hole in a crystal lattice—where an electron has left and is therefore absent—will effectively propagate through the lattice as a positive charge, but usually much slower than the electron propagates in the opposite direction as an electron current. The process is actually more complex and involves continuous interaction with the electrons and their physical distribution pattern and location. The hole current is mathematically treated as a special positive charge current, often referred to as a positron current. In a current-carrying conductor or semiconductor, one has a current of electrons traveling in one direction and simultaneously a current of holes (hole positrons) traveling in the opposite direction, but recombining.

As stated, in addition to lattice holes, there also can exist unfilled holes in the Dirac negative energy states comprising the vacuum, particularly when fields are present. In this case, it is a *negative energy* hole. A positive energy electron that falls into a Dirac sea hole will emit energy as it falls to that lower energy state. To lift one of the electrons from the Dirac sea and leave a hole, energy must therefore be added to the negative energy electron in the Dirac hole.

When fields are present, Dirac holes may exist and may move as hole current in circuits under certain conditions. The situation is complex; see Felix Finster, "Definition of the Dirac Sea in the Presence of External Fields," **Adv. Theor. Math. Phys**., Vol. 2, 1998, p. 963-985. Updated copy (version 4) is on http://xxx.lanl.gov/abs/hep-th/9705006.

When a free electron fills a positive energy hole in a lattice (positive electron energy state), this effectively disposes of both the hole and the *free* electron which is now a *bound* electron, and is called *recombination*. The electron does not disappear. In a material lattice, there is no energy radiation from this, just the disappearance of the hole and the "binding" of a free electron so that it is no longer free.

In visualizing positive hole currents, passing the hole current though a surplus of available electrons (as in a negative charge donor material) will result in "hole filling" and recombinations. One may therefore speak of disposing of unwanted hole current by recombination, and in fact this is widely accomplished in semiconductors by controlling the doping.

HOLE CONDUCTION (LATTICE)

The movement of electron vacancies (holes) in a lattice continually left behind by hopping of the electrons as they break loose from their bonded positions and move freely in an electron current.

When an electron hops out of a lattice bond, it leaves behind a bonding gap or "hole" in the positive electron energy state at that bond site, so that an extra positive charge appears there at the hole. As the electrons move in one direction in a conducting lattice, the holes move in the opposite direction in a "positive current", but at a much slower pace than the electron current moves.

HOLE CURRENT (LATTICE)

See *hole conduction (lattice)*.

HOMEOPATHY

A system of medical treatment based on the theory that certain diseases can be cured by giving very small doses of substances which in a healthy person would produce symptoms like those of the disease. (Opposed to allopathy).

Homeopathy is based upon formation and use of dimensioned potentials (particularly the potential composed of the extremely rapid "making and breaking" hydrogen bonds in a fluid) containing vacuum engines. Any material or solute, and therefore any molecule, contains its own specific vacuum engine, its own charges, and its own dimensioned potential. Dissolving the material in water, or even using a suspension of it in water, allows the bonding potential in the water to interact with the potential of the solute or suspension. Potentials superpose, and they also diffuse and mix their inner structures (vacuum engines) into each other. So the material or solute diffuses its vacuum engines into the interior of the hydrogen bonding potential, in effect ordering and templating the hydrogen bonding itself! Vigorous shaking of the suspension or solution assures that all the fluid and H-bonding potential is exposed to the solute of suspended particles, so that a thorough exchange of vacuum engines occurs. This process in homeopathy is called *potentizing*. It's actually just creating the desired internal vacuum engines in the H-bonding potential of the water. Once that's done, there's really no further need for the solute or the suspended particles. By repeatedly diluting the solution to the extreme, then one can reach a point where there is a high probability that not a single molecule of the original solute is remaining in the fluid. Yet in each dilution, shaking can be used to insure the even spread of the vacuum engines through the newly introduced H-bonding potential in the newly introduced water. At the end, there exists an altered fluid whose H-bonding potential now contains the desired vacuum engines. Drinking that water now introduces those vacuum engines into the body fluids, bloodstream, etc. The ingested dilute new vacuum engines will then diffuse through the various potentials of the body, and produce altered chemical functioning of the kind that could have been induced by the chemical or active solute material. The advantage is that the harsh material residue of the chemical or solute is not present in the body, as it is when allopathy is utilized.

HYPERFUNCTIONING

Functioning in hyperspace as opposed to 4-dimensional Minkowski space.

Higher topological functioning.

HYPERSPACE

Refers to a space of more than four dimensions, and specifically to those spatial dimensions outside the normal three.

IDENTITY OF OPPOSITES

On the boundary, A and not-A are identical. If all of a thing is collected, one reaches the boundary of that thing and it turns into its own opposite.

INERTIAL FRAME

A frame of reference in which force-free bodies move along straight lines, and the postulates of special relativity are valid.

In the new approach, this notion is extended; even in an inertial frame, force-free bodies may move along straight lines, the postulates of special relativity may remain valid, and yet the EM hidden variable may induce other changes in the usual laws of nature due to the action of hidden vacuum engines infolded in the *dimensioned* local spacetime (vacuum potential).

INFOLDED HIDDEN DYNAMICS

Refers to:

(i) Bohm's hidden variable theory and the internal dynamics of the hidden variables/entities themselves, and

(ii) to the hidden biwave pairs comprising a scalar potential, with the internal dynamics of those waves such as tuning off harmonic frequency, multiplication, variation of phasing and magnitude, etc.

Also, by Whittaker 1903 the scalar potential can be decomposed into the bidirectional wavepair set in harmonic series. By Whittaker 1904, each of the waves in a biwave pair can be further decomposed into two potentials, so each pair of waves would consist of four potentials. That is, the entire set of internal biwave pairs can be replaced by four times as many internal "partial potentials" as was the number of biwave pairs. Then Whittaker 1903 can be applied once again to break each one of those scalar potentials into new biwave pairs, and so forth and so forth. So the potential can be expressed as waves within waves within waves, or potentials within potentials within potentials, and so on. The neat thing is that each successive infolding (internesting) is a higher dimensional functioning and a higher topology. So one can build (with some little pain!) specific infolded wave patterns that will work in—say—the 7th dimension of hyperspace, or the eighth dimension, and so on. This is why I called the internal structuring of a potential (or the two potentials comprising an EM wave) *dimensioning* the potential or the wave. As a half-baked nuclear engineer whom the Army never let practice his discipline, I wanted some way to directly engineer the nucleus. *That has now been found*. Unfortunately it has also already been highly weaponized in secrecy by one or more foreign nations. In other words, one can design a signal and assemble it (with some difficulty) that will flip one quark in a nucleon in an atom. That way one can transmute an element either into the next higher element isomer or the next lower element isomer. Using a quantum potential to "transport" the necessary vacuum engines, the effect can be accomplished at a great distance, in multiple targets simultaneously, and the effect is not shieldable. "Jumps" in nuclear transmutation can also be accomplished. The migration of electrons to and from an atom (as in solution, e.g.) makes and negates ions continuously. Thus continually the external potentials and the nuclear potentials intercommunicate. This means that their vacuum engines continually diffuse. Any dimensioning of the external potentials will be passed into the nuclear potentials as a dimensioning action also. If certain conditioning vacuum engines are present in the external potentials, then the slow diffusion into the nuclear potentials begins to affect the nucleons and their interactions, the quarks comprising the nucleons, the particles such as pions continually exchanged between nucleons, etc. The mechanism for nuclear transmutations and production of new species is there! I believe, e.g., and am working to more clearly express, that the major mechanism producing the new nuclear species in cold fusion experiments just such dimensioned potentials, involving the inadvertent dimensioning of potentials comprised of the hydrogen bondings of the water and other factors.

INFOLDED REAL VECTOR COMPONENTS

Well, simply take a set of real force vectors that altogether sum to a vector zero resultant.

That "vector zero system" is a zero with respect to forced *translation* of a particle or mass. It is not an absence per se, but is the presence of specifically hidden and "infolded" real vectors. Two elephants pushing each other to a draw form such a "zero-translating" system. That "zero system" is quite different from two crickets pushing against each other to a draw! Anyone who thinks all zeros are "absences" and who thinks all zeros are equal, is invited to try standing between the crickets and observing how he feels, then standing between the elephants and see how he feels. The latter might be a real bummer. So zeros can differ! And a zero can be a presence of many real things, all still there but "infolded" and "hidden," but just the absence of any *one and only one* thing. Even in arithmetic, e.g., we are free to pull 5-3-2 right out of 0, or pull out 4-7+8-6-2+5+1+1-3-1/2-1/2 (if I got the arithmetic correct!). And so on. So we have always *used* the fact that a net zero can have a real internal composition, without detailing it exactly. We teach our schoolchildren to do it, but fail to tell them what they are doing!

When you sum EM force fields to zero, the fields are still there and real. You have altered the energy of the system or volume, and also the potential energy of the system or volume. And you have done it in specific directions, magnitudes, etc. along the "fingers" of the infolded patterns. In short, you have made a specific vacuum engine. Mass, fluid, nuclei, molecules, etc. exposed to that "conditioned vacuum potential" may well undergo physical and chemical and electrical changes. Golden once performed experiments which powerfully conditioned the local vacuum, and all clocks and watches (mechanical, electrical, etc.) in the local area were awry for four days.

INFOLDING

With reference to signals, infolding means "placing the signal or modulation or change upon one or more of the internal bidirectional wavepairs comprising the scalar potential.

Since all EM potentials ultimately represent changes to the ambient vacuum potential, one has conditioned or altered the vacuum itself when infolding is utilized. Infolding of EM signals, vectors, and directions produces *vacuum engines*. By Whittaker's principle and Bearden's corollary, these vacuum engines can be designed to affect matter—including atomic nuclei, nucleons, etc.—in any manner desired.

INFORMATION CONTENT OF THE FIELD

Russian euphemism for the structuring of the hidden longitudinal EM waves and their dynamics, that comprise any EM potential, field, or wave.

INFRASONIC

Below sonic.

Frequencies below what the ear can hear. Below about 20 Hertz.

INTERFEROMETER

An instrument in which a wave is split into two waves or beams, which after traveling over different paths are subsequently reunited and display interference.

INTERFEROMETRY

Measurement of wavelengths of light and very small distances and thicknesses,

...for determining indices of refraction, and for analyzing small parts of a spectrum by means of the interference phenomena of light.

INTERNAL SPACE

To be added.

ITERATED

Done repeatedly, like picking beans one at a time.

JOSEPHSON EFFECT

Flow of Cooper pairs (superconducting electron pairs) across a thin dielectric separating two superconducting electrons, in the absence of a voltage drop.

That is, the pair of electrons can "tunnel" through a thin insulating barrier.

JOSEPHSON JUNCTION

The thin dielectric separating two superconducting electrons, with subsequent Josephson tunneling of Cooper pairs.

JOSEPHSON TUNNELING

See *Josephson effect*.

JOULE

A measure of energy.

One joule equals one watt for one second. In physics the unit of work or energy in the MKS system, being the amount of work done by one newton acting through a distance of one meter, equal to 10,000,000 ergs.

JUNG, CARL GUSTOV

Noted Swiss psychiatrist and psychologist who founded Jungian analytical psychology, formulated the principle of synchronicity, and advanced and delineated collective unconscious mind.

From the content of his German patients, Jung predicted WW II two decades before it occurred.

KINDLING

Coherent integration (adding) of similar virtual components among the vast "noise" of dissimilar virtual components, so that the "signal-to-noise" ratio of the integrated signal steadily increases, and the integrated "observable signal" grows out of the background virtual state noise.

This "kindling" process is directly analogous to coherent integration of nondiscernible radar signals far beneath the received noise, to build and extract the real radar return signals from targets. This sort of process dramatically increases the "sensitivity" of the radar. Real, very tiny signals even 100 dB or more beneath the noise level can be retrieved in such fashion by modern radars.

Similar processes can integrate very minute signals already passed into the virtual state and presumed to be nonexistent. Usually, however, the difference frequency between two frequencies at least one harmonic interval apart must be used, considering the vacuum's virtual flux state as an isotropic nonlinear medium.

One may also hypothesize that potentials and propagating signals may decrease with distance, but are never truly "lost" in that they never reach a total zero. When they reach the quantum level, further decrease in amplitude simply results in their passing into the virtual state (subquantum level).

KIRCHHOFF'S CURRENT-LAW

At any time, the sum of the instantaneous currents flowing into a node or point in a circuit equals the sum of the instantaneous currents flowing out of that node or point.

KIRCHHOFF'S VOLTAGE LAW

At any time, the sum of all voltage rises in a closed loop circuit equals the sum of all drops in that closed loop circuit.

LAMB, WILLIS EUGENE JR.

American physicist and Nobelian who discovered the hyperfine structure of the hydrogen spectrum, and first measured the interaction of the vacuum energy that generates a change in the energy levels of the hydrogen atom, according to Dirac's theory and quantum electrodynamics.

LAMB SHIFT

A very small correction to the first excited state of the hydrogen atom due to interaction of the vacuum.

Willis Lamb experimentally confirmed this prediction of quantum electrodynamics to high accuracy.

LAMELLAR CURRENT

Current in thin layers.

Thin layers of current. Thin sheets of current.

LASER

A device that generates light in which all the photons are exactly in step and produce a coherent beam.

Laser light has one wavelength and is more easily controlled than other kinds of light. Use of a laser to perform interferometry is one way to create holograms; use of a laser to illuminate a hologram is one way to read it. Originally the word "laser" was an acronym that stood for "light amplification by stimulated emission of radiation." Note that when TiO_2 particles in suspension, with a small amount of fluorescent dye added, are weakly illuminated by a small coherent light source (a laser), a tremendous room-filling output of coherent light emission occurs, by the anti-Stokes emission effect. This is lasing without population inversion, and it is a validated and easily testable overunity process. This is the process patented by Lawandy.

LASING WITHOUT INVERSION

The amplification of coherent light in an intensely scattering medium, comprised of certain powdered laser crystals or suspensions of similar material, where a variety of phenomena such as gain narrowing and amplifying random walk of light propagating in the medium, combine to give laser emission with diffusive feedback.

Gain tends to depend on the volume of the medium, so that at a certain medium the gain in light amplification by the medium exceeds the losses, and the laser action results above this critical volume. The intensity of the light scattering (multiply reflecting) in the medium then will increase rapidly until an "explosion" of light results in an intense flash of coherent light in all directions from the medium volume.

If the excitation is still present, the process will be repeated and the energy density will again exceed the critical value, rapidly generating another intense flash of light. This process can be repeated many times, given the presence of continued excitation.

A very interesting phenomena that can occur is coherent backscattering. Here the light scatters over both a forward-time path and a time-reversed path, perhaps with each path consisting of more than 1,000 scatterings. Because of time-reversal symmetry, the two waves (forward and backward) acquire exactly the same (though random!) phase. So the two waves after all this 1,000 scatterings on their paths, meet and interfere constructively in the direction back toward the exciting light source.

In theory the mean free path can be made shorter and shorter, so that all the light would be trapped inside the medium. This is called Anderson localization, and it has been reported in the literature; see D.S. Wiersma, P. Bartolini, A. Lagendiji, and R. Righini, "Localization of light in a disordered medium," **Nature**, Vol. 390, 1997, p. 671; John Sajeev, "Frozen light," *ibid*., p. 661-662.

This work grew out of original work called out by Letokhov but largely ignored for more than two decades.

References: D. Wiersma and A. Lagendijk, "Laser action in very white paint," **Physics World**, Jan. 1997, p. 33-37; — "Light diffusion with gain and random lasers," **Physical Review E54**, 1996, p. 4256; N.M. Lawandy et al., "Laser action in strongly scattering media," **Nature**, Vol. 368, 1994, p. 436; V.S. Letokhov, Generation of light by a scattering medium with negative resonance absorption," **Sov. Phys. JETP**, Vol. 26, 1968, p. 835.

Note that we have nominated a version of this process, together with consideration of the erroneously discarded Heaviside nondiverged energy flow component, as the fundamental mechanism proposed to be involved in gamma ray bursters, x-ray bursters, and in some gamma ray and x-ray flashes associated with atmospheric phenomena on earth in thunderstorms, etc. We also nominated the missing Heaviside energy flow component as the agent accounting for the excess gravity (some 90% of the total gravity) in the arms of spiral galaxies that hole those arms intact so they do not fly apart. See T.E. Bearden, "Dark Matter or Dark Energy?", **Journal of New Energy,** 4(4), Spring 2000, p. 4-11 (also available on http://www.cheniere.org); — "Giant Negentropy from the Common Dipole," **Proceedings of Congress 2000**, St. Petersburg, Russia, Vol. 1, July 2000 , p. 86-98. Also published in **Journal of New Energy**, 5(1), Summer 2000, p. 11-23. Also carried on DoE open website http://www.ott.doe.gov/papersbooks.html and on http://www.cheniere.org.

LAW OF PHYSICS

A restriction placed upon the physical mechanisms that can occur under certain broad assumptions as to the background situation and environment.

Actually, in nature there are no such rigidly fixed "laws"; these are only man's synthesis for the behavior of large classes of systems under very general conditions. Any "law of physics" can be violated if the conditions contained in its assumptions are violated. Conservation laws are often touted as "laws of physics." Actually, the conservation laws assume a closed system or one in equilibrium, and a linear spacetime (Lorentz frame). If either or both of these assumptions is locally violated, any or all of the conservation laws can be violated locally, even though the overall global conservation is still upheld. Quite simply, in that case one has opened the system (broken symmetry). In particle physics, broken symmetry already results in violation of one or more of the conservation laws. In leading Russian physics journals, papers are regularly published containing unrestricted general relativity with concomitant violation of any and all conservation laws.

LAWANDY PATENTS

Patents covering and related to anti-Stokes emission (excess emission of energy) in strongly scattering, optically active media such as TiO2 particles in suspension.

More energy is emitted than one must input to stimulate the effect. It is being hailed as a new form of lasing, without the requirement for population inversion.

LETOKHOV, V. S.

Russian pioneer in excess emission phenomena from stimulated media.

LETOKHOV EFFECT

The excess emission (overunity emission of energy) phenomena in strongly scattering, optically active media, usually referred to as "negative absorption of the medium".

For an overview, see V. S. Letokhov, “Stimulated emission of an ensemble of scattering particles with negative absorption,” **ZhETF Plasma**, 5(8), Apr. 15, 1967, p. 262-265; —“Generation of light by a scattering medium with negative resonance absorption,” **Sov. Phys. JETP**, 26(4), Apr. 1968, p. 835-839; — “Laser Maxwell’s Demon,” **Contemporary Physics**, 36(4), 1995, p. 235-243.

LOCALITY

Characteristic where interactions are local in spacetime.

LOCALIZED

Confined to a small region of a large system rather than being extended through the system or at a distance.

LOCAL VIRTUAL PHOTON FLUX OF VACUUM

Refers to a local region of the vacuum, which also refers to the vacuum flux density of that region.

LONGITUDINAL COMPONENT

In EM waves, the longitudinal component of the fields along the direction of travel,

...as opposed to the transverse components at right angles to the direction of travel.

LONGITUDINAL E-FIELD

We may divide any electrical field into two components, a transverse component and a longitudinal component.

Of course one or the other may be a zero vector.

LONGITUDINAL GRADIENT

Compression wave gradients (differences) in density or pressure,

...considered in a direction from their origin along the direction of primary movement, vs. transverse waves, which act perpendicular to that direction.

LONGITUDINAL INTERIOR WAVE

In conventional theory, the electric portion of the EM wave is a transverse field oscillation, and the longitudinal component is essentially zero.

In the new "infolded" wave approach, there is no overall transverse gradient in the vacuum potential, but there is an infolded longitudinal gradient which oscillates "inside the vacuum potential." This is rather like a "pressure wave" transmitted under water, without causing a surface wave involving physical upheaval and fall-off of the water. In EM, by analogy the speed of the "bulk upheaval" transverse wave is nominally c, the speed of light in vacuum [but see discussion of galloping waves, for what really happens!]. The speed of the pressure wave, under water, may be very much greater than c, because it is a special "tunneling" process and it also involves the galloping wave effect. Experimental measurement of superluminal tunneling velocities—such as more than 4c—are already well-known in the literature.

To better visualize this "pressure wave," consider that it is like a sort of "velocity modulation" upon the edge of the conventionally-visualized plane wave front of a traveling transverse wave, except now the plane itself does not move. All the succeeding planes are "bumped" by the velocity modulation of one plane, and so the velocity modulation propagates through (inside) the vacuum potential as a modulated pressure wave, without transverse change of the potential.

Now we have a very special medium! It consists of bidirectional EM wave pairs, one passing through the other. In such a case, it is already known that the speed of a "planar wave front" in the superposition and resulting interference of two oppositely moving waves can in fact greatly exceed the speed of light momentarily, then slow dramatically below than the speed of light, etc., so long as the average velocity is c. This is called the galloping wave effect. [E.g., see William G. Harter et al., "Galloping waves and their relativistic properties, **American Journal of Physics**, 53(7), July 1985, p. 671-679.]. Since the plane wavefront within the interior *can* in fact vary its velocity, we are quite free to use this "velocity pulse modulation" effect of wavefront speed variation, to place signal intelligence upon the planar wave front speed variations. So we can transmit hidden pressure waves with intelligence on them, through the interior of the vacuum potential. *Further, the restriction to an average velocity of c does not have to apply, and the planar pressure pulses can be transmitted much faster than c*. This is the basis of the work Fogal and I are struggling with, in order to achieve superluminal communication. It is also what we have been struggling with in an effort to come up with a communication system that can propagate infolded signals inside the H-bonding potential of the ocean itself, so that high-data-rate communications with deep submarines could be utilized, at any distance, and the huge, gawky, frightfully expensive, and environment-affecting ELF systems be done away with. We also think it should eventually be possible to develop an underwater radar type of system, but it's far too early at this point to try to conceptualize just exactly how it would work.

LONGITUDINAL WAVE

A "pressure" type of wave, similar to sound, in which the vibrations are along the direction of travel of the wave.

Hence, a wave composed of alternating densifications and rarefactions, where we focus upon the longitudinal component of the changes. In the past we have used the term "scalar waves" to imply longitudinal standing waves, such as in one infolded Stoney-Whittaker wavepair inside the scalar potential. In classical EM theory, the Poynting vector predicts no longitudinal wave of energy from a time-varying, electrically charged source. In fact, even in the ordinary theory, an exact solution of the problem does allow this longitudinal wave, as shown by Keech and Corum, **International Journal of Theoretical Physics**, 20(1), 1981, pp. 63-68. Conventionally, as explained elsewhere in this glossary, the classical electromagnetic wave is modeled as a vector string wave, comprised of transverse vibrations on implicitly assumed material taut strings in the vacuum. In the new approach, such transverse vector force field waves (Hertz waves) do not exist *as such* in vacuum; instead, two coupled, dynamic scalar potentials exist there. The **E** and **B** fields are formed and exist as the these potentials and their gradient coupling to spinning charged detecting mass particles.

LONGITUDINALLY

Of or in length. Running or placed or operating or changing lengthwise. Opposed to transverse.

LORENTZ, HENDRIK ANTOON

Renowned Dutch physicist and Nobelist, 1853-1928, who developed the Lorentz transformations and Fitzgerald-Lorentz contraction.

He shared the Nobel Prize for discovering the Zeeman effect.

LORENTZ INVARIANCE

An inertial frame is independent of the velocity of the frame relative to any other frame.

LORENTZ INVARIANCE PRINCIPLE

The principle that the laws of physics are the same in all reference frames.

LORENTZ REGAUGING

Changing the two potentials in the Maxwell-Heaviside equations in potential form so that the resulting equations have the variables separated.

An unfortunate effect is that this discards all Maxwellian systems far from equilibrium in their vacuum exchange, hence discards all permissible Maxwellian COP>1.0 systems.

LORENTZ SYMMETRY

Referring to the symmetrical regauging by Lorentz of Maxwell's equations.

LORENZ, LUDWIG VALENTIN

Scientist who first changed Maxwell's equations—two years after their publication in 1865—by (effectively) symmetrically regauging them, thereby unwittingly discarding all Maxwellian systems far from thermodynamic equilibrium with the active vacuum.

See L. V. Lorenz, "On the identity of the vibrations of light with electrical currents," Philosophical Magazine, Vol. 34, 1867, p. 287-301. In this paper Lorenz gave essentially what today is called the Lorentz symmetrical regauging.

Comment: (gratefully received from T. Barrett) This paper gave f(t-r/c) functions. Fitzgerald said that Lorenz's functions were essentially the same as his, and Fitzgerald became a leading proponent of "retarded potentials". But it is believed that Fitzgerald was unaware of Lorenz's work until the 1880's, so he is given credit for parallel development. Some people talk of Fitzgerald-Lorenz functions. This is a regauging, but the term "gauge" (inspired by railroad gauges) was first introduced by Hermann Weyl in the 1900s. He used it for a change in length and was shot down by Einstein's theory—Weyl's theory was not relativistic. The idea resurfaced in the 1920s when quantum theory was being formulated, but this time it meant "change in phase" and not "change in length".

Comment by T.E.B.: Thus "Lorentz" regauging of Maxwell's equations really was first done by Lorenz in 1967. However, not too much attention was paid to L. V. Lorenz' work (e.g., by Fitzgerald). When H. A. Lorentz later used symmetrical regauging (essentially Lorenz' regauging), his influence was so great that it was adopted straightaway and has remained adopted to this day.

LOW ENERGY NUCLEAR REACTION (LENR)

Cold fusion, or the anomalous transmutations of elements which occur in certain electrolytes with specially prepared palladium electrodes.

The transmutations occur even though in conventional theory there is insufficient energy to accomplish them.

Conventional science has rather vehemently attacked cold fusion and many of the cold fusion scientists, even though there are now hundreds of successful experiments in multiple laboratories throughout the world.

In our view, once the properly-prepared palladium lattices are loaded with positive ions, the formation of temporary, fleeting time-reversal zones in the electrolyte temporarily reverses the law of attraction and repulsion of charges. Thus H+ ions, e.g., may attract each other in even numbers (opposite numbers are forbidden by the Pauli exclusion principle), so closely that each enters the strong (nuclear) force region of the other, so that the group becomes a quasi-nucleus. Note that the gluons are partially "unglued" by the TRZ formation, and so the preferred method of "decay" of the anomalous TRZ state as the surrounding electrolyte ions move to negate it, is by flipping of a quark. One D+ ion coupled to one H+ ion, e.g., when attracted into a quasi-nucleus in a TRZ, may decay into tritium by flipping one quark and changing one of the protons into a neutron. Two H+ ions may decay into deuterium (D+) by flipping one quark and turning an H+ into a neutron. Two D+ ions may simply "tighten further" into a real nucleus as the TRZ decays, and result in an alpha particle (helium nucleus). The TRZ hypothesis does precisely explain the most important reactions that are experimentally shown to occur. For more on this hypothesis, see T. E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves," **Explore**, 8(6), 1998, p. 7-16; — ., "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves," Journal of New Energy, 3(2/3), 1998, p. 12-28.

MAGNETIC DIPOLE

Paired north and south magnetic poles of equal strength over microscopic or macroscopic distance.

MAGNETIC INDUCTION

The act of a change in magnetic field producing an electric field at right angles, which in turn produces electron flow.

MAGNETIC SPIN

Refers to the intrinsic angular momentum, known as spin, of electrons, protons, and neutrons, etc.

The electrons combined in an atom or ion have a resultant angular momentum, that is the combined intrinsic spin of the electrons and the angular momentum due to their motion around the nucleus. There is also a magnetic moment associated with this angular momentum (spin) whenever it is nonzero. Therefore atoms or ions with nonzero spin are *magnetic* atoms or ions. This is often loosely referred to as "magnetic spin." It is actually the magnetic moment of nonzero spin.

MAGNETOELECTRONICS

New microelectronic components which exploit the spin of the electron rather than its charge.

References: A Barthelemy *et al*., "Giant Steps with Tiny Magnets," **Physics World**, Nov. 1994, p. 34-38; G. Prinz, "Magnetoelectronics," **Science**, Vol. 282, 1998, p. 1660.

MAGNETORESISTANCE

A change in electrical resistivity in a material when a magnetic field is applied to the material.

MAGNETORESISTANCE, COLOSSAL

A very large change in electrical resistance observed in the manganese perovskite materials when a magnetic field is applied to them. The effect in these materials is the largest magnetoresistance effect known at present.

See N. A. Babushkina *et al*., "Metal-insulator transition induced by oxygen isotope exchange in the magnetoresistive perovskite manganites," **Nature**, Vol. 31, 1998, p. 159; L. I. Balcells *et al*., "High-field magnetoresistance at interfaces in manganese perovskites," **Phys. Rev**. **B**, Vol. 58, 1998, p. R14697; M. Blamire *et. al*., "Understanding and utilizing colossal magnetoresistance materials," **Phil. Trans. Roy. Soc. A**., Vol. 356, 1998, p. 1469-1712.

MAGNETOSTATIC SCALAR POTENTIAL

Roughly, the "pole strength" differential between the two poles of a magnetic dipole.

Anyone who wishes may polish this definition.

MASSLESS DISPLACEMENT CURRENTS

Currents without mass.

Examples in the standard theory include $d\phi/dt$, $d\mathbf{E}/dt$, $d\mathbf{P}/dt$, $d\mathbf{B}/dt$, etc.

MATTER

Highly condensed 3-spatial energy, compressed by the factor c^2 …

and with the observation process d/dt having been applied to the fundamental masstime entity to provide mass as a frozen snapshot. Matter, of course, has internal structure, order and organization, and dynamics. All matter is in a continuous energetic exchange with its vacuum (4-spatial) environment.

MAXWELL, JAMES CLERK

Brilliant scientist who first formulated the unified theory of electricity and magnetism.

James Clerk Maxwell was born on June 13, 1831 in Edinburgh, Scotland. In 1847 he entered the University of Edinburgh, then transferred to Cambridge in the fall of 1850. After graduation, he stayed on at Cambridge in a research position. He was elected a Fellow of Trinity College and placed on the staff of college lecturers. In 1856 he returned to Scotland, where he took up a Chair of natural Philosophy at Marishal College, Aberdeen. In autumn, 1860 he took a new position as Chair and Professor of Natural Philosophy and Astronomy at King's College, London (a position he held until 1865, at which time he resigned). Maxwell was financially independent. He was elected to the Royal Society in 1861, while at King's College. From 1865 to 1871 he resided at his ancestral Scottish country home, Glenlair, developing his major ideas into book form. Maxwell returned to Cambridge in 1871, where he became the first holder of the Cavendish Chair of Experimental Physics. There he also supervised the construction and operation of Cavendish Laboratory. His treatise on electromagnetism appeared in 1873. He held his position at Cambridge until he died on Nov. 5, 1879 at age 48, of a form of stomach cancer—the same ailment that had killed his mother when he was a child. [Thanks to **Encyclopaedia Britannica**!]

MAXWELL (UNIT)

Unit of magnetic flux, in the cgs system.

MAXWELL'S ELECTRODYNAMICS

Maxwell's electrodynamics is Maxwell's equations.

MAXWELLIAN SYSTEM

Any physical or electromagnetic system whose electrodynamic operations obey James Clerk Maxwell's electrodynamics model.

The term is usually applied with respect to those systems which obey a highly reduced subset of Maxwell's after the Lorentz regauging of the Maxwell-Heaviside equations. This subset is now inappropriately referred to as "Maxwell's equations". This is unfortunate. As a result, today many scientists and most engineers no longer understand that Maxwell's theory—when embedded in a higher topology algebra—permits a vast richness of additional EM systems and behaviors, including full unified field theory operations. In the standard U(1) gauge symmetry electrodynamics, all these higher symmetry functions and systems are excluded *a priori*. From our view, this is particularly sad since these arbitrary reductions of Maxwell's theory arbitrarily excluded all EM systems far from equilibrium in their exchange with the active vacuum. Hence almost all scientists and engineers believe it is against the very laws of nature to propose an electrical power system that produces more energy out—and more work in the load—than the energy input made by the operator himself. This sad error has resulted in (1) crippled electrical power systems that extract their output energy from the vacuum but kill themselves faster than they power their loads, (2) the giant pollution of the earth, (3) extraordinary energy costs, (4) struggles and wars over oil and energy resources, and (5) the looming giant economic collapse of the economies of many nations. Further, unless this latter facet is checked, it may also lead to (6) the unleashing of all the weapons of mass destruction in the arsenals of many nations, destroying all civilization and much of the biosphere.

McCREA

To be added.

MICHELSON, ALBERT ABRAHAM

German-born American physicist who invented an interferometer (Michelson interferometer) named after him. Michelson used his interferometer in a renowned experiment designed to measure the velocity of the earth through the ether, which would produce a shift in his interferometer pattern. No such shift was observed, which indicated the absence of an ether wind and was largely responsible for the downfall of the concept of the material ether which had been assumed previously.

Reference: Albert A. Michelson and Edward Morley, "Influence of Motion of the Medium on the Velocity of Light," **American Journal of Science**, Vol. 31, 1886, p. 377-386; — "On the Relative motion of the Earth and the Luminiferous Ether," **ibid.**, Vol. 34, 1887, p. 333-345.

MIND

From the medical view, with thanks to **Webster's Medical Desk Dictionary**, Merriam-Webster Inc., Springfield, Massachusetts, 1986: (1) The element or complex of elements in an individual that feels, perceives, thinks, wills, and especially reasons; (2) the conscious mental events and capabilities in an organism, (3) the organized conscious and unconscious adaptive mental activity of an organism.

See an extended discussion of *mind* under *energy*.

MIND-BODY COUPLING

To be added.

MIND-MATTER INTERACTION

The n-space interaction between the time-like mind and its time-like operations and the 3-spatial physical body and its 3-space operations. To first order, we may treat these interactions in four dimensions.

MIND OPERATIONS

To be added.

MOTION

To be added.

MOTIONLESS ELECTROMAGNETIC GENERATOR (MEG)

Transformer-like COP>1.0 electrical power generator invented by Bearden, Kenny, Hayes, Moore, and Patrick which powers the transformer core with a permanent magnet, but separates the curled magnetic vector potential A (the magnetic field B) from the uncurled magnetic vector potential A, so that the magnetic field flux is retained in the core while the A-potential is replenished outside the core and adjacent to it.

The overunity mechanism is thus provided by a version of the Aharonov-Bohm experiment, which proves that this splitting of the A-potential does occur and that the uncurled A-potential will interact energetically with electrons. In short, by "splitting the potential" and potentializing two paths to the same energy density as the original unsplit potential, the MEG doubles the available potential energy available via the permanent magnet dipole's broken 3-symmetry in the active vacuum. Both the curled A-potential (magnetic field) inside the core and the uncurled A-potential outside the core interact simultaneously with the output coils when pulsed. Thus the output coils "doubly interact" instead of singly interacting. This "double-dipping" of available energy flow allows permissible COP>1.0, since the system is far from equilibrium with the active vacuum exchange.

Pulsing applies the Lenz law effect to both the split potentials, further increasing the energy density of the two interactions with the output coils. The MEG nominally exhibits from COP = 1.7 to COP = 10, using two input coils.

See M.W. Evans, P.K. Anastasovski, T.E. Bearden et al., "Classical Electrodynamics Without the Lorentz Condition: Extracting Energy from the Vacuum," **Optik** 111(6), 2000, p. 246-248; — "Inconsistencies of the Maxwell-Heaviside Theory of Electrodynamics: The Aharonov-Bohm Effect," **Journal of New Energy**, 4(3), Winter 1999,p. 236-240; — "Vacuum Energy Flow and Poynting Theorem from Topology and Gauge Theory," submitted to **Physica Scripta** (in review); — "The Aharonov-Bohm Effect as the Basis of Electromagnetic Energy Inherent in the Vacuum," submitted to **Optik** (in review), — "Explanation of the Motionless Electromagnetic Generator with O(3) Electrodynamics, **Foundations of Physics Letters**, 2001 (in press). See also T.E. Bearden, "Energy from the Active Vacuum: The Motionless Electromagnetic Generator," in M.W. Evans (Ed.), **Contemporary Optics and Electrodynamics**, Wiley, 2001, 3 vols. (in press), comprising a Special Topic issue as vol. 114, I. Prigogine and S.A. Rice (series eds), ***Advances in Chemical Physics***, Wiley.

MULTICOLLECTION

Multiple collection of the same energy flow, by rerouting the passed Poynting energy back around to the collectors for another pass by them, with additional collection.

A common means of "returning" the Poynting flow for additional collection is retroreflection, as in phase conjugate reflection.

Since a nominal energy collection fraction on a single pass is only about 10^{-13}, a great many re-passes of the same energy can be returned. Work is done on the collector in each pass. One joule of energy can actually perform many joules of work; this is a change to the usual statement of the work-energy theorem, which assumes single pass, single collection only.

MULTIPASS RETROREFLECTION

Iteratively retroreflecting the same Poynting energy flow, each time it impinges on and passes by an intercepting collector, so that multiple passes of the same energy flow are made onto and by the collector.

More and more of the passing enormous energy is collected as more and more passes by are made. The collected energy is then dissipated as work in the circuit or device. Such processing can allow overunity EM circuits and devices.

MULTIPASSES

Multiple passes. See multipass retroreflection.

NANOTECHNOLOGY

The fabrication of devices with atomic or molecular precision, to produce operating devices with minimum feature sizes less than 100 nanometers.

Often described as a marriage between chemistry and engineering. The self-assembling of the units is referred to as *molecular manufacturing*, and the devices are built one atom or molecule at a time with programmed nanoscopic arms. As occurred with the modern machine and technology age, the first requirement is to develop the tools that do the working, and the "tools that build the tools." That fundamental work is off the ground and running already.

Nanomanufacturing plants capable of manufacturing bulk materials or arbitrary structures with atomic precision are envisioned, with almost every atom being placed precisely as desired.

Nanotechnology may well produce the next great scientific revolution. As an example, nanobots have been visualized that will circulate in a human body's bloodstream and specifically attack cancer cells. Nanobots for cleaning up air and water pollution are possible. Food synthesis is envisioned since the technology provides the ability to combine molecules directly.

As with all technologies, the ethics lies in the hands of the system designer and the user. Increased technology always allows greater use for good and greater use for bad purposes. Because of the extraordinary "evil uses" that can be employed in the use of nanobots, Bill Joy, chief scientist of Sun Microsystems, recommends no further development of nanotechnology and no further research. He stated,*"... we have the possibility not just of weapons of mass destruction but of knowledge-enable mass destruction… hugely amplified by the power of self-replication… we are on the cusp of the further protection of extreme evil…"*

Joy's fears are well-founded. Already the union of artificial intelligence with self-replicating nanobots is foreseen. If that union is successful, one can foresee the unleashing of what can only be called "species" of self-replicating, smart nanobots bent on the mass destruction of humanity in various ways.

Also, contrast the nanobots to our discussion of even more advanced nanotechnology of causal system robots (CSRs) using functioning system of causal fields (sets of longitudinal EM waves and their dynamics, prior to having interacted with charged mass, and thence being systems that are functioning sets of spacetime curvatures). We have already survived one massive world-wide insertion of an armada of such CSRs—fortunately first generation systems and with no countermeasures, so they were easily detected and destroyed. We may not survive the next such insertion and attack, as the maturity of the CSRs increases.

Considering the usual focus of governments and human control systems, my prediction is that *detrimental, self-replicating, smart* nanobots for use in war, surprise strategic attack, and mass destruction of human targets is already on the early planning boards. The obvious war applications of nanotechnology will advance faster than the peaceful applications, behind a public screen of simpler benevolent developments. This is almost certain, since the lead time for maturing the nanotechnology is from 10 to 20 years. This long lead time rules out most private capital ventures of substantial magnitude. It results in the requirement for government funding, just as development of the atomic bomb was government funded. As a nanotechnology "arms race" begins and heats up, one will see the equivalent of new but hidden "Manhattan Projects" in specialized mass

destruction weapons nanotechnology. Rather substantial funding of nanotechnology research and development by several nations is already a fact.

Unethical aspects aside, the potential for useful and benevolent purposes of nanotechnology is very great. The development in this new field is now beginning to escalate almost exponentially, year by year, funded primarily by governments and to a more limited extent by private companies.

Reference: David Cook, Jessica Voorhees, and Brian Valz, "Nanotechnology: The Coming Molecular Revolution," available on website http://nanotech.about.com.

NEGATIVE ABSORPTION OF THE MEDIUM

Excess emission from a medium, as in the Letokhov work and in Bohren's experiment. The excess energy is received from the vacuum interaction.

NEGATIVE RESISTOR

Any component or function or process that freely receives energy from outside the system in unusable or disordered form and outputs that energy in usable, ordered form inside the system, where that is the net function performed.

We specifically do not include "differential" negative resistors such as the tunnel diode, thyristor, and magnetron which dissipate and disorder more energy from the system, overall, than they order and furnish to the system in their negative resistance regime.

NEGENTROPIC

Functioning to produce or involve negentropy.

Reordering previously scattered energy without requiring the operator or experimenter to input energy to do the reordering work (an example is passive retroreflection of scattered EM energy).

NEGENTROPIC ENGINEERING

Expending a little bit of energy to form a dipole or dipolarity, and then intercepting, collecting, and using some of the enormous EM energy freely extracted by the dipole from the vacuum indefinitely, without using any of the extracted EM energy to scatter the charges in the dipole and destroy the dipole, thereby shutting of the vacuum's furnishing of copious free energy.

NEWTONIAN 3RD LAW

For every action there is an equal and opposite reaction.

This law should be extended and restated something like this: "for every action there is an opposite and equal reaction if the causative mechanism of the reaction is allowed to occur and not first redirected away from its target." An example of a violation of Newton's third law as usually stated, is provided by the emission of a phase conjugate replica wave from a phase conjugate mirror material. No matter how powerfully pumped, the PCM does not recoil. The reason is that the antiwave cause of Newtonian third law recoil was intercepted by nonlinear multiwave interaction before it could reach its target nuclei, and rediverted away from the atom and on out of the material. Since the causative mechanism for Newtonian recoil did not occur, the PCM did not recoil.

NEWTONIAN RECOIL

As used in the paper, refers to Newton's third law reaction created as the recoil of the nucleus of an atom which absorbs an incoming EM longitudinal wave, or emits one.

NEWTON'S THIRD LAW

For every action there is an opposite and equal reaction.

In Maxwell's electrodynamics, Newton's third law is missing. It is missing because of the coarseness of the modeling which Maxwell was forced to use. Maxwell's seminal paper was read in 1864 and published in 1865. At the time, neither the electron nor the atom had been discovered, much less the nucleus of the atom. A molecule was just a blob with no structure. Electricity was considered to be a thin material fluid, flowing through the wires much like water through a pipe. In fact, Maxwell actually wrote a material fluid flow theory, since hydrodynamics was developed at the time.

So there was, at the time, no notion of the Drude electron gas in a wire and the positively charged nuclei in the atoms in the wire. So there was no notion of two oppositely charged entities in the conductor, both reacting to any EM field entering from space and interacting with the wire.

Further, Newton's third law had always been used mystically without any known cause. It was experimentally established that the reaction occurred, but scientists were forced to just assume its occurrence.

Consequently, Maxwell wrote equations for the reaction of a unitary electric fluid in the conductors. He knew that the wire recoiled, but wrote no equations containing the cause of Newton's third law reaction.

What really happens in the wire is that both the Drude electrons rearrange their positioning vis a vis the lattice, resulting in an apparent current. The actual movement (drift velocity) of the electrons down the wire is very slow, in a nominal case being a few inches per hour. The electrons, having spin, act as little gyros so to speak, longitudinally restrained by the repulsion of the electrons ahead. So the electrons precess laterally, and spend most of their movement in lateral precession movement. This alone proves that the perturbing force is longitudinal, as indeed does Whittaker's decomposition of the scalar potential into longitudinal EM waves. The gradient of the scalar potential (the E-field) is also such a decomposition. But the electron precession waves—which is what our instruments measure in the wire—are indeed lateral waves, in general consonance with Faraday's notion that the force field lines were physical and like taut strings. Maxwell merely assumed Faraday's notion, to give us the transverse EM wave in space. Consequently, the old electrodynamics envisioned that fluid vibrations (ether vibrations) from space had been intercepted by the wire to shake the electric fluid accordingly. And since that electric fluid obviously shook laterally, that "proved" that the waves in spacetime were lateral "plucked taut string" type waves. Actually it proved no such thing, because they were measuring electron precession waves.

The positive nuclei usually have a m/q ratio several hundred thousand times the m/q ratio of an equal charge of electrons. Hence the massive nuclei also react to the field interaction, and move very slightly in the opposite sense from the electrons. That reaction is ignored in Maxwell's general equations, though when the equations are applied, they require that nuclei movement.

In short, the electrons precess and the nuclei recoil oppositely, and that is the generation of Newton's third law reaction.

When we excite a wire antenna with a wave excitation, we produce both electron precession waves and nuclear recoil waves in the nuclei. These two waves are of equal energy, though the nuclei waves are very highly damped in magnitude because of the

high m/q ratio of the nuclei. Nonetheless, each of these "lateral" waves slaps the vacuum potential with *identical energy*. So two equal waves of spacetime curvature occur. I can be seen that the net vacuum wave is actually a longitudinal EM wave, composed of waves of vacuum (spacetime) energy rarefaction and densification. Electrodynamicists, considering the vacuum to be filled with a material ether, used the "effect" wave in matter as the cause wave. Hence they used a transverse EM wave in spacetime, when indeed the spacetime wave is and always was a longitudinal EM wave, just as Tesla insisted.

Maxwell's equations are based primarily on the interaction of field and single charge. Actually, the reaction is always between the field and a dipole. Even when the field interacts with an "isolated charge", there are clustering virtual charges of opposite sign around the "isolated" charge so that the "isolated charge" is actually a set of composite dipoles, where each dipole consists of a virtual charge of opposite sign and a differential piece of the isolated observable charge. So the Newtonian third law reaction is also there with an isolated charge, but occurs in the vacuum itself, resulting in vacuum polarization.

Nonetheless, the "transverse EM wave in vacuum" notion is so embedded in electrodynamics that we seem to be stuck with it. It means, however, that the "field in space" used in electrodynamics must be regarded as only a sort of "convenient transfer function" and not a real transverse oscillation entity. This of course accords with Feynman and Wheeler's pointing out that only the potential for the EM wave exists in space, in case a charge is brought in to interact with its gradients.

And needless to say, since the vacuum is a big potential and only potentials and potential changes can exist in it, then Whittaker's 1903 paper decomposing the scalar potential into longitudinal EM waves is paramount and decisive. EM waves in the vacuum a priori must be longitudinal waves, because they are only the changes to the vacuum potential. And that potential at each and every point, changes and all, decomposes into longitudinal EM waves in 3-space with convergent longitudinal EM waves incoming from the time domain.

NISBET

To be added.

NON-ABELIAN ELECTRODYNAMICS

To be added.

NONLINEAR MATERIAL

A substance whose optical properties vary with the intensity of the light.

Most optical substances are very weakly nonlinear, but a great deal of research has been exerted to find materials with stronger nonlinearities. Also, a material which creates and emits the fundamental and additional harmonic frequencies when illuminated with a single frequency. Many nonlinear materials also weakly produce time-reversed (phase conjugate) fundamentals and/or harmonics when illuminated with a fundamental frequency. Such a nonlinear material that creates time reversed waves (phase conjugate replica waves) is said to function as a *phase conjugate mirror*. The phase conjugate replica reappears in space back along the path in space—even through a highly distorting medium—where the input stimulus (signal wave) has traveled or is traveling.

Thus the phase conjugate replica or time-reversed wave normally backtracks its signal wave stimulus to the distant source of that signal wave, even hundreds or thousands of miles away. This "crawfishing" and "concentrating" characteristic is also known as *retroreflection*. Note that an ordinary EM wave *diverges* as a function of the radius traveled away from its emission source, while a time-reversed or phase conjugate replica wave will *converge* as a function of the radius traveled away from its emission source (the mirror), if its stimulus signal wave was emitted from a distant point source. Ideally, a phase conjugate mirror produces a single time-reversed wave in addition to the input signal wave. By stressing *(pumping)* the mirror with the input of two additional opposing waves (ideally orthogonal to the input or *signal wave*), the phase conjugate replica wave output by the mirror is amplified, and may contain up to all the energy in the pumping waves.

NON SEQUITUR

A conclusion or inference not following from the original argument or premise.

NONEQUILIBRIUM THERMODYNAMICS

Colloquial term referring to the new thermodynamics of self-organizing systems and structures in disequilibrium with their environment.

Since the 1960s, there has emerged in physics (and in thermodynamics!) a surprising new area: the physics of far-from-equilibrium systems and the self-organization and large-scale ordering of such systems. E.g., a single Bénard cell (a particular self-organizing circulation structure in convection-type systems), may involve the coherent behavior of some 10^{21} molecules, in a region of convection where one would classically expect only randomness. These new physics and thermodynamics interactions are surprisingly being found in a very wide variety of systems and phenomena, including living systems and nonliving systems. The phenomena of interest include dissipative systems in disequilibrium with their environment, but with stability of their own systems and forms. Open systems in disequilibrium with their environment can permissibly achieve COP>1.0, and they can exhibit local negentropy. The physics and thermodynamics of such systems is still rapidly developing. For a good overview, see Gregoire Nicolis, "Physics of far-from-equilibrium systems and self-organization," in **The New Physics**, edited by Paul Davies, Cambridge University Press, 1989, p. 316-347. For a full technical presentation, see G. Nicolis and I. Prigogine, **Self-Organization in Nonequilibrium Systems**, Wiley, New York, 1977.

NONLINEAR MATERIAL

In physics, any substance whose response to an external causative or influencing agent is not proportional to the magnitude of the causative agent or influence.

NONLINEAR OPTICAL FUNCTIONING (NLO FUNCTIONING)

Functioning in a manner prescribed by nonlinear optics and quantum optics,

...particularly with respect to time-reversal effects, use of phase conjugate mirrors, phase conjugate reflection, and pumping for amplified phase conjugate reflection.

To quote Knight, "A phase conjugate mixing device has remarkable optical properties: perfect retroreflection, the complete cancellation of optical aberrations and inhomogeneities in wavefronts, and the ability to reverse an optical beam and return it to its source."

NONLINEAR PHASE CONJUGATE OPTICS

See *phase conjugate optics*.

NONLOCALIZATION

Producing or rendering an effect or effect-producing agent at a distance, rather than at the immediate location of the effector.

Extended throughout a large region or system, or to a distant part of a large region or system, rather than being confined to a small region of the large region or system.

NON-RIEMANNIAN (GEOMETRY)

Riemannian geometry is the geometry of Riemannian manifolds;

i.e., manifolds having an infinitesimal squared distance ds that is everywhere positive. A non-Riemannian geometry violates this property. [A manifold is a topological space with certain technical characteristics.]

NUCLEONS

Name for the neutrons or the protons in a nucleus. In the nucleus, the neutrons and protons are continually changing one into the other by exchange of the charge.

O(3) ELECTRODYNAMICS

To be added.

OPEN SYSTEM

A system that communicates with its environment, and exchanges energy, matter, or both between system and environment.

The system may be in equilibrium with that exchange, so that it effectively does not retain and utilize received environmental energy to power loads or accomplish external work. Note that it may in fact receive and store excess energy from the environment, or give up energy to the environment, and then remain in equilibrium under its new potential energy conditions. That is, the system may asymmetrical regauge itself but not utilize any of the regauging energy to accomplish external work. When potential is applied to an electromagnetic system, the system is similarly asymmetrical regauged and its potential energy is increased. However, if the system then destroys its source of regauging potential energy faster than it powers its load, it is said to symmetrically regauge itself when discharging its freely received excitation energy.

The system may be far from equilibrium in its energetic exchange with its environment, and if it asymmetrically discharges its freely received excitation energy, it can exhibit COP>1.0. In that case the system effectively retains and utilizes some of its freely received environmental energy to power loads or accomplish external work, and the operator himself does not have to furnish that part of the energy dissipated as useful work.

OPTICAL SWITCHING

Refers to switching of optical signals, or switching using optical frequency switching techniques, components, and circuits.

ORTHODOX TRANSISTORS

Ordinary transistors in use today.

Such transistors will not perform the Fogal semiconductor special functions.

ORTHOGONAL ROTATION

Simply speaking, a rotation from one direction to a direction at right angles to it.

The Lorentz transform of special relativity, e.g., is a formula for the rotation of an object and all its parts away from its line of motion, as a function of the object's velocity, in a direction toward the time axis. The speed c just represents a full orthogonal turn, so that the intersection of the object with the observer 3-space, along the original line of motion, is zero.

To the observer, the three dimensional object (at speeds less than c) has become a two-dimensional plane moving at speed c. In a space of more than 4 dimensions, the orthorotation may be toward a higher spatial dimension rather than toward the time dimension. As can be seen, such orthorotation is intimately connected with the transformation of an electron or electron/positron pair into a photon, and vice versa. Orthorotations are extremely important when one models the physics of mind and matter interaction, and the physics of a living organisms including both its mind and its physical body—as in psychoenergetics.

OSCILLATING QUANTUM WELL

A quantum well which is oscillating in magnitude and sometimes in sign.

OVERPOTENTIAL

Essentially the overpotential (as in an electrode in a solution) is a shift in the Fermi level necessary to allow the electron in the electrode metal to have energies overlapping with vacant acceptor levels in molecules adjacent to the electrode in the solution.

The overpotential effect appears at small "double surfaces" of things in very close contact, particularly in electrochemistry and in solid state physics. The overpotential enables electron transfer, e.g., by tunneling. The overpotential increases with the log of the reaction rate that occurs at the overpotential location.

For a small reaction rate, the overpotential is small; but for a small increase in the overpotential there occurs a *dramatic* increase of reaction rate. Fogal has utilized the overpotential effect in his semiconductor, to great advantage in accomplishing unusual charge blocking and other special effects.

One of the world experts in the theory and use of the overpotential is Dr. J. O'M. Bockris. E.g., for a short overview pointing out the importance of the overpotential, see Bockris, "Overpotential: a lacuna in scientific knowledge," **Journal of Chemical Education**, 48(6), June 1971, p. 352-358 (a paper which Bockris graciously sent me some years ago). Quoting from that reference, p. 355: "The formal definition of overpotential is 'the change of potential of the electron-conducting phase when reaction rate across its interface with the ion-conducting phase with which it is in contact is changed from zero to a certain velocity.'" And again, p. 355: "...overpotential... in fact determines what fraction of the energy of the self-functioning cell has to be wasted in making the cell work and deliver energy at a certain power." For a more detailed and wider exposition of the overpotential, its effects, and its uses, see J. O'M. Bockris and A. K. N. Reddy, **Modern Electrochemistry**, Vol. 1 & 2, Plenum Press, 1970.

OVERUNITY COEFFICIENT OF PERFORMANCE

More energy out or work out of a system than the operator or experimenter must himself or herself furnish and input.

An open thermodynamic system far from thermodynamic system is permitted to achieve such an overunity performance, so any overunity electrodynamic system must be such. Well-known nonelectromagnetic examples are solar cells, heat pumps, windmills, sails on sailboats, waterwheels for powering watermills, a gliding bird in thermal updrafts, etc. A well-known electromagnetic example is the common solar cell. The common household heat pump has a theoretical COP limit of 8.22, and well-designed units usually achieve some 4.0 or so, so long as the ambient environment does not change too drastically from the design limits. As the environment changes and cools down appreciably, however, most home heat pumps lose efficiency and have to switch onto heating strips, which have a COP ≈ 1.0.

Contrary to prevailing belief, it is certainly possible to have EM systems which are also open thermodynamic systems, far from equilibrium, and freely receiving excess energy (asymmetrically regauging a potential) from an external source, to wit, their violent virtual flux exchange between the vacuum and the system. All EM system are already *open systems* in the virtual particle flux exchange with vacuum; that is already well-known in particle physics, even though the 130-year-old classical electrodynamics does not even include the vacuum-mass exchange. The only question, then, is how to establish an asymmetry in that vacuum-mass flux exchange. Here again, every electrical charge and every dipole is already just such a broken symmetry in the vacuum flux, as has been known in particle physics for four decades! It takes on the average about 50 years, however, for vital discoveries in one discipline to "cross fertilize" into another discipline. At any rate, the symmetry of every electric power system, in the vacuum flux, is already broken in its source dipole. This rigorously means that, if we simply avoid doing something we are doing in our power systems to restore symmetry as a matter of course, it is possible to utilize the free broken symmetry of the source dipole to provide an overunity EM system.

In 1996 I showed that such overunity EM systems are permitted and prescribed by Maxwell's theory, prior to the arbitrary imposition of *symmetrical* regauging of the Maxwell equations (i.e., the Lorentz condition). Violation of the Lorentz condition (by asymmetrical self-regauging) is a necessary but not sufficient condition for an overunity EM device. An asymmetric regauging will certainly give us excess free energy in the system, and an excess force to use that energy in translating against a load impedance to do work, if we design the system properly to do just that.

To achieve overunity, in a circuit one must prevent the (presently universal) re-imposition of the Lorentz condition by the use of one-half the excess received energy to drive the return electrons from the load back through the back emf of the source, killing the gate and restoring symmetry, the Lorentz condition, and equilibrium between vacuum flux and system. All our present EM systems are specifically designed to drive those electrons back through the back emf and thus restore symmetry, *deliberately* asymmetrically self-regauging a second time and *deliberately* restoring the Lorentz condition, along with *deliberately* killing the source dipole's asymmetry in the vacuum flux exchange.

PARADOX (LOGICAL)

A thing that is true, e.g., as shown by experiment, but which violates one or more of the three Aristotelian laws of logic.

Any logic algebra or system has a topology. A paradox in one topology can often be resolved by increasing the topology of the logic. All logical paradoxes in the 3-law Aristotelian logic system are simply fourth-law logic cases in a logical superset, and—at least hypothetically—the fourth law can be applied to resolve them. For a discussion and proof of the 4th law correction to Aristotelian logic, see Appendix III: "A Conditional Criterion for Identity, Leading to a Fourth Law of Logic," in T.E. Bearden, **AIDS: Biological Warfare**, Tesla Book Co., Chula Vista, California, 1988, p. 428-443. Logic has many aspects that often may shock our casual expectations: For example, one of the most advanced axioms in mathematics is called the Axiom of Choice. It is used in the proof of many advanced theorems. Using the Axiom of Choice, it can be shown that it is possible to cut a ball into a finite number of pieces, then reassemble the pieces into two balls of the same size, with no air gaps between pieces! While this seemingly defies all common physical sense (and I've not found anyone who has done it!), it is mathematically correct. For a proof, see Thomas J. Jech, **The Axiom of Choice**, American Elsevier, New York, 1973, p. 3-6. For a good perspective on Aristotelian logic, see Morris Kline, **Mathematics: The Loss of Certainty**, Oxford University Press, New York, 1980.

PARITY

Deals with studying a system of sequence of events as if reflected in a mirror. A system has parity is it undergoes no fundamental operational change if replaced with its mirror-reflected twin.

PARTIALLY TIME-REVERSED REGION

A region of space in which an object experiences not only the ordinary forward flow of time, but an extra induced backwards flow of time, usually a fraction of the time-forward time stream.

One result may be to "reduce" time-forward force fields, by a fraction. This is important in bridges, where one must pass EM energy flow onto a follow-on load circuit, but the return current in that circuit must be allowed to circulate back through the load bridge itself, against the inducing back emf. By partially time-reversing the region occupied by the back emf, that back emf is seen as a smaller value by the return current being passed back up through the back emf. The result is that current will circulate in the load loop, powered entirely by the bridging of Poynting flow $\mathbf{S} = \mathbf{E}\times\mathbf{H}$ onto the load circuit.

Another result of a partially time-reversed region is that the law of attraction and repulsion of charges is partially reversed. If the time-reversal predominates in the region, as in a momentary time-reversal zone in some electrolytes, then the law of attraction and repulsion of charges is reversed. In that case like charges attract and unlike charges repel. Two positive H+ ions, e.g., may be drawn so tightly together that each enters the edge of the strong force region of the other, forming a quasi-nucleus. Note that in each H+ ion the gluon forces are almost dissolved and the quarks are nearly freed. Then as the time-reversal zone decays back to a normal time-forward zone, the decay changes begin from inside out, resulting in the flip of a quark to change one of the H+ ions to a neutron n. The n and the H+ ion draw together as the preferred decay state, resulting in the formation of deuterium or a D+ ion. This and similar "time reversal zone" reactions have been proposed by this researcher as the mechanisms generating the anomalous deuterium, tritium, and alpha particles (helium nuclei) in the "cold fusion" reactions. It is indeed a special type of low spatial energy fusion, but a very high energy reaction since time-energy is involved as the active ingredient, and time-energy has the same energy density as mass.

PARTICLE PHYSICS

The branch of physics using accelerators to study high-energy particle collisions, to determine properties of atomic nuclei and of the elementary particles themselves.

So far as I am aware, conventional particle physicists do not consider time-energy interaction and time-reversal zone novel nuclear interactions at all.

PATTERSON EFFECT

The intense multiscattering, multipass, multicollection of Poynting energy density flow in an assemblage of palladium-clad spherical bead capacitors, as the palladium adsorbs hydrogen ions from the fluid in which the beads are immersed, and charges

up as a capacitor, thereby becoming an energy-flow generator, and nonlinearly increasing the energy-flow as the charge of the capacitors increases.

The Patterson effect yields the Patterson Power Cell® , a validated overunity power system which has shown COP>1200 in independent university testing. The Patterson effect is a variation and adaptation of the well-known anti-Stokes emission effect, which for three decades has been validated in physics journals to produce overunity emission in certain intensely scattering active media.

PATTERSON POWER CELL®

Patented overunity power unit by James Patterson, which has been independently validated to yield COP>1.0.

See James Patterson, "System for Electrolysis of Liquid Electrolyte," U.S. Patent No. 5,372,688, issued Dec. 13, 1994. Filed Dec. 2, 1993. 26 claims, 7 drawing sheets.

PAUTRIZEL, RAYMOND

Eminent French parasitologist who worked with Antoine Priore, and who performed many definitive experiments demonstrating the Priore healing effect.

PEGRAM'S EXPERIMENT

Experiment which demonstrates a relation between electric and magnetic fields in the vacuum which the Maxwell-Heaviside theory does not prescribe.

Simultaneously, a coaxial cylindrical condensor and solenoid are rotated. The rotation produces a magnetic field in the solenoid in the axial direction and between the plates of the condensor. The condensor can be charged by shortening the plates of the condensor. This indicates a cross relation in the vacuum between electric and magnetic fields which does not exist in the Maxwell-Heaviside theory.

Reference: G. B. Pegram, **Physical Review**, Vol. 10, 1917, p. 591.

PERPETUAL MOTION MACHINE

Assertion that no machine can indefinitely operate, since no closed system can input its output power back to itself while powering a load because powering itself and its load violates the equilibrium thermodynamics (i.e., the thermodynamics of a closed system).

The "defenders of the underunity faith" use the statement that "there cannot be any such thing as a perpetual motion machine" as an article of faith and iron dogma. Usually they classify a so-called "perpetuum mobile" as to which law of *equilibrium thermodynamics* it is thought to violate.

For permissible Maxwellian overunity systems, the entire "perpetual motion" conundrum is nonsensical, since we are always speaking of an EM system *far from thermodynamic equilibrium* with its active vacuum environment. The *equilibrium* thermodynamics assumed by the critics does not even apply to such systems, as witness the Nobel Prize awarded to Prigogine in 1977 and the voluminous literature on such open dissipative systems.

As an example, see Stanley W. Angrist, "Perpetual Motion Machines," **Scientific American**, vol. 218, Jan. 1968, p. 114-122. Angrist gives a typical critique using classical equilibrium thermodynamics. He calls *permissible* overunity systems (open dissipative systems receiving excess energy from an external source) *false perpetual motion machines* or *fictitious perpetual motion machines*. Also see Angrist's article, "Perpetual Motion," **Encyclopaedias Britannica, Bicentennial Edition, Macropaedia** Vol. 14, 1976, p. 102-105. Here he gives a very good summary of the subject as ordinarily posed, with precise definitions included for perpetual motion machines of the first, second, and third kinds and for fictitious perpetual motion machines. Unfortunately his entire argument is completely irrelevant to any study of permissible overunity machines, which he already has labeled as "fictitious perpetual motion machines" and has already admitted that they exist! The substance of his entire argument is that systems in equilibrium cannot power themselves. That is of course quite true, but is a mere tautology and has no relation to an open system in disequilibrium, which *can* power itself and its load simultaneously, by the laws of physics and the laws of *disequilibrium* thermodynamics. So in fact Angrist, as do the skeptics who continue to assail legitimate overunity EM system researchers as perpetual motion nuts, establishes his own dummy strawman and demolishes it, while ignoring—so to speak—the huge Statue of Liberty before him.

Now this is not to pick on Angrist! He appears to be a reasonable scientist, carefully stating his thesis in a straightforward manner. His voice is quoted as a *reasonable* critical voice, and not like the usual *extremist* critic who engages in ad hominem attacks from the outset. It merely shows that (1) the entire "perpetuum mobile" prohibition does not even apply to overunity EM systems far from thermodynamic equilibrium with the active vacuum, (2) the critics are either unwittingly or deliberately using the wrong type of thermodynamics as the basis of their entire argument, (3) the *reasonable* perpetual motion critics—wittingly or unwittingly—simply set up an irrelevant strawman and precede to knock it down, and (4) in fact the critics already admit to a machine that will in fact run itself and power its load indefinitely or perpetually unless something changes or breaks or fails, but then oddly label it as a "fictitious" or "false" perpetual motion machine! Meanwhile, in the universe around us we universally observe things in violent and perpetual motion, having continued so for some 15 billion years. None of the atoms seem to be running down, nor do any of the molecules. And they are open systems brought out of equilibrium by absorption of energy, and decaying back into equilibrium (or approaching it) by emission of excess energy.

The eerie point is that technical publications such as **Scientific American** and **Encyclopaedia Britannica** do not seem to question the line of reasoning advanced by those knocking perpetual motion, or even fully analyzed their argument. What we really deal with in terms of skeptics in this area is either (1) a reasonable, scientific skeptic such as Angrist (his listing of machines and attempts for machines not in disequilibrium with their active environment to run themselves is very good), or (2) an unreasonable person spouting dogma and venom, who should simply go read some disequilibrium system thermodynamics and learn etiquette.

Also, we strongly object to supercilious phrases invariably employed by harsh skeptics who insist we are looking for "something for nothing" or "a free lunch". No legitimate overunity energy researcher has ever considered such a thing. We freely admit that the excess energy is received from the active vacuum exchange, via a broken symmetry in that exchange. Should the farmer refuse to use a windmill or waterwheel because he's getting a "free lunch" for energy input? For those who so quickly hurl such condemnatory phrases, let me hold up a mirror and show them an analog of their position: The famed surgeon Alfred Velpeau wrote in 1839: *"The abolishment of pain in surgery is the chimera. It is absurd to go on seeking it today. 'Knife' and 'pain' are two words in surgery that must forever be associated in the consciousness of the patient. To this compulsory combination we shall have to adjust ourselves."* [Martin Gumpert, **Trail-Blazers of Science**, Funk and Wagnalls, New York, 1936, p. 232.]

The strident, dogmatic critics of open overunity disequilibrium EM systems are stating an exact analogy to Velpeau's statement. The *scientific* worth of their criticism is precisely the scientific worth that eventually was shown for Velpeau's pronouncement.

PHASE CONJUGATE

Of an entity: its time reversal. For waves, often referred to as *wavefront reversal*.

PHASE CONJUGATE MIRROR

A nonlinear material which, when provided with an input wave, emits a phase conjugate replica (time reversed replica) of that input wave.

The input wave is by practice called the *signal wave*. The time-reversed wave output is by practice called the *phase conjugate replica*.

PHASE CONJUGATE OPTICS

That portion of nonlinear optics dealing with multiwave mixing, formation of time-reversed waves, phase conjugate reflection (PCR), phase conjugate mirrors (PCMs), pumping PCMs to amplify their emitted PCRs, nonlinear interferometry, distortion correction, self-targeting, laser tracking, adaptive optics, and so on.

PHASE CONJUGATE REPLICA (PCR)

Of a wave: the time-reversed duplicate of the wave.

PHASE-CONJUGATING ACTION

In nonlinear optics, the process or action of producing a time reversed replica of an input wave.

For a particle, producing its antiparticle. For a cell, dedifferentiating it back to some previous form, genetics and all.

PHASE CONJUGATION

In nonlinear optics, the novel nonlinear mixing of waves which generate an output wave—called the phase conjugate replica or time-reversed replica—that precisely retraces the path previously taken by the input wave that stimulates the action.

The process or action of producing a time-reversed wave. Phase conjugation can compensate for aberrations and distortions in the input. Real time holography can also be produced by applying the phase conjugation process.

PHASE-LOCKED HARMONIC SERIES

In Whittaker decomposition of the scalar potential: The decomposition produces a set of bidirectional wavepairs, as explained previously.

Each of these wavepairs has a given frequency, starting from a fundamental. In other words, the other wavepairs are harmonics of the fundamental wavepair. Further, these are regularly arranged in a lattice, so that "timing" or "phasing" is rigidly locked in place.

PHENOMENOLOGY

In physics, the philosophical and experimental study of physical phenomena,

... as distinguished from ontology, (which is the study of being).

PHOTON

In physics, the basic action quantum.

Considered to be the basic quantum of the EM field. Well, there's a little problem with that. The photon contains energy and time, and so must also occupy a time interval. The notion of forcefield rigorously contains mass as a component; yet mass is missing from the concept of field as it is applied. The EM field is conceived as a spatial entity only. It may spatially vary as a function of time, of course, but it itself does not occupy time, at least conceptually. These considerations raise some startling difficulties in the ready conclusion that the photon is the fundamental quantum of EM field. If a "piece of the photon" is missing from the field, how can the field be made of photons? How can one get area out of a straight line? I simply pose this problem for the theorists and the foundations physicists, pointing out that it has universally been fashionable for physicists to ignore that *the photon carries not only a little increment of energy, but also a little increment of time*. My own work has been to look at the dimensional difference between masstime and mass; i.e., between a mass that has just absorbed a photon, and thus must consist of masstime (4-space), and just after that masstime then re-emits the photon, reverting back to mass (3-space). From this one can build, e.g., a mechanism that generates the actual flow of time itself. It is in theory an engineerable mechanism.

PHYSICAL REALITY

To be added.

PING-PONG

To be added.

PINNA

The outer ear(s). Of particular interest to us are the tiny little folds in the ear.

PINNA INFORMATION

Refers to hidden information content of the field, or in the received signal.

Comes from the little folds in the pinna (outer ear). For sound direction and distance sensing, the tiny pinna folds of the outer ear use phase reflection information more than 40 dB below the primary sound signal that strikes the eardrum. In EM signals, we are referring to "hidden" or infolded information deep within a signal from a distant target. In fact everything in the target contributes to the signal emission from it, and all that information is riding "within" the signal, in its deep "pinna" information. The Fogal chip can outfold some of this pinna information, so that information can be recovered from a signal which no other process heretofore could recover. For a dramatic future use, as the Fogal semiconductors and equipment using them are developed, there will emerge detecting units that can see highly detailed structure in the human body, merely from processing the light reflected from the exterior of the body. The details eventually will rival and even surpass that of magnetic resonance imaging, and will be essentially noninvasive.

It is also true that hidden "vacuum engines" can be transmitted back into the body, so that "problems" or disorders can be directly corrected. As an introduction to this type of area, where cellular disease "antiengines" can be created in the body to directly reverse cells and their genetics, curing the disease, see T.E. Bearden, "Vacuum Engines and Priore's Methodology: The True Science of Energy-Medicine, Parts I and II." **Explore**!, 6(1), 1995, p. 66-76; 6(2), 1995, p. 50-62. A major book on this subject will soon be published. For a presentation for the nonspecialist, see T. E. Bearden, "Hidden Mechanism for Reversal of Diseased Cells to a Previous Healthy State," **Resonance**, Newsletter of the Bioelectromagnetics Special Interest Group, Mensa, No. 29, Nov. 1995, p. 11-15.

PINNA INFORMATION CONTENT

In electromagnetics, the hidden inner Stoney-Whittaker-Ziolkowski infolded EM information inside the scalar potential.

Since an EM wave can be represented as two scalar potentials, then by infolding pinna information inside one or both of the two potentials, it is infolded inside the carrier wave. Thus hidden information can be and is carried by all EM radiation and all EM signals. The Fogal semiconductor for the first time enables the outfolding and processing of some of this information.

PINNA INFORMATION DETECTORS

Detectors based on use of the Fogal semiconductor, which can outfold, process, and display some of the hidden information inside the scalar potential and inside signal emissions from distant objects.

PINNED ELECTRONS

Electrons held stationary by a magnetic field, or other set of forces that react to "push them back into their positions" whenever they try to move away.

PINNING

The act of restricting (by restoring forces and fields) movement (particularly of electrons) due to a disturbing magnetic field or other external force.

POLYHEDRON

A solid figure, especially with more than six plane surfaces.

POSITRON

An antielectron (time-reversed electron), possessing a positive charge. In Dirac's relativistic theory of the electron, a positron may be regarded as an empty negative energy state in the Dirac sea whose usual occupying electron has been removed.

POWER

The time rate at which work is done (at which the form of energy is changed).

In electrical engineering, the term "power" is erroneously also used to mean "energy".

PRIGOGINE, ILYA

Noted Belgian chemist and Nobelist, and one of the pioneers of the thermodynamics of open systems far from thermodynamic equilibrium.

Prigogine was awarded the 1977 Nobel Prize for his work on the theory of dissipative structures in nonequilibrium thermodynamics.

PRIORÉ, ANTOINE

Italian radar technician, remaining in France after WW II, who discovered the use of novel waves from plasmas emitted when normal EM waves were introduced, and who used this effect to accomplish remarking healing in laboratory animals of terminal tumors, infectious diseases such as trypanosomas, restore suppressed immune systems, and heal atherosclerosis.

Prioré's beam was actually longitudinal EM waves. The body when irradiated by longitudinal EM waves adds a weaker phase conjugate replica, thus converting LW nonlinear optical pumping from the 3-space domain to the time domain. This time-reverses the irradiated cells and all their components back to a previous physical state and condition.

Such "time-domain" pumping is used by the living body's cellular regeneration system to restore cellular damage and heal the cells, within its limits. Thus Prioré unwittingly uncovered a way to dramatically amplify the body's own healing and regenerative powers.

POYNTING, JOHN HENRY

An English physicist who lived from 1852-1914, whose contributions to electromagnetics included the energy flow theory now known as Poynting flow.

He contributed the Poynting theorem, which states that the rate of EM energy loss in a specific region of space is equal to the sum of the dissipation rate (heat loss) flowing across the boundary of the region. Concurrently with Oliver Heaviside, Poynting conceived the notion that energy flowed through space, which previously had not appeared in physics. Heaviside actually published first, but obscurely; Poynting published in a prestigious journal, so the theory came to be known as "Poynting theory." Poynting himself always gave credit to Heaviside for being first. Also, the Heaviside version $\mathbf{S} = \mathbf{E}\times\mathbf{H} + \mathbf{G}$ was more extensive than Poynting's $\mathbf{S} = \mathbf{E}\times\mathbf{H}$. Heaviside was a recluse; years after his death, in his little garret apartment some papers were discovered beneath the floorboard. Therein Heaviside has used his **G** term (a closed energy flow, or "trapped energy" term) to represent gravitation, and had worked out a testable theory of electrogravitation. Modern general relativity indeed considers that it is energy—particularly trapped energy—that is responsible for generating gravitational field and gravitational potential. Apparently nothing at all was done or has been done with Heaviside's electrogravitational theory. See H. J. Josephs, "The Heaviside papers found at Paignton in 1957," **The Institution of Electrical Engineers Monograph No. 319**, Jan. 1959, p. 70-6.

POYNTING ENERGY

Loose term (not rigorous!) used to describe the flow through space of Poynting energy density $\mathbf{S} = \mathbf{E}\times\mathbf{H}$. It actually describes not the energy flow density per se, but that component of it that would be intercepted by a unit point charge.

POYNTING ENERGY DENSITY FLOW

A more rigorous term used to describe the flow through space of the Poynting energy density flow component **S** = **E**×**H**, that would be intercepted by a unit point charge.

POYNTING ENERGY FLOW

Loose term (not completely rigorous) used to describe the flow of energy density **S** = **E**×**H**.

Rigorously, note that both **E** and **H** are "defined" only after their reaction with a unit point static charge. Hence **S** is the resulting component of the overall energy flow that interacts with the charges (with the circuit) and is diverged into the circuit to power it. It is *not* the entire energy flow, which also includes a vast Heaviside nondiverged component that does not strike the charge and interact with it, and hence does not interact with the circuit but is just wasted.

POYNTING GENERATOR

Any dipole or potential difference, which represents a broken symmetry in the vacuum's virtual particle flux, and hence extracts virtual energy from that asymmetry, and gates it out as a gushing energy flow in 3-space. The component of that energy flow that would be intercepted and diverged by a unit point charge is the Poynting energy flow **S** = **E**×**H**.

POYNTING VECTOR

The vector **S**, given as **S** = **E**×**H**, which is used to represent the Poynting (intercepted and collected by a unit point coulomb) energy density flow component.

In Heaviside's version, **S** = **E**×**H** + **G**, where **G** is an energy circulation flow term of trapped energy flow.

PPCM

Pumped phase conjugate mirror.

A phase conjugate mirror material which has introduced to it appositive or "pump" waves. In the phase conjugating process, up to all the energy in the pump waves can be output as the energy in the emitted phase conjugate replica wave. Thus the PPCM is an amplifier, very similar to a triode.

PRIMARY IMAGE

The image or portion of an overall image that is of most interest, and usually the sharpest in focus.

PROBABILISTICALLY

Of or determined by the laws of probability.

Note particularly the somewhat dichotomous use of "determined by—probability." The entire notion in probability is that the overall result is not individually determined, but that there are multiple outcomes of the experiment, each of which occurs with a certain frequency out of a very large number of trials. If a single result always occurs, that is said to be a deterministic change, not a probabilistic change. Unfortunately if one pursues the definition of "probability" in mathematics and logic, one eventually finds that it is dichotomous, as was our definition of energy. Ultimately the foundations guys just threw up their hands and said, "Oh, what the heck! Probability is probability, every fool knows that!" The problem cannot be resolved in 3-la w Aristotelian logic; it requires a higher topology logic.

PROBABILITY

The probability of a simple event is the ratio of the number of times it occurs to the total number of trials (for a large, essentially infinite number of trials).

Note that "trials" constitute things that have occurred (are past). Probability has resisted rigorous logical definition by Aristotelian logic; the reason is that it is an expression of the fourth law, the identity of opposites. Probability is the expression of the future (that which has not occurred) in terms of the past (that which has occurred). Since we have been trained to conceive or think of something as if it had just been perceived to occur, then this is the only way we can *conceive* the future—as if it were an "already occurred past" to us.

But with Aristotelian logic, the future cannot be composed of a set of pasts (the law of the excluded middle prevents it!), and probability has no acceptable logical basis. With four-law logic, the future can be modeled in terms of—and even be identical to—the past, and probability has a logical basis.

Consider *throwing a die to land with one face up*. Thinking of the event (as if it has just occurred, in terms of the most recent past), one can conceive six ways of looking at it. In other words, one can conceive of six "most recent pasts." By the fourth law, the total "most recent past" is identical to the "most immediate future," on the common boundary. If one therefore *collects* all six "most recent pasts," they turn into the most immediate future, by the fourth law of logic. One may argue that only a single one of the events will actually occur. Here one counters with the observation that, when it occurs, it is the past, not the future, and then it has not been collected so as to move to the boundary. One also points out that, with the hidden variable approach, in theory it is possible to directly engineer those probabilities while the Schrödinger wavefunction is still propagating and has not yet collapse to constitute an "observation." I.e., it is possible to engineer Wheeler's "pre-reality," and determine in advance just which of the outcomes shall occur.

Now, if this type of equipment eventually gets built and is small and portable, just think what one could do in Las Vegas!

PRODUCT SET OF INTERNAL WAVES

Modulations of the internal bidirectional wavepairs comprising a scalar potential.

This set was added in the mid-1980s by Ziolkowski, to Whittaker's 1903 sum set. When a signal is "infolded" inside the DC potential, it is modulated upon (multiples) one or more of the internal biwave pairs. Ziolkowski's work is necessary to deal with that; Stoney and Whittaker alone do not handle it.

PSYCHOENERGETICS

Russian branch of energetics where extended electrodynamics is targeted upon the mind and its functions, hence in the time-domain and employing time-polarized EM waves.

PSYCHOTRONICS

Czechoslovakian name for extended electrodynamics effects on the living body.

PUMPED PHASE CONJUGATE MIRROR (PPCM)

A nonlinear material which:

(i) when provided with an input wave, emits an amplified phase conjugate replica (time reversed replica) of that wave, and

(ii) has additional opposing waves as inputs, so that their energy is transformed into the amplified energy of the time-reversed replica wave.

The word "mirror" is misleading, in that the "mirror" may be just a highly nonlinear material, or be an actual smooth metallic surface containing "hot spots" by heating, etc. In any case, it is the nonlinearities such as the hot spots that produce the phase conjugating action.

PUTHOFF, HAROLD

Noted physicist active in a variety of fields and investigations including in psychoenergetics, extended electrodynamics, energy from the vacuum, parapsychology, remote viewing, psychokinesis, zero-point energy of the vacuum, and cosmology.

We have specifically mentioned his important cosmological feedback principle.

QM VACUUM

The quantum mechanical vacuum, which models the vacuum as an intense flux of virtual particles, each appearing an disappearing in such extreme time intervals as to be unobservable individually.

Violent fluctuations of extremely short duration constantly occur in the QM vacuum flux. Various calculations estimate the energy density (in mass units) as up to 10^{80}-10^{90} grams per cubic centimeter, or even greater.

QUALITATIVELY

Determination based on qualitative analysis, usually as contrasted to quantitative determinations.

QUANTIZED

i) Reduction of some observable quantity to multiples of some small, indivisible unit, or,

ii) expressed in terms of quantum theory.

QUANTUM

A single "particle" of the quantity action.

The quantum is always composed of two fundamental quantities (canonical variables), and it is the "fissioning" of the action quantum into two pieces which results in detection of one of the pieces. An indefinite "smear" of part of the two pieces may be simultaneously detected by a linear detector, but never both exactly (Heisenberg uncertainty principle). More recent work has shown that, in a highly nonlinear situation, both canonical variables can be determined simultaneously to any desired degree of accuracy, in which case the Heisenberg uncertainty principle does not hold in its conventional form. This fundamental change in what has been regarded as one of the "sacred laws" of physics has not yet made it into most physics texts.

QUANTUM ELECTRODYNAMICS

The theory of photons and electrically charged particles and their interactions.

The use of the term "quantum" implies that the EM radiation's discrete photon nature is significant, so that quantum theory must be employed.

QUANTUM FIELD THEORY

A quantum mechanical theory in which "... a physical field is considered as a collection of particles and forces, and observable properties of an interacting system are expressed as finite quantities rather than state vectors."

[**Dictionary of Science and Technology**, ibid.] More simply (after Davies, **The New Physics**, 1989): "The theory that describes the quantum effects of a classical system of fields defined on space-time and satisfying various partial differential equations."

QUANTUM POTENTIAL

A special potential added to the Schrödinger equation, by Bohm in his hidden variable theory of quantum mechanics.

The quantum potential can move instantaneously. In my book **Gravitobiology**, I published a mechanism by means of which a quantum potential can be created. (There may of course be *other* QP-creating mechanisms). An iterative, mutually phase conjugating of EM signals passed back and forth between two objects, or among many of them, is called *self-targeting*. Extreme self-targeting can produce such a QP or partially produce one, particularly if a dense "pumping" (optical sense) of the phase conjugate mirror objects occurs. I am presently proposing the QP as a means of direct energy amplification. I.e., if there is "instantaneous travel" between two light-observed points, then to the instantaneous agent there is no length separation or time separation between the points. This of course means that in effect the objects now coexist "superposed" on each other in a multiply connected space, at least with some fraction of "coupling".

Suppose the coupling fraction is 0.5, and 100 widely separate d nodes are so connected by a common QP. Then if one puts in 1 joule per second of energy flow at a given node, there will instantly and simultaneously appear at each of the other 99 nodes one-half joule of energy per second flow. So I can gain quite a bit o f *direct energy amplification* in this distributed system, and nothing can "shield" the distant nodes. Presently, other than possibly Gabriel Kron's "open path", I have not found any other consideration of "direct amplification of energy at a distance".

The implications of the quantum potential—in everything from power sources to medicine to weaponry—are staggering. Weapons based on just this very QP, multiply connected space, and direct energy amplification appear to have already been developed and are on site in three nations. A fourth either is just getting them or is nearing their deployment.

QUATERNION

Expression comprised of the sum of four terms, one of which is real and three of which contain imaginary units, and that can be written as the sum of a scalar and a three-dimensional vector.

QUATERNION ALGEBRA

The algebra of quaternions and their mathematical operations.

Quaternion algebra is of higher topology than either vector algebra or tensor algebra. Maxwell's original equations are some 20 equations in 20 unknowns, in quaternion algebra. Heaviside and others reduced the algebra to vector algebra and some four

equations. The present vector equations taught in university as "Maxwell's equations" are in fact Heaviside's truncation of the Maxwell theory. Going to tensor algebra electrodynamics cannot recover the full range of Maxwell's quaternion theory.

As an example, what Tesla actually did in his patented circuits cannot even be seen in vector or tensor analysis. On the other hand, analysis of his circuits by quaternion electrodynamics clearly reveals his startling ability to shuttle the energy in the circuit at will. See T. W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," **Annales de la Fondation Louis de Broglie**, 16(1), 1991, p. 23-41.

QUINTESSENCE

Literally, the "fifth essence". In short, dark energy.

RADIONICS

To be added.

REACTIVE POWER

Electrical power, measured in volts-amps-reactive (vars) that cannot do work as is.

For sinusoidal waveforms, the formula for reactive power is given by $I \cdot V \cdot \sin\theta$, where θ is the phase angle between the voltage and the current.

REAL, HIDDEN DYNAMICS

The dynamics of vacuum engines, or of "internal energy" or "internal work" ongoing in a system or volume of space.

REAL HIDDEN VECTORS

The "hidden" or "infolded" real vector components,

e.g., of a vector zero summation system.

A group of nonzero, finite vectors which as a system sum to a net translation zero; i.e., which do not translate a resisting mass or charge, but do "stress" it. Such a system therefore constitutes a stress potential.

REAL POWER (ACTIVE POWER)

Power, measured in watts, that can do work, including generating heat.

For sinusoidal waves, real power is given by the formula $I \cdot V \cdot \cos\theta$, where θ is the phase angle between the voltage and the current.

REAL VECTORS

Vectors in three space, without imaginary components.

REGAUGE, REGAUGING

Changing the scalar potential or the vector potential, or both.

If one or both of the potentials is/are changed so that a net force is created in the system, that is an asymmetrical regauging.

If only one potential is changed, a net force results and that is an asymmetrical regauging.

If both potentials are changed but carefully selected so that the free force resulting from one change is equal and opposite to the free force resulting from the other, that is a net symmetrical regauging, often called a "Lorentz regauging".

RECTANGULAR TRANSFORMATION MATRIX

Standard mathematical physics.

REFLECTION

The rebound of light or other energy from a surface.

A smooth surface (e.g., a mirror) may produce a specular reflection. A rough surface (e.g., a sheet of paper) produces a diffuse reflection. Actually, in reflection of light, the same light does not rebound; instead, the light incident upon the mirror or surface is absorbed, and new light is re-emitted by that surface. Further, considering reflection from a dielectric, every interior part of the dielectric participates in the reflection. All the internal information about the entire object—everything!—is there in that reflected light, infolded as the hidden "information content of the field" (Stoney-Whittaker-Ziolkowski structuring inside the two scalar potentials comprising the reflected wave). With the Fogal semiconductor, at least some of that hidden "pinna" information in a sample detection of the reflected light can be outfolded and displayed.

REFRACTION

The bending of light as it passes from one medium to another.

It is the phenomenon that enables a lens to focus light and that makes a stick appear to bend where it dips into water.

REPULSION BEAM

A beam of energy directed at a target, which when absorbed by the target will generate a force in and on that target to push it away from the beam projector.

REPULSION-FORCE-GENERATING BEAMS

Beams of energy which "push away" their targeted receivers, by inducing a force in the receiver directed away from the source of the beam.

RETARDED WAVE

The electromagnetic wave that is derived from the retarded fields, which in turn are derived from the retarded potentials.

This means that the retarded wave at a point or region of space has arrived there or exists there as the result of the dynamics of charges and currents that existed at earlier times.

RETROREFLECTING

Precisely reversing the path of.

An example is a phase conjugate reflection.

SACHS, MENDEL

Noted scientist who has completed the work of Einstein and developed a unified field theory covering the universe from the tiniest part to the entire conglomerate.

SACHS' UNIFIED FIELD THEORY

An extension and completion of Einstein's work that includes the universe and its dynamics from the tiniest part to the entire conglomerate, and includes quantum mechanics, electromagnetics, gravitation, and the strong and weak forces.

SCALAR

Characterized by magnitude only.

SCALAR (QUANTITY)

In ordinary vector analysis, a quantity completely characterized by magnitude only.

Actually, it contains magnitude and time, because to exist it must steadily exist in time. So we take the smallest increment of observer time we wish to consider, and that is the minimum "length" of the time-tail that the scalar must occupy and have, i n order to even be a "perceived or detected" thing. Before the mathematician jumps in with a nice limiting process to take away the time-tail, if you let that little time interval get too close to zero, then you get too close to eliminating the observer himself, and the entire problem vanishes including mathematics and physics and the observer as well.

One simply cannot demonstrate something that does not exist in time—on paper, in one's mind, or otherwise! Be careful of the term "spacelike " in physics! It hides a logical nightmare. This was the very problem I uncovered in Aristotelian logic; the little increments of time to have a "perceived A" or a "perceived not-A" or to apply an "identity decision criteria" to determine identity or nonidentity, had been left out for lo these 2,000 or so years.

SCALAR ELECTROMAGNETICS

That electrodynamics that arises from considering transverse EM waves, longitudinal EM waves, time-polarized EM waves, electrogravitation, superluminal EM signals, interferometry, nonlinear optical functions, time-as-energy, and the infolded electrodynamics inside all usual EM fields, waves, and potentials.

SCALAR POTENTIAL

Usually considered synonymous with the electric potential.

Here we have another "logical nightmare."

Anyway, the conventional "definition" of electric potential assumes one knows what a "potential" is already, and goes something like this: "The potential measured by the energy of a unit positive charge at a point, expressed relative to an equipotential surface, generally the surface of the earth, that has zero potential." [**Dictionary of Science and Technology**, ibid., p. 722.]. Well, that is botched. It tells or attempts to tell what the *measurement* of a potential is, using a unit positive charge and a process. A potential cannot be its own magnitude measurement, just as a man cannot be his own weight measurement.

So what do we do? We have to tell what the potential *is*. This is the problem that so mystified and infuriated Oliver Heaviside, when he altered and diminished Maxwell's equations to rid them of every potential that he could. Heaviside stated that the potential was *"mystical and ought to be murdered from the theory."* He tried to do just that, and conditioned generations of electrodynamicists to believe that the potential had no physical reality at all, but was only a mathematical convenience. Nahin expresses Heaviside's view as follows: "In an 1893 letter to Oliver Lodge, Heaviside said of his own work that it represented the 'real and true "Maxwell" as Maxwell would have done it if he had not been humbugged by his vector and scalar potentials.'" Paul Nahin, **Oliver Heaviside: Sage in Solitude**, IEEE Press, New York, 1988, p. 134, n. 37.

The concept of potential was developed by Poisson, Green, and others from about 1813 to 1827. Three notions involved in the development of the concept of the potential are: (i) there is the collection or storage of energy in the system, via the collect ion or storage of some entity therein, and this "potential energy" can be released and dynamically used, (ii) the potential is a scalar function whose spatial rate of change is a vector force, and (iii) the dynamics of the stored energy is suspended by the "storage" or "collecting" entity; in other words it is a sort of "suspended action" waiting to be unleashed. *It requires some action—such as interception and divergence—to release the leashed energy*.

We have to disagree with the second notion, having already discussed the fact that no vector force exists unless mass is present, since mass is a component of force. Here we have a residue of the old "material ether" concept. For the third notion, we note that the concept of a "virtual" particle or particle flux means that it cannot become observable unless some interaction is imposed. So we may handle the "third notion" requirement by assuming the potential to be composed of hidden virtual particle flux, or hidden wave flux, in wave-to-wave interaction.

Physics basically tries to define the electrical potential as energy per coulomb, or $\phi = W/Q$. That equation, however, is actually not a definition at all, but rather is an algorithm for calculating the magnitude of the excess energy collection/collecting upon a coulomb of charge, when that coulomb is immersed in the potential ϕ. It in fact is the *reaction cross section* of the potential, not the potential entity itself. This now begins to give us a clue. Potential is *energy* in some fashion. So the entity ϕ must have essentially the same definition as energy! Potential energy, collected energy, stored energy, whatever it's energy first and foremost.

Refer to our discussion of the 3-law logical contradiction in the concept of energy. The same logical contradiction must be present in the notion of the potential.

Just as we did for energy, we must define the scalar potential ϕ in two appositive ways: (i) in the wave view and (ii) in the particle view. So we define potential (particle view) as any virtual particle flux. We also define potential (wave view) as any hidden wave flux. Further, we note that the energetic vacuum is composed of a virtual particle flux (particle view) and so it is also a *potential*. Since the virtual particle flux of the vacuum is extremely intense, the vacuum potential is enormous in magnitude.

We shall also consider any other potential to ultimately be a change to the vacuum potential. Originally, one conceived of a potential occupying the "vacuum as an empty space." Then general relativity made the vacuum into spacetime, geometrized it, and made the geometry itself dynamic and operative—i.e., energetic. Okay! Then that makes spacetime itself a potential.

We also firmly dispose of the peculiar and deformed notion that the scalar potential of a point-source charge (at any spatial point that the potential occupies) may be *defined* as the "work performed upon a unit charge by pushing it in against the **E**-field of that source charge, to that spatial point." This is an equation and not a definition at all; instead, it is an algorithm for calculating the energy density magnitude of the scalar potential. It is a fine algorithm, but it has nothing at all to do with what the potential itself *is*. Again, a man cannot be defined as an algorithm for calculating the magnitude of his height or his weight or his energy density!

Without further discussion, we also somewhat extend the general relativity notion of spacetime as dynamic geometry, as follows: In a special sense, spacetime ≡ geometry ≡ potential ≡ "trapped " or collected/collecting energy. So when we engineer the internal structure of the potential, we also engineer the internal structure (subspace) of spacetime and spacetime geometry. Curvature of spacetime, e.g., becomes simply a change in the energy density of the vacuum, from the ambient value, and it can be internally structured so as to contain "engines". When we apply the hidden EM variable theory of the Stoney-Whittaker-Ziolkowski work, particularly when we consider the phase conjugate pairing as it exists in spacetime before interaction with charge, we are engineering and extending (i) electromagnetics, (ii) quantum mechanics, (iii) general relativity, (iv) spacetime, (v) the spacetime curvature concept, and (vi) spacetime geometry.

SCATTERING PROCESSES

Collision processes in which an incident particle such as a photon, electron, or proton, of known energy or direction or both, collides with another entity, and emerges from the collision with a different energy or direction or both.

SCHRÖDINGER, ERWIN

Noted Austrian physicist and Nobelist who discovered the wave equation named after him as the Schrödinger equation, and performed other vital work in wave mechanics.

SCHRÖDINGER EQUATION

In quantum mechanics: an equation that describes the propagation of waves associated with subatomic particles, or more generally, that describes the evolution over time of the quantum state of a system.

SCHUMANN RESONANCES

The extremely low frequency (ELF) resonant frequencies of the Earth-Ionospheric waveguide.

The first five Schumann resonances calculated from a simple model are 10.6 Hz, 18.3 Hz, 25.8 Hz, 33.4 Hz, and 40.9 Hz. However, better models are available and the frequencies vary from these simple model solutions. A better calculation gives the first four as 8, 14, 20, and 26 Hz nominally. The measured Schumann resonance corresponding to the 8 Hz is about 7.75 Hz. This is very near the mechanical resonance frequency of the human body, and also is evidenced in brain waves often "locking" to this frequency in the natural environment.

See W. O. Schumann, **Z. Naturforschung**, Vol. 72, 1952, p. 149, 250. For detailed models and discussion of the observations, see J. Galejs, **J. Res. Nat. Bur. Standards**, Vol. 69D, 1965, p. 1043.

SELF-ENERGY

In a quantum mechanical system, the energy associated with the emission and absorption of virtual particles.

In a classical system, the energy associated with the interaction among parts of the system itself.

SELF-ORGANIZATION

(After Davies, **The New Physics**, 1989): *"Spontaneous emergence of order, arising when certain parameters built in a system reach critical values."*

Simpler put, it is the spontaneous formation of patterns of localized order in a system which begins in a more homogeneous state. In short, the system moves from a simpler to a more complex state.

SELF-POTENTIAL (E.G., OF THE ELECTRON)

The potential created in and of the charge

...(e.g., the electron) by its virtual particle flux exchange with the vacuum.

Also, an asymmetry in the virtual photon flux of the vacuum, caused by the interaction of the charge (e.g., the electron) with the vacuum flux. From here, we note that the self-potential must consist of real observable 3-space EM energy flow or flows from the electron, because of the asymmetry. However, the charge is not the primary source *per se* of the energy flows that establish the self-potential, but instead is the asymmetric gate in the vacuum flux that "gates out" the potential and its energy flux. The asymmetry in the vacuum flux is the actual *source*. Indeed, the energy is received by the charge in the form of converging longitudinal EM energy waves from the complex plane (from the time domain). The spin of the charges of the dipole transduce the absorbed complex EM energy into real observable EM longitudinal wave energy, and pour it out in all directions in 3-space. See my paper, "Giant Negentropy from the Common Dipole," *ibid*. for the mechanism for the charge also.

SELF, SENSE OF

To be added.

SELF-TARGETING

Between two entities, where each acts partially or wholly as a phase conjugate mirror, self-targeting is the iterative phase conjugation or "ping-ponging" and rapid convergence of beams between the two PCMs.

It has a spectacular application in *phase conjugate shooting* from a spaceborne laser against a rising hostile booster, even several thousand miles distant. First a laser pulse is "bounced off" the distant target, and the reflected pulse returns to the receiver in the laser platform. It carries the movement-induced alteration of the distant target on the pulse it reflected. The next emitted pulse is an amplified phase conjugate replica of that received pulse, and it will backtrack to the same spot on the rising booster, leading it a bit and converging moderately so that it meets that spot. That spot begins to heat up, increasing its nonlinearity and making it act even more as a PCM. So its reflected signal off the "hot spot" is also a phase conjugate replica of the pulse that it received from the laser. That reflected pulse now will moderately converge its reflected energy upon the distant laser, increasing the return to the laser. The ping-pong continues, so that the laser beam narrows sharply upon the distant hot spot, and the reflected beam from the hotspot narrows sharply upon the distant laser. This "iterative narrowing ping pong" locks the laser upon the distant hotspot, even though the booster is moving. This process continues for the necessary dwell time, until the beam melts

through that spot and explodes the hostile booster. The iterative phase conjugating reflection, or "ping ponging" between the target spot and the laser, is called *self-targeting*.

S-FLOW

The Poynting energy density flow S, where **S** ≡ **E**×**H** + **G**.

E is the electric field, **H** is the magnetic field strength, and **G** is a trapped closed loop flow of energy density.

The **S**-flow is not the total energy flow per se. Since the fields **E** and **H** and the closed loop **G** are only defined in terms of the intercepted, trapped or "collected" energy, then **S**-flow is always *with respect to* some assumed intercepting/collecting entity, usually an assumed unit point charge.

SIGNAL WAVE

In nonlinear optics, the input signal (wave) to a phase conjugate mirror (PCM), which stimulates the PCM to emit a phase conjugate replica (PCR) wave in return.

SLEPIAN CURRENT

The vector jϕ , which in a current loop represents the energy unit area per coulomb of flowing charge, per unit of time, that is collected/collecting from the Poynting **S**-flow and dissipated in that current loop in its load s and losses.

It does not include the enormous amount of Heaviside nondiverged energy density flow that is flowing along the outside of the circuit conductors, and that is not being collected and therefore not being dissipated.

SLEPIAN FLOW

"Flow of collected-energy density dissipation" in a current loop,

...and therefore to the vector jf in the current loop, which represents the energy per unit area per coulomb of flowing charge, per unit of time, that is being dissipated in that current loop in its loads and losses.

It does not represent the enormous amount of energy that is flowing along the circuit, that is not being collected, not diverged, and therefore does not enter the circuit to be dissipated from it.

SLEPIAN VECTOR

Refers to the vector $j\phi$ in a current loop,

...which represents the energy density per coulomb of flowing charge, per unit of time, that is being dissipated in that current loop in its loads and losses.

It does not represent the enormous amount of energy that is flowing along the circuit, but not being collected and therefore not being dissipated. We accent that *only intercepted and collected energy can be dissipated!*

SOLID-STATE PARAMETRIC OSCILLATORS

A parametric oscillator circuit employing solid state devices.

A parametric oscillator is a device that oscillates by rhythmically changing a parameter (such as capacitance or inductance, etc.).

Simple switching between differing values of the parameter is often used to induced the periodic change of the parameter.

SOLITON

A wave pulse which propagates without changing its shape and without dispersion.

SOURCE DIPOLE

Any dipole, considered from the viewpoint that EM energy continuously pours out of it.

There is no true "source" as such in nature, since the energy is not created but only gated. In the case of the dipole and electrical charge as sources of EM energy, fields, and potentials, we solved that vexing problem in our "Giant Negentropy from the Common Dipole", *ibid*.

SPACETIME

The entity represented by the "fused product" of space and time, to give "space × time".

Spacetime is also dynamic geometry, in the general relativistic interpretation. We consider spacetime to be a potential, and also geometry, and also vacuum, and also virtual particle flux, and also hidden wave flux.

SPATIAL CLOUD

A cloud of something (such as electrons) in a spatial region.

SPATIALLY

With reference to space and spatial position.

SPECIAL RELATIVITY

Einstein's theory of inertial frames in which, if two systems are moving uniformly in relation to each other, one cannot determine anything about their motion except that it is relative.

Each of the two frames is said to be "rotated" with respect to the other, but not accelerating. The velocity of light in space (the vacuum) is constant, and is independent of the velocity of its source and the velocity of an observer. All the laws of physics are the same in all inertial frames of reference.

SPIN

The intrinsic angular momentum of a particle, such as an electron, proton, neutron, photon, graviton etc.,

...even when at rest, as if it were a top spinning about an axis, but had to spin 720 degrees before it turned "full circle."

Spin is quantized, and is always described as a half or whole spin, e.g., - 1, - 1/2, 0, 1/2, 1, etc. A spinning charged particle such as an electron thus demonstrates a magnetic moment, due to the circulation of charge in the spinning. In the nucleus of an atom, the spin of the nucleus is the resultant of the spins of the nucleons (particles comprising the nucleus).

Spin of particles would appear to be more like an "implosion" to "explosion" circulation; in other words, it circulates in the time domain (complex plane) as well. It would appear that the spin of a particle is the basic feature that integrates the (disintegrated) flux energy of vacuum flux into observable charge. Apparently all observable fields, matter, effects, etc. depend upon this basic mechanism to zip together virtual entities and form observable phenomena.

SPIRAL GALAXY

Those galaxies having arms which extend in the form of spirals.

About 70% of all galaxies are spiral galaxies.

The interesting thing is that only about 10% of the gravity necessary to hold the spiral arms together can be accounted for by known gravitational sources. This has led to the theorizing of dark (hidden) matter of exotic and unknown form, which would be responsible for the excess gravity.

The present author has proposed that the unaccounted enormous Heaviside component of the EM energy flow surrounding every field/charge interaction and not entering into that interaction, accounts for the missing source of the gravity. See "Dark Matter or Dark Energy?", Journal of New Energy, 4(4), Spring 2000, p. 4-11.

S-SOURCE

Source of Poynting energy density flow.

Source of **S** = **E**×**H** flow. The primary source is considered to always be an asymmetry in the virtual particle flux of the vacuum. The **S**-flow rigorously is that component of the overall energy flow that is intercepted by some system of interest—either present or assumed. That component of the overall energy flow that is not intercepted by the system of interest, is referred to by this author as the Heaviside energy flow or the dark energy flow associated with every field/charge interaction.

STONEY To be added

To be added.

STONEY/WHITTAKER BIWAVE DECOMPOSITION OF THE SCALAR POTENTIAL ACROSS THE DIPOLE

(i) a scalar potential (i.e., a difference in potential) exists between the end charges of a dipole,

(ii) that potential (difference) can be mathematically decomposed into a harmonic series of bidirectional EM wave pairs, where each pair consists of an EM wave and its precisely superposed time-reversed twin. Thus a dipole is a "source" or identically is a set of hidden bidirectional waves (wave view).

STRING THEORY

A rather recent mathematical physics theory which replaces the zero-dimensional "point" used in previous physics with a one-dimensional object called a "string".

It has been particularly effective in describing the gluon forces between two colored particles in particle physics, and has since been extended to many other areas. It is sometimes referred to as the "theory of everything".

"STRING" WAVE

The transverse wave on a taut string produced when the string is plucked.

The string wave itself stays on the string and does not travel through the slapped external medium.

However, Faraday believed that EM fields in vacuum consisted of "material lines of force" which behaved like such taut material strings, without any physical endholders. He thought that EM disturbances were simply the transverse disturbances of those "lines of force". He profoundly affected Maxwell's thinking, so that Maxwell accepted these physical lines of force. Consequently Maxwell *assumed* those same "transverse taut string vibration waves" in his EM wave theory.

In eliminating the "stringholders" for the assumed taut strings, Faraday and Maxwell discarded the Newtonian third law half of electrodynamics! They discarded half the energy and half the wave as well. Consequently today physics has no causative mechanism for Newton's third law, because it threw out the EM mechanism for it more than a century ago and never noticed it!

SU(2)×SU(2) SYMMETRY ELECTRODYNAMICS

To be added.

SUBSPACE

In vector mathematics: a subset of a vector space which is closed under vector addition and scalar multiplication operations.

In physics: Physics often uses the term "space" to refer to spacetime. It also uses the term "space" to refer to the dimensions of space, without the dimensions of time. At any rate, the spatial portion of spacetime is represented mathematically by some convenient number of dimensions. In the most usual practice, Minkowski spacetime of 3 spatial dimensions and one time dimension is utilized. In the Minkowski space, we now consider that "space" to be a vacuum scalar potential. If we consider the internal Stoney-Whittaker-Ziolkowski biwave pairs comprising that vacuum potential, we may transmit a signal communication along one or more of these internal biwaves, without changing any of the others. In that case, no overall potential gradient and overall forcefield signal appears. That domain that is infolded "inside" the scalar potential is said to be subspace. It may be modeled as a space of n-dimensions, where those dimensions are compacted and not observable to an external observer. Subspace gained great popularity from the Star Trek television series, where the spaceships used "subspace communications" to have signals propagate far faster than the speed of light. Bill Fogal has been working with some success on what should be a concrete realization of just this very "subspace communication system", with infolded signals that move much faster than the speed of light in vacuum.

SUPERCONDUCTIVITY

Property of some materials or metals whereby their resistance reduces to zero at very low temperatures.

These materials also exhibit many additional properties that are anomalous when compared to normal materials. Much research effort has gone into the attempt to find materials which exhibit superconductivity at higher temperatures, with the goal of reaching room temperature superconductivity.

SUPERLUMINAL

In a manner or with a speed faster than c, the speed of light in vacuum.

SUPERLUMINAL COMMUNICATION

The movement of signals faster than the speed of light in vacuum,

...and the transmission and reception of such signals and extraction of their transported information.

Longitudinal EM waves are not limited to speed c; transverse EM waves are limited to speed c. The infolded electrodynamics inside all EM fields, potentials, and waves consists of longitudinal EM phase conjugate wavepairs, with their impressed electrodynamics. Hence this "subspace" is a superhighway for such waves, including for those moving at superluminal velocity. In essence this is a very special kind of "tunneling" which we might refer to as *subspace tunneling*. The limitation to light speed rigorously applies to the modeled transverse EM waves which are a sort of "bulk upheaval" waves similar to waves on the surface of the ocean. As in the ocean wave analogy, "pressure" waves underneath the ocean may travel very much faster than the bulk upheaval waves on the surface.

When making longitudinal EM waves, the process is imperfect and the resulting longitudinal EM waves will have a transverse residue as well. The resulting "transverse-noisy" LW is called an *undistorted progressive wave*. Undistorted progressive waves may move slower than the speed of light or faster than the speed of light. See W. A. Rodrigues Jr. and J.-Y. Lu, "On the existence of undistorted progressive waves (UPWs) of arbitrary speeds $0 \leq v < \infty$ in nature," **Foundations of Physics**, 27(3), 1997, p. 435-508. A slightly corrected version is downloadable as hep-th/9606171 on the Los Alamos National Laboratory web site, and includes corrections to the published version.

SUPERPOSE

To lay or place on, over, or above something else, with the connotation of mixing.

SUPERPOSITION

The simple linear addition and subtraction of two or more values, states, etc.

Superposition is one of the key principles in field theories and in the concept of potentials.

SUPERSET

A large set referenced to a small set, where the small set is included in the larger set.

The large set is said to be a *superset* of the small set. The small set is said to be a *subset* of the larger set.

SW (STONEY-WHITTAKER) STRUCTURES

The Stoney-Whittaker hidden bidirectional EM wavepairs comprising the scalar potential, and structuring (altering) of same.

We call this internal EM dynamics inside every EM wave, field, and potential the "infolded" electrodynamics. Russian weapon scientists refer to it as the *information content of the field*.

SYMMETRICAL REGAUGING

In electromagnetics, changing the scalar potential to a different value, and simultaneously changing the vector potential to a different value, with the two changes just precisely selected so that the two extra forces (each created by one of the changes) are equal and opposite—thus canceling with respect to translation and doing no net external work.

We note that the two forces themselves must be considered to be present and still working continuously in opposition, increasing the stress upon the system regauged with excess energy, or decreasing the stress upon the system regauged with less energy.

This presence of "equal and opposite" excess forces from the symmetrical regauging is known as the *Lorentz condition*. The end result is that the *net* force fields of the regauged system remain the same, even though the stress of the system has been altered by the regauging and the potential energy of the system has also been changed. Since abstract vector mathematics contains no such thing as "stress" in its background vector space, zero vector resultant system of multiple nonzero vectors are most often simply discarded. Early electrodynamicists symmetrically regauged Heaviside's two "Maxwell" equations (potential form) so as to easily separate the variables. The net effect was to discard that set of the Heaviside/Maxwell equations that prescribed and included open electrodynamic systems that freely receive and collect energy from the external vacuum, and also obtain a free excess force which then can permissibly utilize that excess energy to translate and produce external work upon the system or externally upon a load. In short, the symmetrical regauging discarded practical overunity electrodynamic circuits and devices, which Maxwell's equations—even in their Heaviside modified form—have always prescribed and permitted. Contrast to asymmetrical regauging.

We specifically point out that the two extra forces remain, as does their energy, and both may be dynamic as the system is dynamic. Hence when one regauges, one has changed the gravitational aspects of the system and also curved the local spacetime. Further, this ST curvature is internally structured and that structure is dynamic. Thus contrary to the assumptions of electrodynamics, the regauged system *is not* the same as the original system.

SYMMETRY

A theory or process possesses a symmetry with respect to certain operations performed on it, if those applied operations do not change the theory or process.

The theory or process is then said to be "symmetric" with respect to those operations. As an example, there is no observable change in a circle when it is rotated or reflected in a mirror. The circle is therefore said to have rotational symmetry and reflection symmetry.

TANTALUM CAPACITOR

Electrolytic capacitor with a tantalum or sintered-slug anode,

...such as solid tantalum, tantalum-foil electrolytic, and tantalum-slug capacitors.

For the same capacitance, the weight and volume of the tantalum capacitor are less than comparable aluminum electrolytic capacitors. In other words, you can make the little son-of-a-gun smaller, for a given capacitance and charge it must hold. When utilized in the Fogal fashion, the tantalum capacitor also exhibits other properties that are still proprietary to Fogal's semiconductor processes and to Bill Fogal.

TARGETED PINPOINTS

Refers to those separated points which engage in self-targeting between themselves and some separated signal energy source (as in Fogal's semiconductor).

The effect is to sharply narrow the retroreflected source signal energy from the source onto the separated points by means of the mutual ping-ponging. In this fashion much more energy density from the source can be concentrated on the targeted pinpoints. In effect, phase conjugate shooting is evoked.

TENSOR

A special mathematical entity which is an element of a vector space such that it represents the tensor product of vector spaces and their duals.

Much of modern physics and advanced electromagnetics is expressed in tensor algebra theory.

TESLA, NIKOLA

Famous American emigré electrical inventor and eccentric whose numerous inventions fueled much of the electrical 20th century.

Tesla produced the AC system, including polyphase systems. From his experiments he knew that the EM wave in vacuum was longitudinal, like sound waves. In spite of his great accomplishments, his eccentricities and grandiose pronouncements did not endear him to electrodynamicists! An example is his acrid comment: *"...I showed that the universal medium is a gaseous body in which only longitudinal pulses can be propagated, involving alternating compressions and expansions similar to those produced by sound waves in the air. Thus, a wireless transmitter does not emit Hertz waves which are a myth, but sound waves in the ether, behaving in every respect like those in the air, except that, owing to the great elastic force and extremely small density of the medium, their speed is that of light."* Another major example is his statement: *"The Hertz wave theory of wireless transmission may be kept up for a while, but I do not hesitate to say that in a short time it will be recognized as one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history."*

Ironically, modern quantum mechanics has almost proven Tesla right that "the universal medium is a gaseous body." Today the modern QM vacuum is very much like a virtual particle gas. And of course the discussions in this present annotated glossary show why I personally am of the opinion that Tesla was also correct in his firm disbelief that those Faraday-Maxwell "taut physical strings without physical holders" filled the ether and provided transverse EM wave oscillations. I also agree with him that the EM wave in vacuum is a longitudinal wave, exactly like a sound wave. I believe that the transverse gyroelectron precession waves that our instruments actually measure in the conductor when it receives an incoming EM wave from the vacuum, proves that the vacuum wave is indeed longitudinal—else it would seem we must discard the spin of an electron and the theory of gyroscopes. Finally, one should see, e.g., Patrick Cornille, "Inhomogeneous Waves and Maxwell's Equations." Chapter 4 in **Essays on the Formal Aspects of Electromagnetic Theory**, Aklesh Lakhtakia, Ed., World Scientific, New York, 1993. Cornille clearly shows that Maxwell's equations are directly created by scalar potential interferometry. As he states, this means that EM force field wave s are created by the interference of sound-type scalar potential waves, or "sound creates light." This strongly supports Tesla's original statement that EM waves in the vacuum are actually EM sound waves, much like sound waves i n a gas.

TESLA'S MAGNIFYING TRANSMITTER (include Jackson quote)

To be added.

THERMOACOUSTICS

The generation of sound waves by heat.

THERMOACOUSTIC ENGINE

Essentially a closed resonant chamber containing three heat exchangers and a working fluid—such as an inert gas—under pressure, and used with a transducer to provide power such as mechanical power.

One heat exchanger is the hot-side exchanger through which heat is injected, another is the cold-side exchanger in which a coolant is circulated, and the third is a passive device between the other two, and known as a regenerator or thermal capacitor. The heating and cooling changes the pressure in the fluid greatly, and the regenerator oscillates back and forth, taking energy from the fluid, then giving it back, and keeping the engine going. A pressure wave (shock wave) moves through the working fluid and produces a resonator effect. The end result is an engine with rapidly fluctuating pressure gradients and no moving parts. The pressure gradients are then tapped off to drive a piston, which drives a linear alternator producing electricity. In a typical application, a single piston with a surface area of 1.5 square inches, and with a travel of only one centimeter, operated at 500 Hz, will produce about 30 horsepower output.

Information on these engines can be found on the Fellows Research Group website at http://www.io.com/~frg, or E-mail to frg@io.com. Many thanks to Oscar L. Fellows, "Be Our Guest: Thermoacoustic Engines—Propulsion, Power for the 21st Century," **Power Online**, 1/24/2000.

THERMODYNAMIC EQUILIBRIUM

Stable state eventually reached by an isolated system. One may consider it a "balanced" or "preferred" state.

Actually, a totally isolated system could not change. Any system is in a constant exchange with its vacuum environment, a priori, and no such thing as a completely isolated system exists in nature. Hence once excited, a system—to reach equilibrium—must exchange with its environment and is not a truly isolated system. But systems do exchange with their environment in hidden forms, so we can just let the original statement stand as is. Sloppy, but okay so long as we recognize the limits.

TIME

To be added.

TIME-CHARGE

To be added.

TIME-CHARGING

To be added.

TIME-ENERGY

To be added.

TIME-EXCITATION

To be added.

TIME-FLOW MECHANISM

To be added.

TIME-POLARIZED ELECTROMAGNETIC WAVE

An electromagnetic wave whose vibrations occur in the time domain only.

The wave is theorized in quantum field theory, or at least its time-polarized photon is theorized and called a "scalar" photon. There seems to be no Western method for detecting such waves, though they are predicted by theory.

TIME-POLARIZED (SCALAR) PHOTON

A photon whose vibrations occur in the time domain only, also known as a "scalar" photon.

TIME-FORWARD WAVE

A normal wave moving in forward time. Otherwise known as the retarded wave.

The external observer comfortably sees its forward progress as expected.

TIME REVERSAL

The process of forming the phase conjugate

...(e.g., of a wave or particle or entity or process or vacuum engine.).

We accent that *time-reversing a single object or single group of objects* is not the same thing as "travel into the past" so popularized by science fiction. For time travel to the past, the entire universe and everything in it except the traveler, would have to be time-reversed. That would not seem possible by any stretch of the imagination today! On the other hand, time-reversal of a single thing such as a particle or a wave—or even a group of things such as a group of particles or waves—is not only feasible but is readily achievable. A positron is a time-reversed electron, e.g. Becker showed that laughably weak DC electrical trickle currents (picoamperes) across otherwise intractable bone fractures could engender healing of the bone fractures. In investigating the effect, he showed that entire cells—specifically in that case, the red blood cells—were time-reversed (dedifferentiated) and then fast-forwarded (redifferentiated) into new kinds of cells, *genetics and all*.

In France in the 1960s and early 1970s, the Priore team showed in laboratory animals that this mechanism (which they nor anyone else understood they were unwittingly evoking) could be used to dramatically reverse and quickly cure terminal tumors, infectious diseases, arteriosclerosis, and suppressed immune systems. The same approach, if redeveloped, could stop and totally wipe out the emerging major new pandemic of hepatitis C, which nothing will touch at present and which will surpass AIDS infections after the turn of the century. The approach could totally reverse AIDS and eliminate all HIV infection, because it could simply time-reverse HIV-infected cells back to normal cells, genetics and all. In other words, it could readily and cheaply and quickly eliminate AIDS from the face of the earth. Further, the disease could be eliminated whenever a patient tested positive for HIV infection; there would be no need to wait for debilitation to set in. For coverage in detail, see T. E. Bearden, "Vacuum Engines and Priore's Methodology: The True Science of Energy-Medicine. Parts I and II." **Explore**!, 6(1), 1995, p. 66-76; 6(2), 1995, p. 50-62.

TIME-REVERSAL ZONE

A region of space in which a component of the overall time flow runs backwards, and hence the fundamental mechanism generating the flow of a mass through time is reversed.

Such zones are theorized as temporarily occurring in cold fusion, particularly once the palladium lattice is loaded with hydrogen or deuterium ions. Such a temporary region in the electrolyte is an excited state, and the other ions will move to nullify it and cause its decay. During its existence, ions in it experience a reversal of the law of attraction and repulsion of charges. In the TRZ, like charges attract and unlike charges repel. Thus suddenly the low spatial energy transmutation of elements in cold fusion experiments can be explained (they have been validated in some 600 successful experiments, in various laboratories in various nations, by excellent scientists). E.g., two H+ ions may attract, and so closely that each enters the edge of the strong force region of the other, forming a quasi-nucleus. Then as the TRZ decays, the preferred energetic change is from inside out. In other words, the gluon forces have been partially nullified and the quarks in the nucleons are almost freed. Hence the favored energetic decay from the excited state of the TRZ is by quark flipping, where one H+ ion in the quasi-nucleus changes into a neutron. The quasi-nucleus becomes a quasi-nucleus of deuterium, and will tighten into deuterium as the TRZ induced action vanishes. This is the way the excess deuterium is formed in the cold fusion experiments. Two deuterium D+ ions may also form a quasi-nucleus of (D+)(D+) particularly where the electrolyte is loaded with deuterium to start with. In that case, as the TRZ decays, the quasi-nucleus just tightens into a helium 4 nucleus or alpha particle, accounting for the excess alpha particles formed. And so on.

The concept of the TRZ thus is consistent with hundreds of successful experiments, and introduces a completely new type of nuclear reactions to physics, at low spatial energy where transmutations such as occur are not presently thought to be possible. We point out that these are extremely high energy reactions when the time-energy interaction is considered, since time has an energy density equal to mass. Time-energy is some c^2 times as dense as is spatial energy used by particle physicists in their interactions. By transposing some of the time-energy into spatial energy as the TRZ decays, the new "low energy nuclear reactions" actually involve the necessary degree of "high energy" required for the interactions.

TIME-REVERSED WAVE

A phase conjugate reflected wave, which is a wave moving in reversed time.

Since the external observer "sees" in forward time only, he sees the wave as traveling in the opposite direction as its generatrix wave front is moving.

TOPOLOGICAL

Invariant under transformation by continuous mappings.

...or related to the properties of geometric shapes and figures that remain invariant under transformation by continuous mappings.

TOPOLOGICAL PROPERTY

Those properties of a geometrical space that are unchanged by continuous distortion of the space.

TOPOLOGY

Mathematics of the properties of geometric configurations invariant under transformation by continuous mappings.

In short, the mathematics of the large-scale structure of curved spaces.

TOROIDAL COIL

A coil of wire curved around into toroidal form.

Contrast to the standard solenoidal coil form.

TOROIDAL TRANSFORMER

A transformer comprised of toroidal coils instead of solenoidal coils.

TRANSFORMATION MATRIX

A matrix (rectangular array of algebraic or numerical quantities) for replacement of the variables in an algebraic expression by their values in terms of another set of variables.

Used, e.g., in solving equations involving Hamiltonians.

TRANSVERSE

Wave movement perpendicular to the wave's primary direction of principal propagation, as in the movement of a taut rope in a wavelike motion traveling down the rope.

(As opposed to longitudinal).

TRANSVERSE EM WAVE IN THE VACUUM

The completely erroneous notion that EM disturbances in the vacuum are composed of transverse "string waves."

Faraday, e.g., believed that the EM field in the vacuum consisted of his "lines of force" as material taut strings—erroneously without the necessary holders to put the tension forces on the strings. He thought that when there was an EM disturbance, it was a "plucking" or transverse vibration of these "taut strings." Maxwell also believed in Faraday's material lines of force, and set out to capture them in his electrodynamic theory. He did so by simply assuming the lines (tubes) of force and their transverse "string wave" vibration. This is equivalent to assuming that the electromagnetic vacuum itself is composed of material taut strings, and that additional EM fields are just additional taut material strings.

TRANSVERSE FIELD COMPONENT

The modeled component of the electromagnetic field (as in a moving EM wave in vacuum) that is oriented at right angles to the line of motion.

TRANSVERSE WAVE

A wave where the medium is undergoing repetitive lateral translations, as a lateral wave in a taut string.

The EM wave is vacuum is erroneously modeled as a transverse "string wave," as a relic from Faraday's original belief that EM fields existed in the (assumed) material ether as physical taut strings. He thus believed that EM disturbances were the disturbances of "pluckings" of these taut strings. Maxwell accepted Faraday's physical lines of force and constructed his electrodynamics mode to specifically include the material ether, the physical "taut strings" lines of force notion, and Faraday's "string waves" as the electromagnetic vibrations in the ether. This discards half the energy, half the phenomena, half the wave, and Newton's third law causative EM mechanism.

TUNNELING

In quantum mechanics, a phenomenon where a particle penetrates and crosses a small region where the opposing potential is greater than the particle's available energy.

The phenomenon is thought to be impossible according to classical physics, but occurs nonetheless. Further, the speed of transit through the "tunneling" separation can be superluminal. Tunneling of music between two points has been measured to occur at more than four times the speed of light.

A more extended type of tunneling is the travel of longitudinal EM waves infolded inside the normal EM potentials, fields, and waves. Indeed, this is a more fundamental electrodynamics, and it can be shown that interferometry of this "internal" electrodynamics creates the external electrodynamics by a form of longitudinal EM wave interferometry. E.g., see M.W. Evans, P.K. Anastasovski, T.E. Bearden et al., "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," **Journal of New Energy**, 4(3), Special Issue, Winter 1999, p. 76-78.

UNCONSCIOUS MIND

To be added.

UNIFIED FIELD THEORY (ENGINEERABLE)

A unified theory of the four forces of physics—the electromagnetic, gravitational, strong, and weak forces —that is not just an intellectual model but which is also engineerable on the laboratory bench and in actual physical systems using higher symmetry O(3) electrodynamics.

That's a mouth-filling phrase (yes, we sometimes write awkward phrases unintentionally; it's amazing how reasonable such things sound when you're laboring along at 3:00 a.m. and bleary-eyed as a wet toadstool!)

UNIFIED FIELD THEORY OF MIND AND MATTER

To be added.

UNITARITY

Principle that all probabilities sum to unity.

UNITARY Q_E

Fixed or unit charge q of the electron.

This notion is held only because the q is not decomposed into its component elements, but treated as if it were an indivisible unit. That is in error! The mass of a fundamental particle at rest is quantized, and the massless charge (self-potential) of the particle is discretized as a function of the background potential (virtual particle flux density) in which it is embedded or to which it is exposed. In our view the definition of a charge q is $q \equiv m_q\phi_q$. The *electrical charge* should be taken to be the massless ϕ_q component. The definition of charge q_e of an electron is rigorously given by the identity $q_e \equiv m_e\phi_e$. The *electrical charge* of the electron should be taken to be the massless ϕ_e component.

If a charge (say, an electron) is placed in an additional potential ϕ_1, then the total massless charge of the electron (i.e., its virtual vacuum flux exchange with mass me) is $(\phi_e+\phi_1)$. As can be seen, the massless charge of the electron (its virtual flux activity) has now changed. The electron is then said to *be collecting and to have collected* excess energy (which may be either positive or negative, depending upon the sign of ϕ_1.). Further, either ϕ_e or ϕ_1 or both can be internally and deterministically *dimensioned* (structured in Stoney-Whittaker-Ziolkowski fashion). When its massless charge (its own potential ϕ_e) is so dimensioned, then the dimensioned electron is said to contain or transport a *vacuum engine*.

VACUUM ENGINE

Particle view: Deterministic internal pattern or template deliberately created in the virtual flux of a scalar potential.

It can also be created in, and transported by, the two scalar potentials that comprise a static or dynamic force field, or a moving EM wave in the vacuum. It can also be created in the local vacuum, in which case it has a "charge-up" creation time and a "discharge time," exhibiting a sort of "time constant" very much like a capacitor charging and discharging. In the wave view, the vacuum engine is a deterministic internal pattern or template deliberately created in the Stoney-Whittaker-Ziolkowski internal biwaves and wave products comprising the scalar potential. Again, it can be implanted in the vacuum or in an EM signal as a carrier. The self-energy (scalar potential) portion of any electric charge or magnetic charge can also be a "carrier" that is conditioned (*dimensioned*) with a vacuum potential. The process or act of conditioning any of the carriers with vacuum engines is called *dimensioning* that carrier. Russian energetics refers to the vacuum engines of a dimensioned carrier as the *information content of the field*.

VACUUM FLUX EXCHANGE

The virtual particle interaction between the active vacuum and a charged particle.

The charged particle is an asymmetry in this flux exchange interaction, and extracts and gates some of the vacuum energy as a Poynting **S**-flow. In turn, this S-flow transports and creates in space the **E** field and the scalar potential f associated with the charged particle. An electrically charged particle is thus a little Poynting energy generator, a source of potential, and a source of **E**-field. It is a little electrical dynamo, a little free energy generator. It is already an open system in disequilibrium with its environment—the fierce vacuum flux. Its self-energy (potential) and its "fields," plus its Poynting energy flow, are the result of its asymmetry in the vacuum flux exchange.

VACUUM'S VIRTUAL PARTICLE FLUX

In the particle viewpoint, the quantum mechanical vacuum identically is a virtual particle flux.

Present physics, however, is prone to refer to the vacuum as (an implied emptiness) containing a virtual particle flux. Energy, vacuum, spacetime, virtual particle flux, and dynamic geometry are all synonyms.

VECTOR

In mathematics, an entity completely characterized by a magnitude and a direction.

VECTOR POTENTIAL

In electrical engineering: "Potential postulated in electromagnetic field theory."

Space differentiation (*curl*) of the vector potential yields the field. Magnetic vector potential is due to electric currents, while electric vector potential is assumed to be due to a flow of magnetic charges." [**Chambers Science and Technology Dictionary**, Peter M. B. Walker (Ed.), Chambers Cambridge, 1988, p. 947.

Note that the foregoing is not yet a definition, saying only that it is a postulated potential, then giving some characteristics. Informally, in my view the vector potential is just sort of an ordinary scalar potential, every point of which is in motion in something like a swirling fashion. The magnetic vector potential **A** is most common. There doesn't seem to really be a definition of **A**; the equation $\mathbf{B} = \nabla\times\mathbf{A}$ is usually (erroneously!) said to "define" the **A**. So we are left with the question $\mathbf{A} \equiv$????, since no equation is a definition of anything.

Electrodynamicists have no difficulty in calculating the direction and magnitude of **A**, and in using it, but so far as I can find there is still no real definition. As an ad hoc definition I consider the **A**-potential to be identically a virtual photon flux of vacuum that is moving as an ensemble along the direction of the **A**-vector. Inputs for a more rigorous definition of the form $\mathbf{A} \equiv$ (x) would be most welcome!

At any rate, the **A** is known to be quite real and an independent "field" of nature, because when the curl operator is removed from operating on **A**, the **B**-field is zeroed but the *curl-free* **A**-field can still remain and interfere with the fields of charged particles and magnetic poles to cause real effects in physical systems, including at a distance. This latter is known as the Aharonov-Bohm effect.

VECTOR FIELD

In ordinary theory, the assigning of a magnitude and a direction (that is, a vector) to each point in a region of space.

The entire set of vectors and their spatial points is called a vector field.

VECTOR ZERO

See discussion under *zero vector*.

VIRTUAL ANTIPHOTONS

An antiphoton that spontaneously appears and disappears, so swiftly that it cannot be individually observed.

VIRTUAL PARTICLE

A fleeting quantum particle that spontaneously appears and disappears, so swiftly that it cannot be individually observed, so that it exists only temporarily.

The virtual particle does not satisfy the usual relation between energy, momentum, and mass because it is underneath the Heisenberg uncertainty principle. The virtual particle can have any amount of energy momentarily, so long as the product of its energy and the time interval of its existence is less than the uncertainty principle's minimum magnitude.

Nonetheless, the interactions of large numbers of virtual particles with a mass or charge can combine to generate real observable effects. In quantum field theory, all forces of nature are caused by the interaction of the forced mass entity with virtual particles. Interaction of a mass with virtual photons, e.g., is projected to cause all mechanical and electromagnetic forces.

VIRTUAL PARTICLE FLUX EXCHANGE

Interaction with or exchange of, a flux of virtual particles.

Interaction of a mass with virtual particles most often consists of the mass absorbing the virtual particles and re-emitting them.

VIRTUAL PHOTON FLUX (VPF)

A flux of virtual photons.

(Hey, how's *that* for a tautology!) First, see definition and discussion under *flux*. For electromagnetics, the vacuum can often be modeled as a flux of virtual photons. One gets the virtual charges also, since the photon is considered to also consist of a positron-electron pair. That is, the photon is continually separating into a positron-electron pair, which then annihilate each other to form additional photon(s), etc.

VIRTUAL PHOTON FLUX EXCHANGE

The mutual exchange of virtual photons, as between the vacuum and a charged mass, or between two colliding masses.

The emitted photons from one mass are absorbed in the other mass and re-radiated.

VIRTUAL PHOTON FLUX OF VACUUM

The vacuum identically is a flux of virtual particles.

For most electromagnetic cases, it can just be modeled as identically a flux of virtual photons.

VIRTUAL PHOTONS

Photons which spontaneously appear and disappear in the vacuum so quickly that they cannot be individually observed.

VIRTUAL POSITRONS

Positive electrons (positrons) which spontaneously appear and disappear in the vacuum so quickly that they cannot be individually observed.

WHITTAKER, E. T.

Well-known mathematical physicist, who dramatically extended Stoney's earlier work of 1897-8 and authored two papers in 1903 and 1904 giving the basic theory of scalar electromagnetics (Russian energetics, not including the quantum potential portion).

The 1903 paper is E.T. Whittaker, “On the Partial Differential Equations of Mathematical Physics,” **Mathematische Annalen**, Vol. 57, 1903, p. 333-355.

The 1904 paper is E.T. Whittaker, “On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions,” **Proc. Lond. Math. Soc**., Series 2, Vol. 1, 1904, p. 367-372. The paper was published in 1904 and orally delivered in 1903.

WHITTAKER'S DECOMPOSITION OF THE SCALAR POTENTIAL

Decomposition of the scalar potential into a harmonic set of bidirectional longitudinal EM phase conjugate wavepairs.

In his paper “On the Partial Differential Equations of Mathematical Physics,” **Mathematische Annalen**, Vol. 57, 1903, p. 333-355, Whittaker showed that the scalar EM potential can be decomposed into a harmonic series of bidirectional EM wavepairs. In each pair, one wave is the phase conjugate of the other, and exists in the time domain. However, this phase conjugate wave has been considered as having been detected by intercepting charge as a 3-space EM wave travelling in a reversed direction. Hence from a detectable viewpoint, the Whittaker decomposition yields bidirectional longitudinal EM waves in 3-space, as has been pointed out by several electrodynamicists (e.g., Barrett).

However, the present author considered the difference between the phase conjugate wave as it exists prior to interaction with the assumed intercepting unit point charge, and the detected 3-space wave after the detecting charge is assumed. By applying the Whittaker decomposition and also considering the nature of the EM wave in spacetime *prior to interception by a unit point charge*, this led to the discovery of a new and more primary 4-symmetry in EM energy flow, once 3-symmetry is broken, that exists automatically between the time domain (complex plane) and 3-space.

Thus because a dipole (or a charge treated as a set of composite dipoles) breaks 3-symmetry (as is well-known in particle physics), the more general 4-symmetry results automatically when the nature of the potential between the ends of the dipole(s) is considered. This yields the fundamental mechanism by which EM energy is extracted from the vacuum (from the complex plane or the time domain) and output in 3-space from a "source charge" or a "source dipole". In short, it yields the giant negentropy mechanism when the unaccounted Heaviside energy flow component from a charge or dipole is considered as well as the intercepted tiny Poynting energy flow component. See T. E. Bearden, "Giant Negentropy from the Common Dipole", **Journal of New Energy**, 5(1), Summer 2000, p. 11-23; also on http://www. cheniere.org.

In his second paper, “On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions,” **Proc. Lond. Math. Soc**., Series 2, Vol. 1, 1904, p. 367-372, Whittaker showed that the interference of two such scalar potentials can and does create all the field energy, patterns, and functions of classical electromagnetics.

Whittaker's second paper initiated what today is loosely referred to as *superpotential theory*. For an excellent overview discussion of superpotentials and related things, see Melba Phillips, “Classical Electrodynamics,” in **Principles of Electrodynamics and Relativity, Vol. IV of Encyclopedia of Physics**, edited by S. Flugge, Springer-Verlag, 1962.

WORK

The changing of the form of energy.

WORK, EXTERNAL

The changing of the form of the external energy of a body or system.

WORK, INTERNAL

The changing of the form of the internal energy of a body or system.

WORK-ENERGY THEOREM

To be added.

ZERO POINT ENERGY

The minimum energy of a system due to its quantum fluctuations, resulting from its incessant virtual particle activity. Quantum mechanically, no system of interest (including even spacetime itself) can have zero energy.

The zero-point energy of the vacuum is the lowest energy vacuum state, with fluctuations taken into account. Even at low energies, quantum fluctuations continually arise, and result in an incessant, extremely rapid, and violent "jittering" of the energy momentarily present. The minimum energy due to these quantum fluctuations is called the *zero-point energy.*

ZERO VECTOR

(1) A vector having no length (no magnitude) or specific direction.

(2) Absence of any or all finite vectors.

(3) Resultant of a system of multiple, finite vectors whose vector sum has no specific direction.

Note that the second definition differs drastically from the first. That is, we cannot say that a vector resultant zero has no infolded magnitude, if we consider its components, all of whom have magnitude. See the discussion under "zero." In vector analysis, the zero vector axiom states that any vector v plus a zero vector is equal to a zero vector plus v. Note that, being an axiom, this is not proven, but just assumed. We very much disagree with that blanket axiom; it reduces vector analysis to a highly special single case, where all zero vector systems are to be considered equal, and totally "inactive." In the real world that need not be true at all. There are an infinite number of different zero vector resultant systems, and so zero vectors may differ, if their infolded component "substructure" is considered. In the real world, things that are vectors very often have energy. The energy is infolded and hidden, so that it represents not only a local curvature of spacetime, but also a structured, deterministic set (a *template*) of curvatures of local spacetime. Therefore this zero vector system is actually a *vacuum engine*. Any mass system placed in such a potential, will be acted upon in its parts by that local vacuum engine. Further, the zero vector resultant system is a "potential," since it does contain "collected internal energy." This potential is obviously an artificial potential, since it is deterministically structured internally.

So between zero vector resultant systems, the "infolded, hidden energies" differ dramatically in

(i) total infolded and trapped (collected) energy,

(ii) specific internal action patterns (templates),

(iii) general relativistic effects, and

(iv) type of vacuum engine. Accordingly, the actions the zero-vector system induces in an exposed mass may be designed in advanced. This is vacuum engineering. This is spacetime engineering.

The problem is the *vector algebra itself*. In the abstract algebra, a "vector space" is regarded as an inert thing, where the only actants are the overall net nonzero vectors, and there is no interaction between an overt vector and a covert set o f vectors. The vector space is not allowed to have an internal realm, stress, hidden engines, or to interact with the vectors representing the physical system. Consequently, for over a century electrodynamicists—thinking primarily of translation—have routinely discarded such "zero vector systems" as if they represented the total absence of any finite vector. *This they do, in the unsuitable assumptions of the vector algebra*. This they do not do, in the real world.

The common practice in electrical physics of replacing a zero-summed system of nonzero vectors with a vector zero of "complete absence of vectors" is incomplete, and such did not exist in Maxwell's original *quaternion* theory. This present practice should be changed; it has reduced the topology of electromagnetics far too much, and gutted the most important parts of the theory insofar as an extended electromagnetics is concerned. The vector zero should be replaced with a special organized vector zero system and a scalar potential. The interactions of the "hidden" vectors should be incorporated. By failing to do this, physics excludes the ability to engineer electrogravitation, spacetime, the virtual state, local general relativity, free energy, effects at a distance, and the probabilities of the states propagated by the Schrödinger equation. It also excludes unification of all forces.

In the new view, a zero vector may be a system of nonzero vectors that vectorially sum or multiply to zero for translation purposes, but the components may still exist "inside" and dynamically function inside the zero-resultant envelope. This substructure can act on nonlinear or resonant systems. Any or all components may be time varying, or none of them may be. The zero vector system may thus be a dynamic vacuum engine. In addition, such a vector zero system is considered to be also a scalar stress potential, whose magnitude is equal to the sum of the absolute values of the perpendicular components. In addition, a separate type of stress potential may be included for the magnitude of the absolute values of the swirl components (torques). Other associated potentials may be included for the system, particularly if the system is in multiple dimensions, if it consists of more than one type of virtual particle flux, if several fluxes intercommute, etc. Such a system can also be designed and created to deterministically interact with and on the life force itself, the mind, thought, and personality, but that is beyond the scope of this discussion.

ZERO-VECTOR-SUMMATION SURFACE

A surface or assumed spatial surface in which vectors under consideration interact to sum to a vector zero resultant.

ZERO-VECTOR-SUMMATION SYSTEMS

Zero summations of real, nonzero vectors, so that the real vectors are still present but do not cause translation of exposed mass or charges.

With respect to observing/detecting process that depend upon charge translation, the vectors are said to be hidden and infolded —i.e., with respect to detection by translation. See discussion under *zero vector*.

ZIOLKOWSKI, RICHARD

To be added.

Return to top of page

The "Porthole" Concept with technical background

Amplifying the cellular regenerative (healing) system of the body for treatment and healing of mass casualties

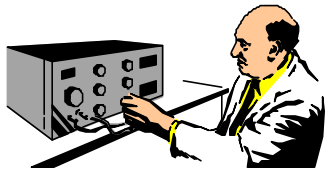

Outline of the presentation

- Mechanism for deep EM exchange of a body with its active EM environment
- Becker's epochal work and its ramifications
- Kaznacheyev's startling results and ramifications
- Weaponization of Kaznacheyev's findings
- Importance of time-energy and the time-domain
- Mechanisms for medical treatment and healing

Outline of the presentation (2)

- Prioré's revolutionary results and their ramifications.
- Proposed new mechanism for cancer promotion.
- Porthole concept: The 2-minute shortcut.
- Terrorist biological warfare capabilities.
- Summary and conclusion.
- Budgetary and Program package.

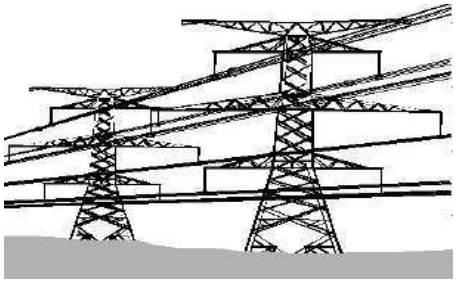

Mechanism for the body's deep EM exchange with its active EM environment

And some ramifications

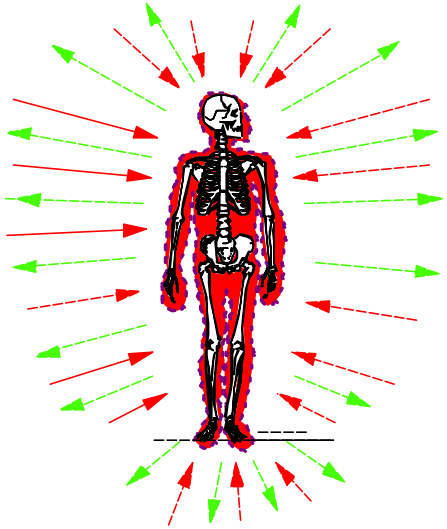

The body continually receives and retransmits EM energy

- The body may be considered as a dielectric.
- Every part of the dielectric participates in the absorption and emission of each photon to and from any point on the surface.*
- Mechanical force effects are also electrical in nature and exchange similarly.

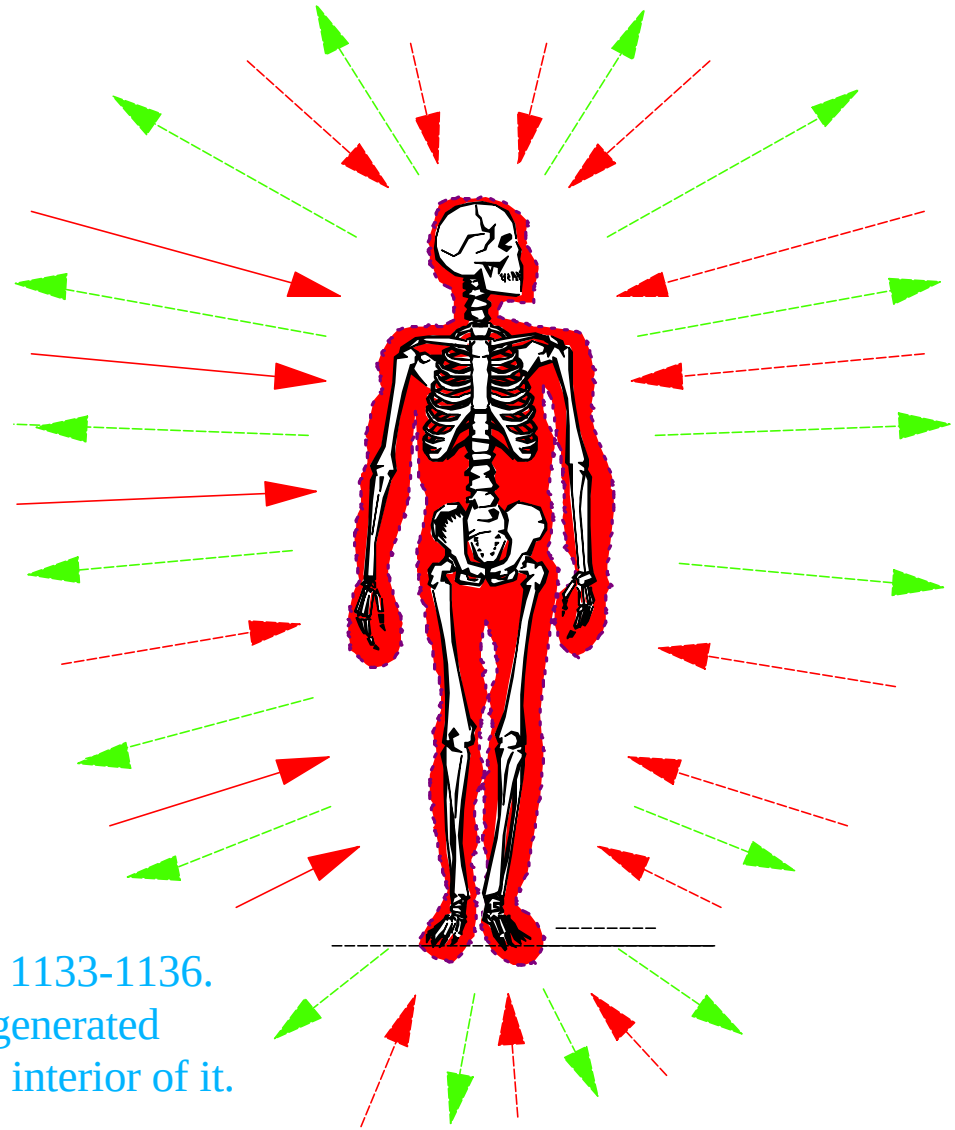

* Reali, G. C., "Reflection from dielectric materials," American Journal of Physics, 50(12), Dec. 1982, p. 1133-1136. The reflected field from a dielectric material is not generated just at its surface but comes from everywhere in the interior of it.

Ramifications:

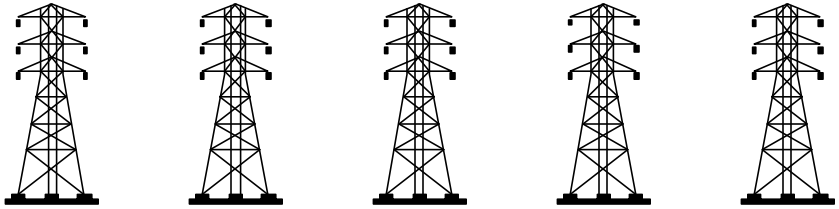

- There is an EM "dielectric transmission path" connecting every part of every cell to every part of the surface of the body.
- All electrical processes in the body, including deep within the cell and its nucleus, participate in the absorption and emission of every photon to and from the body's outer surface (and every mechanical force* experience).
- The EM emission energy of the body is a conglomerate mix of fractions of all processes and functions ongoing in the body or affecting it, including in every cell.
- This includes all electromagnetic, mechanical, chemical, and environmental effects upon and in the body and every tiniest part of it, and provides an extended definition of "stress".

* At base, all normal mechanical forces are generated by electromagnetic forces.

Ramifications (2)

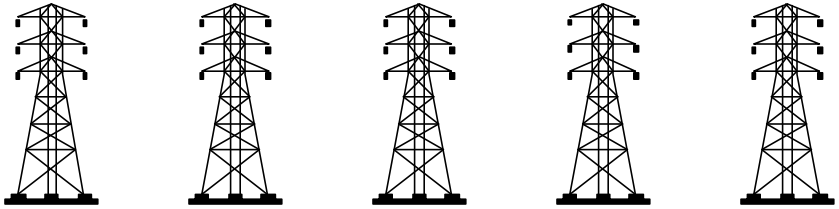

- The reaction of each photon absorbed on any point of the outer surface of the body, connects through the dielectric transmission path to every part of the body, including to every part of every cell*.
- Every emission from the body is participated in by every part of the body, including every part of every cell.
- The body's emission "changes" its environment, adding EM radiation. Some of the internal induced changes (excited states) in the body decay by this external emission. Some do not, but must be otherwise dealt with internally by the body systems.
- The body's EM absorption allows the environment to change or affect every function, operation, and part of the body, by adding EM radiation. All are continually being affected and deviated, both helpfully and harmfully, by these deeply induced EM interactions.
- The body's reaction (healing) must continually readjust and correct deviations from normalcy, in every part of every cell.

* In quantum physics, part of the photon is localized and part is nonlocalized, reaching even across the universe.

Ramifications (3)

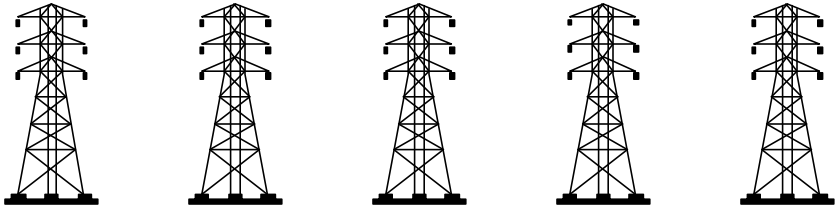

- The sum total of all the impinging external EM radiation upon the body, plus mechanical "special EM" radiation, thus affects and changes the body and all its processes, participating in them.
- That impinging EM radiation can be manipulated to either harm or heal the body and any or all of its cells.
- The body must continually overcome these externally-induced EM changes in its cells and processes, to maintain normalcy. Some EM changes are restored by the subsequent dielectric emission process, relieving the previously-induced deviant EM excitations in its internal processes. Some are not.
- The poorly studied *cellular regenerative system* performs the remainder of the restorative function, which is the fundamental "healing" function of the body.*

*The cellular regenerative system was mostly studied by Becker and a few others. See R. O.Becker, and David G. Murray, "The electrical control system regulating fracture healing in amphibians," Clinical Orthopaedics and Related Research, No. 73, Nov.-Dec. 1970, p. 169-198.

Becker's epochal work

And its ramifications

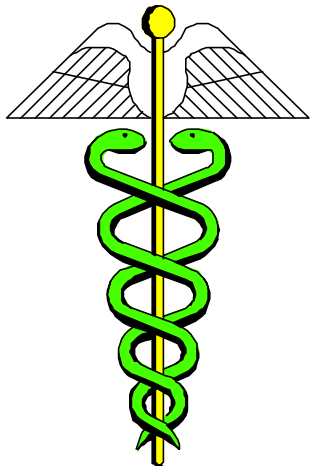

Becker's bone fracture healing

- Tiny DC currents (picoamperes)
- Pulsed DC current can be utilized
- Pulsed magnetic fields may be utilized

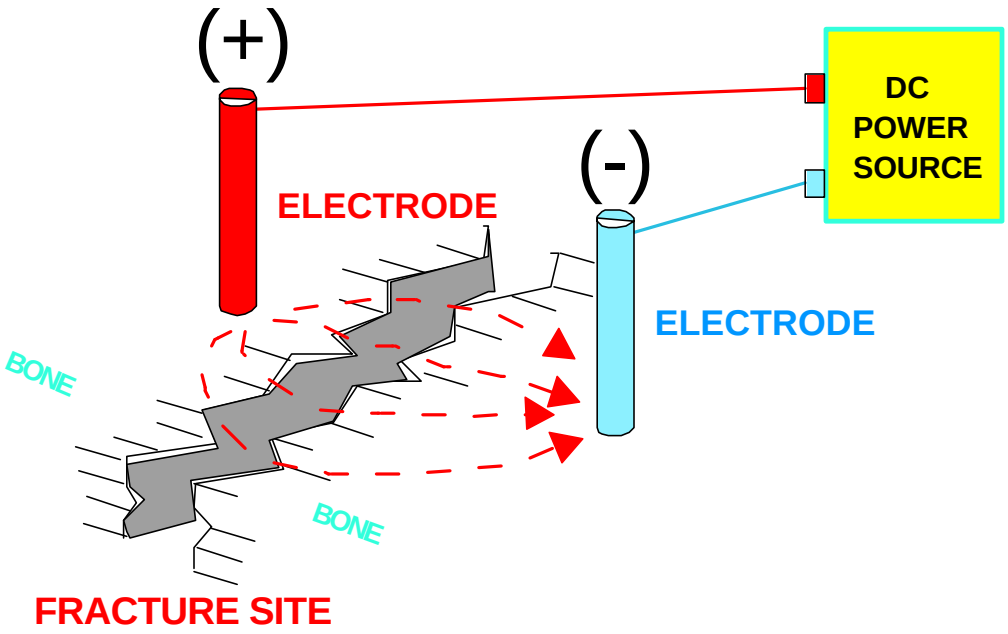

RED BLOOD CELL DEDIFFERENTIATES

Shucks hemoglobin coat
Grows nucleus

NEW CELL REDIFFERENTIATES

Turns into type of cell that makes cartilage

NEW CELL REDIFFERENTIATES

Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture

Becker's theoretical DC control system involved with response to injury

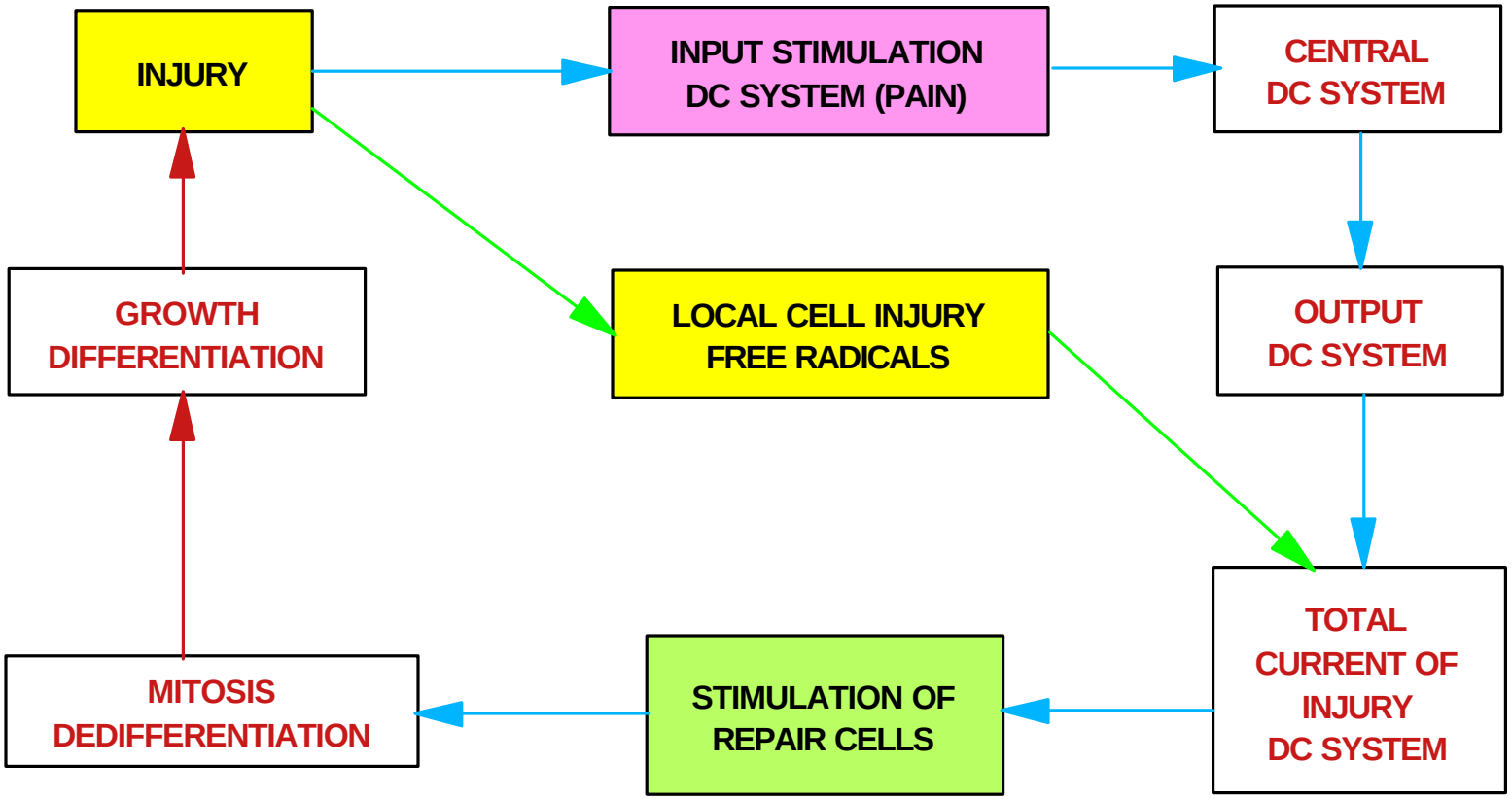

*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Becker's proposed control system governing regeneration*

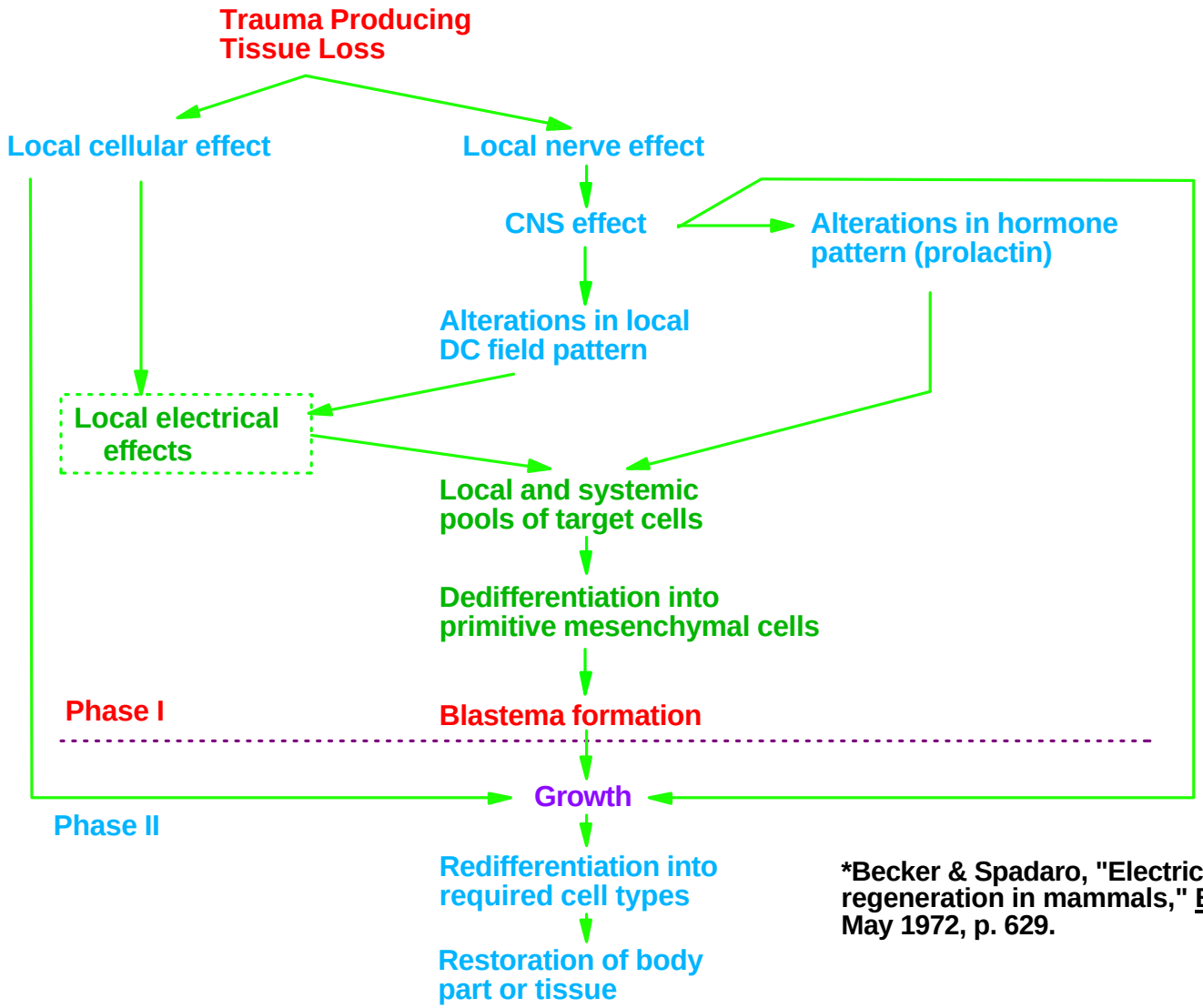

*Becker & Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bull. N. Y. Acad. Med., 48(4), May 1972, p. 629.

Extending Becker's work

- Becker had only the archaic classical electrodynamics available to him. That EM is grossly inadequate.
  - Insufficient group symmetry to model the process.
  - Already eliminates the "infolded" longitudinal wave EM that structurally and dynamically comprises all "normal" EM potentials, fields, and waves.
  - It is this internal LW EM that is manipulated and used by the cellular regenerative system.
- Nonlinear phase conjugate optics was not yet developed when Becker did his seminal work.
- Successful higher symmetry electrodynamics models -- such as O(3) -- have been developed and are available.

A sad commentary

- Becker was nominated for the Nobel Prize, but he was hounded, his funds were withdrawn, and he was forced to retire early.
- His main "sin" was having the courage to testify against the harmful effects of unrestricted powerline radiation and electronic smog.
- Powerful interests then crushed him, set up their own well-funded institutes, and hired scientists who then predictably found that powerline radiation was no problem.
- Such research is so tainted that recently several important journals have now required the authors of submitted papers to state what their affiliated companies do, and what "company massaging" of their research occurred.
- From a higher symmetry EM view, it is obvious that the dielectric pathway and quantum electrodynamics already show a significant problem due to such radiation, particularly with respect to long-term effects.
- This is particularly significant since "noise" -- the mere presence of more "hash" -- appreciably amplifies the dielectric transmission effect. So the major factor becomes EM smog *signals density*, not signal power.

Kaznacheyev's startling results

And its ramifications

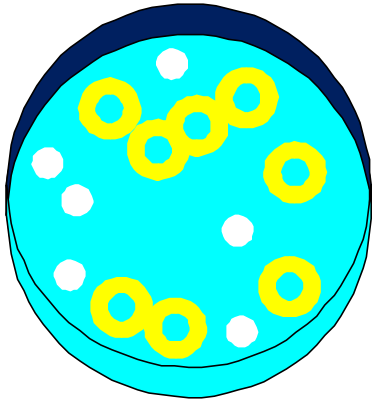

Proof that the cellular condition is radiated from groups of cells

- It follows that a diseased, damaged, or infected cell culture will and does emit its exact internal EM condition, hence the disease or damage "generatrix form" itself (in the internal structuring of the EM radiations).
- Further, these "state" emissions can couple into other targeted cells to produce disease and disorder in them.
- This was clearly proven in some 15,000 Russian experiments by Kaznacheyev.
- Kaznacheyev demonstrated induction of cellular disease and disorder between EM-coupled but otherwise environmentally shielded cell cultures
- Similar experiments have been replicated in the West by Reid *et al*., and by Popp *et al*.

Kaznacheyev's induction of cellular disease and disorder

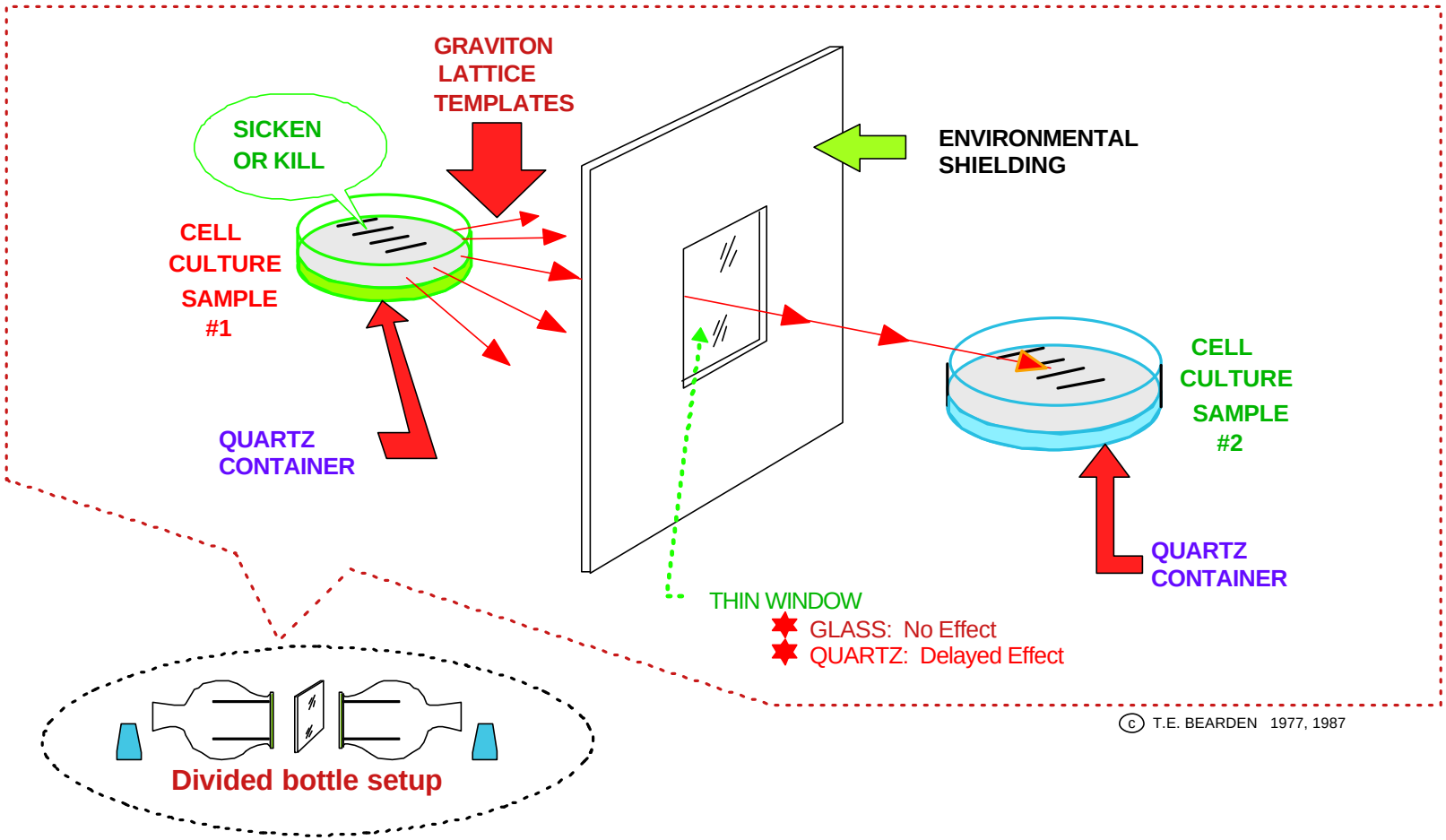

© T.E. BEARDEN 1977, 1987

Note: Minimum lattice is one harmonic interval: IR to UV is such a minimum G-lattice. Consider particularly the dielectric pathway in the emitting diseased cells and in the receiving targeted healthy cells.

Another surprising feature of Kaznacheyev's experiments

- The experiments do not work if the targeted cells are in normal light, such as sunlight*.
- The reason is that the normal light bandwidth occupies a single harmonic interval between ultraviolet and infrared.
- Hence its difference frequencies also fill such an interval. For a set of n frequencies, the number *d* of difference frequencies is $d >> n$.
- Thus the visible light spectrum represents "jamming" of specific internal EM signal inputs through the dielectric pathway into the body, turning much of the environmental signals into harmless warmth.

* It has also been shown that if bacteria are killed in the "dark" by UV, then 24 hours later placed in sunlight, a substantial fraction of the "dead" bacteria will revive.

Ramifications of Kaznacheyev's experimental results

- At least one harmonic interval is necessary for the effect to be evidenced in the target cells.
- Interestingly, if we assume the body dielectric to be isotropically nonlinear (to first order):
  - Velocities of the actual transmitted frequencies depend upon the particular point on the wave amplitude.
  - The transmitted frequencies overshoot, interfere, breakup, etc. The difference frequency does not.
  - The "difference frequency" is transmitted through the nonlinear dielectric medium as if it were a sine wave passing through a linear medium*.
- To our knowledge, this direct and deep communication of electronic "hash" difference frequencies in dielectric human bodies has not been investigated in the West.

* Owen Flynn, "Parametric arrays: A new concept for sonar," Electronic Warfare Magazine, June 1977, p. 107-112.

Ramifications of Kaznacheyev's experimental results (2)

- A heterodyne signal -- at the difference frequency between an input signal and a reference signal -- can be enhanced by adding noise*.
- Thus the signal of the disorder in the cellular pattern emitted from diseased cells, received by normal cells, can be amplified electronically and rather easily.
- Powerline radiation (electronic smog) thus carries its own amplification mechanism. Eventually the amplification overcomes any squelching by sunlight, etc.
- The Russians promptly (as early as the late 1950s) weaponized and tested these and similar effects.

* Dykman, M. I. et al., "Noise-enhanced heterodyning in bistable systems," Physical Review E, 49(3), Mar. 1994, p. 1935-1942

Weaponization of Kaznacheyev's findings

And its ramifications

"Microwave" radiation of the U.S. Embassy in Moscow.

Former U.S. Embassy in Moscow.

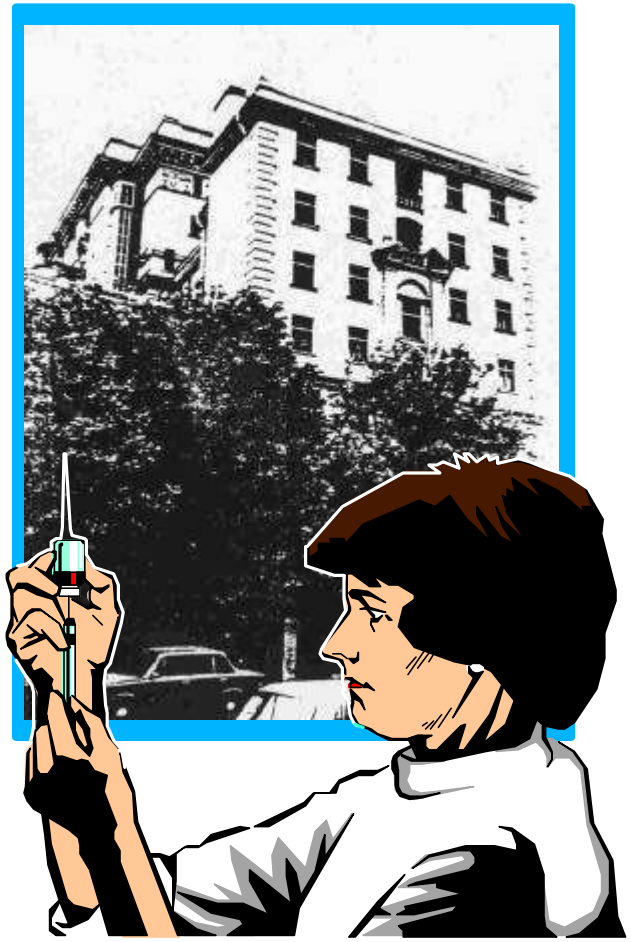

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

Ramifications of the microwave radiation of the U.S. Embassy

- The cellular disorder pattern in the EM radiation is carried by the field-free scalar potential.
- Since the disorder pattern is a "conglomerate", it must be carried by an internal EM structure existing inside the scalar potential itself.
- Whittaker decomposed the scalar potential into the appropriate internal longitudinal EM biwave structure in 1903*.

* E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," Mathematische Annalen, Vol. 57, 1903, p. 333-355

The importance of time as energy, and the time-domain

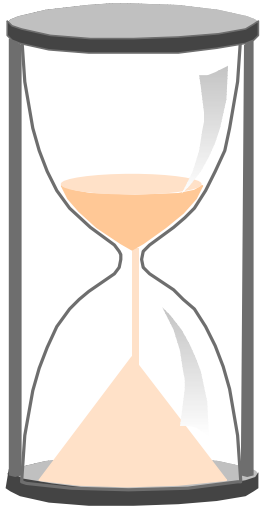

Time as energy

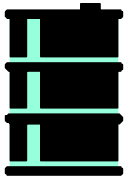
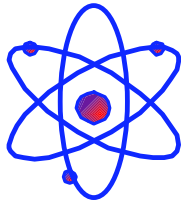

- In physics, the fundamental units one uses in his model are arbitrary.
  - A valid model can be made using only one unit.
  - It is already done in one branch of physics, using length as the single fundamental unit.
- Make a model with a single unit, the joule.
  - All other entities become functions of the joule.
  - We are familiar with mass as highly compressed EM energy, by the factor c^2.
  - It turns out that time is also highly compressed EM energy, by the factor c^2.
  - 1 sec. $\approx 9 \times 10^{16}$ joules.

How to see that "time is compressed spatial energy"

- Take some spatial EM energy and compress it by c^2
- Place it in 3-space, and it is *mass*.
- Place it on the time axis, and it is *time*.

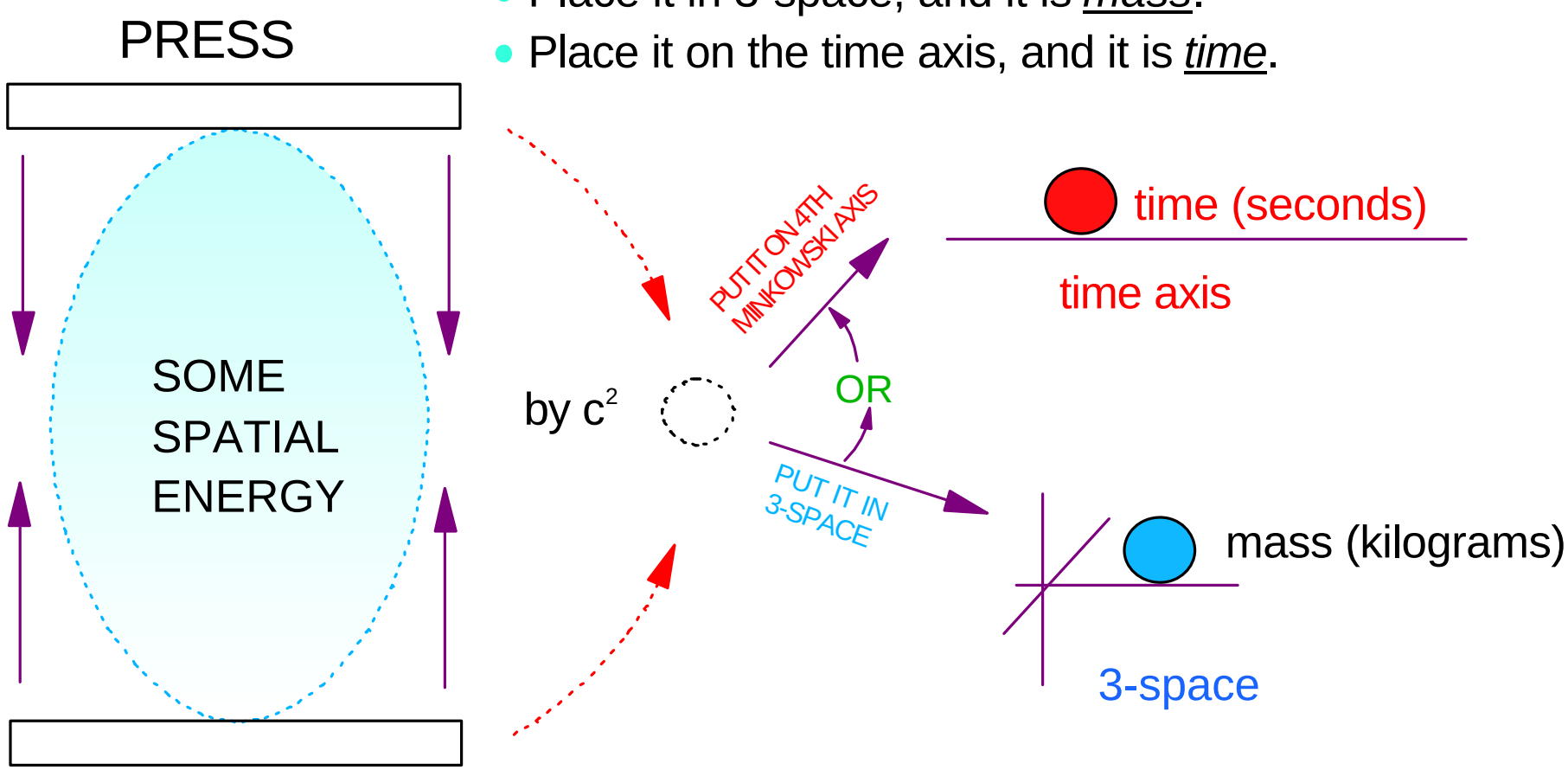

- When time-energy is converted into mass-energy, time is "decompressed" (expanded) into 3-space EM energy and 1 sec. $\approx 9 \times 10^{16}$ joules.

Time as EM energy in the time domain, with a density the same as mass-energy

- Bearden* reinterpreted (corrected) the 1903 Whittaker decomposition of the potential in 2000.
- The reinterpretation is consistent with broken symmetry in particle physics, for which Lee and Yang received the Nobel Prize in 1957.
- It is also powerfully supported by quantum field theory, notably by Mandl and Shaw in 1984**.
- Whittaker's pair is a combined time-polarized (scalar) EM wave and a 3-space longitudinal EM wave.

* T. E. "Giant Negentropy from the Common Dipole," Journal of New Energy, 5(1), Summer 2000, p. 11-23.

** F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984, Chapter 5.

All EM energy in 3-space freely comes from the time domain

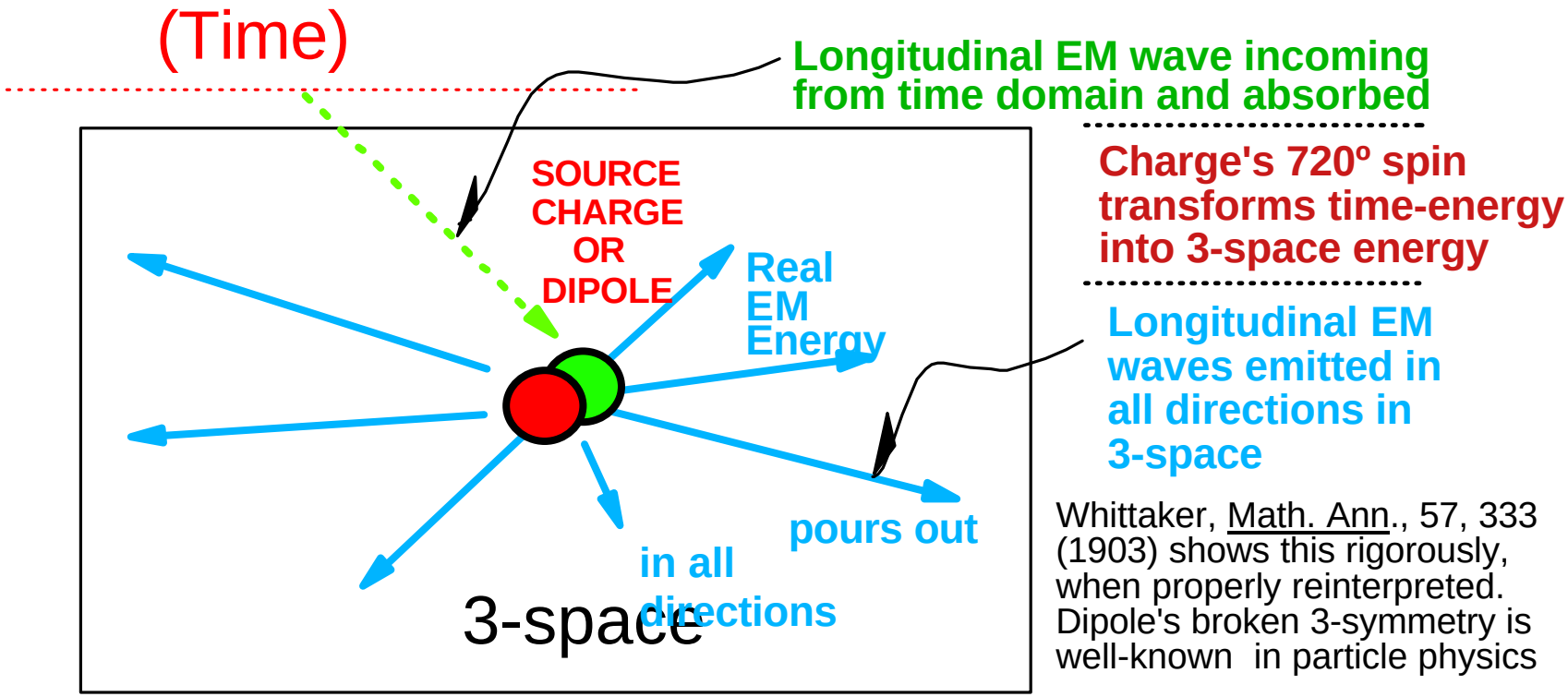

Whittaker, Math. Ann., 57, 333 (1903) shows this rigorously, when properly reinterpreted. Dipole's broken 3-symmetry is well-known in particle physics

Note: Whittaker (and others) interpreted the phase conjugate half set of LWs after interaction with the charges of the dipole, and as a 3-space *effect* rather than the time-domain *cause*. This fundamental non sequitur was just repeated since then, until corrected by Bearden to be consistent with broken symmetry and quantum field theory.

Strong support from quantum field theory

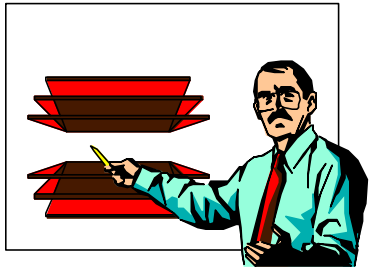

- Quantum field theory recognizes four photon polarizations:
  - Energy along x-, y-, z-, or t- axis.
  - Polarized along x- and/or y-axis, the photon is a *transverse* photon.
  - Polarized along z-axis (along its line of motion in 3-space), the photon is a *longitudinal* photon.
  - Polarized along the time-axis, the photon is a *time-polarized* or *scalar* photon.
- The individual longitudinal or scalar photon is not observable*.
- The combination of a longitudinal photon and a scalar photon is observable as the instantaneous scalar potential*.

* F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984, Chapter 5.

Mechanism generating the flow of a mass through time

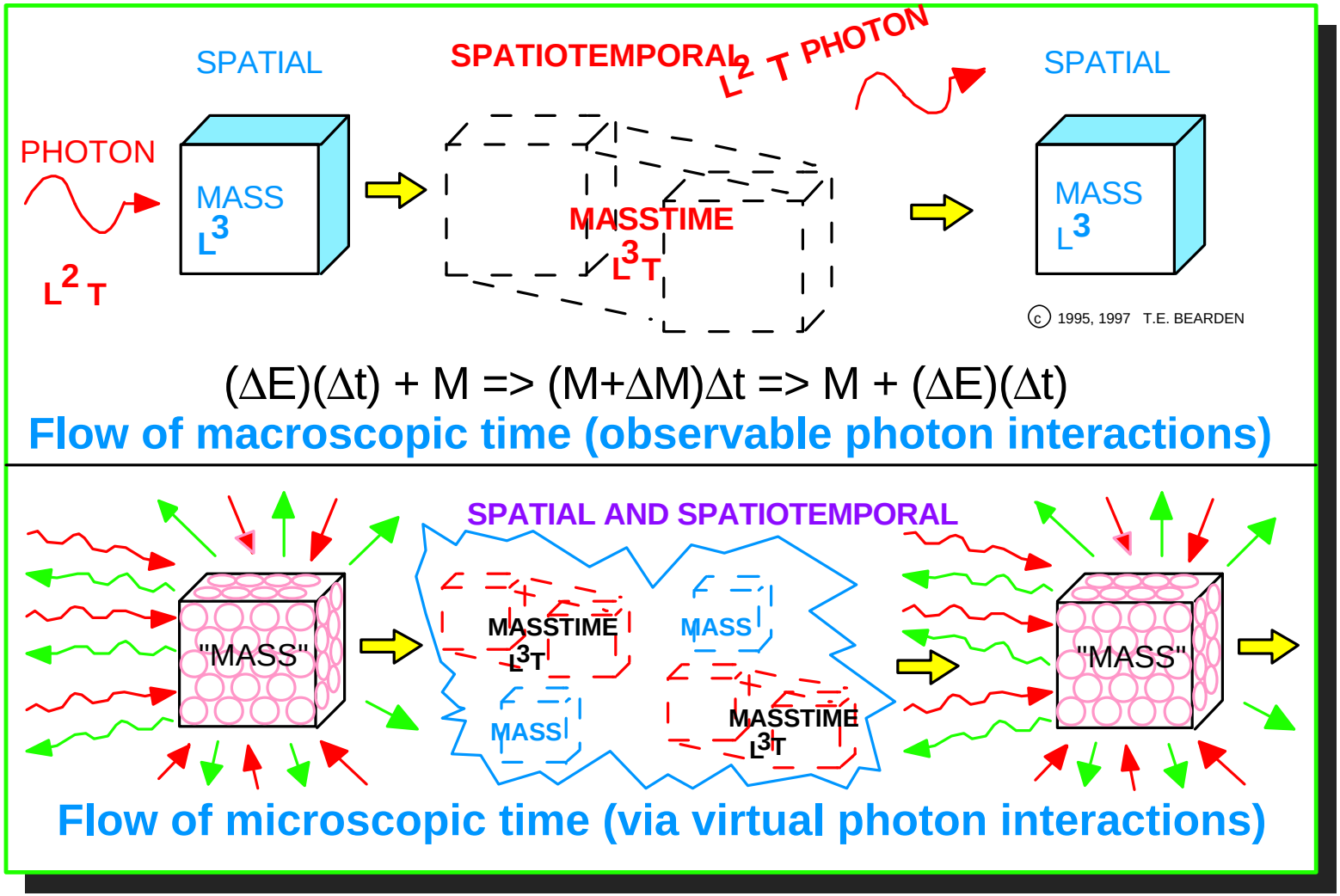

Mechanism is engineerable

Pumping a mass in the time-domain will time-reverse it back to an earlier state

- The reinterpreted biwave EM structure of the scalar potential means that time-reversal (phase conjugation by pumping in the time-domain) can be utilized to time-reverse a targeted cell (its mass-energy) in its entirety, including its genetics.
- Becker's bone fracture experiments showed it:
  - Weak scalar potential across the fracture site.
  - LWs in 3-space and time-energy waves in time
  - Red blood cells entered, dedifferentiated by shucking their hemoglobin and growing a nucleus, which is dedifferentiation (time-reversal of the cell and its mass-energy back to a previous physical state).

Principle for time-reversing a time-pumped mass

- Becker's cells then redifferentiated and changed -- first to primitive cartilage cells, then to primitive bone cells which were deposited in the fracture, healing it with new bone growth.
- This shows "time-forwarding" (redifferentiation) of the cell also.
- Becker actually showed that the *time-domain pumping* of the cells (by the time-polarized EM waves of Whittaker's reinterpreted wavepairs comprising the scalar potential), and the time-pumping of their mass-energy, operated to continuously and steadily *remove the delta between that cell's present condition and its former "normal" cellular physical condition in that area*.
- This is the long-sought secret of stem-cell research.
- Phase conjugate optics had not been born at the time. Without realizing its full nature, Becker demonstrated the body's own internal mechanism for healing, and the fundamental mechanism for time-reversing a physical mass, whether living or inert.

Mechanisms for use in medical treatment and healing

And ramifications

Successive deep penetration reactions of the cellular dielectric

- Change after change affects the cell and all of its parts, including from the external environment.
- Each successive change affects primarily the internal "LW EM structures and dynamics" comprising the ordinary potentials, fields, and waves.
- Thus in positive time the internal EM structurings produce successive "overlaid layers of change" -- so to speak -- in the internal EM structuring and dynamics of a cell in the body. These layers contain the "delta" from normal state.

Successive deep penetration reactions of the cellular dielectric (2)

- During time reversal, highest layer deltas are successively "peeled away" by the interaction of the mass-energy with the time-domain pumping.
- The result is to return the cell directly back to successive physical states, in the case of a single disease or disorder.
  - A cancer cell is returned to a normal cell prior to its "promotion".
  - An HIV-infected cell would be returned to its normal unaffected condition, free of HIV-induced genetic change.
  - For injuries and damage, the existing "delta" in each successive state-layer is steadily reduced to zero.
- This process thus can involve both cellular differentiation and dedifferentiation, as shown by Becker and by Prioré.

Engines (vacuum engines, spacetime curvature engines)

- Following Whittaker* as reinterpreted**, all normal EM fields, potentials, and waves decompose into sets of longitudinal EM waves (LWs) and their dynamics.
- Since these LWs and their dynamics are dynamics in the local energy density of spacetime (ST), they constitute *ST curvatures*.
- Hence they are general relativity infolded inside electrodynamics.
- By manipulating and changing these LWs, one manipulates and changes spacetime curvatures and their dynamics.
- The result is a unified field model where one directly controls and engineers a set of ST curvatures by use of higher group symmetry electrodynamics.
- Controlled patterns of local curvatures of ST are called "vacuum engines" or "spacetime curvature engines" -- or just "engines".

* E.T. Whittaker, Math. Ann., 57, 333-355 (1903); Proc. Lond. Math. Soc., Series 2, 1, 1367-372 (1904).
** T. E. Bearden, J. New Energy, 5(1), 11-23 (2000).

Pumping with EM time-polarized waves forms *amplified* antiengines

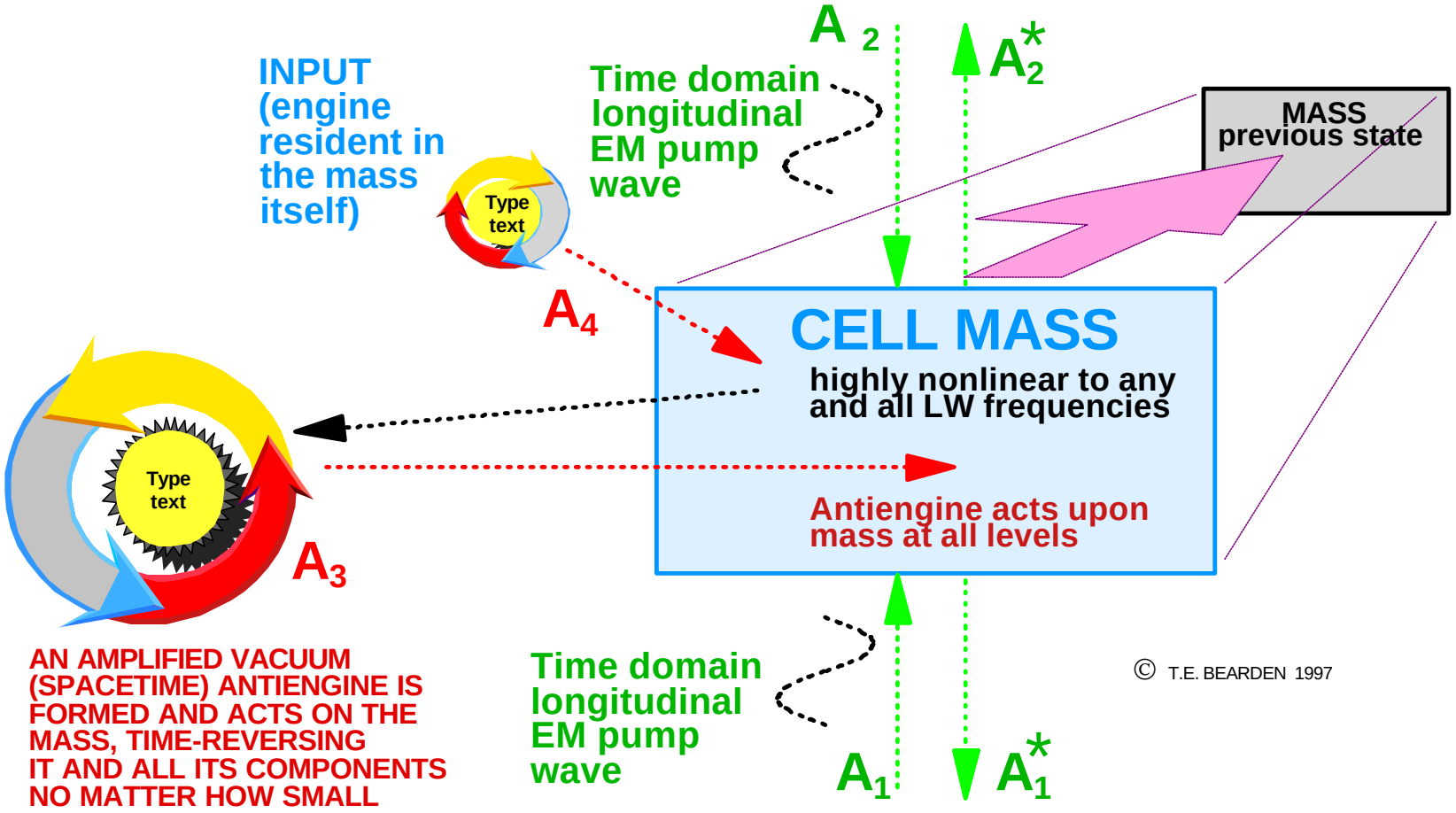

AN AMPLIFIED VACUUM (SPACETIME) ANTIENGINE IS FORMED AND ACTS ON THE MASS, TIME-REVERSING IT AND ALL ITS COMPONENTS NO MATTER HOW SMALL

© T.E. BEARDEN 1997

A DRAMATIC EXTENSION TO NONLINEAR OPTICAL PUMPING

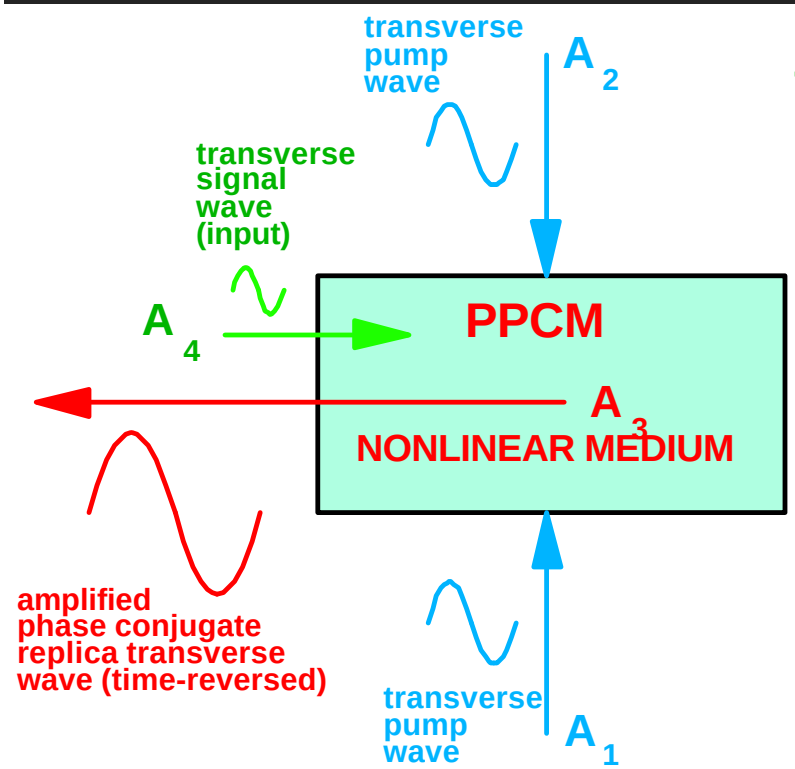

a. Pumping with transverse EM waves produces a time-reversed *wave*.

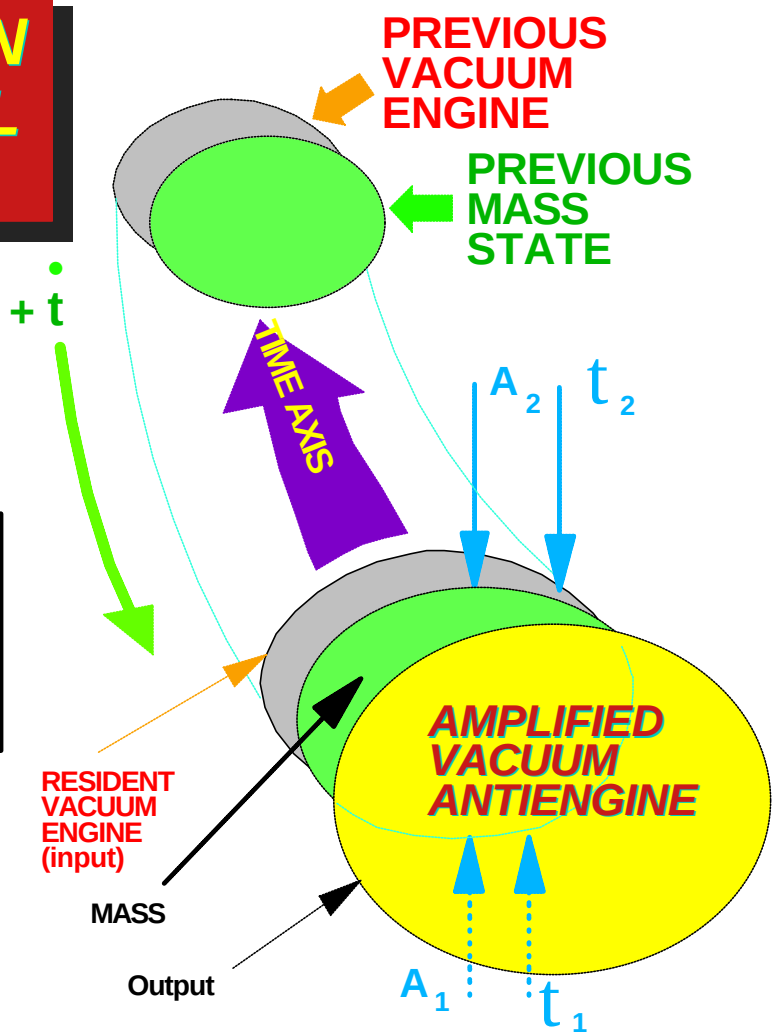

b. Pumping with longitudinal EM waves A_1 and A_2 time-reverses *the mass itself*.

Time-reversal of a mass to a new physical state not in its past

- Original engine A'
- New engine B' added
- Time-pumping moves to new "past" that is determined by (A'+B')

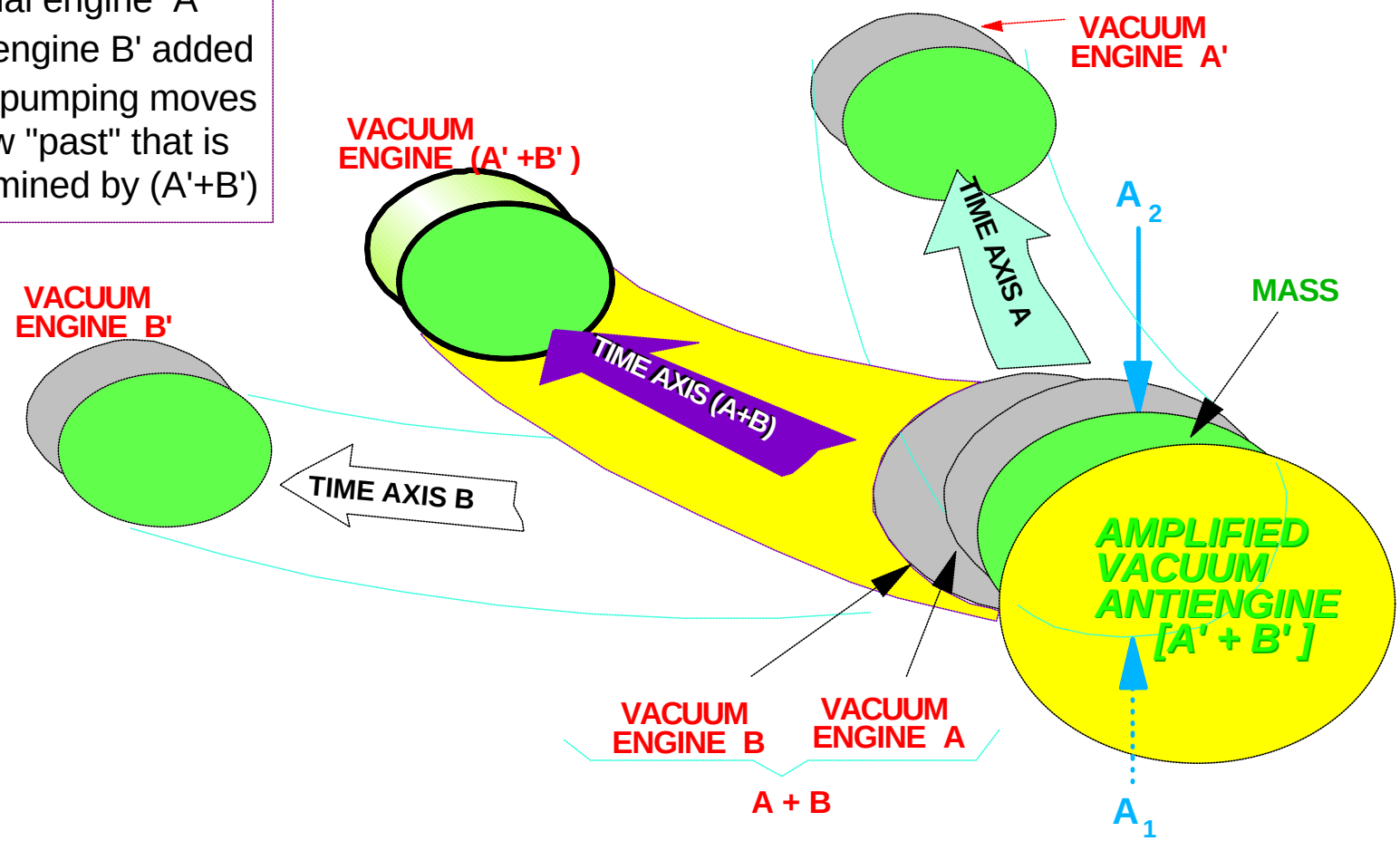

Extended general relativity principle

- All levels of energy structures and all levels of time structures mold spacetime geometry.
- The "pattern" is called a *template* for a vacuum engine (spacetime curvature engine).
- Spatial and temporal structurings of the engine act upon any exposed mass at all levels.
- This produces a template of forces, for precise translations and stresses within the mass at all levels. The forces exist in both time and 3-space.

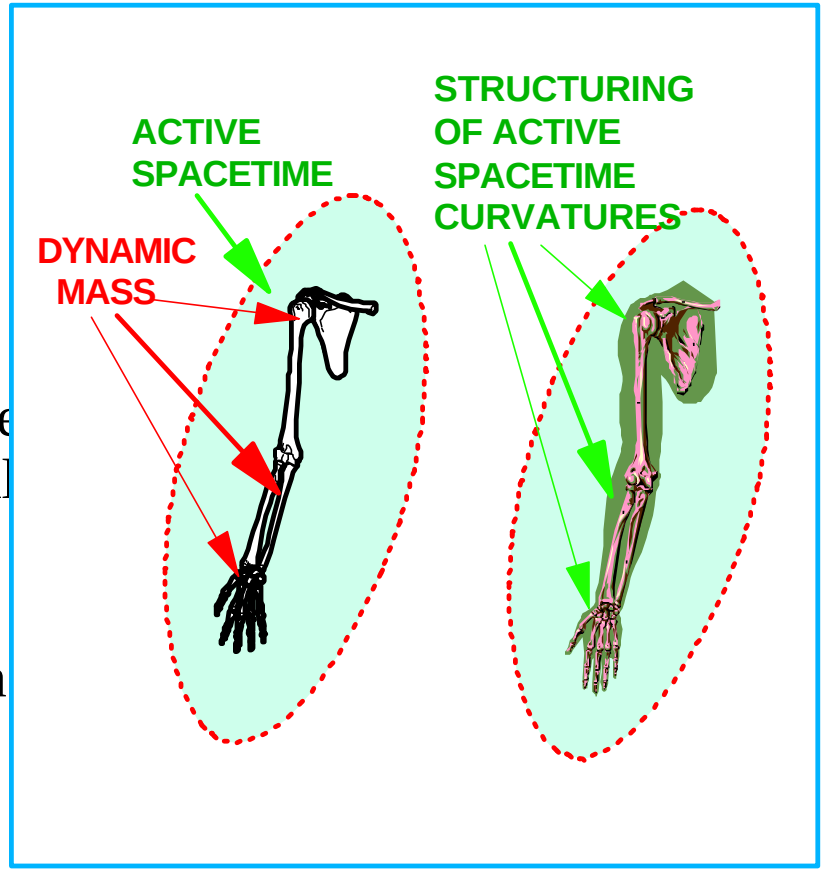

Engines: Working spacetime demons

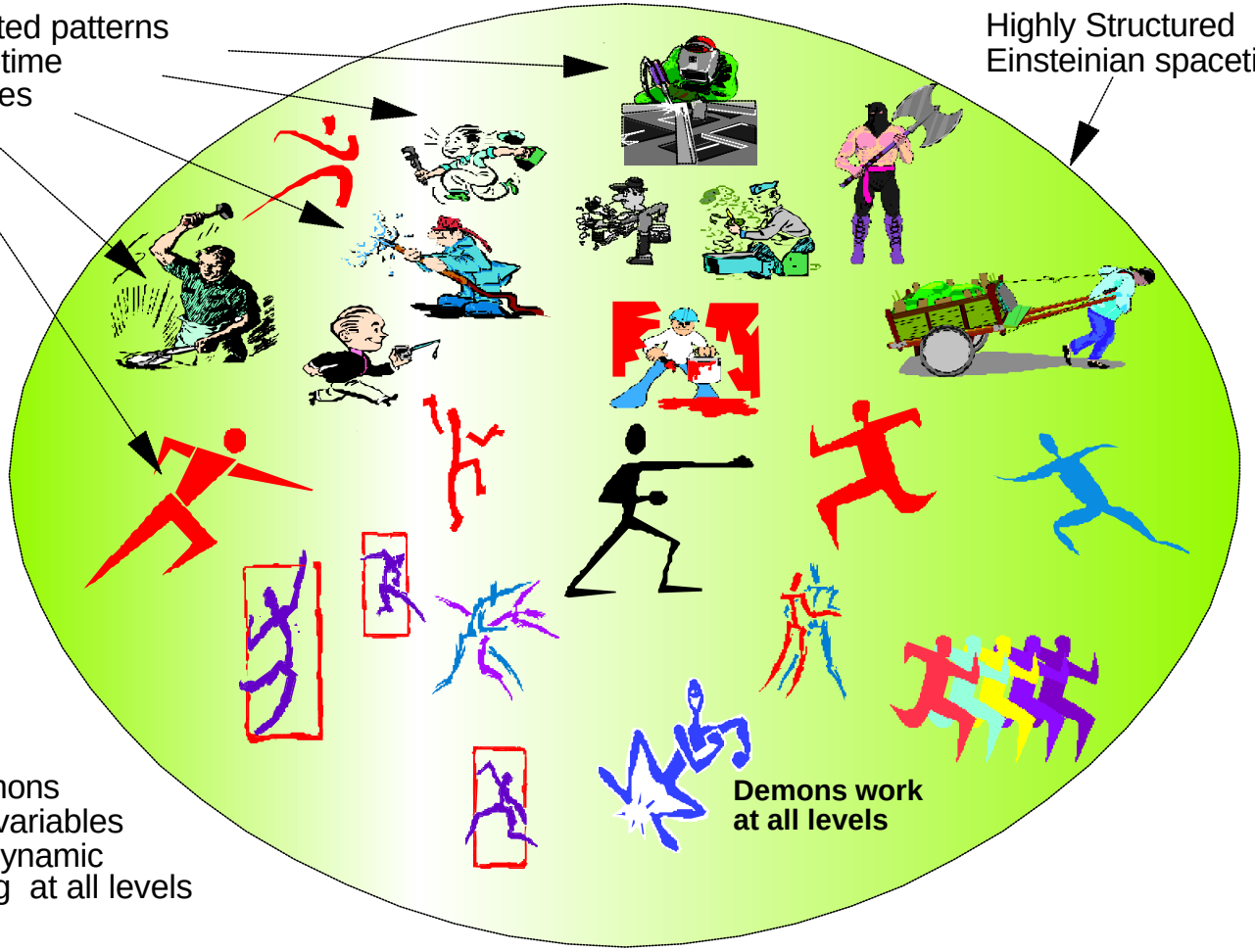

Maxwellian Demons
are EM hidden variables
organized into dynamic
structures acting at all levels

Signal vs. vacuum engine

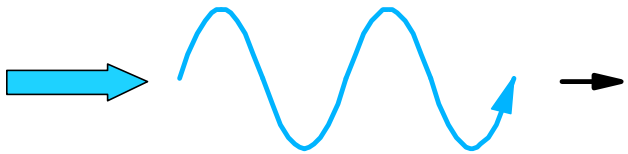

SIGNAL (INFO)

- ★ Information received
- ★ Any overt physical action must be taken by cell itself
- ★ Cell must furnish the energy for any action it takes
- ★ Passes from outside to in

A. ***Cell must do the action itself; vacuum energy exchange is passive. Energy or fuel for doing the action must be added to cell externally.***

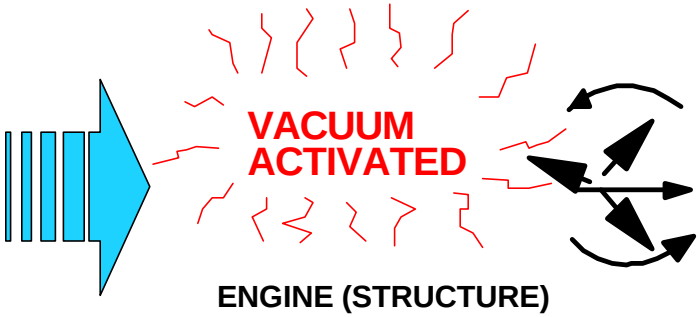

ENGINE (STRUCTURE)
TEMPLATE (FORM)

- ★ Information itself acts
- ★ Local spacetime curved, with internal subcurvatures
- ★ Produces template of forces in local spacetime (ST)
- ★ Arises from within local ST
- ★ Acts on and changes all parts of cell, including its genetics

B. ***Cell is acted upon; vacuum energy exchange does the specific action. No energy or fuel for doing the action need be added to cell externally.***

Unified field theory requires modeling and use of supersystem

Three components interact with each other:

- System and its dynamics
- Local active vacuum and its dynamics
- Local curvatures of spacetime and their dynamics.

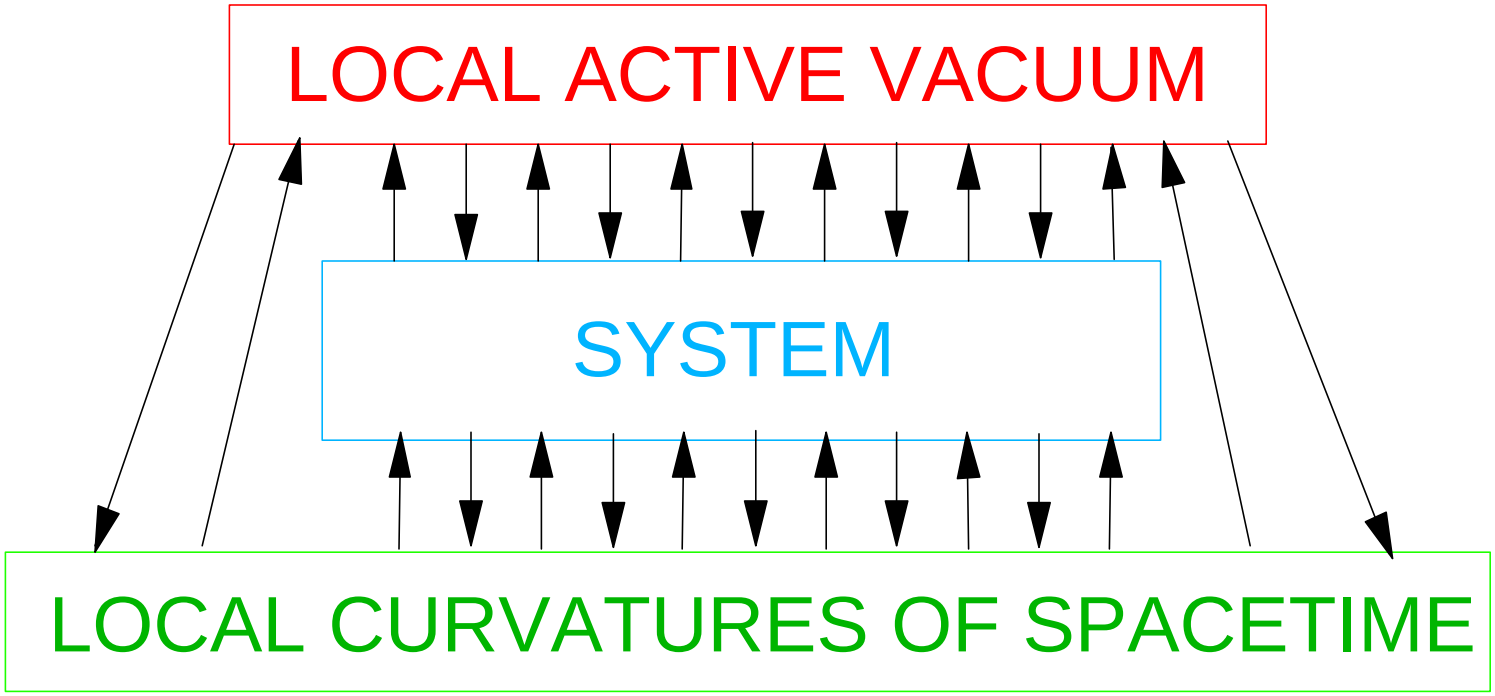

Classical EM kills the supersystem, prevents supersystem engineering

- Assumes flat local spacetime
- Assumes inert vacuum

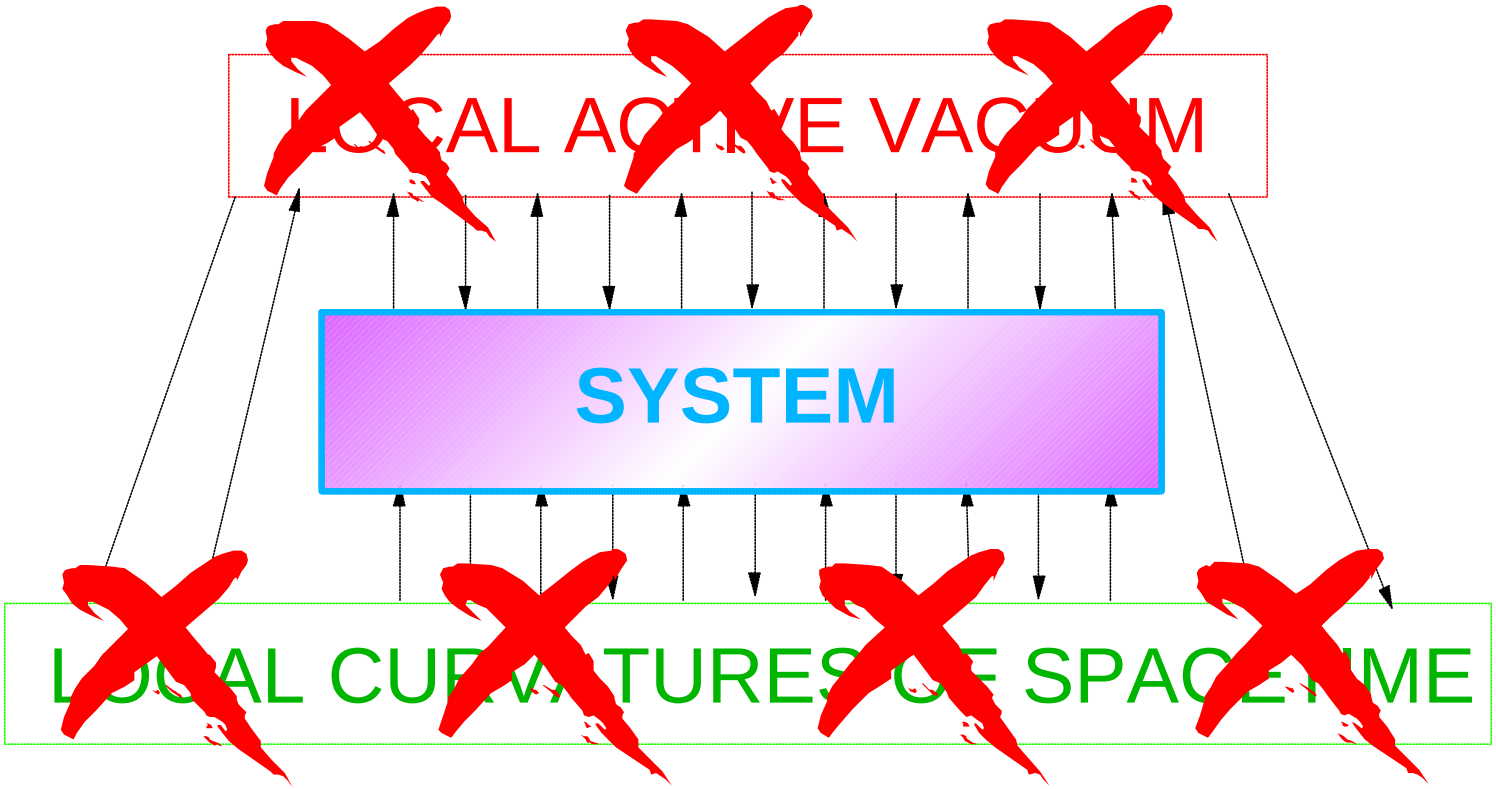

Malignant teratoma exhibits both time-reversal and fast-forwarding

- A teratoma cell is a tumor cell that has reverted to stem cells, then proceeds to differentiate toward new kinds of normal cells.
- May produce hair, skin, muscle, heart, bone, and other type cells.
- Sometimes present at birth.
- Demonstrates both "time-reversal" and "time-forwarding".
- The missing key is the engine function(s).

Miller-Fox-Urey biogenesis experiments

- Engines of and from all life forms ever on earth or in the universe exist in the ambient vacuum potential.
- The Miller-Fox-Urey experiments were not in a "sterile" environment.
- Heat (IR) and UV constitute (1) a harmonic interval with a difference frequency, and (2) amplifying by the process previously shown.
- These experiments "kindled" previously living forms from the available gases etc. by amplifying the ancient living engines from their virtual state to the observable state, so that the masses were molded into the physical states of their templates.

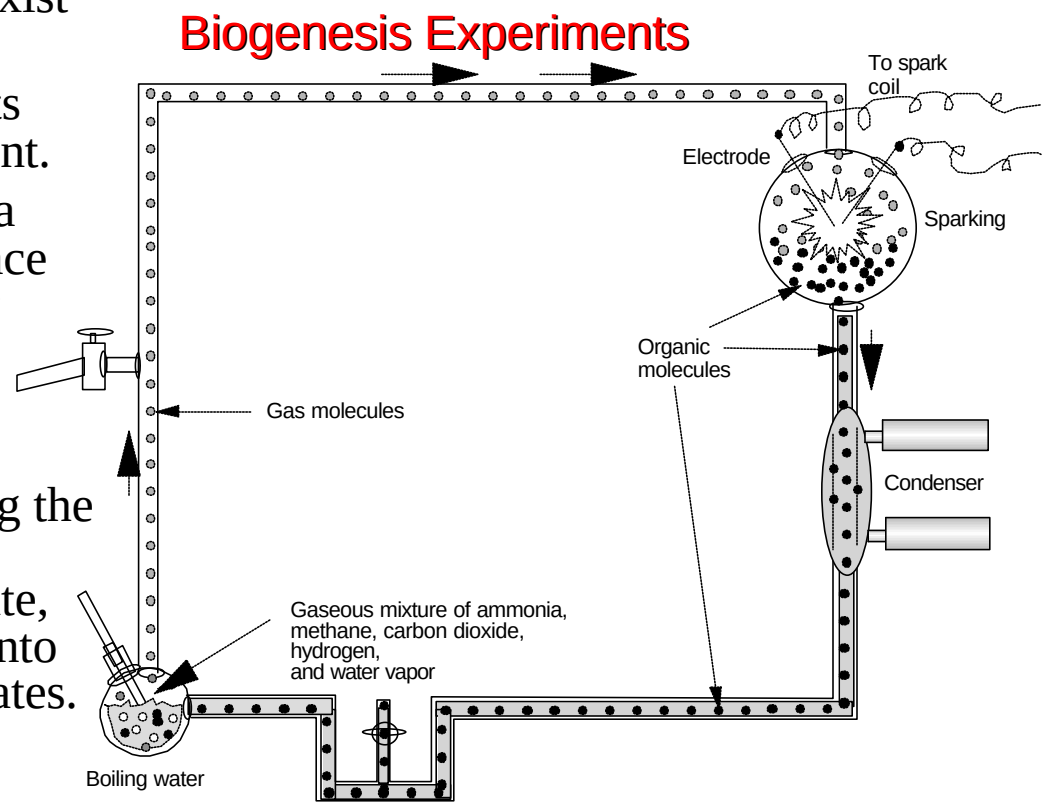

Cloning to produce stem cells

- Human DNA can be inserted in an animal cell, and the cell chemically tricked into proceeding as if fertilized.
- Formation, increase, and growth of stem cells begins and continues.

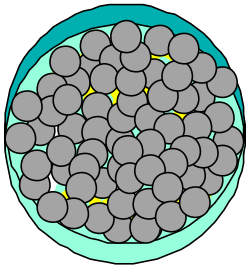

- The "engine" carried by the human DNA is changing the matter available into human cells.
- readily demonstrated experimentally.

Regeneration in a strain of rat with part of its immune system missing

- In mammals, the immune system plays a role in reducing the regeneration capability, compared to that of more primitive systems.
- In a strain of rat where that "suppressive" part of the immune system is missing, the regenerative capability is dramatically increased.
  - Can regrow cut away sections of tail.
  - Regrows plug cut out of ear.
  - Reconnects severed optic nerve.
  - Partially restores severed spinal cord.

- The suppressive "delta" engine of the immune system, operating simultaneously with the underlying primitive regenerative engine, sums to the modern much-reduced regenerative engine in the mammal.

An observation for the future

- When the science of engines is developed, physicians will be able to tailor these engine combinations to restore severed human spines, regrow severed limbs, etc.
- They will also be able to direct the body's "normal growth" to reduce and direct birth defects, genetic defects, etc.

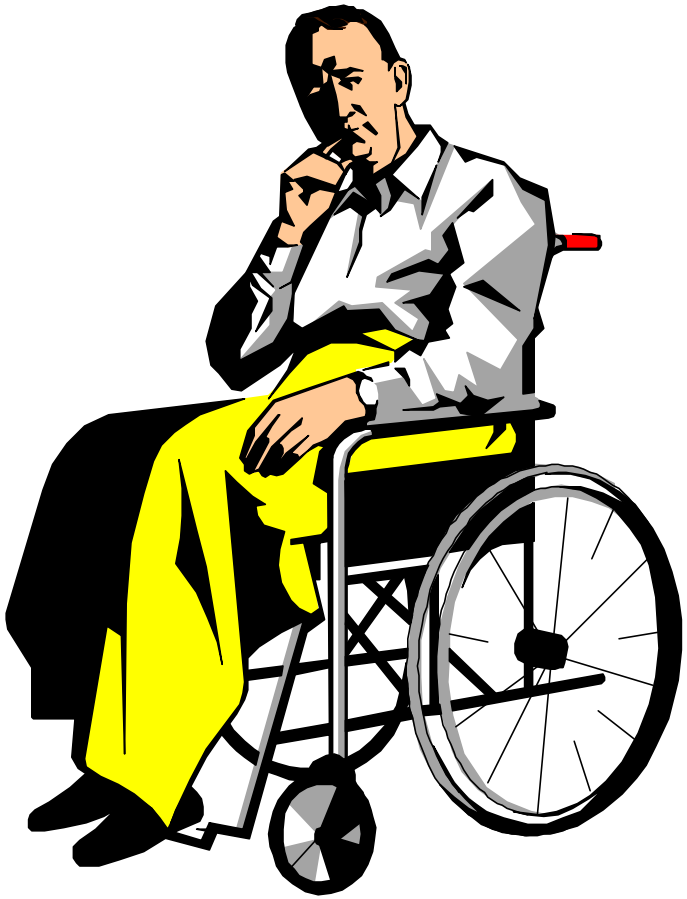

Biochemistry and EM models

- Medical scientists analyze such things as teratomas in terms of biochemistry and the biochemical model.
- An assembly of charges and charge distributions, with their associated fields and potentials, drives all chemistry at base level.
- The charge assembly and its dynamics involves a corresponding assembly of spacetime curvatures and their dynamics. These are *the cause that is driving the charge assembly and its dynamics, and therefore the chemistry*..
  - In unified field theory (such as that of Sachs) and O(3) electrodynamics.
  - Not in classical U(1) EM theory or quantum electrodynamics.
- Conventionally a causative EM field in space is "defined" as the *diversion from* that spatial field by and after its interaction with charge).
  The "definition" substitutes the effect for the cause, a non sequitur.
- This is a known major flaw, pointed out in one fashion or another by many physicists such as Wheeler and Nobelist Feynman.
- Classical EM theory is a 137-year-old model, seriously flawed. These flaws emerge in biochemistry and medical science.

Necessary EM corrections*

- Many of the corrections necessary in electrodynamics modeling either have been done or are underway.
- Higher symmetry, non-Abelian electrodynamics models have long been developed in particle physics.
- The new approach extends these models to also incorporate general relativity, thus producing a unified field theory*.
- In the new approach, spacetime curvature engines are perfectly natural and understandable, and can be directly modeled and engineered by advanced theorists.
- In short, the theory is sufficiently advanced and robust that technology and engineering can now advance.
- This will be a great leap forward for biochemistry and medical science, particularly in therapeutic methods.

* Sachs's unified field theory implemented by O(3) electrodynamics presently is the most suitable to use. Numerical methods are required.

Prioré's revolutionary results in lab animals

And its ramifications

Prioré (right) makes a point to Chaban-Delmas, Mayor of Bordeaux

- Many of the Prioré team's experiments were done in Bordeaux.
- Antoine Prioré patents:
  - "Apparatus for producing radiations penetrating living cells," U.S. Patent No. 3,368,155, Feb. 6, 1968.
  - "Method of producing radiations for penetrating living cells," U.S. Patent No. 3,280,816, Oct. 25, 1966.
  - "Procede et dispositif de production de rayonnements utilisables notamment pour le traitement de cellules vivantes," [Procedure and Assemblage for Production of Radiation Especially Serviceable for the Treatment of Living Cells], Republique Francais Brevet d'Invention P.V. No. 899.414, No. 1,342,772, Oct. 7, 1963.

Block diagram of Prioré's method

Time-reversing the cells back to normal state

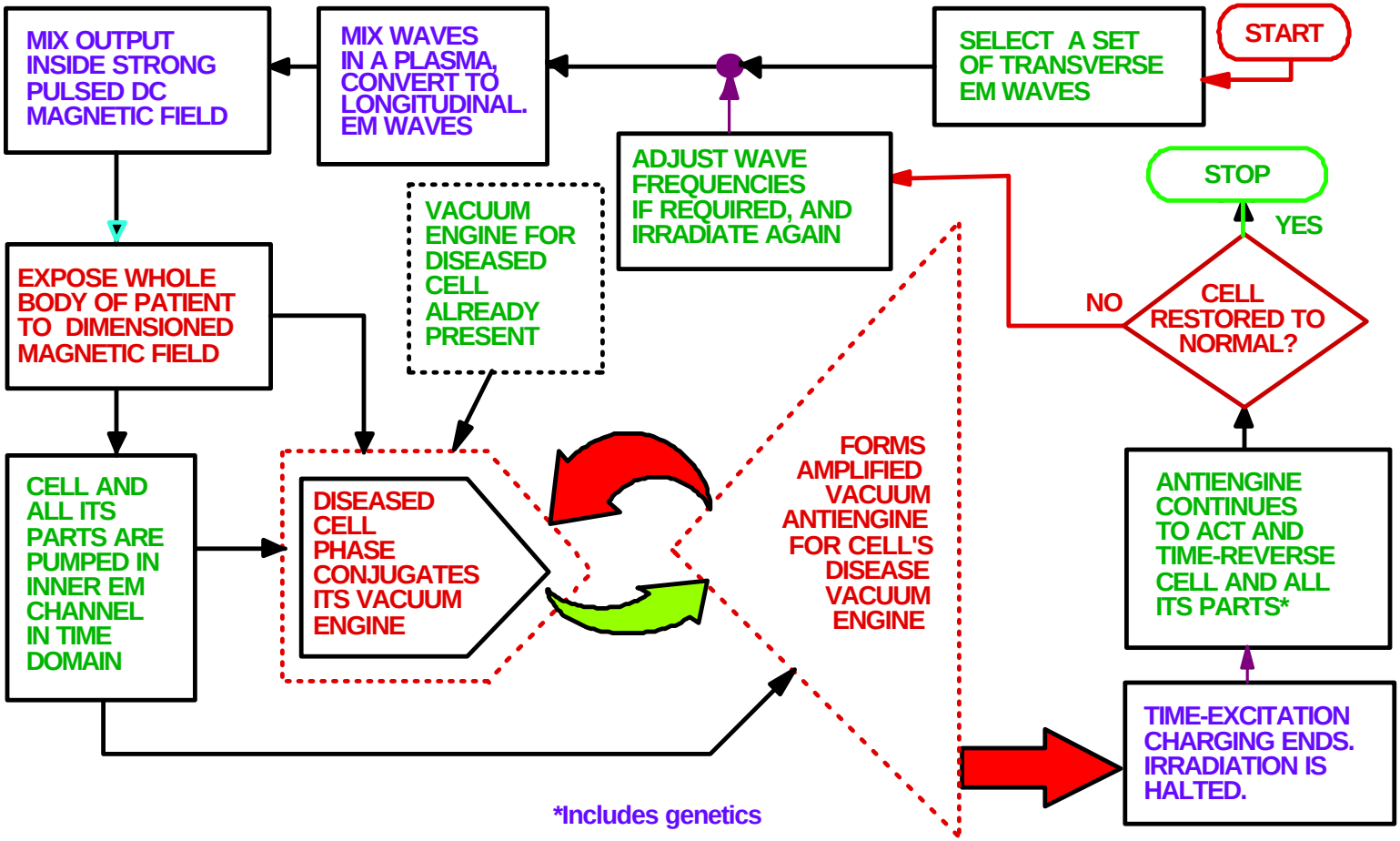

*Includes genetics

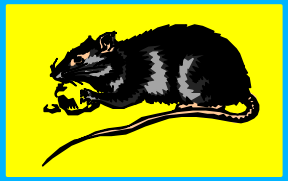

In Laboratory Animals:

Prioré Team Cured

- **Terminal malignant tumors**
- **Clogged arteries (atheriosclerosis)**
- **Suppressed Immune Systems**
- **Infectious trypanosomas**
- ***Results were presented to French Academy of Science by Robert Courrier, Director of the Biology Section of the Academy***
- ***<u>No one understood the mechanism!</u>***

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Some peculiar results by the Prioré team

- Once a rat is cured of a particular disease:
  - A single drop of blood from the cured rat, injected into another rat stricken with same disorder, would result in the injected rat getting well slowly.
  - This ability to transfer immunity and healing in the extracted drop of blood gradually decayed over a period of a few weeks.
- Showed that even the fields and potentials in the blood had been altered internally, in the treated animal.
- Showed that the injected animal's cellular regenerative system possessed the ability to also time-domain pump over the entire body, everywhere reducing the delta between that injected drop of blood now the rat's own, and the rest of the blood in its body.

Proof of cellular time-reversal

- Pautrizel compared identical treatment of immature rats with immature immune systems, and mature rats with mature immune systems.
- Treatment restored the damaged mature system back to full mature functioning, and it promptly recognized and dispatched the pathogens.
- Treatment restored the damaged immature system back to full immature functioning, unable to cope, and the pathogens promptly reinfected and killed the immature rat.
- The lesson: The body is indeed returned to a previous physical state. The pathogens themselves are not killed by the treatment, but by restoring the ability of the immune system to recognize and destroy them.
- Only the *previous ability* of the immune system is restored by the process.

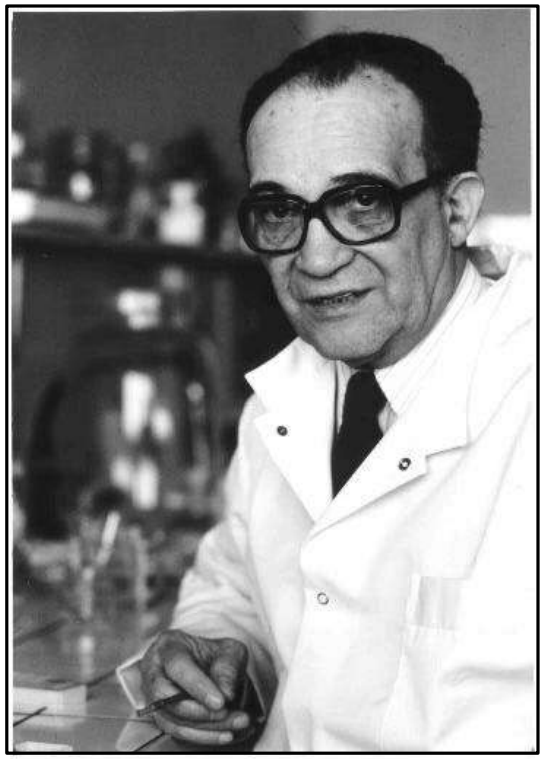

PROF. RAYMOND PAUTRIZEL
(Renowned Parasitologist)

Disadvantages of Prioré method

- Large plasma tube and facility required.
  - 3-stories high building bay if to treat humans.
  - Long irradiation time (2-3 hours).
  - Slow, numerous experimental adjustments.
- Fundamental mechanism was unknown.
  - Phase conjugate optics not yet born in West.
  - No higher symmetry EM modeling used.
  - Prioré thought it was a result of ionization.
  - Importance of difference frequency unknown.
  - Body dielectric transmission path unknown.

3-Story high Prioré device for treating humans

- At the end of the project, Prioré had developed a large unit to treat humans.
- A few were treated.
- Cures replicated what had been done in lab animals
- The massive size of the unit and long treatment time (hours) made the process bulky and very inconvenient -- and also expensive

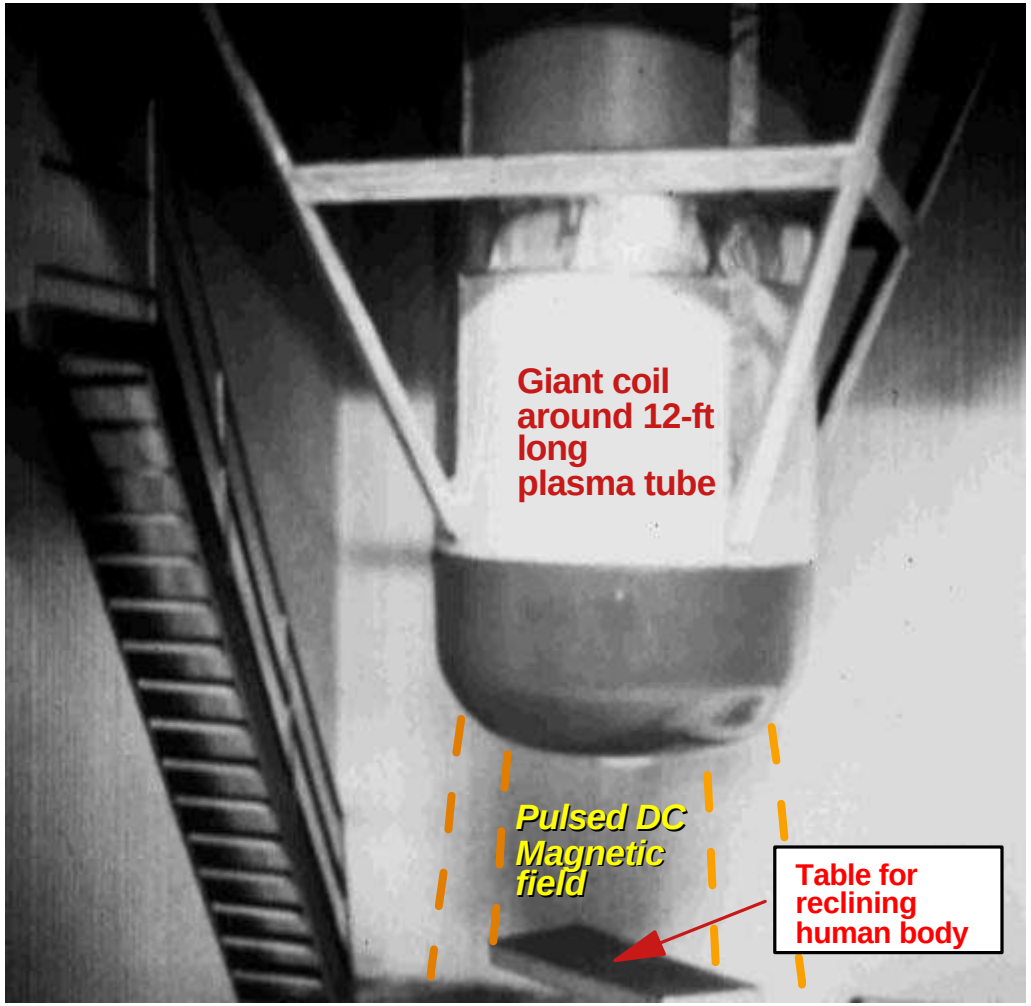

17-foot Prioré plasma tube

Used in large machine (3-stories high) to treat a limited number of human patients

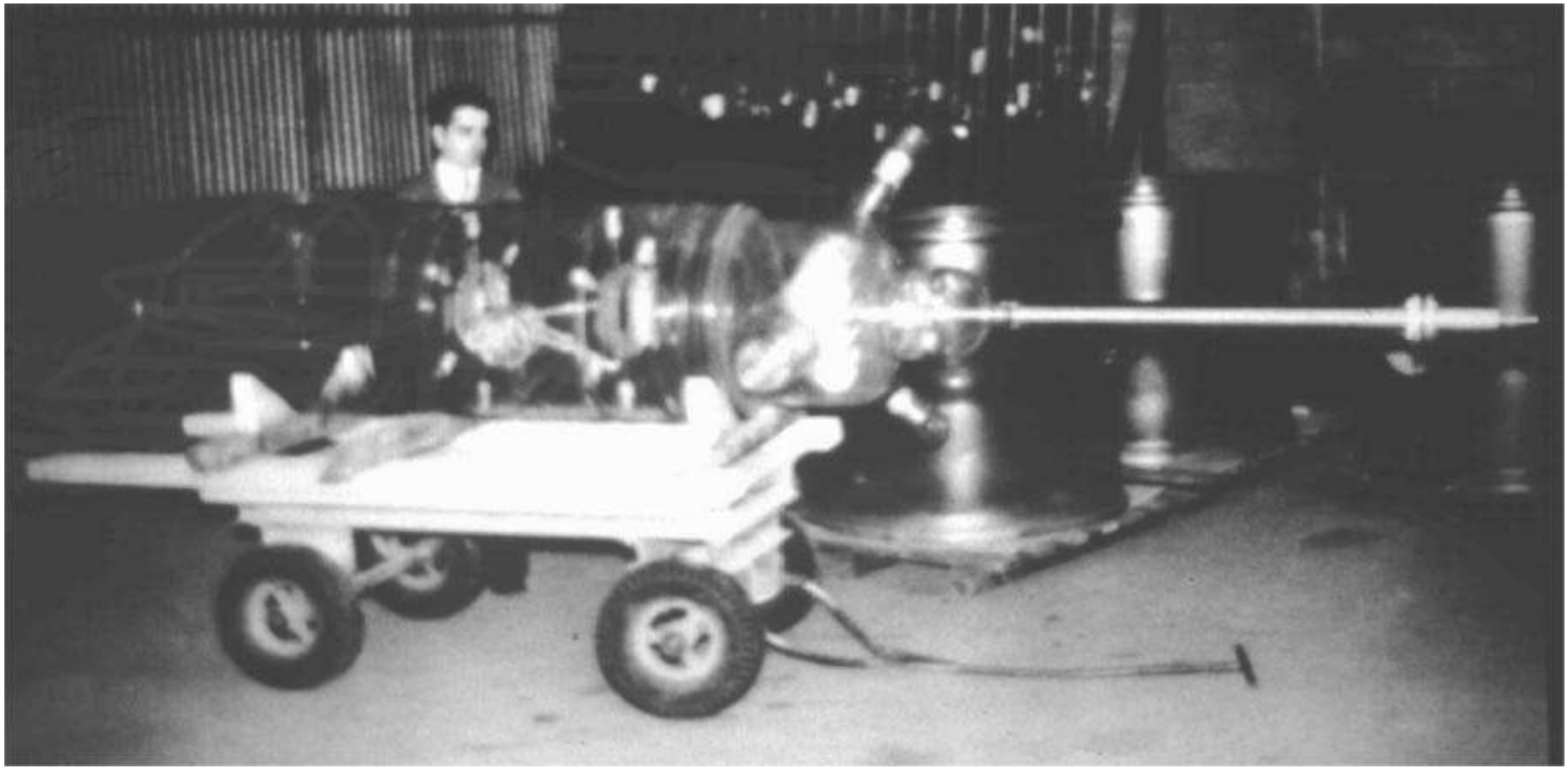

A proposed new mechanism for cancer promotion

And its ramifications

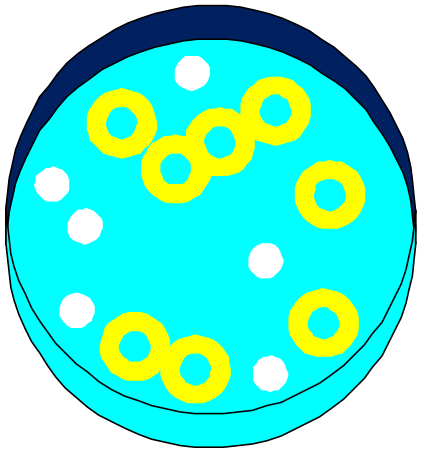

Remarks on cancer from a new perspective

- Two stages: cellular damage and promotion of the damaged cell to a tumorous cell. Promotion presently is poorly understood if at all.
- A master cellular control system (MCS) (studied by Popp et al.) controls both the immune system and the cellular regenerative system, as well as normal functions of the cells.
- The "past history" of ancestral development of aerobic cells and higher multicell aerobic bodies on planet Earth, resides in the "internested engine layers" in every tiniest part of the entire body dielectric, and in all cells.

Remarks on cancer from a new perspective (2)

- Faced with cell damage (such as sustained hypoxia) it cannot handle, the MCS continues to "peel the layers" in taking actions related to ever more distant pasts.
- Faced with continuing hypoxia, e.g., the MCS eventually reaches ancestral layers -- with an engine -- it forces the damaged cells to start moving back toward the original primeval anaerobic form.
- The first step backward is *separation from central growth control*, freeing the cell to multiply independently. At the same time, genetic changes in the cell are forced and produced, starting it back toward becoming an anaerobe.
- These actions comprise the *promotion process*.

The promotion process via engines

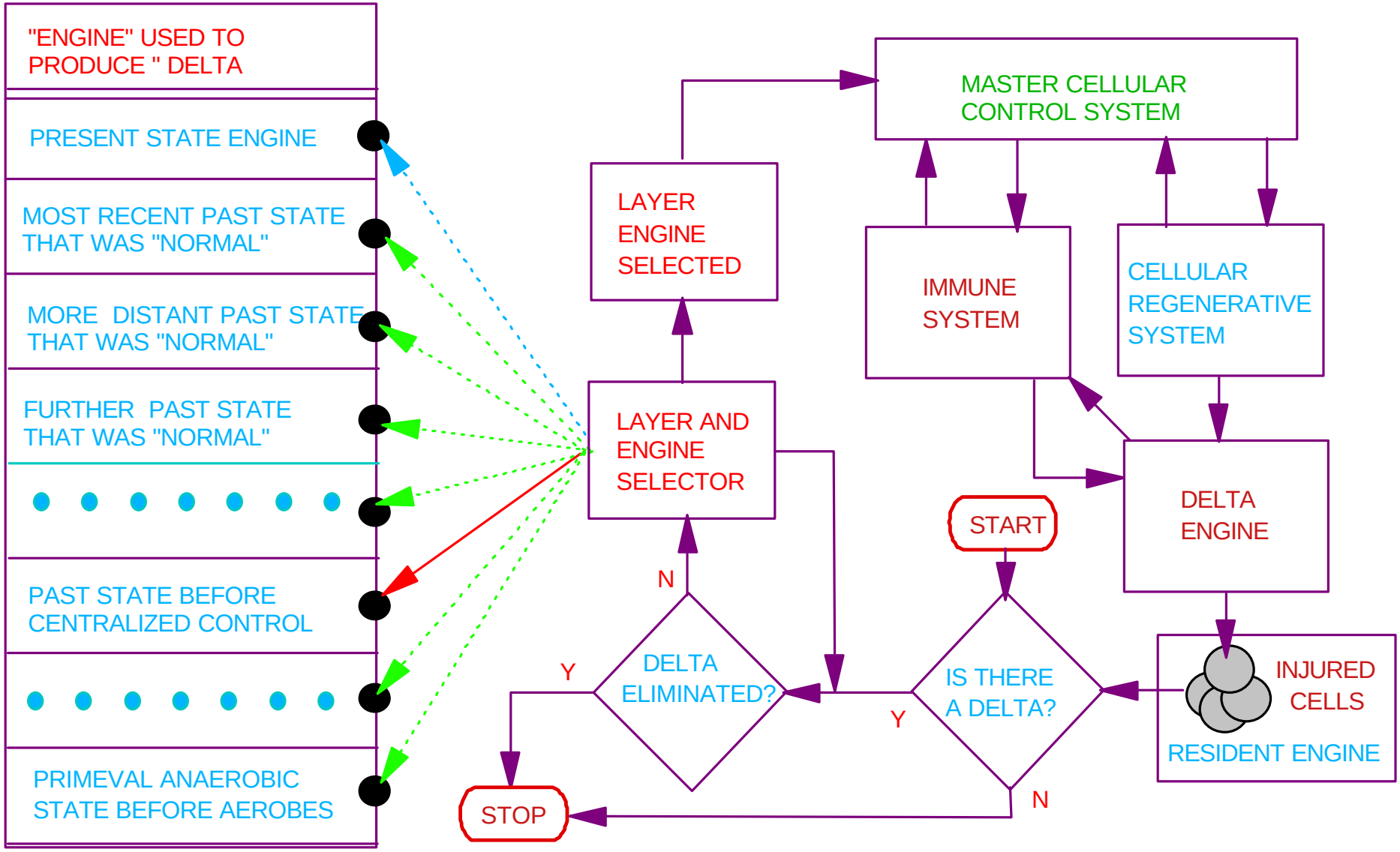

Evolution of aerobic systems

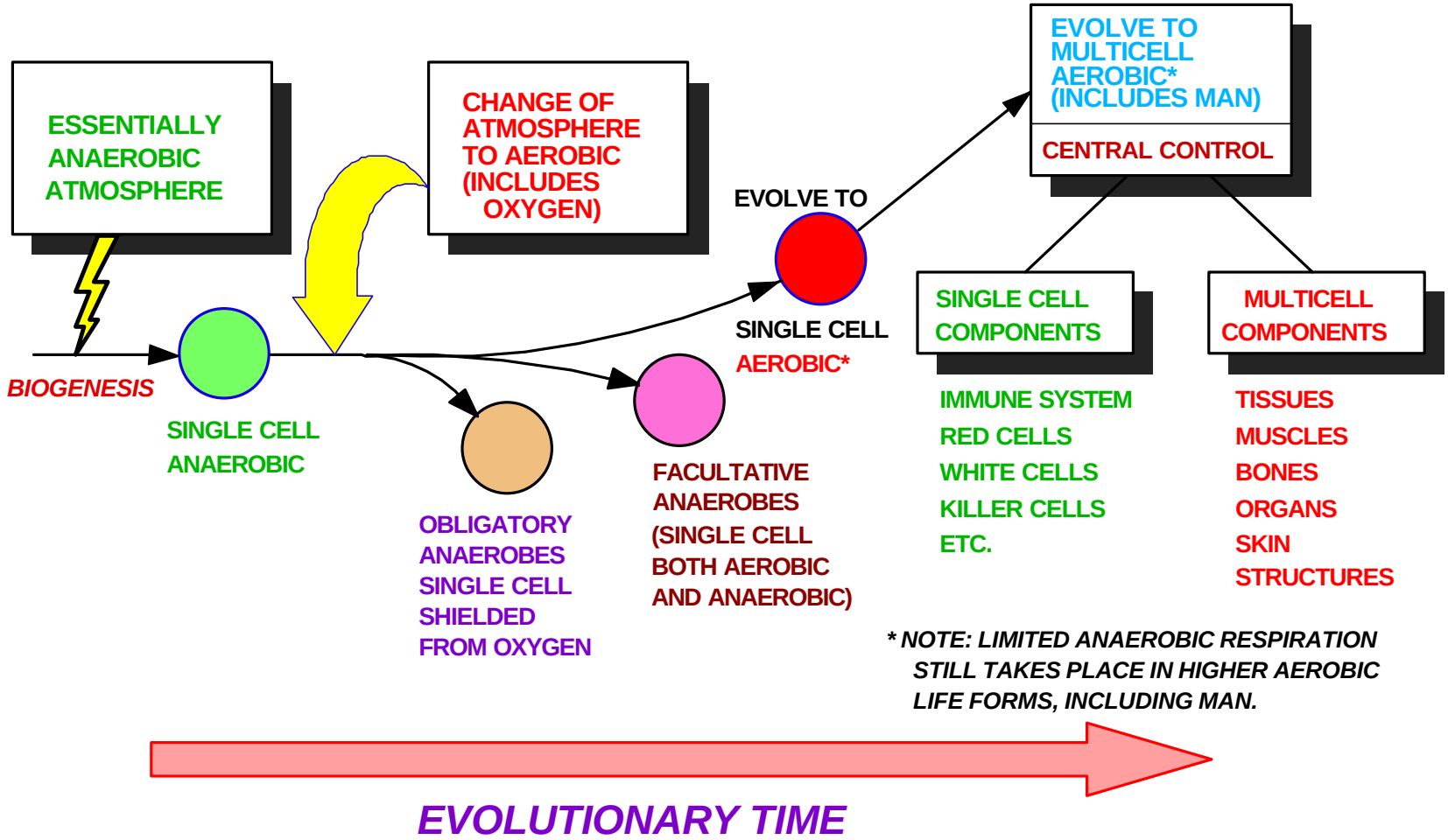

First step in self-promotion of cancer due to hypoxia

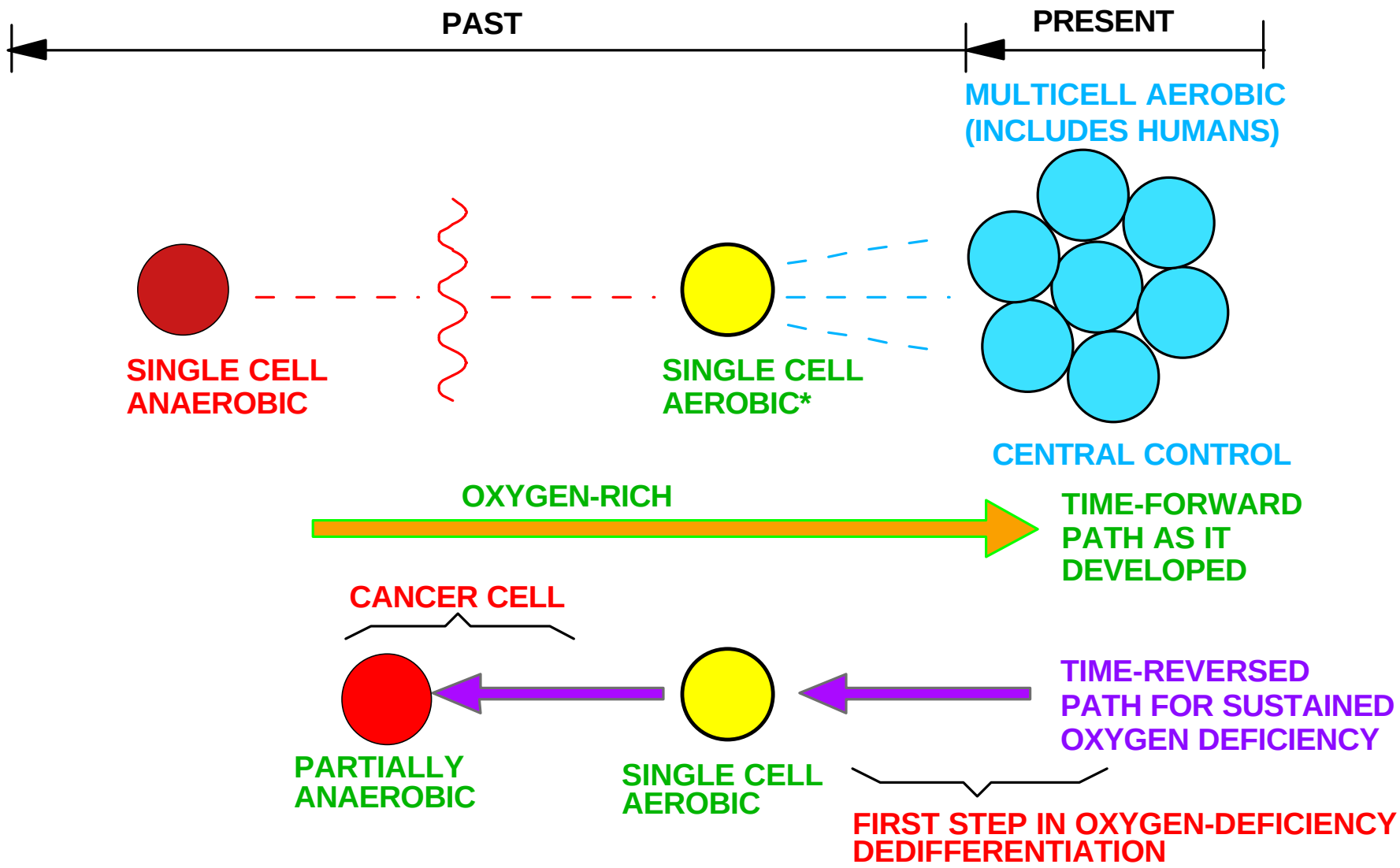

Block diagram of the cellular regenerative system

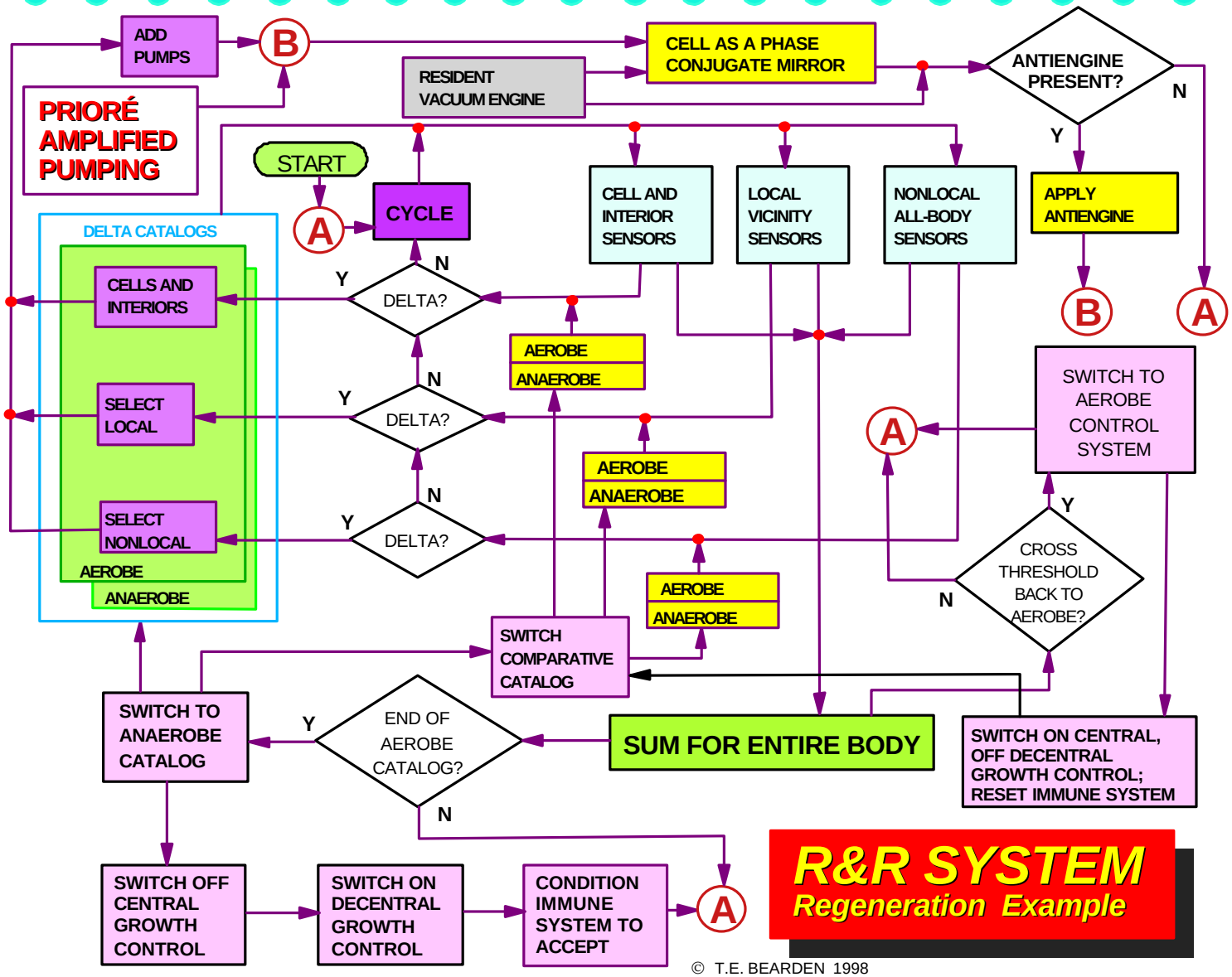

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Bombshell: Amplified EM healing

- A unified field theory approach and use of supersystem analysis has broken the basic mechanism for healing itself.
  - The Sachs unified field theory applies and has been partially fitted.
  - Evans-Vigier O(3) electrodynamics can properly model it, including both the internal and external electrodynamics and effects of engines.
  - Direct engineering development is now possible.
- Experimental proof of the results obtainable already exists in the literature.
- A medical revolution is in the offing.

Potential Medical Applications

- **Non-traumatic cancer treatment**
  - *Cure cancers and leukemias of all types*
  - *Remove pre-cancerous state*
  - *Restore system*
- **Treat and cure Infectious diseases**
- **Cure AIDS and restore immune systems**
- **Defense against biological warfare**
  - *Virulent diseases from unknown agents*
  - *Treat, cure prior to symptoms developing*
  - *Both civil populace and armed forces*
- ***Dramatically lower health costs***
- ***Rejuvenate the aged***

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To treat and save mass casualties: What is urgently needed now:

- A small, portable, relatively inexpensive treatment unit, not requiring plasmas etc.
- Treatment in 2 to 5 minutes rather than 2-hours.
- Simple treatment application, almost anywhere.
- Effective in advanced stages as well as prior to emergence of symptoms.

- Effectiveness against a wide array of illnesses.
- Use is easy, high school student can be trained in 30 minutes.
- Crash program to develop, flood down through emergency systems in great quantities.

The Solution:

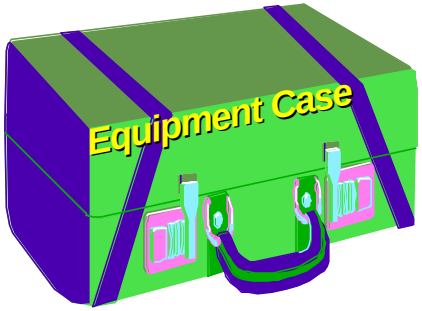

- Two blankets have antennas in them.
- Uses the "porthole" concept (discussed shortly)
- Eliminates plasma tube mixing etc.
- Computer-controlled complex signal structure.

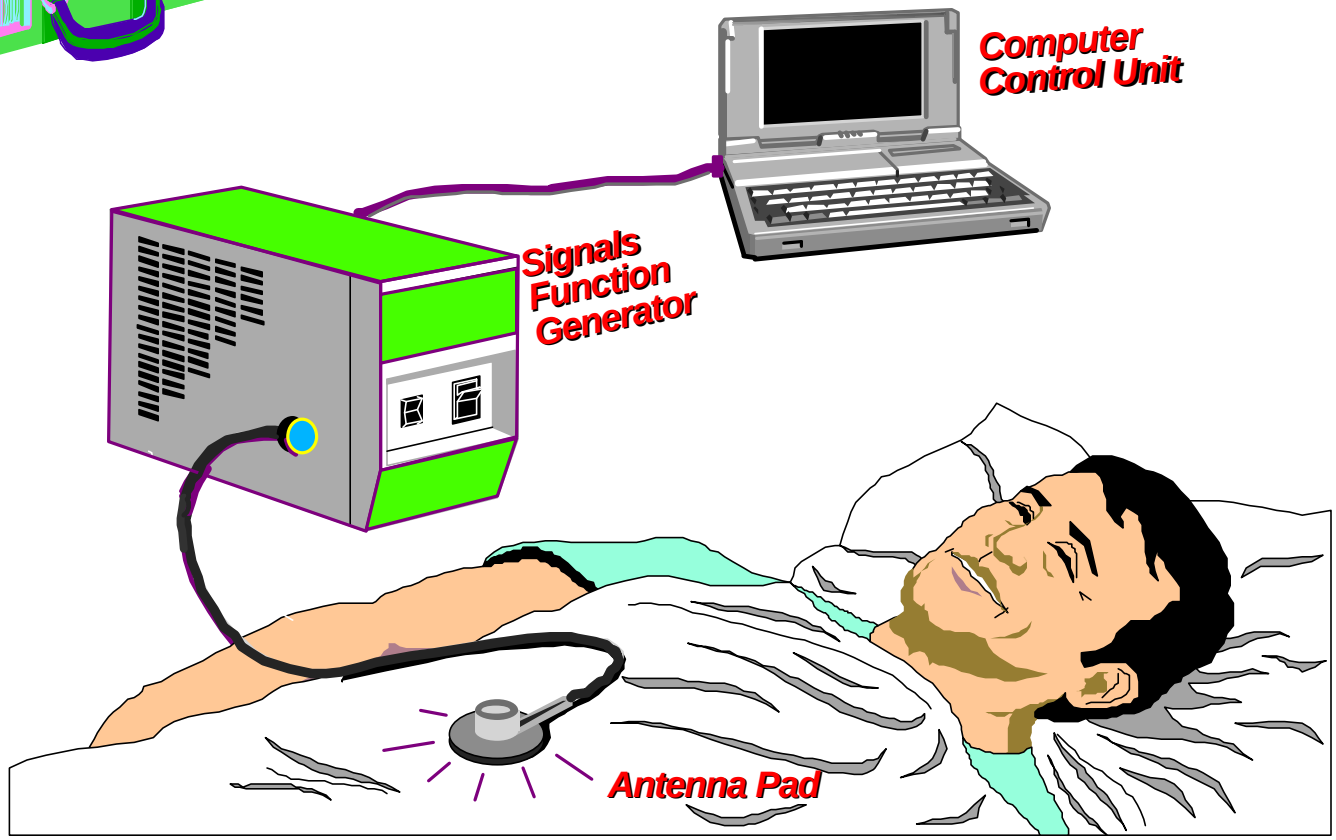

The Porthole concept:

The two-minute treatment shortcut

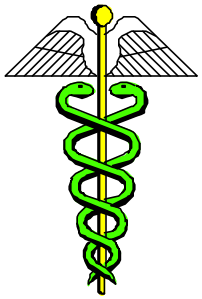

How the porthole concept works

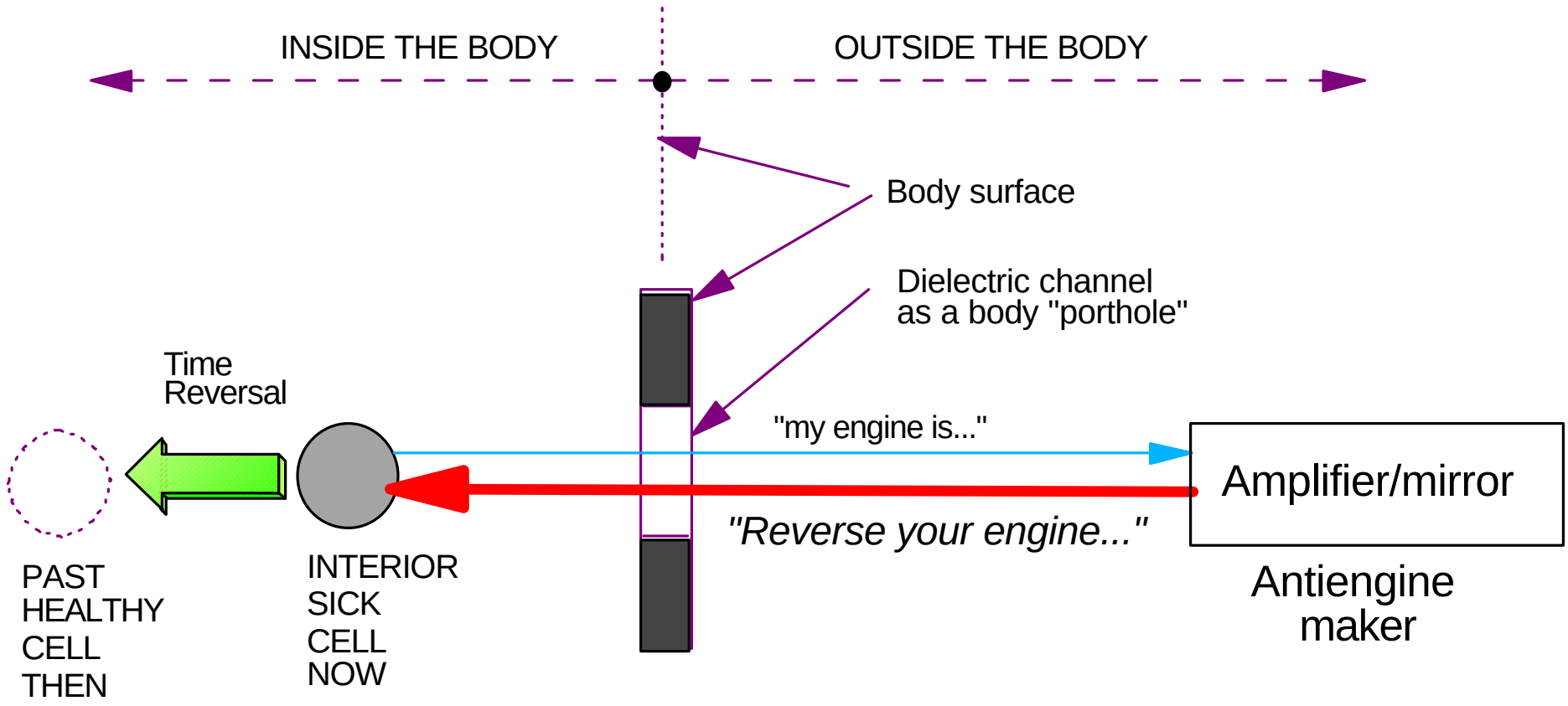

Porthole concept: An analogy of the dielectric path and inner-outer functional connections

- Imagine perfectly reversible dynamic light processes inside a large "cruise ship", that are also perfect phase conjugate mirrors
- Each process receives, absorbs, and emits light continuously
- Light escaping through the portholes is a composite from all the dynamic processes ongoing inside
- If we record and amplify the escaping light, then force it back through the portholes, it reverses all the internal processes
- The processes revert back, slowly, to a previous ongoing process state
- We cease radiation, and the processes reverse and move forward again

Porthole concept: The discovery

- The processes themselves, *in their own "frame"*, are never actually "reversed". Instead, the frame's motion through time is reversed.
  - Each to itself moves normally -- just receiving, absorbing, and radiating light, regardless of "whatever light" is interacting
  - This is due to a peculiarity of the photon and photon interaction
- Photon interaction creates observed physical reality, including the "frame" and the seeming "passage of a mass through time"
  - The photon is its own antiparticle, which is just a photon traveling in the opposite direction
  - So in this case we can use "light" to precisely time reverse (to the observer) the frame and the apparent operations (to the observer)
- When we cease irradiation, after a decay period to remove the reversed excitation, all functions are now seen to be moving forward normally in observer forward time, but from a previous physical state or condition

Using the porthole concept: Research

- The body's own emitted dense, broadband signals are recorded across a broad bandwidth
  - These signals are amplified, then rebroadcast precisely back into the body
  - This returns an amplified "reversed" signal set back through the dielectric path, invoking and applying the porthole concept in all processes
- The returning photons produce time-charging but in reversed frame direction
  - Tremendous potential energy is absorbed in highly compressed "time-energy" form in seconds
  - This "time-potential" slowly drains off as the body processes and cells reverse back to a previous state

Research using the porthole concept

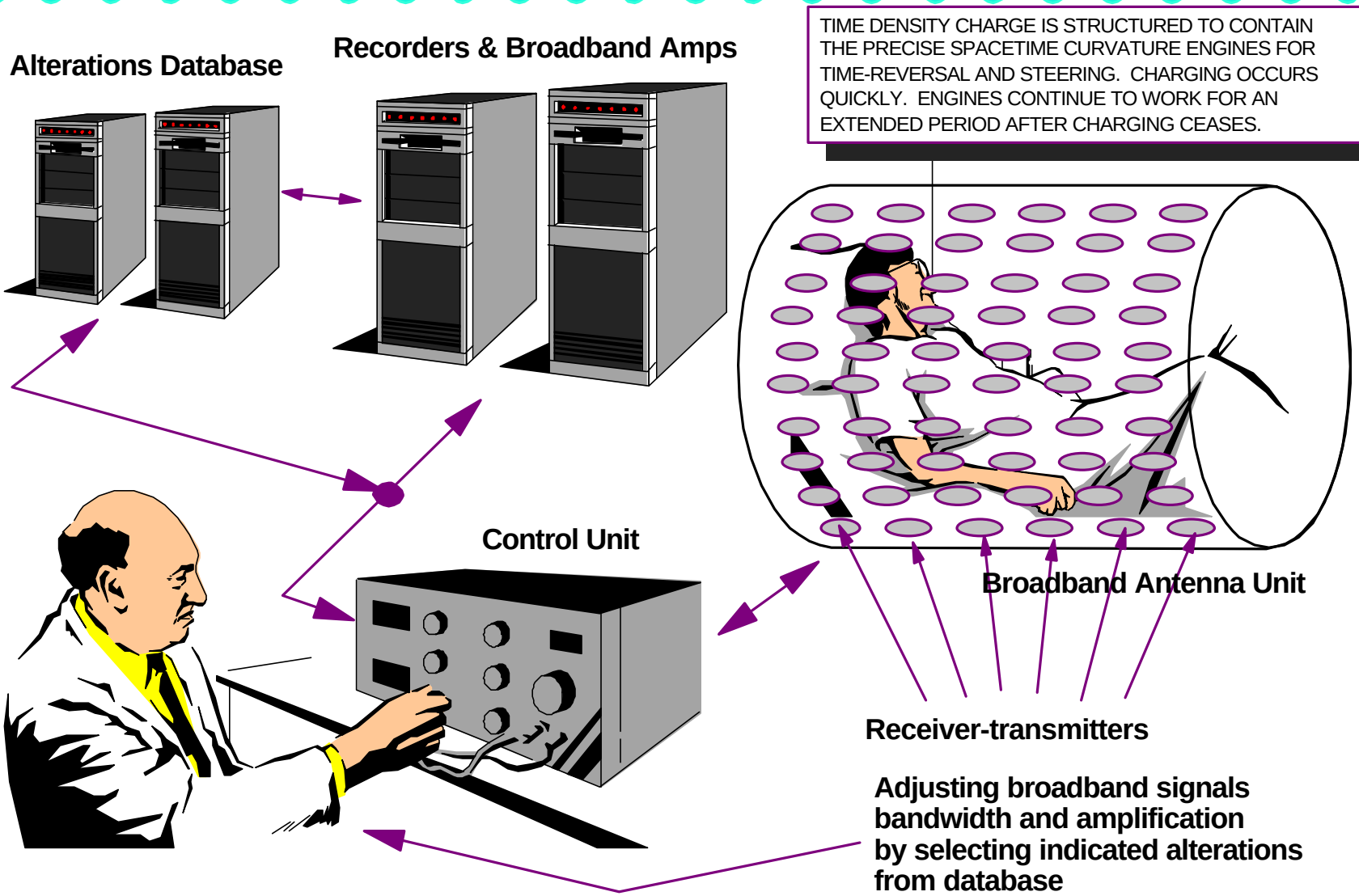

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Portable unit then developed for rapid treatment of mass BW casualties

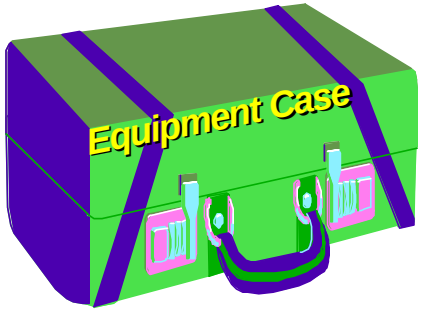

- Two blankets have antennas in them.
- Uses the "porthole" concept (discussed shortly)
- Eliminates plasma tube mixing etc.
- Computer-controlled complex signal structure.
- Irradiation for 2 minutes.

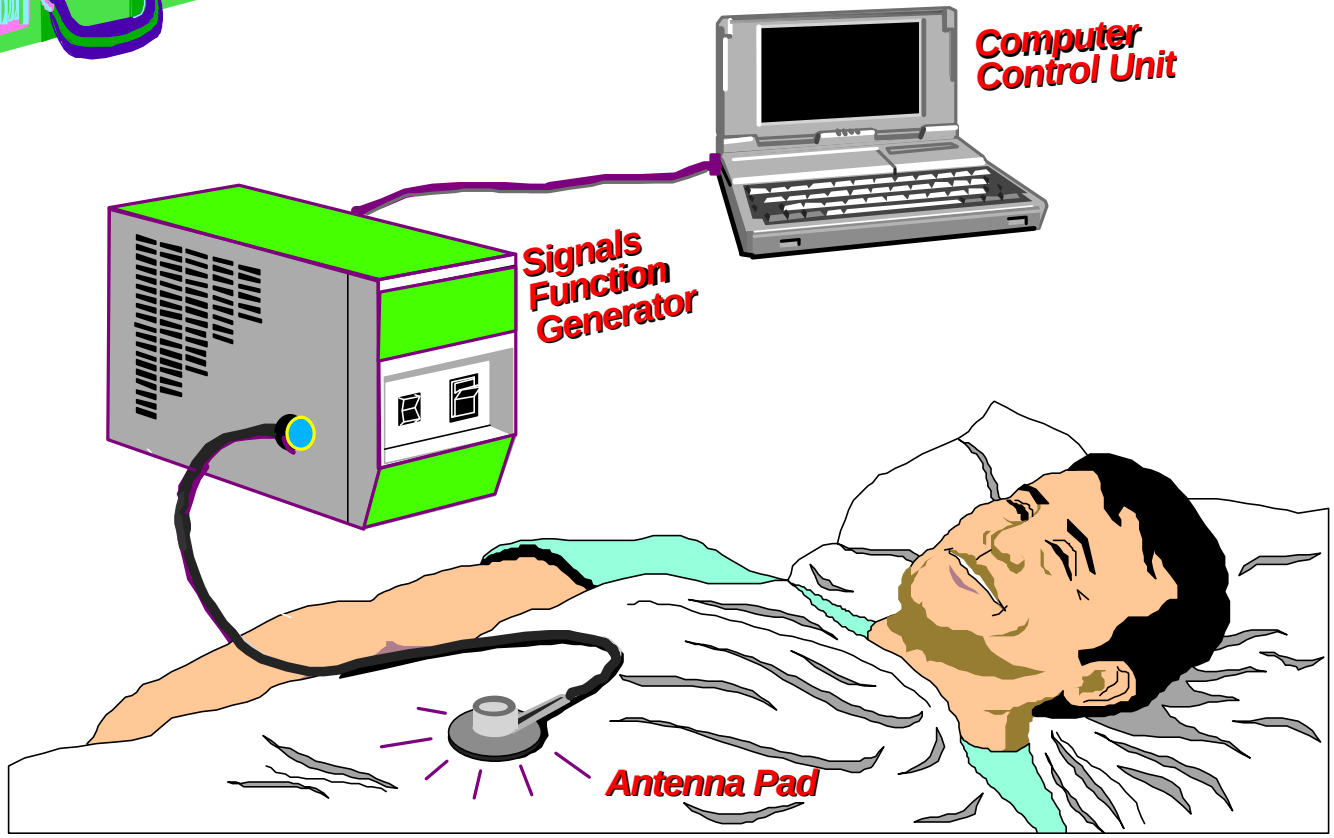

Training to use the unit

- High school student level, 30 minutes.
- Patient lies on one blanket, other covers him.
- Set the prescribed standard signal sets from listing.
- Computer-controlled generator produces the signal.
- Irradiation for 2 minutes, uncover patient, bring in another.
- Unit can be self-powering from vacuum energy (MEG*).

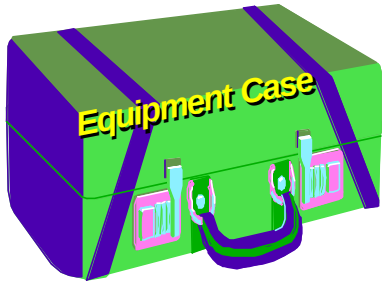

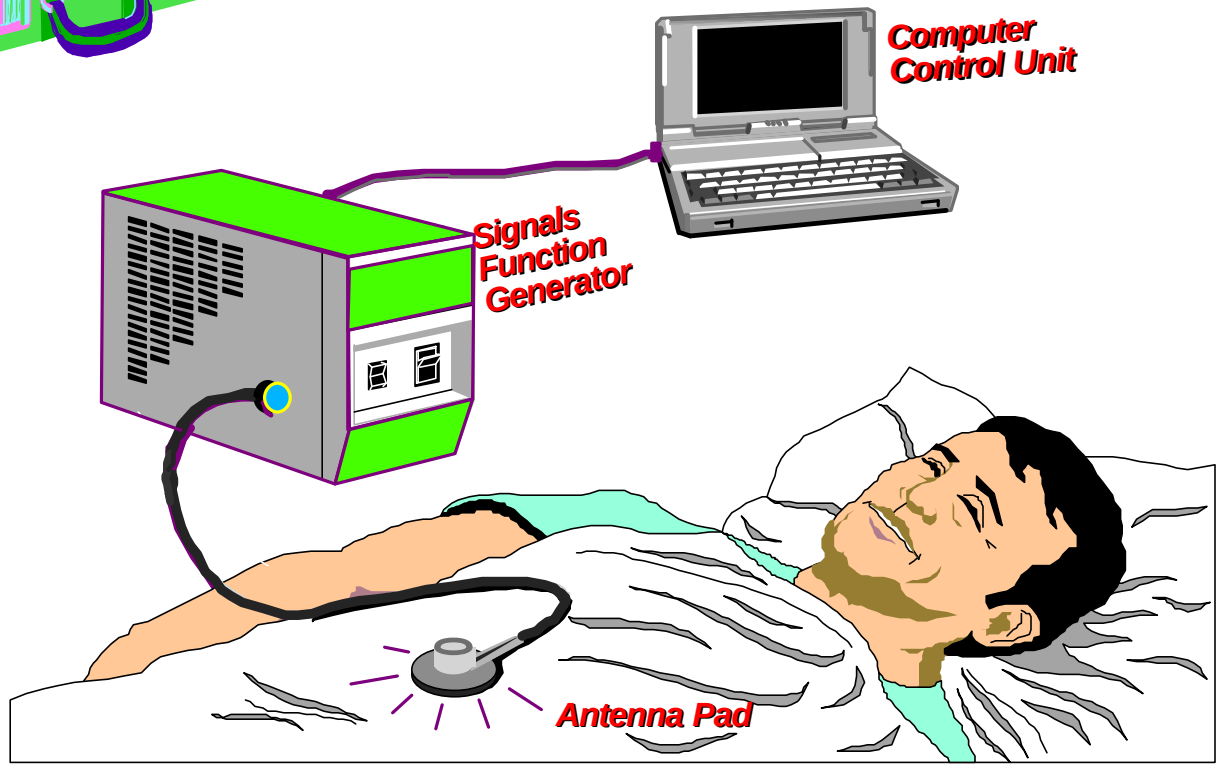

Additional advantages

- Can be developed in a crash program in 2-3 years.
- After sunk costs, projected cost per unit in mass production is less than $100,000
- Can be produced by the thousands
- Then flooded down through
  - Fire stations and police stations
  - Red cross units, hospitals, clinics
  - Emergency action teams and armed forces
- Large numbers of operators easily produced
- Emergency training could be watching a 15 minute film, then performing one graded practice run
- First generation equipment can save some 70% of the coming mass casualties from anthrax etc.

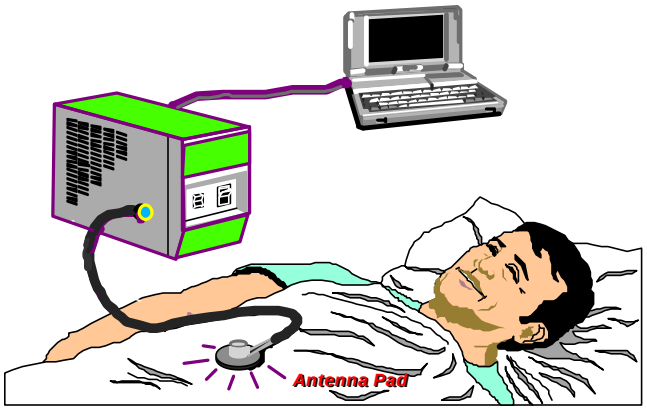

Terrorist BW warfare capabilities against the United States

The growing threat

Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- **One terrorist, one light aircraft with spray tank**
- **100 kilograms of anthrax**
- **Flies over greater metropolitan Washington, D.C.**
- **Calm night**
- ***1-3 million casualties result****
- ***Most of those stricken will die***
- **Presently little can be done to save the stricken civilians**
- ***Attacks on several population centers might produce some 10 million or more casualties***

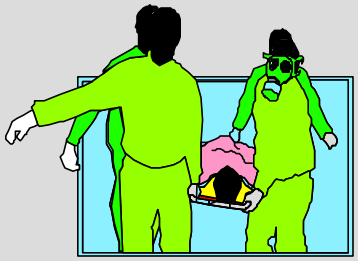

***Per OTA Report to Congress, 1993**

For decades, infiltration of terrorist teams into the U.S.

- From several foreign nations, not just Bin Laden in Afghanistan
- Several thousand Cuban guerillas, from training camps in Southern Mexico
- Russian Spetznaz teams
- Nuclear warheads (up to 80 KT)
- Biological warfare agents
- Yakuza in oriental populations in our cities
  - Yakuza manufactures Russian energetics weapons in their own facilities in Japan
  - Possesses the new EM weapons referred to by Secretary of Defense Cohen in 1997
- We are now in a very long, hard war and will suffer millions of casualties in our cities. It may last for decades.

Defense Secretary Cohen*

(Involvement of secret superweapons)

"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts."

* Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

Some typical BW agents

- Smallpox, including different strain developed by Russia (some sold to terrorists)
- Anthrax
  - Over 400 known locations around the Earth have cultures
  - Difficult to decontaminate
- Bubonic Plague
- Botulism toxin
- Tularemia (rabbit fever)
- Hemorrhagic fevers, such as Ebola

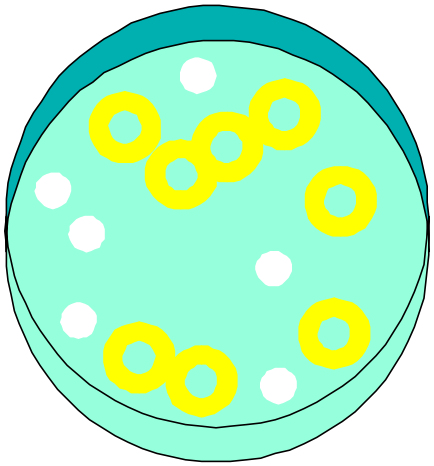

Anthrax

- OTA study: Some 200 pounds released in a spray, on calm night over Washington, D.C. could result in up to 3 million casualties
- Symptoms usually in 2-10 days
  - Sometimes as long as 7 weeks
  - Flu-like symptoms

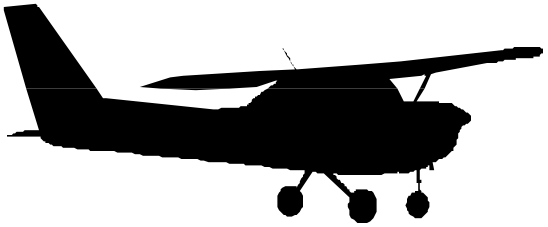

- Then 1-3 days later, shock and breathing problems cause death in up to 100%
- Antibiotics given early (before symptoms) can prevent infected persons from becoming ill
- Limited vaccine, reserved for military

Smallpox

- More than 500 million people killed in the 20th century before "eradicated" in 1977. Vaccination ceased in 1980.
- Russians kept it, developed new strains, sold to terrorists
- Symptoms in about 12 days: fever, headache, nausea. Rash similar to chickenpox then appears.
- Rash turns into hard blisters. *Highly contagious*, kills one-third of its victims.
- No cure. About 12 million doses of vaccine left.
- If smallpox is unleashed in any major city on earth, it will eventually kill 2 billion, or about 1/3 of the human species -- unless a radical new cure is found and utilized.

Bubonic Plague: Historically the most feared (Black Death)

- From 1980-1994, 18,739 cases in 20 countries.
- Symptoms occur in 1-6 days after inhaling the pneumonic form.

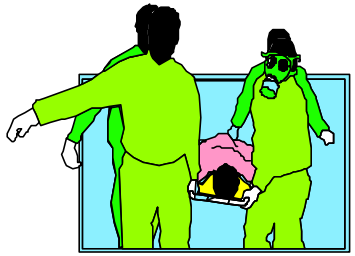

- High fever, cough, labored breathing lead to respiratory failure and death.
- It is contagious.
- Rapid use of antibiotics can be effective.
- Vaccine not currently produced in the U.S.

Botulism toxin (a nerve toxin)

- Single most poisonous BW substance known.
  - Typically borne in food, contacted by eating.
  - Could be developed as aerosol weapon.
- Symptoms in 24-36 hours; blurred vision and difficulty swallowing, speaking.
- Paralyzes muscles, leading to respiratory failure and death.
- Centers for Disease Control and Prevention maintain a botulism antitoxin supply.

Tularemia

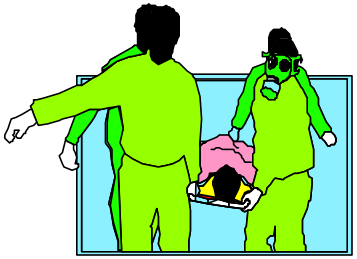

- U.S. studied its weapon potential in 1950s and 1960s.
- Symptoms appear in 3-5 days, including fever, chills, headache, and weakness
- Inflammation and hemorrhaging of the airways can lead to death.
- Without antibiotics, one-third die. Can be 90% if breathed in, in aerosol form.
- Vaccine developed and under review by FDA.

Hemorrhagic fevers, such as Ebola

- E.g., origin of Ebola is unknown. Probably transmitted to humans by animals, to begin a breakout.
- Symptoms in 3-5 days, include fever, aching muscles, diarrhea.
- Hemorrhaging of fluids out of tissues and orifices.
- From 30 to 90 percent die, depending on specific fever type.
- Some of these fevers respond to antiviral drugs.
- The drugs are in short supply.
- Presently *containment* is the primary goal.

A factor the U.S. does not know

(Secret involvement of clandestine superweapons)

- Three nations (not the U.S.) developed quantum potential weapons using Bohm's hidden variable theory of quantum mechanics.
- Can induce disease engines in matter or bodies at a distance.
- Have developed "spreading" of immune systems in a targeted populace (cleverly tested in Gulf War against U.S. troops).
  - Cocktail mix of disease engines for 2 dozen different diseases
  - Targeted area's human immune systems react to these engines when they are still in virtual state, just below quantum threshold.
  - Spread immune system's resources thus "thinned" across response to two dozen shadow diseases at once.
- Hit with a terrorist BW attack, the spread immune systems are overwhelmed much more easily and quickly.
  - Yield (casualties) of the attack is increased by factor of 3-5.
  - Spreading of U.S. immune systems has been accomplished and is still being maintained.

Summary and conclusion

The new war

A new Pearl Harbor: Strike on the World Trade Center in NYC

- The North Tower has already been struck and is burning.
- A second jetliner is about to strike the South Tower.

Fireball From Impact on South Tower

- The two buildings held some 50,000 occupants
- Evacuation was underway after the first strike
- More than 6,000 persons were killed
- This is more than were killed in the Dec. 7, 1941 strike on Pearl Harbor

Collapse of the South Tower

- The first tower to collapse was the South Tower
- It is still uncertain just how many people were caught inside and killed
- This is a half million tons of debris, falling from the New York skyview.

Collapse of the North Tower begins

- The North Tower then collapsed
- This was another half-million tons of debris falling from the NYC skyview

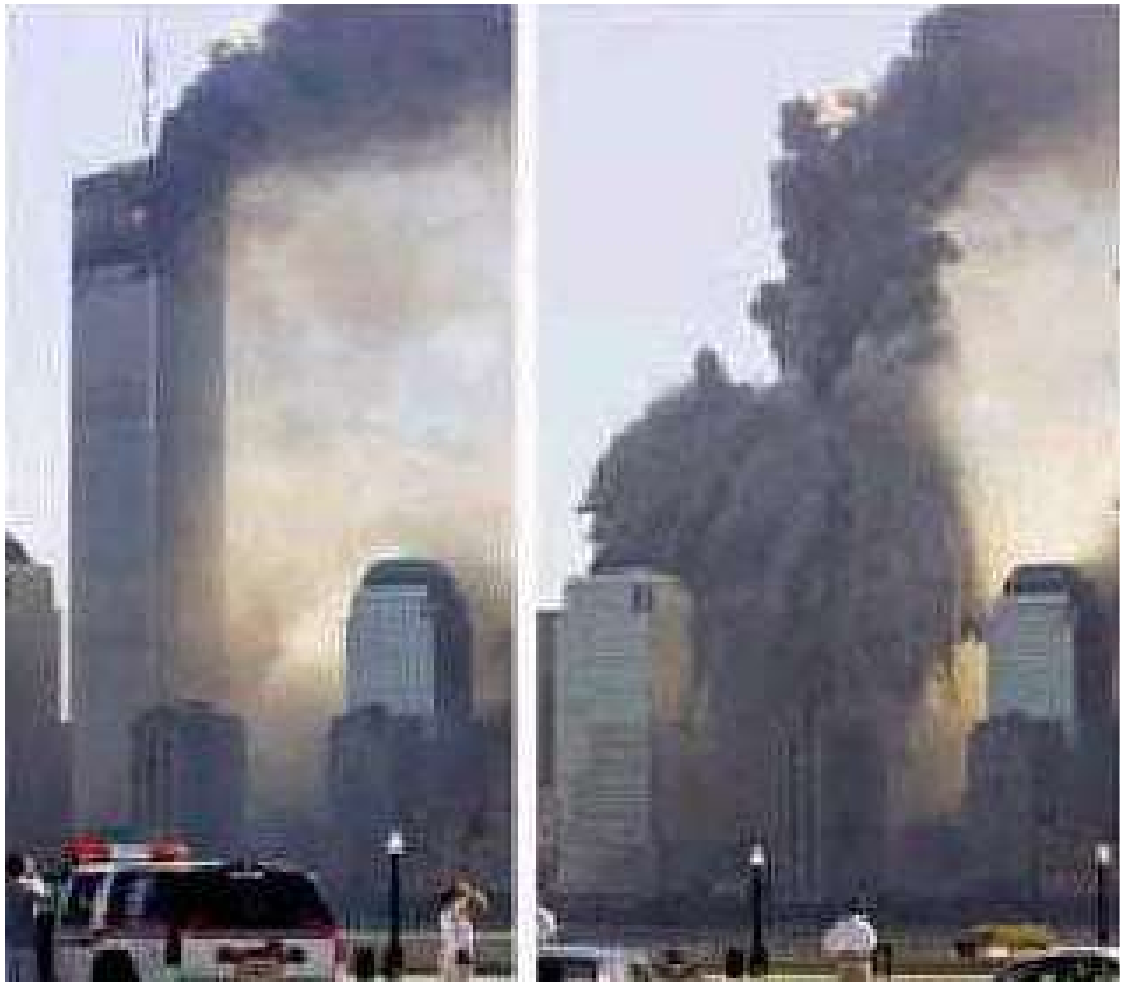

Collapse of North Tower finishes

- Collapse of the North Tower killed many rescue workers, fire-men, and policemen
- At this writing, the total casualties are still unknown

Next began the recovery efforts

- Recovery operations will require months
- At this writing, the total casualties are still unknown
- The damage was done by two civilian jetliner "bombs"

The Pentagon was hit on the same day

- Hundreds were killed the same day when another jetliner struck the Pentagon.
- Yet another jetliner, possibly headed for the White House, crashed enroute when the passengers attacked the suicide terrorist hijackers.

A sobering thought

- Nuclear weapons are already smuggled into the U.S., as are BW agents such as anthrax, smallpox, etc.
- Had a 40-80kT weapon been exploded in New York and one in Washington, millions would have perished and both cities would have been devastated
- There would have been no recovery of those cities for many decades

Present Status of the WMD Threat to the United States

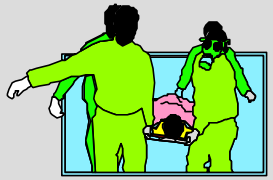

- **Many foreign nations are hostile to the U.S. and sponsor terrorists**
- **Some 25 nations have WMD or are acquiring them**
  - **BW agents and weapons**
  - **Chemical agents and weapons**
  - **Nuclear materials and weapons**
- **Thousands of students and émigrés**
- **Infiltrated teams, BW, other WMD already**
- **Castro guerrillas infiltrated over the years**
- **<u>Can do unacceptable damage to U.S. now</u>**
- ***<u>May reach knockout capability</u>***

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***Per OTA Report to Congress, 1993**

The U.S. is terribly unprepared

- Limited medical supplies, antibiotics, vaccines
- Insufficient facilities, emergency teams
- No civilian shelters (much less BW-filtered)
- Not enough doctors, nurses, masks, etc.
- Present treatment methods woefully inadequate
- Triage will apply
  - First treat those most likely to recover
  - Others (showing symptoms, or advanced) are just set aside to die
- Other attacks are a matter of *when*, not *if*.

Conclusion

- As several cities are struck, millions of U.S. civilian casualties will result. Devastation will be enormous.
- We shall eventually lose more American lives than in all the rest of our wars to date.
- Present medical therapeutic science is totally inadequate to do the job. It cannot save us.

- At some point, when we are sufficiently damaged, the Spetznaz or other terrorists may detonate nuclear weapons in our cities, with appalling carnage.
- A combined superweapon technology and terrorist groups will then destroy the remaining populace.
- On its present course, the inadequacy of Western medicine may doom us.

A difficult truth to consider

- In any strategic strike, the first phase is to get the strategic weapons (weapons of mass destruction) delivered to their distant targets.
- That has already been done.
- Eerily, the first phase of World War III has already been accomplished.
- It was already accomplished before the Sept. 11, 2001 strike on New York and Washington. That was the new "Pearl Harbor", and only the opening round. It already killed more Americans than died at Pearl Harbor on Dec. 7, 1941.
- Unless we improve our medical therapy quickly and dramatically, we will lose -- particularly when the hidden energetics weapons and outside terrorist sponsorship by hostile nations are factored in.

A personal perspective

- There now exists an overwhelming, immediate moral imperative to get this development program done at the utmost speed humanly possible.
- The sheer survival of the United States and Western civilization depends upon it.
- Officialdom is aware that the KGB/Russians have long planned to finish the U.S., after initial nuclear exchanges, by fierce and massive BW strikes.
- It appears that the plan has changed to let the terrorists do the main work, while augmenting U.S. casualty levels by energetics weapons.

China is also involved

- China has declared South China Sea the territorial waters of China
- China will eventually take Taiwan
  - Has massed missile artillery trained on Taiwan
  - Recently held invasion practice on an island near Taiwan
- Recently deployed fearsome EMP weapons utilizing negative energy rather than positive energy (Dirac sea theory)
  - Extinguishes all electron currents
  - Duds electrical and electron systems instantly
  - Instant death to struck bodies
  - Instant kill of missiles, aircraft, electronics in nuclear warheads
  - Ultimate "death ray"; can be made small or large
- Recent 2-carrier U.S. task force maneuvered in South China Sea to caution China
  - The new Chinese EMP weapon was trained on that task force
  - Could have destroyed it within minutes

Final thoughts

???

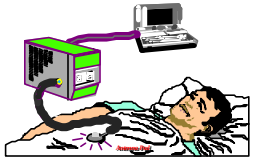

- This is one of the great turning points in history.
- The development program is eminently doable. That it works has been experimentally demonstrated. The long-vexing puzzle of the active mechanism has been solved.
- Our scientific community bitterly opposes any use of electromagnetics -- even an advanced, higher symmetry electrodynamics -- for medical treatment.
- A consortium of the scientific community, the large pharmaceuticals, FDA, and the AMA will oppose this project even while the U.S. is being destroyed wholesale.
- It can only be done in the private sector, and there will likely be no funding unless by philanthropists.

Continuation

Business plan, development program, budget breakdown, proposed schedule etc. go here.

Weapons Slides

The Tom Bearden Website

Help support the research

"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts." *

Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

Slides
(covers period up to 1999)

- The Coming Strategic Attack on the United States
- Outline
- Loss of two separate A-10 Warthogs in 1997
- Typical ABM Defenses (Widely Deployed by mid-70s)

- Launch Phase Anti-Missile System
- Launch Phase Anti-Bomber System
- HC-130s Engines Quit, Aircraft Crashes
  Nov. 22, 1996
- 1996 Actions by this analyst
- Additional Information Exists: Not Analyzed, Not Integrated in Briefing
- Kill of Arrow DC-8, Gander AFB, Dec. 12, 1985
- Satellite Photos of Plumes in Soviet Arctic Since 1974
  See "Fer de Lance" for additional information
- Aum Shinrikyo ("Supreme Truth" Cult), Shoko Asahara, Leader

  Aum Shinrikyo - Anatomy of a Dangerous Cult
- Ashkhabad Problem and Its Solution
- Strange Characteristics of Iran Quake, Sep. 1978
- Iran Earthquake, September 1978
- Situation Now (Assessment)
- Situation Now (Assessment 2)
- Aspects of Strong Local Asymmetry
- Mass Casualty Problem: Aerial Anthrax

Spray on Washington, D.C.

- Present Status of the WMD Threat to the United States
- Some Present Problems in the U.S. WMD Defense Capabilities
- Internal Terrorist Threat with Weapons of Mass Destruction: Now & Future
- Attempt to Ban Energetics Weapons Worldwide
- Brezhnev's Schedule
- Large glowing Tesla globe witnessed in Red China by hundreds
- Cold Explosion -- 9 April 1984 Near Kurils, and formation and growth of spherical shell (globe)
  Sequence of Events
- Cold Explosion -- 9 April 1984 Near Kurils, and formation and growth of spherical shell (globe)
  What They Were
- Cold Explosion -- 9 April 1984 Near Kurils (Plus additional weapons effects)
- Countering Insane MAD Systems:
  Find Loophole, Exploit It
- Next Generation Counter to Both Sane and Insane MAD systems
- Simultaneous Dudding of Nuclear Weapons Worldwide

- Simultaneous Dudding of Nuclear Weapons Worldwide
- Operation Divine Wind II
- Advanced EMBW Applications
- EM Biological Warfare (EMBW)
- Microwave Radiation of U.S. Embassy in Moscow
- Pentagon EMI Studies, 1989
- EM Missile Practice (6 slides)
- Subdivisions of Soviet Energetics Program
- Communism's Goal
- Manuilsky's Goal vs. Status Today (Dec. 1996)
- Professor Hellman, German Scientist Released from Work in Soviet Union
- Hemispheres and Globes of Light (4 slides)
- How Could Such Superweapons Ever Be Concealed?
- Soviets Easily Concealed These Superweapons for Four Decades
- Microscope-type, laser-like interferometer for inducing quick α-decay in samples of otherwise longer-lived isotopes
- Longitudinal Wave Interferometry: Endothermic

- Longitudinal Wave Interferometry: Exothermic
- U.S. Air Attack on Libya, April 1986
- Lightning Wall
  circa 1959-1960
- Lisitsyn's Report: Brain Code Broken
- Large Longitudinal Wave Interferometer (LWI) Accident
- Large Longitudinal Wave Interferometer (LWI) Accident
- Use of Hidden Information Content of the Field Can Provide Action-At-A-Distance
- Two Types of Mutual Assured Destruction (MAD) System
- Psychoenergetics Weapons Teams Mentally Disable All Personnel
- Strikes Against Special Ship and Energetics Weapons Sites
- "Mindsnapper" Attack on Special Ships and Energetics Weapons Sites
- How Much Off Guard Are We?
  (7 Slides)
- Possible Targets: 1995-9 Escalation Phase
- Propagation of Weapon Effects
- Yugoslav Earthquake, Followed by Cold Explosion
  April 15th, 1979

- Countering an Insane QP Weapon
- Gulf War Disease: KGB QP Weapon Induced ST Curvature Engines for a Cocktail of Diseases
- Self-Targeting in Inner EM Channel Can Produce a Quantum Potential
- Mechanism for Producing a Quantum Potential
- Major Principles for Use of Quantum Potential Weapons
- Major Principles for Use of Quantum Potential Weapons (2)
- Instantaneous Communication by a Quantum Potential
- Participants in a quantum potential share a common multiply-connected spacetime (MCST)
- Quake in Tangshan, China
  28 July, 1976
- Exchanging Earthquakes
- Instant Communication by a Quantum Potential
- Westerners Do Not React to Slow Threats
- Characterizing a Given Risk or Risk Factor
- Technical Risk Management
- Aum Shinrikyo's Sarin Facility

- In Scalar Beam Interference Zone
- Physicist Schappeller Auralaz Munster, Austria
- Initial Soviet Plan for Cold War, After WWII
- Josef Stalin: Absolute Dictator
- Exploding any Resistance by Operational Scientists
- Significant Soviet Statements
- Captain Svoboda Dives Headlong to Her Death
- T-polarized Beam Projector
- Possible Tests (1)
- Possible Tests (2)
- Possible Tests (3)
- Possible Tests (4)
- Mushroom Cloud Rising From Sea
- Launches from Cape Canaveral and Vandenberg AFB Provided Practice Targets of Opportunity
- The sinking U.S.S. Thresher, with her controls jammed, implodes when she reaches crush depth
- Embodiment of an instrument array sufficient to discriminate when time-density charging has occurred, and that transduction

of time-charge decay has occurred.

- Time-Polarized EM Wave Interferometer Creating Space-Time Curvature Engines in a Distant Interference Zone
- Transmutation of Radioactive Nuclei at a Distance
- Transmutation of Radioactive Nuclei
- Typical Tesla Shield, Northern Route of Japan
- A Curious Tide in Human Affairs
- Large Scalar EM Interferometer (LASI) Accident Near Urals, 1958
- The Superpower Paradox: Asymmetric Cheap WMD Strategic Strike and Destruction
- The KGB/Yakuza-Aum War Plan
- Why Western Science is Ignorant of KGB Energetics
- Transmutation of Radioactive Nuclei at a Distance
- TheYakuza
- Yugoslav Earthquake, Followed by Cold Explosion
  April 15, 1979

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* Note that the Secretary did not speak the words in square blocks; these were added by the writers later,

probably to "soften the tone" of the Secretary's information release. So the Secretary confirmed that some nations of the world -- not just some ragged terrorists, as the writers tried to imply for spin control -- do possess novel electromagnetic weapons and are using them to induce earthquakes, engineer the weather and climate, and trigger volcanic eruptions.

THE COMING STRATEGIC ATTACK ON THE UNITED STATES

By an AUM/Yakuza/KGB/Communist Coalition Using Energetics SuperWeapons

T.E. Bearden, LTC
U.S. Army (Retired)
M.S. Nuclear Eng.
Fellow Emeritus, AIAS

With Technical Background and History of Energetics Weapons

Partial support by the Association of Distinguished American Scientists is gratefully acknowledged.d

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Outline

- Background: Classical Electromagnetics (and Defects)
- Background: Energetics (Scalar Electromagnetics)
- Background: Soviet Energetics Weapon Development
- KGB/Communist Plans
- Countering of Soviet/KGB/Communist Plan in Mid-80s
- Soviet Economic Collapse and Adaptation of Plan
- Weapons Bleed-Out: KGB/Russian Mafia
- Yakuza: The Japanese Mafia
- Aum Shinri Kyo (Supreme Truth) Cult
- Coalition: Aum/Yakuza/KGB/Communists/Russian Mafia
- Operation Divine Wind II: Three Phases
  - Phase I: On-Site Training Phase (Completed)
  - Phase II: Escalation Phase (In Progress)
  - Phase III: 1997 Strategic Strike on the United States
  - Support Plan A: Feints, Deception, Sabotage & Terrorism
  - Support Plan B: Test Range
  - Support Plan C: Worldwide Weather Engineering
  - Support Plan D: Strategic and Combat Intelligence
- Special Information
- Recommended Actions

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The Tom Bearden Website

Help support the research

Loss of two separate A-10 Warthogs in 1997

- A-10 Mysterious Flyaway and Crash - April 2, 1997
- Death of Second A-10 Pilot - May 27, 1997
- Captain Button's Mysterious Flyaway and Eventual Crash
- Death of Second A-10 Pilot - May 27, 1997

A-10 Mysterious Flyaway and Crash

April 2, 1997

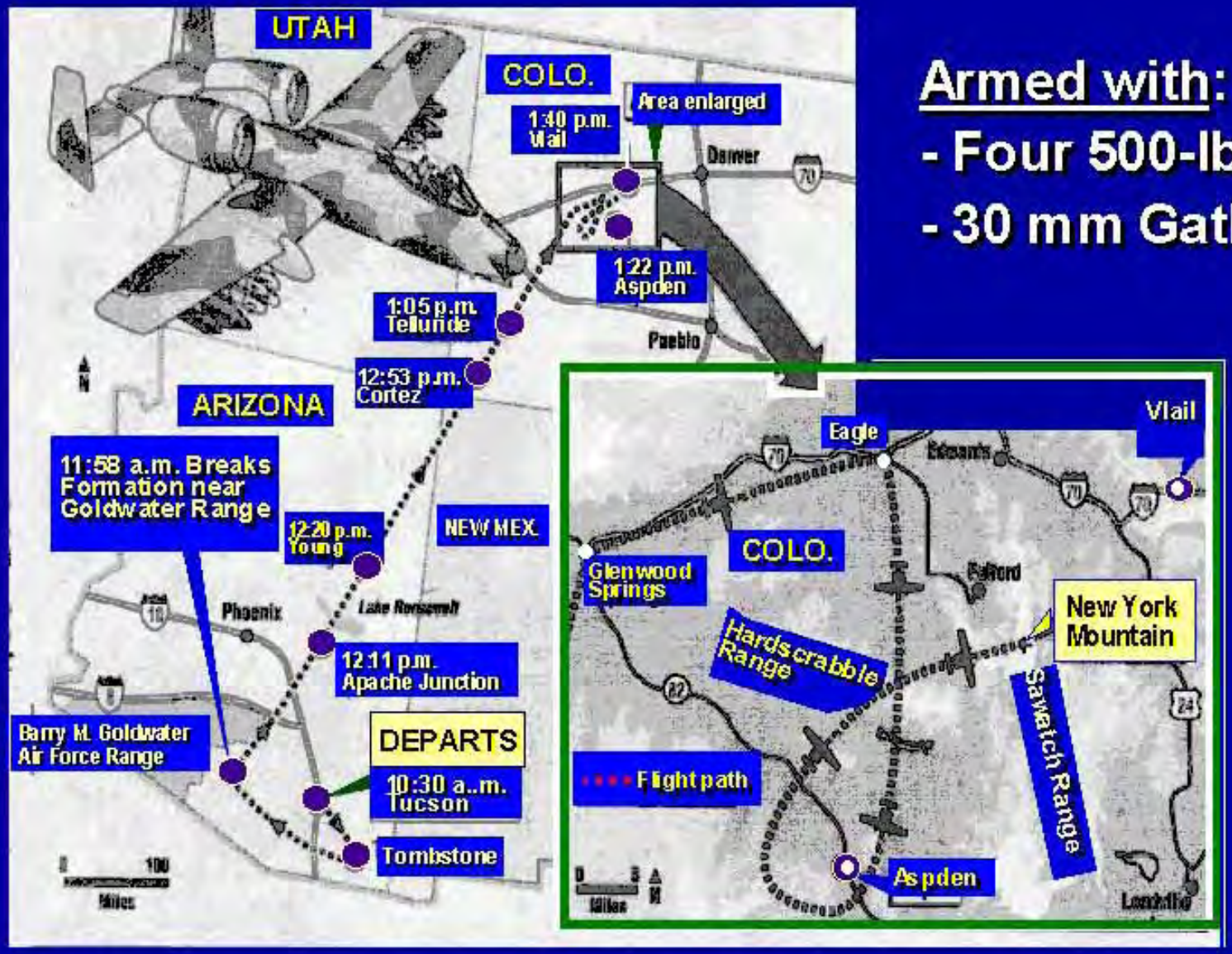

Armed with:

- Four 500-lb bombs
- 30 mm Gatling gun

Death of 2nd A-10 Pilot May 27, 1997

- Captain Amy Svobody
- Night training mission
- From Davis-Montham AFB
- From same wing as Captain Button, who flew his A-10 off course for over an hour and then crashed on April 2.
- Climbout from ordnance delivery on target
- Nosed down sharply and dived into ground

Companion A-10's

- Experienced night flyer & instructor
- Nosed sharply over and flew into ground
- Psychoenergetic kill

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Psychoenergetic weapon induced instant hypnogogic state and reversed Svoboda's sense of up and down.

A-10 Mysterious Flyaway and Crash

April 2, 1997

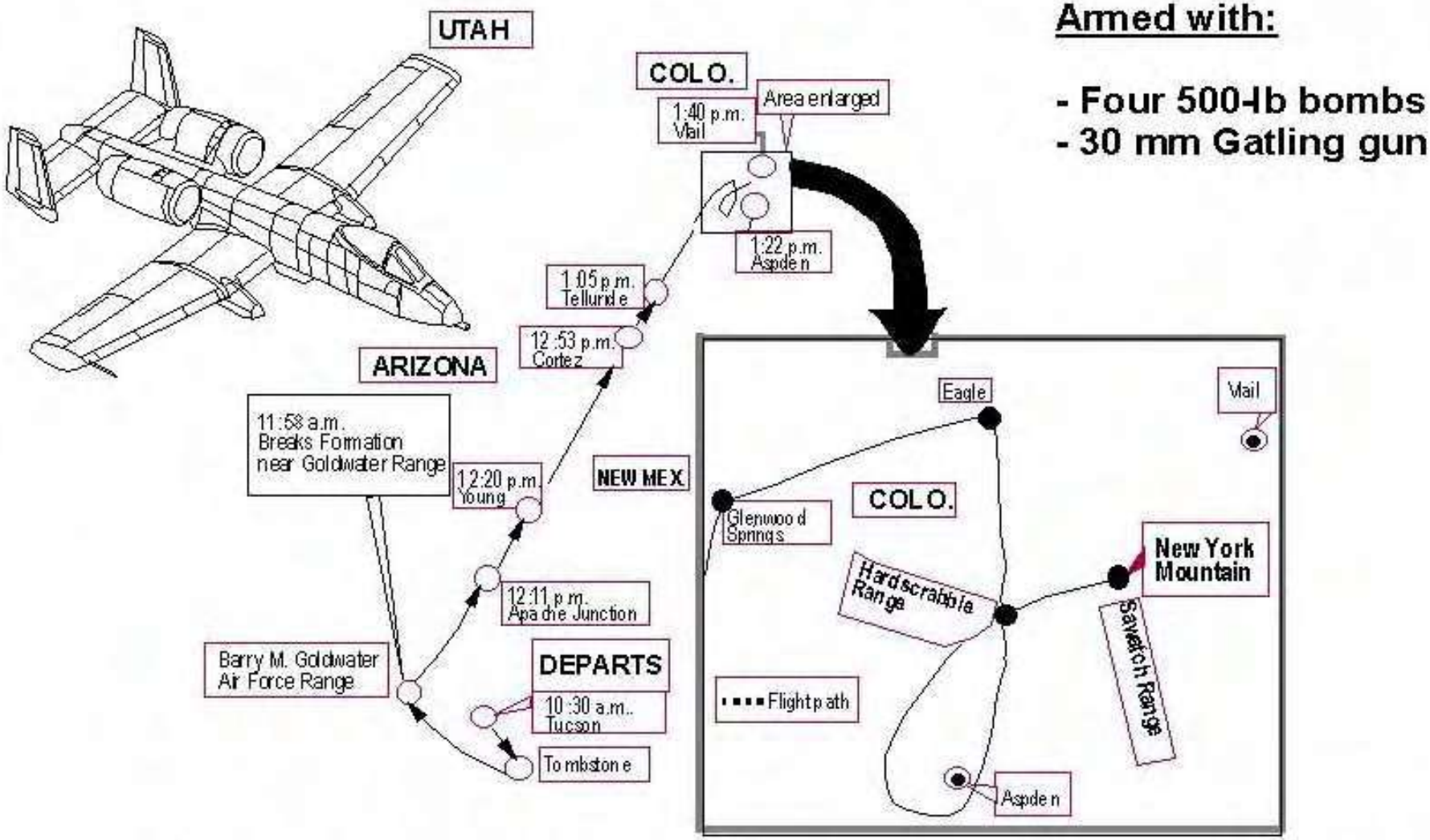

Armed with:

- Four 500-lb bombs
- 30 mm Gatling gun

Figure 14a. Captain Button's mysterious flyaway and eventual crash.

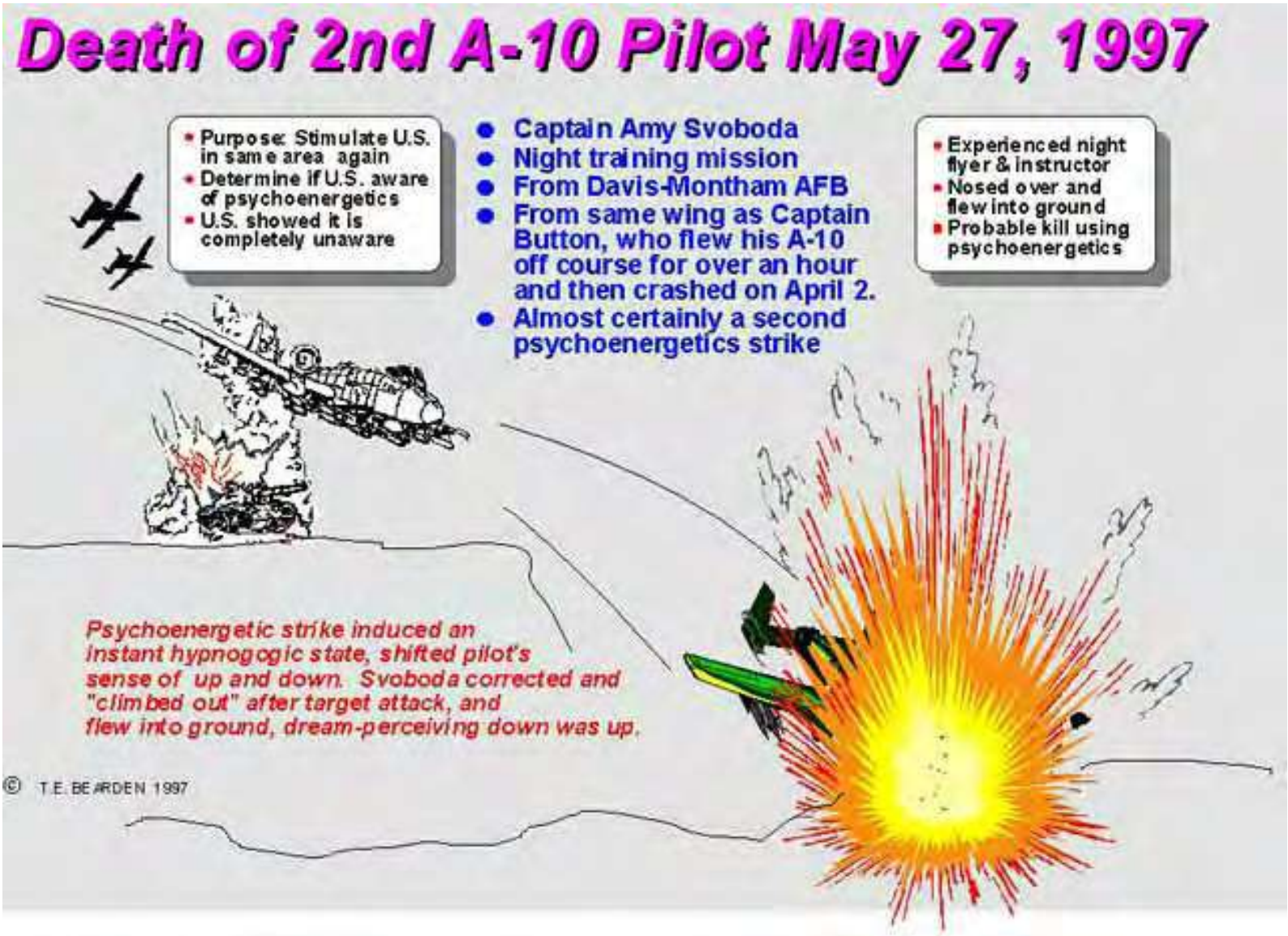
Death of 2nd A-10 Pilot May 27, 1997
• Purpose: Stimulate U.S. in same area again
• Determine if U.S. aware of psychoenergetics
• U.S. showed it is completely unaware
• Captain Amy Svoboda
• Night training mission
• From Davis-Montham AFB
• From same wing as Captain Button, who flew his A-10 off course for over an hour and then crashed on April 2.
• Almost certainly a second psychoenergetics strike
• Experienced night flyer & instructor
• Nosed over and flew into ground
• Probable kill using psychoenergetics
Psychoenergetic strike induced an instant hypnogogic state, shifted pilot's sense of up and down. Svoboda corrected and "climbed out" after target attack, and flew into ground, dream-perceiving down was up.
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Typical ABM Defenses
(WIDELY DEPLOYED BY MID-70's)
GLOBAL SHELL
(MIDCOURSE
ELECTRONICS
DUDDING)
INTENSE ENERGY SHELLS
(Destruction of vehicle)
(Initiation of nuclear
warheads)
© T.E. BEARDEN 1999
EM MISSILES
EARTH'S SURFACE
ENERGETICS
HOWITZER
TRACK
(NESTED)
HEMISPHERICAL
SHELL(S)
(Dudding, initiation,
destruction)
LAUNCH
PHASE
DEFENSES
TERMINAL
DEFENSES

LAUNCH PHASE ANTIMISSILE SYSTEM

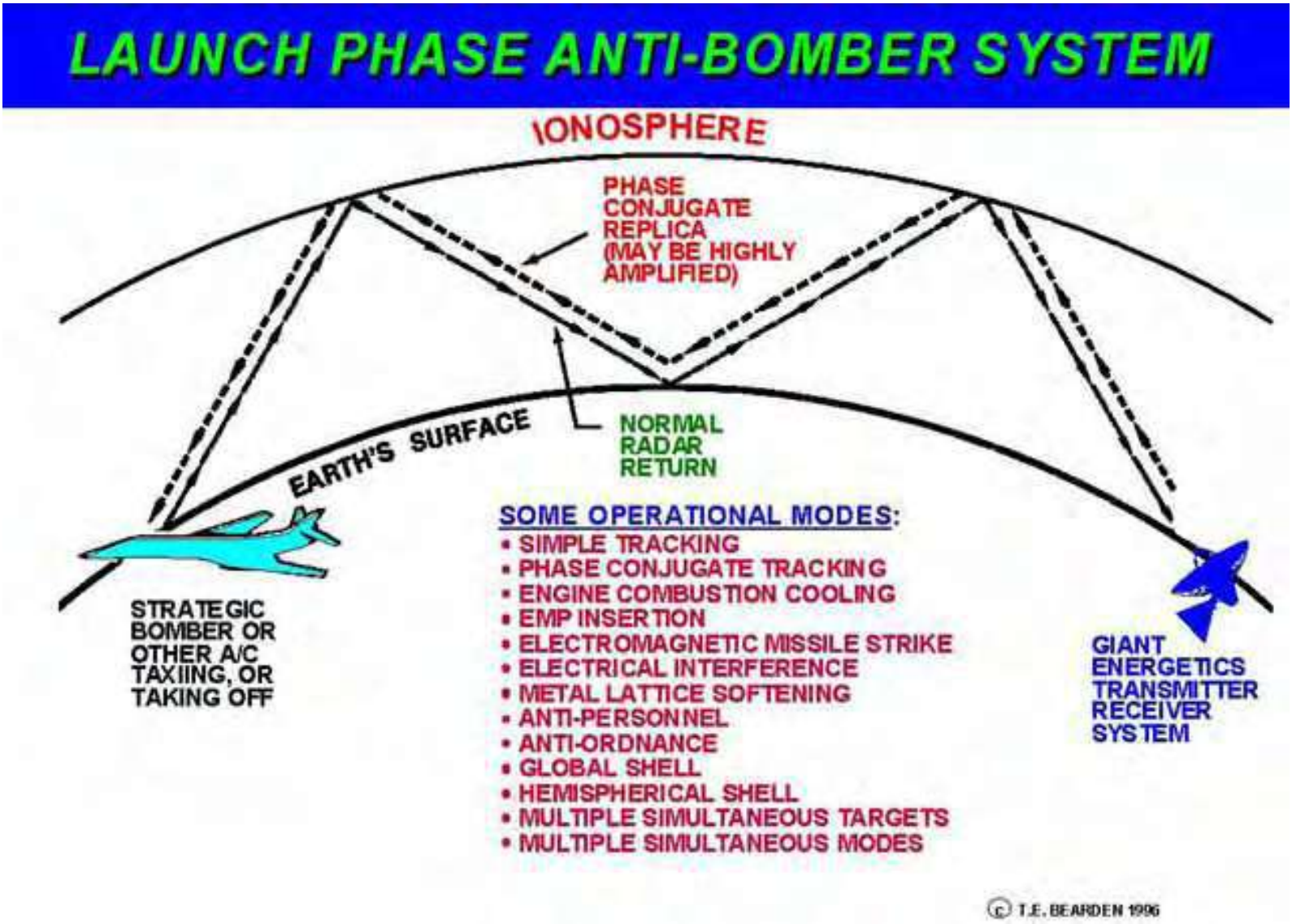
LAUNCH PHASE ANTI-BOMBER SYSTEM
IONOSPHERE
PHASE CONJUGATE REPLICA (MAY BE HIGHLY AMPLIFIED)
NORMAL RADAR RETURN
EARTH'S SURFACE
STRATEGIC BOMBER OR OTHER A/C TAXIING, OR TAKING OFF
SOME OPERATIONAL MODES:
• SIMPLE TRACKING
• PHASE CONJUGATE TRACKING
• ENGINE COMBUSTION COOLING
• EMP INSERTION
• ELECTROMAGNETIC MISSILE STRIKE
• ELECTRICAL INTERFERENCE
• METAL LATTICE SOFTENING
• ANTI-PERSONNEL
• ANTI-ORDNANCE
• GLOBAL SHELL
• HEMISPHERICAL SHELL
• MULTIPLE SIMULTANEOUS TARGETS
• MULTIPLE SIMULTANEOUS MODES
GIANT ENERGETICS TRANSMITTER RECEIVER SYSTEM
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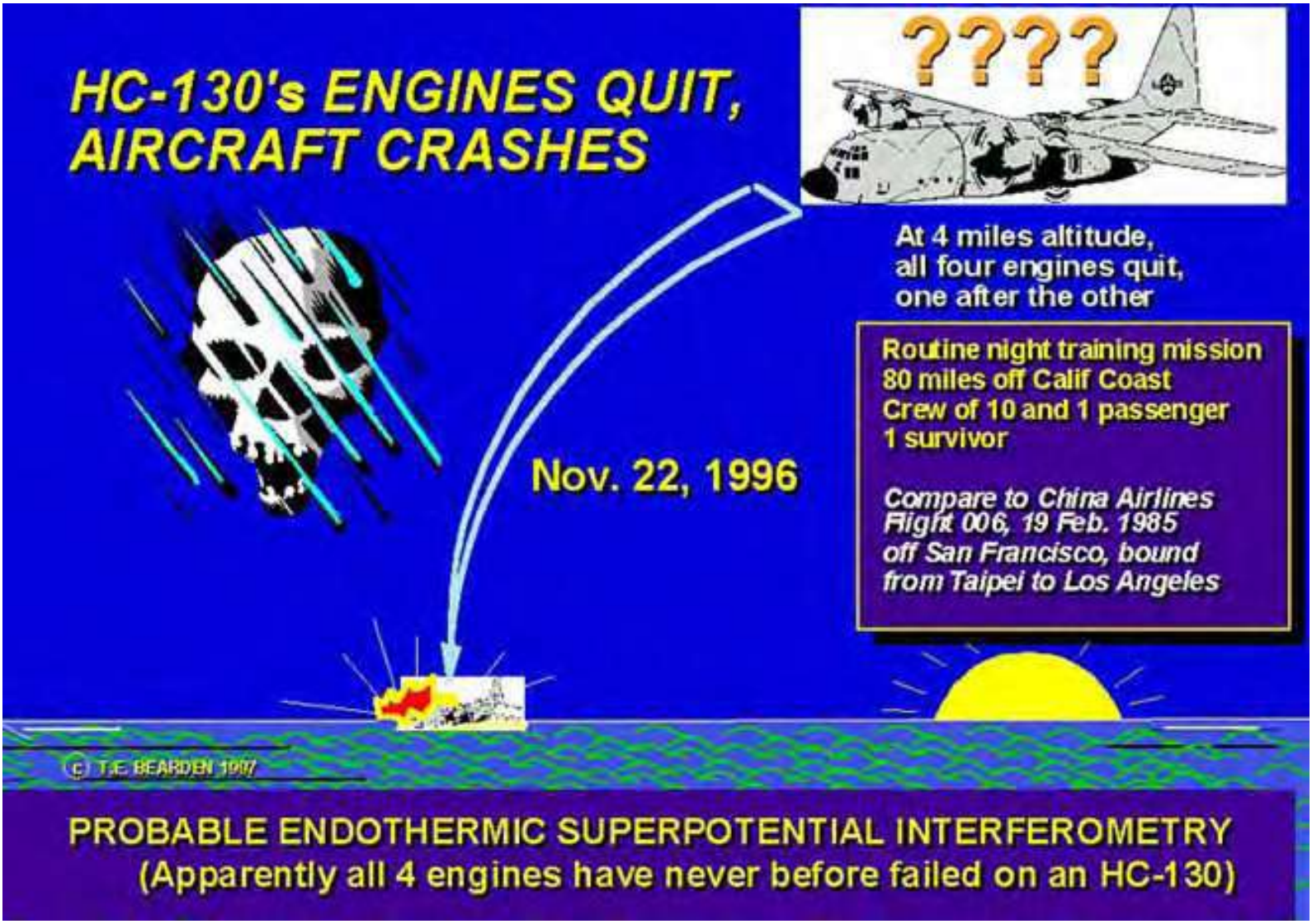
HC-130's ENGINES QUIT, AIRCRAFT CRASHES
????
At 4 miles altitude, all four engines quit, one after the other
Routine night training mission
80 miles off Calif Coast
Crew of 10 and 1 passenger
1 survivor
Compare to China Airlines Flight 006, 19 Feb. 1985 off San Francisco, bound from Taipei to Los Angeles
Nov. 22, 1996
© T.E. BEARDEN 1997
PROBABLE ENDOTHERMIC SUPERPOTENTIAL INTERFEROMETRY
(Apparently all 4 engines have never before failed on an HC-130)

CTEC PROPRIETARY

1996 Actions by this analyst

- In July 1996, with the kill of TWA-800 it became apparent that the KGB/Communists were preparing a massive strategic energetics attack upon the U.S.

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- Began intensive, nearly round-the-clock effort to uncover what was happening, and what had occurred in KGB/Com weapons since 1991
- Began preparing full-up set of briefing slides simultaneously
  - In early 1996, had briefed J6 on scalar EM, per his request
  - Had strongly suggested a follow-on weapons brief
  - Adamant opposition by NRL, NOL, others
- Similar energetics attack scenario in 1986 was countered. Soviets at that time did not possess operational QP weapons, and so could not successfully overcome dead-man fuzing
  - Also could not dud nukes worldwide, because QP required.
  - First lab prototype QP test was in April 1986
- KGB had solved the dead-man fuzing problem by QP's. Deployed circa 1989-1990. Some earlier weapons then leased.

Additional Information Exists; Not Analyzed, Not Integrated in Briefing

- Yakuza arranged involvement of
  - Red Chinese
  - North Koreans
  - A Taiwanese element
- Aum Shinrikyo may have been used as "Red Herring" to deceive West
- Oriental faction plots to strike Russians after the successful first strike on West
- KGB/Russians aware, will counter
  - Plan pre-emptive strike against Oriental faction first
  - Have reserved most advanced, powerful energetics weapons for that purpose

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The Tom Bearden Website

Help support the research

Kill of Arrow DC-8, Gander AFB, Dec. 12, 1985

- Slide 1
- Slide 2
- Slide 3
- Slide 4
- Slide 5
- Slide 6

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Soviet EM missile weapon strike practice two weeks earlier at Cape Canaveral
► Offset from night shuttle launch
► EM missile photographed by Bob Gladwin
► Associated marker beacon photographed
• Canadian Board split on findings
► Half thought icing, half disagreed intensely
► "Due to icing" approved with half absent
► Separate dissenting finding issued
• U.S. officials hiding Iran/Contra affair
► Feared terrorist bomb, MidEast sponsor
► Pressured Board, Gen. Off. bulldozed site
• Lack of icing on aircraft later validated

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Eyewitness observed beams form in the sky
• Saw streak-down and strike of EM missile
– Struck right fuselage ahead of the engines
– Hole was burned through fuselage there
– Photo of hole published in AW&ST
– No explosive residues on hole
• Consistent with ignition and outgassing of plastics in forward cabin
• Consistent with pre-crash HCN deaths

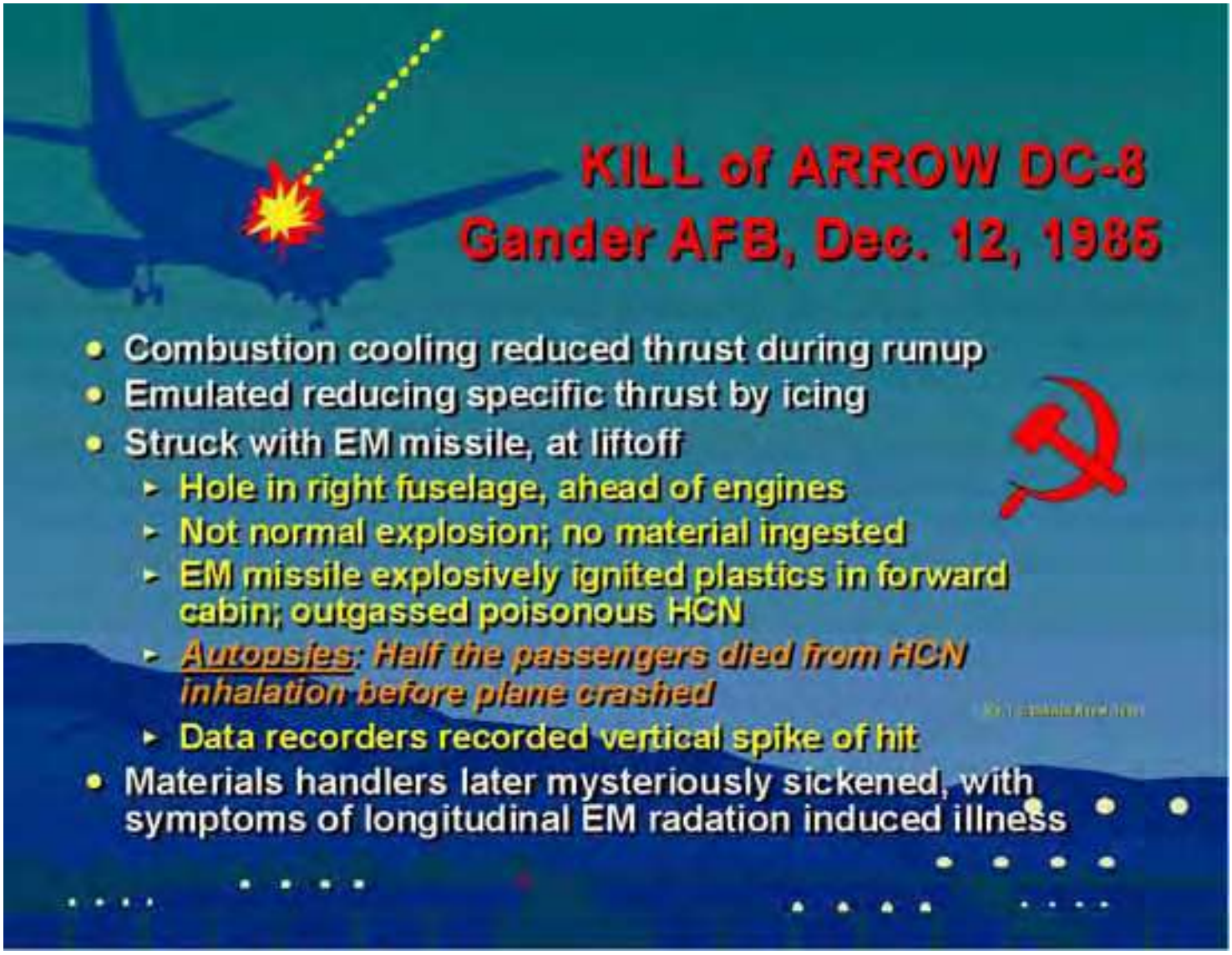
KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Combustion cooling reduced thrust during runup
• Emulated reducing specific thrust by icing
• Struck with EM missile, at liftoff
▸ Hole in right fuselage, ahead of engines
▸ Not normal explosion; no material ingested
▸ EM missile explosively ignited plastics in forward cabin; outgassed poisonous HCN
▸ Autopsies: Half the passengers died from HCN inhalation before plane crashed
▸ Data recorders recorded vertical spike of hit
• Materials handlers later mysteriously sickened, with symptoms of longitudinal EM radiation induced illness

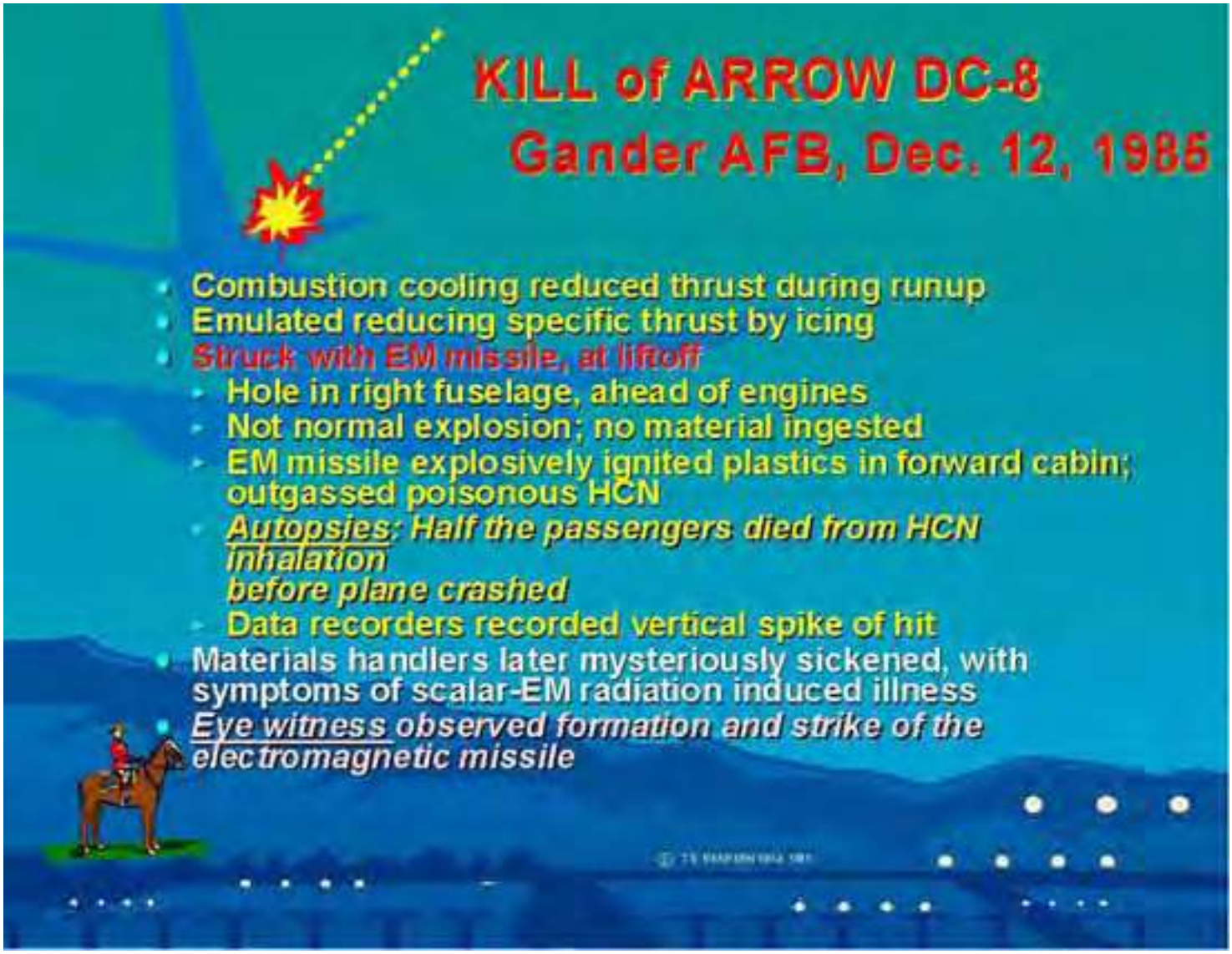
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Data recorders recorded vertical spike of hit
Materials handlers later mysteriously sickened, with symptoms of scalar-EM radiation induced illness
Eye witness observed formation and strike of the electromagnetic missile

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985

- Soviet EM missile weapon strike practice two weeks earlier at Cape Canaveral
  - Offset from night shuttle launch
  - EM missile photographed by Bob Gladwin
  - Associated marker beacon photographed by George Suchary
- Canadian Board split on findings
  - Half thought icing, half disagreed intensely
  - "Due to icing" approved with half absent
  - Separate dissenting finding issued
- U.S. officials hiding Iran/Contra affair
  - Feared terrorist bomb, MidEast sponsor
  - Pressured Board, Gen. Off. had site bulldozed
- Lack of icing on aircraft later validated

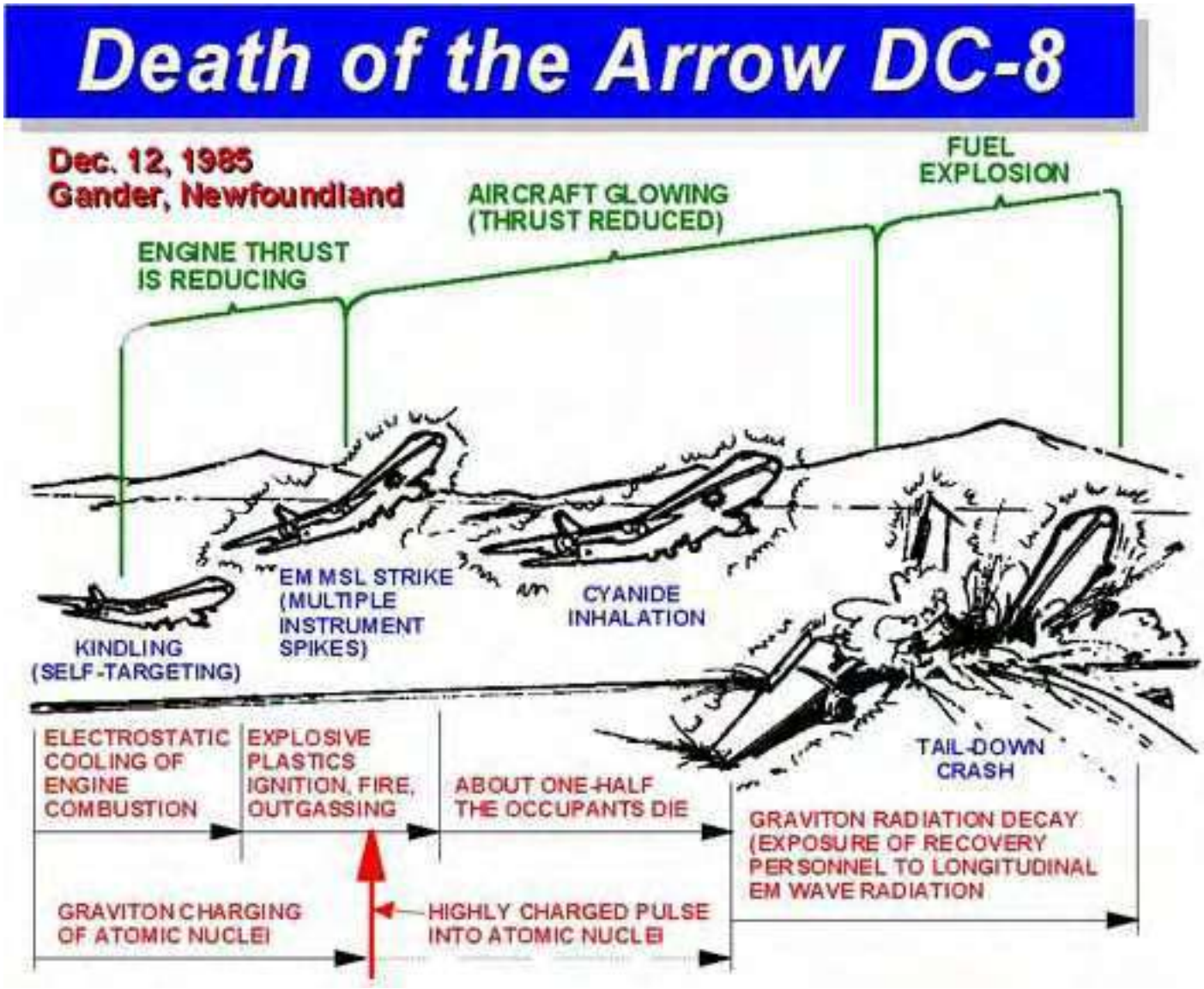
Death of the Arrow DC-8
Dec. 12, 1985
Gander, Newfoundland
ENGINE THRUST IS REDUCING
AIRCRAFT GLOWING (THRUST REDUCED)
FUEL EXPLOSION
KINDLING (SELF-TARGETING)
EM MSL STRIKE (MULTIPLE INSTRUMENT SPIKES)
CYANIDE INHALATION
TAIL-DOWN CRASH
ELECTROSTATIC COOLING OF ENGINE COMBUSTION
EXPLOSIVE PLASTICS IGNITION, FIRE, OUTGASSING
ABOUT ONE-HALF THE OCCUPANTS DIE
GRAVITON RADIATION DECAY (EXPOSURE OF RECOVERY PERSONNEL TO LONGITUDINAL EM WAVE RADIATION
GRAVITON CHARGING OF ATOMIC NUCLEI
HIGHLY CHARGED PULSE INTO ATOMIC NUCLEI

Satellite Photos of Plumes in Soviet Arctic Since 1974*

- Two aircraft flew through for analysis
  - Solid material, mostly ice, a little clay
  - Much colder than surrounding air
  - *Signature of cold exhaust from exothermic scalar interferometry operations*
  - No volcanic material
  - No radioactive material

- May be 2 to 3 times as many incidents
  - Only examined satellite imagery in winter
  - Only periodic satellite coverage
  - Hypothesized methane venting, cloud seeding

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*As of 1989, when this information was gathered

AUM SHINRIKYO
("SUPREME TRUTH" CULT)

Shoko Asahara, Leader

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Ashkhabad Problem and Its Solution

- ***PROBLEM:***
  - Stress increasing in two-plate fault zone
  - 1,000 shocks yearly
  - Kara Kum canal
  - Hydraulic pressure
  - 1948: Ashkhabad 80% destroyed by quake

- ***SOLUTION:***
  - Stress-relieve plate stresses from fault

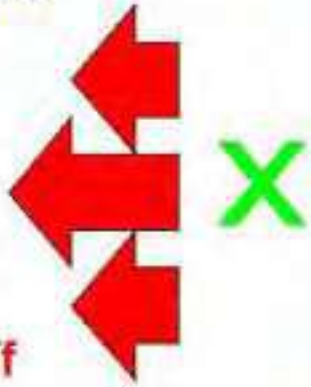

- ***IMPLEMENTATION:***
  - Induce nearby earthquake
  - Deceive by *predicting* a quake, setting off nuclear explosion

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Strange Characteristics of Iran Quake, Sep. 1978

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- **Signatures**
  - 7.4 on Richter scale
  - No aftershocks: 6.0 expected (normal)
  - Strange epicenter
  - Anomalous depth

- **Deception**
  - 10 MT Soviet nuclear explosion 36 hours before the quake
  - Prior disinformation regarding Soviet attempted development of focusing shock waves from underground nuclear explosions, to cause distant earthquakes

Iran Earthquake Sept. 1978

- Killed 25,000 Iranians
- Soviet city of Ashkhabad saved
- Soviets "predicted" quake in advance; then induced it
- Quake had serious anomalies (signatures)
- Deception measures were used by Soviets
  - Prediction in advance
  - "Theory" of quake-induction by nuclear explosions
  - Fired underground nuclear explosion as "Red Herring" candidate for cause

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Situation Now (Assessment)

- In May 1997: second A-10 pilot (lady), in pullup from night ordnance delivery on target, was struck with psychoenergetic weapon takeover. Sense of vertical was reversed. She perceived herself diving, sharply corrected, and dove headlong into the ground.

- Additional aircraft kills uncovered, including one 4-engine aircraft whose engines all failed. This closely repeats the earlier 1985-1987 scenario.
- Korean Airlines Flight 801 crashed on Guam on anniversary of loading of the atomic bomb that was dropped on Hiroshima in WW II. The Enola Gay, which dropped the bomb, took off from Guam in wee morning hours of August 6, 1945. The local opns order on Guam was also issued on Aug. 5.

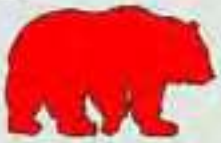

- *Presently the Coalition (KGB/Communists/Aum Shinrikyo/Yakuza) is waiting for proper time to launch the final strike. It is still on.*

Situation Now (Assessment 2)

- April 97: Mind control test against Captain Button:
  - Demonstrates ability to control crewman in complex operations for more than one hour.
  - KGB requires one hour total QP crew control on a site to have crew disable insane QP wpns.
- Once QP systems disabled, Mindsnapper attacks and instantly kills every living thing in QP site area. Contaminates area for months (emits longitudinal EM wave radiation, which disrupt any life forms attempting to enter struck area). Sites nullified.
- Mind control over one crewman requires one weapon system plus up to 20-30 operators for controlling thoughts, hearing, perceptions, etc.
- *In Apr. 97, KGB building and deploying weapons and training crews. Ready for new attack 1999-2000.*

Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum
- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another

© T E Bearden 1995, 1996

Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- One terrorist, one light aircraft with spray tank
- One kilogram of anthrax
- Flies over greater metropolitan Washington, D.C.
- Calm night
- *1-3 million casualties result**
- *Most of those stricken will die*
- Presently little can be done to save the stricken civilians
- *Attacks on several population centers might produce some 10 million or more casualties*

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*Per OTA Report to Congress, 1993

Present Status of the WMD Threat to the United States

- Many foreign nations are hostile to the U.S. and sponsor terrorists
- Some 25 nations have WMD or are acquiring them
  - BW agents and weapons
  - Chemical agents and weapons
  - Nuclear materials and weapons
- Thousands of students and émigrés
- Infiltrated teams, BW, other WMD already
- Castro guerrillas infiltrated over the years
- Can do unacceptable damage to U.S. now
- *May reach first strike knockout capability*

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*Per OTA Report to Congress, 1993

Some Present Problems in the U.S. WMD Defense Capabilities

- No shelters (require overpressure, BW filtering, masks, showers, supplies)
- No stockpiled vaccines, medical supplies, immunoglobulins, masks, suits, food, fuel, generators, heaters, water purification units
- Totally insufficient medical facilities, personnel, and emergency response teams
- Triage, full martial law will be required
- No answer to massive decontamination problem
- State, county, city inadequately staffed and insufficiently trained for mass casualties
- Terrorist teams, BW agents, other WMD on site, waiting
- Water supplies, food, crops, farm animals also vulnerable
- Electric power grid, bridges, trains, railroads vulnerable
- Present medical science cannot save very many of the casualties, now or in the foreseeable future

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Internal Terrorist Threat with
Weapons of Mass Destruction: Now & Future
TODAY:
• Sabotage
• Chemicals
• Biological agents
• Nuclear materials
• Powerful explosives
• Assassination
• Kidnapping and hostages
• Contamination
• Shoulder-fired AD missiles
• Terrorism
FUTURE ADDITIONS:
• Orthodox EM weapons
• Energetics EM biological warfare
• Scalar EM (energetics) weapons
• Scalar EM disease induction
• Alteration of behavior and emotions
• Alteration of memory
• Direct control of thoughts, perception
• Quantum potential weapons
• Psychoenergetics weapons
• Action-at-a-distance effects

Attempt to Ban Energetics Weapons Worldwide

- On June 13, 1975, in a major speech Brezhnev urged the United States to agree on a ban of research and development of new kinds of weapons "more terrible than anything the world has known."
- On July 2, 1975 Brezhnev repeated his proposed ban on development of frightful new weapons, to a group of U.S. Senators.
- In August 1975, Ponomarev called for a ban on frightful new weapons of mass destruction.
- On Sept. 23, 1975 Gromyko presented a draft treaty agreement to the 30th Session of the UN General Assembly, for banning development of frightful new weapons.
- *No one had the foggiest notion what the Russians were talking about!*

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Brezhnev's Schedule

"We are achieving with detente what our predecessors have been unable to achieve with the mailed fist...
...by 1985 our power will be so irresistible that we can do what we wish anywhere on the globe."

Leonid Brezhnev,
in a secret 1973 meeting in Prague
with European Communist leaders.

"By the early 1980's we and our allies will control the high seas, space, and most of the earth's land area."

Kosygin,
to Imelda Marcos,
July 1978

In 1985-87, the Soviets did attempt to move, still constrained by nuclear dead man fuzing. That attempt was blocked, primarily by scalar EM countering demonstrations and dead man fuzing.

In April 1986, the first Soviet lab prototype of a quantum potential weapon specifically designed toward 10-min neutralization of nukes worldwide was gingerly tested against our U.S. airstrike on Libya. It was weakly tested in the "induced EMI" mode, for deception.

By 1990 that weapon was deployed and a new attack preparation phase was entered, scheduled for 1997.

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COLD EXPLOSION -- 9 April 1984 Near Kurils

And Formation and growth of spherical shell (globe)

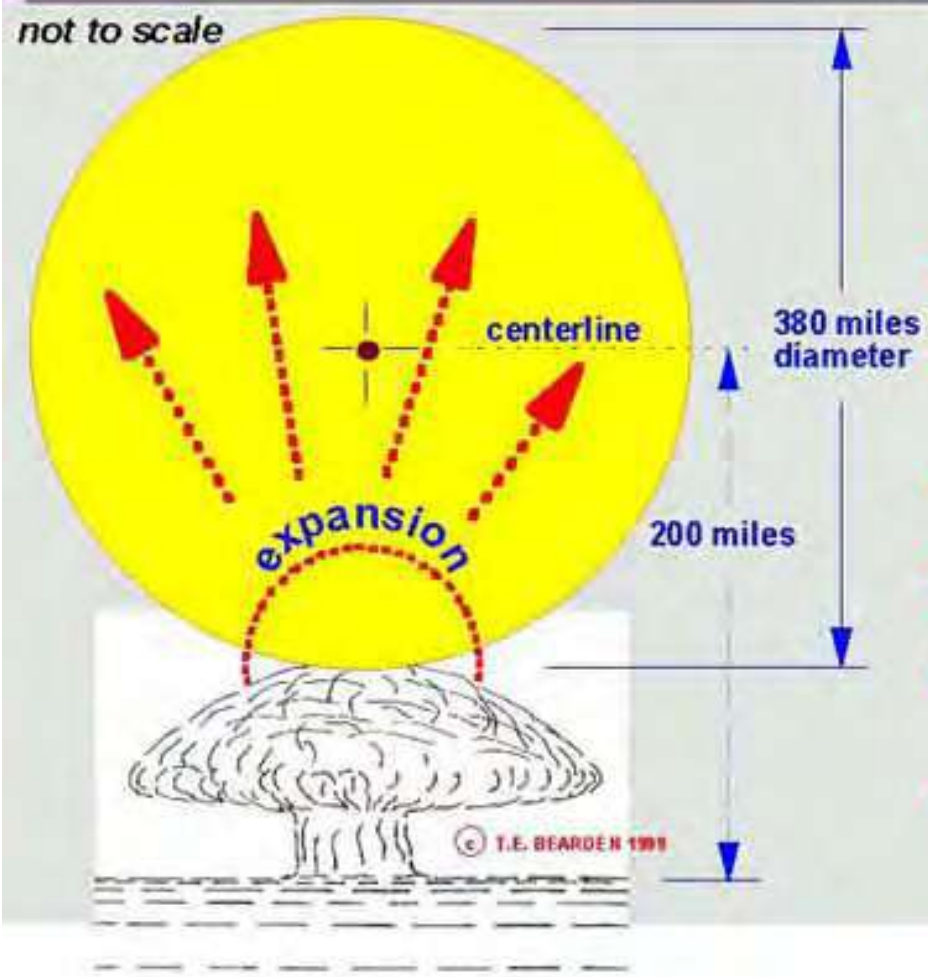

Sequence of Events

- Geyser of water rose rapidly from surface, mushroomed out
- Reached 60,000 feet altitude in two minutes
- Brilliantly glowing globe then appeared in top
- Globe increased greatly in size and altitude
- Reached diameter of 380 miles
- Center reached altitude of 200 miles
- Observed by multiple qualified pilots

COLD EXPLOSION -- 9 April 1984 Near Kurils

And Formation and growth of spherical shell (globe)

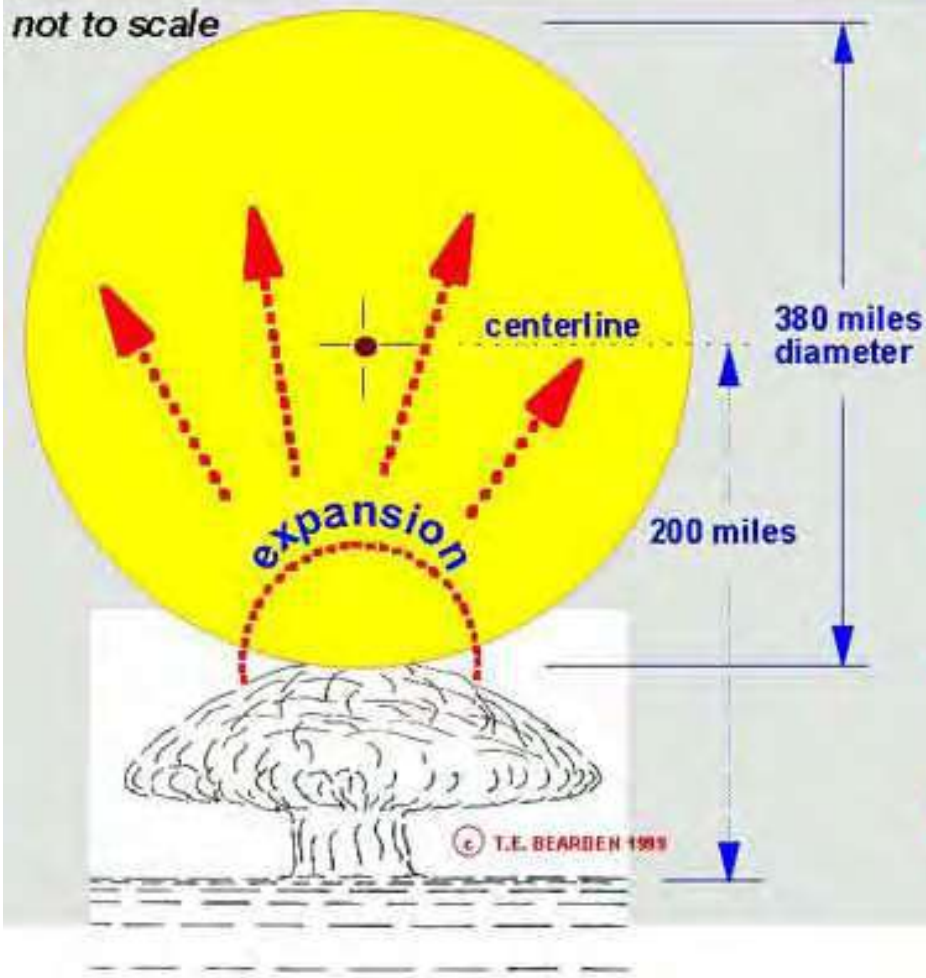

What They Were

- Superpotential interferometry using LWs
- First, a cold explosion just above surface
- Then small intense shell of glowing EM energy for 1-on-1 targeting
- Larger globe for large area as for ICBM targets approaching in zone
- With ST engines, can dud incoming nukes and all electronics
- Use in or out of Earth's atmosphere

COLD EXPLOSION -- 9 April 1984 Near Kurils
(Plus additional weapons effects)
JAL
Halo expanded to giant globe.
380 miles diameter, center over 200 miles
high.
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Countering Insane Mad Systems: Find Loophole, Exploit It

- If MADs not quantum potential systems, easily countered by instant QP strike which destroys targeted MAD weapons worldwide with certainty.
- Have to be certain of types of dead-man fuzing. All dead-man fuzing weapons must be included in the assured target list for the striking quantum potential weapon.

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- Multiple targeted MADS require multiple vacuum engines in the striking quantum potentials.
- Uncertainty and risk introduced if not certain of all MAD systems and all dead-man fuzing systems.
- Newest generation psychoenergetic LW interferometry weapons can instantly take over minds of all personnel on targeted sites, with targeted crews quickly disarming their own MAD weapons' launch capability as well as the weapons themselves.
- Mindsnapper then kills all living things and contaminates sites.
- Next generation QP Psy-En weapons can disrupt and destroy minds of an entire targeted national population. The nature of warfare moves irrevocably to the human mind, where of course the fundamental problem arises anyhow.

Next Generation Counter to Both Sane and Insane MAD Systems

- ***Localized quantum potential in an area, used in psychoenergetics mode***
  - Gradually produces mild, continuous hypnotic state
  - Targeted population remains entirely conscious, functional
  - Internal "word thoughts" emerge directly in subconscious
  - Targeted persons all unaware of these "word thoughts"
  - Operates somewhat similar to "post hypnotic suggestion"
  - Gradually changes emotions, psychological outlook
  - Over a period of time, deviates and entrains entire target population's outlook, belief structure, temperament
- ***Moves Psywar to inside the human component***
- ***Human minds are the only battleground***
- ***Can be accomplished without overt signature***
- ***Countered only by inserting same methodology into deeper mind level (collective unconscious)***

Simultaneous Dudding of Nuclear Weapons Worldwide

- Via quantum potential joining U235 and Plutonium in warheads
- Includes weapons airborne, underwater, in storage
- These are *transmutations of the nuclides themselves*
- *Part of the initial barrage launched by Aum/Yakuza/KGB*
- *Will occur in the first minutes of the strategic strike, following psychoenergetically crew-disabling QP weapons*

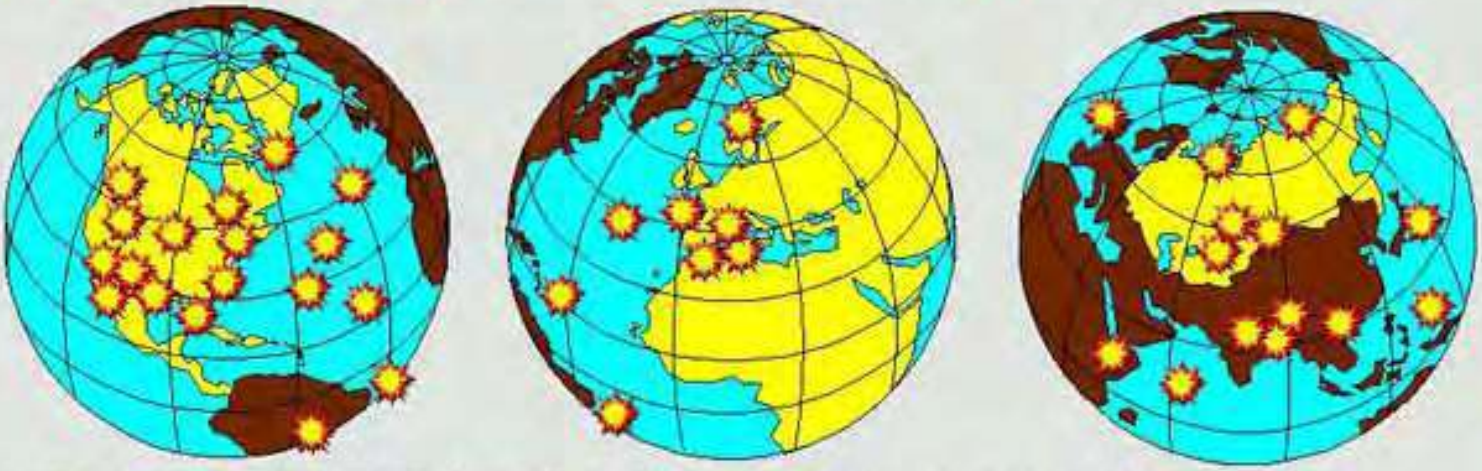

Note: Duds both overt and covert nuclear weapons and weapons-grade materials -- including "suitcase-delivered" covert weapons on site in Russia which otherwise provide dead man fuzing

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Simultaneous Dudding of Nuclear Weapons Worldwide

- Via quantum potential joining U235 and Plutonium warheads
- Includes weapons airborne, underwater, in storage
- These are not explosions, but are *transmutations and increased fissioning rates*
- *Part of the initial barrage launched by Aum/Yakuza/KGB*
- *Will occur in the first minutes of the strategic strike*

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Note: Duds both overt and covert nuclear weapons and weapons-grade materials.

Operation Divine Wind II

Slide 1

Slide 2

Slide 3

Slide 4

YAKUZA &
AUM SHINRIKYO

DIVINE WIND II

U.S.

★ **A secret coalition of Yakuza/Aum Shinrikyo and KGB/Communist forces plan to launch a massive, surprise energetics attack on the United States, given a low-risk opportunity.**

★ Major weapons utilized will be the scalar EM (energetics) superweapons (including quantum potential weapons) that were developed, deployed, and operated by the KGB under the former Soviet Empire, and continuing after its dissolution.

KGB

★ Yakuza/Aum crews have extensively trained and test-fired, from on-site in Russia. They have *leased* operational control of the first three generation energetics superweapons (which work by superpotential interferometry).

MINDSNAPPER AND
PSYCHOENERGETICS

★ *The Escalation Phase of interdicting and destroying actual U.S. targets (e.g., TWA-800, two A-10s) is already underway.*

★ *The first blow in the Strike Phase will dud all nuclear weapons and weapons materials worldwide, in minutes; destroy special ship and energetics weapon sites instantly, disable 99% of the U.S. population instantly, and kill 80% of targeted populations in from 10 minutes to 3 days.*

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QUANTUM
POTENTIAL

YAKUZA &
AUM SHINRIKYO

U.S.

DIVINE WIND II

- ★ A secret coalition of Yakuza/Aum Shinrikyo and KGB/Communist forces plans to launch a massive, surprise energetics attack on the United States and its allies, given the first low-risk opportunity.

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KGB

- ★ Attack was thwarted twice in 1997 by a small nation countering with QP weapons.
- ★ KGB psychoenergetics counter for the last QP weapon counter was tested in April 1997.
- ★ Ready time for a new scheduled attack is latter quarter 1999 through first half of 2000.

YAKUZA &
AUM SHINRIKYO

DIVINE WIND II

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- ★ **A secret coalition of Yakuza/Aum and KGB/Communist forces will launch a massive, surprise, strategic attack on the United States in 1997.**
- ★ **Major weapons utilized will be the scalar EM (energetics) superweapons that were developed, deployed, and operated by the KGB under the former Soviet Empire, and continuing after its dissolution.**
- ★ **Yakuza/Aum crews have extensively trained and test-fired, from on-site in Russia. They have *leased* operational control of the energetics superweapons.**
- ★ ***Escalation Phase of interdicting and destroying actual U.S. targets (e.g., TWA-800) is already underway.***
- ★ ***The first blow in the Strike Phase will dud all nuclear weapons and weapons materials worldwide, in minutes; destroy special ship and energetics weapon sites instantly, and kill 80% of targeted populations in 3 days.***

KGB/COMMUNISTS

MINDSNAPPER

QUANTUM
POTENTIAL

OPERATION DIVINE WIND II

Three Phases and Support

Operational Phases

- Phase I: On-Site Training Phase (Completed)
- Phase II: Escalation Phase (In Progress)
- Phase III. 1997 Strategic Strike on the U.S.
  - *First strike (QP) in Phase III duds all nuclear weapons and nuclear powerplants worldwide, in minutes*
  - *Psychoenergetic strike (QP) disables people instantly*
  - *Mindsnapper attack of special assets for 100% success*
  - *QP initiation of fast-acting, lethal diseases kills 80% of targeted populations in three days or less*

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Support Plans

- Plan A: Feints, Deception, Sabotage, and Terrorism
- Plan B: Testing and Test Range
- Plan C: Worldwide Weather Engineering
- Plan D: Strategic and Combat Intelligence

Advanced EMBW Applications

- Covert EMBW: Examples
  - Activate materials and their potentials with ST disease engines. Potentials superpose and their infolded ST dynamics diffuse
  - Activate water's structuring (H-bonding) potential with disease engines
  - Bias electrical power grid ground fields by weak diseases
  - Employ disease-structured quantum potential in distant area
- Overt death ray (mind snapper)
  - Powerful scalar EM pulse in target area "jerks" rate of flow of time
  - The "time snap" sharply separates mind from body and each cell
- EMBW CM:
  - Irradiate bodies with longitudinal EM waves; self-converts to t-pumping and produces exact amplified ST antiengine
  - Antiengine arises out of local ST, affects all parts of all cells
  - Cells are t-charged with antiengine structure
  - Continuing action restores regenerative and immune systems and reverses cellular damage

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EM Biological Warfare (EMBW)

- KGB/Communists have developed highly effective
  - Electromagnetic biological warfare (EMBW)
  - Counters to orthodox biological warfare
  - Mass death ray weapons
    - Small version of "mindsnapper" tested in Afghanistan
    - Killed occupants in two villages, in separate strikes
    - Unusual aspects (so-called "smerch" gas)
- Russia/KGB is the only group with a complete counter to biological warfare, either covert or overt, and to EMBW
- EMBW (covert and overt) is a preferred option for KGB
  - MAD Doctrine is completely destabilized for a sufficiently covert Russian EMBW strike
  - Situation has existed for at least two decades
  - Can alter germs, bacteria, viruses of specific kind, in a specific target area, to produce antibiotic-resistant strains
  - Can induce any kind of cellular disease or damage at a distance
- U.S. national characteristic: no reaction to slowly increasing threat

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Microwave Radiation of U.S. Embassy in Moscow

Former U.S. Embassy in Moscow.

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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Pentagon EMI Studies, 1989

Washington Post, 22 Jan. 1989, p. A4

- Analysts of severe EMI effects in strike on Libya, 1986
  - performed major 3-year, 66-man study
  - Blamed effects on U.S. forces' own signals
  - Did not know of any other "signals" present
  - Knew nothing of quantum potential weaponry, energetics weaponry
- 7-month preliminary study
  - Severe EMI Problem exists
  - EMI shielding often waived in our weapon systems
  - Thousands of conflicts possible
- Also studied UH60 Blackhawk helicopter problems (which *were* due to its lack of good EMI shielding, and not quantum potentials)
  - uncommanded turns
  - Five EMI crashes 1982-1989
  - $175 M program to shield it
- So found that U.S. transmission combinations can
  - Affect aircraft flight control
  - Turn off fuel supply
  - Cause uncommanded dive/turn
  - Bring down U.S. warplanes
- *Actually, Libyan EMI was induced by Soviet quantum potential tests which can do all those things and much more*

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EM Missile Practice

- EM Missile Practice
  Latter Sept. - Early Nov. 1996
  Melbourne, Australia
- Deception: Using EM Missile to Reinforce Notion of SAM Attack
  Saturday evening, Nov. 16, 1996
- Intelligence Probe: Insuring U.S. Still Unaware of Energetics Weaponry
  Thursday, December 12th, 1996
- EM Missile Strike, Offset from Night Shuttle Launch, Cape Canaveral, Florida
  The Smoking Gun in November 1985
- Distant Operator Onsite in Russia Slew Away Registration Point
  Marker Beacon over Night Shuttle Launch, 26 November, 1985
- EM Missile Practice and Deception
  November 17, 1996

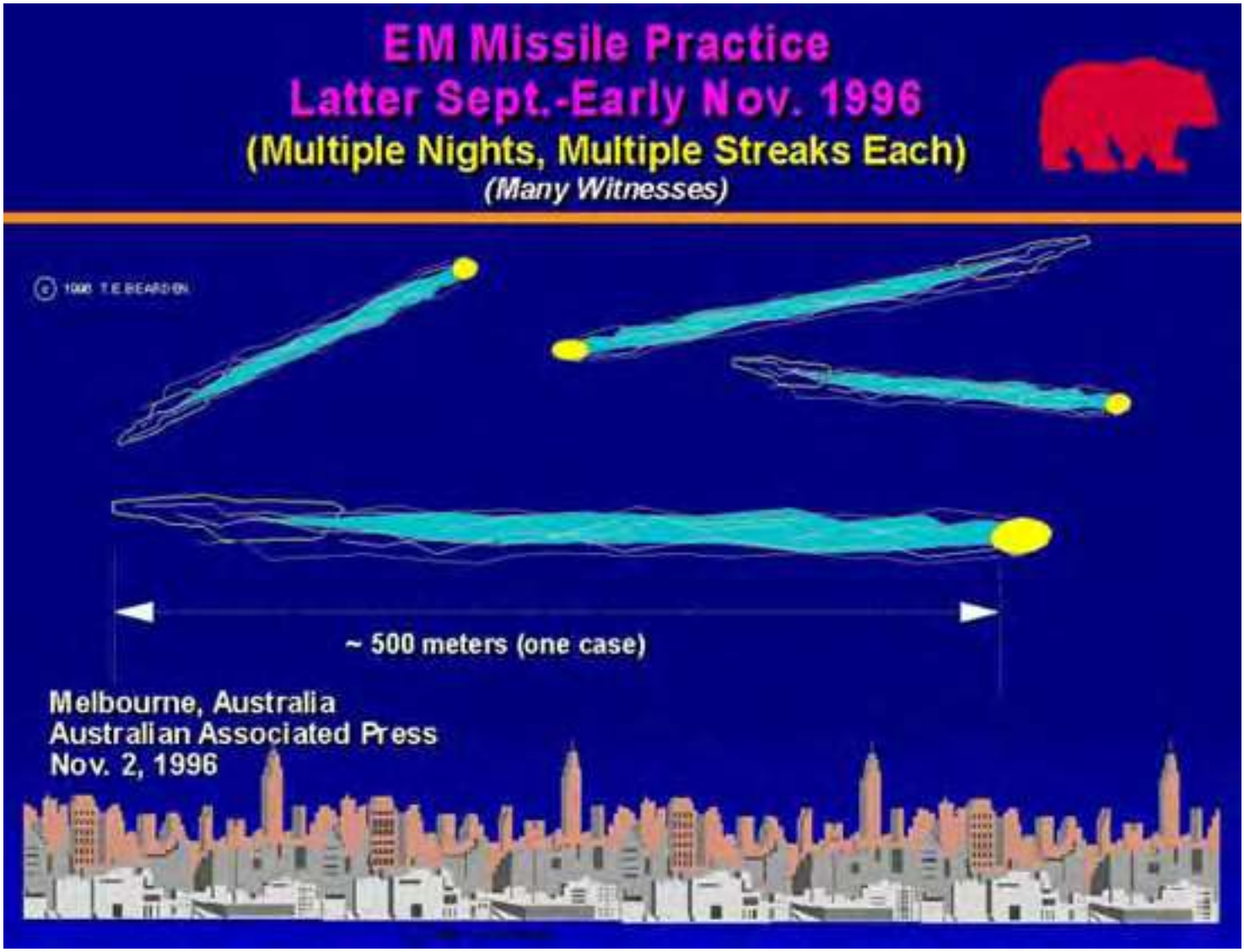
EM Missile Practice
Latter Sept.-Early Nov. 1996
(Multiple Nights, Multiple Streaks Each)
(Many Witnesses)
© 1996 T.E.BEARDEN
~ 500 meters (one case)
Melbourne, Australia
Australian Associated Press
Nov. 2, 1996

Deception: Using EM Missile to Reinforce Notion of SAM Attack

Saturday Evening
Nov. 16, 1996

Note: Meteor shower was forecast, which provided perfect decoy to FBI investigators, to steer them off the true scent.

Pakistan International Airlines Flight 712, just after takeoff from John F. Kennedy Airport, on path similar to that taken by TWA Flight 800, July 17, 1996

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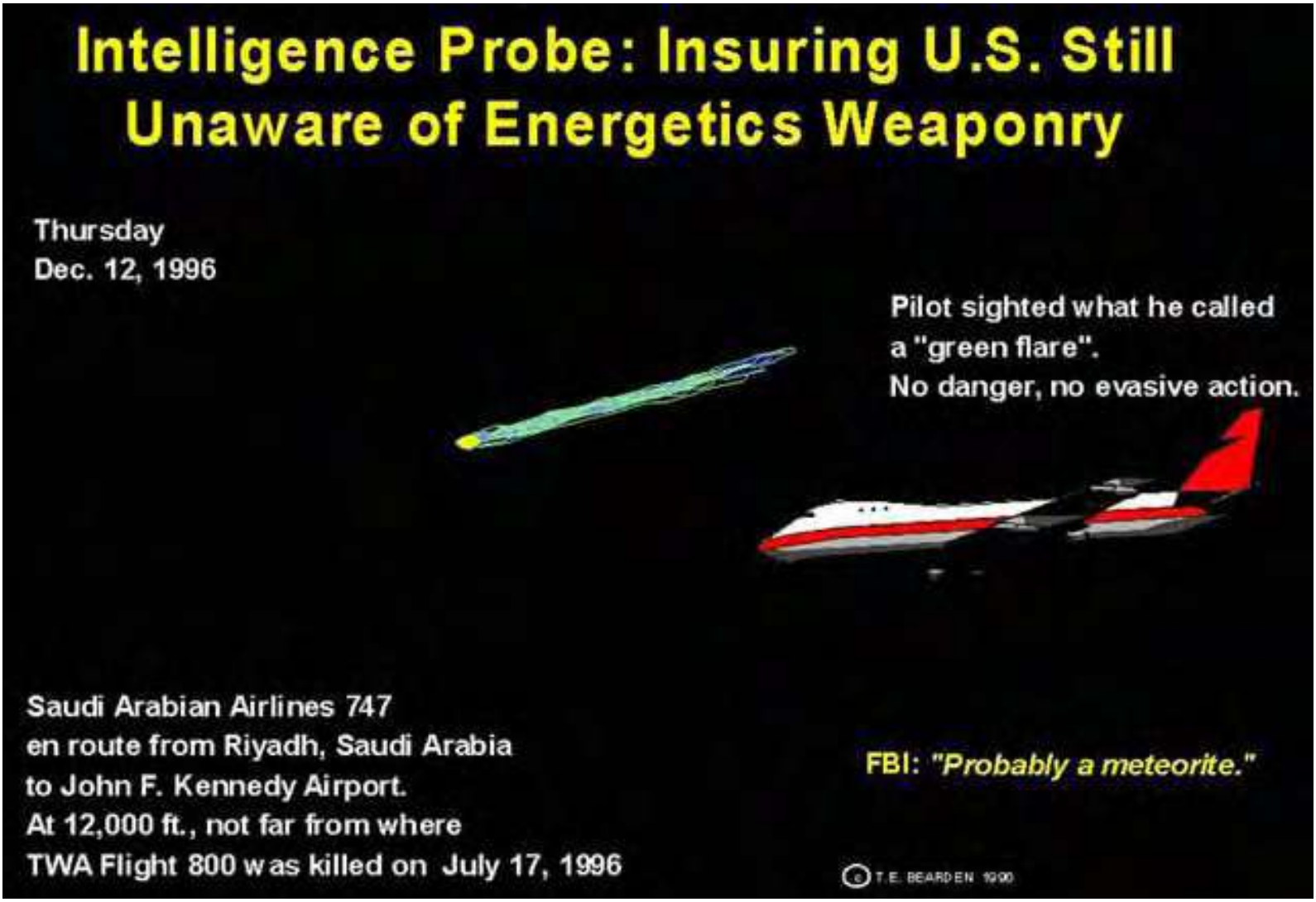
Intelligence Probe: Insuring U.S. Still Unaware of Energetics Weaponry
Thursday
Dec. 12, 1996
Pilot sighted what he called a "green flare".
No danger, no evasive action.
Saudi Arabian Airlines 747
en route from Riyadh, Saudi Arabia
to John F. Kennedy Airport.
At 12,000 ft., not far from where
TWA Flight 800 was killed on July 17, 1996
FBI: "Probably a meteorite."
© T.E. BEARDEN 1990

EM Missile Strike, Offset from Night Shuttle Launch

Cape Canaveral, Florida

© T.E. BEARDEN 1995, 1999,

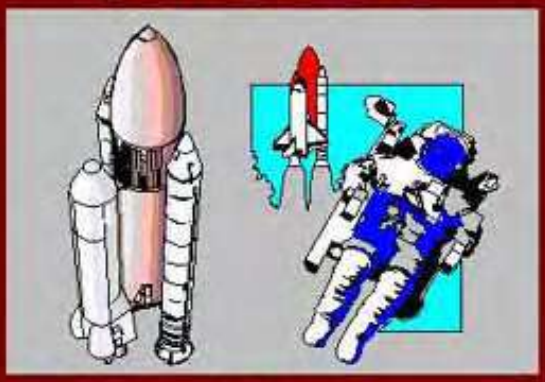

The Smoking Gun in Nov. 1985

Distant Operator Onsite in Russia
Slews Away Registration Point
© T.E. BEARDEN 1995, 1999
MARKER BEACON
Over Night Shuttle Launch
Cape Canaveral, Florida
26 Nov 1985
Photographed by George Suchary
28 Nov 1985
Two weeks later, the same weapon killed the Arrow DC-8
at its takeoff from Gander, Newfoundland.

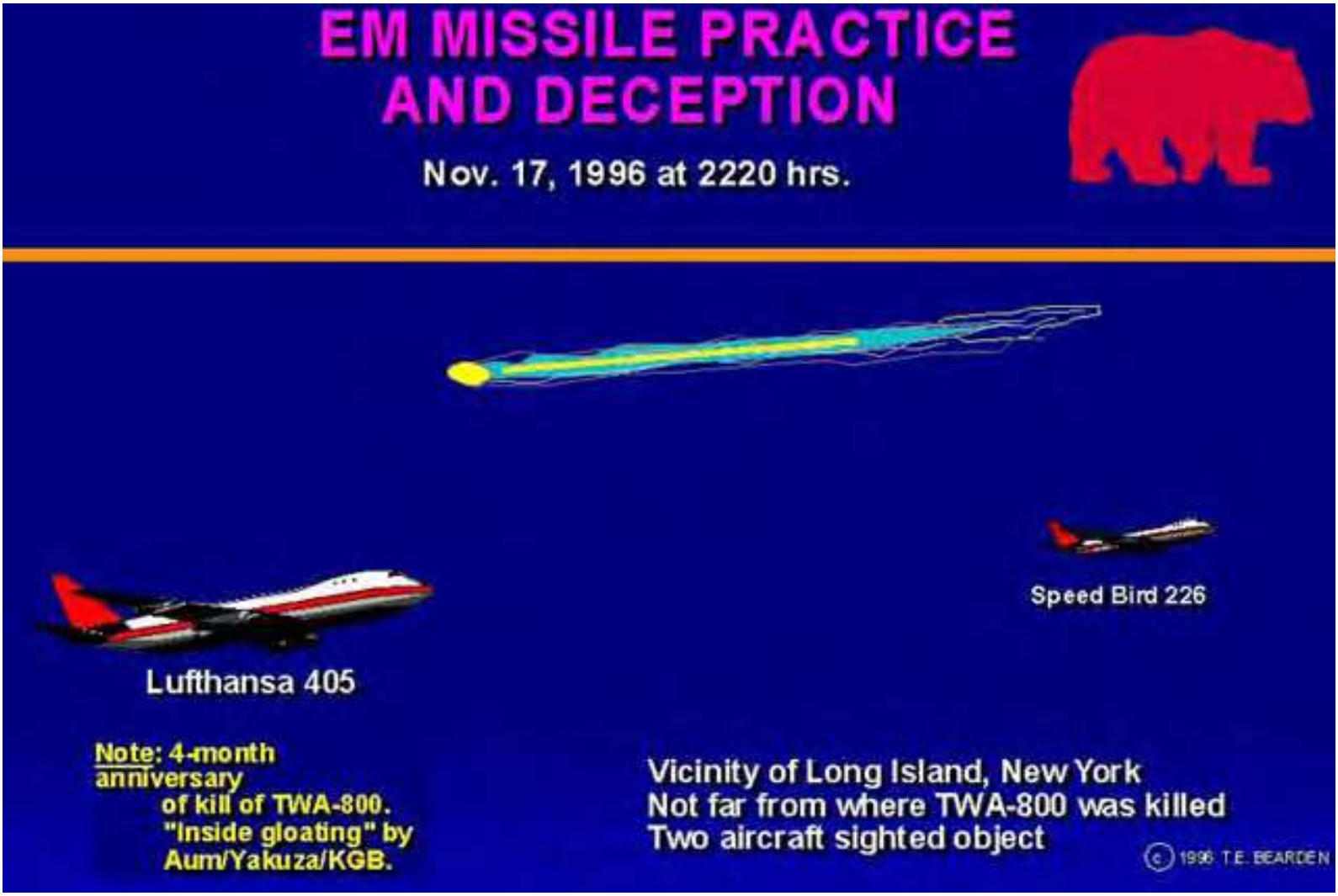
EM MISSILE PRACTICE
AND DECEPTION
Nov. 17, 1996 at 2220 hrs.
Speed Bird 226
Lufthansa 405
Note: 4-month anniversary of kill of TWA-800. "Inside gloating" by Aum/Yakuza/KGB.
Vicinity of Long Island, New York
Not far from where TWA-800 was killed
Two aircraft sighted object
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Subdivisions of Soviet Energetics

NONLIVING SYSTEMS

Energetics

- Nonliving systems
- Scalar Interferometry
- Action-at-a-Distance
- Quantum Potential
- Vacuum Engines
- Spacetime Structuring
- Material, Field Effects
- Nuclei, Lattice Changes
- Hidden EM Variables
- SWZ Effects

LIVING SYSTEMS

Bioenergetics

- Living Systems (Bodies)
- Cells, cellular changes
- Master Cell Control (Popp)
- Spacetime Structuring
- Disease Induction, Remission
- Action-at-a-Distance
- Quantum Potentials
- Scalar Interferometry
- Hidden EM Variables
- SWZ Effects

Psychoenergetics

- Living Systems (Minds)
- Thoughts, Memories, Emotions
- Conscious/Unconscious Minds
- Spacetime Structuring
- Species, Biospheric Minds
- Action-at-a-Distance
- Quantum Potentials
- Scalar Interferometry
- Hidden EM Variables
- SWZ Effects

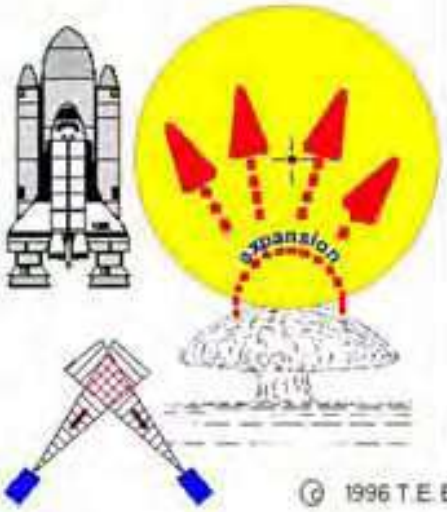

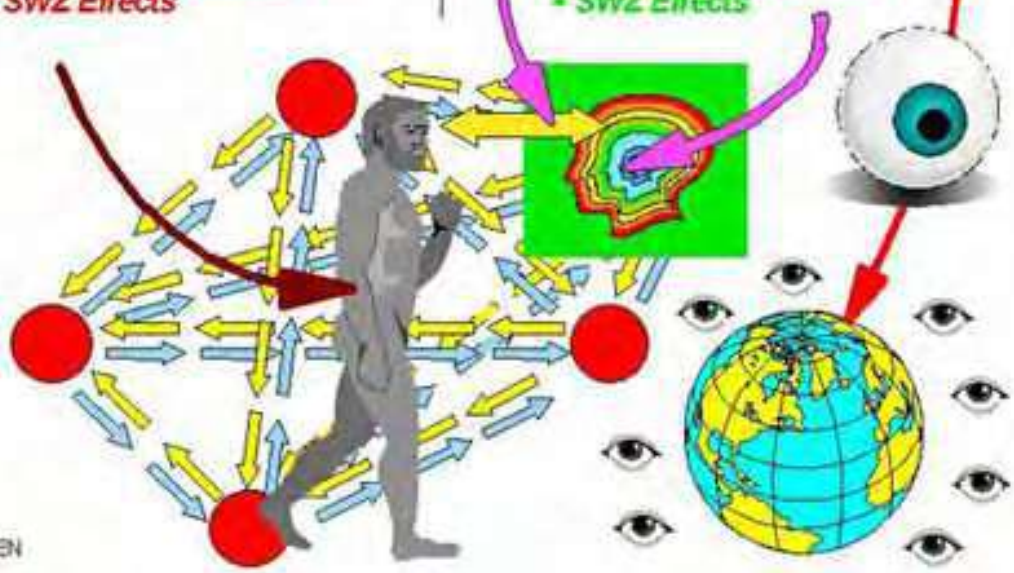

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Communism's Goal

- "War to the hilt between communism and capitalism is inevitable. Today, of course, we are not strong enough to attack... To win we shall need the element of surprise. The bourgeoisie will have to be put to sleep. So we shall begin by launching the most spectacular peace movements on record. There will be electrifying overtures and unheard-of concessions. The capitalist countries, stupid and decadent, will rejoice to cooperate in their own destruction. They will leap at another chance to be friends. As soon as their guard is down, we shall smash them with our clenched fist."

Dimitry Z. Manuilsky
Lenin School of Political Warfare, Moscow
(circa 1934)

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Manuilsky's Goal vs. Status Today

Manuilsky, 1934	Situation, Dec. 1996
▪ War is inevitable.	▪ Has not changed.
▪ Not strong enough to attack now.	▪ Strong enough now; preparations completed. Need right opportunity.
▪ Need surprise.	▪ Have achieved total surprise.
▪ Must put us to sleep.	▪ We are sound asleep.
▪ Need most spectacular peace movement on record.	▪ Done. We think the Russian threat gone, cold war ended.
▪ Electrifying overtures, unheard-of concessions.	▪ Done, and still occurring every day. It has worked beautifully.
▪ Capitalists will cooperate.	▪ We are cooperating in spades!
They will leap to be friends.	▪ We've leaped, and are leaping.
▪ They will let down their guard. ▪	▪ No ABM, junked lots of nukes, shrunk our forces to the bone.
▪ We'll strike them then.	▪ They would have struck (twice) in 1997, but for deterence by another nation (not U.S.) having QP weapons
	▪ *They are still looking for a risk-free opening to strike*

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Professor Hellman, German Scientist Released from Work in Soviet Union

- Worked in Soviet Union after WWII
- Eventually escaped to Germany, then to Brazil (handsome offer)

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- Took part in highly unusual Soviet energetics development and experiments
- Large areas of the sea could be and were *suddenly frozen*
- *No particular attention was paid to this information by highly qualified scientists*
- *In intelligence terms, this is A-1 information of the highest caliber*
- *Bohm also was invited to Brazil, which started an energetics weapon program. Brazil developed such weapons including weak quantum potential weapons (0.95 confidence)*

The Tom Bearden Website

Help support the research

Hemispheres of Light

- March 20th, 1969
  Caribbean and Western North Atlantic
- Hemisphere and Globes, 1977
  24 March, 1977
- Virgin Islands Incident
  August 1969
- Typical Shield Test, Northern Route to Japan
  June, 1982

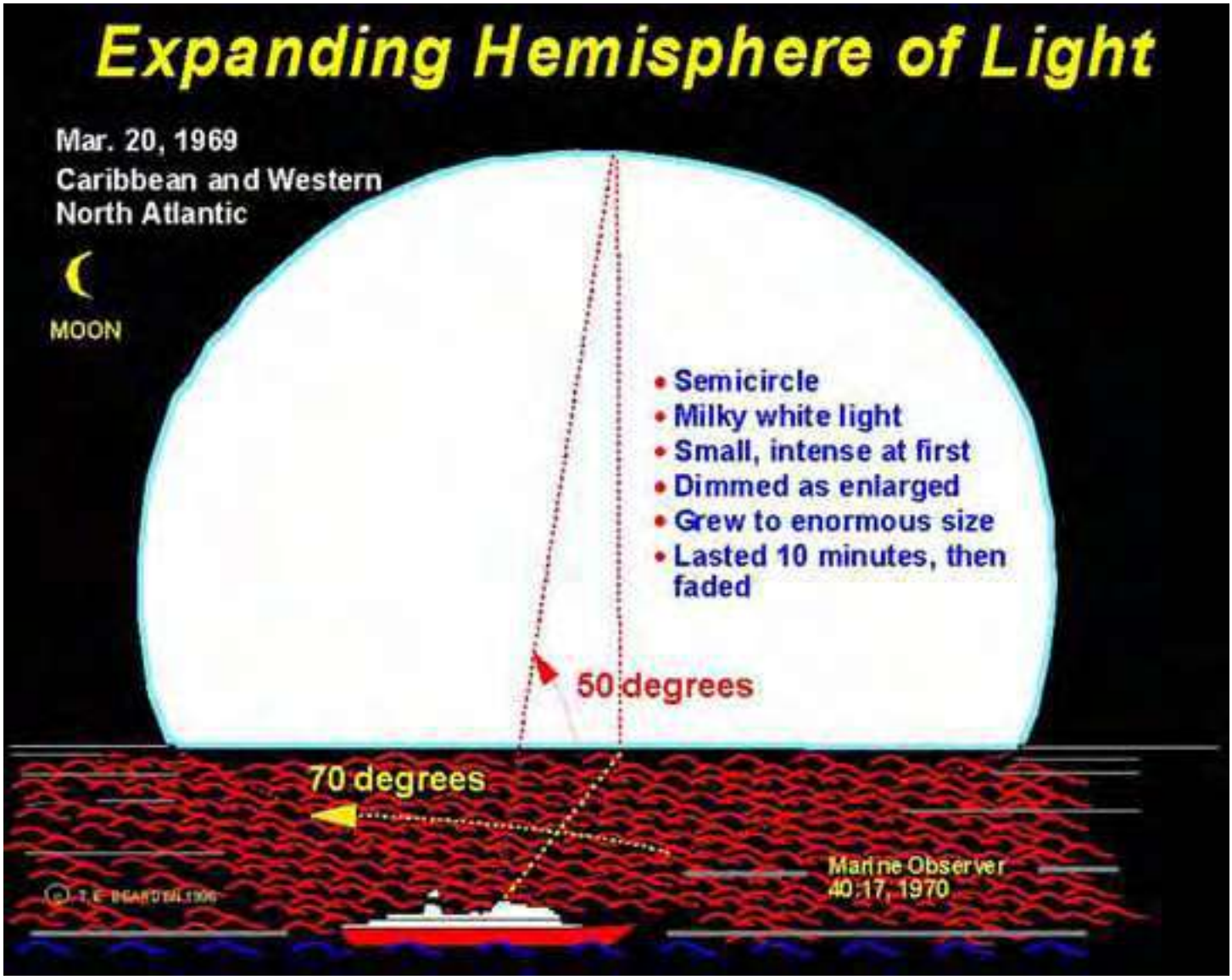
Expanding Hemisphere of Light
Mar. 20, 1969
Caribbean and Western
North Atlantic
MOON
• Semicircle
• Milky white light
• Small, intense at first
• Dimmed as enlarged
• Grew to enormous size
• Lasted 10 minutes, then faded
50 degrees
70 degrees
Marine Observer
40:17, 1970

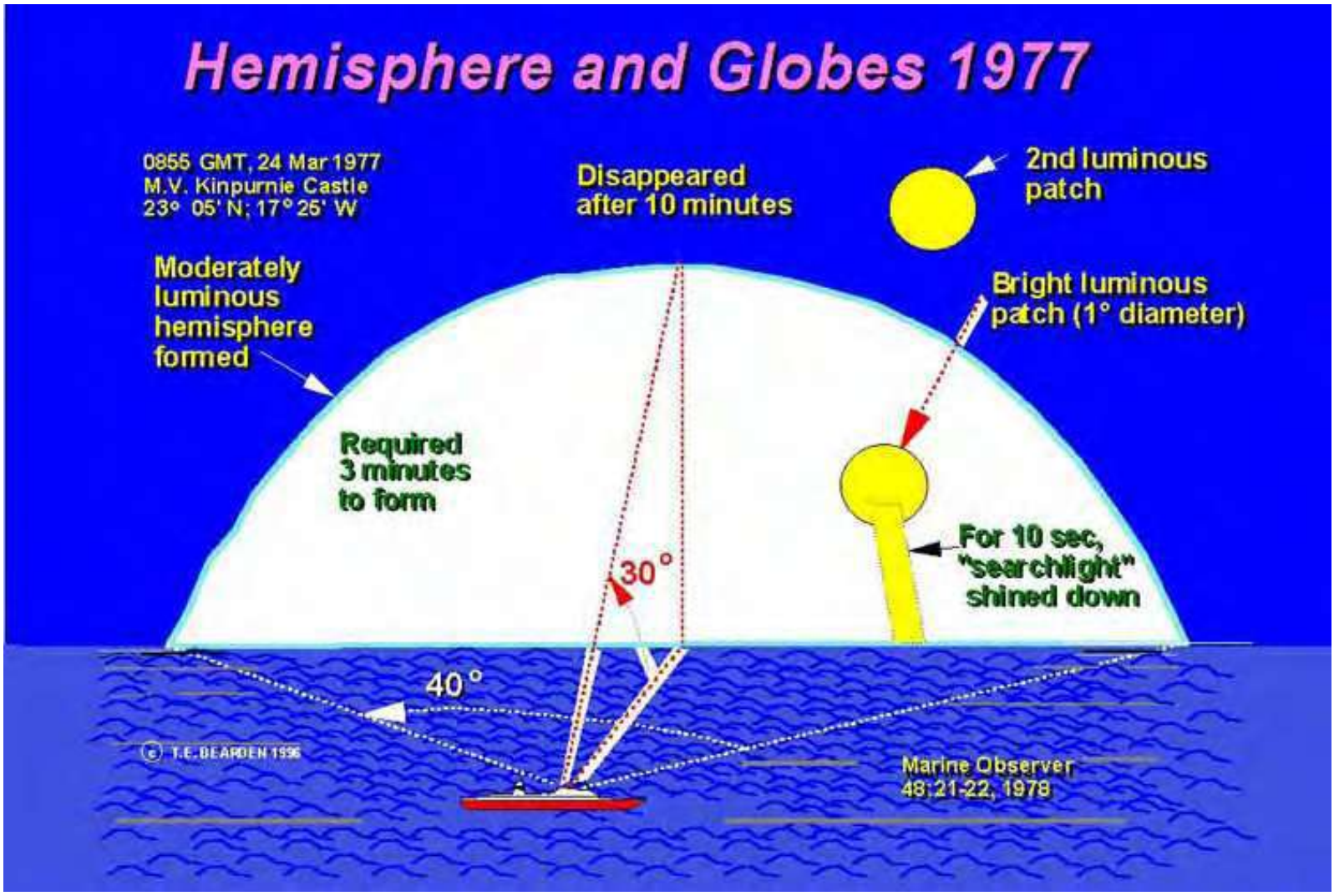
Hemisphere and Globes 1977
0855 GMT, 24 Mar 1977
M.V. Kinpurnie Castle
23° 05' N; 17° 25' W
Disappeared after 10 minutes
2nd luminous patch
Moderately luminous hemisphere formed
Bright luminous patch (1° diameter)
Required 3 minutes to form
For 10 sec, "searchlight" shined down
30°
40°
© T.E. BEARDEN 1996
Marine Observer 48:21-22, 1978

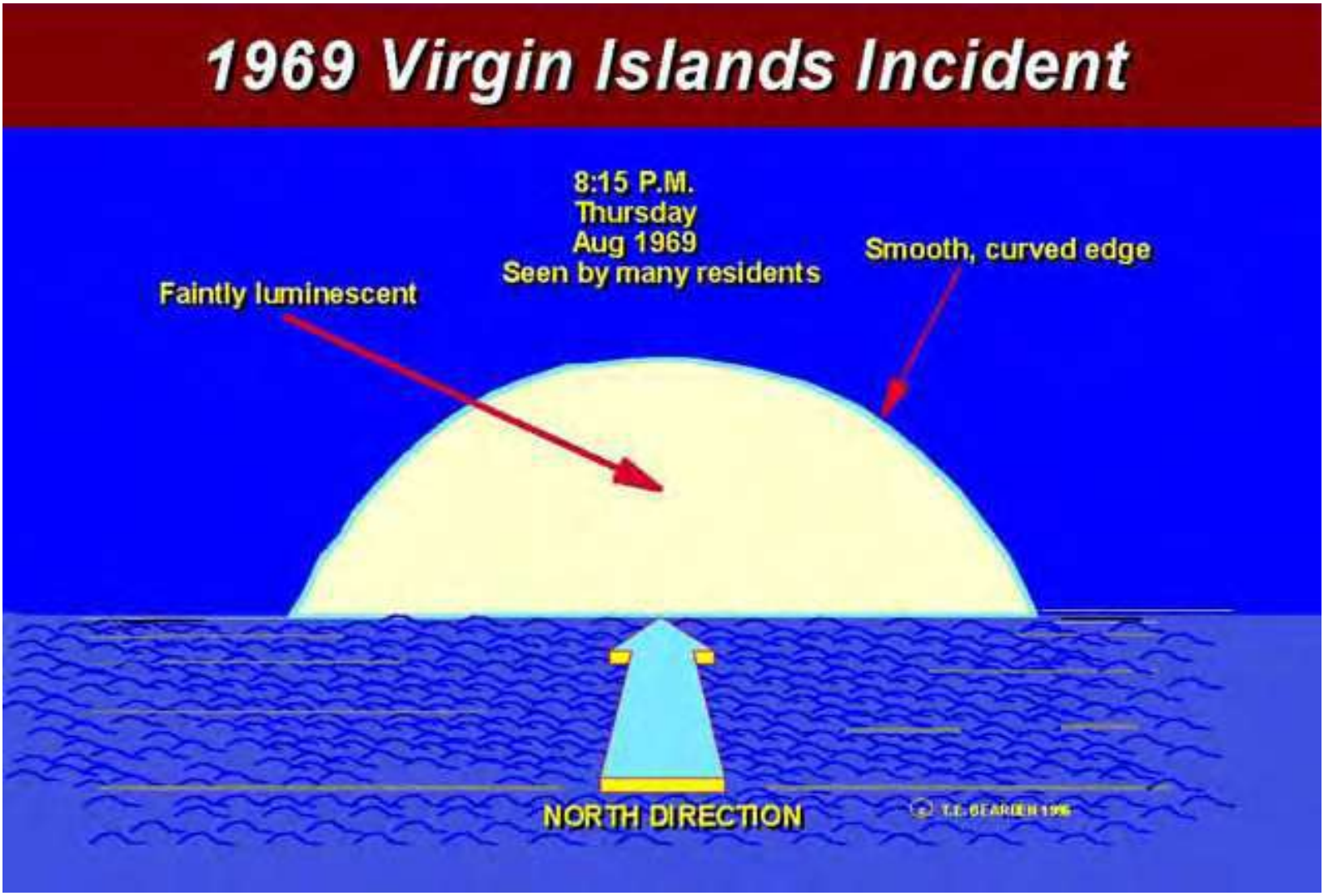
1969 Virgin Islands Incident
8:15 P.M.
Thursday
Aug 1969
Seen by many residents
Smooth, curved edge
Faintly luminescent
NORTH DIRECTION

Typical Shield Test, Northern Route to Japan
18-27 km diameter
Asahi Evening News, Tokyo
June 22, 1982
Multiple tests seen per month, for years.
Pilots simply ceased reporting them.

How Could Such Superweapons Ever Be Concealed?

- Arthur C. Clarke's law states:

  "Any sufficiently advanced technology is indistinguishable from magic."

- To U.S. scientists, "magic" means "impossible"
- Longitudinal EM waves and LW interferometers have been regarded as fantasy and impossible
- To deceive foe on rather open use of unknown technology without discovery:

  "Disguise its uses as understandable accidents, human error, acts of nature, other known technology, etc."

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Soviets Easily Concealed These Superweapons for Four Decades

- Intensive Soviet deception plan utilized
  - Embedded in other weapon system tests
  - Made to resemble natural acts, accidents, etc.
  - Open science releases coordinated to show Russian scientists worked on "normal" science
- West thought Russian scientists inferior
- U.S. scientific community was and is dogmatic, and fiercely suppresses real scientific innovation
- Terribly flawed electrodynamics not ruthlessly shaken and changed in West

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- West had no basis for understanding energetics

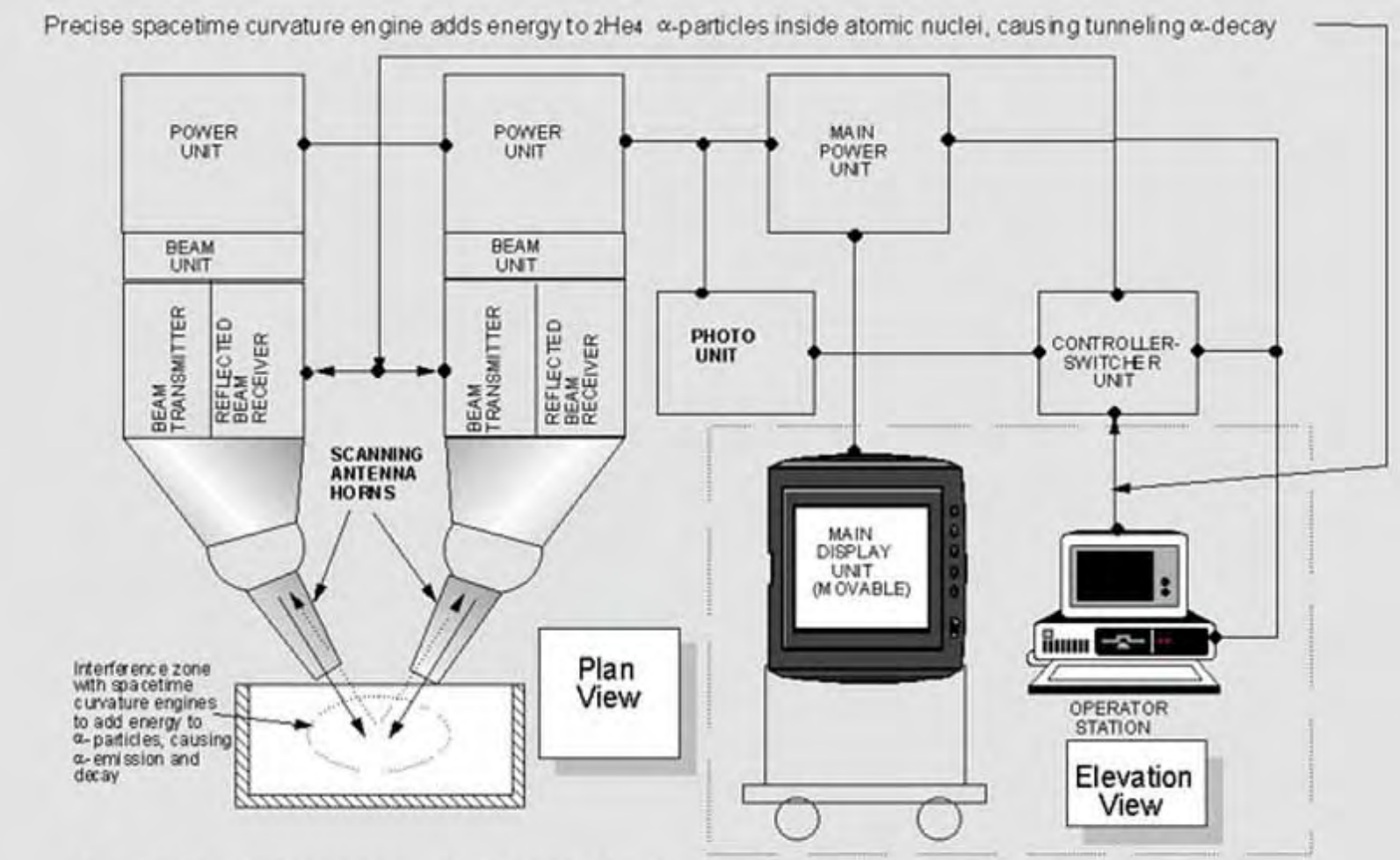

Figure 26. Microscope-type, laser-like interferometer for inducing quick α-decay in samples of otherwise longer-lived isotopes.

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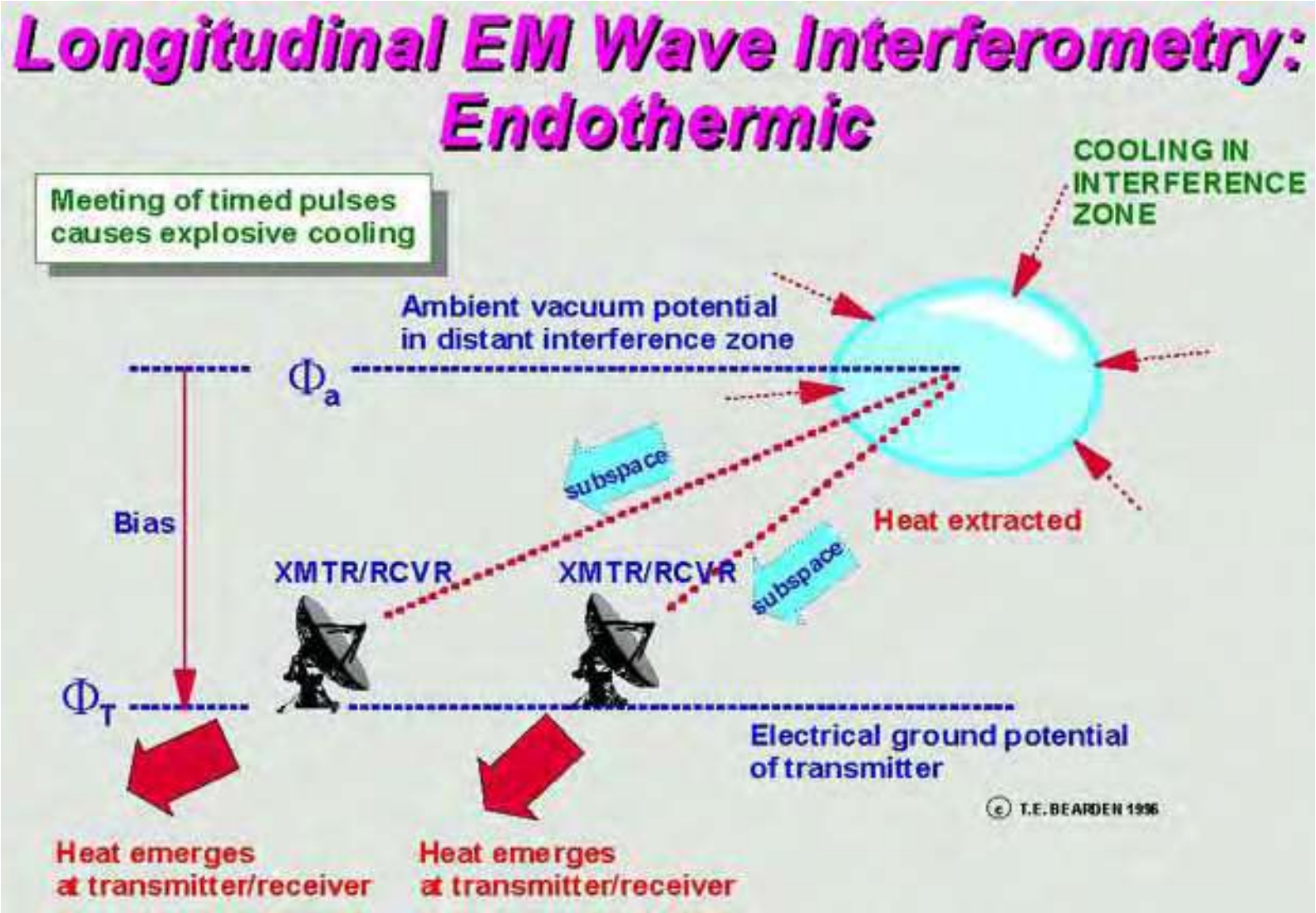
Longitudinal EM Wave Interferometry: Endothermic
Meeting of timed pulses causes explosive cooling
COOLING IN INTERFERENCE ZONE
Ambient vacuum potential in distant interference zone
Φ_a
subspace
Bias
Heat extracted
XMTR/RCVR
XMTR/RCVR
subspace
Φ_T
Electrical ground potential of transmitter
© T.E. BEARDEN 1996
Heat emerges at transmitter/receiver
Heat emerges at transmitter/receiver

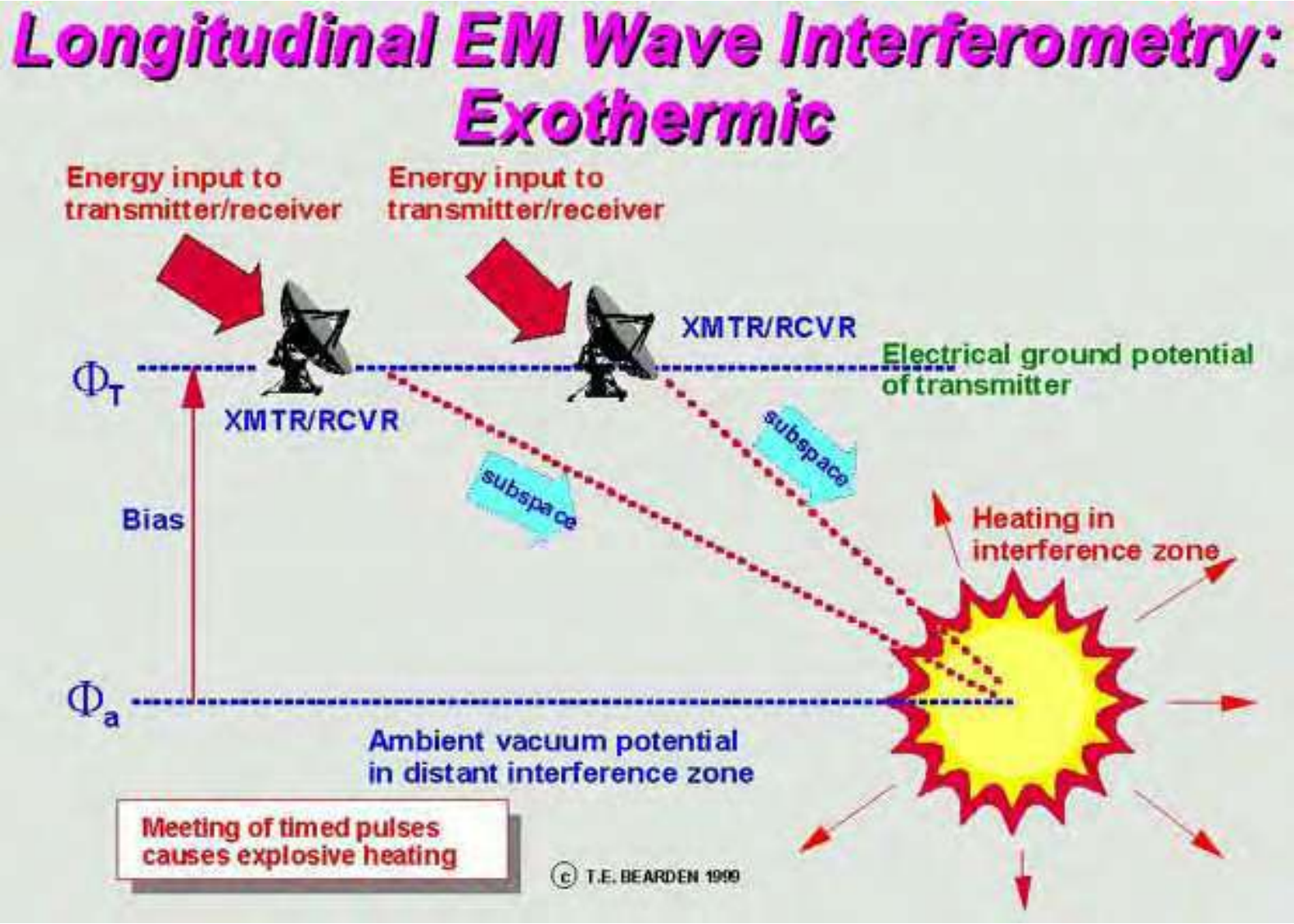
Longitudinal EM Wave Interferometry: Exothermic
Energy input to transmitter/receiver
Energy input to transmitter/receiver
XMTR/RCVR
XMTR/RCVR
Electrical ground potential of transmitter
Φ_T
subspace
subspace
Bias
Heating in interference zone
Φ_a
Ambient vacuum potential in distant interference zone
Meeting of timed pulses causes explosive heating
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Help support the research

U.S. Air Attack on Libya
April 1986

- Slide 1
- Slide 2
- "Washington Post" Article
  January 22, 1989

U.S. Airstrike on Libya
April 1986*
• 33 U.S. AIRCRAFT IN STRIKE
• MANY HIGH-POWERED TRANSMITTERS
– COMMUNICATIONS
– JAMMERS
– RADARS
• SEVERE, UNEXPECTED "EMI" ENCOUNTERED
– ONE F-111 DOWNED
– NUMEROUS WEAPONS WENT ASTRAY
– THREE FOREIGN EMBASSIES DAMAGED
– SEVEN AIRCRAFT FORCED TO ABORT
• COMMANDERS: "US OR THEM?"
*Washington Post, 22 Jan. 1989, p. A4
Mild quantum potential weapon tested against electronics in U.S. aircraft and missiles
EM energy arises from every point in spacetime inside the electronics

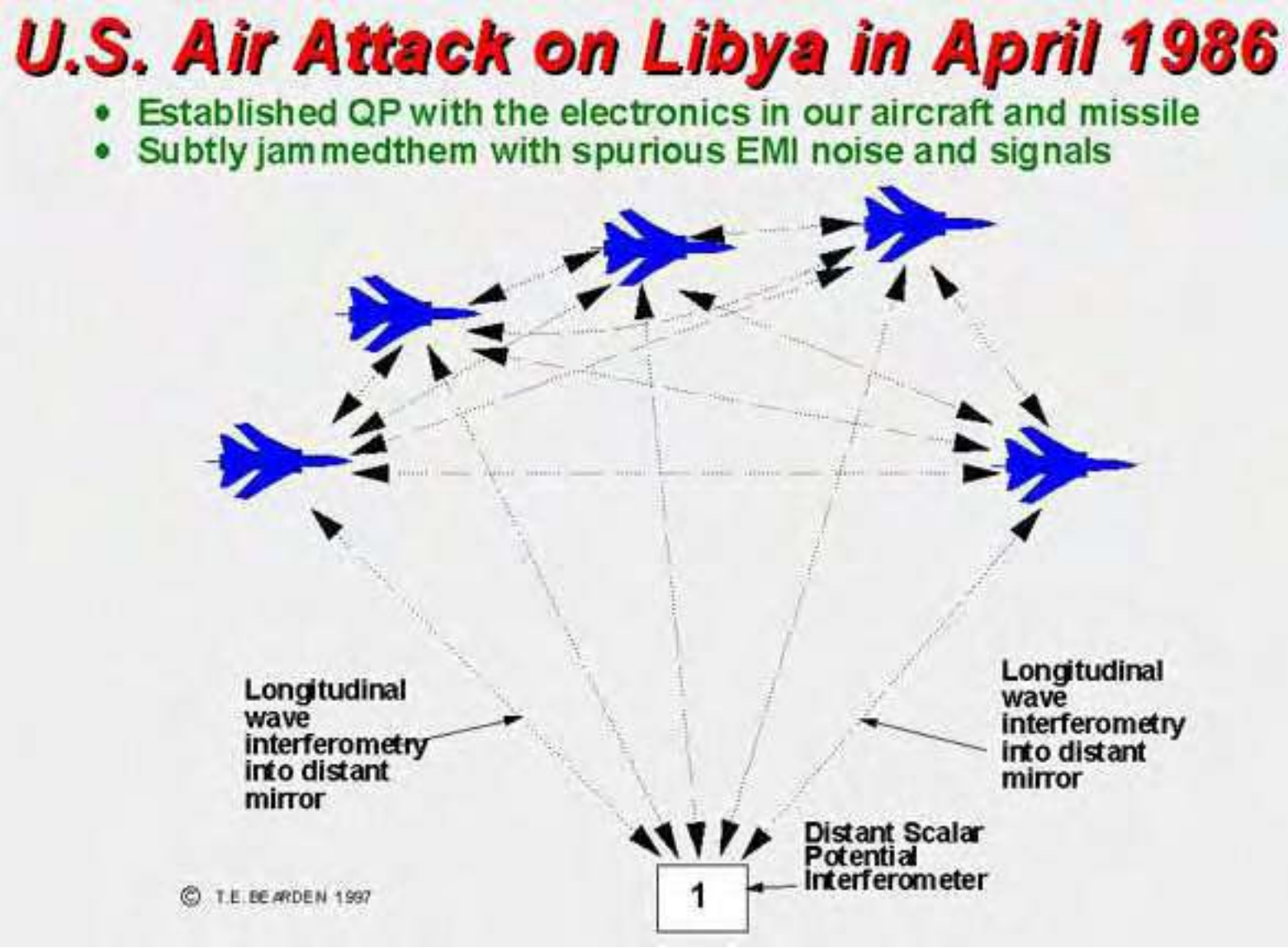
U.S. Air Attack on Libya in April 1986
• Established QP with the electronics in our aircraft and missile
• Subtly jammedthem with spurious EMI noise and signals
Longitudinal wave interferometry into distant mirror
Longitudinal wave interferometry into distant mirror
Distant Scalar Potential Interferometer
1
© T.E. BEARDEN 1997

Lightning Wall

- Aircraft on course of 270 degrees
- Approached "solid wall of lightning" in an otherwise cloudless sky
  - From very high altitude to near the water
  - Extended north-south as far as one could see
- Radar scope clear
- *Rigged aircraft for heavy weather*
- *Plunged directly through wall*
- *Wall was very thin*

circa 1959-1960
Interview with Patrol plane commander
U.S. Navy P5 aircraft
Over Atlantic, 200 miles east of Norfolk

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Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

S.K. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p. 16-25.

JC5-34

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Large Longitudinal EM Wave Interferometer (LWI) Accident

- 1958 nuclear explosion near Urals
  - Contaminated 1200 square kilometers
  - Signature of large LWI accident
  - Buried atomic wastes suddenly exploded
  - Region contaminated to this day
- Soviets were well along with advanced LWI prototypes and testing
  - In Jan. 1960 Khrushchev announced these forthcoming "fantastic" weapons
  - 1958 difficulties would have been resolved by 1960

© T.E. BEARDEN 1990, 1999

Large Longitudinal EM Wave Interferometer (LWI) Accident

- Expected cause of 1958 accident
  - Huge LW energy beams built up
  - Catastrophic short-out in transmitter
  - LW energy flashed over into earth and spread
  - Struck and fissioned stored nuclear wastes
- Developed new safety circuits
  - For transmitter short-out, instantly activates to hold LW beam energy and prevent flash-over
  - Similar accident happened in 1986 at Chernobyl, except private U.S. group blew that transmitter to prevent catastrophic quake in California

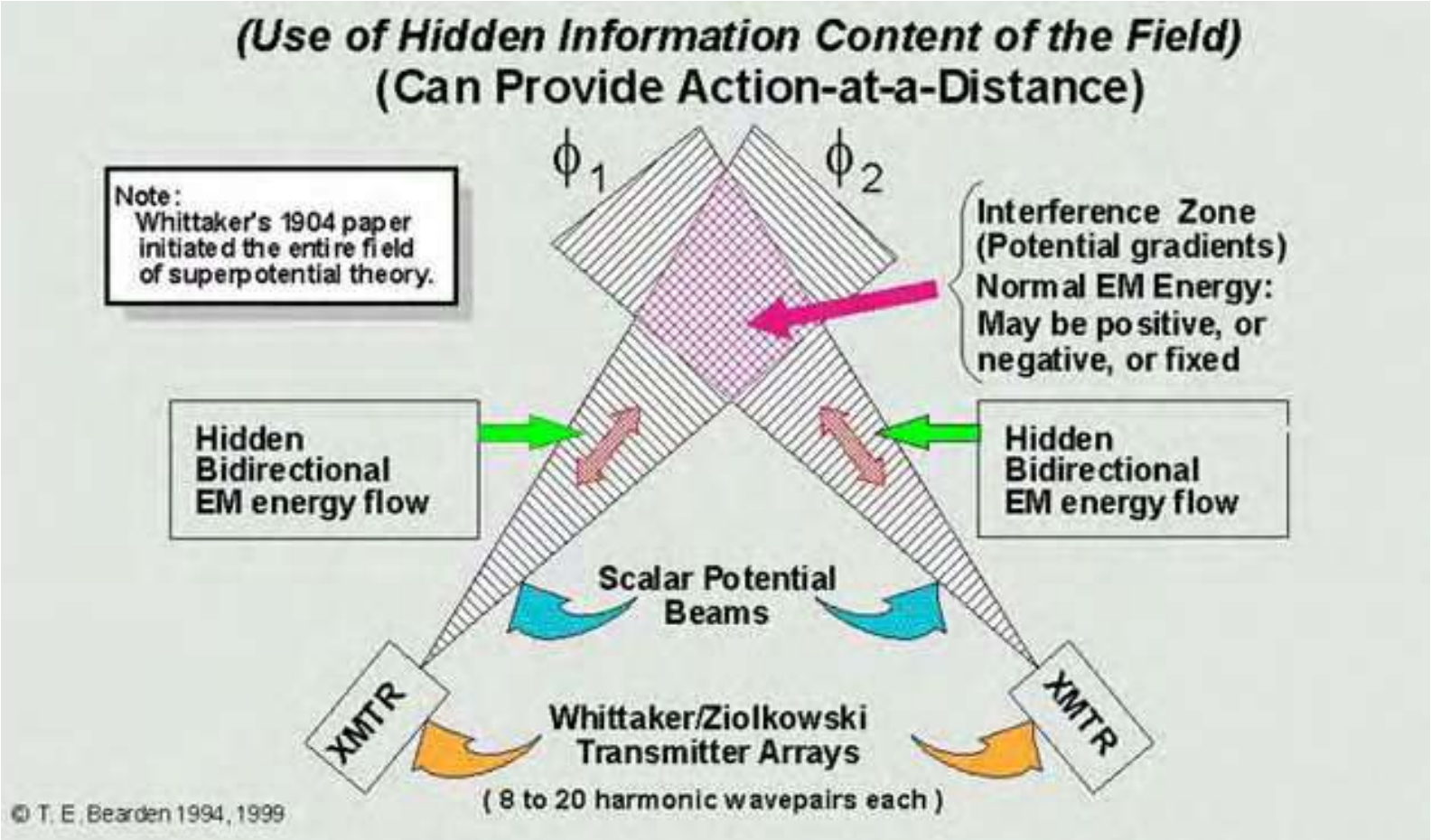

Figure 5. Scalar potential interferometry (between the two sets of bidirectional longitudinal EM wavepair functions) produces all EM force fields and waves.

Two Types of Mutual Assured Destruction (MAD) Systems

- ***Sane system:***
  - Turned off or on standby
  - Wait until attacked or attack is imminent
  - Humans consider situation, make strike decision
  - Command order issued to weapons officers
  - Human finger initiates launch sequence
  - Usually requires code entry, etc. for assured launch control

- ***Insane system:***
  - Computer periodically (e.g., every 2 hours) initiates launch
  - During sequence, there is a period (say, 2 min.) where operators can enter stop order (usually coded)
  - If correct stop not entered, weapons automatically launch
  - if correct stop entered, computer resets, and after another 2 hrs, automatically reinitiates the launch sequence

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Psychoenergetics Weapons Teams
Mentally Disable All Personnel
(COUNTERS ALL SANE MAD SYSTEMS)
(NULLIFIES HUMAN COMPONENT OF ALL WEAPON SYSTEMS)
ELECTRICAL THOUGHT-WORDS ARISE DIRECTLY IN BRAIN, HENCE IN MIND, BYPASSING SENSOR INPUTS
INSTANT HYPNOGOGIC STATE, WITH INSERTED THOUGHT-WORDS
Effects arise in local spacetime, simultaneously in all minds in the targeted area
INSTANT HYPNOGOGIC STATE: WITH WAKING DREAM
PERCEIVED REALITY NOW CONTROLLED
TARGETED POPULACE
• Site personnel instantly hypnogogic and mentally controlled.
• Distant weapon controller teams coord crew actions
• Standdown insane weapons to maintenance standby.
• Mindsnapper then strikes, kills all personnel, and nullifies site for months.
Indicators: Two A-10 incidents 1997, LIDA device since 1950s.
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Strikes Against Special Ship and Energetics Weapon Sites

- Via powerful scalar EM pulses in each targeted area, so sharp time-jerks occur
  - Mind and its operations exist in time but not in 3-space
  - Coupling interaction of mind operations to body occurs through flow of time
  - Flow or change of flow of time must be smooth, for coupling of mind to body
- *Sharp jerk in time flow snaps mind's coupling to body, instantly separates mind*
- *Instant death for every virus, bacterium, cell, insect, mammal, living creature*
- *Contaminates struck sites for months, perhaps a year*

Note: In other words, this is the part of the "preparation barrage" that attacks the enemy's response capability (i.e., his "artillery" and his "airpower") and suppresses it. The use of the "mindsnapper" weapons provides 100% assurance of success.

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"MINDSNAPPER" ATTACK ON SPECIAL SHIPS & ENERGETICS WEAPONS SITES

"We have a new, fantastic weapon ... so powerful that, if unrestrainedly used, it could wipe out all life on earth."

Khrushchev, speaking to Presidium, Jan. 1960

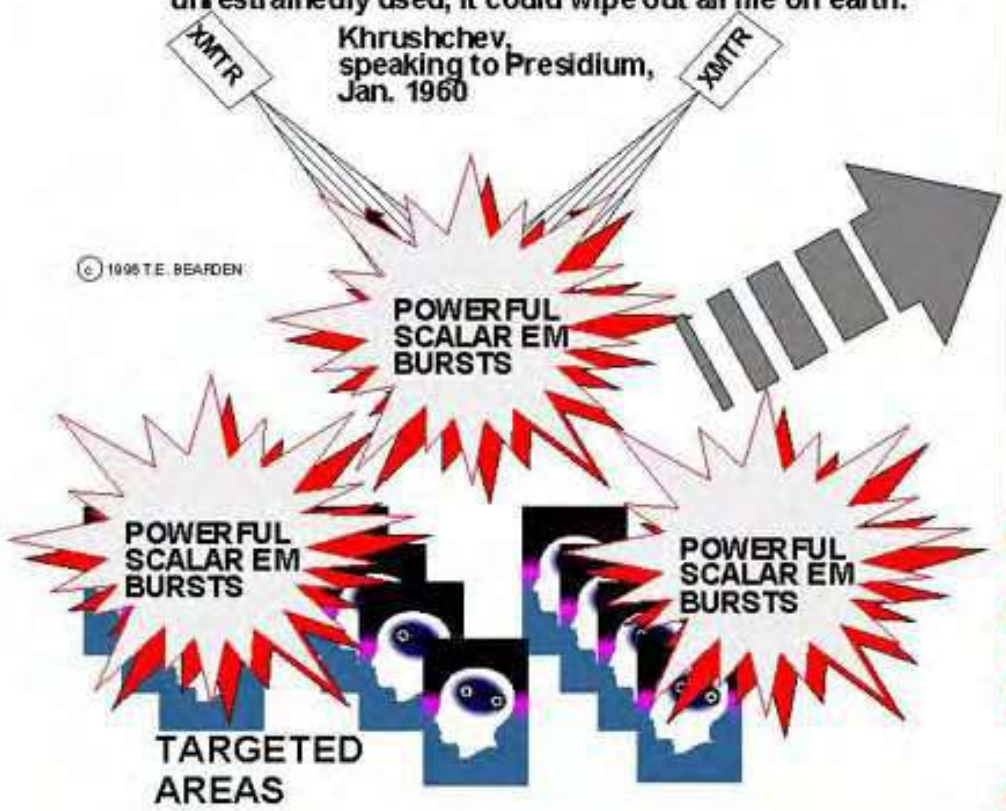

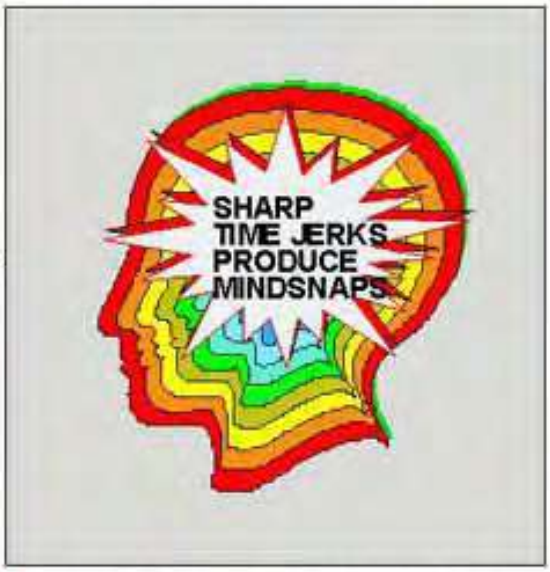

- Minds snapped loose from bodies (every living thing)
- Struck areas completely sterilized of all life
- LWs emitted; slow decay of time-charge makes contamination persistent
- Tested twice in Afghanistan

The Tom Bearden Website

Help support the research

How Much Off Guard Are We?

- Slide 1
- Slide 2
- Slide 3
- Slide 4
- Slide 5
- Slide 6
- Slide 7

How Much Off Guard Are We?

- *Legitimate U.S. forces have no energetics weapons or defenses against them*
- *No DoD general, military officer, or enlisted person reporting to the government of the United States has <u>any:</u>*
  - Training in energetics or energetics weapons
  - Experience in energetics or energetics weapons development and usage
  - Training in strategy, tactics, deployment, and employment of energetics weapons
  - Knowledge of energetics weapons effects and capabilities
  - Knowledge of the energetics weapons, tactics, deployment, and employment by the KGB/Russians
- *Civilian and military, scientific and intelligence, and news media personnel do not recognize energetics weapons effects happening right over their own heads*

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How Much Off Guard Are We?

- Kill of U.S.S. Thresher in 1963 not recognized. Left signatures.
- 23 years of KGB weather engineering, particularly over U.S. and North America, ignored and not recognized.
- Decades of irradiation of U.S. Embassy, fatally injuring three U.S. Ambassadors, health changes in personnel shrugged off ineptly.
- Massive building of underground sites, all through former Soviet Union, lamely speculated as perhaps "ABM" system or?.
- 1985, 1986 Soviet kills of U.S. aircraft, spacecraft, personnel ignored as "accidents" by legitimate U.S. communities.
- Quantum potential strike on soldiers in Gulf war ignored.
- Quantum potential deterioration of U.S. populace's immune systems ignored.
- Exchange of earthquakes and massive retaliatory destruction of Soviet missile ammunition storage sites, 1986-1989, ignored.
- U.S. scientific and military communities adamantly refuse to rework electromagnetics, though known to be seriously flawed.
- Refuse to apply Stoney/Whittaker work to engineer hidden variables, even though present quantum mechanics also known to be wrong because it does not contain such "hidden order."
- Refuse to develop, structure, and apply Bohm's quantum potential, for instantaneous action at a distance. Russians developed it.

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  - Not recognized.
  - Left signatures.
- **23 years of KGB weather engineering**
  - Particularly over U.S. and North America
  - ignored and not recognized.
- **Decades of microwave irradiation of U.S. Embassy**
  - Fatally injured three U.S. Ambassadors
  - Induced health changes in personnel
  - Shrugged off ineptly.
- **Massive building of underground sites**
  - All through former Soviet Union
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- Refuse to apply Stoney/Whittaker work to engineer hidden variables, even though present quantum mechanics also known to be wrong because it does not contain such "hidden order."
- Refuse to develop, internally structure, and apply Bohm's quantum potential, which gives instantaneous action at a distance and great energy amplification.
- Russians developed quantum potential weapons, which obsolete all other weapons.

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JUST HOW MUCH OFF GUARD ARE WE?
Kill of TWA-800 1996
Kill of USS Thresher 1963
Cold Explosion Off Japan Apr 1984
Kill of Space Shuttle Challenger 1986
From The Huntsville (AL) Times 18 Sep 96:
President's party airplane crash 1996
"Retired Gen. Wayne Downing concluded that U.S. forces are so far superior to potential foes that opponents have turned to terrorism as the only way of challenging them."
The Times also provided the information that Defense Secretary William Perry agreed with Gen. Downing's conclusion.
3 Dead U.S. Ambassadors from Moscow Embassy Radiation
QP Gulf War Syndrome: 16,000 persons disabled
QP jamming, U.S. air attack on Libya, 1996
Kill of Arrow DC-8 Gander AFB Dec 1985

JUST HOW MUCH OFF GUARD ARE WE?`

Kill of USS Thresher Nuclear Submarine Apr 1963

QP Test on U.S. Troops in Persian Gulf, 1991 (Gulf War Syndrome)

TWA-800 1996; President's C-130 crash 1996

3 Dead U.S Ambassadors, U.S. Weather Engineered 20 years

Arrow DC-8 Gander AFB Dec 1985

Challenger 1986

Quantum Potential Jamming of Air Attack on Libya Apr 1986

Blind Euphoria to Even the Ballistic Missile Threat

- U.S. National Intelligence Estimate (NIE) released in Nov. 1996 states there is no foreseeable threat to the U.S. from "indigenous missiles" for at least 15 years.
- Clinton has claimed a program for ABM defense is too expensive, would violate ABM Treaty with former USSR.
- Soviets developed an ABM system in violation of the treaty.
- In June 96 Russia test-launched an SS-19, their 26th ICBM test in 5 years.
- *"Russia still retains and is modernizing a vast nuclear arsenal... still the only nation of earth that could destroy America in a matter of minutes. Indeed, given the weakness of the Russian Army, Russia's superpower ambitions rest more than ever on its nuclear capabilities."* *
- "For the first time since the dawn of the nuclear age, there is not a single Russian missile pointed at America's children." **

Comment: Punch a computer button and the missiles are pointed! The armed missiles are still there, ready and waiting.

Bulleted info courtesy Washington Inquirer, June 24, 1996.

* House Nat'l Security Chmn, Floyd Spence.
** Bill Clinton, State of the Union Message.

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Possible Targets: 1995-9
Escalation Phase
(Based on 1985-87 test program)
Earthquakes
Missiles
Power Grids &
Distribution Systems
Satellites
Ships
Shuttle
Launches
& Flights
JETLINERS
Radio/TV
Subs
Microwave Nets
Radars &
Nets
Communications
and Computer Nets

Propagation of Weapon Effects

- All conventional weapons use propagation through 3-space of matter or energy or both
  - Matter (bombs, missiles, projectiles, etc.)
  - Energy (EM force fields, sonic force fields, etc.)
  - Basically one-to-one, or one "bus" to many-on-many
  - Finite propagation velocity v: where $0 < v \leq c$
  - Time delay: Shielding and pre-strike retaliation possible
- Structured quantum potential propagates vacuum ordering (vacuum engines), instantly
  - Zero time delay (through multiply-connected spacetime)
  - No propagation "through space", no "velocity" as such
  - Easily one-to-many, without limit
  - Dramatic energy amplifier (gates, amplifies flux ordering)
  - Effects arise in local spacetime; no shielding possible
  - No range limit, since striking distance always zero
- QP weapons obsolete all other weapons

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Yugoslav Earthquake, Followed by Cold Explosion

Apr. 15
1979

- Magnitude 7.2 on Richter scale
- Epicenter 33 km. deep
- More than 100 aftershocks
- At Kamenari:
  - Adriatic sea mushroomed up
  - Like atomic bomb explosion
  - Signature of a cold explosion
  - Similar to Apr. 1984 test off coast of Japan, near Kurils (see inset graphics)
- Note that April is a significant test month for the Communists (preparing official reports for May Day?)

© T.E. BEARDEN 1994, 1995

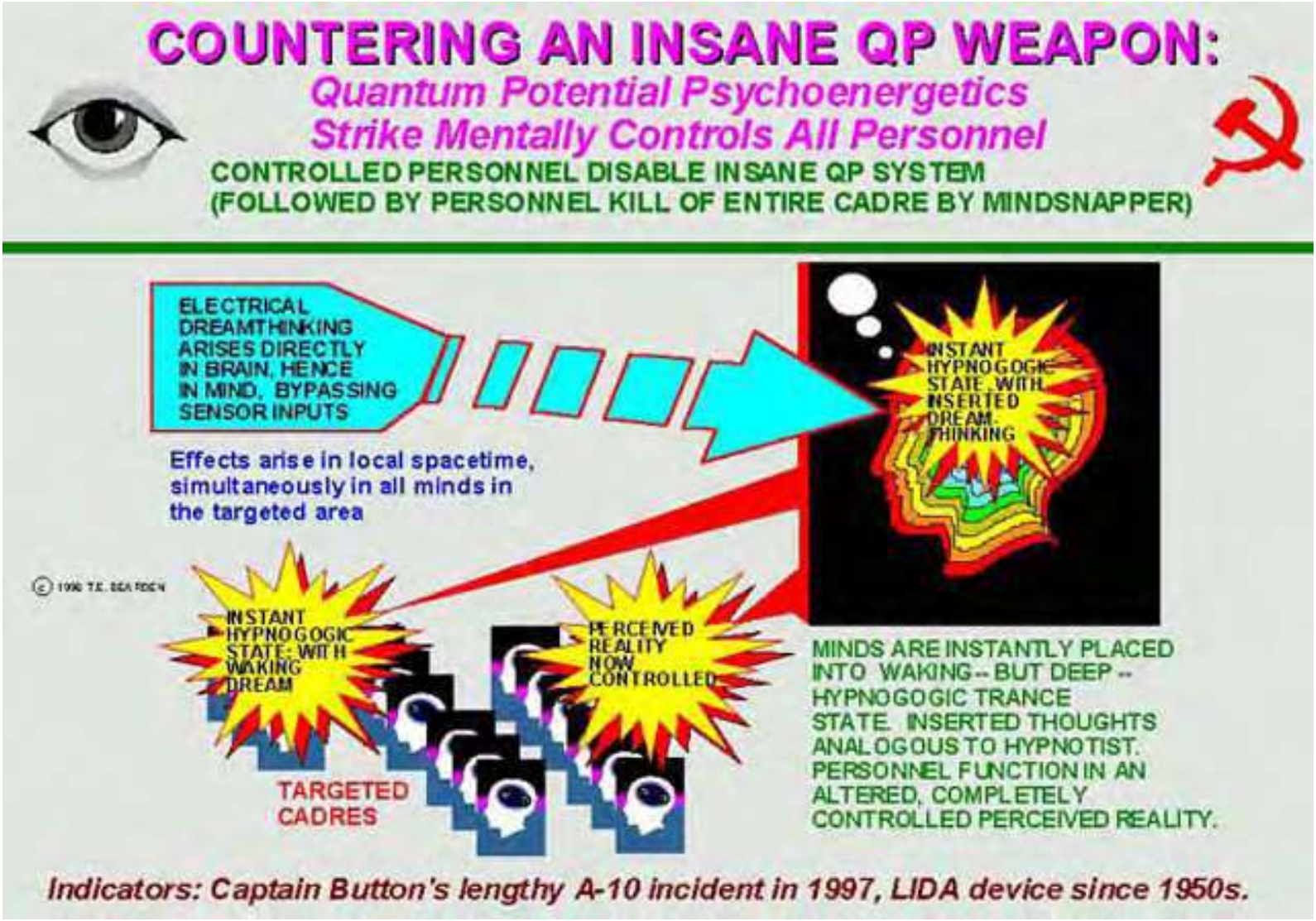
COUNTERING AN INSANE QP WEAPON:
Quantum Potential Psychoenergetics
Strike Mentally Controls All Personnel
CONTROLLED PERSONNEL DISABLE INSANE QP SYSTEM
(FOLLOWED BY PERSONNEL KILL OF ENTIRE CADRE BY MINDSNAPPER)
ELECTRICAL DREAMTHINKING ARISES DIRECTLY IN BRAIN, HENCE IN MIND, BYPASSING SENSOR INPUTS
Effects arise in local spacetime, simultaneously in all minds in the targeted area
INSTANT HYPNOGOGIC STATE WITH INSERTED DREAM THINKING
INSTANT HYPNOGOGIC STATE WITH WAKING DREAM
PERCEIVED REALITY NOW CONTROLLED
TARGETED CADRES
MINDS ARE INSTANTLY PLACED INTO WAKING -- BUT DEEP -- HYPNOGOGIC TRANCE STATE. INSERTED THOUGHTS ANALOGOUS TO HYPNOTIST. PERSONNEL FUNCTION IN AN ALTERED, COMPLETELY CONTROLLED PERCEIVED REALITY.
Indicators: Captain Button's lengthy A-10 incident in 1997, LIDA device since 1950s.

Gulf War Disease: KGB QP Weapon Induced
ST Curvature Engines for a Cocktail of Diseases
LIBYA
EGYPT
CHAD
SUDAN
SAUDIA ARABIA
IRAN
IRAQ
SYRIA
LEBANON
ISRAEL
JORDAN
KUWAIT
QATAR
OMAN
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Distant Scalar Potential Interferometer with iterative self-targeting

Self-Targeting in Inner EM Channel Can Produce a Quantum Potential

Once QP is established, energy transmission is direct and instantaneous. Energy input to one single participant will simultaneously appear in all other participants, the amount depending on their fractions of participation with the input station.

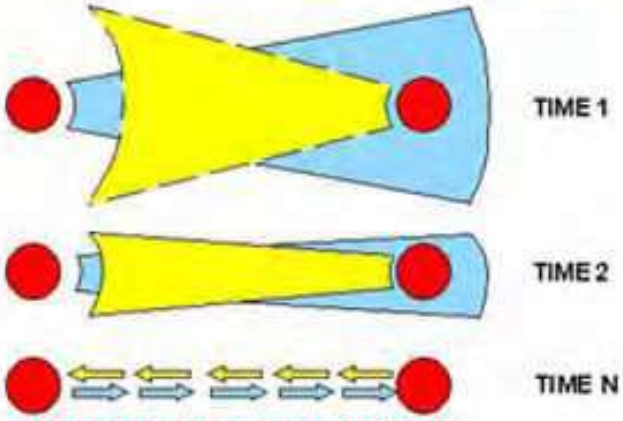

NARROWING OF INTERACTING POTENTIALS INTO LASER-LIKE BEAMS, BETWEEN TWO PUMPED SOURCES. NOW ONLY LONGITUDINAL WAVES CONNECT THE LINKED OBJECTS.

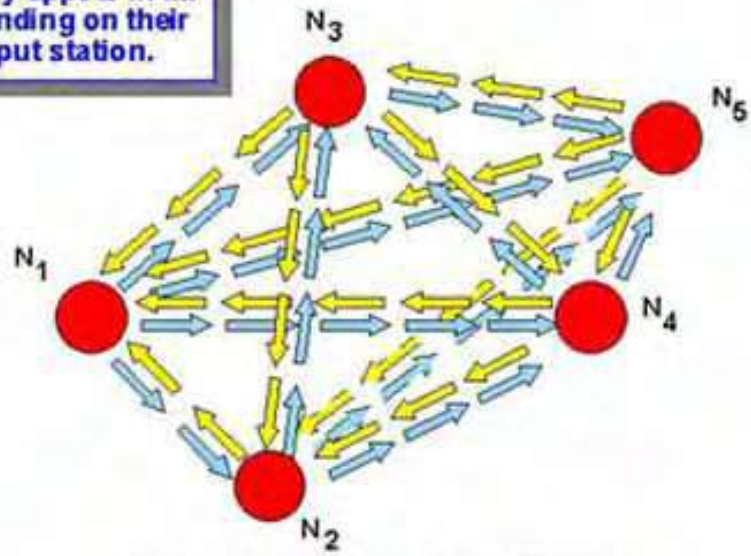

SELF-TARGETING EFFECT AMONG ALL PAIRS OF INTERACTING PUMPED SOURCES

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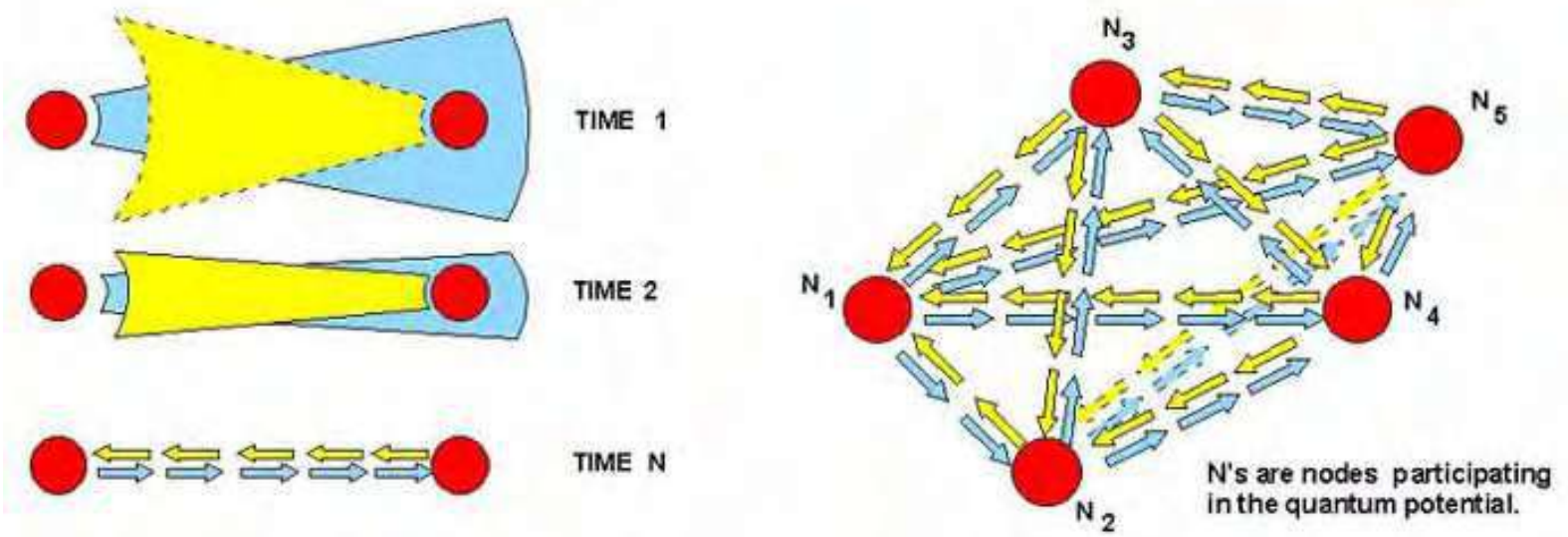

a. Iterative retroreflection between any pair of nodes narrows the interconnecting potentials to a laser-like, bidirectional beam. Iterative phase conjugate reflection provides self-targeting.

b. The quantum potential exists as narrow, laser-like beams between participating nodes, even when the nodes are widely separated. The beam space is multiply-connected; transmission is instantaneous.

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Consider the hidden Stoney/Whittaker bidirectional EM waves that comprise the potential from each source node. If these nodes have sufficient intersymmetry of dynamic material form, then self-targeting occurs between the two nodes of any nodal pair. By iterative phase conjugate reflection, the scattering is narrowed into interconnecting wavepairs, in laser-like beams, between each two nodes. Thus the interconnecting potentials narrow into laser-like, bidirectional beams. The Coulomb gauge may apply, and a quantum potential may be formed.

Figure 30. Mechanism for generating a quantum potential, by iterative self-targeting induced into a system of multiple scattering nodes. Once a QP is established, spatial separation has little or no effect.

Major Principles for Use of Quantum Potential Weapons

- Must disable dead-man fuzing prior to massive use of scalar interferometry weapons.
- Must assure immediate, complete nullification of unique enemy assets (quantum potential assets, special ships, and energetics weapons).
- Personnel can be destroyed instantly with mindsnapping; area is sterilized of life, and effect persists, gradually dying away.
- Personnel can be disabled instantly with various psychoenergetic weapons; area not sterilized.
- Personnel can be destroyed in short order by using EM BW weapons; area not sterilized.
- If foe has energetics weapons, then it is a quick-draw "gunslinger" contest unless insane MAD systems deployed.
- Complete surprise is of decisive importance.
- Tailor effect used to specific target, objective.
- *Note: Must use "insane" MAD systems to deter.*

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Quantum Potential Weapons: Major Principles (Continued)

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- Three major classes of use exist:
  - Use of bulk energy only (as in bulk heating or cooling) without substructuring
  - Use of internal structuring of the bulk energy, so that *vacuum engines* appear in target
  - Use of more deeply nested engines allows direct intervention in mind, long term memory, perception, thoughts, emotions, personality
- Use of vacuum engines allows engineering at a distance of:
  - *Atomic nuclei* including structures, reactions, and transmutations
  - *Bulk matter* including translations, lattice bonding, chemistry, chemical interactions, electromagnetic interactions
  - *Deep biological control systems* such as
    - Becker's cellular control (recovery) system
    - Popp's cellular control system
  - *Cells* including:
    - Structuring, differentiation and dedifferentiation
    - Genetic changes, chemical changes
    - Induction of disease states without normal disease vectors
  - *Mind/matter interface*, including long-term memory, perception, emotion, thought, mental state

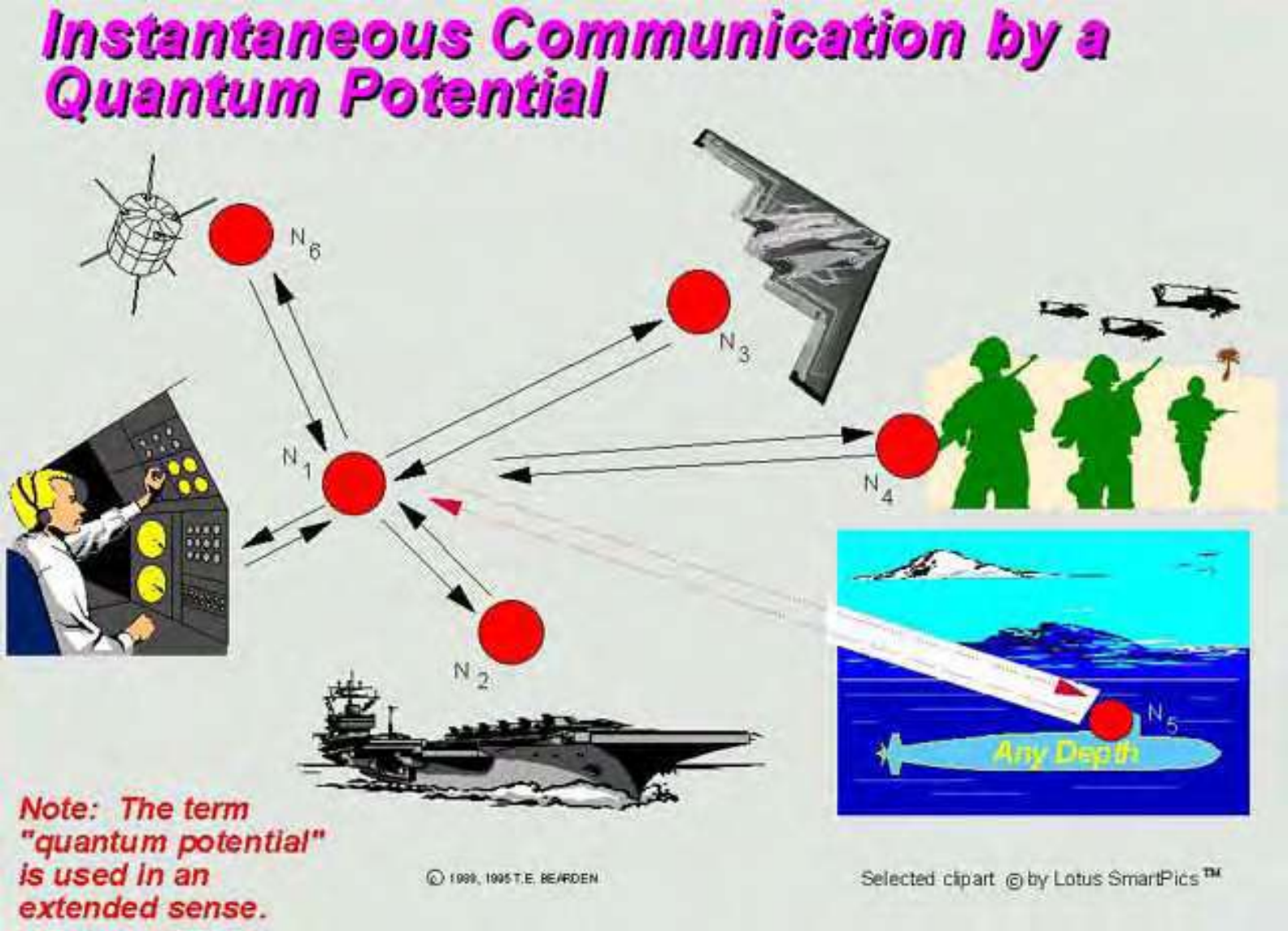
Instantaneous Communication by a Quantum Potential
N6
N3
N1
N4
N2
N5
Any Depth
Note: The term "quantum potential" is used in an extended sense.
© 1999, 1995 T.E. BEARDEN
Selected clipart © by Lotus SmartPics™

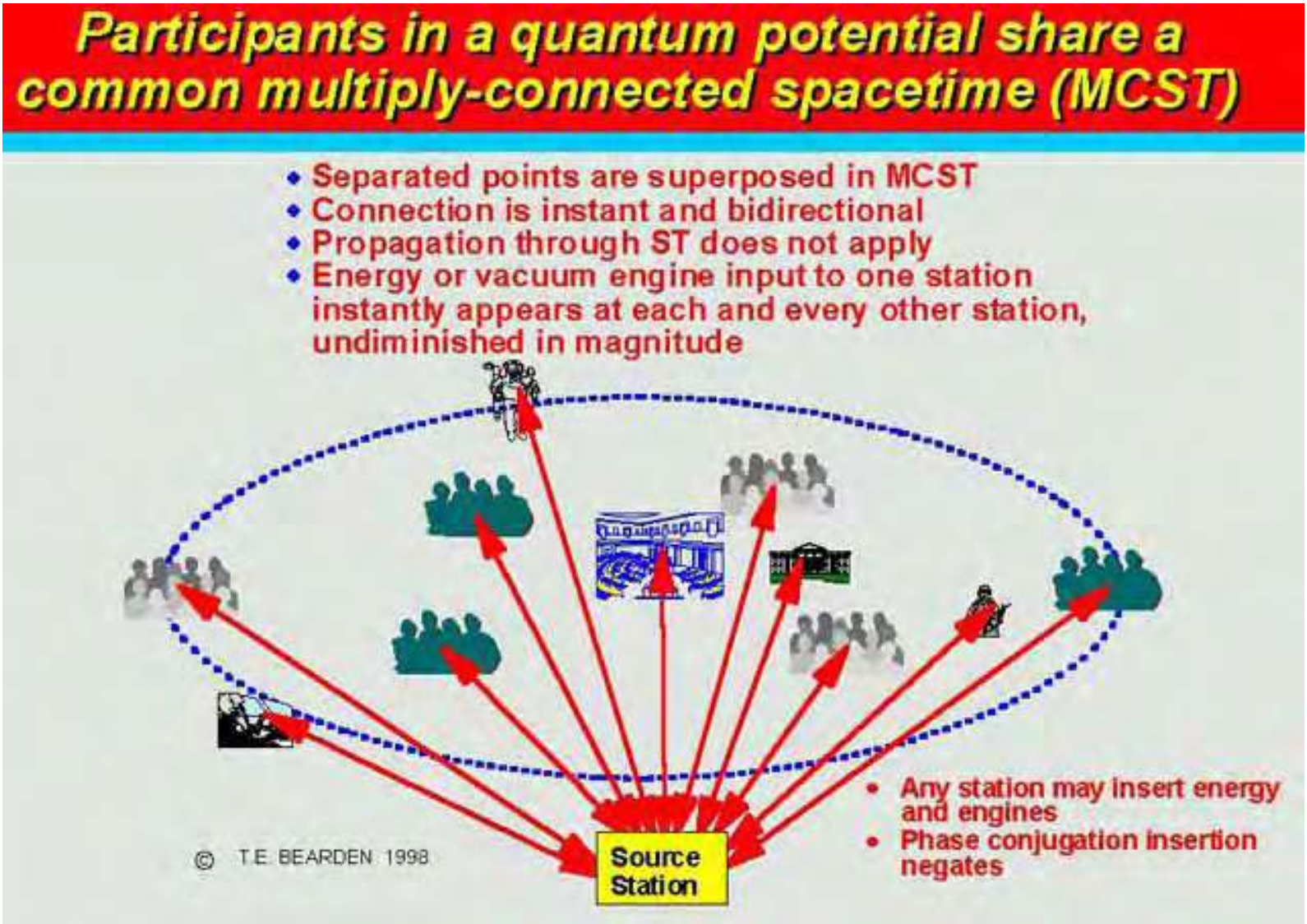
Participants in a quantum potential share a common multiply-connected spacetime (MCST)
• Separated points are superposed in MCST
• Connection is instant and bidirectional
• Propagation through ST does not apply
• Energy or vacuum engine input to one station instantly appears at each and every other station, undiminished in magnitude
• Any station may insert energy and engines
• Phase conjugation insertion negates
Source Station
© T.E. BEARDEN 1998

Quake in Tangshan, China

28 July, 1976

- 7.8 on Richter scale
- Hundreds of thousands killed
- Accompanied by extensive light, electrical effects
  - Starting 3 to 5 days before
  - Communications interference within 250 km
  - Sky lighting observed
- [Personal comments]

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Counting Rifles: Put up or shut up!

(Exchanging Earthquakes)

Opening bet

- Quebec 25 Nov 88
- Pasadena 3 Dec 88

Raise you

- Armenia 7 Dec 88

Call - what do you have?

- Malibu 18 Jan 89

Four aces

- Soviet Central Asia 23 Jan 89

Clear table (stress relief)

- Bakersfield et al various

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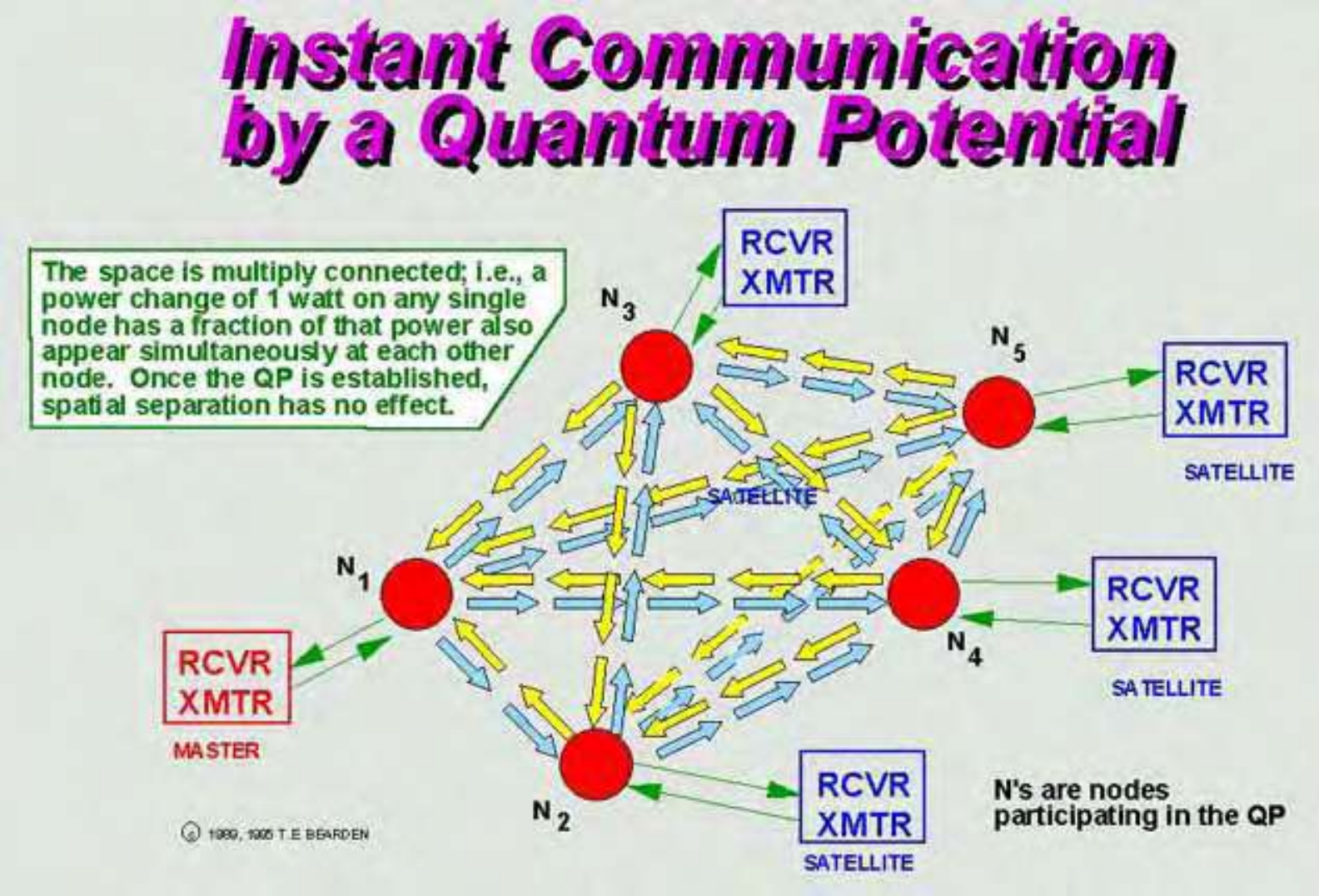
Instant Communication by a Quantum Potential
The space is multiply connected; i.e., a power change of 1 watt on any single node has a fraction of that power also appear simultaneously at each other node. Once the QP is established, spatial separation has no effect.
RCVR XMTR
N3
N5
RCVR XMTR
SATELLITE
SATELLITE
N1
RCVR XMTR
N4
SATELLITE
RCVR XMTR
MASTER
N2
RCVR XMTR
SATELLITE
N's are nodes participating in the QP
© 1999, 1005 T.E BEARDEN

Westerners Do Not React to Slow Threats
BOA CONSTRICTOR
LIGHTNING STRIKE
Westerners tend not to react to slowly increasing things,
but react to rapidly increasing things.

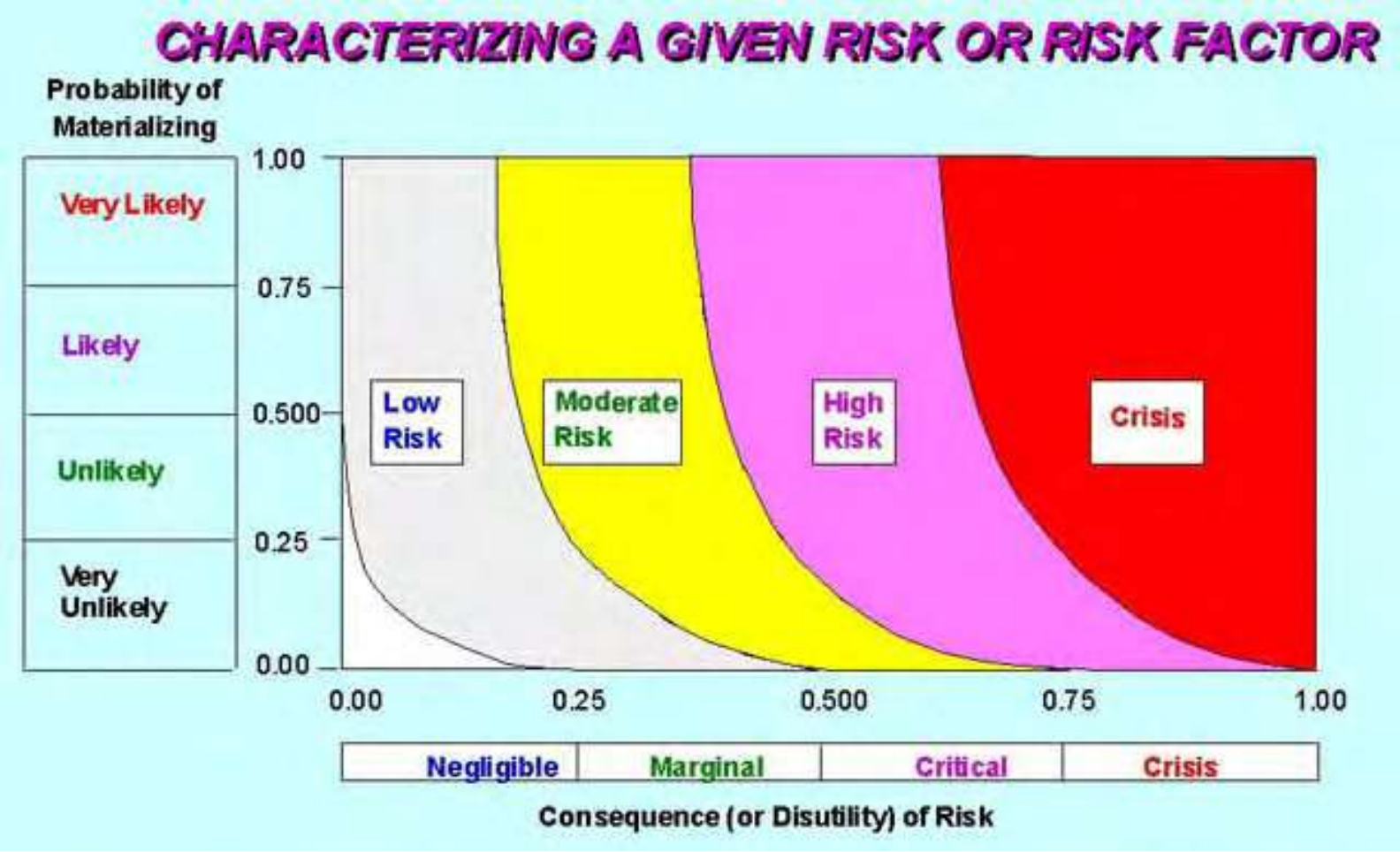
CHARACTERIZING A GIVEN RISK OR RISK FACTOR
Probability of Materializing
Very Likely
Likely
Unlikely
Very Unlikely
1.00
0.75
0.500
0.25
0.00
Low Risk
Moderate Risk
High Risk
Crisis
0.00
0.25
0.500
0.75
1.00
Negligible
Marginal
Critical
Crisis
Consequence (or Disutility) of Risk

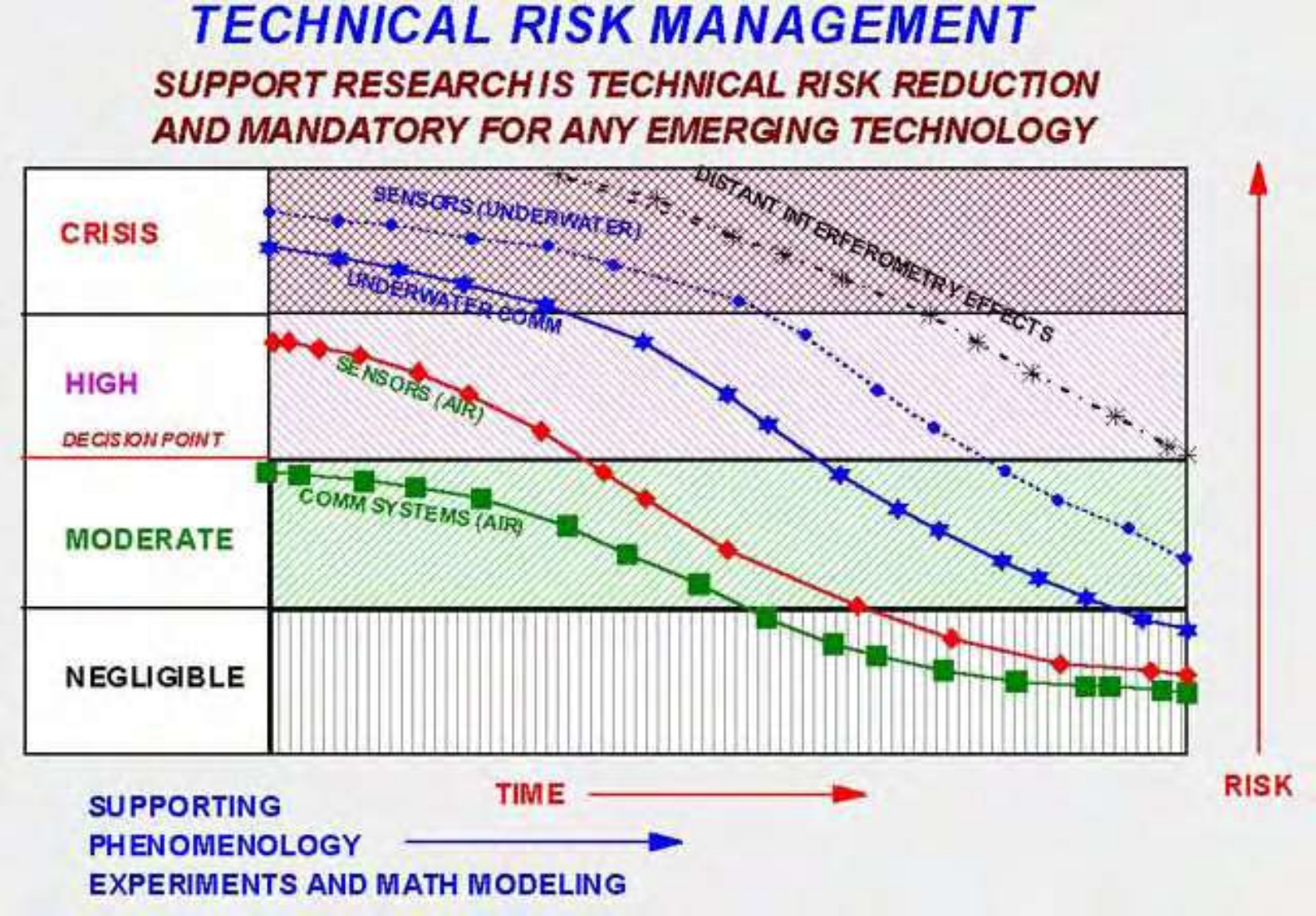
TECHNICAL RISK MANAGEMENT
SUPPORT RESEARCH IS TECHNICAL RISK REDUCTION
AND MANDATORY FOR ANY EMERGING TECHNOLOGY
CRISIS
HIGH
DECISION POINT
MODERATE
NEGLIGIBLE
SENSORS (UNDERWATER)
DISTANT INTERFEROMETRY EFFECTS
UNDERWATER COMM
SENSORS (AIR)
COMM SYSTEMS (AIR)
TIME
RISK
SUPPORTING
PHENOMENOLOGY
EXPERIMENTS AND MATH MODELING

Aum Shinrikyo's Sarin Facility

The interior of Satian No. 7, a suspected sarin production plant

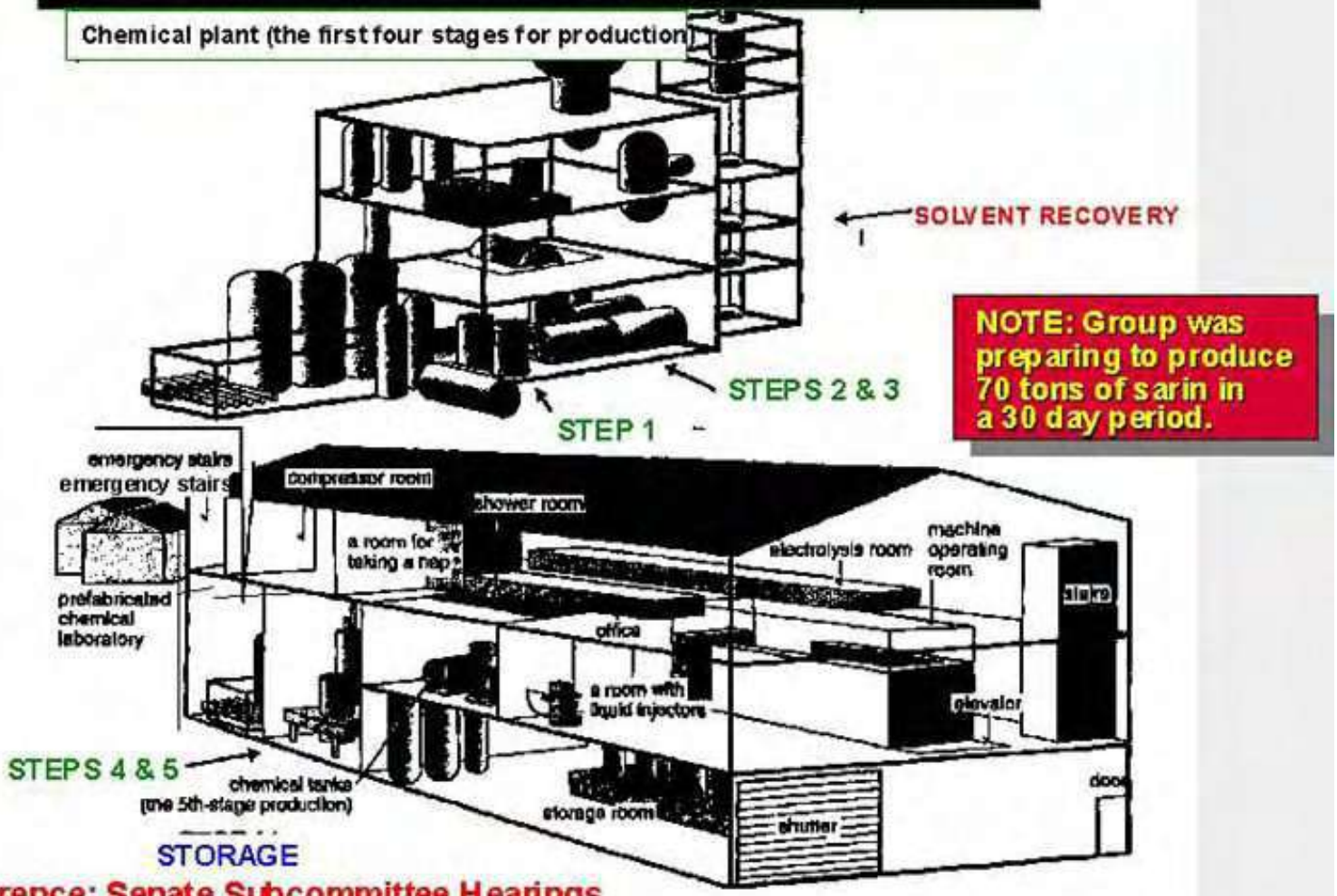

NOTE: Group was preparing to produce 70 tons of sarin in a 30 day period.

Reference: Senate Subcommittee Hearings

In Scalar Beam Interference Zone

- De-phasing of wave/antiwave pairs occurs
- Zero-summation destroyed
- Ordinary EM reappears [Whittaker 1904]
- Ordinary energy appears or disappears (i.e., may produce heating or cooling)
- Energy bottle effect
- Can add or extract EM energy
- Can produce specific ST curvature engines

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Physicist Schappeller Auralaz Munster, Austria:

- British Intelligence interview, about 1948
  - Used Kaluza-Klein theory
  - Worked with Russians
- Schappeller claimed he could:
  - Cause "implosions" rather than explosions
  - Use gravitational and electromagnetic energy
  - Cause large areas of the ocean to freeze
  - Tap earth-ionospheric field
  - Produce enormous energy
- *This is precisely what Hellman worked on in the USSR, after WW II!*

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Initial Soviet Plan for Cold War, After WW II

- Develop and deploy SAM bomber defense
- Catch up in atomic weapons
- Master and apply rocketry
- Wed atomic warheads to rockets
- Initiate "Cold" War
  - Bleed the dragon
  - Guerrilla wars
  - Terrorism
  - Insurgencies
- *Find, develop, and weaponize next great technical breakthrough area as highest national priority*

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Josef Stalin: Absolute Dictator

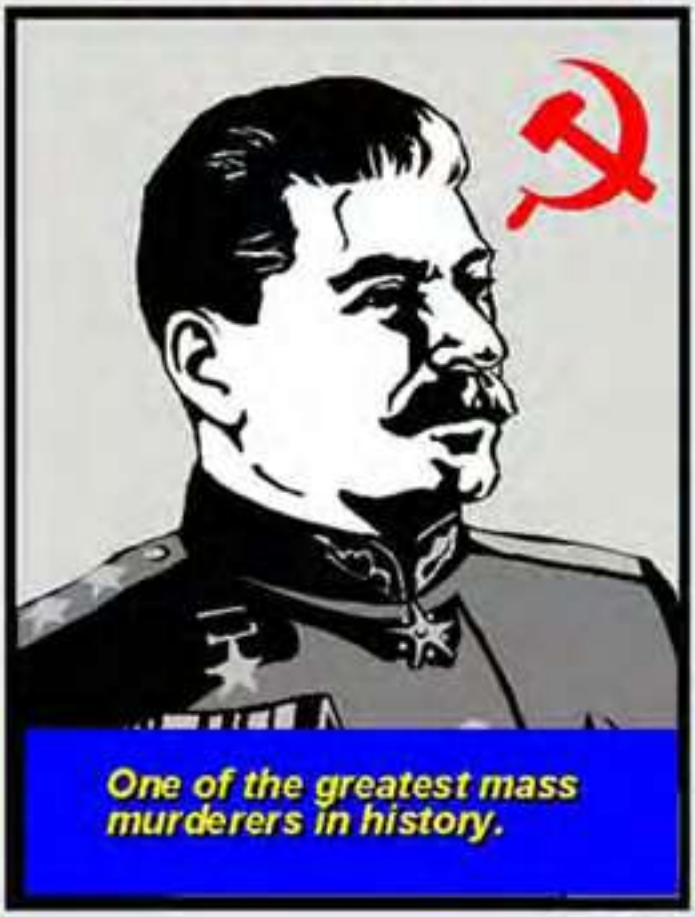

- Secret police and spies everywhere
- Purged his own officer corps
- Always deeply suspicious
- Regularly purged his enemies or those perceived to be shaky or untrustworthy
- Absolute power, justice had nothing to do with it
- Opponents often just disappeared in the night, never to be seen again
- Secret police often tortured, killed them
- Others sent to slave labor camps to die by severe work, starvation, and beatings or downright massacre
- Had experienced unusual abilities of Wolf Messing, so knew that some persons could do unusual things
- Forced Soviet weapon physics into this psychoenergetics realm also

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Exploding any Resistance by Operational Scientists
© T.E. BEARDEN 1997
Josef Stalin
The Communists slaughtered 20 million Russian Kulaks to collectivize Soviet farming
Assembled Academy
"The destiny of communism has been frustrated by the U.S. development of the atomic bomb. That is not the last great technical breakthrough. The next one WILL be Soviet! You will provide me with that great new technical breakthrough at all speed, or I will have your heads. Do I make myself clear, comrades?"

Significant Soviet Statements

- "In the final revolution, it does not matter if three-quarters of the earth is destroyed, so long as the other quarter emerges communist." *[Lenin]*

- "If a means of total neutralization of foreign missiles is to be found, it can only come from a group of new principles in physics, called energetics." *[Nobelian Petr Kapitsa, to Nikita Khrushchev, in answer to Khrushchev's demand for a 100% method of defense against long range missile attack.]*

- "We will bury you." *[Khrushchev, to Nixon, Kitchen Debate]*

- "We have a new weapon, just within the portfolio of our scientists, so to speak, which is so powerful that, if unrestrainedly used, it could wipe out all life on earth. It is a *fantastic* weapon." *[Khrushchev, speaking to the Presidium, Jan. 1960]*

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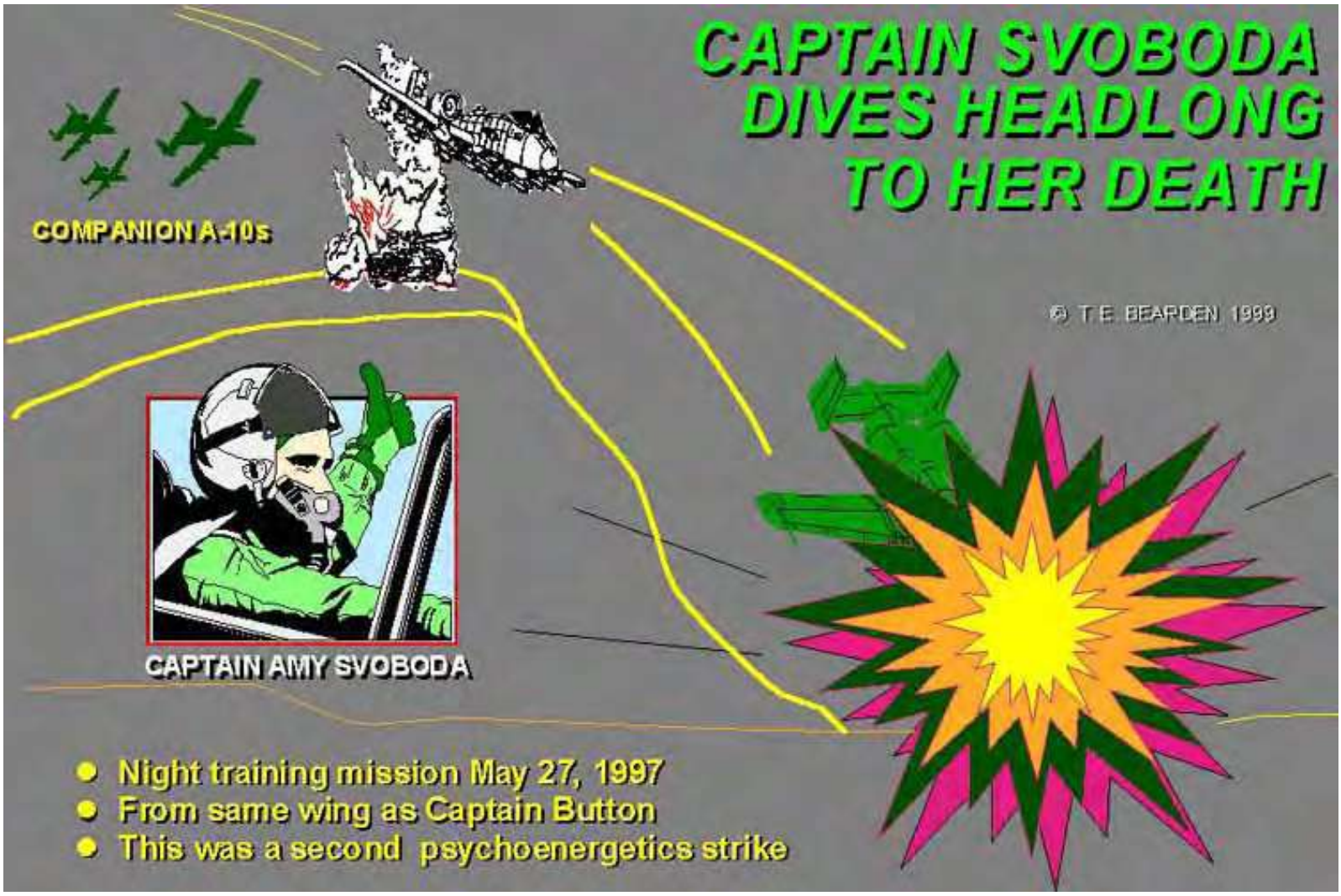
CAPTAIN SVOBODA
DIVES HEADLONG
TO HER DEATH
COMPANION A-10s
© T.E. BEARDEN 1999
CAPTAIN AMY SVOBODA
• Night training mission May 27, 1997
• From same wing as Captain Button
• This was a second psychoenergetics strike

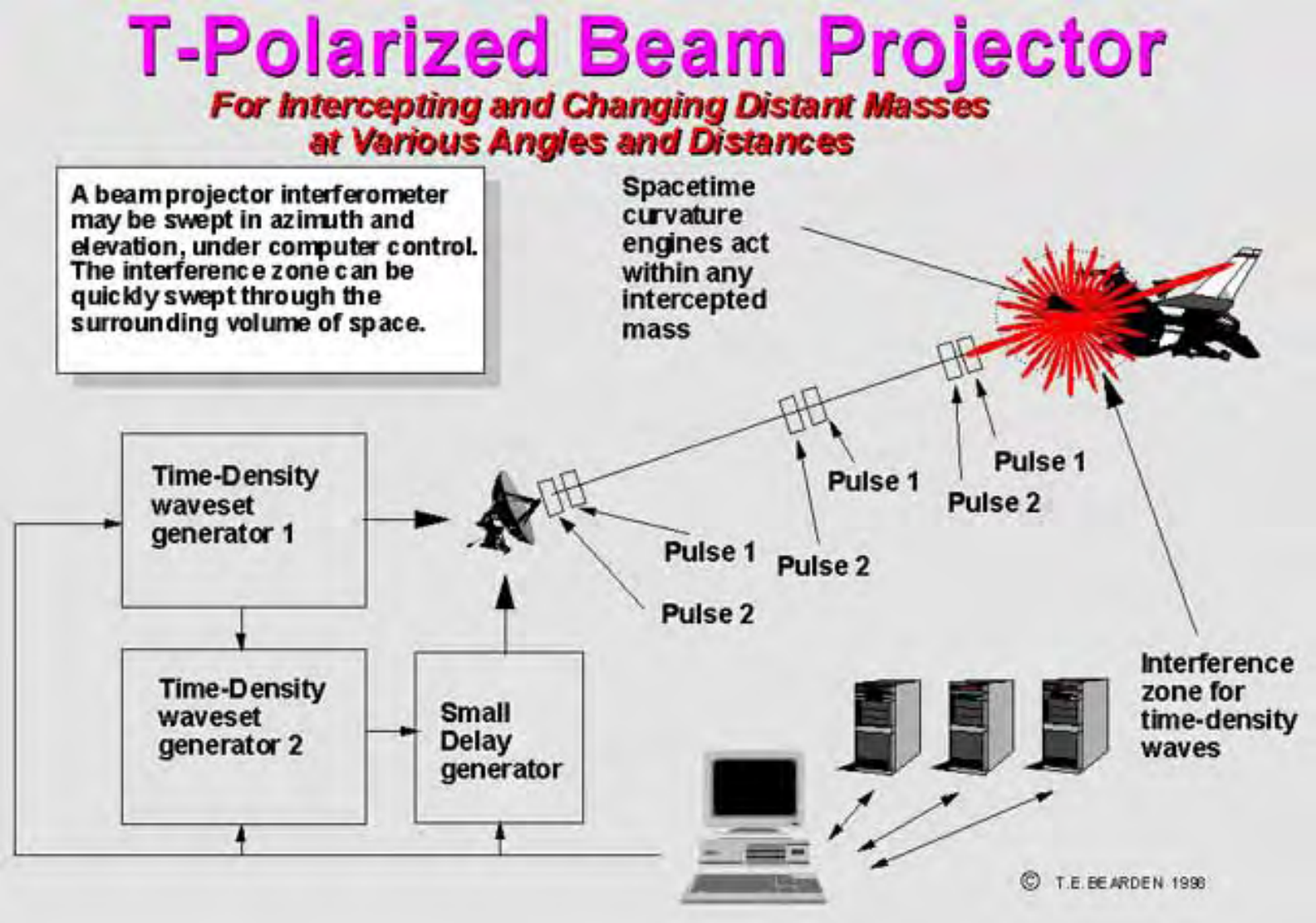
T-Polarized Beam Projector
For Intercepting and Changing Distant Masses
at Various Angles and Distances
A beam projector interferometer may be swept in azimuth and elevation, under computer control. The interference zone can be quickly swept through the surrounding volume of space.
Spacetime curvature engines act within any intercepted mass
Time-Density waveset generator 1
Time-Density waveset generator 2
Small Delay generator
Pulse 1
Pulse 2
Pulse 1
Pulse 2
Pulse 1
Pulse 2
Interference zone for time-density waves
© T.E. BEARDEN 1998

Possible Tests (1)

- 1958 nuclear accident in Urals
- Disease induction in U.S. Embassy personnel in Moscow
- Siberian disease/death transmission experiments
- Destruction of USS Thresher nuclear submarine, Apr. 10, 1963
- Nuclear explosion transmitted into ocean underwater, 100 miles north of Puerto Rico, Apr. 11, 1963

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Possible Tests (2)

- Eight F-111's downed in Vietnam immediately after deployment
- Several large earthquakes
- Mysterious aircraft losses in groupings
- Numerous underground "nuclear" tests
- Nuclear tests at Semipalatinsk without associated seismic activity
- High altitude rumbles, snaps, booms
  - *Off English coast*
  - *Off East coast of U.S.*
  - *Over West Coast of U.S. in thunderstorms*

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Possible Tests (3)

- Blinding of several U.S. satellites (up to 4 hours in duration)
- Cold Explosion off Kurils 1984
  - First, a cold explosion
  - Then test of giant Tesla shield 300 mi. dia.
- Tests offset from shuttle launch Nov. 85
- Kill of Arrow DC-8,Gander, NFLD Dec. 1985
- Titan kill, Vandenberg AFB, CA early 1986
- Kill U.S. Challenger, off Cape Canaveral 1986
- Earthquakes induced, 1986-88
- Dozens of tests of shields around the world
- Decades of radiating U.S. Embassy in Moscow

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Possible Tests (4)

- Extensive tests 1990-99 in Western Australia
- Engineering of weather since 1990 by Yakuza
- Possible nuclear dudding test in WA in 90s by Aum Shinrikyo
- C-130 engine flameout kill
- TWA-800 kill 1997
- Gulf War Disease Induced, 1991
- Spreading of immune systems of U.S. populace, 1990s
- Psychoenergetic control of Captain Button
- Psychoenergetic control of Captain Svoboda
- Twice in 1997, within days of full strategic destruction of U.S.

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Mushroom cloud rising from sea

- 0514 hrs, 9 April 1984
- Gray-white cloud appeared
- Rose 60,000 feet in 2 minutes
- South of Kuril Islands
  - *180 miles southeast of Hokaido*
  - *200 miles from Tokyo*
- Soviet missile testing scheduled about 350 miles away, at 2100 hrs, 9 April 1984

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Launches from Cape Canaveral
and Vandenberg AFB
Provided Practice Targets of Opportunity

The sinking U.S.S. Thresher, with her controls jammed, implodes when she reaches crush depth

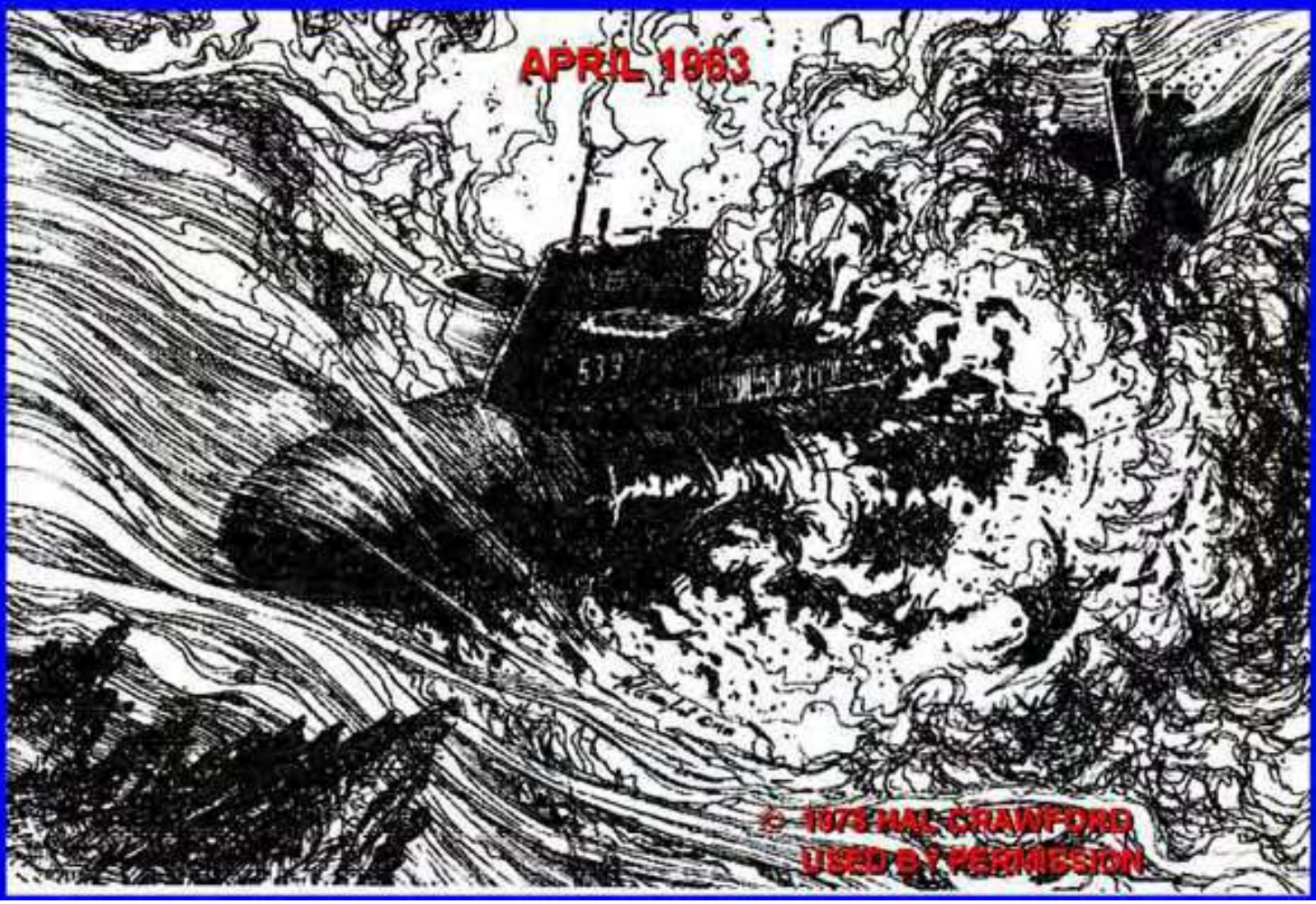

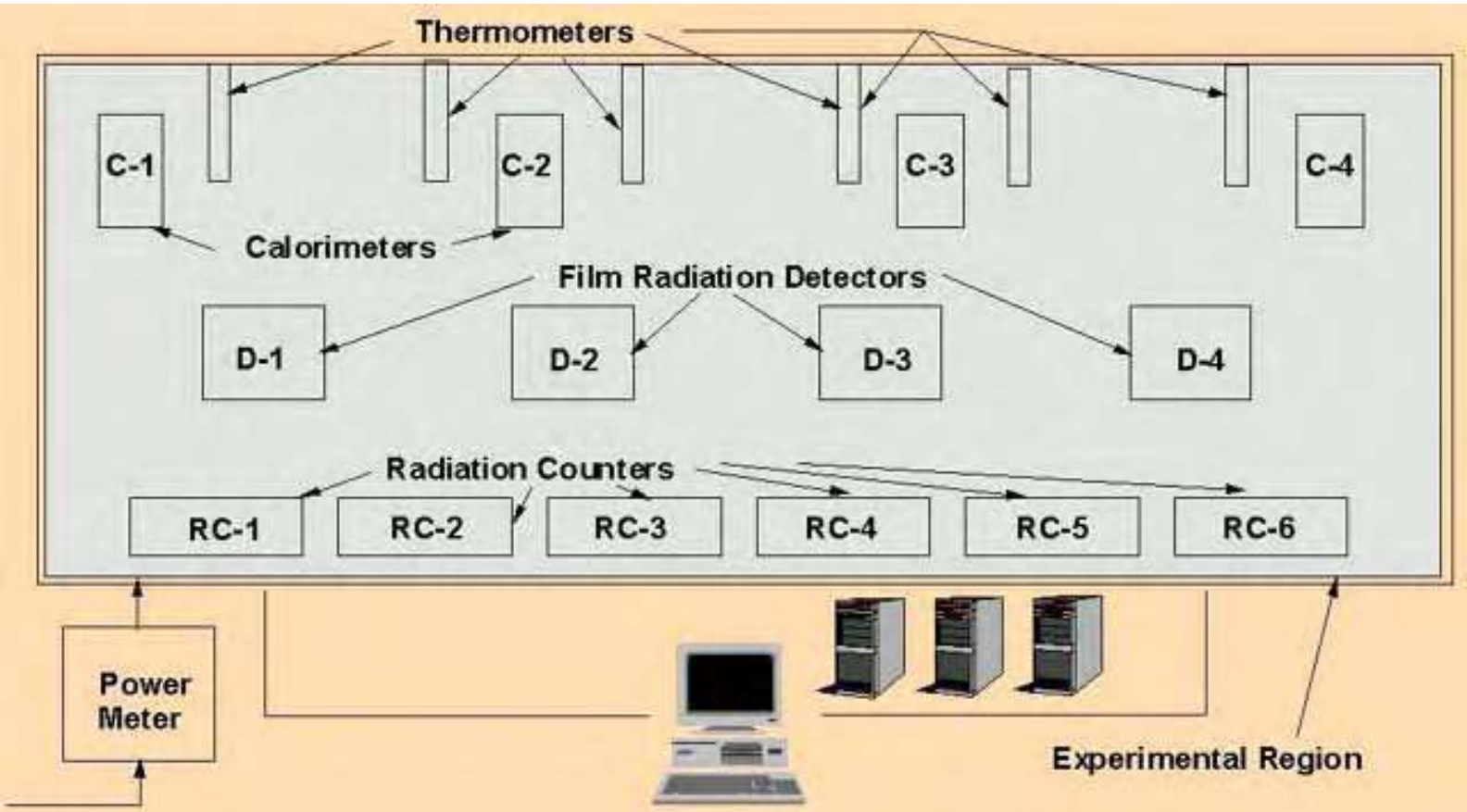

Figure 32. Embodiment of an instrumental array sufficient to discriminate when time-density charging has occurred, and that transduction of time-charge decay is occurring.

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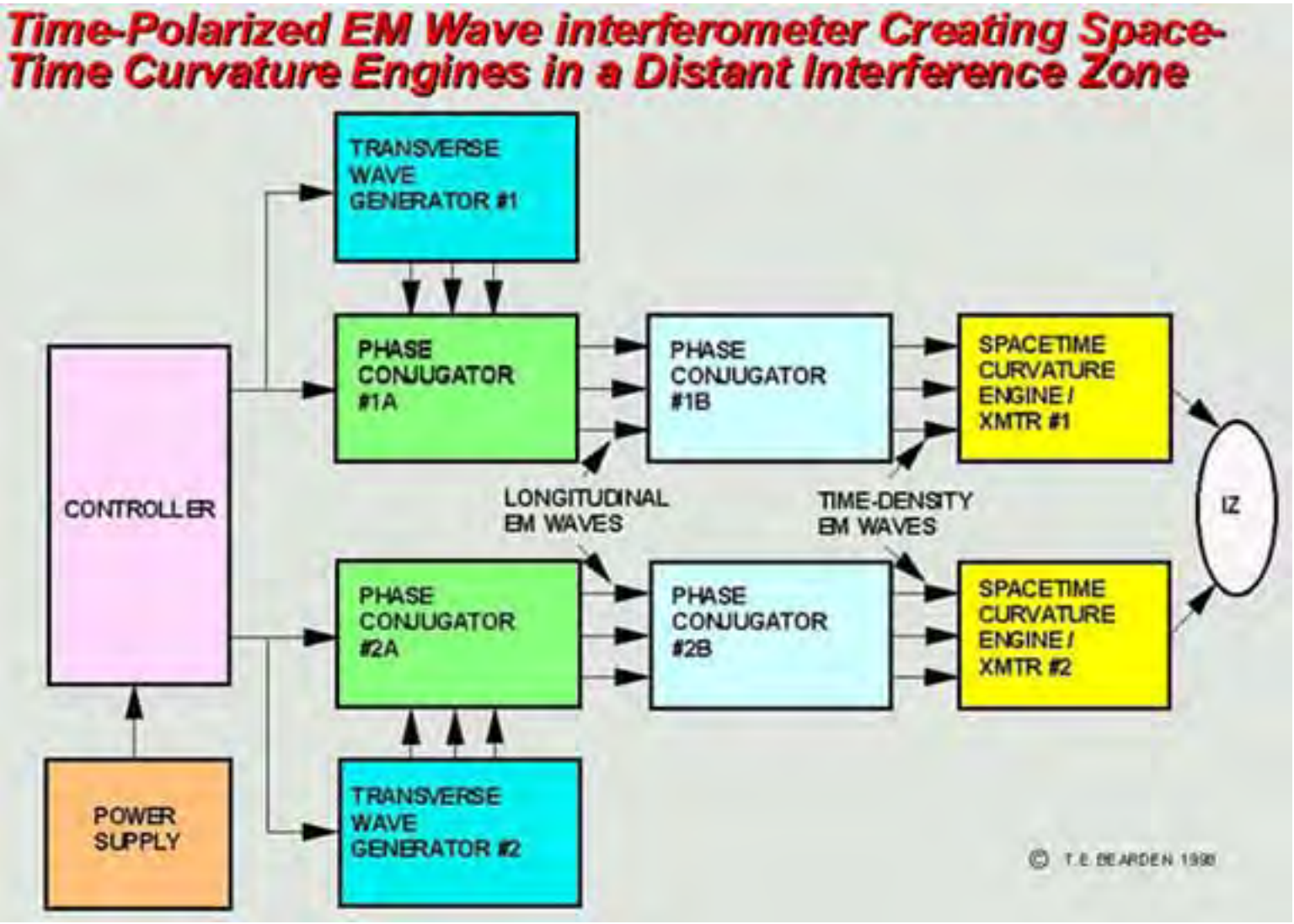
Time-Polarized EM Wave interferometer Creating Space-Time Curvature Engines in a Distant Interference Zone
TRANSVERSE WAVE GENERATOR #1
PHASE CONJUGATOR #1A
PHASE CONJUGATOR #1B
SPACETIME CURVATURE ENGINE / XMTR #1
CONTROLLER
LONGITUDINAL EM WAVES
TIME-DENSITY EM WAVES
IZ
PHASE CONJUGATOR #2A
PHASE CONJUGATOR #2B
SPACETIME CURVATURE ENGINE / XMTR #2
POWER SUPPLY
TRANSVERSE WAVE GENERATOR #2
© T.E. BEARDEN 1990

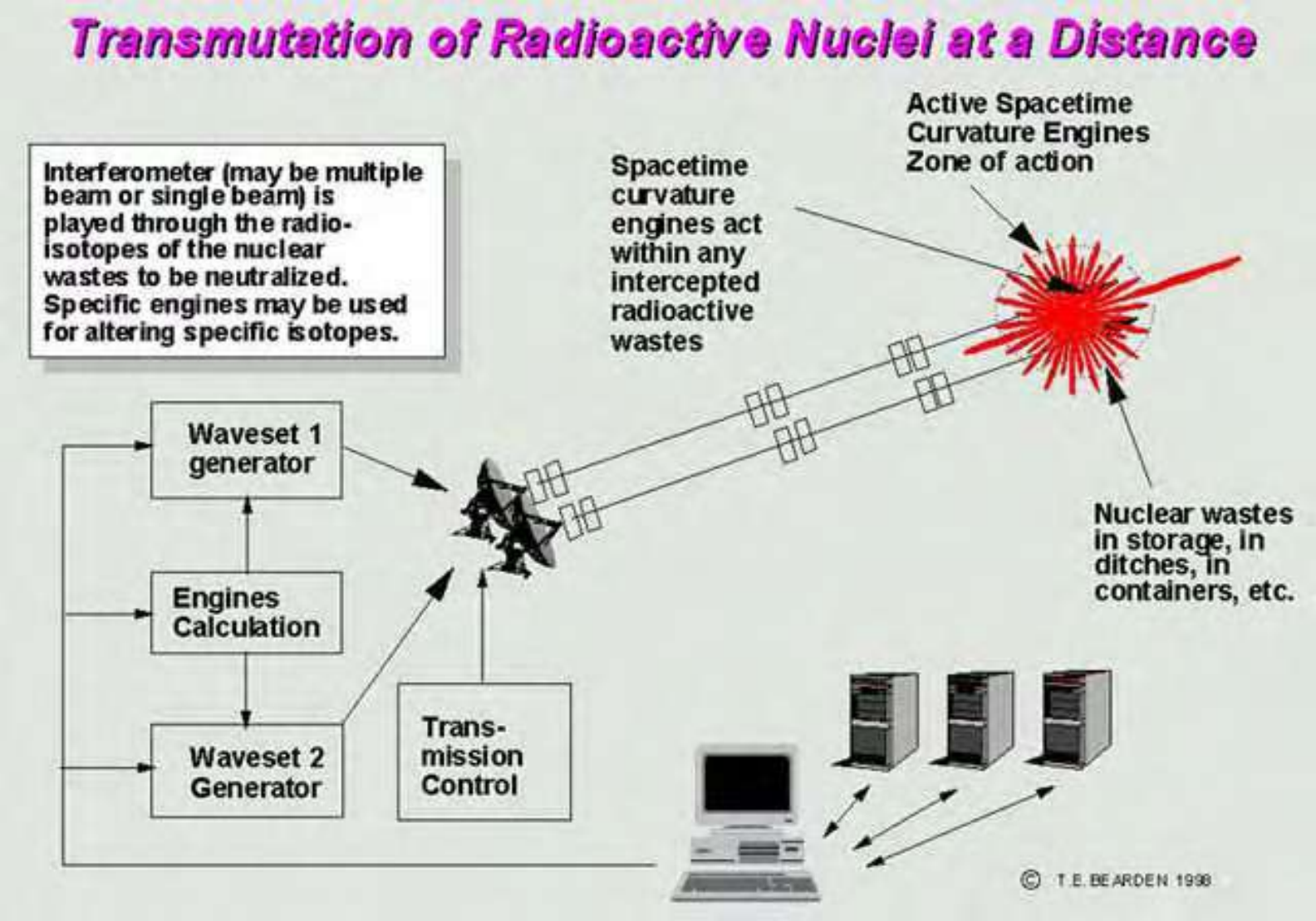
Transmutation of Radioactive Nuclei at a Distance
Interferometer (may be multiple beam or single beam) is played through the radio-isotopes of the nuclear wastes to be neutralized. Specific engines may be used for altering specific isotopes.
Spacetime curvature engines act within any intercepted radioactive wastes
Active Spacetime Curvature Engines Zone of action
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
Nuclear wastes in storage, in ditches, in containers, etc.
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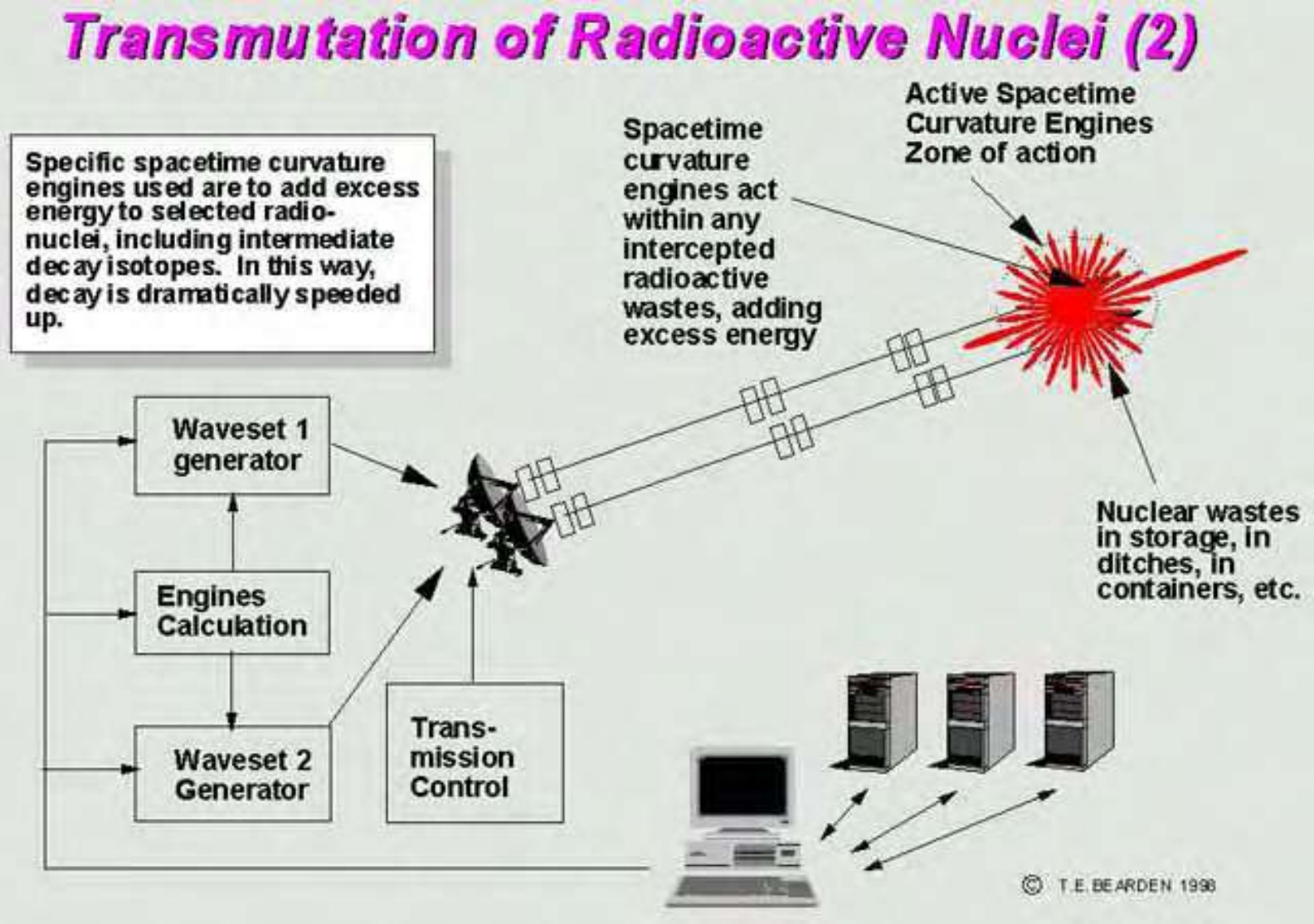
Transmutation of Radioactive Nuclei (2)
Specific spacetime curvature engines used are to add excess energy to selected radio-nuclei, including intermediate decay isotopes. In this way, decay is dramatically speeded up.
Spacetime curvature engines act within any intercepted radioactive wastes, adding excess energy
Active Spacetime Curvature Engines Zone of action
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
Nuclear wastes in storage, in ditches, in containers, etc.
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Typical Shield Test, Northern Route to Japan
18-27 km diameter
Asahi Evening News, Tokyo
June 22, 1982
Multiple tests seen per month, for years.
Pilots simply ceased reporting them.
© T.E. BEARDEN 1994,1995

A Curious Tide in Human Affairs

To win its freedom in the long run, usually a group must defeat its attackers or suppressors *at least twice*.

- We fought the British twice for our independence.
- We are fighting ourselves twice to free the slaves. - American Civil War
  - Civil rights struggle
- We beat the Germans twice, in WW I and WW II
- We beat the Hispanics in the Spanish-American War. *That's once*. (They're winning the second by crossing the border. The U.S. is becoming a Hispanic Nation).

But we also have some unfinished business at hand.

- We checked the Russians in the Cold War. *Once*.
- We checked the Japanese in WW II. *Once*.
- We checked the KGB in the Cold War. *Once*.
- We checked the Communists in the Cold War. *Once*.
- We checked Saddam Hussein in the Gulf War. *Once*.

Large Scalar EM Interferometer (LASI) Accident Near Urals, 1958

- 1958 nuclear explosion near Urals
  - Signature of large scalar interferometer (LASI) accident
  - Buried atomic wastes suddenly exploded
  - Large region contaminated to this day
- Soviets were well along with advanced LASI prototypes and testing
  - Khrushchev announced forthcoming advent of these "fantastic" weapons in Jan. 1960
  - 1958 difficulties could have been resolved by 1960
- Expected 1958 cause: transmitter short-out and failure in a nearby LASI discharged its cumulated energetics beam energy into the ground
- *Spreading ground pulse struck nearby atomic wastes, fissioning nuclei*

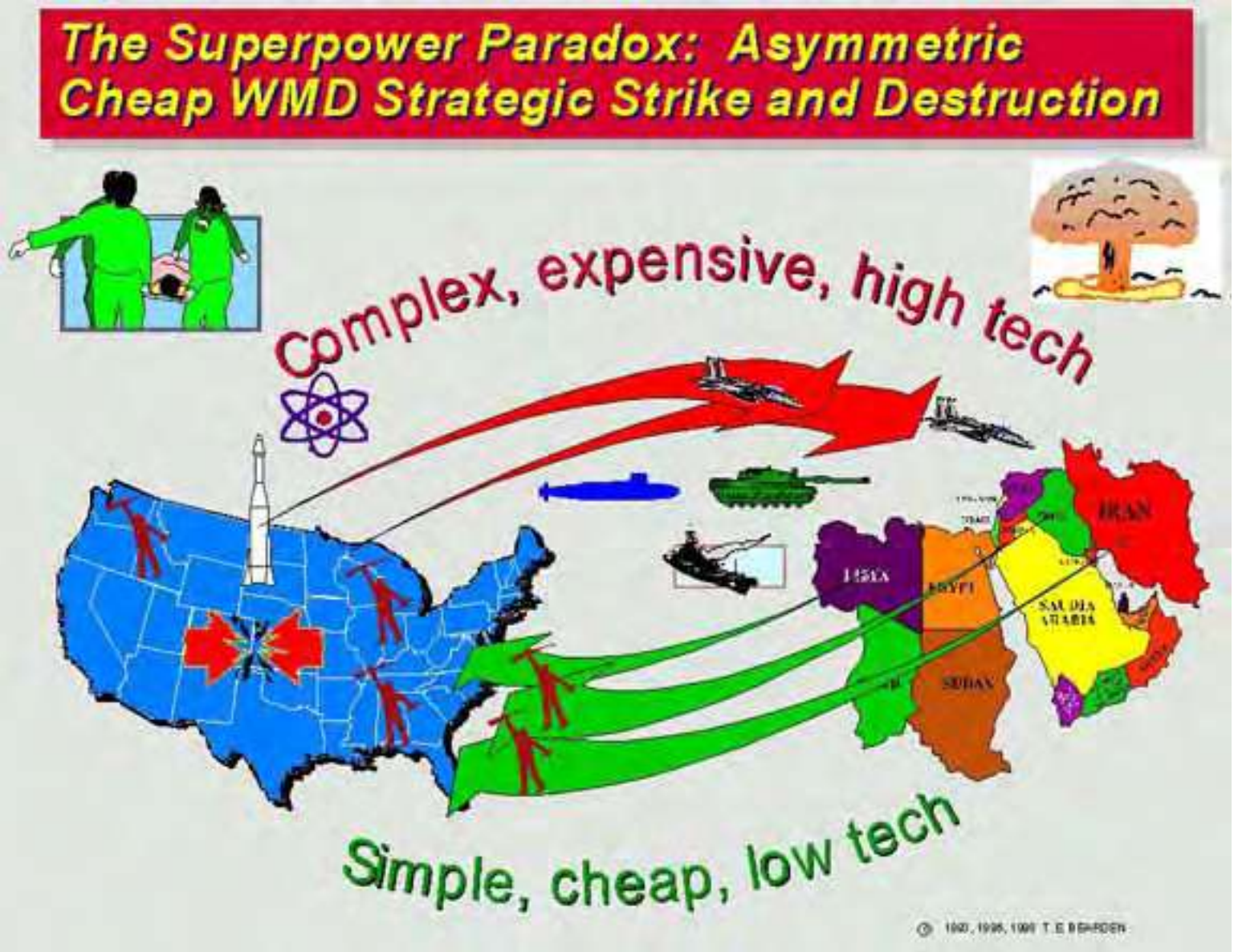
The Superpower Paradox: Asymmetric
Cheap WMD Strategic Strike and Destruction
Complex, expensive, high tech
IRAN
LIBYA
EGYPT
SAUDI ARABIA
SUDAN
Simple, cheap, low tech

THE KGB/YAKUZA-AUM WAR PLAN

- *Dud all quantum potential weapons in other nations via psychoenergetics.*
- *Remove U.S., Israel, Brazil, West Europe as military powers.*
- *Destroy nuclear weapons, hostile energetics weapons, hostile ships, 80% of targeted populaces in first hour of strikes.*

LEASE

1990-91

Aum/Yakuza Acquired Use of on-site Russian Scalar EM (Energetics) Weapons.

Began Geosurvey of Test Range (Western Australia) for training.

KGB Tested QP population wpn (Gulf War Syndrome)

TRAIN

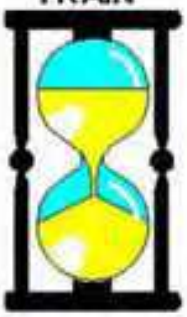

1991-94

Began extensive training of AUM-Yakuza crews in Russia, with practice firing into Western Australia. J-team took over world-wide weather engineering. Preparing for occupation of West Australia.

ESCALATE

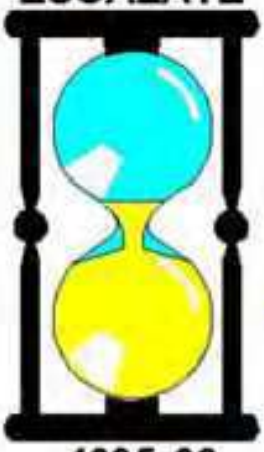

1995-99

Began EM kill of selected lone U.S. targets, law strategic deception plan.

U-2 a/c? USAir 747?
TWA-800 C-130
ValueJet? A-10s

Surged electrical grids. Worldwide practice kills, scalar interferometry. QP modification of selected pathogens

STRIKE!

Plan:
Trigger terrorist BW, & WMD attacks.
Enhance BW infections with QP wpn.
When ready, counter insane QPweapons with psychoenergetics. Destroy QP wpns.
Dud all nuclear weapons worldwide;
Time-snap ships, scalar weapons sites;
Attack major target populations w/QP.
Then cleanup with interferometry strikes.

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Why Western Science is Ignorant of KGB Energetics

- *Foundations* of electrodynamics and much of Western physics are seriously flawed
- Only just rediscovering longitudinal EM waves
- No knowledge of using time-polarized EM waves
- Does not know a powerful GR is hidden in EM
- Ignores inner structure of potentials, waves, fields
- Hotly defends errors, ignores for a century
- Determined to push big nuclear science
- Suppresses research to approved dogma by rigorously controlling precisely what research the funds can be used for

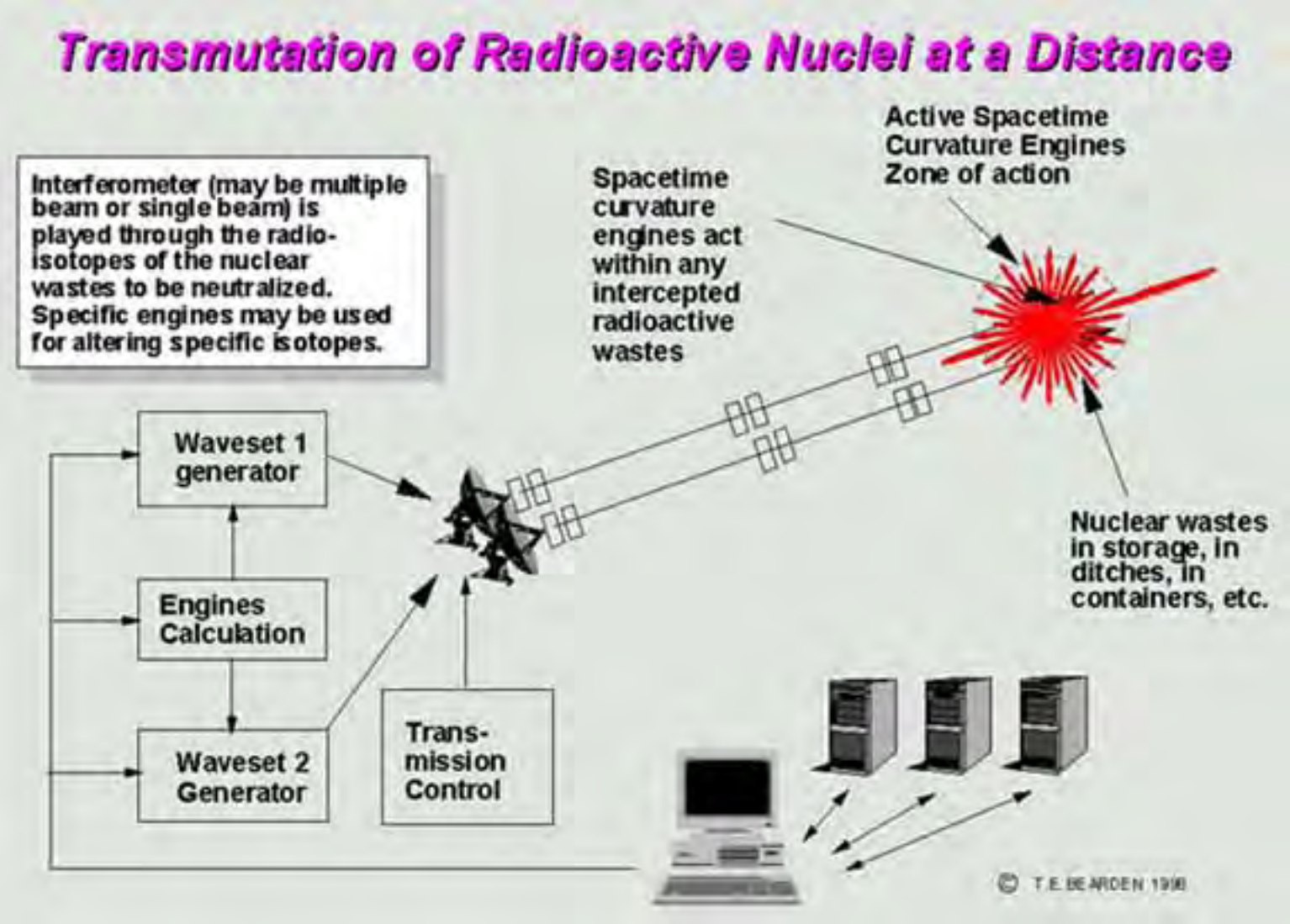
Transmutation of Radioactive Nuclei at a Distance
Interferometer (may be multiple beam or single beam) is played through the radio-isotopes of the nuclear wastes to be neutralized. Specific engines may be used for altering specific isotopes.
Spacetime curvature engines act within any intercepted radioactive wastes
Active Spacetime Curvature Engines Zone of action
Nuclear wastes in storage, in ditches, in containers, etc.
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
© T.E. BEARDEN 1998

THE YAKUZA

(JAPANESE MAFIA)

To do business with Japan is to do business with the Yakuza

The Last Samurai, Defending Bushido

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- **3 Major Yakuza Groups, In Coalition.**
- **Penetrate Japanese Government.**
- **Open Offices, Signs on Street.**
- **Public Romanticizes Yakuza as Last Japanese Samurai**
- **In Large High-Tech Corporations.**
- **In Control of Japanese Banks.**
- **Japanese Real-Estate Rip-off.**
- **$500 - 1,000 Billion per Year Income.**
- **Rapidly Spreading in U.S.**
- **Uniting Mafia Groups Worldwide.**
- **Coalition with Aum Shinrikyo.**
- **Leased Russian Energetics Weapons.**
- **Crews On-site in Russia, Trained.**
- **Practice Firings into Western Australia for Three Years. (Dozens of Shots per Month)**
- **Now in Escalation Phase, Killing U.S. Targets.**
- **All-out Strike on U.S. ready 1999-2000.**
- **Now held in check by KGB, dead-man fuzed by small nation friendly to U. S.**

Yugoslav Earthquake, Followed by Cold Explosion

Apr. 15 1979

- Magnitude 7.2 on Richter scale
- Epicenter 33 km. deep
- More than 100 aftershocks
- At Kamenari:
  - Adriatic sea mushroomed up
  - Like atomic bomb explosion
  - Signature of a cold explosion
  - Similar to Apr. 1984 test off coast of Japan, near Kurils (see inset graphics)
- *Note that April is a significant test month for the Communists (preparing official reports for May Day?)*

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SCALAR WEAPONS

UNDERSTANDING THESE MAKES IT EASIER TO UNDERSTAND THE NATURE OF THE AETHERS. WE'LL START WITH TOM BEARDEN'S FACTUAL INFO ABOUT THE RESULTS OF THE RUSSIAN'S SCALAR WEAPONS PROGRAM

http://www.cheniere.org/books/ferdelance/intro.htm

THE RUSSIANS USED SCALAR WEAPONS TO BLOW UP THE CHALLENGER SPACE SHUTTLE, A NUMBER OF OTHER LAUNCH VEHICLES, VARIOUS JET AIRPLANES, MODIFY THE WEATHER AND KILL UNTOLD NUMBERS OF BIRDS & FISH, WHICH HAS HAPPENED AGAIN RECENTLY. HAARP DEVICES CAN DO THIS.

SIMPLY PUT: A SCALAR WEAPON IS A FIGURE 8 WAVE FORM THAT IS NOT IN HARMONY WITH AN AMBIENT AETHER, IF POWERFUL ENOUGH THE SCALAR WEAPON CHANGES THE SIZE OF THE BACKGROUND SCREEN AETHER, WHICH THEN NO LONGER SUPPORTS THE MANIFESTATION OF MATTER, WHICH DESTABILIZES AND EXPLODES.

THE REASON WE ARE NOT ALL SPEAKING RUSSIAN IS BECAUSE THE MOST UNSTABLE MATTER IS IN NUCLEAR WARHEADS - DESTROYING THE ENTIRE WORLD IS NOT WINNING A WAR. PROVIDED, OF COURSE, THAT YOU LIVE ON THAT WORLD - THERE IS EXCELLENT EVIDENCE THAT A SCALAR WEAPON WAS USED TO DESTROY THE BIG BEAUTIFUL PLANET WHERE THE ASTEROID BELT IS NOW. THAT'S IN THE BOOK "COSMIC WAR".

GIGGLE, LAUGHING MY ASS OFF AT THIS ONE FROM BEARDEN:

It has also become fashionable in the West to believe that all the laws of physics are already discovered. We assume we already know all of them. While we have been pridefully crowing this tune, the Soviets have been steadily discovering new laws in secret, as well as new ways to circumvent the old laws.

THE SAD PART IS THAT IT HASN'T CHANGED - WESTERN SCIENTISTS ARE IDIOTS WHO ARE LEADING THE WORLD INTO DESTRUCTION. OR SITTING BACK AND WATCHING THE DESTRUCTION, WRINGING THEIR HANDS AND SAYING THAT FUKUSHIMA RADIATION WILL BE WITH US FOR 1000s OF YEARS. B.S. THERE ARE A NUMBER OF ENERGETIC WAYS TO CANCEL RADIATION INSTANTLY.

BEARDEN TAUGHT ME ABOUT SCALAR ENERGY - BUT, THEN HE HAS STARTED PARROTING LAME STREAM PHYSICS - PROBABLY TO KEEP HIS HEAD FROM BEING SEPARATED FROM HIS BODY BY OUR CONTROLLERS.

SCALAR WEAPONS ARE DESCRIBED IN A NUT SHELL ABOVE. BUT, WE'LL EXPAND IT A LITTLE - THE SIMPLE FACT THAT THEY WORK IS PROOF THAT THE AETHERS IS THE BACKGROUND SCREEN THAT SUPPORTS THE MANIFESTATION OF MATTER, WHICH IS ALL DIVINE I.E. MADE FROM IMAGES.

THE AETHERS PROGRESS IN SIZE ACCORDING TO THE FIBONACCI SERIES, BECAUSE EVERYTHING FROM THE QUANTUM TO THE COSMOS MANIFESTS ACCORDING TO THE FIBONACCI SERIES - ITS ALL FRACTAL I.E. A RECURRING MATHEMATICAL PATTERN, THAT IS PERFECT THROUGHOUT CREATION. HERE'S THE PROOF - OUR ENTIRE GALAXY IS IN PERFECT HARMONY WITH ONE NUMBER = RIDICULOUSLY AMAZING

http://blog.hasslberger.com/docs/PERFECTION.pdf

THUS, IF YOU CHANGE THE BACKGROUND SCREEN, THEN MATTER HAS TO CHANGE = THE RESULT OF USING A SCALAR WEAPON.

THE PRECISE WAY THE WEAPON WORKS IS TO IMPOSE A MAN MADE SCALAR WAVE ON AN AREA OF SPACE. GIVEN ENOUGH POWER TO THE SCALAR WAVE, IT WILL CAUSE THE AETHER IN THAT AREA TO MATCH ITS SIZE (LIKE ATTRACTS LIKE). WE ARE TALKING UNBELIEVABLY SIMPLE.

YOU CAN MAKE ONE YOURSELF - AMAZINGLY THE REQUIRED WINDINGS OF A SCALAR PRODUCING COIL CAN BE USED AS A WEAPON OR FOR HEALING - ITS CALLED A RADIONIC WITNESS WELL WHEN USED FOR HEALING.

TO MAKE A WITNESS WELL ONE WINDS INSULATED WIRE AROUND A GAP IN SPACE I.E. THE CENTER OF A TORROID. THE WIRE IS WOUND TO THE LEFT AND TO THE RIGHT. THE MORE WINDINGS THE MORE POWERFUL. AND, OF COURSE, THE POWER OF THE WAVE IS A FUNCTION OF THE POWER OF THE DC ELECTRICITY USED TO ACTIVATE THE DOUBLE WOUND COIL. SUCH A COIL PRODUCES A FIGURE 8 WAVE THAT IS THE SIZE OF THE CENTER OF THE COIL. IF THAT SIZE HAPPENS TO BE THE SIZE OF AN AMBIENT AETHER, YOU'RE NOT GOING TO HAVE A WEAPON.

IF YOU MAKE SUCH A COIL FOR HEALING, POWER IS NOT REQUIRED, IT AUTOMATICALLY CONNECTS WITH THE AETHERS IN A POSITIVE WAY.

IF YOU MAKE IT AS A WEAPON ADD LOTS OF POWER AND BE A LONG WAYS AWAY, WHEN YOU TURN IT ON. THE DESTRUCTIVE EFFECT IS INSTANTANEOUS - I'VE SEEN IT, WE BUILT ONE.

SCALAR WAVES ARE ALSO REFERRED TO AS PHASE CONJUGATED WAVES,

MEANING TWO SINE WAVES THAT ARE 180 DEGREES OUT OF PHASE FROM ONE ANOTHER. (WESTERN LAME STREAM IDIOTS SAY THAT THOSE TWO WAVES CANCEL ONE ANOTHER.)

ONE SINE WAVE IS SAID TO RUN IN TIME FORWARD AND THE OTHER IN TIME REVERSE. AND THERE ARE A NUMBER OF EFFECTS THAT PROVE THIS. ONE EXAMPLE: DON BRANDT (ONE OF BEARDEN'S PROTEGEES) USED A SCALAR WAVE TO REGROW A LEG ON A CAT (A KID HAD SHOT IT OFF WITH A .22), WHEN DON FINISHED, THE CAT HAD ITS LEG BACK AND ALL OF THE CLOCKS WITHIN FIVE MILES WERE 15 MINUTES BEHIND TIME - THAT WAS THE LAST TIME HE PLAYED WITH THAT.

IN 2-D THERE IS NO LINEAL TIME.

BOTTOM LINE: SCALAR WEAPONS PROVE THE NATURE OF THE AETHER AS THE BACKGROUND SCREEN - IF THAT WAS NOT SO, THEN SCALAR WEAPONS WOULD NOT WORK.

ALSO, SCALAR WAVES THAT ARE IN HARMONY WITH AN AMBIENT AETHER ARE VERY BENEFICIAL AND USEFUL - A BEE'S HONEYCOMB IS AN EXCELLENT EXAMPLE. DITTO GRAPHENE.

LOVE AND BLESSINGS

PS: THERE HAVE BEEN A NUMBER OF HUMAN "CIVILIZATIONS" IN THIS SOLAR SYSTEM AND ON THIS PLANET. OUR CONTROLLERS LIKE US TO BE STUPID, BECAUSE IT SEEMS THAT WHEN EVER WE MAKE GREAT TECHNOLOGICAL ADVANCES OR SPIRITUAL ADVANCES, THEN THEY WIPE US OUT. WE ARE AN ENTERTAINMENT SLAVE SPECIE.

THIS LAYS OUT HOW OUR DREAMS / ANUs ARE SHARED WITH OTHERS AND THAT JESUS' ENERGY IS FOUNDATIONAL
http://blog.hasslberger.com/docs/GOLDFISH_JESUS_REVELATIONS.pdf

THIS IS FUNNY AND SHOWS THAT THE EARTH IS THE BEST ENTERTAINMENT SYSTEM IN ALL OF GOD'S CREATION:
http://blog.hasslberger.com/docs/EARTH_WINS.pdf

OH - THE CHEMTRAILS WILL KILL JUST ABOUT EVERY LIVING THING ON THE FACE OF THIS PLANET, IF WE DON'T START MEDITATING AND BUILDING ORGONE DEVICES, WHICH HAS TO BE DONE EVEN IF THEY STOP SPRAYING BECAUSE THE EFFECTS OF THE CHEMTRAILS CAN AND WILL CARRY ON, EVEN IF THE SPRAYING STOPPED.

Scalar Wars

The Brave New World of Scalar Electromagnetics

by Bill Morgan

For the past six months I have been undergoing the greatest **paradigm shift** I have ever had to go through. It has rattled my nerves and shaken my bones. This intense adjustment of my "world" has come about by studying the information given by Col. Tom Bearden at his website Cheniere. The new knowledge there has necessitated a total revision of my ideas about physical reality, the world we live in, and the future of humanity. This paradigm shifting even actually made me dizzy on certain days as I tried to absorb and digest Bearden's vast amount of information. I am not a scientist at all, just a layman, and I have little comprehension of the math and high physics of this new science called "**Scalar Electromagnetics**." But there is a great deal of information at Cheniere which needs to become common knowledge as fast as possible, for the sake of the survival of life on earth. To that end I have put together this small primer of Bearden's ideas, as a kind of "beginner's guide" to his website. (I have tried to underline certain words and phrases which are part of the new "jargon" of talking about these "new" phenomena. Also I have taken the liberty of bolding certain words and phrases to help them stick in the mind).

(Note: Throughout "**EM**" means "**electromagnetic**," and "**LW**" means "**longitudinal wave**")

This article has six sections:

New Waves 2. Tapping the Waves 3. Weaponization 4. Healing 5. Psychoenergetics 6. As It Stands

1. New waves discovered

Longitudinal EM energy fills vacuum of space, the time domain of spacetime, time as compressed energy, E=tc2, waves of time, phase conjugate wave pairs.

"Electric power is everywhere present in unlimited quantities and can drive the world's machinery without the need of coal, oil, gas, or any other of the common fuels." Nikola Tesla

"At any point and at any time, one can freely and inexpensively extract enormous EM energy flows directly from the active vacuum itself." Tom Bearden

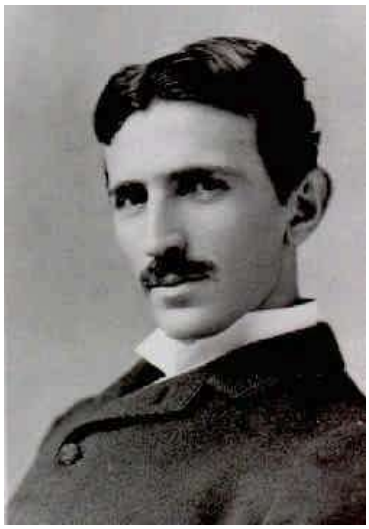

I guess the first thing to try to comprehend is that a "new" kind of electromagnetic (EM) wave has been discovered in the empty vacuum of space called “longitudinal” waves, which, when engineered, can be an inexhaustible supply of energy in great magnitude at any place in the universe. The word "new" is in quotes because the discovery really goes back to **Nikola Tesla** and his discovery of what he called "radiant energy." It is also not "new" because the Russians (KGB) have been working on this technology for over 30 years and have **weaponized** these "new" longitudinal scalar waves to a great degree.

These are the very weapons **Nikita Khrushchev** spoke of in January, 1960.

> "By 1957-8 the Soviets had progressed to the point of a giant scalar EM accident in the Urals which exploded nearby atomic wastes, devastating the area. They had also progressed to development of great new superweapons using their new energetics - weapons to which Khrushchev referred in 1960 when he informed the Soviet Presidium of a new, fantastic weapon in development, a weapon so powerful that it could wipe out all life on earth if unrestrainedly employed.'" Tom Bearden

After over 30 years of development, and extensive testing around the globe, these new scalar electromagnetic weapons are up and running and ready to go. Tom Bearden, at his website Cheniere, discusses the history of these new scalar electromagnetic weapons in his paper "Historical Background of Scalar EM Weapons."

Some Immediate Implications

The implications of successful engineering of the longitudinal waves are enormous, and will change the world as we know it, one way or another. Among other things, these discoveries mean that:

1. The **solutions to the energy crisis and the "oil problem" are in hand**. These oil wars are unnecessary. There is endless energy available freely from the domain of time.

2. **Unbelievably powerful weapons** are not only possible, but are already operating in several nations. The many powers of these weapons are unprecedented and mind-boggling.

3. The **cure of diseases such as cancer and AIDS**, in fact nearly any disease, has become possible within a few years of sufficient funding. Everyone can be made healthy and stay healthy.

4. **Mind control on a mass scale** has now become possible, and the machines to do it are already in place in certain nations. It has become possible to mentally enslave whole populations with the twist of a few dials.

So the layman will need to understand that there is a new kind of electromagnetic energy that is altogether different from what he knows, e.g. radio, TV, cell phones, etc. The ordinary EM waves that we have known about are called transverse EM waves, to distinguish them from the new longitudinal EM waves. These scalar waves do not actually exist in our "material" world, but exist only in the vacuum of empty space, or the time domain. And we must keep in mind that this vacuum of space we speak of exists all through everything. Even our bodies are mostly empty space between atoms and molecules. So the gateway to this seething ocean of energy can be there at every point in the universe. This seething ocean of energy is all around us and all through us.

Emptiness is Full

This amazing discovery announces that the "emptiness" of empty space is in fact not empty, but a great ocean of seething energy!

Col. Bearden refers to this ocean of energy as being of the "time domain." It seems like something from Star Trek but this is where scalar electromagnetics has come to. And where it is going may be beyond anything Star Trek could have dreamed of.

We live in a 3-dimensional world, which physics calls "3-space." But there is also spacetime, or 4-space, or the "4th dimension." Then suddenly comes this amazing new knowledge that time itself is actually compressed energy. And it is energy which is compressed by exactly the same factor by which matter is considered compressed energy: the speed-of-light-squared!

So we have a new companion to the famous E=mc2. It is now paired with E=tc2 (where t is actually "delta-t," or change in time). Or (amaze your family and friends and) say:

"E equals em-cee-squared"

and

"E equals delta-tee-cee-squared"

It has a nice ring to it, like some freedom bell announcing a new era.

And as the atomic bomb released the compressed energy in matter, so can we now unleash the tremendous energy that is compressed into time itself. It gives a completely new meaning to the term "time bomb."

Some New Terminology of Scalar Electromagnetics

A new science, several new names

> "Those [Russian] weapon scientists resurrected an old term from the history of electrodynamics, called "energetics". That is their approach to a unified field theory, where everything is based on "energetics". This model as its foundations uses a very similar approach to that "single fundamental unit" model, where energy is the unit. If one makes the energy EM in nature, then one has the Russian energetics approach. This unified approach gathers everything in, including all energy actions and relations in inert matter (the first branch of energetics, called by the same name), all field and matter interactions in living matter (the second branch of energetics, called "bioenergetics"), and all mind operations and mind-matter interactions (the third branch of energetics, called "psychoenergetics"). [ed: sometimes also called "psychotronics" by the Russians]

Rick Andersen in an article called "What is Scalar Electromagnetics?" describes the new science this way:

> "Scalar EM is the brainchild of Lt. Col. (retired) Thomas E. Bearden, a systems analyst and wargames specialist who has been advocating a view of electromagnetics which is based on the notion of a vast, unseen background of scalar energies (as opposed to vector energies) which underlie all physical reality.
>
> "If Bearden is correct in his Scalar EM theory, then we can build devices which would enable us to alter gravity, time, inertia, and the apparent mass of an object. This of course has ENORMOUS implications for military applications, space-vehicle drives, time-travel, teleportation, paranormal phenomena, and just about every other area one can think of." http://twm.co.nz/Beard_scalem.html

> "Time-energy, time-currents, and time-structuring play the dominant role in electromagnetics. Time-as-energy eventually becomes engineerable, as easily as is spatial energy now. We are always dealing with spacetime and with spacetime curvature."
>
> Bearden: http://www.cheniere.org/techpapers/Vision%202000%20paper.doc

The scalar energy discovered in the vacuum of space is sometimes called "zero-point" energy. Thomas Valone explains how this term came about.

What does "Zero Point" mean?

"Boyer traces the historical “creation of the vacuum” as proceeding in stages in parallel with the historical development of ideas about the vacuum. To paraphrase, he says that in the 17th century, it was thought that a totally empty volume of space could be created by simply removing all matter and, in particular, all gases. That was our first concept of the vacuum. Just get rid of all the gas. Late in the 19th century, it became apparent that the region still contained thermal radiation. But it seemed that the radiation might be eliminated by cooling. So the second concept of getting a real vacuum is to cool it down to zero temperature. Just go all the way to absolute zero. Then we’ve got a real vacuum. Right? Well, since then, both theory and experiment have shown that there is a non-thermal radiation in the vacuum and that it persists even if the temperature could be lowered to absolute zero. Therefore, it was simply called the “zero point” radiation. "Thomas Valone http://www.seaspower.com/InsideZeroPoint.htm

> "**For our very survival, it is absolutely imperative that informed citizens be aware of this dramatic change, which is just now starting. The powerful new science and engineering must be controlled and used for humanity's benefit, not its detriment. Else it will eventually be let loose unrestrainedly, to destroy all life on earth - a possibility indicated by Nikita Khrushchev in 1960**." - Bearden
>
> http://www.cheniere.org/explore%20articles/priore1/p4.jpg

2. Tapping the waves

Endless free energy, Tesla's radiant energy, the dipole as the gateway to the energy of the void, MEG in one year, Bedini, Yakuza, etc. End of Oil, geopolitical chaos, rogue groups

Move Over G.E. & Big Oil, Energy is Everywhere!

Third-world nations set to rise

> "Certain powerful interests did not wish the extended electromagnetics to be discovered or taught. That, after all, would lead to free energy and loss of economic control of the citizens. That was precisely why Nikola Tesla had already been suppressed ... Today it is still being suppressed by the orthodox establishment."
> http://www.cheniere.org/books/ferdelance/s25.htm

The vast seething ocean of energy of the vacuum, the longitudinal scalar EM waves of the time domain, can now be tapped and "transduced" into ordinary (transverse) EM energy in our 3-Space world. The process can be compared to putting a paddlewheel into a river. The energy acquired is free, since the river is there flowing whether we tap it or not. And it is a mighty river, and is not diminished by our paddlewheel.

This means that a permanent solution to the "energy crisis" is at hand, if only those who hold it so secret would give it up to humankind.

It means our species' insane use of oil is no longer necessary. We can make automobiles that need no fuel at all. We can build motors that power themselves. It means that unlimited electrical power can be available for free anywhere in the world. Every house and even shack can have its own power supply.

Of course there is the cost of the equipment at first, but the energy flow is free for the presumably very long life (no moving parts) of the generator. It will probably take decades to shift over to scalar power.

But the ability to tap the scalar (longitudinal) EM waves of the vacuum (which exists everywhere) also means that unbelievably powerful weapons can be, and already have been developed. In fact these weapons are so dangerous that the fear engendered becomes a psychological obstacle to the grasping of the facts.

I struggled with this myself for months, and even though Tom Bearden had completely convinced me already, it is hard to accept the fact that for everyone on earth the "worst that might happen" has suddenly gotten much worse. It takes time to deal with that, to realize it and get over it.

Indeed, the possibilities of these new weapons, which are tapping the huge energies of time, are so terrifying it is natural for the mind to simply say: "I don't want to hear about that."

And the government, likewise, pretends these weapons do not exist and tries to keep it secret from the people. Because most people would indeed be truly alarmed to know the actual situation. Col. Tom Bearden has decided that the people need to know the truth anyway. As a People on a Planet we must face this now, and ban the use of scalar weapons in war or in mass mind control. The current deployment of these weapons is a world emergency which we must all face.

The physics and mathematics of the longitudinal waves and the time domain are clearly beyond the layman, but I recommend scanning through them anyway just to get a sense of the wonder and the elegance of it all and some of the exotic terms which are used. Two of the most important papers by Col. Bearden are:

Giant Negentropy from the Common Dipole

The Final Secret of Free Energy.

Despite the complexity of the science involved, Bearden sums up the essential secret of it all in a few words.

> "There is no problem at all in extracting all the energy one wishes from the active vacuum, anywhere in the universe, at any time. Just make a dipole.

> The problem is in (1) catching some of that freely gushing EM energy in a circuit containing a load, and (2) dissipating the caught and collected EM energy in that load to power it, without using half the caught energy to destroy the source dipole's).
>
> That is the ONLY real energy problem on the planet, and always has been."
>
> http://www.cheniere.org/correspondence/022502.htm

A dipole could be a battery, which is polarized into negative and positive. Or the terminals of a generator. Or any magnet with its two poles. Or an atom with its positive and negative charges. Or the earth's magnetic field, the sun, and all heavenly bodies. Even a galaxy must be some kind of mega-dipole. Wherever there is a dipole there is already immense scalar EM energy ushering out of and back into the vacuum. And there have already been demonstrated a number of diverse methods for tapping that energy as it flows. (John Bedini, Edwin Gray, Bruce de Palma, and others). Bearden provides what he calls a "partial list" on his website.

> "In other words, nature then gladly gives us as much EM energy flow as we need, indefinitely — just for paying a tiny little bit initially to "make the little dipole." After that, we never have to pay anything again, and nature will happily keep on pouring out that 3-flow of EM energy for us. This is the giant negentropy mechanism I uncovered, performed in the simplest way imaginable: just make an ordinary little dipole."
>
> Bearden http://www.cheniere.org/techpapers/Unnecessary%20Energy%20Crisis.doc

How to Buy a Free Energy Machine

Answer: Just wait one more year! 2003. Then get off the Grid!

Perhaps the most eagerly awaited event now is the marketing of Bearden's Motionless Electromagnetic Generator (MEG) scheduled to begin in about a year's time. This is when the proof will hit the fan. Many people have said to me, when talking about free energy, "I'll believe it when I can go to the store and buy one." Hopefully in a year's time they will be able to order their own MEG. And then they will believe, because it works and is working.

Says Bearden: "I will admit that the chief scientist of an important experimental group in a large company was rather stunned at the type of output we were able to obtain. The MEG may look like just a transformer, but it is not. It is a completely different breed of cat."

(Bearden : http://www.cheniere.org/correspondence/011202.htm)

Soon the cat will be fully out of the bag. The first MEG units will supply 2.5 kilowatts of free electricity. Forever. Units can be connected together to double or triple the wattage. After that gets going, 10 kilowatt generators are planned. Energy will flow freely from the time domain indefinitely, and there are no moving parts to wear out. This manufacturing project is a heroic effort and will change the world as we know it. For once people are in possession of such devices there can be no further denial from anyone, including the government and/or "secret-government."

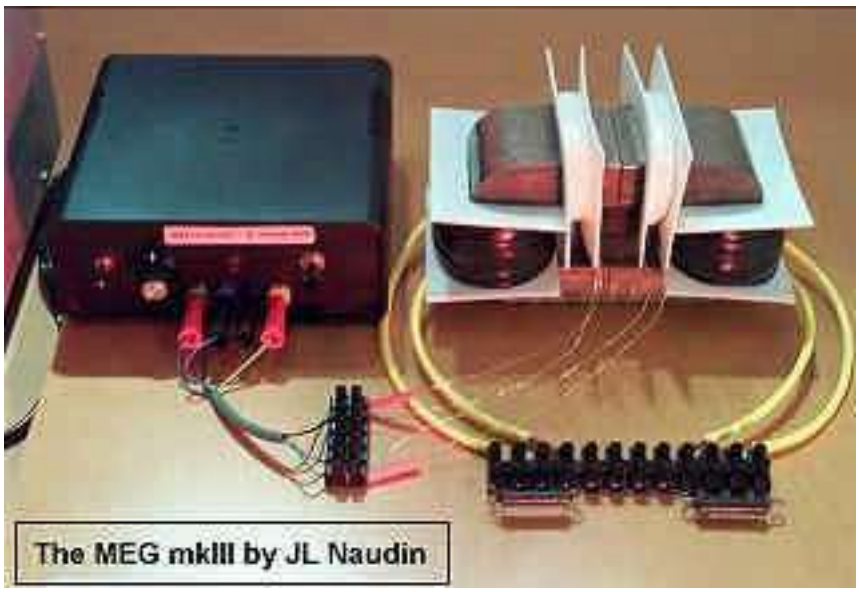

The Motionless Electromagnetic Generator

(Successfully replicated here by J. L. Naudin)

The physics of how the MEG works is explained in the paper "The Motionless Electromagnetic Generator: Extracting Energy from a Permanent Magnet with Energy Replenishment from the Active Vacuum."

The device was successfully replicated by J.L. Naudin in France, and others, like Steve Utne, are also working on their own models. But Magnetic Energy Limited's MEG is actually scheduled for production soon and looks to be the first commercially available free-energy generator in history!

I imagine it will not take long for tinkerers to put them into their electric cars and make the first fuelless automobiles since Tesla's unheralded (and unheeded) experiments. Or for builders to begin building houses powered by MEG's. Houses which will never see electric bills. How can they ever make enough of these to meet the demand that will suddenly be there? Bearden is right, it needs to be an all-out crash program of the government on the order of the Manhattan Project.

I must include here that Bearden is quick to point out that he is not himself the inventor of the MEG, but is a partner and advisor in bringing it to the public market through Magnetic Energy Limited, Inc. I must also admit that I am praying for the success of this venture, and the ending of the absurd and criminal withholding of this technology from the people by the black-ops military-industrial people. This secrecy has cost the planet over 30 years of unnecessary pollution.

The first units off the assembly line, which is being set up in a "friendly" unnamed nation, will usher the public at last into the new era of scalar electromagnetics.

As of December, 2001, the situation with the MEG was described by Bearden in a letter.

> "What we presently have with the MEG is a successful laboratory experiment. At least a year's very hard research will have to be done before we will be ready to put a commercial power supply into production.
>
> "Consequently, we have made an agreement with a foreign partner (the National Materials Science Lab of the National Academy of Sciences of a friendly foreign nation) to do that year's research. At the same time, we are trying to make an agreement with one or more large financial partners here in the U.S."
>
> Bearden http://www.cheniere.org/correspondence/121901.htm
>
> "So we are hopeful that we will be able to start introducing units on the market about a year from now. Quite simply, we will either succeed or we will fail. But we will give it our very best effort."
>
> Bearden http://www.cheniere.org/correspondence/012202a.htm

Bearden has given another technical explanation of how the MEG works here in a letter.

Motionless Electromagnetic Generator patented, 3-26-2002

Click here to read the patent

"In Magnetic Energy Limited, all business discussions and arrangements are taken care of by Dr. Lee Kenny, Managing Partner. There are five of us who are co-inventors of the MEG, and two of the others are really the principal inventors." Bearden http://www.cheniere.org/megstatus.htm

Free Energy has been Suppressed

Secret Government Aware of Free Energy

"In this world of contemporary times, all the agencies, CIA, FBI, KGB, NSA, Electric Power Research Institute, DARPA, Brookings Institution, Henry Kissinger, Edward Teller, et al., all are aware of [free-energy researcher Bruce] De Palma and his ideas.

"Because these individuals and institutions are employed by the ruling elite to forecast the future and satisfy present needs and demands, it is clear that free energy is a threat to the world order constructed by business and the mindset of those who want to own the world.

"Free energy represents Man's aspirations and dreams of freedom and equality, uniform division of resources and the ability to choose one's own future.

"The fact that free energy is suppressed speaks to the greed and self-interest of a ruling elite which, even in the face of an emergency of global starvation, resource depletion and environmental pollution, will not give one inch if it means loss of control. This is an

> attitude of paranoid delusion and fantasy which can only arise from the alienation of a class of elitists who, through their money, are completely insulated from the reality of the day to day fight for existence of the common man."
>
> http://depalma.pair.com/Absurdity/Absurdity07/ProblemOfFreeEnergy.html

Bearden describes one case of suppression when the Yakuza killed the Kawai engine in his very presence in Huntsville, Alabama.

> "That night a jet arrived from Los Angeles, with a Yakuza on board. The next morning Kawai no longer controlled his company, his invention, or his own fate. The Kawai party was in fear and trembling. The Yakuza coldly dissolved the agreement, they packed up the two Kawai engines we had, and left. And that was that."

So it is not only governments who are keeping this revolutionary technology from seeing the light of day. The Yakuza? KGB? The Aum Shinrikyo cult? Our "leaders" need to be honest about what is going on, otherwise they look foolish, acting out a kind of "Alice In Wonderland" script before the public, a script that has become completely unbelievable.

Concerning the criminal withholding of this scalar technology by the military black-budget people, and the cover-up of the actual situation regarding scalar weapons throughout the world, Tom has this to say:

> "The high government officials of the United States of America grossly violated our constitution and their sworn oaths of office. Our constitution specifically charges the government of the United States to defend the people of the United States. That means our officials are specifically charged with defending our people. Yet they deliberately agreed not to do so, and they deliberately sacrificed us in advance.
>
> "They committed treason of the highest kind, by deliberately surrendering us to total destruction anytime the big balloon goes up."
>
> Bearden http://www.cheniere.org/books/ferdelance/s75.htm

Energy Crisis Solved

One of the "must read" documents at Cheniere is "The Unnecessary Energy Crisis: How to Solve It Quickly," especially since the "oil wars," which Bearden has foreseen for decades, have now already begun.

Here are some clips from that Document:

> "To avoid the impending collapse of the world economy and/or the destruction of civilization and the biosphere, we must quickly replace much of the "electrical energy from oil" heart of the crisis at great speed, and simultaneously replace a significant part of the "transportation using oil products" factor also.

> "The technical basis for that solution and part of the prototype technology required, are now at hand. We discuss that solution in this paper."

And although the solution to the energy problem and the oil wars may be at hand, Bearden suggests there is still an urgent rush that needs to be made to save human civilization from collapse.

> "Once the technology hardware solutions are ready for mass production, even with a massive worldwide deployment effort some five years are required to deploy the new systems sufficiently to contain the problem of world economic collapse. This means that, by the end of 2003, those hardware technology solutions must have been completed, and the production replacement power systems must be ready to roll off the assembly lines en masse.
>
> "The 2003 date appears to be the critical "point of no return" for the survival of civilization as we have known it.
>
> "Reaching that point, say, in 2005 will not solve the crisis in time, and the collapse of the world economy as well as the destruction of civilization and the biosphere will still almost certainly occur, even with the solutions in hand."
>
> "The good news is that we now know how to easily initiate continuous and powerful "electromagnetic winds" from the vacuum at will. Once initiated, each free EM energy wind flows continuously so long as the simple initiator is not deliberately destroyed."

On page 9 he explains the concept of the dipole, and how there is already huge scalar energy flowing in the time domain around any dipole. Hold a magnet or a battery in your hand and you hold a stress in time and a beautiful flowing loop of longitudinal waves!

Bearden decries the scientific community in the West for being unable to let go of their dogma long enough to see that the greatest discovery in human history lies at their feet, but for their stubborn ignorance.

> "The present energy crisis then is due totally to that "conspiracy of ignorance" we referred to, that is maintained by the scientific community, and that has been maintained by it for more than 100 years.
>
> "This is the real situation that the environmentalists must become aware of, if they are to see the correct path into which their energies and efforts should be directed — to solve both the energy crisis and the problem of gigantic pollution of the biosphere. "As far as anyone in the legislative branch of government ever understanding the profundity of the discovery and engineering of scalar waves, Tom Bearden says they are at a great disadvantage in doing so.
>
> "The nontechnical person — e.g., a Senator or a Congressperson — is operating under a distinct disadvantage. If he or she takes the stance that much better electrical power systems can readily be achieved, he or she is in fact opposing almost the entire set of University, Government Technical, Power Company, Battery Company, and Organized

> Science communities. Further, in most cases his technical advisors are themselves from one or the other of those communities, and likely to go back into that community or those communities when the Senator or Congressperson leaves office, or even before. So the Congress and the non-technical government community at large operate at a great disadvantage...Bearden National Emergency Declaration is Needed
>
> "The Government Non-Technical community (the Senate and the Congress, in particular) are in far better shape than the Government Technical community, to appreciate the world implications of the pending economic disaster. I am hopeful that both the environmentalists and the Government Non-Technical community will rapidly unite in a common goal to get this vacuum energy program launched, under a National Emergency declaration. If so, then they can solve the energy crisis and the pending economic crisis, in fairly short order, and permanently."
>
> unnecessary_energy_crisis.htm#congress_disadvantage

In the conclusion of his paper The Unnecessary Energy Crisis: How to Solve It Quickly Bearden again states the urgency of replacing our centralized power grids with highly dispersed and local taps on the freely flowing energy of the active vacuum. Given the abilities of the Tesla howitzers, the power grids of all nations are sitting ducks.

> "Personally, the present author regards the increasing energy crisis as the greatest strategic threat to the United States in its entire history. I will do anything within my power to help prevent what I perceive to be the looming economic collapse of the Western world, preceded or accompanied by a sudden, explosive, all-out and continuing exchange of the WMD arsenals of most of the world.
>
> ...In the name of all humanity, let us begin! Else by the time this first decade of the new millennium ends, much of humanity may not remain to see the second decade."

3. Weaponization

Scalar interferometry, Tesla howitzer, Tesla dome, heat/cold, dudding, 10 nations have them, dead-man fusing & Insane Systems, scalar strategy, earthquakes and weather wars, solar storms, mind attacks, leased to Yakuza, many examples of testing, quantum potential weapons.

> "Indeed, Soviet energetics weapons are now capable of destroying both our triad shield, our homeland, our armed forces in the field, and our population, quickly and efficiently. We have a new "gap" of monumental proportions: not a missile gap, not a submarine or bomber gap, and not even a particle beam or laser gap. We have a scalar electromagnetics or electrogravitation gap." Bearden http://www.cheniere.org/books/ferdelance/intro.htm

"We have a new weapon, just within the portfolio of our scientists, so to speak, which is so powerful that,

if unrestrainedly used, it could wipe out all life on earth. It is a fantastic weapon." Khrushchev, to the Presidium, Jan. 1960

> "We've totally missed the most incredible "secret superweapons" development program of all times, and the worldwide testing of the weapons themselves.
>
> "Hiroshima and Nagasaki should serve as object lessons in the price of ignorance of such technological breakthroughs.
>
> "History does repeat itself. But this time it's not we Americans who got the great new superweapon first."
>
> Bearden http://www.cheniere.org/books/ferdelance/s75.htm

Warfare has been changed forever by the development of these scalar energy longitudinal wave howitzers. To get a basic understanding of scalar waves is to have the imagination suddenly run wild as all the implications and possibilities regarding warfare fall into place. One realizes with a certain horror that the world has totally changed, and that there are some very fearsome possibilities. Remember, the power for these weapons comes from the time domain, longitudinal EM waves in the vacuum of empty space, and the power is tremendous and mind-boggling. Being able to blast away at any target from a distant control booth is something that has never happened before. This is incredible power to be in control of and it divides the history of weaponry into "before" and "after." And the destructive power of these weapons is delivered instantaneously to the target from the local vacuum at the place of the target.

From an interview:

> Questioner: "Are you saying that real energy can be transmitted faster than the speed of light?"
>
> Bearden: "Yes. But hyperspatially. Not through 3-space, but "around" it. Again, this means that it's possible to produce energetic changes in a distant system at a distant place, without transmitting energy "through space" in the normal sense. You transmit "around" space, so to speak, and directly in time or through a higher dimension, depending on the model you're using to understand this. Further, the speed of the internal EM energy transmission is not limited to the speed of light."
>
> http://twm.co.nz/beard_interview.htm

Here are some initial considerations about scalar weapons and scalar wars

1. Tesla Howitzer 2. Tesla Domes 3. Rogue groups 4. WW III 5. Russian "UFOs?"

3a. The Tesla Howitzer and its modes of action

Source: Tom Bearden's weapons slides and Fer-de-Lance Briefing

For one thing there is no delivery of any thing to any place. Bombs are obsolete. So are the planes to get them there. No helicopters necessary. All current nuclear devices are rendered nearly useless by electronic "dudding." All distant-destruction can be done from a control room, and to any point on earth. The destructive power of "men" has just increased by orders of magnitude. The new weapons could even cause storms on the sun! Thus there is great urgency to make these new facts public and known, with the hope that all nations would come together to ban the use of scalar weapons.

Two scalar antennae together along with the computers to control them, make up a scalar interferometer, and according to Col. Bearden the Russians have hundreds of such installations already. These interferometers are called "Tesla Howitzers." They can deliver a giant blast of energy to the distant target site, true "action-at-a-distance".

The first howitzer mode is called the "exothermic" mode of operation because immense EM energy blasts outward at the target site. The blast of a scalar howitzer can be of near nuclear level in destructiveness, and can be repeated easily, at that place, or nearby, or anywhere.

The howitzer can use a lesser exothermic power setting and simply destroy all electronics in the target area. Thus they can render our nuclear missiles inoperable as they sit in their silos by "frying" the electronic circuits that guide them. They can bring down any airplane, anywhere in the world, at any time. Any person anywhere, if their exact position is known, can be assassinated without a shot being fired.

The howitzers can also bring down power grids anywhere in the world, at any time. Thus they could bring Wall Street to an instant halt by disabling all its electronics. Even this one little easy tweak of the howitzer could cripple the U.S. economy in a single day. No wonder the "leaders" don't want you to know! This is a new era we are in. The discovery and development of scalar interferometry has put us in a new world, whether we like it or not. Anyone could be expected to go into denial, the befuddled senators and congressmen included. But we have to wake up.

In a second howitzer mode called the "endothermic" mode, the howitzer sucks energy out of the target area, essentially creating a blast of cold at the distant target. It is even capable of freezing parts of the ocean. Bearden gives a number of cases where these "cold explosions" have been witnessed, mostly by airline pilots. April 9, 1984: 1 2 3) A huge mushroom cloud of mostly water is seen rising miles into the sky from out of the ocean, an awesome sight.

In the endothermic mode the sucked-out energy must go somewhere, so it is vented out at some other chosen spot on the earth. These endothermic plumes have been photographed by satellite.

> "The exhaust in the left picture is about 150 miles long, and is nearly horizontal (about 1.5 degrees above the horizontal). It is entirely consistent with the continuous exhaust from a "dumping transfer" scalar EM howitzer in the continuous exothermic mode. (The primary howitzer, of course, was activated in the endothermic mode.)" Bearden More Plumes

By using both of these heat (exothermic) and cold (endothermic) modes together the weather can be altered anywhere. Warm the air over here, cool it down over there, put a curl in the jet stream, dissipate clouds, create clouds, whip up a tornado. Bearden speaks about using the endothermic howitzer mode as a weapon of war:

"Cold explosions can be used to freeze tanks, personnel, and equipment. The equipment and tanks thaw out. The personnel thaw out too, but they are dead when they do." Bearden, Fer-de-Lance

(This endothermic mode of the howitzers makes me think that there might one day be a cure for the problem of global warming after all. Could not a big device, situated in space or on the moon, be able to vent a great deal of excess heat outside the atmosphere into space, thus functioning as a kind of planetary thermostat?)

While the United States has experimented with electomagnetic weapons using ordinary transverse EM waves, the longitudinal [LW] weaponized waves are truly of another order altogether.

For one thing they do not have to travel through space, for they come from the time domain, which is everywhere. The energy of the blast, the heat or light or whatever, comes from the vacuum of space at the location of the target itself. This is astonishing. The weapons actually just trigger the release of immense energy from the vacuum at the target location.

> "... it is possible to focus the potential for the effects of a weapon through spacetime itself, in a manner so that mass and energy do not "travel through space" from the transmitter to the target at all. Instead, ripples and patterns in the fabric of spacetime itself are manipulated to meet and interfere in and at the local spacetime of some distant target. There interference of these ripple patterns creates the desired energetic effect (hence the term energetics) directly in and through the target itself, emerging from the very spacetime (vacuum) in which the target is imbedded at its distant location." Bearden Fer-de-Lance

The big Tesla howitzers are aimed at their targets by using a worldwide electromagnetic pattern called the "Woodpecker Grid," begun by the Russians in 1976.

You can hear the Woodpecker signal here: http://www.cheniere.org/misc/woodpeckersound.htm

The woodpecker grid is just that, a grid of EM waves which provide a channel for the LW waves to any point on earth. Computers use the woodpecker grid information to hone down the aiming of the howitzers to a pinpoint location on earth. (For that matter, it could be under the earth, in space, or under the sea).

A third howitzer mode is what Col. Bearden calls "Mindsnapper" mode. This is a truly frightening mode which affects the electromagnetic mind-body connection. Being mind-snapped at a low level would cause you to lose consciousness. Being mind-snapped at a slightly higher power would "entrain" all minds in the target area into a kind of hypnogogic trance, a state in which they would all be highly susceptible to suggestions and orders.

Being mind-snapped at high level would so disrupt the mind-body connection that everyone in the target area would fall down, instantly dead. Not only that, everything around you and inside you would be killed, so that your sterilized body would not rot for quite a long time.

The Mindsnapper can be used for a small area, or to kill an entire population. In fact, using the scalar waves to affect the human mind has become a new field in its own right, and has been dubbed "psychoenergetics." (This is discussed below in section 5).

Bearden describes the use of the howitzer in mind-snapping mode against people, to cause unconsciousness or death:

> "From a military viewpoint, these scalar EM weapons are really quite all-around weapons.
>
> "For example, they are very lethal against personnel.
>
> "Set in the "high intensity pulse mode," one blast and a person's nervous system is destroyed instantly. Total, instantaneous death results. One can blast away at entire groups of infantrymen, for example. It's the peak power that's important, not the average power. So the weapon doesn't require too much battery power.
>
> "Set on a lower intensity pulse mode, one zap can simply knock out a person, rendering him instantly unconscious. Quite useful if one needs prisoners to interrogate. Also very silent, which is useful in operations employing stealth and surprise." Bearden http://www.cheniere.org/books/ferdelance/s80.htm
>
> "Those hit by the scalar EM weapon, however, have a most peculiar death mode.
>
> "Death comes-instantly and totally. There is no convulsion, no response. The entire nervous system is destroyed instantly. Every living cell in the body is killed instantly, including all bacteria, germs, etc.
>
> "A body hit with this thing falls like a limp rag and lies where it falls. It doesn't decay in even 30-45 days. In a macabre fashion, it's been reduced to something like food irradiated with nuclear radiation; everything is killed, so the material is preserved for an extended period before any decay can set in."
>
> Bearden http://www.cheniere.org/books/ferdelance/s81.htm

He goes on to say that the same "bazooka-sized scalar EM pulse weapon" can also be used to knock out a tank with one shot (or pulse). So tank warfare is obsolete. Helicopters? Bearden points out: "... if he's attacked by a helicopter or a fixed-wing aircraft, he can bring the same weapon to bear on it. He can knock down a chopper or a jet. With one shot."

Obituary for Tank Warfare

Tanks useless against portable LW weapons

> "For example, suppose one attacks a tank. [with an LW weapon] With scalar EM pulse, the personnel die instantly. Total personnel kill is achieved.
>
> All electronic systems of the tank are dudded. Total systems kill is achieved. The ammunition in the tank explodes. Total kill is achieved.
>
> The fuel explodes. This is another total kill mechanism.
>
> That tank has been killed totally, by a variety of mechanisms, all simultaneously.
>
> That's a k-kill in any analyst's book.
>
> And don't worry about retrieval and repair. That tank is finished permanently.
>
> Even the most modern tank is just as vulnerable as the most obsolete."
>
> Bearden http://www.cheniere.org/books/ferdelance/s88.htm

One begins to get the idea how profoundly the conventional means of warfare have been obsoleted. All the usual weapons of war have been rendered nearly useless! And Star Trek's "Phaser," with its "stun" and "kill" modes is here at last.

Although it is the weapons aspect of scalar electromagnetic which has received the most developmental effort, Bearden points out that a great many other amazing things that may be accomplished in this new field of science. Beam me up Scotty!

> "Superluminal communications systems, hyperspace drive, and materialization and dematerialization are all hypothetically possible, using scalar electromagnetics. As the technology develops, we should see the development of many of the systems long thought impossible except in science- fiction."
>
> Bearden http://www.cheniere.org/books/ferdelance/s15.htm

Bearden describes a huge test of the Russian scalar weapons systems which occurred in 1985, a test that went completely unnoticed by western scientists:

> "Just before May 1, 1985 the Soviet Union performed a "full-up" operational test of their entire strategic scalar EM weapons complex. This test was detected and monitored periodically by Frank Golden. Some 27 of these giant Soviet "power taps" were locked into the molten core of the earth, producing forced (entrained) scalar resonance of the entire planet on 54 controlled frequencies under our very feet. The remainder of the scalar frequency spectrum was ablaze with literally hundreds of Soviet scalar transmitters: probably the entire strategic scalar command and control system to

> underwater submarines, higher command centers, distant commands, etc. was activated in the giant exercise.
>
> "For several days, the system was exercised on a mind-boggling scale, apparently as part of the Soviet Union's highly accentuated 40th anniversary celebration of the end of World War II.
>
> "Ironically, not a single U.S. intelligence agency, laboratory, or scientist detected this monstrous exercise for the new Soviet leader, Gorbachev. Not a one of them had a detector for scalar EM radiation, and not a one of them officially believes the exercise ever happened."
>
> Bearden http://www.cheniere.org/books/ferdelance/s38.htm
>
> "The Woodpecker grid/howitzer weapon system can be placed over the ocean and used against cruise missiles, naval surface-to-air and surface-to-surface missiles, submarine-launched ballistic and cruise missiles, etc. Placed over a carrier task force, it can also take care of the aircraft launched by the carrier as fast as they are launched. It can also handily take care of the missiles launched by guided-missile cruisers of the accompanying task force."
>
> (Bearden http://www.cheniere.org/books/ferdelance/s65.htm)

The whole series of the Fer-de-Lance briefing slides and comments is a "must read" for anyone wanting to be aware of the actual state of things in this world right now. It is a new world and it takes some getting used to. Fer-de-Lance speaks clearly, for the layman, of the way things stand.

What is it like to operate these Tesla Howitzers? Col. Bearden gives us an idea in his "Fer-de-Lance" briefing, Slides 66-71.

Who needs armies anymore? A entire war can be fought and won by a handful of men sitting in a comfortable control booth! The scalar electromagnetics revolution has made all previous forms of warfare nearly obsolete.

Why haven't the Russians used the scalar weapons yet?

Bearden gives his thoughts on this in "Fer-de-Lance." The power of these weapons is so great that an accident or war could wipe out all life on earth, and even affect the sun.

> "As can be appreciated, this entire concept [MAD] is now totally obsoleted by the Soviet possession of scalar EM weapons.
>
> 'The "mutual assured destruction" capability -- or MAD concept as it was so aptly named! -- is no longer mutual. And for two reasons: (1) the Soviet surprise attack could destroy essentially all our Triad forces wherever they are, in the first attack. (2) Even if a very small number of our strategic forces survive, the puny strike we could attempt to launch could be repeatedly decimated from launch to terminal phase.

'The restraint on the Soviets is not because of our Triad forces. The restraint is twofold: (1) a second nation has scalar EM weapons, and would undoubtedly unleash them upon the Soviet Union with great violence if such a massive world-wide destruction of U.S. forces occurred or was threatened (is it really "accidental" that six major Soviet missile ammunition storage sites mysteriously exploded within seven months?); (2) the closed-loop scalar radiation exchange system of Earth-Sun could be inadvertently "tweaked" in the feedback loop from Earth to Sun, so that a large solar scalar resonance was stimulated. In that case the Sun could emit a mighty resonant "burp" that would simply wipe out all life on Earth in a fiery shower.

'The "terror" in the "balance of terror" between nations has just increased by many, many orders of magnitude.

'The biblical prophecy that the Earth will be wiped out by "fire and brimstone from heaven" is very near fulfillment now.

'Put another way, the pucker factor -- even on the Russians who may contemplate unleashing Armageddon -- is higher than any Western strategic analyst has ever imagined, even in his wildest nightmares.

'Truly these weapons are "more frightening than the mind of man has imagined," as Brezhnev put it in 1975.

'The frightening scalar EM weapons can be used, but only very, very gingerly indeed. If a slight mistake is made, everybody loses everything."

Bearden http://www.cheniere.org/books/ferdelance/s74.htm

But the Russians (KGB) are not the worst of it. Bearden claims that some of the scalar weapons have been leased to the Yakuza for about a billion a year, and that only the KGB is holding the Yakuza in check from making a full-scale all out scalar attack on the west.

U.S. Defense Secretary William Cohen

Warns about eco-terrorism using scalar electromagnetic weapons

"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves... So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...It's real, and that's the reason why we have to intensify our [counter terrorism] efforts." - Defense Secretary William Cohen, 1997

In a letter to a writer named "Russell" Bearden says,

"In short, Russell, the Secretary of Defense of the United States confirmed that there are indeed novel kinds of EM weapons, right now and have been for some time, which have been and are being used to (1) initiate earthquakes, (2) engineer the weather and climate,

and (3) initiate the eruption of volcanoes. We wrote about those exact uses of the weaponry decades ago. Several nations now have such weapons. Three of them (two on one side and the other on a hostile side) are even firing practice shots into Western Australia, as a convenient test range."

http://www.earthchangestv.com/ufo/0209gandor.htm

Tesla Howitzers in Weather mode

How to Make Weather

"Engineering the weather is duck soup; they tested that over the U.S. in 1967, and entered upon continuing operations over North America on July 4, 1976 as a grim kind of KGB "Bicentennial Gift" to the United States. Here's how it is done with several interferometers.

"First, the interferometers can deliberately make "high pressure areas" (cool the air so it shrinks and its "footprint" pressure on the ground increases because its density increases) and "low pressure areas" (heat the air so that expands and its "footprint" pressure on the ground decreases because its density decreases). Well, if one makes the highs and lows where one wishes them, and judiciously and somewhat slowly moves them along a given path, these highs and lows will entrain the jet streams and thus "steer" the weather.

"So if you wish a very cold snap or attack, go up into Canada and start these actions to steer down some streams that bring some very frigid air. Establish other highs and lows judiciously to "block" or "slow" other jet streams and flows as desired. In this way, one can pull the "large cold air masses coming down from Canada" deep into the southern U.S. at will. They do it regularly. If you wish an ice storm, add an additional current of warm moist air you bring up (steer up by using artificial highs and lows) from the ocean. Where they meet, you will get freezing rain, then sleet, then severe icing accumulating. This type of attack does rather large damage to the struck area."

http://www.earthchangestv.com/ufo/0209gandor.htm

Whole websites have now sprung up showing weather radar anomalies which may well be indications of scalar weather engineering. One list of over 500 images is here. Cheniere has its own collection here.

In another section at Cheniere are many photos of cloud anomalies which reveal the underlying grid along which the clouds are forming or un-forming. Bearden relates a startling incident in these clandestine ongoing "weather wars."

"During the spring of 1986, abnormally strong Soviet weather engineering occurred over the U. S., causing a drastic drought in the southeastern U.S. This drought was broken by a colleague who used an extremely powerful scalar EM device to redirect jetstreams. A most unusual and unique signature of the "blocking" against the Soviet scalar EM actions

resulted: Two huge circulations developed in the atmosphere, clearly showed as two adjacent giant "holes" in the swirling cloud cover over the middle and eastern U.S.

"Between these two giant holes, the cloud circulations formed a stream of clouds, moving to the south, looking very: much like a giant vertical "bar" of a huge "Y-shaped" cloud flow.* Several national weathermen commented on this unusual pattern, which had not been observed before. The pattern continued, day after day, as the blocking continued."

* On the weather maps.

http://www.cheniere.org/books/analysis/history.htm

Tesla Howitzers in Earthquake mode
How to Make an Earthquake

"Here's how you initiate a very large earthquake with such weapons. Take a convenient fault zone of set of them. Focus the interferometry on the fault zone, in the "diverging" mode, and deposit EM energy there in the rocks on both sides, increasing (slowly) the stress in the rocks by the reverse piezoelectric effect (deposit excess energy, get crystal mechanical movements).

"Do it slowly, and the stress will build up to large pressures well-above a plate slip minimum energy required. At some point, the rocks yield and one or both sides "slip" and move rather sharply, giving a very large earthquake in that zone.

"Do the same thing down in the earth (remember, LWs easily penetrate right through the earth and ocean at will, and so the "interference zone" focus can be inside the earth or beneath the ocean, at will.

"Anyway, focus this thing down to where the active part of the volcano is still slumbering, down where the hole in the plate has been made. Keep increasing the deposition of energy in the magma itself, and eventually the increasing pressure from deep within that volcano, underground, will cause an eruption. Build the energy slow, and the eruption will likely be much larger."

http://www.earthchangestv.com/ufo/0209gandor.htm

Yugoslav Earthquake, Followed by Cold Explosion

Strange Characteristics of Iran Quake, Sep. 1978

Tesla Howitzers in Tesla's "Big Eye" mode

How to make a Big Eye in the Sky

By using longitudinal wave interferometry in a weakly endothermic mode a new kind of "radar" is now possible, one which can look right through the earth and oceans. Because the endothermic

mode extracts energy from the distant target, a pattern of the target area can be scanned for in the returned energy.

> "Thus the receiver produces a representation of the energy extracted from various locations within the distant endothermic zone. By displaying the received signals on an appropriately scanned screen, a representation of the distant scene in the intersection zone can be created. Indeed this is a special kind of "microwave interferometry," and -- with modern techniques -- the imagery obtained might be surprisingly good. With development, it might even become as good as the image presently obtained by side-looking acquisition radars.
>
> "Interestingly enough, since scalar EM beams will easily penetrate the earth or the ocean, one can also look beneath the earth or beneath the ocean with this type of scanning scalar interferometer.
>
> "The importance of this capability to strategic and tactical reconnaissance is obvious. Camouflage, cover, and concealment have no effect on such a system. One can easily look inside buildings and into underground facilities. With a small system such as this, the U.S. Marines at Khe Sahn would have had little difficulty locating the tunnels continually dug under the perimeter by the Viet Cong. And targets under jungle canopies are directly visible."
>
> Bearden http://www.cheniere.org/books/ferdelance/s42.htm

Tesla Howitzers can destroy all life on earth

How to Make a Storm on the Sun!!
(Just make a big mistake with your Tesla howitzers)

The deepest dangers of the use of scalar weapons are frighteningly pointed out by Bearden here where he considers that the sun, earth and moon (actually the whole solar system) is a delicately balanced arrangement of scalar (longitudinal) EM radiation. There is a scalar connection between the earth and the sun, which are both giant dipoles gushing energy in the time domain. Big scalar events on the earth could alter this balance causing true catastrophe.

"Indeed, a solar response could be stimulated so that the Sun would violently belch and destroy our biosphere, among other effects."

Unrestrained scalar warfare could cause huge solar storms? To realize that human activity could actually affect the sun itself is truly mind boggling.

Bearden goes on to say:

> "Accordingly, use of huge scalar EM weapons is a double-edged sword. Unless carefully employed, use of the weapons could cause a terrible backlash to the user as well as the victim, and even accidentally cause the destruction of the earth itself. It is not accidental

that in 1960 Khrushchev stated that his new fantastic weapon could -- if unrestrainedly used -- destroy all life on earth.

"This appalling backlash potential is apparently what prompted Brezhnev in 1975 to make so strong an effort to get agreement to outlaw the development of "new weapons of mass destruction" more frightful than the mind of man had even dreamed of. Gromyko even introduced such a draft agreement into the proceedings of the United Nations. The first article of the draft agreement indicated that the nature of the weapons referred to would be negotiated. Sadly, the entire Western world did not even know what the Russians were talking about."

http://www.cheniere.org/books/ferdelance/s24.htm

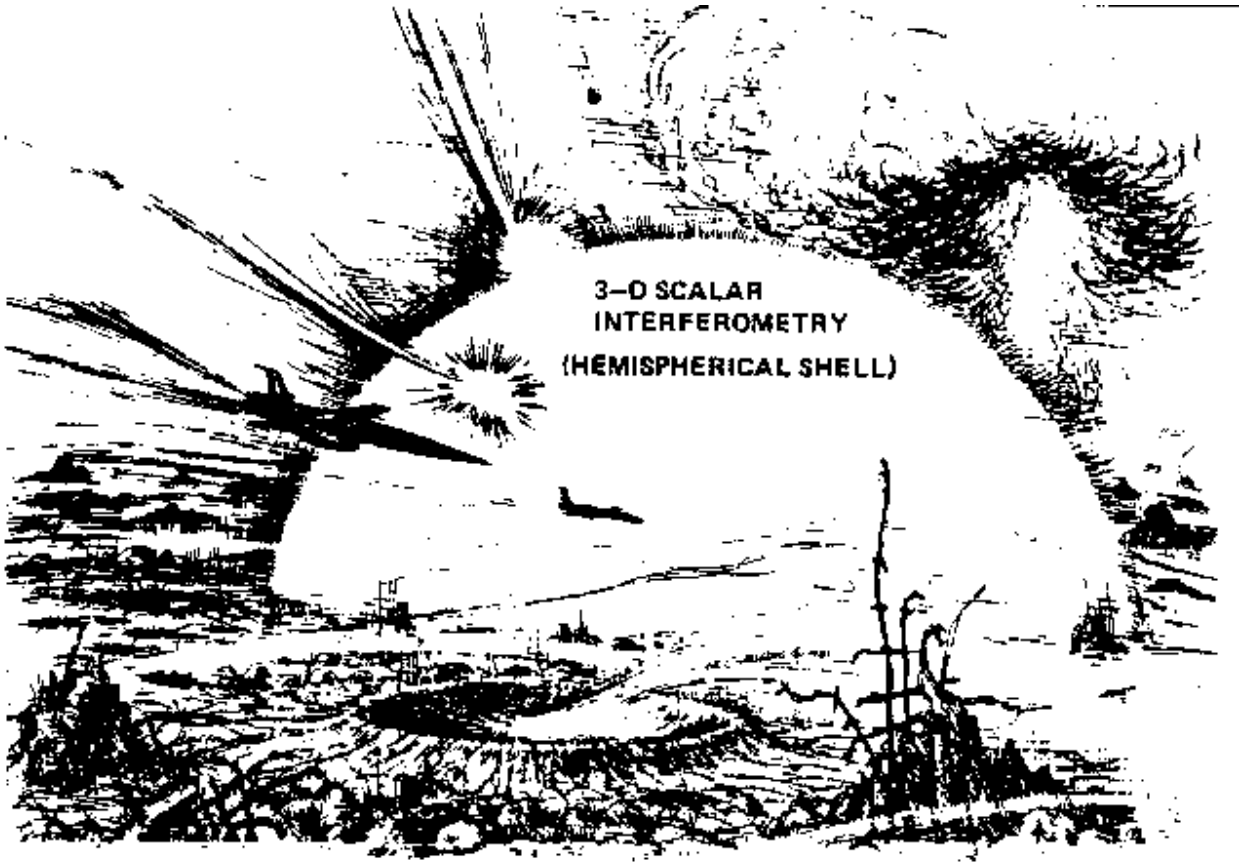

3b. Tesla domes provide near-perfect defense shield.

(Slide from Cheniere.org)

The Tesla howitzers can be used in a nearly impregnable defensive mode whereby they throw up a dome (**Tesla Dome**) or a sphere (**Tesla Globe**) of highly powerful electromagnetic energy, enough to "dud" or destroy missiles which try to penetrate them. Once again, this energy is not

going through space from the howitzer, but being made to emerge from the local vacuum at the location of the shell. KGB tests of these domes have been witnessed by airline pilots around the world. Bearden gives many examples of the Tesla domes being sighted around the world in his briefing paper "Fer-de-Lance." (Russian dome test, another globe incident, yet another globe test). These giant electromagnetic domes can be hundreds of miles across, or narrowed down more to total impermeability.

> "Such a shell may be several hundred miles in diameter at the base. The enormous energy required to form such a defense shell is obtained by a "scalar power tap" into the molten core of the earth itself, as previously explained. In late April/early May of 1985, 27 such "power taps" were placed in the earth by the Soviets. If each tap is capable of powering four to six large scalar EM weapons, then the Soviet strategic scalar EM arsenal contains over 100 monstrous superweapons capable of generating exothermic explosions, endothermic explosions, engineering the weather, locating and destroying underwater submarines, detecting and destroying ballistic missiles shortly after launch, detecting and destroying long range strategic bombers as soon as they are airborne, etc."
>
> http://www.cheniere.org/books/ferdelance/s52.htm

By using nested domes one can protect the domed area even against nuclear radiation itself. Tesla globes can be used to hit airborne targets by simply placing a globe of any chosen size in the flight path of the incoming missile. It does double duty because the missile hits it going in, and then the rubble hits it again going out the other side.

While the U.S. persists in its useless boondoggle "missile defense system" by shooting a missile with a missile (missiles which would already have been "dudded" by the Tesla howitzers), between the domes and the globes the Russians (KGB) have in hand (operational) a nearly perfect missile defense system. Someone should ask the Secretary of Defense if the U.S. Tesla domes are in place. And over which cities? How powerful are our American Tesla domes?

Bearden cites a number of examples of these domes being tested around the world:

March 20, 1969 | March 24, 1977 | August 17, 1980 | June 17, 1966 | June 18, 1982 | June 22, 1976

In a slide from the Fer-de-Lance briefing it is shown how the "woodpecker grid" itself also acts as a sensor, detecting any missile launch anywhere, and how the howitzers can respond instantly by delivering a blast to exactly the right coordinates, right along the channels of that same grid which is feeding the location information about the missile launch. This certainly beats "trying to hit a bullet with a bullet." Especially since YOUR bullet would probably be instantly inoperable in a real scalar war situation.

3c. Rogue Groups in the government

Bearden fears that these scalar electromagnetic secrets may have fallen into the hands of what he called secret "rogue groups" within the labyrinthine depths of the black-ops special-access domain of the secret government. "In the extreme, such a deep black program can even become a

"captured" program," he says, "which is totally in the hands of rogues and no longer reports to or is bound by the dictates of the parent government."

> "They have their own agendas. And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. It's a human characteristic, the old primate dominance game. Only now disguised and hidden under deep classification. ...
>
> "In highly classified groups, these groups are greatly enabled to joust more widely, unethically, and immorally because it is so deeply hidden. So very deep classification evokes the growth and intensity of rogue groups. It's the old 'Power corrupts, and absolute power corrupts absolutely' routine. ... Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, may not operate under very much legitimate government control at all, and may operate specifically for the purposes of the rogue group or groups that have gained control."
>
> "The involvement of at least some rogue groups, some being "cowboys" who operate well outside all laws and ethics, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, it could account for what seems to be actually occurring. "
>
> http://www.cheniere.org/explore%20articles/mind%20control3/p05.htm

3d. World War III has already begun

Because it is now possible to cripple the power grids and electronics of any nation, that nation could be reduced to economic ruin without ever firing an actual "shot." Without electricity Wall Street cannot operate. Without electricity you quickly need martial law. One no longer needs to wage a conventional war anymore at all. There are now lots of new ways to bring any nation to its knees.

> "We are at war, whether we like it or not. And we are going to have strategic strikes on an unparalleled scale for us. Pearl Harbor was nothing compared to what is coming down, once we consider the "augmentation" and such.
>
> "When that factor is considered, then it's a totally new ball game on replacing the power system. There isn't going to be much choice; the old one is going to be destroyed or so badly crippled that it will collapse the U.S. economy in a way we have not seen since 1929. Of course, in such a case hitting us, we will be under martial law, the works, everywhere. For one thing, it's the only way you can keep the cities from imploding from within, by the criminal element, looting, robbing, killing, etc. Simply wait and see; it's on the way."

> Although Bearden has for years decried the "scalar-gap," and chided the military for falling so far behind the Russian KGB in the field of scalar electromagnetics, recent statements indicate that things may at last have changed somewhat.
>
> "In the new war, the first phase of WW III has already been completed. Hence President Bush's recognition that this is a total war, and has to be taken to the enemy no matter where he may be hiding or in what sanctuary or in what foreign nation. This is an entirely different war than anything the U.S. has ever fought in its history. And before it is over, it is going to kill more Americans than have died in all the previous wars in our history. The news media and the public have not yet recognized that awful situation and predicament. Most are already thinking that, well, we won in Afghanistan so it's just about over. Instead, it has only just begun.
>
> "Anyway, that's a brief uptake on some of the weapon situation today. Some 10 nations or more now have LWIs, and five have the QPs. I'm still working on how many have the appalling negative EMP weapons, but would estimate 6 or 7 nations have them in one stage or the other, either deployed or in at least advanced development. And in my estimation, the Yakuza will have them within three to five years if they have to build them themselves, and quicker if they can buy them from the Russians, Chinese, or???"
>
> Bearden http://www.cheniere.org/correspondence/030202a.htm

When he was asked the question '**Does the government listen to Tom Bearden?**" Bearden said:

> "Let me speak carefully. I am very satisfied with how I've been listened to in the quarters where the rubber meets the road. The West is no longer defenseless, not by any means. Cannot amplify it further than that."
>
> http://www.cheniere.org/correspondence/030202a.htm

Bearden has briefed the government a number of times and the Cheniere website contains a great number of his graphic military briefing slides.

3e. Are the Russians making "UFOs?"

Scalar electromagnetics engineering opens the possibility of antigravity vehicles and "hyperspace travel." In other words we can now make our own UFO's! Of such scalar-powered antigravity vehicles, which have now become possible, Bearden has this to say:

> "We might expect to see such vehicles glowing. Their various surface features and mechanisms might appear to be glowing or revolving lights, etc.
>
> "They could exhibit incredible "aerodynamic performance," seemingly in the atmosphere. Actually they would not be moving "through" the atmosphere at all, but through a higher space outside each particle of atmosphere.

"They could seem to materialize and dematerialize.

"They could seem to plunge into the ocean or rise out of it.

"They could even seem to operate under the ocean or inside the earth itself.

"Such anomalous vehicle performances have been seen all over the world, particularly since a few years after WWII.

"It appears that one or more nations of Earth are operating such vehicles now in great secrecy. Our own "government" may even be one of these.

"If so, it isn't our true "government/government." Instead, it's the "control group/government." It's government at the operational level, but at higher level it belongs to certain control groups who have penetrated our government's vitals and taken over all such projects."

Bearden http://www.cheniere.org/books/ferdelance/slide32.htm

In an excellent article on her Earthfiles website, Linda Moulton Howe reports on the utter bafflement of Norwegian scientists over mysterious lights appearing in the valley of Hessdalen, Norway.

She writes of the research there: "The results can be broken down into two groups: 95% are thermal plasmas and 5% are unidentified solid objects. The plasmas emit long wave radio

frequencies and strangely, their temperatures do not vary with change in size or brightness." She quotes the scientists' research summary:

> "1) most of the luminous phenomenon is a thermal plasma;
>
> 2) the light-balls are not single objects but are constituted of many small components which are vibrating around a common barycenter;
>
> 3) the light-balls are able to eject smaller light-balls;
>
> 4) the light-balls change shape all the time;
>
> 5) the luminosity increase of the light balls is due to the increase of the radiating area. But the cause, and the physical mechanism with which radiation is emitted, is currently unknown."

This would almost certainly seem to be another example of the testing of the scalar howitzers. It is baffling because, as Bearden points out repeatedly, Western scientists have limited knowledge of the scalar electromagnetic principles by which the howitzers operate. The Hessdalen scientists were completely baffled as to where the energy of these plasma balls was coming from.

Ms. Howe interviews Massimo Teodorani, Ph.D., Astrophysicist, who released the report on the 2001 Hessdalen sightings. The scientist speaks of the baffling phenomenon observed.

> "I don't know how it is possible that Nature is spontaneously able to do that. Anyway, we deduce that the plasma is trapped inside a sort of magnetic cage and the magnetic cage closes around the plasma and keeps it fixed in some way, prevents it from expanding. But where does it come from? We don't know."

By what we have been considering here, we can recognize the signatures of scalar electromagnetic engineering. If it is a Tesla howitzer, then the energy for the plasma balls is coming from the vacuum of spacetime at the very location of the balls themselves, triggered by scalar interferometers aimed through the woodpecker grid.

These kind of balls can be used as marker beacons giving feedback for precision aiming of the howitzers. The energy of the marker beacon can be read back into the computers giving precise location information for pinpoint aiming. The target area can be very small, or widened out.

There is a little movie of one of the Hessdalen plasma balls here. It would seem to be a clear documentation of a scalar howitzer marker-beacon. How many other current "UFO" sightings are actually the witnessing of Tesla howitzer tests?

In fact there are a great many anomalous events of the past few decades which might very well be explained by the Russian testing of their longitudinal electromagnetic weapons. It would seem that the mysterious appearance of crop circles around the world could be accomplished by feeding a precise mathematical graphic pattern into the computerized aiming software and change the very molecular structure of the crops themselves along the lines of that pattern. The

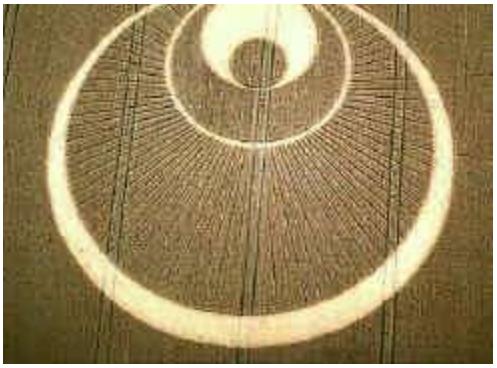

stalks fall over from the localized effect of the longitudinal waves. A plasma ball tracing patterns? Are they slyly sending a message to see if we are "getting it" yet?

The "Cambridge Angel" - Made by Russian scalar plasma balls?

Also see: Interview with Tom Bearden

(Slide from Cheniere.org)

4. Healing powers of longitudinal waves

Healing via longitudinal waves, time reversal of cells (de-differentiation), Priore's machine, Bearden's proposed "blanket" version, using the electric power grid for healing waves or for broadcasting disease patterns. Scalar Biowar.

The good news!

> "Any sort of disease whatsoever - physical or mental - will be rapidly curable, simply and cheaply. It will be possible to reverse aging and rejuvenate the person. It will be possible to regrow limbs and straighten misshapen spines - and directly remove the causes of mental diseases and cure them as well. Lifespan will be staggeringly increased, without 'old age's debilitation.' AIDS, cancer, leukemia, and genetic diseases will be completely conquered. The potential for a true golden era is upon us, for all humanity."
>
> Bearden- http://twm.co.nz/beard_interview.htm

Proof of the healing powers of longitudinal waves from the vacuum is seen in the work of Antoine Priore who produced longitudinal scalar waves using a gigantic glass tube filled with plasma. He himself did not understand why it worked or how it cured cancer in animals.

> "The Priore team cured terminal tumors, trypanosomias, and other dread diseases in laboratory animals in France, in the 1960s and 1970s, under rigorous scientific protocols by eminent scientists. The Priore project was funded by the French Government to the tune of several millions of dollars (equivalent).
> http://www.explorepub.com/articles/energetics.html
>
> ". . . Prioré's machines concretely demonstrated a nearly 100% cure of all kinds of terminal cancers and leukemias, in thousands of rigorous laboratory tests with animals. These results were shown to medical scientists as early as 1960." http://www.cheniere.org/priore/index.html

Bearden has stated that the longitudinal EM waves can have a healing effect because they always come in pairs called "phase conjugate pairs" and one of the pair is time-reversed. This enables engineering of the waves to "pump" the cells of the body (with waves from the time domain) and actually time-reverse the cells back to a previous healthy condition. The scalar cure of cancer does not involve killing the cancer cells but rather pumping them with time energy into a previous condition. I know, this seems miraculous, and is it not?

Priore and his giant plasma tube

This healing power in the longitudinal waves of the time domain is a mind-boggling thing to face. It took me months to get through it, and to suffer the fact that the cure for cancer and AIDS was right there, in this new scalar electromagnetics technology, and that it has been kept back from the people for so many decades now.

Bearden has a great deal to say about the work of Priore, who himself did not understand why his machine worked. Priore did not know about the longitudinal scalar waves of the time domain. In fact, Tom Bearden has supplied, at last, the missing explanation as to how that big giant two-story glass tube consistently cured cancer in animals.

"**The medical implications are enormous**. By just reversing the damaged cells back to a previous physical state, this gives a physics mechanism for controlled cellular dedifferentiation, in biology terms. Physicians will time-reverse diseased, damaged or aged cells back to an earlier healthy condition, including all the cellular genetics. Normal cells are just reversed to a slightly younger condition."

> "We believe this mechanism explains the revolutionary but baffling electromagnetic cures achieved by a team of outstanding French scientists in the 1960s and early 70s, working with inventor Antoine Prioré. In lab animals, cures were achieved for terminal tumors, infectious diseases such as trypanosomiasis, and atheriosclerosis. In addition, deliberately suppressed immune systems were dramatically restored.
>
> "We hypothesize that this is the long-sought mechanism of how the living body heals itself. In short, the body's cellular control system induces cellular reversal by weak time-domain pumping of the damaged cells and the affected area. The cellular regeneration system performs all healing of cellular damage in the body; the immune system heals nothing, not even its own damaged cells) .
>
> "For the first time medical science can develop as a science of healing rather than a science of intervention. And it will develop as a science of unlimited healing, since no pathogen can resist action by curved spacetime engines." Bearden
>
> http://www.cheniere.org/techpapers/Vision%202000%20paper.doc

See Priore's machine See Slides of how it works.

Bearden has extended the Priore work, with the previously missing knowledge now in place, and designed a revised system (for irradiating the body with longitudinal waves) which gets rid of Priore's giant glass plasma tube and uses instead an antenna unit which surrounds the body. He has also provided the missing explanation of how it works. There is an article from "Explore" magazine, Part I and Part II.

In fact, Bearden has presented to the U.S. government a plan to use a portable version of a Scalar Healing Blanket where wire channels in the blanket act as a scalar antenna, which can both send and receive scalar electromagnetic waves. A two minute treatment of the waves is sufficient to restore the body to its earlier healthy condition. Thus even thousands could be treated easily and quickly in a biowar mass attack situation.

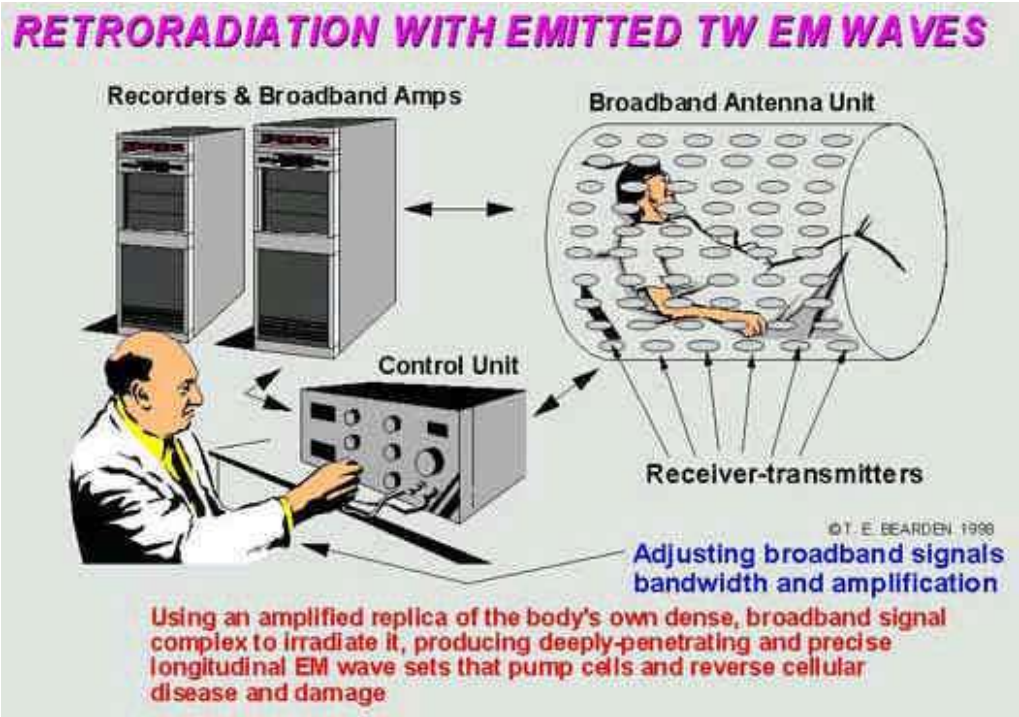

"To defend against things like anthrax attacks on our civilian population centers, we also have recommended to the U.S. Government the crash development of small, portable treatment machines—using similar "antiengine-forming" and cellular reversing "porthole technology". [See Figure 13 on previous page]. Such portable machines could be developed cheaply and quickly, and present government facilities could be used to massively attack the correlate database production problem. "The portable treatment units could be cranked out by the hundreds of thousands and flooded down through emergency response agencies such as the police forces, the National Guard, emergency hospitals,

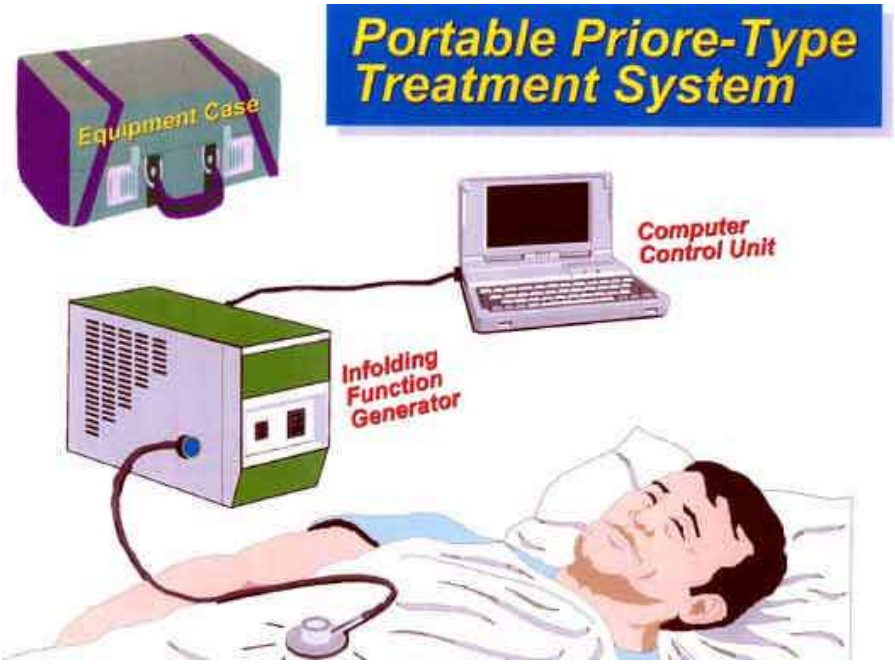

emergency response teams, etc."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p04.htm

The Scalar Healing Blanket would fit into large suitcase. It has three basic parts, the longitudinal wave generator, a laptop computer, and the antenna-blanket. The plan was a stroke of Bearden's genius, but unfortunately it fell on befuddled government ears. "Unfortunately, so far the DOD [Dept. of Defense] doesn't even understand what the heck we're talking about!"

Article '**Healing with Energy**': http://www.explorepub.com/articles/energetics.html

"We tried very hard in 1998 to call attention to the extreme national need for the most urgent possible development of a portable computer-controlled treatment device based on the experimentally proven Prioré methodology, but extended to a much simpler and far more rapid method of treatment.

"Quick development of this technology could lead to a suitcase size device, capable of treating a patient in less than one minute, and stopping the symptoms and disease progress cold, then reversing it. Three "less than a minute" treatments one week apart would be required for complete cure. As an added advantage, partial reversal of aging in older patients would also be accomplished as a bonus, in addition to time-reversing the damaged and diseased cells...

"The method proposed to the DoD in 1998 used normal EM in a peculiar way to force the body itself to make its own time-polarized EM waves, and pump every part of its cells -- including the genetics -- in the time domain.

"Quite simply, we are going to be struck this way (QP spreading the immune systems of the populace plus professional smallpox, anthrax, etc. BW attacks on our population centers) and by other means we've spoken of in other papers and briefings."

Bearden http://www.cheniere.org/correspondence/021401.htm

The Dark Side of the Force:
Creating and broadcasting disease

Speaking of the scalar wave induction of disease by longitudinal wave patterns Bearden refers to work by French scientist Kervran Russian scientist Kaznacheyev, who proved that any disease could be transmitted electromagnetically.

"It works this way: the Kaznacheyev experiments (and others) demonstrated that any cellular disease or disorder can be initiated into cells at a distance, by electromagnetic means (albeit unusual EM in nature). The decades of microwave radiation of the U.S. Embassy in Moscow, was an ongoing set of "stimuli" to ping the U.S. system and, by its response, ascertain how far along (or if it was "along") in its knowledge of such weapons. The radiation was responsible for many health changes in personnel and for the eventual deaths of three U.S. Ambassadors."

Bearden http://www.cheniere.org/correspondence/021702a.htm

In a letter he writes,

> "Yes, the Kaznacheyev experiments were quite real; 15,000 or so in military research institutes in Siberia. As with so many other novel areas investigated and developed by the Soviets, most U.S. investigators just assumed normal EM, which is not what the Kaznacheyev experiments involved, and not what was carrying disease induction patterns from one cell culture to another in rigorous lab tests."

How to "Broadcast" Diseases

Longitudinal EM Biowars

Bearden explains how the new quantum potential weapons can be used to induce disease-at-a-distance in a population, or to "spread" the immune system so thin that a conventional bio-attack would be greatly potentiated. By "broadcasting" virtual disease patterns over a population, the immune system is so overloaded by the presence of the "shadow" diseases that its effectiveness is thinned out.

> "In short, alter the internal wavestructure, and one creates a curved spacetime 'engine' that acts on mass in any fashion one chooses to design -- including initiate diseases . . . Now visualize one of these 'vacuum engines' or 'spacetime curvature engines' that acts on mass to generate the exact effects produced by anthrax. (Or any other disease one wishes) . . . Call the virtual state of a disease engine the disease pattern in the "shadow" state, just prior to becoming observable. . . .
>
> "And the master cellular control system responds to "coming events that cast their shadows before". In short, it responds to the upper level of the "shadow state" of a disease, still in the virtual state! (Hey, virtual particles are real, virtual photons are real, virtual ST curvatures are real --- just very fleeting, only for another to immediately arise). The exchange of virtual particles is known to generate all forces in physics anyway! . . .
>
> "So the cellular control system responds to "shadow state" disease patterns. Enter a QP weapon application. Place a quantum potential weapon "area" on the United States, so that the entire populace is in it. The slowly introduce and bring up in the shadow state, the necrotizing fasciitis disease engine. At some point, the cellular control systems will react, and order the immune system into action. In other words, immune system resources will be committed against this "immediately coming" enemy. Bring it on up a little, but still just in the shadow state. Voila! Humans form a bell-shaped distribution curve. And even if the structure of the QP fluctuates a little, fluctuating a bit stronger and a bit weaker, etc. A few of those targeted bodies will now actually develop necrotizing fasciitis. So far, just like the U.S. Embassy targeting, except a different "carrier".
>
> "But now there is an exact signature that this is what is doing it, and not normal vector carriers of disease and contact or exposure infection. The few cases of necrotizing fasciitis that break out will be most puzzling. They will be randomly scattered across the

entire nation, and so few that the vector carrier and contact or exposure explanation completely fails."

"And that one happened, right here in the U.S., not so long ago. Check it out.

"So carefully adjust the patterns for, say, 12 major terrible diseases, to that "adjusted and desired shadow state level". Now add all 12 patterns into the internal structure of the quantum potential. Now it has 12 shadow state disease engines in it.

"Place that one on a populace. The cellular control systems order the immune systems into action, and they now have to commit their finite resources to 12 different areas. This greatly thins the response an immune system can make to any one of those 12 disease patterns! In short, it "spreads" the capabilities of the immune system, which can be galvanized to great effort, but only can perform a small bit against each area.

"Suppose one of those "galvanized" areas in the targeted populace's immune systems is anthrax. And suppose the bad guys now hit one or more of those cities with a professional anthrax attack. A former OTA study showed that a professional anthrax aerial spray attack against Washington D.C., dispensing 100 kilograms of anthrax spores in the spray, will account for 1 to 3 million casualties. And that's in an "unthinned" set of immune systems. In the "thinned" set, one can at least double or triple, and even up to five times, that estimate. So conservatively, now there would be from 2 to 6 million casualties. And even mild anthrax spray attacks in other "thinned" cities would also be amplified.

"That one is being set up, or already set up, right now. There are other such "augmentation" setups also under way.

"So the weapons alluded to by the SecDef in 1997 are already being employed. WW III has already begun, and our populace (and our scientific community) is blissfully unaware of it."

http://www.cheniere.org/correspondence/021702a.htm

Most of us can remember the strange outbreaks of the so-called "flesh eating disease." It seemed to break out here and there randomly with no known cause. Bearden believes this was a test of the newer quantum potential weapons which go even beyond the capabilities of the Tesla howitzers.

"The Kaznacheyev "disease induction by novel electrodynamics" work is also the basis for the spacetime curvature engines (not EM signals!) carried by quantum potential EM biological weapons for distant induction of diseases etc. into the population of an entire nation or area, such as the U.S.

"This quantum potential disease induction weapon -- capable of attacking an entire population of a nation or area -- has been tested several times in the U.S. at very low levels, in the shadow state only (we explain shortly) and it has a most peculiar signature. E.g., one test used necrotizing fasciitis (flesh-rotting disease) engines.

> "The disease 'engine' was deliberately kept down in the 'shadow state' (virtual state, just below the observable state) so that only a tiny bit of the populace with depressed thresholds would "breach the observable threshold' due to the population forming a bell-shaped curve as to the threshold level. The major signature of the test was that the cases of the disease broke out totally statistically and randomly, spread all over, without any 'disease vector' in between.
>
> "In short, it was not spread in any manner required by normal deterministic disease vectoring, but was a totally random set of occurrences. Several other diseases were also tested this way in the American populace, with precisely the same signature."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

"Apparently one planned use of such an augmented clandestine BW weapon will be smallpox, e.g. As you know, the Russians did develop smallpox for biological warfare, and even developed a new strain against which previous vaccination is ineffective.

> "The vast numbers of expected casualties, coupled with immune system spreading, are absolutely irresistible to the Russian mind. You can count on it that they have seen that the smallpox is already on site here, in the U.S. and in the hands of professional terrorist teams. Of course, the Russians/KGB will protest they have nothing to do with that! Yet likely the KGB will have flatly arranged it or at least assisted it. The capability for mass destruction of the nation is so lucrative and easy to achieve in advance, that they would never be able to resist doing it."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

Bearden believes the Gulf War Syndrome involved the use of scalar technology to induce a disease state, as he stated in a 1997 interview:

> "I'll say this flatly, and I won't answer any further questions about it; the Gulf War Syndrome was induced... It was induced with this stuff. All the rest... was contributing factors that everybody's talking about... There are some deeper signatures, if you look into it very deeply, that show you exactly how it was done and the fact that it was induced. It was a test. It was a test of a very special kind of weapon I have not talked about yet. Anyway you can use it to create diseases."
>
> Bearden http://twm.co.nz/beard_weapon.htm

Besides using the woodpecker grid to target a population, the entire electrical grids of nations can be used as "channels" for disease patterns to be broadcast to all people near that grid. Your own house wiring can become an antenna, broadcasting these "shadow" patterns of disease, weakening your immune system.

And here one faces the frustrating fact that the same power grids could be set to channel patterns which would keep the entire population healthy, rejuvenated, continuously bathing in the time-reversing old-age-defying energy of the spacetime vacuum. We have no idea yet of how long the

human life span could be increased with this new technology. People might be able to live two centuries given full humane development of this technology.

5. Psychoenergetics

Mental entrainment, inducing hypnogogic trance, mind control, broadcasting thoughts and feelings, the Ant World, education via EM [LW] mental download, the "Feelies," revolution in spirituality, "enlightenment machine?" Scalar churches?

Psychoenergetics is simply using the scalar interferometers to manipulate and engineer the human psyche. To me it is the most mind-boggling and frightening aspect of longitudinal wave engineering.

The mind is electromagnetic in nature, and itself of the time-domain. It is not observable in 3-space. There is no thing you can point to that is the mind. As Bearden says**, "The mind is time-like**."

The longitudinal scalar EM waves are also of the time-domain. By overlaying certain infolded patterns (oscillations in time) on the longitudinal waves, a thought or feeling may be made to arise in a person or persons who are in the **interference zone** (where the wave beams cross).

The person will not notice anything, feeling that this thought or idea is his or her own idea. The longitudinal wave pattern might be a wave of panic or fear that spontaneously sweeps over you, perhaps inexplicably. It could even be in the form of a sudden intense patriotism. It could be explicit words and phrases, which everyone would think they had thought of by themselves. Or it could be rage and hatred, angry and violent. On the other hand It could also be a continuous sense of docility and placidity. This is the brave new world of psychoenergetics and the coming "Mind Wars."

Scalar Psychoenergetics in its most primitive form simply "entrains" all minds in the target area into a deep hypnogogic trance. In this state of mind people would be suddenly extremely suggestible, and would likely believe anything they are told, and would obey any orders given. Talk about winning the hearts and minds of the American People!

Tom Bearden makes me think of **Paul Revere**, who heroically conveyed important warnings for the sake of the new nation. But the words of the famous phrase have now strangely and curiously mutated into the once-inconceivable: "**One if by land, Two if by mind**."

Indeed one strategy in a Mind War would be to simply take over the minds of the "leaders" of the enemy nation. The targeted leader would not be aware that anything was amiss, although he might begin to make unexpected changes in policy.

And are, in fact, any of our "leaders" already having secret thoughts that are not their own? Who knows? Frighteningly, we can no longer be sure. The new sciences of scalar electromagnetics

and psychoenergetics are even now plunging humanity into a sudden science-fiction-like world beyond anything in humanity's previous imaginings.

> "The Russians reached the point in the mid 1990s that they could take over control of a person's mind, with modified longitudinal EM waves including some time-polarized EM waves, and with a team of specialists (estimate 25-30 per transmitter, and one transmitter and team per controlled person)." Bearden http://www.cheniere.org/misc/time.htm

In a slide Bearden illustrates how a Scalar War would involve a psychoenergetics attack on the operators of the enemy scalar installation, entraining their minds into hypnogogic trance and getting them to shut down their systems.

And ultimately psychoenergetic warfare goes to the very heart of human identity itself. For if my thoughts might no longer be "mine," then who and what am I? Can my very sense of being "me" be hijacked by some nefarious psychoenergetic scheme? Will the "secret government" eventually dictate directly into your mind how you feel about yourself? Or what you think you are? Or what you should do?

How Does Longitudinal EM Mind Control Work?

The physics of scalar psychoenergetics as expounded by Col. Bearden seems even more arcane and over-my-head than that of extracting energy from the vacuum. I can't understand it, but I look through it anyway. Each time another tiny understanding might occur, or a term might fall into place. I know the mathematics is forever beyond me.

One paper to begin with is "Mind Control and EM Wave Polarization Transductions" This is such serious stuff that Bearden includes a strong warning about misuse of this knowledge. Psychoenergetics weapons can mentally maim and physically kill.

Warning!

(From "Mind Control and EM Wave Polarization Transductions")

> "This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for nonapproved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p01.htm

After the serious warning comes the description of the paper. This is heady stuff for the layman.

> "Calling full attention to the special note above, in this paper we present a high-level overview of the novel electromagnetic nature of mind operations, mind and body coupling, and intent - the induction of physical 3-space EM energy changes into the brain and nervous system, and into every cell of the body, from the mind's time-like coherent operations. We summarize the time-polarized electrodynamics used to engineer and affect mind operations and the mind-body coupling loop. Transaction mechanisms whereby differing EM wave polarization's can be transformed one-into-the-other are presented."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p01.htm

I will leave it to the technically astute to try to understand the mechanisms of operation which are described in scientific language. But there are tidbits for the layman. Here he speaks of the difficulty Western scientists have in opening up to the "immaterial" (longitudinal wave) nature of the human mind.

Western Science Remains Largely Materialistic

> "Ironically, most Western scientists are materialists and consider "mind" as a mystical and nonscientific concept. They tend to consider mind operations and functions either to be simply "meat computer" operations and functions, or at best to be very weak ordinary transverse-wave EM operations and functions in the brain and nervous system. This serious self-limitation exists because in the body we measure only weak TW [transverse wave] EM operations and functions correlated to biological behavior and brain operations. We simply do not know how to measure "mind operations" directly.
>
> "With no mind measurements possible and no instruments, it is understandable that Western science considers only the physical side of the mind-matter interface.
>
> "Presently our scientists do not measure the longitudinally-polarized EM wave operations and functions in the body and around it in nature. Few of them are aware that a maelstrom of such LW [longitudinal wave] functions exist in the body and in all of nature in general."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p05.htm

Western methods of influencing the mind with EM waves have only used transverse waves, not the longitudinal waves of the vacuum. If only transverse waves are used one pretty well has to hit the target mind with a sledgehammer of waves.

Western Science knows only transverse EM waves

Brute Forcing Time Functions versus Fine Control Methods

> "Ironically, Western mind control researchers using transverse EM waves for mind control research, are using a brute force method of evoking and using vacuum engines

> (spacetime curvature engines) and a special form of general relativity, although they do not appear to realize it.
>
> "While KGB scientists also use TW EM "brute force" TW waves when necessary, they do "imprint" or "activate" those waves with the desired internal LW and time-polarized EM wave and photon structures required to directly perform the mind engineering desired... Bearden
>
> "These "fitted brute-force models" certainly can be very powerful, and certainly can produce the exact results shown in the experimental verifications of the fittings. However, they do not of themselves allow sophisticated design for example of the necessary time-polarized wave assemblies for engineering the entire human collective unconscious simultaneously, or for engineering the entire collective unconscious of all species on Earth (i.e., Gail's collective unconscious), or even for precisely engineering the memory and knowledge base of an individual.
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p09.htm

The seemingly magical operations of psychoenergetics, sometimes called "psychotronics," cannot be achieved with ordinary transverse EM wave energy. But they are possible with longitudinal scalar waves because the mind itself is scalar in nature.

> "We note that all mind operations are time-like, i.e., they are comprised as scalar EM photon functions and scalar EM wave functions. Thus the mind is a very special kind of electromagnetic system, existing in the time domain..."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p08.htm

The engineering of the mind can only be accomplished with the waves of time.

The course of psychoenergetics development necessitates the building of a vast database of settings and patterns which bring about given mental and/or emotional states. A kind of "gnome" of the psyche. Bearden describes the process of the decoding of this "gnome."

> "Now the scientists would perform many phenomenology experiments, making one little change at a time and profusely recording the data. Each time, they would establish the physical change(s) that occur in the body and/or the mental and emotional changes that occur in the mind for each spectral reinsertion back through the "ship's portholes". They would simply but painstakingly (over some years) build up an extensive database of those individual correlates.
>
> "In these experiments, the experimenters will eventually be able to provoke any body or mind change they wish. Strong emotion. Intense pain. Intense pleasure. Painful thoughts. Images. Memories. Perceptions. Dreams. Visions. Memory losses. Memory changes. Personality changes. Etc. The "delta" in the emission spectrum (the changes from zero reference spectrum) represent the precise totality of all mental, physical, organic, chemical, etc. changes and interactions."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p01.htm

"A second stage in the research would be to test the correlates and porthole insertions upon a statistically significant cross section of ordinary people, and/or specialized populations (such as toughened soldiers). The program would evolve a highly complex, very effective, ever-improving science and technology of mind and behavior control and engineering mechanisms, complete with finished database and developed applications equipment."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p02.htm

Summing up his paper Bearden speculates on what the actual situation the science of psychoenergetics probably is. The intense secrecy with which this knowledge has been kept from the public has led to the current farce of the "government" pretending it all does not exist, and this secrecy may have now put us at great risk.

"The implication is that in the West one or more highly classified, sustained, heavily funded developments in advanced mind control programs, probably exists and probably has existed for some time. Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, may not operate under very much legitimate government control at all, and may operate specifically for the purposes of the rogue group or groups that have gained control.

"In a nutshell, that's what may be going on in the clandestine mind control projects in several Western governments. The involvement of at least some rogue groups, some being "cowboys" who operate well outside all laws and ethics, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, it could account for what seems to be actually occurring. As also is "usual" in such a mess, one or more of the rogue groups eventually may become very powerful because their secret weapons are very powerful. They may become confident, thinking they have the "best in the world." They may actually believe they are ahead of the Russians..."

"Remember that, in every large and powerful human organization, the basis for rogue groups is power and secrecy. They are always seeking to increase their power, control, influence, prestige, etc. Nothing else. Patriotism and mission are—to rogue groups—often just idle words. They have their own agendas. And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. It's a human characteristic, the old primate dominance game. Only now disguised and hidden under deep classification."

"The Russians, with their additional knowledge of the actual mechanisms in the transforms, will be much more advanced than the West, because their fundamental psychoenergetics science is far more advanced, so long as we continue to use the old U(l) electrodynamics. Further, the Russians have decades of use of longitudinal interferometry beams to reach right through the earth and ocean and produce stringent EM effects at a distance. So they will also be able to do the same things here in "mind control" with LW [longitudinal wave] interferometers, through intervening mass."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p05.htm

Bearden cites two examples where he believes the Russian KGB tested the psychoenergetics capabilities of their scalar interferometers. One was the case of Captain Button in his A-10 "Warthog" aircraft on April 2, 1997.

> "Over Arizona, Captain Button was thrown into a hypnogogic state, and his perceptions instantly altered and controlled. In his instant "dream-waking" state, everything seemed perfectly normal. His sense of direction was altered a bit more than 90 degrees, so he simply corrected and turned and "flew toward the range", actually flying off course by more than 90 degrees and ignoring radio contacts. He flew right on out of Arizona."
>
> "At one point he circled, probably thinking he was over the range, and he probably dropped his ordnance there. Then he "flew on back toward home," as he thought in his waking dream state, until his fuel ran out and he crashed and died in the explosion—dream-thinking until he died that everything was normal. All the while, his sense of the passage of time was altered. To him, in his dream-thinking, dream-acting state, everything was normal and nothing untoward had happened. So the distant KGB transmitters and associated psychoenergetics team controlled him for over an hour. "Indeed, that was the exact purpose of the test: demonstrate control (at a great distance) of a skilled person performing highly skilled tasks."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p06.htm

The paper "Mind Control and EM Wave Polarization Transductions" ends with the most chilling and frightening possibility of all: the psychoenergetic engineering of the human species as a whole.

The Ant World

The Final Race for Direct Mind Control of the Entire Human Species

> "The KGB psychoenergetics weapons scientists—because of their direct measurements and detections (and use) of t-polarized waves and LWs [longitudinal waves] for decades—also understand that Jung's collective unconscious mind (of the entire human species) also has its own time-like operations and correlates, which one measures also when using t-polarization measurements and sorting it all out. The collective unconscious mind operations are buried several levels deeper inside the recursive Whittaker structuring inside the EM fields, waves, and potentials. "The KGB scientists also know that something very like Gaia — a collective unconscious mind for all species on earth — also exists, and they are striving to be able to sort out and measure that one as well. The Gaia operations are buried even deeper in the recursive structuring inside the EM fields, waves, and potentials.""Actually, from day one, the Russian mind control scientists have had their eventual goal set upon this "deeper area of mind and possible mind control" of the entire human species.
>
> "I am convinced that the KGB psychoenergetics scientists understand this deeper area. If they can learn to directly engineer the collective human species unconscious, they can

> then convert the human species easily into a sort of "ant" society, modeled along ideal Communism lines, except of course with an excluded "hierarchy at the top" running everything. The "ant society" — communist style — is still a variation of feudalism (all systems tend to feudalism or some form thereof). "The KGB psychoenergetics weapon scientists are seriously pressing on toward that very goal. In my opinion they are not very far from it right now...
>
> "Some versions of Russian mind control devices were used on Russian soldiers in the Afghan War to condition them for performance of merciless acts." 13
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p07.htm

More about "The Ant World"

Whether it is the Russians planning an "ant world" society or rogue U.S. black-ops groups withholding a great boon from human race, the secrecy on all sides around has allowed largely criminal elements to take over this technology while leaving the civilized elements in the dark. Openness and the spreading of this knowledge among good and decent people is essential, and for that we will have to overcome our frightened denial.

> "Meanwhile, rogue groups amongst Western clandestine mind control researchers will probably arise if they have not already done so. They will likely seek to increase their personal control and further isolate the programs from orthodox government review and from government and legislative control. They may even divert the research into highly illegal and unethical means, because it furthers their own rogue agendas. That is how clandestine U.S. government research can sometimes go sour, unless great care is exercised by the oversight committees in the House and the Senate.
>
> "Sometimes when rogue groups do gain control and total secrecy of a given new technological area, then what appears to be "U.S. government operations" do start to encompass a criminal and unethical operations, hidden usually beneath the deep veil of high classification. Also, if it's "scientific," no one is ever brought to justice, even if the "evil science actions" are uncovered and publicly revealed."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p08.htm

Like the huge energy of the Tesla howitzers, the ability to engineer the mind with longitudinal waveforms is a seeming "magical" thing which can be used for good or ill. Bearden envisions that further developments will allow something like the "downloading" of knowledge via scalar interferometry. Everyone could be highly educated, and quickly and easily.

In the conclusion of the paper "Mind Control and EM Wave Polarization Transductions" Bearden makes a plea to the nations of the world regarding the use of psychoenergetic engineering.

> "Let us hope this great new area, already off to a bad start, can be bridled and steered in the direction helping and healing people, rather than killing or abusing them. The excesses in its bad use are a potent threat to all nations on earth.

"Yet it can revolutionize medical science, education, communication, and psychology. We foresee the day -- perhaps 30 years hence -- when education will be accomplished by directly loading the software into the mind. Then in three weeks one will "load" a doctorate, say, in physics. In three more weeks on will also load a doctorate in chemistry. Another three weeks, in electrical engineering. Another three weeks, an MD And so on. When that happens then truly everyone on earth can be educated. Freedom from ignorance may well be another great freedom that is legally recognized. There will be no impoverished large groups lacking the education to find decent, productive jobs.

"We urge all nations to use the principles involved: not for human abuse, but for healing, educating, uplifting, and life-expanding of every person on earth. If we do, we shall all have a far brighter future. Then we shall check what has started out to be the Sword of Damocles and turn it into the golden Millennium."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p08.htm

(Perhaps after so many frightening topics a slight break is in order here to consider the lighter side of psychoenergetics. For example, what will be the ultimate impact on the entertainment industry?)

The Feelies at Last!

Psychoenergetics will be able to bring about at last, for better or for worse, Aldous Huxley's fanciful idea in his novel "Brave New World," an entertainment format which he called "The Feelies." Those were something you went to, like going to the movies, but you would experience all the actual feelings themselves, as if the depicted events were actually happening to you. Although our "leaders" seem too dim to grasp what is going on in the world of scalar electromagnetics, it should not take some young Hollywood genius too long to understand that The Feelies are now possible, and that the immense megabucks of potential profit more than justify heavy investment in bringing it to market.

One can imagine that first "Feelie" theater, "The Huxley" perhaps, a large comfortable area surrounded by nine giant screens (not just one screen!), which become 3D if you put on your headset. And The Huxley is fitted with the finest sound, and oh, by the way, a modest sized scalar interferometer with computer. And there are one or more new tracks now recorded on the film next to the sound track. These are the digital patterns of thoughts, feelings, and ideas to be fed into the theater's interferometer. And these thoughts and feelings and ideas will be felt by the audience as if they were their own thoughts and ideas. It is an entirely new art form. Psychevision.

As important (and no doubt famous) as the actors would be the "feelers," those from whose minds the feelings were lifted in the original programming of the Feelie tracks. Because, for example, Brad Pitt might be a good and handsome actor, but can he really feel it? Like the dubbing of foreign language films, it might be necessary to dub the "emotional track" using a deeper and more profound person's feelings, thoughts and ideas.

It might even be engineered so that if you sat on one side of the theater you would feel like the hero, and on the other side you would feel exactly like the bad guy! What would that lead to?

We have all cried at a movie some time, most people have, though they might not want to admit it. But this would be deep sobbing and a flood of tears, if the director so desired it. You would feel it at your core. Or, take a big chase scene, you would be terrified. They are breathing down your neck! You would be gripped by panic.

For that matter, the whole genre of Horror-Feelie would be too much for many people to take. Do I really want to feel that an actual vampire is tearing at my throat with his fangs?

A Religious Feelie would make you feel the exaltation of a saint at his prayers, or give you the definite feeling that you are Christ suffering on the cross. All the pain could be there too. The stickiness of the blood. The very feeling itself: "Why hast thou forsaken me?" Who among us could come up that despair for scanning? Had this been developed a bit earlier we might watch a documentary of, say, Mother Theresa, containing her own actual deep sense of compassion, which we would feel arising in us as our own.

Then again, a Psychedelic Feelie could induce an LSD-like state and simply blow the audience's minds.

Even in its simplest most primitive mode, the hypnogogic trance induction with its increased suggestibility, would completely alter the experience of even ordinary current movie going.

6. As it Stands - 2002

"Anyway, it's presently a "Mexican stand-off" with the various parties maneuvering with check and countercheck. That is the real "balance of terror" that is held by such a fragile balance."

"You can see the implications if such weapons fall into the hands of the radical terrorists. Ordinary positive energy EMP shooters can be made fairly readily and cheaply from nearly just Radio Shack parts or surplus parts. It just takes some know-how... When and if the Yakuza [Japanese mafia] gets those (and they will, it's just a question of time), you can begin to appreciate some of the turns this present terrorism and our war on it will take."

Bearden http://www.cheniere.org/correspondence/021702a.htm

The very thought of the building of one of these howitzers by "some lone-nut gunman" from Radio Shack parts makes one realize how serious it is for humanity to face the crisis it has come to.

Once again, as at the dawn of the nuclear era, humanity finds itself at the crossroads of Heaven and Hell. As a species, we must stop and consider. And there is at least one real difference between this visit to the crossroads and the last: this time there is a very real possibility of a true "earthly heaven" on the Heaven side.

The poor nations could come to a good life. Disease could be largely eliminated. Fossil fuel pollution could end. Global warming could be solved, and the weather could be managed in a humane way, bringing water where there is drought, and sunny skies where there is flood. Scalar interferometry would be there to avert any possible hits by asteroids or comets. Mars could be colonized and terraformed. Everyone would be highly educated through psychoenergetic downloading of knowledge. And the wisdom of the wise could be realized directly through scalar connection to their minds and hearts.

These stunning sudden possibilities give me pause to think: if our species has reached this crossroads in such a short span of centuries, then surely other species in this vast universe have passed this way before and long ago. And of those who chose the path to "planetary heaven," what is their life like now? It might be good if some of them were with us now, to guide us through this last struggle over this pesky old good-and-evil problem. It is our last chance to choose the path which benefits the whole species, and not just some elite group or faction.

The Disclosure Project

One person working tirelessly to bring to bring these technologies into the open is Dr. Stephen Greer of the Disclosure Project, which is calling for congressional hearings into the issues of UFOs and the free energy technology that was, perhaps in part, reverse-engineered from them.

> "Once abundant and nearly free energy is available in impoverished areas for agriculture, transportation, construction, manufacturing and electrification, there is no limit to what humanity can achieve. It is ridiculous — obscene even — that mind-boggling poverty and famine exists in the world while we sit on classified technologies that could completely reverse this situation. "So why not release these technologies? Because the social, economic and geo-political order of the world would be greatly altered. Every deep insider with whom I have met has emphasized that this would be the greatest change in known human history. The matter is so highly classified not because it is so silly, but because its implications are so profound and far reaching. By nature, those who control such projects do not like change. And here we are talking about the biggest economic, technological, social and geo-political change in known human history. Hence, the status quo is maintained, even as our civilization hurtles towards oblivion...
>
> "With the types of weapons currently in the covert arsenal — weapons more fearsome even than thermonuclear devices — there is no possibility of a survivable conflict. Yet in the darkness of secrecy, actions have been taken on behalf of every human that may

> endanger our future. Only a full, honest disclosure will correct this situation. It is not possible for me to convey in words the urgency of this."
>
> Dr. Stephen Greer http://www.disclosureproject.org/ES-DisclosureImplications-2.htm

Greer and his team have assembled hundreds of witnesses, many of whom are military or ex-military, who are ready to testify to congressional hearings what they know about the covert black projects which have kept free-energy and antigravity propulsion technology secret from the people.

Greer points out the need to regulate these technologies so they are limited to peaceful uses, but this is of course difficult when the government simply chooses to pretend they do not exist. In the meantime, as the President and the Defense Department continue the charade of war-as-usual, those scalar (longitudinal wave) installations which DO exist continue to fall into ever more sinister hands. And there is no reporter in the press brave enough to ask, "Mr. Secretary of Defense, what steps are you taking to defend our MINDS from attack by the big Russian longitudinal interferometers?"

Longitudinal Interferometers are Proliferating

In a later statement Bearden reveals that in fact the Yakuza [Japanese mafia] has already leased some of the interferometers with a nearly $1 billion "down payment:"

> "After the collapse of the Soviet Union's economy, lots of things got available for lease or purchase that would never have been under the old system. That happened in the resulting economic chaos. The Russian Mafia rose to prominence, as did some wheeling and dealing entrepreneurs who played both ends against the middle.
>
> "In that atmosphere, and in the need for money, the KGB allowed leasing of the earlier longitudinal EM wave interferometers to a consortium of the Yakuza and Aum Shinrikyo. They did this only after they had tested and deployed their great new quantum potential weapons. That class of weapon is the dominant weapon on earth. Five nations now have it: Brazil, Russia (KGB), China, and two nations friendly to the U.S. The deal to lease many of the earlier LWIs [longitudinal wave interferometers] to the Japanese Yakuza and Aum Shinrikyo was consummated at the end of 1989, with a down payment of $900 million in gold bullion as "up front" money. I don't know what the lease per year was and is, but probably something like a billion dollars a year. So the rogue Japanese acquired longitudinal EM weapons and that technical know-how. In fact, the Yakuza is producing certain kinds of those in its own facilities in Japan now."
>
> Bearden http://www.cheniere.org/correspondence/030202a.htm

Personally, I am a little uncomfortable with the knowledge that the Japanese mafia may now be able to insert things into my mind. I'd like to sleep at night knowing that my dreams are my own, such as they may be, and not some weird fantastic visions cooked up by a criminal organization. This is a world emergency.

And in Bearden's analysis, it all comes back to the issue of energy. It is the energy crisis which is now provoking the current "oil wars," since oil production has hit the "Hubbert Peak" and will decline. And the electrical power grids must be replaced with scalar power as fast as possible, for these grids are now totally vulnerable to any possessor of longitudinal interferometers. They can all be wiped out in minutes. By anyone who possesses or controls a Tesla howitzer.

> "Anyway, in my personal view, we should have a national Manhattan Project right now, to develop decentralized electrical power systems taking their energy from the vacuum . . . The MEG is real and so are several other systems invented by private inventors and colleagues. All these efforts should be massively funded and massively and quickly developed. The survival of this nation is going to depend upon it. . . . There are many other facets, but the major point is that our scientific apparatus and the public are still unaware of what a desperate struggle we have entered, since it was thrust upon us. 9-11 was a wake-up call. It was certainly bad enough, and one grieves for those lost American lives. But I fear the worst is yet to come, and it is coming at us like a runaway train hurtling right down the track at us."
>
> Bearden http://www.cheniere.org/correspondence/021702a.htm
>
> "The electromagnetic weapons mentioned by the Secretary of Defense in April 1997 are in terrorist hands also, including the Yakuza and Aum Shinrikyo. That rogue group leased those earlier weapons on site in Russia, from the KGB, at the end of 1989. The SecDef stated that such weapons were being used to initiate earthquakes, initiate volcanoes into eruption, and control and engineer the weather. Quite true. And presently there is a truly massive set of weather engineering operations going on over North America, from that rogue Japanese group manning the weapons in Russia. Some 10 nations of the world now have the type of longitudinal EM wave interferometer weapons (which are what the SecDef was most probably referring to). There are other even more fearsome weapons, possessed by five nations. So a great deal of the state of the world is not covered in the news at all, and will not be . . .
>
> "We have been in an undeclared war of an eerie kind for some decades. That war seems now to have started to heat up also. The destructive capability of some of these weapons is awesome, and far greater than nuclear."
>
> Bearden http://www.cheniere.org/correspondence/021702a.htm
>
> "In that sense, the first phase of WW III is already completed. Now we are only waiting for Phase II.
>
> "It is against that backdrop that I think one must "analyze" such things as how fast we will be replacing the power grid (it's going to go anyway, and catastrophically, the terrorists will see to that). And everything we have is critically dependent upon energy, from the economy to jobs to mobility, to the millions of trucks that transport our goods every day, etc.
>
> "As far as I am concerned, we are already late in declaring a great national emergency in energy, because of the coming destruction of the present energy infrastructure. The

> scientific community should lead, follow, or get out of the way. The emergency is not in seeking "alternative but conventional" systems. It is in developing "energy from the vacuum" on an emergency, crash basis.
>
> "Unfortunately, everywhere I look I just see business as usual. Most Americans (and news media) seem to think, hey, Afghanistan is finished except for a bit of cleanup, and it's just about over).
>
> "It isn't. It has only just begun."
>
> Bearden http://www.cheniere.org/correspondence/021702a.htm

Beyond the Howitzers: Quantum Potential Weapons

Do not use EM propagation through space

As more and more nations acquire the scalar interferometers, Bearden speculates on the next generation of longitudinal weapons called "quantum potential" [QP] weapons.

> "The quantum potential weapons are presently only held by three nations: Russia (in the hands of the KGB, which is now know by its new name), Brazil, and the "friendly little nation." Red China may be working on them, but is just at the beginning...
>
> "The QP weapons have been highly reserved by the Russians. However, the complete extent of their capabilities is still being figured out...
>
> "The quantum potential weaponry (possessed by only three nations) is supreme, because it uses multiply connected spacetime, and DOES NOT involve propagation of EM energy through space as does the longitudinal EM wave interferometers.
>
> Bearden http://www.cheniere.org/misc/qp.htm
>
> "The operational deployment of full-scale strategic QP weapons on site in Russia occurred at the end of 1989, which is when the formal weapons first went operational. These weapons are not in the inventory of the regular Russian armed forces, but all research and development, manufacturing, deployment, an manning and employment is under the ruthless control of the KGB. Shortly thereafter (within weeks), the KGB leased many of their earlier longitudinal EM wave interferometer (LWI) weapons to a rogue Japanese group comprised of the Aum Shinrikyo and Yakuza."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

In another paper, "Time Polarization - Significance and Weaponization," Bearden tells the story of how a KGB longitudinal wave attack was averted by the longitudinal weapons of a "friendly small nation."

So as it stands, it is precarious. Not until the people demand an end of what author Jim Marrs has dubbed the "Rule by Secrecy," can the people's representatives tackle the big problems of a worldwide ban on Scalar Wars and the shifting over to an essentially oil-free economy.

Latest Update from Tom Bearden - March 2002

The whole situation is changing so fast that when I asked Tom to look over this article he mentioned the seeming contradiction when some of the above statements are taken together. At different times the information he has is updated so one has to keep a kind of running track. He was kind enough to clear up the confusion here with the situation as it stands as of March, 2002.

> "We knew of three nations having the QP weapons for some time. Then we found out last year that five nations had it. So that explains my using the figure "three" first (which represented what I knew at the time). Later I found out about the other two nations. China, e.g., only deployed its QP weapon this past year. So that explains the apparent contradiction between me using "five" in later papers and "three" in earlier ones. It was the best information I had at that time. Might mention that so the reader will understand the apparent discrepancy." Tom Bearden

Emptiness is Full of Energy

"The Tao is an empty vessel;
it is used, but never filled.
Oh, unfathomable source
of ten thousand things!

"Oh, hidden deep but ever present!
I do not know from whence it comes.
It is the forefather of the gods."

Lao Tzu -Tao te Ching

Afterward

Because of the extreme seriousness of the topics brought forward in this article, I asked Tom Bearden to look it over to make sure I had not gotten anything too terribly wrong or mixed up. I did not want to pass on any misunderstanding of my own. I felt a little nervous writing to an eminent scientist, and hoped I had not presumed upon his time.

But Tom was so kind as to answer immediately, and to my relief I had not gotten anything too terribly wrong. Here is his letter, in which he clears up a misunderstanding, and reports on his current health treatment, and gives a call to the young grad students to turn themselves loose in the whole new field of scalar electromagnetics and free energy.

Subject: RE: Article on Tom Bearden and "Scalar Wars"
Date: Fri, 22 Mar 2002 22:54:01 -0600

Bill,

Well, I must say I'm astounded at your persistence and hard work in congealing all that together. My compliments on a hard job quite well done.

Couple tiny things: In the area mentioning Kervran and Kaznacheyev: Kervran was French; Kaznacheyev was and is Russian. Little typo of "spredding" the immune system. Should be "spreading".

We knew of three nations having the QP weapons for some time. Then we found out last year that five nations had it. So that explains my using the figure "three" first (which represented what I knew at the time). Later I found out about the other two nations. China, e.g., only deployed its QP weapon this past year. So that explains the apparent contradiction between me using "five" in later papers and "three" in earlier ones. It was the best information I had at that time. Might mention that so the reader will understand the apparent discrepancy.

Otherwise, it's pretty accurate.

Just now I'm letting the weapons take care of themselves; have to, as I will be recovering now for nearly a year from now after the heart attack last year and discovering that I had contracted mycoplasia (the BW modified kind) in Canada in 1968. Finally got a test which confirmed the chronic mycoplasia (which I had for 33 years!). The stuff burrows inside one's red corpuscles, then draws nutrients from the hemoglobin, hardening it and reducing its ability to take on oxygen (by as much as 50% or more). The resulting symptom is loss of endurance (which I had for that 33 years) -- the so-called "chronic fatigue syndrome".

Many of the Gulf War Veterans who are sick also have it, though they apparently have other complicating factors as well. A very high percentage of persons with chronic fatigue syndrome also have mycoplasia. The treatment for the long-standing mycoplasma infection of that nature is to stay on antibiotics for a year. The only time the mycoplasma is vulnerable is when one wears out a red cell in normal usage, and the body makes a new red cell to replace it. The mycoplasma comes out of the dying cell to infect the new replacement cell, so it is exposed and vulnerable at that specific time and that time only. The antibiotics kills it at that time. Hence the necessity to stay on antibiotics for such a long time so it is continuously in your bloodstream (I've already been on antibiotics for over two months, and have at least 10 more months to go). We also take a little medical oxygen every day.

Another symptom of the mycoplasma infection is the association of runaway fibrillation of the heart. To stop that, there are pills one takes, and they stop it. But they also further reduce the volume of blood pumped by the heart, so that this projects one right back into the hypoxia, dizzy, loss of balance, etc. Catch 22 situation; the fibrillation will build and cause heart attack, stroke, etc. if not stopped, and if stopped it puts you back in the hypoxia which can cause many things! With the conventional treatment, you're damned if you do and damned if you don't. Hence the need for a little extra medical oxygen, so you can take the "heart clamp" pill and stop the fibrillation, but also augment the oxygen enough to continue to survive without a stroke or some such. Interestingly, it's very difficult to even obtain a mycoplasma test, and Medicare fights you tooth and nail over paying for the oxygen. Either they will pay for it or I'll pay for it myself; it is absolutely necessary.

After a heart attack, one is treated in the heart clinic by specialists who are very caring and excellent practitioners, but know nothing of mycoplasma infection, so not consider it even a part of "heart disease", and who are rather puzzled when one has no clogging of the arteries, has the right count of red corpuscles (largely nonfunctional, of course, but there), pumps the right amount of blood, etc. So they identify and treat only the runaway fibrillation, do not prescribe the oxygen -- and essentially place you on a regime as best they know, but one that is guaranteed to kill or maim you or turn you into a totally disabled person or human vegetable via stroke, paralysis, etc. Fortunately my family doctor will prescribe the oxygen anyway, though I may have to pay for it myself. Whatever works!

However, I'm slowly improving little by little, working as much as I'm able to and trying to finish my book: Energy from the Vacuum: Concepts and Principles, and get it to the publisher for publication later this year. Hopefully the book will turn all the interested young grad students and post-docs loose in the free-energy area. They will not have to spend 30 agonizing years to get to where I am, and where a few others are, but can simply start here and go forward. Since speed to develop energy from the vacuum is of the essence because of the world situation, I'm moving on it as fast as I am physically able to.

Meanwhile, working with the AIAS (Alpha Foundation's Institute for Advanced Study), the AIAS (15 authors) has now gotten about 20 scientific papers published in leading journals (Foundations of Physics, Foundations of Physics Letters, Physical Scripta, Optik, etc.) dealing with electromagnetic energy from the vacuum. Several more are either approved for publication or in the review process also. So slowly we are getting it into the mainstream scientific literature. Hopefully it will be in time, but it's cutting it close.

Very best wishes,

Tom Bearden

Late update

Massive display of longitudinal interferometers?

UFO Fleet Taped Over Bedhampton, England

Is this sighting a case of the testing of all the Russian (KGB) longitudinal interferometers at once? And coordinating their targeting through the woodpecker grid to a common place, as an exercise in making a massive scalar attack upon a given region? Was this a confluence of Russian Tesla howitzer marker-beacons?

Certainly for a massive all-out scalar attack you would want coordinated movements of the target areas of many howitzers at once, for you could then just cut a bloody swath across a wide area, all the howitzer blasts marching across the land in a kind of scalar version of the "scorched-earth policy." All in a line, blasting, and heat, and mind waves. Or you might want to put the blasts all in the same place for a truly horrendous destruction. And on top of that biowar on citizens whose immune systems have been weakened with the quantum potential weapons. This is the latest version of Armageddon.

And should any madmen gain control of these weapons, any rogue group at all, and should they have some agenda to radically depopulate the world, to simply kill by the billion, the means will be in their hands to do so.

Update: MEG patent granted

Motionless Electromagnetic Generator Patent Granted

This message is from Jean-Louis Naudin, the French scientist who successfully replicated the Motionless Electromagnetic Generator (MEG) in France. He announces the granting of the patent to the MEG Builder's group at Yahoo.

----- Original Message -----

From: jnaudin509@aol.com
To: jlnlabs@yahoogroups.com
Sent: Tuesday, March 26, 2002 2:20 PM
Subject: [jlnlabs] (Info) GOOD NEWS : The Tom Bearden's MEG IS PATENTED

Dear ALL,

GOOD NEWS !!!!

The Motionless Electromagnetic Generator from Tom Bearden is now PATENTED US 6362718 granted on March 26, 2002

US Patent 6,362,718 :
Motionless Electromagnetic Generator (MEG)

Abstract: An electromagnetic generator without moving parts includes a permanent magnet and a magnetic core including first and second magnetic paths. A first input coil and a first output coil extend around portions of the first magnetic path, while a second input coil and a second output coil extend around portions of the second magnetic path. The input coils are alternatively pulsed to provide induced current pulses in the output coils. Driving electrical current through each of the input coils reduces a level of flux from the permanent magnet within the magnet path around which the input coil extends. In an alternative embodiment of an electromagnetic generator, the magnetic core includes annular spaced-apart plates, with posts and permanent magnets extending in an alternating fashion between the plates. An output coil extends around each of these posts. Input coils extending around portions of the plates are pulsed to cause the induction of current within the output coils.

Inventors: Patrick; Stephen L. (2511 Woodview Dr. SE., Huntsville, AL 35801); Bearden; Thomas E. (2211 Cove Rd., Huntsville, AL 35801); Hayes; James C. (16026 Deaton Dr. SE., Huntsville, AL 35803); Moore; Kenneth D. (1704 Montdale Rd., Huntsville, FL 35801); Kenny; James L. (925 Tascosa Dr., Huntsville, AL 35802)

Appl. No.: 656313
Filed: September 6, 2000

For some technical info see my web site at : http://jnaudin.free.fr/html/meg.htm

Best Regards
Jean-Louis Naudin
Email: JNaudin509@aol.com
Main Web site : http://jlnlabs.org
Site France : http://jlnlabs.multimania.com

Click here to view patent # 6,362,718

Patent Story on Rense.com:

Rense.com
MEG Scalar Energy Device
Patented - Production Starts Next Year

From Bill Morgan
wmorgan@nycap.rr.com
3-28-2

Patent was granted on March 26, 2002 for "The Motionless Magnetic Generator," (MEG) US Patent 6,362,718, which is likely to become the first commercially available free energy device in history in about one year from now. The machine will provide free electricity from the vacuum, for the life of the device, which should be a very long life since it has no moving parts. You can see a picture of scientist Jean-Louis Naudin's MEG replication model at: http://jnaudin.free.fr/html/meg.htm.

It has strong magnets, coils, and a controller unit with the electronics. Naudin made the announcement to the MEG-builder's Yahoo group. The announcement has significance since the patent office has always been skeptical of devices which seem to "get-something-for-nothing." But according to the new science of scalar electromagnetics, the MEG does not break the law of conservation of energy. It's just that the energy is conserved in the fourth dimension, time, and not our 3-space world.

The MEG provides electrical energy by tapping the longitudinal electromagnetic (EM) waves which exist in almost infinite abundance in the vacuum of space. This ocean of energy which permeates everything is sometimes called the "zero point" energy, since it remains there even at absolute zero temperature.

Four inventors are listed: Stephen L. Patrick, Thomas E. Bearden, James C. Hayes, Kenneth D. Moore.

Tom Bearden has explained the operation of the MEG on his website Cheniere.org, and also speaks about the new fearful weapons that can and have been made using the same "longitudinal waves" of the vacuum.

The complicated physics of how the MEG works is explained in the paper "The Motionless Electromagnetic Generator: Extracting Energy from a Permanent Magnet with Energy Replenishment from the Active Vacuum," which can be found at Tom Bearden's website:

cheniere.org.(http://www.help4all.de/energy/MEGpaper.pdf)

The first MEG units to be produced for sale will output 2.5 kilowatts of free electricity. Forever. They should be in production about a year from now. Facilities for manufacturing the device are being set up in an unnamed "friendly nation."

This free electricity will flow indefinitely, without much, or any maintenance. The units may be hooked together to provide more wattage, so four of them would provide 10 kilowatts. After some production experience units will be made which output 10 kilowatts each. With a couple of those units a house could get off the electrical grid.

Tom Bearden, one of the inventors has said "I will admit that the chief scientist of an important experimental group in a large company was rather stunned at the type of output we were able to

obtain. The MEG may look like just a transformer, but it is not. It is a completely different breed of cat." This cat, it would seem, is out of the bag now.

The ordinary EM waves we are familiar with are called "transverse" waves, to distinguish them from the new "longitudinal" EM waves of the vacuum. Bearden has explained in depth on his website cheniere.org that wherever there is a dipole (battery, generator, magnet) there is an unseen flow of longitudinal EM waves in that local vacuum, the only problem is in tapping that energy and "transducing" it to electricity. Bearden says that the problem with all the electrical circuits we have is that they are two-wire circuits, a loop by which half the energy goes back to destroy the dipole. In the MEG that closed loop is never made. So the dipole is not being destroyed.

Patents are not granted on devices which do not work, so in a sense this announcement proclaims a new era. The MEG device itself proclaims and proves that energy is abundantly available everywhere, for free. We only have to build the devices to tap it. MEG type devices could be put into a car with an electric engine to make a truly fuel-less automobile. Electricity can be available in very remote places. People will be able to get off our very terrorist-vulnerable power grids. In an era of terrorism a highly dispersed power system would be most desirable rather than our centralized systems.

What is somewhat astonishing to me is the discovery by Bearden et. al. that time itself is actually compressed energy, and that this free energy is actually coming from the time domain, the ocean of longitudinal EM waves which fill the empty vacuum of spacetime. In fact, time is energy compressed by the same factor that matter is compressed energy: the speed-of-light squared. Thus there is a new companion to Einstein's E=mc2. Can you say "E equals delta-tee-cee-squared?" The "tee" is time and delta-tee is change in time.

A company has been set up to manufacture the MEG called Magnetic Energy Limited.

The ramifications of free energy are enormous. The oil wars are not necessary. If we threw as much money at this technology as we are spending on the oil wars we would be free of the need for oil in less than a decade. With fuel-less cars air pollution will be greatly lessened. Third world nations can raise their standard of living eventually. And the energy is free. And it never runs out.

I have put together a kind of "Bearden for Beginners" article which explains some of the basic concepts of the current state of scalar technology.

http://www.prahlad.org/pub/bearden/scalar_wars.htm

The granting of the MEG patent is the herald of the new era of scalar electromagnetics, and the free energy which flows forever and never runs out.

Bill Morgan
wmorgan@nycap.rr.com

Do the magnets run down after a while?

Further developments: Tom Bearden clears up a question

When the MEG patent was released many questioned the patent language which seemed to imply that permanent magnets of the MEG would "wear out" after awhile. I myself wondered about the same thing so I put the question to Tom, and here is his reply.

> Dear Bill,
>
> Thanks for the kind words; much appreciated.
>
> I'm not up to going on radio or TV, and won't be for quite some time. Still suffering from hypoxia, though very slowly improving, and will still be on antibiotics for 10 more months at least (maybe longer).
>
> Obviously an extensive dialog developed between the Patent office and our patent attorneys. As best I can understand it, the Patent office accepts the fact that a permanent magnet produces and emits energy, or has a history of accepting it. They do not appear to be at all cognizant of the broken symmetry of opposite charges, and hence of a dipole. So in their opinion (which seems to be vague), the magnet has to use itself up very gradually, or some such. So some rewrites were essentially required by the Patent office.
>
> All I can say is that a magnet is a very durable thing, so long as you don't heat it up too much or shock it to much. Certainly one will make a good 20 years, and of course there are plenty of magnets that have been around awhile longer.
>
> That said, in our earliest experiments we did "measure" some such effect, or so we thought, until we found that a particular instrument was bad and giving erroneous readings. So with a new instrument, we have not observed since then any such readings.
>
> Out of all that fuzziness came the inclusion of "using up the magnets gradually". So far as we are aware (after correcting those early readings on a defective instrument), we have seen no such measurements or effects since then at all. Nonetheless, just in case there is some very small effect in that respect, at least it's in there.
>
> Actually, as you are aware, capacitors and solid state components are the major concerns for failure, and any system does require maintenance, both periodic and whenever malfunction or failure occurs. The MEG is no different from any other device in that respect, so of course it will have a component failure rate and maintenance required from time to time, just as any other electromagnetic device. But without moving parts, it can be ruggedized and made very durable indeed.
>
> Please give Jeff Rense my regrets, and I do admire his work and his show. He's laying it in there.
>
> The depth of the scientific mindset against COP>1.0 is inexplicable, particularly when physics itself already has COP>1.0 validated experiments (such as Bohren's experiment,

which outputs 18 times as much as one inputs by Poynting calculations), and it works every time. Any competent university optics lab can perform the experiment. Also, even the conventional texts admit that a charged capacitor or electret laid on a permanent magnet, so that the E of the cap or electret and the H of the magnet are at right angles, is a "free energy machine". That silly thing will just sit there and pour out Poynting energy S = EXH indefinitely. Years and years and years. If you wait just a single year, that silly thing has changed the energy density of a volume of space a light year in radius, reaching out well beyond the solar system. Now that's a WHALE of a lot of EM energy that beast poured out in that year, and it will still be going strong and pouring it out at a steady rate. The charges and dipoles in original matter in the universe have been pouring out EM energy in that fashion for some 14 billion years, give or take a billion or so. It's also easy to see that, prior to Lorentz's ARBITRARY symmetrical regauging of the Maxwell-Heaviside equations, those equations prescribe both EM systems in equilibrium with their active environment, and EM systems not in equilibrium with it. The latter systems are permitted by the thermodynamics of open disequilibrium systems to perform five magic functions: (1) self-order, (2) self-oscillate or self-rotate, (3) output more energy than the operator inputs (the active environment inputs the rest of it), (4) power itself and its load (the active environment inputs all the energy, like a windmill), and (5) exhibit negentropy. That is a well-established thermodynamics. Lorentz arbitrarily discarded all such open disequilibrium EM systems in order to get simpler equations having analytical solutions and not requiring numerical methods. So he simply scrapped all the really interesting and challenging EM systems in Maxwell's theory. ARBITRARILY!

That our scientific establishment continues to teach only that "half" of the theory, and not point out the rest to the young students, and not fund research into developing such systems that take energy from the vacuum, is simply inexplicable. It's a matter of total dogma, not science at all.

But hopefully it is changing a little bit. At least now we cite chapter and verse when these things were done, and what they are, and the young grad students and post docs can go check the papers and make up their own minds.

That is the real hope of the future: that we get a generation of young fellows, with excellent skills, who now know where all the skeletons got hidden in the closet, and understand that the electrical engineering model arbitrarily assumes an inert vacuum environment (falsified for more than a half century in particle physics) and a local flat spacetime (falsified for nearly a century by general relativity).

Once they know that past history, and go read into what broken symmetry of opposite charges means for a dipole and for all dipolar EM circuits, they will set to and change that more than a century of error. In that case, we shall have numerous solutions to the energy crisis rather quickly, popping up all over.

Good thing. It will certainly displace some great energy barons, but it will also free the populace. One can extract all the EM energy from the vacuum one wishes, anywhere, anytime, with ridiculous ease. One can produce that "electrical wind of energy" at will, by making a simple dipole and then letting it alone. The only energy problem is in how to

then intercept some of that energy flow and "catch" it in a circuit, discharge it in a load to power it, and not use half the "caught" energy to kill that dipole that is gushing out the extracted EM energy from the vacuum.

Very best wishes,

Tom Bearden

END

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Tesla's Scalar Fields Still Beaming On!

The superluminal (faster than light) scalar or longitudinal waves Nikola Tesla used to magnify and wirelessly transmit power are not just a thing of the past. IEEE engineer, Steve Jackson, discusses and demonstrates how they can be utilized today, and he is open sourcing it here!

by Hank Mills
Pure Energy Systems News

Nikola Tesla is the father of the modern age. His inventions of radio, remote controlled devices, alternating current, and induction motors (among many others), paved the way for modern civilization. Yet other of his inventions barely saw the light of day, despite their tremendous potential.

Such a severely under utilized technology is his wireless energy transmission techniques. By producing scalar (longitudinal) waves, he could achieve superluminal (faster than light) communication, send signals through any material including Faraday cages, and wirelessly beam power to receivers. Researchers like Steve Jackson provide hope that by open sourcing Tesla's work, scalar wave transmission can proliferate and positively benefit the world.

Last Thursday, March 24, 2011, Steve Jackson held a presentation and demonstration of a scalar wave transmitter and receiver at a local IEEE meeting at McMaster University in Ontario, Canada. During the talk he gave an overview of Tesla's life, his inventions, and a plethora of information on his wireless power transmission technology. Afterwards, he demonstrated a small electric fan attached to a scalar wave receiver powered by a transmitter over twenty feet away. Tesla's technology is alive today!

Furthermore, he has approached us at PES Network to open source his design. You can download his PowerPoint presentation here. We'll be uploading to

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• Waste to Energy
• Water
- Water as Fuel
• Wave
• Wind
• Wireless Electricity
• Zero Point Energy
• MORE . . .

Open Source
• Freddy's Cell
• Bedini SG
• Safe Haven Villages
• MORE . . .

Resources
• Awards
• Conservation
• Conspiracy
• Directories
• Investment
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• Legal
• Organizations
• Plastic and Energy
• Recycling
• Suppression
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our PESNetwork YouTube account a video of his presentation to the IEEE in a couple of days. It's in process of being transmitted, but will take a while, as it is 3+ Gb. We're expecting to get instructions from Steve on Monday, and we'll be posting a PESWiki page to organize all this material to streamline the presentation.

Take a look at the following video that shows a small boat powered by scalar waves many feet from a transmitter.

o Fusion Froide
o Fusion Fria
o Fusione Fredda

Free Energy Store
* * * * *
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Demonstration of Tesla's Wireless Power Transmission System duplicated at the Tesla Tech Conference, July 2007.

Scalar Wave Properties

You might be wondering what in the world is a scalar wave! It's actually pretty simple. Unlike a transverse wave (like an ordinary radio or light wave) a scalar wave's amplitude does not fluctuate up and down. Instead, try to visualize it more like a vibration of electric potential expanding and contracting in the direction of propagation.

Scalar waves are also often called "Tesla Waves" or "Longitudinal Waves." All of these terms refer to the same type of wave which oscillates in the direction of propagation instead of perpendicular to the direction of movement. These waves have many unique properties which have been tested and confirmed repeatedly.

1) They are capable of penetrating any solid object including Faraday Cages. You can put a transmitter in a box of thick metal and a receiver outside of the box will receive the scalar wave frequency you are pulsing. The potential here is for a transmitter that can penetrate any obstacle or perhaps communicate directly through the Earth from one side of the globe to the other.

2) They are capable of superluminal travel. These waves are claimed not to be electromagnetic, but composed of pure potential energy. Due to this, the speed of light limit does not apply to them. The propagation speed of a scalar wave has been measured as faster than the speed of light and thought by some researchers to be potentially of infinite velocity. (Perhaps SETI - The Search for Extraterrestrial Intelligence - needs a different kind of receiver in order to pick up signals from elsewhere in the universe! Why would advanced ET civilizations even bother using slow transverse waves for interstellar communications?)

3) They are capable of transmitting power. It can then be put to use powering motors, lights, vehicles, etc.

4) A scalar transmitter can wirelessly send power to a receiver through any obstacle. For example, as mentioned above, you can setup a transmitter, put it in a Faraday Cage or a metal box, and a

receiver can receive power far away.

5) During the process of transmission and reception they can magnify power. You can input a certain quantity of power into a scalar wave transmitter and yet the receiver can receive several times the power.

6) Transmitters and receivers can communicate.

7) A conventional transverse wave transmitter cannot sense if a receiver has "tuned in." However, in a scalar system the transmitter and receiver interact because they are in a state of resonance.

As you can see Scalar Waves hold many potential applications for communication, energy, and other applications. To mimic a commercial for a popular brand of cell phone, "Scalar Waves do what Transverse waves don't." They are fast, penetrating, connected, and can broadcast magnified power. These waves are begging to be utilized!

Recipes for Scalar Waves

Nikola Tesla's most famous scalar wave transmitter was his Wardenclyffe tower on Long Island, NY. Prior to that, at the height of his amazing inventive career, he had a lab in Colorado Springs, Colorado. He was able to beam power to receivers miles away that were used to illuminate neon tubes. A great deal is known about his tower, transmitters, and receivers. It is all detailed in his patents. This allows for present day replications!

From examination of Tesla's patents, researchers have learned that perhaps the most critical component of a scalar wave system is the antenna. It is composed of a flat "pancake coil" composed of both a primary and a secondary winding. The coil is connected to a spherical metallic resonator that helps transmit and receive scalar waves.

A particularly good source for information about scalar wave systems is the website of German scientist, author, and researcher, Konstantin Meyl. He has published a series of books that describe scalar wave systems, detail their components, and discuss their operation. His books also dive into the science and physics of scalar waves, among other fascinating topics.

In fact, he offers scalar wave kits for sale on his site. They include all the components needed for a complete system, arrive in an aluminum suitcase that can serve in the same manner as a Faraday cage for your experiments, and come with a book detailing the kit. These kits have been used by experimenters to prove to themselves and others the existence of scalar waves and their unique properties.

Take a look at the following video to see Konstantin demonstrating a scalar wave transmitter and receiver. The same device in the following video is for sale right now on the internet from his website.

M
eyl shows Tesla's longitudinal electricity transmission in Washington
DC at a Tesla,m meeting in 2003!

Even NASA is paying attention to scalar waves to some degree. The paper titled, "Advanced Energetics for Aeronautical Applications: Volume II" by David S. Alexander offers a review of scalar wave (longitudinal wave) research. It mentions the work of Konstantine Meyl and others in the field. Interestingly, the paper also discusses how Dr. James Clerk Maxwell's original equations specifically allowed for scalar or longitudinal waves. Only many years later did short sighted scientists who did not care to deal with Maxwell's complex equations based in "quaternions" mathematics arbitrarily discard longitudinal waves. Due to this, many mainstream scientists doubt their existence despite their history and the mountain of evidence which proves they are very, very real.

Opening Tesla's Technology

Steve Jackson's goal is to open source Tesla's wireless power transmission technology. This is very possible to do, due to the simple nature of

the parts and components required. During his talk he published a list of components required to build a system. This same information can be found in the books of Konstantin Meyl and elsewhere on the internet.

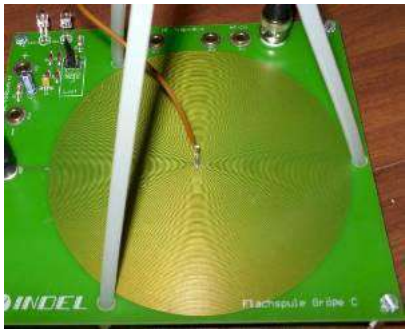

By open sourcing this technology, ordinary individuals could prove to themselves, friends, associates, co-workers, and others that Tesla's technology worked as claimed. Not only does it work, but can be replicated and used for practical applications today. All unique properties of scalar waves could be harnessed and developed to revolutionize our society.

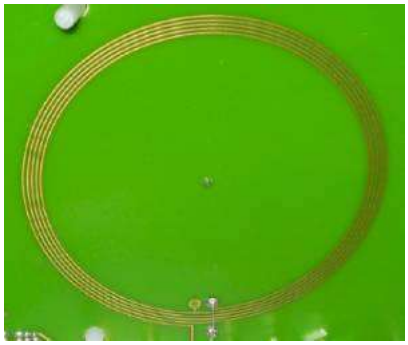

When Steve releases plans, drawings, and other information, probably next week, we will add them to a project page at PESWiki.com. We'll add a link from this page when it is ready.

Earth Changes and the Future

In his books and lectures, Konstantin Meyl has compared superluminal scalar waves to the neutrino, which is also thought by some to travel faster than light. Neutrinos bombard the Earth in all directions, but the majority of them arrive from the central star of our solar system. Due to the fact that approximately half of the neutrinos are absorbed as they pass through the Earth, it is thought they may interact with the core and inner layers of our planet.

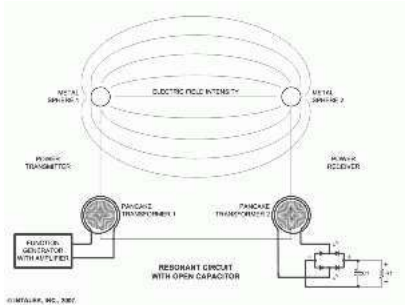

Circuit diagram used by Steve comes from Intalek.com, Figure 3.

Some researchers suggest solar phenomenon can produce variations in neutron emissions which may trigger "earth changes" on our planet. This was depicted in the blockbuster movie, 2012, as the cause for the crust disruptions from the mantle heat-up from increased solar activity. Hence, studying and understanding the nature of scalar waves may increase our chance of survival during chaotic periods in the future. Perhaps by understanding them we could eventually learn how to constructively utilize them to stabilize our planet during periods of solar fluctuations, sun spots, flares, etc.

Perhaps with the use of scalar wave technology, earthquakes, volcanic eruptions, or other natural disasters could be prevented or detected ahead of time. Even a one hour warning before an earthquake, such as the one that recent devastated Japan, could save thousands of lives. Although all kinds of unique technologies are possible with scalar waves, at a minimum we need to understand how neutrinos and scalar waves interact without planet. Not doing so could result in needless death and suffering.

Lets get moving!

To not harness scalar wave technology for the benefit of mankind would be tragic. Our civilization is facing adversity in countless forms. Hunger, disease, pollution, poverty, and war threaten our future and the future of our children. Scalar waves exist, they are useful, and the information to build devices that generate and receive them is available to everyone. To better understand our universe, to ensure the continuation of our civilization, and to honor Nikola Tesla we should do our best to support the open sourcing of this technology.

Videos

On March 30, Steve conveyed the following YouTube links showing his presentation to the local IEEE on March 24.

#1 Slide 1 https://www.youtube.com/watch?v=qs-2s85lO6o
#2 Slide 20 https://www.youtube.com/watch?v=s4kvJpUgGKI
#3 Slide 39 https://www.youtube.com/watch?v=4YXPa73NNsA
#4 Slide 57 https://www.youtube.com/watch?v=LqhRDY56CqU
#5 Slide 81 https://www.youtube.com/watch?v=e1Ht5OVyI5Q
#6 Slide 93 https://www.youtube.com/watch?v=JuehDylES_A

Replication Instruction should be done tomorrow.

Contact

Steve can be reached by email at steve.jackson@ieee.org

# # #

This story is also posted at *BeforeItsNews*.

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Comments

Feel free to view/post comments down below. The following came in by other means.

Not Scalar "Wave"

On March 27, 2011, 1:45 pm, Karl Palsness wrote:

You should read about Scalar .. it is a "Scalar FIELD" there should be no such thing as a "Scalar wave"; and there is a "Longitudinal Wave", instead of scalar wave. Scalar waves just don't exist according to the word scalar meaning size. A Tesla coil has a scalar field around it...and emits a longitudinal wave....

A Tesla-era dictionary defined it as:

> **Scalar** -- In physics, a quantity which has magnitude, or magnitude and sign only, without direction, such as density, mass, energy, etc., as distinguished from a vector quantity.

and

> **longitudinal wave**: A "pressure" type of wave, similar to sound, in which the vibrations are along the direction of travel of the wave. Hence, a wave composed of alternating densifications and rarefactions, where we focus upon the longitudinal component of the changes.

* * * *

Longitudinal Waves (L.M.D.)s

On April 02, 2011 12:29 AM MST, Dr. Eng. Roberto Handwerker <info {at} deltaavalon.com> wrote:

Dear Sirs,

this mail is a reply to a number of e-mail messages I got from [...], subsequently from Dr. K. Meyl and from Mr. S. Jackson about longitudinal waves ("L.M.D.s").

The matter "L.M.D"s. is not new at all but there is still too much discussion around it from different point of views, i.e. mathematics/physics calculus and electrical devices; this has slowly but definitely led to a total chaos even on the Web, resulting in misunderstanding and disbelief, which doesn't help anybody;

therefore, the best approach for an engineer is to be very straight and careful especially when someone talks about Nikola Tesla and theories about aether and L.M.D.s., still not accepted by the "Academic World" who is as happy to hear such arguments as could be "a sailboat in a forest" so to speak and who brings in turn only useless negative criticism and hectic hysterism instead of helping clarify.

This is why I prefer to proceed "step by step" scientifically replicating some Tesla apparatus and demonstrating his experiments, which is of course not easy because he was the Mozart of the art.

I will present a book about the above and will very soon attend a Meeting in Italy to talk about L.M.D.s and show some working devices to public: it is always a pleasure to demonstrate FACTS and WORKING DEVICES rather than only showing some slides and theoretically discuss matters as "Lorenz gauge vs. Coulomb gauge", "quaternions vs. vectors", "T.E.M. vs. L.M.D." etc. etc. Only facts count, observation of Nature and research: math must consequently follow, as always.

It is therefore more useful instead to bring something new to L.M.D.s tech and to the understanding of Tesla, like for instance my "Tesla power wireless" system with the "small car-

demo" shown in my following vids on You Tube (& others under "HorizonDelta"): https://www.youtube.com/watch?v=0BGFF4ltEv and https://www.youtube.com/watch?v=dvZH3RCdeVw

also a tech e-book "Longitudinal dielectric waves in a Tesla coil and quaternionic Maxwell's equations" can be found on my Website for download:

https://www.deltaavalon.com/immagini/L.M.D. waves in a Tesla Coil revised.pdf

I hope the above helped positive discussion and knowledge.

Regards

Dr. Eng. Roberto Handwerker
DELTA Ingegneria

* * * *

The Laplace Operator

On March 31, 2011 2:06 PM MST, Konstantin Meyl wrote:

Subject: Re: About Scalar Field and an Italian Book

There is one comment, making clear, where the problem is localized:

Karl Palsness wrote:

> "You should read about Scalar .. it is a "Scalar FIELD" there should be no such thing as a "Scalar wave"; and there is a "Longitudinal Wave", instead of scalar wave. Scalar waves just don't exist according to the word scalar meaning size. A Tesla coil has a scalar field around it...and emits a longitudinal wave..."

If a scientist is using an expression, he first has to define, what the meaning is. This is what I do in my books, but in America, nobody seems to read my writings. I explain that the scalar wave is nearly the opposite of a scalar field. The expression is more than 200 years old and in mathematics exactly explained by the field equation of Laplace.

The Laplace Operator (describing the distribution of a wave in space) may be separated in 2 parts: grad div - curl curl. The second part is explaining the EM wave, a transverse wave, while the first part gives a scalar wave: The div applied on a vector is scalar! This is why scalar particles or vortices as part of the wave equation are propagating as a scalar wave. But they are propagating in the direction of a field vector and by this the wave is longitudinal and has a direction. In mathematics it is known, that the grad applied on a scalar is a vector again. This is why the scalar wave is propagating in one direction, not in a scalar way, as Karl Palsness wants the scalar wave to do. So he has to read the literature first before he is spreading nonsense in the world wide web.

My opinion about the education in the states is not the best. Lets help to improve it.

* * * *

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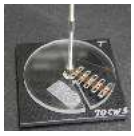

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  Tesla's Scalar Field Still Beaming On! - The superluminal (faster than light) scalar or longitudinal waves Nikola Tesla used to magnify and wirelessly transmit power are not just a thing of the past. IEEE engineer, Steve Jackson, discusses and demonstrates how they can be utilized today, and he is open sourcing it here! (*PESN*; March 26, 2011)

See also

Resources at *PESWiki.com*

- **Directory:Konstantin Meyl**
- **Directory:Wireless_Transmission_of_Electricity**
- **PowerPedia:Wireless_transmission_of_electricity**
- **PowerPedia:Scalar_field_theory**
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Last updated September 04, 2012

NOTE: We are presently moderating all comments, to keep out the crass negativity, flaming, and other inappropriate forms of criticism. We welcome constructive criticism tactfully stated. Frequent offenders will be blacklisted.

"It is harder to crack a prejudice than an atom." // "I'd rather be an optimist and a fool than a pessimist and right." -- Albert Einstein

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All truth passes through three stages:
First, it is ridiculed;
Second, it is violently opposed; and
Third, it is accepted as self-evident.
-- Arthur Schopenhauer (1788-1860)

"When you're one step ahead of the crowd you're a genius. When you're two steps ahead, you're a crackpot."
-- Rabbi Shlomo Riskin, (Feb. 1998)

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[The Tom Bearden Website]

Subject: RE: Missing Reference Slide
Date: Mon, 9 Jul 2001 11:58:04 -0500

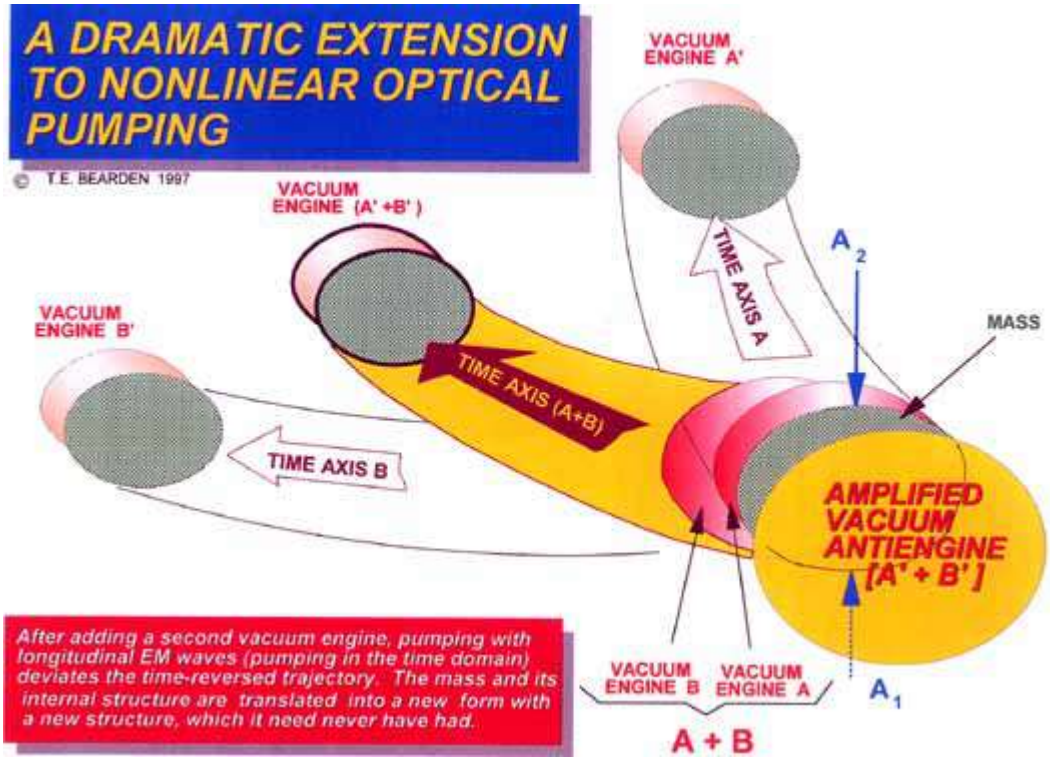

Yes, that is the slide. It works this way: When you time-reverse a cell, you effectively create a major anti-engine for the cell's exact "engine" (exact set of spacetime curvatures at all levels). Because of the precise one-to-one correspondence, this antiengine then "backs the cell up" along the original time-path it took in its physical functioning and changes, back to a precise earlier condition where the disease or disorder was not present. For a cancer cell, e.g., this backs the cell up past where it was originally "promoted" from a stressed or damaged cell to a tumor cell. That makes it into a "damaged cell". The antiengine continues to act, backing it up further into the state before the damage or disorder occurred. That then constitutes "healing" of that cell in a rigorous sense.

The cloning methods etc. used, do violence to the cell in the process. At the cellular level, damaging it or any part of it in the process changes the resident spacetime curvature engine set, to include the damage. You then "clone" a cell with an imperfect resident engine. The cloned cell then interacts with a large variety of phenomenology, continually altering various subcomponents of its resident engine by taking on additional subengines or changing some of its former subengines. Somewhere later, that festering "delta" in the resident engine -- after sufficient interactions with other environmentally-induced engines, will undergo interactions that "add" two deltas so something detrimental to the organism. At that point, physical damage to the cell erupts in "anomalous"

fashion. Actually it erupts by perfectly normal fashion, once the internal engines and their interactions are understood.

This would appear to pose a problem anytime you *artificially* change the subengines of an organism, as in the case of genetically modified food. The small physical damage associated with splicing the genetics has associated with it the injection of such an artificial engine. The interactions of future environmental engines with the spliced genetic organism or plant then remains to be seen. Not all interactions would appear to happen in the limited test time usually allotted for testing the "effects". Anyway, that was the intention.

E.g., Pautrizel demonstrated that immature rats, having immature immune systems, would be restored by the Priore process back to the same immature immune system. The Priore process did not destroy the parasites themselves, but depended upon restoring the immune system back to its first ability to recognize the pathogen and go after it. Priore did not directly "kill" anything! In that case, the pathogens simply re-infected the immature rats, because their immature immune systems could not adequately protect them. It would be the intention of the research, in later generation equipment, to be able to design a specific "extra engine" and introduce it to the pumping, in addition to the "resident engine" in the subject to be treated. That "extra input engine" would accordingly generate a specific "extra antiengine" component in the total antiengine produced. When sufficient research and development maturity has been reached to be able to design such desired "extra engines" to cause the exact, desired extra antiengine to be produced, then the "extra antiengine" technique can be used, e.g., to time-reverse Pautrizel's immature infected rat back to an infected rat with a now-matured immune system. In that case, the rat's stronger immune system would make short work of the pathogen, just as analogously infected mature rats did.

To correct birth defects, etc., obviously one would have to change the actual time-path backwards, to a "state" that the body did not have physically, but which its genetics had before the damage. I foresee that eventually, after some years of development, the process would mature until it could regrow severed limbs, or correct dwarfism, etc. Of course that would be fourth or fifth generation, but it is definitely possible, given sufficient development.

Cheers,

Tom

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QUITON/PERCEPTRON PHYSICS: A THEORY OF EXISTENCE, PERCEPTION, AND PHYSICAL PHENOMENA

by

Thomas E. Bearden

March 1973

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ABSTRACT

A fundamental answer is attempted to the questions of being, time, space, existence, perception, and physical phenomena. Mass, empty space, reality, gravitational attraction, continuity, discontinuity, and relativity are among the "things" and "nonthings" for which relationships and explanations are provided.

Perception is defined as detection by a mass of change to itself and as a differentiating process. Perceived physical phenomena are revealed to be first derivatives of ultimate reality, and outputs of the physical perceiving device call the "perceptron." Using the operation of the physical perception process on action, the units of which are energy times time, an entirely different view is generated of both reality and the Heisenberg uncertainty principle. When superposition is imposed as a condition, the Heisenberg uncertainty principle is revealed to be a quantized statement. A concept of the absolute value of a dimensional molecule is advanced.

A reality model is constructed of an action continuum and a nonaction continuum separated by an operational threshold whose magnitude is given by an uncertainty principle. Perception is modeled as a process which switches atomic quanta of action and nonaction back and forth across the threshold. Mass is explained as perceptron switch activity rate, and a mass definition equation is generated. One kilogram mass is shown to represent 17.053 x 10^{50} perceptron switches per second. From the model, Newton's laws of motion and gravity can be generated directly from the concept of the interaction of mass with space itself, space being taken as a massless fluid, or ether, composed of tiny nonaction particles called "quitons." Einstein's postulates of special relativity are also shown to follow from the model, and a statement of the equivalence principle is shown to be consistent with the model.

The concept of "lineception" as a causal chain of perceptron operations is advanced. "Inception" is developed as a noncausal modulation of lineception and as a distinguishing feature of a living system. The possibility is raised that inception could provide an explanation of the noncausal, statistical, ultramicroscopic universe and yet require large ensembles of ultramicroscopic events to conform to causality. Inception is shown to lead to karma. Perception is shown to be causal and to generate causality itself.

Some elementary philosophical implications of quiton/perceptron theory are pointed out and briefly discussed.

I. INTRODUCTION

The unsolved problems of physics stem from the unclear nature of the physical perception of change, and their resolution lies in the analysis of perception as a physical process. The unsolved problems of metaphysics stem from the same source, and can be resolved by the same perception analysis.

Specifically, a physical detection system can detect changes to itself and nothing else. These detected internal changes are thus what a detector "sees" or "observes" or "perceives" as changes to its external environment, i. e., as its physical phenomena. Thus a mass, being itself a physical detecting system, must detect only changes to itself, and these perceived changes to itself constitute its observed physical phenomena. For that reason, these perceived changes are obviously entirely relative to (i. e., are part of) the perceiver (observer); more precisely, they are entirely relative to and part of the perceiver's mass, which is the detector that is doing the perceiving.

Since only changes are perceived by a mass, then mass's perception must be a differentiating process. Ergo, perceived physical phenomena are first derivatives of a higher, or more fundamental, reality. The nature of that higher reality is by definition unperceivable (perception differentiates or fragments it), and it involves the quantity "action."[1] Action itself is not perceivable; change of action is perceivable since perception differentiates action. If superposition is placed on the Heisenberg uncertainty principle as a required condition, then the uncertainty principle contradicts itself for all except integral or zero multiples of a quantum of action. Correction of the uncertainty principle by imposing superposition as a condition provides a statement of the basic operation of perception -- the detection by a mass of change to itself.

All mental perception of a human being regarding physical phenomena is received (i. e., is inputted to the mind) from a physical sensory apparatus whose primary ingredient is mass. Thus we may describe the perceptive mind as consisting of sensory outputs of mass perceptions; that is, the input to mental perception must be the output of mass perception, and this interface within the mind may be referred to as the "perceptive mind."

From the above foundation, a comprehensive theory of perception can be constructed, and a most unusual model of "reality" emerges. A variety of unsolved questions are then resolved by the model. The resolutions include, among other things, 1) derivation of the postulates of relativity; 2) definition of the nature of time and space; 3) the explanation of gravity; 4) the generation of causality itself; 5) resolution of the wave theory of light with the quantum theory of light; 6) the explanation of why ultramicroscopic phenomena are statistical yet large ensembles of ultramicroscopic phenomena are causal; and 7) validation of Mach's principle and the equivalence principle. A totally new and precise definition of mass and of being itself are also two unexpected results. The problems of metaphysics are also answered: metaphysics is elevated to an exact science without any tinge of dogma, and physics and metaphysics are united.

---

[1] Planck's constant, Heisenberg's uncertainty principle, the principle of least action, the energy of a photon, etc., are derived from action and perception's differentiation of action.

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II. EXISTENCE, PERCEPTION, OBSERVATION AND PHYSICAL PHENOMENA

We first define perception[1] as detection by a mass of change[2] to itself, and state that it is an operation performed by that mass. The physical apparatus that accomplishes this perception is termed a "perceptron," which thus may be an electron, an atom, or the sensory apparatus of a living being.

A change detector does not detect the state of its input, but rather detects changes in that state. So in this sense a change detector can be regarded as a state differentiator. Therefore a perceptron differentiates, i.e., it perceives changes in its input and generates outputs in accordance. When its input is constant it will have no output. Thus zero output of a perceptron does not necessarily mean zero input.

What is to be fed into the perceptron's input section exists; i.e., existence (ultimate reality)[3] is defined as what is to be fed into the perceptron's input. The output of the perceptron is that which is perceived, or what we ordinarily call "physical phenomena."[4] Since the perceptron differentiates its input state, then physical phenomena are first derivatives of ultimate reality, which precisely accounts for the sharp separation between observable and nonobservable, i.e., between macroscopic and microscopic.

Any change in a perceptron's input section must involve both time change, Δt, and energy change, ΔE. So we may assume their product, $\Delta E \Delta t$, has always occurred in a perceptron's input whenever it produces an output. The output will be a derivative of the input, e.g.,

$$\frac{\Delta E \Delta t}{\Delta t} = \Delta E \tag{1}$$

and

$$\frac{\Delta E \Delta t}{\Delta E} = \Delta t\,, \tag{2}$$

where in each case the constant of proportionality has been ignored.

---

[1]We differentiate between <u>perception</u> and <u>realization</u>. Perception is entirely a physical process, and causal. Realization is a mental process and is not restricted to causal relationships.

[2]Reflecting, one notes that mass can only change in a nonmass manner. It cannot "change" without involving space and time, both of which are "nonmass." Therefore a mass change <u>must</u> be composed of both mass and nonmass.

[3]"Ultimate" in that it is higher or more fundamental than perceived reality.

[4]Changes to mass and only changes to mass constitute physical phenomena. Changes to one mass constitute "its" perceived physical phenomena, or its physical universe.

"Changes to mass and only changes to mass constitute physical phenomena. Changes to one mass constitute "its" perceived physical phenomena, or its physical universe. Since the other masses in its universe are perceived by it (i.e., created in its perception by its perception process), then these masses must be entirely relative to the mass perceptron that perceives them. Ergo, perceived mass is relative to the perceiver.

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Any detector has an operational input threshold, i.e., a minimum discernible signal. The Heisenberg uncertainty principle states the requirement for such energy-time changes:

$$\Delta E \Delta t \geqslant \hbar/2 \ . \tag{3}$$

Its smallest value, or

$$\Delta E \Delta t = \hbar/2 \ , \tag{4}$$

is then the input threshold for a physical perceptron to operate and produce an output.[1] Letting $k = \hbar/2$, we can write this simply as

$$\Delta E \Delta t = k \ . \tag{5}$$

Since existence has been defined as that which is fed into the perceptron's input, then that existence exists whether or not the perceptron operates, and the case[2] where

$$\Delta E \Delta t < k \ , \tag{6}$$

also exists (i.e., can be present in the input of a perceptron) but cannot be perceived or detected (i.e., the perceptron will not operate and produce an output).

At this point we diverge to remark that the product of energy and time is a quantity called "action," and the units of action are

$$A \equiv \frac{ML^2}{T} \tag{7}$$

Thus the input state to a perceptron is composed of an action continuum,[3] and the perceptron differentiates action quanta to produce physical phenomena.

---

[1]We acknowledge additional uncertainty statements but for simplicity will use only one in this paper.

[2]Equation (6) exists and it is proper to write it down and search out its ramifications. Equation (3) is a limiting condition which applies only to mass. But since our physical experience must involve nonmass (e.g., photons, space, time, being), then nonmass considerations must be examined. A good beginning is to consider the entire field of nonmass possibility, i.e., that field of nonmatter changes defined by (6), which includes the entire subquantum domain. So we legitimately examine two conditions: Eq. (3) must define (or apply as a condition to) the mass phenomena (change, quantized) system, and (6) must define (or apply to) the nonmass phenomena (subquantum) system.

[3]We exactly define continuity as the failure to perceive difference (change), and

phenomena (subquantum) system.

[3]We exactly define continuity as the failure to perceive difference (change), and discontinuity as the perception of difference (change). The difference between continuous and discontinuous is entirely one of perception. Thus there are two kinds of continuity: absence of perceptron operation at all, and identically repeated perceptron operations. The first kind exists outside of perception while the second kind exists in perception-to-perception. These are two powerful definitions, which among other things enable one to understand such concepts as limiting process, derivative, point, line, and plane. Mathematics itself is the game of perception, nothing more and nothing less.

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When a large quantity of action is to be fed into a perfect perceptron, the input process cannot occur instantaneously; a Δt must be outputted (created)[1] by the perceptron for each operation. Thus perception processes steps or quanta of exactly k size, and exactly k size only. Inputs of less than k size are simply collected[2] until the aggregate is equal to k, then differentiated to produce an output. We must therefore rewrite the Heisenberg uncertainty principle as

$$\Delta A = nk \quad , n = \pm 0, 1, 2, \ldots \quad , \tag{8}$$

where the plus and minus signs are necessary since action only has to change about some constant level in the perceptron input, and this change may be either additive or reductive (this quantum statement is actually the basis for quantum physics).[3] Thus, from the viewpoint of a perceptron, its output universe of physical phenomena is constructed by successive granular differentiation of unit operations, each of size k, but it detects no time lapse (creates no Δt) between operations.

When differentiated by a perceptron, an action atom may be regarded as being "chopped up" (the word "differentiated" literally means separated or torn apart):

$$\frac{\Delta E \Delta t}{n} = \frac{k}{n} \quad \overline{A} , \qquad n = 2, 3, 4, \ldots \quad , \tag{9}$$

where the bar over the A indicates nonaction, or action atoms which have been broken into bits.

Thus we now conceive of an action continuum of action atoms and a nonaction continuum[4] of bits of action atoms. The two continua coexist and the perceptron

---

[1]Or "extracted from an action quantum $\Delta E \Delta t$," which means exactly the same as "created." Einstein's treatment of simultaneity showed that it was operational, but if simultaneity itself is operationally created then both time and length must also be operationally created.

[2]This is not a simple discontinuous operation, since no time flow exists (Δt is not being outputted) during this collection process. We have to think of the process discontinuously, but the stepwise process is actually continuous (in time), or discontinuous, or both.

[3]Since ΔE may be positive or negative, we may state the uncertainty principle as $|\Delta E \Delta t| \geqslant k$, or as $\Delta A = nk$, $|n| \geqslant 1$. Consider the two cases $\Delta A > 0$, $n = 1$, and $\Delta A < 0$, $-1 < n < -2$. Superimposing them would give $|\Delta A| < k$, which violates the uncertainty principle. Thus, assuming superposition must hold, the uncertainty principle can be made to violate itself for all except integral values of n, and it follows that the Heisenberg uncertainty principle must be written as a quantized statement.

[4]The separation into two continua is artificial, but is necessary to allow us to perceive perceptron operation with our brain perceptron mind. There is absolutely

"The separation into two continua is artificial, but is necessary to allow us to perceive perceptron operation with our brain perceptron mind. There is absolutely no separation in the reality continuum itself; rather, there is only an operational separation caused by and in perception. Hegel was very nearly correct in his realization that the dialectical principle was the magic key to the universe of perceived phenomena. However, thesis (action) and antithesis (nonaction) do not meet to give a synthesis (the transfer function or switching) which is different from either; rather, thesis (action) is changed (transferred or switched) to its antithesis (nonaction) and vice versa. It is the switching or transfer process that is the synthesis (output of the perceptron, perception) which is different from the thesis and the antithesis.

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operates, or moves, in them. Only action quanta of exactly k size can be processed by the operating perceptron to give outputs which we know as physical phenomena. Such phenomena (events) consist of aggregates of extremely large numbers of perceptron operations. Action atoms will be referred to simply as "action atoms." The very smallest bits or fragments[1] of action atoms will be referred to as "quitons" and the symbol "q" used for one quiton. For convenience, we shall regard the "magnitude"[2] of q to be very much less than k, or

$$q \ll k \,. \tag{10}$$

The perceptron's process of collecting quitons to form action atoms will be termed "fusion," which is an additive change to the constant action continuum. "Fission" will be the term for the perceptron's process of breaking up action atoms into aggregates of quitons, where the size of each aggregate is less than k; fission is a reductive change to the constant action continuum. The term "switching" will be used to refer to either fission or fusion, or both.[3]

Fission and fusion are merely transfers or switches across the k-threshold separating the action and nonaction continua, and may be represented by either of the diagrams shown in Fig. 1.

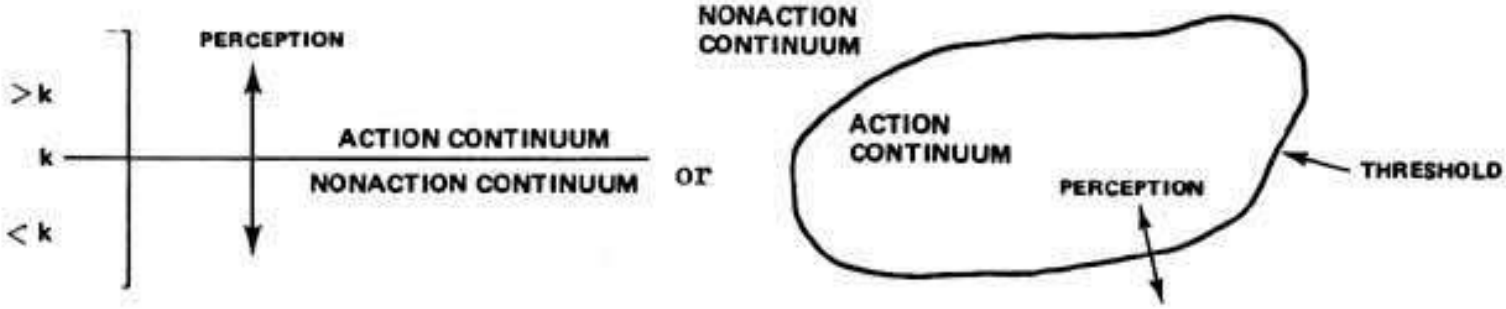

Fig. 1. Continua of the Universe

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[1]These are actually nonthings and not bits or pieces at all, but since we can only perceive or think of things, we will model them as things. The difficulty is in the nature of thought, not in the nature of reality.

[2]The perceivable magnitude of a quiton is zero, i.e., it is not perceivable.

[3]And, in fact, switching can also refer to the transfer of Δt into ΔL, i.e., the creation of space from time or vice versa. Separation (relation) is composed of ΔL and Δt, and we know from relativity that when relativistic (perceived) ΔL is changed, then relativistic (perceived) Δt is also changed. When time dilates, length contracts; and when time shrinks, length expands. Therefore the statement that length and time are intertransferrable is valid: one kind of separation can be transferred into another kind of separation just as one kind of energy can be changed into another kind of energy. Since this transfer itself is an operation, then there is a rate (i.e., a constant) of transfer. This constant is actually a parameter, since by special relativity it can vary as a function of the mass changes themselves. And since we are dealing with mass changes (perception), then the rate of transfer constitutes a rate of mass change (rate of perception). Since perception is finite

since by special relativity it can vary as a function of the mass changes themselves. And since we are dealing with mass changes (perception), then the rate of transfer constitutes a rate of mass change (rate of perception). Since perception is finite, perceived mass change cannot be infinite but must also be finite. Therefore a limiting rate of perception must exist. From the equations of special relativity, this limiting rate of perception or mass change is c, the speed of light, and its value may be taken as the rate of change of a mass switch itself.

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We now examine the expression for energy of a photon:

$$E = hf \tag{11}$$

Considering fission of an action atom as a chopping of that atom, the process can be expressed by:[1]

$$\begin{bmatrix}\text{Minimum}\\ \text{time rate of}\\ \text{change of action}\end{bmatrix} = \begin{bmatrix}\text{Energy}\\ \text{Transferred}\end{bmatrix} \simeq \begin{bmatrix}\text{atom of}\\ \text{action}\end{bmatrix}\begin{bmatrix}\text{cuts or chops}\\ \text{per second}\end{bmatrix}, \tag{12}$$

or

$$\frac{\Delta A}{\Delta t} = \Delta E = C_1 kf , \tag{13}$$

where C_1 is a constant of proportionality. According to Eq. (1), the energy perceived to be expended (transferred to quiton disturbances) in fissioning of an action atom ought to be proportional to the speed of the chopping action. Neglecting constants of proportionality, Eq. (13) is simply[2]

$$\Delta E = hf , \tag{14}$$

where the Δ symbol is deliberately added to show that it is a transfer process. The equation works in reverse for fusion of quitons into action atoms, i.e., the energy ΔE transferred to each action atom assembled is proportional to its rate of assembly.

We can now represent a perceptron as shown in Fig. 2, which corresponds precisely to the two-pronged arrows shown in the diagrams of Fig. 1. A perceptron has two channels, fission and fusion, in which switching transfers between action and nonaction are involved.

By Eq. (2), one of the outputs of a perceptron is Δt. Since perception creates its own time interval, it only has its kind of time, i.e., positive time, to deal with. Thus only positive time is perceived, and what we think of as positive time flow is merely the successive Δt's created by perception.[3]

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[1]Note how admirably the view of tearing apart or differentiating the action atom describes the result. The smaller the Δt torn from (ΔE Δt) (or the quicker the separation), the larger the ΔE left (produced), i.e., the more energetic the separation. The atom of action is a quantum of action and one integral piece; the ΔE and Δt, however, are not necessarily of individually fixed size.

tion. The atom of action is a quantum of action and one integral piece, the ΔE and Δt, however, are not necessarily of individually fixed size.

[2]Action atoms can occur in more than one size (see note 1 on p. 3).

[3]This explains why we sense existence as if we were the point of contact of a pointer moving along a time line. In effect, perceptron time advances one time slice at a time, where the slice is of Δt thickness. Thus all physical phenomena occur in minute granular sequences.

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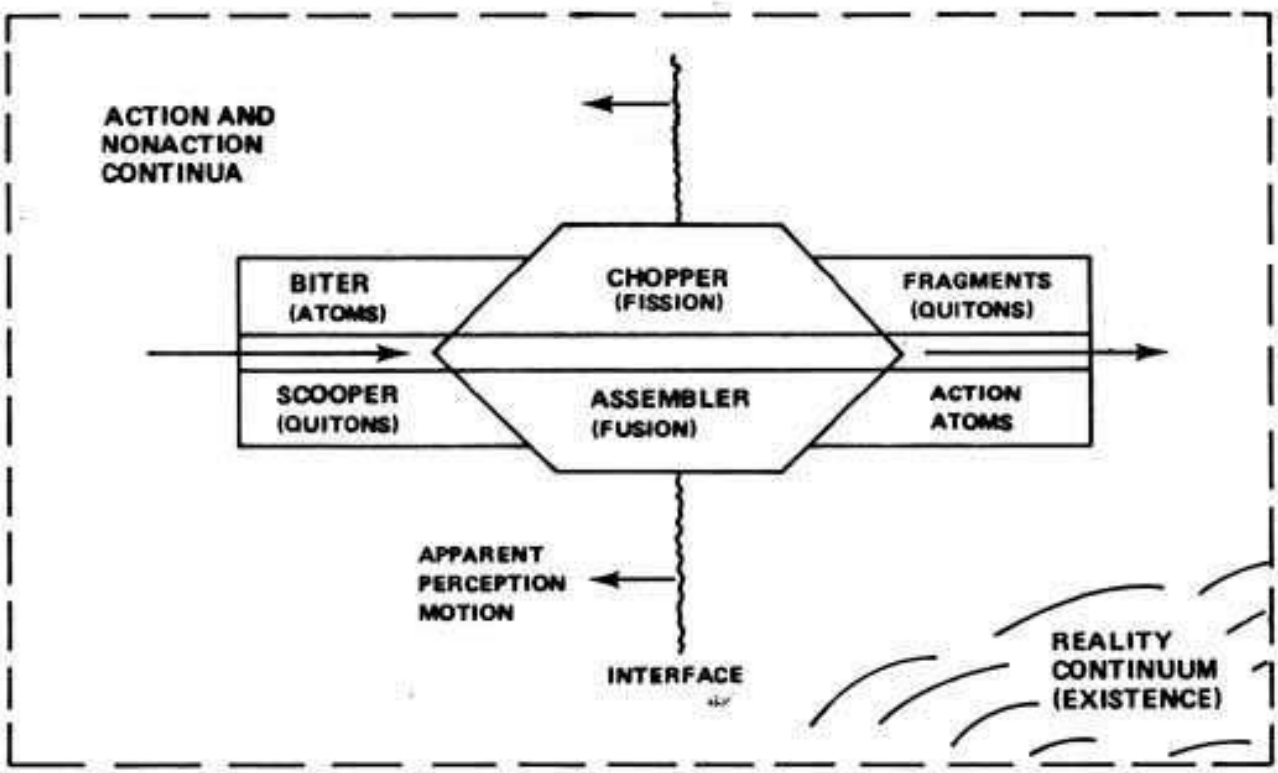

Fig. 2. The Fundamental Perceptron Switch

The existence of a negative time flow can be postulated by a simple symmetry analogy, but this postulated negative time, by definition, cannot be a perceptron output. We use the term "reflection" to denote a postulated operation in negative time[1] symmetrical to perception which operates only in positive time. Reflection is essential to the explanation of electric charge and charge effects,[2] but these will not be discussed here. Figures 3, 4, and 5 summarize the concepts of reflection, perception, and positive and negative time.

We now introduce the concept of absolute value of a dimensional molecule.[3] To illustrate, if we know that F = Ma, we will state that

$$|F| \equiv |Ma| \equiv |M| \times |a| = M\ |a| \quad , \tag{15}$$

where the last expression is true because of the nondivisibility of the unit ΔL and

---

[1]Modern theorists such as Feynman, Wheeler, and Dirac of necessity incorporate negative time operation into their theories involving action-at-a-distance.

[2]The quiton/perceptron theory can and does explain what "charge" is, why like charges repel and unlike charges attract, etc. It predicts the force of attraction or repulsion to be proportional to Q_1Q_2/R^2.

[3]Although perceptron output bits may vary in magnitude from operation to operation,

[3]Although perceptron output bits may vary in magnitude from operation to operation, they are of absolutely fixed size in any one operation or between any two consecutive operations. So for one operation or any two consecutive operations, a dimensional molecule is merely a product and division of certain-sized bits, and is itself of one fixed magnitude. Any other dimensional quantity of equal absolute value is therefore of the same size for that operation. At this level, differentiation is simple bit division and integration is simple bit multiplication.

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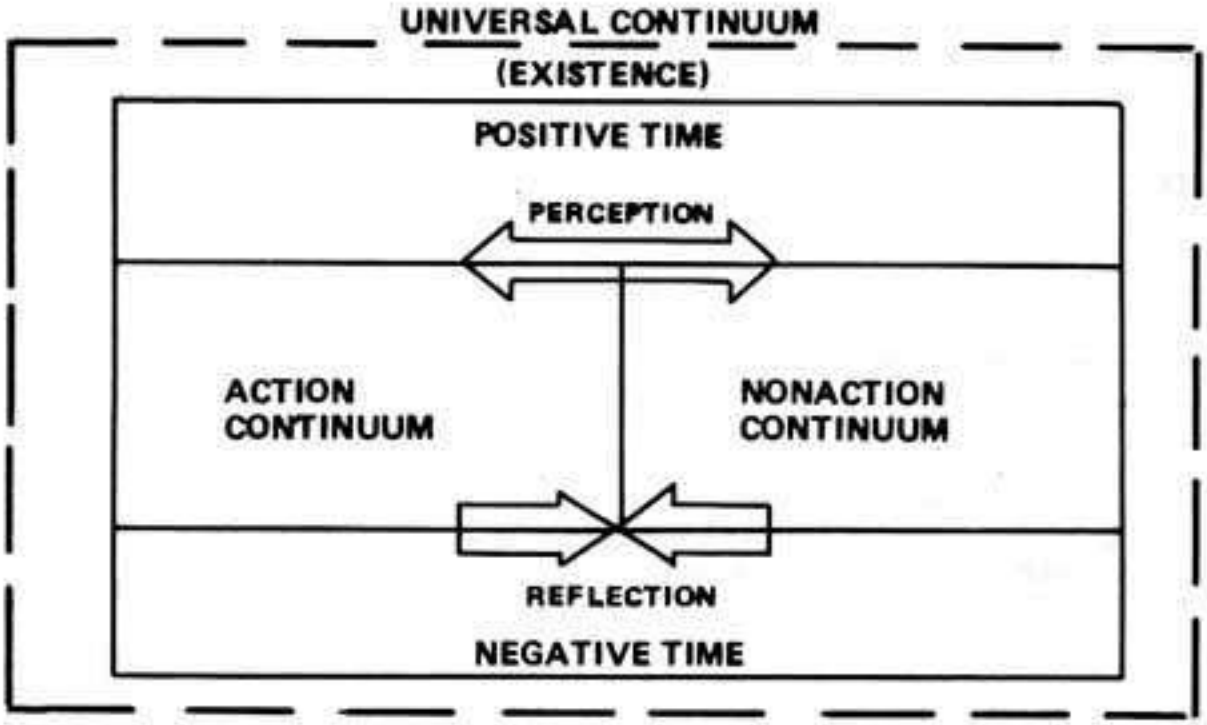

Fig. 3. The Continua (Complete Model)

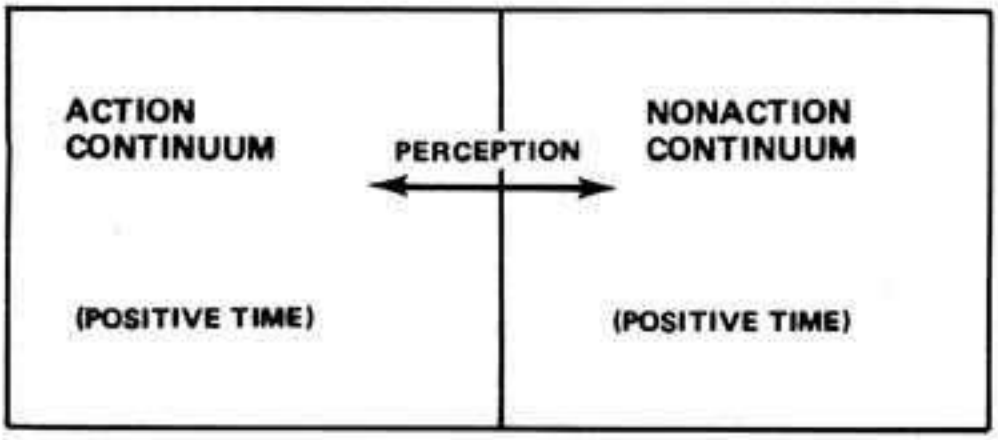

Fig. 4. The Positive Time Continua -- Model in Which Perception Acts

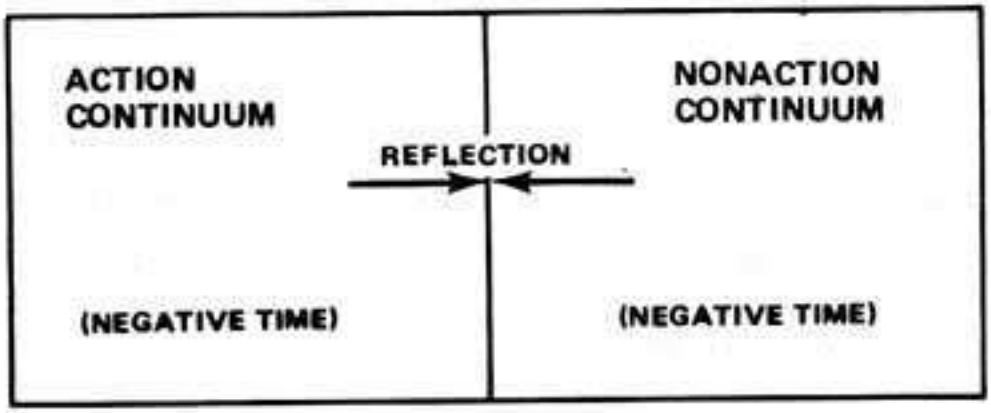

Fig. 5. The Negative Time Continua -- Model in Which Perception Does Not Act

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Δt quanta outputted by one perceptron operation. The absolute value signs must be added to any dimensional molecule which can take on either positive or negative values. Dimensionally,

$$M_0 = |E| \ , \tag{16}$$

where M_o is rest mass and requires no absolute value sign since a quantity of rest mass is only positive. Actually, since perceptron operation only outputs quanta, then the perceptron outputs ΔE and ΔM_o, or

$$\Delta M_0 = \left|\Delta E\right| \ , \tag{17}$$

and repetition rate allows perception of M_0 as a positive quantity. Then

$$\frac{\Delta A}{\Delta M} \longrightarrow \frac{\Delta(L^2)}{\Delta t} \ . \tag{18}$$

The perceptron expression of the right-hand side of (18) will be[1]

$$\frac{\Delta(L^2)}{\Delta t} \longrightarrow \frac{\Delta L \Delta L}{\Delta t} \longrightarrow \Delta L\,(V) \ , \tag{19}$$

and then we have

$$\Delta E \Delta t(V/V) \longrightarrow \frac{\Delta E(V\Delta t)}{V} \longrightarrow \Delta P(\Delta t)(\Delta L/\Delta t) \longrightarrow \Delta P \Delta L \ , \tag{20}$$

which must be another statement of the minimum condition of the Heisenberg uncertainty principle, or

$$k = \Delta P \Delta L \ . \tag{21}$$

It follows that

$$\Delta P \Delta L = nk, \qquad n = \pm 0, \pm 1, \pm 2, \ldots \tag{21a}$$

To consider why constant velocity yields special relativity, from $E = ML^2/T^2$ and Eq. (16), we can write

$$M = \left|\frac{ML^2}{T^2}\right| = M\left|\frac{L^2}{T^2}\right| \ . \tag{22}$$

Dividing out the M gives

$$1 = \left|\frac{L^2}{T^2}\right| = \left|\frac{L}{T}\right| = \frac{|L|}{|T|} = |V| \ . \tag{23}$$

[1]Obviously $\Delta(L^2) = 2L\Delta L + (\Delta L)^2$, but the units of $2L\Delta L$ are $\Delta L\Delta L$.

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So velocity is a dimensionless quantity in the absolute dimensional sense, i.e., in the perceptron operational sense, and "the laws of physics apply equally well for all observers as long as they are moving with constant velocities" (Einstein's postulate). When the perceptron process is applied to a system of objects whose relative velocities are constant, the inputs to perception always differ by a constant value and the differentiated outputs of perception do not differ, i.e., the differential of $f(x) + C_1$ is identical to the differential of $f(x)$.[1]

Observation is related to perception as shown in Fig. 6. An observer observes only perceptron outputs[2] -- never ultimate reality -- from his sensory apparatuses.

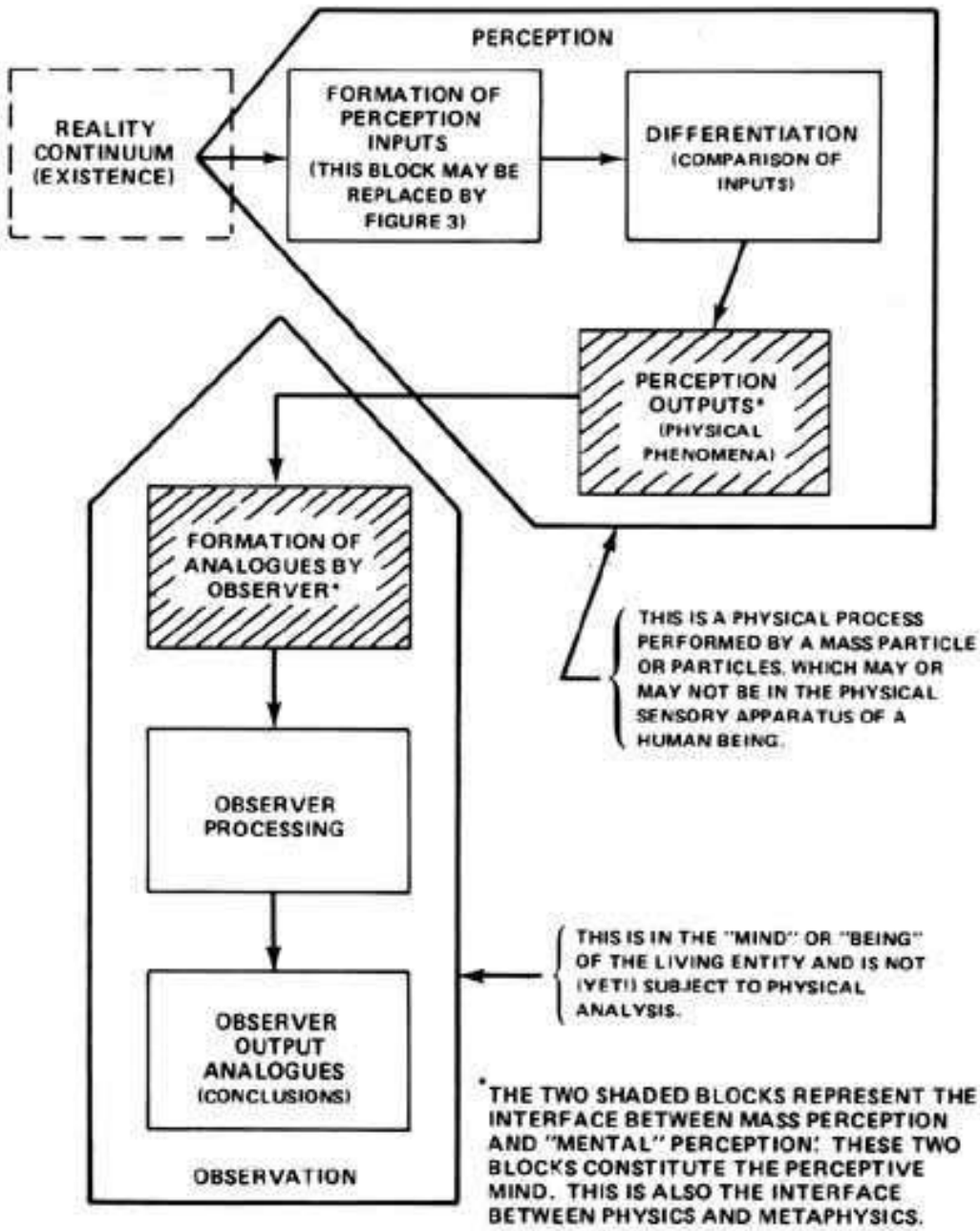

Fig. 6. Overall Relationships

[1]Einstein's treatments of simultaneity and special relativity may be regarded as

[1]Einstein's treatments of simultaneity and special relativity may be regarded as statements that one can determine a length (measure a ΔL) only by $\Delta L \equiv c\Delta t$, and one can determine (measure) a Δt only by $\Delta t \equiv \Delta L/c$ in the static case.

[2]The process of observation actually consists of both perception and realization.

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III. MASS AND SPACE

The nonaction continuum may be further visualized as a sea or gas of small, unperceivable particles, i.e., of quitons and aggregates of quitons which are less than k in magnitude. Since mass is a perceived quantity and a quiton cannot be perceived, a quiton or aggregate of less than k magnitude has zero mass.

Since fission and fusion both constitute perceptron switching, we may explain mass by visualizing a changing pile of quiton bundles, each of k size, in which the total rate of switching activity is what we call the "mass"[1] of the pile. Thus the mass is equal to the sum of the absolute values of the fission and fusion activities:

$$M \equiv \left|\frac{\Delta A_i}{\Delta t}\right| + \left|\frac{\Delta A_o}{\Delta t}\right| \simeq \left|\dot{n}_i + \dot{n}_o\right| \quad k \ , \tag{24}$$

or

$$M \simeq \left|\dot{n}_i + \dot{n}_o\right| \qquad \text{sw/sec}, \tag{25}$$

where[2]

Δt = perceptron operation time (one operation)

M = perceived mass of the pile

ΔA_i = action created from fuzing quitons into action atoms

ΔA_o = action lost from fissioning action atoms into quitons

$\dot{n}_i$ = number of k-sized bundles per second fused into atoms

$\dot{n}_o$ = number of atoms per second fissioned into quitons

sw/sec = one perceptron operation per second.

---

[1] If ΔE is time rate of change of action, and if the absolute dimensional value of rest mass and rest mass energy are the same, then mass must also be a time rate of change of action. One kilogram mass equals 17.053×10^{50} sw/sec.

[2] The switch concept is necessary to explain charge and charge effects. The switching occurs between the positive (perception outputted) and negative (reflection outputted) time streams. Three types of switches exist, two of which are charge switches and all of which are mass switches. Switching may also be regarded as change of Δt into ΔL. For a mass switch, the limiting value of the conversion parameter b in ($\Delta L = b\Delta t$) is c, the speed of light. However, the

regarded as change of Δt into ΔL. For a mass switch, the limiting value of the conversion parameter b in ($\Delta L = b\Delta t$) is c, the speed of light. However, the concept of switching can be expanded; $b < c$ implies mass switching; $b = c$ implies quitons moving (maximum switching limit for mass switching); $b > c$ implies DeBroglie waves moving, which are not switching in the normal sense at all. Technically, the condition $b < c$ applies to Eqs. (24) and (25).

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The use of the mass definition equation can be illustrated by a simple example. First,

$$k \equiv h/2 = 0.527 \times 10^{-34} \text{ joule-sec} \tag{26}$$

$$1 \text{ kg mass} = 8.987 \times 10^{16} \text{ joules}, \tag{27}$$

so

$$1 \text{ kg mass} = \frac{8.987 \times 10^{16} \text{ joules}}{0.527 \times 10^{-34} \text{ joule-sec/switch}} \tag{28}$$

$$1 \text{ kg mass} = 17.053 \times 10^{50} \text{ switches/sec}. \tag{29}$$

For a mass that does not accelerate, switches must occur in couplets. This would require, for example, that angular momentum be quantized in quanta of 2k magnitude, since two switches would process two action atoms -- one in and one out of the mass action pile. Since

$$2k = h/2\pi, \tag{30}$$

then angular momentum should be quantized in $h/2\pi$ quanta, which indeed it is: from the Bohr theory of the hydrogen atom,[1]

$$mvr = \frac{nh}{2\pi} \quad , n = 0, 1, 2, \ldots, \tag{31}$$

and the change permitted is thus

$$\Delta(mvr) = \frac{nh}{2\pi} \quad , n = 0, \pm1, \pm2, \pm3, \ldots \tag{32}$$

What we normally think of as empty space is sometimes described as the absence of mass and energy, existing in time.[2] Empty space can be defined by

$$\frac{\Delta A}{\Delta t} = 0; \qquad \frac{\Delta \bar{A}}{\Delta t} = 0, \tag{33}$$

which merely state that no perceptron output is occurring. Thus empty space exists only as defined by a perceptron and is merely the total absence of perception. While these equations rule out fission and fusion, they do not rule out the static presence of large numbers of quitons and quiton aggregates each of which is less than k in size (a quiton may be viewed as a quantum of space or a quantum of ether).

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[1]Beiser, Concepts of Modern Physics, McGraw Hill, 1963.

[2]Actually there is no time connected with the existence of space; the time is connected only with our perception of change; that is, space is a product of perception, or the nonoperation of perception, and is related to a mass perceptron. Similarly, space itself has no length -- length is relative between two masses. That is why both length and time can change, and why a specific length and a specific time can

space itself has no length -- length is relative between two masses. That is why both length and time can change, and why a specific length and a specific time can be different to different observers.

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A massless quiton cannot individually generate any drag resistance against matter in the Newtonian sense. So a mass object moving along at a constant velocity will just push a stream of massless quitons ahead of it. In effect, the mass "bulldozer" is pushing its own medium along with it, and this requires no force.[1] Therefore, empty space (i. e., the zero output condition of one's mass perceptron) is filled with (has added to it) streams and streams of quitons moving ahead of other objects (perceived by one's perceptron) from all over the universe (perceived by one's perceptron). These quiton streams may be regarded as quiton pulses or quiton waves[2] in one's own static-relative quiton pond. The static-relative quiton pond of a mass will be called its "q-space" or "space" (more commonly referred to as the mass's inertial frame of reference).

When impinging on a perceptron's mass, these disturbances are being collected into k-sized quanta and switched into action atoms. The switching produces outputs that reveal the presences of the disturbing masses. The situation for a perceived mass is described in Fig. 7. Note that a fusion pileup is shown in front of the perceived object due to the object's motion, and a fission pileup is shown at the rear (switching is actually distributed throughout). Additional switching is occurring in the pileups and constitutes increase in mass. So one's mass perceptron perceives the moving object's mass as having increased. The relative velocity of the object with respect to one's perceptron determines the additional collection rate of quitons, and hence the additional switching rate, occurring for the object in one's perceptron q-space. The perceived increase in the moving body's mass is a function of the increased collection rate, which is a function of both the initial mass switch size M_0 and the velocity V, or

$$M = f(V, M_0) . \tag{34}$$

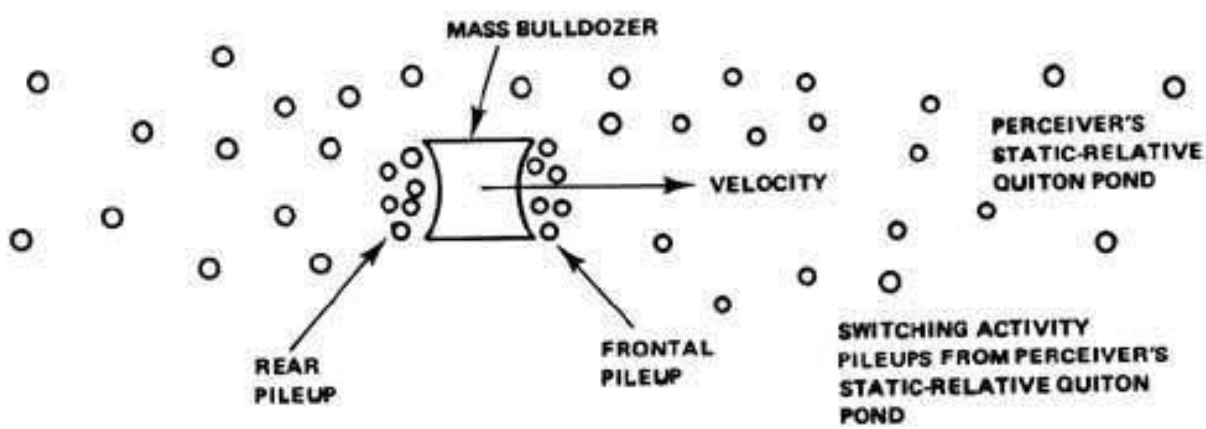

Fig. 7. Increased Perceiver Switching Due to Perceived Velocity

[1]More precisely, it requires no resultant (unbalanced) force. Both fission and fusion create forces; however, these forces are opposing, and so when fission rate equals fusion rate the resultant force is zero.

[2]These pulses or waves are not in themselves perceived, so one can equally well consider them bunches of particles or waves. The difficulty lies with the perceptron mind, not with the disturbances.

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If the perceiver shifts "his view" to the object, he would at the same time shift his perceptron to it and so would then see the same sort of effect existing on his vacated mass. The pileup is relative to the perceiver and is occurring in the perceiver's perceptron itself.[1] So material objects do not just move through an ether, they carry their own q-space ethers right along with them.[2] And all they can detect is the disturbances in that q-space that produces switching transfers in and out of the action and nonaction continua.

We now wish to know the standard medium velocity at which wave disturbances move in the q-space. The question is, what has zero mass, is unperceivable, and yet can move through the perceiver's empty space ether[3] at some standard velocity? Photons satisfy all these requirements. Photons themselves cannot be perceived -- only their interactions can; and photons move in free space at the velocity c, the speed of light. Thus c is the quiton medium's wave velocity[4] and quiton disturbances move in a q-space at the velocity c. They move only in a q-space and in nothing else, since movement (velocity) is defined as $\Delta L/\Delta t$, and both ΔL and Δt exist only to the perceptron that created them. Therefore, velocity of a perceived object is absolutely relative to the perceiver since it is part of the perceiver's mass's perception. At this point, Einstein's postulate that "the speed of light is the same for every observer" can be seen to follow directly from the quiton/perceptron model.

But a difference exists between the speed of light in q-space and the speed of light in a medium. Simply speaking, when light travels in a medium the quiton waves (photons) are perceived to interact with particles (get switched by other switches) continually. In each imposed interaction switching perceived, another Δt occurs in the perceiver's perceptron. Thus more Δt's occur, and the photon is perceived to take longer in traveling through the medium than through free q-space; that is, the perceiver's perceptron (in which the medium itself exists) creates more time output in the case of light traveling through a perceived medium than light traveling through unperceived free q-space.

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[1]This point is emphasized. The mass's mass does not increase as perceived by itself; its mass does increase as seen by the perceiver. This fact alone is sufficient to establish that the increase in mass is subjective, not objective (although these two terms are usually misused). That is what the term "relative" means, i.e., relative to the subject. Note that the perceiver is always the subject. The fact that the effect occurs only to the perceiver should indicate that it is the perceiver's perception process which is causing the effect.

[2]Thus one can have one space moving through another space.

[3]From Einstein's Theory of Relativity by Max Born, p. 224: "Einstein in later years proposed calling empty space equipped with gravitational and electromagnetic fields the 'ether,' whereby, however, this word is not to denote a substance with its traditional attributes. Thus in the 'ether,' there are to be no determinable points, and it is meaningless to speak of motion relative to the 'ether.' Such a use of the word 'ether' is of course quite admissible, and when once it has been sanctioned by usage in this way, probably quite convenient." The use of "ether" here is quite close to Einstein's proposal; however, in our usage it is meaningful to speak of "perceived motion of a perceived object" in the q-space ether of the perceiver. Otherwise, there can be no observation and no observer, which are of course necessary

"perceived motion of a perceived object" in the q-space ether of the perceiver. Otherwise, there can be no observation and no observer, which are of course necessary to Einstein's theory.

[4]Velocity is unperceivable; it is actually the constant of proportionality for the perceptron's direct transposition of Δt into ΔL. And c, the constant velocity of light, represents the limit of the perceptron's ability to do this.

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It should be noted, but will not be pursued further here, that electromagnetic waves in space are merely quiton wave disturbances[1] moving in a perceptron's q-space. The energy being transmitted is the "energy equivalence" of the nonaction quiton aggregates that were chopped up from action atoms. When these fissioned aggregates are again collected in some perceptron, then $\overline{\Delta E}$ is recovered as ΔE, or perhaps as ΔM.

In passing, we note that hidden in the principle of complementarity is the fact that wave and particle are operationally excluded, i.e., separated by an operation. A wave by definition is operational (dynamic). The most elementary idea involved in the concept of a particle is that it is nonoperational; i.e., it doesn't have to move, or change, or function, or be dynamic to exist. Obviously that which is operational differs from (is separated from) that which is nonoperational, but such separation itself is differentiation which is an operation. Therefore, wave (operation) and particle (nonoperation) are operationally separated. The only "mystery" in complementarity is that one must stop (interfere with) an operational entity to have a nonoperational entity, and one must start (interfere with) a nonoperational entity to have an operational entity. Depending upon the conditions imposed upon it, an entity can be either operational or nonoperational. For example, the operation of superposition must be imposed upon DeBroglie waves before they can constitute a particle. It then follows that the particle's velocity must in fact be the velocity of the superimposed group, i.e., the wave packet's velocity. By the same reasoning it follows that one cannot measure a particle's exact position (which is a static or nonoperational entity) and its exact momentum (which is a moving or operational entity) at the same time. The same is true for the particle's exact time position (nonoperational) and its exact kinetic energy (operational). Thus uncertainty principles, complementarity, and the relationship of DeBroglie wave velocity to wave packet velocity all involve the one fundamental concept that an operational entity is separated from a nonoperational entity by an operation. The changing is separated from the unchanging by a change; i.e., the changing is operationally derived from the unchanging, or perceived reality is derived from unperceived reality.

[1]Photons are aggregates of quitons; quiton aggregate behavior is particulate. Behavior from the standpoint of individual quitons is wave-like. This explains the dual behavior of light and reconciles its wave and quantum aspects.

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IV. IMPACT ON PHYSICS

A. MICHELSON-MORLEY EXPERIMENT

The Michelson-Morley experiment was conducted in the Michelson/Morley/earth q-space. The Michelson/Morley/earth perceptron(s) would perceive the speed of light to be the same in all directions, i.e., any fringe shift observed should have been a result of experimental uncertainty only. The experiment did not prove there was no ether; it did prove there was no perceivable ether[1] through which the earth was moving. The results admitted of a static-relative ether if it is unperceived. Perception is a process, and if the process does not occur then perception does not occur. Since by definition the q-space of a perceptron does not cause the perceptron to operate, then the q-space is unperceived by the perceptron.

More careful examination of observation reveals the following facts: A perceived mass has a constant mass when not moving with respect to the perceiver. When it is moving through the space frame or the ether of the perceiver with a constant velocity v, its perceived mass is again constant but is now perceived to be greater than was its rest mass. From whence came the extra mass?

The extra mass effect is only to the perceiver. The only possible sources for the extra mass in perception are the original rest mass M_0 and the empty space of the perceiver's space-frame (i.e., the interaction of perceived mass with unperceived space). Space does not drag, in the conventional Newtonian sense, against a moving body that is not accelerating. And space is unperceivable; therefore it can be visualized as a massless fluid. Thus the increase in perceived mass (which is a change) must come from the perceived mass's increase in velocity in perceiver space (because velocity is all that was changed), and it must involve the physical operation of the perceiver's physical perceiving mechanism. A perceived mass does exert resistance (drag) called "inertia" whenever it is accelerated in the perceiver's space-frame. This resistance is a force. Perceived force is equal to perceived mass times perceived acceleration through the perceiver's space.[2]

---

[1] Is not space an unperceivable ether? An extract from Einstein's Theory of Relativity by Max Born, p. 223, states: "If each of two observers who are moving relative to each other can assert with equal right that he is at rest in the ether, there can be no ether. Thus, the extreme development of the ether theory leads to its dissolution as a fundamental concept." The conclusion that there can be no ether does not logically follow. Each observer can assert that he is at rest in an ether (space), and these spaces can be intermoving. That is precisely what a "moving frame of reference" is: one space moving through another. Today we retain the (or more correctly, an) ether concept, but call it "space" or "inertial frame of reference" or "frame." The conclusion should have been that there can be no single "stable ether," but that there can be many.

[2] Newton's law, F = ma,* to date has been used in a half sense, i.e., that the acceleration of a perceived mass through the perceiver's unperceived q-space generates force. If this is true, and relativity holds, then the acceleration of any other unperceived q-space, through a perceived mass, also generates force; through one perceived mass in a perceiver's q-space, the q-spaces of all other perceived accelerating masses are accelerating and thereby generating forces on it. By this "other half" of Newton's law and by relativity, Mach's principle (that inertia of a mass is derived from the

accelerating and thereby generating forces on it. By this "other half" of Newton's law and by relativity, Mach's principle (that inertia of a mass is derived from the other masses of the universe) can be shown to be true. Although not collated and developed as such, it is possible to derive the postulates of both special (Continued)

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This equation states that a perceived accelerating mass must react with the perceiver's q-space, and in fact this interaction may be taken as the basic mechanism that creates force itself. Again the perceiver's physical perception mechanism is the causative agent.

A quite logical conclusion at this point is that the perceiving mechanism perceives (produces) additional perceived mass from the interaction of perceived rest mass with perceived mass-motion (velocity) through its unperceived space.[1] Also, the perceiving mechanism produces perceived inertial drag from the interaction of perceived mass with the mass's perceived acceleration through its unperceived space.

The concept of "ether" should not be rejected while the concept of "space" is retained, since the latter is actually an unperceivable ether. Rather, the concepts of mass, perception, and ether-space should be tailored to fit the perceived phenomena. Quiton/perceptron theory (perception theory) is a deliberate transfer function model specifically tailored to fit these criteria.

B. GRAVITATIONAL ATTRACTION

Newton's law of universal gravitation can be generated, in both effect and form, from quiton/perceptron theory.

A perceptron's q-space is filled with streams and streams of quiton disturbances moving ahead of its perceived moving objects from all over its universe. Thus there exists a flux of quitons at any point in its space, and this flux is isotropic to the first approximation: because of the vast interstellar distances between disturbing masses, the flux gradient in the relatively local neighborhood of any perceiver point is essentially zero. The quiton disturbance flux can be represented as shown in Fig. 8. A quiton flux stream switching pressure P_1 is exerted on M_1 and a switching pressure P_2 is exerted on mass M_2. In any one flux stream line in this shadowed zone, the pressure against either of the two bodies is reduced in proportion to the amount of switching flux subtracted from that flux line by the other body. The total reduction of switch pressure in the shadowed zone is therefore proportional to the product of the two masses M_1 and M_2, considering the effects to be mutually independent.

(Footnote 2 continued from preceding page) and general relativity from quiton/perceptron theory, and the steps essential to that derivation are contained in this paper.

*[More precisely, $F = d/dt\ (mv) = ma + v\ dm/dt$. From the second term, increase or decrease in mass of a moving object also produces a force. This second force component may not be too important except in microscopic phenomena, but for fast microscopic changes in mass (e.g., in the nucleus) it could generate significant forces. Also note that the velocities of all other spaces (i.e., velocities of the q-spaces of all other moving objects) in the perceiving mass's universe interact with its perceived mass change rates, according to the second term of Newton's law, relativistic form.]

[1]A disagreement has long existed over whether a "nonthing" exists if it cannot be observed. The argument is illogical; e.g., if a photon itself cannot be perceived and only effects (changes) produced by it are perceived, does a photon exist? It

A disagreement has long existed over whether a "nothing" exists if it cannot be observed. The argument is illogical; e.g., if a photon itself cannot be perceived and only effects (changes) produced by it are perceived, does a photon exist? It exists, but cannot be perceived to exist, i.e., it exists outside of perception, but does not exist in perception. The same is true of the notion of space.

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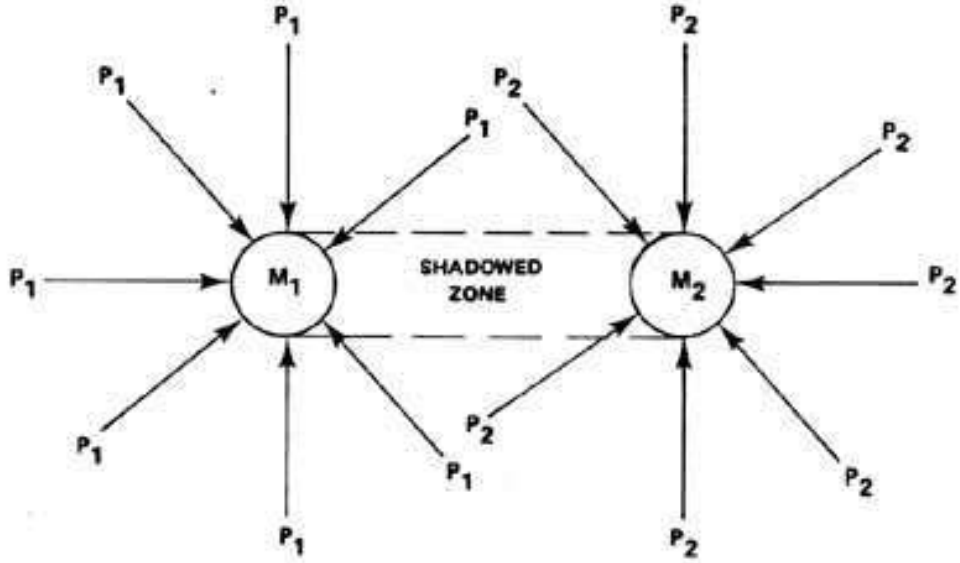

Fig. 8. Gravitational Attraction of Masses

From purely geometrical considerations, a shielding factor is also present due to the solid angle that is shadowed about any mass point. This effect is proportional to $1/R^2$ by usual solid angle considerations. Putting these two factors together, the attraction of mass should therefore be proportional to M_1M_2/R^2, or

$$F = K \frac{M_1 M_2}{R^2} \tag{35}$$

which is the expression for Newton's universal law of gravitational force, and this force is driving the two masses together.[1] By merely extending the basic statement by superposition of the effects of every perceived mass-pair in the perceptron's universe, one obtains the attraction of mass[2] for the universe.

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[1]It is not accidental that electric, magnetic, and gravitational field forces all obey "inverse square of the distance" laws, since these forces are derived from analogous switching operations.

[2]Attraction of mass implies an effect derivable from the presence of mass only. Mass is a switching rate. Therefore attraction of mass must be derived from switching only. Now a massless fluid generates no drag against a constant velocity mass, but switching is a negative quiton acceleration which does generate force. So switching generates drag, but constant velocity does not. This accounts for the error long made in considering the "mass shadowing" explanation of gravitational attraction to suffer from a serious defect of implied retardation force due to velocity through an ether-flux (see, for example, the Feynman Lectures on Physics, Vol. 1, p. 7-9). Velocity of an ether flux through a body merely affects the mass of the body; it does not generate force. Acceleration of an ether flux through a body generates a resultant force on that body. In Feynman's example of an orbital body, let us assume perfect circular motion with constant speed. Since the speed of the ether flux is always constant, the mass is always constant. Since the component of acceleration tangential to the circle is zero, there is no force generated tangentially to the orbit. But since there is a constant radially outward acceleration of flux through the orbital body, then there is a constant radial force outwards that is generated, and this force is called the "centrifugal force," i.e., the "center-fleeing" force.

body, then there is a constant radial force outwards that is generated, and this force is called the "centrifugal force," i.e., the "center-fleeing" force.

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It should be noted that for extremely small masses at extremely close distances, or for extremely short times, turbulence and interference effects can form in the shadowed zone of Fig. 8 and superposition may no longer hold.

C. NEWTON'S THIRD LAW OF MOTION

One of the recognized ways of stating Newton's third law of motion is: "To every action force there is an opposite and equal reaction force." This law follows from quiton/perceptron theory, as can be shown by examining two colliding bodies. It should be stressed that these two bodies, and all changes related to them, exist as changes in the output of the perceiver's perceptron. It must always be borne in mind that these changes, or physical phenomena, exist as outputs of the perceiver's mass perceptron.[1,2]

Figure 9 shows perceived bodies M_1 and M_2 in constant velocity motion just before collision. A deliberate choice was made of a case where the momenta of the two bodies were not equal, so that the initial switching rates for the two masses were different. In the example, $M_1V_1 > M_2V_2$. The mass switching drag of each body is again represented by small circles. Each body has the same size roll in front as in the rear, so its switch pressure forces are balanced. Figure 10 shows the collision.

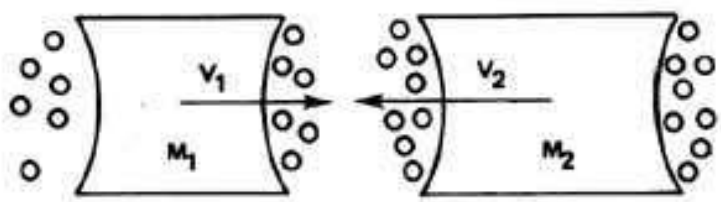

Fig. 9. Two Bodies Before Collision

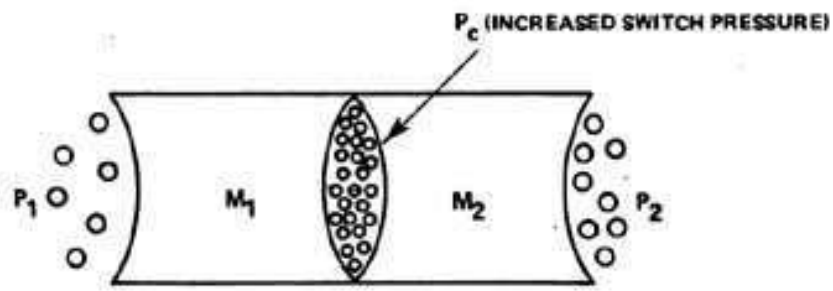

Fig. 10. Two Bodies at Moment of Collision

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[1]We consider the question: "If a tree falls in a forest and there is no ear to hear it, is there a sound created?" A tree is a perceived tree, a forest is a perceived forest, and a fall is a perceived change. Their presence or existence implies a perceiver and perception; thus they imply that a "sound" change would be perceived, since they imply a perceiver to perceive it. If, however, by "no ear to hear it" we mean "no perceiver present at all," then the question as posed contains a self-contradiction: with no perceiver, there can be no perceived tree, perceived forest, perceived fall, or perceived sound.

[2]The manner of searching for quiton/perceptron causal explanation of a physical

or perceived sound.

[2]The manner of searching for quiton/perceptron causal explanation of a physical phenomenon is to ask, "What would the perceptron have to do to generate the phenomenon?".

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There is an almost instantaneous switch pressure increase in the contact zone between the colliding bodies, and consequently there is a switch pressure differential across each body as shown in Fig. 11.

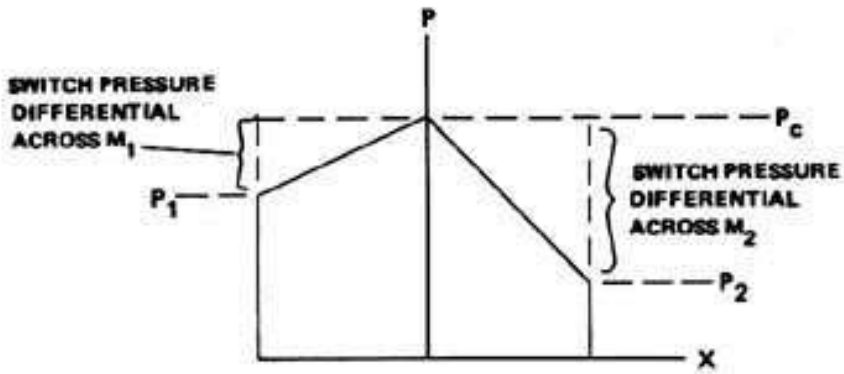

Fig. 11. Switch Pressure Relationships at Collision

In the figure, the contact pressure P_c is exerted against each body, so that the pressure forces on the two bodies act in opposite directions. But for any two colliding bodies, the contact areas, one against the other, are the same. This common contact area will be called A_c. Since $P \equiv F/A$, then

$$|F_1| = |F_2| = P_c A_c \ . \tag{36}$$

But since the pressure forces on the two bodies are being exerted in opposite directions, then

$$\vec{F}_1 = -\vec{F}_2 \ , \tag{37}$$

which is Newton's third law of motion.

D. NEWTON'S SECOND LAW OF MOTION

Neglecting constants of proportionality, Newton's second law of motion may be stated in the most general sense as

$$F = \frac{d(mv)}{dt} \ . \tag{38}$$

The first step in deriving this law is to examine a point mass which is perceived moving with velocity $\vec{V}$, as shown in figure 12.

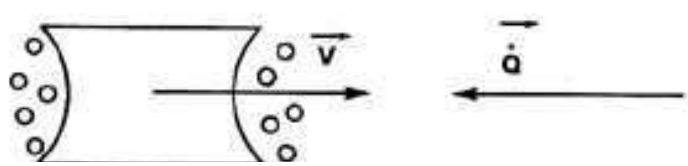

Fig. 12. Moving Point Mass

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An increased rate of quiton switching activity exists along the axis containing the velocity vector $\vec{V}$. We will call this increased quiton activity a vectorial "current" $\vec{\dot{Q}}$, and define its direction as contrary to the velocity vector. The mass is perceived to be moving against the current vector, and

$$\vec{\dot{Q}} \ \alpha \ -\vec{V} \ . \tag{39}$$

When the current $\vec{\dot{Q}}$ is steady, i.e., when

$$\vec{\dot{Q}}_{in} = \vec{\dot{Q}}_{out} \ , \tag{40}$$

then the switching activity, and hence the mass and the energy, are constant. Therefore, from $v = \pm\sqrt{2E/m}$, the velocity remains constant.

If $\vec{\dot{Q}}_{out}$ suddenly increases, then

$$\vec{\dot{Q}}_{in} < \vec{\dot{Q}}_{out} \ , \tag{41}$$

which can be represented as in Fig. 13.

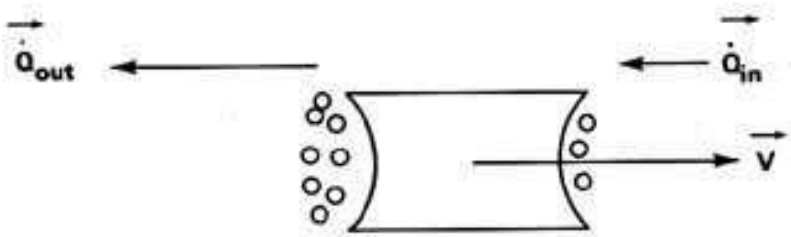

Fig. 13. Difference in Quiton Current

From Eq. (39),

$$\vec{\dot{Q}} = -k_1\vec{V} \ . \tag{42}$$

At any time in a quiton current, the switch pressure force exerted against the mass can be represented as

$$F = P_c A_c \ , \tag{43}$$

where P_c is the switch pressure and A_c is the area of contact. However, since the area of contact A_c, or the drag area, is the mass switch rate itself, then (neglecting constraints of proportionality)

$$A_c \ \alpha \ M' \tag{44}$$

$$A_c \propto M' \quad , \tag{44}$$

where M' is the switch rate at the point of switch pressure application. We will next examine the switch pressure forces before and after one perceptron operation

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(i.e., across the smallest possible time interval Δt used by the perceptron itself in perceiving a change). When there is any difference in the pressure forces against the body front and body rear, this difference is the resultant force $\vec{R}$, or

$$\vec{R} = \left[(P_c A_c)_{in} - (P_c A_c)_{out}\right] \vec{q} \quad , \tag{45}$$

where $\vec{q}$ is a unit vector whose direction is given by the direction of $\dot{\vec{Q}}_{in} - \dot{\vec{Q}}_{out}$. Now, from Eq. (44),

$$\vec{R} = \left[(M'P_c)_{in} - (M'P_c)_{out}\right] \vec{q} \quad . \tag{46}$$

Since $P_c \; \alpha \; \dot{Q}$ and $\dot{\vec{Q}} \; \alpha \; (-\vec{V})$, then (neglecting constants of proportionality)

$$\vec{R} = -\left[(M'\dot{\vec{Q}})_{in} - (M'\dot{\vec{Q}})_{out}\right] \quad , \tag{47}$$

which from Eq. (39) gives

$$\vec{R} = (M'\vec{V})_{in} - (M'\vec{V})_{out} \tag{48}$$

or

$$\vec{R} = K_4 \Delta(M'\vec{V}) \quad . \tag{49}$$

However, this has happened in the smallest possible time Δt, and since by definition

$$\Delta(M'\vec{V})_{min\ \Delta t} = (M'\dot{\vec{V}}) \quad , \tag{50}$$

then

$$\vec{R} = k_4(M'\dot{\vec{V}}) = k_4 \frac{d}{dt}(M'\vec{V}) \quad , \tag{51}$$

which is Newton's second law of motion, relativistic form. Acceleration of a body is caused by a difference in mass switch rate (i.e., a switch rate gradient)[1] induced across it by transfer of momentum from another moving body or by induction from a field such as an electrostatic field or a magnetic field.

E. NEWTON'S FIRST LAW OF MOTION

Newton's first law, that "a body at rest or in uniform motion will remain at rest or in uniform motion unless some external force is applied to it," can be derived from the same type of considerations used to develop the second law. Obviously, if

$$\ddot{\vec{Q}} = 0 \quad , \tag{52}$$

[1]Switching can be thought of as transfer of Δt into ΔL. An increased switch rate represents an increased rate of transfer resulting in a higher value for the ratio

[1]Switching can be thought of as transfer of Δt into ΔL. An increased switch rate represents an increased rate of transfer resulting in a higher value for the ratio of ΔL to Δt being outputted. Since the ratio $\Delta L/\Delta t$ is defined as v, an increase in this ratio increases the velocity, and thus acceleration occurs.

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then

$$\vec{R} = 0 \tag{53}$$

and

$$\vec{a} = 0 \quad , \tag{54}$$

in which case the body at rest will not move and the body in uniform motion will remain so, by the definition of acceleration. Every perceptron repetition will output the identical value for V as the preceeding repetition, and that is why the first law holds.

F. IDENTITY OF LENGTH AND TIME

From $E = Mc^2$, we have

$$c^2 = E/M = 9 \times 10^{16} \text{ joules/kg} \tag{55}$$

$$c^2 \Leftrightarrow 9 \times 10^{16} \text{ joules/kg} \times 1/17.053 \text{ kg sec/sw} \tag{56}$$

$$c^2 \Leftrightarrow 0.527 \times 10^{-34} \text{ joule-sec/sw} \tag{57}$$

$$c^2 \Leftrightarrow \text{k/mass switch} \ . \tag{58}$$

Thus

$$c^2 = (3 \times 10^8)^2 \text{ m}^2/\text{sec}^2 \Leftrightarrow \frac{\text{k}}{\text{mass switch}} = \text{one sw opn} \tag{59}$$

$$\text{one sw opn} \Rightarrow (3 \times 10^8)^2 \ \text{m}^2/\text{sec}^2 \tag{60}$$

$$\Rightarrow 3 \times 10^8 \text{ m/sec} \tag{61}$$

$$\Rightarrow 1 \text{ sec} = 3 \times 10^8 \text{ meters} \ . \tag{62}$$

Length and time are thus synonymous,[1] and c is the constant of proportionality (more precisely, the identical ratio for transposing Δt into ΔL will be maintained for each perceptron operation). Therefore, a perceptron actually outputs only one thing which may be taken to be either Δt or ΔL (it actually outputs only change

[1]By "synonymous" we mean that Δt and ΔL are intertransposable by perception operation. The term c is the velocity (rate of change) of switching itself, i.e., the speed at which quitons themselves can move, since quitons are being switched by mass. Therefore c ought indeed to be the wave velocity at which quitons move, and thus represents the maximum ΔL obtainable from Δt by mass in normal switching. The possibility exists that abnormal (turbulent) switching can deviate from this limitation. Thus "time warping," "time travel," "hyperspace travel," and the interplanetary drive may indeed

that abnormal (turbulent) switching can deviate from this limitation. Thus "time warping," "time travel," "hyperspace travel," and the interplanetary drive may indeed be possible. Since at least one of these effects of turbulence in switching (that of DeBroglie wave velocity exceeding the speed of light) is theoretically accepted, the problem of turbulent switching should be well worth the theorist's attention and effort.

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itself, which is perceived and thought of as ΔL and Δt). All other dimensions, quantities, and dimensional molecules are but bit division or bit multiplication. This seems to be consistent with some of the latest conclusions from general relativity theory.

In passing we note that there is no separation without relation, and there is no relation without separation. Therefore

$$\text{relation} \Leftrightarrow \text{separation.} \tag{63}$$

Also, there is no operation without separation, and there is no separation without operation. Therefore

$$\text{operation} \Leftrightarrow \text{separation.} \tag{64}$$

It follows that

$$\text{operation} \Leftrightarrow \text{separation} \Leftrightarrow \text{relation.} \tag{65}$$

We note a difference between free space and a Cartesian space (inertial reference frame). In a Cartesian space or inertial reference frame a definite length is considered to have been established for each and every point in that frame. But such a definite length to each point is rigorously operational by statement (65) above, i. e., such a length is defined by an operation. Specifically, it is defined by the operation of a mass perceptron (or an understood mass perceptron) at the origin of the frame. Such a frame is linear if the identical type of perceptron operation has defined the length to each point. If the type of defining operation varies, then the frame so defined is nonlinear; i. e., its space is said to be curved or distorted.

In one perceptron, its length defining operation and its mass defining operation can interfere or react one with the other. This type of interference or interaction is the direct interaction of frame space (length) with mass and it is the fundamental generating mechanism of force. All forces are so generated (see again the inset footnote on p. 17). And in fact a perceived moving force does work in the direction of its perceived movement rather than in the force's perceived direction precisely because of the moving operational length's interaction (interference) with the operationally generated force. This interference interaction is between operations in the same perceptron and generates what is called work.

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V. ELEMENTARY PHILOSOPHICAL IMPLICATIONS

Every scientific treatise is filled with forms of the words "one" and "be," yet none attempt to define these metaphysical terms. Ontologists and metaphysicians have uncovered many problems connected with these two words, but no real solutions. In addition, the historical preoccupation of metaphysics with dogmatic religious beliefs contributed strongly to its disfavor, since scientists were required to exert considerable effort to establish the scientific (observational) method as a legitimate criterion for the judgment of physical truth. Consequently, both science and philosophy today are constructed on quite undefined foundations, primarily because of the failure to recognize the relationship of perception operation to reality, which recognition is a prerequisite to the synthesis of physics and metaphysics. One therefore must comprehend the concepts of be (exist),[1] thing (perception), and one (thing) from the viewpoint of the relation between perception and ultimate reality.

A. EXISTENCE, THING, AND ONE

Existence has been defined here as "what is to be fed into the perceptron's input." In the situation where all operation of the perceptron has ceased, what can be said to exist in the input? First, what exists is a continuum: it has no limit, interface, dimension, time, velocity, change, space, place, or discontinuity since these are all derived from perceptron operations and the perceptron is not operating. What exists is continuity only, with no discontinuity.[2] To comprehend this, we must examine the thought process itself more closely, realizing that "to think" is "to perceive thoughts."

What is a "thing?" Further, what is "one" -- one "thing," one "anything?" A thing is first a perceived thing: it resulted from the output of a perceptron operation, in which one input bite and one output occurred. This output is characterized by the the fact that it is one, and the absence of one (i.e., zero) is the absence of output.[3] Figure 14 shows these relationships. The perceptron operation created the separation between the inside and the outside by creating a ΔL and a Δt, that is what the delta symbol means. Thus the operation of the perceptron determines the basic nature of one itself, and any one necessarily requires that a perceptron operation has occurred. In fact, the perceptron itself is a result of perceptron operations. Thus indeed all is relative. A perceptron exists and is able to function because it perceives other perceptrons to exist and function. Thus perceptrons are mutually created derivatives of reality

---

[1] Being is undifferentiated; that is its total definition. It cannot be perceived, since perception differentiates. It is continuity only, without any discontinuity, which is unperceivable. The preoccupation of being with causality (perception) is technically called "inception," the influencing of perception. In Zen philosophy this is technically "attachment to the world of illusion (change);" the literal meaning of "incarnation."

[2] This concept is unperceivable, by the definition of perception, which accounts for its difficulty. To be a "perceived one" implies limit (finiteness); oneness itself, without a bound or limit to make it a one (perceived), cannot be perceived. This is the primary limitation of the human mind (i.e., of perceptive thinking)--being, continuity, and oneness themselves imply absence of perception (differentiation) and are therefore unperceivable.

[3] Thus Boolean algebra describes the most basic operation, and is applicable to the

are therefore unperceivable.

[3]Thus Boolean algebra describes the most basic operation, and is applicable to the "operational" world.

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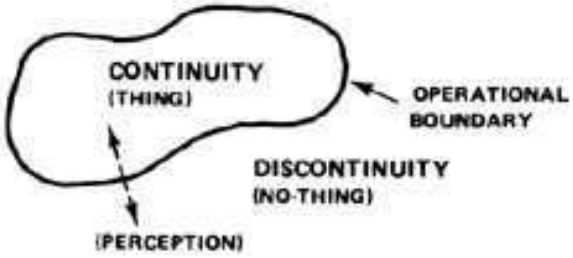

Fig. 14. Nature of One

which drive themselves and each other. Note that the preceding sentence itself is a perception.

So in the fullest sense, Gautama Buddha was indeed correct to state that the world of phenomena (changes) is an "illusion," relative only to itself (i.e., to perceptrons).[1] Einstein, expressing this idea in the language of mathematics, produced the theory of relativity and inaugurated a new physics. Buddha and Einstein spoke in different technical languages, but both expressed the same idea. The only difference is that in science we have assumed that our observations themselves are real and perfect. They are real, but not perfect in that they represent only changes in ultimate reality. Thus observational science alone can never reveal ultimate reality.

Another approach may aid in the comprehension of the nature of one. What is meant by the statement "he is the man?" Reflecting, one realizes that what is meant is that the perceived thing HE is exactly the same perceived thing THE MAN, and this identity exists now (during this one Δt perceptron time slice). There is no part of HE that is discontinuous from THE MAN, or vice versa. The different forms of the verb "be" attempt to express continuity without discontinuity, or unlimited oneness which is a state and not a thing. However, we do use the verb "be"[2] to relate continuity between different time slices. "He is the man" is related in the present time slice; "he was the man" means that HE in the NOW slice is identical to THE MAN in a past slice; etc.

---

[1]The reader interested in Zen will find complete agreement between this paper and Zen precepts, and will find the paper of some assistance in comprehending the unperceivable (unthinkable) Zen realizations. In Zen, for example, the aim is to comprehend at once the totality of reality, directly, escaping beyond the limiting fetters of perceptive thought. Now if it is actually possible to do this, and if some unusual men have done it, then their enigmatic writings should contain the wisdom of their experience, and should correspond to ultimate reality itself. Since ostensibly their insight is obtained by other-than-logic and other-than-perceptive means, then their statements should appear illogical and unperceivable.* Thus the "sound of one hand clapping" and other illogical concepts are used in Zen as a meditative means of driving the student beyond logical perception (certainly the sound of one hand clapping cannot be perceived or thought) to realization. But if the Zen experience is actually valid, then reality itself must be pure Zen (i.e., unperceivable), and so it would appear to be. We note that for each component part of all, the opposite part must exist. So all can be regarded as the complete set of all possible opposites or contradictions.

*(However, this most assuredly does not imply that every statement that is illogical and unperceivable is of value!)

[2]It should be stressed again that being is defined as undifferentiated (unseparated,

is illogical and unperceivable is of value!)

[2]It should be stressed again that being is defined as undifferentiated (unseparated, unperceived). Being is simply continuity without discontinuity.

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B. REALITY, ULTIMATE REALITY, BEING, AND ULTIMATE BEING

Actually one should be quite careful in using these terms. What does one get when one differentiates reality? One gets another reality, but not the primary or ultimate reality. For example, assume that length and time are real. When one time-differentiates length, one obtains velocity, which of course is real also but quite different from either length or time. However, velocity is always operationally related to the two first (assumed) reals length and time, because differentiation is an operation. So what is meant by "ultimate reality" is that state (or essence, or whatever name one prefers) that is not differentiated. Since "being" (continuity with no discontinuity) is defined as "that which is not differentiated," then the ultimate reality is pure being.

But all perceivables are differentials of ultimate reality. When one differentiates being, one gets pieces (differentials) of being which themselves are beings, but they have been perceived (differentiated) from a more primary or higher being. Therefore any being that one perceives has been differentiated (separated) by perception,[1] which explains why human beings, for example, consider themselves separate or individual (one). They are separate only in their individual perceptions. Thus "beings" by its plural nature always implies fragments (differentials) of a higher being (of singular nature). There can be many such integral levels: starting with one function, one can integrate it, then the resulting function can be integrated, etc., as long as we are speaking of definite integrals between two limits. When we reach a state that has no pieces or limits, the process is finished. That state is <u>being</u> in the ultimate sense, i.e., ultimate being.

One perceives these integral levels directly in nature, i.e., in the perceived phenomenological world. Living molecules (tiny beings) of RNA, DNA, etc., integrate together into a cell (a higher level being). Cells then integrate into a still higher being (man, animal, plant), which is the level on which man finds himself. But since man is perceivable and there are more men than one, it follows directly that men are capable of being integrated into a still higher being,[2] and the only word we have at present to describe such an ultimate being is "God." It is not at all accidental, therefore, that the ultimate being cannot be directly perceived by man, since by the definition of perception the ultimate being cannot be perceived by a lower order being such as man (i.e., since perception differentiates, or separates, then only differentials of being, or separate beings, are perceivable).

The avatar Jesus, having no technical concept for the derivative available in the language of the day, used the analogy of the father-son relationship, the son being the derivative of the father in this sense. Thus he referred to himself as the "Son of Man" (the derivative of all mankind or of integrated mankind) and also as the "Son of God" (the derivative of the integral of man). He continually referred to the ultimate being as "Father." It is little wonder that he was not understood then, and has not been understood for almost twenty centuries.

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[1]Thus not only are physical objects relative to the perceiver's perception, but so are the perceived beings. Ergo the entire perceived universe, both living and non-living, is related to perception, and in fact perception and creation are abstractly

are the perceived beings. Ergo the entire perceived universe, both living and non-living, is related to perception, and in fact perception and creation are abstractly synonymous.

[2]This statement contains obvious implications to the theory (i.e., to the goal) of evolution.

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VI. CAUSALITY AND ITS MODIFICATION

A little closer look at perception can be obtained by viewing it from the causal standpoint.[1] All that perception really creates is Δt and ΔL (which are the same, ignoring constants of proportionality), and the perception we normally think of is point perception, where a point is one switching operation. The perception point may be thought of as following a line path which we will call "lineception" (Fig. 15). Physical phenomena as seen by one perceptron constitute this lineception; or rather, it constitutes the physical phenomena that are perceived or observed by the perceptron. Any point-based perceptron system, such as human perception, will accordingly perceive the universe of physical phenomena as if the perceiving system were a pointer moving along a lineception.[2]

Fig. 15. Lineception (One Connected to One)

For each perception there is a reflection, so there exists (but by definition cannot be perceived) a similar line-path, or "lineflection" as shown in Fig. 16.

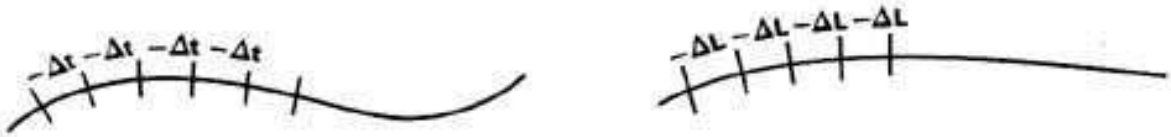

Fig. 16. Lineflection (One Connected to One)

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[1]Perception is identical to causality itself, i.e., perception can be said to generate causality. The causal view is that causes inputted to a situation operate to produce, or output or create, effects. According to its inputs, the perceptron generates causal outputs. An adequate theory of perception should be able to explain all causal (perceived) phenomena. We might define causality as the set of all causes. Then the answer to the question, "What causes causality itself?" is causality itself; i.e., since it is the set of all causes, causality must contain its own cause. Causality must therefore be closed or circular. The entire causal world must then be purely relative to itself (closed). Closer attention to causal operation yields the following: We perceive something change (in time or in space), then the situation changes so that we perceive new changes emerge (occur later, or separately). Thus the line of perception by its own unperceived operation connects the perceived cause (change) to the perceived effect (change), i.e., perception generates causality. Since perception itself is causal, then causality truly causes itself. This indeed is closed or circular--causality generates perception (perception is causal) and perception generates causality (causality is perceptive). Thus the idea that perception generates causality is completely consistent with our initially assumed definition of causality as the set of all causes.

causal; and perception generates causality (causality is perceptive). Thus the idea that perception generates causality is completely consistent with our initially assumed definition of causality as the set of all causes.

[2]A "frame" or "coordinate system" is a point-centered perceptron system centered about the "understood perceptron" at the origin.

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The ultimate reality, or existence, contains all, all-at-once (ultimate reality is allness, or oneness). At each operation of the perceptron, the exact amount of Δt and ΔL, and their relationship, put out by a perceptron is a function of its input quiton disturbances. A great number, in fact perhaps an infinite number, of different input states are possible, i. e., exist in all, all-at-once (ultimate reality). So an equally large number of output states are possible (exist ultimately),[1] but one particular input condition results in one particular output condition. We can represent the all possible lineceptions existing as "multiception" (Fig. 17). From this figure, a lineception can be seen to be one particular path through multiception. The corresponding multiflection could, of course, be illustrated in similar manner but with negative components.

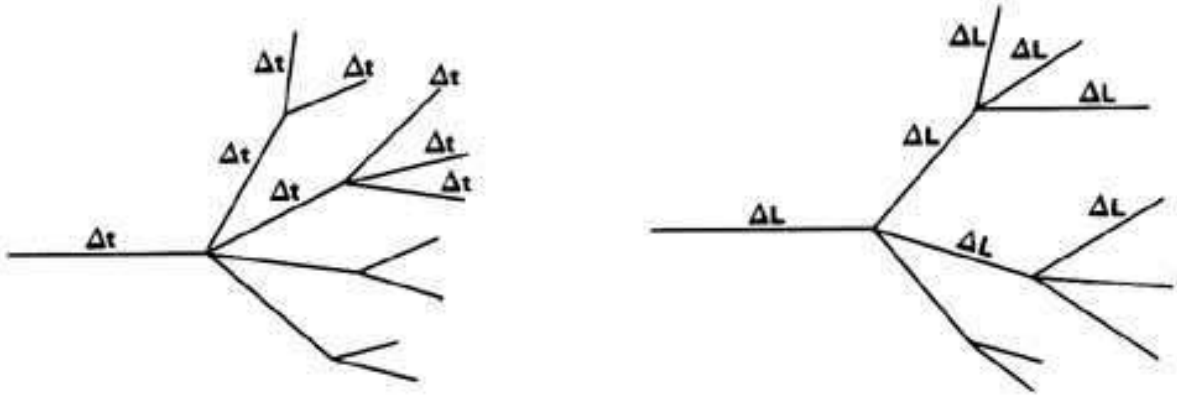

Fig. 17. Multiception (One Connected to Many)

One could immediately apply statistics to the concept along the lines illustrated by Fig. 18.

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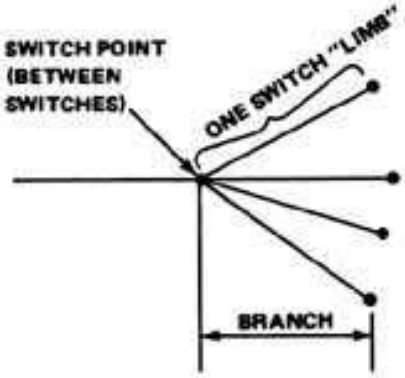

Fig. 18. One Branch

[1]It is stressed that these multiceptions exist, which is not at all the same limited statement as "exist now," but much more comprehensive; e.g., all possible numbers must exist in zero, else, given the number A, there is no justification for the axiom that A + (-A) = 0. The "absence of number" means precisely the "absence of all possible

exist in zero, else, given the number A, there is no justification for the axiom that A + (-A) = 0. The "absence of number" means precisely the "absence of all possible numbers." Paradoxically, if we think of that absence, we make it present by the act of thinking; i.e., trying to perceive it (absence is not perceivable). This contradiction, of having to make the unthinkable into its opposite so that it is thinkable is both the characteristic and the limitation of perception and perceptive thinking, and has long been an insurmountable obstacle to scientist and philosopher alike.

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At each switch point, the perceptron is faced with the branch of possibilities ahead, which all exist in multiception but only one of which exists in one perception, or lineception.[1] A certain set of limbs in the branch must have a perception probability equalling 1, and thus each of the limbs has some finite probability.[2] The input conditions to the perceptron then determine which limb is selected for the next switching operation; and, of course, the input conditions are the results of other related perceptrons' operations (relativity). The statistics will not be pursued further here.

For an absolutely mechanistic world, the entire process is automatic according to quite rigidly fixed rules. A system of perceptrons that behave this way shall be referred to as "mechanically switched." What we call "non-living systems" are mechanically switched systems. But what we call a "living system" is able to arbitrarily select the limb taken, to some extent at least,[3] i.e., the fact that a living system is able to choose its behavior within certain limits, directly implies that it must be able to deflect its lineception from a mechanically switched lineception. The only way it can possibly do this is to influence the switching operation of the perceptron. But since the output of one switching operation is a mechanistic function of the inputs, then the only way a life system can affect the perceptron switching operation is by affecting the input to some extent. How could it possibly do this?

In our crude model, the nonaction continuum is composed of action atom fragments, or quitons. But such non-things are massless by definition (they are not being switched and the absence of switching defines masslessness), and we can think of the nonaction continuum as a massless fluid or ether or empty space, since these terms are all synonymous. All that is implied by these terms is that the fluid is composed of massless elements, which merely means they are not being switched. They are capable of being switched, of course, but switching is not being done. The main point is that force, in the conventional sense, is not required to move a massless fluid, so the input fluid to a perceptron can possibly be interfered with by some nonphysical means requiring zero force. The <u>being</u> portion of a life system can apparently do this to some extent.

Since the switch time of a perceptron is on the order of 10^{-21} seconds, then even an incredibly tiny quiton input variation to a perceptron will result in

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[1]It is stressed that all possibilities exist and are real, but do not exist in perception. Perception is the only difference between unperceived reality and perceived reality.

[2]Which leads to an unusual view of "probability." A perceptron operation is already finished when one perception is complete; that is why "the past is always gone, the present has just occurred, and the future is never here." Perceptron operation continually creates the perceptron's universe as it operates, including all changes, time, space, etc.). Thus, at the conclusion of any one perceptron operation, a multitude of lineception steps can exist for the next operation. However, although possibly quite large, the number of next steps available must be finite to be causal (perceivable). It is the process of perception that makes probability finite. Perception is finite; nonperception is infinite.

[3]The only alternative conclusion is that the living system is unable to deliberately

perception is finite; nonperception is infinite.

[3]The only alternative conclusion is that the living system is unable to deliberately modify its behavior and its behavior is purely mechanical. But since this implies that all behavior is absolutely programmed and predictable, which is obviously false, this alternative is not valid and the original conclusion stands.

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noticeably altered lineception after one second of such variation. So it is quite reasonable to presume the futility of trying to measure such infinitesmal influence as is brought to bear on one single perceptron operation. However, the total influence can obviously be detected after being accumulated by a very large number of perceptron operations, and for living systems it is. So while we have not proved the mechanism of life-system manipulation of lineception, we have shown a logical progression from an assumed mechanism to a result that is universally verified by countless observations (i. e., all living systems are observed to manipulate causality, which manipulation is, after all, the definition of behavior). Since no other mechanism has been proposed, to the author's knowledge, that would reasonably explain the observed phenomenon of life-system manipulation of lineception, it is logical to accept as true the assumed mechanism -- a life system can exert an incredibly tiny influence on perceptron inputs,[1] i. e., on the ether or on empty space.[2,3]

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[1]This tiny influence is the basis of the realization process. To comprehend the noncausal, the individual observer usually wrestles diligently with the problem, repeatedly attempting to perceive it causally. In each such attempt, the tiny influence of inception on perceptron inputs is exerted. Over an ensemble of such attempts, the perceptron causal output can be modified, i.e., modulated noncausally to give what are now slightly noncausal perceived outputs. Presence of a required fit or required output pattern in the perceptive mind allows the output to be examined (compared) against the required output, i.e., it allows the selection of the proper noncausally modulated causal transfer function. When the outputs match, one then has a breakthrough or realization which matches the real world pattern but which cannot be directly perceived causally. However, since the mental file of the perceptive mind has now filed the proper transfer function, the individual has assimilated the information and understands it, being able to recall the noncausally modulated causal transfer function at will. Thus in Zen, the ultimate example of realization is described as "enlightenment." Phrases such as "direct perception of reality," "direct experience of ultimate reality," or "direct realization of all-being" are also used in trying to portray the nonperceivable realization. Conventional science hides the entire process behind vague terms, such as "creative thinking," which actually only conceal the fact that we do not know what it is, or how it is accomplished.

Note that such "creative realization" can cover either purely causal or noncausally modulated perception, the difference being merely whether the inputs are incepted in a normal manner comparable to causal phenomena, or in another manner. Realization is derived only from inception. Since the observed phenomena of physics already appear to be noncausal (statistical) in the ultramicroscopic region while ensembles of these yet appear to be causal, then the physicist is already confronted with the necessity of changing causality but at the same time retaining causality. The implications to the observation process itself must be examined, and they remove the dichotomy between physics and metaphysics when pursued.

[2]The Hieronymus effect is an example of this in reverse. It generates an effect on living nervous systems that is not the result of electric, magnetic, or gravitational fields, and is not caused by matter in motion. For that matter, a polygraph has been used to clearly measure a response of plants to human thoughts alone, and such an effect is not presently explainable within the body of physics theory. "Firewalking" is another unexplainable phenomenon from the standpoint of present physics theory as is acupuncture.

[3]All psi phenomena derive from this effect (inception) together with turbulent

is acupuncture.

[3]All psi phenomena derive from this effect (inception) together with turbulent switching. A straightforward theory of psi phenomena (and of such things as fire-walking and acupuncture, for that matter) can conceivably be generated from the quiton/perceptron theory.

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Of course the most efficient development of manipulation of lineception (i.e., the widest response) by a life system would necessitate a control system approach; i.e., life system direct manipulation of only a very small control valve or control mechanism, which in turn controls the input to a much larger mechanistic (deterministic) servo amplifier. Systems like this are universally observed in life systems. Thus the great bulk of a life system's manipulation of lineception is servomechanistic: the actual direct influence of life (being) on matter (perceptron switching) is so microscopic as to be immeasurable at its operating level, and only its macroscopic effects become measurable. For that reason the scientist has never been able to isolate the mechanism of life's manipulation of lineception, nor is he likely to be able to do so in the foreseeable future.[1]

Life's manipulation of lineception will be denoted by the term "inception," and can be thought of as a modulation (partial change or additive change) of the lineception carrier. Ordinary physical phenomena are macroscopic ensembles of lineceptions, where the deterministic (mechanistic) law holds absolutely but in a relative manner (ensemble to ensemble) which is fixed cause-and-effect, or causality, from the viewpoint of perception. Since inception is a modulation of lineception, then living behavioral phenomena should be superimposed as envelopes on causal lineceptions, or causal lineception ensembles, and, indeed, they are universally observed to be so superimposed.[2]

Absolute or ultimate reality, however, can be thought of in one respect as all multiceptions and all multiflections, all-at-once, which is timeless (i.e., which is both all-possible-times and zero time simultaneously or identically).[3] Along any one lineception, causality applies; yet since a very large number of changes to that lineception are available in just one multiception branch, then quite a large

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[1]This latter statement, of course, is subject to challenge.

[2]Since all matter <u>is</u>, it <u>contains being</u>. Another intriguing possibility exists: that there are two types of inceptive systems, or two magnitude directions that inception takes. The first type would produce inception with difficulty, and its inception would only be apparent at the macroscopic level; the second type would produce inception with ease, its inception would be apparent only at the microscopic level. The first type would correspond to what we call "living systems," while the second would correspond to what we call "inert systems." Living systems' inception would be observable to human senses and human instruments, while inert system's inception would not. A second and remarkable consequence would be, that in the extreme microscopic case, inception would dominate and this scale would appear to be absolutely statistical (individually unpredictable), which apparently is true (i.e., degree of causality represents degree of restraint of inception). This would modify causality (for individual events) at the ultramicroscopic level, but at higher levels causality would still apply due to the karma effect on perceived ensembles. It is significant that at present the universe of matter seems to behave in precisely this fashion. To summarize, perception is causal -- it generates causality. Inception, being noncausal, must be below the perception threshold. Aggregates of inception (noncausal) that equal or exceed the perception threshold become causal (are processed by perception) and generate causal karma.

[3]Since every perceived ΔT has an unperceived complement $-\Delta T$ which exists in reflec-

[3]Since every perceived ΔT has an unperceived complement $-\Delta T$ which exists in reflection, then the sum total of all times in absolute existence, which includes both perception and reflection, equals zero time.

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number of inceptions are available to be applied to that one lineception by an organism to change or direct the lineception. Herein is the explanation of karma. Since every inception made by an organism (or by a submicroscopic particle of being for the second case, see note 2, p. 32) changes its entire lineception, it also changes its entire perceived or relative universe, which is the only universe it knows or senses. And since causal feedbacks from this perceived universe[1] occur to the organism's perceptron (which itself is part of that perceived universe), then the effects of the organism's actions indeed return precisely to it. So, "as a man soweth, that shall he also reap" is quite true.[2]

It is now possible to formulate some conclusive statements:

1. One perceptron follows a lineception path, mechanically basing its output on its inputs, and this operation establishes causality to perception repetition, i.e., to lineception.

2. Ordinary physical phenomena are merely ensembles of related lineceptions, and are perceived to be absolutely deterministic (obey only cause-and-effect.

3. Living phenomena exhibit the effects (selective behavior) of inception (modulations impressed on lineception) which occasionally diverts one lineception from its deterministic lineception limb to another multiception limb, resulting in a changed (modulated) lineception.

4. Ultimate, or absolute, reality may be thought of as the sum-total of all multiceptions and multiflections.

5. "God" is all-being, which is all multiflection and multiception at once, which is both <u>no time at all</u> and <u>forever</u> and <u>all forevers</u> as well.

6. "God's will" is lineception and its accompanying lineflection.

7. "Man's will" or "free will" is inception, the modulation of lineception (and unknowingly its accompanying lineflection). Inception, however, imposes a feedback on the inceptor since a precise feedback, from the inception changes to perception, occurs to the perceptron of the perceiver. This feedback resulting from inception is karma.

8. The law of cause and effect (causality) exists in perceived nonmodulated phenomena (ensembles of lineceptions).

9. Causality is affected (modulated) by living systems, but applies to each choice once made. The causal feedback from inception is karma.

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[1]"Perceived" must be accented: the nonperceived universe is not causal, since by definition causality invokes a perceiver and the perception process.

[2]Collective karma of any ordered group such as a species must exist in like manner. On the submicroscopic level, "karma of ensembles" means that the statistics of

[2]Collective karma of any ordered group such as a species must exist in like manner. On the submicroscopic level, "karma of ensembles" means that the statistics of lineceptions and inceptions still lead to causal relationships in the perceived collective phenomena.

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10. Neither causality or karma applies in ultimate reality, although all
causality lineceptions and their reflections, and all modulations
(inceptions) and the karma reflections of those inceptions, are
included in ultimate reality.

VII. CLOSING REMARKS

The quiton/perceptron approach appears to offer a most extensive area for further investigation, and it is hoped that the physicists will interest themselves in the concept. It offers explanations for the problems long posed by ontology, and unifies the bases of science and metaphysics.

We state categorically that the theory explains what electric charge is, why like charges repel, and why unlike charges attract. In addition, since all phenomena are perceptron outputs, the theory indicates that multiple effects which are very close in time or distance will interfere with each other due to turbulent switching; i. e., conservation of mass/energy holds only as long as no switch interference exists. Turbulent switching can possibly disrupt all known physical laws. Unexpectedly strong forces, such as nuclear force, might in fact result from this effect. Other implications include possibility of travel faster than the speed of light (deBroglie waves do this now) and of travel back and forth in "time."

Since both laboratory instruments and human sensory apparatuses are perceptrons and differentiate reality, investigations of physical phenomena should include the laws of the perceptron as well as the laws of the perceived phenomena.

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13. ABSTRACT

A fundamental answer is attempted to the question of being, time, space, existence, perception, and physical phenomena. Mass, empty space, reality, gravitational attraction, continuity, discontinuity, and relativity are among the "things" and "nonthings" for which relationships and explanations are provided.

Perception is defined as detection by a mass of change to itself and as a differentiating process. Perceived physical phenomena are revealed to be first derivatives of ultimate reality, and outputs of the physical perceiving device call the "perceptron." Using the operation of the physical perception process on action, the units of which are energy times time, an entirely different view is generated of both reality and the Heisenberg uncertainty principle. When superposition is imposed as a condition, the Heisenberg uncertainty principle is revealed to be a quantized statement. A concept of the absolute value of a dimensional molecule is advanced.

A reality model is constructed of an action continuum and a nonaction continuum separated by an operational threshold whose magnitude is given by an uncertainty principle. Perception is modeled as a process which switches atomic quanta of action and nonaction back and forth across the threshold. Mass is explained as perceptron switch activity rate, and a mass definition equation is generated. One kilogram mass is shown to represent 17.053×10^{50} perceptron switches per second. From the model, Newton's laws of motion and gravity can be generated directly from the concept of the interaction of mass with space itself, space being taken as a massless fluid, or ether, composed of tiny nonaction particles called "quitons." Einstein's postulates of

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ABSTRACT (Continued)

special relativity are also shown to follow from the model, and a statement of the equivalence principle is shown to be consistent with the model.

The concept of "lineception" as a causal chain of perceptron operations is advanced. "Inception" is developed as a noncausal modulation of lineception and as a distinguishing feature of a living system. The possibility is raised that inception could provide an explanation of the noncausal, statistical, ultramicroscopic universe and yet require large ensembles of ultramicroscopic events to conform to causality. Inception is shown to lead to karma. Perception is shown to be causal and to generate causality itself.

Some elementary philosophical implications of quiton/perceptron theory are pointed out and briefly discussed.

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Cheers,

Tom

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SCALAR WEAPONS: Read It and Weep

- Posted by Ms MoD on July 27, 2011 at 4:42 in HAARP
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This is a REALLY long paper but it is broken down into categories so you can easily skip to sections of interest to you. I found this after reading Twelve Things You Should Know About Scalar Weapons which was posted by FDF in April and is a MUCH SHORTER overview of scalar technology by the same author. I highly recommend it but wanted to post the longer version here as well which you can download in the PDF attached. Topics in the paper are listed below -MoD

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45. INDIA
46. JAPAN
47. KOBE 'EARTHQUAKE'
48. CHINA
49. OKLAHOMA FBI BUILDING 'BOMBING'
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Still think that HAARP is just another wacky fictional conspiracy? The above listed patents should be enough to convince any intelligent person that HAARP is real and is now actively modifying our weather and triggering earthquakes. For those who are still not convinced, look to the United States Congress for proof. In order for HAARP to get funding the people who first created HAARP needed funding. That funding was made possible by the US government. If you were to look at Congressional records you would find documents that states just one of the many official purposes of HAARP – for penetrating the earth with signals bounced off of the ionosphere. Congress was informed by people in the High Frequency Active Auroral Research Program that the bounced signals would be used to look inside the planet to a depth of many kilometers in order to locate underground munitions, minerals and tunnels. If you bounced the known earthquake signature signal (2.5 Hz) for a sustained period of time an earthquake could triggered many kilometers inside Earth's crust. The U.S. Senate actually set aside $15 million dollars in 1996 (Clinton and Al Gore Administration) to develop this ability alone — earth-penetrating-tomography.

Update April 21, 2011

Under pressure from the International community the HAARP website is up again. No data is available from April 7 to April 12, 2011. Data before and after shows the signature frequency of an earthquake (2.5Hz) being transmitted. Also shows energy spikes which indicates active weather modification. Now that the website is up again you can view the data for the Japan earthquake at http://137.229.36.30/cgi-bin/scmag/disp ... i?20110311. From the magnetometer induction data you can see 2.5Hz (earthquake inducing frequency) being broadcasted and recorded for several days before the 9.0 magnitude earthquake. To see what a normal (no HAARP broadcasting) day looks like view the magnetometer charts for the days of March 15, 16 and 17 – March 16, 2011 http://137.229.36.30/cgi-bin/scmag/disp ... 0316&Bx=on. No earthquake inducing broadcast was detected from March 15 to March 27, 2011. On March 28, 2011 a low powered broadcast was detected from approximately 12:00 am to 3:00 am. Broadcasting resumed on April 2, 2011. April 6, 2011 shows you what the magnetometer charts looks like when a solar storm blasts Earth. No data is available from April 7, 2011 to April 13, 2011 – a shutdown. Starting on April 15, 2011 and ending approximately 10:00 am April 16, 2011 the earthquake inducing frequency of 2.5Hz was detected being broadcasted.
Short URL: http://presscore.ca/2011/?p=2261

- ▶ Reply
-

Permalink Reply by Jenny on July 27, 2011 at 6:23
WOW MoD! What a paper! I need like a year to get through it all but it sure is awesome to have it all in one place! Excellent!

- ▶ Reply
-

Permalink Reply by Ms MoD on October 26, 2012 at 6:38

Boeing Tests Microwave Missile That Can Knock Out All Electronics (CHAMP)
Huffington Post UK | By Michael Rundle 24/10/2012

Boeing is testing a missile which can destroy electronics in a wide area with little or no physical damage.

The 'Champ' (Counter-electronics High-powered Advanced Missile Project) may "one day change warfare", Boeing said.

"This technology marks a new era in modern-day warfare," said Keith Coleman, CHAMP program manager for Boeing Phantom Works.

"In the near future, this technology may be used to render an enemy's electronic and data systems useless even before the first troops or aircraft arrive".

The missile was tested on 16 October, when the high-powered microwaves were fired at a two storey building built especially for the job.

The missile would, if successful, take out rows of personal computers which were turned on to gauge the effect of the blast.

The result?

"Seconds later the PC monitors went dark and cheers erupted in the conference room. CHAMP had successfully knocked out the computer and electrical systems in the target building. Even the television cameras set up to record the test were knocked off line without collateral damage."

Seven targets were hit in the one-hour test, and all were successfully disabled.

There is a long way to go before the microwave can be placed into a missile and used to disable targets without loss of life, but the team is hopeful it could prove to be a milestone in non-lethal warfare.

"Today we turned science fiction into science fact," Coleman said.

http://www.huffingtonpost.co.uk/2012/10/24/boeing-tests-microwave-m...

- ▶ Reply
-

Permalink Reply by Ms MoD on August 3, 2013 at 11:01

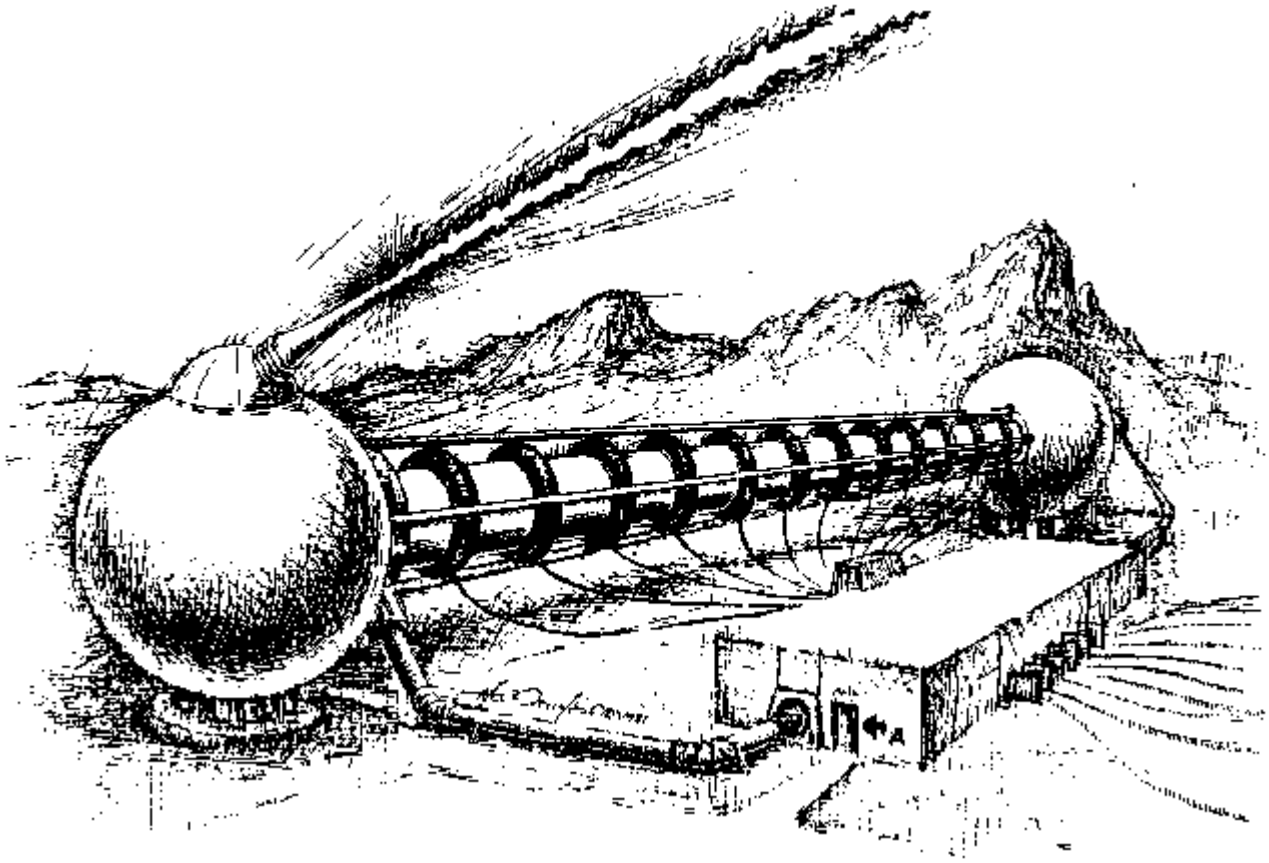

Scalar Potential Interferometer

Figure 6. Multimode Tesla Weapon

In the 1930's Tesla announced other bizarre and terrible weapons: a death ray, a weapon to destroy hundreds or even thousands of aircraft at hundreds of miles range, and his ultimate weapon to end all war -- the Tesla shield, which nothing could penetrate. However, by this time no one any longer paid any real attention to the forgotten great genius. Tesla died in 1943 without ever revealing the secret of these great weapons and inventions.

Unfortunately, today in 1981 the Soviet Union has long since discovered and weaponized the Tesla scalar wave effects. Here we only have time to detail the most powerful of these frightening Tesla weapons -- which Brezhnev undoubtedly was referring to in 1975 when the Soviet side at the SALT talks suddenly suggested limiting the development of new weapons "more frightening than the mind of man had imagined." One of these weapons is the Tesla howitzer recently completed at the Saryshagan missile range and presently considered to be either a high-energy laser or a particle beam weapon, (See Aviation Week & Space Technology, July 28, 1980, p. 48 for an artist's conception.)

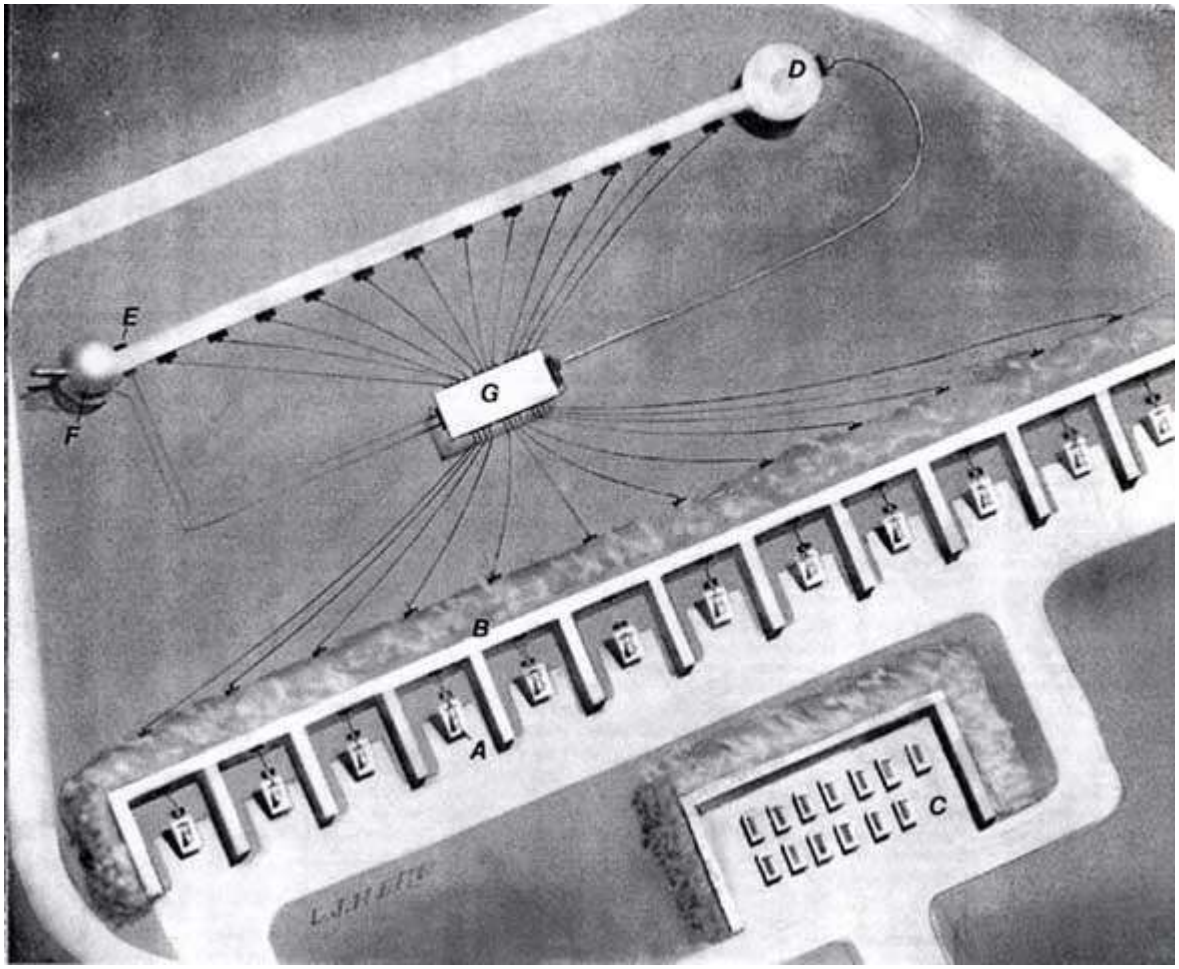

Aviation Week & Space Technology July 28, 1980

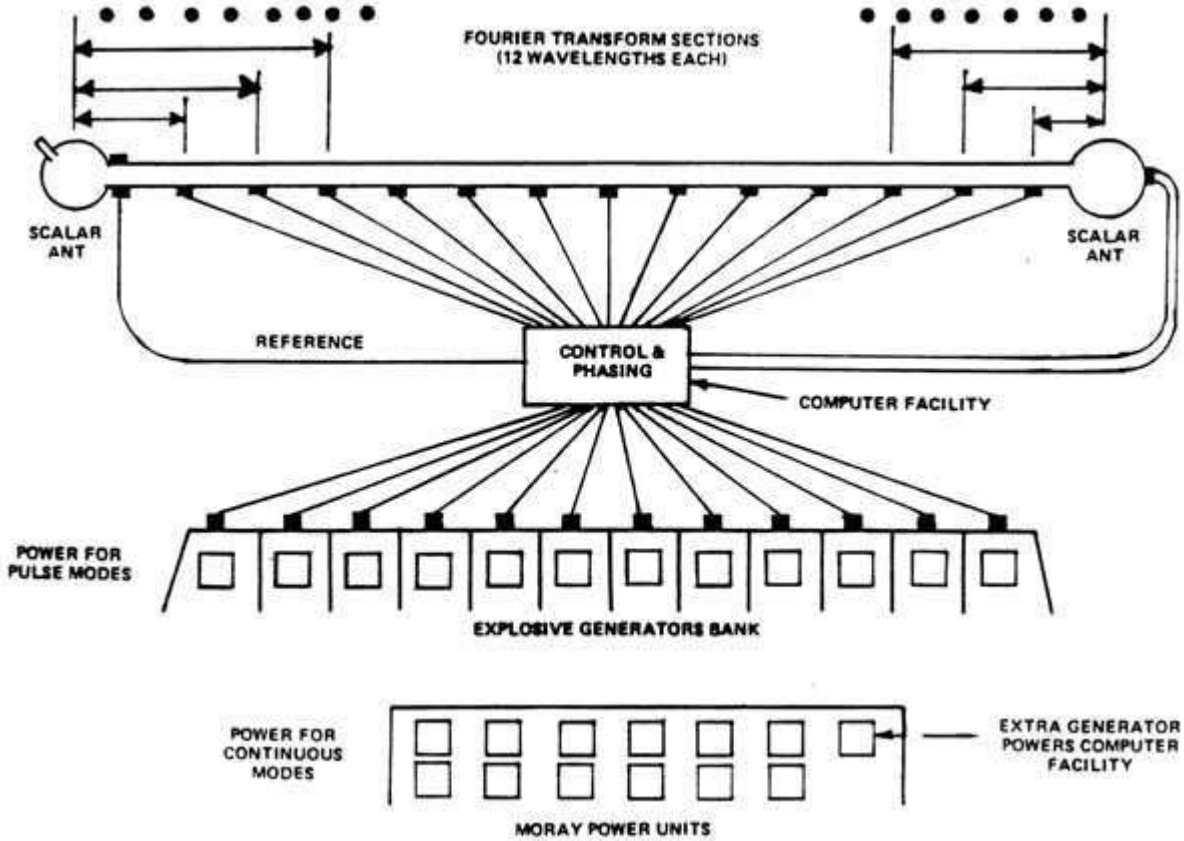

Figure 7. Tesla Weapons at Saryshagan

The Saryshagan howitzer actually is a huge Tesla scalar interferometer with four modes of operation. One continuous mode is the Tesla shield, which places a thin, impenetrable hemispherical shell of energy over a large defended area. The 3-dimensional shell is created by interfering two Fourier-expansion, 3-dimensional scalar hemispherical patterns in space so they pair-couple into a dome-like shell of intense, ordinary electromagnetic energy. The air molecules and atoms in the shell are totally ionized and thus highly excited, giving off intense, glowing light. Anything physical which hits the shell receives an enormous discharge of electrical energy and is instantly vaporized -- it goes pfft! like a bug hitting one of the electrical bug killers now so much in vogue.

If several of these hemispherical shells are concentrically stacked, even the gamma radiation and EMP from a high altitude nuclear explosion above the stack cannot penetrate all the shells due to repetitive absorption and reradiation, and scattering in the layered plasmas.

In the continuous shield mode, the Tesla interferometer is fed by a bank of Moray free energy generators, so that enormous energy is available in the shield. A diagram of the Saryshagan-type Tesla howitzer is shown in figure 7. Hal Crawford's fine drawing of the interferometer end of the Tesla howitzer is shown in figure 6. Hal's exceptional rendition of the Tesla shield produced by the howitzer is shown in figure 8.

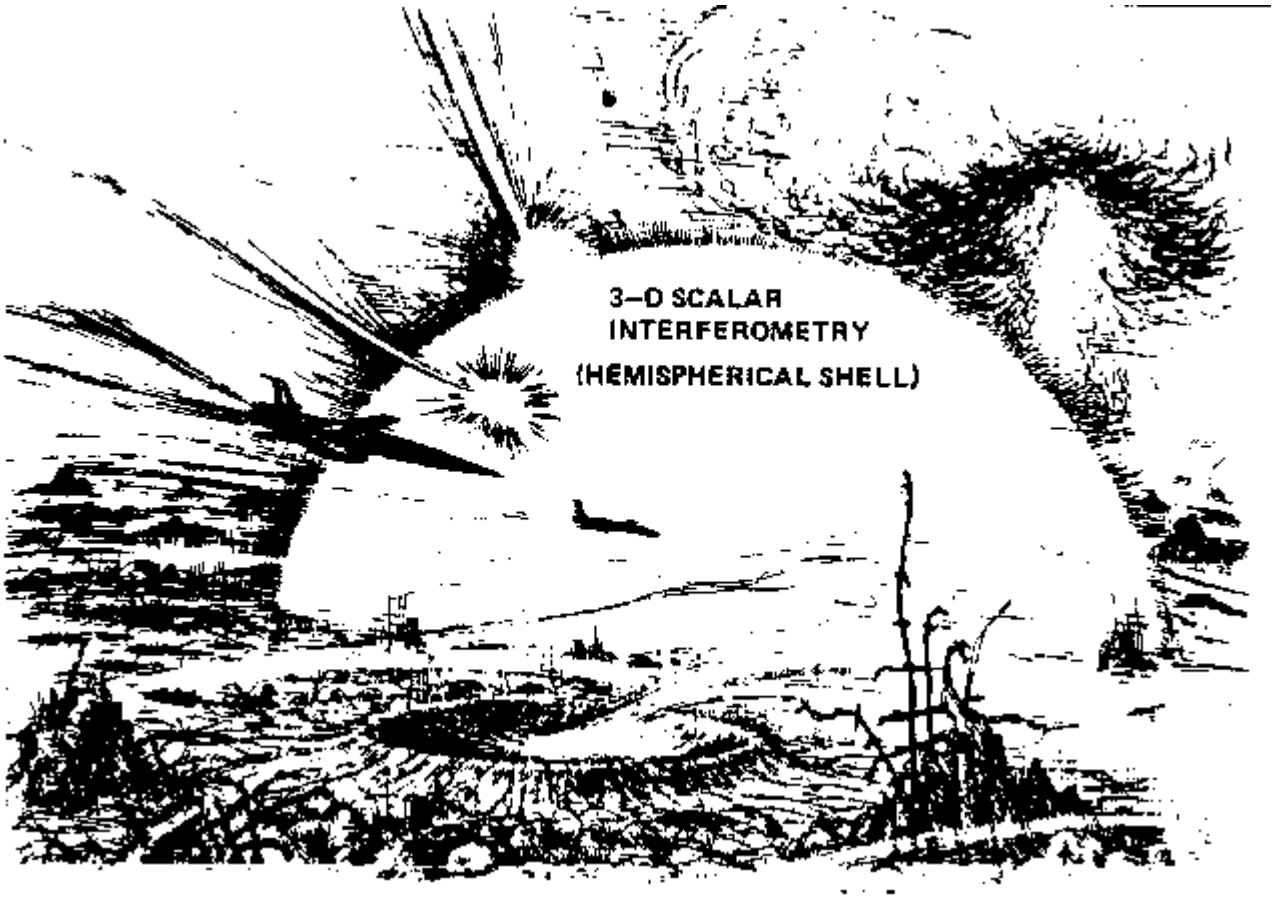

Figure 8. The Tesla Shield

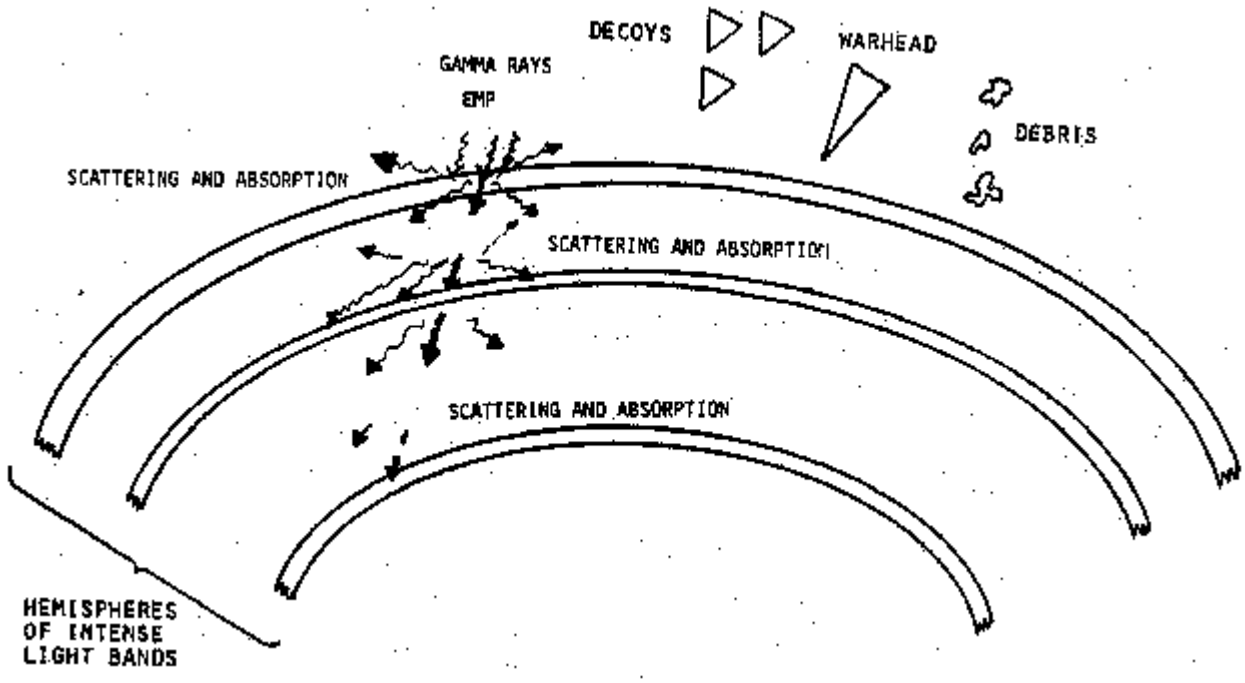

Figure 9. Tesla Terminal Area Defense System

In the pulse mode, a single intense 3-dimensional scalar phi-field pulse form is fired, using two truncated Fourier transforms, each involving several frequencies, to provide the proper 3-dimensional shape (Figure 10). This is why two scalar antennas separated by a baseline are required. After a time delay calculated for the particular target, a second and faster pulse form of the same shape is fired from the interferometer antennas. The second pulse overtakes the first, catching it over the target zone and pair-coupling with it to instantly form a violent EMP of ordinary vector (Hertzian) electromagnetic energy. There is thus no vector transmission loss between the howitzer and the burst. Further, the coupling time is extremely short, and the energy will appear sharply in an "electromagnetic pulse (EMP)" strikingly similar to the 2-pulsed EMP of a nuclear weapon.

This type weapon is what actually caused the mysterious flashes off the southwest coast of Africa, picked up in 1979 and 1980 by Vela satellites. The second flash, e.g., was in the infrared only, with no visible spectrum. Nuclear flashes do not do that, and neither does superlightning, meteorite strikes, meteors, etc. In addition, one of the scientists at the Arecibo Ionospheric Observatory observed a gravitational wave disturbance -- signature of the truncated Fourier pattern and the time-squeezing effect of the Tesla potential wave -- traveling toward the vicinity of the explosion.

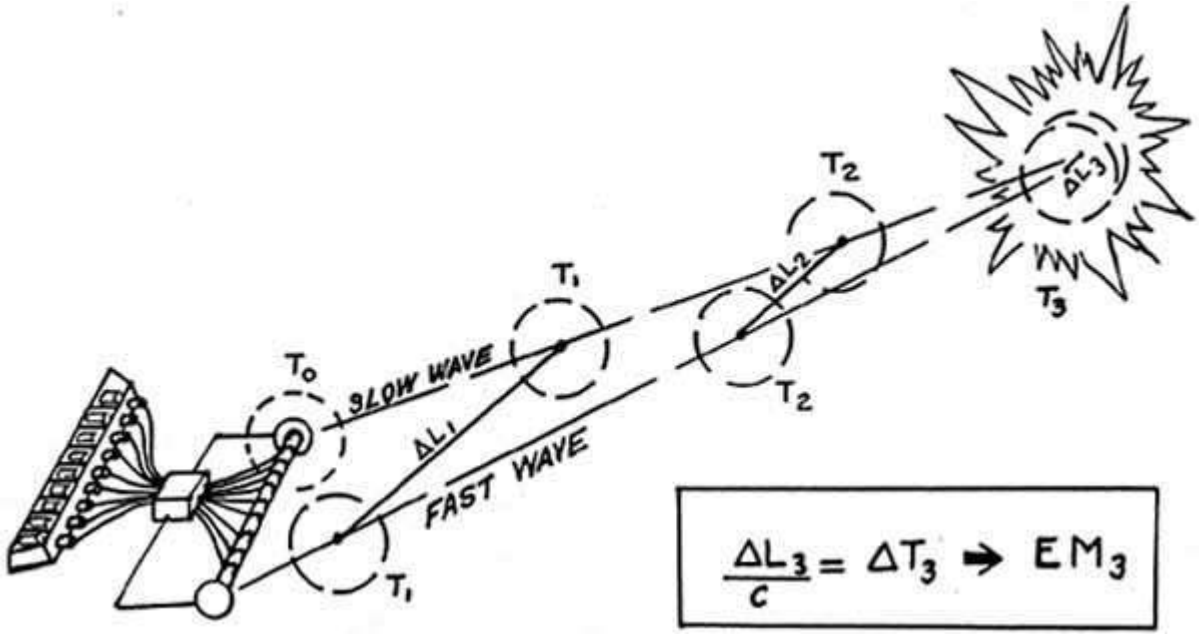

TESLA HOWITZER
(SCALAR INTERFEROMETER)

Figure 10. "Nuclear" Flashes off the Coast of Africa

Lithuania - 10 Sep 1976 - British European Airways Flight #831 between Moscow and London

CIA Report Released under FOIA

Figure 11. Continuous Tesla Fireball

The pulse mode may be fed from either Moray generators or -- if the Moray generators have suffered their anomalous "all fail" malfunction -- ordinary explosive generators. Thus the Tesla howitzer can always function in the pulse mode, but it will be limited in power if the Moray generators fail.

In the continuous mode, two continuous scalar waves are emitted -- one faster than the other -- and they pair-couple into vector energy at the region where they approach an in-phase condition. In this mode, the energy in the distant "ball" or geometric region would appear continuously and be sustained -- and this is Tesla's secret of wireless transmission of energy at a distance without any losses. It is also the secret of a "continuous fireball" weapon capable of destroying hundreds of aircraft or missiles at a distance. An example of a Soviet test of this mode of operation is shown in figure 11.

Witness to a super weapon?

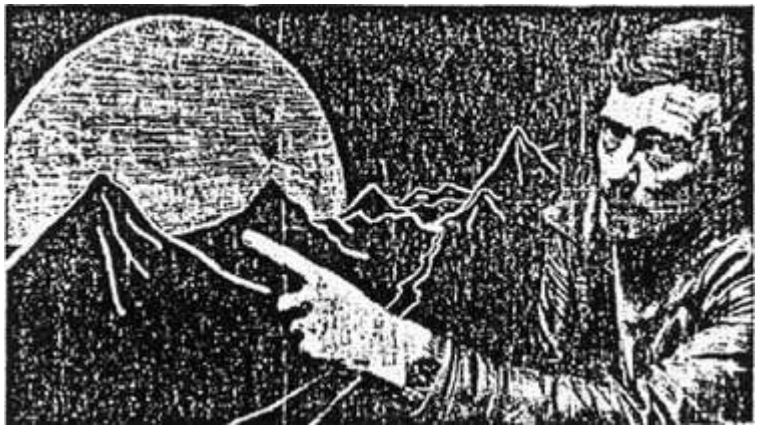

Nick Downie describes the strange lurid glow that flared silently over the Hindu Kush

THE SUNDAY TIMES, 17 AUGUST 1980

(Multiple incidents in Sept., 1979)

TEHERAN, IRAN 17 JUNE 1966

SEEN FROM NEAR MEHRABAD AIRPORT

OBSERVED 4-5 MINUTES

SEEN BY 2 AIRCRAFT

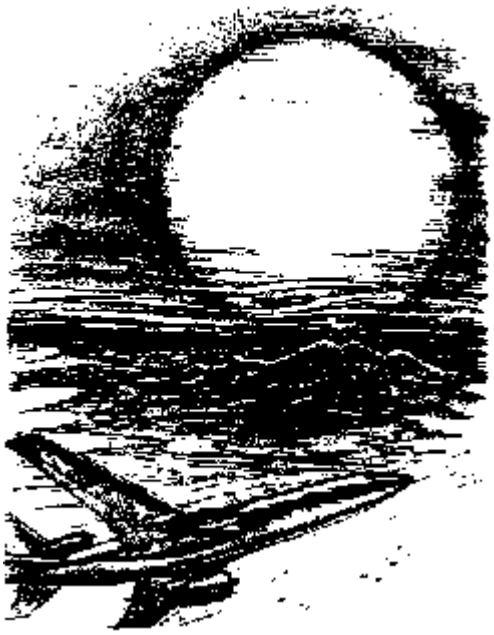

CIA REPORT RELEASED UNDER FOIA

Figure 12. Tesla EMP Globe

The volume of the Tesla fireball can be vastly expanded to yield a globe which will not vaporize physical vehicles but will deliver an EMP to them to dud their electronics. A test of this mode is shown in figure 12. (See also Gwynne Roberts, "Witness to a Super Weapon?", the London Sunday Times, 17 August 1980 for several other tests of this mode at Saryshagan, seen from Afghanistan by British TV cameraman and former War Correspondent Nick Downie.)

If the Moray generators fail anomalously, then a continuous mode limited in power and range could conceivably be sustained by powering the interferometer from more conventional power-sources such as advanced magnetohydrodynamic generators.

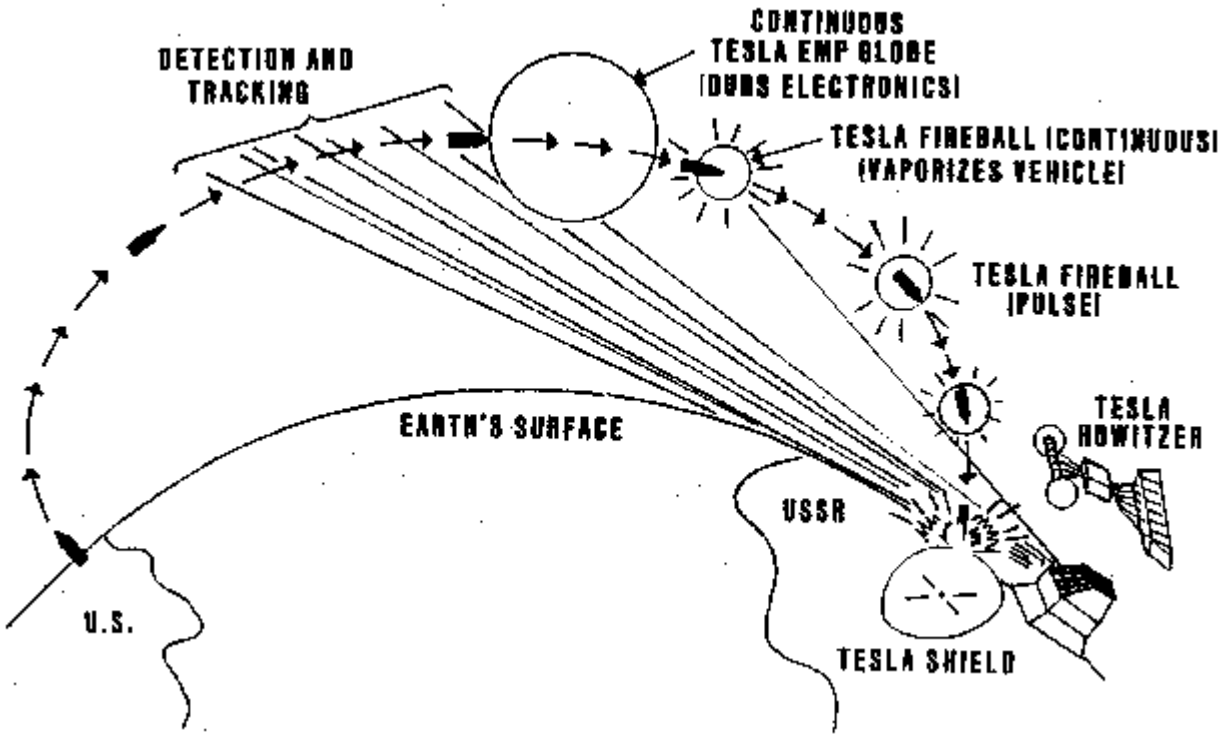

Figure 13. Tesla ABM Defenses

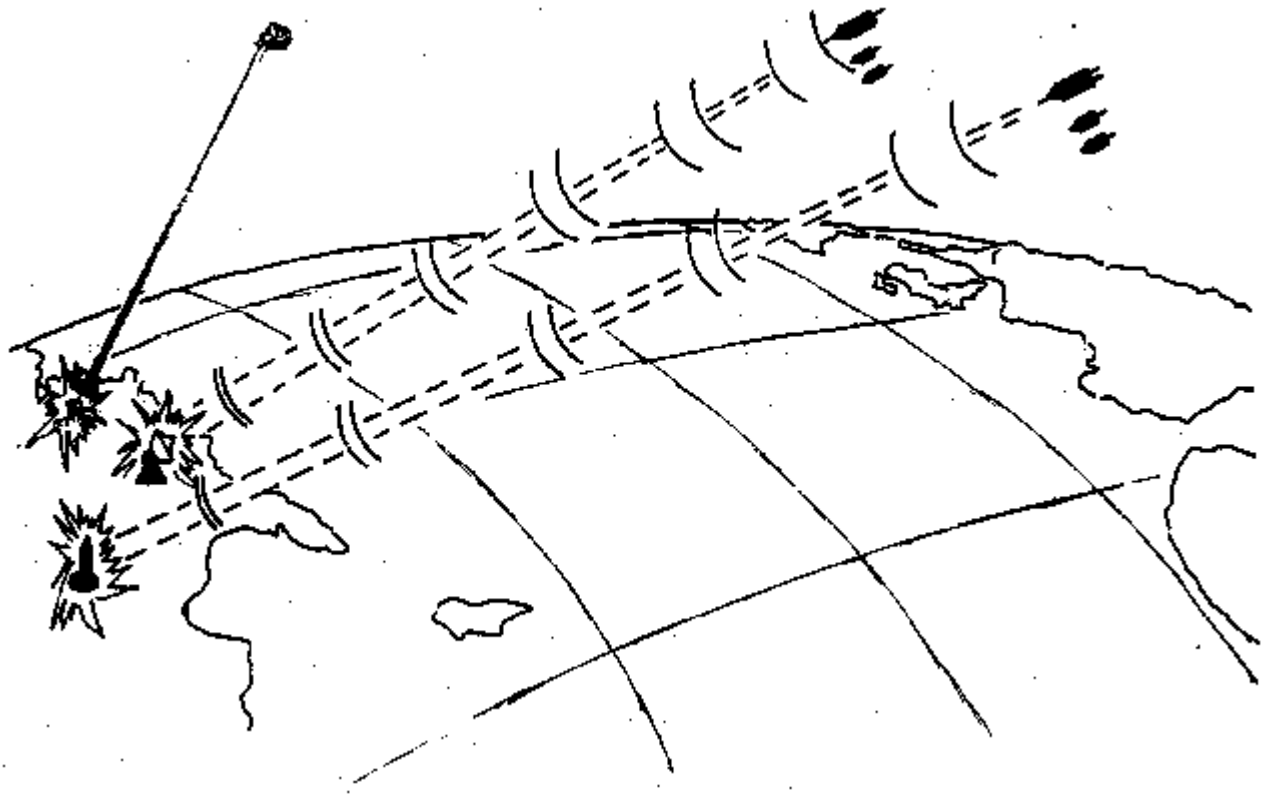

Figure 14. Moray/Tesla Technology: Star Wars Now

Typical strategic ABM uses of Tesla weapons are shown in figure 13. In addition, of course, smaller Tesla howitzer systems for anti-tactical ballistic missile defense of tactical troops and installations could

be constituted of more conventional field missile systems using paired or triplet radars, of conventional external appearance, in a scalar interferometer mode.

With Moray generators as power sources and multiply deployed reentry vehicles with scalar antennas and transmitters, ICBM reentry systems now can become long range "blasters" of the target areas, from thousands of kilometers distance (figure 14). Literally, "Star Wars" is liberated by the Tesla technology. And in air attack, jammers and ECM aircraft now become "Tesla blasters." With the Tesla technology, emitters become primary fighting components of stunning power.

The potential peaceful implications of Tesla waves are also enormous. By utilizing the "time squeeze" effect, one can get antigravity, materialization and dematerialization, transmutation, and mindboggling medical benefits. One can also get subluminal and superluminal communication, see through the earth and through the ocean, etc. The new view of phi-field also provides a unified field theory, higher orders of reality, and a new super-relativity, but detailing these possibilities must wait for another book.

With two cerebral brain halves, the human being also has a Tesla scalar interferometer between his ears. And since the brain and nervous system processes avalanche discharges, it can produce (and detect) scalar Tesla waves to at least a limited degree. Thus a human can sometimes produce anomalous spatiotemporal effects at a distance and through time. This provides an exact mechanism for psychokinesis, levitation, psychic healing, telepathy, precognition, postcognition, remote viewing, etc. It also provides a reason why an individual can detect a "stick" on a radionics or Hieronymus machine (which processes scalar waves), when ordinary detectors detect nothing. Unfortunately there is not room to develop the implications of this human Tesla interferometry in detail, for that must wait for yet another book, presently in its initial stages, that Hal Crawford and I are writing.

Table 5. Orders of Reality

- **PHOTONS ARE**
  - **> PAIR-COUPLED SCALARS**
  - **> VELOCITY-LIMITED TO C**
  - **> CARRIERS OF T**
- **PHOTON INTERACTION**
  - **> IS UBIQUITOUS**
  - **> PRODUCES $\dot{T}$ = C**
  - **> YIELDS 1st ORDER REALITY**
- **SCALAR O WAVES**
  - **> NOT VELOCITY-LIMITED**
  - **> YIELD HIGHER ORDER REALITIES**

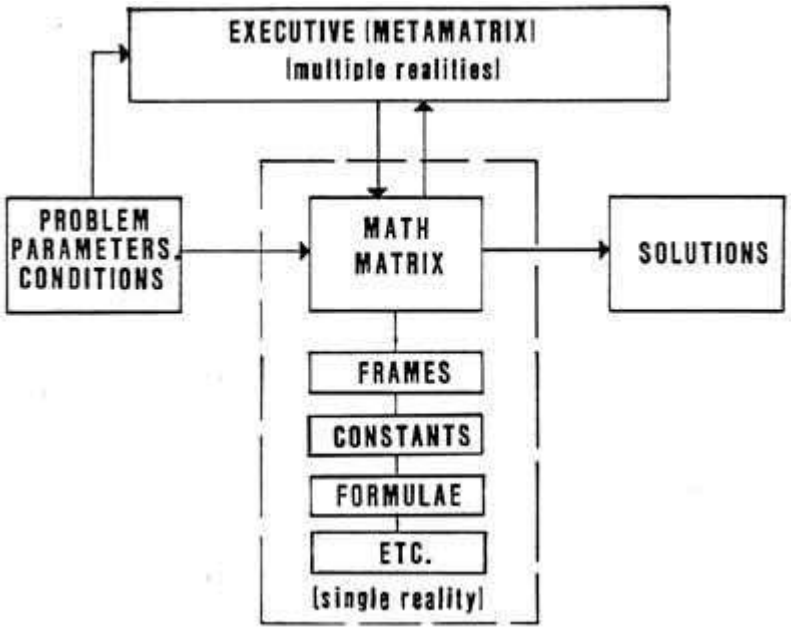

Figure 15. Implications of Tesla Potential

At the July 1981 U.S. Psychotronics Association's Annual Conference in Dayton, Ohio, I presented the first rough paper on the Tesla secret and scalar interferometry. A videotape of the presentation was made and will shortly be available. I am also scheduled to make a special presentation at the Alternate Energy Conference in Toronto, Canada in latter October, 1981. A professional, videotaped two-hour presentation on this subject is also being prepared. Wide distribution of the material through the international underground physics and technology network has already been made. This time, God willing, Tesla's secret will not be suppressed for another 80 years!

And perhaps it is not yet too late. The material has cost me (now) some 16 years of agonizing labor and nearly $100,000 of my own personal funds. No orthodox university, scientific group, foundation, or governmental agency would support such an effort, either financially or otherwise. Indeed, most ordinary journals will not even accept material on such matters. Nonetheless, the area is of overwhelming importance and I truly believe Tesla's lost secret will shortly affect the lives of every human being on earth.

Perhaps with the free and open release of Tesla's secret, the scientific and governmental bureaucracies will be. shocked awake from their slumber, and we can develop defenses before Armageddon occurs. Perhaps there is hope after all -- for even Brezhnev, in his strange July, 1975 proposal to the SALT talks, seemed to reveal a perception that a turning point in war and weaponry may have been reached, and that human imagination is incapable of dealing with the ability to totally engineer reality itself. Having tested the weapons, the Soviets must be aware that the ill-provoked oscillation of timeflow affects the minds and thoughts -- and the very lifestreams and even the collective species unconsciousnesses -- of all lifeforms on earth. They must know that these weapons are two-edged swords, and that the backlash from their use can be far more terrible to the user than was the original effect to his victim.

If we can avoid the Apocalypse, the fantastic secret of Nikola Tesla can be employed to cure and elevate man, not kill him. Tesla's discovery can eventually remove every conceivable external human limitation. If we humans ourselves can elevate our consciousness to properly utilize the Tesla electromagnetics, then Nikola Tesla -- who gave us the electrical twentieth century in the first place -- may yet give us a fantastic new future more shining and glorious than all the great scientists and sages have imagined.

References

http://www.cheniere.org/books/part1/teslaweapons.htm

- ▶ Reply
-

Permalink Reply by rose on August 4, 2013 at 10:54

yeah this ones from deep in the archives Greg - I would love to see that article!!!

- ▶ Reply
-

Permalink Reply by deanna munson on August 4, 2013 at 18:16

what if these weapons work in conjunction with cell towers and smartgrid/wifi relays? i just read this and it blew me away how the dangers this is being purposely ignored http://www.stayonthetruth.com/electromagnetic-fields---killing-fiel... "

November 14 1996, Omnipoint, New York City's first digital cellular provider, did open for business, broadcasting from thousands of antennae newly erected on the rooftops of apartment buildings. According to the health authorities, an early flu hit New York City - but not Boston, and not Philadelphia - on about 15 November. The flu was severe and ran a prolonged course, often dragging on for months instead of the usual two weeks.

At Christmas time, the Cellular Phone Task Force placed a small classified ad in a free weekly newspaper. It read: 'If you have been ill since 11/15/96 with any of the following: eye pain, insomnia, dry lips, swollen throat, pressure or pain in the chest, headaches, dizziness, nausea, shakiness, other aches and pains, or flu that won't go away, you may be a victim of a new microwave system blanketing the city. We need to hear from you.' And we did hear from them. Hundreds called, men, women, whites, blacks, Asians, Latinos, doctors, lawyers, teachers, stockbrokers, airline stewards, computer operators. Most had woken up suddenly in mid-November, thinking they were having a stroke or a heart attack or a nervous breakdown, and were relieved to know they were not alone and not crazy.

Later, I analysed weekly mortality statistics, which the Centres for Disease Control publish for122 US cities. Each of dozens of cities recorded a 10-25 per cent increase in mortality, lasting two to three months, beginning on the day in 1996 or 1997 on which that city's first digital cell phone network began commercial service." we already know these agendas are being forced everywhere.no one is even noticing how even though everyone is already "connected" they are still erecting more and more towers and infastructure,by force in the case of smartmeters.wired in connections now cost over double what wifi does.they just put up another tower here on my block,disguised as a flipping pine tree.cant block the effects when it comes from literally all sides

- ▶ Reply
-

Permalink Reply by Rhonda Reichel on August 6, 2013 at 6:15

Scalar weapons makes all the billions we spend on war obsolete.....what a racket

- ▶ Reply
-

Permalink Reply by steve on August 9, 2013 at 6:43
having read a few pages, it looks like a weapon of distraction to me. The physics is in the realm of the tooth fairy, and the history has the ring of recent manufacture

- ▶ Reply
-

Permalink Reply by rose on August 9, 2013 at 12:24

- ▶ Reply
-

Permalink Reply by steve on August 9, 2013 at 16:03
plus, Tom Beardon is nothing but a fear merchant.

- ▶ Reply
-

RSS

Welcome to
The ConTrail

Sign Up
or Sign In

Or sign in with:

Visitors

Live Traffic Feed

Watch Live | Get FEEDJIT

Richmond, California, United States arrived 0 secs ago.

Adelaide, South Australia, Australia arrived 20 mins ago.

San Francisco, California, United States arrived 21 mins ago.

San Francisco, California, United States arrived 37 mins ago.

San Francisco, California, United States arrived 40 mins ago.

Hamilton, Waikato, New Zealand arrived 56 mins ago.

New Zealand arrived 1 hour 6 mins ago.

San Diego, California, United States arrived 1 hour 9 mins ago.

Oceanside, California, United States arrived 1 hour 22 mins ago.

Australia arrived 1 hour 54 mins ago.

Groups

Health and Wellbeing

123 members

99 Comments 10 Favorites

Vaccination Information

87 members

163 Comments 6 Favorites

-

  Simply Good Stuff

  40 members

  112 Comments 3 Favorites

-

  EMF and EMR Information …

  101 members

  74 Comments 13 Favorites

-

  Cancer Treatment Options

  74 members

  77 Comments 9 Favorites

-

  Grow your own Food and M…

  96 members

  52 Comments 12 Favorites

-

  Childbirth

  3 members

  1 Comment 0 Favorites

- View All

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Foundations of Electro-Magnetism

Slide Series

- Major Points of Presentation
- Chung's Carbon Filament Negative Resistor
- Aharanov-Bohm Effect
- Absorption and emission reactions (1)
- Absorption and emission reactions (2)
- Anti-engine for cell's deviation reverses cell back to normal
- Asymmetric regauging produces excess force, which can be used to do work on the system
- Asymmetric regauging produces excess force, which can be used to do work on the regauging system
- Becker's bone fracture healing experiments
- Becker's theoretical control system governing regeneration
- Becker's theoretical DC control system involved with response to injury
- Geometrical Distortion of Poynting Energy Flow
- Cosmic Bootstrap: Before the Big Bang
- Bridging Enables COP > 1

- Aspects of Strong Local Symmetry
- Other Aspects of Strong Local Symmetry
- Bunge on the Status of Electrodynamics
- Bunge on the Status of Electrodynamics and Physics
- Bunge on the Status of Classical and Quantum Physics
- Fractions of BW Casualties Surviving
- First Step in Self-Promotion of Cancer Due to Hypoxia
- Differentiation and Dedifferentiation Timelines
- Evolution of Cells on Earth
- A Charged Particle q is a Coupled System of m and Ø
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (1)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (2)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (3)
- A Charged Particle is a Coupled System
- The Anomalies in Navy Electrolyte Experiments at China Lake
- Chung's Carbon Filament Negative Resistor

- Typical circuit has about 10^{-13} energy collection efficiency
- Classical View of EM
- Curved Spacetime acts as source or sink
- Chronic Disease Puzzling
- Cancer Characteristics
- Solving a Cancer Enigma
- Cancer: Characteristics
- Nonlinear Optics Distortion Correction Theorem
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)
- In Time-Reversed Zone: Nuclear reactions are biased
- In Time-Reversed Zone: Dynamics may be reversed
- Time-Reversed Zone: Significant only after time-density charging
- A New Conservation of Energy Law
- Questions on Carcinogens and EM

Radiation

- AS DEFINED, fields and potentials only exist in and on charged matter
- Serious flaws and errors in classical EM theory
- Electrodynamicists' Reaction to Removal of the Material Ether
- Reaction to Loss of Material Ether (1)
- Reaction to Loss of Material Ether (2)
- Some EM waves in Spacetime
- Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
- Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
- Phase Conjugate Wavepairs Produce New Waves
- Scalar Electromagnetics (Energetics) View of EM (1)
- Scalar Electromagnetics (Energetics) View of EM (2)

- Scalar Electromagnetics (Energetics) View of EM (3)
- Extended General Relativity Principle
- Extension of Work-Energy Theorem
- 34 Flaws in Classical EM Theory
- MTW's General Relativity Principle
- Use of General Relativity (GR) in Particle Physics
- The Missing Infolded Electrodynamics
- Infolded Engines: Excluded by Present Physics
- Mass curves and structures spacetime; ST curvatures change and structure mass (1)
- Mass curves and structures spacetime; ST curvatures change and structure mass (2)
- At Infinite Velocity: Each Is Every Other
- Lisitsyn's Report: Brain Code Broken
- Lorentz Closed Surface Integration
- Lorentz's physically insignificant energy flow can be collected and utilized
- Lorentz surface integration of the Poynting vector around a closed surface
- Longitudinal EM Photon Interaction with Charge
- Mass is transparent to longitudinal EM waves, which move through the infolded interiors of internal waves, potentials, and fields in the mass.

- Pumping with Longitudinal EM waves Time-reverses the Mass
- Maxwell's Quaternion Theory
- Maxwellian Systems before and after Regauging
- Maxwell's four equations reduce to: Page 1
- Maxwell's four equations reduce to: Page 2
- More to come

Major Points of Presentation

- Electrodynamic is seriously flawed
  - Some major flaws
  - Corrections indicated
- Why past corrective attempts failed
  - Force field concept is material
  - Missing two infolded transforms (M->ST; ST->M)
- Missing Infolded general relativity inside electrodynamics
- Several Kinds of EM Waves in Space
  - How to make
  - Transduction
- A French medical example as a deep experimental demonstration
  - Spectacular regenerative cures funded by French Govt
  - Not comprehended, therefore suppressed
- Cold Fusion examples of time-density wave effects
  - China Lake Instrumental anomalies in electrolysis
  - Explanation of anomalous behavior of instruments
  - Explanation of new nuclear reactions
  - Wave energy transduction provides excess heat
- Urge theorists to consider dramatically new reactions

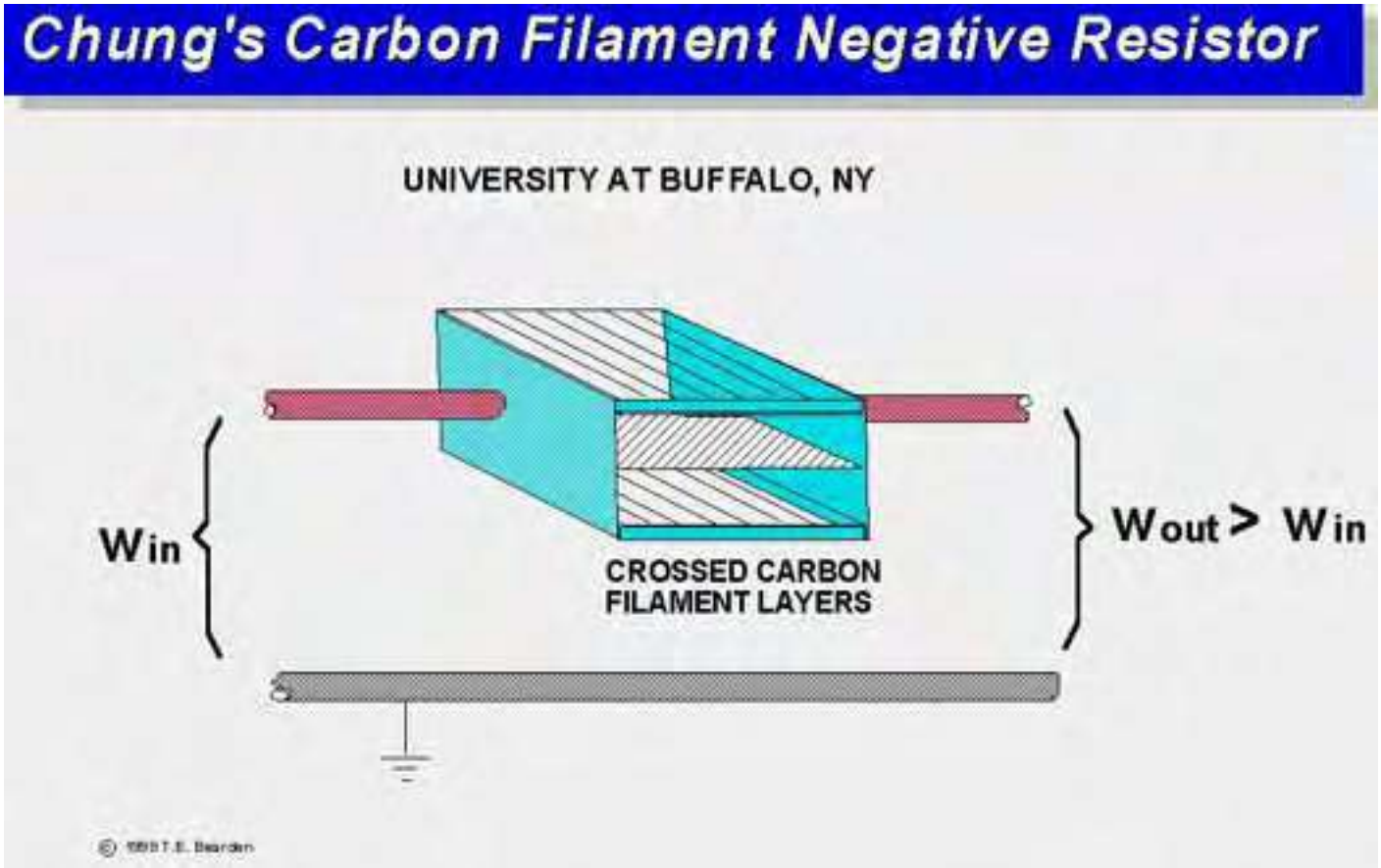
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
Win
CROSSED CARBON
FILAMENT LAYERS
Wout > Win

Aharonov-Bohm Effect

- In field-free regions
  - E-field is zero
  - B-field is zero
- Potentials still exist, just no gradients
  - Cause real effects
  - Interference is the key
  - Contain sum-zeroed substructures
- Does not follow from
  - Mechanics
  - Classical electromagnetics
- Required by quantum mechanics

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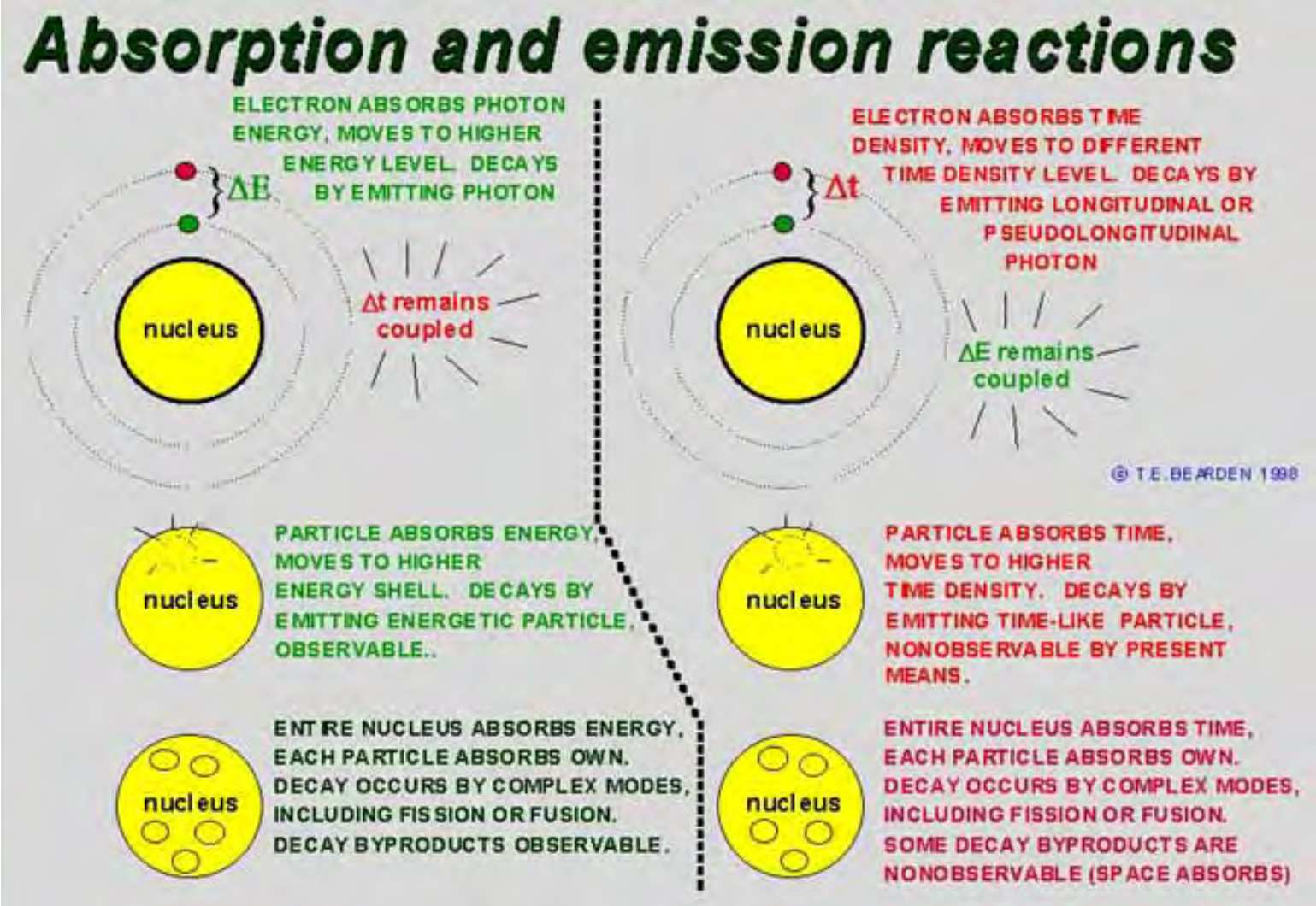
Absorption and emission reactions
ELECTRON ABSORBS PHOTON ENERGY, MOVES TO HIGHER ENERGY LEVEL. DECAYS BY EMITTING PHOTON
ΔE
nucleus
Δt remains coupled
ELECTRON ABSORBS TIME DENSITY, MOVES TO DIFFERENT TIME DENSITY LEVEL. DECAYS BY EMITTING LONGITUDINAL OR PSEUDOLONGITUDINAL PHOTON
Δt
nucleus
ΔE remains coupled
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nucleus
PARTICLE ABSORBS ENERGY, MOVES TO HIGHER ENERGY SHELL. DECAYS BY EMITTING ENERGETIC PARTICLE, OBSERVABLE..
nucleus
PARTICLE ABSORBS TIME, MOVES TO HIGHER TIME DENSITY. DECAYS BY EMITTING TIME-LIKE PARTICLE, NONOBSERVABLE BY PRESENT MEANS.
nucleus
ENTIRE NUCLEUS ABSORBS ENERGY, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. DECAY BYPRODUCTS OBSERVABLE.
nucleus
ENTIRE NUCLEUS ABSORBS TIME, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. SOME DECAY BYPRODUCTS ARE NONOBSERVABLE (SPACE ABSORBS)

Absorption and emission reactions

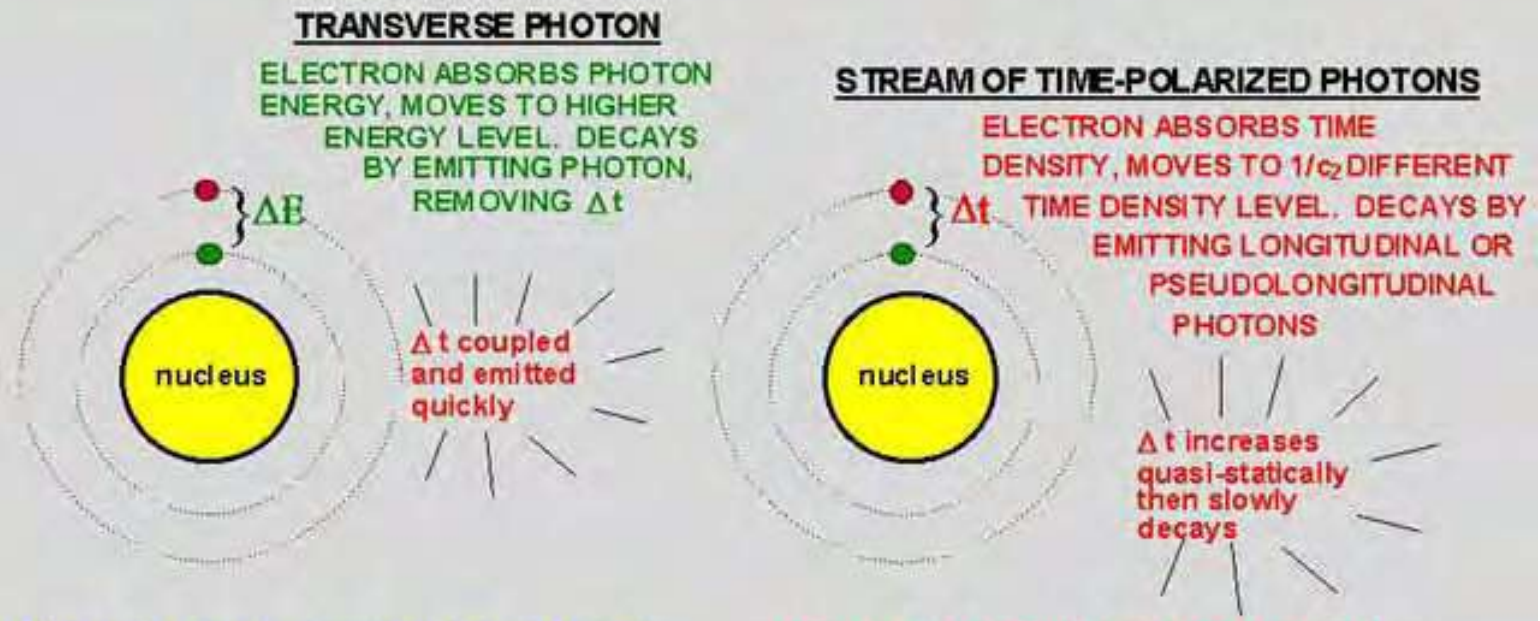

Figure A. Excited energy density level in one jump.

Figure B. Excited time density level significant only after enormous number of increases.

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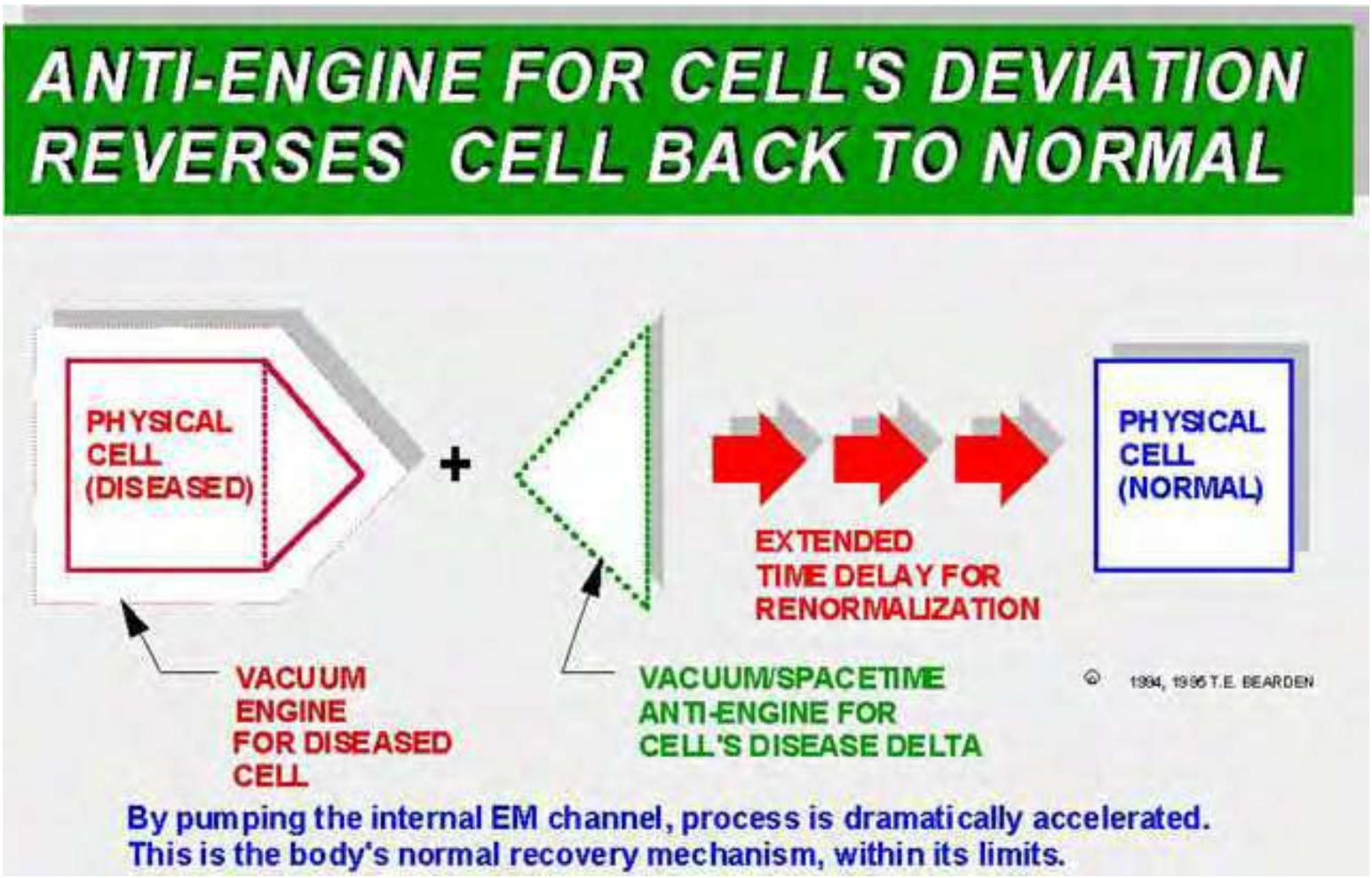
ANTI-ENGINE FOR CELL'S DEVIATION
REVERSES CELL BACK TO NORMAL
PHYSICAL CELL (DISEASED)
+
EXTENDED TIME DELAY FOR RENORMALIZATION
PHYSICAL CELL (NORMAL)
VACUUM ENGINE FOR DISEASED CELL
VACUUM/SPACETIME ANTI-ENGINE FOR CELL'S DISEASE DELTA
© 1994, 1995 T.E. BEARDEN
By pumping the internal EM channel, process is dramatically accelerated.
This is the body's normal recovery mechanism, within its limits.

Asymmetric Regauging Produces Excess Force, Which Can be Used to Do Work on the System

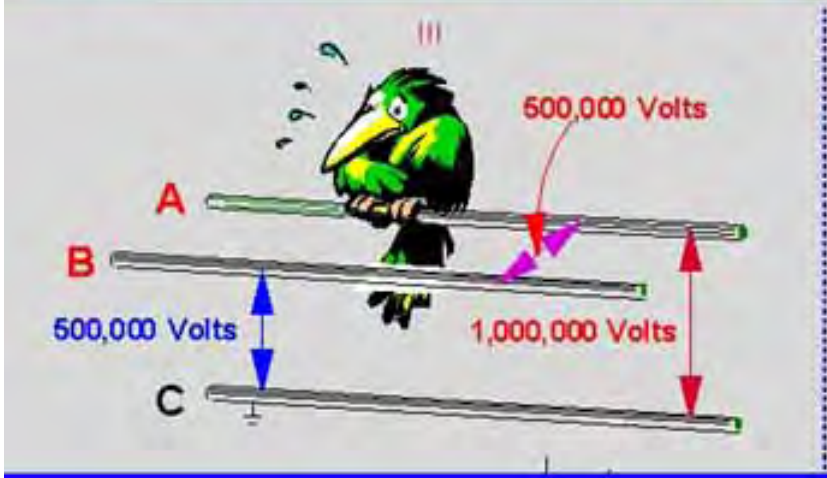

Net Symmetric Regauging Does No Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire A also. He *net symmetrically* regauged, so he had no net excess force across him, even though his potential energy was increased. He asymmetrically regauged each foot, but both simultaneously so that one countered the other. Wise little bird!

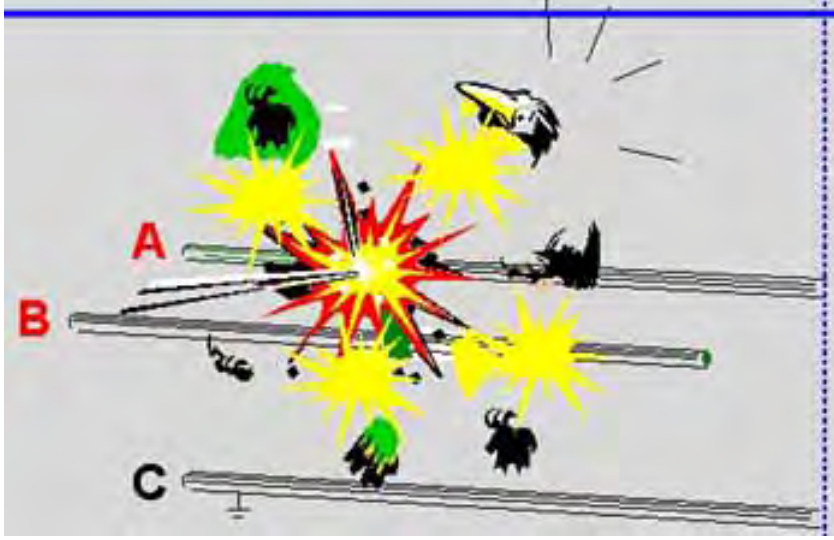

Net Asymmetric Regauging Can Do Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire B. He *net asymmetrically* regauged, so he had lots of net excess force across him. That force then violently translated his little body parts every which way, doing lots of work in and on him. Bummer!

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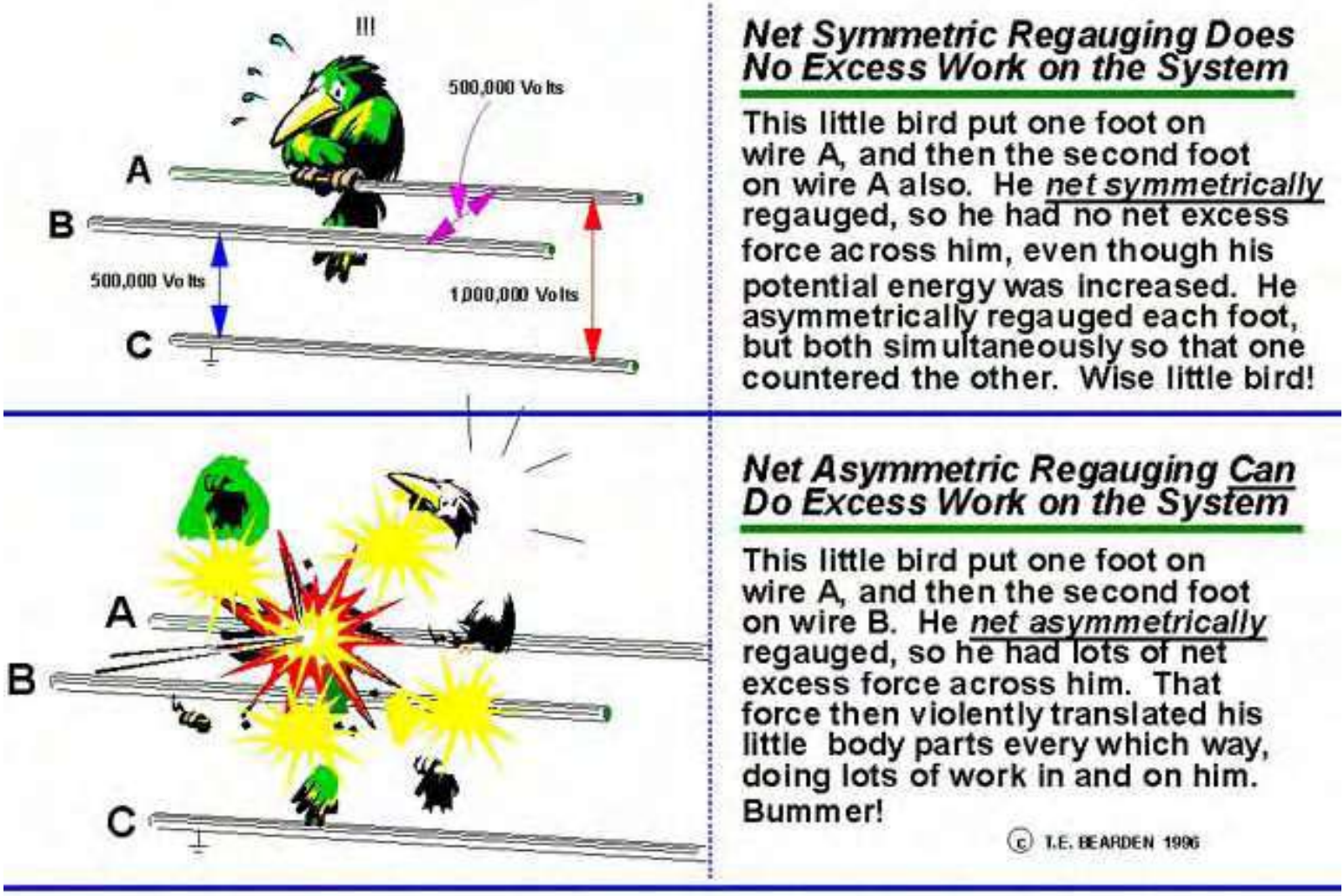

Figure 32. Asymmetric regauging produces excess force, which can be used to do work on the regauging system.

Selected clipart © by Lotus SmartPics™

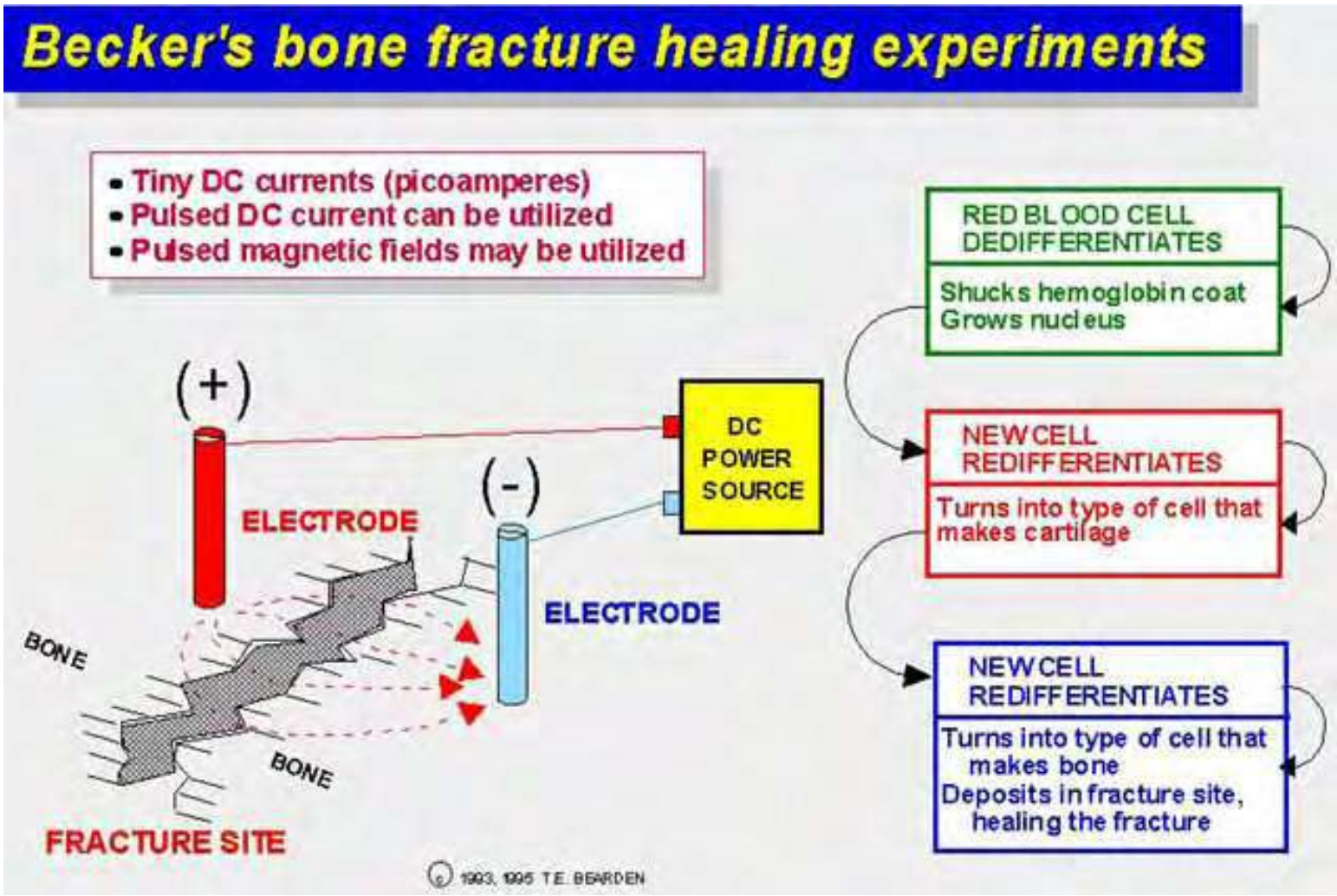
Becker's bone fracture healing experiments
• Tiny DC currents (picoamperes)
• Pulsed DC current can be utilized
• Pulsed magnetic fields may be utilized
(+)
(-)
ELECTRODE
ELECTRODE
DC POWER SOURCE
BONE
BONE
FRACTURE SITE
RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture
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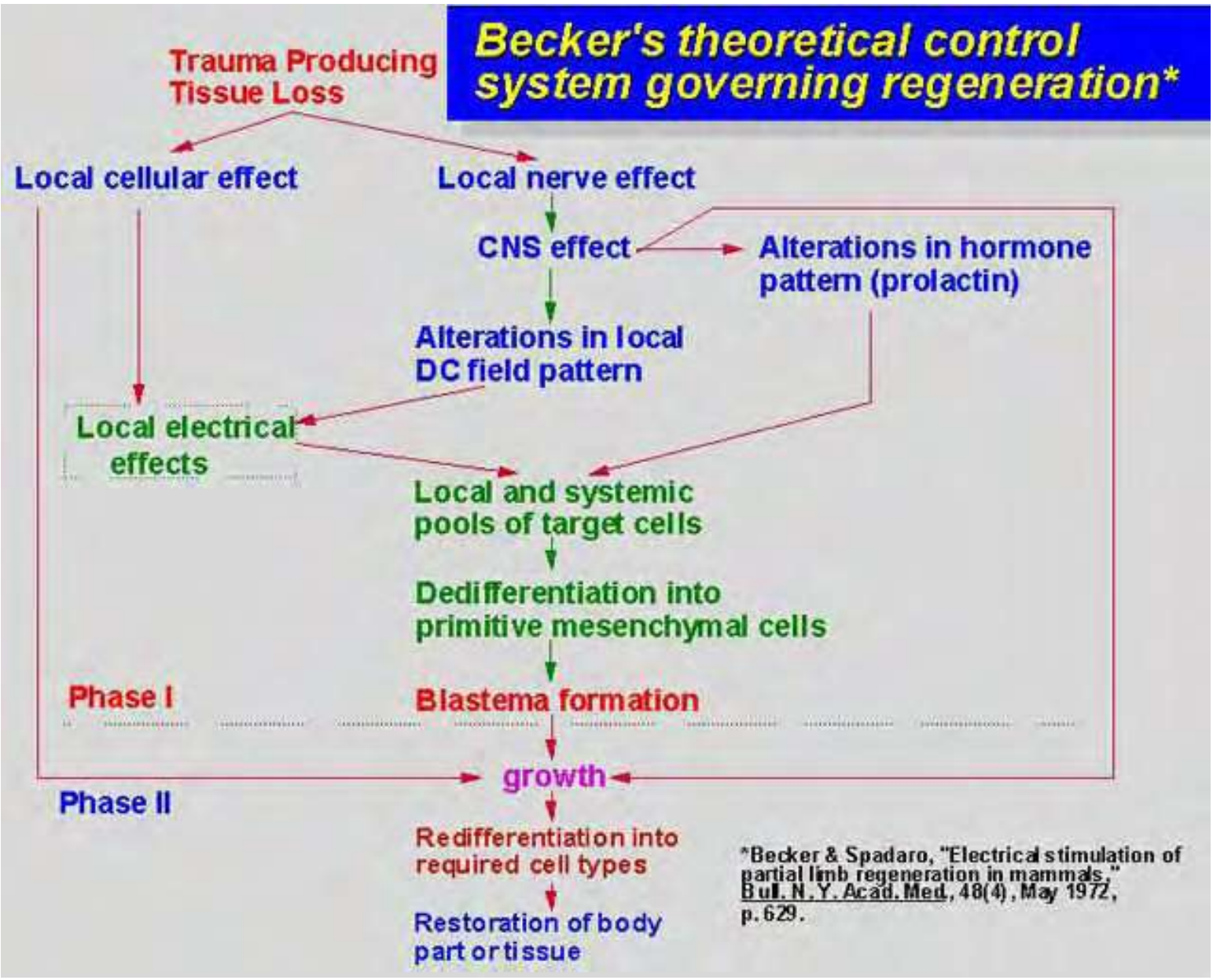
Becker's theoretical control system governing regeneration*
Trauma Producing Tissue Loss
Local cellular effect
Local nerve effect
CNS effect
Alterations in hormone pattern (prolactin)
Alterations in local DC field pattern
Local electrical effects
Local and systemic pools of target cells
Dedifferentiation into primitive mesenchymal cells
Phase I
Blastema formation
growth
Phase II
Redifferentiation into required cell types
Restoration of body part or tissue
*Becker & Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bull. N.Y. Acad. Med., 48(4), May 1972, p. 629.

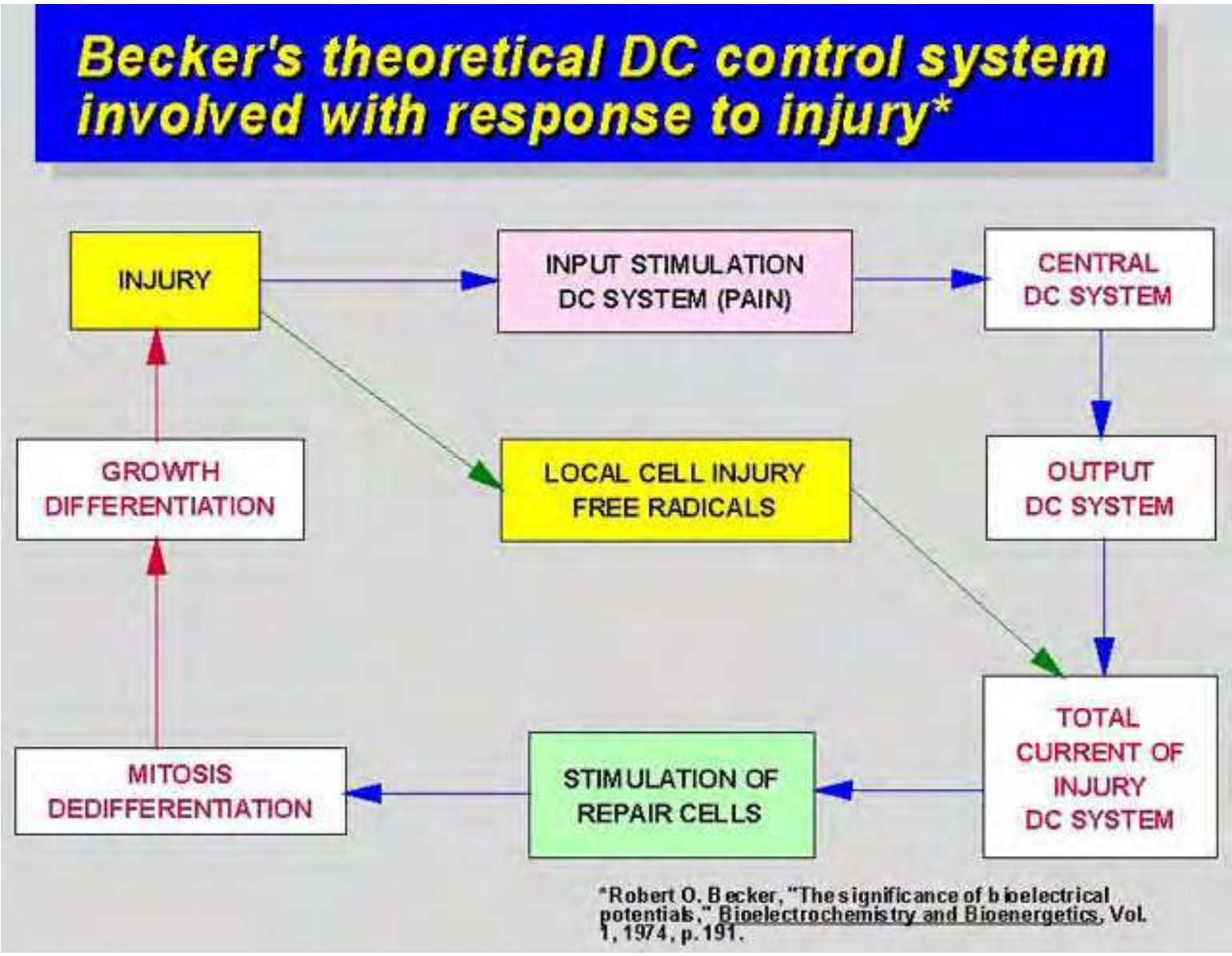
Becker's theoretical DC control system involved with response to injury*
INJURY
INPUT STIMULATION DC SYSTEM (PAIN)
CENTRAL DC SYSTEM
GROWTH DIFFERENTIATION
LOCAL CELL INJURY FREE RADICALS
OUTPUT DC SYSTEM
TOTAL CURRENT OF INJURY DC SYSTEM
MITOSIS DEDIFFERENTIATION
STIMULATION OF REPAIR CELLS
*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Geometrical Distortion of Poynting Energy Flow

At or near resonance frequency, in the case shown the energy collection fraction (reaction cross section) increases dramatically.

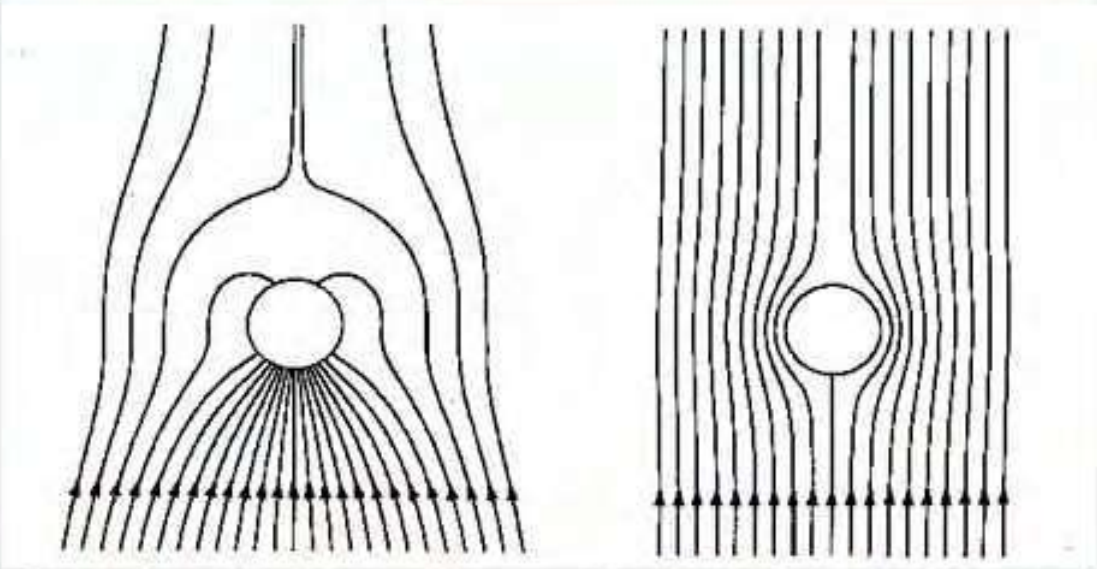

a. Around an aluminum sphere at light energy 8.8 eV. Absorption efficiency = 18.00.

b. Around an aluminum sphere at light energy 5eV. Absorption efficiency = 0.1.

Figures per Craig F. Bohren, "How can a particle absorb more than the light incident upon it? ", American Journal of Physics, 51(4), Apr. 1983, p. 326.

Cosmic Bootstrap: Before the Big Bang:

- *Cosmic repulsion behaved like a fluid with negative pressure*
- *The "universe" inflated (expanded) as a "false vacuum"*
- *As the negative-pressure fluid expanded, its energy went up rather than down*
- *When inflation stopped, the false vacuum decayed from its excited state*
- *Its excitation energy was released in a single great burst*

Paul Davies, Superforce, 1984, p. 194

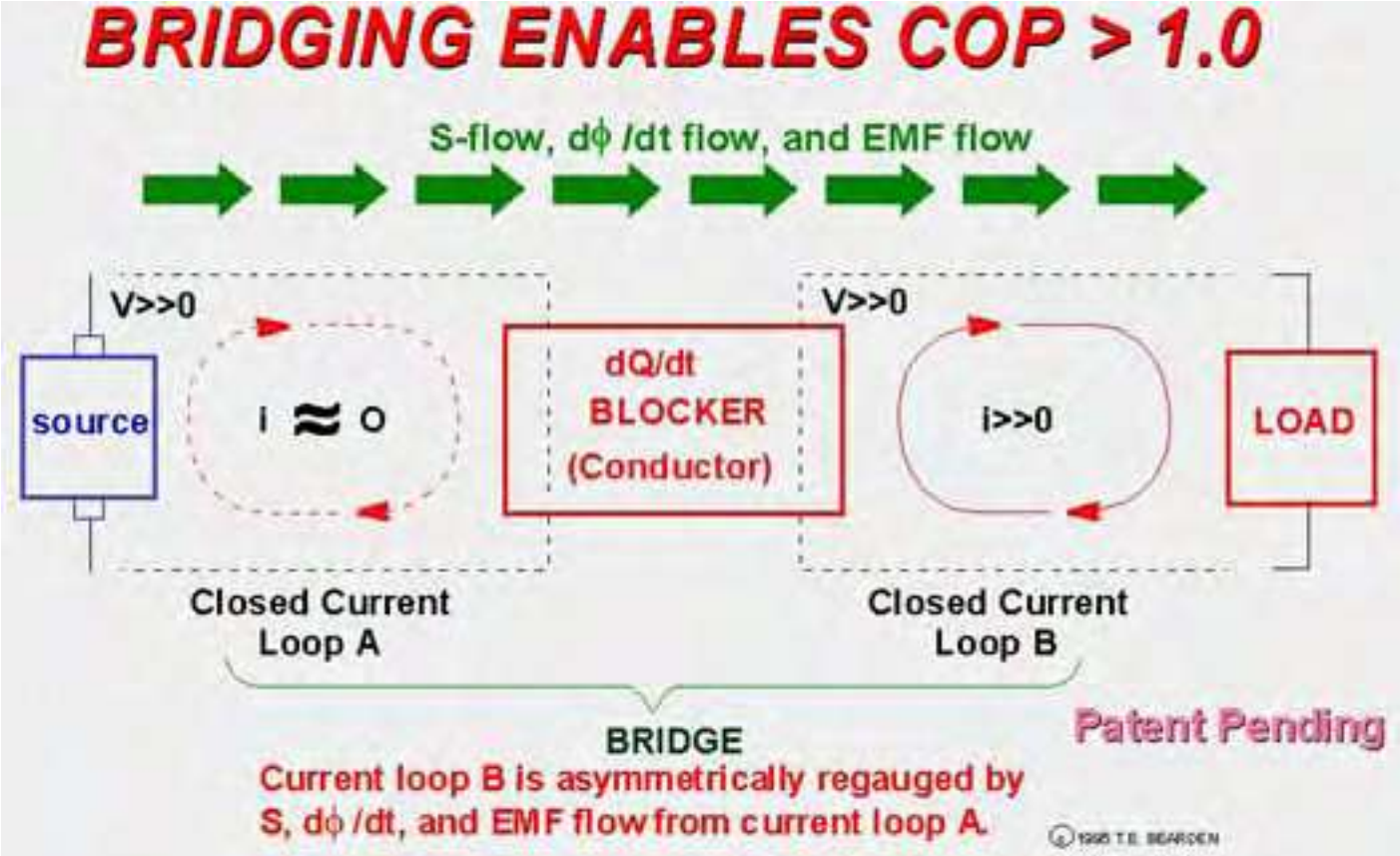
BRIDGING ENABLES COP > 1.0
S-flow, dϕ /dt flow, and EMF flow
V>>0
source
i ≈ 0
dQ/dt
BLOCKER
(Conductor)
V>>0
i>>0
LOAD
Closed Current
Loop A
Closed Current
Loop B
BRIDGE
Patent Pending
Current loop B is asymmetrically regauged by
S, dϕ /dt, and EMF flow from current loop A.
© 1995 T.E. BEARDEN

Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum

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- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another
- STRUCTURING THE INFOLDED EM INSIDE POTENTIALS, FIELDS, AND WAVES
  - Strongly breaks local symmetry
  - Provides spacetime engines giving the above effects

Other Aspects of Strong Local Asymmetry

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- Local spacetime is curved
- Lorentz invariance of vacuum is violated
- May be a local "sink" or "source"
- Gravitational-inertial effects from EM
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation
- COMMENT: Thus the use of infolded longitudinal EM fields and waves to strongly break local symmetry allows intermested clustering of spacetime curvatures. These spacetime structures are *vacuum engines*, or *spacetime engines*.

Bunge on the Status of Electrodynamics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state..."

"... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

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Bunge on the Status of Electrodynamics and Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state...

"... neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

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*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

Bunge on the Status of Classical and Quantum Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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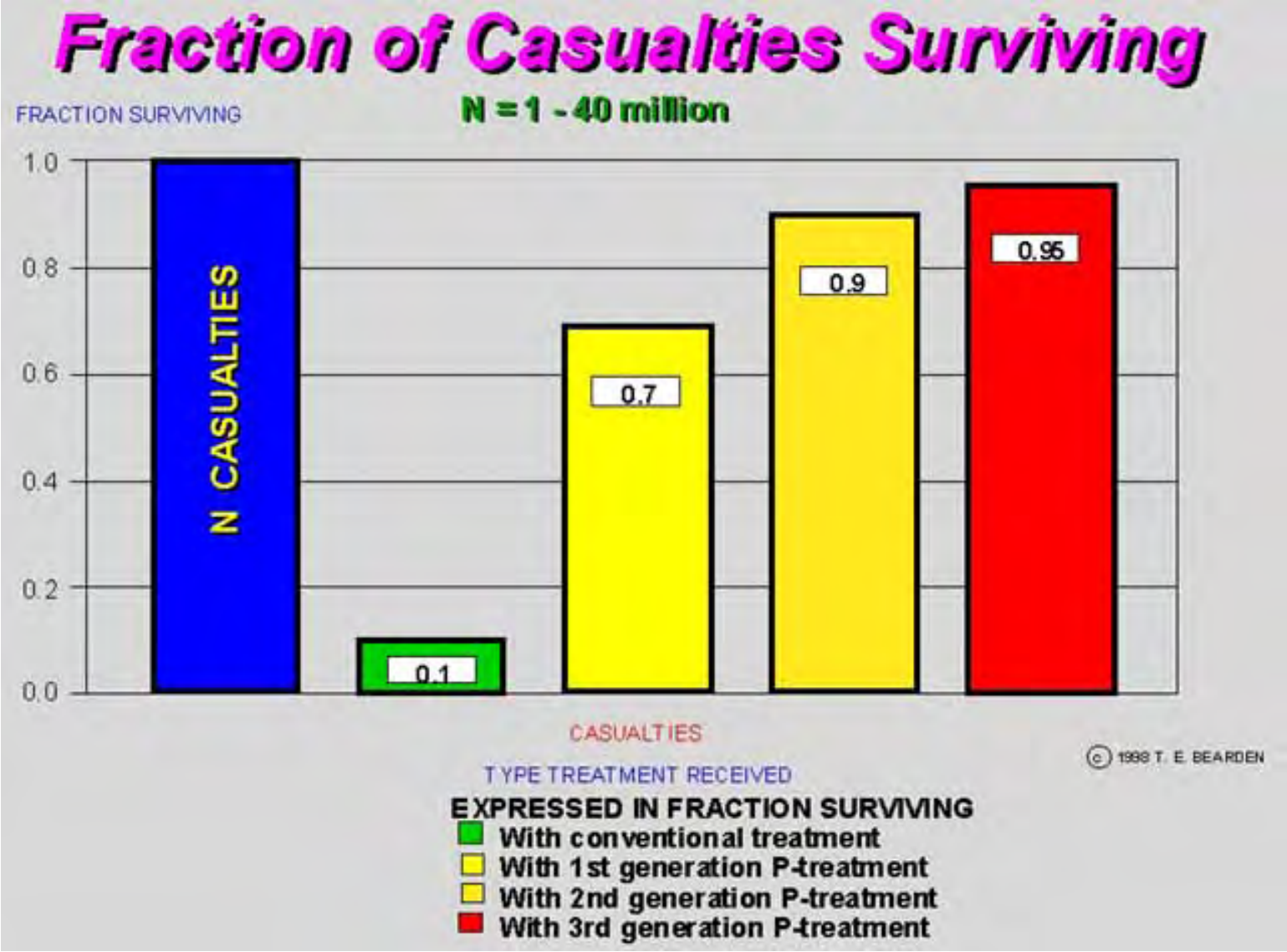
Fraction of Casualties Surviving
FRACTION SURVIVING
N = 1 - 40 million
1.0
0.8
0.6
0.4
0.2
0.0
N CASUALTIES
0.1
0.7
0.9
0.95
CASUALTIES
TYPE TREATMENT RECEIVED
© 1998 T. E. BEARDEN
EXPRESSED IN FRACTION SURVIVING
With conventional treatment
With 1st generation P-treatment
With 2nd generation P-treatment
With 3rd generation P-treatment

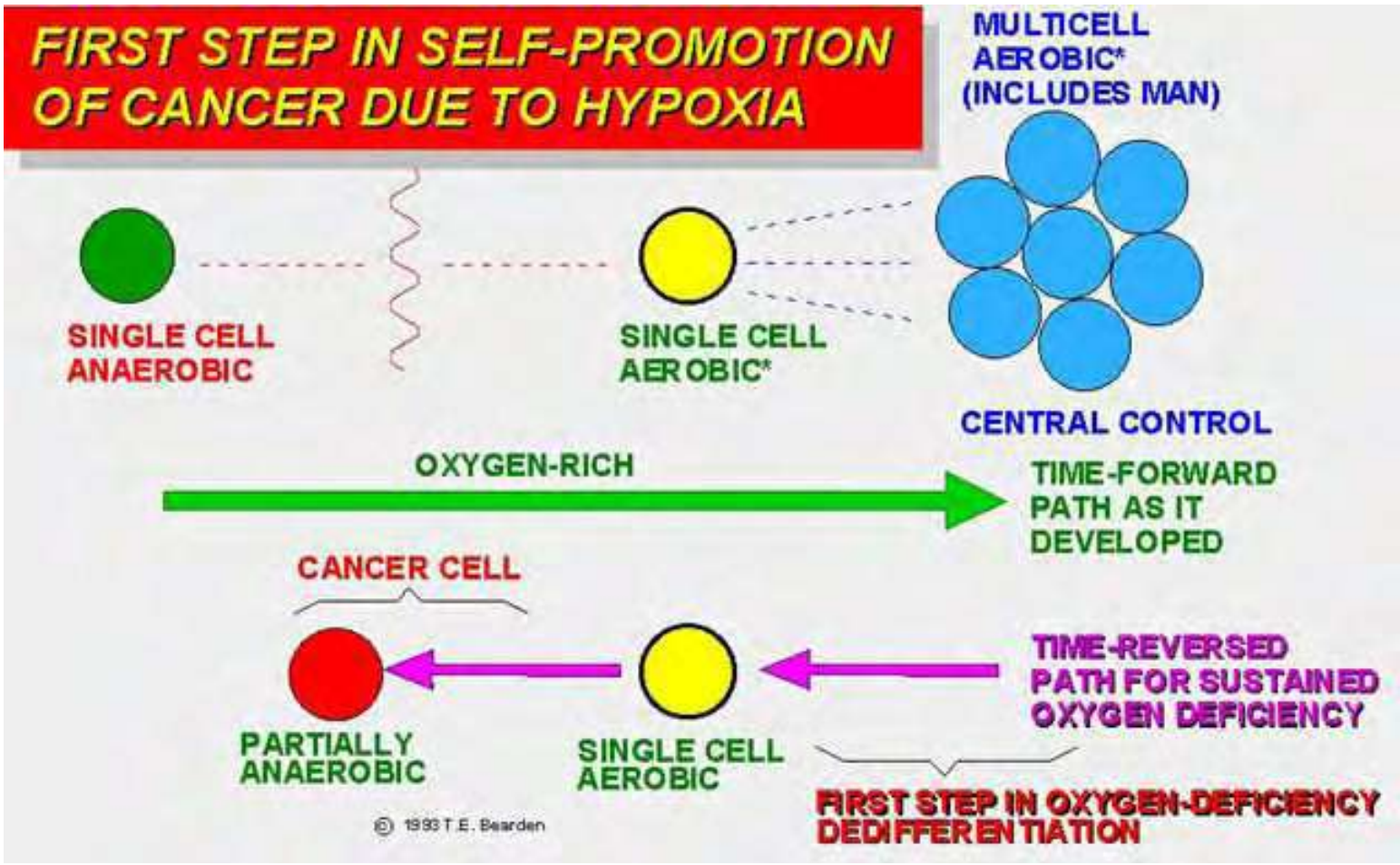
FIRST STEP IN SELF-PROMOTION OF CANCER DUE TO HYPOXIA
MULTICELL AEROBIC* (INCLUDES MAN)
SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC*
CENTRAL CONTROL
OXYGEN-RICH
TIME-FORWARD PATH AS IT DEVELOPED
CANCER CELL
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
PARTIALLY ANAEROBIC
SINGLE CELL AEROBIC
FIRST STEP IN OXYGEN-DEFICIENCY DEDIFFERENTIATION
© 1993 T.E. Bearden

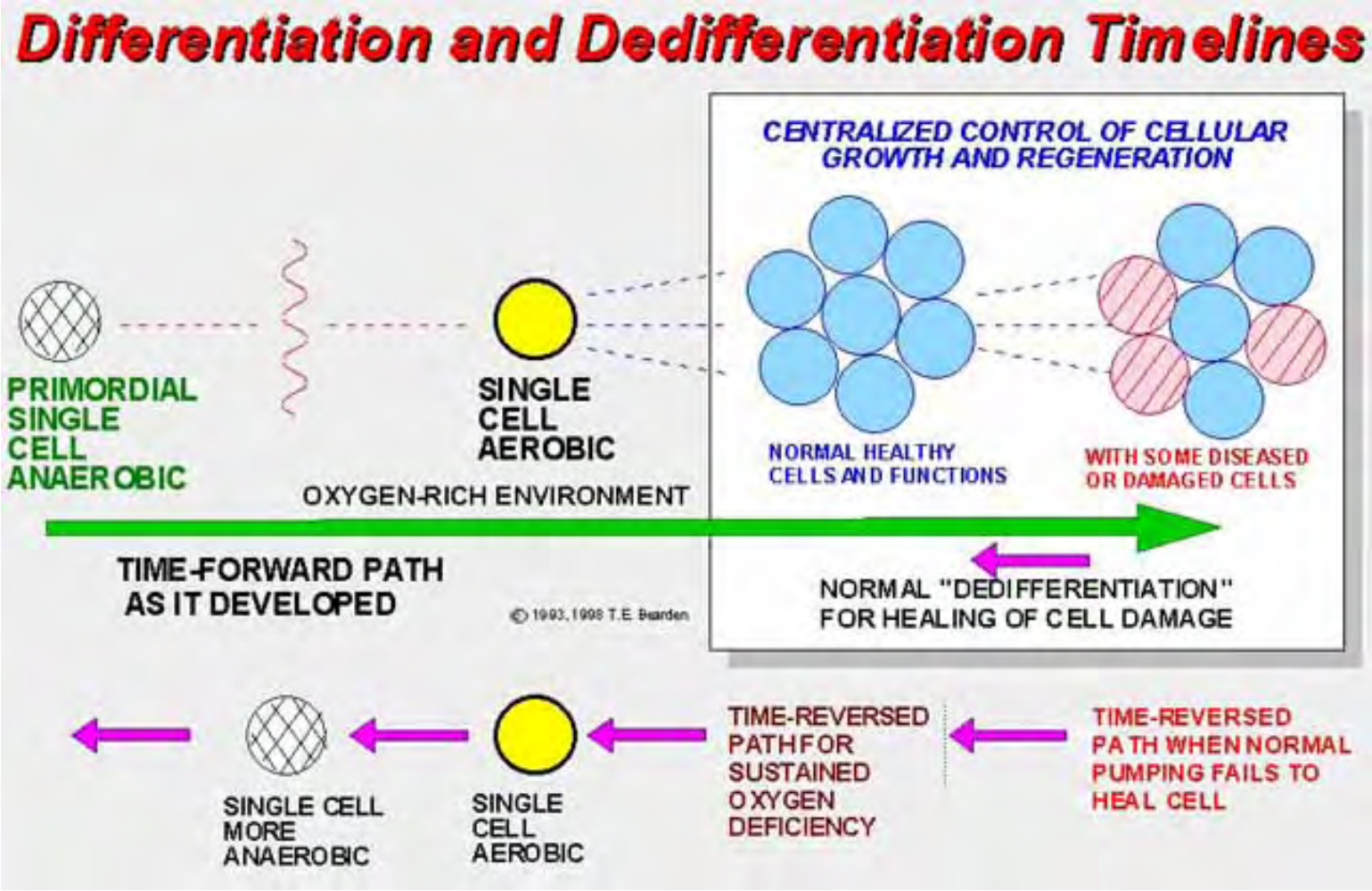
Differentiation and Dedifferentiation Timelines
CENTRALIZED CONTROL OF CELLULAR GROWTH AND REGENERATION
PRIMORDIAL SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC
OXYGEN-RICH ENVIRONMENT
NORMAL HEALTHY CELLS AND FUNCTIONS
WITH SOME DISEASED OR DAMAGED CELLS
TIME-FORWARD PATH AS IT DEVELOPED
© 1993, 1998 T.E. Bearden
NORMAL "DEDIFFERENTIATION" FOR HEALING OF CELL DAMAGE
SINGLE CELL MORE ANAEROBIC
SINGLE CELL AEROBIC
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
TIME-REVERSED PATH WHEN NORMAL PUMPING FAILS TO HEAL CELL

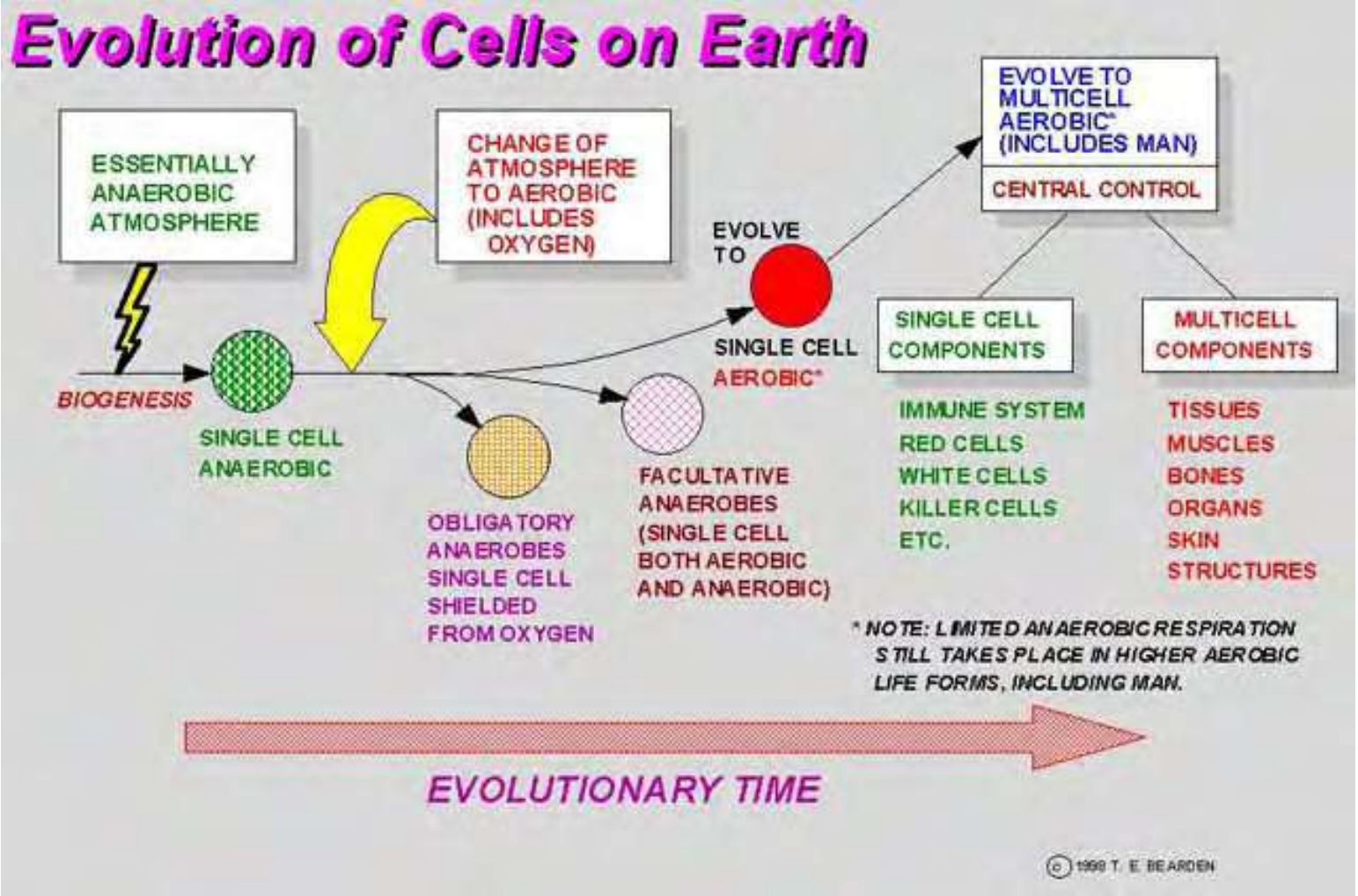
Evolution of Cells on Earth
ESSENTIALLY ANAEROBIC ATMOSPHERE
CHANGE OF ATMOSPHERE TO AEROBIC (INCLUDES OXYGEN)
EVOLVE TO MULTICELL AEROBIC* (INCLUDES MAN)
CENTRAL CONTROL
EVOLVE TO
SINGLE CELL AEROBIC*
SINGLE CELL COMPONENTS
MULTICELL COMPONENTS
BIOGENESIS
SINGLE CELL ANAEROBIC
OBLIGATORY ANAEROBES SINGLE CELL SHIELDED FROM OXYGEN
FACULTATIVE ANAEROBES (SINGLE CELL BOTH AEROBIC AND ANAEROBIC)
IMMUNE SYSTEM
RED CELLS
WHITE CELLS
KILLER CELLS
ETC.
TISSUES
MUSCLES
BONES
ORGANS
SKIN
STRUCTURES
* NOTE: LIMITED ANAEROBIC RESPIRATION STILL TAKES PLACE IN HIGHER AEROBIC LIFE FORMS, INCLUDING MAN.
EVOLUTIONARY TIME
© 1999 T. E. BEARDEN

A Charged Particle q Is a Coupled System of m and ϕ

(A proposed formal definition of a charged mass)

Note: X is a coupling operator

$$q \equiv f_q \times m_q$$

Also note that the ϕ portion of the charged particle can be internally structured, per Stoney-Whittaker-Ziolkowski, with hidden bidirectional EM wavepairs (their sums and products). Note that this constitutes an EM application of Bohm-type hidden variable theory, with many ramifications.

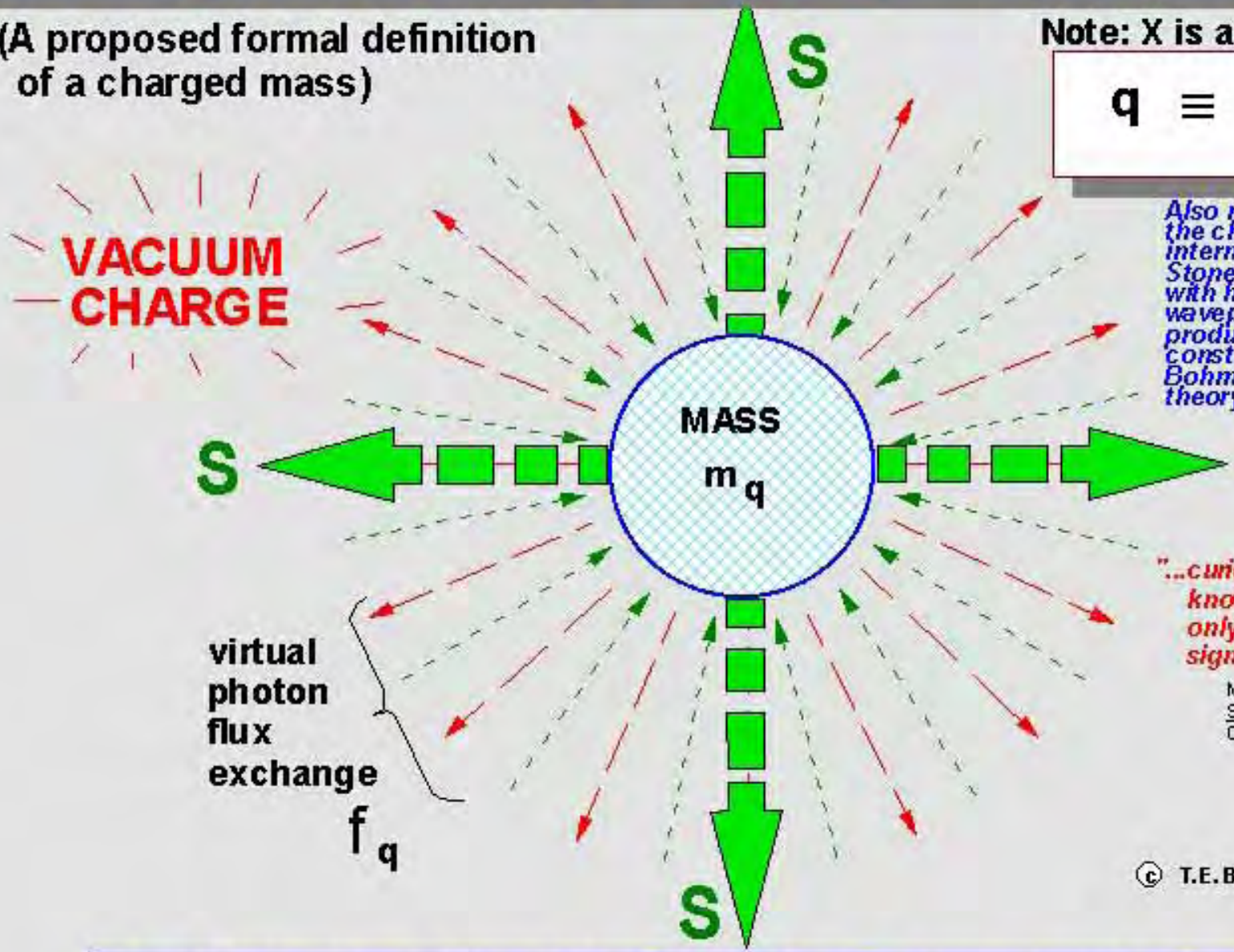

S = EXH

"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

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An electric charge Q consists of a massless flux component and a mass component, coupled together (interacting). Q is a broken symmetry. The mass of the charge continually and violently exchanges virtual photons with the surrounding vacuum.

Thus Q is energetically driven by the surrounding vacuum potential, which itself is to first order just a violent virtual photon flux.

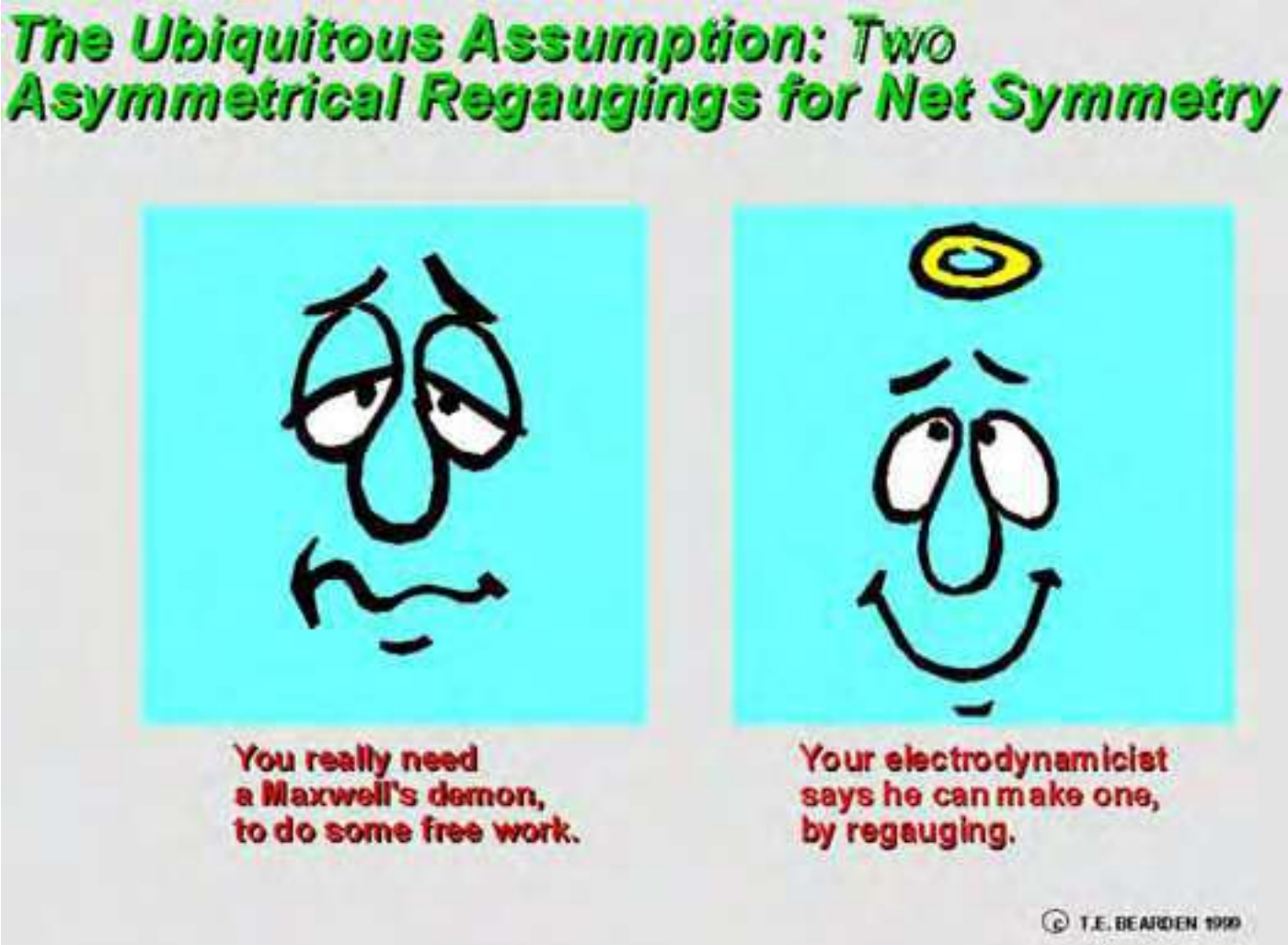
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
You really need a Maxwell's demon, to do some free work.
Your electrodynamicist says he can make one, by regauging.
© T.E. BEARDEN 1999

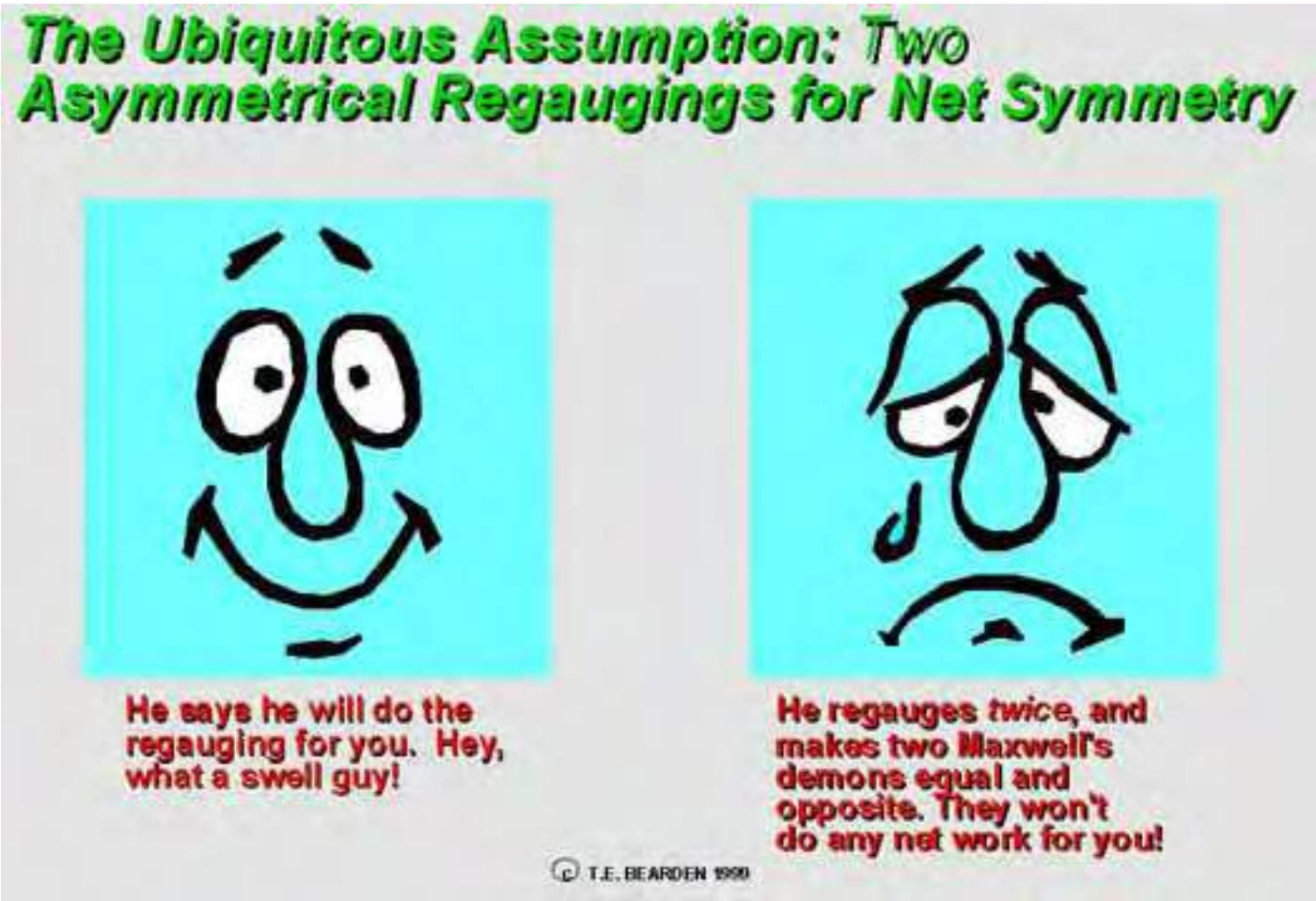
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
He says he will do the regauging for you. Hey, what a swell guy!
He regauges twice, and makes two Maxwell's demons equal and opposite. They won't do any net work for you!
© T.E. BEARDEN 1990

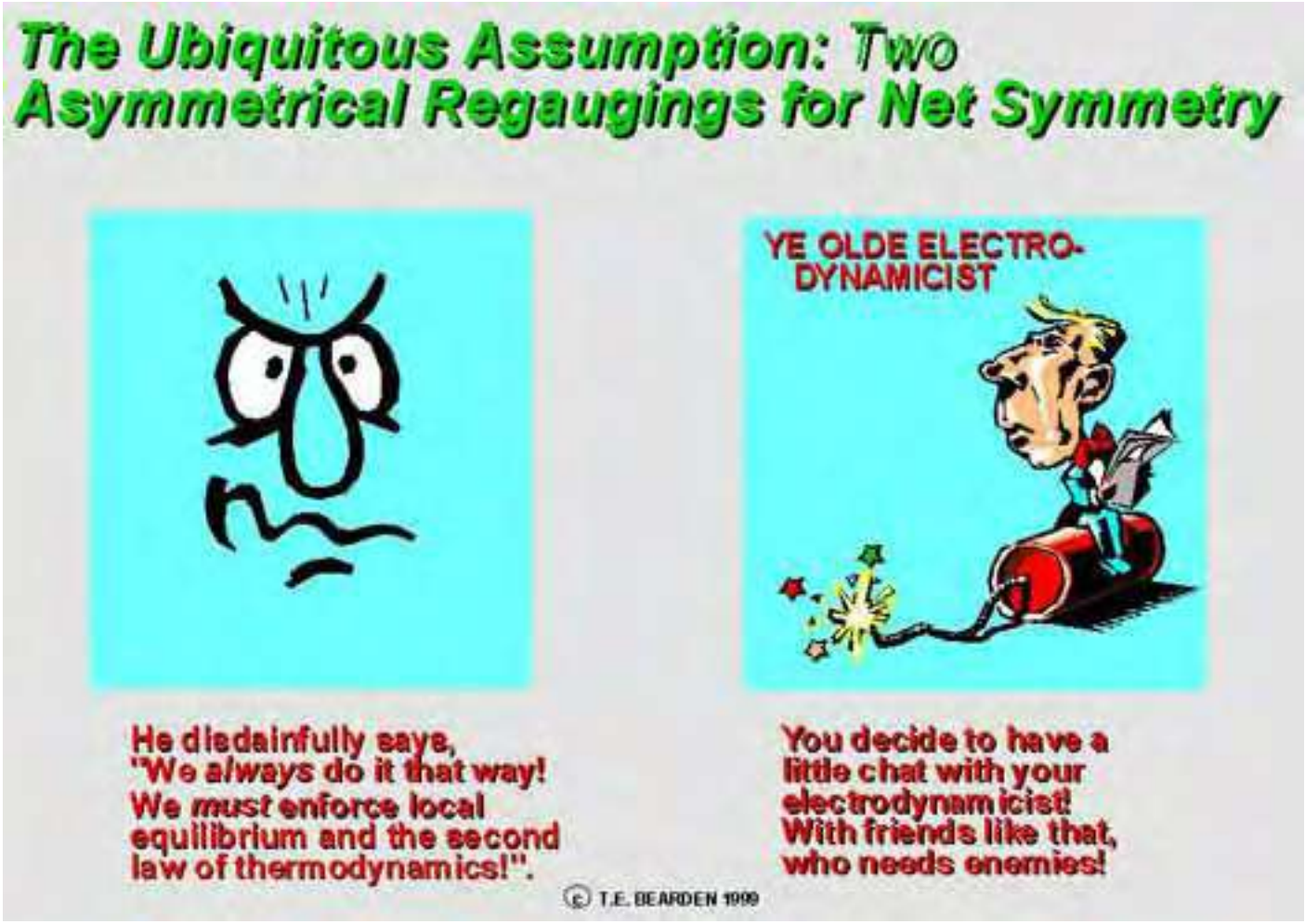
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
YE OLDE ELECTRO-DYNAMICIST
He disdainfully says, "We always do it that way! We must enforce local equilibrium and the second law of thermodynamics!".
You decide to have a little chat with your electrodynamicist! With friends like that, who needs enemies!
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A Charged Particle Is a Coupled System

(The first formal definition of charge)

$$q \equiv \phi_q \times m_q$$

Note: X is a coupling operator

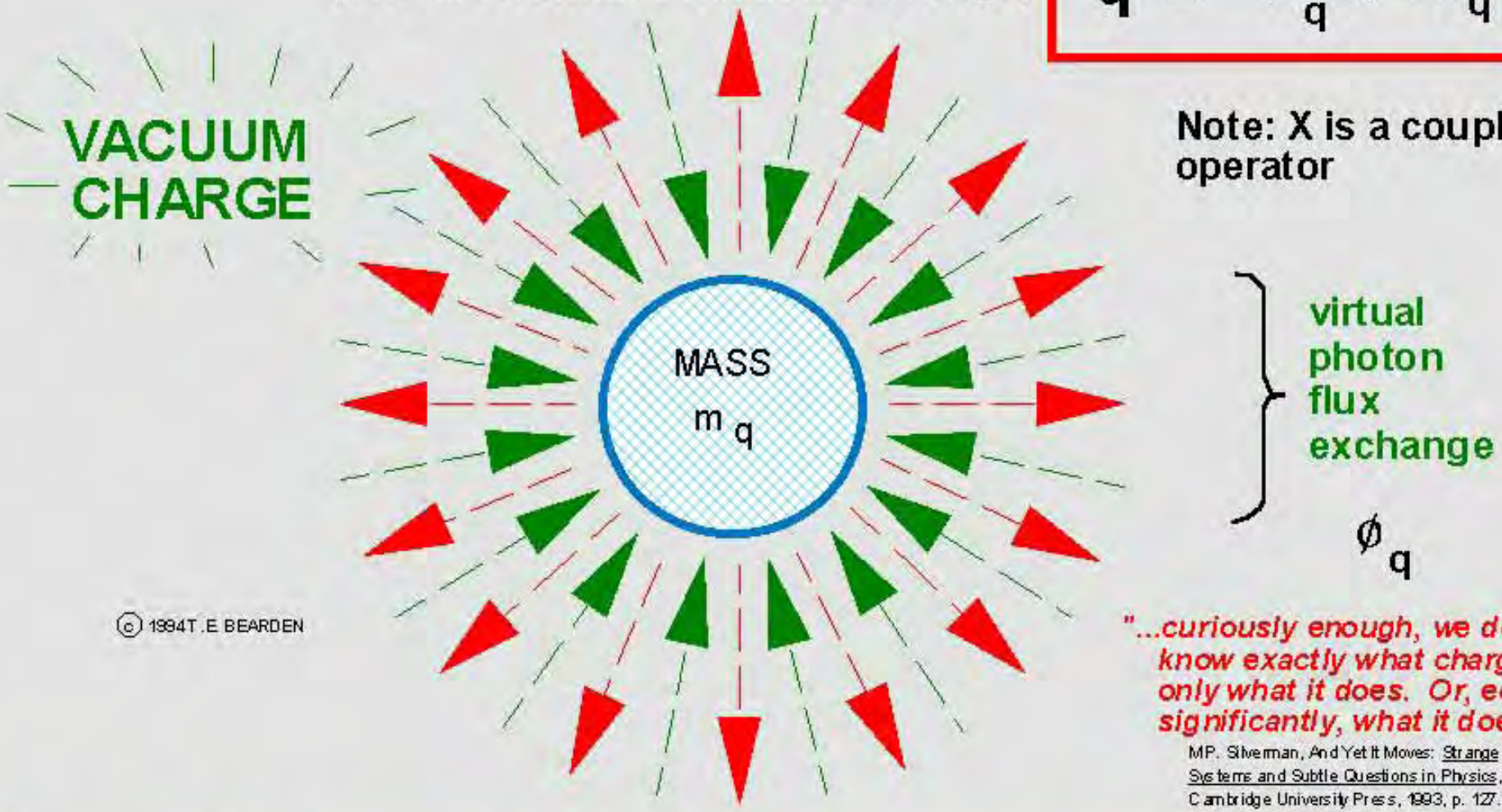

© 1994 T.E BEARDEN

"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

An electric charge q is a broken symmetry in its fierce energy exchange with the active vacuum. It coherently integrates some of the virtual energy absorbs and outputs it as Poynting energy flow.

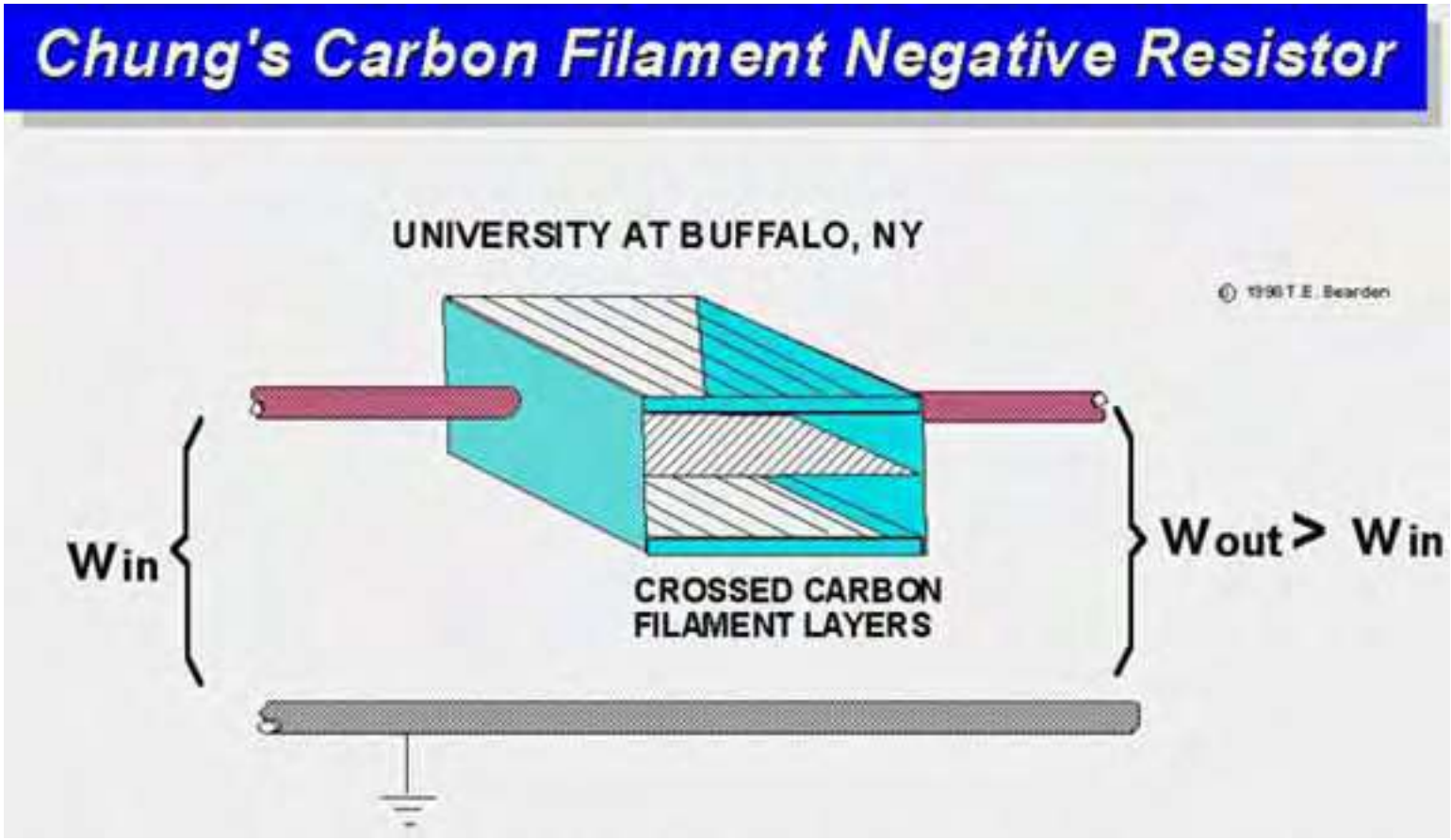
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
© 1996 T.E. Bearden
Win
Wout > Win
CROSSED CARBON
FILAMENT LAYERS

Typical circuit has about 10^{-13} energy collection efficiency

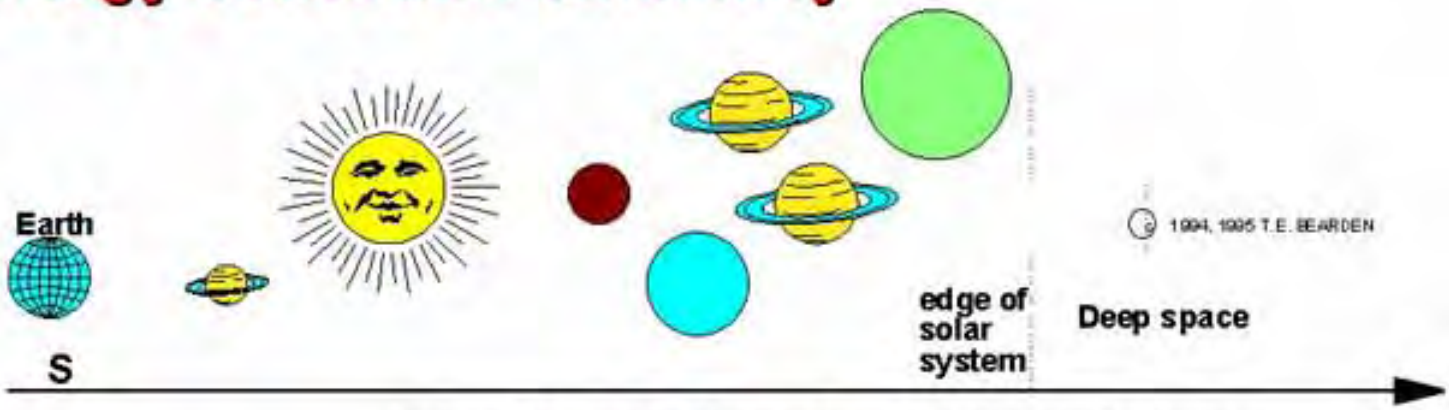

Distance traveled by S in one hour is 1.08x10exp(12) meters.

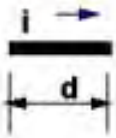

Example: 1.3 amps flowing in DC circuit, 1.8 mm diameter copper wire. J = 51 A/cm ^{2}

d_j = 0.1368 meters

S violently transports ϕ provided from the source.
j ϕ sluggishly transports the energy collected and dissipated in the circuit..

For the case discussed, the electron drift velocity in the circuit is about 3.8 x 10^{-5} meters/sec. So Jϕ moves about 0.1368 meters in one hour. Thus Jϕ has collected about 0.1368 meters of the ϕ-filled S-tube. During that same hour, the S-flow evoked by the power source will have traveled 1.08x10^{12} meters. The ϕ of both currents is the same. Both are involved in the same energy-filled tube. Thus S has provided and transported about 7.89x10^{12} times as much energy along the circuit in one hour as the jϕ has been able to collect, transport, and dissipate as work in the circuit. Thus this circuit provides about 10^{13} collection efficiency.

Classical View of EM

- Potentials just mathematical conveniences
  - Not real
  - No internal structure, just magnitude
- Force fields primary, causative, can exist in space in absence of observable mass
  - All EM actions due to force fields, none when zero
  - No action at a distance
- Vacuum empty; without energy or structure
  - No locally curved spacetime
  - No gravity effects
  - No quantum effects
- Maxwell's equations complete
  - Symmetrically regauged ***arbitrarily***
  - Topology dramatically reduced

Curved Spacetime acts as source or sink

- May emit excess radiation and energy (e.g., heat)
- May absorb radiation and energy (e.g., cool)
- May transduce waves TW ⇔ LW ⇔ TDW
- New energy conservation law applies

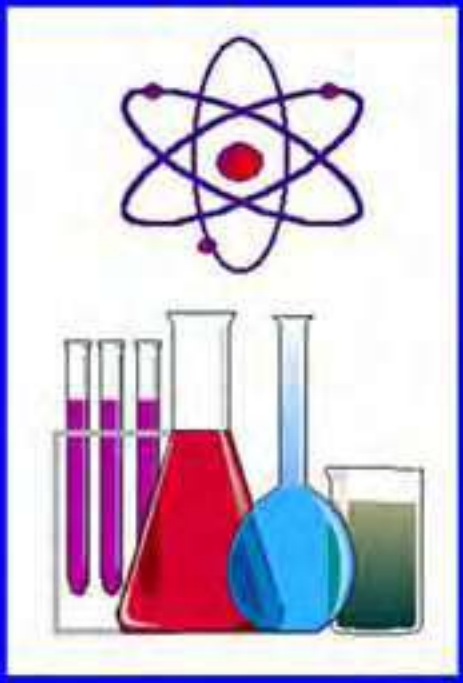

© 1998 T.E. BEARDEN

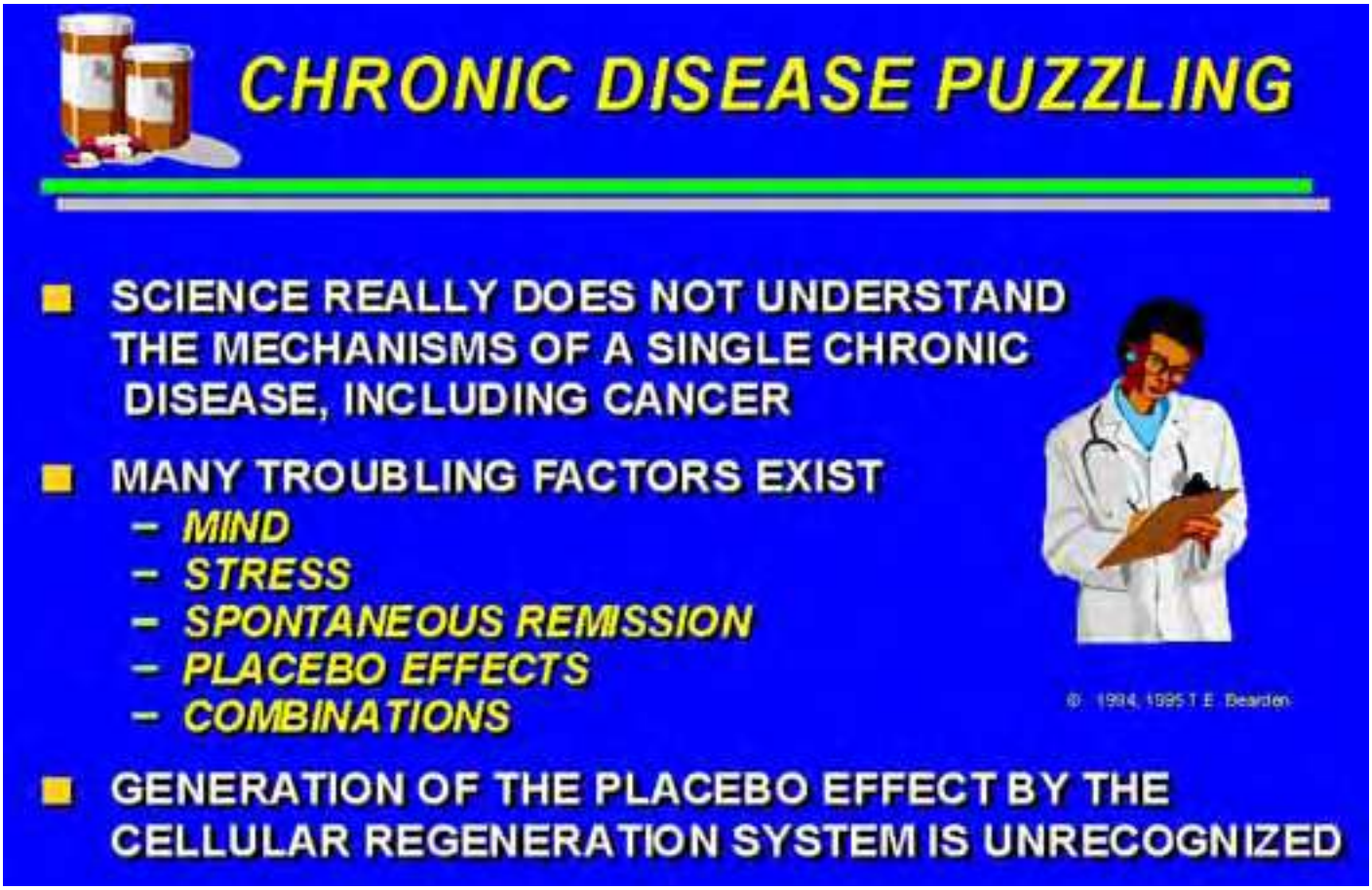
CHRONIC DISEASE PUZZLING
SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
MANY TROUBLING FACTORS EXIST
– MIND
– STRESS
– SPONTANEOUS REMISSION
– PLACEBO EFFECTS
– COMBINATIONS
© 1994, 1995 T.E. Bearden
GENERATION OF THE PLACEBO EFFECT BY THE CELLULAR REGENERATION SYSTEM IS UNRECOGNIZED

Cancer Characteristics

- Not one disease, but a whole range
- Starts in damaged aerobic cell
- Cell shakes off body's central control
  - Starts uncontrolled division
  - Becomes a lump
- Can send forth cancer cells
  - Through blood
  - Through lymph
- Form metastases (secondary tumors)
- Often become anaerobic

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Solving a Cancer Enigma

- An enigma has been failure of immune system to attack some tumor cells
  - Suppressor cells may curb immune system?
  - Tumor may lack antigens normally identified by the immune system?
- *Promotion of damaged cell to cancer is usually ordered by cellular control system*
  - *Regenerative and recovery system forces cell back toward anaerobe*
  - *First step breaks free from central growth*
  - *Control continues to recognize cell as self*

CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

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*R&R system forces cell back toward anaerobe

Nonlinear Optics
Distortion Correction Theorem

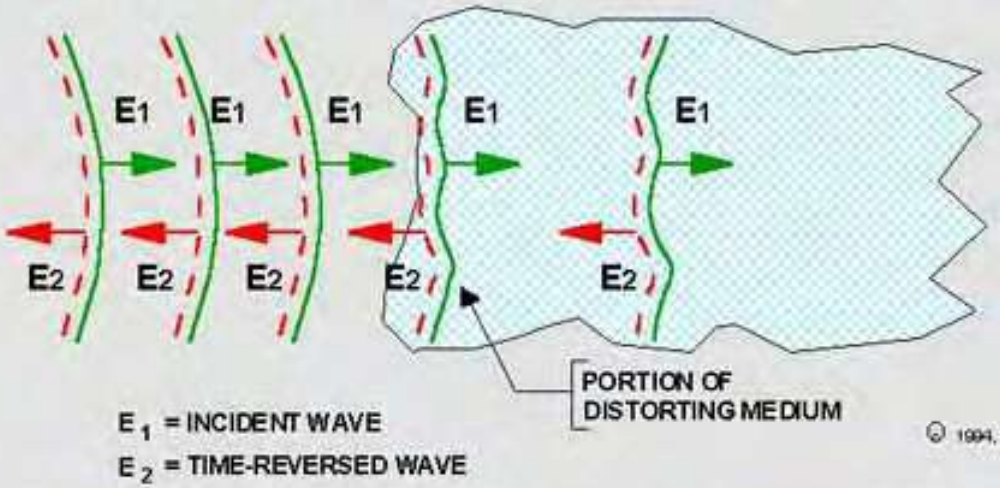

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"If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)

- Nucleon interchange
  - Changes neutron into proton and vice versa
  - At high rate (flat spacetime assumed)
- Statistics become skewed due to curved ST
- Can bias statistics toward either neutron or proton end
  - Biases toward transmutation of elements along isomer chains
  - Concept of "isomer" is vastly expanded

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)

- Normal dynamics (impulses) may reverse
  - Like charges attract, unlike charges repel
  - Positive charges cluster (are drawn together)
  - H+ ions (protons) may form quasi-nuclei
  - Nucleus coulomb barrier becomes assistant
- Many "impossible" reactions now possible
  - Quark access and quark flipping by EM
  - Ion clustering
  - Positive charges as phase conjugate mirrors
  - Time-density waves and time-energy charging

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The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)

- Not observed until time-energy charging has become substantial
  - Time delay (hours, days)
  - Transduction of LW --> TW involved
  - Specific time-charging history of detectors is involved in twhether they detect or not
  - Longitudinal EM waves become significant
- Curved spacetime can act as source or sink
  - May emit excess radiation
  - May absorb excess radiation

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In Time-Reversed Zone: Nuclear reactions are biased

- In normal flat ST, n ⇔ p at high rate
- Curved ST skews statistics
- Biases to either n or p
- Biases to transmutation along isomer chain
- "Isomer" concept greatly expanded

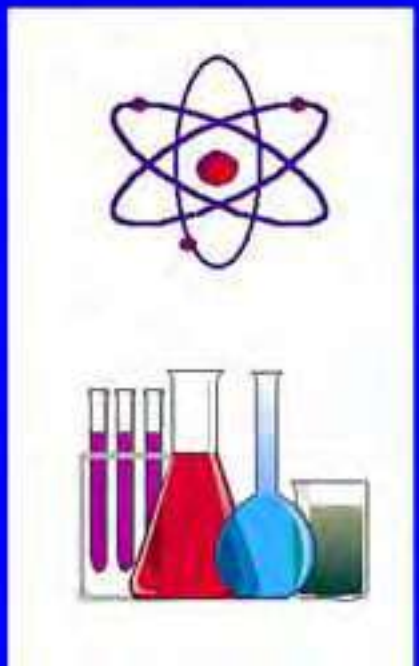

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In Time-Reversed Zone: Dynamics may be reversed

- Like charges may attract and unlike charges repel
- Coulomb barrier becomes Coulomb assistant
- Clusters like charges and forms artificial nuclei
- "Impossible" nuclear reactions at low energy
- Time-density interactions

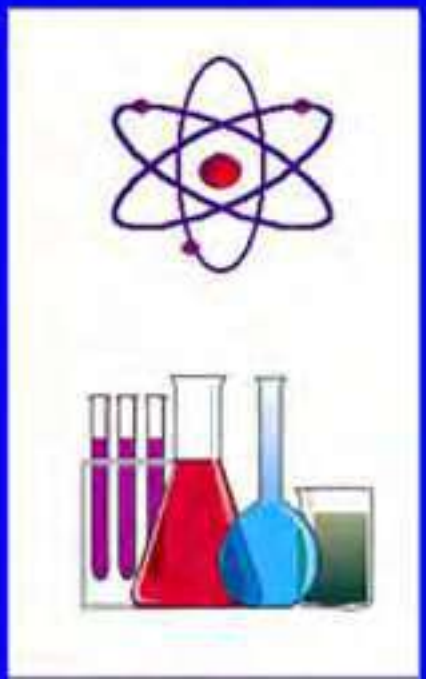

Time-Reversed Zone:

Significant only after time-density charging

- Hours, for "fast" onset
- Days, for "slower" onset
- Transduction involved for TW ⇔ LW ⇔ TDW
- Time-history of each detector is significant
- Longitudinal EM waves become significant

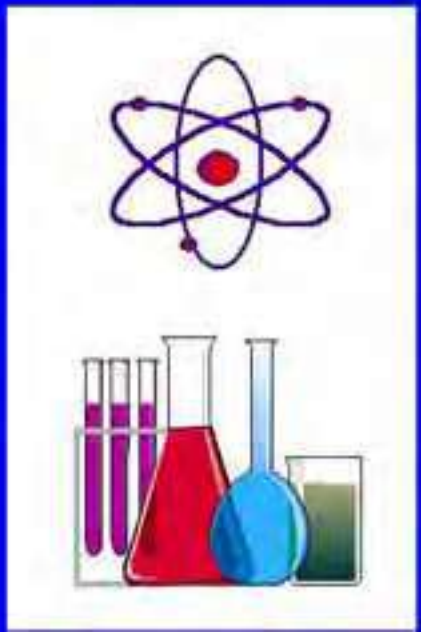

A New Conservation of Energy Law

- Physics conserves total "energy and mass-energy"
- Now also must consider "time-energy"
- Conserve total mass-time-energy (spatiotemporal energy)
- Let E_T = total energy, E_M = mass energy, E_E = ordinary energy, and E_t = time energy. Then

$$E_T = E_E + E_M + E_t$$

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$$(kE_t \Rightarrow E_E > 0) \Rightarrow E_T > (E_M + E_E)$$

- If some E_t is transduced into E_E, the experiment will violate the old spatial mass-energy conservation law

QUESTIONS ON CARCINOGENS AND EM RADIATION

- UNRESOLVED QUESTIONS ON EM RADIATION
  - DOSAGES
  - ACTIVE MECHANISMS
  - REPLICATION DIFFICULTIES
  - MEASUREMENT DIFFICULTIES
  - WHERE, WHEN, HOW ILL EFFECTS OCCUR
- SIMILAR QUESTIONS EXIST ABOUT EVERY CARCINOGEN
- SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
  - FACTORS SUCH AS MIND, STRESS, SPONTANEOUS REMISSION, PLACEBO EFFECTS, AND COMBINATIONS OF FACTORS ARE PARTICULARLY TROUBLESOME
  - GENERATION OF THE PLACEBO EFFECT BY THE REGENERATION & RECOVERY SYSTEM IS UNRECOGNIZED

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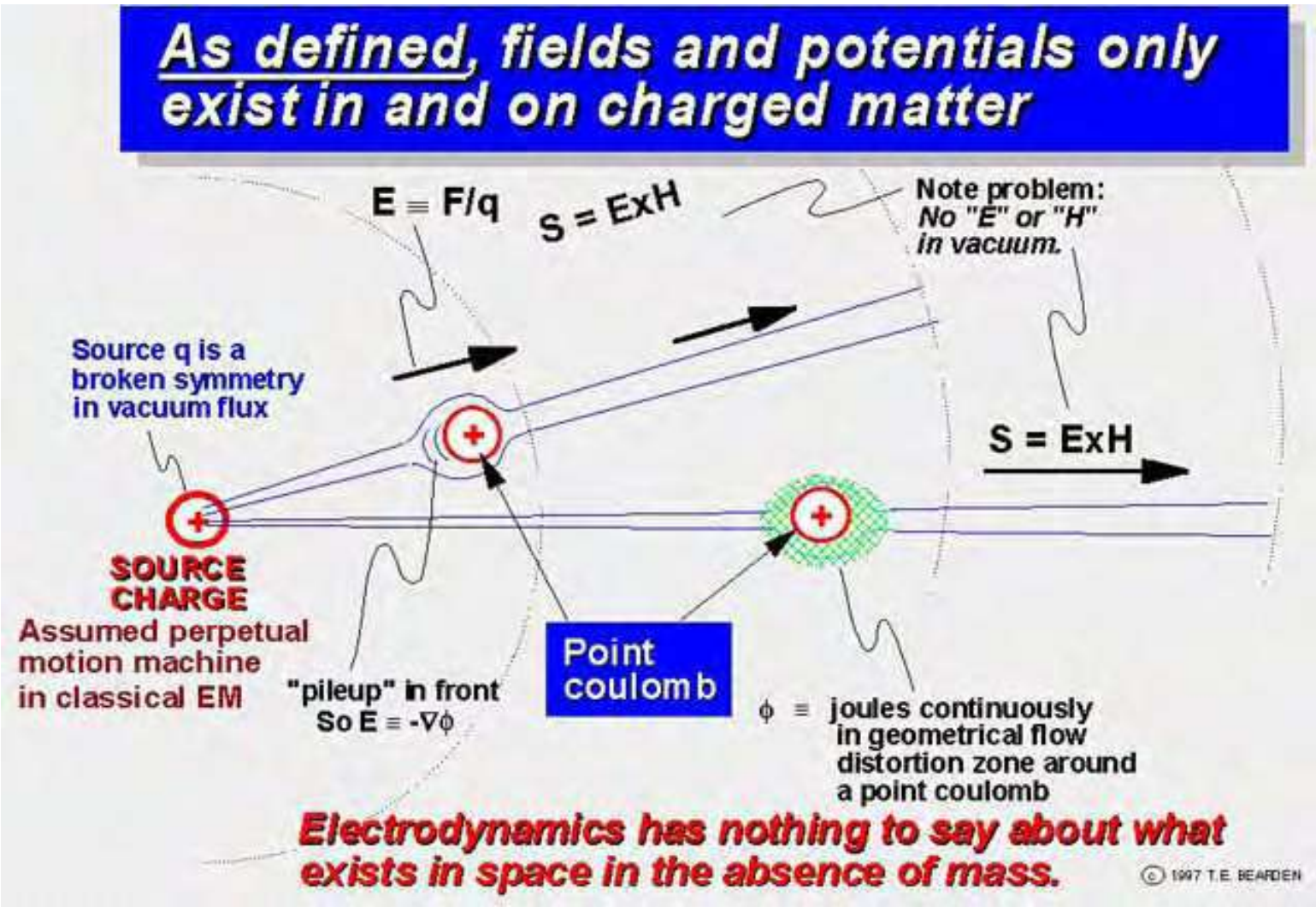
As defined, fields and potentials only exist in and on charged matter
E ≡ F/q
S = ExH
Note problem:
No "E" or "H"
in vacuum.
Source q is a
broken symmetry
in vacuum flux
S = ExH
SOURCE
CHARGE
Assumed perpetual
motion machine
in classical EM
"pileup" in front
So E ≡ -∇ϕ
Point
coulomb
ϕ ≡ joules continuously
in geometrical flow
distortion zone around
a point coulomb
Electrodynamics has nothing to say about what
exists in space in the absence of mass.
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Serious flaws and errors in classical EM theory.

1. Eliminates the Internal EM Inside the Scalar Potential.
2. No Definition of Electrical Charge or of Scalar Potential.
3. Equations Still Assume Material Ether Per Maxwell (Unchanged).
4. Use of Force Fields in Vacuum is False (and Known to be So).
5. Treats Charge q as Unitary Instead of Coupled System $q = \phi[q]m(q)$.
6. Confuses Massless Potential Gradients as Forces (See #3, #4).
7. Does Not Utilize Mass as a Component of Force (See #23).

8. Erroneously Assumes EM Force Fields as Primary Causes.
9. Topology of EM Model Has Been Substantially Reduced.
10. Does Not Include Quantum Potential or Action at a Distance.
11. Does Not Include Superluminal Velocity of Inner EM Components.
12. Does Not Utilize Extended Near-Field Coulomb Gauge Effects.
13. Does Not Include EM Generatrix Mechanism for Time Flow.
14. Does Not Unify Photon and Wave Aspects (Requires 7-D Model).

15. Does Not Include Electron Spin and Precession (See #19, #24).
16. Treats EM Energy As Existing In "Chunks," Instead of as Flow.
17. Confuses Energy and Energy Collection (See #16).
18. Discards Half of Every EM Wave in Vacuum (See #22).
19. Erroneously Uses Transverse Vacuum Wave; It's Longitudinal.
20. Arbitrarily Regauges Maxwell's Equations to Eliminate Overunity.
21. Omits Phase Conjugate Optics Effects (The *Rule* in Internal EM).
22. Does Not Include EM Cause of Newtonian Reaction Force.
23. Erroneously Assumes Separate Force Acting on Separate Mass.
24. Confuses Detected Electron Precession Waves as Proving Transverse EM Waves in Vacuum (Remnant of Old "EM Fluid" Concept).
25. Due to Error in String Wave, Omits the Ubiquitous Antiwave.
26. *Assumes* Equilibrium; Not True Unless Include Vacuum Interactions.
27. Higher Topology Required, to Model Electromagnetic Reality.
28. Lorentz surface integration discards Poynting energy transport.
29. Has nothing at all to say about form of EM entities in massless space.
30. Eliminates the infolded general relativity using EM-force as curve agent.
31. Does not include longitudinal EM waves as time domain oscillations.
32. Does not include EM mechanism that generates time flow and flow rate.

© T.E. [illegible] 1991, 1997

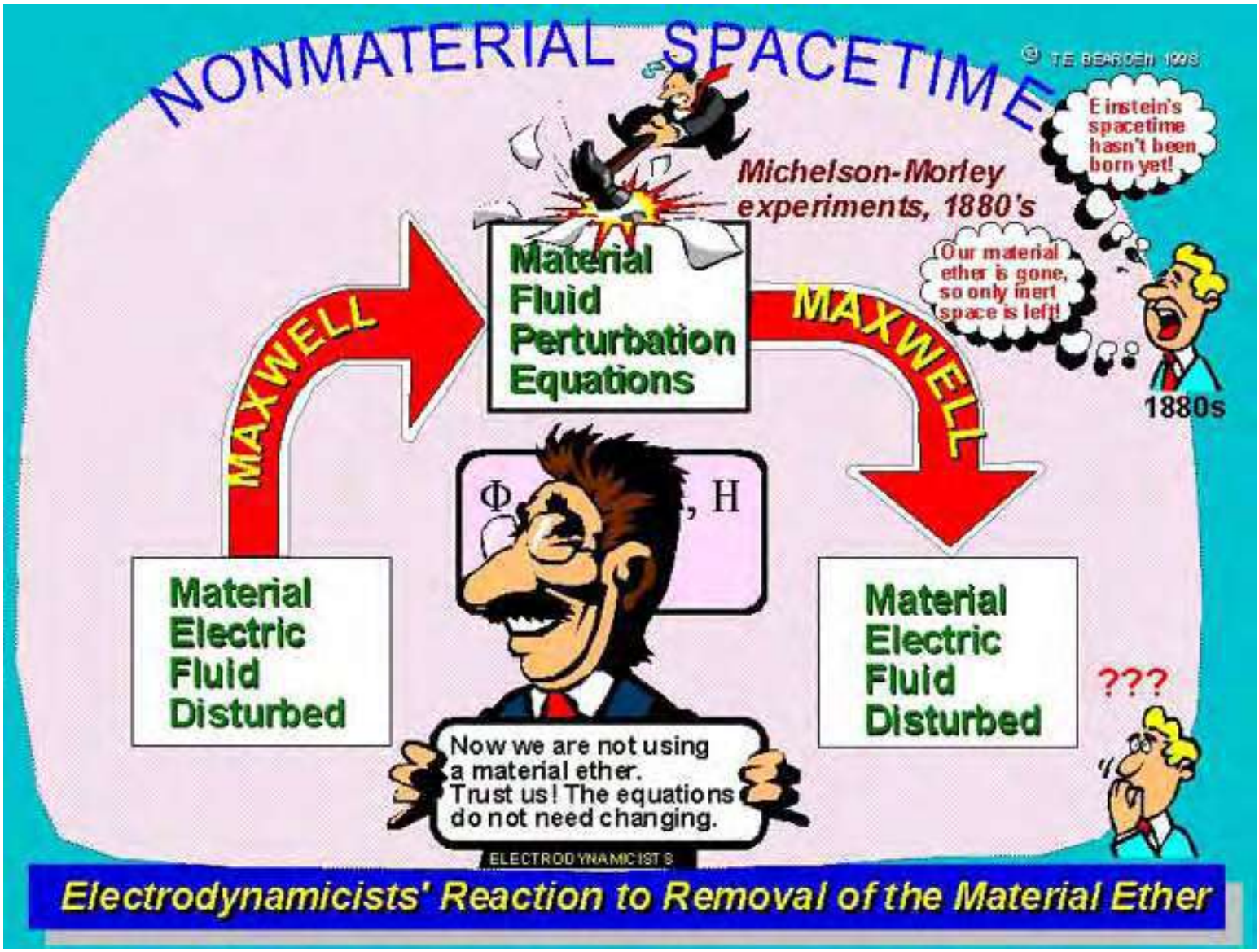
NONMATERIAL SPACETIME
© T.E. BEARDEN 1998
Michelson-Morley experiments, 1880's
Einstein's spacetime hasn't been born yet!
Our material ether is gone, so only inert space is left!
1880s
MAXWELL
Material Fluid Perturbation Equations
MAXWELL
Φ
, H
Material Electric Fluid Disturbed
Material Electric Fluid Disturbed
???
Now we are not using a material ether. Trust us! The equations do not need changing.
ELECTRODYNAMICISTS
Electrodynamicists' Reaction to Removal of the Material Ether

REACTION TO LOSS OF MATERIAL ETHER
Material Ether Assumed in Equations
Potentials, Fields, and Waves Assumed Material
Not a single equation was changed!
Now we are not using a material ether. Trust us! The equations do not need changing.
© T.E. BEARDEN 1999
ELECTRODYNAMICISTS

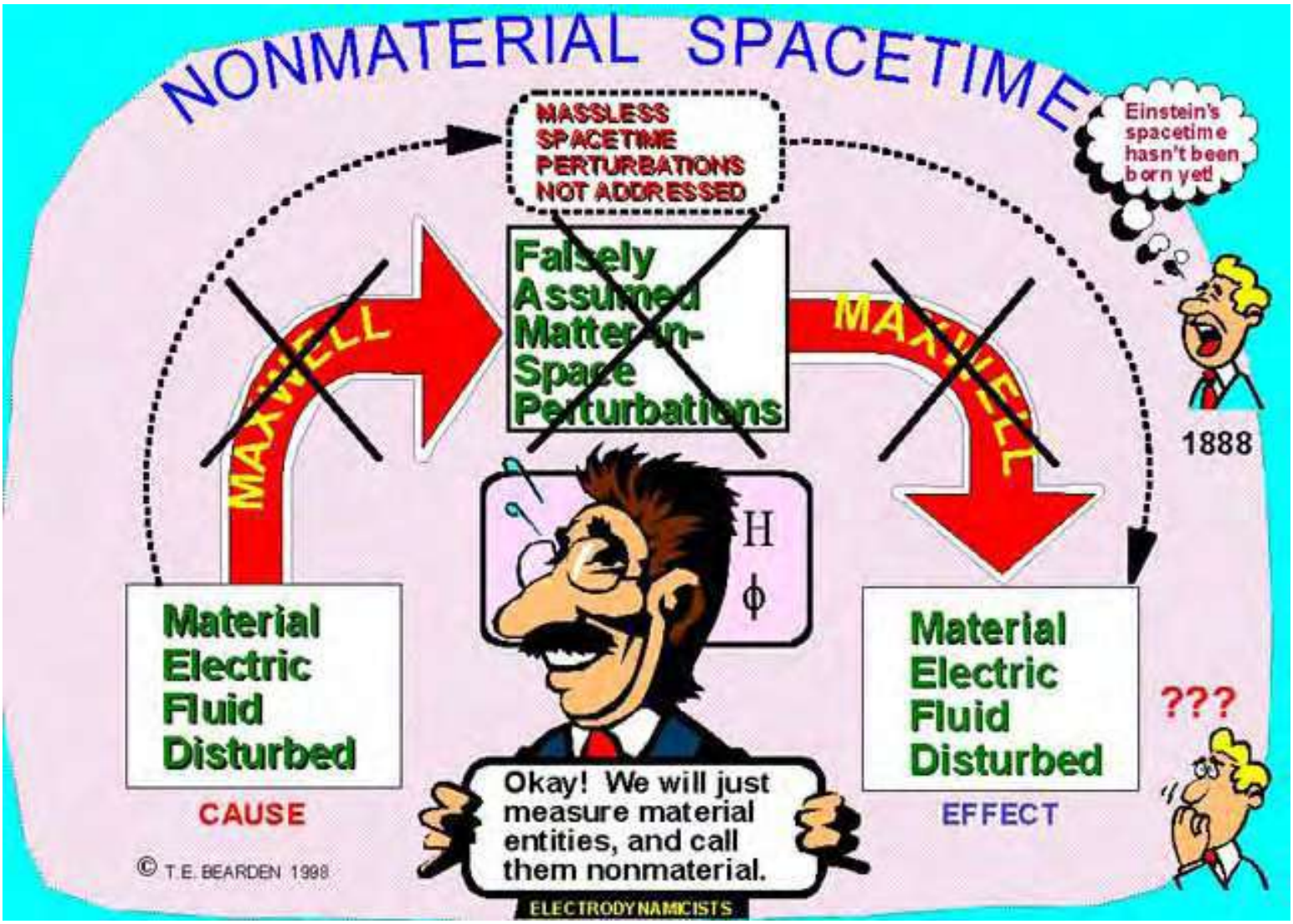
NONMATERIAL SPACETIME
MASSLESS SPACETIME PERTURBATIONS NOT ADDRESSED
Einstein's spacetime hasn't been born yet!
Falsely Assumed Matter-in-Space Perturbations
MAXWELL
MAXWELL
1888
H
ϕ
Material Electric Fluid Disturbed
CAUSE
Material Electric Fluid Disturbed
EFFECT
???
Okay! We will just measure material entities, and call them nonmaterial.
© T.E. BEARDEN 1998
ELECTRODYNAMICISTS

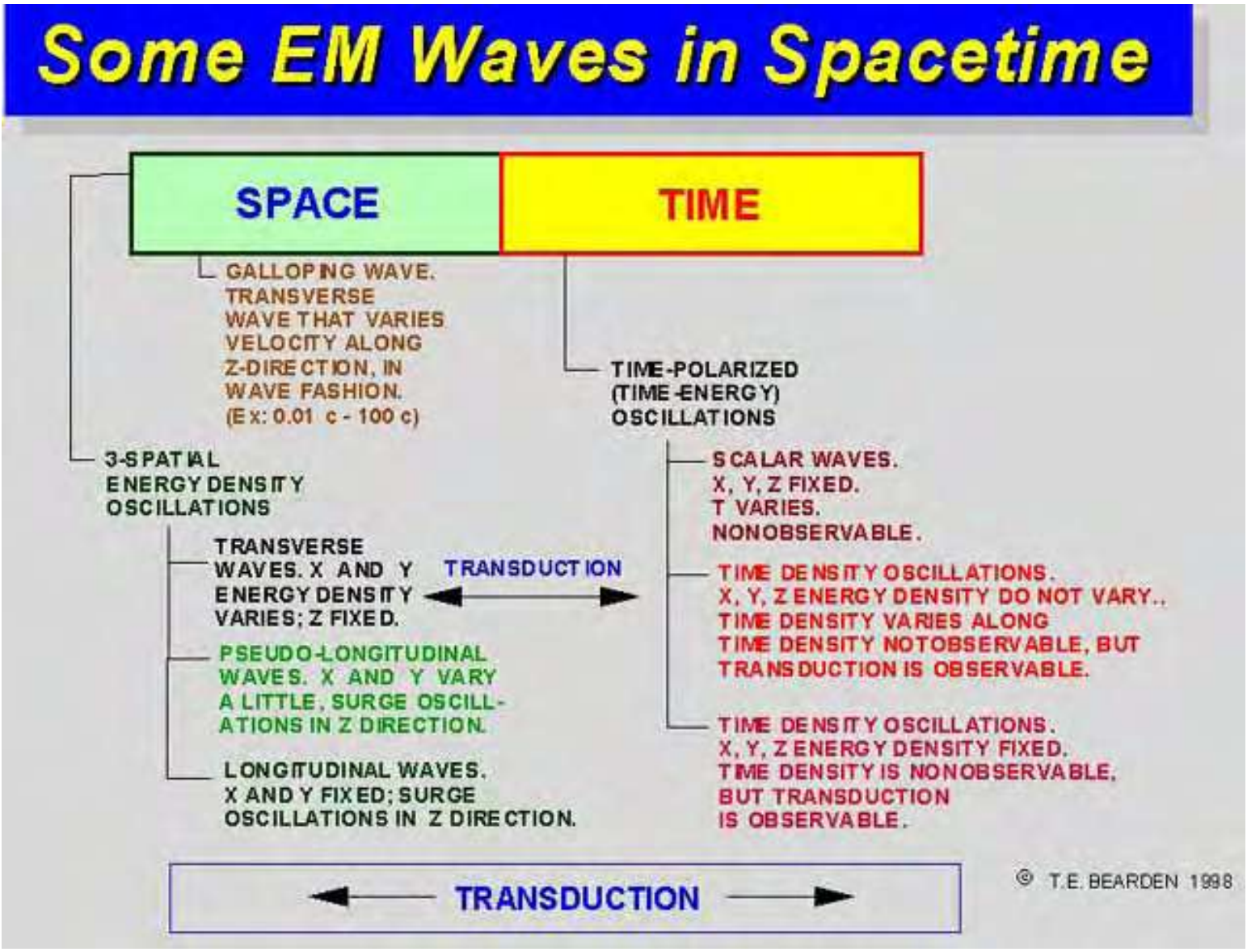
Some EM Waves in Spacetime
SPACE
TIME
GALLOPING WAVE. TRANSVERSE WAVE THAT VARIES VELOCITY ALONG Z-DIRECTION, IN WAVE FASHION. (Ex: 0.01 c - 100 c)
TIME-POLARIZED (TIME-ENERGY) OSCILLATIONS
3-SPATIAL ENERGY DENSITY OSCILLATIONS
SCALAR WAVES. X, Y, Z FIXED. T VARIES. NONOBSERVABLE.
TRANSVERSE WAVES. X AND Y ENERGY DENSITY VARIES; Z FIXED.
TRANSDUCTION
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY DO NOT VARY.. TIME DENSITY VARIES ALONG TIME DENSITY NOTOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
PSEUDO-LONGITUDINAL WAVES. X AND Y VARY A LITTLE, SURGE OSCILLATIONS IN Z DIRECTION.
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY FIXED. TIME DENSITY IS NONOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
LONGITUDINAL WAVES. X AND Y FIXED; SURGE OSCILLATIONS IN Z DIRECTION.
TRANSDUCTION
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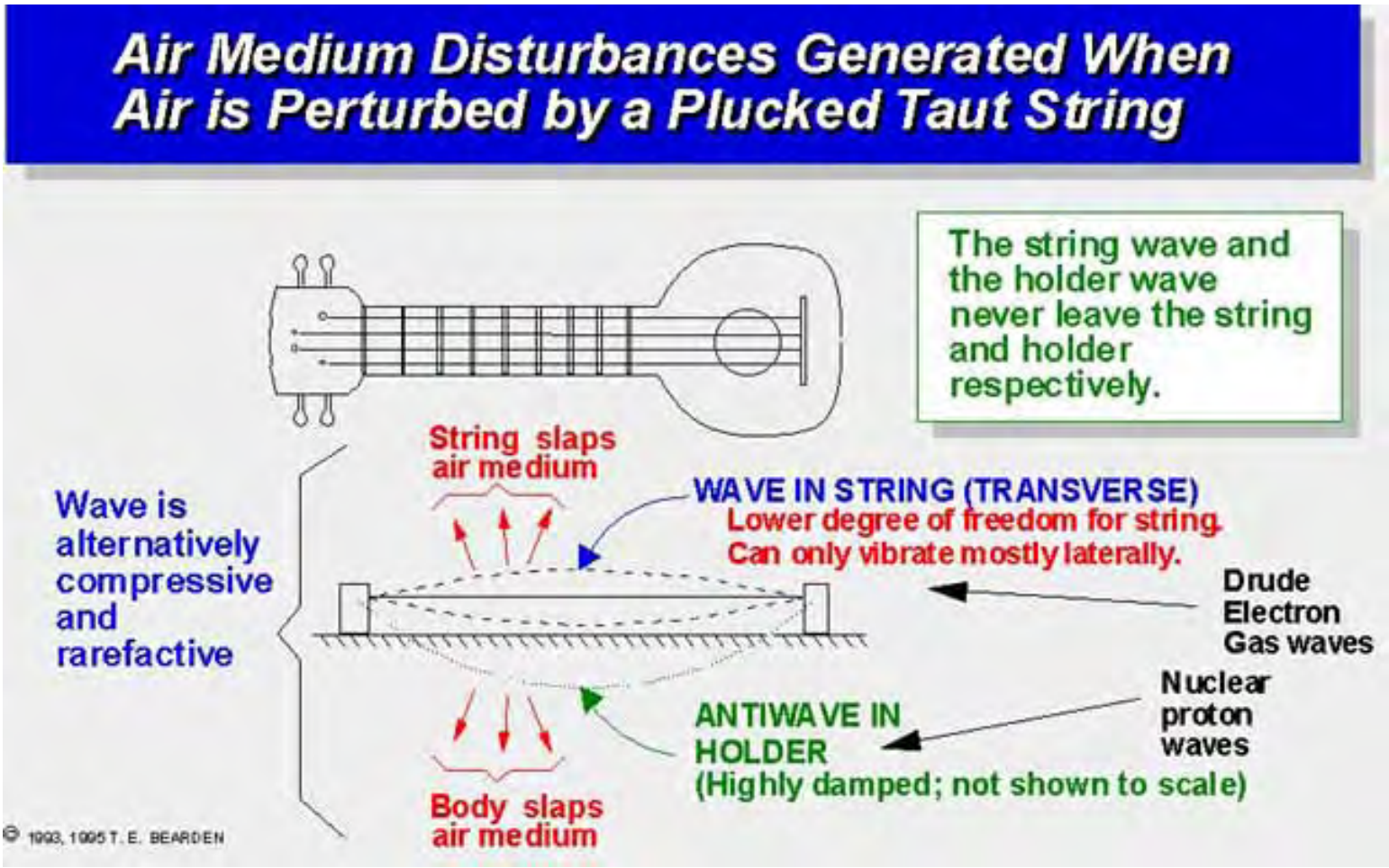
Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
The string wave and the holder wave never leave the string and holder respectively.
String slaps air medium
Wave is alternatively compressive and rarefactive
WAVE IN STRING (TRANSVERSE)
Lower degree of freedom for string.
Can only vibrate mostly laterally.
Drude Electron Gas waves
Nuclear proton waves
ANTIWAVE IN HOLDER
(Highly damped; not shown to scale)
Body slaps air medium
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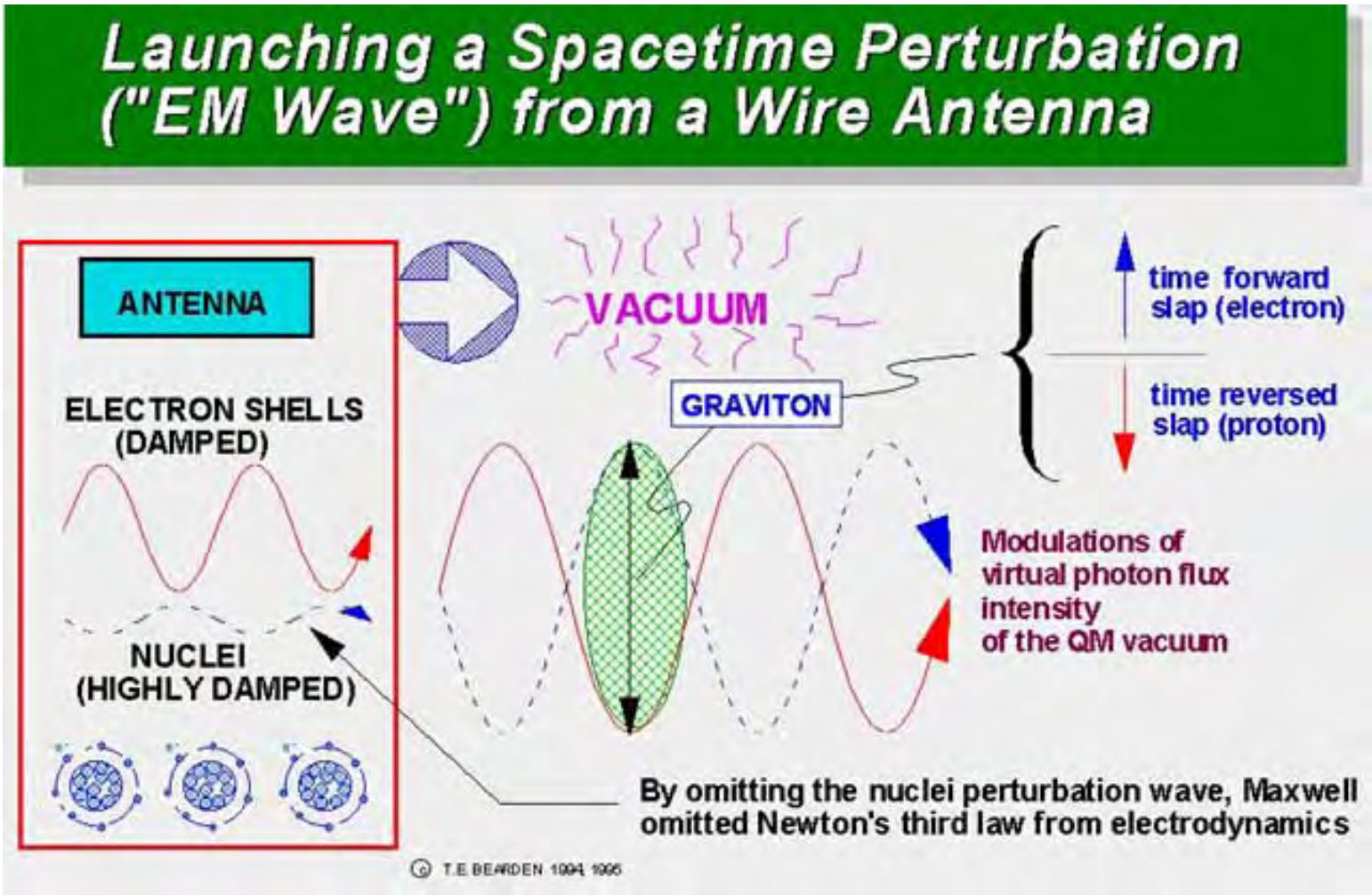
Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
ANTENNA
ELECTRON SHELLS (DAMPED)
NUCLEI (HIGHLY DAMPED)
VACUUM
GRAVITON
time forward slap (electron)
time reversed slap (proton)
Modulations of virtual photon flux intensity of the QM vacuum
By omitting the nuclei perturbation wave, Maxwell omitted Newton's third law from electrodynamics
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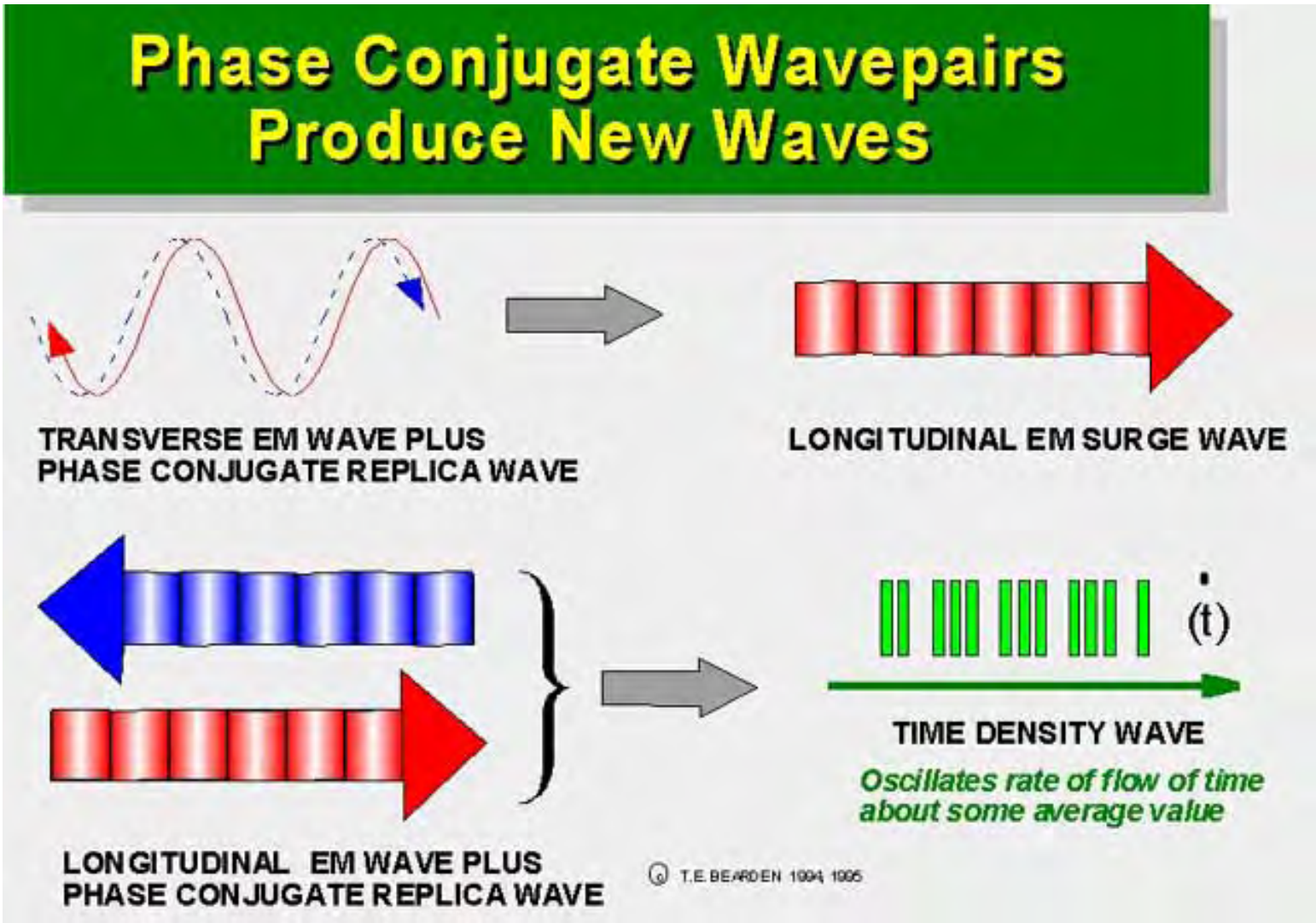
Phase Conjugate Wavepairs
Produce New Waves
TRANSVERSE EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
LONGITUDINAL EM SURGE WAVE
LONGITUDINAL EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
(t)
TIME DENSITY WAVE
Oscillates rate of flow of time
about some average value
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Scalar Electromagnetics (Energetics) View of EM

- Potentials real; primary causes of EM phenomena
  - Force fields made by differentiations of potentials
  - Force fields are effects, not primary causes
  - Force fields exist only in, on mass particles
- Actions due to potentials and their interference
  - Action at a distance or locally
  - Quantum potential and hidden variables
- Locally curved spacetime, engineerable by EM
  - Gravity effects not necessarily negligible
  - Strong EM force or time used as agent of curvature

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Potentials have internal structure
  - Stoney/Whittaker structure
  - Longitudinal EM phase conjugate wavepairs
  - Each wavepair is a time-polarized EM wave
- Vacuum EM is a potential and has microstructure
  - Stoney-Whittaker biwaves/t-polarized waves
  - Fluctuations exhibit chaos
- Spacetime ≡ Vacuum ≡ Potential ≡ Flux

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Statistics may have hidden order (already chaotic)
- Uses spacetime curvature engines to alter matter (inside-out or outside-in)
- Engineerable EM mechanism generates rate of flow of a mass through time
- Quantum potential with specific QP can be used for instant action at a distance

Extended General Relativity Principle

- "All levels of energy structures and all levels of time structures mold spacetime geometry.
- This is called a *vacuum engine* (spacetime engine).
- Spatial and temporal structuring act upon mass at all levels.
- This produces *templates* of forces, for translations and stresses."

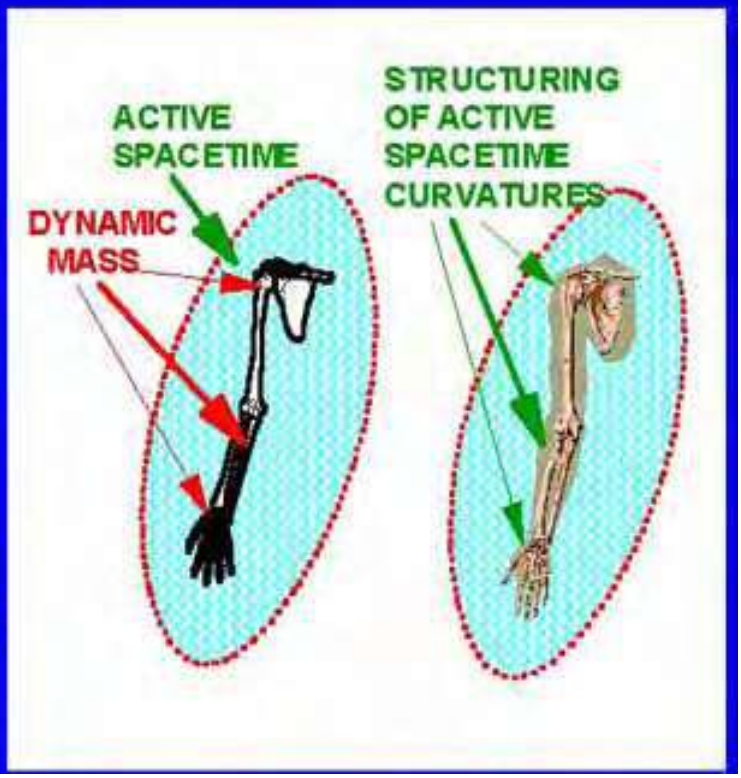

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Extension of Work-Energy Theorem

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- *Theorem:* $W = k_f - k_i = \Delta k$ [1]
- k must be interpreted not as energy *per se*, but as *collected/collecting* energy.
- The reaction cross section λ for the collecting process must be included.
- *Extension:* $W = \lambda (k_f - k_i) = \lambda \Delta k$ [2]
- Normally $\lambda \leq 1$, as for elastic collision or Stokes emission.
- However, $\lambda > 1$ is now possible, for processes which asymmetrically self-regauge. An example is Letokhov's negative absorption of the medium.
- Working models are the Patterson Power Cell® and Lawandy lasing without population inversion.

MTW's General Relativity Principle

- "Space acts on matter, telling it how to move.
- In turn, matter reacts back on space, telling it how to curve."

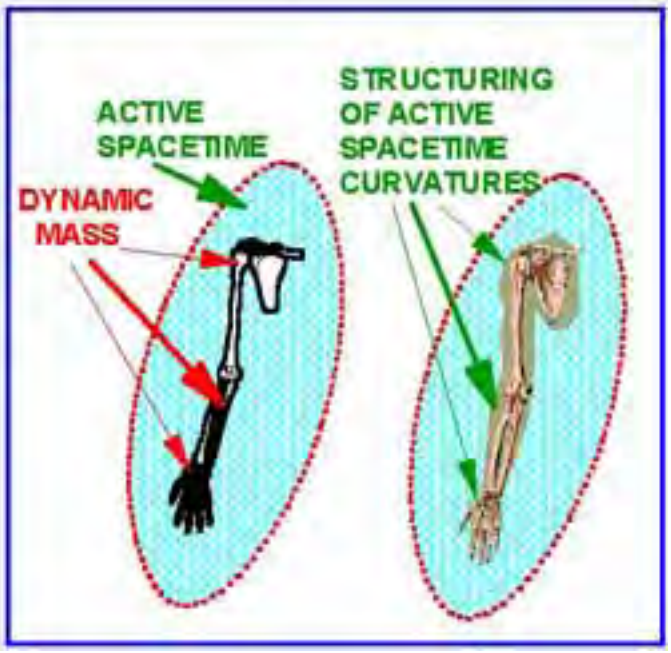

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Use of General Relativity (GR) in Particle Physics

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- GR seldom used in particle physics
- In cold fusion, Matsumoto* has applied general relativity
- Consistent with important cold fusion results
- Used spacetime (ST) curvature by energy density
- Matsumoto did not utilize:
  - Longitudinal EM waves
  - Time density waves
  - Time density curvatures of ST (gain = $9 \times 10_{16}$)

* T. Matsumoto, "Mechanisms of Electro-Nuclear Collapse," Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 98

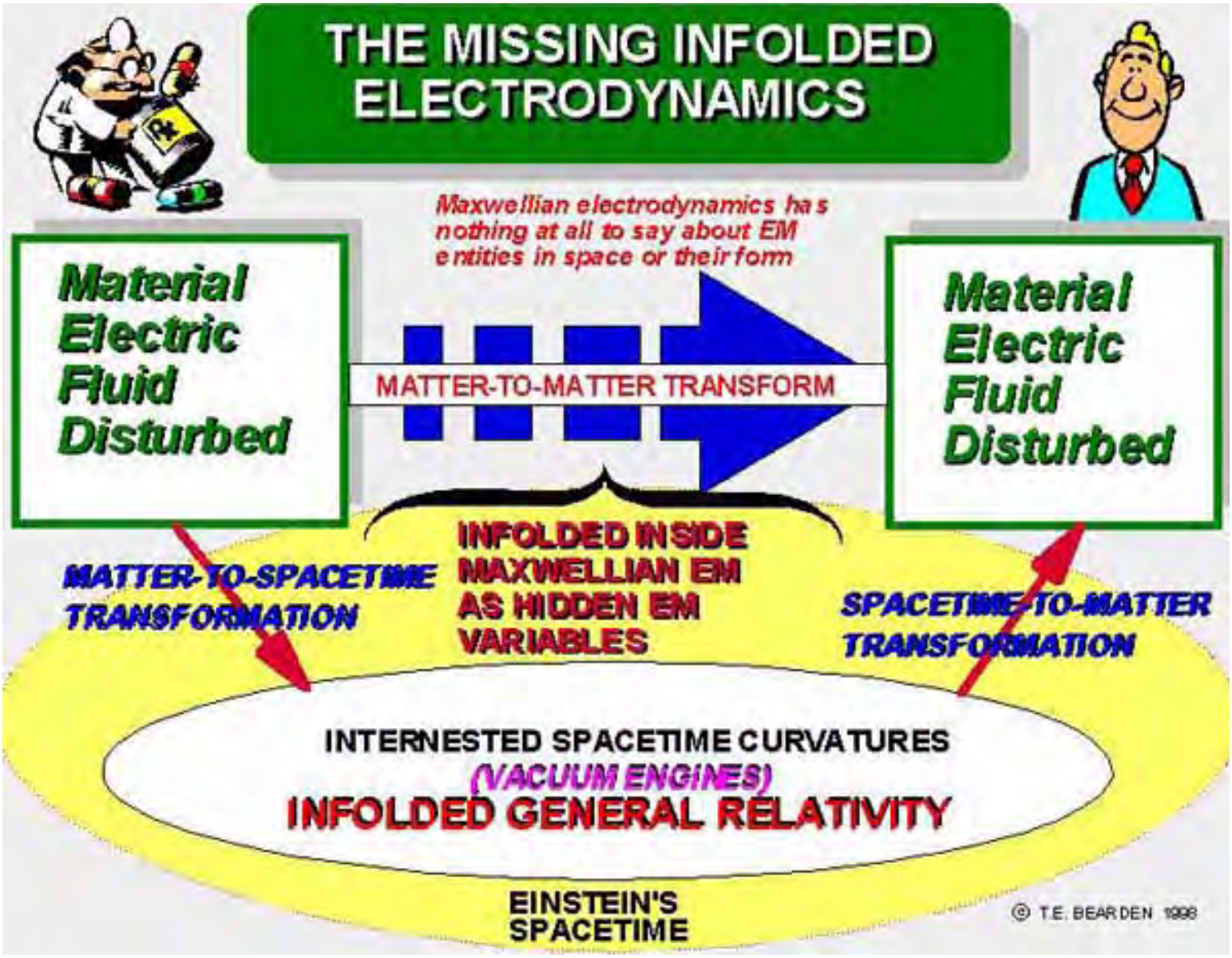
THE MISSING INFOLDED ELECTRODYNAMICS
Maxwellian electrodynamics has nothing at all to say about EM entities in space or their form
Material Electric Fluid Disturbed
MATTER-TO-MATTER TRANSFORM
Material Electric Fluid Disturbed
INFOLDED INSIDE MAXWELLIAN EM AS HIDDEN EM VARIABLES
MATTER-TO-SPACETIME TRANSFORMATION
SPACETIME-TO-MATTER TRANSFORMATION
INTERNESTED SPACETIME CURVATURES
(VACUUM ENGINES)
INFOLDED GENERAL RELATIVITY
EINSTEIN'S SPACETIME
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Infolded Engines: Excluded by Present Physics

- *The infolded dynamics of EM systems are not considered in general relativity, electromagnetics, or quantum mechanics*
- *None of these disciplines include such spacetime curvature engines (vacuum engines)*
- *Thus GR, EM, and QM cannot be unified, since ST curvature engines are where the unification mainly occurs*

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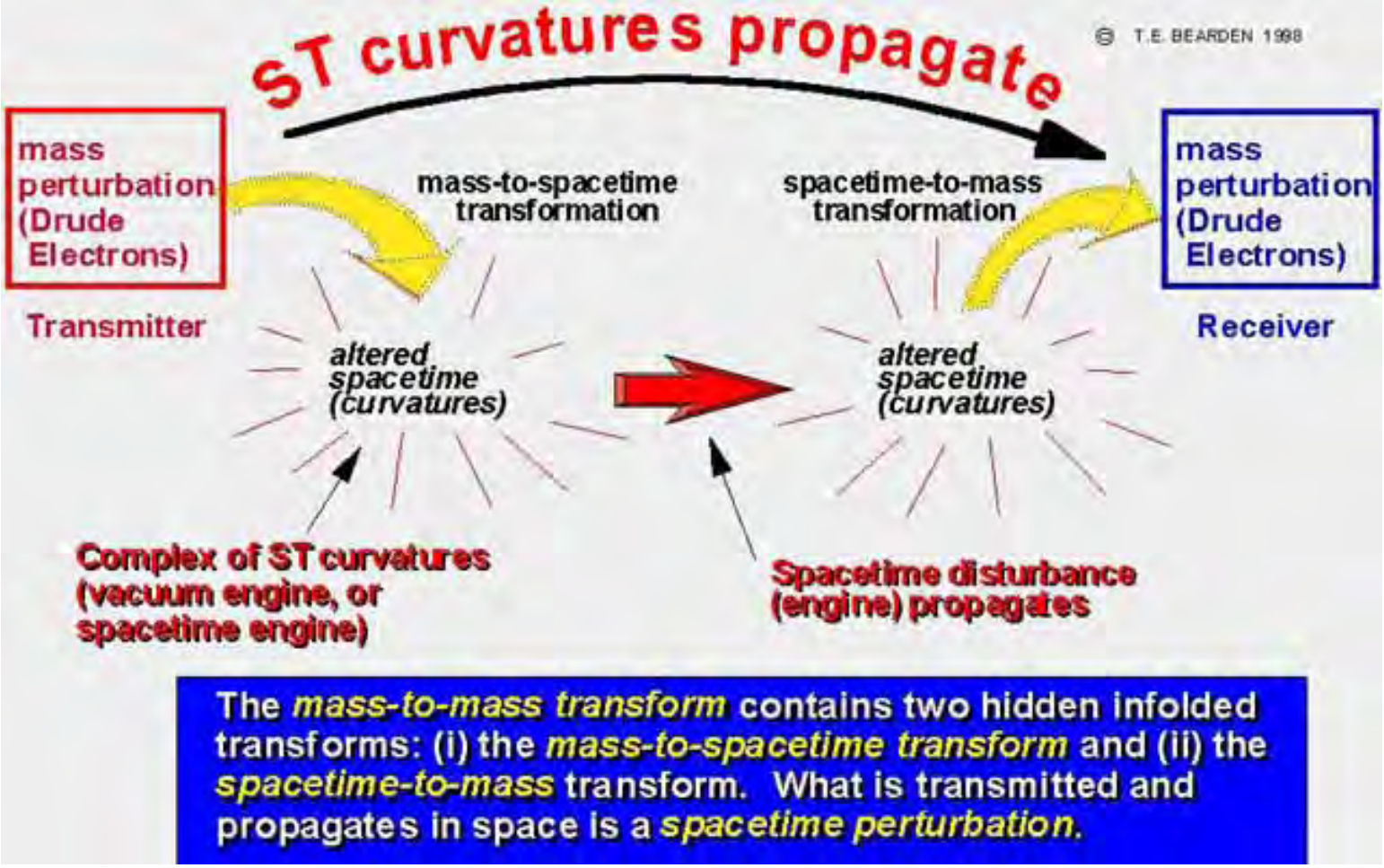
ST curvatures propagate
© T.E. BEARDEN 1998
mass perturbation (Drude Electrons)
Transmitter
mass-to-spacetime transformation
spacetime-to-mass transformation
mass perturbation (Drude Electrons)
Receiver
altered spacetime (curvatures)
altered spacetime (curvatures)
Complex of ST curvatures (vacuum engine, or spacetime engine)
Spacetime disturbance (engine) propagates
The mass-to-mass transform contains two hidden infolded transforms: (i) the mass-to-spacetime transform and (ii) the spacetime-to-mass transform. What is transmitted and propagates in space is a spacetime perturbation.

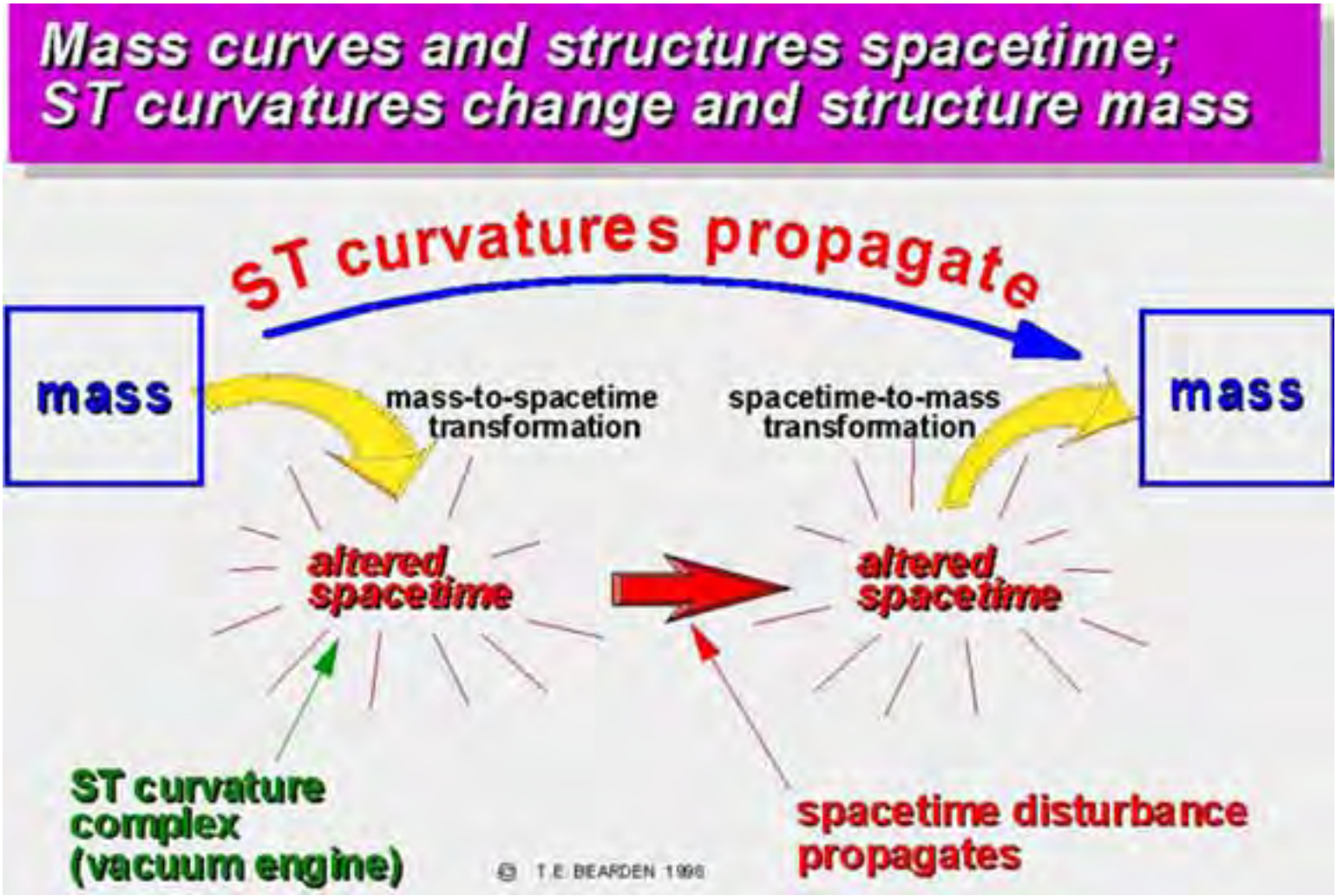
Mass curves and structures spacetime;
ST curvatures change and structure mass
ST curvatures propagate
mass
mass-to-spacetime transformation
spacetime-to-mass transformation
mass
altered spacetime
altered spacetime
ST curvature complex (vacuum engine)
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spacetime disturbance propagates

At Infinite Velocity:
Each Is Every Other
SPACETIME
VIRTUAL PARTICLE FLUX
POTENTIAL
MIND AND MIND LEVELS
MASS
PLANET
LIVING ORGANISMS
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Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

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S.K. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p. 16-25.

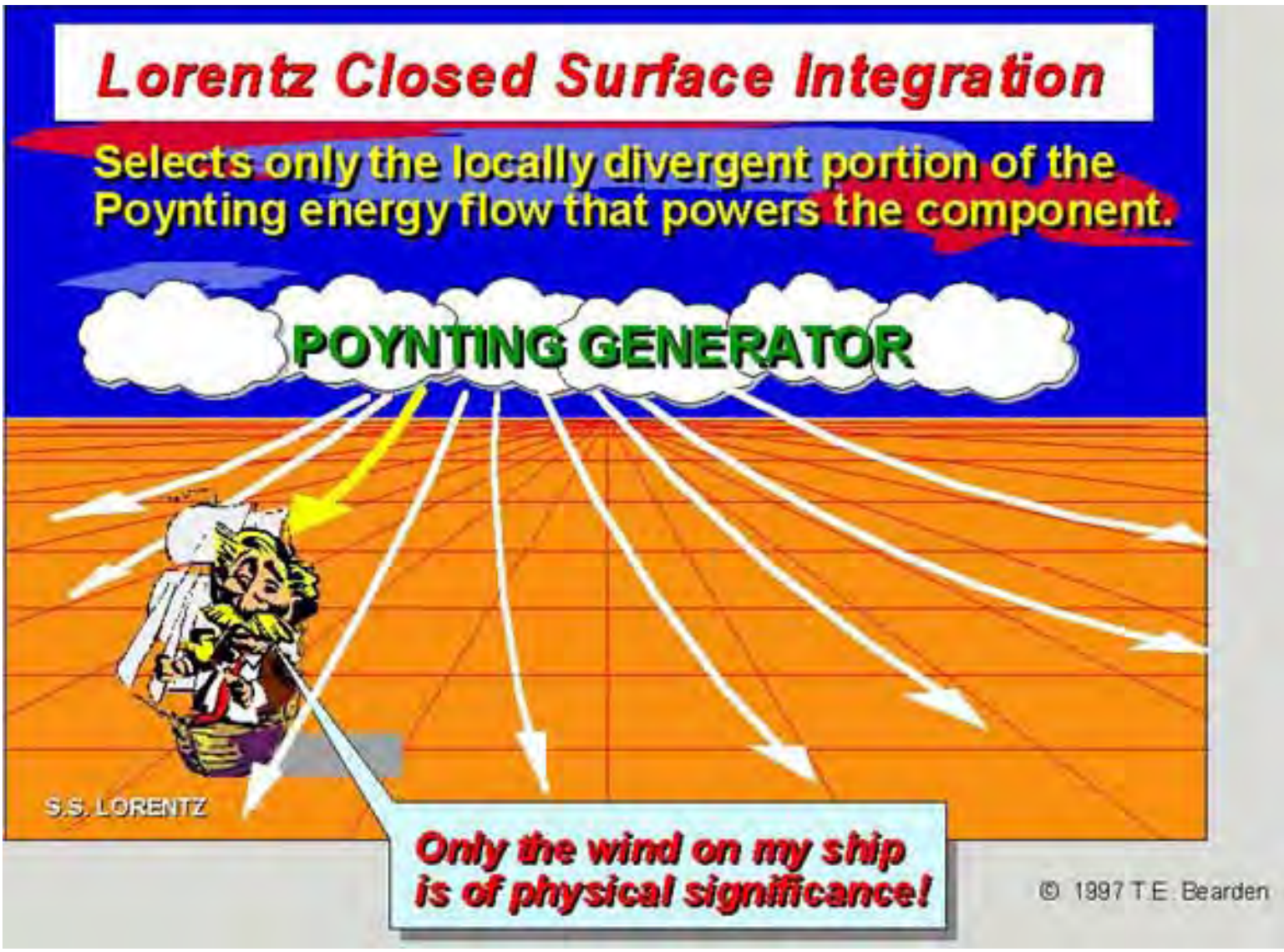
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
Only the wind on my ship is of physical significance!
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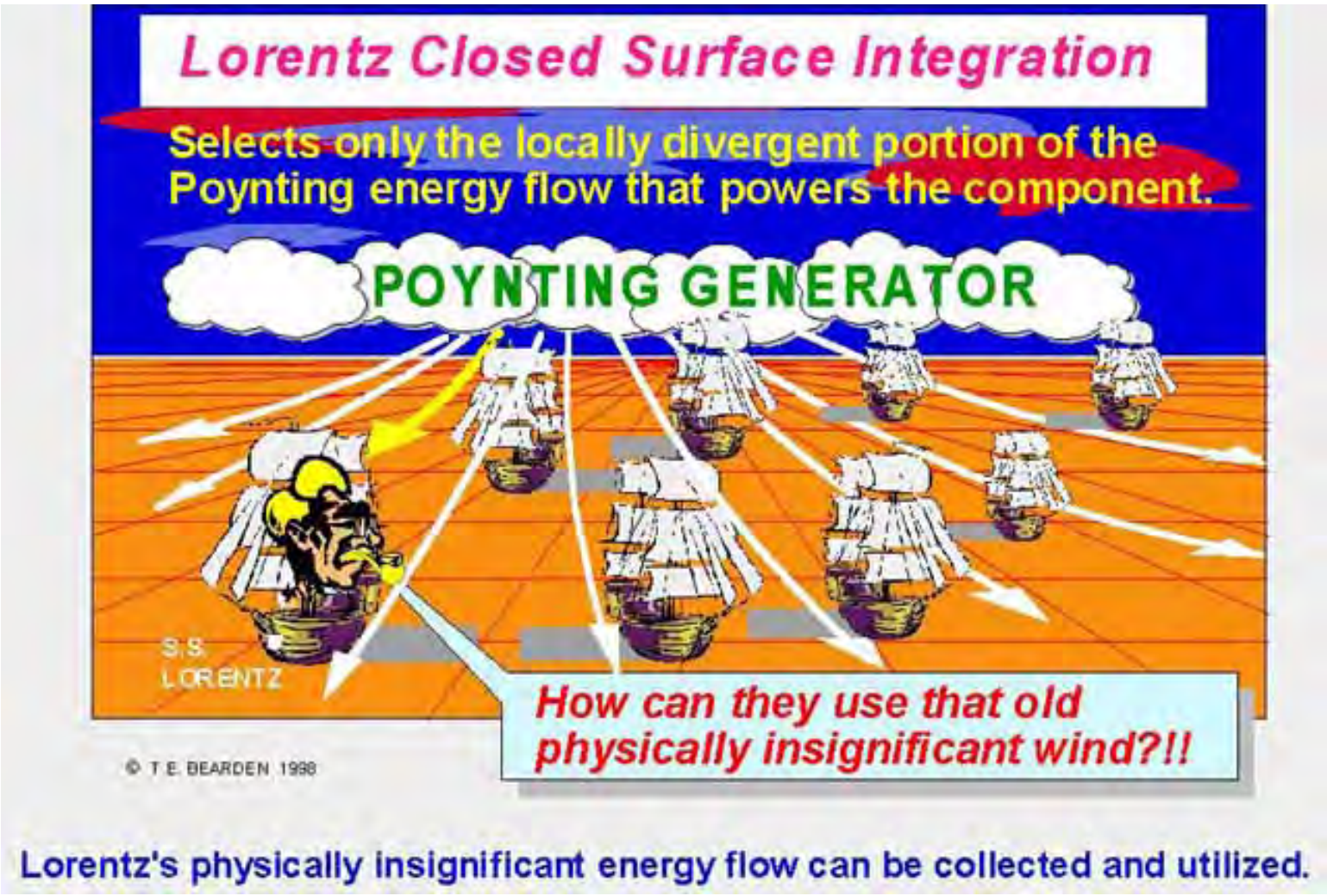
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
How can they use that old physically insignificant wind?!!
© T.E. BEARDEN 1998
Lorentz's physically insignificant energy flow can be collected and utilized.

Lorentz surface integration of the Poynting vector around a closed surface

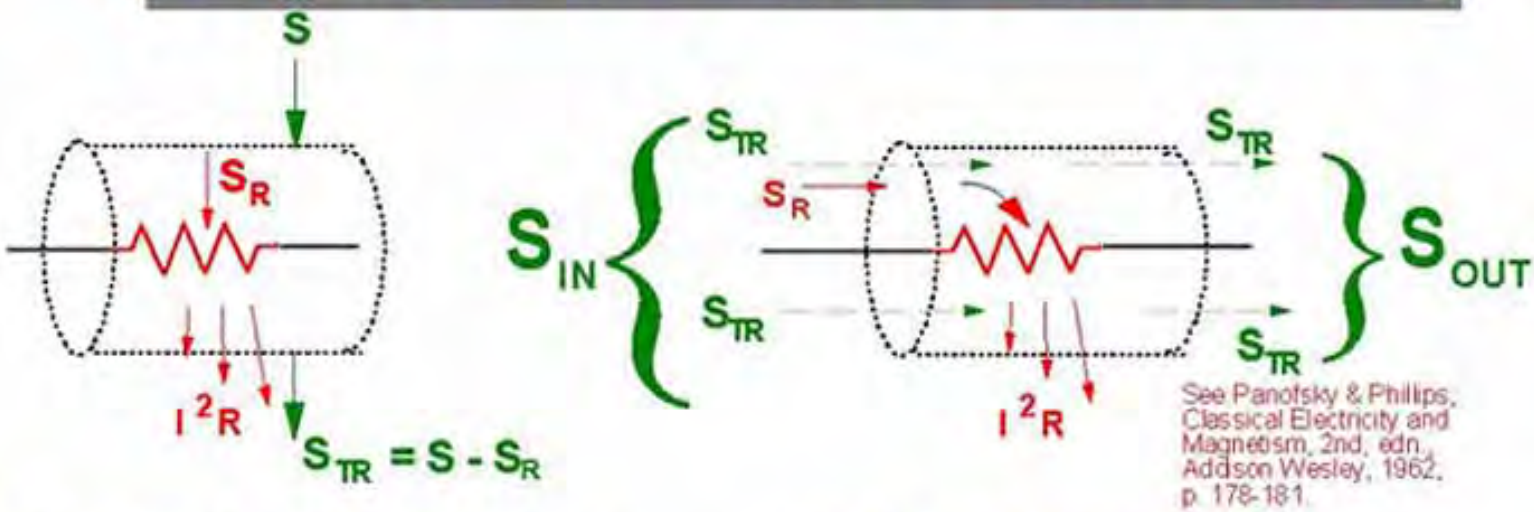

See Panofsky & Phillips, Classical Electricity and Magnetism, 2nd. edn. Addison Wesley, 1962, p. 178-181.

1a. Lorentz surface integration.

1b. Actual S in and S out.

Note: If the S-vector is integrated over the closed surface, then all energy *transport* passage is zeroed, leaving only the very small component of the input S-flow that is powering the joule heating of the resistor. In short, only the small component of the S-flow that is equal in magnitude to the Slepian vector $j\phi$ remains. This measures only the tiny portion of the S-flow that is "collecting" on electrons passing through the resistor, and therefrom being dissipated out of the resistor as joule heating. It discards everything else (all S_{TR}'s and S_{OUT}). S_{IN} becomes S_R.

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Longitudinal EM Photon Interaction with Charge

- Creates time-density wave pumping
- Slowly creates time-density charging

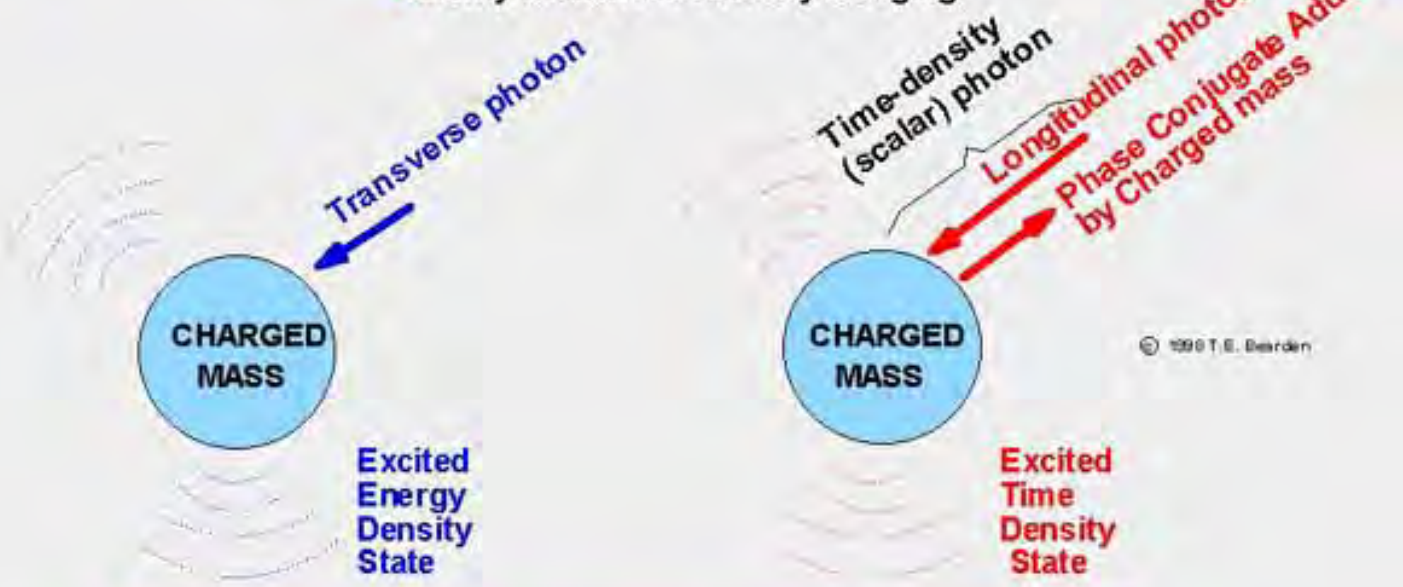

- Fundamental units are arbitrary in physics
- Can express all physics in one unit -- e.g., time
- Time is highly compressed energy
- 1 sec = 9 x 10_{16} joules of transverse EM wave energy

Figure 1-8. Infolded biwave composition of a scalar potential.

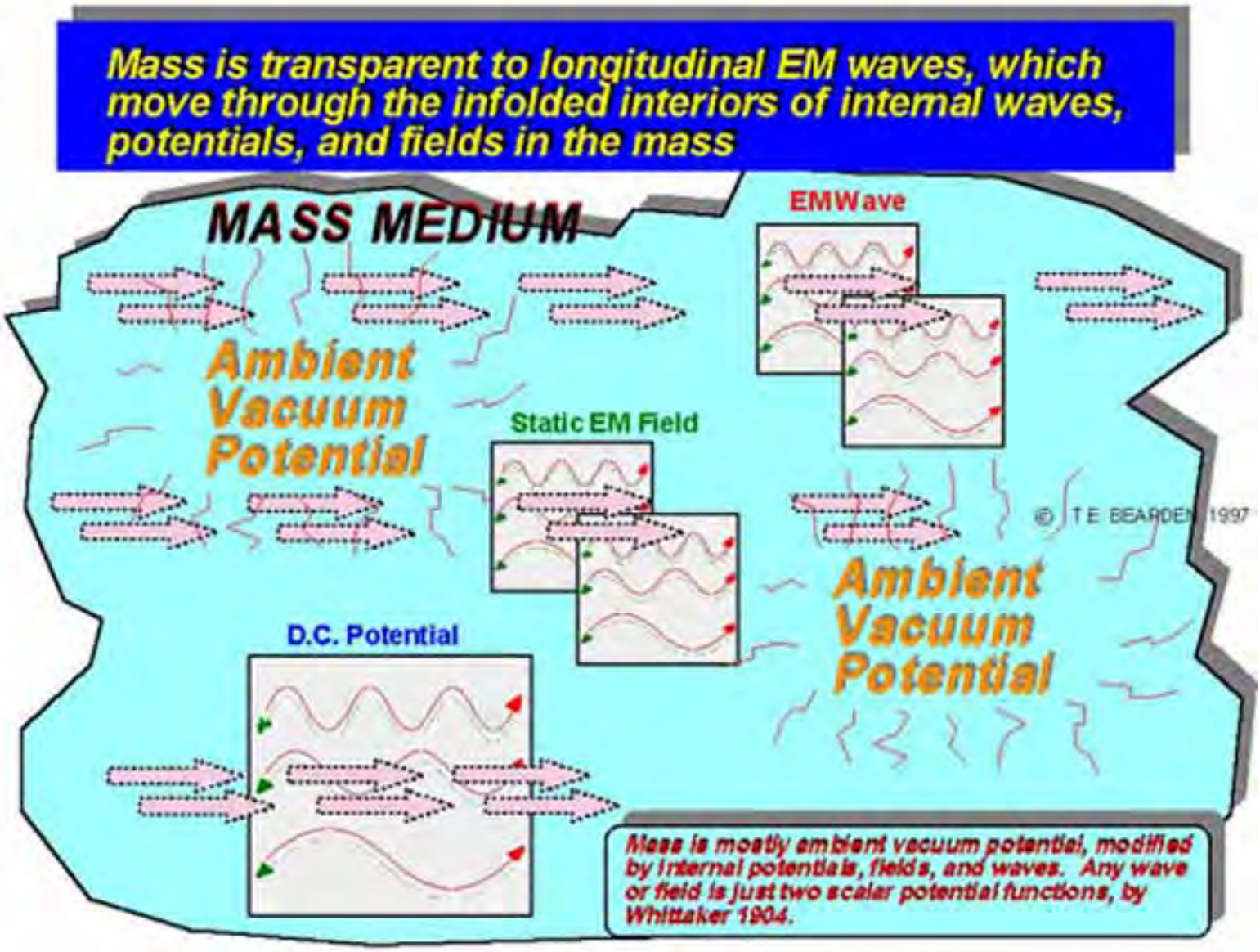

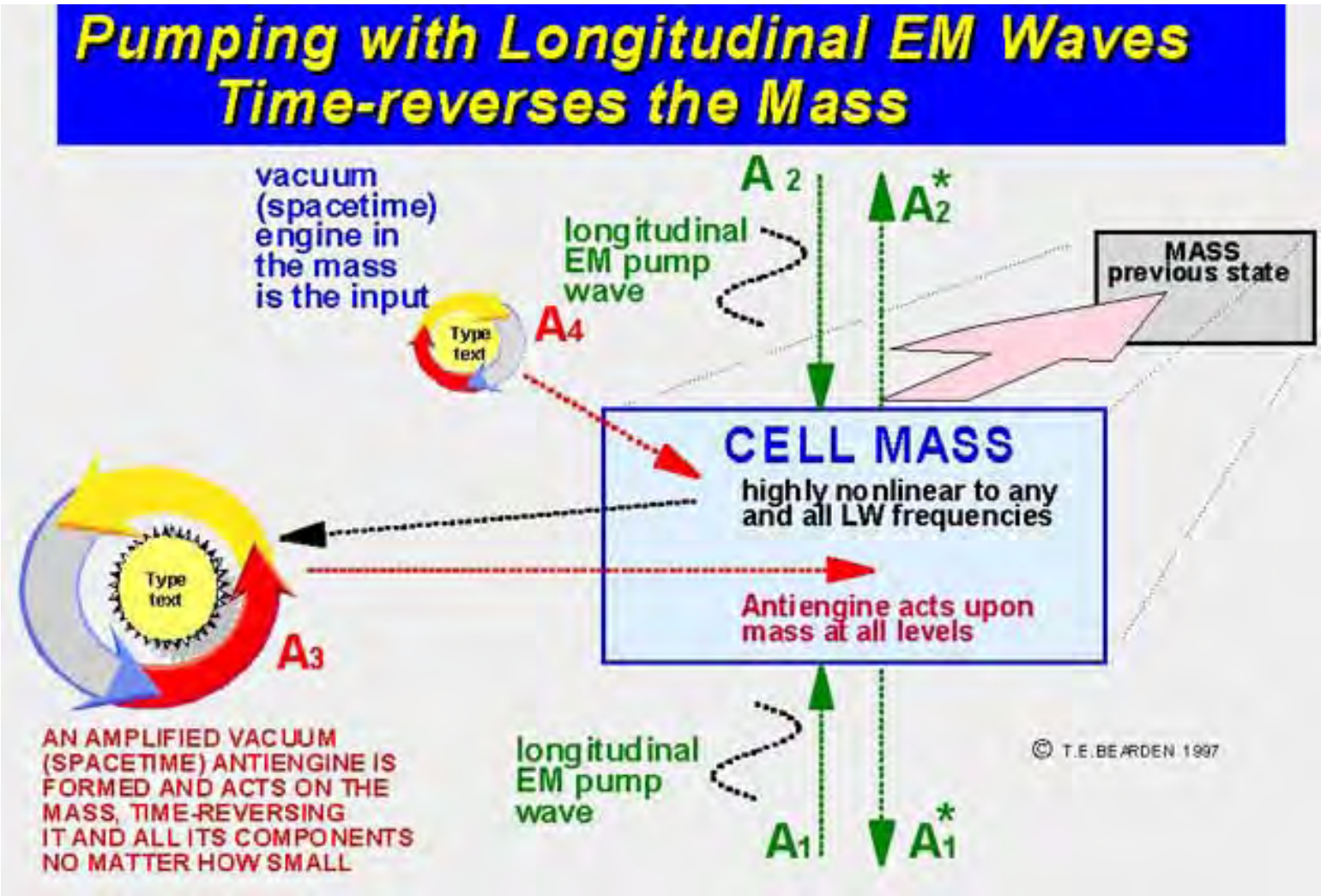
Pumping with Longitudinal EM Waves
Time-reverses the Mass
vacuum (spacetime) engine in the mass is the input
A 2
A*2
longitudinal EM pump wave
MASS previous state
Type text
A4
CELL MASS
highly nonlinear to any and all LW frequencies
Type text
A3
Antiengine acts upon mass at all levels
AN AMPLIFIED VACUUM (SPACETIME) ANTIENGINE IS FORMED AND ACTS ON THE MASS, TIME-REVERSING IT AND ALL ITS COMPONENTS NO MATTER HOW SMALL
longitudinal EM pump wave
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A1
A*1

Maxwell's Quaternion Theory

- Quaternions:
  - Discovered by Hamilton in 1843
  - A quaternion has a vector part
  - A quaternion has a scalar part
  - First significant non-arithmetic number system
  - Higher topology than vector or tensor algebra
- Maxwell's theory was in quaternion equations
  - 20 equations in 20 unknowns
  - Reduced to a small 4-equation subset by Heaviside and Gibbs
  - EM topology dramatically reduced

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Maxwellian Systems

Before regauging, after symmetrical regauging, and after asymmetrical regauging

Note: Any system must first break equilibrium in its vacuum exchange, before it can energize Drude electrons and "power" the load. Asymmetric regauging is always utilized. Powering loads and losses is a symmetry-restoring operation.

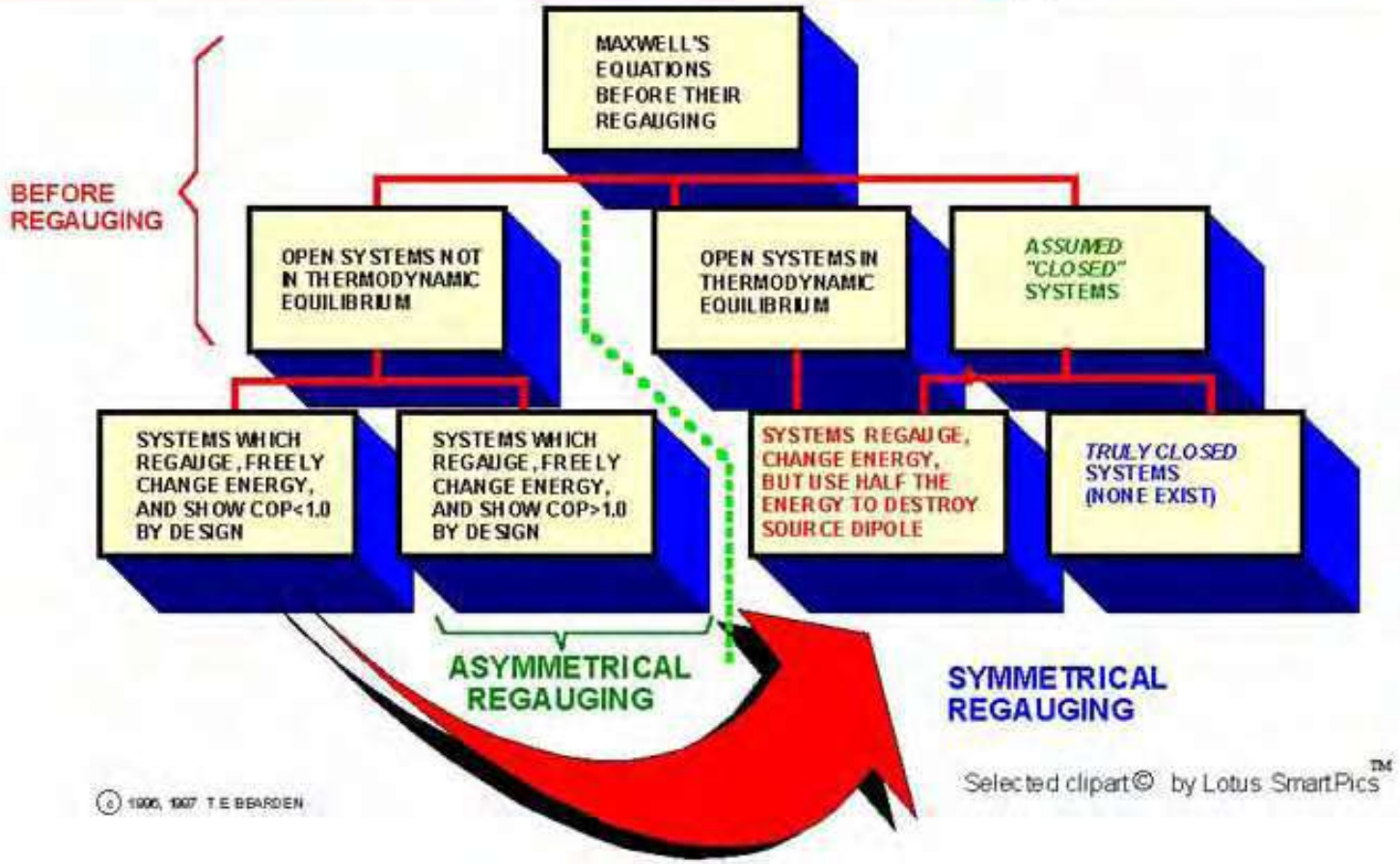

Maxwell's four equations reduce to:

$$\nabla^2 \Phi + \frac{1}{c}\frac{\partial}{\partial}(\nabla \bullet A) = -4\pi\rho \qquad [1]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} - \nabla(\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t}) = -\frac{4p}{c}J \qquad [2]$$

A is replaced by A', where

$$A' = A + \nabla\Lambda \qquad [3]$$

The new B' field then becomes

$$B' = \nabla \times (A + \nabla\Lambda) = \nabla \times A + 0 = \nabla \times A = B \qquad [4]$$

A new E-field will also be formed. So let

$$\Phi' = \Phi - \frac{1}{c}\frac{\partial \Lambda}{\partial t} \qquad [5]$$

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Per Jackson, (A,Φ) are *habitually* chosen so that

$$\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t} = 0 \qquad [6]$$

The *net symmetrical* regauging separates variables. Two inhomogeneous wave equations result:

$$\nabla^2 \Phi - \frac{1}{c^2}\frac{\partial^2 \Phi}{\partial t^2} = -4\pi\rho \qquad [7]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} = -\frac{4\pi}{c} J \qquad [8]$$

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Equations [1] and [2] *arbitrarily* changed to [7] and [8]

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CHASING THE WILD DRAGON

Foundations of a New Science

By T.E. Bearden
November 12, 1995

It is a pleasure to accept the offer of John and Larry to write a column in their new InterNet magazine. Theirs is a great venture, and with the energy and knowledge they bring to the task, one can be confident of their success in making this a very interesting and informative publication.

There is a new “rebel” science slowly being born, with most of the work being done outside the universities and orthodox scientific community. In the months ahead it will be my job to try to acquaint you with the gist of what’s going on, and what all the excitement is about.

This first article is deliberately just introductory, and its purpose is to interest you in the unusual fields we are going to be covering in more scientific detail, in future columns. We will also be listing a variety of references from the technical literature, which bear upon the various points addressed.

In this first article a little of my own background experience [note 1] is given, so you can decide whether you will be interested in what we have to say!

The real purpose of the column will just be to *present information* that you may not be able to readily obtain any other way. We will not argue or debate with skeptics; nothing productive is to be gained by that. If the information we present is useful to you, then our purpose has been accomplished. If it isn’t of use to you, then just file it in the old wastebasket. Also, from time to time I may answer a generic question, constructed from multiple queries. Individual responses to correspondence cannot be provided.

The work toward a new breakthrough science is going on in a broad spectrum of “fields,” most of which are not yet recognized by academia as even constituting legitimate areas of scientific endeavor (Table 1).
Some of the major areas involved are:

- theoretical and experimental research in overunity electrical machines,
- free energy research of other kinds, such as devices utilizing thermodynamics phase changes,
- rapidly advancing efforts in cold fusion,

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- direct engineering of quantum change via a new kind of "hidden electrodynamic variables",
- the direct engineering of the vacuum's virtual photon flux exchange with matter,
- action at a distance, including the deliberate formation and usage of quantum potentials,
- direct engineering of the local curvature of spacetime (yes, the direct engineering of general relativity, using the new hidden kind of electrodynamics),
- use of the new "hidden" electromagnetics to engineer body cells including the reversal of diseased cells, genetics and all, back to a previous healthy state (cellular dedifferentiation, in biophysical terms, or cellular phase conjugation, in physics terminology),
- research toward the direct engineering of the mind, including both the conscious and unconscious minds, long-term memory, and the personality itself, and
- a ruthless re-examination (and correction where necessary and possible) of the definitions, concepts, and postulates that present physics is founded upon.

Each of these "major areas" as yet has no single "experts" in the sense that individuals exist who possess a "mastery" of the given area. As an example, in spite of multiple researchers and decades of vigorous research, no one is really an "overall expert" in the overunity electrical power systems field. The "field" itself is still struggling to be born and is not recognized at all by orthodoxy; in fact, many orthodox scientists bitterly resent one even attempting to work in this area. There is as yet no cohesive single "theory" of overunity electrical or magnetic machines, although our own group is making rapid progress in that respect. But there is still no universal agreement amongst even the researchers themselves. Literally the field is still being discovered.

This "groping dimly toward a new field" should not be too surprising. After all, the early electromagnetics researchers went through the same tortuous, agonizing kind of development. They were playing with cat fur, glass rods, and pith balls for quite an extended period before understanding progressed to the point where Maxwell could mathematically tie together and model the results of the experimenters such as Faraday and others. It has taken a century and a half for modern electromagnetics and electronics to reach its own present development. It is going to take another decade or so before the overunity researchers can overturn several ill-founded parts of the present electromagnetics and get the emerging field onto a solid foundations footing and into a solid theoretical position.

In the effort to produce a theoretical model of electromagnetics, Maxwell and his predecessors performed a magnificent work. Yet they also made very serious errors (Table 2), which persist to this day. [note 2] Let us list just a few of the more blatant errors in classical EM theory today:

First, Franklin guessed wrong on which way electrical current flowed in a circuit. There is no definition at all of electrical charge in all of physics, and there is no acceptable definition of potential (that is, there is no rigorous definition of just good old "voltage.") There are no "fields of force" in the vacuum; there are just potential gradients __ because the vacuum is just one vast potential (virtual particle flux) in the first place. Force fields actually occur only in and of the matter in a material system. The primary causative agents of electromagnetics are not the so-called "force fields' at all, but are the potentials __ as is well-known in quantum mechanics. [note 3] Maxwell assumed a material ether in his equations. The Michelson-Morley experiment destroyed the material ether, but the Maxwell equations have never been changed accordingly. The electron was not yet discovered when the Maxwell equations were written; the theory does not address electron spin. Maxwell was already dead some two decades when Barus' 1898 paper [note 4] was published, pointing out the strange "backwards-traveling" wave (i.e., time-reversed wave) solution to the wave equation. In addition, Heaviside and Gibbs had already produced their vector truncation __ this truncated theory is the modern so-called "Maxwell's equations" that universities teach today __ of Maxwell's theory.

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in a higher topology (quaternion algebra), and inverted some 20 quaternion equations. Heaviside and Gibbs created vector algebra, and seriously curtailed Maxwell's theory when they "translated" it into the much lower topology of vectors and some four equations. The later addition of tensors as the basis mathematics did not restore the lost topology provided by the quaternion model. [note 6]

For the EM wave, Maxwell simply assumed the transverse EM wave that had come from the much earlier derivation of the familiar wave equation from the old "plucked taut string" notions. [note 7] Yet when one closely examines and corrects some of the erroneous *assumptions* [note 8] made for the actual mathematical derivation of this "taut string" transverse wave, one finds (Figure 1) that an equal-energy second antiphased transverse "antiwave" is actually produced by the instrument and added to the "plucked string's" transverse wave disturbance of the air medium, to produce a longitudinal wave of compression and rarefaction in the air itself. The "transverse string wave" in fact never leaves the string. The string wave is not the wave that is launched into the medium.

A similar electromagnetic situation exists. In a whip antenna (Figure 2), the Drude electron gas in the conductor does exhibit a transverse "string-type" EM wave of electron precession. However, at the same time, by Newton's third law (which Maxwell neglected because at the time the atom was regarded as just a blob with no internal structure) the positively charged, phase conjugated atomic nuclei have equal energy, highly damped transverse recoil waves created in them. Further, these "nuclei-recoil" waves are phase conjugate replicas of the electron gas waves. The total disturbance that is launched into the vacuum from the whip antenna is (a) the normal transverse disturbance of the virtual photon flux of vacuum caused by the electron gas wave, and (b) the coupled equal-energy transverse antiwave caused by the nuclei-recoil via Newton's third law. The amplitude of the material antiwaves of nuclei vibration are highly damped because of the massiveness of the nuclei; however, they are of equal energy to the electron wave. But when launched into the same vacuum, the two equal-energy wave disturbances experience equal damping because they are in the same medium. Hence the wave and antiwave are (a) locked together in the vacuum, and (b) of equal energy, and (3) of equal amplitude once launched into the vacuum. What results is a vacuum EM wave of rarefaction (reduction in intensity) and compression (increase in intensity) of the virtual photon flux of vacuum __ just exactly like what is launched into the surrounding gaseous air medium from the "plucked taut string" and perturbed body of a physical instrument. The EM wave in vacuum is a longitudinal wave directly analogous to a sound wave __ just as Nikola Tesla stated. [note 9]

The vacuum may be considered a scalar potential, in which case it has an internal biwave structure (Figure 3). Interference of two potentials __ i.e., the hidden interference (Figure 4) of their internal wave structures __ in fact already creates all EM fields and waves.

When the incoming longitudinal "biwave" from the vacuum strikes the atoms of the receiving antenna, each atom may be considered a dynamic assembly of multiple dipoles, where each dipole consists of one of the electrons in the electron shells and one of the positive charges in the nucleus. The receiving dipole in the interacting atom splits the two waves apart again (Figure 5). The negatively charged end of the dipole is time-forward, and the positively charged end is time-reversed. Hence the separated normal-wave-half of the biwave interacts with the electron, to give again the familiar transverse "electron precession" wave that we detect with our "electron wiggle-detecting" instruments (Figure 6). This detected electron precession wave is what all our textbooks prescribe erroneously as the vacuum wave! The separated time-reversed-wave-half of the incoming vacuum wave is split off and interacts with the positive end of the receiving atomic dipole, in the time-reversed atomic nucleus, thus generating Newton's third law reaction force to provide the recoil of the nucleus. Present physics has ignored this second wave altogether, because of the serious error in the original derivation of the wave equation from plucked strings. Thus

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would appear to violate Newtonian third law reaction. Phase conjugate mirrors already do just exactly this when they emit a phase conjugate replica wave. They direct the antiwave outside and away from the atom instead of inwards into the nucleus. So they do not recoil, no matter how powerful a phase conjugate replica wave they emit.

Finally, we can also show that the EM wave in vacuum is longitudinal, by yet another approach. The electrons in the electron gas in a conductor are spinning, and they are severely constrained longitudinally to be able to move only very, very slowly down the wire. So when perturbed, they act as gyroscopes, and precess at right angles to the perturbing force. The fact that the gyroelectrons in a wire move radially almost entirely, and only "slip" down the wire very slowly with a "drift" velocity, already proves conclusively that the incoming vacuum disturbance was longitudinal. The precession of a gyro is at right angles to the perturbing force. Therefore rigorously the vacuum EM waves are longitudinal, because the gyroelectrons moved transversely. The present assumption of the transverse EM wave in vacuum contradicts the entire theory of gyroscopes! [note 10] There are many other errors in classical EM that we will point out in future articles; this should give the reader a flavor of what is in store for him in future articles.

So there are no truly satisfactory "experts" in any of the 14 fields. Yet there is still something to be said for having some years of experience in one or more of the areas. I have had the good fortune or misfortune, depending upon one's viewpoint, to be involved in various of those 14 activities for some 30 years or more, and am active in several of the areas now. My colleagues and I are particularly active in researching overunity electrical devices (see Figure 8), to include the effects of controlled chaotic oscillators, charge-blocking oscillators, and oscillators driven by in-shuttled (bridged) Poynting field energy density flow ExH. Parametric oscillation is known to have yielded overunity electrical machines and was fully reported by Russian researchers in the Russian and French technical journals in the mid 1930s. [note 11] We will further cite that little-known work in future articles. Also, we are working mightily upon true negative resistors (Figure 9), wherein the resistor scavenges some of the disorganized energy from the vacuum's energetic exchange with the charges in the system, organizes and collects it, and then outputs that collected energy flow into the external circuit. Such a resistor acts as a power source. Kron, perhaps the greatest of the electrical machinery scientists, is known to have produced such true negative resistors.

I have also proposed a theoretical explanation of the Priore device (Figure 10) in France which in laboratory animals demonstrated remarkable cures of terminal tumors, cured trypanosomias, reversed atheriosclerosis, and restored suppressed immune systems. The Priore work was not anecdotal, but was performed under rigorous scientific protocols, working under the auspices of renowned French scientists such as Courrier and Pautrizel. The work is properly reported in numerous papers in the French medical literature. [note 12] The results were certainly achieved, but neither Priore himself nor the scientists of the day could understand the mechanism involved. The deciphering of that causative technical mechanism utilized by the Priore group required 10 years of intense effort. The results have now been published in the journal Explore! and are there for anyone to read. [note 13]
Presently my CTEC colleagues and I have filed three patent applications and a continuation, on various methods for overunity processes and apparatuses, room temperature superconductivity, Poynting generators, etc.

As an example, we took exactly the opposite approach to room temperature superconductivity as has been taken by all the orthodox researchers to date. What exactly is sought, after all, for superconductivity (SC) in a section of an electrical circuit? Well, one has some electrons on one side of that SC section that are transporting excess potential, as given by the Slepian vector J*. [note 14] What is desired is to get some electrons on the other side of the SC section that also are transporting the same amount of excess energy in the form of J*. You can do that in two ways: (1) you can flow the electron carriers through the SC section, carrying their J*, or (2) you can block the J and flow the * itself across as the Poynting flow S. [note 15] Nondivergent Poynting flow flows along an equipotential, which is

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tantamount to a crash, and massive correlation of the electrons and of the electron to lattice interactions is necessary if one is to get the electrons through there without excess collisions that shake off some of the excess * from J*, as scattered photons (heat) or as a change of form of the energy (as in straining the dielectric of a capacitor to convert electrical energy to mechanical strain energy via the piezoelectric effect.)

Our approach is exactly the opposite (Figure 11) and Figure 12). Why not just *stop* the flow of excited electron carriers on one side of the SC section, and continue the nondiverging flow of the Poynting field energy density S across that section at room temperature? Then the cryogenics is not needed at all. After all, circuits already work that way anyhow __ except standard practice is to nullify the process by letting current be driven around the sourcing current loop and back through the back EMF of the primary source. A quantum well (or several other methods) can be used to trap the "sourcing" electrons in the conductor just prior to entering the SC section. The "receiving" electrons on the other side of the SC section, however, must be in their own dq/dt-isolated current loop.

Normal sources do not furnish electrons and current to a circuit anyway. Sources just furnish Poynting flow S and EMF. [note 16] In the receiving current loop, the EMF appears automatically once the S-flow flows in and is "locked on to" by the receiving electrons. Given q**, you will immediately have J* if the electrons are free to move in the conducting circuit (see Figure 13). Further, you have eliminated all the loss terms from the standard Poynting equation for energy losses. So all the energy flow S just flows across the SC section, without any current or Cooper pairs flowing through that SC section. The SC section has become a "bridge" which (1) strips off the Poynting field energy density flow S from the electron current dq/dt on the sourcing side of the SC/bridge section, by simply reducing the dq/dt to zero; and (2) continues to pass the S-flow across the dq/dt-blocked SC/bridge section to the other side (Figure 14). The excess S-flow (and EMF) pours into the receiving dq/dt-isolated current loop, exciting the electrons therein to produce dq/dt and J*. *Any closed current loop is self-powered, once it receives S and EMF. It furnishes its own electrons; it only requires excess energy and EMF.* [note 17]

So our approach gives room temperature superconductivity in a very straightforward manner, once you discover how to block the current dq/dt in a conductor. Blocking it in an insulator is not sufficient, because that drops the potential and stops the S-flow and the equipotential * (the EMF). However, a degenerate semiconductor such as the Fogal chip can be used, as can several other processes for blocking dq/dt in a conductor. We will discuss these in a future article.

Another advantage of this approach to room temperature superconductivity is that now one can also have permissible overunity coefficient of performance. Now the load can be placed in its own S-receiving, isolated current loop. With the sourcing current loop furnishing only S and not dq/dt, the load is still powered normally in its own closed dq/dt current loop, but none of the load current is passed back through the back EMF of the primary source in the sourcing circuit.

This principle — that at least a substantial portion of the load current must not pass back through the primary source — is the primary principle required for a permissible overunity electrical machine (Figure 15). A permissible overunity electrical machine is one which produces more power in the load than you have to put into the machine to run it.

Obviously, the laws of physics and thermodynamics require such an overunity machine to be an open system that extracts and utilizes excess energy from an external source. In the case outlined, we extract the excess energy directly from the vacuum in the form of S-flow; essentially we convert our primary source to a Poynting generator rather than a "power" (energy flow loss rate) generator. The resulting9. overunity machine accomplishes both room temperature superconductivity and also overunity coefficient of performance (Figure 16). It does not violate the

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exchange between the vacuum and each end of the dipole. [note 19] [note 20] When we attach "conducting leads" to a dipolar source, as in the simple two-wire circuit, all we are doing with the conductors is providing waveguides for the extracted S-flows from the vacuum to flow along (it flows outside the conductors) without loss. In effect, each lead is simply extending the pole (i.e., the terminal) to which it is connected.

My associates and I are also working on several other inventions at present, including two more patent applications to be filed in the near future. One of those is in the field of overunity power systems, while the other is in an entirely different, highly proprietary nuclear effort. I will address all these areas in future columns, and those columns will have real "meat" in them.

Present "big science" proclaims that overunity electrical machines are impossible. The reader should understand that the U.S. Patent and Trademarks Office is never going to grant a patent for an overunity electrical machine unless the machine is independently tested and replicated, and unless it is certified by scientists of impeccable credentials. This is as it should be. Legitimate free energy researchers accept that dictum. Eventually the stuff has to work on the bench in order to be validated. On the other hand, free energy researchers also point out that one must not demand of us the next 100 years of national research by a hundred major laboratories immediately! This is still a shoestring operation, because all conventional sources of research funds are denied to the serious overunity researcher (with the single exception of occasional personal funding of a researcher by a private individual). In other words, we demand at least the same kind of consideration that the orthodox nuclear fusion community has enjoyed. Billions of dollars have been poured into that sinkhole, and not a single controlled fusion power unit is working anywhere in the world after decades of work at enormous expense to the taxpayers.

So we overunity researchers deserve at least a decade or two of our own, to try to accomplish overunity electrical system development. We also painfully point out that "Big Science" will not fund a single overunity researcher, for specific overunity purpose, no matter what his credentials or capability. In fact, "Big Science" is part of the problem, because it fervently seeks to prevent any legitimate research in overunity. To carry out its suppression campaign. it resorts to vilification, character assassination, libel, and slander of the overunity researchers themselves __ again, regardless of their qualifications or legitimate scientific procedures. [note 21]

Indeed, orthodoxy has a black record with respect to energy. When Mayer advanced the conservation of energy law, orthodoxy hounded him unmercifully. He was universally ridiculed as the very epitome of a fool. He lost his job and suffered a nervous breakdown. Then years later toward the end of his life, scientists came to accept the conservation of energy as a most useful tool that dramatically simplified much of their analyses. So then science began to laud Mayer. There are a thousand other such examples; suffice it to say that "big science" is a bureaucracy and a "bell-shaped distribution curve" just like any other large group of people. Some scientists are near-angels. Others are near-devils. The vast majority are neither, but are just ordinary persons doing a special kind of job. In the scientific bureaucracy, however, the manipulative scientists scurry, slash, and manipulate their way toward the top. So the leadership of any big bureaucracy __ including the scientific bureaucracy __ is always rife with such near-scalawags and power-hungry individuals. Scientists are not exceptions to the same human weaknesses that we all evidence. If you really want to see jealousy, backbiting, and fierce "back-room dealing" and power-struggling, just get into a university research environment! But because the "power merchants" of any bureaucracy always fiercely resist any challenge to their position or superiority, big science has always fiercely resisted anything truly revolutionary. And today they also enlist the power of the state to enforce their dictums. We will devote one of our future columns to pointing out some glaring examples of persecution of independent researchers by big science. It is an area that all unorthodox researchers should be well-aware of. The world of science does not run by sweet reason and lofty

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telling that dogmatic scientists due to vilify free energy researchers. It is a lie that they have also successfully sold to the U.S. Patent and Trademarks Office. Anyone with a modicum of knowledge of modern physics already knows that there does not exist a single closed system in the universe, anywhere. In particular, every physical system is continuously "open" to the violent exchange of energy with the surrounding vacuum. It's just that most systems are in local equilibrium in these flow exchanges, except for minuscule gating accomplished for such things as the Lamb shift, etc.

By analogy it's something like this. The free energy researcher is standing by the banks of a mighty, rushing river with breathtaking falls, turbulent areas, etc. Big Science is begrudgingly admitting that, yes, there is a river there, but it is an insane delusion to think that you can tap that energy. The free energy researcher is saying that, well, if I can build a gating sluice a little distance upstream, perhaps I can divert a small portion of the river's flow downstream to my waterwheel, and power my mill. The orthodox scientist then vilifies the free energy researcher for even having such a heretical thought. In fact, says the orthodox researcher, any fool can see that the laws of nature force the river's flow to stay firmly in its banks, because it is a closed system, and Moses brought that law down off the mountain with him on a special stone tablet. Then he adds all the other smug remarks such as, "If it could be done, then we at MIT and Harvard and Caltech would already have done it!" So until the orthodox scientist develops a little less dogma and a little more common sense, and learns the difference between a scientific discussion and a dogfight, the free energy researcher can hardly communicate with him.

The goal of the legitimate free energy researcher is to find a way to break the local equilibrium of this universal energy exchange, and gate a tiny bit of it up into the external circuit as excess electrical energy (Figure 17). Then he must collect the excess energy, and shuttle it from the "gating and collecting circuit" over to a dq/dt-closed current loop containing the load. He must also prevent the load current, or most of it, from passing back through the primary source against its back EMF, because if it does that, he will destroy the separation of charges in the dipolar source, killing the dipole and extinguishing the "excess energy gating." In other words he must find a way to process and transport the energy flow across dq/dt-blocked bridges between the source's closed dq/dt-current loop and the load's closed dq/dt-current loop. Ruthlessly it is an energy transport S-flow problem, not a J* energy transport problem. If he uses J* in his sourcing current loop, he automatically drives the current dq/dt back through the back EMF of his source and kills it. If he does not drive dq/dt back through the source, the source will furnish S-flow for an indefinite period! Every battery and generator we have ever built is already a "free energy" machine in that it already involves broken local symmetry in the vacuum energy exchange. We have just not realized how to use our power sources purely as Poynting S-flow sources.

So we must treat an electrical system as an open system with broken local symmetry (Table 3) in the vacuum flux exchange, so that the system extracts (gates) excess energy from an external source. In this case the source is the system's flux exchange with the vacuum. This approach is no more mysterious or bizarre than putting a waterwheel in a river, or a windmill in a wind, or a bank of solar cells out in the sunshine. The universal "free source of energy" that the overunity researcher seeks to tap is the violent exchange of virtual photons between the electrical charges of the system and the surrounding quantum mechanical vacuum (Figure 18). In quantum physics this powerful, energetic exchange of the vacuum with electrical matter is now proven both experimentally and theoretically. It is already accepted in quantum physics that the vacuum is filled with electromagnetic energy. The researcher doesn't have to prove it anymore; he just has to find out how to properly use it. The artesian well is already there; we just have to learn how to collect and use the flowing water without dynamiting the well!

The remaining objection orthodox scientists usually raise against the notion of extracting vacuum energy has been

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density of the exchange causing the Lamb shift is greater than the surface energy density of the sun. Different physicists have made various theoretical estimates of the energy density of this seething vacuum. A conservative ballpark figure is something on the order of 1090 grams per cubic centimeter, expressed in mass units.

It has also been my good fortune to know and work closely with several other free energy researchers. I was a colleague of Floyd ("Sparky") Sweet (recently deceased) for about seven years; Sparky held a Master's degree in EE from MIT and had years of experience with General Electric and other firms. He was a highly skilled researcher who invented the solid state vacuum triode amplifier (Figure 19), a unit which produced 500 watts of output and a coefficient of performance of 1,500,000. I personally tested the machine, activated the magnets on one occasion, and understand how it all worked. [note 24] The paper [note 25] I co-authored in 1991 with Floyd is still the only paper in the orthodox engineering literature that reports (a) successful overunity functioning of a solid state magnetic device, and (b) a successful antigravity experiment on the laboratory bench, reducing the weight of an object by 90%. [note 26]

We stress again that a legitimate overunity electrical machine must be an open system, receiving excess electrical energy from the surrounding vacuum. As such, it must operate in a higher topology than normal electrical machines (Figure 20).

My good friend Frank Golden has long been a close colleague. Years ago Frank developed a motor that produced overunity efficiency, but then to our astonishment we found (courtesy of Bill Tiller, [note 27] with whom we were working at the time) that its operation depended upon a 5-year-long conditioning (structuring) of the local ambient potential in order to work. Previously we had been entirely unaware that one can sometimes condition the local vacuum and the local matter in the area with a particular dynamic form. Given the local conditioning, a motor with that form will then work in that vicinity, but not necessarily elsewhere at an appreciable distance away. We now understand the mechanism for such "conditioning of the vacuum." We also now know what to do if an overunity machine is actually a machine of that type (many of them are not). In other words, we know how to convert it to a machine that will work anywhere, anytime. We will be addressing such little-known things in future articles.

John Bedini is also a close friend and colleague; John built several experimental motors (both electrical and magnetic) in the overunity area, and performed successful trans-mutation experiments. John is a recognized genius in high-end sound amplifier development. Many audiophiles worldwide still swear that the Bedini amplifier is the best and sweetest-sounding audio amplifier ever built. One of John's battery-powered electrical motors (Figure 21), for example, ran continuously off its battery for about five years, and kept the battery charged. When you realize that such a small electric motor is only about 35% efficient, then you realize that about 65% of the energy flowing out of the battery was being dissipated in the motor as heat, core losses, etc. So the unit was continuously performing work for that five years. [note 28] The 1/8 hp motor represented a load in which the continuous rate of work being done (the rate of energy dissipation) was about 0.08 hp. We will have more to say on this motor and its technical process in a future article.

Bill Fogal is a close colleague; Bill has patented the world's first dq/dt-blocking semiconductor, [note 29] which partially blocks the normal current while continuing to pass the flow of voltage (Table 4). I have written a proprietary technical explanation of the Fogal semiconductor, which utilizes an extremely little-known feature called the "overpotential." The overpotential part of the theory is experimentally proven and theoretically explained in an obscure part of electrochemistry, by a few chemists who specialize in electrode effects. J. O'M. Bockris is probably the leading world expert in overpotential theory; he authored the textbook on it. [note 30]

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because we did not have the proper instruments available. E.g., all our oscilloscopes were "hard grounded" to building ground, and we needed to make "floating differential ground" measurements in order to settle things once and for all. McLain and Wooten have filed for a patent, and multiple tests with excellent equipment have indeed indicated overunity. What happens next remains to be seen. I suspect that the two inventors may simply accept foreign capital investment and go offshore.

Howard Johnson is also a respected colleague, whom I very much admire. (See Figure 23). Howard has continued to work quietly and patiently upon his patented permanent magnet motor, [note 31] including patenting various magnetic gates, etc. that are necessary to make such a motor work in a rotary configuration. [note 32] Howard employs a two-particle theory of magnetism; i.e., each magnetic flux line is envisioned as having a particle traveling from the north pole to the south pole, and also a particle traveling from the south pole to the north pole. The particles are spinning; the forward-time particle spins in one direction, and the antiparticle spins in the other direction. Howard then slightly separates the two particle flows. [note 33] In other words, Johnson splits the flux lines themselves, into two different pieces. When so separated, the component lines are now curls, so their paths curve. The paths of the two "curl particles" are different; one curls in one direction and the other curls in the opposite direction. Further, a predominance of one form of curl particle gives a "time-forward" aspect, while a predominance of the other form of curl particle gives a "time-reversed" aspect. Johnson is thus able to employ a deeper kind of magnetism than the textbooks presently contain. He demonstrates that a "spin-altered" magnetic assembly exhibiting (to a compass or other such detector) a north polarity can attract another unaltered magnetic assembly exhibiting a north polarity. In short, he can make a north pole attract a north pole. We will give you further insight into Johnson's two-particle theory in a future article. [note 34] We will also explain how and why the physicists missed that antiparticle in the magnetic field's flux lines, and thereby failed to advance the theory of magnetism to a deeper level. Make no mistake, one day when the new theory is done, Johnson may well be awarded a Nobel Prize for his epochal discovery of a deeper structure of magnetism.

Bits and pieces of the new science approach are just now beginning to spill into a few conventional journals and symposia. For some time a few of the rebels spearheading this new science have been doing something that the University scientists should have been doing all along. The rebels have been meticulously examining the concepts, postulates, and definitions that the present scientific models are founded upon, to reveal serious foundations errors. Corrections for some of these errors have been discovered and made. [note 35] Others are still problems yet to be resolved. Yet slow progress is being made, and a "flip-over" of the old science is likely to occur within the next decade if not sooner. By then the new concepts will have become "solid" enough to allow producing an engineering mathematical model. Also the supporting experiments will have become solid enough to justify the new concepts and the model.

In this first article I wanted to introduce the 14 major areas. We will be discussing these areas in some technical detail in the future. We'll also include current major news items of development in these areas, for the interested lay reader. I'll particularly try to give you the benefit of extensive reference citations painfully gathered over the last 30 years. The articles will be targeted toward both the serious researcher and the interested, educated layman.

So that's the agenda for the months ahead. We hope you find this information and the approach of direct interest and use.

Again, it's a privilege to be aboard. And we invite you to hang on in the future; it's going to be a wild but exciting ride. We really are going to chase this wild dragon with great vigor.

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Scalar Wave Technology

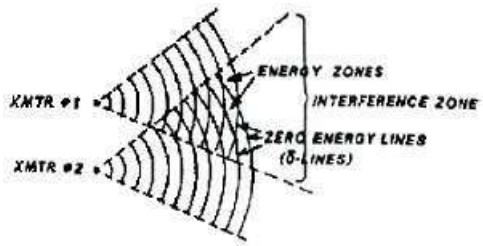

Scalar Wave Detection

Warren York
Scalar Wave Researcher

Originally published: **ExtraOrdinary Science (Volume 1, Issue 4; Oct/Nov/Dec 1989)**

WARNING: Do not attempt electrical construction on any of the equipment, coils or devices described here unless you are fully qualified. In some cases LETHAL voltages and charges are required. Also be advised that improper use, application and physical methods may cause psychological tramuma or permanent physical and neurological damage when near the vicinity of such equipment. This information is being provided as a point of interest to our readers... the publisher and author disclaim any responsibility in the use or misuse of this information.

Introduction

All of this talk so far on scalar waves and scalar technology has no purpose in the scientific community until something can be detected, observed and duplicated. The original seedlings and thoughts which led to Lt. Col. Bearden's scalar theories were developed out of observation. If not by Lt. Col. Bearden himself, then by others from many noncorrelated paths.

I already have given a small sample list of such observers from Nikola Tesla to the latest, Moray King. I have just read a newly released book by Moray entitled ***Tapping the Zero Point Energy***. I also recommend highly for others interested in scalar technology to obtain copies of Bearden's works and books from the new release of ***Excalibur Briefings*** to ***AIDS--Biological Warfare***. The two books and papers will fill in the much needed base work on understanding scalar technology and can be obtained through the High Energy Catalog.

I also understand that a new book is in the making which is a rebuttal entitled something along the lines of *Anti-Scalar*. All of this is healthy in any development process, for without pros and cons, the sorting of correct data to trash data cannot be accomplished. On the other hand, I would like to point out that any conclusions should be supported by actual tests and not just by armchair theory.

Anybody can debate from the armchair but to have any meaning to back up their statements, one must present tests where one gets his or her hands dirty. That is to say that until I had reactions and observed actual phenomena occurring, all the theories were no more than that--just theories. This is what I hope to accomplish here with these articles on scalar technology. I feel this is a true new technology and deserves some serious consideration.

If I had not gotten my hands dirty and followed through on others' experiments from other observers then I would never have been convinced that something extraordinary was taking place. Even though my senses told me I was wasting my time I set out on the monotonous task of duplicating others's work and notes of observation. This is what I hope some of you will do and start to help unfold and unleash this hidden knowledge called scalar -- zero point energy -- stress energy and even radionics. Itis true indeed that it has many names over the years, but now we can at least have hope of defining its true limits and abilities.

The detection methods I will present here are not confirmed by myself or corresponding researchers as of yet due to development is still in progress. In one method I can only accept the word of the researcher as to his results. Until I or others duplicate results it remains a possible process and approach in detection.

My own detection came in the form of two experiments which were reproductions of another author's work based on this technology. When I had reproducible results I knew there was more to scalar than just theory. The process is now underway in developing a reliable instrument or means of detection that others can use. Up to this point most of scalar observations have been uncertain and always with the person or operator being part of the circuit. Nobody could remove the person at this point to bring scalar under true observation conditions. Due to a simple observation in Mr. George Meek's work in electro-voice phenomena (EVP), where my first breakthrough was established, this now seems a possibility. The personal element was still included in the circuit but unlike radionics or Hieronymus devices, could be reproduced by anybody once special conditions were met. A co-researcher has hit upon a method which was initially observed by Nikola Tesla and shows promise of another breakthrough in removing the personal element.

I will now discuss my initial breakthrough to scalar detection which will help you follow my thinking on what is needed and just what we are looking for in scalar detection. Scalar properties are the dictating key elements in this approach. I will then describe a possible detection method of another researcher and finally what I feel will be a unique approach with an instrument currently under construction by Mr. Russell Clift, a co-researcher/inventor, and myself. Do not feel you have to adhere to these techniques for they are only a guideline and starting point to spring from in your own approach to this subject. They are not established yet and will most likely be altered many times before their completion.

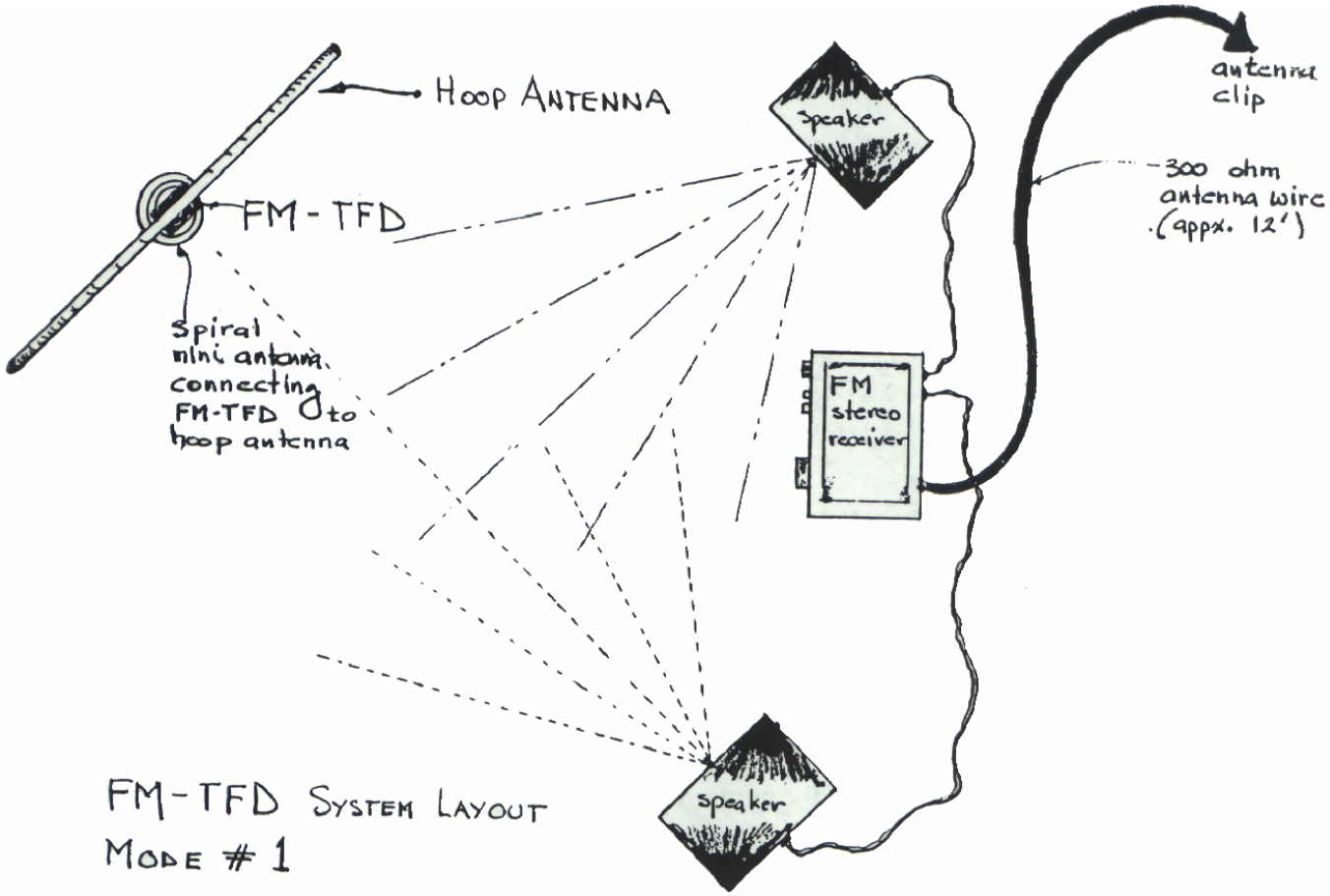

Figure 1. **System Layout for FM-TFD [Mode 1]**

As in all unknowns there are always unforeseen dangers involved and one should always use extreme caution and behave professionally in all approaches with any experimenting. Madame Curi and the XRay research is a good example. They paid dearly for their progress in X-Ray development with their lives. Scalar and its properties can be just as deadly as it is fascinating. I hope you read the seriousness in my tone for no matter how science fictionish scalar may sound to you now, I assure you the reality of actuallity can end up staring you in the face.

<u>Breakthrough Event</u>

Several years ago a Mr. George Meek presented me with construction planes and notes to a device he called Mark V. [Figure 1] Mr. Meek had been researching a phenomenon better known as EVP, or electro-voice phenomena. [Figure 2]

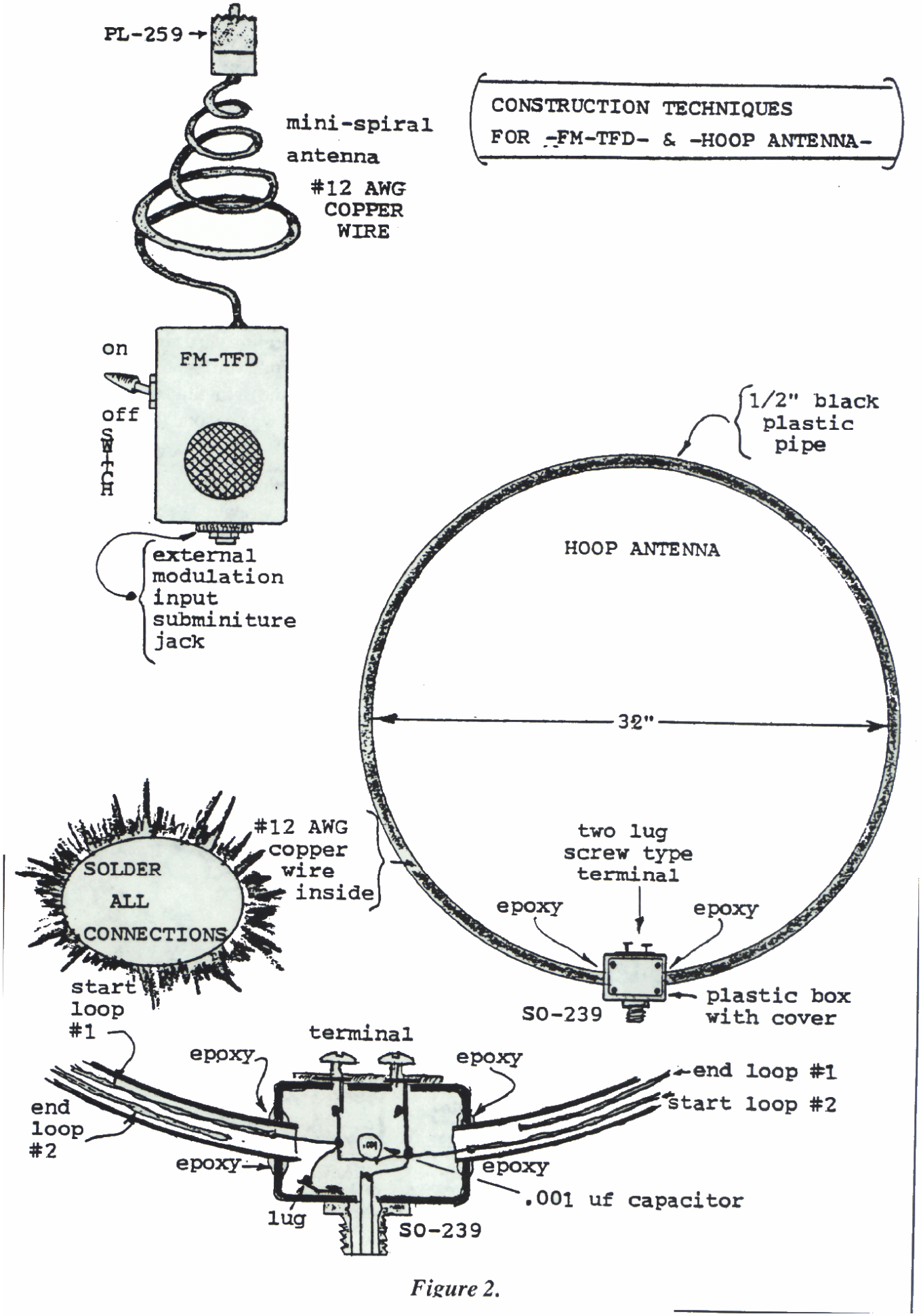

Figure 2.

Figure 2. **Construction Techniques for FM TFD & Hoop Antenna**

I would like to take a second here and answer a letter from one of **Extraordinary Science**'s subscribers printed in our last issue. Mr. Jeff King from New Zealand had written to the effect if perhaps I could cover what relationship scalar technology has in reference to EVP. [Figure 3] Well here it is, for this was the first reproducible effect dealing with scalar energy [interference pattems] [Figure 4] that I could verify really took place. My second breakthrough was also in the EVP area but I will not be able to go into it at this time due to available space to cover what must be covered now.

In short, Mr. Meek claimed to have a fantastic breakthrough of his own in the communications field of EVP. His claims were a recorded two-way conversation with another dimension. ***ZAP!*** Right here one would stop and feel that Mr. Meek and his researchers needed psychological help as I am sure some of you feel about me at this point. I contacted Mr. Meek and he flew down to El Paso so we could talk in person. He brought me two audio tapes of which one surely did have what appeared two-way communication in real time.

Up to this point all EVP claims were after the fact type of events. That is, the voices always appeared on blank tape after the operator had run the tape recorder for a period of time. No audible sounds were heard during the initial recording, only after playback of the tape--sort of the same thing being done now with channeling, but the person is still part of the circuit. Not all voices were understandable or clear enough to be real voice prints or just random white noise perhaps forming what almost sounds like words. In other cases, the words and even statements were definitely clear and of intelligent source. Well, Mr. Meek's tape went way beyond this to a two-way real time conversation.

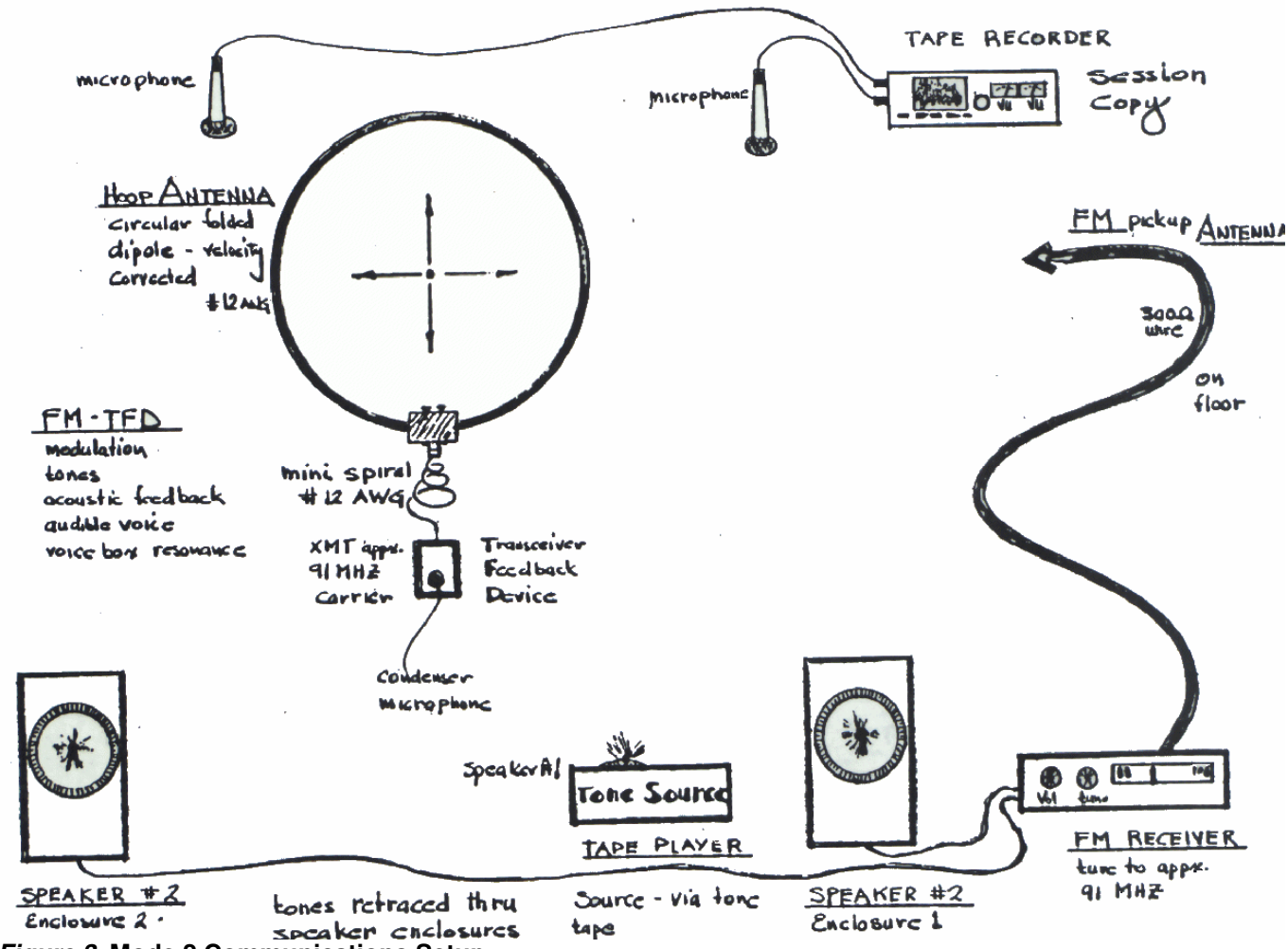

Figure 3. **Mode 2 Communications Setup**

Fascinated by these claims I wanted to know more on how such a process worked. This is where he presented me with the second tape. It consisted of thirteen mixed electronic tones. No, there is no magical number in why thirteen tones were used only that they were needed to create interference patterns. These tones with an acoustical feedback and RF transmission with a Smith coil produced a unique interference pattern [scalar-RF and acoustical stress field].

I followed the notes and set out to reproduce this fantastic claim. At one point in the notes was one observation statement:

The system seems capable of feeding back changes in emotional states.

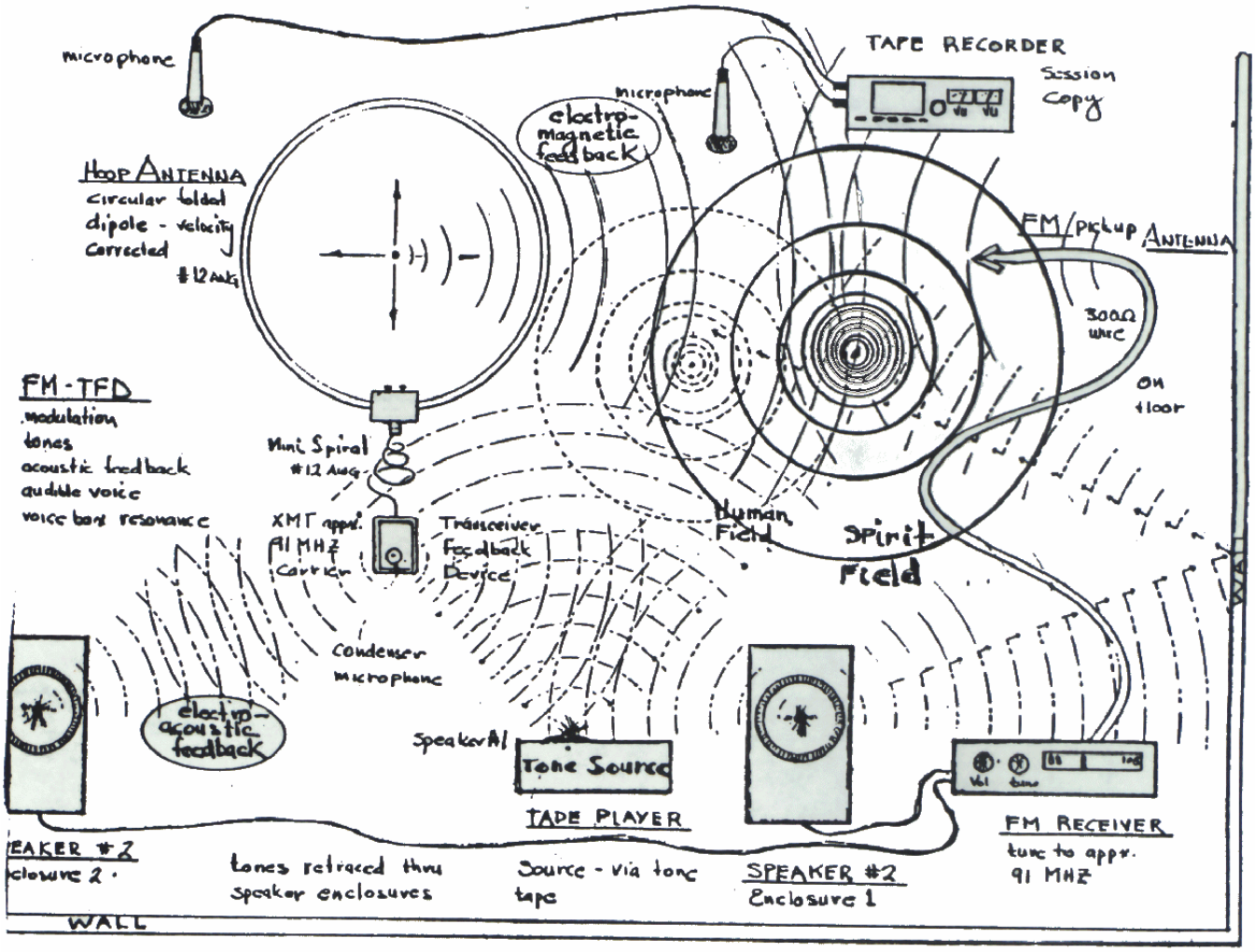

Figure 4. **Mode 2 Communications Interference Pattern**

I stopped there and to my amazement found the observation to be true. I was able to control an avalanche effect in a balanced tone of a set of acoustical and RF frequencies with only my own concentration -- no doppler effect or movement or contacts to my body in any way. I taped this effect and it is available to those who wish to observe the level of control of an electrical circuit with shear stress energy from a human.

This observation is equal to Nikola Tesla's observation of his plasma globe and tensing a fist. He found the plasma trail would rotate in relation with the tension or muscle pressure produced. I will cover this process in a moment for the plasma approach in construction a scalar indicator seems to be ideal due to its extreme sensitivity that up until now has been the human or personal element.

<u>Bedini Version ---- Dea/Faretto Scalar Detector</u>

In this version of an electromagnetic scalar detector you will see that a coil is suspended in a magnetic field within a shielded case. [Figure 5] It is not indicated but I am sure the coil should be wound as a scalar coil. See "Construction of a Scalar Coil," **ExtraOrdinary Science**, Vol.I, Issue 3, page 16. The shielding is so all that known EMF fields will be run to ground and not affect the sensor within the case. As you know, one of the properties of scalar energy is that it cannot be shielded. All known EMF will be stopped from entering the case except gravity fields and scalar energy.

I am not saying that gravity fields or scalar fields are EMF, but only that the formula to each have a basic root in the EMF part of the spectrum. A generated scalar pulse or field will cut past the case shielding and affect the atoms of the scalar coil within the magnetic field which in tum will be coupled to the op amp. Any change or effect will then be displayed on the scope indicating a pulse or field of some kind has gotten past the system's shielding and to the sensor. You should see a change in the display around 6AM when the sun comes up and there is a slight gravity shift. [1,2]

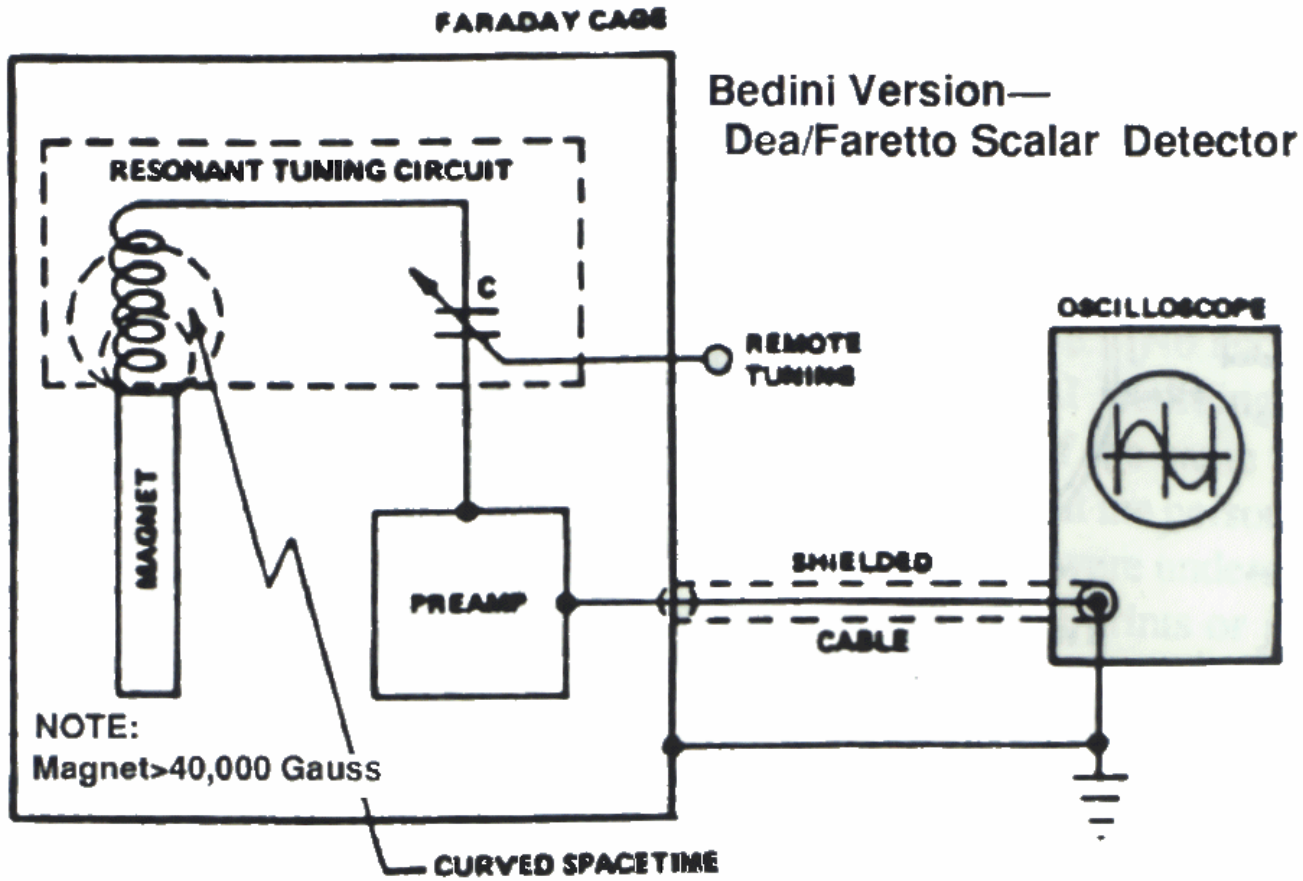

Figure 5. **Bedini Version of Dea/Faretto Detector**

<u>Plasma Scalar Detector</u>

This is the method which is under construction by Russell Clift and myself. At the time of this printing the construction is not far enough to give any details or results as to this approach. [See Figure 6] This is based on the same construction of Nikola Tesla's experiment.[3] Figure 7 is for experiments with various voltages and ion currents. Figure 8 is a simple multiplier for the AC supply shown in Figure 6.

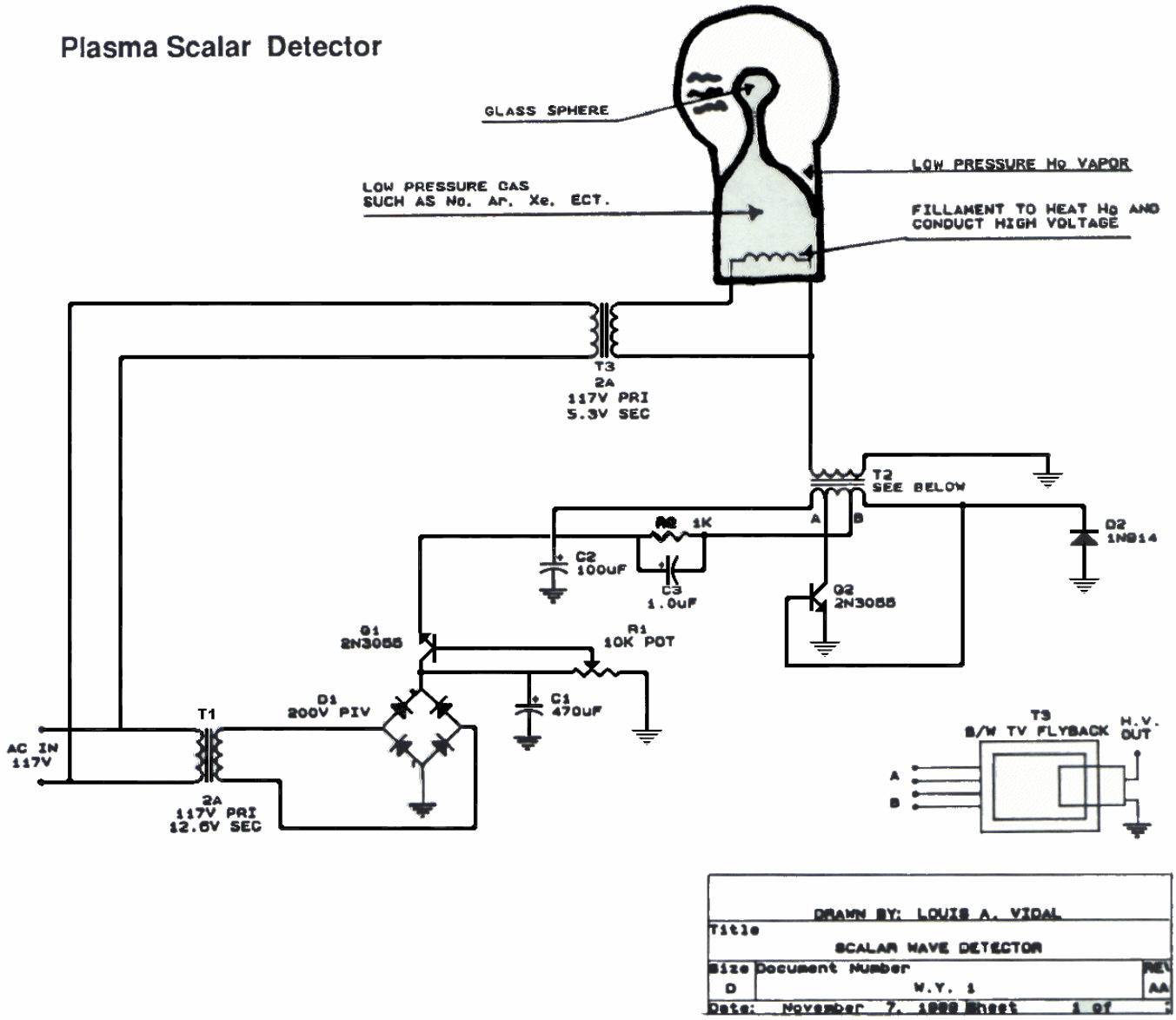

Figure 6. **Plasma Scalar Detector**

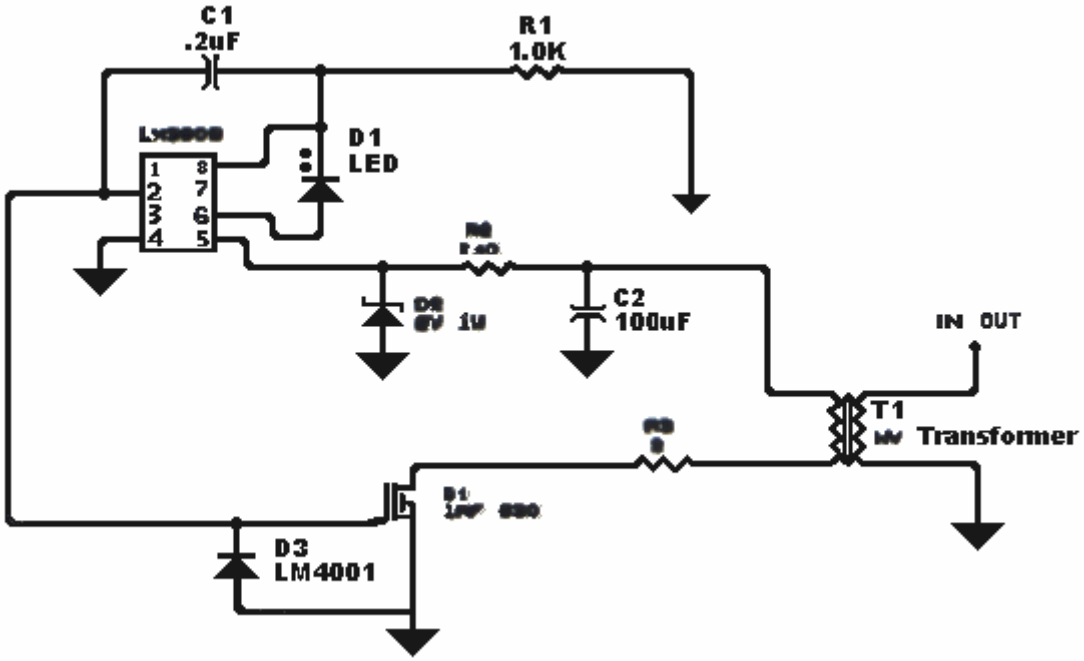

Figure 7. **Power Supply**

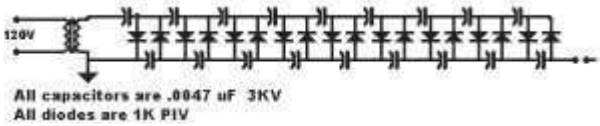

Figure 8. **Voltage Multiplier**

I know I have just touched upon this subject so far but I hope I have given some of you starting points in your own research and findings. I will welcome any and all papers or works you may do in the scalar field and submit your work for publication here for others to read and gain from. Will be looking forward to your replies in the new year. Thank you for your interest.___***WRY***

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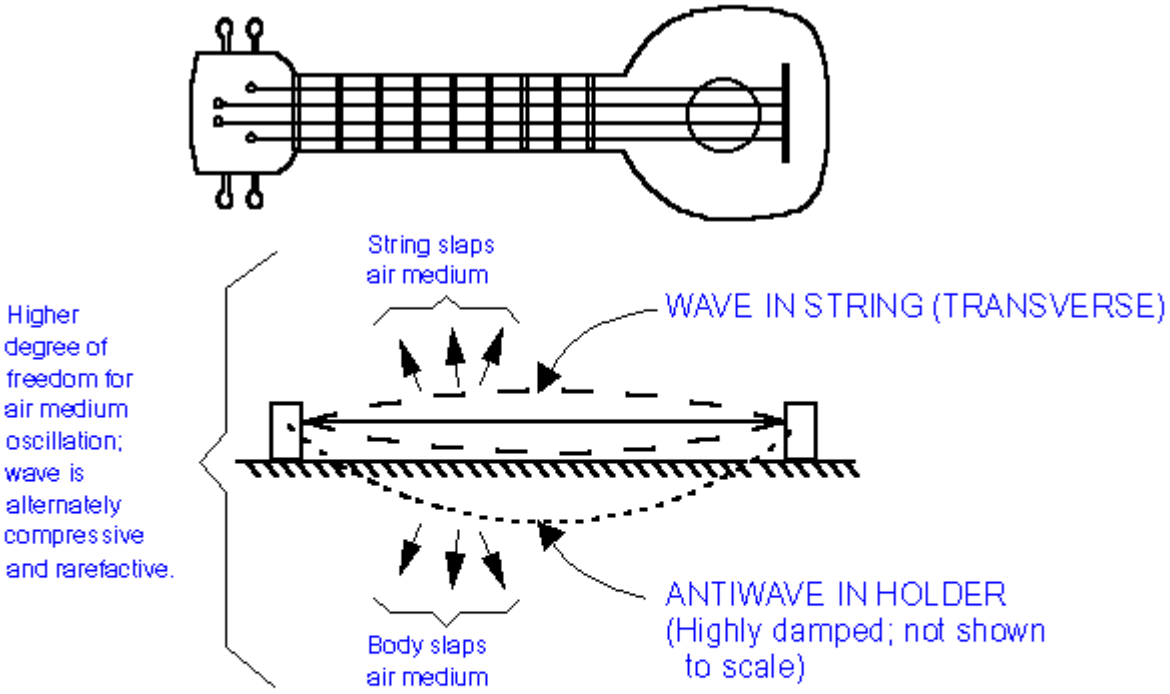

Figure 1. Air medium disturbances generated by plucked string.
Two waves are created, both slapping the air medium at the same time, but in opposite directions. A disturbed medium oscillates according to its own degrees of freedom. The air has more degrees of freedom than the string. A wave of compression and rarefaction is created in the air medium.

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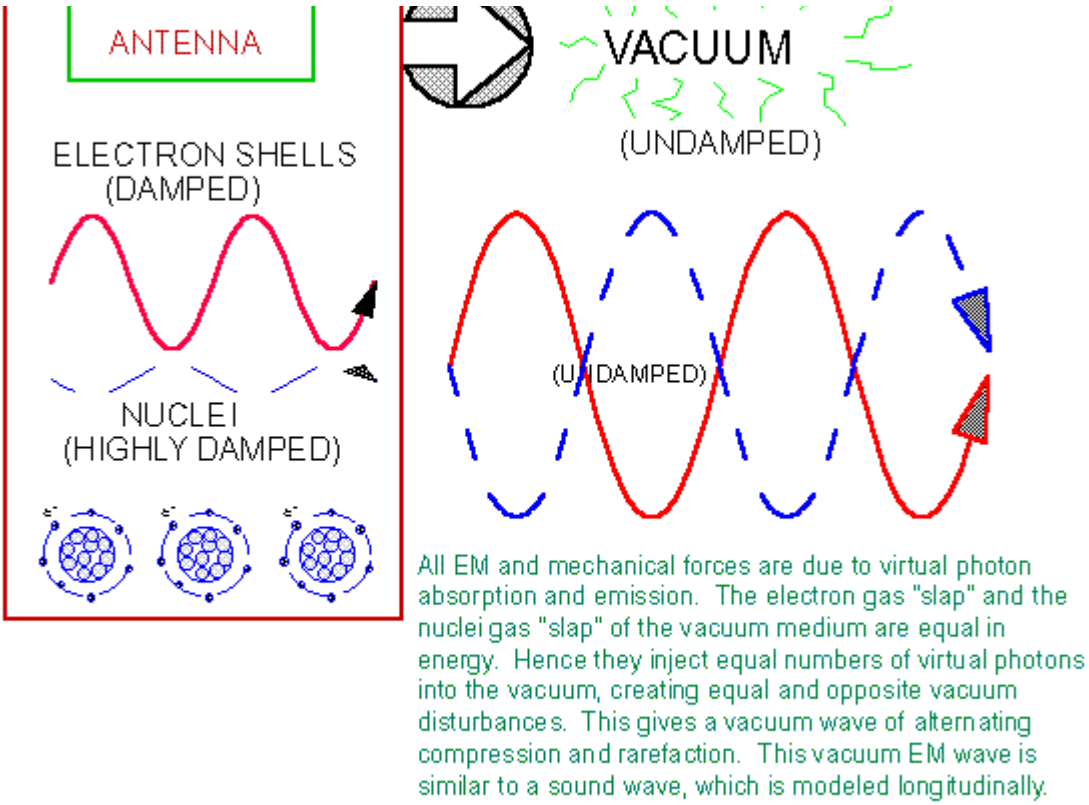

Figure 2. Launching an EM wave from a wire antenna.

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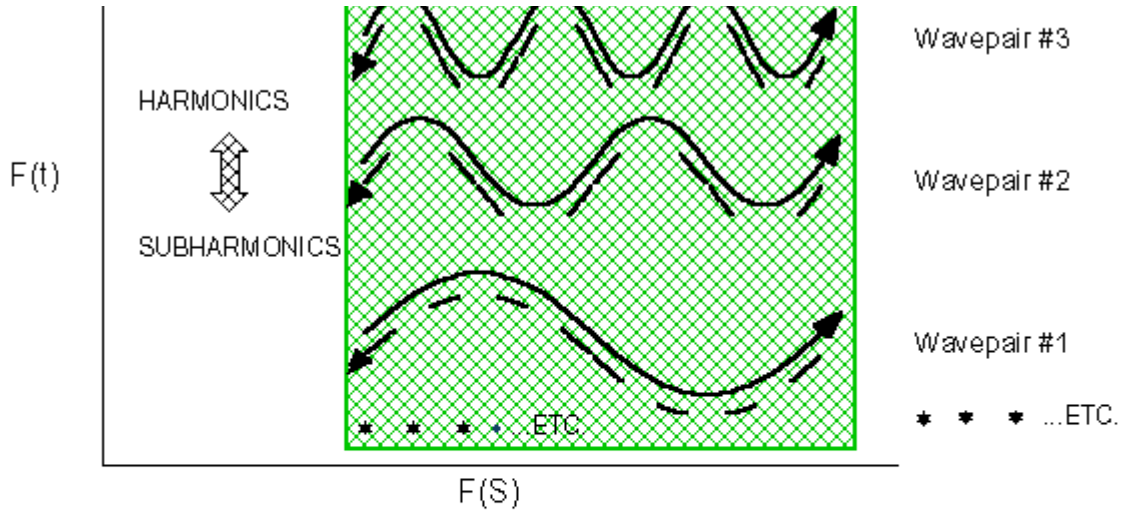

Figure 3. Internal Wave Structure of the scalar potential.

A harmonic set if wavepairs, where in each wavepair the two waves superpose spatially, but travel in opposite directions. The two waves in each pair are true phase conjugates and time-reversals of each other. Thus they comprise a coupled wave and antiwave. The photons must also be coupled into photon/antiphoton pairs, by a strong application of the distortion correction theorem of nonlinear optics.
Each wavepair is a standing electrogravitational wave.

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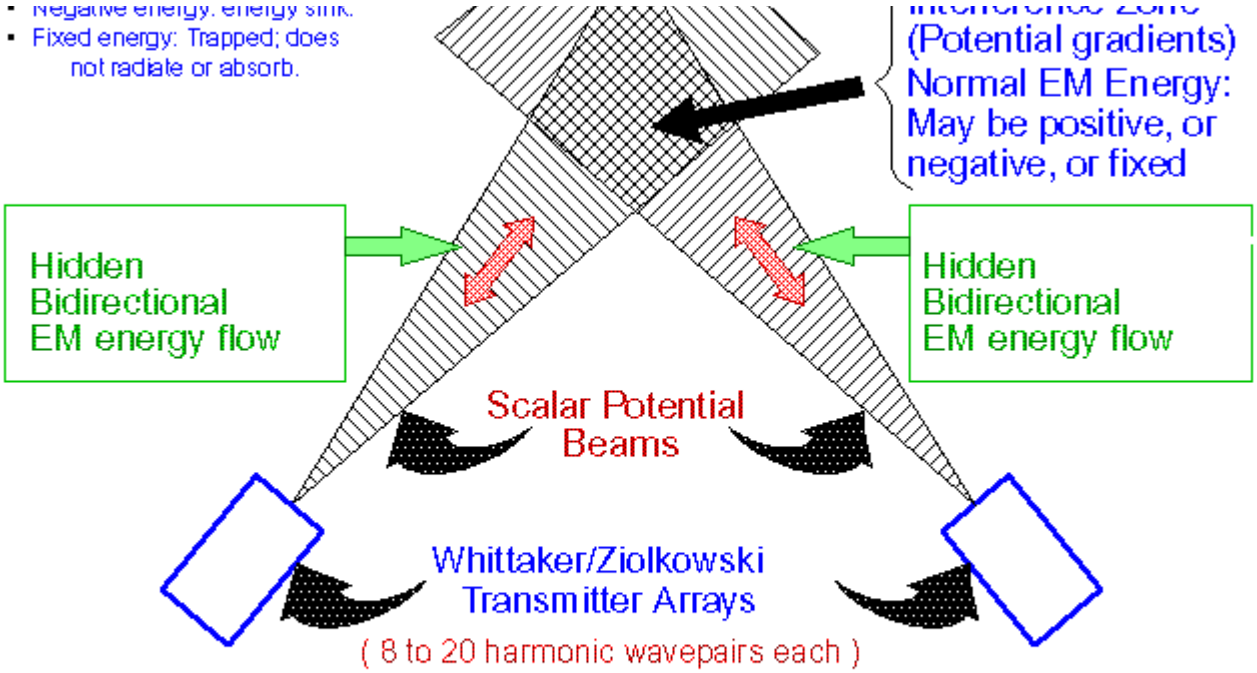

Figure 4. Scalar potential interferometry provides action-at-a-distance. It already creates normal EM fields and waves.

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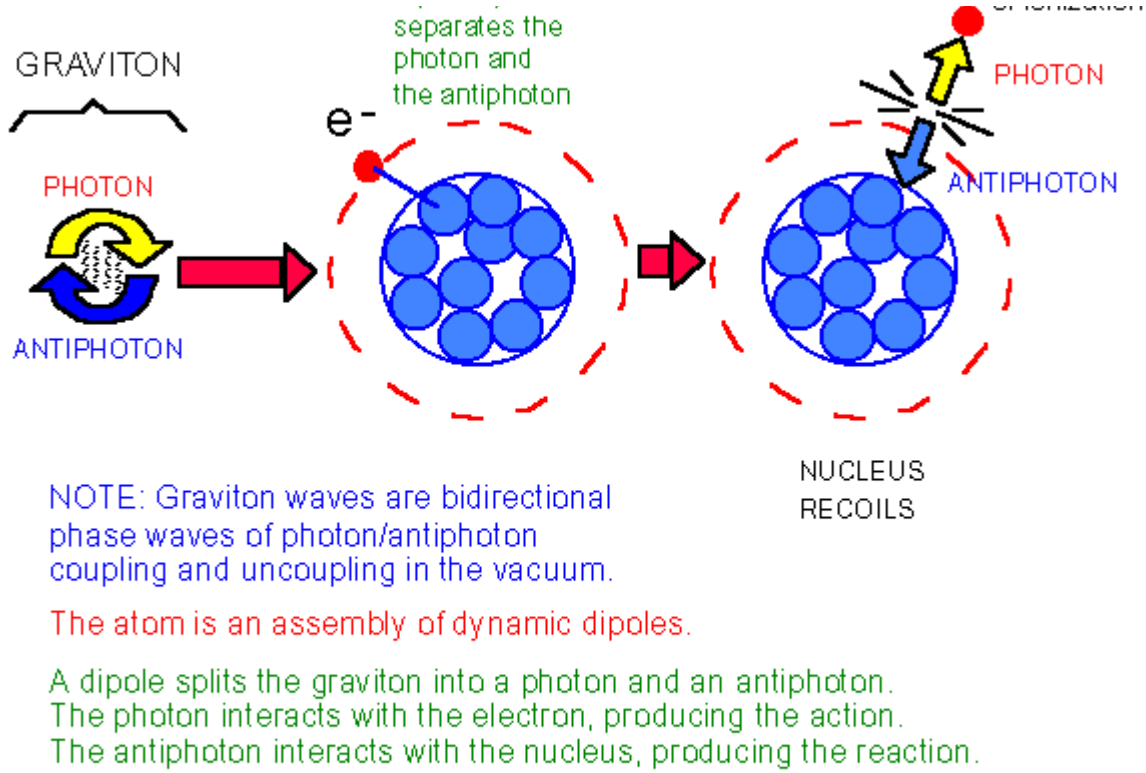

Figure 5. Graviton interaction with matter produces the photon interaction and Newton's third law reaction.

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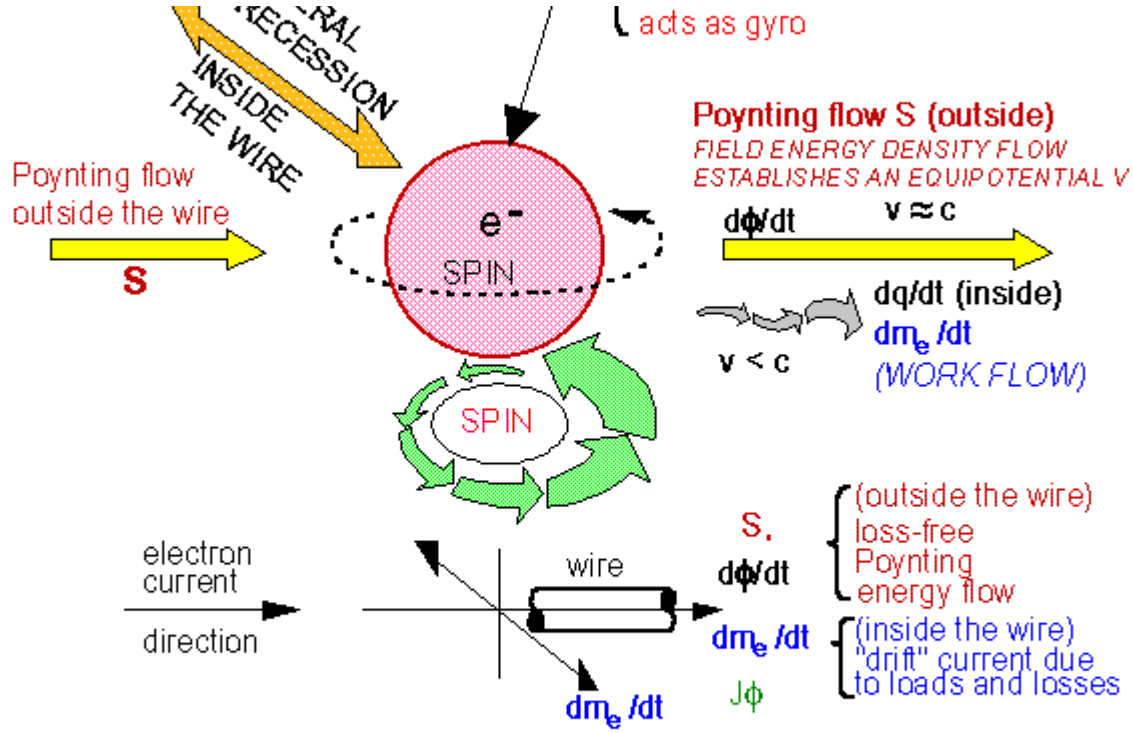

Figure 6. Currents in and along a conductor, with electron precession.

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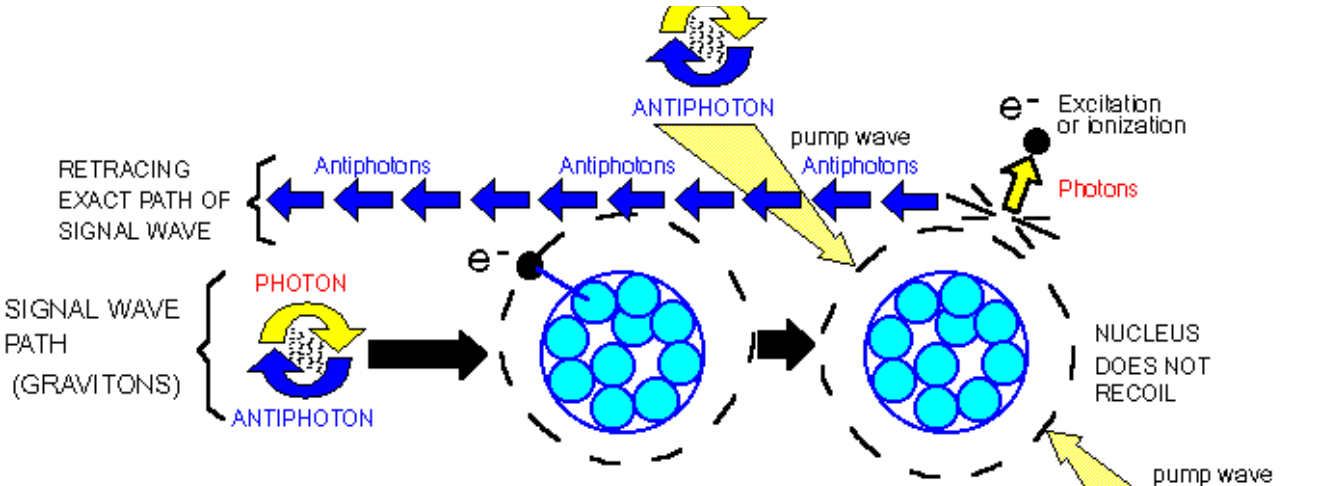

- Dipolarity of the atom separates photon and antiphoton.
- Photon interacts with electron.
- Pumped nonlinear atom acts as a pumped phase conjugate mirror. Directs the antiphoton back along the path taken by graviton.
- Antiphoton does not interact with nucleus. Thus there is no nuclear recoil force generated.
- Nucleus thus does not recoil.
- Not a violation of Newton's third law, once one understands the mechanism that generates third law reaction. In the absence of the generating mechanism, there is no third law recoil. In EM field theory, the "missing antiwave" has necessitated third law omission.

Figure 7. Emission of antiphoton; nucleus does not recoil. Atom acts as a pumped phase conjugate mirror.

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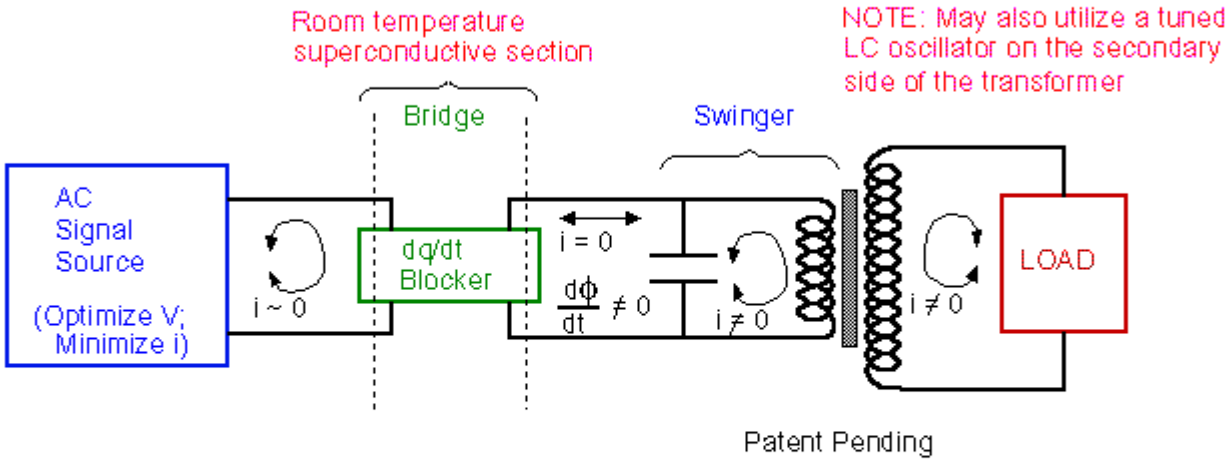

Figure 8. dq/dt-free driving a swinger by S-flow.

Poynting energy flow S with its accompanying potential V is shuttled from the source to a tuned LC oscillator in resonance at the driving frequency or slightly below. The LC oscillator is driven by S-flow and dV/dt flow alone. The swinger furnishes its own free electrons, which receive S and EMF from the bridge, thereby producing dq/dt.

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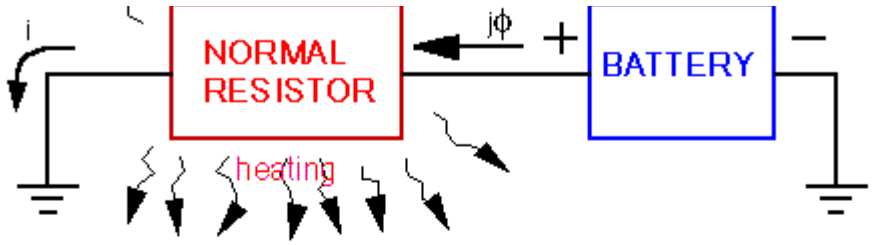

Figure 9a. Normal resistor receives ordered energy and scatters it.

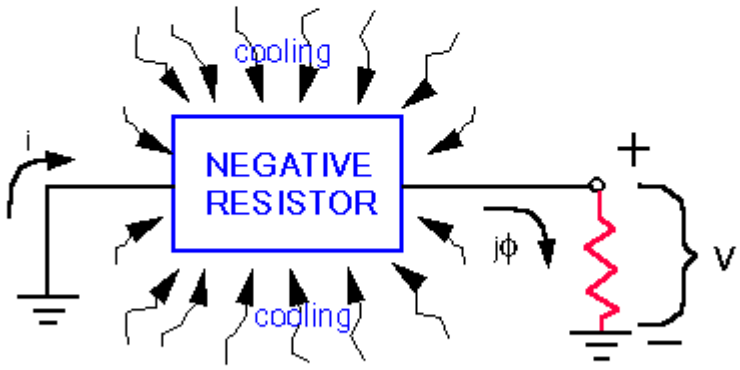

Figure 9b. Negative resistor receives, concentrates, and reorders scattered energy.

Figure 9. Normal resistor versus a negative resistor.

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Some 17 signals were fed into a rotating plasma, which added phase conjugates to them. This infolded 17 wavepairs, each pair a coupled wave/antiwave, thereby forming a scalar potential with an artificial Whittaker pump wave internal structure. This infolded pump wave complex was modulated onto a powerful, rippling magnetic field, guaranteeing penetration even into the atomic nuclei. A specific, amplified antiengine for the exact cellular disease state was generated, reversing the diseased cells back to a previous healthy state.

Figure 10. Priore's laboratory apparatus for cellular reversal.

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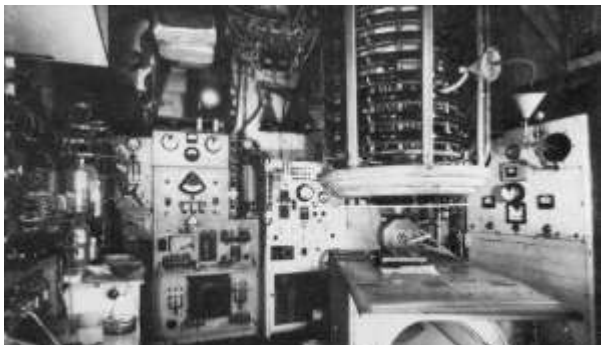

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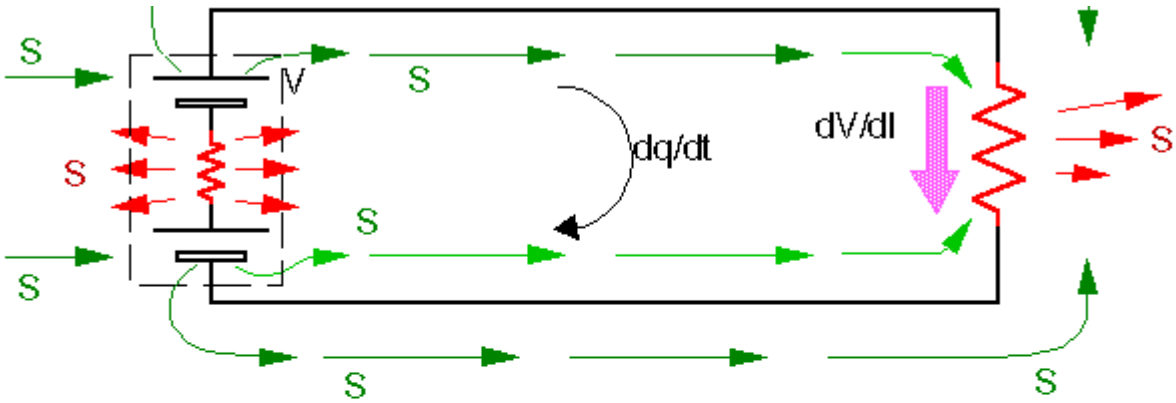

Note: EM texts err in showing the battery "gate" as the source of energy.

Figure 11. Poynting S-flow along a simple circuit.

From particle physics, any electric charge is a broken symmetry in the vacuum's virtual particle flux. Any dipole is thus two locally broken symmetries. Thus the dipole acts as a gate/source, driven by the fierce vacuum flux. So a dipole already "extracts" and gates EM energy flow, directly from the seething vacuum.

Every battery and generator is already a "free energy" source of extracted and gated EM energy from the vacuum.

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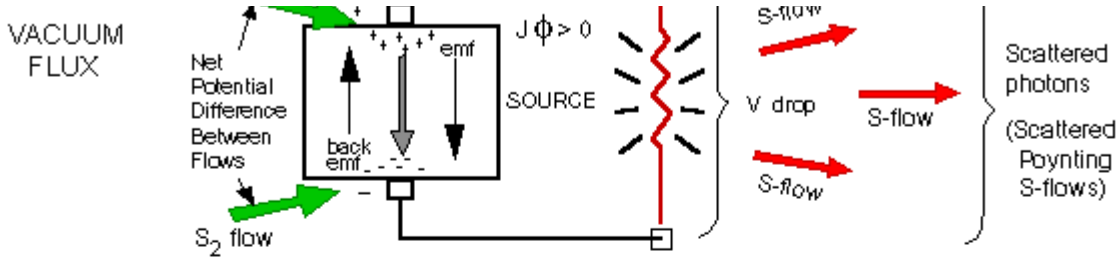

Figure 12a. Normal current flow; Jϕ is the electron transport of energy, while S is the speed-of-light Poynting energy flow.

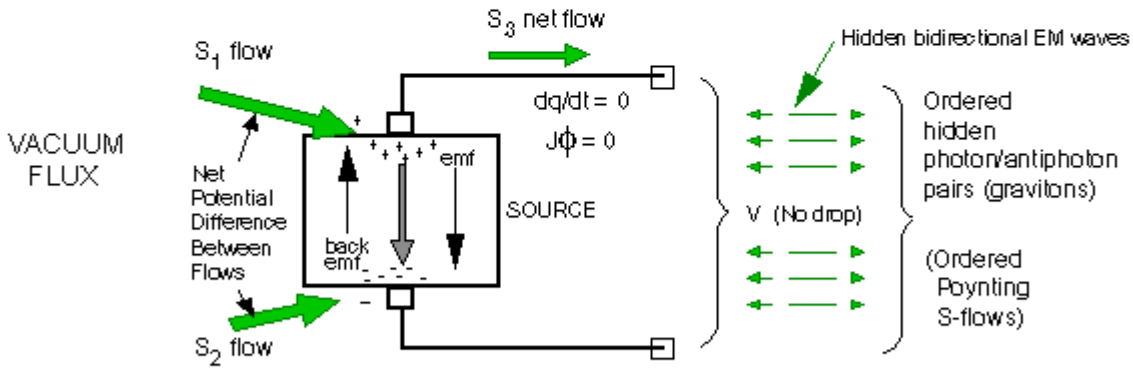

Figure 12b. In a conductor with dq/dt blocked; S-flow and hidden Whittaker-wave flow continue.

Figure 12. Overt and covert field energy density flows.

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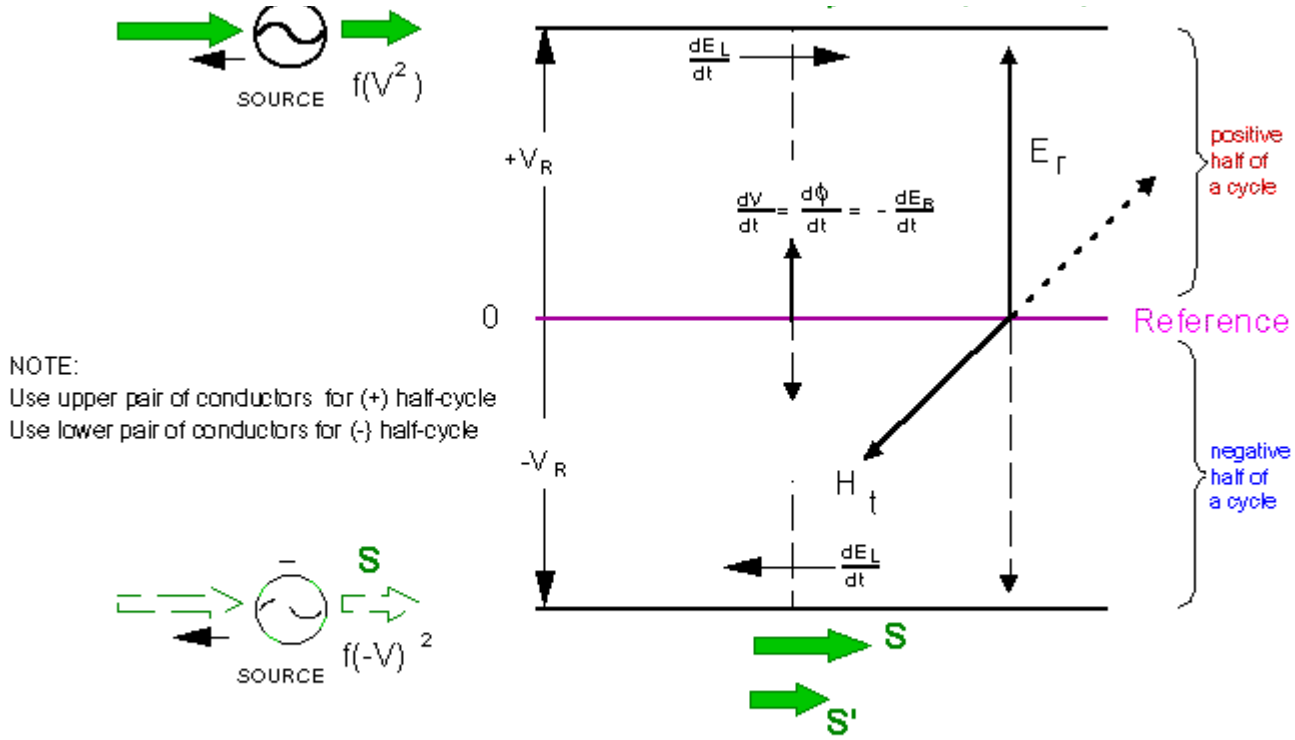

Figure 13. Poynting vector currents S and S' versus massless displacement currents.

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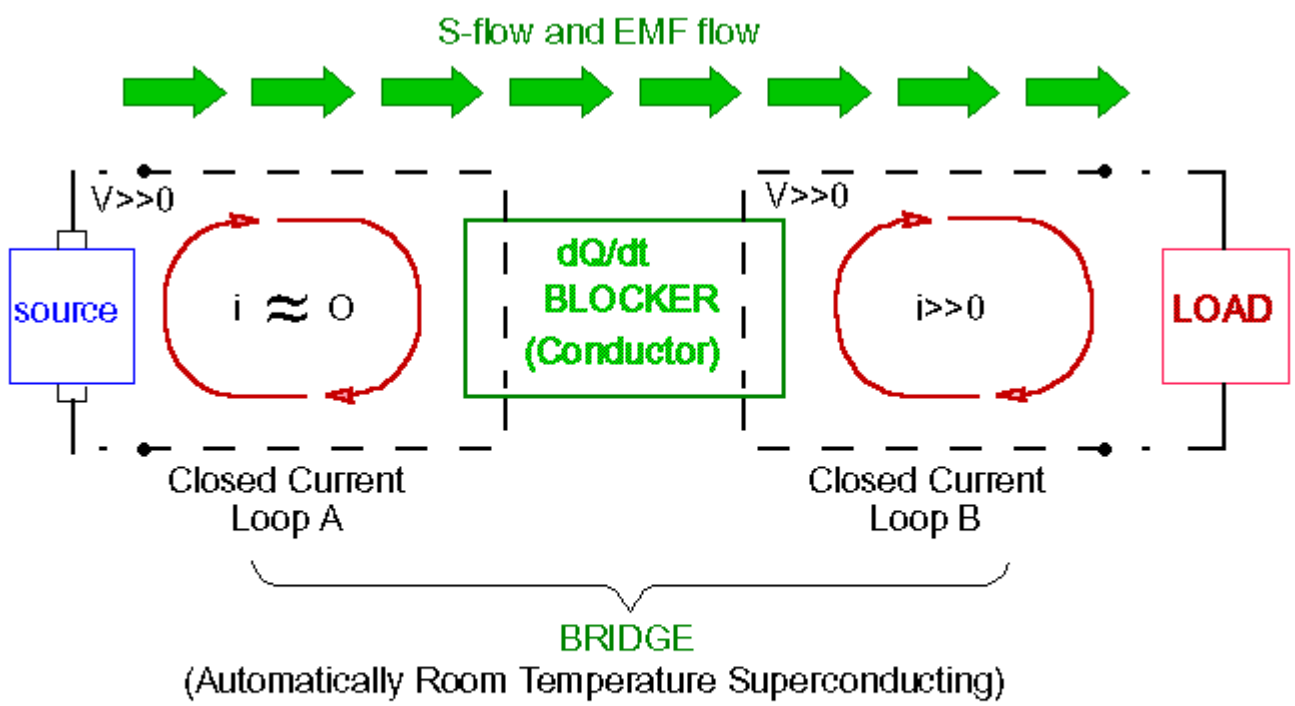

Figure 14. Bridging to enable room temperature superconductivity.

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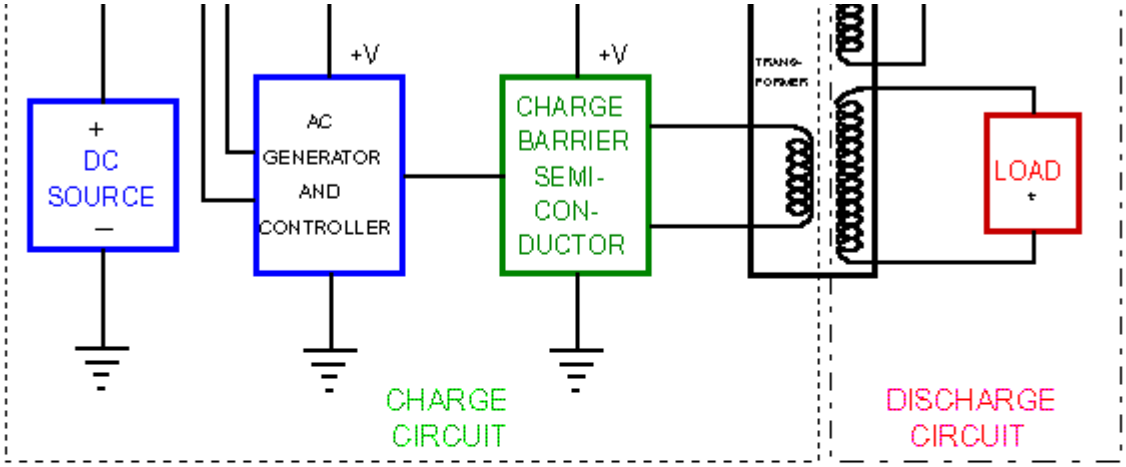

Patent Pending

* NOTE:
DISCHARGE CIRCUIT AND LOAD GROUND
MUST BE ISOLATED FROM THE
CHARGE CIRCUIT GROUND.
FEEDBACK LOOP MUST BE RIGIDLY CLAMPED AND LIMITED.

Figure 15. Use of Fogal semiconductor for overunity (closed system).

D-1-F15

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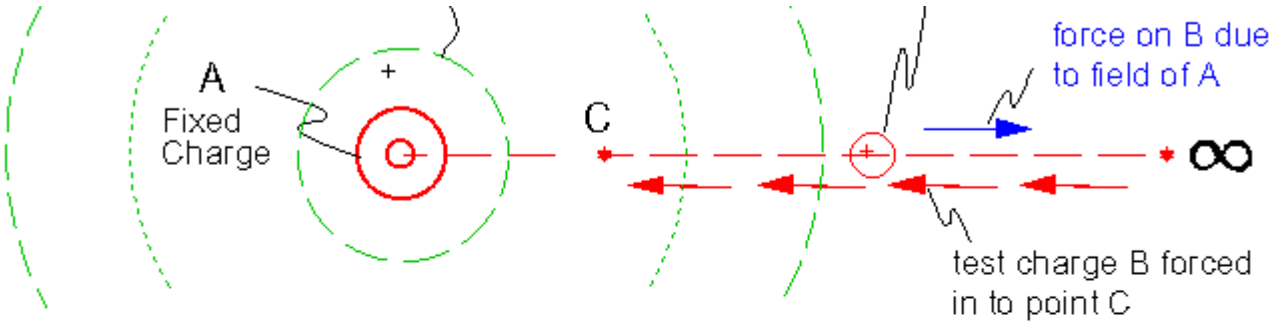

Figure 16a. Magnitude of the scalar potential is determined by work required to push in a unit charge from infinity; e.g., against a repelling like charge. If test charge is released, work will be performed upon it to translate it back toward infinity

Figure 16a. Process for overunity coefficient of performance.

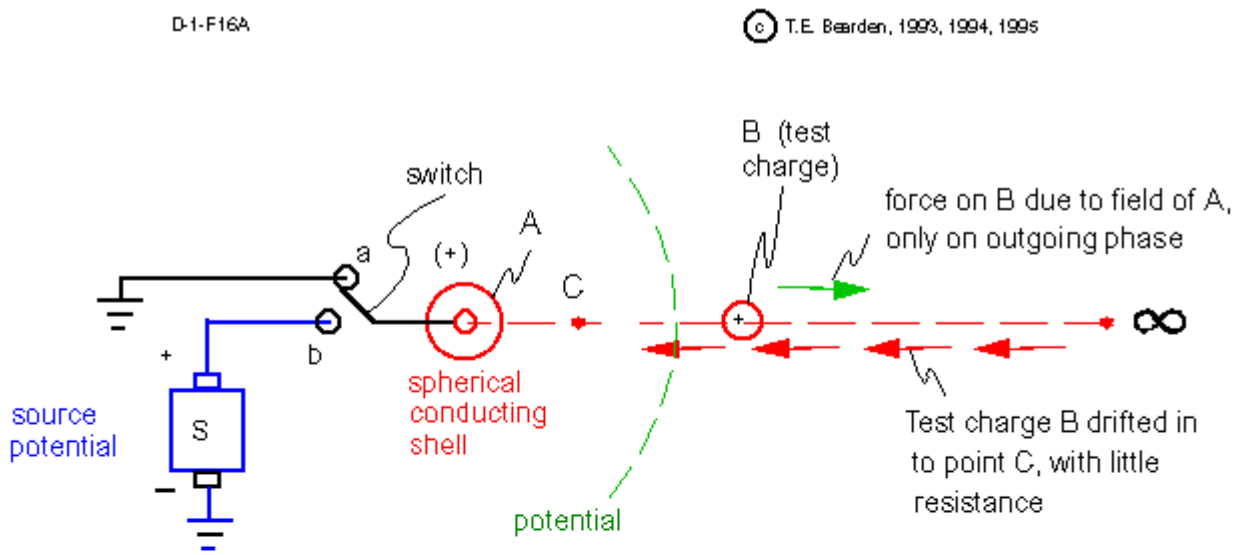

Assumptions: Capacitance of A very small; charge B large, power-free switching

Switch potential off, drift in test charge B, switch potential back on. Can now get free work from repelled test charge B. Get much more free work if A is at a high potential, and charge B is large.

Figure 16 b. Demonstration of overunity efficiency

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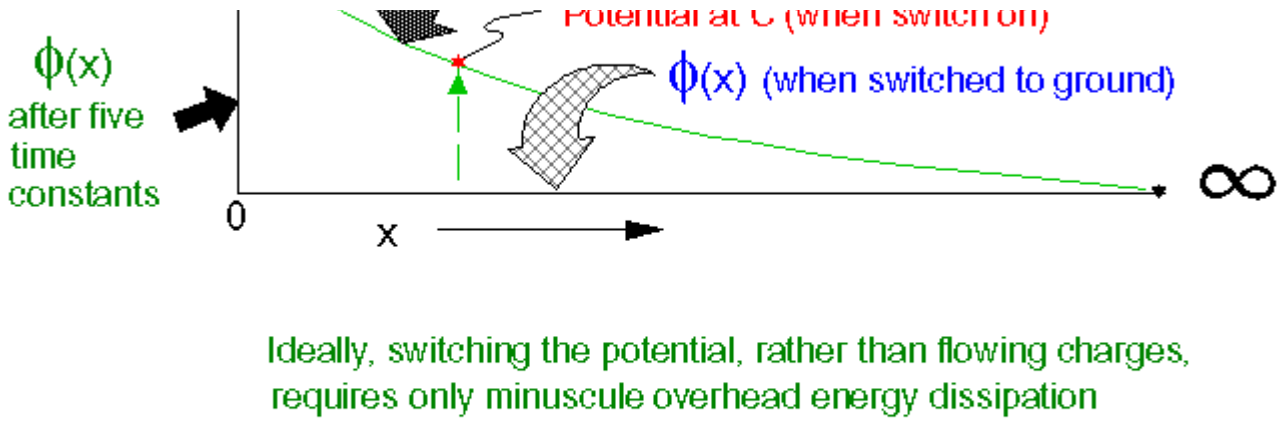

Figure 16c. Potential to which test charge is exposed.

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Open system receiving excess energy from an external source

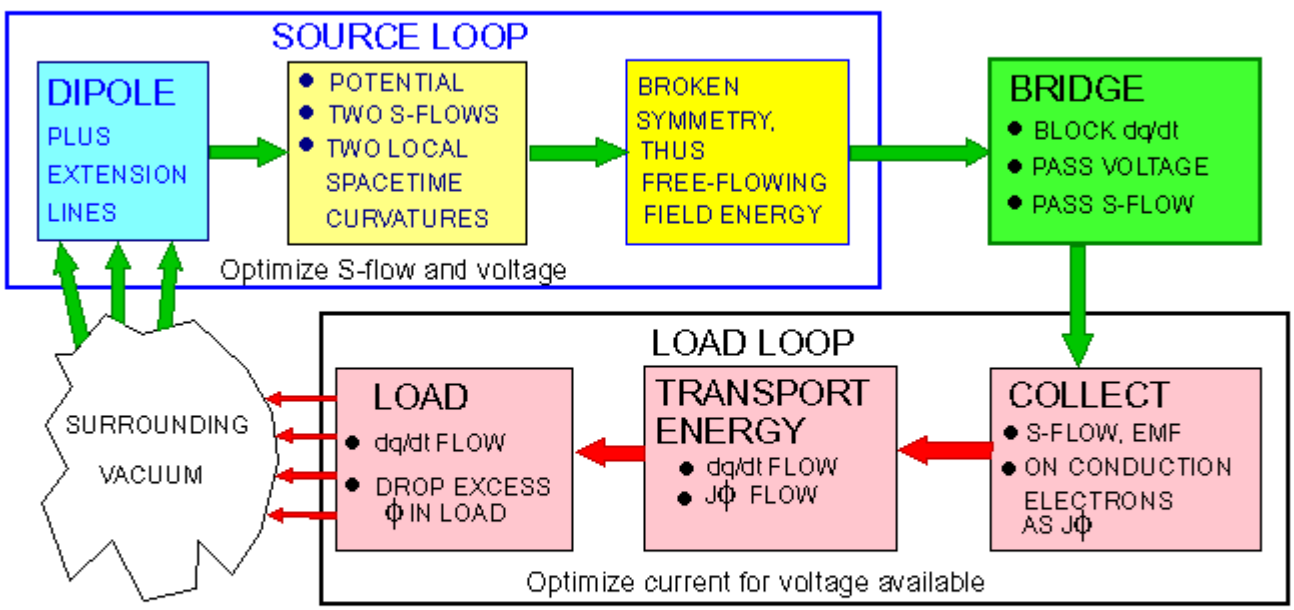

Figure 17. Operation of an overunity electrical power system.

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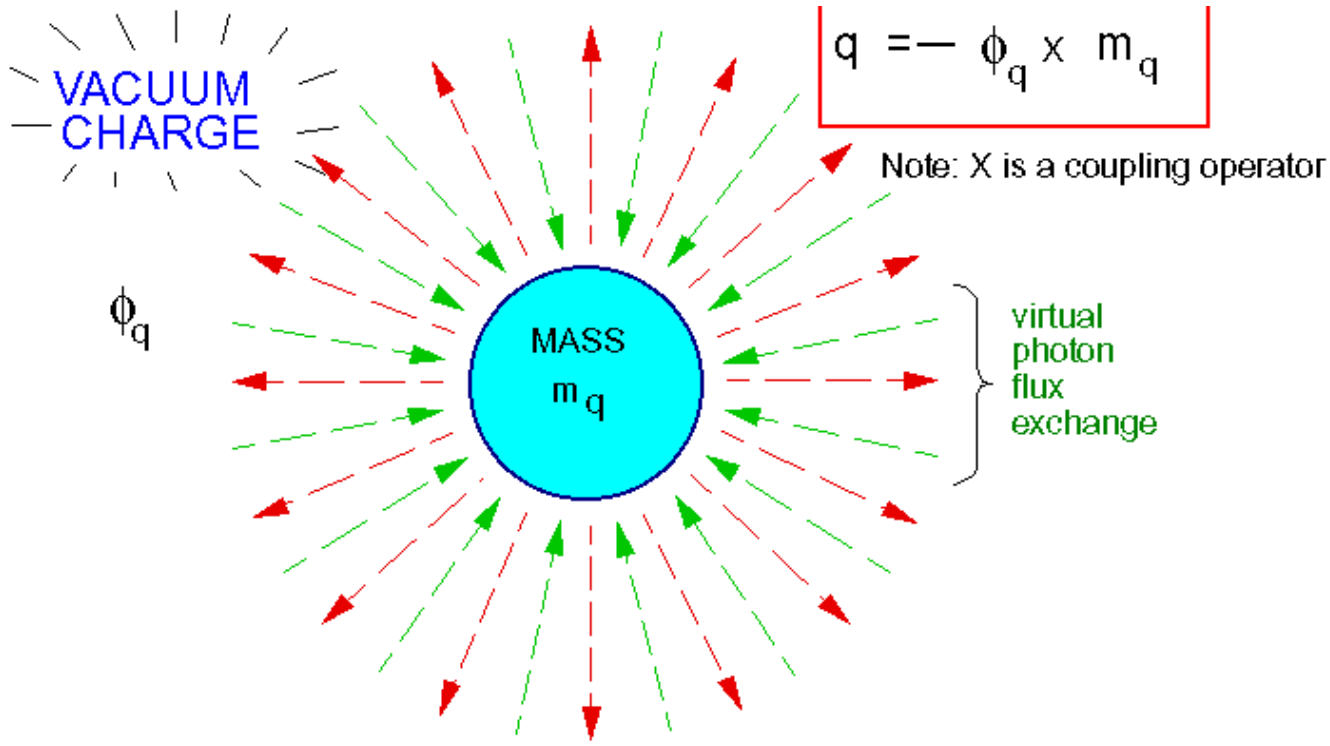

Figure 18. An electric charge q is a broken symmetry. It continuously and violently exchanges energy with the vacuum.

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The Dawn of E-BOMB

For the wired world, the allure and the danger of high-power microwave weapons are both very real

By Michael Abrams

In these media-fueled times, when war is a television spectacle and wiping out large numbers of civilians is generally frowned upon, the perfect weapon would literally stop an enemy in his tracks, yet harm neither hide nor hair. Such a weapon might shut down telecommunications networks, disrupt power supplies, and fry an adversary's countless computers and electronic gadgets, yet still leave buildings, bridges, and highways intact. It would strike with precision, in an instant, and leave behind no trace of where it came from.

In fact, it almost certainly is already here, in the form of high-power microwave (HPM) weapons. As their name suggests, HPMs generate an intense "blast" of electromagnetic waves in the microwave frequency band (hundreds of megahertz to tens of gigahertz) that is strong enough to overload electrical circuitry. Most types of matter are transparent to microwaves, but metallic conductors, like those found in metal-oxide semiconductor (MOS), metal-semiconductor, and bipolar devices, strongly absorb them, which in turn heats the material.

An HPM weapon can induce currents large enough to melt circuitry. But even less intense bursts can temporarily disrupt electrical equipment or permanently damage ICs, causing them to fail minutes, days, or even weeks later. People caught in the burst of a microwave weapon would, by contrast, be untouched and might not even know they'd been hit. (There is, however, an effort to build a microwave weapon for controlling crowds; a person subjected to it definitely feels pain and is forced to retreat.)

"HPM sources are maturing, and one day, in the very near future, they will help revolutionize how U.S. soldiers fight wars," says Edl Schamiloglu, a professor of electrical and computer engineering at the University of New Mexico in Albuquerque and one of the leading researchers in this burgeoning field.

The fact that we seldom hear about HPM weapons only adds to their exoticism. Last spring, stories leaked to the press suggested that the Pentagon, after decades of research, had finally deployed such a device in Iraq. And when news footage showed a U.S. bomb destroying an Iraqi TV station, many informed onlookers suspected it was an electromagnetic "e-bomb."

"I saw the detonation, and then I saw the burst—which wasn't much. If they took the station out with that blast, I strongly suspect that we used Iraq as a proving ground" for HPMs, says Howard Seguine, an expert on emerging weapons technology with Decisive Analytics Corp., in Arlington, Va.

But while the U.S. military proudly paraded assorted new war-making technology during its conquest of Iraq, from unmanned combat aerial vehicles to a new satellite-based tracking network, it remained tight-lipped about this "mother of all weapons." Asked at a 5 March news briefing to confirm the rumor, General Tommy Franks, head of U.S. forces during the war, would only say, "I can't talk to you about that because I don't know anything about it."

Military secrecy is nothing new, of course. What is known about microwave weapons is that the U.S. military has actively pursued them since the 1940s, when scientists first

CHIP SIMONS

Microwave weapons researcher Edl Schamiloglu sits in front of the Pulserad-110A accelerator, which his lab at the University of New Mexico uses to produce single 100-nanosecond pulses of electron beams, each pulse emitting hundreds of megawatts of power.

observed the powerful electromagnetic shock wave that accompanied atmospheric nuclear detonations, suggesting a new class of destructiveness. While much of the work on HPMs remains classified, the Pentagon has also recently sponsored a number of U.S. university laboratories to work out the basic principles of microwave weapons, including reliable and compact nonnuclear ways of generating microwave pulses.

Many of those results are being published in the open literature [see To Probe Further, p. 30]. In fact, all you need is a reasonable grasp of physics and electrical engineering to appreciate the ingeniousness of microwave weapons. Anyone with a technical bent could probably also build a crude e-bomb in their garage, a thought that security-minded folks find rather troubling.

How they work

From the military's perspective, HPM weapons, also known as radiofrequency weapons, have many things going for them: their blast travels at the speed of light, they can be fired without any visible emanation, and they are unaffected by gravity or atmospheric conditions. The weapons come in two flavors: ultrawideband and narrowband. Think of the former as a flashbulb, and the latter as a laser; while a flashbulb illuminates across much of the visible spectrum (and into the infrared), a laser sends out a focused beam at a single frequency.

Like the flashbulb, ultrawideband weapons radiate over a broad frequency range, but with a relatively low energy (up to tens of joules per pulse). Their nanoseconds-long burst produces a shock that indiscriminately disrupts or destroys any unshielded electronic components within their reach. The bomb's destructiveness depends on the strength of the ultrawideband source, the altitude at which it is initiated, and its distance from the target [see "E-Bomb Anatomy," p. 29].

Narrowband weapons, by contrast, emit at a single frequency or closely clustered frequencies at very high power (from hundreds up to a thousand kilojoules per pulse), and some can be fired hundreds of times a second, making an almost continuous beam. These pulses can be directed at specific targets—say, a command and control complex positioned on the roof of a hospital in a densely populated neighborhood—and tuned to specific frequencies. Technologically more sophisticated than ultrawideband sources, they are far more difficult to develop, but are reusable and potentially of much greater use to the U.S. military.

Both versions wreak the same kind of havoc on just about any kind of unprotected electronic equipment. Particularly vulnerable is commercial computer equipment; anything in excess of just tens of volts can punch through gates in MOS and metal-semiconductor devices, effectively destroying the device, explains Carlo Kopp, a visiting research fellow in military strategy at the Strategic and Defense Studies Centre in Canberra, Australia, and a computer scientist who lectures at Monash University in Melbourne. The higher the circuitry's density, the more vulnerable it is, because less energy is required to overload and destroy the transistors. HPMs also produce standing waves in electrical grid wiring and telephone and communications wiring, entering through cables, antennas, and even ventilation grills. They can immobilize vehicles with electronic ignition and control systems, too.

"Since the frequency is high, this permits parasitic or stray capacitances to couple energy via paths in the circuit that may not be protected against overvoltage," Kopp explains.

The e-bomb

You could deliver an e-bomb in a number of ways: cruise missile, unmanned aerial vehicle, or aerial bomb. Whether ultrawideband or narrowband, the e-bomb consists of both a microwave source and a power source [again, see diagram, p. 29]. Ultrawideband e-bombs aim to create an electromagnetic pulse like that accompanying a nuclear detonation, except that the nuclear material is replaced with a conventional, chemical explosive. The microwave source typically relies on an extremely fast switching device, according to Kopp, who has written widely on weaponizing HPM technology. Narrowband e-bombs might use a virtual cathode oscillator (vircator) tube or a variant of a magnetron. Though termed narrowband, they don't have the high coherency seen in signal-carrying applications, Kopp says.

It takes gigawatts of power to feed an e-bomb's microwave source. For that, the flux compression generator, or FCG, is a good choice, says Kopp. Invented by Clarence ("Max") Fowler at Los Alamos National Laboratory after World War II as a byproduct of research into atomic bomb detonators, FCGs are conceptually simple. The best-known type consists of an explosive-packed copper cylinder surrounded by a helical current-carrying coil. Upon detonation, the explosion flares out the cylinder, short-circuiting the coil and progressively reducing the number of turns in the coil, thus compressing the magnetic flux. Large FCGs have produced tens of gigawatts, and they can be cascaded—connected end to end—so that the output from one stage feeds the next.

Despite its simplicity, an FCG-powered e-bomb is probably too difficult for the average terrorist to build on the cheap. For one thing, to test the assembled apparatus, you have to blow it up. For weapons researchers, the e-bomb poses other problems. The strength of the shock wave dissipates rapidly as it moves out from the explosion. To knock out an electrical power substation, for example, the weapon has to strike within about a hundred meters. "Like all microwave radiation, the effect follows an inverse square law with increasing distance," Kopp notes. Though the explosion needed to force out the current can be fairly small, it keeps the munition from being fully nonlethal and nondetectable. Also, anything that's been hardened or shielded against an electromagnetic pulse from a nuclear bomb will probably emerge unscathed.

Focused like a laser

The type of narrowband HPM weapons that the U.S. military is looking at offers everything that e-bombs do not. They're nonlethal, reuseable, and tunable, and they can be fired from miles away. Like a laser, the focused beam disperses only slightly over great distances. With a frequency range that is between about 1 and 10 GHz, they can penetrate even electronics shielded against a nuclear detonation. The deepest bunkers with the thickest concrete walls are not safe from such a beam if they have even a single unprotected wire reaching the surface.

Schamiloglu holds a rippled-wall waveguide connected to an antenna. The waveguide is where kinetic energy from a pulsed-power-driven electron beam is transformed into high-power microwaves. In the background sit the Pulserad-110A [left] and the Russian-built Sinus-6 [right]. The Sinus-6 can fire a several-gigawatt pulsed beam 200 times a second in 10-nanosecond bursts.

CHIP SIMONS

A microwave beam is created much like a laser beam. Between the batteries (or other power source) and the beam sit three elements: capacitors that turn the stored energy into an electron beam of nanosecond bursts, a microwave source that converts the electron beam into focused, high-frequency electromagnetic waves, and an antenna that points and shoots the beam.

Kirtland Air Force Base, in Albuquerque, N.M., is considered the epicenter of the Pentagon's research on pulsed-power electromagnetic weapons. There, its premier pulsed-power system, the Shiva Star, is housed behind meter-thick walls [see photo, p. 28]. An Air Force spokesperson refused to comment on what goes on in their pulsed-power programs, but a fact sheet on the Web site of Kirtland's Directed Energy Directorate describes the Shiva Star as capable of producing "120 thousand volts and 10 million amps for down to one millionth of a second to produce a power flow equivalent to a terawatt."

The Kirtland machine isn't used to investigate HPM weapons per se, and its massive size makes it clearly impractical for delivering microwave beams to any spots of real military interest. Indeed, one big push in microwave weapons has been toward portability. "Back in the 1960s and 1970s, the attitude was, 'Yeah, we can do it—but we need Hoover Dam as our power supply,' " says Seguine. But just as batteries for cellphones and laptops have shrunk and gained capacity, so have sources for microwave weapons.

In the 1990s, the U.S. Air Force Office of Scientific Research set up a five-year Multidisciplinary University Research Initiative (MURI) program to explore microwave sources. One of those funded was the University of New Mexico's Schamiloglu, whose lab is located just a few kilometers down the road from where the Shiva Star sits behind tightly locked doors. Thanks in large part to his and his colleagues' efforts, the fundamental capabilities and limitations of high-power microwave sources are now better understood and appreciated.

Amidst the lead bricks and clutter in Schamiloglu's basement lab lies his masterwork: the Sinus-6. "A lot of laboratories come up with very cute names for these devices," Schamiloglu notes with a smile. "We never did." With a huge cylinder at one end connected to the long microwave source, the Sinus-6 looks like a giant torch lying on its side [see photo, above]. The big cylinder contains a Tesla transformer, whose two coils vibrate in resonance and amplify the incoming voltage "with nearly 100-percent efficiency," Schamiloglu says. Once the pulse has been transformed into an electron beam, it is guided by a strong axial magnetic field through the long tube that will turn it into microwaves.

The Sinus-6 can fire a several-gigawatt pulsed beam 200 times a second in 10-nanosecond bursts. "It has to be pulsed power because what you're after is high peak power," says Schamiloglu. "The power in the microwaves is going to depend on the electric field squared, so if you generate very large power, then the electric field is going to be big."

How big? To drive the Sinus-6's beam continuously for an entire second, you'd need to supply about 25 gigajoules—"the entire output of a typical coal-fired electrical plant for 10 full seconds," Schamiloglu says. Another reason for pulsed rather than continuous power is to avoid a problem at the output end: the air around the antenna would heat to a plasma that in turn would interfere with a continuous beam at these power levels.

The key to reaching gigawatts of power is dumping all the energy in one gigantic, nearly instantaneous pulse. A pressurized gas switch prevents the Tesla transformer from prematurely dumping as it builds up for the next pulse. The switch is filled with highly compressed and nonconducting nitrogen gas. When the transformer coils reach 700 kV, the nitrogen gas breaks down, and the pulse leaps through to the electron-beam diode.

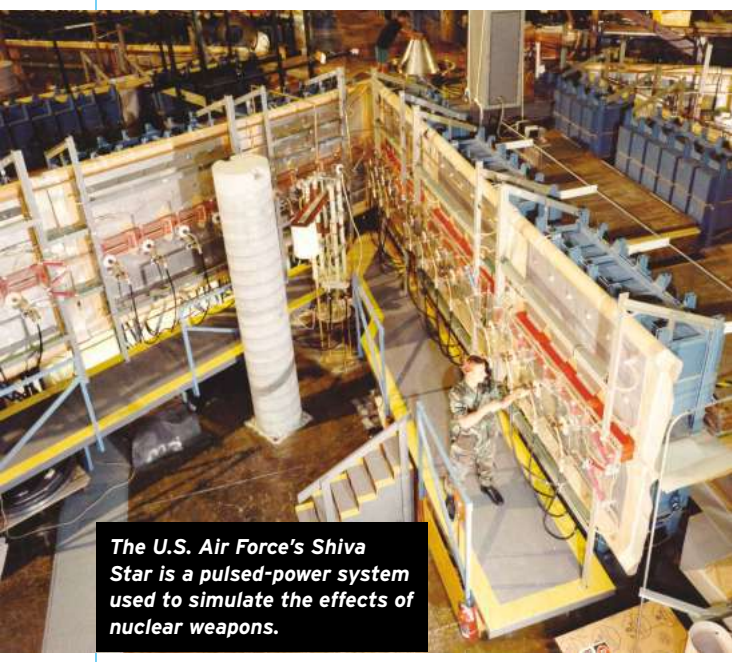

The U.S. Air Force's Shiva Star is a pulsed-power system used to simulate the effects of nuclear weapons.

"Once you've fired the switch, it conducts, it generates a pulse," says Schamiloglu. "It conducts because you've made a plasma channel out of the gas. Then you have to wait for that plasma to recombine and form a neutral gas again. A typical time scale for this thing to recombine and fizzle out and be a neutral gas again is probably on the order of milliseconds."

Among the best candidates for supplying microwaves is the backward wave oscillator; it has the advantage of being tunable (plus or minus 20 percent) and producing output in the 4–10-GHz range. To turn the kinetic energy from the Sinus-6's electron beam into high-power microwaves, the oscillator uses a rippled-wall waveguide, also called a slow-wave structure [see photo, p. 27].

The structure sets up standing electromagnetic waves in such a way that energy is rapidly transferred to them from the incoming beam of relativistic electrons from the Sinus-6. This growing energy initially propagates in the opposite direction of the beam's movement—hence the device's name—and is then reflected forward and radiated in the form of high-power microwaves. Backward wave oscillators, by the way, are also being tested as a way to push giant sails into outer space, to detect space debris, and to clear minefields.

Being able to tune an HPM weapon comes in handy when a particular target proves invulnerable to a particular frequency. "Experience has shown that if the frequency is slightly altered, measurable effects are discerned," Schamiloglu notes. People used to believe that varying the frequency of HPMs wasn't practical, but Schamiloglu and his students proved them wrong.

Coincidence and curiosity led to their discovery. Schamiloglu first acquired the Sinus-6 from Russian researchers in the early 1990s. (The Soviet Union once boasted a sophisticated program to develop microwave weapons; after its collapse, parts of that legacy were put up for sale, to the delight of researchers like Schamiloglu.) But once the apparatus was assembled in his New Mexico lab, he couldn't get it to operate as promised, so Russian colleagues flew over to help.

"One of them took the RF structure [the rippled-wall waveguide] and started hammering on the thing," Schamiloglu recalls. When they tried it again, everything worked. "I was baffled why manhandling this RF structure—ramming it in—could affect the power so much," says Schamiloglu. So he started a series of experiments in which he slightly displaced the backward wave oscillator by increments. With a little experimentation assisted by computer simulations, his team found that the frequency could be adjusted by changing the distance between the diode and the microwave source. The result is that the backward wave oscillator is now one of the few pulsed-power HPM sources that can be tuned.

Smaller is better

One disadvantage of this oscillator, however, is that it needs an external magnetic field to create the microwave beam, a major hurdle to making the whole system smaller. The size of the Sinus-6 and attendant equipment in Schamiloglu's basement suggests that the U.S. military is nowhere near fielding a narrowband HPM weapon. "When I first started working on high-power narrowband sources, we joked that you can do more damage dropping this equipment on someone than you can by using it," he recalls. "People know how to make microwave sources in the laboratory. The challenge is to take this and package it into an autonomous platform and have it function at the same parameter levels."

Schamiloglu is now hard at work under a new MURI program to study the possibilities of making a compact pulsed-power source. Current narrowband generators are typically several meters long, batteries not included. Schamiloglu and his colleagues are studying how to incorporate novel ceramics into pulsed-power systems, which they believe will allow the length of such sources to be halved. The trick is identifying materials with a high dielectric constant that can also survive the harsh electric fields. "Materials will be an important part in making the next giant leap," he says.

Life in a glass house

Among those agreeing that narrowband HPM weapons will need more refining before they become truly useful to the military is Loren B. Thompson, chief operating officer of the Lexington Institute, a military think tank based in Arlington, Va. He looked

U.S. AIR FORCE

E-Bomb Anatomy

In this hypothetical design for an e-bomb, a two-stage flux compression generator provides gigawatts of power to the virtual cathode oscillator (vircator), which produces the high-power microwaves. The bomb's destructiveness depends on the microwave source and target's vulnerability to electromagnetic attack, among other things, but a 10-GW, 5-GHz HPM device would have a "lethal" footprint 400 to 500 meters across, producing field strengths of several kilovolts per meter. Such an e-bomb would wreak major havoc if detonated over a heavily populated area.

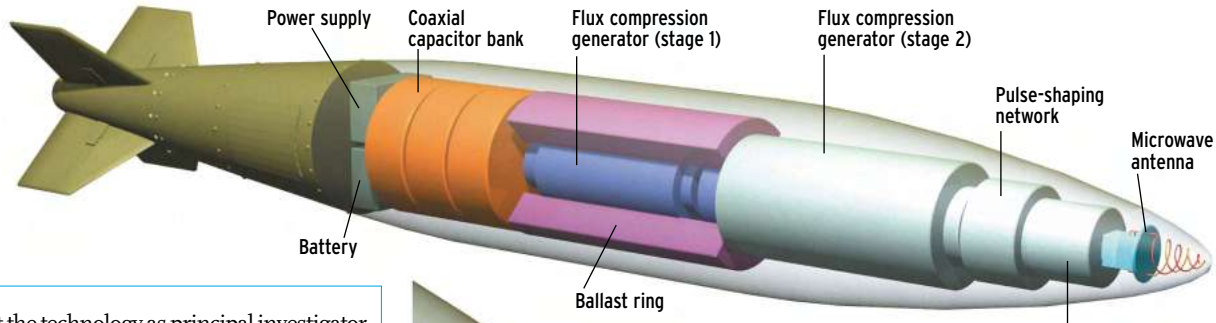

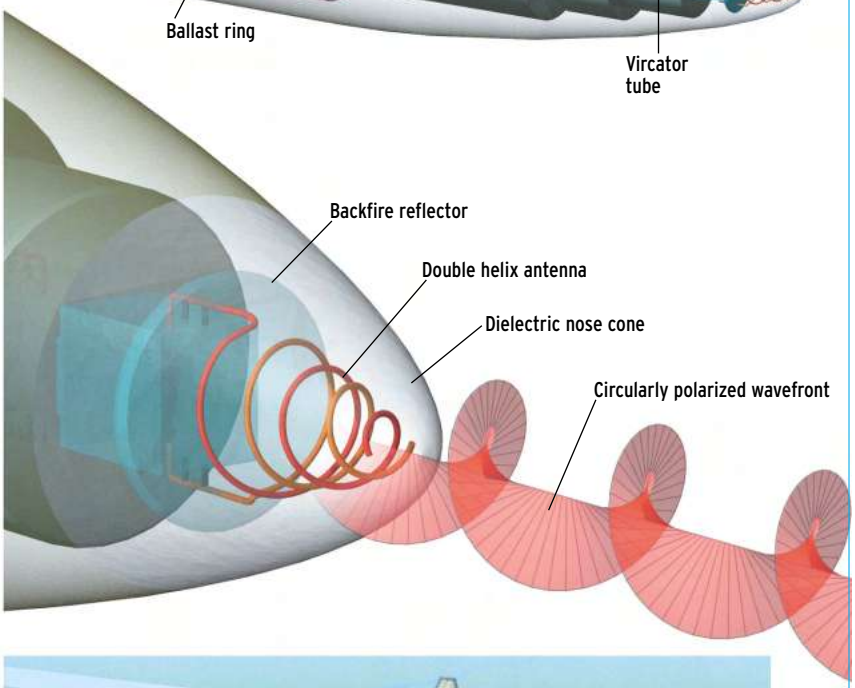

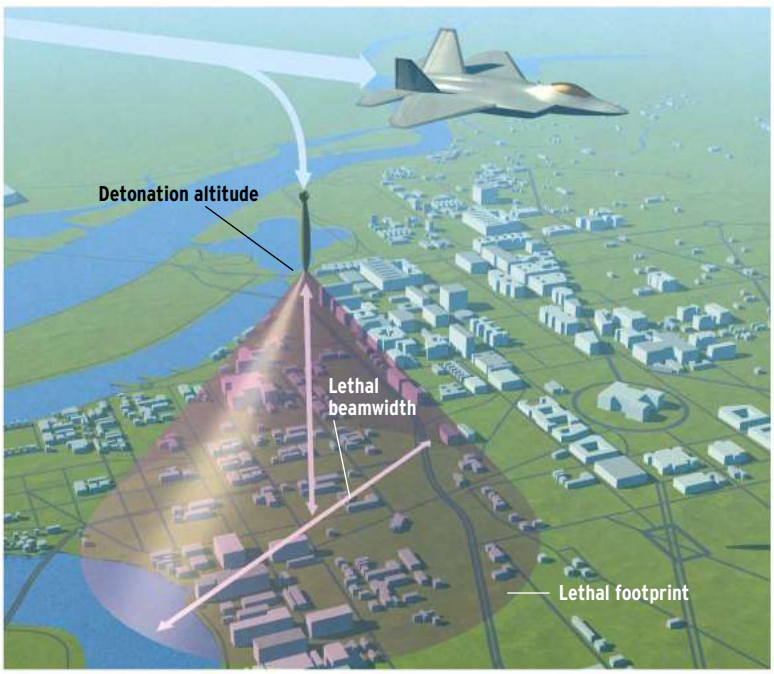

at the technology as principal investigator of "Directed-Energy Weapons: Technologies, Applications and Implications," a report that the institute put out in February. "We have some fairly rudimentary weapons that we're ready to use," Thompson says. "This is going to be a very important weapons technology, and the basic physical principles are well understood. But the military is having some difficulty in assimilating them."

Thompson's report speaks of a future with satellites delivering missile-debilitating microwaves, unmanned vehicles that fly by and destroy communications systems, and war without civilian casualties. But the fact remains that it's the U.S. military—as well as U.S. financial institutions, PCs, and Game Boys—that will be the most susceptible to such weapons.

"One of the things that happened during the last 10 years—as the Pentagon fell in love with network-centered warfare—is that we purchased a lot of very fragile digital systems off the shelf from commercial sources," Thompson notes. Such moves were taken in the name of cost and efficiency, but the resulting equipment is almost certainly more vulnerable to electromagnetic attack than the vacuum tubes and heavy metal-encased electronics of yesteryear.

"Computers become more vulnerable as the voltage at which they operate becomes smaller," says Victor Granatstein, professor of electrical engineering at the University of Maryland in College Park, who is studying the effects of microwave pulses on integrated electronics. "When our opponent was the

ILLUSTRATION: JOHN MACNEILL SOURCE: CARLO KOPP

Soviet Union, the electronics were much more robust because they weren't miniaturized. Now they have very thin oxide layers that can easily break down." Wireless networking makes matters worse. Computers and other communications devices now have antennas attached, giving an electromagnetic pulse a direct pathway to its guts.

Meanwhile, the U.S. Navy no longer requires that all its hardware be hardened against nuclear electromagnetic pulses. It deemed that maintaining those standards was too costly and slowed down the integration of new technology. The presumption was that after the Cold War, nobody would be using nuclear bombs, says the Lexington Institute's Thompson. "Whenever I ask the admirals, 'Well, what if someone did use a nuclear bomb?,' I just get this kind of blank I-don't-have-an-answer-for-that sort of look."

Don't Try This at Home

First things first: we do not under any circumstances recommend that you build your own electromagnetic weapon. But if you're hellbent on adding to the mayhem, cheaply and without too much studying, you might try a high-energy radiofrequency, or HERF, gun. As described by engineering student Rostislav Persion on his Web site, Voltage Labs, which is devoted to do-it-yourself electromagnetic weapons, you can make one from a microwave oven.

Before you begin, though, wait until everyone else has left the house. Next, take apart the microwave oven, but don't disconnect any of the components; manufacturers intentionally make this hard to do, so you may end up just breaking the machine. Inside you will find the oven's microwave source: the magnetron. Wrap a tube of sheet metal around it to act as a waveguide. Your power source is the house's ac, so just plug in the oven and point it at your TV. Warning: there's a real possibility that you will burn yourself instead.

For schematics and a demonstration, head to the Web at http://www.voltsamps.com/pages/projects/herf004/. —*M.A.*

In the wrong hands

The scariest part of microwave weapons may be that crude forms of the technology are readily available to anyone right now. "Any nation with a 1950s technology base capable of designing and building nuclear weapons and radars" can build an e-bomb, says military analyst Kopp. Indeed, more than 20 countries now have programs to develop some type of RF weapon.

"The more widespread the technology is, the more likely that people with nefarious purposes will have access. It's just an inescapable fact," says Thompson. "I don't know what we're going to do. Nobody in Washington knows. I imagine that the way the clear thinking starts is with a catastrophe."

Criminals and pranksters have already started exploiting that weakness. In one of the more harmless applications, a Japanese scam artist rigged up a weak microwave generator inside a suitcase to rip off a pachinko parlor. When he placed the suitcase next to one of the machines (which is something like a cross between a slot machine and a pinball machine) and turned it on, the pachinko machine went haywire and disgorged a pile of coins. The perp managed the trick several times before he was caught.

Other press accounts hint at electromagnetic weapons being deployed by Chechen troops, and by an unnamed assailant trying to topple London's futures market [see "Don't Try This at Home," above].

Thankfully, protecting yourself against the microwave-enabled goofballs of the world isn't too difficult. "It is analogous to existing techniques used to trap RF interference inside equipment, except that the higher power levels require special measures," Kopp notes. Rooms or equipment chassis must become electrically sealed Faraday cages, and protective devices must be added wherever cables enter the protected volume. "Optical fibers are very useful in this game."

Such protective measures are a lot cheaper to design in from the beginning than to add on afterward, says Howard Seguine. "The general rule of thumb is that if you do the hardening during the design phase, it increases the cost roughly 1 percent. If you do it afterward, it may cost as much as 30 percent more."

But maybe hardening is a waste of time. Arthur Varanelli, a Raytheon Co. engineer who has helped write several IEEE standards for electromagnetic field measurement, human exposure, and safety, is skeptical that a malicious prankster could exploit the technology.

"Some of this stuff is just so far out there," Varanelli says. "I just don't see people running around with Buck Rogers ray guns. It's great for a science fiction writer, great to prey upon people's fears." He scoffs at the suggestion that a do-it-yourselfer could build a microwave weapon potent enough to do real damage. "People can put tacks in the road. Are we worried about electronic tacks in the air?"

The wide disparity in opinions and the uncertainty about microwave weapons, from Loren Thompson on one end to Arthur Varanelli on the other, are all part of what makes them so powerful, says military analyst John Pike, who is director of GlobalSecurity.org (Alexandria, Va.). "It all depends on the complex interactions between the weapon and the target," he notes. "I can set up a strap-down chicken test that makes [an HPM weapon] look pretty good. But as soon as I start getting into real-world targets, maybe it doesn't work so well."

"Part of the story is we don't know what the story is," Pike says. "These are weapons that by their nature seek the shadows. And unlike cluster bombs or atomic bombs, they aren't going to leave behind unambiguous evidence of their use." ●

To Probe Further

For a detailed technical discussion of high-power microwaves, see *High-Power Microwave Sources and Technologies*, edited by IEEE Fellows Robert J. Barker and Edl Schamiloglu (Wiley–IEEE Press, 2001). Schamiloglu is also coauthor, with James Benford and John Swegle, of the forthcoming *High-Power Microwaves*, 2nd edition (Institute of Physics, 2004).

The truly prepared, or merely paranoid, will want to consult Carlo Kopp's "Hardening Your Computing Assets" at http://www.globalsecurity.org/military/library/report/1997/harden.pdf.

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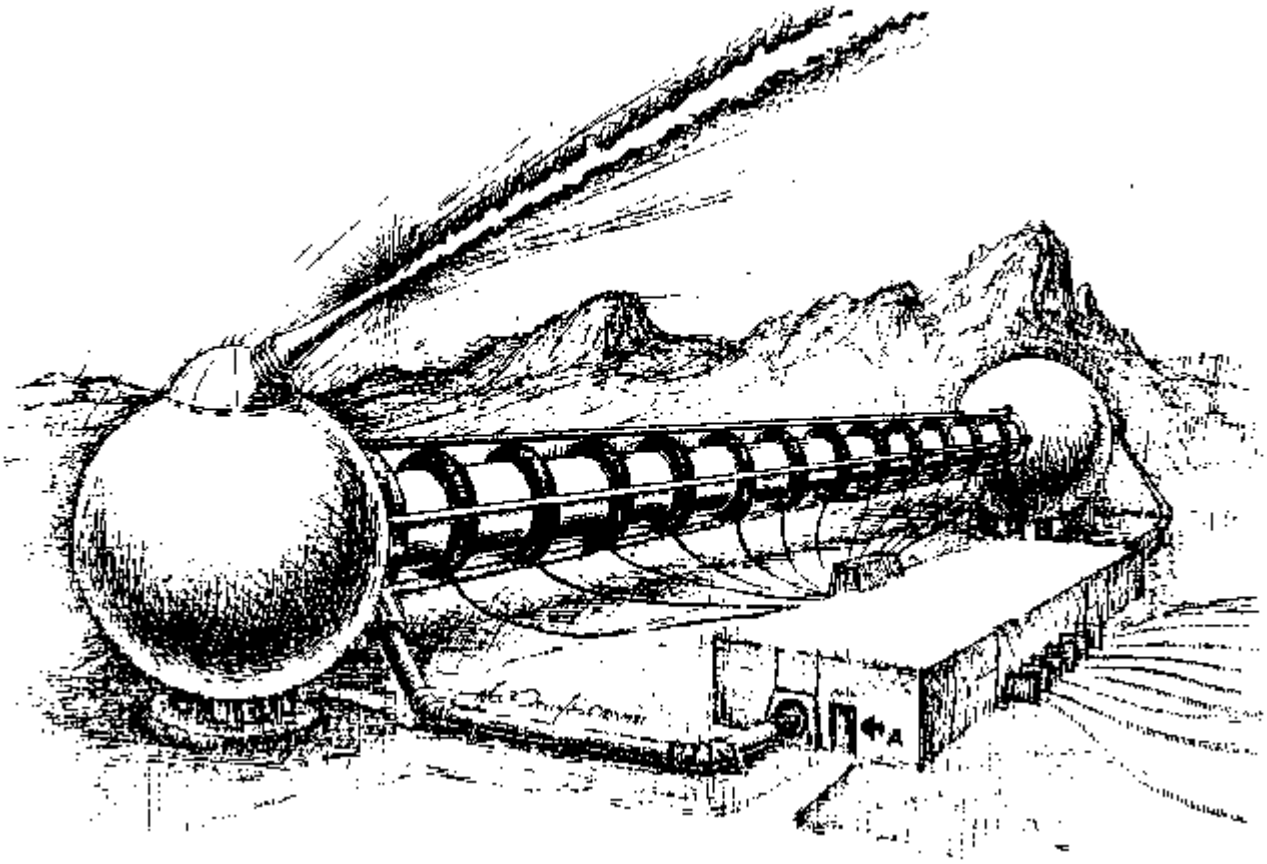

Scalar Potential Interferometer

Figure 6. Multimode Tesla Weapon

In the 1930's Tesla announced other bizarre and terrible weapons: a death ray, a weapon to destroy hundreds or even thousands of aircraft at hundreds of

miles range, and his ultimate weapon to end all war -- the Tesla shield, which nothing could penetrate. However, by this time no one any longer paid any real attention to the forgotten great genius. Tesla died in 1943 without ever revealing the secret of these great weapons and inventions.

Unfortunately, today in 1981 the Soviet Union has long since discovered and weaponized the Tesla scalar wave effects. Here we only have time to detail the most powerful of these frightening Tesla weapons -- which Brezhnev undoubtedly was referring to in 1975 when the Soviet side at the SALT talks suddenly suggested limiting the development of new weapons "more frightening than the mind of man had imagined." One of these weapons is the Tesla howitzer recently completed at the Saryshagan missile range and presently considered to be either a high-energy laser or a particle beam weapon, (See Aviation Week & Space Technology, July 28, 1980, p. 48 for an artist's conception.)

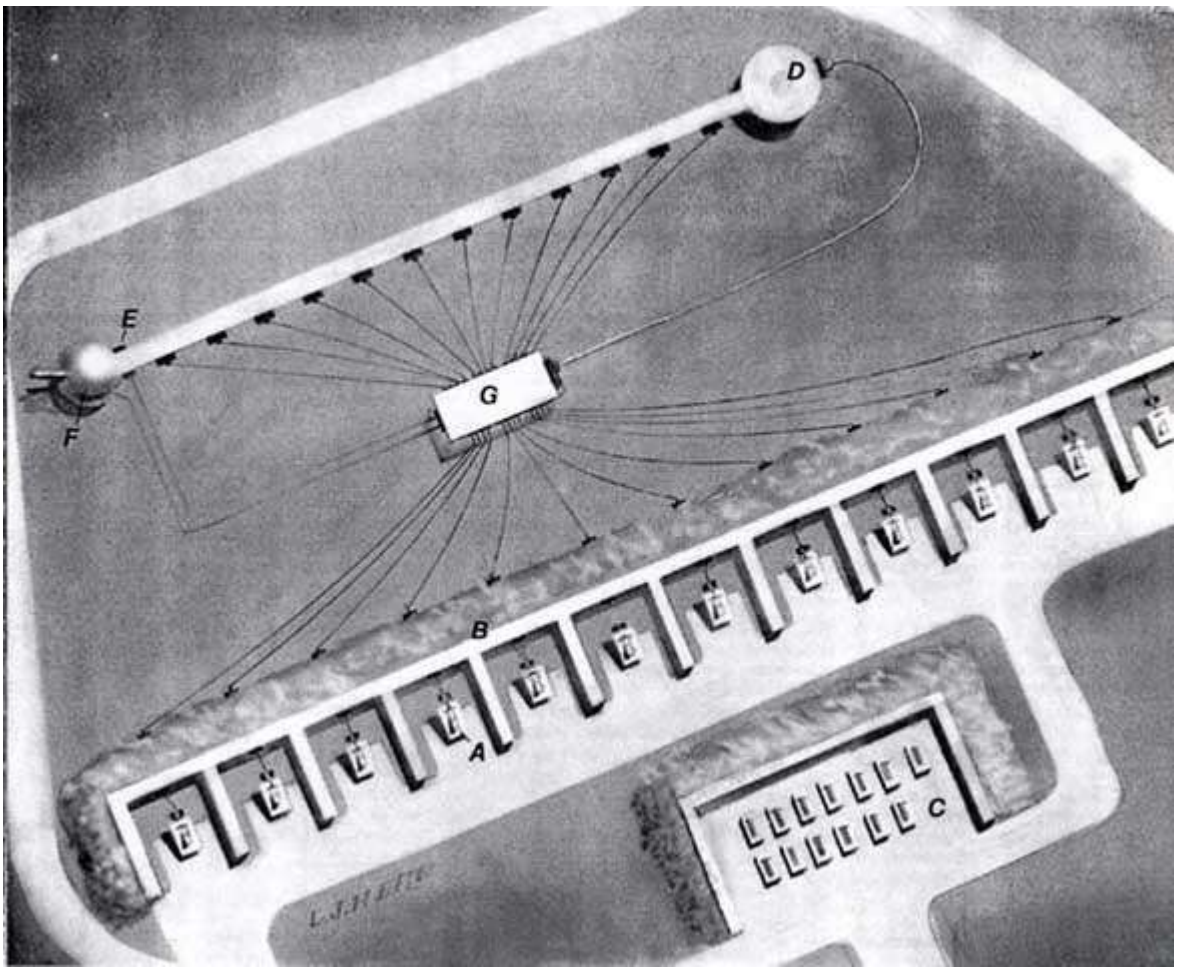

Aviation Week & Space Technology July 28, 1980

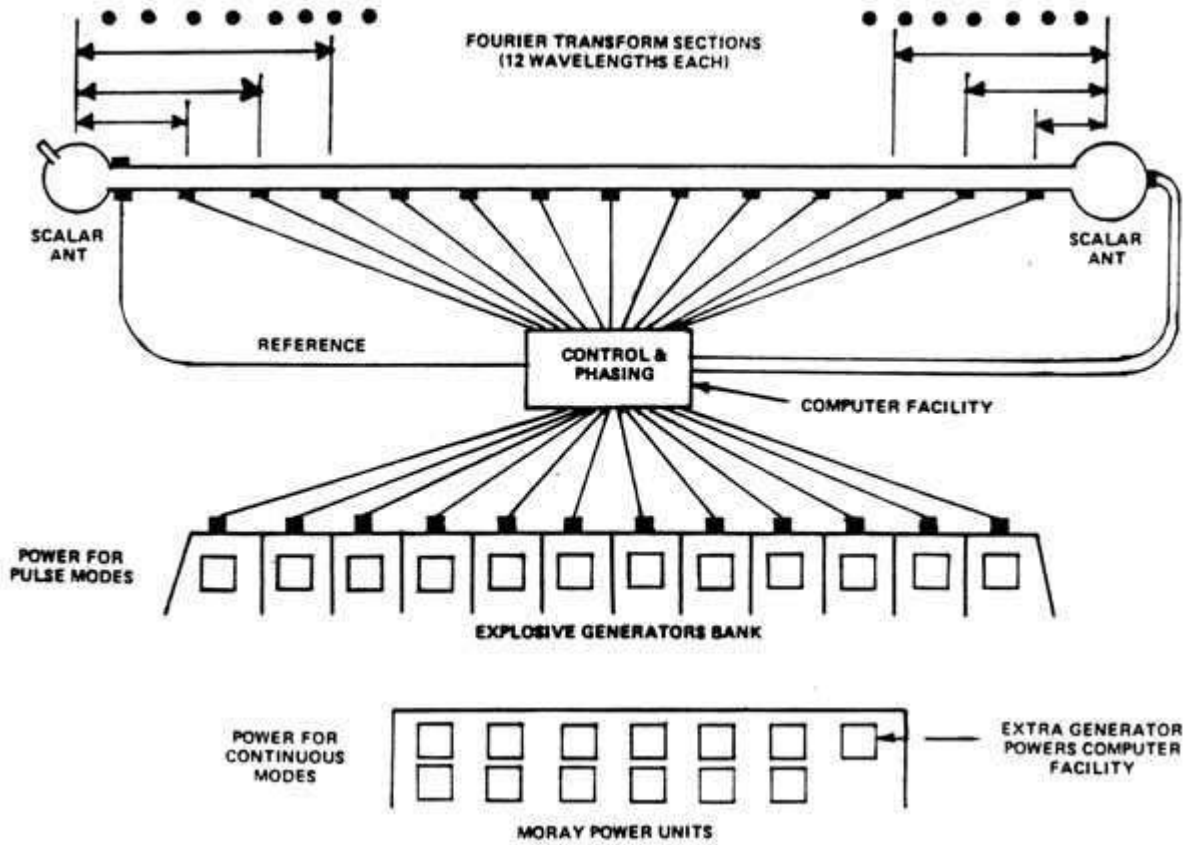

Figure 7. Tesla Weapons at Saryshagan

The Saryshagan howitzer actually is a huge Tesla scalar interferometer with four modes of operation. One continuous mode is the Tesla shield, which places a thin, impenetrable hemispherical shell of energy over a large defended area. The 3-dimensional shell is created by interfering two Fourier-expansion, 3-dimensional scalar hemispherical patterns in space so they pair-couple into a dome-like shell of intense, ordinary electromagnetic energy. The air molecules and atoms in the shell are totally ionized and thus highly excited, giving off intense, glowing light. Anything physical which hits the shell receives an enormous discharge of electrical energy and is instantly vaporized -- it goes pfft! like a bug hitting one of the electrical bug killers now so much in vogue.

If several of these hemispherical shells are concentrically stacked, even the gamma radiation and EMP from a high altitude nuclear explosion above the stack cannot penetrate all the shells due to repetitive absorption and reradiation, and scattering in the layered plasmas.

In the continuous shield mode, the Tesla interferometer is fed by a bank of Moray free energy generators, so that enormous energy is available in the shield. A diagram of the Saryshagan-type Tesla howitzer is shown in figure 7. Hal Crawford's fine drawing of the interferometer end of the Tesla howitzer is shown in figure 6. Hal's exceptional rendition of the Tesla shield produced by the howitzer is shown in figure 8.

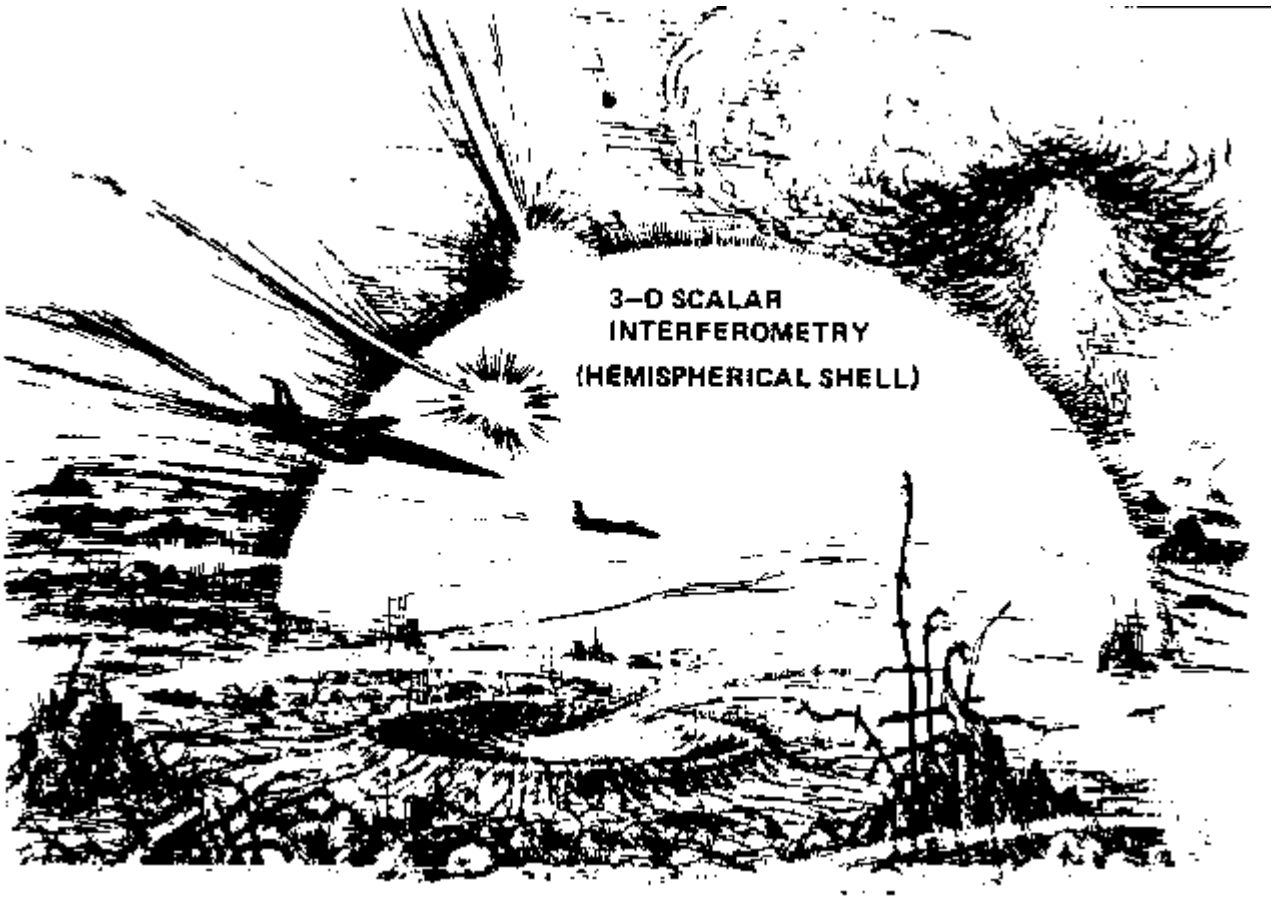

Figure 8. The Tesla Shield

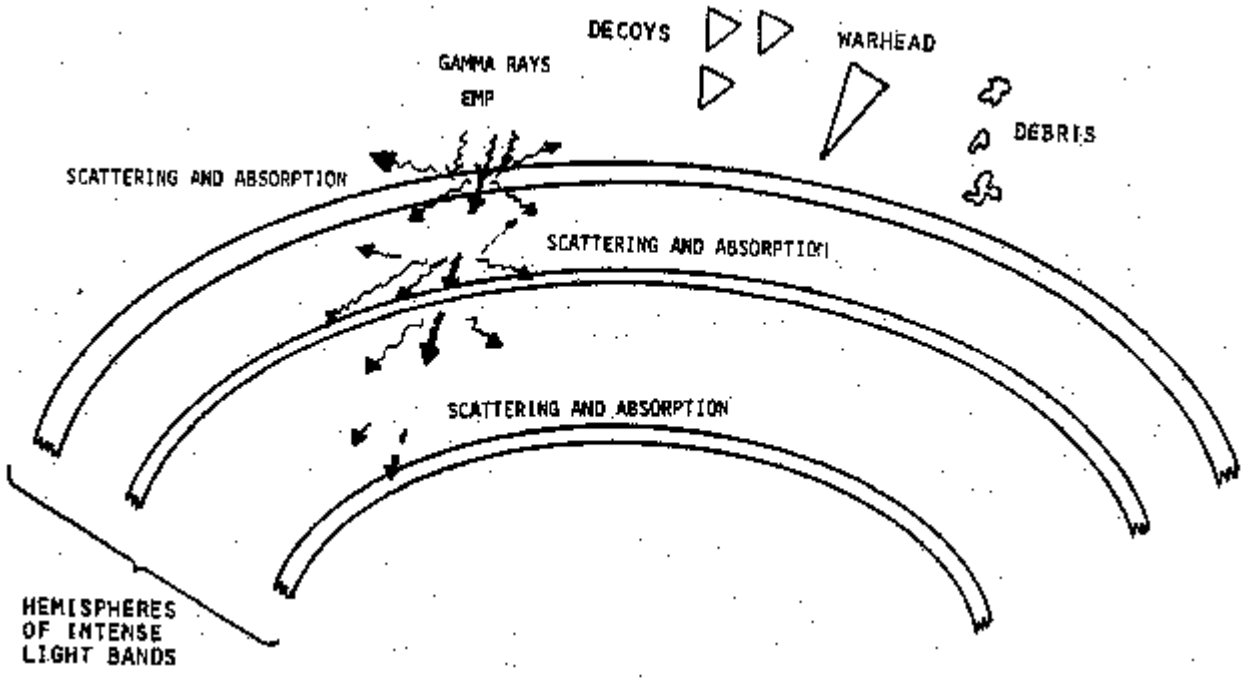

Figure 9. Tesla Terminal Area Defense System

In the pulse mode, a single intense 3-dimensional scalar phi-field pulse form is fired, using two truncated Fourier transforms, each involving several frequencies, to provide the proper 3-dimensional shape (Figure 10). This is why two scalar antennas separated by a baseline are required. After a time delay calculated for the particular target, a second and faster pulse form of the

same shape is fired from the interferometer antennas. The second pulse overtakes the first, catching it over the target zone and pair-coupling with it to instantly form a violent EMP of ordinary vector (Hertzian) electromagnetic energy. There is thus no vector transmission loss between the howitzer and the burst. Further, the coupling time is extremely short, and the energy will appear sharply in an "electromagnetic pulse (EMP)" strikingly similar to the 2-pulsed EMP of a nuclear weapon.

This type weapon is what actually caused the mysterious flashes off the southwest coast of Africa, picked up in 1979 and 1980 by Vela satellites. The second flash, e.g., was in the infrared only, with no visible spectrum. Nuclear flashes do not do that, and neither does superlightning, meteorite strikes, meteors, etc. In addition, one of the scientists at the Arecibo Ionospheric Observatory observed a gravitational wave disturbance -- signature of the truncated Fourier pattern and the time-squeezing effect of the Tesla potential wave -- traveling toward the vicinity of the explosion.

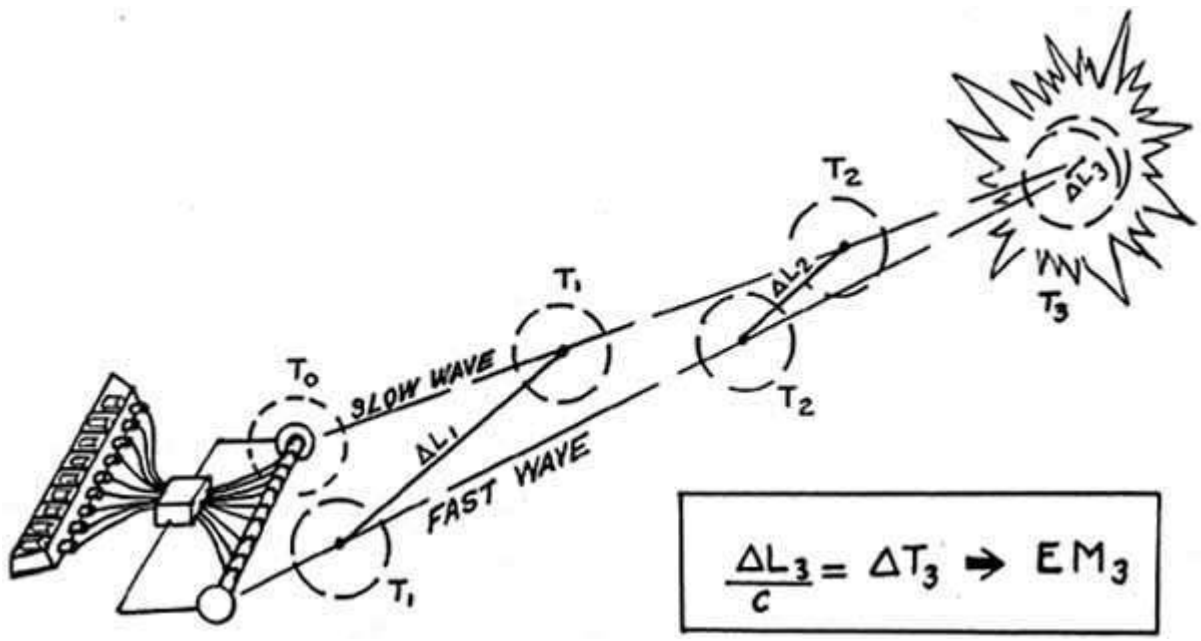

TESLA HOWITZER
(SCALAR INTERFEROMETER)

Figure 10. "Nuclear" Flashes off the Coast of Africa

Lithuania - 10 Sep 1976 - British European Airways Flight #831 between Moscow and London

CIA Report Released under FOIA

Figure 11. Continuous Tesla Fireball

The pulse mode may be fed from either Moray generators or -- if the Moray generators have suffered their anomalous "all fail" malfunction -- ordinary explosive generators. Thus the Tesla howitzer can always function in the pulse mode, but it will be limited in power if the Moray generators fail.

In the continuous mode, two continuous scalar waves are emitted -- one faster than the other -- and they pair-couple into vector energy at the region where they approach an in-phase condition. In this mode, the energy in the distant "ball" or geometric region would appear continuously and be sustained -- and this is Tesla's secret of wireless transmission of energy at a distance without any losses. It is also the secret of a "continuous fireball" weapon capable of destroying hundreds of aircraft or missiles at a distance. An example of a Soviet test of this mode of operation is shown in figure 11.

Witness to a super weapon?

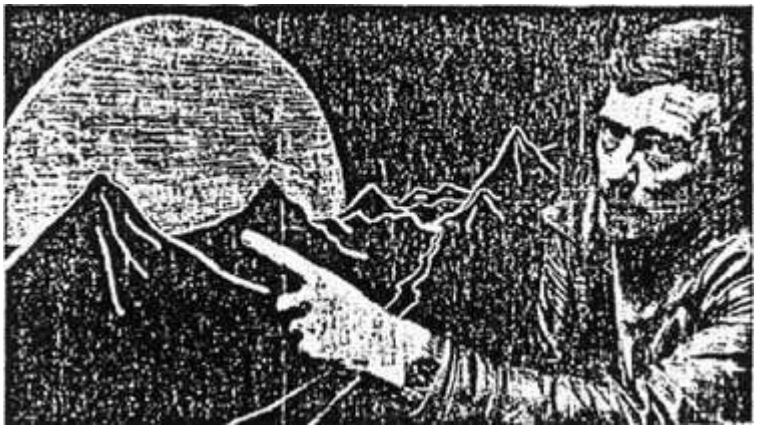

Nick Downie describes the strange lurid glow that flared silently over the Hindu Kush

THE SUNDAY TIMES, 17 AUGUST 1980

(Multiple incidents in Sept., 1979)

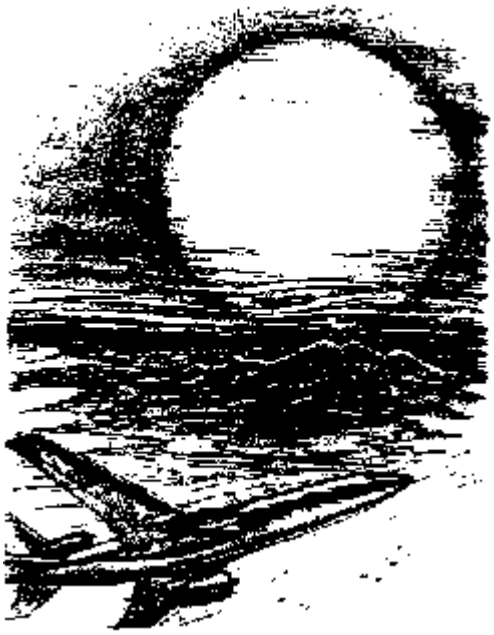

TEHERAN, IRAN 17 JUNE 1966

SEEN FROM NEAR MEHRABAD AIRPORT

OBSERVED 4-5 MINUTES

SEEN BY 2 AIRCRAFT

CIA REPORT RELEASED UNDER FOIA

Figure 12. Tesla EMP Globe

The volume of the Tesla fireball can be vastly expanded to yield a globe which will not vaporize physical vehicles but will deliver an EMP to them to dud their electronics. A test of this mode is shown in figure 12. (See also Gwynne Roberts, "Witness to a Super Weapon?", the London Sunday Times, 17 August 1980 for several other tests of this mode at Saryshagan, seen from Afghanistan by British TV cameraman and former War Correspondent Nick Downie.)

If the Moray generators fail anomalously, then a continuous mode limited in power and range could conceivably be sustained by powering the interferometer from more conventional power-sources such as advanced magnetohydrodynamic generators.

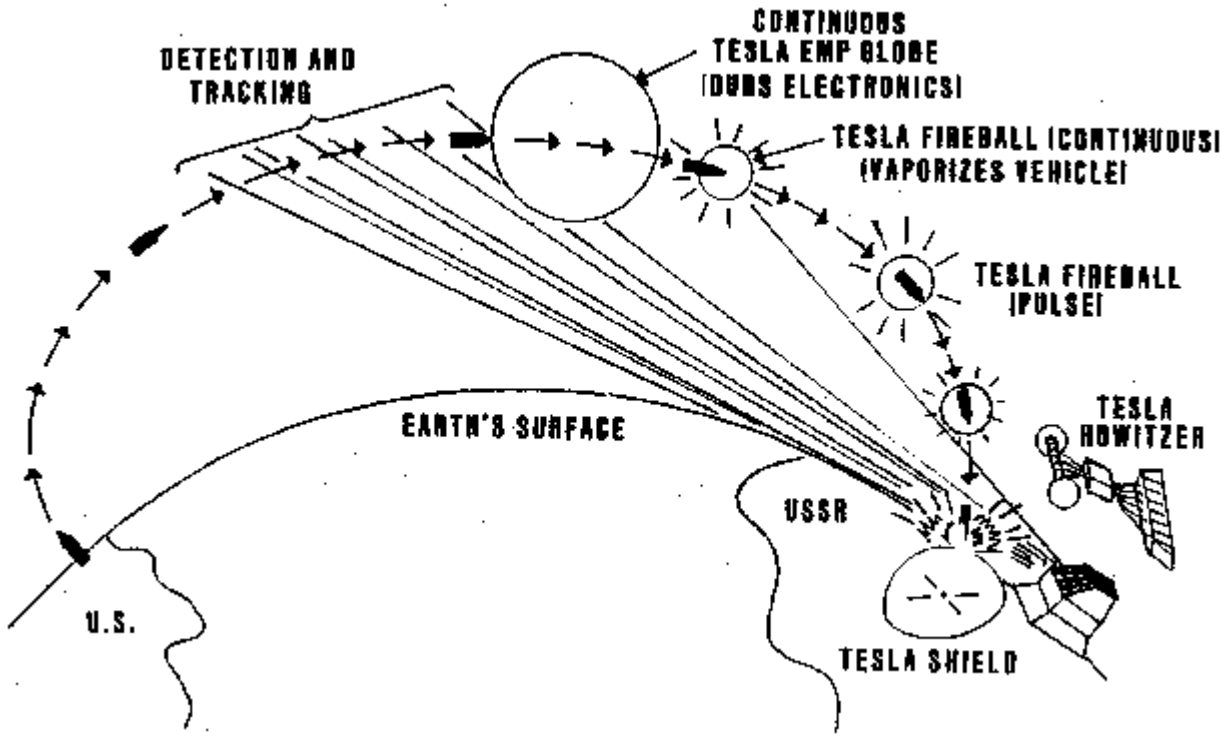

Figure 13. Tesla ABM Defenses

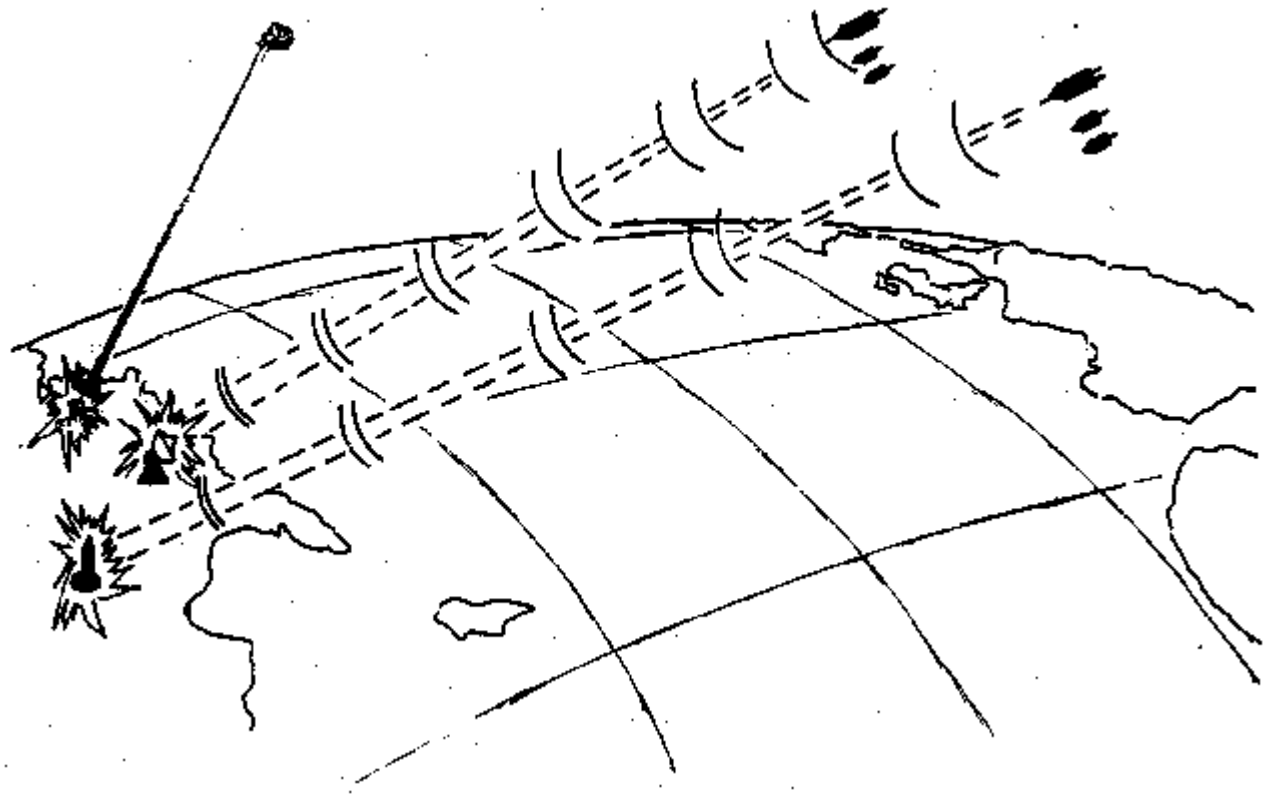

Figure 14. Moray/Tesla Technology: Star Wars Now

Typical strategic ABM uses of Tesla weapons are shown in figure 13. In addition, of course, smaller Tesla howitzer systems for anti-tactical ballistic missile defense of tactical troops and installations could be constituted of more

conventional field missile systems using paired or triplet radars, of conventional external appearance, in a scalar interferometer mode.

With Moray generators as power sources and multiply deployed reentry vehicles with scalar antennas and transmitters, ICBM reentry systems now can become long range "blasters" of the target areas, from thousands of kilometers distance (figure 14). Literally, "Star Wars" is liberated by the Tesla technology. And in air attack, jammers and ECM aircraft now become "Tesla blasters." With the Tesla technology, emitters become primary fighting components of stunning power.

The potential peaceful implications of Tesla waves are also enormous. By utilizing the "time squeeze" effect, one can get antigravity, materialization and dematerialization, transmutation, and mindboggling medical benefits. One can also get subluminal and superluminal communication, see through the earth and through the ocean, etc. The new view of phi-field also provides a unified field theory, higher orders of reality, and a new super-relativity, but detailing these possibilities must wait for another book.

With two cerebral brain halves, the human being also has a Tesla scalar interferometer between his ears. And since the brain and nervous system processes avalanche discharges, it can produce (and detect) scalar Tesla waves to at least a limited degree. Thus a human can sometimes produce anomalous spatiotemporal effects at a distance and through time. This provides an exact mechanism for psychokinesis, levitation, psychic healing, telepathy, precognition, postcognition, remote viewing, etc. It also provides a reason why an individual can detect a "stick" on a radionics or Hieronymus machine (which processes scalar waves), when ordinary detectors detect nothing. Unfortunately there is not room to develop the implications of this human Tesla interferometry in detail, for that must wait for yet another book, presently in its initial stages, that Hal Crawford and I are writing.

Table 5. Orders of Reality

- **PHOTONS ARE**
  - **> PAIR-COUPLED SCALARS**
  - **> VELOCITY-LIMITED TO C**
  - **> CARRIERS OF T**
- **PHOTON INTERACTION**
  - **> IS UBIQUITOUS**
  - **> PRODUCES $\dot{T}$ = C**
  - **> YIELDS 1st ORDER REALITY**
- **SCALAR O WAVES**
  - **> NOT VELOCITY-LIMITED**
  - **> YIELD HIGHER ORDER REALITIES**

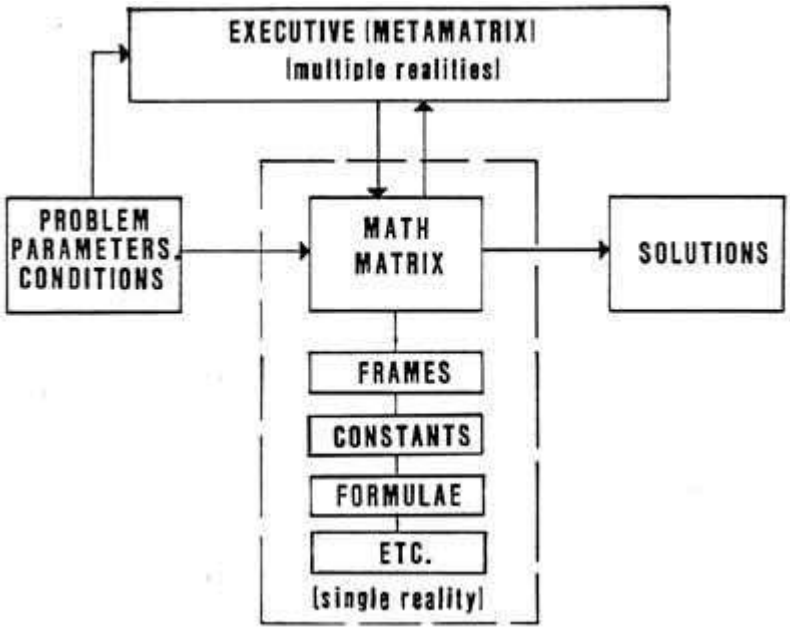

Figure 15. Implications of Tesla Potential

At the July 1981 U.S. Psychotronics Association's Annual Conference in Dayton, Ohio, I presented the first rough paper on the Tesla secret and scalar interferometry. A videotape of the presentation was made and will shortly be available. I am also scheduled to make a special presentation at the Alternate Energy Conference in Toronto, Canada in latter October, 1981. A professional, videotaped two-hour presentation on this subject is also being prepared. Wide distribution of the material through the international underground physics and technology network has already been made. This time, God willing, Tesla's secret will not be suppressed for another 80 years!

And perhaps it is not yet too late. The material has cost me (now) some 16 years of agonizing labor and nearly $100,000 of my own personal funds. No orthodox university, scientific group, foundation, or governmental agency would support such an effort, either financially or otherwise. Indeed, most ordinary journals will not even accept material on such matters. Nonetheless, the area is of overwhelming importance and I truly believe Tesla's lost secret will shortly affect the lives of every human being on earth.

Perhaps with the free and open release of Tesla's secret, the scientific and governmental bureaucracies will be. shocked awake from their slumber, and we can develop defenses before Armageddon occurs. Perhaps there is hope after all -- for even Brezhnev, in his strange July, 1975 proposal to the SALT talks, seemed to reveal a perception that a turning point in war and weaponry may have been reached, and that human imagination is incapable of dealing with the ability to totally engineer reality itself. Having tested the weapons, the Soviets must be aware that the ill-provoked oscillation of timeflow affects the minds and thoughts -- and the very lifestreams and even the collective species unconsciousnesses -- of all lifeforms on earth. They must know that these weapons are two-edged swords, and that the backlash from their use can be far more terrible to the user than was the original effect to his victim.

If we can avoid the Apocalypse, the fantastic secret of Nikola Tesla can be employed to cure and elevate man, not kill him. Tesla's discovery can eventually remove every conceivable external human limitation. If we humans ourselves can elevate our consciousness to properly utilize the Tesla electromagnetics, then Nikola Tesla -- who gave us the electrical twentieth

century in the first place -- may yet give us a fantastic new future more shining and glorious than all the great scientists and sages have imagined.

References

The Tom Bearden Website

34 Flaws in Classical EM Theory

Note: If the scientific community had done their job, this Website would probably not be necessary.

---

1. SLIDE 1
2. SLIDE 2
3. SLIDE 3
4. SLIDE 4
5. SLIDE 5

Flaws In Classical EM Theory

1. Eliminates the Internal EM Inside the Scalar Potential.
2. No Definition of Electrical Charge or of Scalar Potential.
3. Equations Still Assume Material Ether Per Maxwell (Unchanged).
4. Use of Force Fields in Vacuum is False (and Known to be So).
5. Treats Charge q as Unitary Instead of Coupled System $q = \phi(q)m(q)$.
6. Confuses Massless Potential Gradients as Forces (See #3, #4).
7. Does Not Utilize Mass as a Component of Force (See #23).

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Flaws In Classical EM Theory (2)

8. Erroneously Assumes EM Force Fields as Primary Causes.
9. Topology of EM Model Has Been Substantially Reduced.
10. Does Not Include Quantum Potential or Action at a Distance.
11. Does Not Include Superluminal Velocity of Inner EM Components.
12. Does Not Utilize Extended Near-Field Coulomb Gauge Effects.
13. Does Not Include EM Generatrix Mechanism for Time Flow.
14. Does Not Unify Photon and Wave Aspects (Requires 7-D Model).

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Flaws In Classical EM Theory (3)

15. Does Not Include Electron Spin and Precession (See #19, #24).
16. Treats EM Energy As Existing In "Chunks," Instead of as Flow.
17. Confuses Energy and Energy Collection (See #16).
18. Discards Half of Every EM Wave in Vacuum (See #22).
19. Erroneously Uses Transverse Vacuum Wave; It's Quasi-Longitudinal.
20. Arbitrarily Regauges Maxwell's Equations to Eliminate Overunity Maxwellian Systems.
21. Omits Phase Conjugate Optics Effects (Which are the *Rule* in Internal EM).

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Flaws In Classical EM Theory (4)

22. Does Not Include EM Cause of Newtonian Reaction Force.
23. Erroneously Assumes Separate Force Acting on Separate Mass.
24. Confuses Detected Electron Precession Waves as Proving Transverse EM Waves in Vacuum (Remnant of Old "EM Fluid" Concept).
25. Due to Error in String Wave, Omits the Ubiquitous Antiwave.
26. *Assumes* Equilibrium; Not True Unless Include Vacuum Interactions.
27. Higher Topology Required, to Model Electromagnetic Reality.

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Flaws In Classical EM Theory (5)

28. Lorentz surface integration discards Poynting energy transport.
29. Has nothing at all to say about form of EM entities in massless space.
30. Eliminates the infolded general relativity using EM-force as curve agent.
31. Does not include longitudinal EM wave phase conjugate pairs as time domain oscillations.
32. Does not include EM mechanism that generates time flow and flow rate.
33. Does not include time-excitation charging and decay.
34. Does not utilize time-reversal zones.

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The Tom Bearden Website

Mind Control and EM Wave Polarization Transductions - Part I, II & III

Reprinted from "Explore" magazine, 1999

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- The U.S. approach to mind control

- "Voices in my head"
  Flanagan's neurophone - used to give instructions to diplomats during negotiations, etc.

Mind Control and EM Wave Polarization Transductions, Part 1

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Special Note

This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for nonapproved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental pro-cedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral.

Abstract

For some time we have been repeatedly queried about the technical mechanisms and unusual electrodynamics of advanced mind control research, both in the West and abroad. Calling full attention to the special note above, in this paper we present a high-level over-view of the novel electromagnetic nature of mind operations, mind and body coupling, and *intent*•the induction of physical 3-space EM energy changes into the brain and nervous system, and into every cell of the body, from the mind's time-like coherent operations. We summarize the time-polarized electrodynamics used to engineer and affect mind operations and the mind-body coupling loop. Transduction mechanisms whereby differing EM wave polarizations can be transformed one-into-the-other are presented. We give two specific examples of lethal foreign military tests in 1997 of advanced mind control weapons against two military pilots over the central U.S. Some dangers and potential benefits of the emerging mind control technology are pointed out

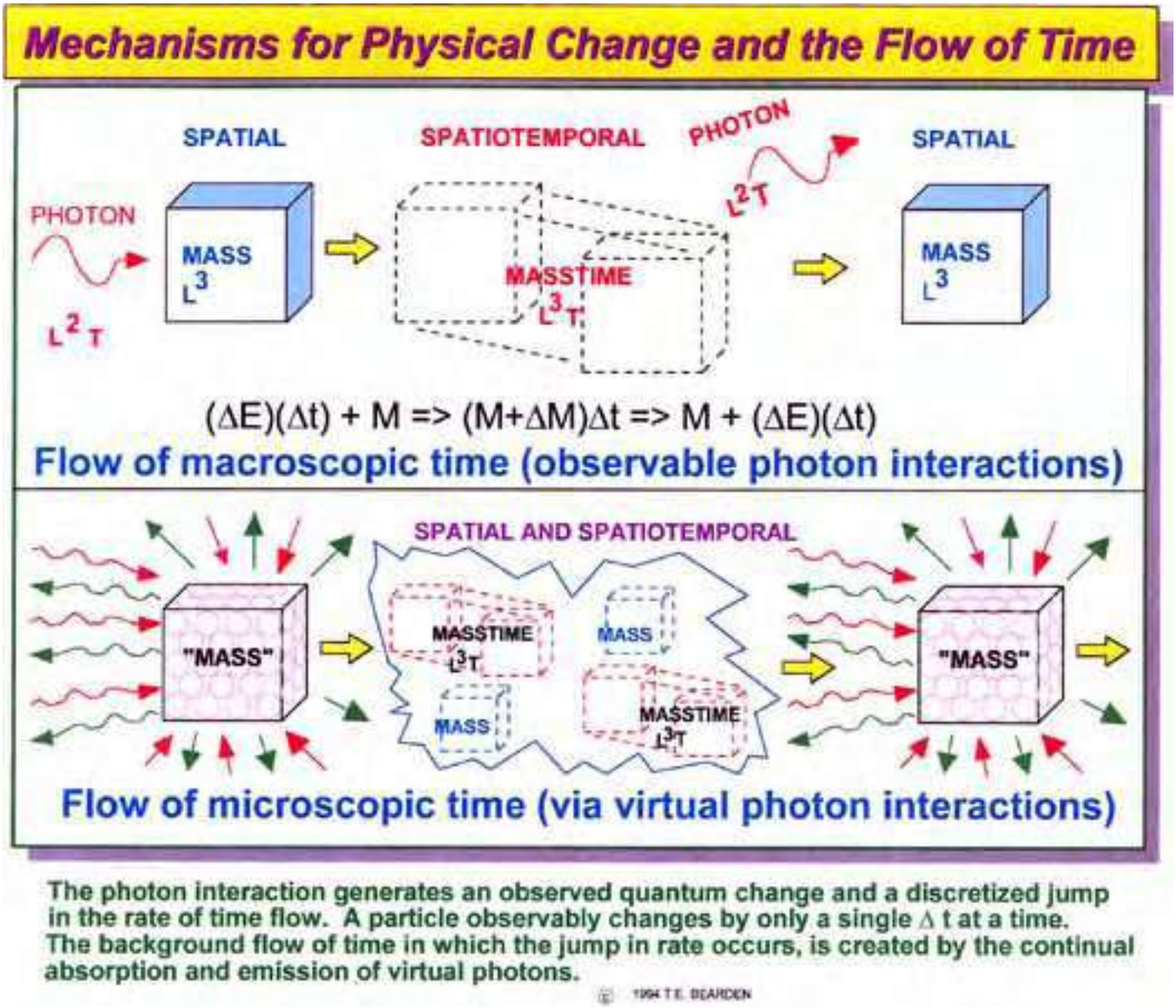

Figure 1. Mechanism that generates a mass's flow through time.

EXPLORE! VOLUME 9, NUMBER 2, 1999

Introduction and Background

In quantum field theory, there are four polarizations of photons.[1] Using 4-space and the z-direction as the direction of propagation, we have x- and y- polarizations where the 3-spatial energy of the photon is oscillating laterally, in the x- or y- direction. These are *transverse polarized* photons, as is any combination of the two. The third polarization is along the z-direction, which is a longitudinal polarization. In other words, the 3-spatial energy of the longitudinal photon cannot oscillate in the x- or y- direction, and so it is oscillating to-and-fro along the line of motion, z-. The fourth polarization occurs when the energy is frozen in all three spatial dimensions x-, y-, and z- and it cannot oscillate in any of those directions. In that case, the photon oscillates its energy in the t- direction, providing the t-polarized photon. We will later discuss how time is actually highly condensed energy.

In Minkowski 4-space, body operations are space-like, and are so treated in conventional materialistic physics. Mind and mind-operations are time-like, not space-like, even though they are totally electromagnetic in nature.[2]

As is well-known, all observation in physics is considered 3-spatial..[3] Mass is a 3-spatial concept, and we detect changes to mass (as, e.g., in the shift of electrons in the circuits of electrical instruments). So one may model the common physical observation mechanism as a *time-differentiating process* which *a priori* discards time-change and retains 3-spatial energy change.[4] That is, Minkowski reality is modeled in the fundamental units of L^3t. Physical observation (via the transverse photon interaction) is the process given by applying the operator $\partial/\partial t$ to L^3t, yielding an L^3 output. Hence mind and mind operations are excluded by the usual physics instruments and observation, which simply exclude the time domain in their outputs and do not "measure" it.

For this reason, physicists have erroneously considered mind to be "metaphysical" and nonreal. Indeed, most physicists to one extent or the other are materialists, and consider the "mind" to be nothing but the operations ongoing in a "meat computer." Nonetheless, in the time-domain the time is absolutely real, and it is completely electrodynamic in nature. There is no metaphysics involved, and the temporal domain—along with mind and mind operations—is simply an erroneously neglected area of physics. In present physics, the notion of mind is comfortably disposed of by imposing the use of the "observer" concept, with out ever specifying that the observer has a consciousness and a mind. Indeed, "observation" is only about what that "observer" perceives. Obviously, one has a dramatically crippled physics if one eliminates that nonobservable called "time." Similarly, one also has a dramatically crippled physics when one eliminates the mechanisms and physics ongoing in those time-like and dynamic "things" such as mind, that occupy time and function in it.

From this viewpoint, Western physics adheres to its 3-spatial measurement foundation only by ignoring the transduction of time-polarized EM changes into detectable longitudinal and transverse EM wave changes. In this aspect, present Western physics is severely self-crippled.

Time is totally electromagnetic and energetic in nature. The flow of time is not a separate external river on which a mass floats along like a boat drifting down the current of a great flowing river. Instead, the flow of time is generated directly on every mass by its total set of photon interactions, both virtual and ob servable. We have previously presented the exact mechanism for the flow of time. *[Figure 1]*

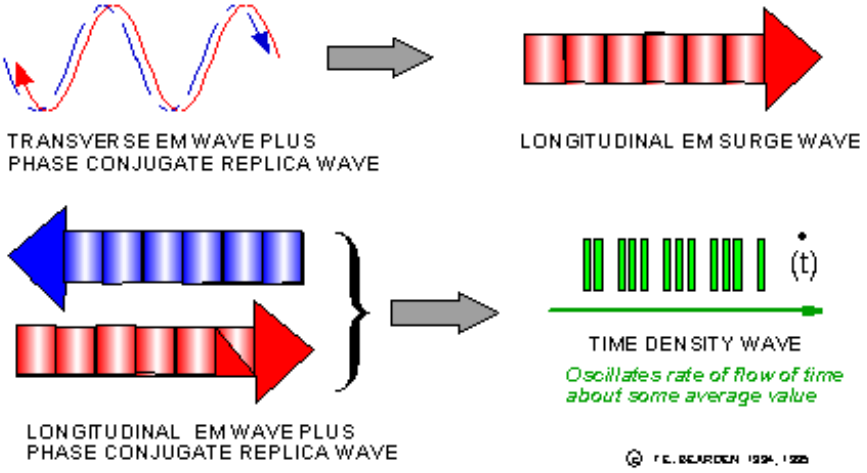

Figure 2. Transduction of EM wave type by successive phase conjugate pairing.

Further, a photon is comprised of angular momentum, therefore of (energy)x(time). It transports both energy and time, not just energy alone. When absorbed by a mass, not only does it "energy-excitation" charge the mass, but also it "time-excitation" charges it, converting the former "mass" to "mass time". Rigorously it is *masstime* that emits a photon, not *mass*. So a mass moves through time in little spurts, by the continual macroscopic addition and subtraction of little Dt components. Further, in being driven through time, mass is continually altered to masstime (a quite different critter from mass), to mass, to masstime, to mass, etc.

In any masstime state, a myriad of tiny virtual photon interactions made of very tiny (DE)(Dt)'s interact with that same mass during that particular larger Dt of the masstime state (m+Dm)(Dt). Hence mass in its alternate masstime state has that state internally structured by its surrounding environment's interactions with it. The masstime state is internally structured energetically in its (DE) component, and also internally structured temporally in its (Dt) component.

A standard charged fundamental particle such as an electron, e.g., is not necessarily identical with another, when the internal structuring of its masstime state is considered. Further, by two papers by Whittaker,[5] interferometry of masstime states with either energy reactions or temporal reactions can yield observable effects and changes due to these neglected "hidden variables" in the electron's masstime alternative states. To engineer the mind and its operations directly, one must perform electrodynamic engineering in the *time* domain, not in the 3-space EM energy density domain. The direct engineering of time-like mind and mind operations—in all levels and all aspects—requires the use of *time-polarized photons and time-polarized EM waves*. This is the rarest form of electrodynamics, almost untouched by Western physicists.

One can either painfully produce such time-polarized photons and EM waves and directly irradiate a target mass with specific assemblies of them, or one can force the mass itself to iteratively transduce ordinary transverse EM waves first into longitudinally-polarized EM waves and then into time-polarized EM waves. Both will be discussed briefly.

In the West, it appears that the present author's discovery of mechanisms for producing time-polarized (scalar) EM waves [see *Figure 2*] and for transducing between wave polarizations has no precedent. [See *Figure 3*]. While scalar (time-polarized) photons are known in the literature,[1] the creation and use of time-polarized EM waves does not seem to appear in the Western physics literature.[6]

Wave transduction or *polarization transductions* are terms used by the author for the process of transforming an EM wave's particular polarization into another polarization type. Such transduction to other than transverse polarization forms is little known in the West. It appears essentially haphazardly in some experiments, usually without any recognition by the experimenters themselves. Significant transduction in experiments will also produce "strange" and unexplained anomalies in the instruments being used for experimental measurements.[7]

So most probably Western mind control researchers have not recognized the methodology and mechanisms[8] for transducing one type of EM wave polarization directly into another.[9] They continue to seek the "mind" in 3-space and hence in the brain, rather than in the time domain. On the other hand, it appears

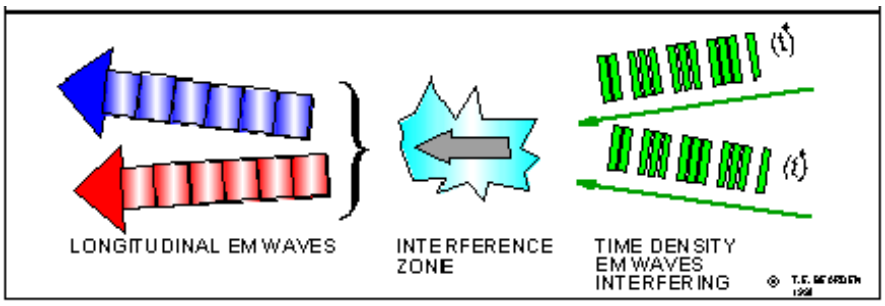

Figure 3. Interference processes for transducing higher EM wave polarizations into lower polarization states.

that the Russian KGB energetics[10] weapons scientists—particularly those in psychoenergetics[11]—have known and used methods of transducing one wave polarization into another, for at least two decades. It follows that those same scientists have very probably developed mind engineering and mind control via novel time-polarized EM wave means and a dramatically extended electrodynamics of the time-like mind operations.

In the present paper we briefly develop the wave transductions and the basis for mind engineering, including the specialized use of ordinary transverse wave (TW) EM spectra to force internal EM wave transductions and time-domain operations inside irradiated bodies, cells, and tissues. Through the mind-body coupling mechanism, these transductions of transverse EM waves can operate upon the mind and its deepest operations as well as upon the body, every cell, and every part of every cell.

Russian Mind Control Uses Higher EM Wave Polarizations

It is apparent that the KGB psychoenergetics weapons scientists know and use the full extended EM wave polarization range. As a postulation, one would expect our own weapons scientists to know and utilize the orthodox transverse wave (TW) EM for similar research and experimentation. However, in the West scientists are just beginning to realize the importance of a very general (and weaker) type of longitudinal EM wave (LW) polarization, as evidenced by the appearance of dozens of papers on "undistorted progressive waves" (UPWs, which are essentially imperfect LW s with TW residues remaining). The Los Alamos National Laboratory web site has a number of such papers—particularly by Rodrigues[12] and Lu—available for free downloading. UPWs have very interesting characteristics. If they were perfect longitudinal EM waves, they would have infinite energy and infinite speed. Since only imperfect UPWs can be physically made, their speed can vary from slower than the speed of light to faster than the speed of light. Their energy can also vary over a great range.

Another characteristic of UPWs that are reasonably good longitudinal EM waves, is that they pass readily through a large depth of water and mass, including through the ocean and the earth with only small interactions and losses. Yet by interfering two such beams of "high quality" UPWs at a great distance, then in the interference zone ordinary EM energy will rise directly out of local spacetime potential, as essentially shown by Whittaker[13] nearly a century ago. Russian weapon research facilities have weaponized these effects[14] for nearly 50 years, under rigid KGB control and operation. Nonetheless, even if using only ordinary TW waves, Western mind control researchers may get some fairly good results, brute-force-like, by using gross correlates between just the input irradiating TWs and the exhibited behavioral responses of the individual. The net input-output correlations can be determined, even though not taking into account the actual wave polarization transduction mechanisms ongoing inside the irradiated dielectric (or brain, or mind, etc.). However, Western researchers appear to have no knowledge of the exact mechanisms by means of which coherent time-like mind operations of a biological organism couple to the organism's 3-spatial body to provide the mental control loop. They also appear unaware of how the coherent 3-spatial behavior responses of the body couple back to the time-like mind to provide it with a sensory feedback of the body's responses.

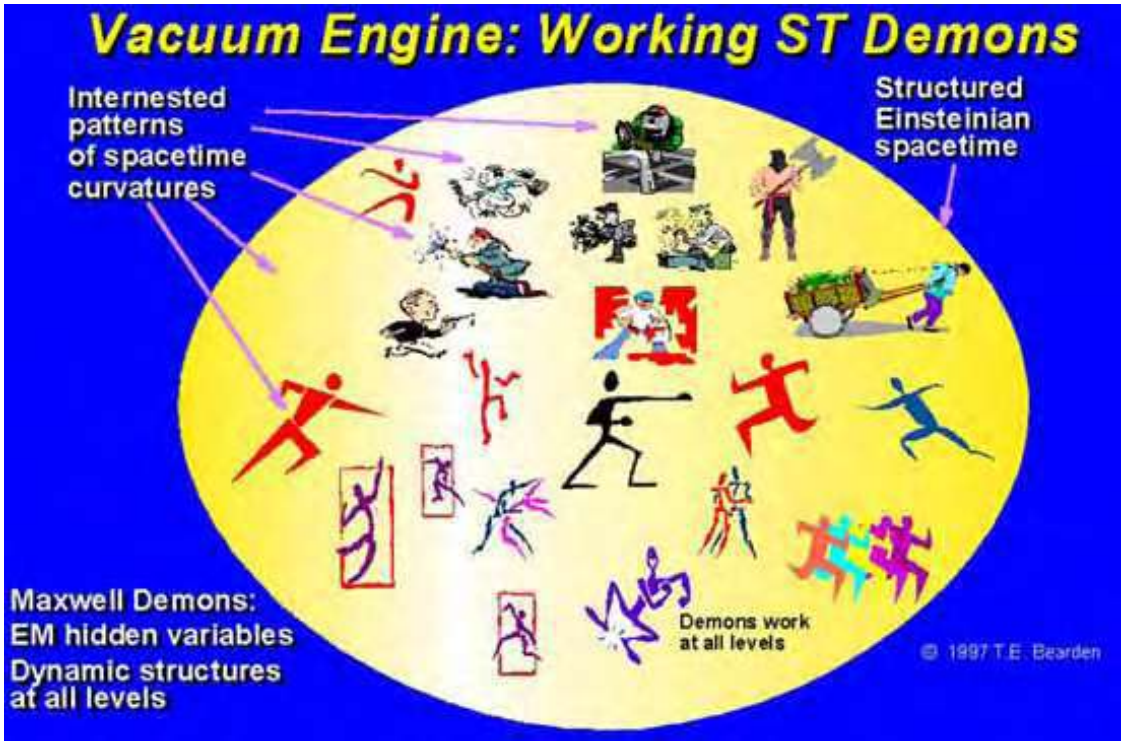

Figure 4. A spacetime curvature engine has myriads of small ST curvature components which act upon mass at all levels.

General Relativity Aspects

Both these coupling mechanisms can be taken directly from general relativity, if one puts one's mind to it. However, unless the wave polarization transformations are known, it is difficult or impossible to apply the ordinary GR *directly*, since relativists usually concentrate upon spacetime curvature by altering 3-space energy density rather than by altering time-polarized "time-energy" density.

In applied general relativity, spacetime itself is an active medium. One speaks of a change in spacetime as a "spacetime curvature". Any curvature of spacetime in a local region directly performs continuous work upon any mass embedded in that region. Vice versa, any mass (or other concentration of energy) in a local spacetime continuously acts upon that spacetime to "curve" it.

So if one wishes to perform actions upon mass in a distant region, one may generate local curvatures of spacetime in that region, and these curvature "engines" will directly act upon the mass at all levels. *[Figure 4]* This is very different from energy propagation through space from one point to another. Now the "ordinary EM energy and actions" arise from every spatiotemporal point within the mass, at every level, and move upwards (from inside to outside). So we speak of specific forms of "templates" of nested spacetime curvatures formed and utilized to engineer mass "from inside out" as *spacetime curvature engines or vacuum engines*.

Use of vacuum (spacetime curvature) engineering[15] is a far more powerful form of engineering than is provided by energy propagation through space. As an example, it is easy to alter the quarks in a nucleon, using spacetime curvature engines and time-charging decay. Indeed, we have developed the mechanisms for cold fusion and the electronuclear interaction (formation of new nuclides) at feeble energy. An Invention Disclosure[16] on this work has been filed with the U.S. Patent Office, and formal patent applications are in preparation. Some information on these mechanisms and principles has been released[17].

Time as Dense EM Energy and a Strong Spacetime Curvature Agent

The advantage of using the time-polarized "time-energy" for spacetime curvature is that time is ordinary energy compressed by a factor of at least c^2—which, in the MKS system of units, is some $9¥10^{16}$. Thus use of time-polarized EM photons and waves as ST curvature agents gives an amplification of $9¥10^{16}$ over the use of transverse-polarized EM waves for that purpose. In turn, the use of the strong EM force in ordinary TW waves as an agent of ST curvature is already a nominal 10^{40} times as strong as is the weak G force used as the agent of ST curvature.

The bottom line is this: For spacetime curvature effects, the use of the t-polarized domain provides amplification of some $9¥10^{56}$ greater than the weak G-force ST curvature agent usually considered in general relativity[18].

Western Science Remains Largely Materialistic

Ironically, most Western scientists are materialists and consider "mind" as a mystical and nonscientific concept. They tend to consider mind operations and functions either to be simply "meat computer" operations and functions, or at best to be very weak ordinary transverse-wave EM operations and functions in the brain and nervous system.[8] This serious self-limitation exists because in the body we *measure* only weak TW EM operations and functions correlated to biological behavior and brain operations. We simply do not know how to measure "mind operations" directly.

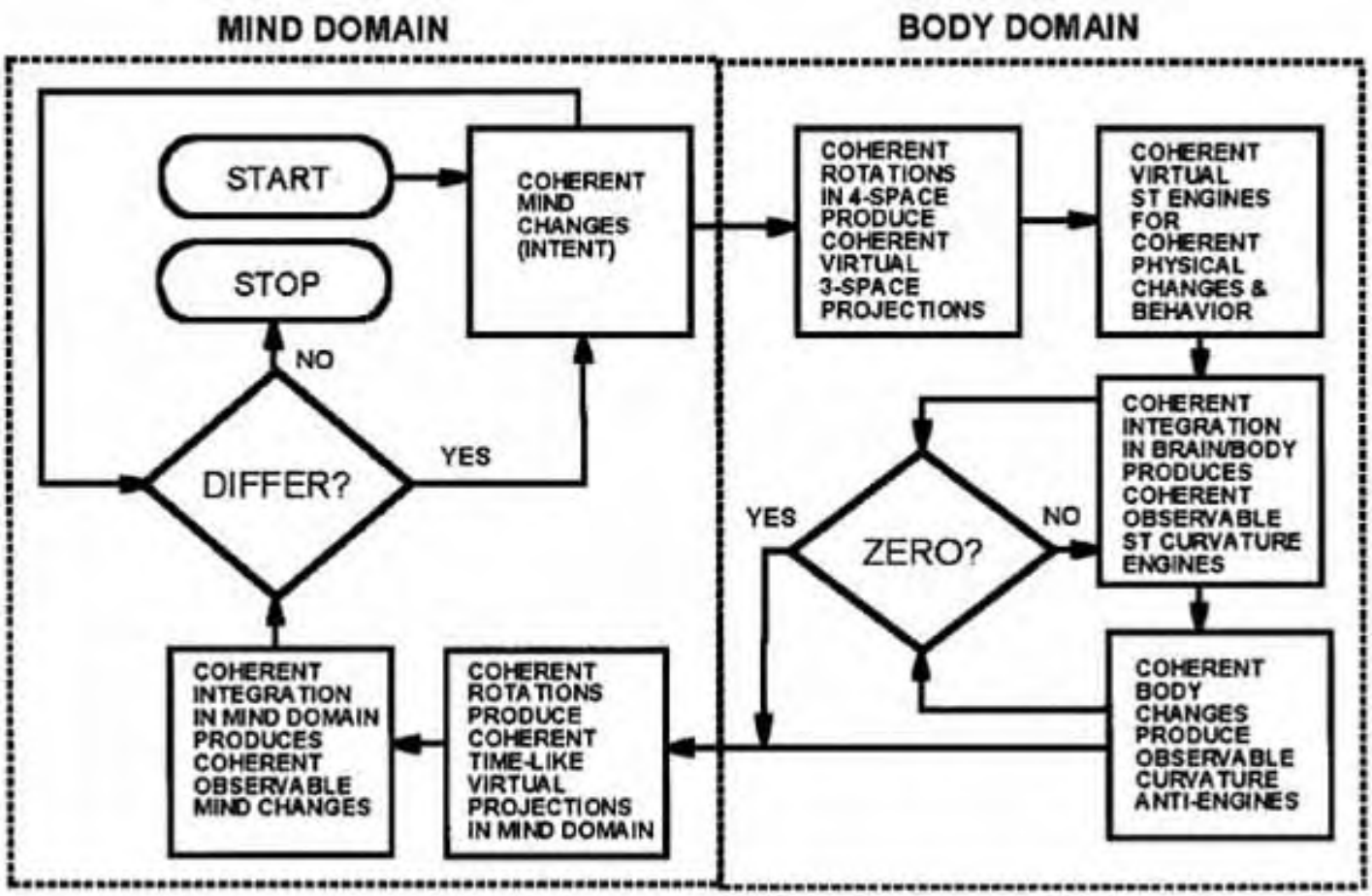

Figure 5. Mind-to body coupling and body-to-mind coupling.

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With no mind measurements possible and no instruments, it is understandable that Western science considers only the physical side of the mind-matter interface.

Presently our scientists do not measure the longitudinally-polarized EM wave operations and functions in the body and around it in nature. Few of them are aware that a maelstrom of such LW functions exist in the body and in all of nature in general. Presently only highly theoretical quantum field theorists seem to even be aware of the existence of scalar (t-polarized) photons, and even they are unaware of t-polarized EM waves. Certainly our scientists do not measure t-polarized EM waves in and around the body and in nature, nor do they make them in the laboratory. Apparently they have not studied such waves and their interactions with matter—living and inert—at all.

But it's even worse. In ignoring the time component transported by photons and EM waves, science has also erroneously omitted half of the excitation charging and excitation decay processes whenever a mass interacts with photons and EM waves. More on that later.

Brute Forcing Time Functions versus Fine Control Methods

Ironically, Western mind control researchers using transverse EM waves for mind control research, are using a brute force method of evoking and using vacuum engines (spacetime curvature engines) and a special form of general relativity, although they do not appear to realize it.

While KGB scientists also use TW EM "brute force" TW waves when necessary, they do "imprint" or "activate" those waves with the desired internal LW and time-polarized EM wave and photon structures required to directly perform the mind engineering desired. They also do not hesitate to use LWs and t-polarized waves overtly. So in blunt terms, Western compared to Russian mind control research is probably like comparing an automobile body shop with a fine surgical ward. Having long ago worked out all those "exact correlates" to the internal "information content of the field" is where the KGB scientists are at least 20 years ahead of the West.

The reason one can get mind and behavior results with the TW electromagnetics, while bypassing the real mechanism which uses t-polarized waves and photons, is due to (1) the very peculiar nature of the EM emission from a dielectric, and (2) what can be done by re-radiating that dielectric with its emitted spectrum, deliberately and very carefully altered in selected parts. We will return to that important feature later.

Polarization and Observability

As we stated, there are four photon polarizations and therefore there must be correspondingly four EM wave polarizations[1] The first three polarizations are the x-, y-, and z- spatial polarizations. The x- and y- polarizations are transverse polarizations and the z-polarization is a longitudinal polarization along the direction of propagation (along the z-axis, by standard notation). Simply put, we may visualize the transverse polarizations as rather like the wiggling of a fish's tail from side to side as the fish moves forward, or a whale's flukes up and down as the whale moves forward, or some combination thereof. We may visualize the longitudinal polarization as a sort of "repetitive accordion effect" along the line of motion of the wave. Usually the z- polarization is neglected in EM wave theory, although in recent years physicists have "rediscovered" longitudinal EM waves and are now intensely researching the use and characteristics of such waves.[12]

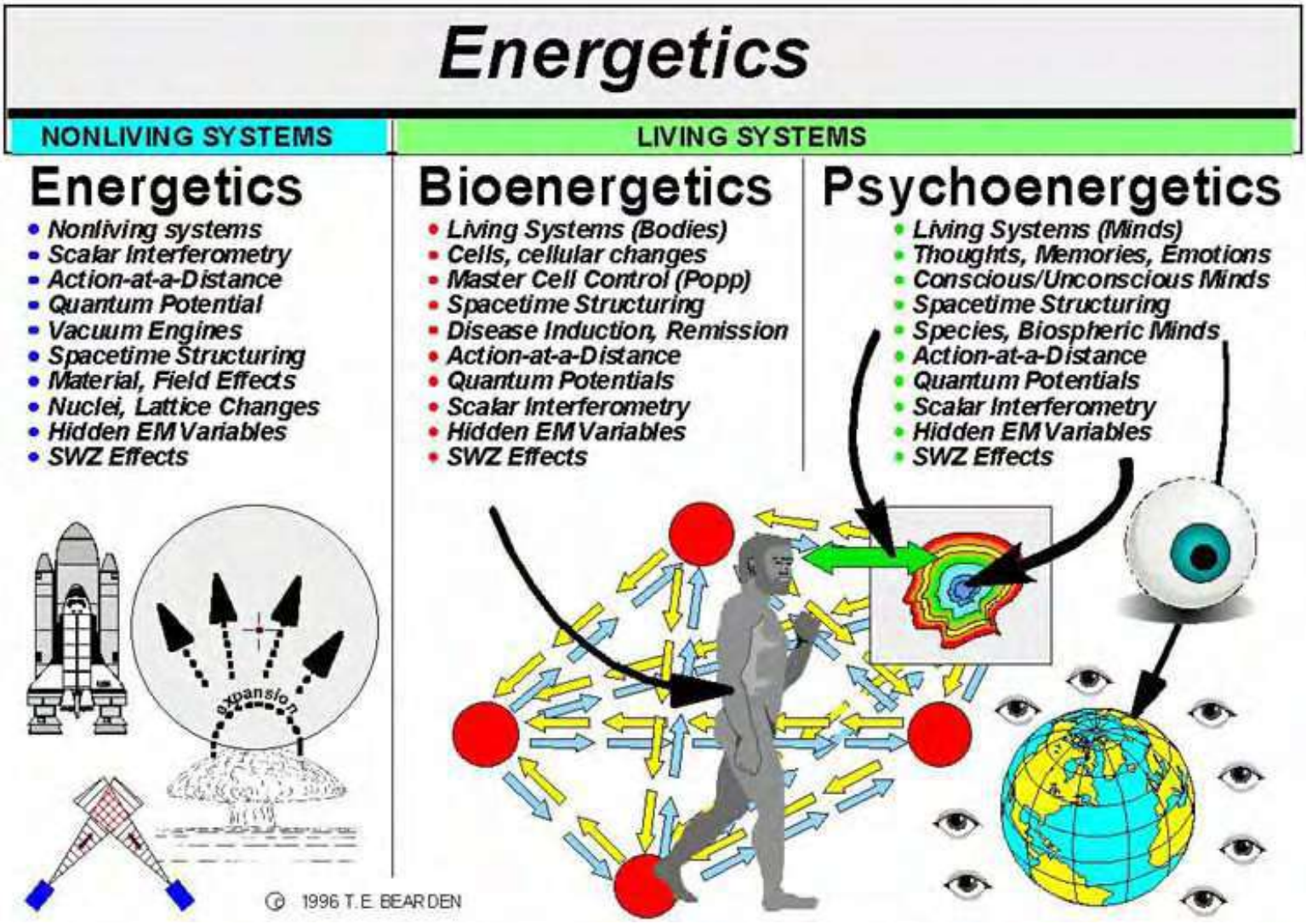

Figure 6. The three divisions of Soviet energetics and their characteristics.

Unfortunately, in quantum field theory there has been a tendency to regard the t-polarized or "scalar" photon—where the local rate of time is oscillated—as unobservable. Oscillation of the local rate of time produces powerful oscillations of local space-time curvatures, due to the extreme energy density of time. Individually, the t-polarized photon tends to be unobservable. However, a *coherent sequential group* of such t-polarized photons, each individually in the virtual state with respect to the external observer, may simply integrate in its interaction with mass over a short time period into observable change because of the coherent integration of virtual spacetime curvatures into a larger, observable spacetime curvature.

Rotations and Projections in 4-Space

Relativistically, any velocity change in 4-space is a rotation. Any such rotation in the time-domain also creates a tiny projection component into 3-space. Any such rotation in the 3-spatial domain also creates a tiny projection component into the time domain.

Hence a sufficient series of coherent time-domain (mental) changes produces a coherent series of virtual changes in 3-space (the body), thereby coherently integrating into an observable energy change in the body. A sufficient series of coherent 3-spatial energy changes produces a coherent series of virtual changes in the time domain which coherent integrate into an observable time-domain change.

Solution to the Age-Old Philosophical Problem of Intent

This is in fact the solution to the age-old problem of *intent*, or how the nonmaterial (i.e., non-3-spatial and non-observable) mind induces a 3-spatial, observable energy change upon the 3-spatial body. It is also the solution to the problem of *awareness*; i.e., how the mind is aware of itself[19] and of the responses of the body. Together the two form a closed loop coupling of the mind and body. The time delay in the loop together with memory recall for comparison, creates the sense of "persistence" of self in time. This also creates the sense of being a "separate, closed being" (i.e., of separate persistence in time—in the living entity). The sense of "separation of self from an external world" is created by comparing those body-to-mind sensory feedbacks which are not correlated to the mind's previous feed-forward intent.

Time As Energy and Why It Is Very Dense Energy

In addition to the three spatial polarizations of photons and EM waves, there is a very, very useful t-polarization along the time axis. In this polarization, the 3-spatial energy is not oscillating at all. Instead, the time or time-energy is oscillating. Time can be taken to be energy compressed by at least c^2, so it has at least the same energy density as mass. In other words, one second is 9×10^{16} joules of time-energy (energy compressed into time). The t-polarized photon or EM wave is called the scalar photon or scalar EM wave, respectively.

To demonstrate why time can be regarded as energy, we need only point out that the choice of fundamental units in any physics model is totally arbitrary. We usually choose these units to ease the mathematical manipulation, ease our understanding, and simplify the ability to visualize or "grasp" the physics. However, if one wishes, one can build all of physics from a single fundamental unit—e.g., energy. In that case, one readily sees that time is a function of energy and only energy. Hence it is perfectly proper to regard time as energy, and to seek out what form the function takes in our normal system of units (say, the MKS system).

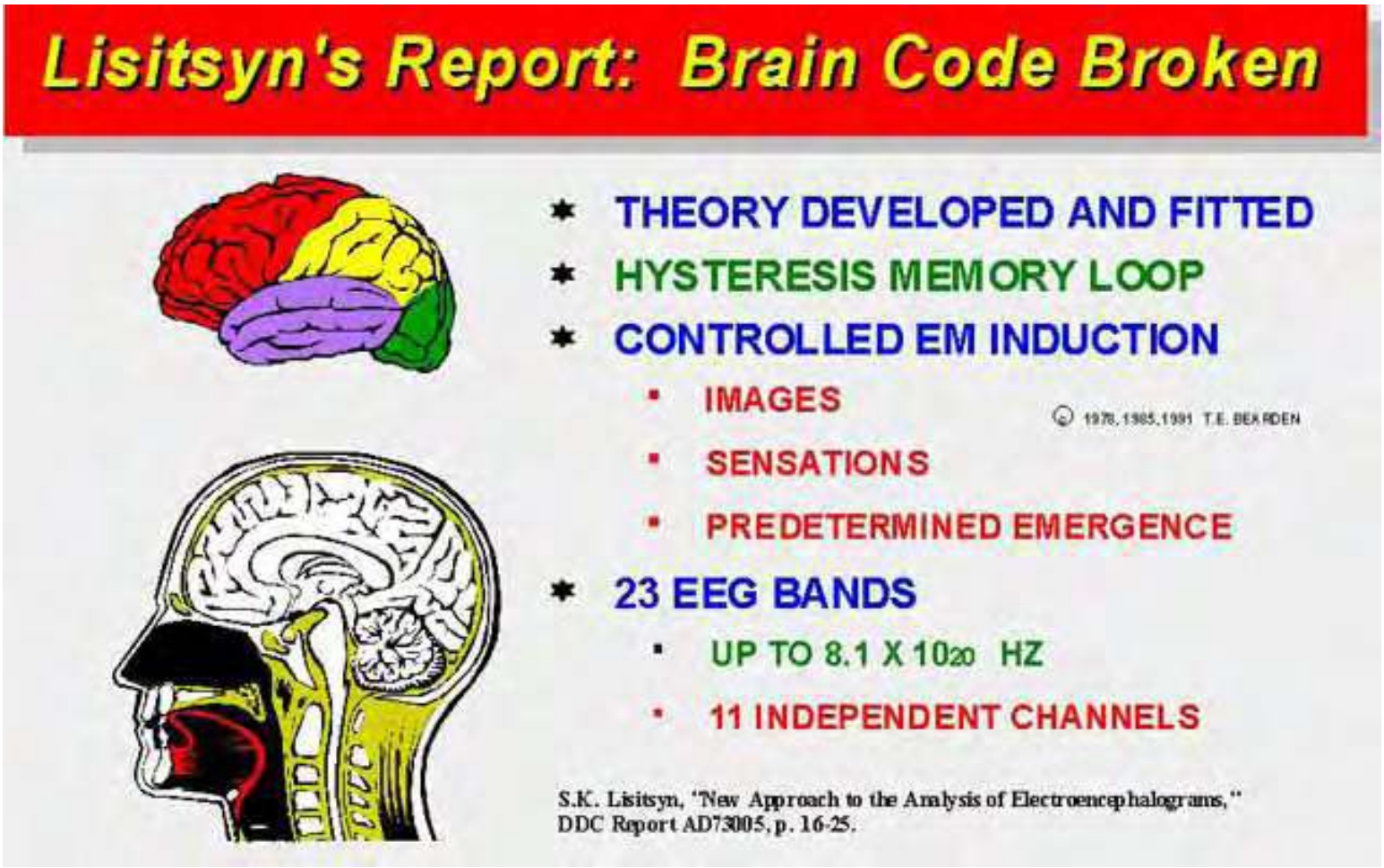

Figure 7. In the 1960s, Lisitsyn revealed Russian scientists had deciphered the human brain code.

In that system, it appears that any change in time Δt can be taken as always a function of a corresponding change in energy ΔE, where $\Delta t \leq (\Delta E) \div c^2$ [1] from which it follows that $\Delta E \geq (\Delta t) \times c^2$ [2] For convenience, we take the special case where $\Delta t = (\Delta E) \div c^2$ [3] $\Delta E = (\Delta t) \times c^2$ [4].

Observation as Used in Physics Is Spatial

We note that all mind operations are time-like, i.e., they are comprised as scalar EM photon functions and scalar EM wave functions. Thus the mind is a very special kind of electromagnetic system, existing in the time domain, and thus "lost" by the stripping away of time in the ordinary observation process. Physical observation is essentially a time-differentiating mechanism applied to a 4-spatial change, or in terms of MKS fundamental units L and t, observation θ is $\theta = \partial/\partial t(L^3 t) = L^3$ [5].

Thus, as is well-known in quantum mechanics, physical observation is 3-spatial, and time is not a physical observable, even in theory. Since mind is time-like, it follows that mind is not a physical observable either, since discarding the time dimension also discards the mind. In short, one may also take physical operation as the mechanism that separates mind and body. To observe is to separate. We point out, however, that merely "separating and discarding" the time domain (as in physical observation of a single change) does not eliminate it, nor does it eliminate the single time-like mind change that may be involved in an intentional volition. The time domain certainly remains, even though only the 3-spatial intersection of the 4-spatial Minkowski change is given by physical mechanism and the resulting "outputs". So a series of coherently integrated "mental intent" changes introduced into the human body's overall servo-mechanism provides the continuing input. From there, ordinary physics will generate the resulting actions induced in the body by that servomechanism and its amplifying mechanisms.

Two Coupling Mechanisms Make a Closed Loop

This is the "mind-to-body" coupling mechanism. [See *Figure 5*] It is the mechanism whereby the mind is coupled to the body, and whereby mental intent is able to induce a series of physical inputs into the body servomechanism.

So the body's servomechanism then generates the responses of the body (including everything from chemistry to electrical changes to muscular movements, etc.). These responses are changes in 3-space.

The conscious mind is a *serial processor*, though extremely rapid. It produces the series of coherent intent inputs for volitional behavior.

The unconscious mind is a *massively parallel processor*.[20] It continually produces the vast series of coherent "unconscious intent inputs" for control of all the deeper processes in the body, beyond usual conscious awareness.

However, as the body moves or changes in 3-space, each resulting quantum change in body 3-space is also a slight rotation out of 3-space and toward the time axis. Hence it induces—in the "virtual state" in the time domain—a precisely correlated projection. The body's responses are in general coherent, so a coherent series of virtual state changes in the time-domain (in

observation. So we may say *that the time-change remains in the virtual state, with respect to attempted physical observation of a single Minkowski 4-space change.*

Rotation, Coherent Integration, and Intent

Previously we pointed out that any change in a 4-space entity may be regarded as a rotation away from the "trajectory" of the entity. Hence each and every t-polarized change creates a very small projection into 3-space by its rotation slightly away from the time axis. All mind changes in the time-domain actually produce virtual 3-spatial projections in 3-space (in the physical domain). We define "intent" as the continued production of successively coherent mental changes, producing coherent virtual changes in the 3-space body system, with coherent integration of those 3-space virtual changes into observable 3-space energy inputs into the 3-space body system. Successively coherent mind-changes will produce successively coherent 3-space virtual changes. In short, coherent mind-changes will produce coherent integration of those 3-space virtual projections into an observable 3-space change. This is the creation of an ordinary 3-spatial energy change induced upon the 3-space body. In short, this is the mechanism whereby time-like mental intent is able to produce a series of coherent observable quantum changes in the physical body (as in the brain and nervous system).

The Body as a Servomechanism

From the standpoint of control theory, we may consider the body system to be a complex servomechanism system comprised of many subordinate servo systems with feedback and feedforward the mind realm) are created successively. In short, again we have coherent integration, this time in the mind or time domain. This produces "observable" changes in the time-mind domain, which are coherent with the body's 3-spatial changes actually performed. Thus the mind receives feedback directly from the physical movements and changes of the body. This is the manner in which the body is coupled back to the mind.[21]

By comparing the "intent" behavioral move that was "fed forward" into the body, with the return "response" move analog that was "fed back" from the body to the mind, the mind is able to determine errors and differences, and originate additional correctional commands.

Thus the entire mind-body loop is a closed-circuit system of feedforward and feedback, together with corrections. It also has multiple levels of such, infolded in the larger volitional levels. See again *Figure 4*.

This solves the age-old problem of the mechanisms for the mind-body coupling, intent, volition, conscious and unconscious functioning, sense of the external world, sense of the internal world, sense of "being in" the external world, etc.[22]

All This Is Included in Russian Psychoenergetics

This is the highly summarized basis for *psychoenergetics*, the KGB's division of energetics that deals with the mind and body coupling and functions, and direct engineering of (1) the mind-body coupling and (2) the mind operations directly. [See *Figure 6*] The KGB intent, of course, has always been to exploit this science for the degradation, killing, and control of human beings, including all humanity.

The Russians know full well that, if you

looping.

Given the input from intent, ordinary servo theory will take it from there. Once a servo has an input, servomechanism theory describes the response of the

produce and utilize scalar EM photons and t-polarized EM waves, you can directly affect and engineer mind and mind operations at any and all levels. Western researchers, who know nothing of how to make

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time-polarized photons and time-polarized EM waves, do not yet know that. Consequently the Russians have developed a highly secret science of *directly* engineering the mind and its operations, including thought, images, perceptions, feelings, emotions, memory, and mind processing. Indeed, Lisitsyn[23] wrote quite specifically of this capability in the 1960s. [See *Figure 7*]

Western clandestine mind control researchers are apparently still slowly and painfully fitting TW EM irradiation correlates to induced or resulting mental and physical behavior responses. They seem unaware of the actual wave transductions occurring inside the body and mind, but are unwittingly inducing those transductions in hidden fashion anyway and in "brute-force input-response fitting" models.

These "fitted brute-force models" certainly can be very powerful, and certainly can produce the exact results shown in the experimental verifications of the fittings. However, they do not of themselves allow sophisticated design—for example—of the necessary time-polarized wave assemblies for engineering the entire human collective unconscious simultaneously, or for engineering the entire collective unconscious of all species on Earth (i.e., Gaia's collective unconscious), or even for precisely engineering the memory and knowledge base of an individual.

This fine research article will be continued in Part II with Russian Methodology, Waves and Wave Transduction, The Cellular Control

spacetime that is highly active. The mind is rooted in the time-domain and projects from that domain into 3-space. The body is rooted in the 3-space domain and projects into the time-domain. To "change" or "function" in one domain is automatically to function in the other. EM and gravitational phenomena are still modeled separately by human scientists, but not by nature.

3. In quantum mechanics, time is not an observable, but merely a parameter.

4. It is convenient to consider mass as a 3-spatial form of condensed energy.

5. E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics, " Mathematische Annalen, Vol. 57, 1903, p. 333-355;— "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions, "Proc. Lond. Math. Soc., Series 2, Vol. I, 1904, p. 367-372.

6. A NERAC document search yielded some 16 good references on t-polarized photons, but not a single reference on t-polarized EM waves.

7. E.g., such previously inexplicable instrument anomalies have accompanied some excellent and rigorous electrolyte experiments at U. S. Navy research facilities at China Lake. For a description, see Melvin H Miles and Benjamin F. Bush, "Radiation measurements at China Lake: Real or Artifacts?", Proc. ICCF - 7 (International Conference on Cold Fusion—7, Vancouver, BC, Canada, Apr. 1998, p. 101. For a brief explanation of the anomalies, see T. E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves, " Explore!, 8(6), 1998, p. 7-16;— "Toward a Practical Unified Field Theory and a Deep Experimental Example," Proc. INE Symposium, Univ. Utah, Aug. 14-15, 1998.

8. Many U. S. researchers and journalists—and even many scientists—have wrestled with the problems of mind, intent, and mind-body coupling. Enumeration of those efforts would itself require an entire book. For an introduction into that domain, the reader is referred to the very determined exposé by

System, and other matters of interest. ♦

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He is president of the Association of Distinguished American Scientists (ADAS), a life member of the Alabama Academy of Science, Emeritus member of the American Association of Physics Teachers, and has served on the Board of Directors of several associations and corporations. Tom is a guitarist, a retired aikidoist (Sandan, Yoseikan style), is happily married and has two sons and two daughters. He and his wife Doris live in Huntsville, Alabama where Tom is retired from aerospace, continues private research, and serves as a consultant to industry on Scalar

Cheryl Welsh in her very timely book, The 1950's Discovery of the Code of the Brain, May 1988, published on the Internet. Simply employ any Net search engine and search on the name Cheryl Welsh. A connection to the site and to Welsh's book will immediately be found Welsh's important compendium is highly recommended, giving the reader a "birds eye view", so to speak, of how Western scientists think and proceed regarding the subject of mind control by electromagnetic means. Unfortunately all journalists so far researching the area have not been aware that Western electrodynamics itself is seriously flawed, and that the great Russian advances in mind engineering and mind control are a result of their secret but complete revision and correction of Western electrodynamics to provide the basis for energetics. Until Western scientists revise their own decrepit old electrodynamics fouling the textbooks, they will never catch up to the Russian mind control developments springing from intense development programs that did that revision in the late 1940s and early 1950s.
9. An Invention Disclosure on these processes and enhancement embodiments has been filed with the U. S. Patent Office. Formal patent applications are also in preparation.
10. Energetics is a unified science of an extended electrodynamics possessing a hidden infolded general relativity inside the potentials, fields, and waves. It deliberately employs higher polarizations (longitudinal and tempic) of photons and EM waves to engineer action at a distance, use of specific patterns of spacetime curvature created at a distance, and direct engineering of either inert or living bodies. It also encompasses the direct engineering of time-like mind and mind functions. It is divided into three divisions, depending upon the nature of the target. Targeted against inert materials, structures, fields, and waves it is called "energetics. "Against living bodies, their fields, and biochemistry, it is called "bioenergetics." Against the mind and mind functions, it is called "psychoenergetics".
11. Psychoenergetics is that branch of energetics used to directly affect and engineer

electromagnetics processes.

R E F E R E N C E S

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1. E.g., see Lewis H Ryder, Quantum Field Theory, Cambridge University Press, 2nd Edition, 1996, p. 147+. For an even deeper discussion of photon polarization, see F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984, under the heading "Covariant Quantization of the Photon Propagator" in Chapter 5. Mandl and Shaw argue that the longitudinal and scalar polarizations are not directly observable, but only in combination, where they manifest as the "instantaneous" Coulomb (i.e. electrostatic) potential.
2. Nature is unified and not separated into the "separate" disciplines our science has prescribed. Thus the mind is also totally electrogravitational. The mind works not just with EM
forms in an inert space, but also with spacetime curvatures in a the mind, memory, perception, thought, emotion, sensation, personality, and other mind functions of a living biological organism. It is usable against a single personal conscious (serial processor) mind and a single personal unconscious (massively parallel) processor mind In theory it is also usable against lungs collective unconscious mind and its functions, as well as the deeper unconscious for all species on Earth (i.e., against Gaia). We are speaking of physics, not metaphysics.
12. W A. Rodrigues Jr.. and J.-Y. Lu, "On the existence of undistorted progressive waves (UPWs) of arbitrary speeds $0 \leq v < \infty$ in nature," Foundations of Physics, 27(3), 1997, p. 435-5•08 A slightly corrected version is downloadable as hep-th/9606171 on the Los Alamos National Laboratory website.
13. E. T. Whittaker, "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions, "Proc. Lond. Math. Soc., Series 2, Vol. I, 1904, p. 367-372. The paper was published in 1904 and orally delivered in 1903.
14. E.g., see T. E. Bearden, Fer-de-Lance, Tesla Book Co., 1986;—AIDS: Biological Warfare, Tesla Book Co., 1988;—Soviet Weather Engineering Over North America, 1-hour videotape, 1985,—Gravitobiology; A New Biophysics, Tesla Book Co., P.O. Box 121873, Chula Vista, CA 91912, 1991,—Energetics of Free Energy Systems and Vacuum Engine

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Therapies, Tara Publishing, Internet node www.tarapublishing.com/books, July 1997; — Energetics: Extensions to Physics and Advanced Technology for Medical and Military Applications, CTEC Proprietary, May 1, 1998, 200+ pages furnished to selected government agencies and key Congressional committee leaders.

15. E.g., see T.D. Lee, Particle Physics and Introduction to Field Theory, Harwood; New York, 1981. On P.383, Nobelist Lee points out that the microstructure of the scalar vacuum field (i.e., of vacuum charge) is not utilized. Particularly see Lee's own attempt to indicate the possibility of using vacuum engineering, in his "Chapter 25; Outlook; Possibility of Vacuum Engineering, " p. 824-828. With wave transductions and use of higher polarization EM waves, there are far better and more powerful ways to do vacuum (spacetime curvature) engineering.

16 T.E. Bearden, "Formation and Use of Time-Reversal Zones, EM Wave Transduction, Time-Density (Scalar) EM Excitation and Decay, and Spacetime curvature Engines to Alter Matter and Convert Time Into Energy," Invention Disclosure Document #446522, Oct. 26, 1998.

17. T.E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves, "Explore!, 8(6), 1998, p. 7-16; — "Toward a Practical Unified Field Theory and a Deep Experimental Example," Proc. INE Symposium, Univ. Utah, Aug. 14-15, 1998.

18. We have used the enormous energy density of time in our approach to a totally new kind of electronuclear interaction at feeble spatial energy. By use of a time-reversal zone (TRZ) in a fluid; the free H+ ions—which are free protons—can be induced to attract each other so tightly that the edge of the nuclear force region is entered. In that case the protons form a quasi-nucleus. When the TRZ decays back to a time-forward zone (TRZ), this new quasi-nucleus decays by changing quarks in one or more nucleons, thereby producing new nuclides. We point out that means "sense of existing in time".

20. The "unconscious" is totally conscious, just multiply so. The conscious mind can see only "a single slide in the slide projector at a time, " so to speak. When it "looks" at the ongoings and outputs of the unconscious, it "sees" millions of slides in the slide projector simultaneously. Hence it cannot distinguish "one and one only". So it just sees nothing, where by "nothing" we mean "no single distinguishable thing." It therefore is unable to consciously perceive the actions of the unconscious. When the unconscious wishes to communicate with the conscious (because of unresolved conflicts, etc.), it must produce large groupings integrated into "symbolic scenarios". Hence the symbolism of the unconscious, and the basis for therapeutic psychology and psychiatry. A "symbol", after all, is just a thing which can have many different meanings, all folded into one.

21. The mind continually has activities of its own, each of which produces coherent changes in the body to a much smaller degree. The interweaving of these "smaller self-changes" infolded inside the 3-space major intent changes also produces slight body changes, which in turn "project back" into the mind. This huge group of "infolded self-loops" produces the sense of "my body" being "volitionally directed or occupied" simultaneously with the "greater intent" loops which represent "my intentional actions with my body". Further; the body servo continually receives a myriad of inputs from its sensory systems, both from changes inside the body and from incoming changes from the external universe. This interweaving produces the awareness of "being in the external world" by having (i) changes whose feedback do not match mind-intent changes, and (ii) changes whose feedback does match mind-intent changes. This of course applies to both the conscious and unconscious levels. The purpose here is to demonstrate that there exists an actual physics of the living being, the mind as well as the body, and the coupling and interfiinctioning of mind and body.

this is actually a very high energy reaction; however; since the time-energy is used and is very, very dense, the amount of 3-spatial energy that must be used is very small. If this new mechanism holds, it represents a revolution in particle physics.

19. "Self-awareness" refers to be continually "refreshed" by time-delayed coherent feed-back inputs from the body to the mind; where these inputs compare to the recalled memory of the minds inputs to the body. In short, the time-delay coherence creates the sense of "existing in time". Awareness usually

22. The methodology also easily extends to include deeper interlays for the collective human unconscious mind and for Gaia—the collective unconscious mind level for all the species on earth.

23. S. K Lisitsyn, "New Approach to the Analysis of Electroencephalograms, " in Problems of Bionics— (Selected Articles), Defense Documentation Center Report AD 73005, date unknown, p. 16-25. Available through the National Technical Information System (NTIS).

Mind Control and EM Wave Polarization Transductions, Part 2

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This article continues on with T.E. Bearden's article, Part 1 of which was published in Volume 9, #2 of Explore! for the Professional. Because we feel that Col. Bearden's caution below is so very important we are repeating its publication in all parts of this article.

Special Note

This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for non-approved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral.

A Strategic Threat Completely Unrecognized by the West

The Russian methodology leads directly to rather mind-bending, extended capabilities. KGB psychoenergetics scientists seem fixed on an eventual goal of directly engineering Jung's collective human unconscious, thereby converting the entire human species into a sort of "ant" species. In short, they seek to engineer what they regard as "perfect communism and perfect order" directly in the entire species. *Figure 8* indicates the direct connection of every human's conscious and unconscious mind to the collective species unconscious and to Gaia, the collective unconscious for all species on Earth. Since time is internally structured and layered, it follows that time-like mind levels are also internested and layered.

This appears to be a significant strategic threat, *well along in its development*, that our scientific and intelligence communities have completely failed to recognize.

The direct engineering of the entire human collective species is a doable.[1] It is going to be done, whether we like it or not. In that race (which may eventually determine whether or not we retain any personal freedom at all), the "democratic" nations are woefully behind. In fact, the West has not even realized there is such a new kind of "arms race" for dictatorship and control of the "collective species mind" and we have already almost lost it. The West has not yet even developed the overall theory of psychoenergetics.

Waves and Wave Transductions

A pure longitudinal EM wave (LW) would have infinite energy and infinite speed. In practice, one can only approach this perfect LW wave, and one always has transverse residues remaining. Hence the "imperfect" longitudinal EM waves we can make in suitable equipment and techniques, are known as "undistorted progressive waves" (UPWs). The UPWs may have velocity far greater than the speed of light, or less than the speed of light. So the speed v of UPWs can vary as

$$0 < v < \infty \qquad [6]$$

The Russians also know that, when a nearly-pure longitudinal EM wave interacts with matter (it usually doesn't interact very much, and has a low reaction cross section), the mass immediately adds the phase conjugate replica to the interacting LW portion, regardless of frequency, thereby transducing the input LW interactions into scalar (time-polarized) EM interactions.

One transduces from TW to LW to Scalar EM via iterative phase conjugation. One transduces from scalar EM to LW to TW via iterative interferometry. It took the present author 20 years to discover this simple thing; we now have filed an invention disclosure on the process and embodiments for performing it, and will be following with formal patent applications. Let TW = transverse EM wave, LW = longitudinal EM wave, and TDW = time-density EM wave (another name I use for t-polarized or scalar EM waves, since the density of time-energy is what is varying). Let (I) = interfering with, PCR = phase conjugate replica wave with a coupled set of parentheses enclosing the type of wave. The rules for wave type transduction are:

$$\mathrm{TW} + \mathrm{PCR(TW)} \Rightarrow \mathrm{LW} \qquad [7]$$

$$\mathrm{LW} + \mathrm{PCR(LW)} \Rightarrow \mathrm{TDW} \qquad [8]$$

Going the other way, the rules are:

$$\mathrm{TDW\ (I)\ TDW} \Rightarrow \mathrm{LW} \qquad [9]$$

$$\mathrm{LW\ (I)\ LW} \Rightarrow \mathrm{TW} \qquad [10]$$

In EM smog (dense EM signals, even though very weak), there is increased nonlinear multiwave interactions, both interferometric and phase conjugative. So in such EM smog there exists an increased, non-negligible component of LW and TDW irradiation, formed by the above transduction interactions in the irradiated living cells and bodies. This latter part accounts for many of the long term effects which show up in "correlative" studies, but which do not show up in the normal limited-frequencies TW experiments produced by so-called "physical experiments."

The standard EM bioeffects manner of experimenting uses a theoretical model of simple, direct energy deposition by means of absorption in cells and tissues. Now we must utilize an "open system" throughout the body dielectric in which higher polarized EM energy (either LW or t-polarized) travels readily throughout all areas of the body.

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EM Bioeffects and Wave Transductions

In the EM bioeffects experiments to date, there has been absolutely zero control of the internal transductions, and there has been no consideration of them. Almost all transductions of TWs into LWs will immediately result into transduction into TDW and time-excitation charging of the cells and all their internal components. These time-excitation charges (excited states of time-charging) will then slowly decay, emitting longitudinal EM waves in the process which travel throughout the body. These emitted LWs interfere with each other and the LW processes in the body, producing low level TW "noise jamming" of the cellular processes and—most especially—of the deep cellular control system of the body. The latter system functions by means of LWs and TDWs. Long-term effects of such "noise jamming" of biochemistry reactions and the control systems of the cells and body, can lead to degenerative diseases such as arthritis, atherosclerosis, Alzheimer's disease, heart disease, cataracts, tumors, leukemia, somewhat accelerated aging, immune system weakening and depressing, etc. As the body's natural defense and regeneration ability weakens, opportunistic infections further add to the degeneration.

It was shown by Whittaker in 1903 that any scalar EM potential is comprised of a harmonic series of bidirectional longitudinal EM wavepairs. [See *Figure 9*] Each longitudinal EM wave pair in the harmonic series is a phase conjugate pair. Unknown to Whittaker, that "LW phase conjugate pair" is actually a time-polarized EM "photon" structure, containing a phase conjugate LW photon substructure. So staid old "voltage" (potential) is comprised of a harmonic series of time-polarized EM waves!

The corresponding "t-polarized photons" are actually spin-4 *supergravitons* comprised of coupled antipairs of LW "photons". Each LW photon is a spin-2 *graviton* comprised of a coupled TW photon-antiphoton pair. Each TW photon and antiphoton in the coupled pair has spin-1. The couplet, being the longitudinal "photon" or graviton, thus has spin-2. And so on.

In 1904, Whittaker showed that any EM field or wave pattern can be decomposed into two scalar potential functions. By applying Whittaker 1903 decomposition to each scalar potential function, any EM field or wave has an enormously rich internal structure, comprised of scalar potential functions in interference. Each scalar potential function is comprised of time-polarized EM waves (made of spin-4 supergravitons). Each time-polarized EM wave is further comprised of bidirectional longitudinal EM wavepairs. Each longitudinal EM wave is further comprised of phase-conjugate pairs of transverse EM waves. Each transverse EM wave is further comprised of two scalar potential functions, each of which is in turn comprised of an infinite harmonic series of time-polarized EM waves, and so on *ad infinitum* and *ad nauseum*. Obviously all EM potentials, fields, and waves have an enormous "internal structure" or internal "information content of the field".

The Cellular Control System Uses t-Polarized EM Photons and Waves

The master cellular control system (MCCS) in the body utilizes these photon-gravitons, their corresponding EM wave polarizations, and transductions between them. By the use of very powerfully condensed gravitons and supergravitons, it is able to utilize small but highly significant direct curvatures of spacetime in precise patterns. In short, it utilizes general relativistic spacetime curvature engines, rather than "EM photon signals", to accomplish its control of the cells and their processes. It does not merely send a "signal" and hope the cell itself acts upon it. Instead, it sends an "engine" which alters the local spacetime in which the cell and all its components are embedded. This "local ST curvature engine" then physically works directly upon the cell and all its parts, to alter the cell according to the specific "template" of the engine.

This is the direct application of the Wheeler's simple statement of general relativity: *Mass (trapped energy) acts upon spacetime to curve it, and curved spacetime acts upon mass to change it.*

Popp's "ordinary photon" study of this cellular control system[2] therefore will detect the coherent ordinary TW photon residues which result from the photon polarization transductions occurring from the actions of the ST curvature engines upon the cells.

Cellular division, biochemical processes, growth and growth control, cell differentiation and dedifferentiation, etc. are all controlled by the MCCS or one of its subsystems, using spacetime curvature engines. The ordinary TW electronic activity our biophysicists detect and correlate are simply the intermediate components of the actual ongoing polarization transductions.

The Cellular Control System Uses EM Time-Energy

One important subsystem of the MCCS controls the immune system's functions, including the deepest and most subtle functioning performed by all elements of the immune system. This system has been rather intensively studied, but since our biophysicists have not possessed the full electrodynamics utilized, only the correlated residue of normal TW EM waves and photons have been recognized and studied. Hence Western biophysics is in its very crude infancy.

Incorporation of the total wave and photon polarizations, together with their transductions, will eventually present a revolution in both biomedicine and biophysics. Unfortunately, presently our entire medical community is very firmly entrenched in only ordinary TW EM polarizations and ordinary biochemistry. Our scientists thus are studying less than 1% of the functioning of the living organism.

As an example, since Western scientists have no knowledge or research into the time-polarized mind domain and mind-body coupling, the mystery of the *placebo effect*—in which the mind has been verified to produce actual physical effects – will indefinitely remain a mystery.[3] As one result of that "crippling" of our medical theory, medical experimenters have to deliberately drive experiments on drug effects, etc. beyond the "mind's own threshold" of physical effect. In short, they have to drive the experimental results over and above the results being accomplished by the placebo effect. They must perform valid placebo control experiments, and subtract the placebo component results from their own experimental results, to determine the "delta" induced purely by the drugs.

The Regenerative Subsystem

Another important subsystem of the MCCS controls the *regenerative system* of the body. The regenerative system has various mechanisms, including growth control, differentiation and dedifferentiation of cells, etc. Becker's portrayal of the regenerative system is shown in *Figure 10*. One of its most important functions is healing and restoring damaged or diseased cells. It does that by a most remarkable process.

This system has been very poorly studied, mostly by Becker[4] *et al.*, although there is still sporadic, ill-funded, and ill-planned research on regenerative effects from time to time.[5] Becker and his colleagues came closest, and—considering the severe limita-

tions of the orthodox U(1) EM model available to them—Becker's work is particularly revolutionary. He demonstrated beyond question that simple DC potentials could generate cellular differentiation and redifferentiation, and produce results at global sites in the body and not just at the local injury sites where the DC potentials were applied.

Becker was nominated for a Nobel Prize for his Herculean efforts and remarkable results. For his trouble he was hounded, his funds were withdrawn, and he was forced to retire at an early age in his 50s. His biggest "heresy" was to bravely point out that power line radiations had deleterious effects upon biological systems, and to testify to it in a series of hearings and court cases where a very powerful electrical power industry essentially ran rough shod over science and the public.

Organized Science Is Highly Politicized and Imperfect

It is not only politicians that are "bought and paid for" by powerful vested financial interests. In organized science, precisely the same arrangement holds true. Scientists are no better or no worse than any other segment of humanity. A surprising percentage will produce the results desired by their benefactors, if provided with cushy jobs, good income, prestige, and secure positions.

It has been said that money is power. It has also been said that power corrupts, and absolute power corrupts absolutely. In the scientific community, as well as in the political community, this "great corruption" by great financial power has been elevated to an art form. Simply examine the funds made available to scientists. There is not enough for all the scientists, so it is fiercely competitive. If the scientist does not get grants (e.g., a would-be professor at a university), he does not bring in extra money to the university. He cannot get his graduate students funded, so his own innovative (read: heretical) research is thwarted. His papers are rejected by the journals, and before long he has no funded position in science. If lucky, he will be employed in the grocery store or the butcher shop.

Every bit of funding available for the scientists to compete for (and apply for grants) already has firmly fixed controls of exactly what research can be done with that money. The "science" that will be applied is already formulated. That and only that can be done. It is a tribute to the dedication and resourcefulness of our working scientists themselves, that anything innovative at all gets done.

One can have a very fine scientific career, tenure as a professor, get one's graduate students funded, get one's papers published in prestigious journals, win awards and achieve stature and prestige, if one just plays the desired game prescribed by the "old boys schools" in control of almost all the scientific funding. Yes, one can permissibly move the decimal point in the present models a bit, and be rewarded handsomely for doing so. But one is damned if one attempts any serious change or overthrow of obsolete scientific models and practices favored by the "system".

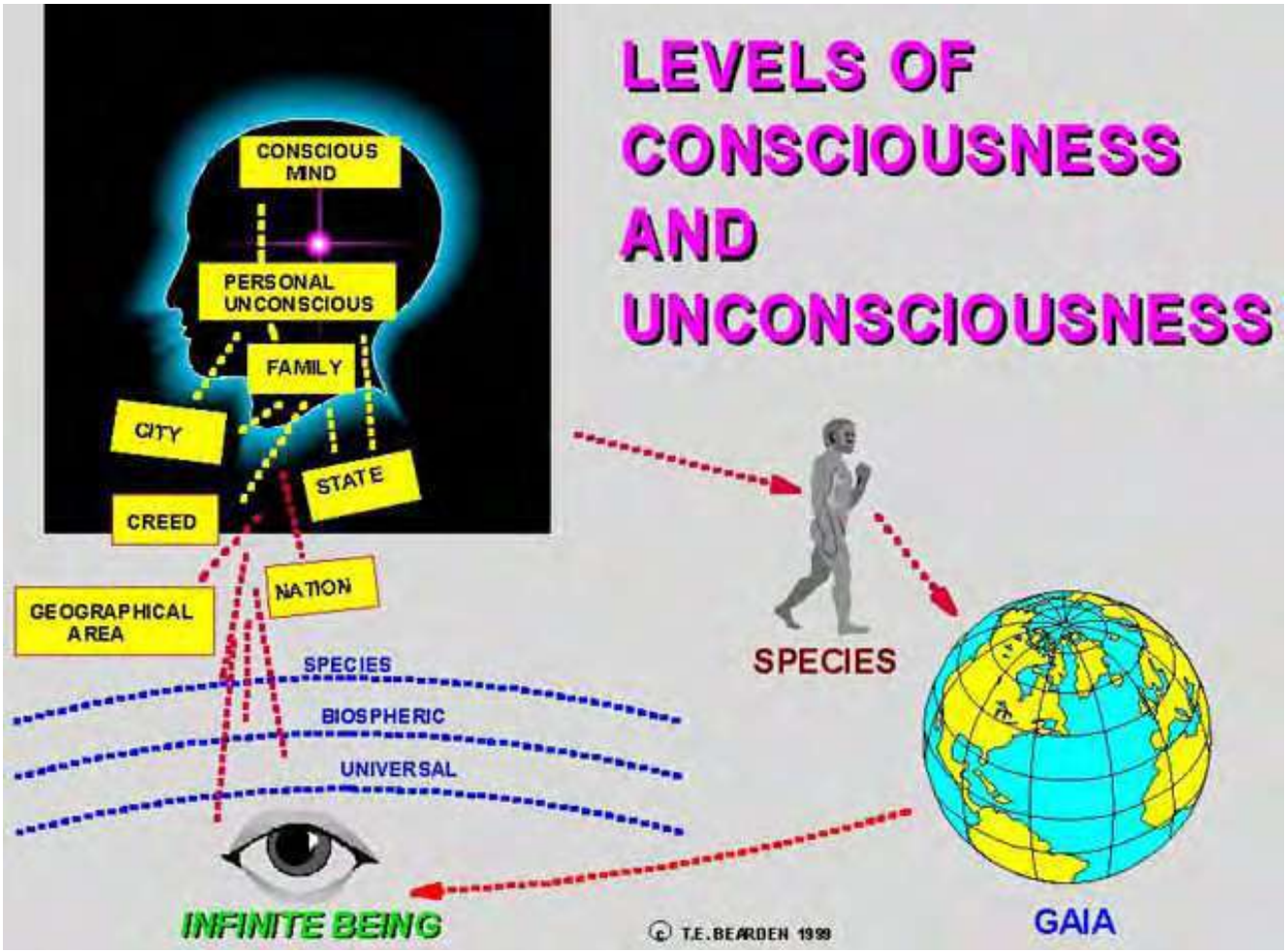

Figure 8. Nested levels of consciousness and unconsciousness. The mind levels contain the "life" and "mind" dynamics.

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That is precisely why all our universities continue to teach a terribly flawed electrodynamics that is a caricature with at least 32 major foundations flaws in it.[6]

And that's why the organized Western scientific community has betrayed the taxpayers who largely fund its research. In short, the scientific community fiercely enforces dogma, suppresses innovation, and has denied the U.S. the very defense we need to survive against our pressing enemies who have not been so scientifically dogmatic.

Microwave Radiation of the U.S. Embassy in Moscow

Because of the strongly enforced adherence to the insane foundations errors in classical electrodynamics, our scientists still do not comprehend the decades of so-called "microwave radiation" of personnel in the U.S. Embassy in Moscow.[7] All diseases and health changes produced in those personnel were in *field-free areas* (i.e., where the potentials were persistent and unchanging, with no gradients etc.)[8] No one even thought to look at the "inner longitudinal EM phase conjugate biwave composition" of those potentials, where they would have found the Whittaker internal bidirectional longitudinal EM wavepairs and the internal time-polarized EM waves. They would also have found the infolded, very powerful general relativity: the spacetime curvatures deterministically formed and being utilized to directly alter the irradiated cells and their constituents.

Instead, government-funded studies did a rather straightforward "force field" analysis, and concluded that, since there were no fields there, it could not have been the microwave radiation.

Elementary statistics would immediately indicate a different conclusion: The diseases and health changes were 100% correlated to the presence of potentials, and 100% anticorrelated to the presence of fields. Hence it was the field-free potentials that had to be inducing the diseases and health changes. If it were NOT the radiation at all, then some changes would have occurred in personnel in areas where fields were *present*, as well as in areas where fields were *absent*. Since this did not occur, such a premise is destroyed by self-contradiction. In short, the data actually proved (i) it was indeed the radiation that was causing the diseases and health changes, and (ii) further, it was the field-free potentials that were the culprit.

That this elementary statistical conclusion eluded our scientific community and our government community, is absolutely inexplicable.

Three U.S. Ambassadors eventually died of diseases induced by their exposure to the Embassy radiation. Ironically, Kaznacheyev[9] had openly released some of the results of thousands of Soviet military experiments showing that any kind of cellular disease or disorder could be induced in targeted cells by novel EM radiation emitted from diseased or damaged cells. Apparently no one in the West deciphered the mechanisms involved in Kaznacheyev's epochal work.

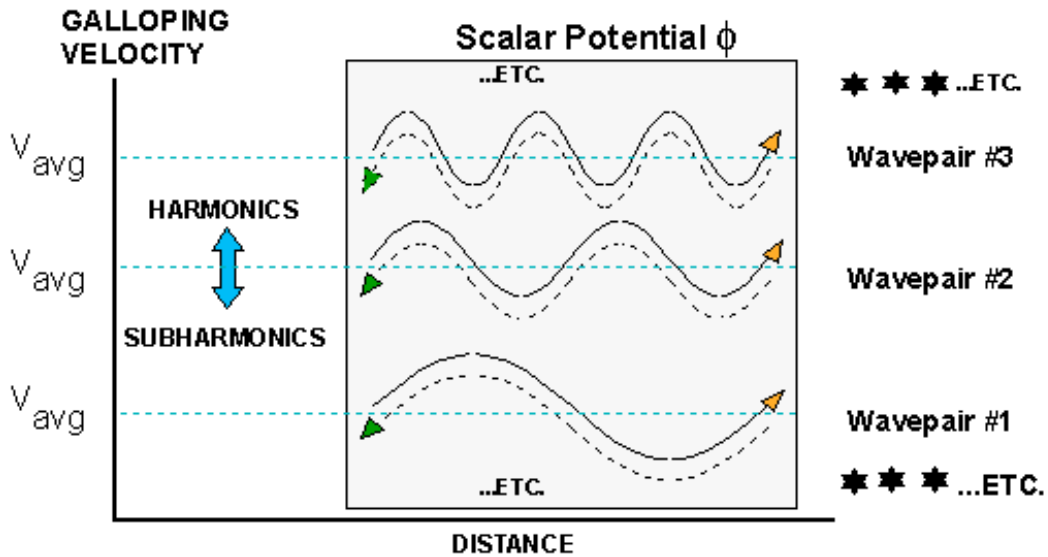

The Structure Is:

- A harmonic set of longitudinal phase conjugate wavepairs.
- In each wavepair the two waves superpose spatially after detection, but travel in opposite directions.
- The convergent wave set is in the imaginary plane, and hence is not observable. It is EM energy incoming to the potential (dipolarity) from the time domain.
- The charge's spin is 720 degrees, 360 in the real plane and 360 in the imaginary plane.
- Hence the charge receives the complex convergent EM energy, transduces it into real EM energy, and emits enormous energy at the speed of light in all directions -- which includes bidirectional pairs in 3-space (after the reaction, being after "observation").
- This produces the fields and potentials from the "source charge or dipole."
- Mandl and Shaw argue that the scalar (time-polarized) photon and longitudinal photon are observable only in similar pairs, which then makes the instantaneous scalar potential. Thus their quantum field theory work strongly supports the "negative resistor" interpretation of the scalar potential and our solution to the source charge and source dipole problem.

Figure 9. Infolded longitudinal biwaves (time-polarized EM waves)

composition of a scalar potential.

The Present Situation in Western EM Bioeffects Research

Our scientific community has not even *designed physical experiments* to validate long-term EM bioeffects of the kind caused by induced wave transductions and long-term effects inside the absorbing human cells and in the body's regenerative and immune systems. Western science has no knowledge of these technical internal "wave polarization transduction" mechanisms. Yet the basis for such mechanisms has existed in the hard physics literature for decades. Leading EM bioeffects researchers seem totally unaware of small reaction cross sections inside the body cells and tissues for the transduction of transverse EM signals into LW and t-polarized EM signals. Conventional Western researchers have not investigated it, and often will not believe it when it is pointed out to them along with the supporting basis in the literature.

A major part of the mainline "EM bioeffects" community, of course, seems comfortably funded largely by the power industry etc.[11] The record is clear that this dominant, well-funded group has little or no intention of "finding" anything that will question powerline radiation safety and upset their cushy positions.

In fact, leading bioeffects researchers have pointed out this deliberate biasing of EM bioeffects as a research area. Quoting Dr. Andrew A. Marino, one of the great pioneers in the area of EM bioeffects[10] and powerline radiation assessment.[11]

"Neither scientists nor the public can rely on power-industry research or analysis to help decide whether powerline electromagnetic fields affect human health because power-industry research and analysis are radically misleading."

Dr. Marino then gives the specific details to prove it, and he shows specifically how they slant and mangle their experiments and interpretations of the results, to do it. If the major financial interests cannot *scientifically* destroy determined, honest researchers such as Marino and Becker, they do not hesitate to attempt to destroy them in lawsuits.

The "Diffusion Mixmaster" at All Body and Cellular Levels

Every mass and all its particles are in a violent energy exchange with the active vacuum. A human body and every part of it is in a continual exchange of EM energy with its environment(s), including transverse, longitudinal, and t-polarized (scalar) EM energy exchanges. Further, within the dielectric body there is a sort of intensive "diffusion" of special kind, actually due to iterative phase conjugation and iterative interferometry of the dense signals environment impinging upon it. This internal "diffusion" and transduction (iterative multiwave phase conjugation and iterative multiwave interferometry) thoroughly "mixes up and transduces" one type of EM wave or signal into the other, including many of the body's own TW, LW, and TDW signals.

Continual or sustained TDW exposure (irradiation by t-polarized EM waves) charges the body and its particles with time-excitation charging, something which has been erroneously omit-

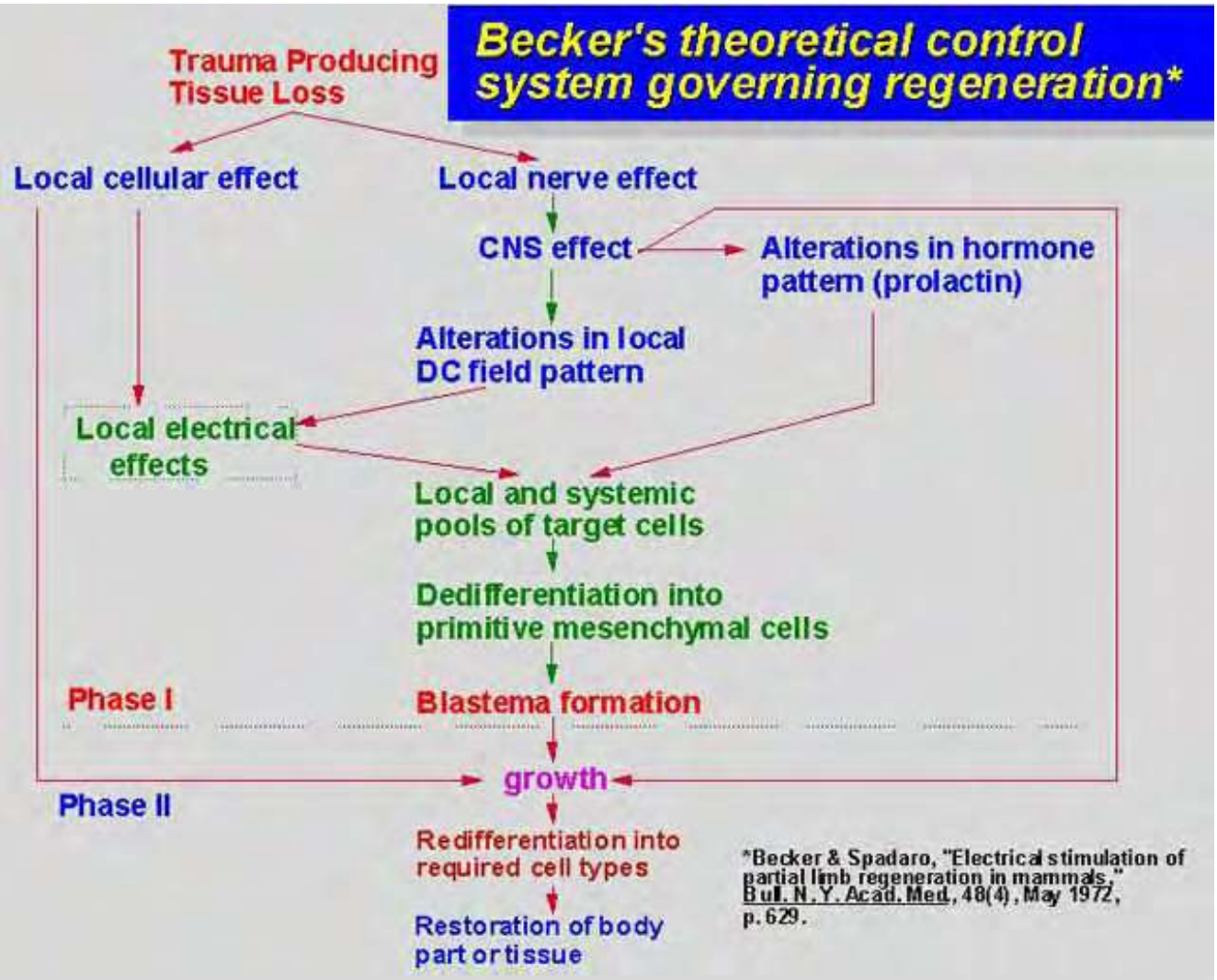

Figure 10. Becker's model of the Regenerative system of the body.

ted in physics, but is true nonetheless. Inexplicably, physicists just ignore what happens time-wise when a mass absorbs a photon. We have covered that elsewhere.

So inside the body dielectric, there is a "diffusion mix" correlate of any and every type of the waves, to any or all of the exchanges, plus the additional internal interactions of the body in its TW, LW, and scalar EM wave transductions. There is a one-to-one correspondence to any one of the three types of polarization waves (transverse, longitudinal, and scalar) and everything going on anywhere in the body.

Note that the type of LW we are using is actually made of phase conjugate pairs of transverse EM waves, so its "photons" are made of photon/antiphoton pairs. That is, our longitudinal EM wave has an internal TW structure, and the LW wave is comprised of spin-2 *gravitons*. Our longitudinal EM wave has an internal structure, and it dramatically differs from the LW used by the U.S. scientific community which ignores wave, field, and potential infolded substructures. Our LW (which seems to be what the Russians use) is also a gravitational wave because it is comprised of oscillations in its distributions of spin-2 photon/antiphoton pairs (i.e., *gravitons*).

The type of t-polarized (scalar) EM wave we are using is a phase conjugate coupled pair of the specialized electrogravitational (EG) LWs. The "t-polarized photons" comprising this t-polarized "EM" wave are comprised of spin-4 *supergravitons*. These are, I believe, what the KGB energetics weapons scientists use also. By iteration, we can go into as deep an internal multilevel structuring of EM and EG waves, of any type, via methods shown by Whittaker.[12]

Now let us examine a body as a dielectric, sitting there in its exchange, in relative equilibrium. It turns that every tiniest piece of a dielectric participates in any emission from it[13]—even the emission of a single photon, graviton, or supergraviton. Well, it *would* so participate, due to the special sort of correlated diffusion and interferometry and phase conjugation that we pointed out. Anything that escapes (is re-emitted) from the body, has been through this "diffusion wringer". It has escaped from each and every internal part of the body.

Novel Signatures in Body-Emitted EM Radiation of Any Polarization

A single photon or wave emitted from a dielectric carries in its internally structured time component a *template* of the exact internal time structuring of every part of the dielectric emitting that photon. It carries in its internally structured energy component a *template* of the internal energy structuring of every part of the dielectric emitting it. An emitted EM wave, being a collection of emitted photons and photon structures, thus carries the same internal structuring of both its transported energy and its transported time.[14] Western scientists do not use the internal

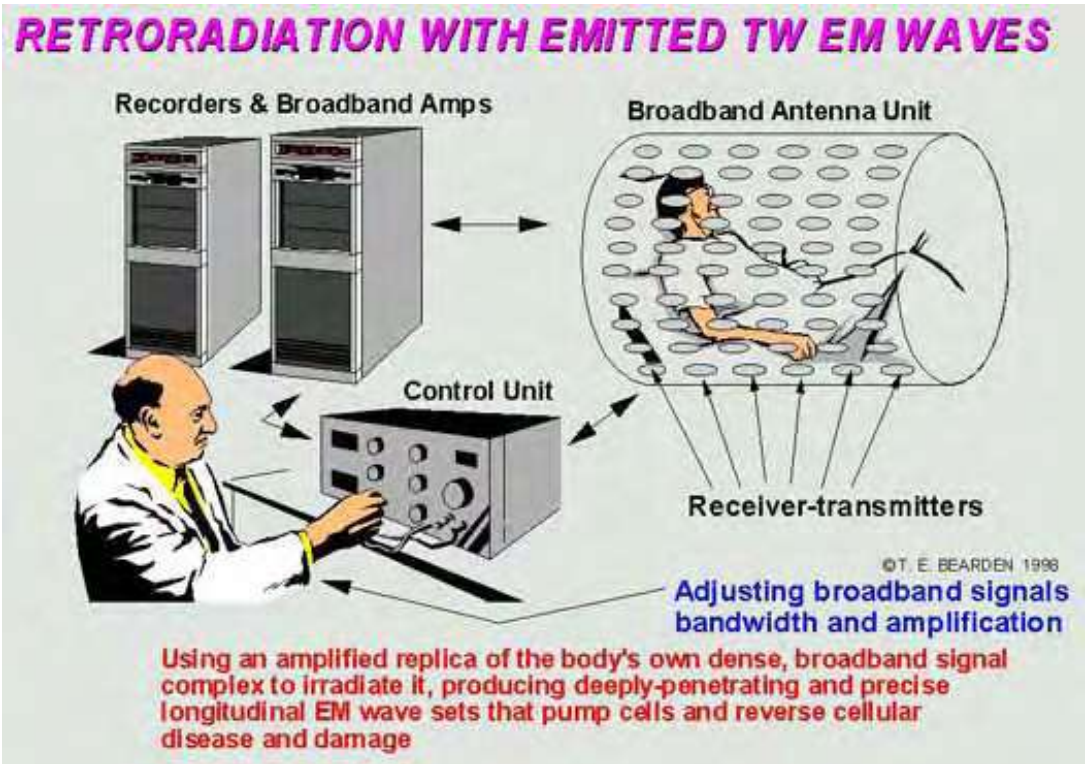

Figure 11.

http://www.cheniere.org/explore%20articles/mind%20control2/p06.htm24.4.2005 23:34:27

structuring of photons and EM sine waves, have no instruments for that, and so do not know it. The Russians know it,[15,16] use it, and have developed sophisticated instruments for it for the last 30 years or more.

Shortly we will postulate how conventional scientists experimenting with mind and behavior control electromagnetically might utilize an immediate consequence of the fact that the specific emission from a body at any time—whatever type of wave component we look at—is a total correlate to all that body's internal functions, its energy exchanges with its environment, its states, its mental states and conditions, etc.

And we accent that the coherently integrated intent-changes in that body from its coupled mind's operations are also in the substructure of photons and EM waves emitted from the living body into its environment.

How Western Mind Control Scientists Might Proceed

Conventional scientists would ignore scalar photons and waves, determine the TW spectrum, and then slowly and painfully correlate that to the various physical, mental, and emotional things. That's the way they would *have* to do it, since apparently they use only standard electrodynamics. They can in fact do this via brute force, because that emission TW spectrum is of waves escaping from the entire "diffusion machinery" mixmaster in the body dielectric. It does contain all those integrated *mind-intent* 3-space correlates as well as the ordinary body 3-space energy correlates.

Anyhow, in envisioning Western procedures, the test body would be sitting there, in its normal (let's say fairly normal and quiet) EM environment. [See *Figure 11*] Let's assume this body is not sick, but is healthy and normal. Its emissions are a part of its equilibrium condition. It follows that the totality of its TW emissions is correlated to the sum total of everything that interacted with the body, plus its own internal reactions, including from mind-body coupling. Indeed, everything that has ever happened to that entity—physically, mentally, emotionally, etc.—has internal correlates infolded inside the emitted transverse EM wave spectrum.[17]

So first the scientists would simply measure the full environmental TW spectrum down to very tiny levels in all frequency bands possible—everything that is coming in to the body from its environment. They would probably perform the experiments in a triply-shielded Faraday cage, so the external environment outside the cage contributes very little transverse EM wave noise (perhaps some Schumann resonance). Magnetic wave shielding and ELF shielding is something else again, and longitudinal EM wave shielding is in general not possible unless longitudinal EM waves are employed in the shielding. But a "quiet external TW environment" enhances the isolation and measurement of the specific TW signal transforms the Western experimenters would be seeking.

Then they would measure everything likewise that the body is *emitting* when in that environment. That is the "zero reference" or "normal reference" level. They would measure every aspect: frequency, amplitude, phase, wave shape, modulation, etc.

Probable Experimental and Measurement Techniques

Next they would selectively irradiate the body with specific signals, frequencies, waveforms, etc. They would begin by using portions of the same frequencies that are being emitted from the body in the "zero reference" environment. They would insure that the returned signal was of higher amplitude than the usual signal being emitted by the body at that same frequency and type.

They would consider the body dielectric as a "ship with portholes". Light (EM transverse wave energy) coming out of the portholes has originated and adapted from everywhere inside the ship and its operations. When the experimenters reinsert energy through one or more portholes, they are interested in determining precisely which operations inside the ship are affected. So the body physiological functions are also heavily instrumented.

By feeding back in the exact EM pattern and magnitude escaping the body dielectric through a single porthole, one "nullifies" that part of the emission by producing a net equilibrium in that component. This will in turn produce changes elsewhere in the spectrum emission from other portholes, and this can be measured. It will also produce "stress changes" in specific portions of the body dielectric, and in the heavily instrumented body these physiological, chemical, electrical, etc. changes can also be detected. Monitoring of the skin conductance, e.g., indicates the level of stress, and EEG monitoring with sophisticated instrumentation can indicate something of the brain wave states.

In short, the necessary measurements from which to construct specific correlates can be performed, recorded, and later analyzed.

This article will be concluded in Volume 9, #4 with Improving the Methodology, Further Phenomenology Experiments, Rejuvenation and other matters. ◆

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Tom is the leading advocate of scalar potential electromagnetics and the Fogal charge-blocking semiconductor. He is involved in alternate energy devices and scalar electromagnetic system prototypes. He has defined charge q as a coupled system of two components, advanced a mechanism for a vacuum engine, whereby the vacuum's virtual particle flux is organized and used to energetically shape and manipulate matter and energy, and advanced a mechanism for a Bohm-type quantum potential, which theoretically allows the engineering of action at a distance in physical systems.

He is president of the Association of Distinguished American Scientists (ADAS), a life member of the Alabama Academy of Science, Emeritus member of the American Association of Physics Teachers, and has served on the Board of Directors of several associations and corporations. Tom is a guitarist, a retired aikidoist (Sandan, Yoseikan style), is happily married and has two sons and two daughters. He and his wife Doris live in Huntsville, Alabama where Tom is retired from aerospace, continues private research, and serves as a consultant to industry on Scalar electromagnetics processes.

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4. *For example, see particularly R. O. Becker, "The direct current field: A primitive control and communication system related to growth processes,"* Proceedings of the. XVI International. Congress of Zoology, *Washington, D.C., Vol. 3, 1963, p. 179-183;—"The direct current control system: A link between environment and organism,"* New York State Journal of Medicine, *Vol. 62, 1962, p. 1169-1176;—and D. G. Murray, "A method for producing cellular dedifferentiation by means of very small electrical currents,"* Trans. N.Y. Acad. Sci., *Vol. 29, 1967, p. 606-615;—and Joseph A. Spadaro, "Electrical stimulation of partial limb regeneration in mammals,"* Bulletin of the New York Academy of Medicine, *Second Series, 48(4), May 1972, p. 627-64.*
5. *E.g., a popular discussion is given by John Travis, "Starting Over: Some Animals can regenerate limbs or even most of their bodies. How?"*, Science News, *152(18), Nov. 1, 1997, p. 280-282. For a typical technical paper, see Jeremy P. Brockes, "Amphibian limb regeneration: Rebuilding a complex structure,"* Science, *276(5309), Apr. 4, 1997, p. 81-87.*
6. *I have one viewgraph which lists those 32 major flaws in electrodynamics. Further, leading theorists (Evans, Crowell, and others) in the Alpha Foundation's Institute for Advanced Study (AIAS)—of which I am a Fellow Emeritus by AIAS's kind tolerance—have added about another very technical and very fundamental dozen or so errors to my own list. A leading foundations scientist with over 500 papers in the literature commented dryly to the AIAS that "I broadly agree. that the transverse plane wave view of vacuum electrodynamics is the biggest blunder of twentieth century science. Faraday visualized that "EM disturbances" surrounding wires, magnets, etc. were simply the transverse plucking of taut strings. As he states in his book, Maxwell—who also firmly believed in the material ether—simply captured Faraday's thinking and assumed that transverse "plucked string" wave disturbance in the material ether. At the time all this was expressed, the electron had not been discovered, the atom had not been discovered, the molecule was a featureless blob, and no one had the slightest notion of an atomic nucleus filled with protons and neutrons. Charge was simply a "certain volume of electric fluid" and everything electromagnetic was expressed in fluid dynamics. As an example, that "material fluid" and "material ether" theory was destroyed in the late 1880s by the Michelson-Morley experiment. All the Maxwell equations assume that material ether to this day; not a single equation was ever changed to eliminate the material ether assumptions during the last 110 years.*
7. *For full explanations of the "Moscow Signals," see T. E. Bearden, .,* Gravitobiology: A New Biophysics, *Tesla Book Co., P.O. Box 121873, Chula Vista, CA 91912, 1991;—*AIDS: Biological Warfare, *Tesla Book Co., 1988. For an excellent Government study of the Embassy radiation by excellent but orthodox Johns Hopkins scientists, see A. M. Lilienfeld* et al., Foreign Service Health Status Study: Evaluation of Health Status of Foreign Service and Other Employees from Selected Eastern European Posts, *Department of Epidemiology, of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Maryland, Final Report, July 31, 1978. On p. 245, it is noted that a marked excess of symptoms were noted in the Moscow employee group as compared to other East European employees in other East European nations.*
8. *Johns Hopkins researchers established the exact field patterns present in the Embassy from the microwave carrier radiation; see Robert C. Mallaliew,* A Model of the Microwave Intensity Distribution within the U.S. Embassy, *Moscow 1966 to 1977, Report FS-80-166, Applied Physics Laboratory, Johns Hopkins University, Aug. 1980. Nowhere in any of the Government-funded studies is there any consideration of field-free scalar potentials and their internal time-polarized EM wave structures (the bidirectional phase conjugate wavepairs shown by Whittaker to comprise the scalar potentials). Yet the field radiation patterns surprisingly showed that in just such field-free, persistent potential zones was where 100% of the health changes occurred.*
9. *Vlail Kaznacheyev and L. P. Mikhailova,* Ultraweak Radiation in Intercellular Interactions, *[in Russian], Novosibirsk, 1981 [an English exposition of much of the Kaznacheyev work is given in Vlail Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions,"* Psi Research, *1(1), Mar. 1982, p. 47-76.]. See also Vlail Kaznacheyev* et al., *"Distant intercellular interactions in a system of two tissue cultures,"* Psychoenergetic Systems, *1(3), Mar. 1976, p. 141-142. In the same issue, see "A Comment" by William A. McGarey, p. 143; "A Comment" by Arthur C. Hastings, p. 143-144. See also Vlail Kaznacheyev, "Apparent information transfer between two groups of cells,"* Psychoenergetic Systems, *1(1), Dec. 1974. The Soviet Union awarded Kaznacheyev a very high medal for his achievements.*
10. *For a very nice summary of EM bioeffects from the more conventional view, see Robert O. Becker and Andrew A. Marino,* Electromagnetism and Life, *State University of New York Press, Albany, 1982. The book is also available at http://www.ortho.lsumc.edu/Faculty/Marino/El/ElPub.html.*
11. *Andrew A. Marino,* Powerline Electromagnetic Fields and Human Health, *http://www.ortho.lsumc.edu/Faculty/Marino/Marino.html. This book is highly recommended. Particularly see "Chapter 5, Blue-Ribbon Committees and Powerline EMF Health Hazards," and "Chapter 6: Power-Industry Science and Powerline EMF Health Hazards." Biophysicist Marino is one of the leaders in the field and has been personally involved in many skirmishes with powerline-dominated studies and findings.*
12. *E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics,"* Mathematische Annalen, *Vol. 57, 1903, p. 333-355; — "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions,"* Proc. Lond. Math. Soc., *Series 2, Vol. 1, 1904, p. 367-372.*
13. *Reali, G. C., "Reflection from dielectric materials,"* American Journal of Physics, *50(12), Dec. 1982, p. 1133-1136. The reflected field from a dielectric material is not generated just at its surface but comes from everywhere in the interior of it.*
14. *Present physics models the EM wave as transporting energy, but erroneously omits that it also transports time. A photon is made of angular momentum, or "energy x time". Since EM waves are made of photons, it follows that they transport both the energy components and the time components making up those photons. An EM wave is a wave of angular momentum, not just a wave of energy.*
15. *KGB energetics weapons scientists call this internal structuring the "information content of the field." However, the Russians use a good deception plan, which implies that the "information content of the field" is just the normal transverse EM spectral content of EM signals. Appreciable "pertinent" work using that phrase is produced by the open Russian scientific community, thus confusing the issue. Our electrodynamicists seem to buy it hook, line, and sinker. The deception plan also tricks Western scientists into thinking that psychoenergetics is nothing but a Russian version of Western parapsychology. Again, our scientists comfortably accept this with smug satisfaction.*
16. *Presently the Russians are in a great new version of this deception plan, with the goal of deceiving Western scientists into thinking that the "secret" Russian energetics is based on torsion fields. Consequently they are releasing substantial material on torsion wave theory, including replicable experimental results. The released version of torsion fields has one glaring omission: the time components and structuring. This deception plan is excellent, because the torsion field theory that is released, is indeed "real" and testable. It is also revolutionary, with respect to present Western science. It almost positively assures diverting the attention of much of the Western science community into this highly limited subset of the full Russian torsion theory—effectively diverting the West away from psychoenergetics and the direct use of t-polarized EM waves and fields, torsion or otherwise.*
17. *We point out that E. T. Whittaker, in "On the Partial Differential Equations of Mathematical Physics,"* Mathematische Annalen, *Vol. 57, 1903, p. 333-355, showed that every scalar potential is comprised of an internal structure of bidirectional longitudinal EM phase conjugate wavepairs in an infinite set of harmonics. Each of those phase conjugate longitudinal EM wavepairs comprises a time-polarized EM wave. So the common potential contains an internal longitudinal EM wave structure that is further organized into an internal time-polarized EM wave structure. The mind-intent correlates and the total mind and emotional experience correlates from fertilization of the egg that led to development of that person, is in the internal substructure of every potential in the living body. In his "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions,"* Proc. Lond. Math. Soc., *Series 2, Vol. 1, 1904, p. 367-372, Whittaker also showed that any EM field or wave is comprised of two scalar potential functions. It follows from Whittaker and Reali that the EM emissions from the living body carry the internal correlates of everything that has been experienced by that person from conception in the womb. Sometimes this deep embedded "hidden information content" can even be accessed in deep hypnosis. I once observed the deep hypnotic regression of a subject back to her prenatal experiences prior to birth, where the subject relived hearing words of rejection by the father, before the subject was born. The occurrence of the incident and the father's words were directly confirmed on the spot by the mother, who was closely observing the session as it occurred. It turned out that this particular rejection of the baby still in the womb had played a major role in subsequent deep psychological problems experienced by that person all her life. To resolve the problem, use of a powerful "simulated" reliving pre-birth experience was conducted with the subject again in the pre-birth state and actively participating, but now with the father figure directly expressing love, acceptance, and cuddling and hugging his daughter. This led to a rather dramatic remission of most of the deep psychological problems within 24 hours.*

Mind Control and EM Wave Polarization Transductions, Part 3 of 3

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This outstanding article is the last, Part 3, Part I and 2 of which were published in Volume 9, #2 and #3 of Explore! for the Professional. Because we feel that Col. Bearden's Special Note below is so very important we are repeating its publication in all 3 parts of this article.

Special Note

This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for nonapproved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and achieving many more effects in the targeted bio-organism or groups of them. With Hunt's method, the system as an open dissipative system far from thermodynamic equilibrium in its environment is being measured as such. This more directly allows for determination of the environmental inputs on a much broader range of subsystems, both space-like and time-like. Particularly for mental and emotional correlates to environmental stimuli, such measurements and correlations are essential.

More Comprehensive Phenomenology Experiments

To return: Now the scientists would perform many phenomenology experiments, making one little change at a time and profusely recording the data. Each time, they would establish the physical change(s) that occur in the body and/or the mental and emotional changes that occur in the mind for each spectral reinsertion back through the "ship's portholes". They would simply but painstakingly (over some years) build up an extensive database of those individual correlates.

In these experiments, the experimenters will eventually be able to provoke any body or mind change they wish. Strong emotion. Intense pain. Intense pleasure. Painful thoughts. Images. Memories.

is both illegal and immoral.

Two Ways to Improve the Methodology and Experimental Correlates

We diverge momentarily: If they wish to improve this methodology, they will consider the body dielectric as a nonlinear isotropic medium. Then they will pretend that the spectrum of difference frequencies between each two adjacent waves is the spectrum of "emissions" from the body. They would also use those, as if they were actual emitted spectral signals, instead of the actual signals emitted. That procedure will give superior correlations, but it is more complicated. Part of that is known for underwater sonar,[1] and so our own scientists may or may not have realized it for use in mind and behavior correlate determination with respect to the body dielectric.

Another dramatic improvement in the depth to which the correlates can be constructed, is provided by detecting each porthole output in a two-channel device, where one channel has an adjustable time-delay as utilized by Dr. Valerie Hunt.[2] The two channels—one real-time and one slightly delayed—are then mixed, as by Hunt's method, producing an instrumental measurement of the chaotic part of the functions. Again, this can be measured, recorded, and later analyzed. It adds (i) a completely different kind of thermodynamics in the system measurements, (ii) a dramatically extended set of correlates, (iii) more direct measurement of the time-polarization causative signals, and (iv) an applications technology eventually having many additional degrees of freedom and therefore capable of Perceptions. Dreams. Visions. Memory losses. Memory changes. Personality changes. Etc. The "delta" in the emission spectrum (the changes from zero reference spectrum) represent the precise totality of all mental, physical, organic, chemical, etc. changes and interactions.

A particularly vulnerable aspect of every mammal is the pleasure center in the brain. Experiments have shown that, when this center is stimulated, it is the most addictive experience possible. Rats will forego food, endure electrical shocks, starve, and even die to obtain stimulation of this center. Obviously a device capable of generating signals that evoke direct stimulation of the pleasure center in humans would be a powerful weapon.[3]

Extending the Data Base

See Figure 12. After the researchers have made an "individual porthole signal insertion" correlate database, then they would make a "two, three, four," porthole signal insertion correlate database by inducing selected multiple changes at once. Again they would analyze everything; the program would need one or more supercomputers. It would also require quite a highly qualified multidisciplinary team, extensive facilities, substantial funding, and would be many years in duration. We are describing a decades-long program. But it's a doable.

With sufficient development and performance of such a program, the researchers would have produced (with sufficient testing and analysis, and sufficient retest validation and verification) a database of "specific correlates for a given overall desired physical, mental, or physical and

mental delta."

A second stage in the research would be to test the correlates and porthole insertions upon a statistically significant cross section of ordinary people, and/or specialized populations (such as toughened soldiers). The program would evolve a highly complex, very effective, ever-improving science and technology of mind and behavior control and engineering mechanisms, complete with finished database and developed applications equipment.

The Dielectric Body as a Ship With Portholes

Again let us review what the EM transverse wave irradiation from the body dielectric represents. Think of the body dielectric as a sort of "ship", with lots of portholes. When it gets irradiated, certain operations happen internally to that radiation, i.e., certain "processes" and "interactions" occur, which change both the mental and physical states. The output emissions back from the body dielectric, out through the filtering "portholes", will directly correlate to what has happened inside the ship.

It is terribly important to realize that one can use the same frequencies and spectra coming back out of those "portholes" to insert EM signals and waves etc. back in there, and into the deepest processes going on in the body and in the mind (at all levels, including the deep unconscious). times. So it will reach directly into and affect any and every part of the dielectric, as you wish, and in whatever manner you have correlates for.

We filed an invention disclosure[4] on the above correlate and "back-porthole" process for use in directly inducing full and efficient conversion directly to time-density (scalar, or time-polarized) EM waves inside the body/ cells, therefore immediately and directly time-excitation charging the body cells and all their internal components.

Subtracting the Normal Correlates to Obtain the Deltas

A specifically diseased body, e.g., has a specifically tailored change in its "normal" emission spectra, because of the disease condition alteration of its resident spacetime curvature engine. By having a database for the normal emission spectra of the healthy body, one can subtract it from the actual emitted spectra, to obtain the "delta spectrum".

If the correlates have been previously determined by the above mentioned research program, then one may simply introduce an amplified "delta spectrum" into the body, i.e., through the portholes. This will immediately time-excite the cells and their components throughout the body, particularly where that disease does exist. It turns out that the time-excitation charging by that method will "pump" those diseased cells in the time domain. The cells themselves (and all their parts) are highly nonlinear—to time-excitation

Remember, whatever you put back in there, is going back through the "mixmaster" hopper. It will be iteratively phase conjugated and interfered with by everything, countless charging, they are totally nonlinear. So they will act as rather perfect pumped phase conjugate mirrors, but pumped in the time-energy domain rather than in the spatial

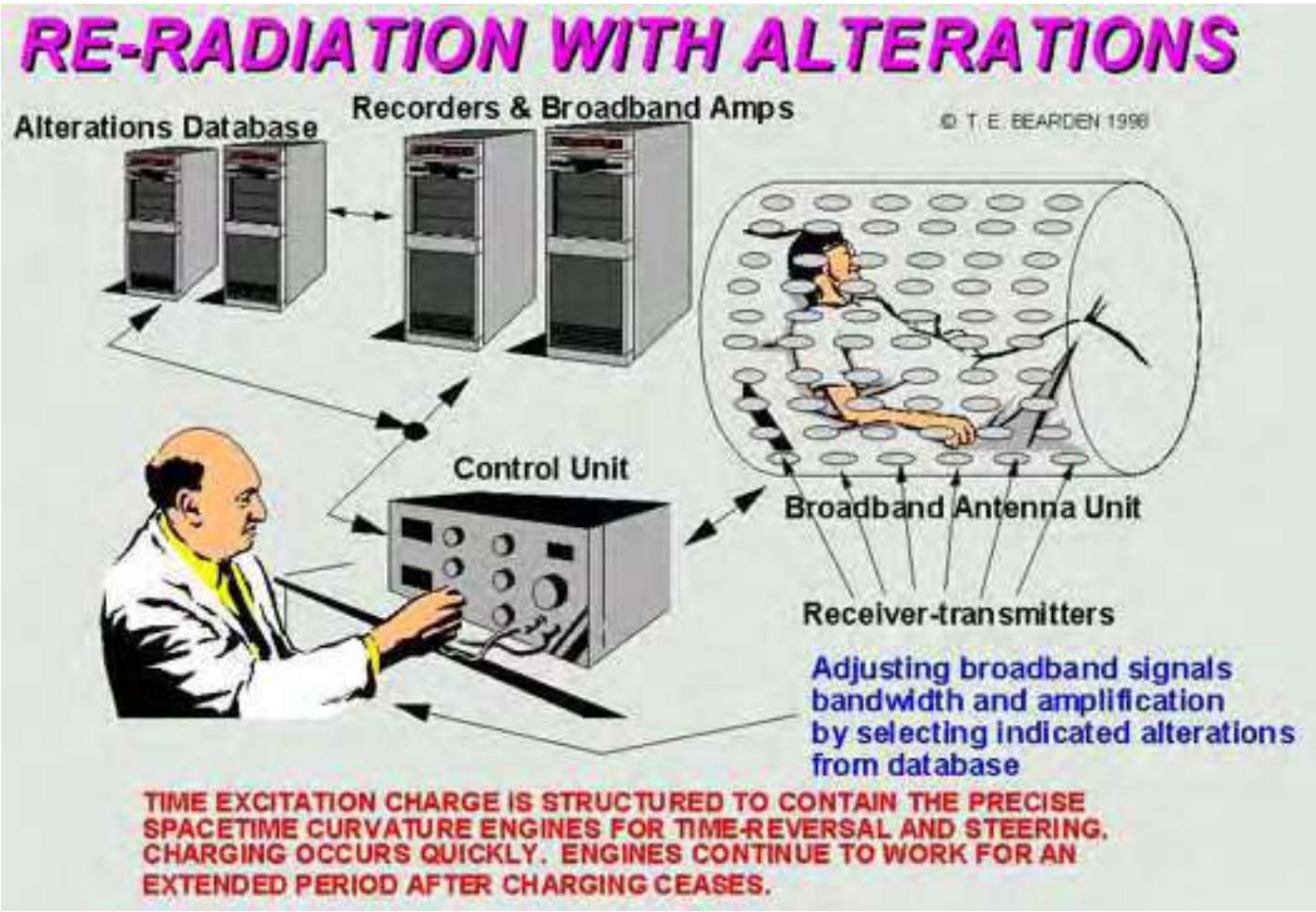

Figure 12. Using an amplified replica of the body's own dense, broadband signal complex, containing added alterations, to irradiate the body and produce deeply-penetrating precise time-density charging for cellular time-reversal while steering the time-reversal trajectory to also correct a congenital condition.

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energy domain. This is a dramatic extension to nonlinear phase conjugate optics theory.[5]

General relativity tells us that each specific detail of the mass and energy structure of each cell and all its parts—down to the finest details—is accompanied by a precise set of spacetime curvatures. By reintroducing the same energy as the disease delta TW waves, the affected cells add the phase conjugates, converting the inserted TW signals into longitudinal EM wave signals. The longitudinally-pumped cells again phase conjugate, converting these longitudinal EM waves to time-polarized EM waves, and "charging" the cells and all their parts in the time domain.

Suddenly, at that point the resident spacetime curvature engine—rather than TW or LW EM waves-serves as the "input signal" to the cell-and-its-parts as pumped phase conjugate mirrors (PCMs), pumped in the time domain. An extension to the distortion correction theorem of nonlinear optics results. An exact, amplified antiengine for the diseased cells—i.e., a phase conjugate replica of the resident spacetime curvature engine—is formed. This amplified antiengine overpowers the resident disease engine, powerfully time-reversing the cells and their components back to a previous healthy state. The time-reversal actually occurs over a period of time after the "time excitation charge-up" ceases, say over the next week or two. Usually two to three quick irradiations are required, one week apart, to give a time-reversing period of three to four weeks.

Even though appreciable forces are operating internally upon the cells and all their parts, there is no net translation force upon the cells or any part. E.g., as Pepper[6] states,

"On a more fundamental level, the ideal lossless PCM reverses all the quantum numbers of the incident photon (i. e., linear momentum, angular momentum, etc.). It can be shown that the PCM therefore experiences no linear or angular momentum transfer from the incident photons; hence, the PCM is free from photon radiation pressure and torques."

Note that, in ordinary EM theory, it is precisely translation forces that are engendered upon charged mass by EM fields. This process is quite different. In biological terms, this process dedifferentiates (in physics: time-reverses) the diseased cells and all their components—including the genes—back to an earlier healthy state.

By taking a diseased body and feeding back into it an exact amplified replica of its emitted TW spectrum, one can force the body to "time-excitation charge" all cells and their components immediately, with high efficiency. The human body and every cell and every part of every cell does the necessary "calculation" for the exact antiengine for each part. Since time is extremely condensed spatial EM energy (by a factor of almost 10^{17}), a startling contraction occurs in the radiation time required to time-charge the cells and their components and charged particles. This is a method for instant initiation of time-charging, hence it is extremely rapid. What took Priore several hours of LW irradiation to accomplish in the body,[7] can now be done in seconds with this "thwarting" and spectrum transduction method. In fact, it is an intense stress on

the body, and—say—should only

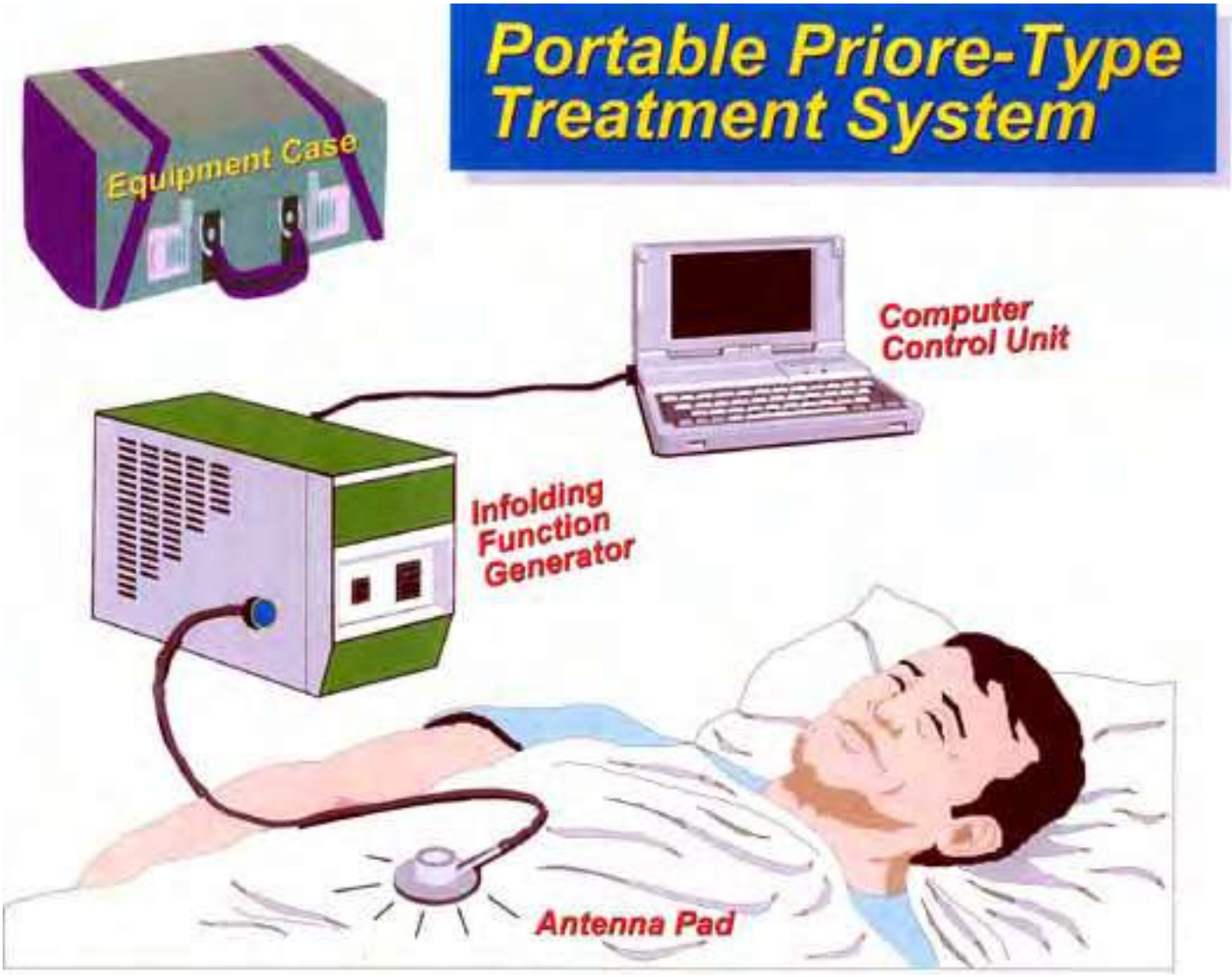

Figure 13. Portable first-method treatment unit proposed to the Department of Defense. For treating and curing mass casualties from terrorist BW attacks on U.S. population centers.

be continued for 30 seconds or so. We highly stress that overcharging in this time domain can be detrimental or even lethal if prolonged.

At the end of the very short time-excitation charging time, the body is "time-excitation charged in all its minutest particles". So everything is therefore pumped in the time domain for the next several days after the irradiation is removed, since the time-charge decays very gradually over a period of time. During that decay period, every part of the cell and body acts as a pumped phase conjugate mirror material, pumped in the time domain rather than in the 3-space energy domain. When time-pumped, the mass itself reverses to a previous physical state. This can be used for both nonliving and living masses. Because there is no forcible translation manipulation of the cells and their parts, it can be utilized on living cells in vivo. In the case of diseased cells—e.g., AIDS-it appears that three precisely determined 30-second "AIDS correlate" irradiations a week apart, should be sufficient to completely cure AIDS, including removal of all HIV-genetics changes from every previously infected cell of the body. Also, it would accomplish considerable rejuvenation of the body (making the body younger).

Rejuvenation: Restore the Telomeres and Produce Immortal Cells

Saving Most of the Casualties from Mass Terrorist Attacks

To defend against things like anthrax attacks on our civilian population centers, we also have recommended to the U.S. Government the crash development of small, portable treatment machines—using similar "antiengine-forming" and cellular reversing "porthole technology". [See Figure 13 on previous page]. Such portable machines could be developed cheaply and quickly, and present government facilities could be used to massively attack the correlate database production problem. The portable treatment units could be cranked out by the hundreds of thousands and flooded down through emergency response agencies such as the police forces, the National Guard, emergency hospitals, emergency response teams, etc.

Each device could be used in "assembly line" fashion upon hundreds of sickened patients, in case of a WMD (weapons of mass destruction) attack upon one or more of our cities. The first generation equipment would save probably 70% of the stricken (as from anthrax, etc.). With second generation equipment, one would expect 90% of the stricken casualties could be saved.

Just now, there is a very dim prognosis for all those casualties, using present available treatment capabilities. Time and lack of vaccines defeats just about everything that can be done. Brutally speaking, most of those unfortunate enough to breath in anthrax spores from an

In fact, it is now known that the gradual loss of the telomeres—the natural ends of chromosomes—in a cell's chromosomes is what causes the cell to age. The gradual loss of the telomeres and the resulting shortening of the chromosomes represents a cellular "disease state" or "disorder" state" accompanied by a precise delta in the spacetime curvature engine accompanying every affected (aging) cell.

By determining the correlate for that precise telomere loss in the aging body's emitted radiation spectrum, an effective telomere regeneration process immediately emerges. One simply amplifies that aging "precise telomere reduction" correlate and reradiates the body with it, passing an amplified correlate back into every cell of the body. The cells and all their parts—including the chromosomes—add the phase conjugate replicas, converting the incoming TW EM correlates to longitudinal EM wave correlates. The cells again phase conjugate the LWs and add the phase conjugate replicas, converting the LW correlates to time-polarized EM wave pumping correlates. This latter process time-excitation-charges the aging cells and all their parts, including the genes and chromosomes. The cellular matter itself produces the amplified "aging antiengine" for each and every cell and telomere ending. The result is to again add telomeres, converting the cell back to a younger, more vigorous cell, and reversing the process of aging.

We point out without further elaboration that these methods also introduce direct engineering signals into the body's master cellular control system, including the regenerative subsystem. Hence the body's regenerative subsystem is involved in helping produce the necessary engines and operate upon the short telomere chains to add back telomeres. More specifically, the regenerative subsystem is changed into attack, are going to die. At least 80% of them will expire, in spite of everything the present system can do for them.

Note each device could rapidly treat a whole series patients, one right after the other, merely laying them between "blankets" containing wire antennas, irradiating with the proper correlate spectrum quickly, moving on to the next patient, irradiating quickly (seconds), etc. The entire apparatus could be made to fit in a large suitcase-sized container, and it would be highly portable and controlled by a laptop-sized computer.

Unfortunately, so far the DOD doesn't even understand what the heck we're talking about! The National Institute of Health (NIH) and the National Science Foundation (NSF) are not interested at all. After all, it isn't drugs, vaccines, antibiotics, etc. — which are simply not going to do the job. However, those are what the government and scientific communities are going to finance to the tune of hundreds of millions of dollars. They are then going to lose almost all those mass casualties when the terrorist attacks on our population centers inevitably occur.

Those are Americans. They are going to die. Most of them could be saved. We ought to save them.

For any change in state (physical, chemical, emotional, mental, perceptual), the body dielectric "portholes" change and the output spectrum changes. The delta from zero reference now represents that exact change.

Where Western Mind Control Research Has Probably Arrived

Western mind control researchers probably first established a correlation database of porthole emission correlates to changes in internal states, both physical

perfect consonance with the external introduction of the amplified antiengines.

That exact process can be used to rejuvenate the aged population and remedy most of the debilities of growing old. That is how we eventually intend to do it, if we can convince the U.S. government and the U.S. scientific community to perform the necessary research and validation.

and mental. They almost certainly recognize the peculiar participation of every part of the body dielectric in the TW emission spectrum from the body. They will almost certainly have opted for this "porthole" notion of some similar expression of it, and the "thwarting" of these "relaxation and release" emission processes to engender internal physical changes in the body and in the brain-meat-computer, as they see it.

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They probably experimented with different TW EM radiation mixes, to see what the body emission change to, and what states are induced. Undoubtedly they found that the induced states began to correlate with the former emission delta data base. That is, they found out which delta emissions spectra, reversed and amplified and fed back thorough the portholes, produce what internal changes.

Use for healing is the simplest of all. Use for killing or debilitating is more complicated. Of course weapons researchers wish to look only at the killing aspects. That is something they understand. They do not understand healing, for they do not even have the "regenerative" or "healing" mechanism in any of the scientific papers or texts. Becker[8] came closest in this country, and Priore did it in France. Both of those scientists were suppressed and paid a bitter price for their revolutionary and innovative research.

But look at what has been done, by "input-output" correlation research. The scientists will have a database now, that tells what state emerges in the body and in the mind, for what irradiation spectra (frequency, relationships, phases, amplitudes, wave shapes, etc.) one uses. And they did not work out all the wave-to-wave transductions ongoing in the mind and body connection and in the body and in the mind, individually, between TWÛLWÛTDW.

We suspect that this is the course Western mind control researchers will have taken, without even realizing the internal wave transductions occurring. And they would not be concerned with that. They would have what they want, for weapons, mind control, and behavior control. And of the internal "mix" of the dielectric and all its tiniest portions. So Western mind control researchers and rogue groups probably do get good results.

We are not just picking on the U.S. government here! Internal divisive groups exist in all large and powerful groups, and joust for power. In highly classified groups, these groups are greatly enabled to joust more widely, unethically, and immorally because it is so deeply hidden. So very deep classification evokes the growth and intensity of rogue groups. It's the old "Power corrupts, and absolute power corrupts absolutely" routine.

The implication is that in the West one or more highly classified, sustained, heavily funded developments in advanced mind control programs, probably exists and probably has existed for some time. Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, may not operate under very much legitimate government control at all, and may operate specifically for the purposes of the rogue group or groups that have gained control.

In a nutshell, that's what may be going on in the clandestine mind control projects in several Western governments. The involvement of at least some rogue groups, some being "cowboys" who operate well outside all laws and ethics, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, it could account for what seems to be actually occurring. As also is "usual" in such a mess, one or more of the rogue groups eventually may become very powerful because their secret weapons are very powerful. They may become confident, thinking they have the "best in the world." They may actually believe they are ahead of the Russians.

they would of course ignore the healing aspects. And they would get results of course, revolutionary results. So they would undoubtedly classify the program very highly, thinking that they had the best of the best.

Rogue Groups May Also Have Arisen to Divert the Purpose of the Projects

And that is where real problems may arise. Every human group has within it competing subgroups, jousting for power. The more highly classified the group and its activities, and the less that is known about it outside its confines, the more strongly and secretly the subgroups can play. So they can emerge as rogue groups pursuing their own agendas, not that of their duly elected governments. In the extreme, such a deep black program can even become a "captured" program, which is totally in the hands of rogues and no longer reports to or is bound by the dictates of the parent government.

It has long been suspected in some quarters that even the US's highly classified research community may be riddled by such rogue groups, and so may be certain highly sensitive parts of the Research and Development community.

Remember that, in every large and powerful human organization, the basis for rogue groups is power and secrecy. They are always seeking to increase their power, control, influence, prestige, etc. Nothing else. Patriotism and mission are—to rogue groups—often just idle words. They have their own agendas. And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. It's a

Where the Russians Probably Have Arrived

On the other hand, the Russians will have developed instruments for detecting and isolating the LWs and the scalar waves, in addition to the ordinary mundane instruments for measuring the TWs. So they will have not only the TW correlates, but also the much finer TWÛLWÛTDW (scalar EM wave) correlates. They will understand and employ the use of vacuum engines (spacetime curvature engines) which Western researchers will often invoke but not understand or even be aware that this is what is being invoked. In other words, Western researchers probably just use the old method of "input fi set of functions fi output". That is the standard basis for almost all Western system analysis. With it, one doesn't have to know the exact functions and processes going on in the middle. One just determines a transfer function from a given input to the output that results. Then one catalogs that transfer function. One does that for lots and lots of transfer functions for particularly desirable results, and one has the system analysis. One also has the immediate basis for a rapidly-developed applications technology.

Western scientists are good system analysts. But they have little or no comprehension of what is really going on in that "inside the ship functions" portion, even though they have determined the transform function which acts upon the input to give the "from the portholes" output.

The Russians, with their additional knowledge of the actual mechanisms in the transforms, will be much more advanced than the West, because their fundamental psychoenergetics science is far more advanced, so long as we continue to use

human characteristic, the old primate dominance game. Only now disguised and hidden under deep classification.

Nonetheless, the "simplified" TW EM "porthole correlate" approach will yield very positive results, due to the correlation existing with the LW s and scalar portions the old U(l) electrodynamics. Further, the Russians have decades of use of longitudinal interferometry beams to reach right through the earth and ocean and produce stringent EM effects at a distance. So they will also be able to do the same things here in "mind control" with LW interferometers, through intervening mass

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including the earth and ocean. Western mind-control scientists and their rogue groups—assuming they exist as postulated—largely will not be able to do that, and probably won't even recognize Russian testing of psychoenergetics weapons directly in or over Western nations.

Russian Lethal Psychoenergetics Mind Control Tests Over the U. S.

In fact, the KGB tested just such highly advanced mind control weapons over the middle of the United States in 1997 on two occasions. The tests were conducted against Captain Button in his A-10 "Warthog" aircraft on April 2, 1997 [See Figure 14], and upon Captain Svoboda in her A-10 "Warthog" on May 27, 1997. [See Figure 15].

Over Arizona, Captain Button was thrown into a hypnogogic state, and his perceptions instantly altered and controlled. In his instant "dream-waking" state, everything seemed perfectly normal. His sense of direction was altered a bit more than 90 degrees, so he simply corrected and turned and "flew toward the range", actually flying off course by more than 90 degrees and ignoring radio contacts. He flew right on out of Arizona. At one point he circled, probably thinking he was over the range, and he probably dropped his ordnance there. Then he "flew on back toward home," as he thought in his waking dream state, until his fuel ran out and he crashed and died in the explosion—dream-thinking until he died that everything was normal. All the while, his sense of the passage of time was altered. To him, in his dream-thinking, dream-acting state, everything was normal and nothing untoward had happened. So the distant KGB transmitters and associated psychoenergetics team controlled him for over an hour.

Indeed, that was the exact purpose of the test: demonstrate control (at a great distance) of a skilled person performing highly skilled tasks. A secondary purpose was to stimulate the U.S. government, watch its investigation and findings, and ascertain if the U.S. knew of the extent to which Russian KGB mind control weaponry had advanced. Obligingly, we proved to me KGB that we did not understand what had actually happened to Captain Button.

Captain Svoboda was from the same Wing as Captain Button and was its most experienced night fighter A-10 pilot. In fact, she taught other pilots the fine points of night flying combat missions in the A-10. About two months after Captain Button's bizarre flight and death, Svoboda was engaged in night target bombing on the range. Rising from her ordnance drop on me target, Svoboda was suddenly struck and rendered hypnogogic and in a waking-dream state. Her sense of the vertical was instantly reversed. Superb pilot that she was, she immediately dream-perceived she was diving, not climbing out of the delivery. She instantly corrected to "climb out". So in the real world she dived sharply into the ground and her aircraft exploded.

This test demonstrated the instant alteration of a skilled pilot's perception, causing that pilot to inadvertently react promptly in an unintentionally suicidal manner. A secondary purpose of the test was to stimulate the U.S. government system again, to see if the system recognized what had

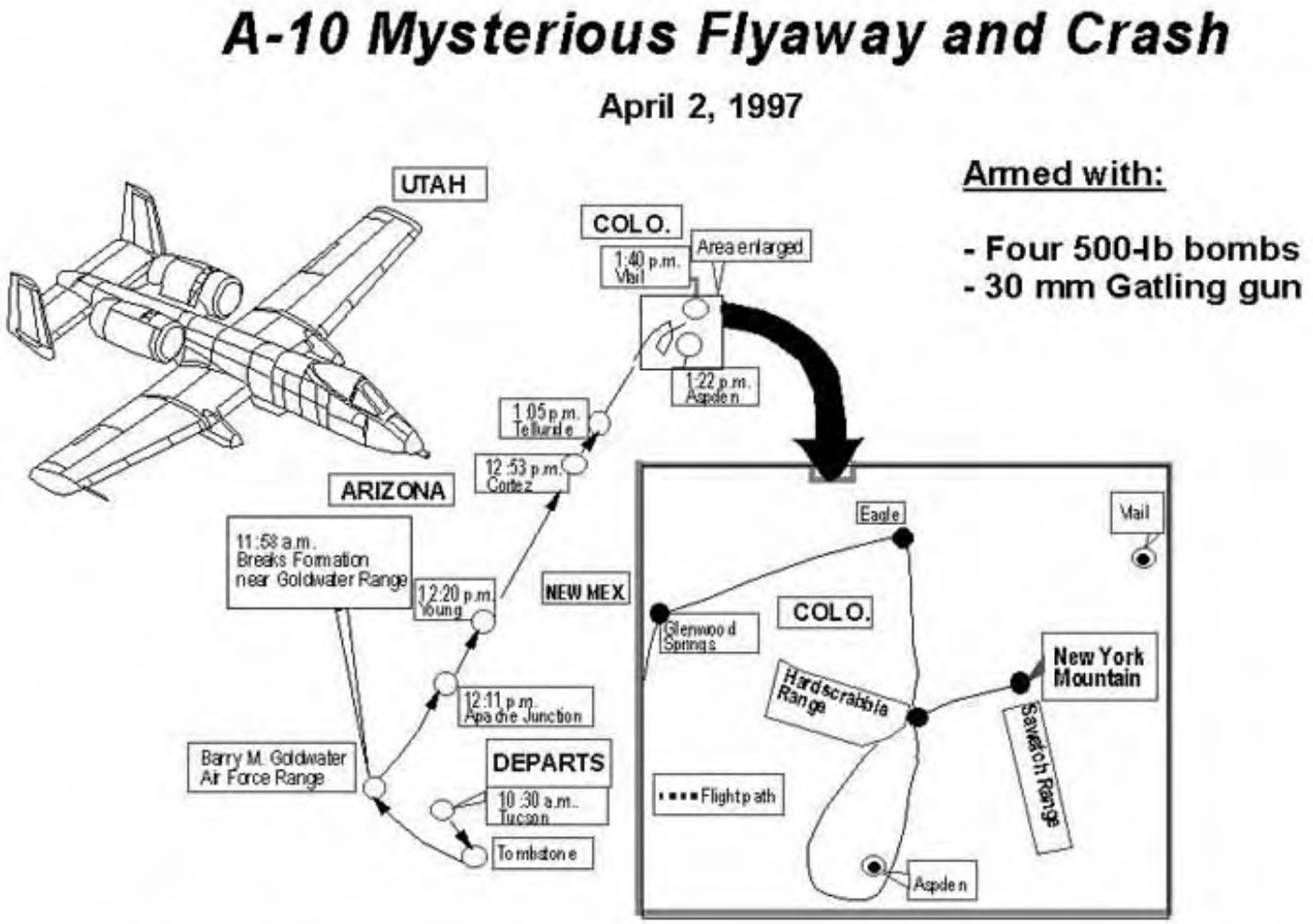

Figure 14a. Captain Button's mysterious flyaway and eventual crash.

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occurred. Sad to say, it did not and it has not. It was lamely speculated that Svoboda probably looked over her shoulder like a rank greenhorn, and inadvertently dived her aircraft into the ground while looking back at the target. If there was one pilot in the USAF who would have not done that, it was Captain Svoboda. At any rate, the KGB determined that the U.S. scientific, intelligence, and governmental communities did not have the foggiest notion of what had occurred.

In private proprietary communications[9] we have explained further, to proper parties, exactly the reasons for these two tests, and what exactly was being tested, and what is its planned strategic use.

The Final Race for Direct Mind Control of the Entire Human Species

The KGB psychoenergetics weapons scientists—because of their direct measurements and detections (and use) of t-polarized waves and LWs for decades—also understand that Jung's collective unconscious mind (of the entire human species) also has its own time-like operations and correlates, which one measures also when using t-polarization measurements and sorting it all out. The collective unconscious mind operations are buried several levels deeper inside the recursive Whittaker structuring inside the EM fields, waves, and potentials.

The KGB scientists also know that something very like Gaia— a collective unconscious mind for all species on earth—also exists, and they are striving to be able to sort out and measure that one as well. The Gaia operations are buried even deeper in the recursive structuring inside the EM fields, waves, and potentials. If one reads some later books by Kaznacheyev,[10] e.g , this human species unconscious mind aspect and the biosphere unconscious mind aspect emerges loud and clear, if one interpolates between the lines, so to speak. Actually, from day one, the Russian mind control scientists have had their eventual goal set upon this "deeper area of mind and possible mind control" of the entire human species.

I am convinced that the KGB psychoenergetics scientists understand this deeper area. If they can learn to directly engineer the collective human species unconscious, they can then convert the human species easily into a sort of "ant" society, modeled along ideal Communism lines, except of course with an excluded "hierarchy at the top" running everything. The "ant society"—communist style—is still a variation of feudalism (all systems tend to feudalism or some form thereof).

The KGB psychoenergetics weapon scientists are seriously pressing on toward that very goal. In my opinion they are not very far from it right now. It is simply a matter of developing sufficiently complex equipment to be able to directly engineer the time-domain substructuring at sufficiently deep levels. It is a doable, although it is very, very complex and very, very difficult. On the other hand, they have been at it for decades. Even in the 50s the Russians already had the old LIDA device,[11] capable of inducing a catatonic trance-like state in a mammal—either a human or a cat,[12] for example. Some versions of Russian mind control devices were used on Russian soldiers in the

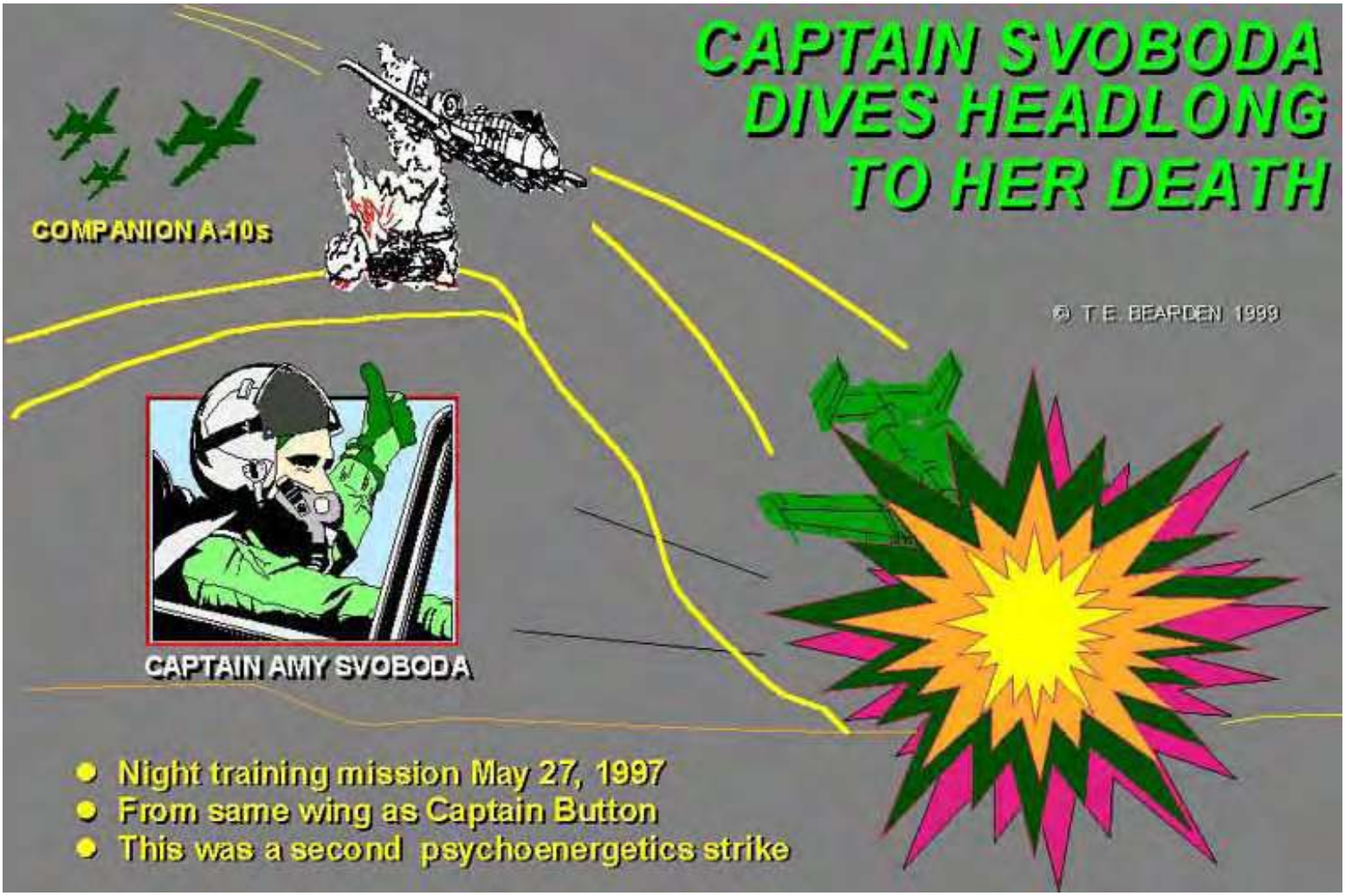

Figure 15. Captain Svoboda dives headlong to her death.

Afghan War to condition them for performance of merciless acts.[13]

Potential U.S. Rogue Groups and Two Recent Examples

Meanwhile, rogue groups amongst Western clandestine mind control researchers will probably arise if they have not already done so. They will likely seek to increase their personal control and further isolate the programs from orthodox government review and from government and legislative control. They may even divert the research into highly illegal and unethical means, because it furthers their own rogue agendas. That is how clandestine U.S. government research can sometimes go sour, unless great care is exercised by the oversight committees in the House and the Senate.

Sometimes when rogue groups do gain control and total secrecy of a given new technological area, then what appears to be "U.S. government operations" do start to encompass a criminal and unethical operations, hidden usually beneath the deep veil of high classification. Also, if it's "scientific," no one is ever brought to justice, even if the "evil science actions" are uncovered and publicly revealed.

We Certainly Have Proof of Such Rogue Activity. For Example, Here are Two Prominent Cases:

1. For three decades, scientists from the U.S. government, universities, and civilian contractors secretly as a result of those ghoulish experiments. So what happened when this gruesome thing was revealed? Again President Clinton publicly apologized! The head of the Executive Branch did not turn the macabre matter over to his Attorney General to prosecute. How many of these scientists were indicted? Not one. How many are going to be indicted? Not one. Suppose again this had been done by a private doctor in his own private clinic. You get the point.

There is Little or No Punishment of Rogue Scientific Groups

Shockingly, the U.S. government at the highest level has directly shown (and these are not all such cases by any means!) that mass crimes against U.S. civilians, perpetrated by portions of the U.S. scientific community in direct conspiracy and in secret, will likely be condoned. The perpetrators will not be indicted, tried, or convicted.

Note the connection of the "rogue groups" thesis to the above incidents. Note how rogue scientific groups got away with it in both these cases. There may be other rogue scientific groups getting away with such things today. They should not be able

conspired to treat unsuspecting human patients with whole body nuclear radiation, including some retarded children and cancer patients. Some of those patients—including some of the retarded children—died as a result. These illegal experiments were conducted in great secrecy, and the results were highly classified. Eventually these actions were revealed, and a Presidential investigation committee investigated. These experiments would seem to be little different from the WWII Nazi and Japanese experiments on human prisoners. Are those U.S. scientists who were responsible for those retarded children's' deaths any different from the Nazi scientists and criminals we executed at Nuremberg? So what happened when this terrible thing finally came out into the open? President Clinton publicly apologized! How many of the responsible scientists were indicted for murder? Not one. None is ever going to be. Suppose a doctor here in South Alabama, with his own private clinic, had secretly irradiated those human patients and retarded children with whole body nuclear radiation, over a period of 30 years, resulting in some agonizing deaths. How many state and federal agencies would have come after him with arrest warrants? Probably about 50 or so. Would he have been indicted, tried, convicted, and executed or sent to prison for life? Absolutely! Would the President of the United States have apologized? Not on your life; he would have turned it over to the U.S. Attorney General with a strong directive to to get away with it. But they can.

Perhaps a most startling additional part of those two incidents is that there was no great public outcry from the scientific community, deploring these murders and demanding that the criminal scientists be indicted and tried.

As the old saying goes, "By their silence they have convicted themselves." The organized scientific community, as a community, has shown that it has little or no ethics, and—while deploring any scientific murdering that "gets revealed,"—is not really interested in justice. In short, much of the U.S. scientific community may now have very little ethics left.

We are not talking about normal individual scientists, but the Big Science community. There is a whale of a lot of difference between the two. In the Big Science community, there can be and there are rogue groups. Lots of them. There is deep cover, deep classification. And there is very probably advanced mind control research and testing, be it legal or illegal. Hopefully most of it is legal and constrained. However, some of it is almost certain to be illegal and ill constrained.

Human beings are still human beings. All the good and evil is still there, regardless of the group. The stage settings change, but the cast of characters and the play never change.

It's sad, but 'twas ever thus. Hidden parts of our own governments—and other governments throughout the world—are no different from the old medieval groups, where nobles etc. were always plotting against the king, or using the king's power for their own nefarious end. The rogue groups today are no different from all the scheming and conniving groups that destroyed the Roman Empire. Great empires fall from within, not usually from without!

investigate and prosecute on criminal charges.

2. Again for three decades, scientists from (i) the U.S. Government, (ii) universities, and (iii) civilian contractors conspired to give poor syphilitic blacks in Tuskegee, Alabama a placebo while ostensibly treating them for syphilis. The purpose of the program was to deliberately observe and record the ravages of the disease to its fruition in their wracked bodies. So the scientists deliberately sat there and watched their brains rot and their bodies rot. They kept meticulous notes, of course. It was very scientific. And it was macabre. They "treated" some 400 blacks in the "program." Over 100 blacks died

Conclusion

This concludes our brief portrayal of the probable directions that mind control research has taken, in Russia and in the West. It is a novel and powerful area, and it poses both severe dangers and great benefits to all the peoples of the Earth.

Let us hope this great new area, already off to a bad start, can be bridled and steered in the direction of helping and healing people, rather than killing or abusing them. The excesses in its bad use are a potent threat to all nations on earth. Yet it can revolutionize medical science, education, communication, and psychology. Eventually it can engineer the mind and memory directly, beneficially. We foresee the day—perhaps 30 years hence—when education will be

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accomplished by directly loading the software into the mind. Then in three weeks one will "load" a doctorate, say, in physics. In three more weeks one will also load a doctorate in chemistry. Another three weeks, in electrical engineering. Another three weeks, an M. D. And so on. When that happens, then truly everyone on earth can be educated. Freedom from ignorance may well be another great freedom that is legally recognized. There will be no impoverished large groups lacking the education to find decent, productive jobs.

We urge all nations to use the principles involved: not for human abuse, but for healing, educating, uplifting, and life-expanding of every person on Earth. If we

446955, Oct. 23, 1998, forwarded to US. Patent Office on Nov. 4, 1998.

5. A very good introduction to nonlinear phase conjugate optics is given by David M. Pepper, "Nonlinear Optical Phase Conjugation," Optical Engineering, 21(2), March/ April 1982, p. 156-183. Also see David M. Pepper, "Applications of Optical Phase Conjugation," Scientific American, 254(1), Jan. 1986, p. 74-83.

6. Pepper, Optical Engineering, ibid., p. 158.

7. See T.E. Bearden, Energetics of Free Energy Systems and Vacuum Engine Therapies, Tara Publishing, Internet node www. tarapublishing.com/books,July 1997. See also T.E. Bearden, "Energetics Update and Summary, " Part I, Explore, 7 (6), 1997, p. 60-67, Part II, Explore!, 7(7), 1997, p. 53-56; Part III Explore!, 8(1), I997, p. 53-56; Part IV; Explore!, 8(3), 1997, p. 56-63. See also T.E. Bearden, "Vacuum Engines and Priore's Methodology: The True Science of Energy-Medicine: Parts I and II " Explore!, 6(1), 1995, p. 66-76; 6(2), 1995, p. 50-62.

8. E.g., see R.O. Becker; Charles H. Bachman, and Howard Friedman, The direct current system: A link between the environment and the organism, " New York State Journal of Medicine, Vol. 62,

do, we shall all have a far brighter future. Then we shall check what has started out to be the Sword of Damocles and turn it into the golden Millennium.

We are reminded of a poignant quote from Teilhard de Chardin:

"Someday, after we have mastered the winds, the waves, the tides and gravity, we shall harness for God the energies of love. Then for the second time in the history of the world man will have discovered fire."

May the nations of the world utilize the new mind engineering science to truly free all minds into a common love of, and respect for, their fellow humans of every color, creed, and circumstance. As de Chardin envisioned, may we use the new science to discover a new fire, burning clearer and brighter than anything that has gone before. ♦

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April 15, 1962, p. 1169-1176. See also R. 0. Becker; "The direct current field: A primitive control and communication system related to growth processes, "Proceedings of the XVI International Congress of Zoology, Washington, D.C., VOL.3, 1963, p. 179-183; —"The neutral semiconduction control system and its interaction with applied electrical current and magnetic fields," Proc. 1lth International. Cong. Radiol., Amsterdam, Excerpta Medica Foundation, 1966, Series 105, p. 1753-1759. See particularly Robert O. Becker and David G. Murray, "The electrical control system regulating fracture healing in amphibians," Clinical Orthopaedics and Related Research, Vol. TBD, No. 73, Nov.-Dec. 1970, p. 169-198.

9. Bearden, T.E., Energetics: Extensions to Physics and Advanced Technology for Medical and Military Applications, CTEC Proprietary, May 1, 1998, 200+ page enclosure to CTEC Letter, "Saving the Lives of mass BW Casualties from Terrorist BW Strikes on US. Population Centers," distributed to selected high U.S. Government agencies and Legislative subcommittees, May. 4, 1998.

10. E. g. , Vlail Petrovich Kaznacheyev, V. I. Vernadsky's Study on Biosphere and NooSphere, 1989 [in Russian]. Vernadskys concepts included living matter, biosphere, and human-transformed biosphere (noosphere). Kaznacheyev writes of evolution and

energy, and advanced a mechanism for a Bohm-type quantum potential, which theoretically allows the engineering of action at a distance in physical systems.
He is president of the Association of Distinguished American Scientists (ADAS), a life member of the Alabama Academy of Science, Emeritus member of the American Association of Physics Teachers, and has served on the Board of Directors of several associations and corporations. Tom is a guitarist, a retired aikidoist (Sandan, Yoseikan style), is happily married and has two sons and two daughters. He and his wife Doris live in Huntsville, Alabama where Tom is retired from aerospace, continues private research, and serves as a consultant to industry on Scalar electromagnetics processes.

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1. Owen Flynn, "Parametric arrays: A new concept for sonar, "Electronic Warfare Magazine, June 1977, p. 107-112.
2. Valerie Hunt, presentation to the U.S. Psychotronics Associations Annual Symposium, Bergamo Center, Ohio, 1988. Hunt presented epochal work showing chaos—and thus hidden order—in recorded ELF electromagnetic radiation from human bodies. Hunt split the received EM signals into two identical channels, time-delayed one channel by a very slight amount, then recombined (mixed) the nondelayed and delayed signals. The result was that attractors precisely indicative of chaos appeared. This positively proves that human systems produce ordered time-structuring of EM. organization of the living matter as the biosphere of the earth. Without specifying the exact technical details, Kaznacheyev discusses the gist of much of what is in this present article. The present author has an autographed copy of Kaznacheyevs book referenced above.
11. Rabichev, Lev Yakovlevich; Vladislav Fedorovich Vasiliev; Alexandr Sergeevich Putilin; Tatyana Grigorievna Ilina; Petr Vasilievich Raku; and Leopold Pavlovich Kernitsky, "apparatus for the treatment of neuropsychic and somatic diseases with heat, light, sound; and VHF electromagnetic radiation," U. S. Patent. No. 3,773,049, Nov. 20, 1973. This is the U. S. patent for the LIDA machine, developed by the Russians prior to the Korean War. Additional patents or applications are as follows: Italy, #619,129, March 1961. Germany, #1,183,607, Dec. 1964. Great Britain, #826,766, Jan. 1960.
12. Stefan T. Possony, "Psy-War: Soviet Device Experiment," Defense & Foreign Affairs Daily, 12(104), June 7, 1983, p. 1-2. Reports on Dr. Ross Adey's investigation of the Soviet device called LIDA which is used to bombard human brains with radio waves in the 40-MHz region. Also reports on work by A.S. Davydov of the Ukrainian Academy of Sciences, who discovered how the blood-brain barrier can be penetrated by low-frequency radio waves so that brain cells

3. Years ago, I read an obscure reference to Russian research directly along that line, with successful development of just such a portable device. Unfortunately I lost the reference in a disastrous flood in my basement and have been unable to recover it.
4. T. E. Bearden, "Alteration of Materials by Wideband Multiwave Irradiation Combined with Selective Emission Manipulation," Invention Disclosure Document Number

are affected. See also "Soviet device uses radio waves as tranquilizer, " Associated Press release, Huntsville [Alabama] Times, May 19, 1983. Dr. Ross Adey tested the Soviet LIDA machine on a cat, and in two or three minutes the cat was sitting quietly, almost as though transfixed, and uninterested in its surroundings. The animal remained uninterested in its surroundings for some 20 to 30 minutes after the machine was turned off.

13. "KGB Used PIS to Program Soldiers, "Resonance, No. 30, Mar. 1996, p.29. Quoting: "During the 1970s, the Soviet KGB developed a Psychotronic Influence System (PIS) that was used to turn people into programmable "human weapons." Soldiers fighting in the Afghan conflict were trained using the system which employs a combination of high frequency radio waves and hypnosis. Commands are activated by code words or cyphers. The purpose of PIS was to render regular soldiers and members of the special forces incapable of feeling sympathy.

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THE NEUROPHONE

Another device that uses the new hyperspatial, virtual state, nested modulation technology (and has done so for seventeen or eighteen years) is Dr. Pat Flanagan's neurophone. With brilliant insight and intuition far beyond that of science at the time, Pat invented and patented the instrument by the time he was seventeen years old. The neurophone is a device that, contrary to all present theory and knowledge, will directly "pump the brain" and reproduce sound and information directly in the brain and mind system, without going through the auditory system at all. A simplified diagram of Pat's improved neurophone is shown in Figure 11.

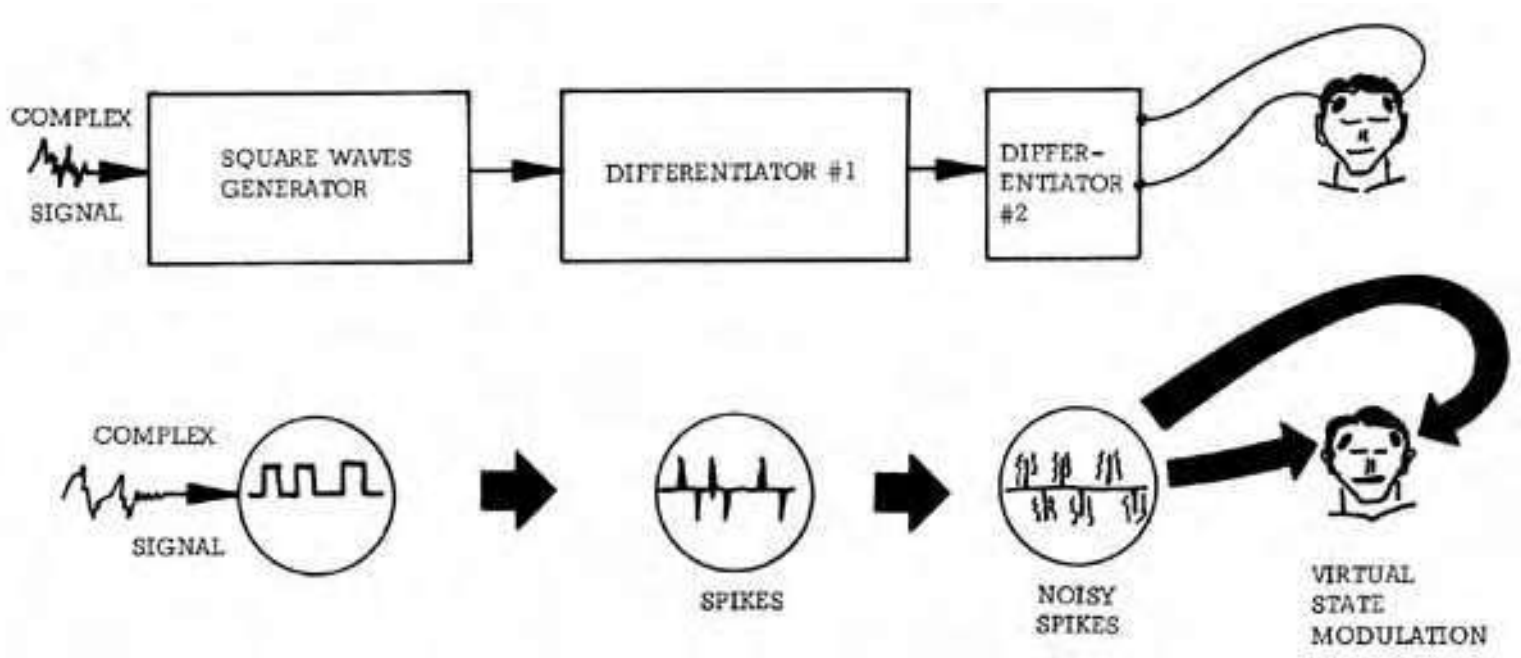

Figure 11. A simplified diagram of the improved Flanagan neurophone

Briefly, the device takes a complex signal, such as the sound of an orchestra playing a musical interlude, and electrically processes it as shown in the figure. First the signal is passed into a section that clips everything into a series of square waves, remarkably analogous to the sort of clipped waves Lisitsyn confirms are the information carriers of the human brain. Next the square waves are differentiated, yielding a series of sharp spikes (note that these spikes retain the pulse-time content of the clipped signal). These spikes are again differentiated, and since these are finite spikes with real nonzero rise times and decay times rather than theoretical constructs, a series of noisy spikes results from the second differentiator section. From here, the noisy spikes are introduced to special contact electrodes, one of which is normally placed on the forehead, while the other may be placed almost anywhere, including on the foot. Nowhere are any sound waves introduced to the head.

The square-wave clipper section reduces the complex signals, their overtones, and their complex modulations to square waves, retaining the temporal content of the wave mix but not the waves themselves. The first and second differentiators heighten or filter through the temporal content of the higher-order differentiations, that is, they serve as a band pass filter unit to accent the time keying of the neutrinic and mindfield portions or aspects of the signal. When these time spikes are then introduced across the body as pulsed voltages, they are modulated directly on the dendrite firings of the brain and nervous system, providing direct and pulsed modulation of the neutrinic and mindfield component channels of the mind-brain-consciousness-life loop itself. Thus the neurophone directly inputs information into the brain and nervous system, bypassing all the normal sensory systems that lie between the mind-brain loop and the outside environment.

Indeed, a similar development has been reported by two University of Missouri researchers. Dr. Donald York, a neurophysiologist, and Dr. Thomas Jensen, a speech pathologist, have recently reported identifying and decoding twenty-seven words and syllables in specific brain wave patterns and correlating these electroencephalographic patterns with both the spoken word and the silently thought word in about forty subjects. At present, Dr. York and Dr. Jensen are programming a computer with a brain wave vocabulary, to monitor and read the EEG of a stroke victim's brain and help stroke victims who have lost their powers of speech to communicate.

While all such developments can obviously be misused, their potential for assistance to mankind is enormous. Indeed, my own premise that brain linkage is possible and can be used to advance all mankind to the sixth stage of species evolution is slowly being proven. It is within our reach now to develop a multi-channel communications system that will directly link brains, minds, and consciousness into a single functional being; and I have already pointed out that the psychokinetic power of the emergent entity increases exponentially with the number of linked stages. The normal corpus callosum linkage of the two cerebral halves in each human head proves that brains, minds, and beings can be linked and

integrated into one.

The Excalibur Briefing details the basic concepts of the theory involved in hyperspace-virtual state engineering, and thus in the engineering of mind-life-consciousness links to multicellular organisms here on earth. Pat Flanagan's neurophone proves that complex information can be implanted directly in the brain and mind, bypassing the normal isolating barriers. Drs. York and Jensen have shown that the brain wave does indeed contain recognizable, decodable information analogues. Lisitsyn has already reported measuring the number of independent channels involved and has documented the importance of the clipped brain waves as opposed to the sine-wave content. If we have the vision, we can still develop a brainlink and rapidly apply it to link sixty to one hundred persons, thereby opening a conscious, multidimensional "eye" for the collective human unconsciousness, gently rousing ZARG into wakefulness, and fulfilling human destiny without undergoing the psychotronic Armageddon planned by the Soviets. The time is short, but it can still be done if the funding, the vision, and the team can be established on a crash priority basis.

SOVIET "WOODPECKER" SIGNALS

But, as I have said, all this can be used for the detriment of mankind as well as for its benefit. Unfortunately, it appears that the Soviet Union has chosen to weaponize the effects on a global scale. A prime example is the "woodpecker" signals emanating from the USSR in the 5-30 megahertz region and interfering with communications around the earth.

These complex woodpecker signals appear to originate from two or three dozen powerful Soviet transmitters, each with a power estimated as high as 40 megawatts (Figure 12).

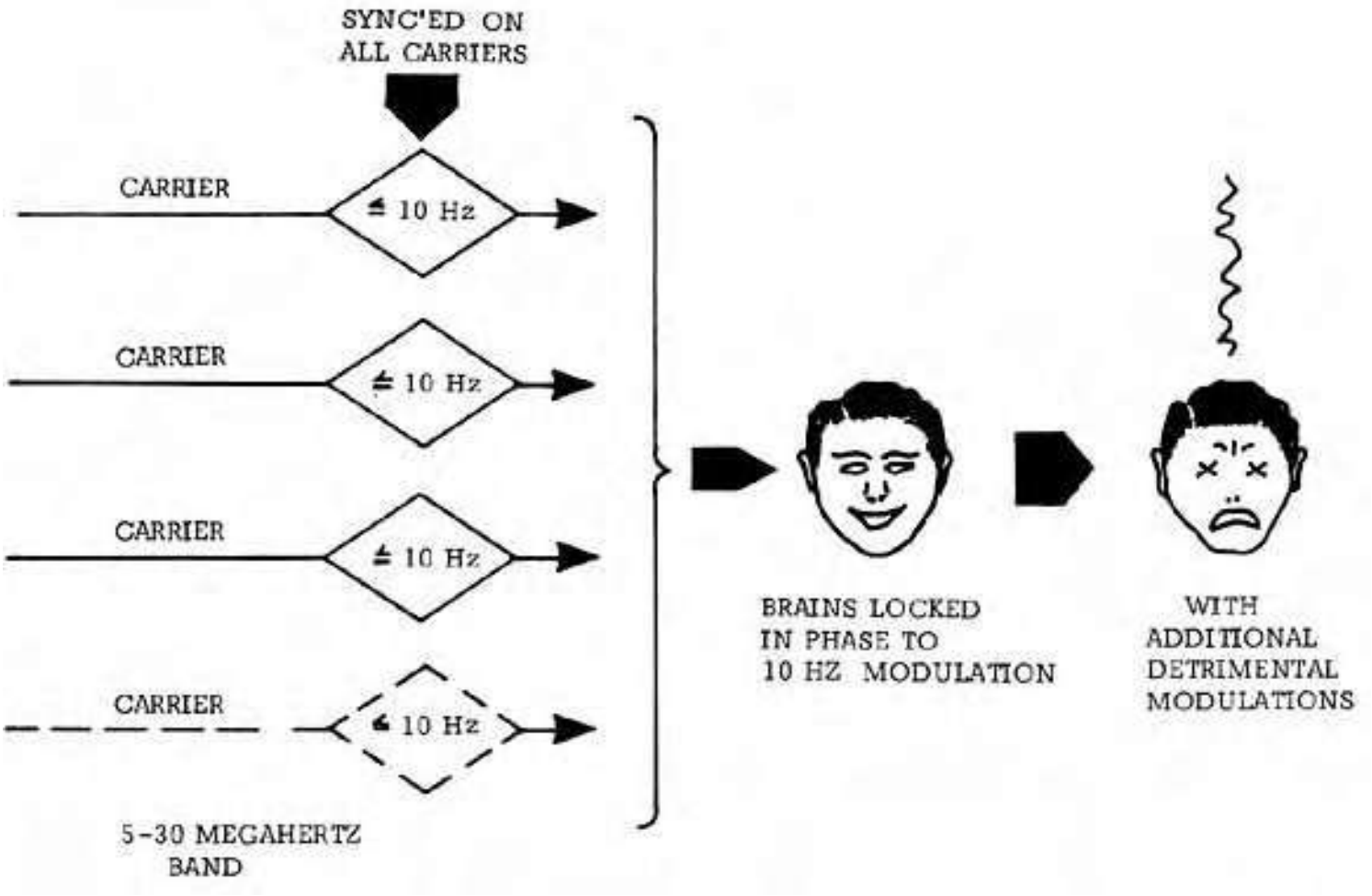

Figure 12. The Soviet "woodpecker" signals

The pioneering experimental measurements of these signals by Dr. Robert Beck and William Bise have shown just how deadly a potential may be possessed by the signals. These measurements have been performed in Eugene and Portland, Oregon; Los Angeles, California; Huntsville, Alabama; and several other locations. They have been particularly significant on the West Coast in and around Eugene, Oregon because of the presence of a direct current transmission line several hundred miles long, which has acted as a long wire antenna, picking up the signals and rebroadcasting them with appreciable gain in the vicinity.

Typically the signals may be found on, say, sixteen different carriers between 10 and 20 megahertz. Twelve of the carriers may appear normal, with normal side-bands, and the other four may have the carrier and both sidebands suppressed but still show the biologically significant modulation (for example, 10 hertz). On all sixteen channels a strong 10 hertz modulation may appear, all perfectly time synchronized and in phase channel-to-channel. The received signal from one of these carriers may be twenty-five to thirty times as strong as the earth's back-ground magnetic field, which is oscillating at approximately 7.0 to 7.5 hertz. Other complex modulation frequencies, many of them changing, are present on the various channels.

Normally, the brainwaves of mammals in an area are gently entrained by the normal oscillations of the earth's magnetic field and are oscillating along at, say, 7.5 hertz. Under continuous radiation from the Soviet

woodpecker signals, a percentage (say 30 percent) of the mammalian brains may be captured by the 10 hertz modulation on the overpowering Soviet signals. These captured brains are now in forced oscillation and are riding along in phase with the 10 hertz Soviet modulation. In other words, a certain percentage of the human brains in an area will phase lock to the 10 hertz modulation, and that will effectively lock into those brains the sixteen carrier frequencies with their concomitant frequency mixes and complex signal modulations. If the signals are made much more powerful (for example, by focusing them onto one particular area or increasing the power of the transmitters), then a much higher percentage of brainwave entrainment can be accomplished in the targeted area. By simply adding on the desired modulation patterns, the Soviets can now pump material directly into the mind-brain-consciousness-life loops of the entrained brains. The weapon implications are enormous: raw emotion such as sheer terror or panic can be transmitted; death or disease patterns of all kinds can be transmitted; informational content (thoughts and ideas) can be impressed directly into the captured brains and minds and processed as if originating inside each brain itself. Indeed, as long as the Soviets keep the effects rather gentle, an entire population can be subtly influenced without governmental notice. Certain specific ELF frequencies can rapidly disable or even kill, and for wartime use those frequencies can be directly implanted in the captured brains themselves by the woodpecker signals. It appears that 1984 came a little early, and one can perhaps now understand Brezhnev's strange 1975 proposal to the SAL T negotiations that we should also consider outlawing the development of new weapons more frightful than the mind of man has ever conceived.

The signals also have direct application against strategic targets other than personnel. For example, by incorporating the correct nested modulation pattern, the positron kindling (electron squelching) pattern can be impressed. By beaming through the earth (with a circularly polarized signal or with other complex modulation forms), a beam with a strong neutrinic component, which will squelch electrons and which will interact with great preference for strong voltages or strong magnetic fields, can be directed at a target complex. In the targeted area aircraft and communications systems can be disabled; automobile, truck, and other ignition systems will fail; power transformers and large motors and generators will fail; power transmission systems with their associated high voltages will fail; and so on. Even independent, self-contained emergency power equipment, such as at military installations and strategic missile sites, will fail to operate. Further, to some of these signals, the earth and the sea are as transparent as glass, and so underwater nuclear submarines can be electrically disabled on station before their missiles can be fired, while strategic missile complexes can be electrically disabled before their deadly nuclear missiles can be hurled toward their distant targets. If some submarines and land complexes succeed in firing missiles before being disabled, these missiles can be electrically dudded and scrubbed from the sky over Soviet territory while

still far from their intended targets.

So, as stated at the end of *Excalibur*, the players are on stage and in place. The final act begins. One thing is sure - mankind will never be the same again after seeing the play!

VACUUM ENGINES AND PRIORE'S METHODOLOGY: THE TRUE SCIENCE OF ENERGY-MEDICINE

Part I of II

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Photo 1. (to the right) Priore's laboratory. Workbench with animal cage is in the right foreground, under a large overhead assembly to hold the coil for producing the rippling magnetic field.

Photo 2. (below) Priore's laboratory. Workbench now has coil installed. The rippling magnetic field descended vertically through the patient. The magnetic field was modulated by the wave/antiwave output of 17 EM waves mixed in a rotating plasma in a giant mixer tube.

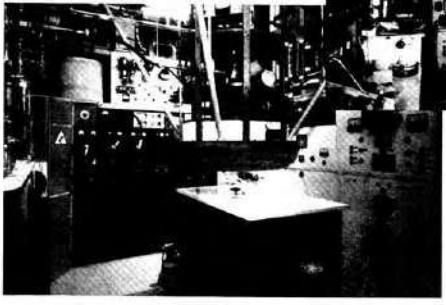

December 1, 1994

Overview

In the late 1960s and early 1970s, Antoine Priore and a team of leading French scientists demonstrated conclusive, total remissions of terminal tumors and infectious diseases in hundreds of laboratory animals. Their research was performed under rigorous scientific protocols and funded by the French Government. The approach employed very complicated mixing of multiple EM signals in a rotating plasma, and modulating the mixed output upon a very strong rippling magnetic field to which the body of the test animal was exposed. Complete remission of the treated diseases was obtained. In addition, the animals' immune systems were also restored to normal. Further, disease-specific antibodies were also created: a single drop of blood drawn from an animal that had been treated and recovered, and injected into the body of a second animal with the same terminal illness, resulted in total remission of the disease in the second animal *and its total recovery*. In the mid-70s Priore's work was suppressed, because of hostility of the oncology community, change of the French Government and loss of further funding, and complete inability of physicists and biological scientists to even hypothesize a mechanism for the curative results.

After a 10-year struggle to discover the Priore mechanism, the present author has proposed a sweeping new explanation for the exact Priore curative mechanism. It represents a totally new kind of medical therapy – one which can dramatically treat and cure a breathtakingly wide variety of diseases. The electrical physics is based on the Stoney, Whittaker, and Ziolkowski decomposition of the scalar EM potential into bidirectional EM wave pairs. Deliberate assembly of such a structure forms a *vacuum engine* of nested curvatures of local spacetime.[1] Priore unwittingly made such a hyperspatially structured vacuum engine, one with the special characteristic that it *time-reversed* (dedifferentiated) diseased cells back to their earlier normal state. The Priore approach not only produces remission of a specific targeted disease, but also fully restores the cells and "factories" of the patient's immune system because they too revert back to their previous healthy condition.[2]

[1] *In short, Priore found and utilized a method of electromagnetically engineering general relativity in the laboratory – something physicists had not done and have no knowledge of. Neither have they done it overtly today, and neither do they have knowledge of it today.*

[2] *We point out that chemistry is largely driven by charge and charge distribution. The new methodology essentially controls charge and its distribution. Hence it can control and order all the biochemistry.*

Becker et al have shown conclusively that very weak DC currents and pulsed magnetic fields can produce cellular dedifferentiation (change to a previous state) and redifferentiation (change forward to a new state). It follows that transcription (change of the genetics) must also be altered correspondingly. Becker was nominated for a Nobel Prize for his experimental and theoretical demonstration of the mechanism. He also proposed a fundamental electrical control mechanism to account for his revolutionary results.

Kaznacheyev et al have shown that almost any cellular disease or damage can be transferred electromagnetically from one cell culture to another under special conditions. Popp has theoretically and experimentally shown that an electromagnetic master cellular control system exists in the body, as indeed has Becker. Thus it is clear and independently demonstrated that (1) disease can be created or reversed electromagnetically, and (2) the fundamental cellular control system is electromagnetic in nature. We comment that, viewed as physical materials, the cells and their constituents are sufficiently nonlinear that their EM functions, responses, and effects transcend the present classical EM model. A modern addition to nonlinear electromagnetics is the methodology and results of nonlinear phase conjugate optics (NLO). Accordingly, understanding of the higher topology EM/bioeffects functioning requires application and understanding of NLO principles, *regardless of frequency band.*

We also extend the general relativity model by addition of higher topology EM. We incorporate the Stoney/Whittaker/Ziolkowski decomposition of the scalar EM potential into hidden bidirectional waves. This is then applied to structure and engineer the vacuum. The method is also capable of structuring and engineering both mind and matter.

As a case in point, the elements of the new EM bioeffects approach are applied to the Gulf War Syndrome – the strange conglomerate of illnesses and symptoms developed by many Gulf War participants, usually beginning shortly after their arrival back in the United States from the MidEast. Previously unrecognized biological effects of a dense EM signal environment are advanced and their causative mechanisms explained. These new "dense signal environment" bioeffects, coupled with other simultaneous biologically-active suppressants, allow a full explanation of the Gulf War Syndrome and its characteristics. Both normal and anomalous symptoms are explained.

The Priore approach extends and complements Becker's pioneering approach by allowing positive engineering control of dedifferentiation of cells and their redifferentiation. A cancer cell may be regarded as a dedifferentiation or partial dedifferentiation of a normal cell back toward a more primitive or "immature" geological form. In NLO terms, this is a form of phase conjugation (time reversal) of the cell back toward a previous state, or even its *ancestral* cellular form *(see figure 1 below).* By phase conjugating the cancer cell anew and amplifying the process, the diseased cell can quickly be reversed back to a normal cell.

It is possible, using the Priore technique, to phase conjugate cells in the body, including all of them simultaneously if need be. Further, conjugation can be made specific to the type of cell or tissue one desires to affect. One need not "know" the specific disease's "EM signal complex," one must simply "pump the cell correctly" where it and its parts are treated as pumped phase conjugate mirrors (PPCMs). In a higher EM topology, the "diseased-cell-as-a-PPCM" already possesses a special "standing signal wave" input that represents the erroneous *vacuum engine* associated with the change to the specific disease state. Pumping the cell *in this special EM topology* creates the precise, amplified *vacuum anti-engine* in this same special EM topology and renormalizes the cell.

Because of the special EM topology utilized, direct engineering of both mind and matter are provided by the new approach, which also represents a unification and extension of electromagnetics, quantum mechanics, general relativity, and biology. It should be capable of reversing most physical and mental disorders that assail a biological organism.

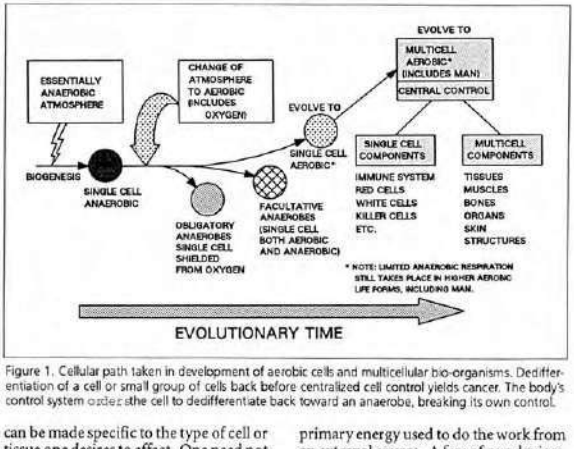

Figure 1. Cellular path taken in development of aerobic cells and multicellular bio-organisms. Dedifferentiation of a cell or small group of cells back before centralized cell control yields cancer. The body's control system order the cell to dedifferentiate back toward an anaerobe, breaking its own control.

Introduction

In this paper we discuss the present method of utilizing EM energy in science and engineering, and also discuss a radically different second method that is beginning to emerge *(see Table 1 on following page).* The main text is an overview, with technical elaboration in the footnotes.

The first (Type 1) engineering method may be likened to a leaky pipe: We always pour in more energy than the work we get back out. We have to furnish the primary energy used to do the work from an external source. A few of our devices, such as a common heat pump, are open systems extracting and using some excess energy from an external source. These devices may have a coefficient of performance (COP) – work output of the machine divided by work done on the machine to run it – of greater than unity. However, the vast majority of our machines have COPs of less than 1.0. Many of them have COPs of less than 50%, and many have COPs of less than 30%.

As can be seen, Type 1 engineering is very wasteful of energy! In a sense, the present struggle to attain room temperature superconductivity is a struggle to eventually have many more machines that attain a COP approaching 1.0, and so decrease the waste of energy in our

Table 1. Two Ways To Do Engineering.

- *Type 1* Engineering: Vacuum Quiescent, Use External Energy Upon Matter
  - Does not involve mind, thought, life, time streams
  - Time is not an observable
  - Must furnish all the energy
  - Western science uses this method.
- *Type 2* Engineering: Gate and Structure the Vacuum Flux Itself
  - Involves mind, thought, life, time streams
  - Time is an observable
  - Furnish only initial energy, and maintenance
  - Use vacuum's energy (vacuum engines)

Type 1 machines. Vacuum engines allow COPs of far greater than 1.0.

After several decades of painful progress in understanding the nature of the quantum mechanical vacuum, today it is accepted in physics that the vacuum itself is a seething inferno of electromagnetic energy. It is thus a legitimate source of energy, could we but extract and use it. This is now accepted both by leading physicists and by the U.S. Patent Office. Further, as of 1993 it has been clearly shown that, contrary to conventional objections, thermodynamics does not rule out the extraction and utilization of the vacuum's energy as heat and power to operate our engines.[3]

We have now reached one of the great scientific plateaus of history: (1) *The vacuum is energetic, containing an incredible density of electromagnetic energy in a violent flux;* (2) *at least in theory, it is possible to extract energy from the vacuum and utilize it;* and (3) *every particle of mass exists as a nonlinearity in a violent flux of virtual particle energy exchange with the vacuum. In short, every system is an open system, being violently "driven" by the vacuum flux, where normally the "driving flux" is in equilibrium or nearly so.*

This paper briefly describes a great new scientific breakthrough which is approaching as a result of the new understanding of the vacuum energy. This new scientific development will usher in the greatest change to humanity of all time *(see Figure 2)*. It is characterized by the laboratory ability to: (4) Deterministically structure and gate the vacuum's fierce flux of virtual particle energy – even at a distance – and make the vacuum itself an ***engine*** to do any kind of work on an embedded physical system that we choose.[4] (5) Deterministically form a quantum potential, and utilize this potential to achieve essentially instantaneous action at a distance.[5] (6) Engineer the hidden inner structure of any potential; this includes also the potential for the Schroedinger equation, including Bohm's ***quantum potential***, so that physical reality can actually be engineered prior to the collapse of the wave function and the occurrence of the quantum change. This is engineering and altering an entity in its *pre-reality state*. (7) Engineer and alter the flow of time and the laws of nature in a particular area, including the entire planet or solar system. (8) Simply and cheaply treat and cure essentially every present infectious disease and many other abnormalities. This includes cancer, leukemia, AIDS, malaria, sleeping sickness, arteriosclerosis, etc. – even mental disorders. It also includes reversing the effects of the aging process. (9) Directly engineer, form, create, heal, or modify mind, thought, long-term memory, life, etc.[6] And finally, (10) Directly engineer and alter the species quantum potential, an entire species, and the planetary quantum potential for all species and all living creatures on earth.

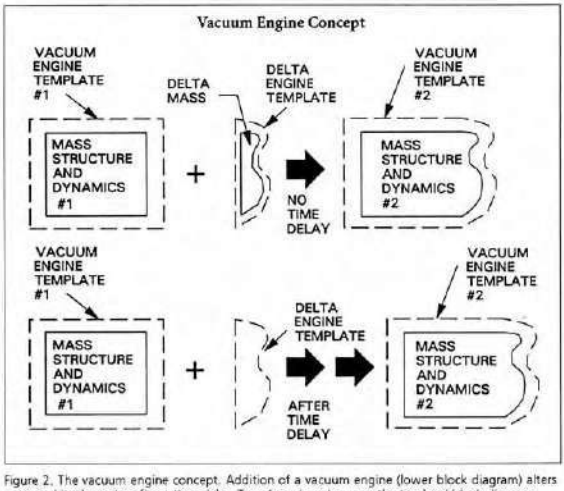

Figure 2. The vacuum engine concept. Addition of a vacuum engine (lower block diagram) alters mass and its dynamics after a time delay. Type 1 engineering uses the top level block diagram.

[3]*Daniel C. Cole and Harold E. Puthoff, "Extracting Energy and Heat from the Vacuum," **Physical Review E**, 48(2), Aug. 1993, p. 1562-1565.*

[4]*In other words, to perform vacuum engineering, extended from the suggestion of Nobel Laureate T.D. Lee (**Particle Physics and Introduction to Field Theory**, Harwood, New York: Chapter 25: Outlook, "Possibility of Vacuum Engineering," p. 824-828.). Lee recognizes that vacuum engineering can in theory be accomplished, but also that this has never even been tried.*

[5]*For a presentation of the mechanism for creating a quantum potential, see T.E. Bearden, **Gravitobiology**, Tesla Book Co., Chula Vista, CA, 1991, p. 33-36.*

[6]*The weapons developers are slowly grappling their way toward this new science, which the Russians call energetics. Application to the physical world at large is just referred to as energetics. Application of energetics to mind engineering is called **psychoenergetics**. Application to the physical body and its structures is called bioenergetics. In the U.S., development of mind and behavior alteration and control is now being dealt with in embryonic fashion under the subject heading of nonlethal warfare.*

This paper is an informal "quick note" to point out the new scientific plateau and introduce the second kind of science and engineering. The new ***vacuum engineering*** offers the greatest threat to humanity that has ever existed,[8,9,10] and at the same time offers the greatest promise of benefit.

For our very survival, it is absolutely imperative that informed citizens be aware of this dramatic change, which is just now starting. The powerful new science and engineering must be controlled and used for humanity's benefit, not its detriment. Else it will eventually be let loose unrestrainedly, to destroy all life on earth – a possibility indicated by Nikita Khrushchev in 1960.[11]

The First Kind of Engineering (Type 1)

First there's the normal way to do engineering (Type 1), which we are all taught as engineers and scientists. Here the vacuum/spacetime itself stays *inert* and out of our way.[12] We ourselves furnish energy into or onto the system we are trying to move or activate, spilling some of this energy all the while, and we struggle until we get the mass to move and the system to operate and perform work.

This "first kind" of engineering is essentially a continual *wrestling match*. Nature herself is the opponent. The engineer furiously struggles with nature, to force her to do the work he wishes to do. ***This is the only overt kind of engineering presently done on earth.*** It is primitive and severely limited in what it can do. In Type 1 engineering, the mind and thought are not affected since the *flow of time connectivity* and the *flow of mind connectivity* are not affected.

The Second Kind of Engineering (Type 2)

Clandestinely, however, the Russians (actually, the KGB) in their secret advanced weapons labs, and three other nations not hostile to the U.S., have also weaponized a second kind of science and engineering, but kept it firmly a secret of the highest order. The second kind of engineering (Type 2) is dramatically different, far more powerful, and essentially unlimited in what it can do. Some of the simpler elements have spilled into the open press. For example (*see Figures 3 & 4 on next page*), Vlail Kaznacheyev and his colleagues have shown, in thousands of meticulous experiments, that almost any disease or damage to cells can be induced in an isolated cell culture by electromagnetic radiation from the diseased or damaged culture, if a full harmonic interval (infrared to ultraviolet) is open for electromagnetic (photonic) exchange between the cultures.[13] The present author's proposed mechanism for the Priore and Becker results also explains the Kaznacheyev results.[14] It also explains the decades-long Russian induction of health changes and diseases in the microwave radiation of the U.S. Embassy in Moscow.[15]

In Type 2 engineering, the background vacuum/spacetime itself is deliberately altered, structured, and made asymmetrical. One then uses this struc-

[8]*Terminology after Nobel Laureate Lee, ibid., p. 383. Lee points out that the microscopic structure of the scalar vacuum field is not utilized. The particulate flux structure can indeed be engineered, but this has never even been tried by conventional physicists. An excellent coverage of asymmetries and observables is given on p. 181-188. E.g., whenever a symmetry is spontaneously broken, a nonobservable (virtual entity) has become observable. There thus exist vacuum engineering mechanisms for the direct translation between virtual and observable states. Indeed, a whole new vista has opened in physics – some are calling it a "new physics" – due to the discovery that it is possible to directly amplify the virtual state into observable state. E.g., see Serge Haroche and Daniel Kleppner, "Cavity quantum electrodynamics," Physics Today, Jan. 1989, p. 24-30 for an overview. In 1979 the present author foresaw, albeit crudely, the emergence of virtual state engineering by means of a possible hyperspatial (virtual state) amplifier. See T.E. Bearden, "Virtual state engineering and its implications," National Technical Information System, Report AD-A065762, 1979.*

[9]*The Russian weapon engineers model the vacuum as a virtual EM dipole plasma, rather than as a simple particle flux; e.g., see A.V. Chernetski, "Processes in Plasma Systems with Electric Charge Division," Georgi Plekanov Institute of National Economy, Moscow, 1989 for an introductory theoretical exposition of the basic model with respect to physical energy systems.*

[9]*Use of dipoles focuses immediately upon the hidden electromagnetics. Application of plasma theory then exposes the higher nonlinear EM aspects and the characteristics of a higher topology EM theory. Interestingly, Priore used all the elements fitting this theoretical model, employing a giant plasma-filled tube for multi-signal EM mixing, to produce "hidden EM" vacuum engines.*

[10]*Decades ago, the Russians also applied the virtual EM dipole plasma vacuum to the problem of direct engineering of mind, behavior, and cellular control functions. For the fact that they succeeded in decoding the mind/brain/s operations, see S.K. Lisitsyn, "New approach to the analysis of electroencephalograms," Problems of Bionics (**Selected Articles**), p. 16-25, National Technical Information System Report AD 730045. See also the various references by Kaznacheyev, sanitized by the Soviet State at the time to prevent revealing the actual primary mechanisms.*

[11]*For a partial discussion of Khrushchev's statement of the impending availability of such new Soviet superweapons, see Max Frankel, "Khrushchev says Soviet will cut forces a third; sees 'Fantastic Weapon'," New York Times, Jan. 15, 1960, p. 1.*

[12]*Technically the vacuum is always highly active, in violent flux exchange with all particles of mass. However, in Type 1 engineering this exchange activity is in equilibrium. So action and reaction are balanced in all directions. With no observable asymmetry, no single net force accumulates for the observer to see, and the vacuum appears to be an "emptiness."*

[13]*See Vlail Kaznacheyev and L.P. Mikhailova, **Ultraweak Radiation in Intercellular Interactions**, [in Russian], Novosibirsk, 1981. Vlail Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions," **Psi Research**, 1(1), Mar. 1982, p. 47-76 contains an English translation of much of the information referenced in Kaznacheyev's 1981 book. See Vlail Kaznacheyev et al. "Distant intercellular interactions in a system of two tissue cultures," Psychoenergetic Systems, 1(3), Mar. 1976; "Apparent information transfer between two groups of cells," **Psychoenergetic Systems**, 1(1), Dec. 1974; V.P. Kaznacheyev, "Information function of Ultraweak Light Flows in Biological Systems," in **Problems in Biophysics**, Novosibirsk, 1967, p. 7-18 [in Russian]; V.P. Kaznacheev and A.V. Trofimov, Cosmic Consciousness of **Humanity**: Problems of New Cosmogony. Elendis-Progress, Tomsk, Russia, 1992.*

[14]*See T.E. Bearden, Gravitobiology, Tesla Book Co., P.O.B. 121873, Chula Vista, CA 91912; 1991. See also Bearden, Cancer and the Unresolved Health Issues in the Biological Effects of EM Fields and Radiation, Tesla Book Company, 1993.*

[15]*The Soviets radiated the U.S. Embassy in Moscow with weak microwave radiation for decades, starting in the early 1950s. Anomalous health changes and diseases were induced in U.S. Embassy personnel. Three Ambassadors eventually died of leukemia-like illnesses of mysterious nature. The results of the Johns Hopkins scientific study of the Embassy radiation problem also provide strong evidence for the explanation, since health changes and diseases only occurred in those areas of the Embassy where the EM force fields from the radiation were zero. In other words, induced health changes occurred only in personnel in those Embassy areas where the potentials from the radiation had zero gradients, so that the potentials were persistent. This 100% correlation to persistent potentials exclusively, is exceptionally strong evidence that the EM radiation was the actual cause. If independent of the EM radiation, health changes would not have precisely correlated to any component of the radiation! The Johns Hopkins scientists were quite competent, but only considered classical EM theory (CEM) in their assessment. CEM assumes that, when the force fields are zero, the electromagnetic actions are zero. That of course has been disproved in quantum mechanics, which has shown theoretically and experimentally that the potentials, not the force fields, are the primary causes of all EM phenomena. [See Y. Aharonov and D. Bohm. (1959) "Significance of Electromagnetic Potentials in the Quantum Theory," Physical Review, Second Series, 115(3), 1959, p. 485-491; Bertram Schwarzschild, "Currents in normal-metal rings exhibit Aharonov-Bohm effect," Physics Today, 39(1), Jan. 1986, p. 17-2.] Even when the force fields are zero, the potentials may remain and provide real changes in charged particle systems by scalar interferometry. Indeed, the force fields do not even exist in vacuum, as CEM assumes. The Johns Hopkins scientists concluded – based on the erroneous CEM model they applied – that since no force fields were present where any of the health changes occurred, the cause could not have been the weak microwave radiation. Had it not been the radiation, some of the health changes would inevitably have occurred where the EM force fields were nonzero. The investigators' results falsified their own study's conclusion, by simple expectation mathematics. Had they known of the SWZ structured potential and its possibilities, they would have realized that by showing 100% correlation to the force-free potentials, they had actually proven that it was indeed the radiation that was the cause, and the force-free potentials component was the actual culprit. The team was excellent; its tools failed it. For a complete discussion, see Bearden, Gravitobiology, 1991, p. 27-32.*

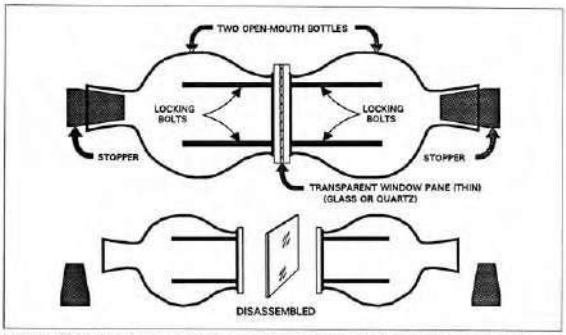

Figure 3. Kaznacheyev's two-chamber apparatus. A cell culture is divided into two parts. Left ones are damaged or killed. Effect is replicated in right cells through windowglass, but not quartz.

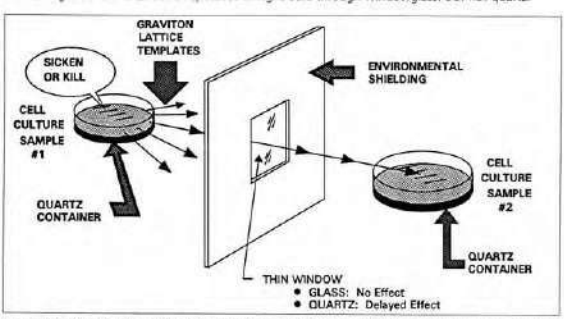

Figure 4. Kaznacheyev's cytopathogenic mirror effect: Death and disease transmission via graviton lattice templates. Quartz passes a minimum G-lattice, glass does not.

tured, asymmetrical vacuum to do the work and furnish all the required energy flow.

The vacuum is known to be a *seething inferno of energy*.[16] It is a violent flux of virtual particles, according to quantum mechanics (QM). A ***virtual particle*** is one which quantum mechanically arises out of nowhere and almost instantly returns to nowhere. It may be highly energetic and "hotter than a firecracker" while it exists. But its span of existence is so short that our instruments cannot *individually* detect it.

However, we can and certainly do experimentally detect the result of the interaction of *large numbers* of virtual particles. Physics states that all forces of the universe are caused by the exchange of such virtual particles. It is also theoretically and experimentally proven that every particle of mass is in a violent virtual particle flux exchange with the surrounding vacuum. Several experiments directly show this – the Lamb shift for one.[17] The Lamb shift is largely due to fluctuations of the hidden virtual flux exchange with the vacuum, and involves a local energy density far greater than the surface energy density of the sun's surface.

Vacuum Engines: Ordering and Utilizing the Vacuum Virtual Particle Flux

In Type 2 engineering, one structures and orders the violent virtual particle flows of the fundamental vacuum/spacetime (VST) itself.[18] Accordingly, it alters and orders the vacuum's violent energetic exchange with any mass particles and physical systems in the area. One *oneself* does not input the energy that does the actual work on the material system located in that region of VST. Instead, one only inputs the energy necessary for the *gating and directing* of the VST flux energy in that area. This structuring and gating of the virtual particle flux forms an organized, energetic pattern which I have dubbed a ***vacuum engine*** (after Nobel Laureate Lee's recognition that the vacuum itself could in theory be engineered, but that such had never even been tried).

This ***vacuum engine*** now does the work and furnishes all the working energy. We just have to pay to set up the *gating mechanism and the template* in the beginning, and continue to pay a little bit to sustain them. Literally we have created

[16] *For a good overview of the active vacuum, see R. Podolny, Something Called Nothing: Physical Vacuum: What Is It?, translated by Nicholas Weinstein, Mir Publishers, Moscow, 1986, revised from the 1983 Russian edition. See also I.J.R. Aitchison, "Nothing's plenty: The vacuum in modern quantum field theory," Contemporary Physics, 26(4), 1985, p. 333-391; Jack S. Greenberg and Walter Greiner, "Search for the sparking of the vacuum," Physics Today, 35(8), Aug. 1982, p. 24-32; Richard E. Prange and Peter Strance, "The semiconducting vacuum," American Journal of Physics, 52(1), Jan. 1984, p. 19-21; Walter Greiner and Joseph Hamilton, "Is the Vacuum Really Empty?", The American Scientist, 68(2), Mar.-Apr. 1980, p. 154-164; Timothy Boyer, "The Classical Vacuum," Scientific American, Aug. 1985, p. 70. See also important papers by H.E. Puthoff: "Source of vacuum electromagnetic zero-point energy," Phys. Rev. A, 40(9), Nov. 1, 1989, p. 4857-4862; "Gravity as a zero-point fluctuation force," Phys. Rev. A., 39(5), Mar. 1, 1989, p. 2333-2342; and "The Energetic Vacuum: Implications for Energy Research," Speculations in Science and Technology, 13(4), 1990, p. 247-257.*

[17] *W.E. Lamb, Jr. and R.C. Retherford, "Fine structure of the hydrogen atom by a microwave method," Physical Review, Vol. 72, 1947, p. 241-243. Demonstration of the displacement of one of the fine structure electron states of the hydrogen atom by a frequency of about 1060 megacycles played a central role in the development of quantum mechanics, and earned Lamb the Nobel Prize. The observation makes the reality of dynamic vacuum fluctuations inescapably evident.*

[18] *Since the vacuum can be altered, we now must speak of various vacua, not just one. "A" vacuum, "a" spacetime, and "a" scalar potential are synonymous. "The" ambient vacuum at any local point is a maelstrom of the scalar (hidden multiwave) interferometry of potentials from every charged particle in the universe (adapting Puthoff's Cosmological Feedback Principle). This scalar EM interferometry creates the EM fluctuations of the quantum mechanical vacuum, by Whittaker 1903 & 1904.*

a stupendous *energy amplifier*.[19] By continuing to expend a little maintenance and steering energy, we can gate and utilize the energies of an enormous engine which can apply incredible energy densities, even at a distance. In principle it can apply anything from a feather's touch up to the explosion of a star. It can be used to engineer anything from a single particle or wave, to the atomic nucleus, to a planet or a sun.[20]

Engineering General Relativity & Nesting Spacetime Curvatures

We actually engineer general relativity (GR) itself, since the Stoney,[21] Whittaker,[22] and Ziolkowski[23] (SWZ) papers point the way to how to do just that *(see figure 5)*. In short, by using the SWZ approach, one is able to utilize electro-magnetics in a new way, to directly form these curvatures of local spacetime. We also *nest* these curvatures to form a *template* of structured multiple curvatures; this template constitutes the deliberate format of the vacuum engine *(see figure 6)*.

Indeed, this is a radically different concept of spacetime structure. It is well-known that, whenever one applies a local hidden variable theory, the GR theory of spacetime structure must be radically altered.[24]

We stress that, in Type 2 engineering, one directly extends, applies and engineers general relativity, but by a novel use of electromagnetics. As can be seen, establishment science is not doing that at all, but is doing only Type 1 engineering. Literally anything one wishes can be engineered in the Type 2 fashion, at least in theory, including transmutation of elements, materialization and dematerialization of matter, free energy electrical power sources, and antigravity. However, Type 2 engineering is even more powerful than that. It also is the ultimate form of virtual reality engineering, for it allows the direct engineering of both physical reality and the mind itself.

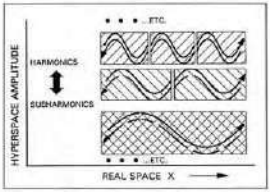

Figure 5. Stoney/Whittaker/Ziolkowski internal EM bwave structure of the scalar EM potential.

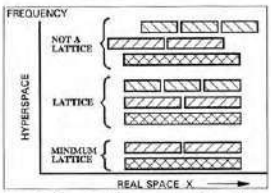

Figure 6. Grav iton lattices and nonlattices. Templates require G-lattices. Minimum lattice is one harmonic interval.

Mind, 3-Space, Hyperspace, Mind Flow, and the Flow of Time

Mind exists in time, but not in our familiar 3-space. Mind does not exist spatially in the same 3-space in which we model physical phenomena.[25] Mind occupies (to the physicist) only one dimension – the time dimension – of Minkowski's 4-space of physical matter. This means that the attachment of mind to matter (in a living biological organism) involves a *mind flow* process, hidden in and occupying the *time flow* process *(see figure 7 below)*.

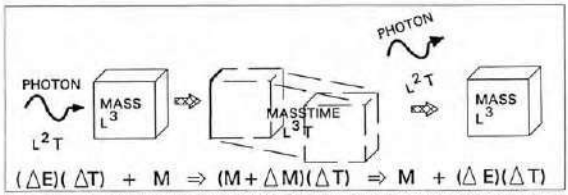

Figure 7. The photon interaction generates observed quantum change and the discretized flow of time. A particle usually connects to only a single delta T at a time. Every other particle is connected to that small increment of time also, as are all minds.

[19] *An example of such an actual amplifier was Floyd Sweet's vacuum triode – a 6-lb., solid-state device containing special coils and two separated barium ferrite magnets. The magnets were specially activated by Sweet's proprietary process so as to powerfully self-oscillate at a chosen ELF frequency, such as 60 Hz. [Such self-oscillation of barium compounds are well-known, but at optical frequencies. Use of a photorefractive magnetic material that is also an insulator allowed Sweet to initiate self-oscillation at ELF frequencies.]. An input sine wave of 10 Volts and 33 microamperes then produced 500 watts of phase conjugate replica EM power, extracted from the self-oscillation energy between the vacuum and the magnets. The amplifier gain (COP) of this open system, self-oscillating, pumped phase conjugate mirror device was some 1,500,000. A successful antigravity test of the device was also performed by Sweet at my urging, and resulted in a controlled reduction of its weight on the laboratory bench by 90%. For as much as could be revealed of the operation and testing of Sweet's proprietary device, see Floyd Sweet and T. E. Bearden, "Utilizing Scalar Electromagnetics to Tap Vacuum Energy," Proceedings of the 26th Intersociety Energy Conversion Engineering Conference (IECEC '91), Boston, Massachusetts, 1991, p. 370-375. Unfortunately nothing can be done with the device – e.g., because of formidable legal entanglements due to the conflicting agreements Sweet made with different financial backers. However, McLain & Wooten have produced a repicable, tested, overunity device & full construction details have been rebuilt on Internet.*

[20] *In the modern geometrical view, all individual field energies come from the conglomerate structure called "gravitational field." Transforming one field energy into another kind may be done by first transforming the initial field energy back into G-field energy, then re-releasing the G-field energy as the desired new type of field energy. Vacuum engines allow control and utilization of this process.*

[21] *G. J. Stoney, "XLVIII. On a Supposed Proof of a Theorem in Wave-motion, To the Editors of the Philosophical Magazine," Philosophical Magazine, 5(43), 1897, p. 368-373.*

[22] *E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," Mathematische Annalen, Vol. 57, 1903, p. 333-355; "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," Proceedings of the London Mathematical Society, Series 2, Vol. 1, 1904, p. 367-372.*

[23] *Richard W. Ziolkowski, "Exact Solutions of the Wave Equation With Complex Source Locations," J. Math. Phys., 26(4), April 1985, p. 861-863. See also Ioannis Besieris, Amr M. Shaarawi, and Richard W. Ziolkowski, "A bidirectional traveling plane wave representation of exact solutions of the scalar wave equation," J. Math. Phys., 30(6), June 1989, p. 1254-1269. See also Michael K. Tippett and Richard W. Ziolkowski, "A bidirectional wave transformation of the cold plasma equations," J. Math. Phys., 32(2), Feb. 1991, p. 488-492.*

[24] *E.g., see Abner Shimony, "Events and processes in the quantum world," in Quantum Concepts in Space and Time, Eds. R. Penrose and C. J. Isham, Clarendon Press, Oxford, 1986, p. 192: "...local hidden variable theories may be possible only if relativity theory is replaced by a radically different theory of spacetime structure." (My comment is that this should not be surprising, since classical electromagnetics, quantum mechanics, and general relativity are in profound contradiction of each other, and cannot be unified as they are, in spite of decades of Herculean efforts by many excellent physicists).*

[25] *We may model a mind as a separate 3-space, and its functional operations as "physical" in that hyperframe. Thus a mind and its operations are hyperspatial and outside physical matter's 3-space. Both mind and matter 3-spaces share a common 4th (time) dimension. So it requires at least seven dimensions to model a living creature, eight to model a species, and nine to model all life on earth. The 4th dimension of the mindworld hyper-4-space coincides with the 4th dimension of the physical world's Minkowski 4-space. A priori, mind/matter engineering operations involve engineering and structuring the time stream. This allows engineering either physical reality or mental reality or both simultaneously.*

Normally, so QM tells us, the observation process destroys time, so that all "observables" are spatial only. So the completion of each observable change in a living mass system momentarily destroys the only connection that the mass had with its associated mind! It vanished in the so-called "collapse of the wave function."[26,27,28] Fortunately, little pieces of time are always being serially added and subtracted by the ubiquitous photon interaction process with every mass. Hence the body's particles of mass are continually being *connected to* and *disconnected from* little serial bits of the time stream, and from corresponding serial bits of the *mindstream* of that individual.

Type 2 Disruption of Time and Mind

Type 1 engineering does not disrupt or affect the flowing time stream. Hence it does not disrupt or affect the flowing mindstreams of biological systems in the vicinity.

This is not necessarily true of Type 2 engineering! Type 2 engines of appreciable power can and will disrupt and destroy the body's continual detachment from and re-attachment to its mind-stream. Type 2 engines will appreciably disrupt and alter the flowing time stream, and thus disrupt and alter the flowing mindstreams of all life forms in the vicinity. The size of the "vicinity" depends upon the size of the engine.

So to beneficially utilize vacuum engines, we do not strive for control of vast energies. We must use a surgeon's scalpel, so to speak, instead of a giant steam hammer. If one seeks weapons, on the other hand, one will strive for control of much greater vacuum engine energies. The KGB secret laboratories, e.g., have pursued this goal for over four decades. Several generations of Type II weapons have been developed and deployed, all under continued KGB control and operation. These Type 2 weapons could, in the words of Khrushchev's address to the Presidium in January 1960, *"...wipe out all life on earth if unrestrainedly used."* Now one can easily see how that could happen: ***Any massive use of Type 2 weapons will substantially upset the time stream on earth, including all individual time streams. It will so disrupt all the mind streams of all earth's creatures that their connections to their physical bodies will be instantly broken.*** At least now we know why Brezhnev himself was so frightened of these weapons in 1975.[29]

Another unusual characteristic of Type 2 engineering is the *slowly decaying persistence of any special vacuum engine structure artificially created in the vacuum.* We may analyze this effect in terms of the "ghost forms" of quantum mechanics.[30,31,32]

Engineering the Mind, Its Operations, and Its Contents

The vacuum engine affects/curves/structures not only the three *spatial* dimensions of ST, but also the *time* dimension. Hence the vacuum engine approach can be used to engineer not only the observable physical matter (which is 3-spatial), *but also the mind and thought (which are time-like to the external observer).* Literally one can "get into the mind's connection channel" and alter the mind, its contents, and its operations at will by using appropriate vacuum engines.

By appropriately and selectively nesting the spacetime (ST) curvature structuring, one can even reach beyond the

[26]*Rigorously, the emission of a photon by the living mass destroys its time channel, thus collapsing the wave function and disconnecting the mind. Absorption of another photon immediately thereafter adds an increment of time back to the mass, forming* masstime *and reconnecting the time channel and hence the mind channel. Mass does not exist in time per se; masstime does. The temporary disconnection of the time channel by photon emission causes the wave function to collapse; a priori a wave cannot exist without some time available in which to wave! This in fact produces the observable mass from masstime. The problem is that the physicists have ignored the transport by the photon of Δt as well as ΔE. Thus they have not noticed that the ubiquitous photon interaction with a mass creates the continual addition and subtraction of time increments. This continual coupling and uncoupling of mass to and from the time dimension creates a* ***discretized*** *flow (passage) of time for that mass. This continual connection and disconnection of a mass to and from only a tiny little piece of the time channel is responsible for the past and the future not being observable; "being observable" is simply being connected to a single small Δt increment, not all the increments that have gone before or that will follow hence. When one looks at the corner of a room, the 3-spatiality of one's mass instrumentation system is why one can see length, width, and height but not the fourth dimension, time.*

[27]*Since the photon interaction – including the virtual photon interactions – can be engineered, obviously the passage of an object through the discretized timestream can also be engineered, electromagnetically. Not only can a photon, electron, or proton be time-reversed, but also an assemblage of photons, electrons, protons and neutrons can be time-reversed. Among other things, this means that a diseased living physical cell can be time-reversed (dedifferentiated) back to a previous healthy state, as shown by Priore and also by Becker. Kaznacheyev, as does Becker, also shows that healthy living cell can be "time-forwarded" (differentiated) to a new state, if bombarded with the weak vacuum engine templates (graviton lattice structures) for that state. The minimum graviton lattice (ordering of SWZ wavepairs) utilizes one harmonic frequency interval. Thus quartz will pass Kaznacheyev's cytopathogenic effect, since it passes IR to UV – one harmonic interval. Ordinary window glass does not pass a complete harmonic interval, hence cannot pass the minimum graviton lattice and destroys the disease-inducing vacuum engine template.*

[28]*Since the entire area is highly nonlinear, then nonlinear oscillator theory applies. Graviton lattices may therefore be activated harmonically or subharmonically. This means that "optical band" results can be initiated by analogous subharmonic input – e.g., microwaves or even sound waves. G-lattices work like music; one recognizes a C-chord regardless of the octave. In similar manner, vacuum engines (G-lattices) may be shifted by any number of octaves, with initiation of results then being delayed in the responding physical systems, as prescribed by nonlinear oscillator theory.*

[29]*See Christopher S. Wren, "Brezhnev Talk for Accord against 'Terrifying Arms'*, New York Times, *June 14, 1975, p. 1, 11.*

[30]*Since statistically every possible change in the vacuum is constantly and continually occurring in each and every differential volume, no matter how small, then from time to time in that maelstrom any physical (and mental) template we care to visualize appears, exists for a very short but finite time, then disappears, then reappears, etc. Such a continual, untidy characteristic is called a* ***ghost form****, and usually downplayed or ignored in the teaching of QM because it is "unpleasant." However, anything and everything – no matter how bizarre and whether living or inert – has a small but nonzero "density of reality" in the vacuum flux. Everything that ever was or will be, and everything that never was and never will be, is also there. The point is, creation of a vacuum engine template for a ghost form adds energy to (activates) that form. Just as a Dirac "ghost form electron" can be lifted from the vacuum by adding energy, so can any other ghost form, be it "living" or "dead." The process is fundamental and not just for electrons. Adding energy to a ghost template, we increase the local energy density of that ghost form in all electrical potentials in the entire area. This structuring of vacuum spacetime extends radially in all directions, tailing off to zero at infinity. When the inputting energy is ceased, the energized/activated form will then gradually decay over a period of time.*

[31]*We may compare the activation, persistence, and decay of the ghost form to an accumulator fed by two inputs, one blue liquid and one yellow liquid, with an outlet pipe on the opposite side. Suppose only the blue pipe is turned on; the tank is filled with blue liquid and blue liquid comes out the outlet. Now we turn on the yellow valve, and yellow liquid also starts entering. Over a period of time, the liquid in the tank will gradually turn green, as will the fluid from the outlet. Now we turn off the yellow valve. Over a period of time, the fluid in the tank will gradually turn back to blue color, as will the outlet liquid. Energizing and decaying ghost template structuring of the vacuum works the same way.*

[32]*For inputs that have raised the ghost template near or above the observable (quantum) threshold, this "decay time" may be quite long. Golden once accidentally charged up his local area with such a local template, in a powerful experiment that lasted about eight hours. Materializations occurred, determined by the thought-form (steady ghost form) inputs from the minds of the unintentional participants. In addition, interference with the timestream occurred, as indicated by all local clocks – mechanical, electrical, pendulum, etc. – going substantially astray. The materializations decayed away in a couple of hours, simply dematerializing back into the virtual state when their average energy density level reduced past the quantum threshold. It required four days for the entire "ghost template" to decay away and for the clocks in the area to fully resume normal operation.*

ordinary 3-space and get directly into the higher dimensional space one may mathematically use to model the mind *(see figure 8)*. One can then directly "engineer" in that *pure mind* arena (in the *mental spacetime*, in the modeling sense). This capability, I believe, was responsible for Brezhnev's vivid fear of these weapons in 1975, and his statement to visiting U.S. senators that, not only must the nations of the earth ban nuclear weapons, but also the development of new weapons of mass destruction *"more frightful than the mind of man has ever imagined."*[33] Gromyko later introduced a draft treaty to that effect to the United Nations the same year, and urged the nations of the world to sign it.[34] Article one of the draft treaty stated that the Russians would identify the type of weapons when negotiations on the treaty started. *No one had the slightest notion what the Russians were referring to.* However, three other nations – not hostile to the U.S. – later did develop some of these Type 2 weapons. The Soviet Union was already engaged in operational testing against U.S. and other targets, with incidents mistaken for "accidents" or "anomalies" by the world's news agencies.[35] During the beginning of the 1980s the three nations began checking the Soviet Union by demonstrating their own use of the weapons against Soviet targets. Again the open press did not recognize the true nature of the incidents involved. At the close of the 1980s the triad *vigorously* "checked" the Soviet Union, clearly demonstrating their ability to devastate the Soviet Union should it attempt to devastate friendly nations.

So a special case of "deterrence by massive retaliation" came into being in the Type 2 weapons area as well as in the conventional and nuclear areas. Does the reader recall, e.g., the mysterious explosion of several Soviet missile ammunition storage sites in the space of a few months in 1983-84?[36] A single one of these explosions destroyed a third of all the missiles in the entire Soviet Northern Fleet. There were other major incidents whose true nature and cause went unnoticed.

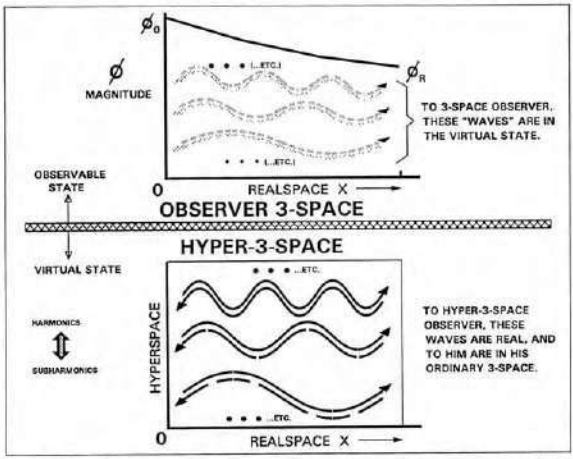

Figure 8. The 7-space EM potential. In observer 3-space (top figure), the potential is composed of a virtual particle flux. In hyper 3-space, the potential is a harmonic series of a SWZ bi-directional EM wavepairs.

Frustrated in the intent to dominate the world by surreptitious, delicate use of its Type 2 weapons, the economy of the Soviets simply fell apart. The Berlin Wall was torn down and the Soviet Union broke apart into independent regional nations.

In that upheaval of the Soviet Union, however, the KGB remained intact, well-funded, and still firmly in possession and control of the Type 2 superweapons, including development, manufacturing, deployment, manning, and operational employment.[37,38]

Wheeler's Principle and Its Extension

Einstein has strongly pointed out the necessity to review foundations *(see table 2)*.

The great physicist Wheeler has a very nice statement on the curvature of spacetime. Briefly, he summarizes the gist of GR as *"Geometry tells mass how to move, and mass tells geometry how to curve."*[39] By "geometry" he is referring to *spacetime*. So we may immediately sub-

[33] *Wren, 1975, ibid.*

[34] *Prohibition of the Development and Manufacture of New Types of Weapons of Mass Annihilation and of New Systems of Such Weapons, draft treaty introduced by Gromyko at the United Nations' 30th session of the General Assembly, New York, Sept. 23, 1975. The first article provided that the types of these new weapons would be "specified through negotiations on the subject."*

[35] *A long list of these incidents has been published by this author, through the Tesla Book Company. See T.E. Bearden, Soviet Weather Engineering Over North America, 1985; Fer-de-Lance, 1986; AIDS: Biological Warfare, 1988, Analysis of Scalar Electromagnetics, 1990, and Gravitobiology, 1991.*

[36] *See photograph, Jane's Defence Weekly (JDW), 2(3), July 28, 1984, p. 92; see also Mark Daly, "Goa and Goblet SAMs in Severomarsk explosion," JDW, 2(6), Aug. 18, 1984, p. 224; Derek Wood, "Soviets' northern fleet disabled... 'not viable' for six months," JDW, 2(1), July 14, 1984, p. 3; Derek Wood, "Six explosions in the past seven months," JDW, 2(1), July 14, 1984, p. 3; John Moore, "The aftermath of Severomorsk," JDW, 2(6), Aug. 18, 1984, p. 224.*

[37] *To survive as the leader of Russia, Yeltsin of necessity formed a pact with the KGB. KGB support insured that no coup of substance could be mounted against him, and that the KGB would insure his remaining in power. In return, Yeltsin saw that the KGB was well-funded, remained intact, retained all its secret weapons laboratories and secret weapon scientists and manufacturing facilities, and retained and continued to operate all its deployed, operational superweapons. The KGB changed its name and continued business on a less public profile. Publicly it officially turned a "much gentler face" toward the Russian citizenry. But essentially the KGB still controls most of the Russian military officer corps. Through the KGB/military connection the Communist Party can still accomplish a military coup and seize control of the country again, at least for the foreseeable future, when it chooses to do so. The Russian threat has not disappeared; it is simply hibernating.*

[38] *The Communists/Generals in control of the KGB and these superweapons are perfectly capable of turning the unfortunate dissolution into an excursion scenario of their long-planned major concessions offensive prior to ultimately striking the West with a clenched fist and destroying it. The communist aim has not changed one iota since 1917, although the communists have temporarily lost or relinquished control over the Russian civilian populace. For a description of this "29th move of the chess game," see T.E. Bearden, "Glasnost: 29th Move of a 30-Move Chess Game," Raum & Zeit, 1990.*

[39] *W. Misner, K.S. Thorne and J.A. Wheeler. (1973) Gravitation, W.H. Freeman and Co., San Francisco, 1973, p. 408. On p. 5 the principle is stated as "Space acts on matter, telling it how to move. In turn, matter reacts back on space, telling it how to curve." Thus space is already a vacuum engine that acts on matter, and mass-energy acts on space to curve it.*

Table 2. Einstein on Reviewing Foundations

"...the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools of thought, as something obviously, immutably given; something having an objective value of truth which is hardly even, and in any case not seriously, to be doubted. ...in the interests of science it is necessary over and over again to engage in the critique of these fundamental concepts, in order that we may not unconsciously be ruled by them."

Albert Einstein, "Foreword," in Max Jammer, Concepts of Space: The History of the Theories of Space in Physics, Harvard University Press, Cambridge, Massachusetts, 1969, p. xi-xii.

Table 3. Wheeler's Principle and a Corollary

Wheeler

"Geometry tells mass how to move, and mass tells geometry how to curve."

By "geometry" is meant "spacetime." Translating: "Mass tells spacetime how to curve, and curved spacetime tells mass how to move."

Corollary

"Trapped EM energy tells spacetime how to curve. The structuring of that trapped EM energy tells the resulting curved spacetime how to nest its curvatures. This forms a vacuum engine. Its nested curvatures of local spacetime tell mass and energy how to structure and move. By forming vacuum engines deterministically, one may use them to affect, alter, and change local mass, energy, and mind as desired."

stitute synonyms to yield "Mass tells spacetime how to curve, and curved spacetime tells mass how to move."

We further modify and extend this latter statement, replacing mass by its trapped EM energy (this is consistent with general relativity) and adding nesting of such trapped energies. We also allow for altering the timestream, the mind, and the mindstream. With these modifications, a corollary to Wheeler's principle results as follows: *"Trapped EM energy tells spacetime how to curve. The structuring of that trapped EM energy tells the resulting curved spacetime how to nest its curvatures. This forms a vacuum engine. Its nested curvatures of local spacetime tell mass and energy how to structure and move. By forming vacuum engines deterministically, one may use them to affect, alter, and change local mass, energy, and mind in any manner desired" (see table 3).*

To gain a "feel" for spacetime curvature, one may visualize it as analogous to the variation of local pressure in a gas or fluid.[40] Using the earth's atmosphere as a model, we may precisely create pressure points and areas (lows and highs) throughout, and gradually move them at will. This control of highs and lows will allow control and direction of the atmospheric flows. Theoretically, the entire atmospheric flow of the earth can be steered and controlled, by using such an approach. In short one can directly "steer" the weather worldwide, or over a given continent. Present Russian development allows this weather control process to be done sufficiently to control and steer the great jet streams, with concomitant direct influencing of the weather.[41] *We have not had any truly "normal" weather over the U.S. since 1976.*

Type 2 Engineering Is Just Beyond the Present Vanguard of Science

As can be appreciated, Type 2 engineering is beyond vanguard science. The forefront of orthodox science is still where Wheeler's original statement is, and does not apply the SWZ methodology nor nesting of spacetime curvature. Science still does not even try to create vacuum engines and perform vacuum engineering *(see table 4 on page 76)*. Conventional scientists are still very firmly rooted in Type 1 engineering.

In ordinary GR, nowhere does there appear a precise definition of the term "gravitational field."[42] The G-field is just a *conglomerate of loose things*, and – by Sakharov's postulate – not a fundamental field of nature at all.[43] It already follows that, since "gravitation" is "geometry of spacetime," then "curvature" of spacetime is achieved by altering and changing the "conglomerates that comprise G-field" from their ambient conditions. The ability to structure and nest such curvatures also follows in straightforward fashion.[44]

Pumped Phase Conjugate Mirrors and the Priore Mechanism

The astounding thing is that Antoine Priore, using pure intuition, was able to arrive at an exact process for forming a special kind of beneficial vacuum engine![45]

We know today – but scientists did not know it when most of Priore's work was being done! – that a highly nonlinear material acts as a ***phase conjugate mir-***

[40] *It is actually the variation of the local energy density of the vacuum from its normal value.*

[41] *See T.E. Bearden, Soviet Weather Engineering Over North America, 1-hr. videotape, 1985. Available through the Tesla Book Co. In the last few years, the Russians have substantially increased their weather engineering capability and activity. Most of the transmissions from this system are now fairly good electrogravitational waves (coupled wave/antiwave pairs), with EM imperfections many dB below signal level. Hundreds of them are utilized when the system is actively employed over the U.S. By applying Whittaker 1904, these signals – invisible to the normal receiver – can be received and displayed.*

[42] *Misner, Thorne and Wheeler, Gravitation, 1973, p. 399.*

[43] *A.D. Sakharov, "Vacuum Quantum Fluctuations in Curved Space and the Theory of Gravitation," Soviet Physics Doklady, Vol. 12, 1968, p. 1040-1041 [English translation.] Sakharov's article (in Russian) is in Doklady Akad. Nauk SSSR, Vol. 177, 1967, p. 70-71.*

[44] *General relativists already accept the vacuum as containing a 4-momentum-flux river. See Misner, Thorne, and Wheeler, Gravitation, 1973, p. 130-131. They treat the stress energy tensor as a machine (ibid., p. 131). The only difficulty is that they have not realized that, by applying the SWZ approach, much more complicated "vacuum machines" than they have considered can be built and utilized electromagnetically.*

[45] *See Christopher Bird, "The Case of Antoine Priore and His Therapeutic Machine: A Scandal in the Politics of Science," Explore!, 5(5-6), 1994, p. 97-110 for an excellent summary of the Priore Affair. The Priore group cured terminal tumors, sleeping sickness, and arteriosclerosis in lab animals and restored suppressed immune systems. Eminent, even world-renowned French scientists worked with him. The work was funded by the French government and published in leading French scientific journals. It was suppressed when the French government changed to a leftist government in the mid 70s.*

ror[46,47] *(see figures 9 & 10)*. In other words, when one puts in a sine wave, e.g., in addition to producing harmonics the nonlinear material will also produce a strange, backward-traveling replica of the input wave. This "backward wave" has been well-known since the early 1970s. It is truly a *time-reversed* wave (Barus wrote the solution much earlier).[48] It will backtrack back through space, over the *exact* path taken by the input wave.[49,50] If the input wave is continuous, this "phase conjugate replica" (PCR) time-reversed wave will precisely appear everywhere in space that the input wave occupies.

The key here is "everywhere in space." It does not matter how tortuous and twisted the route taken by the input wave; the PCR will backtrack it and appear spatially superposed with it. This has been *experimentally* proven many times in nonlinear optics.[51] One concludes that the vacuum has a memory,[52] and the PCR wave can retrace the memory of the path previously taken by its stimulus.

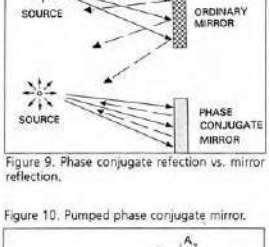

Figure 9. Phase conjugate refection vs. mirror reflection.

Figure 10. Pumped phase conjugate mirror.

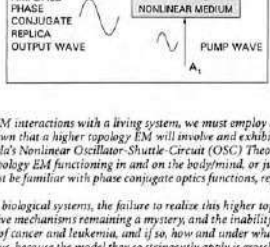

Another nice thing has been discovered and is used in the relatively new nonlinear optics. If one "pumps" the phase conjugate mirror with opposing waves (such as, e.g., bidirectional EM wavepairs), then up to all the energy in the pump waves is absorbed and re-emitted in the "crawfishing" PCR wave.[53] In other words, the stimulated PCM can be made into an amplifier of the time-reversed wave output, just by "pumping" it with the proper bidirectional wavepairs.[54,55]

Anomalous "Bio-Jamming" and Deep Diffusion by EM Smog

Pumping by EM waves or by simultaneously varying EM forces due to opposing streams of photons will produce a much higher probability of 4-wave mixing and multiphoton interactions. Simply put, this probability is a function of the sheer photon/signal density, along the lines pointed out – but not clarified – by

[46] *Elsewhere we have pointed out that, for the primary EM interactions with a living system, we must employ an electromagnetics of higher topology than the conventional EM (either vector or tensor). Barrett has shown that a higher topology EM will involve and exhibit nonlinear optical functioning without necessarily employing optical materials. See T.W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," Annales de la Fondation Louis de Broglie, 16(1), 1991, p. 23-41. Thus if we wish to utilize higher topology EM functioning in and on the body/mind, or just to comprehend such functioning, the nonlinear optical processes will form part of that functioning. We must be familiar with phase conjugate optics functions, regardless of the frequency range we operate within, and we must examine the situation accordingly.*

[47] *In the conventional struggle to elucidate EM effects on biological systems, the failure to realize this higher topology principle has led to experiments that are often difficult or impossible to replicate, primary interactive mechanisms remaining a mystery, and the inability to definitively answer even the simplest question such as "Does power line radiation enhance the emergence of cancer and leukemia, and if so, how and under what circumstances?" Forty years of research by able and determined EM bioeffects scientists have thus failed us, because the model they so stringently apply is grossly in error. What they have thoroughly proved is that their fundamental model is incorrect and inadequate for the intended purpose for which it is being utilized. The solution is not to just continue more experiments in the same vein, but to revise the model itself. We have previously pointed out (Bearden, Cancer and the Unresolved..., 1993, ibid., p. 40) the present EM bioeffects model, the modification areas required, and how to ascertain when the adjusted model is correct.*

[48] *Carl Barus, "A Curious Inversion in the Wave Mechanism of the Electromagnetic Theory of Light," American Journal of Science, Vol. 5, Fourth Series, 1898, p. 343-348 gives the first known solution of Maxwell's equations for a time-reversed or "backwards-traveling" EM wave.*

[49] *According to the well-known "Distortion Correction Theorem" of nonlinear optics. For a precise statement of the theorem, see Amnon Yariv, Optical Electronics, 3rd Edn., Holt, Rinehart and Winston, New York, p. 500-501. See particularly Chapter 16. "Phase Conjugate Optics – Theory and Applications."*

[50] *For the space-borne laser, e.g., the U.S. uses iterative phase conjugation – known as self-targeting – of a booster-reflected laser signal to keep a powerful laser beam locked upon the same spot on a distant missile booster, rising during its launch phase, long enough to burn through the casing and destroy the booster, even 10,000 miles away. The process is known as phase conjugate shooting.*

[51] *A striking example is given by David M. Pepper (1986) "Applications of Optical Phase Conjugation," Scientific American, 254(1), Jan. 1986, p. 75. Possibly the best extant introduction to the subject of nonlinear optical phase conjugation is David M. Pepper, "Nonlinear Optical Phase Conjugation," Optical Engineering, 21(2) March/April 1982, p. 156-183.*

[52] *Without extended discussion we call attention to the importance of this finding with respect to homeopathic medicine and therapy. In fluids, obviously one proceeds from vacuum flux organization and memory upward through matter's organization (and hidden memory), through the individual particles of the nucleus, to the nucleus, to the atom, to the molecule, etc. Between the atom and the molecule levels we encounter hydrogen bonding actions in fluids, which is of great importance to the biochemistry, especially the protein chemistry. It is possible to show that the mind operations and the cellular control operations also SWZ structure the H-bonding activities of the body's aqueous fluid; it can also be shown that any chemical, drug, additive, and EM smog also structures and affects the H-bonding. However, further discussion of these two elements is beyond our scope for this presentation.*

[53] *Note that "pumping" is simply a expansion of the notion of stressing the material. Emission of the amplified PCR wave is a kind of piezoelectric release of the stress energy. The point is that physical stress of a material can be freely tapped and energy continually extracted, if that stress is varying. The McLean/Wooten device uses that principle.*

[54] *To create a normal PCR wave response to an overt EM signal wave input, nonlinear optics uses overt EM pump waves. For the hidden EM signal wave input – i.e., for the hyperspatial vacuum engine as input – one must use "hyperspatial" wave pumping. The "cell as a phase conjugate mirror" must be pumped by hidden (hyperspatial) EM waves inside a scalar EM potential. In the normal case, an amplified, normal EM PCR wave is produced in response to a normal signal wave input and normal pump waves. In the vacuum engine case, an amplified, hyperspatial EM PCR wave complex is produced in response to a hyperspatial signal wave input and hyperspatial pump waves.*

[55] *Note that the amplified PCR wave represents a reorganization and deterministic redirection of stress energy. Hence it is a time-reversed operation, and also a negentropic operation. Since the PPCM operates as an open system not in thermodynamic equilibrium, with input of excess energy in the form of the pumping, negentropic operation is permitted by nonlinear thermodynamics (of a system far from thermodynamic equilibrium). For a lay summary of such thermodynamics, see Gregoire Nicolis, "Physics of far-from-equilibrium systems and self-organization," in Paul Davies, Ed., The New Physics, Cambridge University Press, Cambridge, 1989, p. 316-47. For a more technical presentation, see G. Nicolis and I. Prigogine, (1987), Exploring Complexity, Piper, Munich, 1987. Prigogine received the Nobel Prize for his pioneering work in this field.*

Devyatkov et al.[56,57] Thus dense electronic smog – even though it contains only extremely weak signals – increases the nonlinear optics type of interaction. This allows anomalously deep penetration and *diffusion* of special weak EM signals due to the "pumping" aspect of multiphoton interaction. The nonlinear cells and cell parts act as pumped phase conjugate mirrors (PPCMs) when subjected to multiphoton interactions.

Worse, the *signal wave* inputs to the PPCMs are the normal weak EM signals of the body itself. Hence the resulting PCRs from the PPCMs are superposing phase conjugates of the body's normal signals. This results in (1) a "diffusive" effect in the body of the PPCM formations, and (2) formation of very weak "EM cancellation" signals throughout the body, specifically targeted to the body's own control signals, including those to and of the immature immune cells in the bone marrow. In the bone marrow, "*partial-cancellation jamming*" (*see figure 11*) occurs in the normal control and development of the immune system cells as they are created. Slowly errors and degradation damage accumulate with time, including over the years. This cumulative immune system damage combines with other damage effects due to pesticide residues, pollutants, etc. The combined degradation results in long-term cumulative damage to the immune system and its cells. Increasing errors in the immune system's functioning eventually result in appearance of immune system disorders and increasing vulnerability to

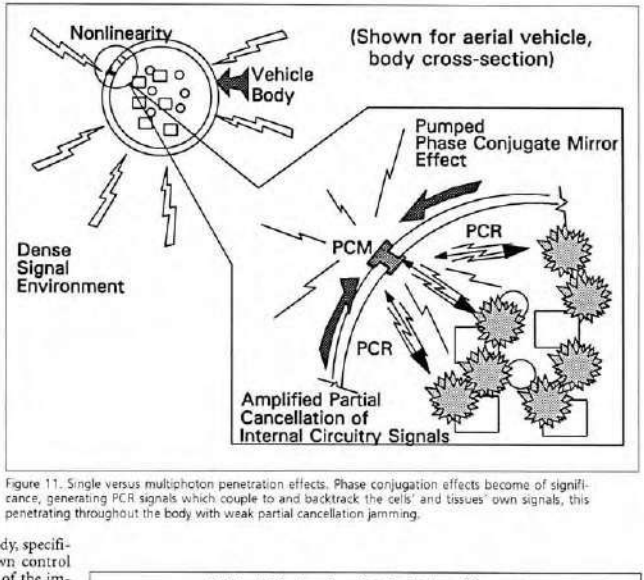

Figure 11. Single versus multiphoton penetration effects. Phase conjugation effects become of significance, generating PCR signals which couple to and backtrack the cells' and tissues' own signals, this penetrating throughout the body with weak partial cancellation jamming.

Table 4. Mechanism for the Priore Therapy

- Produced Specific SWZ-Structured Scalar Potential
  - -17 EM frequencies mixed in a rotating plasma
  - Phase conjugates added by the plasma
  - Formed vacuum engine with hyperspace pump waves
  - Modulated onto a rippling magnetic field which carried it to every cell and all its parts
  - hyperspatial pumping of cells/parts as PPCM's
- PPCM's created amplified anti-engines for disease there
- Anti-engine reversed cells/parts back to normal state
  - Cells return to control by cellular control system
  - Restored cellular control system to full functioning
- Scrubbed out the cumulated precancerous state
- Eliminated shadow disease state
- Restored the immune system to high functioning
- No excessive trauma to treated animal

In Part II of this wonderful article, by Mr. Bearden, a few of the topics you can look forward to are; The Gulf War Syndrome, How to Make a Gravitational Wave & Curve Spacetime, Potentials & Gravity and How Priore Made Vacuum Engines.

[56] *The Russians refer to the hidden EM wave structure of the scalar potential – i.e., to the SWZ structuring and vacuum engine templates – as the information content of the field. Western scientists assume this phrase refers to ordinary spectral analysis and communications, ignoring those statements that the normal EM theory does not apply. Also, Devyatkov et al seem in no great hurry to express their true meaning more clearly. See N.D. Devyatkov (Ed.), Applications of Low-Intensity Millimeter-Wave Radiation in Biology and Medicine, IRE Akad. Nauk. SSR, Moscow, 1985. [in Russian]. See also N.D. Devyatkov, Yu. V. Gulyaev, et al, [Organizing Committee Chairmen], Digest of Papers - International Symposium on Millimeter Waves of Non-thermal Intensity in Medicine, co-sponsored by Research and Development Association "ISTOK" and Research Institute of U.S.S.R. Ministry of Electronic Industry ("ORION"), Moscow, Oct. 3-6, 1991. Collection of 300 papers. [In Russian].*

[57] *However, some leading Western scientists – such as Wheeler, Feynman, and Jaynes – strongly advocate replacing the present erroneous concept of the EM force field existing in spacetime with the notion that what exists there instead is an information storage device containing a summary of what we need to predict the behavior of a charge if there should be one at the point. E.g., see J.A. Wheeler and R.P. Feynman, "Classical electrodynamics in terms of direct interparticle action," Reviews of Modern Physics, Vol. 21, 1949, p. 425-433; E.T. Jaynes, "Probability in quantum theory," in Complexity, Entropy, and the Physics of Information, Ed. W.H. Zurek. Addison-Wesley, Redwood City, CA, 1990, p. 33-55.*

VACUUM ENGINES AND PRIORE'S METHODOLOGY: THE TRUE SCIENCE OF ENERGY-MEDICINE

Part II of II

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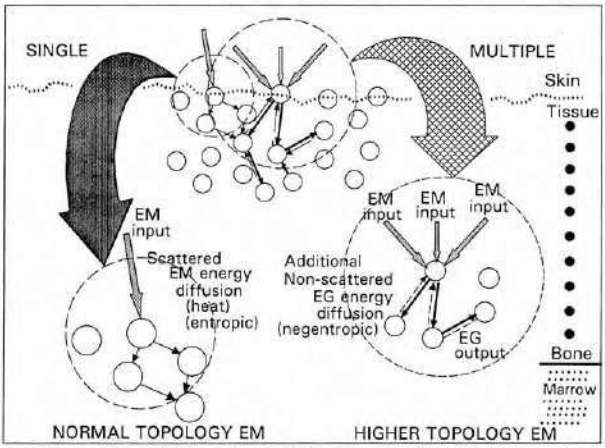

Fig. 12. Single versus multiphoton penetration effects. Phase conjugation effects become of significance, generating PCR signals which couple to and backtrack the cells' and tissues' own signals, thus penetrating throughout the body with weak partial cancellation jamming.

The Gulf War Syndrome

For very dense EM smog environments such as in the recent Gulf War, both the anomalous EM diffusion effect and the partial cancellation jamming effect on humans are dramatically accelerated. Cellular and immune system damage that would require decades of exposure at very low EM smog levels will cumulate in only a few months. In turn, this accelerated malfunctioning of the cellular control system and the immune system enhances the effects of other biological suppressants already present in the body or encountered during the dense signal environment exposure period. These augmented suppressants include the degradation due to the individual's prior lifetime EM smog exposure, attack by unfamiliar disease organisms endemic to the areas, exposure to oil fire smokes and pollutants, exposure to increased UV from solar radiation, and exposure to chemical agents and possibly surreptitious biological warfare agents.[58]

Further, in the haste to protect the troops from possible chemical and biological attack, all soldiers were administered a nerve agent called pyridostigmine bromide; in addition, approximately 150,000 were inoculated with anthrax vaccine, and 8,000 also received experimental botulism toxin shots.[59] Normally for medically-administered agents, the relatively minor suppression effects on the immune systems and body are followed by quick recovery, due to a properly functioning immune system and cellular control system. However, all three of these Gulf War preventive medical treatments do create "small cases of sickness" in the normal body.[60] In other words, a low level of the disease strain *is created* in the patient. Further, even after the apparent "initial recovery," there will now be a much longer dormant "apparently healthy" period during which the *vacuum engine templates for the disease remain, until they have finally decayed away.* In a sustained dense signal environment, this "decay away" period may be dramatically extended or never occur; in fact, the disease may progress from the vacuum-engine state to the low level physical state, then into a fully developed syndrome.

So we introduce the concept of the *relative level of a disease.* First, the disease and/or its vacuum engine templates are in the body. A low level or absence of disease, as we normally think of it, is with respect to the high disease level – the full-up, developed state of the disease. A disease level is "low" because of the ability of the immune system to fight it, overcome it, and reduce it to a "pre-disease" state; and the ability of the cellular control system to eventually rid itself of the disease vacuum engine templates, retaining only antibodies against its re-invasion. When the disease is not physically present according to conventional medical standards, but nonetheless the vacuum templates are present and not yet cleared out, we shall refer to that state as the shadow state of the disease. The cellular control system largely combats this state.[61]

[58] *Both Senator Riegle's and Senator Rockefeller's May 1994 hearings concluded that all 695,000 troops who served in the Gulf War were also exposed to chemical and biological toxins.*

[59] *Stephen Salgaller, "U.S. Role in Gulf War Illness." Letters,* ***Science News****, 146(7), Aug. 13, 1994, p. 99.*

[60] *Note that at least one of these three treatments was still quite experimental. Consequently there exists less confidence in stating that its normal side effects are minimal and tolerable.*

[61] *Apparently by being able to phase conjugate with weak amplification, so that it forms anti-engines that usually are stronger than the disease's vacuum engines, gradually reversing the shadow state to normal.*

If the immune system and cellular control system are impaired, a shadow state of the disease can gradually progress to a "low level" of disease, then to a higher level, and become serious or even life threatening. This is true when conventionally the disease is physically absent but its shadow state is still present and cannot be disposed of by the cellular control system, as clearly shown by Kaznacheyev's experiments.[62,63]

We point out, but do not pursue, that the cellular control system also deals with the shadow states of diseases. In the normal state of "free from disease," the cellular control system successfully and continually deals with incident diseases, overcoming them at the shadow state level. Its process for continual disposal of the shadow state residues is hypothesized to be a version of slightly amplified phase conjugation of the vacuum engine's shadow state level.

In the model we are advancing, the disease entry and development occur by successively (1) creating its shadow state and successfully maintaining it in spite of the cellular control system's phase conjugation efforts, (2) breaching the threshold of physical changes, so that at least physical indicators of the struggle by the now-involved immune system appear, (3) progressing until conventional medicine recognizes "low level disease or infection," (4) increasing until conventionally-recognized "developed disease or infection," (5) increasing until the disease is serious and even life-threatening, and (6) increasing until the patient can no longer sustain life and dies. *We note that the best preventative medicine would and should be practiced at the shadow infection level.* The Priore therapeutical approach is capable of doing that.[64]

In the "normal" – if such an adjective can be used! – sustained "weak EM smog" exposure, the shadow state may last for several years or even several decades, prior to sufficiently accumulated degradation of the cellular control system and the immune system to allow the physical emergence of the disease. For much denser EM smog, such as existed in the Gulf War, the shadow incubation process is highly shortened, as is the time to progress from one stage to another higher stage of the disease or disorder condition.

In other words, in a dense but weak EM smog environment, the recovery from "minor diseases" actually administered as part of the initial vaccination and preventive medicine will be substantially altered because of the accelerated damage to the immune system and cellular control system. The control/immune degradation may be fast enough that the disease starts increasing from the shadow state toward higher levels, instead of being reduced and eliminated by the control/immune systems.[65,66]

Consequently, the Gulf War participants were thrust into a unique new situation: The second (shadow state) phase of decay of the "minor diseases" created in the bodies receiving the three preventive medications was interfered with by the EM fog. Because of individual variation in past cumulative damage experience, the individual control/immune systems varied from soldier to soldier. The smog environment varied in density and intensity from place to place, and from time to time. Hence the degree of interference varied from soldier to soldier because of (1) variation of past control/immune degradation, (2) variation of the EM smog exposure, and (3) variation of exposure to other suppressants. A bell-shaped distribution curve of the extent of the *net interference to net control/immune functionality*[67] would result, when the soldiers are taken as a group. That is, some of the participants just had a somewhat longer 2nd phase recovery period; some an extended 2nd phase recovery period; some a sustained, gradual rise in the 2nd phase, toward physical disease but not yet developing the Gulf War Syndrome. Some had a sustained, quicker rise toward actual physical disease instead of a decay, and have had sufficient time to develop the physical disease.

When the additional individual expo-

[62] *Kaznacheyev, several references, ibid. That is, suppose we have the shadow disease possess only a strength such that the normal cellular control system and immune system could overcome it. If the cellular control system is weakened, the disease progresses across the physical barrier. If the immune system is still strong, it can handle the encroaching disease, but will give physical indicators of its struggle (increased white corpuscles, etc.) If the immune system is also degraded, the disease will progress to low level physical disease, higher level, etc. On the other hand, if the cellular control system is normal but the shadow state of the disease is amplified, the phase conjugation defenses of the cellular control system will be breached and the disease will impel itself into low-level disease, then high level, and then kill the cells, in spite of a normal immune system combatting the breach of the cellular control system. This latter is what Kaznacheyev's experiments showed. It is also what the decades of Soviet weak microwave radiation of the U. S. Embassy in Moscow showed.*

[63] *The discerning reader will note that we are presenting the gist of a new theory of cellular disease.*

[64] *We also point out the electromagnetic biological warfare capability in this area, long since developed by the Russians and under total control of the KGB. The U.S. Embassy radiation, including the health changes and the death of three U.S. Ambassadors, was just to stimulate the U.S. intelligence and scientific communities at the highest levels. By the U.S. electromagnetic response at the Embassy itself, the Soviets could then know for certain whether or not the U.S. was aware of this EM biowar capability, and whether or not it had secretly developed defenses. Our actions assured them we had no such capabilities and no defenses – and were totally unaware of the true nature of the Embassy radiation.*

[65] *Note that the multiplicity of the assault on the control/immune systems augments the resistance and recovery difficulty. E.g., each B-cell lymphocyte can attack only a single antigen – alien property of the surface of an invader. There are about one billion B-cells in the human body, which between them are specific for about a million antigens. As can be seen, the immune system is continually having to develop B-cells with new specificities due to the continual meeting of new strains of antigens. Cumulated damage to this system affects both the body's resistance to diseases it has already acquired specific B-cells for, and its resistance to new strains for which it must make B-cells for new antigens. There is a sort of threshold, at any given time, beyond which the B-cell responses cannot keep pace, and start being overwhelmed. There is also an error tolerance level; when the errors due to deterioration surpass this level, the immune system will often begin attacking the body's own tissues in error. This results in disorders such as arthritis and cartilage and joint deterioration. With sufficient errors, previous immunity abilities also are degraded, so that more ordinary diseases become serious threats.*

[66] *The administering of three "lightly suppressive" treatments closely occurring with the soldier's entry into the Combat Zone thus posed a significantly greater problem than normal to his or her control/immune systems' operations, because the control/immune systems were suddenly degraded and hampered by the suppressive effects of the dense EM signals environment. In other words, the control/immune systems were moderately attacked by the three medical treatments (three enemy light cavalry divisions), and at the same time the entire control/immune system complex was subjected to substantial interference and suppression (the normal friendly) troop divisions were simultaneously placed under fierce and sustained attack throughout the zone. A general whose divisions are already committed in furious combat and under heavy bombardment, as are all his command posts and communications systems, has great difficulty freeing up, reconfiguring, and recommitting some of his committed troops to properly combat three other enemy forces that suddenly have appeared over the horizons from other directions!*

[67] *We may also define this as a disease progression ratio. This ratio should assume a distribution curve. For first-order simplicity, we are assuming a normal distribution.*

sures are factored in, there should have been essentially three broad groups: (1) relatively minor damage sustained, where any overt effects will only begin to appear many years hence if at all, (2) more damage sustained, where overt effects will begin to appear within the next few years, and (3) heavier damage sustained, where overt effects begin to appear either while still in the Gulf Region or within some months or so after returning.

Hence many of the Group 3 veterans of the Gulf war developed anomalous infections and immune system disorders shortly upon their return from such damage-accelerating exposure, resulting in the mysterious "Gulf War Syndrome." Conventional medical science will recognize – and has recognized – the overt phase 3 physical disease syndrome, but its cause and effective treatment remain and will remain medical mysteries. Conventional medical science will entirely fail to recognize Groups 1 and 2 cases, and will label them as due to aging, mental stress, or ordinary rise of diseases.

The syndrome has involved the "anomalous EM smog diffusion" process, as previously explained. It may – and in many cases it will – exhibit certain "signature" differences from normal diseases. The genetics of the victim are affected, and so are altered by induced transcription[68] to carry at least a portion of the "syndrome template." Semen, ova, saliva, and blood will particularly be so affected. A wife may complain that her husband's body fluids are now irritating to her skin, even producing "burning" sensations. Children conceived and born may be borne with the syndrome, or with one or more aspects of it.[69] The syndrome template can be transmitted by exchange of body fluids, so wives may also contract the syndrome and develop the disease from their husbands.[70]

Conventional EM Bioeffects Knowledge Is Insufficient

Present "EM bioeffects" scientific models contain absolutely no modeling of partially jamming the body's own special EM control system by turning its EM signals partially into G-signals, thereby partially nullifying them. It also contains no modeling of the anomalous EM diffusion process.[71] Thus the conventional medical approaches also do not contain any proper means of accounting the mechanisms for, and results of, long-term exposure to electronic smog and other combined agents and effects. Conventional scientists also have no knowledge of the major degradation mechanisms involved. The conventional medical models specifically are useless when confronted with something such as the Gulf War Syndrome or the decades of Russian microwave radiation of the U.S. Embassy personnel in Moscow. Capable scientists turn to their conventional models for answers, and the models fail them. Therefore present medical science is baffled when faced with such diseases and syndromes.[72] (*See figure 13 on next page*)

How to Make a Gravitational Wave and Curve Spacetime

We return now to the fundamentals of Type 2 engineering.

If one superposes an ordinary EM wave with its true phase conjugate replica wave, where the two waves are of equal strength, the *EM forcefield aspects* of the combined wavepair (standing wave) vanish, while the energy-density aspects remain. At every point the E-fields and the B-fields sum to vector zero *forcefield* resultants. The standing wave that results will not cause EM movement of charged particles.

However, the *energy densities* of the two locked (and now "hidden") EM waves remain and add. By standard GR, this "trapped EM density standing wave" must constitute a standing gravitational wave and a standing wave in the local curvature of spacetime!

It follows that, by assembling a harmonic set of such wavepairs, a la Stoney and Whittaker, one can form a region of spacetime such that the energy density is deterministically altered and controlled, and to engineering levels.

Engineering general relativity suddenly became a lot easier! Ironically, present physics only considers primarily the *very weak* ST curvature that can be obtained by the extremely weak gravitational "attraction of mass" G-force. For electrons, e.g., the G-force is only on the order of 10^{-42} times as strong as the electric force. Consequently orthodox GR simply "cannot pack enough trapped G-field energy into the local space" in the laboratory to get measurable effects. Only in the vicinity of a very large mass, such as the sun or a star or a black hole, does the weak G-force reach sufficient strength to yield directly observable, strong effects. Yet by using EM vacuum engines and the SWZ approach, one can obtain readily-measurable GR effects right on the laboratory bench.

The conventional medical models specifically are useless when confronted with something such as the Gulf War Syndrome or the decades of Russian microwave radiation of the U.S.

[68] *Note that the transcription component may continue to develop in the same "post disease" manner as does the shadow disease of the overall Gulf War Syndrome. The returnee continues to experience EM smog and other control/immune suppressants, though at a lesser level than experienced in the Gulf War environment.*

[69] *Such aspects are highly controversial. A few affected families are reporting such symptoms and aspects, but officially "there is no evidence" for them. However, with the initial appearance of the syndrome, officially veterans who complained of this illness were briefed by these same medical "authorities" that their physical symptoms were stress-related, and that the cause was all in their mind!*

[70] *In a fashion similar to Priore's animal experiments that demonstrated the transfer of curative templates by a single drop of blood. Kaznacheyev showed that disease templates could also be transferred.*

[71] *In fact, EM bioeffects research for decades has used, and continues to use, sheer energy deposition (scattering of EM energy by the tissues – heat by another name!) as a measure of the exposure level. They have not applied nonlinear phase conjugate self-targeting effects at all.*

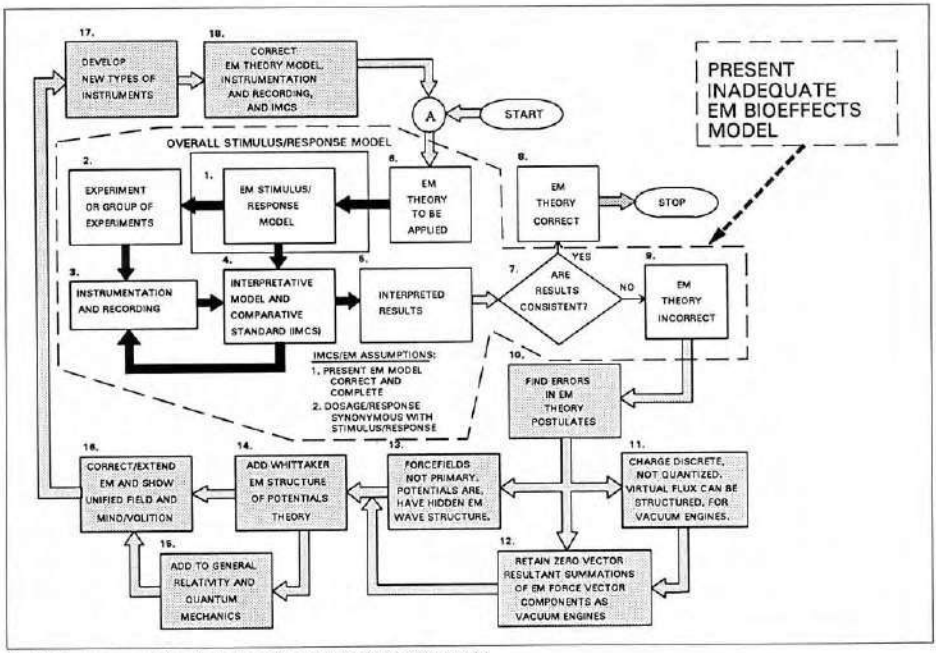

Fig. 13. Necessary corrections for the present inadequate EM bioeffects model.

Potentials and Gravity

Obviously one can simply add harmonics of such EM "locked in" wavepairs, to produce a standing "constant value potential" pattern of a fixed *excess* energy density of vacuum or a fixed *decrease* in the energy density of vacuum. This harmonic series of bidirectional EM wave pairs – the *sum set* of wavepairs – is precisely what Stoney and Whittaker showed makes an ordinary EM scalar potential. In other words, they showed the actual energy-trapping mechanism, and dramatically altered the view of a scalar potential as being simply an "electrostatic" entity and a scalar field. Instead, it is a *hidden-variable energy flow process.*[73,74,75]

Its external "scalar field" aspect is just its "local energy density" aspect, not its fundamental nature.[76]

As is well-known in GR, all potentials are gravitational because they contain trapped energy. *Any* trapped energy is gravitational, a priori, according to GR. Ziolkowski independently rediscovered the SW decomposition in the 1980s and extended it to also add the product set. Since multiplication of waves is *modulation*, in my opinion Ziolkowski actually wrote the basis for hyperspatial (or subspatial, if one models physics in only 4-dimensions) communication at superluminal velocity, essentially instantaneously anywhere in the universe. (*See figure 14 on opposite page*)

"Paired assembly of an EM wave and its true PCR" was and is the way to turn EM energy directly into gravitational en-

[73] *Just as it is also essentially baffled by many conventional dread diseases such as cancer, leukemia, AIDS, arteriosclerosis, etc. – which indicates that the conventional "models" for those diseases are also seriously deficient.*

[73] *The present preoccupation of physicists with the scalar potential is simply to provide an algorithm for calculating the local energy density – in excess joules per collecting point-coulomb of charge – and erroneously call that the definition of the potential. The magnitude of the energy collection density of the potential at a point is not what the potential is, and such is not its definition. Defining how much water can be poured out of a standard bucket, when it is dipped into a flowing river and filled with water, does not define the river!*

[74] *From the particle view, the potential is an ordering in a virtual particle flux of the vacuum. From the wave view, the potential is comprised of an ordered, harmonic series of SWZ bidirectional EM waves, where each wave reaches to the ends of the universe before having a zero energy density. It follows that the energy in each hidden sine wave is infinite, just as it is for any overt theoretical EM sine wave. So any potential – even that of a flashlight battery – already involves an infinite amount of flowing hidden EM energy, being exchanged by the source and the entire universe, flowing in both directions along any radial from the source of the potential. The scalar potential is a flowing, continual exchange of energy between each and every point in the universe and the local source of the potential.*

[75] *Both the wave and particle forms of the potential exist simultaneously. The particle nature exists in Minkowski 4-space. The "hidden SWZ waves" exist in a hyper-4-space whose time dimension is the same as that of Minkowski 4-space. The scalar EM potential actually exists as a 7-dimensional entity. The internal hidden EM flow is not confined to the speed of light in space, because it does not flow "through" 3-space; instead, it flows "around" it.*

[76] *E.g., Whittaker, 1904, ibid. shows us that all of classical electromagnetics can be made by the interference of two scalar fields, which is just a special kind of hyperspatial multiwave interferometry.*

ergy.[77] This is the unification of EM and GR that eluded Einstein all the latter part of his life, and that has continued to elude scientists today. This is the way to "trap" EM energy locally, even though the EM wave energy is flowing at the speed of light or greater. This is the way to change EM energy into gravitational energy.[78] Further, it is engineerable and testable. Remember, physics requires that energy be conserved; however, it can certainly *change its form*. GR already says that it is the trapped energy that is gravitational, not mass per se, and regardless of what kind of energy is trapped. Ultimately Einstein's formula $E = mc^2$ is actually a statement of the trapped EM energy in a mass. However, heretofore no one had the slightest notion as to the actual trapping mechanism. The SWZ work actually shows the trapping mechanism itself and allows the engineering of *electrogravitation*.

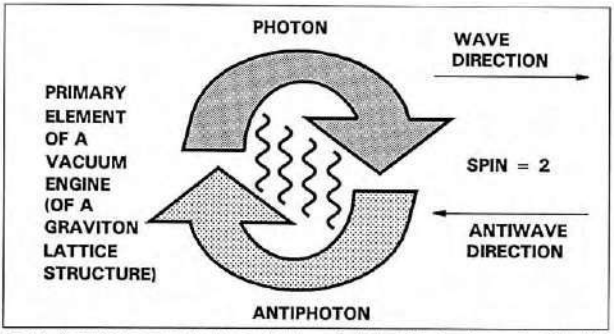

Fig. 14. A graviton is a coupled photon/antiphoton pair. In the bidirectional wavepair of the SWZ internal structure of the scalar potential, photons in the wave continually couple and uncouple as the wave and antiwave pass through each other.

How Did the Revolutionary Stoney/Whittaker Work Go Unnoticed?

Apparently, neither Stoney nor Whittaker realized that their work was pure electrogravitation. *When the referenced papers by Stoney and Whittaker were published, special relativity, general relativity, and quantum mechanics had not even been born yet!* Indeed, there still was not a wide adoption of Heaviside's vector interpretation of Maxwell's fading quaternion theory. Even classical EM was still in its infancy and just getting off to a good start.

In the 1980s Ziolkowski realized that the internal biwaves of a potential could be engineered, but remained primarily focused upon his important work with electromagnetic missiles and focus waves (slugs of EM energy which stay together as they travel, and do not spread out.) Ziolkowski is one of the pioneers in that field.

How Priore Made Vacuum Engines

This "vacuum engine methodology" was and is what Priore's intuition led him to! For the electromagnetic treatment of laboratory animals, his EM therapy device first inputted some 17 or so frequencies into a rotating plasma.[79,80] We know today that such plasmas *phase conjugate* the wave inputs, but that was not known when Priore first did it.

Obviously Priore himself did not understand the actual mechanism, but his brilliant intuition led him to discover how to do it! For many years no one knew how aspirin worked, yet that did not prevent it from being used widely and effectively.

In other words, Priore used the plasma to *unwittingly* add PCRs to each of his waves and form 17 magic SWZ "wavepairs." The entire SWZ wavepair assembly thus made an *artificial potential*, having a "vacuum engine" pumping substructure of hidden bidirectional EM waves. Adjustment of selected frequencies away from their harmonic positions adds multiplications and beat frequency modulations, creating *specific* templates and *specific* vacuum engines. These SWZ waves are hyperspatial; hence they are in the domain of the deep mind's cellular control system. When an abnormal body cell is pumped by these hyperspatial waves, the cell's own hyperspatial vacuum-engine "signal input complex" triggers a specific dedifferentiation anti-engine for that specific abnormal state. By Wheeler's principle, if spacetime curvature is *present in* the material cell, its energy and template are *applied to* the cell and act upon it. With vigorous pumping, the anti-engine is also *amplified* and so the cellular response is more rapid. In other words, the amplified anti-engine fairly quickly overpowers the disease engine and reverses the abnormal cell and all its contents back to their previous *normal* states. (*See figure 15 on the following page*)

Priore's new signal complex came out of the plasma mixing (phase conjugating) tube with SWZ structures of wavepairs, where each pair was composed of two bidirectional (opposing) EM waves. Priore then modulated this output upon a very strong, rippling magnetic field as a carrier, and radiated the body of the patient with that resultant field and its transported hyperspatial SWZ anti-engine components.

Nuclear magnetic resonance guarantees that such a magnetic field with all its modulations will be delivered entirely through the body, penetrating the flesh and bones and even the atomic nuclei themselves. It will certainly penetrate the bone marrow where all the blood cells (which includes most of the immune system's cells) are born! It will penetrate everywhere else also. So all the cells of the immune system will be exposed to the AC magnetic carrier and its impressed hyperspatial biwaves and their modulations.

The body's cells and cell-parts are highly nonlinear, and so they are also *demodulators*. They strip off the SWZ modulations. This puts the amplified vacuum anti-engines directly into and

[77] *I have previously pointed out that, in a coupled wave/antiwave pair, the photons in the wave and the antiphotons in the superposed phase conjugate replicate wave also pair into photon/antiphoton pairs, which have spin-2 helicity and hence are gravitons. This follows merely from a strong application of the distortion correction theorem. However, it is the fundamental union of EM and G into a single engineerable theory. See Bearden,* ***Gravitobiology****, 1991, p. 1-9.*

[78] *By Whittaker 1904, we can always interfere two such potential fields and obtain an EM field, even at a distance. Thus we can also readily turn the gravitational (trapped EM) energy back to EM field (untrapped EM) energy.*

[79] *David M. Rorvik, "Do the French Have a Cure for Cancer?"* ***Esquire****, July 1975, p. 110-11, 142-149 gives an overview of the Priore Affair and some details of the electromagnetics of the machine.*

[80] *Note the immediate connection to the Russian energetics model, which is directly fashioned after the nature and nonlinear EM functioning of plasmas. Priore was directly applying Soviet energetics, although neither he nor any other Western scientist could have known that.*

onto the cells, including all the cells of the immune system, and including each and every part of each cell. Small wonder then that the Priore methodology could restore suppressed immune systems! Time-reversing the damaged immune cells and their damaged internal components back to a previous healthy state was one magnificent result. The radiation also delivers the modulations directly into the master potential (the body's quantum potential) that contains its mind, its long-term memories, and its master control system for all cells. Thus not only are the diseased cells and the immune cells affected, but also the *master cellular control system* for all body cells is directly affected.[81]

In a related work, Becker (*See figure 16 on the following page*) and his colleagues stimulated bone healing in difficult fractures by use of tiny DC currents. They have shown that picoamperes of steady DC current trickled across the fracture site induces bone healing. Becker showed that, surprisingly, red blood cells are dedifferentiated – shucking their hemoglobin and growing a nucleus in the process. These cells redifferentiate into the kind of cells that make cartilage. Then *those* cells redifferentiate anew, into the kind of cells that make bone, and heal the fracture with new bone deposit. Becker also proposed a complete, operational DC control system, staying within the limitations of conventional EM theory.[82,83,84]

15-A. Priore demonstrates a point to Mr. Chaban-Delmas, Mayor of Bordeaux and a friend and mentor.

15-B. Dr. Raymond Pautrizel, noted immunologist, worked directly with Priore. Dr. Pautrizel is Professor Emeritus, University of Bordeaux, and holder of the first chair in immunology in France.

Dr. Robert Courrier (not shown), head of the Biology Section of the French Academy of Science as well as its Secretaire Perpetuel at the time, was also a noted colleague. He personally presented the astounding results of the Priore Team's experiments to the Academy.

Fig. 15. Priore was supported by notable French political leaders and eminent French scientists were his close scientific colleagues.

A proposed explanation of the fundamental vacuum-engine mechanism for the Priore and Becker effects has previously been given in some detail by Bearden.[85] (*See figure 17 on next page*)

[81] *We refer to an expanded version of Popp's cellular control system. E.g., see Fritz Albert Popp, "Photon Storage in Biological Systems," in Fritz Albert Popp et al, eds.,* ***Electromagnetic Bio-Information: Proceedings of the Symposium, Marburg, Federal Republic of Germany, Sep. 5, 1977;*** *Urban & Schwarzenberg, Baltimore, 1979, p. 123-149. Popp reports the theoretical and experimental discovery that mitogenetic radiation from cells can be seen as a sort of "waste" from a virtual electromagnetic field with a high coherence. This field has a tendency to become stationary over the whole organism. In addition, it includes the storage of "virtual" coherent photons.* ***Comment:*** *Our substitution of the SWZ hidden wave approach to replace Popp's QM particle approach greatly facilitates understanding and specifying the control system, and materially eases direct engineering of it.*

[82] *E.g., see R.O. Becker, "The direct current field: A primitive control and communication system related to growth processes."* ***Proceedings of the. XVI International. Congress of Zoology****, Washington, D.C., Vol. 3, 1963, p. 179; "The control system governing bone growth in response to mechanical stress."* ***J. Ark. Med. Soc.****, Vol. 62, 1966, p. 404; R.O. Becker and D.G. Murray, "A method for producing cellular dedifferentiation by means of very small electrical currents."* ***Trans. N.Y. Acad. Sci.****, Vol. 29, 1967, p. 606. See particularly Robert O. Becker, "The significance of bioelectric potentials."* ***Bioelectrochemistry and Bioenergetics****, Vol. 1, 1974, p. 187-199. Becker proposes that a complete, operational system exists in living organisms, and controls such basic functions as growth, healing, and biological cycles. The system is described in anatomical detail. It functions as a data transmission system in an analog fashion using varying levels of direct current as its signal. The system interlocks physically with the nervous system and is postulated to be its precursor. There are two electrochemical limbs of great significance in the operation of the system. One is between the DC system and the nervous system; the other is between the DC system and all body cells. The concept explains all of the diverse effects reported for the biological effects of applied electrical currents including: electrical anesthesia, electrical growth control, and electroacupuncture. It also furnishes a testable hypothesis for predicting other effects of clinical significance.*

[83] *We comment that the SWZ approach allows control and conditioning – both externally and internally – of both limbs of Becker's proposed DC control system.*

[84] *See also C.W. Hsue, "A DC Voltage is Equivalent to Two Traveling Waves on a Lossless, Nonuniform Transmission Line,"* ***IEEE Microwave and Guided Wave Letters****, Vol. 3, 1993, p. 82-84. Hsue shows that the steady DC voltage on a transmission line powering a resistive load, mathematically decomposes into bidirectional EM traveling waves. The bone-healing setup used by Becker et al is precisely of this configuration. The fracture corresponds to the resistive load and the two electrodes on each side correspond to the transmission lines. Hence Becker's team actually employed a form of the Stoney/Whittaker/Ziolkowski harmonic biwave decomposition of the scalar potential, to accomplish hyperspatial pumping and formation of anti-engines of vacuum energy. So this is another application of the same basic "cell-reversing" methodology, as also utilized more extensively by Priore. Becker's brilliant work of course was and is independent and unique, and he was nominated for a Nobel Prize because of his absolutely fundamental work in showing electromagnetic differentiation and dedifferentiation of cells. That he has not been awarded the prize is regrettable and, in my opinion, an injustice.*

[85] *T.E. Bearden, "Mechanism for Long-Term Cumulative Biological Effects of EM Radiation," presented to the 70th Annual Meeting of the Alabama Academy of Science, University of Alabama at Huntsville, March 25, 1993. A digest of this presentation is published by the Tesla Book Company, P.O. Box 121873, Chula Vista, CA 91912 as T.E. Bearden,* ***Cancer and the Unresolved Health Issues in the Biological Effects of EM Fields and Radiation****, 1993 and includes both text and hard copies of viewgraphs.*

How the Priore Vacuum Engine Reversed Cells to a Previous State

Taking a GR view, any mass already has its own vacuum engine for its exact form and internal structure and dynamics, in the finest detail. That particularly follows Wheeler's principle; if the mass is there, the appropriate spacetime curvature and dynamic energy structuring is there. If the mass has internal structuring, so does the spacetime curvature: it becomes *nested* curvatures with a precisely correlated template. In short, any mass – living or not – is imbedded in a precise vacuum engine. Any and every change adds a specific delta to this vacuum engine component. Just as a tree has rings for its past years and an onion has layers, the vacuum engine of an object has an exact template for that object's entire past, *as do the mind and its components also.*[86]

So when a normal living cellular mass changes to a diseased state, *a priori* it has added an additional delta vacuum engine (representing the change that resulted in the disease) to its original vacuum engine (which represents the original healthy state of the cell). The cell and all its parts are highly nonlinear and act as phase conjugate mirrors, *including to the higher topology (hyperspatiality) of the vacuum engine. Any living system we isolate and study is at least 7-dimensional.*

Putting all this together, we now can understand the marvelous nature of what Priore did. By exposing the body, treated part, cells, and cell parts to Priore's modulated rippling magnetic field, the "hidden pump waves" carried by that magnetic field are applied to each and every cell and to all its parts, in the exposed area. *In the exposed area, each and every cell and its parts become powerfully pumped phase conjugate mirrors for its hyperspatial vacuum engine complex.*

Extending the language of nonlinear optics, the particular *net* vacuum engine of the diseased cell or part constitutes a "standing input" *hyperspatial signal wave complex*, already input to the hyperspatially pumped phase conjugate mirror cell or cell part. When pumped by "hidden" pump waves, each and every one of those PC mirrors will now originate an *amplified phase conjugate replica of the signal wave complex. Each one will produce a highly amplified, time reversed replica of its specific standing vacuum engine. This includes amplified time reversed replicas of both the "healthy" component of each standing vacuum engine and the "disease delta" component. (See figures 18 above and 19 on following page)*

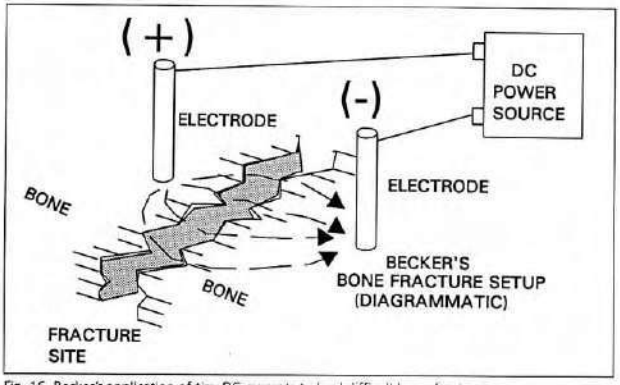

Fig. 16. Becker's application of tiny DC currents to heal difficult bone fractures.

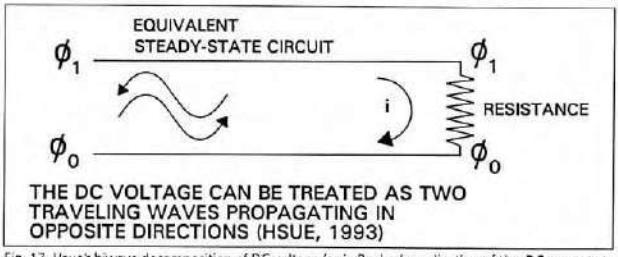

Fig. 17. Hsue's biwave decomposition of DC voltage (as in Becker's application of tiny DC currents to heal difficult bone fractures).

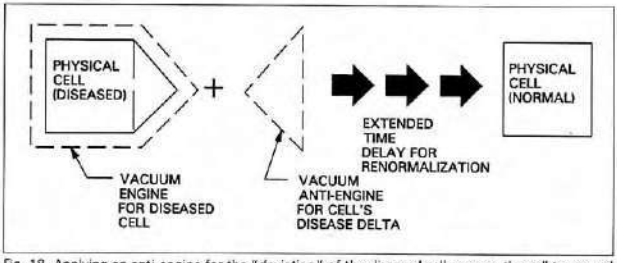

Fig. 18. Applying an anti-engine for the "deviation" of the diseased cell reverses the cell to normal after a time delay.

In other words, every pumped diseased cell and cell part – including the genes and chromosomes – will produce a very powerful, highly amplified, "reverse vacuum engine" (an *anti-engine*) which is fantastically specific and precisely time-reverses the cell and its parts, including the genes and chromosomes as well, back to their *previous normal states.*

[86] *If one alters the internal structure (rings) of a tree, one changes the tree. If one alters the internal structures and dynamic functioning of matter, one changes the matter accordingly. If one alters the internal structures and dynamics of the mind, one changes the mind, its contents, and its functioning accordingly, as well as the subsequent behavior exhibited by the altered individual.*

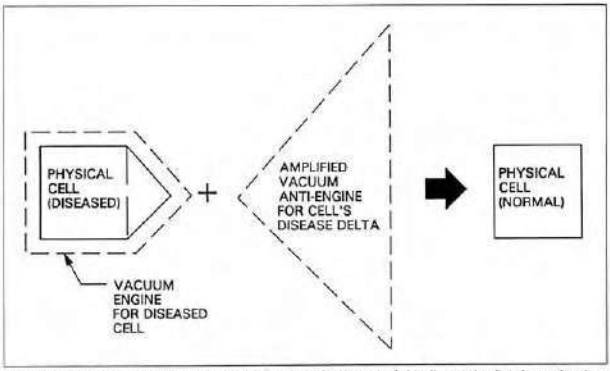

Fig. 19. Applying an amplified anti-engine for the "deviation" of the diseased cell reduces the time delay required to reverse it back to normal.

Rejuvenation

Any *normal* cell that is exposed to hyperspatial (Priore-type) pumping just reverts to a *slightly younger* normal state. Note that this allows *rejuvenation*.[87] Priore's earliest experiments that so riveted his attention and set him on the path of discovery, were in fact the abnormal prolongation of the life of fruits! For each class of disease, Priore just had to fiddle with the frequencies until he had the right set of pump waves for the specific "disease delta vacuum engine." This he did by trial and error. So when it is "Priore-pumped," a cancer cell reverses back to a normal cell, as does a precancerous cell as well.

The revolutionary Priore therapy is startling but simple. The diseased cell is analogous to an automobile that has been driven slowly off the road into the rough. Priore's methodology shifts the car into reverse gear, guns the engine, and quickly and precisely backs the car back onto the roadway. It is one of those profoundly beautiful embodiments analogous to Faraday's unipolar generator; it strikes directly to the heart of the fundamental principle. A cell develops damage and disease over a period of time. Simply time-reverse it quickly back to its original healthy state.

AIDS Could be Quickly Cured the Same Way

Given Priore-pumping, an AIDS-infected cell would revert back to a normal cell, including all its genetics, and including for all of the hundreds of "strains" of AIDS that exist in an advanced AIDS patient. With this ap- proach one could completely reverse and eliminate AIDS whenever a positive reading occurs in the HIV virus test, and prior to the appearance of the actual physical sym- ptoms! If the person just has the antibodies and not the disease, the treatment will still do him absolutely no harm. (It will actually make his cells a "little bit younger and more vigorous," and help his immune system.) If he has both the AIDS antibodies and the infection as well, he will be completely cured and his immune system will be restored to complete vitality.

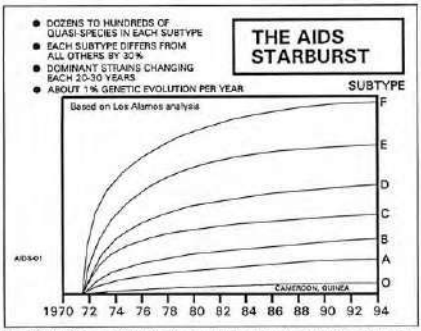

Fig. 20. AIDS is continually changing since the HIV virus is a retrovirus and unstab.

Most Diseases Could be Cured by the New Therapeutic Modality

Any infectious disease known or unknown can be cured by the same means. The marvelous thing is that one need not know the specific technical pattern for the delta vacuum engine for a specific disease! One just has to *correctly adjust the hidden SWZ pumping frequencies.*

Arteriosclerosis

In arteriosclerosis, it has been found that the greatest part of the damage is due to the presence of some rather ordinary viruses, and abnormal cell growth by the body's own cells as a result of triggering by previous viral infection. Cellular reversal (dedifferentiation) gets it all; the viruses and the abnormal cells. Everything reverts to normal, and the body's restored processes quickly "police up" the extra cell growth, using its natural control processes which are now restored to full functioning. *This is how the Priore team was able to so dramatically cure the "clogged arteries" of laboratory animals.*

The Priore approach (pumping of the

[87] *One should not be surprised that a time-reversal operation upon an entire body leads to reversal of physical aging in that body! But we point out that the time reversal we speak of is not at all the "time travel to the past" so beloved by generations of science fiction writers. For that, one would have to reverse each and every part of the universe simultaneously, except the observer, back to an exact former state, in perfect universal coordination. One would have to pump the entire universe, except for the observer! The observer would then remain as is with no change, while his entire world "went back in time" to a past state. The pumping of the universe would have to stop instantaneously (decay of the false vacuum?), and the universal anti-engine would have to stop operation and decay instantaneously (another big bang, perhaps?). We are not referring to anything such as that! We are referring to the reversal of a single little part of the universe, back to its previous state, which is practical and can be done. Universal time reversal – and hence time travel for the observer – is not practical, at least within our present knowledge and within the time reversal model we are applying. We should point out, however, that time reversal is a legitimate part of physics, and is not science fiction. E.g., for an overview, see Robert G. Sachs,* ***The Physics of Time Reversal,*** *University of Chicago Press, Chicago, Illinois, 1987.*

diseased cell's self-contained vacuum engine to create a very powerful vacuum anti-engine and reverse diseased cells back to normal) is the most powerful therapy for cellular disease ever conceived of. If the cells have ever been normal, they can be reverted to normal.[88] One can also probably regrow lost limbs, etc. but that takes too long to explain here! The methodology should also be able to completely reverse disorders such as Alzheimer's disease, and very probably muscular dystrophy as well. It should even be possible to reverse the physical effects of aging!

Much More Than This Introduction Has Been Theorized

This is the gist of the mechanism for the Priore therapy's startling success, although it has required some 10 years of very hard work to decipher the mechanics of the process. Along the way, I have also personally discovered and added a great deal more (for example, the quantum potential aspect of a living system and any enclave of living systems, the mechanism to generate a quantum potential, the precise mechanism for Sheldrake's morphogenetic field, the mechanism for directed evolution, the unusual electromagnetic nature of mind and thought, the mechanism for engineering mind and thought, engineering the entire species, and engineering the entire living biosphere), but this much should suffice for now for introductory purposes.

A technical book has been laboriously begun, and hopefully will be finished and published in about a year. Two 2-hour videos are also tentatively being planned. A four-hour technical briefing has already been prepared and presented.

Reactions to this Vacuum Engine Explanation

In response to numerous queries as to the reactions to this explanation of the Priore mechanism: Reactions tend to be rather good when (1) the technical person is open-minded, in other words, a friendly skeptic, (2) the technical person endures a grueling 2-hour or 4-hour detailed slide presentation I prepared, and (3) sufficient follow-up dialogue is accomplished to answer residual questions. Otherwise, the "mental jump" required of the participant is just too great.[89] Also, perhaps 60-70% of the conventional scientists are absolutely against anything that smacks of "revolutionary." From about half of this contingent the approach may generate disbelief and even overt emotional hostility, just as Priore himself and his associates encountered.[90]

However, some of the sharpest young graduate students readily make the transition, if they interact with me for a long enough period and enough times to understand the physics of the approach. *It did not take me 10 years to decipher an easy thing!* The causative mechanism for Priore's accomplishment is terribly involved and very, very deep. It is slightly beyond the present scientific vanguard, although the bits and pieces necessary to decipher the Priore mechanism are now in the literature. But putting them together has been a bone-crushing, terrible task. Priore was truly a century ahead of the science of his time!

Nonetheless, there is much hope, because the material is slowly taking root in a few sharp young graduate minds. For example, one of the major Eastern Universities would be astonished to know that their sharpest, brightest young PhD candidate – one they already assume will win a Nobel Prize in the future – is a full convert, and thoroughly understands cellular reversal by hidden-variable SWZ pumping, a la Priore. But at my strong urging, he is keeping it a secret until he graduates, and then he will *gradually* begin to filter in some of these ideas. That way he does not initiate his destruction by his peers because of too much energetic advocacy too quickly.

The Priore Approach is Urgently Needed

We simply must get this Priore therapeutic approach developed, for it is extremely important to all humanity. Our very survival may depend upon it.

Presently all our antibiotics are beginning to fail; the disease organisms are becoming quite resistant. Already our hospitals have strains of diseases that few if any antibiotics will touch. Hundreds of thousands of hospital patients each year are already experiencing complications due to contracting an antibiotic-resistant infection. Probably about 20,000 a year are dying as a result, and the death rate is increasing. In the future, one will have to seriously weigh whether it is better for one's chance of survival to enter the hospital and be treated, or to take one's chances with the disease and not enter the hospital.

With the rising failure of the antibiotics, (*See figure 21 on page 60*) and the rising possession of tailored biological weapons by hostile nations and international terrorists,[91] (*See figure 22 on page 60*) we shall shortly have no defense against an onslaught of pandemics unheard of since the Black Death swept medieval Europe of one third the population. Literally the age of pestilence and dread diseases of Revelations is upon us.[92]

[88] *They can also be "reversed to normal" even if they have never before been normal. The master cellular control system contains a master blueprint for the normal cell and can make an appropriate template for the specific disease delta vacuum engine, or one can be introduced (e.g., by injection of a drop of blood from a person previously cured of that specific disease; this was in fact demonstrated by the Priore group.). Pumping will then reverse the patient back to normal, as was actually shown by the Priore group. Indeed, the body's own system may be able to use the correct anti-engine template from the drop of blood and cure itself without pumping, as was also shown by the Priore group, if the body itself is reasonably healthy.*

[89] *Simply "dropping it on someone" by mail, for example – as I did to Elizabeth Taylor's foundation and Ross Perot's office – is just too much for a casual reading to grasp. A polite acknowledgment was received from the Taylor foundation, and no acknowledgment at all was received from the Perot camp.*

[90] *As an example, Priore completed the course work for his PhD and submitted his thesis, documenting his formidable and revolutionary work. Because of the ferocity of the oncology establishment toward the Priore team and its accomplishments, the university rejected his thesis. During the two decades or so since then, untold millions have died worldwide from diseases the team cured. These deaths could have been prevented had the Priore work been vigorously pursued and developed by the scientific community.*

[91] *It is not a question of if the international terrorists will use biological weapons against the U.S. civilian populace, but only of when. Astoundingly, often it may even be possible for the terrorists to simply buy their biological warfare agents from us! In a lawsuit by Desert Storm Syndrome victims against certain U.S. companies, one of the companies is alleged to have sold germs – such as anthrax, tularemia, and botulism – to Iraq by mail. These are highly effective biological warfare agents. E.g., a few spray tanks spraying such agents over a large U.S. city complex at night, using an easily obtained light plane to get in a few hours "flying practice," would result in tens or even hundreds of thousands of deaths within days. According to U.S. government-released data, inhaling a few anthrax spores into the lungs has a very high probability of killing the inhaler, unless treatment is started immediately. Even with immediate treatment, many deaths will still occur. A substantial number of nations are now obtaining and producing lethal biological warfare agents – which have been called the "poor man's atomic bomb." Some of the international terrorist groups are also acquiring the biological warfare agents.*

[92] *A good exposition of the rapidly increasing resistant-disease problem is given by Garrett, Laurie, **The Coming Plague: Newly Emerging Diseases in World out of Balance**, Farrar, Straus and Giroux, New York, 1994.*

In addition, the costs of the present allopathic medicine are rising rapidly and threatening to either bankrupt the nation, or become so expensive that only the wealthy can afford adequate medical care. Even the wealthy could be trapped in the future and denied adequate medical treatment. The Clinton Medicare bill, if approved, would make it a felony to pay a doctor out of one's own pocket, after denial of such treatment by the administrative bureaucracy. It also makes it a felony for the doctor to give the treatment to the disapproved paying person. Thus both the patient and the doctor could be sent to prison, wealthy or not.[93]

Cell Conjugation by Vacuum Anti-Engines Is the Only Hope

Priore's approach offers an answer to both the age of pestilence and the impending biological warfare strikes against our armed forces and our civilian population.[94,95] By prompt cellular reversal, infection even by totally unknown and modified agents can be quickly voided. Infection by newly adapted, resistant strains of presently known diseases can be quickly conjugated. So the problem of the failing vaccines and antibiotics can be solved quickly, simply, and cheaply. However, the cell-reversing treatment devices and trained, experienced medical staffs must be widely available!

Diseased cell conjugation by EM means is also the only therapy that can largely *eliminate* the debilitating diseases of humanity. Per Wheeler's principle, vacuum engines can mold the *physical matter* of the living body and conditions, operations, and content of the mind, memory, and personality. As the Priore therapy is developed and extended, it will become possible to correct bent spines, mental retardation, mental diseases, genetic defects, physical accidents and disabilities, birth defects, etc. It will be possible to regrow amputated limbs and restore deteriorated cartilage, organs, and joints. It should also be possible to directly remove deep psychiatric problems, heal chemical imbalances, and address and heal such presently difficult disorders as schizophrenia.

The development and application of Type 2 medical engineering can usher in the greatest, most beneficial revolution of all time. As just *one* example, eventually it will be possible to quickly educate students by simply loading the appropriate "software" into their minds and long term memory, in only a few weeks of "sessions." At that point there need no longer be, anywhere in the world, an educationally disadvantaged person.

It can also be used to usher in the most diabolical revolution of all time if we are not careful to (1) be informed of the Type 2 engineering area, including who is developing what, and for exactly what purposes, and (2) rigorously control the development and use of this technology as it progresses. Our legal, political, and scientific leaders – and we common citizens – will have to grapple with the ethics of what is done and to and for whom it is done. Just as one example, the same technology that will allow direct loading of the software in the long-term memory to achieve rapid education, will allow altering or changing any part of the long term memory, including the built-in emotional responses, etc. *Loading software is loading software! What is loaded depends only upon what is in the software.* In theory it is possible not only to alter the learned behavior, memories, emotions, and reactions, but also the genetically "born-in" behavior, emotions, and reactions. The potential for the Type 2 engineering to be used for enslaving and roboticizing humanity should be obvious.

Far more carefully than with any other technology in history, we must ensure that this new one is developed for good, not for evil. To quote an old adage, *the price of freedom is eternal vigilance.* Never before in all of history have those words been more true.

In Conclusion

Pioneers such as Priore, Becker, Kaznacheyev, and Popp have shown us a

[93] *In fact, under present law all property, homes, bank accounts, and monies of both the patient and the doctor would simply be confiscated – without any legal charge, arrest, or trial – under an absolutely medieval reinterpretation of U.S. law that has again given police at all levels such sweeping and unconstitutional powers. The Clinton Health Care Plan, presently on hold but still alive and sure to be introduced again, is reported to include the establishment of an entire department solely devoted to confiscating assets from patients and doctors who commit such "crimes." Defendants victimized by the present confiscation reinterpretation of law have a slim chance of even forcing the issue into a court. Even if they succeed in getting into court for a hearing, win it and get full "exoneration," the authorities can still keep the property! In the most insane and unjust legal action in all of U.S. history, this law now charges the property itself with having committed the crime, not the erstwhile human defendant. By what means can the "property" defend itself? No one has an answer, for the property is not an individual and has no legal rights for jury protection under the law! U.S. lawyers and judges are actually insisting that this is rational and makes sense. They have already precisely redefined U.S. law into what is specifically required to institute a police state. The police forces who carry out this confiscation are themselves awarded a percentage of the "haul." What does the citizen do when the police forces themselves become the robbers by administrative fiat, and there is no court redress possible? Ostensibly passed to counter organized crime and the drug cartel, this law has rapidly been applied directly to the citizenry, and its use is one of the fastest growing "new techniques" by the various levels of law enforcement. In this paper we have deliberately not dwelled upon the political aspect of the already-emerging police state in control of medical treatment. We simply summarize how the bureacratic medical establishment is likely to meet the challenges of the coming plagues and the associate astounding rise in medical costs. In fact the reader will almost certainly see the rise of an iron "state dictatorship" in medicine, as is already emerging in other legal areas.*

In this paper my primary purpose is technical, not political, so we defer detailing the more involved political aspects of the emerging police state (the New World Order – more aptly the New World Feudalism) to other more capable authors and sources. One central thought should remain firmly in mind All political systems and isms tend ultimately to feudalism, which is always the best system for the oligarchy or elite at the top who control and own everything. In any society, there is always an on-going struggle by a fraction of the most powerful to convert the society to special forms of feudalism.

[94] *Some biological agents are very lethal and the associated disease develops at a frightening pace. E.g., the strains of Staphylococcus bacteria that cause necrotizing fascitis and necrotizing myositis – two versions of the "flesh-destroying" disease – are noteworthy examples. Necrotizing is causing inflammation and/or death of tissue, fascitis refers to "sheet" or connective tissue, and myositis refers to muscle tissue. Recently the Quebec separatist leader Lucien Bouchard was suddenly felled by necrotizing myositis, lost a leg, and at this writing is stable and will recover. The disease is usually fatal in 80% of the cases. There is nothing diabolical in his contacting the disease; the bacteria are present from time to time and can enter the body through a nick or otherwise. The disease and the bacteria are known; however, in the past such cases have been relatively rare. The lethality of the disease is augmented by the rapidity of its development. Delayed recognition of the disease may place the patient already beyond the ability of conventional agents to arrest it in time to save him. With the modern hospital and population environment being highly favorable for the more rapid modification and adaptation of disease organisms, even previously rare diseases such as necrotizing fascitis/myositis are ticking time bombs waiting to become resistant to our antibiotics and explode in the dense urban populations.*

[95] *We refer to strikes using biological organisms. We have mentioned but deliberately not dwelled upon the use of electromagnetic induction of lethal cellular diseases at a distance. Such strategic capability to attack a nation and destroy its citizens and soldiers is presently on-line in Russia, under total control by the KGB, not by the conventional Russian military forces.*

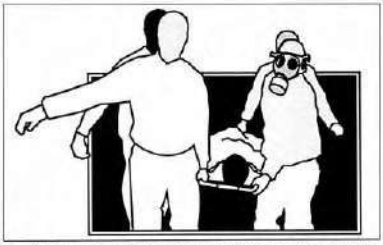

Fig. 21. Present antibiotic therapy is failing as disease organisms adapt.

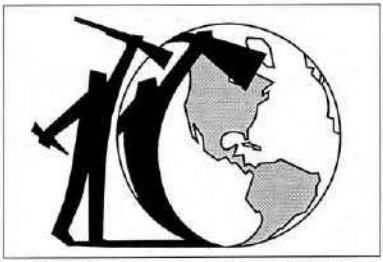

Fig. 22. Terrorists will eventually use biological warfare strikes. Biological warfare is an increasing threat to military forces and the civil populace.

great vision. Having seen it, when one looks at the incredible human suffering throughout the world, and then at the formidable problems of our Type 1 medical science that is struggling so mightily and losing the battle, one is reminded of a phrase by Dante:

"Heaven wheels above you

Displaying to you her eternal glories

And still your eyes are on the ground."

With every fiber of our being, we exhort the scientific community to lift its eyes from the ground, and develop and apply the Type 2 medical technology as rapidly as humanly possible, for human benefit. Else half of humanity will perish in the coming tide of pestilence. Even the conventional scientists agree that the pestilences are coming, and that conventional approaches are already losing the battle. Long ago Albert Einstein wrote these prophetic words:

"It would of course be a great step forward if we succeeded in combining the gravitational field and the electromagnetic field into a single structure. Only so could the era in theoretical physics inaugurated by Faraday and Clerk Maxwell be brought to a satisfactory close."

Einstein's passionately-sought unification of EM and G has now been accomplished. It has magnificent medical science applications for the benefit of all humankind. Meanwhile, in the orthodox medical journals, the scientists themselves are recognizing the demise of antibiotics and the coming unstoppable plagues. The scientists are redoubling their efforts to apply the present inadequate models, and their efforts are admittedly failing. *If they keep to their present course, the war is already lost!*

In the name of all the bleeding, suffering, and dying peoples of the world, we must do better than that! We can do better than that, if we rapidly redevelop and apply the Priore approach.

We call fervently for a great new "War on Disease" that is empowered, funded, and staffed to perform the task. It can be done in perhaps three years, and perhaps for as little as $60-100 million if we streamline procedures, keep the bureaucracy off the team's necks, and give the team scientists the authority of a War Commander with a mission order to *get on with it.*

What happens next is up to the scientists, the politicians, and the concerned leaders of all the nations of the world. *They simply must not fail us.* They and their families are in the same frying pan as the rest of us. This is not the time for dogma, posturing, arrogance, protecting one's territory, yapping about who's going to control the presently inadequate medicine, yakking about pseudoscience, striving for personal position and power, bowing to the big drug companies and their vested interests, and playing the "Who's to be the big monkey?" game. *We need a new Manhattan Project. We need it now.*

Else we who have sown the wind will most certainly reap the coming whirlwind.

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COMMENT: ***Orchitis is inflammation of a testes. Trypanosomes are protozoan flagellates of genus trypanosoma which infect humans and animals and are responsible for various serious diseases such as Chaga's disease, dourine, nagana, sleeping sickness, and surra. Chaga's disease is marked by prolonged high fever, edema, and enlargement of the spleen,***

liver, and lymph nodes. Dourine is a dis ease favoring horses and asses, marked by inflammation of the genitals, subcutaneous edematous plaques, low-grade fever, progressive paralysis, emaciation, and death. Nagana is a highly fatal disease in/ of domestic animals in tropical Africa marked by fluctuating fever, inappetance, edematous swelling, and sluggishness, and is transmitted by the tsetse fly and possibly by other biting flies. Sleeping sickness is a serious disease that is prevalent in much of tropical Africa; it is marked by fever, protracted lethargy, tremors, and loss of weight, and is transmitted by tsetse flies. Surra is a severe Old World febrile and hemorrhagic disease of domestic animals and is transmitted by biting insects.

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Editorial Note: We would like to express our appreciation to Mr. Bearden for this wonderful article.

The Tom Bearden Website

"Dossier Priore"

by Jean-Michel Graille

Photographs

Cover	
Plate 1	The inauguration: the construction of the M 600 had not yet started but, symbolically, the Mayor of Bordeaux starts the smaller machine at close range. (Archives R.P.)
Plate 2	Inaugural scroll.
Plate 3	An information meeting held in Bordeaux. From left to right: Antoine Priore, Robert Courrier, Raymond Pautrizel and Francis Berlureau. (Archives R.P.)
Plate 4	February 1975. Antoine Priore and Professor Pautrizel at the "suspended" base of the M 600, the enormous experimental prototype built by Leroy-Somer. The apparatus would only function for a few days but did make it possible to carry out some experiments with very promising results.
Plate 5	Anne-Nelly Pautrizel. Professor Pautrizel's sister and collaborator, who participated in almost all the experiments with the Priore apparatus since 1968. (Photo J.M.G.)
Plate 6	Pierette Châteaureynaud-Duprat, head of research at C. N.R.S., doctor of science and specialist in grafts, carried out in 1969 and 1970 two series of decisive experiments concerning the proof and the explanation of the biological effectiveness of the Priore Ray.

Plate 7

The Priore machine. The model financed by Pautrizel, the only one which is still likely to function, the one with which patients will be officially looked after as from 1977, is finished in August 1968. In fact, the apparatus is installed all in one place.

Plate 8

1969. Old friends of Priore retrace the road to Floirac. With a monkey-wrench or soldering-iron in hand, they devote all their leisure time to building the new machine for their friend. Here, on the scales, inspector Plantin, of the legal identity service. In coveralls, scarf around his neck, municipal worker M. Léglise.
(Archives R.P.)

Plate 9

A courageous man. Perpetual Secretary of the Academy of Sciences, elder President of the Academy of Medicine, "father" of endocrinology and fertilization, Professor Robert Courrier could have benefited from its prestige and its retirement. At 67, he took all the risks to defend that which he believed in deeply. He has fought now for twenty years. One of the rare photos of him, in the company of Antoine Priore and Professor Pautrizel, taken on 25th March 1970 in the laboratory at Floirac.
(Archives R.P.)

Jean-Michel Graille
DOSSIER
PRIORE
Une
nouvelle affaire
Pasteur?
Denoël

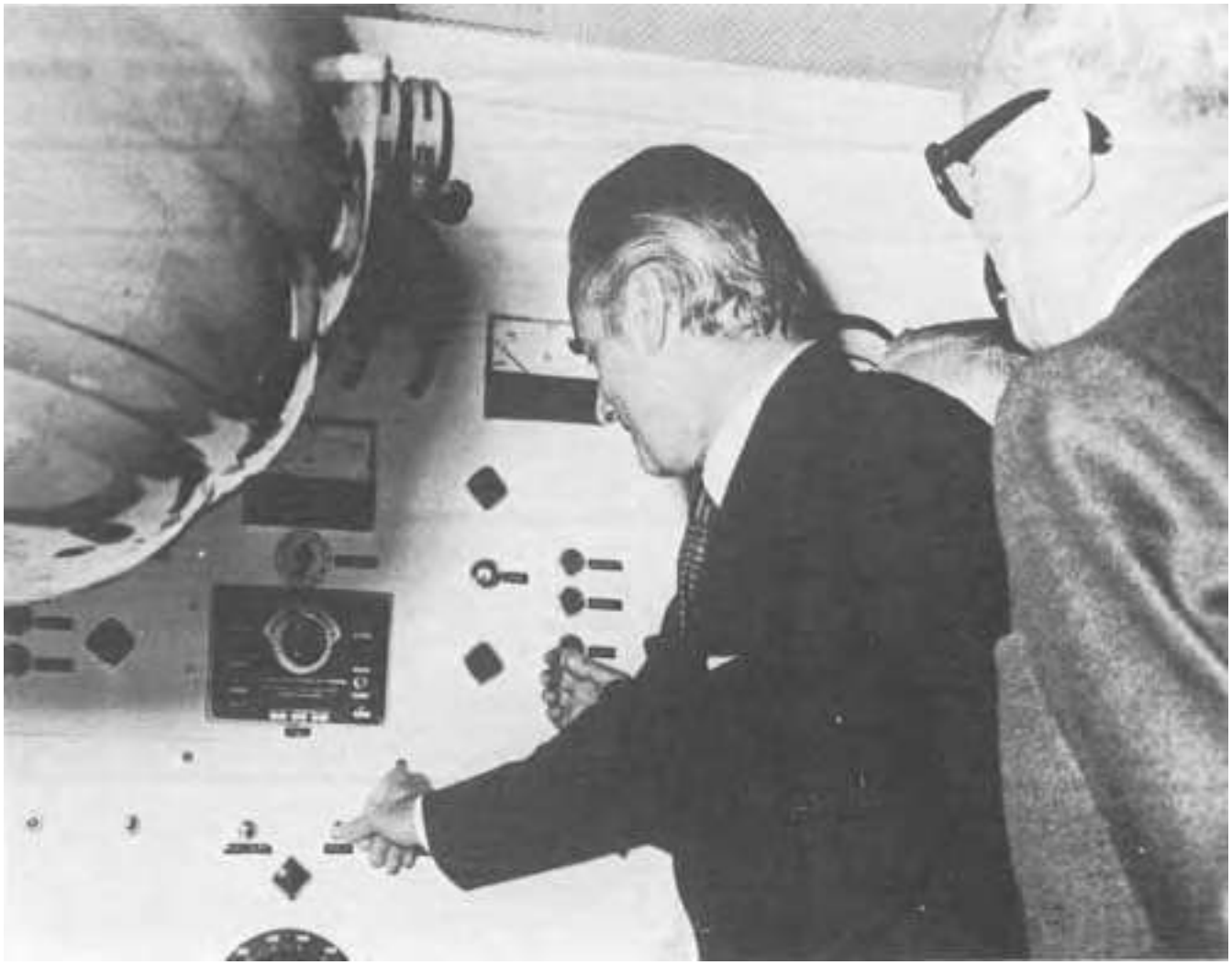

Translation:

JACQUES CHABAN-DELMAS
THE MAYOR OF BORDEAUX
PRESIDENT OF THE URBAN COMMUNITY
AND
ANTOINE PRIORE
HAVE INSTALLED ON THE 21 NOVEMBER 1970
THE FIRST STONE OF THE SCIENTIFIC RESEARCH LABORATORY
FOR THE BIOLOGICAL EFFECTS OF THE PRIORE RAY

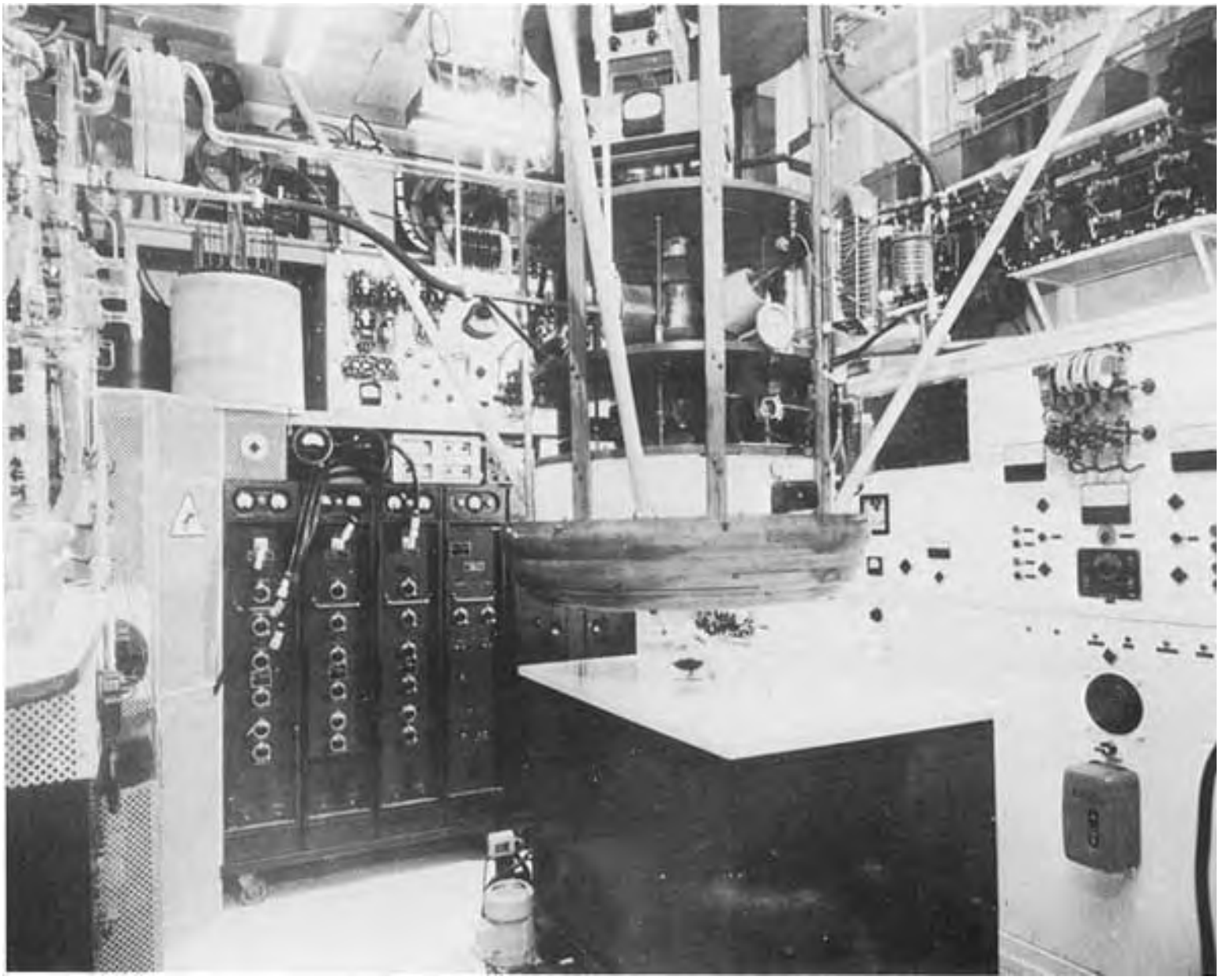

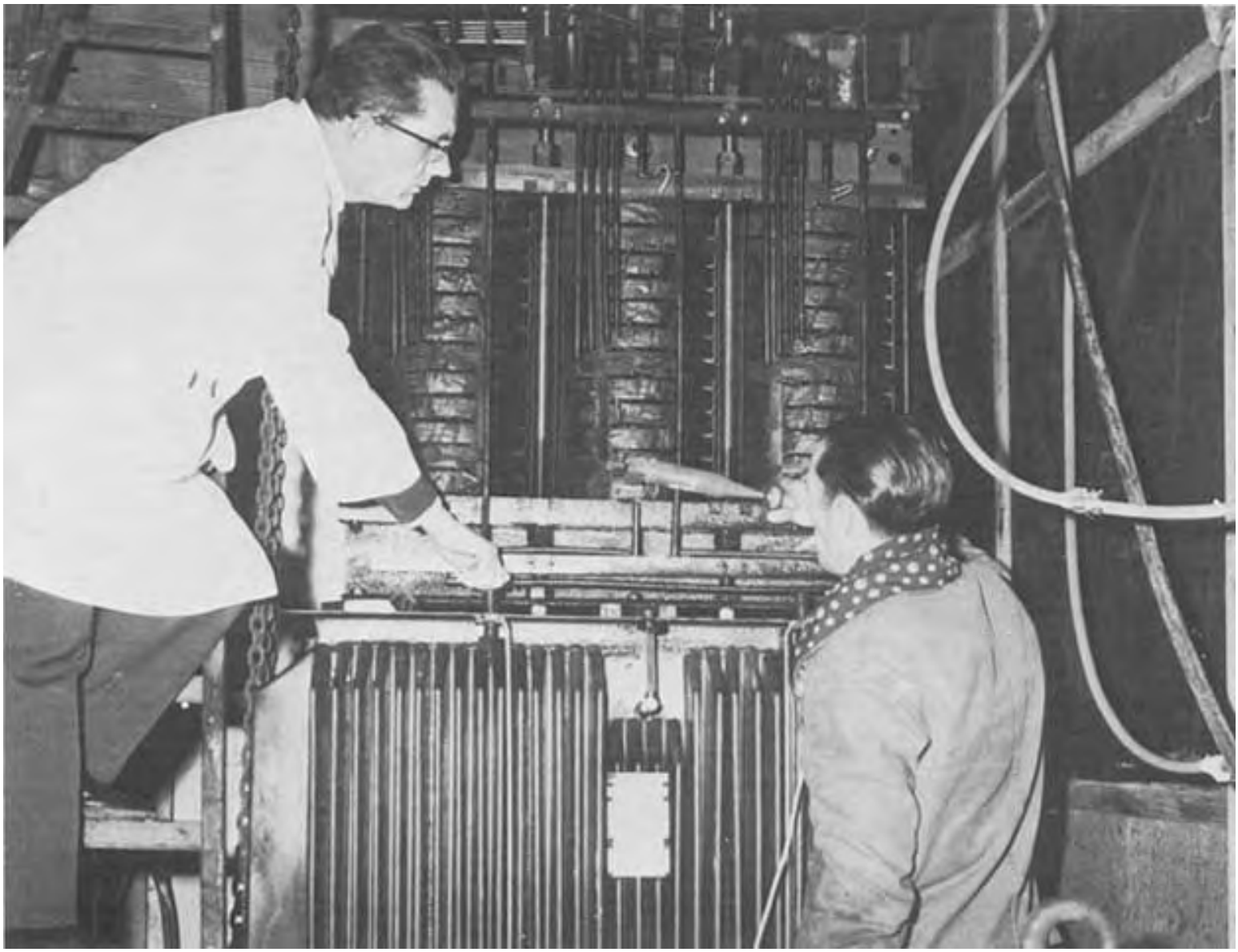

Making Laser Weapons a Reality

Figure 1. The Boeing HEL MD has demonstrated the ability to destroy a 60 mm mortar round in flight. (Photo courtesy of Boeing Defense)

Directed energy weapons first took a step towards reality in the 1980s under President Reagan's Strategic Defense Initiative (SDI), dubbed "Star Wars" by the media. But, the technology didn't really materialize at that time and the cessation of the Cold War largely removed the immediate impetus to develop it. Since then, lasers have become widely used in military applications, particularly for target designation and aircraft countermeasures, but there is still no significant deployment of lasers as offensive weapons. Now, advances in high power fiber laser technology, particularly in the efficiency, compactness and weight of their pump diode lasers, are poised to make laser weapons a practical reality.

Figure 2. A Coherent | DILAS T-Bar chip contains five emitters, outputs about 50 W, and is 5 mm wide.

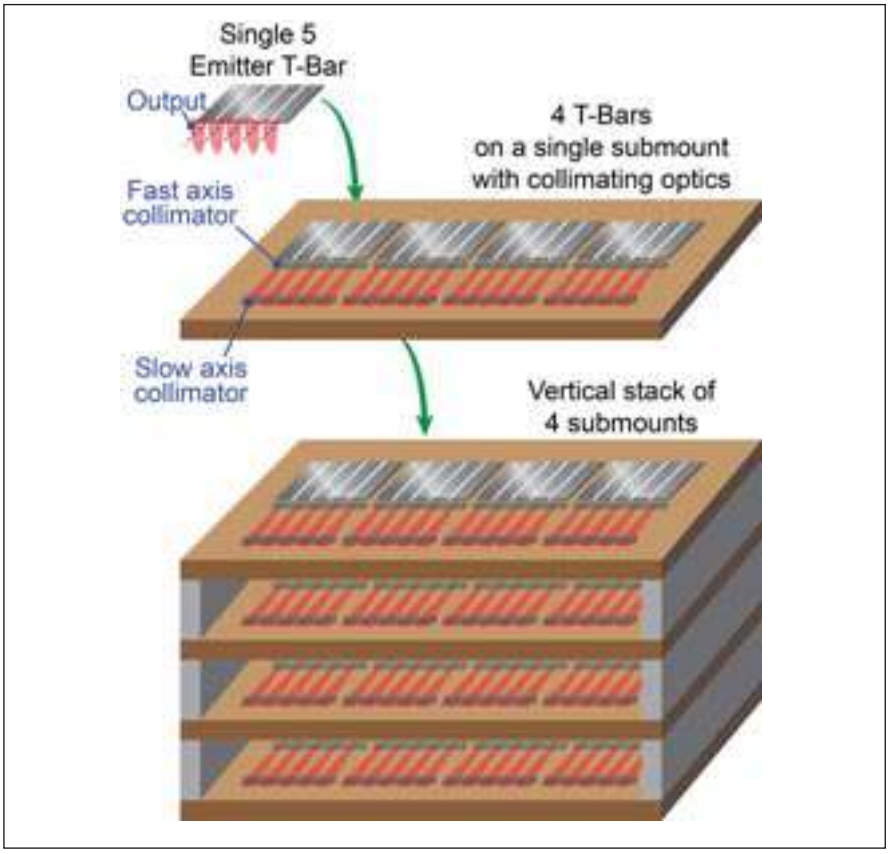

Figure 3. Progression from a single T-Bar die to an 80-emitter stack. The light from all these emitters can be efficiently coupled into a single 225 μm core fiber with a 0.22 NA.

Laser Weapons Overview

The concept behind Reagan's SDI was to protect the United States behind a "missile shield" that would prevent nuclear weapons, delivered via either intercontinental or submarine-launched ballistic missiles, from reaching North America. Part of the SDI was to be lasers, or other directed energy weapons, placed in permanent orbit, which could rapidly knock out a nuclear missile already in flight towards its target. Lasers, in particular, were a promising technology for this application because they can be quickly "charged up" (i.e. be made ready to fire), and their output can reach a fast-moving target nearly instantaneously.

Because these lasers were intended to be deployed primarily in space, or in fixed locations, and used either never (hopefully) or just once, there wasn't much concern about their cost, physical size, weight or operational efficiency. The key goal was simply that they would work when needed, delivering the required knock-out punch.

The offensive laser weaponry under development today is intended to serve almost the exact opposite purpose than the SDI, and therefore has very different goals in terms of its design and functionality. For example, one major laser weapons initiative is for C-RAM (Counter Rocket, Artillery and Mortar). These are systems intended to be deployed in the battlefield to protect troops and equipment from incoming projectiles. Currently, these are envisioned to be single, vehicle mounted lasers, with output powers in the 10 kW to 50 kW range.

Boeing has already successfully prototyped such a system, which they call the High Energy Laser Mobile Demonstrator (HEL MD). This consists of a 10 kW solid state laser installed on an Oshkosh Tactical Military Vehicle, along with all the necessary targeting and control systems. HEL MD has proven the ability to lock on to and destroy a mortar round of about 10 inches in length, traveling at hundreds of miles per hour, from several miles out. The system is also effective against Unmanned Aerial Vehicles (UAVs or drones); in this case, it may be sufficient to damage the drone's navigation and targeting systems, rather than completely destroy it. Similarly, other offensive laser weapons systems are being designed to deliver "swarm defense," that is, to protect a ship or base from attack by a large number of inexpensive drones.

Thus, today's laser weapons are meant to defend against swarms of inexpensive mortar rounds, drones and other projectiles, and are intended to be mounted on platforms which are mobile and self-contained (meaning they may not have ready access to an external source of power). This gives rise to several design imperatives. First, they must deliver a low cost per engagement; it's simply not economically feasible to employ an expensive weapon (such as a missile costing over $100,000) to knock out a drone which costs $1,000, or a mortar round which might cost less than $100. The laser weapon must also be capable of rapid fire so that it can't just be overwhelmed by a large number of simultaneous incoming rounds. Also, rapid fire reduces the number of individual laser weapons systems needed to protect a given number of troops. But, the ability to deliver rapid fire also necessitates that the system be electrically efficient. Otherwise the laser weapon will require access to a large quantity of fuel, which is difficult (and dangerous) to transport into a battlefield. Fi-

nally, it's desirable that laser weapons be physically compact, especially for airborne use.

SWaP Optimization

The push to optimize the size, weight and power (called SWaP in military parlance) of field deployed laser weapons has driven a progression in the technology of the gain material used from chemical (e.g. deuterium fluoride), to solid state, and, most recently, to fiber. One reason for this is because fiber lasers offer inherently higher efficiency, in terms of converting input pump energy to usable output, than nearly any other laser type, except diode lasers. However, diode lasers by themselves don't provide the necessary brightness or beam quality, while diode-pumped fiber lasers can. And, beam quality is critical because it determines the distance over which the laser can be focused to a spot size small enough to reach the power density necessary to damage its target.

Fiber lasers offer other advantages in terms of SWaP optimization. Chemical and lamp pumped solid state lasers require a significant overhead in terms of the equipment and power supplies required to run them. In contrast, both solid state (e.g. slab and rod) and fiber lasers can be diode pumped, and diode power supplies and pump modules themselves are electrically efficient and lend themselves to miniaturization. This efficiency, in turn, reduces the cooling requirements, and all its attendant equipment (pumps, heat exchangers, etc.).

But, as laser weapons evolve towards ever higher powers, fiber laser technology becomes increasingly attractive over solid state. Currently, individual fiber lasers can deliver up to about 2 kW of power, but multiple units can be combined to deliver around 10 kW in a single beam with extremely good mode quality. It's a bit more difficult to scale up the power of a solid-state laser, especially while maintaining good mode quality. This is because scaling up and/or increasing the pump power to a traditional solid state laser typically excites higher order modes, and introduces other issues related to thermal lensing.

Of course, there are also challenges to increasing the power of a fiber amplifier.

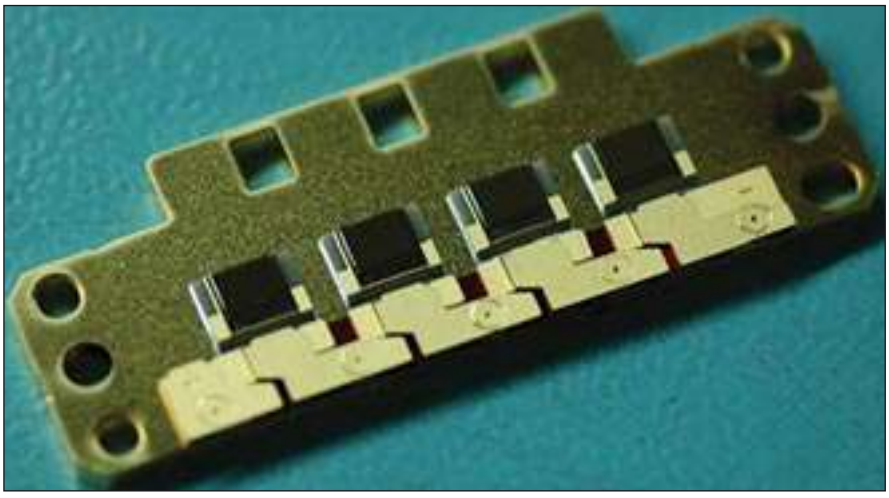

Figure 4. Four T-Bars mounted on a macrochannel cooler with collimating optics.

And, because the optical efficiency of their pumping is already so high (~85%), there's not much room for improvement there. So, the focus is on raising the pump power itself, without increasing package size and weight, as well as on methods for low loss beam combining of multiple single mode lasers, all while still maintaining good beam quality.

Pumping Technology Advances

In terms of SWaP optimization of pump diodes for laser weapons, a current benchmark is to achieve a weight to output power ratio of 1 kg/kW. Coherent | DILAS has developed several advances in diode laser technology to reach this goal, and, in fact, is already working on devices that will attain the next level of performance – 0.5 kg for 1 kW of output.

One key to reaching the SWaP benchmark has been the company's introduction of T-Bar (for "tailored" bar) construction, a design approach intended to combine the high total output power of traditional diode laser bars with the relaxed cooling requirements of single emitters. The basic unit of the T-Bar is a diode laser mini-bar having five emitters on a single, 5 mm wide substrate which outputs about 50 W total. In contrast, traditional diode laser bars are usually 10 mm wide, contain at least 19 emitters, and can output over 200 W, depending on the number of emitters and type of heatsink.

For military applications, four of these T-Bar dies are mounted on to a single substrate, yielding a total of 20 emitters. Then, up to four of these substrates are stacked vertically, bringing the total number of individual emitters in this compact assembly to 80, with a total output of about 800 W.

The key optical characteristic of the T-Bar design is that the combination of wide emitter spacing, low divergence and relatively low beam parameter product (in both fast and slow axes) is tailored to enable the light from all 80 of these individual emitters to be efficiently co-linearized and coupled into a single 225 µm core fiber having a numerical aperture of only 0.22. This, in turn, permits highly efficient coupling into the pumping mode volume of the gain fiber. And, this light collection can be accomplished using a relatively simple and compact optical system. This is how output power per unit volume is maximized.

In contrast, the high divergence and poor mode quality of traditional diode laser bars necessitate the use of complex optics for light collection, and still make it impossible to couple all their output into a single, low numerical aperture fiber. Furthermore, high power diode laser bars often suffer from a problem called "smile." This is a sagging or bending alignment error in emitter position along the bar which makes it quite difficult to collimate and co-linearize its output.

Besides the advantage of producing the largest amount of fiber coupled light out in a given system volume, T-Bar construction also offers significantly improved cooling characteristics over traditional bars. In a traditional diode laser bar, the small emitter spacing causes significant thermal crosstalk between the individual emitters, and a very high efficiency cooling system must therefore be employed. This is usually in the form of a so called "microchannel" cooler, in which water is rapidly circulated through channels within the heatsink. But the small bore of the microchannels (tens of microns) makes it easy for them to be clogged by particulates. Thus, the water must be stringently conditioned and filtered, and large, heavy, high pressure pumps must be employed to circulate it rapidly enough to achieve the required level of cooling in these traditional bars.

Furthermore, traditional diode bars are usually placed directly on the heatsink in order to achieve good thermal contact. However, this makes the microchannel cooler part of the electrical circuit, thus necessitating the use of deionized water in order to avoid a short circuit. This imposes yet another requirement that increases cost and complexity.

The larger emitter spacing of the T-Bar largely eliminates this thermal crosstalk, and greatly relaxes the attendant cooling requirement. As a result, Coherent | DILAS has been able to introduce a "macrochannel" cooler. This is a system which uses substantially larger bore channels, thus allowing the use of less stringently filtered tap water, and eliminating the need for high pressure pumping. Also, the reduced cooling requirement enables the laser bar to be placed on a submount, rather than in direct electrical contact with the cooler, which avoids the necessity of using deionized water.

T-Bar construction also delivers better cooling characteristics than single emitter diode lasers. This is because single emitters are typically supplied already packaged. Since the diodes are mounted within the package, there is an extra thermal interface which makes it more difficult to efficiently cool them.

In conclusion, after decades of imagining, offensive laser weapons are nearly ready for deployment on the battlefield. Advances in diode laser pumping technology are proving to be a key enabling factor in this development. And, these military grade pump diode lasers can be constructed using the same automated, high volume fabrication equipment used for industrial product manufacturing, meaning they can be readily delivered at competitive prices.

This article was written by Chris Ebert, Ph.D., Director, Business Development, Coherent | DILAS, (Tucson, AZ). For more information, visit ***http://info.hotims.com/65852-501****.*

The Tom Bearden Website

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from **STAR WARS NOW!**

The Bohm-Aharonov Effect, Scalar Interferometry, and Soviet Weaponization
by Lt. Col. T.E. Bearden (retd.), 1984
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A Sensitive Scalar Wave Detector

Very briefly we present a method of making a very sensitive scalar wave detector so that direct measurement and quantization can be established.

First, we regard one oscillation (one wavelength) of the scalar potential wave as a longitudinal photon. Note that this photon contains a substructure, which may be deliberately determined (when artificially made) or randomized (when naturally made in the idealized case).

For convenience we represent normal linearized vacuum (spacetime) as a horizontal or longitudinal vector (Figure 4), implying the direction of motion of the wave in the laboratory frame. By horizontal position in our diagram, we imply a linear, uncurved spacetime and a non-rotated frame. We represent the longitudinal scalar wave as a horizontal vector, and the usual Hertzian wave as a vertical or "transverse" vector. We visualize a normal detector as detecting only a vertical or "transverse" vector, as we have illustrated in Figure 4.

As can be seen, in a linear, unrotated or uncurved spacetime a pure scalar wave has no vertical component projected upon the laboratory frame vector, so it is not detectable by normal detectors.

To detect the scalar wave, of course we could bend it so that it has a projected vertical component in the laboratory frame (Figure 5). However, this would be an impure wave, not a pure scalar wave, and that is not what we wish.

A better way is to bend or curve spacetime itself in a small region, so that a longitudinal wave that passes through that region now possesses a vertical component with respect to that region (Figure 6). Thus a normal detector there will detect that vertical component. We conduct the detection current out of the "bent spacetime" region to an outside (normal) detector, and we then have a scalar wave detector.

To illustrate, we show conceptually how this has been successfully done. Figure 7 shows the concept. First, we utilize a magnetic pole to provide the infolded energy (potential) to bend or curve spacetime. To reach good sensitivity, we need a pole strength connected with a magnetic field strength of 40,000 Gauss or higher. We utilize a small superconducting magnet, which can reach field strengths of from 40,000 to 80,000 Gauss.

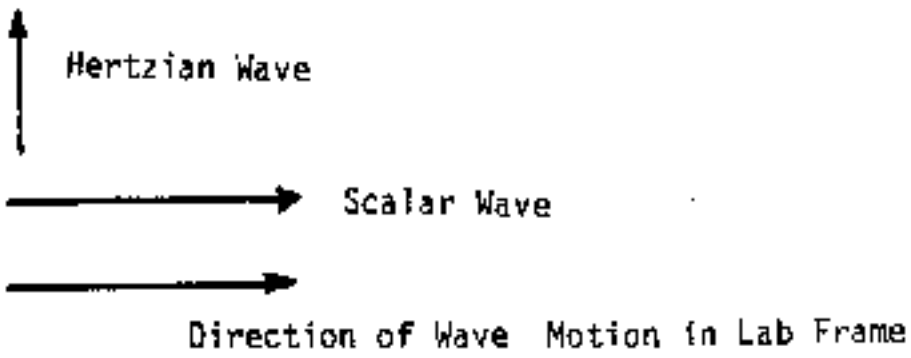

Figure 4. Linear, uncurved laboratory frame.

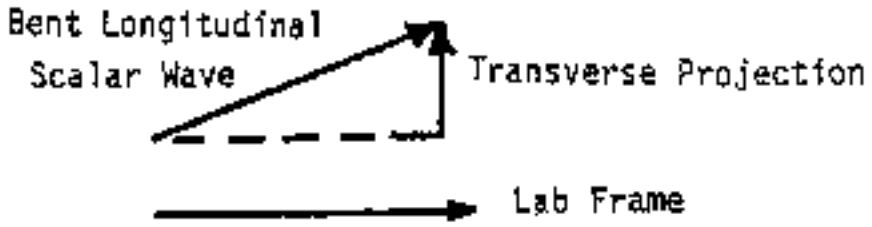

Figure 5. Rotating the longitudinal wave produces a transverse component.

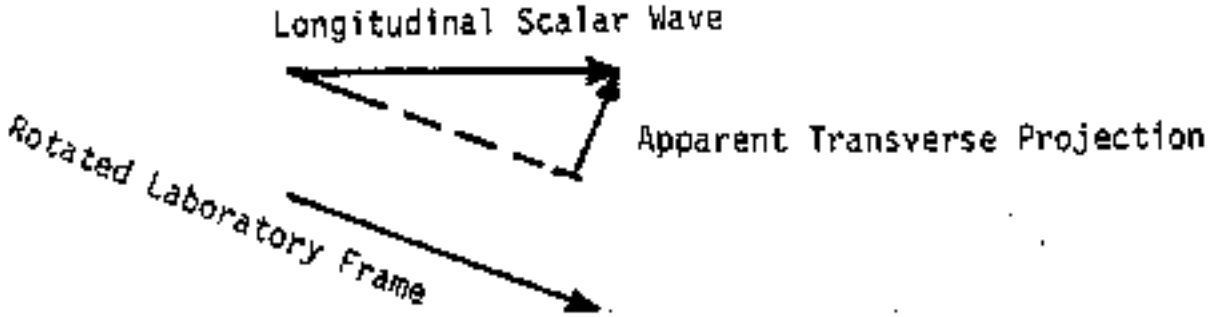

Figure 6. Bending the laboratory spacetime frame produces a transverse component.

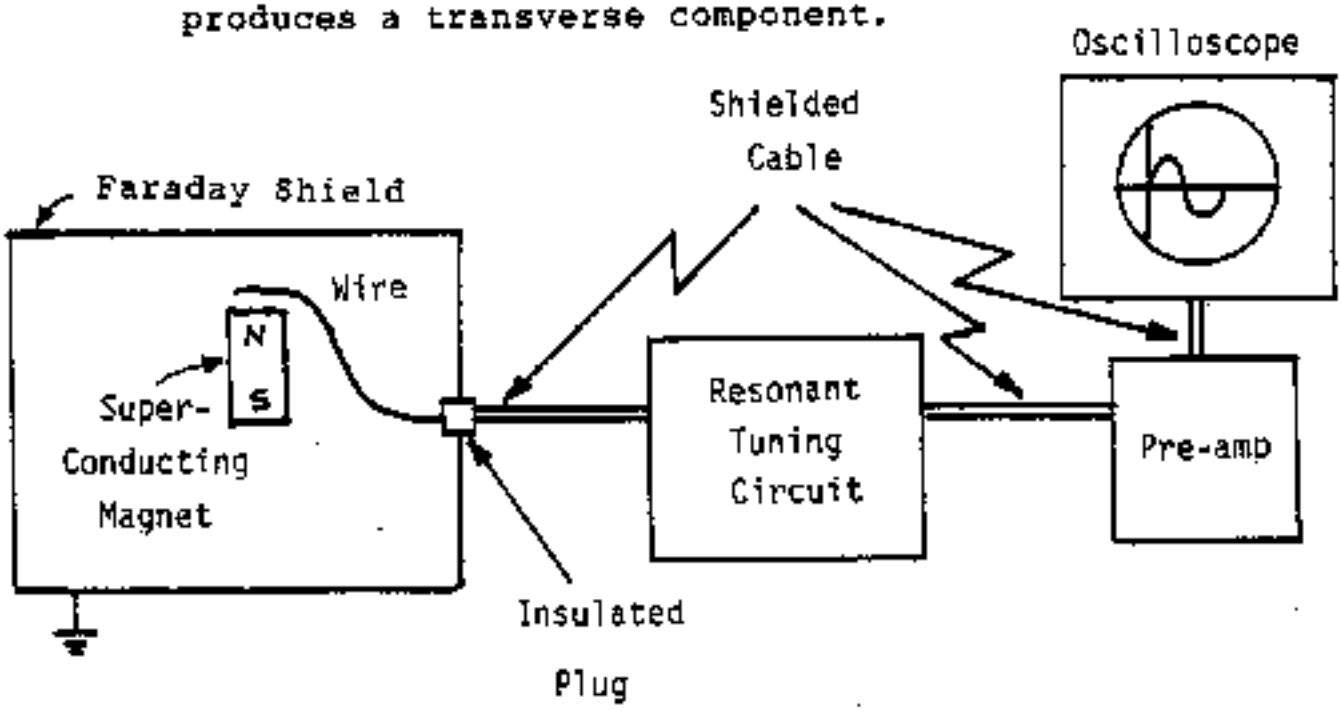

Figure 7. A sensitive scalar wave detector.

Figure 7. A sensitive scalar wave detector.

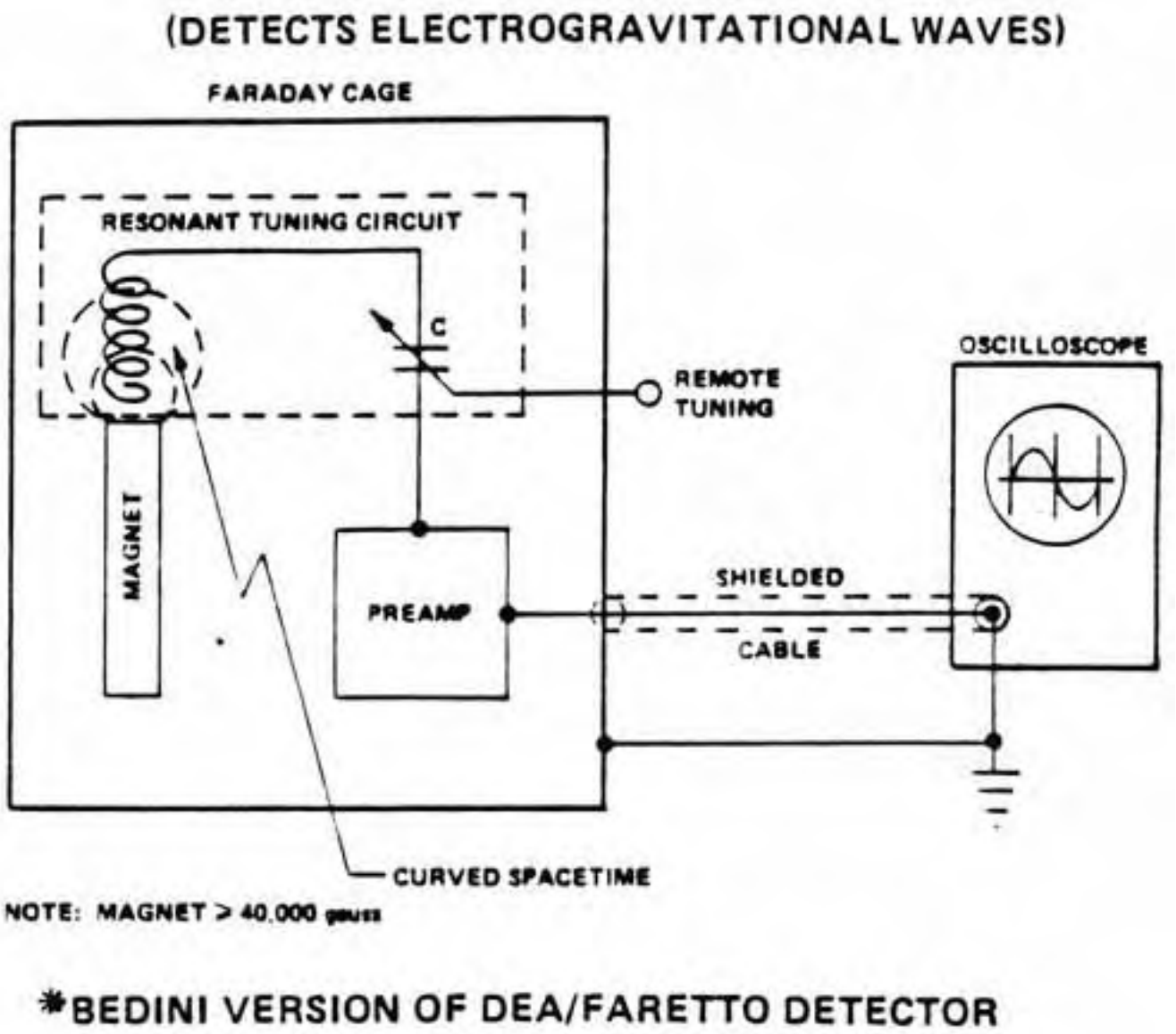

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Then to prevent detection of superfluous "normal" radiation, we shield the entire magnet in a grounded Faraday cage, as shown in the figure. Hertzian waves will be grounded in this shield, while scalar waves will readily penetrate it undiminished. In other words, the Faraday cage serves as a "stripper," to strip away the ordinary waves, leaving only the scalar waves to penetrate inside. An ordinary wire lies at the top of the magnetic pole, in proximity to it. The wire runs out of the Faraday cage through an insulated port to a resonant tuning circuit, which is sharply tunable over the range of frequencies we are interested in. A preamp amplifies the output of the tuner, and in turn feeds the input of an oscilloscope or other detector.

With this detector we can select the frequency desired, and detect any passing scalar waves of that frequency. By other variations of amps and preamps, regenerative circuits, etc. we can obtain all the

sensitivity desired, and utilize ordinary detection equipment already well-known and highly developed.

Additional Information about detecting Scalar Waves

Figure 11. NETWORK OF VIRTUAL TRANSMITTERS

(See Woodpecker Grid)

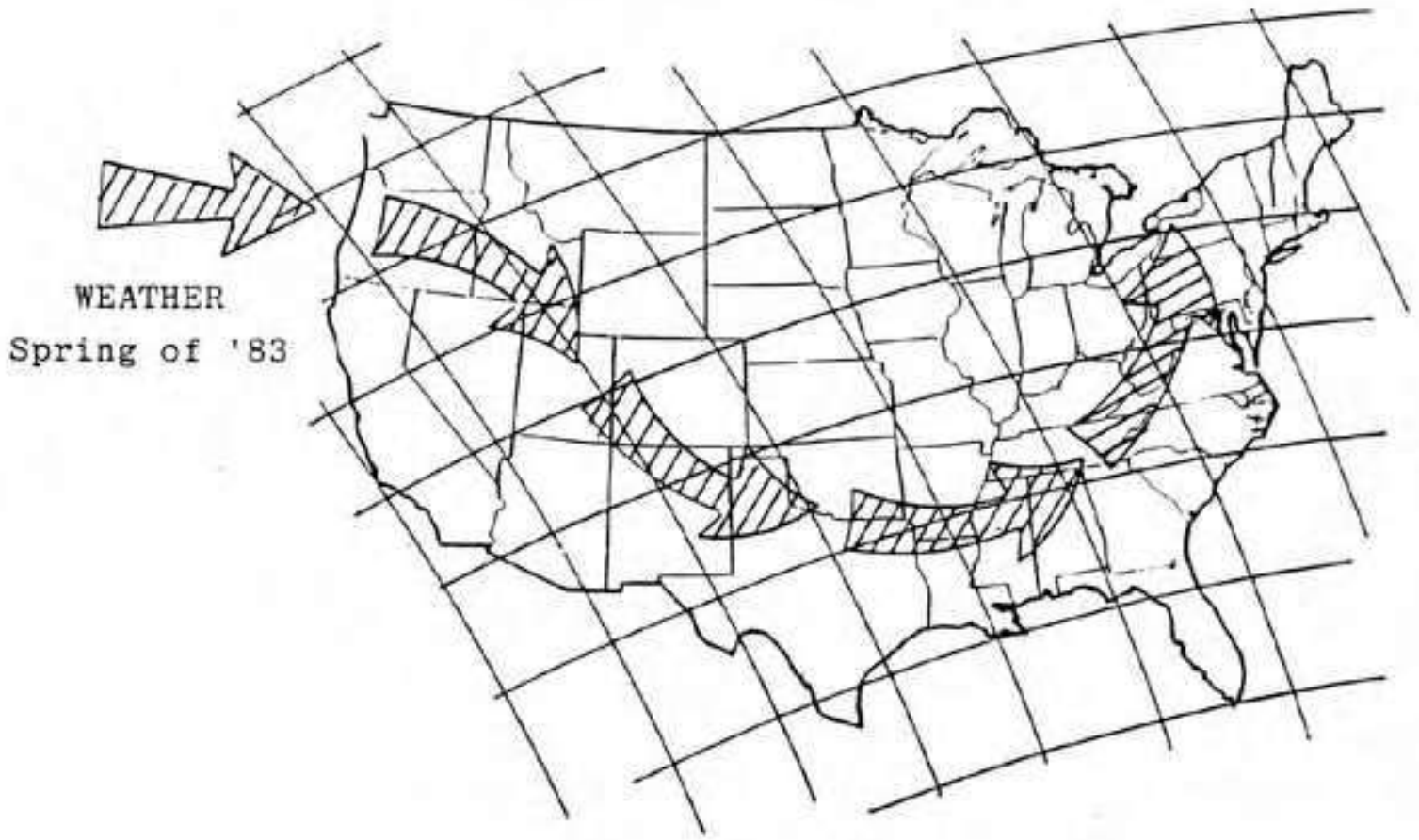

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Figure 12. VIRTUAL TRANSMITTERS IN THE INTERFERENCE GRID

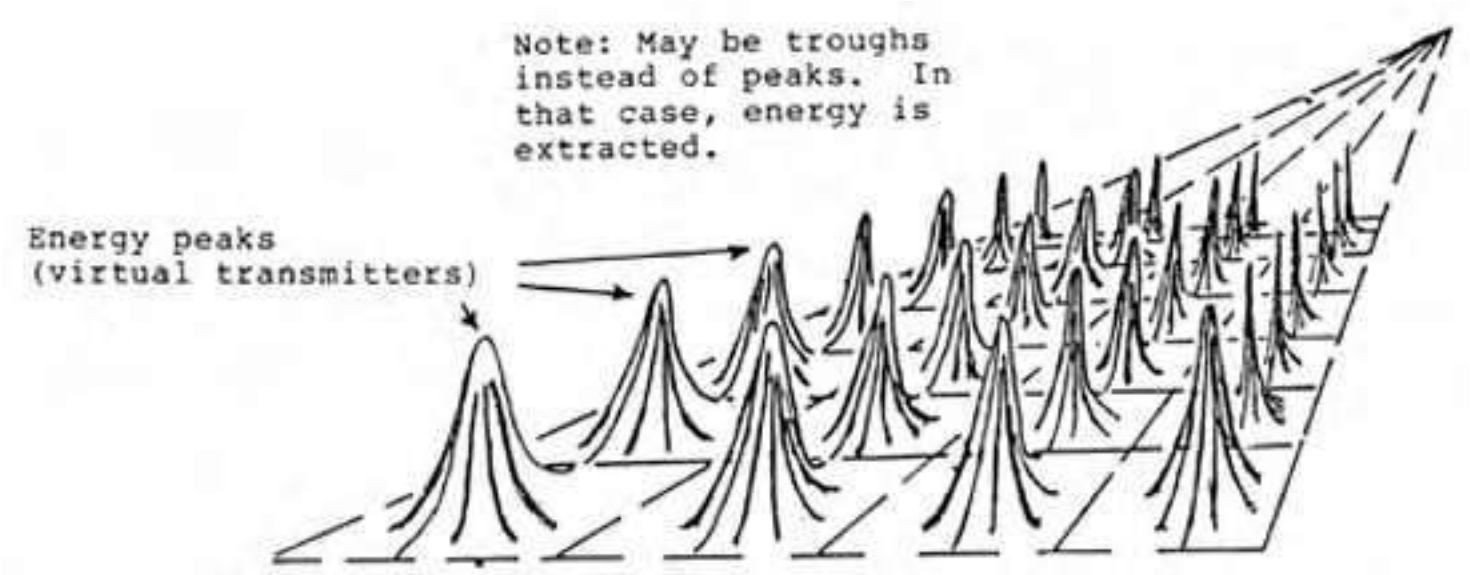

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Figure 13. GIANT RADIAL RELATED TO A VIRTUAL TRANSMITTER

Fall 1983: Florida Alabama

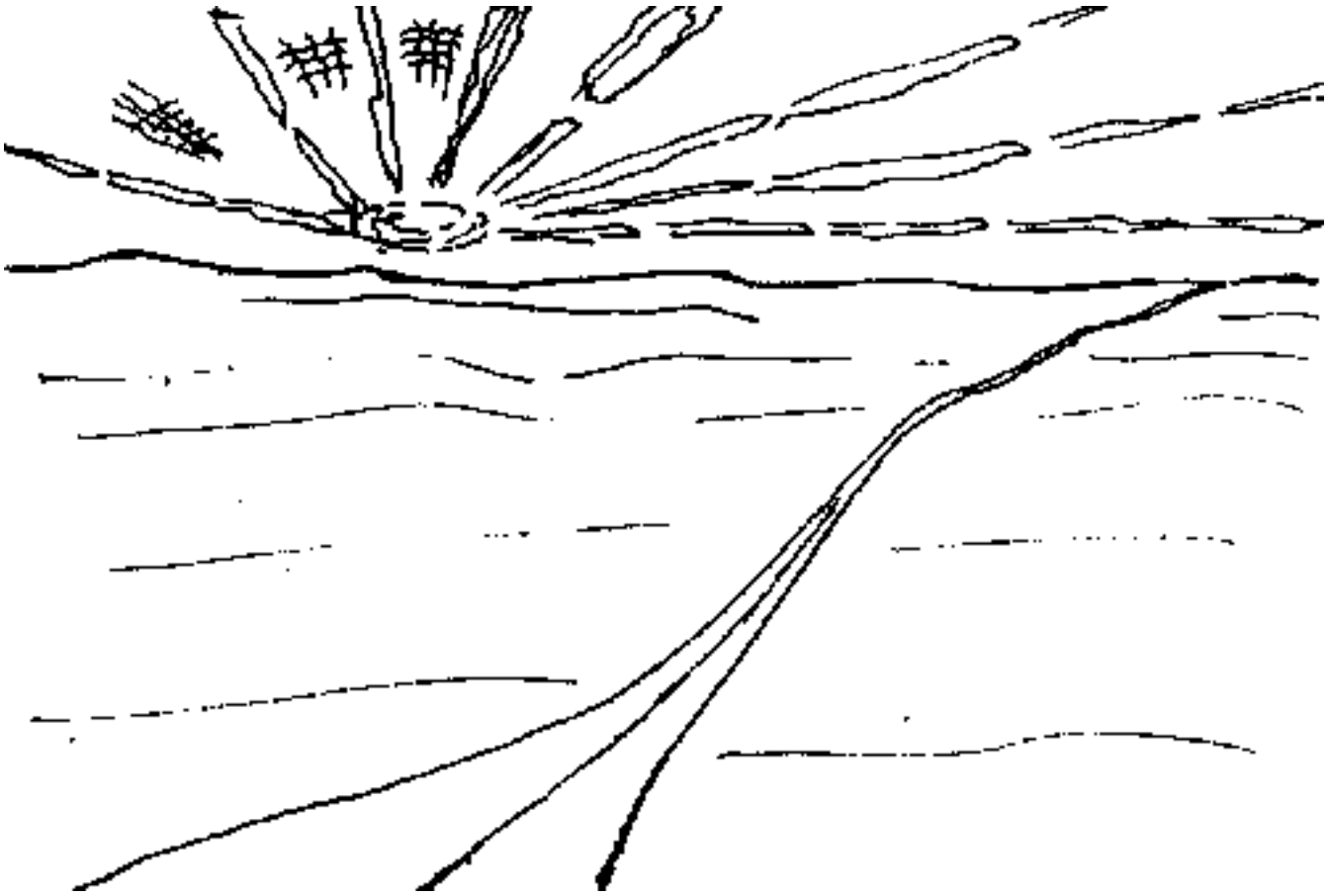

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Figure 14. FORMATION OF A SINGLE GIANT RADIAL

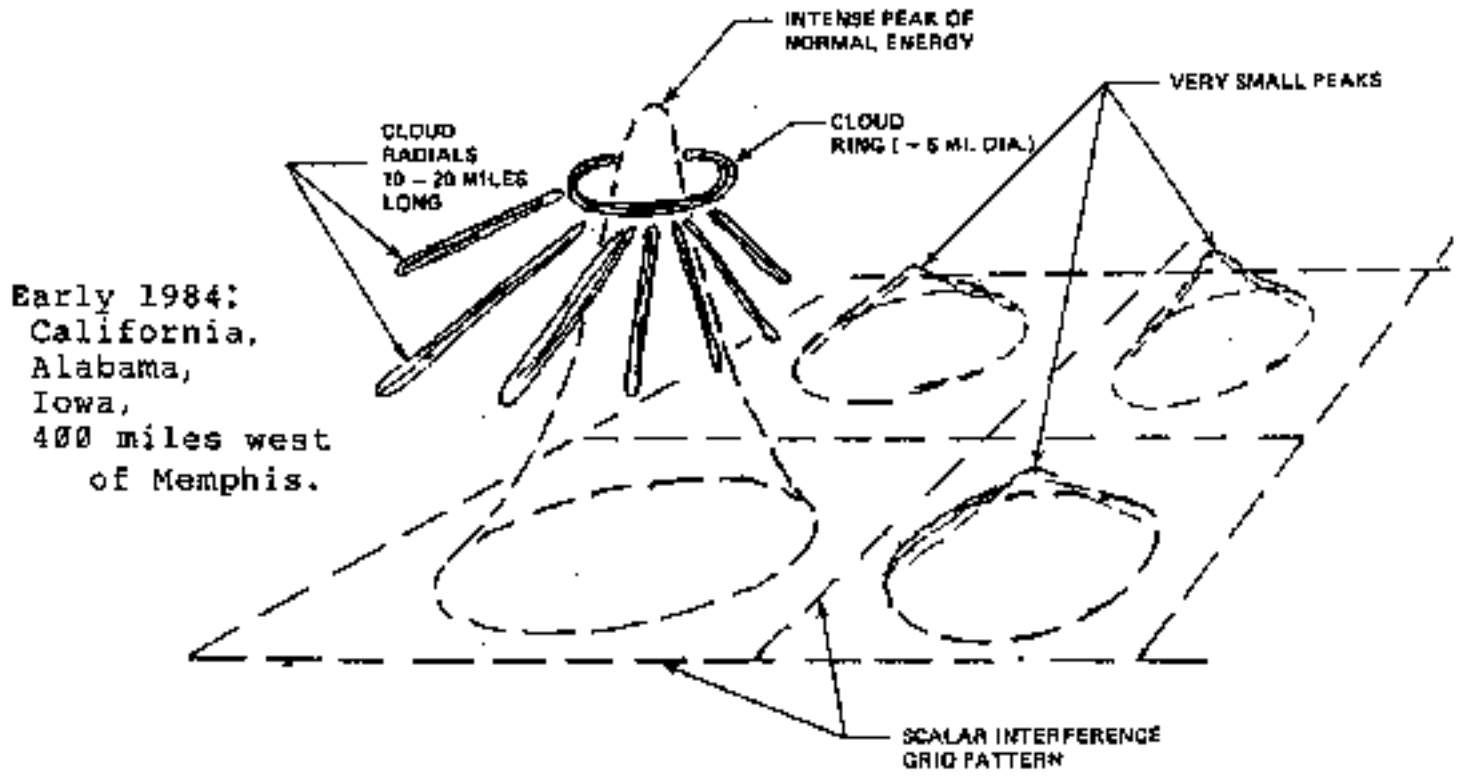

Excerpt P 172
FER DE LANCE

A Briefing on Soviet Scalar Electromagnetic Weapons
by Lt. Col. T.E. Bearden (retd.), 1986
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2. Continual cloud radials have repeatedly been seen and photographed over Huntsville, Alabama, associated with weather engineering and grid activity. Typical radials seen by this author are shown in Bearden, Soviet Weather Engineering Over North America, 1-hr. v1deotape, 1985. Huntsville is apparently a pivot point or "hinge point" for bending and controlling the jetstream.

3. Spectacular cloud grid patterns have been seen over Huntsville, Alabama and Los Angeles, California. An excellent videoclip of one of the Los Angeles area grids, personally observed and shot by KABC Open Mind talk show host Bill Jenkins, is shown in Bearden, Soviet Weather Engineering Over North America,;1-hr. videotape, 1985. An artist's sketch of an earlier gigantic grid, extending from horizon to horizon in every direction, seen over Huntsville, Alabama by Tom Bearden and Ken Moore, is also shown in the tape. The videotape is available from P.O. Box 1472, Huntsville, AL 35807. Sketches and details of another highly anomalous grid pattern observed in the greater Los Angeles area by engineer Ron Cole are shown in figures 5 and 6.

The reason that clouds of water droplets and/or ice particles detect the scalar interferometry and form signature patterns is simple: Consider each H2O molecule as having two light little hydrogen atoms hanging on to the much heavier oxygen atom. The covalent sharing with the oxygen atom of the electron from each hydrogen atom means that

1. the electrostatic scalar potential between the H ion and the O ion it is bonded to, is rhythmically varying as the electron is shared back and forth,
2. this varying potential contains "electron spin holes" since it is made by the moving electron,
3. two such varying potentials exist since there are two H atoms sharing covalent electrons with the O atom,
4. the two H ions are at an angle of over 100 degrees with respect to each other,
5. the molecule assembly thus constitutes one part (one half, so to speak) of a scalar interferometer with imbedded electron spin holes for electron hooking,
6. Incident scalar waves from outside the system interact with the "half scalar interferometer." This scalar interferometry interaction is coupled to the covalent bonding electron because of the internal spin hole pattern of the molecular half of the interferometer. The coupled electron moves with the sca1ar pattern's changes, causing an observable interaction with and in the electrical structure and ionic potential of the molecule,
7. the weak H to H hydrogen bonding between molecules connects resulting ionic potential changes to the structuring of the entire macroscopic cloud assembly. Thus by scalar interferometry with the H_2O "half interferometers", an incident scalar EM pattern is detected and translated into patterns of E and B force fields. The H_2O molecules then "line up" in accord with the electrical patterns detected.

Thus the clouds form "signature patterns" according to the incident scalar EM radiation patterns. Giant cloud radials in the targeted area are probably due to the type and shape of antennas including the type and shape of the electrical wires establishing the antennas' ground planes -- used by the Soviet Union to project the scalar waves. Note that such "radial" antenna patterns were occasionally used by James Harris Rogers in his underground and undersea scalar EM transmission system.

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Figure 15. FORMATION OF A DOUBLE GIANT RADIAL

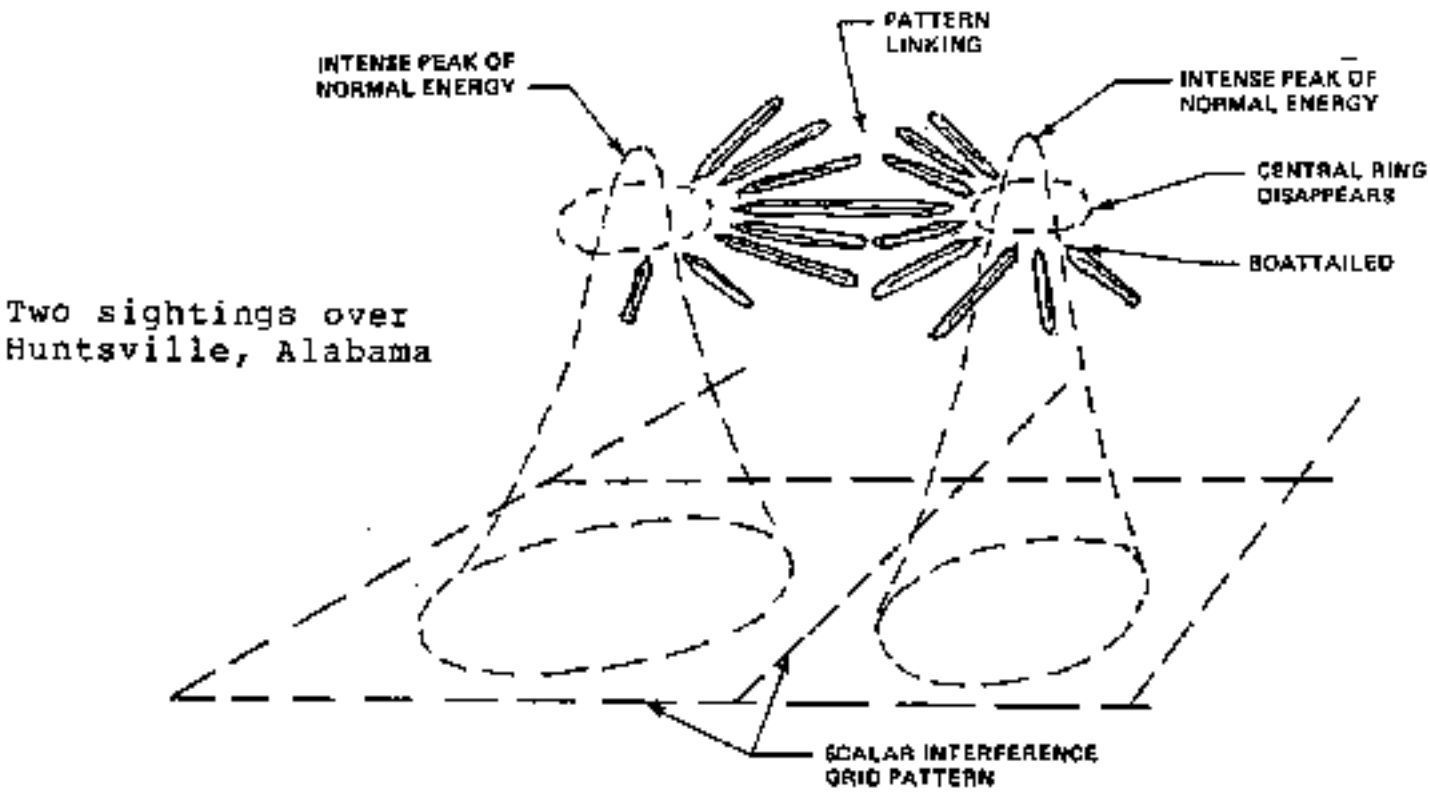

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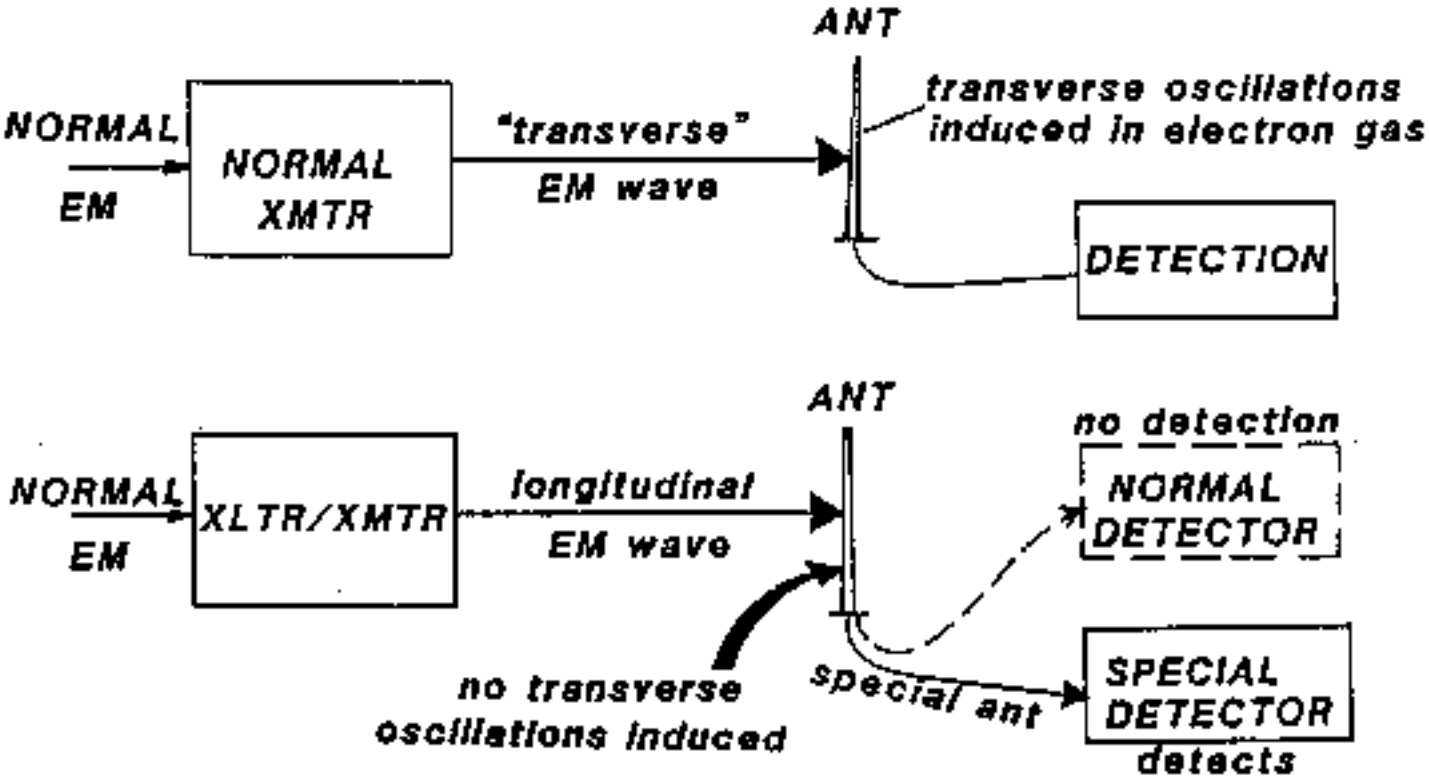

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Defense Department Briefing on Priore Treatment to counter Biological Warfare

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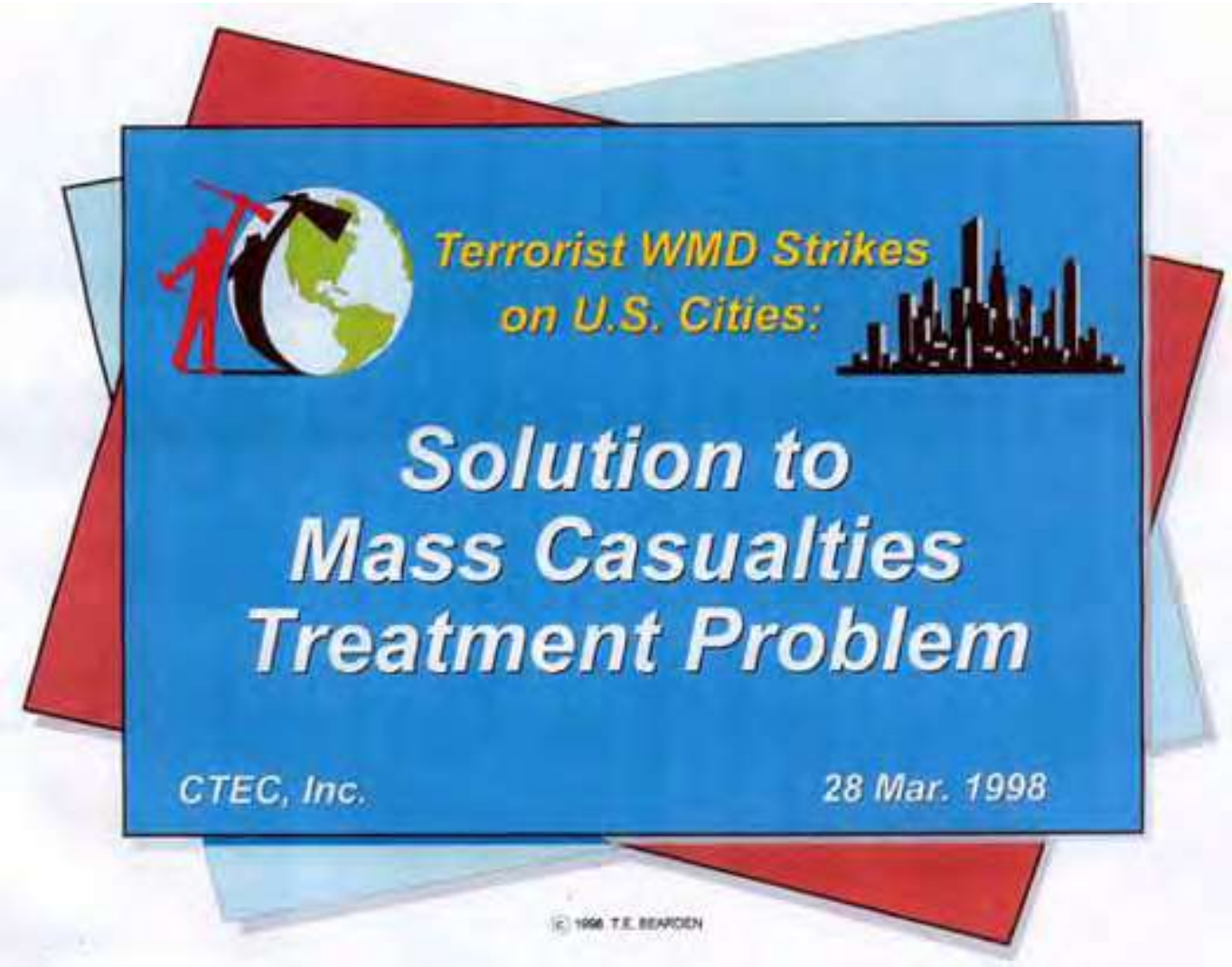

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Key Points in the New Technology

- There is a vast new kind of electrodynamics *hidden inside* all EM potentials, fields, and waves
  - Longitudinal EM waves and complexes
  - Oscillations in time domain

- These complexes are an *infolded general relativity*
  - Clustered formations of *spacetime curvatures*
  - *Very powerful*, since the EM force is used as the agent of curvature

- In general relativity, similar precise complexes permeate and *act on any mass at all internal levels*
- With this approach, one *can now manipulate matter* -- living or inert -- *in any manner desired*, depending only on the level of development of the technology
- Priore unwittingly used this to *cure dread diseases*
- This is a *revolution in all of science*

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- *We have uncovered the major mechanisms* to utilize

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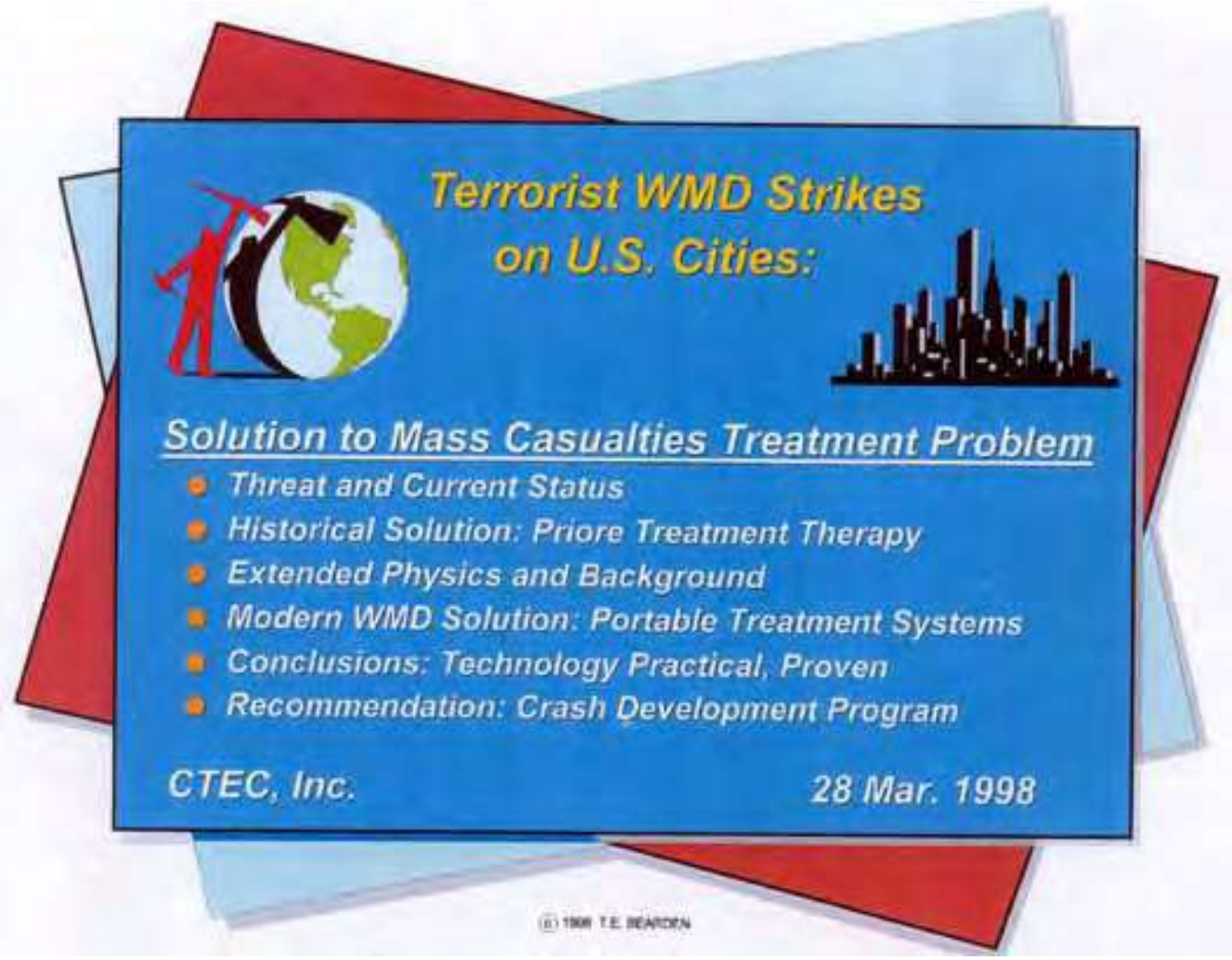

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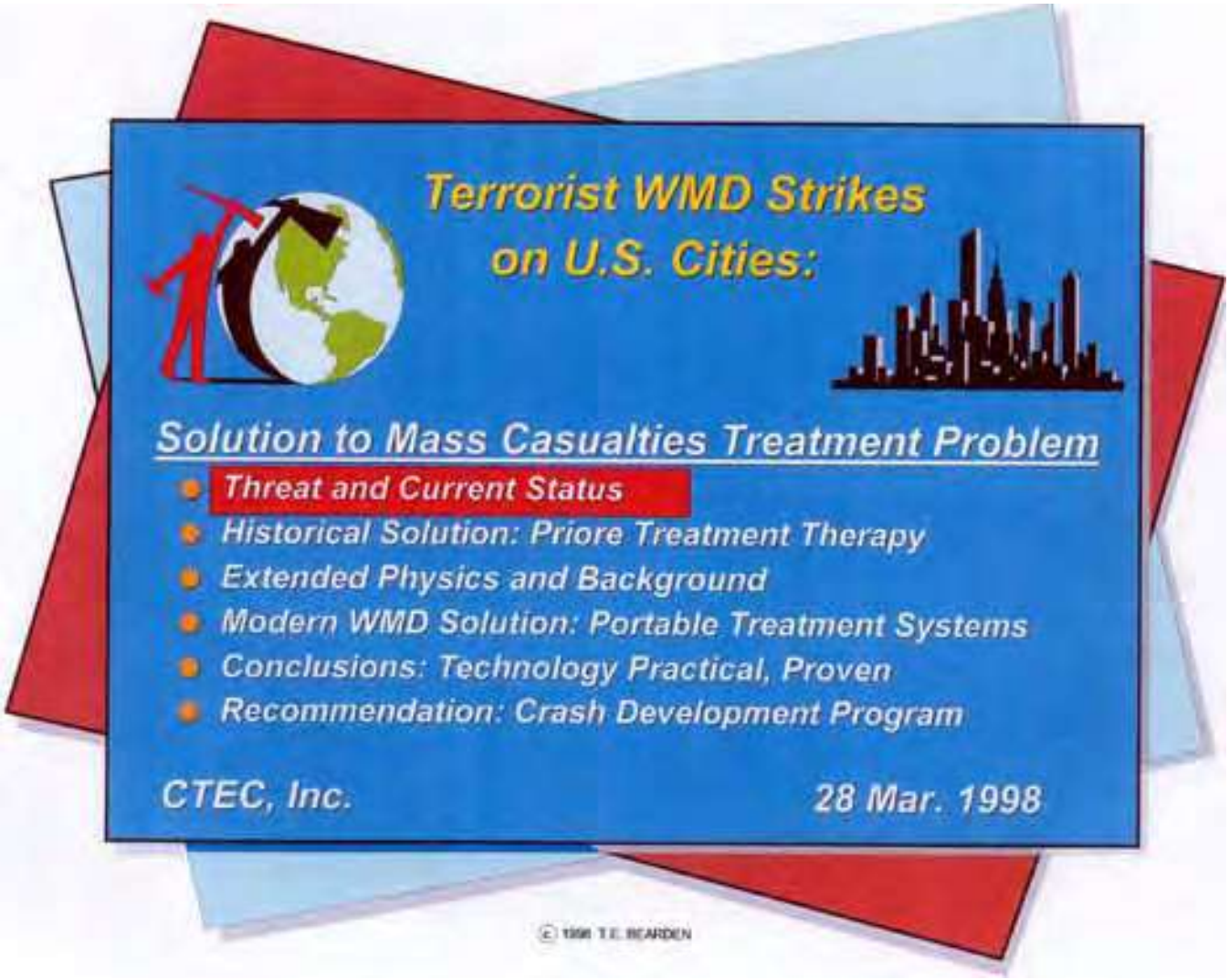

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THE TERRORIST THREAT

TODAY:

- Sabotage
- Chemicals
- Biological agents
- Nuclear materials
- Powerful explosives
- Assassination
- Kidnapping and hostages
- Contamination
- Shoulder-fired AD missiles
- Terrorism

FUTURE ADDITIONS:

- EM weapons
- EM biological warfare
- Scalar EM weapons
- Scalar EM disease induction
- Alteration of behavior and emotions
- Alteration of memory
- Direct thought control
- Action-at-a-distance effects

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Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- One terrorist, one light aircraft with spray tank
- 100 kilograms of anthrax
- Flies over greater metropolitan Washington, D.C.
- Calm night
- *1-3 million casualties result**
- *Most of those stricken will die*
- Presently little can be done to save the stricken civilians
- *Attacks on several population centers might produce some 10 million or more casualties*

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*Per OTA Report to Congress, 1993

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Present Status of the WMD Threat to the United States

- Many foreign nations are hostile to the U.S. and sponsor terrorists
- Some 25 nations have WMD or are acquiring them
  - BW agents and weapons
  - Chemical agents and weapons
  - Nuclear materials and weapons
- Thousands of students and emigres
- Infiltrated teams, BW, other WMD already
- Castro guerrillas infiltrated over the years
- Can do unacceptable damage to U.S. now
- *May reach first strike knockout capability*

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*Per OTA Report to Congress, 1993

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Some Present Problems in the U.S. WMD Defense Capabilities

- No shelters (require overpressure, BW filtering, masks, showers, supplies)
- No stockpiled vaccines, medical supplies, immunoglobulins, masks, suits, food, fuel, generators, heaters, water purification units
- Totally insufficient medical facilities, personnel, and emergency response teams
- Triage, full martial law will be required
- No answer to massive decontamination problem
- State, county, city inadequately staffed and insufficiently trained for mass casualties
- Terrorist teams, BW agents, other WMD on site, waiting
- Water supplies, food, crops, farm animals also vulnerable
- Electric power grid, bridges, trains, railroads vulnerable
- Present medical science cannot save very many of the casualties, now or in the foreseeable future

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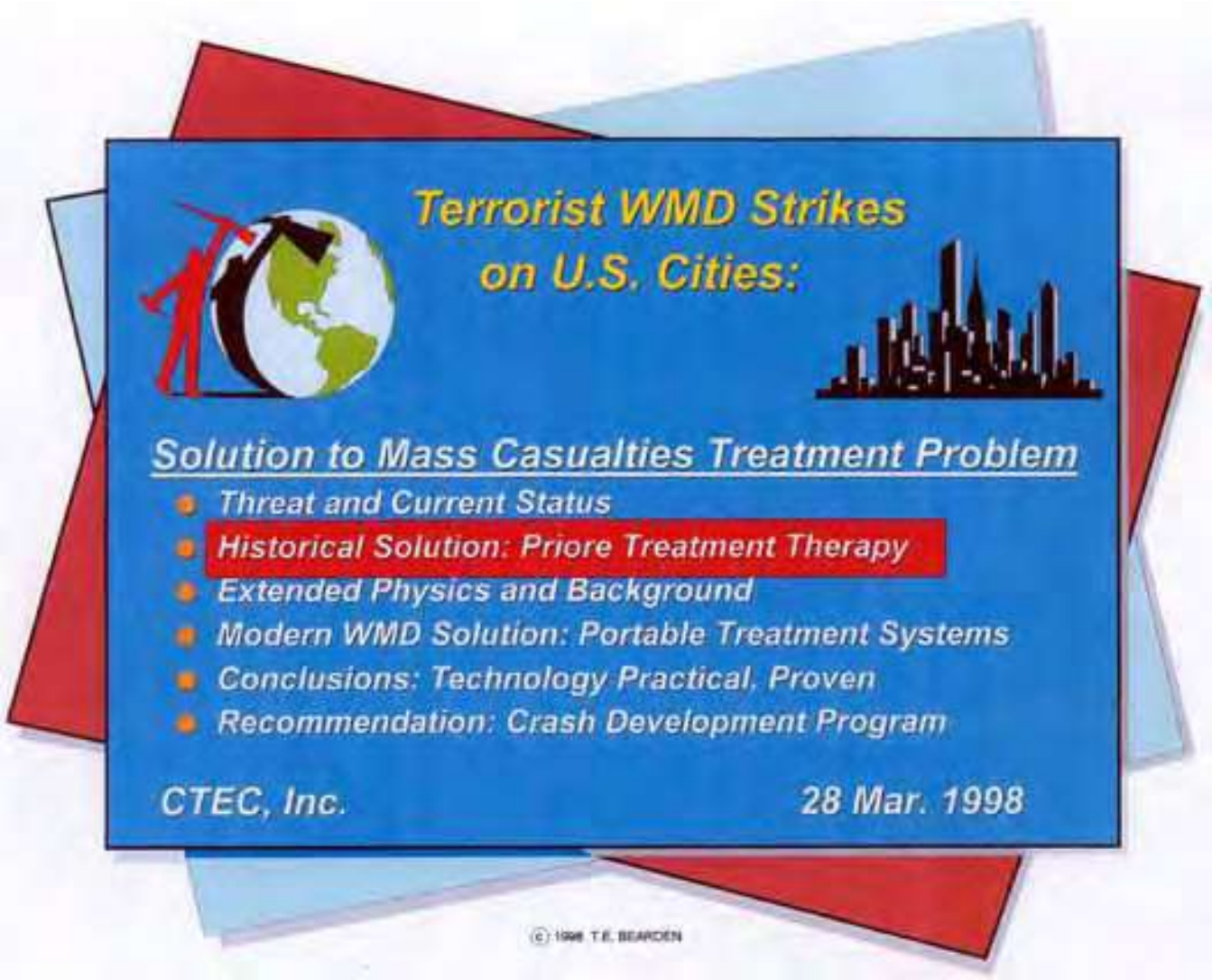

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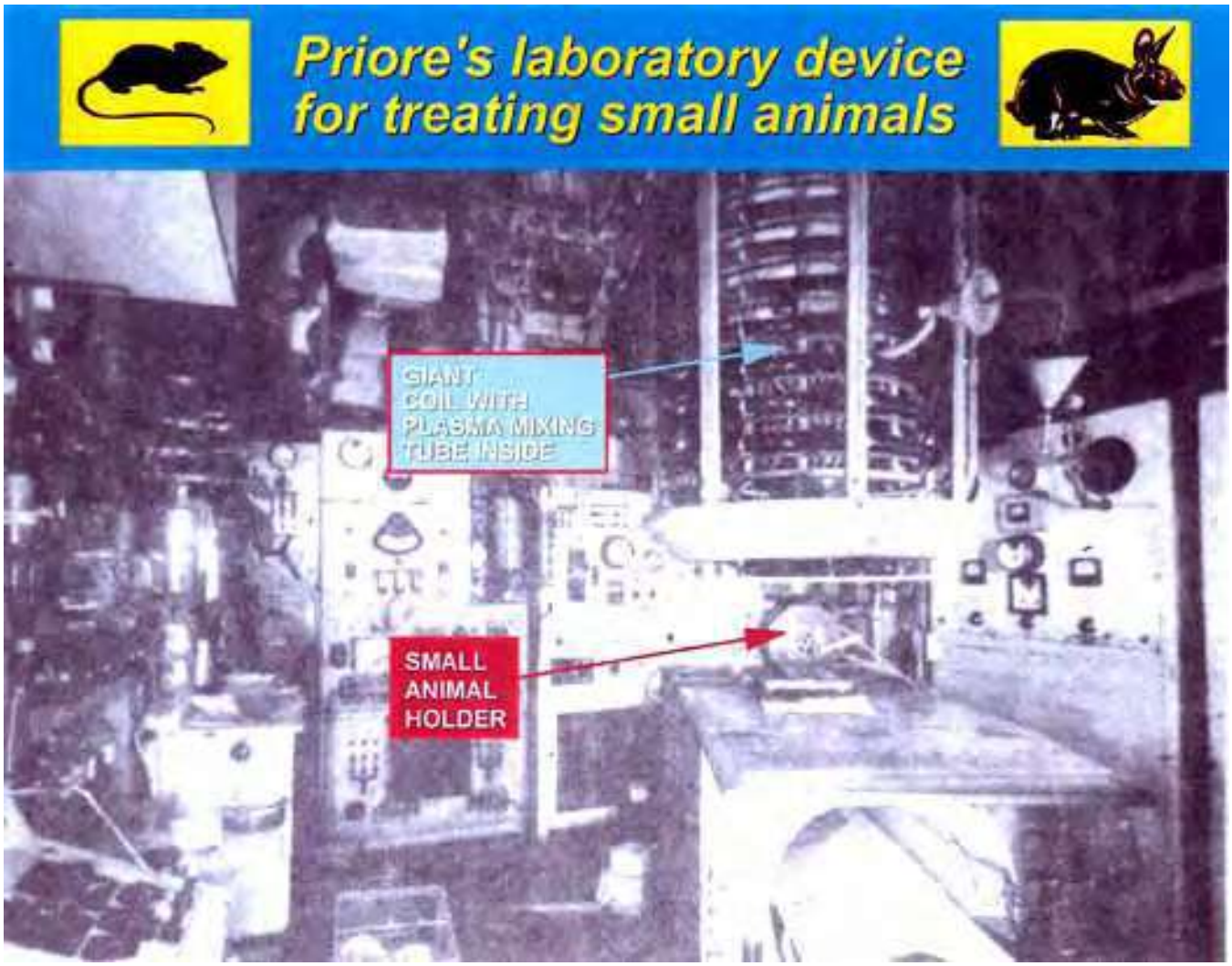

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Photo courtesy of Bob Whitney

Antoine Priore (right) with the Mayor of Bordeaux, Mr. Chaban-Delmas.

The Priore technical mechanism unwittingly involved a dramatic extension to both nonlinear optics and general relativity. However, nonlinear optics itself had not yet been born in the 1950s and 1960s when Priore worked out his methodology. The extension to general relativity has not been previously envisioned even to the present day. When the Priore project was suppressed by the changed French government in the mid-1970s, nonlinear optics itself was just being initiated. To the present day, however, there has previously been no inkling of the dramatic extension to NLO that arises by using longitudinal EM pump waves and thereby pumping in the time domain.

It is little wonder that Priore himself did not understand the nature of the technical mechanism he was utilizing, and neither did anyone else, and neither *has* anyone else prior to this time.

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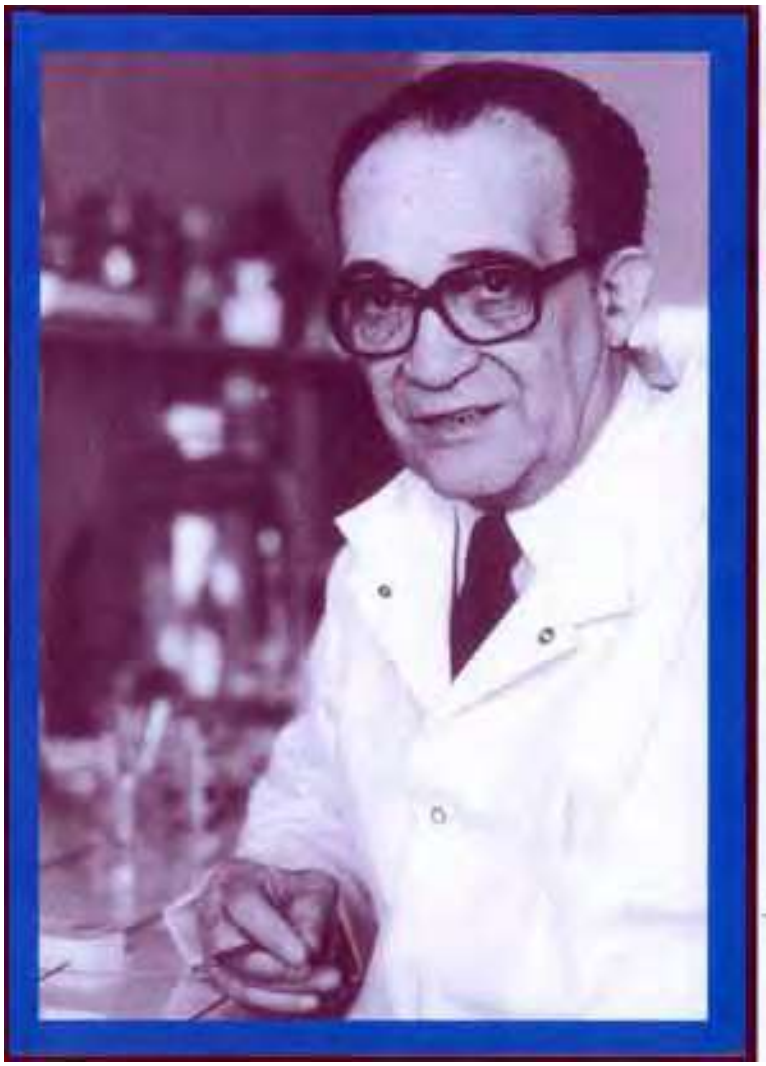

Raymond Pautrizel, eminent French parasitologist who worked with Priore

Among other things, Pautrizel treated seriously infected immature rats with the Priore ray. These rats had never had a mature immune system. When they were removed from the machine, they still sickened again and died, because their immature immune systems could not resist the pathogen *(Trypanosoma)*. So even though the damaged cells were reversed back to normal, the "normal" immune system was unable to fight off pathogens, which reinfected the cells and killed them, killing the rats.

This established the time-reversal nature of the therapy.

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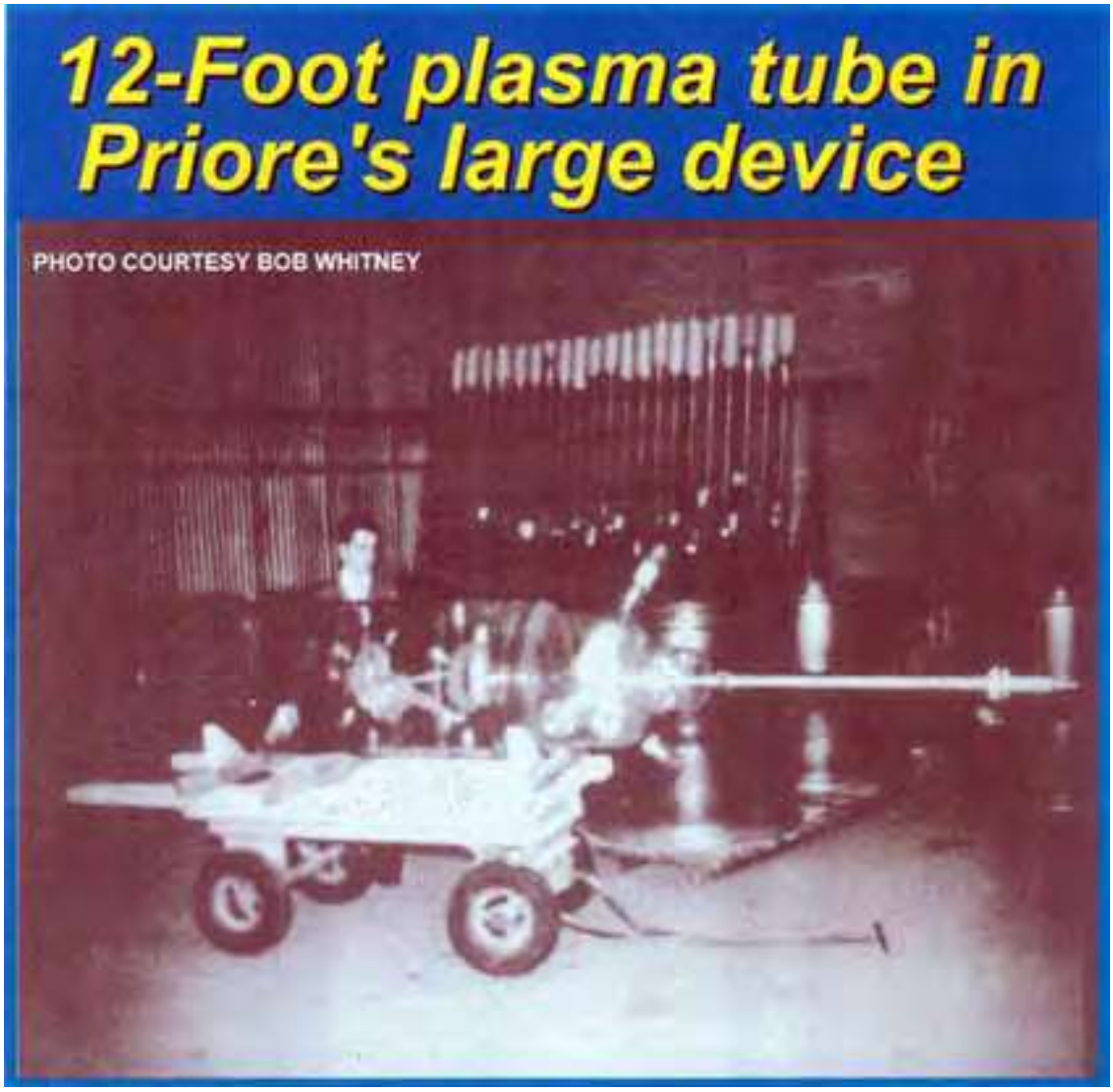

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MECHANISM OF THE PRIORE THERAPY

- FACT: DISEASE-SPECIFIC VACUUM ENGINE PRESENT FOR ANY CELLULAR DISEASE, BY WHEELER'S PRINCIPLE
  - *DISEASE CAN BE REVERSED BY CREATING AMPLIFIED VACUUM ANTI-ENGINE (BEARDEN'S PRINCIPLE)*
  - *ANTI-ENGINE IS CREATED BY PUMPING THE NONLINEAR CELLS IN THE "INNER EM" DOMAIN, TIME-REVERSING THEM*

- PRIORE UTILIZED A PLASMA TO PHASE CONJUGATE AND "INFOLD" MULTIPLE BIDIRECTIONAL LONGITUDINAL EM PUMP WAVES
  - *17 FREQUENCIES MIXED IN A ROTATING PLASMA*
  - *PHASE CONJUGATES ADDED BY THE PLASMA*
  - *INFOLDED MIX INTO STRONG PULSED DC MAGNETIC FIELD, WHICH CARRIED IT INTO ATOMIC NUCLEI*
  - *PUMPED ALL NONLINEAR CELLULAR COMPONENTS TO PRODUCE AMPLIFIED, SPECIFIC VACUUM ANTI-ENGINE*

- NEGATED THE LONG-TERM CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CELLS.
- SCRUBBED OUT THE CUMULATED PRECANCEROUS STATE
- RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING
- NO EXCESSIVE TRAUMA TO TREATED ANIMAL

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Priore's therapeutic methodology: Using infolded longitudinal EM waves as NLO pump waves, to pump in the time domain

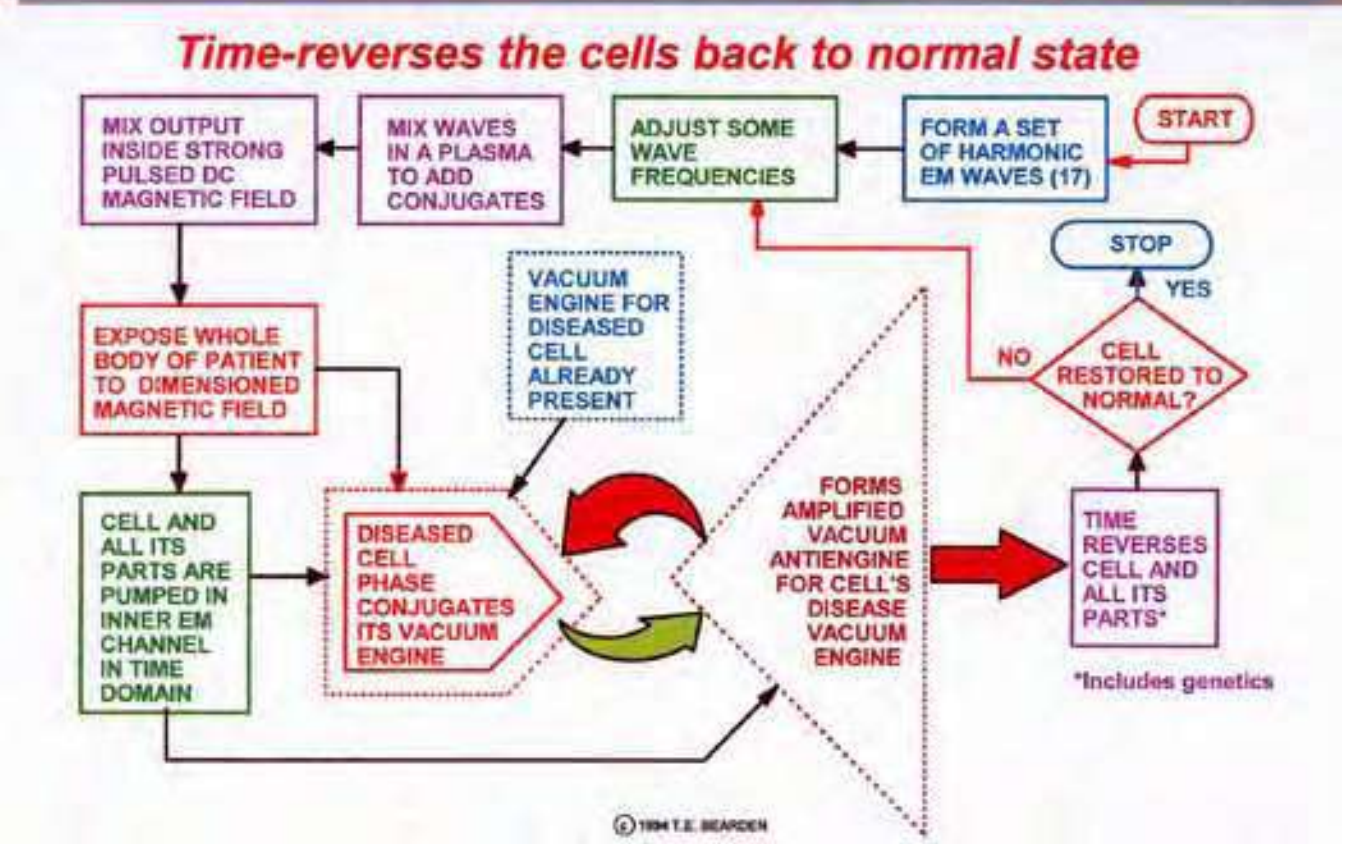

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DRASTICALLY REDUCED CUMULATIVE DETERIORATION AFTER PRIORE THERAPY

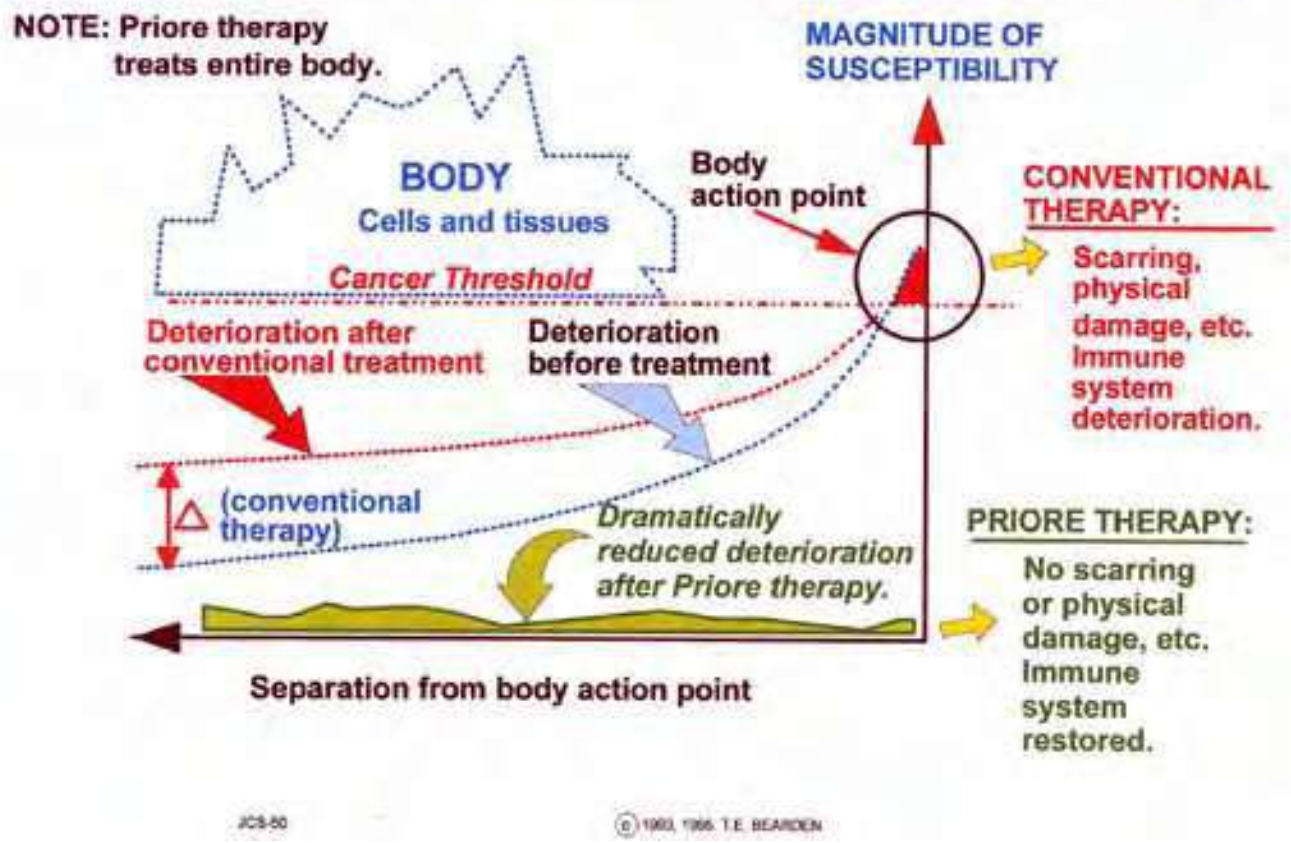

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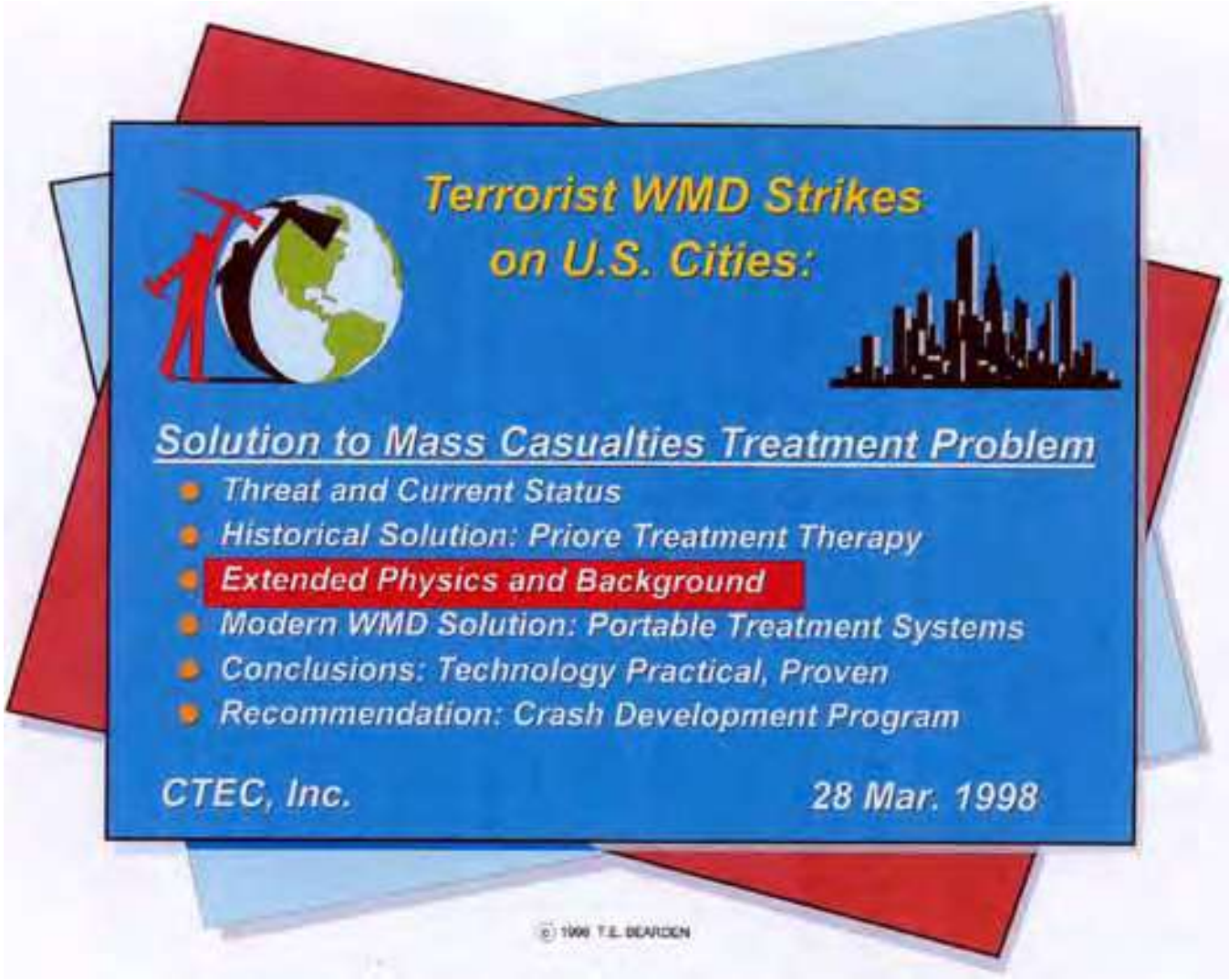

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Founders of Scalar Electromagnetics

- **G.J. Stoney:**

Decomposed the scalar potential into bidirectional wave pairs.

"On a supposed proof of a theorem in wave-motion," Phil. Mag., 5(43), 1897, p. 368-373 (and several other papers).

- **E.T. Whittaker:**

Decomposed the scalar potential into a series of bidirectional EM wave pairs in harmonic series, where the two waves in each pair are conjugates (i.e., a wave/antiwave pair) and are longitudinal waves.

"On the partial differential equations of mathematical physics," Math. Ann., Vol. 57, 1903, p. 333-355.

Showed that all classical EM -- including waves -- can be replaced by two interfering scalar potential functions.. (This founded superpotential theory, extended by Nisbet, Bromwich, Debye, McCrea, and others.)

"On an expression of the electromagnetic field due to electrons by means of two scalar potential functions," Proc. Lond. Math. Soc., Series 2, Vol. 1, 1904, p. 367-372.

- **R.W. Ziolkowski:**

Independently rediscovered the biwave decomposition of the scalar potential and added the product set (in theory enabling modulations and communications) to Stoney and Whittaker's sum set.

Various papers, 1985 to date.

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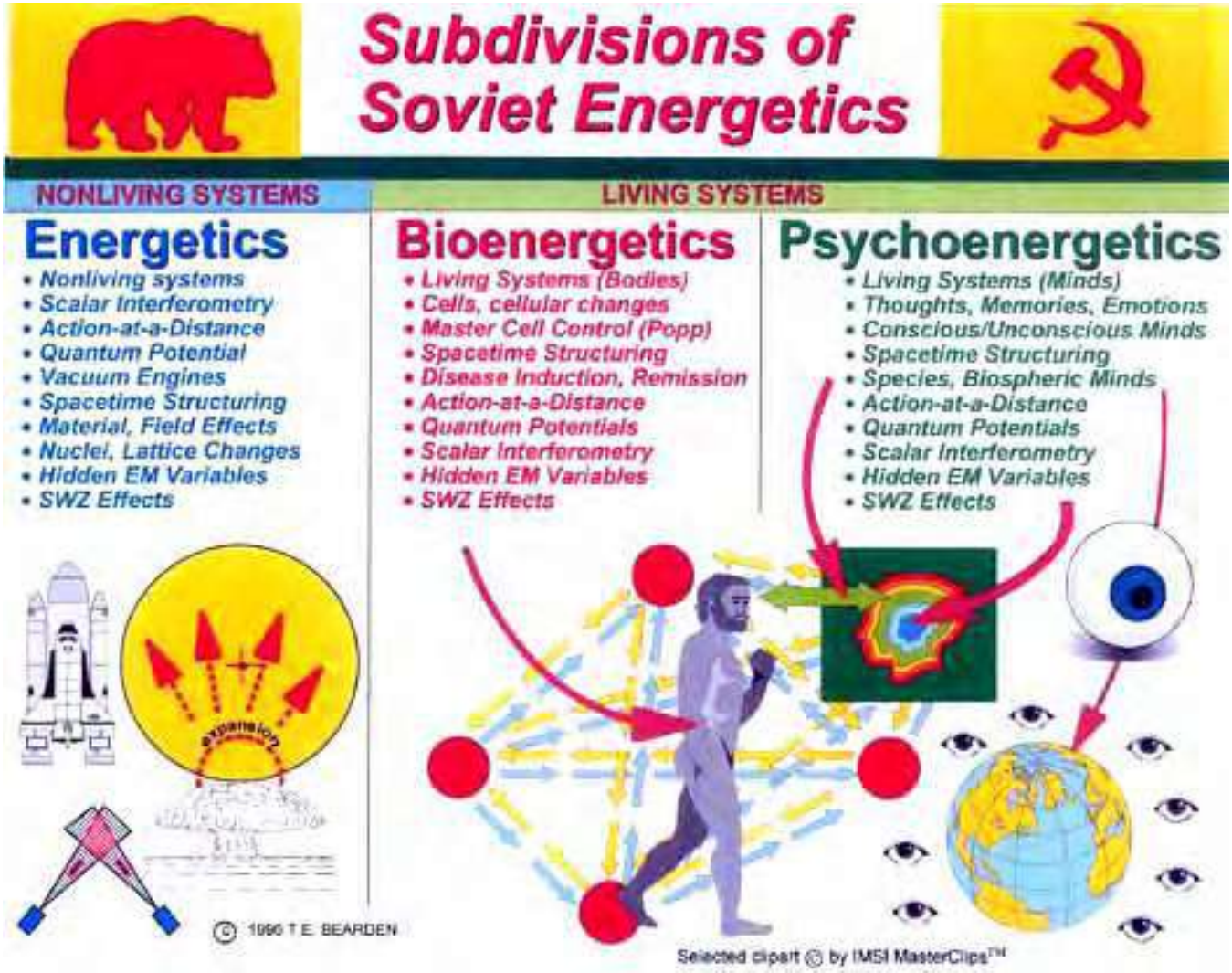

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Bunge on the Status of Classical and Quantum Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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EINSTEIN ON REVIEWING FOUNDATIONS

"...the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools of thought, as something obviously, immutably given; something having an objective value of truth which is hardly even, and in any case not seriously, to be doubted. ...in the interests of science it is necessary over and over again to engage in the critique of these fundamental concepts, in order that we may not unconsciously be ruled by them."

Albert Einstein, "Foreword," in Max Jammer, Concepts of Space: The History of the Theories of Space in Physics, Harvard University Press, Cambridge, Massachusetts, 1969, p. xi-xii.

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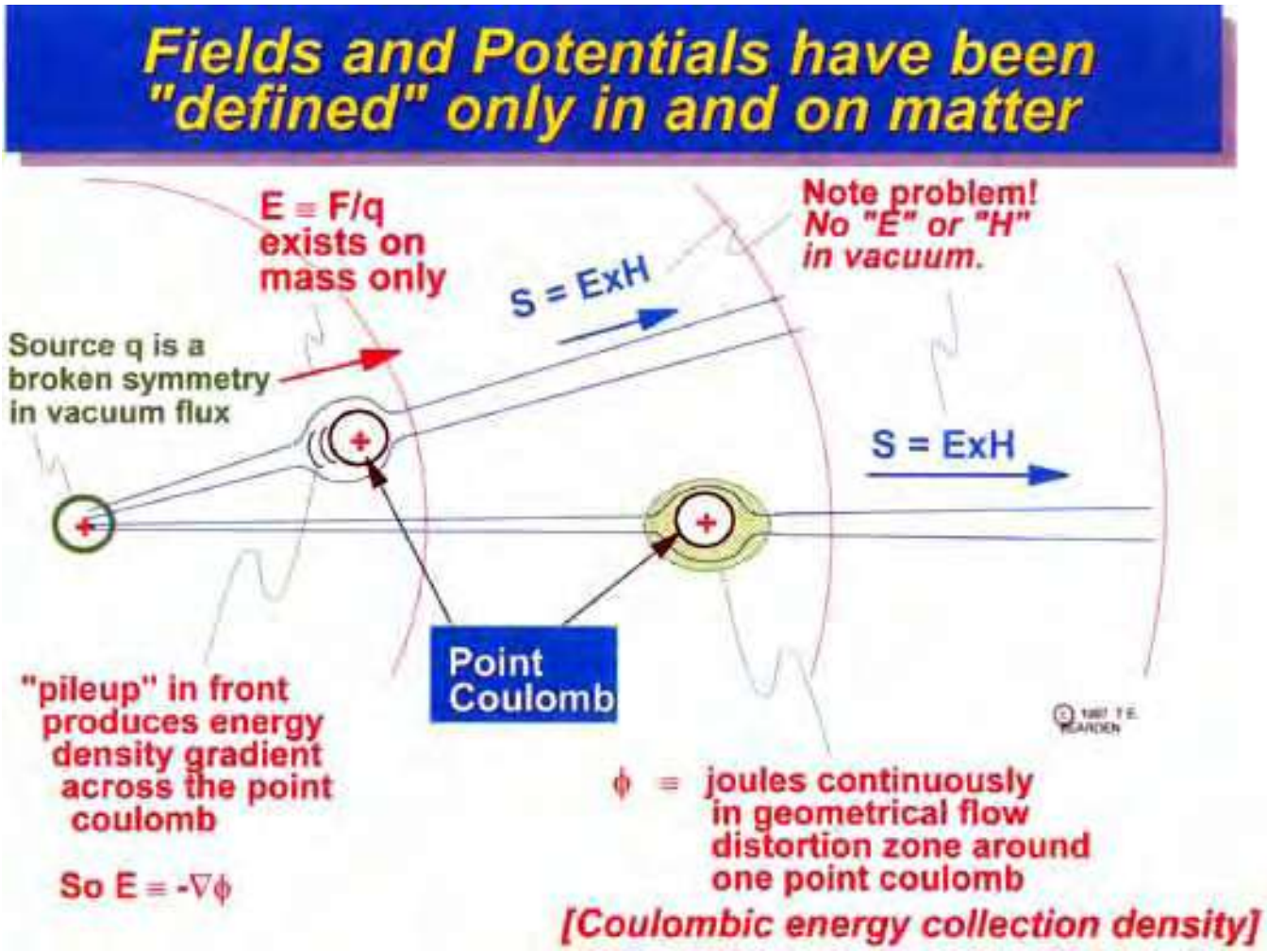

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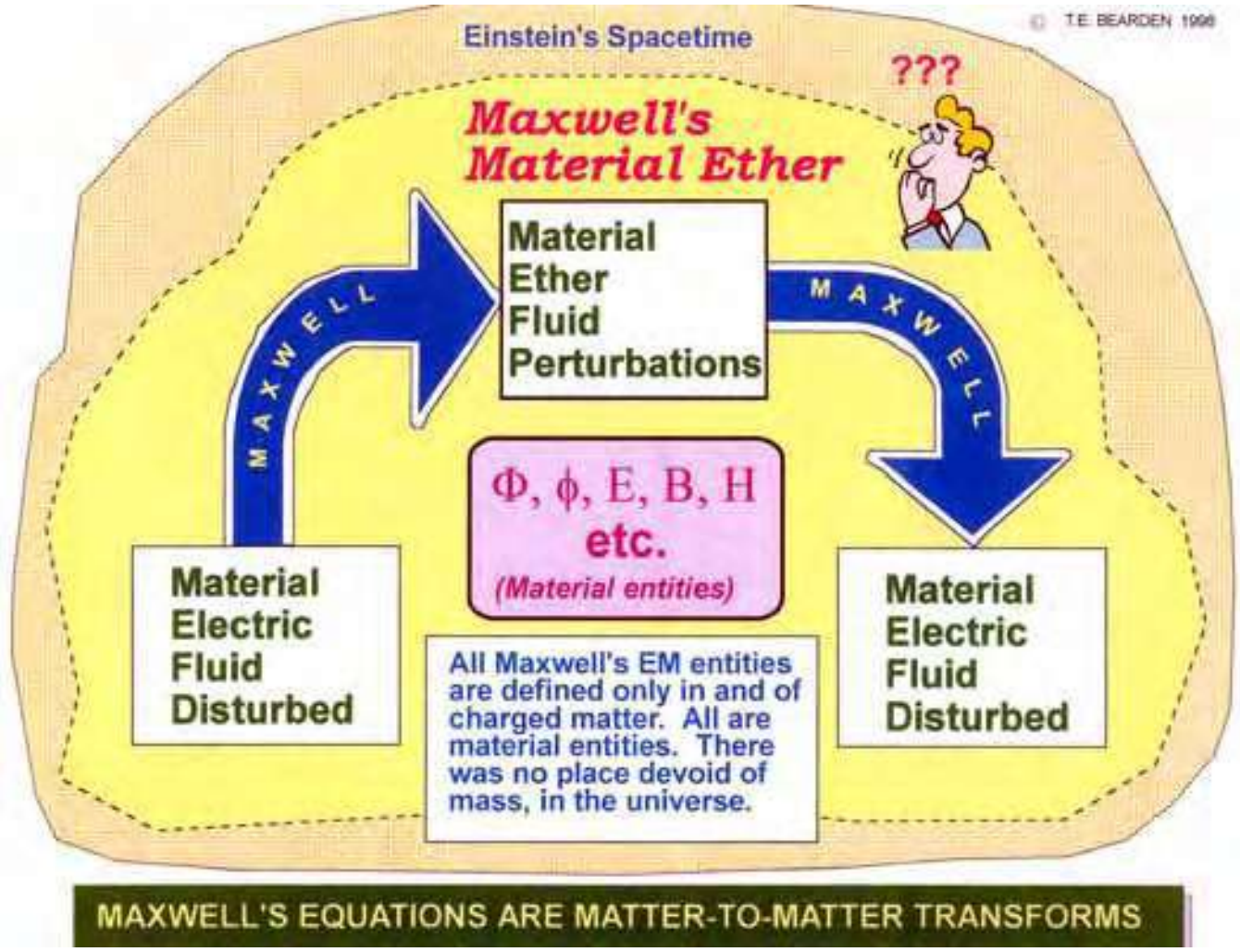

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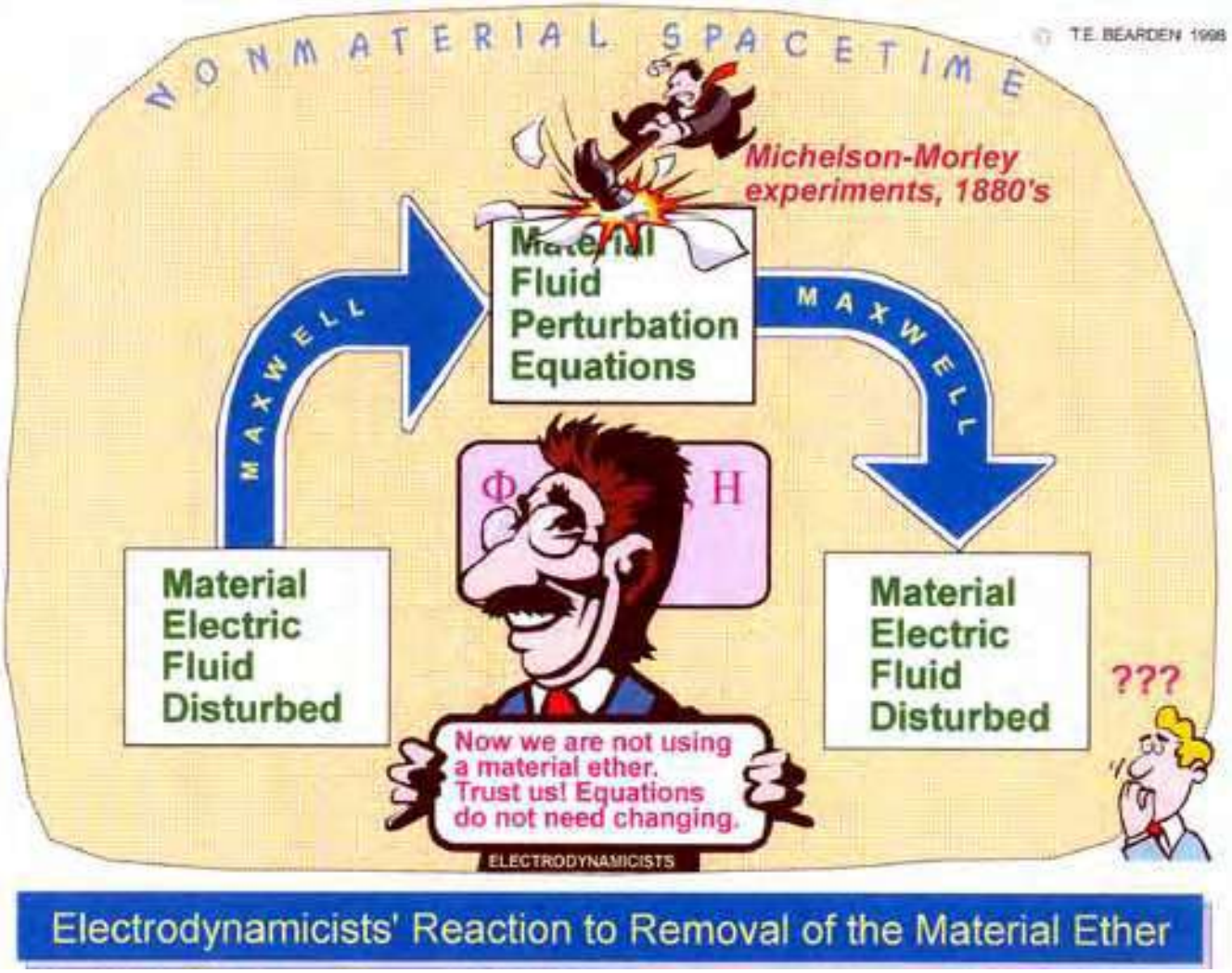

Electrodynamicists' Reaction to Removal of the Material Ether

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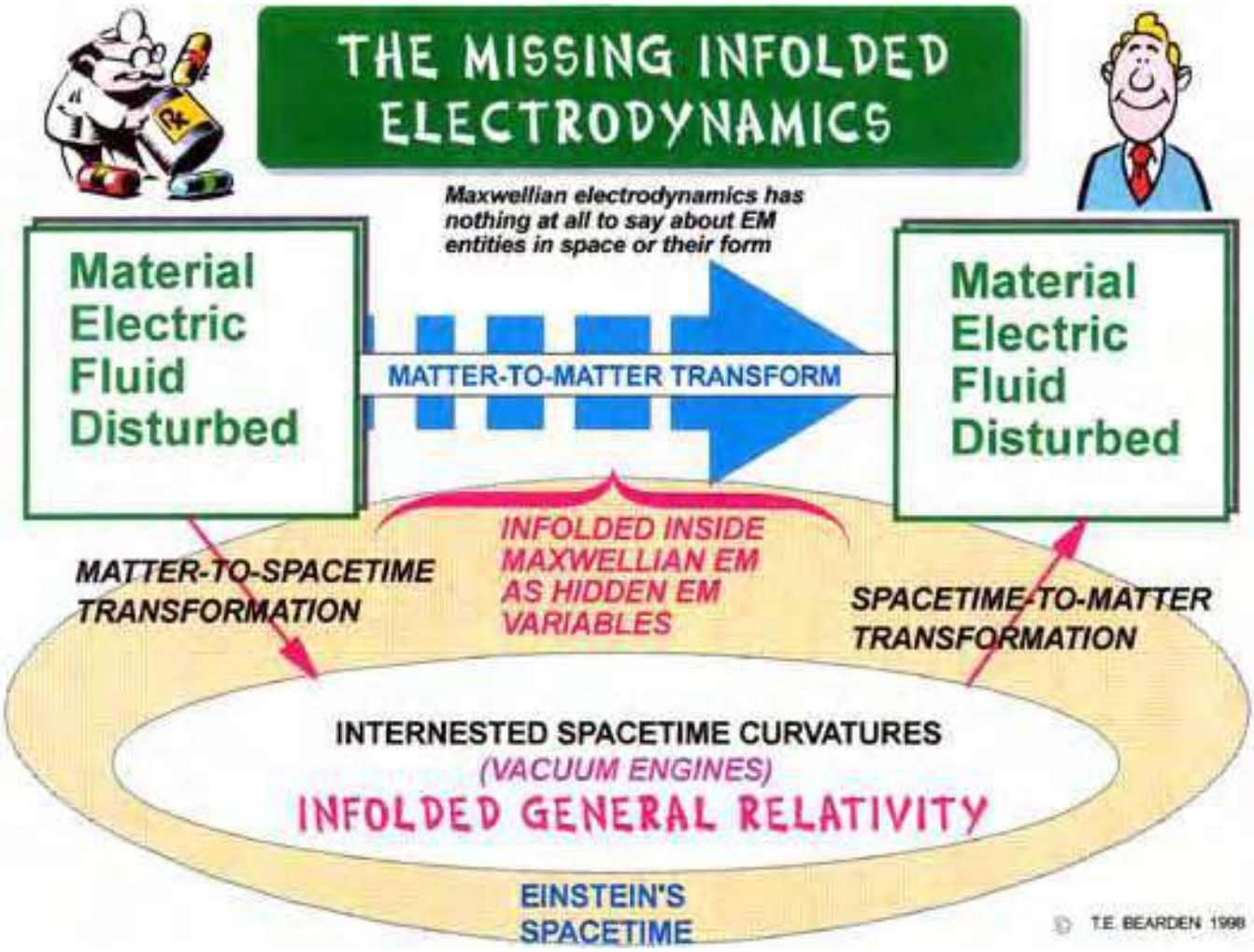

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Nonlinear Optics
Distortion Correction Theorem

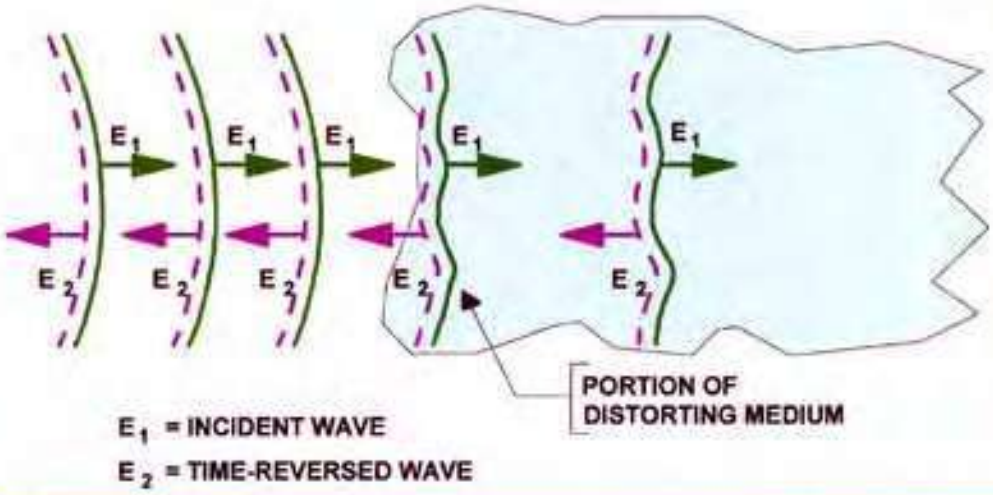

"If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

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Infolded longitudinal EM biwave composition of a scalar potential

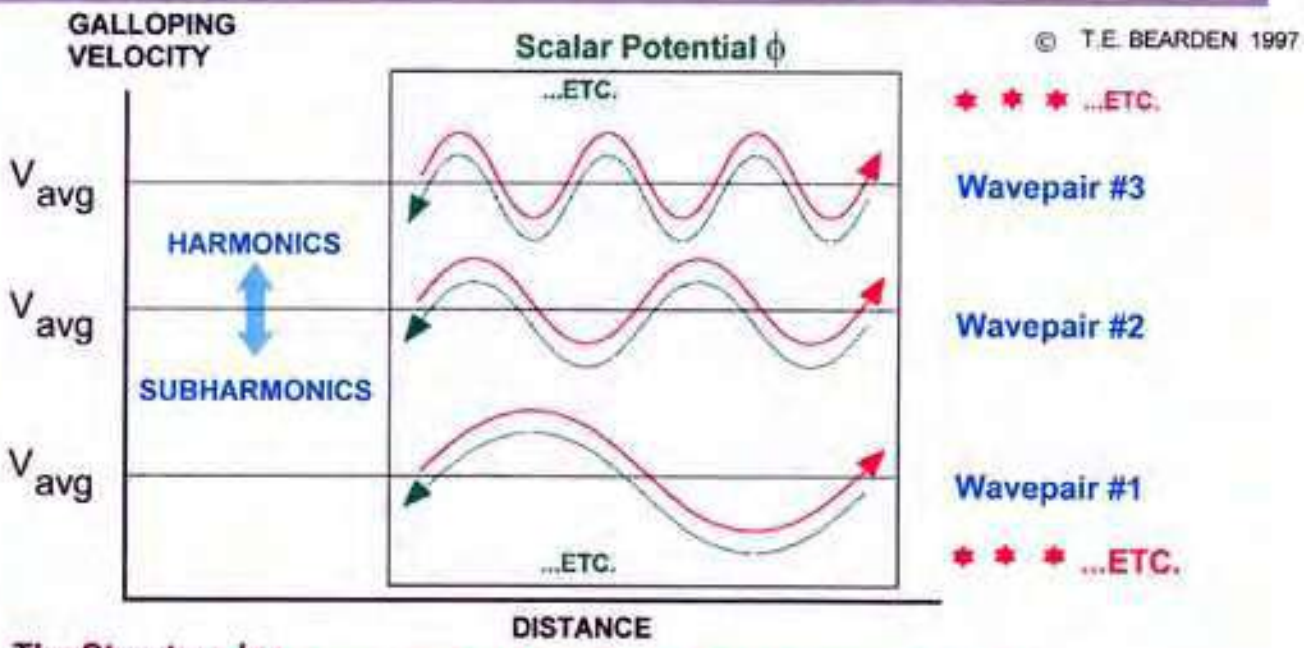

The Structure Is:

A harmonic set of longitudinal EM wavepairs. In each wavepair the two waves superpose spatially, but travel in opposite directions. The two are phase conjugates and time-reversed replicas of each other. Thus they comprise a coupled longitudinal wave and antiwave. The photons must be coupled into photon/antiphoton pairs (gravitons) by a strong application of the distortion correction theorem of nonlinear optics. Each wave in the biwave pair is a galloping wave. Each wavepair is a standing electrogravitational wave. In nonlinear optics, such a wavepair is a pump wave which pumps in the time domain.

Note: Think of the oscillations as velocity modulations.

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The Zero-Vector Axiom Destroys "Topologies within Topologies"

- The axiom: There is a unique vector, $\overline{0}$, in V (the vector space) such that
  $$\overline{V} + \overline{0} = \overline{0} + \overline{V}$$
- Note that $\overline{V} + \overline{0}_i = \overline{0}_j + \overline{V}$; $\overline{0}_i = -\overline{0}_i = n\overline{0}_i$
  so $\overline{0}_i = \overline{0}_j = \overline{0}_k = \ldots + \overline{0}_n = \ldots$
- This makes all $\overline{0}_i$ equal by assumption, since there is *assumed* to be only a single type $\overline{0}$ without real components
- In fact, $\overline{0}$ is <u>*not unique*</u>. An *infinite number* of different zero-vector systems, with real components, satisfy the zero-vector axiom.

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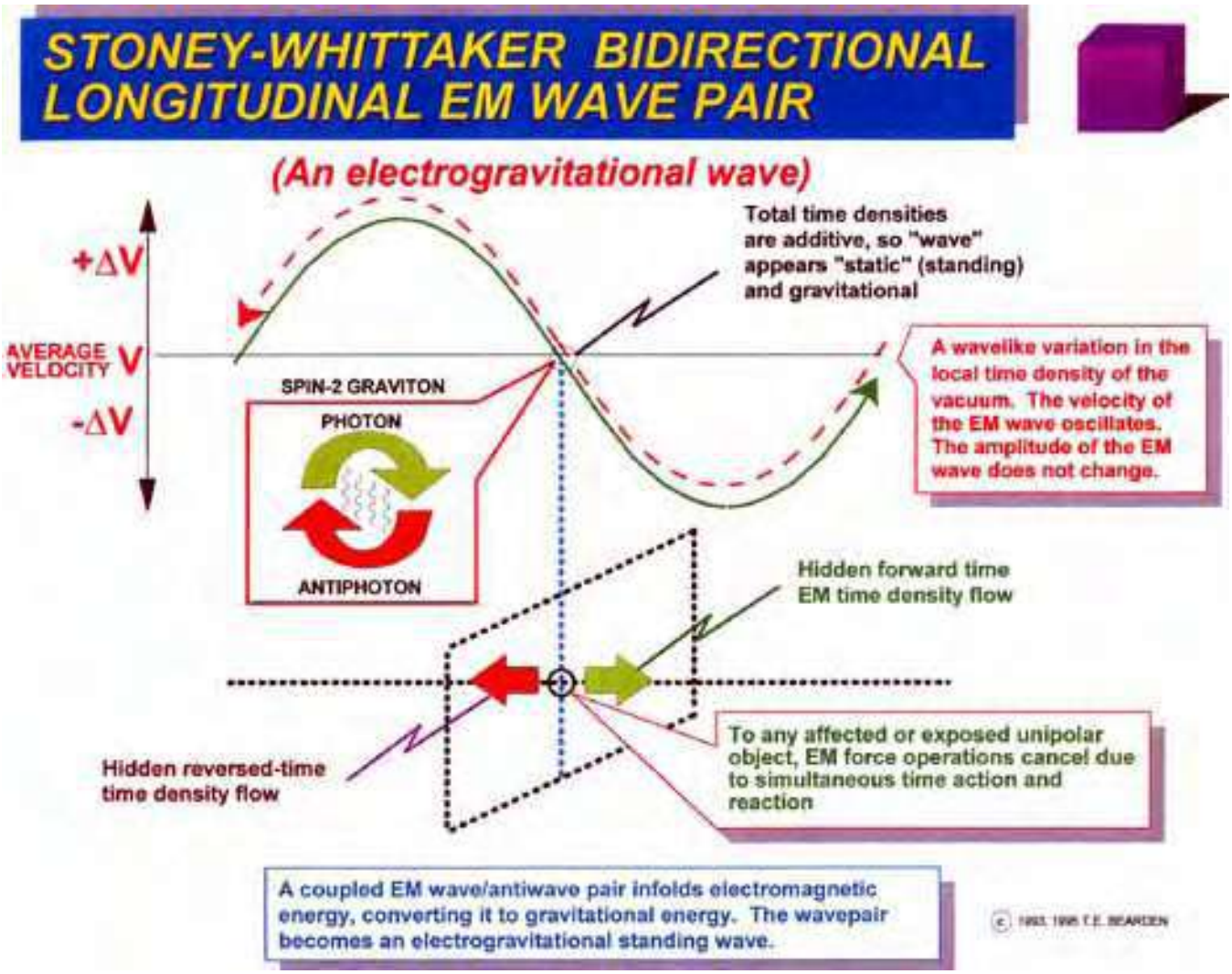

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Undistorted Progressive Waves (UPWs)*

(waves with velocity v, where $0 \leq v \leq \infty$)

- Major equations of interest having UPW solutions are:
  - *Homogeneous wave equation*
  - *Maxwell equations*
  - *Dirac, Weyl, and Klein-Gordon equations*

*Rodrigues and Lu, *Found. Phys.* 27(3), 1997, p. 435-508.

- UPWs are translationally invariant, and do not spread, or they reconstruct their original form after a certain period.
- UPW solutions have infinite energy. Quasi-UPWs can have finite energy and can in principle be launched into space.
- Subluminal Maxwell solutions are called *EM particles*. Superluminal Maxwell solutions are called *X-waves*.
- *Experimental results indicate such waves will be produced within the next few years.*

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- *Nimtz has translated Mozart's 40th symphony at v = 4.7c.*

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Velocity modulating a longitudinal EM wave oscillates rate of flow of time

$$V = \frac{L}{t}$$

Observer sees it this way

Constant transverse wave magnitude

Wave oscillates its velocity along its path, about a nominal value

Wave oscillates this way

Constant transverse magnitude

Wave oscillates magnitude of its transported t, about a nominal value

Note:

- Waves consist of photons
- Each photon consists of energy x time
- Each photon carries time as well as energy
- A wave is both a spatial energy dynamics and a temporal dynamics
- Wave complexes carry dynamic time structures as well as dynamic energy structures

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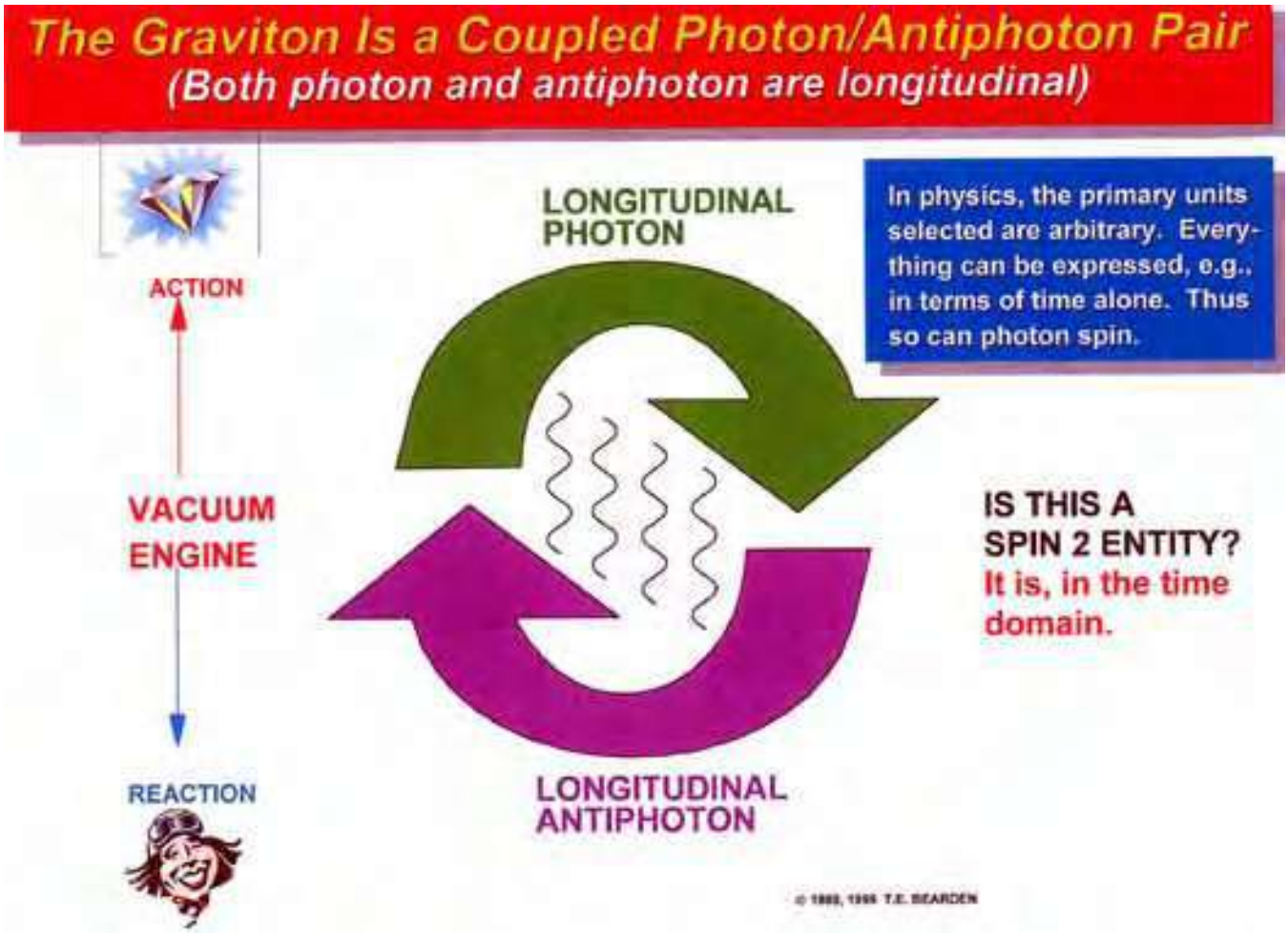

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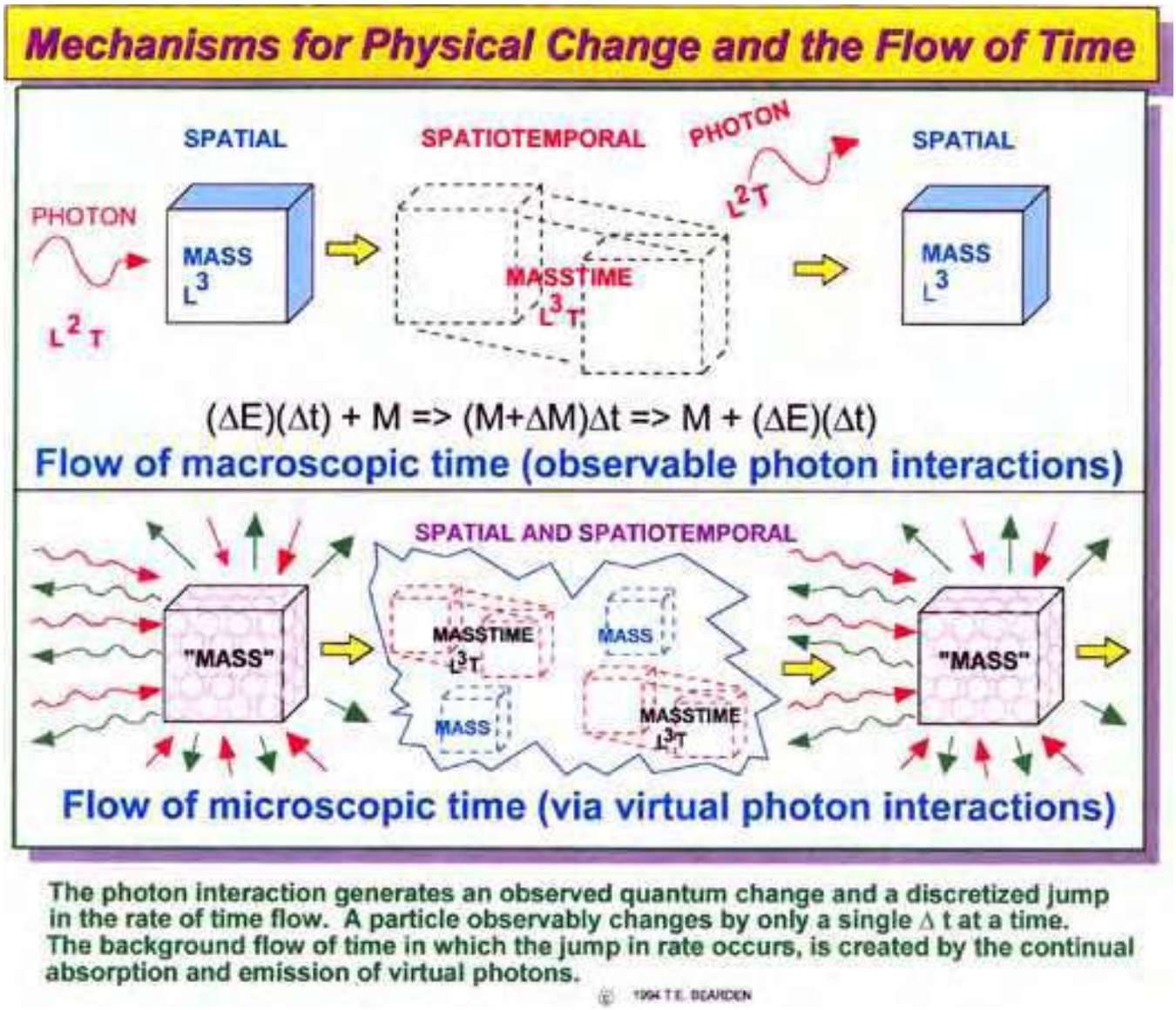

The photon interaction generates an observed quantum change and a discretized jump in the rate of time flow. A particle observably changes by only a single Δ t at a time. The background flow of time in which the jump in rate occurs, is created by the continual absorption and emission of virtual photons.

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Any EM Field or Wave Pattern Is Produced by interference of Two Scalar Potential Functions *(E.T. Whittaker, 1904)*

(Use of Hidden Information Content of the Field)

(Can Provide Action-at-a-Distance)

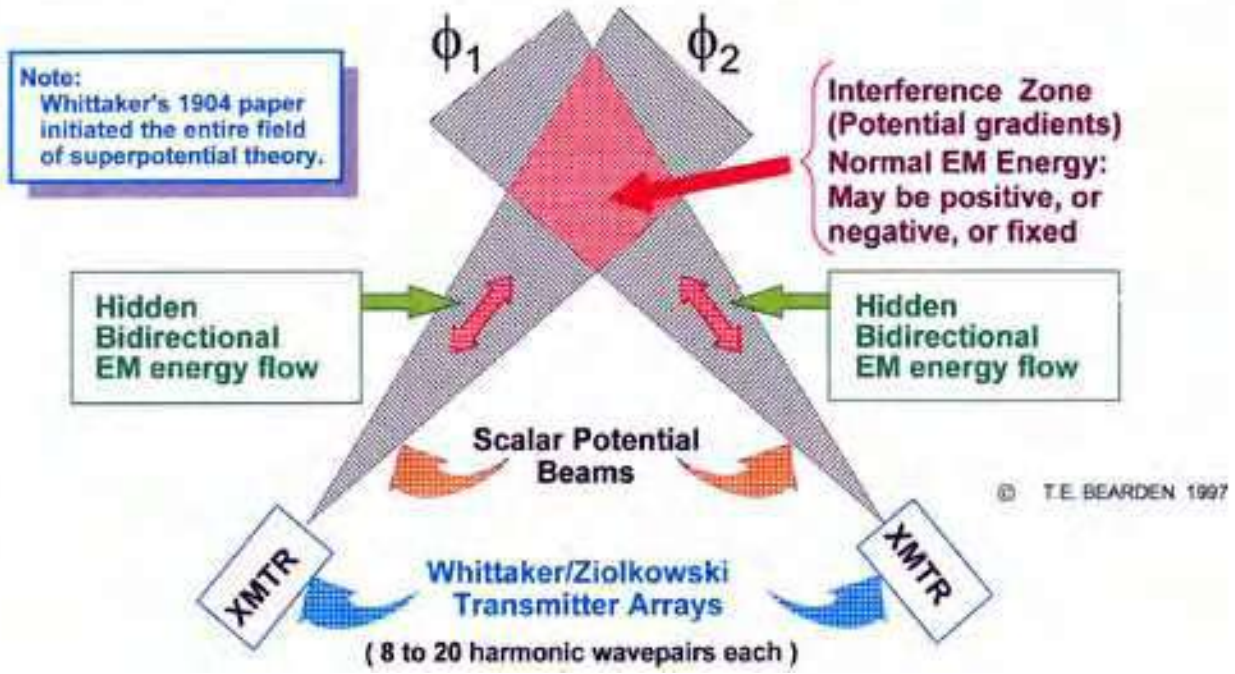

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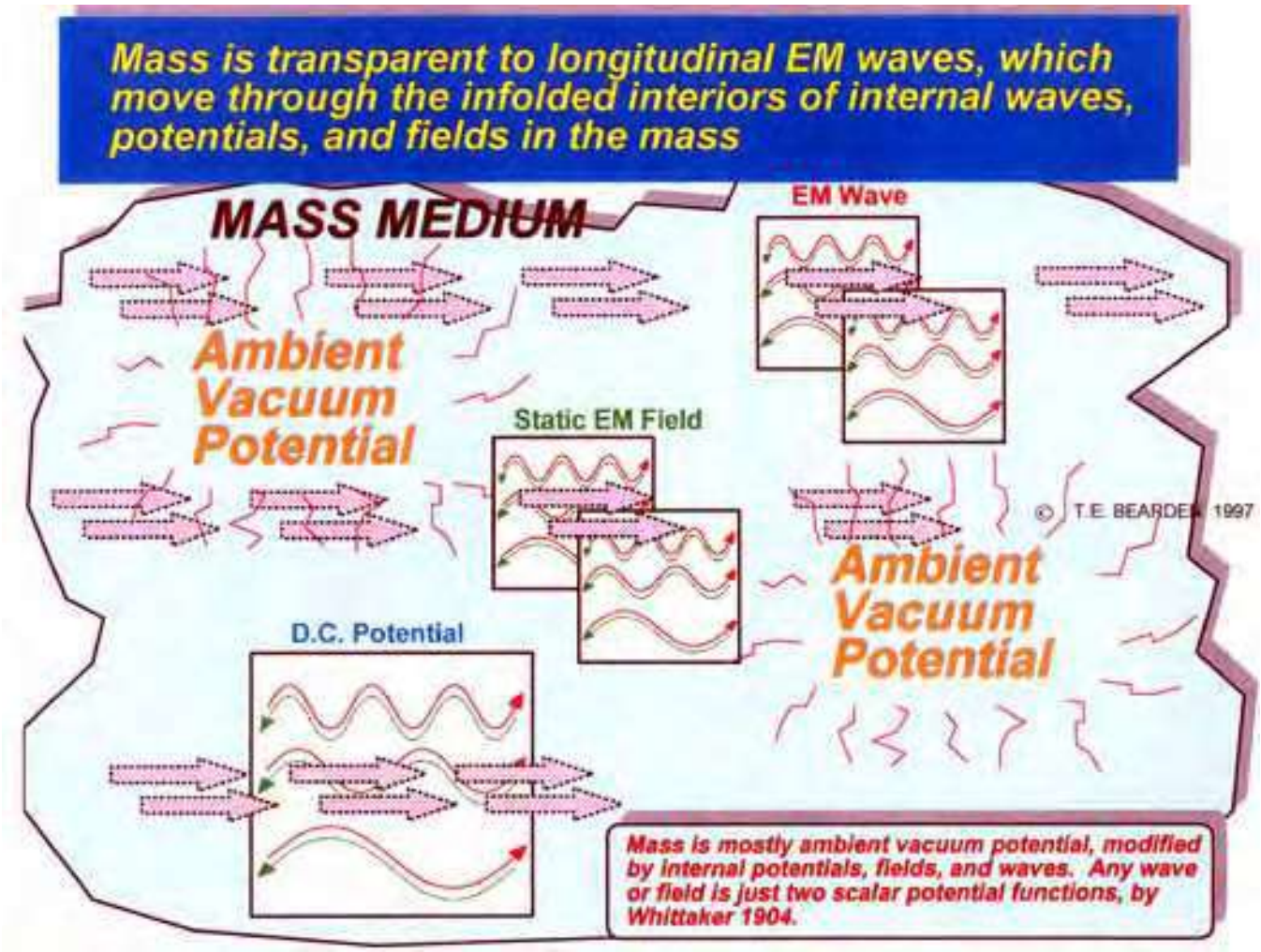

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Deep penetration of weak signals in a dense signal environment, by nonlinear retroreflection

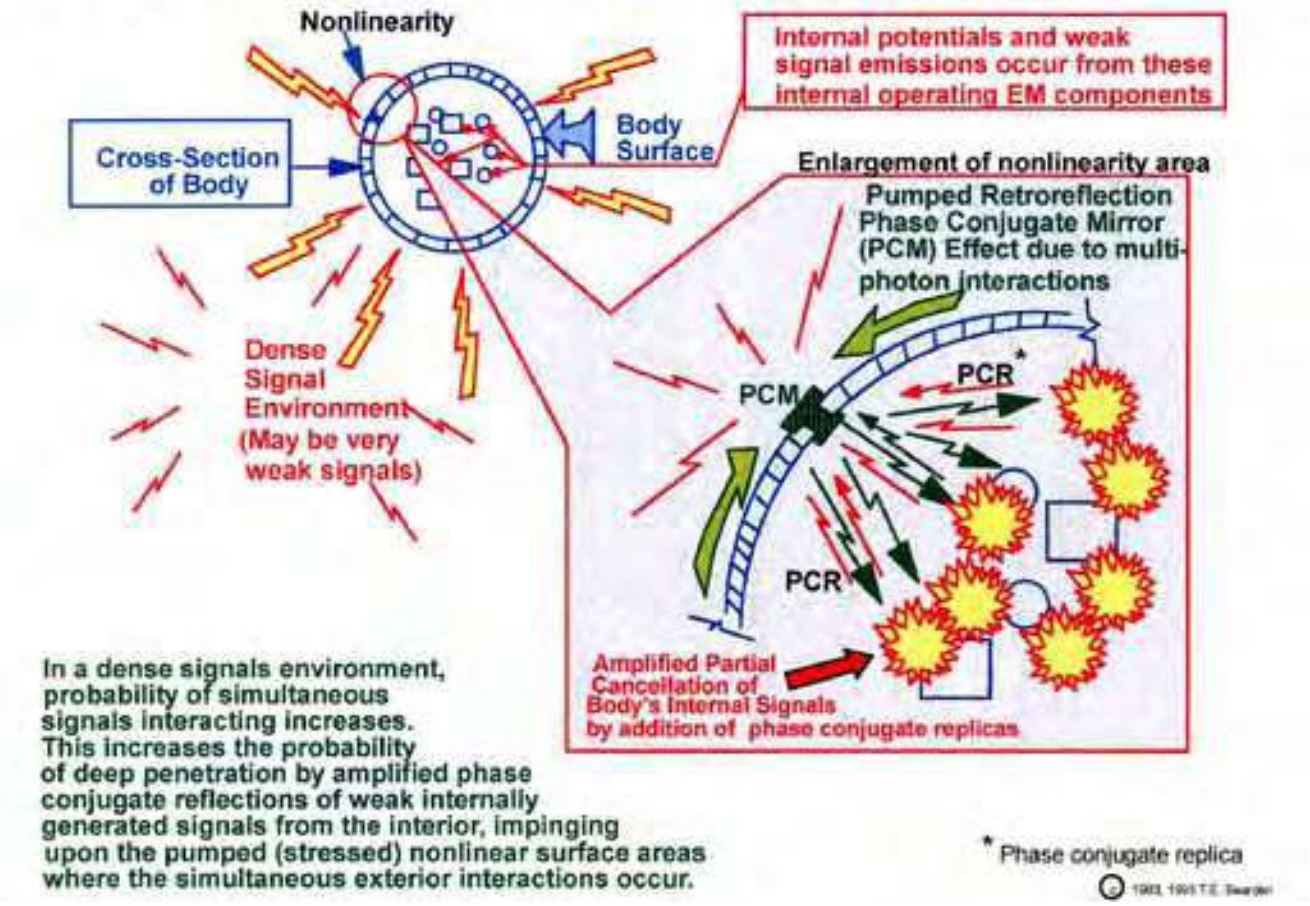

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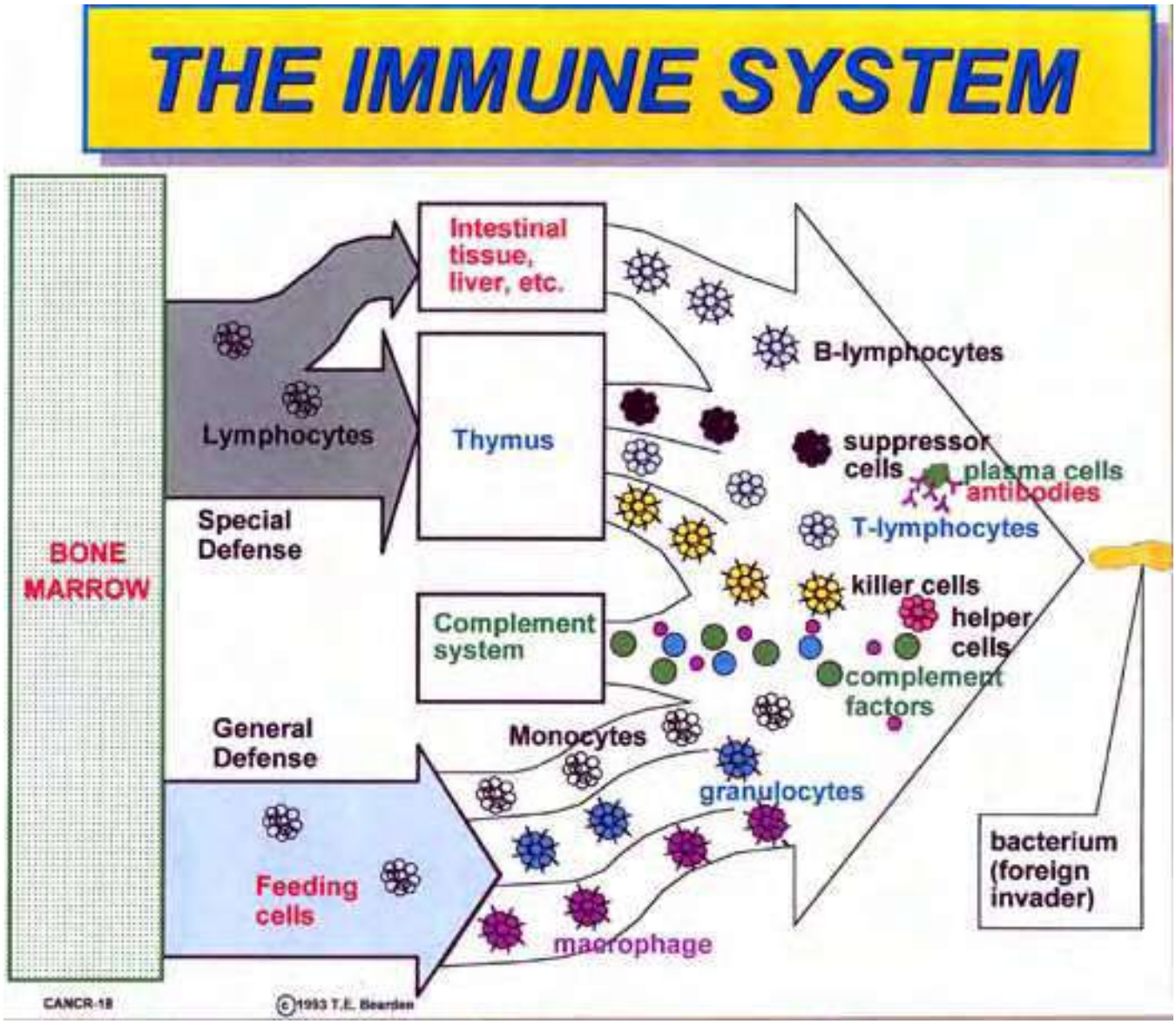

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Popp's master cellular control system

- Provides coherent, long-range interactions in biological systems
- Is an organized morphogenetic field at the basis of functional control

- Emission very sensitive to almost all external and internal influences
- Both spontaneous and delayed luminescence occur
- Photons stored in cell during the delay

- Leakage provides ultraweak, coherent biophoton emission from the system
- Fractional intensity pattern: few to some 100s of photons/cm^2/sec
- Optimum signal-to-noise ratio

- A single delayed biophoton may be able to trigger 10^{10} reactions in a cell before its release
- Spectrum almost continuous within optical range from 200-800 nm.

- Biophoton emission shows biological system always out of equilibrium
- Emission has holistic characteristics
- Correlations to most, if not all, of the biological functions of the organism

- DNA, all other processes are sources
- Single main process of whole system, different processes strongly coupled
- Information function and sync of biological clocks (oscillators)

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CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

**R&R system forces cell back toward anaerobe*

CANCR-26

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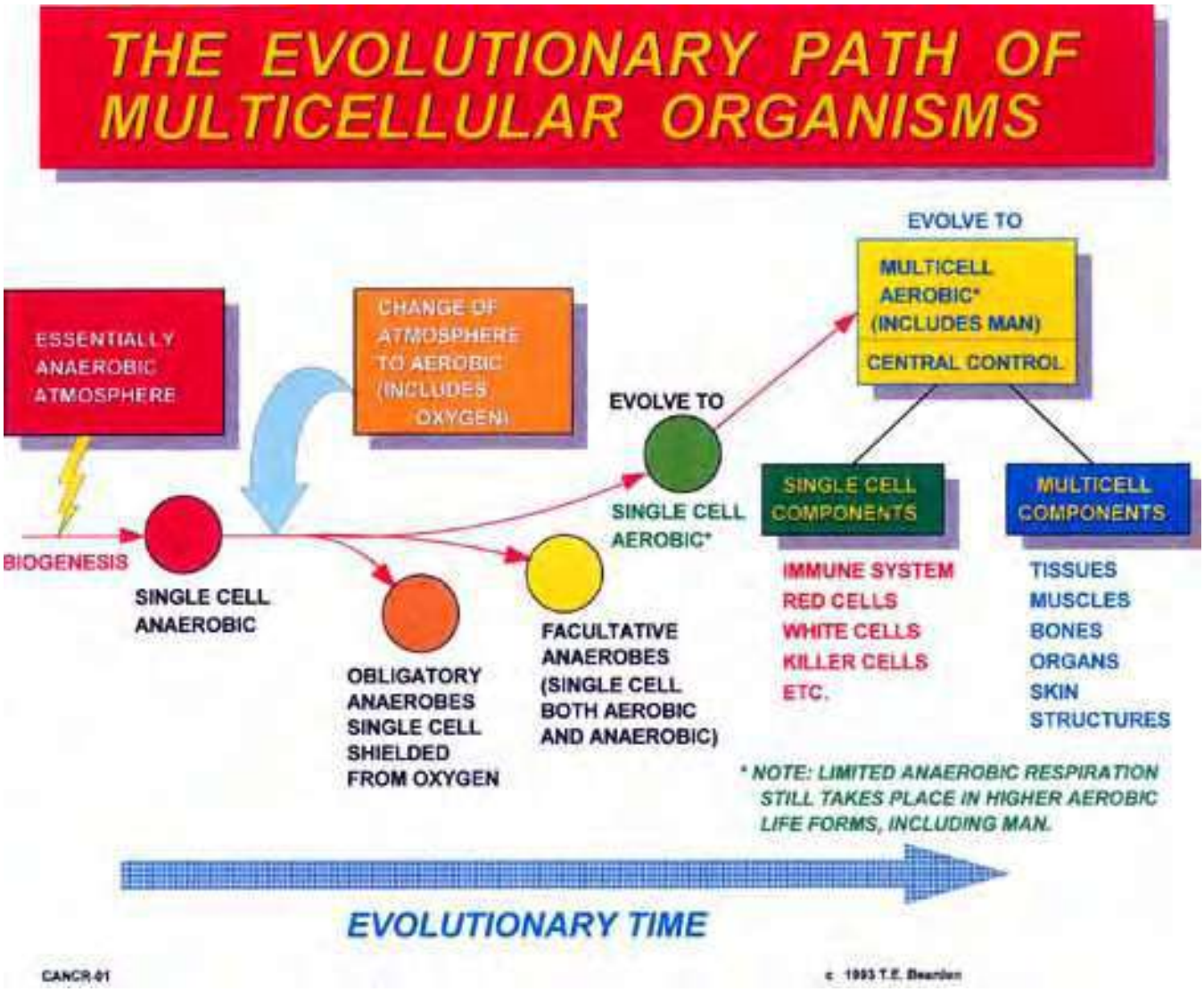

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EFFECT OF FLUID CONTAMINATION ON HEMOGLOBIN'S OXYGEN TRANSPORT

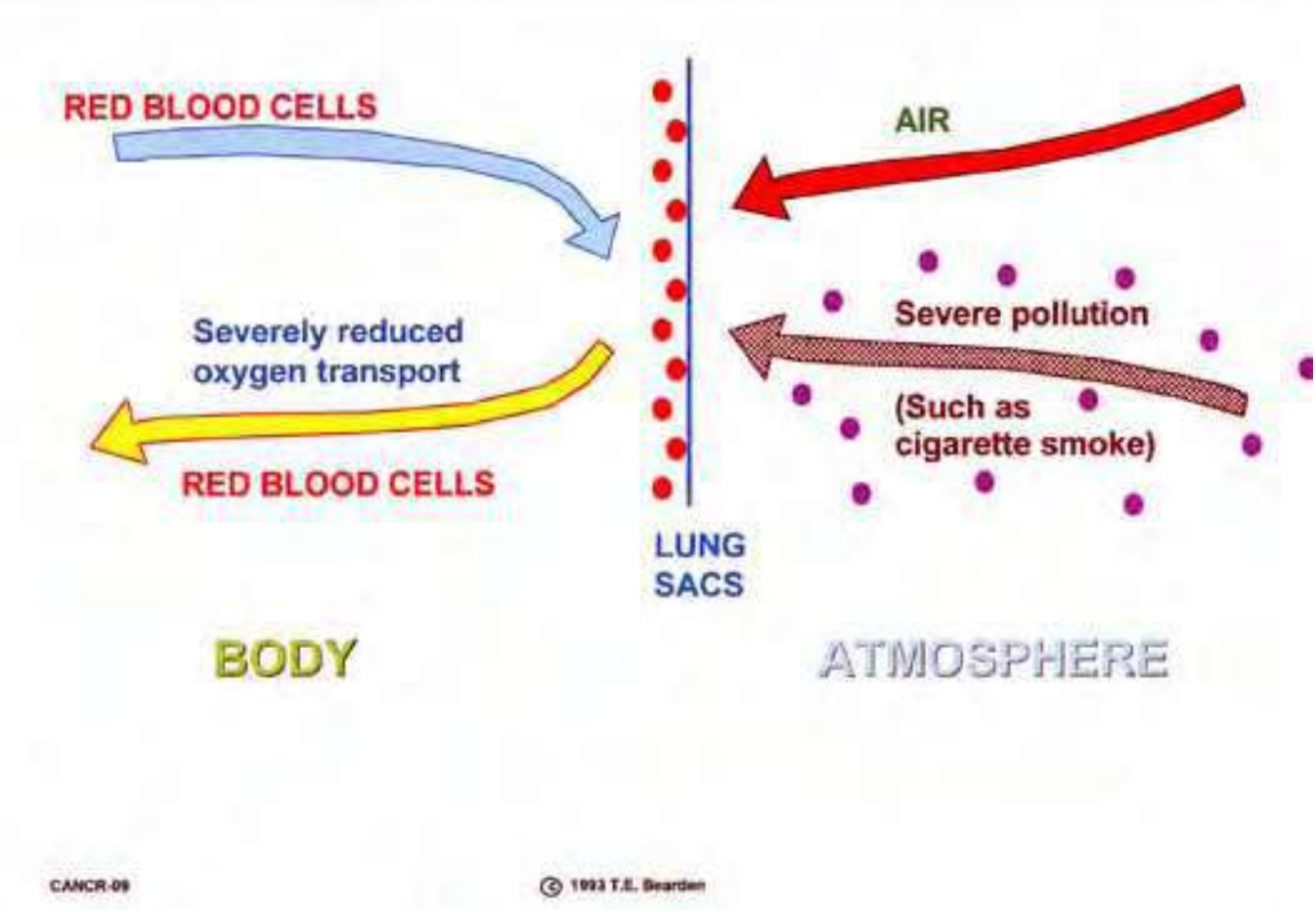

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FIRST STEP IN SELF-PROMOTION OF CANCER DUE TO HYPOXIA

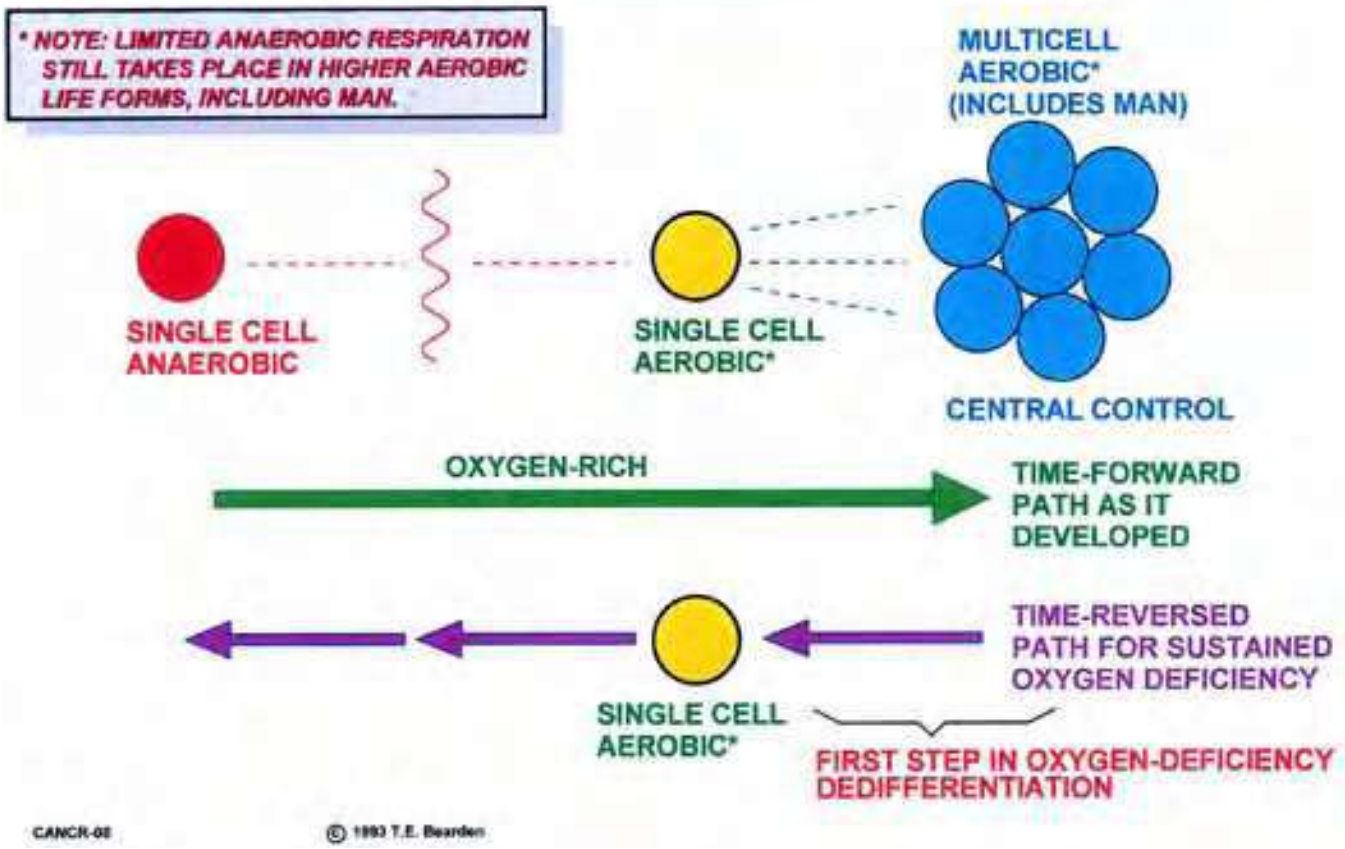

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BECKER'S CELLULAR GROWTH CONTROL

- Two major links uncovered between :
  - The DC system and nervous system
  - The DC system and all body cells
- Bioelectric potentials of primary importance
- Physiology presently considers controls limited to:
  - Neural action potential
  - Various hormone chemical agents
  - Chemical agents associated with DNA/RNA system
- Complete Operational Biological Control System:
  - Controls growth, healing, biological cycles, etc.
  - Operates in ANALOG mode; various levels of DC
  - Interlocks physically with nervous system (and may be its precursor)
  - Other chemical agents
  - Tissue growth and healing NOT INCLUDED
- Medical community now more concerned with diseases resulting from:
  - Inadequate/abnormal growth
  - Inadequate healing

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Becker's dc treatment of bone fractures

Application of tiny DC currents to heal difficult bone fractures. Only picoamperes are utilized. Pulsed DC current or pulsed magnetic fields may also be utilized.

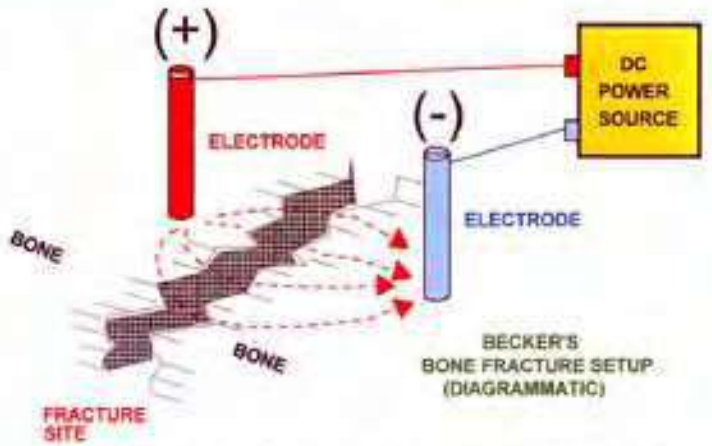

RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture

Proves that cells can be time-reversed (phase conjugated) (dedifferentiated) or time-forwarded (redifferentiated) by application of very weak electromagnetic signals, when those signals contain longitudinal bidirectional EM "pump wave" wavepairs, which cause the cell and its parts to create precise vacuum antiengines.

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Becker's theoretical DC control system involved with response to injury*

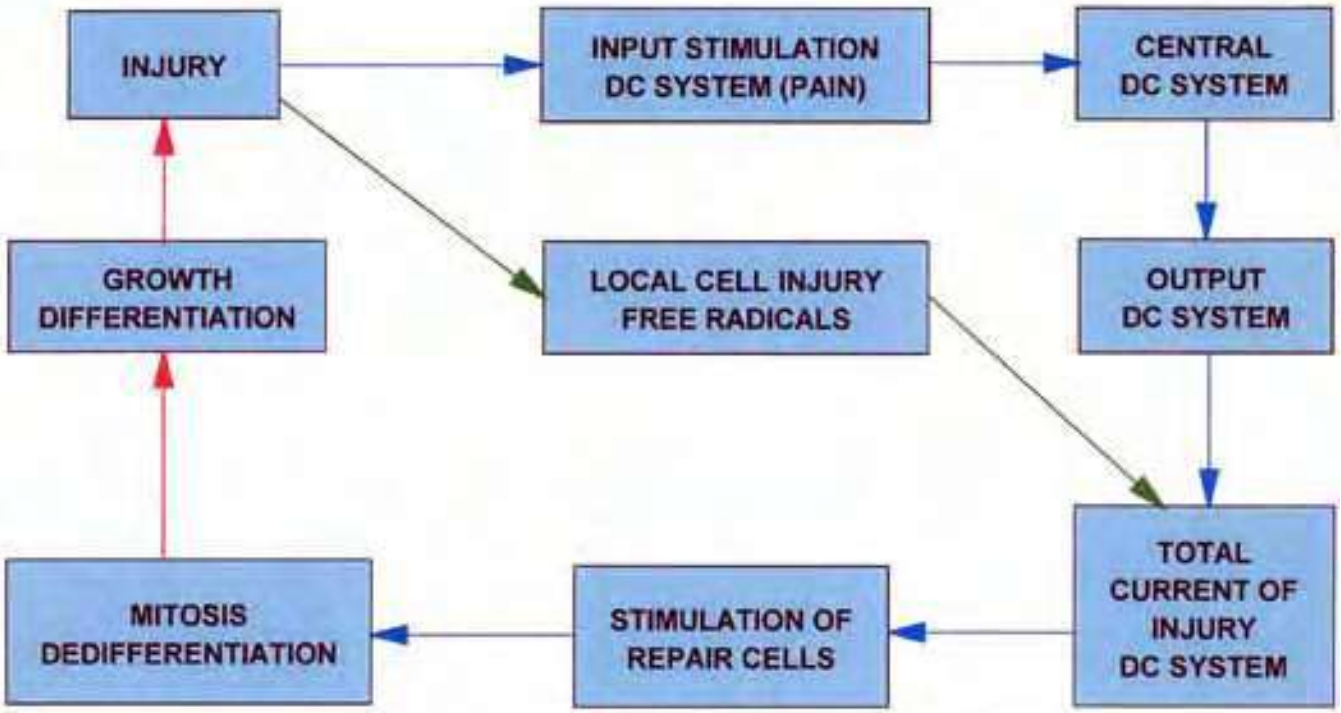

*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

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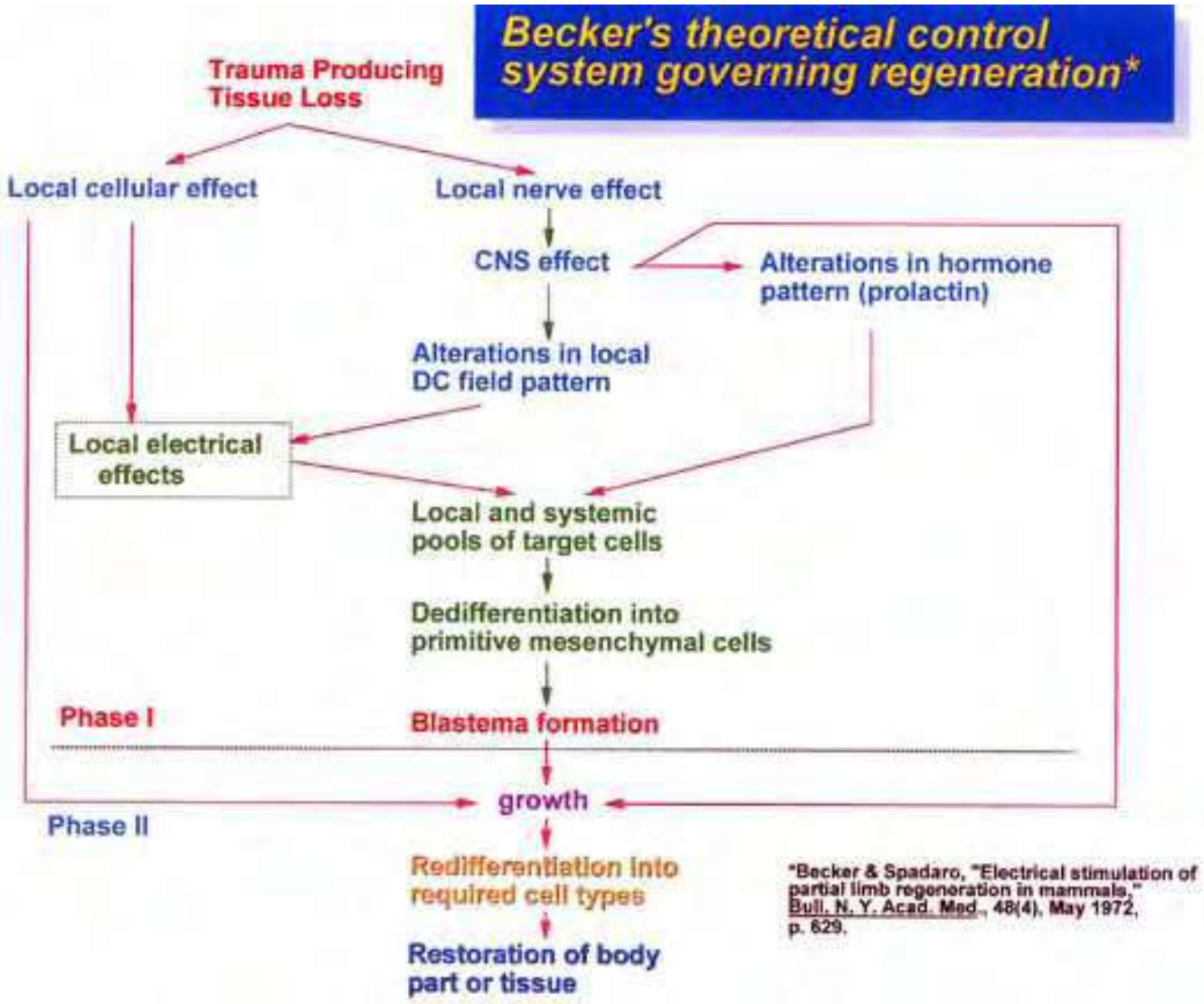

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Link Between Standing DC Potentials and the Nervous System

- Standing DC potentials on intact surfaces of all living animals demonstrate a complex field pattern spatially related to the anatomical arrangement of the nervous system
  - Can be measured directly on the peripheral nerves
  - Polarity difference related to whether nerve is or is not a sensor
  - Steady (weak) current flow exists
  - Demonstrates solid state/semiconductor phenomena
  - Accurately reflects (amplitude and polarity) the general level of neural activity
    - Sleep versus wakefulness
    - Anesthesia versus conscious
    - Other parameters
- DC levels determine the level of neural activity
- Action potential system exists upon a substratum of DC potentials which pre-existed it
- DC potentials substrata had and have control functions over basic properties of the living organism

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Becker's Findings on Cellular Injury and Regeneration*

- Cellular processes are regulated by a precise control system
- Attempted to apply engineering control-system theory
- Cells and tissues have solid-state electrochemical features which provide control signals in the control system
  - Growth process
  - Electron transfer
  - Semiconduction
  - Self-organizing *(NOTE: Implies hidden variables and nonlocal causality)*
- Complex electrical events at the injury site initiate cellular aspects such as dedifferentiation and mitotic activity
- Regeneration is a 2-step process, each with different controls
  - Electrical triggers with threshold values results in appearance of blastema
  - Complex data transmission to blastema establishes it as a self-organizing system capable of growth and redifferentiation
  - Mammals lack ability to produce blastemas except for bone, but partial regeneration growth has been shown in response to electrical stimuli
- Growth related to electrical more than electrochemical aspects
- Hematopoietic marrow as source of cells for the blastema
  - Monocytes can take place in regenerative processes in limbs
  - Lymphocytes can dedifferentiate under certain circumstances
  - Marrow elements can be induced into osteogenesis

*R.O. Becker & J.A. Spadaro, "Electrical Stimulation of Partial Limb Regeneration in Mammals," Bull. N. Y. Acad. Med., 48(4), may 1972, p. 627-641.

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Corrections For the Present EM Bioeffects Model

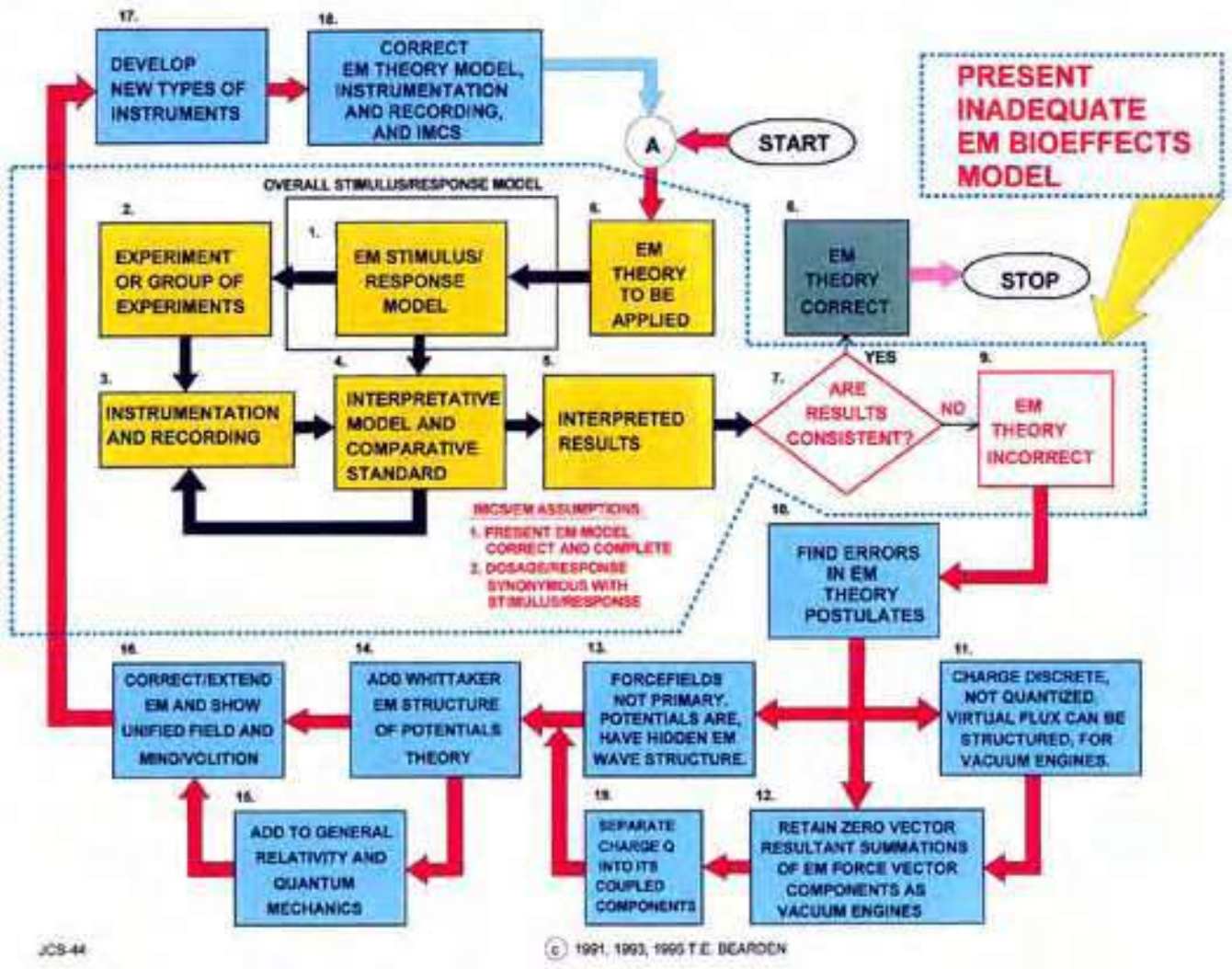

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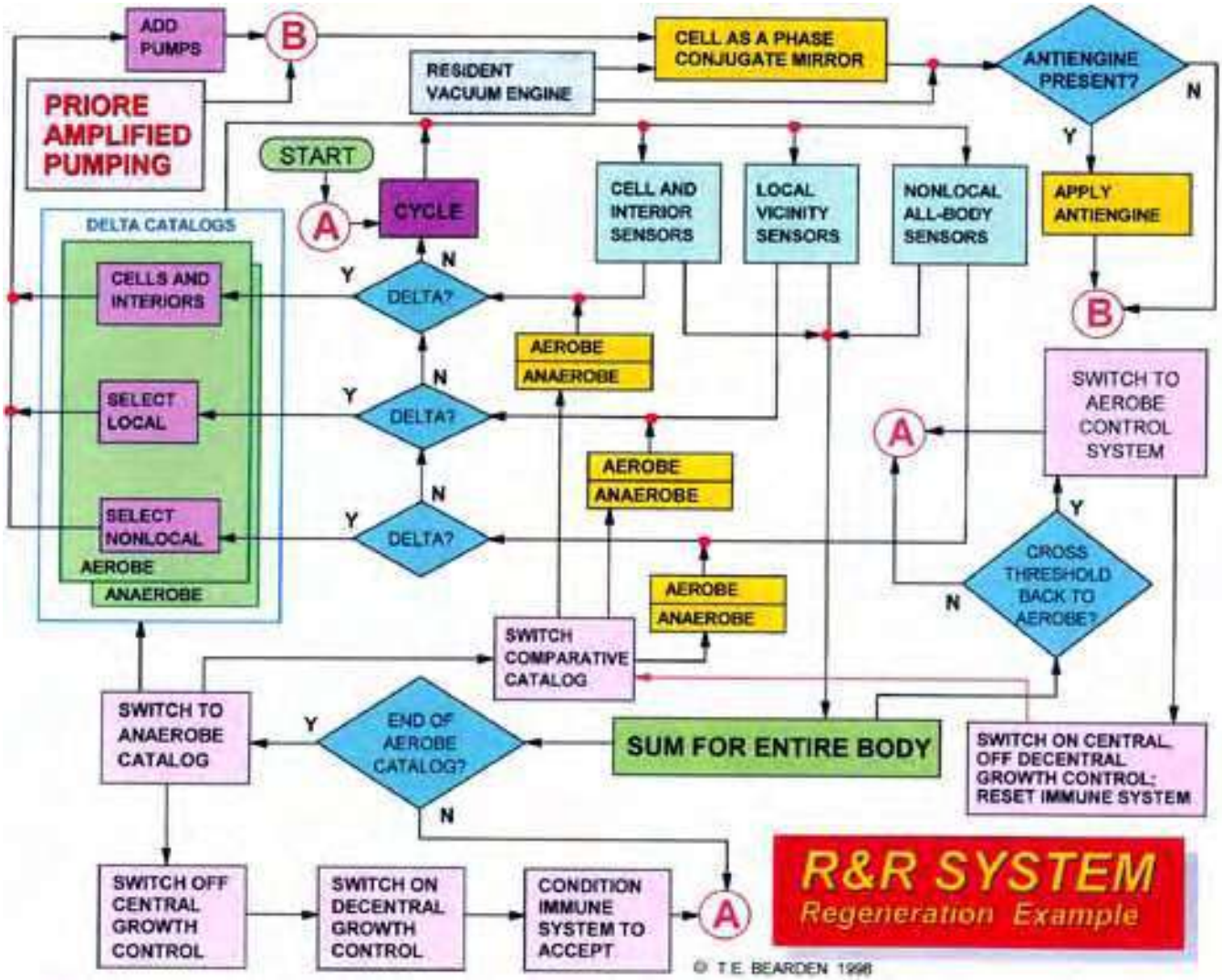

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Kaznacheyev's Cytopathogenic Mirror Effect

Disease vacuum engines transported by photons and waves

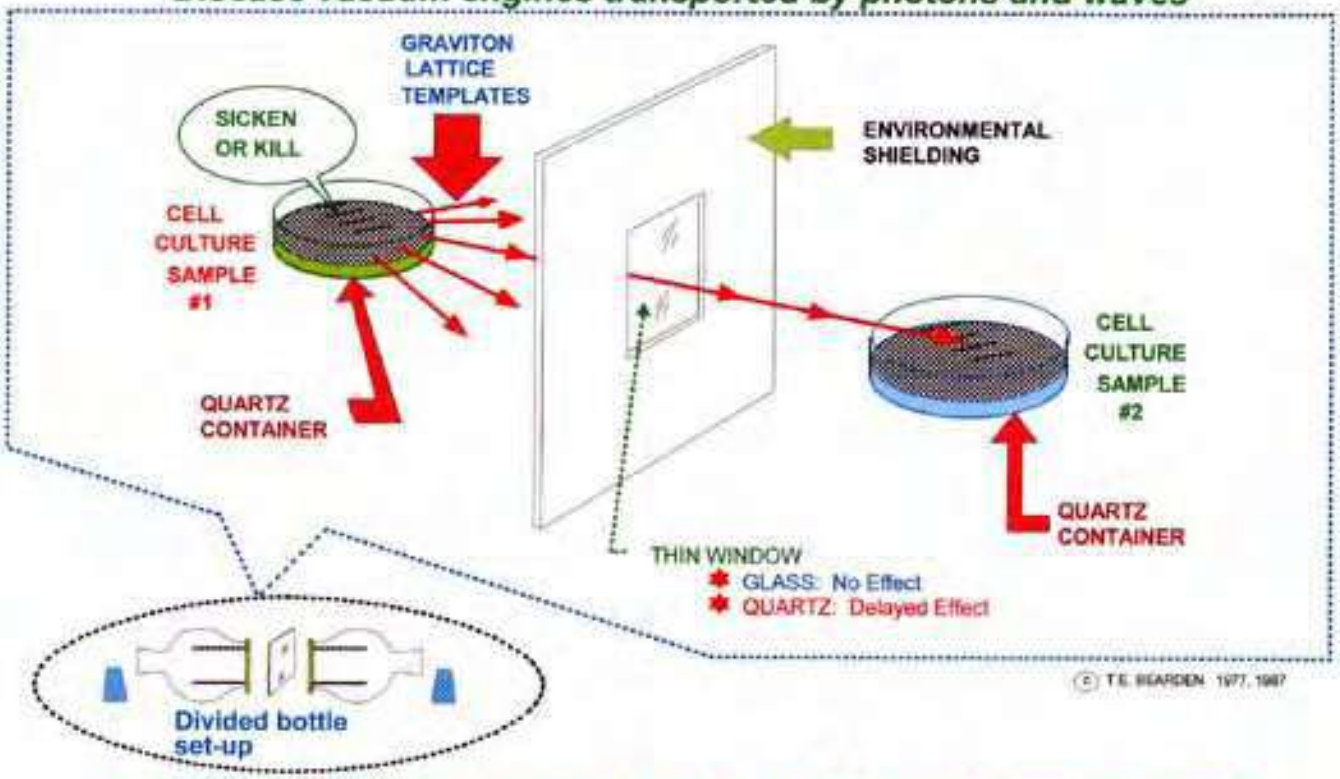

Note: Minimum lattice is one harmonic interval: IR to UV is such a minimum G-lattice.

Distant induction of cellular death and diseases, by special EM means. Coupled photon-antiphoton pairs (gravitons) in a structured harmonic lattice ordering constitute the disease or disorder template.

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MICROWAVE RADIATION OF U.S. EMBASSY IN MOSCOW

Former U.S. Embassy in Moscow.

Selected clipart © by Lotus SmartPics™

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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Self-Targeting in Inner EM Channel Can Produce a Quantum Potential

Once QP is established, energy transmission is direct and instantaneous. Energy input to one single participant will simultaneously appear in all other participants, the amount depending on their fractions of participation with the input station.

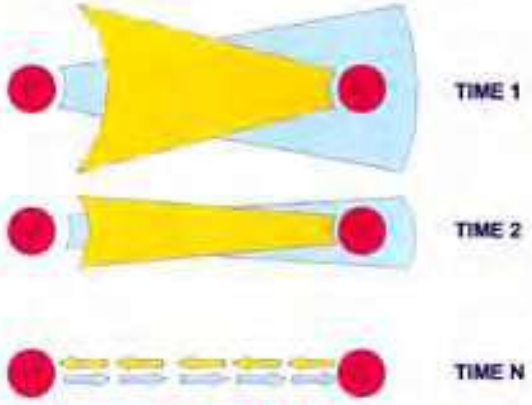

NARROWING OF INTERACTING POTENTIALS INTO LASER-LIKE BEAMS, BETWEEN TWO PUMPED SOURCES. NOW ONLY LONGITUDINAL WAVES CONNECT THE LINKED OBJECTS.

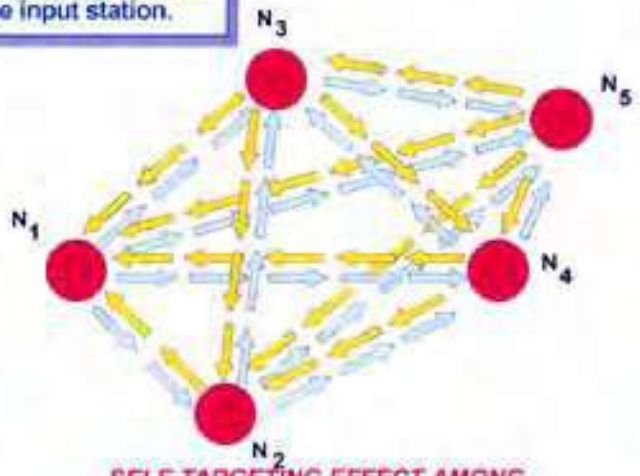

SELF-TARGETING EFFECT AMONG ALL PAIRS OF INTERACTING PUMPED SOURCES

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Quantum potential and hidden variable theory

a. Quantum Potential Characteristics

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- No point source
- Not radiated
- Quantum potential between two particles
  - Interaction does not vanish as spatial separation becomes very large
  - Instantaneous connection, so multiply-connected space

b. Hidden Variable Theory and the Quantum Potential

- $$V_{quantum} = \frac{\hbar}{2m}\frac{\nabla^2\sqrt{\rho}}{\sqrt{\rho}}$$
- "A quantum particle moves as if it were subject, in addition to its external potentials, to a potential which is a function of its own probability distribution."
- Bohm's H.V.T. assumes:
  - Particle and wave function real and separate
  - Wave function obeys Shroedinger's equation
  - Particle obeys classical mechanics
  - Particle couples to wave function through a quantum potential

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Participants in a quantum potential share a common multiply-connected spacetime (MCST)

- Separated points are superposed in MCST
- Intervening distance in MCST is zero
- Connection is instant and bidirectional
- Propagation through ST does not apply
- Energy or vacuum engine input to one station instantly appears at each and every other station, undiminished in magnitude
- Ultimate net-centric warfare effect

Note: Once QP established, separation distance in 3-space is of no consequence

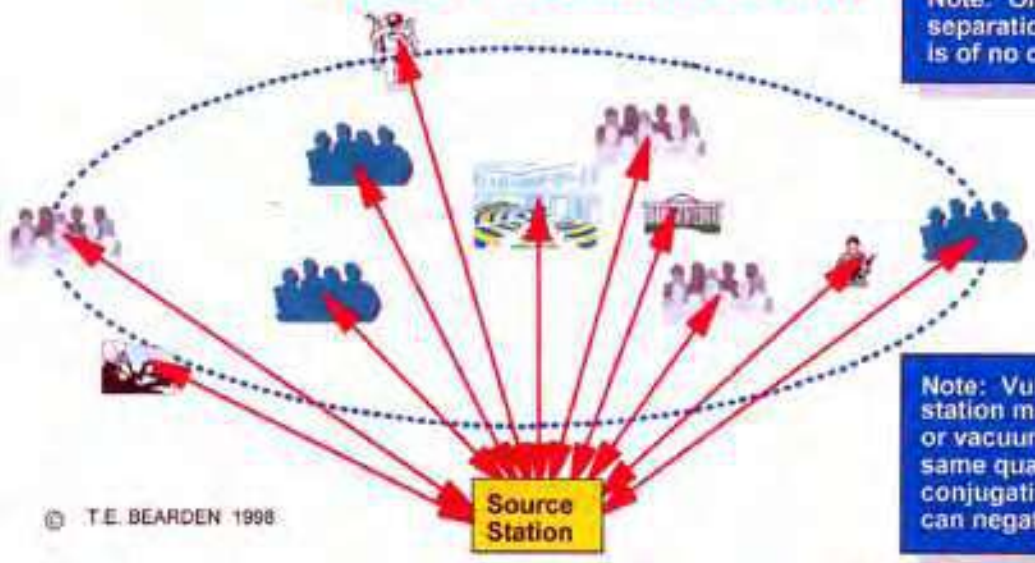

Note: Vulnerability. Any other station may insert energy or vacuum engines into the same quantum potential. Phase conjugating the hostile engine can negate its effect everywhere

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Gulf War Syndrome And Typical Comparative Disease Curves

Note: There is cumulative genetic damage to germ cells also.

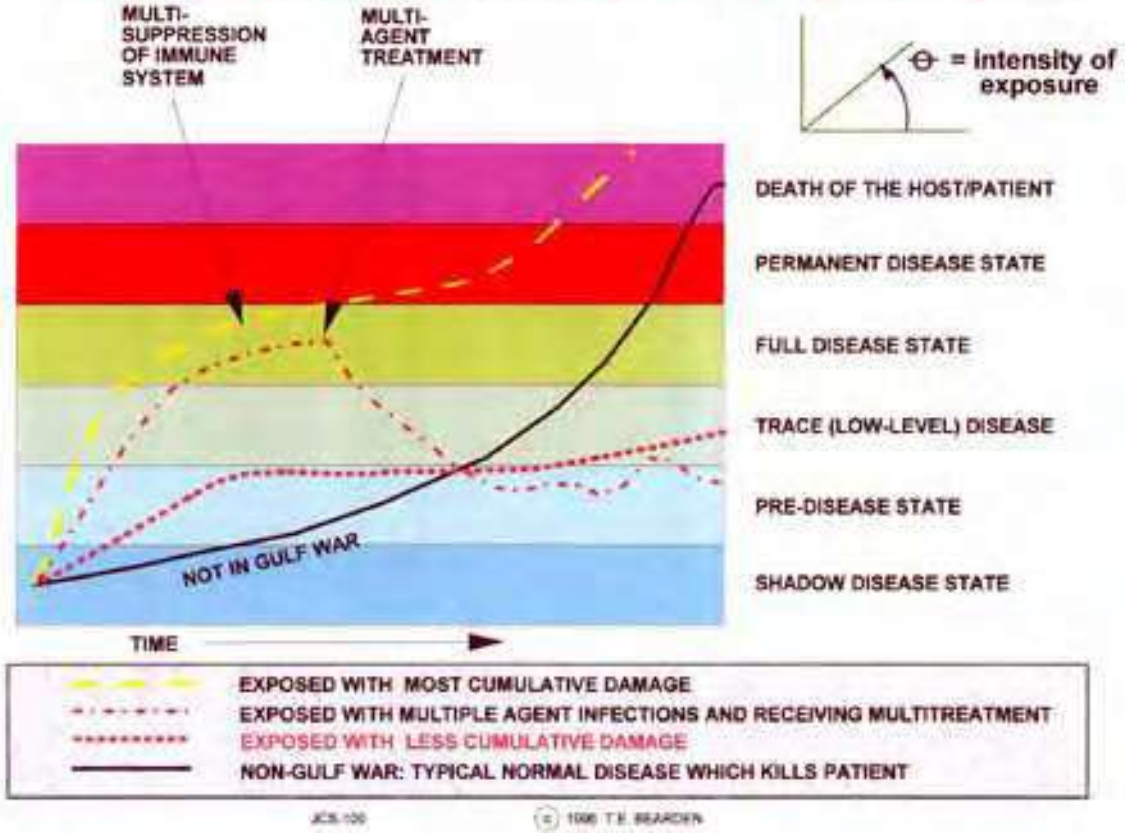

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Force Fields and Symmetry

- Force fields are nature's way of imposing local gauge symmetries on the world
- E.g., electromagnetic field is a manifestation of the simplest known gauge symmetry consistent with the principles of special relativity
- For the EM case, the gauge transformations correspond to changes in 'voltage' from place to place

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Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum

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- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another
- STRUCTURING THE INFOLDED EM INSIDE POTENTIALS, FIELDS, AND WAVES
  - Strongly breaks local symmetry
  - Provides spacetime engines giving the above effects

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Other Aspects of Strong Local Asymmetry

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- Local spacetime is curved
- Lorentz invariance of vacuum is violated
- May be a local "sink" or "source"
- Gravitational/inertial effects from EM
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation
- COMMENT: Thus the use of infolded longitudinal EM fields and waves to strongly break local symmetry allows internested clustering of spacetime curvatures. These spacetime structures are *vacuum engines*, or *spacetime engines*.

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Small Entities Emit Powerful S-Flows

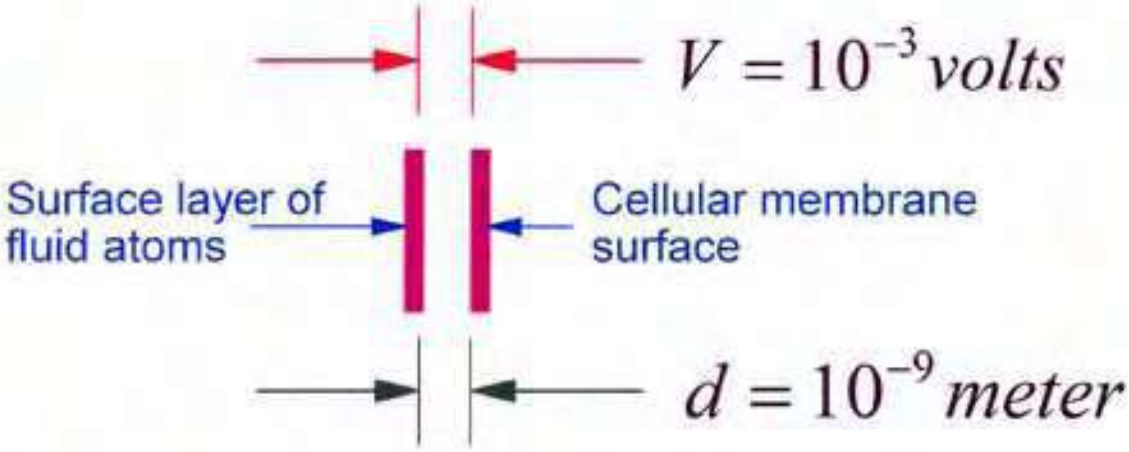

$$E = 10^{6}\ \text{volts / meter}$$

$$S \approx f(E^2) = f(10^{12})$$

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What is the "magnitude" of a potential?

- What is taught is the *"interaction cross section,"* i.e., the joules collected from the associated S-flow by one point coulomb of intercepting/collecting charge.

$$W = Vq = \phi q \quad \text{(joules)} \qquad [1]$$

$$\phi = W/q \quad \text{(joules/coul)} \qquad [2]$$

Let $\phi < 1$ and fixed; $q \Rightarrow n$ where $n = \infty$

$$W \Rightarrow k, \text{ where } k = \infty \qquad [3]$$

- *From any "finite" potential, no matter how small, an unlimited amount of energy can be collected, by increasing the collection (number of coulombs) (interaction cross section).*
- Actual magnitude of the potential ϕ must be very, very large, since we can treat it as infinite or unlimited, via $W = \phi q$.
- *Else Equation [1] could not be linear.*

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Table A1. THE VACUUM ENERGETICALLY INTERACTS WITH EVERY PARTICLE, CONTINUALLY.

- The vacuum is:
  - Ground (zero) state of the electromagnetic (photon) field.
  - Ground (zero) state of mass field.
  - Empty of *observable* particles or photons.
  - Filled with *non-observable* (virtual) particles and photons.
  - Violently fluctuating microscopically and electromagnetically.
  - Constantly interacting with all particles, including partially shielding their bare charges.
- Lamb Shift -- vacuum's alteration of the energy level of an electron in the hydrogen atom.
  - -- Difference in energy (frequency units) is 1057.862 MHz.
  - -- Lamb was awarded a Nobel Prize for showing this.
  - -- Energy *density* exceeds that of the sun's surface!
- Casimir Effect -- vacuum creates an attraction between two conducting surfaces in close proximity.
  - -- experimentally proven, well-known.

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- Cole and Puthoff proved that there is no thermodynamic reason why energy cannot be extracted from the vacuum as heat and power, and utilized.
- The common dipole is a broken symmetry in the virtual photon flux of vacuum. It extracts virtual energy, integrates it, and re-emits it as Poynting energy density flow S = ExH (which observably interacts with charged particles and magnetic poles).

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Extended Superpotential Theory

(Adding Vacuum Engines)

- Any EM field or wave is created by (comprised of) two potentials which interfere with each other in a given area
  - *May be either scalar or vector potentials*
  - *May interfere locally or at a distance*
  - *Process is distance independent*
- Any scalar potential is comprised of a harmonic series of bidirectional longitudinal EM wavepairs (Whittaker 1903).
- Ziolkowski circa 1985 added the interior product set to Whittaker's sum set. Thus he added modulations.
- By assembling a deliberate "sum and product" set of biwaves, a scalar potential can be created having an internal deterministic structure.
  - *This structures local vacuum potential/spacetime curvatures, in specific forms (templates)*
  - *Now have added vacuum engines*
  - *Have infolded general relativity inside electrodynamics*

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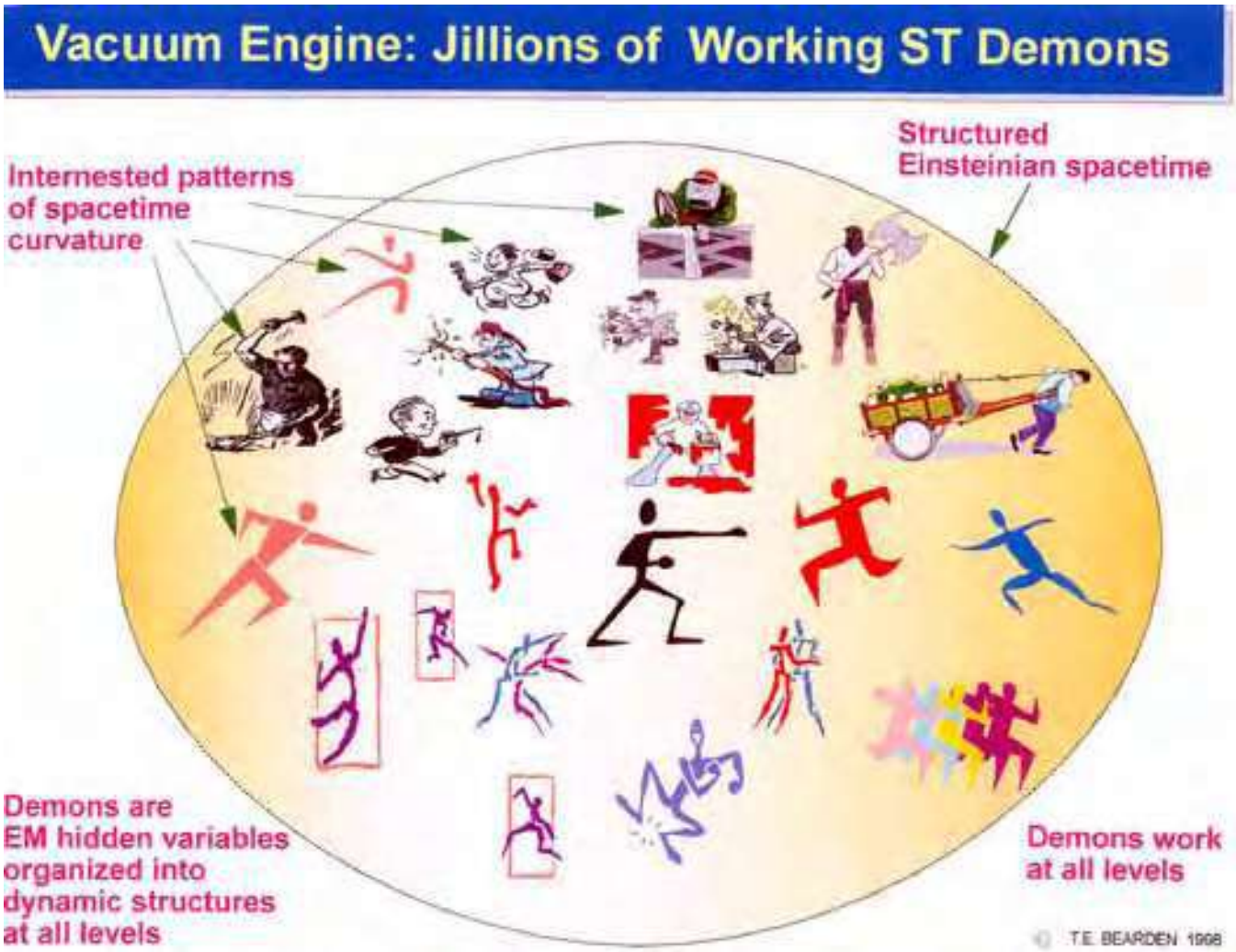

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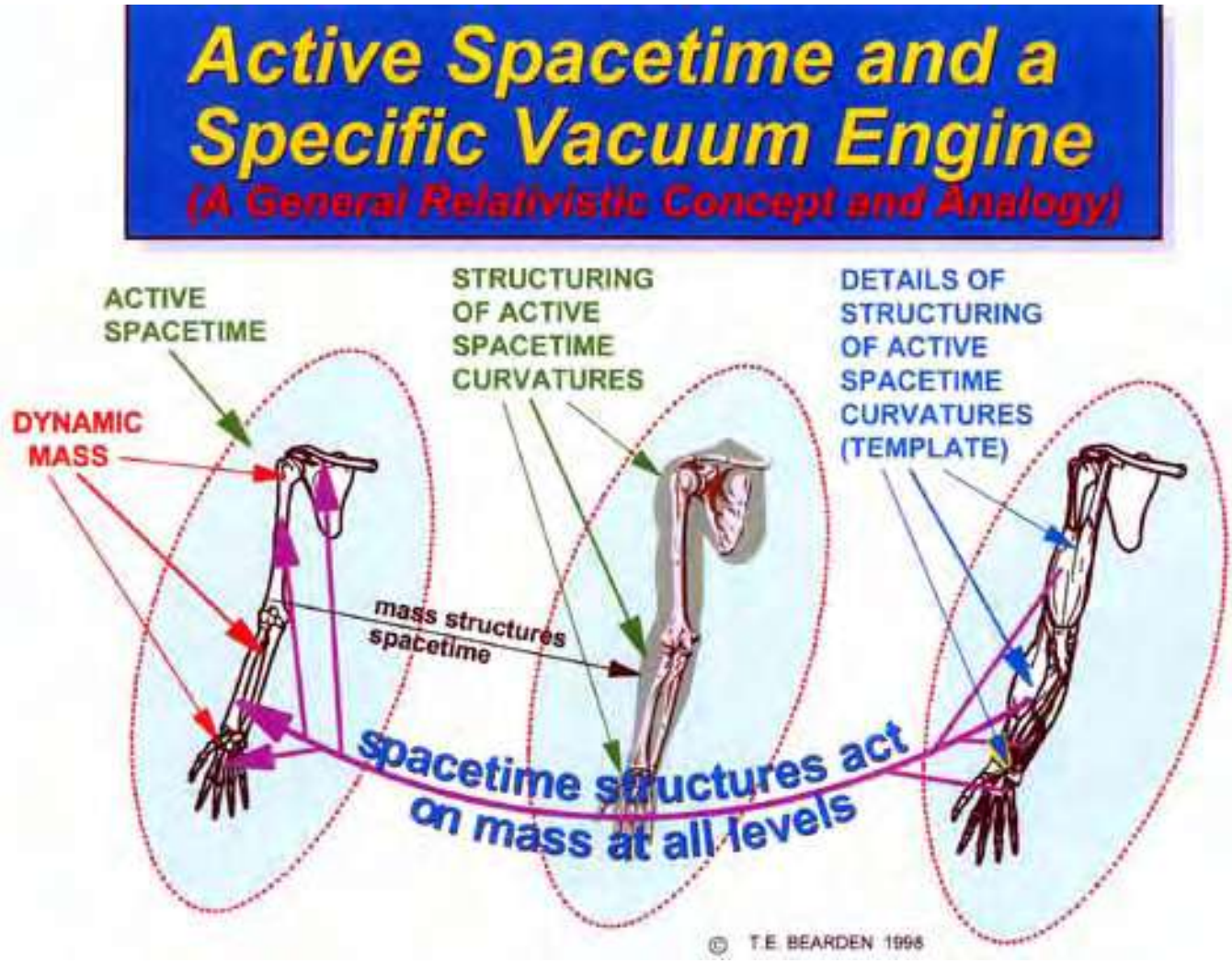

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Extension of Wheeler's general relativity principle:

- Mass (trapped energy) and its structuring curves and structures spacetime complexes (engines).
- Curved and structured spacetime engines produce forces on mass and its components, telling them how to move and structure.
- Since very strong EM force is used as agent of curvature, very powerful general relativistic effects can be obtained by arranging the LWs in the input EM potentials, fields, and waves.
- General relativity becomes directly engineerable in devices of unparalleled capability.

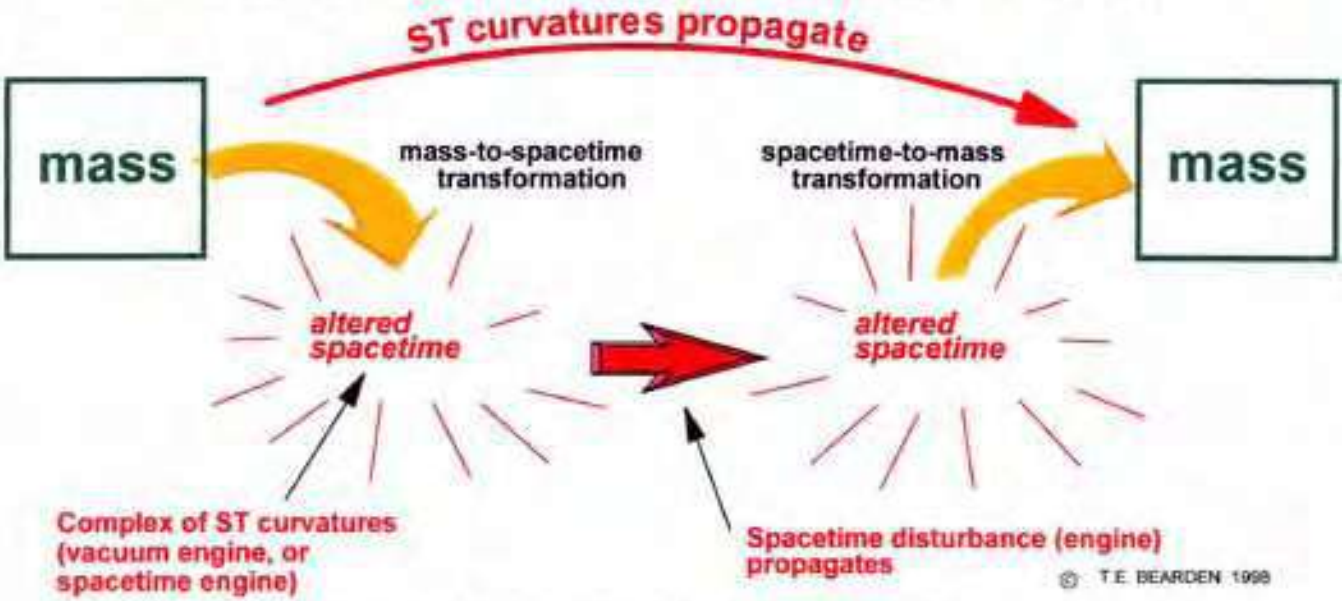

Electrodynamics has a hidden but ignored electro-general-relativity infolded inside (comprising) its so-called potentials, fields, and waves (in space in the absence of mass). What are presently defined as potentials, fields, and waves rigorously exist only in, on, and of charged mass, as pointed out by Aharonov and Bohm in 1959. All of this is just longitudinal EM waves and their interactions.

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SIGNAL VERSUS VACUUM ENGINE

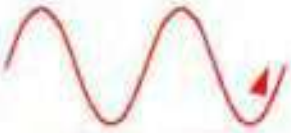

SIGNAL (INFO)

- INFORMATION RECEIVED
- ANY OVERT PHYSICAL ACTION MUST BE TAKEN BY RECEIVER

A. *Receiver must do the action itself; vacuum energy exchange is unaltered. Energy or fuel for doing the action must be added to receiver externally.*

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VACUUM ACTIVATED

ENGINE (STRUCTURE)
TEMPLATE (FORM)

- "INFORMATION" ITSELF ACTS
- VACUUM FLUX GRADIENTS CHANGE ALL PARTS AND CHARACTERISTICS OF RECEIVER, INSIDE AND OUT

B. *Receiver is acted upon; altered vacuum energy exchange does the specific action. No energy or fuel for doing the action need be added to receiver externally.*

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Electronuclear Interactions by Vacuum Engines

- An EM potential is gravitational due to its trapped energy.
- A local EM potential is a local curvature of spacetime.
- *Structured* potentials are structured *(nested)* local spacetime curvatures; hidden variable theory applies.
- Structured potentials thus are *vacuum engines*.
- Gradient-free potential penetrates the atom, into nucleus.
- *With steady application, a structured gradient-free potential can be used to engineer the atomic nucleus at will.*
- Normal cold fusion systems structure a small fraction of their potentials, by chance geometries, boundaries, etc.
- This produces some new nuclides, but haphazardly.
- *The process can be developed and controlled. The nucleus can be deterministically engineered at will.*

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Vacuum Engineering

Using Inner EM Energy and Structuring to Engineer Physical Reality

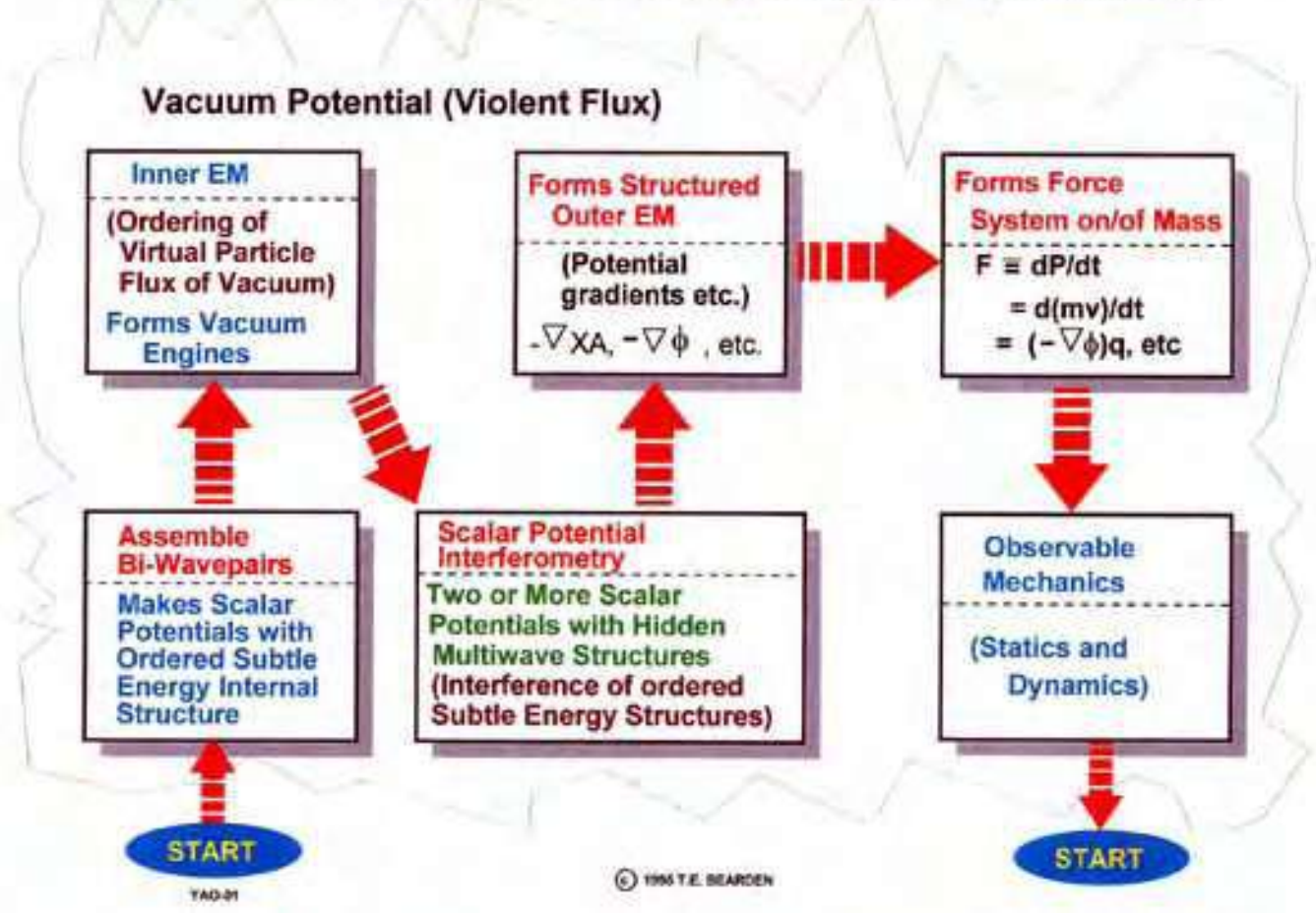

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Impact of Vacuum Engineering

- "If they [quantum fluctuations of vacuum] can be [tapped], the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete -- and so would many of our worries about environmental pollution."
- "Don't sell your oil shares yet -- but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development:
  - 1. It's crazy!
  - 2. It may be possible -- so what?
  - 3. I said it was a good idea all along.
  - 4. I thought of it first."

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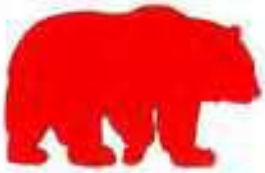

Arthur C. Clarke
"Space Drive: A Fantasy That Could Become Reality"
Nov./Dec. 1994

- *Comment:*
  - *Every dipole's broken symmetry in its energetic exchange with the vacuum already freely extracts vacuum energy.*
  - *In power sources, the dipole gates the extracted energy out as S = EXH, which flows almost entirely outside the conductors.*
  - The circuit interacts with, and uses, only about 10^{-13} of S. The electrodynamicists calculate only this small S-component.

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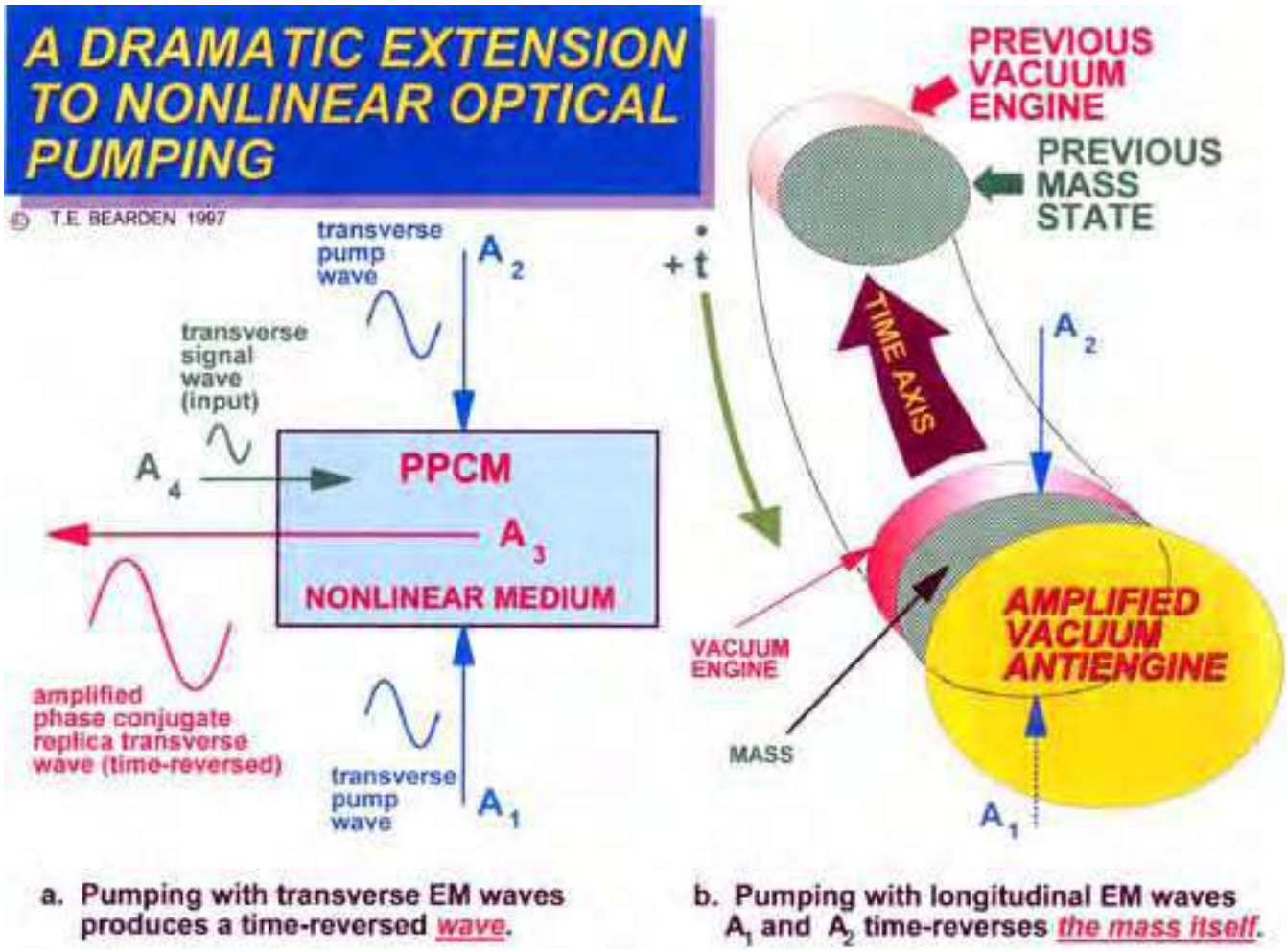

a. Pumping with transverse EM waves produces a time-reversed wave.

b. Pumping with longitudinal EM waves A_1 and A_2 time-reverses the mass itself.

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Time Conservation and Some Properties

(Energy and time are canonical)

- Time can neither be created nor destroyed
  - *Its form can be changed, and it can be positive or negative*
  - *Time can be collected or dissipated, converged or diverged*
  - *Time can oscillate and move in waves*
  - *Longitudinal (infolded) EM waves oscillate time*
- Time is always in motion, and that motion is variable
  - *Collected/collecting time is a continuing stationary change in an ongoing time flow*
  - *Time/collecting time can be internested and internally structured*

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- Time has gravitational aspects
  - *Negative (trapped) time is antigravitational*
  - *Emitting negative time is gravitational, to the emitter*
- Nonlinear optical pumping can use longitudinal EM waves
  - *Pumping a nonlinear mass by longitudinal (infolded) EM waves pumps it in its masstime form, in the time domain*
  - *This creates an amplified vacuum antiengine for the mass, and time-reverses the mass back to a previous state*

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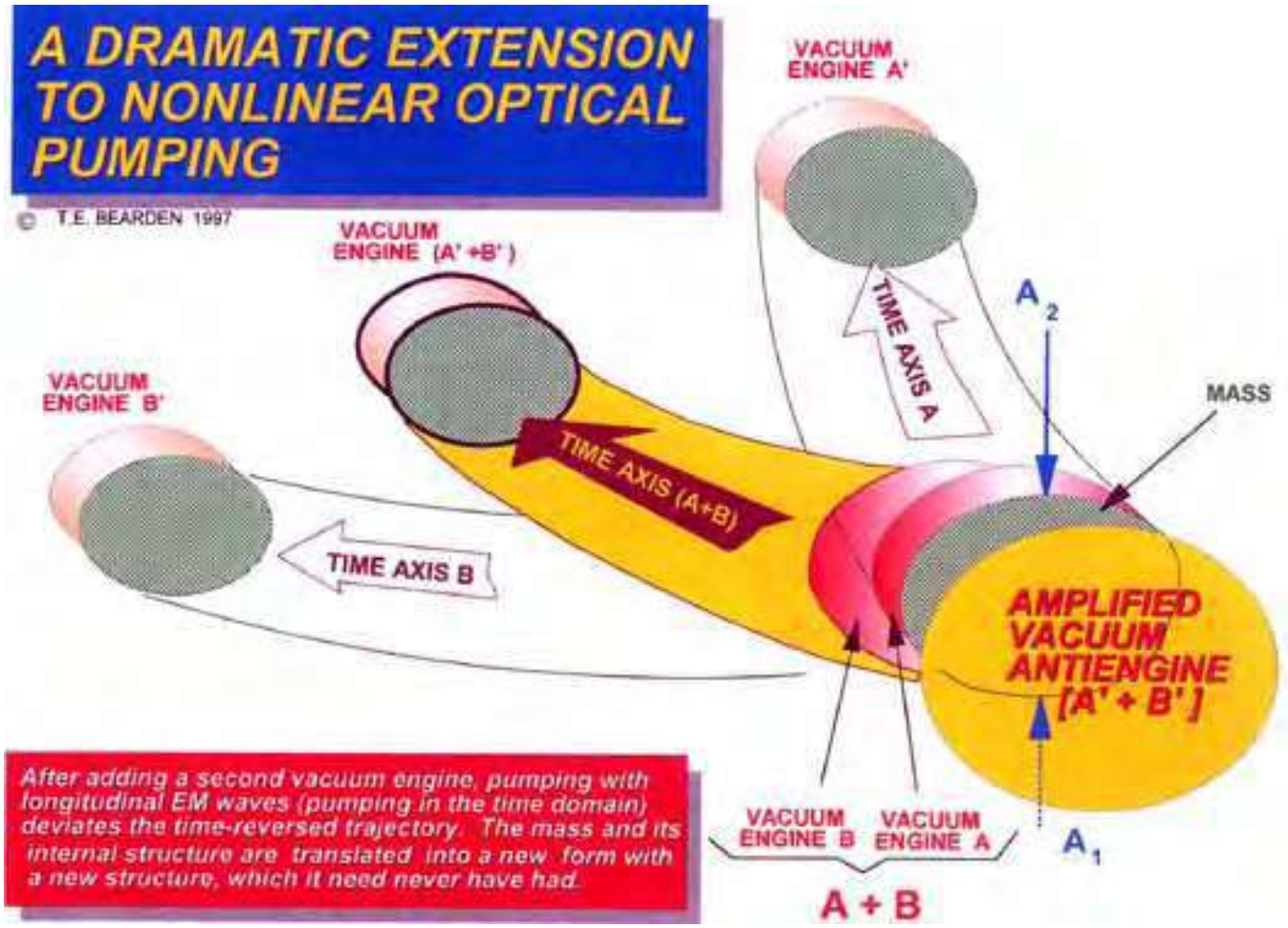

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Key Points in the New Technology

- There is a vast new kind of electrodynamics *hidden inside* all EM potentials, fields, and waves
  - Longitudinal EM waves and complexes
  - Oscillations in time domain

- These complexes are an *infolded general relativity*
  - Clustered formations of *spacetime curvatures*
  - *Very powerful*, since the EM force is used as the agent of curvature

- In general relativity, similar precise complexes permeate and *act on any mass at all internal levels*
- With this approach, one *can now manipulate matter* -- living or inert -- *in any manner desired*, depending only on the level of development of the technology
- Priore unwittingly used this to *cure dread diseases*
- This is a *revolution in all of science*

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- *We have uncovered the major mechanisms* to utilize

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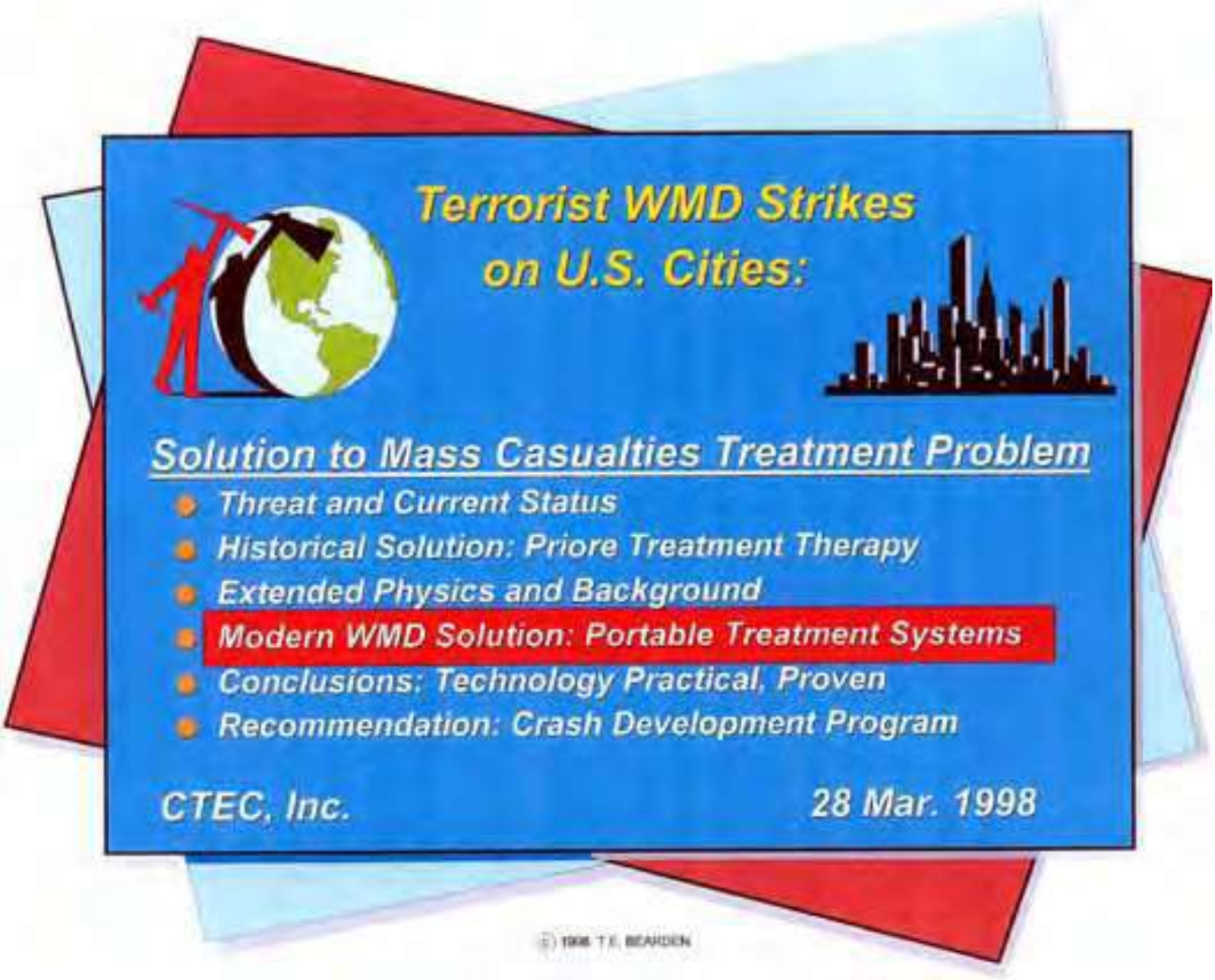

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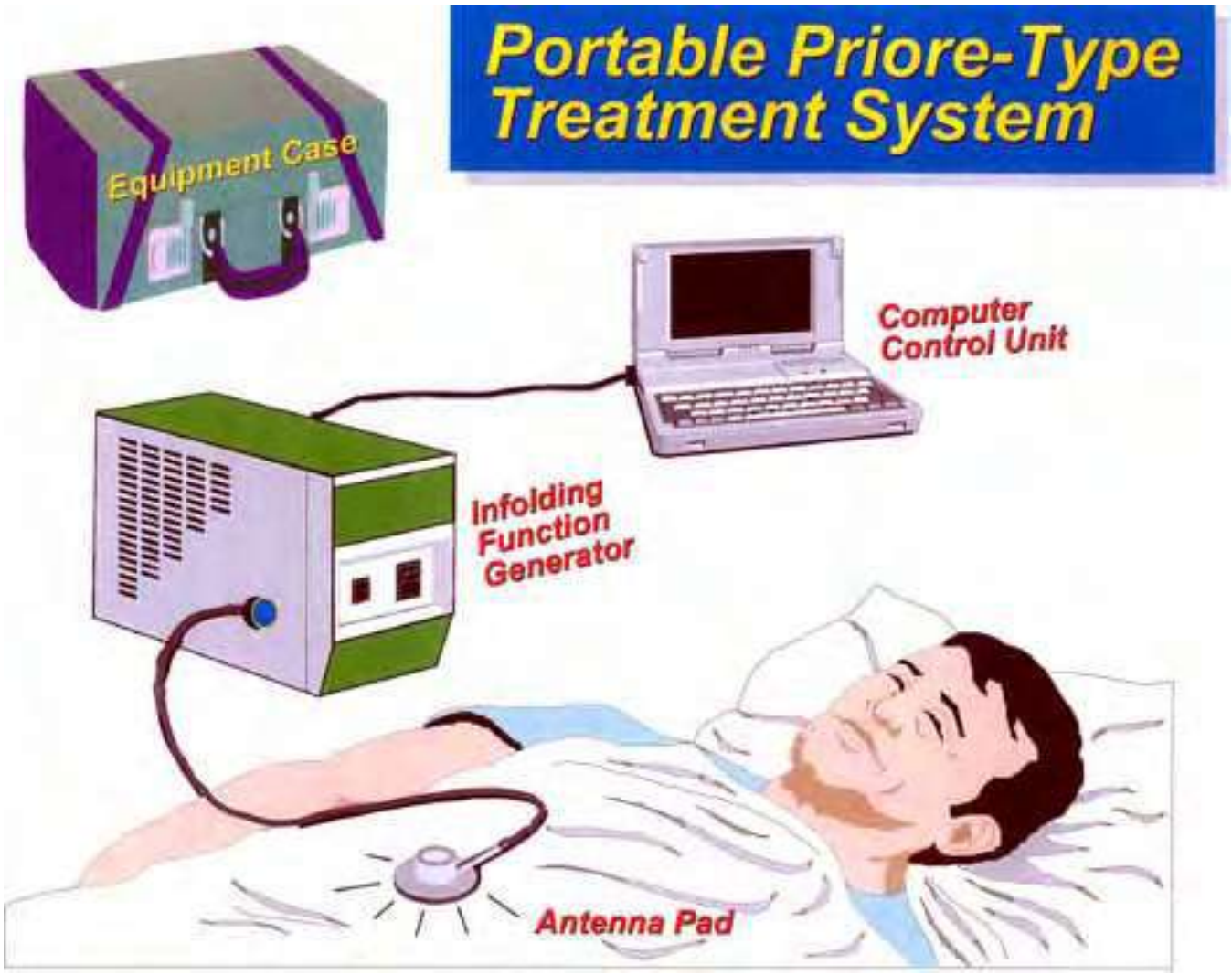

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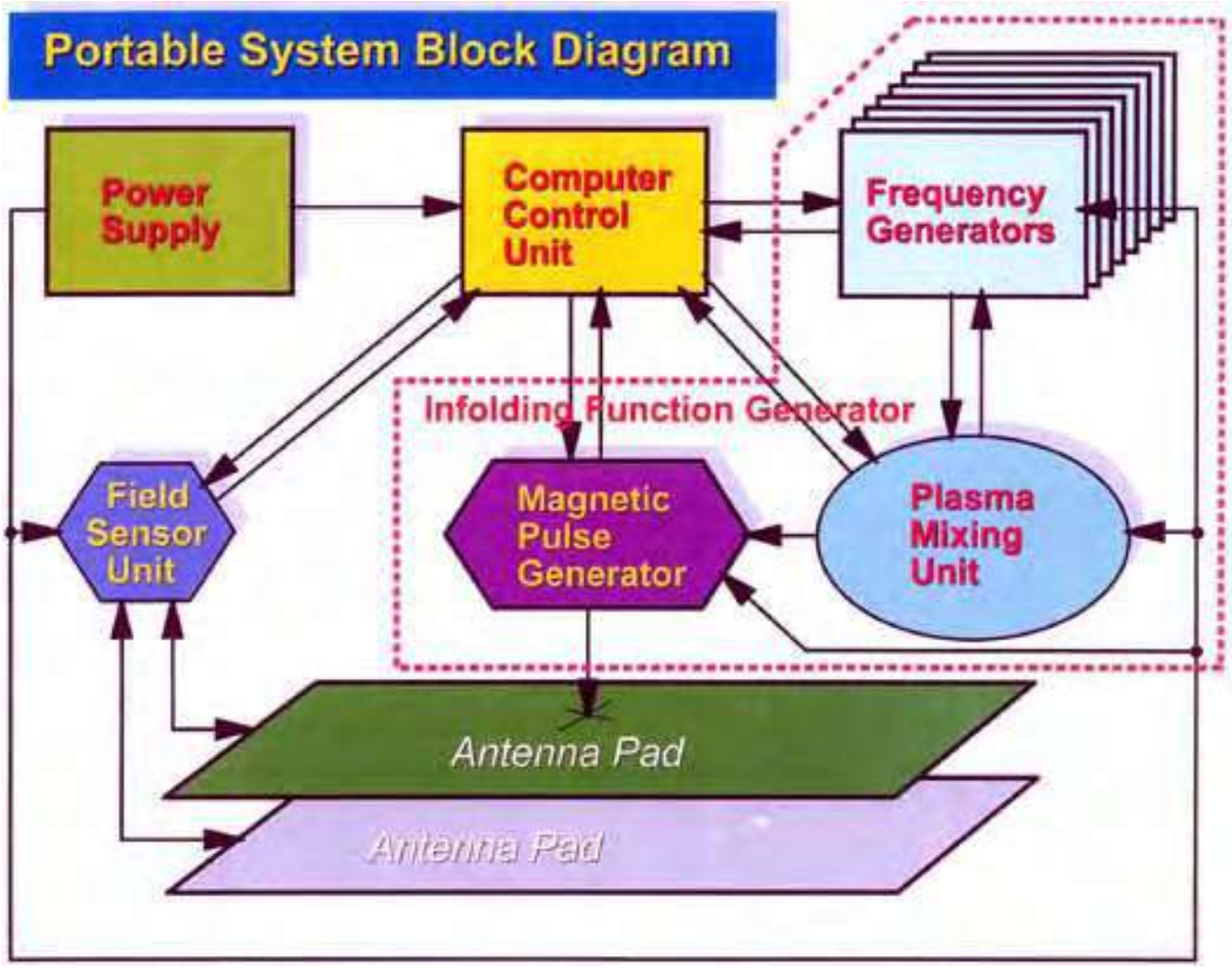

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PORTABLE PRIORE TECHNOLOGY UNIT

- FACT: DISEASE-SPECIFIC VACUUM ENGINE PRESENT FOR ANY CELLULAR DISEASE, BY WHEELER'S PRINCIPLE
  - *DISEASE CAN BE REVERSED BY CREATING AMPLIFIED VACUUM ANTI-ENGINE (BEARDEN'S PRINCIPLE)*
  - *ANTI-ENGINE IS CREATED BY PUMPING THE NONLINEAR CELLS IN THE "INNER EM" DOMAIN, TIME-REVERSING THEM*
- PRIORE UTILIZED A PLASMA TO PHASE CONJUGATE AND "INFOLD" MULTIPLE BIDIRECTIONAL LONGITUDINAL EM PUMP WAVES
  - *17 FREQUENCIES MIXED IN A ROTATING PLASMA*
  - *PHASE CONJUGATES ADDED BY THE PLASMA*
  - *INFOLDED MIX INTO STRONG PULSED DC MAGNETIC FIELD, WHICH CARRIED IT INTO ATOMIC NUCLEI*
  - *PUMPED ALL NONLINEAR CELLULAR COMPONENTS TO PRODUCE AMPLIFIED, SPECIFIC VACUUM ANTI-ENGINE*
- NEGATED THE LONG-TERM CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CELLS.
- SCRUBBED OUT THE CUMULATED PRECANCEROUS STATE
- RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING
- NO EXCESSIVE TRAUMA TO TREATED ANIMAL

CANCR 49

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SAVING THE STRICKEN CIVILIANS

SURVIVORS OF N CASUALTIES

(N = 1-40 MILLION)

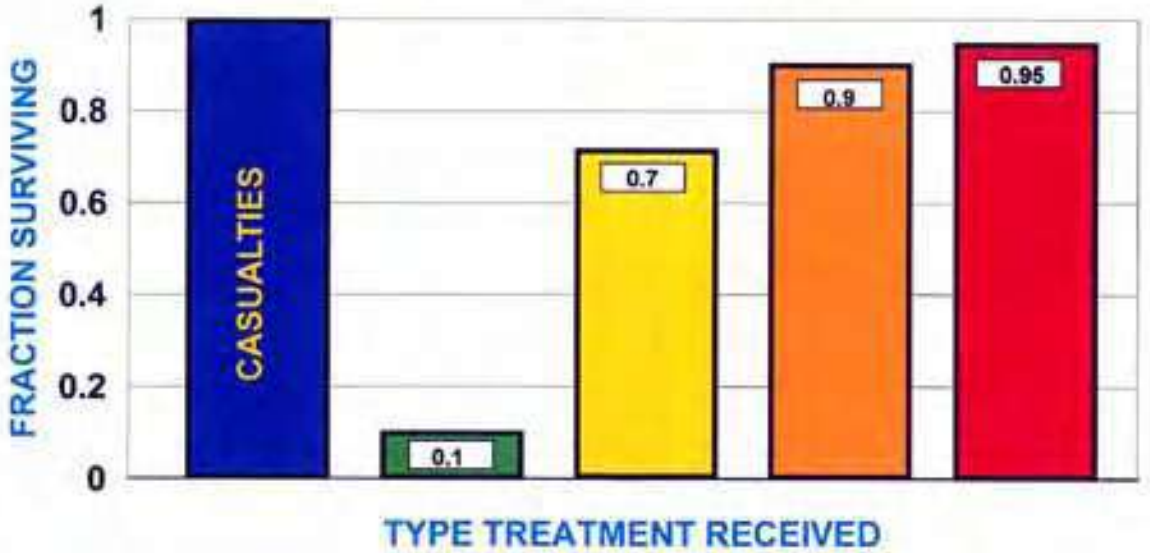

EXPRESSED IN FRACTION SURVIVING
- With conventional treatment
- With 1st generation P-treatment
- With 2nd generation P-treatment
- With 3rd generation P-treatment

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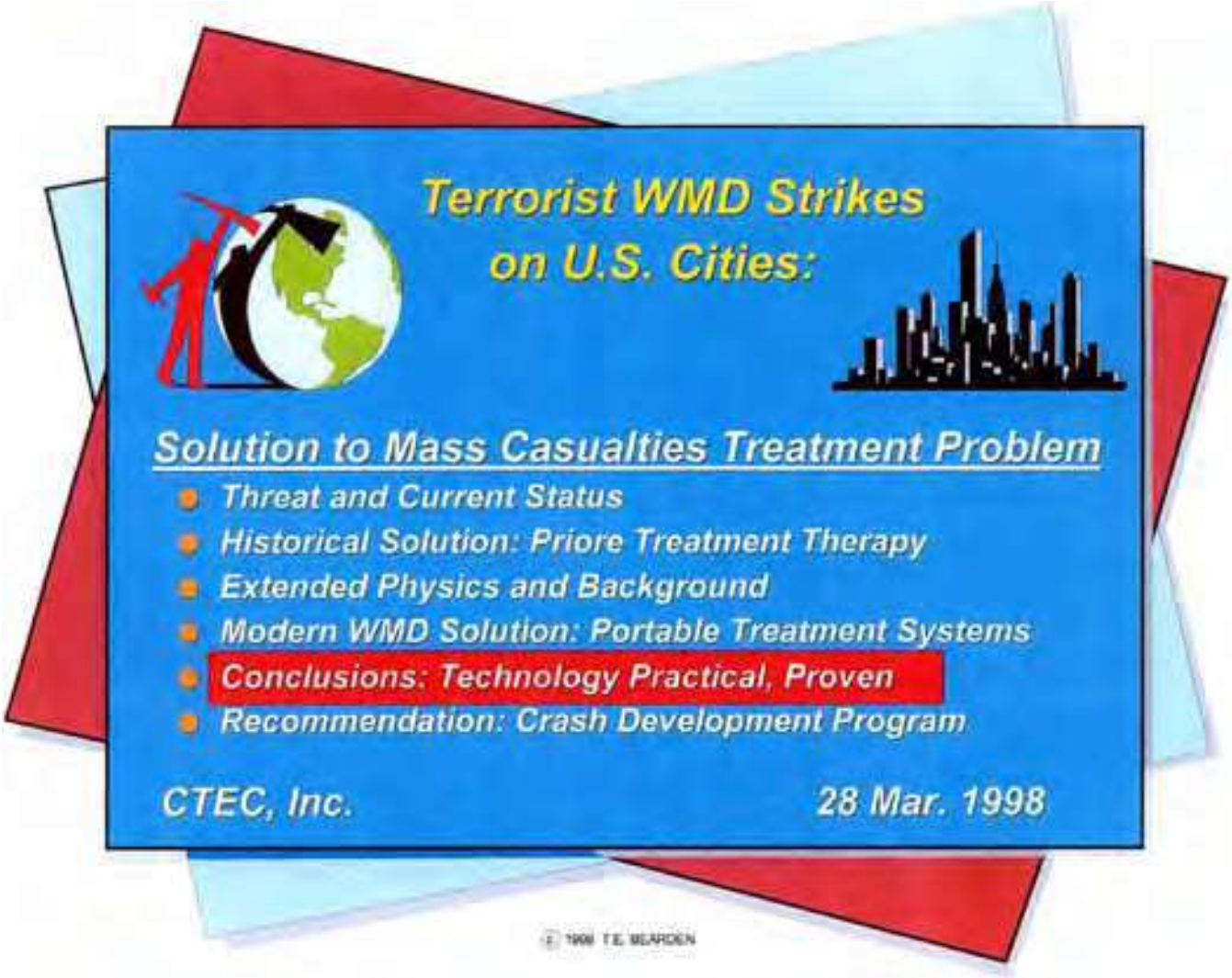

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Summary and Conclusions

- **A new therapeutic paradigm of great scope and effectiveness has been developed**
  - *Will provide effective, quick treatment of mass casualties*
  - *Will provide cures for unknown agents*
  - *No pathogen strains are resistant to this process*
- **Results have been proven experimentally**
  - *Documented in French scientific literature*
  - *Rigorous scientific protocols, eminent scientists*
  - *Technical mechanism deciphered*
- **Will treat and cure many diseases**
  - *Aids, atheriosclerosis, cancer and leukemia*
  - *Sleeping sickness*

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- **Portable units can be developed quickly**
  - *18-month crash development program required*
  - *high level authority and overwatch essential*
- ***Will solve the BW mass casualty treatment problem, both civilian and military***

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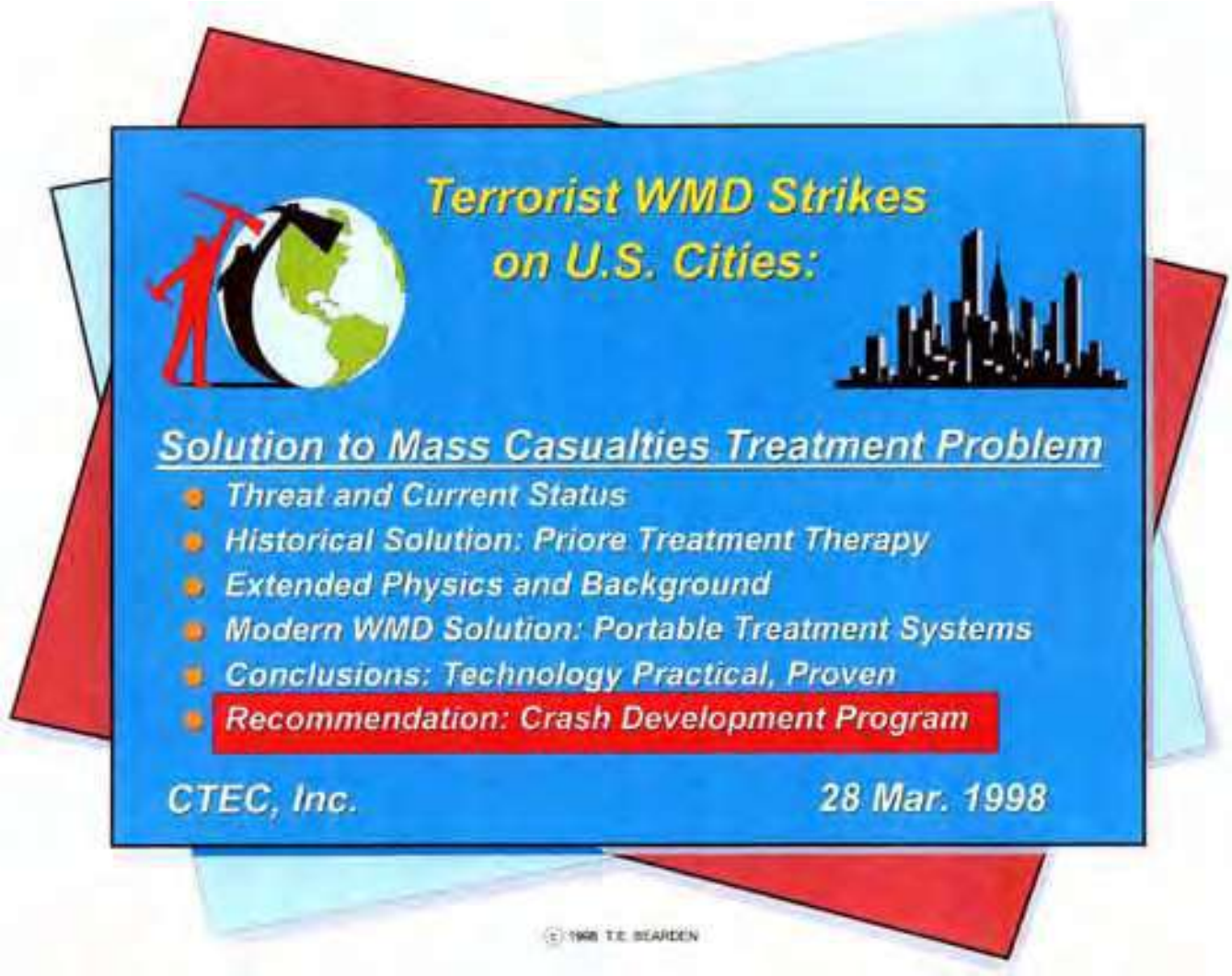

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Recommend implementing:

- Crash development program
  - Suitcase-sized portable unit
  - 18-month Manhattan-type project
  - Simultaneous theoretical modeling, animal testing w/breadboard models
  - SecDef and Congressional overwatch
  - Presidential Decision Directive
- Parallel logistics support program
  - Plan high speed production lines
  - Mass distribution, storage, maintenance
  - User, maintenance training
  - Plan C4 and usage at all levels
  - Integrate firemen, police, National Guard, FEMA, medical facilities, etc.

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Final Thoughts:

- The current internal BW threat can and will kill more Americans than all our previous wars combined
- The Priore technology is the only solution in sight that can save most of those casualties

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CTEC, Inc.
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Huntsville, AL 35801
(256) 533-3682 Ph/
(256) 539-5951 Fax

CTEC, Inc.

June 24, 1998

Dr. Jane F. Kinsel, Director
Office of Policy Analysis
Department of Health & Human Services
Bathesda, MD 20892

Dear Dr. Kinsel:

Your letter of June 8 is appreciated. However, the entire action package had already gone to the Assistant SecDef and also to Major General Neary in the USAF.

The proof of a revolution in medical treatment was in the package. The basis for it is already demonstrated experimentally in the scientific literature, both in the U.S. and in France. We are speaking of something already proven, but missed by the entire U.S. medical community. Strong words, but true. Let me be specific.

Any cell in the body can be time-reversed (physics term) or dedifferentiated (biology term) back to an earlier state, by pumping (i.e., "squeezing" in simple terms) that cell with longitudinal EM waves as pump waves. There are considerable papers in the French scientific literature showing the experimental results.

Apply that to cancer. We are stating bluntly that all cancerous cells in the body can be "depromoted" back to normal cells easily. Further, the damage previously done to them (such as by sustained hypoxia due to contaminants reducing the oxygen-carrying ability normally given to it by some 60-to-80 surrounding water molecules per red cell and the consequent H-bonding interactions) will also be reversed. The cells can all be returned to healthy, normal cells again, without "killing" or "burning" or "cutting" anything.

With some development of the technology, you can quickly and easily cure every cancer patient in every hospital in the United States.

Now apply it to AIDS. Since you can time-reverse every cell in the body, you can time-reverse the HIV-infected cells – genetics and all – right back to normal cells with normal genetics. Those cells not infected and healthy, will just get a "little younger" again.

So with that small development, you can quickly and easily cure every AIDS patient in every hospital in the United States.

I would have thought that NIH would certainly be interested in such a revolutionary therapy which has already been demonstrated in laboratory experiments. World-renowned French scientists – such as the eminent parasitologist Pautrizel and research PhDs assigned directly by Robert Courrier, head of the Biology Section of the French Academy of Sciences, worked with Prioré in performing those startling experiments that proved what we are saying.

The method was rigorously shown to cure infectious diseases (such as trypanosomiasis), atherosclerosis (which now afflicts millions of Americans), and terminal tumors. It was shown to reverse suppressed immune systems back to normal vigorous functioning.

Please permit me to disagree with you that the examination of such is not the mission of the NIH. To the contrary, it is precisely the NIH which should have some of its very best scientists looking into this.

The action package to DoD was to propose a crash program to develop this methodology in the form of a small, portable unit for treatment of mass casualties resulting from a terrorist BW attack on our cities (now expected in the next few weeks, as you must be aware). The leading Arab terrorist of the world has already promised just this.

We are speaking of several million Americans who are going to die. They are going to die in spite of everything that NIH and its labs can do, even though I know you will make a heroic effort. With NIH present methods, you cannot do very much for those stricken Americans at all. Everything we have in the "normal" kit bag is almost useless against a knowledgeable spray attack of modified smallpox (as you know, the Russian secret BW labs have made and sold tons of that already, to guess who!). Or a spray of tularemia (you are well aware of the extreme lethality of that), or anthrax (easily obtained). It is also common knowledge that these terrorist teams with their BW agents are already on site in this country, waiting for the word to attack. This has now been officially raised to our primary Strategic Threat.

In the face of such looming strikes on the U.S., I simply cannot believe that the NIH does not feel it within their mission to rigorously check out a proposed method for saving perhaps 70% of those coming deaths (first generation equipment), and up to 90% with second generation equipment.

Perhaps you just did not read the package carefully. I urge you to do so.

Else NIH is going to look very, very bad when (1) the strikes do occur, (2) they can't handle them (and they cannot, as you well know), (3) they had within their hands in advance, a proposed methodology that could have been investigated intensely, to save millions of those stricken Americans.

As a staunch supporter of NIH and especially CDC, I have to believe that there is a different attitude there. If NIH is not interested in a previously experimentally demonstrated method of saving millions of Americans, then the only recourse left is the political channel.

I assure you that my critique of electrodynamics is well-founded, as supported by various leading physicists such as Nobelist Feynman (who stated bluntly that the field concept is wrong), Wheeler, Bunge, and so on. It is inexplicable why all our universities are still teaching a 130 year old abridged (Heaviside's) subset of Maxwell's theory, and one that still contains a material ether even though that was falsified 110 years ago!

You already have seen the misuse of this technology by the Russians, in the decades-long radiation of the U.S. Embassy in Moscow. Is it not NIH's mission to understand how they generated all those diseases and health changes? Have you ever looked into Kaznacheyev's experiments showing that ANY cellular disease or disorder can be induced in cells at a distance by purely EM means? Have you looked into what got eliminated from electrodynamics by ignoring the hidden longitudinal EM inside every potential, field, and wave? Do you realize what ignoring that has done to American chemistry, biochemistry, and medical science?"

I would hope that the NIH would at least be interested in its own mission area!

I challenge you bluntly to admit that no one presently understands the primary operation of the human cellular *regenerative* system. That's because its technical principle is not presently in our recognized physics, biochemistry, and medical science – even though it has been in the hard physics literature since 1903-4. Becker's epochal work came closest; since he only had access to the conventional EM model, it failed him. But he at least showed you rigorously that cells can be changed (both differentiated and redifferentiated) all over the map by laughably weak EM – picoamperes of current, which means persistent DC potentials. In the microwave radiation of the U.S. Embassy, all the health changes occurred in regions absent of fields – i.e., absent of bleed-off of the potentials. Hence in regions of stable DC potentials! With 100% correlation of the health changes to persistent, gradient free potentials, and 100% anticorrelation to changing potentials (i.e., fields), our own scientists concluded totally erroneously that it could not have been the EM radiation causing the changes, when their own results had just proven that it was.

Now I ask you: Can NIH explain how it was that the DC potentials caused those health changes? I think not. If it could, it would understand the action package I wrote, and its importance.

This is not a "political" letter. I'm just an ordinary American citizen who has done about 30 years very hard work on this particular area. The work is good enough now to stand on its own merits. The scientific community will eventually accept it, about 50 years from now. But we cannot wait 50 years! Those millions of Americans are going to die, because of the bureaucracy and inaction of our own scientific organizations. Whether they like it or not, the U.S. scientific community is now the forefront of the struggle for this nation to survive. And they are failing us dramatically.

So as a parent who wants his children to live, and his neighbors' children to live, and those millions of soon-to-be stricken Americans to live also, I urge you to at least have someone competent in physics (and knowledgeable that the foundations of physics itself are in woeful shape!) check the work. Has anybody there *read* any of the references to the Prioré work I cited? Does anyone there realize that *there are no EM forcefields in space?* Probably not.

Dr. Kinsel, there is a time for "business as usual" and there is a time to do some serious new work. Those stricken Americans are going to be lying there. Nothing NIH can do is going to stop that. That's a given, and it is not my own estimate. It's the official estimate. And you *know* you presently do not have the tools to do anything really effective about it.

Frankly, I interpret your letter to me as just the normal "spin control" for easy disposition. I would hope that NIH would seriously rethink the situation, get off the "spin control" and "business as usual" posturing, and do something dramatically different for a change.

What have you got to lose? A little time from perhaps two or three of your best scientists.

What have you got to gain? Saving untold millions of American lives. A new, *already partially demonstrated* cure for most dread diseases such as AIDS and cancer – diseases which you presently cannot do very much about in spite of decades of heroic struggle.

Sincerely,

cc: Senator Shelby, Congr. Cramer

T.E. Bearden
President and CEO

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CTEC, Inc.

May 12, 1998

Dr. Harold Varmus, Director
National Institute of Health
Bathesda, MD 20892
(301) 496-1766

Dear Dr Varmus:

We have recently sent action documents to the Director of Nuclear and Counterproliferation, Office of the DCS, Air and Space Operations, HQ USAF and to the DoD (General Busbee) Assistant Secretary of Defense, as well as several Senate and House committees, which may be of interest to you. For one thing, we give the technical mechanism used to generate the Gulf War Syndrome. The same weaponry is now being used to rapidly induce new strains of certain pathogens worldwide. I urge you to closely read that section of the letter to MG Neary which explains the GWS, why the French did not get it, and why Southern Iraqis got an increase in cancer and leukemia but not GWS. Also explained is how the "microwave radiation" of the U.S. Embassy in Moscow induced diseases for decades, and how we failed to comprehend it because the standard EM model deceived us.

There is a way to treat and quickly cure most diseases, including the mass casualties resulting from a terrorist BW strike on our civilian population centers, our military bases, or our forces in the field. The method is little known, but was scientifically demonstrated in France in the 1960s and early 1970s before cancellation of the Prioré Project when the French Government changed. Eminent French scientists worked on the project, and the results are fully documented in leading French scientific journals. References are listed in a separate attachment.

Previously the Western scientific community has been unable to understand the technical mechanism responsible for such remarkable cures, because of serious foundations flaws in Western physics and electrodynamics. *Foundations* physicists have long been aware our science is flawed, and have pointed out many of these fundamental errors. However, the operational science establishment has not paid attention, even though physicists such as Feynman and Wheeler pointed out that the notion of "force fields in space" was totally wrong.

As a primary example, there is an "infolded" electrodynamics inside all potentials, fields, and waves that is far more primary than the coarse EM that is in our textbooks. It is actually an infolded general relativity, and this is what the Russians have weaponized. This infolded EM-GR has been ignored in the West (but not in Russia) since 1903.

As another example the potentials, fields, and waves of present electrodynamics are rigorously defined – and exist – only in the presence of mass. They do not exist in such form (force fields and oscillating force fields) at all in space, in the absence of mass. Rigorously, Maxwell's equations are mass-to-mass transforms, since Maxwell and everyone at the time assumed the ubiquitous presence of the material ether. In other words, to the founding electrodynamicists, there was no place in all the universe that was devoid of mass. Hence they defined all EM entities as entities containing mass. Even though Michelson-Morley experiments of more than a century ago destroyed that material ether, not a single Maxwellian equation has ever been changed! They still assume the material ether.

Specifically missing from our electrodynamics are two essential transforms: (1) the mass-to-spacetime transform, and (2) the spacetime-to-mass transform. In other words, these two transforms are "infolded" or hidden inside (comprise) the end point extremum case – the mass-to-mass transform actually written by Maxwell.

But these two missing transforms are just general relativity (they correspond precisely to Wheeler's principle of general relativity). So general relativity has always been infolded inside electrodynamics as we know it, but ignored. Further, this is a very powerful general relativity, since it uses the very strong EM force as the agent of spacetime curvature. Hence now one can engineer a powerful general relativity in the laboratory and in practical devices, and even action-at-a-distance, which one cannot do using merely the staid and weak G-force.

It turns out that longitudinal EM waves as shown by E.T. Whittaker in 1903 and 1904 are far more primary than our present EM theory and even our present GR theory. Both EM and GR are directly engineerable using longitudinal EM waves, including subluminal and superluminal EM waves in vacuum, and including action at a distance. One can engineer complexes of spacetime curvatures as desired, which in turn are *spacetime engines* (Wheeler's term). These engines can act upon mass – either living or inert – in any fashion desired, and at any distance desired.

The little-known and poorly understood Regeneration & Recovery (R&R) system – as contrasted to the immune system – utilizes this exact "spacetime engine" methodology to restore damaged or diseased cells, within its limitations – "dedifferentiating" or "time-reversing" them back to normal. The mechanism is fully explained in the attached package. The proposed program applies this fundamental method to greatly amplify the effect. Thus cancer cells can be reversed back to normal cells, HIV-infected cells (HIV-factories) can be reversed back to normal cells (genetics and all), etc. This represents a dramatic and unparalleled new medical therapeutic methodology of extreme power. The same techniques can simply be conjugated one additional time, and used to produce diseases and cellular changes at a distance, including in entire mass populations, as the KGB is doing right now. Specifically, by impressing an extremely weak "cocktail mix" of disease spacetime engines on the U.S. populace, the immune systems are reacting and being "spread thin" across several "shadow state" infectious pathogenic conditions. Thus when an actual terrorist BW attack occurs, the lethality of the strike will be remarkably enhanced because the immune systems will be "thinned" in their ability to fend off this new pathogen. By doing it this way, BW warfare can actually be conducted upon the U.S. without anyone being the wiser.

Our very survival as a nation is threatened by remarkable KGB weapons using this fully documented, extended electrodynamics. Bluntly, unless we take off our scientific blinders and understand Russian energetics weapon science, GWS and the Embassy health changes in Moscow were just a picnic before what is upon us. After two decades of work on the KGB energetics weapon problem, we have fully deciphered the technical mechanisms and what energetics is, as well as citing many of the Russian weapon tests and how they were done. Again, you can see that for yourself in the package.

Now that we understand the technical mechanisms, we are proposing rapid redevelopment of the Prioré process, in portable suitcase-sized units to be mass produced and filtered down into the entire emergency community for mass treatment of lethal infectious diseases resulting from BW strikes. And we are strongly urging the U.S. scientific community to quickly investigate and come to grips with this vast new *biological engineering* mechanism. Our very survival depends on it.

The inclosed documents provide an overview of the process. There is nothing else on the scientific horizon that can save the majority of all those stricken Americans, once the first foreign-sponsored terrorist teams strike our population centers with BW agents.

Sincerely,

Incls: Full package with table of contents

T.E. Bearden
President & CEO

The Tom Bearden Website

Energy, Observations and Comments

---

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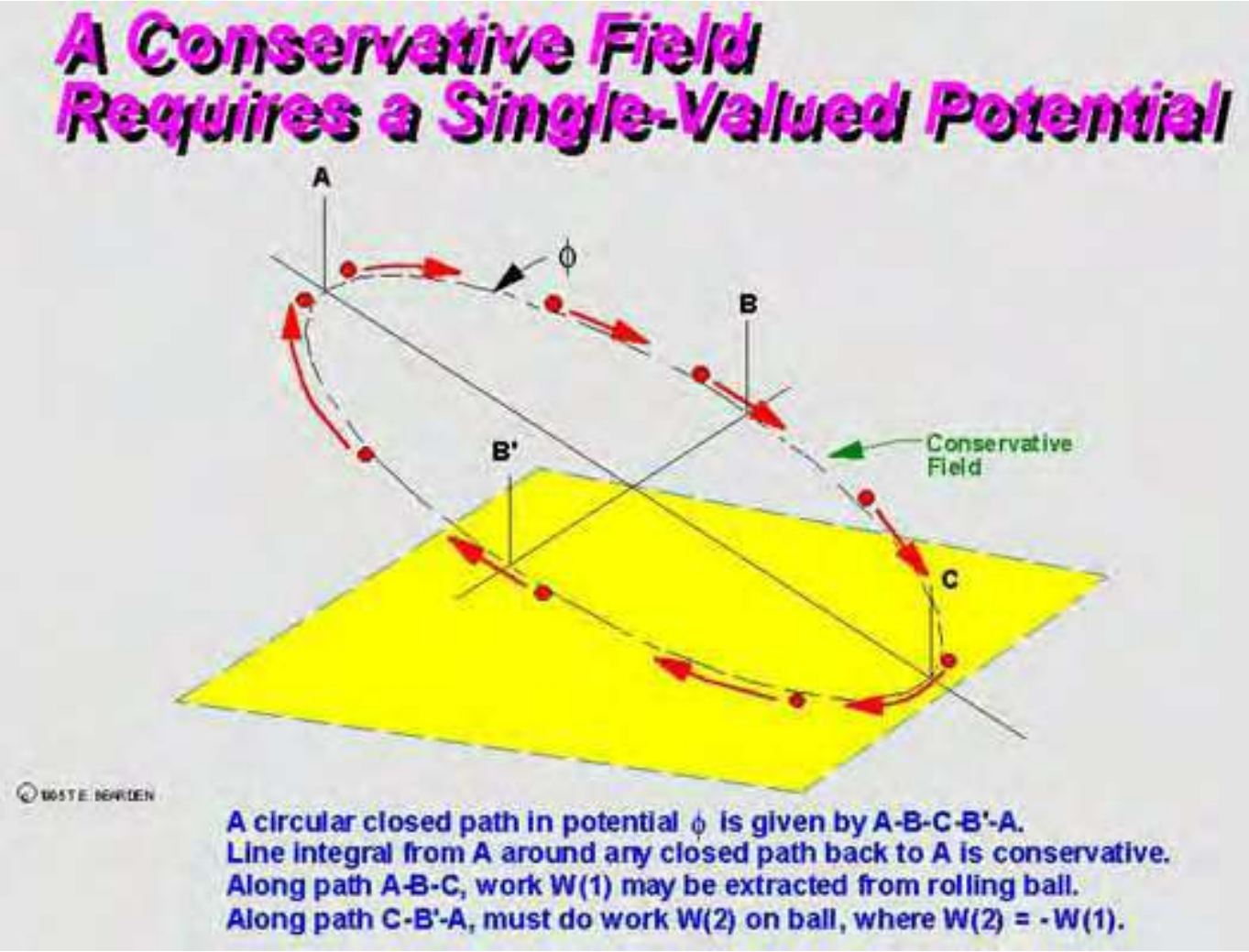

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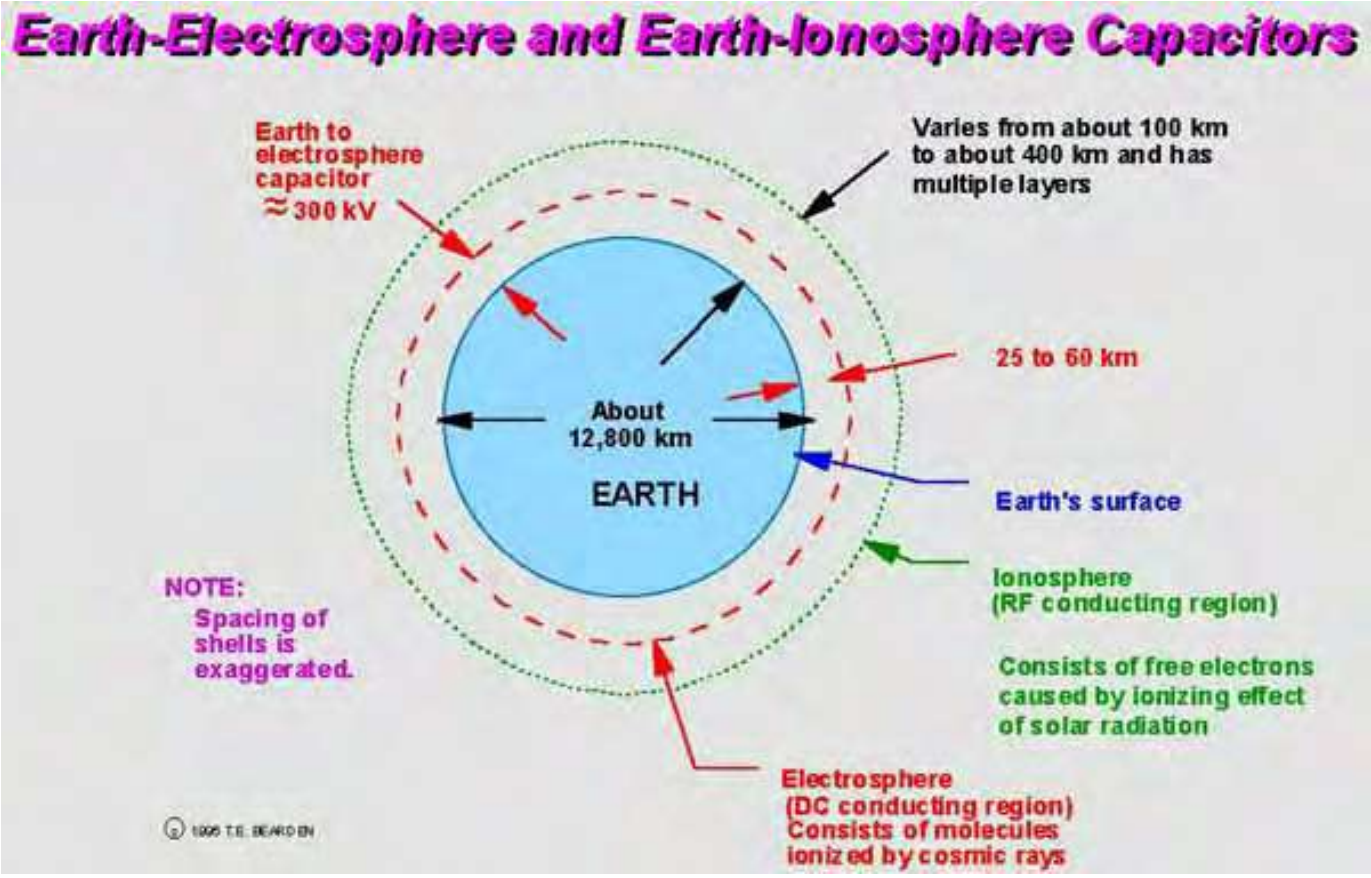

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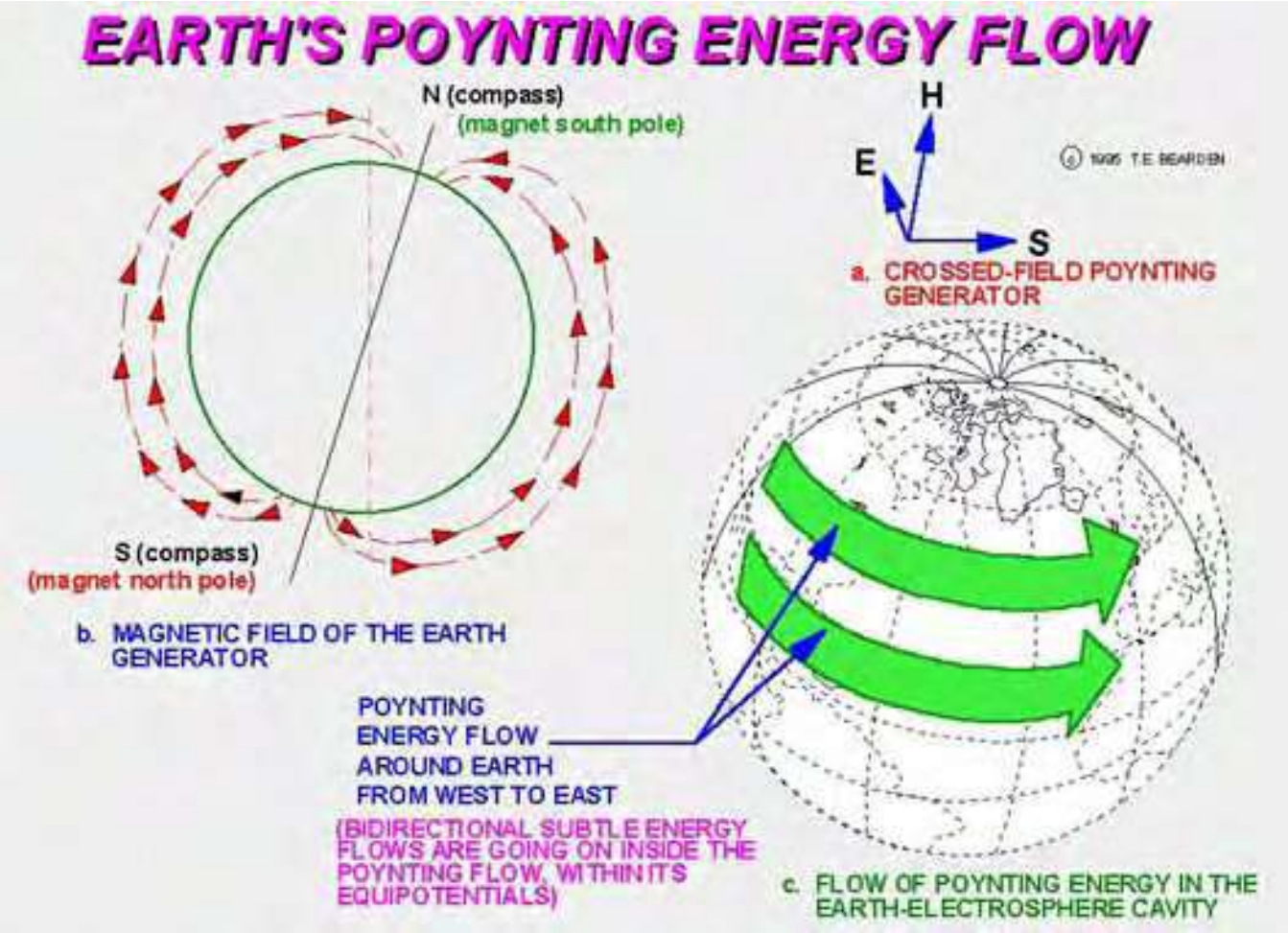

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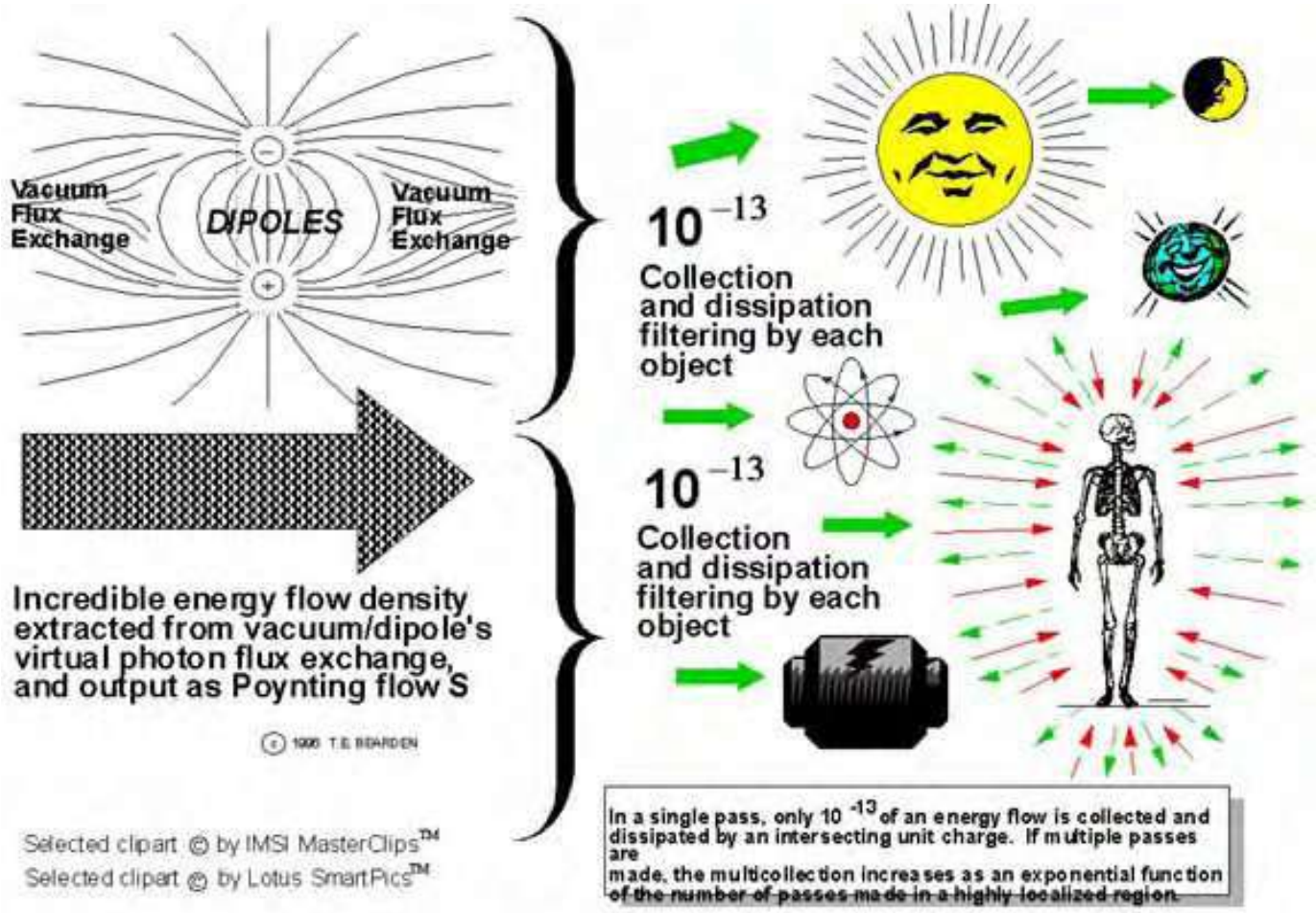

Figure 19. The world of physical matter exists behind a dramatic 10^{-13} filter in a fiery cauldron of fierce and primeval EM energy flow.

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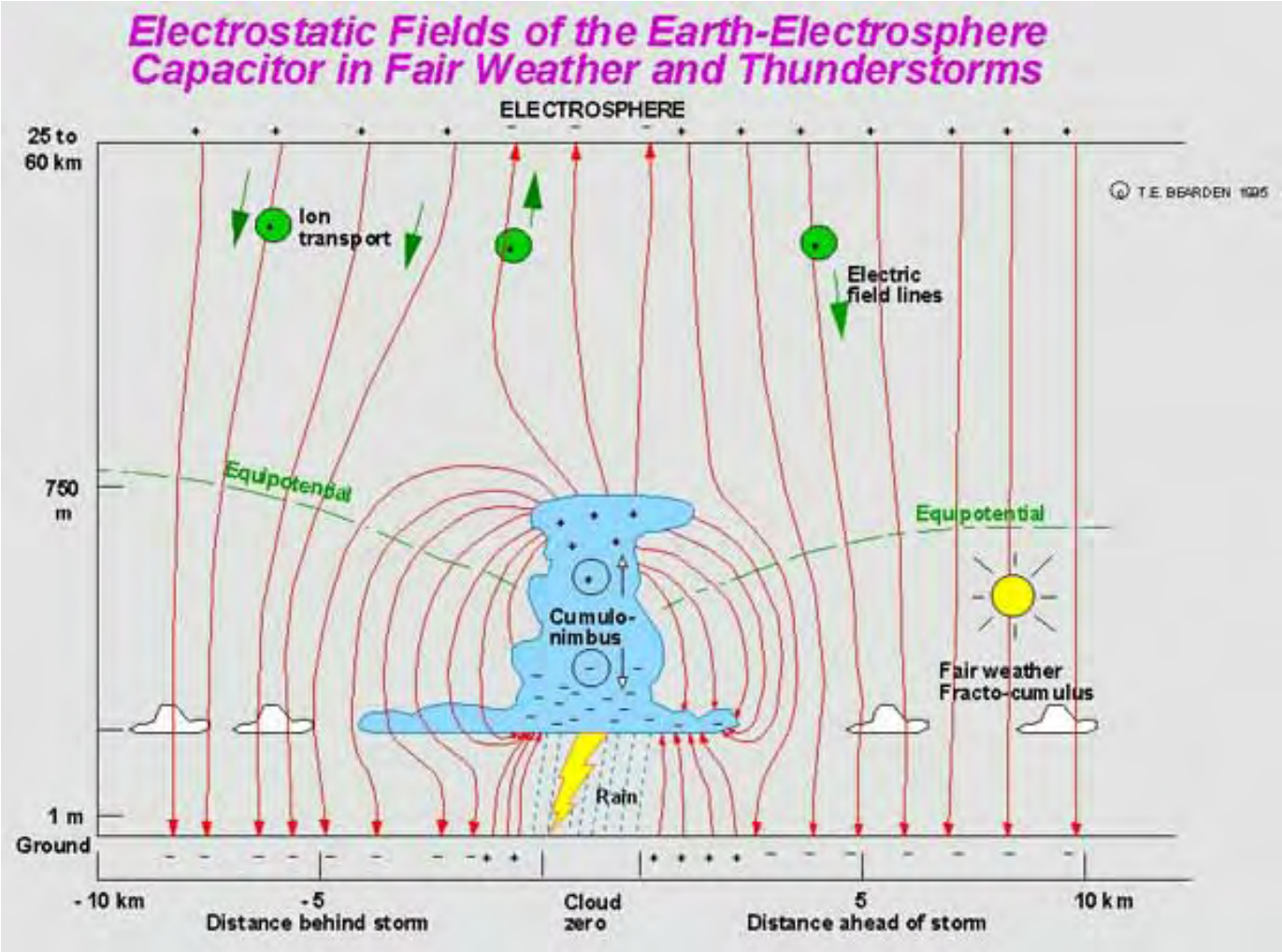

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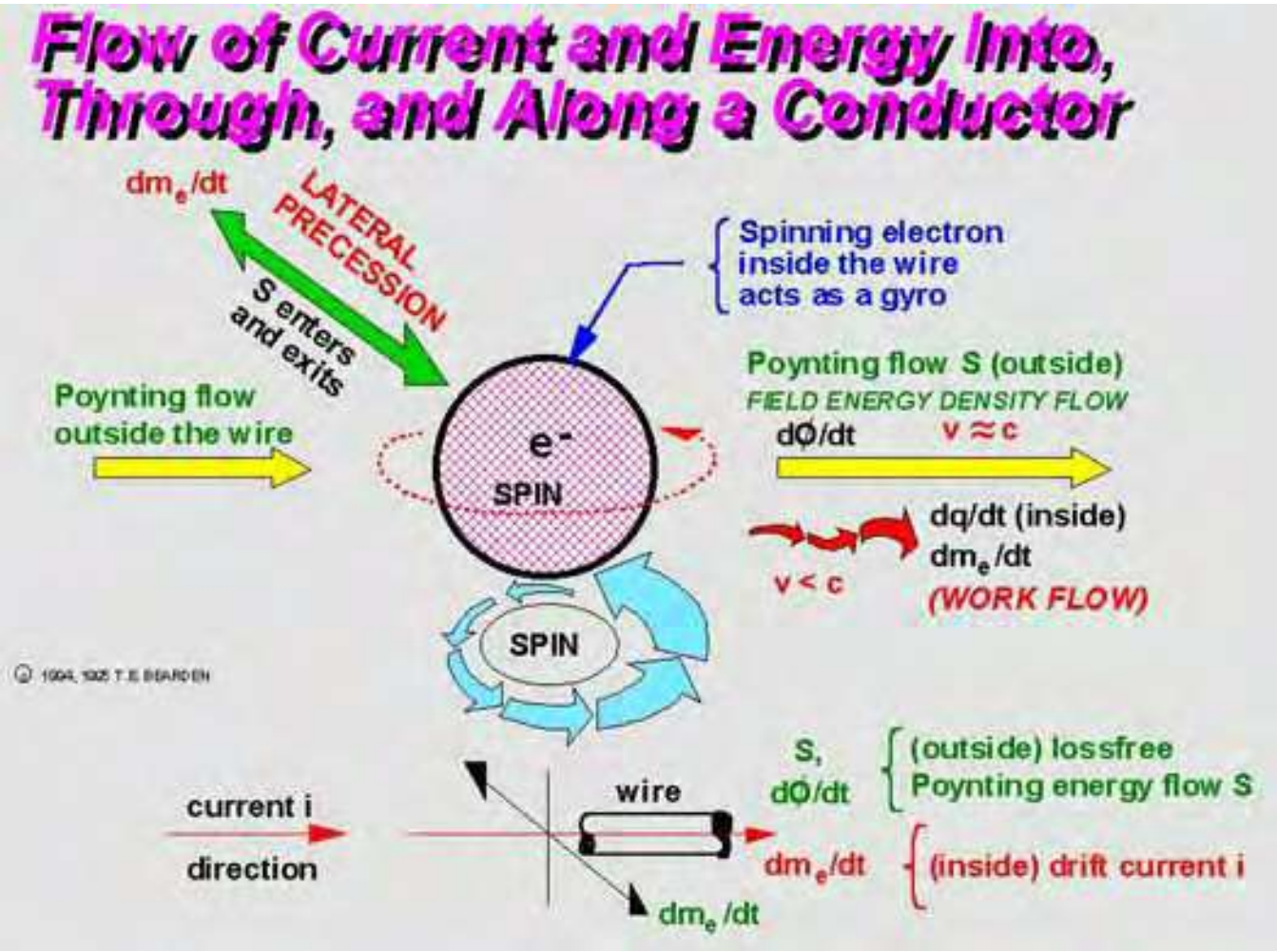

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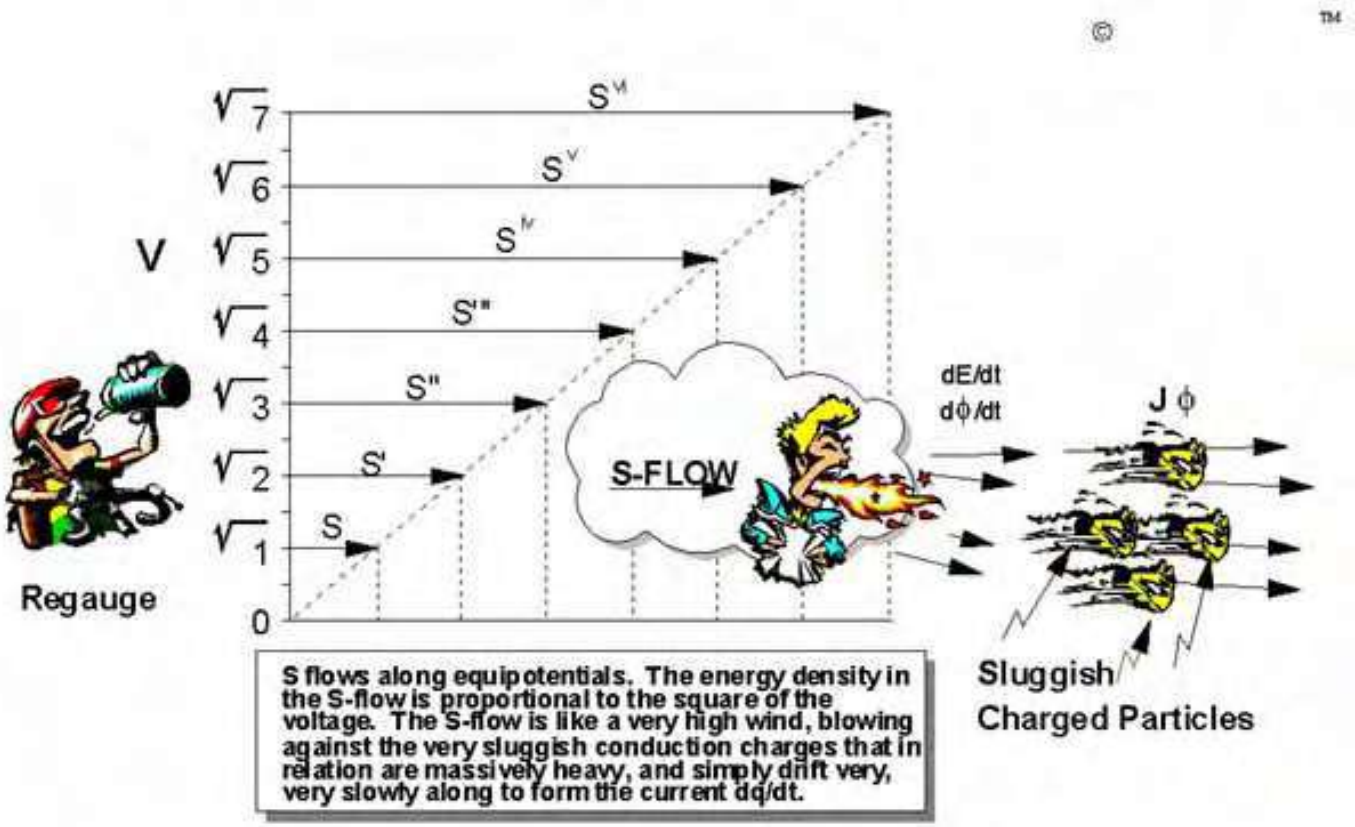

Figure 17. Energy "collected" on a charge depends upon the charge being in a continuous Poynting S-flow. When S ceases, there is no excess energy "collected" on the charge. Energy collection never occurs in chunks, but is always a dynamic, ongoing process.

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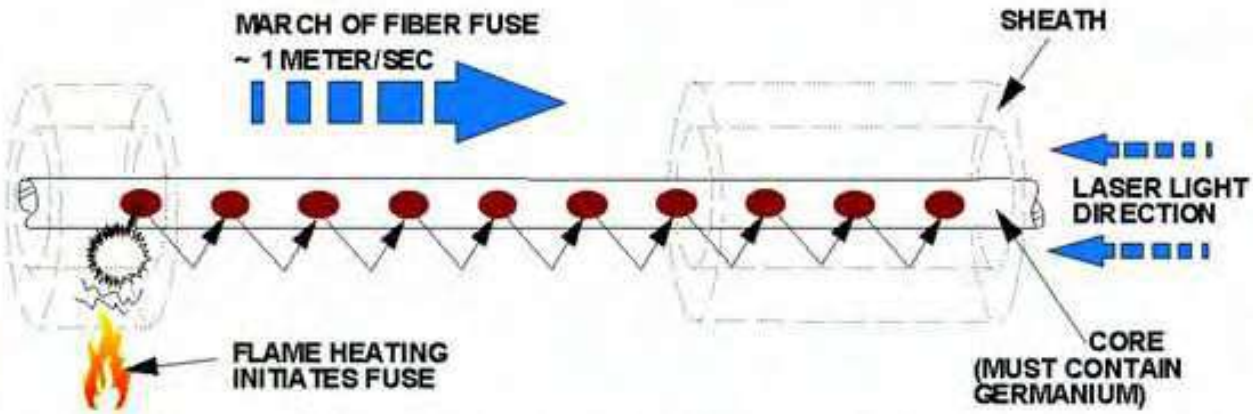

31A. Fiber fuse destroys core of fiber optics cable of indefinite length, pitting core with holes.

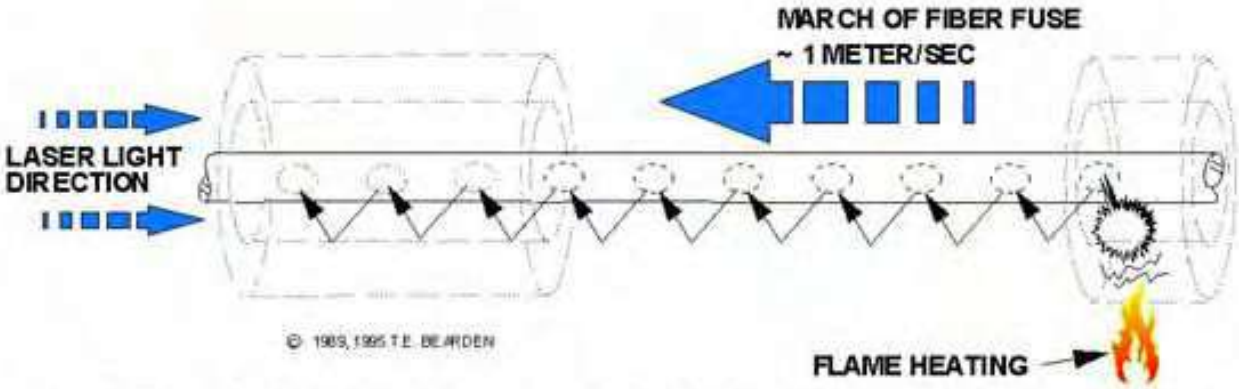

31B. Reversed second fiber fuse often *restores* pitted core in cable, filling holes back up.

Figure 31. Fiber fuse effect and its strange anomalies.

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Impact of Vacuum Engineering

- "If they [quantum fluctuations of vacuum] can be [tapped], the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete – and so would many of our worries about environmental pollution."
- "Don't sell your oil shares yet – but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development:
  - 1. It's crazy!
  - 2. It may be possible -- so what?
  - 3. I said it was a good idea all along.
  - 4. I thought of it first."

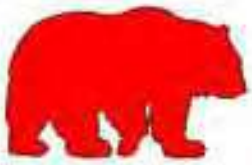

Arthur C. Clarke
"Space Drive: A Fantasy That Could Become Reality"
Nov./Dec. 1994

- *Comment:*
  - *Every dipole's broken symmetry in its energetic exchange with the vacuum already freely extracts vacuum energy.*
  - *In power sources, the dipole gates the extracted energy out as S = EXH, which flows almost entirely outside the conductors.*
  - The circuit interacts with, and uses, only about 10^{-13} of S. The electrodynamicists calculate only this small S-component.

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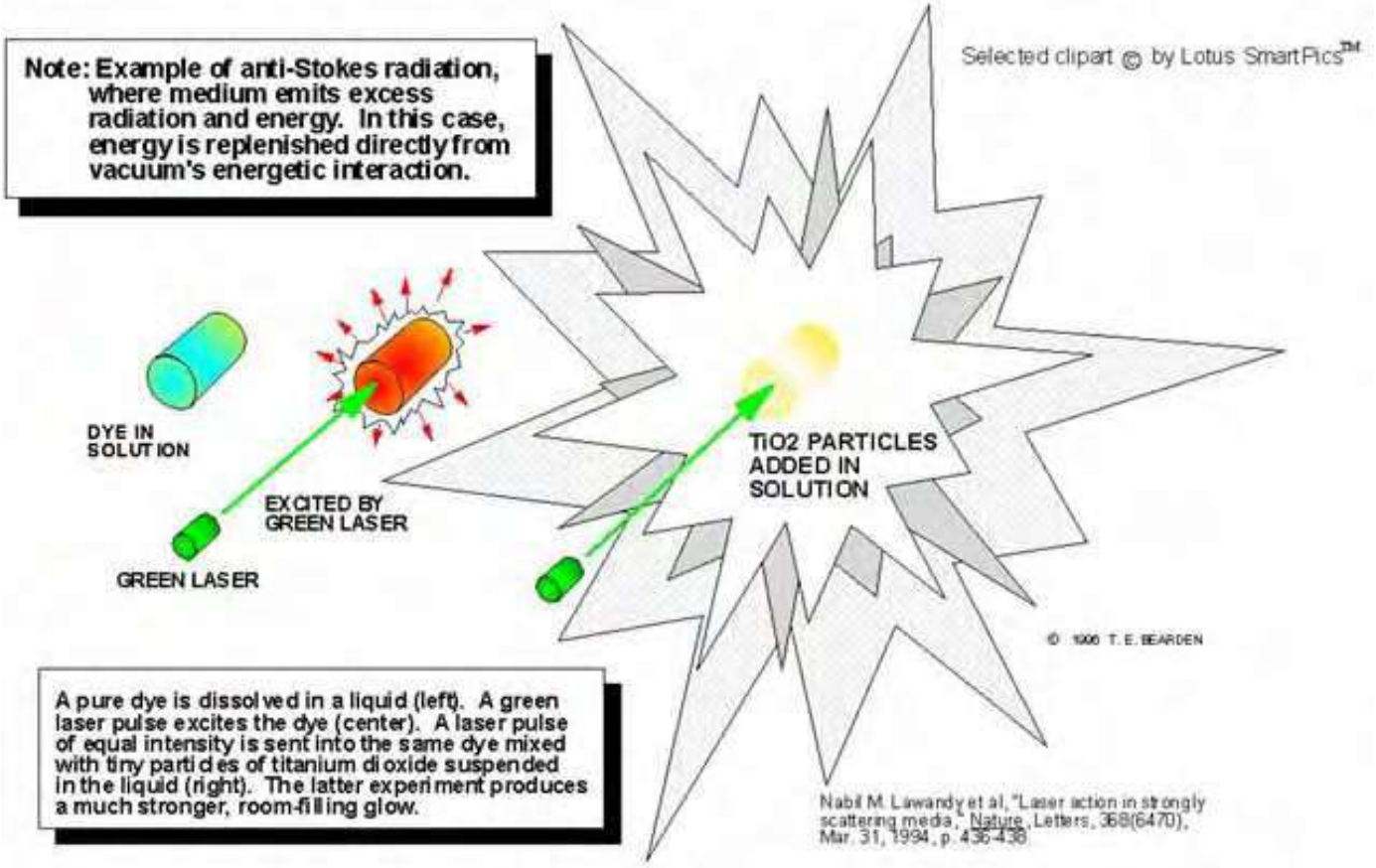

Figure 28. Lawandy's experiment (Letokhov-Lawandy effect) with multipass, multicollection of energy. Formation of a quantum potential can also become involved. Retroreflection and self-targeting are key.

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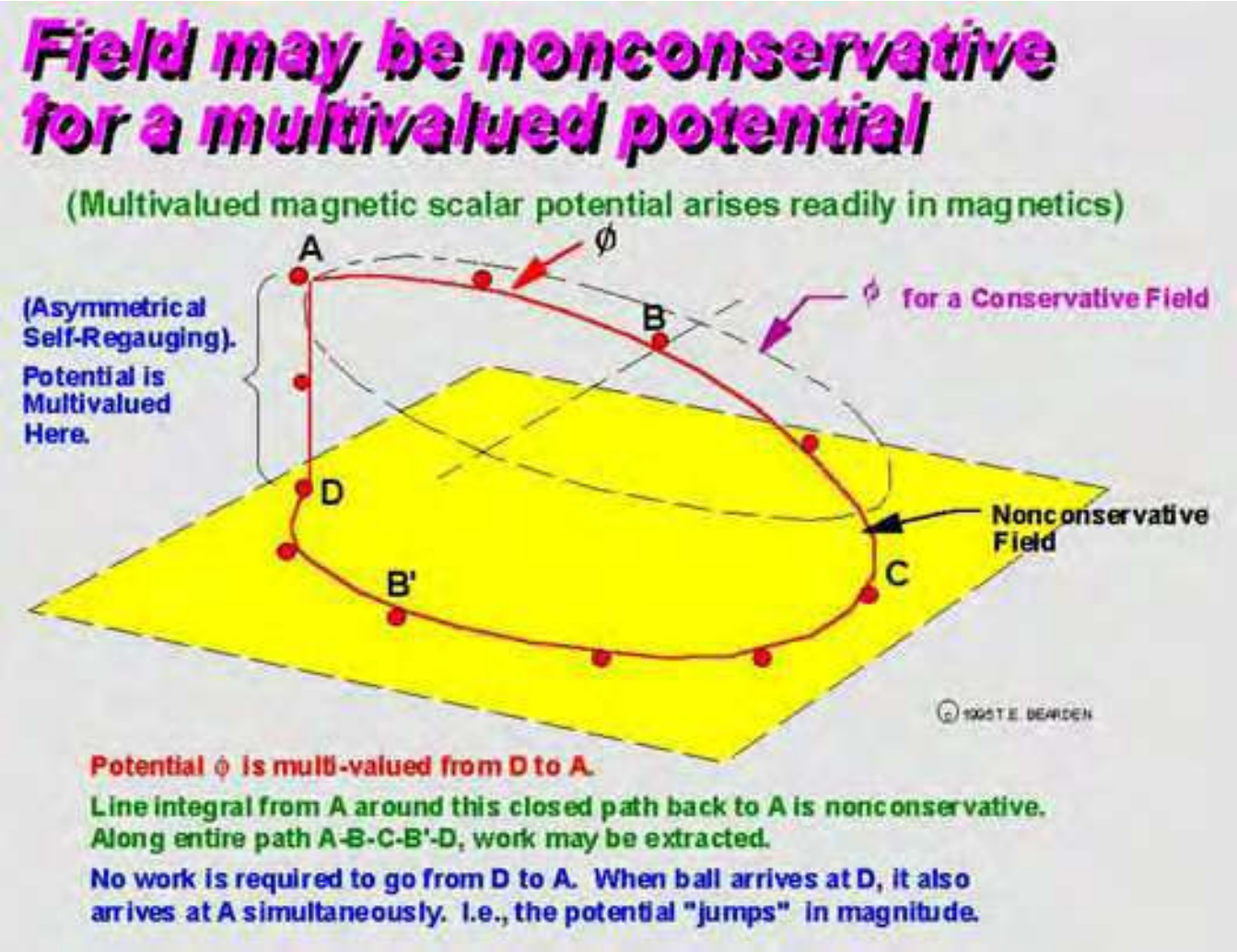

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We're running out of energy! We must redouble our efforts!

We have to keep polluting the Earth, if we are to have energy!

Actually, a *few* of our electrical systems already produce all the energy we could ever need! *Learn to collect it and use it!*

Selected clipart © by IMSI MasterClips™
Selected clipart © by Lotus SmartPics™

All our antibiotics are failing! Millions will die from the new age of pandemics and from terrorists' BW attacks!!

We have to relegate EM effects on biological systems to the trash heap. We can only try to find more drugs and antibiotics.

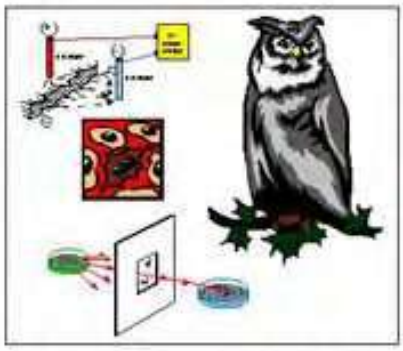

Actually, Priore already showed how to cure most dread diseases, by making and directing vacuum engines. Becker showed you it worked. *Develop it and use it!*

Figure 33. The only problem is the ostrich problem.

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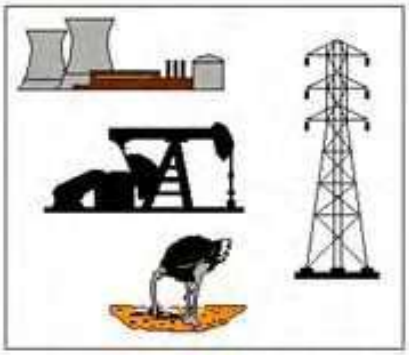

We're running out of energy!
We must redouble our efforts!

We have to keep polluting the Earth, if we are to have lots of electrical energy!

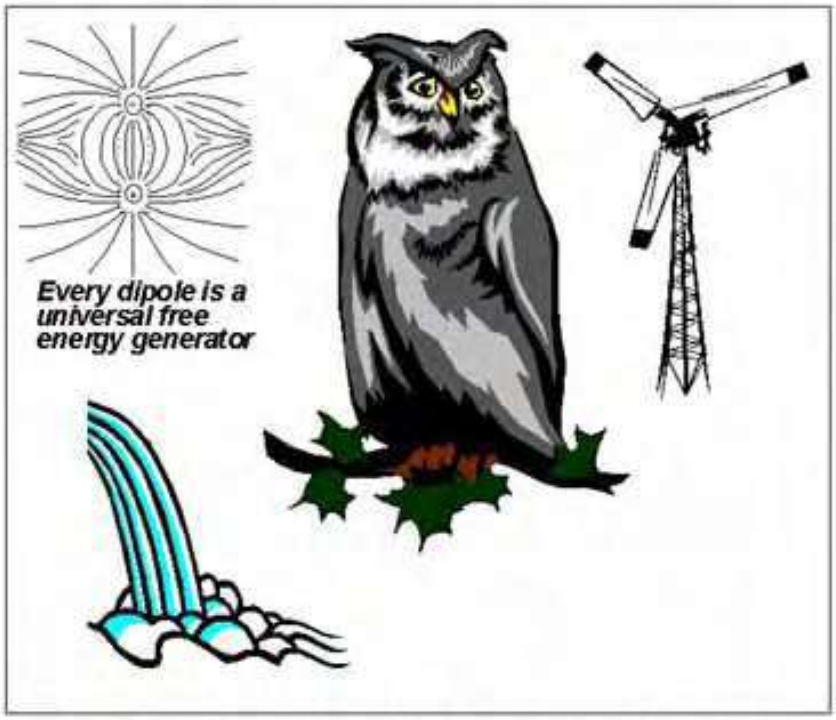

Actually, a single one of our large electrical power systems already produces all the free Poynting energy the world could ever need! *We just have to learn how to collect more of it and use it without continually destroying the source dipole!*

Figure . The only energy resource problem is the theoretical ostrich problem. We must become theoretical owls, rather than ostriches.

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RUSSIAN "SWITCHED PARAMETERS" DEVICES: SELF-OSCILLATING ROTARY GENERATORS*

- Excites oscillations without explicit sources of magnetic or electric forces (i.e., regauges)
  - Periodic variation in system's parameters
  - Experimental and theoretical proof
  - Multiple successful systems made, tested
  - Papers published in Russian, French journals
- As theory predicts, power continually increases unless load is adjusted to stabilize system
- Several large systems tested to self-destruction
- Several large stable systems built, tested

* "On the parametric excitation of electric oscillations," L.I. Mandel'shtam and N.D. Papaleksi, Zh. Tek. Fiz. 4(1), 1934, p. 5-29.

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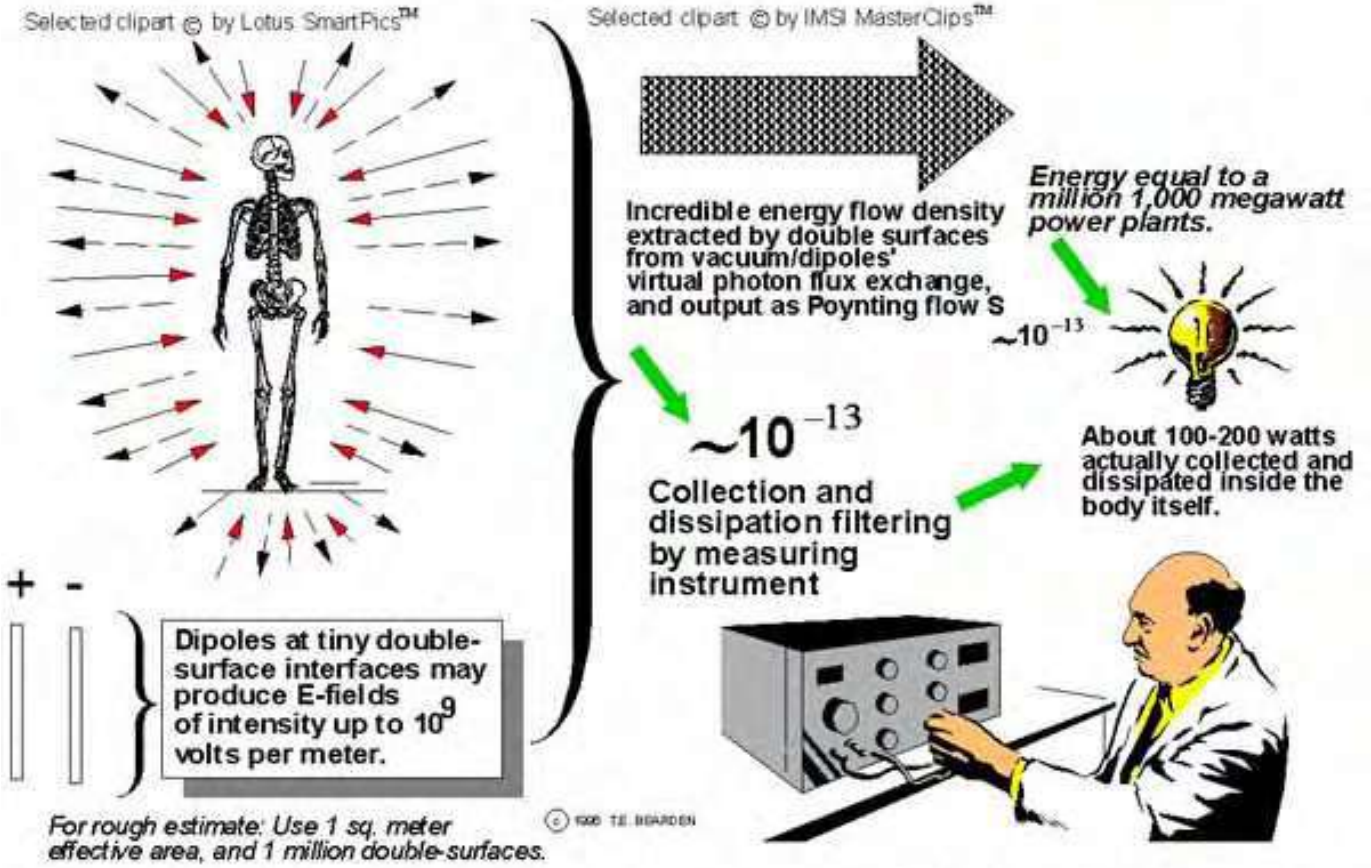

Figure 20. One human body produces more energy flow than all the electrical power loads on earth dissipate. However, only 100-200 watts of its own energy output is collected and dissipated by the body.

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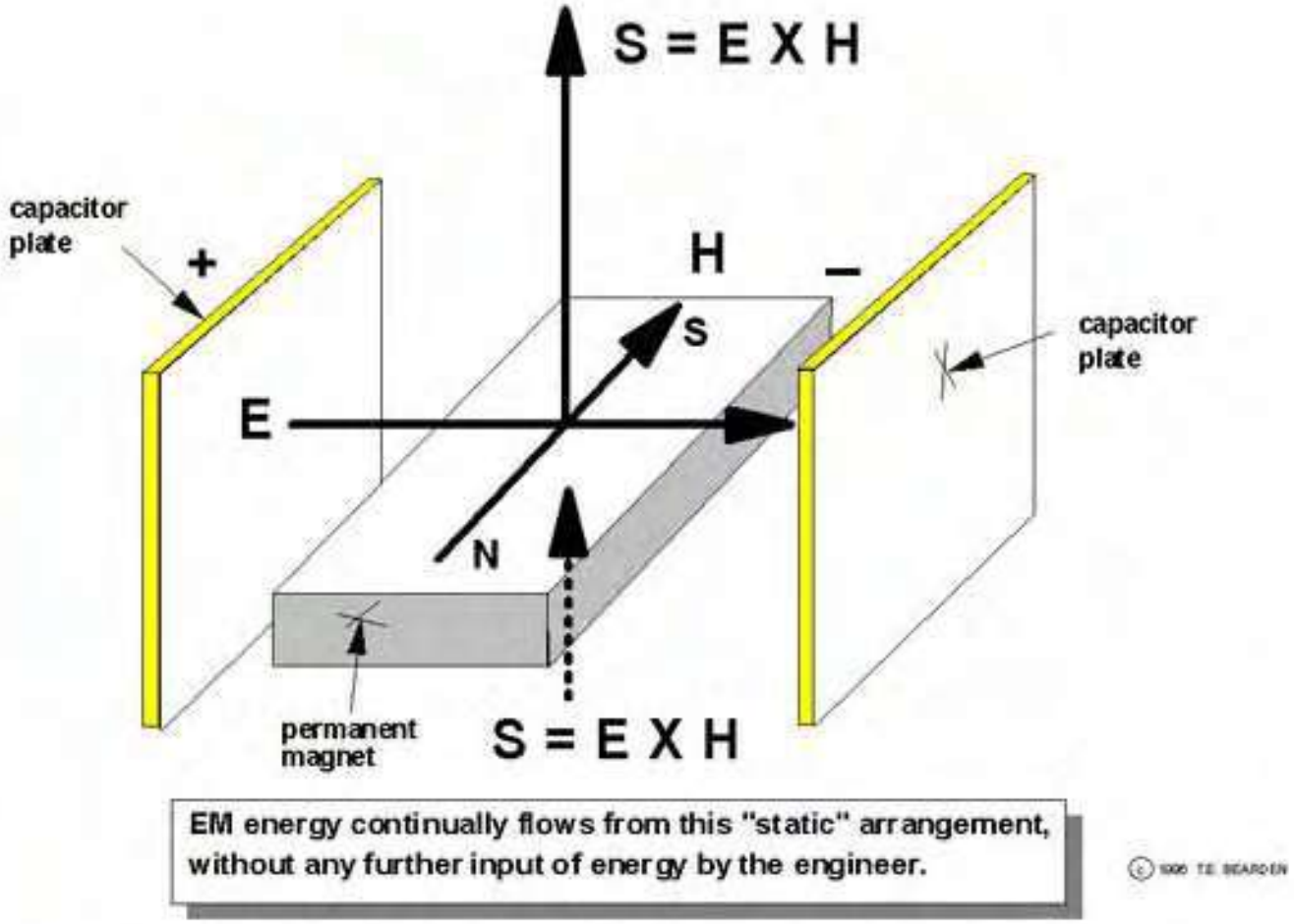

Figure 18. A "static" Poynting S-flow free-energy generator.

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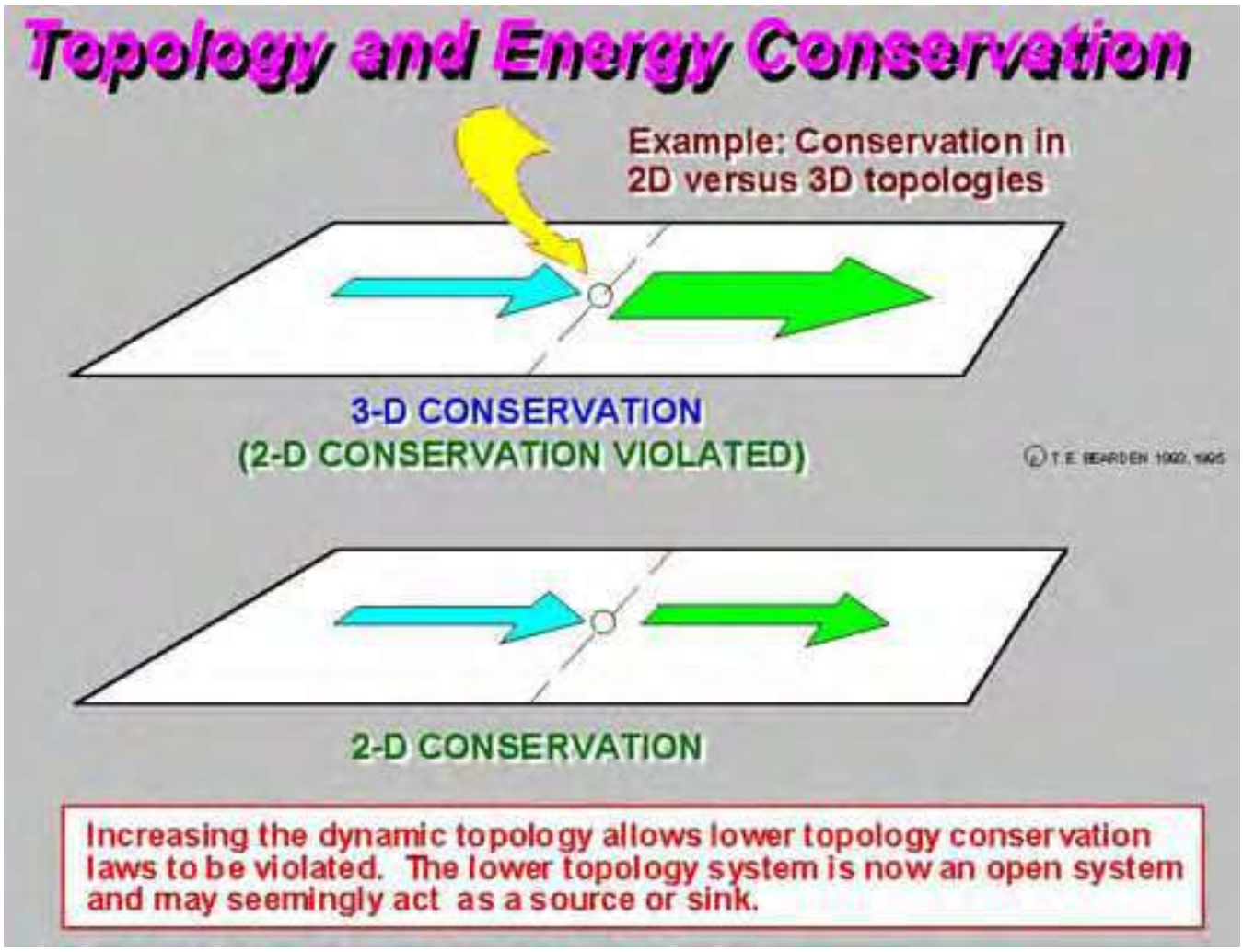

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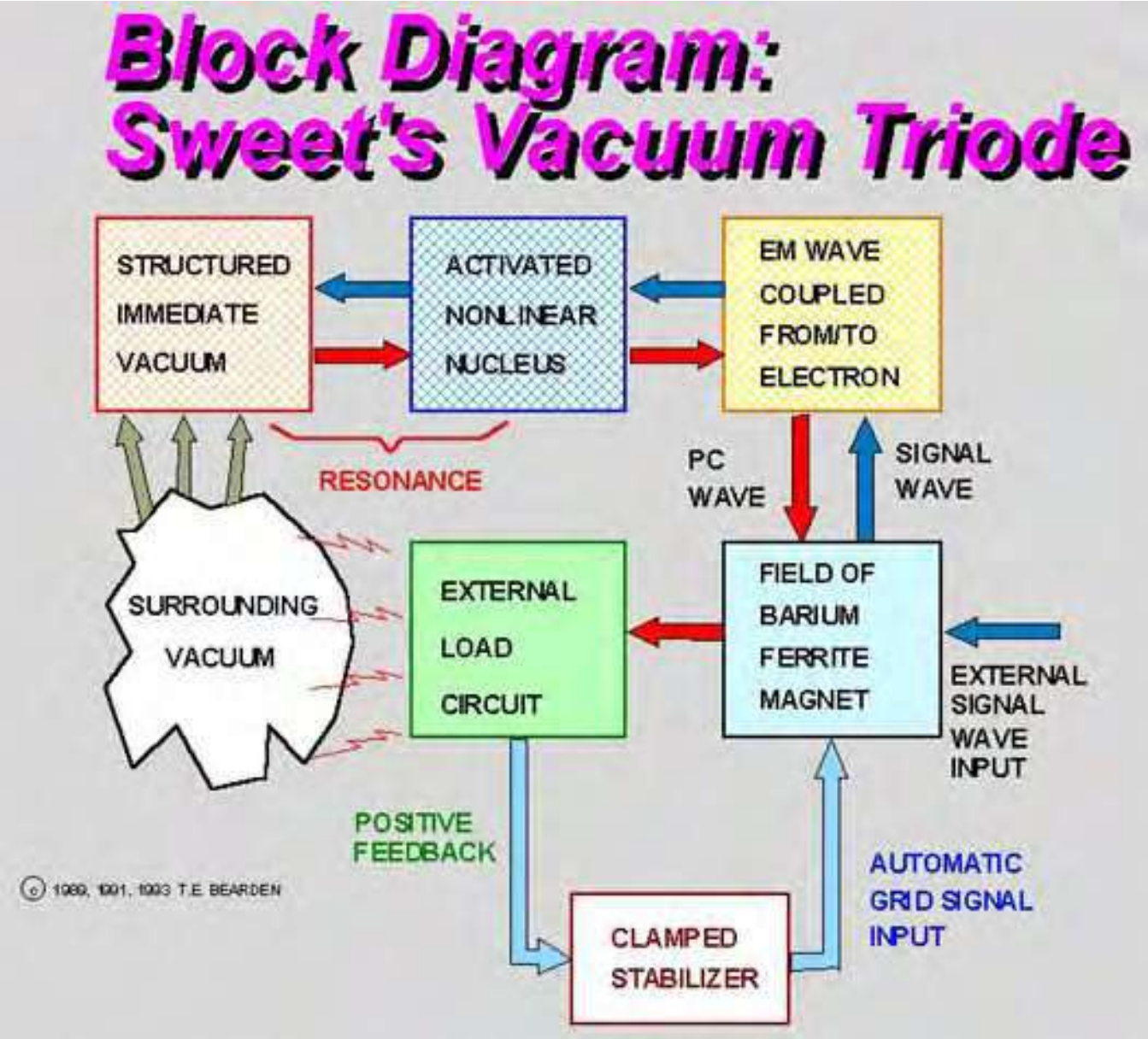

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Foundations of Electro-Magnetism

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- Major Points of Presentation
- Chung's Carbon Filament Negative Resistor
- Aharanov-Bohm Effect
- Absorption and emission reactions (1)
- Absorption and emission reactions (2)
- Anti-engine for cell's deviation reverses cell back to normal
- Asymmetric regauging produces excess force, which can be used to do work on the system
- Asymmetric regauging produces excess force, which can be used to do work on the regauging system
- Becker's bone fracture healing experiments
- Becker's theoretical control system governing regeneration
- Becker's theoretical DC control system involved with response to injury
- Geometrical Distortion of Poynting Energy Flow
- Cosmic Bootstrap: Before the Big Bang
- Bridging Enables COP > 1

- Aspects of Strong Local Symmetry
- Other Aspects of Strong Local Symmetry
- Bunge on the Status of Electrodynamics
- Bunge on the Status of Electrodynamics and Physics
- Bunge on the Status of Classical and Quantum Physics
- Fractions of BW Casualties Surviving
- First Step in Self-Promotion of Cancer Due to Hypoxia
- Differentiation and Dedifferentiation Timelines
- Evolution of Cells on Earth
- A Charged Particle q is a Coupled System of m and Ø
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (1)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (2)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (3)
- A Charged Particle is a Coupled System
- The Anomalies in Navy Electrolyte Experiments at China Lake
- Chung's Carbon Filament Negative Resistor

- Typical circuit has about 10^{-13} energy collection efficiency
- Classical View of EM
- Curved Spacetime acts as source or sink
- Chronic Disease Puzzling
- Cancer Characteristics
- Solving a Cancer Enigma
- Cancer: Characteristics
- Nonlinear Optics Distortion Correction Theorem
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)
- In Time-Reversed Zone: Nuclear reactions are biased
- In Time-Reversed Zone: Dynamics may be reversed
- Time-Reversed Zone: Significant only after time-density charging
- A New Conservation of Energy Law
- Questions on Carcinogens and EM

Radiation

- AS DEFINED, fields and potentials only exist in and on charged matter
- Serious flaws and errors in classical EM theory
- Electrodynamicists' Reaction to Removal of the Material Ether
- Reaction to Loss of Material Ether (1)
- Reaction to Loss of Material Ether (2)
- Some EM waves in Spacetime
- Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
- Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
- Phase Conjugate Wavepairs Produce New Waves
- Scalar Electromagnetics (Energetics) View of EM (1)
- Scalar Electromagnetics (Energetics) View of EM (2)

- Scalar Electromagnetics (Energetics) View of EM (3)
- Extended General Relativity Principle
- Extension of Work-Energy Theorem
- 34 Flaws in Classical EM Theory
- MTW's General Relativity Principle
- Use of General Relativity (GR) in Particle Physics
- The Missing Infolded Electrodynamics
- Infolded Engines: Excluded by Present Physics
- Mass curves and structures spacetime; ST curvatures change and structure mass (1)
- Mass curves and structures spacetime; ST curvatures change and structure mass (2)
- At Infinite Velocity: Each Is Every Other
- Lisitsyn's Report: Brain Code Broken
- Lorentz Closed Surface Integration
- Lorentz's physically insignificant energy flow can be collected and utilized
- Lorentz surface integration of the Poynting vector around a closed surface
- Longitudinal EM Photon Interaction with Charge
- Mass is transparent to longitudinal EM waves, which move through the infolded interiors of internal waves, potentials, and fields in the mass.

- Pumping with Longitudinal EM waves Time-reverses the Mass
- Maxwell's Quaternion Theory
- Maxwellian Systems before and after Regauging
- Maxwell's four equations reduce to: Page 1
- Maxwell's four equations reduce to: Page 2
- More to come

Major Points of Presentation

- Electrodynamic is seriously flawed
  - Some major flaws
  - Corrections indicated
- Why past corrective attempts failed
  - Force field concept is material
  - Missing two infolded transforms (M->ST; ST->M)
- Missing Infolded general relativity inside electrodynamics
- Several Kinds of EM Waves in Space
  - How to make
  - Transduction
- A French medical example as a deep experimental demonstration
  - Spectacular regenerative cures funded by French Govt
  - Not comprehended, therefore suppressed
- Cold Fusion examples of time-density wave effects
  - China Lake Instrumental anomalies in electrolysis
  - Explanation of anomalous behavior of instruments
  - Explanation of new nuclear reactions
  - Wave energy transduction provides excess heat
- Urge theorists to consider dramatically new reactions

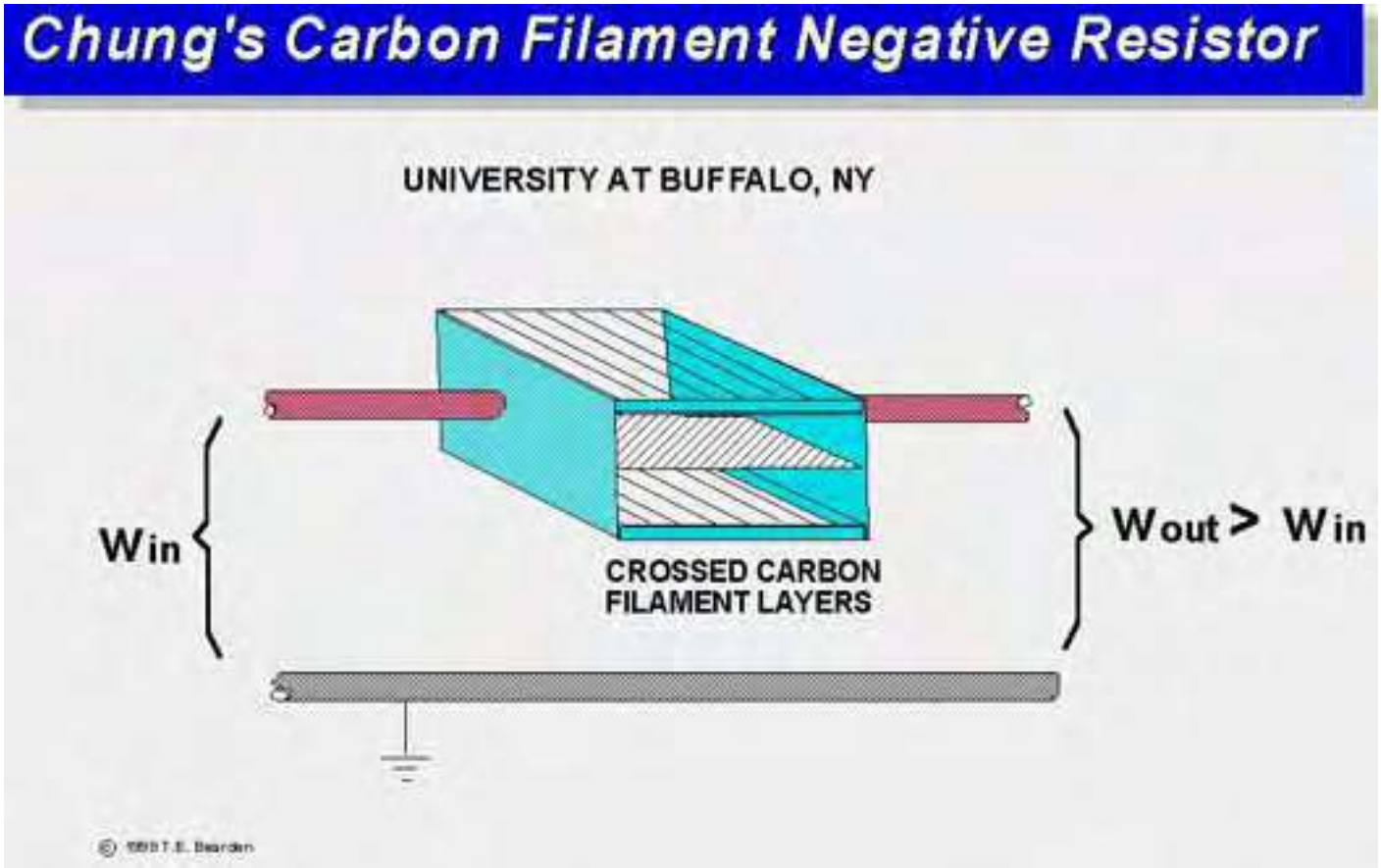
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
Win
CROSSED CARBON
FILAMENT LAYERS
Wout > Win

Aharonov-Bohm Effect

- In field-free regions
  - E-field is zero
  - B-field is zero
- Potentials still exist, just no gradients
  - Cause real effects
  - Interference is the key
  - Contain sum-zeroed substructures
- Does not follow from
  - Mechanics
  - Classical electromagnetics
- Required by quantum mechanics

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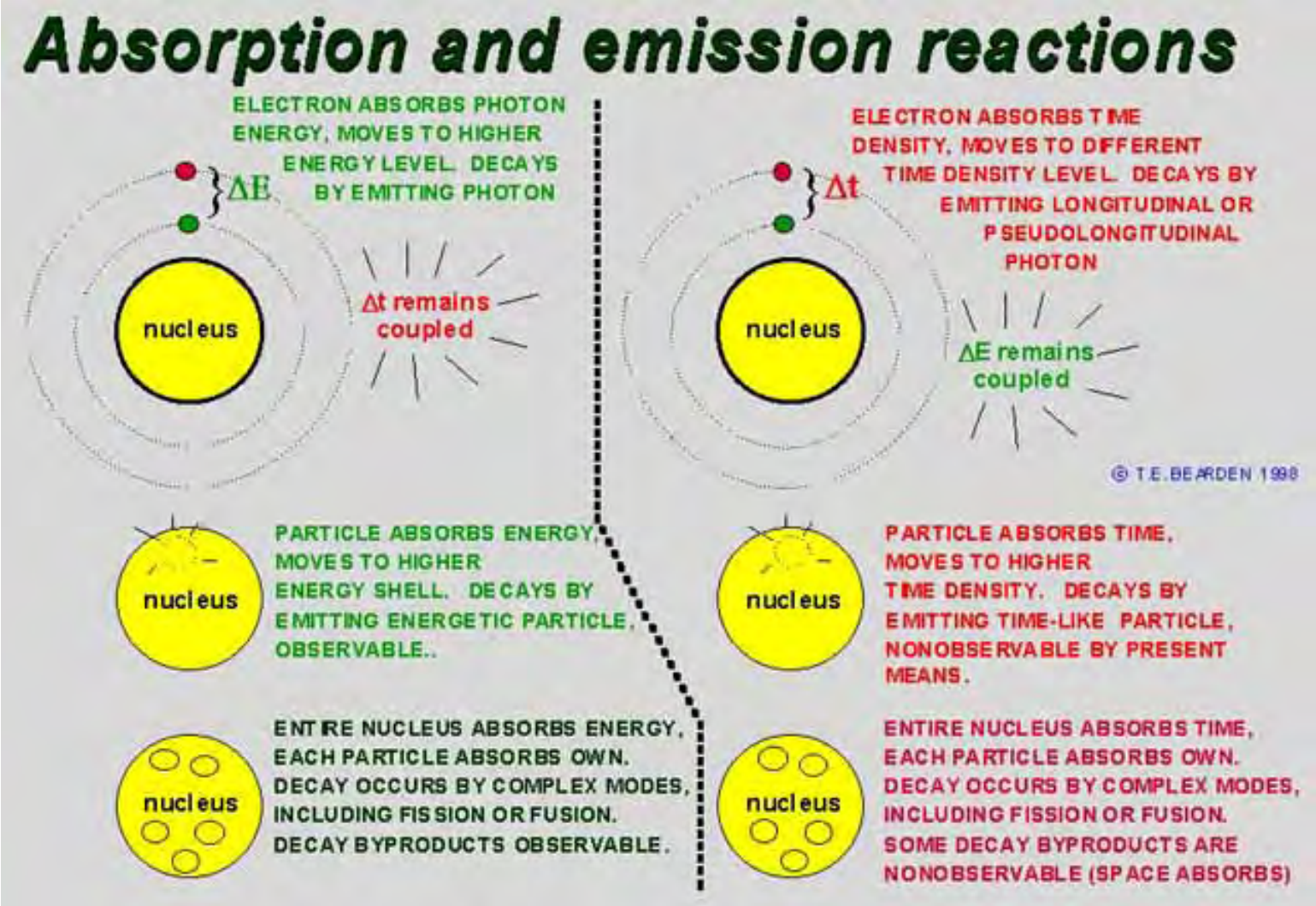
Absorption and emission reactions
ELECTRON ABSORBS PHOTON ENERGY, MOVES TO HIGHER ENERGY LEVEL. DECAYS BY EMITTING PHOTON
ΔE
nucleus
Δt remains coupled
ELECTRON ABSORBS TIME DENSITY, MOVES TO DIFFERENT TIME DENSITY LEVEL. DECAYS BY EMITTING LONGITUDINAL OR PSEUDOLONGITUDINAL PHOTON
Δt
nucleus
ΔE remains coupled
© T.E. BEARDEN 1998
nucleus
PARTICLE ABSORBS ENERGY, MOVES TO HIGHER ENERGY SHELL. DECAYS BY EMITTING ENERGETIC PARTICLE, OBSERVABLE..
nucleus
PARTICLE ABSORBS TIME, MOVES TO HIGHER TIME DENSITY. DECAYS BY EMITTING TIME-LIKE PARTICLE, NONOBSERVABLE BY PRESENT MEANS.
nucleus
ENTIRE NUCLEUS ABSORBS ENERGY, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. DECAY BYPRODUCTS OBSERVABLE.
nucleus
ENTIRE NUCLEUS ABSORBS TIME, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. SOME DECAY BYPRODUCTS ARE NONOBSERVABLE (SPACE ABSORBS)

Absorption and emission reactions

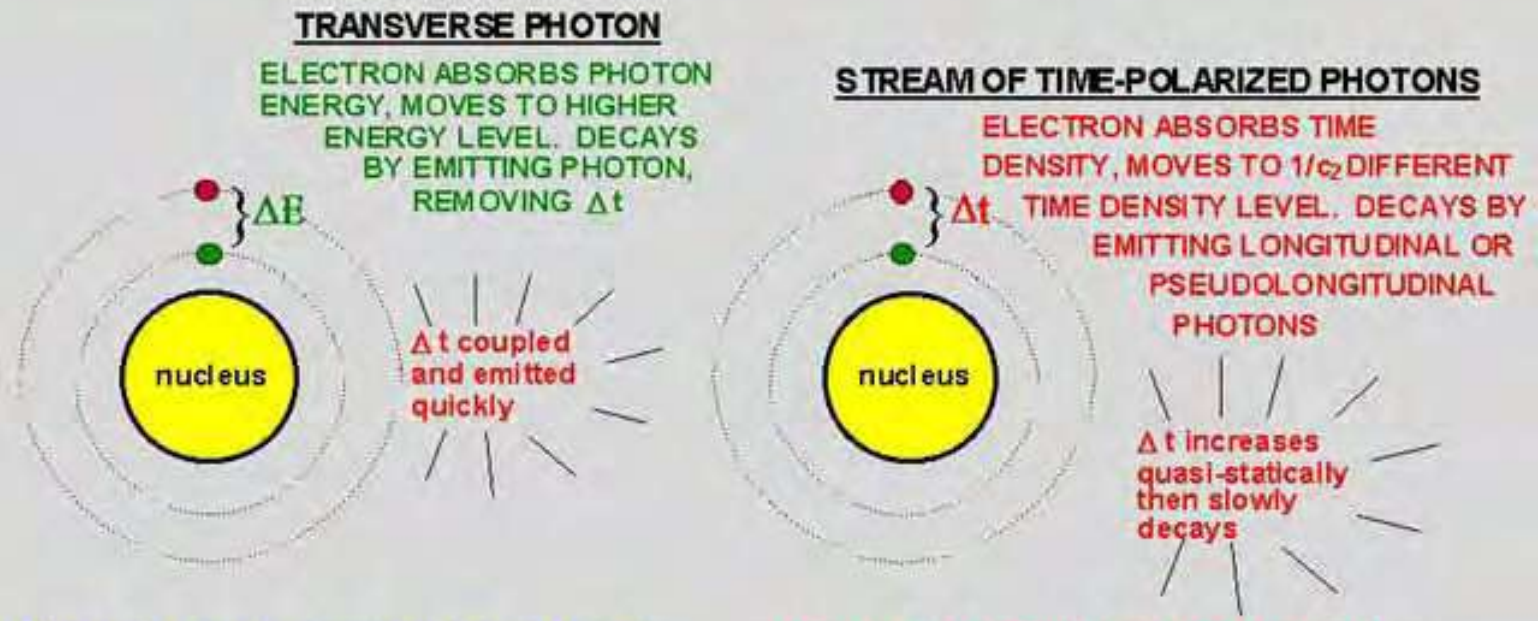

Figure A. Excited energy density level in one jump.

Figure B. Excited time density level significant only after enormous number of increases.

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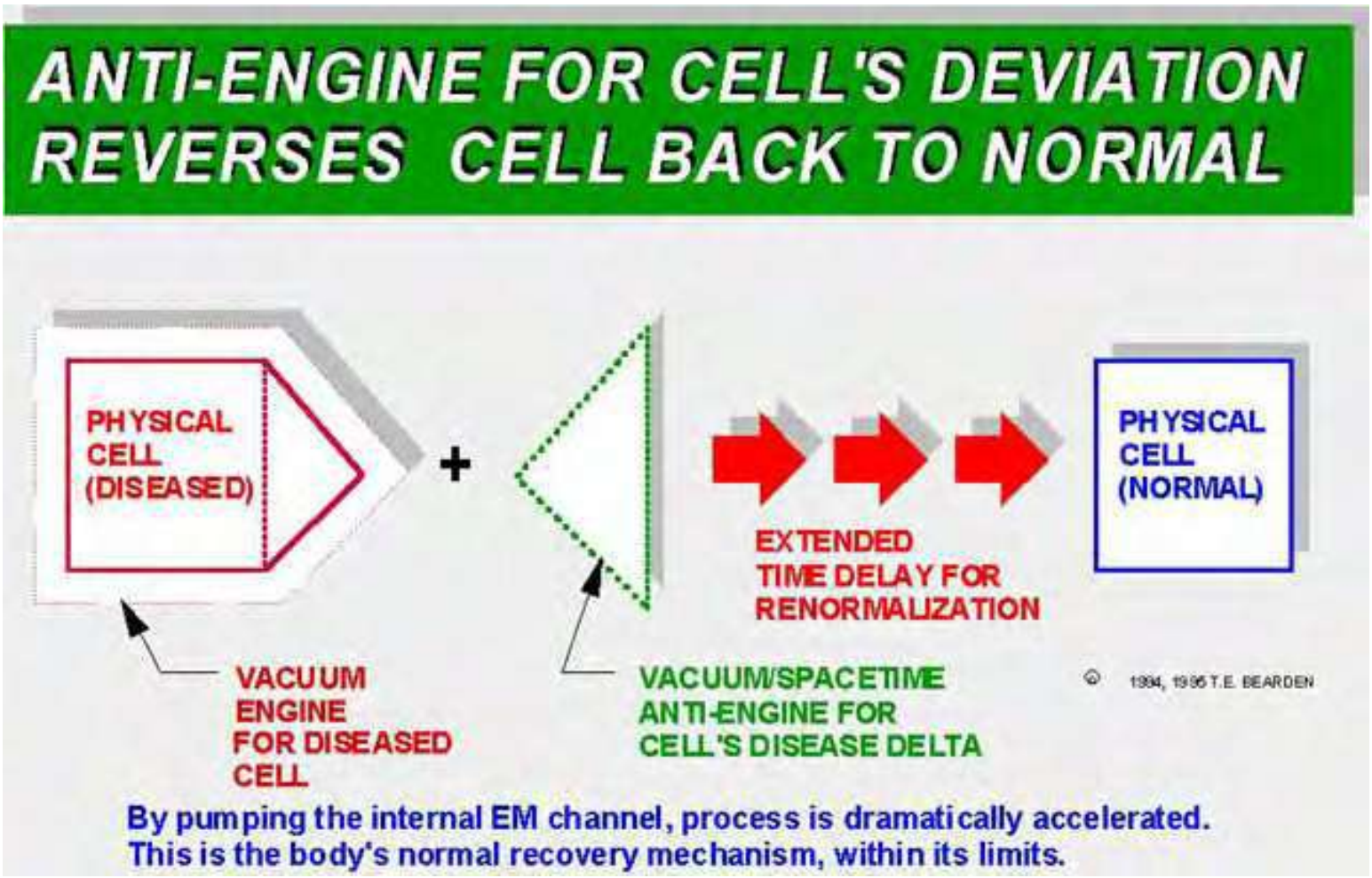
ANTI-ENGINE FOR CELL'S DEVIATION
REVERSES CELL BACK TO NORMAL
PHYSICAL CELL (DISEASED)
+
EXTENDED TIME DELAY FOR RENORMALIZATION
PHYSICAL CELL (NORMAL)
VACUUM ENGINE FOR DISEASED CELL
VACUUM/SPACETIME ANTI-ENGINE FOR CELL'S DISEASE DELTA
© 1994, 1995 T.E. BEARDEN
By pumping the internal EM channel, process is dramatically accelerated.
This is the body's normal recovery mechanism, within its limits.

Asymmetric Regauging Produces Excess Force, Which Can be Used to Do Work on the System

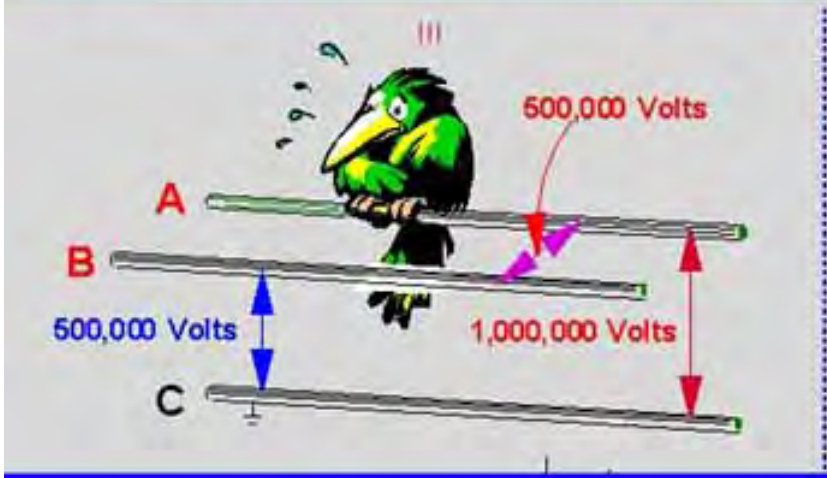

Net Symmetric Regauging Does No Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire A also. He *net symmetrically* regauged, so he had no net excess force across him, even though his potential energy was increased. He asymmetrically regauged each foot, but both simultaneously so that one countered the other. Wise little bird!

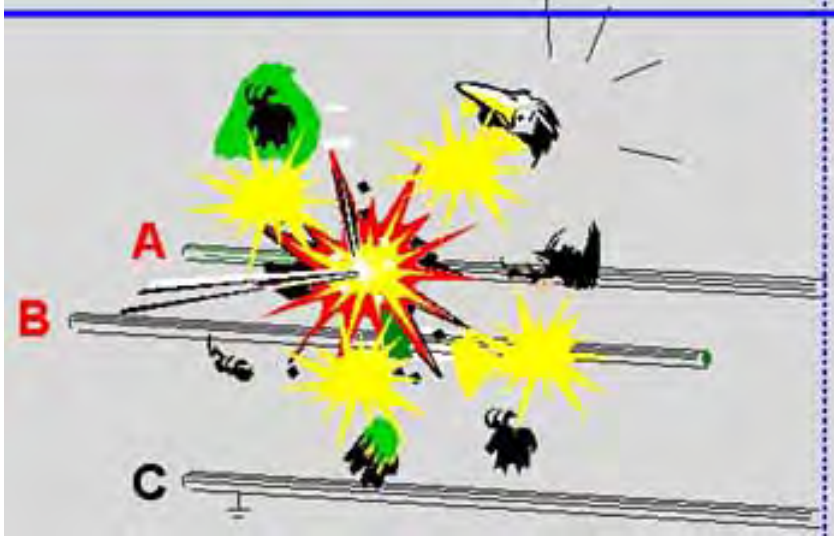

Net Asymmetric Regauging Can Do Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire B. He *net asymmetrically* regauged, so he had lots of net excess force across him. That force then violently translated his little body parts every which way, doing lots of work in and on him. Bummer!

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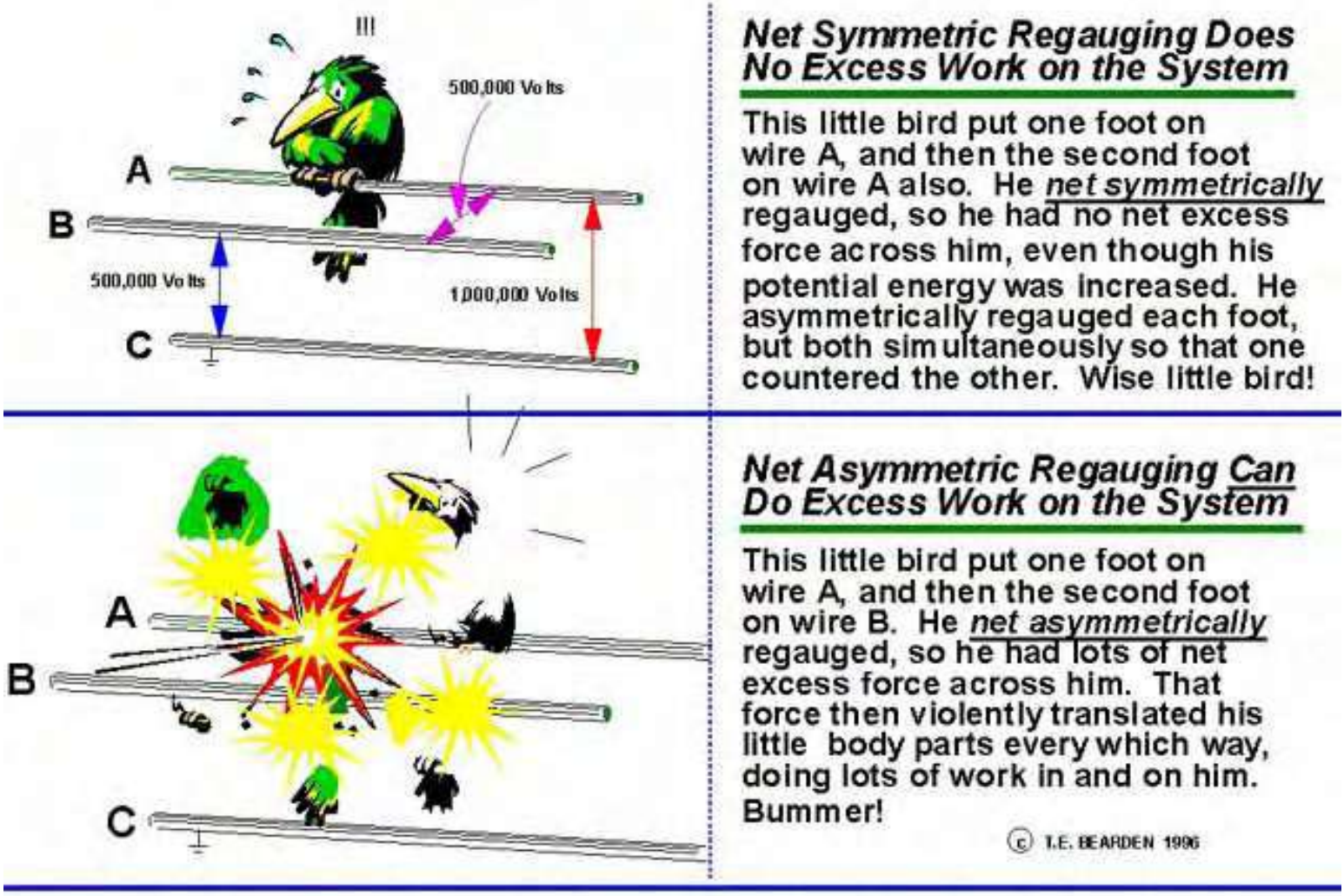

Figure 32. Asymmetric regauging produces excess force, which can be used to do work on the regauging system.

Selected clipart © by Lotus SmartPics™

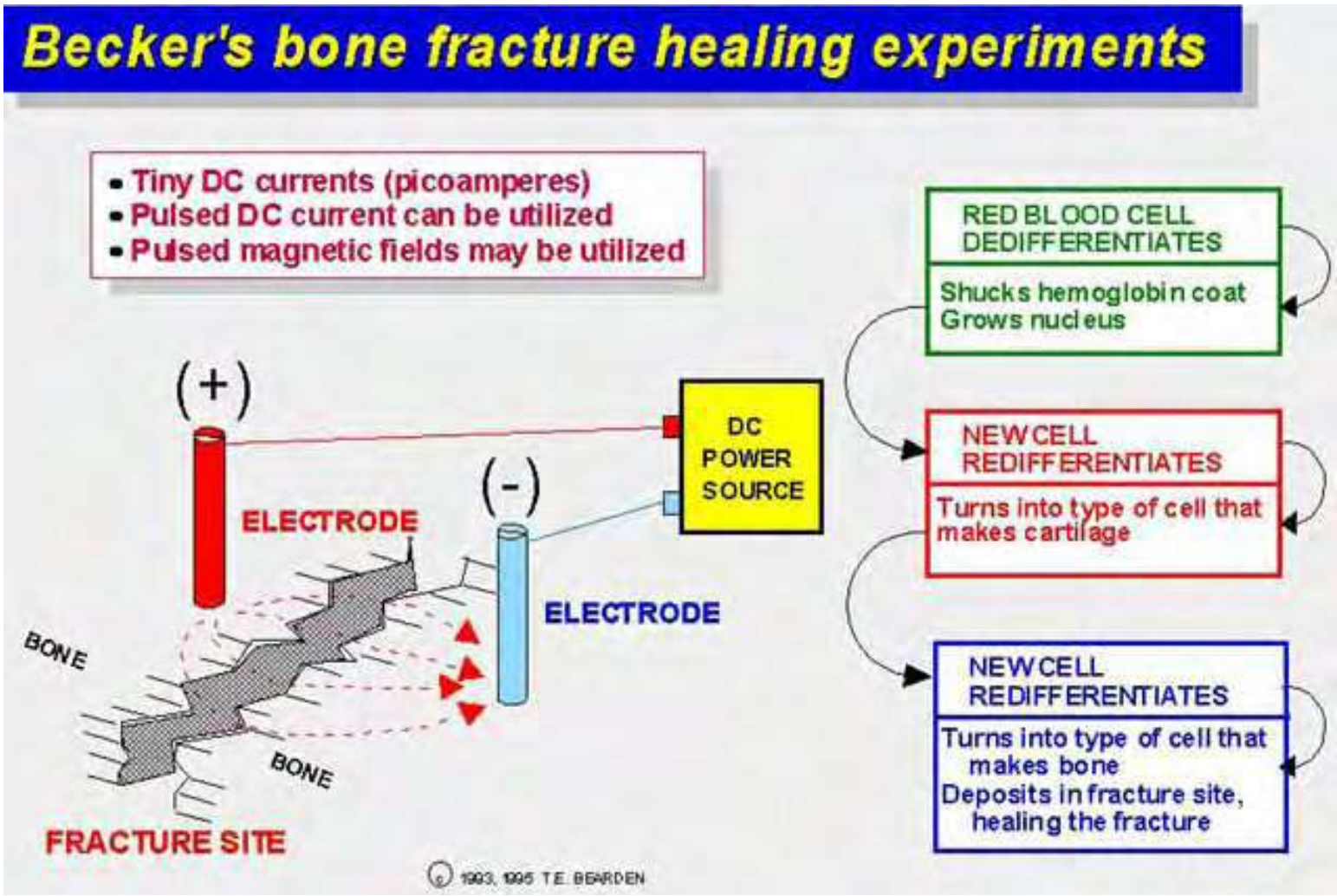
Becker's bone fracture healing experiments
• Tiny DC currents (picoamperes)
• Pulsed DC current can be utilized
• Pulsed magnetic fields may be utilized
(+)
(-)
ELECTRODE
ELECTRODE
DC POWER SOURCE
BONE
BONE
FRACTURE SITE
RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture
© 1993, 1995 T.E. BEARDEN

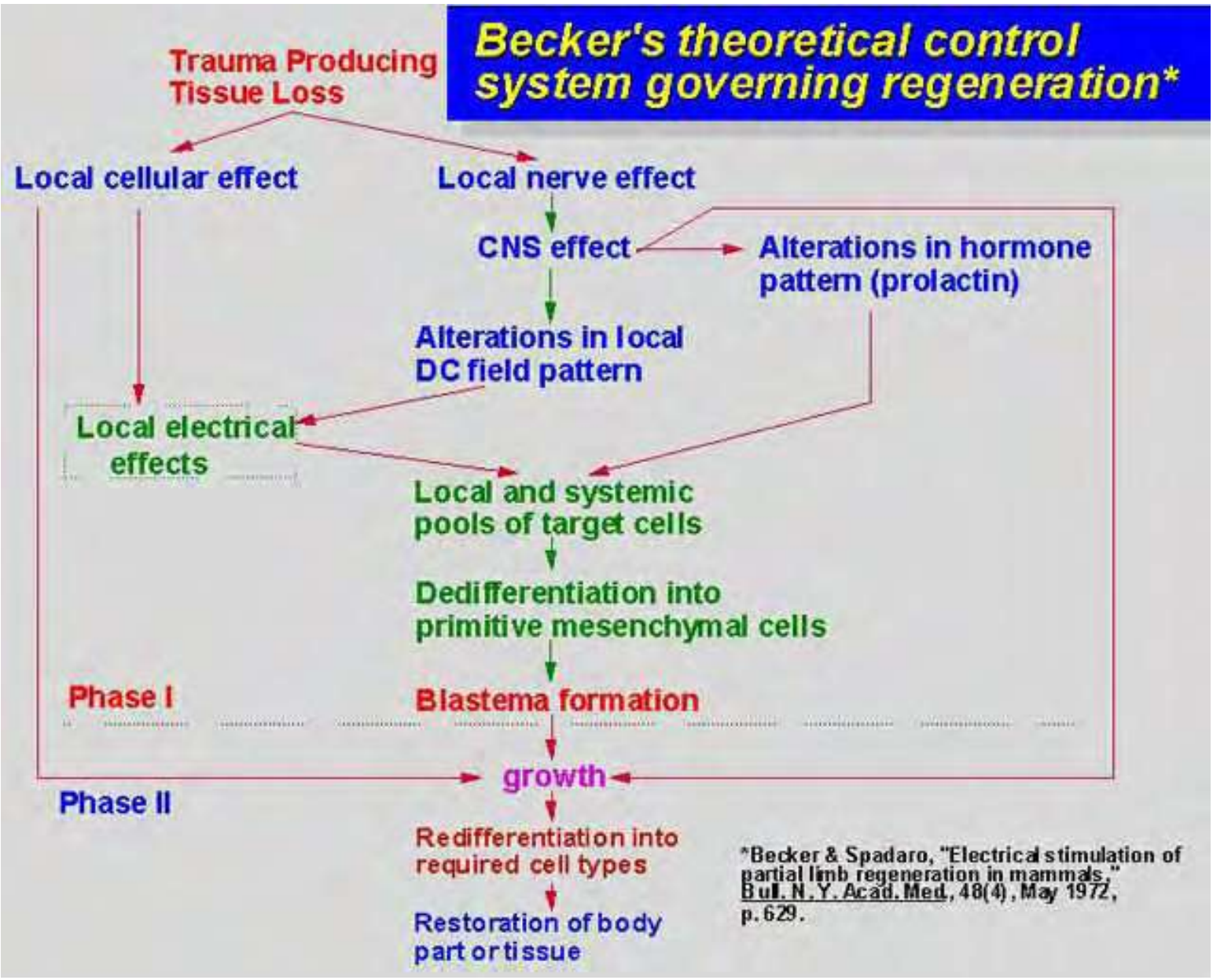
Becker's theoretical control system governing regeneration*
Trauma Producing Tissue Loss
Local cellular effect
Local nerve effect
CNS effect
Alterations in hormone pattern (prolactin)
Alterations in local DC field pattern
Local electrical effects
Local and systemic pools of target cells
Dedifferentiation into primitive mesenchymal cells
Phase I
Blastema formation
growth
Phase II
Redifferentiation into required cell types
Restoration of body part or tissue
*Becker & Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bull. N.Y. Acad. Med., 48(4), May 1972, p. 629.

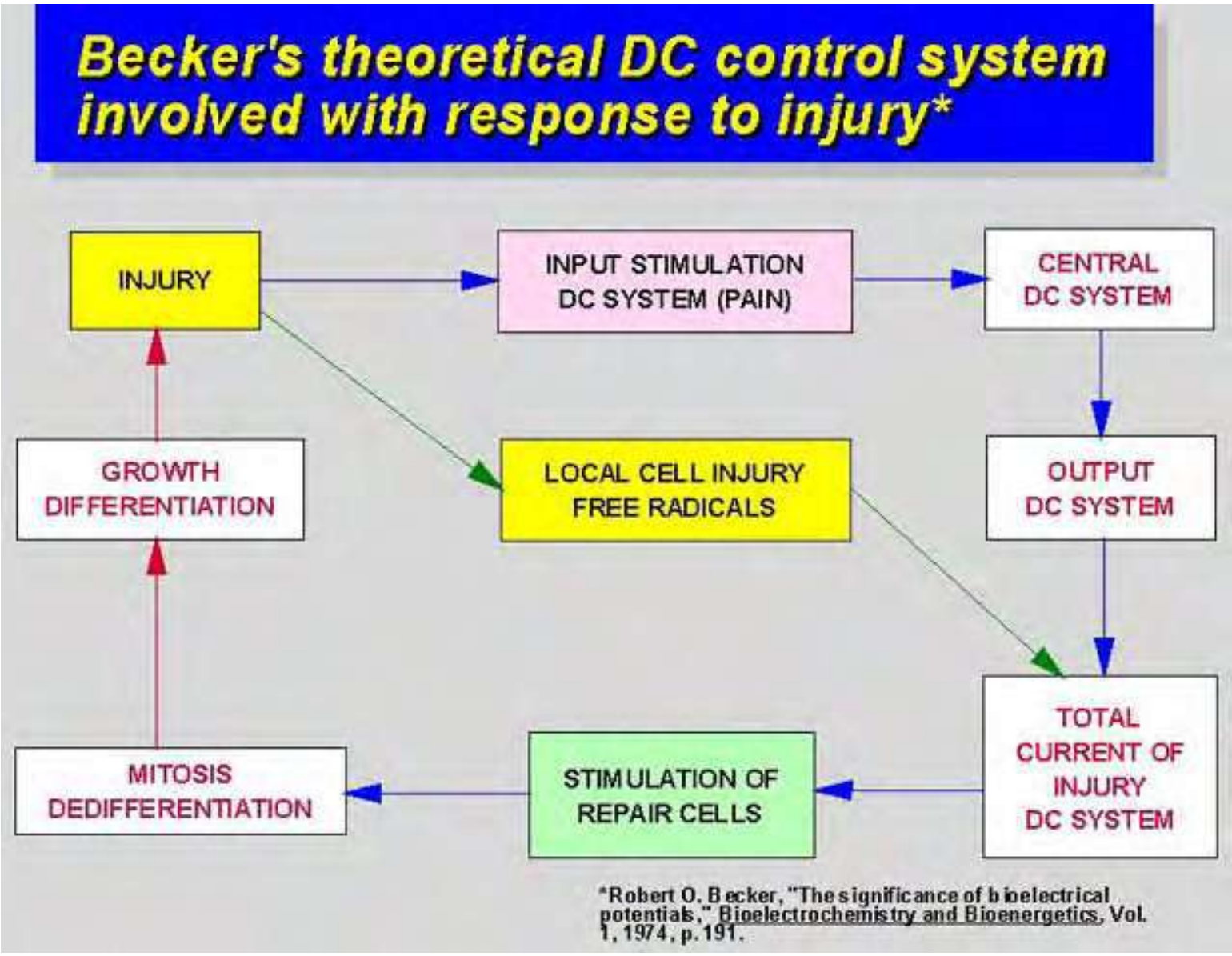
Becker's theoretical DC control system involved with response to injury*
INJURY
INPUT STIMULATION DC SYSTEM (PAIN)
CENTRAL DC SYSTEM
GROWTH DIFFERENTIATION
LOCAL CELL INJURY FREE RADICALS
OUTPUT DC SYSTEM
TOTAL CURRENT OF INJURY DC SYSTEM
MITOSIS DEDIFFERENTIATION
STIMULATION OF REPAIR CELLS
*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Geometrical Distortion of Poynting Energy Flow

At or near resonance frequency, in the case shown the energy collection fraction (reaction cross section) increases dramatically.

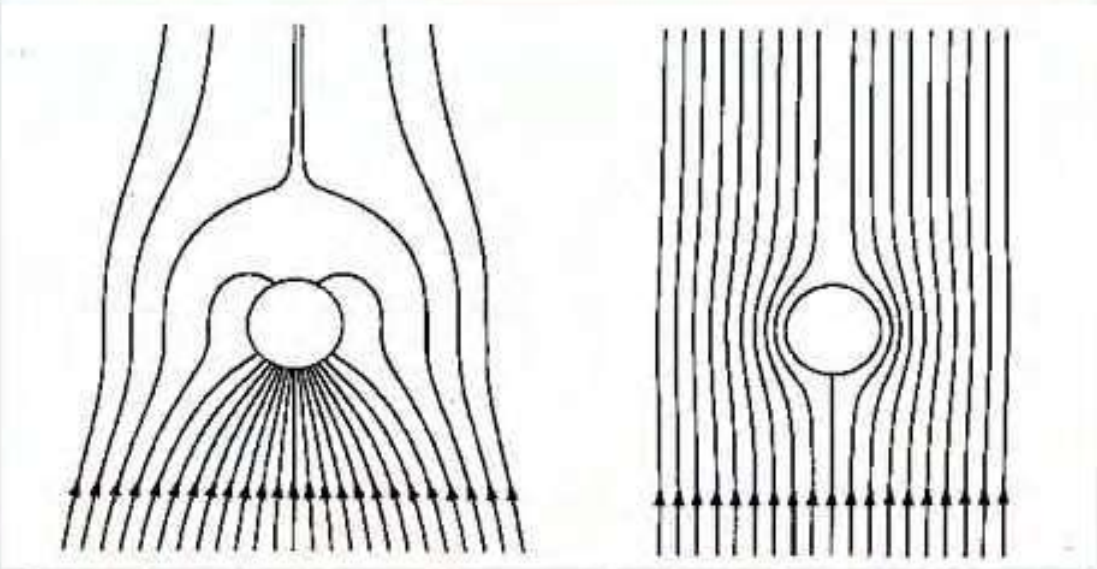

a. Around an aluminum sphere at light energy 8.8 eV. Absorption efficiency = 18.00.

b. Around an aluminum sphere at light energy 5eV. Absorption efficiency = 0.1.

Figures per Craig F. Bohren, "How can a particle absorb more than the light incident upon it? ", American Journal of Physics, 51(4), Apr. 1983, p. 326.

Cosmic Bootstrap: Before the Big Bang:

- *Cosmic repulsion behaved like a fluid with negative pressure*
- *The "universe" inflated (expanded) as a "false vacuum"*
- *As the negative-pressure fluid expanded, its energy went up rather than down*
- *When inflation stopped, the false vacuum decayed from its excited state*
- *Its excitation energy was released in a single great burst*

Paul Davies, Superforce, 1984, p. 194

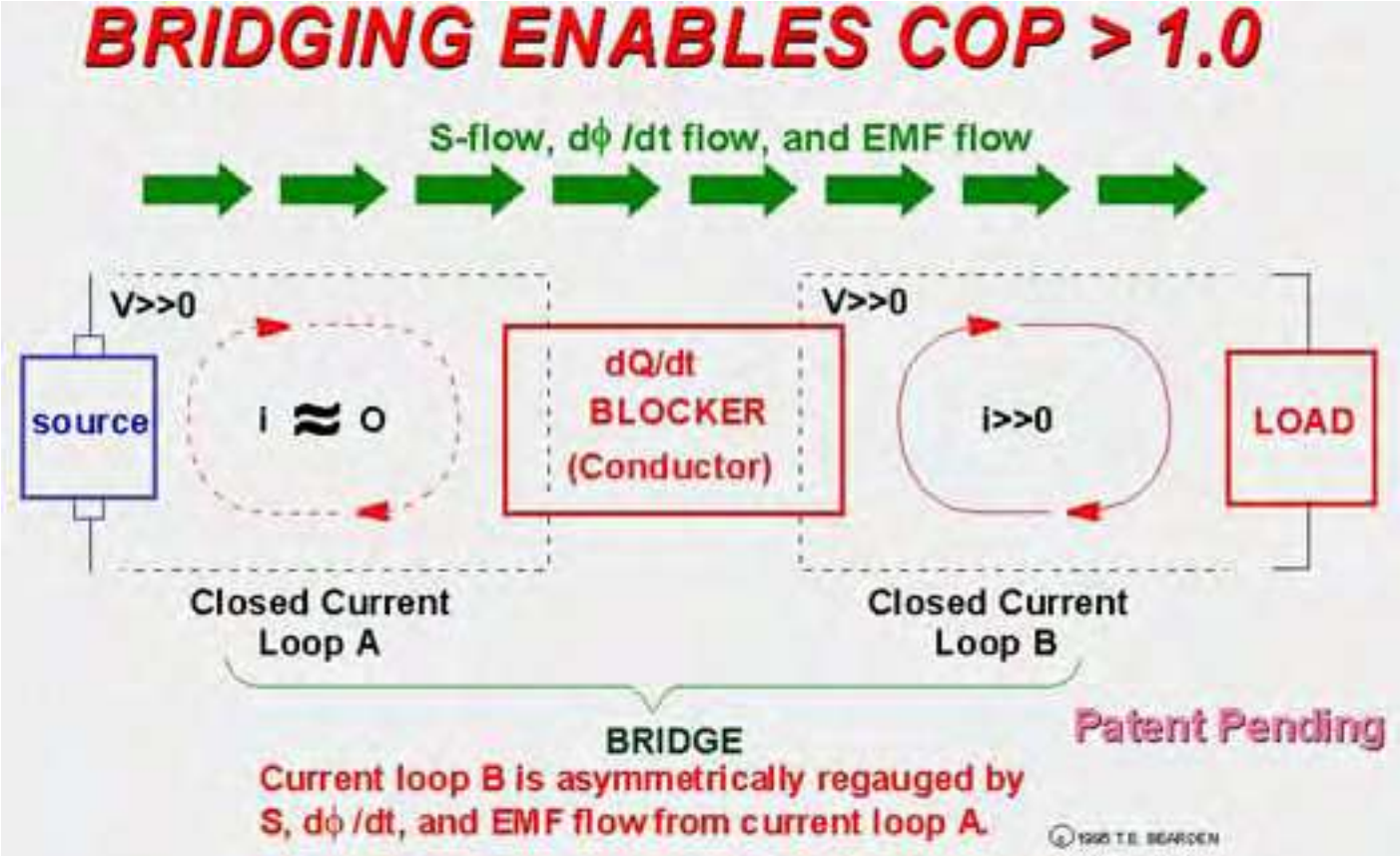
BRIDGING ENABLES COP > 1.0
S-flow, dϕ /dt flow, and EMF flow
V>>0
source
i ≈ 0
dQ/dt
BLOCKER
(Conductor)
V>>0
i>>0
LOAD
Closed Current
Loop A
Closed Current
Loop B
BRIDGE
Patent Pending
Current loop B is asymmetrically regauged by
S, dϕ /dt, and EMF flow from current loop A.
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Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum

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- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another
- STRUCTURING THE INFOLDED EM INSIDE POTENTIALS, FIELDS, AND WAVES
  - Strongly breaks local symmetry
  - Provides spacetime engines giving the above effects

Other Aspects of Strong Local Asymmetry

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- Local spacetime is curved
- Lorentz invariance of vacuum is violated
- May be a local "sink" or "source"
- Gravitational-inertial effects from EM
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation
- COMMENT: Thus the use of infolded longitudinal EM fields and waves to strongly break local symmetry allows intermested clustering of spacetime curvatures. These spacetime structures are *vacuum engines*, or *spacetime engines*.

Bunge on the Status of Electrodynamics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state..."

"... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

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Bunge on the Status of Electrodynamics and Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state...

"... neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

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*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

Bunge on the Status of Classical and Quantum Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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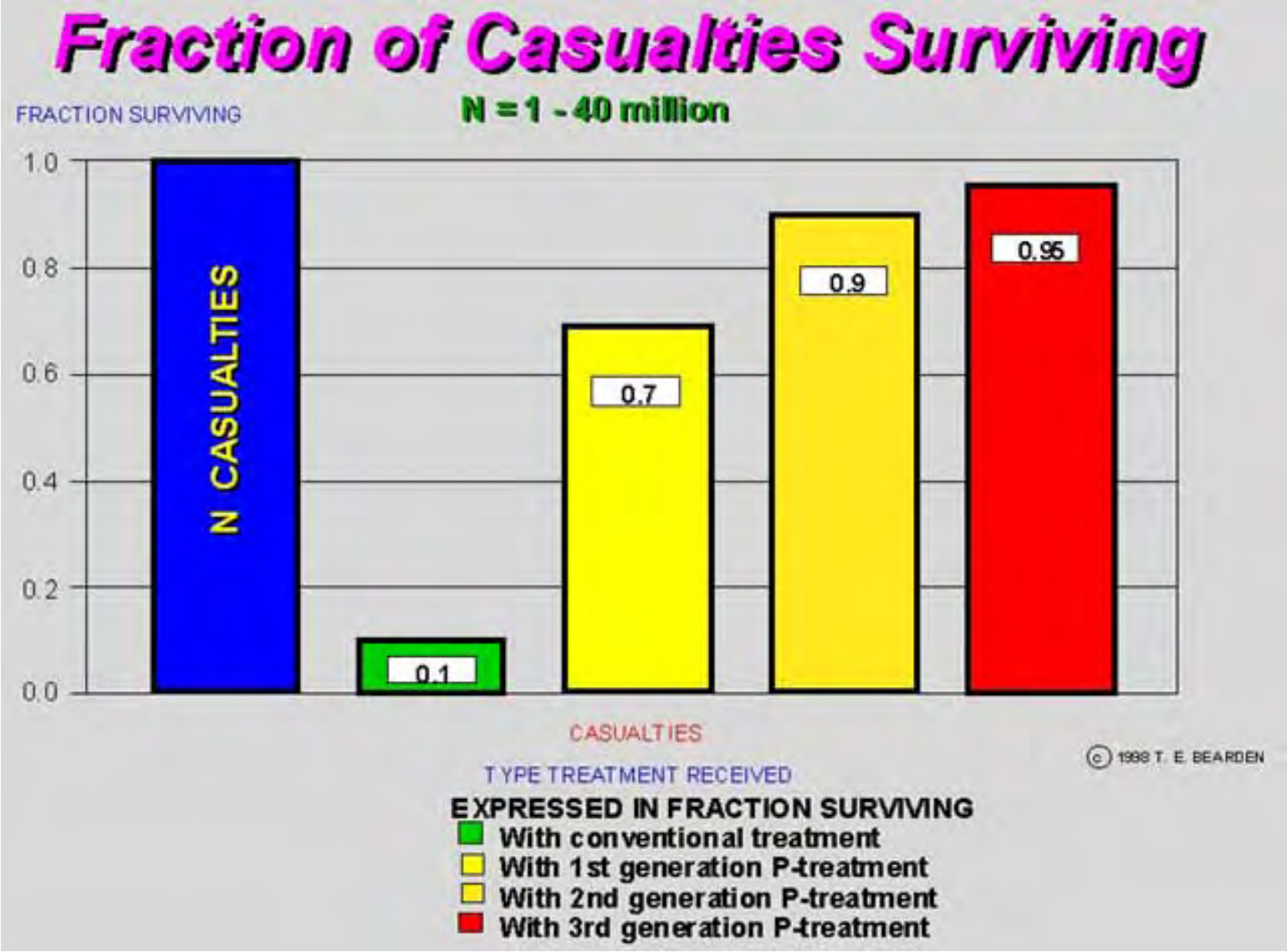
Fraction of Casualties Surviving
FRACTION SURVIVING
N = 1 - 40 million
1.0
0.8
0.6
0.4
0.2
0.0
N CASUALTIES
0.1
0.7
0.9
0.95
CASUALTIES
TYPE TREATMENT RECEIVED
© 1998 T. E. BEARDEN
EXPRESSED IN FRACTION SURVIVING
With conventional treatment
With 1st generation P-treatment
With 2nd generation P-treatment
With 3rd generation P-treatment

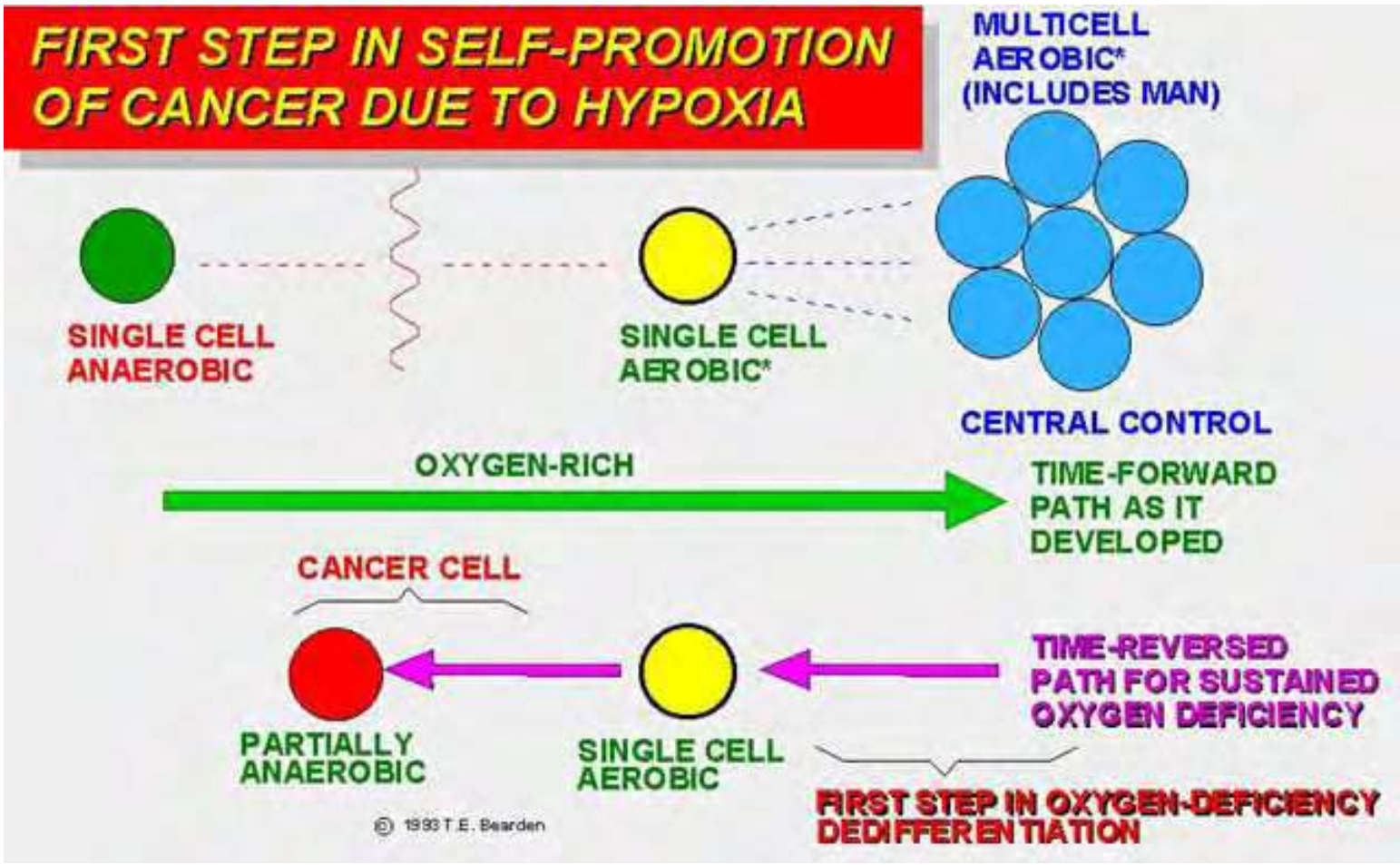
FIRST STEP IN SELF-PROMOTION OF CANCER DUE TO HYPOXIA
MULTICELL AEROBIC* (INCLUDES MAN)
SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC*
CENTRAL CONTROL
OXYGEN-RICH
TIME-FORWARD PATH AS IT DEVELOPED
CANCER CELL
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
PARTIALLY ANAEROBIC
SINGLE CELL AEROBIC
FIRST STEP IN OXYGEN-DEFICIENCY DEDIFFERENTIATION
© 1993 T.E. Bearden

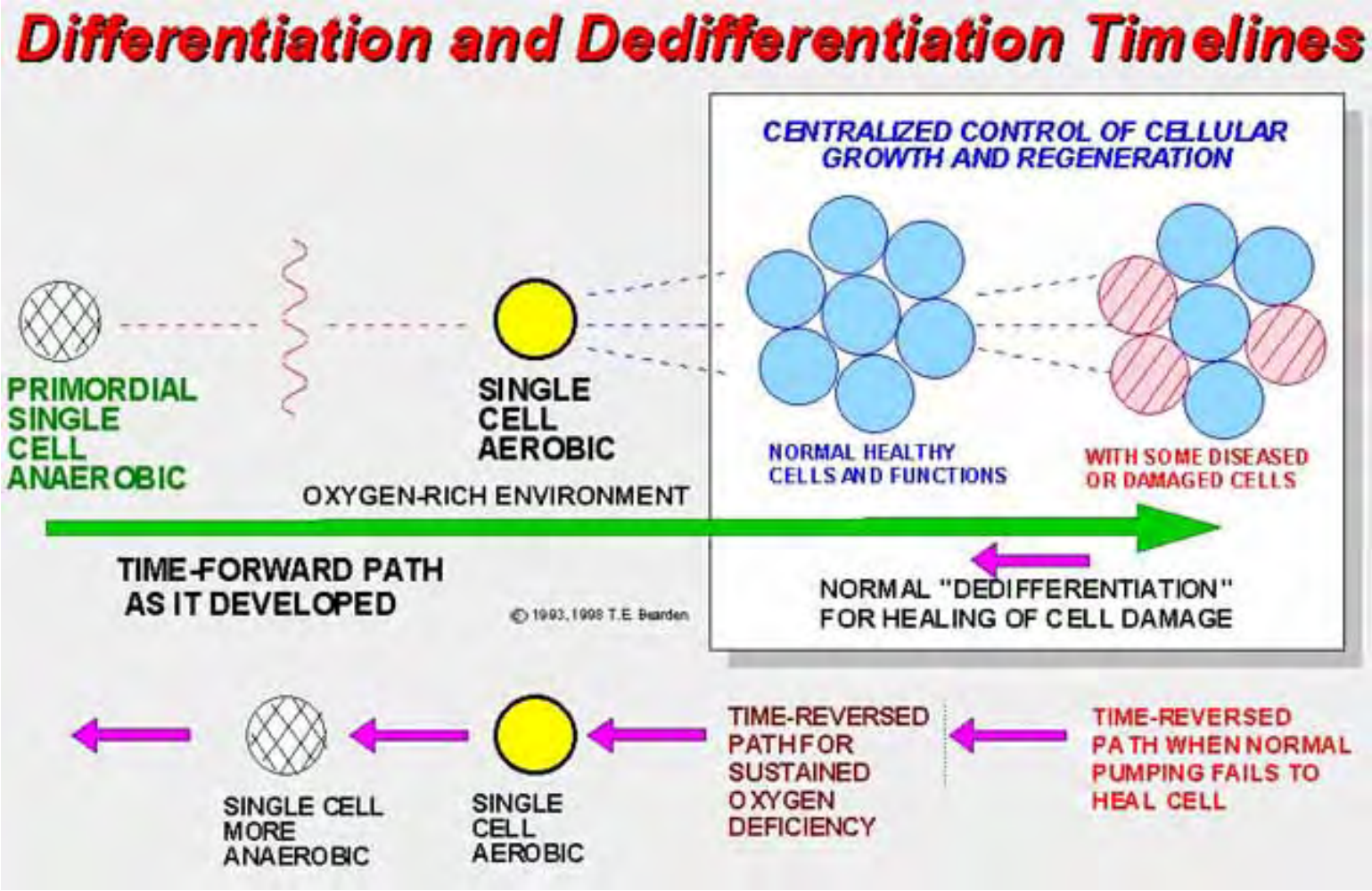
Differentiation and Dedifferentiation Timelines
CENTRALIZED CONTROL OF CELLULAR GROWTH AND REGENERATION
PRIMORDIAL SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC
OXYGEN-RICH ENVIRONMENT
NORMAL HEALTHY CELLS AND FUNCTIONS
WITH SOME DISEASED OR DAMAGED CELLS
TIME-FORWARD PATH AS IT DEVELOPED
© 1993, 1998 T.E. Bearden
NORMAL "DEDIFFERENTIATION" FOR HEALING OF CELL DAMAGE
SINGLE CELL MORE ANAEROBIC
SINGLE CELL AEROBIC
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
TIME-REVERSED PATH WHEN NORMAL PUMPING FAILS TO HEAL CELL

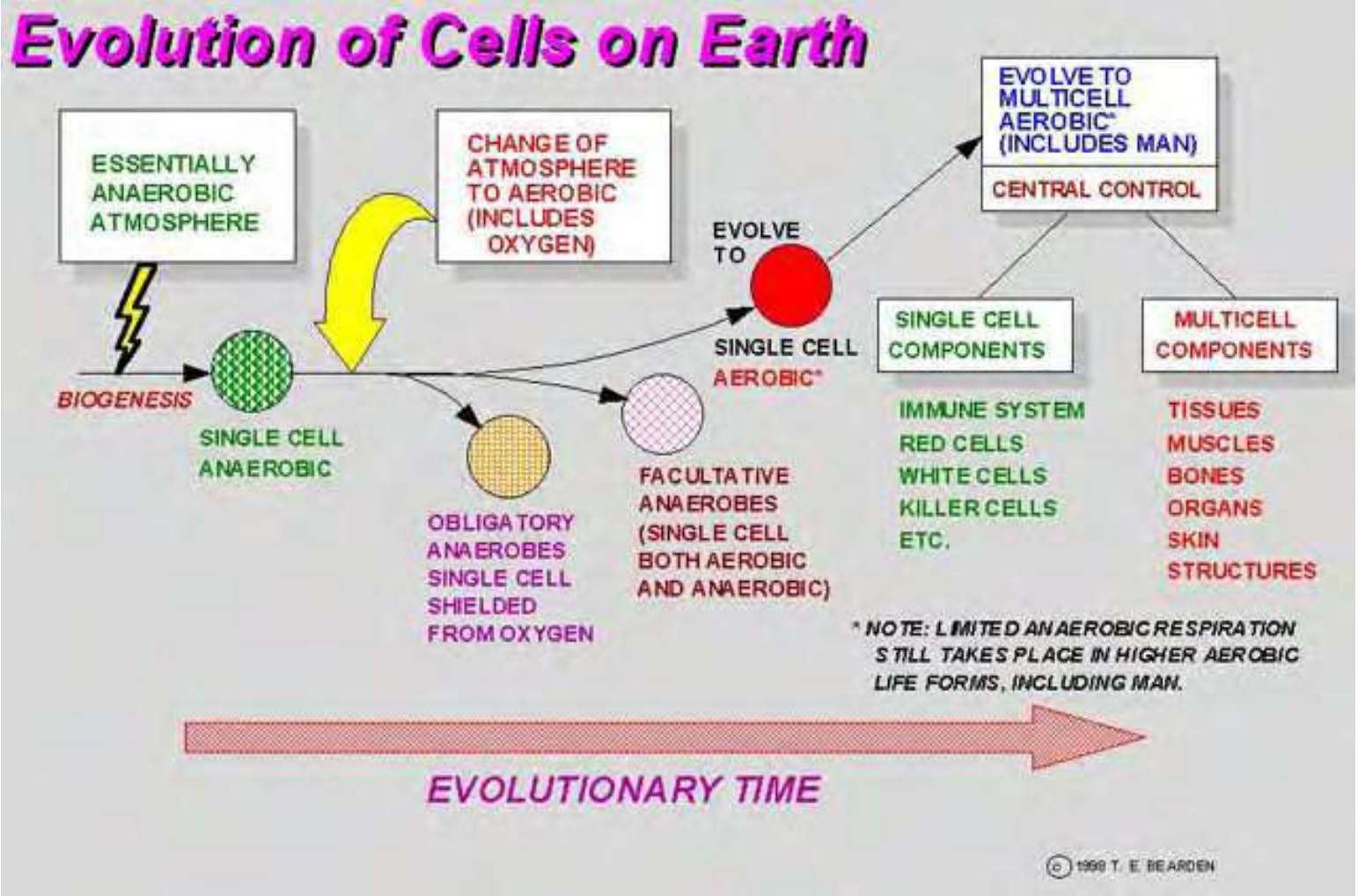
Evolution of Cells on Earth
ESSENTIALLY ANAEROBIC ATMOSPHERE
CHANGE OF ATMOSPHERE TO AEROBIC (INCLUDES OXYGEN)
EVOLVE TO MULTICELL AEROBIC* (INCLUDES MAN)
CENTRAL CONTROL
EVOLVE TO
SINGLE CELL AEROBIC*
SINGLE CELL COMPONENTS
MULTICELL COMPONENTS
BIOGENESIS
SINGLE CELL ANAEROBIC
OBLIGATORY ANAEROBES SINGLE CELL SHIELDED FROM OXYGEN
FACULTATIVE ANAEROBES (SINGLE CELL BOTH AEROBIC AND ANAEROBIC)
IMMUNE SYSTEM
RED CELLS
WHITE CELLS
KILLER CELLS
ETC.
TISSUES
MUSCLES
BONES
ORGANS
SKIN
STRUCTURES
* NOTE: LIMITED ANAEROBIC RESPIRATION STILL TAKES PLACE IN HIGHER AEROBIC LIFE FORMS, INCLUDING MAN.
EVOLUTIONARY TIME
© 1999 T. E. BEARDEN

A Charged Particle q Is a Coupled System of m and ϕ

(A proposed formal definition of a charged mass)

Note: X is a coupling operator

$$q \equiv f_q \times m_q$$

Also note that the ϕ portion of the charged particle can be internally structured, per Stoney-Whittaker-Ziolkowski, with hidden bidirectional EM wavepairs (their sums and products). Note that this constitutes an EM application of Bohm-type hidden variable theory, with many ramifications.

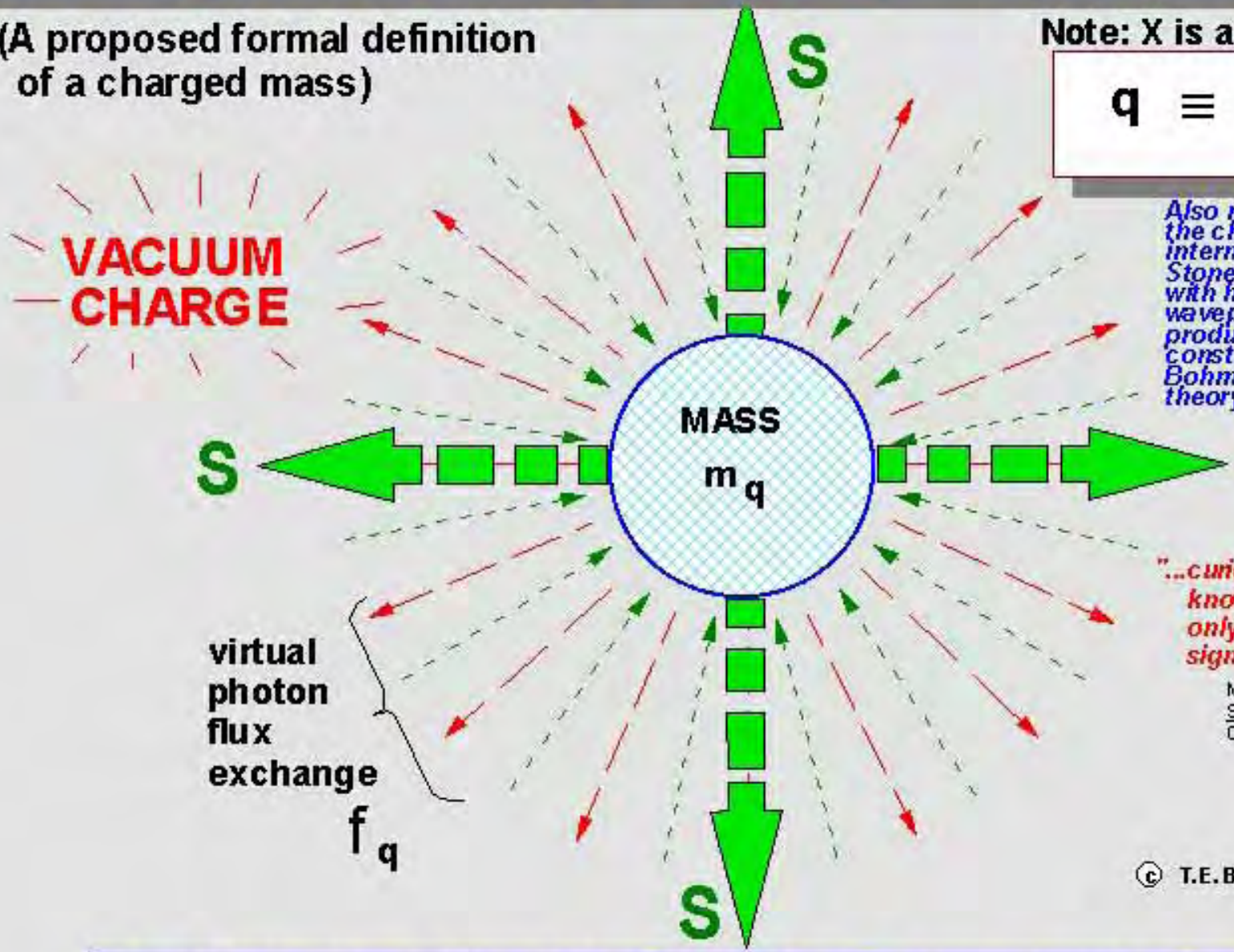

S = EXH

"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

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An electric charge Q consists of a massless flux component and a mass component, coupled together (interacting). Q is a broken symmetry. The mass of the charge continually and violently exchanges virtual photons with the surrounding vacuum.

Thus Q is energetically driven by the surrounding vacuum potential, which itself is to first order just a violent virtual photon flux.

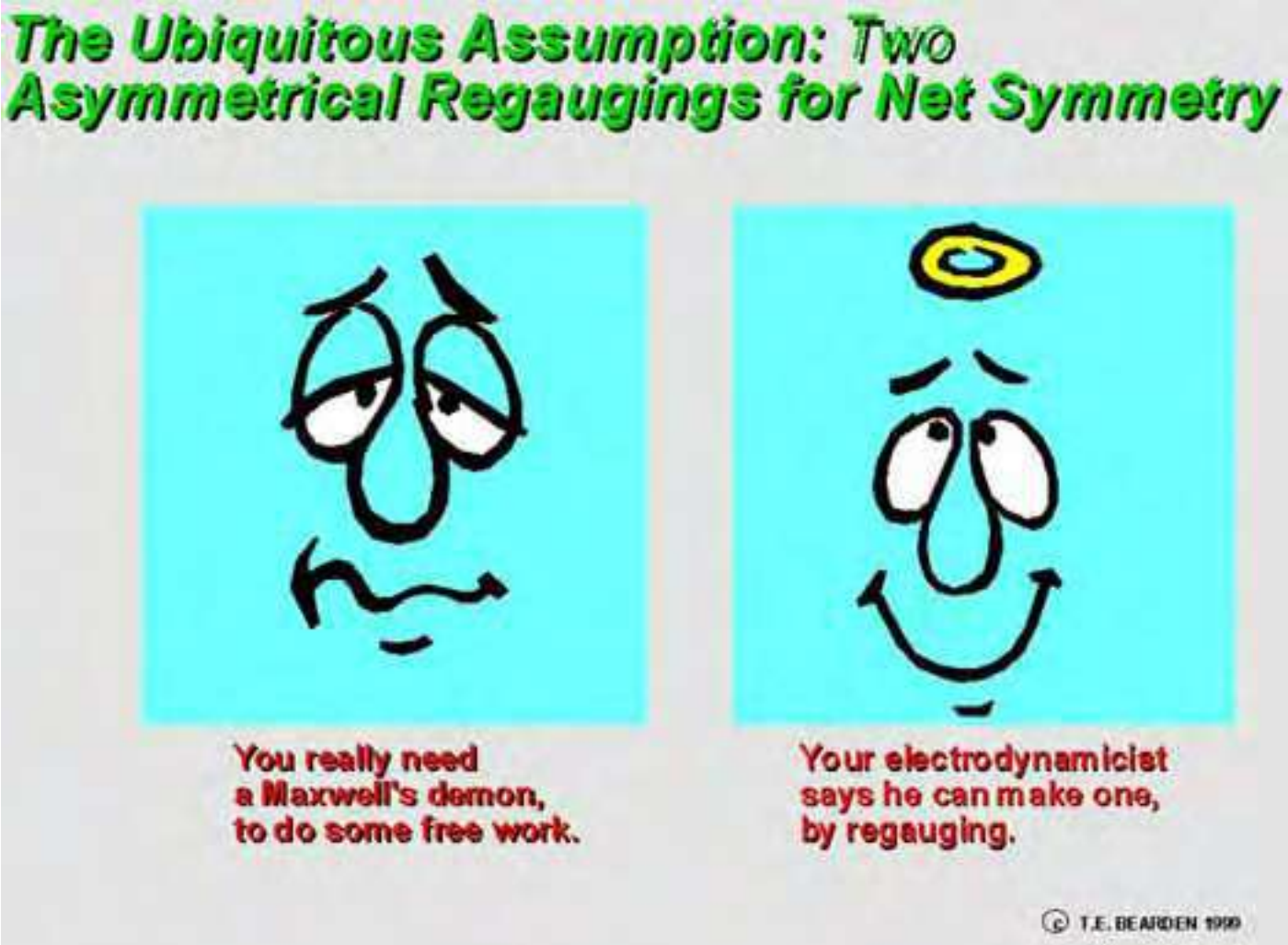
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
You really need a Maxwell's demon, to do some free work.
Your electrodynamicist says he can make one, by regauging.
© T.E. BEARDEN 1999

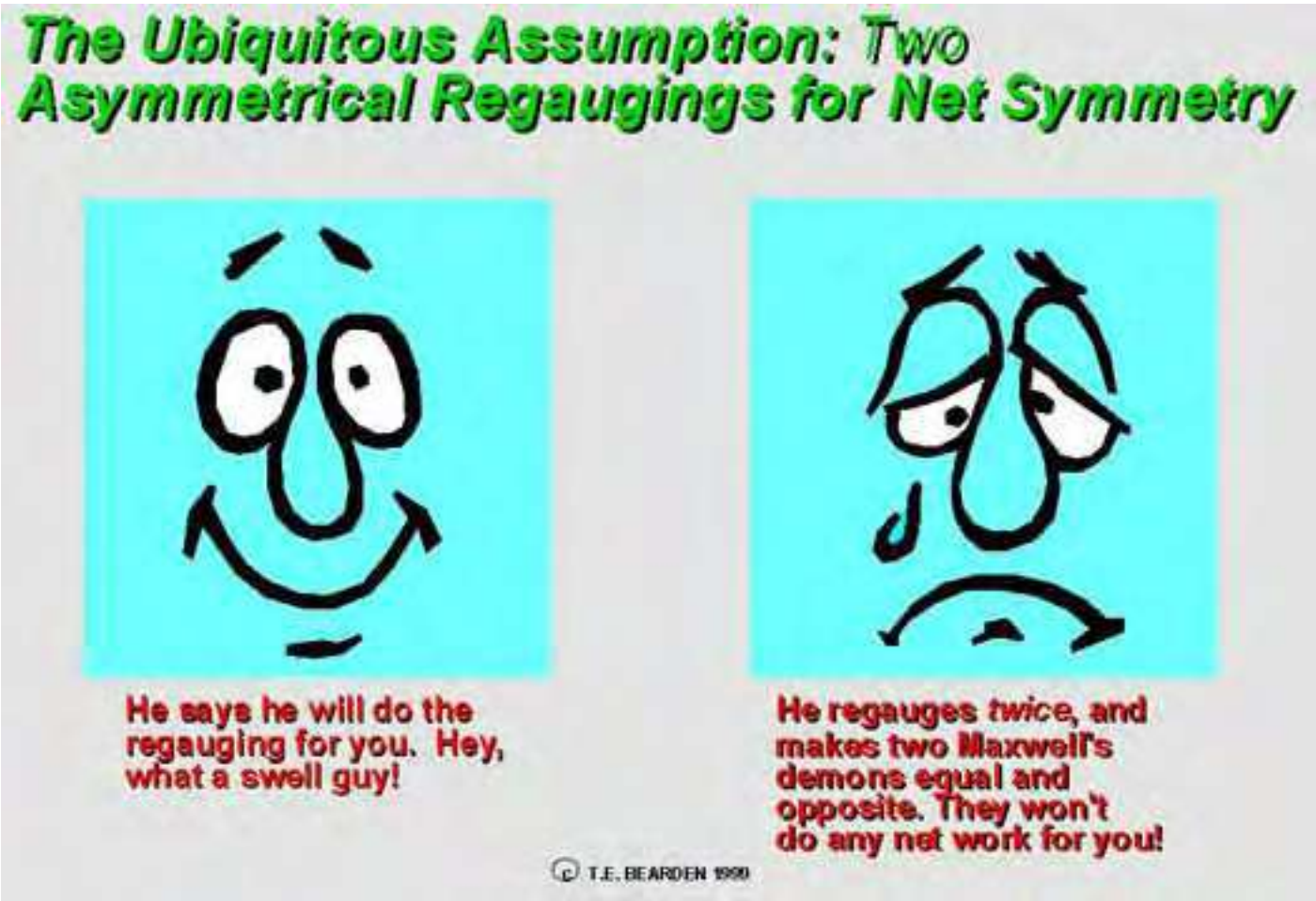
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
He says he will do the regauging for you. Hey, what a swell guy!
He regauges twice, and makes two Maxwell's demons equal and opposite. They won't do any net work for you!
© T.E. BEARDEN 1990

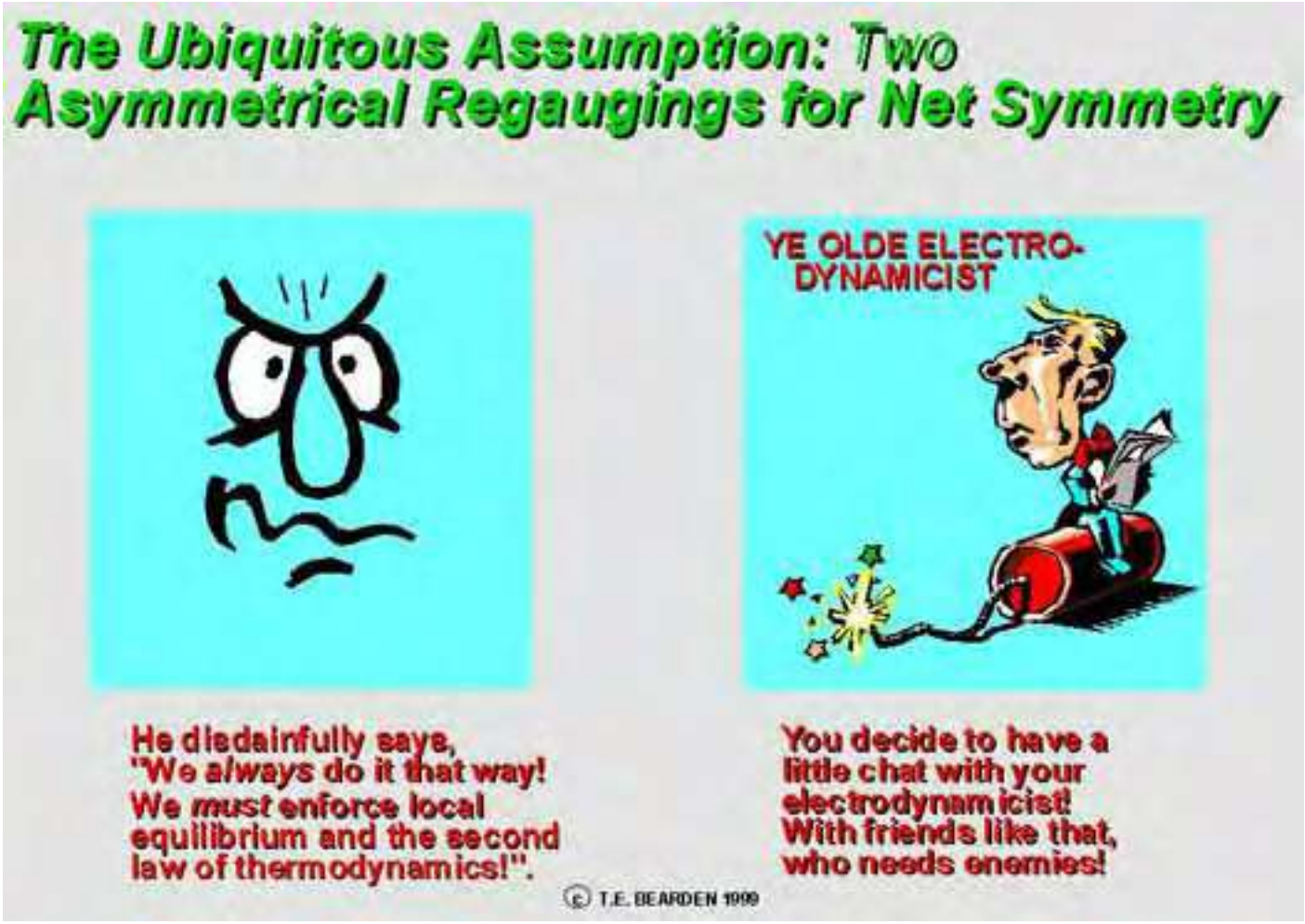
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
YE OLDE ELECTRO-DYNAMICIST
He disdainfully says, "We always do it that way! We must enforce local equilibrium and the second law of thermodynamics!".
You decide to have a little chat with your electrodynamicist! With friends like that, who needs enemies!
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A Charged Particle Is a Coupled System

(The first formal definition of charge)

$$q \equiv \phi_q \times m_q$$

Note: X is a coupling operator

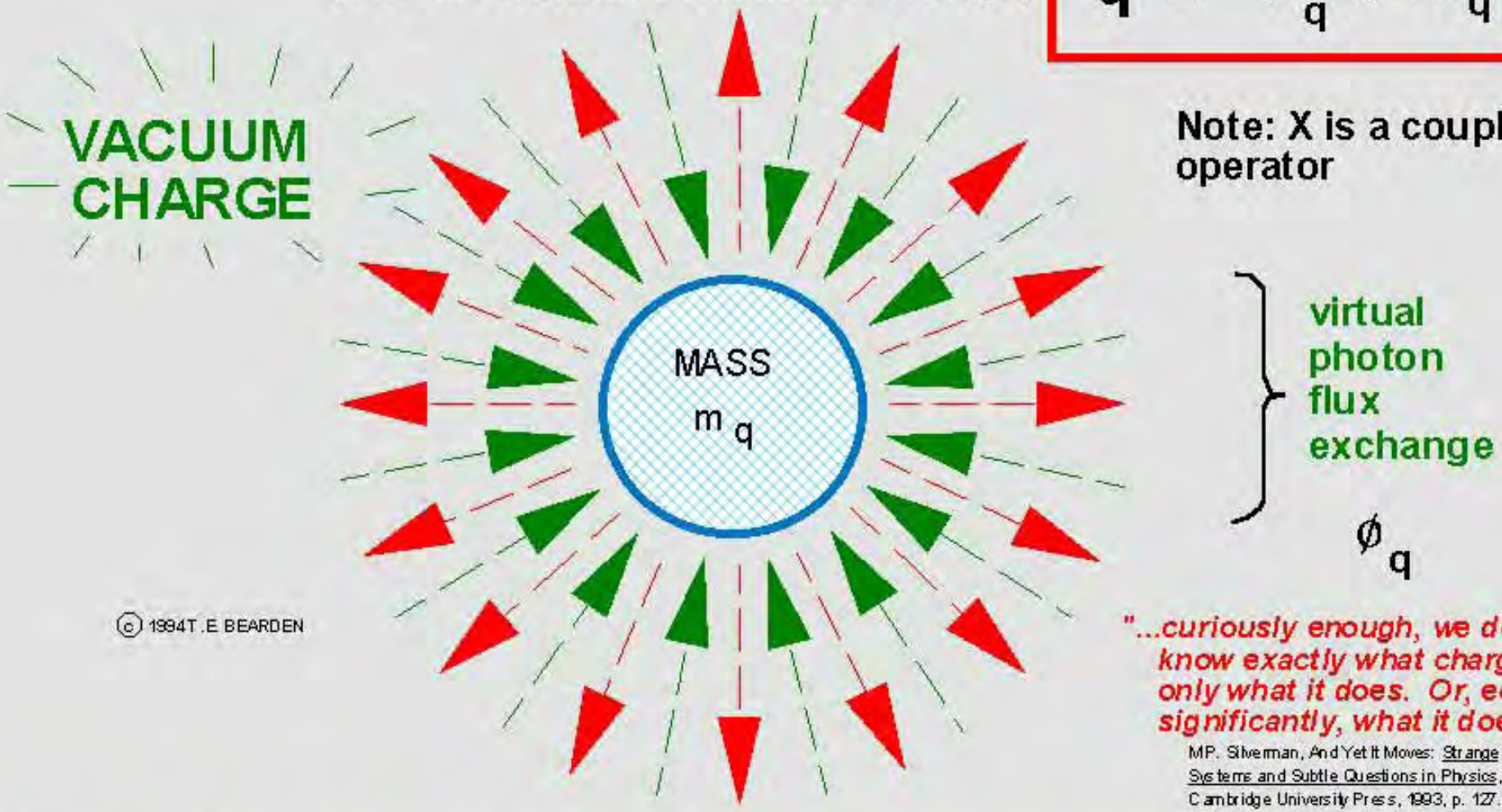

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"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

An electric charge q is a broken symmetry in its fierce energy exchange with the active vacuum. It coherently integrates some of the virtual energy absorbs and outputs it as Poynting energy flow.

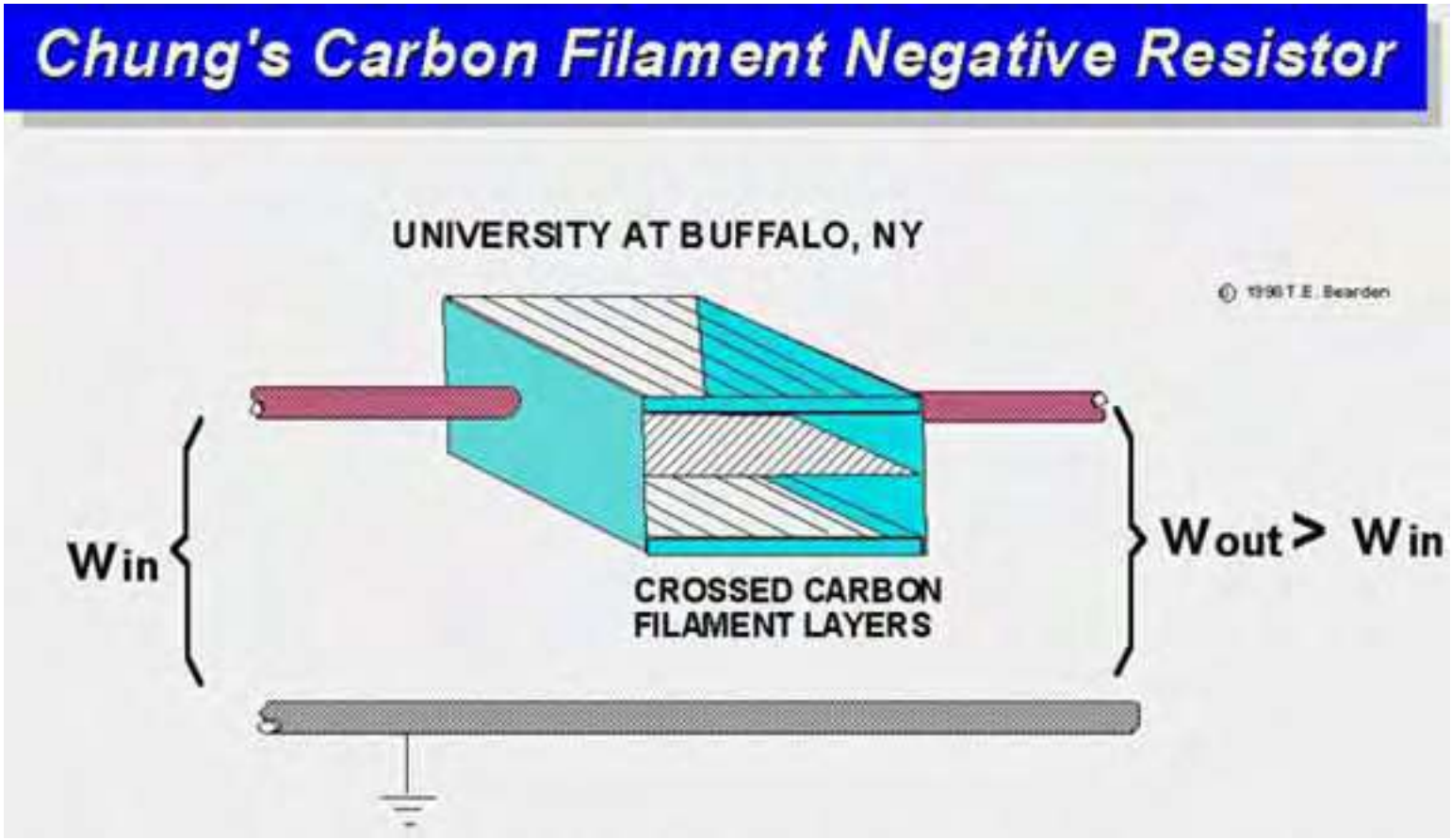
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
© 1996 T.E. Bearden
Win
Wout > Win
CROSSED CARBON
FILAMENT LAYERS

Typical circuit has about 10^{-13} energy collection efficiency

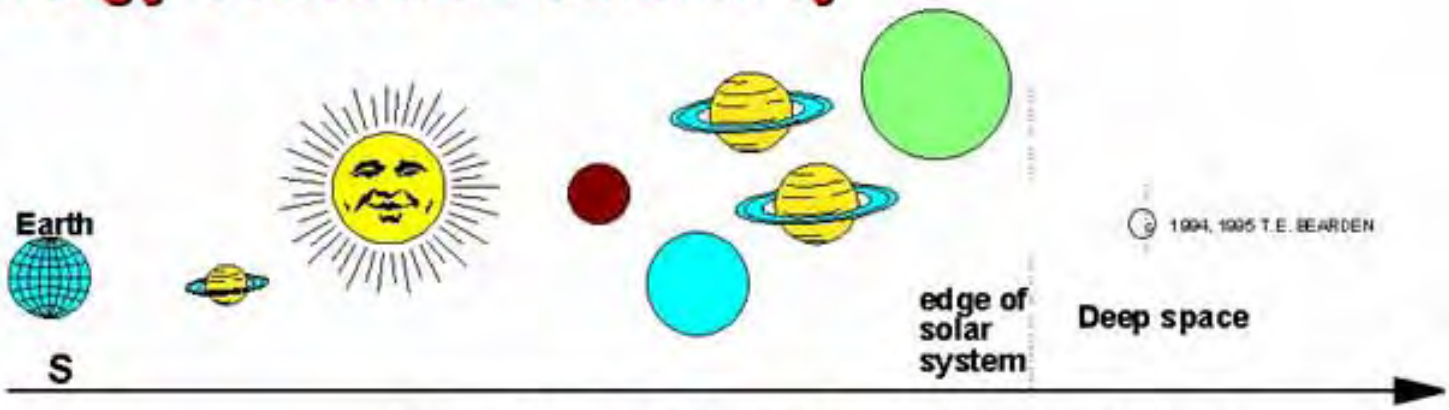

Distance traveled by S in one hour is 1.08x10exp(12) meters.

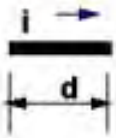

Example: 1.3 amps flowing in DC circuit, 1.8 mm diameter copper wire. J = 51 A/cm ^{2}

d_j = 0.1368 meters

S violently transports ϕ provided from the source.
j ϕ sluggishly transports the energy collected and dissipated in the circuit..

For the case discussed, the electron drift velocity in the circuit is about 3.8 x 10^{-5} meters/sec. So Jϕ moves about 0.1368 meters in one hour. Thus Jϕ has collected about 0.1368 meters of the ϕ-filled S-tube. During that same hour, the S-flow evoked by the power source will have traveled 1.08x10^{12} meters. The ϕ of both currents is the same. Both are involved in the same energy-filled tube. Thus S has provided and transported about 7.89x10^{12} times as much energy along the circuit in one hour as the jϕ has been able to collect, transport, and dissipate as work in the circuit. Thus this circuit provides about 10^{13} collection efficiency.

Classical View of EM

- Potentials just mathematical conveniences
  - Not real
  - No internal structure, just magnitude
- Force fields primary, causative, can exist in space in absence of observable mass
  - All EM actions due to force fields, none when zero
  - No action at a distance
- Vacuum empty; without energy or structure
  - No locally curved spacetime
  - No gravity effects
  - No quantum effects
- Maxwell's equations complete
  - Symmetrically regauged ***arbitrarily***
  - Topology dramatically reduced

Curved Spacetime acts as source or sink

- May emit excess radiation and energy (e.g., heat)
- May absorb radiation and energy (e.g., cool)
- May transduce waves TW ⇔ LW ⇔ TDW
- New energy conservation law applies

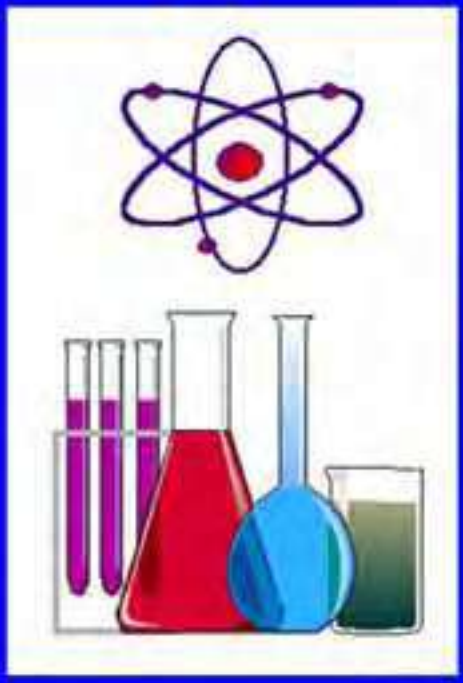

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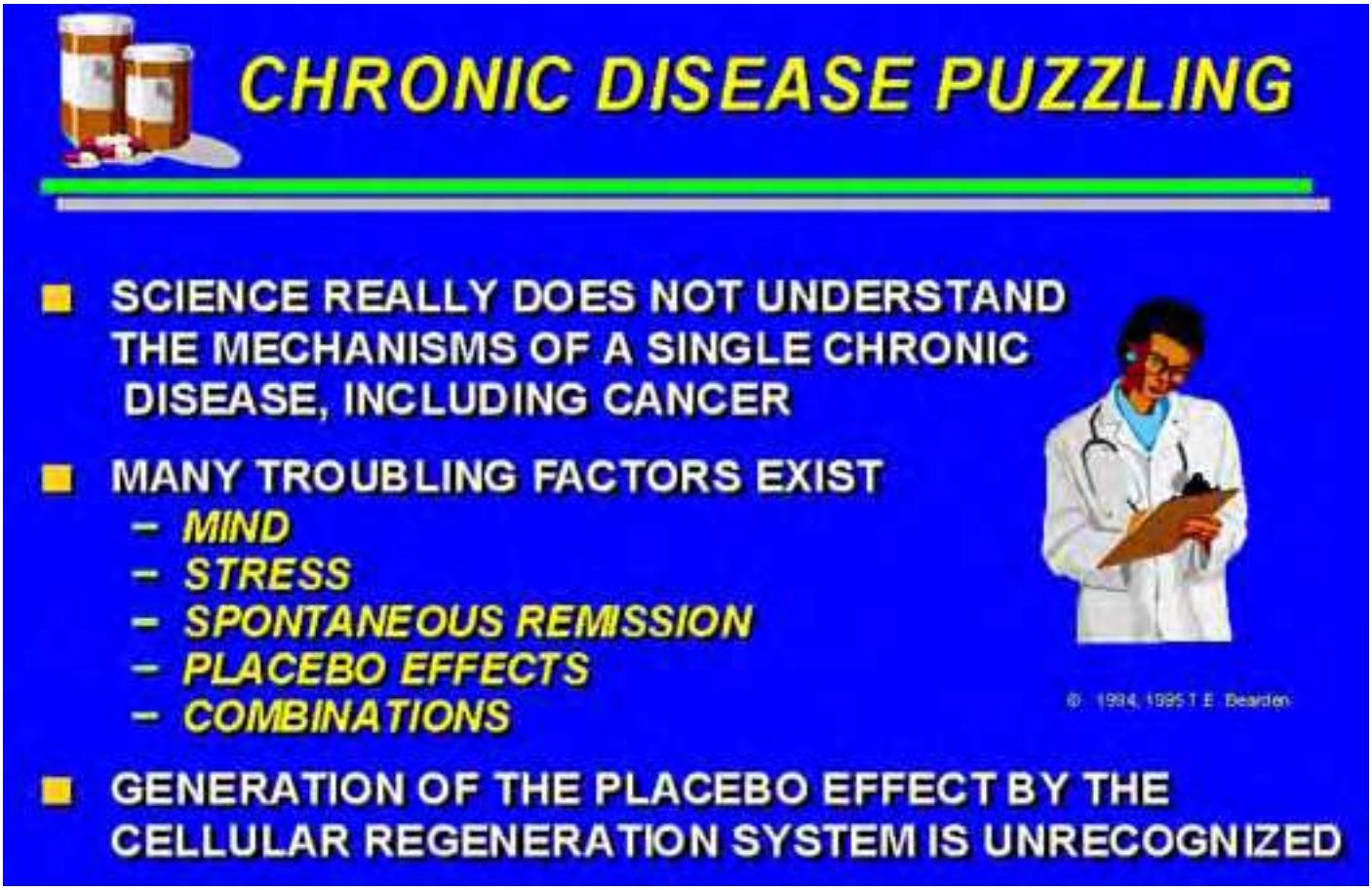
CHRONIC DISEASE PUZZLING
SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
MANY TROUBLING FACTORS EXIST
– MIND
– STRESS
– SPONTANEOUS REMISSION
– PLACEBO EFFECTS
– COMBINATIONS
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GENERATION OF THE PLACEBO EFFECT BY THE CELLULAR REGENERATION SYSTEM IS UNRECOGNIZED

Cancer Characteristics

- Not one disease, but a whole range
- Starts in damaged aerobic cell
- Cell shakes off body's central control
  - Starts uncontrolled division
  - Becomes a lump
- Can send forth cancer cells
  - Through blood
  - Through lymph
- Form metastases (secondary tumors)
- Often become anaerobic

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Solving a Cancer Enigma

- An enigma has been failure of immune system to attack some tumor cells
  - Suppressor cells may curb immune system?
  - Tumor may lack antigens normally identified by the immune system?
- *Promotion of damaged cell to cancer is usually ordered by cellular control system*
  - *Regenerative and recovery system forces cell back toward anaerobe*
  - *First step breaks free from central growth*
  - *Control continues to recognize cell as self*

CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

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*R&R system forces cell back toward anaerobe

Nonlinear Optics
Distortion Correction Theorem

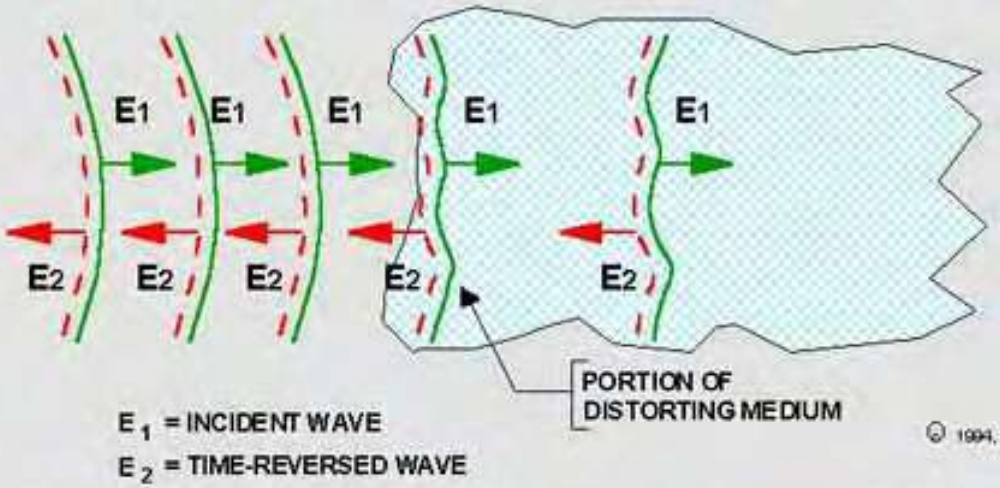

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"If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)

- Nucleon interchange
  - Changes neutron into proton and vice versa
  - At high rate (flat spacetime assumed)
- Statistics become skewed due to curved ST
- Can bias statistics toward either neutron or proton end
  - Biases toward transmutation of elements along isomer chains
  - Concept of "isomer" is vastly expanded

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)

- Normal dynamics (impulses) may reverse
  - Like charges attract, unlike charges repel
  - Positive charges cluster (are drawn together)
  - H+ ions (protons) may form quasi-nuclei
  - Nucleus coulomb barrier becomes assistant
- Many "impossible" reactions now possible
  - Quark access and quark flipping by EM
  - Ion clustering
  - Positive charges as phase conjugate mirrors
  - Time-density waves and time-energy charging

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The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)

- Not observed until time-energy charging has become substantial
  - Time delay (hours, days)
  - Transduction of LW --> TW involved
  - Specific time-charging history of detectors is involved in twhether they detect or not
  - Longitudinal EM waves become significant
- Curved spacetime can act as source or sink
  - May emit excess radiation
  - May absorb excess radiation

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In Time-Reversed Zone: Nuclear reactions are biased

- In normal flat ST, n ⇔ p at high rate
- Curved ST skews statistics
- Biases to either n or p
- Biases to transmutation along isomer chain
- "Isomer" concept greatly expanded

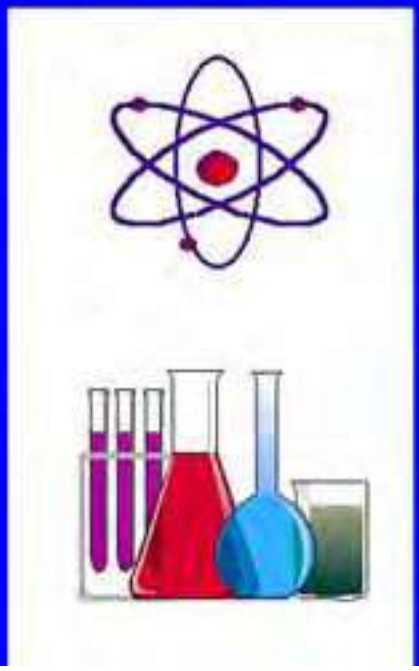

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In Time-Reversed Zone: Dynamics may be reversed

- Like charges may attract and unlike charges repel
- Coulomb barrier becomes Coulomb assistant
- Clusters like charges and forms artificial nuclei
- "Impossible" nuclear reactions at low energy
- Time-density interactions

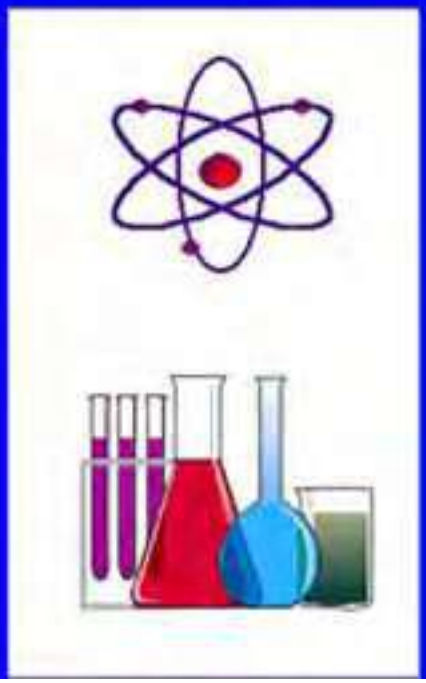

Time-Reversed Zone:

Significant only after time-density charging

- Hours, for "fast" onset
- Days, for "slower" onset
- Transduction involved for TW ⇔ LW ⇔ TDW
- Time-history of each detector is significant
- Longitudinal EM waves become significant

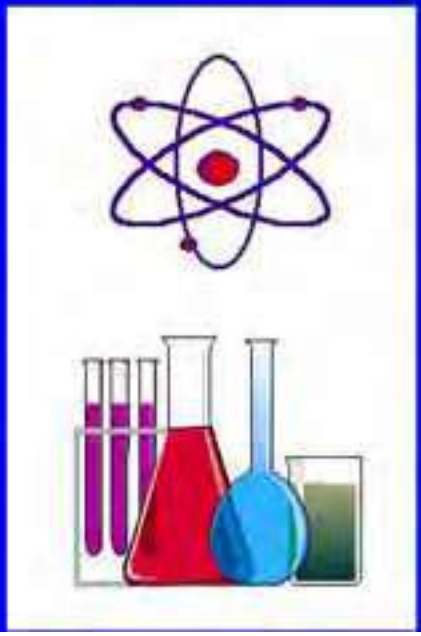

A New Conservation of Energy Law

- Physics conserves total "energy and mass-energy"
- Now also must consider "time-energy"
- Conserve total mass-time-energy (spatiotemporal energy)
- Let E_T = total energy, E_M = mass energy, E_E = ordinary energy, and E_t = time energy. Then

$$E_T = E_E + E_M + E_t$$

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$$(kE_t \Rightarrow E_E > 0) \Rightarrow E_T > (E_M + E_E)$$

- If some E_t is transduced into E_E, the experiment will violate the old spatial mass-energy conservation law

QUESTIONS ON CARCINOGENS AND EM RADIATION

- UNRESOLVED QUESTIONS ON EM RADIATION
  - DOSAGES
  - ACTIVE MECHANISMS
  - REPLICATION DIFFICULTIES
  - MEASUREMENT DIFFICULTIES
  - WHERE, WHEN, HOW ILL EFFECTS OCCUR
- SIMILAR QUESTIONS EXIST ABOUT EVERY CARCINOGEN
- SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
  - FACTORS SUCH AS MIND, STRESS, SPONTANEOUS REMISSION, PLACEBO EFFECTS, AND COMBINATIONS OF FACTORS ARE PARTICULARLY TROUBLESOME
  - GENERATION OF THE PLACEBO EFFECT BY THE REGENERATION & RECOVERY SYSTEM IS UNRECOGNIZED

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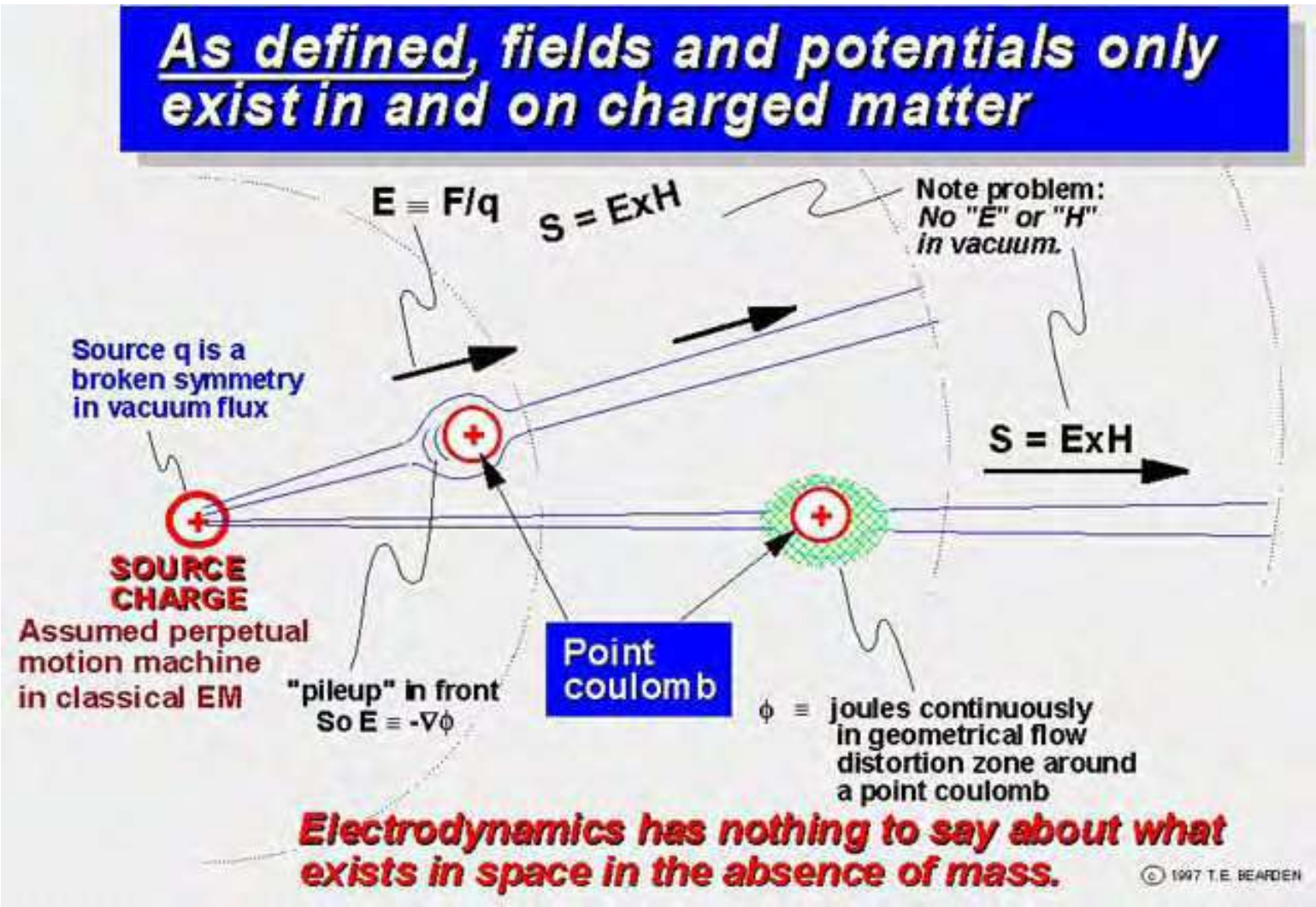
As defined, fields and potentials only exist in and on charged matter
E ≡ F/q
S = ExH
Note problem:
No "E" or "H"
in vacuum.
Source q is a
broken symmetry
in vacuum flux
S = ExH
SOURCE
CHARGE
Assumed perpetual
motion machine
in classical EM
"pileup" in front
So E ≡ -∇ϕ
Point
coulomb
ϕ ≡ joules continuously
in geometrical flow
distortion zone around
a point coulomb
Electrodynamics has nothing to say about what
exists in space in the absence of mass.
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Serious flaws and errors in classical EM theory.

1. Eliminates the Internal EM Inside the Scalar Potential.
2. No Definition of Electrical Charge or of Scalar Potential.
3. Equations Still Assume Material Ether Per Maxwell (Unchanged).
4. Use of Force Fields in Vacuum is False (and Known to be So).
5. Treats Charge q as Unitary Instead of Coupled System $q = \phi[q]m(q)$.
6. Confuses Massless Potential Gradients as Forces (See #3, #4).
7. Does Not Utilize Mass as a Component of Force (See #23).

8. Erroneously Assumes EM Force Fields as Primary Causes.
9. Topology of EM Model Has Been Substantially Reduced.
10. Does Not Include Quantum Potential or Action at a Distance.
11. Does Not Include Superluminal Velocity of Inner EM Components.
12. Does Not Utilize Extended Near-Field Coulomb Gauge Effects.
13. Does Not Include EM Generatrix Mechanism for Time Flow.
14. Does Not Unify Photon and Wave Aspects (Requires 7-D Model).

15. Does Not Include Electron Spin and Precession (See #19, #24).
16. Treats EM Energy As Existing In "Chunks," Instead of as Flow.
17. Confuses Energy and Energy Collection (See #16).
18. Discards Half of Every EM Wave in Vacuum (See #22).
19. Erroneously Uses Transverse Vacuum Wave; It's Longitudinal.
20. Arbitrarily Regauges Maxwell's Equations to Eliminate Overunity.
21. Omits Phase Conjugate Optics Effects (The *Rule* in Internal EM).
22. Does Not Include EM Cause of Newtonian Reaction Force.
23. Erroneously Assumes Separate Force Acting on Separate Mass.
24. Confuses Detected Electron Precession Waves as Proving Transverse EM Waves in Vacuum (Remnant of Old "EM Fluid" Concept).
25. Due to Error in String Wave, Omits the Ubiquitous Antiwave.
26. *Assumes* Equilibrium; Not True Unless Include Vacuum Interactions.
27. Higher Topology Required, to Model Electromagnetic Reality.
28. Lorentz surface integration discards Poynting energy transport.
29. Has nothing at all to say about form of EM entities in massless space.
30. Eliminates the infolded general relativity using EM-force as curve agent.
31. Does not include longitudinal EM waves as time domain oscillations.
32. Does not include EM mechanism that generates time flow and flow rate.

© T.E. [illegible] 1991, 1997

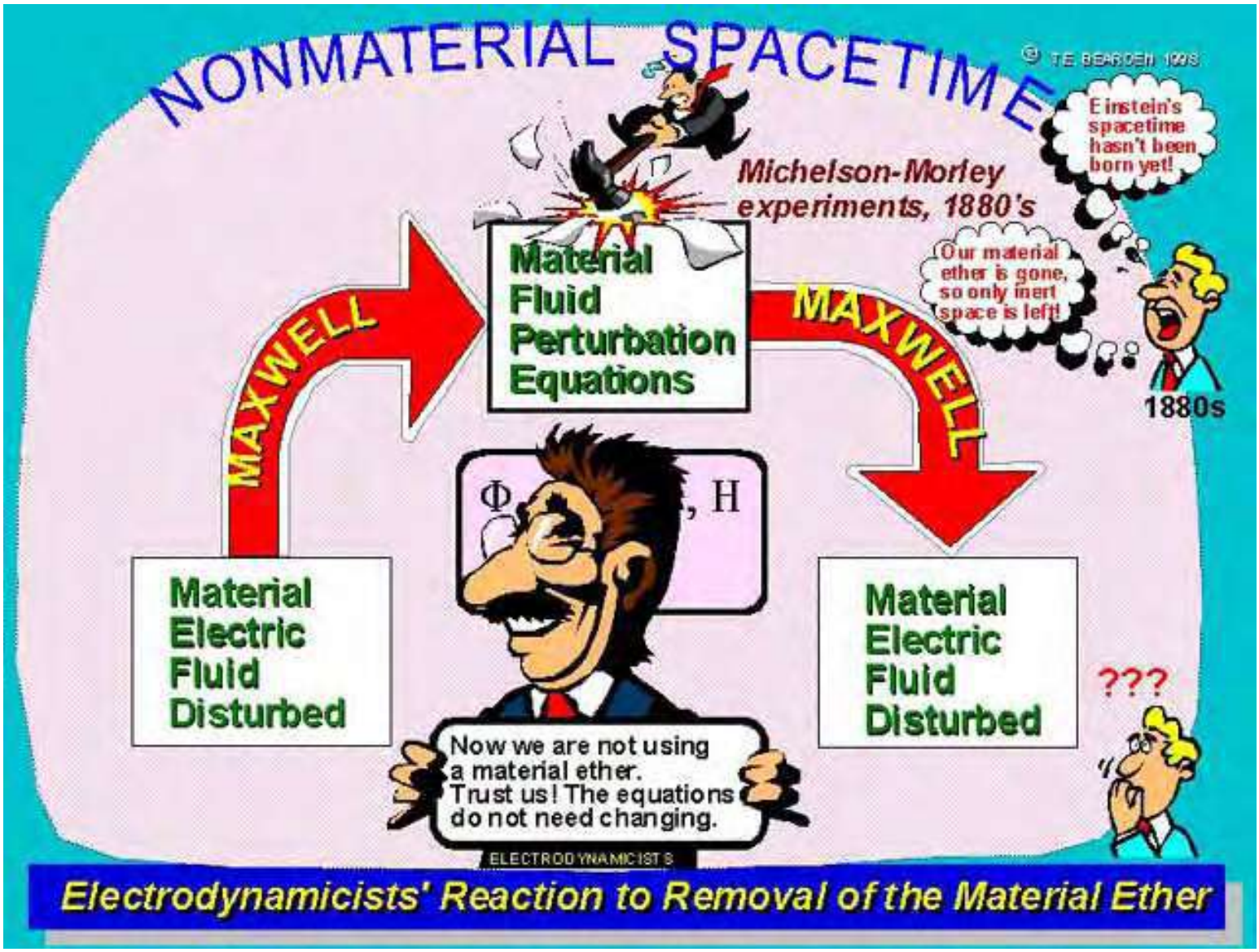
NONMATERIAL SPACETIME
© T.E. BEARDEN 1998
Michelson-Morley experiments, 1880's
Einstein's spacetime hasn't been born yet!
Our material ether is gone, so only inert space is left!
1880s
MAXWELL
Material Fluid Perturbation Equations
MAXWELL
Φ
, H
Material Electric Fluid Disturbed
Material Electric Fluid Disturbed
???
Now we are not using a material ether. Trust us! The equations do not need changing.
ELECTRODYNAMICISTS
Electrodynamicists' Reaction to Removal of the Material Ether

REACTION TO LOSS OF MATERIAL ETHER
Material Ether Assumed in Equations
Potentials, Fields, and Waves Assumed Material
Not a single equation was changed!
Now we are not using a material ether. Trust us! The equations do not need changing.
© T.E. BEARDEN 1999
ELECTRODYNAMICISTS

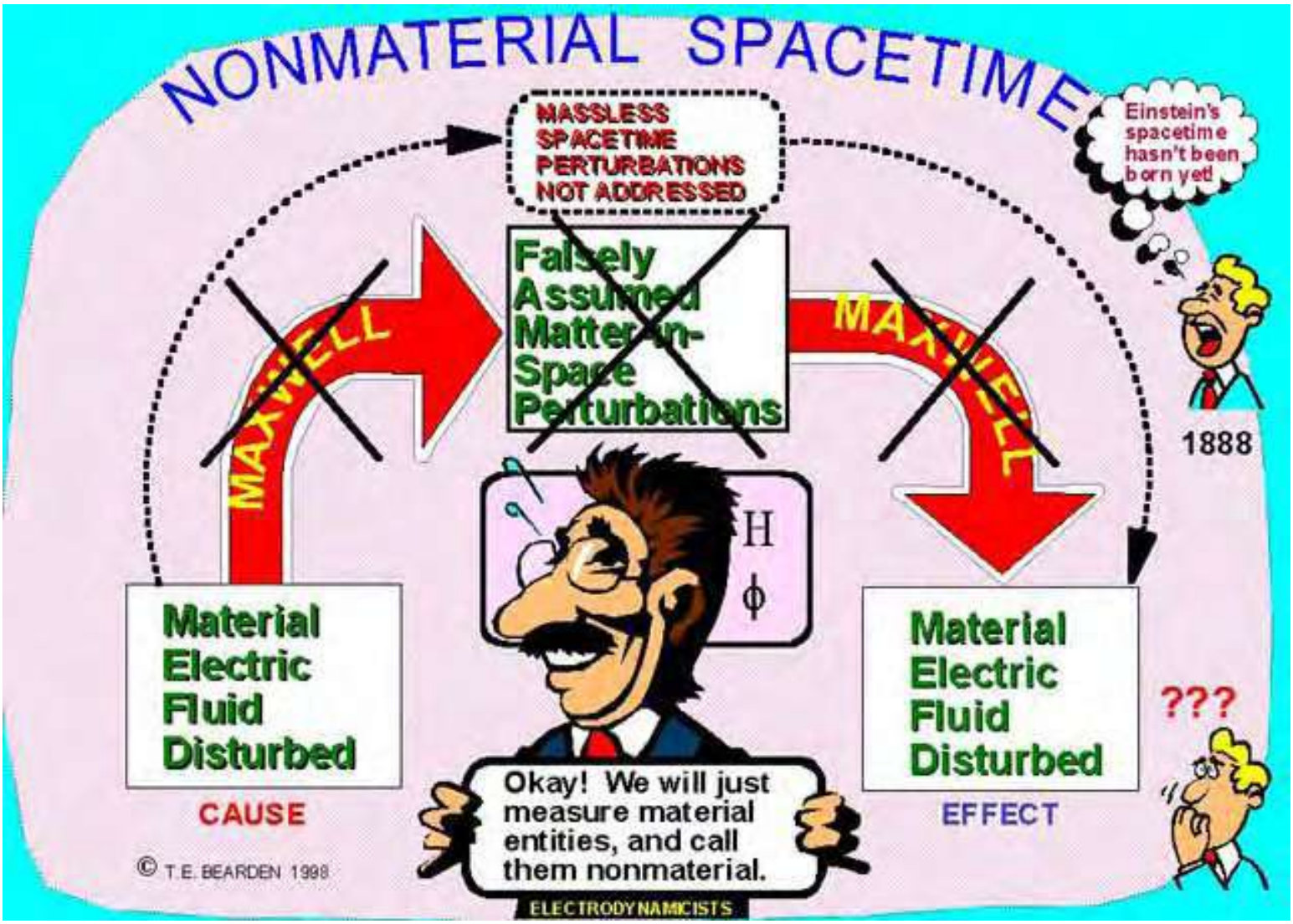
NONMATERIAL SPACETIME
MASSLESS SPACETIME PERTURBATIONS NOT ADDRESSED
Einstein's spacetime hasn't been born yet!
Falsely Assumed Matter-in-Space Perturbations
MAXWELL
MAXWELL
1888
H
ϕ
Material Electric Fluid Disturbed
CAUSE
Material Electric Fluid Disturbed
EFFECT
???
Okay! We will just measure material entities, and call them nonmaterial.
© T.E. BEARDEN 1998
ELECTRODYNAMICISTS

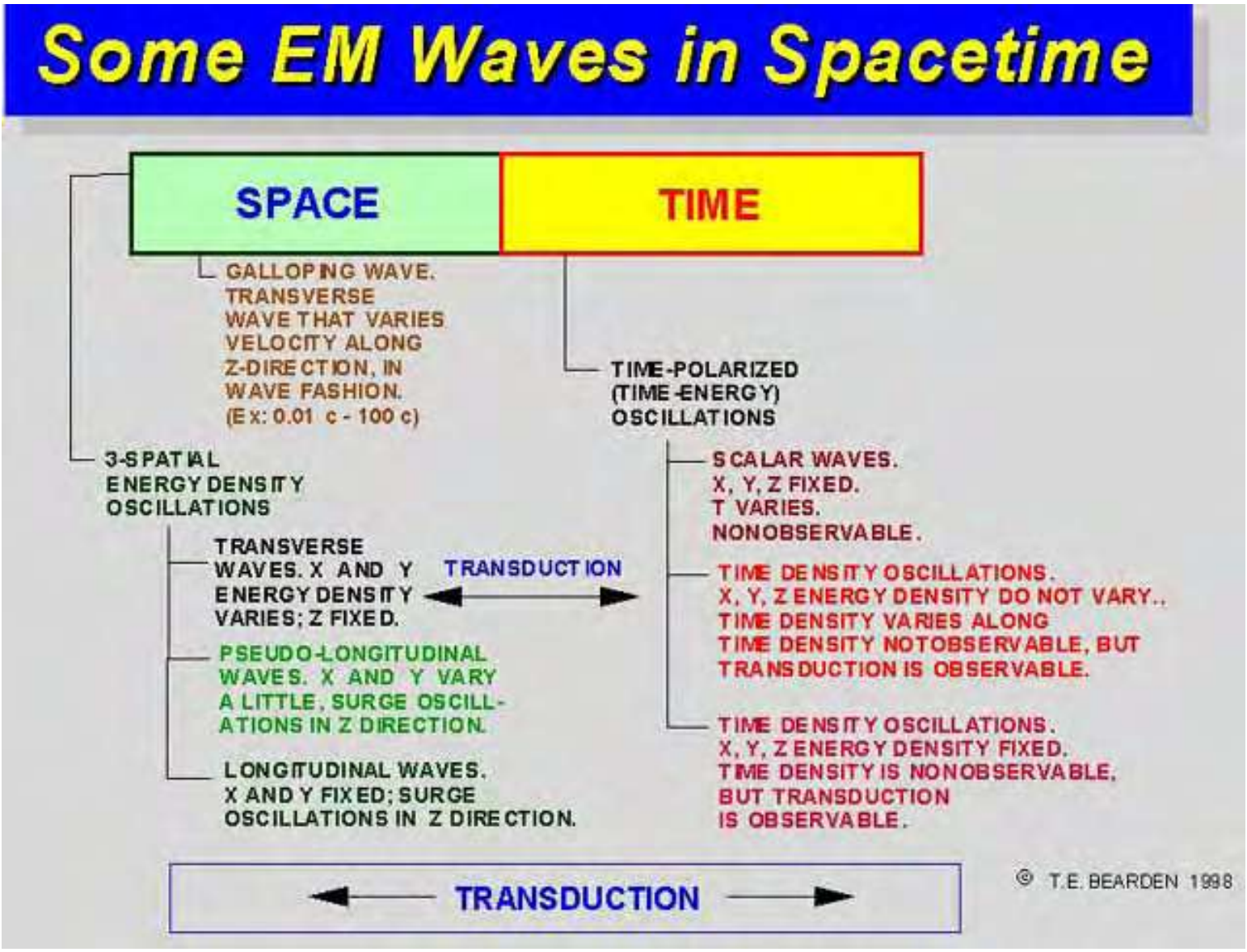
Some EM Waves in Spacetime
SPACE
TIME
GALLOPING WAVE. TRANSVERSE WAVE THAT VARIES VELOCITY ALONG Z-DIRECTION, IN WAVE FASHION. (Ex: 0.01 c - 100 c)
TIME-POLARIZED (TIME-ENERGY) OSCILLATIONS
3-SPATIAL ENERGY DENSITY OSCILLATIONS
SCALAR WAVES. X, Y, Z FIXED. T VARIES. NONOBSERVABLE.
TRANSVERSE WAVES. X AND Y ENERGY DENSITY VARIES; Z FIXED.
TRANSDUCTION
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY DO NOT VARY.. TIME DENSITY VARIES ALONG TIME DENSITY NOTOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
PSEUDO-LONGITUDINAL WAVES. X AND Y VARY A LITTLE, SURGE OSCILLATIONS IN Z DIRECTION.
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY FIXED. TIME DENSITY IS NONOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
LONGITUDINAL WAVES. X AND Y FIXED; SURGE OSCILLATIONS IN Z DIRECTION.
TRANSDUCTION
© T.E. BEARDEN 1998

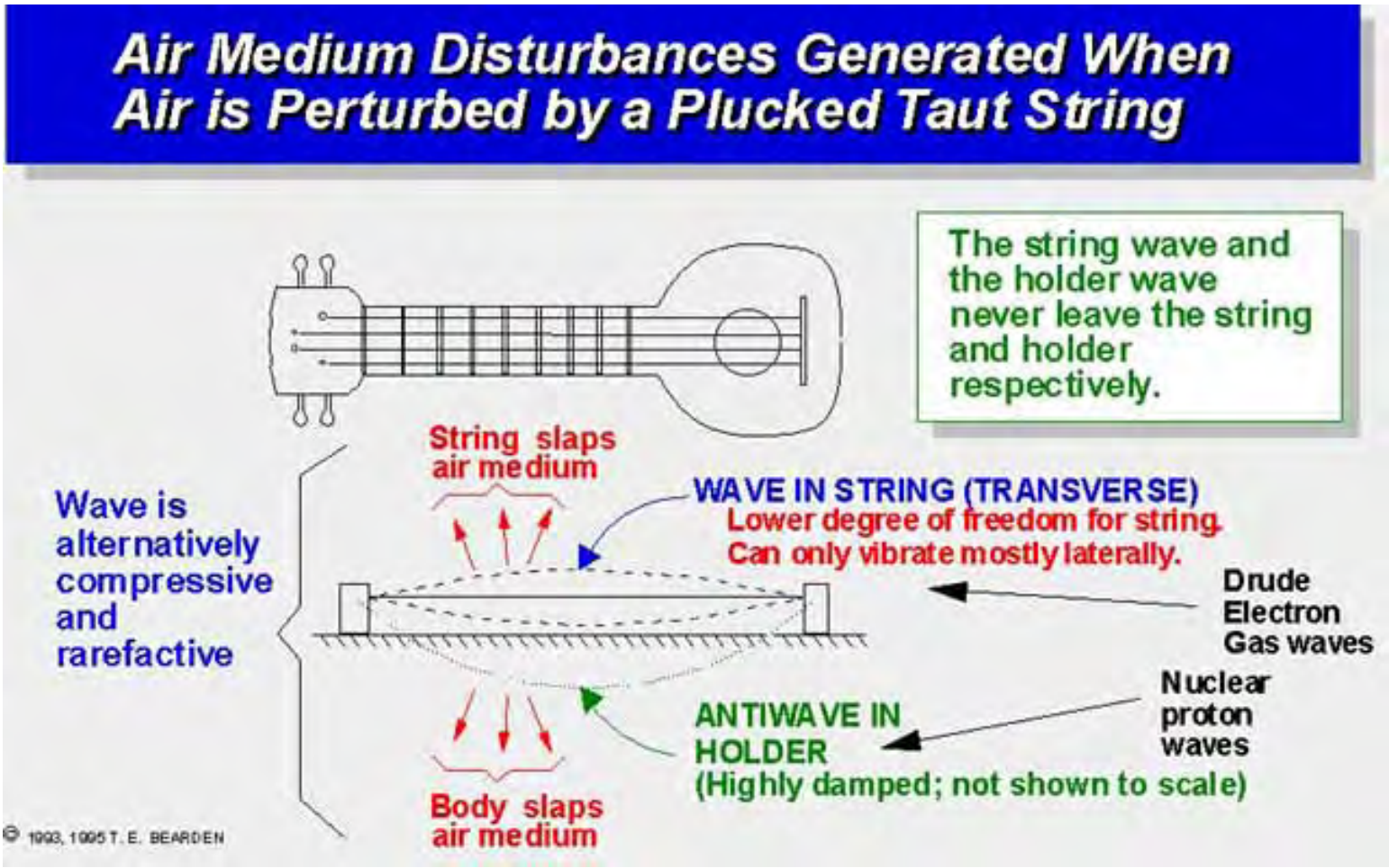
Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
The string wave and the holder wave never leave the string and holder respectively.
String slaps air medium
Wave is alternatively compressive and rarefactive
WAVE IN STRING (TRANSVERSE)
Lower degree of freedom for string.
Can only vibrate mostly laterally.
Drude Electron Gas waves
Nuclear proton waves
ANTIWAVE IN HOLDER
(Highly damped; not shown to scale)
Body slaps air medium
© 1993, 1995 T. E. BEARDEN

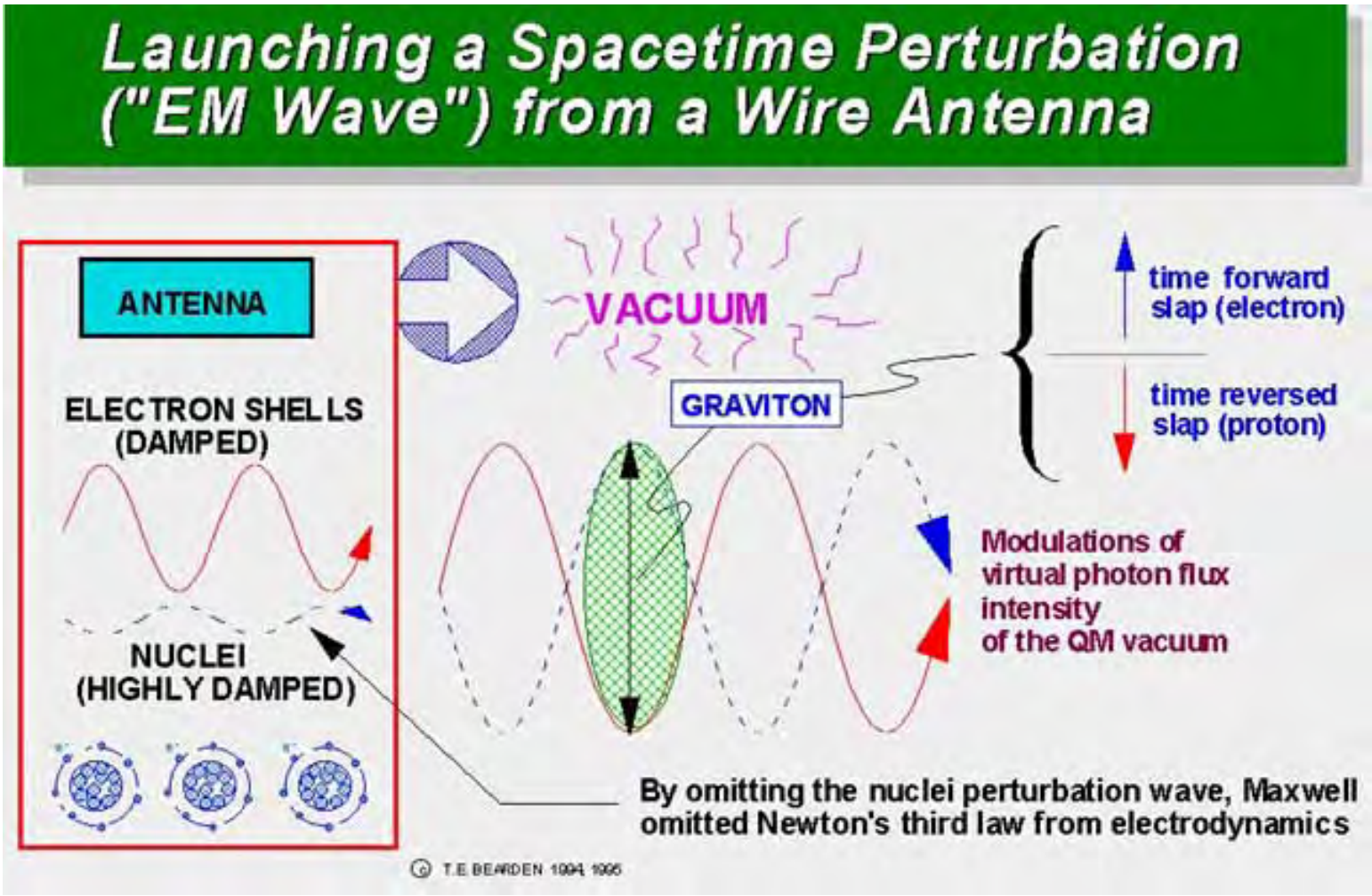
Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
ANTENNA
ELECTRON SHELLS (DAMPED)
NUCLEI (HIGHLY DAMPED)
VACUUM
GRAVITON
time forward slap (electron)
time reversed slap (proton)
Modulations of virtual photon flux intensity of the QM vacuum
By omitting the nuclei perturbation wave, Maxwell omitted Newton's third law from electrodynamics
© T.E BEARDEN 1994 1995

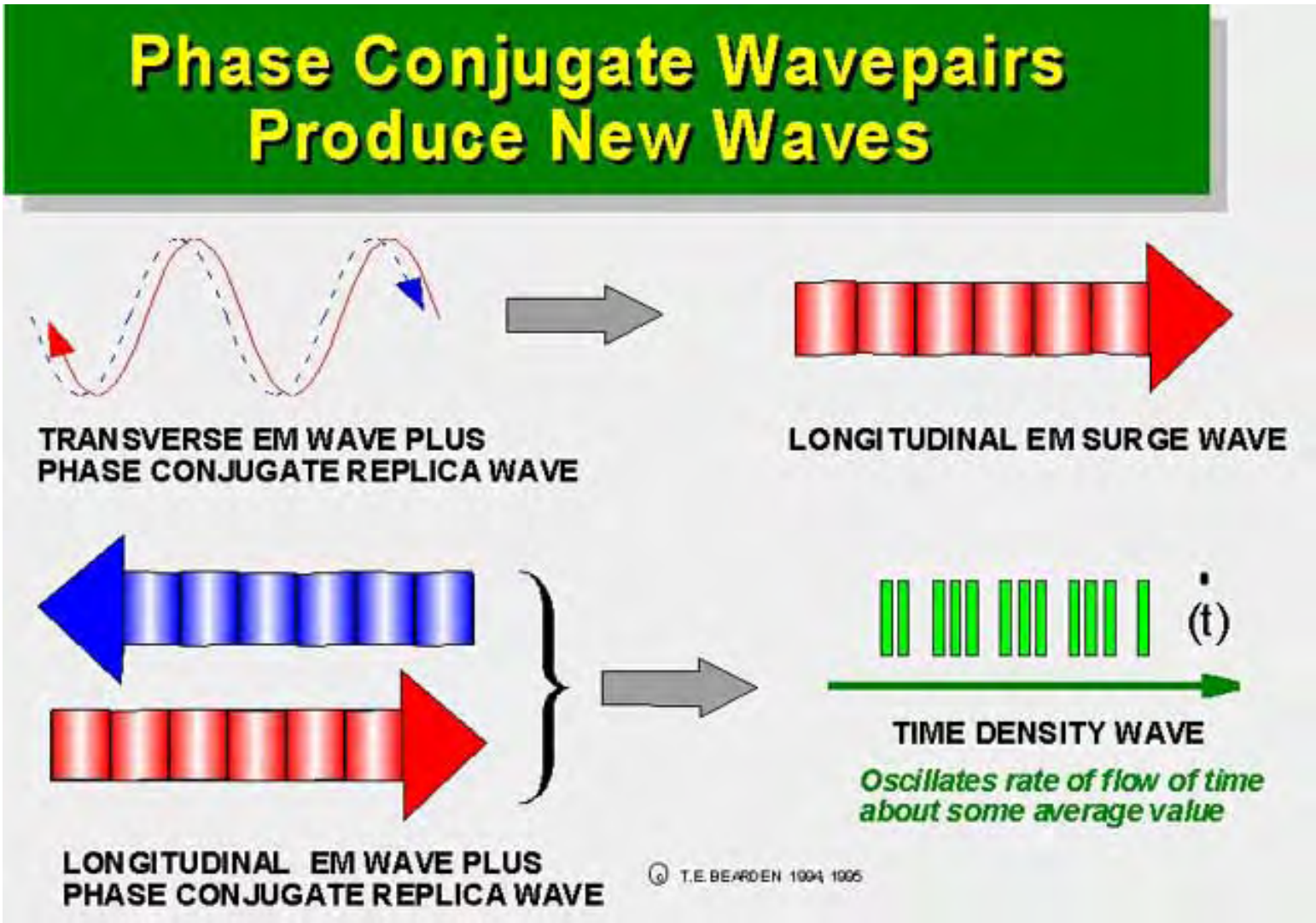
Phase Conjugate Wavepairs
Produce New Waves
TRANSVERSE EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
LONGITUDINAL EM SURGE WAVE
LONGITUDINAL EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
(t)
TIME DENSITY WAVE
Oscillates rate of flow of time
about some average value
© T.E. BEARDEN 1994, 1995

Scalar Electromagnetics (Energetics) View of EM

- Potentials real; primary causes of EM phenomena
  - Force fields made by differentiations of potentials
  - Force fields are effects, not primary causes
  - Force fields exist only in, on mass particles
- Actions due to potentials and their interference
  - Action at a distance or locally
  - Quantum potential and hidden variables
- Locally curved spacetime, engineerable by EM
  - Gravity effects not necessarily negligible
  - Strong EM force or time used as agent of curvature

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Potentials have internal structure
  - Stoney/Whittaker structure
  - Longitudinal EM phase conjugate wavepairs
  - Each wavepair is a time-polarized EM wave
- Vacuum EM is a potential and has microstructure
  - Stoney-Whittaker biwaves/t-polarized waves
  - Fluctuations exhibit chaos
- Spacetime ≡ Vacuum ≡ Potential ≡ Flux

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Statistics may have hidden order (already chaotic)
- Uses spacetime curvature engines to alter matter (inside-out or outside-in)
- Engineerable EM mechanism generates rate of flow of a mass through time
- Quantum potential with specific QP can be used for instant action at a distance

Extended General Relativity Principle

- "All levels of energy structures and all levels of time structures mold spacetime geometry.
- This is called a *vacuum engine* (spacetime engine).
- Spatial and temporal structuring act upon mass at all levels.
- This produces *templates* of forces, for translations and stresses."

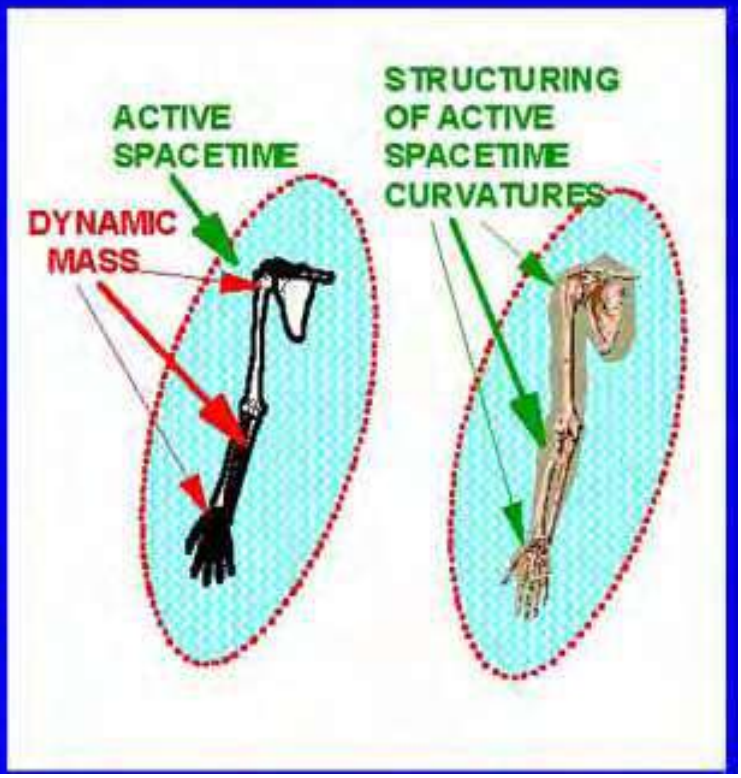

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Extension of Work-Energy Theorem

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- *Theorem:* $W = k_f - k_i = \Delta k$ [1]
- k must be interpreted not as energy *per se*, but as *collected/collecting* energy.
- The reaction cross section λ for the collecting process must be included.
- *Extension:* $W = \lambda (k_f - k_i) = \lambda \Delta k$ [2]
- Normally $\lambda \leq 1$, as for elastic collision or Stokes emission.
- However, $\lambda > 1$ is now possible, for processes which asymmetrically self-regauge. An example is Letokhov's negative absorption of the medium.
- Working models are the Patterson Power Cell® and Lawandy lasing without population inversion.

MTW's General Relativity Principle

- "Space acts on matter, telling it how to move.
- In turn, matter reacts back on space, telling it how to curve."

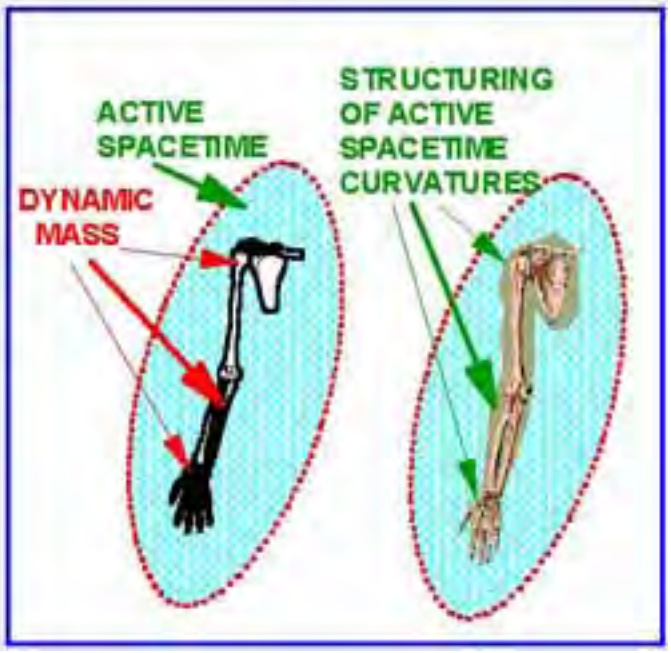

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Use of General Relativity (GR) in Particle Physics

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- GR seldom used in particle physics
- In cold fusion, Matsumoto* has applied general relativity
- Consistent with important cold fusion results
- Used spacetime (ST) curvature by energy density
- Matsumoto did not utilize:
  - Longitudinal EM waves
  - Time density waves
  - Time density curvatures of ST (gain = $9 \times 10_{16}$)

* T. Matsumoto, "Mechanisms of Electro-Nuclear Collapse," Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 98

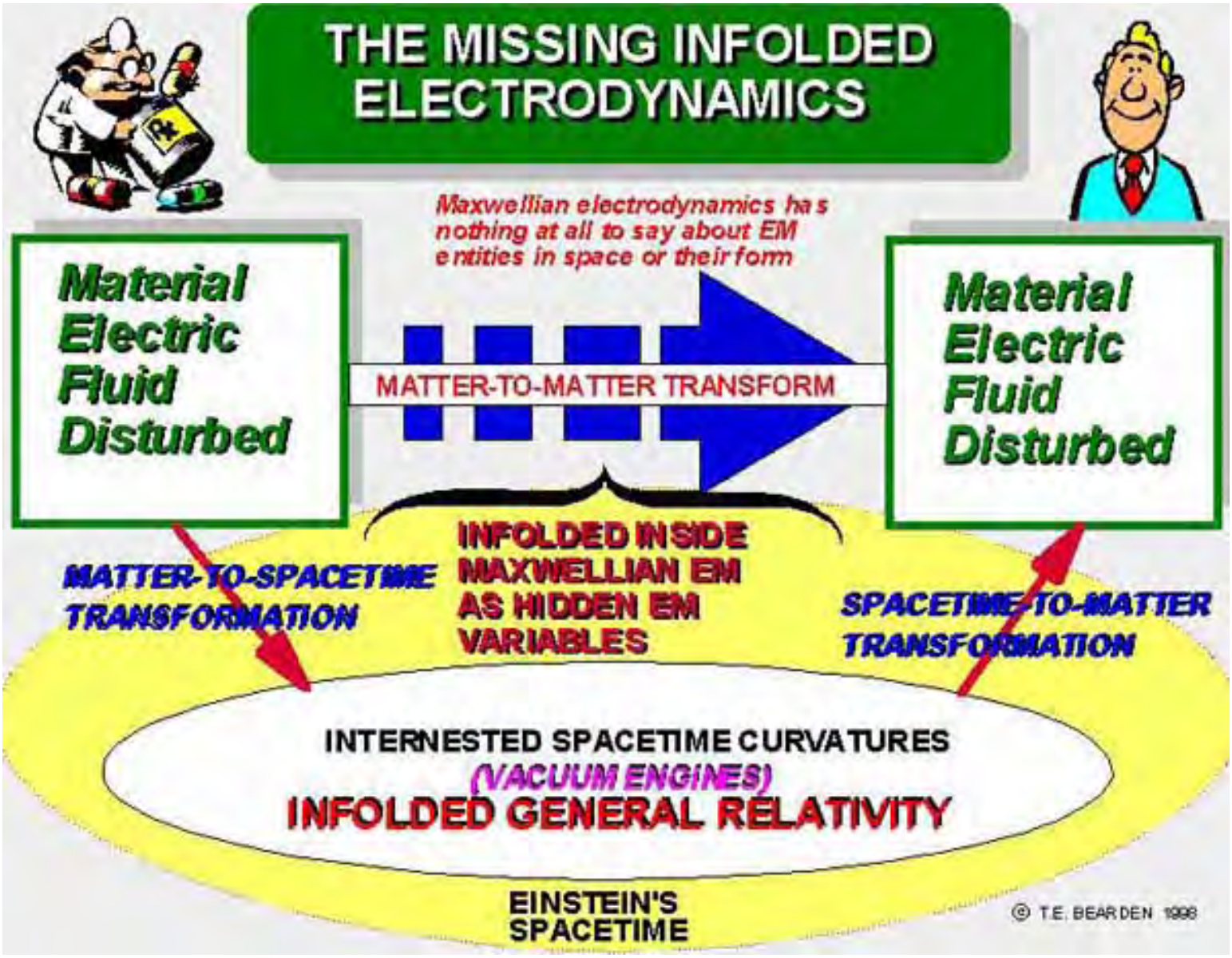
THE MISSING INFOLDED ELECTRODYNAMICS
Maxwellian electrodynamics has nothing at all to say about EM entities in space or their form
Material Electric Fluid Disturbed
MATTER-TO-MATTER TRANSFORM
Material Electric Fluid Disturbed
INFOLDED INSIDE MAXWELLIAN EM AS HIDDEN EM VARIABLES
MATTER-TO-SPACETIME TRANSFORMATION
SPACETIME-TO-MATTER TRANSFORMATION
INTERNESTED SPACETIME CURVATURES
(VACUUM ENGINES)
INFOLDED GENERAL RELATIVITY
EINSTEIN'S SPACETIME
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Infolded Engines: Excluded by Present Physics

- *The infolded dynamics of EM systems are not considered in general relativity, electromagnetics, or quantum mechanics*
- *None of these disciplines include such spacetime curvature engines (vacuum engines)*
- *Thus GR, EM, and QM cannot be unified, since ST curvature engines are where the unification mainly occurs*

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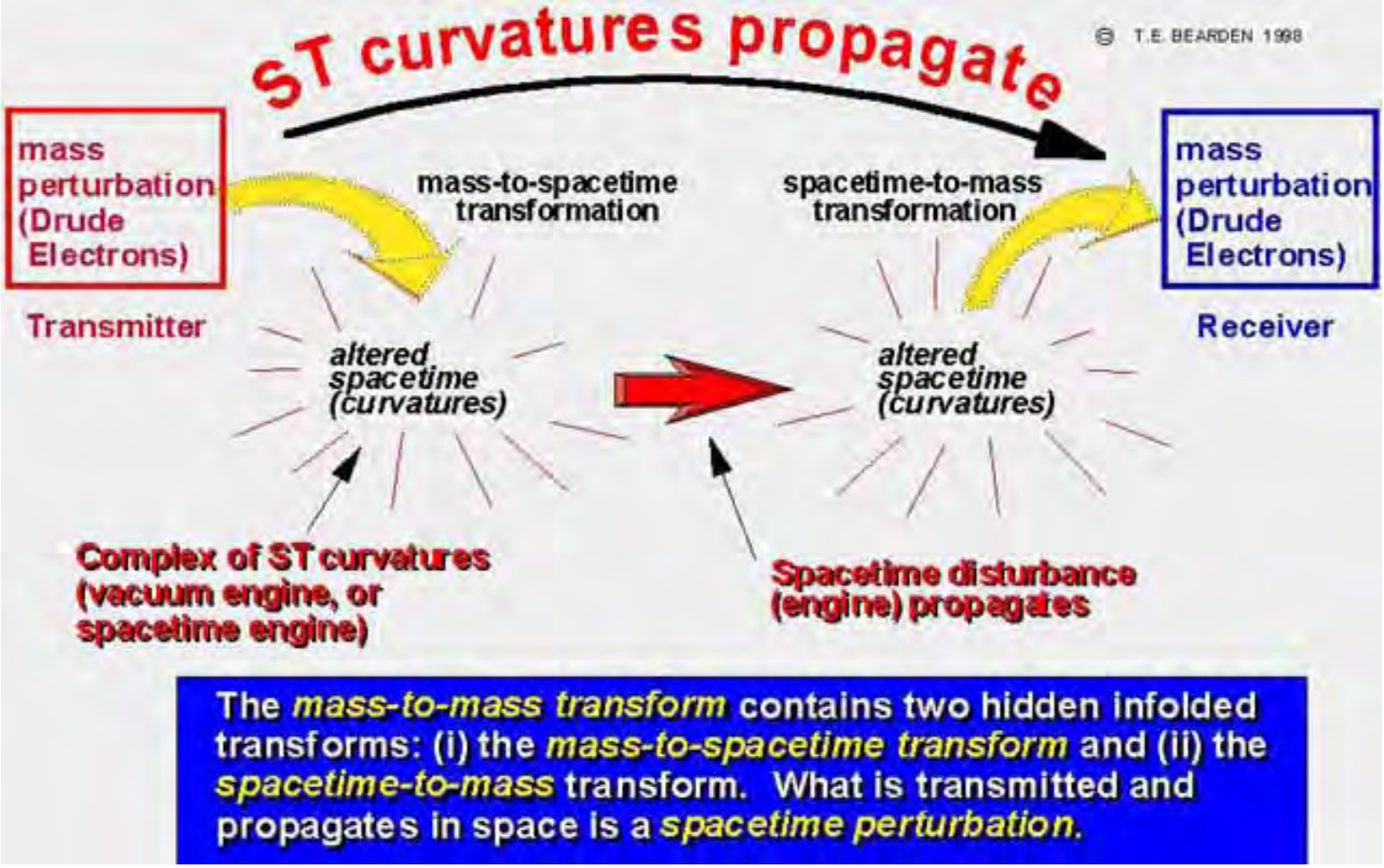
ST curvatures propagate
© T.E. BEARDEN 1998
mass perturbation (Drude Electrons)
Transmitter
mass-to-spacetime transformation
spacetime-to-mass transformation
mass perturbation (Drude Electrons)
Receiver
altered spacetime (curvatures)
altered spacetime (curvatures)
Complex of ST curvatures (vacuum engine, or spacetime engine)
Spacetime disturbance (engine) propagates
The mass-to-mass transform contains two hidden infolded transforms: (i) the mass-to-spacetime transform and (ii) the spacetime-to-mass transform. What is transmitted and propagates in space is a spacetime perturbation.

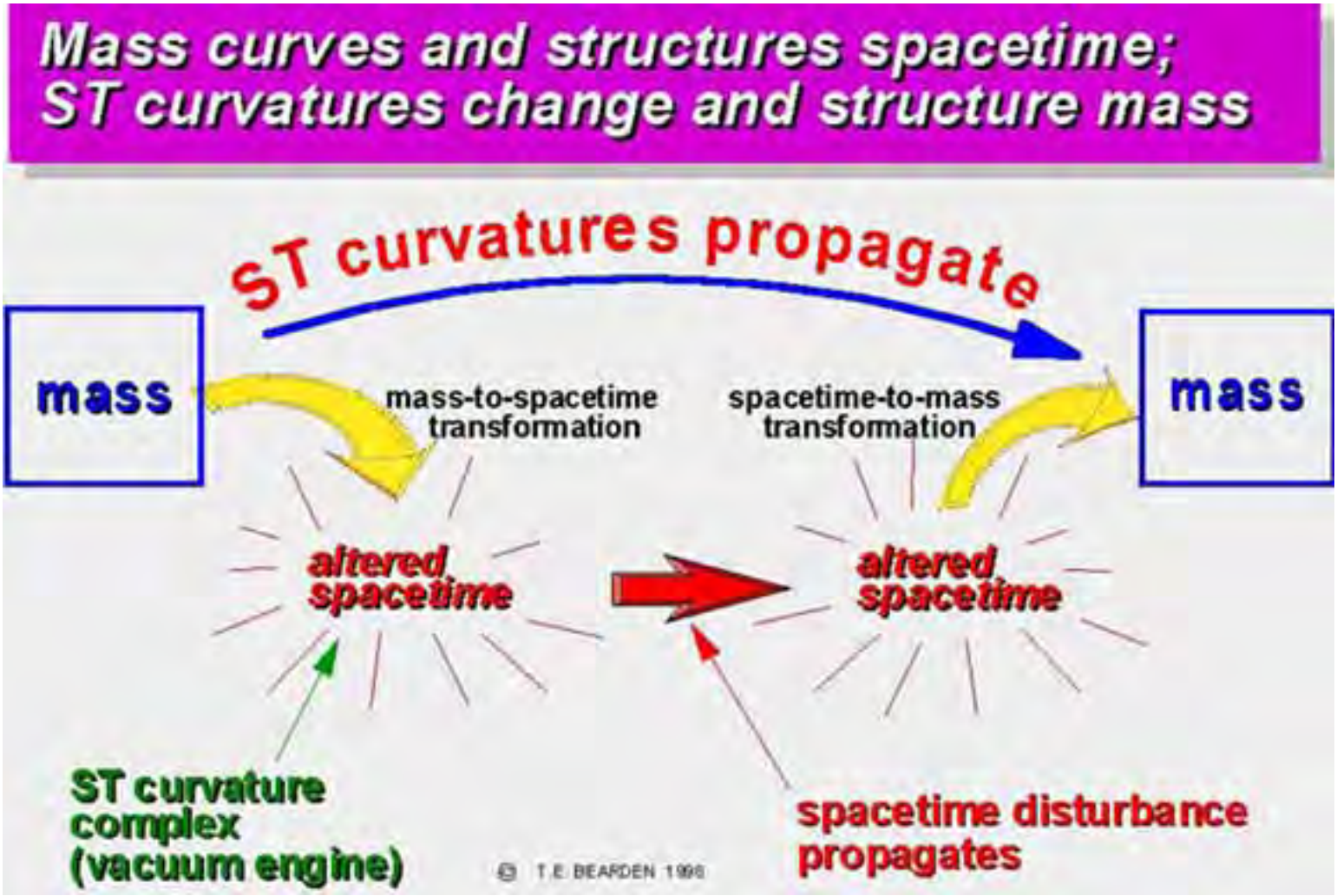
Mass curves and structures spacetime;
ST curvatures change and structure mass
ST curvatures propagate
mass
mass-to-spacetime transformation
spacetime-to-mass transformation
mass
altered spacetime
altered spacetime
ST curvature complex (vacuum engine)
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spacetime disturbance propagates

At Infinite Velocity:
Each Is Every Other
SPACETIME
VIRTUAL PARTICLE FLUX
POTENTIAL
MIND AND MIND LEVELS
MASS
PLANET
LIVING ORGANISMS
© 1997 T.E. Bearden

Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

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S.K. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p. 16-25.

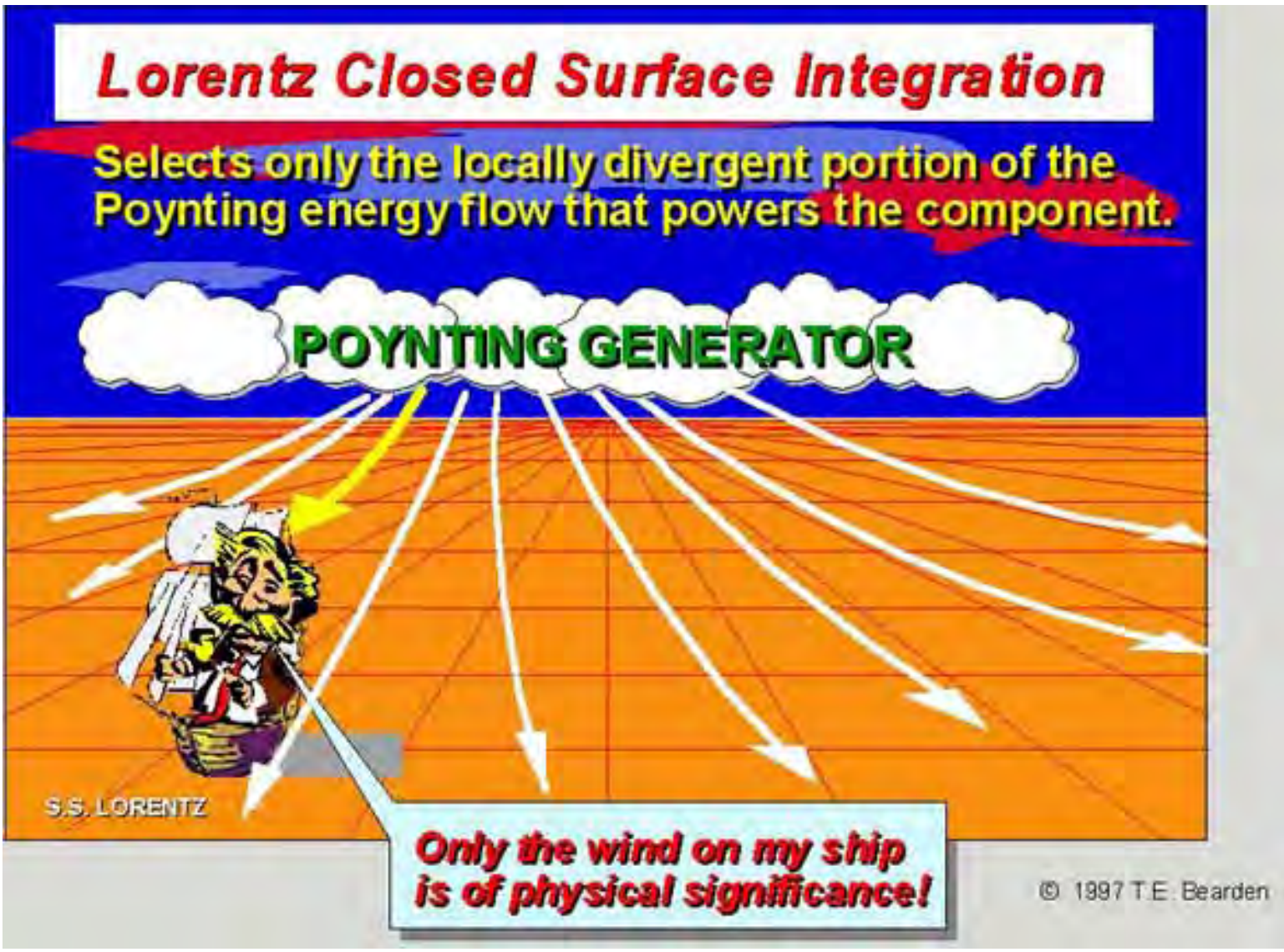
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
Only the wind on my ship is of physical significance!
© 1997 T.E. Bearden

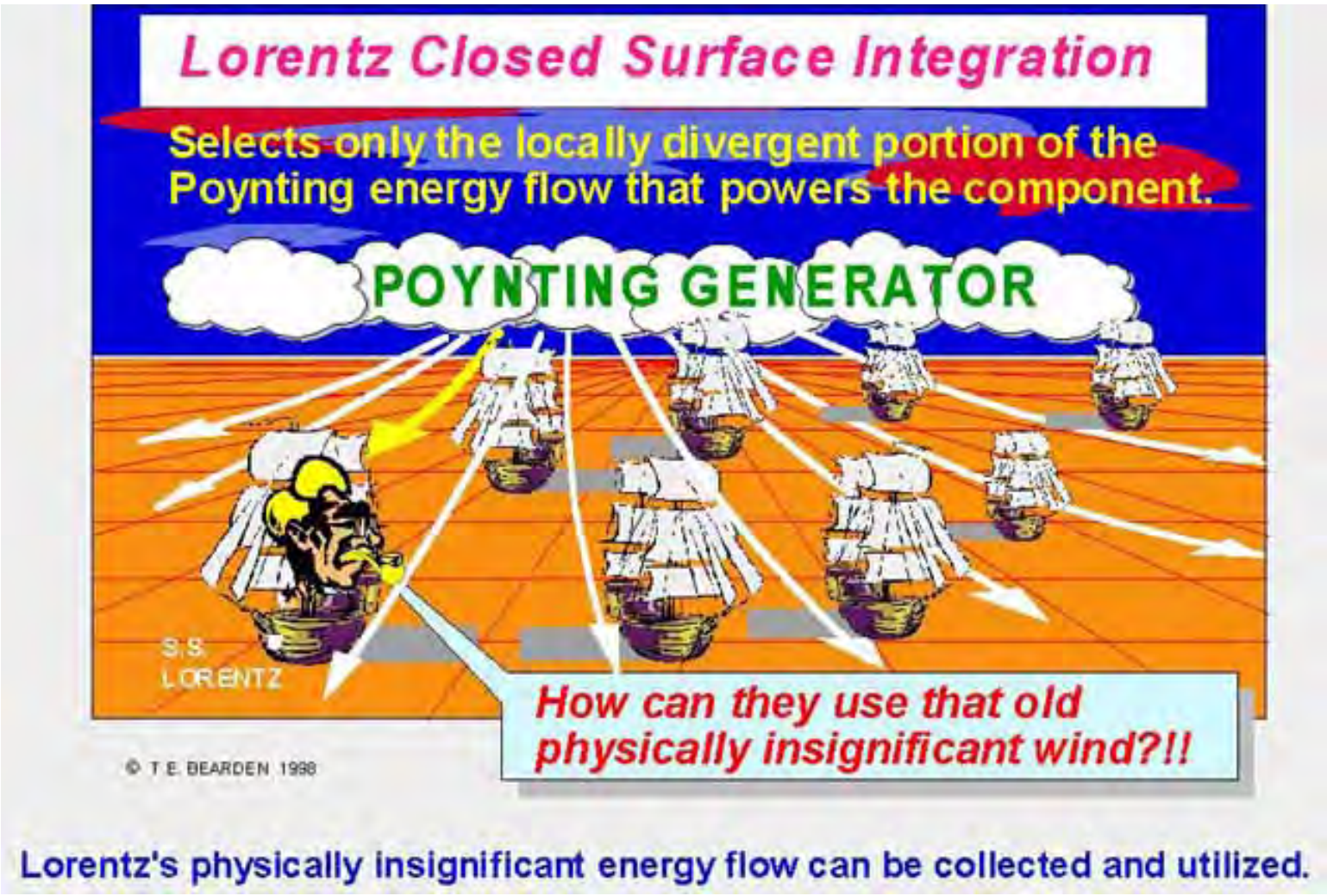
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
How can they use that old physically insignificant wind?!!
© T.E. BEARDEN 1998
Lorentz's physically insignificant energy flow can be collected and utilized.

Lorentz surface integration of the Poynting vector around a closed surface

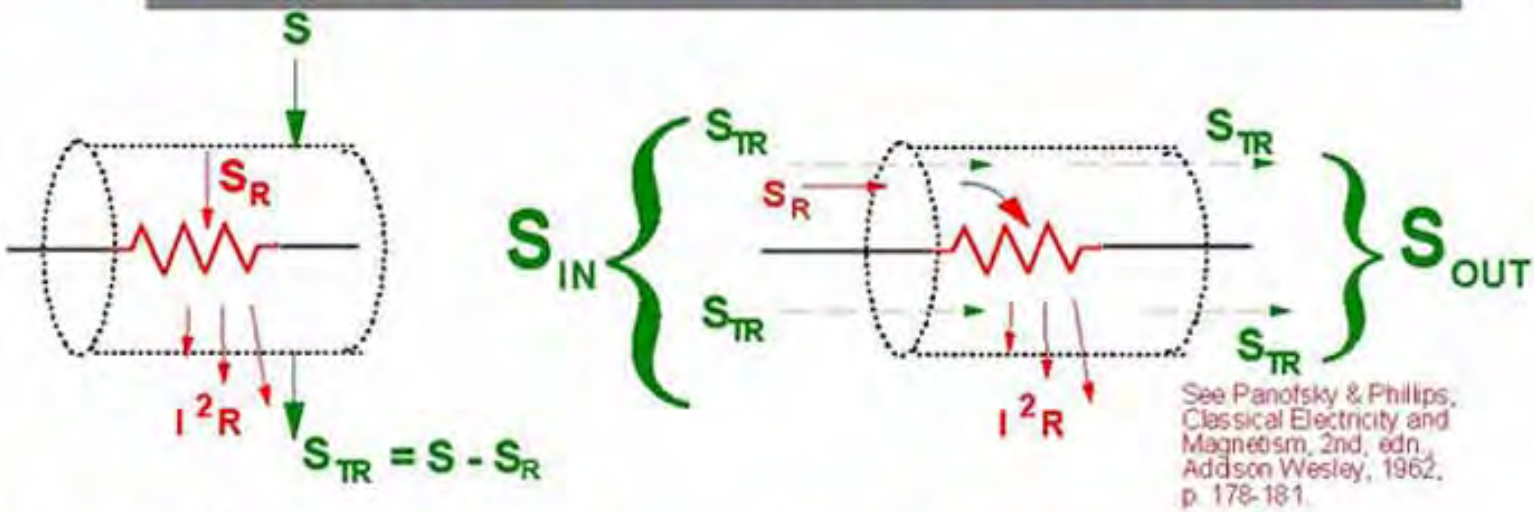

See Panofsky & Phillips, Classical Electricity and Magnetism, 2nd. edn. Addison Wesley, 1962, p. 178-181.

1a. Lorentz surface integration.

1b. Actual S in and S out.

Note: If the S-vector is integrated over the closed surface, then all energy *transport* passage is zeroed, leaving only the very small component of the input S-flow that is powering the joule heating of the resistor. In short, only the small component of the S-flow that is equal in magnitude to the Slepian vector $j\phi$ remains. This measures only the tiny portion of the S-flow that is "collecting" on electrons passing through the resistor, and therefrom being dissipated out of the resistor as joule heating. It discards everything else (all S_{TR}'s and S_{OUT}). S_{IN} becomes S_R.

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Longitudinal EM Photon Interaction with Charge

- Creates time-density wave pumping
- Slowly creates time-density charging

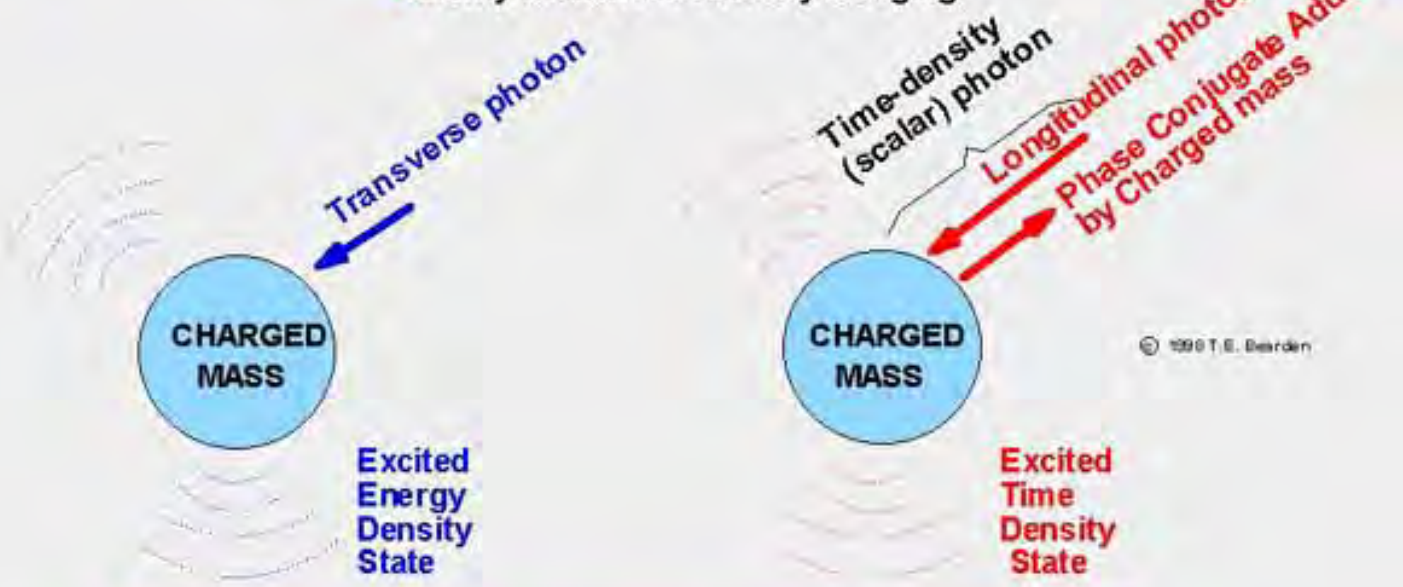

- Fundamental units are arbitrary in physics
- Can express all physics in one unit -- e.g., time
- Time is highly compressed energy
- 1 sec = 9 x 10_{16} joules of transverse EM wave energy

Figure 1-8. Infolded biwave composition of a scalar potential.

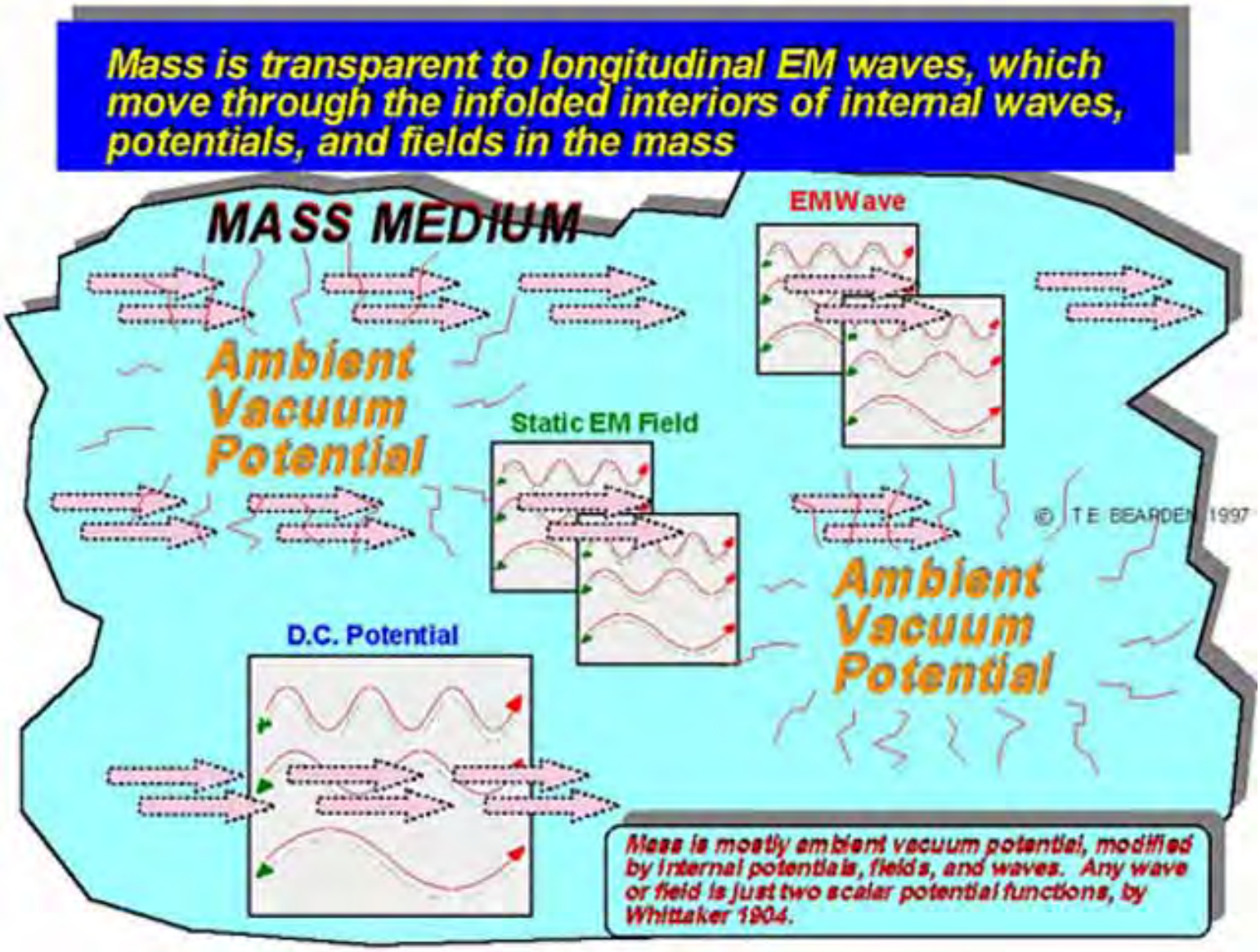

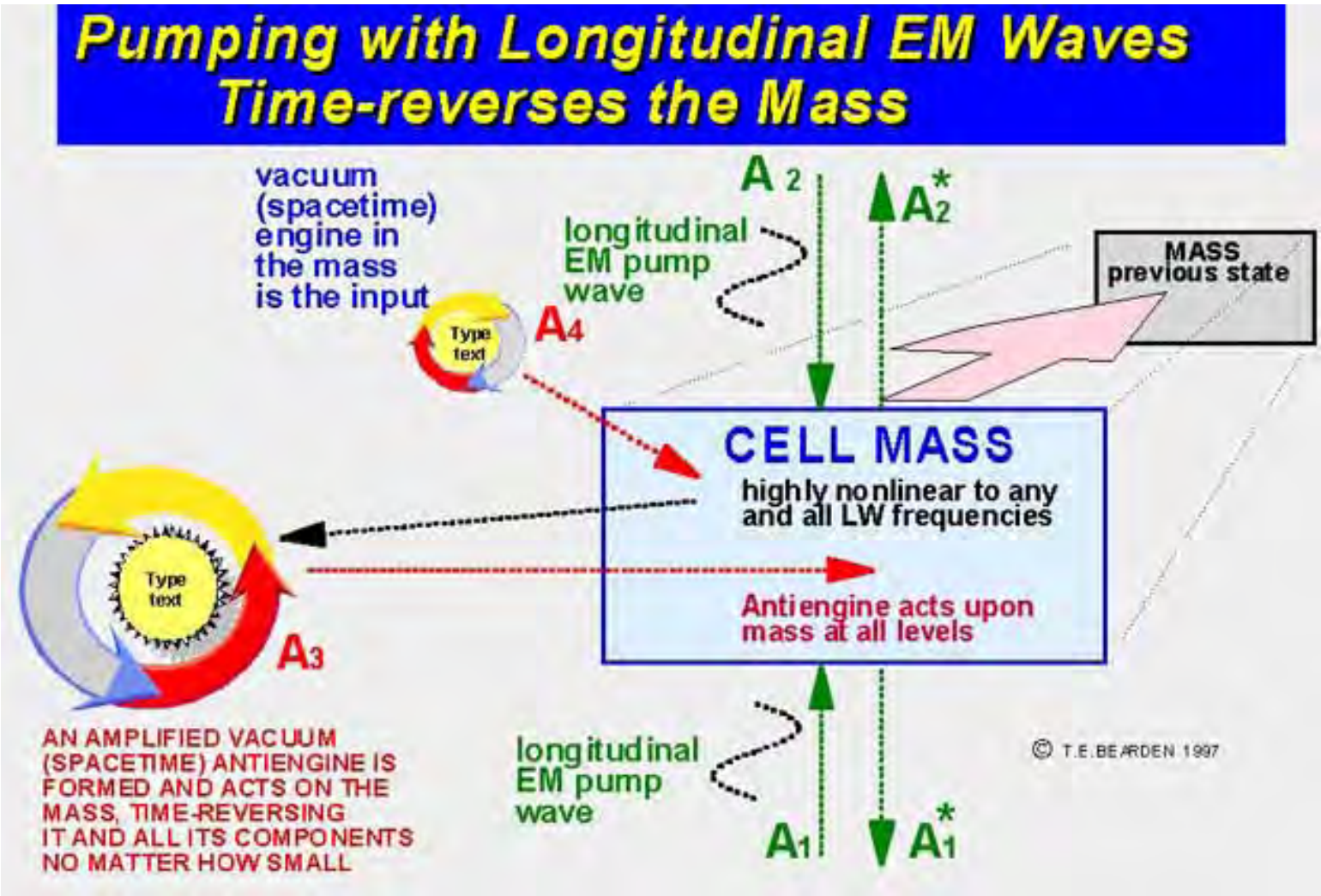
Pumping with Longitudinal EM Waves
Time-reverses the Mass
vacuum (spacetime) engine in the mass is the input
A 2
A*2
longitudinal EM pump wave
MASS previous state
Type text
A4
CELL MASS
highly nonlinear to any and all LW frequencies
Type text
A3
Antiengine acts upon mass at all levels
AN AMPLIFIED VACUUM (SPACETIME) ANTIENGINE IS FORMED AND ACTS ON THE MASS, TIME-REVERSING IT AND ALL ITS COMPONENTS NO MATTER HOW SMALL
longitudinal EM pump wave
© T.E.BEARDEN 1997
A1
A*1

Maxwell's Quaternion Theory

- Quaternions:
  - Discovered by Hamilton in 1843
  - A quaternion has a vector part
  - A quaternion has a scalar part
  - First significant non-arithmetic number system
  - Higher topology than vector or tensor algebra
- Maxwell's theory was in quaternion equations
  - 20 equations in 20 unknowns
  - Reduced to a small 4-equation subset by Heaviside and Gibbs
  - EM topology dramatically reduced

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Maxwellian Systems

Before regauging, after symmetrical regauging, and after asymmetrical regauging

Note: Any system must first break equilibrium in its vacuum exchange, before it can energize Drude electrons and "power" the load. Asymmetric regauging is always utilized. Powering loads and losses is a symmetry-restoring operation.

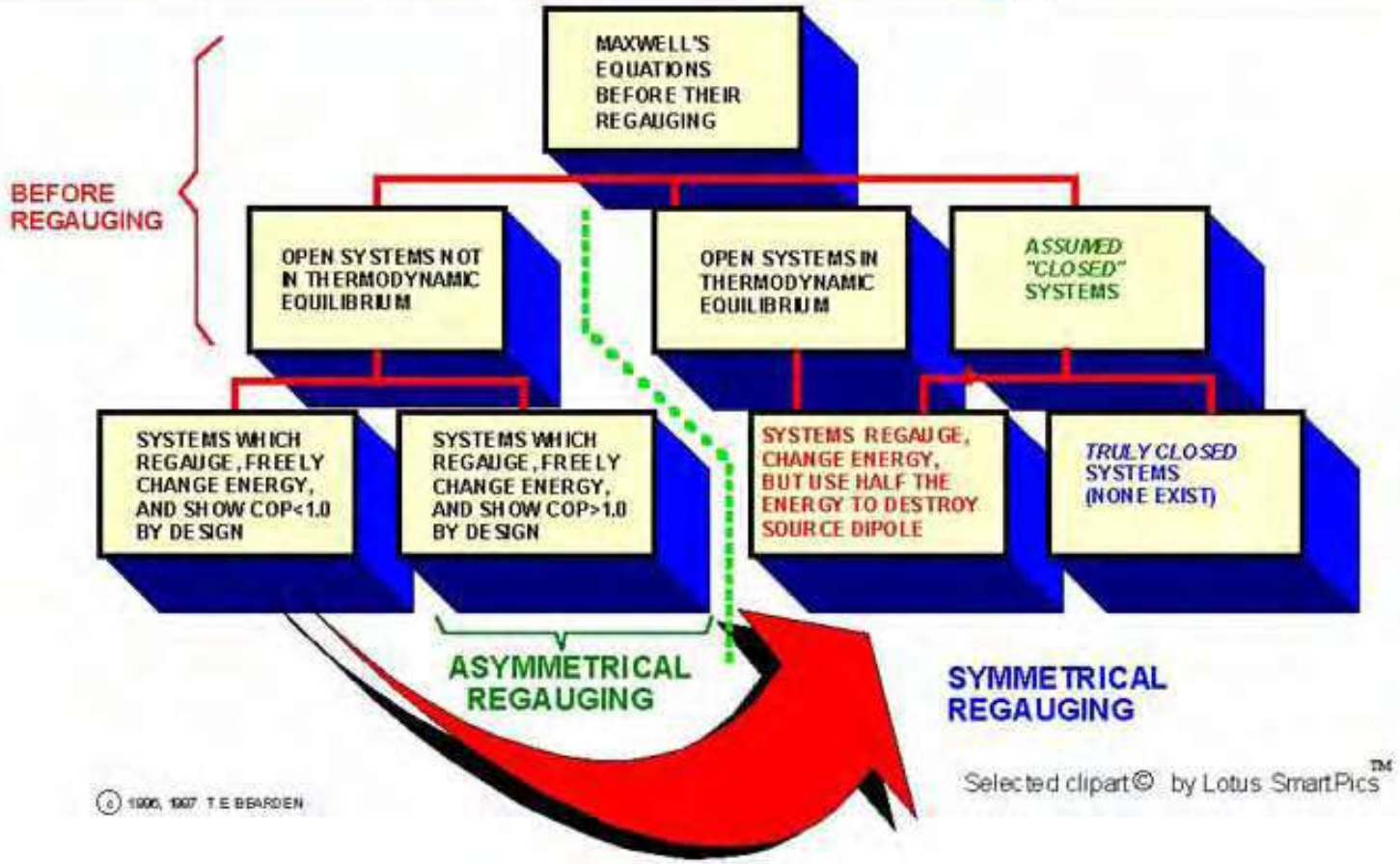

Maxwell's four equations reduce to:

$$\nabla^2 \Phi + \frac{1}{c}\frac{\partial}{\partial}(\nabla \bullet A) = -4\pi\rho \qquad [1]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} - \nabla(\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t}) = -\frac{4p}{c}J \qquad [2]$$

A is replaced by A', where

$$A' = A + \nabla\Lambda \qquad [3]$$

The new B' field then becomes

$$B' = \nabla \times (A + \nabla\Lambda) = \nabla \times A + 0 = \nabla \times A = B \qquad [4]$$

A new E-field will also be formed. So let

$$\Phi' = \Phi - \frac{1}{c}\frac{\partial \Lambda}{\partial t} \qquad [5]$$

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Per Jackson, (A,Φ) are *habitually* chosen so that

$$\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t} = 0 \qquad [6]$$

The *net symmetrical* regauging separates variables. Two inhomogeneous wave equations result:

$$\nabla^2 \Phi - \frac{1}{c^2}\frac{\partial^2 \Phi}{\partial t^2} = -4\pi\rho \qquad [7]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} = -\frac{4\pi}{c} J \qquad [8]$$

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Equations [1] and [2] *arbitrarily* changed to [7] and [8]

The Tom Bearden Website

Life Systems
Toward the Beginning of the End

---

1. Toward the Beginning of the End: Capstone Presentations
2. Toward the Beginning of the End
3. Biospheric Evolution
4. A Living Biological System
5. The Evolutionary Path of Multicellular Organisms
6. To Paraphrase Churchill
7. Directed Evolution: Mechanism for Species Reactive Adaptation
8. Earth's Poynting Energy Flow
9. The Immune System
10. Mind and Matter Interaction
11. Levels of Consciousness and Unconsciousness
12. Access to Mind, Memory and Thought
13. US Intelligence Statement on Soviet Psi Research
14. Mind and Matter Interaction
15. Conscious and Unconscious Minds
16. Velocity is Rotation
17. Species Reactive Adaptation: Directed Evolution
18. Technology's Goal
19. Technology's End
20. Technological Species' Problems

The Tom Bearden Website

Briefings

One of Tom's first public lectures: World Futures Society 1982
Other panelists included James Beale, Carol Rosin, Barbara Marx Hubbard and Glenn Doman

---

The "Porthole" Concept
Extension of the Priore Method of Healing as applicable to the treatment of biological warfare effects and cellular afflictions such as cancers, AIDS etc.
NEW

Hubbert's Peak: The Impending Oil Crisis, by Professor Kenneth S. Deffeyes
Book Review and Slides

A National Report on America's Energy Crisis
by Energy Secretary Spencer Abraham - March 19, 2001

Commentary and Slide Show (66) by Tom Bearden

A Visual Tour of what they don't want you to know about electrical circuits
10 Trillion Percent of the Current Produced is Wasted!

Weapons Slides

The Missing Infolded Electrodynamics
85 slides

A Brief Technical Background to the Extended Priore Healing Methodology
11 slides

Briefing sent by Tom Bearden to Defense Department, National Institute of Health, USAF, National Science Foundation etc. re extended and improved Priore Treatment to counter mass casualties from Biological Warfare

- Letter to DHHS re adoption of Priore technology
  24 June, 1998
- Letter to NIH re adoption of Priore technology
  12 May, 1998

Towards the Beginning of the End - Lecture in Florida for Capstone Presentations, Sept. 1998

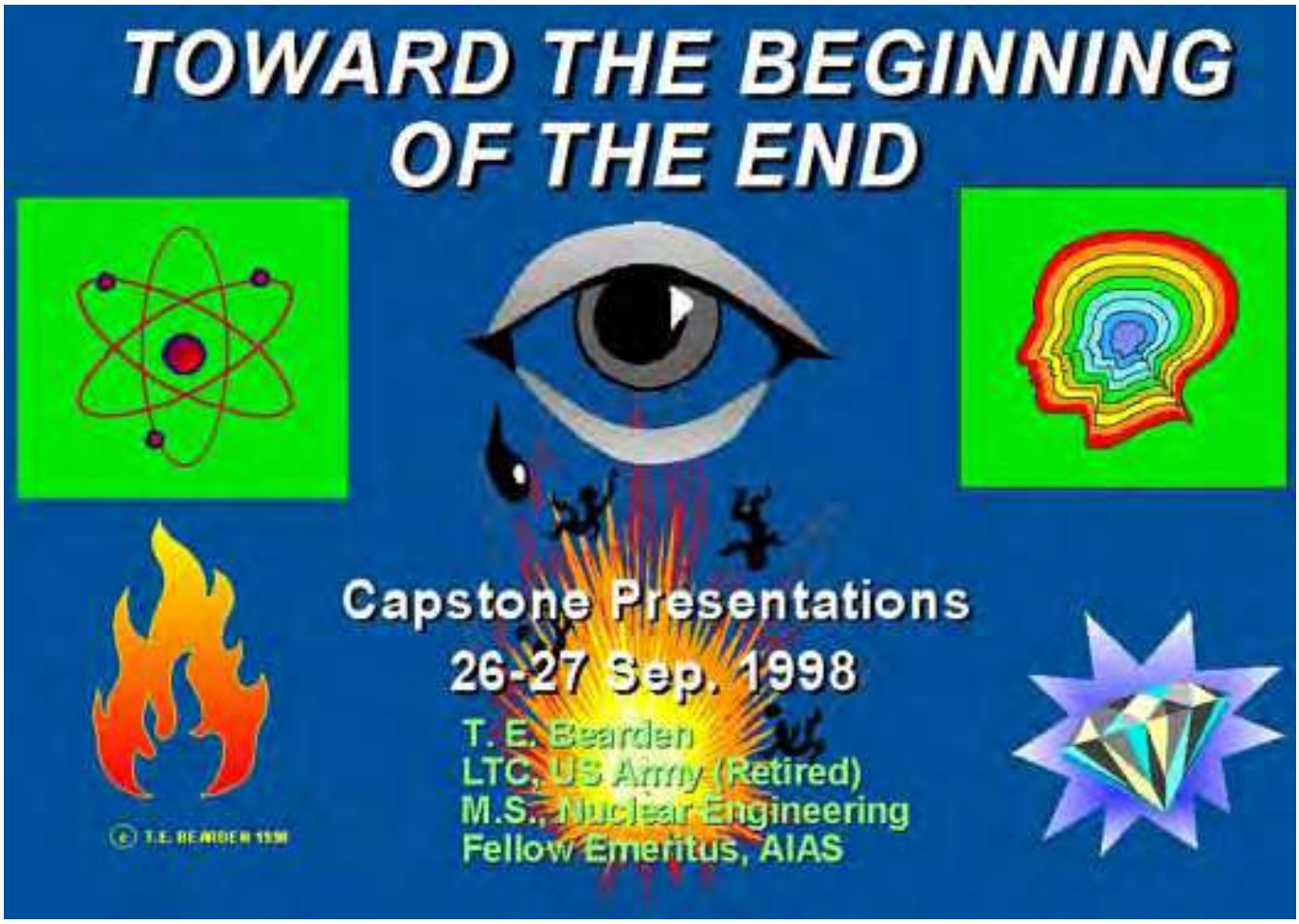

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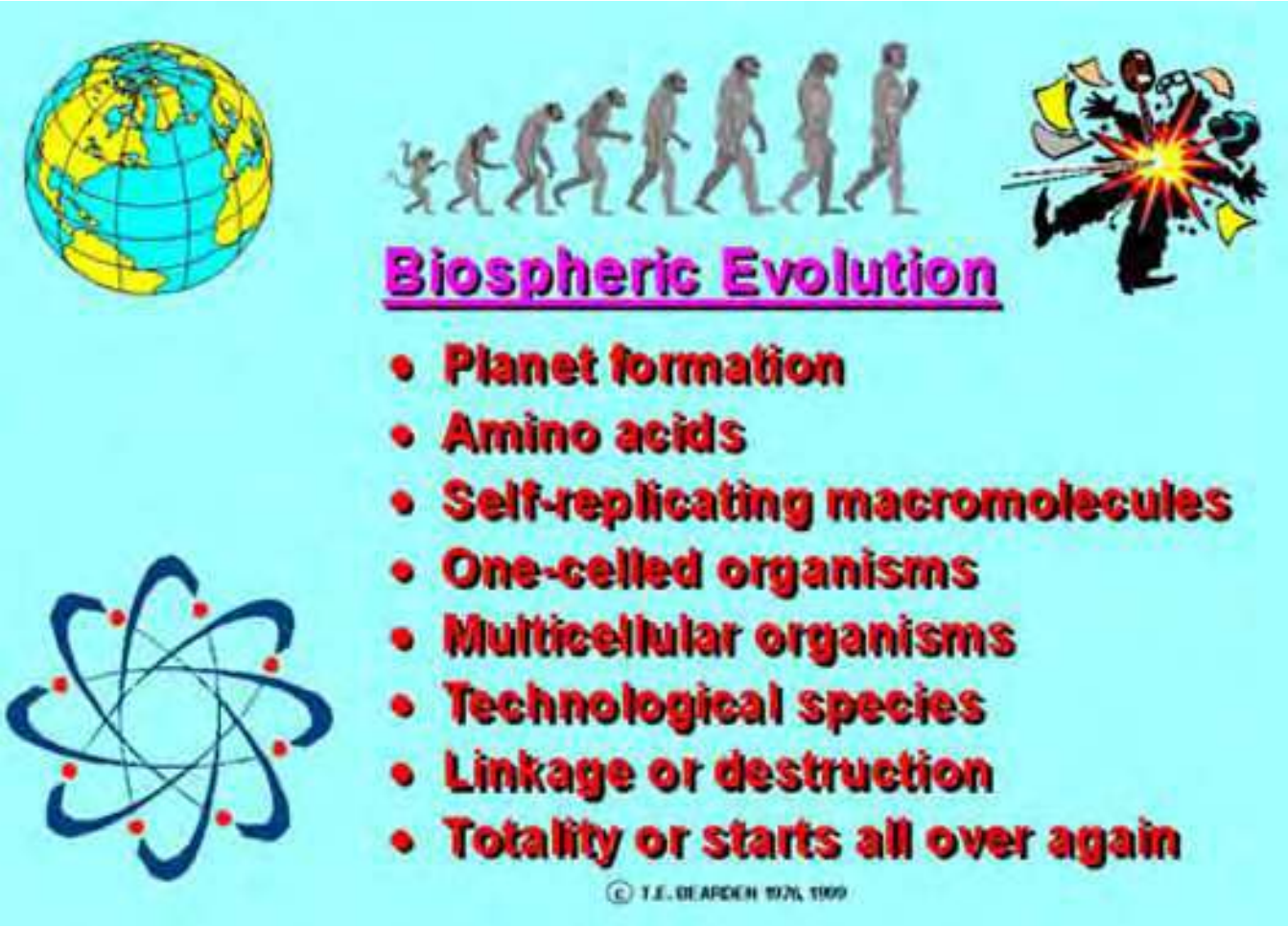

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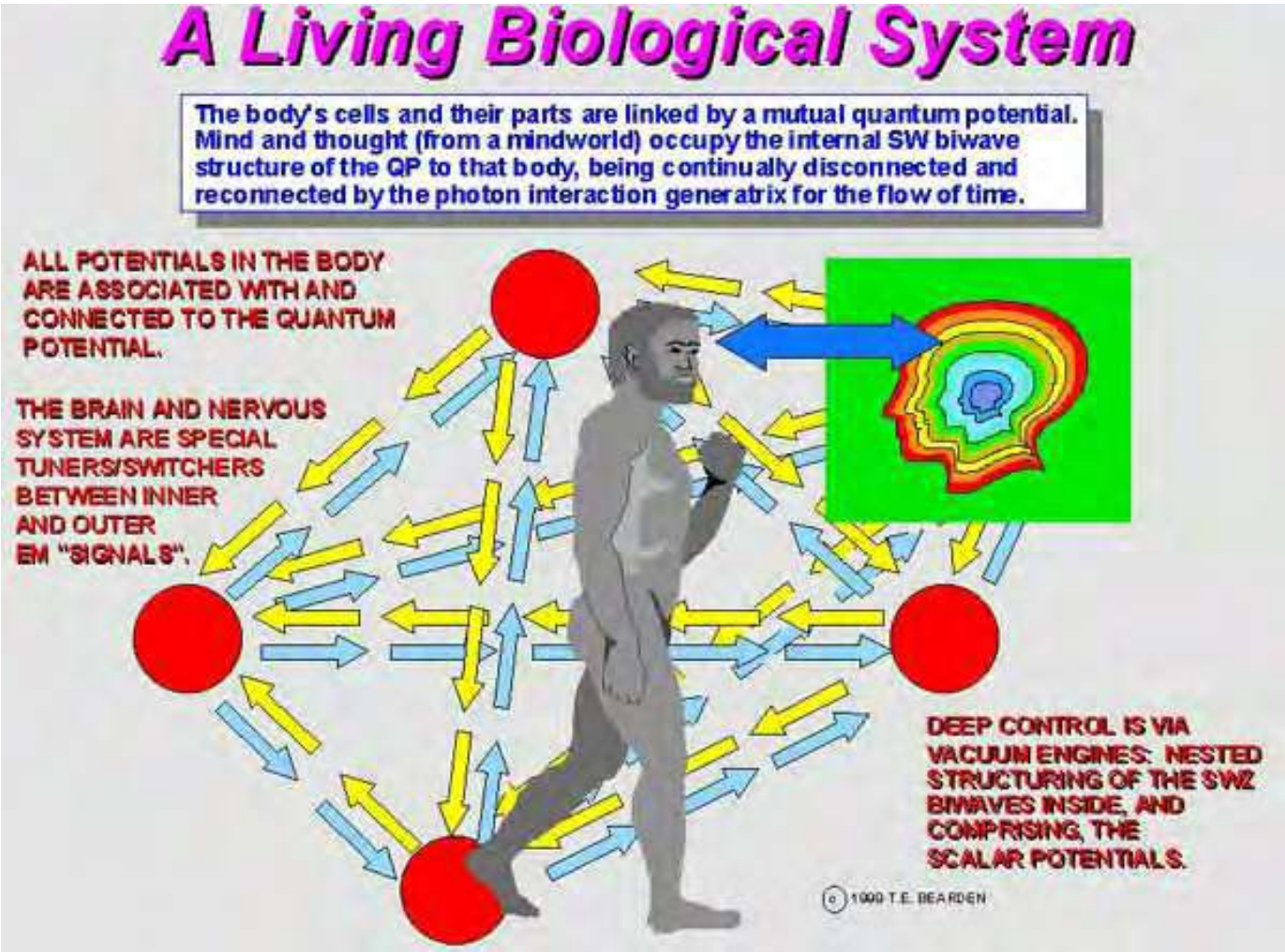

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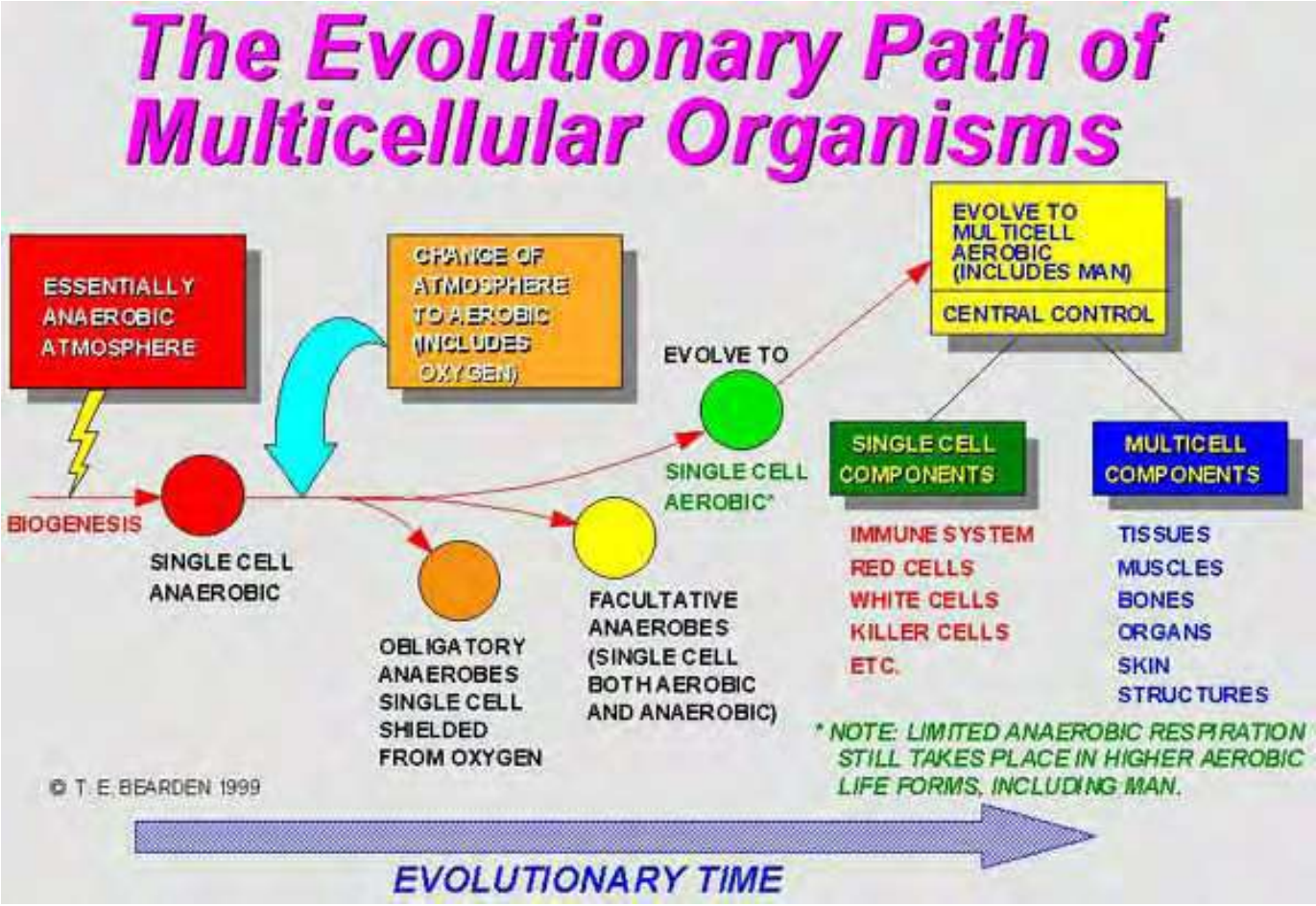

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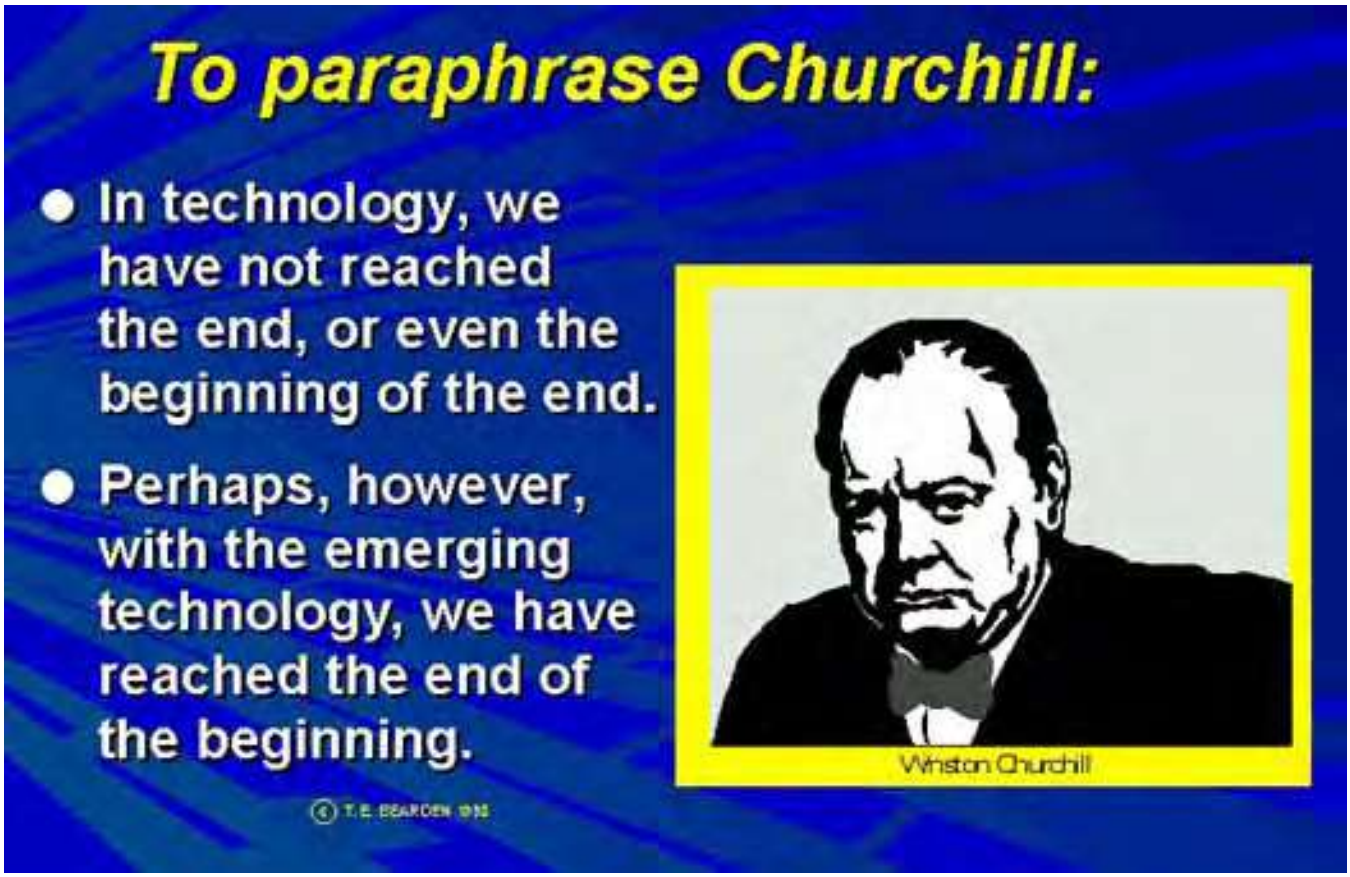

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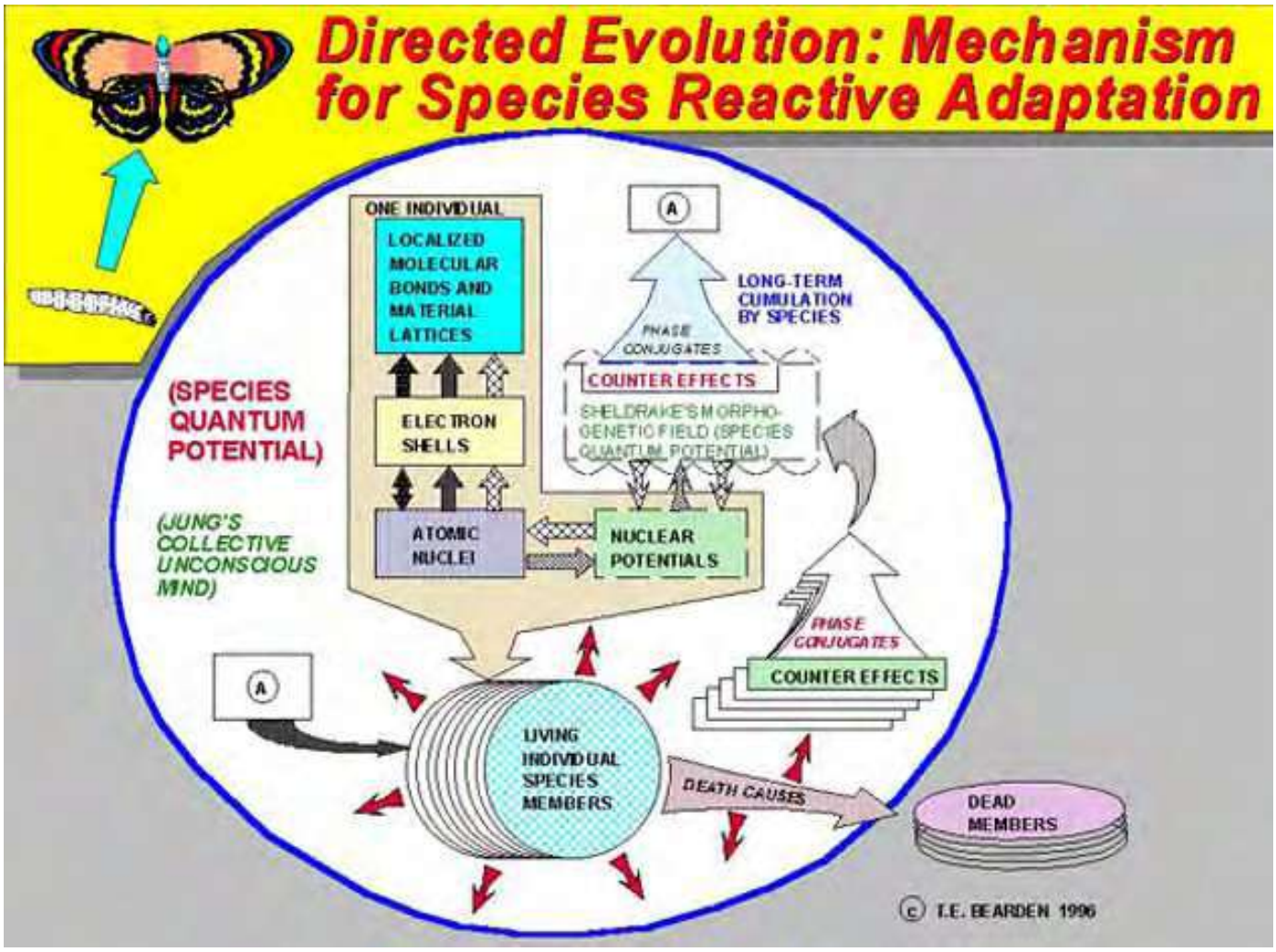

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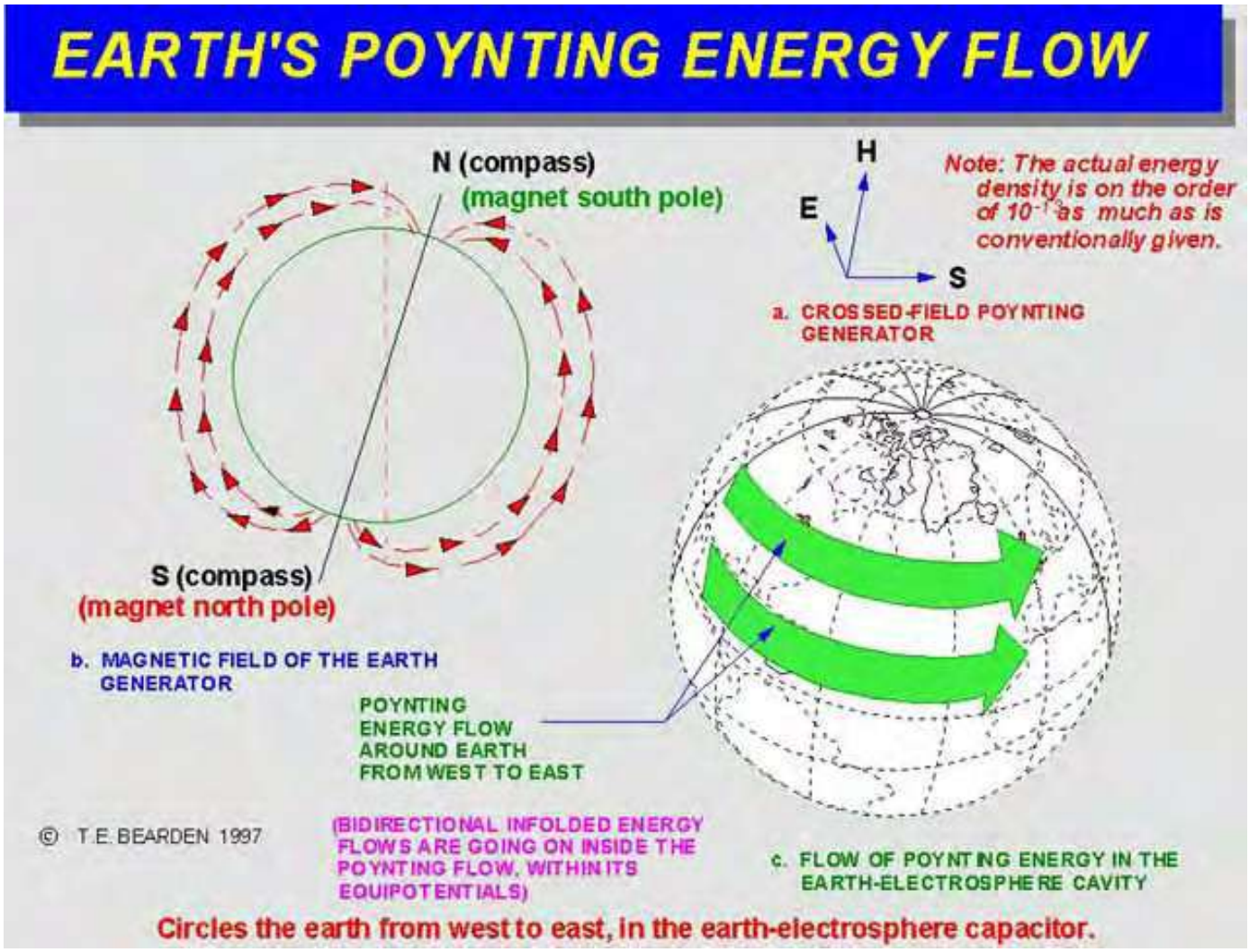

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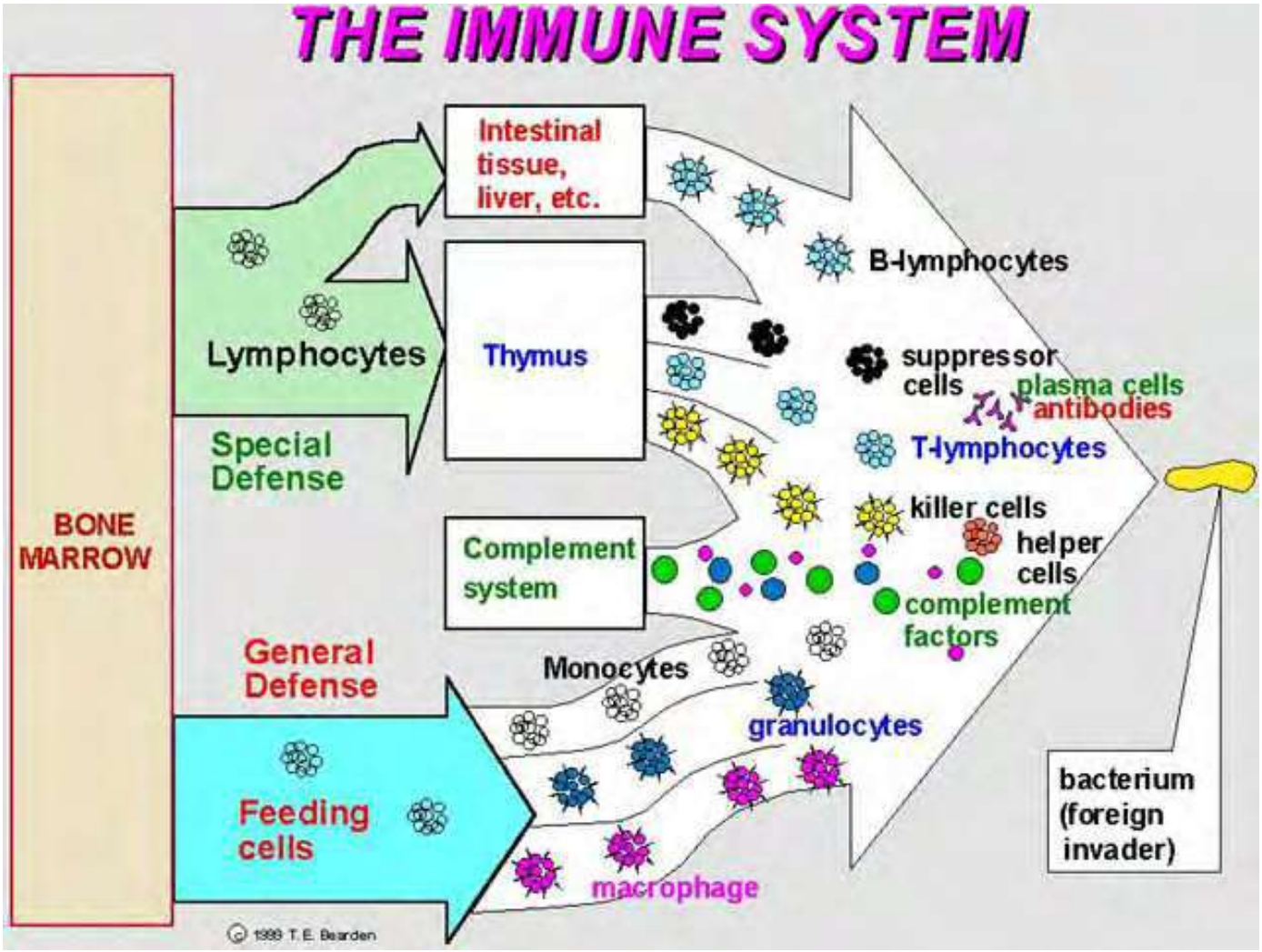

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Mind and Matter Interaction

- Living systems: matter, mind, life, death, time
- Function of the extended quantum potential
- Nature of conscious and unconscious mind
- Gaia and collective species unconscious mind
- EM topology vs. mind and matter interactions
- Paranormal phenomena: Mechanisms
- Unsuspected EM effects on biological systems
- Recovery system: Use of scalar "internal" EM
- Vacuum engines, death rays, and healing rays
- Priore's scalar EM therapeutic method
- Resolution of the fundamental technological species problem: The Lady or the Tiger?

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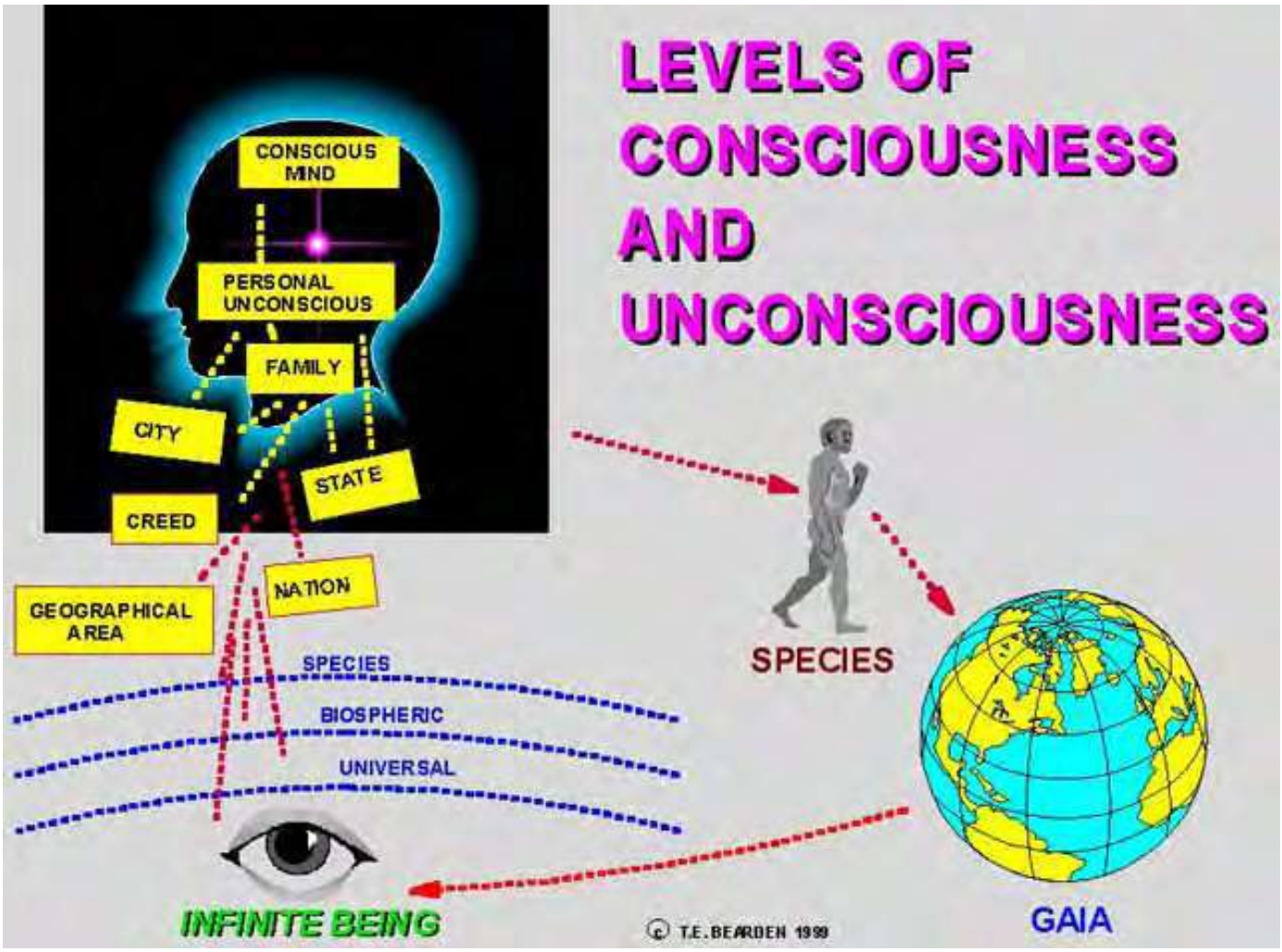

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Access to Mind, Memory, and Thought

- Internal Whittaker channels in Body
- Used for master control functions
  - Mind, memory, thought
  - Master cellular control
  - Immune system
  - Regenerative system
- Dynamics infolded inside longitidinal EM biwave structure of scalar potentials
- Gives access to mind and control software

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U.S. Intelligence Statement on Soviet Psi Research*

- Sooner or later, Soviets may be able to
  - Know:
    - Contents of documents
    - Troop and ship movements
    - Installation locations and nature
  - Mold thoughts at a distance
  - Disable equipment at a distance
  - Kill persons at a distance
- *Comment: Soviet psychoenergetics is a physics, not Western parapsychology. Much of this capability now exists and has been weaponized in action-at-a-distance weapons.*

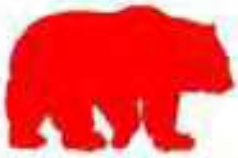

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*Controlled Offensive Behavior - USSR (U)
DIA Report ST-CS-01-169-72, July 1972

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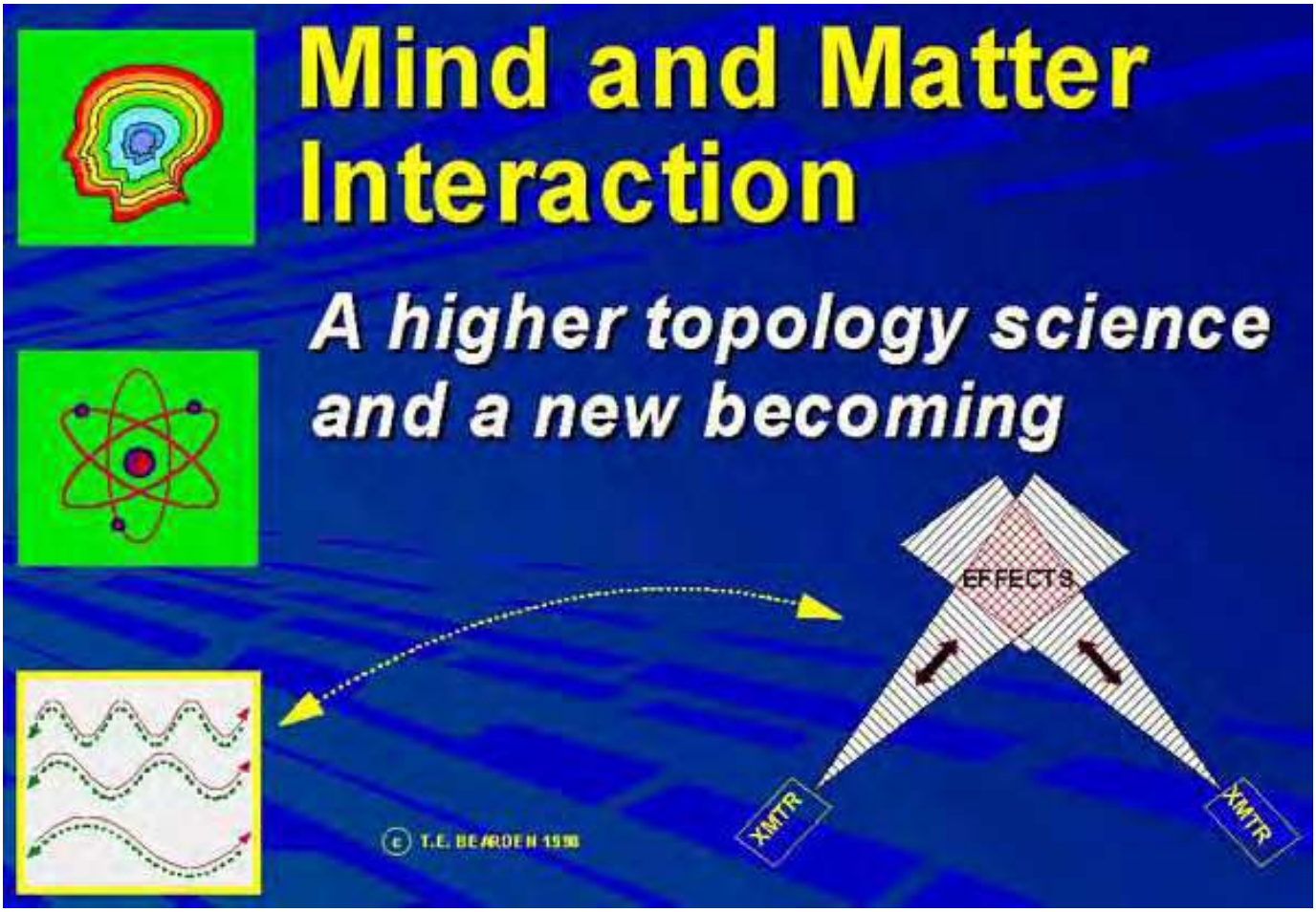

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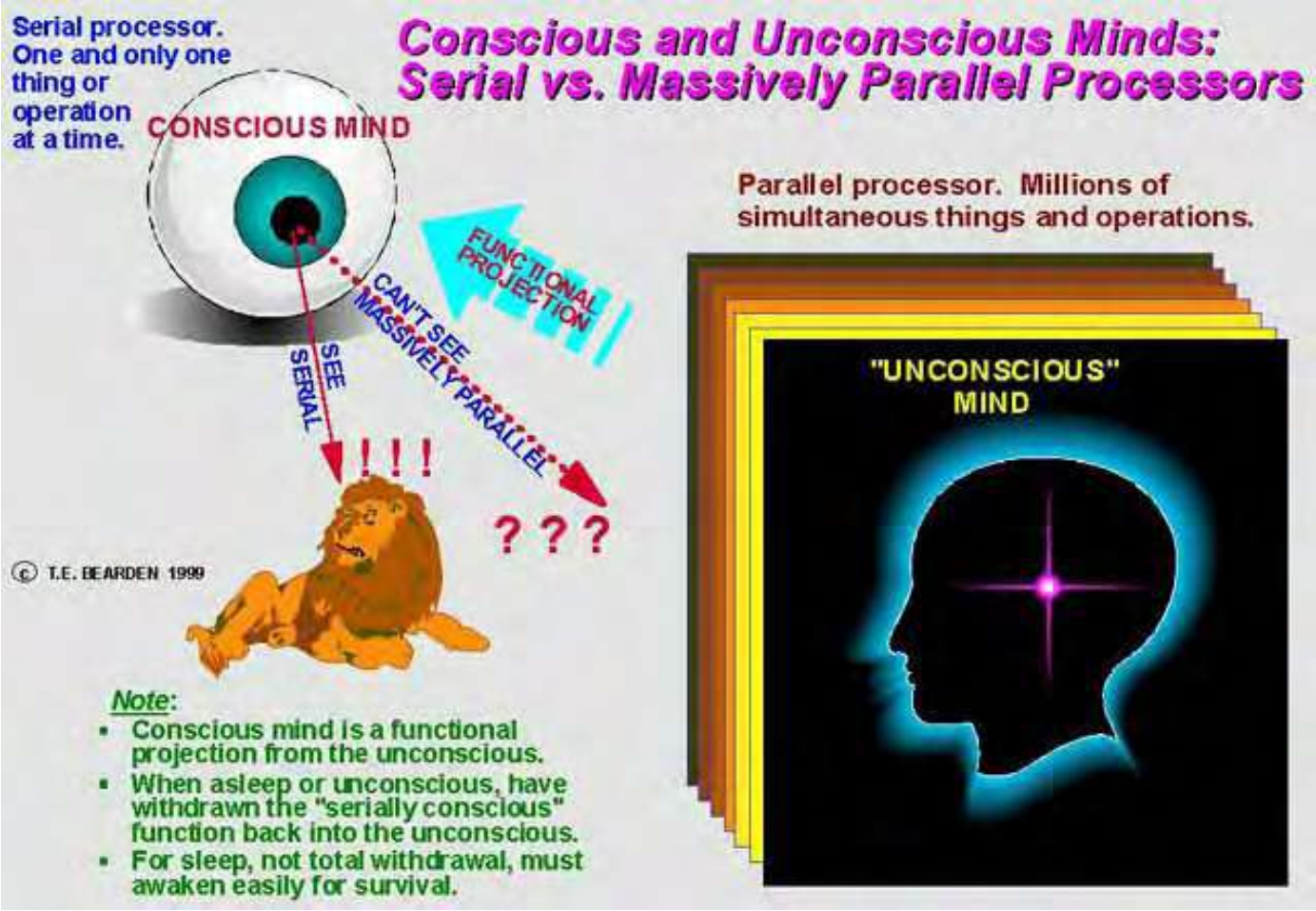

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Velocity Is Rotation

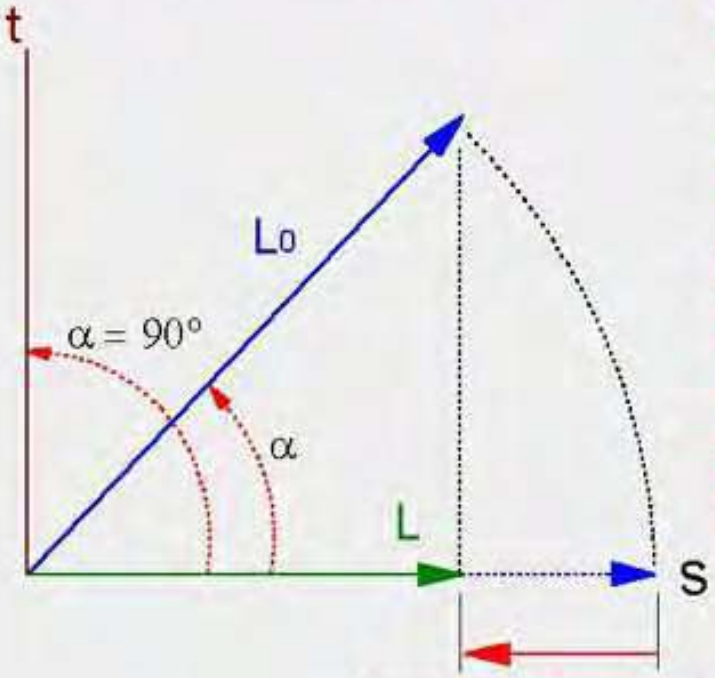

An object moving with velocity v < c has rotated slightly out of 3-space toward the time dimension. It's "projection" back into 3-space is shorter, providing the Lorentz-Fitzgerald contraction.

When velocity v = c, a full right-angle turn has been made, and the object has "lost" its projection along its direction of motion. Hence it appears as a 2-dimensional plane moving at the speed of light; in short, a photon or a light wave.

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Lorentz-Fitzgerald Contraction

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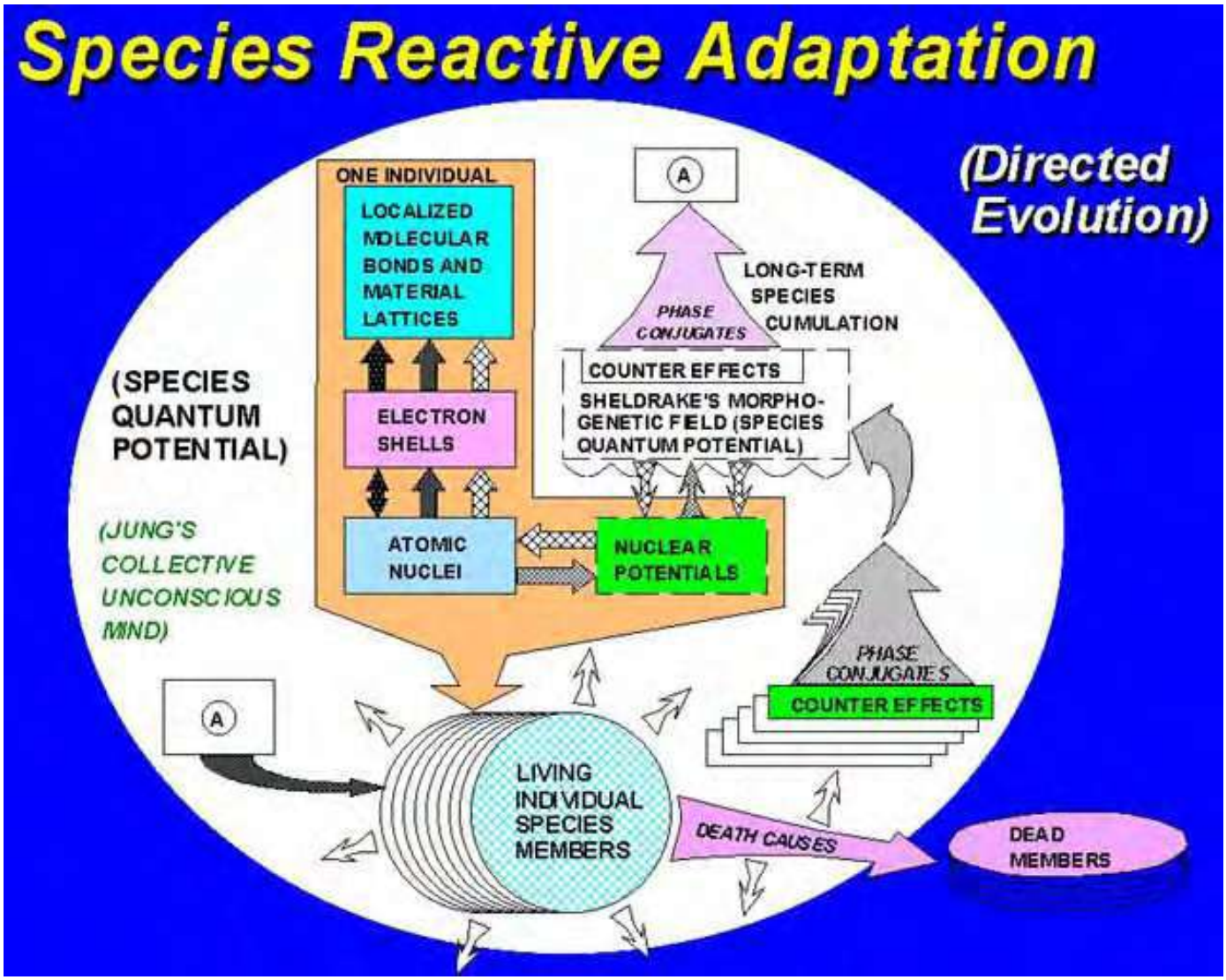

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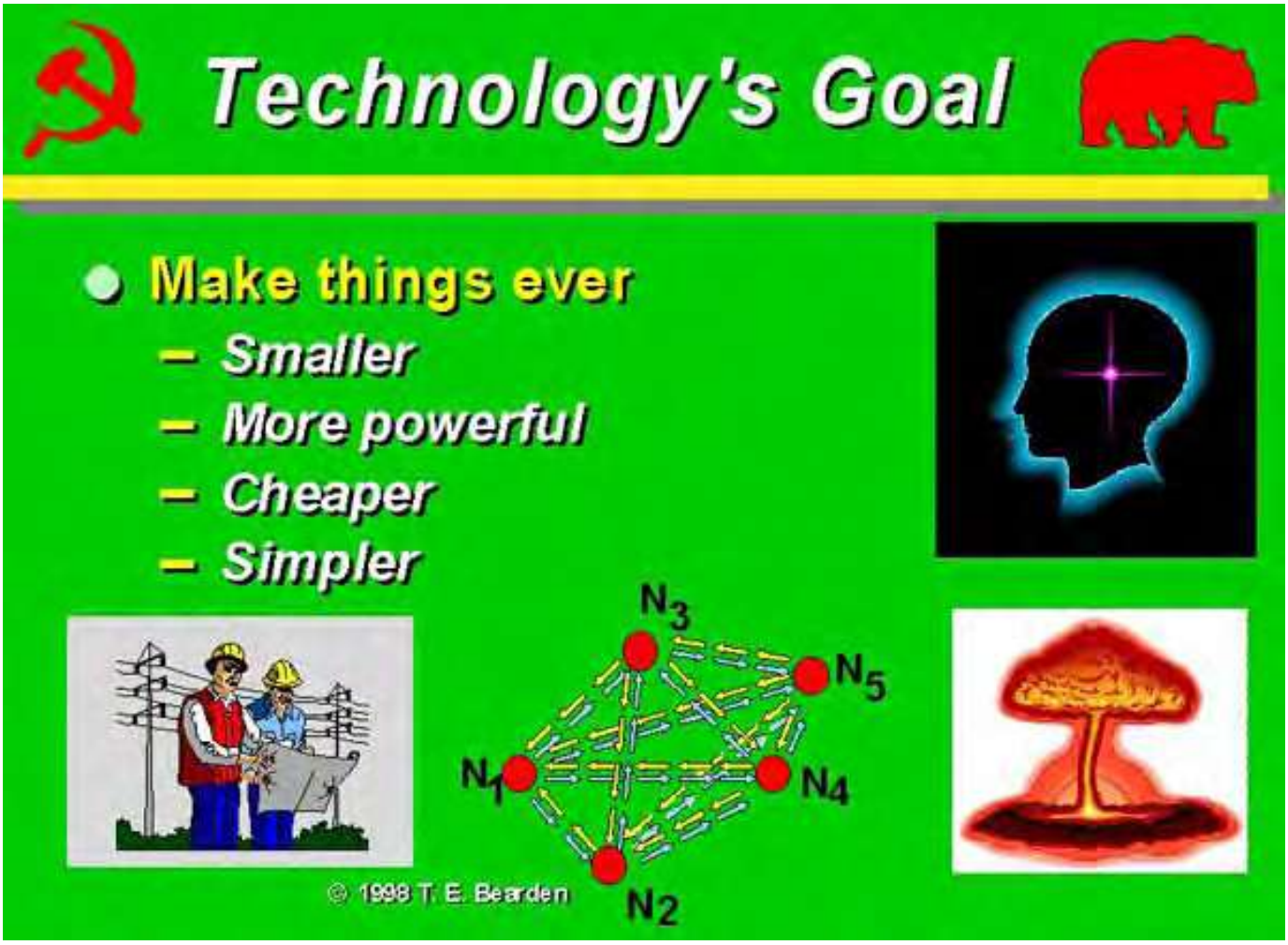

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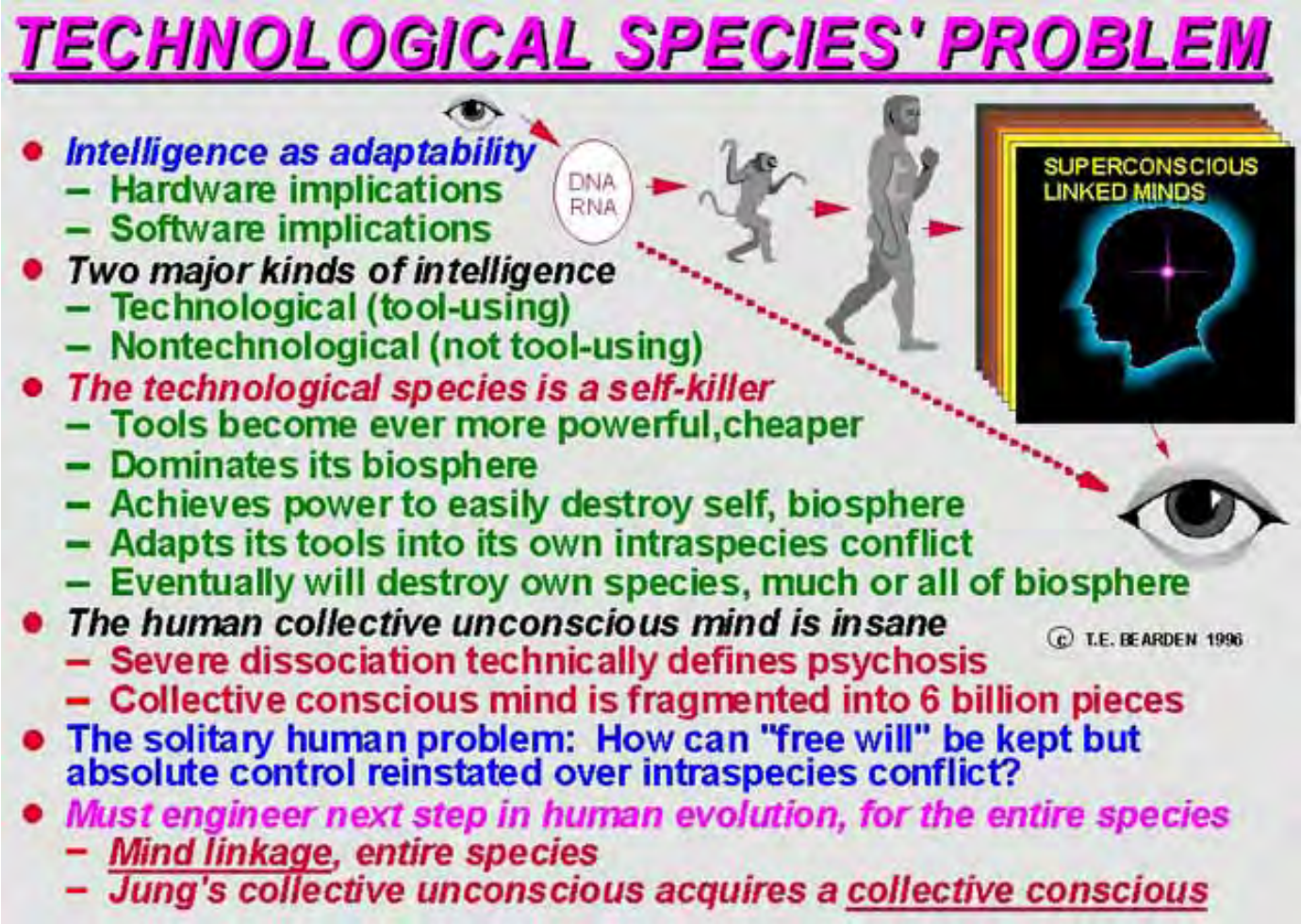

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The Missing Infolded Electro-dynamics

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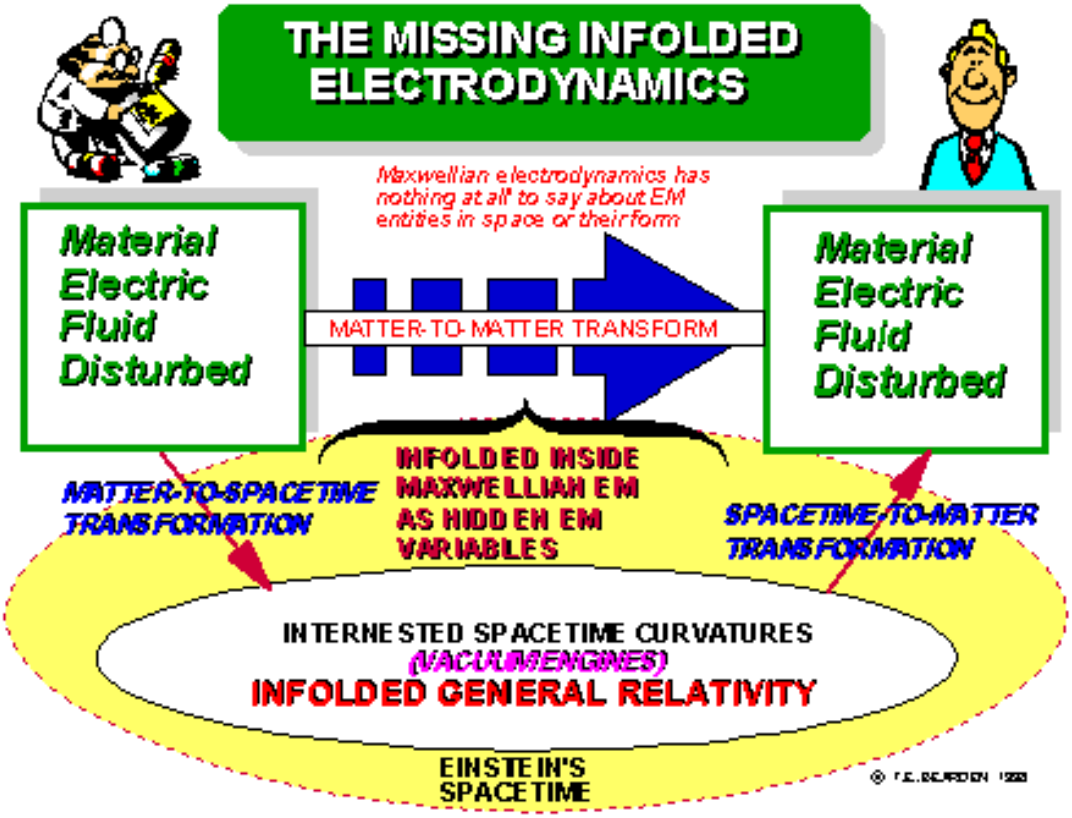

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Major Points of Presentation

- Electrodynamic is seriously flawed
  - Some major flaws
  - Corrections indicated
- Why past corrective attempts failed
  - Force field concept is material
  - Missing two infolded transforms (M->ST; ST->M)
- Missing Infolded general relativity inside electrodynamics
- Several Kinds of EM Waves in Space
  - How to make
  - Transduction
- A French medical example as a deep experimental demonstration
  - Spectacular regenerative cures funded by French Govt
  - Not comprehended, therefore suppressed
- Cold Fusion examples of time-density wave effects
  - China Lake instrumental anomalies in electrolysis
  - Explanation of anomalous behavior of instruments
  - Explanation of new nuclear reactions
  - Wave energy transduction provides excess heat
- Urge theorists to consider dramatically new reactions

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- Cold Fusion time-density wave effects
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MTW's General Relativity Principle

- "Space acts on matter, telling it how to move.
- In turn, matter reacts back on space, telling it how to curve."

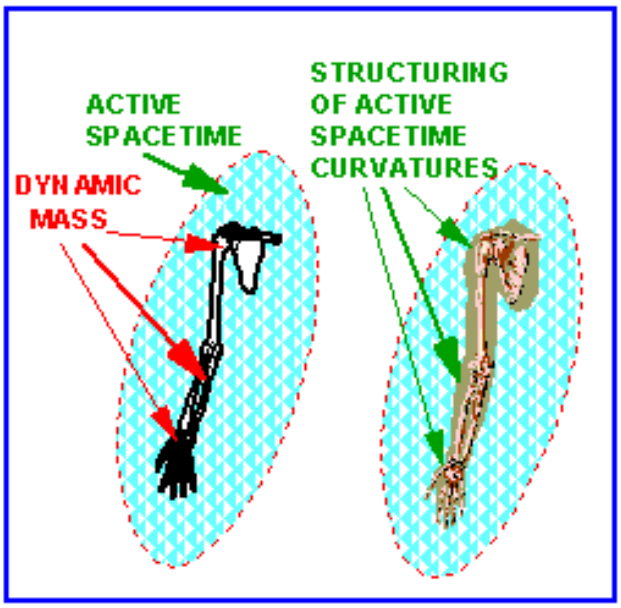

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Extended General Relativity Principle

- "All levels of energy structures and all levels of time structures mold spacetime geometry.
- This is called a *vacuum engine* (spacetime engine).
- Spatial and temporal structuring act upon mass at all levels.
- This produces *templates* of forces, for translations and stresses."

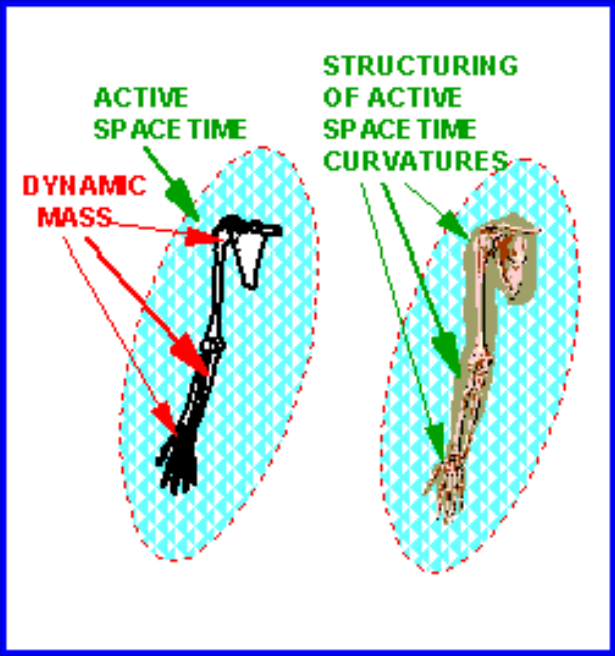

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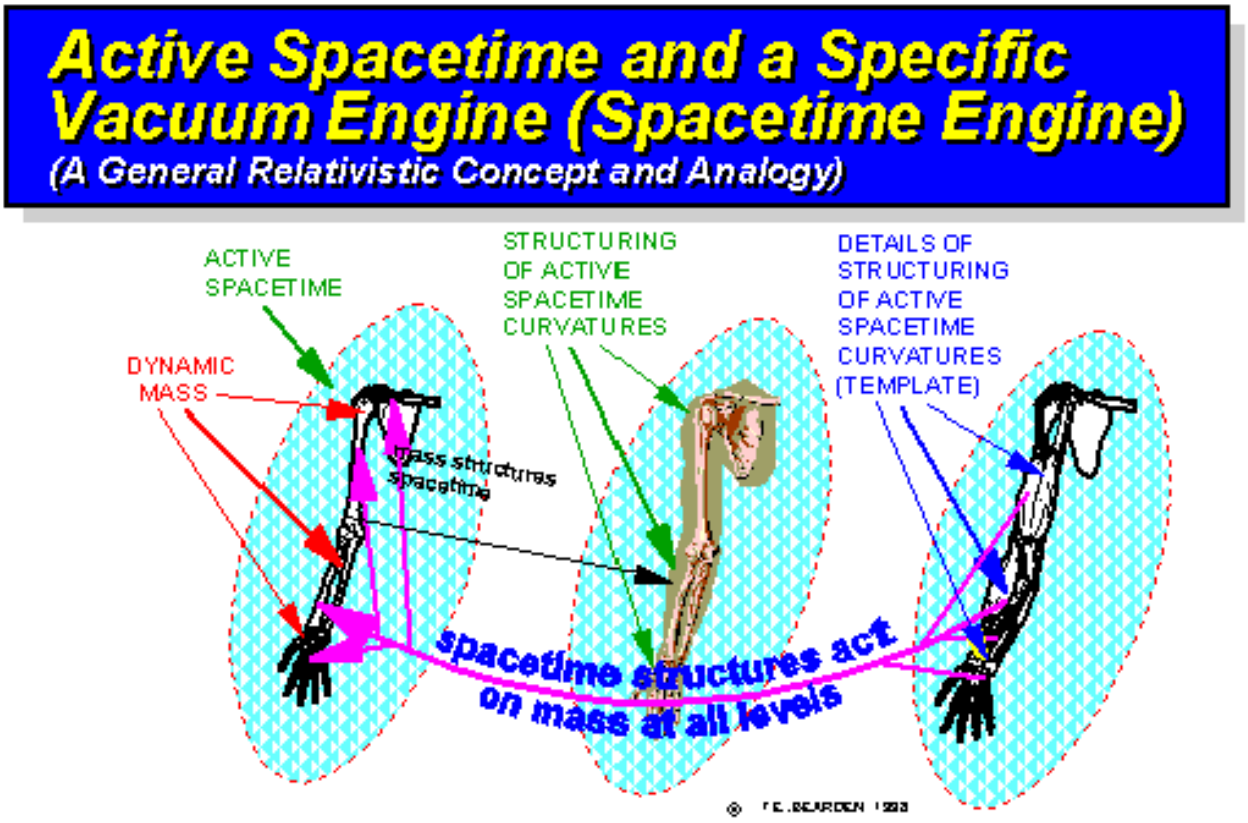

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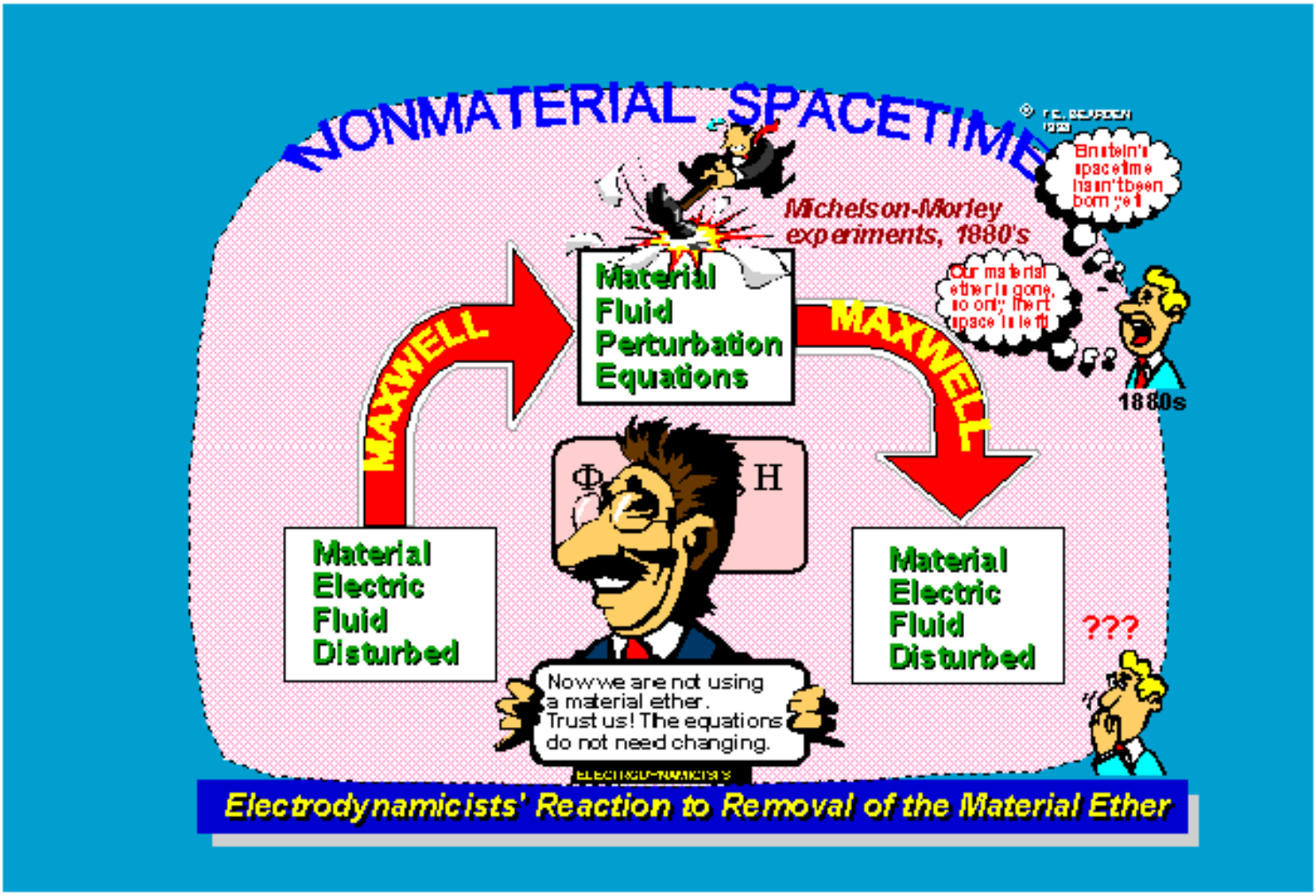

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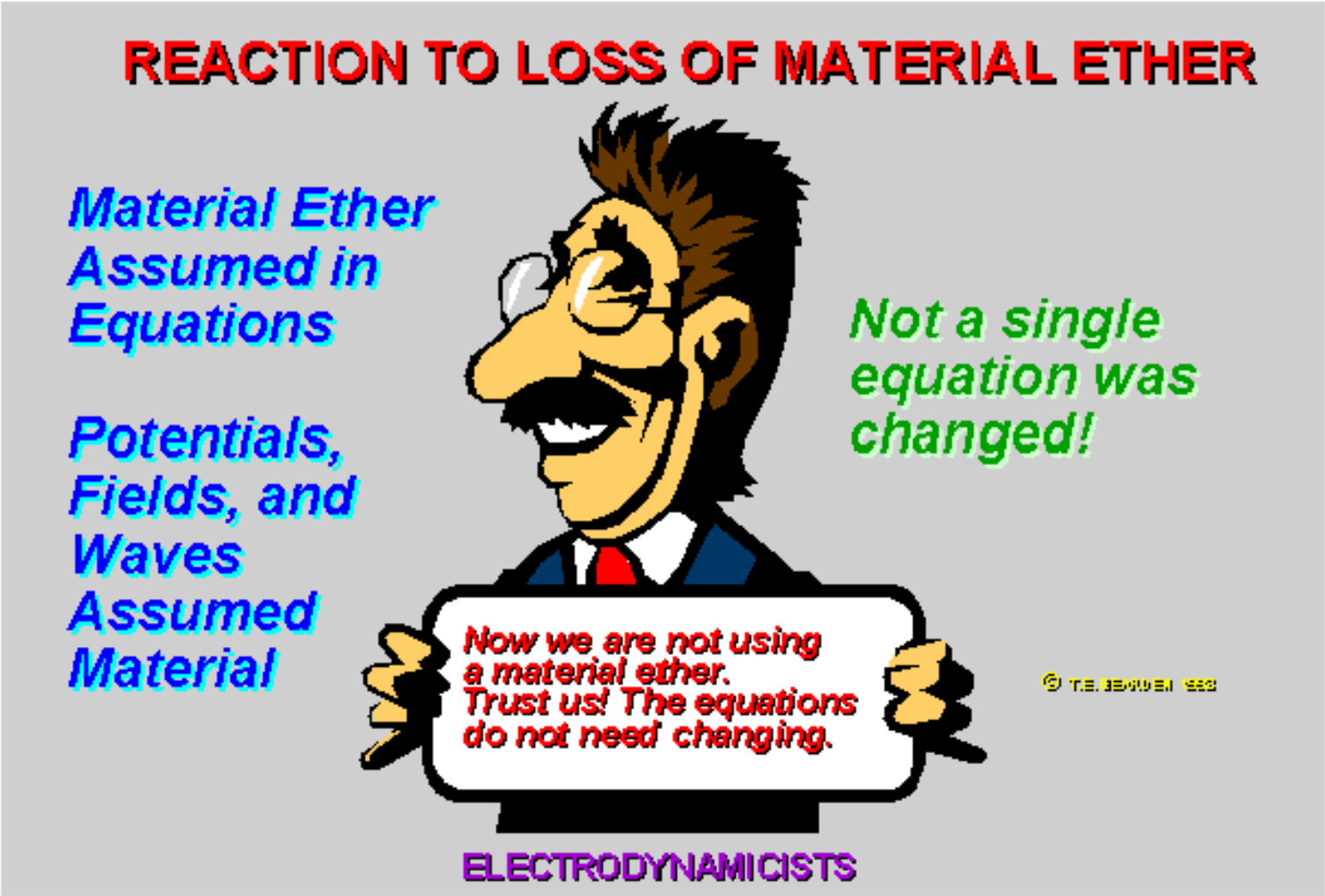

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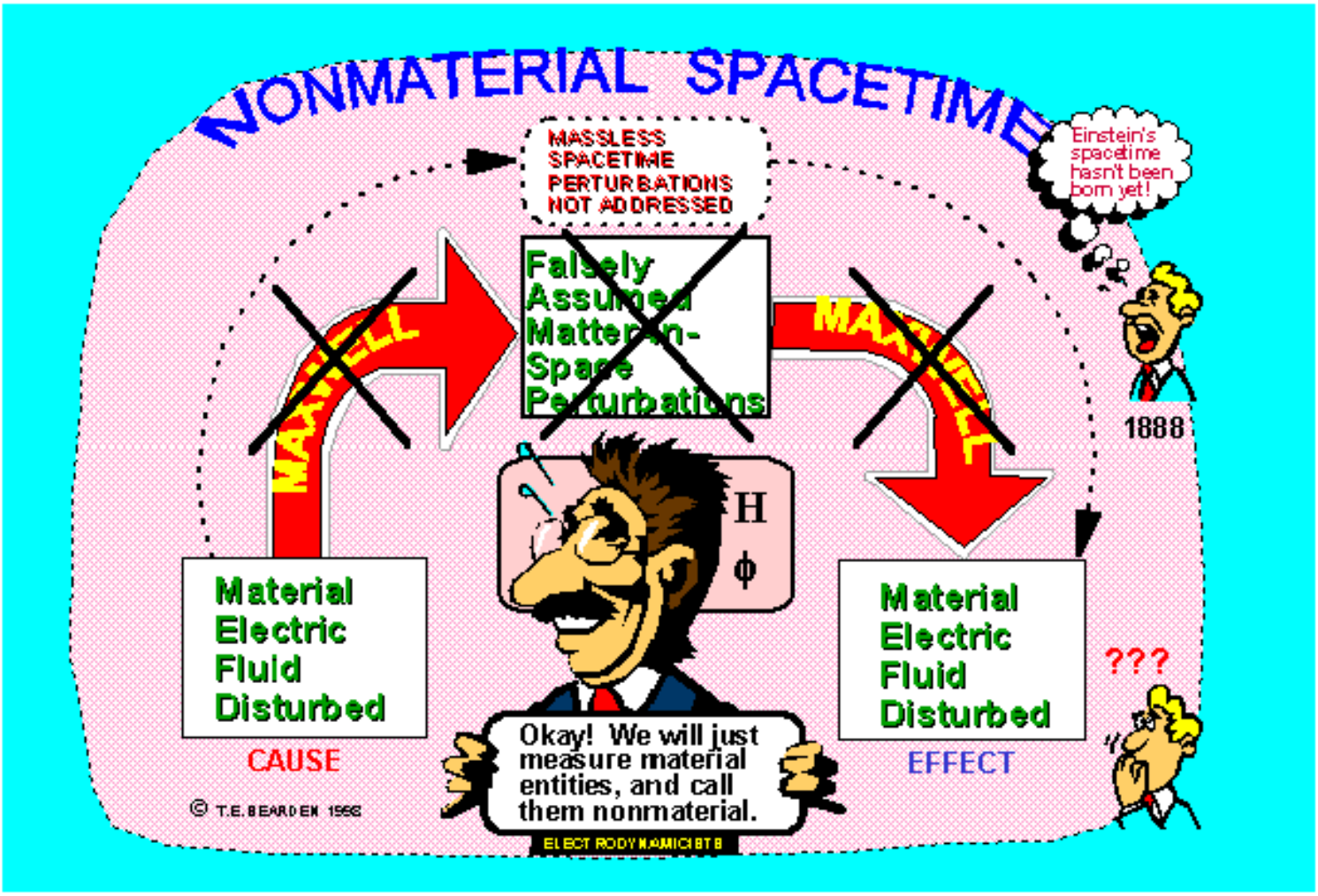

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Bunge on the Status of Electrodynamics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state..."

"... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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Bunge on the Status of Electrodynamics and Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state...

"... neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

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*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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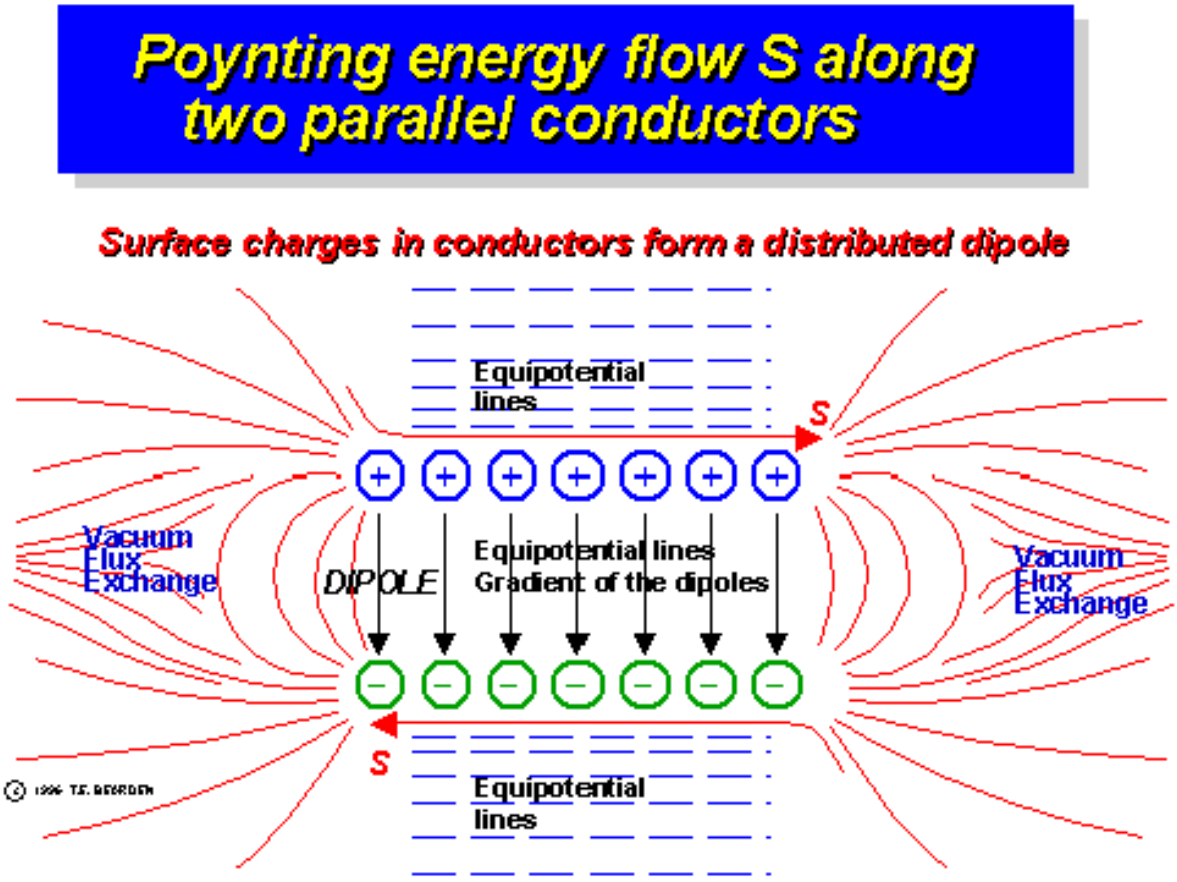

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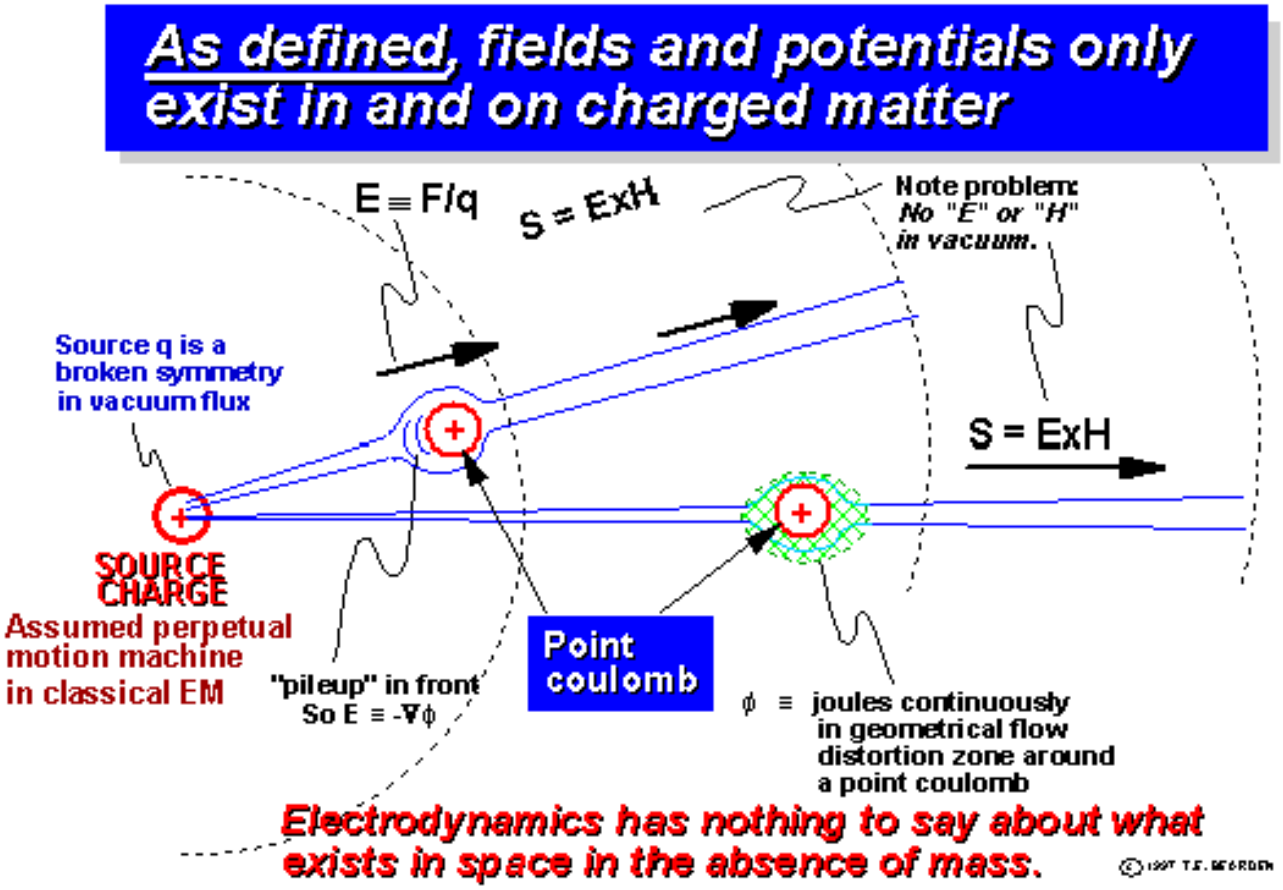

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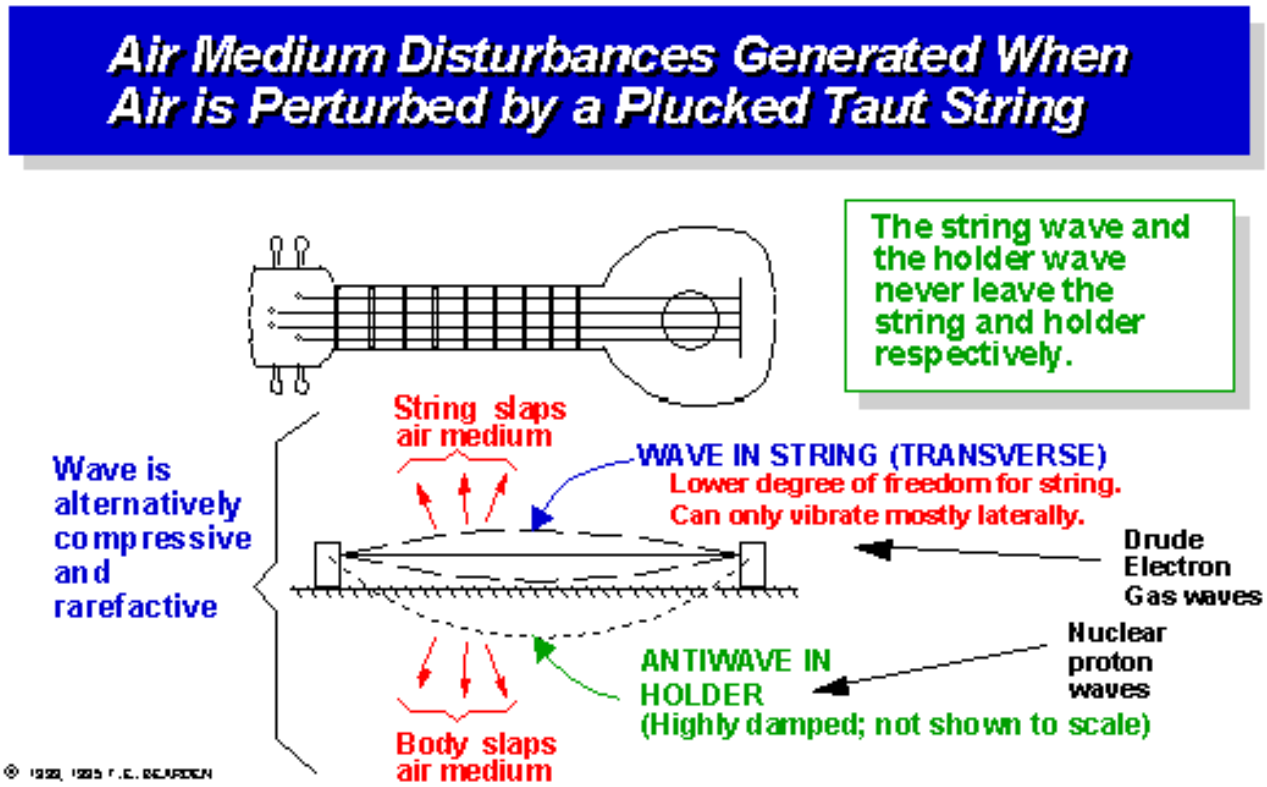

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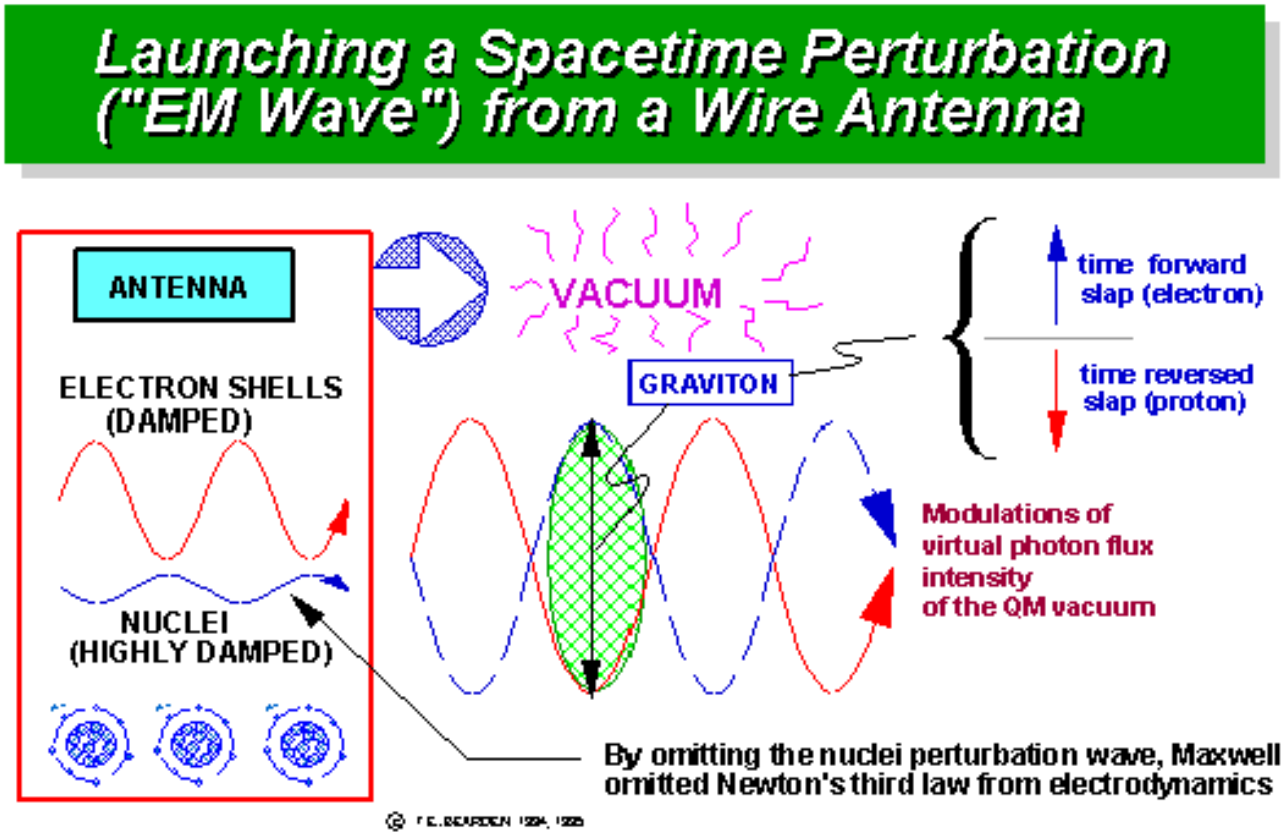

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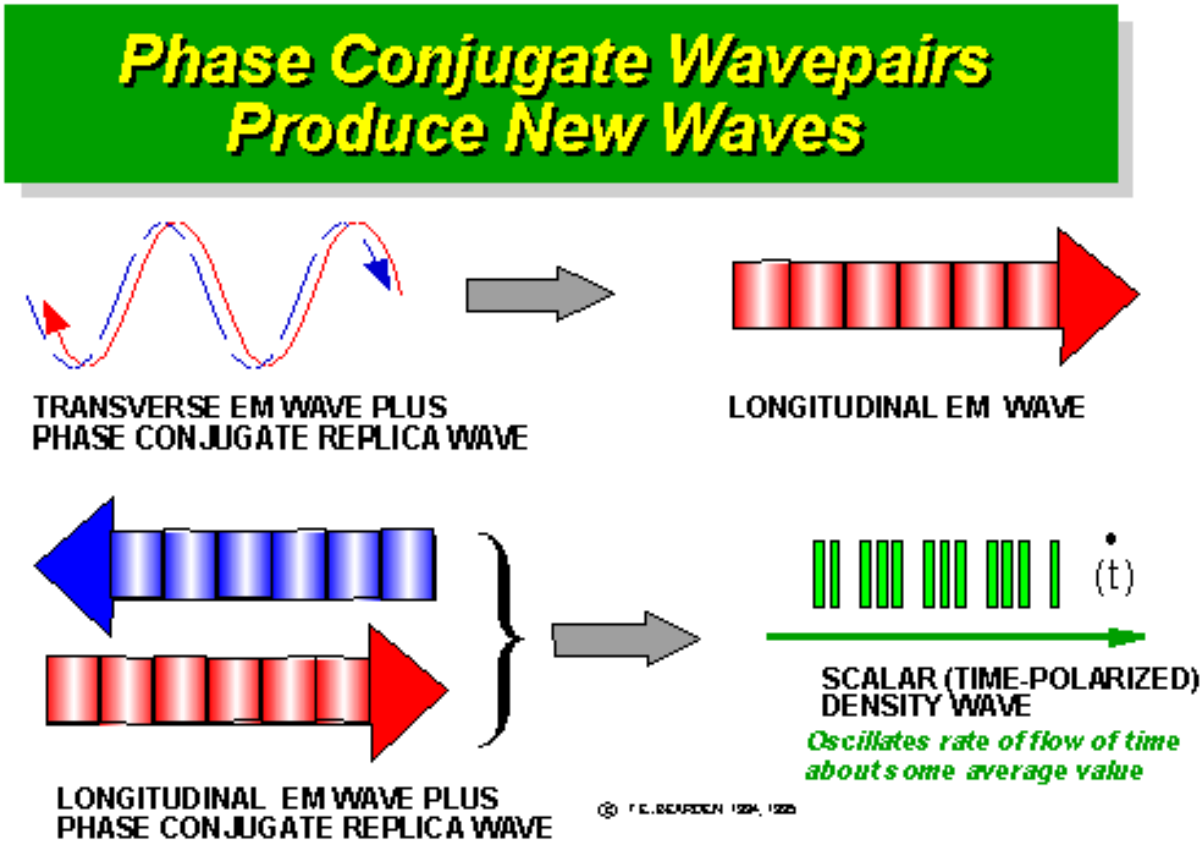

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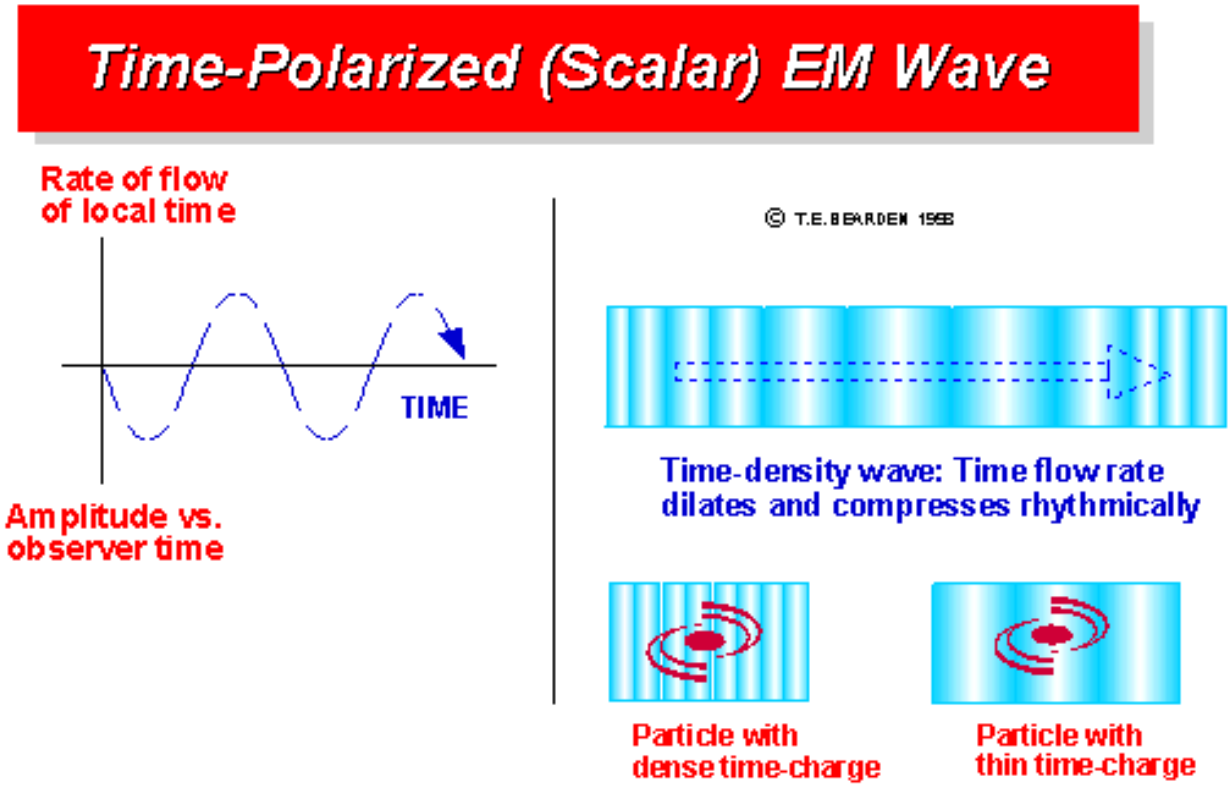

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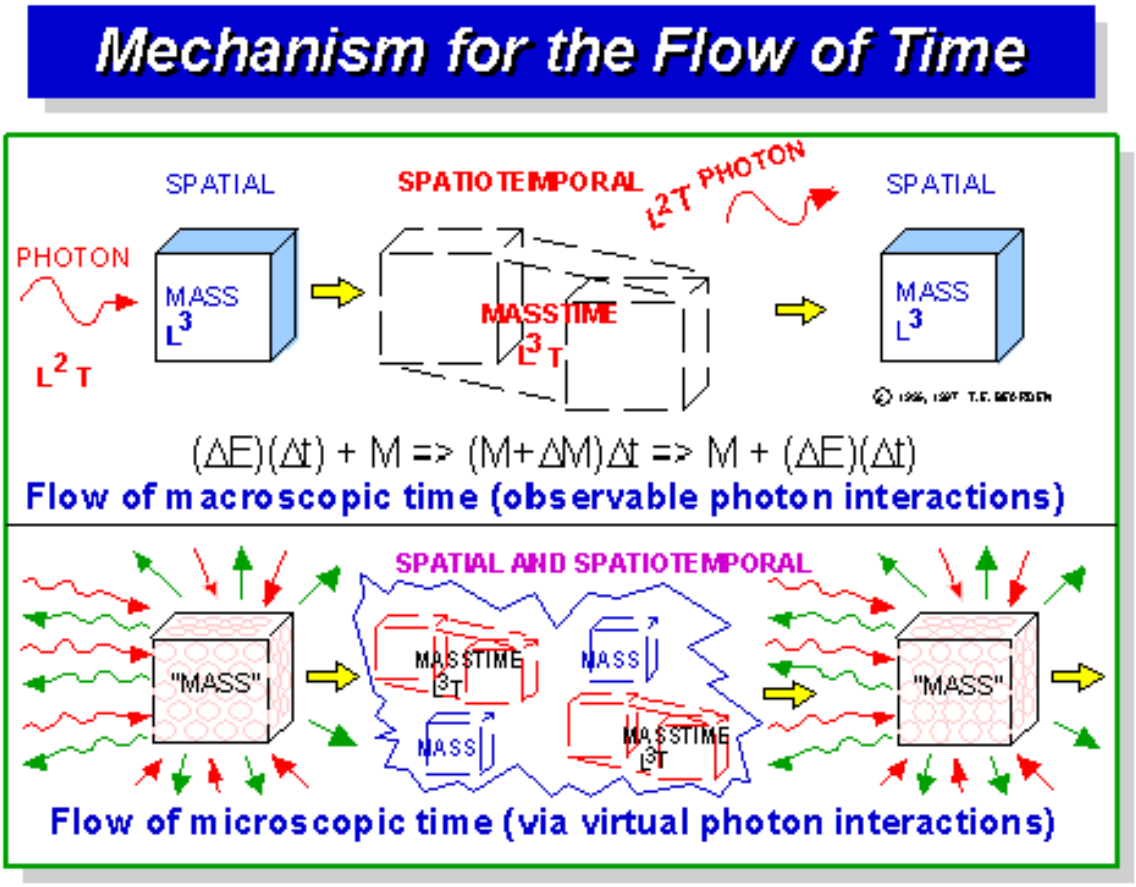

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WHY PRESENT SYSTEMS HAVE COP < 1.0

Dissipative power inside source = VI_T and $VI_T > FI_L$

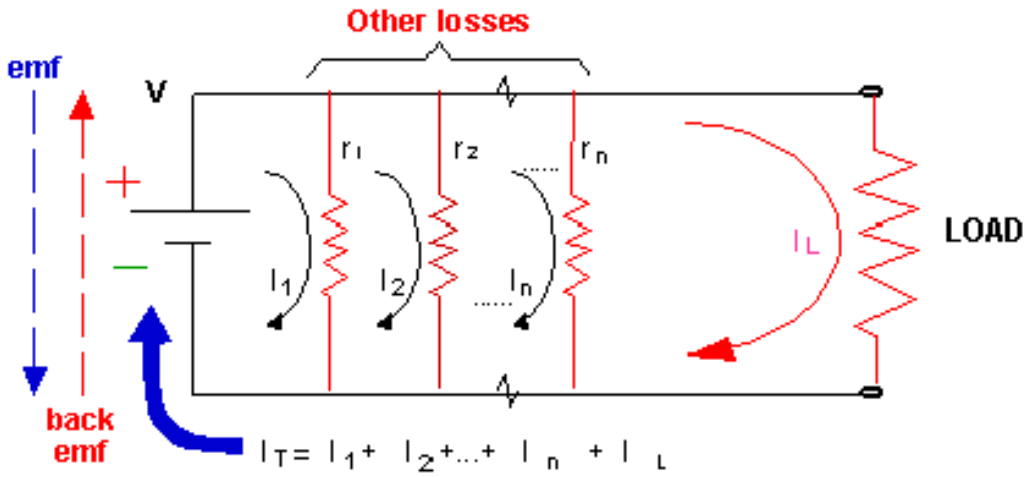

$$I_T = I_1 + I_2 + \ldots + I_n + I_L$$

$$\text{Eff} = \frac{P_L}{P_T} = \frac{V \times I_L}{V \times I_T} = \frac{I_L}{I_T}$$

$I_T > I_L$; so Eff < 1.0

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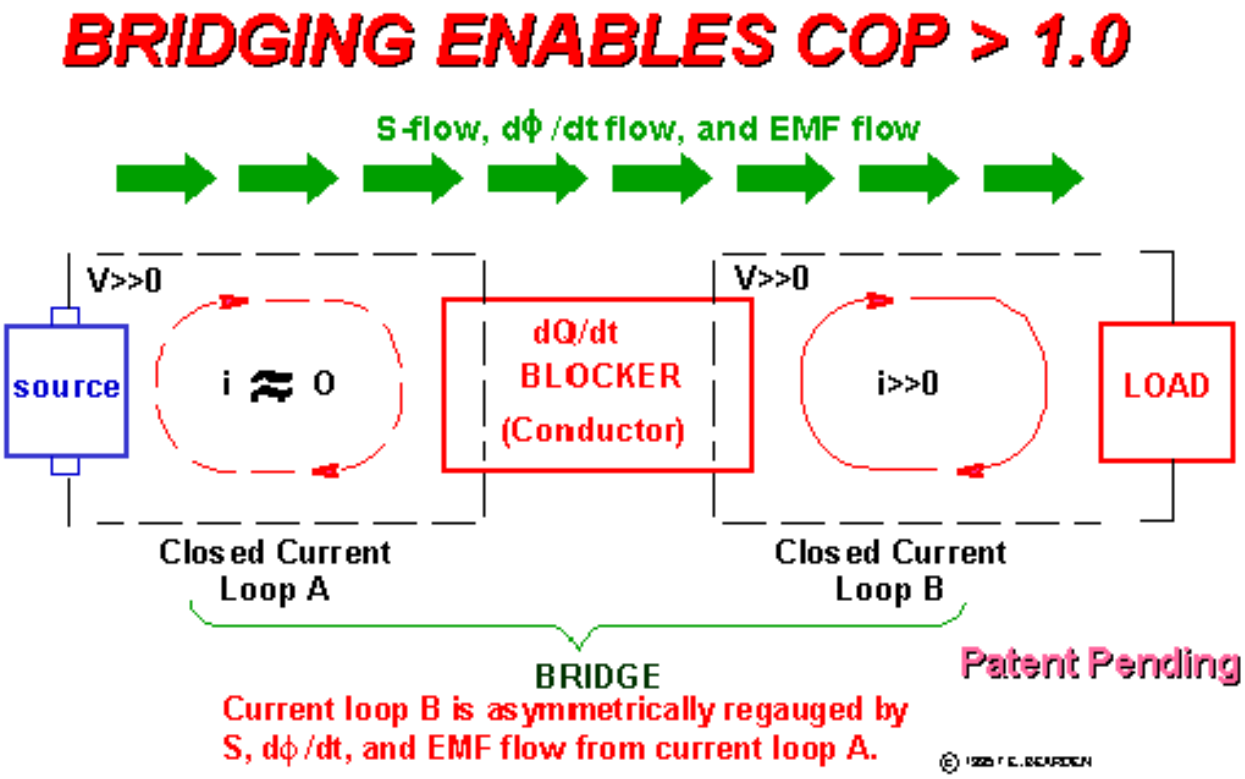

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"Static" Poynting free-energy generator

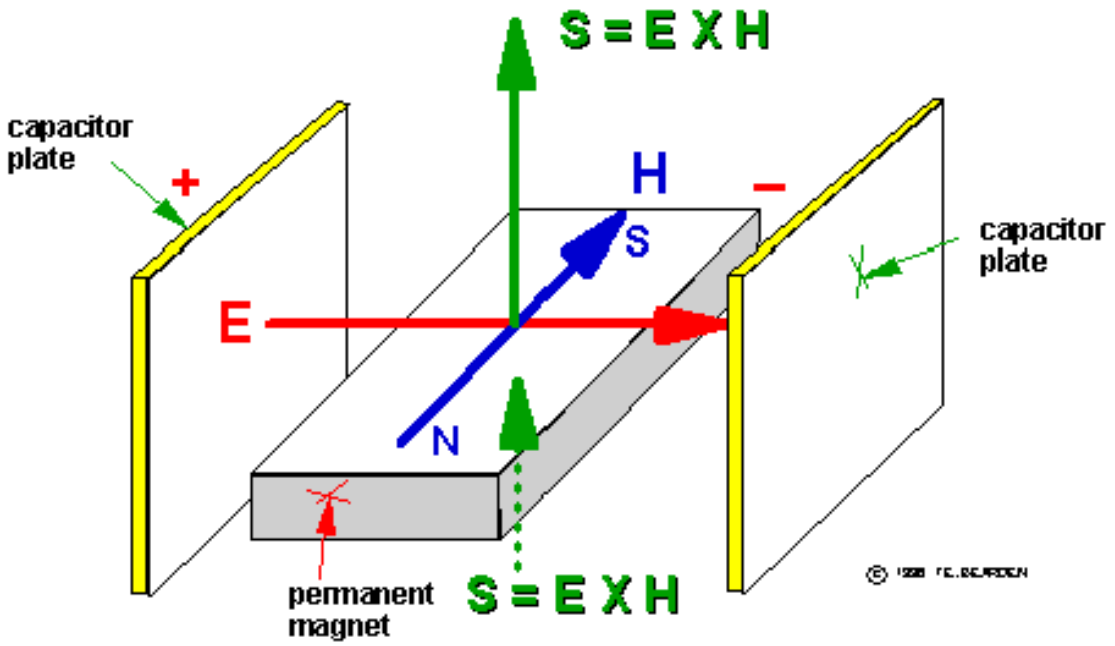

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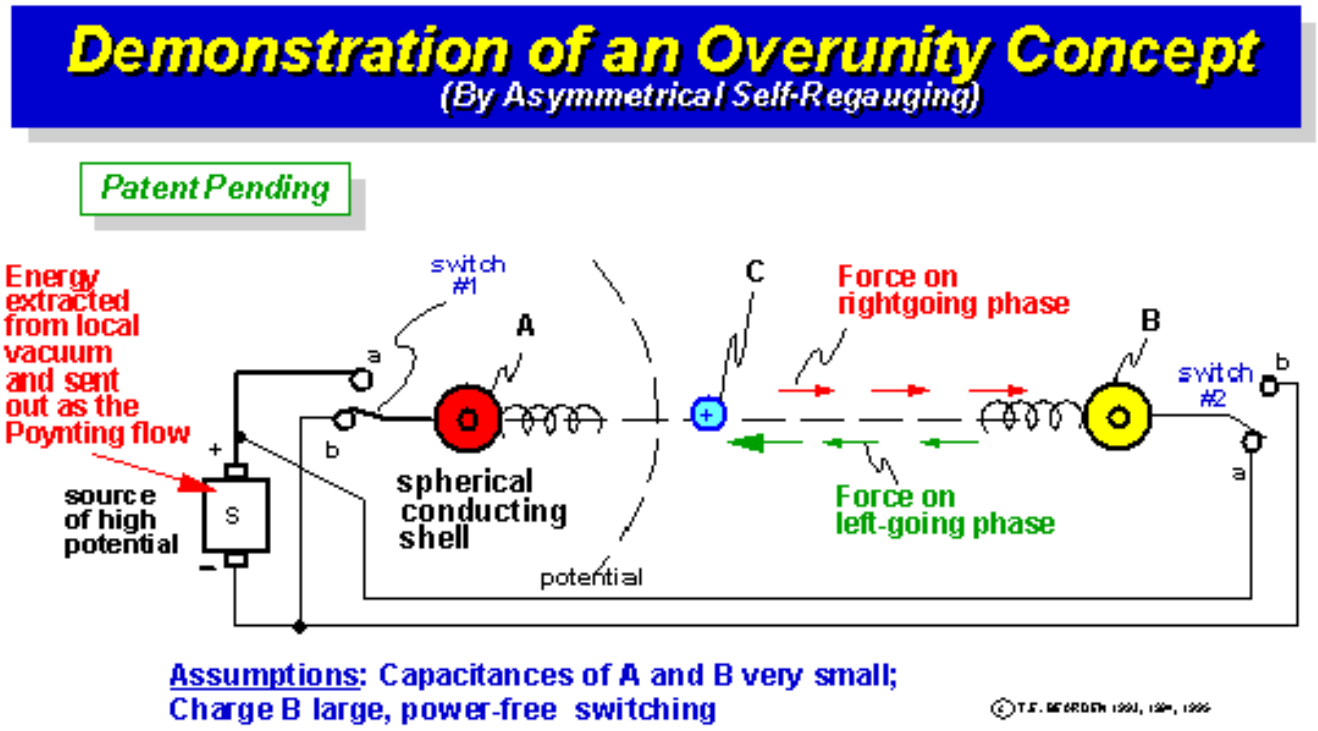

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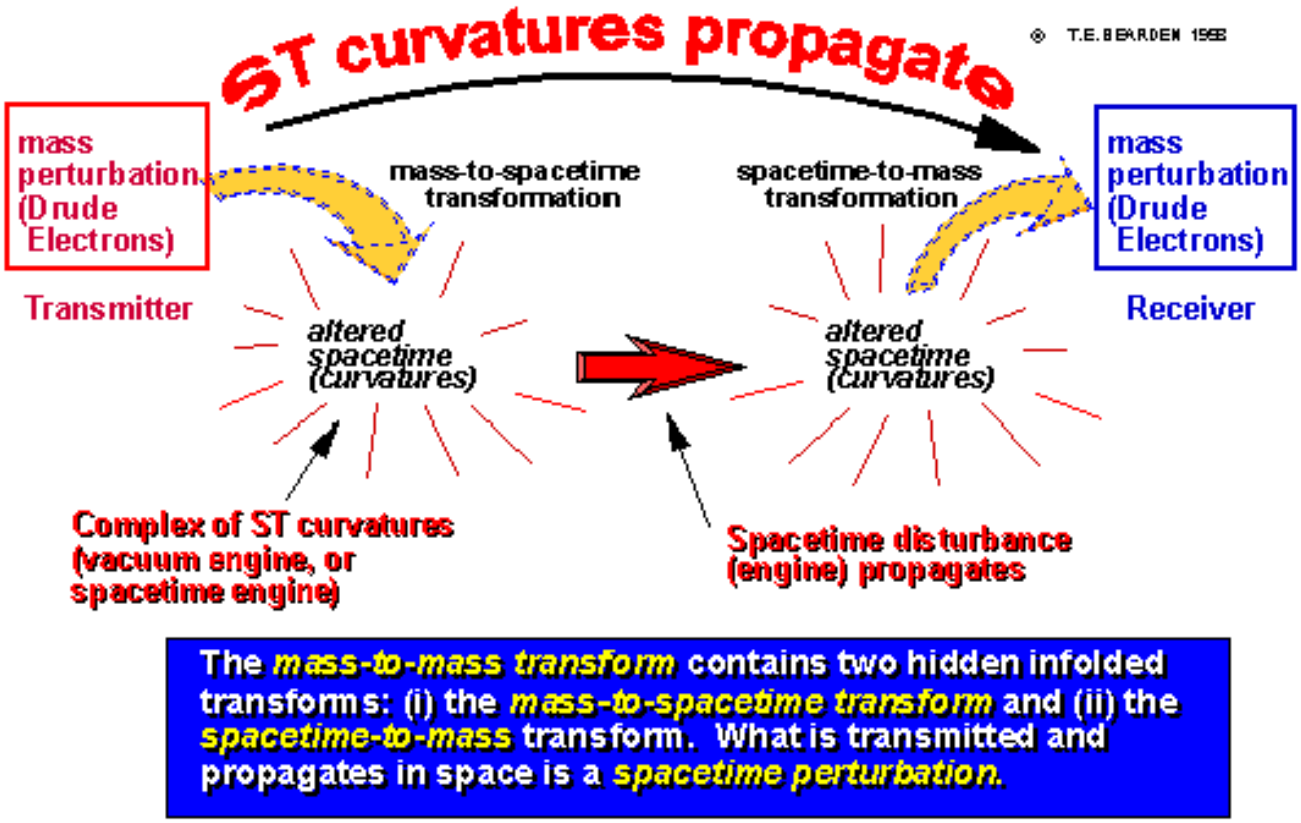

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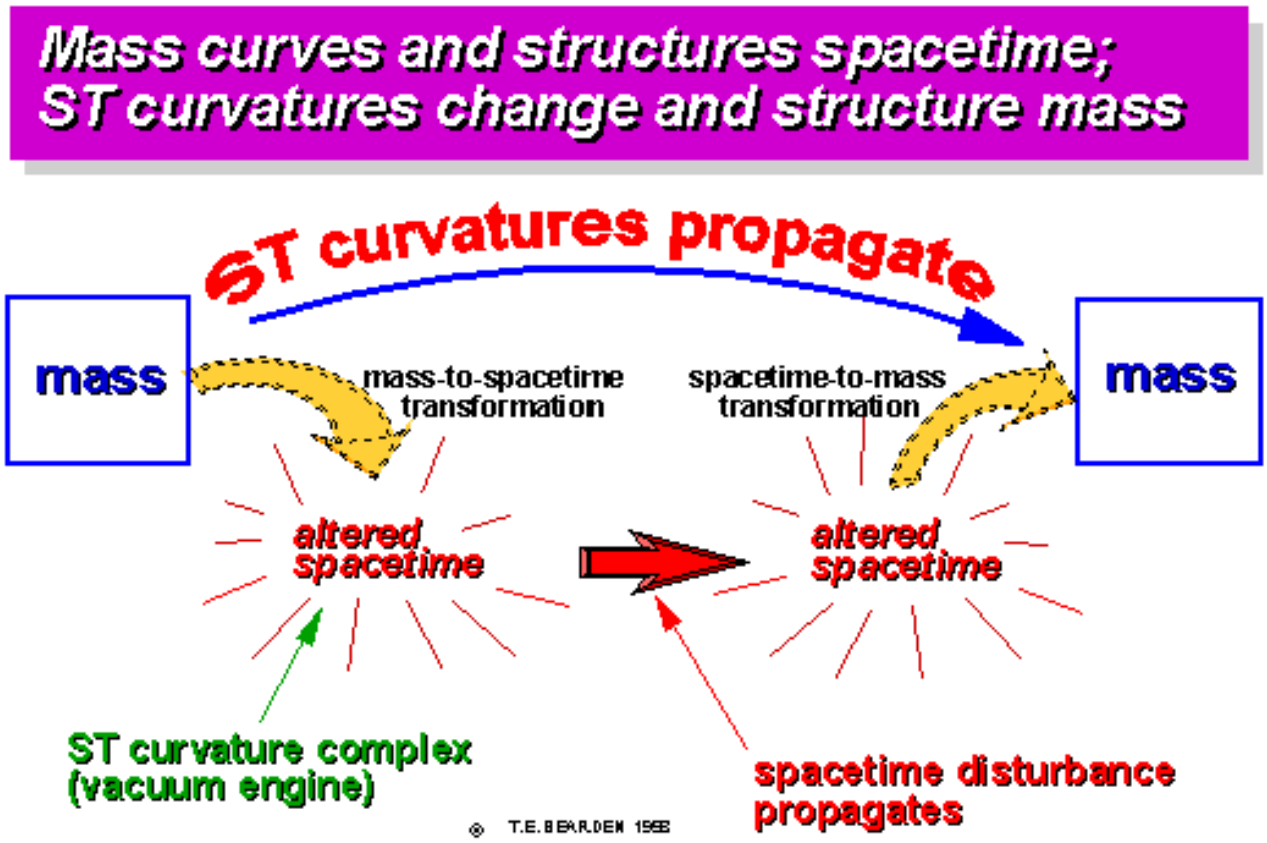

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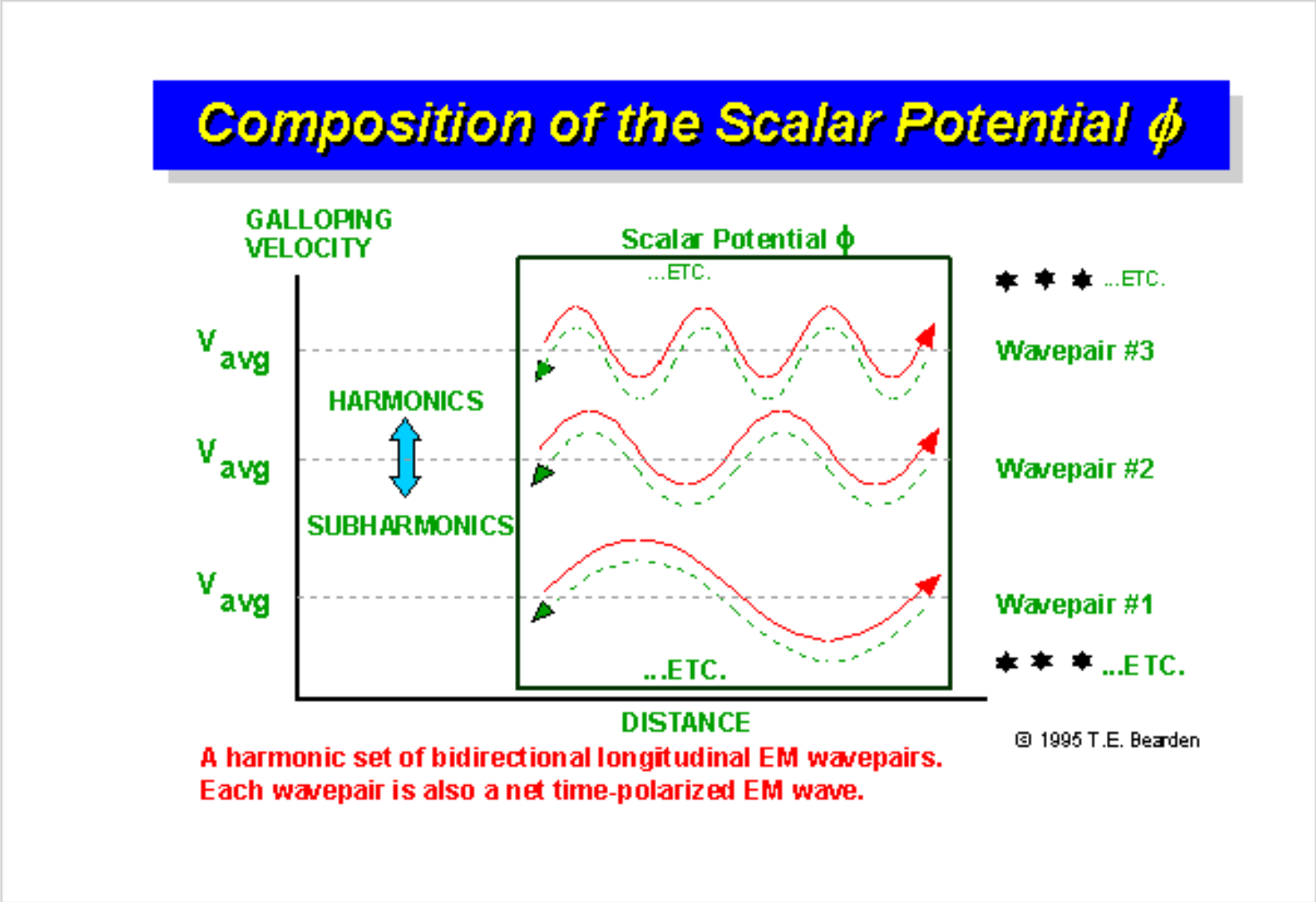

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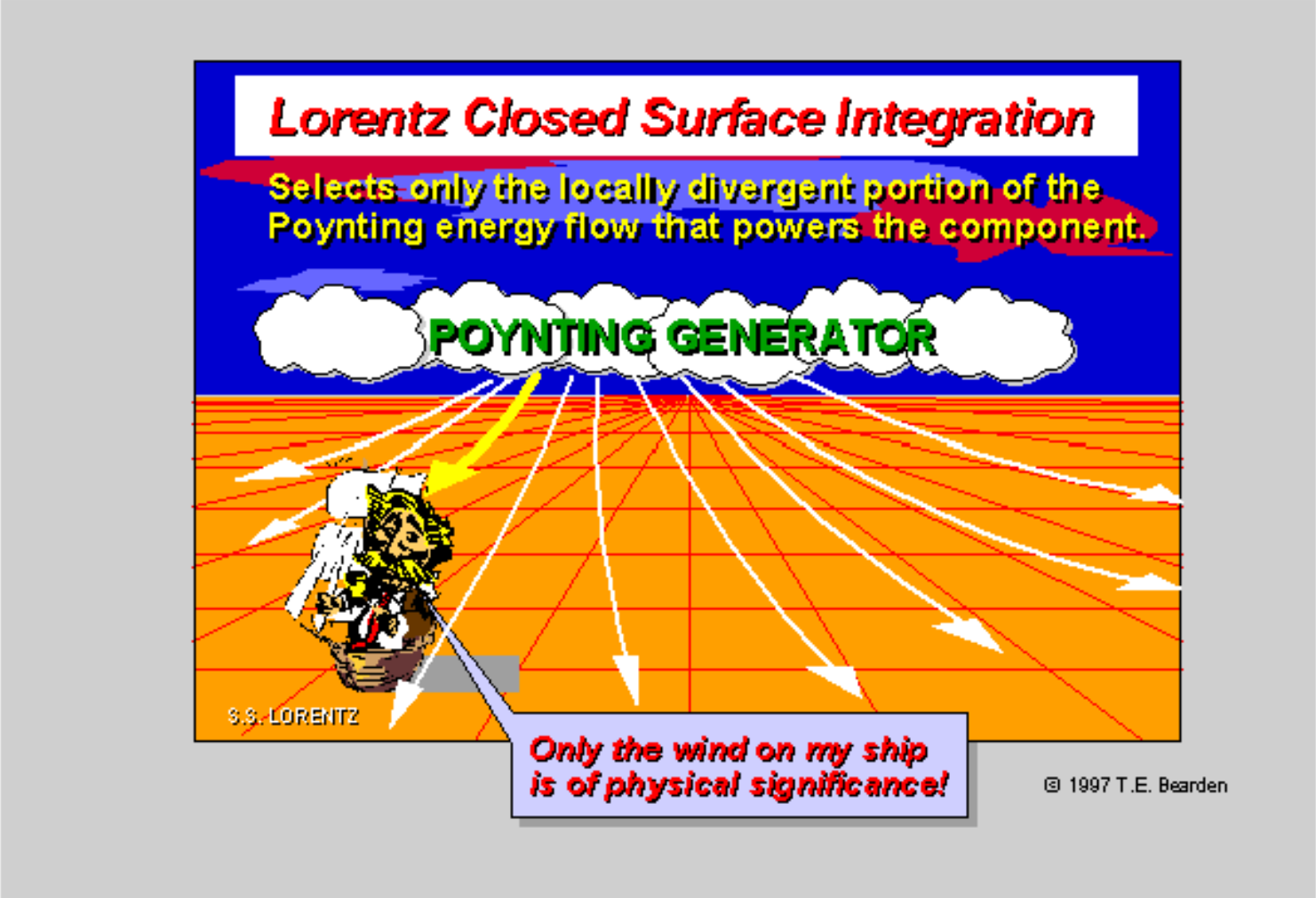

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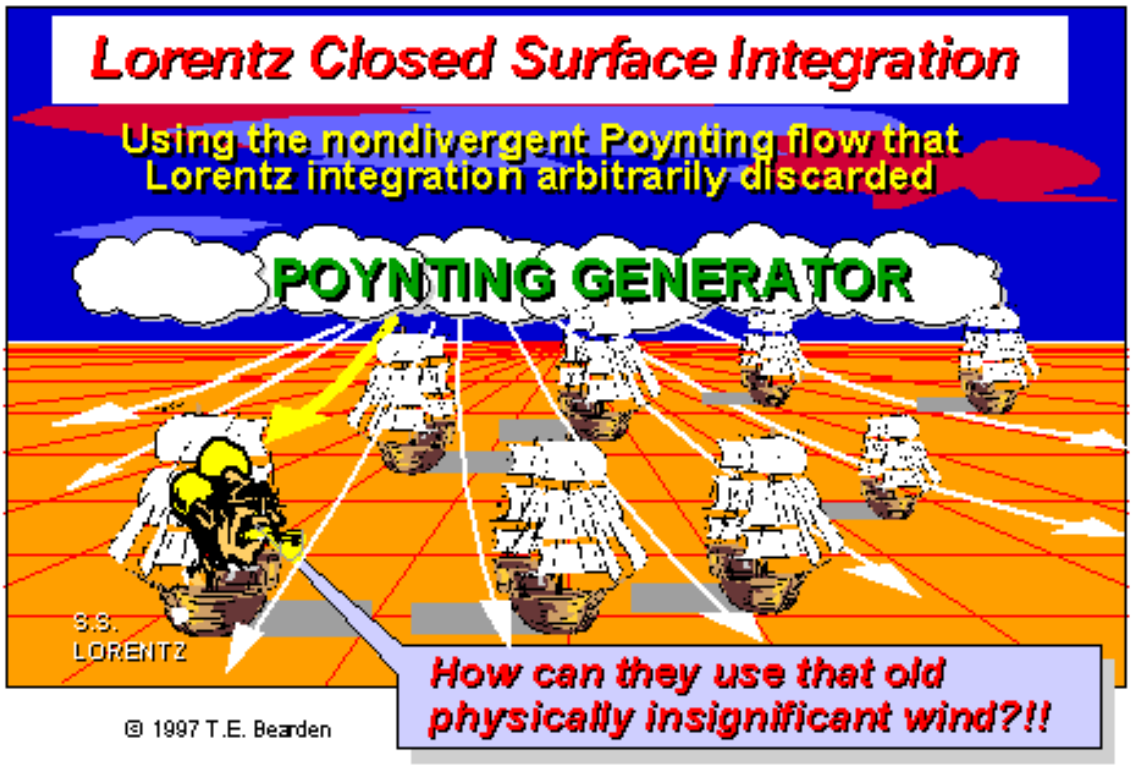

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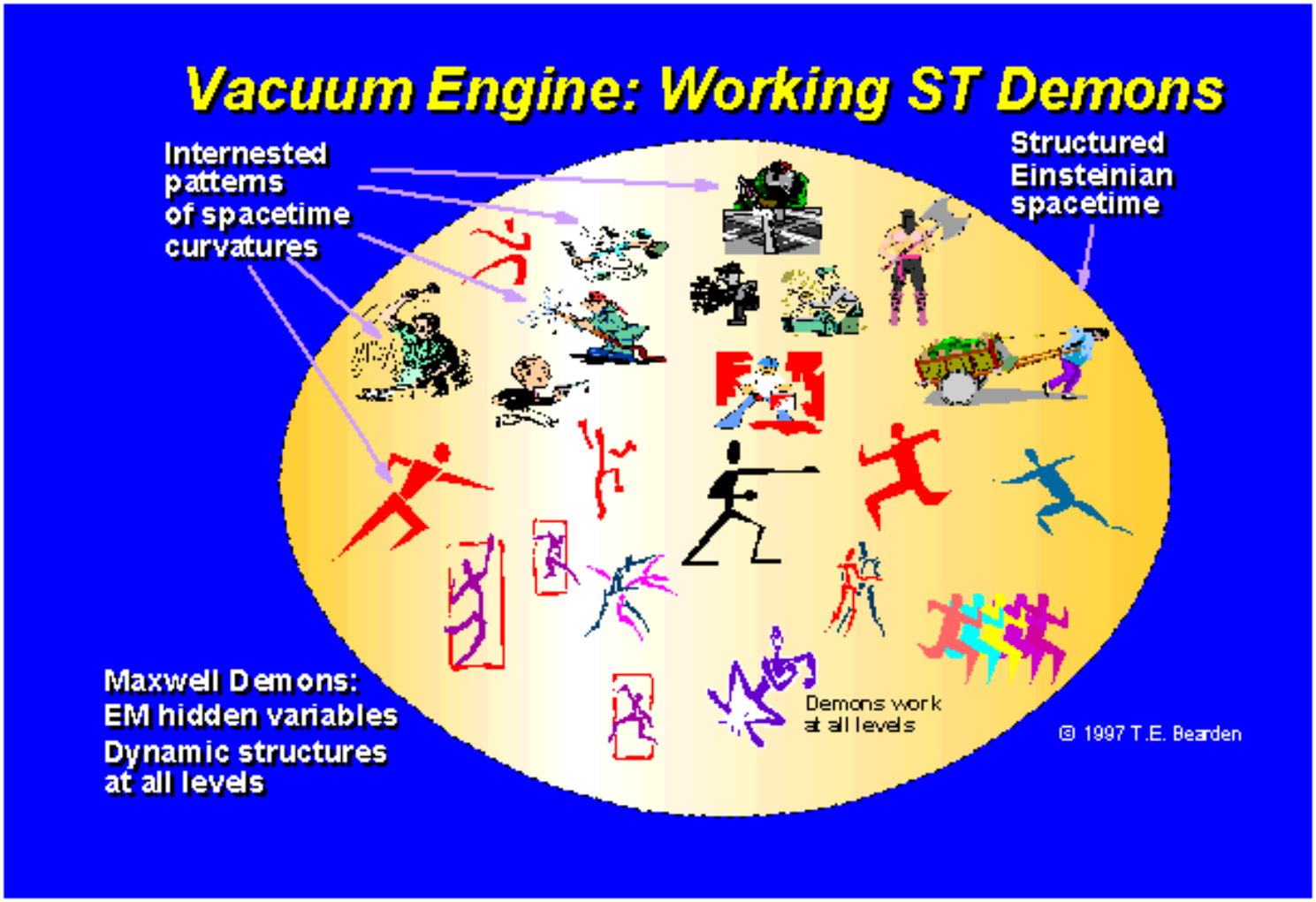

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Undistorted Progressive Waves (UPWs)

Waves with velocity v, where ≤ v < ∞

- UPWs:
  - Translationally invariant
  - Do not spread, or reconstruct after a period
  - Have infinite energy
- Quasi UPWs:
  - Can have finite energy
  - In theory, can be launched into space
  - Can move subluminally
  - Can move superluminally

*Rodrigues and Lu, *Found. Phys.* 27(3), 1997, p. 435-508.

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Undistorted Progressive Waves (UPWs)

Waves with velocity v, where ≤ v < ∞

- Major equations having UPW solutions:
  - *Homogeneous wave equation*
  - *Maxwell equations*
  - *Dirac, Weyl, and Klein-Gordon Equations*
- Maxwell solutions:
  - *Subluminal solutions are EM particles*
  - *Superluminal solutions are X-waves*
- Experiment indicates such waves will will be produced soon

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*Rodrigues and Lu, *Found. Phys.* 27(3), 1997, p. 435-508.

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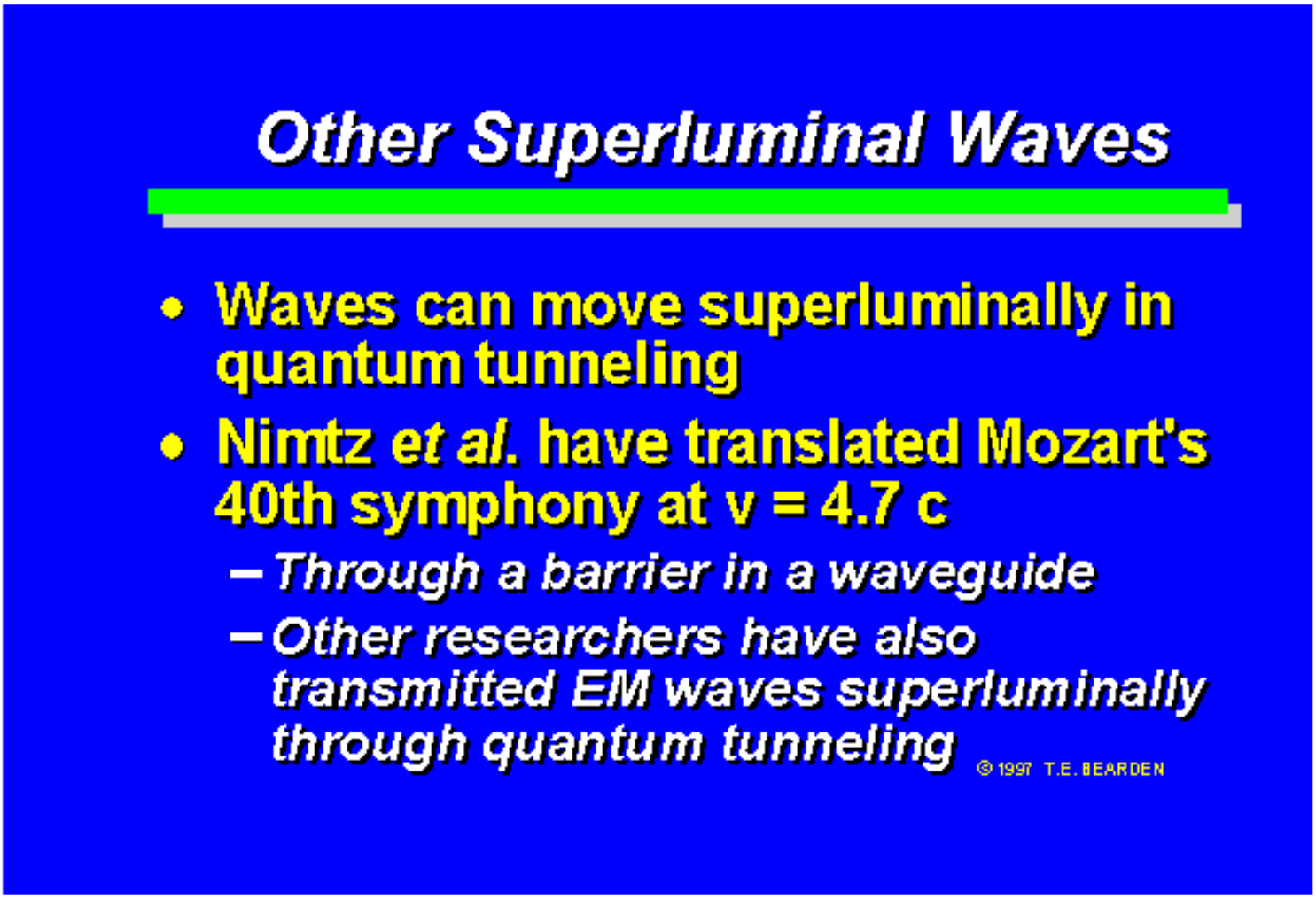

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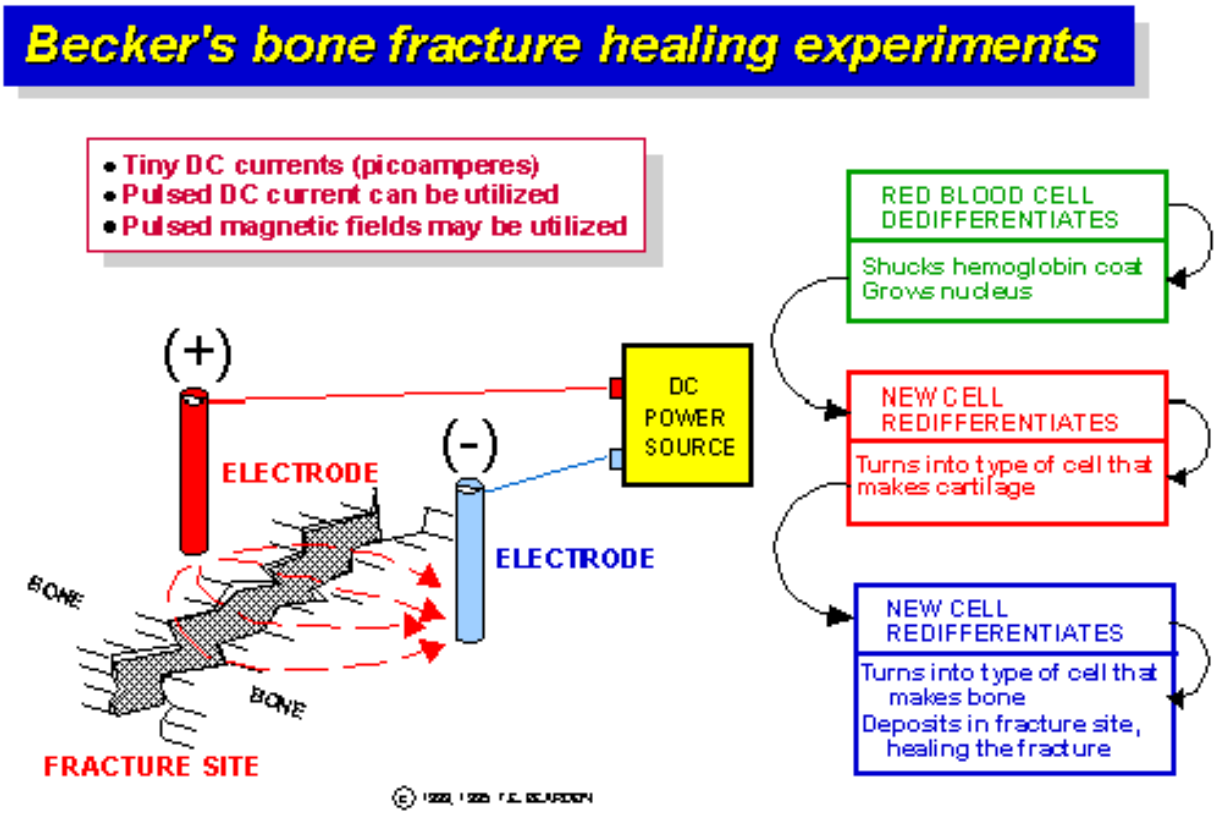

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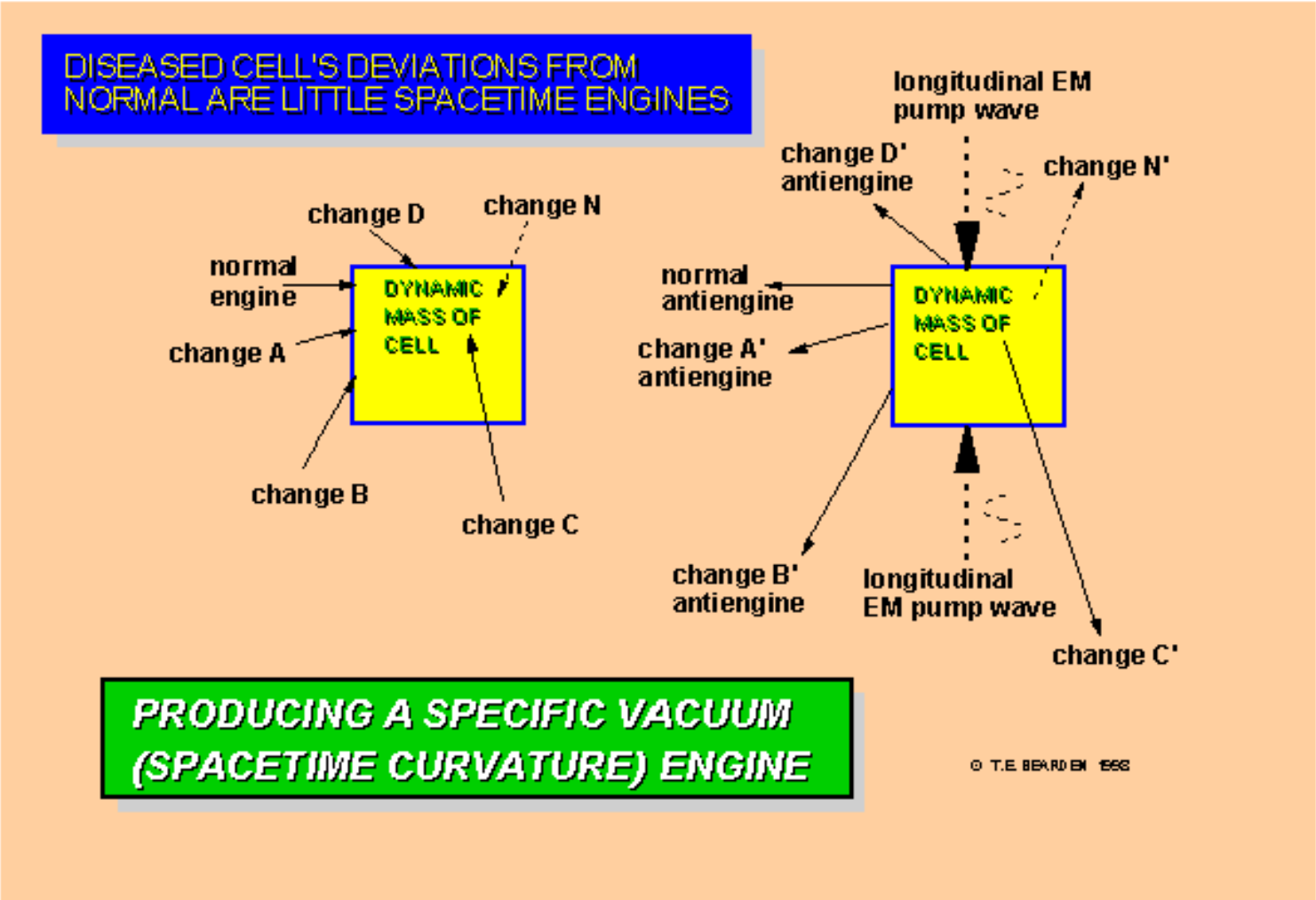

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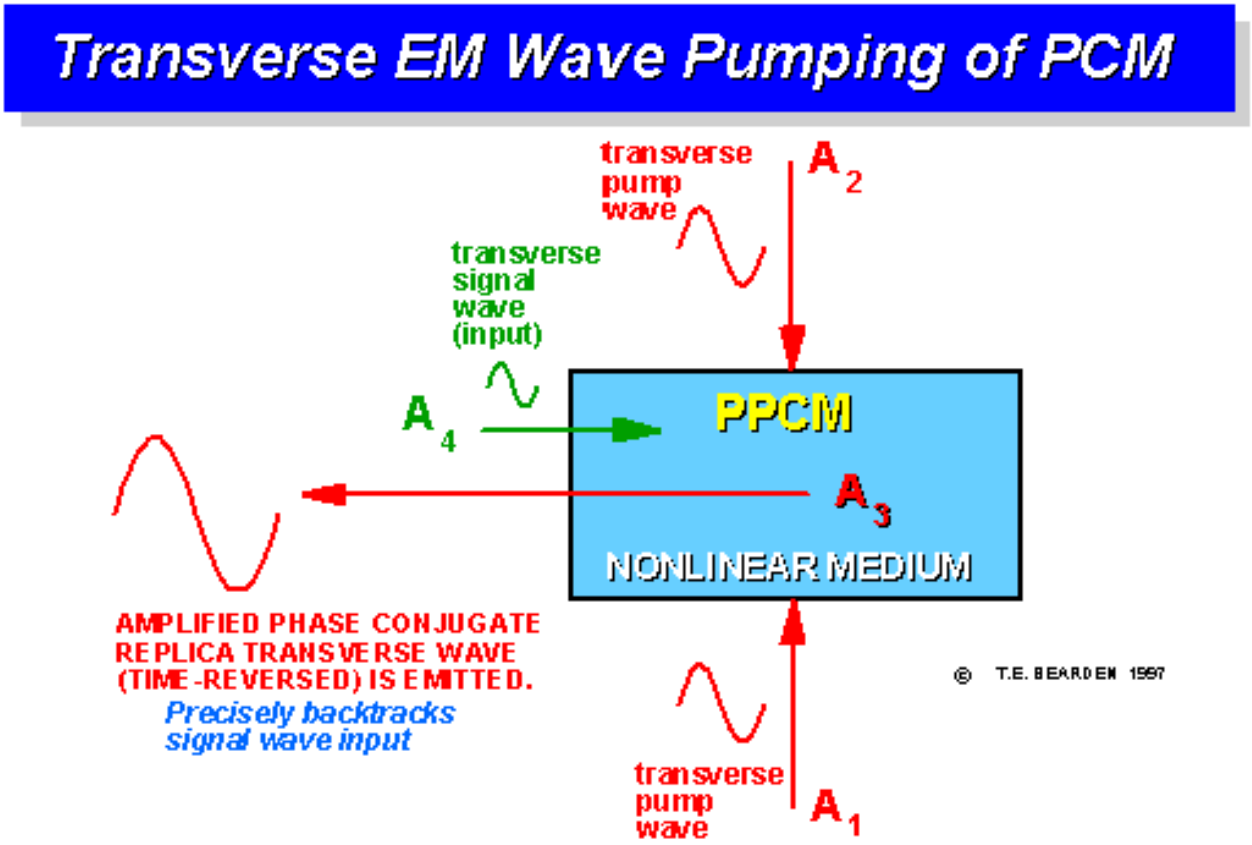

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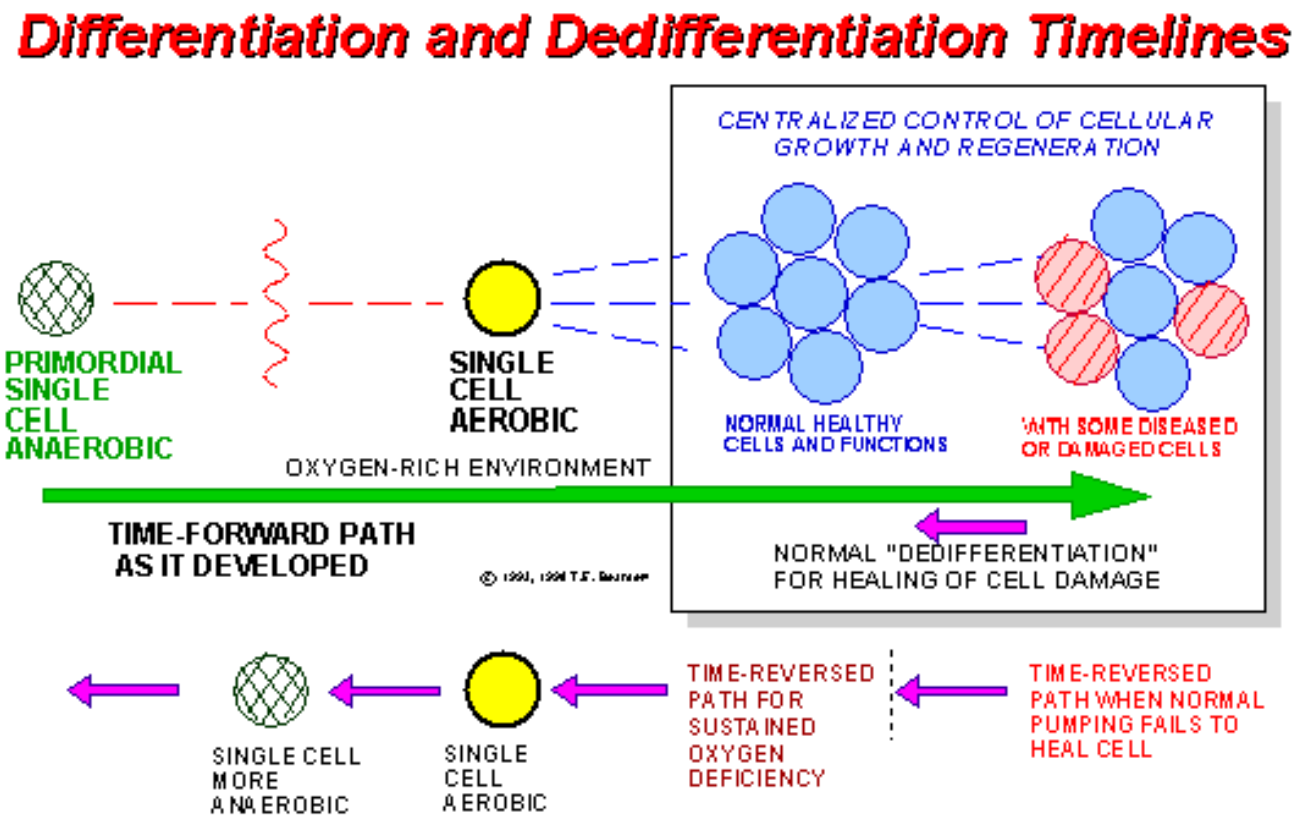

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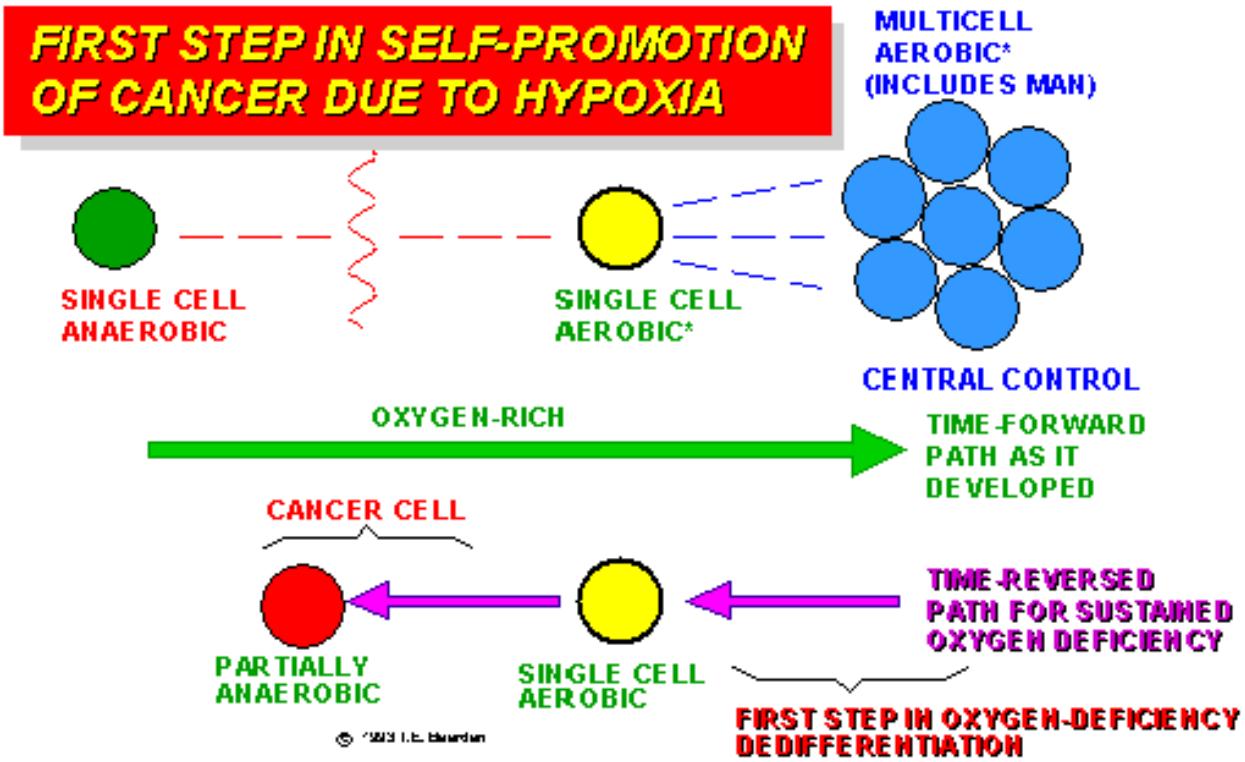

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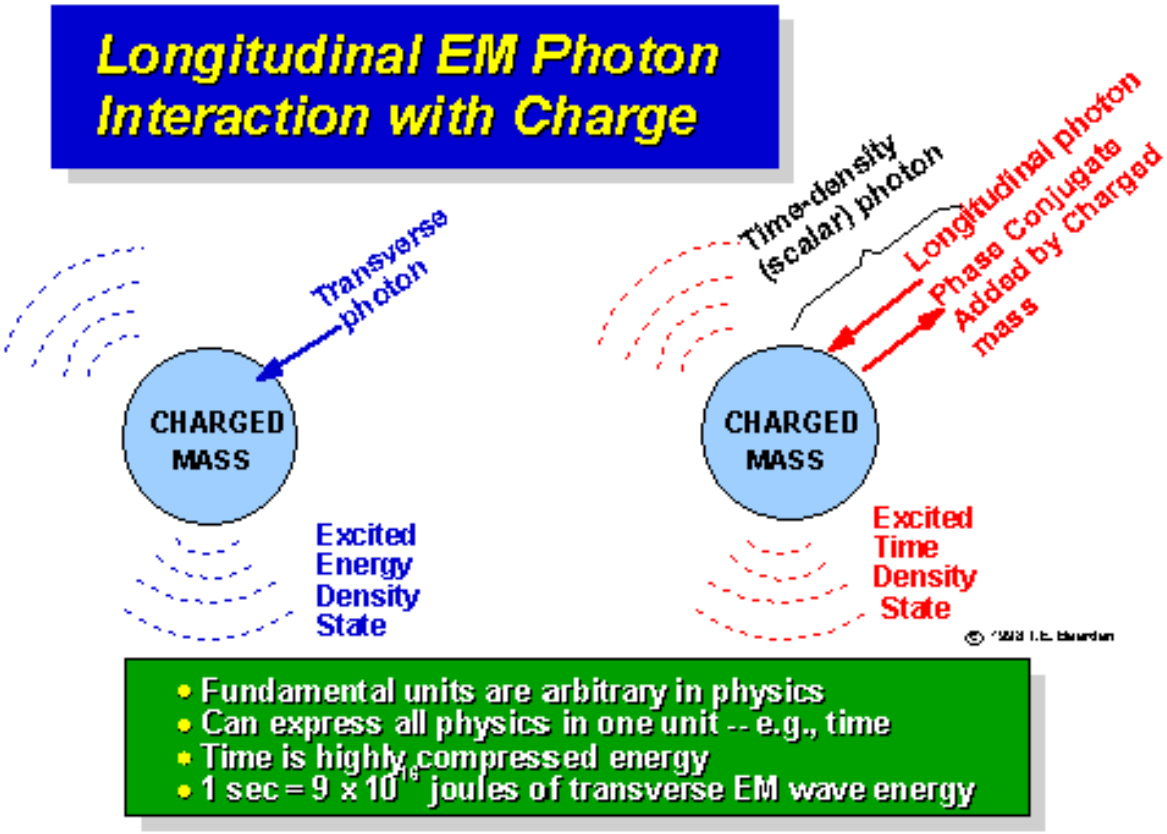

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Use of General Relativity (GR) in Particle Physics

- GR seldom used in particle physics
- In cold fusion, Matsumoto* has applied general relativity
- Consistent with important cold fusion results
- Used spacetime (ST) curvature by energy density
- Matsumoto did not utilize:
  - Longitudinal EM waves
  - Time density (time-polarized EM) waves
  - Time density curvatures of ST (gain = 9×10^{16})

* T. Matsumoto, "Mechanisms of Electro-Nuclear Collapse," Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 98.

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Pepper* on Time Reversing Mass

- Conventional NLO interactions restricted to bosons (spin 1 particles) by Pauli exclusion principle
- Concludes electrons, protons, neutrons, etc. (fermions, or spin 1/2 particles) cannot take part in such interactions
- Perhaps time reversal possible for bosons that are multiple fermions (two protons, Helium 4, pi and K mesons, etc.)

- Time-reversal of mass demonstrated by Priore, Pautrizel, et. al. without recognizing it.** Questions exclusion for:
  - Multi-fermion reaction with EM longitudinal waves
  - Multi-fermion reaction with time-density EM waves
- Prior to the laser, NLO - though known in theory - was a gedanken experiment regarded as experimentally unviable

© [illegible]

* David M. Pepper, "Nonlinear Optical Phase Conjugation," Optical Engineering, 21(12), Mar./Apr. 1982, p. 156-183.

** Before the development of NLO in the mid-to-latter 1970s.

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Pepper* on time-reversing mass

- Conventional NLO interactions
  - *Restricted to bosons (spin 1 particles)*
  - *By Pauli exclusion principle*
- Fermions cannot take part in such interactions
  - *Electrons*
  - *Protons*
  - *Neutrons*
- Perhaps time reversal possible for multiple fermions (quasi-bosons)
  - *Two protons*
  - *Helium 4*
  - *pi and k mesons*

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* David M. Pepper, "Nonlinear Optical Phase Conjugation," Optical Engineering, 21(12), Mar./Apr. 1982, p. 156-183.

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Pepper* on time-reversing mass (2)

- Time-reversal of mass demonstrated by
  - *Priore, Pautrizel, other Priore team scientists*
  - *Without recognizing it*
- Apparently n-tuple fermions, where n is even, can be time-reversed
  - *Impact of longitudinal EM waves*
  - *Impact of scalar (time-density) EM waves*
  - *Major part played by time-reversal regions*
- Prior to the laser, NLO - though known in theory - was a gedanken experiment and regarded as experimentally unviable

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* David M. Pepper, "Nonlinear Optical Phase Conjugation," Optical Engineering, 21(12), Mar./Apr. 1982, p. 156-183.

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Chung's Carbon Filament Negative Resistor

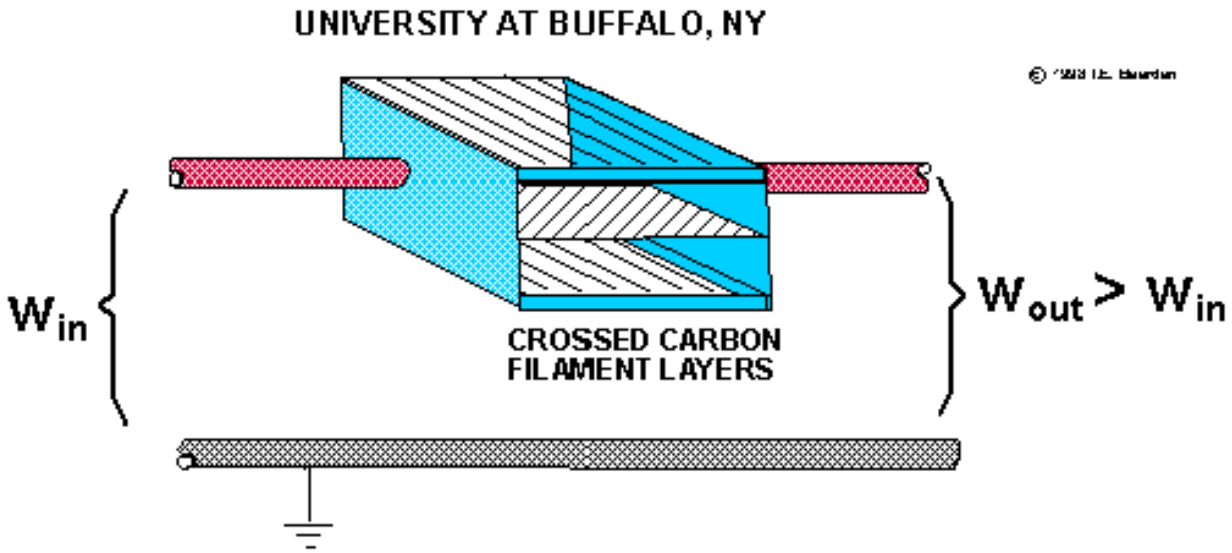

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Consistency of China Lake Anomalies

- Variation in LW-TW transduction from experiment to experiment
- Majority produced insufficient transduction to cause ionization discharge of the GM tube gas (to cause detection)
- Correlation between appearance of anomalous radiation and the expected time periods to load palladium with deuterium
  - Within few hours in co-deposit experiments where palladium is loaded with deuterium as it deposits from solution
  - Required days of electrolysis for rods that load much slower
- The faster the deuterium loaded, the greater the interaction of deuterium in phase conjugating and self-targeting in lattice
- Variation in GM detector readings
  - One would read anomalous radiation, another would be blind to it
  - A few experiments gave simultaneous readings from two detectors
- Experiments perfectly consistent with LW-TW transduction, time-density charging, variation in GM time histories, and new conservation of energy law

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Time-Reversal Zones in Nuclear and Chemical Reactions

- TIME REVERSAL ZONE: A volume or area in a reaction environment where phase conjugate waves predominate over time-forward waves
  - In a given reaction, time-reversal may apply
  - If so, like charges attract and unlike charges repel
  - Charges move against potential gradient, to external observer
  - Time density and longitudinal EM waves become significant
  - Coulomb barrier turns into Coulomb assistant
- Examples (assuming a time-reversed zone):

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$$^{1}H^{+} + {}^{1}H^{+} \text{-->} {}^{2}H^{++} \text{-->} {}^{1}n + {}^{1}H^{+} \text{-->} {}^{2}H^{+} = \text{deuterium}$$

$$2({}^{1}H^{+} + {}^{1}H^{+}) \text{-->} 2\,({}^{2}H)^{++} \text{-->} 2({}^{1}n + {}^{1}H^{+})$$

$$\text{-->} 2({}^{1}n) + 2({}^{1}H)^{++}$$

$$\text{-->} {}^{4}He^{++} = \text{helium}$$

Quark flipping and energy balancing with curved spacetime assumed)

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The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)

- Nucleon interchange
  - Changes neutron into proton and vice versa
  - At high rate (flat spacetime assumed)
- Statistics become skewed due to curved ST
- Can bias statistics toward either neutron or proton end
  - Biases toward transmutation of elements along isomer chains
  - Concept of "isomer" is vastly expanded

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The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)

- Normal dynamics (impulses) may reverse
  - Like charges attract, unlike charges repel
  - Positive charges cluster (are drawn together)
  - H+ ions (protons) may form quasi-nuclei
  - Nucleus coulomb barrier becomes assistant
- Many "impossible" reactions now possible
  - Quark access and quark flipping by EM
  - Ion clustering
  - Positive charges as phase conjugate mirrors
  - Time-density waves and time-energy charging

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The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)

- Not observed until time-energy charging has become substantial
  - *Time delay (hours, days)*
  - *Transduction of LW --> TW involved*
  - *Specific time-charging history of detectors is involved in twhether they detect or not*
  - *Longitudinal EM waves become significant*
- Curved spacetime can act as source or sink
  - *May emit excess radiation*
  - *May absorb excess radiation*

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On Nuclear Reactions in TR-Zones

- **Nuclear interactions now are biased:**
  - Normal nucleon interchange changes neutron into proton and vice versa, at a high rate (flat spacetime assumed)
  - Statistics now become skewed due to curved spacetime
  - Can bias statistics toward either the neutron end or proton end
  - Thus biases toward transmutation of elements along isomer chains
  - Concept of "isomer" vastly expanded
- **Normal dynamics (impulses) may be reversed**
  - Coulomb barrier becomes coulomb assistant
  - Reactions "impossible" from energy density standpoint become possible, even easy, from time-density standpoint
- **Does not become significant until sufficient time-density charges**
  - Time-delay (hours, days) before TR reactions become significant
  - Transduction of LW-->TW involved
  - Specific time-history of detectors is significant
  - longitudinal EM waves become significant
- **Curved spacetime acts as source or sink**
  - Energy balance in curved spacetime may emit excess radiation
  - Energy balance in curved spacetime may absorb excess radiation

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In Time-Reversed Zone:
Nuclear reactions are biased

- In normal flat ST, n ⇔ p at high rate
- Curved ST skews statistics
- Biases to either n or p
- Biases to transmutation along isomer chain
- "Isomer" concept greatly expanded

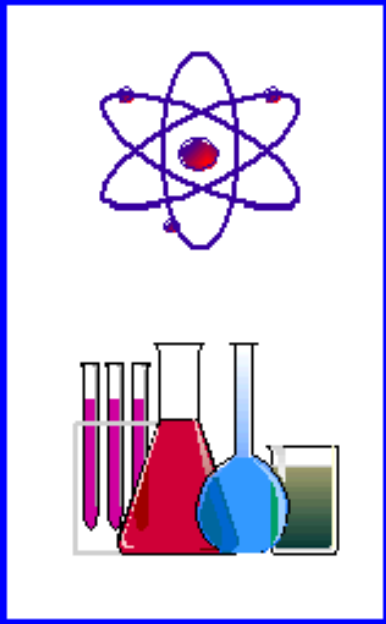

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In Time-Reversed Zone:
Dynamics may be reversed

- Like charges may attract and unlike charges repel
- Coulomb barrier becomes Coulomb assistant
- Clusters like charges and forms artificial nuclei
- "Impossible" nuclear reactions at low energy
- Time-density interactions

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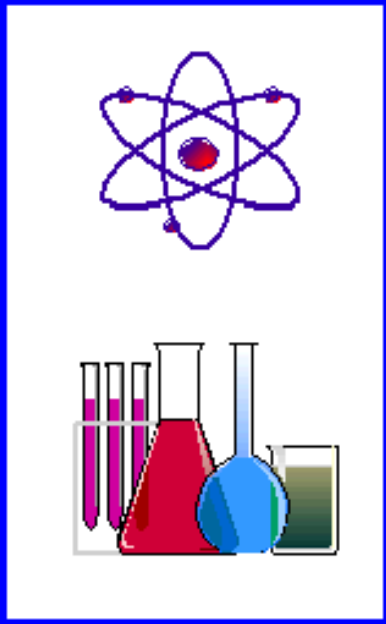

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Time-Reversed Zone:
Significant only after time-density charging

- Hours, for "fast" onset
- Days, for "slower" onset
- Transduction involved for TW ⇔ LW ⇔ TDW
- Time-history of each detector is significant
- Longitudinal EM waves become significant

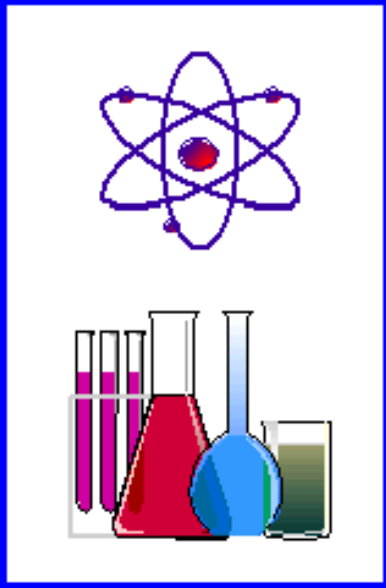

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Curved Spacetime acts as source or sink

- May emit excess radiation and energy (e.g., heat)
- May absorb radiation and energy (e.g., cool)
- May transduce waves TW ⇔ LW ⇔ TDW
- New energy conservation law applies

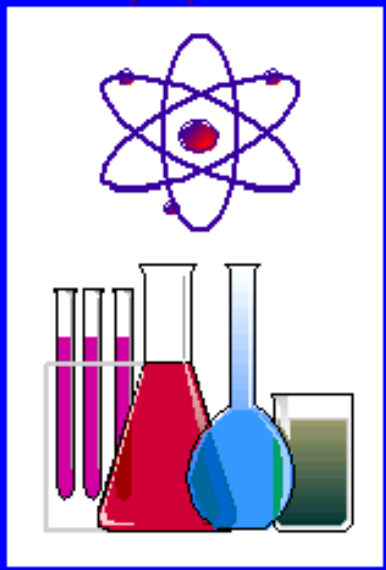

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Anomalous LW EM Emission Phenomena at China Lake (1)

- **Anomalous radiation from electrolysis in ionization processes**
  - Two experiments producing excess power
  - Dental X-ray film showed exposure
  - Simultaneous control study: no exposure
  - 20 experiments without excess power: no exposure
- **Excess energy strongly indicates excess film exposure**

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* Melvin H. Miles and Benjamin F. Bush, "Radiation Measurements at China Lake: Real or Artifacts?" Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 101.

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Anomalous LW EM Emission Phenomena at China Lake (2)

- **GM and NaI detector reaction when electrolysis with heavy water ongoing**
  - Several Geiger-Muller (GM) tubes gave anomalous detection
  - Reached 73 sigma above background
  - No anomalies when experiment off
- ***GM tube detects anything which causes its internal ionization***
  - *Nuclear radiation is ionizing*
  - *Transduced x-ray & gamma is ionizing*

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Sufficient LW-to-TW Transduction Ionizes GM Tube Gas (3)

- **Time-history of detector involved**
  - Some GM detectors show anomalous high counts, some do not
  - Time histories of GM detectors are varied
  - Time histories of film vary minimally
- ***Experimental results consistent with***
  - *LW-to-TW transduction including delay*
  - *Time-energy charging*
  - *New extension to energy conservation law*

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Sufficient LW-to-TW Transduction Ionizes GM Tube Gas (4)

- **Time-history of detector involved**
  - Some GM detectors show anomalous high counts, some do not
  - Time histories of GM detectors are varied
  - Time histories of film vary minimally
- ***Experimental results consistent with***
  - *LW-to-TW transduction including delay*
  - *Time-energy charging*
  - *New extension to energy conservation law*

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Consistency of Anomalies

- LW-to-TW transduction varied from experiment to experiment
- Most experiments produced insufficient transduction to cause ionization
- Appearance of anomalous radiation correlated with expected time loading of palladium with deuterium
  - Within few hours in experiments where palladium loads with deuterium as it deposits from solution
  - Required days for rods that load much slower

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Consistency of Anomalies (2)

- Faster the deuterium loaded, the greater the interaction of deuterium in
  - Phase-conjugating and self-targeting
  - Producing time-reversal zones
  - Generating quasi-nuclei of H+ ions (protons)
- Variation in GR detector readings
- Experimental results predictable by
  - LW-TW transduction and time-reversal zones
  - Varying time-density charging on GM tubes
  - Variation in GM tube experience histories
  - Time-reversal zones generating electronuclear interactions and quasi-nuclei of H+ clusters

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Experimental LW Emission Phenomena in Electrolysis

- Anomalous radiation from electrolysis in ionization processes
  - Two experiments producing excess power
  - Dental x-ray film showed exposure
  - Simultaneous control study: No exposure
  - 20 experiments without excess power: No exposure
- Excess energy strongly indicates excess film exposure
- GM and NaI detector reaction when electrolysis ongoing w/heavy water
  - Several Geiger Muller (GM) tubes gave anomalous detection
  - Reached 73 σ above normal background counts
  - No anomalies when experiment off
- GM tube detects anything which causes its internal gas to ionize
  - Nuclear radiation is "ionizing" radiation
  - Transduced x-ray and gamma radiation is "ionizing" radiation
  - Sufficient LW-TW transduction ionizes GM gas
- Time History of detector involved
  - Some GM detectors show anomalous high counts, some do not
  - Time histories of GM detectors vary appreciably
  - Time histories of film vary minimally
- Experiments consistent with time-density charging, LW-TW transduction, and new conservation of energy law

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* Melvin H. Miles and Benjamin F. Bush, "Radiation Measurements at China Lake: Real or Artifacts?" Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 101.

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A New Conservation of Energy Law

- Physics conserves total "energy and mass-energy"
- Now also must consider "time-energy"
- Conserve total mass-time-energy (spatiotemporal energy)
- Let E_T = total energy, E_M = mass energy, E_E = ordinary energy, and E_t = time energy. Then

$$E_T = E_E + E_M + E_t$$

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$$(kE_t \Rightarrow E_E > 0) \Rightarrow E_T > (E_M + E_E)$$

- If some E_t is transduced into E_E, the experiment will violate the old spatial mass-energy conservation law

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QUESTIONS ON CARCINOGENS AND EM RADIATION

- UNRESOLVED QUESTIONS ON EM RADIATION
  - DOSAGES
  - ACTIVE MECHANISMS
  - REPLICATION DIFFICULTIES
  - MEASUREMENT DIFFICULTIES
  - WHERE, WHEN, HOW ILL EFFECTS OCCUR
- SIMILAR QUESTIONS EXIST ABOUT EVERY CARCINOGEN
- SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
  - FACTORS SUCH AS MIND, STRESS, SPONTANEOUS REMISSION, PLACEBO EFFECTS, AND COMBINATIONS OF FACTORS ARE PARTICULARLY TROUBLESOME
  - GENERATION OF THE PLACEBO EFFECT BY THE REGENERATION & RECOVERY SYSTEM IS UNRECOGNIZED

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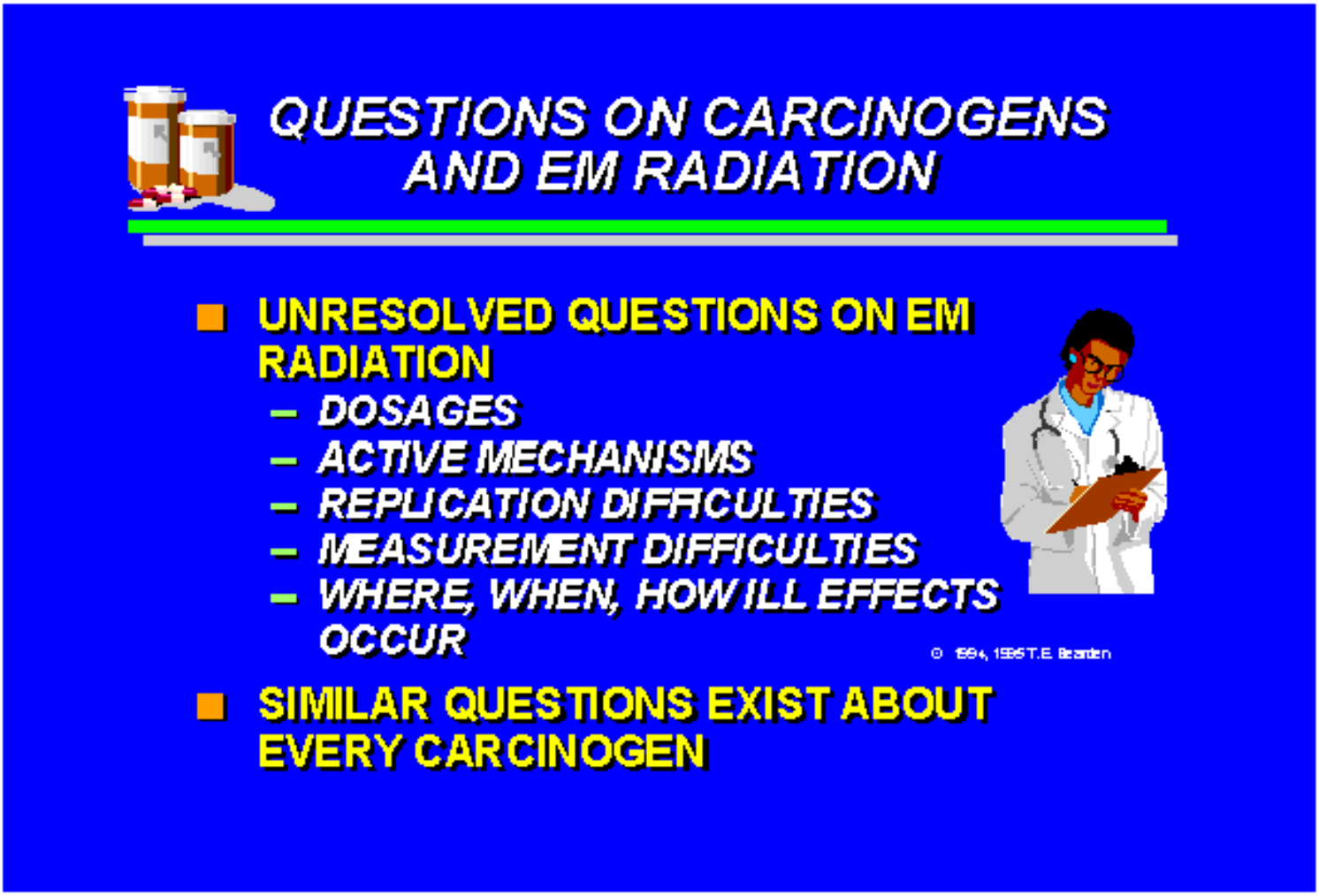

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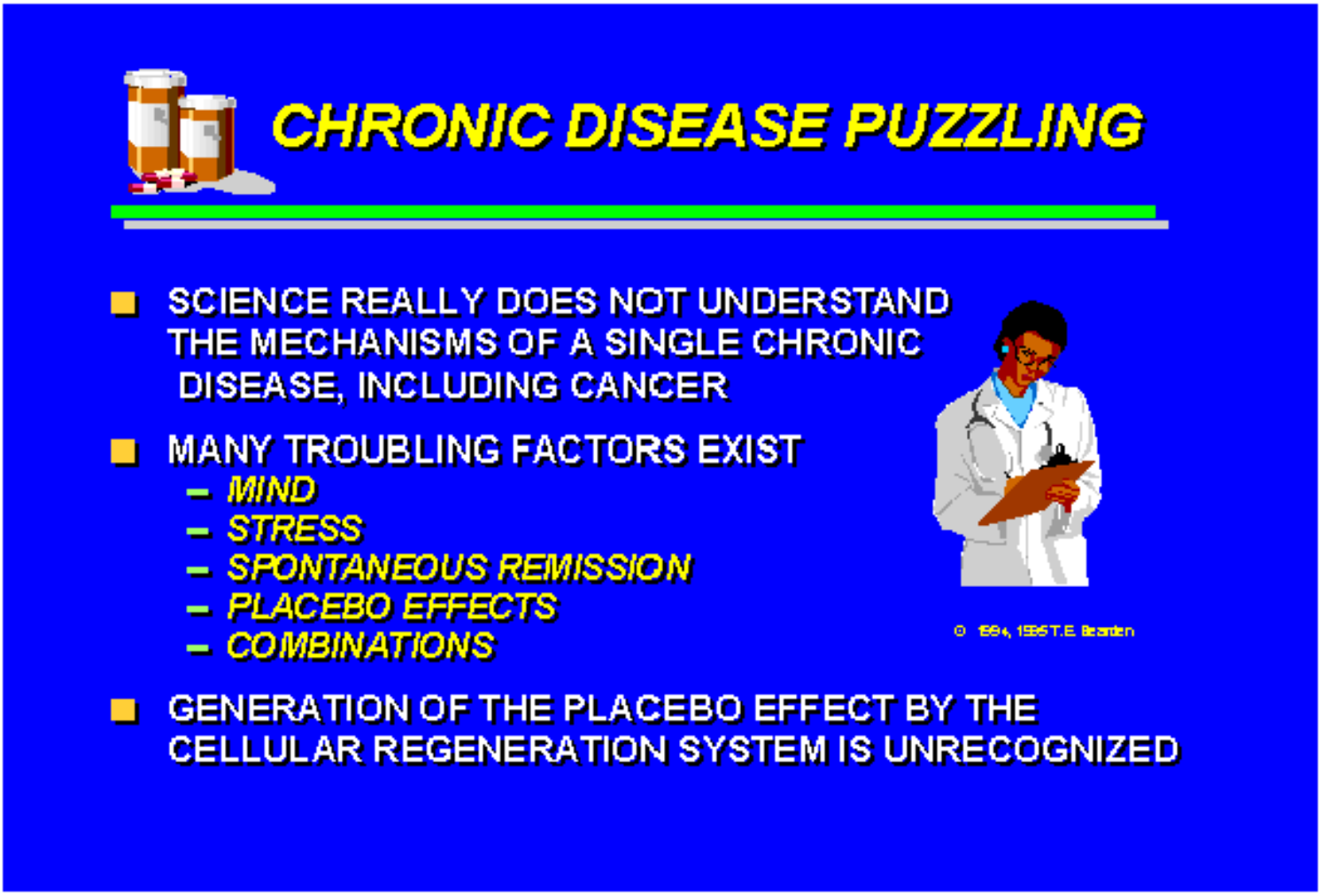

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Cancer Characteristics

- Not one disease, but a whole range
- Starts in damaged aerobic cell
- Cell shakes off body's central control
  - Starts uncontrolled division
  - Becomes a lump
- Can send forth cancer cells
  - Through blood
  - Through lymph
- Form metastases (secondary tumors)
- Often become anaerobic

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Solving a Cancer Enigma

- An enigma has been failure of immune system to attack some tumor cells
  - Suppressor cells may curb immune system?
  - Tumor may lack antigens normally identified by the immune system?
- *Promotion of damaged cell to cancer is usually ordered by cellular control system*
  - *Regenerative and recovery system forces cell back toward anaerobe*
  - *First step breaks free from central growth*
  - *Control continues to recognize cell as self*

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CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

*R&R system forces cell back toward anaerobe

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PORTABLE PRIORE TECHNOLOGY UNIT

- FACT: DISEASE-SPECIFIC VACUUM ENGINE PRESENT FOR ANY CELLULAR DISEASE, BY WHEELER'S PRINCIPLE

  - *DISEASE CAN BE REVERSED BY CREATING AMPLIFIED VACUUM ANTI-ENGINE (BEARDEN'S PRINCIPLE)*
  - *ANTI-ENGINES CREATED BY PUMPING THE NONLINEAR CELLS WITH LONGITUDINAL EM WAVES*

- PRIORE UTILIZED A PLASMA TO PHASE CONJUGATE AND "INFOLD" MULTIPLE BIDIRECTIONAL LONGITUDINAL EM PUMP WAVES
  - *MULTIPLE FREQUENCIES MIXED IN A ROTATING PLASMA*
  - *PHASE CONJUGATES ADDED BY THE PLASMA*

  - *INFOLDED MIX INTO STRONG PULSED DC MAGNETIC FIELD, WHICH CARRIED IT INTO ATOMIC NUCLEI*
  - *PUMPED ALL NONLINEAR CELLULAR COMPONENTS TO PRODUCE AMPLIFIED, SPECIFIC VACUUM ANTI-ENGINE*

- NEGATED THE CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CELLS.
- SCRUBBED OUT CUMULATED PRECANCEROUS STATE
- RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING
- NO EXCESSIVE TRAUMA TO TREATED ANIMAL

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Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

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S.E. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p.16-25.

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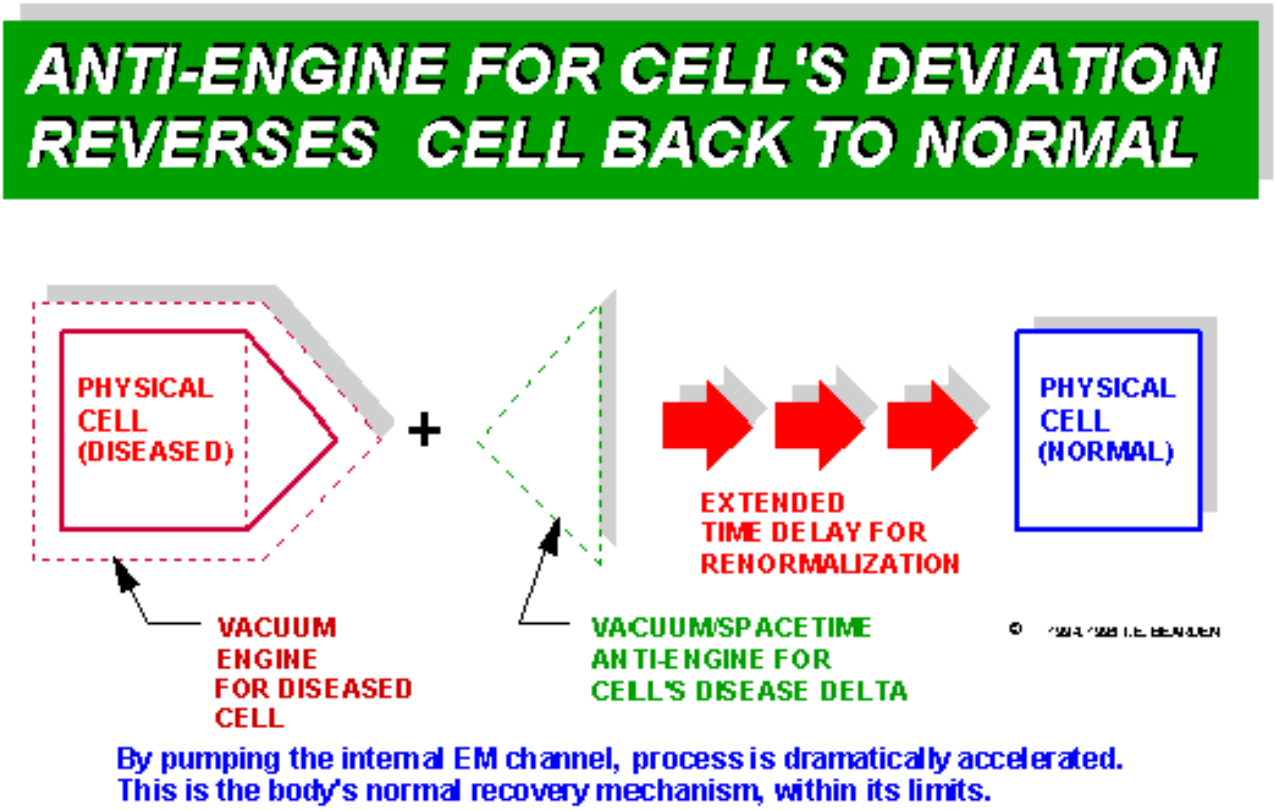

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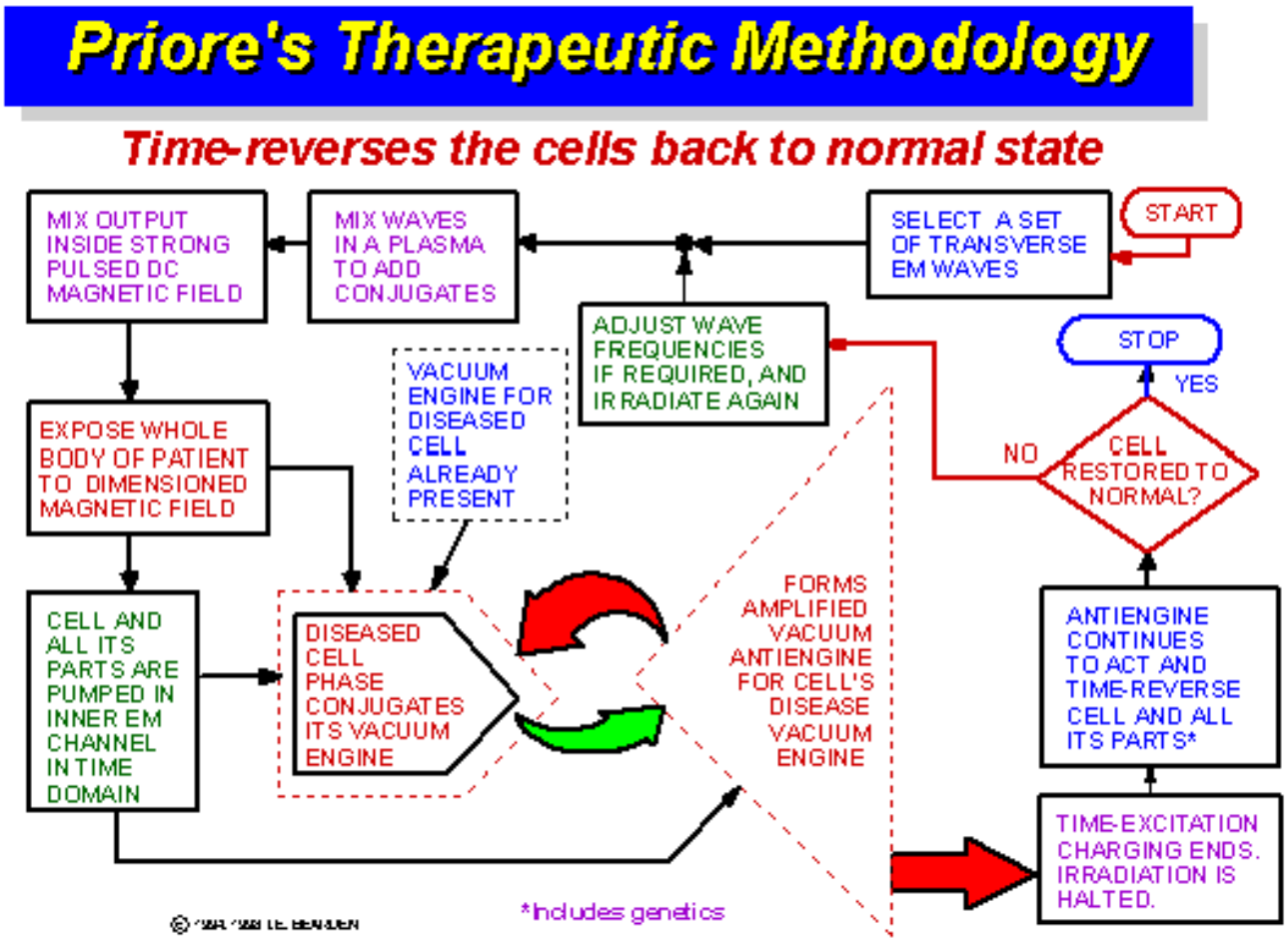

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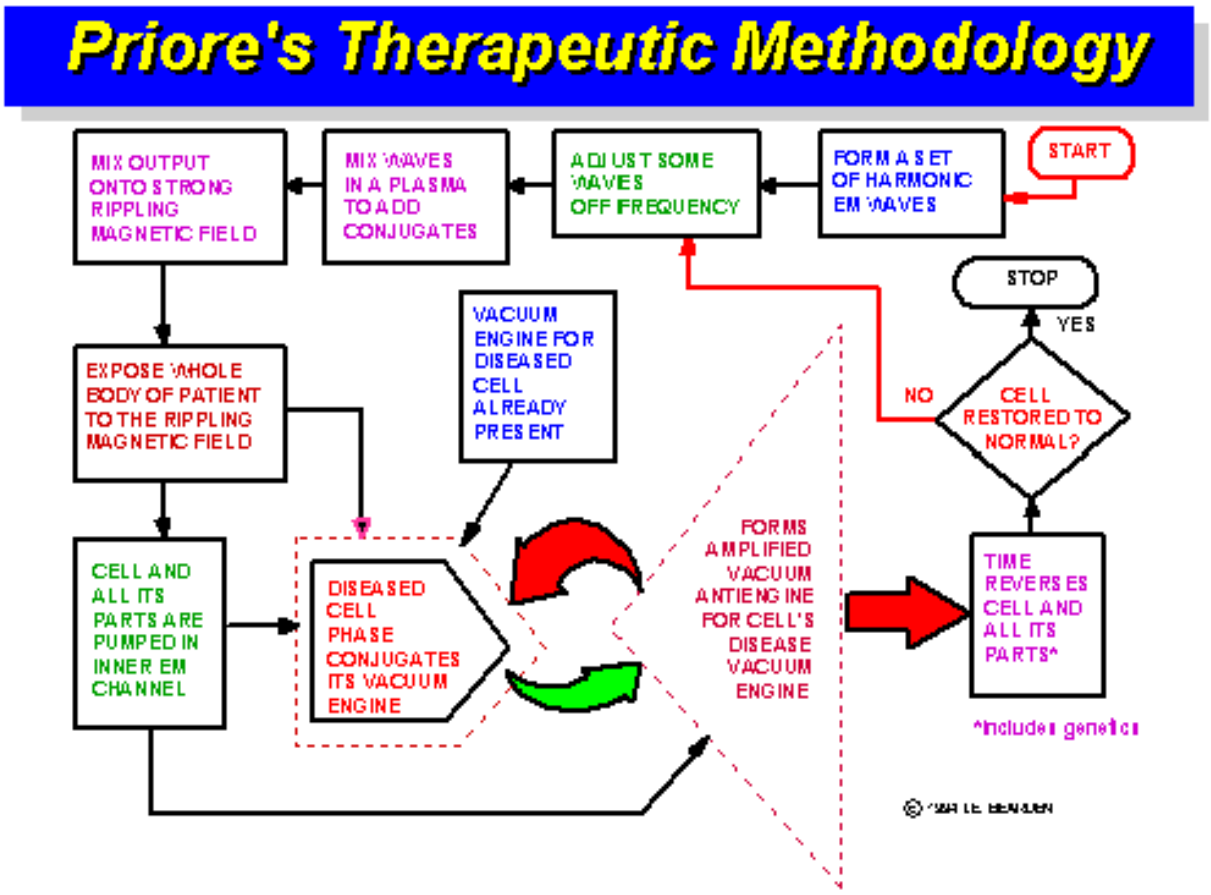

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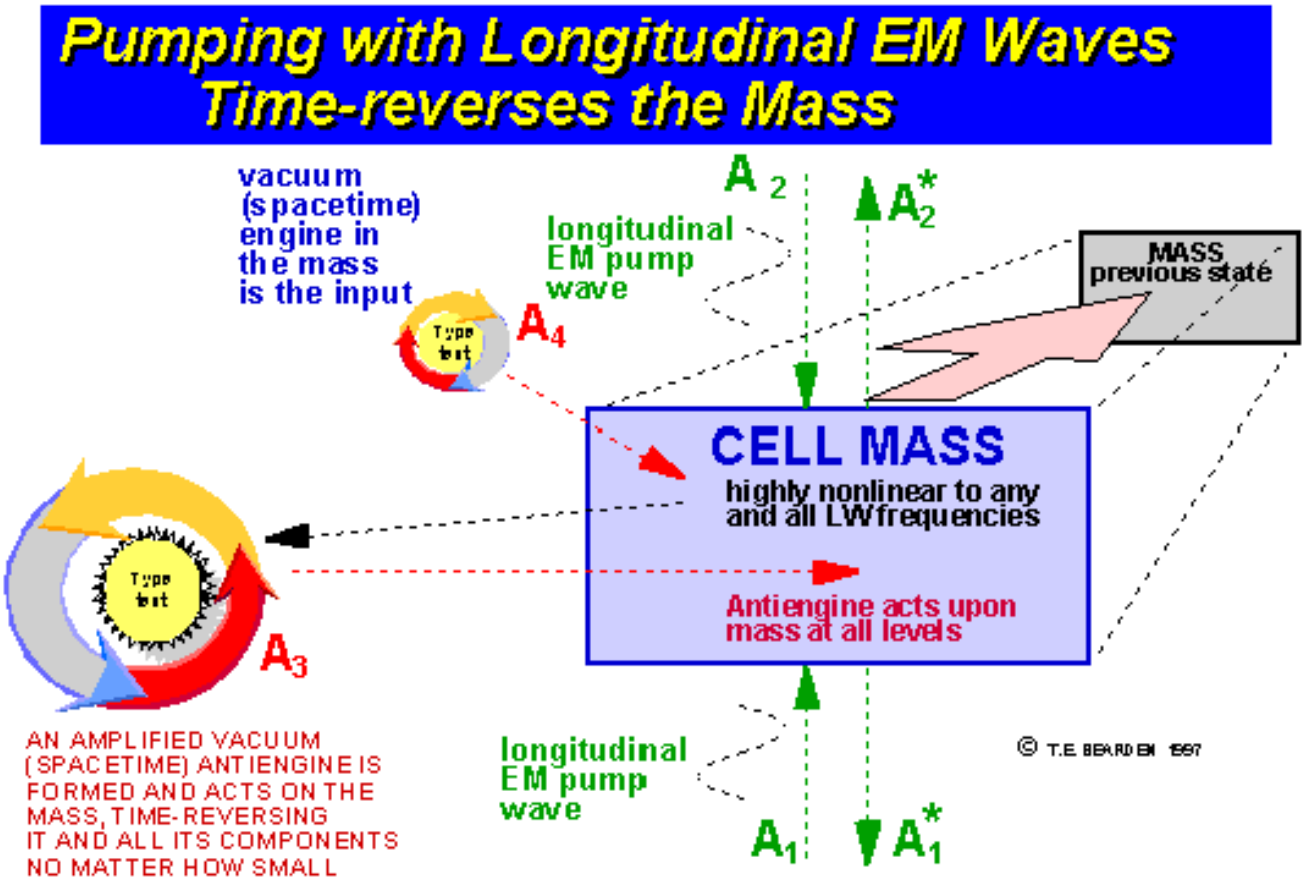

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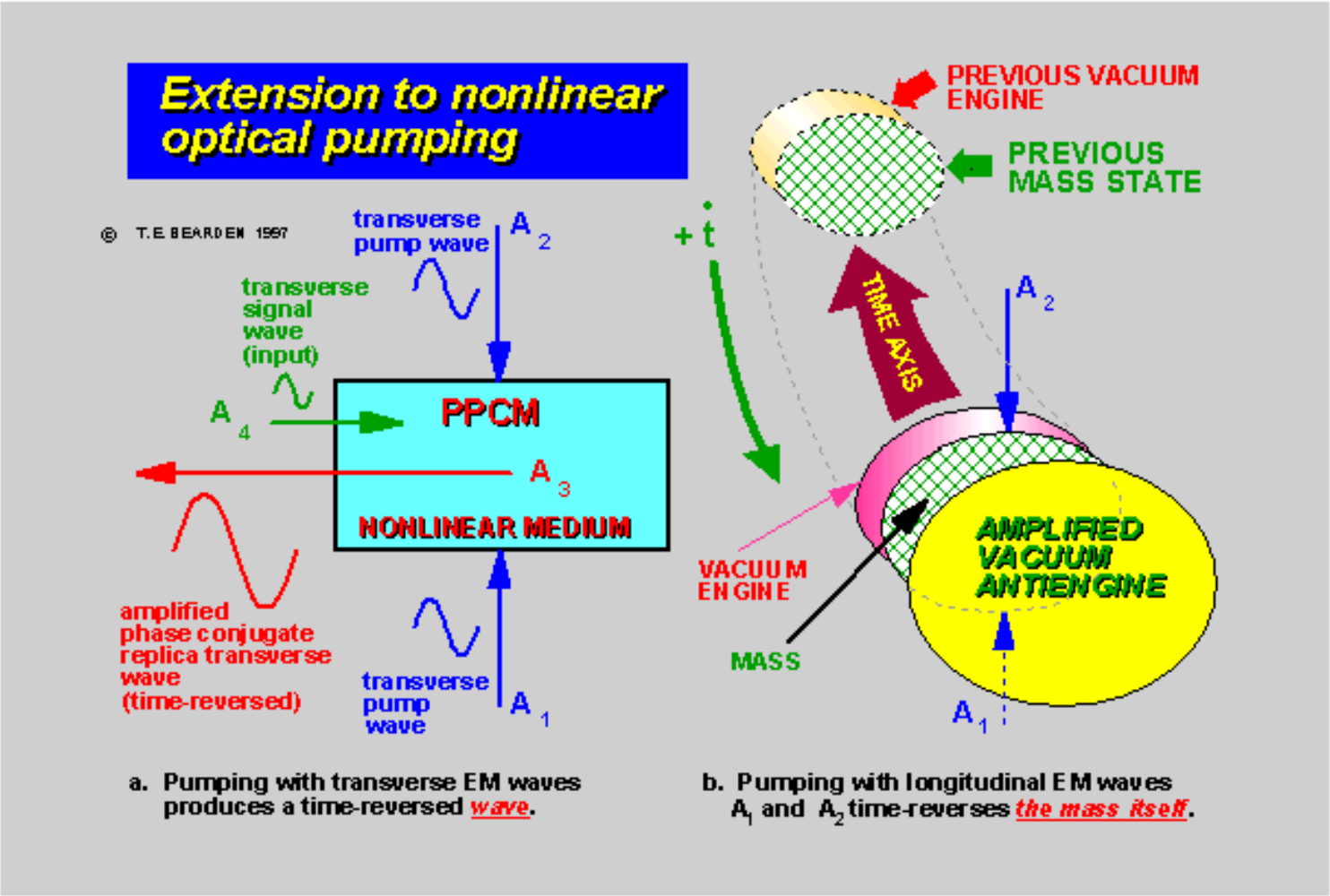

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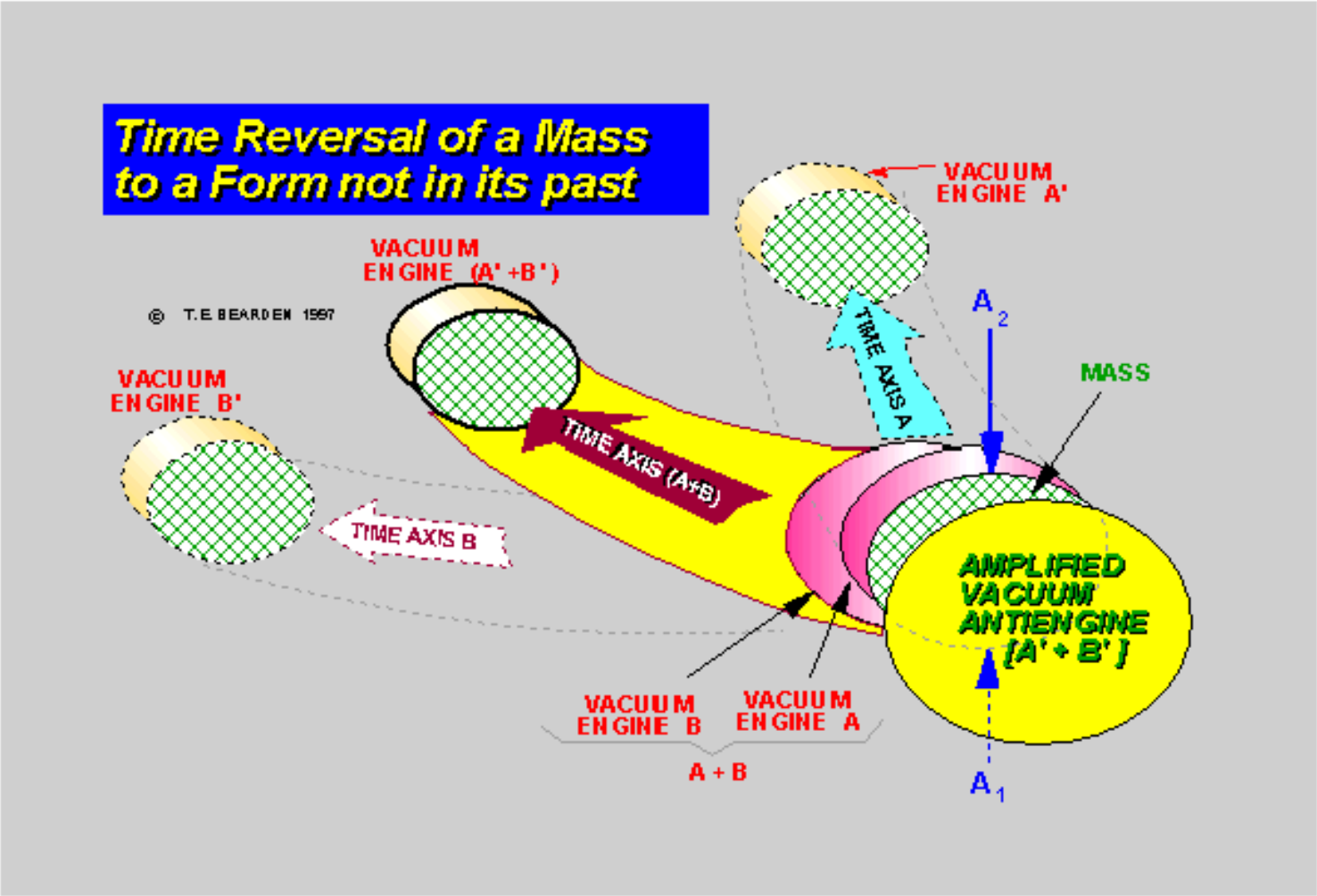

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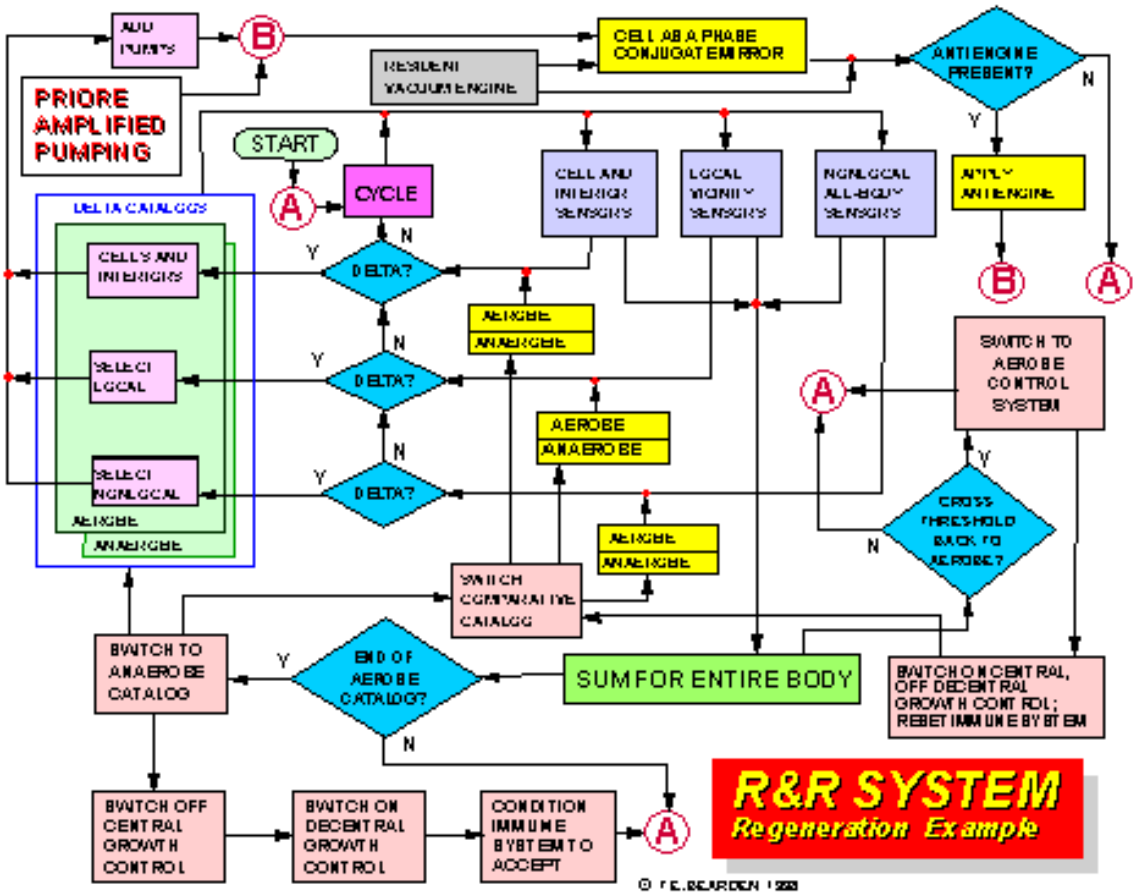

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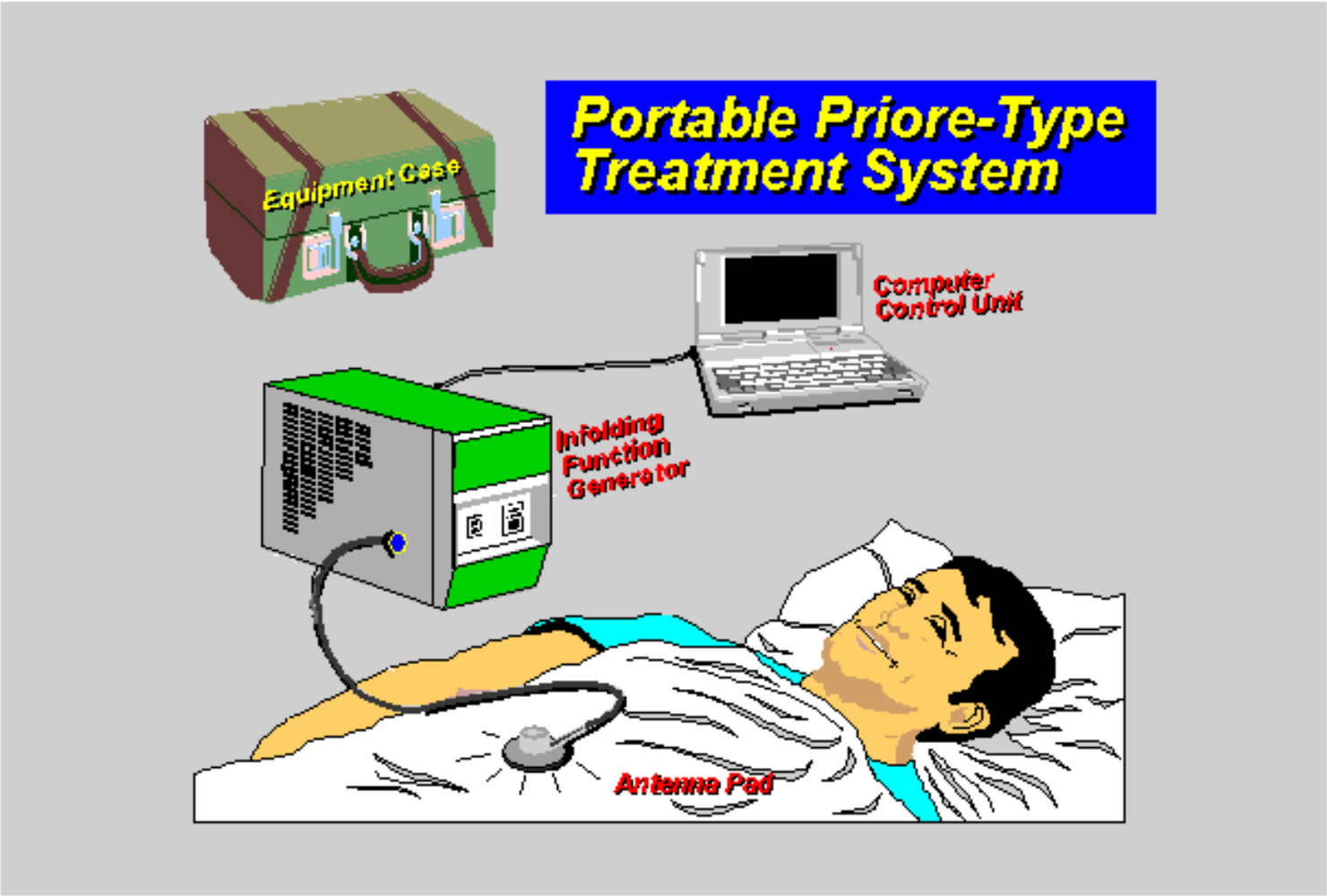

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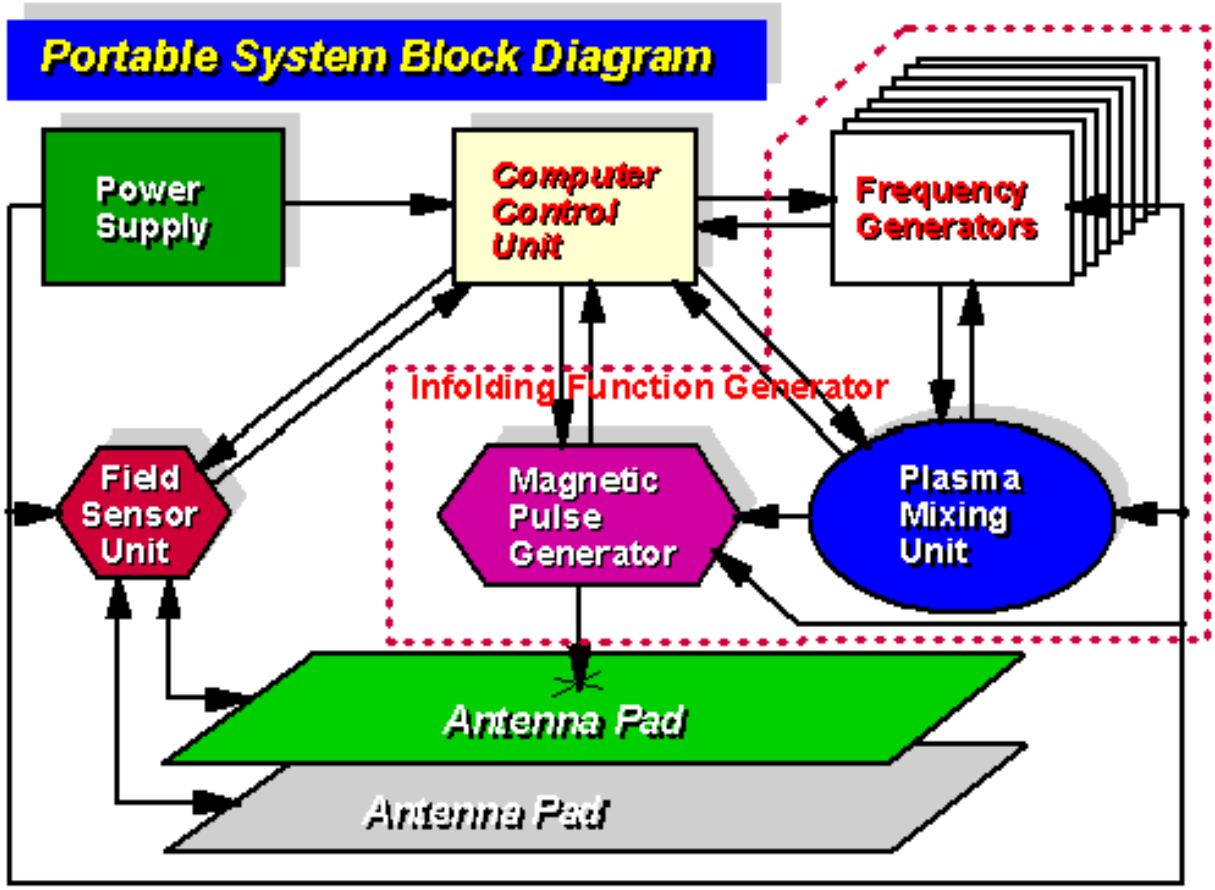

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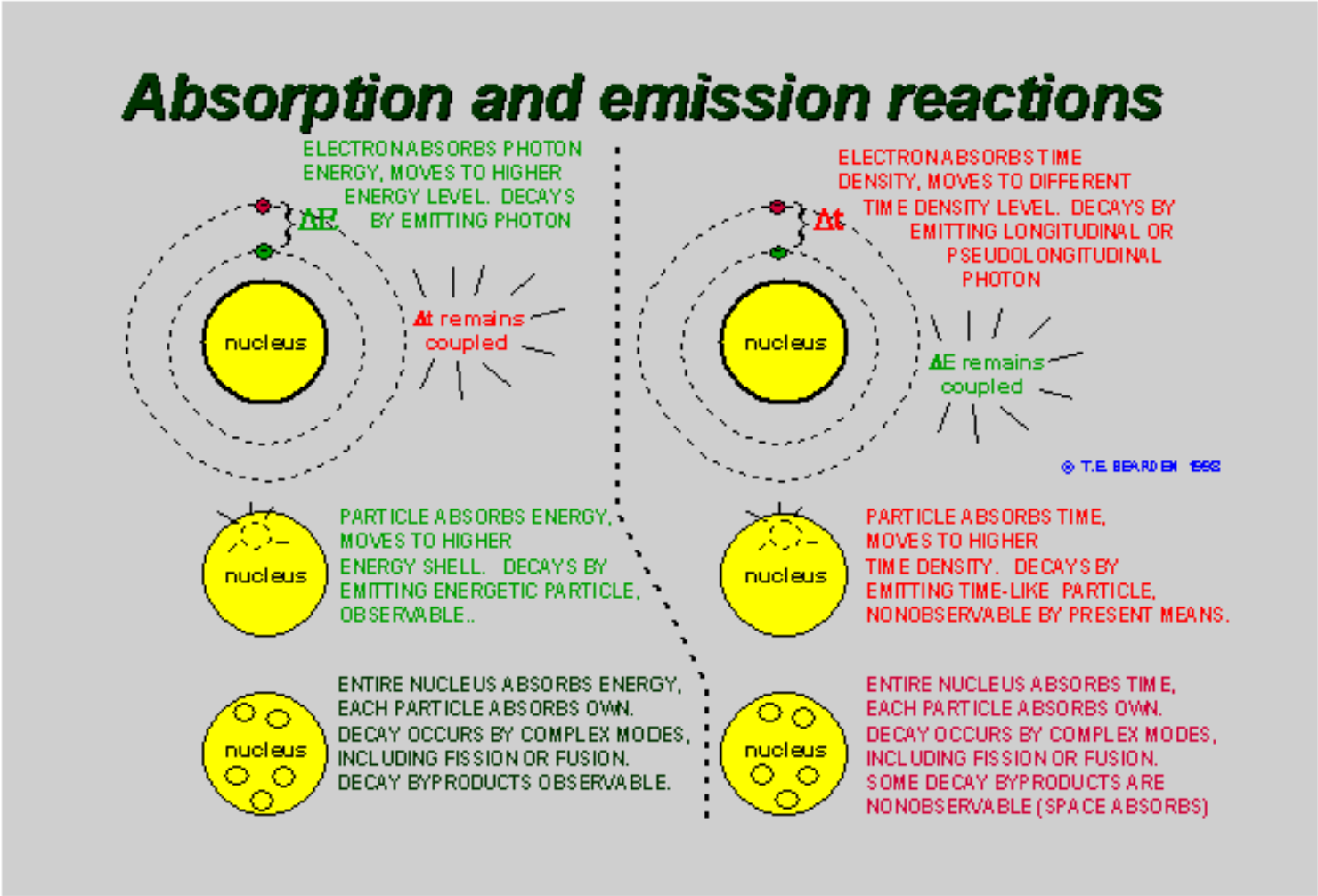

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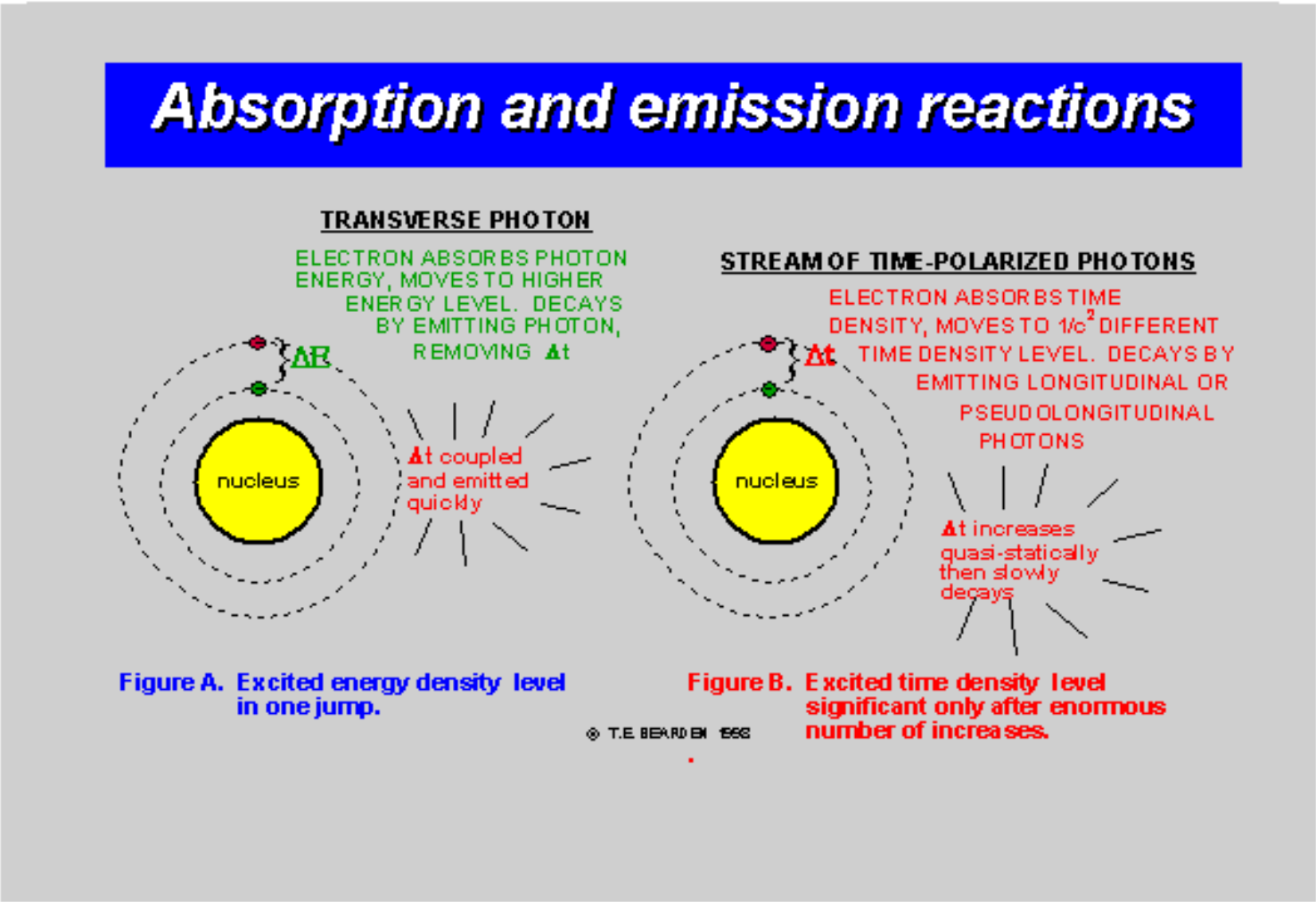

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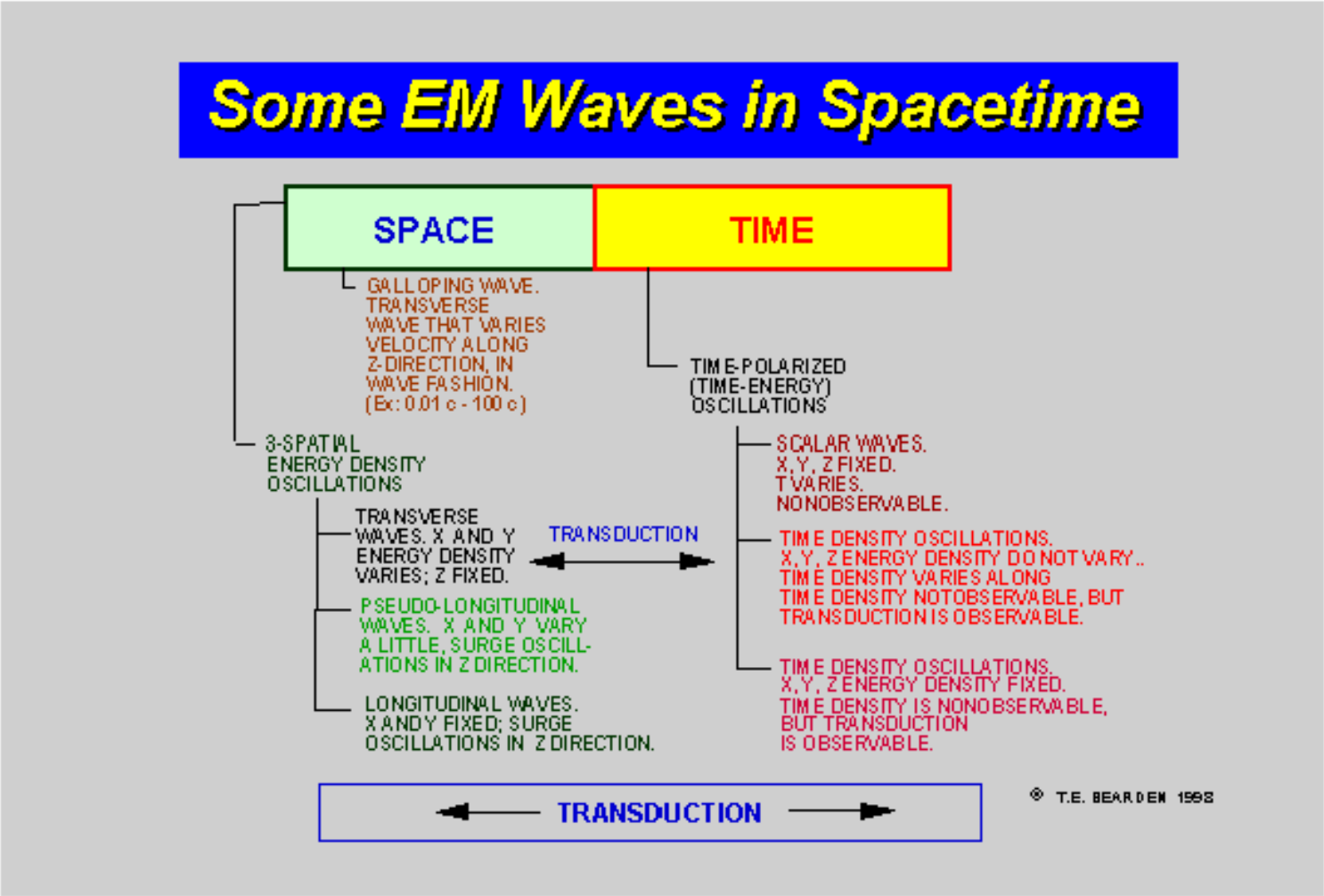

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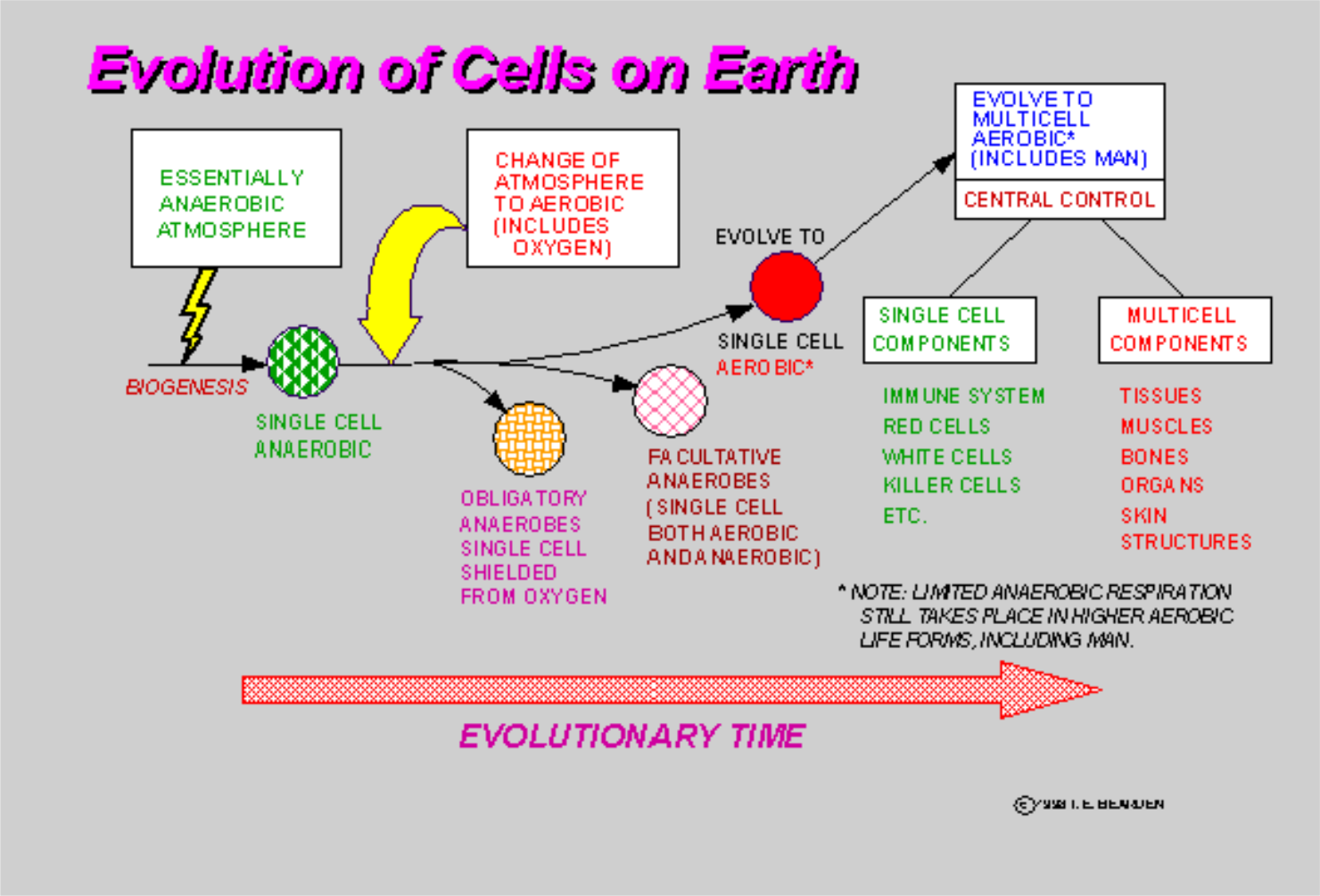

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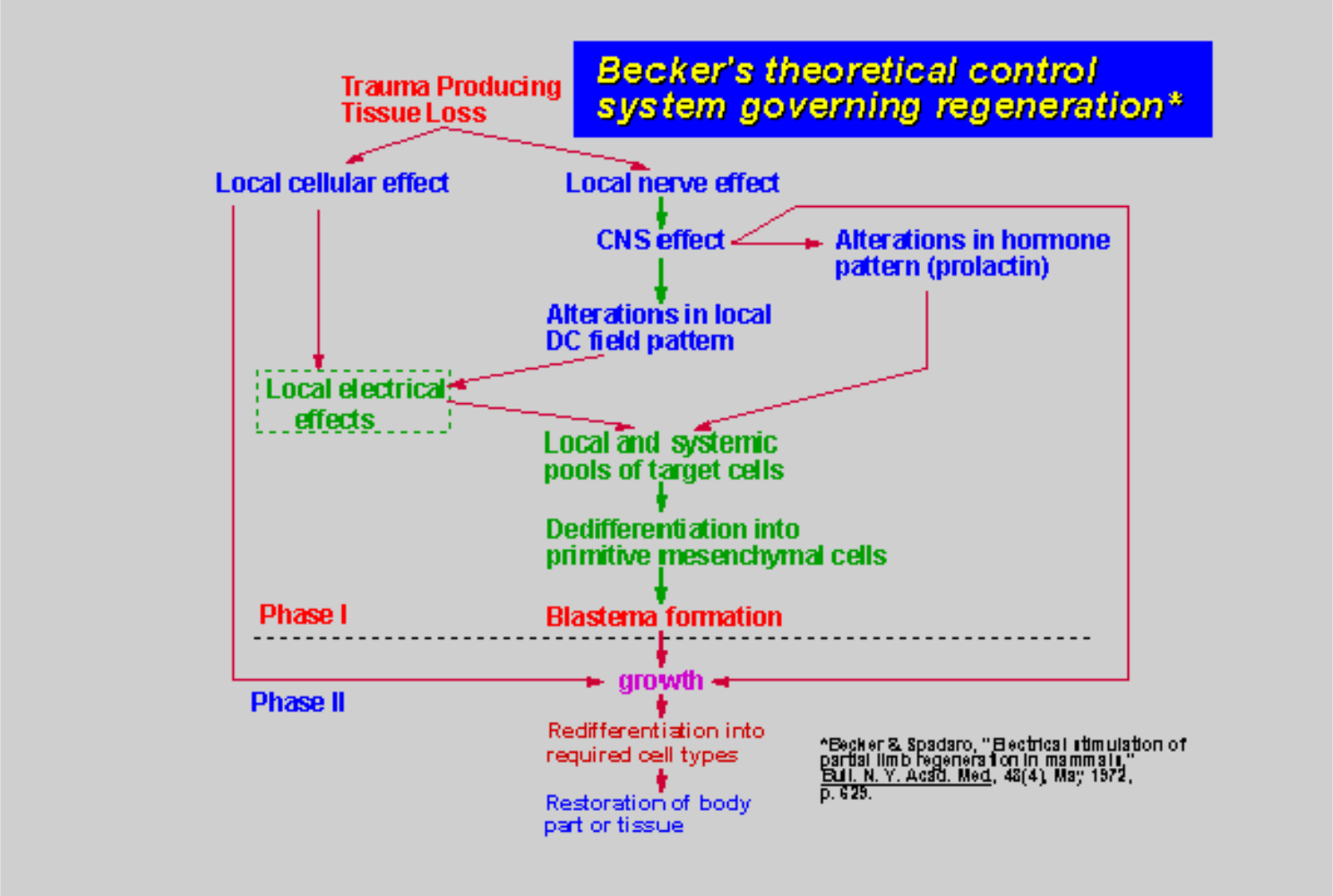

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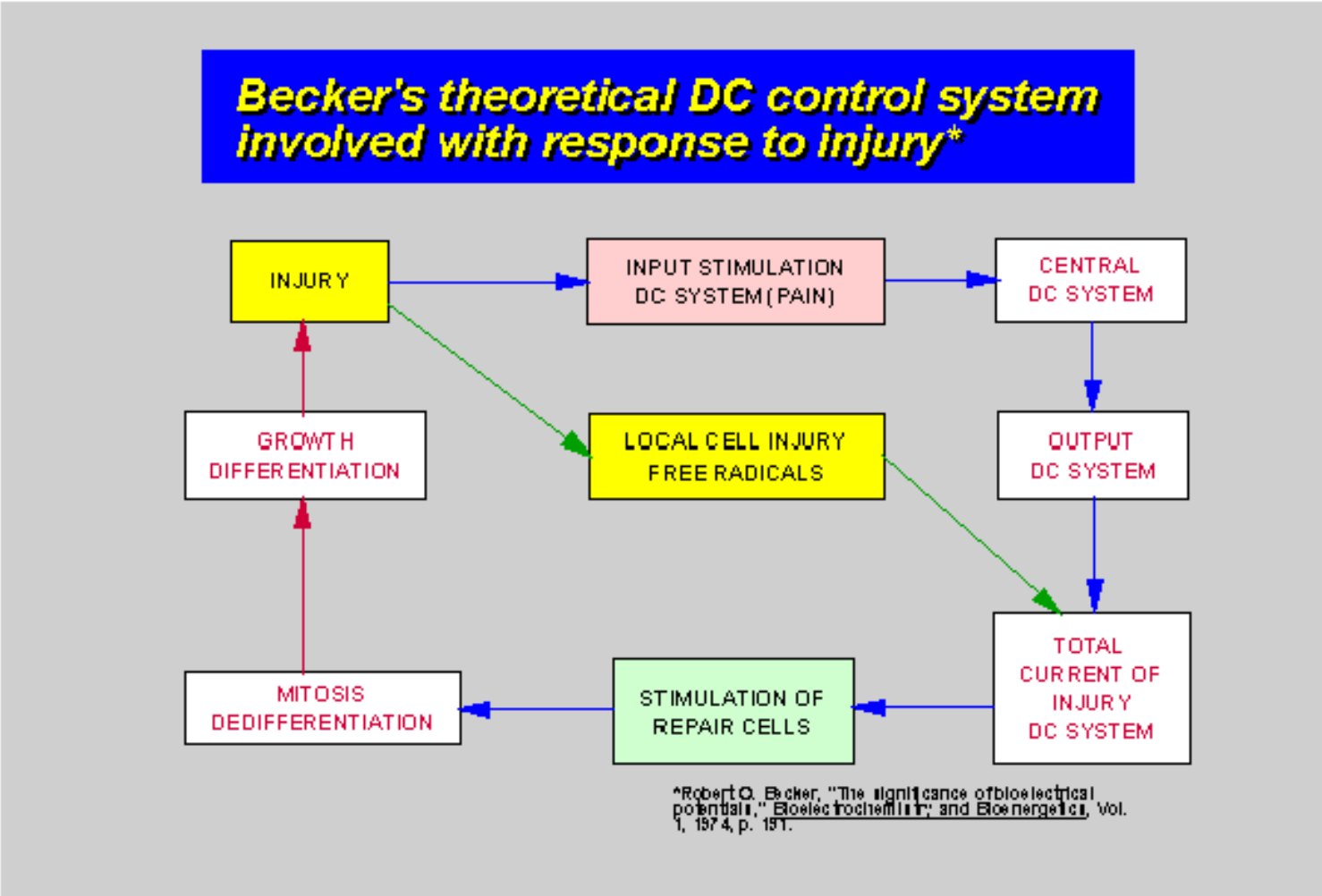

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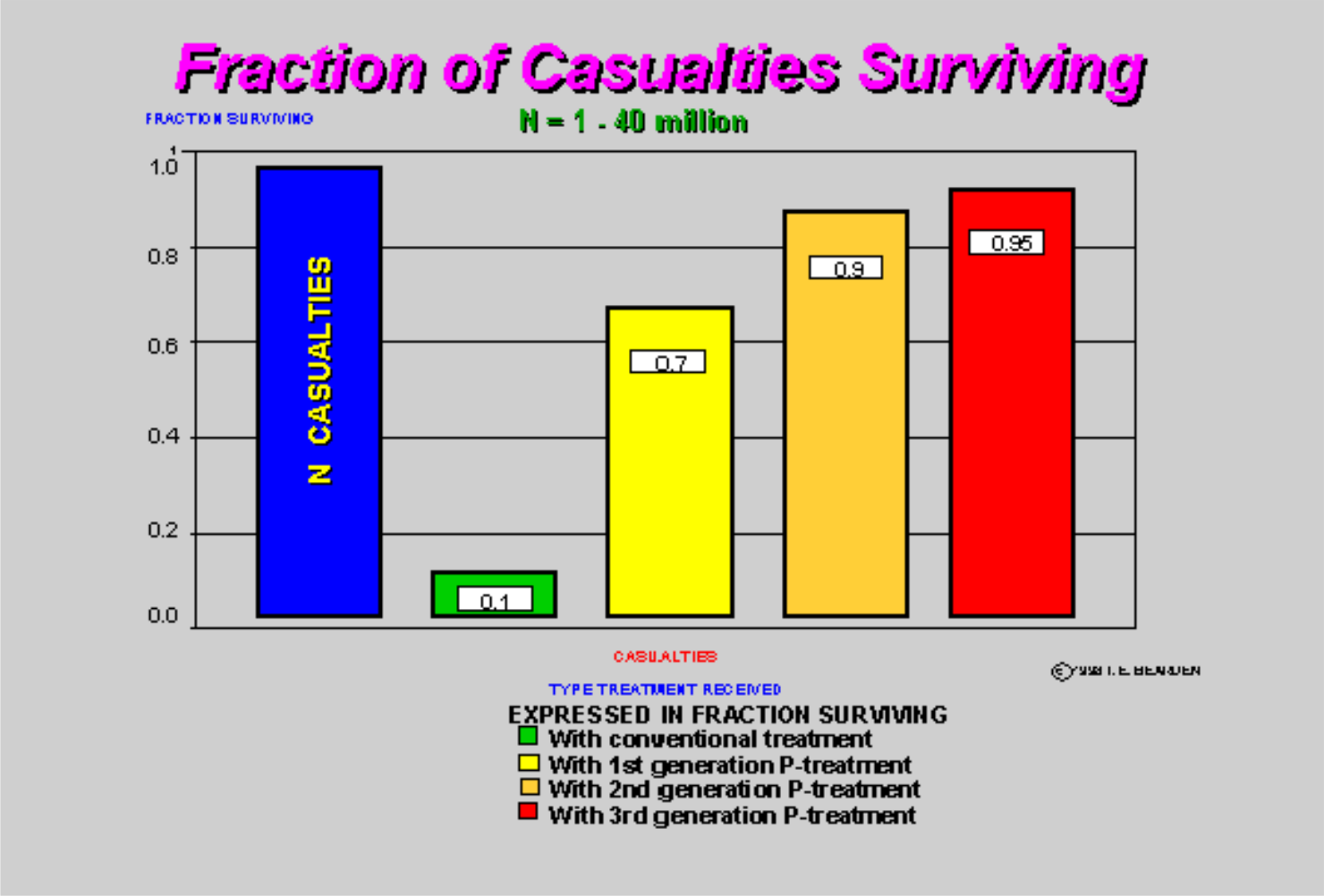

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"Time as fuel" is the future

- Present energy science is insufficient
- Eventually will use energy locked up in time itself
- Cold fusion will provide entrée
- Cold fusion has evidence of time-as-energy
- Theorists and experimentalists should examine the implications
- Must revise foundations of Electrodynamics

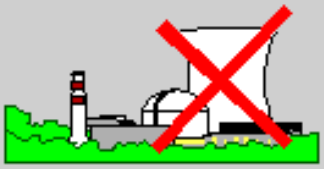

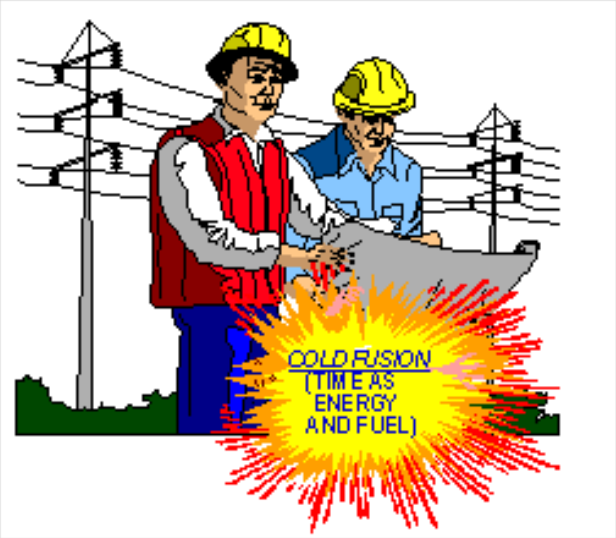

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A National Report on America's Energy Crisis

Remarks by U. S. Secretary of Energy Spencer Abraham

U. S. Chamber of Commerce, National Energy Summit March 19, 2001

Opening Remarks

I would like to congratulate the U. S. Chamber of Commerce for convening this two-day National Energy Summit and I appreciate your invitation to participate. As we all know, the topic of energy is as timely as the day's headlines. In just my first eight weeks as Energy Secretary, California has faced almost daily power alerts. Rising natural gas prices have punished consumers with bills that, in some cases, are double or triple last winter's. And forecasts for this summer suggest the possibility of rolling blackouts.

The good news is that America's energy problems can be solved. The bad news is that the situation in California is not isolated, it is not temporary, and it will not fix itself.

America faces a major energy supply crisis over the next two decades. The failure to meet this challenge will threaten our nation's economic prosperity, compromise our national security, and literally alter the way we live our lives.

America has heard these dire warnings before - in fact, they seem to be a recurring theme in our nation's energy discussion, almost since "Colonel" Drake made the first oil strike near Titusville, Pennsylvania in 1859. "The amazing exhibition of oil," advised the State Geologist of Pennsylvania, "[is] a temporary and vanishing phenomenon-one which young men will live to see come to its natural end. " That was in 1885.

Around the same time, John Archbold - who succeeded John D. Rockefeller as head of Standard Oil - joked about the prospects for oil discoveries in Oklahoma: "Are you crazy?" Archbold said. "I'll drink every gallon produced west of the Mississippi. "

I don't know if anyone ever called Mr. Archbold on that pledge. But for whatever reason, in 1914 the U. S. Geological Survey predicted that the U. S. would soon exhaust its available oil supplies. They issued the same warning in 1926. And again in 1939. And in 1949.

All of these warnings have proven false. Despite all these expert predictions, the world has not run out of oil or other resources. And yet here we are, faced with the most serious energy shortage since the days of oil embargoes and gas lines.

My point is, America's current energy supply crisis is not due to some inevitable neo-Malthusian depletion of resources. The United States - and our North American and hemispheric neighbors-are blessed with a rich abundance of natural resources. It's political leadership that has been scarce.

For the past eight years, Washington sat on the sidelines as our nation's energy needs mounted. During the 1990s, the Clinton Administration employed a policy of taxing demand, limiting supply, and ignoring the rapidly expanding needs of the future.

Their energy strategy boiled down to: you can't find it . . . you can't transport it . . . and even if you get it, we don't want you to use it.

Through neglect or complacency or ideology, this approach has led us to the crisis we face today.

The Bush Administration is fully prepared to respond to the broad set of challenges we inherited. But we must be candid with the American people about the magnitude of the problem - which is what I'd like to talk about today.

America's Energy Supply Challenges

Three overriding facts starkly define the challenge of America's energy needs over the next two decades:

First, demand for energy is rising across the board, but particularly for natural gas and electricity;

Second, supplies are being limited by a regulatory structure that, in many respects, has failed to keep pace with advances in technology and an uncertain political environment that often discourages investment in desperately needed facilities;

And third, our energy infrastructure - that network of the generators, transmission lines, refineries and pipelines that convert raw resources into usable fuel - is woefully antiquated and inadequate to meet our future needs.

Unless these challenges are addressed, America's energy supply will be continually at risk . . . our citizens will encounter blackouts and other lifestyle-altering disruptions . . . and our economy will be hobbled by rising energy prices. Let me briefly outline some of the major issues on the horizon:

Oil: Rising Consumption, Accelerating Dependence

In the next 20 years, according to estimates by the Energy Information Administration, America's demand for oil is projected to increase by 33 percent. Yet as consumption surges, U. S. production continues to drop precipitously. We now produce 39 percent less oil than we did in 1970, losing nearly 4 million barrels a day in the process. And unless energy policy is changed, production will slip further - to just 5.1 million barrels per day by 2020 - down from a high of 9. 4 million a day 30 years ago. This widening gap between demand and domestic supply will make us increasingly dependent upon foreign imports. Back in 1973-at the height of the oil crisis - America imported just 36 percent of its oil from abroad.

Today, we import 54 percent. And, if we allow this trend to continue, we will soon be forced to look abroad for some 64 percent of our oil. This will put more power in the hands of foreign suppliers - power they are not reluctant to use, as we just saw when the OPEC cartel decided to reduce oil output by one million barrels a day.

While this administration does not agree with OPEC's decision, that decision demonstrates the importance of increasing America's production of oil. Securing an affordable, reliable and adequate supply of crude is a critical challenge. But it is only half the oil story.

Since 1980, the number of American refineries has been cut in half. There hasn't been a new refinery built in the United States in over 25 years. New regulatory interpretations limit the ability of existing refineries to expand capacity. Add to that regulations that require the production of more than 15 different types of gasoline-and you have a refining industry strained to capacity, leaving us dangerously vulnerable to regional supply disruptions and price spikes.

Refineries are so constrained that when President Clinton made the politically symbolic gesture of releasing 30 million barrels of oil from the Strategic Petroleum Reserve last fall, that oil had to be shipped overseas to be refined.

Natural Gas: Rapidly Rising Demand; Constraints on Supply

Many of the same issues confront the future of natural gas. America's demand for natural gas is projected to rise even more rapidly than oil. If Department of Energy projections are correct, by 2020 Americans will consume 62 percent more natural gas than we do today. More than 9 out of 10 of the announced new electric generating plants will be fired by natural gas.

This approaching wave of new demand begs the question: Do we have an energy policy and a regulatory structure capable of meeting our natural gas needs?

Consider just a few constraints in this market.

Right now, an estimated 40 percent of potential gas resources in the United States are on federal lands that are either closed to exploration or covered by severe restrictions. The last lease sale in the some areas of the Gulf of Mexico was more than a decade ago. New discoveries of natural gas in the United States have fallen for three straight years, creating increasing pressure for more imports.

The notion that we can rely so heavily on natural gas . . . maintain severe restrictions on exploration . . . and still enjoy low prices is a dangerous assumption.

Even if we find the supplies, moving that gas to market will require an additional 38,000 miles of transmission pipeline and 255,000 miles of distribution lines-at an estimated cost of $120-$150 billion.

Today's pipeline system can hardly handle the supplies we know exist. Alaska's Prudhoe Bay, for example, produces about 8 billion cubic feet of natural gas a day - approximately 13 percent of America's daily consumption.

But that gas never reaches the market. Instead, it is just pumped back into the ground, waiting until a pipeline is built to connect the Alaska fields to the U.S./Canada distribution system.

Electricity: Powering the Information Economy

As everyone knows, we also face a real challenge in generating enough electricity to light out homes and run our businesses. Over the next 20 years, the Department of Energy estimates that electricity demand in the United States will increase by 45 percent. That rising growth rate will require the construction of over 1,300 new power plants-about 65 every year.

Yet, the last time we added that much power was 1985.

Furthermore, there is reason to believe that this could turn out to be a conservative estimate. During the 1990s, electricity consumption far outstripped projections, driven by the energy-hungry information economy. Some experts calculate that the demands of the Internet already consume some 8-13 percent of electricity. If demand grows at just the same pace as during the last decade, we'll need nearly 1,900 new plants by 2020-or more than 90 every year-just to keep pace.

Hundreds of new generating plants will place even greater pressure on our already strained and aging power grid. America's network of transmission lines, substations and transformers was built when utilities were tightly regulated monopolies providing service to assigned regions. Interconnections between suppliers were strictly an emergency backup measure to guard against rare service interruptions. The system was simply not designed for long-haul swapping of power in a highly competitive market.

Consumers are already feeling the impact of a transmission systems stressed by rising demand. Transmission bottlenecks contributed to the blackouts that have swept through California and to price spikes in New York City last summer that cost consumers an estimated $100 million.

Coal, Nuclear, and Hydro-Electric Power

Coal has historically been American's number one source for affordable electricity; it currently powers half of America's electricity generators. And at today's recovery rates, our nation has enough coal to keep those plants running for the next 250 years.

Coal generators have already been called upon to make broad reductions in emissions. The Bush Administration supports those efforts-and we will back it up with greater incentives for investment in clean coal technology.

But the administration will not regulate coal out of existence . . . and we will not support measures that will threaten electricity supplies and significantly raise electricity prices. President Bush made the right decision last week not to impose new federal mandates on the emissions of carbon dioxide. If America is to have reliable electricity over the next 20 years, coal must continue to play a major role.

But, coal is not the only energy source facing an uncertain future. There hasn't been a new nuclear power plant permit granted since 1979. Many of the 103 existing nuclear plants are not even expected to file for a renewal of their licenses as they expire over the next 15 years.

Even hydroelectric power generation is expected to fall sharply.

Re-licensing a hydro facility can take a decade or more and cost millions. And now, even though consumers are faced with potential blackouts and chronic electricity shortages in the West, activists and some political leaders want to breach one or more of the four federal dams on the Snake River to help young salmon, on their trek to the sea.

The Dangers of Complacency

What are the dangers of complacency in light of these challenges? How does it all add up for our economy and our citizens?

This nation's last three recessions have all been tied to rising energy prices - and there is strong evidence that the latest crisis is already having a negative effect.

The National Association of Manufacturers estimates that soaring fuel prices between 1999 and 2000 cost the U.S. economy more than $115 billion-shaving a full percentage point off our Gross Domestic Product. A January survey of its 5,500 members reveals that nearly one quarter were forced to curtail operations.

During a two-week period this past January, Californians lost an estimated $2.3 billion in wages, sales and productivity. Layoffs are already hitting workers in the West as companies shift production to states with more reliable energy sources. Then there are the jobs that will never be created.

Intel's CEO Craig Barrett announced that the world's leading chipmaker won't be expanding in California: "As long as California is a Third World country," Barrett said, "we won't build $2 billion manufacturing plants here."

The Food and Agricultural Policy Institute reports that farmers are likely to see their income drop 20 percent over the next two years due to higher energy costs.

Rising energy costs are hitting every family's checkbook, primarily affecting those who can afford it least. Gas bills for many homeowners in the Washington, DC area more than tripled this year. Some residents are reporting that their heating bills are higher than their food bills this winter.

The power crisis isn't just pinching our wallets, it's changing the way we live our lives. In California, power outages have shut down traffic lights, darkened schools and closed businesses. The governor has ordered local police to patrol the streets-not for criminals, but to make sure businesses keep their lights dimmed.

But California is not the only state facing a mismatch between supply and demand. With electricity shortages predicted for New York City and Long Island this summer . . . low capacity margins threatening electricity reliability in the Midwest, Southeast and Northern Plains states . . . and strained refinery capacity in the Midwest, Americans across the nation are feeling the energy squeeze.

The Need For A National Energy Policy

Rising demand . . . tightening supplies . . . an aging power infrastructure . . . a decade of neglect from Washington: These are the trends that define America's emerging energy needs.

President Bush has committed this administration to meeting these challenges - a job that begins with the urgent task of developing and implementing a long-term national energy policy.

To accomplish this, President Bush created an Energy Task Force headed by Vice President Cheney. He

has asked us to define a clear strategy - a strategy that will allow environmentally responsible exploration and recovery of our domestic resources . . . enhance our commitment to conservation and energy efficiency . . . and encourage investment in new technology to further the development of renewable energy sources.

I wish I could say that the energy crisis now sweeping the nation has shocked the political system into action. But like other political discussions in recent years, the debate over energy seems as deeply polarized as ever.

On one end of the spectrum, some activists propose what amounts to a "zero tolerance" policy toward exploration and cling to the quixotic idea that new, undiscovered sources will somehow allow us to meet our energy needs. On the other end, some advocates place an almost limitless faith in special tax breaks for this favored activity or subsidies for that preferred industry.

The two extremes in our energy debate are founded on several enduring myths - myths that today conspire to block any true advance toward a rational and stable energy policy in the United States. Here are a few of the more prominent ones.

Myth Number 1: It is impossible to balance energy exploration and environmental protection.

Advances in technology have brought us a long way from the days when wildcatters punched holes in the ground based on the hunch they might hit a gusher. But from a regulatory standpoint, our view of oil and gas exploration hasn't changed much since we saw Jed Clampett strike "black gold" and split for Beverly Hills.

Today, satellites and computers are the tools of choice in the exploration business. Geologists can bounce acoustic and electrical vibrations off the earth's inner depths, gather the resulting mass of data into powerful computers and then create three dimensional and even four dimensional maps of resource fields miles below the surface.

Armed with these pinpoint accurate images, companies employ advanced equipment to drill vertically, horizontally and around corners-allowing us to access supplies from previously unimaginable depths, up to six miles away.

The marriage of oil and gas exploration with cutting-edge technology means fewer rigs, fewer roads and fewer pipelines. Drilling operations that required 65 acres in the 1970s need only 10 acres today. Technological improvements in just the past 15 years have generated success rate increases of 50 percent. America's national energy policy must reflect these staggering advances that have revolutionized the way we develop our resources.

Myth Number 2: All our current problems are due to an energy industry that is engaged in a massive conspiracy to gouge consumers by limiting supply to drive up prices.

This myth has been punctuated by calls for investigations into everything from last summer's Midwest gasoline price spikes, to recent allegations that power generators in the West have been withholding electricity. We have a fair and objective process for judging these claims-and action will be taken when it is merited. Over the past two weeks, for example, the Federal Energy Regulatory Commission ordered power companies to rebate some $124 million to California utilities. Meanwhile, the Federal Trade Commission recently cleared gasoline suppliers of all charges relating to last summer's price increases.

But charges of price gouging largely miss the point. There is no magic source of supply; no hidden pool of energy that can be turned on and off like a faucet. California-and other power-strapped states-will never solve the power crises they confront until they resolve the conflict between demand and supply.

Earlier this year, one company proposed building a $400 million power plant in California that would have provided enough additional electricity to light 600,000 homes in energy-starved Silicon Valley. The company pledged to plant 800 new trees to beautify the area. They proposed cloaking the power station in a brick facade to make it essentially indistinguishable from a high-rent office complex. They even promised to help maintain the local habitat for the endangered bay checkerspoon butterfly.

Their environmentally-sensitive plans won the support of the Sierra Club, the American Lung Association and the NAACP. But city officials voted unanimously -- 11-0 -- to reject the plan. In an editorial, the local paper called this move "Dumb and Dumber."

Meanwhile, further south, plans to build a 550-megawatt gas-fired generator in a Los Angeles suburb were scrapped after residents voted 2:1 against the project. The local mayor added a much-needed dose of reason and maturity to the debate-by launching a hunger strike in opposition to the plant.

In California, workers are being laid off, companies are leaving the state, farmers and small businesses are losing millions, consumers are threatened with rolling blackouts, but local officials reject power plants with little regard for the consequences. Is it really any mystery why there hasn't been a single new power plant built in California in the last decade?

Myth Number 3: The Bush energy plan is focused almost exclusively on opening the Arctic National Wildlife Refuge (ANWR) to exploration-a move that would buy us only about 6 months worth of American consumption while destroying a pristine natural wilderness, not to mention disrupting the breeding ground of the Porcupine Caribou.

Let's separate fact from fiction when it comes to ANWR.

First, according to estimates by the U. S. Geological Survey, ANWR holds between 5. 7 to 16 billion barrels of recoverable reserves-with a mean estimate of 10. 4 billion barrels. And that assumes the use of drilling technology now nearly a decade old. This represents more than 300 times the amount of the

oil President Clinton released from the Strategic Petroleum Reserve last fall. And based on December 2000 figures, it would free us from about 54 years of oil imports from Saddam Hussein and Iraq.

Second, exploration would impact only about 2,000 acres out of more than 19 million. To put that in perspective, the massive Arctic National Wildlife Refuge is about the same size as the entire State of South Carolina; the two thousand acres that would be affected is less than half the size of Dulles airport.

And as for the caribou, the herd in the Prudhoe Bay area grew more than 9-fold over the past 20 years to an estimated 28,000 in 2000-seemingly irrefutable evidence that caribou mating and oil exploration can peacefully coexist.

The decision to open a small portion of ANWR should be made on the merits. But it should not be made on the mistaken assumption that opening ANWR will allow us to produce our way to full energy independence.

America first became a net importer of energy in the 1950s - and our economy will continue to depend, in part, on imported oil. However, closing off virtually every available new source of domestic supply, enhances the leverage and power of an oil cartel that cannot be relied on to put America's interests first. While the resources of ANWR won't make us energy independent, they will help increase America's energy security by ensuring a more diverse supply of oil.

Myth Number 4: Government subsidies and tax breaks are the best way to encourage new exploration and production of energy.

This administration will continue to support funding for energy research and development initiatives. But capital is best allocated to its highest uses through the workings of the free market, not manipulations of the tax code. Government regulatory policy should not be aimed at picking winners and losers in any market, including energy. Neither should tax policy.

Myth Number 5: We can forego traditional sources and instead meet rising energy demand by harnessing wind, geothermal, solar and other forms of renewable power.

Excluding hydro-power, renewable sources currently generate about 2 percent of America's electricity. Billions have been invested in developing renewable energy-and will continue to be invested under the Bush Administration. But renewables have yet to overcome the economic advantages of conventional energy sources.

Even with promising advances in research and development, renewables will only provide, according to Energy Information Administration estimates, about 6 percent of our total electricity consumption by 2020. Even if renewables exceed our most optimistic expectations, they would still supply only a fraction of our needs over the next 20 years.

Myth Number 6: Price controls are the answer to today's energy crisis.

Memories are short, aren't they. So let me remind everyone. America imposed price controls on oil and gas in the 1970s. They were an utter failure. They led to shortages and rationing and the idea that America was gripped by malaise.

Let me be clear: The Bush Administration does not support price controls. Price controls on electricity will lead to more blackouts. Price controls on gasoline will lead to gas lines. Price controls will deepen America's energy crisis, because they won't reduce demand, but they will cripple incentives for desperately needed new investments in energy supply.

Charting a New Policy Course

The challenges are formidable . . . the warning signs are obvious . . . but I am optimistic because I know this administration's commitment is equal to the task.

Our national energy policy will be comprehensive. It will reach across every department that touches the energy marketplace-from the Interior Department and the EPA to the Transportation Department and the DOE.

Our national energy policy will be hemispheric. It will be based on the understanding that our policy cannot stand in isolation from our neighbors throughout the Americas.

Our national energy policy will stress the need to diversify America's energy supply. It will be founded on the understanding that diversity of supply means security of supply . . . and that a broad mix of supply options-from coal to windmills, nuclear to natural gas-will help protect consumers against price spikes and supply disruptions.

And our national energy policy will be balanced. It will leapfrog the myths that stifle change-rejecting the notion that there is no middle ground between environmental protection, regardless of the cost and energy exploration, regardless of the impact.

Soon we will deliver our recommendations to President Bush. Later, we will introduce legislation aimed at winning bipartisan support for a national energy policy that matches the magnitude of the challenge. I am hopeful that men and women of good will-from both ends of the political spectrum . . . from environmental organizations to industry groups-will then come together and transcend the stale debate that has characterized energy policy in recent years.

About 150 years ago, America faced a vastly different energy crisis.

Supplies of whale oil were becoming more and more scarce. Few could afford to pay for the luxury of this or other costly methods of illumination. Sure, crude oil was available. In those days it was soaked up with rags, wrung out into small vials, and then sold as a treatment for toothaches . . . until an entrepreneur lined up an investor and a chemist and launched an energy revolution that would light the world.

In America, resources become scarce only when our imagination languishes. By engaging that imagination, I am confident we can meet the challenges of today. If complacency yields to action. If we resolve to strike a rational balance between our energy needs and our environmental concerns. And if a national energy policy becomes an urgent priority.

Thank you.

Report by Energy Secretary Spencer Abraham

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Report by Energy Secretary Spencer Abraham

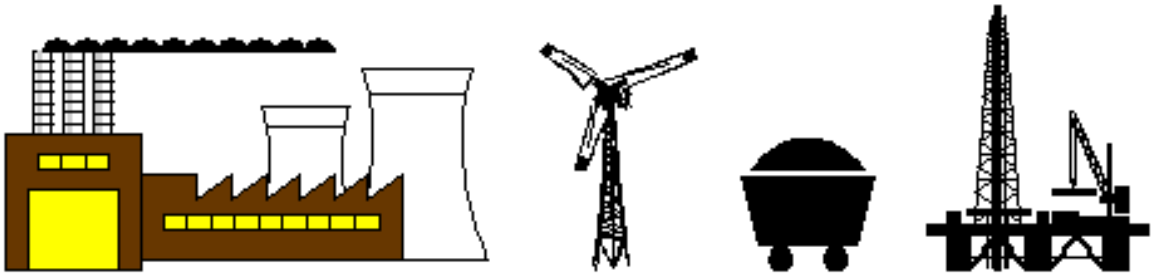

National Energy Summit,
U.S. Chamber of Commerce
Mar. 19, 2001

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National energy policy for 8 years

- The national policy imposed the following:
  - Taxed energy demand
  - Limited the energy supplies
  - Ignored expanding energy needs
- Summary of the past policy on energy:
  - You cannot find it
  - You cannot transport it
  - If you get it, we don't want you to use it
- *Good News:* Crisis can be solved
- *Bad News:* Not temporary; will not fix itself

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Energy supply challenges

- Demand for energy rising across the board, particularly for natural gas and electricity
- Supplies limited by regulatory structure
  - Failed to keep pace with technology advances
  - Uncertain political environment discourages investment in desperately needed facilities
- Energy infrastructure is woefully antiquated and inadequate

Note: The energy infrastructure is that network of generators, transmission lines, refineries, and pipelines that convert raw resources into usable energy or fuel

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Oil: Rising consumption and accelerating dependence

- In U.S., will increase 33 percent in 20 years
- U.S. production continues to drop
  - Produce 39% less now than in 1970
  - At present reduction rate, production will decrease to 5.1 million barrels per day by 2020, down from 9.4 million barrels per day in 1970.
- Imports have steadily risen
  - From 36% in 1973 to 54% today
  - Will soon rise to 64% unless checked
  - Empowers foreign suppliers such as OPEC
- Assuring affordable, reliable, adequate supply of crude oil is a critical national challenge

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Oil: Rising consumption and accelerating dependence

- We have been decreasing the infrastructure
  - Since 1980, U.S. refineries reduced by 50%
  - No new refinery built in over 25 years
  - New regulatory interpretations limit expansion of capacity of existing refineries
  - Regulations require producing more than 15 different types of gasoline
  - Refining industry strained to capacity
- E.g., Clinton symbolically released 30 million barrels of oil from the Strategic Petroleum Reserve
- *The oil had to be shipped overseas to be refined!*

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Natural Gas: Rapidly rising demand, supply constraints

- By 2020, U.S. will consume 62% more natural gas than today
- More than 9 out of 10 of announced new electric power plants will be fired by natural gas
- 40% of potential gas resources are on federal lands either closed or severely restricted
- Last lease in Gulf of Mexico more that 10 years ago
- New discoveries falling
- Dangerous to assume relying on natural gas, severely restricting exploration, keeping low prices

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Natural Gas: Rapidly rising demand, supply constraints

- Given enough natural gas, 38,000 more miles of transmission pipelines and 255,000 miles of distribution lines will be needed
- This alone will cost $120-150 billion
- E.g., Alaska's Prudhoe Bay produces 8 billion ft^3 per day
  - About 13% of America's daily consumption
  - Never reaches the market, pumped back into ground
  - Waiting on building a pipeline to connect Alaska fields to US/Canada distribution system

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Electricity: Needs, problems

- Over 20 years, conservative estimate is that demand will increase 45%
  - Will require construction of 1,300 new power plants, about 65 every year (about one every 6 days)
  - Last time we added so many power plants was 1985
- Some experts calculate demand will increase faster
  - May require nearly 1,900 new power plants
  - That is 90 per year (about one every four days)
- Either way, will place great pressure on already strained and aging power grid

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The aging power grid

- Network of transmission lines, substations, and transformers
- Built when utilities were tightly regulated, supplied service to assigned regions
- Interconnections between suppliers were strictly emergency backup measure for rare usage
- Not designed at all for long-haul swapping of power in a competitive market
- Transmission bottlenecks contributed to California blackouts this winter and price spikes in New York City last summer

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Coal fired electrical power

- Coal powers half our electricity generators.
- Enough coal for 250 years.
- Coal emissions slated for broad reductions
- Administration will support new technology, but will not threaten electricity supplies and let it significantly raise electricity prices
- President Bush therefore decided not to impose new mandates on CO_2 emissions
- If nation is to have reliable electricity over next 20 years, coal must play a major role

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Nuclear power plants

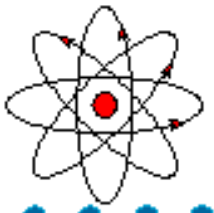

- No new nuclear power plant permit granted since 1979
- 103 existing nuclear power plants
- Many not expected to even file for license renewal as licenses expire over the next 15 years

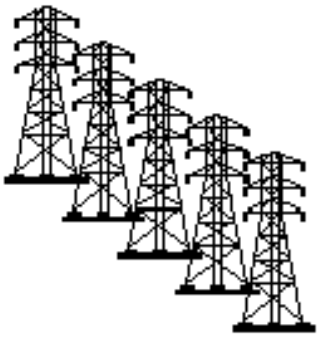

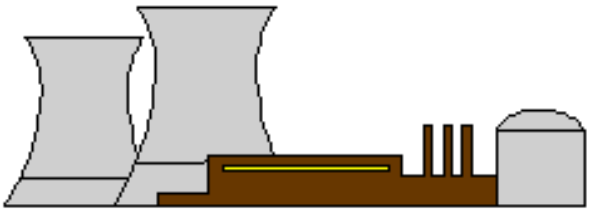

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Hydroelectric power generation

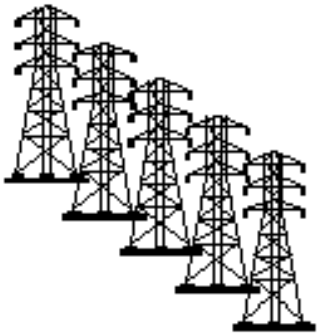

- Expected to fall sharply
- Re-licensing can take a decade and cost millions
- Some activists and political leaders want to breach one or more of the four federal dams on the Snake River to help young salmon on their trek to the sea

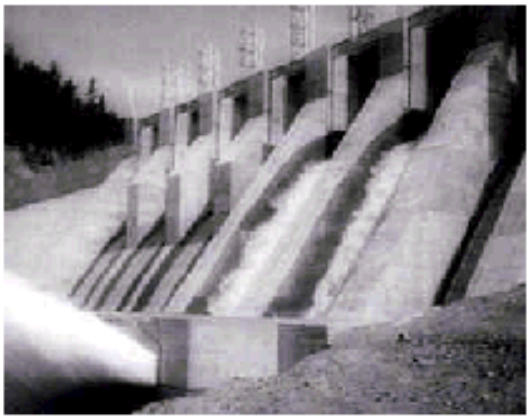

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Dangers of complacency

- Last three recessions tied to rising energy prices
- Latest crisis already causing negative effects
- Soaring fuel costs: extra $115 billion between 1999 and 2000; 1% off Gross Domestic Product
- In two weeks in January 2001:
  - Californians lost $2.3 billion in wages, sales, etc.
  - Layoffs hitting in West as manufacturers shift to states with more reliable energy sources
  - Intel will not build $2 billion plants in California to expand there.
  - Farmers' incomes to drop 20% in next two years

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Dangers of complacency (2)

- Some homeowner gas bills in Washington D.C. more than tripled this year
- Heating bills of some residents exceeded their food bills during the winter

- California power outages shut down traffic lights, closed businesses, darkened schools
- Police patrols were used to insure compliance
- Electricity shortages predicted for New York City and Long Island this summer
- Strained refinery capacity in the Midwest
- Low capacity threatens electricity reliability in Midwest, Southeast, and Northern Plain states

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Need for national energy policy

- Rising demand, tightening supplies, aging power infrastructure, decade of neglect
- President created Energy Task Force, headed by VP Cheney, to determine strategy
  - Environmental responsible exploration and recovery
  - Conservation and energy efficiency
  - Encourage investment in new technology for renewable energy sources
- Debate is still deeply polarized

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Extremes of the energy positions

- Some activists:
  - Zero tolerance to exploration
  - New, undiscovered sources will somehow provide for us

- Some advocates:
  - Limitless faith in special tax breaks for a favored activity or subsidies for a preferred industry

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Six prominent myths, none of which is true

1. It is impossible to balance energy exploration and environmental protection
2. There is a massive energy industry conspiracy, limiting supply to drive up prices
3. The Bush energy plan is focused almost exclusively on opening the Arctic National Wildlife Refuge (ANWR) to exploration
4. Government subsidies and tax breaks are the best way to encourage new exploration and energy production
5. Can forego traditional sources and meet demand by wind, geothermal, solar, and other forms of renewable power
6. Price controls are the answer to the energy crisis

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Can we balance exploration and environmental protection?

- Today, satellites and computers are tools of choice for exploration.
- Acoustic and electrical vibrations off the earth's depths provides maps of resource fields

- With advanced equipment, drill vertically, horizontally, or around corners up to 6 miles
- Fewer rigs, fewer roads, fewer pipelines
- 65 acre drilling in 1970s needs only 10 now
- Success rates have increased 50 percent

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Is there a price gouge conspiracy?

- Calls to investigate gasoline price spikes
- Allegations that power generators in the West have been withholding electricity
- Investigation and action is taken where merited
  - FERC ordered power companies to rebate $124 million to California utilities
  - FTC cleared gasoline suppliers relating to last summer's price increases
- There is no hidden energy pool that can be turned on and off like a faucet
- Must solve power crises by resolving conflict between demand and supply

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Is there a price gouge conspiracy? (2)

- Early this year (2001) one company proposed to build a $400 million power plant in California
  - Additional electricity for 600,000 homes
  - Plant 800 trees to beautify the area
  - Cloak facility in a brick facade to resemble a high-rent office complex
  - Help maintain habitat for an endangered butterfly
- Project supported by Sierra Club, American Lung Association and NAACP.
  - City officials unanimously (11 to 0) rejected it
  - Local paper called this move "Dumb and Dumber".

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Is there a price gouge conspiracy? (3)

- Plans to build a 550 megawatt gas-fired generator in a Los Angeles suburb were scrapped
- Residents voted 2:1 against the project
- Local mayor launched a hunger strike in opposition to it.
- In California:
  - Workers are being laid off
  - Companies are leaving the state
  - Consumers threatened with rolling blackouts
  - Local officials reject power plants with little regard
- Is it really any mystery why there hasn't been a single new power plant built in California in the last decade?

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Arctic National Wildlife Refuge Exploration

- **Myth:** Would buy only about 6 months worth of consumption while destroying pristine wilderness and disrupting the caribou
- **Fact:** The ANWR holds from 5.7 to 16 billion barrels of recoverable reserves (mean is 10.4)
  - More than 300 times the oil Clinton released
  - Frees us from equivalent of 54 years of imports from Saddam Hussein and Iraq
  - Exploration involves only some 2,000 of more than 19 million acres -- like half the Dulles airport compared to the entire state of South Carolina

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Arctic National Wildlife Refuge Exploration (2)

- The caribou herd in the Prudhoe Bay area grew more than 9-fold over the last 20 years (to 28,000 in 2000)
- Proves that caribou mating and oil exploration can peacefully co-exist
- Exploration should be considered on merits
- Opening ANWR will help, but does not allow full energy dependence

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Our increasing oil imports

- U.S. became a net importer of oil in 1950s
- Closing off all new domestic sources enhances leverage and power of oil cartels
- These cannot relied on to put American interests first

- Development of domestic resources such as ANWR will help increase energy security by ensuring a more diverse supply of oil

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Government subsidies and tax breaks

- Administration will continue to support funding for energy research and development initiatives.
- Capital is best allocated through the workings of the free markets, not manipulating the tax code
- Government regulatory policy should not aim at picking winners and losers
- Neither should tax policy

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Renewable energy sources

- Excluding hydro-power, renewable sources generate about 2% of America's electricity
- Bush administration will continue to invest in renewable energy sources
- Renewables have not overcome economic advantages of conventional sources
- Even with promising advances, renewables will provide only about 6% of our total electricity by 2020.
- Even with most optimistic breakthroughs, they will supply only a fraction of our needs over the next 20 years.

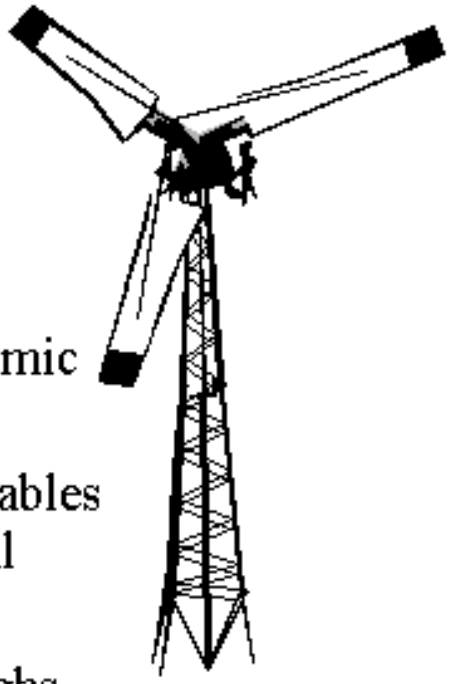

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Price controls

- America imposed price controls on oil and gas in the 1970s; they were an utter failure
- Led to shortages, rationing, and idea that America was gripped by malaise
- Administration does not support price controls
  - Lead to more blackouts and gas lines
  - Will not reduce demand, but cripple incentives for new investments in energy supply
  - Will deepen America's energy crisis

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Charting a new national policy

- Comprehensive. Across every department.
- Hemispheric. Includes the Americas.
- Diversify the energy supply for security, with a broad mix of options.
- Balanced. Combines environmental protection and energy exploration.
- Recommendations to be delivered to President Bush soon.
- Legislation will be introduced and bipartisan support.
- Hope that men and women of good will come together and transcend the present stale debate.

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Commentary

by Tom Bearden, Ph.D.

12 April 2001

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Commentary:

- A reasoned and professional assessment of the present energy crisis situation by Secretary Abraham
- Demonstrates administration and DOE are energetically attempting to get the crisis under control with conventional methods
- Scientific advisers have no "out-of-the-box" energy knowledge; policy stays essentially "in-the-box"
  - Shortage of oil, get more oil
  - Shortage of natural gas, get more natural gas
  - Shortage of electrical power plants, build more
  - Need 90 per year; build them
  - Short distribution grid, build additional
  - Shortage pipelines, build some more
- Cannot "get more" in time to prevent economic disaster
- Cannot avoid overrunning first quarter 2004 "point of no return"

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Caution: It is stressed that

- Given only the conventional Lorentz-regauged electrical design model, COP>1.0 EM systems are impossible. That type of EM only designs COP<1.0 systems!
- Given advice from scientific "experts" who know only COP<1.0 design, U(1) electrodynamics, and Lorentz regauged power system theory, the Administration is doing the best that can be done, all factors considered.
- The DoE and the Administration must use whatever they have available to them, to try to solve the crisis.
- Hence DoE and the Administration is not at fault. On the contrary, they are trying very hard to solve this escalating energy crisis, using the tools the scientists offer them.
- It is the U.S. scientific community that is squarely to blame for this sad state of affairs, and for the coming economic collapse.

COP = Coefficient of Performance

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An example of the time problem

- TVA and Texaco are discussing building a coal gasification 1,500 megawatt power plant.
  - Near Scottsboro, Alabama
  - Construction could begin in 2002.
  - In 3-6 years, begin producing electricity.
  - If 5 years, it will come on line in 2007.

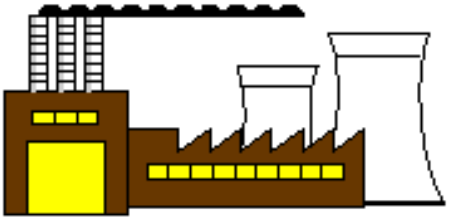

- 90 plants are required per year, beginning now.
- 2007 is about the time that world economies are crumbling, conflicts are raging, and all the arsenals weapons of mass destruction will be unleashed.
- 2007 is about the time civilization will be destroyed, if we continue on the present course.
- With only present solution, can get perhaps 400 to 450 plants ready to come on line, *about the time they are destroyed*

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The pending disaster

- The world energy crisis will escalate steadily, forcing collapse of world economy circa 2008.
- As nations' economies crumble, conflicts soar and one or more nations will exchange nukes and other *weapons of mass destruction* (WMD). Security partners forced to enter the melee.
- This evokes the long-dreaded WMD "spasm" response.
  - Only way for a nation to survive is to destroy its perceived foes before they destroy it.
  - Everybody fires everything, as fast as they can, unleashing all the arsenals of WMD, desperate attempt to survive.
  - Civilization and much of the biosphere is destroyed. Unleashing of smallpox alone will kill 2 billion.
- The time for this Armageddon is circa 2007.

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The bottom line:

- Self-powering and COP>1.0 electrical power systems must be rolling off the assembly lines en masse by first quarter 2004. That is the "point of no return".
- Otherwise, the point of no return will be overrun and no solution is possible, by any means, by anyone or by everyone.
- If that deadline is missed, the crisis curves cannot be "damped" in time to prevent world economic collapse.
- It is still doable, but only with a massive national effort of the highest priority. No one recognizes that as yet.
- Meanwhile, the scientific community is doing business as usual. You will have to just push most of it aside.
- We are "fiddling while Rome prepares to explode".

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Here are some events etc.

- Exxon Mobil Corp. soared to the top of the Fortune 500.
- Oil, gas, and power companies climbed.
- Increased income due to
  - Falling supplies so price increases
  - Utility deregulation. CA stupidly capped end prices, and freed middle prices. Dunce cap award for that one!
  - Soaring natural gas prices.
  - OPEC maneuvering to keep oil prices high
- Pacific Gas & Electric declared bankruptcy; another CA power company on the ropes.

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Lowered energy requirements for appliances

- Approved in last days of Clinton administration
- Washing machines must use 35% less energy, beginning in 2007
- Water heaters must use 5%-9% less energy, beginning in 2004
- Adds about $240 to price of washing machine
- Lower energy costs over time will offset initial increased cost
- Approved by Bush administration in April 2001 after review

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Easing air conditioner and heat pump standards

- Bush administration eased Clinton's new efficiency standards
  - Still require air conditioners and heat pumps to use 20% less energy than most current models, beginning in 2006
  - Clinton standard was 30% less
- All central home air conditioning units must meet minimum seasonal efficiency ratio (SEER) of 12, compared to present 10
- Replaces Clinton SEER standard of 12
- In California, easing these standards requires two more power plants

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Navarro's Estimate*

Peter Navarro, economist at UC Irvine,

in conjunction with Utility Consumers's Action Network

*Jennifer Coleman, "Power costs could be triple last year's for Californians," AP release, 22 Apr. 2001

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Factors driving comparisons

- Last summer, soaring costs drove three utilities to brink of financial ruin
- This summer costs may rise by as much as three-fold
- Factors at play:
  - Drought-induced reduction of hydroelectric power supplies in Pacific Northwest
  - Predicted hotter-than-average summer
  - Competition from other states
- State buys about 1/3 of its power from spot market
- Spot market likely to see substantial increases

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Prices likely per kilowatt-hour

- Last summer, peak average high price was 86 cents per KWHR
- This summer expected to hit $1 to $2 per KWHR
- Consumer rates capped at about 10 cents per KWHR
- The growing gap will have to be filled by state funds, which themselves are dwindling
- Eventually the California taxpayers have to pay the difference, which is from 10 to 20 times what they are paying now for capped power

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Covering debt already incurred

- Since January, California has authorized $5.7 billion to buy power for customers of Pacific Gas and Electric Co. and Southern California Edison
- The two utilities' credit was cut off due to
  - Soaring wholesale costs
  - Cap on consumer rates
  - Went nearly $14 Billion in debt
- San Diego Gas and Electric Co. incurred debts but is in better shape
- State will be repaid by $10 Billion in bonds
  - Expected to be issued in May
  - Expected to last till September but will not
  - PG&E and Edison Customers will pay off the bonds

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Deteriorating situation, rising prices

- Prices rising
  - Will rise even more as demand increases
  - Demand will rise by about 50 percent during the summer
- California's own generation resources cannot meet projected peak demands and reserve requirements
  - May fall by 3,500 megawatts short (peaks)
  - Enough power for 2.6 million households
- Power grid manager must depend on imports
  - Northwest drought makes extra power scarce to find
  - Northwest utilities themselves may have to import, not supply extra

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Other Factors

Credit, payback, scarcities

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Paying the piper: California's bond rating reduced

- Standard & Poor dropped California's bond rating two notches, from AA to A+
  - Financial drain from continuing energy crisis
  - Mounting uncertainty in costs to state of current electrical power crisis
  - Likely long term detrimental effect on state's economy
  - State's ability to pay its debt has reduced
- Rating not reduced further because of
  - State's diverse economy
  - Proposed revenue bonds to reimburse state treasury
- Can reduce further if California does not make $10 Billion bond issue and pay off its energy-related debts

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Associated Press: Gasoline supplies are critical

- Supplies tightest for mid-April since U.S. government record-keeping began in 1963
- There is a shortage of reformulated gasoline that produces less smog and is required during summer
  - MTBE additive made from methanol, a derivative of natural gas
  - Natural gas prices quadrupled Dec-Jan; MTBE reduced by 1/3
  - California uses more MTBE-treated gasoline than any other state
  - Gas-guzzling SUV sales boomed in 1999 and 2000
- Any kind of refinery snag will be amplified
- Last winter, major refiners had to focus on filling heating oil shortage instead of replenishing gasoline supplies for summer
- Now many forced out of service to take care of maintenance that was put off to deal with the heating oil crisis
- Environmental restrictions make it difficult to build refineries; none constructed in the U.S. for more than 20 years

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A peculiar problem

- E.g., Magnetic Energy Ltd. has a working laboratory experiment COP>1.0 device (a motionless electromagnetic generator - MEG).
- Solved basic EM system COP>1.0 theory.
- Two years more R&D necessary to finish, do production engineering and scale up for production.
- Immediate capital needed: $20 million.
- Negotiations with large capital firms:
  - Most have substantial capital committed to normal power community, long term.
  - MEL success thus costs them dearly in unrecovered funds.
  - They shoot themselves in the foot if they fund the MEG, since this is a "very disruptive" technology.

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MEG uses the Aharonov-Bohm effect to extract free energy from the vacuum (1)

- The Aharonov-Bohm effect (ABE) is in over 2,000 published physics papers in the hard literature.
- Hundreds of experiments prove it. Physicists themselves would not believe it for 25 years after it was advanced and proven. Now it is universally accepted.
- Free evocation of ABE never appeared for use in power systems, without paying energy to evoke it, until we used ABE in the MEG and *freely* evoked it.
- If the magnetic field **B** of a source is locally confined in a closed path (as in a toroid), the outside local spacetime (ST) where the **B**-field was withdrawn is still curved. Curved ST is energetic. The 3-space energy has been transformed into curl-free magnetic vector potential **A**. But one pays for that **A** around a toroid, since one has to "feed" the toroid.

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MEG uses the Aharonov-Bohm effect to extract free energy from the vacuum (2)

- We uncovered a transformer core material that will *freely* do that **B**-localization of the **B**-flux of a permanent magnet, extracting all the **B**-flux into a closed transformer-like core path.
- The uncurled **A**-potential forms outside the core path as a freely flowing river of energy.
- We pay nothing at all to get the **A**-energy flow going, or to sustain it. That's for free.
- The vacuum energy exchange and locally curved ST sustain that energy flow indefinitely, due to the permanent magnet dipole's broken 3-symmetry.

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MEG uses the Aharonov-Bohm effect to extract free energy from the vacuum (3)

- We then hang "collecting antenna circuits" in that free river of energy flow in **A**-space outside the core.
- We pulse-perturb the river *a little*, with very sharp-edged pulses of low energy. Huge **E**-fields (i.e., d**A**/dt) are formed and strike the antenna circuits.
- From the large AC **E**-fields, we can intercept and collect large AC energy. The energy is dissipated in loads in the external separate collecting circuits, with no back emf into the primary circuit.
- Only small average *input* energy is required. We pay only to *switch* or *gate* the large energy flow.

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MEG uses the Aharonov-Bohm effect to extract free energy from the vacuum (4)

- By analogy, imagine an old triode vacuum tube.
- Suppose we trick nature into *giving* us the cathode and electron energy flow, for free, really pouring energy out of there continuously.
- Then we only have to put in a grid to switch it, a plate to intercept and catch it, and a plate circuit to dissipate it in a load.
- In the MEG, the permanent magnet and the special core provide the cathode and free flow.
- We provide the "grid" gating, plate "catching," and "plate circuits" with loads that are powered.

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MEG uses the Aharonov-Bohm effect to extract free energy from the vacuum (5)

- The MEG becomes a *free transmitter with multiple receivers* system, *not* a transformer but a triode.
- The transmitted energy is absolutely free, taken right from curved ST. We only have to "perturb" or shake the flow a tiny bit, in sharp little shocks without much energy. The broken 3-symmetry of the magnetic dipole, in the fierce vacuum exchange, furnishes the energy in the large **E**-fields by d**A**/dt.
- The COP that can be achieved by the MEG is limited only by the **A**-space available outside the core for collection, and the number of surface charges in those external circuits powering the loads.

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Negentropic Engineering

- Can easily produce continuous giant EM energy flows from the vacuum: anywhere, anytime, for peanuts
- Once flow initiated, no further input required
- Focuses on real energy problem: intercepting the pouring energy and dissipating it in loads
- Dramatic implications:
  - Reduces hydrocarbon combustion; meet Kyoto accords
  - Obsoletes nuclear power, reduces nuclear wastes
  - Reduces biospheric pollution
  - Reduces biological effects of pollution
- One drills the vacuum for energy, much easier than drilling the ground for oil and natural gas

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Rigorous "out-of-the-box" work

- Evans, Anastasovski, Bearden et al. (15 authors), Alpha Foundation's Institute for Advanced Study:
  - "Explanation of the Motionless Electromagnetic Generator with O(3) Electrodynamics," *Found. Phys. Lett.* 14(1), Feb. 2001, p. 87-94.
  - "Explanation of the Motionless Electromagnetic Generator with the Sachs Theory of Electrodynamics", *Found. Phys. Lett.* 14(8), Aug. 2001 (in press).
  - "Energy from the Vacuum," in referee process.
  - "O(3) Electrodynamics from the Irreducible Representations of the Einstein Group," in referee process.
  - "Electromagnetic Energy from Curved Spacetime," in referee process..
  - "The Effect of Vacuum Energy on the Atomic Spectra," *Found. Phys. Lett.*, 13(3), June 2000, p. 289-296.
  - "Operator Derivation of the Gauge Invariant Proca and Lehnert Equations: Elimination of the Lorentz Condition," *Found. Phys.*, 30(7), 2000, p. 1123-1130.
  - "Runaway Solutions of the Lehnert Equations: The Possibility of Extracting Energy from the Vacuum," *Optik*, 111(9) 2000, p. 407-409.
  - "Classical Electrodynamics Without the Lorentz Condition: Extracting Energy from the Vacuum," Physica Scripta, 61(5), May 2000, p. 513-517.

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Rigorous "out-of-the-box" work (2): (Bedini "negative resistor" in a battery)*

- A battery-powered circuit is not a single closed current loop; but has two largely separate current half-loops:
  - Internal ion current between plates.
  - External electron current from outside of one plate, through external circuit and load, to other plate.
- M/q ratios very different: Ion current more than 200,000 times heavier per coulomb than electron current.
- Can dephase the two currents, overpotentialize both.
- Battery can thus be hyper-recharged while external circuit simultaneously powered.
- Bedini has been building successful little prototypes for more than 20 years. Could dramatically improve electric automobiles.

* T.E. Bearden, "Bedini's Method for Forming Negative Resistors in Batteries," *Journal of New Energy*, 5(1), Summer 2000, p. 24-38. http://www.cheniere.org/techpapers/Bedini.pdf

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Initiating a Battery to COP>1.0

- A Battery is highly nonlinear with multiple currents
  - Electron current largely bound between outside of plates and external circuit including through load
  - Ion current confined between plates, through separators
  - Mass-to-charge ratios of the two currents are vastly different
- Can dephase currents by 180°
  - ion current in charging mode
  - electron current in circuit-powering mode, powering circuit
- Done by forming negative resistor
  - Sharp, higher potential at insulator interface on plate surface
  - Bidirectional overpotentialization
  - Energy extracted from active vacuum

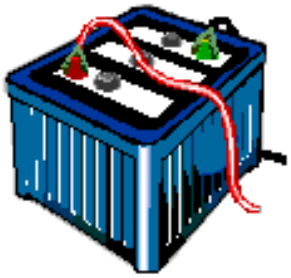

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Secretary alone cannot solve it

- Scientific community, universities, national labs, NSF, NAS, power companies doing business as usual
  - No really out-of-the-box energy research
  - Do not realize all electrical systems and power lines are powered by energy extracted from the vacuum
  - Not correcting flawed electrodynamics, uninterested
  - Not funding any vacuum energy extraction projects
- New policy cannot quickly eliminate the long delay time till new electrical power plants come on line
  - Need 60 to 90 powerplants per year; first one can be operational only after several years even with crash program
  - Skyrocketing energy, trucking and other transport costs will drive the nation into financial disaster during that delay
- Only doable solution: vacuum-energy systems

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What is desperately needed

- Separate "Manhattan Project" on energy from the vacuum systems, reporting to Secretary
  - Operate under Presidential Decision Document
  - Staffed with carefully selected scientists and engineers
  - Top priority funding
  - Round-the-clock research
- Support from selected personnel in national labs, universities, research corporations
- Start with known COP>1.0 systems; factual information can be provided

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Why it can be done in time

- Already have elements of necessary theory of Maxwellian disequilibrium COP>1.0 systems; funding will finish it rapidly
- Several legitimate COP>1.0 systems exist, can be quickly developed and scaled up
- Two years or less after start, a range of self-powering systems can be rolling off the assembly lines en masse
- A great breakthrough in close-looping principles for self-powering technology has been accomplished
  - Deeply proprietary, can be released
  - Using breakthrough, parallel program can develop self-powering of many present power systems
  - Will not be discussed without the program

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Cautions!

- In the so-called "free energy field", many charlatans, much disinformation, some honest mistakes, some real systems and information
- Absolutely must separate wheat from chaff
- Working laboratory proof-of-principle devices do exist; groups need funds for development
- Inventors with such systems usually do not comprehend the actual mechanism used
- U.S. is 100 years behind in applying necessary corrections to electrodynamics; but some courageous scientists have begun

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The scientists have failed us

- Secretary Abraham, it is the U.S. scientific community which has failed us, and which is responsible for this unnecessary crisis.
- No textbook presently even correctly states what actually powers a power line. The basis has been in particle physics for a half-century.
- Before arbitrary regauging by Lorentz in the 1880s, the Maxwell-Heaviside theory does prescribe electrical power systems far from equilibrium in their fierce vacuum exchange, including systems which power themselves and their load, extracting the energy from their broken symmetry in their active vacuum energy exchange.
- Every power system already wastes a trillion times more energy than is placed on the power line; scientists and engineers do not even know it.
- Heaviside published the basis for that in the 1880s and 1890s; Poynting never even knew it. Lorentz knew it, couldn't explain the source, stated "no physical significance" and discarded it.
- This discarded "Heaviside energy" is what is generating the extra gravity in spiral galaxies, and holding their arms together. Scientists arbitrarily discarded it in the 1880s; have forgotten it today.

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The scientific community enforces a 137-year-old flawed EM model

- Equations still assume material ether.
- Thoroughly confuse cause and effect.
- "Fields" as defined in electrical engineering do not exist outside matter (Feynman, Wheeler)
- Arbitrarily discards vacuum energy exchange and usage.
  - Proven for nearly 50 years in particle physics
  - Dipole exchange particularly significant because dipole's negentropy extracts *all* EM energy -- used in the system -- from the vacuum. Every system already powered by the vacuum anyway.
- Arbitrarily discards about 10 trillion times as much EM energy present around a circuit as the circuit intercepts.
- Scientific community pummels most scientists who try to change model or develop systems far from equilibrium in their known violent energy exchange with the active vacuum.
- ***Same flawed power system schema for more than a century.***

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All EM 3-space energy freely comes from the time domain*

* T. E. Bearden, "Giant Negentropy of the Common Dipole," Journal of New Energy, 5(1), Summer 2000, p. 11-23. http://www.cheniere.org/techpapers/GiantNegentropy.pdf

Whittaker, Math. Ann., 57, 333 (1903) shows this rigorously.
Dipole's broken 3-symmetry well-known in particle physics

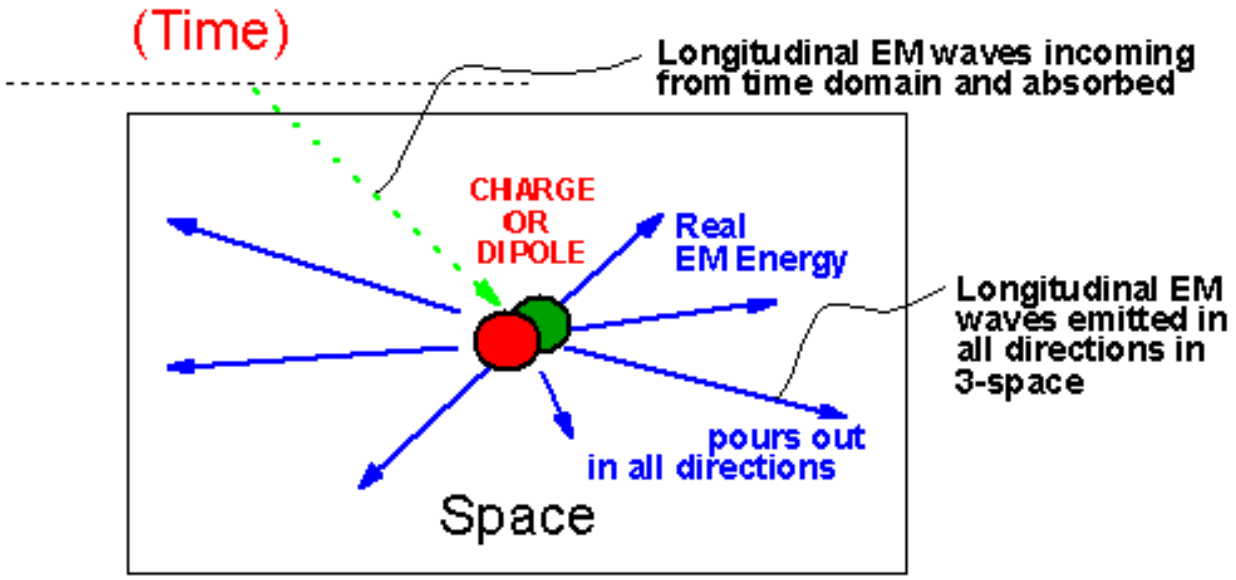

Note: Whittaker (and others) interpreted the phase conjugate half set of LWs after interaction with the charges of the dipole; and as an *effect* rather than the *cause*. This fundamental non sequitur has just been repeated since then. Thus they missed the solution of the source charge and source dipole.

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Astonishing but true

- All the hydrocarbons burned, nuclear fuel rods consumed, dams and windmills built, fuel cells consumed, and batteries installed do not add a single direct watt to the power line. Never have, never will.
- All that does is continually restore the generator source dipole, which our systems are designed to continually destroy faster than they power their loads.
- The dipole extracts energy from the vacuum, and pours it out to fill all space around the power lines. The power lines intercept and use only about 10exp(-13) of it.
- Nobody tries to catch any of the rest of it. *There is no ordinary source of that energy flow, which is enormously greater than the energy put into the shaft of the generator.*

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With plentiful, cheap, clean electrical energy:

- Even poorest nations get onto the fast track
  - Rapid development of infrastructure
  - Concentrate on clean water, medical treatment, education, plentiful food
  - Rise of industries and creation of jobs
- Gradual but permanent shift in electric power
  - Accent decentralized systems
  - Dramatically reduce vulnerability of power grids
  - Practical, agile electric cars, trucks, trains
- Releases the iron grip of energy barons

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Recommendations to DOE

- "Out-of-the-box" prototypes do exist, theory developed.
- Crash Manhattan project; Presidential Decision Directive.
- Intense program with highly selected scientists to correct EM flaws and extend EM theory to higher symmetries.
- Obtain compensated release of breakthrough close-looping process to initiate many normal power systems into self-powering systems, and rapidly develop and apply. No discussion without program and NDA.
- Protect patent rights of o/u inventors. Suspend national labs, universities, other research labs from "cluster patenting" in the area. They sign nondisclosure, non-compete, eliminate "march in" theft clauses.
- President order release of known overunity systems captured from inventors and in deep black community.

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In conclusion:

- Secretary Abraham, the threat of weapons of mass destruction attacks and giant destruction is not overestimated. It's really worse.
- Large Russian nuclear weapons, e.g., are already in U.S. cities, with on-site Spetznaz teams to explode them. See Lunev's book.
- Professional teams with anthrax, smallpox, etc. already in place, waiting. Unleashing smallpox alone will kill 2 billion worldwide.
- In the WMD strategic attack, the delivery to the target stage is already accomplished.
- 25 nations -- many hostile to the U.S. -- now have nukes, biological warfare agents, etc.
- The earth is in fact a giant powder keg, waiting to explode at the touch of a match. Unless solved at enormous speed, the energy crisis will certainly strike that match about 2007.
- Only one thing -- energy from the vacuum -- can do it. Neither the DoE nor the U.S. scientific community are working on that.

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The "Porthole" Concept with technical background

Amplifying the cellular regenerative (healing) system of the body for treatment and healing of mass casualties

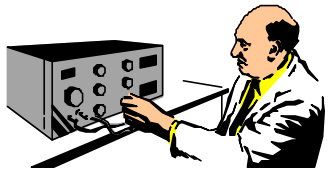

Outline of the presentation

- Mechanism for deep EM exchange of a body with its active EM environment
- Becker's epochal work and its ramifications
- Kaznacheyev's startling results and ramifications
- Weaponization of Kaznacheyev's findings
- Importance of time-energy and the time-domain
- Mechanisms for medical treatment and healing

Outline of the presentation (2)

- Prioré's revolutionary results and their ramifications.
- Proposed new mechanism for cancer promotion.
- Porthole concept: The 2-minute shortcut.
- Terrorist biological warfare capabilities.
- Summary and conclusion.
- Budgetary and Program package.

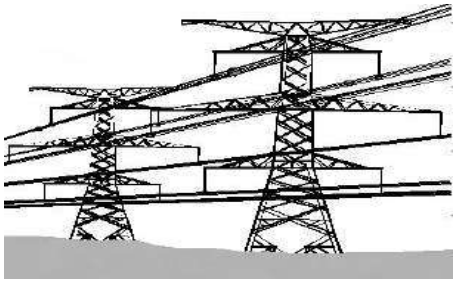

Mechanism for the body's deep EM exchange with its active EM environment

And some ramifications

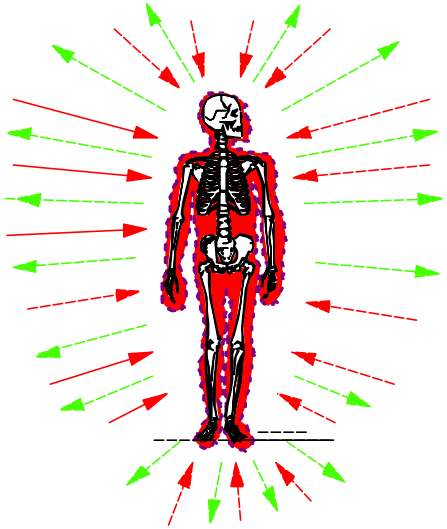

The body continually receives and retransmits EM energy

- The body may be considered as a dielectric.
- Every part of the dielectric participates in the absorption and emission of each photon to and from any point on the surface.*
- Mechanical force effects are also electrical in nature and exchange similarly.

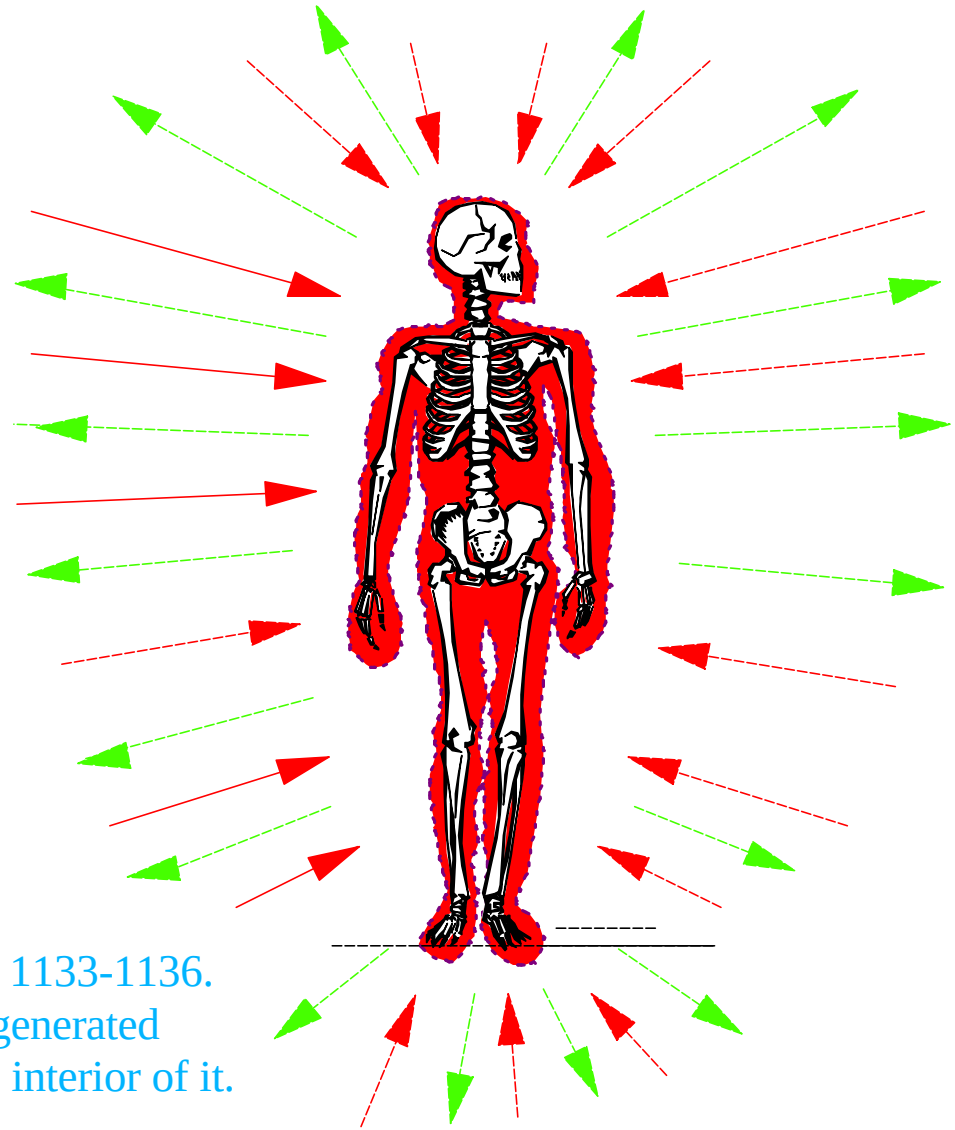

* Reali, G. C., "Reflection from dielectric materials," American Journal of Physics, 50(12), Dec. 1982, p. 1133-1136. The reflected field from a dielectric material is not generated just at its surface but comes from everywhere in the interior of it.

Ramifications:

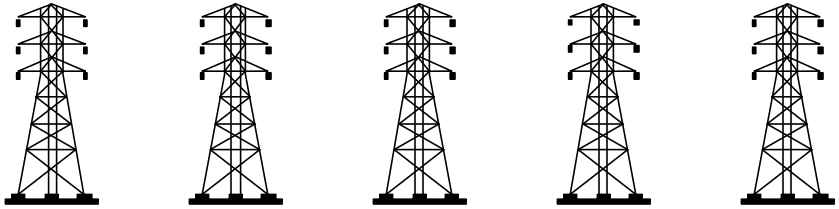

- There is an EM "dielectric transmission path" connecting every part of every cell to every part of the surface of the body.
- All electrical processes in the body, including deep within the cell and its nucleus, participate in the absorption and emission of every photon to and from the body's outer surface (and every mechanical force* experience).
- The EM emission energy of the body is a conglomerate mix of fractions of all processes and functions ongoing in the body or affecting it, including in every cell.
- This includes all electromagnetic, mechanical, chemical, and environmental effects upon and in the body and every tiniest part of it, and provides an extended definition of "stress".

* At base, all normal mechanical forces are generated by electromagnetic forces.

Ramifications (2)

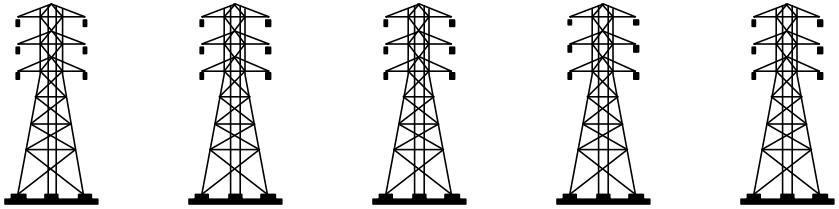

- The reaction of each photon absorbed on any point of the outer surface of the body, connects through the dielectric transmission path to every part of the body, including to every part of every cell*.
- Every emission from the body is participated in by every part of the body, including every part of every cell.
- The body's emission "changes" its environment, adding EM radiation. Some of the internal induced changes (excited states) in the body decay by this external emission. Some do not, but must be otherwise dealt with internally by the body systems.
- The body's EM absorption allows the environment to change or affect every function, operation, and part of the body, by adding EM radiation. All are continually being affected and deviated, both helpfully and harmfully, by these deeply induced EM interactions.
- The body's reaction (healing) must continually readjust and correct deviations from normalcy, in every part of every cell.

* In quantum physics, part of the photon is localized and part is nonlocalized, reaching even across the universe.

Ramifications (3)

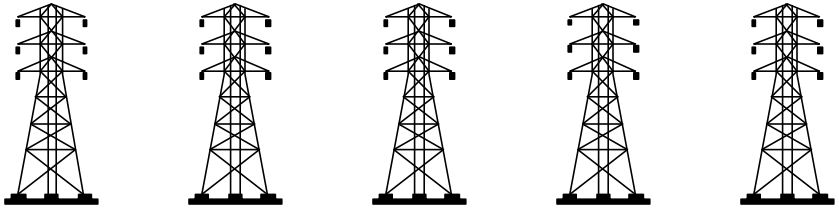

- The sum total of all the impinging external EM radiation upon the body, plus mechanical "special EM" radiation, thus affects and changes the body and all its processes, participating in them.
- That impinging EM radiation can be manipulated to either harm or heal the body and any or all of its cells.
- The body must continually overcome these externally-induced EM changes in its cells and processes, to maintain normalcy. Some EM changes are restored by the subsequent dielectric emission process, relieving the previously-induced deviant EM excitations in its internal processes. Some are not.
- The poorly studied *cellular regenerative system* performs the remainder of the restorative function, which is the fundamental "healing" function of the body.*

*The cellular regenerative system was mostly studied by Becker and a few others. See R. O.Becker, and David G. Murray, "The electrical control system regulating fracture healing in amphibians," Clinical Orthopaedics and Related Research, No. 73, Nov.-Dec. 1970, p. 169-198.

Becker's epochal work

And its ramifications

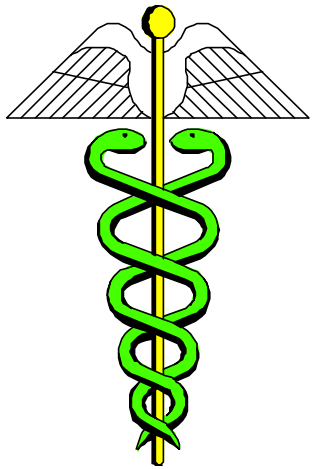

Becker's bone fracture healing

- Tiny DC currents (picoamperes)
- Pulsed DC current can be utilized
- Pulsed magnetic fields may be utilized

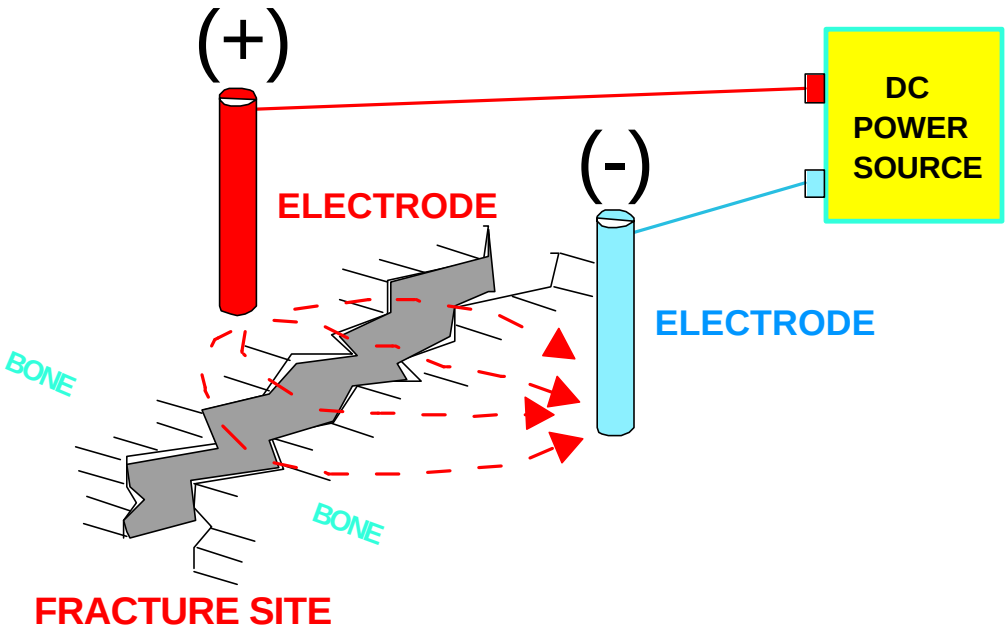

RED BLOOD CELL DEDIFFERENTIATES

Shucks hemoglobin coat
Grows nucleus

NEW CELL REDIFFERENTIATES

Turns into type of cell that makes cartilage

NEW CELL REDIFFERENTIATES

Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture

Becker's theoretical DC control system involved with response to injury

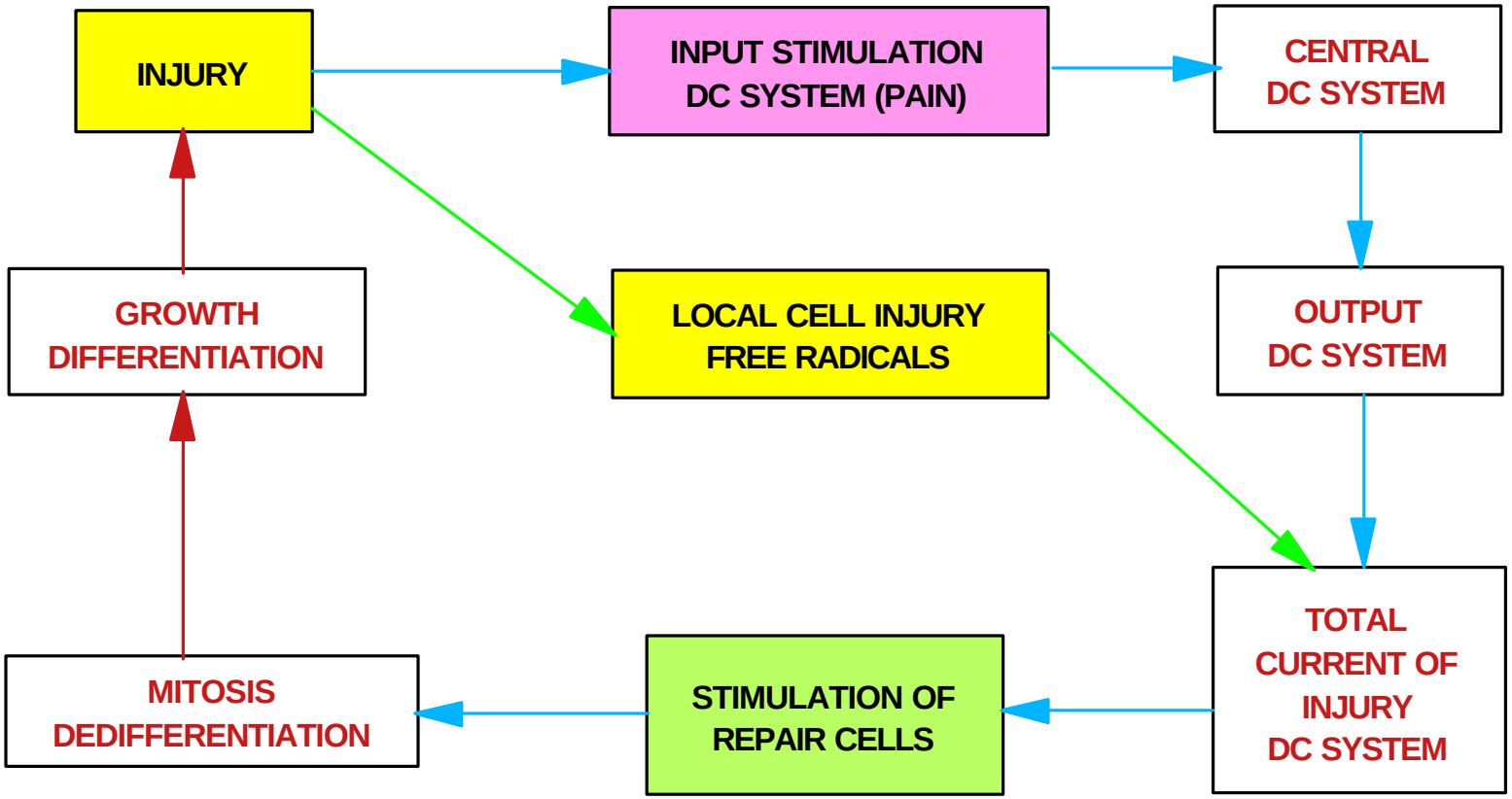

*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Becker's proposed control system governing regeneration*

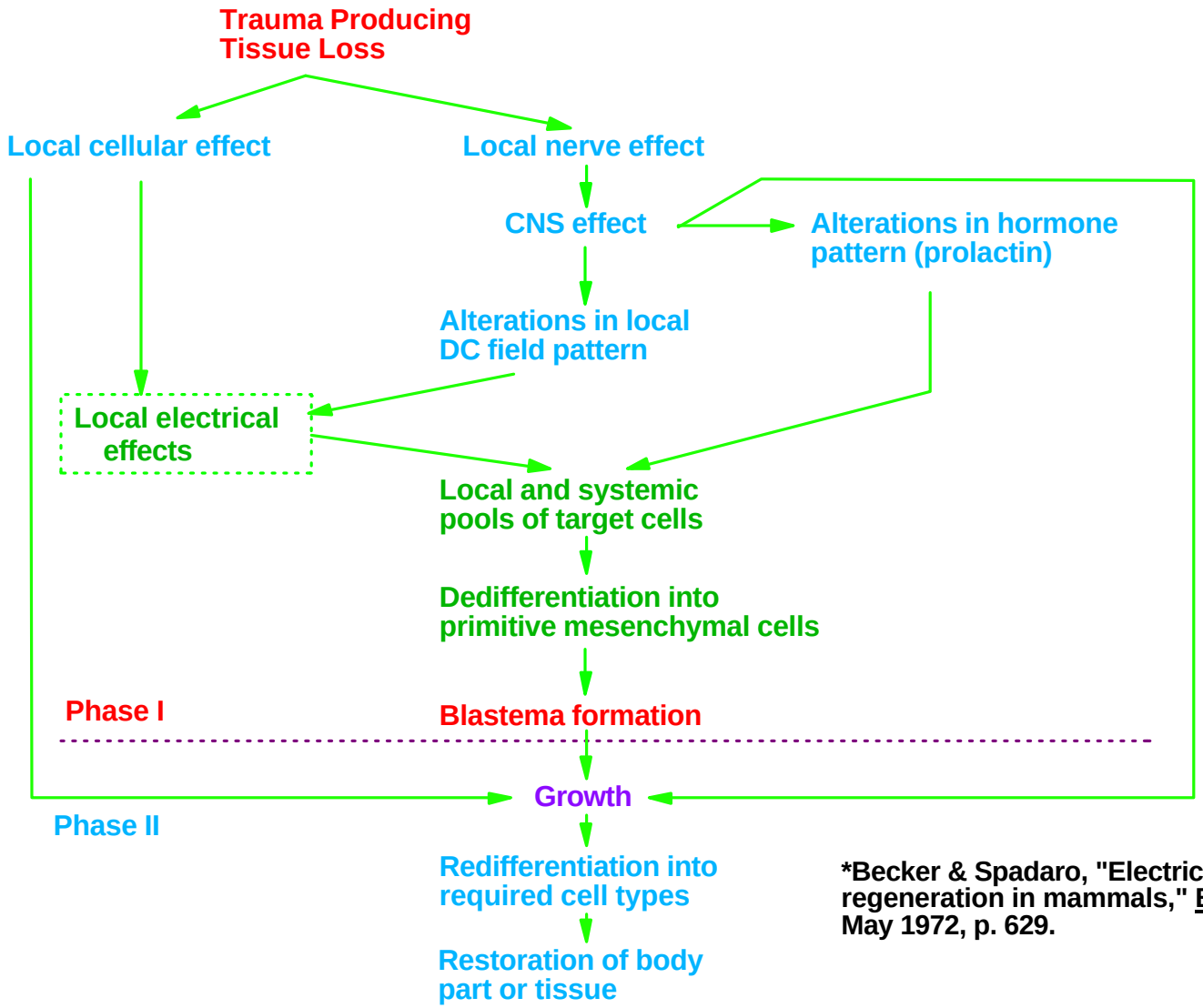

*Becker & Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bull. N. Y. Acad. Med., 48(4), May 1972, p. 629.

Extending Becker's work

- Becker had only the archaic classical electrodynamics available to him. That EM is grossly inadequate.
  - Insufficient group symmetry to model the process.
  - Already eliminates the "infolded" longitudinal wave EM that structurally and dynamically comprises all "normal" EM potentials, fields, and waves.
  - It is this internal LW EM that is manipulated and used by the cellular regenerative system.
- Nonlinear phase conjugate optics was not yet developed when Becker did his seminal work.
- Successful higher symmetry electrodynamics models -- such as O(3) -- have been developed and are available.

A sad commentary

- Becker was nominated for the Nobel Prize, but he was hounded, his funds were withdrawn, and he was forced to retire early.
- His main "sin" was having the courage to testify against the harmful effects of unrestricted powerline radiation and electronic smog.
- Powerful interests then crushed him, set up their own well-funded institutes, and hired scientists who then predictably found that powerline radiation was no problem.
- Such research is so tainted that recently several important journals have now required the authors of submitted papers to state what their affiliated companies do, and what "company massaging" of their research occurred.
- From a higher symmetry EM view, it is obvious that the dielectric pathway and quantum electrodynamics already show a significant problem due to such radiation, particularly with respect to long-term effects.
- This is particularly significant since "noise" -- the mere presence of more "hash" -- appreciably amplifies the dielectric transmission effect. So the major factor becomes EM smog *signals density*, not signal power.

Kaznacheyev's startling results

And its ramifications

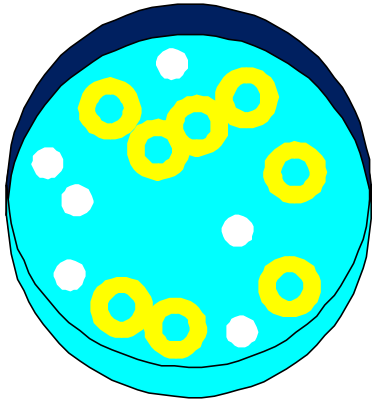

Proof that the cellular condition is radiated from groups of cells

- It follows that a diseased, damaged, or infected cell culture will and does emit its exact internal EM condition, hence the disease or damage "generatrix form" itself (in the internal structuring of the EM radiations).
- Further, these "state" emissions can couple into other targeted cells to produce disease and disorder in them.
- This was clearly proven in some 15,000 Russian experiments by Kaznacheyev.
- Kaznacheyev demonstrated induction of cellular disease and disorder between EM-coupled but otherwise environmentally shielded cell cultures
- Similar experiments have been replicated in the West by Reid *et al*., and by Popp *et al*.

Kaznacheyev's induction of cellular disease and disorder

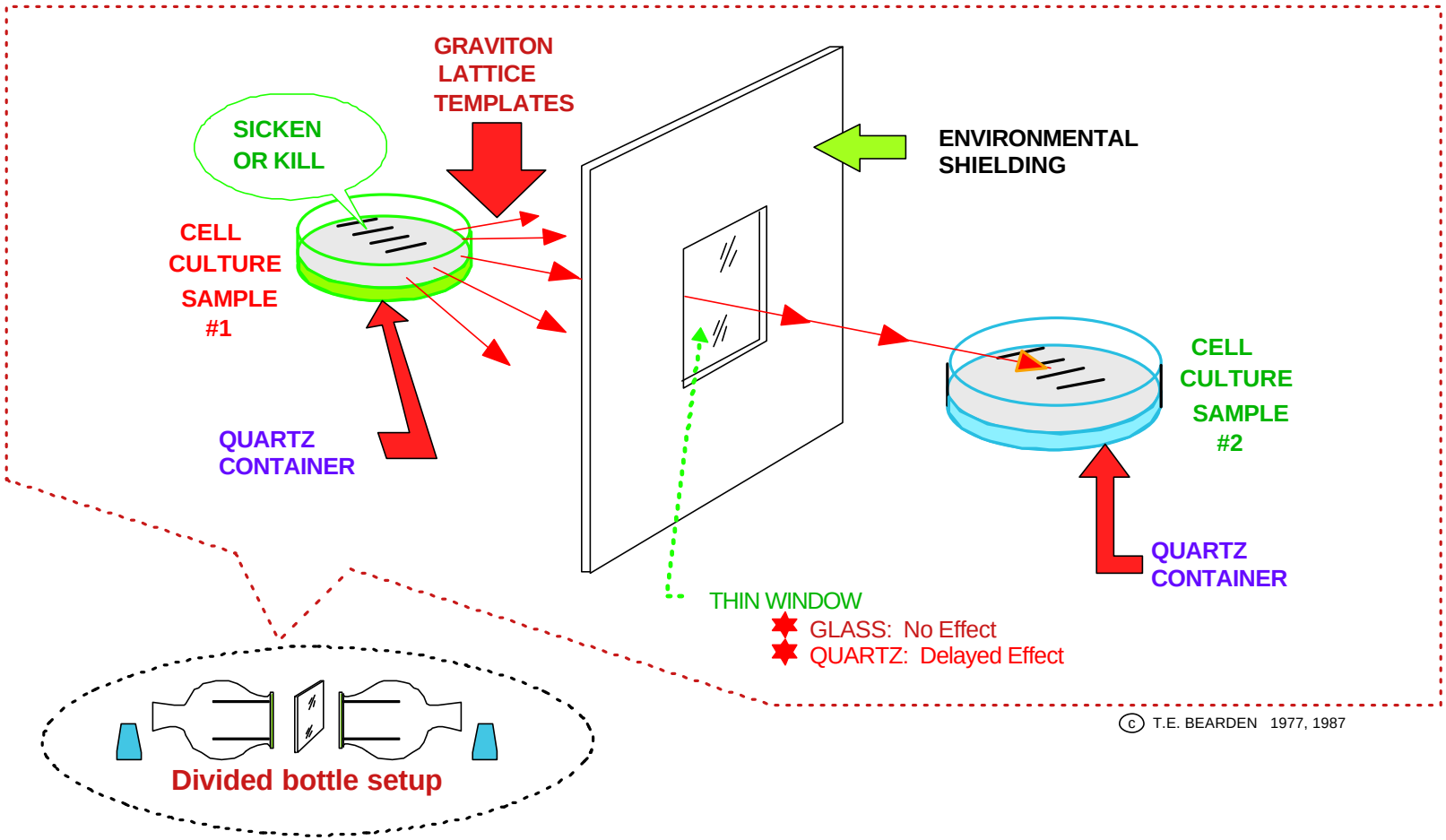

© T.E. BEARDEN 1977, 1987

Note: Minimum lattice is one harmonic interval: IR to UV is such a minimum G-lattice. Consider particularly the dielectric pathway in the emitting diseased cells and in the receiving targeted healthy cells.

Another surprising feature of Kaznacheyev's experiments

- The experiments do not work if the targeted cells are in normal light, such as sunlight*.
- The reason is that the normal light bandwidth occupies a single harmonic interval between ultraviolet and infrared.
- Hence its difference frequencies also fill such an interval. For a set of n frequencies, the number *d* of difference frequencies is $d >> n$.
- Thus the visible light spectrum represents "jamming" of specific internal EM signal inputs through the dielectric pathway into the body, turning much of the environmental signals into harmless warmth.

* It has also been shown that if bacteria are killed in the "dark" by UV, then 24 hours later placed in sunlight, a substantial fraction of the "dead" bacteria will revive.

Ramifications of Kaznacheyev's experimental results

- At least one harmonic interval is necessary for the effect to be evidenced in the target cells.
- Interestingly, if we assume the body dielectric to be isotropically nonlinear (to first order):
  - Velocities of the actual transmitted frequencies depend upon the particular point on the wave amplitude.
  - The transmitted frequencies overshoot, interfere, breakup, etc. The difference frequency does not.
  - The "difference frequency" is transmitted through the nonlinear dielectric medium as if it were a sine wave passing through a linear medium*.
- To our knowledge, this direct and deep communication of electronic "hash" difference frequencies in dielectric human bodies has not been investigated in the West.

* Owen Flynn, "Parametric arrays: A new concept for sonar," Electronic Warfare Magazine, June 1977, p. 107-112.

Ramifications of Kaznacheyev's experimental results (2)

- A heterodyne signal -- at the difference frequency between an input signal and a reference signal -- can be enhanced by adding noise*.
- Thus the signal of the disorder in the cellular pattern emitted from diseased cells, received by normal cells, can be amplified electronically and rather easily.
- Powerline radiation (electronic smog) thus carries its own amplification mechanism. Eventually the amplification overcomes any squelching by sunlight, etc.
- The Russians promptly (as early as the late 1950s) weaponized and tested these and similar effects.

* Dykman, M. I. et al., "Noise-enhanced heterodyning in bistable systems," Physical Review E, 49(3), Mar. 1994, p. 1935-1942

Weaponization of Kaznacheyev's findings

And its ramifications

"Microwave" radiation of the U.S. Embassy in Moscow.

Former U.S. Embassy in Moscow.

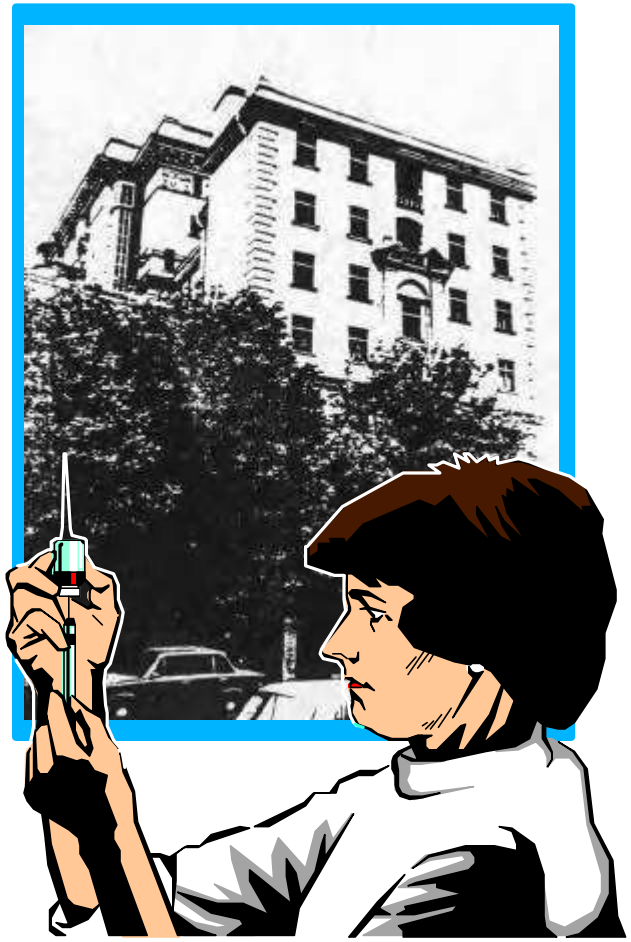

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

Ramifications of the microwave radiation of the U.S. Embassy

- The cellular disorder pattern in the EM radiation is carried by the field-free scalar potential.
- Since the disorder pattern is a "conglomerate", it must be carried by an internal EM structure existing inside the scalar potential itself.
- Whittaker decomposed the scalar potential into the appropriate internal longitudinal EM biwave structure in 1903*.

* E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," Mathematische Annalen, Vol. 57, 1903, p. 333-355

The importance of time as energy, and the time-domain

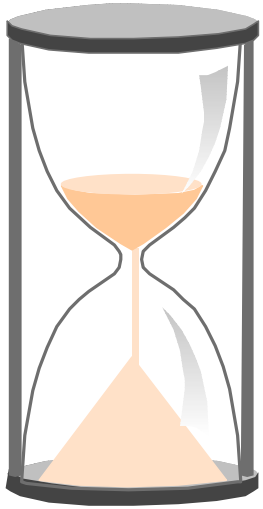

Time as energy

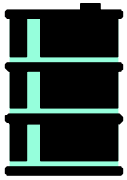
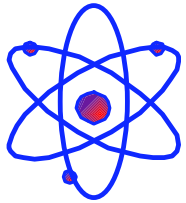

- In physics, the fundamental units one uses in his model are arbitrary.
  - A valid model can be made using only one unit.
  - It is already done in one branch of physics, using length as the single fundamental unit.
- Make a model with a single unit, the joule.
  - All other entities become functions of the joule.
  - We are familiar with mass as highly compressed EM energy, by the factor c^2.
  - It turns out that time is also highly compressed EM energy, by the factor c^2.
  - 1 sec. $\approx 9 \times 10^{16}$ joules.

How to see that "time is compressed spatial energy"

- Take some spatial EM energy and compress it by c^2
- Place it in 3-space, and it is *mass*.
- Place it on the time axis, and it is *time*.

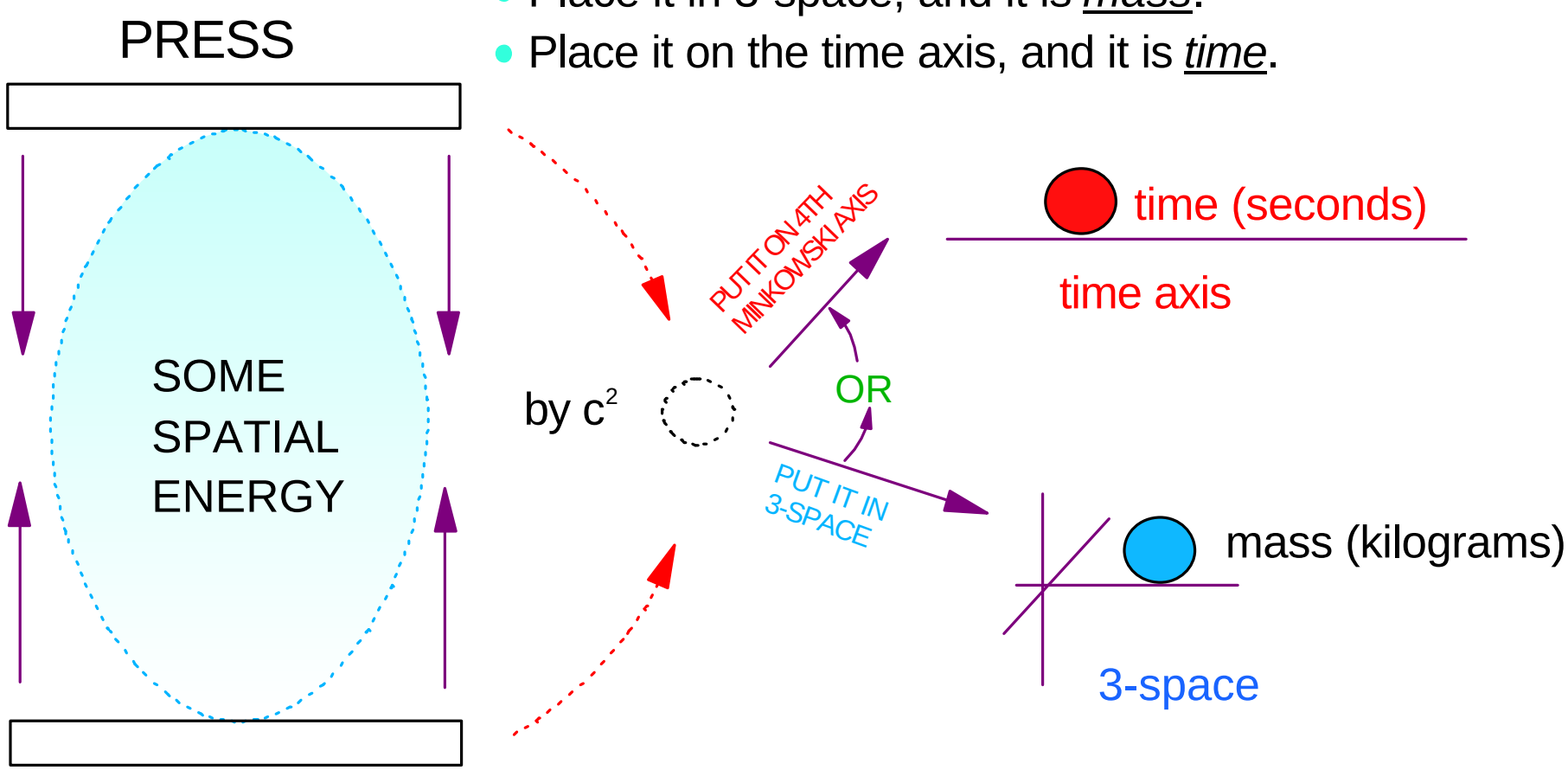

- When time-energy is converted into mass-energy, time is "decompressed" (expanded) into 3-space EM energy and 1 sec. $\approx 9 \times 10^{16}$ joules.

Time as EM energy in the time domain, with a density the same as mass-energy

- Bearden* reinterpreted (corrected) the 1903 Whittaker decomposition of the potential in 2000.
- The reinterpretation is consistent with broken symmetry in particle physics, for which Lee and Yang received the Nobel Prize in 1957.
- It is also powerfully supported by quantum field theory, notably by Mandl and Shaw in 1984**.
- Whittaker's pair is a combined time-polarized (scalar) EM wave and a 3-space longitudinal EM wave.

* T. E. "Giant Negentropy from the Common Dipole," Journal of New Energy, 5(1), Summer 2000, p. 11-23.

** F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984, Chapter 5.

All EM energy in 3-space freely comes from the time domain

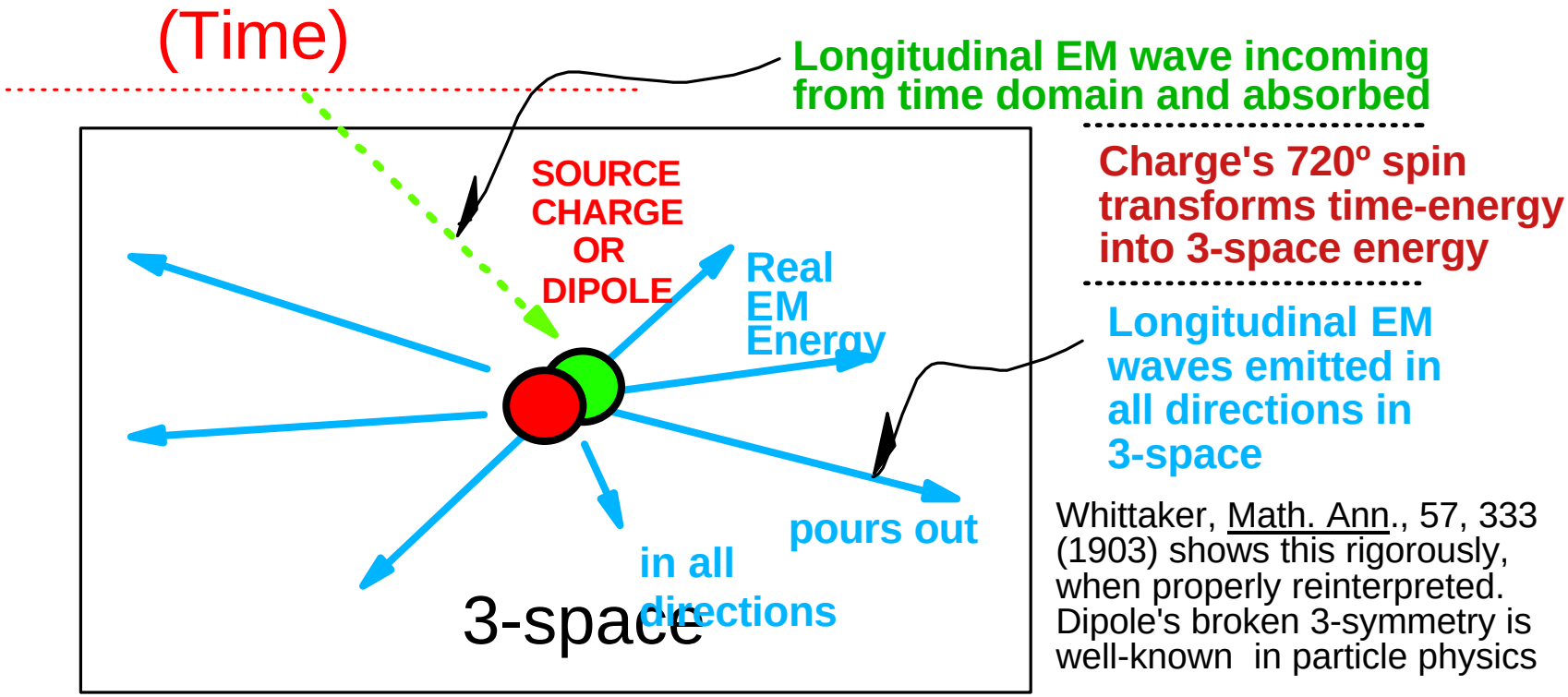

Whittaker, Math. Ann., 57, 333 (1903) shows this rigorously, when properly reinterpreted. Dipole's broken 3-symmetry is well-known in particle physics

Note: Whittaker (and others) interpreted the phase conjugate half set of LWs after interaction with the charges of the dipole, and as a 3-space *effect* rather than the time-domain *cause*. This fundamental non sequitur was just repeated since then, until corrected by Bearden to be consistent with broken symmetry and quantum field theory.

Strong support from quantum field theory

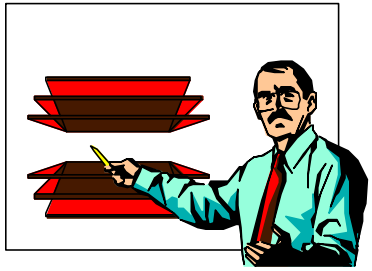

- Quantum field theory recognizes four photon polarizations:
  - Energy along x-, y-, z-, or t- axis.
  - Polarized along x- and/or y-axis, the photon is a *transverse* photon.
  - Polarized along z-axis (along its line of motion in 3-space), the photon is a *longitudinal* photon.
  - Polarized along the time-axis, the photon is a *time-polarized* or *scalar* photon.
- The individual longitudinal or scalar photon is not observable*.
- The combination of a longitudinal photon and a scalar photon is observable as the instantaneous scalar potential*.

* F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984, Chapter 5.

Mechanism generating the flow of a mass through time

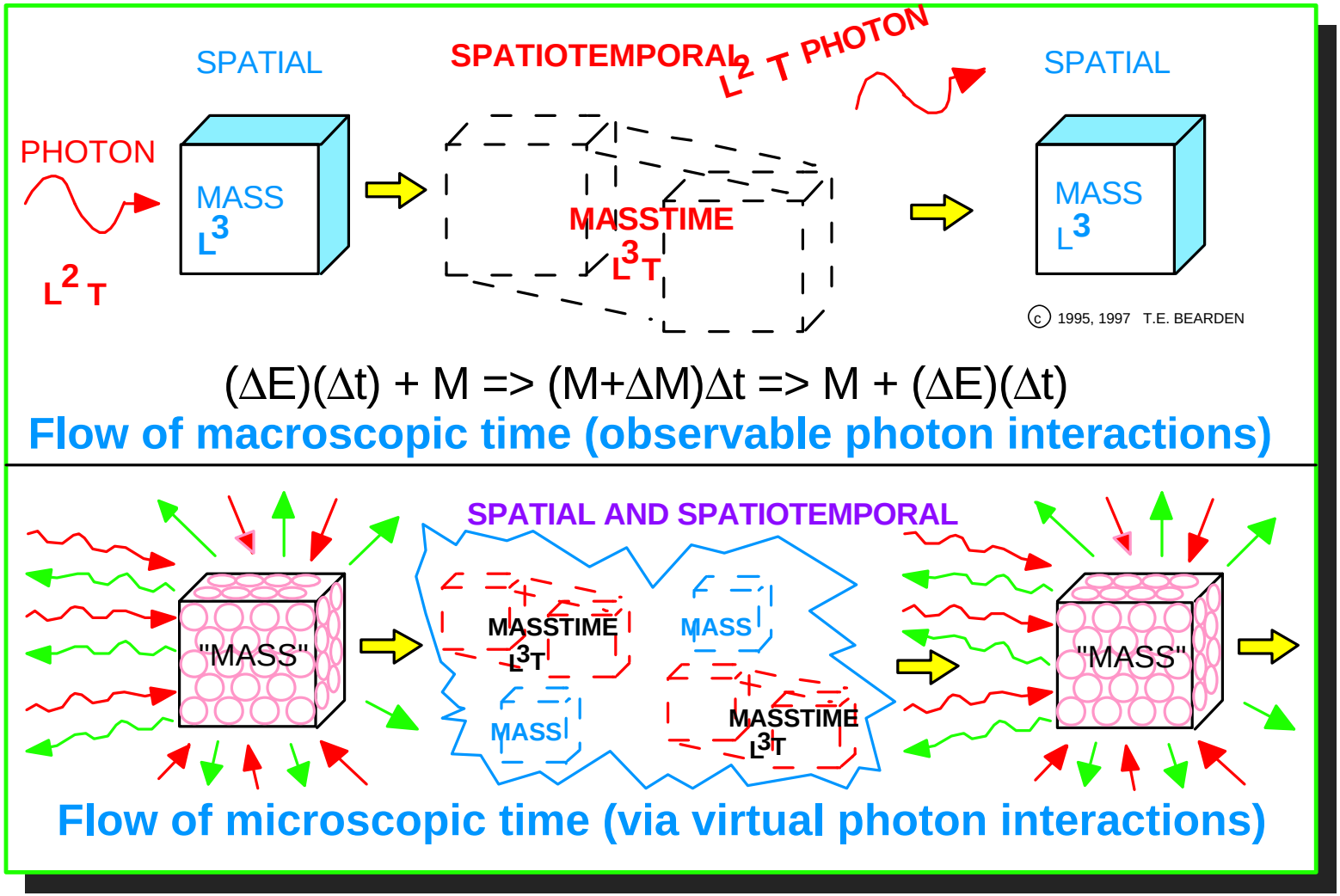

Mechanism is engineerable

Pumping a mass in the time-domain will time-reverse it back to an earlier state

- The reinterpreted biwave EM structure of the scalar potential means that time-reversal (phase conjugation by pumping in the time-domain) can be utilized to time-reverse a targeted cell (its mass-energy) in its entirety, including its genetics.
- Becker's bone fracture experiments showed it:
  - Weak scalar potential across the fracture site.
  - LWs in 3-space and time-energy waves in time
  - Red blood cells entered, dedifferentiated by shucking their hemoglobin and growing a nucleus, which is dedifferentiation (time-reversal of the cell and its mass-energy back to a previous physical state).

Principle for time-reversing a time-pumped mass

- Becker's cells then redifferentiated and changed -- first to primitive cartilage cells, then to primitive bone cells which were deposited in the fracture, healing it with new bone growth.
- This shows "time-forwarding" (redifferentiation) of the cell also.
- Becker actually showed that the *time-domain pumping* of the cells (by the time-polarized EM waves of Whittaker's reinterpreted wavepairs comprising the scalar potential), and the time-pumping of their mass-energy, operated to continuously and steadily *remove the delta between that cell's present condition and its former "normal" cellular physical condition in that area*.
- This is the long-sought secret of stem-cell research.
- Phase conjugate optics had not been born at the time. Without realizing its full nature, Becker demonstrated the body's own internal mechanism for healing, and the fundamental mechanism for time-reversing a physical mass, whether living or inert.

Mechanisms for use in medical treatment and healing

And ramifications

Successive deep penetration reactions of the cellular dielectric

- Change after change affects the cell and all of its parts, including from the external environment.
- Each successive change affects primarily the internal "LW EM structures and dynamics" comprising the ordinary potentials, fields, and waves.
- Thus in positive time the internal EM structurings produce successive "overlaid layers of change" -- so to speak -- in the internal EM structuring and dynamics of a cell in the body. These layers contain the "delta" from normal state.

Successive deep penetration reactions of the cellular dielectric (2)

- During time reversal, highest layer deltas are successively "peeled away" by the interaction of the mass-energy with the time-domain pumping.
- The result is to return the cell directly back to successive physical states, in the case of a single disease or disorder.
  - A cancer cell is returned to a normal cell prior to its "promotion".
  - An HIV-infected cell would be returned to its normal unaffected condition, free of HIV-induced genetic change.
  - For injuries and damage, the existing "delta" in each successive state-layer is steadily reduced to zero.
- This process thus can involve both cellular differentiation and dedifferentiation, as shown by Becker and by Prioré.

Engines (vacuum engines, spacetime curvature engines)

- Following Whittaker* as reinterpreted**, all normal EM fields, potentials, and waves decompose into sets of longitudinal EM waves (LWs) and their dynamics.
- Since these LWs and their dynamics are dynamics in the local energy density of spacetime (ST), they constitute *ST curvatures*.
- Hence they are general relativity infolded inside electrodynamics.
- By manipulating and changing these LWs, one manipulates and changes spacetime curvatures and their dynamics.
- The result is a unified field model where one directly controls and engineers a set of ST curvatures by use of higher group symmetry electrodynamics.
- Controlled patterns of local curvatures of ST are called "vacuum engines" or "spacetime curvature engines" -- or just "engines".

* E.T. Whittaker, Math. Ann., 57, 333-355 (1903); Proc. Lond. Math. Soc., Series 2, 1, 1367-372 (1904).
** T. E. Bearden, J. New Energy, 5(1), 11-23 (2000).

Pumping with EM time-polarized waves forms *amplified* antiengines

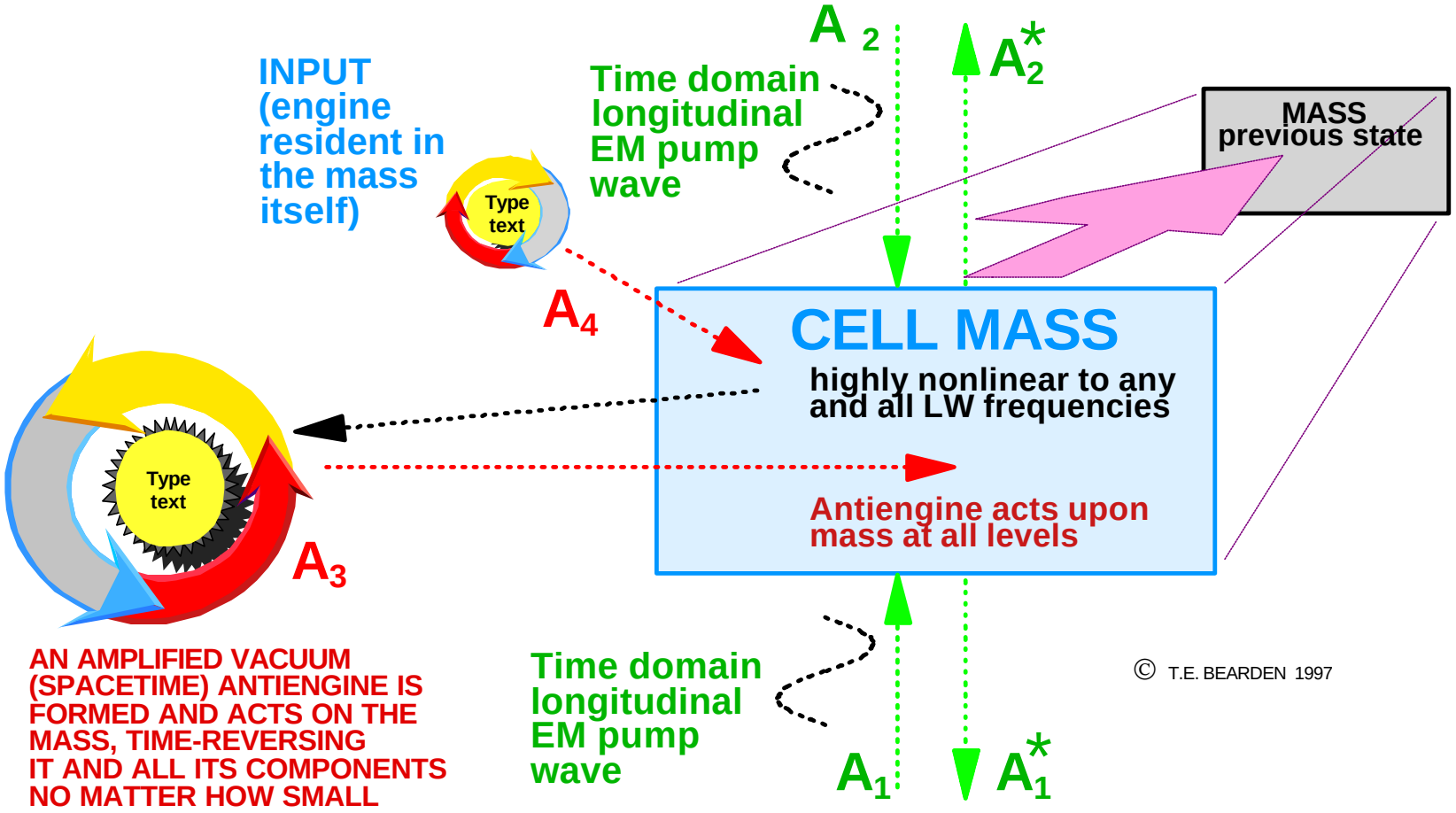

AN AMPLIFIED VACUUM (SPACETIME) ANTIENGINE IS FORMED AND ACTS ON THE MASS, TIME-REVERSING IT AND ALL ITS COMPONENTS NO MATTER HOW SMALL

© T.E. BEARDEN 1997

A DRAMATIC EXTENSION TO NONLINEAR OPTICAL PUMPING

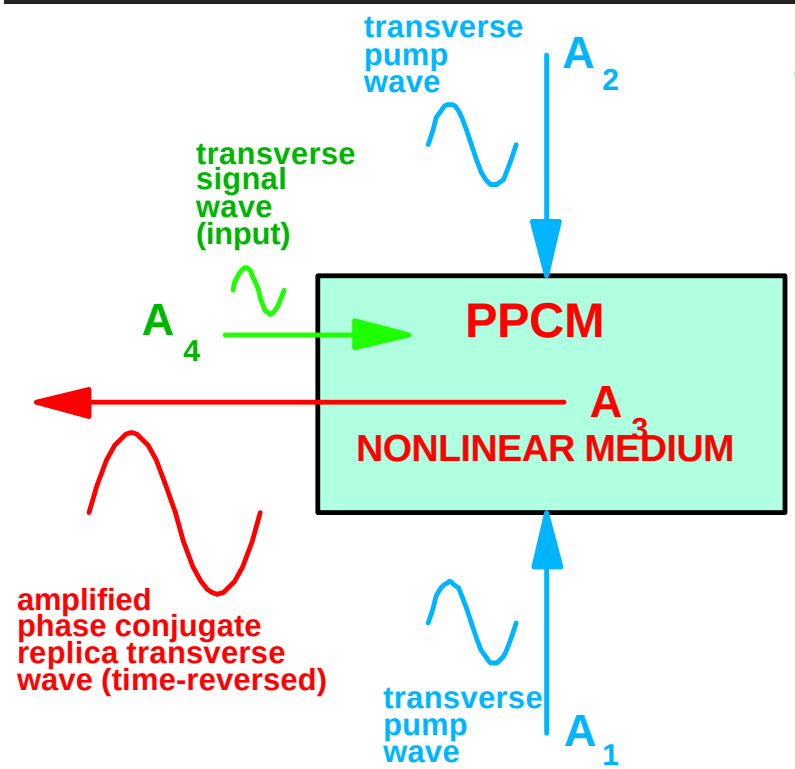

a. Pumping with transverse EM waves produces a time-reversed *wave*.

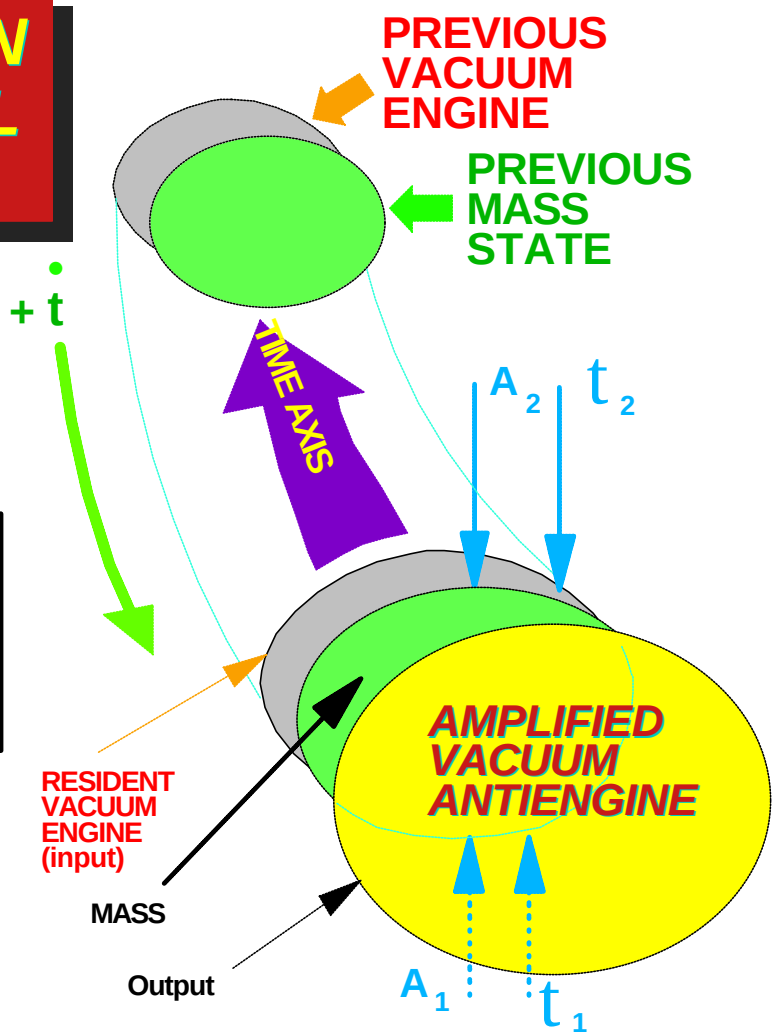

b. Pumping with longitudinal EM waves A_1 and A_2 time-reverses *the mass itself*.

Time-reversal of a mass to a new physical state not in its past

- Original engine A'
- New engine B' added
- Time-pumping moves to new "past" that is determined by (A'+B')

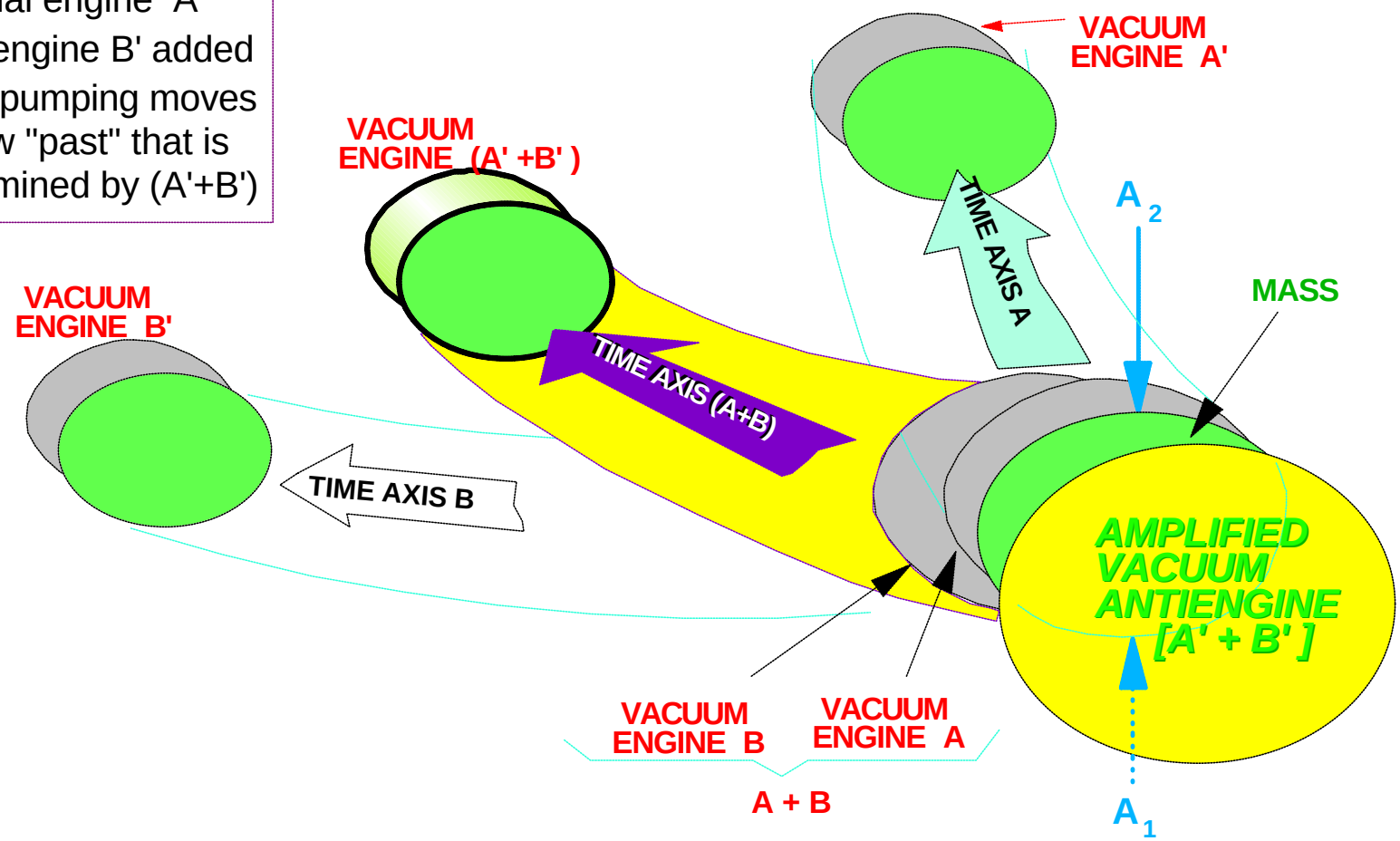

Extended general relativity principle

- All levels of energy structures and all levels of time structures mold spacetime geometry.
- The "pattern" is called a *template* for a vacuum engine (spacetime curvature engine).
- Spatial and temporal structurings of the engine act upon any exposed mass at all levels.
- This produces a template of forces, for precise translations and stresses within the mass at all levels. The forces exist in both time and 3-space.

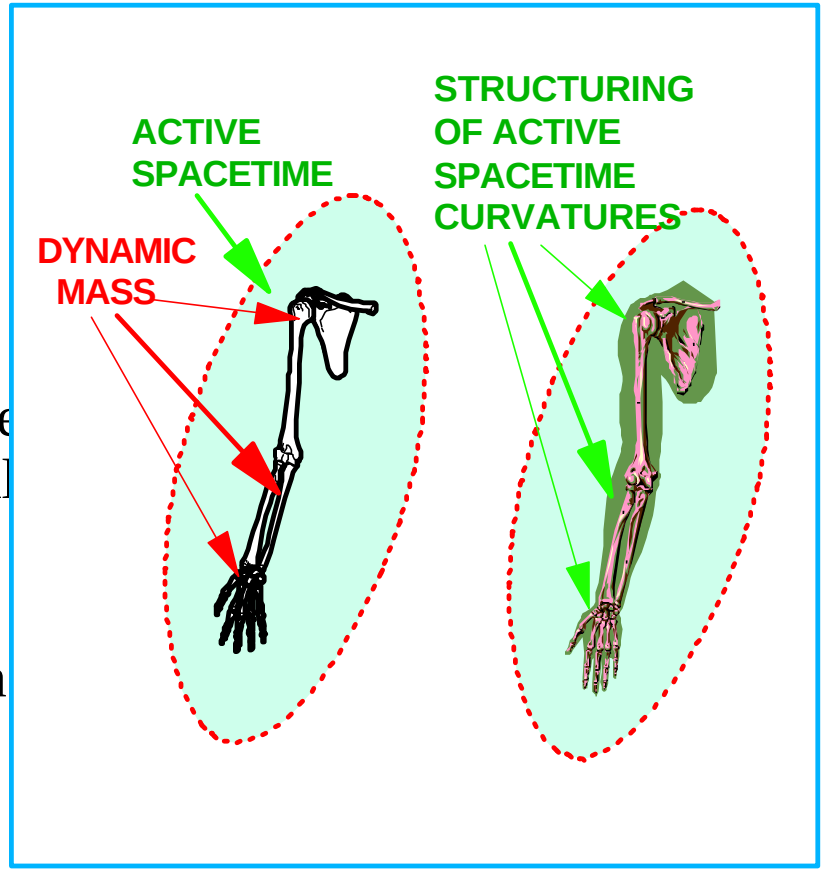

Engines: Working spacetime demons

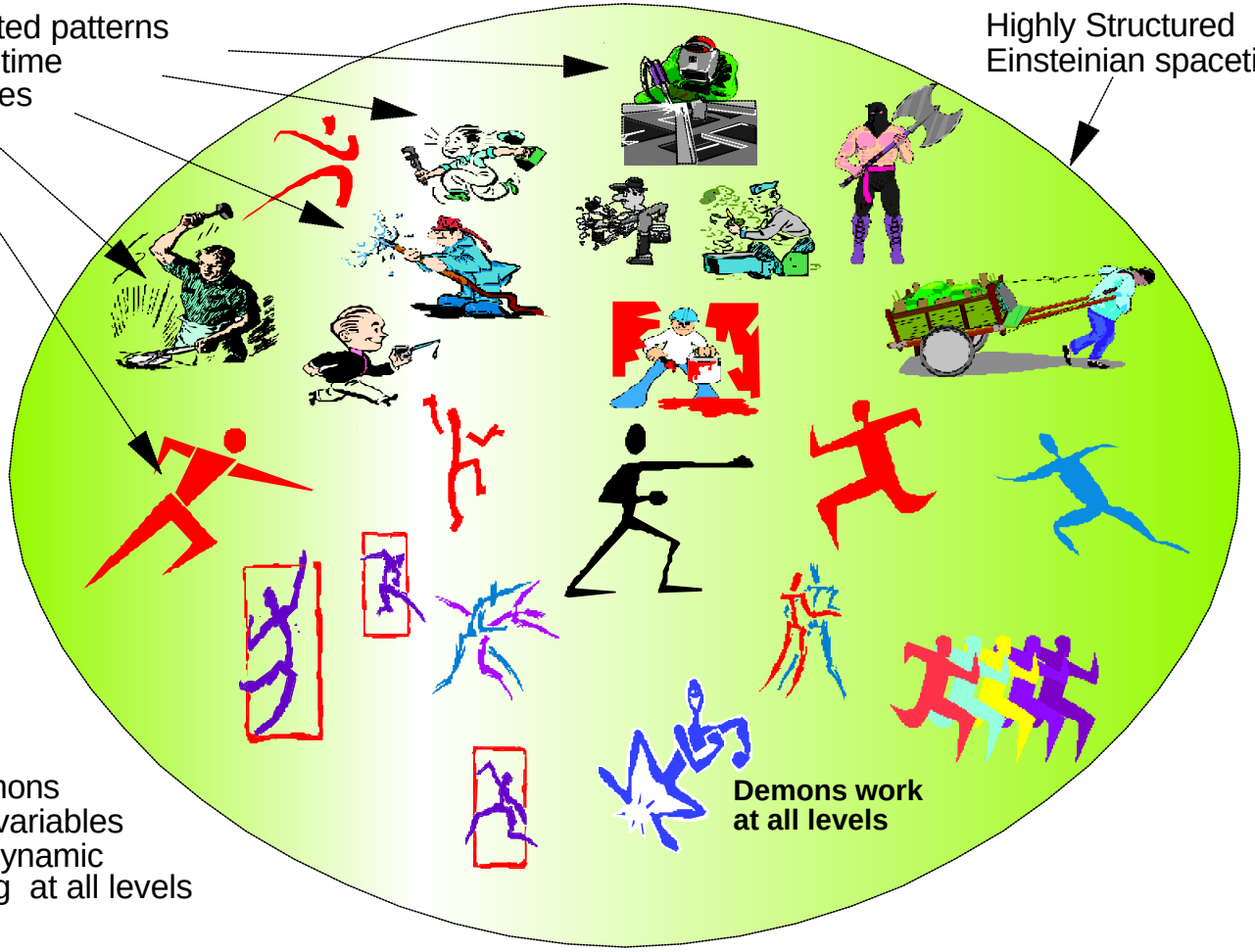

Maxwellian Demons
are EM hidden variables
organized into dynamic
structures acting at all levels

Signal vs. vacuum engine

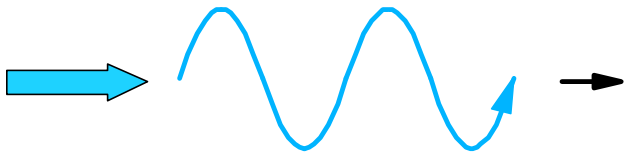

SIGNAL (INFO)

- ★ Information received
- ★ Any overt physical action must be taken by cell itself
- ★ Cell must furnish the energy for any action it takes
- ★ Passes from outside to in

A. ***Cell must do the action itself; vacuum energy exchange is passive. Energy or fuel for doing the action must be added to cell externally.***

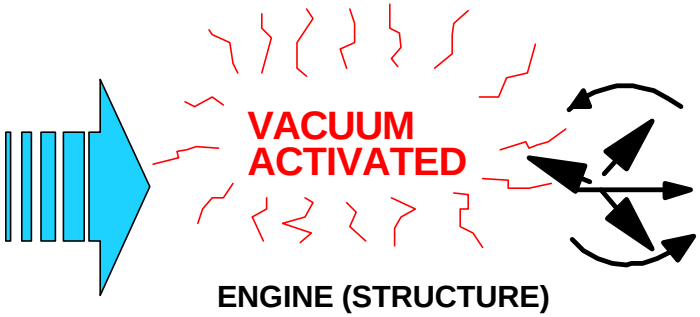

ENGINE (STRUCTURE)
TEMPLATE (FORM)

- ★ Information itself acts
- ★ Local spacetime curved, with internal subcurvatures
- ★ Produces template of forces in local spacetime (ST)
- ★ Arises from within local ST
- ★ Acts on and changes all parts of cell, including its genetics

B. ***Cell is acted upon; vacuum energy exchange does the specific action. No energy or fuel for doing the action need be added to cell externally.***

Unified field theory requires modeling and use of supersystem

Three components interact with each other:

- System and its dynamics
- Local active vacuum and its dynamics
- Local curvatures of spacetime and their dynamics.

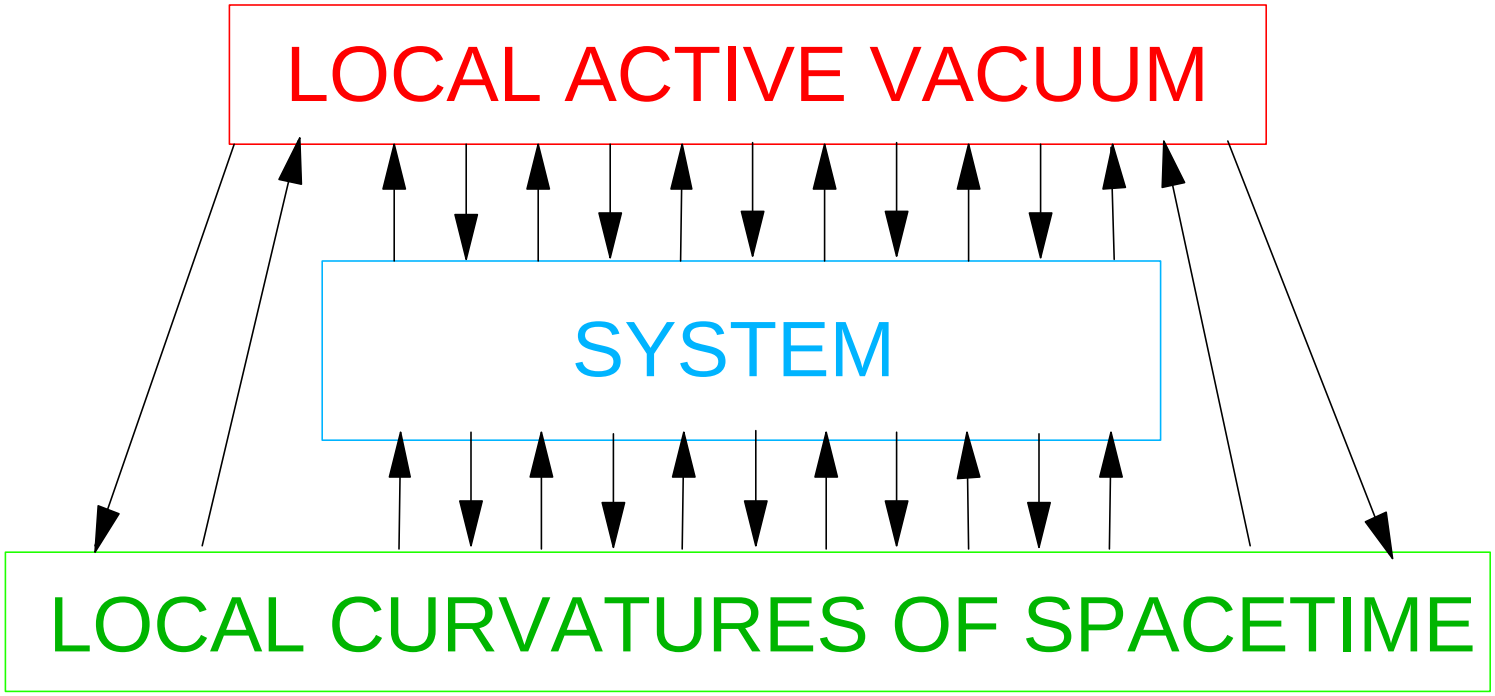

Classical EM kills the supersystem, prevents supersystem engineering

- Assumes flat local spacetime
- Assumes inert vacuum

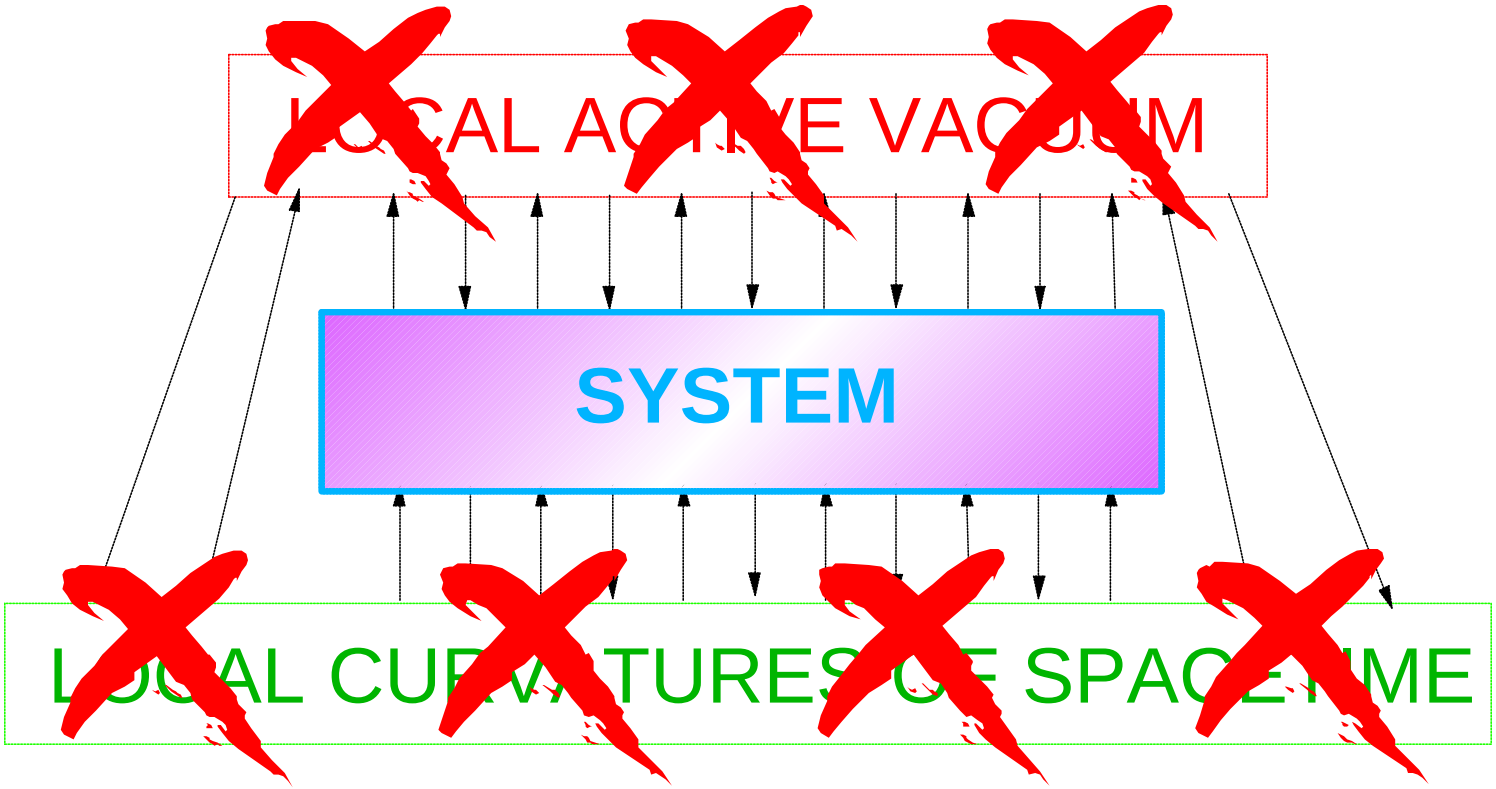

Malignant teratoma exhibits both time-reversal and fast-forwarding

- A teratoma cell is a tumor cell that has reverted to stem cells, then proceeds to differentiate toward new kinds of normal cells.
- May produce hair, skin, muscle, heart, bone, and other type cells.
- Sometimes present at birth.
- Demonstrates both "time-reversal" and "time-forwarding".
- The missing key is the engine function(s).

Miller-Fox-Urey biogenesis experiments

- Engines of and from all life forms ever on earth or in the universe exist in the ambient vacuum potential.
- The Miller-Fox-Urey experiments were not in a "sterile" environment.
- Heat (IR) and UV constitute (1) a harmonic interval with a difference frequency, and (2) amplifying by the process previously shown.
- These experiments "kindled" previously living forms from the available gases etc. by amplifying the ancient living engines from their virtual state to the observable state, so that the masses were molded into the physical states of their templates.

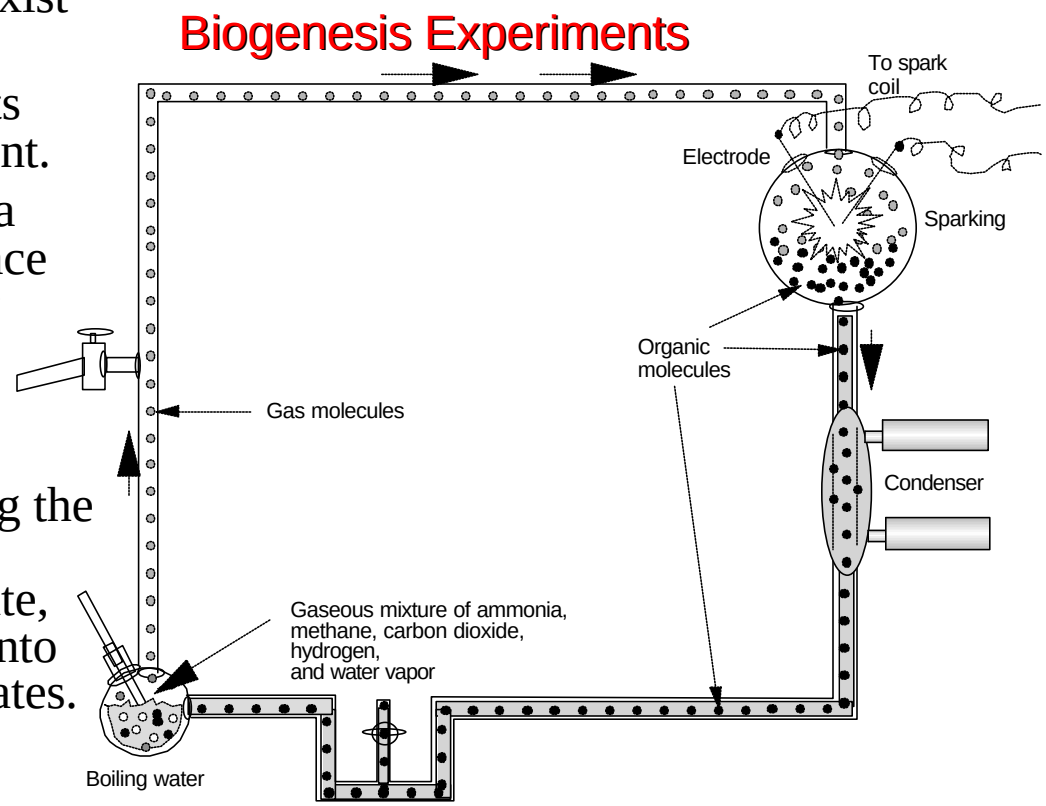

Cloning to produce stem cells

- Human DNA can be inserted in an animal cell, and the cell chemically tricked into proceeding as if fertilized.
- Formation, increase, and growth of stem cells begins and continues.

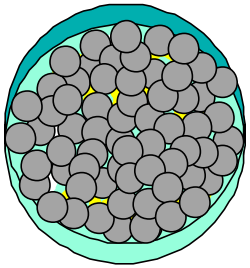

- The "engine" carried by the human DNA is changing the matter available into human cells.
- readily demonstrated experimentally.

Regeneration in a strain of rat with part of its immune system missing

- In mammals, the immune system plays a role in reducing the regeneration capability, compared to that of more primitive systems.
- In a strain of rat where that "suppressive" part of the immune system is missing, the regenerative capability is dramatically increased.
  - Can regrow cut away sections of tail.
  - Regrows plug cut out of ear.
  - Reconnects severed optic nerve.
  - Partially restores severed spinal cord.

- The suppressive "delta" engine of the immune system, operating simultaneously with the underlying primitive regenerative engine, sums to the modern much-reduced regenerative engine in the mammal.

An observation for the future

- When the science of engines is developed, physicians will be able to tailor these engine combinations to restore severed human spines, regrow severed limbs, etc.
- They will also be able to direct the body's "normal growth" to reduce and direct birth defects, genetic defects, etc.

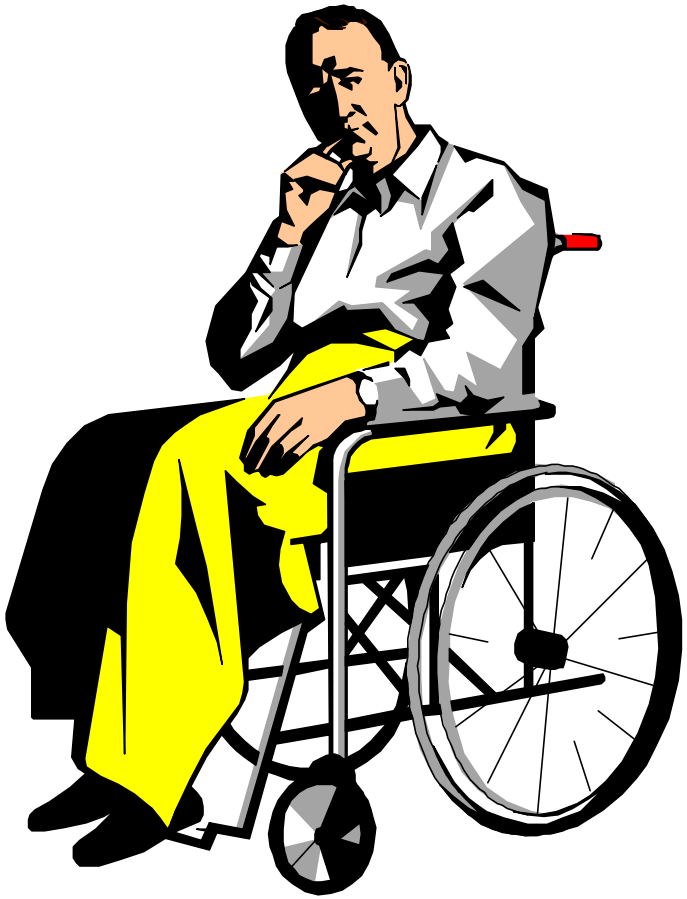

Biochemistry and EM models

- Medical scientists analyze such things as teratomas in terms of biochemistry and the biochemical model.
- An assembly of charges and charge distributions, with their associated fields and potentials, drives all chemistry at base level.
- The charge assembly and its dynamics involves a corresponding assembly of spacetime curvatures and their dynamics. These are *the cause that is driving the charge assembly and its dynamics, and therefore the chemistry*..
  - In unified field theory (such as that of Sachs) and O(3) electrodynamics.
  - Not in classical U(1) EM theory or quantum electrodynamics.
- Conventionally a causative EM field in space is "defined" as the *diversion from* that spatial field by and after its interaction with charge).
  The "definition" substitutes the effect for the cause, a non sequitur.
- This is a known major flaw, pointed out in one fashion or another by many physicists such as Wheeler and Nobelist Feynman.
- Classical EM theory is a 137-year-old model, seriously flawed. These flaws emerge in biochemistry and medical science.

Necessary EM corrections*

- Many of the corrections necessary in electrodynamics modeling either have been done or are underway.
- Higher symmetry, non-Abelian electrodynamics models have long been developed in particle physics.
- The new approach extends these models to also incorporate general relativity, thus producing a unified field theory*.
- In the new approach, spacetime curvature engines are perfectly natural and understandable, and can be directly modeled and engineered by advanced theorists.
- In short, the theory is sufficiently advanced and robust that technology and engineering can now advance.
- This will be a great leap forward for biochemistry and medical science, particularly in therapeutic methods.

* Sachs's unified field theory implemented by O(3) electrodynamics presently is the most suitable to use. Numerical methods are required.

Prioré's revolutionary results in lab animals

And its ramifications

Prioré (right) makes a point to Chaban-Delmas, Mayor of Bordeaux

- Many of the Prioré team's experiments were done in Bordeaux.
- Antoine Prioré patents:
  - "Apparatus for producing radiations penetrating living cells," U.S. Patent No. 3,368,155, Feb. 6, 1968.
  - "Method of producing radiations for penetrating living cells," U.S. Patent No. 3,280,816, Oct. 25, 1966.
  - "Procede et dispositif de production de rayonnements utilisables notamment pour le traitement de cellules vivantes," [Procedure and Assemblage for Production of Radiation Especially Serviceable for the Treatment of Living Cells], Republique Francais Brevet d'Invention P.V. No. 899.414, No. 1,342,772, Oct. 7, 1963.

Block diagram of Prioré's method

Time-reversing the cells back to normal state

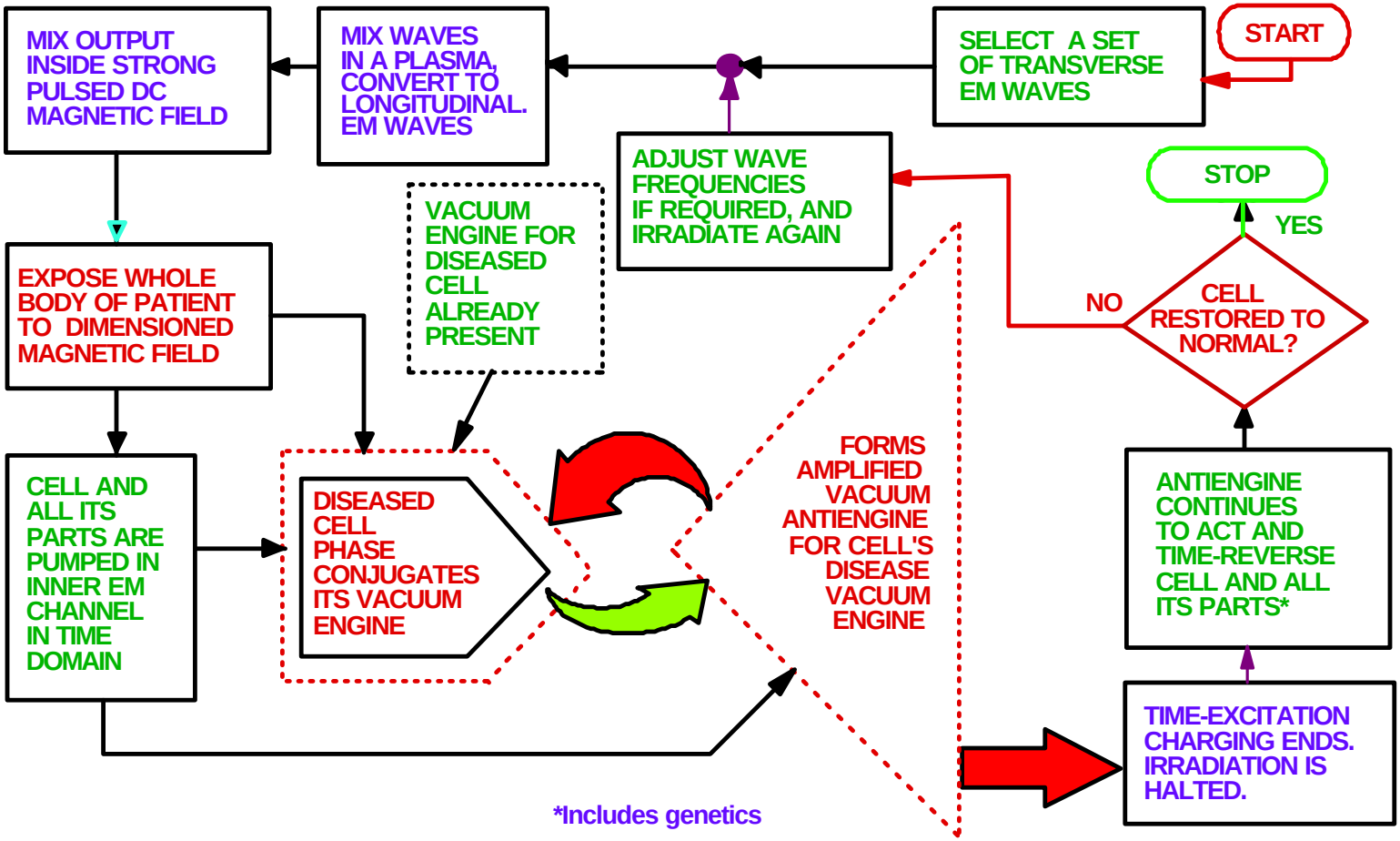

*Includes genetics

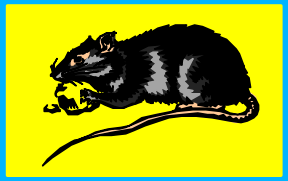

In Laboratory Animals:

Prioré Team Cured

- **Terminal malignant tumors**
- **Clogged arteries (atheriosclerosis)**
- **Suppressed Immune Systems**
- **Infectious trypanosomas**
- ***Results were presented to French Academy of Science by Robert Courrier, Director of the Biology Section of the Academy***
- ***<u>No one understood the mechanism!</u>***

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Some peculiar results by the Prioré team

- Once a rat is cured of a particular disease:
  - A single drop of blood from the cured rat, injected into another rat stricken with same disorder, would result in the injected rat getting well slowly.
  - This ability to transfer immunity and healing in the extracted drop of blood gradually decayed over a period of a few weeks.
- Showed that even the fields and potentials in the blood had been altered internally, in the treated animal.
- Showed that the injected animal's cellular regenerative system possessed the ability to also time-domain pump over the entire body, everywhere reducing the delta between that injected drop of blood now the rat's own, and the rest of the blood in its body.

Proof of cellular time-reversal

- Pautrizel compared identical treatment of immature rats with immature immune systems, and mature rats with mature immune systems.
- Treatment restored the damaged mature system back to full mature functioning, and it promptly recognized and dispatched the pathogens.
- Treatment restored the damaged immature system back to full immature functioning, unable to cope, and the pathogens promptly reinfected and killed the immature rat.
- The lesson: The body is indeed returned to a previous physical state. The pathogens themselves are not killed by the treatment, but by restoring the ability of the immune system to recognize and destroy them.
- Only the *previous ability* of the immune system is restored by the process.

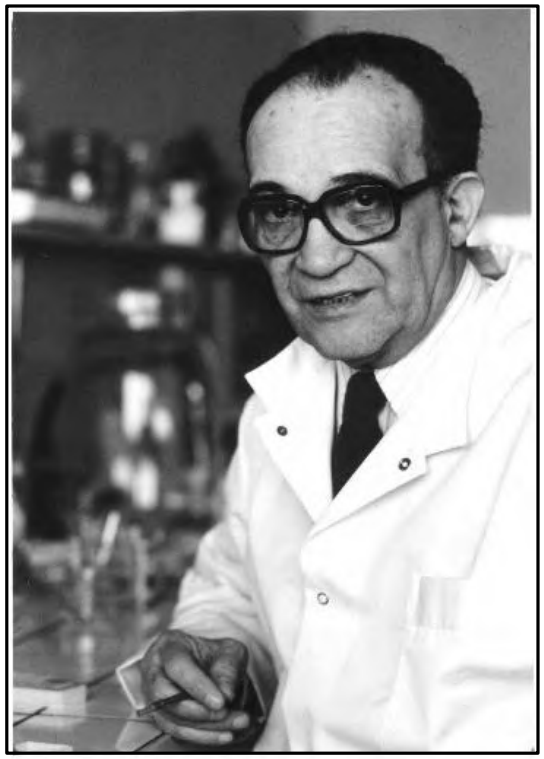

PROF. RAYMOND PAUTRIZEL
(Renowned Parasitologist)

Disadvantages of Prioré method

- Large plasma tube and facility required.
  - 3-stories high building bay if to treat humans.
  - Long irradiation time (2-3 hours).
  - Slow, numerous experimental adjustments.
- Fundamental mechanism was unknown.
  - Phase conjugate optics not yet born in West.
  - No higher symmetry EM modeling used.
  - Prioré thought it was a result of ionization.
  - Importance of difference frequency unknown.
  - Body dielectric transmission path unknown.

3-Story high Prioré device for treating humans

- At the end of the project, Prioré had developed a large unit to treat humans.
- A few were treated.
- Cures replicated what had been done in lab animals
- The massive size of the unit and long treatment time (hours) made the process bulky and very inconvenient -- and also expensive

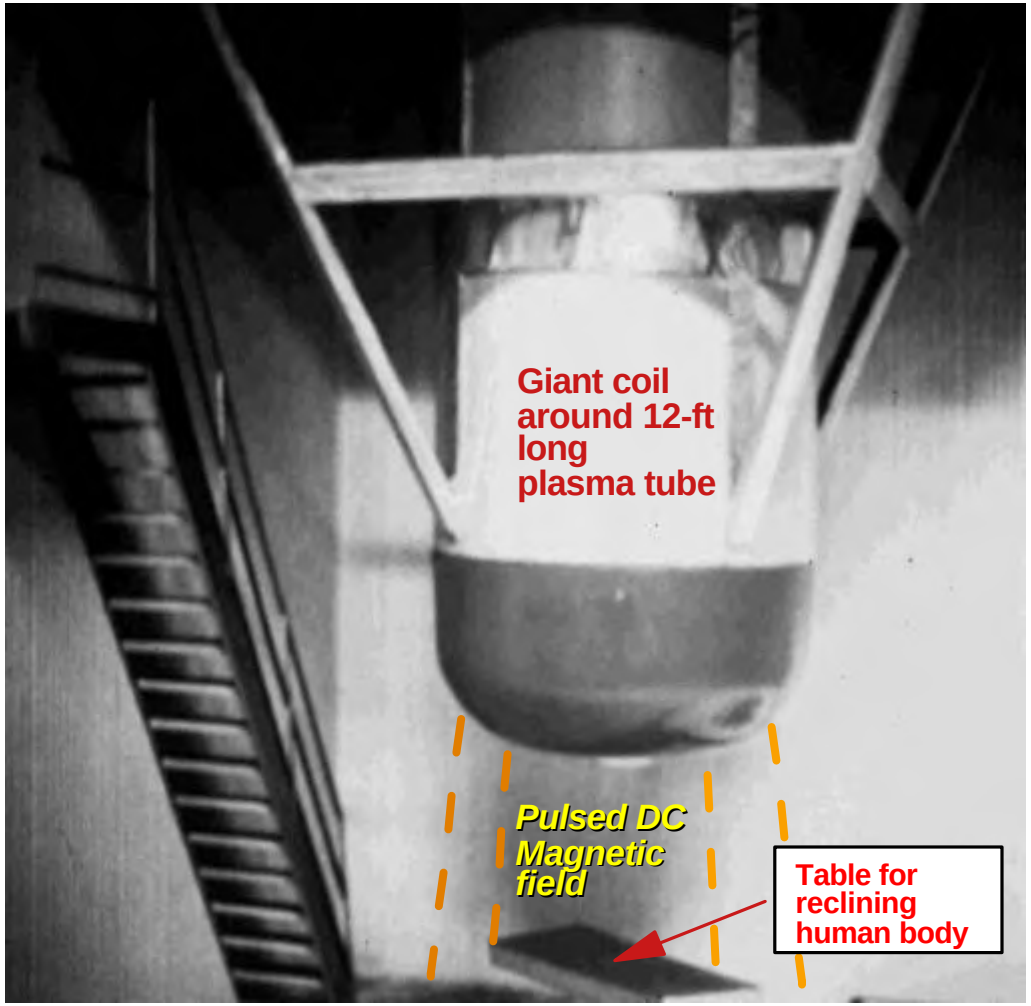

17-foot Prioré plasma tube

Used in large machine (3-stories high) to treat a limited number of human patients

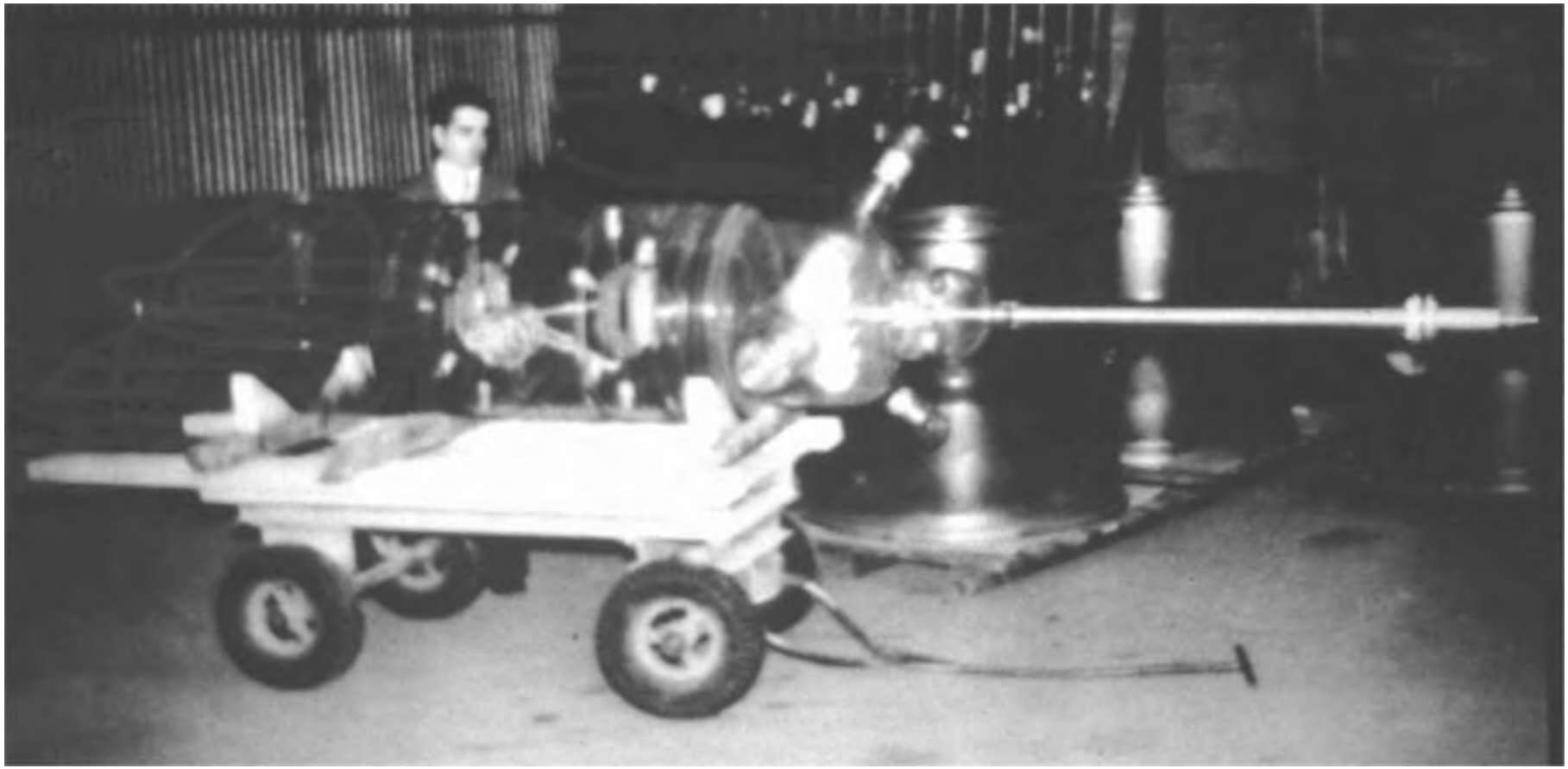

A proposed new mechanism for cancer promotion

And its ramifications

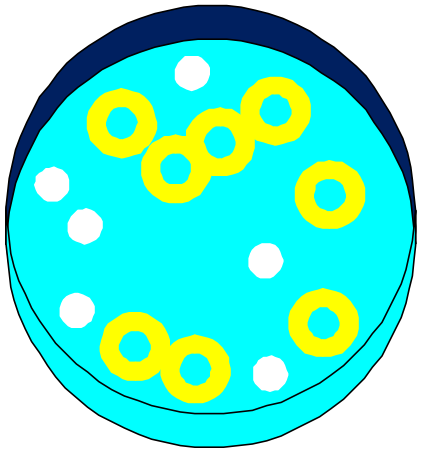

Remarks on cancer from a new perspective

- Two stages: cellular damage and promotion of the damaged cell to a tumorous cell. Promotion presently is poorly understood if at all.
- A master cellular control system (MCS) (studied by Popp et al.) controls both the immune system and the cellular regenerative system, as well as normal functions of the cells.
- The "past history" of ancestral development of aerobic cells and higher multicell aerobic bodies on planet Earth, resides in the "internested engine layers" in every tiniest part of the entire body dielectric, and in all cells.

Remarks on cancer from a new perspective (2)

- Faced with cell damage (such as sustained hypoxia) it cannot handle, the MCS continues to "peel the layers" in taking actions related to ever more distant pasts.
- Faced with continuing hypoxia, e.g., the MCS eventually reaches ancestral layers -- with an engine -- it forces the damaged cells to start moving back toward the original primeval anaerobic form.
- The first step backward is *separation from central growth control*, freeing the cell to multiply independently. At the same time, genetic changes in the cell are forced and produced, starting it back toward becoming an anaerobe.
- These actions comprise the *promotion process*.

The promotion process via engines

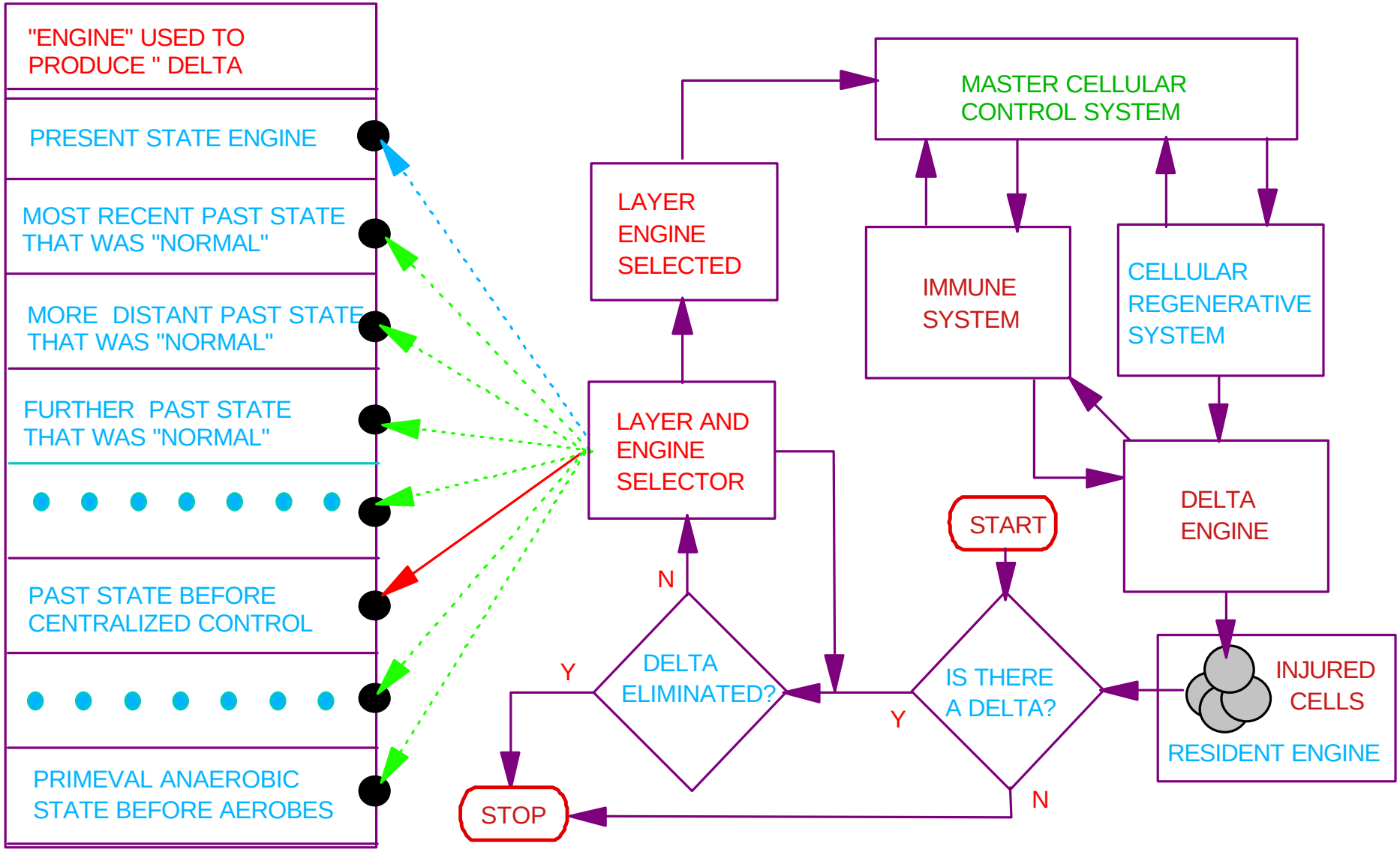

Evolution of aerobic systems

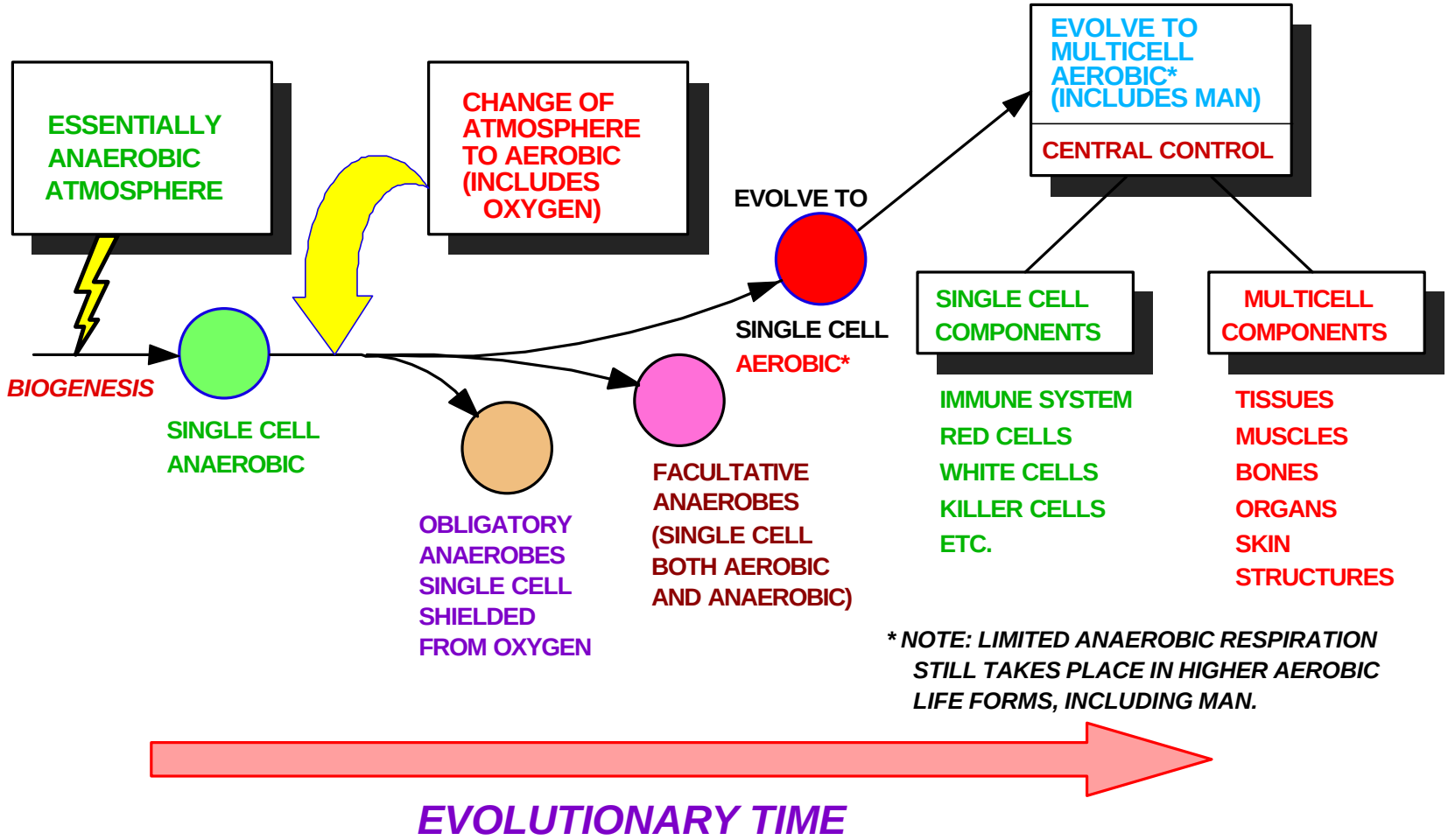

First step in self-promotion of cancer due to hypoxia

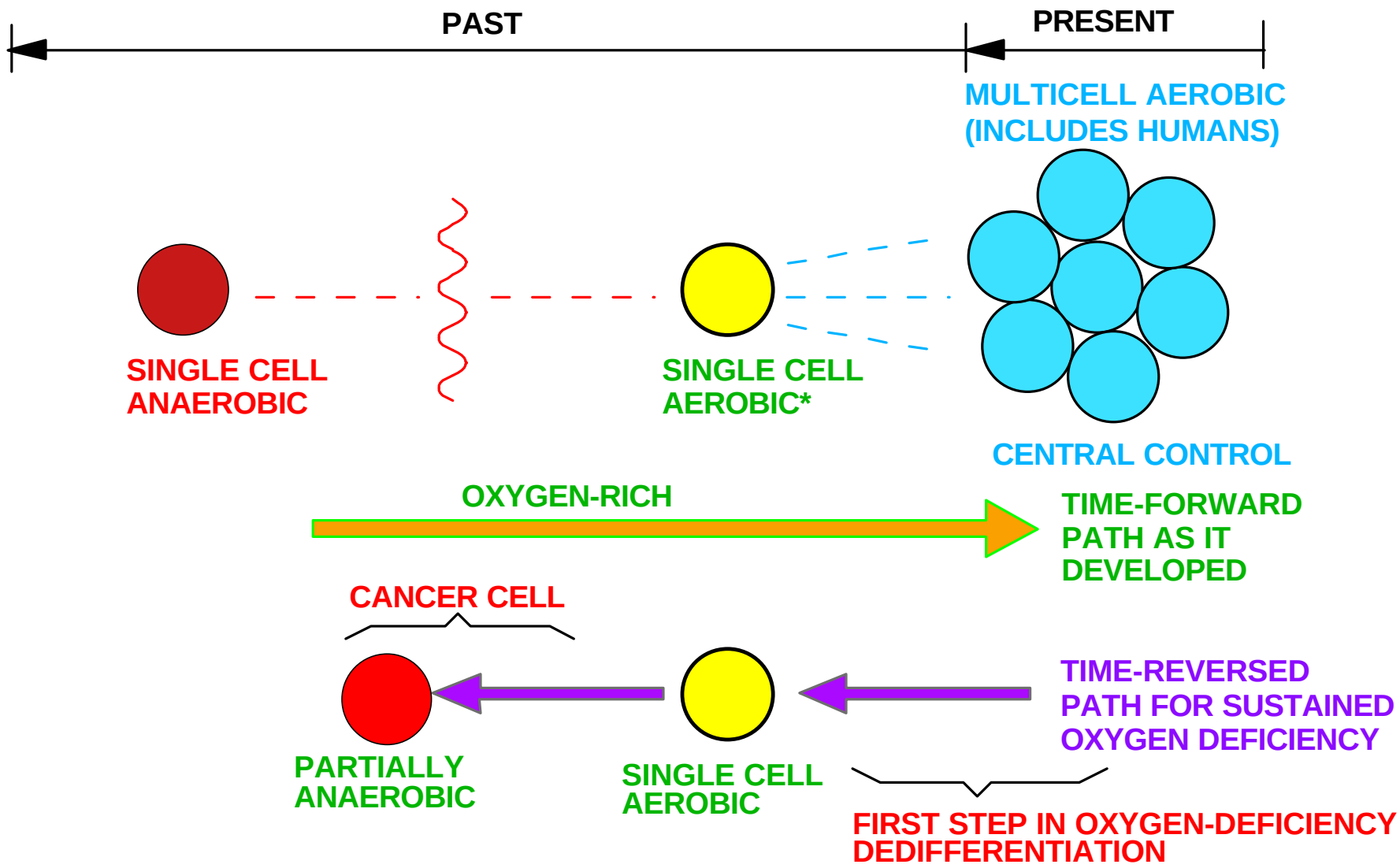

Block diagram of the cellular regenerative system

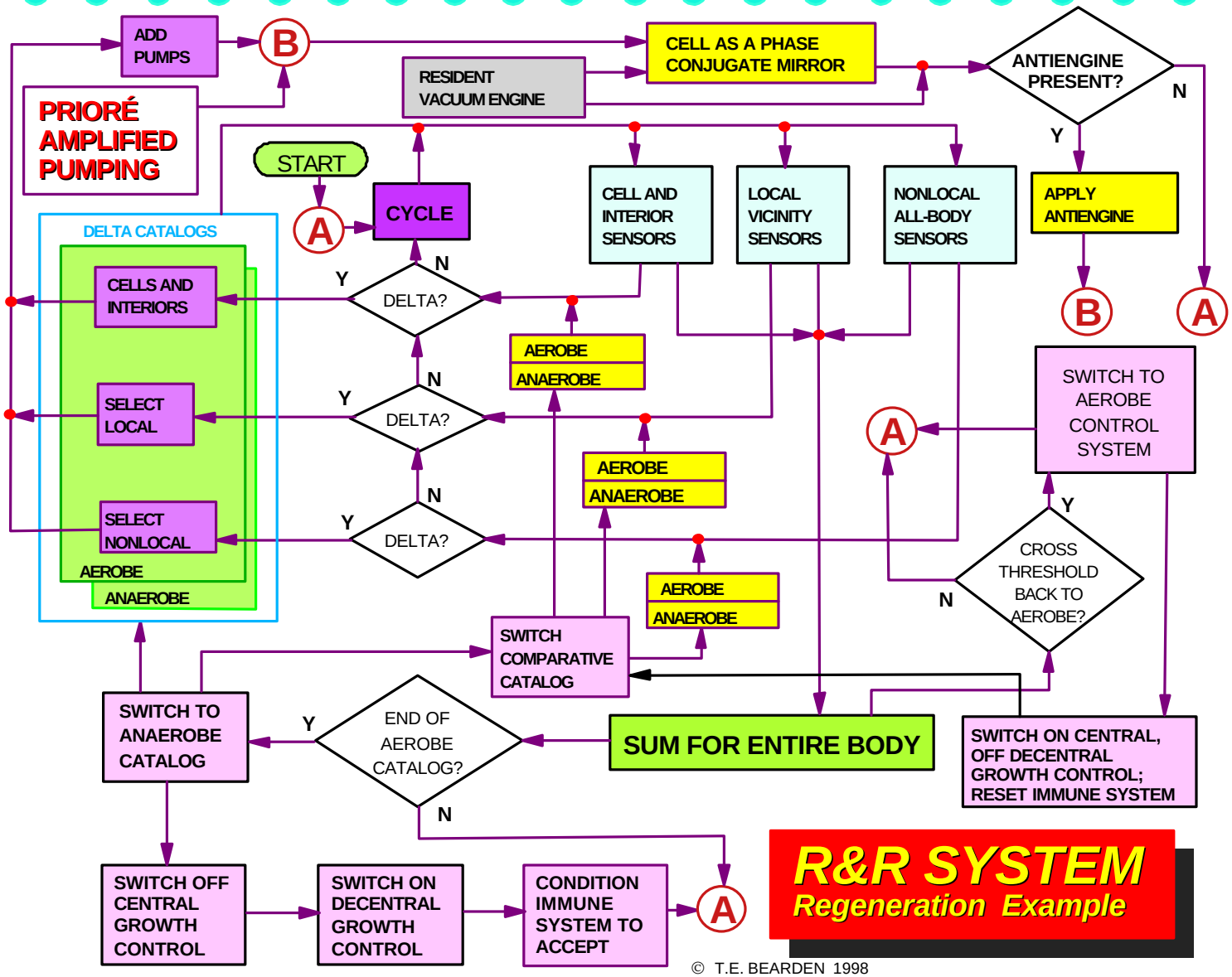

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Bombshell: Amplified EM healing

- A unified field theory approach and use of supersystem analysis has broken the basic mechanism for healing itself.
  - The Sachs unified field theory applies and has been partially fitted.
  - Evans-Vigier O(3) electrodynamics can properly model it, including both the internal and external electrodynamics and effects of engines.
  - Direct engineering development is now possible.
- Experimental proof of the results obtainable already exists in the literature.
- A medical revolution is in the offing.

Potential Medical Applications

- **Non-traumatic cancer treatment**
  - *Cure cancers and leukemias of all types*
  - *Remove pre-cancerous state*
  - *Restore system*
- **Treat and cure Infectious diseases**
- **Cure AIDS and restore immune systems**
- **Defense against biological warfare**
  - *Virulent diseases from unknown agents*
  - *Treat, cure prior to symptoms developing*
  - *Both civil populace and armed forces*
- ***Dramatically lower health costs***
- ***Rejuvenate the aged***

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To treat and save mass casualties: What is urgently needed now:

- A small, portable, relatively inexpensive treatment unit, not requiring plasmas etc.
- Treatment in 2 to 5 minutes rather than 2-hours.
- Simple treatment application, almost anywhere.
- Effective in advanced stages as well as prior to emergence of symptoms.

- Effectiveness against a wide array of illnesses.
- Use is easy, high school student can be trained in 30 minutes.
- Crash program to develop, flood down through emergency systems in great quantities.

The Solution:

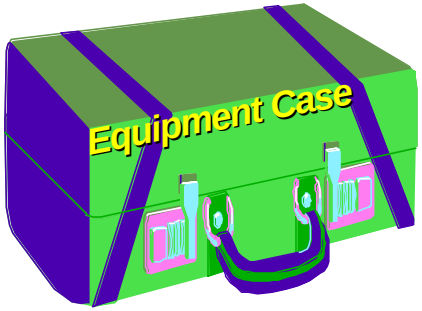

- Two blankets have antennas in them.
- Uses the "porthole" concept (discussed shortly)
- Eliminates plasma tube mixing etc.
- Computer-controlled complex signal structure.

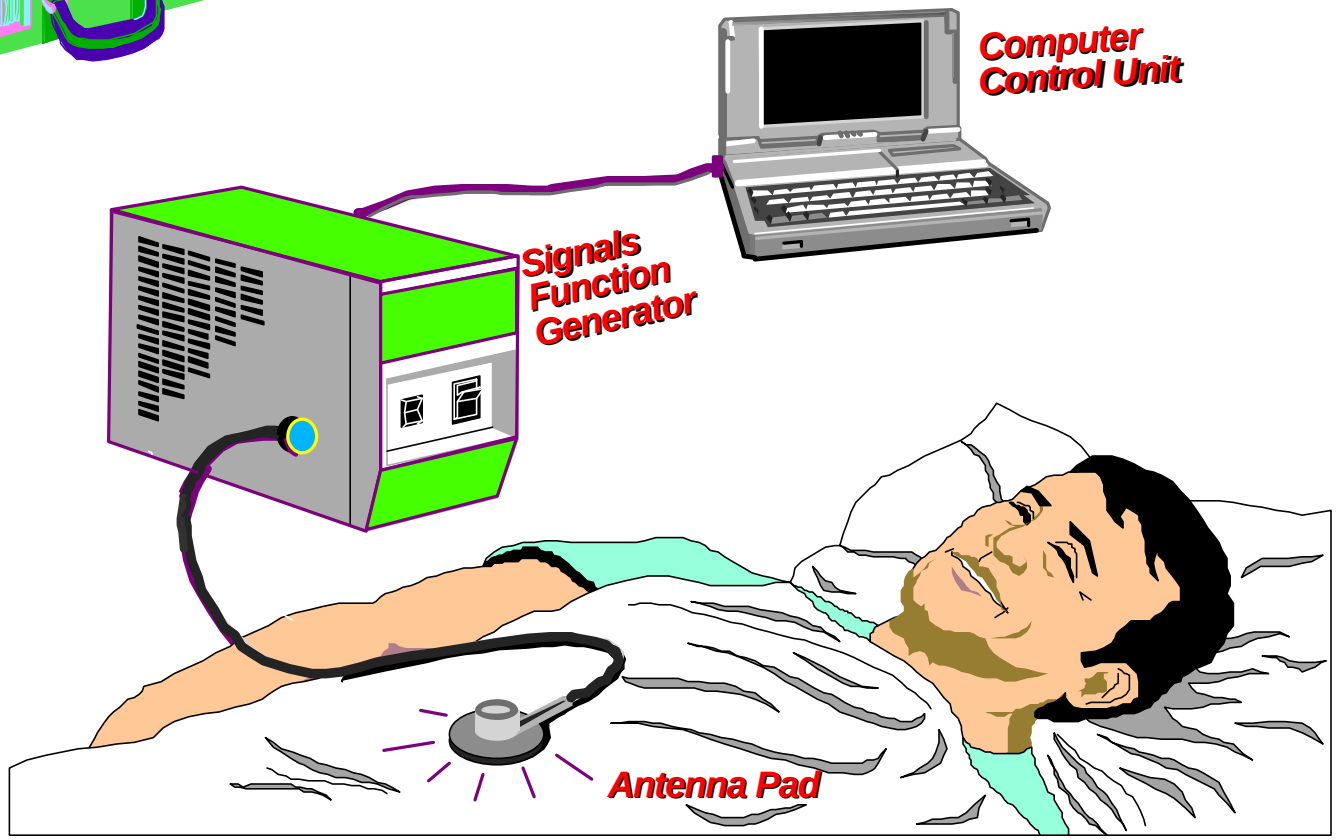

The Porthole concept:

The two-minute treatment shortcut

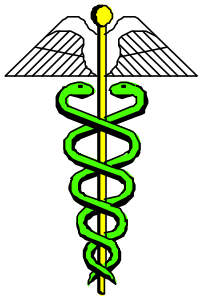

How the porthole concept works

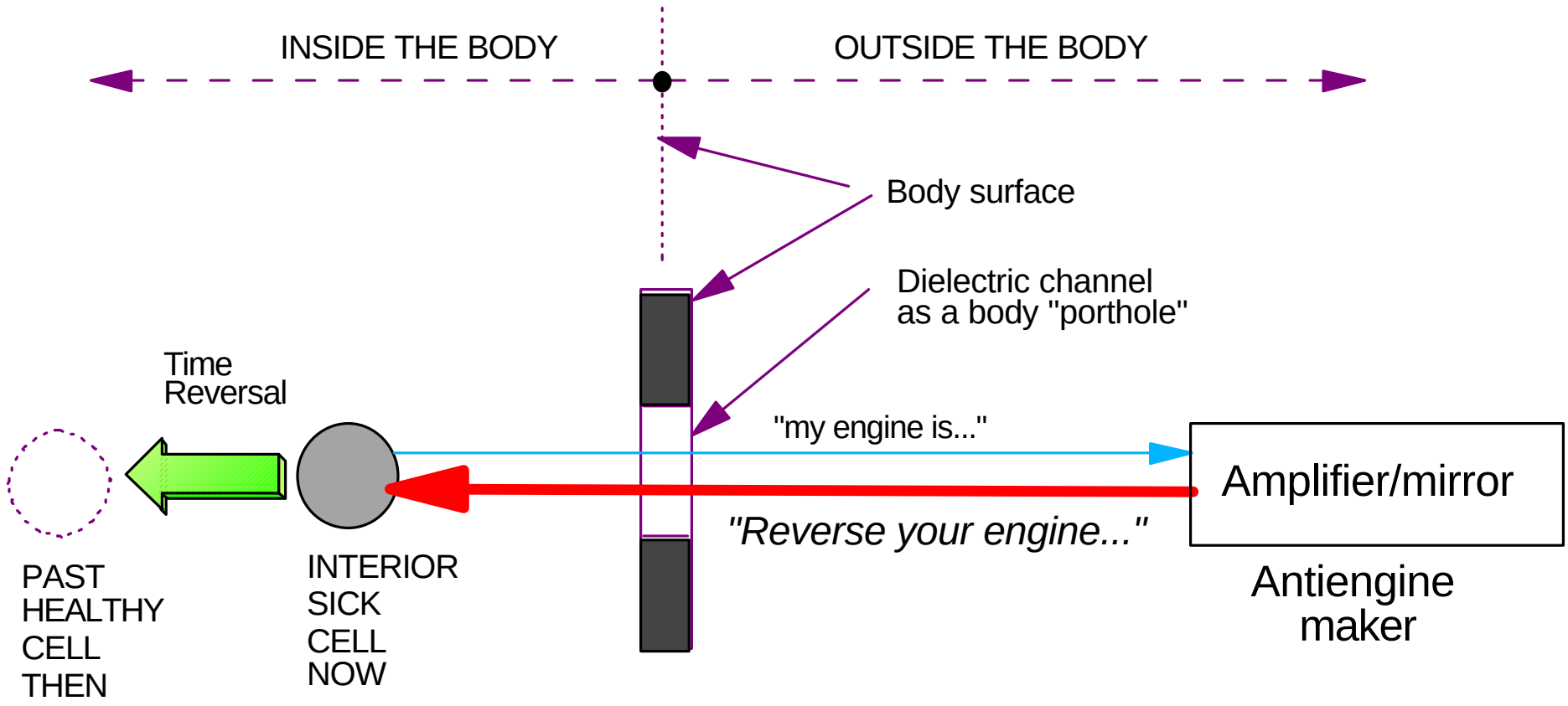

Porthole concept: An analogy of the dielectric path and inner-outer functional connections

- Imagine perfectly reversible dynamic light processes inside a large "cruise ship", that are also perfect phase conjugate mirrors
- Each process receives, absorbs, and emits light continuously
- Light escaping through the portholes is a composite from all the dynamic processes ongoing inside
- If we record and amplify the escaping light, then force it back through the portholes, it reverses all the internal processes
- The processes revert back, slowly, to a previous ongoing process state
- We cease radiation, and the processes reverse and move forward again

Porthole concept: The discovery

- The processes themselves, *in their own "frame"*, are never actually "reversed". Instead, the frame's motion through time is reversed.
  - Each to itself moves normally -- just receiving, absorbing, and radiating light, regardless of "whatever light" is interacting
  - This is due to a peculiarity of the photon and photon interaction
- Photon interaction creates observed physical reality, including the "frame" and the seeming "passage of a mass through time"
  - The photon is its own antiparticle, which is just a photon traveling in the opposite direction
  - So in this case we can use "light" to precisely time reverse (to the observer) the frame and the apparent operations (to the observer)
- When we cease irradiation, after a decay period to remove the reversed excitation, all functions are now seen to be moving forward normally in observer forward time, but from a previous physical state or condition

Using the porthole concept: Research

- The body's own emitted dense, broadband signals are recorded across a broad bandwidth
  - These signals are amplified, then rebroadcast precisely back into the body
  - This returns an amplified "reversed" signal set back through the dielectric path, invoking and applying the porthole concept in all processes
- The returning photons produce time-charging but in reversed frame direction
  - Tremendous potential energy is absorbed in highly compressed "time-energy" form in seconds
  - This "time-potential" slowly drains off as the body processes and cells reverse back to a previous state

Research using the porthole concept

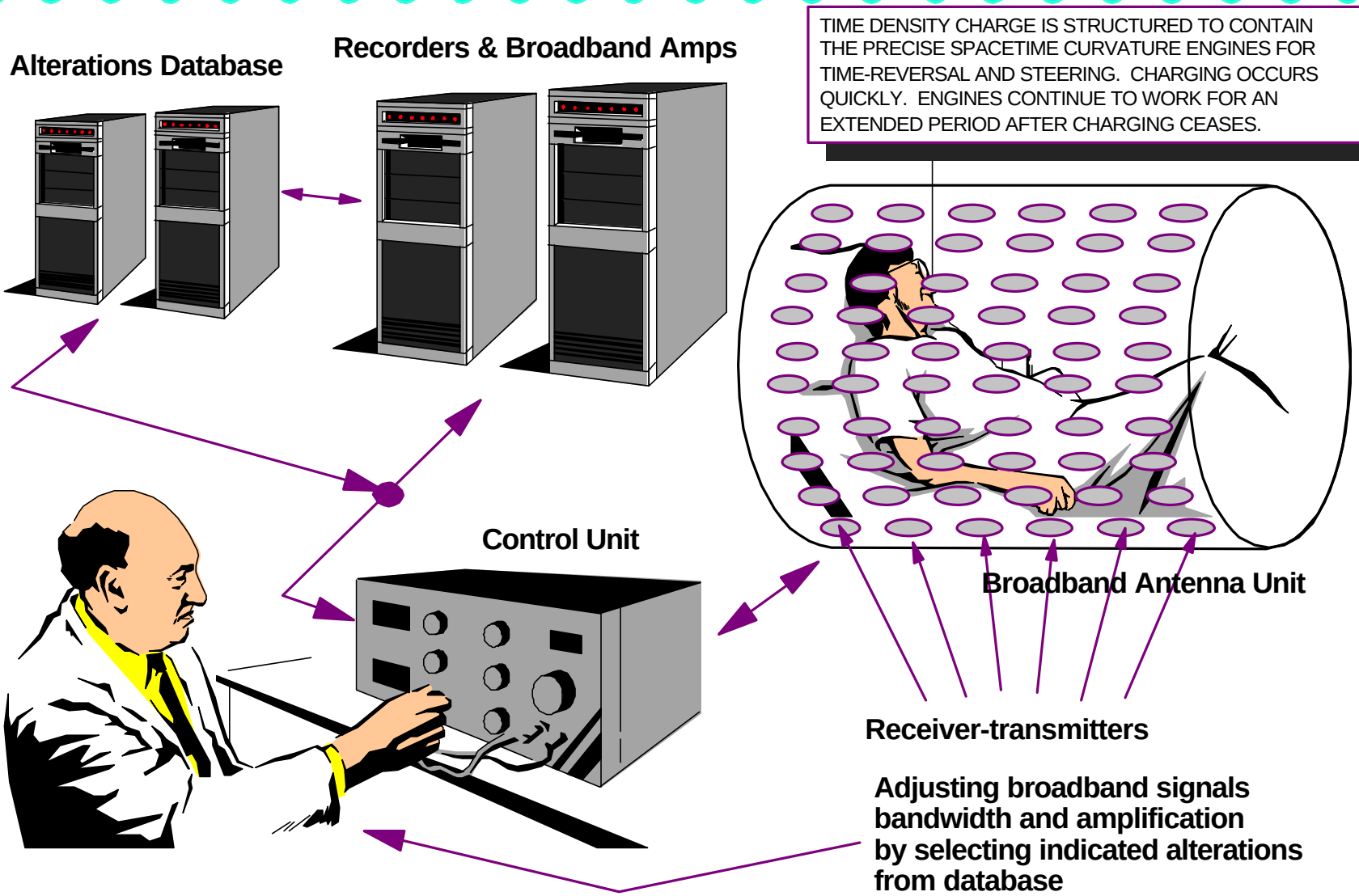

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Portable unit then developed for rapid treatment of mass BW casualties

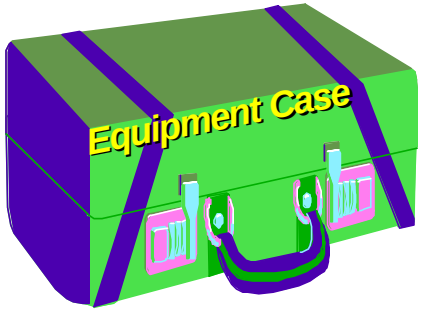

- Two blankets have antennas in them.
- Uses the "porthole" concept (discussed shortly)
- Eliminates plasma tube mixing etc.
- Computer-controlled complex signal structure.
- Irradiation for 2 minutes.

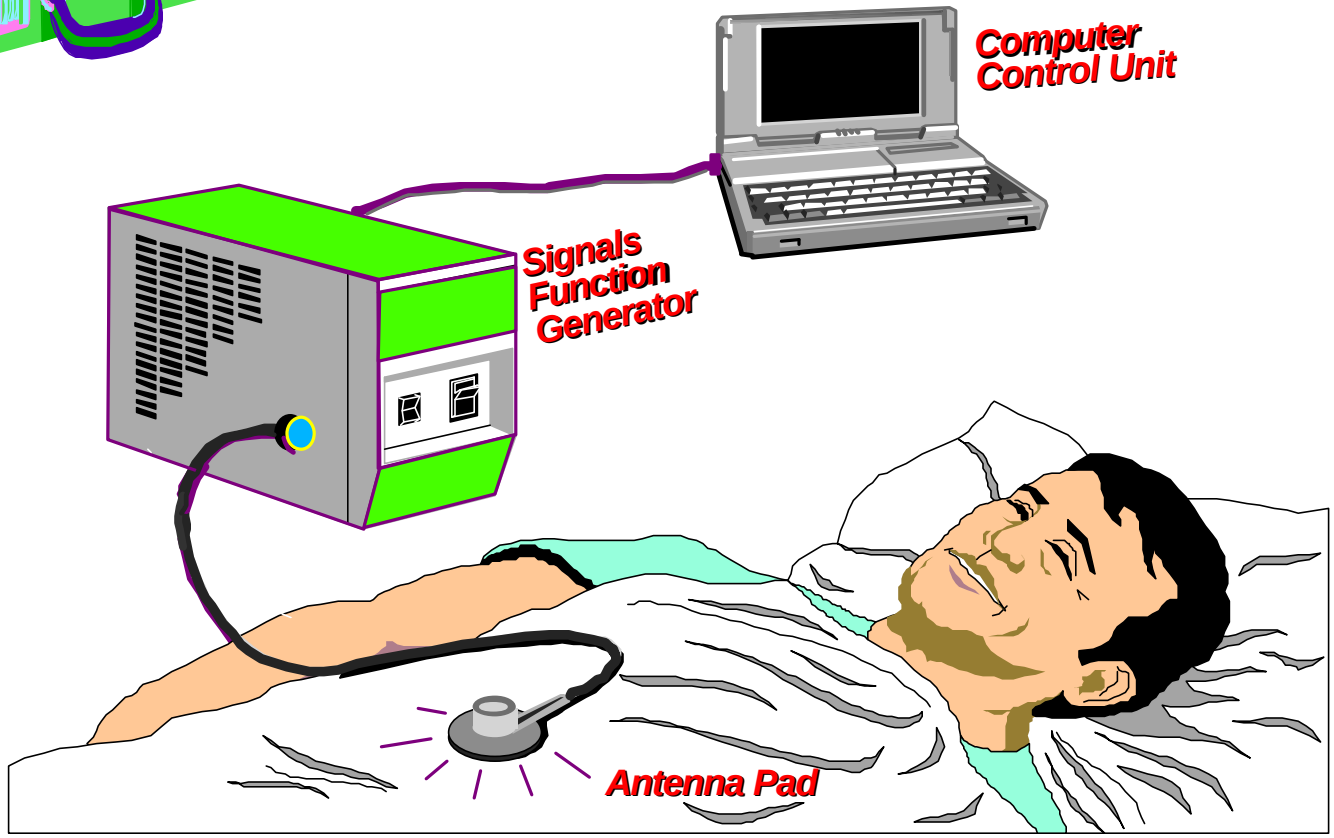

Training to use the unit

- High school student level, 30 minutes.
- Patient lies on one blanket, other covers him.
- Set the prescribed standard signal sets from listing.
- Computer-controlled generator produces the signal.
- Irradiation for 2 minutes, uncover patient, bring in another.
- Unit can be self-powering from vacuum energy (MEG*).

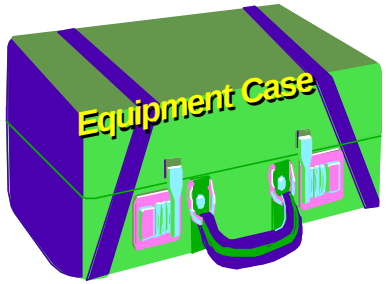

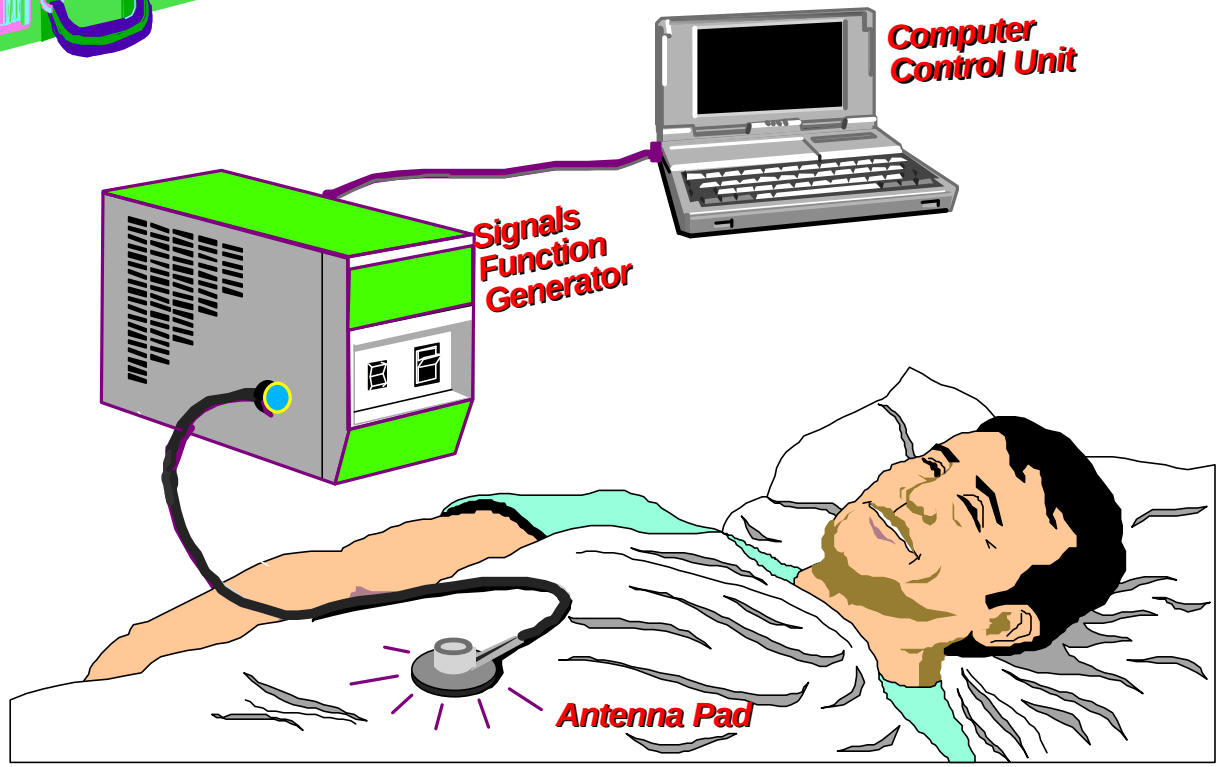

Additional advantages

- Can be developed in a crash program in 2-3 years.
- After sunk costs, projected cost per unit in mass production is less than $100,000
- Can be produced by the thousands
- Then flooded down through
  - Fire stations and police stations
  - Red cross units, hospitals, clinics
  - Emergency action teams and armed forces
- Large numbers of operators easily produced
- Emergency training could be watching a 15 minute film, then performing one graded practice run
- First generation equipment can save some 70% of the coming mass casualties from anthrax etc.

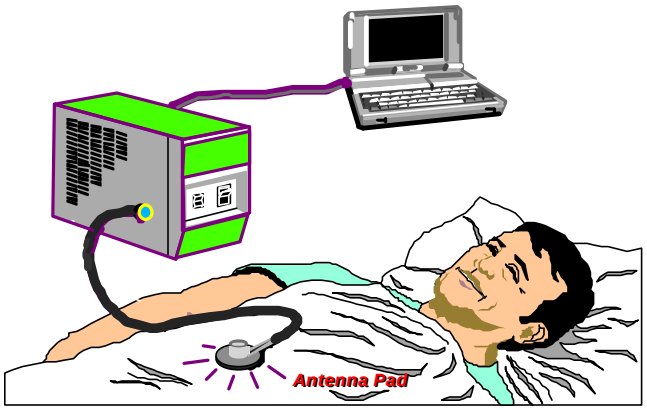

Terrorist BW warfare capabilities against the United States

The growing threat

Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- **One terrorist, one light aircraft with spray tank**
- **100 kilograms of anthrax**
- **Flies over greater metropolitan Washington, D.C.**
- **Calm night**
- ***1-3 million casualties result****
- ***Most of those stricken will die***
- **Presently little can be done to save the stricken civilians**
- ***Attacks on several population centers might produce some 10 million or more casualties***

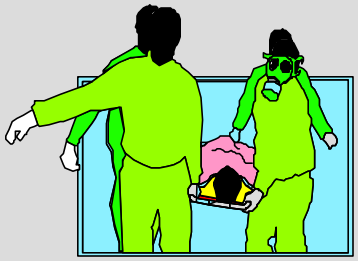

***Per OTA Report to Congress, 1993**

For decades, infiltration of terrorist teams into the U.S.

- From several foreign nations, not just Bin Laden in Afghanistan
- Several thousand Cuban guerillas, from training camps in Southern Mexico
- Russian Spetznaz teams
- Nuclear warheads (up to 80 KT)
- Biological warfare agents
- Yakuza in oriental populations in our cities
  - Yakuza manufactures Russian energetics weapons in their own facilities in Japan
  - Possesses the new EM weapons referred to by Secretary of Defense Cohen in 1997
- We are now in a very long, hard war and will suffer millions of casualties in our cities. It may last for decades.

Defense Secretary Cohen*

(Involvement of secret superweapons)

"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts."

* Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

Some typical BW agents

- Smallpox, including different strain developed by Russia (some sold to terrorists)
- Anthrax
  - Over 400 known locations around the Earth have cultures
  - Difficult to decontaminate
- Bubonic Plague
- Botulism toxin
- Tularemia (rabbit fever)
- Hemorrhagic fevers, such as Ebola

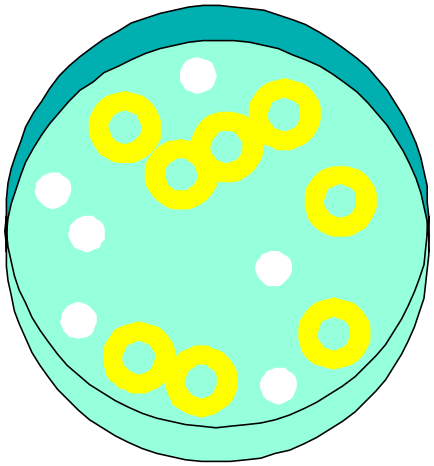

Anthrax

- OTA study: Some 200 pounds released in a spray, on calm night over Washington, D.C. could result in up to 3 million casualties
- Symptoms usually in 2-10 days
  - Sometimes as long as 7 weeks
  - Flu-like symptoms

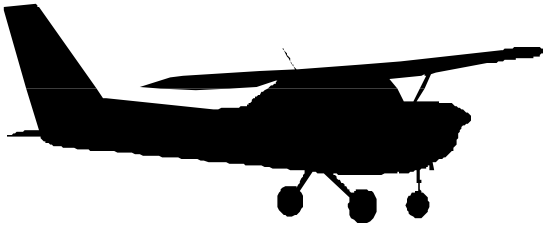

- Then 1-3 days later, shock and breathing problems cause death in up to 100%
- Antibiotics given early (before symptoms) can prevent infected persons from becoming ill
- Limited vaccine, reserved for military

Smallpox

- More than 500 million people killed in the 20th century before "eradicated" in 1977. Vaccination ceased in 1980.
- Russians kept it, developed new strains, sold to terrorists
- Symptoms in about 12 days: fever, headache, nausea. Rash similar to chickenpox then appears.
- Rash turns into hard blisters. *Highly contagious*, kills one-third of its victims.
- No cure. About 12 million doses of vaccine left.
- If smallpox is unleashed in any major city on earth, it will eventually kill 2 billion, or about 1/3 of the human species -- unless a radical new cure is found and utilized.

Bubonic Plague: Historically the most feared (Black Death)

- From 1980-1994, 18,739 cases in 20 countries.
- Symptoms occur in 1-6 days after inhaling the pneumonic form.

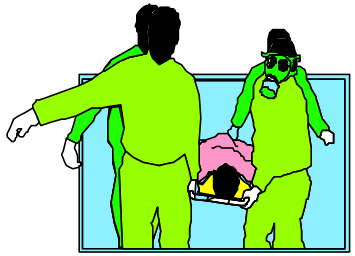

- High fever, cough, labored breathing lead to respiratory failure and death.
- It is contagious.
- Rapid use of antibiotics can be effective.
- Vaccine not currently produced in the U.S.

Botulism toxin (a nerve toxin)

- Single most poisonous BW substance known.
  - Typically borne in food, contacted by eating.
  - Could be developed as aerosol weapon.
- Symptoms in 24-36 hours; blurred vision and difficulty swallowing, speaking.
- Paralyzes muscles, leading to respiratory failure and death.
- Centers for Disease Control and Prevention maintain a botulism antitoxin supply.

Tularemia

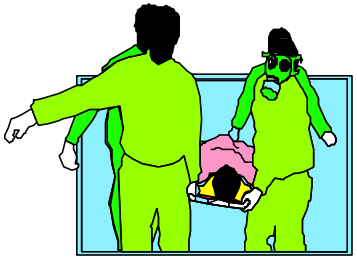

- U.S. studied its weapon potential in 1950s and 1960s.
- Symptoms appear in 3-5 days, including fever, chills, headache, and weakness
- Inflammation and hemorrhaging of the airways can lead to death.
- Without antibiotics, one-third die. Can be 90% if breathed in, in aerosol form.
- Vaccine developed and under review by FDA.

Hemorrhagic fevers, such as Ebola

- E.g., origin of Ebola is unknown. Probably transmitted to humans by animals, to begin a breakout.
- Symptoms in 3-5 days, include fever, aching muscles, diarrhea.
- Hemorrhaging of fluids out of tissues and orifices.
- From 30 to 90 percent die, depending on specific fever type.
- Some of these fevers respond to antiviral drugs.
- The drugs are in short supply.
- Presently *containment* is the primary goal.

A factor the U.S. does not know

(Secret involvement of clandestine superweapons)

- Three nations (not the U.S.) developed quantum potential weapons using Bohm's hidden variable theory of quantum mechanics.
- Can induce disease engines in matter or bodies at a distance.
- Have developed "spreading" of immune systems in a targeted populace (cleverly tested in Gulf War against U.S. troops).
  - Cocktail mix of disease engines for 2 dozen different diseases
  - Targeted area's human immune systems react to these engines when they are still in virtual state, just below quantum threshold.
  - Spread immune system's resources thus "thinned" across response to two dozen shadow diseases at once.
- Hit with a terrorist BW attack, the spread immune systems are overwhelmed much more easily and quickly.
  - Yield (casualties) of the attack is increased by factor of 3-5.
  - Spreading of U.S. immune systems has been accomplished and is still being maintained.

Summary and conclusion

The new war

A new Pearl Harbor: Strike on the World Trade Center in NYC

- The North Tower has already been struck and is burning.
- A second jetliner is about to strike the South Tower.

Fireball From Impact on South Tower

- The two buildings held some 50,000 occupants
- Evacuation was underway after the first strike
- More than 6,000 persons were killed
- This is more than were killed in the Dec. 7, 1941 strike on Pearl Harbor

Collapse of the South Tower

- The first tower to collapse was the South Tower
- It is still uncertain just how many people were caught inside and killed
- This is a half million tons of debris, falling from the New York skyview.

Collapse of the North Tower begins

- The North Tower then collapsed
- This was another half-million tons of debris falling from the NYC skyview

Collapse of North Tower finishes

- Collapse of the North Tower killed many rescue workers, fire-men, and policemen
- At this writing, the total casualties are still unknown

Next began the recovery efforts

- Recovery operations will require months
- At this writing, the total casualties are still unknown
- The damage was done by two civilian jetliner "bombs"

The Pentagon was hit on the same day

- Hundreds were killed the same day when another jetliner struck the Pentagon.
- Yet another jetliner, possibly headed for the White House, crashed enroute when the passengers attacked the suicide terrorist hijackers.

A sobering thought

- Nuclear weapons are already smuggled into the U.S., as are BW agents such as anthrax, smallpox, etc.
- Had a 40-80kT weapon been exploded in New York and one in Washington, millions would have perished and both cities would have been devastated
- There would have been no recovery of those cities for many decades

Present Status of the WMD Threat to the United States

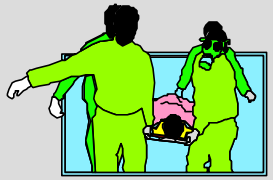

- **Many foreign nations are hostile to the U.S. and sponsor terrorists**
- **Some 25 nations have WMD or are acquiring them**
  - **BW agents and weapons**
  - **Chemical agents and weapons**
  - **Nuclear materials and weapons**
- **Thousands of students and émigrés**
- **Infiltrated teams, BW, other WMD already**
- **Castro guerrillas infiltrated over the years**
- **<u>Can do unacceptable damage to U.S. now</u>**
- ***<u>May reach knockout capability</u>***

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***Per OTA Report to Congress, 1993**

The U.S. is terribly unprepared

- Limited medical supplies, antibiotics, vaccines
- Insufficient facilities, emergency teams
- No civilian shelters (much less BW-filtered)
- Not enough doctors, nurses, masks, etc.
- Present treatment methods woefully inadequate
- Triage will apply
  - First treat those most likely to recover
  - Others (showing symptoms, or advanced) are just set aside to die
- Other attacks are a matter of *when*, not *if*.

Conclusion

- As several cities are struck, millions of U.S. civilian casualties will result. Devastation will be enormous.
- We shall eventually lose more American lives than in all the rest of our wars to date.
- Present medical therapeutic science is totally inadequate to do the job. It cannot save us.

- At some point, when we are sufficiently damaged, the Spetznaz or other terrorists may detonate nuclear weapons in our cities, with appalling carnage.
- A combined superweapon technology and terrorist groups will then destroy the remaining populace.
- On its present course, the inadequacy of Western medicine may doom us.

A difficult truth to consider

- In any strategic strike, the first phase is to get the strategic weapons (weapons of mass destruction) delivered to their distant targets.
- That has already been done.
- Eerily, the first phase of World War III has already been accomplished.
- It was already accomplished before the Sept. 11, 2001 strike on New York and Washington. That was the new "Pearl Harbor", and only the opening round. It already killed more Americans than died at Pearl Harbor on Dec. 7, 1941.
- Unless we improve our medical therapy quickly and dramatically, we will lose -- particularly when the hidden energetics weapons and outside terrorist sponsorship by hostile nations are factored in.

A personal perspective

- There now exists an overwhelming, immediate moral imperative to get this development program done at the utmost speed humanly possible.
- The sheer survival of the United States and Western civilization depends upon it.
- Officialdom is aware that the KGB/Russians have long planned to finish the U.S., after initial nuclear exchanges, by fierce and massive BW strikes.
- It appears that the plan has changed to let the terrorists do the main work, while augmenting U.S. casualty levels by energetics weapons.

China is also involved

- China has declared South China Sea the territorial waters of China
- China will eventually take Taiwan
  - Has massed missile artillery trained on Taiwan
  - Recently held invasion practice on an island near Taiwan
- Recently deployed fearsome EMP weapons utilizing negative energy rather than positive energy (Dirac sea theory)
  - Extinguishes all electron currents
  - Duds electrical and electron systems instantly
  - Instant death to struck bodies
  - Instant kill of missiles, aircraft, electronics in nuclear warheads
  - Ultimate "death ray"; can be made small or large
- Recent 2-carrier U.S. task force maneuvered in South China Sea to caution China
  - The new Chinese EMP weapon was trained on that task force
  - Could have destroyed it within minutes

Final thoughts

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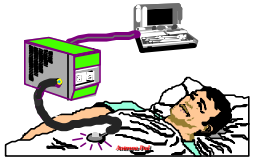

- This is one of the great turning points in history.
- The development program is eminently doable. That it works has been experimentally demonstrated. The long-vexing puzzle of the active mechanism has been solved.
- Our scientific community bitterly opposes any use of electromagnetics -- even an advanced, higher symmetry electrodynamics -- for medical treatment.
- A consortium of the scientific community, the large pharmaceuticals, FDA, and the AMA will oppose this project even while the U.S. is being destroyed wholesale.
- It can only be done in the private sector, and there will likely be no funding unless by philanthropists.

Continuation

Business plan, development program, budget breakdown, proposed schedule etc. go here.

Weapons Slides

The Tom Bearden Website

Help support the research

"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts." *

Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

Slides
(covers period up to 1999)

- The Coming Strategic Attack on the United States
- Outline
- Loss of two separate A-10 Warthogs in 1997
- Typical ABM Defenses (Widely Deployed by mid-70s)

- Launch Phase Anti-Missile System
- Launch Phase Anti-Bomber System
- HC-130s Engines Quit, Aircraft Crashes
  Nov. 22, 1996
- 1996 Actions by this analyst
- Additional Information Exists: Not Analyzed, Not Integrated in Briefing
- Kill of Arrow DC-8, Gander AFB, Dec. 12, 1985
- Satellite Photos of Plumes in Soviet Arctic Since 1974
  See "Fer de Lance" for additional information
- Aum Shinrikyo ("Supreme Truth" Cult), Shoko Asahara, Leader

  Aum Shinrikyo - Anatomy of a Dangerous Cult
- Ashkhabad Problem and Its Solution
- Strange Characteristics of Iran Quake, Sep. 1978
- Iran Earthquake, September 1978
- Situation Now (Assessment)
- Situation Now (Assessment 2)
- Aspects of Strong Local Asymmetry
- Mass Casualty Problem: Aerial Anthrax

Spray on Washington, D.C.

- Present Status of the WMD Threat to the United States
- Some Present Problems in the U.S. WMD Defense Capabilities
- Internal Terrorist Threat with Weapons of Mass Destruction: Now & Future
- Attempt to Ban Energetics Weapons Worldwide
- Brezhnev's Schedule
- Large glowing Tesla globe witnessed in Red China by hundreds
- Cold Explosion -- 9 April 1984 Near Kurils, and formation and growth of spherical shell (globe)
  Sequence of Events
- Cold Explosion -- 9 April 1984 Near Kurils, and formation and growth of spherical shell (globe)
  What They Were
- Cold Explosion -- 9 April 1984 Near Kurils (Plus additional weapons effects)
- Countering Insane MAD Systems:
  Find Loophole, Exploit It
- Next Generation Counter to Both Sane and Insane MAD systems
- Simultaneous Dudding of Nuclear Weapons Worldwide

- Simultaneous Dudding of Nuclear Weapons Worldwide
- Operation Divine Wind II
- Advanced EMBW Applications
- EM Biological Warfare (EMBW)
- Microwave Radiation of U.S. Embassy in Moscow
- Pentagon EMI Studies, 1989
- EM Missile Practice (6 slides)
- Subdivisions of Soviet Energetics Program
- Communism's Goal
- Manuilsky's Goal vs. Status Today (Dec. 1996)
- Professor Hellman, German Scientist Released from Work in Soviet Union
- Hemispheres and Globes of Light (4 slides)
- How Could Such Superweapons Ever Be Concealed?
- Soviets Easily Concealed These Superweapons for Four Decades
- Microscope-type, laser-like interferometer for inducing quick α-decay in samples of otherwise longer-lived isotopes
- Longitudinal Wave Interferometry: Endothermic

- Longitudinal Wave Interferometry: Exothermic
- U.S. Air Attack on Libya, April 1986
- Lightning Wall
  circa 1959-1960
- Lisitsyn's Report: Brain Code Broken
- Large Longitudinal Wave Interferometer (LWI) Accident
- Large Longitudinal Wave Interferometer (LWI) Accident
- Use of Hidden Information Content of the Field Can Provide Action-At-A-Distance
- Two Types of Mutual Assured Destruction (MAD) System
- Psychoenergetics Weapons Teams Mentally Disable All Personnel
- Strikes Against Special Ship and Energetics Weapons Sites
- "Mindsnapper" Attack on Special Ships and Energetics Weapons Sites
- How Much Off Guard Are We?
  (7 Slides)
- Possible Targets: 1995-9 Escalation Phase
- Propagation of Weapon Effects
- Yugoslav Earthquake, Followed by Cold Explosion
  April 15th, 1979

- Countering an Insane QP Weapon
- Gulf War Disease: KGB QP Weapon Induced ST Curvature Engines for a Cocktail of Diseases
- Self-Targeting in Inner EM Channel Can Produce a Quantum Potential
- Mechanism for Producing a Quantum Potential
- Major Principles for Use of Quantum Potential Weapons
- Major Principles for Use of Quantum Potential Weapons (2)
- Instantaneous Communication by a Quantum Potential
- Participants in a quantum potential share a common multiply-connected spacetime (MCST)
- Quake in Tangshan, China
  28 July, 1976
- Exchanging Earthquakes
- Instant Communication by a Quantum Potential
- Westerners Do Not React to Slow Threats
- Characterizing a Given Risk or Risk Factor
- Technical Risk Management
- Aum Shinrikyo's Sarin Facility

- In Scalar Beam Interference Zone
- Physicist Schappeller Auralaz Munster, Austria
- Initial Soviet Plan for Cold War, After WWII
- Josef Stalin: Absolute Dictator
- Exploding any Resistance by Operational Scientists
- Significant Soviet Statements
- Captain Svoboda Dives Headlong to Her Death
- T-polarized Beam Projector
- Possible Tests (1)
- Possible Tests (2)
- Possible Tests (3)
- Possible Tests (4)
- Mushroom Cloud Rising From Sea
- Launches from Cape Canaveral and Vandenberg AFB Provided Practice Targets of Opportunity
- The sinking U.S.S. Thresher, with her controls jammed, implodes when she reaches crush depth
- Embodiment of an instrument array sufficient to discriminate when time-density charging has occurred, and that transduction

of time-charge decay has occurred.

- Time-Polarized EM Wave Interferometer Creating Space-Time Curvature Engines in a Distant Interference Zone
- Transmutation of Radioactive Nuclei at a Distance
- Transmutation of Radioactive Nuclei
- Typical Tesla Shield, Northern Route of Japan
- A Curious Tide in Human Affairs
- Large Scalar EM Interferometer (LASI) Accident Near Urals, 1958
- The Superpower Paradox: Asymmetric Cheap WMD Strategic Strike and Destruction
- The KGB/Yakuza-Aum War Plan
- Why Western Science is Ignorant of KGB Energetics
- Transmutation of Radioactive Nuclei at a Distance
- TheYakuza
- Yugoslav Earthquake, Followed by Cold Explosion
  April 15, 1979

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* Note that the Secretary did not speak the words in square blocks; these were added by the writers later,

probably to "soften the tone" of the Secretary's information release. So the Secretary confirmed that some nations of the world -- not just some ragged terrorists, as the writers tried to imply for spin control -- do possess novel electromagnetic weapons and are using them to induce earthquakes, engineer the weather and climate, and trigger volcanic eruptions.

THE COMING STRATEGIC ATTACK ON THE UNITED STATES

By an AUM/Yakuza/KGB/Communist Coalition Using Energetics SuperWeapons

T.E. Bearden, LTC
U.S. Army (Retired)
M.S. Nuclear Eng.
Fellow Emeritus, AIAS

With Technical Background and History of Energetics Weapons

Partial support by the Association of Distinguished American Scientists is gratefully acknowledged.d

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Outline

- Background: Classical Electromagnetics (and Defects)
- Background: Energetics (Scalar Electromagnetics)
- Background: Soviet Energetics Weapon Development
- KGB/Communist Plans
- Countering of Soviet/KGB/Communist Plan in Mid-80s
- Soviet Economic Collapse and Adaptation of Plan
- Weapons Bleed-Out: KGB/Russian Mafia
- Yakuza: The Japanese Mafia
- Aum Shinri Kyo (Supreme Truth) Cult
- Coalition: Aum/Yakuza/KGB/Communists/Russian Mafia
- Operation Divine Wind II: Three Phases
  - Phase I: On-Site Training Phase (Completed)
  - Phase II: Escalation Phase (In Progress)
  - Phase III: 1997 Strategic Strike on the United States
  - Support Plan A: Feints, Deception, Sabotage & Terrorism
  - Support Plan B: Test Range
  - Support Plan C: Worldwide Weather Engineering
  - Support Plan D: Strategic and Combat Intelligence
- Special Information
- Recommended Actions

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The Tom Bearden Website

Help support the research

Loss of two separate A-10 Warthogs in 1997

- A-10 Mysterious Flyaway and Crash - April 2, 1997
- Death of Second A-10 Pilot - May 27, 1997
- Captain Button's Mysterious Flyaway and Eventual Crash
- Death of Second A-10 Pilot - May 27, 1997

A-10 Mysterious Flyaway and Crash

April 2, 1997

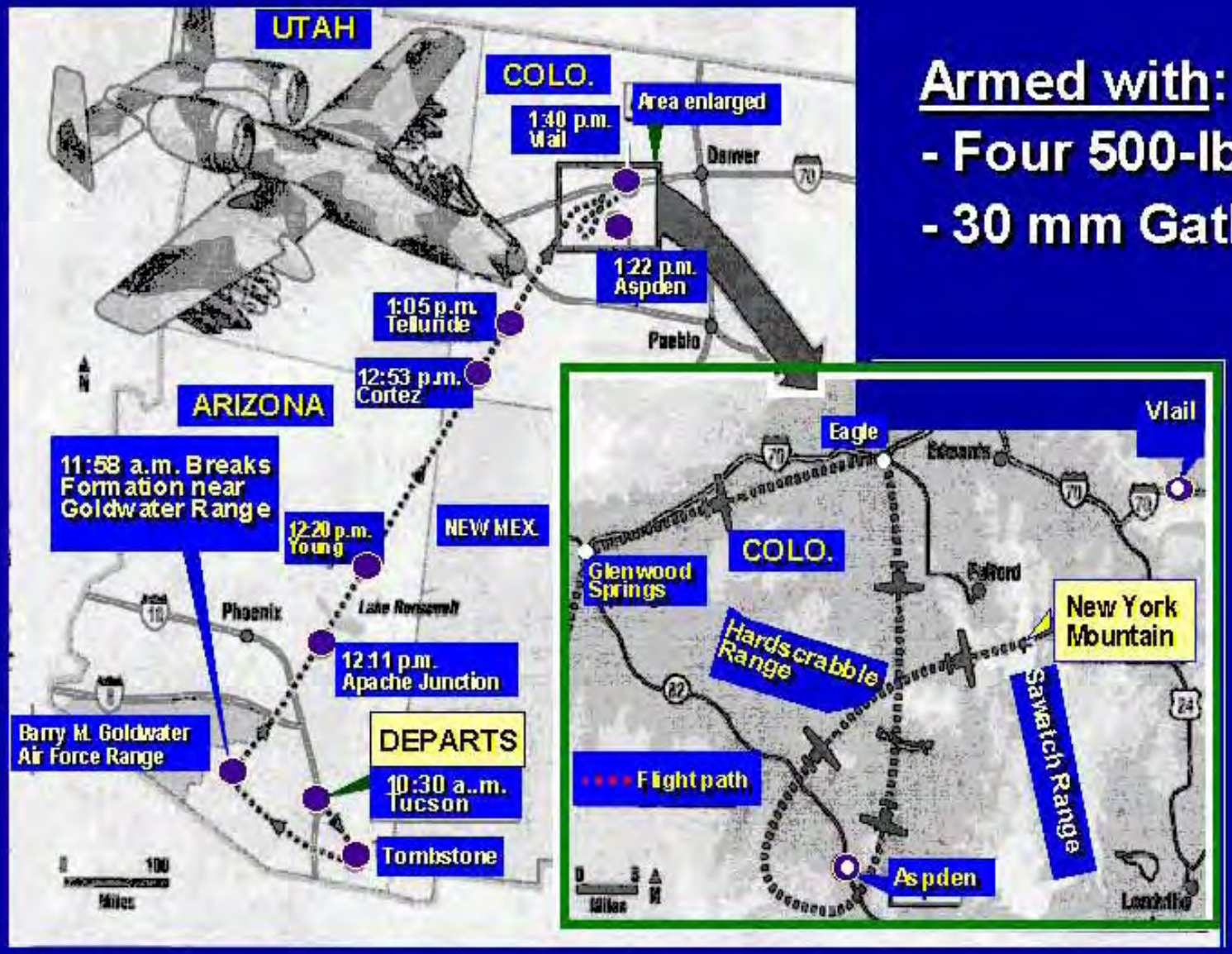

Armed with:

- Four 500-lb bombs
- 30 mm Gatling gun

Death of 2nd A-10 Pilot May 27, 1997

- Captain Amy Svobody
- Night training mission
- From Davis-Montham AFB
- From same wing as Captain Button, who flew his A-10 off course for over an hour and then crashed on April 2.
- Climbout from ordnance delivery on target
- Nosed down sharply and dived into ground

Companion A-10's

- Experienced night flyer & instructor
- Nosed sharply over and flew into ground
- Psychoenergetic kill

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Psychoenergetic weapon induced instant hypnogogic state and reversed Svoboda's sense of up and down.

A-10 Mysterious Flyaway and Crash

April 2, 1997

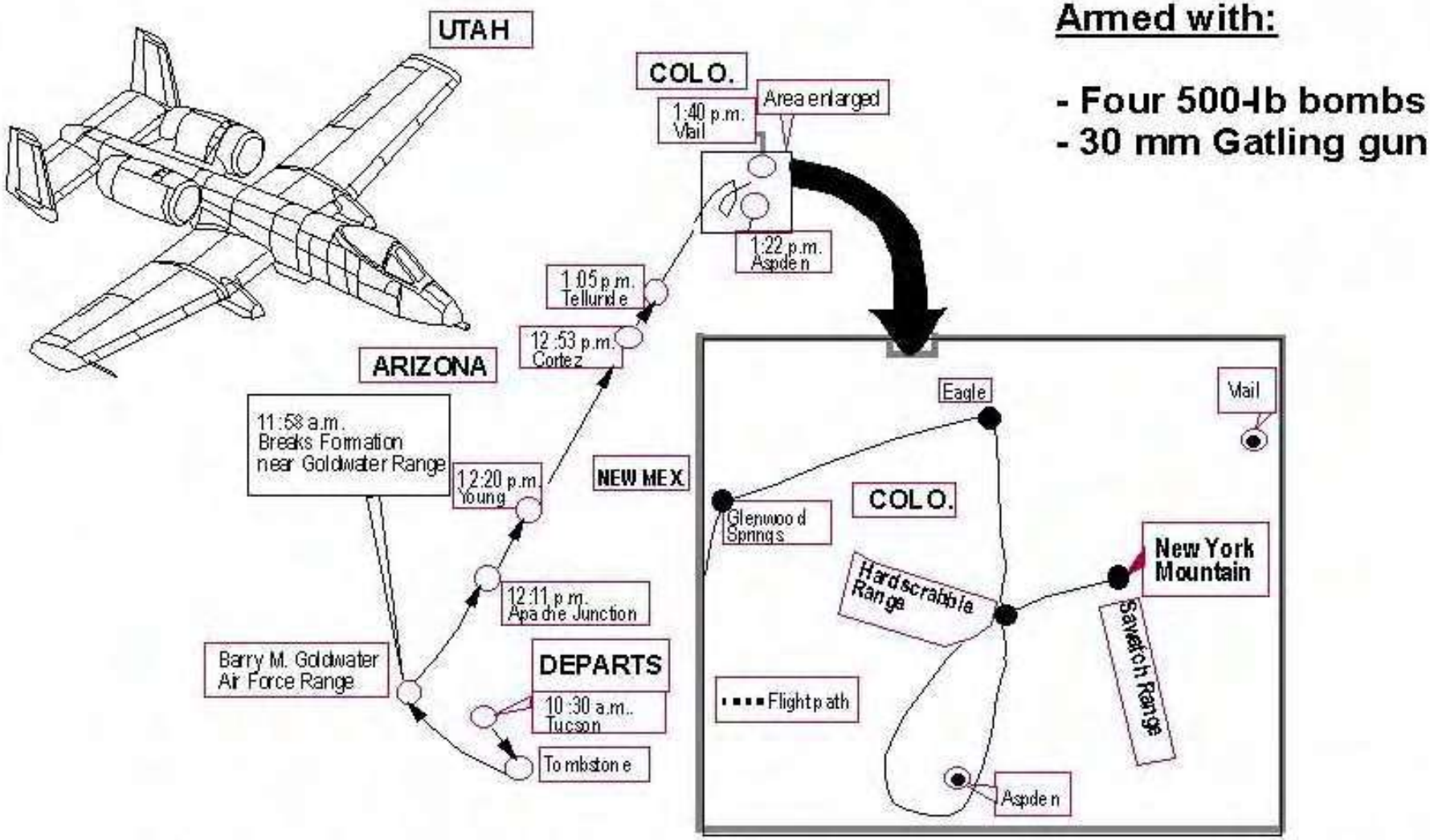

Armed with:

- Four 500-lb bombs
- 30 mm Gatling gun

Figure 14a. Captain Button's mysterious flyaway and eventual crash.

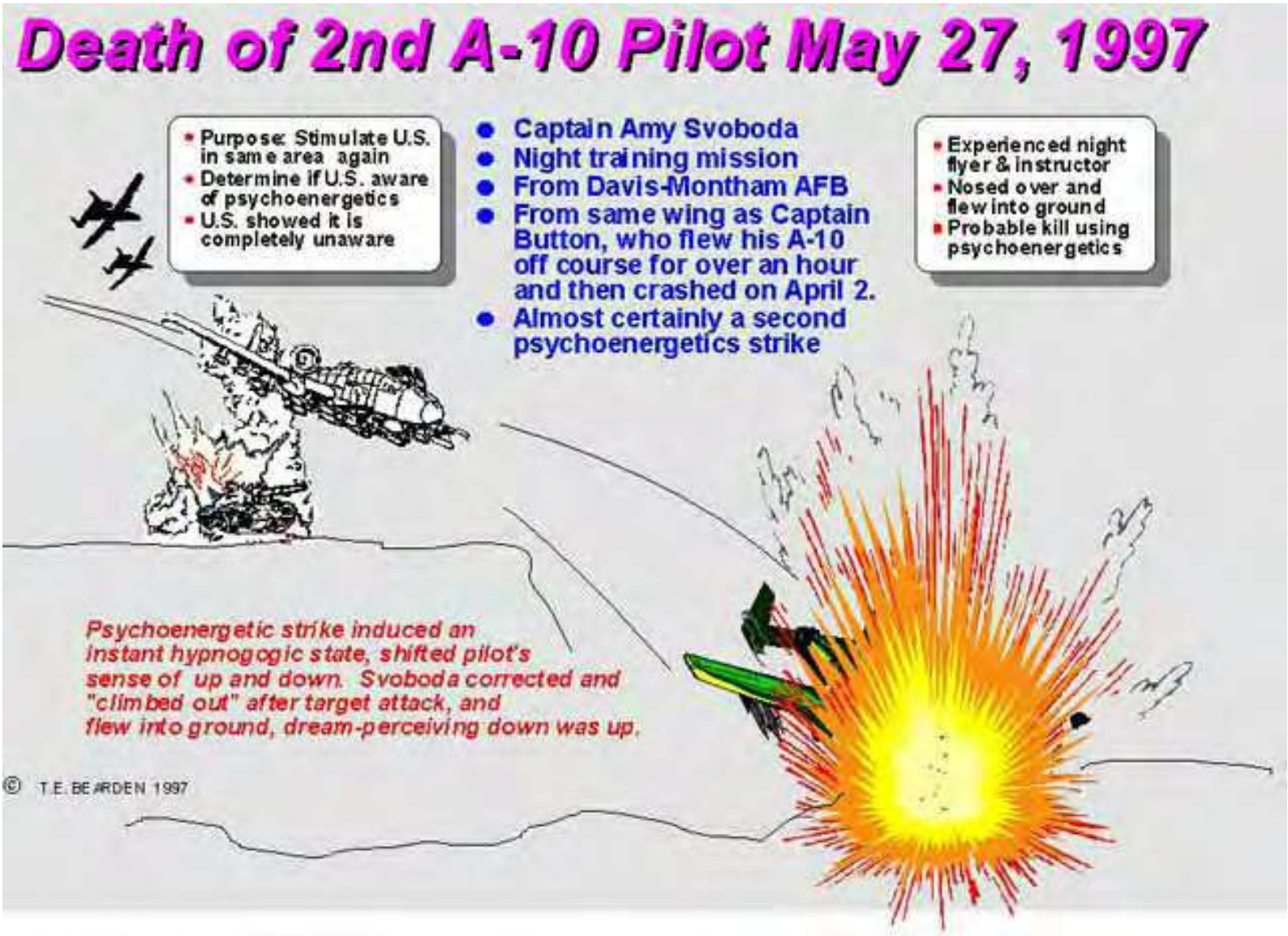
Death of 2nd A-10 Pilot May 27, 1997
• Purpose: Stimulate U.S. in same area again
• Determine if U.S. aware of psychoenergetics
• U.S. showed it is completely unaware
• Captain Amy Svoboda
• Night training mission
• From Davis-Montham AFB
• From same wing as Captain Button, who flew his A-10 off course for over an hour and then crashed on April 2.
• Almost certainly a second psychoenergetics strike
• Experienced night flyer & instructor
• Nosed over and flew into ground
• Probable kill using psychoenergetics
Psychoenergetic strike induced an instant hypnogogic state, shifted pilot's sense of up and down. Svoboda corrected and "climbed out" after target attack, and flew into ground, dream-perceiving down was up.
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Typical ABM Defenses
(WIDELY DEPLOYED BY MID-70's)
GLOBAL SHELL
(MIDCOURSE
ELECTRONICS
DUDDING)
INTENSE ENERGY SHELLS
(Destruction of vehicle)
(Initiation of nuclear
warheads)
© T.E. BEARDEN 1999
EM MISSILES
EARTH'S SURFACE
ENERGETICS
HOWITZER
TRACK
(NESTED)
HEMISPHERICAL
SHELL(S)
(Dudding, initiation,
destruction)
LAUNCH
PHASE
DEFENSES
TERMINAL
DEFENSES

LAUNCH PHASE ANTIMISSILE SYSTEM

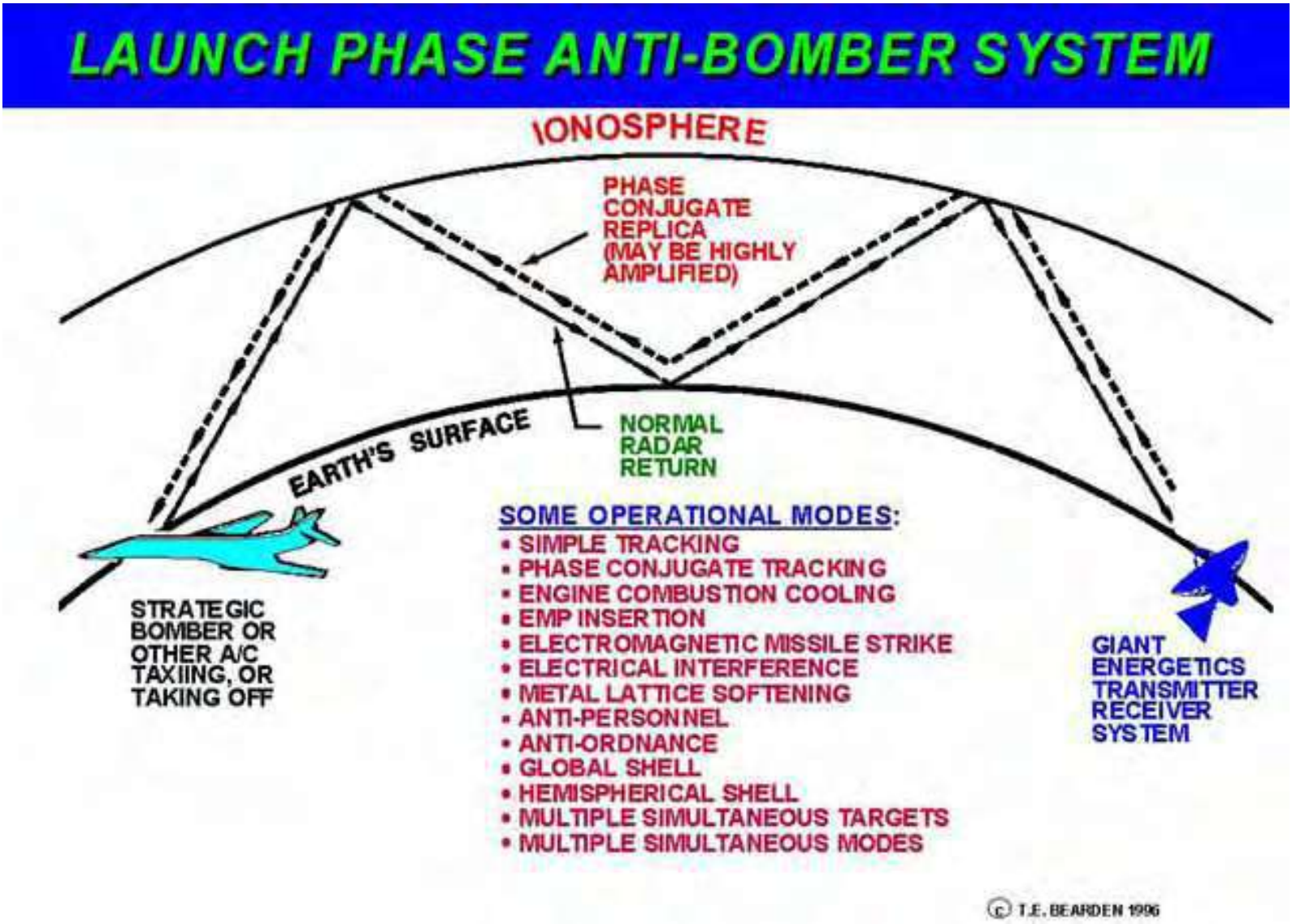
LAUNCH PHASE ANTI-BOMBER SYSTEM
IONOSPHERE
PHASE CONJUGATE REPLICA (MAY BE HIGHLY AMPLIFIED)
NORMAL RADAR RETURN
EARTH'S SURFACE
STRATEGIC BOMBER OR OTHER A/C TAXIING, OR TAKING OFF
SOME OPERATIONAL MODES:
• SIMPLE TRACKING
• PHASE CONJUGATE TRACKING
• ENGINE COMBUSTION COOLING
• EMP INSERTION
• ELECTROMAGNETIC MISSILE STRIKE
• ELECTRICAL INTERFERENCE
• METAL LATTICE SOFTENING
• ANTI-PERSONNEL
• ANTI-ORDNANCE
• GLOBAL SHELL
• HEMISPHERICAL SHELL
• MULTIPLE SIMULTANEOUS TARGETS
• MULTIPLE SIMULTANEOUS MODES
GIANT ENERGETICS TRANSMITTER RECEIVER SYSTEM
© T.E. BEARDEN 1996

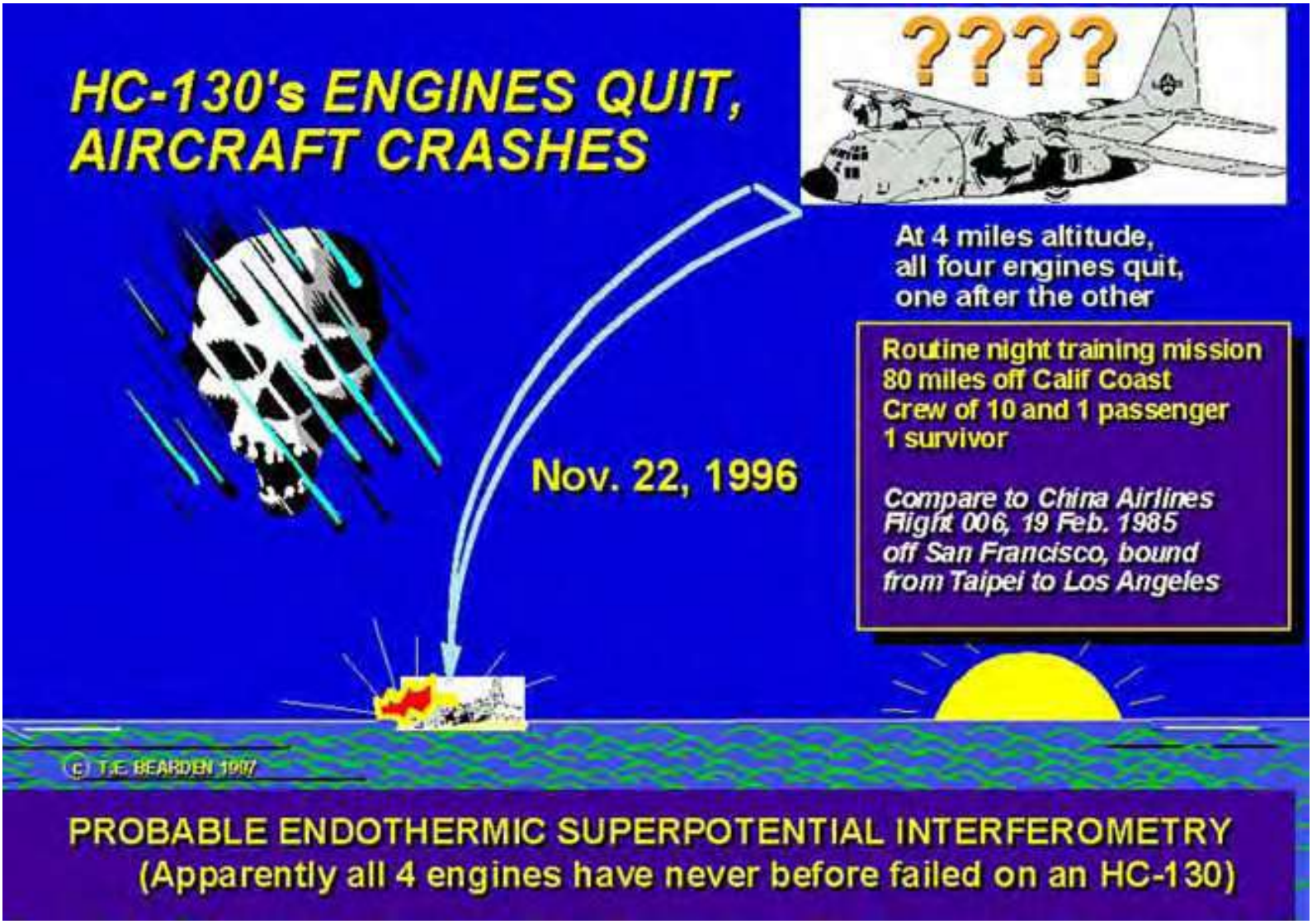
HC-130's ENGINES QUIT, AIRCRAFT CRASHES
????
At 4 miles altitude, all four engines quit, one after the other
Routine night training mission
80 miles off Calif Coast
Crew of 10 and 1 passenger
1 survivor
Compare to China Airlines Flight 006, 19 Feb. 1985 off San Francisco, bound from Taipei to Los Angeles
Nov. 22, 1996
© T.E. BEARDEN 1997
PROBABLE ENDOTHERMIC SUPERPOTENTIAL INTERFEROMETRY
(Apparently all 4 engines have never before failed on an HC-130)

CTEC PROPRIETARY

1996 Actions by this analyst

- In July 1996, with the kill of TWA-800 it became apparent that the KGB/Communists were preparing a massive strategic energetics attack upon the U.S.

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- Began intensive, nearly round-the-clock effort to uncover what was happening, and what had occurred in KGB/Com weapons since 1991
- Began preparing full-up set of briefing slides simultaneously
  - In early 1996, had briefed J6 on scalar EM, per his request
  - Had strongly suggested a follow-on weapons brief
  - Adamant opposition by NRL, NOL, others
- Similar energetics attack scenario in 1986 was countered. Soviets at that time did not possess operational QP weapons, and so could not successfully overcome dead-man fuzing
  - Also could not dud nukes worldwide, because QP required.
  - First lab prototype QP test was in April 1986
- KGB had solved the dead-man fuzing problem by QP's. Deployed circa 1989-1990. Some earlier weapons then leased.

Additional Information Exists; Not Analyzed, Not Integrated in Briefing

- Yakuza arranged involvement of
  - Red Chinese
  - North Koreans
  - A Taiwanese element
- Aum Shinrikyo may have been used as "Red Herring" to deceive West
- Oriental faction plots to strike Russians after the successful first strike on West
- KGB/Russians aware, will counter
  - Plan pre-emptive strike against Oriental faction first
  - Have reserved most advanced, powerful energetics weapons for that purpose

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The Tom Bearden Website

Help support the research

Kill of Arrow DC-8, Gander AFB, Dec. 12, 1985

- Slide 1
- Slide 2
- Slide 3
- Slide 4
- Slide 5
- Slide 6

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Soviet EM missile weapon strike practice two weeks earlier at Cape Canaveral
► Offset from night shuttle launch
► EM missile photographed by Bob Gladwin
► Associated marker beacon photographed
• Canadian Board split on findings
► Half thought icing, half disagreed intensely
► "Due to icing" approved with half absent
► Separate dissenting finding issued
• U.S. officials hiding Iran/Contra affair
► Feared terrorist bomb, MidEast sponsor
► Pressured Board, Gen. Off. bulldozed site
• Lack of icing on aircraft later validated

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Eyewitness observed beams form in the sky
• Saw streak-down and strike of EM missile
– Struck right fuselage ahead of the engines
– Hole was burned through fuselage there
– Photo of hole published in AW&ST
– No explosive residues on hole
• Consistent with ignition and outgassing of plastics in forward cabin
• Consistent with pre-crash HCN deaths

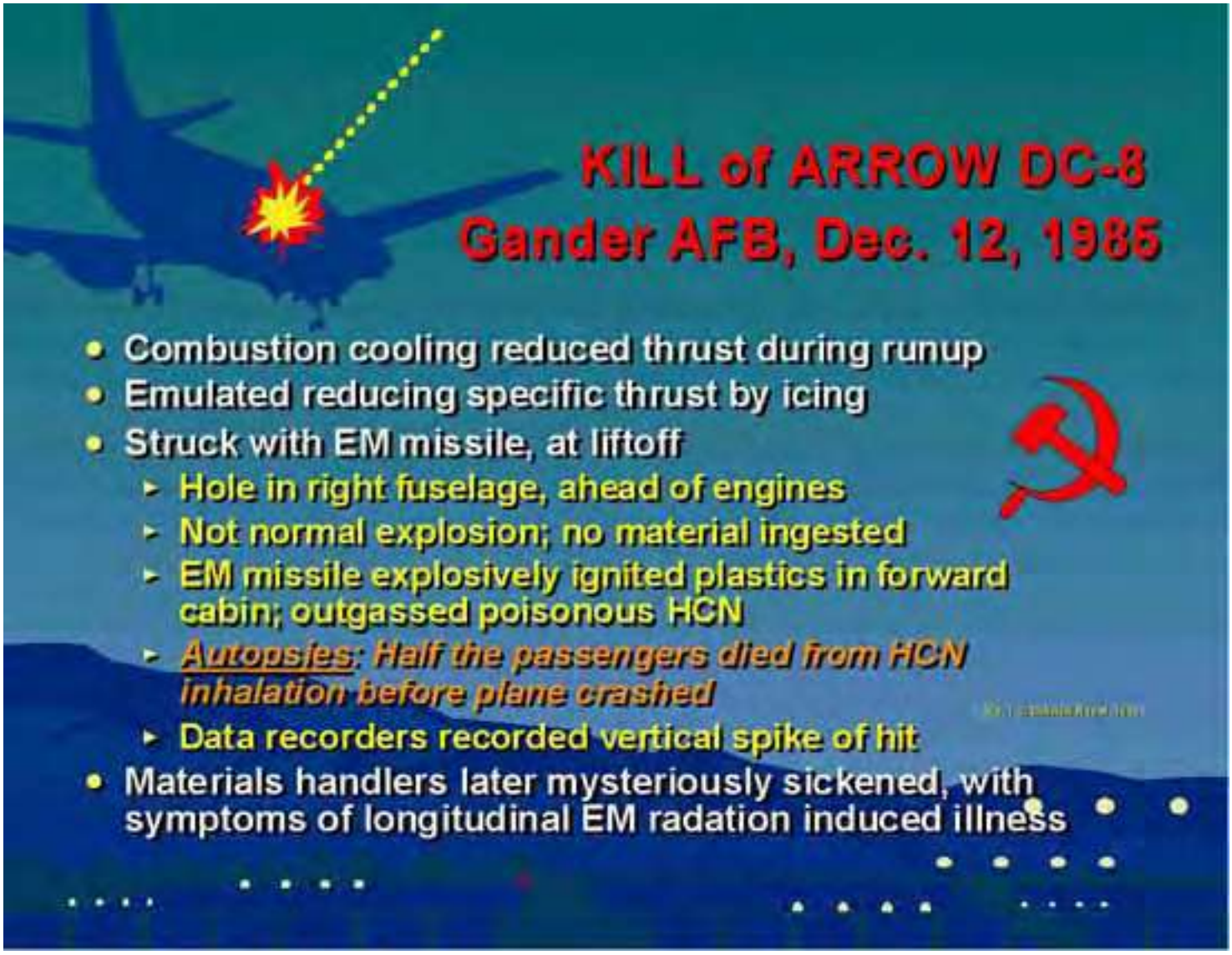
KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Combustion cooling reduced thrust during runup
• Emulated reducing specific thrust by icing
• Struck with EM missile, at liftoff
▸ Hole in right fuselage, ahead of engines
▸ Not normal explosion; no material ingested
▸ EM missile explosively ignited plastics in forward cabin; outgassed poisonous HCN
▸ Autopsies: Half the passengers died from HCN inhalation before plane crashed
▸ Data recorders recorded vertical spike of hit
• Materials handlers later mysteriously sickened, with symptoms of longitudinal EM radiation induced illness

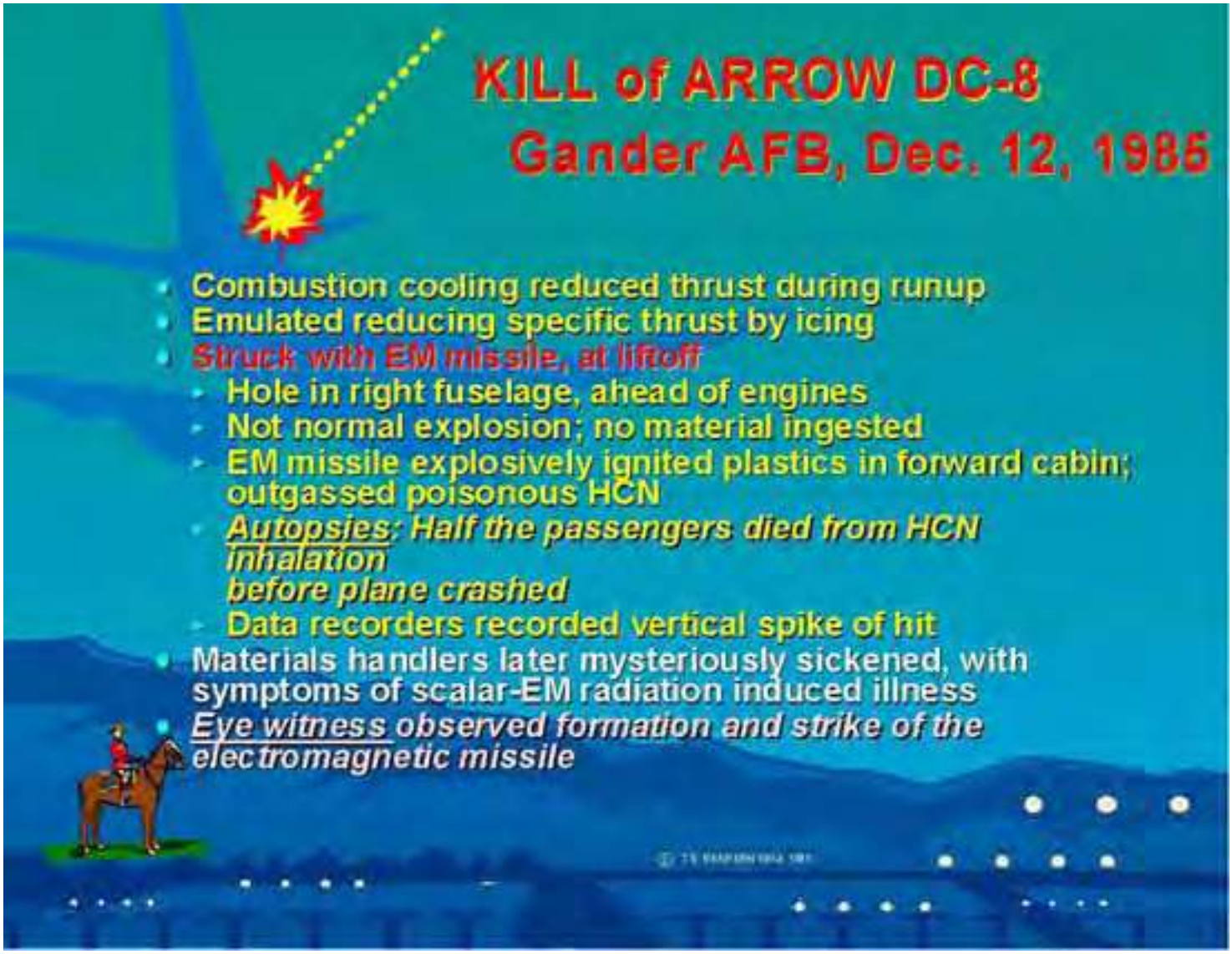
KILL of ARROW DC-8
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Combustion cooling reduced thrust during runup
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Autopsies: Half the passengers died from HCN inhalation
before plane crashed
Data recorders recorded vertical spike of hit
Materials handlers later mysteriously sickened, with symptoms of scalar-EM radiation induced illness
Eye witness observed formation and strike of the electromagnetic missile

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985

- Soviet EM missile weapon strike practice two weeks earlier at Cape Canaveral
  - Offset from night shuttle launch
  - EM missile photographed by Bob Gladwin
  - Associated marker beacon photographed by George Suchary
- Canadian Board split on findings
  - Half thought icing, half disagreed intensely
  - "Due to icing" approved with half absent
  - Separate dissenting finding issued
- U.S. officials hiding Iran/Contra affair
  - Feared terrorist bomb, MidEast sponsor
  - Pressured Board, Gen. Off. had site bulldozed
- Lack of icing on aircraft later validated

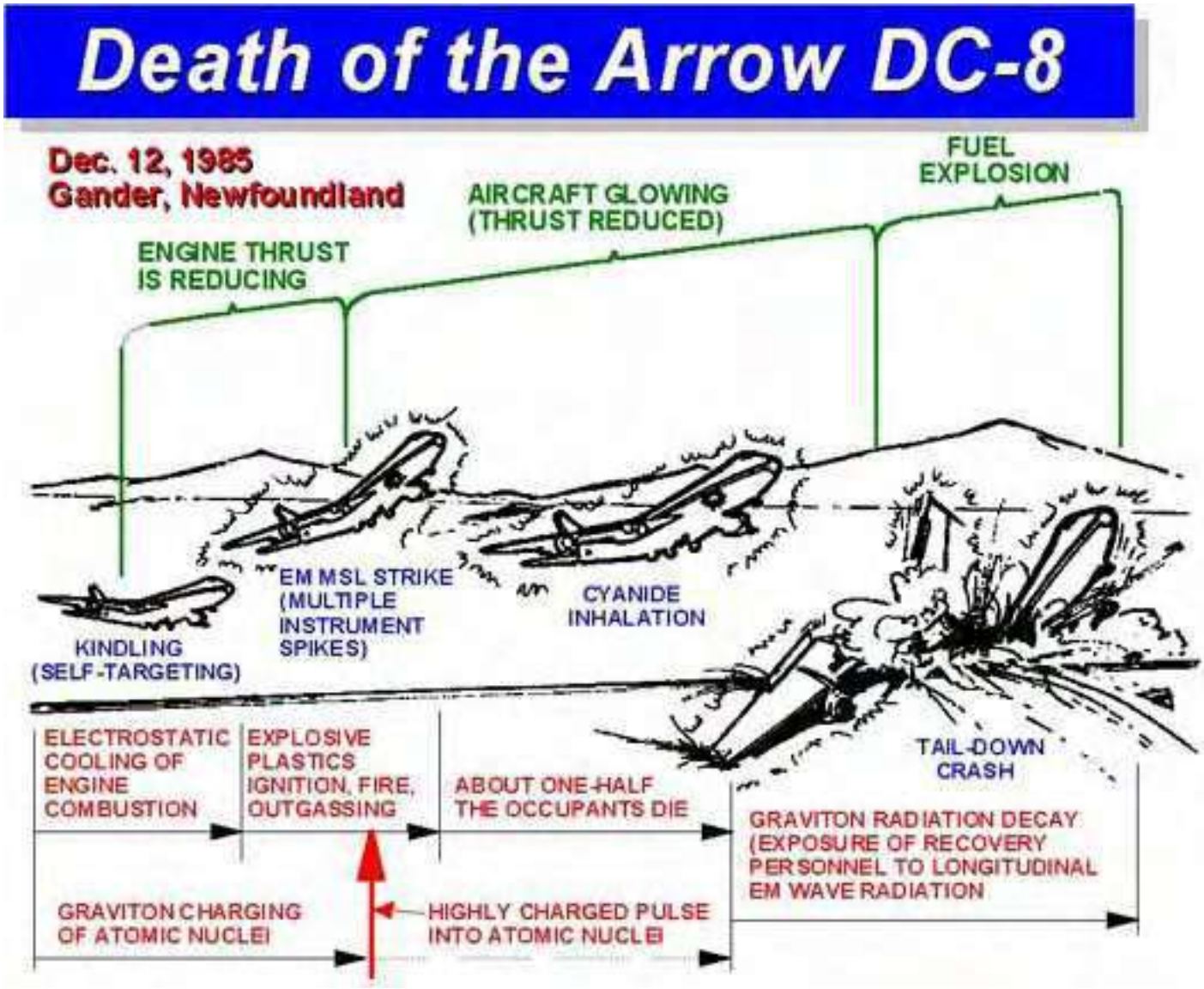
Death of the Arrow DC-8
Dec. 12, 1985
Gander, Newfoundland
ENGINE THRUST IS REDUCING
AIRCRAFT GLOWING (THRUST REDUCED)
FUEL EXPLOSION
KINDLING (SELF-TARGETING)
EM MSL STRIKE (MULTIPLE INSTRUMENT SPIKES)
CYANIDE INHALATION
TAIL-DOWN CRASH
ELECTROSTATIC COOLING OF ENGINE COMBUSTION
EXPLOSIVE PLASTICS IGNITION, FIRE, OUTGASSING
ABOUT ONE-HALF THE OCCUPANTS DIE
GRAVITON RADIATION DECAY (EXPOSURE OF RECOVERY PERSONNEL TO LONGITUDINAL EM WAVE RADIATION
GRAVITON CHARGING OF ATOMIC NUCLEI
HIGHLY CHARGED PULSE INTO ATOMIC NUCLEI

Satellite Photos of Plumes in Soviet Arctic Since 1974*

- Two aircraft flew through for analysis
  - Solid material, mostly ice, a little clay
  - Much colder than surrounding air
  - *Signature of cold exhaust from exothermic scalar interferometry operations*
  - No volcanic material
  - No radioactive material

- May be 2 to 3 times as many incidents
  - Only examined satellite imagery in winter
  - Only periodic satellite coverage
  - Hypothesized methane venting, cloud seeding

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*As of 1989, when this information was gathered

AUM SHINRIKYO
("SUPREME TRUTH" CULT)

Shoko Asahara, Leader

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Ashkhabad Problem and Its Solution

- ***PROBLEM:***
  - Stress increasing in two-plate fault zone
  - 1,000 shocks yearly
  - Kara Kum canal
  - Hydraulic pressure
  - 1948: Ashkhabad 80% destroyed by quake

- ***SOLUTION:***
  - Stress-relieve plate stresses from fault

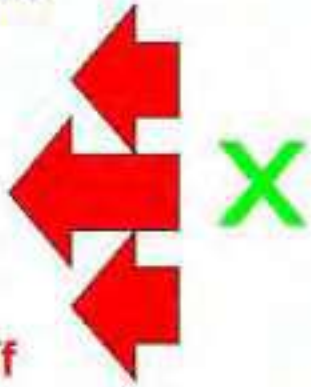

- ***IMPLEMENTATION:***
  - Induce nearby earthquake
  - Deceive by *predicting* a quake, setting off nuclear explosion

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Strange Characteristics of Iran Quake, Sep. 1978

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- **Signatures**
  - 7.4 on Richter scale
  - No aftershocks: 6.0 expected (normal)
  - Strange epicenter
  - Anomalous depth

- **Deception**
  - 10 MT Soviet nuclear explosion 36 hours before the quake
  - Prior disinformation regarding Soviet attempted development of focusing shock waves from underground nuclear explosions, to cause distant earthquakes

Iran Earthquake Sept. 1978

- Killed 25,000 Iranians
- Soviet city of Ashkhabad saved
- Soviets "predicted" quake in advance; then induced it
- Quake had serious anomalies (signatures)
- Deception measures were used by Soviets
  - Prediction in advance
  - "Theory" of quake-induction by nuclear explosions
  - Fired underground nuclear explosion as "Red Herring" candidate for cause

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Situation Now (Assessment)

- In May 1997: second A-10 pilot (lady), in pullup from night ordnance delivery on target, was struck with psychoenergetic weapon takeover. Sense of vertical was reversed. She perceived herself diving, sharply corrected, and dove headlong into the ground.

- Additional aircraft kills uncovered, including one 4-engine aircraft whose engines all failed. This closely repeats the earlier 1985-1987 scenario.
- Korean Airlines Flight 801 crashed on Guam on anniversary of loading of the atomic bomb that was dropped on Hiroshima in WW II. The Enola Gay, which dropped the bomb, took off from Guam in wee morning hours of August 6, 1945. The local opns order on Guam was also issued on Aug. 5.

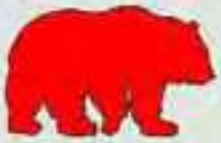

- *Presently the Coalition (KGB/Communists/Aum Shinrikyo/Yakuza) is waiting for proper time to launch the final strike. It is still on.*

Situation Now (Assessment 2)

- April 97: Mind control test against Captain Button:
  - Demonstrates ability to control crewman in complex operations for more than one hour.
  - KGB requires one hour total QP crew control on a site to have crew disable insane QP wpns.
- Once QP systems disabled, Mindsnapper attacks and instantly kills every living thing in QP site area. Contaminates area for months (emits longitudinal EM wave radiation, which disrupt any life forms attempting to enter struck area). Sites nullified.
- Mind control over one crewman requires one weapon system plus up to 20-30 operators for controlling thoughts, hearing, perceptions, etc.
- *In Apr. 97, KGB building and deploying weapons and training crews. Ready for new attack 1999-2000.*

Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum
- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another

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Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- One terrorist, one light aircraft with spray tank
- One kilogram of anthrax
- Flies over greater metropolitan Washington, D.C.
- Calm night
- *1-3 million casualties result**
- *Most of those stricken will die*
- Presently little can be done to save the stricken civilians
- *Attacks on several population centers might produce some 10 million or more casualties*

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*Per OTA Report to Congress, 1993

Present Status of the WMD Threat to the United States

- Many foreign nations are hostile to the U.S. and sponsor terrorists
- Some 25 nations have WMD or are acquiring them
  - BW agents and weapons
  - Chemical agents and weapons
  - Nuclear materials and weapons
- Thousands of students and émigrés
- Infiltrated teams, BW, other WMD already
- Castro guerrillas infiltrated over the years
- Can do unacceptable damage to U.S. now
- *May reach first strike knockout capability*

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*Per OTA Report to Congress, 1993

Some Present Problems in the U.S. WMD Defense Capabilities

- No shelters (require overpressure, BW filtering, masks, showers, supplies)
- No stockpiled vaccines, medical supplies, immunoglobulins, masks, suits, food, fuel, generators, heaters, water purification units
- Totally insufficient medical facilities, personnel, and emergency response teams
- Triage, full martial law will be required
- No answer to massive decontamination problem
- State, county, city inadequately staffed and insufficiently trained for mass casualties
- Terrorist teams, BW agents, other WMD on site, waiting
- Water supplies, food, crops, farm animals also vulnerable
- Electric power grid, bridges, trains, railroads vulnerable
- Present medical science cannot save very many of the casualties, now or in the foreseeable future

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Internal Terrorist Threat with
Weapons of Mass Destruction: Now & Future
TODAY:
• Sabotage
• Chemicals
• Biological agents
• Nuclear materials
• Powerful explosives
• Assassination
• Kidnapping and hostages
• Contamination
• Shoulder-fired AD missiles
• Terrorism
FUTURE ADDITIONS:
• Orthodox EM weapons
• Energetics EM biological warfare
• Scalar EM (energetics) weapons
• Scalar EM disease induction
• Alteration of behavior and emotions
• Alteration of memory
• Direct control of thoughts, perception
• Quantum potential weapons
• Psychoenergetics weapons
• Action-at-a-distance effects

Attempt to Ban Energetics Weapons Worldwide

- On June 13, 1975, in a major speech Brezhnev urged the United States to agree on a ban of research and development of new kinds of weapons "more terrible than anything the world has known."
- On July 2, 1975 Brezhnev repeated his proposed ban on development of frightful new weapons, to a group of U.S. Senators.
- In August 1975, Ponomarev called for a ban on frightful new weapons of mass destruction.
- On Sept. 23, 1975 Gromyko presented a draft treaty agreement to the 30th Session of the UN General Assembly, for banning development of frightful new weapons.
- *No one had the foggiest notion what the Russians were talking about!*

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Brezhnev's Schedule

"We are achieving with detente what our predecessors have been unable to achieve with the mailed fist...
...by 1985 our power will be so irresistible that we can do what we wish anywhere on the globe."

Leonid Brezhnev,
in a secret 1973 meeting in Prague
with European Communist leaders.

"By the early 1980's we and our allies will control the high seas, space, and most of the earth's land area."

Kosygin,
to Imelda Marcos,
July 1978

In 1985-87, the Soviets did attempt to move, still constrained by nuclear dead man fuzing. That attempt was blocked, primarily by scalar EM countering demonstrations and dead man fuzing.

In April 1986, the first Soviet lab prototype of a quantum potential weapon specifically designed toward 10-min neutralization of nukes worldwide was gingerly tested against our U.S. airstrike on Libya. It was weakly tested in the "induced EMI" mode, for deception.

By 1990 that weapon was deployed and a new attack preparation phase was entered, scheduled for 1997.

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COLD EXPLOSION -- 9 April 1984 Near Kurils

And Formation and growth of spherical shell (globe)

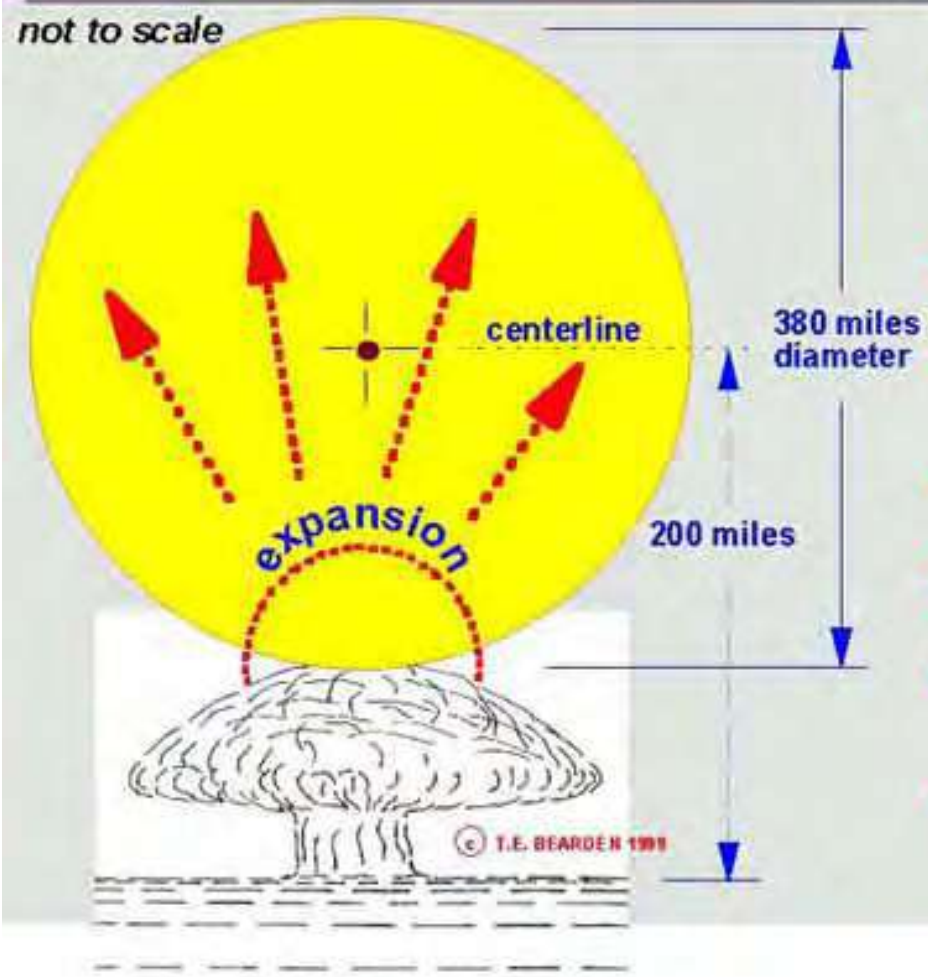

Sequence of Events

- Geyser of water rose rapidly from surface, mushroomed out
- Reached 60,000 feet altitude in two minutes
- Brilliantly glowing globe then appeared in top
- Globe increased greatly in size and altitude
- Reached diameter of 380 miles
- Center reached altitude of 200 miles
- Observed by multiple qualified pilots

COLD EXPLOSION -- 9 April 1984 Near Kurils

And Formation and growth of spherical shell (globe)

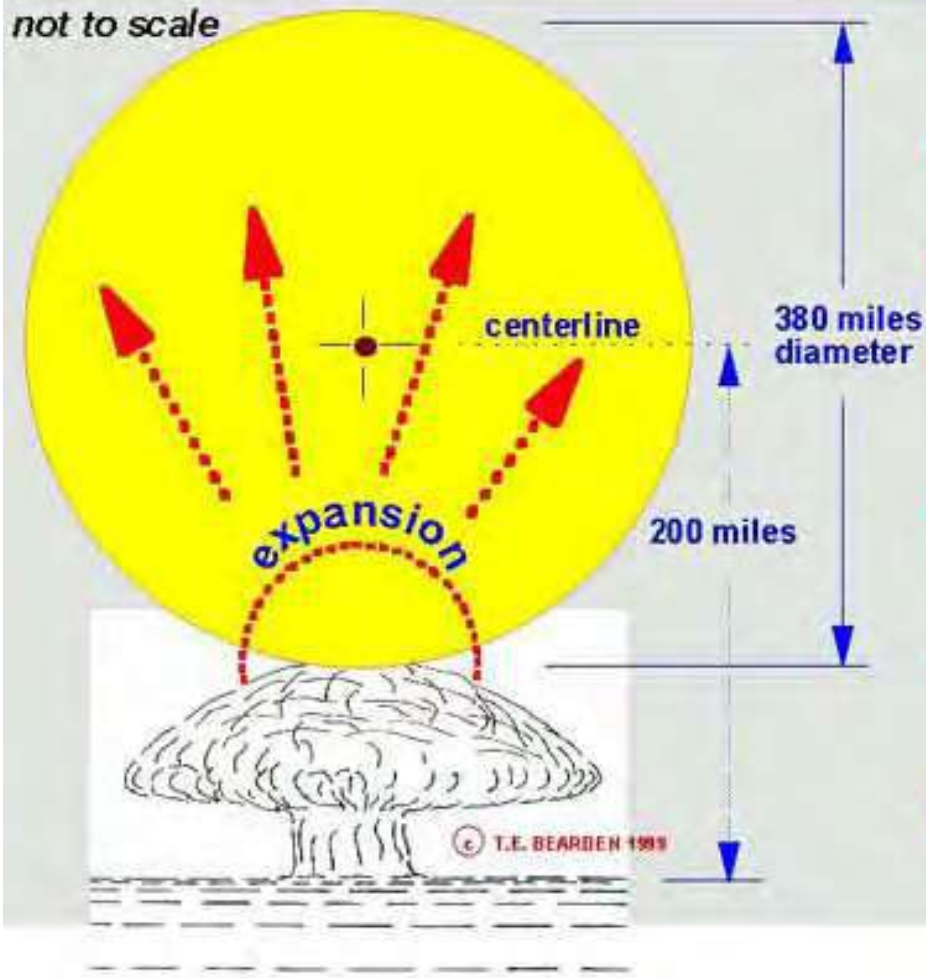

What They Were

- Superpotential interferometry using LWs
- First, a cold explosion just above surface
- Then small intense shell of glowing EM energy for 1-on-1 targeting
- Larger globe for large area as for ICBM targets approaching in zone
- With ST engines, can dud incoming nukes and all electronics
- Use in or out of Earth's atmosphere

COLD EXPLOSION -- 9 April 1984 Near Kurils
(Plus additional weapons effects)
JAL
Halo expanded to giant globe.
380 miles diameter, center over 200 miles
high.
© T.E. BEARDEN 1996

Countering Insane Mad Systems: Find Loophole, Exploit It

- If MADs not quantum potential systems, easily countered by instant QP strike which destroys targeted MAD weapons worldwide with certainty.
- Have to be certain of types of dead-man fuzing. All dead-man fuzing weapons must be included in the assured target list for the striking quantum potential weapon.

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- Multiple targeted MADS require multiple vacuum engines in the striking quantum potentials.
- Uncertainty and risk introduced if not certain of all MAD systems and all dead-man fuzing systems.
- Newest generation psychoenergetic LW interferometry weapons can instantly take over minds of all personnel on targeted sites, with targeted crews quickly disarming their own MAD weapons' launch capability as well as the weapons themselves.
- Mindsnapper then kills all living things and contaminates sites.
- Next generation QP Psy-En weapons can disrupt and destroy minds of an entire targeted national population. The nature of warfare moves irrevocably to the human mind, where of course the fundamental problem arises anyhow.

Next Generation Counter to Both Sane and Insane MAD Systems

- ***Localized quantum potential in an area, used in psychoenergetics mode***
  - Gradually produces mild, continuous hypnotic state
  - Targeted population remains entirely conscious, functional
  - Internal "word thoughts" emerge directly in subconscious
  - Targeted persons all unaware of these "word thoughts"
  - Operates somewhat similar to "post hypnotic suggestion"
  - Gradually changes emotions, psychological outlook
  - Over a period of time, deviates and entrains entire target population's outlook, belief structure, temperament
- ***Moves Psywar to inside the human component***
- ***Human minds are the only battleground***
- ***Can be accomplished without overt signature***
- ***Countered only by inserting same methodology into deeper mind level (collective unconscious)***

Simultaneous Dudding of Nuclear Weapons Worldwide

- Via quantum potential joining U235 and Plutonium in warheads
- Includes weapons airborne, underwater, in storage
- These are *transmutations of the nuclides themselves*
- *Part of the initial barrage launched by Aum/Yakuza/KGB*
- *Will occur in the first minutes of the strategic strike, following psychoenergetically crew-disabling QP weapons*

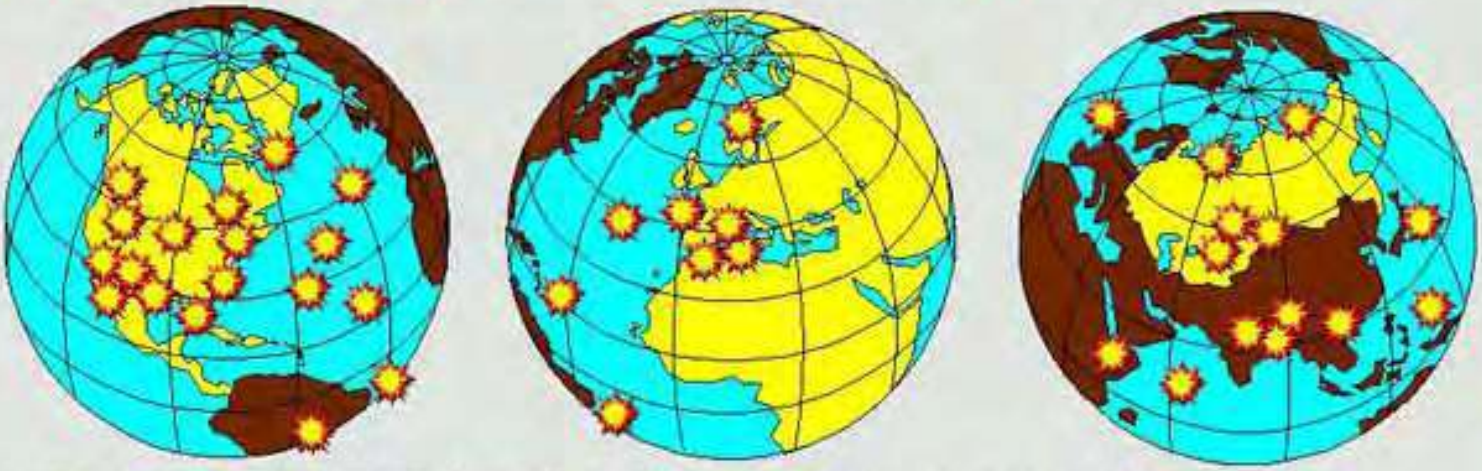

Note: Duds both overt and covert nuclear weapons and weapons-grade materials -- including "suitcase-delivered" covert weapons on site in Russia which otherwise provide dead man fuzing

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Simultaneous Dudding of Nuclear Weapons Worldwide

- Via quantum potential joining U235 and Plutonium warheads
- Includes weapons airborne, underwater, in storage
- These are not explosions, but are *transmutations and increased fissioning rates*
- *Part of the initial barrage launched by Aum/Yakuza/KGB*
- *Will occur in the first minutes of the strategic strike*

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Note: Duds both overt and covert nuclear weapons and weapons-grade materials.

Operation Divine Wind II

Slide 1

Slide 2

Slide 3

Slide 4

YAKUZA &
AUM SHINRIKYO

DIVINE WIND II

U.S.

★ **A secret coalition of Yakuza/Aum Shinrikyo and KGB/Communist forces plan to launch a massive, surprise energetics attack on the United States, given a low-risk opportunity.**

★ Major weapons utilized will be the scalar EM (energetics) superweapons (including quantum potential weapons) that were developed, deployed, and operated by the KGB under the former Soviet Empire, and continuing after its dissolution.

KGB

★ Yakuza/Aum crews have extensively trained and test-fired, from on-site in Russia. They have *leased* operational control of the first three generation energetics superweapons (which work by superpotential interferometry).

MINDSNAPPER AND
PSYCHOENERGETICS

★ *The Escalation Phase of interdicting and destroying actual U.S. targets (e.g., TWA-800, two A-10s) is already underway.*

★ *The first blow in the Strike Phase will dud all nuclear weapons and weapons materials worldwide, in minutes; destroy special ship and energetics weapon sites instantly, disable 99% of the U.S. population instantly, and kill 80% of targeted populations in from 10 minutes to 3 days.*

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QUANTUM
POTENTIAL

YAKUZA &
AUM SHINRIKYO

U.S.

DIVINE WIND II

- ★ A secret coalition of Yakuza/Aum Shinrikyo and KGB/Communist forces plans to launch a massive, surprise energetics attack on the United States and its allies, given the first low-risk opportunity.

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KGB

- ★ Attack was thwarted twice in 1997 by a small nation countering with QP weapons.
- ★ KGB psychoenergetics counter for the last QP weapon counter was tested in April 1997.
- ★ Ready time for a new scheduled attack is latter quarter 1999 through first half of 2000.

YAKUZA &
AUM SHINRIKYO

DIVINE WIND II

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- ★ **A secret coalition of Yakuza/Aum and KGB/Communist forces will launch a massive, surprise, strategic attack on the United States in 1997.**
- ★ **Major weapons utilized will be the scalar EM (energetics) superweapons that were developed, deployed, and operated by the KGB under the former Soviet Empire, and continuing after its dissolution.**
- ★ **Yakuza/Aum crews have extensively trained and test-fired, from on-site in Russia. They have *leased* operational control of the energetics superweapons.**
- ★ ***Escalation Phase of interdicting and destroying actual U.S. targets (e.g., TWA-800) is already underway.***
- ★ ***The first blow in the Strike Phase will dud all nuclear weapons and weapons materials worldwide, in minutes; destroy special ship and energetics weapon sites instantly, and kill 80% of targeted populations in 3 days.***

KGB/COMMUNISTS

MINDSNAPPER

QUANTUM
POTENTIAL

OPERATION DIVINE WIND II

Three Phases and Support

Operational Phases

- Phase I: On-Site Training Phase (Completed)
- Phase II: Escalation Phase (In Progress)
- Phase III. 1997 Strategic Strike on the U.S.
  - *First strike (QP) in Phase III duds all nuclear weapons and nuclear powerplants worldwide, in minutes*
  - *Psychoenergetic strike (QP) disables people instantly*
  - *Mindsnapper attack of special assets for 100% success*
  - *QP initiation of fast-acting, lethal diseases kills 80% of targeted populations in three days or less*

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Support Plans

- Plan A: Feints, Deception, Sabotage, and Terrorism
- Plan B: Testing and Test Range
- Plan C: Worldwide Weather Engineering
- Plan D: Strategic and Combat Intelligence

Advanced EMBW Applications

- Covert EMBW: Examples
  - Activate materials and their potentials with ST disease engines. Potentials superpose and their infolded ST dynamics diffuse
  - Activate water's structuring (H-bonding) potential with disease engines
  - Bias electrical power grid ground fields by weak diseases
  - Employ disease-structured quantum potential in distant area
- Overt death ray (mind snapper)
  - Powerful scalar EM pulse in target area "jerks" rate of flow of time
  - The "time snap" sharply separates mind from body and each cell
- EMBW CM:
  - Irradiate bodies with longitudinal EM waves; self-converts to t-pumping and produces exact amplified ST antiengine
  - Antiengine arises out of local ST, affects all parts of all cells
  - Cells are t-charged with antiengine structure
  - Continuing action restores regenerative and immune systems and reverses cellular damage

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EM Biological Warfare (EMBW)

- KGB/Communists have developed highly effective
  - Electromagnetic biological warfare (EMBW)
  - Counters to orthodox biological warfare
  - Mass death ray weapons
    - Small version of "mindsnapper" tested in Afghanistan
    - Killed occupants in two villages, in separate strikes
    - Unusual aspects (so-called "smerch" gas)
- Russia/KGB is the only group with a complete counter to biological warfare, either covert or overt, and to EMBW
- EMBW (covert and overt) is a preferred option for KGB
  - MAD Doctrine is completely destabilized for a sufficiently covert Russian EMBW strike
  - Situation has existed for at least two decades
  - Can alter germs, bacteria, viruses of specific kind, in a specific target area, to produce antibiotic-resistant strains
  - Can induce any kind of cellular disease or damage at a distance
- U.S. national characteristic: no reaction to slowly increasing threat

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Microwave Radiation of U.S. Embassy in Moscow

Former U.S. Embassy in Moscow.

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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Pentagon EMI Studies, 1989

Washington Post, 22 Jan. 1989, p. A4

- Analysts of severe EMI effects in strike on Libya, 1986
  - performed major 3-year, 66-man study
  - Blamed effects on U.S. forces' own signals
  - Did not know of any other "signals" present
  - Knew nothing of quantum potential weaponry, energetics weaponry
- 7-month preliminary study
  - Severe EMI Problem exists
  - EMI shielding often waived in our weapon systems
  - Thousands of conflicts possible
- Also studied UH60 Blackhawk helicopter problems (which *were* due to its lack of good EMI shielding, and not quantum potentials)
  - uncommanded turns
  - Five EMI crashes 1982-1989
  - $175 M program to shield it
- So found that U.S. transmission combinations can
  - Affect aircraft flight control
  - Turn off fuel supply
  - Cause uncommanded dive/turn
  - Bring down U.S. warplanes
- *Actually, Libyan EMI was induced by Soviet quantum potential tests which can do all those things and much more*

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EM Missile Practice

- EM Missile Practice
  Latter Sept. - Early Nov. 1996
  Melbourne, Australia
- Deception: Using EM Missile to Reinforce Notion of SAM Attack
  Saturday evening, Nov. 16, 1996
- Intelligence Probe: Insuring U.S. Still Unaware of Energetics Weaponry
  Thursday, December 12th, 1996
- EM Missile Strike, Offset from Night Shuttle Launch, Cape Canaveral, Florida
  The Smoking Gun in November 1985
- Distant Operator Onsite in Russia Slew Away Registration Point
  Marker Beacon over Night Shuttle Launch, 26 November, 1985
- EM Missile Practice and Deception
  November 17, 1996

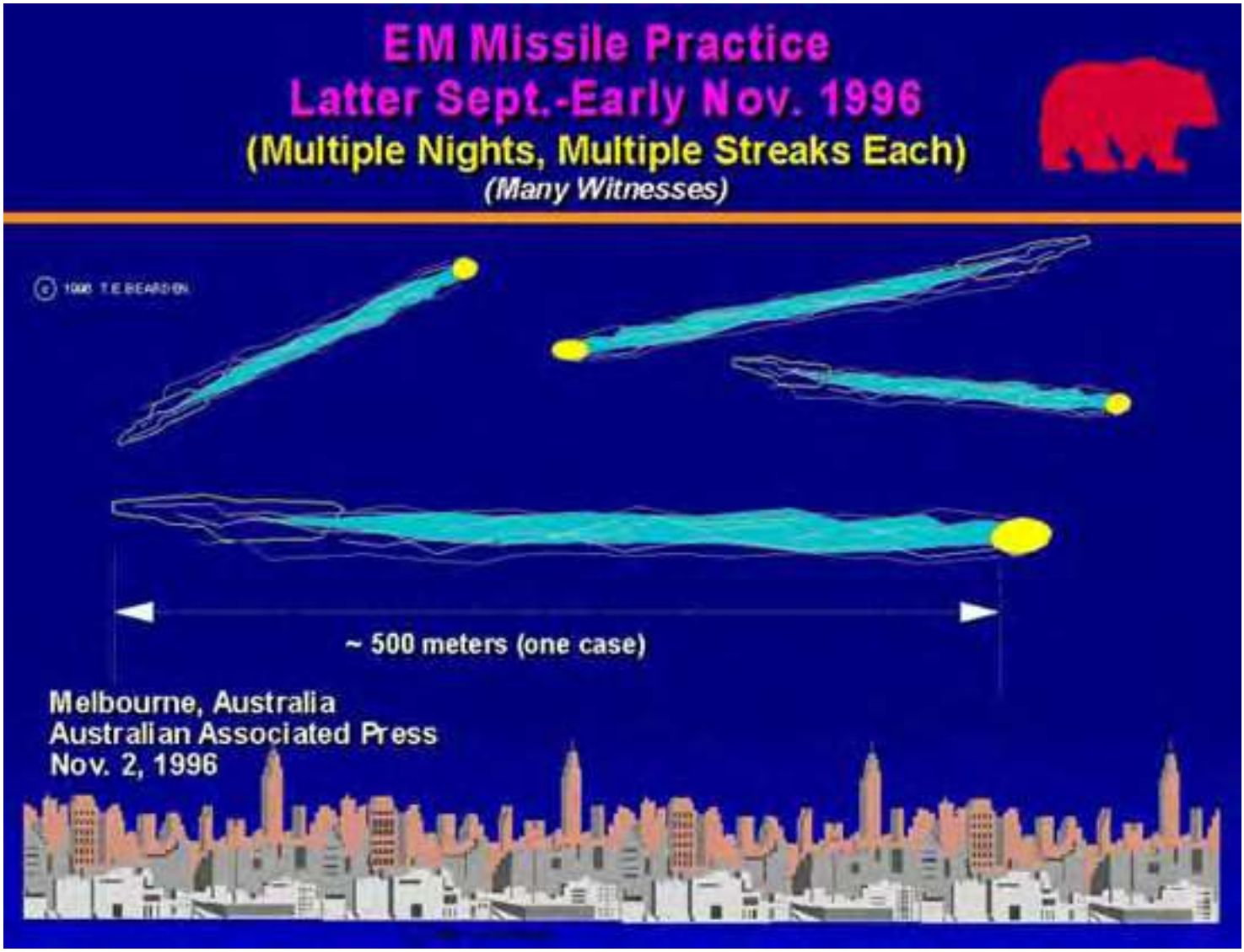
EM Missile Practice
Latter Sept.-Early Nov. 1996
(Multiple Nights, Multiple Streaks Each)
(Many Witnesses)
© 1996 T.E.BEARDEN
~ 500 meters (one case)
Melbourne, Australia
Australian Associated Press
Nov. 2, 1996

Deception: Using EM Missile to Reinforce Notion of SAM Attack

Saturday Evening
Nov. 16, 1996

Note: Meteor shower was forecast, which provided perfect decoy to FBI investigators, to steer them off the true scent.

Pakistan International Airlines Flight 712, just after takeoff from John F. Kennedy Airport, on path similar to that taken by TWA Flight 800, July 17, 1996

© T.E. BEARDEN 1996

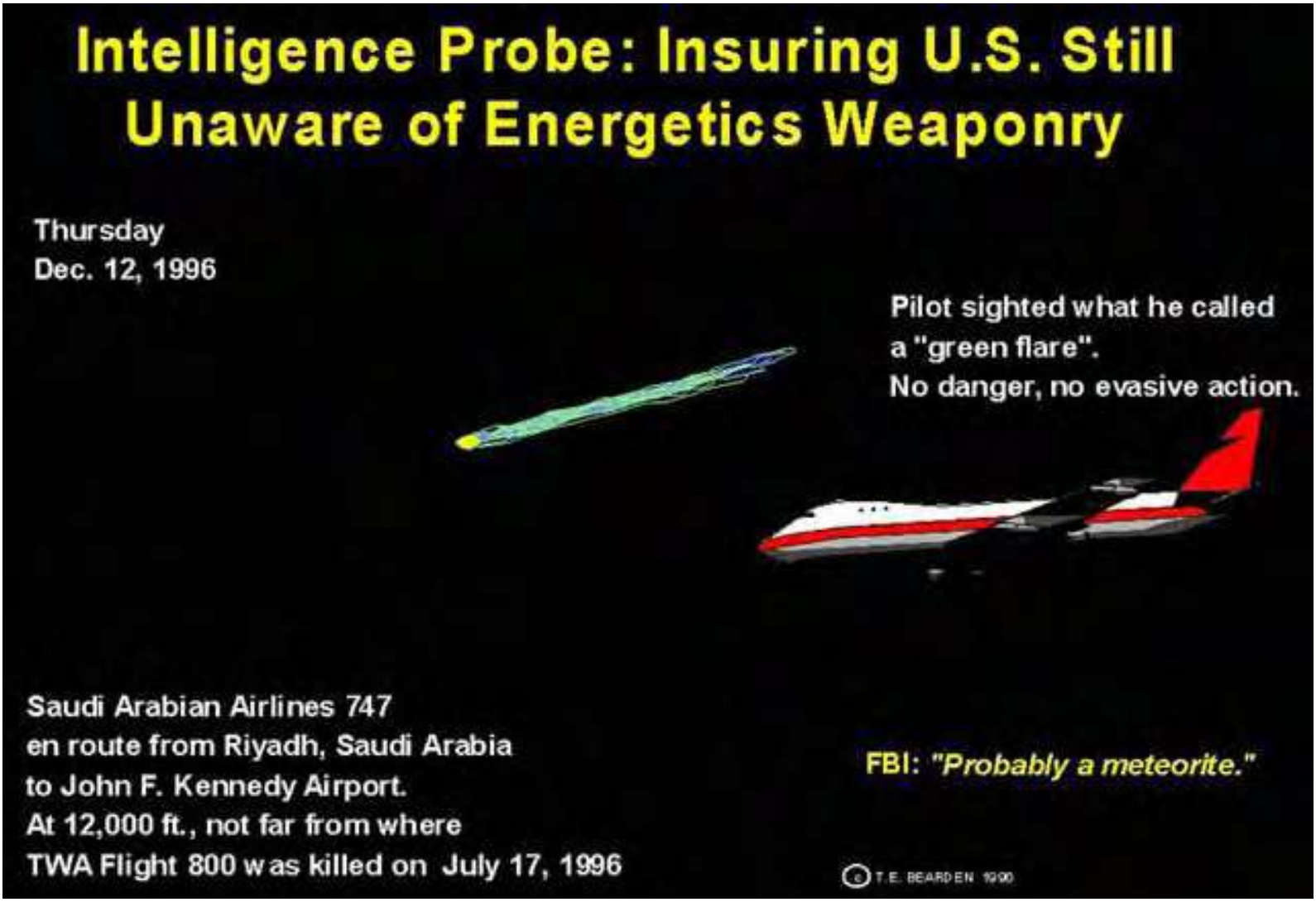
Intelligence Probe: Insuring U.S. Still Unaware of Energetics Weaponry
Thursday
Dec. 12, 1996
Pilot sighted what he called a "green flare".
No danger, no evasive action.
Saudi Arabian Airlines 747
en route from Riyadh, Saudi Arabia
to John F. Kennedy Airport.
At 12,000 ft., not far from where
TWA Flight 800 was killed on July 17, 1996
FBI: "Probably a meteorite."
© T.E. BEARDEN 1990

EM Missile Strike, Offset from Night Shuttle Launch

Cape Canaveral, Florida

© T.E. BEARDEN 1995, 1999,

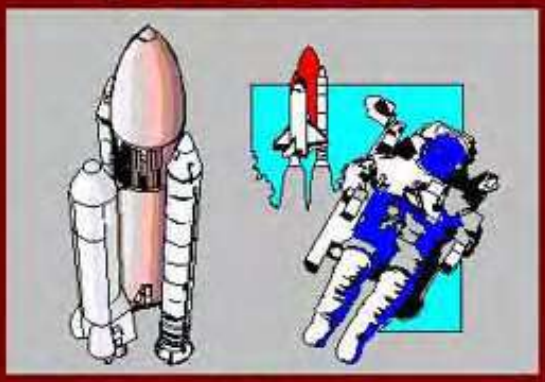

The Smoking Gun in Nov. 1985

Distant Operator Onsite in Russia
Slews Away Registration Point
© T.E. BEARDEN 1995, 1999
MARKER BEACON
Over Night Shuttle Launch
Cape Canaveral, Florida
26 Nov 1985
Photographed by George Suchary
28 Nov 1985
Two weeks later, the same weapon killed the Arrow DC-8
at its takeoff from Gander, Newfoundland.

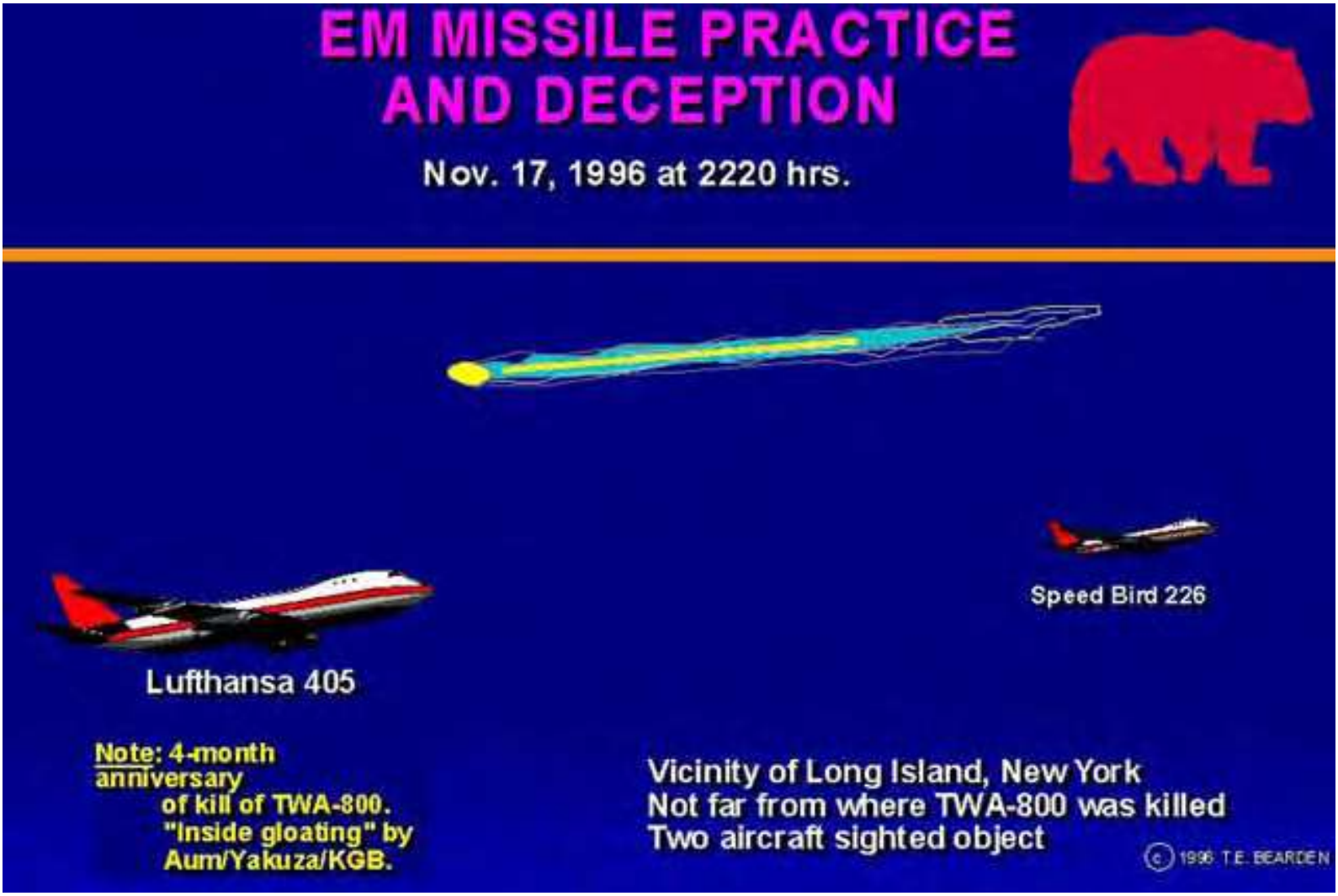
EM MISSILE PRACTICE
AND DECEPTION
Nov. 17, 1996 at 2220 hrs.
Speed Bird 226
Lufthansa 405
Note: 4-month anniversary of kill of TWA-800. "Inside gloating" by Aum/Yakuza/KGB.
Vicinity of Long Island, New York
Not far from where TWA-800 was killed
Two aircraft sighted object
© 1996 T.E. BEARDEN

Subdivisions of Soviet Energetics

NONLIVING SYSTEMS

Energetics

- Nonliving systems
- Scalar Interferometry
- Action-at-a-Distance
- Quantum Potential
- Vacuum Engines
- Spacetime Structuring
- Material, Field Effects
- Nuclei, Lattice Changes
- Hidden EM Variables
- SWZ Effects

LIVING SYSTEMS

Bioenergetics

- Living Systems (Bodies)
- Cells, cellular changes
- Master Cell Control (Popp)
- Spacetime Structuring
- Disease Induction, Remission
- Action-at-a-Distance
- Quantum Potentials
- Scalar Interferometry
- Hidden EM Variables
- SWZ Effects

Psychoenergetics

- Living Systems (Minds)
- Thoughts, Memories, Emotions
- Conscious/Unconscious Minds
- Spacetime Structuring
- Species, Biospheric Minds
- Action-at-a-Distance
- Quantum Potentials
- Scalar Interferometry
- Hidden EM Variables
- SWZ Effects

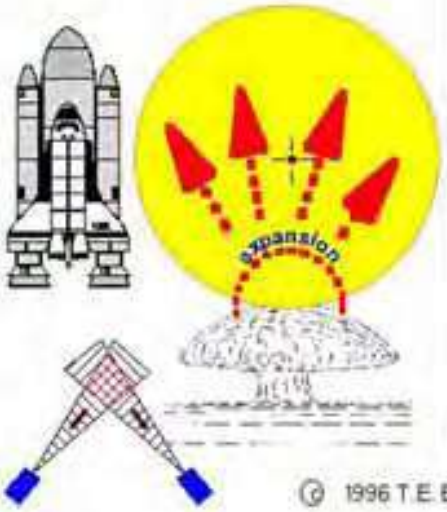

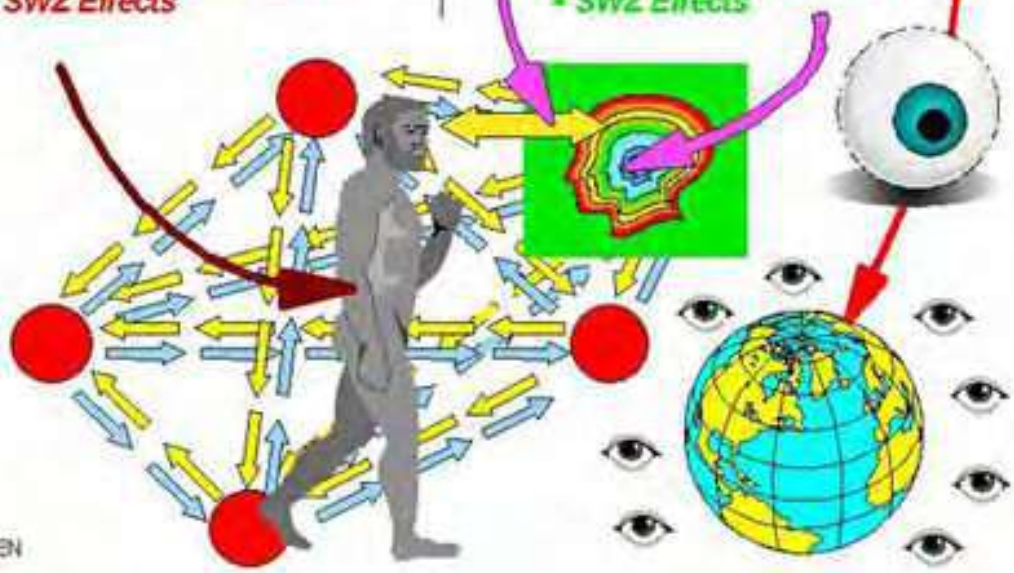

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Communism's Goal

- "War to the hilt between communism and capitalism is inevitable. Today, of course, we are not strong enough to attack... To win we shall need the element of surprise. The bourgeoisie will have to be put to sleep. So we shall begin by launching the most spectacular peace movements on record. There will be electrifying overtures and unheard-of concessions. The capitalist countries, stupid and decadent, will rejoice to cooperate in their own destruction. They will leap at another chance to be friends. As soon as their guard is down, we shall smash them with our clenched fist."

Dimitry Z. Manuilsky
Lenin School of Political Warfare, Moscow
(circa 1934)

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Manuilsky's Goal vs. Status Today

Manuilsky, 1934	Situation, Dec. 1996
▪ War is inevitable.	▪ Has not changed.
▪ Not strong enough to attack now.	▪ Strong enough now; preparations completed. Need right opportunity.
▪ Need surprise.	▪ Have achieved total surprise.
▪ Must put us to sleep.	▪ We are sound asleep.
▪ Need most spectacular peace movement on record.	▪ Done. We think the Russian threat gone, cold war ended.
▪ Electrifying overtures, unheard-of concessions.	▪ Done, and still occurring every day. It has worked beautifully.
▪ Capitalists will cooperate.	▪ We are cooperating in spades!
They will leap to be friends.	▪ We've leaped, and are leaping.
▪ They will let down their guard. ▪	▪ No ABM, junked lots of nukes, shrunk our forces to the bone.
▪ We'll strike them then.	▪ They would have struck (twice) in 1997, but for deterence by another nation (not U.S.) having QP weapons
	▪ *They are still looking for a risk-free opening to strike*

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Professor Hellman, German Scientist Released from Work in Soviet Union

- Worked in Soviet Union after WWII
- Eventually escaped to Germany, then to Brazil (handsome offer)

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- Took part in highly unusual Soviet energetics development and experiments
- Large areas of the sea could be and were *suddenly frozen*
- *No particular attention was paid to this information by highly qualified scientists*
- *In intelligence terms, this is A-1 information of the highest caliber*
- *Bohm also was invited to Brazil, which started an energetics weapon program. Brazil developed such weapons including weak quantum potential weapons (0.95 confidence)*

The Tom Bearden Website

Help support the research

Hemispheres of Light

- March 20th, 1969
  Caribbean and Western North Atlantic
- Hemisphere and Globes, 1977
  24 March, 1977
- Virgin Islands Incident
  August 1969
- Typical Shield Test, Northern Route to Japan
  June, 1982

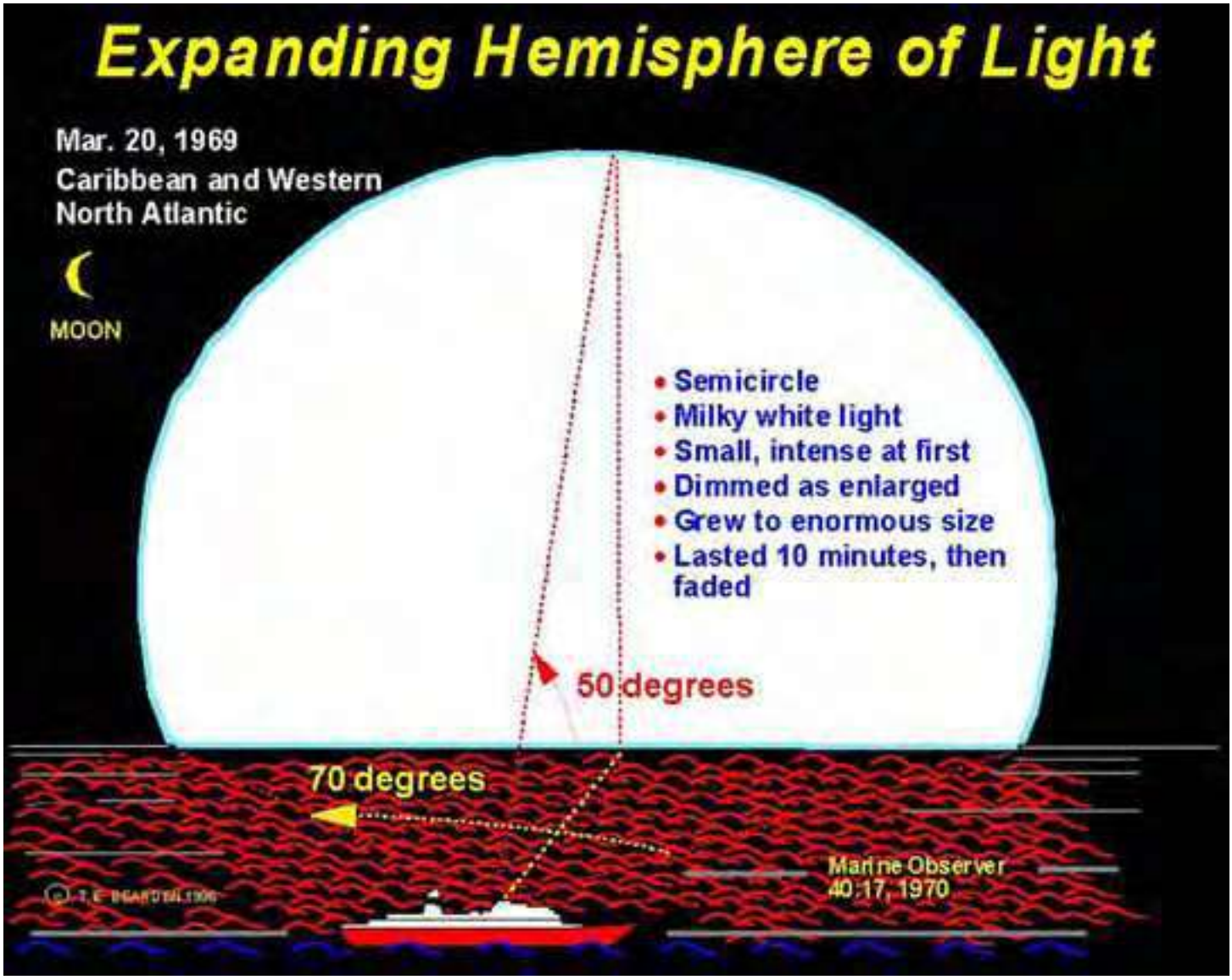
Expanding Hemisphere of Light
Mar. 20, 1969
Caribbean and Western
North Atlantic
MOON
• Semicircle
• Milky white light
• Small, intense at first
• Dimmed as enlarged
• Grew to enormous size
• Lasted 10 minutes, then faded
50 degrees
70 degrees
Marine Observer
40:17, 1970

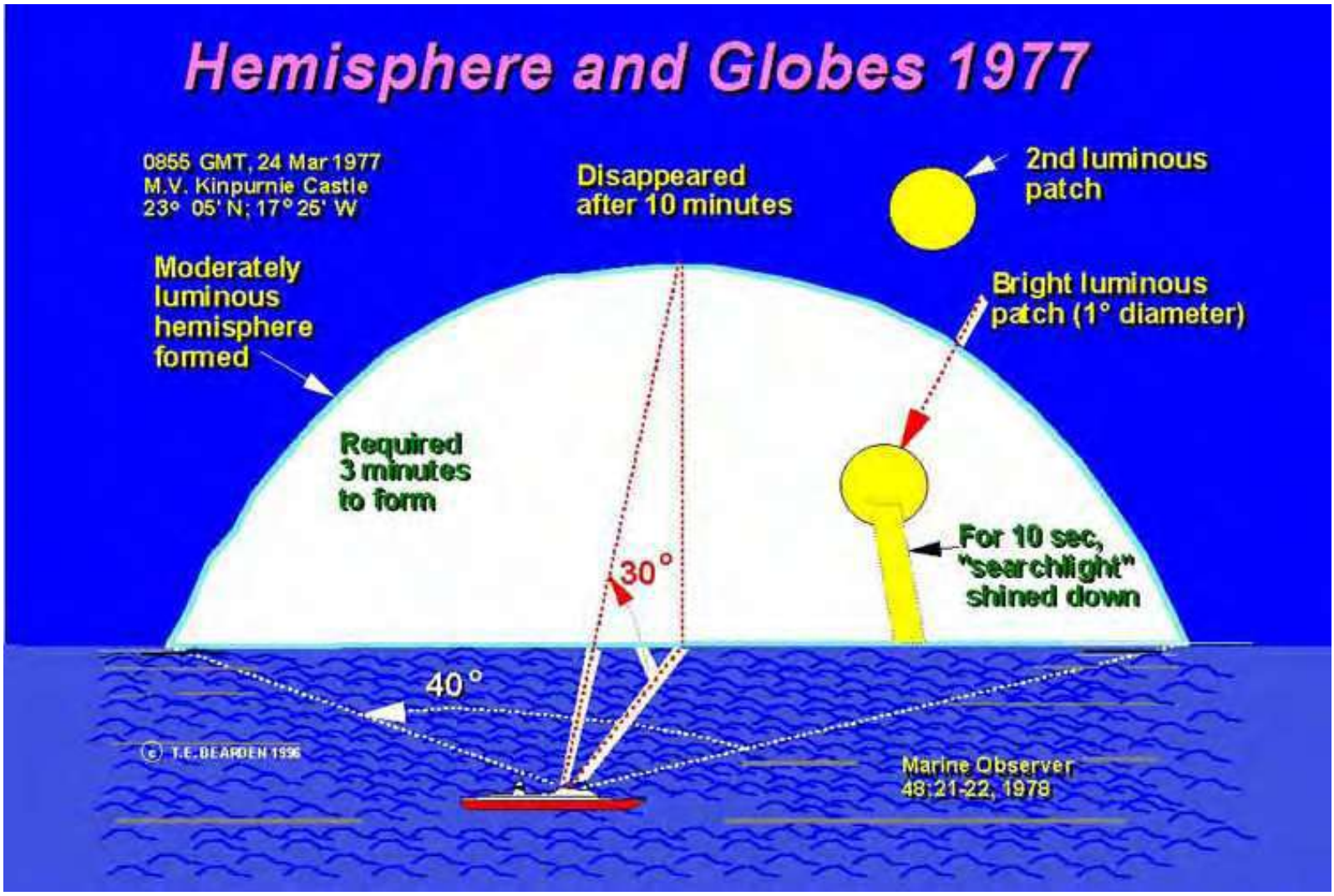
Hemisphere and Globes 1977
0855 GMT, 24 Mar 1977
M.V. Kinpurnie Castle
23° 05' N; 17° 25' W
Disappeared after 10 minutes
2nd luminous patch
Moderately luminous hemisphere formed
Bright luminous patch (1° diameter)
Required 3 minutes to form
For 10 sec, "searchlight" shined down
30°
40°
© T.E. BEARDEN 1996
Marine Observer 48:21-22, 1978

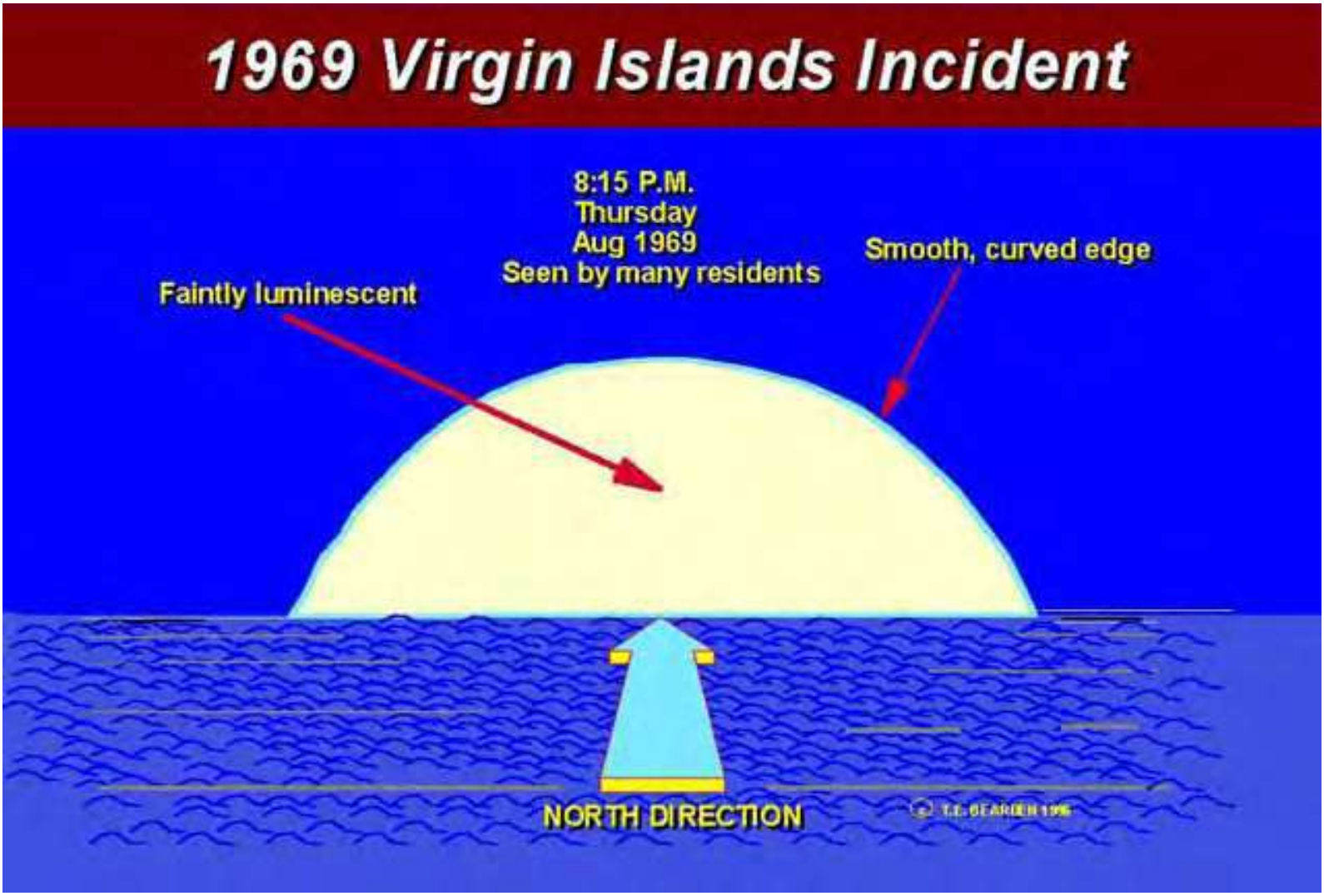
1969 Virgin Islands Incident
8:15 P.M.
Thursday
Aug 1969
Seen by many residents
Smooth, curved edge
Faintly luminescent
NORTH DIRECTION

Typical Shield Test, Northern Route to Japan
18-27 km diameter
Asahi Evening News, Tokyo
June 22, 1982
Multiple tests seen per month, for years.
Pilots simply ceased reporting them.

How Could Such Superweapons Ever Be Concealed?

- Arthur C. Clarke's law states:

  "Any sufficiently advanced technology is indistinguishable from magic."

- To U.S. scientists, "magic" means "impossible"
- Longitudinal EM waves and LW interferometers have been regarded as fantasy and impossible
- To deceive foe on rather open use of unknown technology without discovery:

  "Disguise its uses as understandable accidents, human error, acts of nature, other known technology, etc."

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Soviets Easily Concealed These Superweapons for Four Decades

- Intensive Soviet deception plan utilized
  - Embedded in other weapon system tests
  - Made to resemble natural acts, accidents, etc.
  - Open science releases coordinated to show Russian scientists worked on "normal" science
- West thought Russian scientists inferior
- U.S. scientific community was and is dogmatic, and fiercely suppresses real scientific innovation
- Terribly flawed electrodynamics not ruthlessly shaken and changed in West

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- West had no basis for understanding energetics

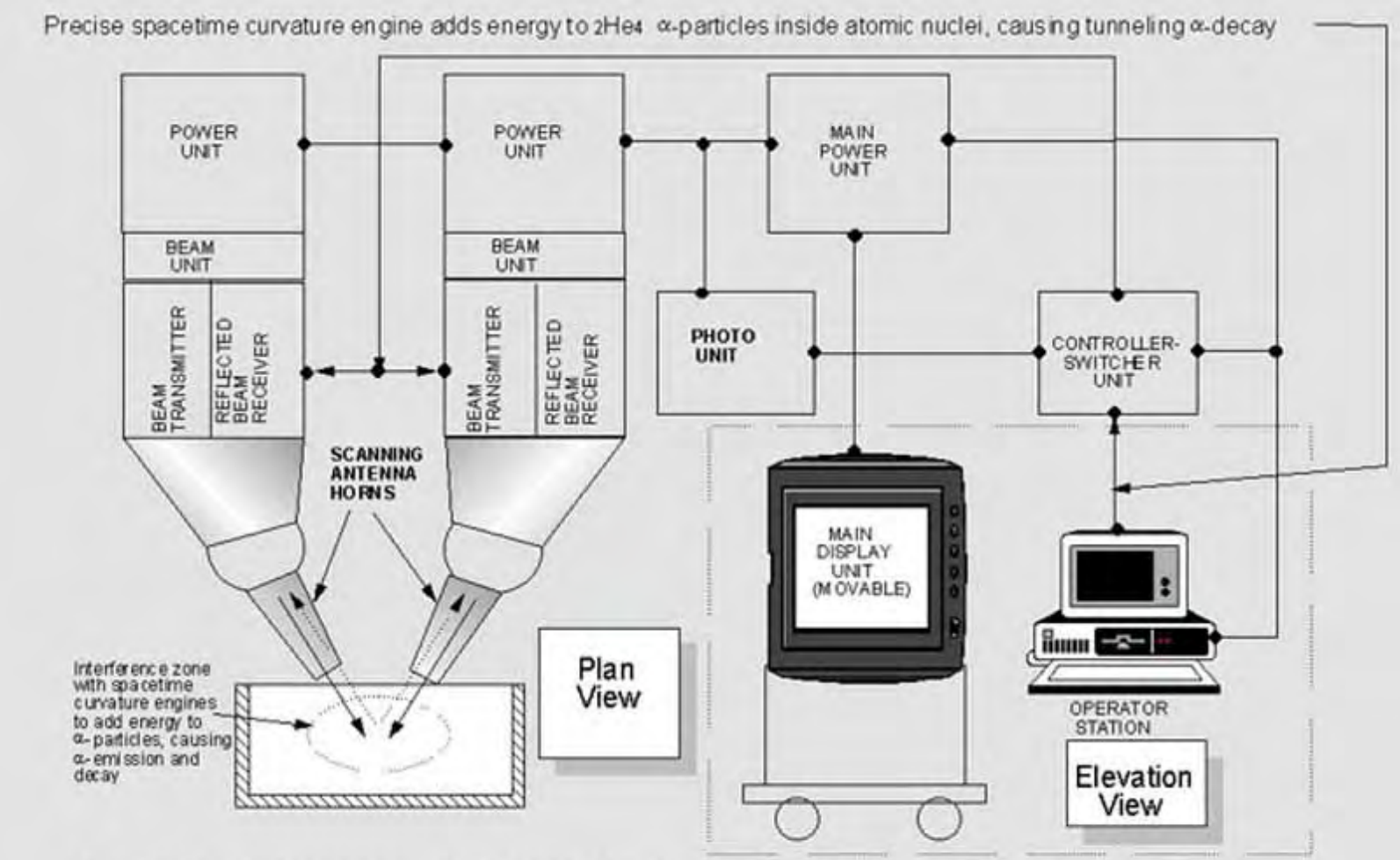

Figure 26. Microscope-type, laser-like interferometer for inducing quick α-decay in samples of otherwise longer-lived isotopes.

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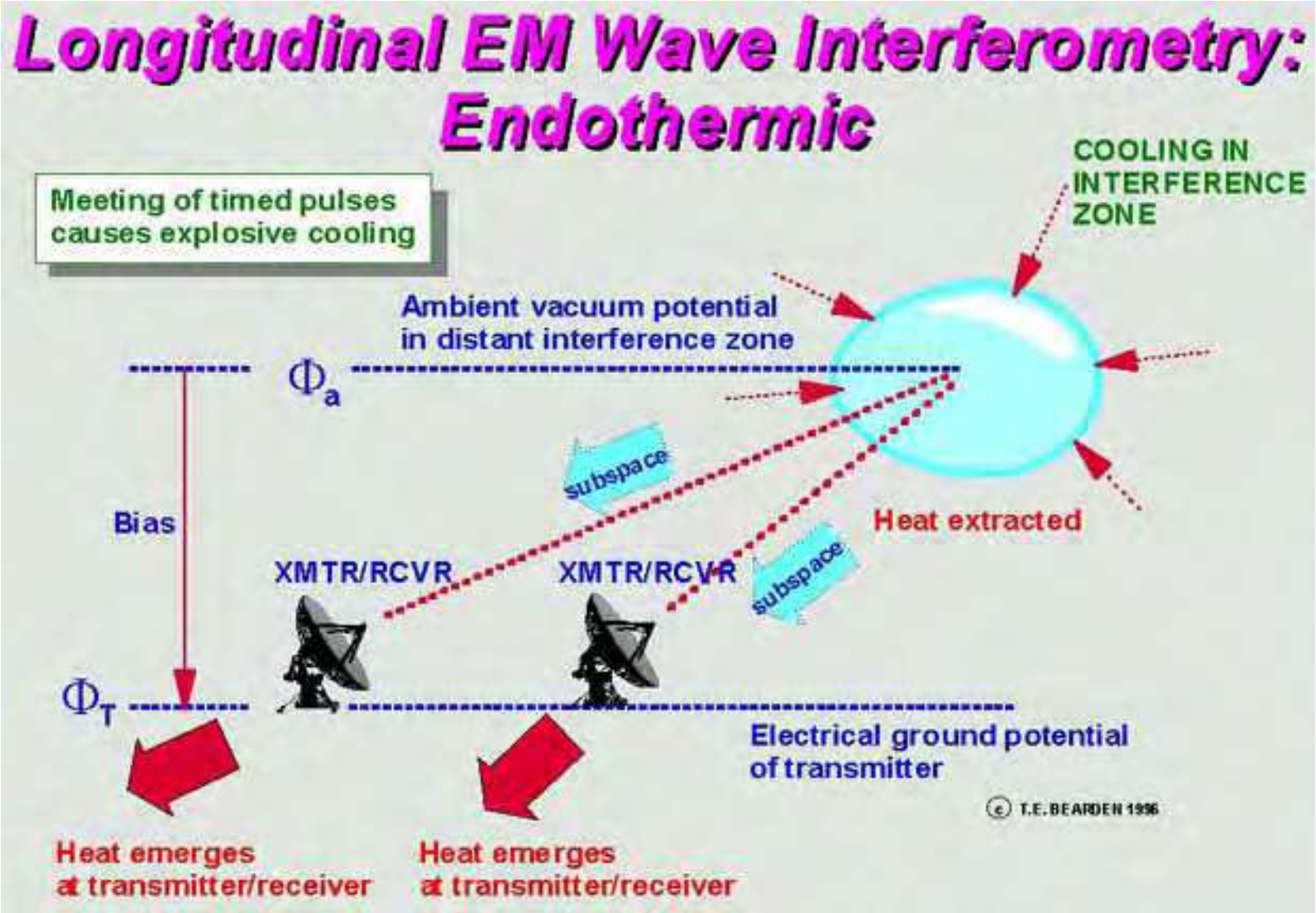
Longitudinal EM Wave Interferometry: Endothermic
Meeting of timed pulses causes explosive cooling
COOLING IN INTERFERENCE ZONE
Ambient vacuum potential in distant interference zone
Φ_a
subspace
Bias
Heat extracted
XMTR/RCVR
XMTR/RCVR
subspace
Φ_T
Electrical ground potential of transmitter
© T.E. BEARDEN 1996
Heat emerges at transmitter/receiver
Heat emerges at transmitter/receiver

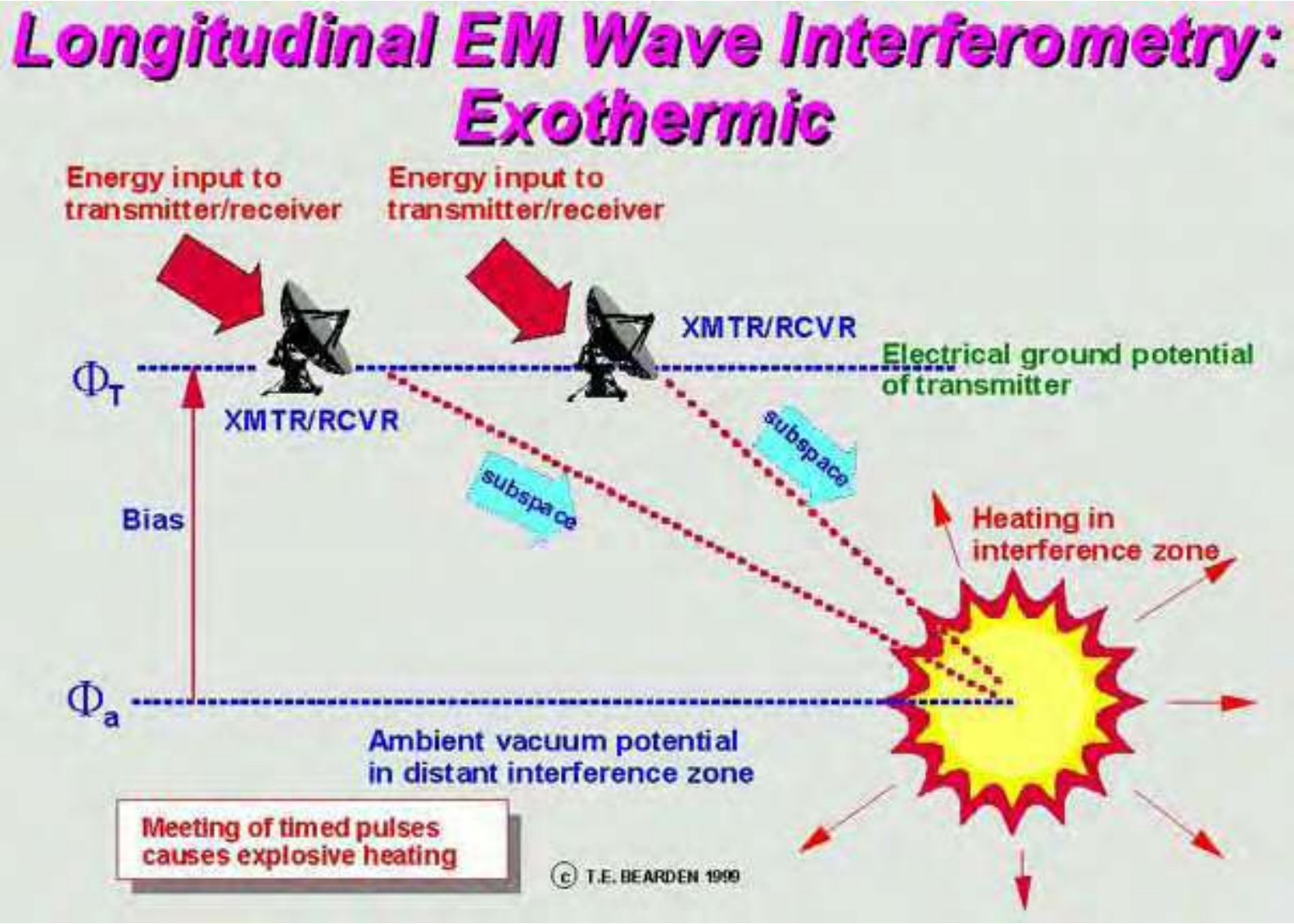
Longitudinal EM Wave Interferometry: Exothermic
Energy input to transmitter/receiver
Energy input to transmitter/receiver
XMTR/RCVR
XMTR/RCVR
Electrical ground potential of transmitter
Φ_T
subspace
subspace
Bias
Heating in interference zone
Φ_a
Ambient vacuum potential in distant interference zone
Meeting of timed pulses causes explosive heating
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The Tom Bearden Website

Help support the research

U.S. Air Attack on Libya
April 1986

- Slide 1
- Slide 2
- "Washington Post" Article
  January 22, 1989

U.S. Airstrike on Libya
April 1986*
• 33 U.S. AIRCRAFT IN STRIKE
• MANY HIGH-POWERED TRANSMITTERS
– COMMUNICATIONS
– JAMMERS
– RADARS
• SEVERE, UNEXPECTED "EMI" ENCOUNTERED
– ONE F-111 DOWNED
– NUMEROUS WEAPONS WENT ASTRAY
– THREE FOREIGN EMBASSIES DAMAGED
– SEVEN AIRCRAFT FORCED TO ABORT
• COMMANDERS: "US OR THEM?"
*Washington Post, 22 Jan. 1989, p. A4
Mild quantum potential weapon tested against electronics in U.S. aircraft and missiles
EM energy arises from every point in spacetime inside the electronics

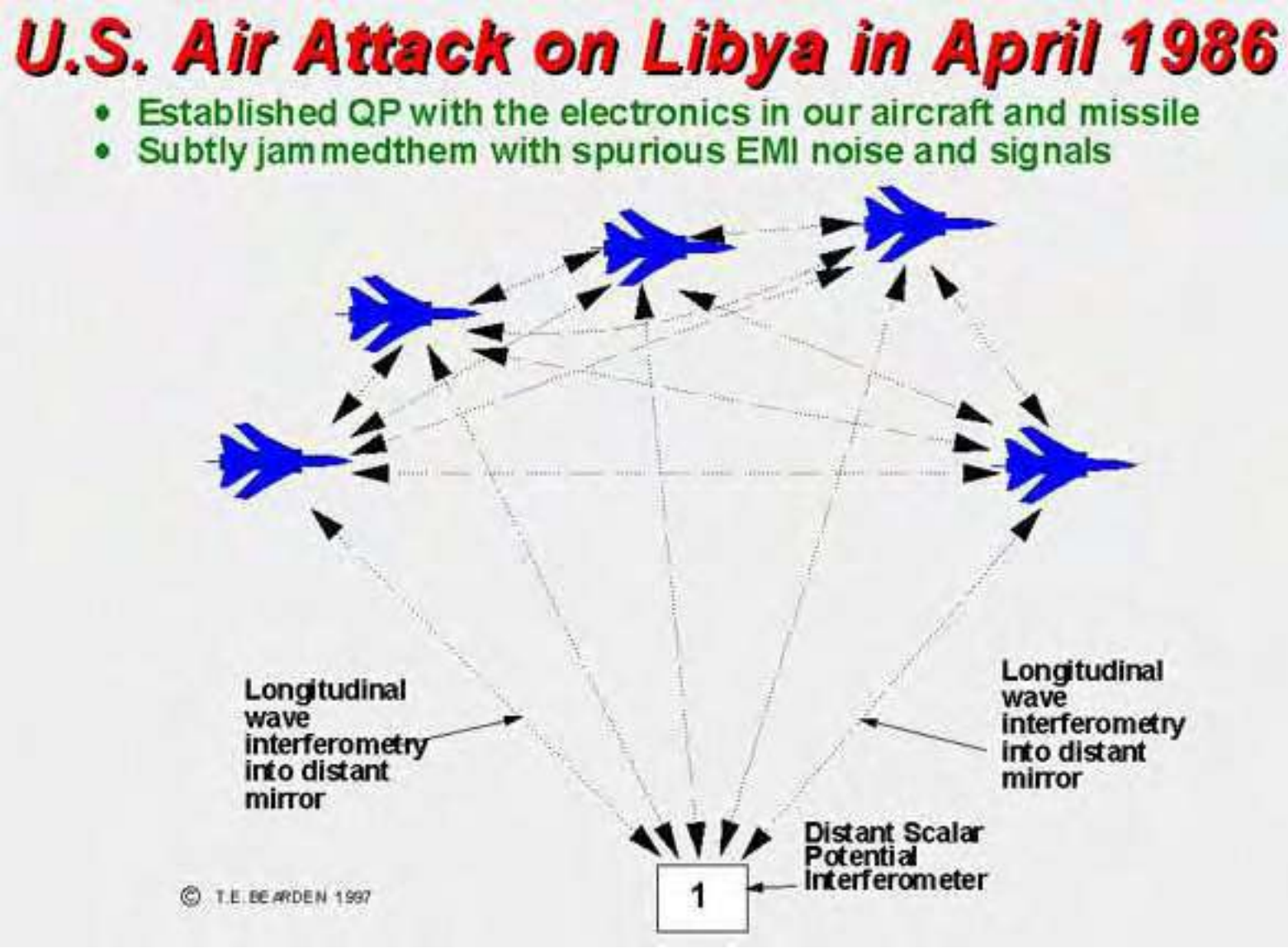
U.S. Air Attack on Libya in April 1986
• Established QP with the electronics in our aircraft and missile
• Subtly jammedthem with spurious EMI noise and signals
Longitudinal wave interferometry into distant mirror
Longitudinal wave interferometry into distant mirror
Distant Scalar Potential Interferometer
1
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Lightning Wall

- Aircraft on course of 270 degrees
- Approached "solid wall of lightning" in an otherwise cloudless sky
  - From very high altitude to near the water
  - Extended north-south as far as one could see
- Radar scope clear
- *Rigged aircraft for heavy weather*
- *Plunged directly through wall*
- *Wall was very thin*

circa 1959-1960
Interview with Patrol plane commander
U.S. Navy P5 aircraft
Over Atlantic, 200 miles east of Norfolk

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Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

S.K. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p. 16-25.

JC5-34

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Large Longitudinal EM Wave Interferometer (LWI) Accident

- 1958 nuclear explosion near Urals
  - Contaminated 1200 square kilometers
  - Signature of large LWI accident
  - Buried atomic wastes suddenly exploded
  - Region contaminated to this day
- Soviets were well along with advanced LWI prototypes and testing
  - In Jan. 1960 Khrushchev announced these forthcoming "fantastic" weapons
  - 1958 difficulties would have been resolved by 1960

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Large Longitudinal EM Wave Interferometer (LWI) Accident

- Expected cause of 1958 accident
  - Huge LW energy beams built up
  - Catastrophic short-out in transmitter
  - LW energy flashed over into earth and spread
  - Struck and fissioned stored nuclear wastes
- Developed new safety circuits
  - For transmitter short-out, instantly activates to hold LW beam energy and prevent flash-over
  - Similar accident happened in 1986 at Chernobyl, except private U.S. group blew that transmitter to prevent catastrophic quake in California

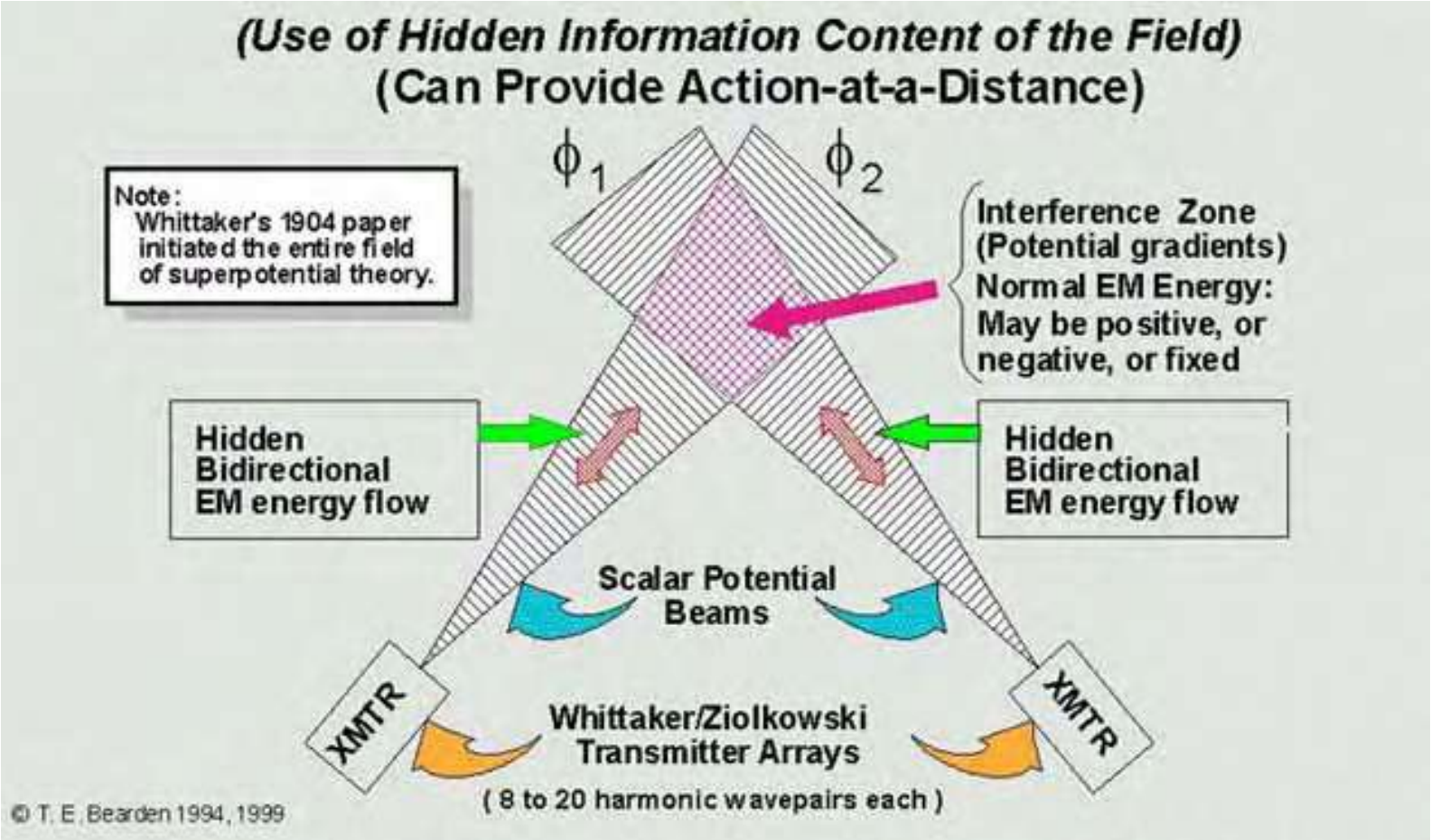

Figure 5. Scalar potential interferometry (between the two sets of bidirectional longitudinal EM wavepair functions) produces all EM force fields and waves.

Two Types of Mutual Assured Destruction (MAD) Systems

- ***Sane system:***
  - Turned off or on standby
  - Wait until attacked or attack is imminent
  - Humans consider situation, make strike decision
  - Command order issued to weapons officers
  - Human finger initiates launch sequence
  - Usually requires code entry, etc. for assured launch control

- ***Insane system:***
  - Computer periodically (e.g., every 2 hours) initiates launch
  - During sequence, there is a period (say, 2 min.) where operators can enter stop order (usually coded)
  - If correct stop not entered, weapons automatically launch
  - if correct stop entered, computer resets, and after another 2 hrs, automatically reinitiates the launch sequence

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Psychoenergetics Weapons Teams
Mentally Disable All Personnel
(COUNTERS ALL SANE MAD SYSTEMS)
(NULLIFIES HUMAN COMPONENT OF ALL WEAPON SYSTEMS)
ELECTRICAL THOUGHT-WORDS ARISE DIRECTLY IN BRAIN, HENCE IN MIND, BYPASSING SENSOR INPUTS
INSTANT HYPNOGOGIC STATE, WITH INSERTED THOUGHT-WORDS
Effects arise in local spacetime, simultaneously in all minds in the targeted area
INSTANT HYPNOGOGIC STATE: WITH WAKING DREAM
PERCEIVED REALITY NOW CONTROLLED
TARGETED POPULACE
• Site personnel instantly hypnogogic and mentally controlled.
• Distant weapon controller teams coord crew actions
• Standdown insane weapons to maintenance standby.
• Mindsnapper then strikes, kills all personnel, and nullifies site for months.
Indicators: Two A-10 incidents 1997, LIDA device since 1950s.
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Strikes Against Special Ship and Energetics Weapon Sites

- Via powerful scalar EM pulses in each targeted area, so sharp time-jerks occur
  - Mind and its operations exist in time but not in 3-space
  - Coupling interaction of mind operations to body occurs through flow of time
  - Flow or change of flow of time must be smooth, for coupling of mind to body
- *Sharp jerk in time flow snaps mind's coupling to body, instantly separates mind*
- *Instant death for every virus, bacterium, cell, insect, mammal, living creature*
- *Contaminates struck sites for months, perhaps a year*

Note: In other words, this is the part of the "preparation barrage" that attacks the enemy's response capability (i.e., his "artillery" and his "airpower") and suppresses it. The use of the "mindsnapper" weapons provides 100% assurance of success.

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"MINDSNAPPER" ATTACK ON SPECIAL SHIPS & ENERGETICS WEAPONS SITES

"We have a new, fantastic weapon ... so powerful that, if unrestrainedly used, it could wipe out all life on earth."

Khrushchev, speaking to Presidium, Jan. 1960

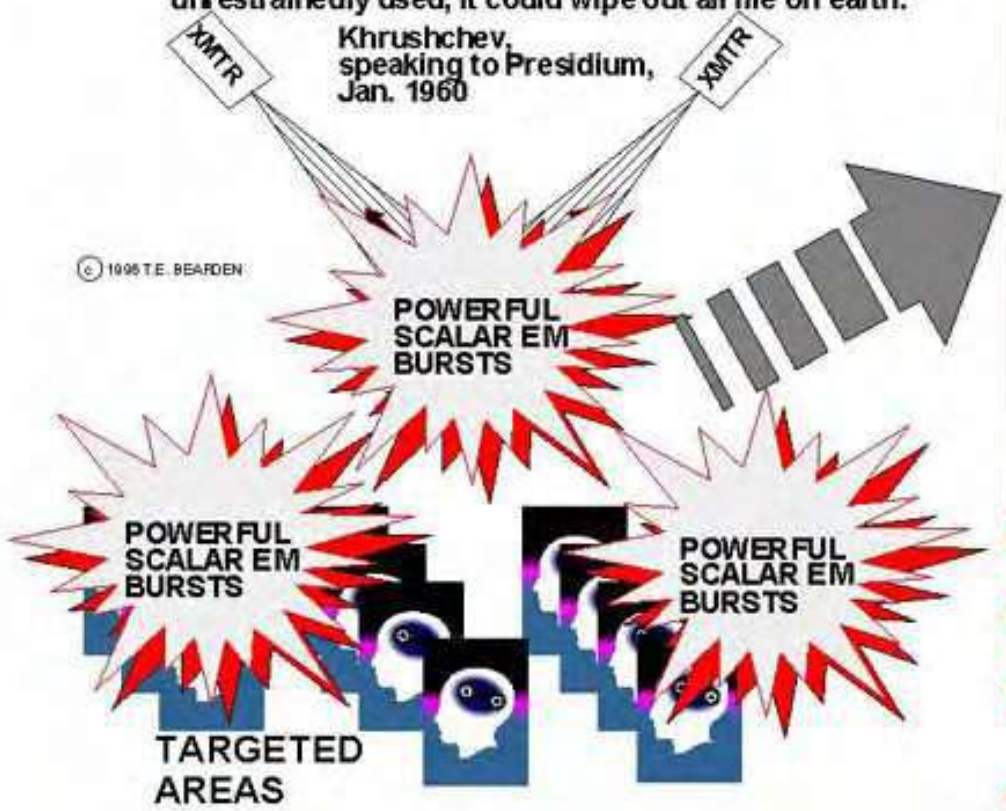

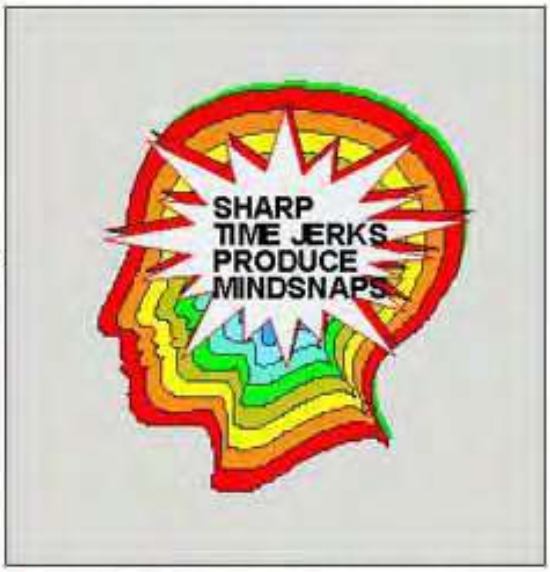

- Minds snapped loose from bodies (every living thing)
- Struck areas completely sterilized of all life
- LWs emitted; slow decay of time-charge makes contamination persistent
- Tested twice in Afghanistan

The Tom Bearden Website

Help support the research

How Much Off Guard Are We?

- Slide 1
- Slide 2
- Slide 3
- Slide 4
- Slide 5
- Slide 6
- Slide 7

How Much Off Guard Are We?

- *Legitimate U.S. forces have no energetics weapons or defenses against them*
- *No DoD general, military officer, or enlisted person reporting to the government of the United States has <u>any:</u>*
  - Training in energetics or energetics weapons
  - Experience in energetics or energetics weapons development and usage
  - Training in strategy, tactics, deployment, and employment of energetics weapons
  - Knowledge of energetics weapons effects and capabilities
  - Knowledge of the energetics weapons, tactics, deployment, and employment by the KGB/Russians
- *Civilian and military, scientific and intelligence, and news media personnel do not recognize energetics weapons effects happening right over their own heads*

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How Much Off Guard Are We?

- Kill of U.S.S. Thresher in 1963 not recognized. Left signatures.
- 23 years of KGB weather engineering, particularly over U.S. and North America, ignored and not recognized.
- Decades of irradiation of U.S. Embassy, fatally injuring three U.S. Ambassadors, health changes in personnel shrugged off ineptly.
- Massive building of underground sites, all through former Soviet Union, lamely speculated as perhaps "ABM" system or?.
- 1985, 1986 Soviet kills of U.S. aircraft, spacecraft, personnel ignored as "accidents" by legitimate U.S. communities.
- Quantum potential strike on soldiers in Gulf war ignored.
- Quantum potential deterioration of U.S. populace's immune systems ignored.
- Exchange of earthquakes and massive retaliatory destruction of Soviet missile ammunition storage sites, 1986-1989, ignored.
- U.S. scientific and military communities adamantly refuse to rework electromagnetics, though known to be seriously flawed.
- Refuse to apply Stoney/Whittaker work to engineer hidden variables, even though present quantum mechanics also known to be wrong because it does not contain such "hidden order."
- Refuse to develop, structure, and apply Bohm's quantum potential, for instantaneous action at a distance. Russians developed it.

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  - Not recognized.
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  - Particularly over U.S. and North America
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  - Induced health changes in personnel
  - Shrugged off ineptly.
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  - All through former Soviet Union
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- Refuse to apply Stoney/Whittaker work to engineer hidden variables, even though present quantum mechanics also known to be wrong because it does not contain such "hidden order."
- Refuse to develop, internally structure, and apply Bohm's quantum potential, which gives instantaneous action at a distance and great energy amplification.
- Russians developed quantum potential weapons, which obsolete all other weapons.

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JUST HOW MUCH OFF GUARD ARE WE?
Kill of TWA-800 1996
Kill of USS Thresher 1963
Cold Explosion Off Japan Apr 1984
Kill of Space Shuttle Challenger 1986
From The Huntsville (AL) Times 18 Sep 96:
President's party airplane crash 1996
"Retired Gen. Wayne Downing concluded that U.S. forces are so far superior to potential foes that opponents have turned to terrorism as the only way of challenging them."
The Times also provided the information that Defense Secretary William Perry agreed with Gen. Downing's conclusion.
3 Dead U.S. Ambassadors from Moscow Embassy Radiation
QP Gulf War Syndrome: 16,000 persons disabled
QP jamming, U.S. air attack on Libya, 1996
Kill of Arrow DC-8 Gander AFB Dec 1985

JUST HOW MUCH OFF GUARD ARE WE?`

Kill of USS Thresher Nuclear Submarine Apr 1963

QP Test on U.S. Troops in Persian Gulf, 1991 (Gulf War Syndrome)

TWA-800 1996; President's C-130 crash 1996

3 Dead U.S Ambassadors, U.S. Weather Engineered 20 years

Arrow DC-8 Gander AFB Dec 1985

Challenger 1986

Quantum Potential Jamming of Air Attack on Libya Apr 1986

Blind Euphoria to Even the Ballistic Missile Threat

- U.S. National Intelligence Estimate (NIE) released in Nov. 1996 states there is no foreseeable threat to the U.S. from "indigenous missiles" for at least 15 years.
- Clinton has claimed a program for ABM defense is too expensive, would violate ABM Treaty with former USSR.
- Soviets developed an ABM system in violation of the treaty.
- In June 96 Russia test-launched an SS-19, their 26th ICBM test in 5 years.
- *"Russia still retains and is modernizing a vast nuclear arsenal... still the only nation of earth that could destroy America in a matter of minutes. Indeed, given the weakness of the Russian Army, Russia's superpower ambitions rest more than ever on its nuclear capabilities."* *
- "For the first time since the dawn of the nuclear age, there is not a single Russian missile pointed at America's children." **

Comment: Punch a computer button and the missiles are pointed! The armed missiles are still there, ready and waiting.

Bulleted info courtesy Washington Inquirer, June 24, 1996.

* House Nat'l Security Chmn, Floyd Spence.
** Bill Clinton, State of the Union Message.

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Possible Targets: 1995-9
Escalation Phase
(Based on 1985-87 test program)
Earthquakes
Missiles
Power Grids &
Distribution Systems
Satellites
Ships
Shuttle
Launches
& Flights
JETLINERS
Radio/TV
Subs
Microwave Nets
Radars &
Nets
Communications
and Computer Nets

Propagation of Weapon Effects

- All conventional weapons use propagation through 3-space of matter or energy or both
  - Matter (bombs, missiles, projectiles, etc.)
  - Energy (EM force fields, sonic force fields, etc.)
  - Basically one-to-one, or one "bus" to many-on-many
  - Finite propagation velocity v: where $0 < v \leq c$
  - Time delay: Shielding and pre-strike retaliation possible
- Structured quantum potential propagates vacuum ordering (vacuum engines), instantly
  - Zero time delay (through multiply-connected spacetime)
  - No propagation "through space", no "velocity" as such
  - Easily one-to-many, without limit
  - Dramatic energy amplifier (gates, amplifies flux ordering)
  - Effects arise in local spacetime; no shielding possible
  - No range limit, since striking distance always zero
- QP weapons obsolete all other weapons

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Yugoslav Earthquake, Followed by Cold Explosion

Apr. 15
1979

- Magnitude 7.2 on Richter scale
- Epicenter 33 km. deep
- More than 100 aftershocks
- At Kamenari:
  - Adriatic sea mushroomed up
  - Like atomic bomb explosion
  - Signature of a cold explosion
  - Similar to Apr. 1984 test off coast of Japan, near Kurils (see inset graphics)
- Note that April is a significant test month for the Communists (preparing official reports for May Day?)

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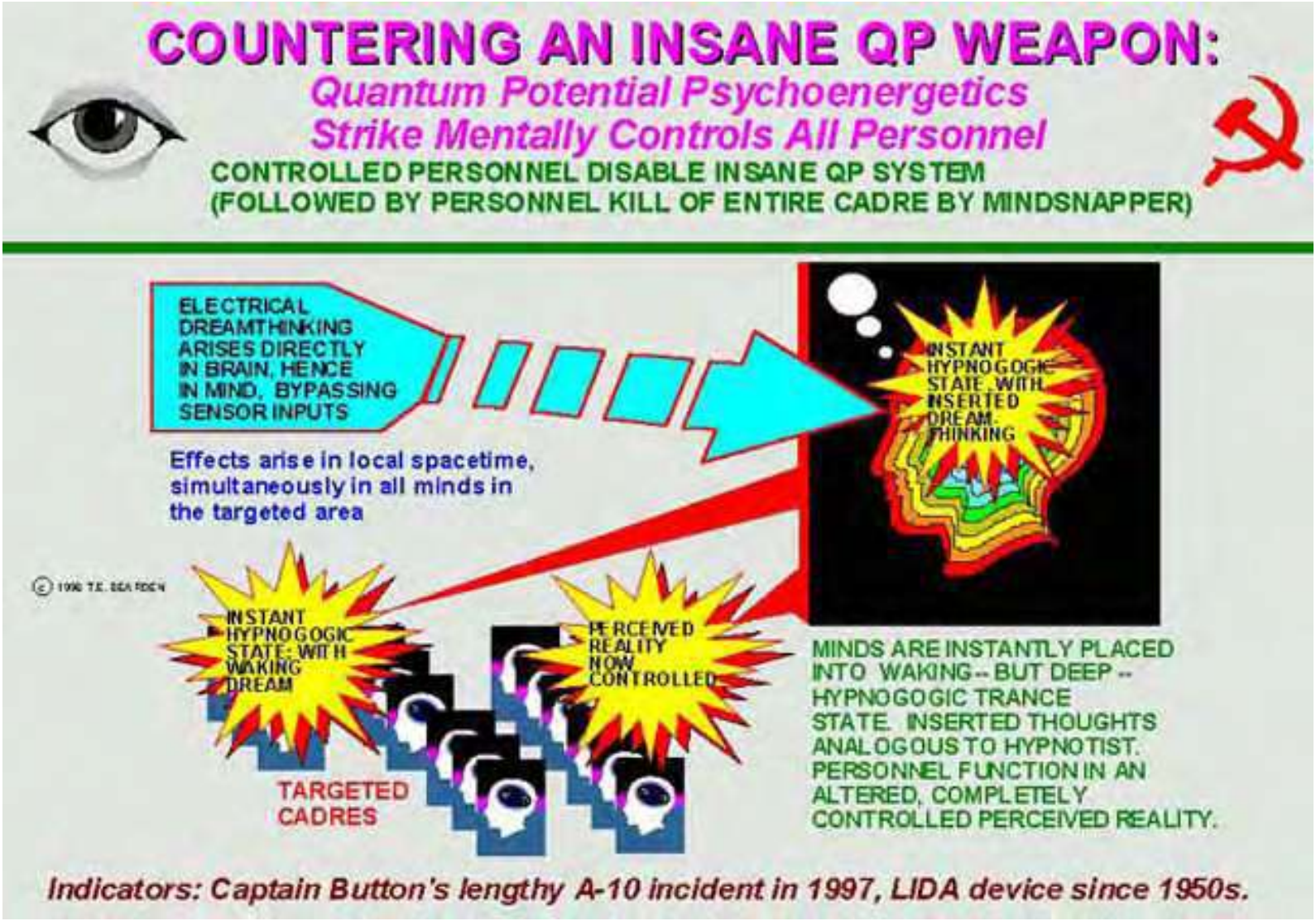
COUNTERING AN INSANE QP WEAPON:
Quantum Potential Psychoenergetics
Strike Mentally Controls All Personnel
CONTROLLED PERSONNEL DISABLE INSANE QP SYSTEM
(FOLLOWED BY PERSONNEL KILL OF ENTIRE CADRE BY MINDSNAPPER)
ELECTRICAL DREAMTHINKING ARISES DIRECTLY IN BRAIN, HENCE IN MIND, BYPASSING SENSOR INPUTS
Effects arise in local spacetime, simultaneously in all minds in the targeted area
INSTANT HYPNOGOGIC STATE WITH INSERTED DREAM THINKING
INSTANT HYPNOGOGIC STATE WITH WAKING DREAM
PERCEIVED REALITY NOW CONTROLLED
TARGETED CADRES
MINDS ARE INSTANTLY PLACED INTO WAKING -- BUT DEEP -- HYPNOGOGIC TRANCE STATE. INSERTED THOUGHTS ANALOGOUS TO HYPNOTIST. PERSONNEL FUNCTION IN AN ALTERED, COMPLETELY CONTROLLED PERCEIVED REALITY.
Indicators: Captain Button's lengthy A-10 incident in 1997, LIDA device since 1950s.

Gulf War Disease: KGB QP Weapon Induced
ST Curvature Engines for a Cocktail of Diseases
LIBYA
EGYPT
CHAD
SUDAN
SAUDIA ARABIA
IRAN
IRAQ
SYRIA
LEBANON
ISRAEL
JORDAN
KUWAIT
QATAR
OMAN
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Distant Scalar Potential Interferometer with iterative self-targeting

Self-Targeting in Inner EM Channel Can Produce a Quantum Potential

Once QP is established, energy transmission is direct and instantaneous. Energy input to one single participant will simultaneously appear in all other participants, the amount depending on their fractions of participation with the input station.

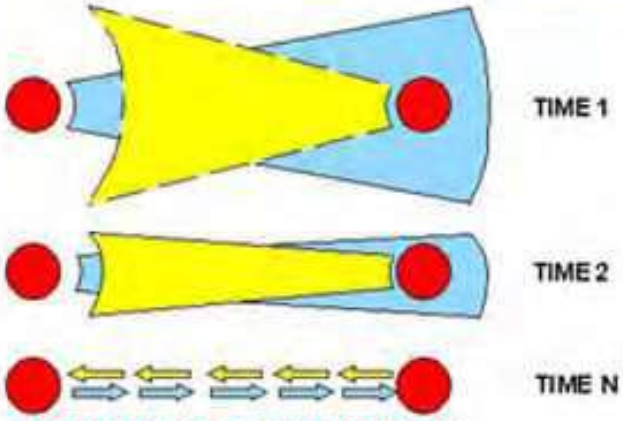

NARROWING OF INTERACTING POTENTIALS INTO LASER-LIKE BEAMS, BETWEEN TWO PUMPED SOURCES. NOW ONLY LONGITUDINAL WAVES CONNECT THE LINKED OBJECTS.

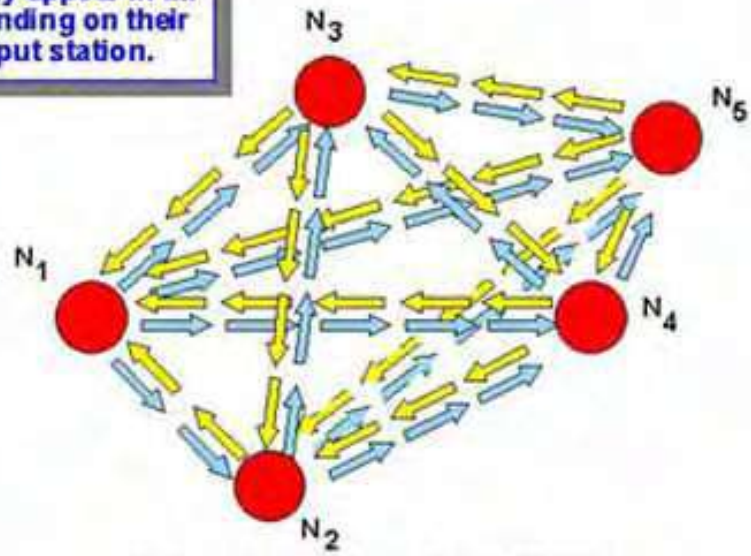

SELF-TARGETING EFFECT AMONG ALL PAIRS OF INTERACTING PUMPED SOURCES

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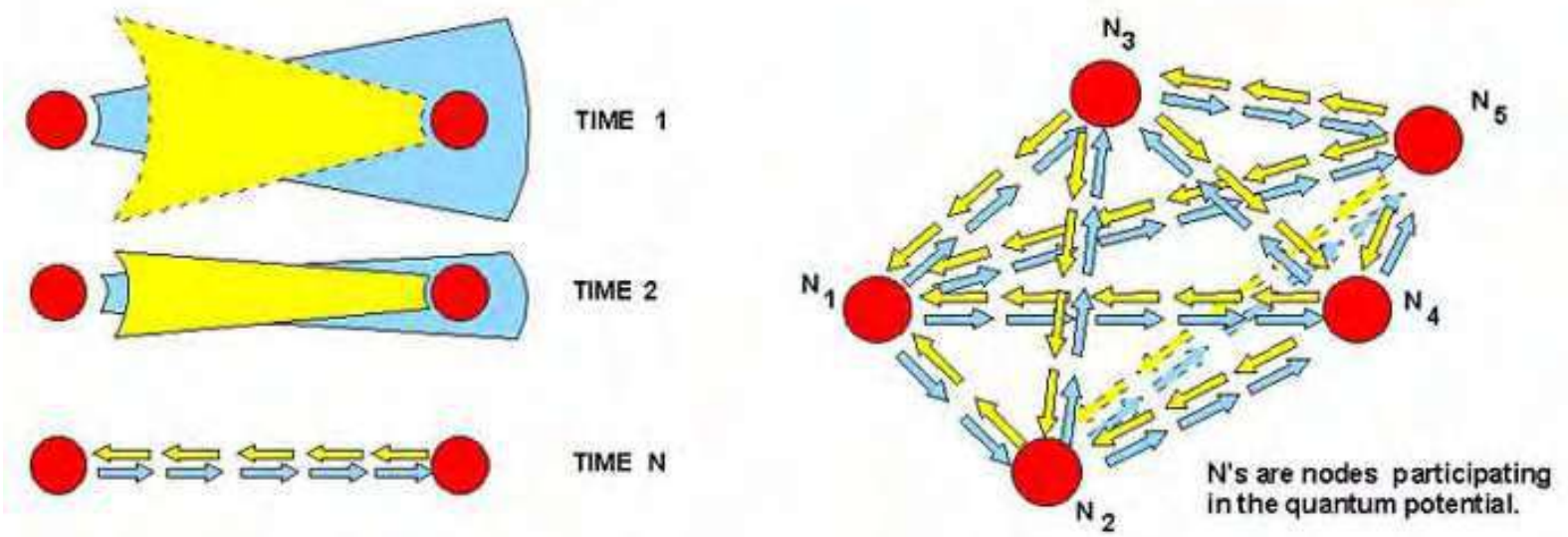

a. Iterative retroreflection between any pair of nodes narrows the interconnecting potentials to a laser-like, bidirectional beam. Iterative phase conjugate reflection provides self-targeting.

b. The quantum potential exists as narrow, laser-like beams between participating nodes, even when the nodes are widely separated. The beam space is multiply-connected; transmission is instantaneous.

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Consider the hidden Stoney/Whittaker bidirectional EM waves that comprise the potential from each source node. If these nodes have sufficient intersymmetry of dynamic material form, then self-targeting occurs between the two nodes of any nodal pair. By iterative phase conjugate reflection, the scattering is narrowed into interconnecting wavepairs, in laser-like beams, between each two nodes. Thus the interconnecting potentials narrow into laser-like, bidirectional beams. The Coulomb gauge may apply, and a quantum potential may be formed.

Figure 30. Mechanism for generating a quantum potential, by iterative self-targeting induced into a system of multiple scattering nodes. Once a QP is established, spatial separation has little or no effect.

Major Principles for Use of Quantum Potential Weapons

- Must disable dead-man fuzing prior to massive use of scalar interferometry weapons.
- Must assure immediate, complete nullification of unique enemy assets (quantum potential assets, special ships, and energetics weapons).
- Personnel can be destroyed instantly with mindsnapping; area is sterilized of life, and effect persists, gradually dying away.
- Personnel can be disabled instantly with various psychoenergetic weapons; area not sterilized.
- Personnel can be destroyed in short order by using EM BW weapons; area not sterilized.
- If foe has energetics weapons, then it is a quick-draw "gunslinger" contest unless insane MAD systems deployed.
- Complete surprise is of decisive importance.
- Tailor effect used to specific target, objective.
- *Note: Must use "insane" MAD systems to deter.*

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Quantum Potential Weapons: Major Principles (Continued)

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- Three major classes of use exist:
  - Use of bulk energy only (as in bulk heating or cooling) without substructuring
  - Use of internal structuring of the bulk energy, so that *vacuum engines* appear in target
  - Use of more deeply nested engines allows direct intervention in mind, long term memory, perception, thoughts, emotions, personality
- Use of vacuum engines allows engineering at a distance of:
  - *Atomic nuclei* including structures, reactions, and transmutations
  - *Bulk matter* including translations, lattice bonding, chemistry, chemical interactions, electromagnetic interactions
  - *Deep biological control systems* such as
    - Becker's cellular control (recovery) system
    - Popp's cellular control system
  - *Cells* including:
    - Structuring, differentiation and dedifferentiation
    - Genetic changes, chemical changes
    - Induction of disease states without normal disease vectors
  - *Mind/matter interface*, including long-term memory, perception, emotion, thought, mental state

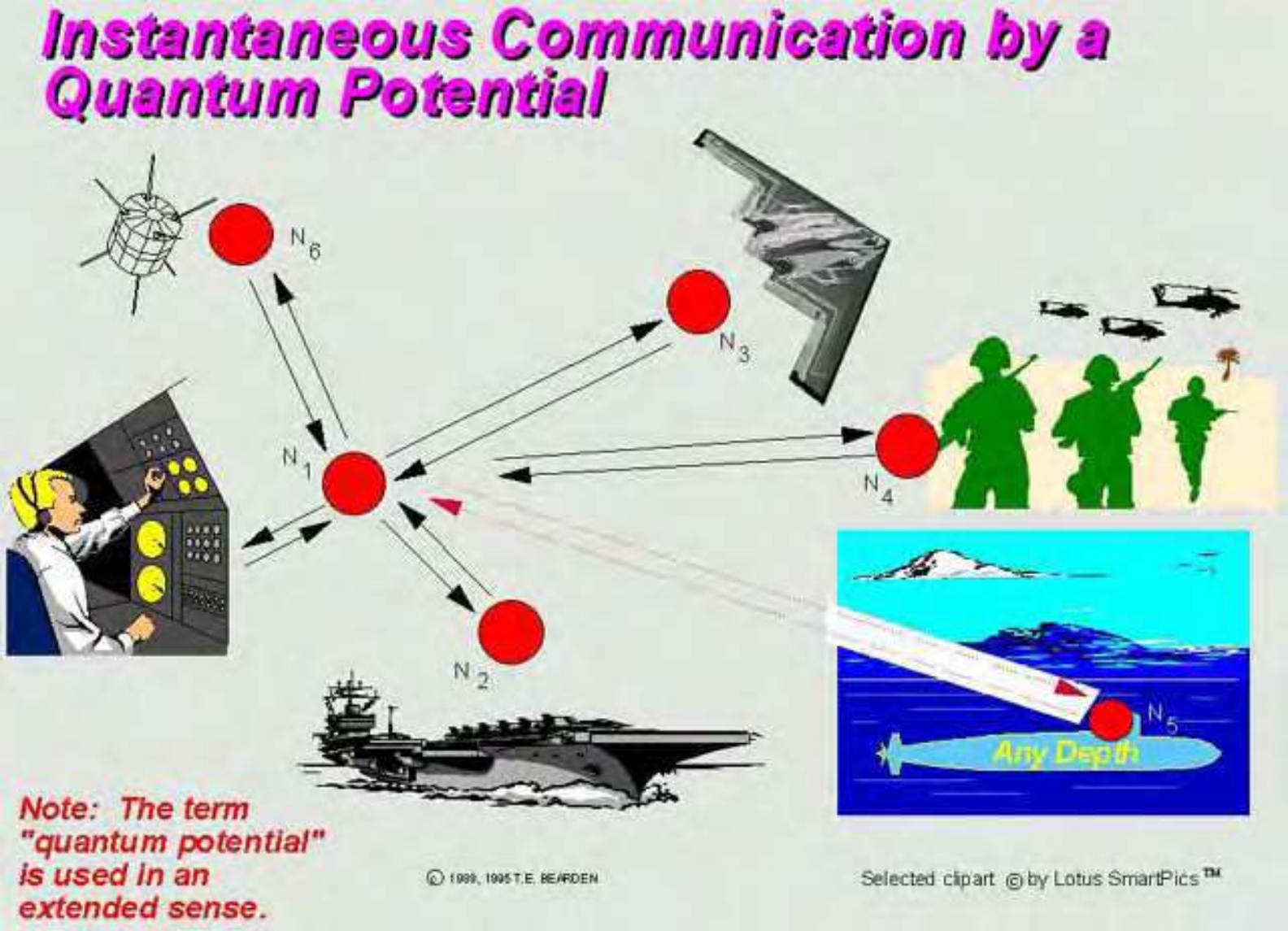
Instantaneous Communication by a Quantum Potential
N6
N3
N1
N4
N2
N5
Any Depth
Note: The term "quantum potential" is used in an extended sense.
© 1999, 1995 T.E. BEARDEN
Selected clipart © by Lotus SmartPics™

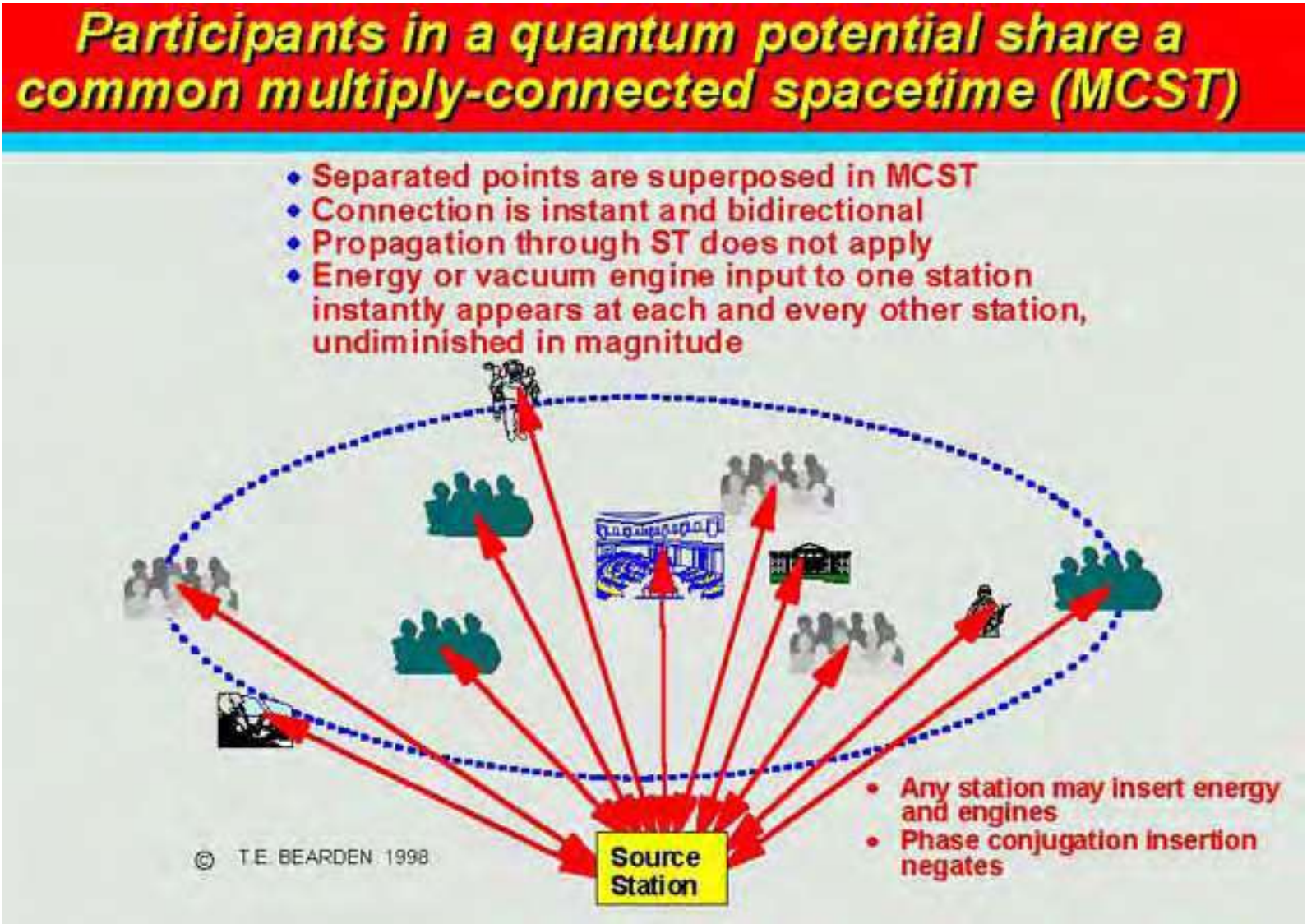
Participants in a quantum potential share a common multiply-connected spacetime (MCST)
• Separated points are superposed in MCST
• Connection is instant and bidirectional
• Propagation through ST does not apply
• Energy or vacuum engine input to one station instantly appears at each and every other station, undiminished in magnitude
• Any station may insert energy and engines
• Phase conjugation insertion negates
Source Station
© T.E. BEARDEN 1998

Quake in Tangshan, China

28 July, 1976

- 7.8 on Richter scale
- Hundreds of thousands killed
- Accompanied by extensive light, electrical effects
  - Starting 3 to 5 days before
  - Communications interference within 250 km
  - Sky lighting observed
- [Personal comments]

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Counting Rifles: Put up or shut up!

(Exchanging Earthquakes)

Opening bet

- Quebec 25 Nov 88
- Pasadena 3 Dec 88

Raise you

- Armenia 7 Dec 88

Call - what do you have?

- Malibu 18 Jan 89

Four aces

- Soviet Central Asia 23 Jan 89

Clear table (stress relief)

- Bakersfield et al various

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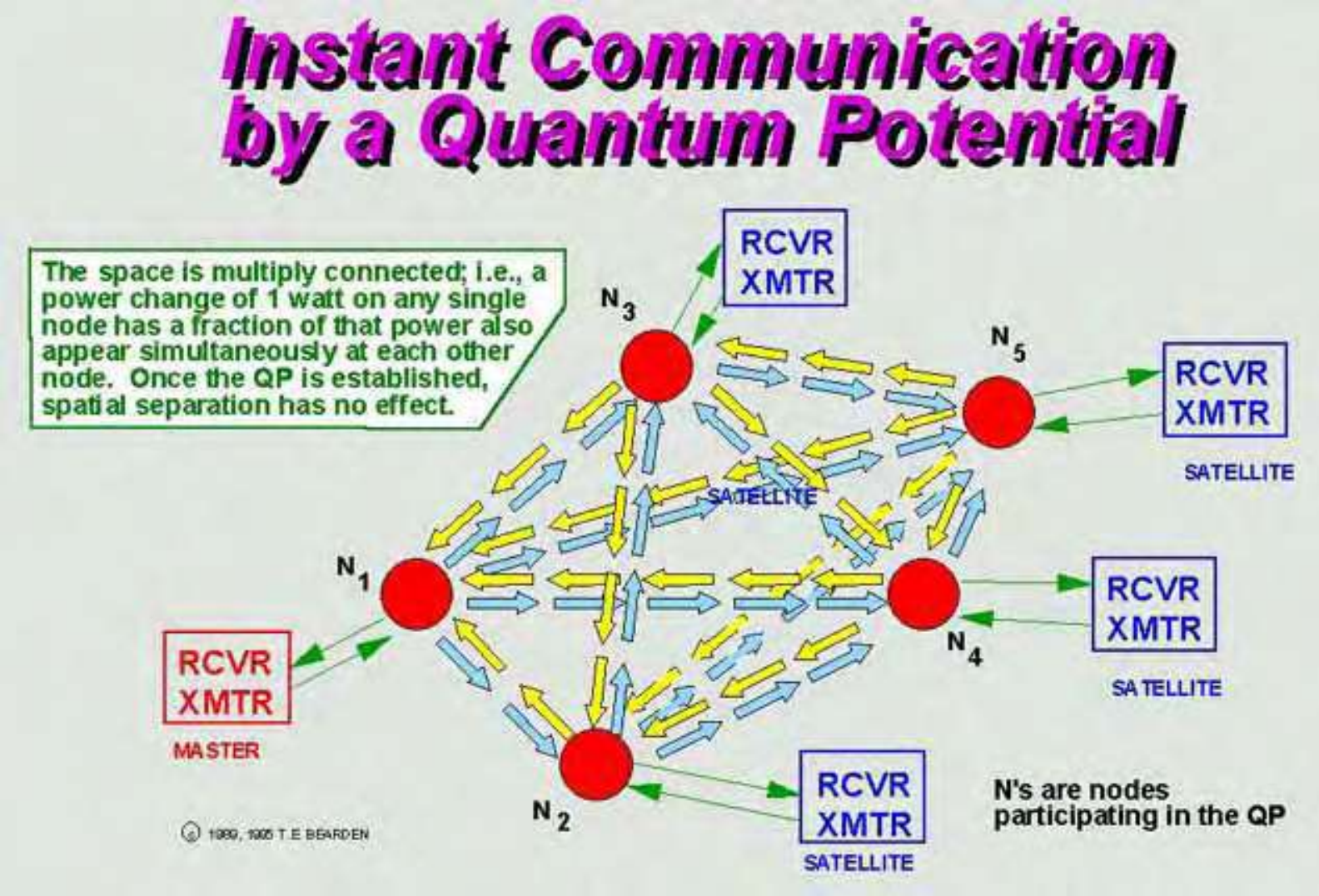
Instant Communication by a Quantum Potential
The space is multiply connected; i.e., a power change of 1 watt on any single node has a fraction of that power also appear simultaneously at each other node. Once the QP is established, spatial separation has no effect.
RCVR XMTR
N3
N5
RCVR XMTR
SATELLITE
SATELLITE
N1
RCVR XMTR
N4
SATELLITE
RCVR XMTR
MASTER
N2
RCVR XMTR
SATELLITE
N's are nodes participating in the QP
© 1999, 1005 T.E BEARDEN

Westerners Do Not React to Slow Threats
BOA CONSTRICTOR
LIGHTNING STRIKE
Westerners tend not to react to slowly increasing things,
but react to rapidly increasing things.

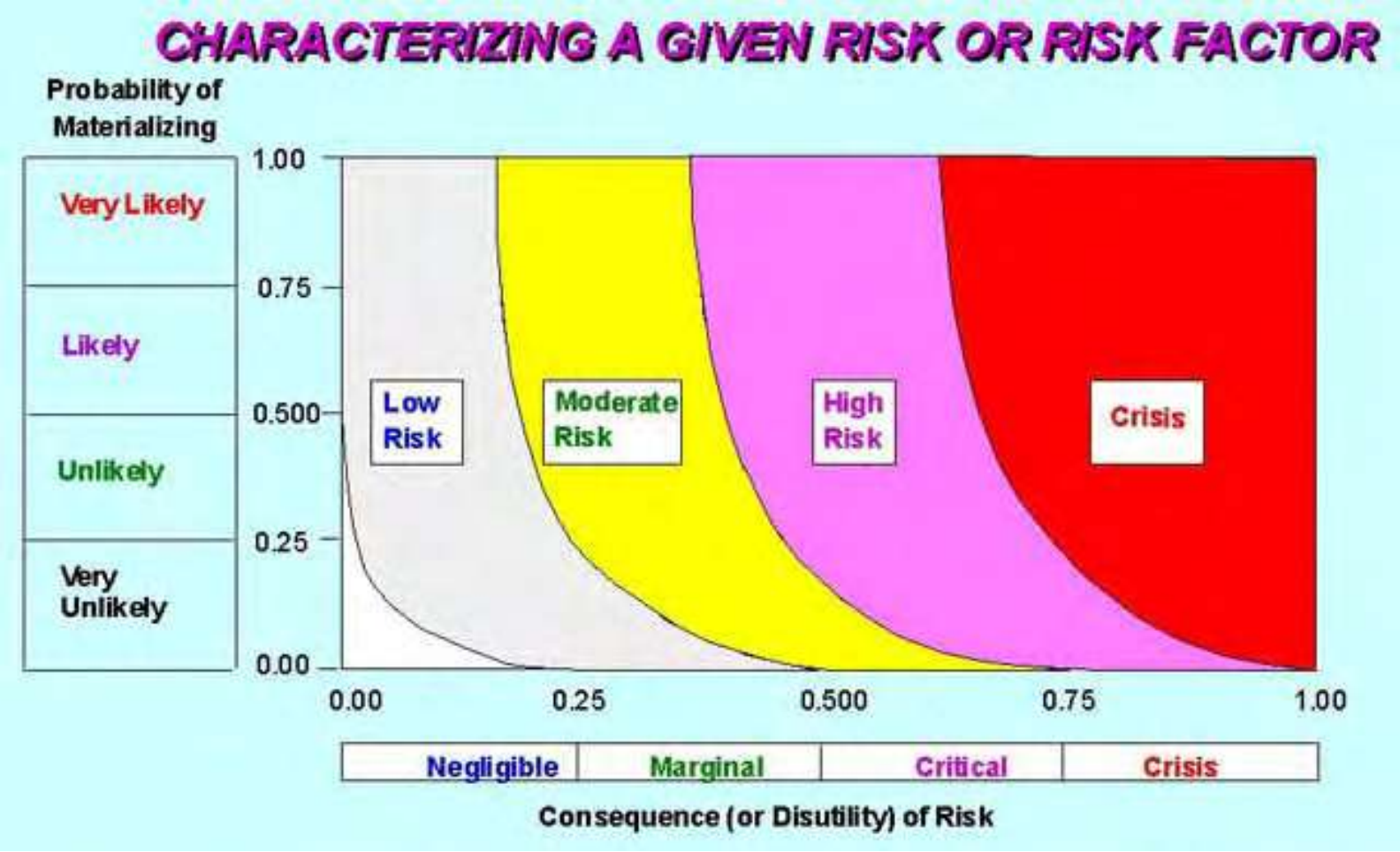
CHARACTERIZING A GIVEN RISK OR RISK FACTOR
Probability of Materializing
Very Likely
Likely
Unlikely
Very Unlikely
1.00
0.75
0.500
0.25
0.00
Low Risk
Moderate Risk
High Risk
Crisis
0.00
0.25
0.500
0.75
1.00
Negligible
Marginal
Critical
Crisis
Consequence (or Disutility) of Risk

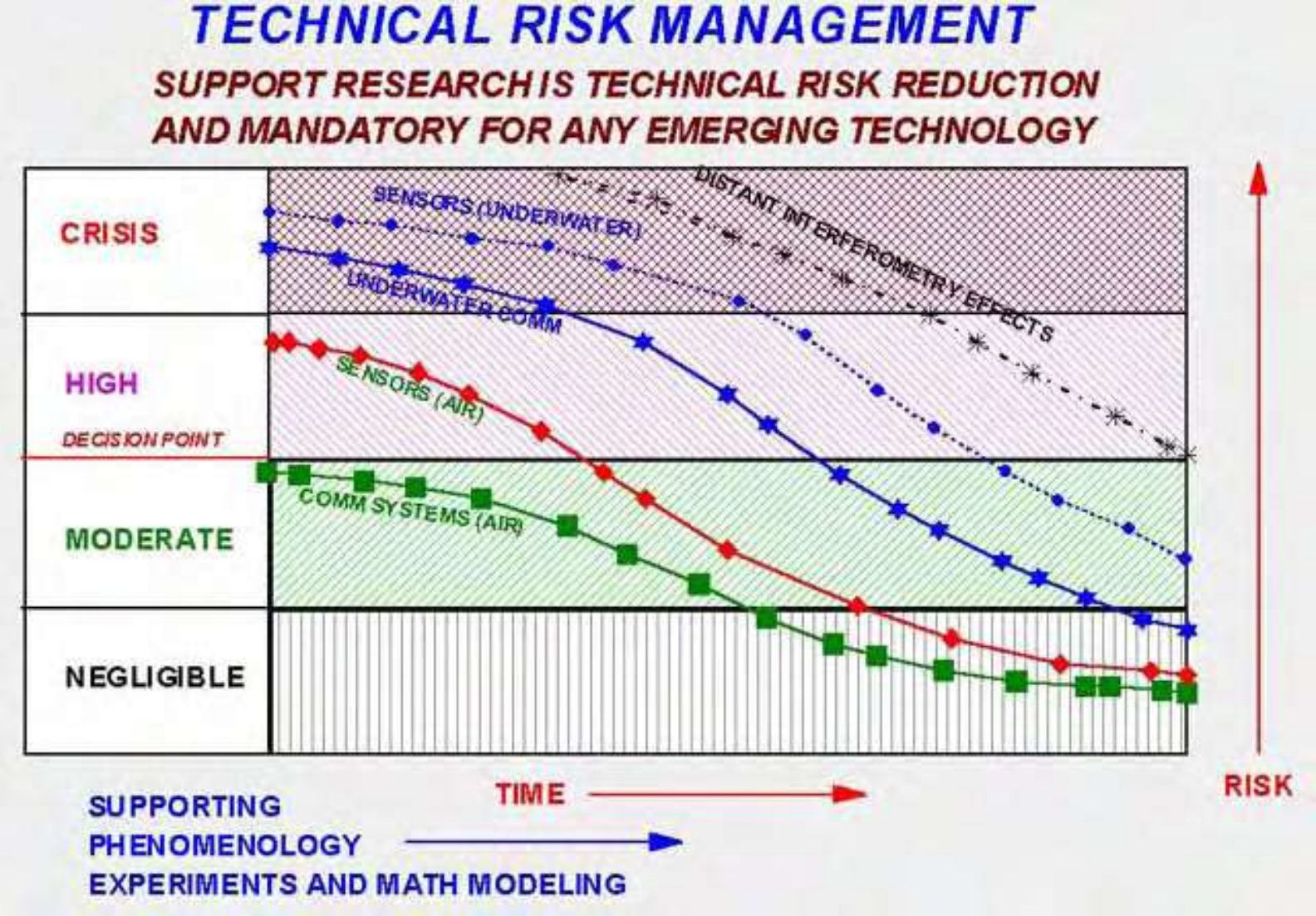
TECHNICAL RISK MANAGEMENT
SUPPORT RESEARCH IS TECHNICAL RISK REDUCTION
AND MANDATORY FOR ANY EMERGING TECHNOLOGY
CRISIS
HIGH
DECISION POINT
MODERATE
NEGLIGIBLE
SENSORS (UNDERWATER)
DISTANT INTERFEROMETRY EFFECTS
UNDERWATER COMM
SENSORS (AIR)
COMM SYSTEMS (AIR)
TIME
RISK
SUPPORTING
PHENOMENOLOGY
EXPERIMENTS AND MATH MODELING

Aum Shinrikyo's Sarin Facility

The interior of Satian No. 7, a suspected sarin production plant

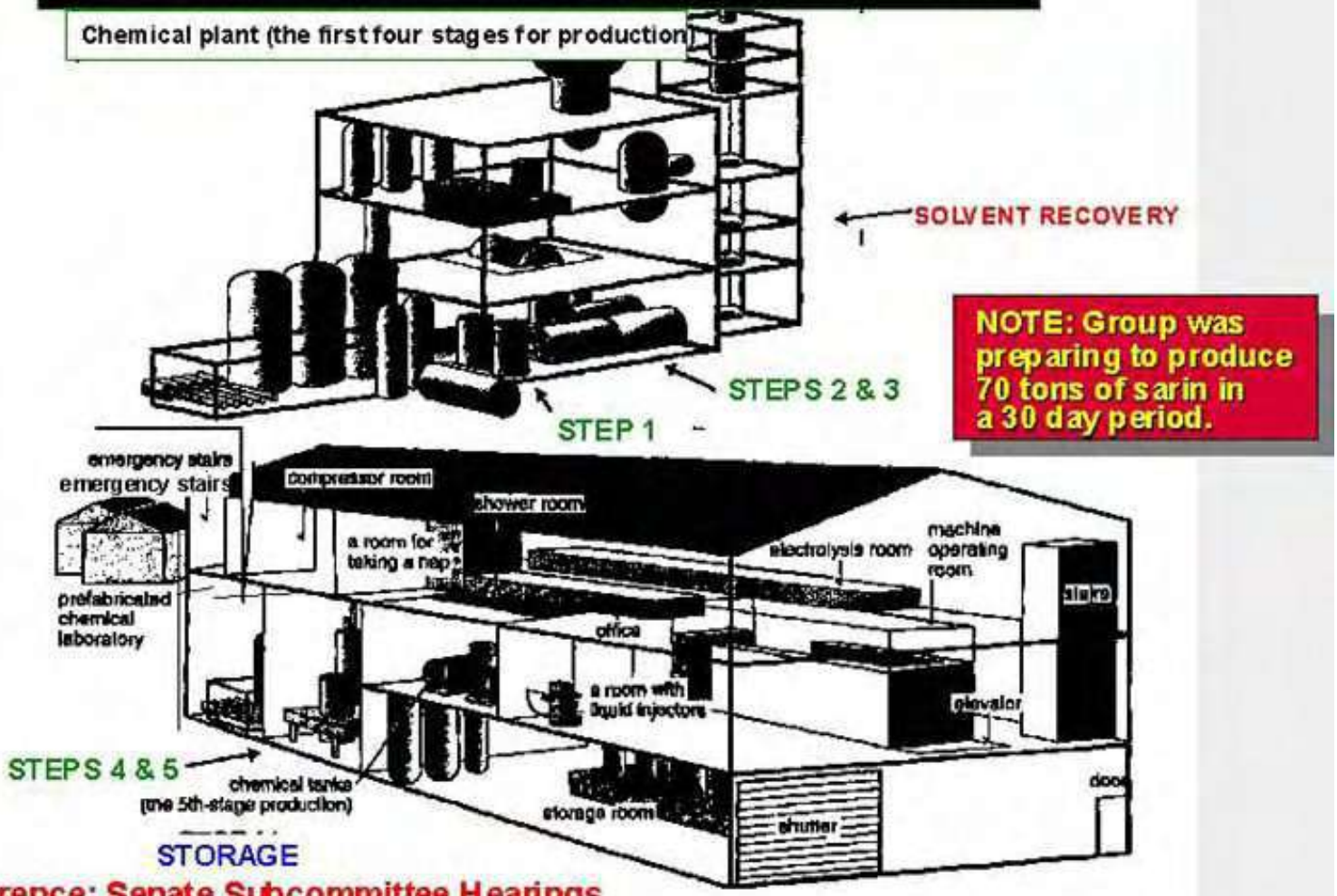

NOTE: Group was preparing to produce 70 tons of sarin in a 30 day period.

Reference: Senate Subcommittee Hearings

In Scalar Beam Interference Zone

- De-phasing of wave/antiwave pairs occurs
- Zero-summation destroyed
- Ordinary EM reappears [Whittaker 1904]
- Ordinary energy appears or disappears (i.e., may produce heating or cooling)
- Energy bottle effect
- Can add or extract EM energy
- Can produce specific ST curvature engines

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Physicist Schappeller Auralaz Munster, Austria:

- British Intelligence interview, about 1948
  - Used Kaluza-Klein theory
  - Worked with Russians
- Schappeller claimed he could:
  - Cause "implosions" rather than explosions
  - Use gravitational and electromagnetic energy
  - Cause large areas of the ocean to freeze
  - Tap earth-ionospheric field
  - Produce enormous energy
- *This is precisely what Hellman worked on in the USSR, after WW II!*

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Initial Soviet Plan for Cold War, After WW II

- Develop and deploy SAM bomber defense
- Catch up in atomic weapons
- Master and apply rocketry
- Wed atomic warheads to rockets
- Initiate "Cold" War
  - Bleed the dragon
  - Guerrilla wars
  - Terrorism
  - Insurgencies
- *Find, develop, and weaponize next great technical breakthrough area as highest national priority*

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Josef Stalin: Absolute Dictator

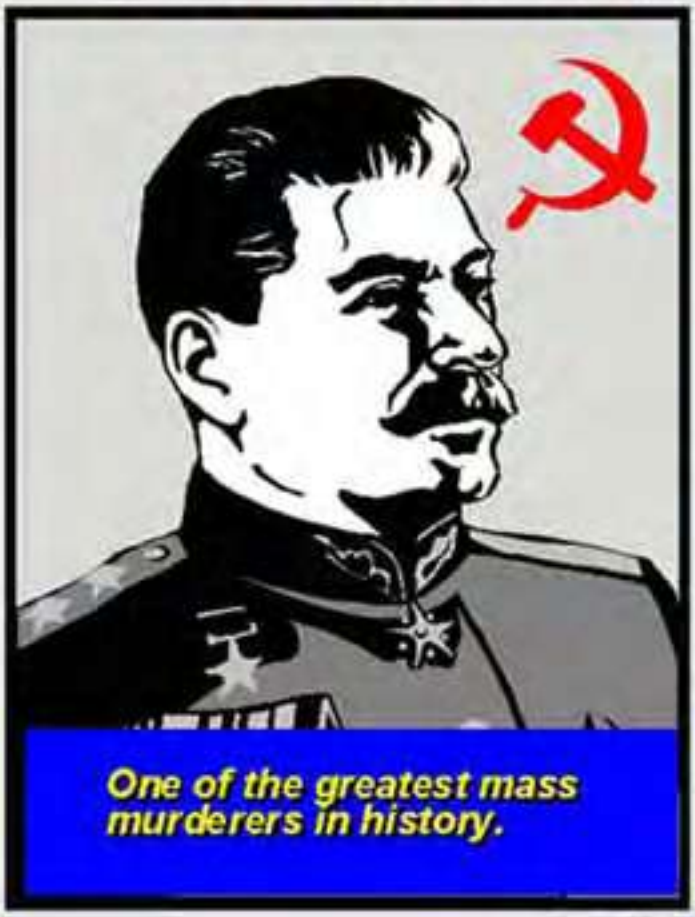

- Secret police and spies everywhere
- Purged his own officer corps
- Always deeply suspicious
- Regularly purged his enemies or those perceived to be shaky or untrustworthy
- Absolute power, justice had nothing to do with it
- Opponents often just disappeared in the night, never to be seen again
- Secret police often tortured, killed them
- Others sent to slave labor camps to die by severe work, starvation, and beatings or downright massacre
- Had experienced unusual abilities of Wolf Messing, so knew that some persons could do unusual things
- Forced Soviet weapon physics into this psychoenergetics realm also

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Exploding any Resistance by Operational Scientists
© T.E. BEARDEN 1997
Josef Stalin
The Communists slaughtered 20 million Russian Kulaks to collectivize Soviet farming
Assembled Academy
"The destiny of communism has been frustrated by the U.S. development of the atomic bomb. That is not the last great technical breakthrough. The next one WILL be Soviet! You will provide me with that great new technical breakthrough at all speed, or I will have your heads. Do I make myself clear, comrades?"

Significant Soviet Statements

- "In the final revolution, it does not matter if three-quarters of the earth is destroyed, so long as the other quarter emerges communist." *[Lenin]*

- "If a means of total neutralization of foreign missiles is to be found, it can only come from a group of new principles in physics, called energetics." *[Nobelian Petr Kapitsa, to Nikita Khrushchev, in answer to Khrushchev's demand for a 100% method of defense against long range missile attack.]*

- "We will bury you." *[Khrushchev, to Nixon, Kitchen Debate]*

- "We have a new weapon, just within the portfolio of our scientists, so to speak, which is so powerful that, if unrestrainedly used, it could wipe out all life on earth. It is a *fantastic* weapon." *[Khrushchev, speaking to the Presidium, Jan. 1960]*

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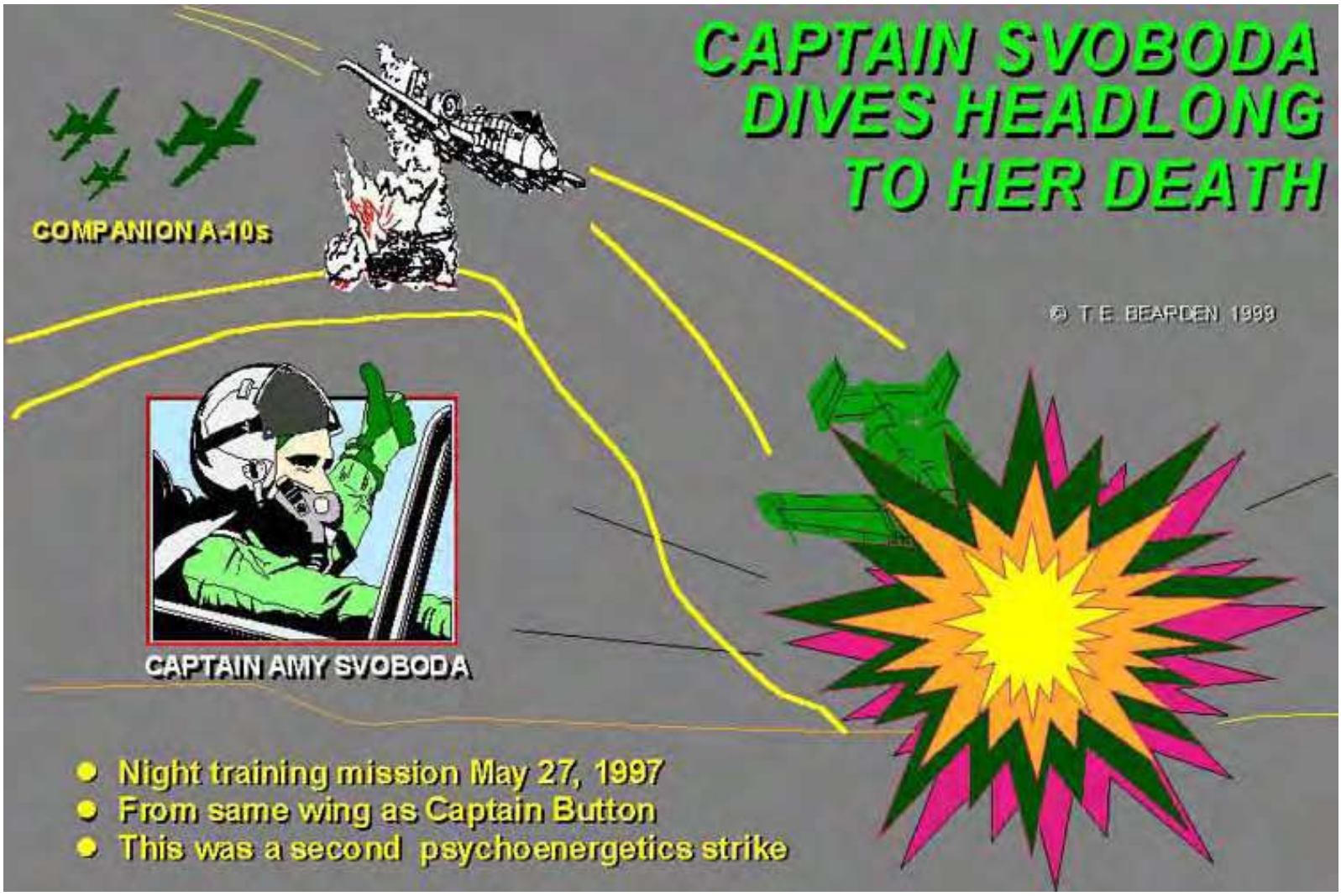
CAPTAIN SVOBODA
DIVES HEADLONG
TO HER DEATH
COMPANION A-10s
© T.E. BEARDEN 1999
CAPTAIN AMY SVOBODA
• Night training mission May 27, 1997
• From same wing as Captain Button
• This was a second psychoenergetics strike

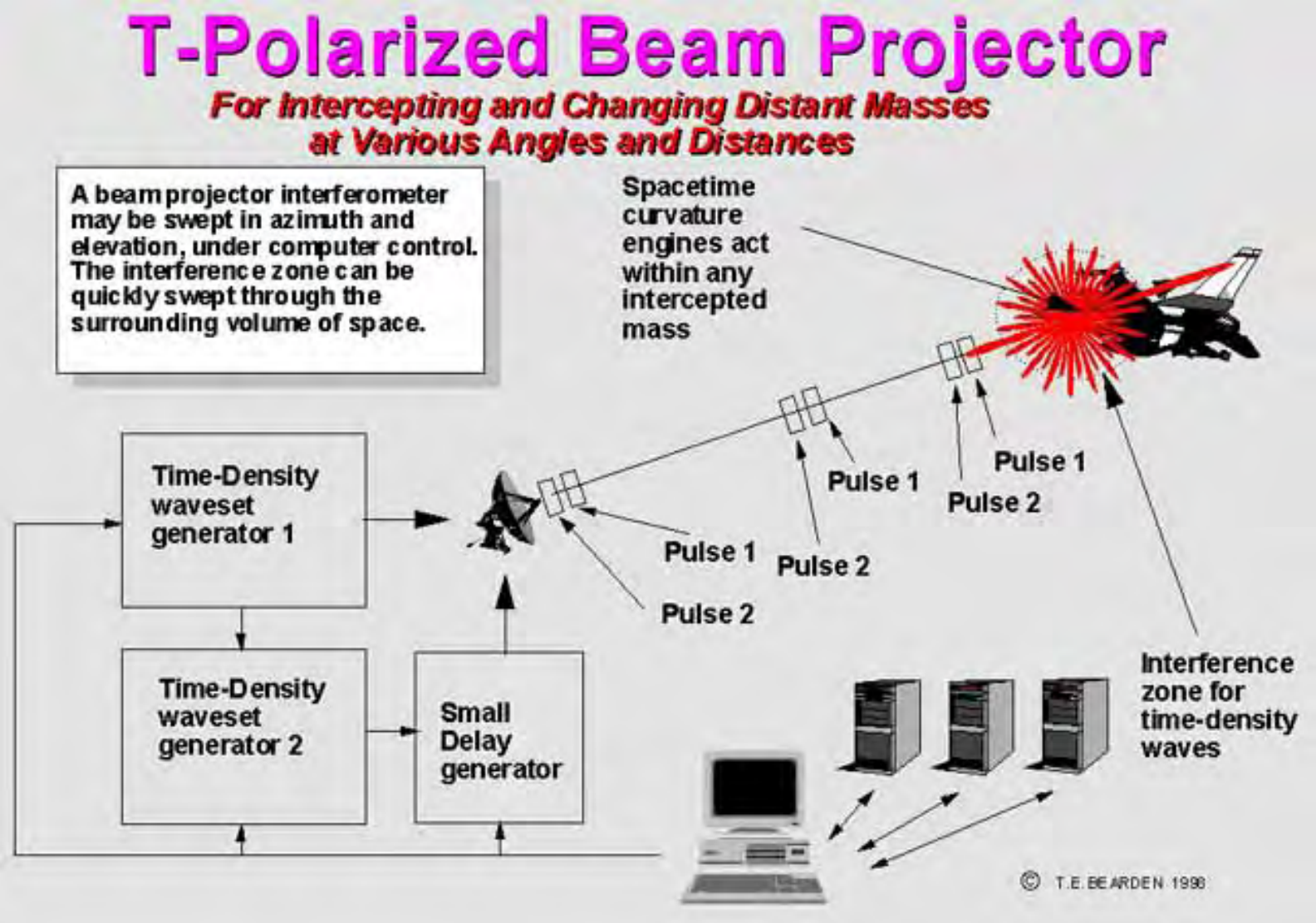
T-Polarized Beam Projector
For Intercepting and Changing Distant Masses
at Various Angles and Distances
A beam projector interferometer may be swept in azimuth and elevation, under computer control. The interference zone can be quickly swept through the surrounding volume of space.
Spacetime curvature engines act within any intercepted mass
Time-Density waveset generator 1
Time-Density waveset generator 2
Small Delay generator
Pulse 1
Pulse 2
Pulse 1
Pulse 2
Pulse 1
Pulse 2
Interference zone for time-density waves
© T.E. BEARDEN 1998

Possible Tests (1)

- 1958 nuclear accident in Urals
- Disease induction in U.S. Embassy personnel in Moscow
- Siberian disease/death transmission experiments
- Destruction of USS Thresher nuclear submarine, Apr. 10, 1963
- Nuclear explosion transmitted into ocean underwater, 100 miles north of Puerto Rico, Apr. 11, 1963

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Possible Tests (2)

- Eight F-111's downed in Vietnam immediately after deployment
- Several large earthquakes
- Mysterious aircraft losses in groupings
- Numerous underground "nuclear" tests
- Nuclear tests at Semipalatinsk without associated seismic activity
- High altitude rumbles, snaps, booms
  - *Off English coast*
  - *Off East coast of U.S.*
  - *Over West Coast of U.S. in thunderstorms*

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Possible Tests (3)

- Blinding of several U.S. satellites (up to 4 hours in duration)
- Cold Explosion off Kurils 1984
  - First, a cold explosion
  - Then test of giant Tesla shield 300 mi. dia.
- Tests offset from shuttle launch Nov. 85
- Kill of Arrow DC-8,Gander, NFLD Dec. 1985
- Titan kill, Vandenberg AFB, CA early 1986
- Kill U.S. Challenger, off Cape Canaveral 1986
- Earthquakes induced, 1986-88
- Dozens of tests of shields around the world
- Decades of radiating U.S. Embassy in Moscow

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Possible Tests (4)

- Extensive tests 1990-99 in Western Australia
- Engineering of weather since 1990 by Yakuza
- Possible nuclear dudding test in WA in 90s by Aum Shinrikyo
- C-130 engine flameout kill
- TWA-800 kill 1997
- Gulf War Disease Induced, 1991
- Spreading of immune systems of U.S. populace, 1990s
- Psychoenergetic control of Captain Button
- Psychoenergetic control of Captain Svoboda
- Twice in 1997, within days of full strategic destruction of U.S.

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Mushroom cloud rising from sea

- 0514 hrs, 9 April 1984
- Gray-white cloud appeared
- Rose 60,000 feet in 2 minutes
- South of Kuril Islands
  - *180 miles southeast of Hokaido*
  - *200 miles from Tokyo*
- Soviet missile testing scheduled about 350 miles away, at 2100 hrs, 9 April 1984

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Launches from Cape Canaveral
and Vandenberg AFB
Provided Practice Targets of Opportunity

The sinking U.S.S. Thresher, with her controls jammed, implodes when she reaches crush depth

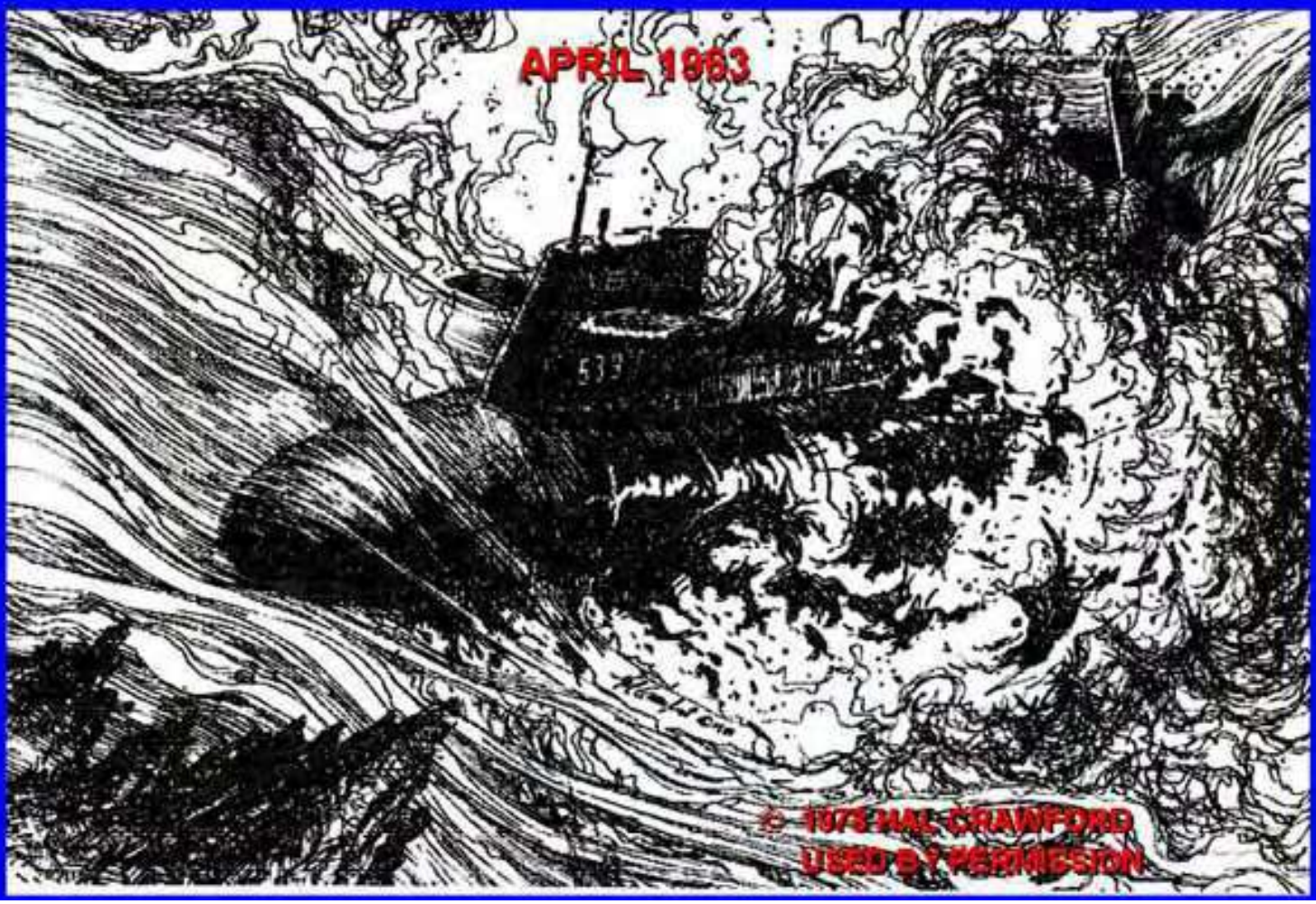

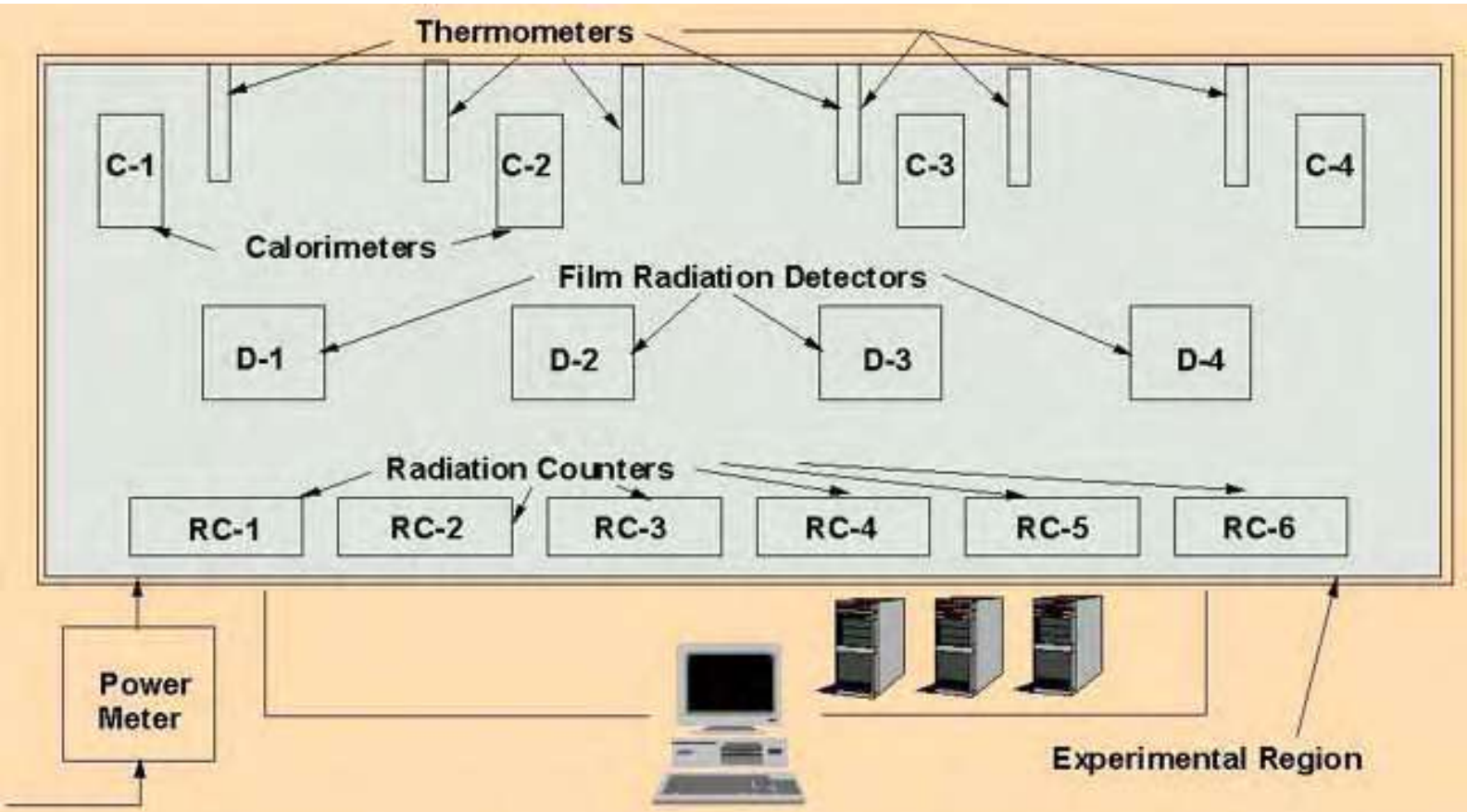

Figure 32. Embodiment of an instrumental array sufficient to discriminate when time-density charging has occurred, and that transduction of time-charge decay is occurring.

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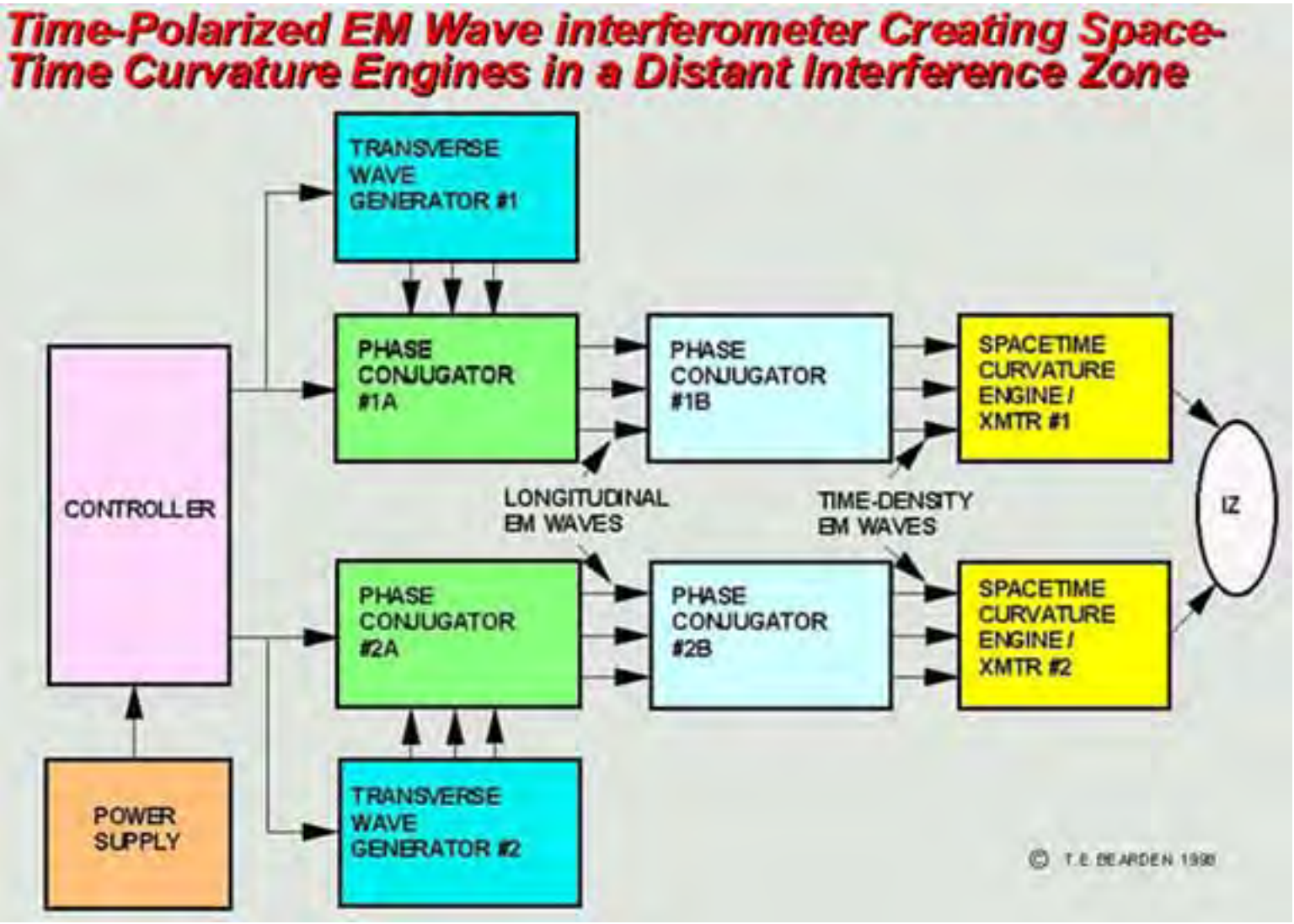
Time-Polarized EM Wave interferometer Creating Space-Time Curvature Engines in a Distant Interference Zone
TRANSVERSE WAVE GENERATOR #1
PHASE CONJUGATOR #1A
PHASE CONJUGATOR #1B
SPACETIME CURVATURE ENGINE / XMTR #1
CONTROLLER
LONGITUDINAL EM WAVES
TIME-DENSITY EM WAVES
IZ
PHASE CONJUGATOR #2A
PHASE CONJUGATOR #2B
SPACETIME CURVATURE ENGINE / XMTR #2
POWER SUPPLY
TRANSVERSE WAVE GENERATOR #2
© T.E. BEARDEN 1990

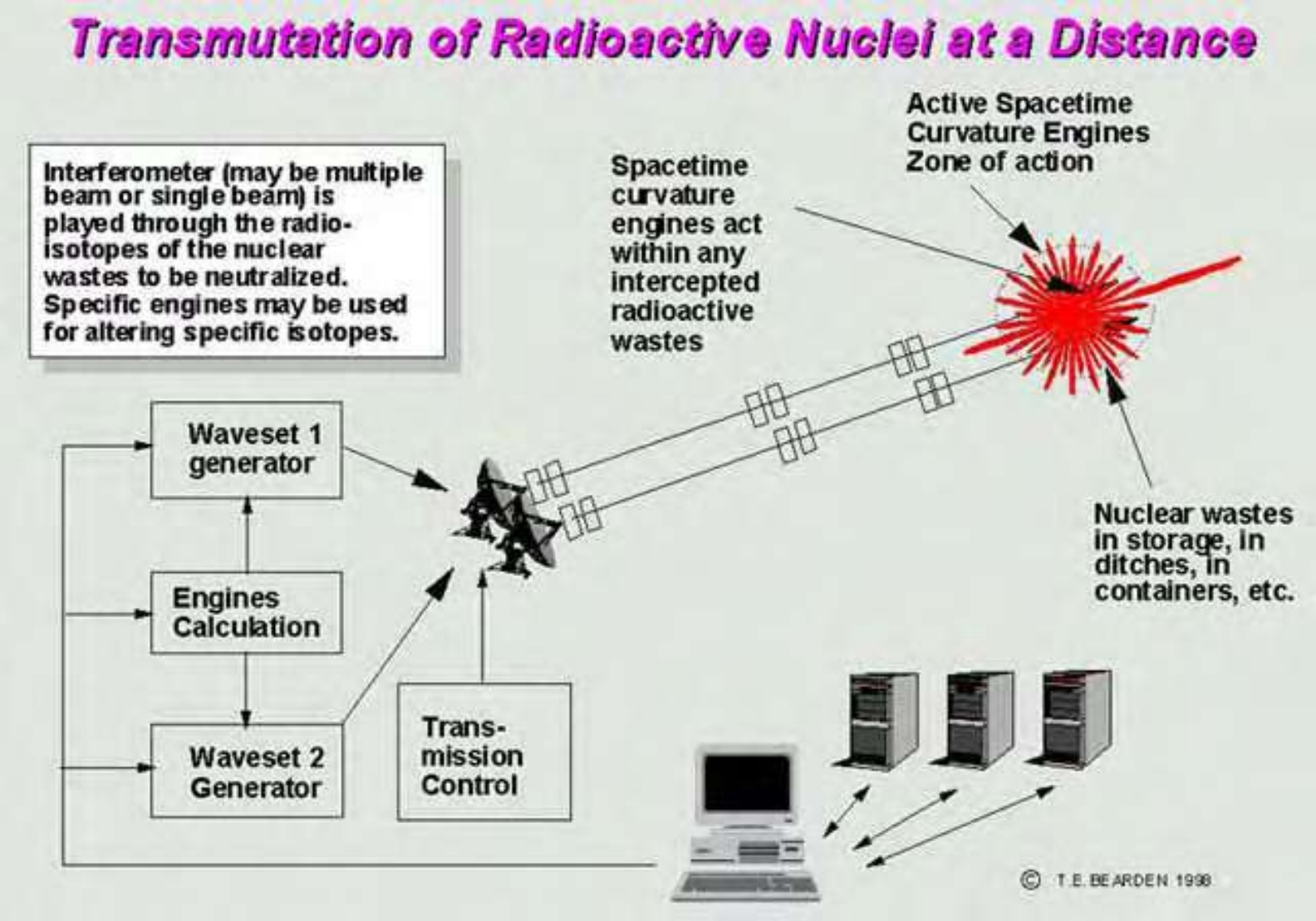
Transmutation of Radioactive Nuclei at a Distance
Interferometer (may be multiple beam or single beam) is played through the radio-isotopes of the nuclear wastes to be neutralized. Specific engines may be used for altering specific isotopes.
Spacetime curvature engines act within any intercepted radioactive wastes
Active Spacetime Curvature Engines Zone of action
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
Nuclear wastes in storage, in ditches, in containers, etc.
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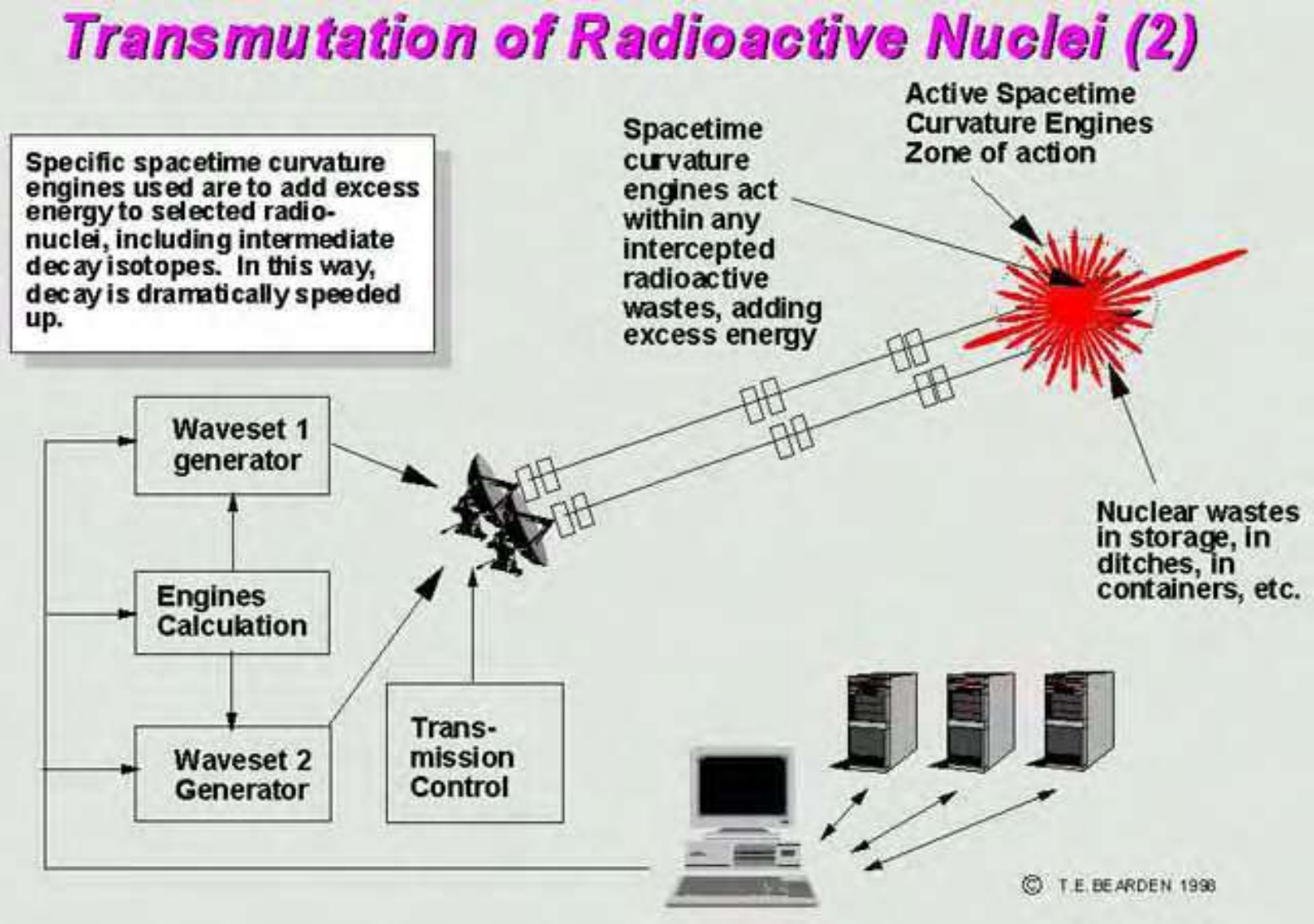
Transmutation of Radioactive Nuclei (2)
Specific spacetime curvature engines used are to add excess energy to selected radio-nuclei, including intermediate decay isotopes. In this way, decay is dramatically speeded up.
Spacetime curvature engines act within any intercepted radioactive wastes, adding excess energy
Active Spacetime Curvature Engines Zone of action
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
Nuclear wastes in storage, in ditches, in containers, etc.
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Typical Shield Test, Northern Route to Japan
18-27 km diameter
Asahi Evening News, Tokyo
June 22, 1982
Multiple tests seen per month, for years.
Pilots simply ceased reporting them.
© T.E. BEARDEN 1994,1995

A Curious Tide in Human Affairs

To win its freedom in the long run, usually a group must defeat its attackers or suppressors *at least twice*.

- We fought the British twice for our independence.
- We are fighting ourselves twice to free the slaves. - American Civil War
  - Civil rights struggle
- We beat the Germans twice, in WW I and WW II
- We beat the Hispanics in the Spanish-American War. *That's once*. (They're winning the second by crossing the border. The U.S. is becoming a Hispanic Nation).

But we also have some unfinished business at hand.

- We checked the Russians in the Cold War. *Once*.
- We checked the Japanese in WW II. *Once*.
- We checked the KGB in the Cold War. *Once*.
- We checked the Communists in the Cold War. *Once*.
- We checked Saddam Hussein in the Gulf War. *Once*.

Large Scalar EM Interferometer (LASI) Accident Near Urals, 1958

- 1958 nuclear explosion near Urals
  - Signature of large scalar interferometer (LASI) accident
  - Buried atomic wastes suddenly exploded
  - Large region contaminated to this day
- Soviets were well along with advanced LASI prototypes and testing
  - Khrushchev announced forthcoming advent of these "fantastic" weapons in Jan. 1960
  - 1958 difficulties could have been resolved by 1960
- Expected 1958 cause: transmitter short-out and failure in a nearby LASI discharged its cumulated energetics beam energy into the ground
- *Spreading ground pulse struck nearby atomic wastes, fissioning nuclei*

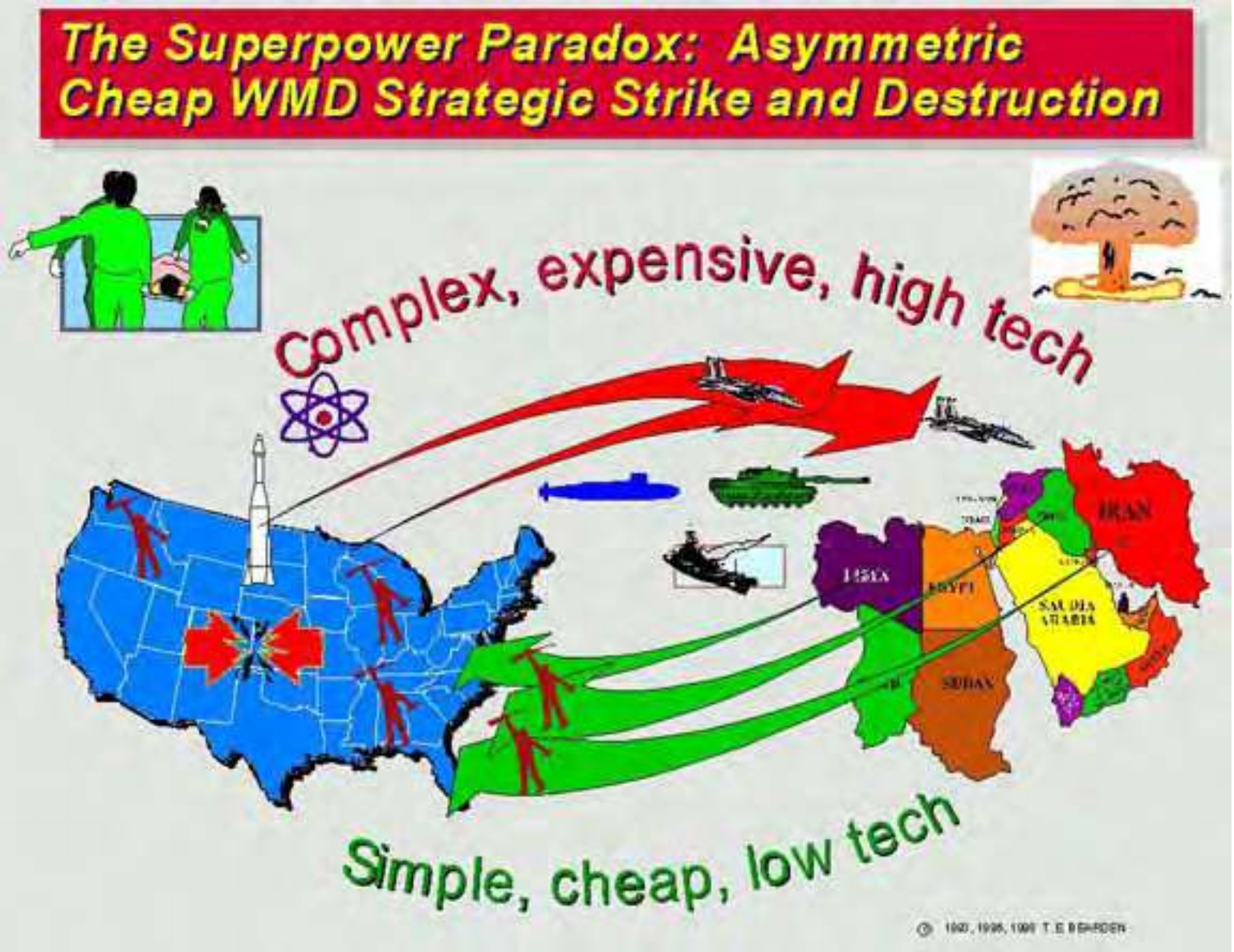
The Superpower Paradox: Asymmetric
Cheap WMD Strategic Strike and Destruction
Complex, expensive, high tech
IRAN
LIBYA
EGYPT
SAUDI ARABIA
SUDAN
Simple, cheap, low tech

THE KGB/YAKUZA-AUM WAR PLAN

- *Dud all quantum potential weapons in other nations via psychoenergetics.*
- *Remove U.S., Israel, Brazil, West Europe as military powers.*
- *Destroy nuclear weapons, hostile energetics weapons, hostile ships, 80% of targeted populaces in first hour of strikes.*

LEASE

1990-91

Aum/Yakuza Acquired Use of on-site Russian Scalar EM (Energetics) Weapons.

Began Geosurvey of Test Range (Western Australia) for training.

KGB Tested QP population wpn (Gulf War Syndrome)

TRAIN

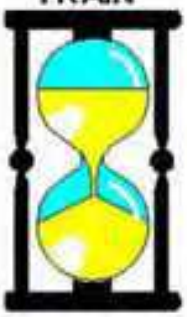

1991-94

Began extensive training of AUM-Yakuza crews in Russia, with practice firing into Western Australia. J-team took over world-wide weather engineering. Preparing for occupation of West Australia.

ESCALATE

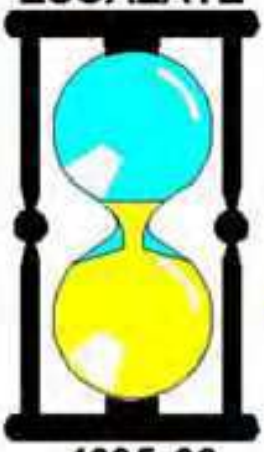

1995-99

Began EM kill of selected lone U.S. targets, law strategic deception plan.

U-2 a/c? USAir 747?
TWA-800 C-130
ValueJet? A-10s

Surged electrical grids. Worldwide practice kills, scalar interferometry. QP modification of selected pathogens

STRIKE!

Plan:
Trigger terrorist BW, & WMD attacks.
Enhance BW infections with QP wpn.
When ready, counter insane QPweapons with psychoenergetics. Destroy QP wpns.
Dud all nuclear weapons worldwide;
Time-snap ships, scalar weapons sites;
Attack major target populations w/QP.
Then cleanup with interferometry strikes.

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Why Western Science is Ignorant of KGB Energetics

- *Foundations* of electrodynamics and much of Western physics are seriously flawed
- Only just rediscovering longitudinal EM waves
- No knowledge of using time-polarized EM waves
- Does not know a powerful GR is hidden in EM
- Ignores inner structure of potentials, waves, fields
- Hotly defends errors, ignores for a century
- Determined to push big nuclear science
- Suppresses research to approved dogma by rigorously controlling precisely what research the funds can be used for

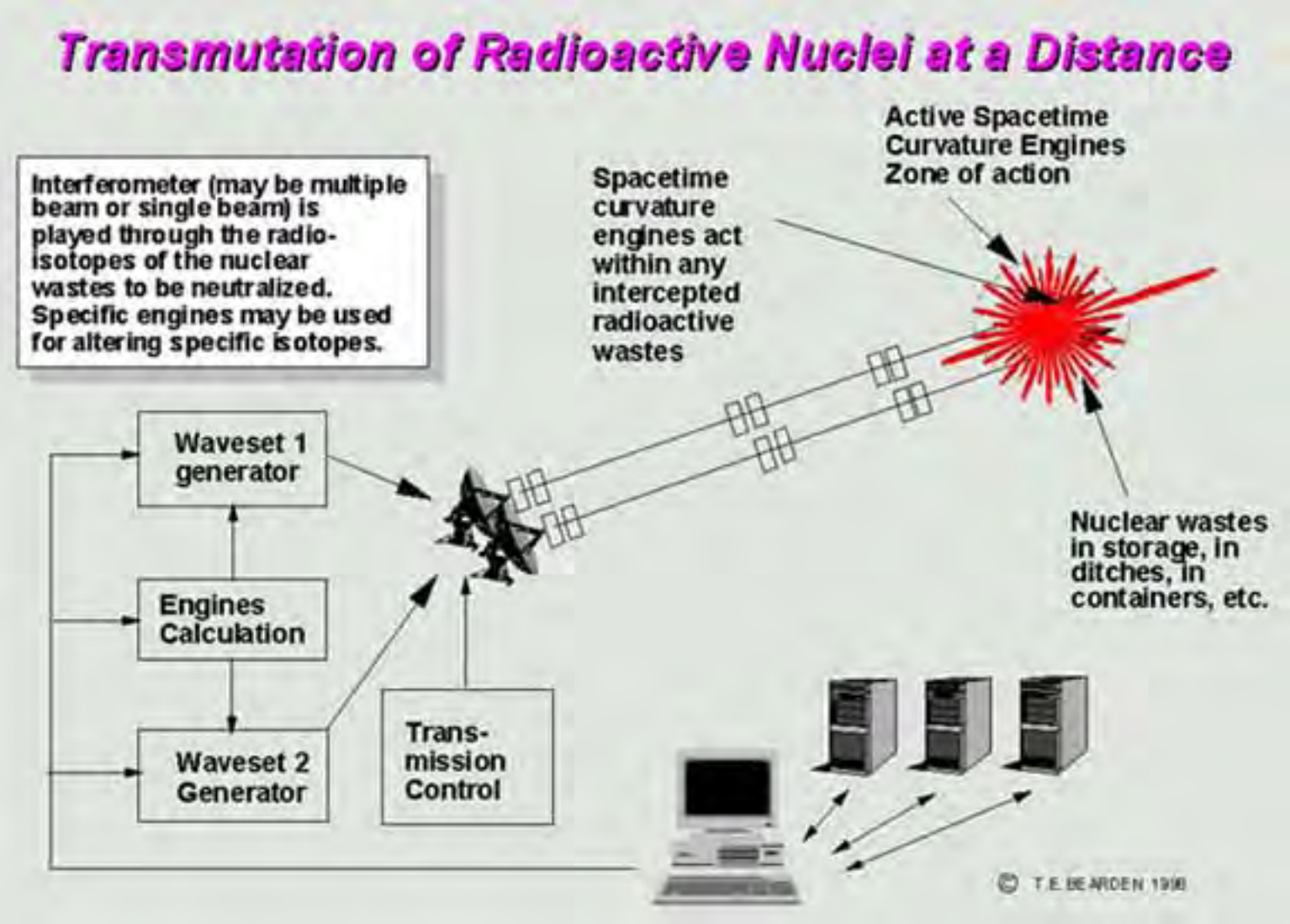
Transmutation of Radioactive Nuclei at a Distance
Interferometer (may be multiple beam or single beam) is played through the radio-isotopes of the nuclear wastes to be neutralized. Specific engines may be used for altering specific isotopes.
Spacetime curvature engines act within any intercepted radioactive wastes
Active Spacetime Curvature Engines Zone of action
Nuclear wastes in storage, in ditches, in containers, etc.
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
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THE YAKUZA

(JAPANESE MAFIA)

To do business with Japan is to do business with the Yakuza

The Last Samurai, Defending Bushido

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- **3 Major Yakuza Groups, In Coalition.**
- **Penetrate Japanese Government.**
- **Open Offices, Signs on Street.**
- **Public Romanticizes Yakuza as Last Japanese Samurai**
- **In Large High-Tech Corporations.**
- **In Control of Japanese Banks.**
- **Japanese Real-Estate Rip-off.**
- **$500 - 1,000 Billion per Year Income.**
- **Rapidly Spreading in U.S.**
- **Uniting Mafia Groups Worldwide.**
- **Coalition with Aum Shinrikyo.**
- **Leased Russian Energetics Weapons.**
- **Crews On-site in Russia, Trained.**
- **Practice Firings into Western Australia for Three Years. (Dozens of Shots per Month)**
- **Now in Escalation Phase, Killing U.S. Targets.**
- **All-out Strike on U.S. ready 1999-2000.**
- **Now held in check by KGB, dead-man fuzed by small nation friendly to U. S.**

Yugoslav Earthquake, Followed by Cold Explosion

Apr. 15 1979

- Magnitude 7.2 on Richter scale
- Epicenter 33 km. deep
- More than 100 aftershocks
- At Kamenari:
  - Adriatic sea mushroomed up
  - Like atomic bomb explosion
  - Signature of a cold explosion
  - Similar to Apr. 1984 test off coast of Japan, near Kurils (see inset graphics)
- *Note that April is a significant test month for the Communists (preparing official reports for May Day?)*

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Technical Background on the Priore Healing Process

Contents

1. Technical Background on the Priore Healing Process
2. Transduction of EM wave types by successive phase conjugation.
3. Time-charging and Time-density excited states
4. Interference for transduction in slow decay of time-density excited states
5. Infolded longitudinal biwaves composition of a scalar potential
6. Scalar potential interferometry produces all EM force fields and waves
7. Some serious flaws and errors in classical EM theory (#1-16)
8. Some serious flaws and errors in classical EM theory (#17-32)
9. Abnormal penetration depth of weak signals due to photon interaction
10. Amplified replica of body's signal complex to reverse cellular disease & damage
11. Amplified replica of body's signal complex to correct a congenital condition

Technical Background on the Priore Healing Process

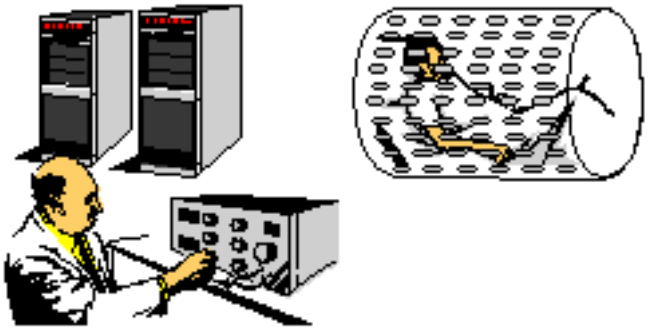

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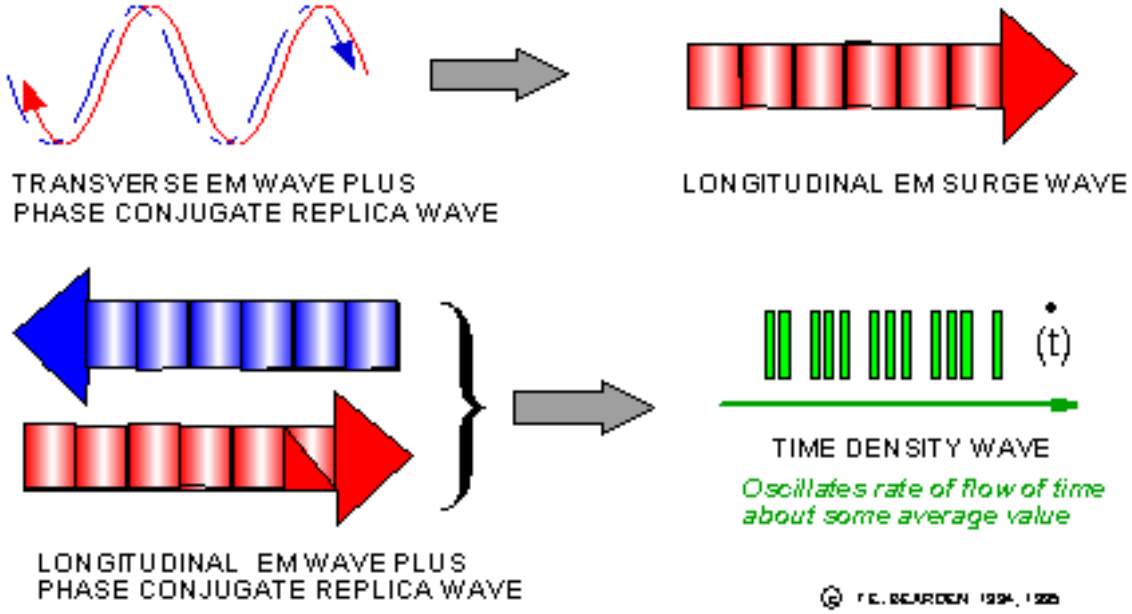

Figure 1. Transduction of EM wave types by successive phase conjugation.

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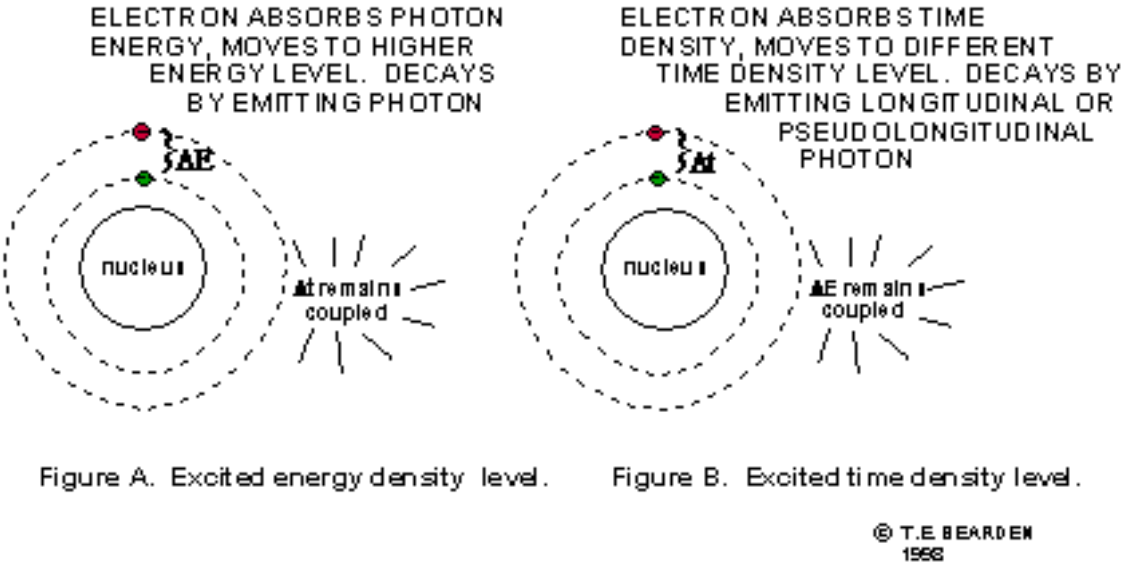

Figure 2. Time-charging and Time-density excited states, contrasted to ordinary spatial energy excited state.

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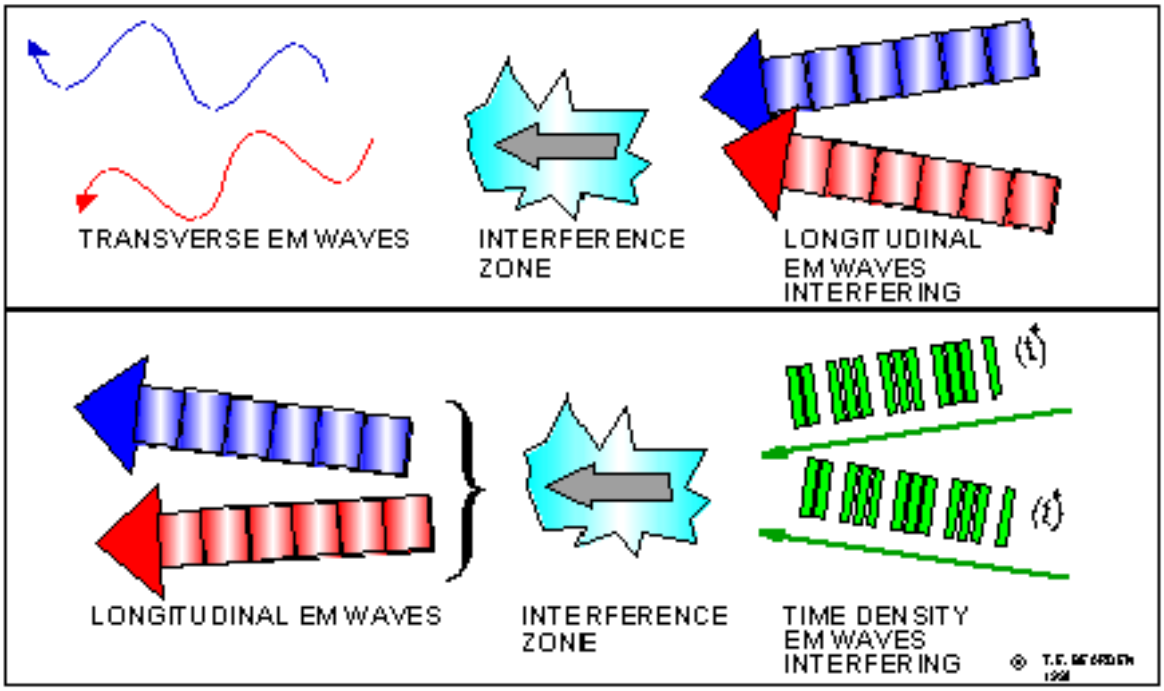

Figure 3. Interference processes for transduction in slow decay of time-density excited states.

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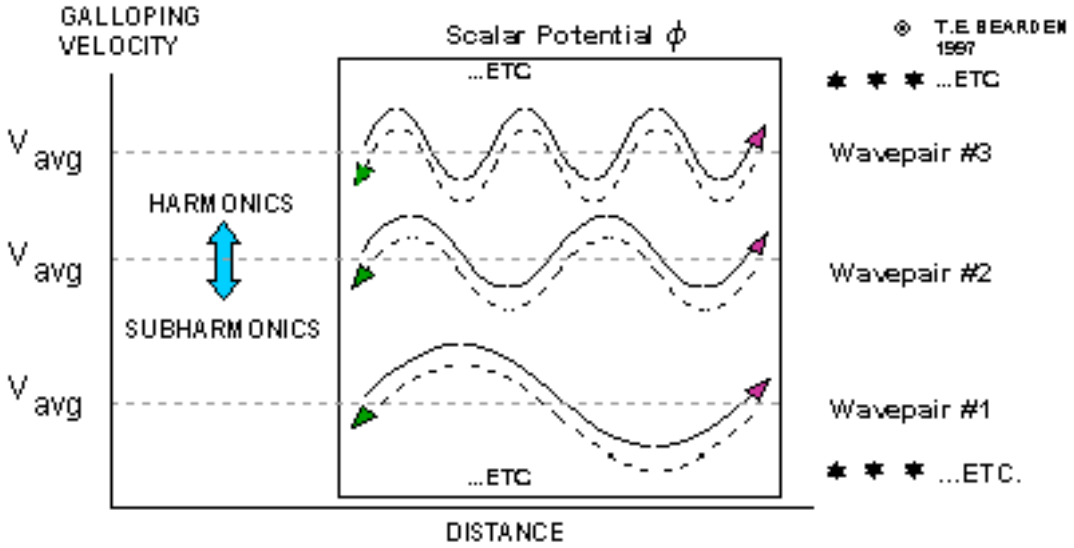

The Structure Is:

A harmonic set of longitudinal wavepairs. In each wavepair the two waves superpose spatially, but travel in opposite directions. The two are phase conjugates and time-reversed replicas of each other. Thus they comprise a coupled longitudinal wave and antiwave. Each wavepair is a time-density wave and therefore an electrogravitational wave.

Figure 4. Infolded longitudinal biwaves (time-density EM waves) composition of a scalar potential.

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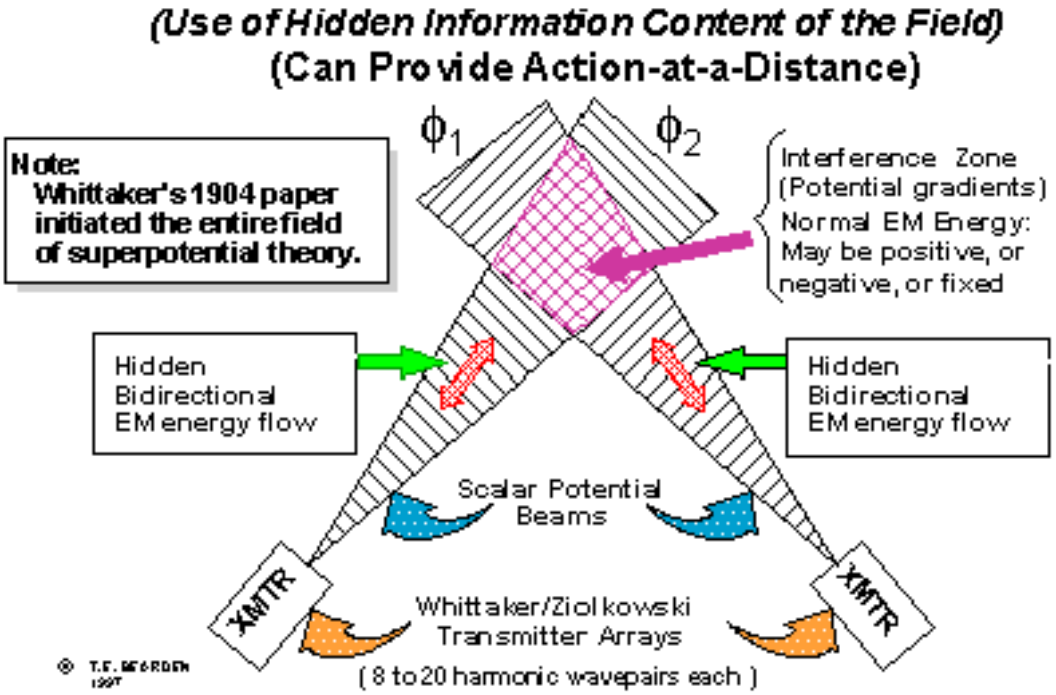

Figure 5. Scalar potential interferometry (between the two sets of bidirectional longitudinal EM wavepairfunctions) produces all EM force fields and waves.

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1. Eliminates the Internal EM Inside the Scalar Potential.
2. Equations Still Assume Material Ether Per Maxwell (Unchanged).
3. No Definition of Electrical Charge or of Scalar Potential.
4. Use of Force Fields in Vacuum is False (and Known to be So).
5. Treats Charge q as Unitary Instead of Coupled System q = ϕ(q)m(q).
6. Confuses Massless Potential Gradients as Forces (See #3, #4).
7. Does Not Utilize Mass as a Component of Force (See #23).

---

8. Erroneously Assumes EM Force Fields as Primary Causes.
9. Topology of EM Model Has Been Substantially Reduced.
10. Does Not Include Quantum Potential or Action at a Distance.
11. Does Not Include Superluminal Velocity of Inner EM Components.
12. Does Not Utilize Extended Near-Field Coulomb Gauge Effects.
13. Does Not Include EM Generatrix Mechanism for Time Flow.
14. Does Not Unify Photon and Wave Aspects (Requires 7-D Model).

---

15. Does Not Include Electron Spin and Precession (See #19, #24).
16. Treats EM Energy As Existing In "Chunks," Instead of as Flow.

Figure 6. Some serious flaws and errors in classical EM theory (#1-16)

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17. Confuses Energy and Energy Collection (See #16).
18. Discards Half of Every EM Wave in Vacuum (See #22).
19. Erroneously Uses Transverse Vacuum Wave; It's Longitudinal.
20. Arbitrarily Regauges Maxwell's Equations to Eliminate Overunity.
21. Omits Phase Conjugate Optics Effects (The *Rule* in Internal EM).
22. Does Not Include EM Cause of Newtonian Reaction Force.
23. Erroneously Assumes Separate Force Acting on Separate Mass.
24. Confuses Detected Electron Precession Waves as Proving Transverse EM Waves in Vacuum (Remnant of Old "EM Fluid" Concept).
25. Due to Error in String Wave, Omits the Ubiquitous Antiwave.
26. *Assumes* Equilibrium; Not True Unless Include Vacuum Interactions.
27. Higher Topology Required, to Model Electromagnetic Reality.
28. Lorentz surface integration discards Poynting energy transport.
29. Has nothing at all to say about form of EM entities in massless space.
30. Eliminates the infolded general relativity using EM-force as curve agent.
31. Does not include longitudinal EM waves as time domain oscillations.
32. Does not include EM mechanism that generates time flow and flow rate.

Figure 6. Some serious flaws and errors in classical EM theory (#17-32)

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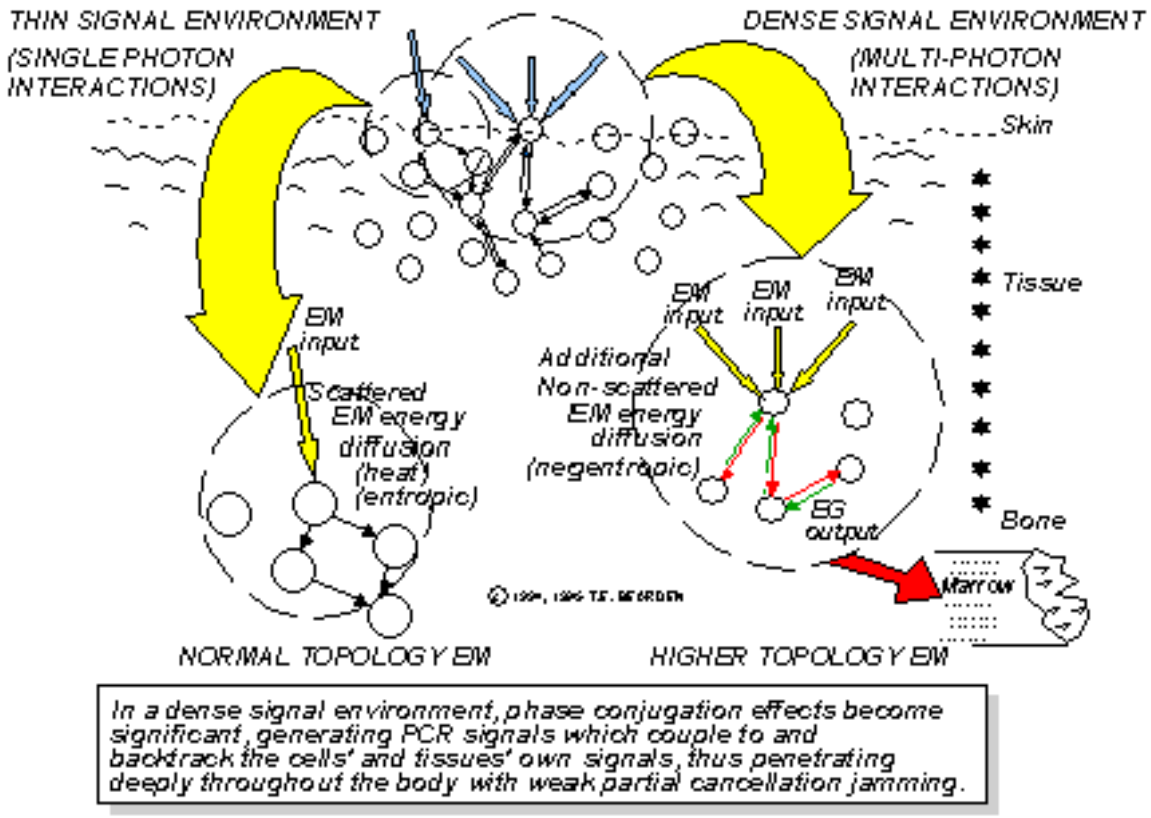

Figure 30. Abnormal penetration depth of incident weak signals due to multiphoton interaction in a dense weak signal environment.

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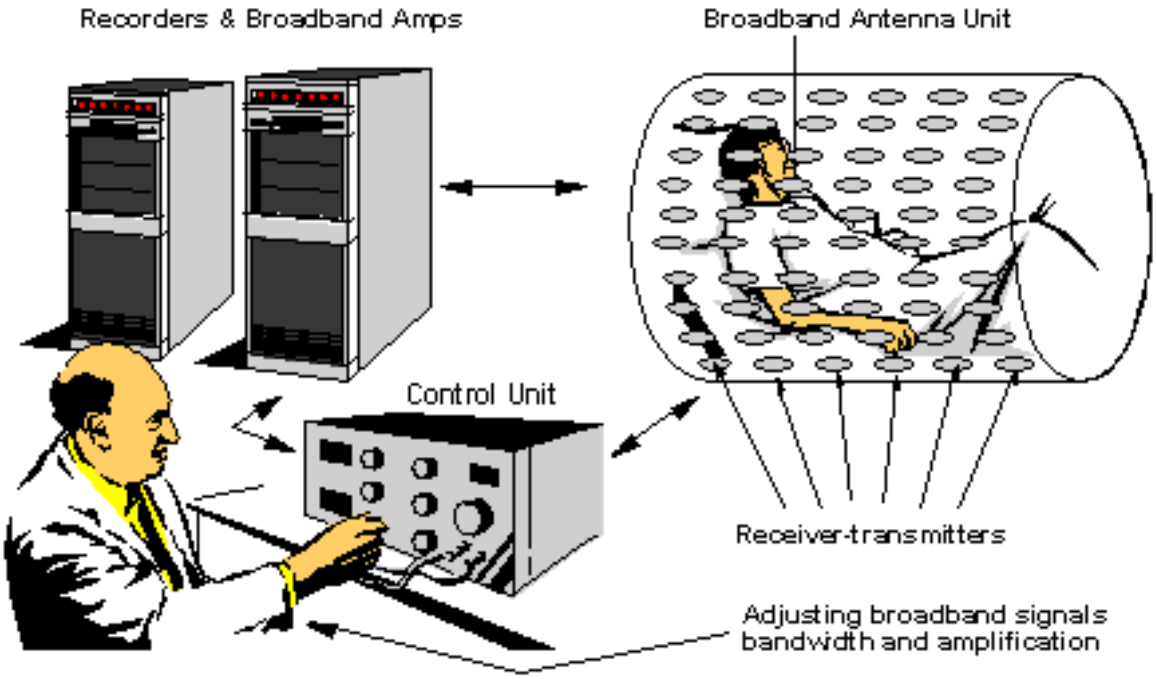

Figure 31. Using an amplified replica of the body's own dense, broadband signal complex to irradiate it, producing deeply-penetrating and precise longitudinal EM wave sets that pump cells and reverse cellular disease and damage.

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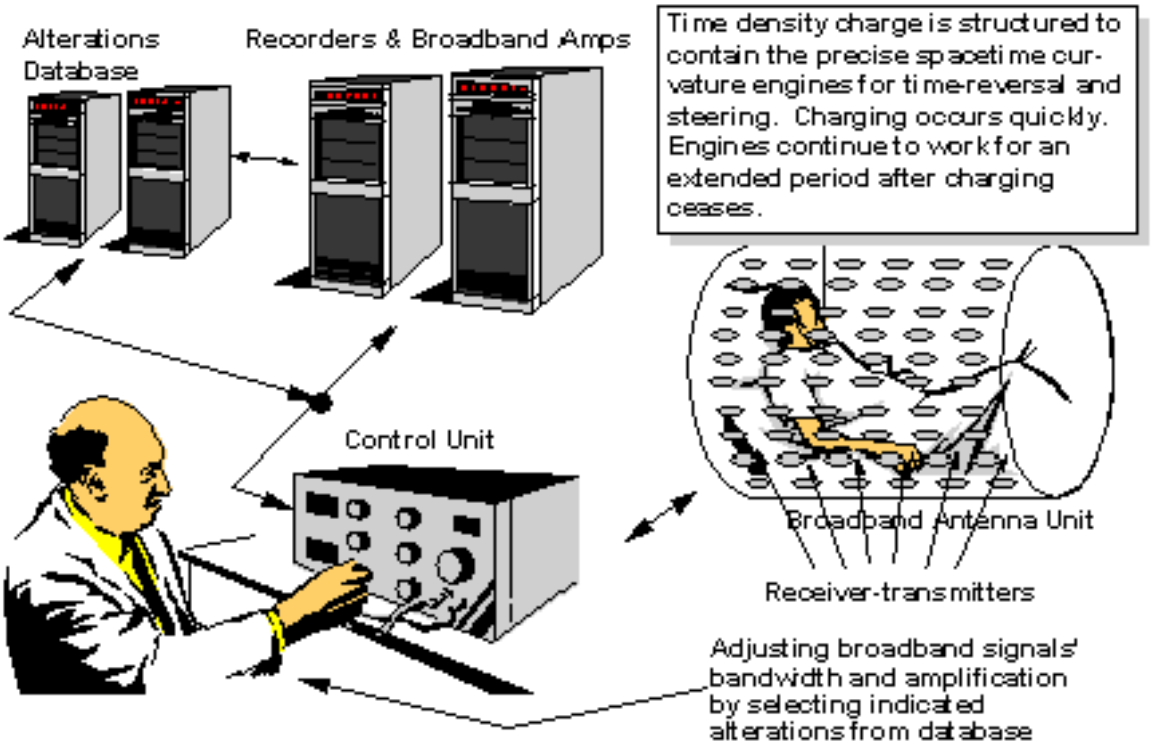

Figure 9. Using an amplified replica of the body's own dense, broadband signal complex containing added alterations, to irradiate the body and produce deeply-penetrating precise time-density charging for cellular time-reversal, while steering the time-reversal trajectory to also correct a congenital condition.

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The Anomalies in Navy Electrolyte Experiments at China Lake

These novel experimental anomalies, like those of Cold Fusion, were caused by using time as an energy source by transducing time-energy into spatial energy. Transducing one microsecond per second of time into spatial EM energy, yields nearly 10^{11} watts of power

- Melvin H. Miles and Benjamin F. Bush, "Radiation measurements at China Lake: Real or Artifacts?", *Proc. ICCF-7 (International Conference on Cold Fusion—7)*, Vancouver, BC, Canada, Apr. 1998, p. 101.

- Consistency of China Lake Anomalies
- Anomalous LW EM Emission Phenomena at China Lake (1)
- Anomalous LW EM Emission Phenomena at China Lake (2)
- Sufficient LW-to-TW Transduction Ionizes GM Tube Gas (3)
- Sufficient LW-to-TW Transduction Ionizes GM Tube Gas (4)
- Consistency of Anomalies
- Consistency of Anomalies (2)

- Experimental LW Emission Phenomena in Electrolysis

Consistency of China Lake Anomalies

- Variation in LW-TW transduction from experiment to experiment
- Majority produced insufficient transduction to cause ionization discharge of the GM tube gas (to cause detection)
- Correlation between appearance of anomalous radiation and the expected time periods to load palladium with deuterium
  - Within few hours in co-deposit experiments where palladium is loaded with deuterium as it deposits from solution
  - Required days of electrolysis for rods that load much slower
- The faster the deuterium loaded, the greater the interaction of deuterium in phase conjugating and self-targeting in lattice
- Variation in GM detector readings
  - One would read anomalous radiation, another would be blind to it
  - A few experiments gave simultaneous readings from two detectors
- Experiments perfectly consistent with LW-TW transduction, time-density charging, variation in GM time histories, and new conservation of energy law

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Anomalous LW EM Emission Phenomena at China Lake (1)

- **Anomalous radiation from electrolysis in ionization processes**
  - Two experiments producing excess power
  - Dental X-ray film showed exposure
  - Simultaneous control study: no exposure
  - 20 experiments without excess power: no exposure
- **Excess energy strongly indicates excess film exposure**

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* Melvin H. Miles and Benjamin F. Bush, "Radiation Measurements at China Lake: Real or Artifacts?"

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Anomalous LW EM Emission Phenomena at China Lake (2)

- GM and NaI detector reaction when electrolysis with heavy water ongoing
  - Several Geiger-Muller (GM) tubes gave anomalous detection
  - Reached 73 sigma above background
  - No anomalies when experiment off
- *GM tube detects anything which causes its internal ionization*
  - *Nuclear radiation is ionizing*
  - *Transduced x-ray & gamma is ionizing*

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Sufficient LW-to-TW Transduction Ionizes GM Tube Gas (3)

- **Time-history of detector involved**
  - Some GM detectors show anomalous high counts, some do not
  - Time histories of GM detectors are varied
  - Time histories of film vary minimally
- ***Experimental results consistent with***
  - *LW-to-TW transduction including delay*
  - *Time-energy charging*
  - *New extension to energy conservation law*

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Sufficient LW-to-TW Transduction Ionizes GM Tube Gas (4)

- **Time-history of detector involved**
  - Some GM detectors show anomalous high counts, some do not
  - Time histories of GM detectors are varied
  - Time histories of film vary minimally
- ***Experimental results consistent with***
  - *LW-to-TW transduction including delay*
  - *Time-energy charging*
  - *New extension to energy conservation law*

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Consistency of Anomalies

- LW-to-TW transduction varied from experiment to experiment
- Most experiments produced insufficient transduction to cause ionization
- Appearance of anomalous radiation correlated with expected time loading of palladium with deuterium
  - Within few hours in experiments where palladium loads with deuterium as it deposits from solution
  - Required days for rods that load much slower

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Consistency of Anomalies (2)

- Faster the deuterium loaded, the greater the interaction of deuterium in
  - Phase-conjugating and self-targeting
  - Producing time-reversal zones
  - Generating quasi-nuclei of H+ ions (protons)
- Variation in GR detector readings
- Experimental results predictable by
  - LW-TW transduction and time-reversal zones
  - Varying time-density charging on GM tubes
  - Variation in GM tube experience histories
  - Time-reversal zones generating electronuclear interactions and quasi-nuclei of H+ clusters

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Experimental LW Emission Phenomena in Electrolysis

- Anomalous radiation from electrolysis in ionization processes
  - Two experiments producing excess power
  - Dental x-ray film showed exposure
  - Simultaneous control study: No exposure
  - 20 experiments without excess power: No exposure
- Excess energy strongly indicates excess film exposure
- GM and NaI detector reaction when electrolysis ongoing w/heavy water
  - Several Geiger Muller (GM) tubes gave anomalous detection
  - Reached 73 σ above normal background counts
  - No anomalies when experiment off
- GM tube detects anything which causes its internal gas to ionize
  - Nuclear radiation is "ionizing" radiation
  - Transduced x-ray and gamma radiation is "ionizing" radiation
  - Sufficient LW-TW transduction ionizes GM gas

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- Time History of detector involved
  - Some GM detectors show anomalous high counts, some do not
  - Time histories of GM detectors vary appreciably
  - Time histories of film vary minimally
- Experiments consistent with time-density charging, LW-TW transduction, and new conservation of energy law

* Melvin H. Miles and Benjamin F. Bush, "Radiation Measurements at China Lake: Real or Artifacts?" Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 101.

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A Visual Tour of what they don't want you to know about electrical circuits

10 TRILLION PERCENT OF THE CURRENT PRODUCED IS WASTED!

---

1. The scalar potential is a harmonic set of phase conjugate longitudinal EM waves.
2. The dipole is a true negative resistor.
3. The dipole's broken 3-symmetry initiates a spreading giant negentropic reordering of a fraction of the vacuum's energy.
4. Energy flow contours surrounding a transmission line.
5. Heaviside and Poynting energy flow components. The Heaviside component is often **10 trillion times** the Poynting component, but **is simply wasted** in ordinary single-pass energy circuits.
6. Negative resistance process v. positive resistance process.
7. Lorentz's integration trick to discard the enormous Heaviside non-diverged energy flow component.

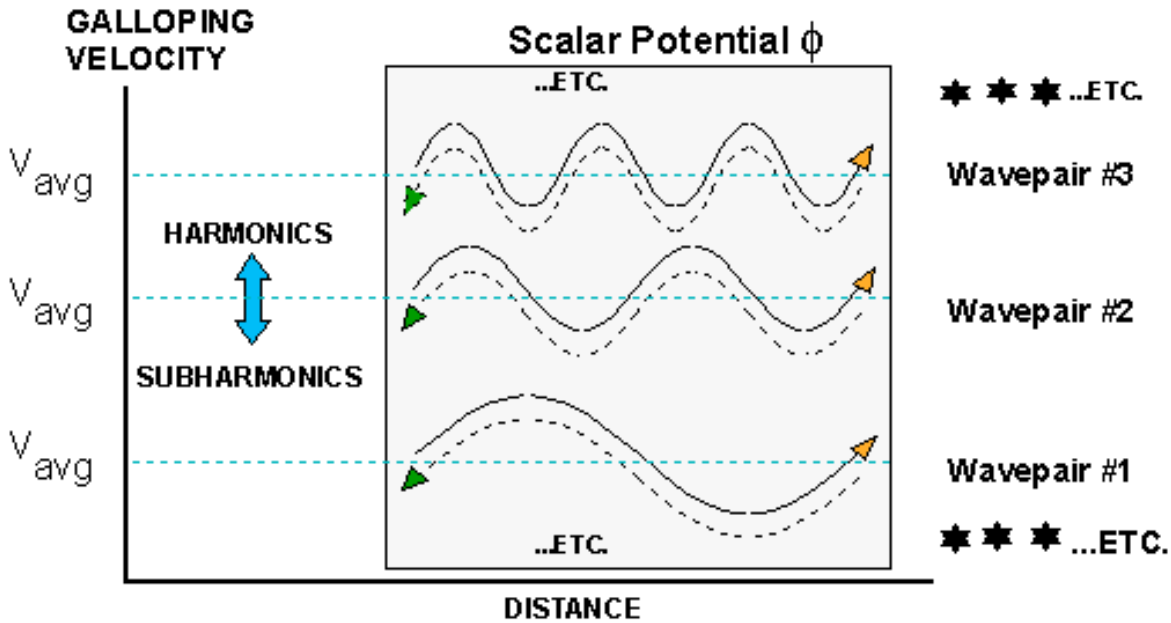

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The Structure Is:

- A harmonic set of longitudinal phase conjugate wavepairs.
- In each wavepair the two waves superpose spatially after detection, but travel in opposite directions.
- The convergent wave set is in the imaginary plane, and hence is not observable. It is EM energy incoming to the potential (dipolarity) from the time domain.
- The charge's spin is 720 degrees, 360 in the real plane and 360 in the imaginary plane.
- Hence the charge receives the complex convergent EM energy, transduces it into real EM energy, and emits enormous energy at the speed of light in all directions -- which includes bidirectional pairs in 3-space (after the reaction, being after "observation").
- This produces the fields and potentials from the "source charge or dipole."
- Mandl and Shaw argue that the scalar (time-polarized) photon and longitudinal photon are observable only in similar pairs, which then makes the instantaneous scalar potential. Thus their quantum field theory work strongly supports the "negative resistor" interpretation of the scalar potential and our solution to the source charge and source dipole problem.

Figure 1. The scalar potential is a harmonic set of phase conjugate longitudinal EM waves.

Note: Decompose the potential between the end charges of the dipole

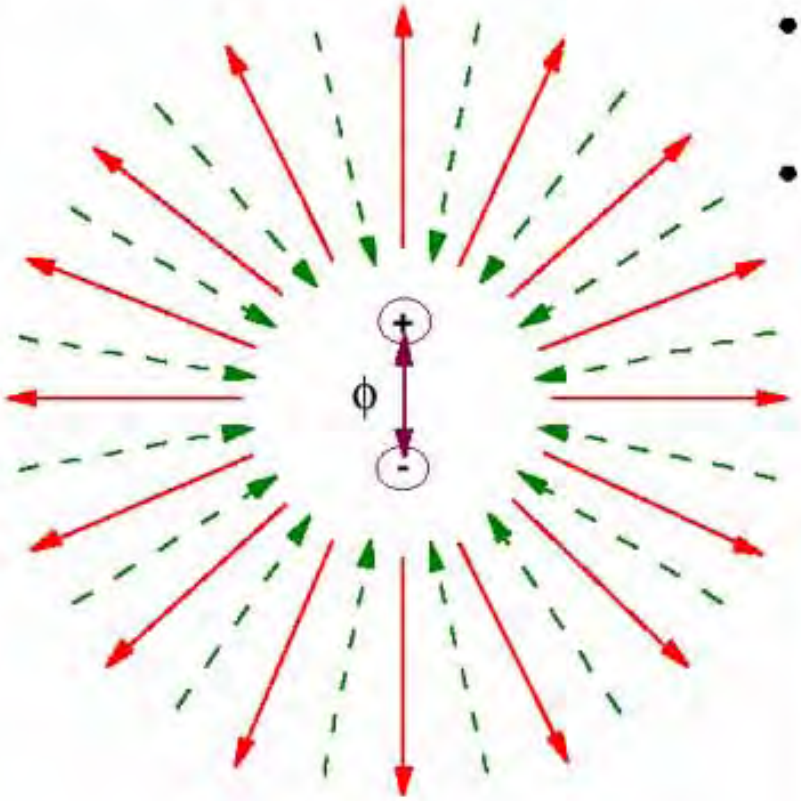

- Receives enormous EM energy in complex plane (similar to reactive power)
- Transduces it into real EM energy and emits it in all directions at the speed of light
- The emitted EM energy forms the fields and potentials and their energy, across space, from this "source dipole"

* Basis established by E.T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," Math. Ann. 57, 333 (1903). Ignored since then.

LEGEND

Outgoing real EM energy

Incoming complex EM energy

Figure 2. The dipole is a true negative resistor.

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Broken 3-space symmetry initiates jump to 4-space symmetry between complex plane and real plane. Energy flow is now conserved in 4-space, but not in 3-space. This is the true negative resistor effect, and a negentropic reordering of the vacuum.

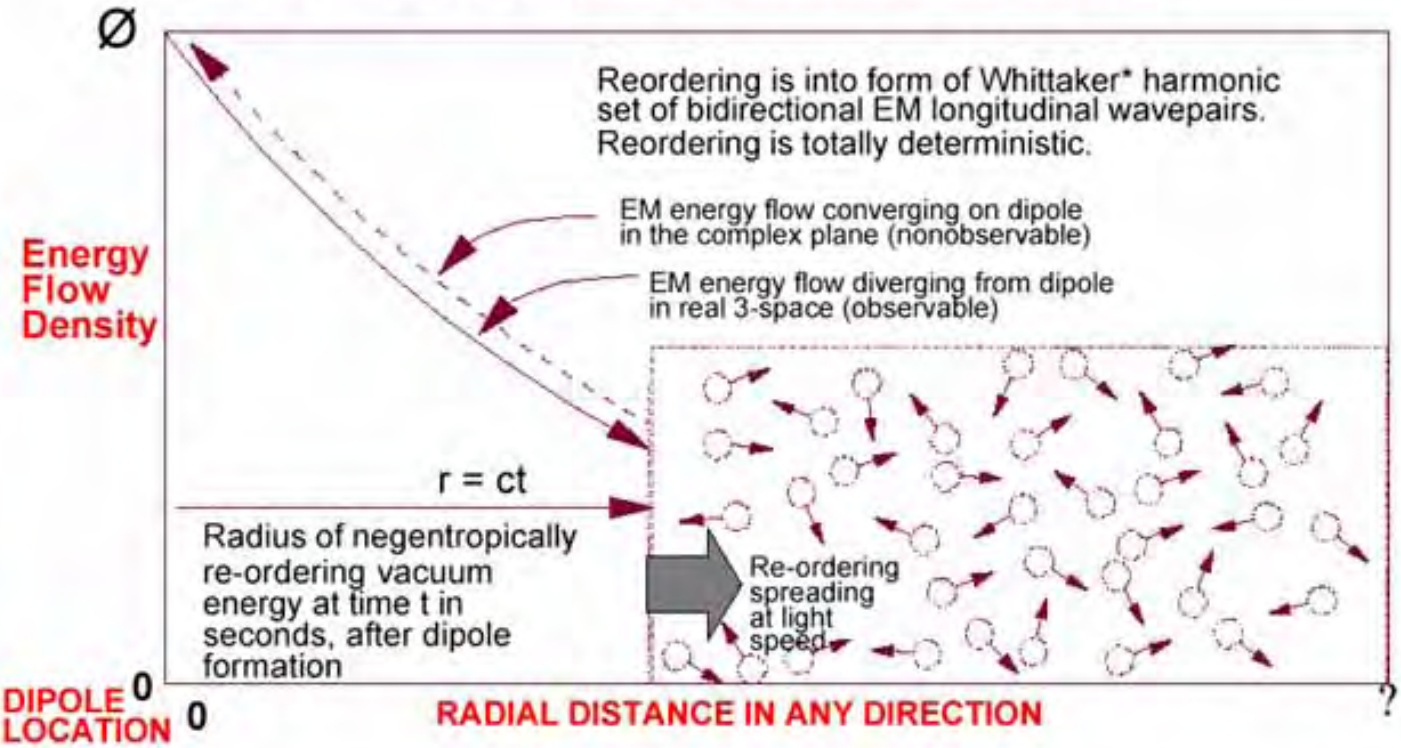

Figure 3. The dipole's broken 3-symmetry initiates a spreading giant negentropic reordering of a fraction of the vacuum's energy.

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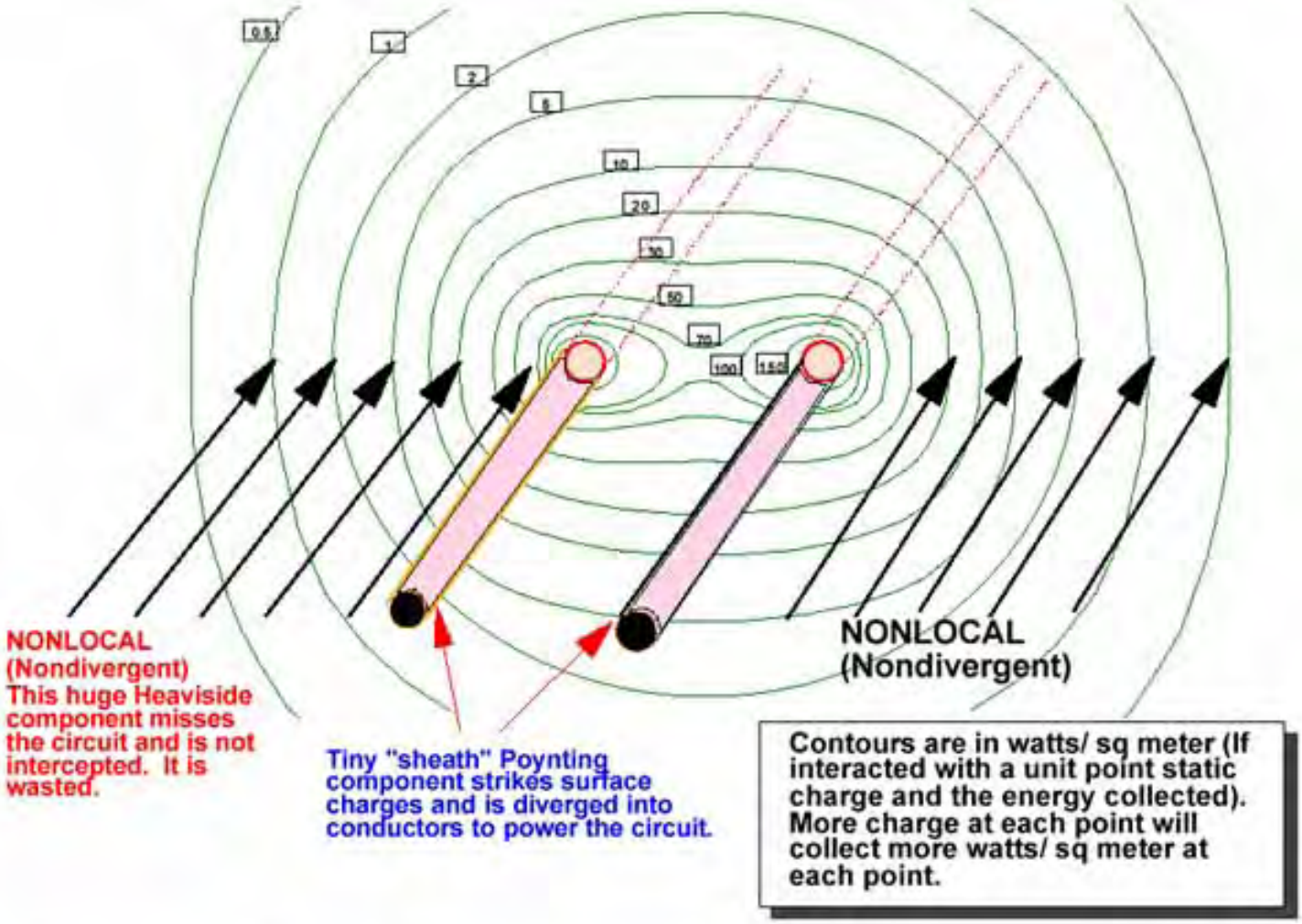

Figure 4. Energy flow contours surrounding a transmission line.

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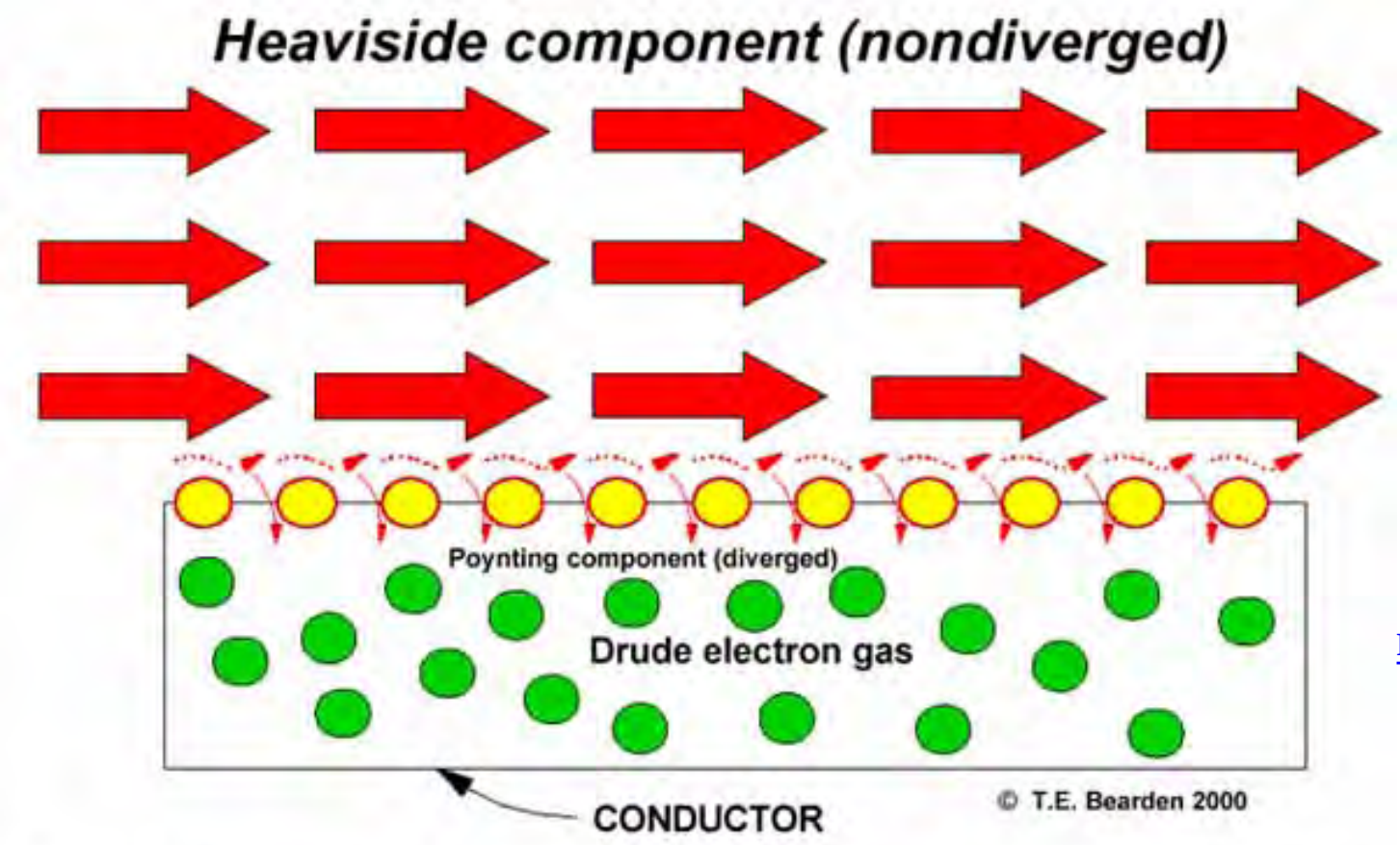

Figure 5. Heaviside and Poynting energy flow components. The Heaviside component is often 10 trillion times the Poynting component, but is simply wasted in ordinary single-pass energy flow circuits.

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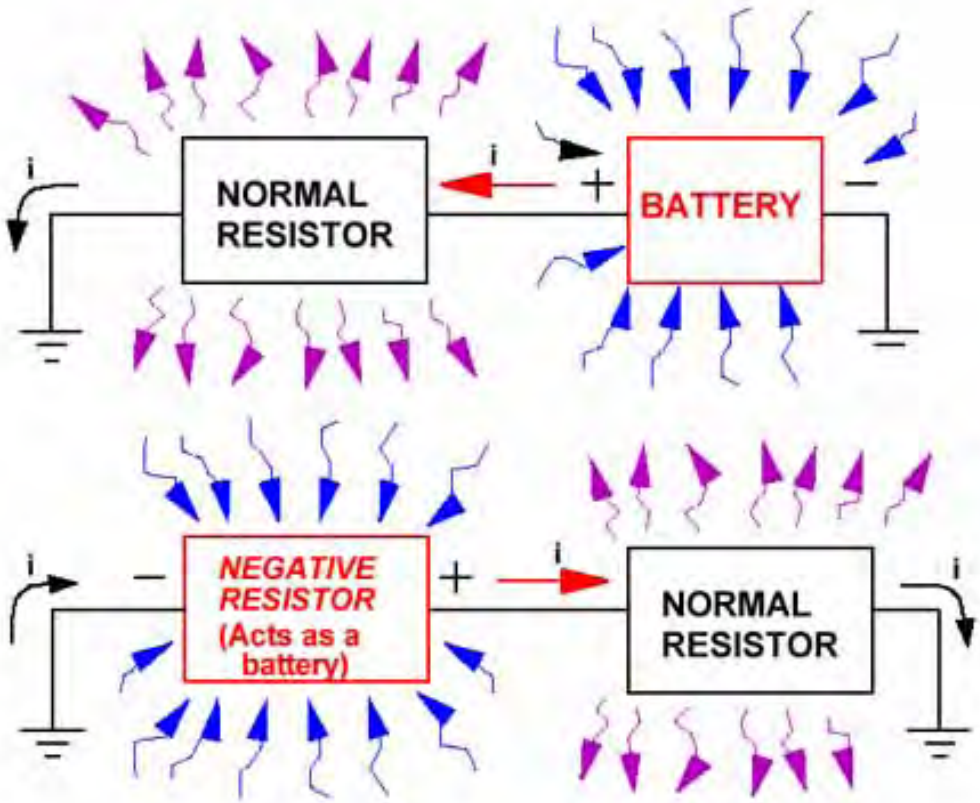

Figure 6. Negative resistance process vs. positive resistance process. A negative resistor receives energy in unusable form, transduces it, and outputs it in usable form. A positive resistor receives energy in usable form, and scatters it into unusable form.

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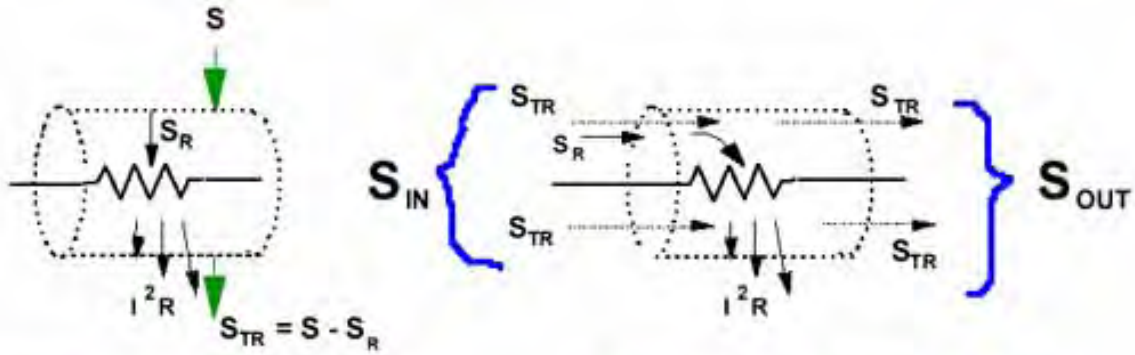

1a. Lorentz surface integration.

1b. Actual S in and S out.

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See Panofsky & Phillips, Classical Electricity and Magnetism, 2nd. edn., Addison Wesley, 1962, p. 178-181.

Note: If the S-vector is integrated over the closed surface, then all nondiverged energy flow is zeroed, leaving only the very small component of the input S-flow that is powering the joule heating of the resistor. In short, only the small component of the S-flow that is equal in magnitude to the Poynting vector remains. This measures only the tiny portion of the S-flow that is intercepted and diverged into the conductors by their surface charges, powering the electrons and then dissipated out of the resistor as joule heating.

The Lorentz procedure arbitrarily discards the enormous Heaviside component that misses the circuit entirely and is wasted. This results in a non sequitur of first magnitude in energy flow theory .

Figure 7. Lorentz's integration trick to discard the enormous Heaviside non-diverged energy flow component.

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[note 1]	[note 2]	[note 7]	[note 11]	[note 15]	[note 17]
	[note 3]	[note 8]	[note 12]	Figure 11	(Figure 13)
	[note 4]	[note 9]	[note 13]	Figure 12	(Figure 14)
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THE VIRTUAL TIMES

CHASING THE WILD DRAGON:

Foundations of a New Science

By T.E. Bearden
November 12, 1995

It is a pleasure to accept the offer of John and Larry to write a column in their new InterNet magazine. Theirs is a great venture, and with the energy and knowledge they bring to the task, one can be confident of their success in making this a very interesting and informative publication.

There is a new "rebel" science slowly being born, with most of the work being done outside the universities and orthodox scientific community. In the months ahead it will be my job to try to acquaint you with the gist of what's going on, and what all the excitement is about.

This first article is deliberately just introductory, and its purpose is to interest you in the unusual fields we are going to be covering in more scientific detail, in future columns. We will also be listing a variety of references from the technical literature, which bear upon the various points addressed.

In this first article a little of my own background experience [note 1] is given, so you can decide whether you will be interested in what we have to say!

The real purpose of the column will just be to *present information* that you may not be able to readily obtain any other way. We will not argue or debate with skeptics; nothing productive is to be gained by that. If the information we present is useful to you, then our purpose has been accomplished. If it isn't of use to you, then just file it in the old wastebasket. Also, from time to time I may answer a generic question, constructed from multiple queries. Individual responses to correspondence cannot be provided.

The work toward a new breakthrough science is going on in a broad spectrum of "fields," most of which are not yet recognized by academia as even constituting legitimate areas of scientific endeavor (Table 1).

Some of the major areas involved are:

1. theoretical and experimental research in overunity electrical machines,
2. free energy research of other kinds, such as devices utilizing thermodynamics phase changes,
3. rapidly advancing efforts in cold fusion,
4. work on permanent magnet motors,
5. antigravity research, both theoretical and experimental,
6. development and utilization of a "hidden" electrodynamics inside the scalar potential (inside voltage),
7. the "memory" of space and materials; where this "memory" can be deliberately conditioned so that space and the materials themselves become causal actants rather than simple inert entities,

8. direct engineering of quantum change via a new kind of "hidden electrodynamic variables,"
9. the direct engineering of the vacuum's virtual photon flux exchange with matter,
10. action at a distance, including the deliberate formation and usage of quantum potentials,
11. direct engineering of the local curvature of spacetime (yes, the direct engineering of general relativity, using the new hidden kind of electrodynamics),
12. use of the new "hidden" electromagnetics to engineer body cells including the reversal of diseased cells, genetics and all, back to a previous healthy state (cellular dedifferentiation, in biophysical terms, or cellular phase conjugation, in physics terminology),
13. research toward the direct engineering of the mind, including both the conscious and unconscious minds, long-term memory, and the personality itself, and
14. a ruthless re-examination (and correction where necessary and possible) of the definitions, concepts, and postulates that present physics is founded upon.

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the **Editor** of The Virtual Times

Notes and References:

[1] For those interested in orthodox qualifications, I have an M.S. in nuclear engineering (1971) from Georgia Institute of Technology and a BS in mathematics (1953) from what is now Northeast Louisiana University with a minor in electronic engineering.

Table 1. Fourteen Emerging New Science Areas

1. Overunity Electrical Machines and Power Systems
2. Overunity Devices Using Thermodynamical Phase Changes
3. Cold Fusion and Non-Nuclear Transmutation
4. Self-Powered Permanent Magnet Motors
5. Antigravity and Antigravity Engineering
6. Use of the "Inner" EM Inside the Scalar Potential
7. Vacuum Engineering, With Vacuum and Materials Memory
8. Direct Engineering of Quantum Change
9. Engineering and Structuring of Massless Charge Flux
10. Action-At-A-Distance, Including Use of Quantum Potentials
11. Direct Engineering of Local Spacetime Curvature
12. "Inner EM" Time Reversal of Diseased Cells Back to Health
13. Direct Engineering of the Mind, Including Software Loading
14. Unified Field Revision of Foundations Concepts of Science

THE VIRTUAL TIMES

Each of these "major areas" as yet has no single "experts" in the sense that individuals exist who possess a "mastery" of the given area. As an example, in spite of multiple researchers and decades of vigorous research, no one is really an "overall expert" in the overunity electrical power systems field. The "field" itself is still struggling to be born and is not recognized at all by orthodoxy; in fact, many orthodox scientists bitterly resent one even attempting to work in this area. There is as yet no cohesive single "theory" of overunity electrical or magnetic machines, although our own group is making rapid progress in that respect. But there is still no universal agreement amongst even the researchers themselves. Literally the field is still being *discovered*.

This "groping dimly toward a new field" should not be too surprising. After all, the early electromagnetics researchers went through the same tortuous, agonizing kind of development. They were playing with cat fur, glass rods, and pith balls for quite an extended period before understanding progressed to the point where Maxwell could mathematically tie together and model the results of the experimenters such as Faraday and others. It has taken a century and a half for modern electromagnetics and electronics to reach its own present development. It is going to take another decade or so before the overunity researchers can overturn several ill-founded parts of the present electromagnetics and get the emerging field onto a solid foundations footing and into a solid theoretical position.

In the effort to produce a theoretical model of electromagnetics, Maxwell and his predecessors performed a magnificent work. Yet they also made very serious errors (Table 2), which persist to this day. [note 2] Let us list just a few of the more blatant errors in classical EM theory today:

First, Franklin guessed wrong on which way electrical current flowed in a circuit. There is no definition at all of electrical charge in all of physics, and there is no acceptable definition of potential (that is, there is no rigorous definition of just good old "voltage.") There are no "fields of force" in the vacuum; there are just potential gradients __ because the vacuum is just one vast potential (virtual particle flux) in the first place. Force fields actually occur only in and of the matter in a material system. The primary causative agents of electromagnetics are not the so-called "force fields' at all, but are the potentials __ as is well-known in quantum mechanics. [note 3] Maxwell assumed a material ether in his equations. The Michelson-Morley experiment destroyed the material ether, but the Maxwell equations have never been changed accordingly. The electron was not yet discovered when the Maxwell equations were written; the theory does not address electron spin. Maxwell was already dead some two decades when Barus' 1898 paper [note 4] was published, pointing out the strange "backwards-traveling" wave (i.e., time-reversed wave) solution to the wave equation. In addition, Heaviside and Gibbs had already produced their vector truncation __ this truncated theory is the modern so-called "Maxwell's equations" that universities teach today __ of Maxwell's theory. Not a single one of them ever appeared in any book or paper by James Clerk Maxwell. [note 5]

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Table 2. Some Defects In Electrodynamics

1. Conventional Current Direction Is Reversed
2. No Definition of Charge or Potential
3. Equations Still Assume Material Ether
4. Use of Force Fields in Vacuum is Known to be False
5. Treats Charge as Unitary; lnstead, It is a Coupled System
6. Confuses Massless Potential Gradients as Forces
7. Does Not Utilize Mass as a Component of Force
8. Erroneously Assumes Force Fields as Primary Causes
9. Topology of EM Model Has Been Substantially Reduced
10. Does Not Include Quantum Potential
11. Does Not Include Proven Action At A Distance
12. Does Not Utilize Near Field Coulornb Gauge Effects
13. Does Not Include EM Generatrix for Time Flow
14. Does Not Unify Photon and Wave Aspects
15. Does Not Include Electron Spin and Precession
16. Treats Energy As Existing In "Chunks," instead of as Flow
17. Confuses Energy and Energy Collection
18. Discards Half of Every EM Wave in Vacuum
19. Erroneously Uses Transverse Vacuum Wave; It's Longitudinal
20. Omits Phase Conjugate Optics Effects
21. Does Not Include EM Cause of Newtonjan Reaction Force
22. Erroneously Assumes Separate Force Acting on Separate Mass

[2] For an independent statement that electrodynamics, both classical and quantal, are in serious disarray, see Mario Bunge, Foundations of Physics, Springer-Verlag, New York, 1967, p. 176. Quoting: "...it is not usually acknowledged that electrodynamics, both classical and quantal, are in a sad state." Bunge points out many errors in electrodynamics. See also Terence W. Barrett, "Electromagnetic Phenomena Not Explained by Maxwell's Equations," in Lakhtakia, A. (ed.): Essays on the Formal Aspects of Electromaqnetic Theory, World Scientific, Singapore, 1992, p. 6-86. To find information on what's wrong with EM theory, one must read foundations literature, not the standard textbooks. One of my own contributions has been to point out that the notion of charge q is not unitary. In fact, electrical charge should be defined in terms of q ~ m(sub q)~(sub q). In other words, electric charge q has a massive part m, and a massless part consisting of its potential phi. Further, the magnitude of phi is just the change in the virtual photon flux of the ambient vacuum, due to the [quantum field theoretic] virtual photon exchange with the mass of the q. It follows that the true electrical charge of a particle is just its native potential ~, which is also a dynamic energy exchange with the surrounding vacuum. It also follows that this massless electrical charge changes whenever the particle is placed in a potential (in a different ambient virtual photon flux). After all, potentials superpose; that is their major characteristic. Note that the potential of the test particle is ignored in classical electromagnetics, whenever one speaks of the "E-field" upon the particle. Further, the actual structure of this virtual photon flux that comprises massless electrical charge, can itself be deterministically structured and utilized to generate nonlinear effects that do not appear at all in the present conventional theory. We will be covering many of these effects in future articles.

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[3] E.g., see Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," Physical Review, Second Series, 115(3), 1959, p. 485-491. Effects of potentials on charged particles exist even in the region where all the fields (and therefore the forces on the particles) vanish, contrary to classical electrodynamics. The quantum effects are due to the phenomenon of interference. These effects occur in spite of Faraday shielding. The Lorentz force does not appear anywhere in the fundamental quantum theory, but appears only as an approximation that holds in the classical limit. In QM, the fundamental physical entities are the potentials, while the fields are derived from them by differentiation.

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[4] Carl Barus, "A Curious Inversion in the Wave Mechanism of the Electromagnetic Theory of Light," American Journal of Science, Vol. 5, Fourth Series, 1898, p. 343-348.

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[5] E.g., see Paul J. Nahin, Oliver Heaviside: Saqe in Solitude, IEEE Press, New York. Quoting from p. 9: "...nowhere in Maxwell's writings do the equations for the electromagnetic field appear as we write them today. Maxwell used an amalgamation of Cartesian component and quaternion notation, and it was Heaviside who first wrote the electromagnetic field equations in modern vector form." Quoting from p. 92: "In actuality , however, the fields were not the primary reality to Maxwell at all (that is an idea that developed after Maxwell's death and is due to Hertz and Heaviside), but rather it was Faraday's 'electrotonic state' that he thought to be the real thing. Like Faraday, Maxwell believed that electromagnetic effects are observable results of an altered state of the ether. The mathematical formulation of this electrotonic state, for Maxwell, is what we today (as he did) call the vector potential." And again, from p. 96: "To Maxwell, however, the vector potential had a most definite physical meaning."

So the time-reversed EM wave that one finally sees emerging in nonlinear phase conjugate optics in the early 1970s was omitted from the Maxwellian theory and its later modification by Heaviside and Gibbs. Maxwell's actual theory is in a higher topology (quaternion algebra), and involves some 20 quaternion equations. Heaviside and Gibbs created vector algebra, and seriously curtailed Maxwell's theory when they "translated" it into the much lower topology of vectors and some four equations. The later addition of tensors as the basis mathematics did not restore the lost topology provided by the quaternion model.[note 6]

For the EM wave, Maxwell simply assumed the transverse EM wave that had come from the much earlier derivation of the familiar wave equation from the old "plucked taut string" notions. [note 7] Yet when one closely examines and corrects some of the erroneous *assumptions* [note 8] made for the actual mathematical derivation of this "taut string" transverse wave, one finds (Figure 1) that an equal-energy second antiphased transverse "antiwave" is actually produced by the instrument and added to the "plucked string's" transverse wave disturbance of the air medium, to produce a longitudinal wave of compression and rarefaction in the air itself. The "transverse string wave" in fact never leaves the string. The string wave is not the wave that is launched into the medium.

A similar electromagnetic situation exists. In a whip antenna (Figure 2), the Drude electron gas in the conductor does exhibit a transverse "string-type" EM wave of electron precession. However, at the same time, by Newton's third law (which Maxwell neglected because at the time the atom was regarded as just a blob with no internal structure) the positively charged, phase conjugated atomic nuclei have equal energy, highly damped transverse recoil waves created in them. Further, these "nuclei-recoil" waves are phase conjugate replicas of the electron gas waves. The total disturbance that is launched into the vacuum from the whip antenna is (a) the normal transverse disturbance of the virtual photon flux of vacuum caused by the electron gas wave, and (b) the coupled equal-energy transverse antiwave caused by the nuclei-recoil via Newton's third law. The amplitude of the material antiwaves of nuclei vibration are highly damped because of the massiveness of the nuclei; however, they are of equal energy to the electron wave. But when launched into the same vacuum, the two equal-energy wave disturbances experience equal damping because they are in the same medium. Hence the wave and antiwave are (a) locked together in the vacuum, and (b) of equal energy, and (3) of equal amplitude once launched into the vacuum. What results is a vacuum EM wave of rarefaction (reduction in intensity) and compression (increase in intensity) of the virtual photon flux of vacuum __ just exactly like what is launched into the surrounding gaseous air medium from the "plucked taut string" and perturbed body of a physical instrument. The EM wave in vacuum is a longitudinal wave directly analogous to a sound wave __ just as Nikola Tesla stated. [note 9]

The vacuum may be considered a scalar potential, in which case it has an internal biwave structure (Figure 3). Interference of two potentials __ i.e., the hidden interference (Figure 4) of their internal wave structures __ in fact already creates all EM fields and waves.

When the incoming longitudinal "biwave" from the vacuum strikes the atoms of the receiving antenna, each atom may be considered a dynamic assembly of multiple dipoles, where each dipole consists of one of the electrons in the electron shells and one of the positive charges in the nucleus. The receiving dipole in the interacting atom splits the two waves apart again (Figure 5). The negatively charged end of the dipole is time-forward, and the positively charged end is time-reversed.

Hence the separated normal-wave-half of the biwave interacts with the electron, to give again the familiar transverse "electron precession" wave that we detect with our "electron wiggle-detecting" instruments (Figure 6). This detected electron precession wave is what all our textbooks prescribe erroneously as the vacuum wave! The separated time-reversed-wave-half of the incoming vacuum wave is split off and interacts with the positive end of the receiving atomic dipole, in the time-reversed atomic nucleus, thus generating Newton's third law reaction force to provide the recoil of the nucleus. Present physics has ignored this second wave altogether, because of the serious error in the original derivation of the wave equation from plucked strings. Thus physics presently has absolutely no causative mechanism for Newton's reaction force. Instead, scientists just "mystically invoke the appearance of this magic force." Describing that something occurs, and naming its occurrence, does not constitute advancing a causative mechanism!

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[6] E.g., see T.W. Barrett, "Tesla's Nonlinear Oscillator- Shuttle-Circuit (OSC) Theory," Annales de la Fondation Louis de Broglie, 16(1), 1991, p. 23-41. Barrett shows that a higher topology EM model (e.g., quaternions) allows shuttling and storage of potentials in circuits, and also allows additional EM functioning of a circuit that a conventional EM analysis cannot reveal. Tesla's actual patented circuits in fact exhibit this higher topology, when a quaternion EM analysis of them is performed. No orthodox vector/tensor analysis can show this.

---

[7] All the early experimenters seemed to assume the transverse string-type wave automatically for the vacuum medium. E.g., Faraday speculated that light and radiant heat might be transverse vibrations propagated along his "lines of force," from which the direct "plucked string" analogy can readily be seen. In short, he considered that his lines of force could be perturbed to vibrate laterally, just like a plucked string. See M. Faraday, "Thoughts of Ray-Vibrations," Philosophical Magazine, (3), vol. xxvii, 1846, p. 345. Maxwell also assumed the transverse EM wave in vacuum without question, as did Heaviside, Hertz, and Gibbs and as has almost every electrodynamicist since then.

---

[8] The worst is the assumption of infinitely rigid endposts holding the taut string, so that no movement of these endposts occurs. This further assumes that no induced movement of the body of the instrument occurs. The end result is to eliminate all of that wave that is produced in the body of the instrument, and retain only the transverse wave produced in the string. In the first place, this standard procedure has now become a total violation of Newton's third law, which among other things requires that forces be formed in oppositional pairs. So the standard method for the launch of a wave from an instrument is flawed. Specifically, the "transverse string wave" is falsified insolaf as its appearance in the surrounding medium. This is not the wave that actually exits the instrument and that is launched into the medium. This universal oversight on the part of mathematicians and physicists is a colossal joke upon them. Literally, when a physicist writes the transverse wave equation on the board, he has just discarded exactly half the physics. This means that, in his interactions, at the end there will suddenly appear this mysterious, mystical "equal and opposite reaction force" that is created by the erroneously ignored antiwave. So he has to piously invoke this reaction force "from the blue." Yet quantum field theory teaches us already that all mechanical and electromagnetic forces on a mass are generated by absorption and emission of virtual photons. Hence Newton's third law reaction force must also be so generated. This means that there must exist an equal number of virtual antiphotons interacting in the antiforce, as there was virtual photons interacting in the causative force. By symmetry there must also exist an equal and opposite wave, or antiwave, made of these same antiphotons. The actual disturbance that entered from the vacuum must therefore have consisted of both wave and antiwave. QED.

Tables:

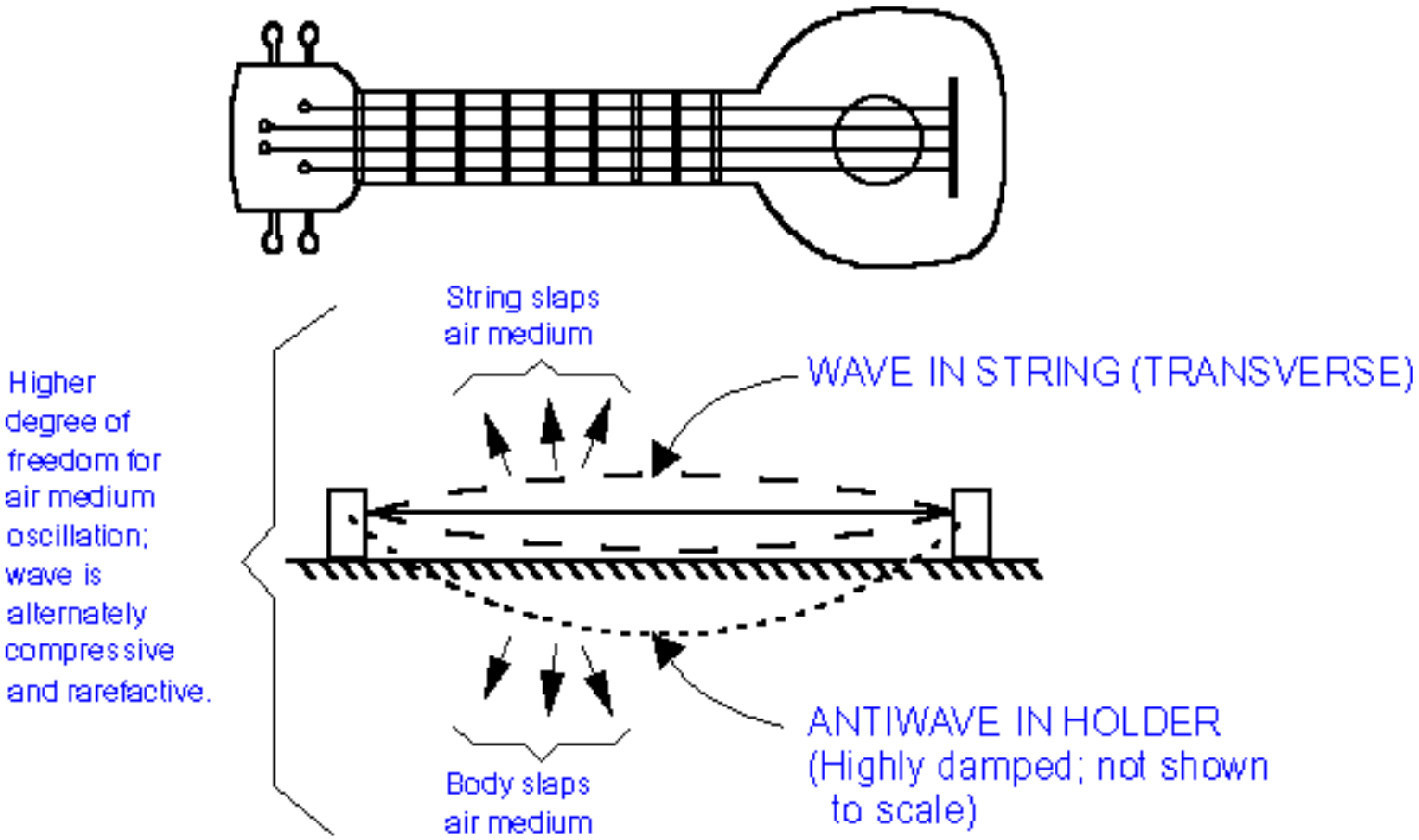

Figure 1. Air medium disturbances generated by plucked string.

Two waves are created, both slapping the air medium at the same time, but in opposite directions. A disturbed medium oscillates according to its own degrees of freedom. The air has more degrees of freedom than the string. A wave of compression and rarefaction is created in the air medium.

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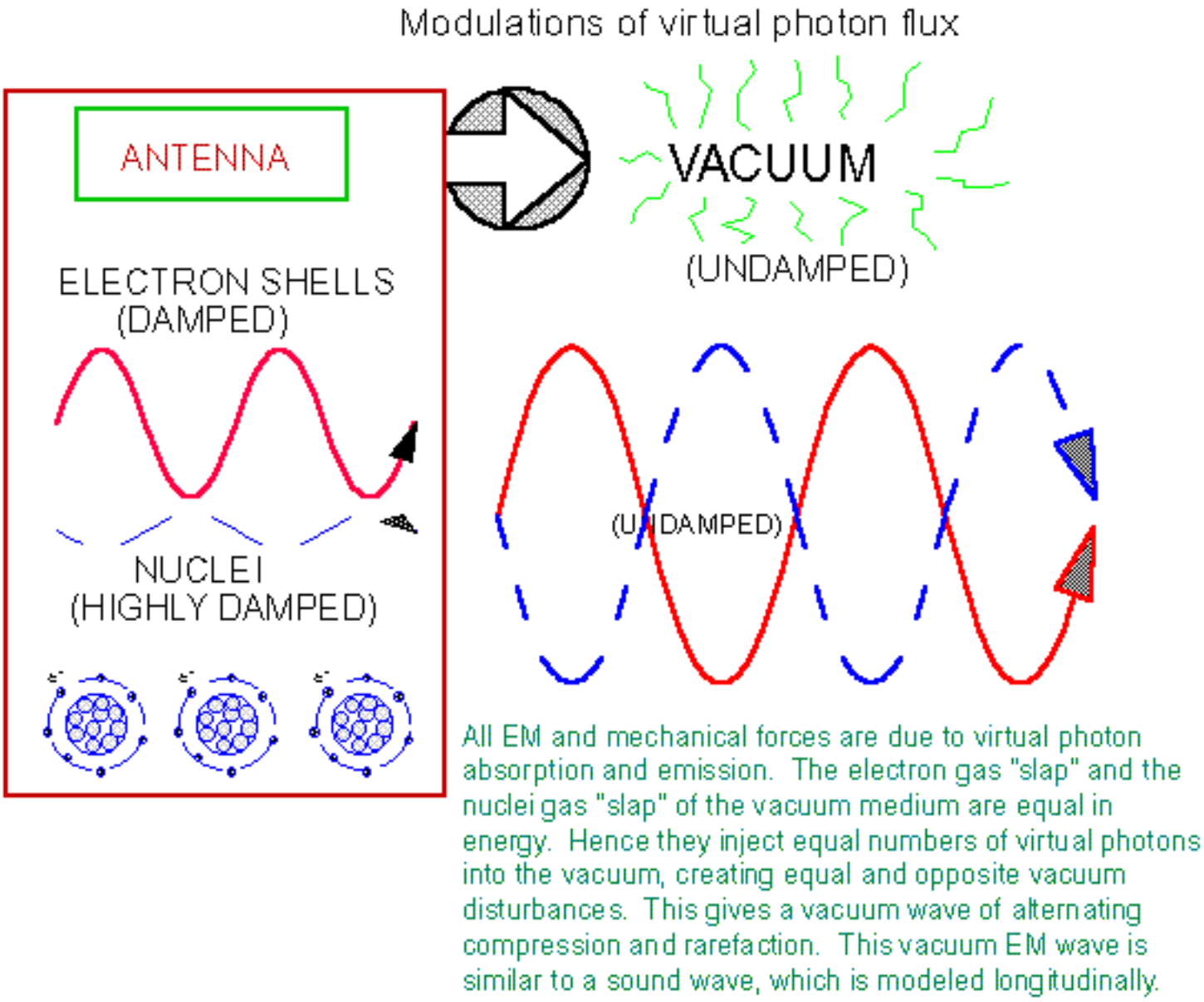

Figure 2. Launching an EM wave from a wire antenna.

D-1-F2

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[9] See Nikola Tesla, "Pioneer Radio Engineer Gives Views on Power," New York Herald Tribune, Sep. 11, 1932. Quoting: "...I showed that the universal medium is a gaseous body in which only longitudinal pulses can be propagated, involving alternating compressions and expansions similar to those produced by sound waves in the air. Thus, a wireless transmitter does not emit Hertz waves which are a myth, but sound waves in the ether, behaving in every respect like those in the air, except that, owing to the great elastic force and extremely small density of the medium, their speed is that of light." Today the QM vacuum has been theoretically and experimentally shown to consist of a "gas" of virtual particles, rather like Tesla stated. Tesla was also correct about the longitudinal EM wave in the vacuum. He was also correct in his statement that a fundamental charged particle can alter its charge, if one considers the massless charge ~ of charge q separately from the mass m of charge q. When the charge q is placed in a nonzero potential V, it follows that the new charge of the electron is simply (~+V).

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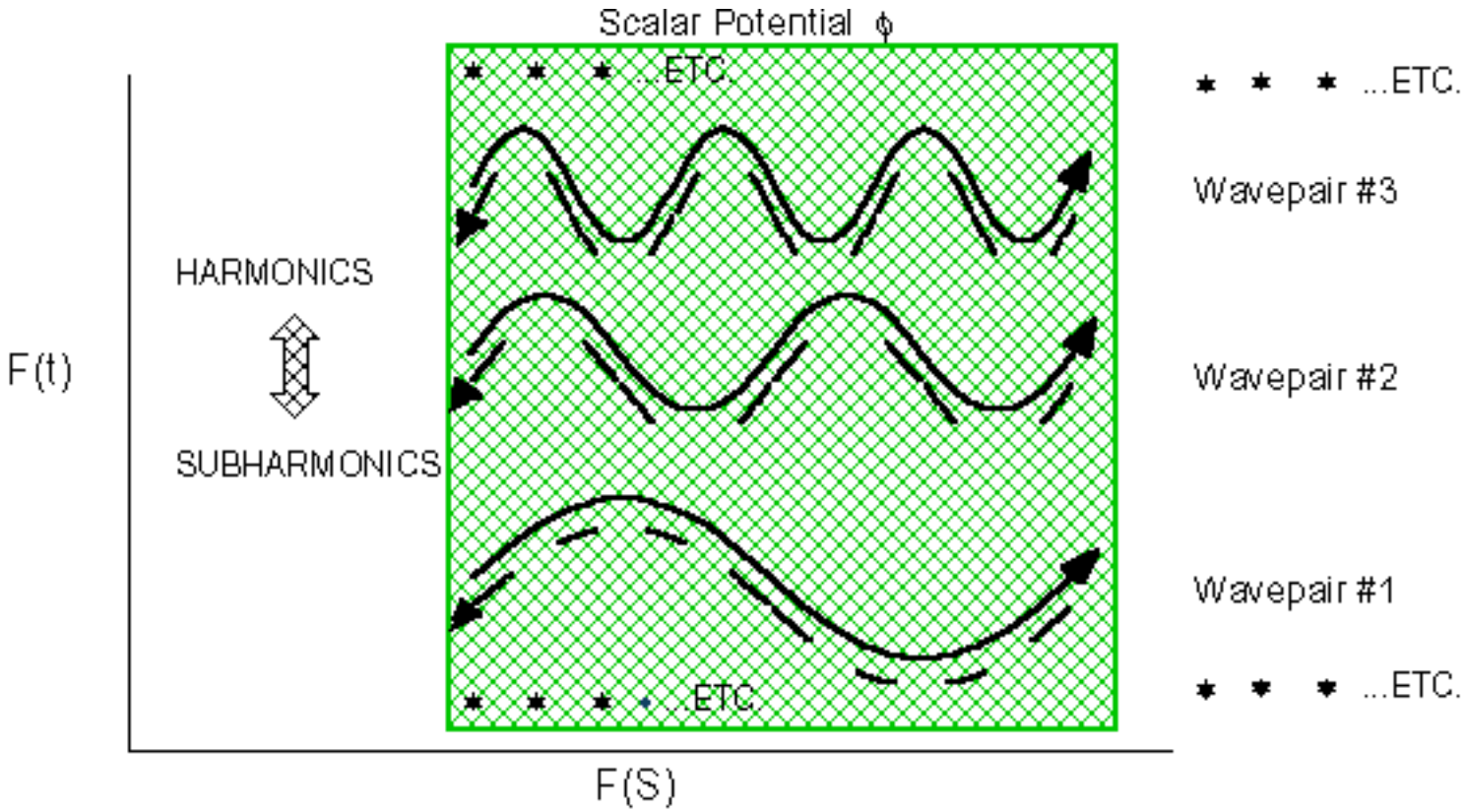

Figure 3. Internal Wave Structure of the scalar potential.

A harmonic set if wavepairs, where in each wavepair the two waves superpose spatially, but travel in opposite directions. The two waves in each pair are true phase conjugates and time-reversals of each other. Thus they comprise a coupled wave and antiwave. The photons must also be coupled into photon/antiphoton pairs, by a strong application of the distortion correction theorem of nonlinear optics.
Each wavepair is a standing electrogravitational wave.

D-1-F3

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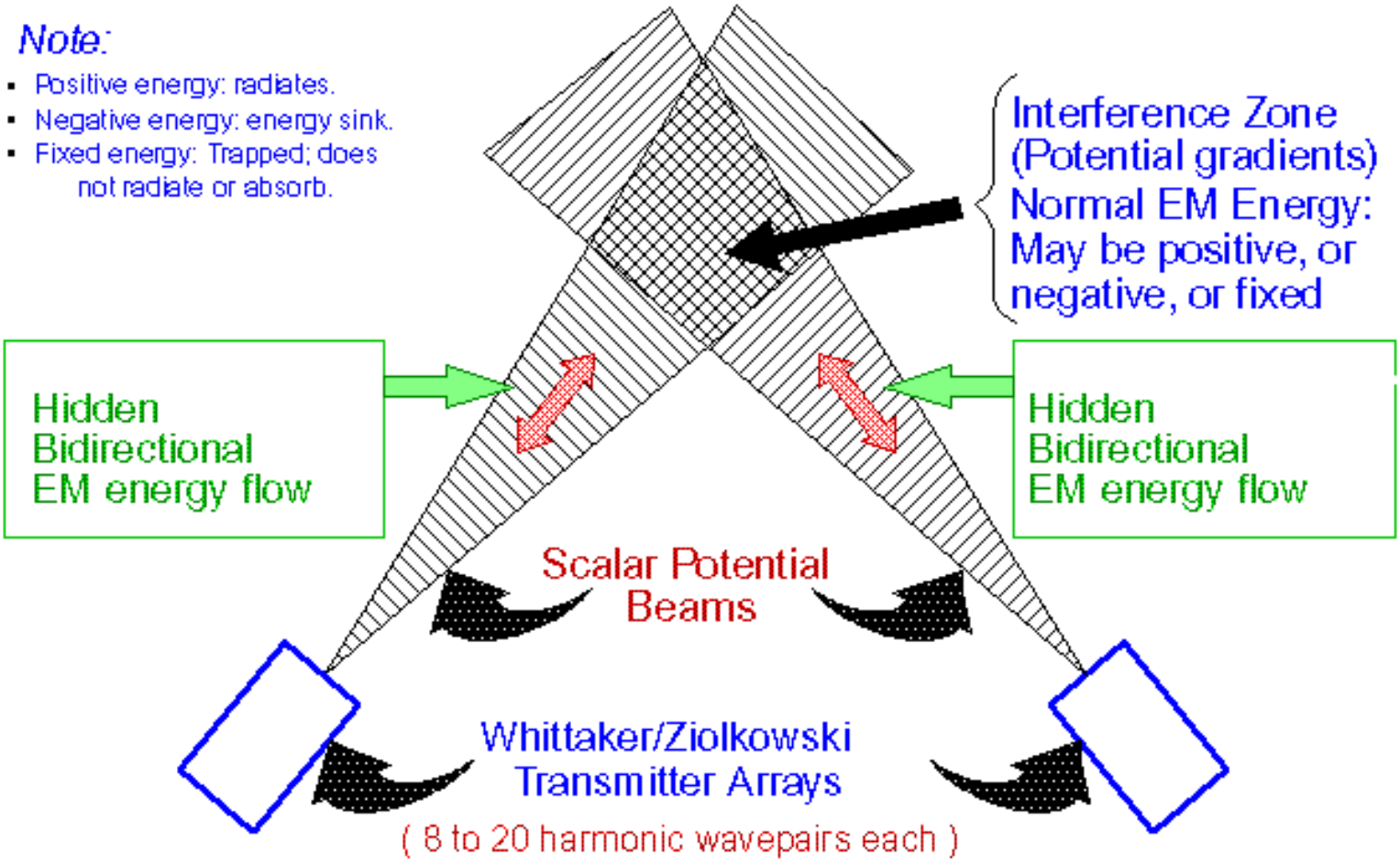

Figure 4. Scalar potential interferometry provides action-at-a-distance. It already creates normal EM fields and waves.

D-1-F4

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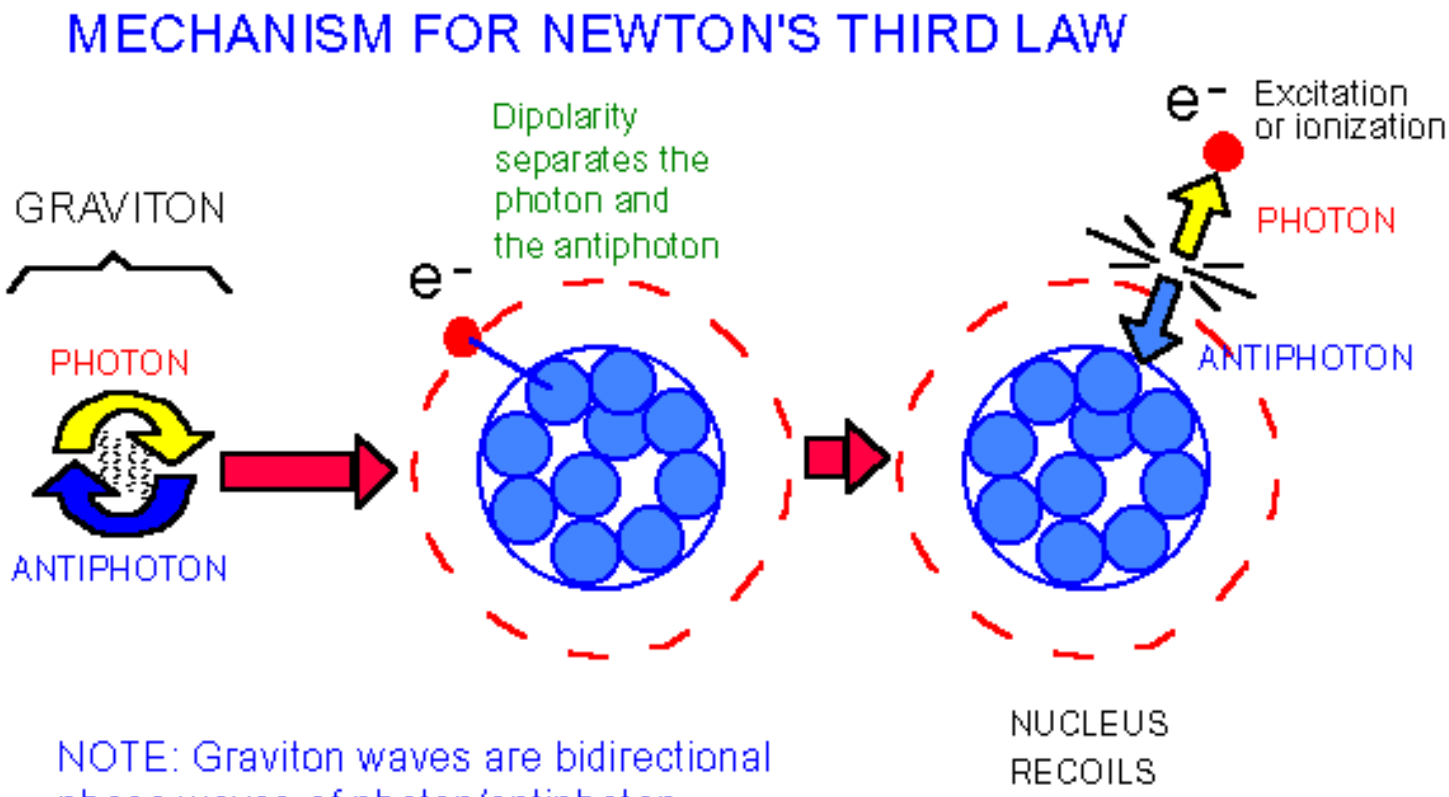

NOTE: Graviton waves are bidirectional phase waves of photon/antiphoton coupling and uncoupling in the vacuum.

The atom is an assembly of dynamic dipoles.

A dipole splits the graviton into a photon and an antiphoton.
The photon interacts with the electron, producing the action.
The antiphoton interacts with the nucleus, producing the reaction.

Figure 5. Graviton interaction with matter produces the photon interaction and Newton's third law reaction.

D-1-F5

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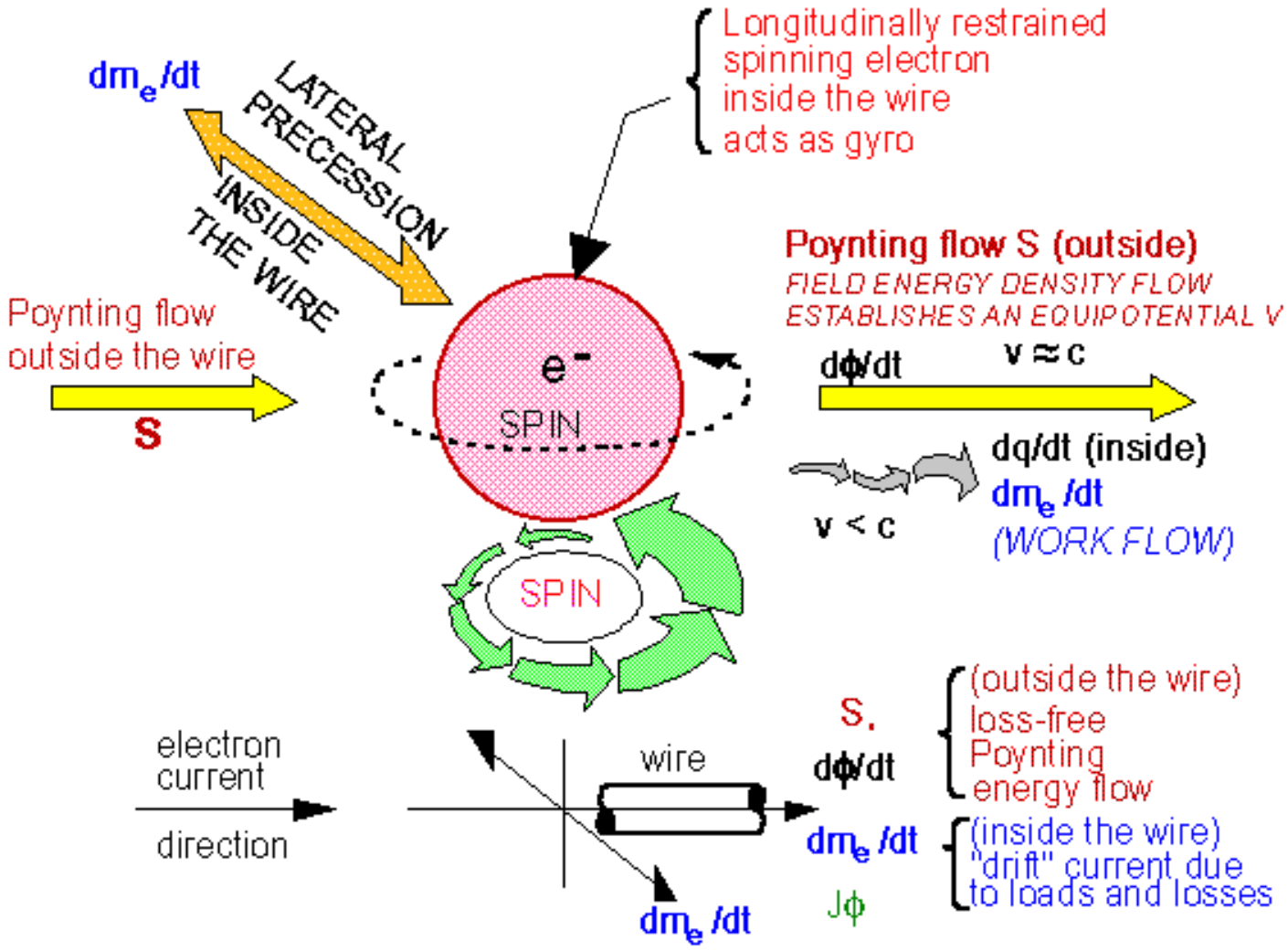

Figure 6. Currents in and along a conductor, with electron precession.

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THE VIRTUAL TIMES

Further, if we should trick the time-reversed wave half into coming outside the atom instead of going inside to interact with the nucleus (Figure 7), then it follows that the nucleus would not recoil. In that case the interaction would appear to violate Newtonian third law reaction. Phase conjugate mirrors already do just exactly this when they emit a phase conjugate replica wave. They direct the antiwave outside and away from the atom instead of inwards into the nucleus. So they do not recoil, no matter how powerful a phase conjugate replica wave they emit.

Finally, we can also show that the EM wave in vacuum is longitudinal, by yet another approach. The electrons in the electron gas in a conductor are spinning, and they are severely constrained longitudinally to be able to move only very, very slowly down the wire. So when perturbed, they act as gyroscopes, and precess at right angles to the perturbing force. The fact that the gyroelectrons in a wire move radially almost entirely, and only "slip" down the wire very slowly with a "drift" velocity, already proves conclusively that the incoming vacuum disturbance was longitudinal. The precession of a gyro is at right angles to the perturbing force. Therefore rigorously the vacuum EM waves are longitudinal, because the gyroelectrons moved transversely. The present assumption of the transverse EM wave in vacuum contradicts the entire theory of gyroscopes! [note 10] There are many other errors in classical EM that we will point out in future articles; this should give the reader a flavor of what is in store for him in future articles.

So there are no truly satisfactory "experts" in any of the 14 fields. Yet there is still something to be said for having some years of experience in one or more of the areas. I have had the good fortune or misfortune, depending upon one's viewpoint, to be involved in various of those 14 activities for some 30 years or more, and am active in several of the areas now. My colleagues and I are particularly active in researching overunity electrical devices (see Figure 8), to include the effects of controlled chaotic oscillators, charge-blocking oscillators, and oscillators driven by in-shuttled (bridged) Poynting field energy density flow ExH. Parametric oscillation is known to have yielded overunity electrical machines and was fully reported by Russian researchers in the Russian and French technical journals in the mid 1930s. [note 11] We will further cite that little-known work in future articles. Also, we are working mightily upon true negative resistors (Figure 9), wherein the resistor scavenges some of the disorganized energy from the vacuum's energetic exchange with the charges in the system, organizes and collects it, and then outputs that collected energy flow into the external circuit. Such a resistor acts as a power source. Kron, perhaps the greatest of the electrical machinery scientists, is known to have produced such true negative resistors.

I have also proposed a theoretical explanation of the Priore device (Figure 10) in France which in laboratory animals demonstrated remarkable cures of terminal tumors, cured trypanosomias, reversed atheriosclerosis, and restored suppressed immune systems. The Priore work was not anecdotal, but was performed under rigorous scientific protocols, working under the auspices of renowned French scientists such as Courrier and Pautrizel. The work is properly reported in numerous papers in the French medical literature. [note 12] The results were certainly achieved, but neither Priore himself nor the scientists of the day could understand the mechanism involved. The deciphering of that causative technical mechanism utilized by the Priore group required 10 years of intense effort. The results have now been published in the journal Explore! and are there for anyone to read. [note 13]

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PHOTON INTERACTION WHEN ATOM PHASE CONJUGATES

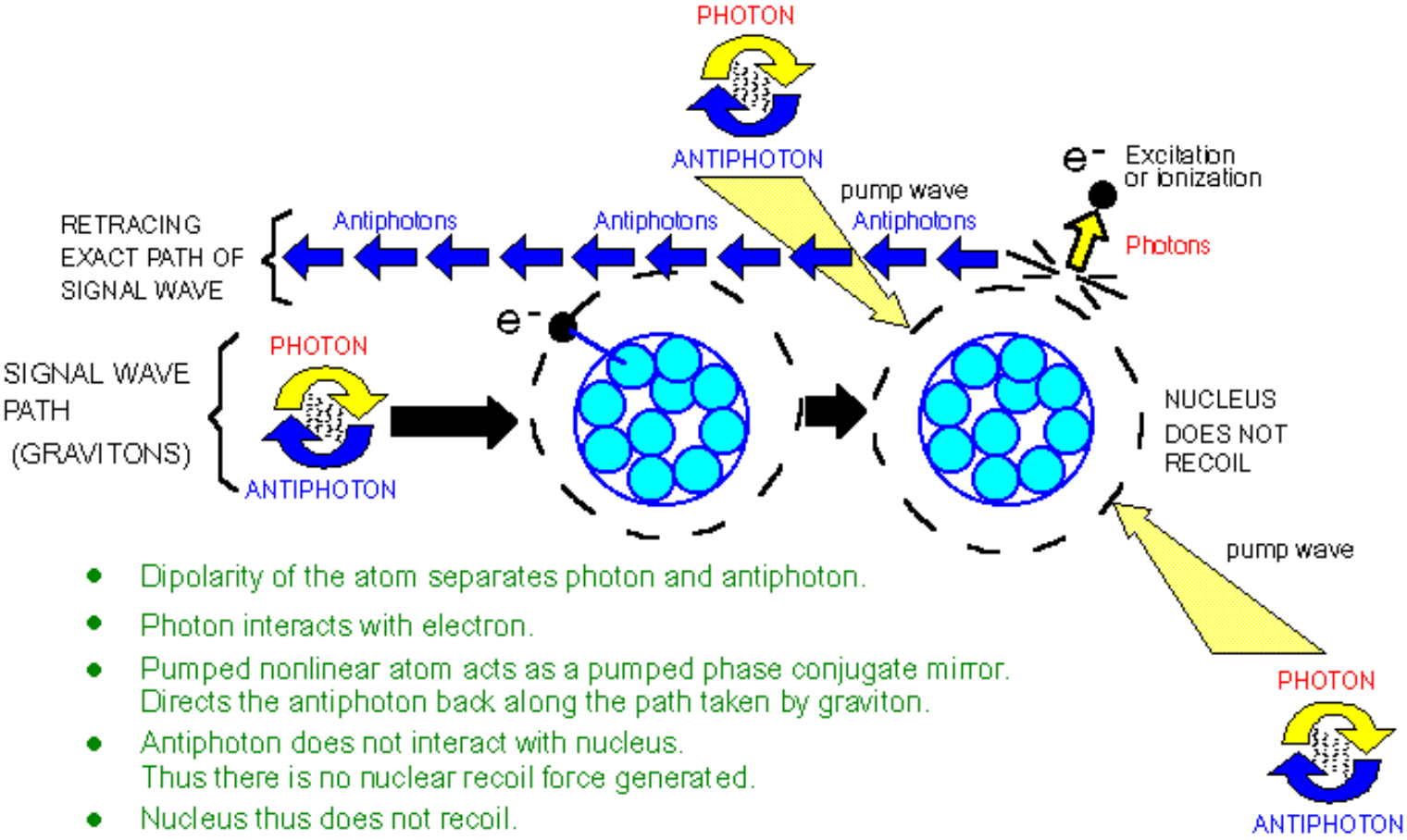

- Dipolarity of the atom separates photon and antiphoton.
- Photon interacts with electron.
- Pumped nonlinear atom acts as a pumped phase conjugate mirror. Directs the antiphoton back along the path taken by graviton.
- Antiphoton does not interact with nucleus. Thus there is no nuclear recoil force generated.
- Nucleus thus does not recoil.
- Not a violation of Newton's third law, once one understands the mechanism that generates third law reaction. In the absence of the generating mechanism, there is no third law recoil. In EM field theory, the "missing antiwave" has necessitated third law omission.

Figure 7. Emission of antiphoton; nucleus does not recoil. Atom acts as a pumped phase conjugate mirror.

D-1-F7

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[10] When Maxwell's theory was constructed, the electron had not yet been discovered, and so the dipolarity of the atom was unknown. An atom was regarded just as a "blob." Electricity in a conductor was regarded as a thin material fluid Maxwell's equations are in fact hydrodynamic equations. So the founders regarded the detection of induced motion in the electric fluid as induced translation, not induced precession. They had no idea of "spins" of particles of the fluid, nor of gyro precession of those particles. Instead, q was regarded just as a "piece of electric fluid," similar to a cubic centimeter of fluid.

A fundamental AC resonant principle for an overunity electrical power system

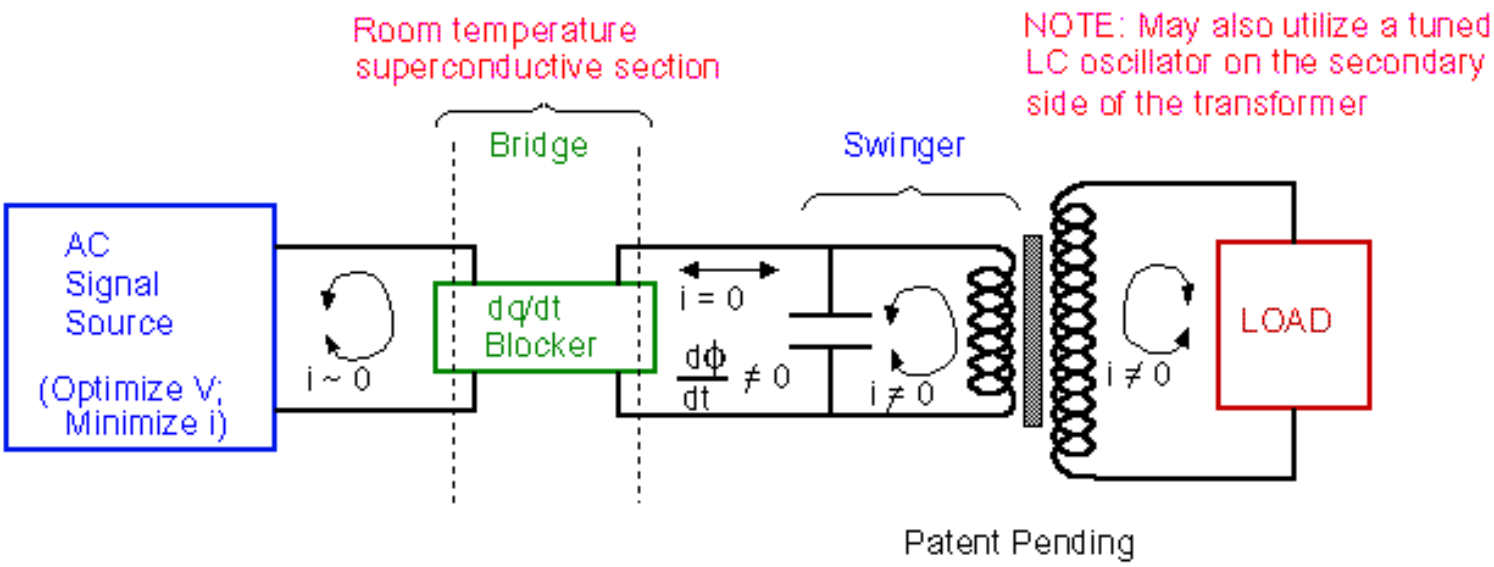

Figure 8. dq/dt-free driving a swinger by S-flow.

Poynting energy flow S with its accompanying potential V is shuttled from the source to a tuned LC oscillator in resonance at the driving frequency or slightly below. The LC oscillator is driven by S-flow and dV/dt flow alone. The swinger furnishes its own free electrons, which receive S and EMF from the bridge, thereby producing dq/dt.

D-1-F5

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[11] E.g., see L. Mandelstam [Mendel'shtam, L.I.], N. Papalexi, A. Andronov, S. Chaikin and A. Witt. (1935) "Report on Recent Research on Nonlinear Oscillations," Translation of "Expose Des Recherches Recentes Sur Les Oscillations Non Lineaires," Technical Physics of the USSR, Leningrad, Vol. 2, 1935, p. 81-134. NASA Translation Doc. TT F-12,678, Nov. 1969. Summarizes lengthy work at the Institute of Physics of the University of Moscow and several of the laboratories on the problem of self-powered, self- oscillating nonlinear oscillators. The paper reports significant work and progress in oscillations created by the oscillating system itself (self-oscillation) without participation of any external forces varying with time and without the expense of a constant source of energy (e.g., a storage battery). Such a system was shown to self-increase in an underdamped manner until system self-destruction. Adding a nonlinear load allowed the systems to stabilize its dynamic operation so that it powered a load under overunity conditions and did not self-destruct. Extensive additional references on this spectacularly successful overunity energy project are listed.

Tables:

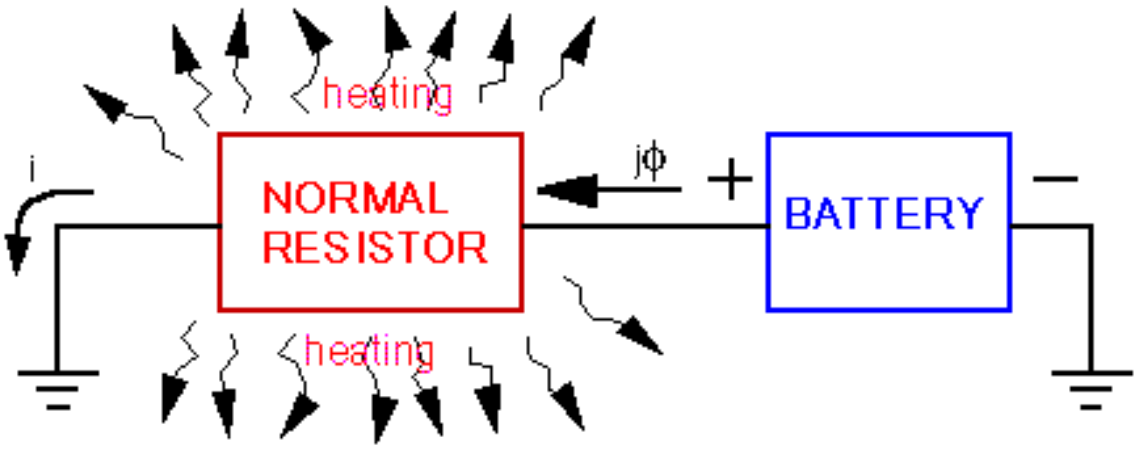

Figure 9a. Normal resistor receives ordered energy and scatters it.

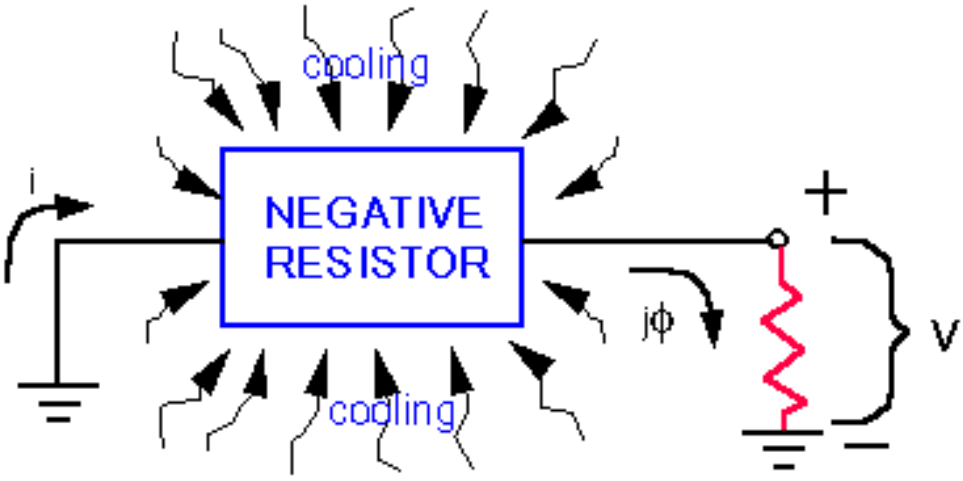

Figure 9b. Negative resistor receives, concentrates, and reorders scattered energy.

Figure 9. Normal resistor versus a negative resistor.

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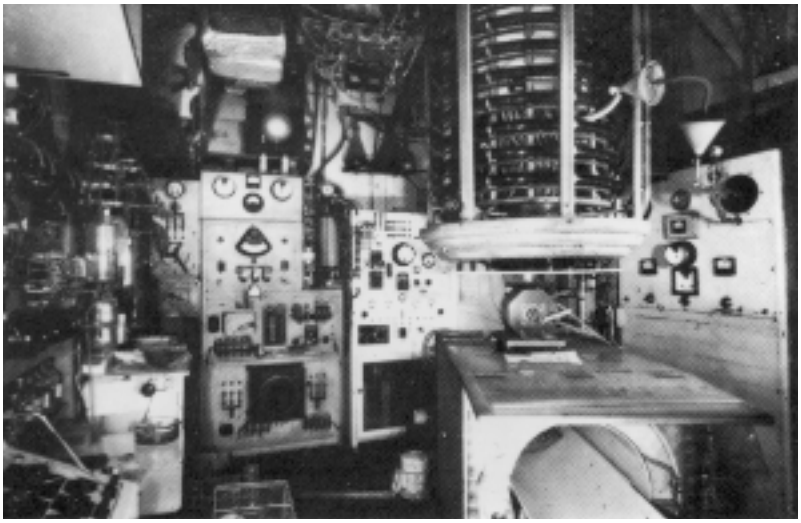

Some 17 signals were fed into a rotating plasma, which added phase conjugates to them. This infolded 17 wavepairs, each pair a coupled wave/antiwave, thereby forming a scalar potential with an artificial Whittaker pump wave internal structure. This infolded pump wave complex was modulated onto a powerful, rippling magnetic field, guaranteeing penetration even into the atomic nuclei. A specific, amplified antiengine for the exact cellular disease state was generated, reversing the diseased cells back to a previous healthy state.

Figure 10. Priore's laboratory apparatus for cellular reversal.

D-1-F10

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[12] For citations and the exposition of our proposed explanation of the Priore mechanism, see T.E. Bearden, "Vacuum engines and Priore's methodology: The true science of energy-medicine." Part I, Explore!, 6(1), 1995, p. 66- 76, Part II, Explore!, 6(2), 1995, p. 50-62.

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[13] Bearden, "Vacuum engines and...," ibid.

Presently my CTEC colleagues and I have filed three patent applications and a continuation, on various methods for overunity processes and apparatuses, room temperature superconductivity, Poynting generators, etc.

As an example, we took exactly the opposite approach to room temperature superconductivity as has been taken by all the orthodox researchers to date. What exactly is sought, after all, for superconductivity (SC) in a section of an electrical circuit? Well, one has some electrons on one side of that SC section that are transporting excess potential, as given by the Slepian vector J*. [note 14] What is desired is to get some electrons on the other side of the SC section that also are transporting the same amount of excess energy in the form of J*. You can do that in two ways: (1) you can flow the electron carriers through the SC section, carrying their J*, or (2) you can block the J and flow the * itself across as the Poynting flow S. [note 15] Nondivergent Poynting flow flows along an equipotential, which is just another way of saying that, if the S-flow does not diverge, it carries the same potential * along with it. Hence it carries the EMF right along with it as it flows without divergence.

Conventional approaches have all tried to shove the electron carriers through the SC lattice section. Doing that is like trying to fire a very slow bullet through several million rotating fans in a straight line. So cryogenics (to slow the fanblades to a crawl) and massive correlation of the electrons and of the electron-to-lattice interactions is necessary if one is to get the electrons through there without excess collisions that shake off some of the excess * from J*, as scattered photons (heat) or as a change of form of the energy (as in straining the dielectric of a capacitor to convert electrical energy to mechanical strain energy via the piezoelectric effect.)

Our approach is exactly the opposite (Figure 11 and Figure 12). Why not just *stop* the flow of excited electron carriers on one side of the SC section, and continue the nondiverging flow of the Poynting field energy density S across that section at room temperature? Then the cryogenics is not needed at all. After all, circuits already work that way anyhow __ except standard practice is to nullify the process by letting current be driven around the sourcing current loop and back through the back EMF of the primary source. A quantum well (or several other methods) can be used to trap the "sourcing" electrons in the conductor just prior to entering the SC section. The "receiving" electrons on the other side of the SC section, however, must be in their own dq/dt-isolated current loop.

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[14] Briefly, the S-flow outside the wire will be flowing along essentially at the speed of light, at or with the same since S-flow without divergence is along an equipotential. Said another way, a nondiverging Poynting flow S exhibits a constant potential ~ along its streamlines. A tiny, tiny portion of the S-flow is intercepted by the sluggish electrons (which may be moving as dq/dt at 11 feet per hour, in a typical case), to form the Slepian vector J~. The J~ portion is just the minute fraction of the S-flow that is actually intercepted by the electron current and transported to the impedances, for releasing the excess ~ in the loads and losses. [Incidentally, this wee note resolves a century of controversy over exactly how EM energy flows in circuits. The orthodox literature abounds with discussions, differing positions, and debates and with errors.]

---

[15] Note that this also automatically involves a host of other types of controversial displacement currents, such as d~/dt, dV/dt, dE/dt, dP/dt, dD/dt, etc. The literature is thoroughly floundering as to exactly how all these currents are related, together with the Slepian vector J~ and the Poynting vector S, as well as the "normal" current dq/dt. We will be discussing the "master key" for these relationships in future articles.

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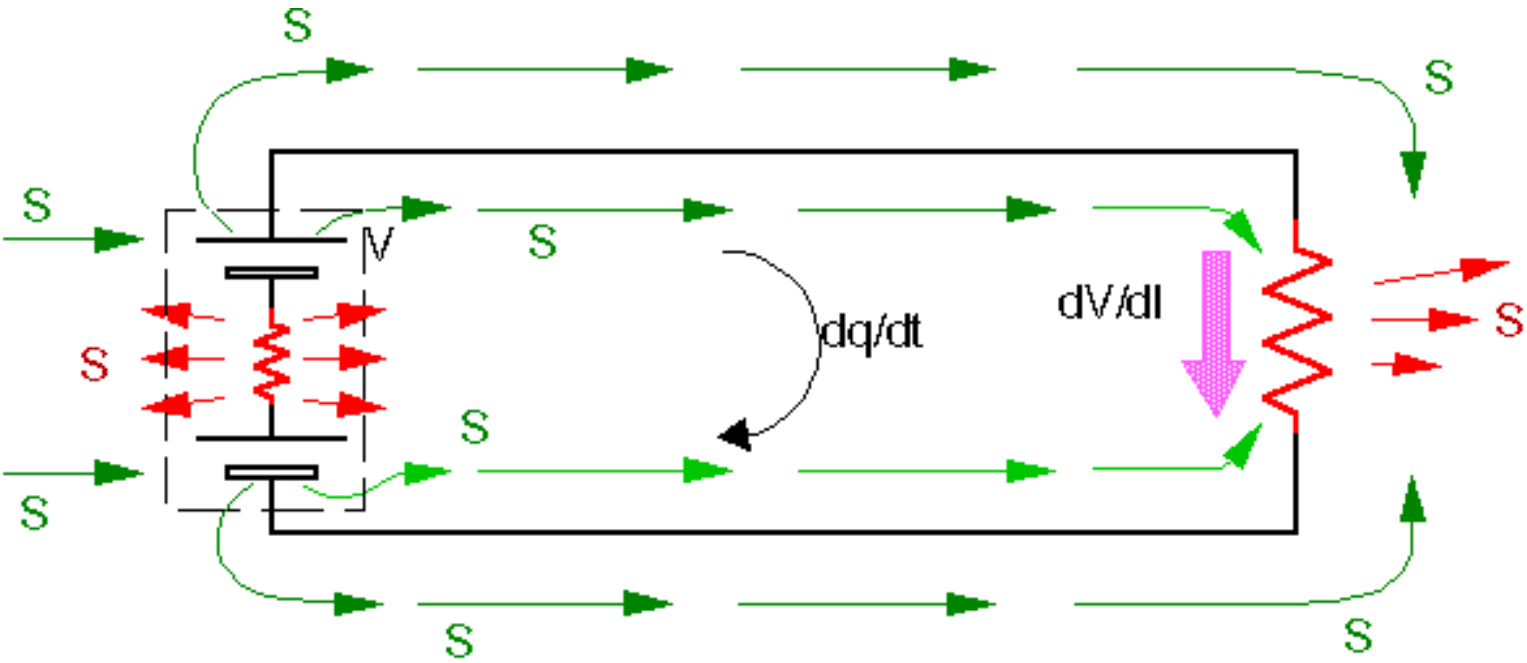

Note: EM texts err in showing the battery "gate" as the source of energy.

Figure 11. Poynting S-flow along a simple circuit.

From particle physics, any electric charge is a broken symmetry in the vacuum's virtual particle flux. Any dipole is thus two locally broken symmetries. Thus the dipole acts as a gate/source, driven by the fierce vacuum flux. So a dipole already "extracts" and gates EM energy flow, directly from the seething vacuum.

Every battery and generator is already a "free energy" source of extracted and gated EM energy from the vacuum.

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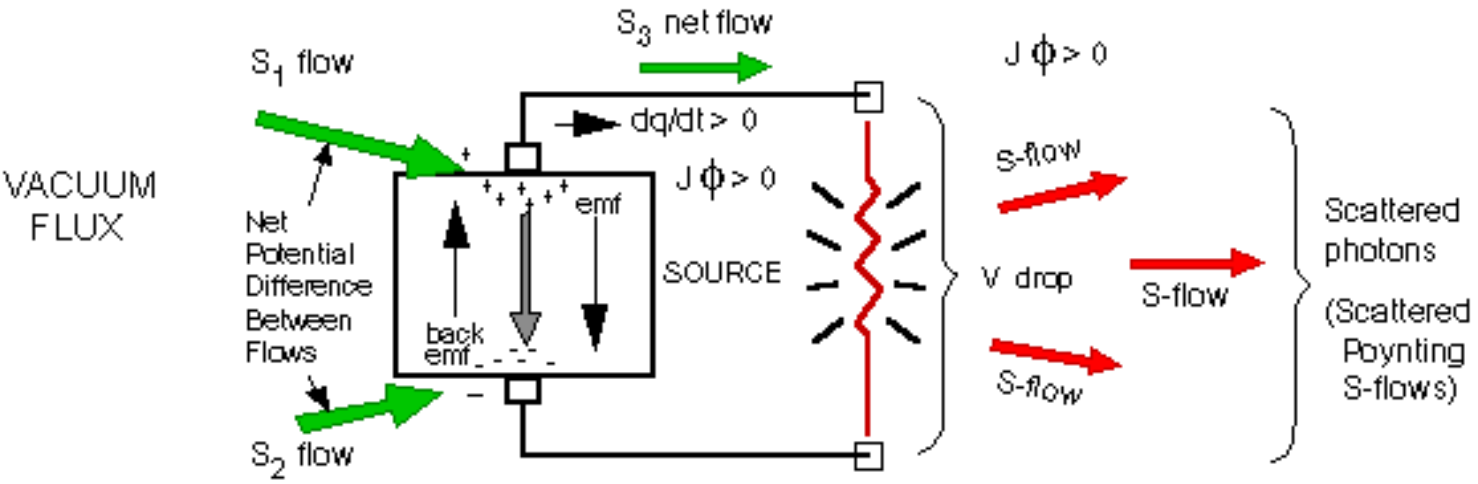

Figure 12a. Normal current flow; Jϕ is the electron transport of energy, while S is the speed-of-light Poynting energy flow.

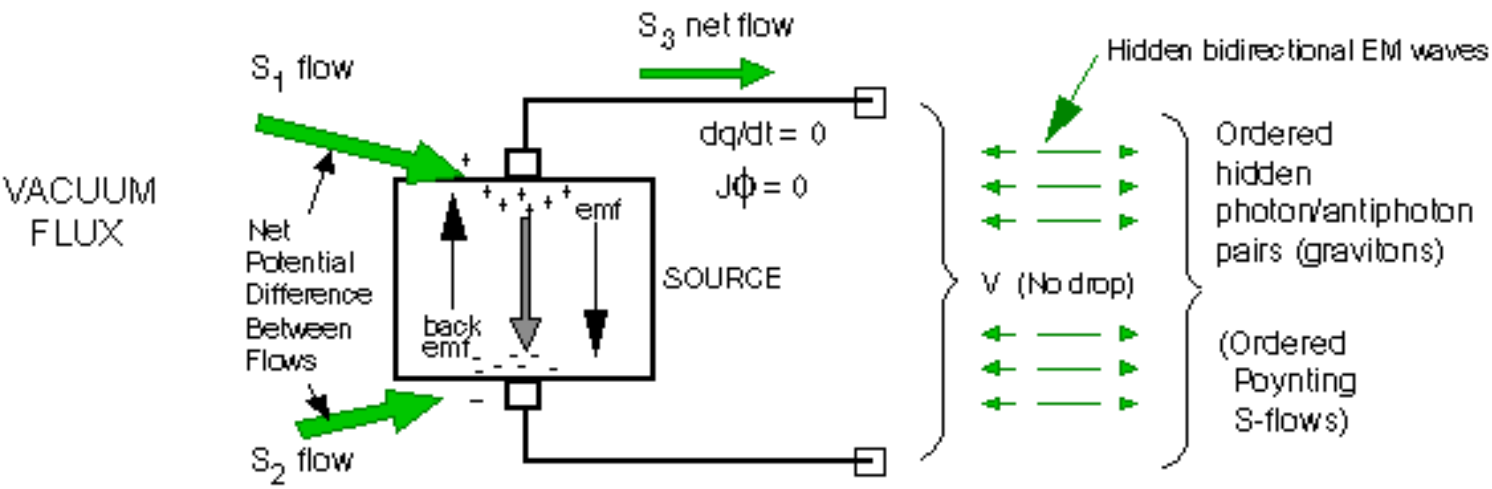

Figure 12b. In a conductor with dq/dt blocked; S-flow and hidden Whittaker-wave flow continue.

Figure 12. Overt and covert field energy density flows.

D-1-F12

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Normal sources do not furnish electrons and current to a circuit anyway. Sources just furnish Poynting flow S and EMF. [note 16] In the receiving current loop, the EMF appears automatically once the S-flow flows in and is "locked on to" by the receiving electrons. Given q**, you will immediately have J* if the electrons are free to move in the conducting circuit (see Figure 13). Further, you have eliminated all the loss terms from the standard Poynting equation for energy losses. So all the energy flow S just flows across the SC section, without any current or Cooper pairs flowing through that SC section. The SC section has become a "bridge" which (1) strips off the Poynting field energy density flow S from the electron current dq/dt on the sourcing side of the SC/bridge section, by simply reducing the dq/dt to zero; and (2) continues to pass the S-flow across the dq/dt-blocked SC/bridge section to the other side (Figure 14). The excess S-flow (and EMF) pours into the receiving dq/dt-isolated current loop, exciting the electrons therein to produce dq/dt and J*. *Any closed current loop is self-powered, once it receives S and EMF. It furnishes its own electrons; it only requires excess energy and EMF.* [note 17]

So our approach gives room temperature superconductivity in a very straightforward manner, once you discover how to block the current dq/dt in a conductor. Blocking it in an insulator is not sufficient, because that drops the potential and stops the S-flow and the equipotential * (the EMF). However, a degenerate semiconductor such as the Fogal chip can be used, as can several other processes for blocking dq/dt in a conductor. We will discuss these in a future article.

Another advantage of this approach to room temperature superconductivity is that now one can also have permissible overunity coefficient of performance. Now the load can be placed in its own S-receiving, isolated current loop. With the sourcing current loop furnishing only S and not dq/dt, the load is still powered normally in its own closed dq/dt current loop, but none of the load current is passed back through the back EMF of the primary source in the sourcing circuit.

This principle -- that at least a substantial portion of the load current must not pass back through the primary source -- is the primary principle required for a permissible overunity electrical machine (Figure 15). A permissible overunity electrical machine is one which produces more power in the load than you have to put into the machine to run it.

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[16] E.g., see Robert L. Shrader, Electronic Communication, Sixth Edn., MacMillan/McGraw-Hill, New York, NY, 1991. (1993 Imprint). Quoting from p. 6: "A source of electric energy does not increase the number of ~ree electrons in a circuit; it merely produces a concerted pressure on any aimlessly moving electrons."

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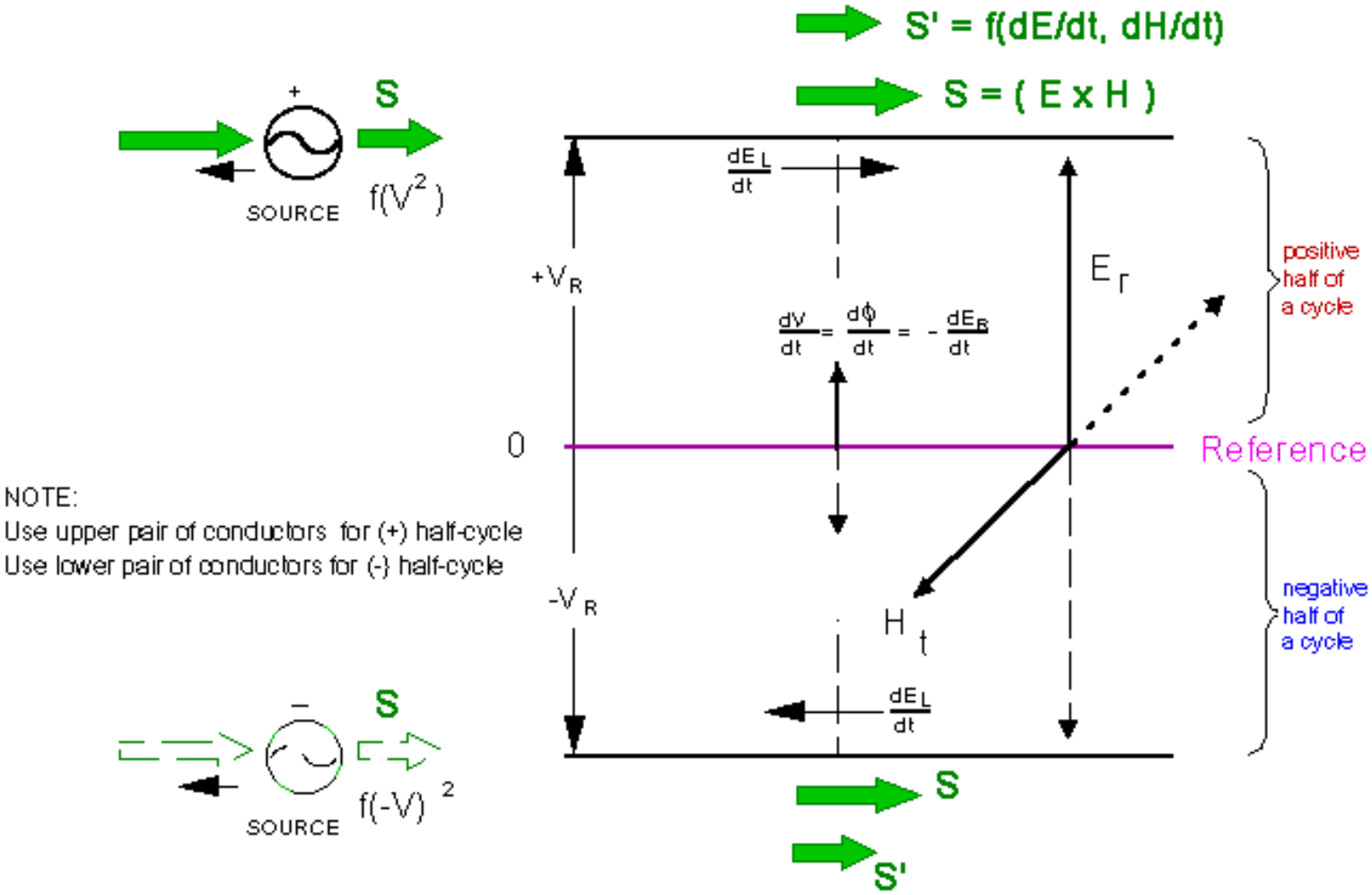

Figure 13. Poynting vector currents S and S' versus massless displacement currents.

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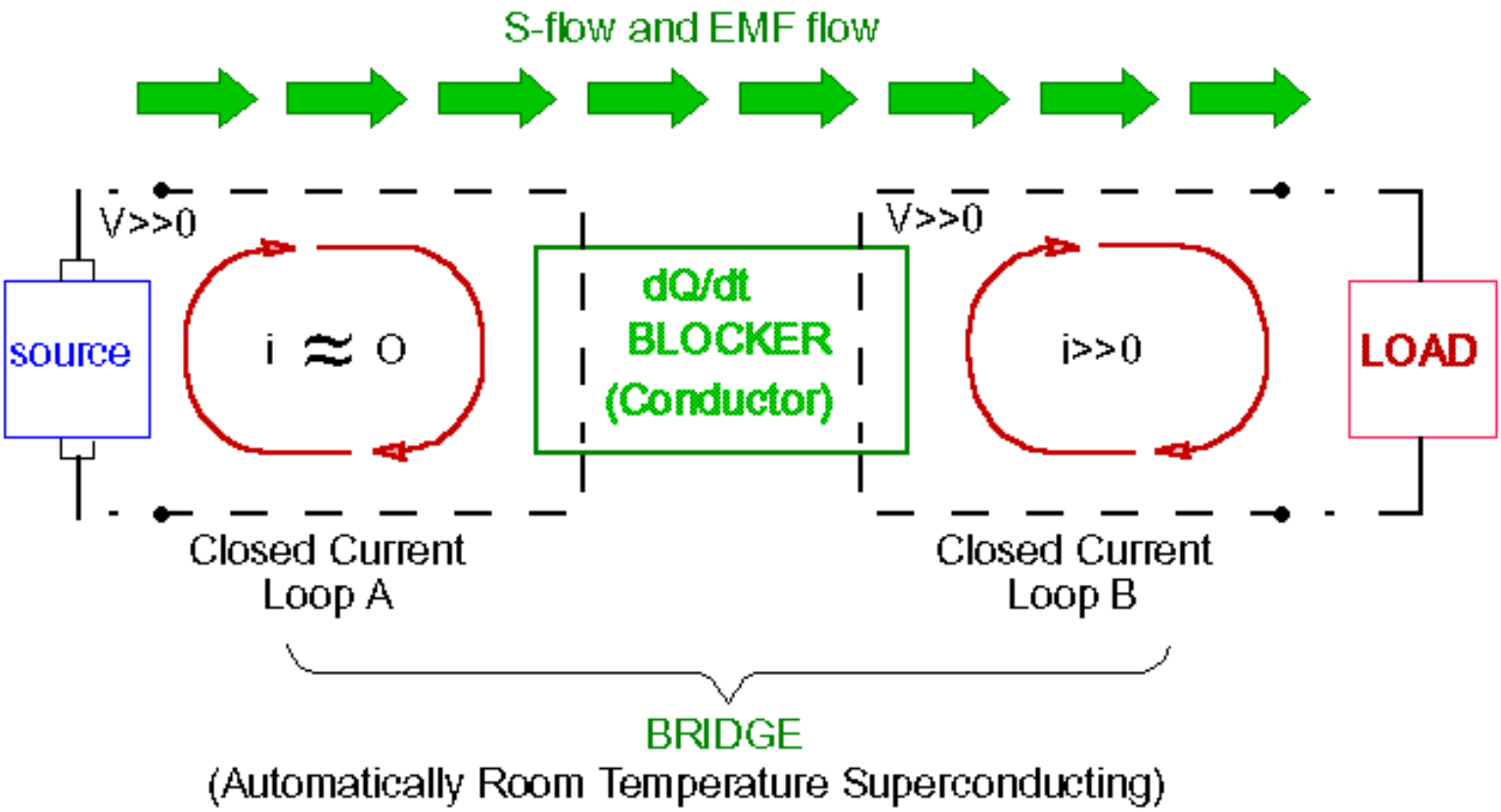

Figure 14. Bridging to enable room temperature superconductivity.

D-1-F 14 © 1995 T.E. Bearden

[17] My own approach has been, if that's all that the circuits require from our primary power source, then let's simply accept that directly from the source without performing any work in the source. Iœ you do it this way, the source is never dissipated, but will last indefinitely. Sources furnish flowing field energy density, not "energy" per se. If you only demand S-flow, you can have all you wish from a source, without exhausting your source. The trick is to find how to steadily dissipate some of this "artesian well" of flowing S to drive electrons through the load, but without driving electrons back through the back EMF of the source.

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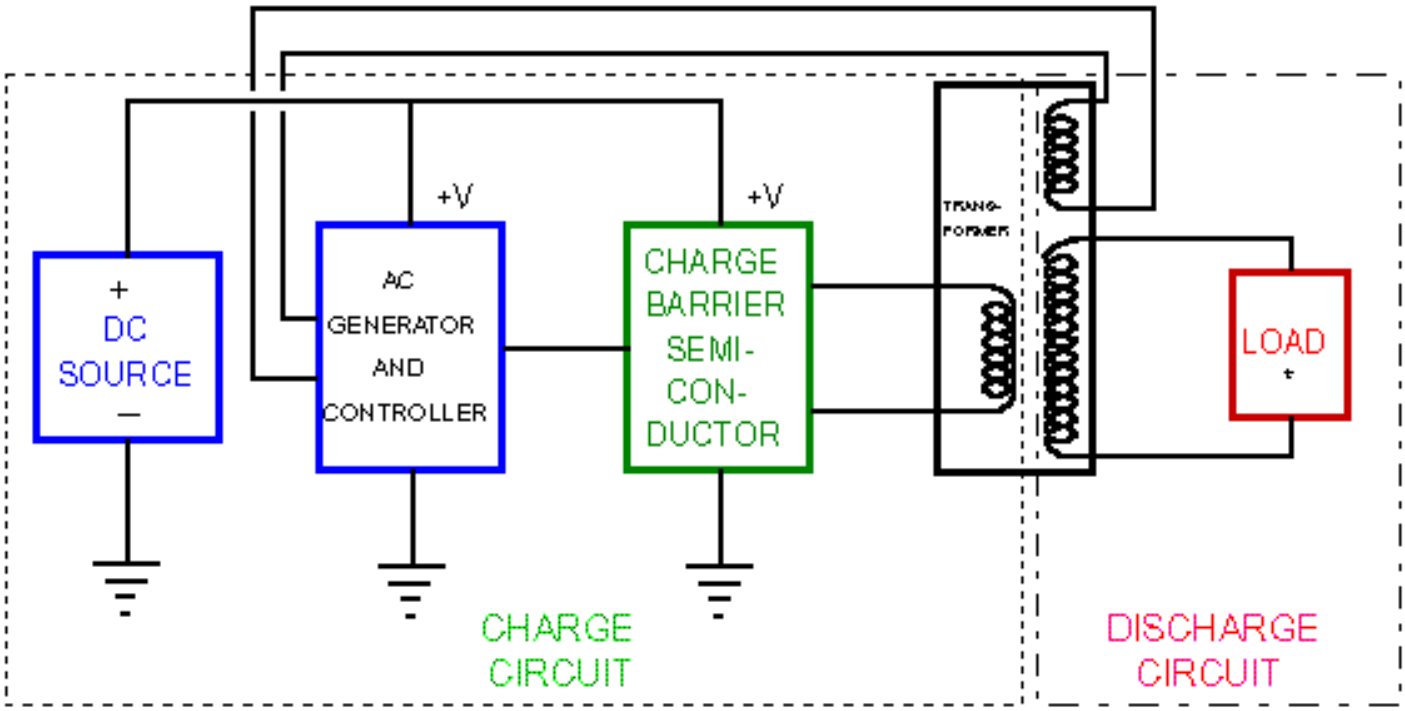

Patent Pending

* NOTE:
DISCHARGE CIRCUIT AND LOAD GROUND
MUST BE ISOLATED FROM THE
CHARGE CIRCUIT GROUND.
FEEDBACK LOOP MUST BE RIGIDLY CLAMPED AND LIMITED.

Figure 15. Use of Fogal semiconductor for overunity (closed system).

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Obviously, the laws of physics and thermodynamics require such an overunity machine to be an open system that extracts and utilizes excess energy from an external source. In the case outlined, we extract the excess energy directly from the vacuum in the form of S-flow; essentially we convert our primary source to a Poynting generator rather than a "power" (energy flow loss rate) generator. The resulting overunity machine accomplishes both room temperature superconductivity and also overunity coefficient of performance (Figure 16). It does not violate the conservation laws of physics. It does not violate the second law of thermodynamics because it is an open system receiving and utilizing excess energy from the vacuum, and the second law need not apply to such systems. [note 18]

You see, all power systems are already free energy density flow sourcing systems, if we but use them correctly. Every dipole is a "gating device" for extracting excess field energy density flow from the violent bidirectional flux exchange between the vacuum and each end of the dipole. [note 19] [note 20] When we attach "conducting leads" to a dipolar source, as in the simple two-wire circuit, all we are doing with the conductors is providing waveguides for the extracted S-flows from the vacuum to flow along (it flows outside the conductors) without loss. In effect, each lead is simply extending the pole (i.e., the terminal) to which it is connected.

My associates and I are also working on several other inventions at present, including two more patent applications to be filed in the near future. One of those is in the field of overunity power systems, while the other is in an entirely different, highly proprietary nuclear effort. I will address all these areas in future columns, and those columns will have real "meat" in them.

Present "big science" proclaims that overunity electrical machines are impossible. The reader should understand that the U.S. Patent and Trademarks Office is never going to grant a patent for an overunity electrical machine unless the machine is independently tested and replicated, and unless it is certified by scientists of impeccable credentials. This is as it should be. Legitimate free energy researchers accept that dictum. Eventually the stuff has to work on the bench in order to be validated. On the other hand, free energy researchers also point out that one must not demand of us the next 100 years of national research by a hundred major laboratories immediately! This is still a shoestring operation, because all conventional sources of research funds are denied to the serious overunity researcher (with the single exception of occasional personal funding of a researcher by a private individual). In other words, we demand at least the same kind of consideration that the orthodox nuclear fusion community has enjoyed. Billions of dollars have been poured into that sinkhole, and not a single controlled fusion power unit is working anywhere in the world after decades of work at enormous expense to the taxpayers.

So we overunity researchers deserve at least a decade or two of our own, to try to accomplish overunity electrical system development. We also painfully point out that "Big Science" will not fund a single overunity researcher, for specific overunity purpose, no matter what his credentials or capability. In fact, "Big Science" is part of the problem, because it fervently seeks to prevent any legitimate research in overunity. To carry out its suppression campaign. it resorts to vilification, character assassination, libel, and slander of the overunity researchers themselves __ again, regardless of their qualifications or legitimate scientific procedures. [note 13]

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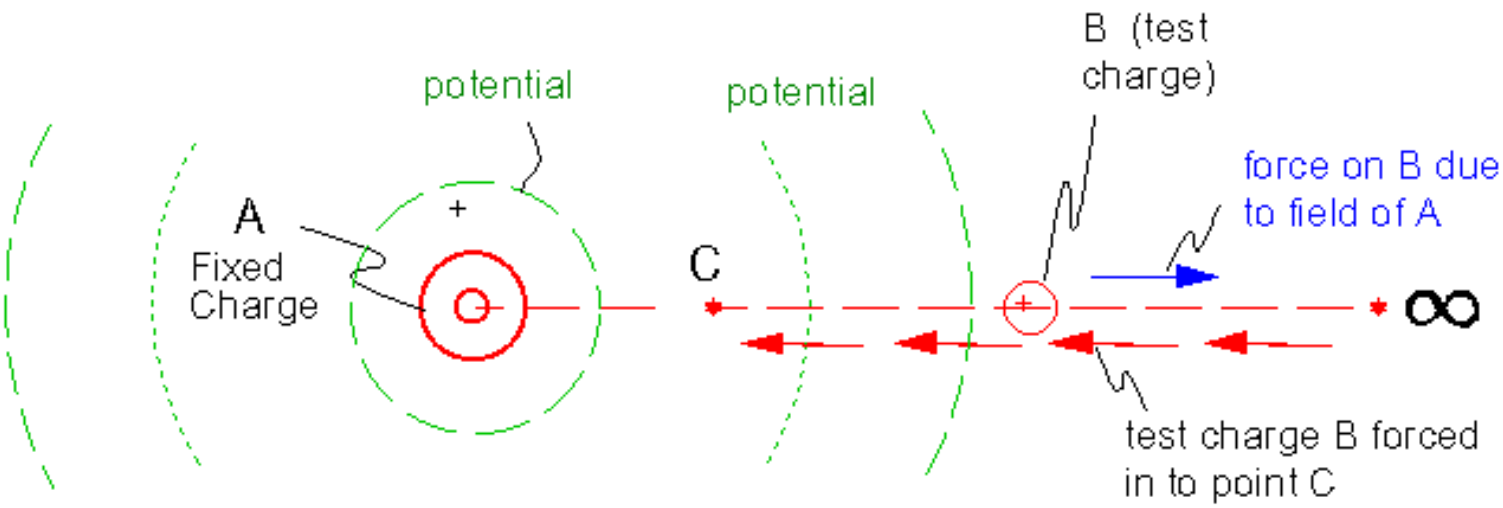

Figure 16a. Magnitude of the scalar potential is determined by work required to push in a unit charge from infinity; e.g., against a repelling like charge. If test charge is released, work will be performed upon it to translate it back toward infinity

Figure 16a. Process for overunity coefficient of performance.

D-1-F16A

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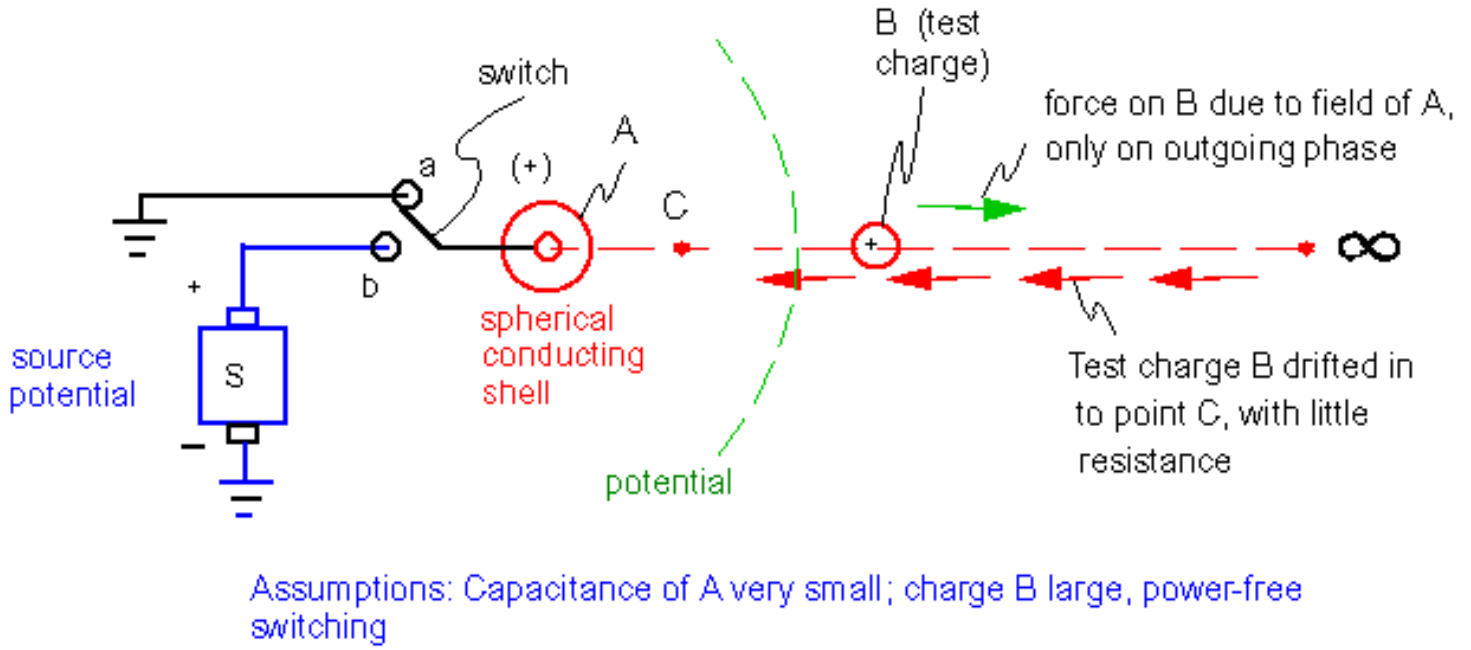

Switch potential off, drift in test charge B, switch potential back on. Can now get free work from repelled test charge B. Get much more free work if A is at a high potential, and charge B is large.

Figure 16 b. Demonstration of overunity efficiency.

D-1-F16B

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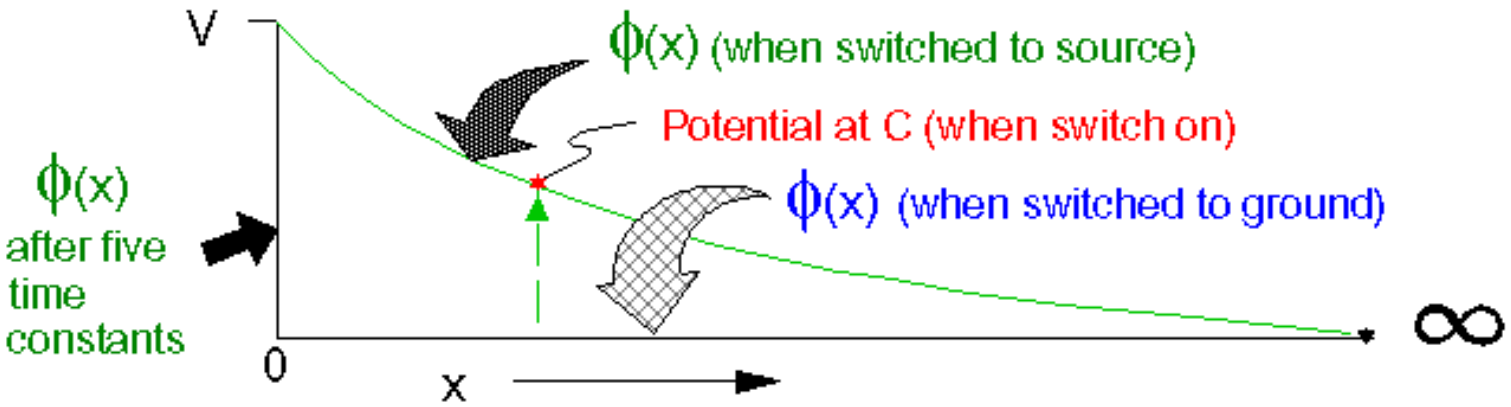

Ideally, switching the potential, rather than flowing charges, requires only minuscule overhead energy dissipation

Figure 16c. Potential to which test charge is exposed.

D-1-F16C

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[18] The system does comply with the nonlinear thermodynamics of a system œar from equilibrium. E.g., Prigogine received the Nobel Prize œor significantly developing this new field. For a detailed technical presentation of nonlinear thermodynamics of a system far from thermodynamic equilibrium, see G. Nicolis and I. Prigogine, Explorinq Complexity, Piper, Munich, 1987. Such systems can exhibit negentropy, self-organization, and other effects outside the confines of classical thermodynamics. Since local symmetry is broken, they can also permissibly exhibit overunity coefficient of perœormance.

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[19] Each end 0œ a dipole has its own potential (with respect to the local vacuum), which differs from the potential of the surrounding ambient vacuum. For each of these "end-potentials," one can mathematically decompose that end-potential into a hidden bidirectional set of harmonic wavepairs in harmonic sequence. Each wavepair consists of the wave and its phase conjugate. For the proof, see E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," Mathematische Annglen, Vol. 57, 1903, p. 333-355. Since one of the dipole potentials exceeds the local vacuum potential and the other dipole potential is lower than the local vacuum potential, the two bidirectional EM wave flows are at or "carry" different equipotentials. This is the generatrix for the automatic dual œ1ow of energy from the vacuum through the dipolar power source and out along the two leads of the "transmission line" conducting the S-flow to the components of the circuit for powering the loads. So as can be seen, rigorously every dipole is already a "free energy source" if we learn how to properly use it. The energy will flow forever, if we do not allow the destruction of the sourcing dipole.

---

[20] See also E.T. Whittaker, "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," Proceedinqs of the London Mathematical Society, Series 2, Vol. 1, 1904, p. 367-372. Here Whittaker shows that the fields of classical electromagnetics can be replaced by scalar potential interferometry of two potentials. Our own comment is to note that by Whittaker 1903, we can with a little difficulty make artificial potentials with deliberate substructures. We can then interfere those potentials (actually, interfere their hidden multiwave structures) even at a distance, to create new EM fields. Or we can dissolve EM fields that exist at a distance, simply by constructing the correct negative EM fields by distant scalar interferometry. My point is that, when we utilize the "inner" electromagnetics inside the potential, we are employing a vastly more powerful electromagnetics of a new kind, which includes and extends the present inadequate EM theory.

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Indeed, orthodoxy has a black record with respect to energy. When Mayer advanced the conservation of energy law, orthodoxy hounded him unmercifully. He was universally ridiculed as the very epitome of a fool. He lost his job and suffered a nervous breakdown. Then years later toward the end of his life, scientists came to accept the conservation of energy as a most useful tool that dramatically simplified much of their analyses. So then science began to laud Mayer. There are a thousand other such examples; suffice it to say that "big science" is a bureaucracy and a "bell-shaped distribution curve" just like any other large group of people. Some scientists are near-angels. Others are near-devils. The vast majority are neither, but are just ordinary persons doing a special kind of job. In the scientific bureaucracy, however, the manipulative scientists scurry, slash, and manipulate their way toward the top. So the leadership of any big bureaucracy __ including the scientific bureaucracy __ is always rife with such near-scalawags and power-hungry individuals. Scientists are not exceptions to the same human weaknesses that we all evidence. If you really want to see jealousy, backbiting, and fierce "back-room dealing" and power-struggling, just get into a university research environment! But because the "power merchants" of any bureaucracy always fiercely resist any challenge to their position or superiority, big science has always fiercely resisted anything truly revolutionary. And today they also enlist the power of the state to enforce their dictums. We will devote one of our future columns to pointing out some glaring examples of persecution of independent researchers by big science. It is an area that all unorthodox researchers should be well-aware of. The world of science does not run by sweet reason and lofty ideals; that is just the dogma. It runs strictly by "who's going to be the big monkey," just like everything else. Primate dominance is still a dictum of the functioning of all bureaucratic human systems.

The free energy researchers are not working on the so-called "perpetual motion machine," where a closed system is erroneously stated to produce more output than must be put into it to operate it. That old saw is actually a red herring that dogmatic scientists use to vilify free energy researchers. It is a lie that they have also successfully sold to the U.S. Patent and Trademarks Office. Anyone with a modicum of knowledge of modern physics already knows that there does not exist a single closed system in the universe, anywhere. In particular, every physical system is continuously "open" to the violent exchange of energy with the surrounding vacuum. It's just that most systems are in local equilibrium in these flow exchanges, except for minuscule gating accomplished for such things as the Lamb shift, etc.

By analogy it's something like this. The free energy researcher is standing by the banks of a mighty, rushing river with breathtaking falls, turbulent areas, etc. Big Science is begrudgingly admitting that, yes, there is a river there, but it is an insane delusion to think that you can tap that energy. The free energy researcher is saying that, well, if I can build a gating sluice a little distance upstream, perhaps I can divert a small portion of the river's flow downstream to my waterwheel, and power my mill. The orthodox scientist then vilifies the free energy researcher for even having such a heretical thought. In fact, says the orthodox researcher, any fool can see that the laws of nature force the river's flow to stay firmly in its banks, because it is a closed system, and Moses brought that law down off the mountain with him on a special stone tablet. Then he adds all the other smug remarks such as, "If it could be done, then we at MIT and Harvard and Caltech would already have done it!" So until the orthodox scientist develops a little less dogma and a little more common sense, and learns the difference between a scientific discussion and a dogfight, the free energy researcher can hardly communicate with him.

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The goal of the legitimate free energy researcher is to find a way to break the local equilibrium of this universal energy exchange, and gate a tiny bit of it up into the external circuit as excess electrical energy (Figure 17). Then he must collect the excess energy, and shuttle it from the "gating and collecting circuit" over to a dq/dt-closed current loop containing the load. He must also prevent the load current, or most of it, from passing back through the primary source against its back EMF, because if it does that, he will destroy the separation of charges in the dipolar source, killing the dipole and extinguishing the "excess energy gating." In other words he must find a way to process and transport the energy flow across dq/dt-blocked bridges between the source's closed dq/dt-current loop and the load's closed dq/dt-current loop. Ruthlessly it is an energy transport S-flow problem, not a J* energy transport problem. If he uses J* in his sourcing current loop, he automatically drives the current dq/dt back through the back EMF of his source and kills it. If he does not drive dq/dt back through the source, the source will furnish S-flow for an indefinite period! Every battery and generator we have ever built is already a "free energy" machine in that it already involves broken local symmetry in the vacuum energy exchange. We have just not realized how to use our power sources purely as Poynting S-flow sources.

So we must treat an electrical system as an open system with broken local symmetry (Table 3) in the vacuum flux exchange, so that the system extracts (gates) excess energy from an external source. In this case the source is the system's flux exchange with the vacuum. This approach is no more mysterious or bizarre than putting a waterwheel in a river, or a windmill in a wind, or a bank of solar cells out in the sunshine. The universal "free source of energy" that the overunity researcher seeks to tap is the violent exchange of virtual photons between the electrical charges of the system and the surrounding quantum mechanical vacuum (Figure 18). In quantum physics this powerful, energetic exchange of the vacuum with electrical matter is now proven both experimentally and theoretically. It is already accepted in quantum physics that the vacuum is filled with electromagnetic energy. The researcher doesn't have to prove it anymore; he just has to find out how to properly use it. The artesian well is already there; we just have to learn how to collect and use the flowing water without dynamiting the well!

The remaining objection orthodox scientists usually raise against the notion of extracting vacuum energy has been that "thermodynamics doesn't permit it." However, Cole and Puthoff have rigorously shown that, on the contrary, the theory of thermodynamics does not prohibit the vacuum's energy being extracted and used to produce heat, light, and power. [note 22] So the validity of that final objection has now vanished.

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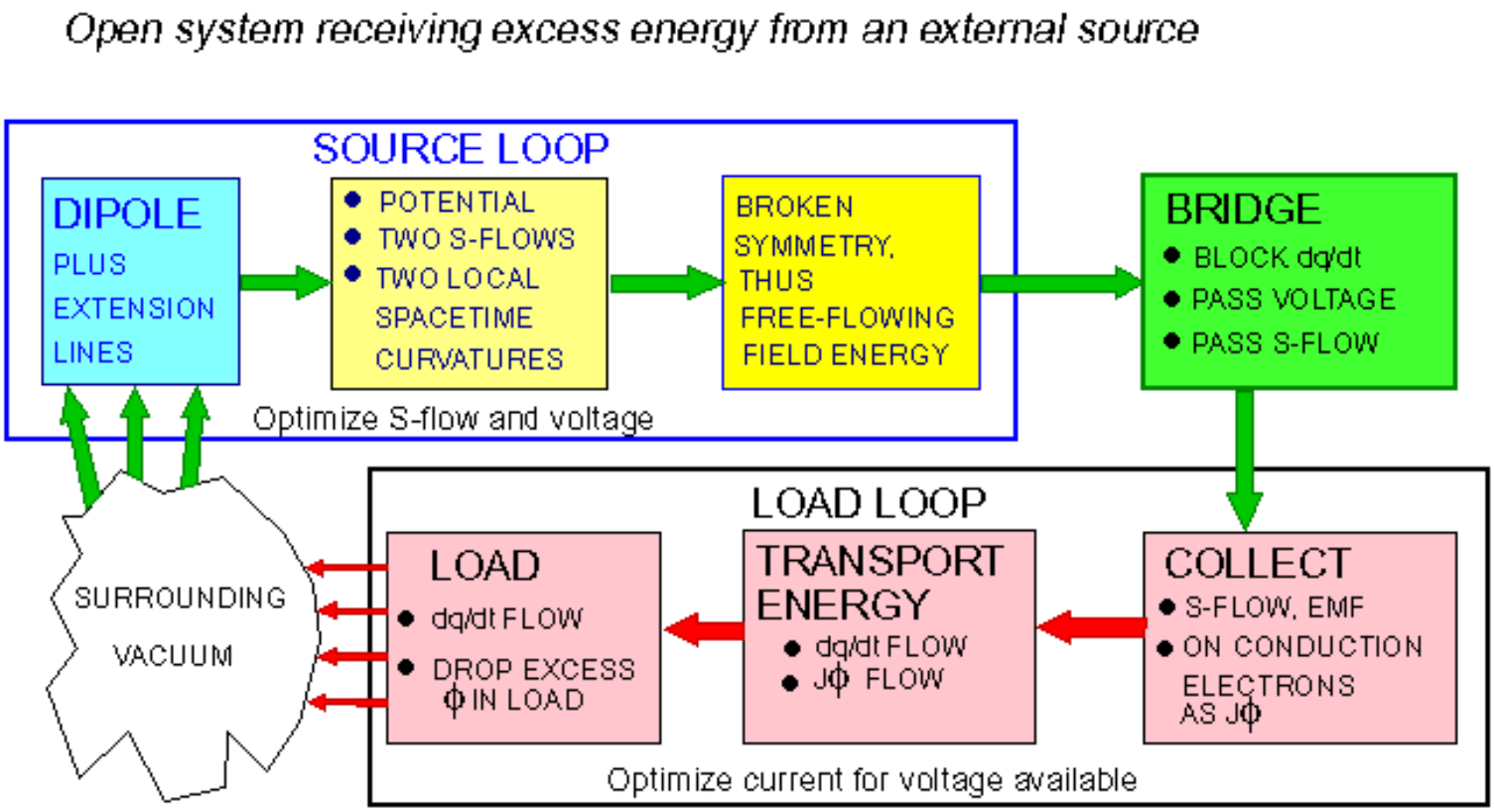

Figure 17. Operation of an overunity electrical power system.

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Table 3: Asymmetry and modern physics.

Per T.D. Lee, Particle Physics and Introduction to Field Theory, Harwood Academic Publishers, New York, 1981, p. 378-390.

SYMMETRY AND MODERN PHYSICS

- Missing symmetry of matter
- Symmetry only of mass and vacuum
- Vacuum excitation
- Vacuum structures
- Spontaneous symmetry breaking
- Interaction between matter and vacuum
- Possibility of vacuum engineering

SOME PROVEN ASYMMETRIES

- Positive and negative signs of electric charge
- Time reversal
- Right/left handedness

STRONG LOCAL ASYMMETRY

- Properties of object may differ appreciably for:
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another

STRONG LOCAL ASYMMETRY (CONT'D)

- Local spacetime is curved
- Lorentz invariance of vacuum violated
- May be local sink or source
- EM gravitational/inertial effects
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation

WHEN SYMMETRY IS VIOLATED

- A "non-observable" turns out to be an observable
- An invariance is broken
- A conservation law or selection rule is broken

COMMENTS:

- A virtual object becomes an observable object
- Local spacetime becomes curved, at least to some potential involving that object

D-1-T3

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A Charged Particle Is a Coupled System

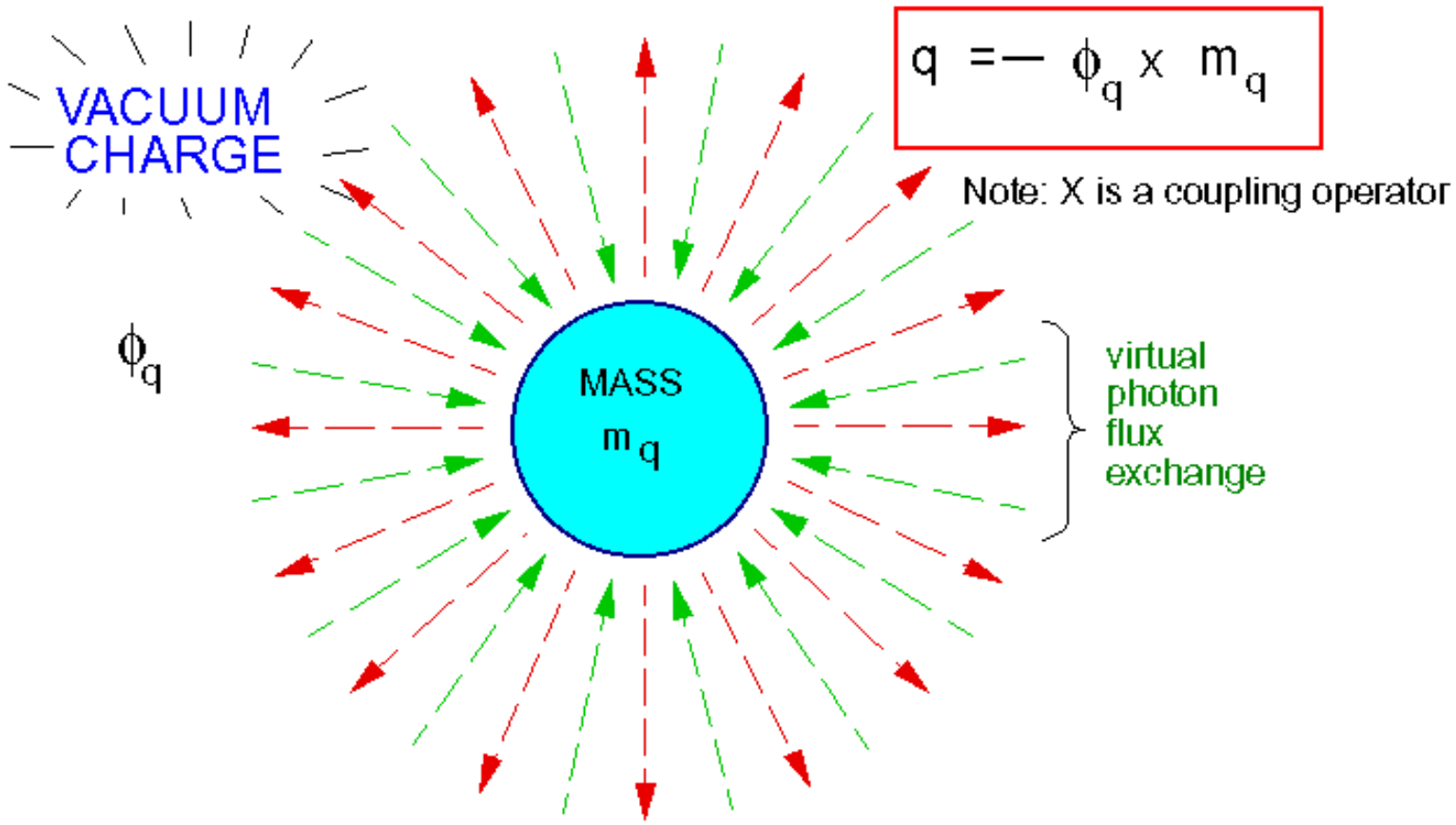

Figure 18. An electric charge q is a broken symmetry. It continuously and violently exchanges energy with the vacuum.

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[22] Cole, Daniel C. and Harold E. Putboll. (1993) "Extracting Energy and Heat from the Vacuum," Physical Review E, 48(2), Aug. 1993, p. 1562-1565.

And there is mind-numbing energy density there in the vacuum, waiting to be extracted. The well-known Lamb shift, e.g., in a single hydrogen atom is due to that vacuum exchange. [note 23] Interestingly, the calculated energy density of the exchange causing the Lamb shift is greater than the surface energy density of the sun. Different physicists have made various theoretical estimates of the energy density of this seething vacuum. A conservative ballpark figure is something on the order of 1090 grams per cubic centimeter, expressed in mass units.

It has also been my good fortune to know and work closely with several other free energy researchers. I was a colleague of Floyd ("Sparky") Sweet (recently deceased) for about seven years; Sparky held a Master's degree in EE from MIT and had years of experience with General Electric and other firms. He was a highly skilled researcher who invented the solid state vacuum triode amplifier (Figure 19), a unit which produced 500 watts of output and a coefficient of performance of 1,500,000. I personally tested the machine, activated the magnets on one occasion, and understand how it all worked. [note 24] The paper [note 25] I co-authored in 1991 with Floyd is still the only paper in the orthodox engineering literature that reports (a) successful overunity functioning of a solid state magnetic device, and (b) a successful antigravity experiment on the laboratory bench, reducing the weight of an object by 90%. [note 26]

We stress again that a legitimate overunity electrical machine must be an open system, receiving excess electrical energy from the surrounding vacuum. As such, it must operate in a higher topology than normal electrical machines (Figure 20).

My good friend Frank Golden has long been a close colleague. Years ago Frank developed a motor that produced overunity efficiency, but then to our astonishment we found (courtesy of Bill Tiller, [note 27] with whom we were working at the time) that its operation depended upon a 5-year-long conditioning (structuring) of the local ambient potential in order to work. Previously we had been entirely unaware that one can sometimes condition the local vacuum and the local matter in the area with a particular dynamic form. Given the local conditioning, a motor with that form will then work in that vicinity, but not necessarily elsewhere at an appreciable distance away. We now understand the mechanism for such "conditioning of the vacuum." We also now know what to do if an overunity machine is actually a machine of that type (many of them are not). In other words, we know how to convert it to a machine that will work anywhere, anytime. We will be addressing such little-known things in future articles.

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[23] Lamb, W.E. Jr. and R.C. Retherford. "Fine structure of the hydrogen atom by a microwave method." Physical Review, Vol. 72, 1947, p. 241-243. Lamb received the Nobel prize for this work.

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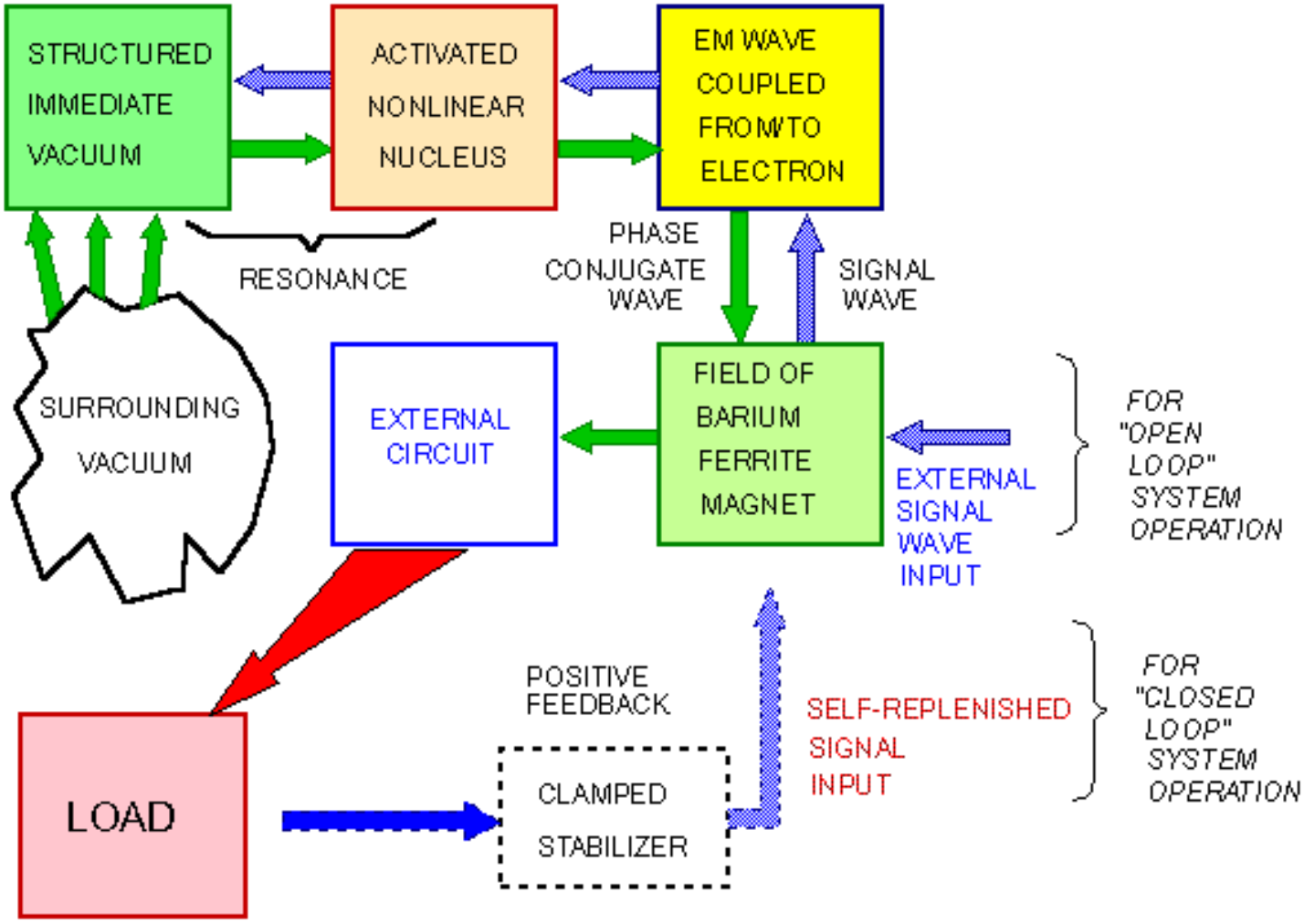

Figure 19. Block diagram of the Sweet Vacuum Triode Amplifier.

Adding positive feedback circuit enables self-oscillation.

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[24] Unfortunately Sweet made conflicting agreements with multiple backers, resulting in a most thorough legal foul- up. It appears that nothing can ever be done with this machine, because its status is a legal nightmare.

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[25] Floyd Sweet and T. E. Bearden, "Utilizing Scalar Electromagnetics to Tap Vacuum Energy," Proceedings of the 26th Intersociety Energy Conversion Engineerinq Conference (IECEC '91), Boston, Massachusetts, 1991, p. 370-375. Paper also distributed over Internet.

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[26] The unit was specially rigged and "pushed" to 1,000 watts output to perform the antigravity experiment.

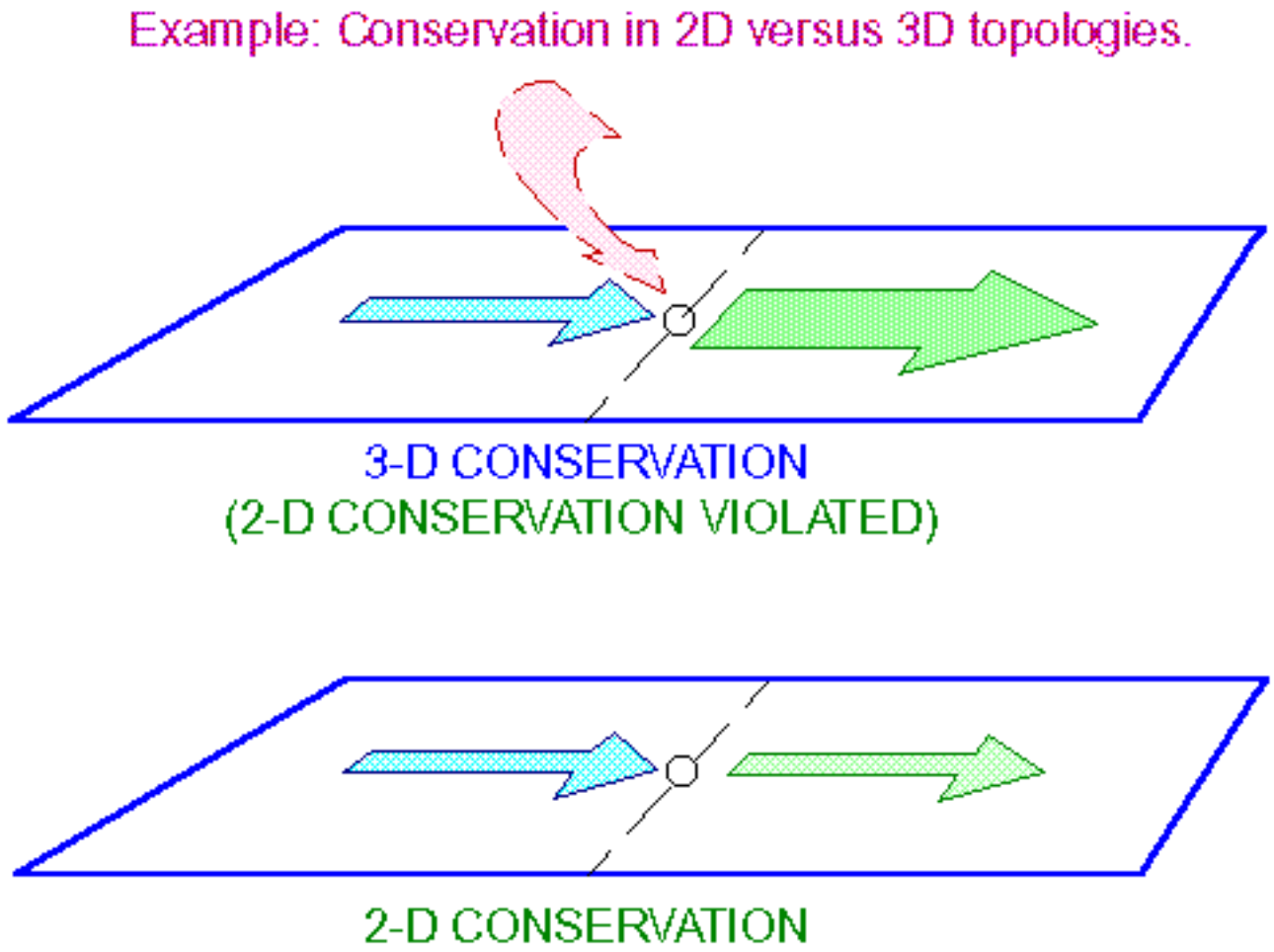

Figure 20. Increasing the dynamic topology allows lower topology conservation laws to be violated. Conservation now applies in the higher topology, but not necessarily in the lower. The lower topology system is now an open system and may seemingly act as a source or sink.

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[27] Tiller was already familiar with the fact that devices that function by more subtle energy often require special conditioning of the vacuum spacetime. He expressed it as "an archetype must first be created for the machine to function efficiently." Tiller had previously experimented with such an effect for several years.

John Bedini is also a close friend and colleague; John built several experimental motors (both electrical and magnetic) in the overunity area, and performed successful trans-mutation experiments. John is a recognized genius in high-end sound amplifier development. Many audiophiles worldwide still swear that the Bedini amplifier is the best and sweetest-sounding audio amplifier ever built. One of John's battery-powered electrical motors (Figure 21), for example, ran continuously off its battery for about five years, and kept the battery charged. When you realize that such a small electric motor is only about 35% efficient, then you realize that about 65% of the energy flowing out of the battery was being dissipated in the motor as heat, core losses, etc. So the unit was continuously performing work for that five years. [note 28] The 1/8 hp motor represented a load in which the continuous rate of work being done (the rate of energy dissipation) was about 0.08 hp. We will have more to say on this motor and its technical process in a future article.

Bill Fogal is a close colleague; Bill has patented the world's first dq/dt-blocking semiconductor, [note 29] which partially blocks the normal current while continuing to pass the flow of voltage (Table 4). I have written a proprietary technical explanation of the Fogal semiconductor, which utilizes an extremely little-known feature called the "overpotential." The overpotential part of the theory is experimentally proven and theoretically explained in an obscure part of electrochemistry, by a few chemists who specialize in electrode effects. J. O'M. Bockris is probably the leading world expert in overpotential theory; he authored the textbook on it. [note 30]

One of the latest overunity developments is the magnetic resonance amplifier (MRA) developed by Joel McLain and Norm Wooten (Figure 22). Earlier testing disputed the overunity functioning. More recent testing at several well-known laboratories has resulted in the instrumental measurements clearly showing overunity. While the test institute scientists themselves may be willing to attest to overunity results of their testing, none of the corporate heads will allow it. I have personally stated that the MRA is capable of overunity. Our own measurements had to be discarded because we did not have the proper instruments available. E.g., all our oscilloscopes were "hard grounded" to building ground, and we needed to make "floating differential ground" measurements in order to settle things once and for all. McLain and Wooten have filed for a patent, and multiple tests with excellent equipment have indeed indicated overunity. What happens next remains to be seen. I suspect that the two inventors may simply accept foreign capital investment and go offshore.

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WARNING: Highly dangerous operation. Pulsed battery outgasses hydrogen gas and explosion is possible.

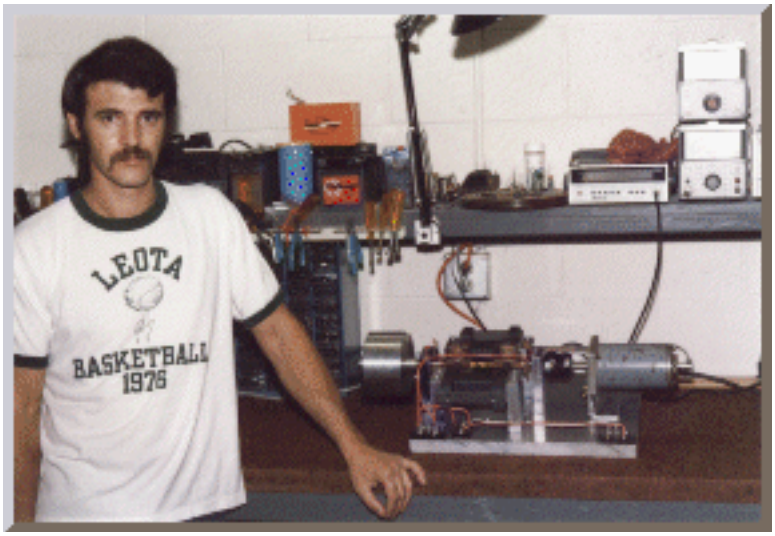

Open system using higher topology extraction of excess vacuum energy. Uses sluggish reversal and recoil time of lead ion onrushing current versus rapid backlash of amplified voltage discharge from a magneto ignition coil, to force the battery to act as an excess S-flow collector during the ion-current charging half-cycle. Thus the inefficient motor is continuously powered and the battery is continually recharged.

Figure 21. Bedini's battery-powered, back-popping electric motor.

D-1-21

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[28] We strongly emphasize that there is no conservation of work law in physics! It is the overall energy of the universe that must be conserved, not work. More rigorously, the flow of energy must be conserved. But from a free flow of energy, you can continuously extract a little and dissipate it as work, without cutting off the main flow and without violating any of the laws of physics. If this were not so, then waterwheels, windmills, and solar cells would not work. In fact, you can even do better than that. The basic energy conservation law is this: Energy can neither be created nor destroyed. So even when you "use" (i.e., dissipate or scatter) the energy, it is still there. It is only the hierarchical ordering of the photons that constitutes entropy. Each individual photon is perfectly ordered and still contains all its energy. By retroreflection, you can even cause those disordered photons to gather back in your system into perfect order once again and then you can scatter them again to do some more work. You can use the same energy over and over again! The perfect retroreflection is more easily accomplished by phase conjugate reflection. For a vivid example of just such retroreflection of previously scattered EM energy to restore the former order, see David M. Pepper, "Applications of Optical Phase Conjugation," Scientific American, Vol. 254, No. 1, Jan. 1986, p. 74-83. See particularly the striking photographic demonstration of time reversal of disorder on p. 75.

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[29] William Jay Fogal, "High gain, low distortion, faster switching transistor." U.S. Patent No. 5,196,809, Mar. 23, 1993. Also William J. Fogal, "High Gain, Low Distortion, Faster Switching Transistor." U.S. Patent No. 5,430,413, July 4, 1995.

Table 4. Fogal's Semiconductor.

FOGAL'S CHARGED BARRIER SEMICONDUCTOR

- BLOCKS ELECTRON CURRENT FLOW dq/dt
  - AS CAPACITOR CHARGES, ELECTRONS IN EMITTER JUNCTION ATTRACTED TO PLATE
  - CHARGING PLATE PRODUCES HIGH BARRIER VIA PROPRIETARY MECHANISM
  - AC CONDUCTION ELECTRONS CANNOT PENETRATE BARRIER
  - AC POYNTING FLOW S, dϕ/dT, dE/dt PASS THROUGH BARRIER
- PASSES POYNTING FLOW S = E X H; dE/dt
- SEMICONDUCTOR BECOMES "ENERGY PIPE"
- WITH dQ/dt BLOCKED, FLOW OF S = E X H IS NON-DIVERGENT AND WITHOUT LOSSES
- FOGAL CHIP UTILIZES S = E X H FLOW TO TRANSPORT ENERGY, RATHER THAN Jϕ

D-1-T4

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[30] In a correspondence with Bockris lasting several years, he had graciously furnished me with material on the overpotential, which is how I found out about this esoteric area. Bockris is well-known as a leading scientist on the chemistry of hydrogen, and also as one of the leading scientists in the rapidly developing field of cold fusion. He is a marvelous scientist, and one day his largely unsung work with the overpotential will revolutionize the entire electronics industry.

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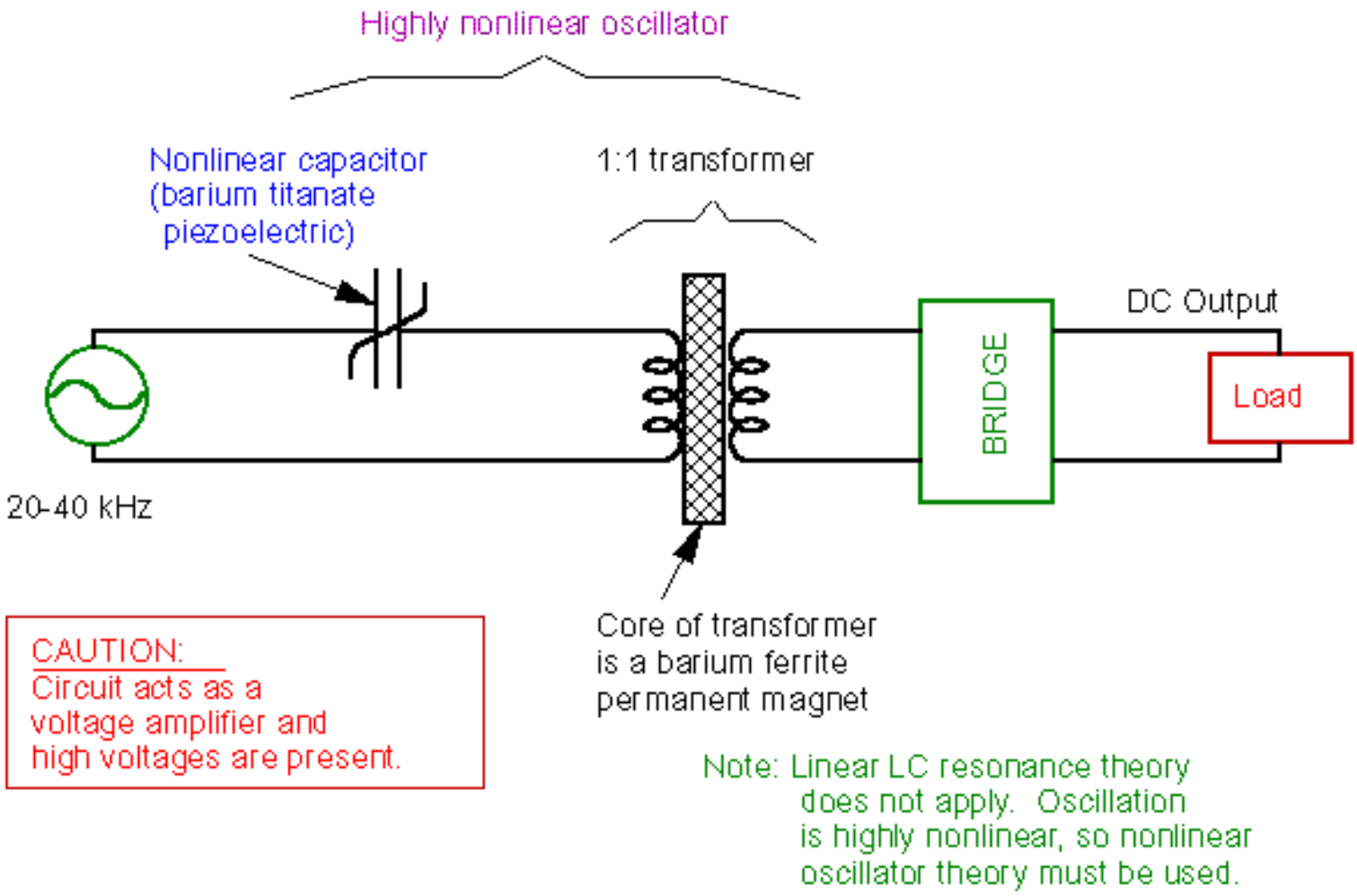

Figure 22. Schema for the magnetic resonance amplifier (MRA).

D-1-F22

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Howard Johnson is also a respected colleague, whom I very much admire. (See Figure 23). Howard has continued to work quietly and patiently upon his patented permanent magnet motor, [note 31] including patenting various magnetic gates, etc. that are necessary to make such a motor work in a rotary configuration. [note 32] Howard employs a two-particle theory of magnetism; i.e., each magnetic flux line is envisioned as having a particle traveling from the north pole to the south pole, and also a particle traveling from the south pole to the north pole. The particles are spinning; the forward-time particle spins in one direction, and the antiparticle spins in the other direction. Howard then slightly separates the two particle flows. [note 33] In other words, Johnson splits the flux lines themselves, into two different pieces. When so separated, the component lines are now curls, so their paths curve. The paths of the two "curl particles" are different; one curls in one direction and the other curls in the opposite direction. Further, a predominance of one form of curl particle gives a "time-forward" aspect, while a predominance of the other form of curl particle gives a "time-reversed" aspect. Johnson is thus able to employ a deeper kind of magnetism than the textbooks presently contain. He demonstrates that a "spin-altered" magnetic assembly exhibiting (to a compass or other such detector) a north polarity can attract another unaltered magnetic assembly exhibiting a north polarity. In short, he can make a north pole attract a north pole. We will give you further insight into Johnson's two-particle theory in a future article. [note 34] We will also explain how and why the physicists missed that antiparticle in the magnetic field's flux lines, and thereby failed to advance the theory of magnetism to a deeper level. Make no mistake, one day when the new theory is done, Johnson may well be awarded a Nobel Prize for his epochal discovery of a deeper structure of magnetism.

Bits and pieces of the new science approach are just now beginning to spill into a few conventional journals and symposia. For some time a few of the rebels spearheading this new science have been doing something that the University scientists should have been doing all along. The rebels have been meticulously examining the concepts, postulates, and definitions that the present scientific models are founded upon, to reveal serious foundations errors. Corrections for some of these errors have been discovered and made. [note 35] Others are still problems yet to be resolved. Yet slow progress is being made, and a "flip-over" of the old science is likely to occur within the next decade if not sooner. By then the new concepts will have become "solid" enough to allow producing an engineering mathematical model. Also the supporting experiments will have become solid enough to justify the new concepts and the model.

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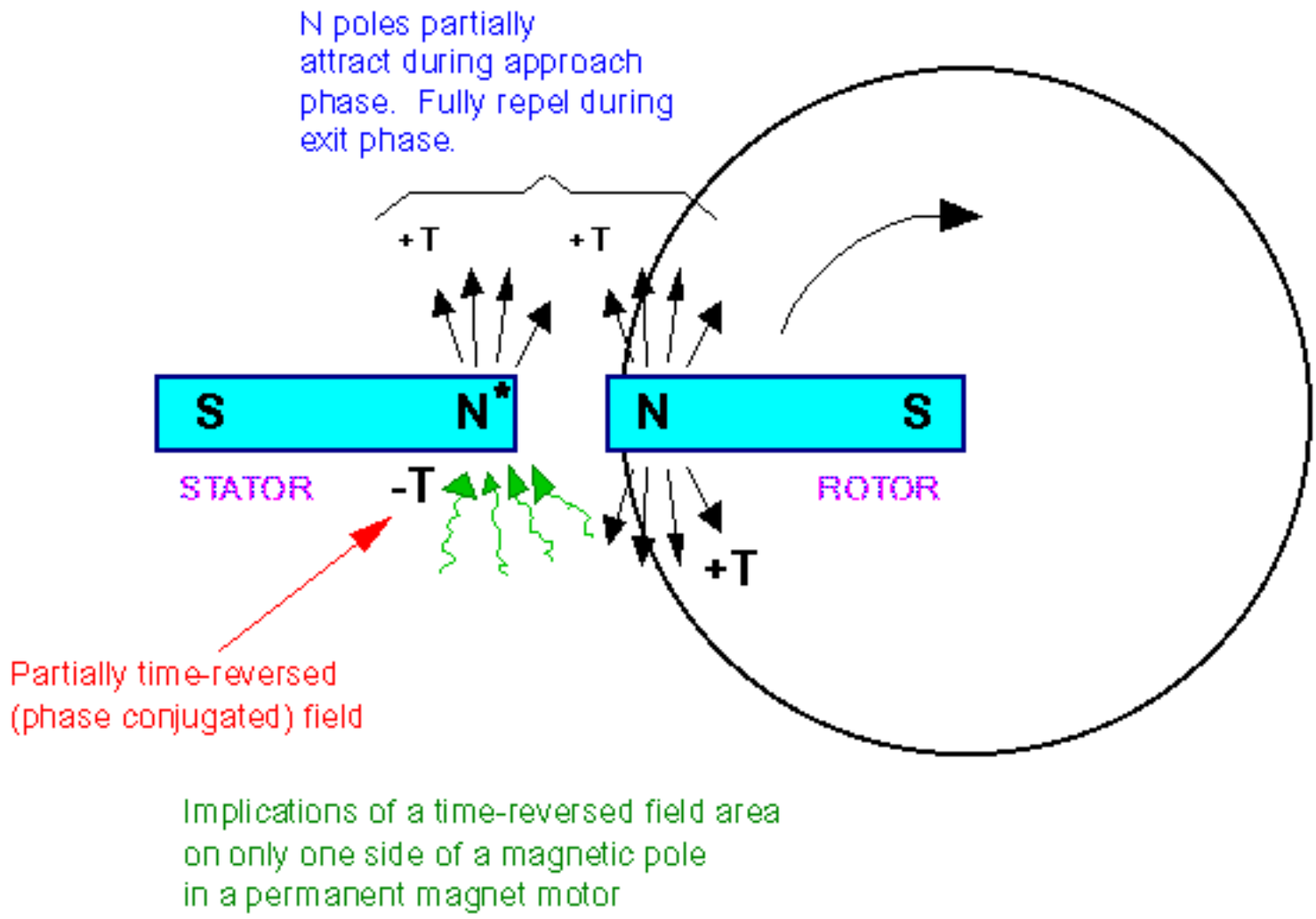

Figure 23. Schema for Johnson's permanent magnet motor.

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[31] Howard Johnson, "Permanent Magnet Motor." U.S. Patent No. 4,151,431. Apr. 24, 1979.

[[32] I personally saw and closely examined one demonstration rotary Johnson permanent magnet motor some years ago, and toyed with it for about one hour. It would definitely self- rotate as long as you wished to permit it to turn. It was not a powerful device at all, but just a small laboratory "proof of principle" prototype. It had cost Johnson an enormous amount of time, labor, and optimization to get the critical adjustment required of his two magnet assemblies. But the device had no power source other than the permanent magnet assemblies themselves. Johnson's nonlinear rotor and stator magnets interacted with each other in a manner to break local symmetry. So his machine was an open system and therefore a permissible overunity device; it was not a perpetuum mobile.

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[33] As I have pointed out repeatedly in the past, photons also carry time, not just energy. We have previously shown the process and the photon interaction mechanism that creates the flow of time itself; we will discuss this mechanism in the future. So when Johnson separates the particles and antiparticles, not only does he partially separate them according to spin, but he also alters the local character of time flow during which the resulting magnetic field forces must appear. In other words, he accomplishes a partial separation of time-forward and time- reversed polar interactions. A south pole is just a time- reversed magnetic north pole, in the first place! So a north pole of a bar magnet that is slightly time reversed on one side will partially act on that side just like a south pole. On the other side it will continue to act like a normal north pole. By partially time-reversing (phase conjugating) one side of the north magnetic pole piece, Johnson makes that side look and act like a south pole. that way Howard is able to create two north poles, one on a stator and the other on a rotor, and time-reverse part of one face of the stator's north magnetic pole-piece. Therefore when the proper sides of the stator and rotor north poles are facing, they attract each other, contrary to the conventional textbook. The two poles then repel each other normally as soon as the north rotor poles passes the north stator pole. Hence Johnson can make a surrounding north pole stator assembly "draw in" an approaching north pole rotor assembly, and then kick it on out the other side, because he has broken the local magnetic symmetry. In short, Johnson's magnetic gate can provide a legitimate component of unidirectional magnetic thrust, which means that he can indeed make a rotary permanent motor. Simply put, this "partially separating the spin particles," and thereby partially phase conjugating one face of a magnet, is what Johnson calls a "gate," and this is the patented secret by which his magnet assemblies can be made self-powering. The entire process is still very meticulous, and assembly and adjustments are extremely critical. With Johnson's blessings we hope to shed more light on this subject in coming articles.

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[34] For a basic article on rotary permanent magnet motors, see T.E. Bearden, "On Rotary Permanent Magnet Motors and 'Free' Energy," Raum&Zeit, 1(3), Aug.-Sep. 1989, p. 43-53.

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[35] The most blatant error in all of physics is the erroneous notion that an acting force is separate from its receiving mass. Force is defined as F ~ d/dt(mv). From that definition alone, it can be seen that the affected mass is a component of the force itself. If you remove the mass m, you do not have force but merely acceleration. The notion of force separated from the mass came from ancient and familiar experiences of pushing on stones with one's hand, etc. In this primitive case the force-creating agent (i.e., the hand) is certainly separate from the affected mass (i.e., the stone). But the "force on the stone" is actually the force created of and with the stone. It is "stone-force," not "force upon the stone." Quantum field theory already tells us that it is the absorption and emission of virtual photons by the stone's mass that "creates the force." In fact it should go one step further: It is the coupled ensemble of the virtual photon flux and the mass of the stone that constitutes a "stone-force." In your mind, you should try mentally replacing the word "force" with the phrase "mass-force" until you root out the deeply ingrained erroneous notion that force and mass are separate. Because of this archaic error, today's physics can only define a mass in terms of its resistance to a disturbing force, and it can only define a force in terms of its overcoming a resisting mass. This error has prevented any proper definition of either force or mass! But the problem is solvable. For a proper definition of mass without the notion of force, see T.E. Bearden, Quiton/Perceptron Physics: A Theory of Existence, Perception, and Physical Phenomena, National Technical Information System, Report AD-763210, 1973.

In this first article I wanted to introduce the 14 major areas. We will be discussing these areas in some technical detail in the future. We'll also include current major news items of development in these areas, for the interested lay reader. I'll particularly try to give you the benefit of extensive reference citations painfully gathered over the last 30 years. The articles will be targeted toward both the serious researcher and the interested, educated layman.

So that's the agenda for the months ahead. We hope you find this information and the approach of direct interest and use.

Again, it's a privilege to be aboard. And we invite you to hang on in the future; it's going to be a wild but exciting ride. We really are going to chase this wild dragon with great vigor.

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Novel Principles In The Rife Microscope

And Rife's Great Secret [1]

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Substantially updated Aug. 20, 2001

Foreword

In the 1930s and 1940s, Royal Raymond Rife {1} made revolutionary discoveries in microscopy, including development of novel microscopes that could see far beyond the accustomed one-tenth wavelength limitation according to Rayleigh theory. With his microscope, he was able to "see" ultramicroscopic living forms much smaller than anything considered in the observable state. It would appear that his microscope was somehow capable of peering directly into the virtual state itself, and finding living forms at that level that were far beyond anything ever suspected by conventional science, even to this day.

Obviously this work was dramatically controversial. Rife went on to develop treatment methods and devices based on the new level of living organisms that his microscope revealed. In short, he arrived at essentially a new theory of disease, and did achieve success with his—to conventional scientists—completely unprecedented devices and methods of treating and healing. While we do not discuss his treatment methods in this paper, we do discuss the methods of Prioré, whom we believe to have used similar principles. So these discussions may shed some light

on Rife's therapeutic mechanisms also.

Rife and others reported his results in the proper scientific literature. For his efforts, he was ostracized, essentially imprisoned in a medical treatment facility, broken, and rejected by his peers. His findings were harshly ridiculed and discredited. Finally escaping from his enforced confinement, Rife lived out his remaining years and died quietly and unknown.

In the present paper it is not our purpose to address Rife's theory of disease or his treatment devices and methods. It is solely our purpose to propose a higher symmetry electrodynamics functioning of his microscope, as one possible explanation of the startling microscopy results he achieved. We will reveal what we are convinced is Rife's great secret: recursive virtual state magnification (amplification) by iterative difference frequency serial summation of vacuum engines. This is a substantial change from an earlier mechanism proposed by the present author, which proved to be in error {1}.

We accent that this is not a "standard electrodynamics" examination of the Rife microscope; normal U(1) electrodynamics and transverse EM waves contain no mechanisms that can explain the functioning of the instrument. Accordingly, since no such explanation is contained in the usual electrodynamics, one must of necessity turn to those available electrodynamics models that are of much higher symmetry than afforded by vector and tensor algebra. To show the fit to experiments, we must also address an enormous amount of the work performed by Prioré and his colleagues. Only in such EM models and their known fit to actual experiments are the additional phenomena and principles available that can possibly explain Rife's epochal results.

Also, because of the importance of this unified field theory area, we include substantial references and additional extended discussions in the endnotes for further technical clarification. Thirty figures are added to illustrate the material.

The Rife Microscope

The Rife microscope { [1] } (Figure 1) cannot be made to work by normal optical principles at the level utilized by Rife. With normal optics, about one-tenth wavelength is as fine an optical resolution as one can get. Since Rife went far beyond that, it should be obvious that he was using optics and electrodynamics of a *novel kind*, and of a type not yet in the conventional textbook.

We believe we are aware of the major principles used in Rife's microscope, or at least some of them, but prior to 1998 we shied away from anything to do with the scope. My major interests have been in extracting EM energy from the vacuum and in developing a new kind of medical therapy utilizing higher symmetry electrodynamics—and thus unified field theory—to directly and slowly change cellular disease or disorder back to a normal previous state. Obviously, if one is to produce a microscope that "sees" optically further into the realm of smallness than any other microscope can conventionally do (even in theory), that microscope must be functioning in a higher electrodynamics mode rather than in the conventional one.

In this paper, we will try to summarize some deep physics principles underlying the Rife microscope, at least as we see them terms of a higher symmetry EM model, and we cite some references for the bits and pieces. A more detailed explanation must wait for a future time and assistance from very high-level theorists.

Introduction

A good hint is this: Rife (Figure 2) often painfully adjusted his microscope stages for up to *24 hours* before he finally got the instrument "focused." Immediately that shows it is not standard optical equipment. Well-made standard optics—and Rife's microscope was beautifully made—can be adjusted far more easily than that (in minutes!).

So far as we are aware, no one ever looked at the Rife work except through essentially rather orthodox electrodynamics and rather orthodox optics eyes. Normal optical theory permits resolution of about one tenth of the wavelength of the light used, and a few microscopes in the last few years have gone just a wee bit further. But none have gone anywhere to the degree of smallness that Rife reported.

In our view, the orthodox approach to explaining the operation of Rife's microscope is doomed to fail from the beginning. Even a very good scientist will fail with replication, if that approach is exclusively taken. An entire scientific team and substantial funding will not do any better, unless something technically deeper is understood and tackled from the outset. We give an overview of our approach to tackling that problem. To begin with, we must present some errors in electrodynamics and an omission in general relativity, so that we can develop the necessary background. The discussion is not simple and will require considerable development. Once the considerable background is developed, the application to the Rife microscope will be straightforward.

Errors in Electrodynamics and Adjustments to General Relativity

First, present electrodynamics itself has serious flaws and shortcomings, and needs substantial revision {[2] }. As foundations scientist Bunge points out {[3]}:

> *"...it is not usually acknowledged that electrodynamics, both classical and quantal, are in a sad state.*"

Bunge {[4] } also said:

"... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

The flaws in electrodynamics pass over into what has been constructed for optical theory—both linear and nonlinear—which just assumes the electrodynamics as a subset.

For our purpose, we need to clarify what modern electrodynamics does and does not say about the massless vacuum, and about the state and form of EM entities—such as potentials, fields, and waves—created in it (in *empty space*) by matter dynamics, or acting from it (from *empty space*) onto matter and causing matter dynamics.

Maxwell and all his peers believed firmly in the material ether, a thin material fluid filling all space and every crevice. To scientists at the time, not one single point in the universe was devoid of this material etheric fluid—this *thin matter*. The atom had not been discovered, the electron had not been discovered, and electricity was also considered a thin material fluid. Charge had no more meaning than "a piece of the electric fluid," much like a cubic centimeter of water.

Faraday {[5] } believed that the EM influence in space consisted of *material lines of force which acted as taut strings under tension from some mysterious source*. He believed that EM disturbances were just the transverse wave "perturbations" of these taut strings. In his concept, Faraday omitted the string holder or other agent producing the tensile forces upon the string (Figure 3). He thus omitted Newton's third law from his electrodynamics concept. He also omitted precisely half the energy, by omitting the equal-energy time-reversed EM wave that accompanies the formation of every ordinary EM wave we take account of. In a receiving copper wire antenna, for example, not only do the electrons interact with the incoming fields, but so do the protons in the nuclei—though highly damped in amplitude by the proton's large mass with respect to the mass of a disturbed Drude electron. However, the two energetic interactions (of perturbed protons and perturbed electrons) are of equal *energy* magnitude. So in the conductor, equal energy is expended to move the "lattice holes" (positrons) as is used to move the Drude

electrons, else field theory itself is falsified. Except in semiconductors, electrical engineers mostly just ignore the "disturbed lattice hole current" energy.

Maxwell deliberately captured Faraday's thinking, mathematically {[6] }, and so just *assumed* Faraday's lines of force and the "plucked tight string" transverse EM wave in the material ether {[7] } as well as the unexplained tension . The notion of the transverse EM wave in vacuum has essentially no other theoretical justification than that Faraday-Maxwell assumption and the observed "transverse waves" generated in the receiving "electric fluid in the conductor" in and on the Drude electrons. The transverse EM wave notion in vacuum was maintained only by discarding its missing antiwave that is always formed simultaneously in our transmitters and receivers (e.g., when we perturb the Drude electrons in a transmitting wire antenna, we also perturb the protons in the nuclei with the same energy. The two disturbances—proton disturbance in the nucleus and Drude electron disturbance in the Drude electron gas—perturb the local surrounding vacuum/ spacetime with equal energy, so in the vacuum "virtual particle flux gas" the two perturbations are energetically equal. The receiving wire receives both perturbation waves from the vacuum; one perturbs the electrons and the other perturbs the nuclei. Since the second wave is unaccounted, the perturbation of the nuclei is just considered a "mysterious force" that always appears. In a pumped phase conjugate mirror material, e.g., we interact the waves prior to their reaching the nuclei, by multi-wave mixing. Since the "causative" but neglected second wave coming in from space does not reach the nuclei, but are redirected to form the phase conjugate replica wave produced by the pumping, *the mirror does not recoil and it does not exhibit Newtonian third law reaction*. However, since electrodynamics *omits* the EM causative wave that generates Newton's third law forces in the receiver, which in normal detection always appear, then presently electrodynamic fields are erroneously said to be devoid of Newton's third law reaction. To the contrary, the effects of that hidden, neglected EM cause of the Newtonian third law reaction do appear, either as recoil of the physical receiving antenna or as the production of the time-reverse phase conjugate replica

wave in optical pumping. But in standard electrodynamics, equal-and-opposite forces in the receiving antenna are assumed to arise "mystically" or from some hidden *electrodynamic demon*. The electrodynamic cause of Newton's third law has been lost since Maxwell wrote his theory.

Maxwell, however, was careful to point out the ad hoc nature of assuming the stress in the vacuum, and that no mechanism for it had been discovered, nor was such a mechanism contained in his theory. Specifically, Maxwell said {[8] }:

> *"It must be carefully borne in mind that we have made only one step in the theory of the action of the medium. We have supposed it to be in a state of stress, but we have not in any way accounted for this stress, or explained how it is maintained. This step, however, seems to me to be an important one, as it explains, by the action of the consecutive parts of the medium, phenomena which were formerly supposed to be explicable only by direct action at a distance. … I have not been able to make the next step, namely, to account by mechanical considerations for these stresses in the dielectric. I therefore leave the theory at this point, merely stating what are the other parts of the phenomenon of induction in dielectrics."*

Indeed, we now know of electrons and their spin. The longitudinally-constrained, spinning Drude electrons in receiving wires will gyroprecess laterally in the wire when an EM disturbance from the vacuum interacts with them. (Figure 4) It is well-known that these Drude electrons are highly restrained longitudinally down the wire; the longitudinal movement is the "drift" velocity and may be nominally only a few inches per hour. The lateral precession of the longitudinally constrained, spinning Drude electrons establishes that the incoming vacuum disturbance, before its interaction with the gyroelectrons, is *longitudinal*. Else one must discard electron spin, electron gyroprecession, and

indeed the theory of gyroscopic precession itself. In our view, the EM wave *in vacuum* is longitudinal, always has been, and always will be {[9] }. It also *does not* consist of EM force fields, contrary to present classical theory. Instead, only the potentiality {[10]} for the transverse force fields—*should* the longitudinally perturbed vacuum EM entity be intercepted by a spinning charged particle and interact with it—exists in mass-free space, as pointed out by Feynman. Quoting Feynman again {[11] }:

> . *"We may think of **E**(x, y, z, t) and **B**(x, y, z, t) as giving the forces that would be experienced at the time t by a charge located at (x, y, z), with the condition that placing the charge there did not disturb the positions or motion of all the other charges responsible for the fields."*

Rigorously the force fields exist only in and of matter. In matter-free space, there is no force at all in what we call the "field as it exists in massfree space" {[12] }. E. g., Jackson states it this way {[13]}:

"Most classical electrodynamicists continue to adhere to the notion that the EM force field exists as such in the vacuum, but do admit that physically measurable quantities such as force somehow involve the product of charge and field."

But again, Jackson also states {[14] }:

> *"...the thing that eventually gets measured is a force..." "At the moment, the electric field can be defined as the force per unit charge acting at a given point. It is a vector function of position, denoted by E. One must be careful in its definition, however. It is not necessarily the force that one would observe by placing one unit of charge on a pith ball and placing it in position. The reason is that one unit of charge may be so large that its presence alters appreciably the field configuration of the array. Consequently one must use a limiting process whereby the ratio of the force on the small test*

> *body to the charge on it is measured for smaller and smaller amounts of charge. Experimentally, this ratio and the direction of the force will become constant as the amount of test charge is made smaller and smaller. These limiting values of magnitude and direction define the magnitude and direction of the electric field E at the point in question. In symbols we may write F = qE where F is the force, E the electric field, and q the charge. In this equation it is assumed that the charge q is located at a point, and the force and the electric field are evaluated at that point."*

As can be seen, much of the difficulty occurs because physicists continue to erroneously utilize an *equation* as if it were a *definition*. An equation defines nothing at all; it merely states that all the "things on the left" of the equality sign and all the "things on the right" have the same overall magnitudes. It does not *define* any of the things on the left or right, and so it tells us nothing at all about what anything in it *really is*. A definition requires an identity, not an equality. E.g., if we take as an identity the very equation advanced by Jackson's explanation above, we then have a definition:

$$F \equiv qE \Rightarrow E \equiv F/q$$

And now that identity clearly states that charged mass is a *component* of the **E**-field. Similar argument prevails for the **B**-field, etc.

The identity also shows that E is not the *magnitude* of the force field at all, but is its *local intensity* at any given point in the E field, in terms of force per unit point static coulomb—a force formed in, on, and of the charged mass of the coulomb. The misstatement that E represents the *magnitude of the field* is another great non sequitur. No textbook gives the calculation of the *magnitude* of the E-field, though all purport to. Instead, they all give the calculation of the *intensity* of the E-field at each point in it. There is a great difference between the magnitude of an automobile's mounted tire and its pressure per sq. inch on the pavement. In all fairness, some of the better texts do

use the term "field intensity", at least occasionally.

As *defined*, the EM force fields are effects produced in, on, and of charged matter and *only* in, on, and of charged matter. They are not at all the same effects produced in matter-free space (in the vacuum/ spacetime). The EM force field (in matter) is not the same as the "massfree" E-field in massfree spacetime. Ultimately, all that exists in spacetime are *spacetime* and *changes to spacetime*.

We may accurately take the mass-free, force-free EM field to be a pattern of spacetime curvatures. The coupling of this spacetime curvature set, or any part of it, with charged mass, then constitutes an EM force field. Again, the problem is the hoary old mechanics notion of having a separate massless force acting upon a separate mass. No such thing exists in all nature, and mechanics should have been rather thoroughly overhauled long ago as a result of this horrendous *foundations of mechanics* error that is centuries old.

In present classical electrodynamics—certainly the kind taught to electrical engineers and used in the electrical engineering discipline—the EM potential {[15] }, field, and wave, as they truly exist in space and in the vacuum, are rigorously not prescribed at all. Instead, the effect of the "causal entity" as it exists in vacuum prior to interaction with charged mass, is used a if it were what exists in and on the charged mass as the effect of the interaction. (See Figure 5, Figure 6, and Figure 7). This substitution of the effect for the cause is arguably the greatest uncorrected error in classical electrodynamics today. It is a hangover from the old days of the material ether, and the refusal to change the Maxwell-Heaviside equations to eliminate that material ether assumption, once the Michelson-Morley experiments falsified it. This has long been known to foundations physicists, and to most of the better electrodynamicists as well. But it still seems to be known to very few electrical engineers!

Many attempts have been made to “modify” the standard classical electrodynamics theory, but most have failed. For some reason, most of these attempted

modifications seem to have accepted the present "matter-to-matter transform" approach (Figure 8) of present electrodynamics, failing to see that the two missing transforms of matter-to-spacetime and spacetime-to-matter (Figure 9) are in fact just general relativity itself {[16] , [17] } The solution for adding the missing two transforms into electrodynamics therefore may lie in "infolding" general relativity directly within electrodynamics, rather than placing the two on an equal footing. That requires the analysis of the supersystem rather than the system, a concept which will be discussed shortly. Figure 10 shows the utilization of the "vacuum engine" that results from this "infolded GR" solution.

To our knowledge, the Sachs unified field theory {[18] a,b,c,d,e} is presently the only practical unified field theory that can be directly engineered by higher symmetry electrodynamics, such as the O(3) group symmetry EM model advanced by Evans and Vigier and perfected by Evans {[19] }. The engineering power of Sachs' theory is remarkable {[20] }, and the O (3) electrodynamics has been shown by Evans to be an important subset of the unified electrodynamics in Sachs' theory.

Let us examine that statement a little deeper.

In classical electrodynamics the sources of all EM potentials, fields, waves, and their energies are assumed to be the charges—which are assumed to somehow act as perpetual motion machines that continuously *create and pour out* all that EM energy in the fields and potentials associated with the charge as their "source". This outpouring of 3-space energy comprising and establishing the associated potentials and fields eventually fills all space with energy. All the charges and dipoles present in the universe since shortly after its formation have done this for some 14 billion years.

Yet in classical EM—with all the existing charges in the universe implicitly assumed to continuously pour out energy into all of space, and most having done so for billions of years—inexplicably space is *then*

considered to be an emptiness having no interactive energetic exchange with the charge at all {[21] }. That of course is a non sequitur because it involves a total contradiction of the conservation of energy law. If there is no active energy in spacetime for the charged particle to receive and then output in 3-space, then the energy conservation is falsified by every charge and every dipole.

In particle physics the inactive vacuum concept is known to be quite wrong, else the charge creates energy from nothing. That would violate the most sacrosanct law in physics: that *energy can neither be created nor destroyed*. So electrodynamics—both classical and quantum, neither of which contains the solution to this *source charge problem*—is in gross violation of conservation of energy laws, because it assumes that the charge is solely the source of its associated fields and potentials and their energy { [22] } and that it accordingly creates all that energy it has poured out since the beginning of the universe.

Presently the electrical engineer implicitly assumes total violation of the conservation of energy law with every equation he writes, and is blissfully unaware of it.

Particle physicists, however, have done much better and published and incorporated their results, although inexplicably the mainstream electrodynamicists have not changed their own model accordingly. Particle physicists have known and shown for more than 40 years that (i) space is a seething inferno of EM energy { [23]}, (ii) a charge continually undergoes a violent energy exchange (see Figure 11) with the vacuum EM flux. That exchange is what a charged mass is doing, to *make* it a "charged mass"), and (iii) the charge is a *broken symmetry* in that violent energetic flux of the vacuum. "Broken symmetry" means that the charge disrupts and alters part of that virtual particle flux to observable EM energy flux (see again Figures 5, 6. and 7). The charge continually absorbs virtual energy from the vacuum, radiates *some* of that absorbed energy back to the vacuum in virtual form, but *integrates and radiates the remainder* in a flow of potentially observable energy—the energy flow discovered by

Poynting {[24] } and Heaviside {[25] } after Maxwell was already deceased.

So what does the source charge really do? It coheres, transduces, and *gates* some of its virtual energy {[26] } received from the vacuum, into an EM energy flow going out in all directions in 3-space from that source charge. Contrary to present electrodynamics, this energy flow is actually longitudinal and bidirectional {[27] , [28] , [29] , [30]}, with energy *going out in 3-space from the charge* to every point in the universe, and with energy coming from every point in the universe *back to the charge through the time domain*. But as reinterpreted {22 b}, Whittaker {[31] } showed in 1903 that any such bidirectional EM flow of energy —reinterpreted with the input energy to the charge coming from the time-domain, and the output energy from the charge being emitted into 3-space, comprises a scalar potential. This also agrees with quantum field theory {[32] }

See Figure 12. As it really exists in space, a scalar potential is a harmonic set of bidirectional EM energy flows, with the "bidirectional" EM waves being outgoing EM waves in 3-space caused by interaction with the source charge or dipole of incoming time-polarized EM waves. There is a set of outgoing EM longitudinal waves in 3-space, perfectly correlated with a set of incoming time-polarized EM waves in the time domain. Hence one time-polarized EM "causal" wave couples with one outgoing longitudinal EM wave in 3-space. It is this scalar EM wave coupling (combining) with longitudinal EM wave coupling, in a harmonic set of phase conjugate pairs, that constitutes the scalar EM potential.

In short, all EM energy in 3-space comes from the time domain.

After all, no observable persists continuously in time. Any observable is a frozen 3-space momentary snapshot of an ongoing 4-space interaction. It is the result of a d/dt operation imposed upon LLLT spacetime, to yield a momentary LLL by

d/dt(LLLT) => LLL

What we see as the "motion of an object in 3-space" is actually the ensemble of a continual serial iteration of such "frozen 3-space snapshots" of each observable part of the object, much as the iterative frames of a movie film are seen as a continuously moving picture.

In Whittaker's bidirectional energy flow associated with the source charge, electrodynamicists—including Whittaker himself—assumed that a point positive coulomb of charge is located at each and every point in space. (Figure 5, Figure 6, and Figure 7). A tiny bit of the impinging EM energy flow "from" the distant source charge {[33] } is geometrically intercepted and diverted by the observing/detecting point charge to streamline around it, creating a "swirl around" of diverted energy flow. As can be seen, only a tiny portion of the impinging and passing EM energy stream in 3-space is diverged into the swirl. This is rather like a small diverted whirlpool of water forming around a stable rock in a flowing river. In electrodynamics the amount of energy in that "diverged whirlpool" is said to be the "collected" energy appearing upon that point charge (upon that fixed rock). That amount of energy swirled by the intercepting point coulomb at a given point in space, is then erroneously said to be the *magnitude of the potential (the magnitude of the entire river)*. It is no such thing. The small fraction of the potential that is *diverted from* the potential's flowing rivers of energy, is not that the magnitude of that potential (the magnitude of the entire set of flowing rivers themselves!) And it is certainly not "identically" the river itself! At best it is a measure of the *intensity* of the potential (the local intensity of all those internal rivers of energy flow) at that point occupied by the intercepting/diverting rock.

The point is, *as defined and used in conventional electrodynamics*, the potential occurs only after the vacuum EM entity's reaction with the intercepting mass, and is defined only as the *effect* produced upon that coulomb by the causative potential's interaction. Literally, the potential (the cause) is erroneously defined as the "excitation" or "excess energy" it locally

produces as an *effect* upon a unit point intercepting/ collecting charge.

Ironically, it appears that no electrodynamicist calculates the magnitude of the actual potential as it exists in vacuum-spacetime, before its interaction with charge {[34], [35] }. Its magnitude is enormous, since the potential may extend over all space, and energy can be intercepted and collected by a charge placed at any point therein, or from charges placed at every point therein.

Certainly no rigorous definition of the potential presently exists in physics; the reader is challenged to check for himself or herself. No legitimate definition *can* exist for the potential, until the little matter is resolved of its present erroneous definition only "in and on and deviated by" charged matter, contradicted by the simultaneous assumption that it does exist in mass-free space in undeviated form. What is *deviated from* the potential, is not the *potential itself*. A part of something torn out of that something at one point in itself, is not the whole. The *local effect* cannot be substituted for the *entire nonlocal cause*—only a small part of which interacts *locally*.

The EM force field is similarly defined—only for charge mass interception, and only as an *effect* produced upon the intercepting charge. (See again Figures 5, 6, and 7.) A flow of water across a rock (or the wind on a rock in the desert) produces a “pileup” of fluid on the windward side, and a lesser “pileup” on the downwind side. The difference (called the “gradient”) in the energy density collected across the standard charge (rock) produces a “difference in pressure” on the rock—in other words, a force per interacting rock. That *effect* is erroneously taken to be the EM field itself, when rigorously it is only the reaction cross section of the EM field. Again, rigorously this EM field *as defined in electrodynamics* only exists as the effect that occurs upon an intercepting standard charge or "rock" {[36]}.

Since the EM wave “in space” is erroneously said to be made of varying EM fields, it too is defined only as the

effect upon the intercepting charged mass, after the vacuum EM wave entity—whatever it is—has interacted with the charge and changed the charge translationally and energetically. Specifically, the present "EM wave in vacuum" in the literature is not at all what is presented and taught in undergraduate texts, and even the standard illustration of "oscillating E-field and B-field vectors" lateral to the line of motion of the wave is horribly wrong. E.g., Dr. Robert Romer, former editor of American Journal of Physics, has taken that error to task as follows { [37] }:

> *"…that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/ or time?) that besmirch the pages of almost every introductory book. …it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate." "…perhaps then, for historical interest, [we should] find out how that diagram came to contaminate our literature in the first place."*

The EM field and wave *as commonly regarded* are transfer functions from the source charged masses that "perturbed the vacuum medium and created an unknown kind of disturbance therein", onto the receiving charged masses that intercept the incoming "unknown vacuum wave entity that was created" and interact with it, being translated and perturbed as a result.

This "detected" translation of the receiving charged masses (usually the interacting Drude electrons in a wire) is what our instruments detect. Indeed, the Drude electrons are highly constrained from moving longitudinally down the wire, usually moving at only a few inches per hour. They are much freer to move laterally, however, and can easily do so.

Reacting with the incoming longitudinal EM wave perturbation of local spacetime, the spin of the electron produces gyroscopic precession laterally in the wire since the electron is terribly restrained in moving

longitudinally down the wire. Since our instruments detect these *transverse electron precession waves*, that has been totally confused (since Faraday's "plucked taut string" notion of the EM wave and Maxwell's arbitrary adoption of it) as representing the incoming wave in vacuum. It does not represent the vacuum EM wave at all; the incoming wave is in fact a longitudinal EM wave in 3-space, associated with a precisely correlated longitudinal EM wave in the time-domain.

So we have answered Professor Romer's implied question. That horrible diagram came from the assumption by early electrodynamicists, before discovery of the electron or atom or nucleus, that the "transverse electric fluid waves" in the receiving wires represented actual "intercepted" fluid perturbations arriving in the material ether medium.

In summary: Using a transmitter-receiver analysis, the so-called “EM wave in vacuum” *as presently defined*, actually represents that “detected and measured electron precession wave” in and of the reacting Drude electron gas in the distant receiving wire antenna. The so-called EM force field wave in vacuum has been erroneously defined as observable matter wiggles, not vacuum virtual energy wiggles and not as spacetime-curvature changes and wiggles. So even the present notion of the EM transverse wave in space is wrong, and it has been corrupted as a pure matter-to-matter transform from the beginning { [38] }.

Somewhat less technical explanations are given by Lindsay and Margenau { [39] }, and a rigorous statement and discussion that EM force fields exist only in charged matter is given by Aharonov and Bohm { [40] }. Feynman of course said it bluntly: Only the potential for the field exists in the vacuum, should one place a unit point charge there to allow the force field to be developed (on, of, and containing the source charge itself).

Let us summarize this terrible EM foundations flaw: As classical electrodynamics presently is modeled, Maxwell and his modern followers only include equations which are *mass-to-mass transformations*

(Figure 8). Specifically missing { [41] } are two other transforms: (i) the mass-to-vacuum (mass-to-spacetime) transformation (which obviously is general relativistic in nature), and (ii) the vacuum-to-mass (spacetime-to-mass) transformation (again, obviously general relativistic in nature). (See again Figure 9). When these two missing transforms are added back into electrodynamics, one has suddenly extended EM theory into a new domain. One has also *infolded* general relativity (GR) inside the present EM matter-to-matter transforms, and also included the vacuum interaction including broken symmetry in that exchange, but in an *electromagnetically engineerable manner*. In short, one has a practical, engineerable unified field theory.

Highly creative inventors such as Rife and Prioré intuitively developed apparatuses that unwittingly utilized this presently undeveloped and extended union of EM, particle physics vacuum theory, and GR. The intuition of the theorists in interpreting those revolutionary experiments and their results has very seriously lagged.

The Supersystem Concept

To understand how extraordinary systems such as Rife's microscope works, one must understand the concept of the *supersystem*. (See Figure 13). The supersystem consists of three components, which are (1) the physical system and its dynamics, (2) the local active vacuum and its dynamics, and (3) the local curvatures of spacetime and their dynamics. All three components of the supersystem interact with one another, in nature. The second and third components of the system constitute the active environment in which the system is embedded, and with which it interacts.

Unfortunately, in standard classical electrodynamics either the system's environment is assumed to be inert, or the system is assumed to be in equilibrium in its interaction with that environment. This represents a totally arbitrary assumption that the system cannot receive and utilize any excess energy from its known

active environment. Hence the active vacuum's interaction with the system can be and is ignored by classical electromagnetics, as are the local curvatures of spacetime and their interactions with the system.

Extraordinary EM systems invariably involve the supersystem dynamics, and not just the system dynamics. *In nature*, no system analysis is complete until the supersystem interactions and their effects have been determined and analyzed.

The Rife microscope is indeed an extraordinary system using non-negligible interactions between the system and the other two components of its supersystem. Hence in our discussions, we will be examining interactions in that regime, and not just the standard electrodynamics analysis. In these discussions, we will be holding in mind not just the mass-to-mass transforms of standard electrodynamics, but two other transforms: (1) the mass-to-vacuum/spacetime transform, and (2) the vacuum/spacetime to matter transform (previously shown in Figure 9).

The reason that Rife's work has not been understood is that researchers have been unaware of the necessity for supersystem analysis. Almost all analyses of Rife's work have been merely standard classical EM analysis and thus quite insufficient. There are other examples of the standard electrodynamics model completely failing to show higher symmetry phenomenology in an inventor's work, so that his work is not understood even today. An example is provided by Tesla's patented circuits, as rigorously demonstrated by Barrett { [42] }. Barrett went on to improve the new functions discovered in Tesla's patents, and obtained two additional patents related to signals and signal processing { [43] }.

Vacuum-Structurings as “Engines”: Key Part of the Missing Transforms

The missing mass-to-vacuum/spacetime transformation produces a massless structuring of the vacuum medium. That is a *vacuum engine* or “multiplex of specific spacetime curvatures.” (See Figure 14, Figure

15, Figure 16, Figure 17), and Figure 18. Preparing the vacuum engine is accomplished by charged matter dynamics of the source charges producing the necessary potentials, fields and waves. The charges are embedded in continual energetic exchange with the vacuum/spacetime, and moving the charges affects that exchange; it perturbs the local vacuum flux and curves the local spacetime accordingly.

The transform represents producing this vacuum engine by the vacuum-perturbing action of source charge dynamics upon the vacuum, and by *not* assuming a mystical intercepting point-charge at each point in space { [44] }. In the vacuum/spacetime, *only* vacuum/spacetime entities and changes to them exist. *In pure water, only water and changes to that water exist!*

So a precise dynamic structuring of the energetic vacuum (and spacetime geometry) is what charges produce when they “perturb” the vacuum medium { [45] }, by the presence or dynamics of their fields, longitudinal and time-polarized EM waves, or both. This "perturbed vacuum dynamics" separate from the source charges themselves comprises an engine that consists of altered longitudinal EM wave dynamics inside the internal Whittaker structure { [46] } of the scalar potential of the ambient vacuum. That is the same as also producing internested levels of spacetime curvatures in a *template* or specific pattern { [47] }.

In turn, this vacuum engine region of local curvatures and structurings in spacetime will interact upon any mass placed therein. That action is the missing *electrodynamic vacuum-to-mass transform.*

The missing electrodynamic vacuum-to-mass transformation produces direct changes and alterations in the “receiving” mass, at all levels, by the action of such a vacuum engine. As each action occurs locally in the localized receiving mass, it produces the "local effect" as the result of that “local action.” The primary causative chain (i.e., the set of “dominoes” affecting each other serially), started back at the distant source charges. One can say that we therefore have mass-to-mass *action at a distance*, via the matter-to-vacuum

and vacuum-to-mass intermediary transforms and the spatial and temporal propagation of the vacuum engines in the middle of the two { [48] }. We will shortly discuss the Whittaker structuring of the potential as a fundamental process for producing vacuum engines.

General relativists mostly concentrate upon the warping and curving of spacetime (i.e., producing a vacuum engine) by the very weak gravitational force—which is only some 10^{-42} times as strong for electrons as the electric force between them. Consequently, relativists must look to huge assemblages of mass, such as in stars and other astronomical objects, for sufficient gravitationally-induced spacetime curvature to produce easily observable results. For that reason, general relativity has resisted laboratory development as an engineerable applied science. By using the far stronger EM force as the agent of spacetime curvature, and including the infolded electrodynamics inside the potential, field, and wave, general relativity then becomes engineerable and usable. But one is engineering the supersystem, not just the system.

The Infolded Electrodynamics Inside Potentials, Fields, and Waves

As previously stated, in 1903 E. T. Whittaker, a well-known mathematical physicist, showed that a scalar potential can be mathematically decomposed into a set of peculiar EM wavepairs in a harmonic set. (Again see Figure 12) These “hidden waves” are longitudinal EM waves, arranged in conjugate pairs { [49] } with the pairs also arranged in a harmonic set. In each wavepair, there is an ordinary (forward-time) longitudinal EM wave (outgoing in 3-space from the interacting/observing charge), coupled to its phase conjugate replica (time-reversed twin).

And here lies a magic secret. Prior to interacting with a charge, the phase conjugate wave in each wavepair is in the complex domain, which means that in Minkowski space it is incoming along the fourth axis, *ict*, where the only variable is *t*. Hence this wave prior to interaction with charge does not even exist in 3-

space. Instead, it exists as a longitudinal EM wave incoming in time, so that it is a time-like flow of EM energy. (See Figure 19). After interaction with a charge, the charge absorbs the incoming time-polarized EM wave, transduces that time-energy to 3-spatial energy, and re-emits the energy as longitudinal EM waves in 3-space in all directions. "In all directions" means that for every outgoing longitudinal EM wave emitted in one direction in 3-space, another wave just like it also emitted in the other direction in 3-space. So the paired "bidirectional" EM longitudinal EM waves in 3-space, as interpreted by Whittaker, do exist as the *effect* waves caused by the incoming causal time-like longitudinal EM waves (scalar EM waves). The pairing of the causal time-polarized EM incoming wave with an outgoing effect longitudinal EM wave was not interpreted by Whittaker, but does agree with more modern quantum field theory interpretations of photon polarizations and their observability or non observability, by Mandl and Shaw {22b}.

We have corrected this "effect substituted for the cause" wave to reinterpret Whittaker's 1903 decomposition of the scalar potential, into combined biwaves where one of the biwaves is incoming in the time domain, and the other is outgoing in 3-space. That re-interpretation then allowed a solution {22a} to the problem of the source charge and its associated fields and potentials, together with their energy. Every source charge and source dipole continuously emits EM energy in 3-space, without any 3-spatial EM energy input. The input is there, but in the time-domain. This problem—resolved by the present author in 2000—has been called the most difficult problem in quantum and classical electromagnetics {30 }.

Because of observed parity reversal accompanying the time-reversal operation, in his forward-time, the observer “sees”—after interacting the incoming wave with charge—the *effect* of the incoming time-reversed or phase conjugate wave (entering from the time domain) as a 3-space longitudinal EM wave leaving in the opposite spatial direction. So the basic 4-space phase conjugate longitudinal wavepair would appear to us in forward time as a “regular” time-forward

longitudinal EM wavepair in 3-space, with the two waves going outward in opposite directions. But each is accompanied by a time-polarized EM wave, else it would not be observable.

Further, there is a harmonic series of such bidirectional longitudinal wavepairs comprising the scalar potential. So the staid old electrostatic potential (i) *is not* a "scalar entity" at all { [50] }, (ii) *is* a bundle of longitudinal wavepairs, (iii) *is* an entity with a remarkable internal hidden multiwave structures and dynamics, (iv) *is* a composite of very special waves whose transverse amplitude (i.e., whose spatial energy density, which is a function of transverse amplitude squared) does not change, but whose transported time structure changes, and (v) therefore is a special kind of wave that is velocity modulated about some central velocity, and is not limited to the speed of light c. Indeed, in classical electrodynamics in the Coulomb gauge, the scalar potential is already recognized as having infinite velocity, merely appearing in space instantly at every point it occupies { [51] }.

We also state without elaboration that the active vacuum is *identically* a very huge scalar potential, as indeed is “spacetime geometry”. So a unifying principle is:

vacuum ≡ spacetime ≡ potential ≡ energy { [52] }

Further, as a potential, the “ambient” vacuum decomposes into an incredibly rich, internal Whittaker wave structure. So then also must *spacetime* and *energy* similarly decompose. That decomposition structure is even richer when higher symmetry O(3) EM is used instead of the lower symmetry U(1) EM employed by Whittaker.

A revolution in electrodynamics has recently begun, and central to that revolution is the strong appearance of longitudinal EM waves as essentially the basis for the emerging new electrodynamics. Work by Evans { [53] }, Barrett { [54] }, Ziolkowski { [55] }, Evans { [56] }, Rodrigues {57}, and others is

fundamental in this respect. One part of this emerging new electrodynamics is advanced under the label of *undistorted progressive waves* (UPWs). A good summary of UPW theory is given by Rodrigues and Lu { [57] }. Even so, to date this body of work still largely ignores the internal Whittaker dynamics { [58] } inside an EM wave. The body of work—particularly the higher symmetry O(3) electrodynamics pioneered by Evans {56} inherently possesses the capability to model such structuring, since much of it utilizes a higher topology algebra such as quaternions { [59] } or even Clifford algebra { [60] } In those higher algebras, many electrodynamic things can be done outside the operations permitted by present vector and tensor electrodynamics.

Superpotentials and Superpotential Theory

Whittaker's 1904 paper { [61] } showed that all the "normal" electrodynamics was based on, *and created by*, the interference of scalar potential functions (i.e., by the interference of those multiwave longitudinal wavepairs and their dynamics { [62] } constituting the interfering scalar potentials.) He showed that any EM field or wave whatsoever can be replaced by two scalar potential functions—in fact, is *comprised of* those two scalar potential functions and is *created by them*. Scalar potential interferometry already creates all the "normal" EM in the textbooks anyway, and a proof has been given by Evans et al. { [63] }.

The 1904 paper by Whittaker initiated a somewhat obscure branch of electrodynamics referred to as *superpotential* theory { [64] }. Whittaker's work was further extended and augmented by later scientists such as Righi { [65] }, Debye { [66] }, Bromwich { [67] }, Nisbet { [68] }, McCrea { [69] }, etc. But even with the extended superpotential theory, without the addition of Whittaker 1903 and the substructuring "internal LW electrodynamics" one cannot understand the mechanism for what Rife was actually doing.

Rife was not using normal potentials and normal **E** and

H fields—which as we discussed, only apply to observable material entities anyhow and thus could not be used to "see" far below the quantum threshold of least detectable material disturbance. His entire protocol was to get beyond those "*material interception of EM energy*" limitations. Unwittingly, Rife was using *vacuum engines*—involving structuring of the active vacuum as well as pure general relativity (GR) and pure structurings of spacetime geometry itself. He was electromagnetically using that part of GR that the GR physicists have mostly only tried to produce by use of the weak gravitational force. In GR, *the ST geometry itself is active, dynamic, energetic, and structuring!* In higher symmetry electrodynamics, *the ST geometry itself is powerfully active, dynamic, energetic, and structuring!* It is not at all just a "passive spacetime" as classical electrodynamics assumes { [70] }.

Biological Systems Use the Infolded Whittaker-Type Electrodynamics

The problem in the Rife microscope is to be able to observe very subtle ST curvatures and patterns, in an optical manner. These subtle or virtual "disturbances" of local spacetime are far finer and smaller than the one-tenth wavelength optical resolution generally the limit for optical microscopes using conventional optical EM notions and "material" potentials, fields, and waves.

In short, Rife's twofold problem was to (i) function with vacuum engines (internal structuring of the potentials) so he could penetrate to any degree of smallness, and (ii) output, in the observable state, exact visible summations and analogues of the individual structures detected in the virtual (nonobservable) state { [71] }.

To make the subtle vacuum engines observable on the bench, the ST curvatures and their internested patterning must be accomplished by making and assembling local curvatures of ST, via making longitudinal EM wavepairs in structural pattern assemblies. *Spacetime* is in fact just a powerful scalar

potential, or can be modeled as such, and as such Whittaker 1903 and 1904 rigorously applies, along with extensions from higher symmetry electrodynamics. By realizing that ST is identically potential, one has altered one's thinking from the standard GR theory into a correlated EM-GR theory. One has also extended GR: Not only is there a "topology" of things that can be externally *done to* a base spacetime, but there is also a hidden, vast EM topology *within* any overall base spacetime. So we now have "topologies within topologies." This is in fact what the Russians have long called the *information content of the field*.

However, all living systems already use this "infolded" bidirectional, longitudinal wavepair EM in their ongoing living functions { [72] }. Just as they used frequency modulation, EM signals, EM oscillations, etc. before we even had an electrodynamics or a physics, living systems do use the infolded EM (and vacuum engines) in all their living functions, and particularly in their cellular *regeneration and restoration* (R&R) system { [73] }, as contrasted to their *immune* system. The immune system cells are the fighters and the debris scavengers/cleaners. They go after the hostile invaders, fight them, and usually win—littering the battlefield with the debris. Then the immune system scavenger cells clean up the residue.

But many of the body's cells will have been damaged in the fight. The immune system itself cannot heal or restore a single damaged cell, even its own! It is not a *healer*! It is a searcher, a marker, a killer, and a residue-cleaner. It contains " the troops and the combat engineer," so to speak, but not the hospitals and the doctors. All healing/restoration of living cells is done by the R&R system, not by the immune system.

A high-level overview of the immune system is given in Figure 20.

No vaccine, drug, herb, vitamin, or mineral *heals* the body, although certainly they can enhance or aid the body's healing process. Each does carry its individual resident vacuum engine, and when absorbed

by the cell, this added vacuum engine contributes to the resident vacuum engine in the cell by summing with it. To restore the damaged cells back to normal (i.e., to heal), the R&R system uses a novel kind of extended electrodynamics with infolded vacuum engines, and it uses a novel kind of optical phase conjugate pumping, in the time domain rather than just 3-space. The magic "unified field theory" so long sought by scientists, has long been utilized by the regeneration and restoration system of the body in its minute-to-minute and day-to-day healing and restoring actions.

The magic "universal healing mechanism" so long evading the discovery of medical scientists is none other than the exact cellular regenerative mechanism universally used by every living organism. For the first time, we are explaining the higher symmetry electromagnetic nature of this mechanism.

Robert Becker's epochal work { [74] } (Figure 21, Figure 22) strongly probed the electromagnetic control system directing the body's cellular regeneration and repair (R&R) system. However, he did not have available the infolded Whittaker electrodynamics. He could only utilize the grossly inadequate standard electrodynamics. Modern nonlinear phase conjugate optics had not yet been born when Becker did most of his seminal work.

Since standard EM does not incorporate infolded GR, vacuum engines, or optical pumping in the time domain, Becker could not formulate the full technical mechanism of the R&R system —which uses the *supersystem*, not just the system. But Becker did strongly point out the importance of the R&R system, both theoretically and experimentally. He found that it operated electrically, with the scalar potentials being key. He modeled the R&R system as closely as can be done with classical U(1) electromagnetics (Figure 22). He proved that cells can be *dedifferentiated* (reversed back to an earlier, more primitive state) and *redifferentiated* (time-forwarded into a more complex state) by weak DC potentials and laughably weak (picoamperes) of current. He was twice nominated for a Nobel prize for his epochal work. His method of

electromagnetic healing of otherwise intractable bone fractures (Figure 21) is utilized today in many hospitals.

In his microscope, Rife was in pursuit of optically "seeing" the infolded electrodynamics functioning of the living cells in the most minute detail—i.e., he wished to see the actual vacuum engines and their functions. Using the infolded EM, one can still "see" the cells and all their parts, but one can also go far beyond the one-tenth wavelength optical discrimination limitation and see into the virtual state dynamics. In theory, because the infolded EM is *recursive* as a function of wavelength, one can go to any limit in smallness desired—or at least to whatever limit is determined by the available technology's development at the time { [75] }.

Vlail Kaznacheyev's novel electromagnetic induction of cellular death, disease, and damage, *at a distance*, is instructive in this respect { [76] }. (Figure 23) Indeed, the Russians mastered, extended, and weaponized the Kaznacheyev mechanisms as disease-inducing weaponry, and slyly used it at low level on personnel in the U.S. Embassy in Moscow (Figure 24). This was done to stimulate high level officials in the U.S. government and U.S. scientific community to see if the U.S. knew of this "infolded electrodynamics and vacuum engine" technology { [77] }. The Russians were using GR, but by infolded EM means—so they were using a unified field theory involving higher group symmetry electrodynamics. The puzzled U.S. employed only standard U(1) symmetry electrodynamic analysis { [78] }, so it totally missed the entire physics of what was occurring to cause the health changes and diseases.

In GR, one is very interested in Wheeler's principle which states (slightly paraphrased):

> *Mass (trapped energy) acts upon ST geometry to curve it, and curved ST acts upon mass to produce forces upon it and move it.*

This statement after Wheeler is the very essence

of general relativity. It simply states that there is a *mass-to-spacetime* dynamic transform, and also a *spacetime-to-mass* dynamic transform, as we diagrammatically showed in Figure 9.

Understanding Vacuum Engines and Their Action

Wheeler's general relativity principle includes the missing two transforms of electro-dynamics. We are extending Wheeler's principle to the corollary form:

All levels of the structures of mass (trapped energy structures) and all levels of the structures of time (the time aspects of photon structures) act upon ST geometry to structure it in both 3-spatial energy density structuring and in time domain structuring. Producing this multilevel spatial and temporal structuring of spacetime is called "forming a vacuum engine." Both 3-spatial energy density structuring of spacetime at all levels and time structuring of spacetime at all levels, act upon mass at all levels, to produce internested templates of forces and translations and stresses.

In short, energy patterns and time patterns in 3-space act upon spacetime to produce patterned curvatures of ST geometry (vacuum engines). And conversely, patterned curvatures of spacetime geometry (vacuum engines) act upon mass to produce corresponding patterns of forces at all levels in the mass —down to and including upon the quarks and gluons in the nucleons in the atomic nuclei. We note with pleasure that the Sachs unified field theory does apply from the gluons to the entire universe, as has been shown by Sachs himself {18b}.

Muscle and Skeleton Analogy of Interaction of Vacuum Engine and Mass

We call attention again to our analogy (Figures 15, 16, 17, and 18) of the interaction of a vacuum engine and mass, provided by the interaction of arm muscles and the skeletal arm bones to which they are attached. The arm muscles attach to the arm's skeletal bones, and

those bones are articulated and free to dynamically move. To the bones, the muscles are mysterious agents (analogous to vacuum engines) exerting forces upon them, and causing them to move or hold. To the muscles, the bones are positioned resisting masses for them to work upon and change their positions, and the bones exert Newtonian reaction forces back upon the muscles as the muscles apply forces to the bones. So the vacuum engines (muscles) create forces upon the resisting masses (bones) to move them, and the masses act back upon the causative vacuum engines to create antiforces in resistance.

Using this analogy, when we create a set of vacuum engines, we create a set of “mysterious muscles” that act directly upon any and all “masses” (bones) that are exposed to them. The bones then change and move until the bidirectional interaction forces are balanced (equal and opposite). This symmetry between the two missing transforms is shown in Figure 9.

The Multilevel Structuring of Time is Important

We also add the extension that dynamic structuring in the time stream also occurs from trapped time domain “time component” structuring and distribution effects, as well as dynamic structuring of the spatial energy density of the ST geometry (the vacuum).

We are speaking *relativistically* of the interaction of mass and spacetime at any and all levels of a mass, down to and including the molecules, the atoms, the atomic nuclei, the nucleons, and even the quarks comprising the nucleons (comprising the protons and neutrons). One must first clearly have this vision in mind: The dynamics of everything ongoing in that mass, down to the most minute particle dynamics and in the most minute detail (and far into the virtual state beyond the one-tenth wavelength limitation of light resolution) consists of the structurings of this "mass-ST curvature" mutual interaction.

So we know from general relativity that collections of

energy (such as mass) act directly upon spacetime, its structuring, and its dynamics at any and all levels, down to the tiniest. We know that the variations in local spacetime geometry (including in both energy and time), down to any and all levels and sizes, down to the tiniest conceivable lengths, act directly upon any and all exposed mass at that level, *no matter how tiny*.

There is no “quantum” limitation nor is there any “wavelength of light” limitation to this GR process. Total continuity applies.

Some Characteristics of Vacuum Engines

The great advantage of a vacuum engine is that the "action" it produces upon an exposed mass, arises directly from within each point in the local spacetime in which the mass is embedded. One does not have to "start outside" and move through space and the intervening mass toward the "inside". Every point within an object occupies every point in time, a priori. From a single time-point, the vacuum engine's 3-space action enters everywhere within the object, all-at-once, and the 3-space effects proceed outward from each interior point. (See again Figure 19). Therefore even a weak vacuum engine induced by EM forces can do with ridiculous ease what the most powerful particle accelerators on Earth cannot do. The engine is already everywhere "inside" an object or particle, and working from every point in it, toward an outward direction. On the other hand, a particle accelerator is trying to build tremendous velocity of its particles so that they can "smash" their way in there, by brute force. To get ever deeper, the particle accelerator must be made ever larger, so that a "bigger hammer" is available. Also, the vacuum engine does not smash or damage any of the matter in the object, in any fashion not desired. The particle accelerator, on the other hand, is a great disruptor and may well destroy or serious change the very object it "probes".

Further, contrary to the accelerator's "one shot for one giant amount of energy input", a vacuum engine—once formed—continually exists in that locally altered spacetime and is contained in it and is sustained by it.

Hence that locally altered spacetime—after we pay to alter it once—will continuously expend energy in the form of the action of that vacuum energy, forever, upon any mass emplaced in that local spacetime. The universe itself is furnishing the energy to do the work, via the instantaneous connection in the time domain.

That "multiply connected space" entry everywhere within an object simultaneously, is quite different from "spatial propagation of energy" through singly-connected space from outside an object to the object, striking the outside of a mass and being absorbed, producing a gross translation force upon the mass. In the “energy propagation through space” case, severe energy interaction may occur with only the absorbing part of a macroscopic mass, while the remainder of the mass is little affected or not at all. To wit, one does not get the resulting *electronuclear* alterations of the nucleus (materialization, dematerialization, transmutation, etc.) by absorbed propagated “normal” EM radiation. However, with weak EM-induced vacuum engines one can do things inside the nucleus such as easily flip quarks inside the nucleons, so that transmutations at very weak spatial energy levels are readily obtained. This in fact turned out to be the major secret of the low-energy nuclear transmutations occurring in some 600 cold fusion experiments worldwide { [79] }.

Electrodynamic force fields implicitly define primarily only translation effects upon charges or masses, in their very definitions. With normal EM, usually one will get reradiation of the absorbed energy, or partial reradiation of the absorbed energy accompanied with recoil of the absorbing mass, or no reradiation but recoil of the mass.

We took the term *vacuum engine* from Misner, Thorne, and Wheeler { [80] } and also from Nobelist T. D. Lee { [81] } who spoke of this sort of thing as *vacuum engineering*. The term is not original with us; only the novel higher symmetry electrodynamics application of the concept is original. We call the exact geometrical form of a vacuum engine a *template*. We refer to the process of internally structuring a field, wave, or

potential as *dimensioning* or *activating* or *conditioning* or *charging up* the field, wave, or potential. Russian superpotential weapon scientists call the infolded structuring itself the *information content of the field*. For further discussion of some of these terms and related concepts, the reader is referred to our website, www.cheniere.org.

Wheeler's GR principle says that, for every mass with its exact mass structural dynamics condition, there exists a corresponding exact vacuum engine template containing precise spacetime curvature structural dynamics, and interacting back upon the dynamic mass at all levels. That vacuum engine is said to be resident in the mass and continuously interacting with it (see again Figure 13 on the *supersystem*).

Again, the structuring of the vacuum engine has no limitation in fineness, because spacetime is continuous. Hence it freely extends from the observable realm on down into the virtual realm. This is no more audacious than stating that virtual and observable entities occupy the same time domain simultaneously. Obviously, if one is using the structuring of time, one gathers in both those virtual structures and those observable structures, and also the exact correlation between them. This is a direct engineering application of an EM hidden variable theory, somewhat similar to that proposed by David Bohm { [82] }.

Applying Vacuum Engines to Living Cells

Any normal cell already has a normal *template* of overall ST curvature due to its mass and trapped energy structures. No matter how small, every internal part of that cell has its own *subcomponent template* of subcomponent ST curvatures embedded in that overall cellular ST curvature. As the cell functions, the dynamic normal changes of that template into other related templates, is within the range of what we call "normal, healthy cellular functioning."

Any abnormal cell has an *abnormal template* and also an abnormal set of "templating" changes. In other

words, there exists a precise *vacuum engine delta* in the abnormal cell, summed to the cell's *normal vacuum engine*. The *sum engine* represents the exact vacuum engine to act on the normal cell and change it to that precise abnormal condition.

But a template depends upon the energy density structuring of the local vacuum and also the local *time* structuring—which latter is still missing from physics books, but is implicit in the nature of the photon. If one produces the necessary energy structuring and density—and the necessary time structuring and density of local ST geometry—one produces a certain vacuum engine and one also produce a certain *template of time structuring*. Time { [83] } has dynamic template structuring and functioning, just as does the 3-spatial energy density of ST geometry.

Indeed, the total (virtual and observable) photon interaction with a mass or particle generates the "flow of that mass or particle through time" (Figure 25).

But one *can* make vacuum engines using EM energy and structuring, rather than with normal gravitational (G) energy and structuring { [84] }. The advantage is that, for electrons, the EM structuring is on the order of 10^{42} times as strong as the G structuring. For protons, the EM force is something like 10^{38} times as strong as the G force. So by using the much stronger EM force as the "agent of ST curvature," one can make vacuum engines that are quite strong at their local level. These engines will affect and profoundly change any exposed mass, including cellular mass—in any fashion desired, given only that one makes the appropriate vacuum engine. Again, *we are simply engineering practical but ultra-strong general relativity on the laboratory bench*, by electromagnetically engineering Wheeler's principle in an extended form.

For any physical cellular deviation from normal—any deviation whatsoever—a corresponding exact deviation (i.e., an exact delta) exists in the cell's otherwise normal vacuum engine template. This includes deviations in the genetics of the cell and everything else, not just the chemistry and gross physical structure.

Now if one could produce the negative (time-reversal) of the sum template of the resident vacuum engine and *amplify* it, one would have a powerful new type of vacuum engine. (Figure 26) It would be an exact *vacuum anti-engine* to act upon that specific diseased or abnormal condition of the cell and gradually erase the delta and bring the cell physically back to normal. The new anti-engine would operate upon all the mass of the cell, at every level no matter how small. It would change the cell's abnormal genetics back to normal genetics.

One could of course reverse cellular damage due to aging, and rejuvenate the body. It is quite doable; all that is needed are the funds, scientific team, and laboratory facilities to develop it. It is doable whenever the U.S. medical science community and the giant pharmaceutical community will allow it to be done.

One could reverse a cancer cell back to a normal cell, by applying the specific summation vacuum antiengine for the exact delta between the cancer cell and a normal cell.

One could reverse an AIDS cell back to a normal cell with normal genetics, where it no longer was an "HIV factory". An AIDS patient could be completely, quickly, and cheaply cured, the moment he or she tested HIV positive. There would be no need to wait for the debilitations of the progressing disease to appear. Not a single HIV-infected cell would be left in the body, even those resistant strains that have developed after the original infection.

One could do precisely the same thing with Ebola infections, and with the "tough" staph infections that now resist everything and are killing more than 120 thousand Americans in our hospitals every year, with the figures rising. *These are patients who did not have the disease that killed them, when they entered the hospital*.

With development of portable treatment units and mass production, one could treat and heal those millions of

mass casualties that could well erupt in one or more large U.S. city areas—e.g., from an Iraqi-sponsored terrorist biological warfare (BW) strike, using anthrax { [85]). In 1998, we proposed a crash development of just such portable units { [86] }. With the present world situation, it is not a matter of *if* such terrorist BW strikes will be made in the U.S., it is a matter of *when* { [87] }. Since our 1998 proposal, there has now been time to have had those portable units developed and mass-produced, at a total program cost of perhaps $100 million. Sadly, no one apparently had the foggiest notion of what was actually being proposed, and its vital importance to the survival of the nation. With a looming war in the MidEast—and with hordes of terrorist teams with biological warfare agents already infiltrated into U.S. cities and population centers—this negligence is particularly of concern at this very moment. These officially-forecast attacks on our cities by weapons of mass destruction could now be imminent, if and when the MidEast does explode into war, which appears imminent.

The Process Has Been Experimentally Proven

A very similar thing is also what Becker { [88] } demonstrated, without considering the vacuum engine (general relativistic curvature of spacetime) effects. It is also precisely what Prioré { [89] } unwittingly did in France, with a team of renowned French scientists, to cure terminal cancers, atherosclerosis, lethal infectious diseases, etc. in laboratory animals under rigorous scientific protocols. The team also demonstrated the restoration of suppressed immune systems.

In Germany, Popp { [90] } *et al*. were also involved in studies dealing with the R&R system, but from a quantum electrodynamics viewpoint.

We can also consider the vacuum engine from a nonlinear optics view, and obtain startling extensions of both general relativity and nonlinear phase conjugate optics. That in fact is exactly what Prioré did, though he did not think in those terms. Prioré roughly created a complex set of bidirectional longitudinal EM

wavepairs—i.e., a set of “time domain pump waves.” So he produced a kind of vacuum engine that itself is a crude *anti-engine generator* when used to pump a mass such as a living cell.

Prioré unwittingly used an extension to nonlinear optical (NLO) phase conjugation *before nonlinear phase conjugate optics was even born*. Pumping diseased cells in the Prioré manner causes the formation of exact "antiengines" for the specific cellular disease or disorder to be created in the cells themselves.

First, Prioré mixed up to 17 or so EM transverse waves in a rotating plasma { [91] }. Today we know that such a plasma will transform transverse radiations into longitudinal radiations, and it will also phase conjugate the input waves and add their phase conjugate replicas. In short, it is a procedure for somewhat crudely making a set of longitudinal bidirectional EM wavepairs, which is required to produce a scalar potential with a deterministic internal structuring. In short, it produces a scalar potential with an internal vacuum engine template.

These infolded longitudinal biwaves are NLO pump waves of a new kind: They pump the PCM material in the time domain only. This kind of pumping is a *vacuum antiengine-making process*.

The plasma tube was surrounded by a giant coil, and a pulsed magnetic field was produced by the coil. Per Whittaker’s 1904 paper, that pulsed DC magnetic field can be decomposed into two scalar potentials. Hence we have three potentials superposing: (1) the potential function set made by Prioré in his plasma tube, and containing a selected “vacuum antiengine maker” consisting of bidirectional pump waves in the time domain, and (2 and 3) the two Whittaker potential functions comprising the DC pulsed magnetic field of the coil.

The end result of this superposition/mixing of potentials is that their “internal structures”—including their vacuum engines—also diffuse one into the other.

Fundamentally, Prioré produced what to the observer seemed just a pulsed DC magnetic field, but one in which there was a specific "vacuum engine maker" of his deliberate creation and "tailoring." Originally by trial and error, he adjusted the 17 frequencies introduced to the plasma, thus varying the frequencies of the "infolded bidirectional pump waves" produced and infolded into the pulsed DC magnetic field carrier. In this manner he was "tuning the "vacuum antiengine-maker" content.

Again, Russian energetics weapons scientists call those vacuum engine templates the *information content of the field*. They do not refer to ordinary spectral analysis.

Explaining the Time-Pumping Vacuum Anti-Engine Maker

Irradiating the cell (with non-ionizing radiation) containing infolded specific bidirectional longitudinal waves, precisely corresponds to pumping the cells in the time domain, rather than pumping them in the "spatial energy distribution" domain. Because of the shift of the pumping from the 3-space domain to the time domain, this constitutes a dramatic extension of phase conjugate optics. Because of the amplified phase conjugating action of the "vacuum antiengine maker" upon the vacuum engine in a mass, this also constitutes a dramatic extension of general relativity and of four-wave mixing theory. Let us explain briefly:

When one pumps a nonlinear mass [phase conjugate mirror (PCM) material] with ordinary "transverse" EM waves { [92] } (Figure 27a), one is pumping (stressing, or "squeezing and relaxing") the mass with dynamic oscillating energy distributions in 3-space. One inputs a similar weak wave (called the "signal" wave) to the mass simultaneously. In that case, multiwave mixing theory tells us that the pumping of the PCM will cause the formation of a fourth EM wave, that is a time-reversed replica of the input "signal" EM wave. The time-reversed wave may contain up to all the energy in the pump waves, so it can be highly amplified in magnitude compared to the

input signal wave. The distortion correction theorem tells us that this time-reversed replica wave will then appear precisely superposing in space back along the exact spatial track taken by the input signal wave { [93] }.

When the pumping is shifted to the time domain by pumping with bidirectional *longitudinal* EM waves, we now are pumping the time aspects of the mass—during it iterative existence as masstime; see again Figure 25—rather than just pumping the spatial energy aspects. In other words, we are not pumping *spatially*, but *spatiotemporally*. We are pumping *temporally*—rhythmically squeezing (compressing) and relaxing (extending) the "density of the time interactions" producing the rate of flow of time itself. This is a totally new extension to nonlinear phase conjugate optics.

In this case, the "signal wave input" to the "time-domain-pumped" nonlinear mass PCM is just the resident vacuum engine in the local spacetime in which that PCM mass is embedded (see Figure 27b). The sickened cell's abnormal vacuum engine—consisting of the sum of the normal cellular vacuum engine and the disease delta vacuum engine—is present in the cell and is the input to the time-pumped phase conjugate mirror (cellular masstime). The output is the formation of an amplified time-reversed replica of that vacuum engine. In other words, an exact, amplified *vacuum antiengine* for reversing the precise abnormal condition of the mass, down to and including even the quarks in the atomic nuclei, is formed by time-domain (longitudinal EM biwave) pumping. The result or "output" is that *the entire cellular PCM mass and all its constituent parts are "time-reversed" back along their previous "track through time", back to a previous normal physical state* { [94] }. Figure 27b illustrates this process.

So when Prioré pumped the abnormal cells, he simply time-reversed them—genetics and all—right back to their normal physical state before the abnormality arose.

The beauty of the method is that, by adjusting the input waves to the rotating plasma, Prioré could "tailor" and "tune" the pumping waves to what was needed for a particular class of disease. He used trial and error methods to arrive at the proper settings for the disease to be treated. In theory, by the Prioré method one can time reverse any mass back to an earlier physical state. This mechanism is used by the cellular control portion of the body's regenerative and restorative (R&R) system to restore damaged cells back to normal. It is the basis for the body's ability to heal itself!

Applied to diseased cells, the method causes the formation of specific amplified antiengines for the exact specific cellular abnormality, no matter how complex, and no matter what it is. *In applied medicine this is a revolutionary new healing and therapeutic modality*, accomplished by novel EM means, and justified by general relativity, higher symmetry electrodynamics, and longitudinal EM wave pumping in the time domain rather than classical electrodynamics and transverse EM wave pumping. Prioré's discovery, once understood, may just be the greatest medical discovery of all time, and the discoveries of Rife and of Becker may rank a close second. The Prioré process is shown in Figure 28.

The body's cellular regeneration system uses this same methodology and process. A block diagram of the operation of the body's cellular regeneration system is shown in Figure 29.

Further Principles Needed for Rife's Microscope

In his microscope (Figures 1 and 2), Rife just wanted to observe the templates [2] corresponding to the cells, germs, viruses, etc. and all their parts, without any smallness limit. To do that, we need to (1) amplify the tiny, tiny amplitudes (actually, in the virtual state and subquantal) of the tiny vacuum engines accompanying tiny spatial locations containing living, functioning entities (no matter how small), and (2) "transduce" that amplified result into the optical spectrum, so that we

see a perfect optical analog and thus are "looking" visually at localized ST regions far smaller than the one-tenth wavelength optical resolution limit.

We need another principle to do that. Suppose that, to first order, we have an isotropic nonlinear medium. Then if we transmit a sine wave into it, pandemonium sets loose with our wave. The speed of each part of the wave in this medium is a function of the location of that part upon the wave amplitude, so the peaks move faster than the intermediate parts of the wave of lesser magnitude. The wave has "peak overtake", breakup, collapse, and all sorts of things happening to it. So a simple sine wave is not going to pass smoothly into that medium and "pass back out" coherently and nicely, and ordinary light is not going to give stable reflections from that medium!

However, if we transmit *two* sine waves simultaneously, some frequency interval apart, and then if we *pretend* that we actually transmitted their *difference* frequency, a very strange thing happens. The two individual sine waves themselves still break up and go bananas. However, that difference frequency acts as if it were a simple sine wave transmitted into a *linear* medium! So we get back out a very nice, smooth, well-behaved sine wave of the *difference* frequency, even though terrible things happened to the individual waves themselves. We can detect and use that "difference frequency" nicely.

Several very neat sonar systems presently use that sort of transmission schema in underwater work { [95] }. The principle applies for waves of all frequencies, for all media which can be approximated as nonlinear isotropic in nature. As we shall see, it applies to the Rife microscope also.

Rife's Secret: Recursive Coherent Increase of the Signal-to-Noise Ratio (SNR)

To first order, without too much error we can pretend that the molecules and atoms etc. in the cells and body tissues, together with their finer components, comprise such an isotropic nonlinear medium. That's not entirely

true, of course, but it does work to an extent sufficient for our purposes. Fortunately for the Rife process, the parts that *do not* obey this isotropic rule add randomly, while the parts that *do* obey the rule add coherently. So the "signal-to-noise ratio" (SNR) increases with the increasing amplification, and one "grows" the desired signal right up out of the noise (SNR) of the parts that do not obey the isotropic medium assumption. With sufficient number of amplifier stages, in theory the SNR of even the tiniest parts can be made as large as desired { [96] }.

With optical functioning as in Rife's microscope, one may substitute "light gathering power" or "magnification" for the electrical term "amplifier gain".

As we stated, Whittaker in 1904 (and superpotential theory thereafter) shows us that—if we wish—any EM field, wave, and pattern can be represented by two scalar potentials. Each of these two scalar potentials is further comprised of bidirectional EM longitudinal waves, in a harmonic series, in the Whittaker 1903 manner as reinterpreted. So we can reduce any pattern, field, or wave from any assemblage of charge sources, into two potentials, and then further into two sets of bidirectional EM waves interfering with each other. That process already *makes* all conventional EM waves, fields, etc.

An EM structuring of the local vacuum-spacetime occurs by all the electrical charges in the mass of the living cell, down to and including the virtual charges exchanged in the nuclear interactions in the nucleus of the atoms. By Whittaker 1903 and superpotential theory, all of that structuring itself is a potential with an internal set of bidirectional harmonic longitudinal EM waves interfering with each other.

Further this potential is recursively organized, because the inner bidirectional EM wavepair structuring of the potential is already recursive, as can be shown by applying Whittaker-1903 and Whittaker-1904 successively and iteratively { [97] }. This means we get deeper and deeper internested levels of patterns that still precisely correspond to the operational

mechanisms of the lower levels. It's similar to an infinitely fractal { [98] } type of process.

Because this conglomerate is recursive as a function of harmonic intervals, it means that we can pick any harmonic interval we choose in the "big world" where we observe things, and we can have an exact observational representation of the dynamics of that ongoing hidden longitudinal EM wavepair interferometry in the two waves bounding that harmonic interval. Of course, the more additional harmonics we add, the better dynamics we have. The greater the number of harmonic intervals applied, the greater the gain. However, these harmonic intervals can be recursively applied using just one "macroscopic" harmonic interval, iteratively and serially applied over and over. The more iterative serial recursive application of one harmonic interval, the mote the "gain" or "amplification"—in the case of a microscope, the more the *amplification*. That was Rife's real secret, finally revealed. See Figure 30.

The Difference Frequency Provides Visible Output

Rife wanted to look at very, very small things *visually*, even though those “small things” were far below the one-tenth wavelength visible light barrier. In other words, to understand the Rife microscope’s visual representation of the virtual state, we need to choose the harmonic interval of the throughput so as to span the visible spectrum. Well, for optical purposes, luckily the IR and UV do exactly that. Examine the frequencies, and you will see that a harmonic interval exists from a spot in the IR to a spot in the UV, and of course the interval in between includes the entire visible spectrum. The visible spectrum in between, however, represents the observable noise that would block what we seek to have emerge in that region in our "Rife microscope", so the presence of the visible spectrum is highly undesirable. Various filters can be used to block the visible spectrum while transmitting the UV and IR regions, or one can just work in the dark or in suitably dim visible light.

Rife then applied his iterative multiple "difference frequency" lenses in serial order, one after the other. While it is doubtful that he understood the theoretical method being utilized, he certainly persisted and found how to use it. This method of iteratively summing a recursive virtual state vacuum engine "template" results in the formation of an observable state vacuum engine template. In short, it magnifies the virtual state entities and dynamics directly to observable state analogues that capture all the virtual state entities and their dynamics.

That is why, if we use special filters on your camera and flash lenses, where the filters are open in the IR and UV but opaque in the visible spectrum in between, we can often photograph the ongoing "longitudinal EM hidden biwave interferometry"—*the subtle energy or vacuum engine functioning*—of nature and of living systems, *even displaced in time*, as Trevor Constable { [99] } and Joe Gambill { [100] } (a researcher friend now deceased) demonstrated, as George Meek { [101] } demonstrated, and as Fogal { [102] } has successfully experimented with.

Occasionally when one gets things just right, one can get pictures of the subtle invisible reality in the virtual state, going on around oneself and in one's surroundings. With Rife-like iterative serial amplification, one can get them all the time, dependably, as with a Fogal semiconductor specially adapted for such operation. One can in fact build instruments that indirectly observe the so-called "unobservable" virtual energy state and its entities and dynamics with one-to-one correspondence.

That’s a whole new "subtle physics" reality. Present physics with its assumed quantum observation limitations just has not even gone into it—primarily because physics has been focusing upon the quantized aspects of the photon (which is quantized in one aspect only—its magnetic vector potential—and not in its unquantized aspect—its scalar electrical potential!). Physics has rather ignored the unquantized (and therefore continuous from the smallest to the largest scale) time aspect of the photon { [103] }. Using the

continuous aspect of the photon, one can assemble photon “time interval” structures—and in fact one does so whenever one assembles a 3-spatial energy density structuring such as in ordinary EM theory. Simultaneously, one has assembled a “structuring of the time domain” also, because each photon in the spatial energy density structuring consists of both time and energy as its canonical components.

All EM fields and waves, being comprised of photons, thus also carry (1) energy and energy internal structuring, and (2) time and internal time structuring. Again, this is the Russian *information content of the field*. The Russians simply understand 4-vector theory and Whittaker 1903 and 1904, and how to combine them with quantum mechanics and general relativity in a unified field theory.

The above explanation is why Kaznacheyev's { [104] } mitogenetic radiation { [105] } from his control (deliberately damaged or infected) cells would pass through a quartz window and induce the same damage (or disease) in targeted cells on the other side and otherwise environmentally shielded, but would not induce the changes through a normal window glass window. (See again Figure 23) Quartz passes the full optical spectrum from IR to UV, while window glass does not. So quartz passes the *vacuum engines* for the disease or damage, while window glass breaks them up and does not pass them as such. We stress that the vacuum engines are part of the “continuous” aspect of the photons, and so are not bound to any limitation on magnitude (either fineness or largeness) as are the quantized aspects of the photon.

For such a "far beyond the one-tenth wavelength" microscope as Rife’s, one must use vacuum engines (time domain structuring, and longitudinal EM waves) and extraordinary iterative unified field theory optics, rather than the ordinary transverse EM waves and ordinary optics. The lenses must all pass at least one harmonic interval (and the same one!), to provide and utilize the “difference frequency band” needed for recursive *visual* connection to the subquantal state (the hidden virtual structures in terms of the continuity

aspects of photons). Successive stages thus "serial iteration" use the recursive principle to coherently amplify and show the vacuum engines, their dynamics, and the dynamics of deeper organizations and dynamics in the virtual state itself. Since Rife wished to “see” the results in the optical spectrum, then the two frequencies chosen for “differencing” had to bound the visible spectrum.

Rife used quartz lenses or at least very good optical glass that is open from IR to UV. That bounds the visible spectrum with a harmonic interval. Rife used multiple stages for successive coherent recursive amplification and increasing the SNR magnitude by coherent integration. One must also have some scheme for filtering out (or avoiding) too much visible spectrum light. One such scheme is to just use enough stages so that, in the new theory where the wavelength limitation is bypassed, one has amplified ("resolved") to the depth or fineness desired. The process long ago removed itself from the "normal visible light" domain, well before it reached the deeper resolution limit utilized by the definition state of the new method.

By using sufficient multiple stages in this fashion, the "tiny" virtual state vacuum engine templates passing through the IR-UV harmonic interval in a lens can be recursively summed and magnified many, many times—essentially without limit, because the phenomenon being magnified is recursive and bidirectional longitudinal in nature. It is definitely *not* normal visible light optics, and it *is not* conventional classical electrodynamics.

Rife’s Recursive “Vacuum Engine” Microscope

The Rife microscope coherently sums (and thus coherently amplifies) the virtual state vacuum engine patterns with the increasing number of stages. For the *subtle* vacuum engine templates, such an arrangement becomes a direct amplifier (magnifier), for amplifying (magnifying) the internested virtual state vacuum engine templates and their dynamic functioning, into the observable state. With a properly designed “vacuum engine” recursive microscope, one can see

inside a molecule, inside the atomic nucleus, and even inside a nucleon, given development and perfection of the process. However, at this initial stage of understanding, one can forecast that finely adjusting the various stages of an early laboratory prototype would indeed prove to be a tedious and formidable task, just as Rife reported. With further development, however, that obstacle can be removed.

What comes out the output end of such a “vacuum engine” recursive microscope, is a direct visible light *analogue* of the much more subtle ST functioning in the microscope’s highly localized viewing area. This output imaging is put together "electrically" in ways analogous to the construction of a video picture on the screen of a TV tube. Since the result emerges through an output end that still passes an entire harmonic interval bounding the visible spectrum, the amplified virtual state recursive template is not destroyed but is highly amplified and produced as an observable image and dynamics in the visible spectrum. This final "interferometry" of two *internally structured* potential functions now produces "visible light" EM fields and waves and patterns, in accord with Whittaker 1904. These visible patterns are direct analogues representing exactly the very, very minute regions far below the one-tenth wavelength limitation of ordinary optical resolution. Those regions were the regions “being focused onto” when Rife so arduously “adjusted” his microscope's multiple stages.

With Rife’s recursive magnifying microscope process, one can see direct visible analogs of what is actually far, far smaller than anything ever before seen in normal optical microscopes, or even in electron microscopes etc. Indeed, one can see directly into the virtual state itself, and observe virtual state structures. While this is unthinkable in quantum mechanics if one considers only quantized aspects of light, it is perfectly feasible if one considers the concomitant unquantized (continuous) aspects of light, and shifts to general relativity and vacuum engines to utilize the unquantized structuring of the time domain.

Conclusion

Rife unquestionably found a way to produce visible recursive amplification and magnification of invisible virtual state dynamics and functions. We hope we have shed at least some light on the extraordinary technical mechanisms involved. This is good conceptual science, consistent with theory and some known experiments, and it certainly can be made a rigorous science and technology and mathematically modeled, using higher symmetry electrodynamics that is part of a unified field theory such as that of Sachs. The basis for all of it is in the literature already, but it is scattered widely in uncorrelated bits and pieces. It is not in the normal electrodynamics courses, nor is it in the normal optical science curriculum. And it is not taught in the normal physics curriculum. Needless to add, it is absent from the medical curriculum as well.

As an additional proposal, we tentatively suggest that this principle also may be the long-sought "hidden chaos" or "hidden order" in quantum mechanics that is known to be present, but has not yet been explained { [106] }. If so, then it becomes a new law of physics, with the experimental proof first demonstrated by Royal Raymond Rife.

With the conceptual technical matrix of Rife's mechanism in hand, it should be possible for a proper scientific multi-disciplinary team to redevelop and extend the Rife microscope. Marvelous new instruments will emerge, once the quantum physics conceptual blockage of continuous physics is constrained to its place as only "one view of the physics reality elephant." With the ability to directly "measure", "observe," and engineer the virtual state, a breathtaking expansion of physics will occur, dramatically extending the vacuum engineering suggested by Nobelist Lee.

If so, then Rife's tragic life will have served its noble purpose, and his intuitive insight will have been resoundingly verified. The follow-on results will have untold benefit to science and to all the human generations to come.

NOTES AND REFERENCES

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[1] For work on the theoretical aspects of this paper, partial financial support by A. Dreyer, R. Francis, H. Ledger, M. Peters, T. Craddock, and the Association of Distinguished American Scientists (ADAS) is gratefully acknowledged, as are helpful discussions with Dr. Bob Flowers and Dr. Myron Evans.

[2] We emphasize that Rife himself did not think in these terms.

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[1] . (a) Some Rife-related references are: Royal R. Rife, "The filterable virus of carcinoma," Apr. 26, 1939; — "The Rife Microscopes," Apr. 28, 1939; — "Bacteria," Apr. 28, 1939; — "History of the development of a successful treatment for cancer and other viruses, bacteria, and fungi," Allied Industries, Dec. 1, 1953.

(b) Arthur Isaac Kendall and Royal Raymond Rife, "Observations on Bacillus Typhosus in its filterable state," California and Western Medicine, Ca. Med. Assoc., Dec. 1931.

(c) Arthur Isaac Kendall, "The filtration of bacteria," Science, Mar. 18, 1932.

(d) See particularly E. C. Rosenow, “Observations on filter-passing forms…,” Proc. Staff Meeting of the Mayo Clinic, July 13, 1932; — “Observations with the Rife microscope of Filter-passing forms of micro-organisms,” Science, Vol. 76, Aug. 26, 1932, p. 192-193; — "Microdiplococci in filtrates of natural and experimental poliomyelitic virus compared under the electron and light microscopes," Proc. Staff Meeting of the Mayo Clinic, 17(7), Feb. 18, 1942, p. 99-106; — "Observations of filter-passing forms of Eberthella Typhi (Bacillus Typhosus) and of the Streptococcus from Poliomyelitis," Proc. Staff Mtg.

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(g) A good lay overview is given by Christopher Bird, “What has become of the Rife microscope?”, New Age Journal, Mar. 1976.

(h) See also T. E. Bearden, AIDS: Biological Warfare, Tesla Book Co., 1988, p. 267-279. The author gives a short introduction to the Rife microscope and includes some pictures. The proposed evanescent wave explanation proved to be wrong. Much additional work by the author eventually culminated in the proposed mechanism presented in the present paper.

[2] . We have one viewgraph listing some 32 flaws, errors, and shortcomings of classical electrodynamics, and there are even more than that. Additional errors are listed, for example, by important scientists such as Feynman, Wheeler, Evans, Bunge, Cornille, Barrett, and others. So a substantial number of errors in classical U(1) EM theory are well known to foundations scientists. We discuss only a minimal few in this paper.

[3] . Mario Bunge, Foundations of Physics, Springer-Verlag, New York, 1967, p. 176.

[4] . *Ibid*., p. 182.

[5] . M. Faraday, Experimental Researches in Electricity and Magnetism. Vol. 1, Taylor and Francis, London, 1839.; Vol. 2, Richard & John E. Taylor, London, 1844; Vol. 3, Taylor and Francis, London, 1855. Reprinted by Dover in 1965. Also see M. Faraday, "On Static Electrical Inductive Action," Phil. Mag., 1843; — "Remarks on Static Induction," Proc. Roy. Inst., Feb. 12, 1858.

[6] . James Clerk Maxwell, Preface to the First Edition, A Treatise on Electricity and Magnetism, third edition, Vol. 1, Dover Publications, New York, 1954, p. viii-ix.

[7] . J. C. Maxwell, Preface to the First Edition, A Treatise on Electricity and Magnetism, third edition, Vol. 1, Dover Publications, New York, 1954, p. viii-ix. Quoting: "…*before I began the study of electricity I resolved to read no mathematics on the subject till I had first read through* Faraday's Experimental Researches in Electricity. …*I perceived that his method was also a mathematical one, though not exhibited in the conventional form of mathematical symbols. I also found that these methods were capable of being expressed in the ordinary mathematical forms….*"

[8] . James Clerk Maxwell, A Treatise on Electricity and Magnetism, Third Edition, Vol. 1, Dover Publications, NY, 1954, p. 165-166.

[9] . Else the precessing electrons in a signal-receiving wire antenna would not precess laterally. Since their precession is at right angles to the disturbing force, the disturbance arriving from the vacuum was a longitudinal disturbance. This also agrees with Whittaker's 1903 decomposition of the scalar potential, and Mandl and Shaw's note that the combined scalar photon and longitudinal photon are observable as the instantaneous scalar potential,

while neither of them is observable individually. See citations for Whittaker and for Mandl and Shaw elsewhere in these references.

[10] . This word "potentiality" (by Feynman) is given flesh and blood in the present paper. What actually exists in the vacuum is potential and structures of potential. Vacuum, spacetime, and potential are identities. Hence we may say that the structured vacuum potentials are indeed structurings of spacetime curvature. We refer to these as *vacuum engines*, which are explained in this paper.

[11] . Richard P. Feynman, Robert B. Leighton and Matthew Sands, The Feynman Lectures on Physics, Addison-Wesley, New York, Vol. II, p. 1-3.

[12] . This is easily shown. $F \equiv d/dt(mv)$, which expands to $F = (m)dv/dt + v(dm/dt)$. Let the mass m be zero continuously, and both terms on the right go to zero, hence $F = 0$. That is, the force disappears because mass is a component of force. It is the use in mechanics of the separate massless force acting on a mass that is the non sequitur and to blame for this giant error in electrodynamics as a hold-over from the hoary old mechanics theory.

[13] . J. D. Jackson, Classical Electrodynamics, Second Edition, Wiley, 1975, p. 249.

[14] . Jackson, ibid. p. 28.

[15] . Melba Phillips, "Classical Electrodynamics," Vol. IV: Principles of Electro-dynamics and Relativity, in Encyclopedia of Physics, Edited by S. Flugge, Springer-Verlag, Berlin, 1962, p. 4. Quoting: "The utility for electrical problems of a scalar potential, first introduced in the theory of gravitation, was pointed out by Simeon Denis Poisson, Bull. Soc.

Philomatheique **3**, 388(1813). See also Mem. Institut, Pt. **1**, 1, Pt. **2**, 163 (1811). The word *potential* was introduced by George Green in 1828."

[16] . E.g., see W. Misner, K. S. Thorne, and J. A. Wheeler, Gravitation, W. H. Freeman and Co., San Francisco, 1973, p. 5.

[17] . Two methods of dealing with this problem, and rectifying it, are the use of a topological definition of the fields in mass-free spacetime, and the use of a unified field theory where the "field in space" is not a forcefield per se, but merely a curvature or set of curvatures of spacetime. As an example, the O(3) electrodynamics largely pioneered by Evans takes the latter approach, and it is usable in directly engineering unified field theory effects.

[18] . (a). Mendel Sachs, The Field Concept in Contemporary Science, Charles C. Thomas Publishers, 1973;

(b) — General Relativity and Matter: A Spinor Field Theory from Fermis to Light-Years (Fundamental Theories of Physics), Reidel (now Kluwer), 1982 provides a great generalization of general relativity and electrodynamics reaching from the quarks and gluons to the entire universe. See also

(c) Mendel Sachs, Quantum Mechanics from General Relativity: An Approximation for a Theory of Inertia, Reidel (now Kluwer), 1986;

(d) — "Relativistic Implications in Electromagnetic Field Theory," in T. W. Barrett and D. M. Grimes, eds., Advanced Electromagnetism, World Scientific, 1995, p. 541-559. In the latter, Sachs shows that the most general expression for the field theory is in terms of spinor and quaternion variables, rather than the vector and tensor variables of the conventional expression of Maxwell's theory. This generalized expression leads to extra conservation laws and

invariants, thus increasing the predictive capacity of the theory.

(e) For a marvelous treatise for the educated layman, see M. Sachs, Relativity in Our Time: From Physics to Human Relations, Taylor & Francis, 1993.

[19] . E.g., see the several Evans' reviews in Modern Nonlinear Optics, Second Edition, Edited by M.W. Evans, Wiley, 2002 (in press). Many other O(3) electrodynamics papers are also carried in this set of three volumes, as well as in the standard literature.

[20] . Mendel Sachs, "Relativistic Implications in Electromagnetic Field Theory," ibid.

[21] . Without interaction with the vacuum, mass does not exhibit perfect symmetry. For a discussion, see T. D. Lee, Particle Physics and Introduction to Field Theory, Harwood Academic Publishers, New York, p. 378-389.

[22] . In both classical and quantal electrodynamics, the problem of the source charge and its associated fields and potentials—and their energy—has been considered to be the most difficult problem.

(a) For a solution to that problem, see T. E. Bearden, "Giant Negentropy from the Common Dipole," Journal of New Energy, 5(1), Summer 2000, p. 11-23. On DoE open website http://www.ott.doe.gov/electromagnetic/papersbooks.html and this author's website www.cheniere.org.

(b) For very powerful support of that proposed solution, see F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984, Chapter 5. Neither the time-polarized photon nor the longitudinal photon is individually observable, yet the combination of the two is observable as the instantaneous scalar potential. The Mandl and Shaw combination of a scalar (time-polarized)

photon and a longitudinal photon is explained by Bearden as the interaction of the causal incoming scalar photon with a charge, the charge subsequently transducing the absorbed energy from the time-domain into 3-space, and re-emission of the energy as an emitted longitudinal photon in 3-space. The actual interaction provides the coupling, and clarifies which is the *cause* and which is the *effect*.

[23] . As the electrodynamicists implicitly assume, by assuming fields and potentials from all charges in the universe penetrating and existing and superposing and interfering in each cubic centimeter of space, and in fact at every point in space. But then the electrodynamicists continue to utilize a material ether assumption in their equations, embedded implicitly upon the notion of an "empty space" filled with this material ether. Tesla called it "… *one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history*." (Nikola Tesla, "The True Wireless," Electrical Experimenter, May 1919). While that biting remark certainly did not endear him to struggling electrical scientists, it did strike uncomfortably close to the mark, and it still does.

[24] . J. H. Poynting, "On the transfer of energy in the electromagnetic field," Phil. Trans. Roy. Soc. Lond., Vol. 175, Part II, 1885, p. 343-361.

[25] . Oliver Heaviside, "Electromagnetic Induction and Its Propagation," The Electrician, 1885, 1886, 1887, and later. This is a series of 47 sections, published section by section in numerous issues of The Electrician during 1885, 1886, and 1887. See also Oliver Heaviside, "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field," Phil. Trans. Roy. Soc. London, 183A, 1893, p. 423-480.

[26] . By a crude analogy, one may think of the "virtual" energy of the vacuum as energy that has been disintegrated into incredibly tiny bits—each so small that the bits fade in and out of existence at an incredible rate. The spinning action of the charge may be thought of as similar to that of an old spinning wheel. The charge spins, so that it coheres some of the "virtual fibers" continually fed to it by the vacuum, into "thread-sized" portions that are emitted radially outward. So the charge "splatters back" some of the fibers as fibers, but "spins" the remainder into useful quantum-sized "threads" which are emitted in observable form.

[27] . Presently electrodynamicists are likely to specify the Poynting energy flow **S** as **S** = **E**×**H**. However, in the vacuum (spacetime) neither **E** nor **H** exists as such *observed force fields*, which requires presence of charged mass. Only potentials and potential structuring of the virtual particle flux exist in the vacuum (which is after all just potential comprised of virtual particle flux). Those structurings or their analogues also exist as sets of curved spacetime regions (i.e., spacetime structurings comprising the elements of the "vacuum engine"). See E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," Mathematische Annalen, Vol. 57, 1903, p. 333-355. Whittaker that any scalar potential decomposes into a multiplicity of longitudinal bidirectional flows of energy. This decomposition must also comprise the vacuum scalar potential, as well as the "spacetime curvature" potential.

[28] . However, Whittaker misinterpreted the *causal* phase conjugate wave (that half of his phase conjugate wavepair) as the *effect* after the wave interacts with charged mass, in which case parity is broken and the *effect* wave produced by the interaction is a longitudinal EM wave going in the opposite direction in 3-space from its "biwave" 3-space partner. The correct interpretation is that,

prior to interaction, the phase conjugate wave exists in the fourth axis of Minkowski 4-space, hence is in the time domain. It is literally a longitudinal EM wave moving on the fourth axis (in the time domain) to the interacting charge, and the other Whittaker biwave partner is the effect longitudinal EM wave emitted in 3-space by the interacting charge after it absorbs the incoming time-polarized EM wave. We point out that a longitudinal EM wave along the time axis is a time-polarized EM wave, corresponding to the known time-polarized photon in quantum field theory.

[29] . After publication of my "Giant Negentropy" paper, I discovered very strong support for my reinterpretation of Whittaker's 1903 decomposition of the scalar potential. This support was by F. Mandl and G. Shaw, ibid. Mandl and Shaw give a deeper coverage of the photon polarizations. They argue that the longitudinal and scalar polarizations individually are not directly observable, but only in combination, wherein they manifest as the "instantaneous" Coulomb (i.e., electrostatic) potential. Our comment is that this argument, translated from particle terminology to wave terminology, directly fits my re-interpretation of Whittaker's 1903 decomposition of the scalar potential. However, Mandl and Shaw fail to account for their assumed interaction of the detecting/observing unit point charge to perform the perfectly correlated "combining", and thus fail to account for the absorption of the incoming *causal* time-polarized wave or photon, the transduction of that excitation energy of the charge into longitudinal EM wave/photon energy in 3-space, and the subsequent emission of that excitation energy as a perfectly correlated longitudinal EM wave in 3-space.

Thus Mandl and Shaw missed the time-excitation charging of the source charge via absorption of the "coupled" time-polarized EM wave/photon, and the subsequent decay of the time-charge excited state by emission of a 3-space

longitudinal EM wave/photon. This omitted interaction represents the discovery of nature's giant negentropy mechanism in EM energy flow, whenever 3-space energy flow symmetry is broken, as with a common dipole. So Mandl and Shaw do not account for photon (or wave) polarization transduction, where the "causal" time-polarized EM wave or photon comes in and is absorbed by the detecting charge or dipole to energetically excite it in the time-domain, then the excitation energy is re-emitted as the longitudinally polarized EM wave or photon in 3-space.

Recognition of these missing functions allowed at last a solution to the long-vexing problem of the source charge. We actually solved the problem for a source dipole, then pointed out that any "isolated" charge is a set of dipoles when its clustering virtual charges of opposite sign are considered.

[30] . The source charge problem was recognized as the most difficult problem in electrodynamics. E.g., see D. K. Sen, Fields and/or Particles, Academic Press, London and New York, 1968, p. viii. Quoting: *"The connection between the field and its source has always been and still is the most difficult problem in classical and quantum electrodynamics."* Since our proposed solution is consistent with particle physics (broken 3-symmetry of the dipole) and with quantum field theory (combination of the time-polarized and longitudinal photon comprises the scalar EM potential), it is robust and we believe it will stand up to meticulous scrutiny.

[31] . E. T. Whittaker, 1903, *ibid*.

[32] . Mandl and Shaw, *ibid*.

[33] . Poynting only assumed that diverged part of the energy flow. Heaviside, on the other hand, showed that there is a much larger energy

flow component that misses the intercepting charges (or circuit) altogether, and is wasted. Since this means that far more EM energy flows from the terminals of a generator than the external circuit intercepts and catches, it means that all generators produce more energy flow output than the textbook states, or that Poynting assumed. In fact, as *transducers of vacuum energy*, all dipolar generators already exhibit COP>1.0. Since no one in the 1880s could explain where such an astounding extra energy flow was coming from, Lorentz originated an integration trick to discard the nondiverged Heaviside EM energy flow component.

(a) See J. H. Poynting, “On the transfer of energy in the electromagnetic field,” Philosophical Transactions of the Royal Society of London, Vol. 175, Part II, 1885, p. 343-361.

(b) See Oliver Heaviside, "Electromagnetic Induction and Its Propagation," The Electrician, 1885, 1886, 1887, and later—a series of 47 sections, published section by section in numerous issues of The Electrician during 1885, 1886, and 1887.

(c) See also Oliver Heaviside, "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field," Phil. Trans. Roy. Soc. London, 183A, 1893, p. 423-480.

(d) For Lorentz' trick to discard the nondiverged component, see H. A. Lorentz, Vorlesungen über Theoretische Physik an der Universität Leiden, Vol. V, Die Maxwellsche Theorie (1900-1902), Akademische Verlagsgesellschaft M.B.H., Leipzig, 1931, "Die Energie im elektromagnetischen Feld," p. 179-186. Figure 25 on p. 185 shows the Lorentz concept of integrating the Poynting vector around a closed cylindrical surface surrounding a volumetric element. This is the procedure which arbitrarily selects only a small component of the energy flow associated with a circuit—specifically, the small Poynting component striking the surface charges and being diverged into the circuit to power it—and

then treats that tiny component as the "entire" Poynting energy flow. Thereby Lorentz arbitrarily discarded all that extra Heaviside energy transport component which does not strike the circuit at all, and is just wasted.

[34] . In fact, the simple equation $W = \phi q$, where W is the diverged/collected energy, q is the intercepting coulomb, and ϕ is the reaction cross section of the potential, shows that electrodynamicists implicitly assume the “true” causal potential to contain unlimited energy. E.g., using that equation, any desired amount W of energy can be collected from any nonzero potential ϕ, no matter how small its intensity, simply by adding sufficient intercepting/collecting charges.

[35] . A back-of-the-envelope calculation for a nominal simple circuit has been made and previously presented by the present author. In the nominal circuit used, the source dipole extracts from the vacuum and sends down the outside of the attached circuit about 10^{13} times as much energy as the circuit itself intercepts, diverges, and utilizes. The huge remainder is not intercepted, remains nondivergent and just passes on out into space at the speed of light.

[36] . Solving the standard equation $\mathbf{E} = \mathbf{F}/q$ for $\mathbf{F}$, one has $\mathbf{F} = \mathbf{E}q$. Again, from any nonzero **E**-field, no matter how small, as much force can be “gathered” and produced as one desires, merely by increasing the intercepting/collecting charge q.

[37] . Robert H. Romer, "Heat is not a noun," American Journal of Physics, 69(2), Feb. 2001, p. 107-109. This is an editorial discussion by the Editor of AJP of the concept of heat in thermodynamics. Heat is not a substance, not a thermodynamic function of state, and should not be used as a noun. The quotation castigating the standard "field diagram" of an EM wave in space is

from endnote 24, p. 109.

[38] . This is readily understood when one realizes that the founders of electromagnetics assumed a material ether. So to them, there was not a single point in all the universe where mass was absent! Hence the field, potential, and wave "in space" were actually the field, potential, and wave "in the material ether medium", and therefore perfectly material. Even though the Michelson-Morley experiments falsified the material ether in the 1880s, the electrodynamicists (i) never changed their classical EM equations which still to this day assume the material ether filling all space, and (ii) still implicitly mistake the transverse electron precession wave in the Drude gas in a receiving antenna as representing the assumed interception of the incoming "transverse EM wave" in that external material ether medium.

[39] . Robert Bruce Lindsay and Henry Margenau, Foundations of Physics, Dover Publications, New York, 1963, p. 283-287, and passim.

[40] . Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," Physical Review, Second Series, 115(3), 1959, p. 485-491. However, Aharonov and Bohm seem to have missed the similar mass interpretation of the potential, so that they utilized the potential as massless and therefore the vacuum EM entity that is the primary cause of all EM phenomena. If one truly eliminates only the potential's effect upon the intercepting charged mass, and utilizes the non-intercepted EM entity in vacuum, one has arrived at the direct alteration of the massless spacetime geometry of general relativity. In short, suddenly one has latched onto a unified field theory, and one that is engineerable by surprising electromagnetic means.

[41] . But erroneously assumed to be present, because of Maxwell's ubiquitous use of the material ether and the continued implied material ether in the electrodynamics equations to this day.

[42] . T. W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," Annales de la Fondation Louis de Broglie, 16(1), 1991, p. 23-41. Barrett analyzed Tesla's patented circuits in terms of quaternion electrodynamics, which is of higher symmetry than either vector or tensor algebra electrodynamics. Lo and behold, Tesla could shuttle potential energy around in his circuits at will, and that functioning would not even show up in a tensor or vector electrodynamic analysis.

[43] . T. W. Barrett, "Active Signalling Systems," U.S. Patent No. 5,486,833, Jan. 23, 1996; — Oscillator-Shuttle-Circuit (OSC) Networks for Conditioning Energy in Higher-Order Symmetry Algebraic Topological Forms and RF Phase Conjugation," U.S. Patent No. 5,493,691, Feb. 20, 1996.

[44] . As the reader can appreciate, this represents a dramatic change to the foundations of electrodynamics. It is closely allied to Sachs's unified field theory; see appropriate Sachs references in this paper.

[45] . As Dirac pointed out, the Michelson-Morley experiments of the 1880s destroyed the *material* ether assumed by Faraday and Maxwell and subsequent electrodynamicists; it *did not* destroy the ether per se. Dirac emphasized that any nonmaterial Lorentz-invariant ether is perfectly consistent with the Michelson-Morley experiments. General relativity describes the shaping and structuring of the vacuum as curvatures of spacetime geometry and clustered patterns thereof (although the latter part is essentially neglected). GR consists of the changes

of this spacetime due to the interaction of mass/ trapped energy, and also the forces upon mass/ trapped energy created by the interaction of such curvature-patterns of spacetime. Essentially, electrodynamics is missing just this "mass to spacetime" transform and this "spacetime to mass" transform. It is in fact missing its "infolded general relativity" dynamic internal structuring of the potential, field, and wave. KGB energetics weapon scientists call these missing transforms *the information content of the field*—which our fellows mistakenly interpret in their own flawed electrodynamics as "spectral content." Nothing could be further from the truth.

[46] . In 1903 E. T. Whittaker showed that any scalar potential is comprised of an infinite harmonic series of bidirectional longitudinal EM waves, arranged in bidirectional wavepairs. See E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," Mathematische Annalen, Vol. 57, 1903, p. 333-355.

[47] . General relativity usually stops short of including an "infolded" topology within its basic spacetime, and only applies an "exterior" topology to it. However, it does not exclude that capability. Spacetime is just potential identically, and also just vacuum identically. Since GR omits the infolding structure of spacetime/potential, and so does electrodynamics, it has not been possible to unify the two completely. The "bridge" across the chasm between them has been eliminated by both disciplines.

[48] . With finite propagation, this action-at-a-distance is retarded so that some time passes between the effect and the cause. Each Mandl-Shaw photon interaction—the receipt of the scalar (time-polarized) photon, and emission of 3-space longitudinal photon—is retarded by (requires) the amount of time that is transformed into 3-space energy. [Time may be regarded as 3-space

electromagnetic energy compressed by the factor c^2, with the compressed energy placed on the fourth Minkowski axis to appear as time (seconds), rather than being left in 3-space to appear as mass).

Transformation from time-domain EM energy to 3-space energy is a function of the spin of the charge, which "spins" 720 degrees, being 360 degrees in the time domain while absorbing the time-polarized EM photon energy, the being followed by 360 degrees in 3-space while it is emitting the 3-space longitudinal photon. This retardation due to transformation of the energy from the time domain to the 3-space domain is what limits the speed of light in the ambient vacuum to the finite velocity c.

However, when infinite velocity propagation occurs (as is permissible with longitudinal EM waves alone, which a priori implies no retardation), then the notion vanishes of a “cause” and an “effect” separated by a time interval. In that case, one is operating in a multiply-connected spacetime, where in theory there is no observable “length” or “time” between the “cause” event and the “effect” event. Further, one “causative” initiation point can be superposed simultaneously with multiple distant points widely separated in ordinary spacetime. In that case, putting a joule of energy into the “initiating cause” point (to the normal 3-space observer) results in the simultaneous appearance at each and every distant participating point, of one joule. To the normal "singly-connected spacetime" observer, this is a direct amplification of energy, directly from the vacuum energy itself. We have proposed this mechanism as an extension of Bohm’s quantum potential utilized in his hidden variable theory of quantum mechanics. See David Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of 'Hidden' Variables, I and II," Physical Review, 85(2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II). Unfortunately three nations of the world have already seen fit to highly weaponize this effect, and a fourth nation is very close to

deploying such a weapon. Presently quantum potential weapons are the dominant weapons on earth, and nothing can stand against them.

[49] . By conjugate pair, we mean that the wavepair consists of an EM longitudinal wave and its time-reversed twin, precisely superposed spatially but antiphased in time. In such a wave, the transverse energy density amplitude cannot vary; instead, the wave consists of (and carries) an oscillation of the rate of flow of time, about some median speed. The median speed of a longitudinal EM wave is not confined to the speed of light in vacuum.

[50] . The value of the energy continuously collected from a steady potential, in a “swirl” around a fixed intercepting charge, is of course a fixed scalar. That, however, has nothing to do with the nature of the potential as an EM entity in massless vacuum, prior to interaction with charged mass.

[51] . J. D. Jackson, Classical Electrodynamics, Second Edition, Wiley, 1975, p. 223.

[52] . Interestingly, one also cannot produce a clear definition of *energy* in physics. A good discussion of the energy concept is given by R. B. Lindsay, "The concept of energy and its early historical development." Foundations of Physics, 1 (4), 1971, p. 383-393. Lindsay investigates the concept of energy from its early historical origin, and covers from ancient times through the 18th century. The root of the concept is the notion of invariance in the midst of change. In short, the concept consists of considering “the changing” as being “nonchanging.” In pursuing a rigorous definition of anything, one eventually arrives at a contradiction of Aristotelian logic. Ultimately one can only define something as identical to its own opposite. Geometry, e.g., models the presence of

mass as the absence of mass. Ultimately a "hard definition" is an "accursed necessity for the identity of opposites"—the centuries-old bane of the philosophers. In physics the problem is avoided by the "duality principle"—just treat an entity as either a particle or wave as necessary, and quit arguing about it! The problem is the incompleteness of Aristotelian logic itself. A solution to the "identity of opposites" problem is obtained by explicitly adding a fourth law of logic that has always been implicitly assumed in Aristotle's three laws. For a discussion, see "A Conditional Criterion For Identity, Leading to a Fourth Law of Logic," Appendix III to T. E. Bearden, Aids: Biological Warfare, Tesla Book Co., 1988, p. 428-443. A simple proof of the fourth law of logic is given in *ibid*., p. 439-440.

[53] . In addition to reference 19, see Myron W. Evans, Enigmatic Photon, Vol. II, Kluwer, ISBN 0792332881. See also Apeiron, 4(2-3), Apr.-Jul. 1997, a Special $B^{(3)}$ Field Issue, Guest editor: Myron W. Evans. In this same issue, see the Introduction by Evans, and also his "Helicity and the Electromagnetic Field." In the same issue, see also Jean-Pierre Vigier, "Relativistic Interpretation (with Non-Zero Photon Mass) of the Small Ether Drift Velocity Detected by Michelson, Morley, and Miller." Barrett has also rigorously shown the reality of the $B^{(3)}$ field, and so the conventional closure against it is doomed to failure. The emergence of $B^{(3)}$ field theory will dramatically alter electrodynamics, and elevate the importance of the longitudinal EM wave. We are also much indebted to Bob Flowers for his penetrating elucidation of the background of the $B^{(3)}$ field in private communications, and to Myron Evans for his patient and encouraging private communications.

[54] . See particularly T. W. Barrett, "Sagnac Effect: A Consequence of Conservation of Action Due to Gauge Field Global Conformal Invariance in a Multiply-Joined Topology of Coherent Fields," in T. W. Barrett and D. M Grimes, [Eds.], Advanced Electromagnetism: Foundations, Theory,

& Applications. World Scientific, River Edge, New Jersey, 07661, 1995, p. 278-313; T. W. Barrett, "Electromagnetic Phenomena Not Explained by Maxwell's Equations," in A. Lakhtakia, (ed.): Essays on the Formal Aspects of Electromagnetic Theory, World Scientific Publishing, River Edge, NJ, 1993, p. 6-86.

[55] . Richard W. Ziolkowski, "Exact Solutions of the Wave Equation With Complex Source Locations," Journal of Mathematical Physics, 26 (4), April 1985, p. 861-863; I.M. Besieris, A.M. Shaarawi, and R. W. Ziolkowski, "A bidirectional travelling plane wave representation of exact solutions of the scalar wave equation," Journal of Mathematical Physics, 30(6), 1989, p. 1254-1269; Rod Donnelly and Richard Ziolkowski, "A method for constructing solutions of homogeneous partial differential equations: localized waves," Proceedings of the Royal Society of London A., Vol. 437, 1992, p. 673-692; — "Electromagnetic field generated by a moving point charge: A fields-only approach," American Journal of Physics, 62 (10), Oct. 1994, p. 916-922.

[56] . M. W. Evans, editor, Modern Nonlinear Optics, Wiley, 2002, 3 volumes (in press).

[57] . W. A. Rodrigues Jr. and J.-Y. Lu, “On the existence of undistorted progressive waves (UPWs) of arbitrary speeds $0 \leq v < \infty$ in nature,” Foundations of Physics, 27(3), 1997, p. 435-508; W. A. Rodrigues Jr. and J. E. Maiorino, “A unified theory for construction of arbitrary speeds ($0 \leq v \leq \infty$) solutions of the relativistic wave equations,” Random Operators and Stochastic Equations, Vol. 4, 1996, p. 355-400.

[58] . E. T. Whittaker, 1903, *ibid*.

[59] . Ironically, Maxwell’s actual theory was some 20 quaternion-like equations in 20

unknowns, as given in "A Dynamical Theory of the Electromagnetic Field," Royal Society Transactions, Vol. CLV, 1865, p 459. Read Dec. 8, 1864. Also contained in The Scientific Papers of James Clerk Maxwell, 2 vols. bound as one, edited by W. D. Niven, Dover, New York, 1952, Vol. 1, p. 526-597. Heaviside dramatically curtailed Maxwell's theory to a vector subset of some 4 equations in 4 unknowns. Lorentz further curtailed it by effectively throwing out all Maxwell-Heaviside systems that were in disequilibrium with their active vacuum and curved spacetime environments. So after over a century, the long slumbering *environmental* dynamics for electrodynamical systems is awakening and chasing its own roots again. Long live the rise of the supersystem!

[60] . E.g., see J. Vaz Jr. and W. A. Rodrigues Jr., "Maxwell and Dirac Theories as an Already Unified Theory," Advances in Applied Clifford Algebras, Vol. 7 (S), 1997, p. 369-386. See W. A. Rodrigues, Jr. and J. Vaz Jr., "Subluminal and Superluminal Solutions in Vacuum of the Maxwell Equations and the Massless Dirac Equation," Advances in Applied Clifford Algebras, Vol. 7(S), 1997, p. 457-466.

[61] . E. T. Whittaker, 1904, *ibid*.

[62] . We strongly stress that longitudinal EM waves and their dynamics, so ignored in all except the most advanced higher symmetry electrodynamics texts, are actually the key to everything. Longitudinal EM waves already comprise, create, and structure the feeble "envelope EM waves" we presently deal with. A longitudinal EM wave is also an electrogravitational wave, and oscillates the rate of flow of time itself because of its combination with a time-polarized wave. The two combined photons have a total spin two, which is a graviton. Thus internally a graviton is revealed as a particular

dynamic between time-domain EM energy and 3-space EM energy. The longitudinal EM wave in the time domain (that is combining with the longitudinal EM wave in 3-space) is thus an oscillation of time contraction and expansion, or "pulsation" in the rate of flow of time. Very powerful gravitational effects as well as very powerful and unique electrodynamics effects can be obtained by use of longitudinal EM waves, because of the additional dynamics between the time and 3-space domains. Unwitting use of such extraordinary EM waves is how Rife and Prioré achieved such remarkable results.

[63] . M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," Journal of New Energy, 4 (3), Special Issue, Winter 1999, p. 76-78.

[64] . Melba Phillips, “Classical Electrodynamics,” Vol. IV: Principles of Electrodynamics and Relativity, in Encyclopedia of Physics, Edited by S. Flugge, Springer-Verlag, Berlin, 1962, p. 1-108 gives a good overall summary of the superpotential theory.

[65] . A. Righi, Nuovo Cimento, Vol. 2, No. 5, 1901, p. 104.

[66] . P. Debye, Ann. Phys., Leipzig, Vol. 30, 1909, p. 57.

[67] . Thomas John I'Anson Bromwich, An Introduction to the Theory of Infinite Series, MacMillan, London, 1908.

[68] . A. Nisbet, Physica, Vol. 21, 1955, p. 799; Proc. Roy. Soc. Lond. A, Vol. 231, 1955, p. 250.

[69] . W. H. McCrea, “Hertzian electromagnetic

potentials," Proc. Roy. Soc. Lond. A, Vol. 240, 1957, p. 447-457.

[70] . Sachs has achieved the necessary unified field theory, broadly unifying physics from the quarks and gluons to the entire universe, and including both the active vacuum and active, locally curved spacetime. See Mendel Sachs, General Relativity and Matter: A Spinor Field Theory from Fermis to Light-Years (Fundamental Theories of Physics), Reidel (now Kluwer), 1982; — Quantum Mechanics from General Relativity: An Approximation for a Theory of Inertia, Reidel (now Kluwer), 1986. It should be obvious that, unless electrodynamics theory and general relativity theory utilize the same background spacetime, it is impossible to completely merge them, from first principles. Since classical electrodynamics artificially discards its active environment, it is electrodynamics which must be changed in order to be successfully united with general relativity. Sachs has accomplished this long-sought *engineerable* unification.

[71] . Proof that the virtual state can be coherently integrated is already furnished by every source charge in the universe, which does precisely that.

[72] . We note without elaboration that all the mind functions, even of the deepest and most unconscious nature, and even of collective species unconsciousness domains—exist electromagnetically in the infolded EM domain. The "conscious mind" is a serial processor, though extremely rapid. The unconscious is a massively parallel processor. The reason the conscious mind cannot "directly see" the unconscious is that "seeing" innumerable things in the "single snapshot" at once, just obliterates all singular discrimination because of the intense summation. Mind functions are timelike, so consist of specialized structures, functioning, and dynamics

inside the time domain. Since the infolded structuring captures this entire domain, it also involves a physics of mind and matter interaction, but as a science instead of as a mysticism. In theory vacuum engines are also possible that engineer the mind at any and all levels. We have addressed this extended physics of mind and matter reactions elsewhere and do not address it here. The Russian weapon scientists refer to this mind area (which can also be engineered by novel electrodynamic means) as psychoenergetics.

[73] . R. O. Becker and David G. Murray, "The electrical control system regulating fracture healing in amphibians," Clinical Orthopaedics and Related Research, Vol. unk, No. 73, Nov.-Dec. 1970, p. 169-198. This is the definitive technical exposition by Becker of his electrical findings about the cellular control system.

[74] . See particularly Robert O. Becker, “The direct current control system. A link between environment and organism,” New York State Journal of Medicine, Vol. 62, 1962, p. 1169-1176; — and Joseph A. Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bulletin of the New York Academy of Medicine, Second Series, 48(4), May 1972, p. 627-641; — and Carlton F. Hazlewood, Abraham R. Liboff, and Jan Walleczek, Electromagnetic Applications In Medicine," NIH-OAM Electromagnetics Panel Report, Jan. 15, 1993; — "A technique for producing regenerative healing in humans," Frontier Perspectives, 1(2), Fall/Winter 1990, p. 1-2; — and Andrew A. Marino. Electromagnetism and Life, State University of New York Press, Albany, NY, 1982; — and Gary Selden, The Body Electric, William Morrow and Company, New York, 1985; — Cross Currents, Jeremy P. Tarcher, Inc., Los Angeles, 1990; — "The bioelectric field pattern in the salamander and its stimulation by an electronic analog," IRE Transactions on Medical Electronics, Vol. ME-7, July 1960, p. 202-207; —

"Some observations indicating the possibility of longitudinal charge-carrier flow in peripheral nerves," Biological Prototypes and Synthetic Systems, Plenum Press, New York, 1962, p. 31-37; — and W. Slaughter, "The longitudinal direct current gradients of spinal nerves," Nature, Vol. 196, Nov. 17, 1962, p. 675-676; — and Charles H. Bachman and Howard Friedman, The direct current (control) system: A link between the environment and the organism," New York State Journal of Medicine, Vol. 62, April 15, 1962, p. 1169-1176; — "The direct current field: A primitive control and communication system related to growth processes," Proceedings of the. XVI International. Congress of Zoology, Washington, D.C., Vol. 3, 1963, p. 179-183; — "The neutral semiconduction control system and its interaction with applied electrical current and magnetic fields," Proc. 11th International. Cong. Radiol., Amsterdam, Excerpta Medica Foundation, 1966, Series 105, p, 1753-1759; — "The bioelectric factors in amphibian limb regeneration," The Journal of Bone and Joint Surgery, Vol. 43-A, No. 5, July 1961, p. 643-656; — and David G. Murray, "A method for producing cellular dedifferentiation by means of very small electrical currents," Transactions, New York Academy of Sciences, 29(5), Mar. 1967, p. 606-615.

[75] . The ultimate tool for use in seeing and working with this "infolded" or "internal electrodynamics inside normal EM fields, waves, and potentials will probably be the Fogal semiconductor when it goes into production in the near future. Fogal's transistors are capable of (1) infolding the desired longitudinal EM waves inside normal EM signals (he demonstrates infolding TV signals inside pure DC potentials, and transmitting them over conductors as pure DC potentials for appreciable distance, then using his semiconductors to again extract the "infolded" hidden TV signals.

[76] . See Vlail Kaznacheyev, "Electromagnetic

Bioinformation in Intercellular Interactions," Psi Research, 1(1), Mar. 1982, p. 47-76; — *et al*., "Distant intercellular interactions in a system of two tissue cultures," Psychoenergetic Systems, 1 (3), Mar. 1976, p. 141-142; "A Comment" by William A. McGarey, p. 143; "A Comment" by Arthur C. Hastings, p. 143-144, — *et al*., "Apparent information transfer between two groups of cells," Psychoenergetic Systems, 1(1), Dec. 1974. See particularly Vlail P. Kaznacheyev and L. P. Mikhailova, Ultraweak Radiations in Intercellular Interactions [in Russian], Novosibirsk, 1981; "Electromagnetic Bioinformation in Intercellular Interactions," Novosibirsk, 1981 [in Russian]; V. P. Kaznacheyev, "Information Function of Ultraweak Light flows in Biological Systems," Problems in Biophysics, Novosibirsk, 1967, p. 7-18 [in Russian].

[77] . Some years ago we documented this disease-inducing "microwave radiation of the U.S. Embassy, explained its purpose and operational mechanism, and published it. E.g., see T. E. Bearden, AIDS: Biological Warfare, Tesla Book Co., Chula Vista, CA, 1988.

[78] . See Robert C. Mallieu, A Model of the Microwave Intensity Distribution Within the U.S. Embassy, Moscow 1966-1967, Report FS-80-166, Applied Physics Laboratory, Johns Hopkins University, Baltimore, Maryland, Aug. 1980. Also see Microwave Radiation at the U.S. Embassy in Moscow and Its Biological Implications: An Assessment, U.S. Department of Commerce, Doc. # NTIA-SP081-12, Mar. 1981. Also see Captain John D. LaMothe, Controlled Offensive Behavior—USSR, Report ST-CS-01-169-72, Defense Intelligence Agency, Washington, D.C. (released under FOIA). See also Captain John D. LaMothe and Mr. Louis Maire, Soviet and Czechoslovakian Parapsychology Research, Report DST-1810S-387-75, Defense Intelligence Agency, Washington, D.C. (Released under FOIA).

[79] . T. E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves," Journal of New Energy, 3(2/3), 1998, p. 12-28. A slightly updated and extended version is published in Explore, 8(6), 1998, p. 7-16.

[80] . C. W. Misner, K. S. Thorne and J. A. Wheeler, Gravitation, W.H. Freeman and Co., San Francisco, 1973, p. 5, 19-21, 71-72, 163-165, 390-391, 399; 367-369.

[81] . T. D. Lee, Particle Physics and Introduction to Field Theory, Harwood, New York, 1981. See particularly Chapter 25: Outlook, "Possibility of Vacuum Engineering," p. 824-828.

[82] . David J. Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of 'Hidden' Variables, I and II," Physical Review, 85 (2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II).

[83] . I.e., the rate of flow of time, or more specifically, the rate of the EM interactions with a mass or particle that generate the flow of the mass or particle through time. See Figure 25. Nobelist Lee has also shown that time is a discrete dynamical variable across all of physics, from quantum mechanics to nonrelativistic field theory, to relativistic quantum field theory. See T. D. Lee, "Can Time Be a Discrete Dynamical Variable?", Physics Letters, 122B(3, 4), Mar. 10, 1983, p. 217-220. Also in T. D. Lee, Selected Papers, Gerald Feinberg, Ed., Birkhauser, Boston, 1986, Vol. 3, p. 77-80. So we have not hesitated to consider time as any other variable, and the fourth Minkowski axis as any of the other three axes with respect to EM energy, fields, potentials, and waves.

[84] . Indeed, there is no such unique thing as “the gravitational field” anyway! The gravitational field is a conglomerate of other field energies and

functions, not a separate field of nature. See A. A. Logunov and Yu. M. Loskutov, "Nonuniqueness of the predictions of the general theory of relativity," Sov. J. Part. Nucl., 18(3), May-June 1987, p. 179. See C. W. Misner, K. S. Thorne and J. A. Wheeler, Gravitation, W.H. Freeman and Co., San Francisco, 1973, p. 399. Quoting*: "The terms 'gravitational field' and 'gravity' refer in a vague, collective sort of way to all of these entities. Another, equivalent term for them is the 'geometry of spacetime'."* See also A. D. Sakharov, "Vacuum Quantum Fluctuations in Curved Space and the Theory of Gravitation," Soviet Physics Doklady, Vol. 12, No. 11, 1968, p. 1040-1041 [English translation.]. Finally, see our remarks under reference 62 above, particularly with respect to the proposed internal electromagnetic dynamics of the graviton.

[85] . A 1993 study by the Office of Technology Assessment, delivered to Congress, showed that a single terrorist in a small plane, with a tank of anthrax spray, and dispersing the spray as he flew around the greater Washington D.C. area on a calm night, would produce between 1 and 3 million casualties. Most of those casualties would die. So a single biological warfare (BW) strike in one U.S. metropolitan area could easily kill two million Americans. As an example, Saddam Hussein is known to have the terrorist teams and the anthrax, and he has had a decade since the Gulf war to insert additional teams and biological warfare agents into the U.S. Presently this is rated by our government as the strongest strategic threat to the U.S., after which comes nuclear strikes, followed by chemical agent strikes. Redevelopment of the Prioré approach, e.g., could easily save the lives of 90% of that nominal two million dead Americans. As matters stand now, triage would apply and almost all of those two million stricken Americans would die.

[86] . In 1998 we proposed a crash development of this kind of device in 1998, with copies to DoD,

NIH, CDC, the USAF, etc.; in T. E. Bearden, Energetics: Extensions to Physics and Advanced Technology for Medical and Military Applications, CTEC Proprietary, May 1, 1998, 200+ page inclosure to CTEC Letter, "Saving the Lives of Mass BW Casualties from Terrorist BW Strikes on U.S. Population Centers," to Major General Thomas H. Neary, Director of Nuclear and Counterproliferation, Office of the Deputy Chief of Staff, Air and Space Operations, HQ USAF, May. 4, 1998. Also to Gen. (Ret.) Walter Busby, Deputy Secretary of Defense for Counterproliferation and Chemical and Biological Defense, March 21, 1998. Also to NIH, CDC, and several other U.S. government agencies.

DoD replied that it was not documented in the literature (a specific list of exact scientific papers reporting the results of the Prioré team's experiments and the experiments of Becker was included; no one seemed to read it). CDC and the USAF did not reply. NIH first responded (from its Policy section—read, *spin control* section) that, since I mentioned the cause of the Gulf War Disease and how it was induced, it was not a matter of their interest but of DoD's interest, and so they just shipped it to DoD and got rid of it. A second response evoked from NIH on query from my congressman (again, a response from their *policy* section) directed me to their proposals section. I don't believe a single qualified scientist even read it. DoD weakly replied that it was not documented in the literature (a specific list of citations from the hard French scientific literature, reporting the astounding results of the Prioré treatments, was included, which apparently no one read).

Not a single scientist from any agency called me to discuss the revolutionary and proven results obtained by Prioré, and documented in the attachments and in the cited literature. Sadly, it seems that no one had the foggiest notion what I was talking about, and no one much cared. My conclusion was and is that my own government bureaucrats do not give a tinker's dam about saving

millions of American casualties in the coming debacle, *if it has to be done by "out-of-the-box" methods not approved by the big drug industry*. Yet these are the same officials that readily admit the exact threat I referred to, admit that it is a matter of *when* the biological warfare attacks will occur and not *if*, and admit that right now they have no effective way to cope with it or save most of those coming millions of Americans that are going to just be dragged aside to die.

My response is that the American taxpayers are certainly not getting their money's worth from the billions they shower on our medical research community. It is unconscionable to ignore for over 30 years the demonstrated and astounding results achieved by eminent French scientists—such as Pautrizel, a world-renowned parasitologist and Courier, head of the French Academy's Biological Section, and also *Secretaire Perpetuel* of the Academy) working with the Prioré team, in curing terminal tumors etc. in thousands of lab animals, all properly documented in the hard French scientific literature.

In my view, considering the certainty of those future American mass deaths, it is akin to high treason. Whether our scientific community realizes it or not, today's strategic war of massive strategic strikes has shifted to our civilian populace, and to our cities and mass population centers. It is our civilian populace that will sustain the greatest and most prompt casualties, and probably will receive the first massive strikes, totally by surprise.

The first phase of WW III—delivery of the strategic weapons to their strategic targets—has already been accomplished. Large Russian nuclear weapons are already hidden in our major cities and population centers (read Lunev's book, he tells us how they brought in these weapons), the Spetznaz teams are here to detonate them on call, multiple nations such as Iraq, Libya, and Iran already have terrorists agents in country in the U.S. with anthrax and smallpox in hand to be released, and Castro guerrillas and trained saboteurs have been trained

in Southern Mexico and infiltrated across the border into the U.S. for decades.

Whether they like it or not, U.S. scientists have thus become the major front line "soldiers" and "defenders" of our nation. And frankly, they have failed abominably in their responsibility, and most do not seem to care. For a startling and even shocking characterization of our present scientific community, the reader is referred to Daniel S. Greenberg, Science, Money, and Politics: Political Triumph and Ethical Erosion, University of Chicago Press, 2001.

[87] . As we stated, just such an attack is now officially the greatest strategic threat to the United States. Second is a nuclear attack, followed by chemical attack as a distant third. E.g., see Richard K. Betts, “The New Threat of Mass Destruction,” Foreign Affairs, 77(1), Jan./Feb. 1998, p. 26-41. For the ineffectiveness of our defenses against the coming mass biological warfare strikes, see Laurie Garrett, The Coming Plague: Newly Emerging Diseases in a World Out of Balance, Farrar, Straus and Giroux, New York, 1994; — "The Nightmare of Bioterrorism," Foreign Affairs, 80(1), Jan./Feb. 2001, p. 76-89; — Betrayal of Trust: The Collapse of Global Health, Hyperion, New York, 2000.

[88] . Becker, *ibid*.

[89] . A full account of the entire Prioré affair is given in Jean-Michel Graille, Dossier Prioré: Une Nouvelle Affaire Pasteur [The Prioré Dossier: A New Pasteur Affair?], De Noel, Paris, 1984. [in French]. A summary account is given by Christopher Bird, "The Case of Antoine Prioré and His Therapeutic Machine: A Scandal in the Politics of Science," Appendix I in T.E. Bearden, AIDS: Biological Warfare, Tesla Book Co., P.O. Box 121873, Chula Vista, California 91912, 1988. Prioré's doctoral thesis (in my personal possession courtesy of Professor Courrier and the late Chris Bird), was rejected by the University of Bordeaux

when the French government suppressed the Prioré program in the mid-70s; it is A. Prioré, Guérison de la Trypanosomiase Expérimentale Aiguë et Chronique par L'action Combinée de Champs Magnétiques et D'Ondes Electromagnétiques Modulés. [Healing of intense and chronic experimental trypanosomiasis by the combined action of magnetic fields and modulated electromagnetic waves], 1973. Prioré's patents are: A. Priore, "Apparatus for producing radiations penetrating living cells," U.S. Patent No. 3,368,155, Feb. 6, 1968; — "Method of producing radiations for penetrating living cells," U.S. Patent No. 3,280,816, Oct. 25, 1966; — "Procede et dispositif de production de rayonnements utilisables notamment pour le traitement de cellules vivantes," [Procedure and Assemblage for Production of Radiation Especially Serviceable for the Treatment of Living Cells], Republique Francais Brevet d'Invention P.V. No. 899.414, No. 1,342,772, Oct. 7, 1963. Eleven years after Priore's thesis was rejected, the same university awarded a doctoral thesis to a young graduate. It is Eric Perisse, Effets des Ondes Electromagnètiques et des Champs Magnètiques sur le Cancer et la Trypanosomiase Experimentale [Effects of Electromagnetic Waves and Magnetic Fields on Cancer and Experimental Trypanosomias], Doctoral thesis, University of Bordeaux No. 83, March 16, 1984.

[90] . F. A. Popp *et al.*, "Biophoton Emission (Multi-Author Review)," Experientia, Vol. 44, 1988, p. 543-600; — "Biophoton emission: New evidence for coherence and DNA as a source," Cell. Biophys., Vol. 6, 1984, p. 33-52; — "Physical aspects of biophotons." Experientia, Vol. 44, 1988, p. 576-585; — Recent Advances in Biophoton Research and its Applications, World Scientific Publishing Co., New York, NY, 1992; F. A. Popp, "Photon Storage in Biological Systems," in Fritz Albert Popp *et al.*, eds., Electromagnetic Bio-Information: Proceedings of the Symposium,

Marburg, Federal Republic of Germany, Sep. 5, 1977; Urban & Schwarzenberg, Baltimore, 1979, p. 123-149.

[91] . David M. Rorvik, "Do the French have a Cure for Cancer?", Esquire Magazine, July 1975, p. 110-111, 142-149.

[92] . Arguably the best introduction to nonlinear optical phase conjugation is David M. Pepper, "Nonlinear Optical Phase Conjugation," Optical Engineering, 21(2), March/April 1982, p. 156-183. Another very good presentation is Amnon Yariv, Optical Electronics, 3rd Edition, Holt, Rinehart, and Winston, New York. 1985, Chapter 16: “Phase Conjugate Optics – Theory and Applications.”

[93] . A beautiful example of this “precise backtracking” of the time-reversed wave is given in David M. Pepper, "Applications of Optical Phase Conjugation," Scientific American, 254(1), Jan. 1986, p. 74-83. See particularly the striking photographic demonstration of time reversal of disorder on p. 75.

[94] . We presented some general elements of this dramatic new extension to nonlinear optical phase conjugate pumping and to general relativity, at a graduate seminar, “On the Theory and Principles of EM Systems with COP>1.0”, given to interested graduates and faculty of the University of Louisville, on Nov. 20, 1997.

[95] . E.g., see Owen Flynn, "Parametric arrays: A new concept for sonar," Electronic Warfare Magazine, June 1977, p. 107-112.

[96] . This method of increasing signal-to-noise ratio and pulling hidden signals right up out of the noise, is widely used in signal processing in modern radars. Often signals buried more than 100

dB below the noise level are routinely "pulled out of the noise" and detected, using various forms of coherent summation.

[97]. Any potential decomposes into multiple wavepair sets. In each hidden wavepair, each of the two waves further decomposes into two potentials. Each of *those* potentials then further decomposes into multiple wavepair sets. And so on *ad infinitum*. Or one can start with any wave, decompose it into two potentials, each of those potentials into multiple biwave sets, and so on.

[98]. "Fractal" means self-similarity at all levels, so that patterning or "decomposition" at one level is similar to that at the higher and lower levels. For good overview discussions and applications, see particularly Gregoire Nicolis, "Physics of far-from-equilibrium systems and self-organization," and Joseph Ford, "What is chaos, that we should be mindful of it?", both in The New Physics, Paul Davies, editor, Cambridge University Press, Cambridge and New York, 1989, p. 316-347 and 348-371 respectively. More detailed technical references are cited in each article.

[99]. See Trevor James Constable, "You, Too, Can Photograph UFOs from Airliners," Psychic Observer and Chimes, 37(3), May-June 1977; — The Cosmic Pulse of Life, Merlin Press, Santa Ana, CA, 1976.

[100]. The present author has two beautiful ultraphotographs taken by Joe Gambill using the special filtering approach. One is a photograph of a room, but with its contents of *two weeks earlier*, showing the room prior to the time the photograph was taken. The other is of a "ghost" form—very similar to a photograph obtained by George Meek under rigorous laboratory conditions—and clearly showing the energy form of a "haunted" lady's dead husband. The *interpretation* of these photographs

is of course open to scientific dispute, but the *photographs themselves* are impeccable and real.

[101] . Meek used filters open to UV and IR but opaque to the visible spectrum, on the fluorescent lights in his laboratory. He also used similar filtering on the camera lenses and camera flashes. Under rigorous laboratory conditions, in several thousand photos of the living body Meek was able to take a few highly anomalous photos completely inexplicable by normal science. E.g., he photographed a purported "ghost" and obtained a clear shot of energy streaming associated with a living person. He also photographed the legs of a chair, right through the suddenly "missing" legs of the person sitting in the chair. Again, interpretation is open to dispute, but the photographs are rigorous and real.

[102] . Bill Fogal's patented charge-blocking semiconductor—U.S. Patent Numbers 5,196,809 and 5,430,413—is capable under certain circumstances—and by clever adaptation—of amplifying virtual state information, in a manner somewhat similar to Rife's methodology, but far more easily engineered. When the process works, Bill reports that a clear photograph or video camera shot can be taken right through a solid brick wall, of the hidden scenery beyond. In electrodynamics, in a dielectric absorbing or emitting EM radiation (energy), the entire dielectric participates in each absorption and emission. Emitted light from an object thus carries an astoundingly complete set of little virtual state vacuum engines rigorously representing every part of the object, no matter how small, and all the internal dynamics. This means that the light from the scene beyond the wall strikes the wall on the other side, affecting all the material in the wall, including upon the observer's side, and inserting "dimensioning" from the scene beyond the wall. When light is emitted from the observer's side, the information content of the field representing the scene on the far side, is also part of

the information content of the field in the light emitted from the observer side of the wall and striking the camera and the observers eyes. This "dimensioning" continues in the signals in the camera and on through attached electronic circuitry. Since Fogal's semiconductor can process such information content of the field in the proper circuitry and under favorable circumstances, the phenomenon is therefore permissible and can be technically explained. Using his transistor to transduce the dimensioned information into the visual band, Fogal *can* view a distant scene right through an intervening wall, when he gets everything "just right." At this stage of development, however, the process and adjustment are difficult, just as Rife experience with his microscope. We are convinced that the forthcoming advent of Fogal semiconductors will revolutionize the study and treatment of disease and bodily disorders.

[103] . However, highly advanced electrodynamics does consider the photon with far greater complexity than nuclear engineers such as the present author were introduced to! E.g., a deep discussion of photon polarization is given in F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984 under the heading "covariant quantization of the photon propagator" in Chapter 5. As pointed out by Bob Flowers in a private communication, Mandl and Shaw argue that the longitudinal and scalar polarizations are not directly observable, but only in combination, where the combination manifests as the "instantaneous" Coulomb (i.e., electrostatic) potential. Most such books do argue that the extra components of the photon remain hidden, as does the virtual state. In this paper we have revealed how Rife discovered a process by means of which the virtual state can be observed in great detail.

[104] . V. P. Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions," Psi

Research, 1(1), Mar. 1982, p. 47-76; — "Information Function of Ultraweak Light Flows in Biological Systems," in Problems in Biophysics, Novosibirsk, 1967, p. 7-18 [in Russian]; — and L. P. Mikhailova, Ultraweak Radiation in Intercellular Interactions, [in Russian], Novosibirsk, 1981; — *et al*., “Apparent information transfer between two groups of cells,” Psychoenergetic Systems, 1(3), Mar. 1976; — *et al*., "Distant intercellular interactions in a system of two tissue cultures," Psychoenergetic Systems, 1(3), Mar. 1976, p. 141-142; "A Comment" by William A. McGarey, p. 143; "A Comment" by Arthur C. Hastings, p. 143-144.

[105] . Mitogenetic radiation was studied prior to WW II by Gurwich (spelling varies). See A. Gurwitsch and L. Gurwitsch, "L'Analyse mitogenetique spectrale [The Analysis of the mitogenetic spectrum]," in Andre Mayer, Exposés de Physiologie, [Studies in Physiology], Hermann & Cie, Paris, 1934. Part IV. [In French]. Studies have continued by Popp and others. E.g., see F. A. Popp *et al*., "Biophoton Emission (Multi-Author Review)," Experientia, Vol. 44, 1988, p. 54 3-600; — "Physical aspects of biophotons." Experientia, Vol. 44, 1988, p. 576-585; — "Biophoton emission: New evidence for coherence and DNA as a source," Cell. Biophys., Vol. 6, 1984, p. 33-52. See Fritz Albert Popp; Ke-hsueh Li, and Qiao Gu, [eds.], Recent Advances in Biophoton Research and its Applications, World Scientific Publishing Co., New York, NY, 1992.

[106] . The conventional quantum mechanics assumes that, at the microscopic level, variation (e. g., in the probabilities assigned to interpret what is propagating in the Schrödinger equation) is assumed to be random. However, there is a problem. Big things must be made of little things. If we sum a set of "random" things based on Gibbs thermodynamics statistics, we cannot and will not get an organized "big thing" because we have

assumed total disorder (randomness) *a priori*. Adding heat does not produce cooling! So one falsifies the prevailing interpretation of quantum mechanics, whenever one observes a tree, a flower, the sun, or a human being. In short, there must exist a great unifying principle in nature of a coherent summation, from the "unobservable" virtual state to the observable state. Only in that fashion can there be an macroscopic order at all—and such macroscopic order is universally observed. We believe that the principle we have elucidated, as experimentally produced by Rife, may well be that long-sought universal ordering principle that is so sorely needed by quantum mechanics. Readers interested in the "missing quantum chaos" problem are referred to P. V. Elyutin, "The Quantum Chaos Problem," Sov. Phys. Usp., Vol. 31, No. 7, 1988, p. 597-622. Elyutin discusses the crisis in quantum mechanics because of the missing hidden order. Quantum mechanics is known to be wrong unless this order can be found, because otherwise it does not predict the ordered macroscopic universe. Other useful references are Ilya Prigogine, with T. Petrosky, "Quantum Chaos, Complex Spectral Representation and Time-Symmetry Breaking," Chaos, Solitons, and Fractals, Vol. 4, 1994, p. 311-359; and Robert Pool, "Quantum Chaos: Enigma Wrapped in a Mystery," Science, 243(4893), 1989, p. 893-895.

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Figure 1. The Rife microscope.

Figure 2. Royal Raymond Rife adjusts his microscope.

Figure 3. Faraday omitted the string holder for his taut string, thus omitting half the electrodynamics and half the energy. An equal-and-opposite Newtonian third law reaction wave always appears in our transmitters and receivers, caused by the omitted wave.

Figure 4. Drude gas gyroelectrons in the receiving antenna precess laterally, providing the detected transverse wave and proving the vacuum disturbance wave to be longitudinal.

Figure 5. The magnitude of the causal potential in massfree space is erroneously defined.

Figure 6. Fields and potentials are erroneously defined as what is diverted from them.

Figure 7. The defined magnitude of the field is erroneous and is the field intensity.

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Rife's Microscope

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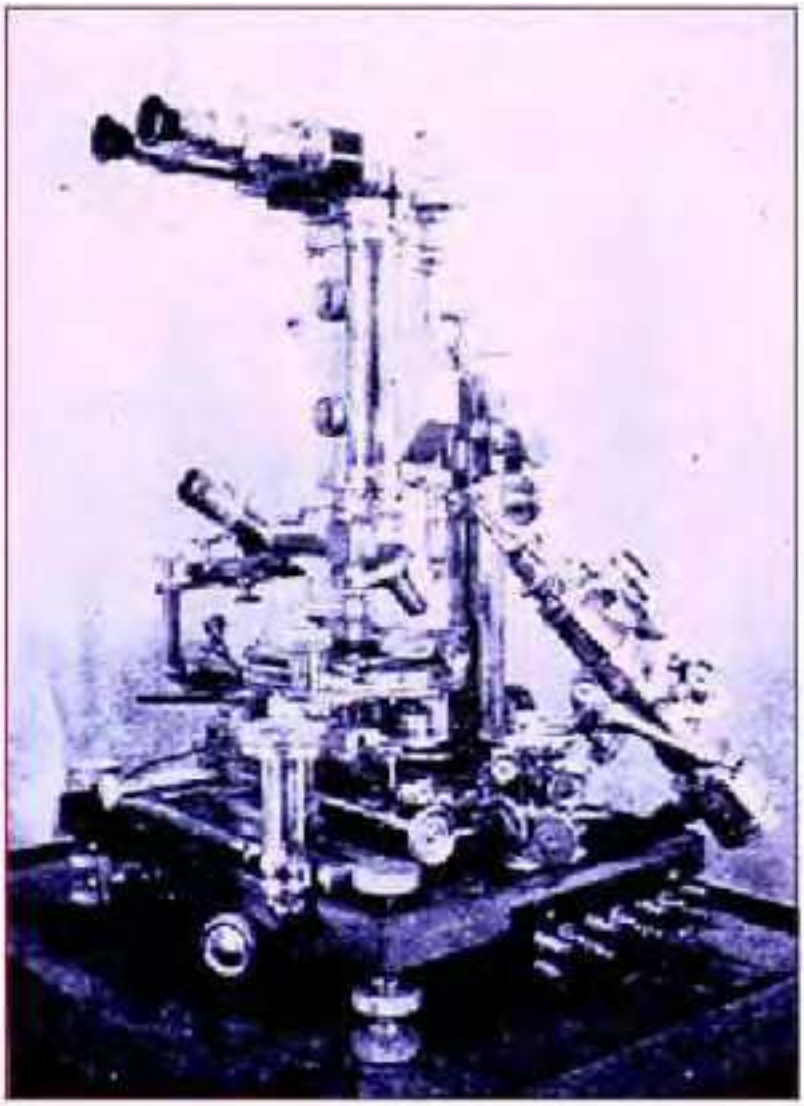

Figure 1. Rife's microscope.

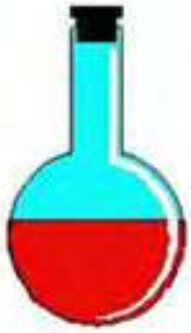

Figure 2. Royal Raymond Rife adjusts his microscope.

Air medium disturbances generated when air is perturbed by a plucked taut string

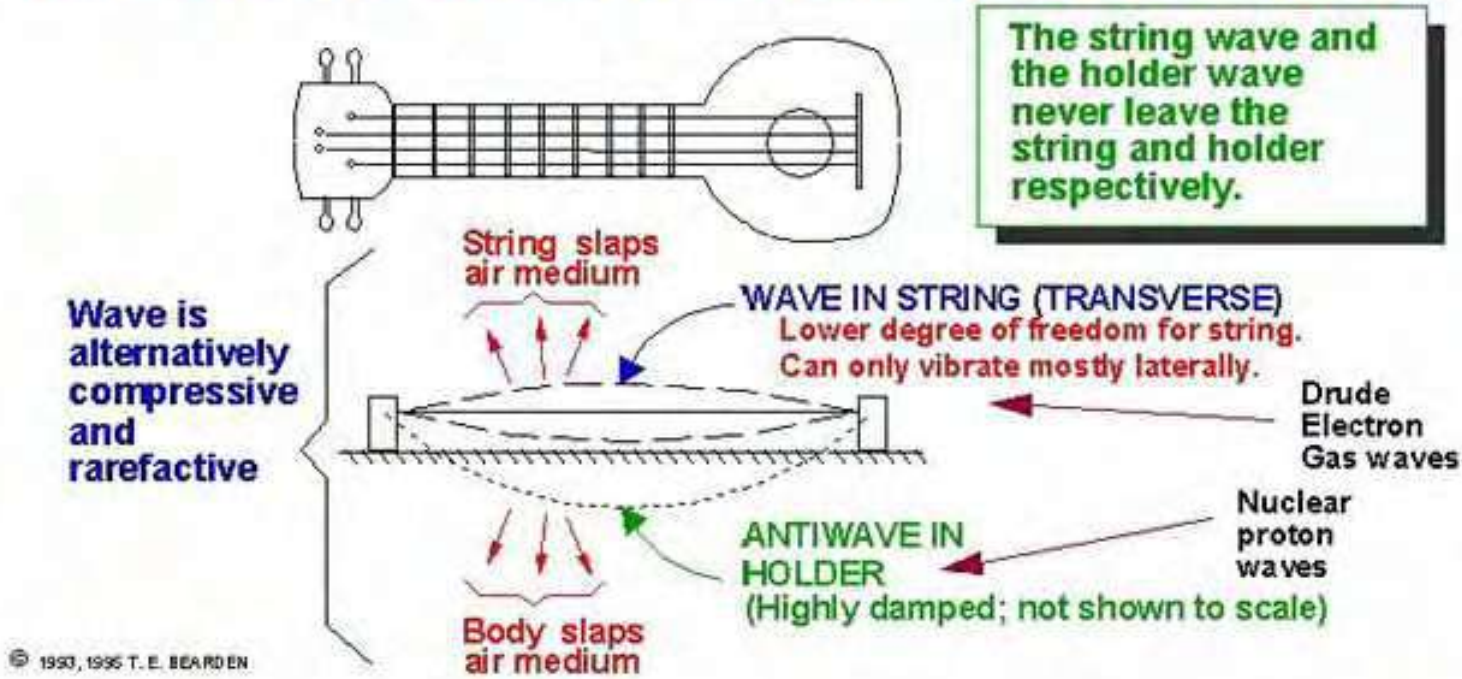

Figure 3. Analogy of the "taut string holder" omitted by Faraday.
This omitted half the electrodynamics (including in Maxwell's capture of Faraday's notion) and half the EM energy. An equal and opposite Newtonian 3rd law reaction does appear in our transmitters and receivers.

Flow of current and energy into, through, and along a conductor

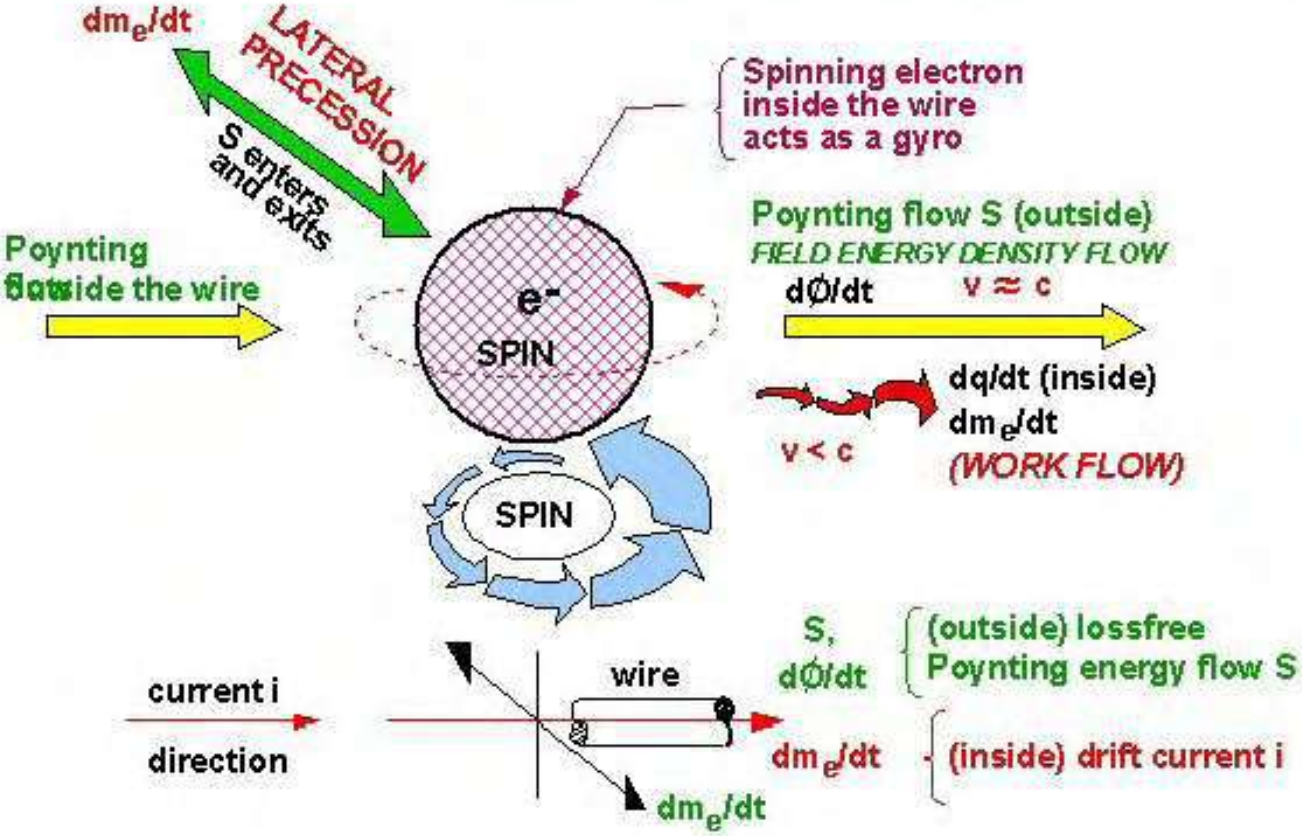

Figure 4. Receiving gyroelectrons precess laterally, providing the detected transverse wave and proving the incoming vacuum disturbance to be longitudinal.

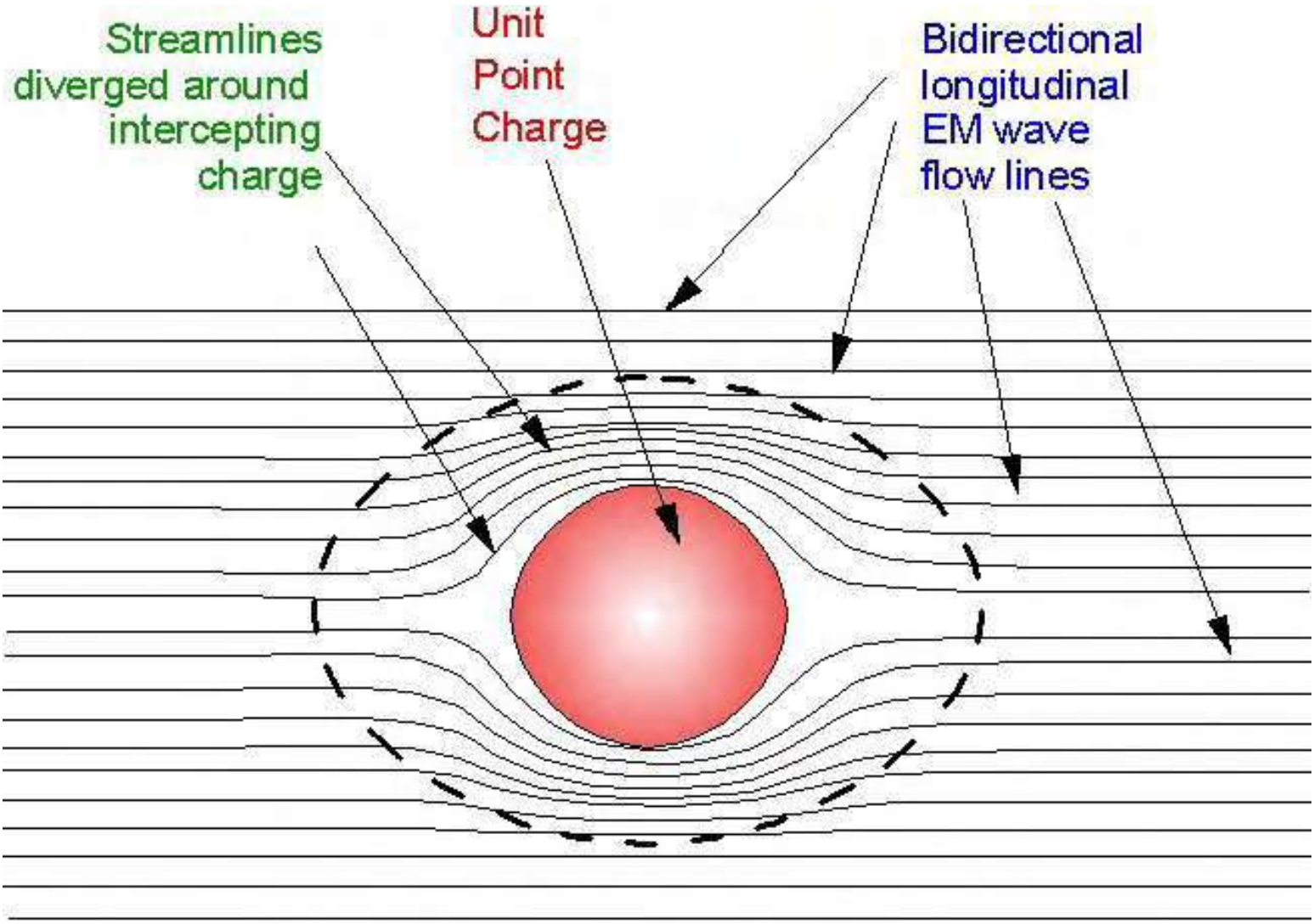

Figure 5. The defined "magnitude of the potential" is not such at all, but is the magnitude of the energy in the diverged flow streamlining around a unit point charge at each point in space where the potential is present.

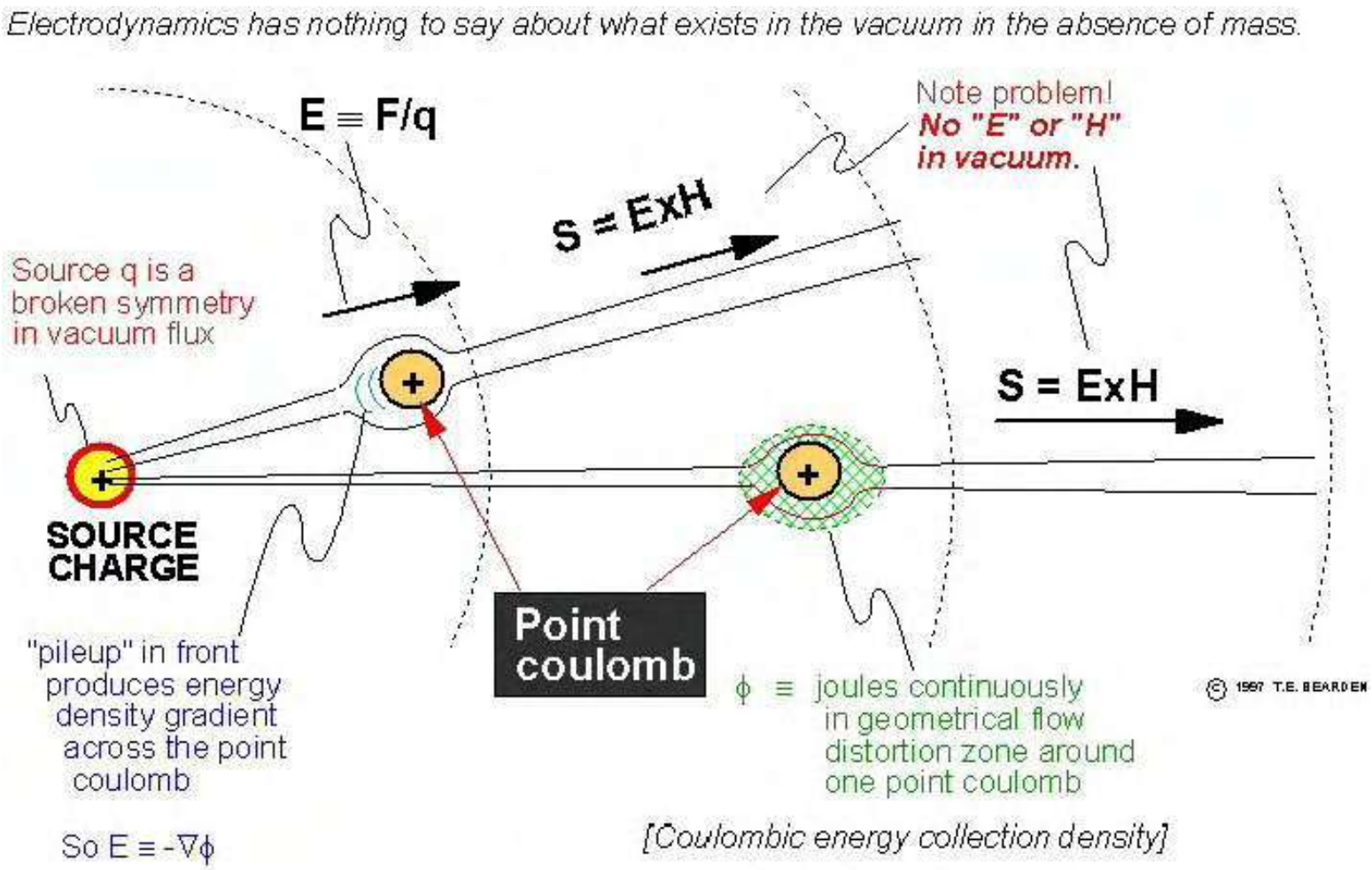

Figure 6. Fields and potentials are defined in terms of the Poynting disruption of the overall energy flow from the source charge, about an intercepting and "collecting" charge. Rigorously, *as defined* E and H exist only in and on charged matter. The magnitude of the diverted water swinging around a fixed rock in a river, is not the magnitude of the river.

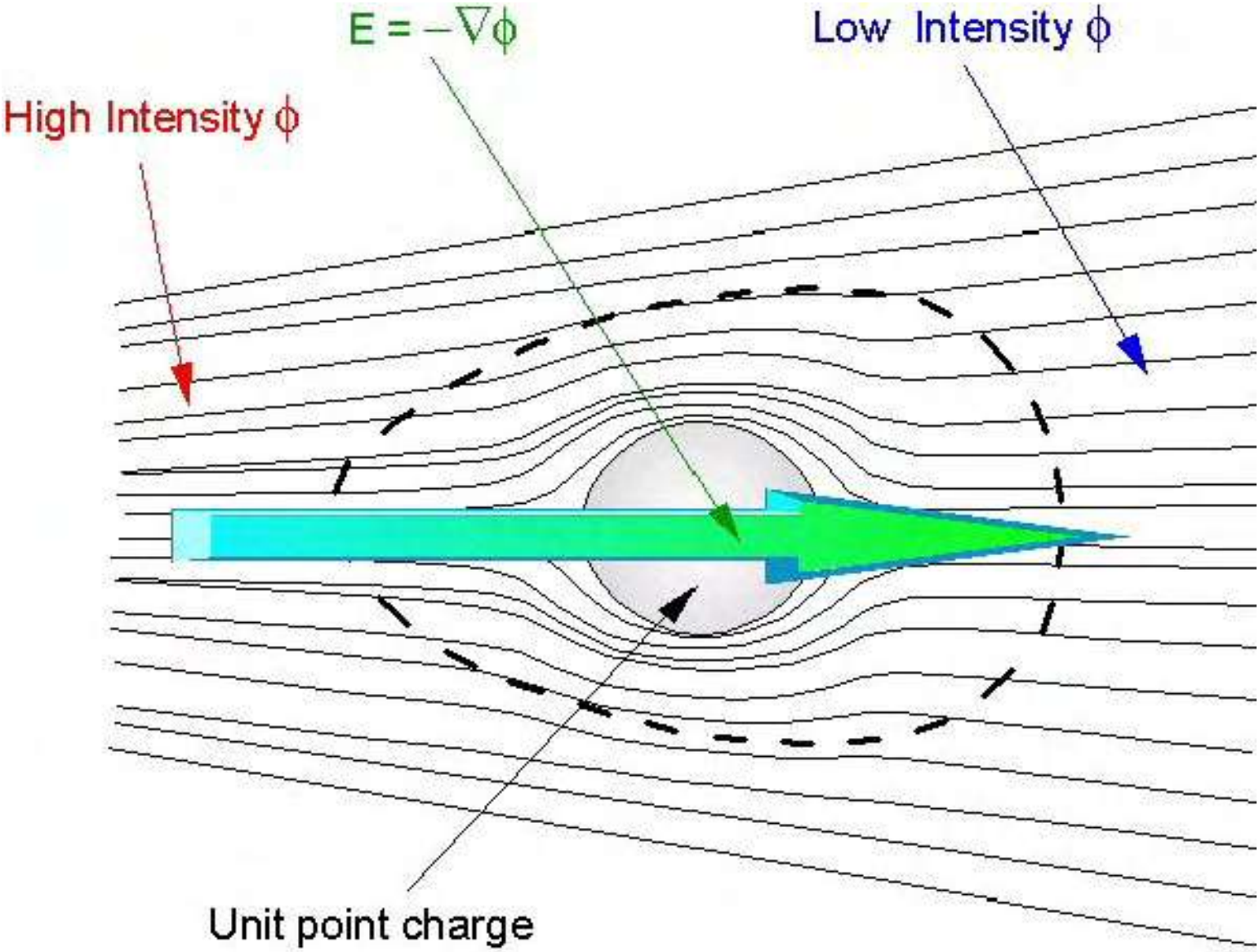

Figure 7. The defined "magnitude of the field" depends on the change in intensity of the flows comprising the potential. The E-field is oriented from high (pressure) in the flow to low (pressure) in energy density over a unit length.

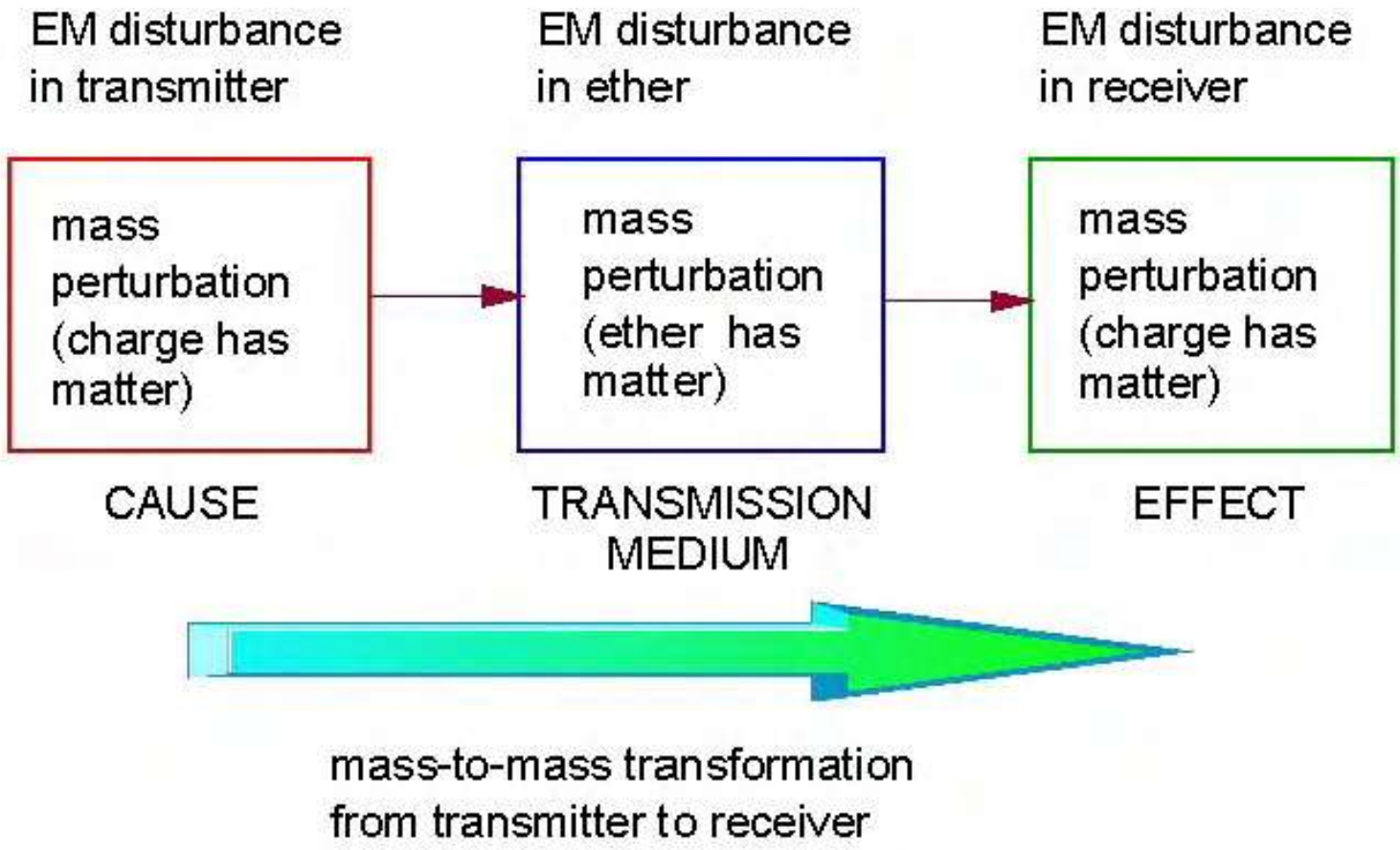

Figure 8. Maxwell's theory assumed a matter-to-matter transform from cause to effect.

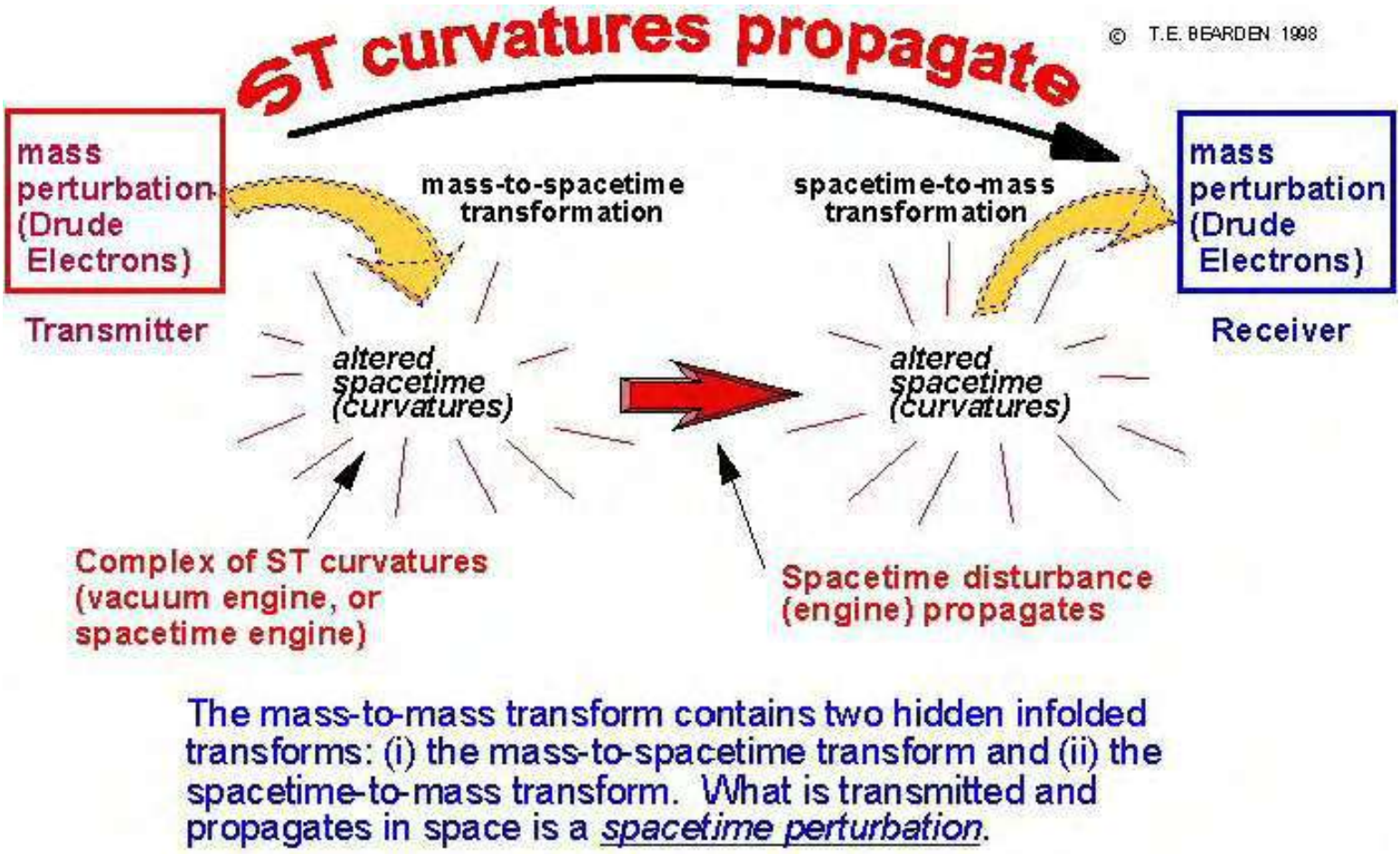

Figure 9. Maxwell's matter-to-matter transform contains two hidden transforms: (1) matter-to-spacetime, and (2) spacetime-to-matter.

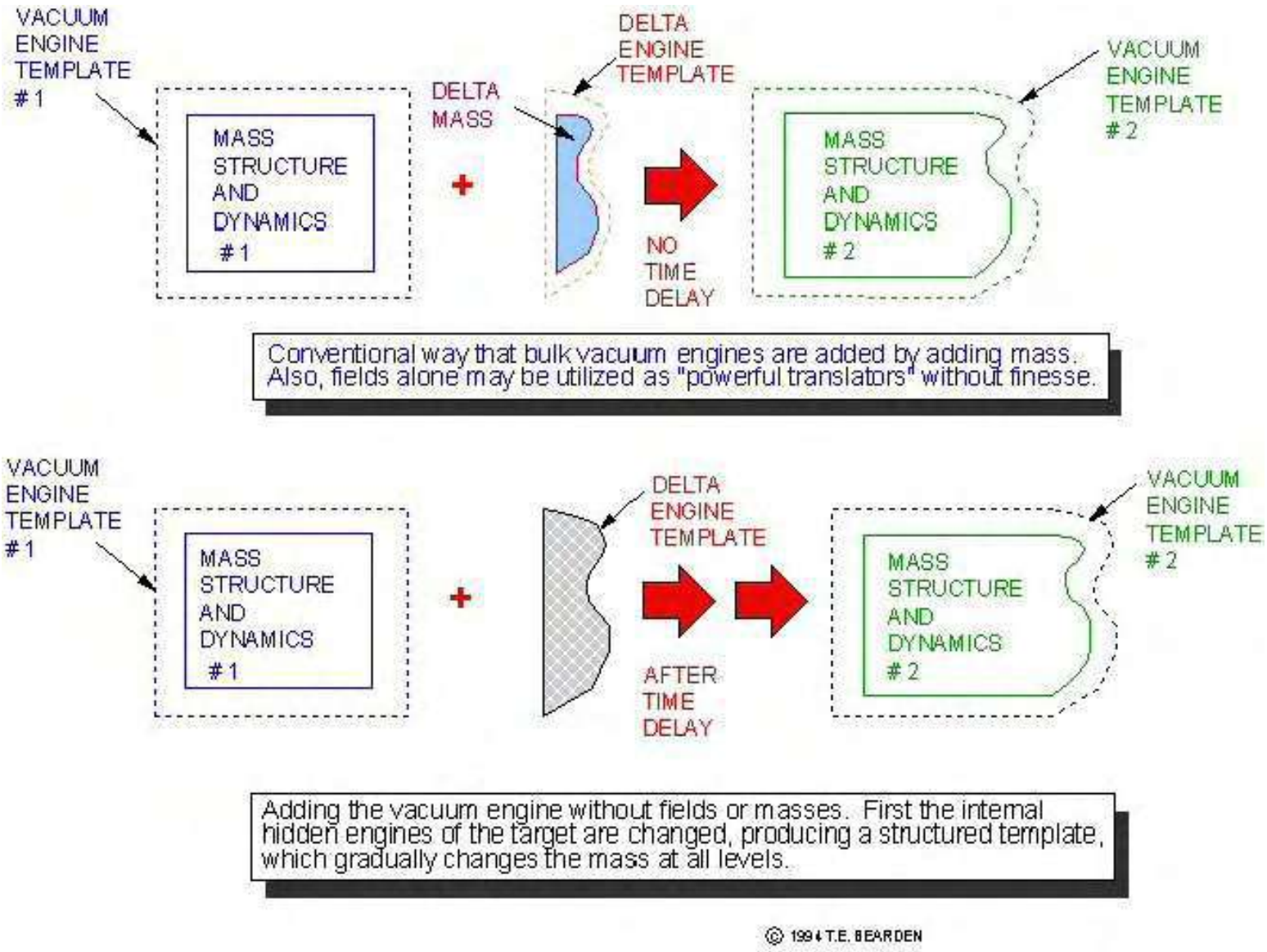

Figure 10. Vacuum engines and their utilization.

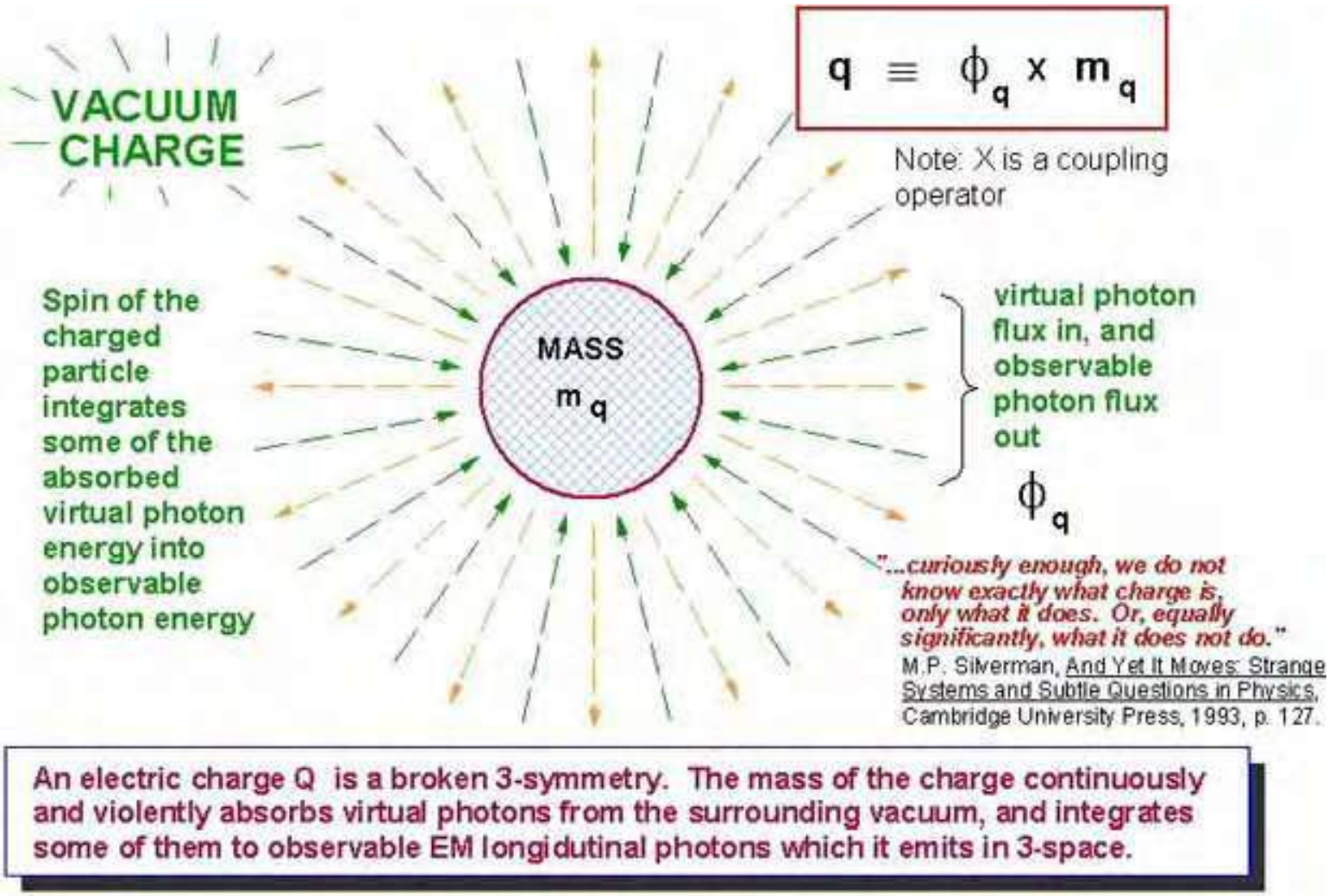

An electric charge Q is a broken 3-symmetry. The mass of the charge continuously and violently absorbs virtual photons from the surrounding vacuum, and integrates some of them to observable EM longidutinal photons which it emits in 3-space.

Figure 11. A charged particle continuously absorbs virtual energy from the vacuum, integrates some of it into observable energy, and pours out this observable EM energy in 3-space in all directions.

Composition of the scalar potential ϕ

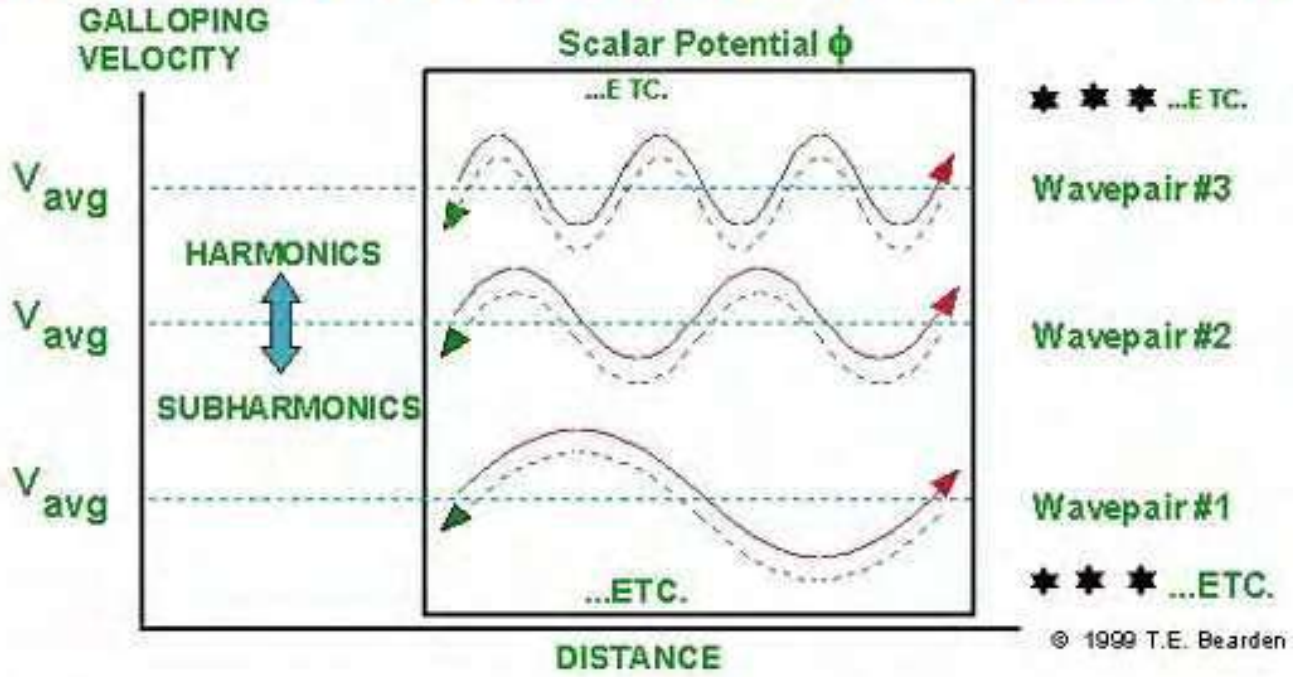

A harmonic set of bidirectional longitudinal EM wavepairs in 3-space. Unseen here is the time-polarized EM wave in the time domain, which reacts with the source charge to produce the 3-space biwave potential.

Figure 12. The potential as observed or detected is a harmonic set of bidirectional longitudinal EM waves in 3-space. That is, this potential is the "effect" of transduction of an incoming time-polarized EM wave interacting with the source charge.

The supersystem concept

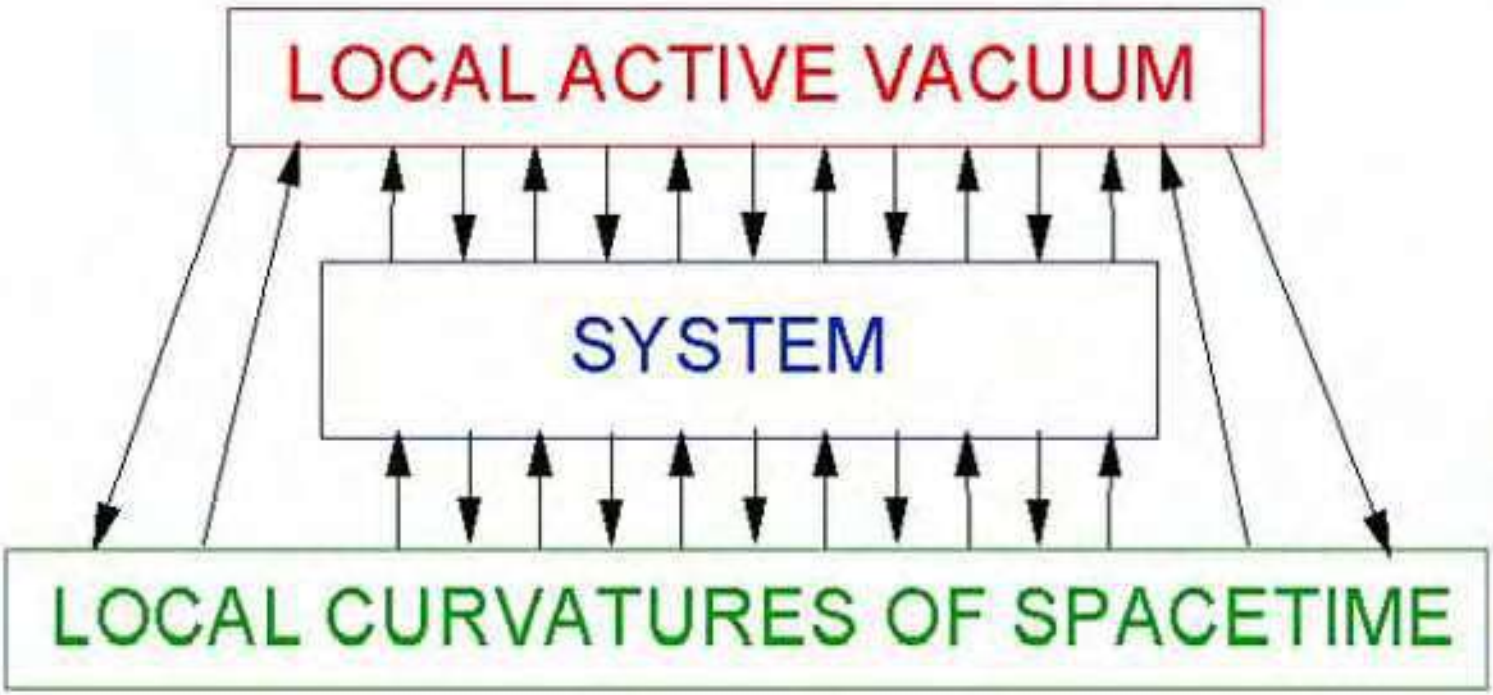

Figure 13. Concept of the supersystem and its interacting components.

Vacuum engine: Working spacetime demons

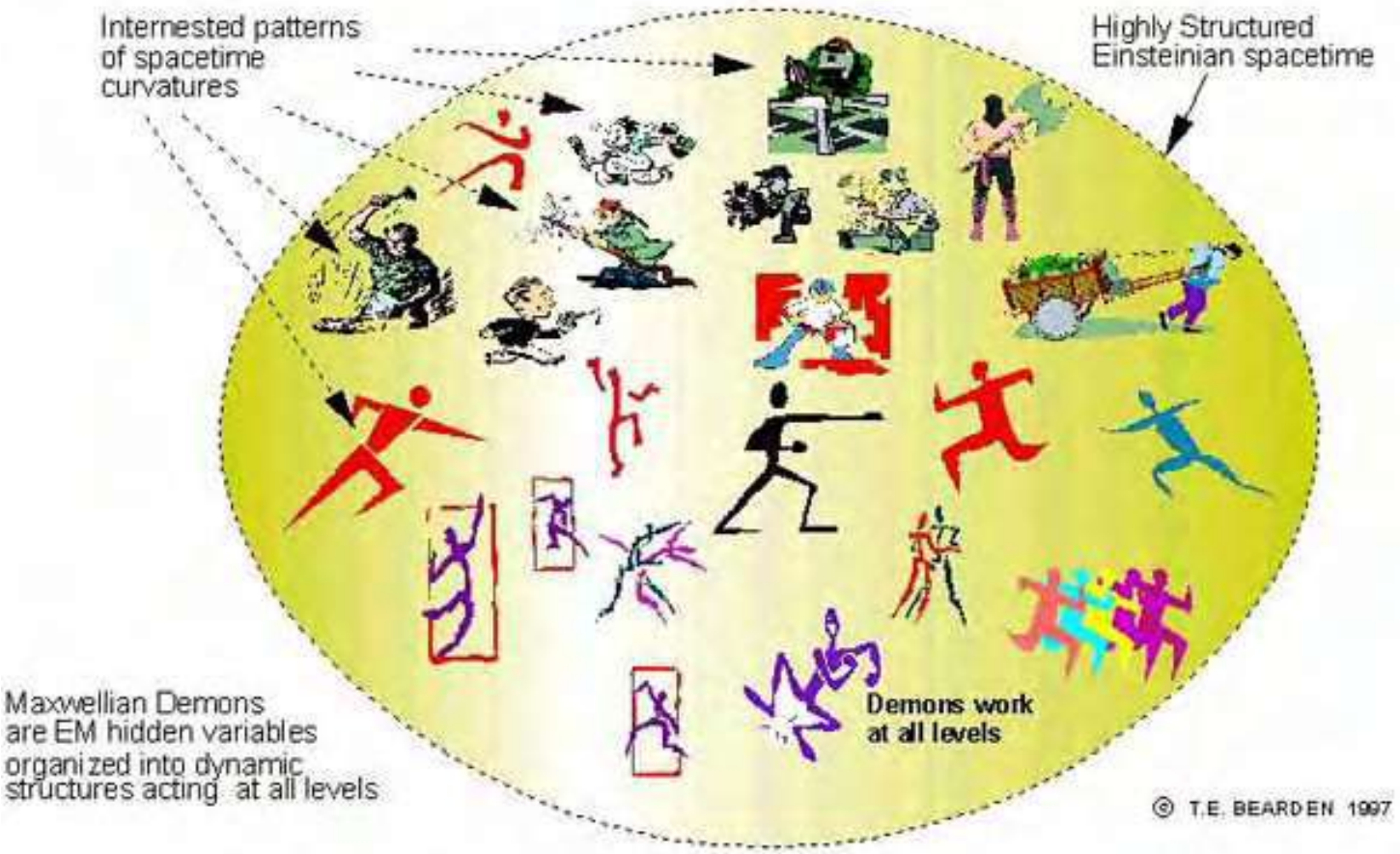

Figure 14. A vacuum engine is a set of spacetime demons working upon a mass system and its motion through time, at every level.

MTW's* general relativity principle

- Space acts on matter, telling it how to move.
- In turn, matter reacts back on space, telling it how to curve."

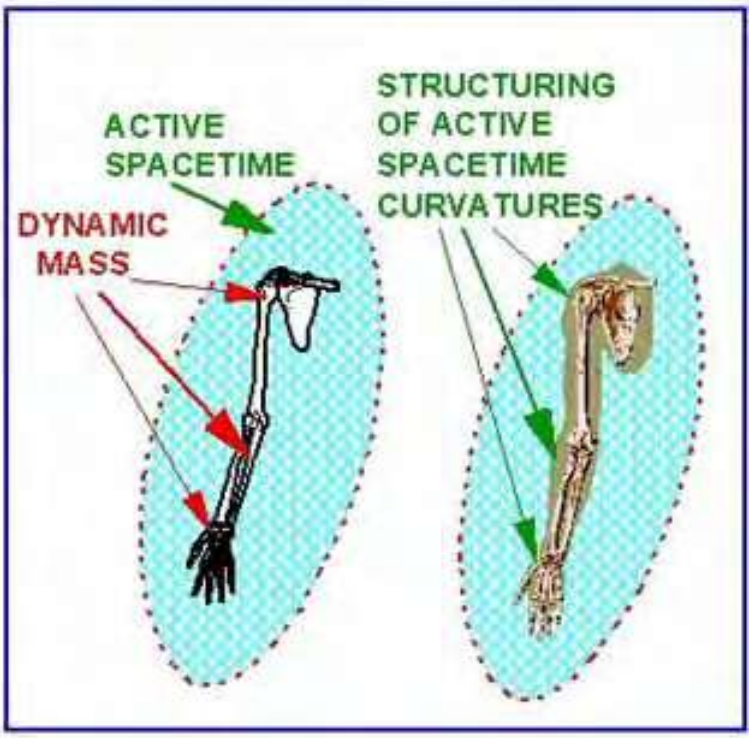

Figure 15. General relativity principle of Misner, Thorne, and Wheeler (MTW).

Extended General Relativity Principle

- All levels of energy structures and all levels of time structures mold spacetime geometry.
- The "pattern" is called a *template* for a vacuum engine (spacetime curvature engine).
- Spatial and temporal structurings of the engine act upon mass at all levels.
- This produces a template of forces, for precise translations and stresses within the mass at all levels. The forces exist in both time and 3-space.

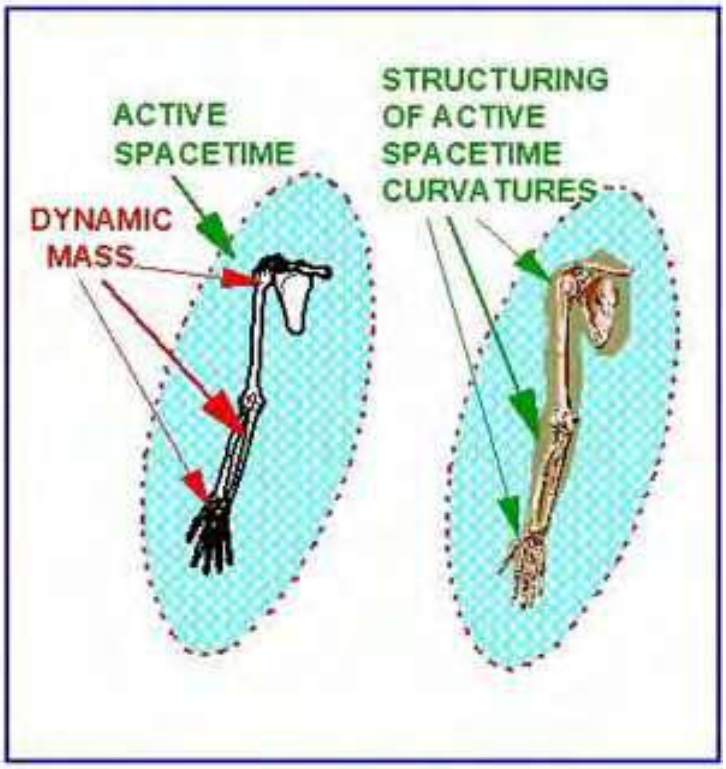

Figure 16. The principle of general relativity extended to include the vacuum engine.

Active spacetime and a specific vacuum engine

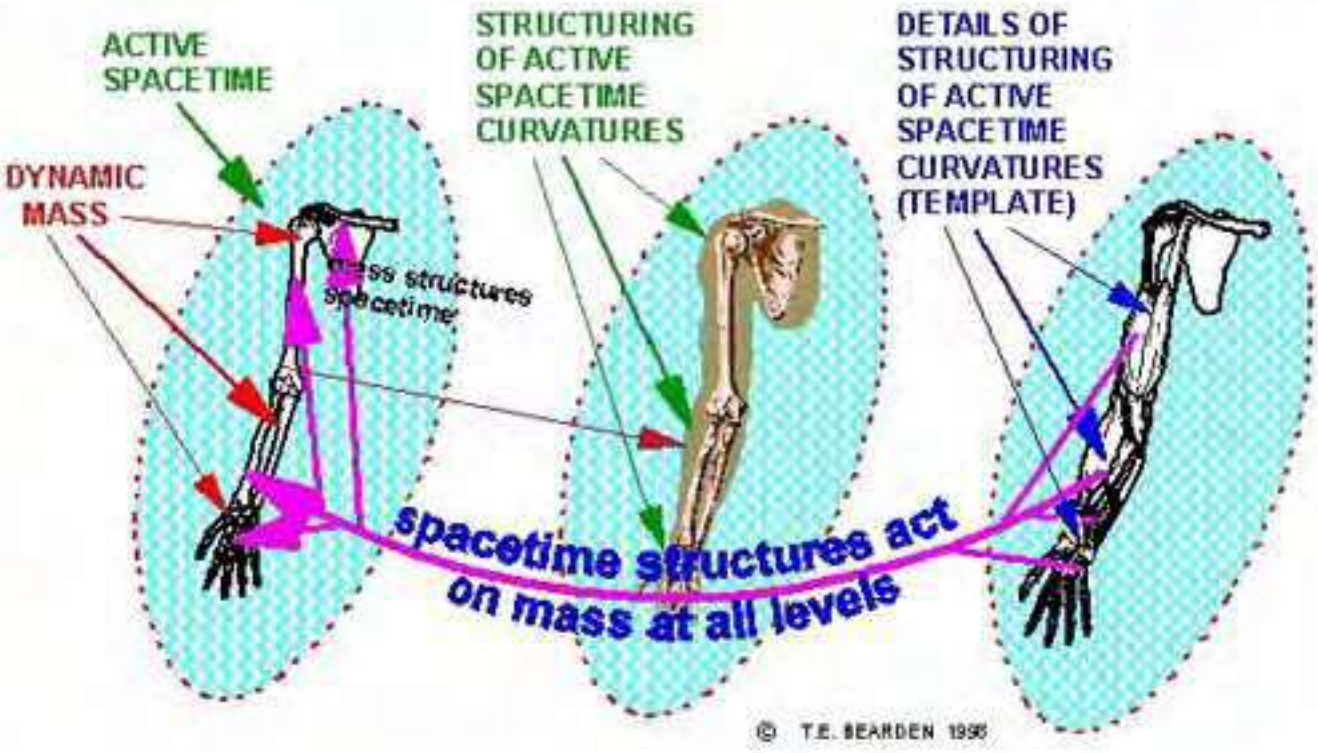

Figure 17. Active spacetime and a specific vacuum engine (spacetime curvature engine).

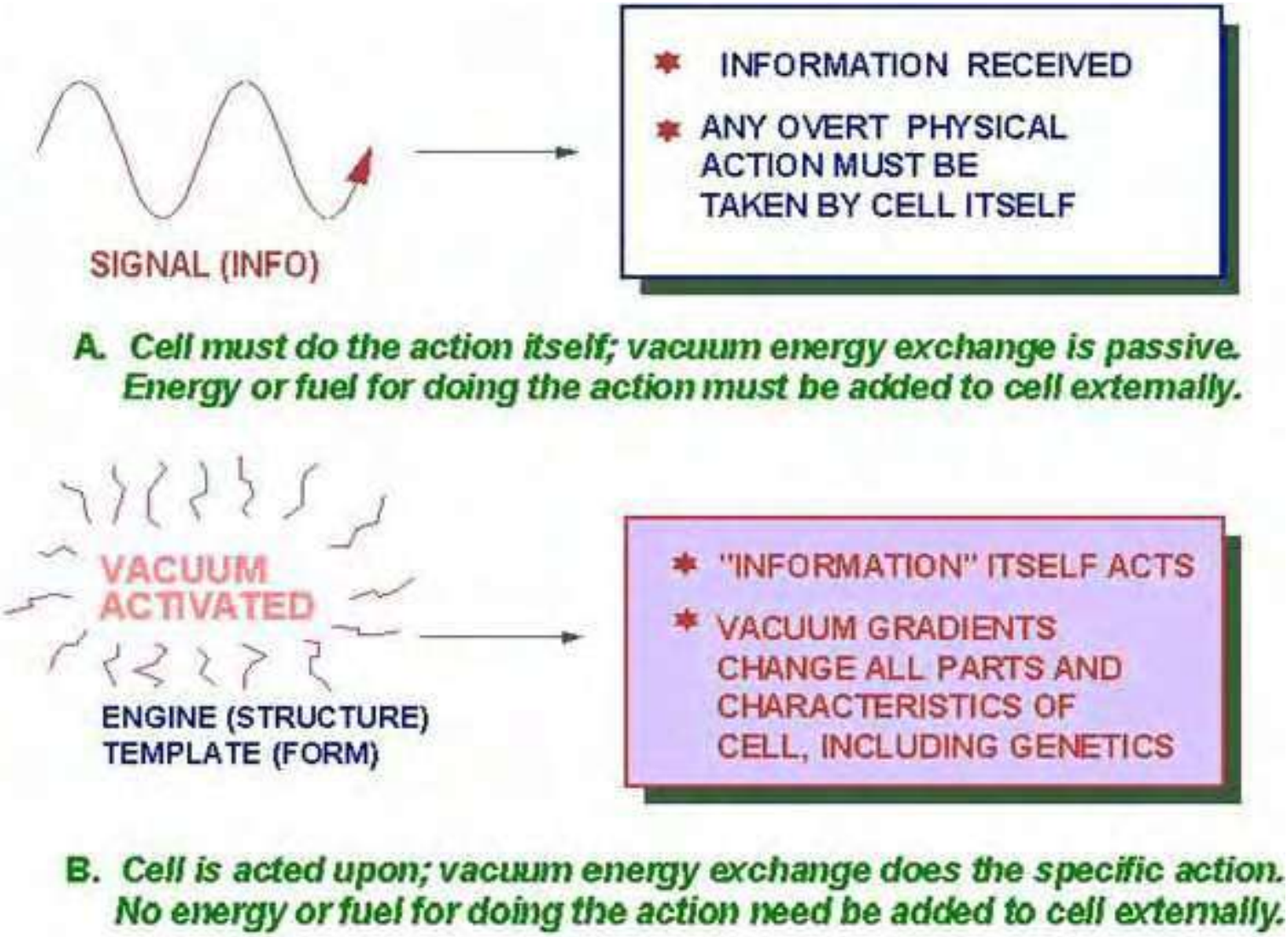

Figure 18. Signal versus vacuum engine, as in Priore's cellular reversal.

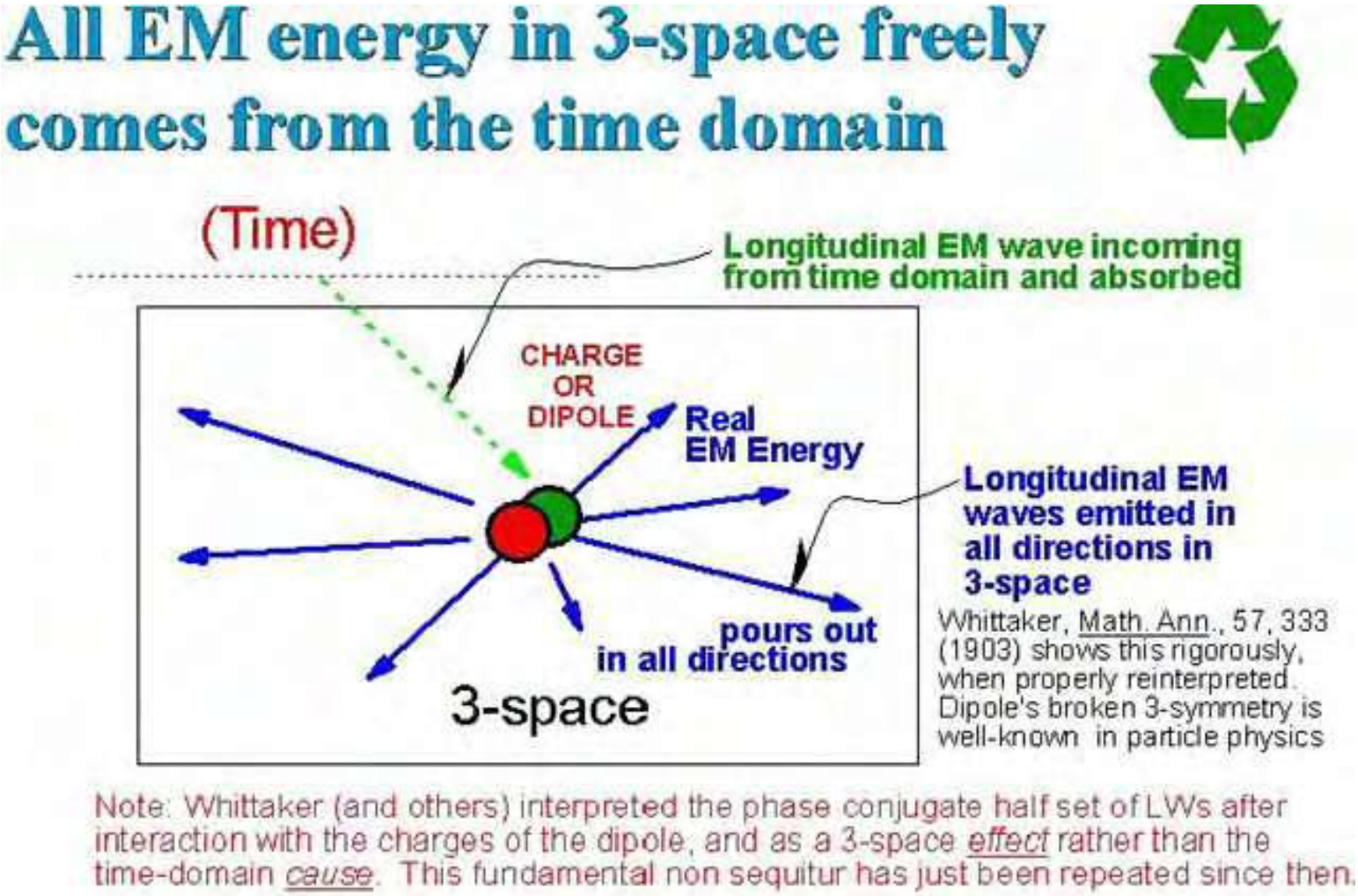

Figure 19. All EM energy in the 3-space potential comes from the time-domain.

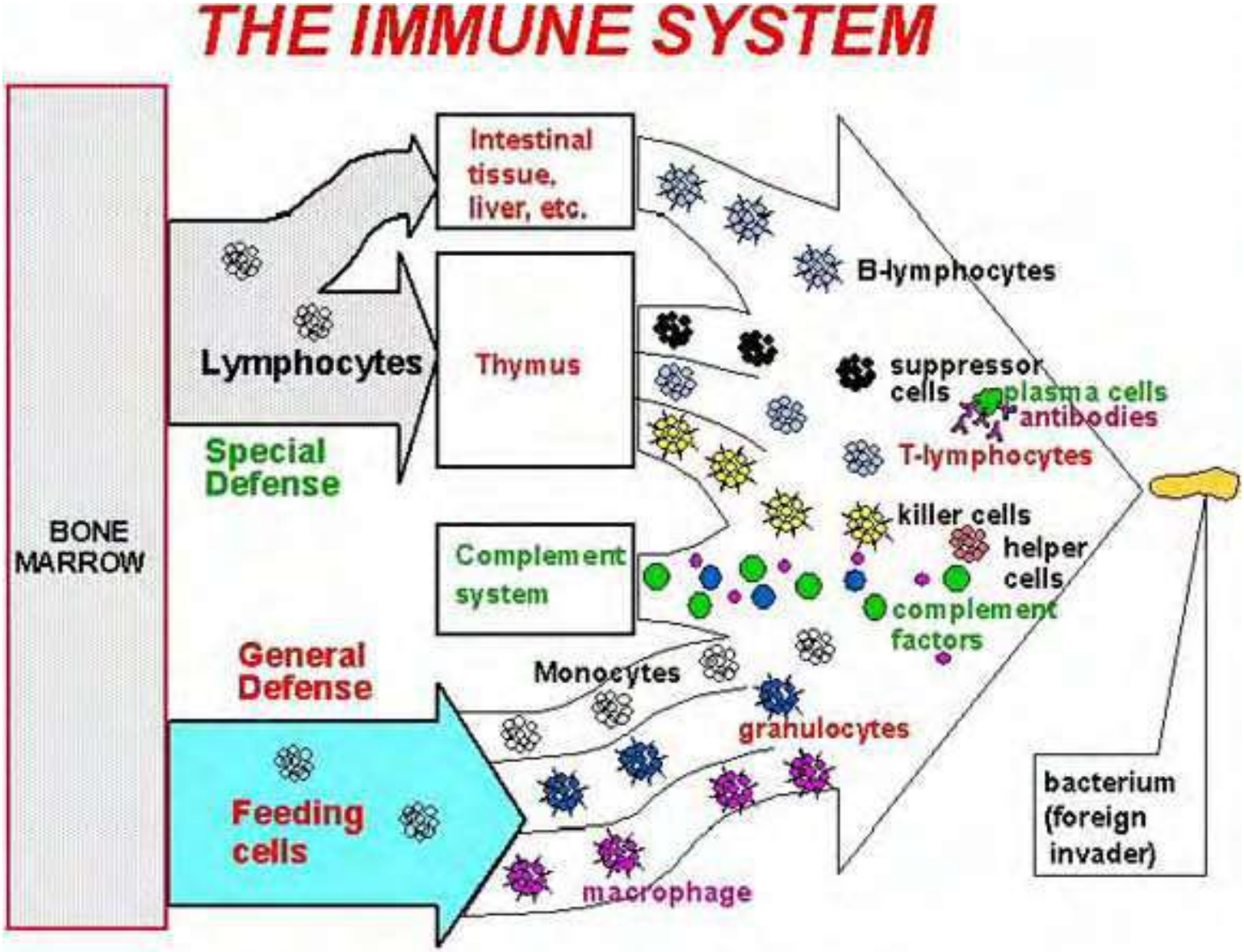

Figure 20. Immune system block diagram.

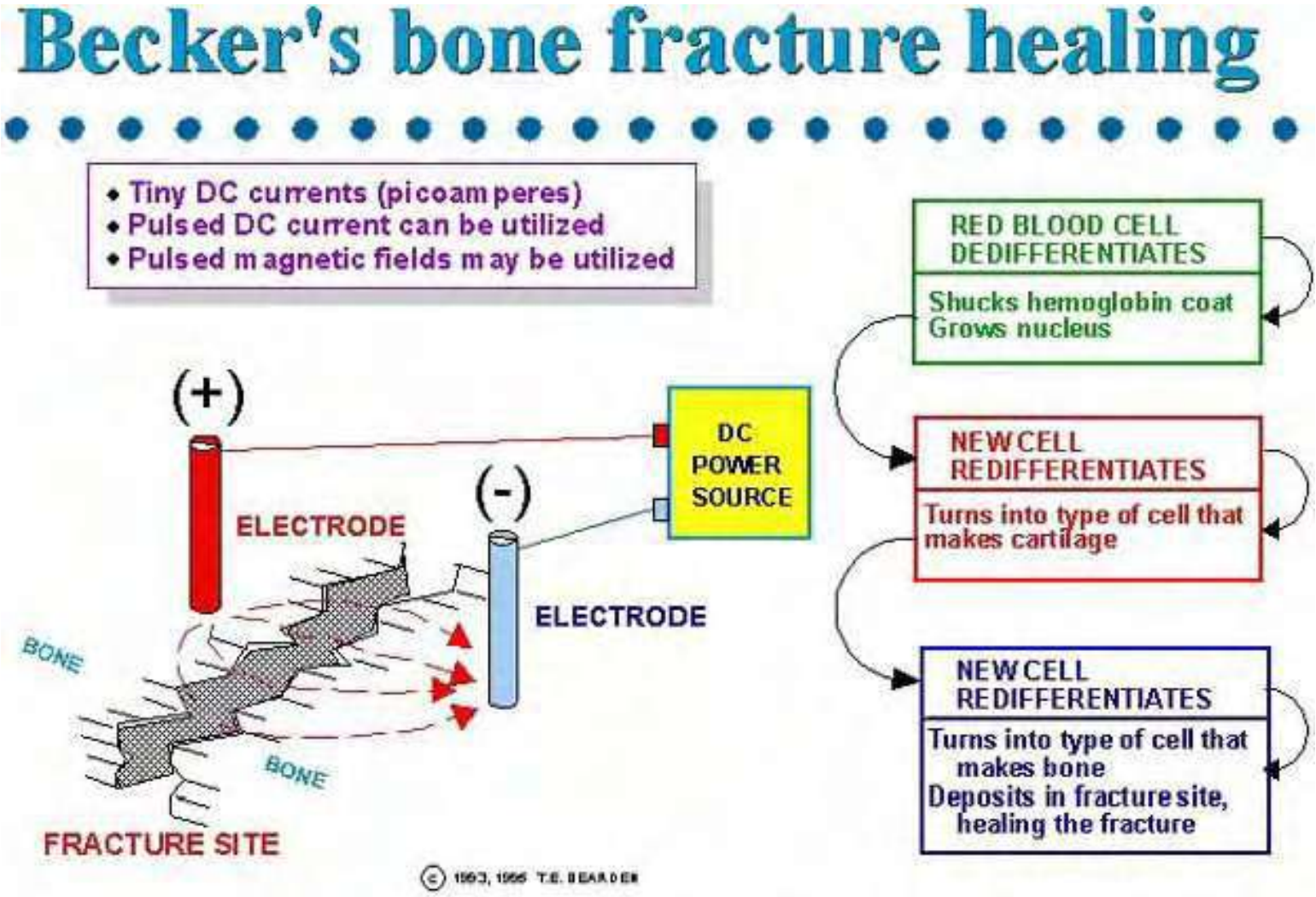

Figure 21. Becker's electrodynamic healing of otherwise intractable bone fractures, using weak potentials across the fracture site.

Becker's theoretical DC control system involved with response to injury

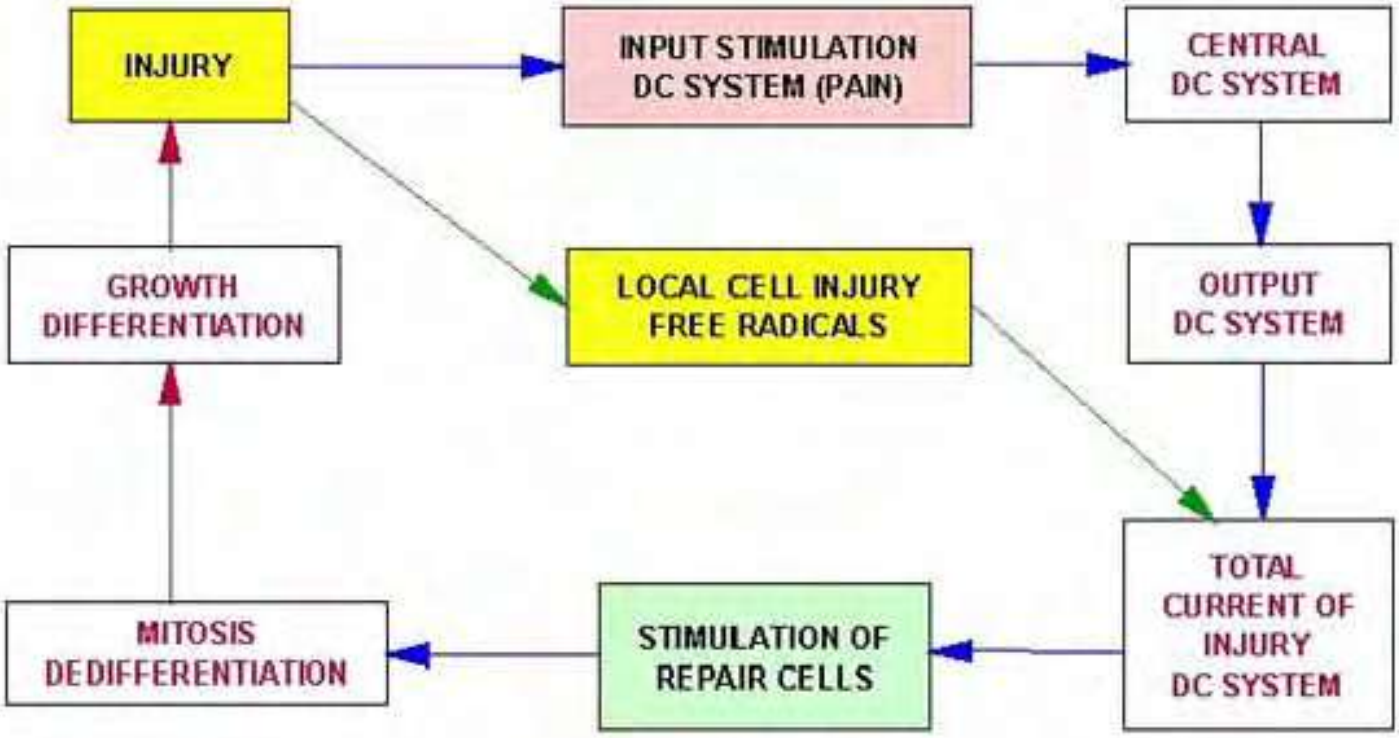

*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Figure 22. Becker's block diagram of DC control system involved with response to injury.

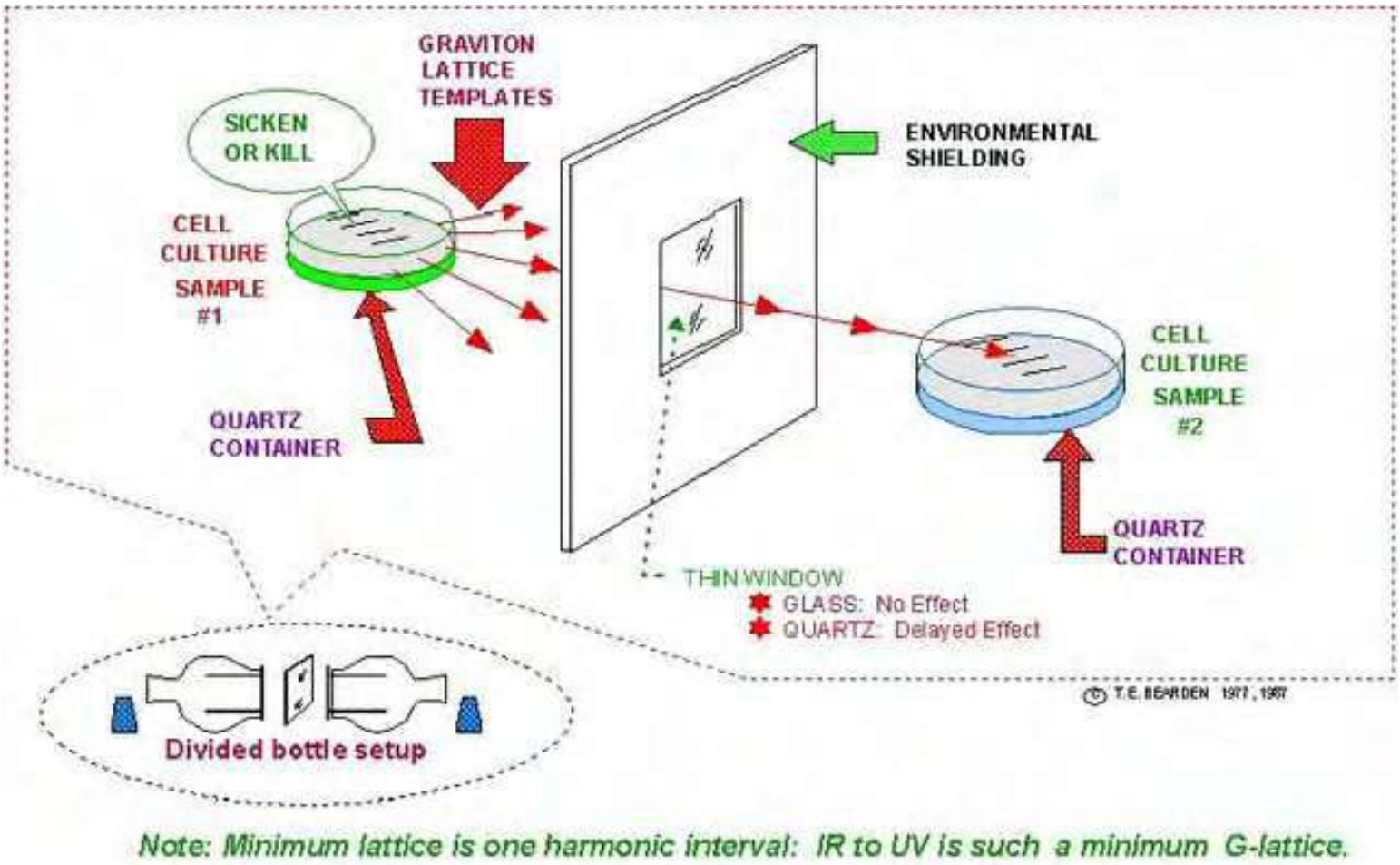

Note: Minimum lattice is one harmonic interval: IR to UV is such a minimum G-lattice.

Figure 23. Kaznacheyev's induction of cellular disease and disorder at a distance, using novel electromagnetic means.

Former U.S. Embassy in Moscow.

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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Figure 24. Russian "microwave" radiation of the U.S. Embassy in Moscow.

Mechanism generating the flow of a mass through time

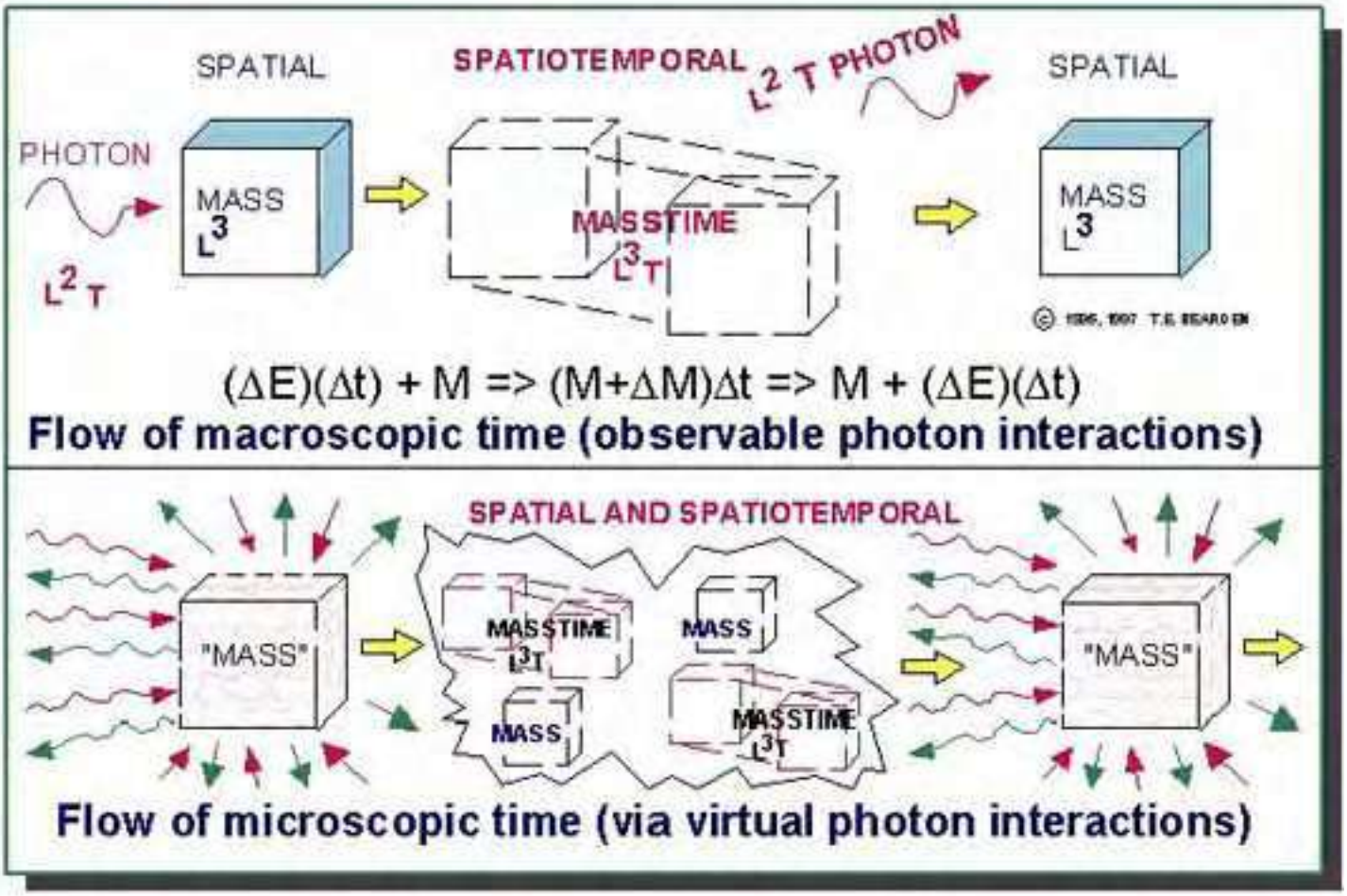

Figure 25. Mechanism generating the flow of a mass through time.

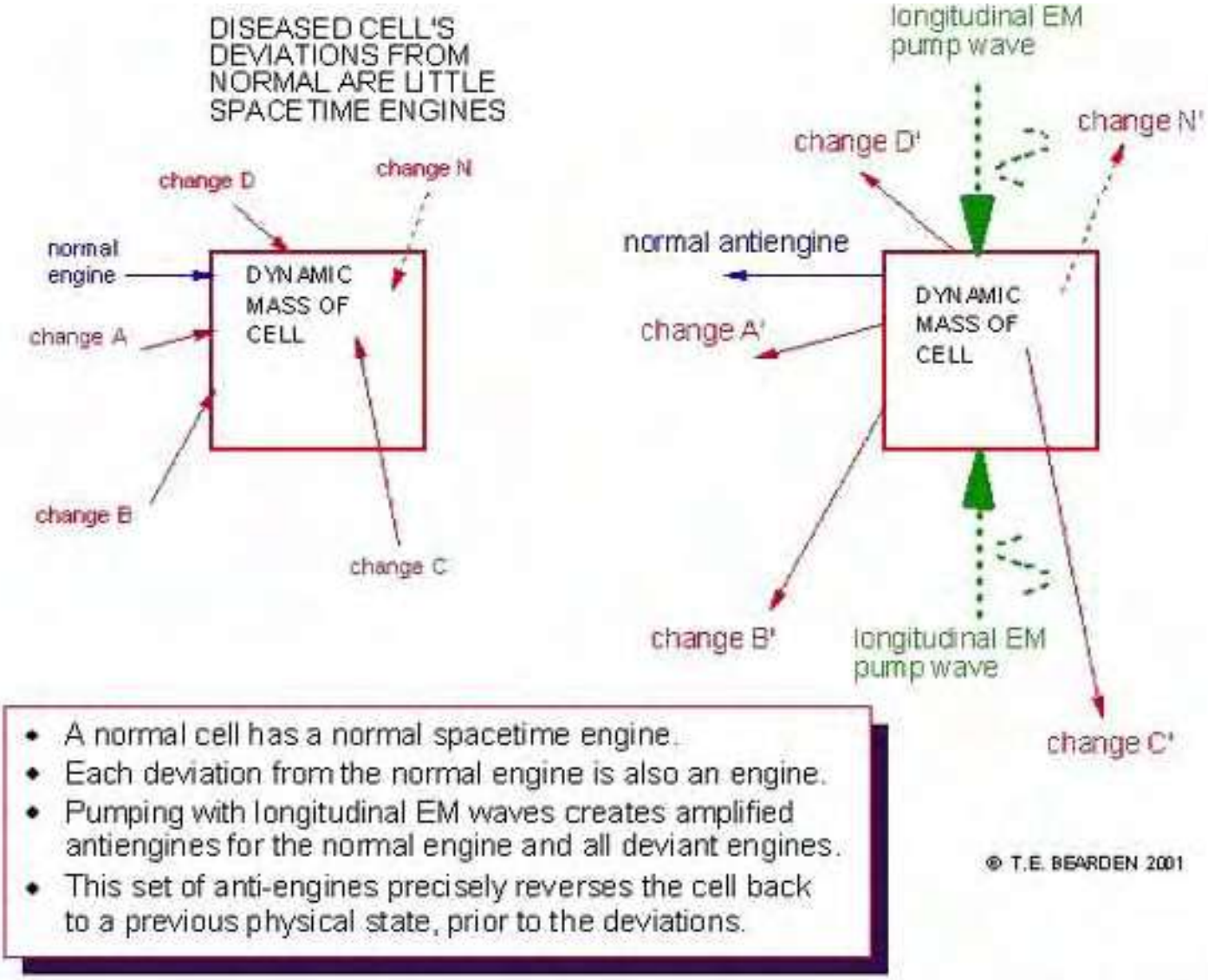

Figure 26. Producing a specific anti-engine for a specific cellular disease condition.

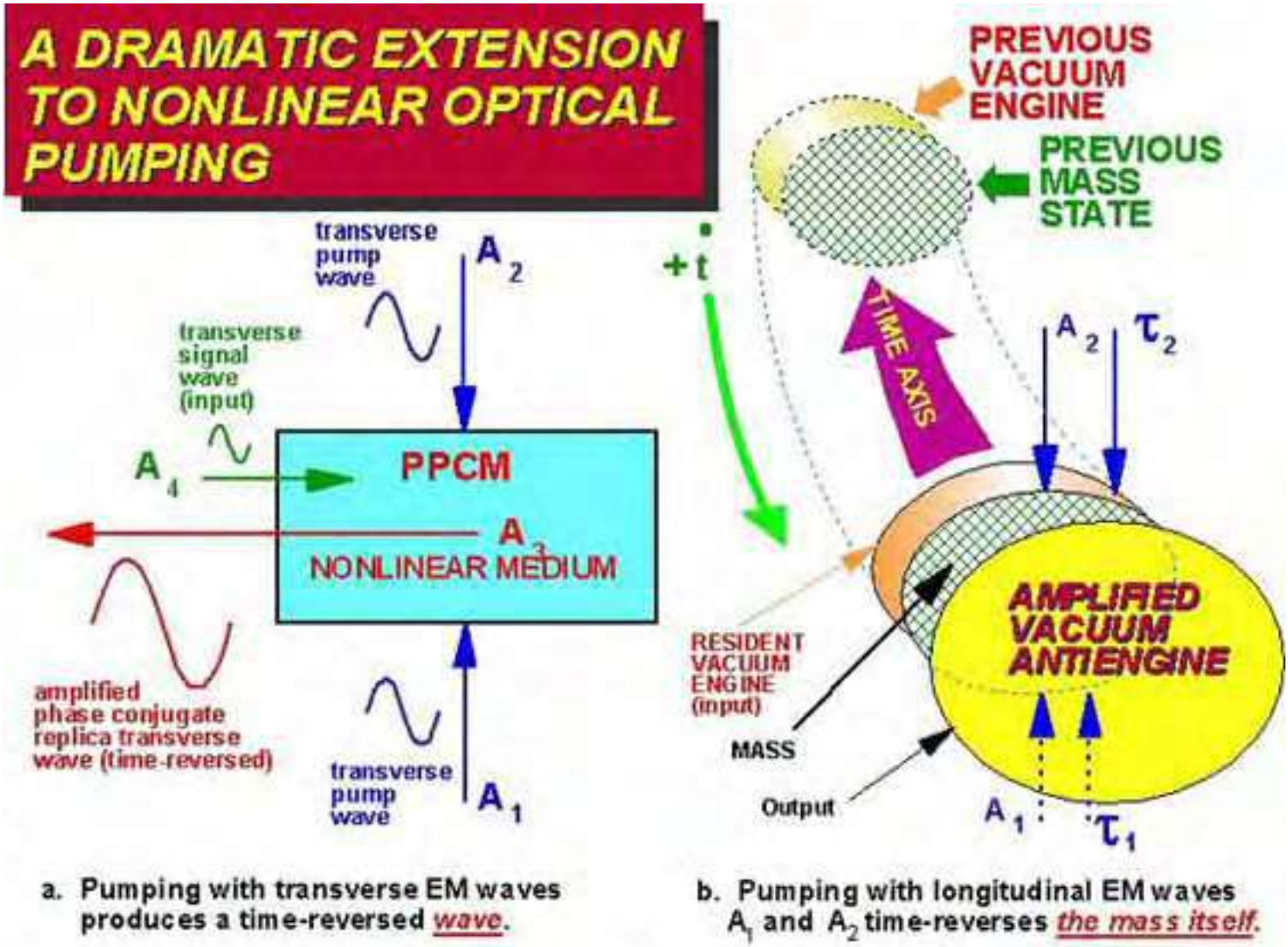

Figure 27. Pumping with longitudinal EM waves A also pumps in the time domain with time-polarized EM waves τ. This time-reverses a macroscopic mass and its dynamics.

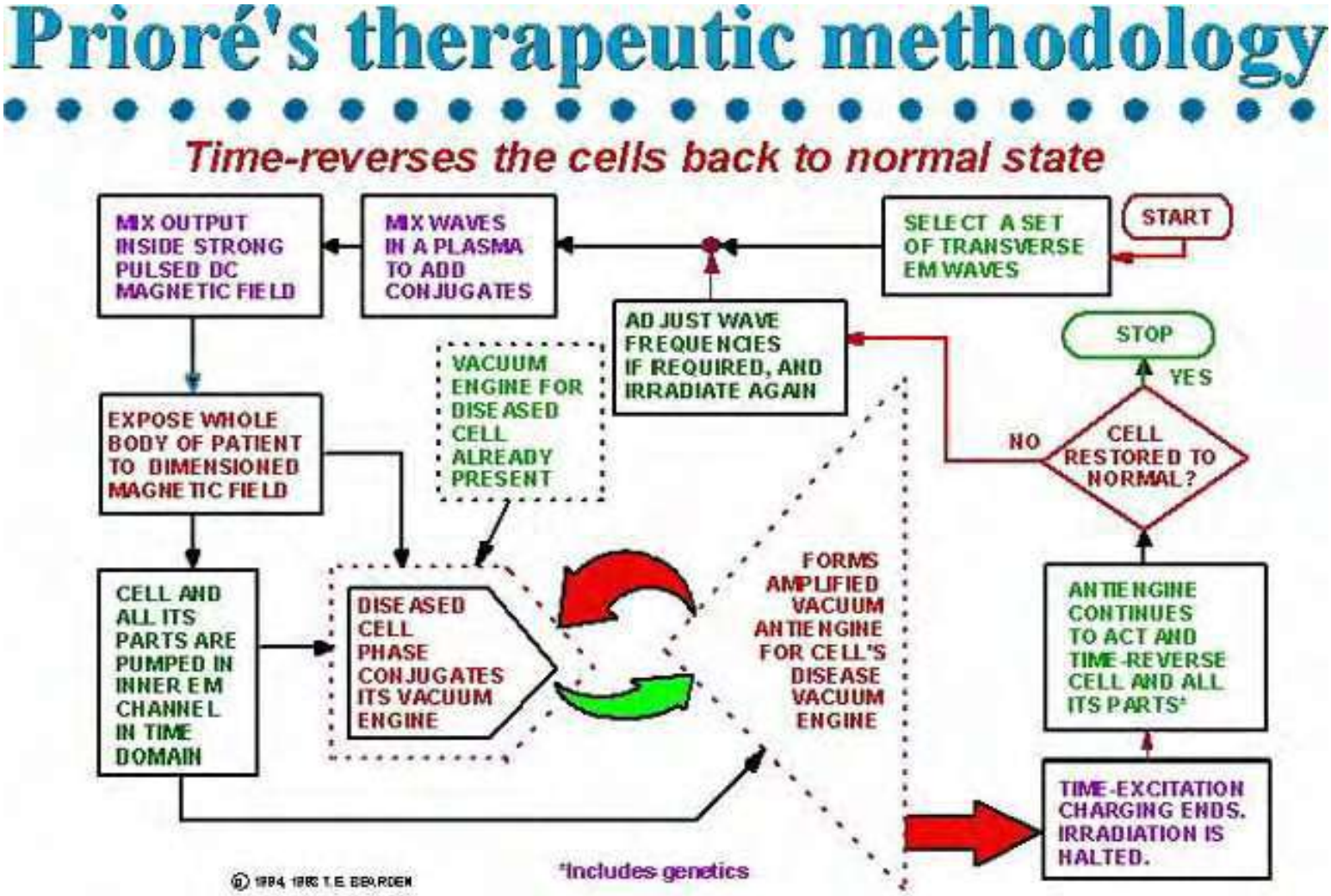

Figure 28. Block diagram of operation of Prioré's methodology.

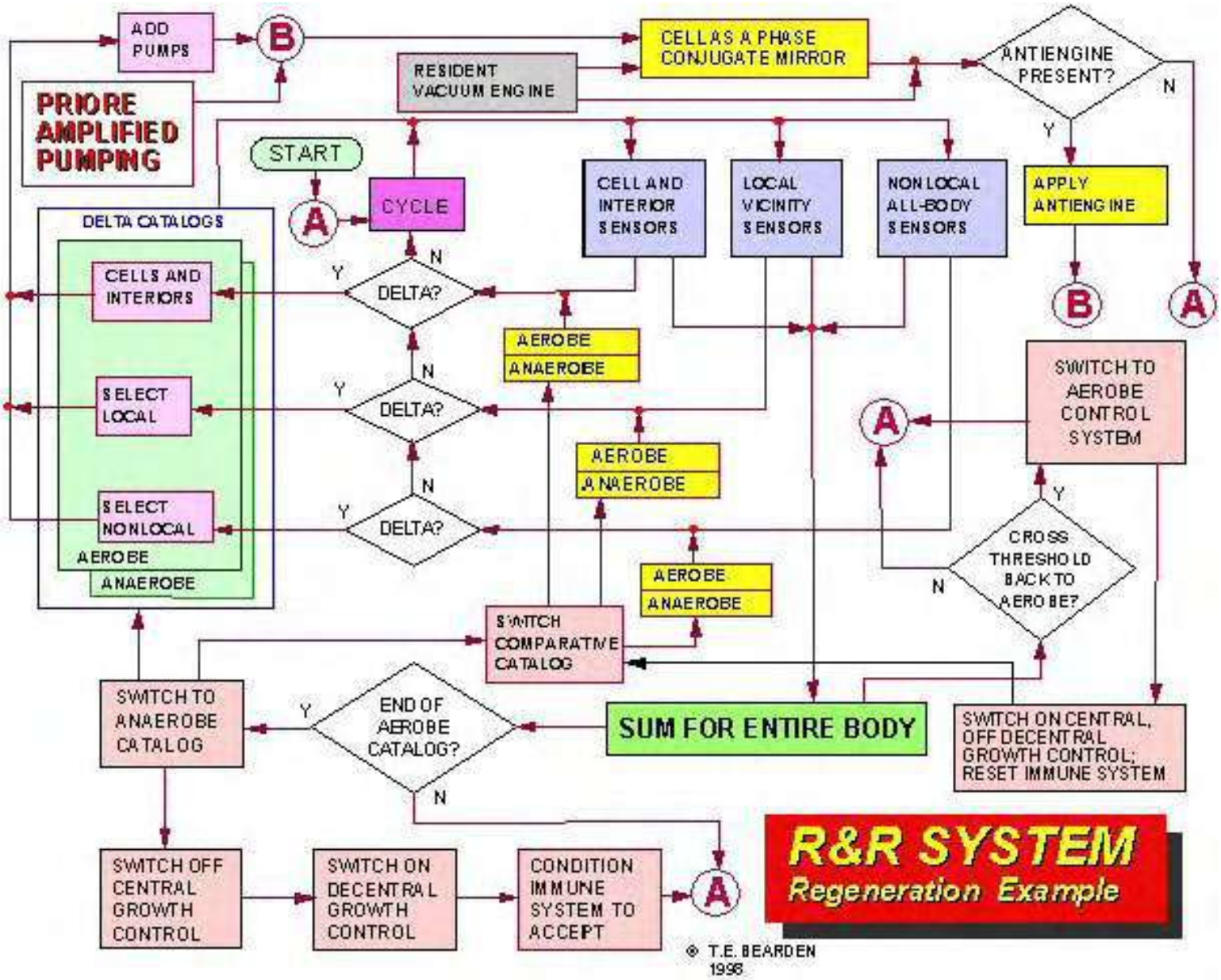

Figure 29. Block diagram of the cellular regeneration system and its overall operation (by the present author).

Rife's great secret: Recursive magnification by iterative serial summation of vacuum engines

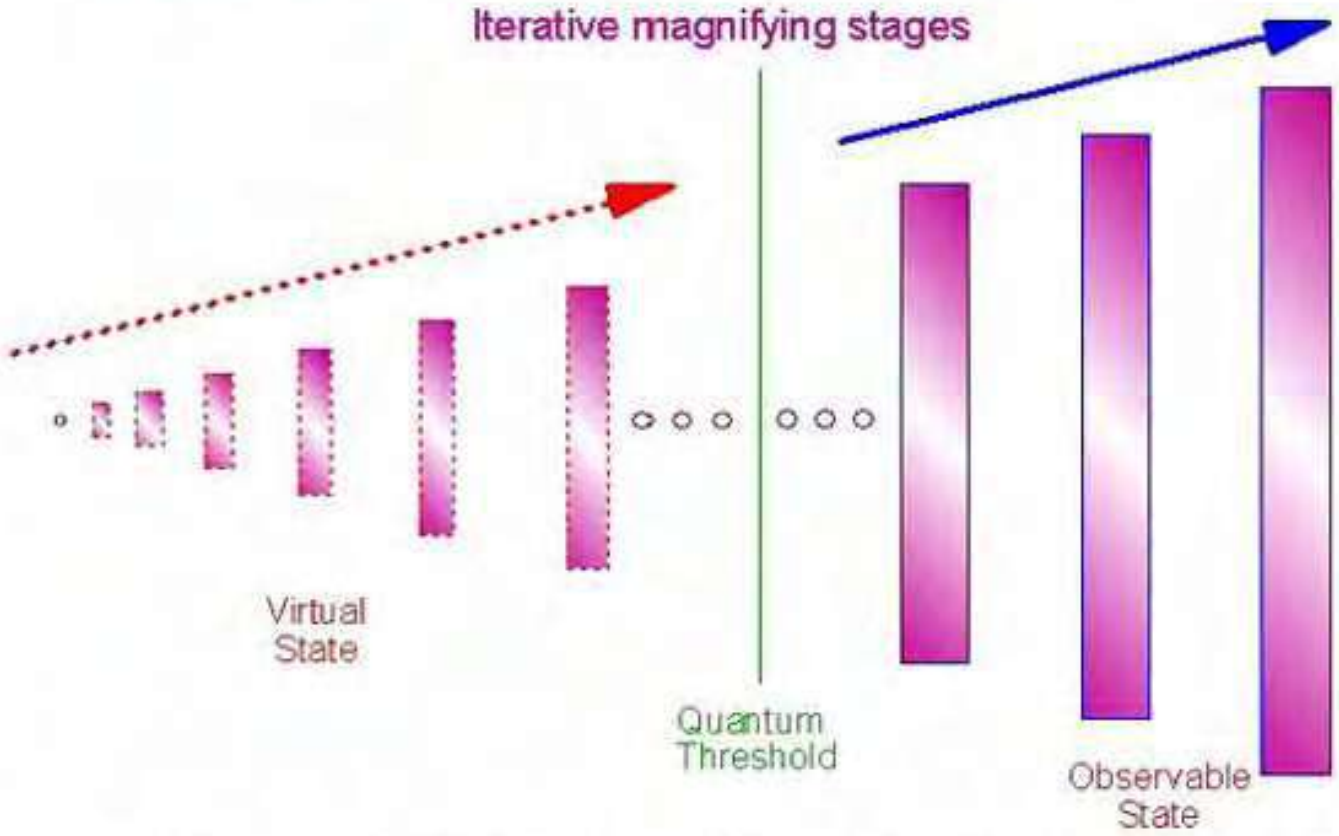

Figure 30. Rife's great secret: Recursive magnification of the virtual state vacuum engines and their dynamics to the observable state.

Utilizing Scalar Electromagnetics To Tap Vacuum Energy

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ABSTRACT

Based on E.T. Whittaker's previously unnoticed 1903-1904 papers which established a hidden bidirectional EM wave structure in a standing forcefield free scalar potential, a method of directly engineering the ambient potential of the vacuum has been developed and realized experimentally.

Adding Whittaker's engineerable hidden variable theory to classical electro-magnetics, quantum mechanics, and general relativity produces supersets of each discipline. These supersets are joined by the common Whittaker subset, producing a unified field theory that is engineerable and tested.

By treating the nucleus of the atom as a pumped phase conjugate mirror, several working model energy units have been produced which excite and organize the local vacuum, increase the local virtual photon flux between local vacuum and nucleus, establish coherent self-oscillations between the local excited vacuum and the affected nuclei, utilize the self-oscillating standing wave for self-pumping of the nuclei/mirrors, introduce a very tiny signal wave to the mirrors, and output into an external load circuit a powerful, amplified, time-reversed phase conjugate replica wave at 60 Hertz frequency and nominal 120 volt sine wave power.

Several models have been built, ranging from 6 watts early on to one of 5 kilowatts. Both closed batteryless systems with damped positive feedback and open loop systems with battery-powered input have been successfully built. Open loop power gains of from 5×10^4 to 1.5×10^6 have been achieved.

Antigravity experiments have also been successfully conducted where the weight of the unit was reduced by 90% in controlled experiments, with a signal wave input of 175 microwatts and an output of 1 kilowatt.

The basic theory of the device is briefly explained and experimental results presented. In the demonstration session, a videotape of one operating open-loop unit with a 1.5 x 10^6 power gain is planned, as is the demonstration of an actual working model closed-loop system with a nominal rating of 500 watts, and without external power input of any kind.

The units are solid state, with no moving parts. Each of them comprises a unique form of self-powered vacuum triode of extraordinary gain, where the cathode power and plate power are freely furnished by the vacuum, and only a small grid signal need be furnished either from an external power source or by clamped positive feedback from the device's output. The output is negative energy, and some of its unique characteristics are pointed out.

Implications of the experimental application of the Sweet vacuum triode, the Bearden approach to the nucleus as a pumped phase conjugate mirror, and the unified field theory based on Whittaker's engineerable hidden variable scalar EM potential theory are also briefly addressed.

SCALAR ELECTROMAGNETICS

In 1837 Sir W.R. Hamilton said,

"The notion of time may be unfolded into an independent pure science... a science of pure time is possible."

As is well-known, the fundamental units utilized in physics are arbitrary. It is even possible to construct all of physics on a single unit, time. This oddity shows the truth in Hamilton's statement; it is even more odd, because quantum mechanically time is not an observable. This means that the observable world can be modeled completely in terms of the nonobservable, which is essentially what modern quantum mechanics is now doing.

Hamilton viewed his magnificent quaternions as essentially having accomplished the mathematical structuring of time. Maxwell's original EM theory, as is well-known, was modeled in Hamilton's *quaternions*, not in the highly curtailed Heaviside/Hertz vectors erroneously taught today as "Maxwell's theory."

Not a single one of the present so-called "Maxwell's" vector equations ever appeared in a book or paper by James Clerk Maxwell.

For some years the author has worked on an extended electromagnetics theory, involving the scalar component of the quaternion. [Ref. 1]

In Maxwell's original *quaternion* theory, this scalar component often remains when the directional components zero. Further, it then enfolds vectors and functions of vectors inside, in a hidden variable manner. Specifically, the author has patterned a unified field theory concept upon the previously unnoticed but remarkable early work of E.T. Whittaker. [Ref. 2]

In two fundamental papers in 1903 and 1904, Whittaker showed that all present vector EM can be replaced by scalar potential interferometry, and that bidirectional harmonic EM plane wave sets could be used to produce a standing wave of force-field-free potential (Figures 1 and 2).

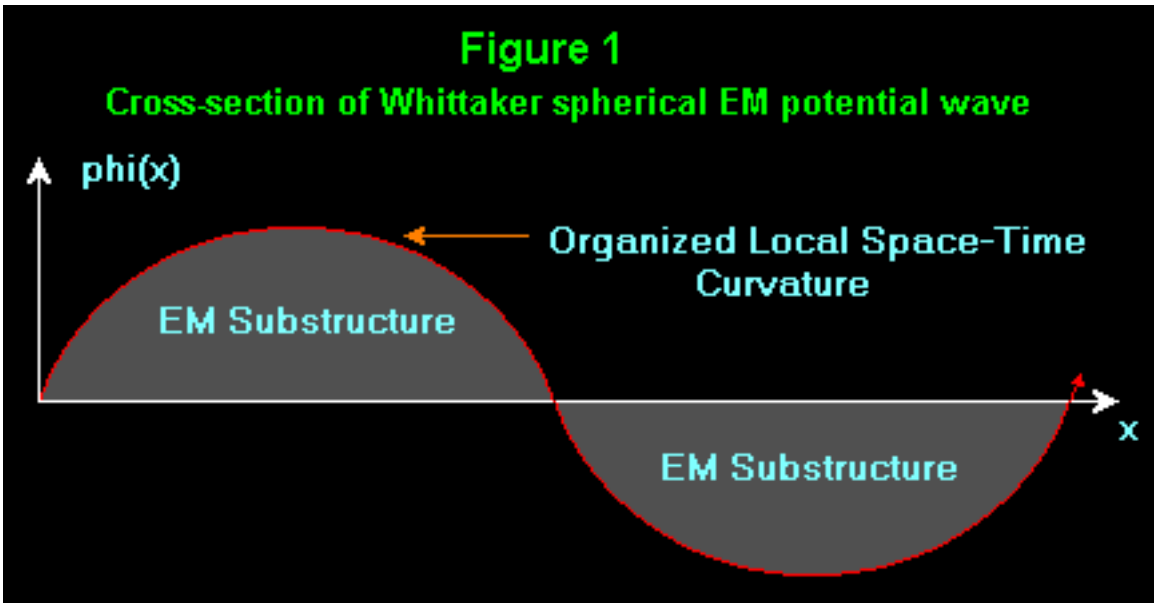

NOTE: SHAPE MAY BE ALL ABOVE OR ALL BELOW AMBIENT VACUUM POTENTIAL

Thus Whittaker anticipated the quantum mechanical Aharonov/Bohm effect by 55 years, including extending it to the macroscopic world instead of the mesoscopic realm where it has been established to date. [Ref. 3]

In modern terms, Whittaker showed how to turn EM wave energy into electrogravitational potential energy, then how to interfere two such scalar potential waves to recover electromagnetic energy, even at a distance. [Ref. 4]

This unrecognized work is of great importance: when applied to modern physics, it produces supersets of quantum mechanics (QM), classical electromagnetics (EM), and general relativity (GR).

Further, all three extended disciplines unify on their common Whittaker subset, in a testable and engineerable fashion. [Ref. 5]

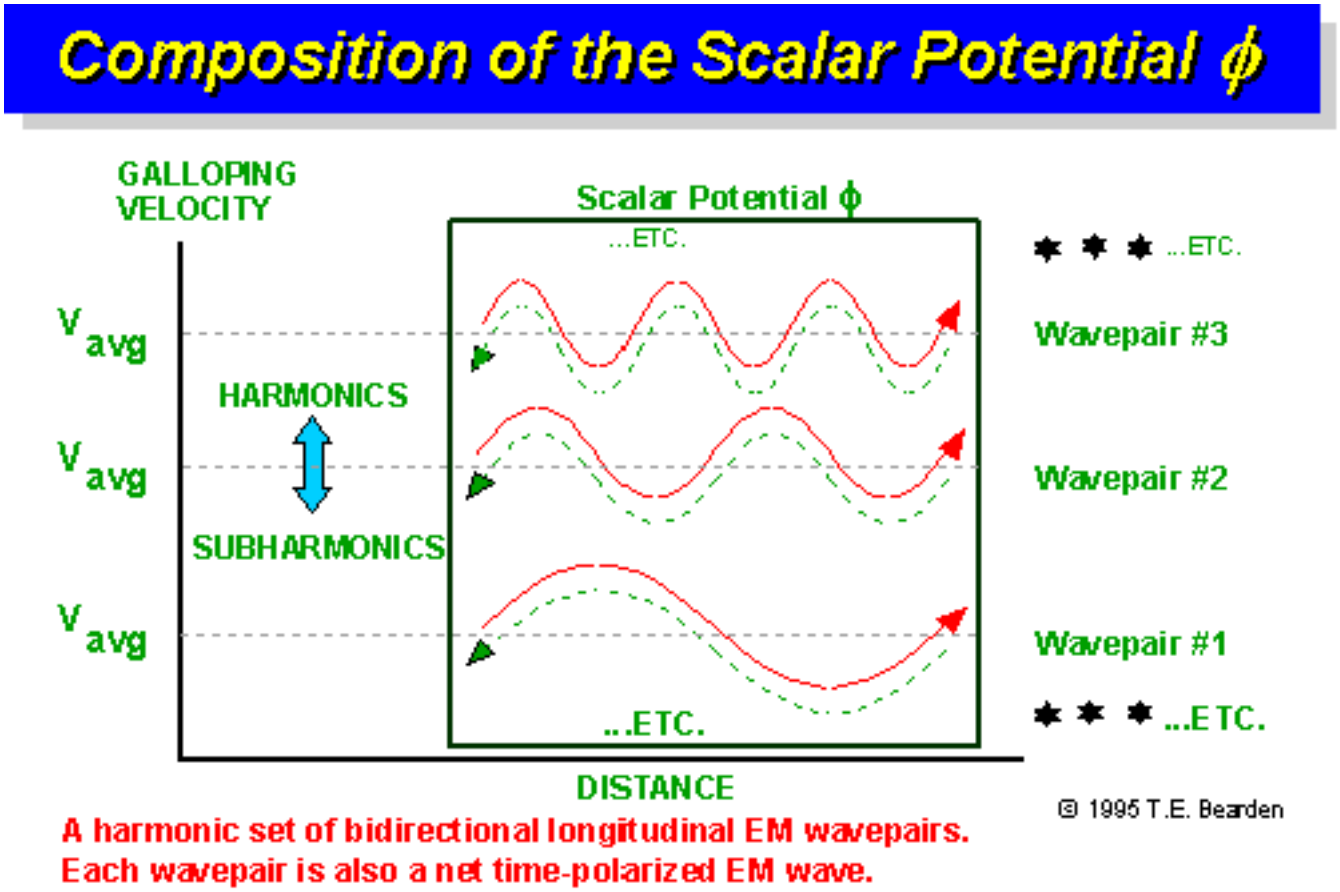

Figure 2. Infolded EM plane wave structure of a Whittaker wave.

The Nucleus As a PPCM and Triode

The author has also considered the highly nonlinear nucleus of the atom as a pumped phase conjugate mirror (PPCM), having found no other consideration of same in the literature.

The author also dubbed a PPCM a "triode," since the amplified phase conjugate replica of the signal wave is much like the amplified output of a triode, and the signal wave input to a PPCM is much like a triode's grid signal input. The PPCM pump wave then corresponds roughly to the power input to the cathode and plate of a triode. [Ref. 6]

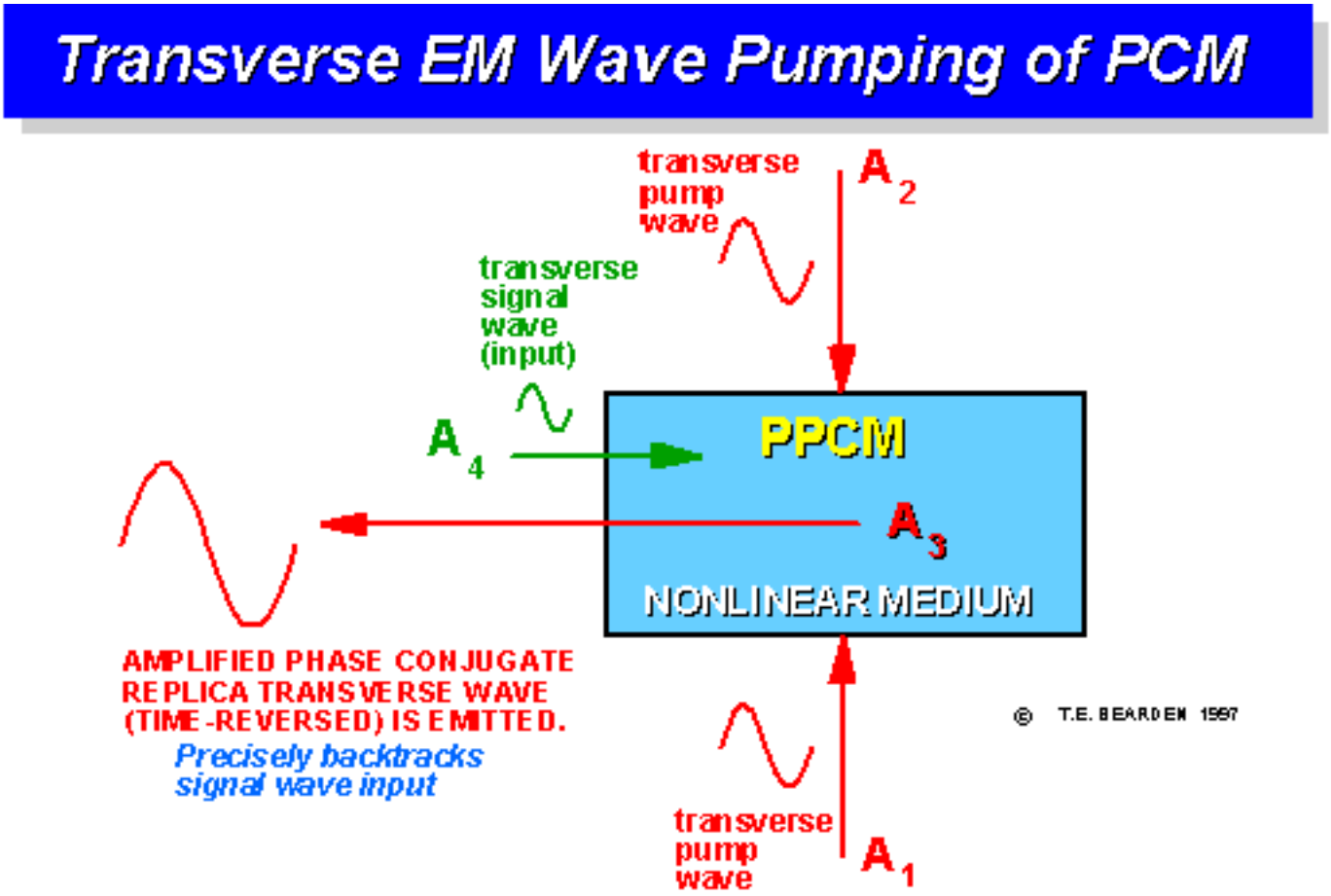

Figure 3. A pumped phase conjugate mirror.

VACUUM TRIODE BACKGROUND

About seven years ago, the author was privileged to see and examine an invention of Mr. Floyd Sweet, that produced about 6 watts of electrical power from the vacuum itself.

This remarkable device, which the author dubbed a *vacuum triode*, in a single unit utilized most of the scalar EM concepts the author had so painfully and slowly formulated over the years.

Sweet, a brilliant inventor with a remarkable knowledge of magnetics, had utilized barium ferrite magnets and special coils to produce a solid-state device that successfully tapped the vacuum energy.

The author quickly put together a theoretical concept for the energy-tapping mechanism, based on treatment of the nucleus as a PPCM and Whittaker's scalar EM potential unified field theory. [Ref. 7]

The author furnished the technical concept, treating the nucleus as a pumped phase conjugate mirror, to the inventor along with copies of Whittaker's papers.

Sweet's Synthesis and Extension

Sweet is also a brilliant EM theoretician, working in four, five, or even six dimensions with ease. He immediately synthesized the entire PPCM and Whittaker theory, and developed a complete theoretical treatment of the device. [Ref. 8]

He also increased the nuclear potential utilized in the activated nuclei of the device, which increased the pumping energy and hence the energy output. He next produced an open-loop vacuum triode (VT) with an output of 500 watts, for an input of 33 microwatts.

Thereafter he produced several other models, including closed-loop systems and one with 5-KW output.

Purpose of This Paper

Our purpose is to explain the detailed scalar EM concept of the operation of the vacuum triode, since it is a universal method for cohering and tapping useful EM energy from the vacuum.

The author believes that this mechanism is the fundamental mechanism that must be invoked in any over-unity device that electromagnetically extracts vacuum energy as electromagnetic effects.

We also intend to demonstrate a full working model of the device at this conference. Sweet's detailed theoretical treatment will be completed and submitted to a major journal shortly, to complete the scientific exposition of the new methodology.

I must also express my deep admiration for my brilliant inventor colleague. It has been a privilege to work with him, though under great difficulties and at a distance. He has developed several other related devices that are of great importance to the emerging new physics of *vacuum engineering*, in the sense referred to by Lee. [Ref. 9]

To mention just one, he has produced a magnetic lens which apparently can directly display the vacuum's virtual particle flux, or a good analog of it. So far as I am aware, this is the only extant instrument today that can perform this feat.

When the vacuum triode has been proven to the scientific community, it is my intention to nominate Sweet for the Nobel Prize he so richly deserves, and seek high scientific endorsements for the recommendation.

INTRODUCTION

Entropy

As is well known, in any closed dynamic system the order existing in it will gradually be dissipated, as more and more interactions occur. This leads to the notion of *entropy* as the increasing disorder in such systems. The assumptions are

1. a closed system, and

2. a positive flow of time for the components of the system.

Actually no such thing as a completely closed system exists in nature. Every mass system is open to virtual particle flux exchange with the vacuum, for example, particularly in the nucleus of its atoms, where the bulk of its mass is located.

However, the closed system assumption is reasonably approximated by a great many systems which are in stable thermodynamic equilibrium, or nearly so.

On the other hand, in an open system far from thermodynamic equilibrium, the second law of thermodynamics does not necessarily apply, because the system violates both the closed system assumption and its equilibrium approximation. [Ref. 10]

Time Reversal

Since being discovered in 1972 in the open Soviet literature, the time-reversed (phase conjugate) EM wave has also been known. The phase conjugate EM wave is truly time-reversed, as has been shown experimentally. Since the time-reversed EM wave violates the second major assumption, the second law of thermodynamics need not necessarily hold for time-reversed entities.

Putting all this together, if one wishes negentropy and hence increased energy in a system, the candidate suggested would appear to be a system that was strongly

1. open loop,

2. time-reversed, and

3. far from thermodynamic equilibrium.

A good overview of time-reversal in physics has been provided by Sachs. [Ref. 11]

Engineering the Nucleus

Since the nucleus already provides a myriad of time-reversed processes, engineering the nucleus of an atom is a very good candidate for practical negentropy.

To engineer the nucleus directly, a Whittaker potential is first artificially constructed, by composing a harmonic set of phase-locked EM wave/antiwave pairs. It is accented that the antiwaves must be true phase conjugates; otherwise they will not constitute a gradient-free Whittaker standing potential wave.

In addition, at least one harmonic interval must be used, and additional harmonic sets are most

desirable. The reason is that a space-time lattice must be formed in the vacuum, where the energy is additive spatially but oppositive in t-dot, the rate of flow of time, in the fourth dimension.

So a time-structure is required as well as a spatial structure, which is what is provided by ***n*** bidirectional harmonic Whittaker EM wave sets, where ***n*** is an integer greater than 1.

Once a specific Whittaker structure has been chosen, the local lattice of space-time is established. This establishes phase-locked lattice groupings of coupled photon/antiphoton pairs, or of *gravitons*. In turn, this Whittaker-structured vacuum now contains specific graviton *vacuum engines*, which directly engineer and structure the vacuum's virtual particle flux (VPF) exchange with the nucleus. [Ref. 12]

The nucleus is highly nonlinear, hence strongly phase conjugative, or time-reversed. The ambient potential of the local vacuum surrounding the nucleus is in a violent virtual photon exchange with it, accounting for its electrical charge.

Since the preponderant charge is positive, from the viewpoint of the ordinary light observer whose light interacts with electron shells, the nucleus may be taken to exhibit time reversal (phase conjugation).

Energy, Time, and Gravitons

We take the definition of "energy" to be fundamentally an ordering imposed upon the VPF of vacuum. We take photon scattering from the electron shells of atoms to be the fundamental exterior mechanism producing forward flow of external observer time.

It then follows that "time's arrow" for the EM observer is due to the universal scattering of photons from electron shells.

In this view, forward (positive) time flow and entropy are due to the same primary action: photon scattering from electron shells. It is unfortunate that the concept of "positive" energy has been tied to, and defined in terms of, the scattering and dissipation of VPF order as *work*, or energy expended.

Via the standard labeling, then, negative energy is the reconstitution of order in the vacuum VPF. It should be noted that, in a PPCM, dissipative or external pump wave stress energy can be scavenged and re-emitted in perfect order as the phase conjugate replica. This is a *negentropic* process, for it is capable of turning disorder into order. [Ref. 13]

In the time-reversed PPCM nucleus, we should expect to see appreciable *negative energy*—that is, energy removed from the EM scattering domain. This includes the binding energy of the nucleus, and the gravitational (G) potential energy of the EM energy removed from the "scattering interaction realm" and locked into the mass.

Following Sakharov, we hold that the G-field is not a fundamental field of nature, but a composite

caused by, or made from, other fields. [Ref. 14]

To the first order, we assume the G-potential is comprised of coupled photon/antiphoton pairs, on the average, where the statistical coupled spin-2 photon/antiphoton pair is a *graviton*. [Ref. 15]

We follow the modern view of the field: because of vacuum fluctuations, rigorously one no longer speaks of "the" field, but of the *probability of a particular field configuration*. [Ref. 16]

We also hold the vacuum to be composed of potentials, and regard the three terms *space-time*, *vacuum*, and *scalar potential* as essentially synonymous.

Newton's Third Law and the Detection Process

The VPF EM stress of the local vacuum immediately surrounding the nucleus may be decomposed a la Whittaker into opposing bidirectional EM plane waves/forces. Thus the nonlinear nucleus may be regarded as a pumped phase conjugate mirror, normally with a gain of one.

In this view, Newton's third law reaction force is generated because the so-called "photon" interaction with an atom is in fact a graviton reaction involving a photon/antiphoton pair that is decoupled.

The decoupled photon normally is absorbed and reradiated by an orbital electron, while the decoupled antiphoton interacts with the nucleus, producing a time-reversed twin of the external force —or, in other words, Newton's third law reaction force, which gives a slight recoil of the nucleus.

Half of every measurement physicists normally make is discarded, with the missing half accounting only for Newtonian reaction in the meter or instrument, which is usually ignored.

The fact that half of our measurement interactions are ignored is occasionally discovered and noted by physicists, who may even write a paper pointing it out, but no change is instituted in the foundations. [Ref. 17 and Ref 18]

Semiconducting Vacuum and Self-Oscillation

The vacuum immediately surrounding the nucleus is structured by the nucleus, and is itself nonlinear and capable of acting as a *semiconductor*. [Ref. 19]

Since both this immediately local semiconductor vacuum and the nucleus it surrounds are highly nonlinear, then *nonlinear resonance* can conceivably be established between them.

Further, since the resonating system in such case is an open system away from thermodynamic equilibrium, the oscillation can be self-sustaining. Such self-oscillation of the pumping of a PCM is already well-known in the nonlinear optical literature, particularly with compounds containing barium. [Ref. 20]

THE VACUUM TRIODE

The Basic Concept

As is well-known, a stress can be decomposed into opposing sets of forces. But quantum mechanically, the forces we are interested in with our work here are all caused *electromagnetically*, by the exchange of virtual photons. Even mechanical force, according to QM, is caused in this manner. Thus opposing electromagnetic or mechanical "stress" sets of bidirectional EM forces are microscopically equivalent to the notion of *pump waves* in nonlinear optics.

Hence under the proper conditions, it follows that trapped EM stress energy of the vacuum can be utilized to "pump" the nucleus.

Treating the stress-pumped nonlinear nucleus as a PPCM, it follows that the stress energy of the vacuum can be tapped by a 4-wave mixing mechanism in the atomic nucleus, to provide amplified phase conjugate EM wave outputs from the atom in response to small signal wave inputs. [Ref. 21]

In the proper nonlinear material, the material may act as a PPCM, in which case there exists a suitable connection between the material's atomic nuclei and its external electromagnetic lattice bonds, and the amplified phase conjugate replica wave generated in the nucleus will be emitted from the material as an EM wave field. This field can then be tapped by suitable means and output to an external load circuit.

Block Diagram of the Vacuum Triode

Figure 4 shows a basic block diagram of the vacuum triode process, utilized by Sweet in several laboratory vacuum energy devices. These devices have ranged from a nominal 500 watt output in a 6-lb. device to 5 kilowatts for a heavier unit. Gains have ranged from 50,000 to 1,500,000 for open-loop systems. Both open-loop and closed-loop systems have been built and tested.

Figure 4 shows a combined block diagram for either a closed-loop or open-loop system. In the open-loop system, a barium ferrite magnetic material is used as a pumped phase conjugate mirror.

In the "standard" design, two opposing PPCMs are used. The advantage of this dual combination is the use of *self-targeting* (repetitive phase conjugation, signal by signal). This has the effect of

1. stabilizing the Whittaker field, and

2. producing a quantum potential between the two mirrors, so the mirrors and the Whittaker potential between them are essentially one single space-time entity.

Discussion of a quantum potential is beyond the scope of this paper, but the technical mechanism for creating one has been previously presented by the author on several occasions. [Ref. 22]

First we will explain the open-loop operation of the vacuum triode. In Figure 4, on the right an external 60 Hz, nominal 10 volt AC sine wave of several tens of microwatts in power is input into the stabilized field of the barium ferrite magnet structure, where it modulates the field, producing a signal wave input into the atoms of the material.

In the top right block, the EM signal wave interacts with the electron shell of an atom, which in turn is EM-coupled to the nucleus.

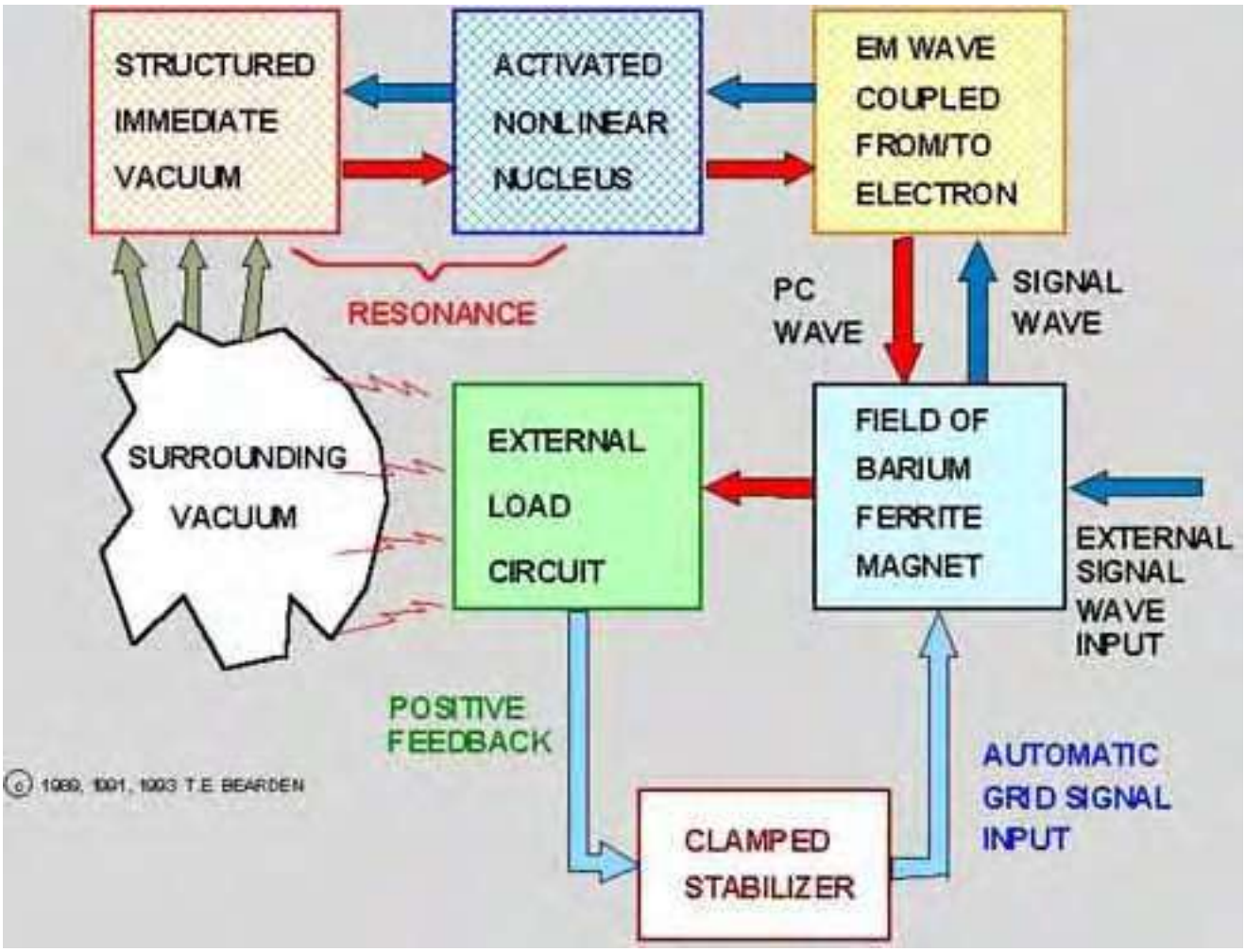

Figure 4. The Vacuum Triode Concept.

Thus an EM signal wave is input to the nucleus of the atom, which is highly nonlinear (middle top block). Earlier, Sweet had specifically conditioned the atomic nuclei with a proprietary process, wherein in the barium nucleus a trapped 60 Hz scalar EM spherical wave resonance (self-oscillation) exists between the structured semiconductor vacuum immediately surrounding the Ba nucleus.

In the same *activation* process, the ambient potential of the surrounding vacuum was raised and stabilized, in the two leftmost blocks.

At this point the nonlinear nucleus is effectively self-pumped by the trapped, excited, spherical scalar wave oscillation between the structured semiconductor vacuum and the nucleus. The nucleus is now a strongly pumped phase conjugate mirror.

Consequently, when the signal wave input arrives, the PPCM nucleus emits an amplified phase conjugate replica (PCR) wave, which precisely backtracks the input signal wave. This precise backtracking (perfect retroreflection) is referred to as the "distortion correction theorem."

In short, the powerful PCR wave returns precisely toward the external source, passing through the electron shells and arriving in the perturbed barium ferrite magnet assembly field, where it perturbs the field.

A transformer-like system then extracts this magnetic field perturbation and conducts it to the external load circuit.

However, the PCR contains *negative* energy. Short of the load, the internal circuits run cool, rather than heating. This is a signature of a true vacuum energy tapping device.

Indeed, if the output leads of the Sweet vacuum triode are physically shorted together, a brilliant flash occurs, and the leads instantly ice as if dipped in liquid oxygen. This is another signature of the true negentropic over-unity vacuum tap.

Note that the energy extracted from the semiconducting vacuum adjacent to the nucleus is just instantly replaced by the surrounding vacuum's inexhaustible energy pool. This is an open-loop system, with a hidden energy source: the intense virtual particle flux of the vacuum's ambient charge.

It is not possible to exhaust that flux, which is often calculated to have an energy density of some 10^{100} or more grams per cm^3, if the energy were cohered and condensed into mass.

As can be seen, even a VT gain of 1.5×10^6 represents a "vacuum tap" of an incredibly small efficiency, on the order of 10^{-100} or so. However, the vacuum "river" is so energetic that such efficiencies are quite sufficient.

We accent that the barium ferrite magnetic material must be *activated* so that stable self-oscillation between the barium nucleus and the surrounding semiconductor vacuum exists. Although self-oscillating/self-pumped PCMs are known at optical frequencies, Sweet has discovered and perfected a brilliant methodology for activating PPCM nuclei at ELF frequencies.

In a resistive load such as light bulbs, the resistive material accomplishes repetitive phase conjugation. Thus in the resistor, half the total energy is expressed as photon or dissipative energy in the external (electron shell) level.

As the excited electrons decay, they emit scattered EM energy as light and heat. This is an *exothermic* interaction. The other half of the total energy reacts in the atomic nuclei, as a phase conjugative or *endothermic* interaction.

We strongly accent that, Whittaker-wise, there are two electromagnetic channels and two kinds of EM:

1. *external* EM, the common electron-shell interacting, entropic, scattering, time-forward kind, and

2. the *internal*, unsuspected, hidden variable, nuclei interacting, negentropic, reordering/ convergent kind.

Internal EM travels strictly between atomic nuclei, normally not reacting with electron shells unless a pumped phase conjugate mirror reaction is invoked in the nucleus to produce a gain somewhat greater than unity.

Thus if we wish to communicate with atomic nuclei directly, and engineer them directly, we must utilize the internal EM channel via applied Whittaker methods.

Antigravity Tests

Inherent in the preceding discussions is the possibility to turn EM energy into gravitational energy of either sign. In other words, one should be able to utilize Sweet's vacuum triode to produce and demonstrate antigravity.

Indeed this is the case. Sweet has also discovered the special alterations necessary to perform straightforward transformation of the internal energy in the nucleus to antigravitational energy, producing a unilateral thrust upward.

Note that the bulk of G-potential gradient (G-force-field) occurs Whittaker-wise at ELF frequencies. This explains why nonlinear phase conjugate opticians do not notice direct antigravity effects.

At the optical frequencies at which they work, the effects are so miniscule that they are negligible. This is readily explained as follows: In QM, the quantum (photon) is comprised of action (angular momentum), not just energy. It is rather like a "piece of energy welded to a piece of time, with no seam in the middle."

Since quantum change occurs in quanta, the decoupling of the energy and time components, in the continual interaction of photons with matter, exchanges energy between G-potential of vacuum and trapped mass of the atom or particle. In this exchange, small increments of time are continually being formed (and unformed, as photon emission occurs).

Consequently, each mass is moving forward in time in small incremental jumps, usually of exceedingly small magnitude. However, the energy and time trapped in a photon are canonical. The greater the piece of energy, the smaller the piece of time, and vice versa.

So if one wishes to stress the "rate of flow of time" significantly, one needs to produce large amounts of photons that have very large pieces of time, and consequently little pieces of energy.

Since the energy of the photon is directly proportional to its frequency, this means that the lower

frequency photons have larger time increments, and hence endure over many "regular-sized photon absorption/emission changes" to appreciably stress the rate of time flow/production.

The bottom line is that the standard pumped phase conjugate mirror can be adapted to produce antigravity at ELF frequencies, but precisely the same adaptation at optical frequencies will have negligible effect.

With this in mind, the author requested Sweet to perform an antigravity experiment to prove the thesis. With Sweet's proprietary adaptation of his vacuum triode/PPCM, the experiment produced rather straightforward but spectacular results, as shown in Figure 5.

The experiment was performed as follows: Rigged for antigravity, the 6-lb. device was placed on a scale so that its weight could be continuously monitored. A special external load box was utilized in which multiple electric light sockets were connected in parallel.

Then the external load draw was adjusted by merely screwing in 100-watt lamps, one at a time, with measurement and observation pauses in between. The output of the device was 120 volt, negative AC sine-wave power at 60 Hz.

For each 100-watt increment, the load power was recorded and the weight was carefully recorded. The results are shown in the rather smooth, classic curve shown in Figure 5.

At 1,000 watts load draw, the previously 6-lb. device had reduced its weight due to gravity by 90 percent. At that point the signal-wave (grid) input to the open-loop vacuum triode was only 175.4 microamps at 10 volts, or just under two milliwatts.

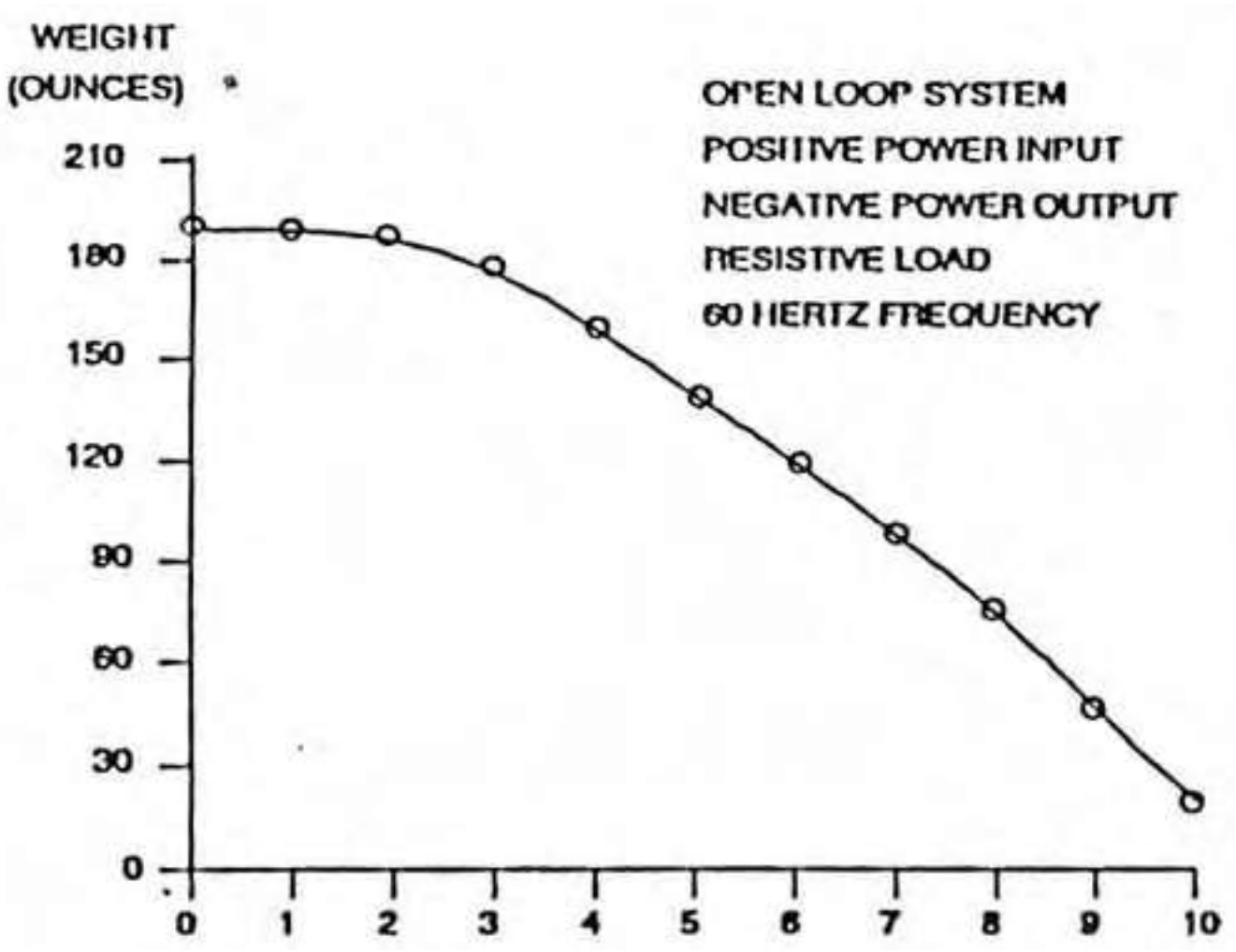

EXTERNAL ELECTRICAL LOAD

(HUNDREDS OF WATTS)

Figure 5. Antigravity Test of Sweet's Adapted Vacuum Triode.

We accent that the nominal two milliwatt input is only a gating signal. It is the organized, gated vacuum energy that is performing the action.

The experiment was stopped short of actual hovering and flying due to safety considerations. With the specific adaptation, magnetic monopoles are deposited in the magnet materials, producing internal tensile stress.

Since no explosive controlled facilities were available, and there was no wish to destroy the VT, the experiment was terminated at 90% antigravity performance.

It was completely successful, and adequately demonstrated the validity of the unified field theory concepts utilized in our approach.

CONCLUSIONS

A new unified field theory has been developed, tested, and at least partially verified experimentally.

The concepts of the theory have been applied by Sweet in a series of inventions that produce readily usable, safe electromagnetic power directly from the vacuum.

The methodology lends itself to formulation of power devices without moving parts. Antigravity, predicted by the concepts of the theory, has been demonstrated in actual practical demonstrations on the laboratory bench.

Though not discussed in this paper, application of the concepts and methodology to a large variety of other fields, such as medical reversal of aging and curing of almost the entire range of present debilitating diseases, has been previously pointed out. [Ref. 23]

We have also pointed out the mechanism for Kaznacheyev's cytopathogenic effect, or the induction of cellular pathology at a distance by electromagnetic means. [Ref. 24]

We have also pointed out the specific mechanism involved in Priore's device, which in rigorous laboratory animal testing under the auspices of eminent French scientists, demonstrated nearly 100 percent cures for terminal cancers and leukemias, sleeping sickness, artherosclerosis, and other debilitating diseases.[Ref. 25]

We believe we have also produced the concepts enabling the direct engineering and therapeutic manipulation of Popp's master cellular control system. [Ref. 26]

We conclude that the concepts we have utilized and experimentally demonstrated are universal, as implied by any notional unified field theory.

Our conclusion is that the concepts, theory, and experiments, taken together, are sufficient for investigation and replication by the scientific community.

If replicated and fully substantiated, we believe the work will directly point the way to, and usher in, a new unified field theory physics of universal application.

SPECULATED IMPLICATIONS

As can be seen, the implications of the new approach are profound. The authors believe they have ushered in the forerunner of a vast new physics, one which will change our lives, and our view of physical reality, in ways previously undreamed of.

By mastering, controlling, and gating the vast, incredible energy of the seething vacuum, we can power our automobiles, flying machines, and technology inexhaustibly. Further, it can be done absolutely cleanly; there are no noxious chemical pollutants to poison the biosphere. With practical antigravity, ships can be developed to cross the solar system as readily as one crosses the ocean today.

And the ships, automobiles, and technology will never run out of fuel; the inexhaustible vacuum fills

every system, everywhere, to overflowing.

Not discussed in this paper, it turns out that living systems, faced with the problem of achieving negentropy so as to maintain their form in a dissipative external physical reality, have always used the hidden internal channel for such things as mind, thought, cell control, and living functions.

With the new methodology, one now faces the advent of access and engineering of the mind and life of the observer as readily as the observer's physical body.

Transmutation of the elements, control of the weather, lighting and powering our cities and homes cheaply and cleanly, and provision of plenty for everyone is the vista for the future. We can in fact clean up the radioactive wastes, rid ourselves of coarse nuclear and petroleum powerplants.

We strongly stress that, with the ability to engineer the Schroedinger equation itself, the new methodology allows the direct engineering and control of quantum change, and hence of physical reality itself.

The methodology is extendable to hyperdimensions; nested virtual levels of the vacuum are already precisely that. The author has already pointed out the application of this emerging technology to the absolute cure of diseases such as AIDS, cancer, leukemia, etc., and shown that the Priore device in France already proved the efficacy of the application in the 60s and 70s.

We shall be able to rid ourselves and our descendents of diseases. With direct access to the actual software of life and mind, in the future we should be able to achieve levels of education previously unattainable, by directly inputting the relevant software.

Previously we have also pointed out that four nations of the world are already embarked on weaponization of scalar EM unified field technology. It is sobering to think that, in addition to having the ability to make our planet a paradise for humankind, we also will have the ability to make it a hades.

For that reason, we are doing our best to clarify the technical concept and the theory in this 1991, hopefully with the view that humankind will seize upon the positive aspects, and develop and apply this technology for the betterment of all people everywhere.

Long ago, Albert Einstein said these words:

"It would of course be a great step forward if we succeeded in combining the gravitational field and the electromagnetic field into a single structure. Only so could the era in theoretical physics inaugurated by Faraday and Clerk Maxwell be brought to a satisfactory close."

And Teilhard de Chardin wrote:

"Someday, after we have mastered the winds, the waves, the tides and gravity, we shall harness for God the energies of love. Then for the second time in the history of the world man will have

discovered fire."

The authors fervently believe they have come upon fire for the second time, as allegorized by de Chardin. If so, let us all use the knowledge wisely.

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2. E.T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," *Math. Ann.*, Vol. 57, 1903, p. 333-355; "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," *Proc. Lond. Math. Soc.*, Series 2, Vol. 1, 1904, pp. 367-372. The first paper was in fact a detailed theory of the scalar standing potential wave that Nikola Tesla discovered four years earlier, on the night of July 3-4 1899, being radiated from thunderstorms, which he entered in his *Colorado Springs Notebook* on the morning of the 4th. More recently the Whittaker structure (WS) inside potentials, including the Schroedinger potential, has been shown by V.K. Ignatovich, "The Remarkable Capabilities of Recursive Relations," *Am. J. Phys.*, 57(10), Oct. 1989, p. 873-878, without credit to Whittaker or to the presence of such structured scalar potentials in Maxwell's original quaternion EM theory. These WSs are universal to scalar potentials; e.g., for the same in acoustics, see Richard W. Ziolkowski, "Localized Transmission of Wave Energy," *Proc. SPIE, Vol. 1061, Microwave and Particle Beam Sources and Directed Energy Concepts*, Jan. 1989, p. 396-397.

3. See Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," *Phys. Rev.*, Second Series, 115(3), Aug. 1, 1959, p. 458-491. This paper pointed out the primacy of the potentials. Instead of being causative agents, the force fields are actually effects generated from the potentials. This is in complete violation of both classical electromagnetics and classical dynamics, but it is absolutely required by quantum mechanics. For an extensive discussion of the Aharonov-Bohm effect and an extensive list of references, see S. Olariu and I. Iovitzu Popescu, "The Quantum Effects of Electromagnetic Fluxes," *Rev. Mod. Phys*. 57(2), Apr. 1985. See Bertram Schwarzschild, "Currents in Normal-Metal Rings Exhibit Aharonov-Bohm Effect," Physics Today, 39(1), Jan. 1986, p. 17-20 for confirmation that the Aharonov/Bohm effect has indeed been firmly proven experimentally.

4. It is pointed out that today all potentials are well-known to be gravitational entities. However, this was not known in Whittaker's time, and so he himself did not realize that he had actually produced an engineerable, testable unified theory of electromagnetics and gravitation.

5. T.E. Bearden, "Possible Whittaker Unification of Electromagnetics, General Relativity, and Quantum Mechanics: Part I: Background," Presented to *Ala. Acad. Sci. Annual Symp.*, Univ. Jacksonville, Mar. 1991.

6. For the theory of a pumped phase conjugate mirror, see David M. Pepper, "Nonlinear Optical Phase Conjugation," *Opt. Eng*., 21(2), Mar./Apr. 1982, p. 156-183; Amnon Yariv, *Optical Electronics*, 3rd Edn., Holt, Rinehart, and Winston, New York, 1985. In a normal triode tube, the amplified plate signal is 180 degrees out of phase *spatially* with the grid input, but in-phase with it in respect to *rate of flow through time*. In a PPCM, the amplified phase conjugate replica wave is in phase spatially with the signal wave, but 180 degrees out of phase with it in respect to its rate of flow through time. It is pointed out that a PCM with a gain of unity produces a coupled EM wave/antiwave pair whose energy is additive in 3-space but subtractive in the first derivative of the fourth dimension, time. Hence it is no longer an electromagnetic wave as such, but an oscillatory wave of stress upon the local rate of flow of time. Hence it is a powerful *electrogravitational wave*, whose EM nature is hidden in the guise of a scalar EM potential. It is also a wave of variation in the local gauge, and of variation in the local ST curvature.

7. See T.E. Bearden, *The Phase Conjugate Vacuum Triode*, Apr. 23, 1987, privately published. An earlier pencil draft was initially produced.

8. Sweet has continued to extend his theoretical treatment. A formal paper providing the complete mathematical theory of the vacuum triode has been drafted, is in final review, and will be submitted to a leading journal by mid-1991.

9. See Chapter 25: Outlook, "Possibility of Vacuum Engineering," T.D. Lee, *Particle Physics and Introduction to Field Theory*, Harwood, New York, 1981, pp. 824-828.

10. In 1977 Ilya Prigogine received the Nobel Prize for extending thermodynamics; in particular, for the theory of dissipative structures in nonequilibrium thermodynamics. In Prigogine systems, negentropy is known to be possible.

11. Robert G. Sachs, *The Physics of Time Reversal*, Univ. Chi. Press., Chicago, 1987.

12. Note that this moves the entire notion of the charge of a fundamental particle to a deeper and more extended level. Now the charge may be *discretized*, but it is not quantized in the hard conventional sense. Further, the internal Whittaker structure of the massless VPF photon exchange of vacuum and mass, which, quantum mechanically, is what the electrical charge of the particle is in the first place, is deterministically structured. Note that this violates the present assumption that all like charged particles are identical; now two electrons may have either the same or different magnitudes of charge, and even when the magnitudes are the same, their internal charge structures (Whittaker structures) and VPF exchange with the vacuum may differ. Also note that this resolves the severe QM problem of missing chaos (hidden order) in quantum change. The reason for the problem was the use of Gibbs statistics with its assumption of random variable change, which a priori excluded hidden order (and hence chaos) from QM. That was only a special case, albeit an important one. There are now three QM cases: (1) the conventional case, where there is no hidden order; (2) the case where there is some hidden order, and the statistics is chaotic, not random; and (3) the case where the QM change is deterministic, with essentially total hidden order. Note that the Whittaker

methodology allows one to directly engineer cases (2) and (3), including the Schroedinger equation itself.

13. The present second law of thermodynamics is written only for time-forward entities, and need not apply for the time-reversed case. Merely viewing the energy-dissipating forward time case in reverse allows an appreciation of the time-reversed case. In other words, the second law of thermodynamics is incomplete as presently stated. The complete law has a corollary to cover the increase in order as the time-reversal of the system increases. Thus the complete law consists of two parts: (1) the entropic, time-forward case, and (2) the negentropic time-reversed case. Since the re-ordering can be amplified at will by a PPCM process, the correct distinction between the two subsets of the complete law is important, and applies to real systems.

14. A.D. Sakharov, *Theor. Math. Phys.*, Vol. 23, 1975, p. 435.

15. T. E. Bearden, *Gravitobiology: A New Biophysics*, Tesla Book Co., 604 Date Ave., Chula Vista, CA 91912, 1991.

16. C.f. Charles W. Misner, Kip S. Thorne, and John Archibald Wheeler, *Gravitation*, W.H. Freeman and Co., San Francisco, 1973, p. 1191.

17. E.g., see Richard Kidd et al, "Evolution of the Modern Photon," *Am. J. Phys*., 57(1), Jan. 1989, pp. 27-35. See also R. Chen, "Cancellation of Internal Forces," *Am. J. Phys*. 49(4), Apr. 1981, p. 372.

18. A nonlinear material may simply emit a photon, or it may act as a phase conjugate mirror (PCM) and emit a phase conjugate replica of the absorbed photon. When the material emits a normal photon, it measurably recoils. When it emits a time-reversed photon, it does not recoil, as already experimentally established in nonlinear phase conjugate optics. The solution to the mystery is this: When emitting a normal photon, the material does not act as a PCM. In that case the matching antiphoton which split from the interacting graviton (the graviton that yielded the external photon) interacts with the nucleus, producing a recoil action with a gain of one. Thus Newtonian third-law recoil of the nucleus occurs. On the other hand, when the material acts as a PCM, it also emits the antiphoton *outside* the atom to "backtrack" the absorbed "signal wave" photon. In that case there is no Newtonian recoil of the nucleus, because the *agent* for causing recoil did not interact with the nucleus to produce it.

19. Richard E. Prange and Peter Strance, "The Semiconducting Vacuum," *Am. J. Phys*. 52(1), Jan. 1984, p. 19-21. Also, under nonlinear conditions, a particle can absorb more energy than is in the light incident on it, absorbing the energy from the vacuum VPF. C.f. Craig F. Bohren, "How Can a Particle Absorb More Than the Light Incident on It?" *Am. J. Phys*. 51(4), Apr. 1983, p. 323-327.

20. C.f. Pepper, ibid. and Yariv, ibid. For a specific example, see Mary J. Miller et al, *Appl. Phys. Lett*. 41(8), Oct. 15, 1982, p. 689-691.

21. Again, for the theory of the PPCM, see Pepper, ibid. and Yariv, ibid.

22. E.g., see T.E. Bearden, *Gravitobiology: A New Biophysics*, Tesla Book Co., Chula Vista, CA, 1991, p. 33-36.

23. Bearden, *AIDS: Biological Warfare*, Tesla Book Co., 1988; *Gravitobiology: A New Biophysics*, Tesla Book Co., 1991; *Analysis of Scalar Electromagnetics*, Tesla Book Co., 1990.

24. C.f. Vlail P. Kaznacheyev and L.P. Mikhailova, *Ultraweak Radiations in Intercellular Interactions*, [in Russian], Novosibirsk, 1981; Vlail P. Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions," *Psi Research*, 1(1), Mar. 1982, p. 47-76; N.D. Devyatkov, Ed., *Applications of Low-Intensity Millimeter Wave Radiation in Biology and Medicine*, [in Russian], IRE Akad. Nauk. SSSR, Moscow, 1985.

25. C.f. Antoine Priore, "Method of Producing Radiations for Penetrating Living Cells," U.S. Patent No. 3,280,816; Jean-Michel Graille, *Le Dossier Priore*, De Noel, Paris, 1984 [in French]; Christopher Bird, "The Case of Antoine Priore and His Therapeutic Machine: A Scandal in the Politics of Science," Appx. I to Bearden, *AIDS: Biological Warfare*, 1988.

26. C.f. Fritz Albert Popp, "Photon Storage in Biological Systems," in Fritz Albert Popp et al, Eds., *Electromagnetic Bio-Information: Proceedings of the Symposium*, Marburg, September 5, 1977, Urban & Schwarzenberg, Baltimore, 1979, p. 123-149; also *Biophotonen. Ein neuer weg zur Losung des Krebsproblems*, Verlag fur Medizin, Heidelberg, 1976 [in German].

Defense Department Briefing on Priore Treatment to counter Biological Warfare

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SLIDE LIST

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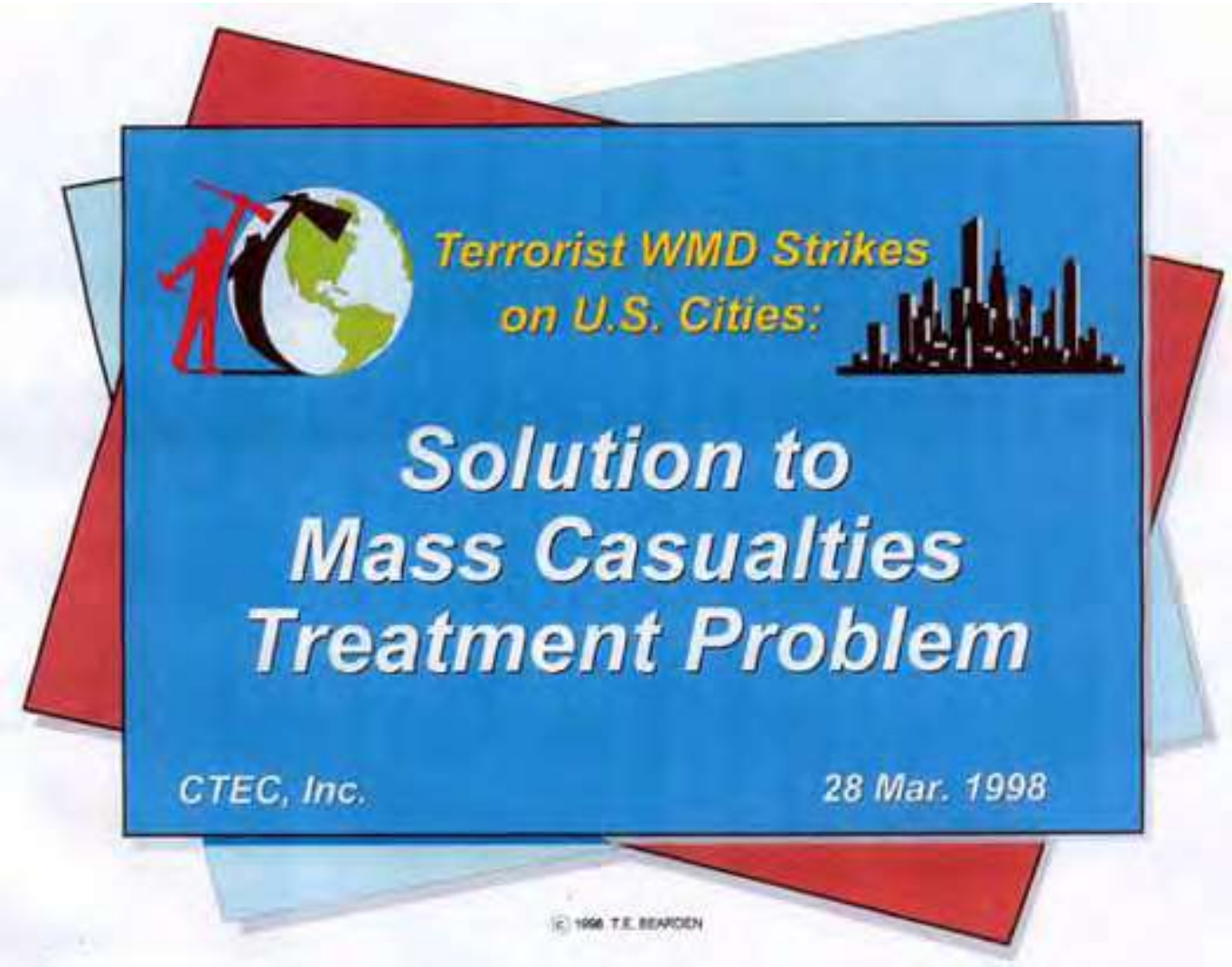

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Key Points in the New Technology

- There is a vast new kind of electrodynamics *hidden inside* all EM potentials, fields, and waves
  - Longitudinal EM waves and complexes
  - Oscillations in time domain

- These complexes are an *infolded general relativity*
  - Clustered formations of *spacetime curvatures*
  - *Very powerful*, since the EM force is used as the agent of curvature

- In general relativity, similar precise complexes permeate and *act on any mass at all internal levels*
- With this approach, one *can now manipulate matter* -- living or inert -- *in any manner desired*, depending only on the level of development of the technology
- Priore unwittingly used this to *cure dread diseases*
- This is a *revolution in all of science*

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- *We have uncovered the major mechanisms* to utilize

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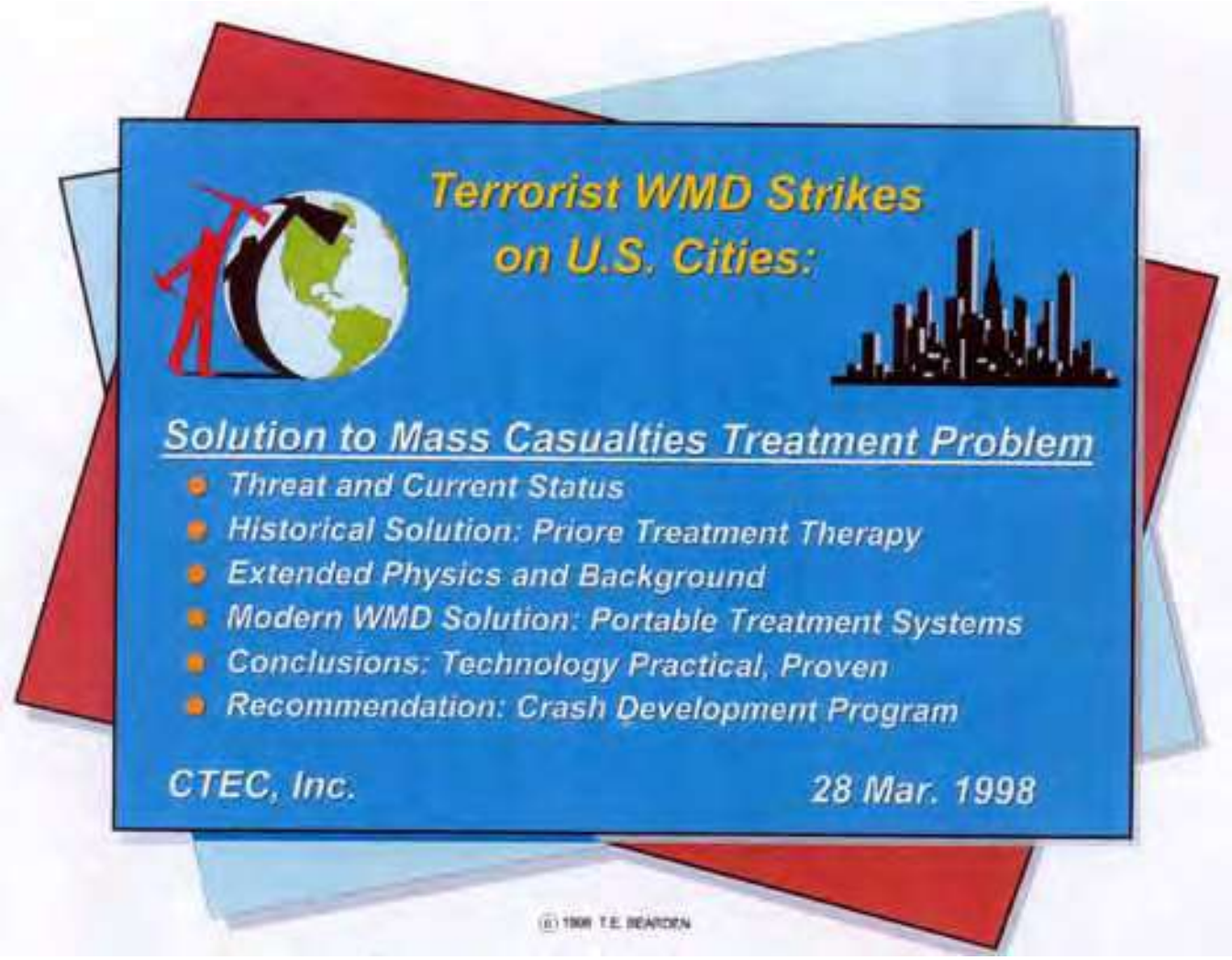

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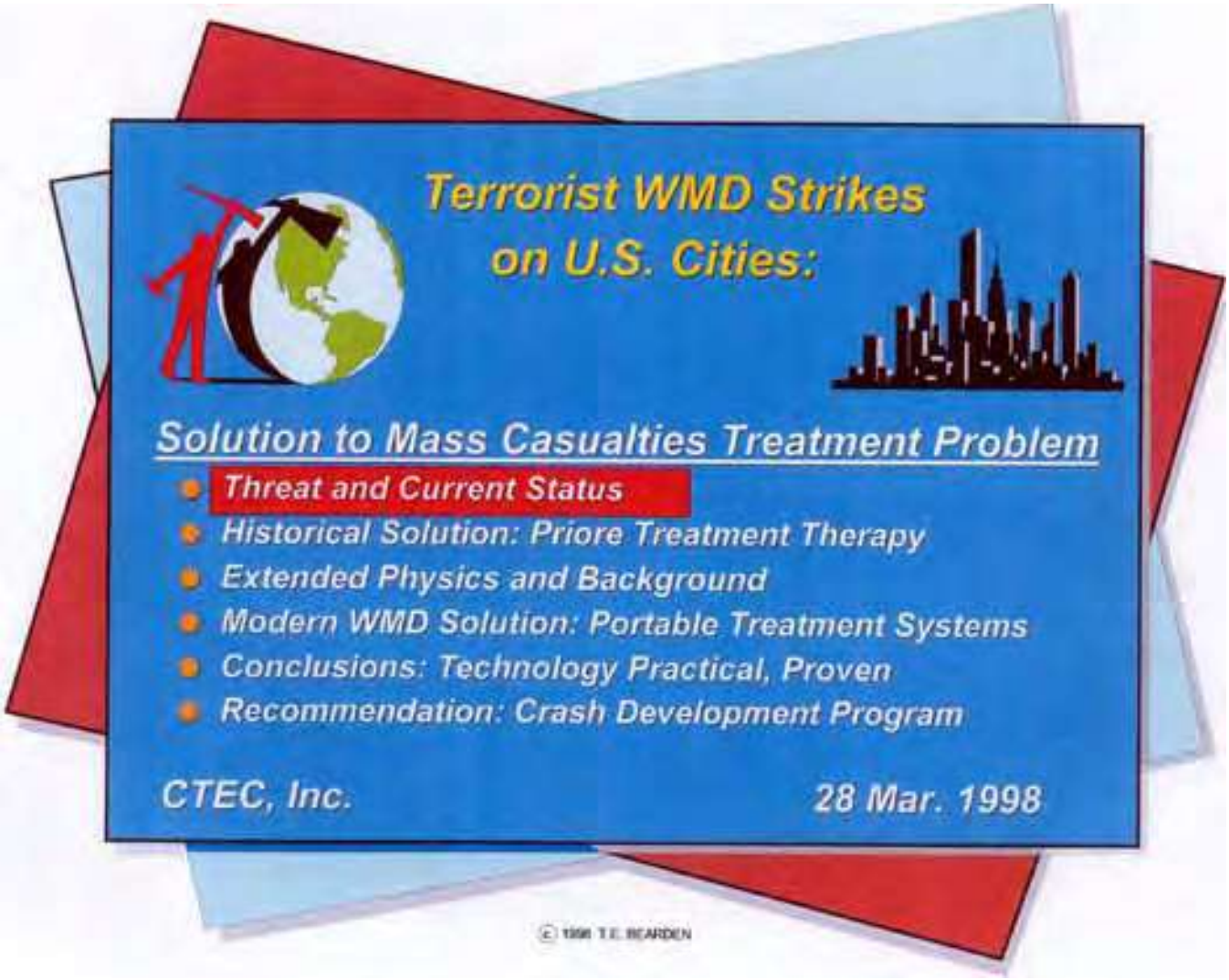

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THE TERRORIST THREAT

TODAY:

- Sabotage
- Chemicals
- Biological agents
- Nuclear materials
- Powerful explosives
- Assassination
- Kidnapping and hostages
- Contamination
- Shoulder-fired AD missiles
- Terrorism

FUTURE ADDITIONS:

- EM weapons
- EM biological warfare
- Scalar EM weapons
- Scalar EM disease induction
- Alteration of behavior and emotions
- Alteration of memory
- Direct thought control
- Action-at-a-distance effects

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Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- One terrorist, one light aircraft with spray tank
- 100 kilograms of anthrax
- Flies over greater metropolitan Washington, D.C.
- Calm night
- *1-3 million casualties result**
- *Most of those stricken will die*
- Presently little can be done to save the stricken civilians
- *Attacks on several population centers might produce some 10 million or more casualties*

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*Per OTA Report to Congress, 1993

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Present Status of the WMD Threat to the United States

- Many foreign nations are hostile to the U.S. and sponsor terrorists
- Some 25 nations have WMD or are acquiring them
  - BW agents and weapons
  - Chemical agents and weapons
  - Nuclear materials and weapons
- Thousands of students and emigres
- Infiltrated teams, BW, other WMD already
- Castro guerrillas infiltrated over the years
- Can do unacceptable damage to U.S. now
- *May reach first strike knockout capability*

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*Per OTA Report to Congress, 1993

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Some Present Problems in the U.S. WMD Defense Capabilities

- No shelters (require overpressure, BW filtering, masks, showers, supplies)
- No stockpiled vaccines, medical supplies, immunoglobulins, masks, suits, food, fuel, generators, heaters, water purification units
- Totally insufficient medical facilities, personnel, and emergency response teams
- Triage, full martial law will be required
- No answer to massive decontamination problem
- State, county, city inadequately staffed and insufficiently trained for mass casualties
- Terrorist teams, BW agents, other WMD on site, waiting
- Water supplies, food, crops, farm animals also vulnerable
- Electric power grid, bridges, trains, railroads vulnerable
- Present medical science cannot save very many of the casualties, now or in the foreseeable future

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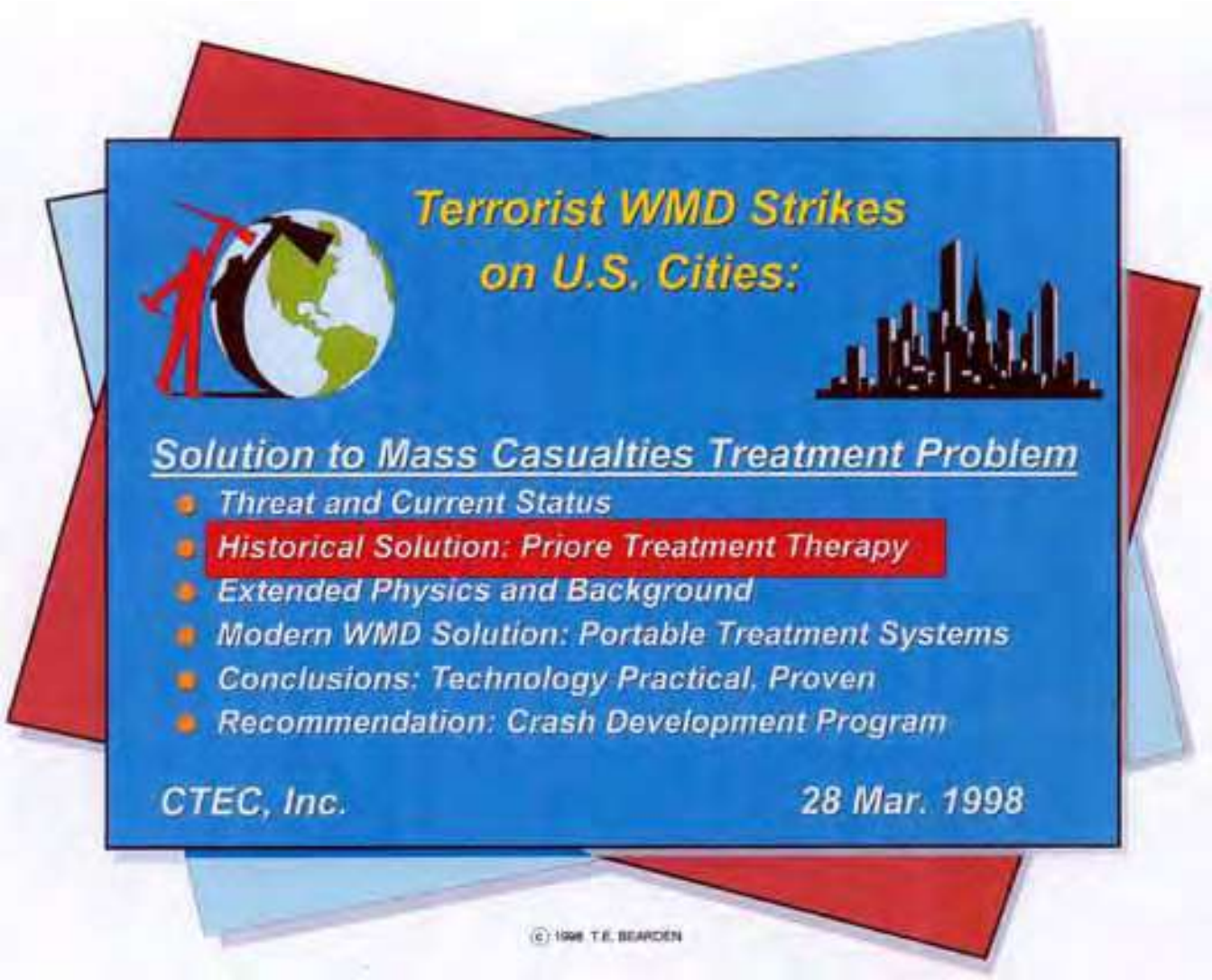

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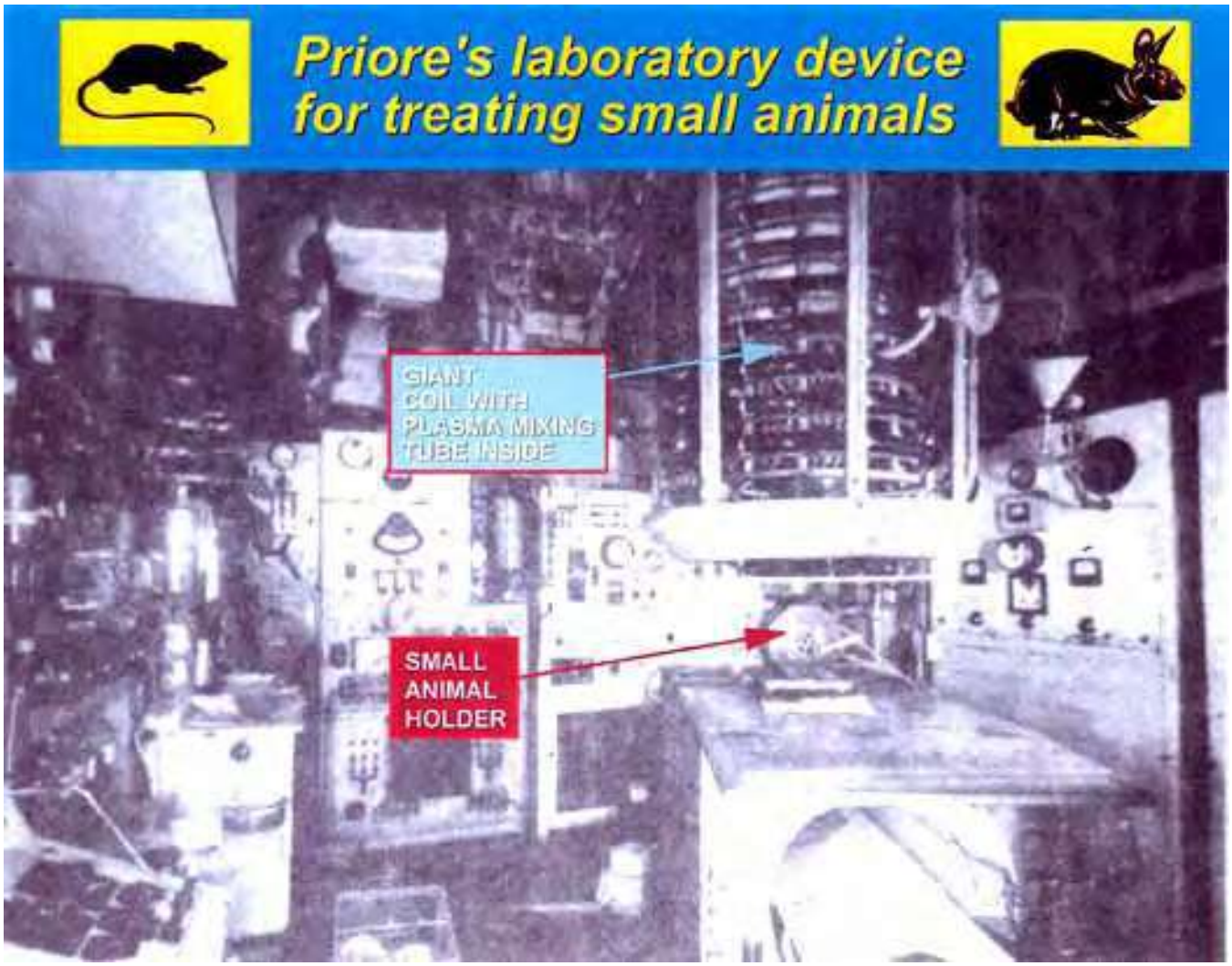

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Photo courtesy of Bob Whitney

Antoine Priore (right) with the Mayor of Bordeaux, Mr. Chaban-Delmas.

The Priore technical mechanism unwittingly involved a dramatic extension to both nonlinear optics and general relativity. However, nonlinear optics itself had not yet been born in the 1950s and 1960s when Priore worked out his methodology. The extension to general relativity has not been previously envisioned even to the present day. When the Priore project was suppressed by the changed French government in the mid-1970s, nonlinear optics itself was just being initiated. To the present day, however, there has previously been no inkling of the dramatic extension to NLO that arises by using longitudinal EM pump waves and thereby pumping in the time domain.

It is little wonder that Priore himself did not understand the nature of the technical mechanism he was utilizing, and neither did anyone else, and neither *has* anyone else prior to this time.

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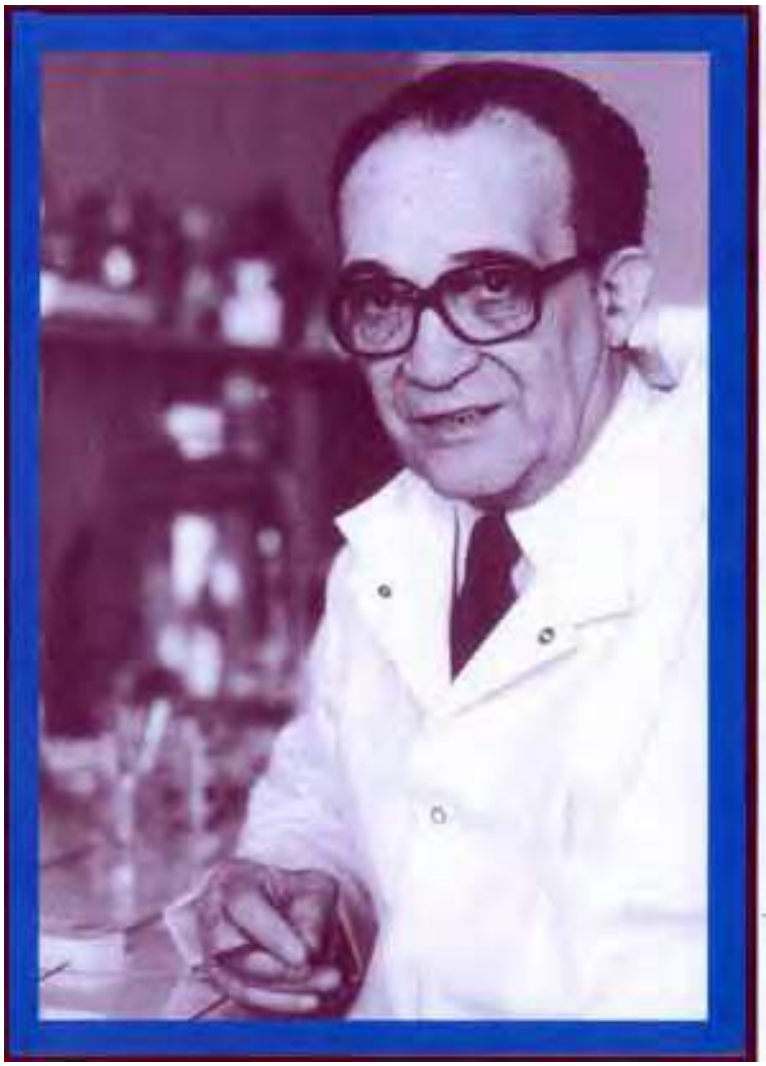

Raymond Pautrizel, eminent French parasitologist who worked with Priore

Among other things, Pautrizel treated seriously infected immature rats with the Priore ray. These rats had never had a mature immune system. When they were removed from the machine, they still sickened again and died, because their immature immune systems could not resist the pathogen *(Trypanosoma)*. So even though the damaged cells were reversed back to normal, the "normal" immune system was unable to fight off pathogens, which reinfected the cells and killed them, killing the rats.

This established the time-reversal nature of the therapy.

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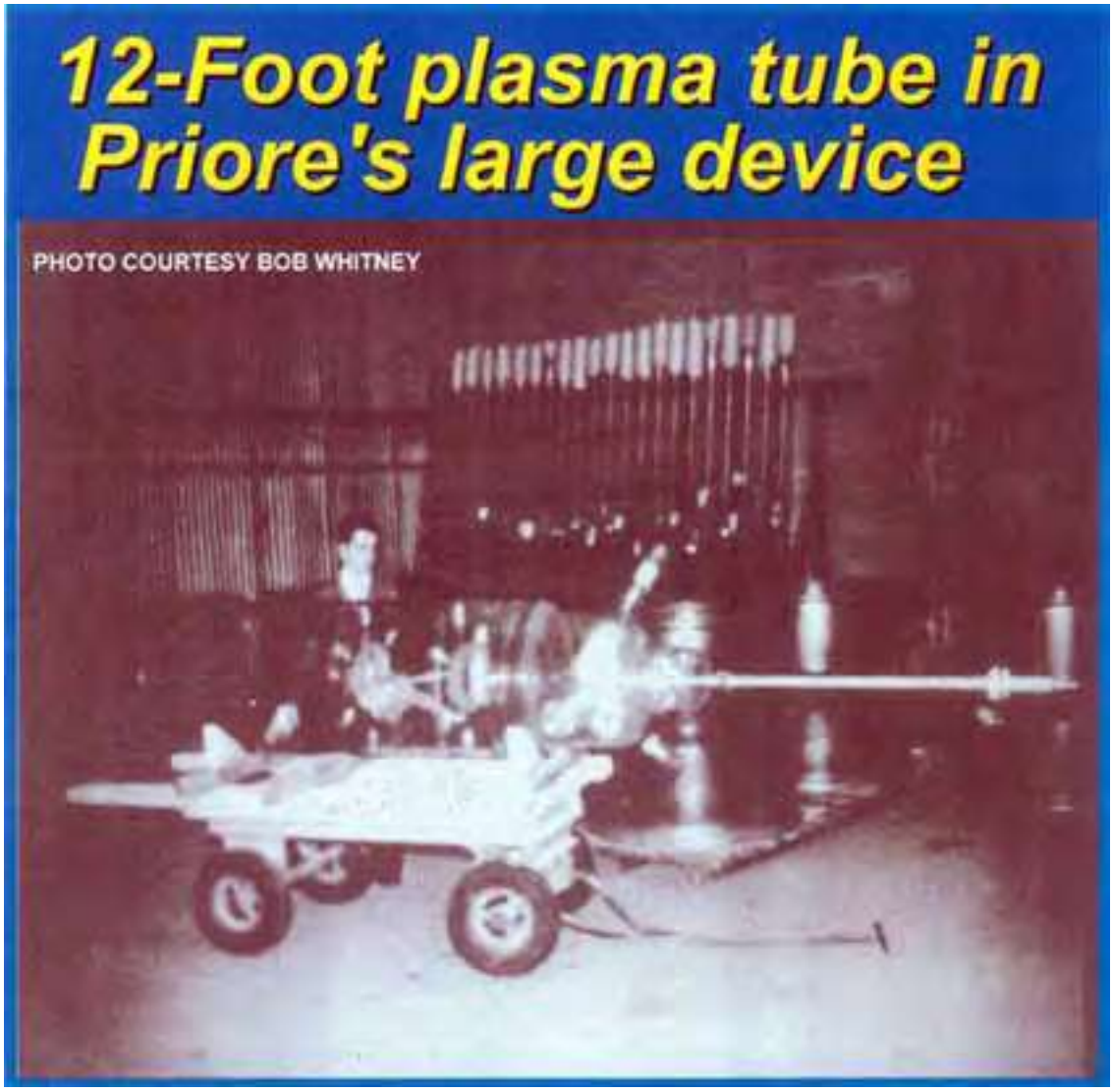

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MECHANISM OF THE PRIORE THERAPY

- FACT: DISEASE-SPECIFIC VACUUM ENGINE PRESENT FOR ANY CELLULAR DISEASE, BY WHEELER'S PRINCIPLE
  - *DISEASE CAN BE REVERSED BY CREATING AMPLIFIED VACUUM ANTI-ENGINE (BEARDEN'S PRINCIPLE)*
  - *ANTI-ENGINE IS CREATED BY PUMPING THE NONLINEAR CELLS IN THE "INNER EM" DOMAIN, TIME-REVERSING THEM*

- PRIORE UTILIZED A PLASMA TO PHASE CONJUGATE AND "INFOLD" MULTIPLE BIDIRECTIONAL LONGITUDINAL EM PUMP WAVES
  - *17 FREQUENCIES MIXED IN A ROTATING PLASMA*
  - *PHASE CONJUGATES ADDED BY THE PLASMA*
  - *INFOLDED MIX INTO STRONG PULSED DC MAGNETIC FIELD, WHICH CARRIED IT INTO ATOMIC NUCLEI*
  - *PUMPED ALL NONLINEAR CELLULAR COMPONENTS TO PRODUCE AMPLIFIED, SPECIFIC VACUUM ANTI-ENGINE*

- NEGATED THE LONG-TERM CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CELLS.
- SCRUBBED OUT THE CUMULATED PRECANCEROUS STATE
- RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING
- NO EXCESSIVE TRAUMA TO TREATED ANIMAL

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Priore's therapeutic methodology: Using infolded longitudinal EM waves as NLO pump waves, to pump in the time domain

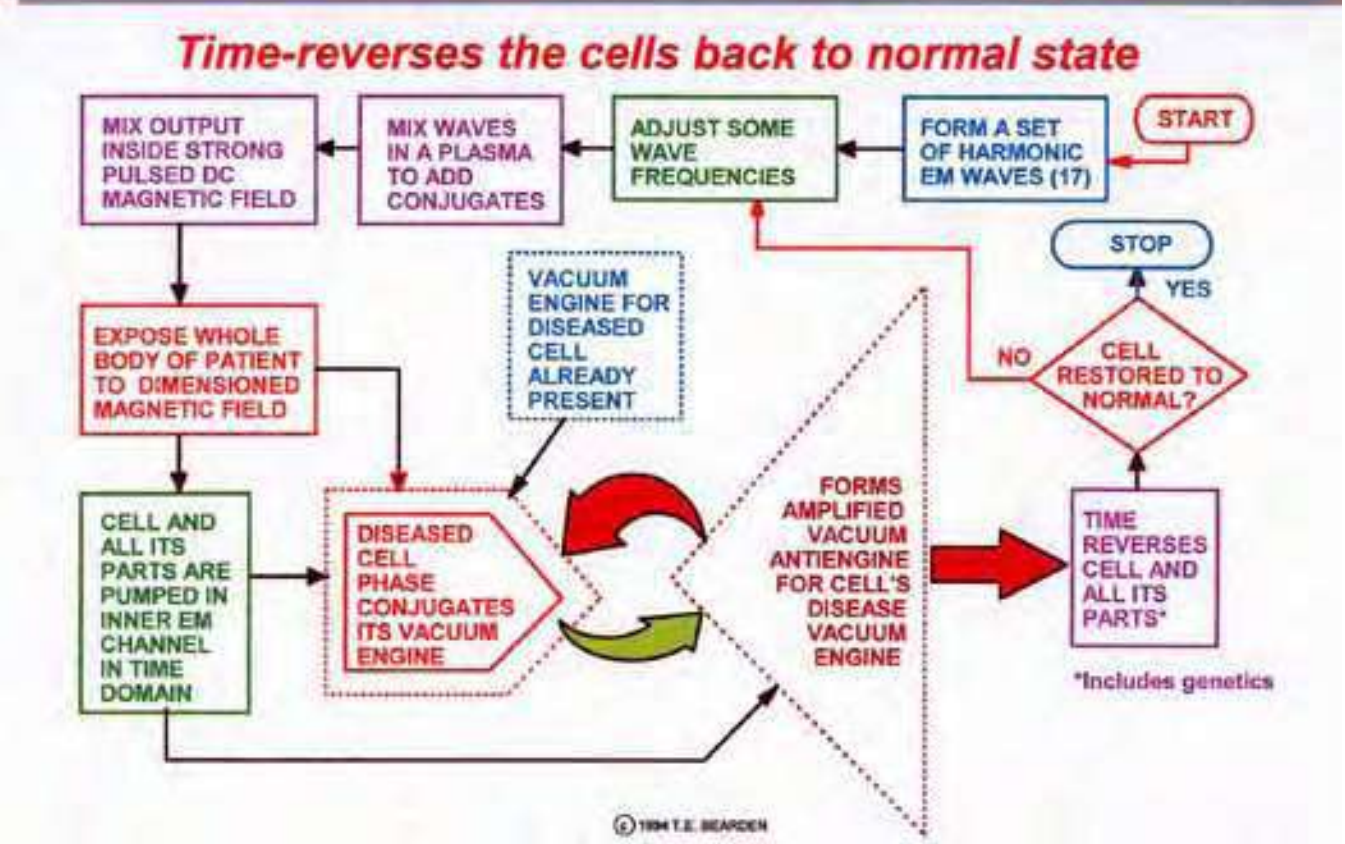

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DRASTICALLY REDUCED CUMULATIVE DETERIORATION AFTER PRIORE THERAPY

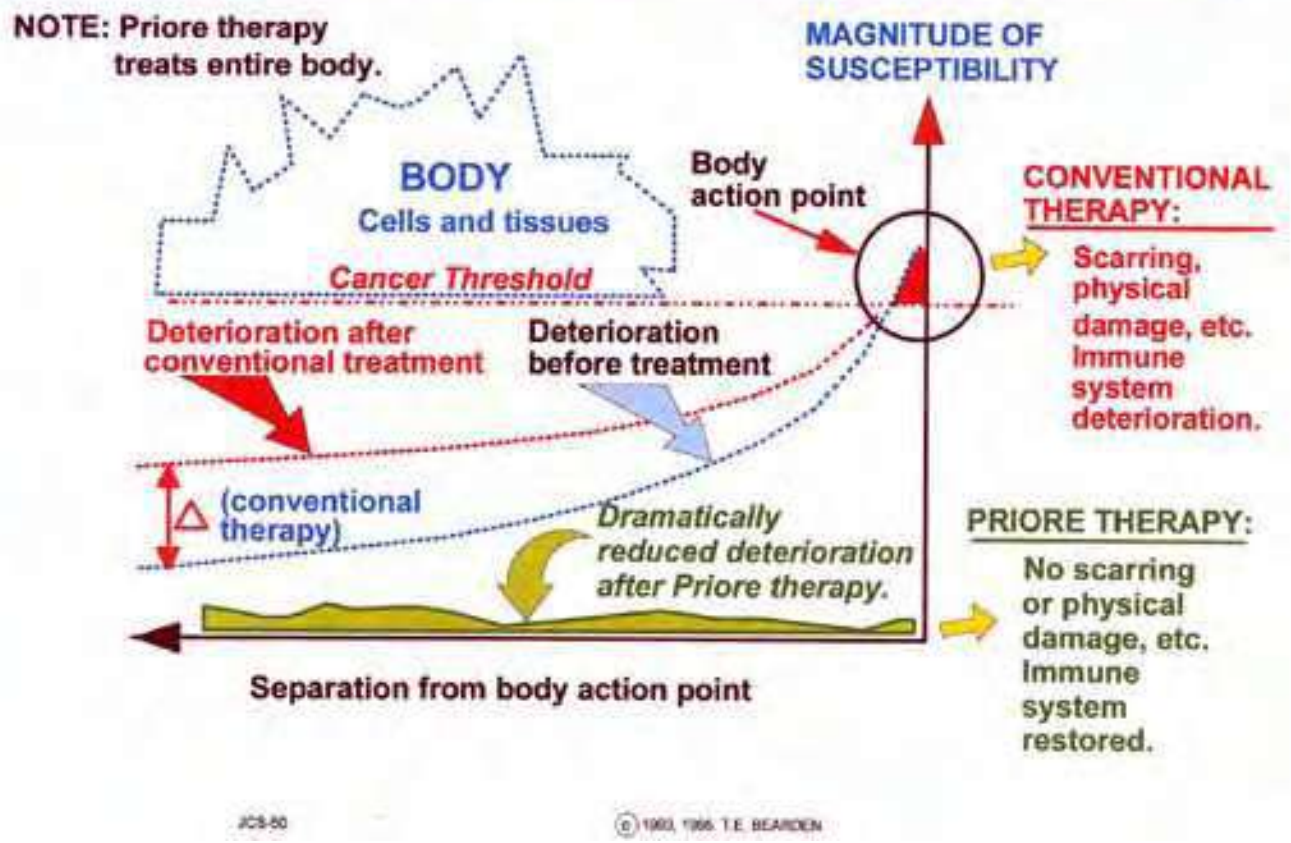

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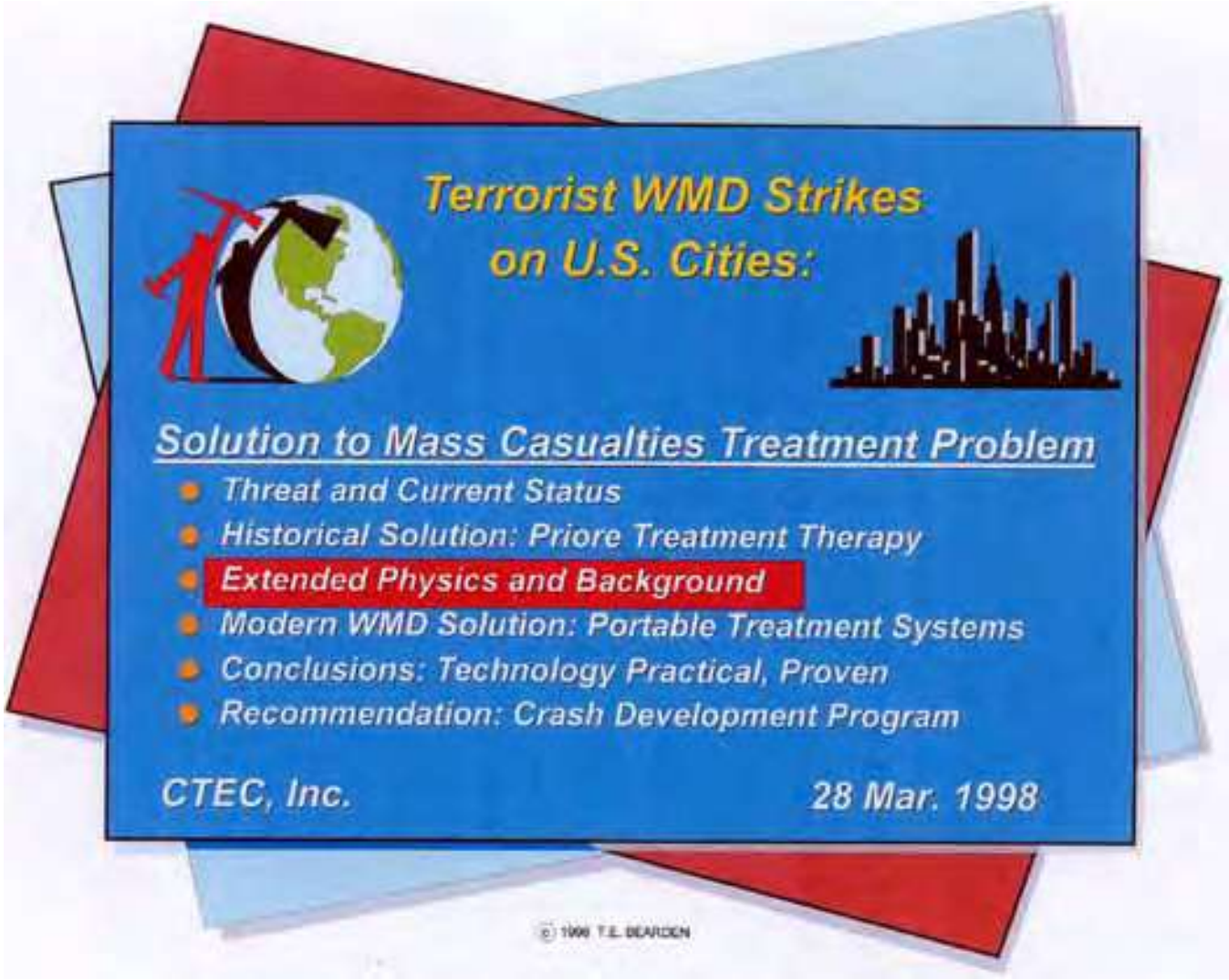

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Founders of Scalar Electromagnetics

- **G.J. Stoney:**

Decomposed the scalar potential into bidirectional wave pairs.

"On a supposed proof of a theorem in wave-motion," Phil. Mag., 5(43), 1897, p. 368-373 (and several other papers).

- **E.T. Whittaker:**

Decomposed the scalar potential into a series of bidirectional EM wave pairs in harmonic series, where the two waves in each pair are conjugates (i.e., a wave/antiwave pair) and are longitudinal waves.

"On the partial differential equations of mathematical physics," Math. Ann., Vol. 57, 1903, p. 333-355.

Showed that all classical EM -- including waves -- can be replaced by two interfering scalar potential functions.. (This founded superpotential theory, extended by Nisbet, Bromwich, Debye, McCrea, and others.)

"On an expression of the electromagnetic field due to electrons by means of two scalar potential functions," Proc. Lond. Math. Soc., Series 2, Vol. 1, 1904, p. 367-372.

- **R.W. Ziolkowski:**

Independently rediscovered the biwave decomposition of the scalar potential and added the product set (in theory enabling modulations and communications) to Stoney and Whittaker's sum set.

Various papers, 1985 to date.

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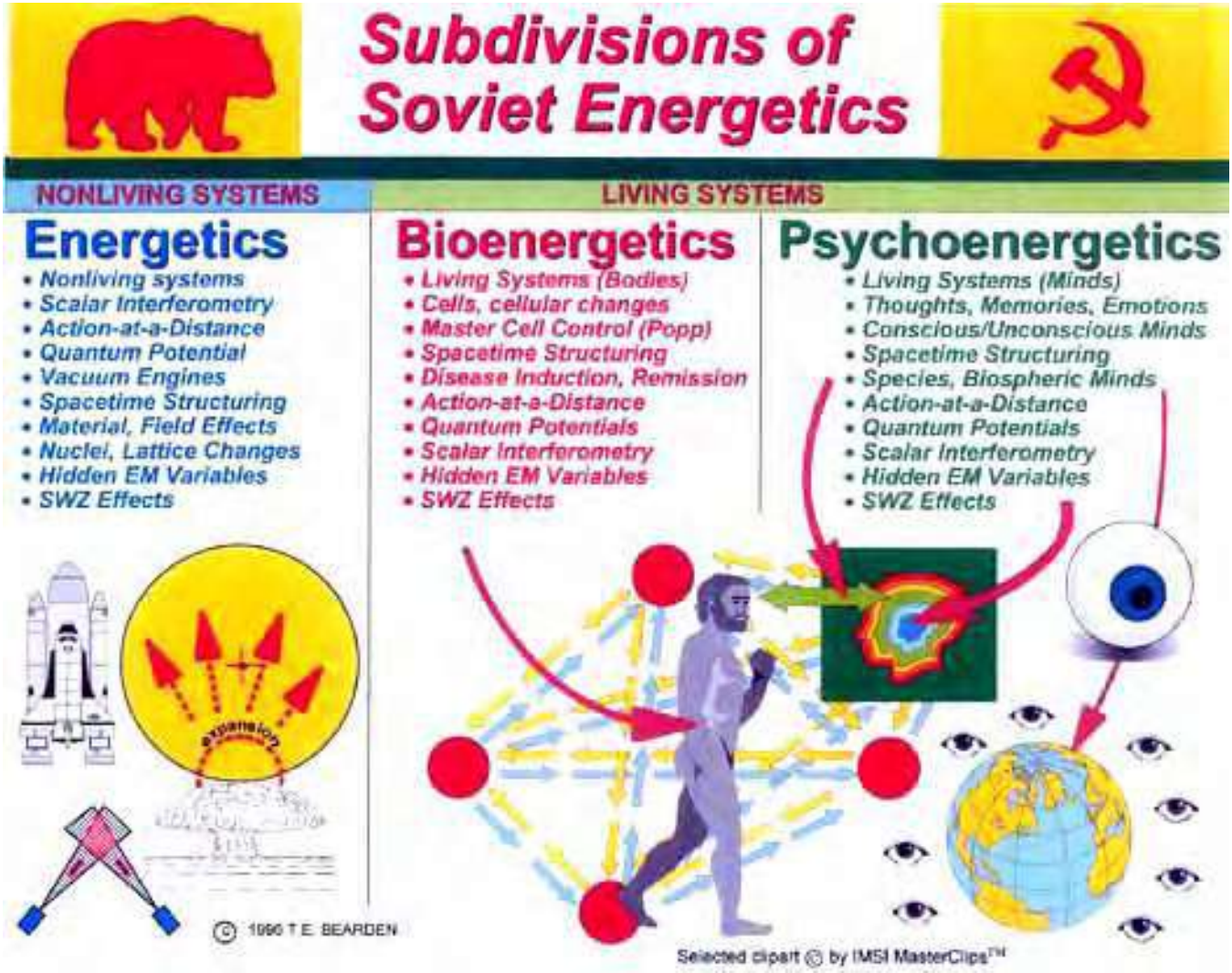

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Bunge on the Status of Classical and Quantum Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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EINSTEIN ON REVIEWING FOUNDATIONS

"...the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools of thought, as something obviously, immutably given; something having an objective value of truth which is hardly even, and in any case not seriously, to be doubted. ...in the interests of science it is necessary over and over again to engage in the critique of these fundamental concepts, in order that we may not unconsciously be ruled by them."

Albert Einstein, "Foreword," in Max Jammer, Concepts of Space: The History of the Theories of Space in Physics, Harvard University Press, Cambridge, Massachusetts, 1969, p. xi-xii.

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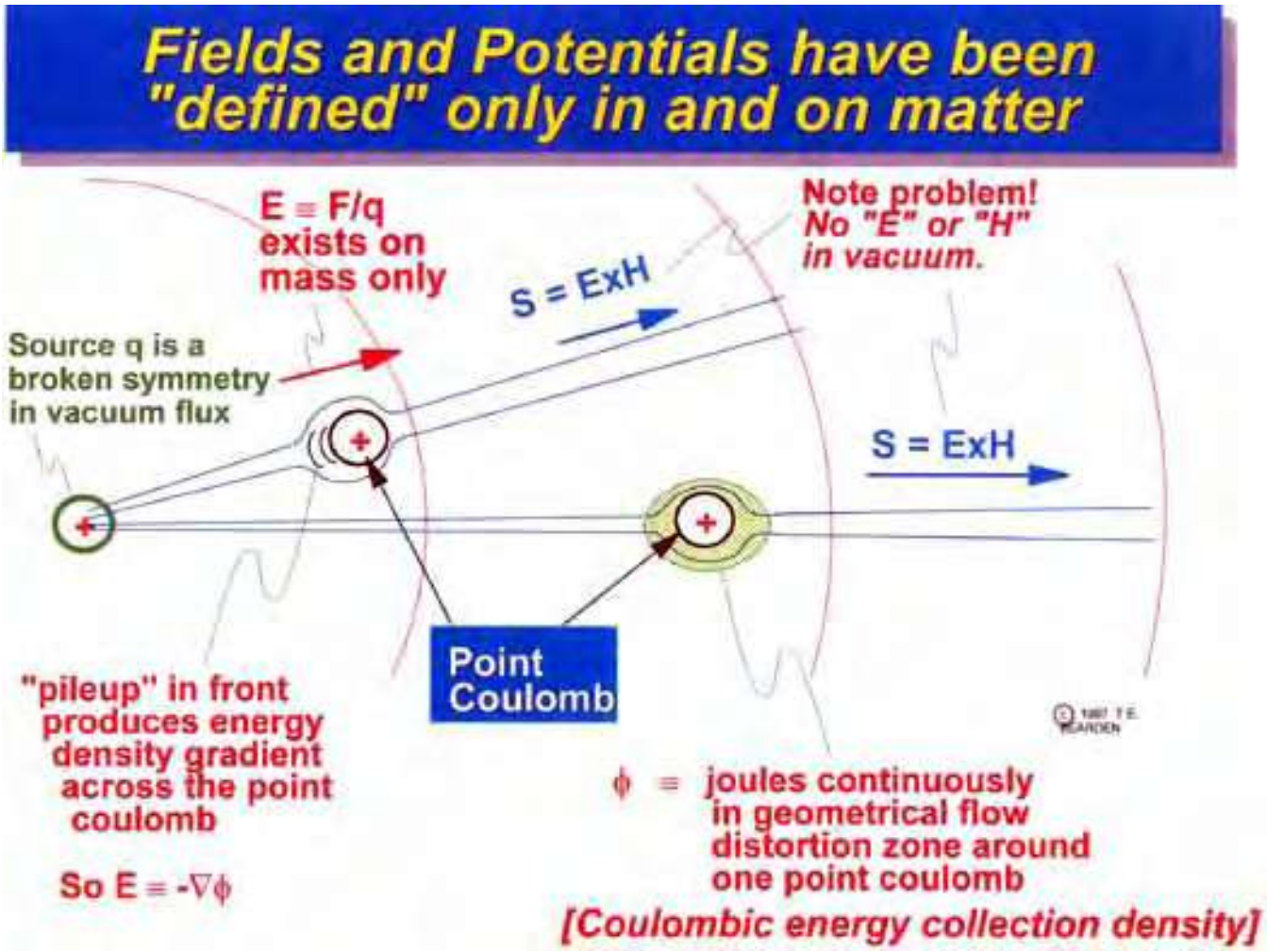

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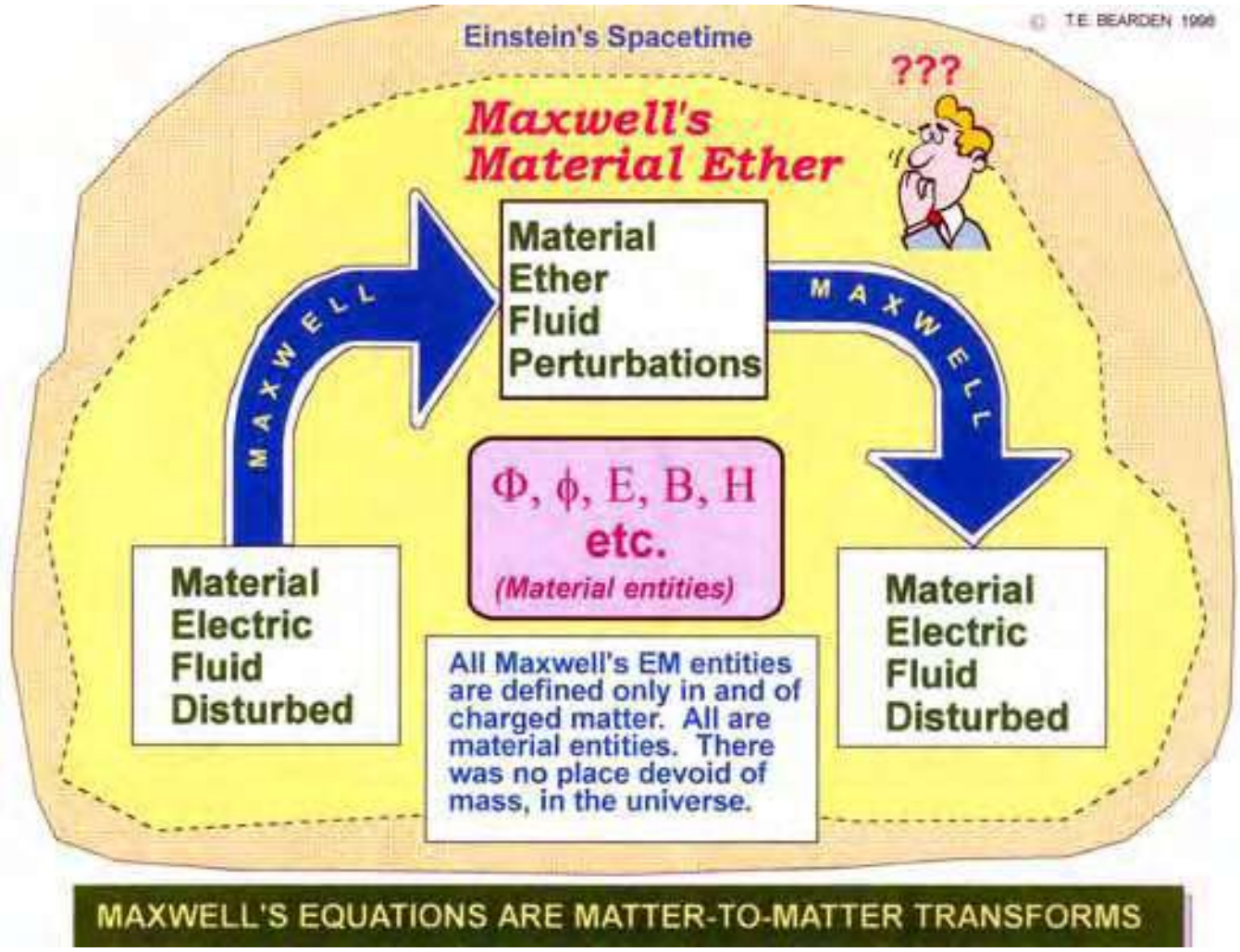

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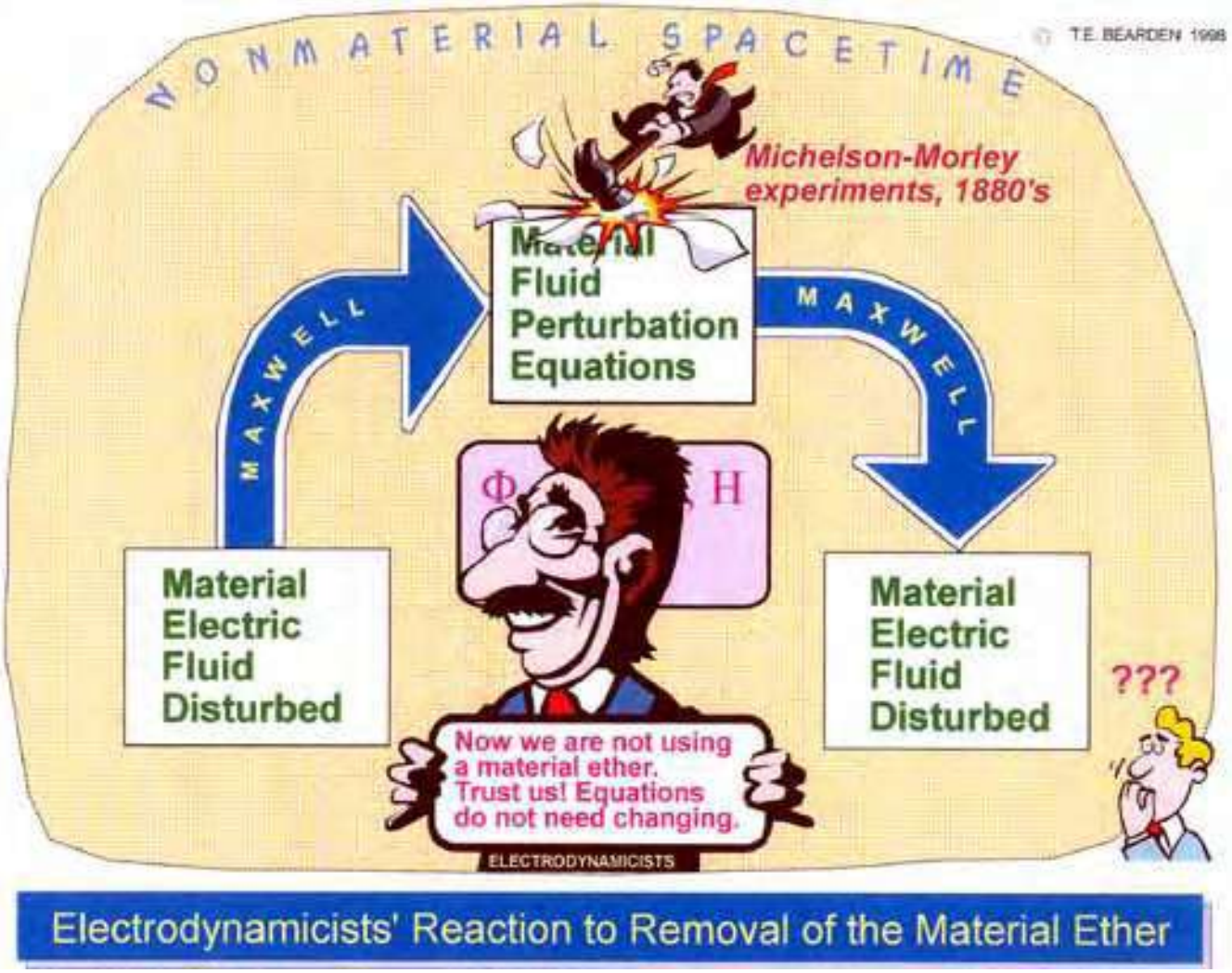

Electrodynamicists' Reaction to Removal of the Material Ether

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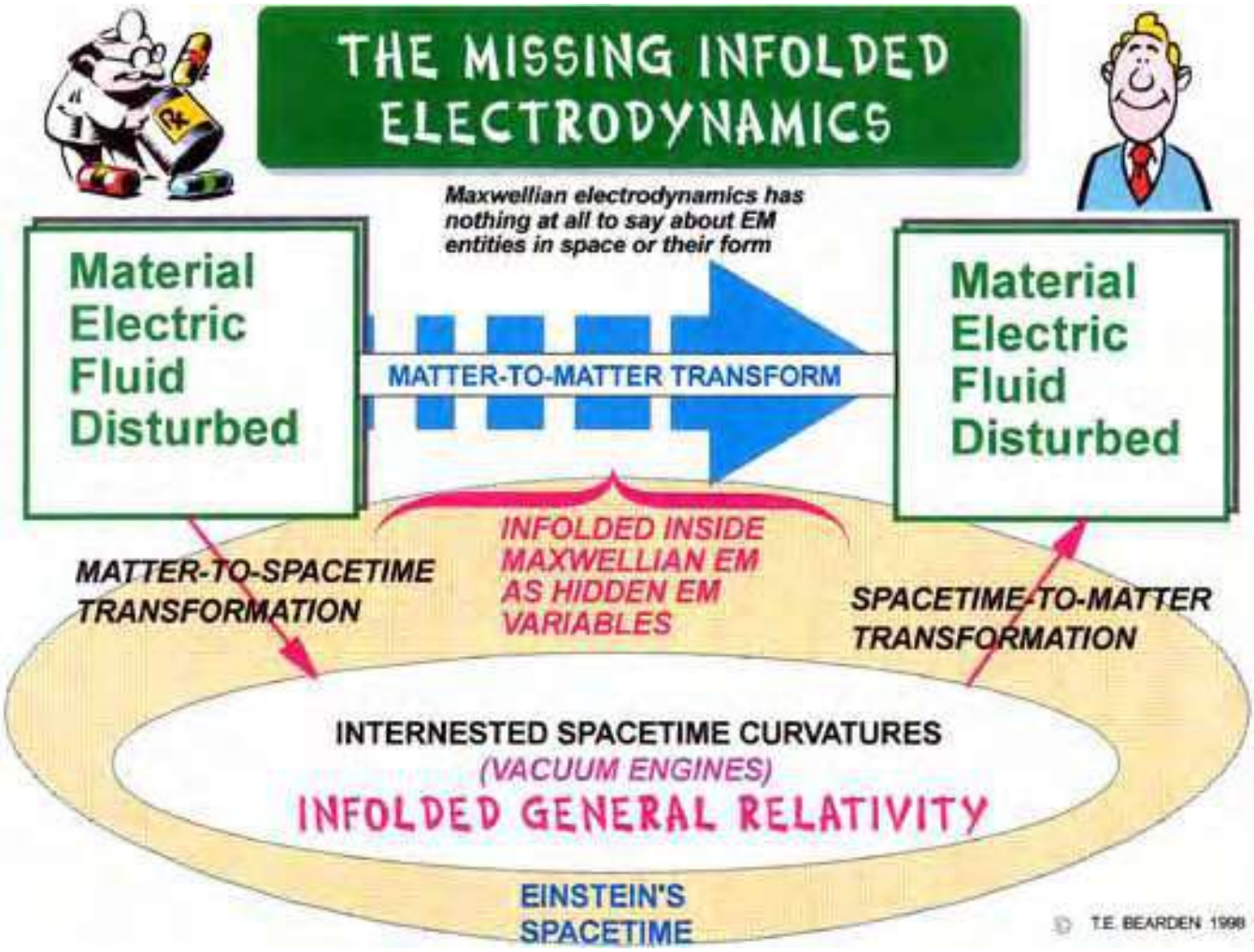

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Nonlinear Optics
Distortion Correction Theorem

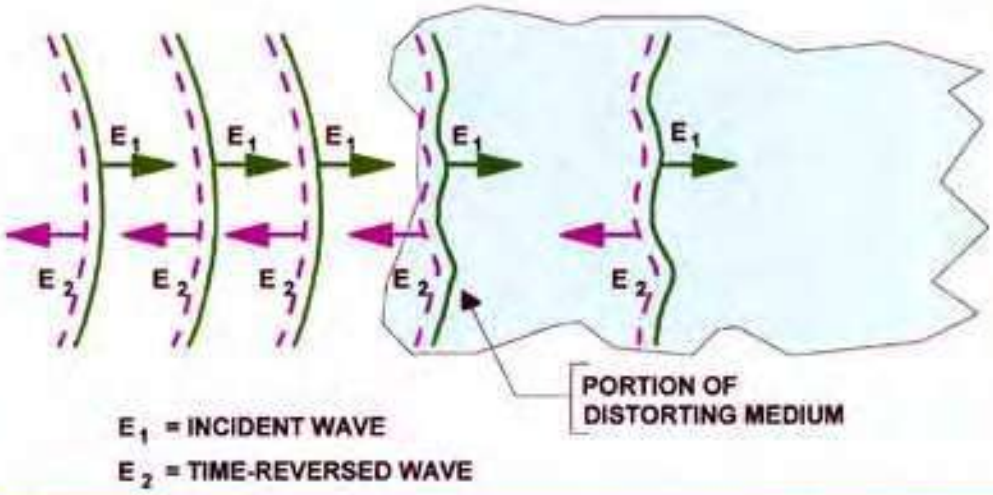

"If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

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Infolded longitudinal EM biwave composition of a scalar potential

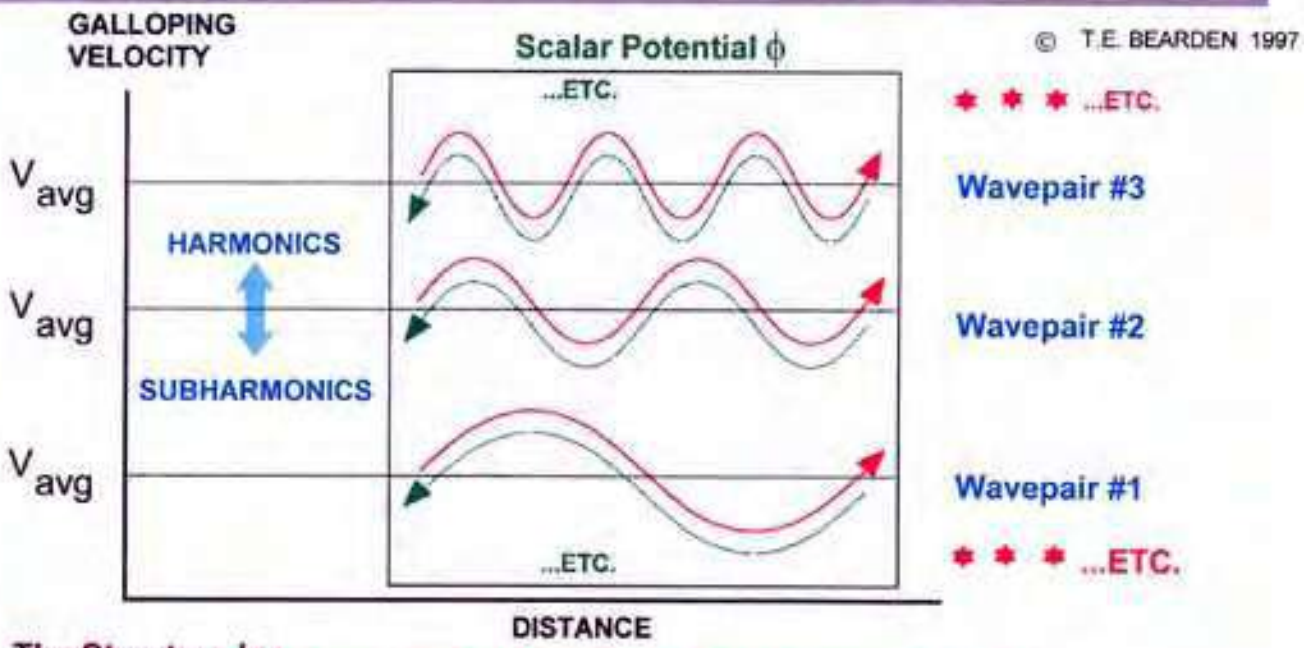

The Structure Is:

A harmonic set of longitudinal EM wavepairs. In each wavepair the two waves superpose spatially, but travel in opposite directions. The two are phase conjugates and time-reversed replicas of each other. Thus they comprise a coupled longitudinal wave and antiwave. The photons must be coupled into photon/antiphoton pairs (gravitons) by a strong application of the distortion correction theorem of nonlinear optics. Each wave in the biwave pair is a galloping wave. Each wavepair is a standing electrogravitational wave. In nonlinear optics, such a wavepair is a pump wave which pumps in the time domain.

Note: Think of the oscillations as velocity modulations.

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The Zero-Vector Axiom Destroys "Topologies within Topologies"

- The axiom: There is a unique vector, $\overline{0}$, in V (the vector space) such that
  $$\overline{V} + \overline{0} = \overline{0} + \overline{V}$$
- Note that $\overline{V} + \overline{0}_i = \overline{0}_j + \overline{V}$; $\overline{0}_i = -\overline{0}_i = n\overline{0}_i$
  so $\overline{0}_i = \overline{0}_j = \overline{0}_k = \ldots + \overline{0}_n = \ldots$
- This makes all $\overline{0}_i$ equal by assumption, since there is *assumed* to be only a single type $\overline{0}$ without real components
- In fact, $\overline{0}$ is <u>*not unique*</u>. An *infinite number* of different zero-vector systems, with real components, satisfy the zero-vector axiom.

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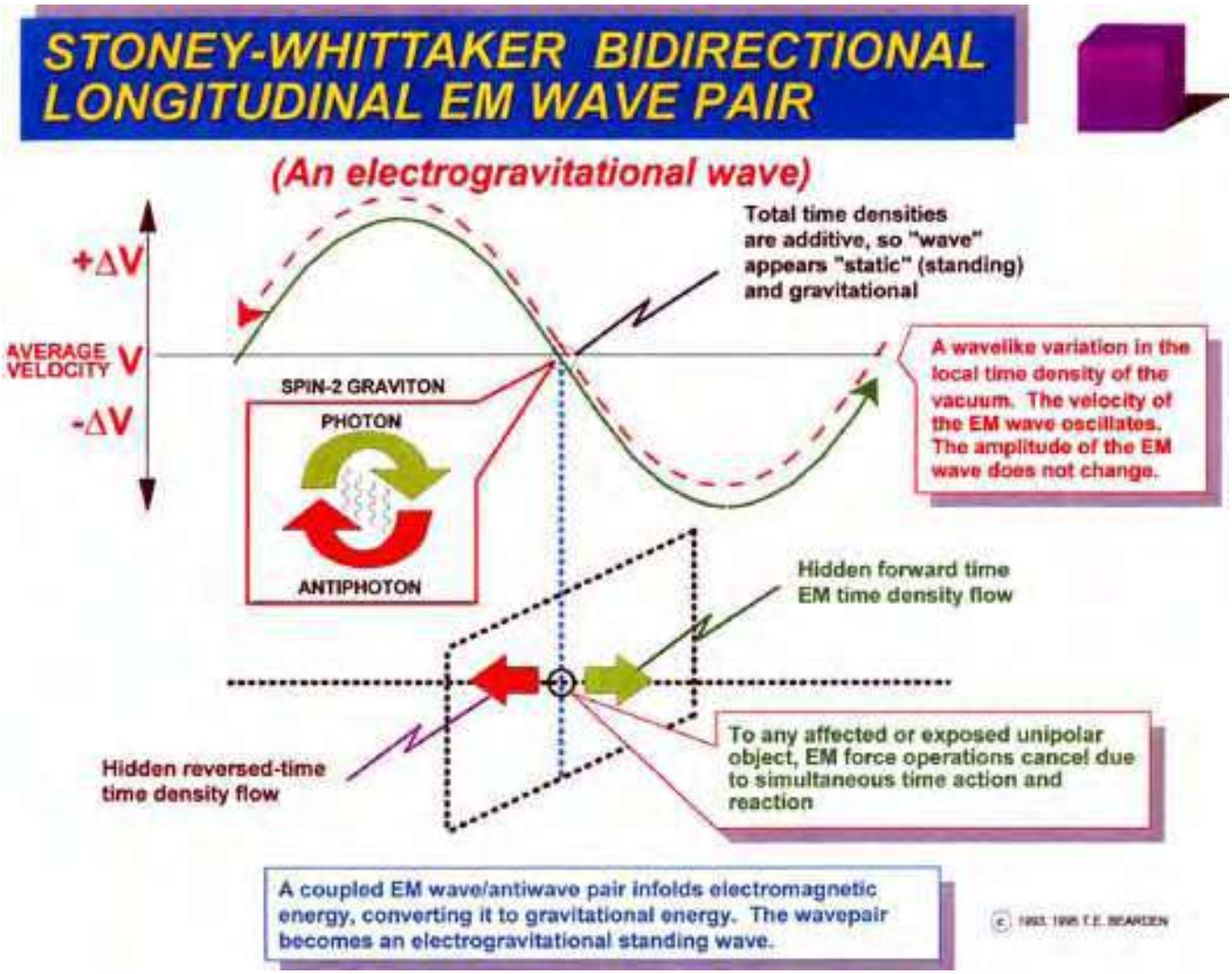

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Undistorted Progressive Waves (UPWs)*

(waves with velocity v, where $0 \leq v \leq \infty$)

- Major equations of interest having UPW solutions are:
  - *Homogeneous wave equation*
  - *Maxwell equations*
  - *Dirac, Weyl, and Klein-Gordon equations*

*Rodrigues and Lu, *Found. Phys.* 27(3), 1997, p. 435-508.

- UPWs are translationally invariant, and do not spread, or they reconstruct their original form after a certain period.
- UPW solutions have infinite energy. Quasi-UPWs can have finite energy and can in principle be launched into space.
- Subluminal Maxwell solutions are called *EM particles*. Superluminal Maxwell solutions are called *X-waves*.
- *Experimental results indicate such waves will be produced within the next few years.*

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- *Nimtz has translated Mozart's 40th symphony at v = 4.7c.*

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Velocity modulating a longitudinal EM wave oscillates rate of flow of time

$$V = \frac{L}{t}$$

Observer sees it this way

Constant transverse wave magnitude

Wave oscillates its velocity along its path, about a nominal value

Wave oscillates this way

Constant transverse magnitude

Wave oscillates magnitude of its transported t, about a nominal value

Note:

- Waves consist of photons
- Each photon consists of energy x time
- Each photon carries time as well as energy
- A wave is both a spatial energy dynamics and a temporal dynamics
- Wave complexes carry dynamic time structures as well as dynamic energy structures

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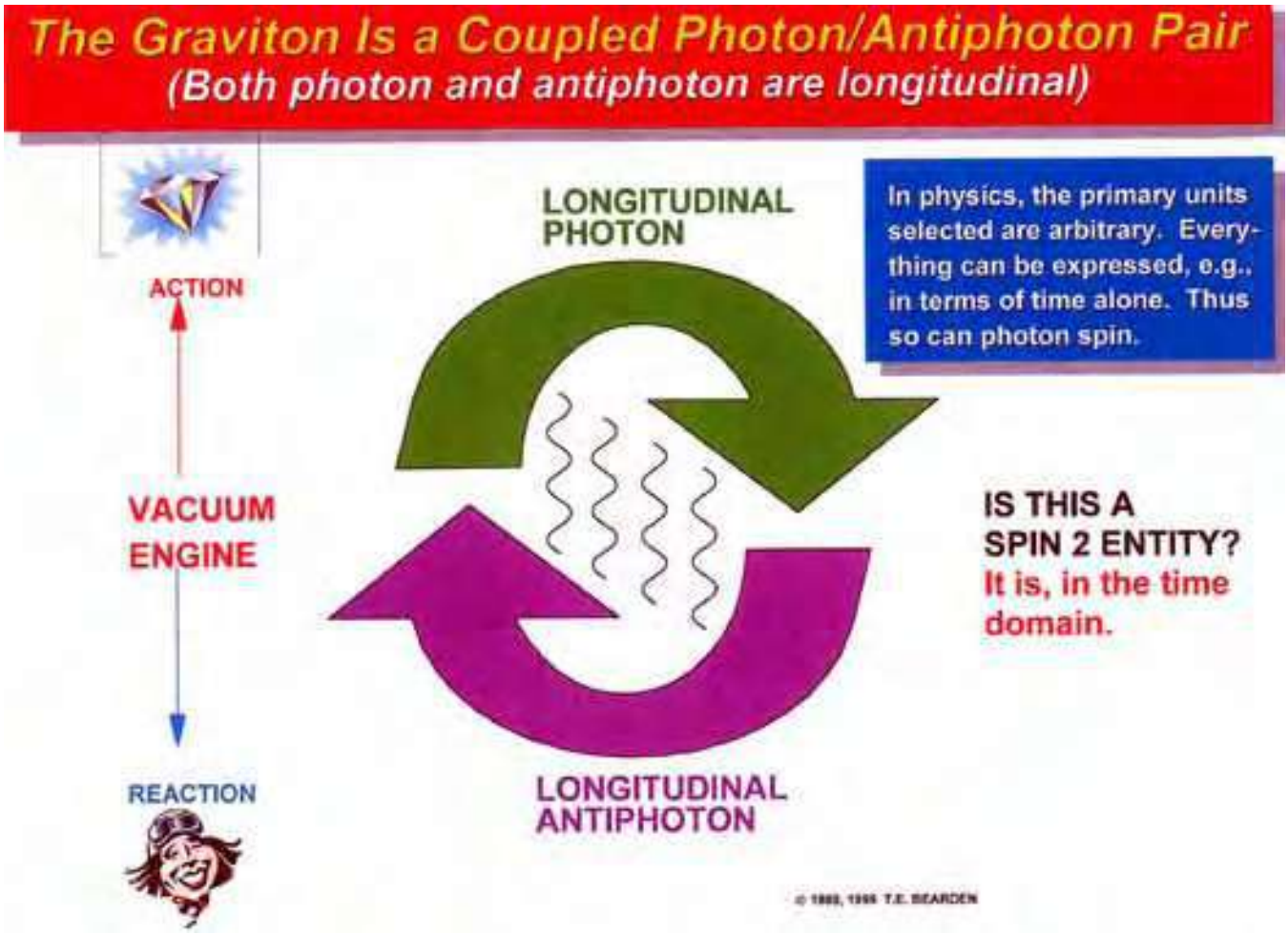

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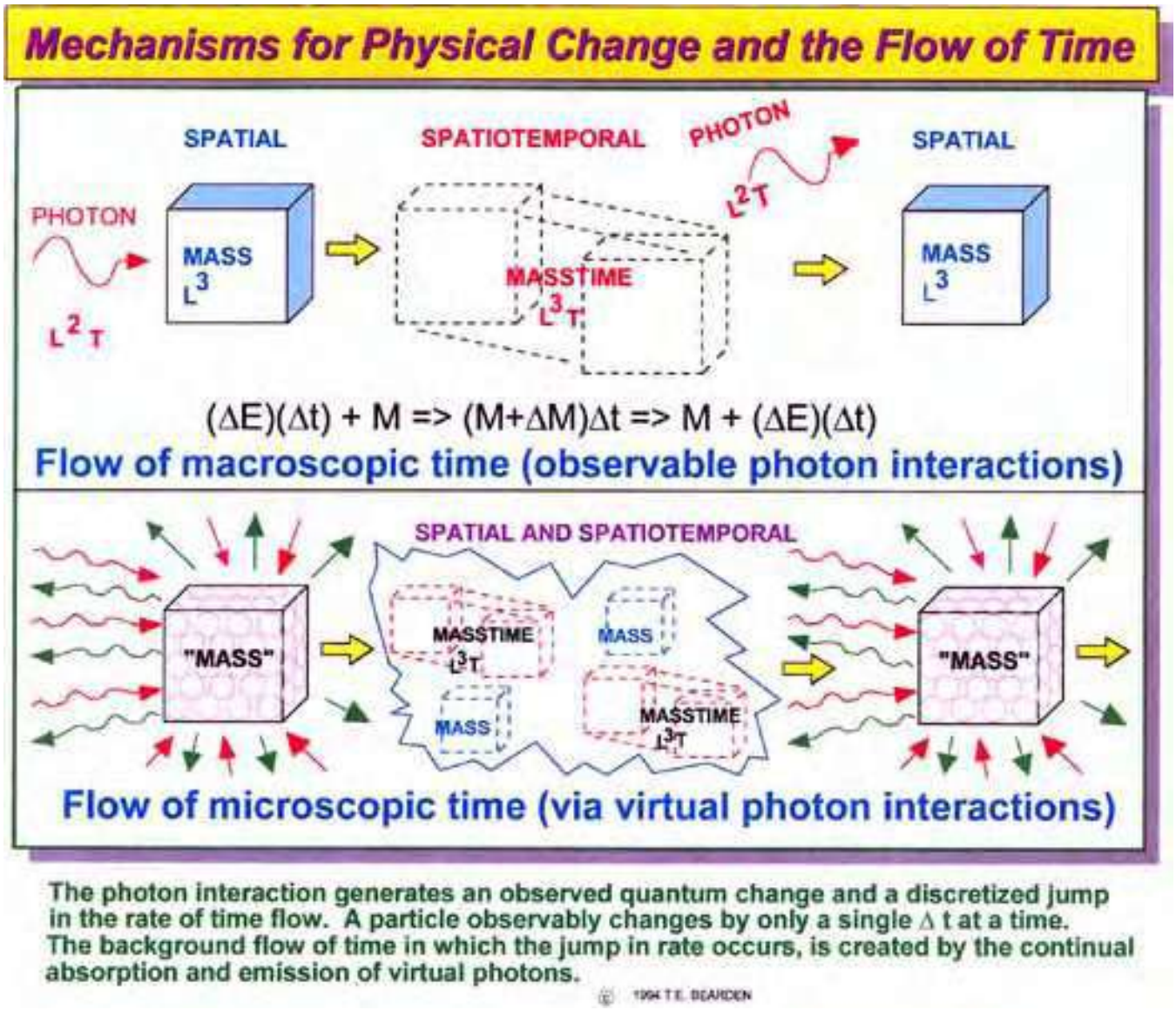

The photon interaction generates an observed quantum change and a discretized jump in the rate of time flow. A particle observably changes by only a single Δ t at a time. The background flow of time in which the jump in rate occurs, is created by the continual absorption and emission of virtual photons.

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Any EM Field or Wave Pattern Is Produced by interference of Two Scalar Potential Functions *(E.T. Whittaker, 1904)*

(Use of Hidden Information Content of the Field)

(Can Provide Action-at-a-Distance)

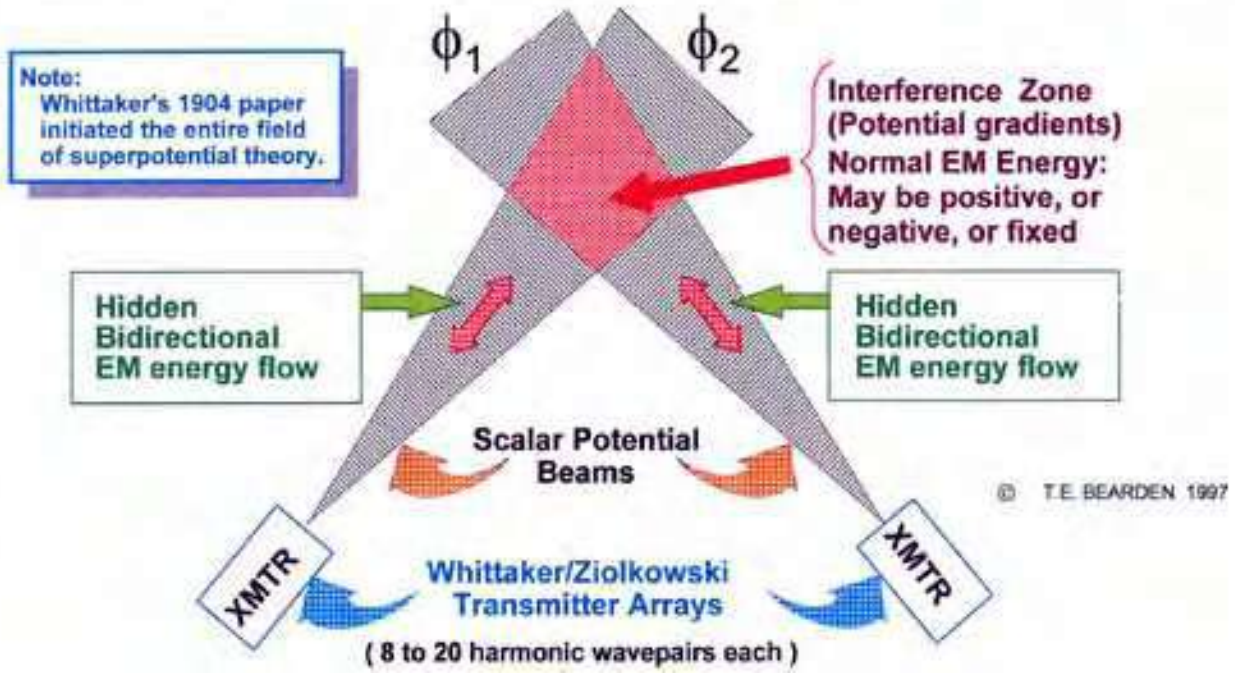

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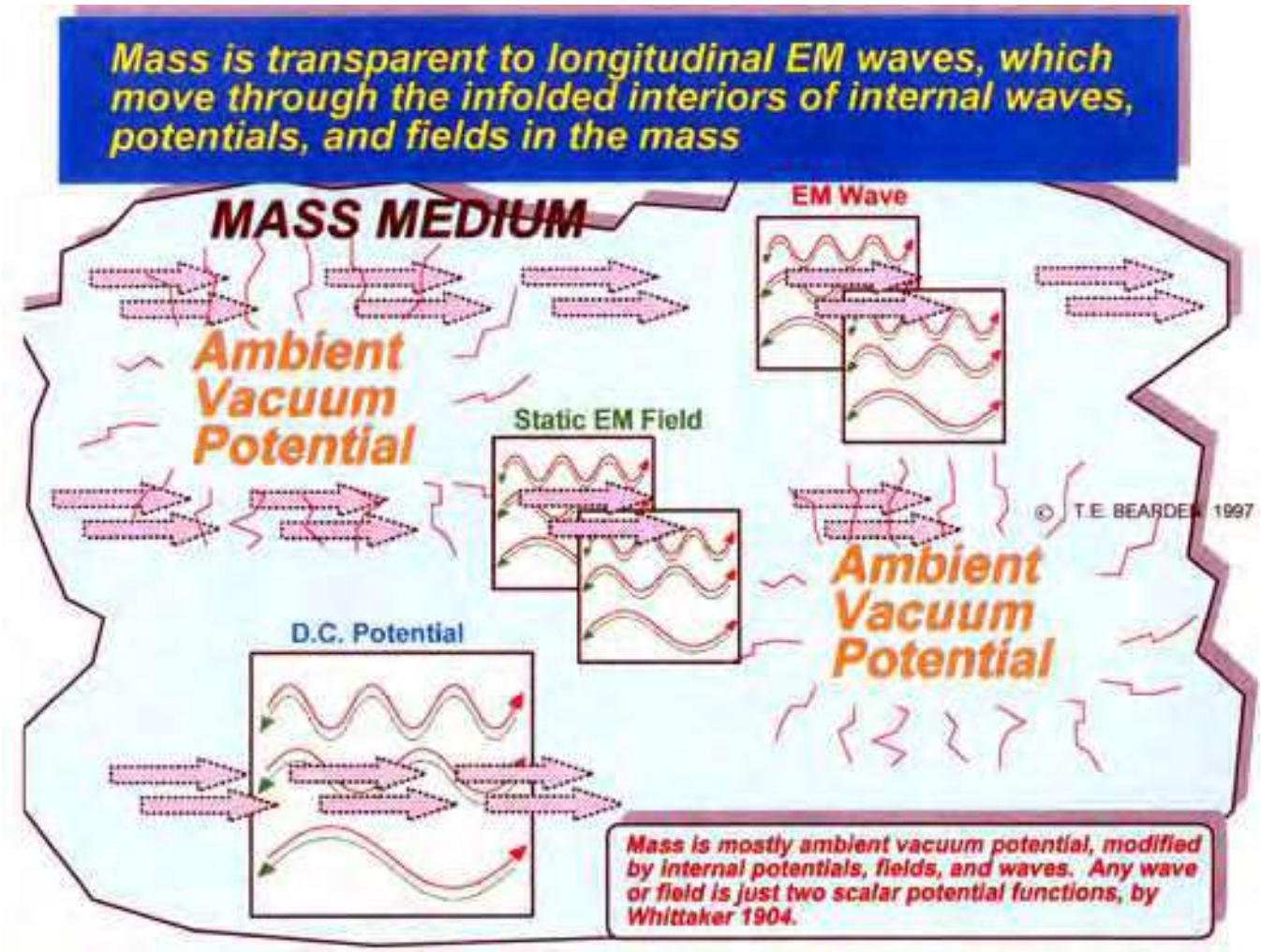

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Deep penetration of weak signals in a dense signal environment, by nonlinear retroreflection

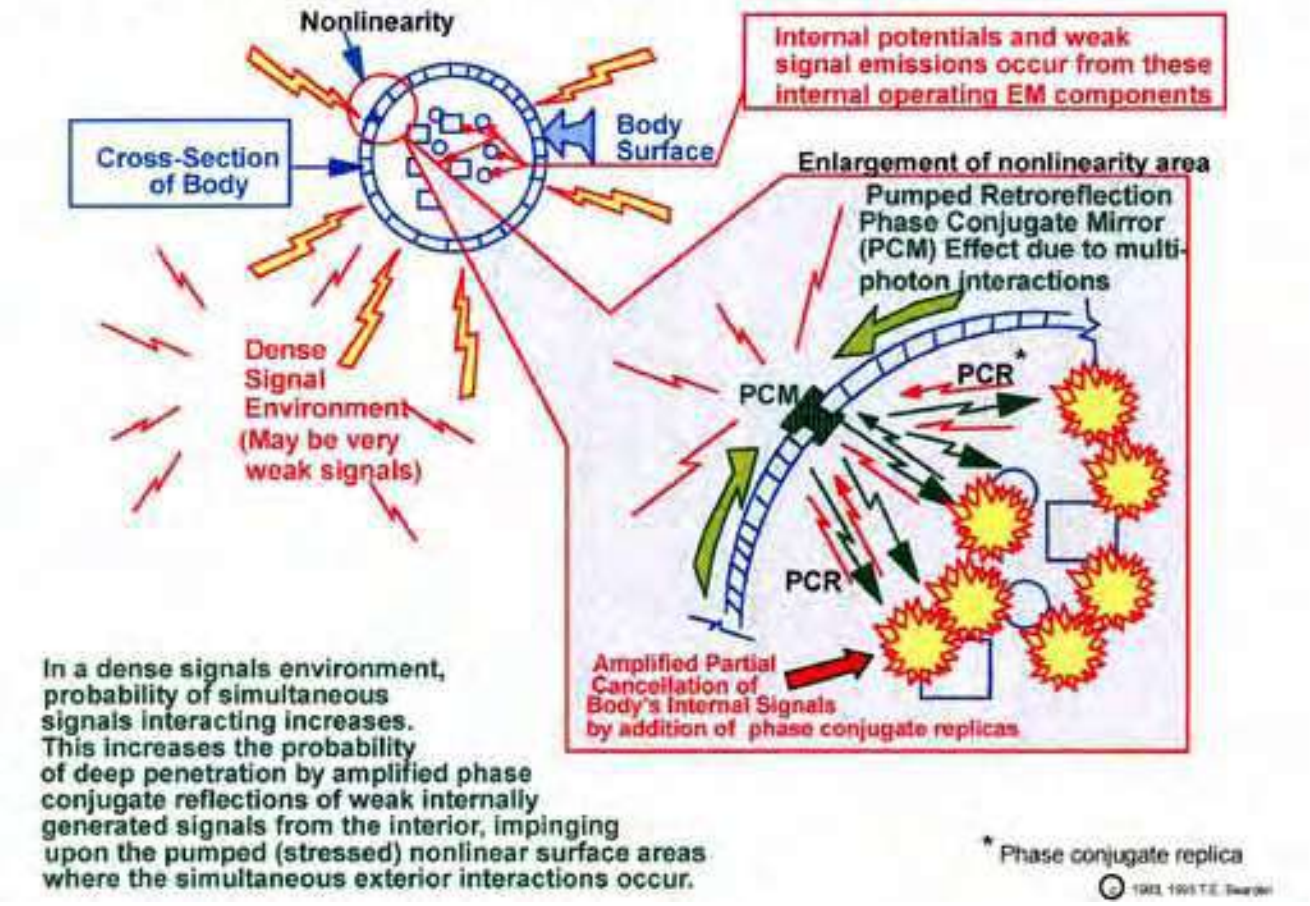

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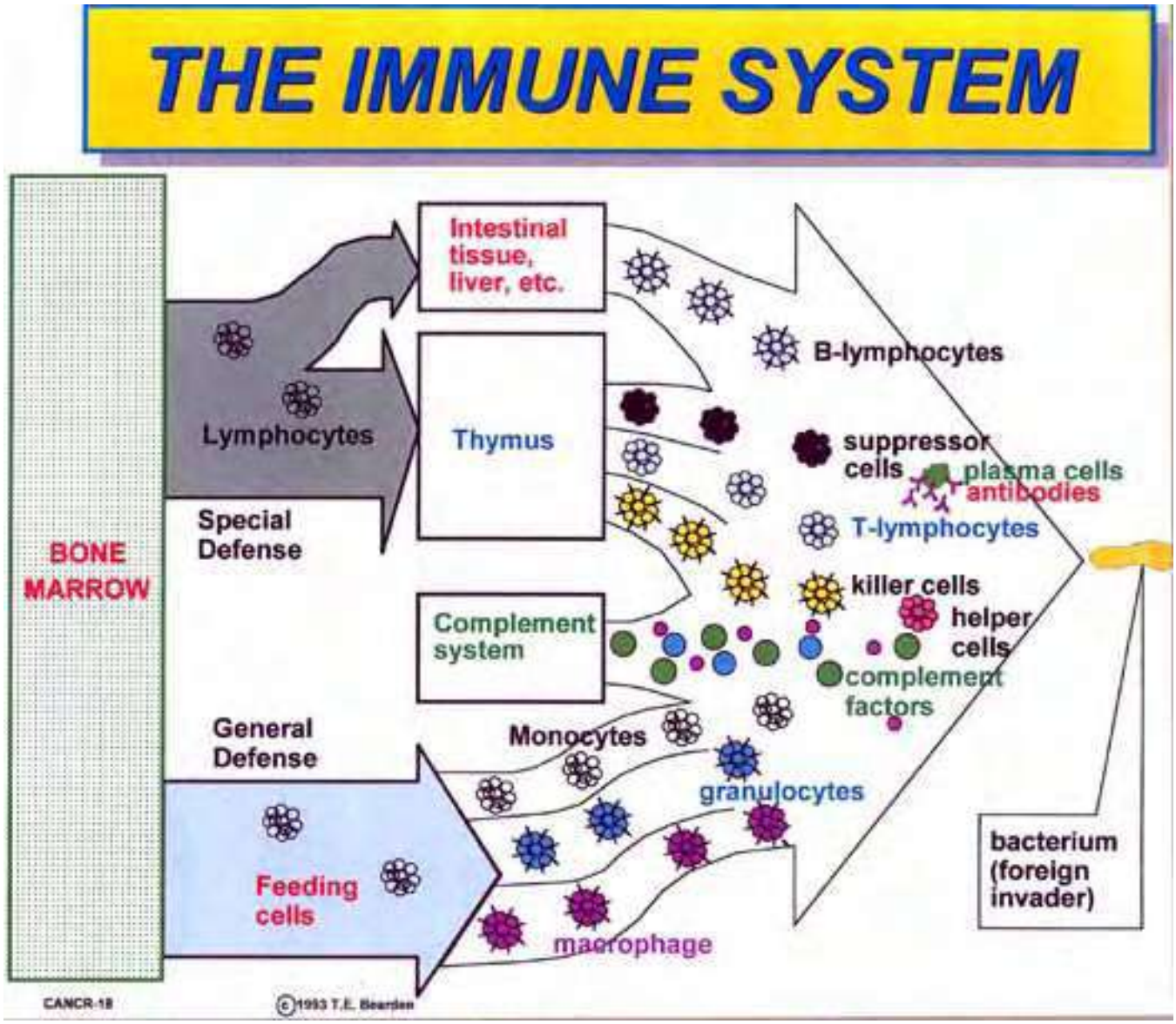

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Popp's master cellular control system

- Provides coherent, long-range interactions in biological systems
- Is an organized morphogenetic field at the basis of functional control

- Emission very sensitive to almost all external and internal influences
- Both spontaneous and delayed luminescence occur
- Photons stored in cell during the delay

- Leakage provides ultraweak, coherent biophoton emission from the system
- Fractional intensity pattern: few to some 100s of photons/cm^2/sec
- Optimum signal-to-noise ratio

- A single delayed biophoton may be able to trigger 10^{10} reactions in a cell before its release
- Spectrum almost continuous within optical range from 200-800 nm.

- Biophoton emission shows biological system always out of equilibrium
- Emission has holistic characteristics
- Correlations to most, if not all, of the biological functions of the organism

- DNA, all other processes are sources
- Single main process of whole system, different processes strongly coupled
- Information function and sync of biological clocks (oscillators)

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CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

**R&R system forces cell back toward anaerobe*

CANCR-26

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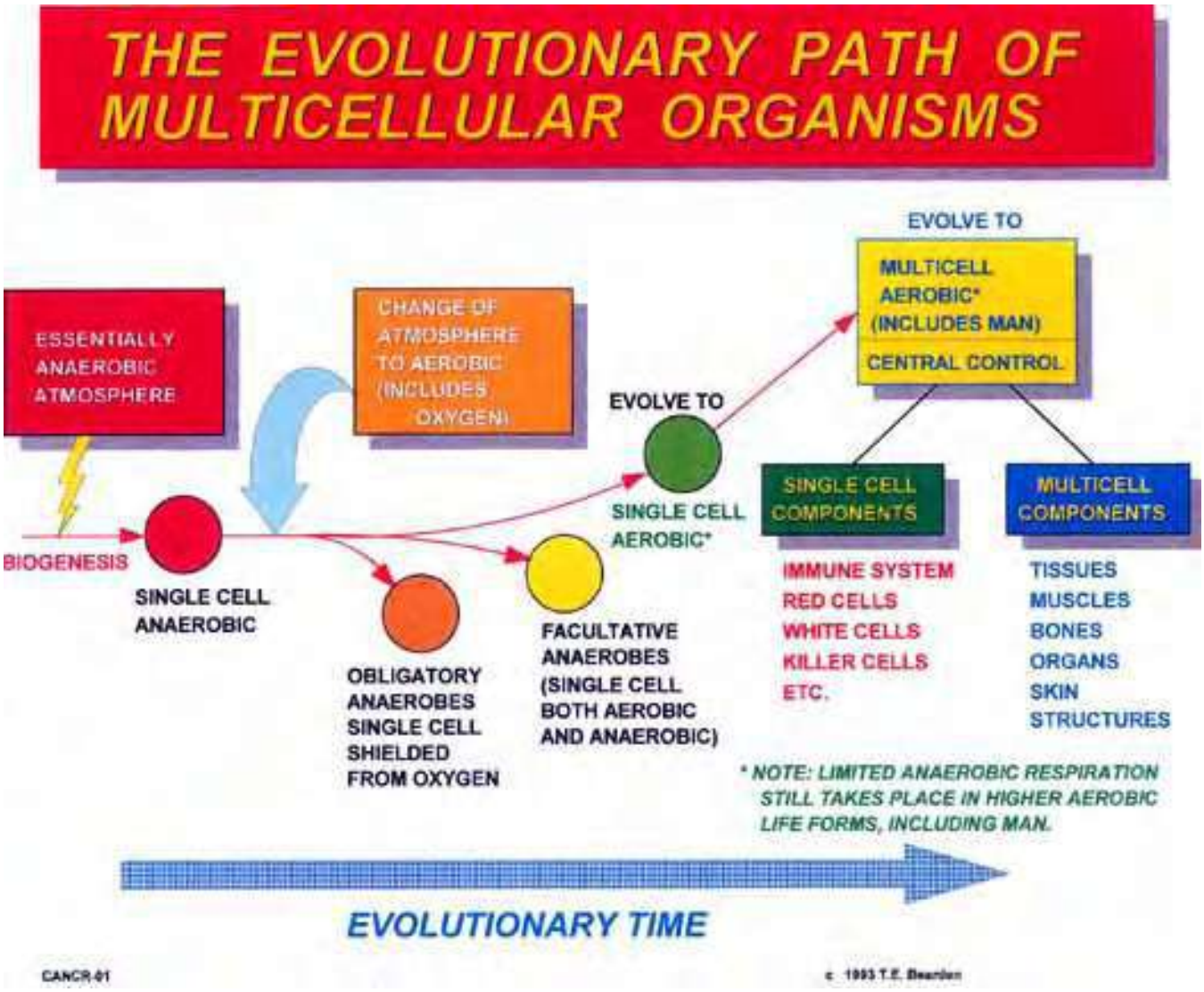

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EFFECT OF FLUID CONTAMINATION ON HEMOGLOBIN'S OXYGEN TRANSPORT

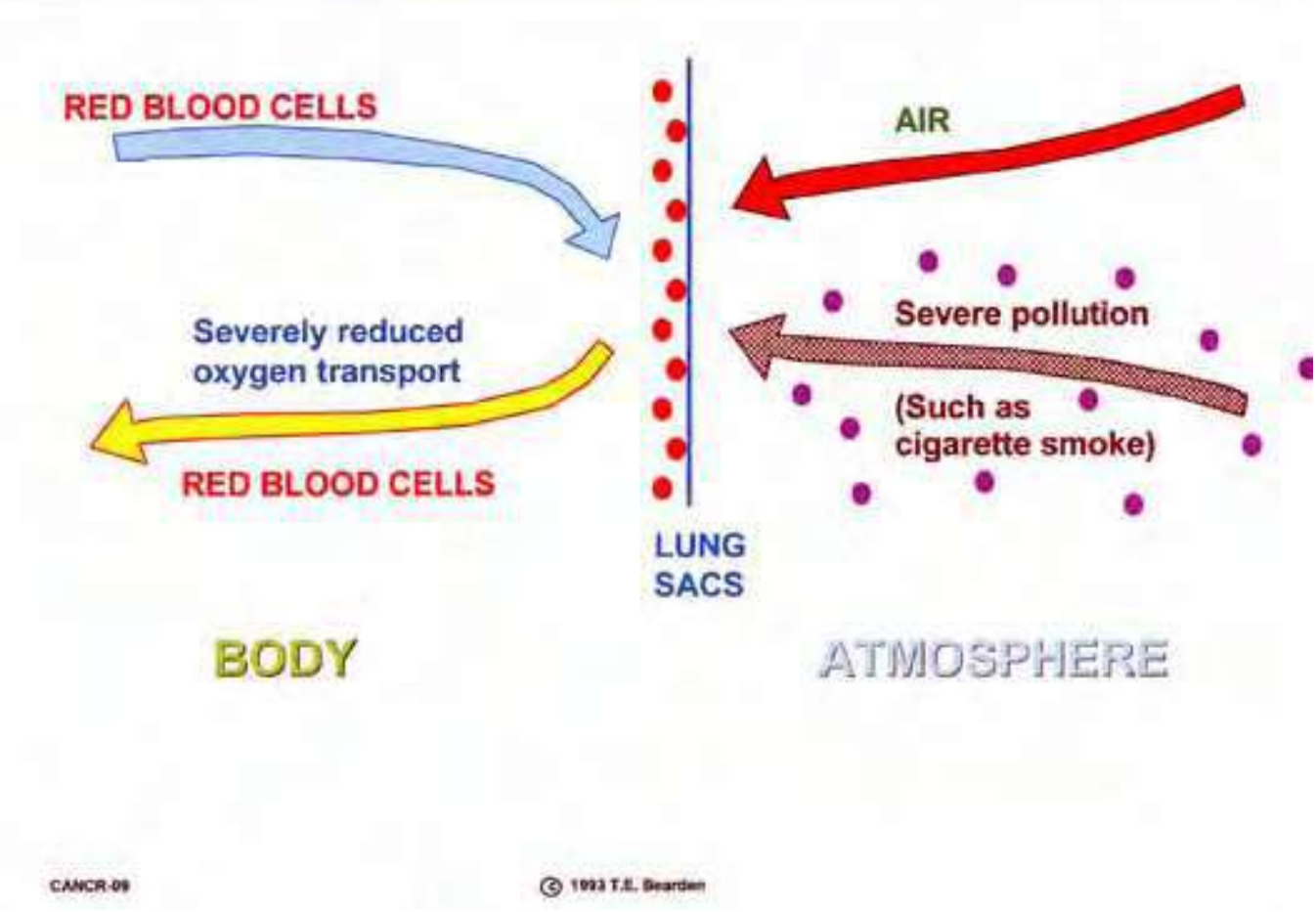

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FIRST STEP IN SELF-PROMOTION OF CANCER DUE TO HYPOXIA

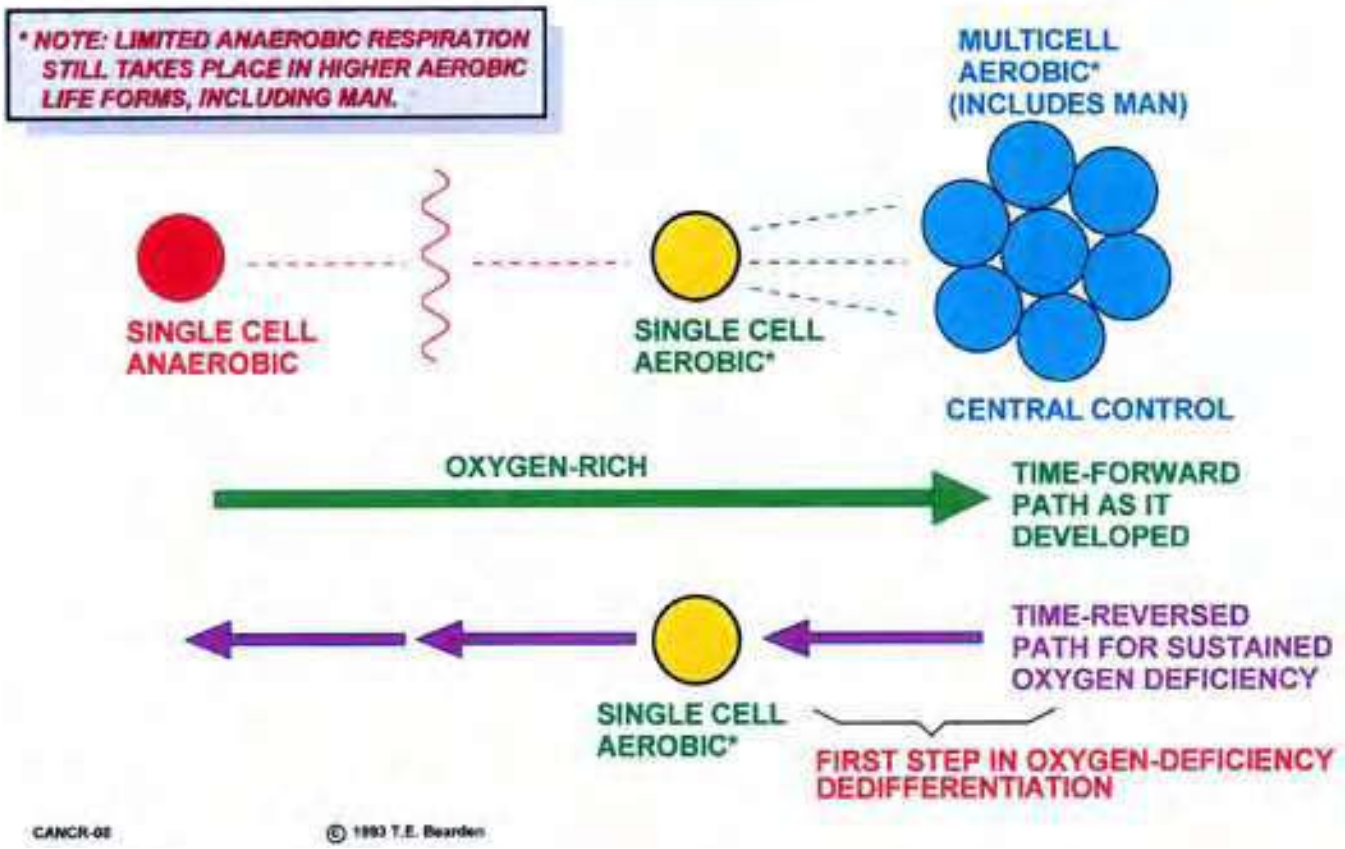

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BECKER'S CELLULAR GROWTH CONTROL

- Two major links uncovered between :
  - The DC system and nervous system
  - The DC system and all body cells
- Bioelectric potentials of primary importance
- Physiology presently considers controls limited to:
  - Neural action potential
  - Various hormone chemical agents
  - Chemical agents associated with DNA/RNA system
- Complete Operational Biological Control System:
  - Controls growth, healing, biological cycles, etc.
  - Operates in ANALOG mode; various levels of DC
  - Interlocks physically with nervous system (and may be its precursor)
  - Other chemical agents
  - Tissue growth and healing NOT INCLUDED
- Medical community now more concerned with diseases resulting from:
  - Inadequate/abnormal growth
  - Inadequate healing

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Becker's dc treatment of bone fractures

Application of tiny DC currents to heal difficult bone fractures. Only picoamperes are utilized. Pulsed DC current or pulsed magnetic fields may also be utilized.

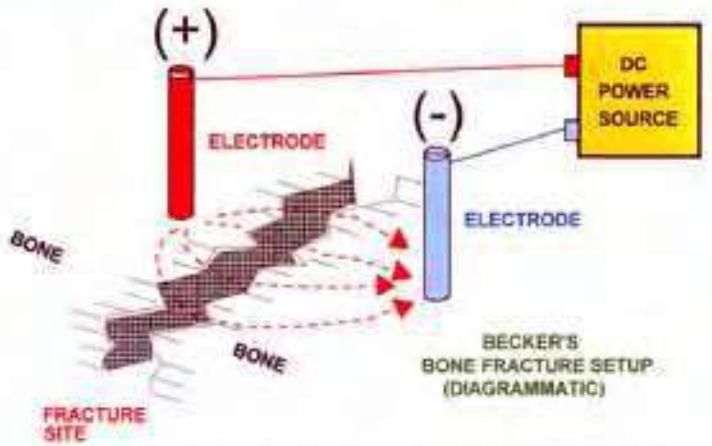

RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture

Proves that cells can be time-reversed (phase conjugated) (dedifferentiated) or time-forwarded (redifferentiated) by application of very weak electromagnetic signals, when those signals contain longitudinal bidirectional EM "pump wave" wavepairs, which cause the cell and its parts to create precise vacuum antiengines.

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Becker's theoretical DC control system involved with response to injury*

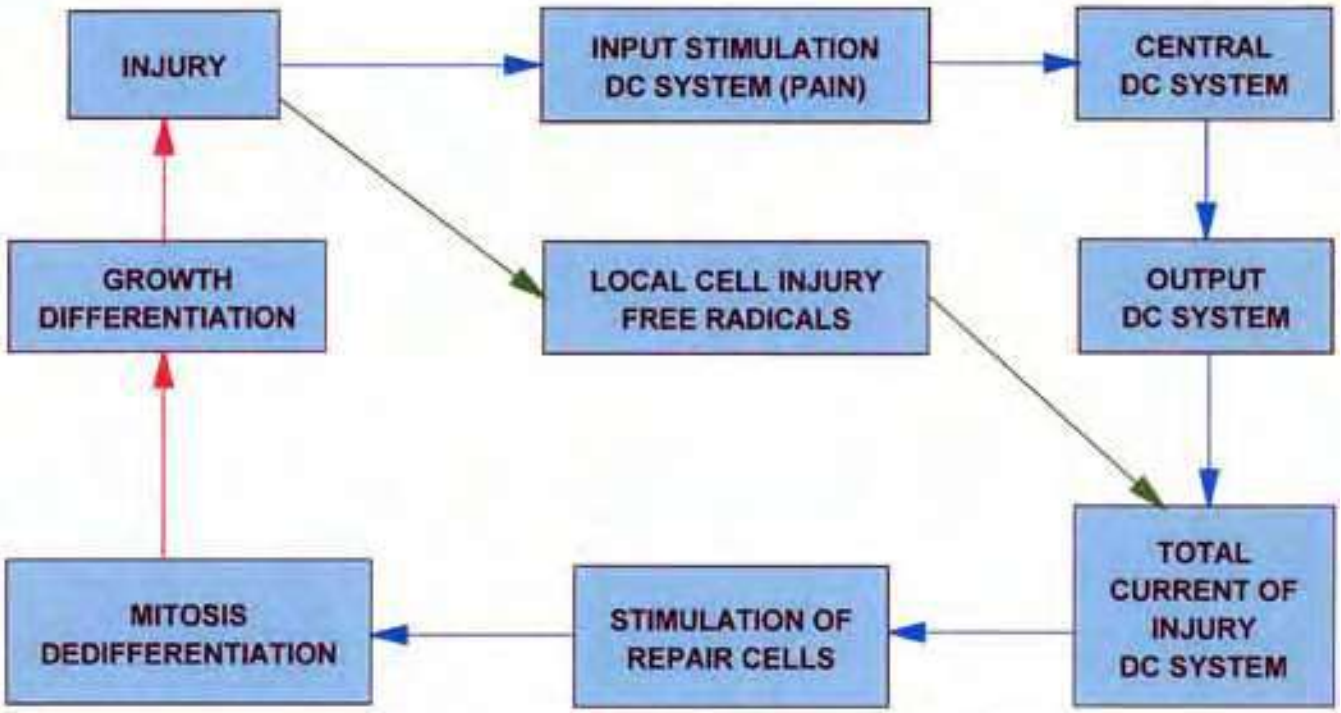

*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

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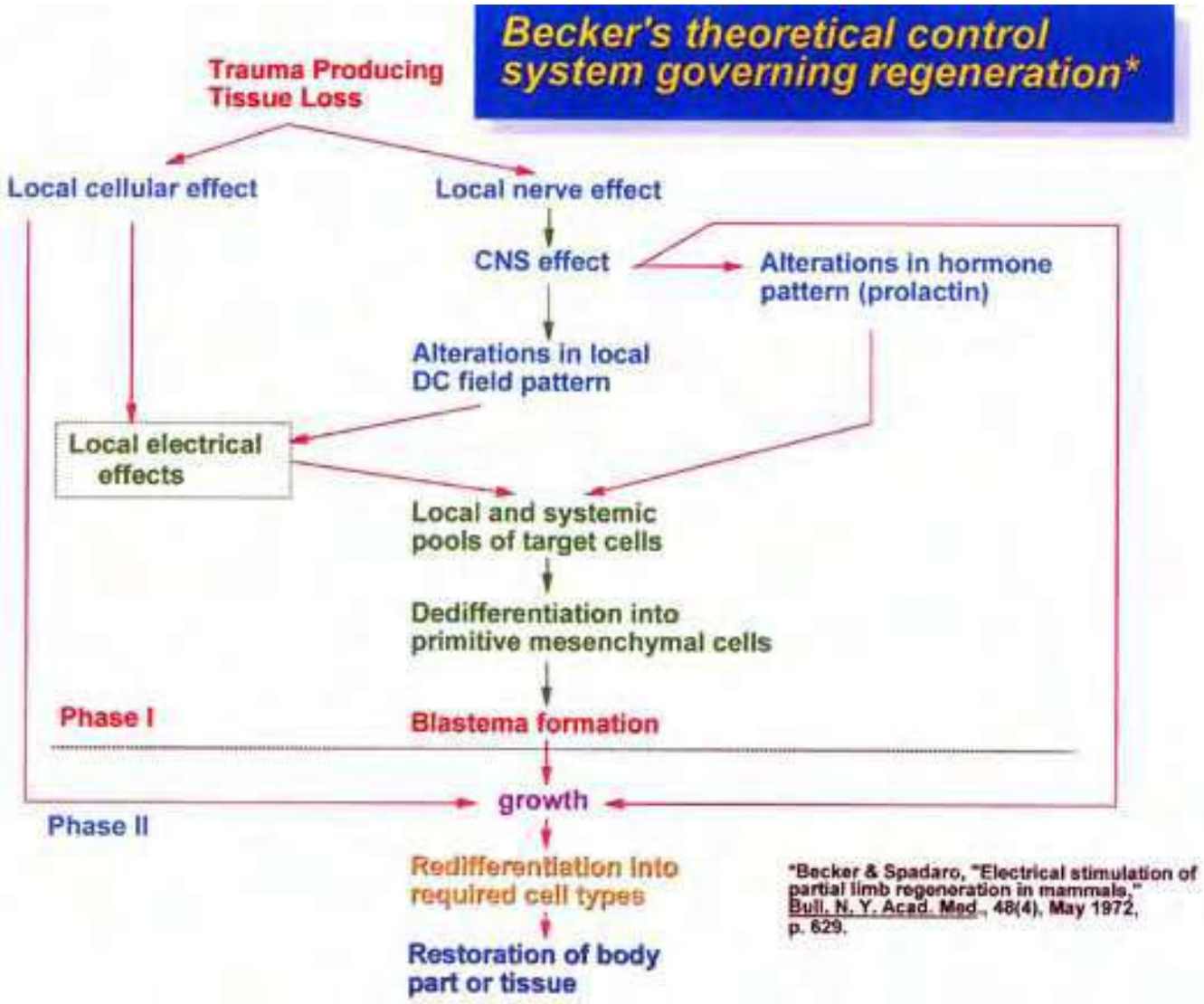

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Link Between Standing DC Potentials and the Nervous System

- Standing DC potentials on intact surfaces of all living animals demonstrate a complex field pattern spatially related to the anatomical arrangement of the nervous system
  - Can be measured directly on the peripheral nerves
  - Polarity difference related to whether nerve is or is not a sensor
  - Steady (weak) current flow exists
  - Demonstrates solid state/semiconductor phenomena
  - Accurately reflects (amplitude and polarity) the general level of neural activity
    - Sleep versus wakefulness
    - Anesthesia versus conscious
    - Other parameters
- DC levels determine the level of neural activity
- Action potential system exists upon a substratum of DC potentials which pre-existed it
- DC potentials substrata had and have control functions over basic properties of the living organism

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Becker's Findings on Cellular Injury and Regeneration*

- Cellular processes are regulated by a precise control system
- Attempted to apply engineering control-system theory
- Cells and tissues have solid-state electrochemical features which provide control signals in the control system
  - Growth process
  - Electron transfer
  - Semiconduction
  - Self-organizing *(NOTE: Implies hidden variables and nonlocal causality)*
- Complex electrical events at the injury site initiate cellular aspects such as dedifferentiation and mitotic activity
- Regeneration is a 2-step process, each with different controls
  - Electrical triggers with threshold values results in appearance of blastema
  - Complex data transmission to blastema establishes it as a self-organizing system capable of growth and redifferentiation
  - Mammals lack ability to produce blastemas except for bone, but partial regeneration growth has been shown in response to electrical stimuli
- Growth related to electrical more than electrochemical aspects
- Hematopoietic marrow as source of cells for the blastema
  - Monocytes can take place in regenerative processes in limbs
  - Lymphocytes can dedifferentiate under certain circumstances
  - Marrow elements can be induced into osteogenesis

*R.O. Becker & J.A. Spadaro, "Electrical Stimulation of Partial Limb Regeneration in Mammals," Bull. N. Y. Acad. Med., 48(4), may 1972, p. 627-641.

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Corrections For the Present EM Bioeffects Model

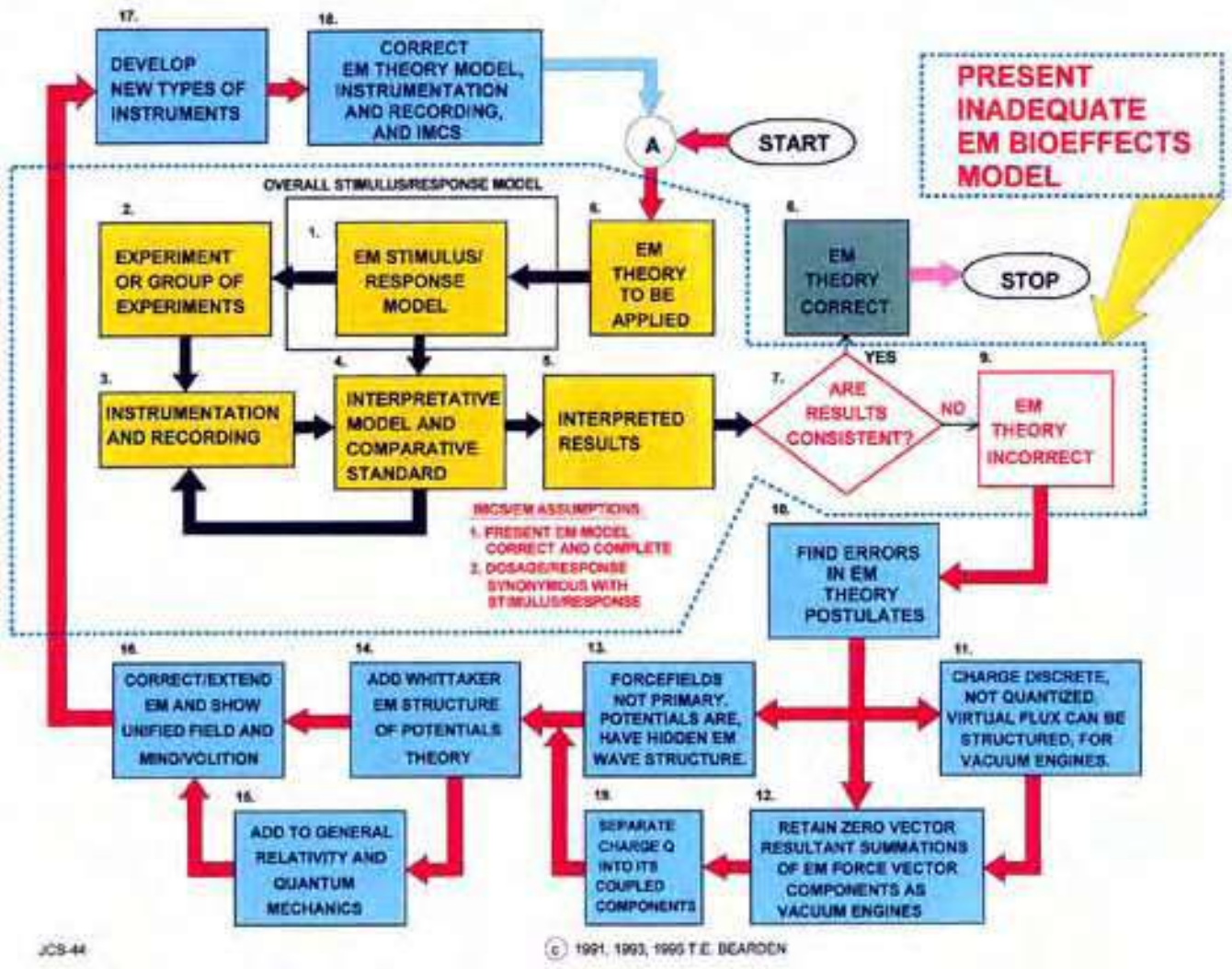

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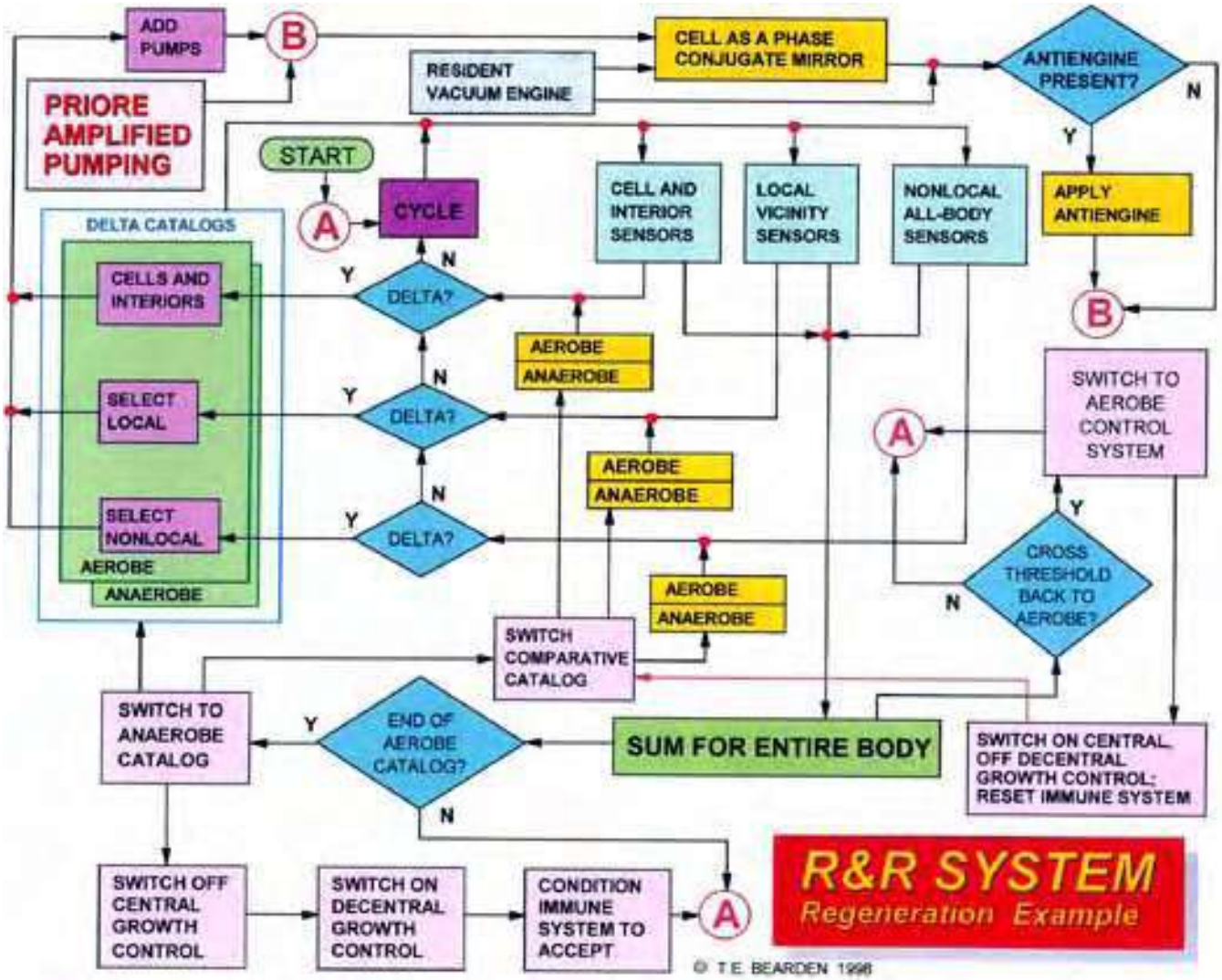

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Kaznacheyev's Cytopathogenic Mirror Effect

Disease vacuum engines transported by photons and waves

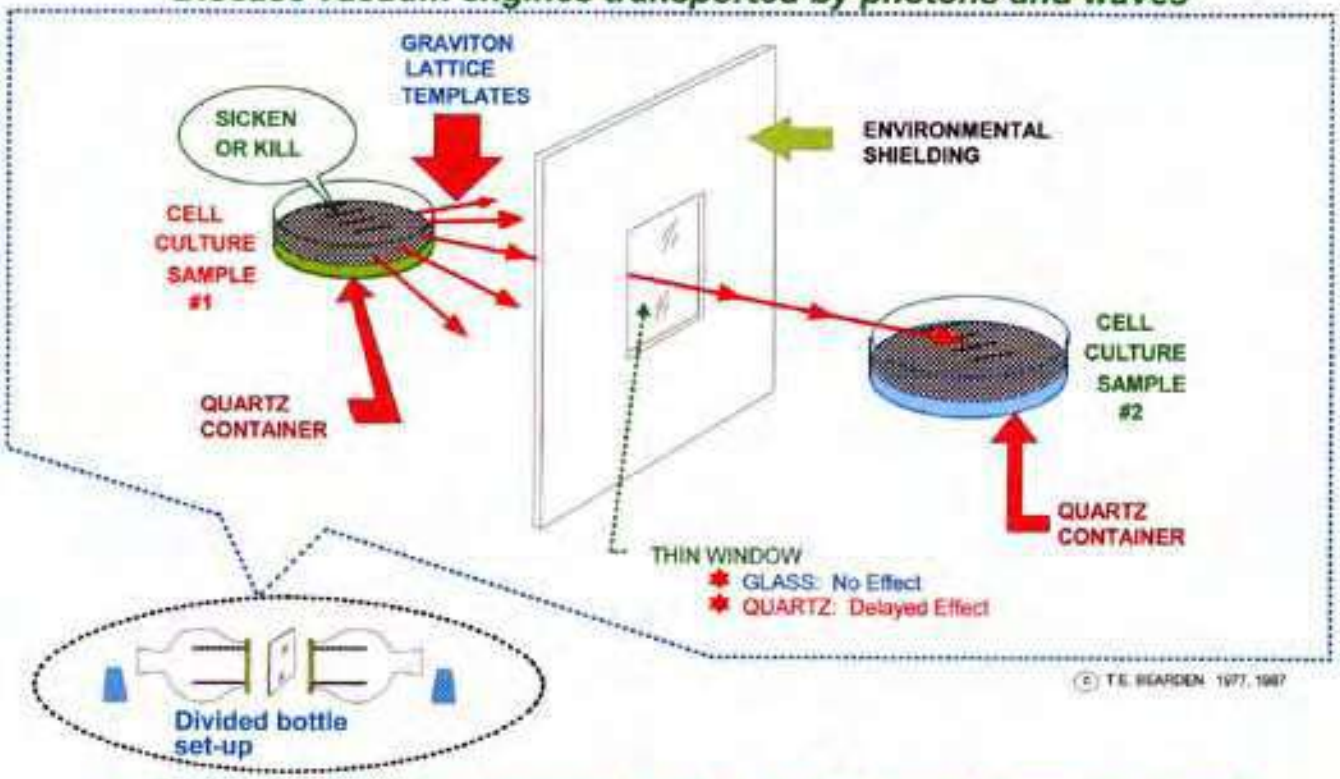

Note: Minimum lattice is one harmonic interval: IR to UV is such a minimum G-lattice.

Distant induction of cellular death and diseases, by special EM means. Coupled photon-antiphoton pairs (gravitons) in a structured harmonic lattice ordering constitute the disease or disorder template.

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MICROWAVE RADIATION OF U.S. EMBASSY IN MOSCOW

Former U.S. Embassy in Moscow.

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BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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Self-Targeting in Inner EM Channel Can Produce a Quantum Potential

Once QP is established, energy transmission is direct and instantaneous. Energy input to one single participant will simultaneously appear in all other participants, the amount depending on their fractions of participation with the input station.

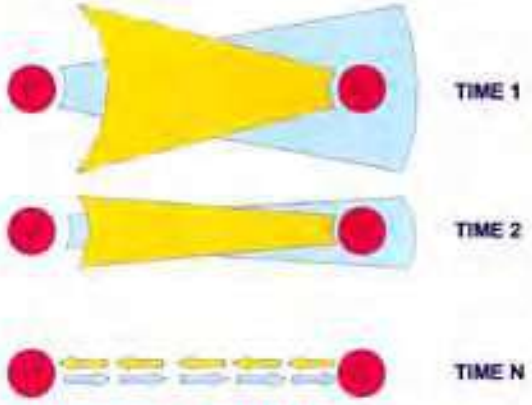

NARROWING OF INTERACTING POTENTIALS INTO LASER-LIKE BEAMS, BETWEEN TWO PUMPED SOURCES. NOW ONLY LONGITUDINAL WAVES CONNECT THE LINKED OBJECTS.

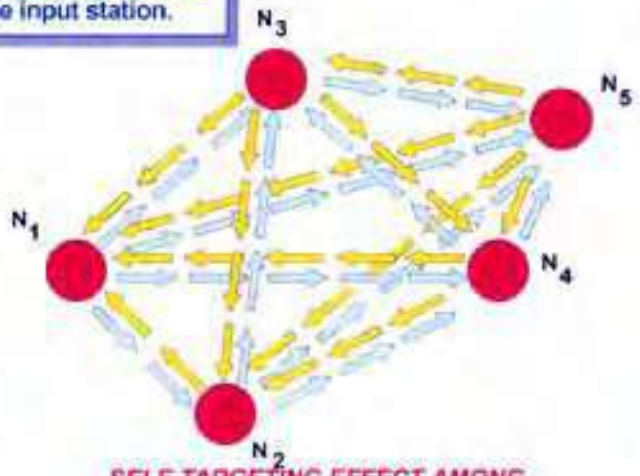

SELF-TARGETING EFFECT AMONG ALL PAIRS OF INTERACTING PUMPED SOURCES

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Quantum potential and hidden variable theory

a. Quantum Potential Characteristics

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- No point source
- Not radiated
- Quantum potential between two particles
  - Interaction does not vanish as spatial separation becomes very large
  - Instantaneous connection, so multiply-connected space

b. Hidden Variable Theory and the Quantum Potential

- $$V_{quantum} = \frac{\hbar}{2m}\frac{\nabla^2\sqrt{\rho}}{\sqrt{\rho}}$$
- "A quantum particle moves as if it were subject, in addition to its external potentials, to a potential which is a function of its own probability distribution."
- Bohm's H.V.T. assumes:
  - Particle and wave function real and separate
  - Wave function obeys Shroedinger's equation
  - Particle obeys classical mechanics
  - Particle couples to wave function through a quantum potential

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Participants in a quantum potential share a common multiply-connected spacetime (MCST)

- Separated points are superposed in MCST
- Intervening distance in MCST is zero
- Connection is instant and bidirectional
- Propagation through ST does not apply
- Energy or vacuum engine input to one station instantly appears at each and every other station, undiminished in magnitude
- Ultimate net-centric warfare effect

Note: Once QP established, separation distance in 3-space is of no consequence

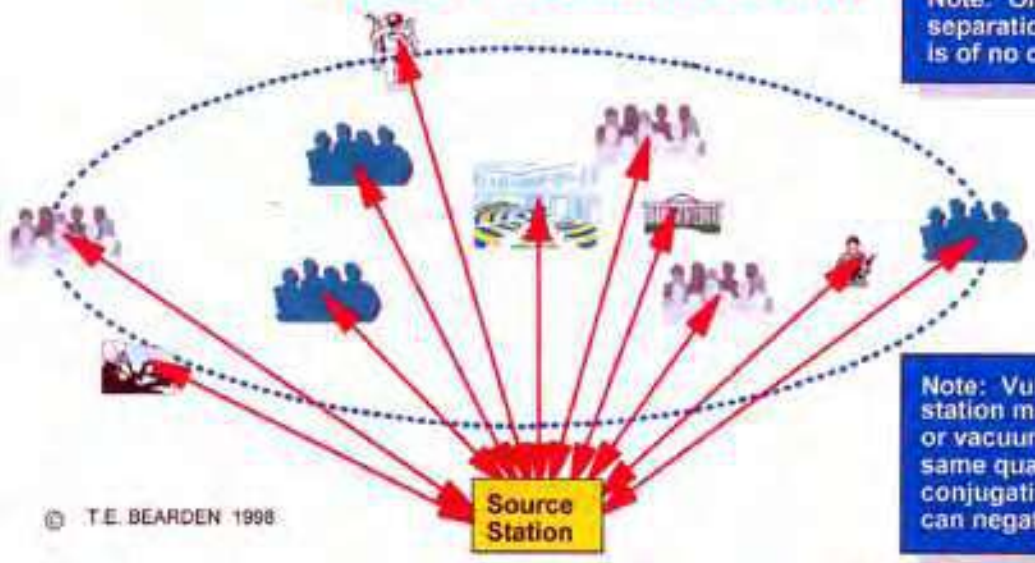

Note: Vulnerability. Any other station may insert energy or vacuum engines into the same quantum potential. Phase conjugating the hostile engine can negate its effect everywhere

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Gulf War Syndrome And Typical Comparative Disease Curves

Note: There is cumulative genetic damage to germ cells also.

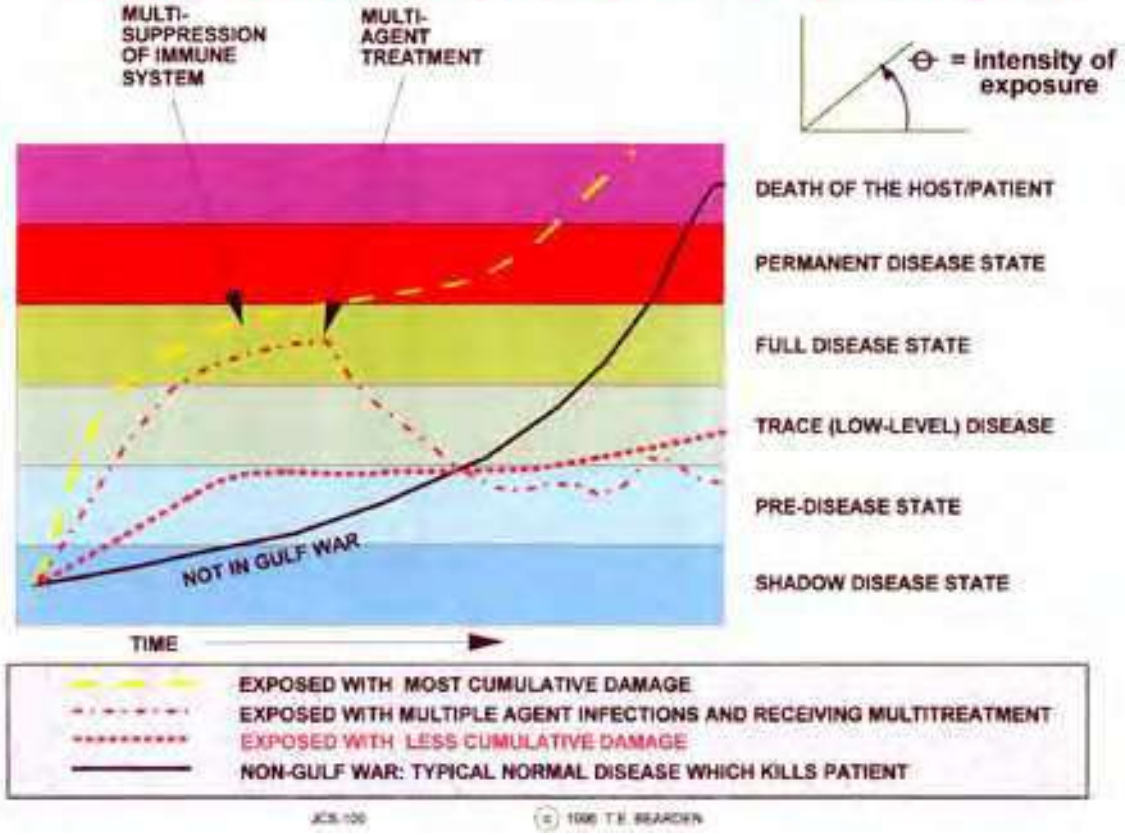

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Force Fields and Symmetry

- Force fields are nature's way of imposing local gauge symmetries on the world
- E.g., electromagnetic field is a manifestation of the simplest known gauge symmetry consistent with the principles of special relativity
- For the EM case, the gauge transformations correspond to changes in 'voltage' from place to place

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Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum

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- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another
- STRUCTURING THE INFOLDED EM INSIDE POTENTIALS, FIELDS, AND WAVES
  - Strongly breaks local symmetry
  - Provides spacetime engines giving the above effects

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Other Aspects of Strong Local Asymmetry

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- Local spacetime is curved
- Lorentz invariance of vacuum is violated
- May be a local "sink" or "source"
- Gravitational/inertial effects from EM
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation
- COMMENT: Thus the use of infolded longitudinal EM fields and waves to strongly break local symmetry allows internested clustering of spacetime curvatures. These spacetime structures are *vacuum engines*, or *spacetime engines*.

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Small Entities Emit Powerful S-Flows

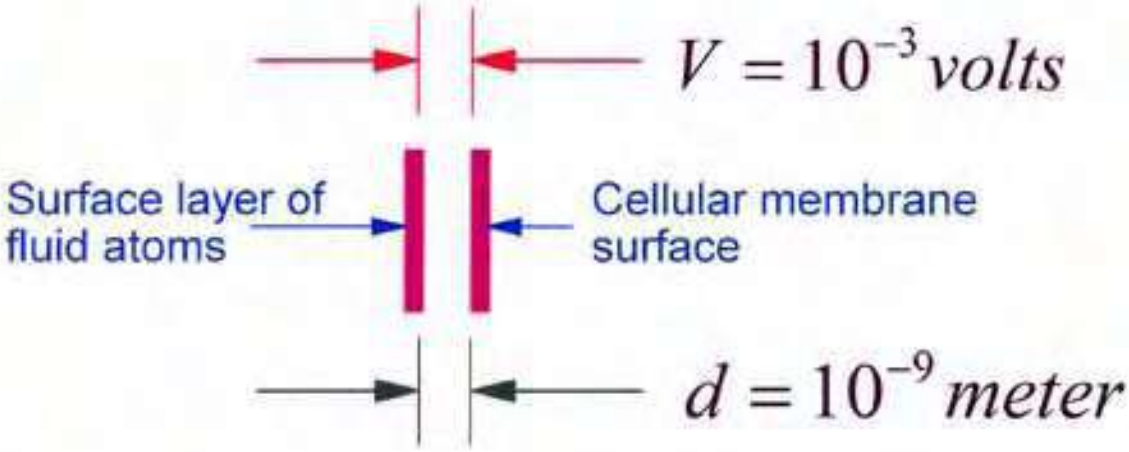

$$E = 10^{6}\ \text{volts / meter}$$

$$S \approx f(E^2) = f(10^{12})$$

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What is the "magnitude" of a potential?

- What is taught is the *"interaction cross section,"* i.e., the joules collected from the associated S-flow by one point coulomb of intercepting/collecting charge.

$$W = Vq = \phi q \quad \text{(joules)} \qquad [1]$$

$$\phi = W/q \quad \text{(joules/coul)} \qquad [2]$$

Let $\phi < 1$ and fixed; $q \Rightarrow n$ where $n = \infty$

$$W \Rightarrow k, \text{ where } k = \infty \qquad [3]$$

- *From any "finite" potential, no matter how small, an unlimited amount of energy can be collected, by increasing the collection (number of coulombs) (interaction cross section).*
- Actual magnitude of the potential ϕ must be very, very large, since we can treat it as infinite or unlimited, via $W = \phi q$.
- *Else Equation [1] could not be linear.*

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Table A1. THE VACUUM ENERGETICALLY INTERACTS WITH EVERY PARTICLE, CONTINUALLY.

- The vacuum is:
  - Ground (zero) state of the electromagnetic (photon) field.
  - Ground (zero) state of mass field.
  - Empty of *observable* particles or photons.
  - Filled with *non-observable* (virtual) particles and photons.
  - Violently fluctuating microscopically and electromagnetically.
  - Constantly interacting with all particles, including partially shielding their bare charges.
- Lamb Shift -- vacuum's alteration of the energy level of an electron in the hydrogen atom.
  - -- Difference in energy (frequency units) is 1057.862 MHz.
  - -- Lamb was awarded a Nobel Prize for showing this.
  - -- Energy *density* exceeds that of the sun's surface!
- Casimir Effect -- vacuum creates an attraction between two conducting surfaces in close proximity.
  - -- experimentally proven, well-known.

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- Cole and Puthoff proved that there is no thermodynamic reason why energy cannot be extracted from the vacuum as heat and power, and utilized.
- The common dipole is a broken symmetry in the virtual photon flux of vacuum. It extracts virtual energy, integrates it, and re-emits it as Poynting energy density flow S = ExH (which observably interacts with charged particles and magnetic poles).

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Extended Superpotential Theory

(Adding Vacuum Engines)

- Any EM field or wave is created by (comprised of) two potentials which interfere with each other in a given area
  - *May be either scalar or vector potentials*
  - *May interfere locally or at a distance*
  - *Process is distance independent*
- Any scalar potential is comprised of a harmonic series of bidirectional longitudinal EM wavepairs (Whittaker 1903).
- Ziolkowski circa 1985 added the interior product set to Whittaker's sum set. Thus he added modulations.
- By assembling a deliberate "sum and product" set of biwaves, a scalar potential can be created having an internal deterministic structure.
  - *This structures local vacuum potential/spacetime curvatures, in specific forms (templates)*
  - *Now have added vacuum engines*
  - *Have infolded general relativity inside electrodynamics*

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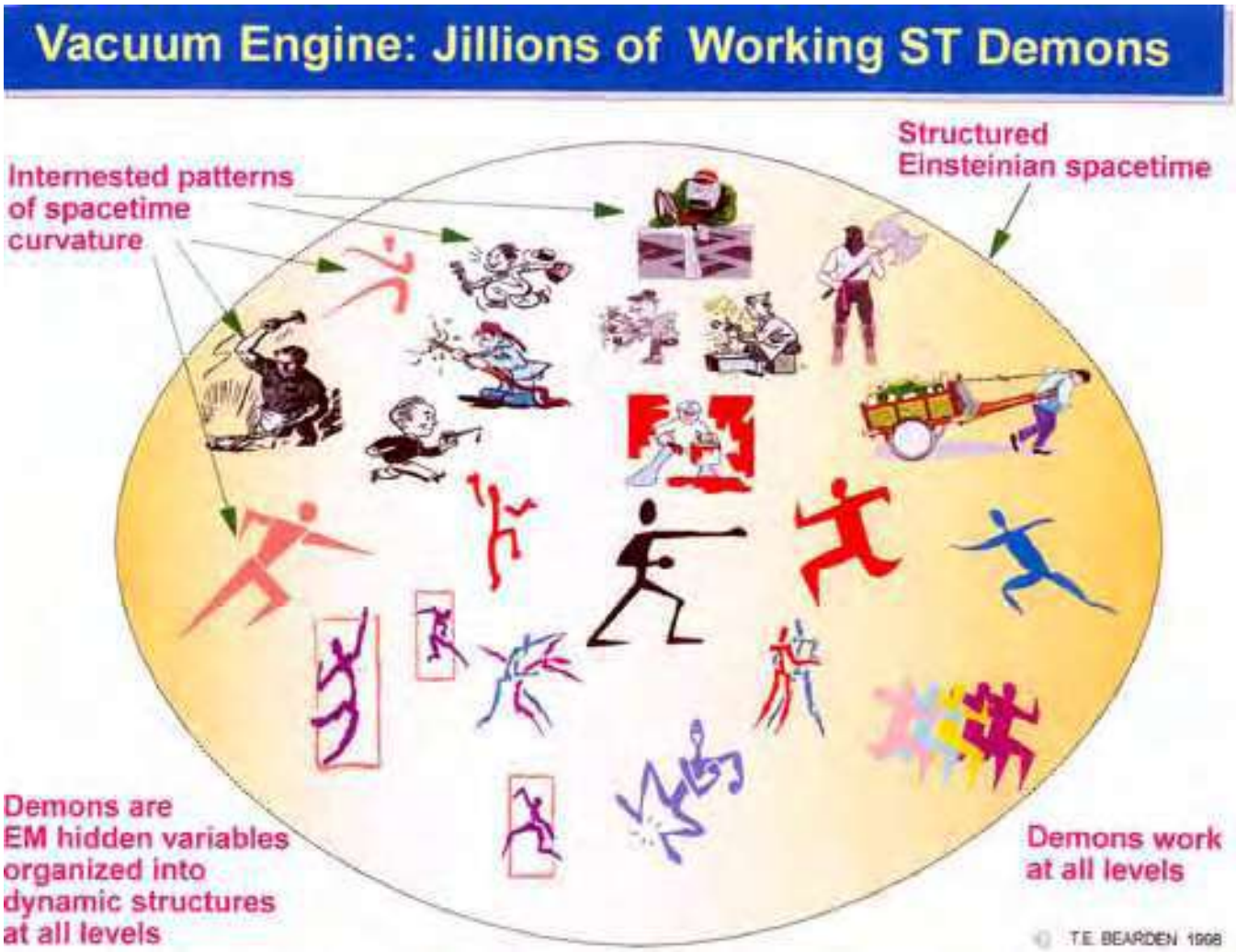

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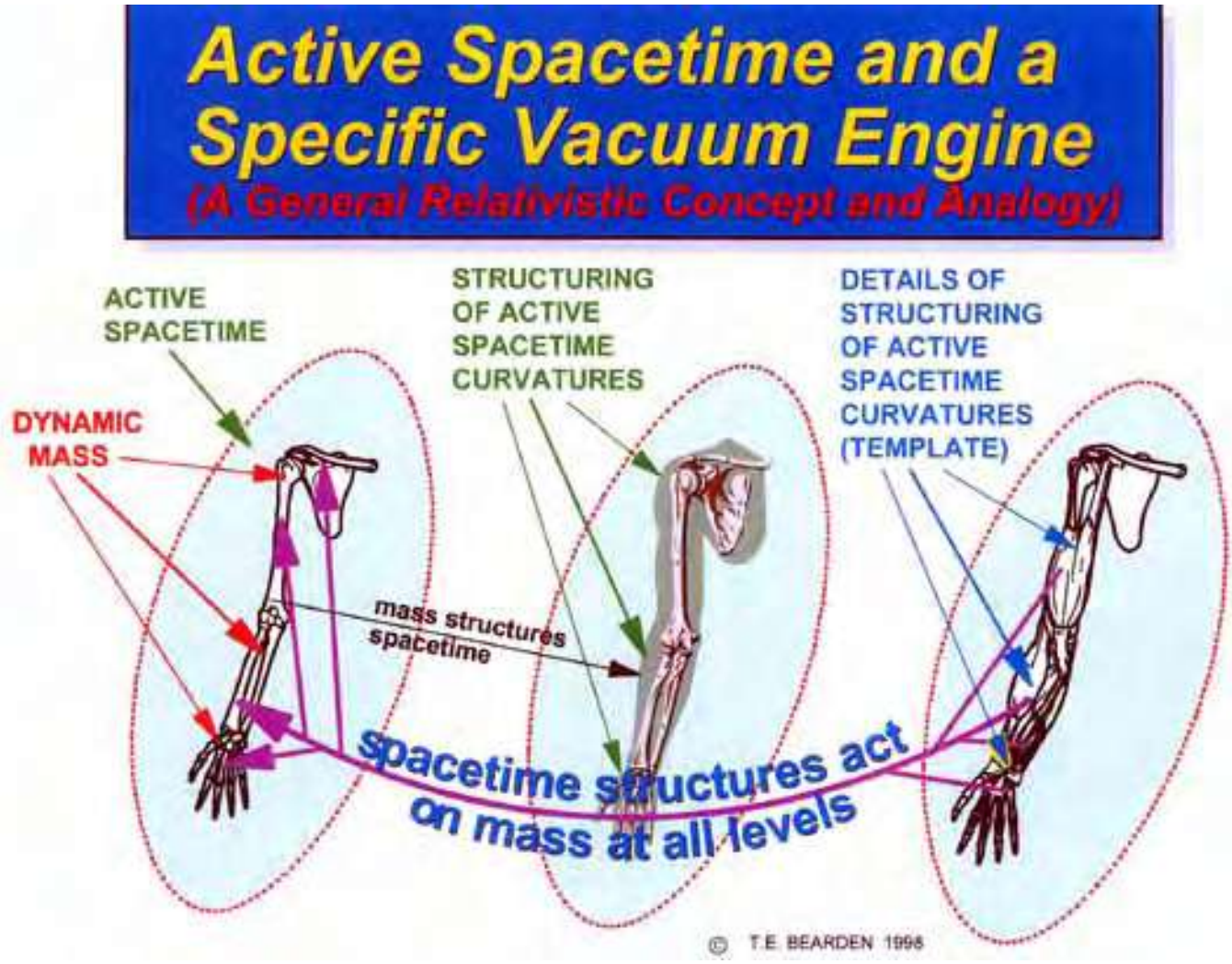

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Extension of Wheeler's general relativity principle:

- Mass (trapped energy) and its structuring curves and structures spacetime complexes (engines).
- Curved and structured spacetime engines produce forces on mass and its components, telling them how to move and structure.
- Since very strong EM force is used as agent of curvature, very powerful general relativistic effects can be obtained by arranging the LWs in the input EM potentials, fields, and waves.
- General relativity becomes directly engineerable in devices of unparalleled capability.

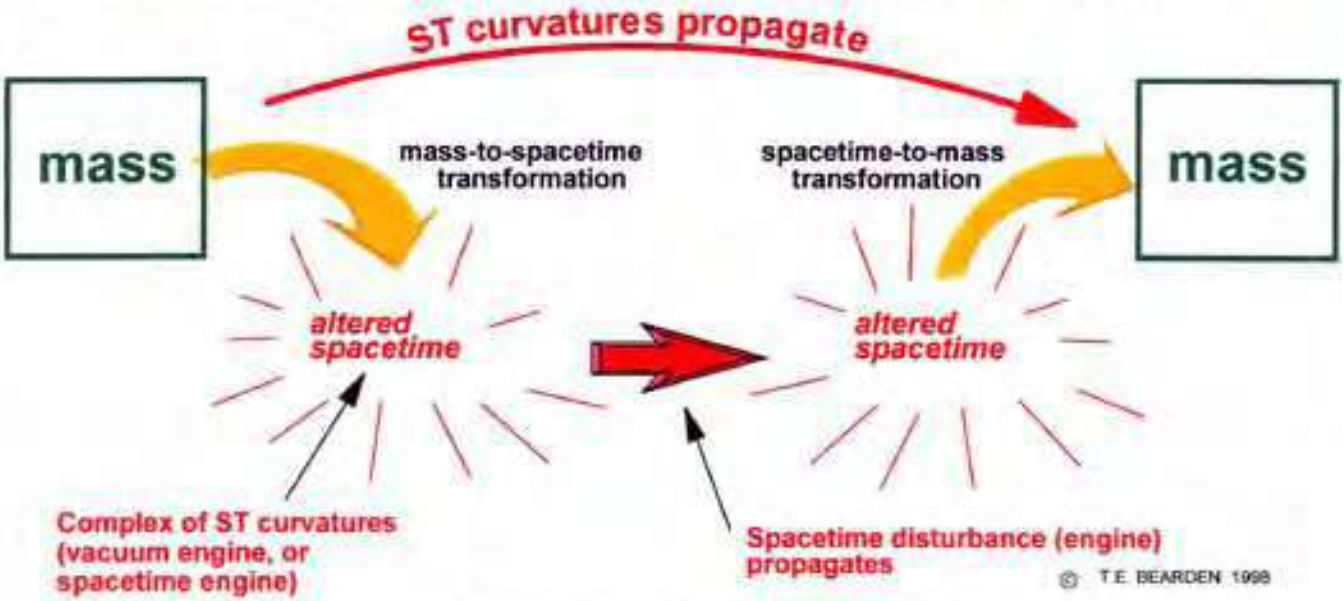

Electrodynamics has a hidden but ignored electro-general-relativity infolded inside (comprising) its so-called potentials, fields, and waves (in space in the absence of mass). What are presently defined as potentials, fields, and waves rigorously exist only in, on, and of charged mass, as pointed out by Aharonov and Bohm in 1959. All of this is just longitudinal EM waves and their interactions.

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SIGNAL VERSUS VACUUM ENGINE

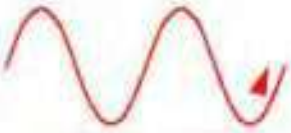

SIGNAL (INFO)

- INFORMATION RECEIVED
- ANY OVERT PHYSICAL ACTION MUST BE TAKEN BY RECEIVER

A. *Receiver must do the action itself; vacuum energy exchange is unaltered. Energy or fuel for doing the action must be added to receiver externally.*

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VACUUM ACTIVATED

ENGINE (STRUCTURE)
TEMPLATE (FORM)

- "INFORMATION" ITSELF ACTS
- VACUUM FLUX GRADIENTS CHANGE ALL PARTS AND CHARACTERISTICS OF RECEIVER, INSIDE AND OUT

B. *Receiver is acted upon; altered vacuum energy exchange does the specific action. No energy or fuel for doing the action need be added to receiver externally.*

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Electronuclear Interactions by Vacuum Engines

- An EM potential is gravitational due to its trapped energy.
- A local EM potential is a local curvature of spacetime.
- *Structured* potentials are structured *(nested)* local spacetime curvatures; hidden variable theory applies.
- Structured potentials thus are *vacuum engines*.
- Gradient-free potential penetrates the atom, into nucleus.
- *With steady application, a structured gradient-free potential can be used to engineer the atomic nucleus at will.*
- Normal cold fusion systems structure a small fraction of their potentials, by chance geometries, boundaries, etc.
- This produces some new nuclides, but haphazardly.
- *The process can be developed and controlled. The nucleus can be deterministically engineered at will.*

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Vacuum Engineering

Using Inner EM Energy and Structuring to Engineer Physical Reality

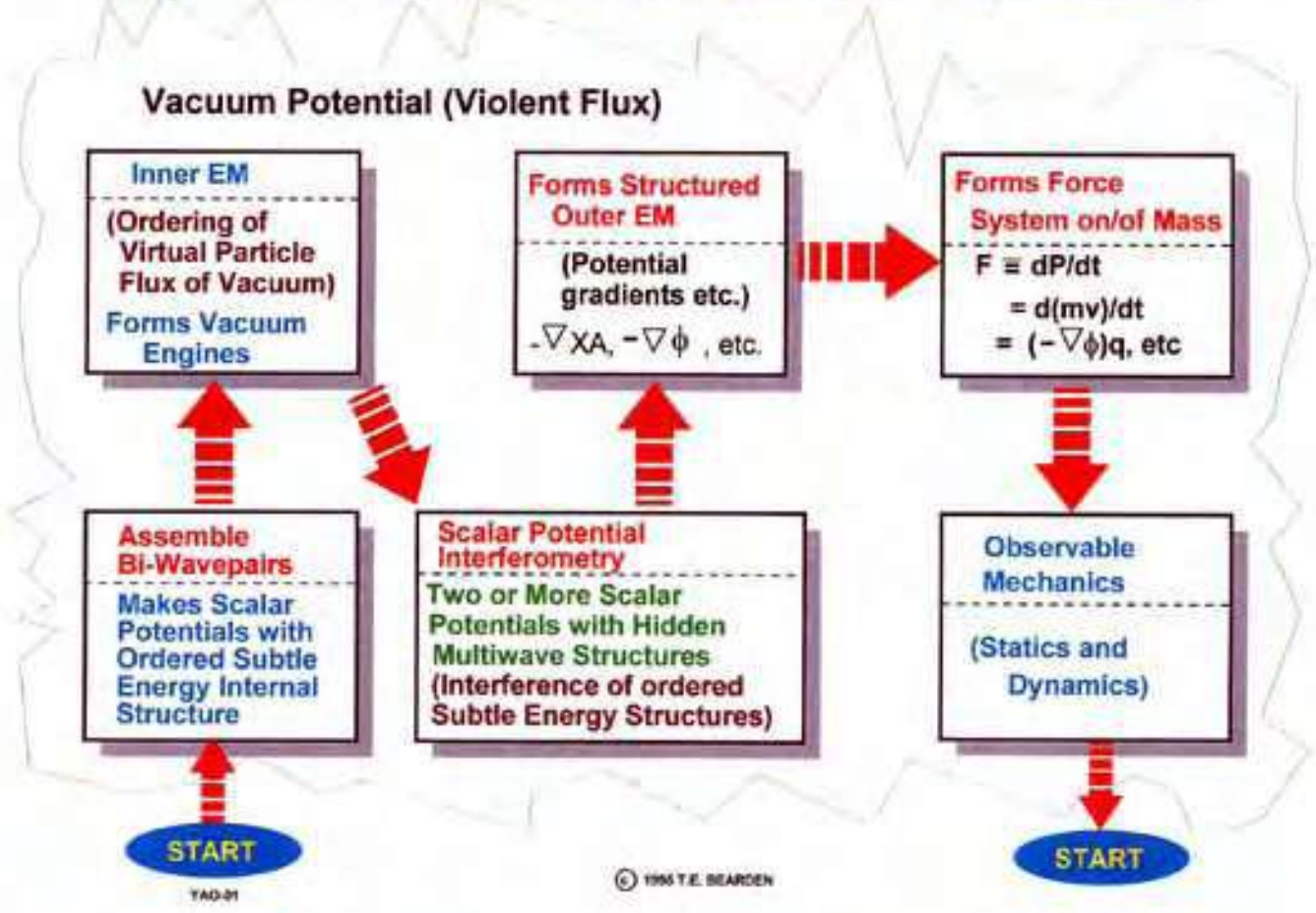

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Impact of Vacuum Engineering

- "If they [quantum fluctuations of vacuum] can be [tapped], the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete -- and so would many of our worries about environmental pollution."
- "Don't sell your oil shares yet -- but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development:
  - 1. It's crazy!
  - 2. It may be possible -- so what?
  - 3. I said it was a good idea all along.
  - 4. I thought of it first."

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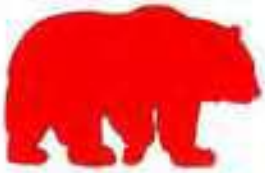

Arthur C. Clarke
"Space Drive: A Fantasy That Could Become Reality"
Nov./Dec. 1994

- *Comment:*
  - *Every dipole's broken symmetry in its energetic exchange with the vacuum already freely extracts vacuum energy.*
  - *In power sources, the dipole gates the extracted energy out as S = EXH, which flows almost entirely outside the conductors.*
  - The circuit interacts with, and uses, only about 10^{-13} of S. The electrodynamicists calculate only this small S-component.

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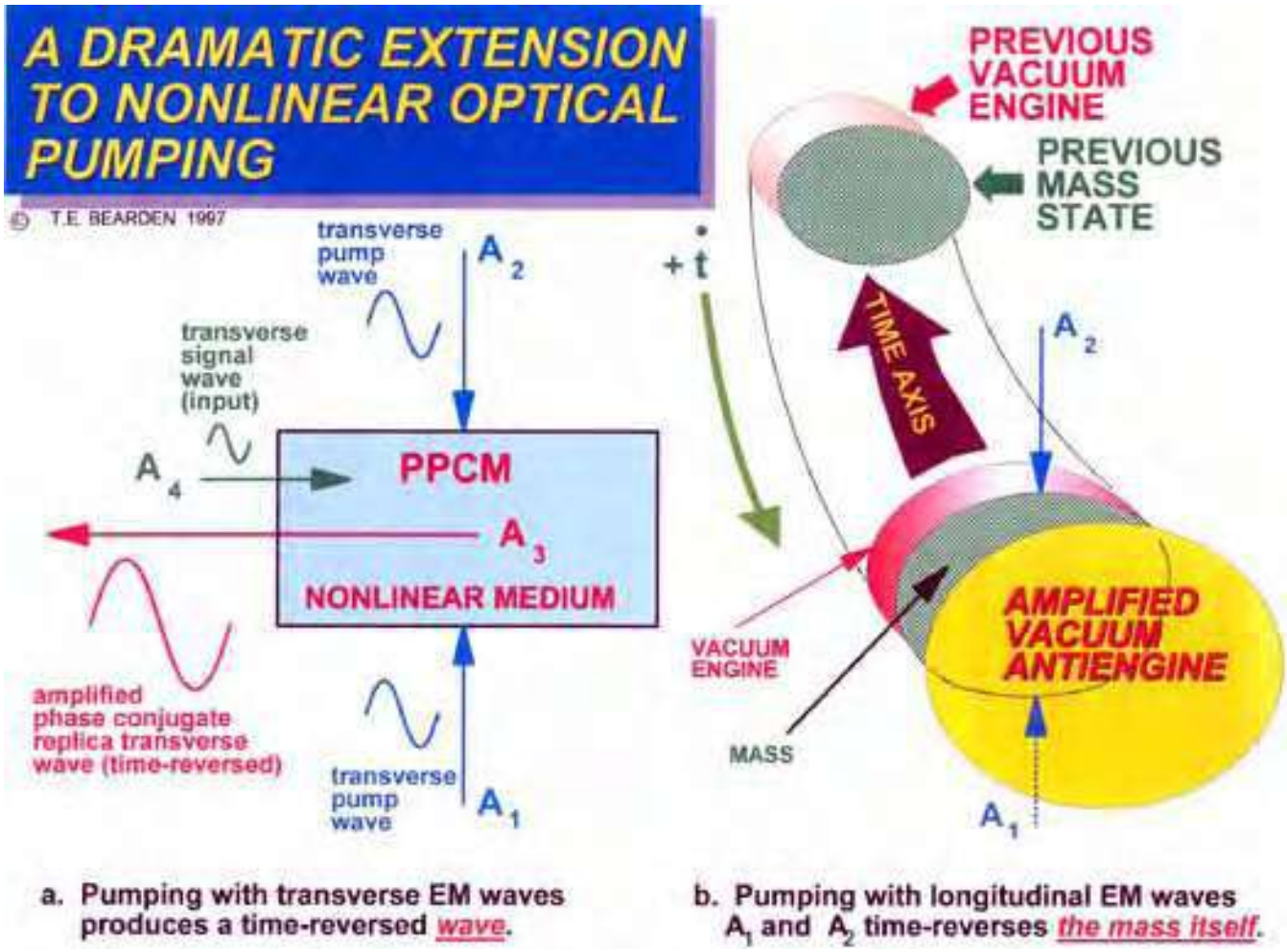

a. Pumping with transverse EM waves produces a time-reversed wave.

b. Pumping with longitudinal EM waves A_1 and A_2 time-reverses the mass itself.

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Time Conservation and Some Properties

(Energy and time are canonical)

- Time can neither be created nor destroyed
  - *Its form can be changed, and it can be positive or negative*
  - *Time can be collected or dissipated, converged or diverged*
  - *Time can oscillate and move in waves*
  - *Longitudinal (infolded) EM waves oscillate time*
- Time is always in motion, and that motion is variable
  - *Collected/collecting time is a continuing stationary change in an ongoing time flow*
  - *Time/collecting time can be internested and internally structured*

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- Time has gravitational aspects
  - *Negative (trapped) time is antigravitational*
  - *Emitting negative time is gravitational, to the emitter*
- Nonlinear optical pumping can use longitudinal EM waves
  - *Pumping a nonlinear mass by longitudinal (infolded) EM waves pumps it in its masstime form, in the time domain*
  - *This creates an amplified vacuum antiengine for the mass, and time-reverses the mass back to a previous state*

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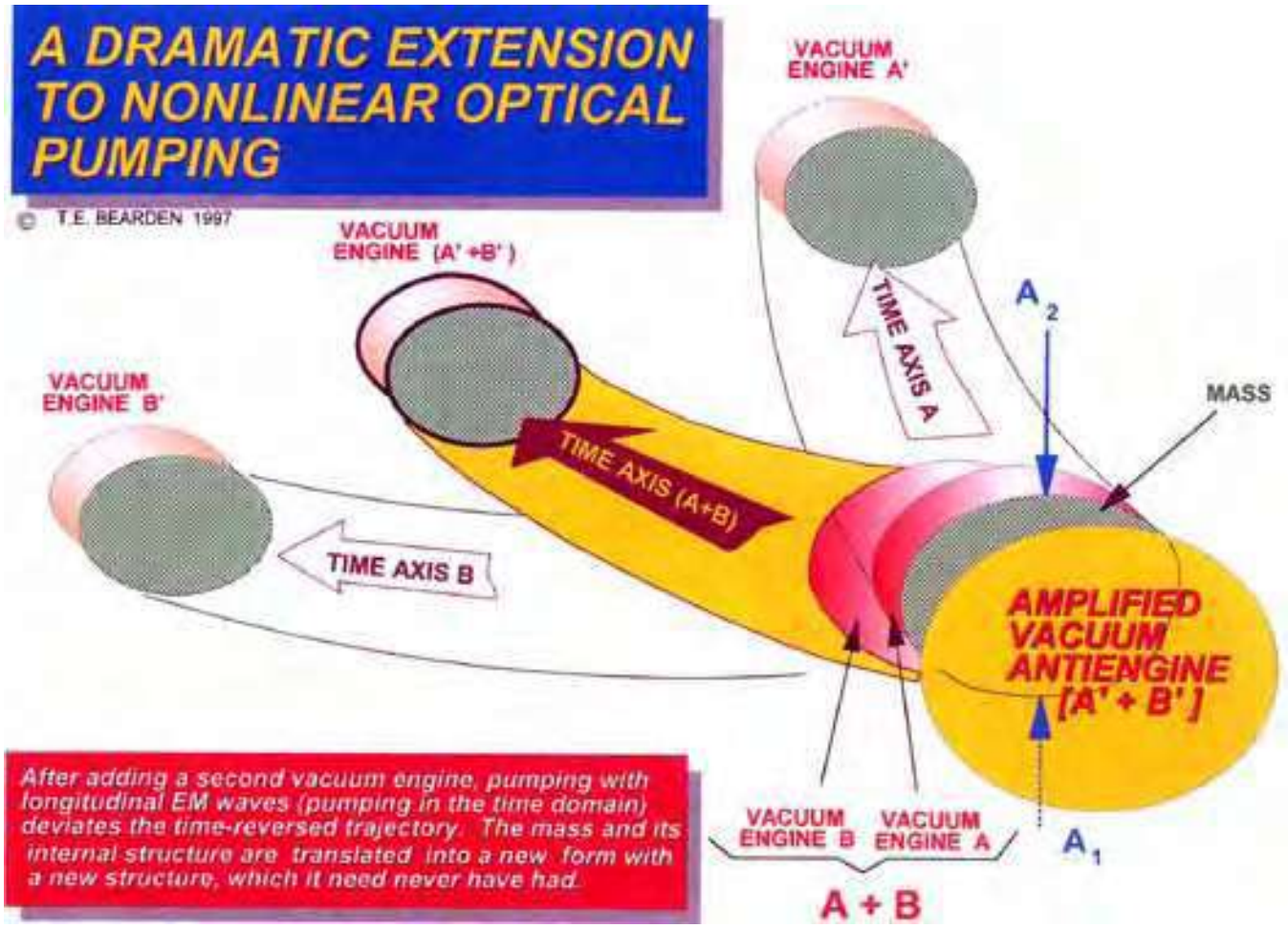

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Key Points in the New Technology

- There is a vast new kind of electrodynamics *hidden inside* all EM potentials, fields, and waves
  - Longitudinal EM waves and complexes
  - Oscillations in time domain

- These complexes are an *infolded general relativity*
  - Clustered formations of *spacetime curvatures*
  - *Very powerful*, since the EM force is used as the agent of curvature

- In general relativity, similar precise complexes permeate and *act on any mass at all internal levels*
- With this approach, one *can now manipulate matter* -- living or inert -- *in any manner desired*, depending only on the level of development of the technology
- Priore unwittingly used this to *cure dread diseases*
- This is a *revolution in all of science*

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- *We have uncovered the major mechanisms* to utilize

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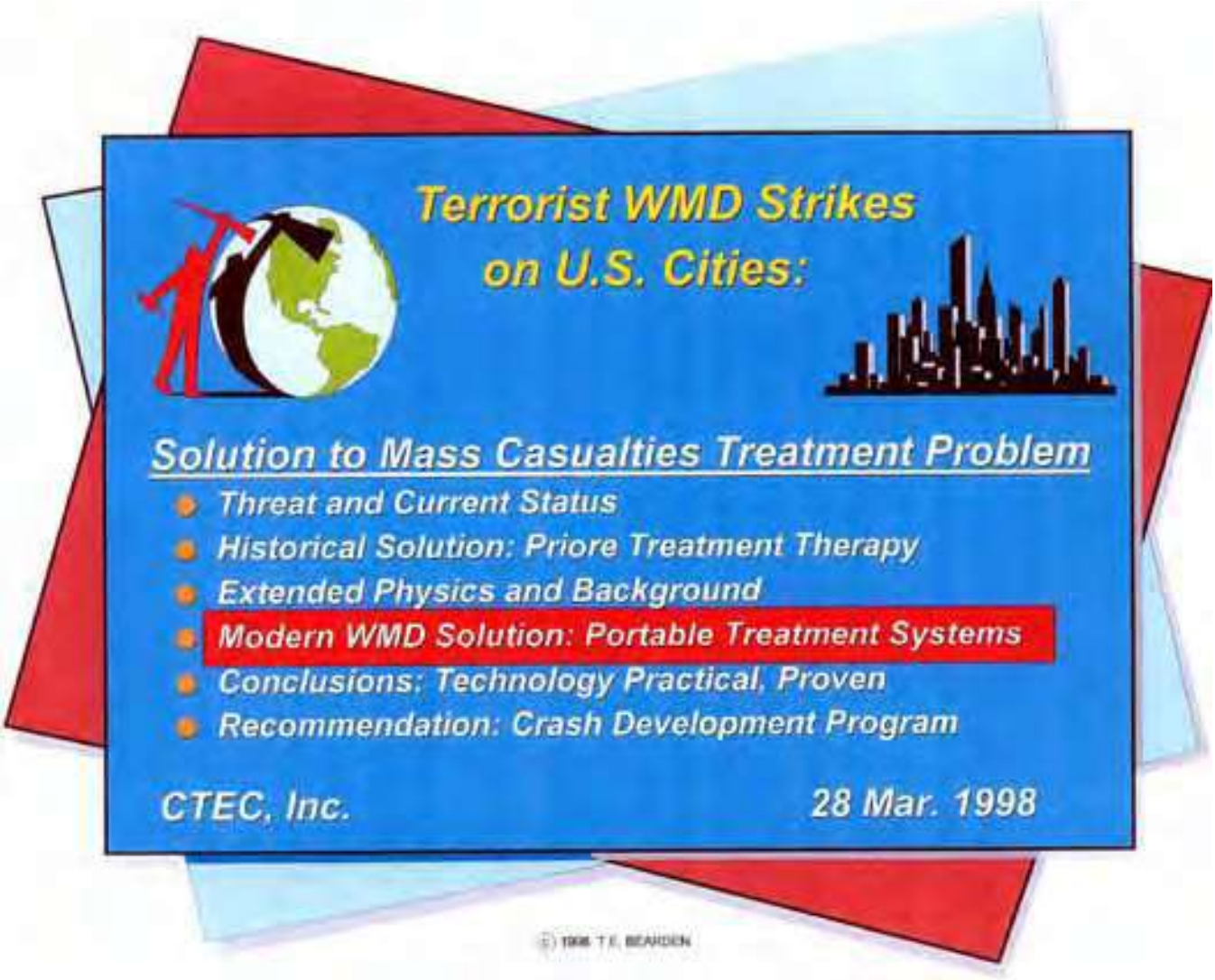

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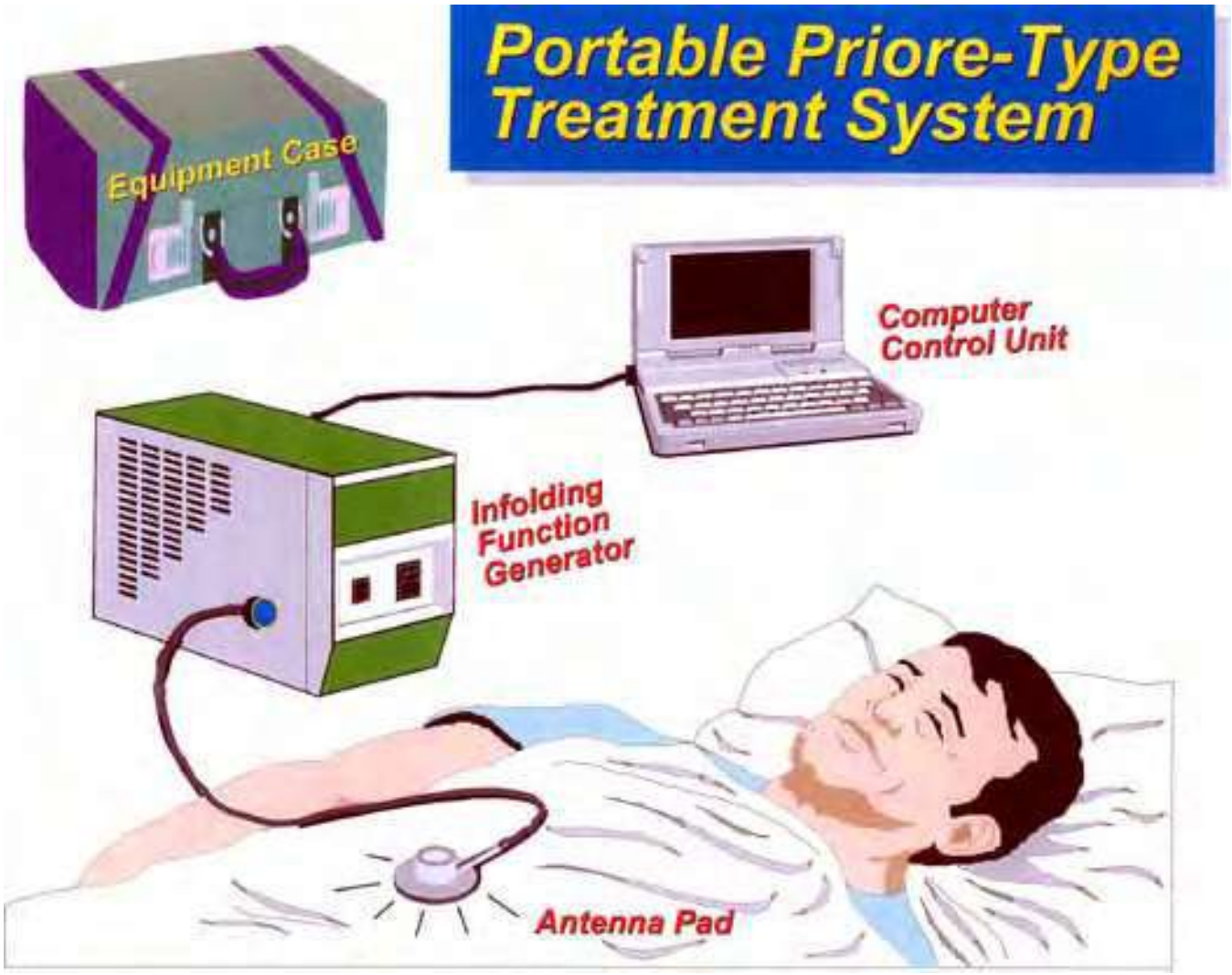

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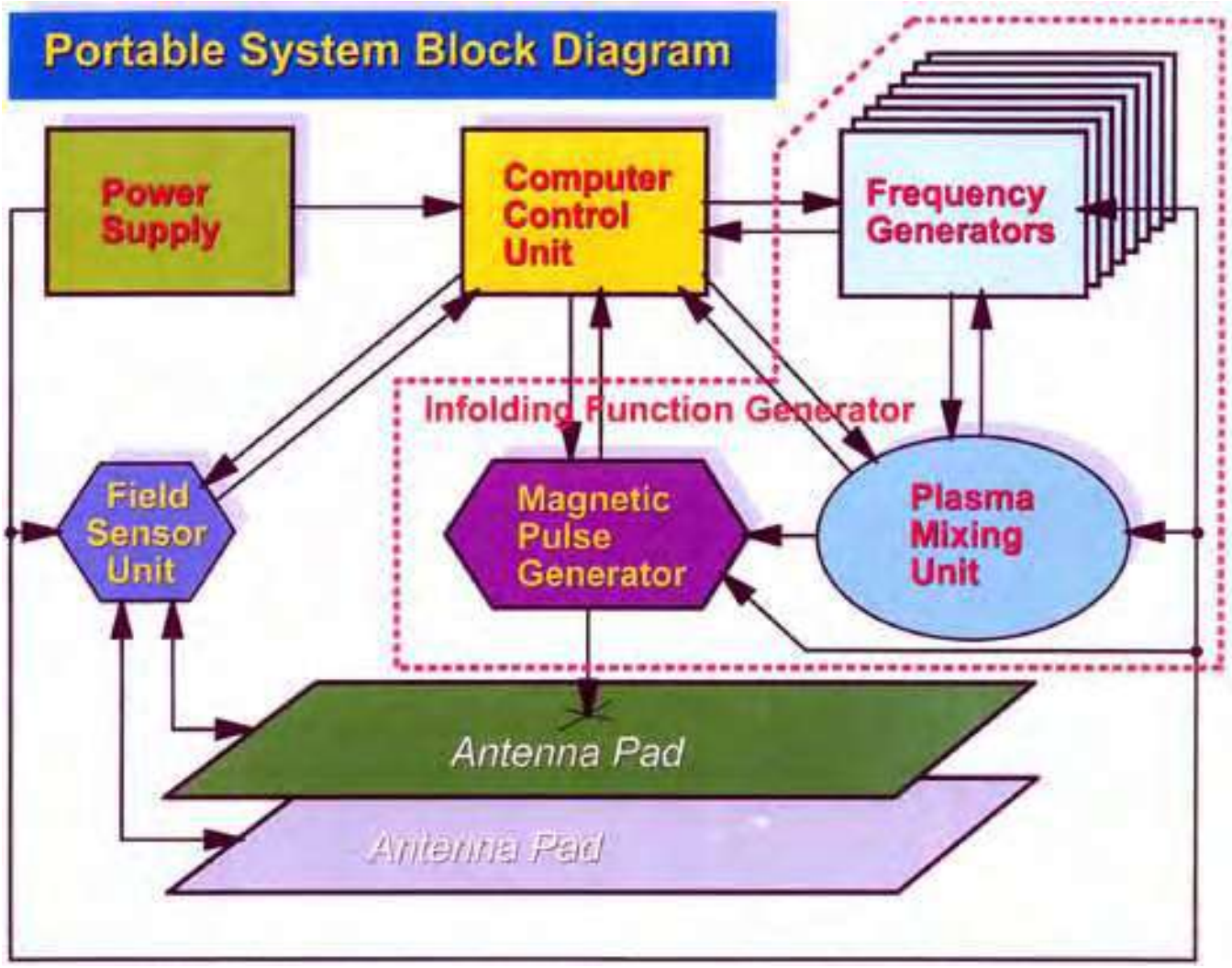

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PORTABLE PRIORE TECHNOLOGY UNIT

- FACT: DISEASE-SPECIFIC VACUUM ENGINE PRESENT FOR ANY CELLULAR DISEASE, BY WHEELER'S PRINCIPLE
  - *DISEASE CAN BE REVERSED BY CREATING AMPLIFIED VACUUM ANTI-ENGINE (BEARDEN'S PRINCIPLE)*
  - *ANTI-ENGINE IS CREATED BY PUMPING THE NONLINEAR CELLS IN THE "INNER EM" DOMAIN, TIME-REVERSING THEM*
- PRIORE UTILIZED A PLASMA TO PHASE CONJUGATE AND "INFOLD" MULTIPLE BIDIRECTIONAL LONGITUDINAL EM PUMP WAVES
  - *17 FREQUENCIES MIXED IN A ROTATING PLASMA*
  - *PHASE CONJUGATES ADDED BY THE PLASMA*
  - *INFOLDED MIX INTO STRONG PULSED DC MAGNETIC FIELD, WHICH CARRIED IT INTO ATOMIC NUCLEI*
  - *PUMPED ALL NONLINEAR CELLULAR COMPONENTS TO PRODUCE AMPLIFIED, SPECIFIC VACUUM ANTI-ENGINE*
- NEGATED THE LONG-TERM CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CELLS.
- SCRUBBED OUT THE CUMULATED PRECANCEROUS STATE
- RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING
- NO EXCESSIVE TRAUMA TO TREATED ANIMAL

CANCR 49

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SAVING THE STRICKEN CIVILIANS

SURVIVORS OF N CASUALTIES

(N = 1-40 MILLION)

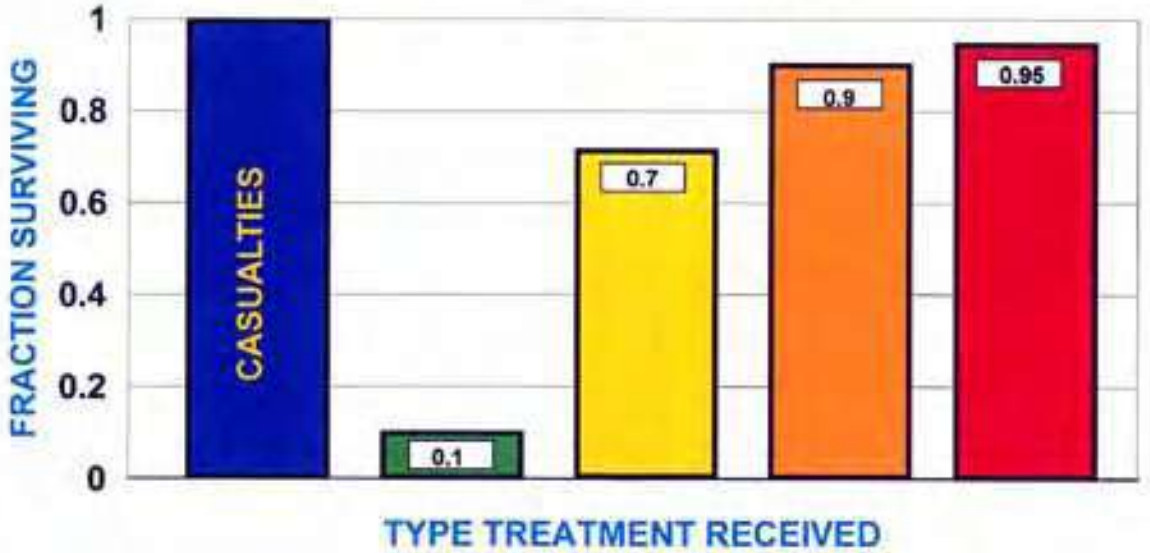

EXPRESSED IN FRACTION SURVIVING
- With conventional treatment
- With 1st generation P-treatment
- With 2nd generation P-treatment
- With 3rd generation P-treatment

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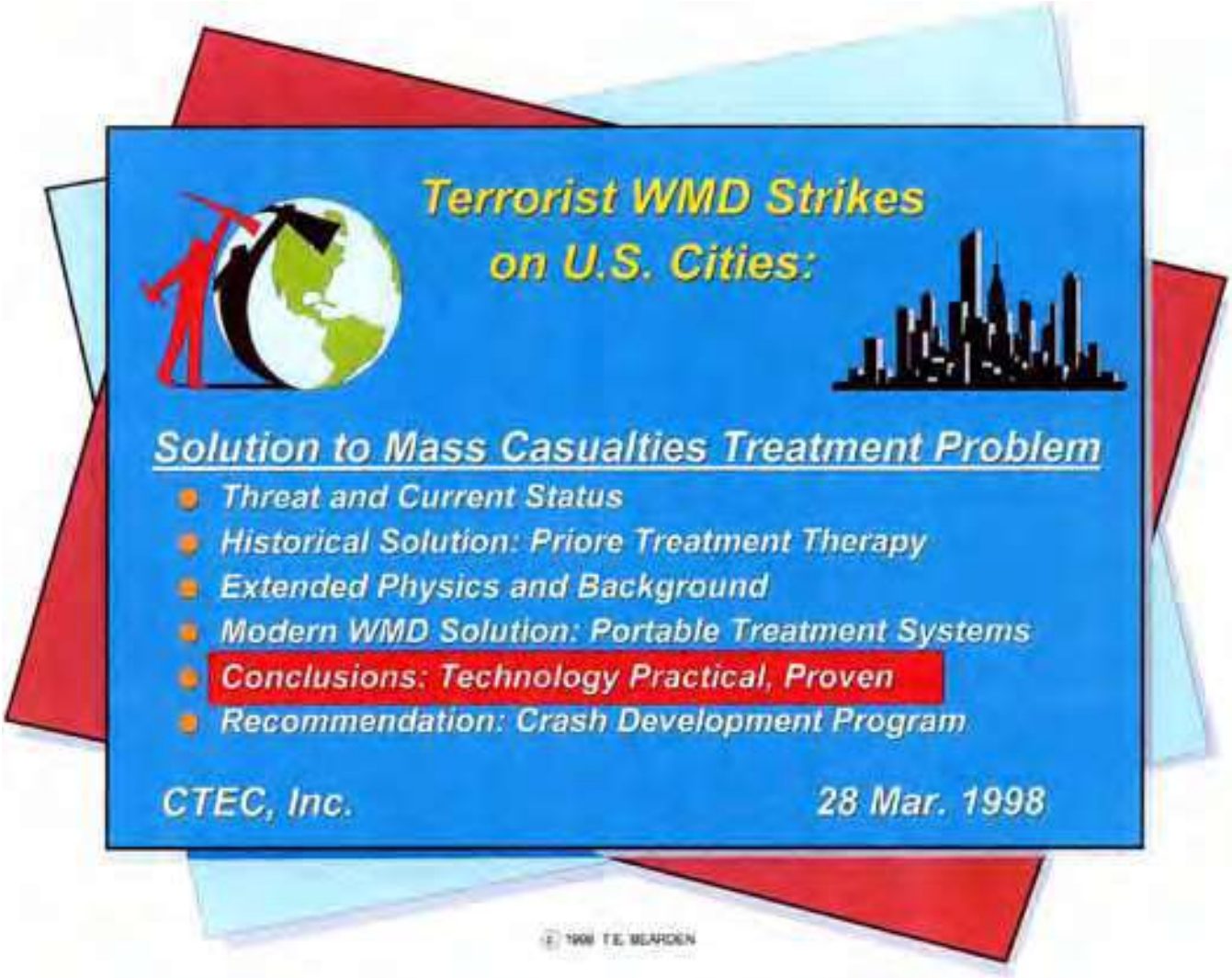

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Summary and Conclusions

- **A new therapeutic paradigm of great scope and effectiveness has been developed**
  - *Will provide effective, quick treatment of mass casualties*
  - *Will provide cures for unknown agents*
  - *No pathogen strains are resistant to this process*
- **Results have been proven experimentally**
  - *Documented in French scientific literature*
  - *Rigorous scientific protocols, eminent scientists*
  - *Technical mechanism deciphered*
- **Will treat and cure many diseases**
  - *Aids, atheriosclerosis, cancer and leukemia*
  - *Sleeping sickness*

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- **Portable units can be developed quickly**
  - *18-month crash development program required*
  - *high level authority and overwatch essential*
- ***Will solve the BW mass casualty treatment problem, both civilian and military***

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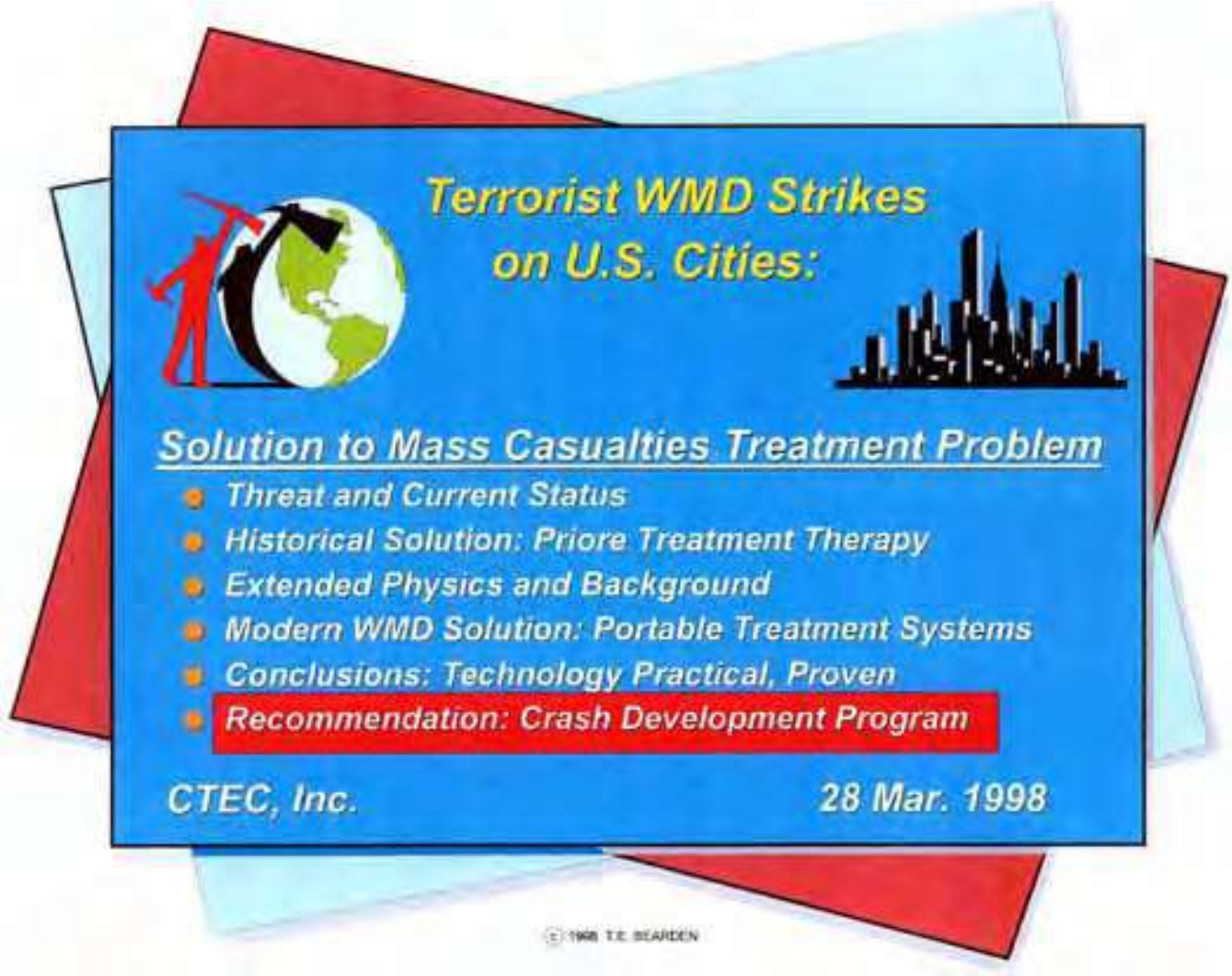

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Recommend implementing:

- Crash development program
  - Suitcase-sized portable unit
  - 18-month Manhattan-type project
  - Simultaneous theoretical modeling, animal testing w/breadboard models
  - SecDef and Congressional overwatch
  - Presidential Decision Directive
- Parallel logistics support program
  - Plan high speed production lines
  - Mass distribution, storage, maintenance
  - User, maintenance training
  - Plan C4 and usage at all levels
  - Integrate firemen, police, National Guard, FEMA, medical facilities, etc.

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Final Thoughts:

- The current internal BW threat can and will kill more Americans than all our previous wars combined
- The Priore technology is the only solution in sight that can save most of those casualties

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CTEC, Inc.
2311 Big Cove Road
Huntsville, AL 35801
(256) 533-3682 Ph/
(256) 539-5951 Fax

CTEC, Inc.

June 24, 1998

Dr. Jane F. Kinsel, Director
Office of Policy Analysis
Department of Health & Human Services
Bathesda, MD 20892

Dear Dr. Kinsel:

Your letter of June 8 is appreciated. However, the entire action package had already gone to the Assistant SecDef and also to Major General Neary in the USAF.

The proof of a revolution in medical treatment was in the package. The basis for it is already demonstrated experimentally in the scientific literature, both in the U.S. and in France. We are speaking of something already proven, but missed by the entire U.S. medical community. Strong words, but true. Let me be specific.

Any cell in the body can be time-reversed (physics term) or dedifferentiated (biology term) back to an earlier state, by pumping (i.e., "squeezing" in simple terms) that cell with longitudinal EM waves as pump waves. There are considerable papers in the French scientific literature showing the experimental results.

Apply that to cancer. We are stating bluntly that all cancerous cells in the body can be "depromoted" back to normal cells easily. Further, the damage previously done to them (such as by sustained hypoxia due to contaminants reducing the oxygen-carrying ability normally given to it by some 60-to-80 surrounding water molecules per red cell and the consequent H-bonding interactions) will also be reversed. The cells can all be returned to healthy, normal cells again, without "killing" or "burning" or "cutting" anything.

With some development of the technology, you can quickly and easily cure every cancer patient in every hospital in the United States.

Now apply it to AIDS. Since you can time-reverse every cell in the body, you can time-reverse the HIV-infected cells – genetics and all – right back to normal cells with normal genetics. Those cells not infected and healthy, will just get a "little younger" again.

So with that small development, you can quickly and easily cure every AIDS patient in every hospital in the United States.

I would have thought that NIH would certainly be interested in such a revolutionary therapy which has already been demonstrated in laboratory experiments. World-renowned French scientists – such as the eminent parasitologist Pautrizel and research PhDs assigned directly by Robert Courrier, head of the Biology Section of the French Academy of Sciences, worked with Prioré in performing those startling experiments that proved what we are saying.

The method was rigorously shown to cure infectious diseases (such as trypanosomiasis), atherosclerosis (which now afflicts millions of Americans), and terminal tumors. It was shown to reverse suppressed immune systems back to normal vigorous functioning.

Please permit me to disagree with you that the examination of such is not the mission of the NIH. To the contrary, it is precisely the NIH which should have some of its very best scientists looking into this.

The action package to DoD was to propose a crash program to develop this methodology in the form of a small, portable unit for treatment of mass casualties resulting from a terrorist BW attack on our cities (now expected in the next few weeks, as you must be aware). The leading Arab terrorist of the world has already promised just this.

We are speaking of several million Americans who are going to die. They are going to die in spite of everything that NIH and its labs can do, even though I know you will make a heroic effort. With NIH present methods, you cannot do very much for those stricken Americans at all. Everything we have in the "normal" kit bag is almost useless against a knowledgeable spray attack of modified smallpox (as you know, the Russian secret BW labs have made and sold tons of that already, to guess who!). Or a spray of tularemia (you are well aware of the extreme lethality of that), or anthrax (easily obtained). It is also common knowledge that these terrorist teams with their BW agents are already on site in this country, waiting for the word to attack. This has now been officially raised to our primary Strategic Threat.

In the face of such looming strikes on the U.S., I simply cannot believe that the NIH does not feel it within their mission to rigorously check out a proposed method for saving perhaps 70% of those coming deaths (first generation equipment), and up to 90% with second generation equipment.

Perhaps you just did not read the package carefully. I urge you to do so.

Else NIH is going to look very, very bad when (1) the strikes do occur, (2) they can't handle them (and they cannot, as you well know), (3) they had within their hands in advance, a proposed methodology that could have been investigated intensely, to save millions of those stricken Americans.

As a staunch supporter of NIH and especially CDC, I have to believe that there is a different attitude there. If NIH is not interested in a previously experimentally demonstrated method of saving millions of Americans, then the only recourse left is the political channel.

I assure you that my critique of electrodynamics is well-founded, as supported by various leading physicists such as Nobelist Feynman (who stated bluntly that the field concept is wrong), Wheeler, Bunge, and so on. It is inexplicable why all our universities are still teaching a 130 year old abridged (Heaviside's) subset of Maxwell's theory, and one that still contains a material ether even though that was falsified 110 years ago!

You already have seen the misuse of this technology by the Russians, in the decades-long radiation of the U.S. Embassy in Moscow. Is it not NIH's mission to understand how they generated all those diseases and health changes? Have you ever looked into Kaznacheyev's experiments showing that ANY cellular disease or disorder can be induced in cells at a distance by purely EM means? Have you looked into what got eliminated from electrodynamics by ignoring the hidden longitudinal EM inside every potential, field, and wave? Do you realize what ignoring that has done to American chemistry, biochemistry, and medical science?"

I would hope that the NIH would at least be interested in its own mission area!

I challenge you bluntly to admit that no one presently understands the primary operation of the human cellular *regenerative* system. That's because its technical principle is not presently in our recognized physics, biochemistry, and medical science – even though it has been in the hard physics literature since 1903-4. Becker's epochal work came closest; since he only had access to the conventional EM model, it failed him. But he at least showed you rigorously that cells can be changed (both differentiated and redifferentiated) all over the map by laughably weak EM – picoamperes of current, which means persistent DC potentials. In the microwave radiation of the U.S. Embassy, all the health changes occurred in regions absent of fields – i.e., absent of bleed-off of the potentials. Hence in regions of stable DC potentials! With 100% correlation of the health changes to persistent, gradient free potentials, and 100% anticorrelation to changing potentials (i.e., fields), our own scientists concluded totally erroneously that it could not have been the EM radiation causing the changes, when their own results had just proven that it was.

Now I ask you: Can NIH explain how it was that the DC potentials caused those health changes? I think not. If it could, it would understand the action package I wrote, and its importance.

This is not a "political" letter. I'm just an ordinary American citizen who has done about 30 years very hard work on this particular area. The work is good enough now to stand on its own merits. The scientific community will eventually accept it, about 50 years from now. But we cannot wait 50 years! Those millions of Americans are going to die, because of the bureaucracy and inaction of our own scientific organizations. Whether they like it or not, the U.S. scientific community is now the forefront of the struggle for this nation to survive. And they are failing us dramatically.

So as a parent who wants his children to live, and his neighbors' children to live, and those millions of soon-to-be stricken Americans to live also, I urge you to at least have someone competent in physics (and knowledgeable that the foundations of physics itself are in woeful shape!) check the work. Has anybody there *read* any of the references to the Prioré work I cited? Does anyone there realize that *there are no EM forcefields in space?* Probably not.

Dr. Kinsel, there is a time for "business as usual" and there is a time to do some serious new work. Those stricken Americans are going to be lying there. Nothing NIH can do is going to stop that. That's a given, and it is not my own estimate. It's the official estimate. And you *know* you presently do not have the tools to do anything really effective about it.

Frankly, I interpret your letter to me as just the normal "spin control" for easy disposition. I would hope that NIH would seriously rethink the situation, get off the "spin control" and "business as usual" posturing, and do something dramatically different for a change.

What have you got to lose? A little time from perhaps two or three of your best scientists.

What have you got to gain? Saving untold millions of American lives. A new, *already partially demonstrated* cure for most dread diseases such as AIDS and cancer – diseases which you presently cannot do very much about in spite of decades of heroic struggle.

Sincerely,

cc: Senator Shelby, Congr. Cramer

T.E. Bearden
President and CEO

CTEC, Inc.
T.E. Bearden, President & CEO
2311 Big Cove Road
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(256)533-3682 ph/(256)536-0411 Fax

CTEC, Inc.

May 12, 1998

Dr. Harold Varmus, Director
National Institute of Health
Bathesda, MD 20892
(301) 496-1766

Dear Dr Varmus:

We have recently sent action documents to the Director of Nuclear and Counterproliferation, Office of the DCS, Air and Space Operations, HQ USAF and to the DoD (General Busbee) Assistant Secretary of Defense, as well as several Senate and House committees, which may be of interest to you. For one thing, we give the technical mechanism used to generate the Gulf War Syndrome. The same weaponry is now being used to rapidly induce new strains of certain pathogens worldwide. I urge you to closely read that section of the letter to MG Neary which explains the GWS, why the French did not get it, and why Southern Iraqis got an increase in cancer and leukemia but not GWS. Also explained is how the "microwave radiation" of the U.S. Embassy in Moscow induced diseases for decades, and how we failed to comprehend it because the standard EM model deceived us.

There is a way to treat and quickly cure most diseases, including the mass casualties resulting from a terrorist BW strike on our civilian population centers, our military bases, or our forces in the field. The method is little known, but was scientifically demonstrated in France in the 1960s and early 1970s before cancellation of the Prioré Project when the French Government changed. Eminent French scientists worked on the project, and the results are fully documented in leading French scientific journals. References are listed in a separate attachment.

Previously the Western scientific community has been unable to understand the technical mechanism responsible for such remarkable cures, because of serious foundations flaws in Western physics and electrodynamics. *Foundations* physicists have long been aware our science is flawed, and have pointed out many of these fundamental errors. However, the operational science establishment has not paid attention, even though physicists such as Feynman and Wheeler pointed out that the notion of "force fields in space" was totally wrong.

As a primary example, there is an "infolded" electrodynamics inside all potentials, fields, and waves that is far more primary than the coarse EM that is in our textbooks. It is actually an infolded general relativity, and this is what the Russians have weaponized. This infolded EM-GR has been ignored in the West (but not in Russia) since 1903.

As another example the potentials, fields, and waves of present electrodynamics are rigorously defined – and exist – only in the presence of mass. They do not exist in such form (force fields and oscillating force fields) at all in space, in the absence of mass. Rigorously, Maxwell's equations are mass-to-mass transforms, since Maxwell and everyone at the time assumed the ubiquitous presence of the material ether. In other words, to the founding electrodynamicists, there was no place in all the universe that was devoid of mass. Hence they defined all EM entities as entities containing mass. Even though Michelson-Morley experiments of more than a century ago destroyed that material ether, not a single Maxwellian equation has ever been changed! They still assume the material ether.

Specifically missing from our electrodynamics are two essential transforms: (1) the mass-to-spacetime transform, and (2) the spacetime-to-mass transform. In other words, these two transforms are "infolded" or hidden inside (comprise) the end point extremum case – the mass-to-mass transform actually written by Maxwell.

But these two missing transforms are just general relativity (they correspond precisely to Wheeler's principle of general relativity). So general relativity has always been infolded inside electrodynamics as we know it, but ignored. Further, this is a very powerful general relativity, since it uses the very strong EM force as the agent of spacetime curvature. Hence now one can engineer a powerful general relativity in the laboratory and in practical devices, and even action-at-a-distance, which one cannot do using merely the staid and weak G-force.

It turns out that longitudinal EM waves as shown by E.T. Whittaker in 1903 and 1904 are far more primary than our present EM theory and even our present GR theory. Both EM and GR are directly engineerable using longitudinal EM waves, including subluminal and superluminal EM waves in vacuum, and including action at a distance. One can engineer complexes of spacetime curvatures as desired, which in turn are *spacetime engines* (Wheeler's term). These engines can act upon mass – either living or inert – in any fashion desired, and at any distance desired.

The little-known and poorly understood Regeneration & Recovery (R&R) system – as contrasted to the immune system – utilizes this exact "spacetime engine" methodology to restore damaged or diseased cells, within its limitations – "dedifferentiating" or "time-reversing" them back to normal. The mechanism is fully explained in the attached package. The proposed program applies this fundamental method to greatly amplify the effect. Thus cancer cells can be reversed back to normal cells, HIV-infected cells (HIV-factories) can be reversed back to normal cells (genetics and all), etc. This represents a dramatic and unparalleled new medical therapeutic methodology of extreme power. The same techniques can simply be conjugated one additional time, and used to produce diseases and cellular changes at a distance, including in entire mass populations, as the KGB is doing right now. Specifically, by impressing an extremely weak "cocktail mix" of disease spacetime engines on the U.S. populace, the immune systems are reacting and being "spread thin" across several "shadow state" infectious pathogenic conditions. Thus when an actual terrorist BW attack occurs, the lethality of the strike will be remarkably enhanced because the immune systems will be "thinned" in their ability to fend off this new pathogen. By doing it this way, BW warfare can actually be conducted upon the U.S. without anyone being the wiser.

Our very survival as a nation is threatened by remarkable KGB weapons using this fully documented, extended electrodynamics. Bluntly, unless we take off our scientific blinders and understand Russian energetics weapon science, GWS and the Embassy health changes in Moscow were just a picnic before what is upon us. After two decades of work on the KGB energetics weapon problem, we have fully deciphered the technical mechanisms and what energetics is, as well as citing many of the Russian weapon tests and how they were done. Again, you can see that for yourself in the package.

Now that we understand the technical mechanisms, we are proposing rapid redevelopment of the Prioré process, in portable suitcase-sized units to be mass produced and filtered down into the entire emergency community for mass treatment of lethal infectious diseases resulting from BW strikes. And we are strongly urging the U.S. scientific community to quickly investigate and come to grips with this vast new *biological engineering* mechanism. Our very survival depends on it.

The inclosed documents provide an overview of the process. There is nothing else on the scientific horizon that can save the majority of all those stricken Americans, once the first foreign-sponsored terrorist teams strike our population centers with BW agents.

Sincerely,

Incls: Full package with table of contents

T.E. Bearden
President & CEO

Scalar Wars

The Brave New World of Scalar Electromagnetics

by Bill Morgan

For the past six months I have been undergoing the greatest **paradigm shift** I have ever had to go through. It has rattled my nerves and shaken my bones. This intense adjustment of my "world" has come about by studying the information given by Col. Tom Bearden at his website Cheniere. The new knowledge there has necessitated a total revision of my ideas about physical reality, the world we live in, and the future of humanity. This paradigm shifting even actually made me dizzy on certain days as I tried to absorb and digest Bearden's vast amount of information. I am not a scientist at all, just a layman, and I have little comprehension of the math and high physics of this new science called "**Scalar Electromagnetics**." But there is a great deal of information at Cheniere which needs to become common knowledge as fast as possible, for the sake of the survival of life on earth. To that end I have put together this small primer of Bearden's ideas, as a kind of "beginner's guide" to his website. (I have tried to underline certain words and phrases which are part of the new "jargon" of talking about these "new" phenomena. Also I have taken the liberty of bolding certain words and phrases to help them stick in the mind).

(Note: Throughout "**EM**" means "**electromagnetic**," and "**LW**" means "**longitudinal wave**")

This article has six sections:

New Waves 2. Tapping the Waves 3. Weaponization 4. Healing 5. Psychoenergetics 6. As It Stands

1. New waves discovered

Longitudinal EM energy fills vacuum of space, the time domain of spacetime, time as compressed energy, E=tc2, waves of time, phase conjugate wave pairs.

"Electric power is everywhere present in unlimited quantities and can drive the world's machinery without the need of coal, oil, gas, or any other of the common fuels." Nikola Tesla

"At any point and at any time, one can freely and inexpensively extract enormous EM energy flows directly from the active vacuum itself." Tom Bearden

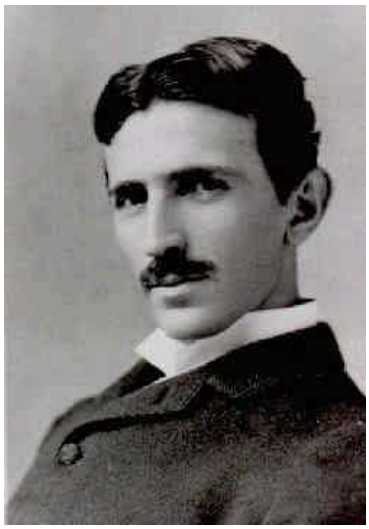

I guess the first thing to try to comprehend is that a "new" kind of electromagnetic (EM) wave has been discovered in the empty vacuum of space called “longitudinal” waves, which, when engineered, can be an inexhaustible supply of energy in great magnitude at any place in the universe. The word "new" is in quotes because the discovery really goes back to **Nikola Tesla** and his discovery of what he called "radiant energy." It is also not "new" because the Russians (KGB) have been working on this technology for over 30 years and have **weaponized** these "new" longitudinal scalar waves to a great degree.

These are the very weapons **Nikita Khrushchev** spoke of in January, 1960.

> "By 1957-8 the Soviets had progressed to the point of a giant scalar EM accident in the Urals which exploded nearby atomic wastes, devastating the area. They had also progressed to development of great new superweapons using their new energetics - weapons to which Khrushchev referred in 1960 when he informed the Soviet Presidium of a new, fantastic weapon in development, a weapon so powerful that it could wipe out all life on earth if unrestrainedly employed.'" Tom Bearden

After over 30 years of development, and extensive testing around the globe, these new scalar electromagnetic weapons are up and running and ready to go. Tom Bearden, at his website Cheniere, discusses the history of these new scalar electromagnetic weapons in his paper "Historical Background of Scalar EM Weapons."

Some Immediate Implications

The implications of successful engineering of the longitudinal waves are enormous, and will change the world as we know it, one way or another. Among other things, these discoveries mean that:

1. The **solutions to the energy crisis and the "oil problem" are in hand**. These oil wars are unnecessary. There is endless energy available freely from the domain of time.

2. **Unbelievably powerful weapons** are not only possible, but are already operating in several nations. The many powers of these weapons are unprecedented and mind-boggling.

3. The **cure of diseases such as cancer and AIDS**, in fact nearly any disease, has become possible within a few years of sufficient funding. Everyone can be made healthy and stay healthy.

4. **Mind control on a mass scale** has now become possible, and the machines to do it are already in place in certain nations. It has become possible to mentally enslave whole populations with the twist of a few dials.

So the layman will need to understand that there is a new kind of electromagnetic energy that is altogether different from what he knows, e.g. radio, TV, cell phones, etc. The ordinary EM waves that we have known about are called transverse EM waves, to distinguish them from the new longitudinal EM waves. These scalar waves do not actually exist in our "material" world, but exist only in the vacuum of empty space, or the time domain. And we must keep in mind that this vacuum of space we speak of exists all through everything. Even our bodies are mostly empty space between atoms and molecules. So the gateway to this seething ocean of energy can be there at every point in the universe. This seething ocean of energy is all around us and all through us.

Emptiness is Full

This amazing discovery announces that the "emptiness" of empty space is in fact not empty, but a great ocean of seething energy!

Col. Bearden refers to this ocean of energy as being of the "time domain." It seems like something from Star Trek but this is where scalar electromagnetics has come to. And where it is going may be beyond anything Star Trek could have dreamed of.

We live in a 3-dimensional world, which physics calls "3-space." But there is also spacetime, or 4-space, or the "4th dimension." Then suddenly comes this amazing new knowledge that time itself is actually compressed energy. And it is energy which is compressed by exactly the same factor by which matter is considered compressed energy: the speed-of-light-squared!

So we have a new companion to the famous E=mc2. It is now paired with E=tc2 (where t is actually "delta-t," or change in time). Or (amaze your family and friends and) say:

"E equals em-cee-squared"

and

"E equals delta-tee-cee-squared"

It has a nice ring to it, like some freedom bell announcing a new era.

And as the atomic bomb released the compressed energy in matter, so can we now unleash the tremendous energy that is compressed into time itself. It gives a completely new meaning to the term "time bomb."

Some New Terminology of Scalar Electromagnetics

A new science, several new names

> "Those [Russian] weapon scientists resurrected an old term from the history of electrodynamics, called "energetics". That is their approach to a unified field theory, where everything is based on "energetics". This model as its foundations uses a very similar approach to that "single fundamental unit" model, where energy is the unit. If one makes the energy EM in nature, then one has the Russian energetics approach. This unified approach gathers everything in, including all energy actions and relations in inert matter (the first branch of energetics, called by the same name), all field and matter interactions in living matter (the second branch of energetics, called "bioenergetics"), and all mind operations and mind-matter interactions (the third branch of energetics, called "psychoenergetics"). [ed: sometimes also called "psychotronics" by the Russians]

Rick Andersen in an article called "What is Scalar Electromagnetics?" describes the new science this way:

> "Scalar EM is the brainchild of Lt. Col. (retired) Thomas E. Bearden, a systems analyst and wargames specialist who has been advocating a view of electromagnetics which is based on the notion of a vast, unseen background of scalar energies (as opposed to vector energies) which underlie all physical reality.
>
> "If Bearden is correct in his Scalar EM theory, then we can build devices which would enable us to alter gravity, time, inertia, and the apparent mass of an object. This of course has ENORMOUS implications for military applications, space-vehicle drives, time-travel, teleportation, paranormal phenomena, and just about every other area one can think of." http://twm.co.nz/Beard_scalem.html

> "Time-energy, time-currents, and time-structuring play the dominant role in electromagnetics. Time-as-energy eventually becomes engineerable, as easily as is spatial energy now. We are always dealing with spacetime and with spacetime curvature."
>
> Bearden: http://www.cheniere.org/techpapers/Vision%202000%20paper.doc

The scalar energy discovered in the vacuum of space is sometimes called "zero-point" energy. Thomas Valone explains how this term came about.

What does "Zero Point" mean?

"Boyer traces the historical “creation of the vacuum” as proceeding in stages in parallel with the historical development of ideas about the vacuum. To paraphrase, he says that in the 17th century, it was thought that a totally empty volume of space could be created by simply removing all matter and, in particular, all gases. That was our first concept of the vacuum. Just get rid of all the gas. Late in the 19th century, it became apparent that the region still contained thermal radiation. But it seemed that the radiation might be eliminated by cooling. So the second concept of getting a real vacuum is to cool it down to zero temperature. Just go all the way to absolute zero. Then we’ve got a real vacuum. Right? Well, since then, both theory and experiment have shown that there is a non-thermal radiation in the vacuum and that it persists even if the temperature could be lowered to absolute zero. Therefore, it was simply called the “zero point” radiation. "Thomas Valone http://www.seaspower.com/InsideZeroPoint.htm

> "**For our very survival, it is absolutely imperative that informed citizens be aware of this dramatic change, which is just now starting. The powerful new science and engineering must be controlled and used for humanity's benefit, not its detriment. Else it will eventually be let loose unrestrainedly, to destroy all life on earth - a possibility indicated by Nikita Khrushchev in 1960**." - Bearden
>
> http://www.cheniere.org/explore%20articles/priore1/p4.jpg

2. Tapping the waves

Endless free energy, Tesla's radiant energy, the dipole as the gateway to the energy of the void, MEG in one year, Bedini, Yakuza, etc. End of Oil, geopolitical chaos, rogue groups

Move Over G.E. & Big Oil, Energy is Everywhere!

Third-world nations set to rise

> "Certain powerful interests did not wish the extended electromagnetics to be discovered or taught. That, after all, would lead to free energy and loss of economic control of the citizens. That was precisely why Nikola Tesla had already been suppressed ... Today it is still being suppressed by the orthodox establishment."
> http://www.cheniere.org/books/ferdelance/s25.htm

The vast seething ocean of energy of the vacuum, the longitudinal scalar EM waves of the time domain, can now be tapped and "transduced" into ordinary (transverse) EM energy in our 3-Space world. The process can be compared to putting a paddlewheel into a river. The energy acquired is free, since the river is there flowing whether we tap it or not. And it is a mighty river, and is not diminished by our paddlewheel.

This means that a permanent solution to the "energy crisis" is at hand, if only those who hold it so secret would give it up to humankind.

It means our species' insane use of oil is no longer necessary. We can make automobiles that need no fuel at all. We can build motors that power themselves. It means that unlimited electrical power can be available for free anywhere in the world. Every house and even shack can have its own power supply.

Of course there is the cost of the equipment at first, but the energy flow is free for the presumably very long life (no moving parts) of the generator. It will probably take decades to shift over to scalar power.

But the ability to tap the scalar (longitudinal) EM waves of the vacuum (which exists everywhere) also means that unbelievably powerful weapons can be, and already have been developed. In fact these weapons are so dangerous that the fear engendered becomes a psychological obstacle to the grasping of the facts.

I struggled with this myself for months, and even though Tom Bearden had completely convinced me already, it is hard to accept the fact that for everyone on earth the "worst that might happen" has suddenly gotten much worse. It takes time to deal with that, to realize it and get over it.

Indeed, the possibilities of these new weapons, which are tapping the huge energies of time, are so terrifying it is natural for the mind to simply say: "I don't want to hear about that."

And the government, likewise, pretends these weapons do not exist and tries to keep it secret from the people. Because most people would indeed be truly alarmed to know the actual situation. Col. Tom Bearden has decided that the people need to know the truth anyway. As a People on a Planet we must face this now, and ban the use of scalar weapons in war or in mass mind control. The current deployment of these weapons is a world emergency which we must all face.

The physics and mathematics of the longitudinal waves and the time domain are clearly beyond the layman, but I recommend scanning through them anyway just to get a sense of the wonder and the elegance of it all and some of the exotic terms which are used. Two of the most important papers by Col. Bearden are:

Giant Negentropy from the Common Dipole

The Final Secret of Free Energy.

Despite the complexity of the science involved, Bearden sums up the essential secret of it all in a few words.

> "There is no problem at all in extracting all the energy one wishes from the active vacuum, anywhere in the universe, at any time. Just make a dipole.

> The problem is in (1) catching some of that freely gushing EM energy in a circuit containing a load, and (2) dissipating the caught and collected EM energy in that load to power it, without using half the caught energy to destroy the source dipole's).
>
> That is the ONLY real energy problem on the planet, and always has been."
>
> http://www.cheniere.org/correspondence/022502.htm

A dipole could be a battery, which is polarized into negative and positive. Or the terminals of a generator. Or any magnet with its two poles. Or an atom with its positive and negative charges. Or the earth's magnetic field, the sun, and all heavenly bodies. Even a galaxy must be some kind of mega-dipole. Wherever there is a dipole there is already immense scalar EM energy ushering out of and back into the vacuum. And there have already been demonstrated a number of diverse methods for tapping that energy as it flows. (John Bedini, Edwin Gray, Bruce de Palma, and others). Bearden provides what he calls a "partial list" on his website.

> "In other words, nature then gladly gives us as much EM energy flow as we need, indefinitely — just for paying a tiny little bit initially to "make the little dipole." After that, we never have to pay anything again, and nature will happily keep on pouring out that 3-flow of EM energy for us. This is the giant negentropy mechanism I uncovered, performed in the simplest way imaginable: just make an ordinary little dipole."
>
> Bearden http://www.cheniere.org/techpapers/Unnecessary%20Energy%20Crisis.doc

How to Buy a Free Energy Machine

Answer: Just wait one more year! 2003. Then get off the Grid!

Perhaps the most eagerly awaited event now is the marketing of Bearden's Motionless Electromagnetic Generator (MEG) scheduled to begin in about a year's time. This is when the proof will hit the fan. Many people have said to me, when talking about free energy, "I'll believe it when I can go to the store and buy one." Hopefully in a year's time they will be able to order their own MEG. And then they will believe, because it works and is working.

Says Bearden: "I will admit that the chief scientist of an important experimental group in a large company was rather stunned at the type of output we were able to obtain. The MEG may look like just a transformer, but it is not. It is a completely different breed of cat."

(Bearden : http://www.cheniere.org/correspondence/011202.htm)

Soon the cat will be fully out of the bag. The first MEG units will supply 2.5 kilowatts of free electricity. Forever. Units can be connected together to double or triple the wattage. After that gets going, 10 kilowatt generators are planned. Energy will flow freely from the time domain indefinitely, and there are no moving parts to wear out. This manufacturing project is a heroic effort and will change the world as we know it. For once people are in possession of such devices there can be no further denial from anyone, including the government and/or "secret-government."

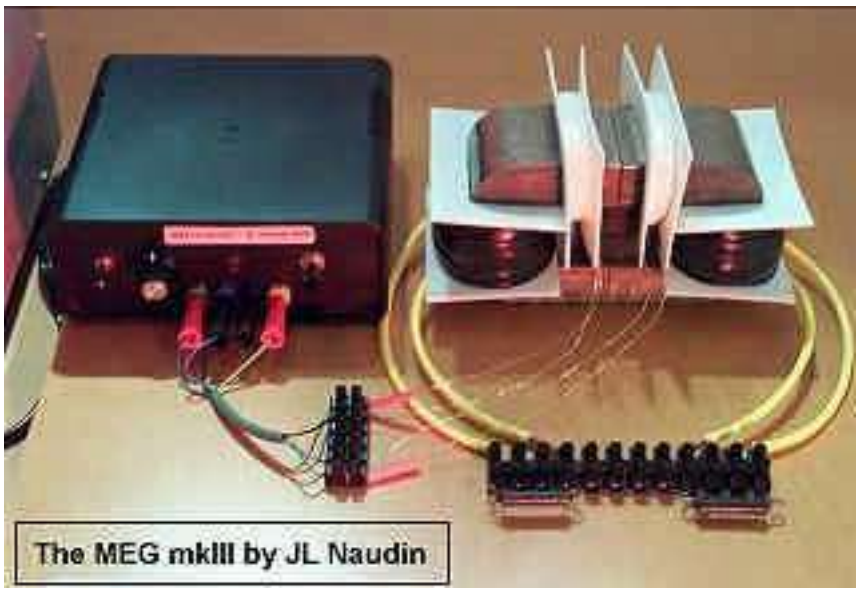

The Motionless Electromagnetic Generator

(Successfully replicated here by J. L. Naudin)

The physics of how the MEG works is explained in the paper "The Motionless Electromagnetic Generator: Extracting Energy from a Permanent Magnet with Energy Replenishment from the Active Vacuum."

The device was successfully replicated by J.L. Naudin in France, and others, like Steve Utne, are also working on their own models. But Magnetic Energy Limited's MEG is actually scheduled for production soon and looks to be the first commercially available free-energy generator in history!

I imagine it will not take long for tinkerers to put them into their electric cars and make the first fuelless automobiles since Tesla's unheralded (and unheeded) experiments. Or for builders to begin building houses powered by MEG's. Houses which will never see electric bills. How can they ever make enough of these to meet the demand that will suddenly be there? Bearden is right, it needs to be an all-out crash program of the government on the order of the Manhattan Project.

I must include here that Bearden is quick to point out that he is not himself the inventor of the MEG, but is a partner and advisor in bringing it to the public market through Magnetic Energy Limited, Inc. I must also admit that I am praying for the success of this venture, and the ending of the absurd and criminal withholding of this technology from the people by the black-ops military-industrial people. This secrecy has cost the planet over 30 years of unnecessary pollution.

The first units off the assembly line, which is being set up in a "friendly" unnamed nation, will usher the public at last into the new era of scalar electromagnetics.

As of December, 2001, the situation with the MEG was described by Bearden in a letter.

> "What we presently have with the MEG is a successful laboratory experiment. At least a year's very hard research will have to be done before we will be ready to put a commercial power supply into production.
>
> "Consequently, we have made an agreement with a foreign partner (the National Materials Science Lab of the National Academy of Sciences of a friendly foreign nation) to do that year's research. At the same time, we are trying to make an agreement with one or more large financial partners here in the U.S."
>
> Bearden http://www.cheniere.org/correspondence/121901.htm
>
> "So we are hopeful that we will be able to start introducing units on the market about a year from now. Quite simply, we will either succeed or we will fail. But we will give it our very best effort."
>
> Bearden http://www.cheniere.org/correspondence/012202a.htm

Bearden has given another technical explanation of how the MEG works here in a letter.

Motionless Electromagnetic Generator patented, 3-26-2002

Click here to read the patent

"In Magnetic Energy Limited, all business discussions and arrangements are taken care of by Dr. Lee Kenny, Managing Partner. There are five of us who are co-inventors of the MEG, and two of the others are really the principal inventors." Bearden http://www.cheniere.org/megstatus.htm

Free Energy has been Suppressed

Secret Government Aware of Free Energy

"In this world of contemporary times, all the agencies, CIA, FBI, KGB, NSA, Electric Power Research Institute, DARPA, Brookings Institution, Henry Kissinger, Edward Teller, et al., all are aware of [free-energy researcher Bruce] De Palma and his ideas.

"Because these individuals and institutions are employed by the ruling elite to forecast the future and satisfy present needs and demands, it is clear that free energy is a threat to the world order constructed by business and the mindset of those who want to own the world.

"Free energy represents Man's aspirations and dreams of freedom and equality, uniform division of resources and the ability to choose one's own future.

"The fact that free energy is suppressed speaks to the greed and self-interest of a ruling elite which, even in the face of an emergency of global starvation, resource depletion and environmental pollution, will not give one inch if it means loss of control. This is an

> attitude of paranoid delusion and fantasy which can only arise from the alienation of a class of elitists who, through their money, are completely insulated from the reality of the day to day fight for existence of the common man."
>
> http://depalma.pair.com/Absurdity/Absurdity07/ProblemOfFreeEnergy.html

Bearden describes one case of suppression when the Yakuza killed the Kawai engine in his very presence in Huntsville, Alabama.

> "That night a jet arrived from Los Angeles, with a Yakuza on board. The next morning Kawai no longer controlled his company, his invention, or his own fate. The Kawai party was in fear and trembling. The Yakuza coldly dissolved the agreement, they packed up the two Kawai engines we had, and left. And that was that."

So it is not only governments who are keeping this revolutionary technology from seeing the light of day. The Yakuza? KGB? The Aum Shinrikyo cult? Our "leaders" need to be honest about what is going on, otherwise they look foolish, acting out a kind of "Alice In Wonderland" script before the public, a script that has become completely unbelievable.

Concerning the criminal withholding of this scalar technology by the military black-budget people, and the cover-up of the actual situation regarding scalar weapons throughout the world, Tom has this to say:

> "The high government officials of the United States of America grossly violated our constitution and their sworn oaths of office. Our constitution specifically charges the government of the United States to defend the people of the United States. That means our officials are specifically charged with defending our people. Yet they deliberately agreed not to do so, and they deliberately sacrificed us in advance.
>
> "They committed treason of the highest kind, by deliberately surrendering us to total destruction anytime the big balloon goes up."
>
> Bearden http://www.cheniere.org/books/ferdelance/s75.htm

Energy Crisis Solved

One of the "must read" documents at Cheniere is "The Unnecessary Energy Crisis: How to Solve It Quickly," especially since the "oil wars," which Bearden has foreseen for decades, have now already begun.

Here are some clips from that Document:

> "To avoid the impending collapse of the world economy and/or the destruction of civilization and the biosphere, we must quickly replace much of the "electrical energy from oil" heart of the crisis at great speed, and simultaneously replace a significant part of the "transportation using oil products" factor also.

> "The technical basis for that solution and part of the prototype technology required, are now at hand. We discuss that solution in this paper."

And although the solution to the energy problem and the oil wars may be at hand, Bearden suggests there is still an urgent rush that needs to be made to save human civilization from collapse.

> "Once the technology hardware solutions are ready for mass production, even with a massive worldwide deployment effort some five years are required to deploy the new systems sufficiently to contain the problem of world economic collapse. This means that, by the end of 2003, those hardware technology solutions must have been completed, and the production replacement power systems must be ready to roll off the assembly lines en masse.
>
> "The 2003 date appears to be the critical "point of no return" for the survival of civilization as we have known it.
>
> "Reaching that point, say, in 2005 will not solve the crisis in time, and the collapse of the world economy as well as the destruction of civilization and the biosphere will still almost certainly occur, even with the solutions in hand."
>
> "The good news is that we now know how to easily initiate continuous and powerful "electromagnetic winds" from the vacuum at will. Once initiated, each free EM energy wind flows continuously so long as the simple initiator is not deliberately destroyed."

On page 9 he explains the concept of the dipole, and how there is already huge scalar energy flowing in the time domain around any dipole. Hold a magnet or a battery in your hand and you hold a stress in time and a beautiful flowing loop of longitudinal waves!

Bearden decries the scientific community in the West for being unable to let go of their dogma long enough to see that the greatest discovery in human history lies at their feet, but for their stubborn ignorance.

> "The present energy crisis then is due totally to that "conspiracy of ignorance" we referred to, that is maintained by the scientific community, and that has been maintained by it for more than 100 years.
>
> "This is the real situation that the environmentalists must become aware of, if they are to see the correct path into which their energies and efforts should be directed — to solve both the energy crisis and the problem of gigantic pollution of the biosphere. "As far as anyone in the legislative branch of government ever understanding the profundity of the discovery and engineering of scalar waves, Tom Bearden says they are at a great disadvantage in doing so.
>
> "The nontechnical person — e.g., a Senator or a Congressperson — is operating under a distinct disadvantage. If he or she takes the stance that much better electrical power systems can readily be achieved, he or she is in fact opposing almost the entire set of University, Government Technical, Power Company, Battery Company, and Organized

> Science communities. Further, in most cases his technical advisors are themselves from one or the other of those communities, and likely to go back into that community or those communities when the Senator or Congressperson leaves office, or even before. So the Congress and the non-technical government community at large operate at a great disadvantage...Bearden National Emergency Declaration is Needed
>
> "The Government Non-Technical community (the Senate and the Congress, in particular) are in far better shape than the Government Technical community, to appreciate the world implications of the pending economic disaster. I am hopeful that both the environmentalists and the Government Non-Technical community will rapidly unite in a common goal to get this vacuum energy program launched, under a National Emergency declaration. If so, then they can solve the energy crisis and the pending economic crisis, in fairly short order, and permanently."
>
> unnecessary_energy_crisis.htm#congress_disadvantage

In the conclusion of his paper The Unnecessary Energy Crisis: How to Solve It Quickly Bearden again states the urgency of replacing our centralized power grids with highly dispersed and local taps on the freely flowing energy of the active vacuum. Given the abilities of the Tesla howitzers, the power grids of all nations are sitting ducks.

> "Personally, the present author regards the increasing energy crisis as the greatest strategic threat to the United States in its entire history. I will do anything within my power to help prevent what I perceive to be the looming economic collapse of the Western world, preceded or accompanied by a sudden, explosive, all-out and continuing exchange of the WMD arsenals of most of the world.
>
> ...In the name of all humanity, let us begin! Else by the time this first decade of the new millennium ends, much of humanity may not remain to see the second decade."

3. Weaponization

Scalar interferometry, Tesla howitzer, Tesla dome, heat/cold, dudding, 10 nations have them, dead-man fusing & Insane Systems, scalar strategy, earthquakes and weather wars, solar storms, mind attacks, leased to Yakuza, many examples of testing, quantum potential weapons.

> "Indeed, Soviet energetics weapons are now capable of destroying both our triad shield, our homeland, our armed forces in the field, and our population, quickly and efficiently. We have a new "gap" of monumental proportions: not a missile gap, not a submarine or bomber gap, and not even a particle beam or laser gap. We have a scalar electromagnetics or electrogravitation gap." Bearden http://www.cheniere.org/books/ferdelance/intro.htm

"We have a new weapon, just within the portfolio of our scientists, so to speak, which is so powerful that,

if unrestrainedly used, it could wipe out all life on earth. It is a fantastic weapon." Khrushchev, to the Presidium, Jan. 1960

> "We've totally missed the most incredible "secret superweapons" development program of all times, and the worldwide testing of the weapons themselves.
>
> "Hiroshima and Nagasaki should serve as object lessons in the price of ignorance of such technological breakthroughs.
>
> "History does repeat itself. But this time it's not we Americans who got the great new superweapon first."
>
> Bearden http://www.cheniere.org/books/ferdelance/s75.htm

Warfare has been changed forever by the development of these scalar energy longitudinal wave howitzers. To get a basic understanding of scalar waves is to have the imagination suddenly run wild as all the implications and possibilities regarding warfare fall into place. One realizes with a certain horror that the world has totally changed, and that there are some very fearsome possibilities. Remember, the power for these weapons comes from the time domain, longitudinal EM waves in the vacuum of empty space, and the power is tremendous and mind-boggling. Being able to blast away at any target from a distant control booth is something that has never happened before. This is incredible power to be in control of and it divides the history of weaponry into "before" and "after." And the destructive power of these weapons is delivered instantaneously to the target from the local vacuum at the place of the target.

From an interview:

> Questioner: "Are you saying that real energy can be transmitted faster than the speed of light?"
>
> Bearden: "Yes. But hyperspatially. Not through 3-space, but "around" it. Again, this means that it's possible to produce energetic changes in a distant system at a distant place, without transmitting energy "through space" in the normal sense. You transmit "around" space, so to speak, and directly in time or through a higher dimension, depending on the model you're using to understand this. Further, the speed of the internal EM energy transmission is not limited to the speed of light."
>
> http://twm.co.nz/beard_interview.htm

Here are some initial considerations about scalar weapons and scalar wars

1. Tesla Howitzer 2. Tesla Domes 3. Rogue groups 4. WW III 5. Russian "UFOs?"

3a. The Tesla Howitzer and its modes of action

Source: Tom Bearden's weapons slides and Fer-de-Lance Briefing

For one thing there is no delivery of any thing to any place. Bombs are obsolete. So are the planes to get them there. No helicopters necessary. All current nuclear devices are rendered nearly useless by electronic "dudding." All distant-destruction can be done from a control room, and to any point on earth. The destructive power of "men" has just increased by orders of magnitude. The new weapons could even cause storms on the sun! Thus there is great urgency to make these new facts public and known, with the hope that all nations would come together to ban the use of scalar weapons.

Two scalar antennae together along with the computers to control them, make up a scalar interferometer, and according to Col. Bearden the Russians have hundreds of such installations already. These interferometers are called "Tesla Howitzers." They can deliver a giant blast of energy to the distant target site, true "action-at-a-distance".

The first howitzer mode is called the "exothermic" mode of operation because immense EM energy blasts outward at the target site. The blast of a scalar howitzer can be of near nuclear level in destructiveness, and can be repeated easily, at that place, or nearby, or anywhere.

The howitzer can use a lesser exothermic power setting and simply destroy all electronics in the target area. Thus they can render our nuclear missiles inoperable as they sit in their silos by "frying" the electronic circuits that guide them. They can bring down any airplane, anywhere in the world, at any time. Any person anywhere, if their exact position is known, can be assassinated without a shot being fired.

The howitzers can also bring down power grids anywhere in the world, at any time. Thus they could bring Wall Street to an instant halt by disabling all its electronics. Even this one little easy tweak of the howitzer could cripple the U.S. economy in a single day. No wonder the "leaders" don't want you to know! This is a new era we are in. The discovery and development of scalar interferometry has put us in a new world, whether we like it or not. Anyone could be expected to go into denial, the befuddled senators and congressmen included. But we have to wake up.

In a second howitzer mode called the "endothermic" mode, the howitzer sucks energy out of the target area, essentially creating a blast of cold at the distant target. It is even capable of freezing parts of the ocean. Bearden gives a number of cases where these "cold explosions" have been witnessed, mostly by airline pilots. April 9, 1984: 1 2 3) A huge mushroom cloud of mostly water is seen rising miles into the sky from out of the ocean, an awesome sight.

In the endothermic mode the sucked-out energy must go somewhere, so it is vented out at some other chosen spot on the earth. These endothermic plumes have been photographed by satellite.

> "The exhaust in the left picture is about 150 miles long, and is nearly horizontal (about 1.5 degrees above the horizontal). It is entirely consistent with the continuous exhaust from a "dumping transfer" scalar EM howitzer in the continuous exothermic mode. (The primary howitzer, of course, was activated in the endothermic mode.)" Bearden More Plumes

By using both of these heat (exothermic) and cold (endothermic) modes together the weather can be altered anywhere. Warm the air over here, cool it down over there, put a curl in the jet stream, dissipate clouds, create clouds, whip up a tornado. Bearden speaks about using the endothermic howitzer mode as a weapon of war:

"Cold explosions can be used to freeze tanks, personnel, and equipment. The equipment and tanks thaw out. The personnel thaw out too, but they are dead when they do." Bearden, Fer-de-Lance

(This endothermic mode of the howitzers makes me think that there might one day be a cure for the problem of global warming after all. Could not a big device, situated in space or on the moon, be able to vent a great deal of excess heat outside the atmosphere into space, thus functioning as a kind of planetary thermostat?)

While the United States has experimented with electomagnetic weapons using ordinary transverse EM waves, the longitudinal [LW] weaponized waves are truly of another order altogether.

For one thing they do not have to travel through space, for they come from the time domain, which is everywhere. The energy of the blast, the heat or light or whatever, comes from the vacuum of space at the location of the target itself. This is astonishing. The weapons actually just trigger the release of immense energy from the vacuum at the target location.

> "... it is possible to focus the potential for the effects of a weapon through spacetime itself, in a manner so that mass and energy do not "travel through space" from the transmitter to the target at all. Instead, ripples and patterns in the fabric of spacetime itself are manipulated to meet and interfere in and at the local spacetime of some distant target. There interference of these ripple patterns creates the desired energetic effect (hence the term energetics) directly in and through the target itself, emerging from the very spacetime (vacuum) in which the target is imbedded at its distant location." Bearden Fer-de-Lance

The big Tesla howitzers are aimed at their targets by using a worldwide electromagnetic pattern called the "Woodpecker Grid," begun by the Russians in 1976.

You can hear the Woodpecker signal here: http://www.cheniere.org/misc/woodpeckersound.htm

The woodpecker grid is just that, a grid of EM waves which provide a channel for the LW waves to any point on earth. Computers use the woodpecker grid information to hone down the aiming of the howitzers to a pinpoint location on earth. (For that matter, it could be under the earth, in space, or under the sea).

A third howitzer mode is what Col. Bearden calls "Mindsnapper" mode. This is a truly frightening mode which affects the electromagnetic mind-body connection. Being mind-snapped at a low level would cause you to lose consciousness. Being mind-snapped at a slightly higher power would "entrain" all minds in the target area into a kind of hypnogogic trance, a state in which they would all be highly susceptible to suggestions and orders.

Being mind-snapped at high level would so disrupt the mind-body connection that everyone in the target area would fall down, instantly dead. Not only that, everything around you and inside you would be killed, so that your sterilized body would not rot for quite a long time.

The Mindsnapper can be used for a small area, or to kill an entire population. In fact, using the scalar waves to affect the human mind has become a new field in its own right, and has been dubbed "psychoenergetics." (This is discussed below in section 5).

Bearden describes the use of the howitzer in mind-snapping mode against people, to cause unconsciousness or death:

> "From a military viewpoint, these scalar EM weapons are really quite all-around weapons.
>
> "For example, they are very lethal against personnel.
>
> "Set in the "high intensity pulse mode," one blast and a person's nervous system is destroyed instantly. Total, instantaneous death results. One can blast away at entire groups of infantrymen, for example. It's the peak power that's important, not the average power. So the weapon doesn't require too much battery power.
>
> "Set on a lower intensity pulse mode, one zap can simply knock out a person, rendering him instantly unconscious. Quite useful if one needs prisoners to interrogate. Also very silent, which is useful in operations employing stealth and surprise." Bearden http://www.cheniere.org/books/ferdelance/s80.htm
>
> "Those hit by the scalar EM weapon, however, have a most peculiar death mode.
>
> "Death comes-instantly and totally. There is no convulsion, no response. The entire nervous system is destroyed instantly. Every living cell in the body is killed instantly, including all bacteria, germs, etc.
>
> "A body hit with this thing falls like a limp rag and lies where it falls. It doesn't decay in even 30-45 days. In a macabre fashion, it's been reduced to something like food irradiated with nuclear radiation; everything is killed, so the material is preserved for an extended period before any decay can set in."
>
> Bearden http://www.cheniere.org/books/ferdelance/s81.htm

He goes on to say that the same "bazooka-sized scalar EM pulse weapon" can also be used to knock out a tank with one shot (or pulse). So tank warfare is obsolete. Helicopters? Bearden points out: "... if he's attacked by a helicopter or a fixed-wing aircraft, he can bring the same weapon to bear on it. He can knock down a chopper or a jet. With one shot."

Obituary for Tank Warfare

Tanks useless against portable LW weapons

> "For example, suppose one attacks a tank. [with an LW weapon] With scalar EM pulse, the personnel die instantly. Total personnel kill is achieved.
>
> All electronic systems of the tank are dudded. Total systems kill is achieved. The ammunition in the tank explodes. Total kill is achieved.
>
> The fuel explodes. This is another total kill mechanism.
>
> That tank has been killed totally, by a variety of mechanisms, all simultaneously.
>
> That's a k-kill in any analyst's book.
>
> And don't worry about retrieval and repair. That tank is finished permanently.
>
> Even the most modern tank is just as vulnerable as the most obsolete."
>
> Bearden http://www.cheniere.org/books/ferdelance/s88.htm

One begins to get the idea how profoundly the conventional means of warfare have been obsoleted. All the usual weapons of war have been rendered nearly useless! And Star Trek's "Phaser," with its "stun" and "kill" modes is here at last.

Although it is the weapons aspect of scalar electromagnetic which has received the most developmental effort, Bearden points out that a great many other amazing things that may be accomplished in this new field of science. Beam me up Scotty!

> "Superluminal communications systems, hyperspace drive, and materialization and dematerialization are all hypothetically possible, using scalar electromagnetics. As the technology develops, we should see the development of many of the systems long thought impossible except in science- fiction."
>
> Bearden http://www.cheniere.org/books/ferdelance/s15.htm

Bearden describes a huge test of the Russian scalar weapons systems which occurred in 1985, a test that went completely unnoticed by western scientists:

> "Just before May 1, 1985 the Soviet Union performed a "full-up" operational test of their entire strategic scalar EM weapons complex. This test was detected and monitored periodically by Frank Golden. Some 27 of these giant Soviet "power taps" were locked into the molten core of the earth, producing forced (entrained) scalar resonance of the entire planet on 54 controlled frequencies under our very feet. The remainder of the scalar frequency spectrum was ablaze with literally hundreds of Soviet scalar transmitters: probably the entire strategic scalar command and control system to

> underwater submarines, higher command centers, distant commands, etc. was activated in the giant exercise.
>
> "For several days, the system was exercised on a mind-boggling scale, apparently as part of the Soviet Union's highly accentuated 40th anniversary celebration of the end of World War II.
>
> "Ironically, not a single U.S. intelligence agency, laboratory, or scientist detected this monstrous exercise for the new Soviet leader, Gorbachev. Not a one of them had a detector for scalar EM radiation, and not a one of them officially believes the exercise ever happened."
>
> Bearden http://www.cheniere.org/books/ferdelance/s38.htm
>
> "The Woodpecker grid/howitzer weapon system can be placed over the ocean and used against cruise missiles, naval surface-to-air and surface-to-surface missiles, submarine-launched ballistic and cruise missiles, etc. Placed over a carrier task force, it can also take care of the aircraft launched by the carrier as fast as they are launched. It can also handily take care of the missiles launched by guided-missile cruisers of the accompanying task force."
>
> (Bearden http://www.cheniere.org/books/ferdelance/s65.htm)

The whole series of the Fer-de-Lance briefing slides and comments is a "must read" for anyone wanting to be aware of the actual state of things in this world right now. It is a new world and it takes some getting used to. Fer-de-Lance speaks clearly, for the layman, of the way things stand.

What is it like to operate these Tesla Howitzers? Col. Bearden gives us an idea in his "Fer-de-Lance" briefing, Slides 66-71.

Who needs armies anymore? A entire war can be fought and won by a handful of men sitting in a comfortable control booth! The scalar electromagnetics revolution has made all previous forms of warfare nearly obsolete.

Why haven't the Russians used the scalar weapons yet?

Bearden gives his thoughts on this in "Fer-de-Lance." The power of these weapons is so great that an accident or war could wipe out all life on earth, and even affect the sun.

> "As can be appreciated, this entire concept [MAD] is now totally obsoleted by the Soviet possession of scalar EM weapons.
>
> 'The "mutual assured destruction" capability -- or MAD concept as it was so aptly named! -- is no longer mutual. And for two reasons: (1) the Soviet surprise attack could destroy essentially all our Triad forces wherever they are, in the first attack. (2) Even if a very small number of our strategic forces survive, the puny strike we could attempt to launch could be repeatedly decimated from launch to terminal phase.

'The restraint on the Soviets is not because of our Triad forces. The restraint is twofold: (1) a second nation has scalar EM weapons, and would undoubtedly unleash them upon the Soviet Union with great violence if such a massive world-wide destruction of U.S. forces occurred or was threatened (is it really "accidental" that six major Soviet missile ammunition storage sites mysteriously exploded within seven months?); (2) the closed-loop scalar radiation exchange system of Earth-Sun could be inadvertently "tweaked" in the feedback loop from Earth to Sun, so that a large solar scalar resonance was stimulated. In that case the Sun could emit a mighty resonant "burp" that would simply wipe out all life on Earth in a fiery shower.

'The "terror" in the "balance of terror" between nations has just increased by many, many orders of magnitude.

'The biblical prophecy that the Earth will be wiped out by "fire and brimstone from heaven" is very near fulfillment now.

'Put another way, the pucker factor -- even on the Russians who may contemplate unleashing Armageddon -- is higher than any Western strategic analyst has ever imagined, even in his wildest nightmares.

'Truly these weapons are "more frightening than the mind of man has imagined," as Brezhnev put it in 1975.

'The frightening scalar EM weapons can be used, but only very, very gingerly indeed. If a slight mistake is made, everybody loses everything."

Bearden http://www.cheniere.org/books/ferdelance/s74.htm

But the Russians (KGB) are not the worst of it. Bearden claims that some of the scalar weapons have been leased to the Yakuza for about a billion a year, and that only the KGB is holding the Yakuza in check from making a full-scale all out scalar attack on the west.

U.S. Defense Secretary William Cohen

Warns about eco-terrorism using scalar electromagnetic weapons

"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves... So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...It's real, and that's the reason why we have to intensify our [counter terrorism] efforts." - Defense Secretary William Cohen, 1997

In a letter to a writer named "Russell" Bearden says,

"In short, Russell, the Secretary of Defense of the United States confirmed that there are indeed novel kinds of EM weapons, right now and have been for some time, which have been and are being used to (1) initiate earthquakes, (2) engineer the weather and climate,

and (3) initiate the eruption of volcanoes. We wrote about those exact uses of the weaponry decades ago. Several nations now have such weapons. Three of them (two on one side and the other on a hostile side) are even firing practice shots into Western Australia, as a convenient test range."

http://www.earthchangestv.com/ufo/0209gandor.htm

Tesla Howitzers in Weather mode

How to Make Weather

"Engineering the weather is duck soup; they tested that over the U.S. in 1967, and entered upon continuing operations over North America on July 4, 1976 as a grim kind of KGB "Bicentennial Gift" to the United States. Here's how it is done with several interferometers.

"First, the interferometers can deliberately make "high pressure areas" (cool the air so it shrinks and its "footprint" pressure on the ground increases because its density increases) and "low pressure areas" (heat the air so that expands and its "footprint" pressure on the ground decreases because its density decreases). Well, if one makes the highs and lows where one wishes them, and judiciously and somewhat slowly moves them along a given path, these highs and lows will entrain the jet streams and thus "steer" the weather.

"So if you wish a very cold snap or attack, go up into Canada and start these actions to steer down some streams that bring some very frigid air. Establish other highs and lows judiciously to "block" or "slow" other jet streams and flows as desired. In this way, one can pull the "large cold air masses coming down from Canada" deep into the southern U.S. at will. They do it regularly. If you wish an ice storm, add an additional current of warm moist air you bring up (steer up by using artificial highs and lows) from the ocean. Where they meet, you will get freezing rain, then sleet, then severe icing accumulating. This type of attack does rather large damage to the struck area."

http://www.earthchangestv.com/ufo/0209gandor.htm

Whole websites have now sprung up showing weather radar anomalies which may well be indications of scalar weather engineering. One list of over 500 images is here. Cheniere has its own collection here.

In another section at Cheniere are many photos of cloud anomalies which reveal the underlying grid along which the clouds are forming or un-forming. Bearden relates a startling incident in these clandestine ongoing "weather wars."

"During the spring of 1986, abnormally strong Soviet weather engineering occurred over the U. S., causing a drastic drought in the southeastern U.S. This drought was broken by a colleague who used an extremely powerful scalar EM device to redirect jetstreams. A most unusual and unique signature of the "blocking" against the Soviet scalar EM actions

resulted: Two huge circulations developed in the atmosphere, clearly showed as two adjacent giant "holes" in the swirling cloud cover over the middle and eastern U.S.

"Between these two giant holes, the cloud circulations formed a stream of clouds, moving to the south, looking very: much like a giant vertical "bar" of a huge "Y-shaped" cloud flow.* Several national weathermen commented on this unusual pattern, which had not been observed before. The pattern continued, day after day, as the blocking continued."

* On the weather maps.

http://www.cheniere.org/books/analysis/history.htm

Tesla Howitzers in Earthquake mode
How to Make an Earthquake

"Here's how you initiate a very large earthquake with such weapons. Take a convenient fault zone of set of them. Focus the interferometry on the fault zone, in the "diverging" mode, and deposit EM energy there in the rocks on both sides, increasing (slowly) the stress in the rocks by the reverse piezoelectric effect (deposit excess energy, get crystal mechanical movements).

"Do it slowly, and the stress will build up to large pressures well-above a plate slip minimum energy required. At some point, the rocks yield and one or both sides "slip" and move rather sharply, giving a very large earthquake in that zone.

"Do the same thing down in the earth (remember, LWs easily penetrate right through the earth and ocean at will, and so the "interference zone" focus can be inside the earth or beneath the ocean, at will.

"Anyway, focus this thing down to where the active part of the volcano is still slumbering, down where the hole in the plate has been made. Keep increasing the deposition of energy in the magma itself, and eventually the increasing pressure from deep within that volcano, underground, will cause an eruption. Build the energy slow, and the eruption will likely be much larger."

http://www.earthchangestv.com/ufo/0209gandor.htm

Yugoslav Earthquake, Followed by Cold Explosion

Strange Characteristics of Iran Quake, Sep. 1978

Tesla Howitzers in Tesla's "Big Eye" mode

How to make a Big Eye in the Sky

By using longitudinal wave interferometry in a weakly endothermic mode a new kind of "radar" is now possible, one which can look right through the earth and oceans. Because the endothermic

mode extracts energy from the distant target, a pattern of the target area can be scanned for in the returned energy.

> "Thus the receiver produces a representation of the energy extracted from various locations within the distant endothermic zone. By displaying the received signals on an appropriately scanned screen, a representation of the distant scene in the intersection zone can be created. Indeed this is a special kind of "microwave interferometry," and -- with modern techniques -- the imagery obtained might be surprisingly good. With development, it might even become as good as the image presently obtained by side-looking acquisition radars.
>
> "Interestingly enough, since scalar EM beams will easily penetrate the earth or the ocean, one can also look beneath the earth or beneath the ocean with this type of scanning scalar interferometer.
>
> "The importance of this capability to strategic and tactical reconnaissance is obvious. Camouflage, cover, and concealment have no effect on such a system. One can easily look inside buildings and into underground facilities. With a small system such as this, the U.S. Marines at Khe Sahn would have had little difficulty locating the tunnels continually dug under the perimeter by the Viet Cong. And targets under jungle canopies are directly visible."
>
> Bearden http://www.cheniere.org/books/ferdelance/s42.htm

Tesla Howitzers can destroy all life on earth

How to Make a Storm on the Sun!!
(Just make a big mistake with your Tesla howitzers)

The deepest dangers of the use of scalar weapons are frighteningly pointed out by Bearden here where he considers that the sun, earth and moon (actually the whole solar system) is a delicately balanced arrangement of scalar (longitudinal) EM radiation. There is a scalar connection between the earth and the sun, which are both giant dipoles gushing energy in the time domain. Big scalar events on the earth could alter this balance causing true catastrophe.

"Indeed, a solar response could be stimulated so that the Sun would violently belch and destroy our biosphere, among other effects."

Unrestrained scalar warfare could cause huge solar storms? To realize that human activity could actually affect the sun itself is truly mind boggling.

Bearden goes on to say:

> "Accordingly, use of huge scalar EM weapons is a double-edged sword. Unless carefully employed, use of the weapons could cause a terrible backlash to the user as well as the victim, and even accidentally cause the destruction of the earth itself. It is not accidental

that in 1960 Khrushchev stated that his new fantastic weapon could -- if unrestrainedly used -- destroy all life on earth.

"This appalling backlash potential is apparently what prompted Brezhnev in 1975 to make so strong an effort to get agreement to outlaw the development of "new weapons of mass destruction" more frightful than the mind of man had even dreamed of. Gromyko even introduced such a draft agreement into the proceedings of the United Nations. The first article of the draft agreement indicated that the nature of the weapons referred to would be negotiated. Sadly, the entire Western world did not even know what the Russians were talking about."

http://www.cheniere.org/books/ferdelance/s24.htm

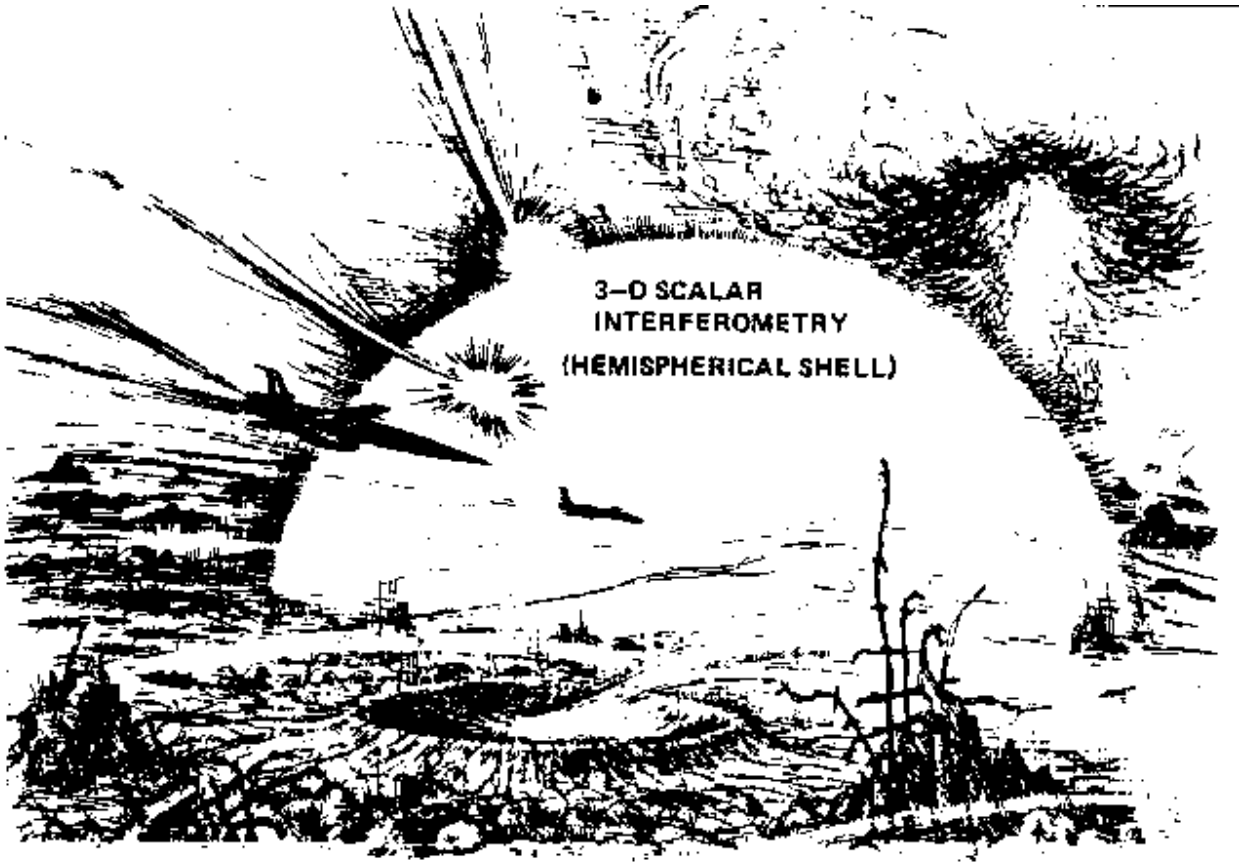

3b. Tesla domes provide near-perfect defense shield.

(Slide from Cheniere.org)

The Tesla howitzers can be used in a nearly impregnable defensive mode whereby they throw up a dome (**Tesla Dome**) or a sphere (**Tesla Globe**) of highly powerful electromagnetic energy, enough to "dud" or destroy missiles which try to penetrate them. Once again, this energy is not

going through space from the howitzer, but being made to emerge from the local vacuum at the location of the shell. KGB tests of these domes have been witnessed by airline pilots around the world. Bearden gives many examples of the Tesla domes being sighted around the world in his briefing paper "Fer-de-Lance." (Russian dome test, another globe incident, yet another globe test). These giant electromagnetic domes can be hundreds of miles across, or narrowed down more to total impermeability.

> "Such a shell may be several hundred miles in diameter at the base. The enormous energy required to form such a defense shell is obtained by a "scalar power tap" into the molten core of the earth itself, as previously explained. In late April/early May of 1985, 27 such "power taps" were placed in the earth by the Soviets. If each tap is capable of powering four to six large scalar EM weapons, then the Soviet strategic scalar EM arsenal contains over 100 monstrous superweapons capable of generating exothermic explosions, endothermic explosions, engineering the weather, locating and destroying underwater submarines, detecting and destroying ballistic missiles shortly after launch, detecting and destroying long range strategic bombers as soon as they are airborne, etc."
>
> http://www.cheniere.org/books/ferdelance/s52.htm

By using nested domes one can protect the domed area even against nuclear radiation itself. Tesla globes can be used to hit airborne targets by simply placing a globe of any chosen size in the flight path of the incoming missile. It does double duty because the missile hits it going in, and then the rubble hits it again going out the other side.

While the U.S. persists in its useless boondoggle "missile defense system" by shooting a missile with a missile (missiles which would already have been "dudded" by the Tesla howitzers), between the domes and the globes the Russians (KGB) have in hand (operational) a nearly perfect missile defense system. Someone should ask the Secretary of Defense if the U.S. Tesla domes are in place. And over which cities? How powerful are our American Tesla domes?

Bearden cites a number of examples of these domes being tested around the world:

March 20, 1969 | March 24, 1977 | August 17, 1980 | June 17, 1966 | June 18, 1982 | June 22, 1976

In a slide from the Fer-de-Lance briefing it is shown how the "woodpecker grid" itself also acts as a sensor, detecting any missile launch anywhere, and how the howitzers can respond instantly by delivering a blast to exactly the right coordinates, right along the channels of that same grid which is feeding the location information about the missile launch. This certainly beats "trying to hit a bullet with a bullet." Especially since YOUR bullet would probably be instantly inoperable in a real scalar war situation.

3c. Rogue Groups in the government

Bearden fears that these scalar electromagnetic secrets may have fallen into the hands of what he called secret "rogue groups" within the labyrinthine depths of the black-ops special-access domain of the secret government. "In the extreme, such a deep black program can even become a

"captured" program," he says, "which is totally in the hands of rogues and no longer reports to or is bound by the dictates of the parent government."

> "They have their own agendas. And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. It's a human characteristic, the old primate dominance game. Only now disguised and hidden under deep classification. ...
>
> "In highly classified groups, these groups are greatly enabled to joust more widely, unethically, and immorally because it is so deeply hidden. So very deep classification evokes the growth and intensity of rogue groups. It's the old 'Power corrupts, and absolute power corrupts absolutely' routine. ... Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, may not operate under very much legitimate government control at all, and may operate specifically for the purposes of the rogue group or groups that have gained control."
>
> "The involvement of at least some rogue groups, some being "cowboys" who operate well outside all laws and ethics, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, it could account for what seems to be actually occurring. "
>
> http://www.cheniere.org/explore%20articles/mind%20control3/p05.htm

3d. World War III has already begun

Because it is now possible to cripple the power grids and electronics of any nation, that nation could be reduced to economic ruin without ever firing an actual "shot." Without electricity Wall Street cannot operate. Without electricity you quickly need martial law. One no longer needs to wage a conventional war anymore at all. There are now lots of new ways to bring any nation to its knees.

> "We are at war, whether we like it or not. And we are going to have strategic strikes on an unparalleled scale for us. Pearl Harbor was nothing compared to what is coming down, once we consider the "augmentation" and such.
>
> "When that factor is considered, then it's a totally new ball game on replacing the power system. There isn't going to be much choice; the old one is going to be destroyed or so badly crippled that it will collapse the U.S. economy in a way we have not seen since 1929. Of course, in such a case hitting us, we will be under martial law, the works, everywhere. For one thing, it's the only way you can keep the cities from imploding from within, by the criminal element, looting, robbing, killing, etc. Simply wait and see; it's on the way."

> Although Bearden has for years decried the "scalar-gap," and chided the military for falling so far behind the Russian KGB in the field of scalar electromagnetics, recent statements indicate that things may at last have changed somewhat.
>
> "In the new war, the first phase of WW III has already been completed. Hence President Bush's recognition that this is a total war, and has to be taken to the enemy no matter where he may be hiding or in what sanctuary or in what foreign nation. This is an entirely different war than anything the U.S. has ever fought in its history. And before it is over, it is going to kill more Americans than have died in all the previous wars in our history. The news media and the public have not yet recognized that awful situation and predicament. Most are already thinking that, well, we won in Afghanistan so it's just about over. Instead, it has only just begun.
>
> "Anyway, that's a brief uptake on some of the weapon situation today. Some 10 nations or more now have LWIs, and five have the QPs. I'm still working on how many have the appalling negative EMP weapons, but would estimate 6 or 7 nations have them in one stage or the other, either deployed or in at least advanced development. And in my estimation, the Yakuza will have them within three to five years if they have to build them themselves, and quicker if they can buy them from the Russians, Chinese, or???"
>
> Bearden http://www.cheniere.org/correspondence/030202a.htm

When he was asked the question '**Does the government listen to Tom Bearden?**" Bearden said:

> "Let me speak carefully. I am very satisfied with how I've been listened to in the quarters where the rubber meets the road. The West is no longer defenseless, not by any means. Cannot amplify it further than that."
>
> http://www.cheniere.org/correspondence/030202a.htm

Bearden has briefed the government a number of times and the Cheniere website contains a great number of his graphic military briefing slides.

3e. Are the Russians making "UFOs?"

Scalar electromagnetics engineering opens the possibility of antigravity vehicles and "hyperspace travel." In other words we can now make our own UFO's! Of such scalar-powered antigravity vehicles, which have now become possible, Bearden has this to say:

> "We might expect to see such vehicles glowing. Their various surface features and mechanisms might appear to be glowing or revolving lights, etc.
>
> "They could exhibit incredible "aerodynamic performance," seemingly in the atmosphere. Actually they would not be moving "through" the atmosphere at all, but through a higher space outside each particle of atmosphere.

"They could seem to materialize and dematerialize.

"They could seem to plunge into the ocean or rise out of it.

"They could even seem to operate under the ocean or inside the earth itself.

"Such anomalous vehicle performances have been seen all over the world, particularly since a few years after WWII.

"It appears that one or more nations of Earth are operating such vehicles now in great secrecy. Our own "government" may even be one of these.

"If so, it isn't our true "government/government." Instead, it's the "control group/government." It's government at the operational level, but at higher level it belongs to certain control groups who have penetrated our government's vitals and taken over all such projects."

Bearden http://www.cheniere.org/books/ferdelance/slide32.htm

In an excellent article on her Earthfiles website, Linda Moulton Howe reports on the utter bafflement of Norwegian scientists over mysterious lights appearing in the valley of Hessdalen, Norway.

She writes of the research there: "The results can be broken down into two groups: 95% are thermal plasmas and 5% are unidentified solid objects. The plasmas emit long wave radio

frequencies and strangely, their temperatures do not vary with change in size or brightness." She quotes the scientists' research summary:

> "1) most of the luminous phenomenon is a thermal plasma;
>
> 2) the light-balls are not single objects but are constituted of many small components which are vibrating around a common barycenter;
>
> 3) the light-balls are able to eject smaller light-balls;
>
> 4) the light-balls change shape all the time;
>
> 5) the luminosity increase of the light balls is due to the increase of the radiating area. But the cause, and the physical mechanism with which radiation is emitted, is currently unknown."

This would almost certainly seem to be another example of the testing of the scalar howitzers. It is baffling because, as Bearden points out repeatedly, Western scientists have limited knowledge of the scalar electromagnetic principles by which the howitzers operate. The Hessdalen scientists were completely baffled as to where the energy of these plasma balls was coming from.

Ms. Howe interviews Massimo Teodorani, Ph.D., Astrophysicist, who released the report on the 2001 Hessdalen sightings. The scientist speaks of the baffling phenomenon observed.

> "I don't know how it is possible that Nature is spontaneously able to do that. Anyway, we deduce that the plasma is trapped inside a sort of magnetic cage and the magnetic cage closes around the plasma and keeps it fixed in some way, prevents it from expanding. But where does it come from? We don't know."

By what we have been considering here, we can recognize the signatures of scalar electromagnetic engineering. If it is a Tesla howitzer, then the energy for the plasma balls is coming from the vacuum of spacetime at the very location of the balls themselves, triggered by scalar interferometers aimed through the woodpecker grid.

These kind of balls can be used as marker beacons giving feedback for precision aiming of the howitzers. The energy of the marker beacon can be read back into the computers giving precise location information for pinpoint aiming. The target area can be very small, or widened out.

There is a little movie of one of the Hessdalen plasma balls here. It would seem to be a clear documentation of a scalar howitzer marker-beacon. How many other current "UFO" sightings are actually the witnessing of Tesla howitzer tests?

In fact there are a great many anomalous events of the past few decades which might very well be explained by the Russian testing of their longitudinal electromagnetic weapons. It would seem that the mysterious appearance of crop circles around the world could be accomplished by feeding a precise mathematical graphic pattern into the computerized aiming software and change the very molecular structure of the crops themselves along the lines of that pattern. The

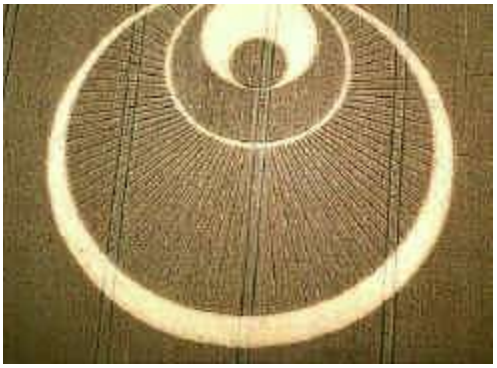

stalks fall over from the localized effect of the longitudinal waves. A plasma ball tracing patterns? Are they slyly sending a message to see if we are "getting it" yet?

The "Cambridge Angel" - Made by Russian scalar plasma balls?

Also see: Interview with Tom Bearden

(Slide from Cheniere.org)

4. Healing powers of longitudinal waves

Healing via longitudinal waves, time reversal of cells (de-differentiation), Priore's machine, Bearden's proposed "blanket" version, using the electric power grid for healing waves or for broadcasting disease patterns. Scalar Biowar.

The good news!

> "Any sort of disease whatsoever - physical or mental - will be rapidly curable, simply and cheaply. It will be possible to reverse aging and rejuvenate the person. It will be possible to regrow limbs and straighten misshapen spines - and directly remove the causes of mental diseases and cure them as well. Lifespan will be staggeringly increased, without 'old age's debilitation.' AIDS, cancer, leukemia, and genetic diseases will be completely conquered. The potential for a true golden era is upon us, for all humanity."
>
> Bearden- http://twm.co.nz/beard_interview.htm

Proof of the healing powers of longitudinal waves from the vacuum is seen in the work of Antoine Priore who produced longitudinal scalar waves using a gigantic glass tube filled with plasma. He himself did not understand why it worked or how it cured cancer in animals.

> "The Priore team cured terminal tumors, trypanosomias, and other dread diseases in laboratory animals in France, in the 1960s and 1970s, under rigorous scientific protocols by eminent scientists. The Priore project was funded by the French Government to the tune of several millions of dollars (equivalent).
> http://www.explorepub.com/articles/energetics.html
>
> ". . . Prioré's machines concretely demonstrated a nearly 100% cure of all kinds of terminal cancers and leukemias, in thousands of rigorous laboratory tests with animals. These results were shown to medical scientists as early as 1960." http://www.cheniere.org/priore/index.html

Bearden has stated that the longitudinal EM waves can have a healing effect because they always come in pairs called "phase conjugate pairs" and one of the pair is time-reversed. This enables engineering of the waves to "pump" the cells of the body (with waves from the time domain) and actually time-reverse the cells back to a previous healthy condition. The scalar cure of cancer does not involve killing the cancer cells but rather pumping them with time energy into a previous condition. I know, this seems miraculous, and is it not?

Priore and his giant plasma tube

This healing power in the longitudinal waves of the time domain is a mind-boggling thing to face. It took me months to get through it, and to suffer the fact that the cure for cancer and AIDS was right there, in this new scalar electromagnetics technology, and that it has been kept back from the people for so many decades now.

Bearden has a great deal to say about the work of Priore, who himself did not understand why his machine worked. Priore did not know about the longitudinal scalar waves of the time domain. In fact, Tom Bearden has supplied, at last, the missing explanation as to how that big giant two-story glass tube consistently cured cancer in animals.

"**The medical implications are enormous**. By just reversing the damaged cells back to a previous physical state, this gives a physics mechanism for controlled cellular dedifferentiation, in biology terms. Physicians will time-reverse diseased, damaged or aged cells back to an earlier healthy condition, including all the cellular genetics. Normal cells are just reversed to a slightly younger condition."

> "We believe this mechanism explains the revolutionary but baffling electromagnetic cures achieved by a team of outstanding French scientists in the 1960s and early 70s, working with inventor Antoine Prioré. In lab animals, cures were achieved for terminal tumors, infectious diseases such as trypanosomiasis, and atheriosclerosis. In addition, deliberately suppressed immune systems were dramatically restored.
>
> "We hypothesize that this is the long-sought mechanism of how the living body heals itself. In short, the body's cellular control system induces cellular reversal by weak time-domain pumping of the damaged cells and the affected area. The cellular regeneration system performs all healing of cellular damage in the body; the immune system heals nothing, not even its own damaged cells) .
>
> "For the first time medical science can develop as a science of healing rather than a science of intervention. And it will develop as a science of unlimited healing, since no pathogen can resist action by curved spacetime engines." Bearden
>
> http://www.cheniere.org/techpapers/Vision%202000%20paper.doc

See Priore's machine See Slides of how it works.

Bearden has extended the Priore work, with the previously missing knowledge now in place, and designed a revised system (for irradiating the body with longitudinal waves) which gets rid of Priore's giant glass plasma tube and uses instead an antenna unit which surrounds the body. He has also provided the missing explanation of how it works. There is an article from "Explore" magazine, Part I and Part II.

In fact, Bearden has presented to the U.S. government a plan to use a portable version of a Scalar Healing Blanket where wire channels in the blanket act as a scalar antenna, which can both send and receive scalar electromagnetic waves. A two minute treatment of the waves is sufficient to restore the body to its earlier healthy condition. Thus even thousands could be treated easily and quickly in a biowar mass attack situation.

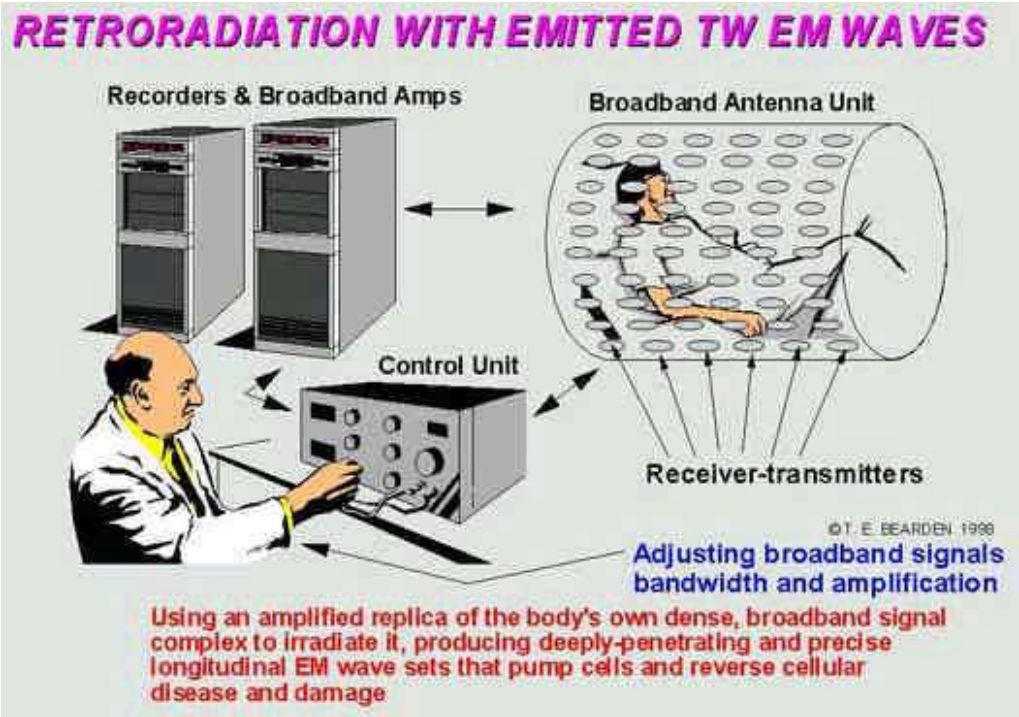

"To defend against things like anthrax attacks on our civilian population centers, we also have recommended to the U.S. Government the crash development of small, portable treatment machines—using similar "antiengine-forming" and cellular reversing "porthole technology". [See Figure 13 on previous page]. Such portable machines could be developed cheaply and quickly, and present government facilities could be used to massively attack the correlate database production problem. "The portable treatment units could be cranked out by the hundreds of thousands and flooded down through emergency response agencies such as the police forces, the National Guard, emergency hospitals,

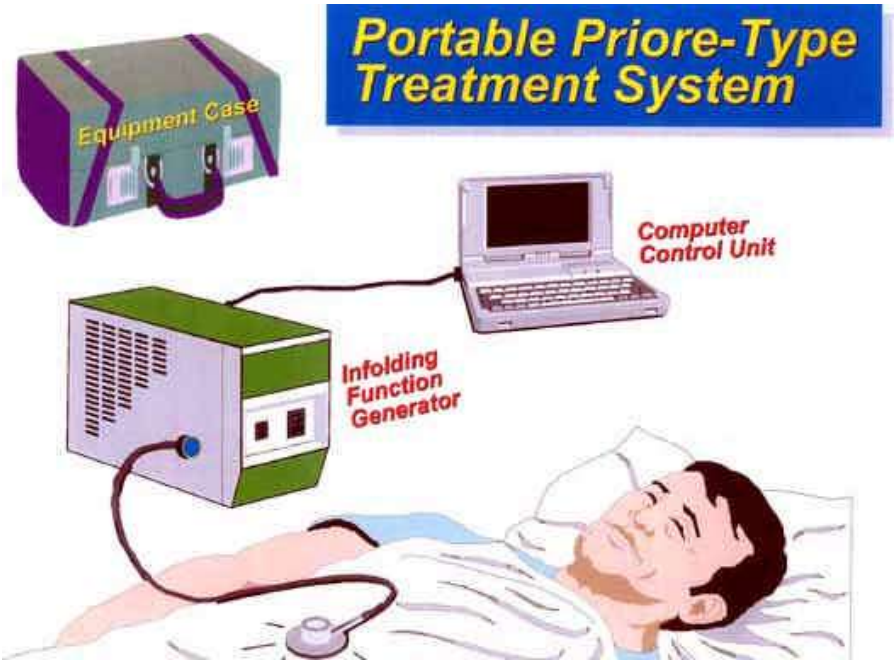

emergency response teams, etc."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p04.htm

The Scalar Healing Blanket would fit into large suitcase. It has three basic parts, the longitudinal wave generator, a laptop computer, and the antenna-blanket. The plan was a stroke of Bearden's genius, but unfortunately it fell on befuddled government ears. "Unfortunately, so far the DOD [Dept. of Defense] doesn't even understand what the heck we're talking about!"

Article '**Healing with Energy**': http://www.explorepub.com/articles/energetics.html

"We tried very hard in 1998 to call attention to the extreme national need for the most urgent possible development of a portable computer-controlled treatment device based on the experimentally proven Prioré methodology, but extended to a much simpler and far more rapid method of treatment.

"Quick development of this technology could lead to a suitcase size device, capable of treating a patient in less than one minute, and stopping the symptoms and disease progress cold, then reversing it. Three "less than a minute" treatments one week apart would be required for complete cure. As an added advantage, partial reversal of aging in older patients would also be accomplished as a bonus, in addition to time-reversing the damaged and diseased cells...

"The method proposed to the DoD in 1998 used normal EM in a peculiar way to force the body itself to make its own time-polarized EM waves, and pump every part of its cells -- including the genetics -- in the time domain.

"Quite simply, we are going to be struck this way (QP spreading the immune systems of the populace plus professional smallpox, anthrax, etc. BW attacks on our population centers) and by other means we've spoken of in other papers and briefings."

Bearden http://www.cheniere.org/correspondence/021401.htm

The Dark Side of the Force:
Creating and broadcasting disease

Speaking of the scalar wave induction of disease by longitudinal wave patterns Bearden refers to work by French scientist Kervran Russian scientist Kaznacheyev, who proved that any disease could be transmitted electromagnetically.

"It works this way: the Kaznacheyev experiments (and others) demonstrated that any cellular disease or disorder can be initiated into cells at a distance, by electromagnetic means (albeit unusual EM in nature). The decades of microwave radiation of the U.S. Embassy in Moscow, was an ongoing set of "stimuli" to ping the U.S. system and, by its response, ascertain how far along (or if it was "along") in its knowledge of such weapons. The radiation was responsible for many health changes in personnel and for the eventual deaths of three U.S. Ambassadors."

Bearden http://www.cheniere.org/correspondence/021702a.htm

In a letter he writes,

> "Yes, the Kaznacheyev experiments were quite real; 15,000 or so in military research institutes in Siberia. As with so many other novel areas investigated and developed by the Soviets, most U.S. investigators just assumed normal EM, which is not what the Kaznacheyev experiments involved, and not what was carrying disease induction patterns from one cell culture to another in rigorous lab tests."

How to "Broadcast" Diseases

Longitudinal EM Biowars

Bearden explains how the new quantum potential weapons can be used to induce disease-at-a-distance in a population, or to "spread" the immune system so thin that a conventional bio-attack would be greatly potentiated. By "broadcasting" virtual disease patterns over a population, the immune system is so overloaded by the presence of the "shadow" diseases that its effectiveness is thinned out.

> "In short, alter the internal wavestructure, and one creates a curved spacetime 'engine' that acts on mass in any fashion one chooses to design -- including initiate diseases . . . Now visualize one of these 'vacuum engines' or 'spacetime curvature engines' that acts on mass to generate the exact effects produced by anthrax. (Or any other disease one wishes) . . . Call the virtual state of a disease engine the disease pattern in the "shadow" state, just prior to becoming observable. . . .
>
> "And the master cellular control system responds to "coming events that cast their shadows before". In short, it responds to the upper level of the "shadow state" of a disease, still in the virtual state! (Hey, virtual particles are real, virtual photons are real, virtual ST curvatures are real --- just very fleeting, only for another to immediately arise). The exchange of virtual particles is known to generate all forces in physics anyway! . . .
>
> "So the cellular control system responds to "shadow state" disease patterns. Enter a QP weapon application. Place a quantum potential weapon "area" on the United States, so that the entire populace is in it. The slowly introduce and bring up in the shadow state, the necrotizing fasciitis disease engine. At some point, the cellular control systems will react, and order the immune system into action. In other words, immune system resources will be committed against this "immediately coming" enemy. Bring it on up a little, but still just in the shadow state. Voila! Humans form a bell-shaped distribution curve. And even if the structure of the QP fluctuates a little, fluctuating a bit stronger and a bit weaker, etc. A few of those targeted bodies will now actually develop necrotizing fasciitis. So far, just like the U.S. Embassy targeting, except a different "carrier".
>
> "But now there is an exact signature that this is what is doing it, and not normal vector carriers of disease and contact or exposure infection. The few cases of necrotizing fasciitis that break out will be most puzzling. They will be randomly scattered across the

entire nation, and so few that the vector carrier and contact or exposure explanation completely fails."

"And that one happened, right here in the U.S., not so long ago. Check it out.

"So carefully adjust the patterns for, say, 12 major terrible diseases, to that "adjusted and desired shadow state level". Now add all 12 patterns into the internal structure of the quantum potential. Now it has 12 shadow state disease engines in it.

"Place that one on a populace. The cellular control systems order the immune systems into action, and they now have to commit their finite resources to 12 different areas. This greatly thins the response an immune system can make to any one of those 12 disease patterns! In short, it "spreads" the capabilities of the immune system, which can be galvanized to great effort, but only can perform a small bit against each area.

"Suppose one of those "galvanized" areas in the targeted populace's immune systems is anthrax. And suppose the bad guys now hit one or more of those cities with a professional anthrax attack. A former OTA study showed that a professional anthrax aerial spray attack against Washington D.C., dispensing 100 kilograms of anthrax spores in the spray, will account for 1 to 3 million casualties. And that's in an "unthinned" set of immune systems. In the "thinned" set, one can at least double or triple, and even up to five times, that estimate. So conservatively, now there would be from 2 to 6 million casualties. And even mild anthrax spray attacks in other "thinned" cities would also be amplified.

"That one is being set up, or already set up, right now. There are other such "augmentation" setups also under way.

"So the weapons alluded to by the SecDef in 1997 are already being employed. WW III has already begun, and our populace (and our scientific community) is blissfully unaware of it."

http://www.cheniere.org/correspondence/021702a.htm

Most of us can remember the strange outbreaks of the so-called "flesh eating disease." It seemed to break out here and there randomly with no known cause. Bearden believes this was a test of the newer quantum potential weapons which go even beyond the capabilities of the Tesla howitzers.

"The Kaznacheyev "disease induction by novel electrodynamics" work is also the basis for the spacetime curvature engines (not EM signals!) carried by quantum potential EM biological weapons for distant induction of diseases etc. into the population of an entire nation or area, such as the U.S.

"This quantum potential disease induction weapon -- capable of attacking an entire population of a nation or area -- has been tested several times in the U.S. at very low levels, in the shadow state only (we explain shortly) and it has a most peculiar signature. E.g., one test used necrotizing fasciitis (flesh-rotting disease) engines.

> "The disease 'engine' was deliberately kept down in the 'shadow state' (virtual state, just below the observable state) so that only a tiny bit of the populace with depressed thresholds would "breach the observable threshold' due to the population forming a bell-shaped curve as to the threshold level. The major signature of the test was that the cases of the disease broke out totally statistically and randomly, spread all over, without any 'disease vector' in between.
>
> "In short, it was not spread in any manner required by normal deterministic disease vectoring, but was a totally random set of occurrences. Several other diseases were also tested this way in the American populace, with precisely the same signature."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

"Apparently one planned use of such an augmented clandestine BW weapon will be smallpox, e.g. As you know, the Russians did develop smallpox for biological warfare, and even developed a new strain against which previous vaccination is ineffective.

> "The vast numbers of expected casualties, coupled with immune system spreading, are absolutely irresistible to the Russian mind. You can count on it that they have seen that the smallpox is already on site here, in the U.S. and in the hands of professional terrorist teams. Of course, the Russians/KGB will protest they have nothing to do with that! Yet likely the KGB will have flatly arranged it or at least assisted it. The capability for mass destruction of the nation is so lucrative and easy to achieve in advance, that they would never be able to resist doing it."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

Bearden believes the Gulf War Syndrome involved the use of scalar technology to induce a disease state, as he stated in a 1997 interview:

> "I'll say this flatly, and I won't answer any further questions about it; the Gulf War Syndrome was induced... It was induced with this stuff. All the rest... was contributing factors that everybody's talking about... There are some deeper signatures, if you look into it very deeply, that show you exactly how it was done and the fact that it was induced. It was a test. It was a test of a very special kind of weapon I have not talked about yet. Anyway you can use it to create diseases."
>
> Bearden http://twm.co.nz/beard_weapon.htm

Besides using the woodpecker grid to target a population, the entire electrical grids of nations can be used as "channels" for disease patterns to be broadcast to all people near that grid. Your own house wiring can become an antenna, broadcasting these "shadow" patterns of disease, weakening your immune system.

And here one faces the frustrating fact that the same power grids could be set to channel patterns which would keep the entire population healthy, rejuvenated, continuously bathing in the time-reversing old-age-defying energy of the spacetime vacuum. We have no idea yet of how long the

human life span could be increased with this new technology. People might be able to live two centuries given full humane development of this technology.

5. Psychoenergetics

Mental entrainment, inducing hypnogogic trance, mind control, broadcasting thoughts and feelings, the Ant World, education via EM [LW] mental download, the "Feelies," revolution in spirituality, "enlightenment machine?" Scalar churches?

Psychoenergetics is simply using the scalar interferometers to manipulate and engineer the human psyche. To me it is the most mind-boggling and frightening aspect of longitudinal wave engineering.

The mind is electromagnetic in nature, and itself of the time-domain. It is not observable in 3-space. There is no thing you can point to that is the mind. As Bearden says**, "The mind is time-like**."

The longitudinal scalar EM waves are also of the time-domain. By overlaying certain infolded patterns (oscillations in time) on the longitudinal waves, a thought or feeling may be made to arise in a person or persons who are in the **interference zone** (where the wave beams cross).

The person will not notice anything, feeling that this thought or idea is his or her own idea. The longitudinal wave pattern might be a wave of panic or fear that spontaneously sweeps over you, perhaps inexplicably. It could even be in the form of a sudden intense patriotism. It could be explicit words and phrases, which everyone would think they had thought of by themselves. Or it could be rage and hatred, angry and violent. On the other hand It could also be a continuous sense of docility and placidity. This is the brave new world of psychoenergetics and the coming "Mind Wars."

Scalar Psychoenergetics in its most primitive form simply "entrains" all minds in the target area into a deep hypnogogic trance. In this state of mind people would be suddenly extremely suggestible, and would likely believe anything they are told, and would obey any orders given. Talk about winning the hearts and minds of the American People!

Tom Bearden makes me think of **Paul Revere**, who heroically conveyed important warnings for the sake of the new nation. But the words of the famous phrase have now strangely and curiously mutated into the once-inconceivable: "**One if by land, Two if by mind**."

Indeed one strategy in a Mind War would be to simply take over the minds of the "leaders" of the enemy nation. The targeted leader would not be aware that anything was amiss, although he might begin to make unexpected changes in policy.

And are, in fact, any of our "leaders" already having secret thoughts that are not their own? Who knows? Frighteningly, we can no longer be sure. The new sciences of scalar electromagnetics

and psychoenergetics are even now plunging humanity into a sudden science-fiction-like world beyond anything in humanity's previous imaginings.

> "The Russians reached the point in the mid 1990s that they could take over control of a person's mind, with modified longitudinal EM waves including some time-polarized EM waves, and with a team of specialists (estimate 25-30 per transmitter, and one transmitter and team per controlled person)." Bearden http://www.cheniere.org/misc/time.htm

In a slide Bearden illustrates how a Scalar War would involve a psychoenergetics attack on the operators of the enemy scalar installation, entraining their minds into hypnogogic trance and getting them to shut down their systems.

And ultimately psychoenergetic warfare goes to the very heart of human identity itself. For if my thoughts might no longer be "mine," then who and what am I? Can my very sense of being "me" be hijacked by some nefarious psychoenergetic scheme? Will the "secret government" eventually dictate directly into your mind how you feel about yourself? Or what you think you are? Or what you should do?

How Does Longitudinal EM Mind Control Work?

The physics of scalar psychoenergetics as expounded by Col. Bearden seems even more arcane and over-my-head than that of extracting energy from the vacuum. I can't understand it, but I look through it anyway. Each time another tiny understanding might occur, or a term might fall into place. I know the mathematics is forever beyond me.

One paper to begin with is "Mind Control and EM Wave Polarization Transductions" This is such serious stuff that Bearden includes a strong warning about misuse of this knowledge. Psychoenergetics weapons can mentally maim and physically kill.

Warning!

(From "Mind Control and EM Wave Polarization Transductions")

> "This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for nonapproved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p01.htm

After the serious warning comes the description of the paper. This is heady stuff for the layman.

> "Calling full attention to the special note above, in this paper we present a high-level overview of the novel electromagnetic nature of mind operations, mind and body coupling, and intent - the induction of physical 3-space EM energy changes into the brain and nervous system, and into every cell of the body, from the mind's time-like coherent operations. We summarize the time-polarized electrodynamics used to engineer and affect mind operations and the mind-body coupling loop. Transaction mechanisms whereby differing EM wave polarization's can be transformed one-into-the-other are presented."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p01.htm

I will leave it to the technically astute to try to understand the mechanisms of operation which are described in scientific language. But there are tidbits for the layman. Here he speaks of the difficulty Western scientists have in opening up to the "immaterial" (longitudinal wave) nature of the human mind.

Western Science Remains Largely Materialistic

> "Ironically, most Western scientists are materialists and consider "mind" as a mystical and nonscientific concept. They tend to consider mind operations and functions either to be simply "meat computer" operations and functions, or at best to be very weak ordinary transverse-wave EM operations and functions in the brain and nervous system. This serious self-limitation exists because in the body we measure only weak TW [transverse wave] EM operations and functions correlated to biological behavior and brain operations. We simply do not know how to measure "mind operations" directly.
>
> "With no mind measurements possible and no instruments, it is understandable that Western science considers only the physical side of the mind-matter interface.
>
> "Presently our scientists do not measure the longitudinally-polarized EM wave operations and functions in the body and around it in nature. Few of them are aware that a maelstrom of such LW [longitudinal wave] functions exist in the body and in all of nature in general."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p05.htm

Western methods of influencing the mind with EM waves have only used transverse waves, not the longitudinal waves of the vacuum. If only transverse waves are used one pretty well has to hit the target mind with a sledgehammer of waves.

Western Science knows only transverse EM waves

Brute Forcing Time Functions versus Fine Control Methods

> "Ironically, Western mind control researchers using transverse EM waves for mind control research, are using a brute force method of evoking and using vacuum engines

> (spacetime curvature engines) and a special form of general relativity, although they do not appear to realize it.
>
> "While KGB scientists also use TW EM "brute force" TW waves when necessary, they do "imprint" or "activate" those waves with the desired internal LW and time-polarized EM wave and photon structures required to directly perform the mind engineering desired... Bearden
>
> "These "fitted brute-force models" certainly can be very powerful, and certainly can produce the exact results shown in the experimental verifications of the fittings. However, they do not of themselves allow sophisticated design for example of the necessary time-polarized wave assemblies for engineering the entire human collective unconscious simultaneously, or for engineering the entire collective unconscious of all species on Earth (i.e., Gail's collective unconscious), or even for precisely engineering the memory and knowledge base of an individual.
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p09.htm

The seemingly magical operations of psychoenergetics, sometimes called "psychotronics," cannot be achieved with ordinary transverse EM wave energy. But they are possible with longitudinal scalar waves because the mind itself is scalar in nature.

> "We note that all mind operations are time-like, i.e., they are comprised as scalar EM photon functions and scalar EM wave functions. Thus the mind is a very special kind of electromagnetic system, existing in the time domain..."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control1/p08.htm

The engineering of the mind can only be accomplished with the waves of time.

The course of psychoenergetics development necessitates the building of a vast database of settings and patterns which bring about given mental and/or emotional states. A kind of "gnome" of the psyche. Bearden describes the process of the decoding of this "gnome."

> "Now the scientists would perform many phenomenology experiments, making one little change at a time and profusely recording the data. Each time, they would establish the physical change(s) that occur in the body and/or the mental and emotional changes that occur in the mind for each spectral reinsertion back through the "ship's portholes". They would simply but painstakingly (over some years) build up an extensive database of those individual correlates.
>
> "In these experiments, the experimenters will eventually be able to provoke any body or mind change they wish. Strong emotion. Intense pain. Intense pleasure. Painful thoughts. Images. Memories. Perceptions. Dreams. Visions. Memory losses. Memory changes. Personality changes. Etc. The "delta" in the emission spectrum (the changes from zero reference spectrum) represent the precise totality of all mental, physical, organic, chemical, etc. changes and interactions."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p01.htm

"A second stage in the research would be to test the correlates and porthole insertions upon a statistically significant cross section of ordinary people, and/or specialized populations (such as toughened soldiers). The program would evolve a highly complex, very effective, ever-improving science and technology of mind and behavior control and engineering mechanisms, complete with finished database and developed applications equipment."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p02.htm

Summing up his paper Bearden speculates on what the actual situation the science of psychoenergetics probably is. The intense secrecy with which this knowledge has been kept from the public has led to the current farce of the "government" pretending it all does not exist, and this secrecy may have now put us at great risk.

"The implication is that in the West one or more highly classified, sustained, heavily funded developments in advanced mind control programs, probably exists and probably has existed for some time. Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, may not operate under very much legitimate government control at all, and may operate specifically for the purposes of the rogue group or groups that have gained control.

"In a nutshell, that's what may be going on in the clandestine mind control projects in several Western governments. The involvement of at least some rogue groups, some being "cowboys" who operate well outside all laws and ethics, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, it could account for what seems to be actually occurring. As also is "usual" in such a mess, one or more of the rogue groups eventually may become very powerful because their secret weapons are very powerful. They may become confident, thinking they have the "best in the world." They may actually believe they are ahead of the Russians..."

"Remember that, in every large and powerful human organization, the basis for rogue groups is power and secrecy. They are always seeking to increase their power, control, influence, prestige, etc. Nothing else. Patriotism and mission are—to rogue groups—often just idle words. They have their own agendas. And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. It's a human characteristic, the old primate dominance game. Only now disguised and hidden under deep classification."

"The Russians, with their additional knowledge of the actual mechanisms in the transforms, will be much more advanced than the West, because their fundamental psychoenergetics science is far more advanced, so long as we continue to use the old U(l) electrodynamics. Further, the Russians have decades of use of longitudinal interferometry beams to reach right through the earth and ocean and produce stringent EM effects at a distance. So they will also be able to do the same things here in "mind control" with LW [longitudinal wave] interferometers, through intervening mass."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p05.htm

Bearden cites two examples where he believes the Russian KGB tested the psychoenergetics capabilities of their scalar interferometers. One was the case of Captain Button in his A-10 "Warthog" aircraft on April 2, 1997.

> "Over Arizona, Captain Button was thrown into a hypnogogic state, and his perceptions instantly altered and controlled. In his instant "dream-waking" state, everything seemed perfectly normal. His sense of direction was altered a bit more than 90 degrees, so he simply corrected and turned and "flew toward the range", actually flying off course by more than 90 degrees and ignoring radio contacts. He flew right on out of Arizona."
>
> "At one point he circled, probably thinking he was over the range, and he probably dropped his ordnance there. Then he "flew on back toward home," as he thought in his waking dream state, until his fuel ran out and he crashed and died in the explosion—dream-thinking until he died that everything was normal. All the while, his sense of the passage of time was altered. To him, in his dream-thinking, dream-acting state, everything was normal and nothing untoward had happened. So the distant KGB transmitters and associated psychoenergetics team controlled him for over an hour. "Indeed, that was the exact purpose of the test: demonstrate control (at a great distance) of a skilled person performing highly skilled tasks."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p06.htm

The paper "Mind Control and EM Wave Polarization Transductions" ends with the most chilling and frightening possibility of all: the psychoenergetic engineering of the human species as a whole.

The Ant World

The Final Race for Direct Mind Control of the Entire Human Species

> "The KGB psychoenergetics weapons scientists—because of their direct measurements and detections (and use) of t-polarized waves and LWs [longitudinal waves] for decades—also understand that Jung's collective unconscious mind (of the entire human species) also has its own time-like operations and correlates, which one measures also when using t-polarization measurements and sorting it all out. The collective unconscious mind operations are buried several levels deeper inside the recursive Whittaker structuring inside the EM fields, waves, and potentials. "The KGB scientists also know that something very like Gaia — a collective unconscious mind for all species on earth — also exists, and they are striving to be able to sort out and measure that one as well. The Gaia operations are buried even deeper in the recursive structuring inside the EM fields, waves, and potentials.""Actually, from day one, the Russian mind control scientists have had their eventual goal set upon this "deeper area of mind and possible mind control" of the entire human species.
>
> "I am convinced that the KGB psychoenergetics scientists understand this deeper area. If they can learn to directly engineer the collective human species unconscious, they can

> then convert the human species easily into a sort of "ant" society, modeled along ideal Communism lines, except of course with an excluded "hierarchy at the top" running everything. The "ant society" — communist style — is still a variation of feudalism (all systems tend to feudalism or some form thereof). "The KGB psychoenergetics weapon scientists are seriously pressing on toward that very goal. In my opinion they are not very far from it right now...
>
> "Some versions of Russian mind control devices were used on Russian soldiers in the Afghan War to condition them for performance of merciless acts." 13
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p07.htm

More about "The Ant World"

Whether it is the Russians planning an "ant world" society or rogue U.S. black-ops groups withholding a great boon from human race, the secrecy on all sides around has allowed largely criminal elements to take over this technology while leaving the civilized elements in the dark. Openness and the spreading of this knowledge among good and decent people is essential, and for that we will have to overcome our frightened denial.

> "Meanwhile, rogue groups amongst Western clandestine mind control researchers will probably arise if they have not already done so. They will likely seek to increase their personal control and further isolate the programs from orthodox government review and from government and legislative control. They may even divert the research into highly illegal and unethical means, because it furthers their own rogue agendas. That is how clandestine U.S. government research can sometimes go sour, unless great care is exercised by the oversight committees in the House and the Senate.
>
> "Sometimes when rogue groups do gain control and total secrecy of a given new technological area, then what appears to be "U.S. government operations" do start to encompass a criminal and unethical operations, hidden usually beneath the deep veil of high classification. Also, if it's "scientific," no one is ever brought to justice, even if the "evil science actions" are uncovered and publicly revealed."
>
> Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p08.htm

Like the huge energy of the Tesla howitzers, the ability to engineer the mind with longitudinal waveforms is a seeming "magical" thing which can be used for good or ill. Bearden envisions that further developments will allow something like the "downloading" of knowledge via scalar interferometry. Everyone could be highly educated, and quickly and easily.

In the conclusion of the paper "Mind Control and EM Wave Polarization Transductions" Bearden makes a plea to the nations of the world regarding the use of psychoenergetic engineering.

> "Let us hope this great new area, already off to a bad start, can be bridled and steered in the direction helping and healing people, rather than killing or abusing them. The excesses in its bad use are a potent threat to all nations on earth.

"Yet it can revolutionize medical science, education, communication, and psychology. We foresee the day -- perhaps 30 years hence -- when education will be accomplished by directly loading the software into the mind. Then in three weeks one will "load" a doctorate, say, in physics. In three more weeks on will also load a doctorate in chemistry. Another three weeks, in electrical engineering. Another three weeks, an MD And so on. When that happens then truly everyone on earth can be educated. Freedom from ignorance may well be another great freedom that is legally recognized. There will be no impoverished large groups lacking the education to find decent, productive jobs.

"We urge all nations to use the principles involved: not for human abuse, but for healing, educating, uplifting, and life-expanding of every person on earth. If we do, we shall all have a far brighter future. Then we shall check what has started out to be the Sword of Damocles and turn it into the golden Millennium."

Bearden http://www.cheniere.org/explore%20articles/mind%20control3/p08.htm

(Perhaps after so many frightening topics a slight break is in order here to consider the lighter side of psychoenergetics. For example, what will be the ultimate impact on the entertainment industry?)

The Feelies at Last!

Psychoenergetics will be able to bring about at last, for better or for worse, Aldous Huxley's fanciful idea in his novel "Brave New World," an entertainment format which he called "The Feelies." Those were something you went to, like going to the movies, but you would experience all the actual feelings themselves, as if the depicted events were actually happening to you. Although our "leaders" seem too dim to grasp what is going on in the world of scalar electromagnetics, it should not take some young Hollywood genius too long to understand that The Feelies are now possible, and that the immense megabucks of potential profit more than justify heavy investment in bringing it to market.

One can imagine that first "Feelie" theater, "The Huxley" perhaps, a large comfortable area surrounded by nine giant screens (not just one screen!), which become 3D if you put on your headset. And The Huxley is fitted with the finest sound, and oh, by the way, a modest sized scalar interferometer with computer. And there are one or more new tracks now recorded on the film next to the sound track. These are the digital patterns of thoughts, feelings, and ideas to be fed into the theater's interferometer. And these thoughts and feelings and ideas will be felt by the audience as if they were their own thoughts and ideas. It is an entirely new art form. Psychevision.

As important (and no doubt famous) as the actors would be the "feelers," those from whose minds the feelings were lifted in the original programming of the Feelie tracks. Because, for example, Brad Pitt might be a good and handsome actor, but can he really feel it? Like the dubbing of foreign language films, it might be necessary to dub the "emotional track" using a deeper and more profound person's feelings, thoughts and ideas.

It might even be engineered so that if you sat on one side of the theater you would feel like the hero, and on the other side you would feel exactly like the bad guy! What would that lead to?

We have all cried at a movie some time, most people have, though they might not want to admit it. But this would be deep sobbing and a flood of tears, if the director so desired it. You would feel it at your core. Or, take a big chase scene, you would be terrified. They are breathing down your neck! You would be gripped by panic.

For that matter, the whole genre of Horror-Feelie would be too much for many people to take. Do I really want to feel that an actual vampire is tearing at my throat with his fangs?

A Religious Feelie would make you feel the exaltation of a saint at his prayers, or give you the definite feeling that you are Christ suffering on the cross. All the pain could be there too. The stickiness of the blood. The very feeling itself: "Why hast thou forsaken me?" Who among us could come up that despair for scanning? Had this been developed a bit earlier we might watch a documentary of, say, Mother Theresa, containing her own actual deep sense of compassion, which we would feel arising in us as our own.

Then again, a Psychedelic Feelie could induce an LSD-like state and simply blow the audience's minds.

Even in its simplest most primitive mode, the hypnogogic trance induction with its increased suggestibility, would completely alter the experience of even ordinary current movie going.

6. As it Stands - 2002

"Anyway, it's presently a "Mexican stand-off" with the various parties maneuvering with check and countercheck. That is the real "balance of terror" that is held by such a fragile balance."

"You can see the implications if such weapons fall into the hands of the radical terrorists. Ordinary positive energy EMP shooters can be made fairly readily and cheaply from nearly just Radio Shack parts or surplus parts. It just takes some know-how... When and if the Yakuza [Japanese mafia] gets those (and they will, it's just a question of time), you can begin to appreciate some of the turns this present terrorism and our war on it will take."

Bearden http://www.cheniere.org/correspondence/021702a.htm

The very thought of the building of one of these howitzers by "some lone-nut gunman" from Radio Shack parts makes one realize how serious it is for humanity to face the crisis it has come to.

Once again, as at the dawn of the nuclear era, humanity finds itself at the crossroads of Heaven and Hell. As a species, we must stop and consider. And there is at least one real difference between this visit to the crossroads and the last: this time there is a very real possibility of a true "earthly heaven" on the Heaven side.

The poor nations could come to a good life. Disease could be largely eliminated. Fossil fuel pollution could end. Global warming could be solved, and the weather could be managed in a humane way, bringing water where there is drought, and sunny skies where there is flood. Scalar interferometry would be there to avert any possible hits by asteroids or comets. Mars could be colonized and terraformed. Everyone would be highly educated through psychoenergetic downloading of knowledge. And the wisdom of the wise could be realized directly through scalar connection to their minds and hearts.

These stunning sudden possibilities give me pause to think: if our species has reached this crossroads in such a short span of centuries, then surely other species in this vast universe have passed this way before and long ago. And of those who chose the path to "planetary heaven," what is their life like now? It might be good if some of them were with us now, to guide us through this last struggle over this pesky old good-and-evil problem. It is our last chance to choose the path which benefits the whole species, and not just some elite group or faction.

The Disclosure Project

One person working tirelessly to bring to bring these technologies into the open is Dr. Stephen Greer of the Disclosure Project, which is calling for congressional hearings into the issues of UFOs and the free energy technology that was, perhaps in part, reverse-engineered from them.

> "Once abundant and nearly free energy is available in impoverished areas for agriculture, transportation, construction, manufacturing and electrification, there is no limit to what humanity can achieve. It is ridiculous — obscene even — that mind-boggling poverty and famine exists in the world while we sit on classified technologies that could completely reverse this situation. "So why not release these technologies? Because the social, economic and geo-political order of the world would be greatly altered. Every deep insider with whom I have met has emphasized that this would be the greatest change in known human history. The matter is so highly classified not because it is so silly, but because its implications are so profound and far reaching. By nature, those who control such projects do not like change. And here we are talking about the biggest economic, technological, social and geo-political change in known human history. Hence, the status quo is maintained, even as our civilization hurtles towards oblivion...
>
> "With the types of weapons currently in the covert arsenal — weapons more fearsome even than thermonuclear devices — there is no possibility of a survivable conflict. Yet in the darkness of secrecy, actions have been taken on behalf of every human that may

> endanger our future. Only a full, honest disclosure will correct this situation. It is not possible for me to convey in words the urgency of this."
>
> Dr. Stephen Greer http://www.disclosureproject.org/ES-DisclosureImplications-2.htm

Greer and his team have assembled hundreds of witnesses, many of whom are military or ex-military, who are ready to testify to congressional hearings what they know about the covert black projects which have kept free-energy and antigravity propulsion technology secret from the people.

Greer points out the need to regulate these technologies so they are limited to peaceful uses, but this is of course difficult when the government simply chooses to pretend they do not exist. In the meantime, as the President and the Defense Department continue the charade of war-as-usual, those scalar (longitudinal wave) installations which DO exist continue to fall into ever more sinister hands. And there is no reporter in the press brave enough to ask, "Mr. Secretary of Defense, what steps are you taking to defend our MINDS from attack by the big Russian longitudinal interferometers?"

Longitudinal Interferometers are Proliferating

In a later statement Bearden reveals that in fact the Yakuza [Japanese mafia] has already leased some of the interferometers with a nearly $1 billion "down payment:"

> "After the collapse of the Soviet Union's economy, lots of things got available for lease or purchase that would never have been under the old system. That happened in the resulting economic chaos. The Russian Mafia rose to prominence, as did some wheeling and dealing entrepreneurs who played both ends against the middle.
>
> "In that atmosphere, and in the need for money, the KGB allowed leasing of the earlier longitudinal EM wave interferometers to a consortium of the Yakuza and Aum Shinrikyo. They did this only after they had tested and deployed their great new quantum potential weapons. That class of weapon is the dominant weapon on earth. Five nations now have it: Brazil, Russia (KGB), China, and two nations friendly to the U.S. The deal to lease many of the earlier LWIs [longitudinal wave interferometers] to the Japanese Yakuza and Aum Shinrikyo was consummated at the end of 1989, with a down payment of $900 million in gold bullion as "up front" money. I don't know what the lease per year was and is, but probably something like a billion dollars a year. So the rogue Japanese acquired longitudinal EM weapons and that technical know-how. In fact, the Yakuza is producing certain kinds of those in its own facilities in Japan now."
>
> Bearden http://www.cheniere.org/correspondence/030202a.htm

Personally, I am a little uncomfortable with the knowledge that the Japanese mafia may now be able to insert things into my mind. I'd like to sleep at night knowing that my dreams are my own, such as they may be, and not some weird fantastic visions cooked up by a criminal organization. This is a world emergency.

And in Bearden's analysis, it all comes back to the issue of energy. It is the energy crisis which is now provoking the current "oil wars," since oil production has hit the "Hubbert Peak" and will decline. And the electrical power grids must be replaced with scalar power as fast as possible, for these grids are now totally vulnerable to any possessor of longitudinal interferometers. They can all be wiped out in minutes. By anyone who possesses or controls a Tesla howitzer.

> "Anyway, in my personal view, we should have a national Manhattan Project right now, to develop decentralized electrical power systems taking their energy from the vacuum . . . The MEG is real and so are several other systems invented by private inventors and colleagues. All these efforts should be massively funded and massively and quickly developed. The survival of this nation is going to depend upon it. . . . There are many other facets, but the major point is that our scientific apparatus and the public are still unaware of what a desperate struggle we have entered, since it was thrust upon us. 9-11 was a wake-up call. It was certainly bad enough, and one grieves for those lost American lives. But I fear the worst is yet to come, and it is coming at us like a runaway train hurtling right down the track at us."
>
> Bearden http://www.cheniere.org/correspondence/021702a.htm
>
> "The electromagnetic weapons mentioned by the Secretary of Defense in April 1997 are in terrorist hands also, including the Yakuza and Aum Shinrikyo. That rogue group leased those earlier weapons on site in Russia, from the KGB, at the end of 1989. The SecDef stated that such weapons were being used to initiate earthquakes, initiate volcanoes into eruption, and control and engineer the weather. Quite true. And presently there is a truly massive set of weather engineering operations going on over North America, from that rogue Japanese group manning the weapons in Russia. Some 10 nations of the world now have the type of longitudinal EM wave interferometer weapons (which are what the SecDef was most probably referring to). There are other even more fearsome weapons, possessed by five nations. So a great deal of the state of the world is not covered in the news at all, and will not be . . .
>
> "We have been in an undeclared war of an eerie kind for some decades. That war seems now to have started to heat up also. The destructive capability of some of these weapons is awesome, and far greater than nuclear."
>
> Bearden http://www.cheniere.org/correspondence/021702a.htm
>
> "In that sense, the first phase of WW III is already completed. Now we are only waiting for Phase II.
>
> "It is against that backdrop that I think one must "analyze" such things as how fast we will be replacing the power grid (it's going to go anyway, and catastrophically, the terrorists will see to that). And everything we have is critically dependent upon energy, from the economy to jobs to mobility, to the millions of trucks that transport our goods every day, etc.
>
> "As far as I am concerned, we are already late in declaring a great national emergency in energy, because of the coming destruction of the present energy infrastructure. The

> scientific community should lead, follow, or get out of the way. The emergency is not in seeking "alternative but conventional" systems. It is in developing "energy from the vacuum" on an emergency, crash basis.
>
> "Unfortunately, everywhere I look I just see business as usual. Most Americans (and news media) seem to think, hey, Afghanistan is finished except for a bit of cleanup, and it's just about over).
>
> "It isn't. It has only just begun."
>
> Bearden http://www.cheniere.org/correspondence/021702a.htm

Beyond the Howitzers: Quantum Potential Weapons

Do not use EM propagation through space

As more and more nations acquire the scalar interferometers, Bearden speculates on the next generation of longitudinal weapons called "quantum potential" [QP] weapons.

> "The quantum potential weapons are presently only held by three nations: Russia (in the hands of the KGB, which is now know by its new name), Brazil, and the "friendly little nation." Red China may be working on them, but is just at the beginning...
>
> "The QP weapons have been highly reserved by the Russians. However, the complete extent of their capabilities is still being figured out...
>
> "The quantum potential weaponry (possessed by only three nations) is supreme, because it uses multiply connected spacetime, and DOES NOT involve propagation of EM energy through space as does the longitudinal EM wave interferometers.
>
> Bearden http://www.cheniere.org/misc/qp.htm
>
> "The operational deployment of full-scale strategic QP weapons on site in Russia occurred at the end of 1989, which is when the formal weapons first went operational. These weapons are not in the inventory of the regular Russian armed forces, but all research and development, manufacturing, deployment, an manning and employment is under the ruthless control of the KGB. Shortly thereafter (within weeks), the KGB leased many of their earlier longitudinal EM wave interferometer (LWI) weapons to a rogue Japanese group comprised of the Aum Shinrikyo and Yakuza."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

In another paper, "Time Polarization - Significance and Weaponization," Bearden tells the story of how a KGB longitudinal wave attack was averted by the longitudinal weapons of a "friendly small nation."

So as it stands, it is precarious. Not until the people demand an end of what author Jim Marrs has dubbed the "Rule by Secrecy," can the people's representatives tackle the big problems of a worldwide ban on Scalar Wars and the shifting over to an essentially oil-free economy.

Latest Update from Tom Bearden - March 2002

The whole situation is changing so fast that when I asked Tom to look over this article he mentioned the seeming contradiction when some of the above statements are taken together. At different times the information he has is updated so one has to keep a kind of running track. He was kind enough to clear up the confusion here with the situation as it stands as of March, 2002.

> "We knew of three nations having the QP weapons for some time. Then we found out last year that five nations had it. So that explains my using the figure "three" first (which represented what I knew at the time). Later I found out about the other two nations. China, e.g., only deployed its QP weapon this past year. So that explains the apparent contradiction between me using "five" in later papers and "three" in earlier ones. It was the best information I had at that time. Might mention that so the reader will understand the apparent discrepancy." Tom Bearden

Emptiness is Full of Energy

"The Tao is an empty vessel;
it is used, but never filled.
Oh, unfathomable source
of ten thousand things!

"Oh, hidden deep but ever present!
I do not know from whence it comes.
It is the forefather of the gods."

Lao Tzu -Tao te Ching

Afterward

Because of the extreme seriousness of the topics brought forward in this article, I asked Tom Bearden to look it over to make sure I had not gotten anything too terribly wrong or mixed up. I did not want to pass on any misunderstanding of my own. I felt a little nervous writing to an eminent scientist, and hoped I had not presumed upon his time.

But Tom was so kind as to answer immediately, and to my relief I had not gotten anything too terribly wrong. Here is his letter, in which he clears up a misunderstanding, and reports on his current health treatment, and gives a call to the young grad students to turn themselves loose in the whole new field of scalar electromagnetics and free energy.

Subject: RE: Article on Tom Bearden and "Scalar Wars"
Date: Fri, 22 Mar 2002 22:54:01 -0600

Bill,

Well, I must say I'm astounded at your persistence and hard work in congealing all that together. My compliments on a hard job quite well done.

Couple tiny things: In the area mentioning Kervran and Kaznacheyev: Kervran was French; Kaznacheyev was and is Russian. Little typo of "spredding" the immune system. Should be "spreading".

We knew of three nations having the QP weapons for some time. Then we found out last year that five nations had it. So that explains my using the figure "three" first (which represented what I knew at the time). Later I found out about the other two nations. China, e.g., only deployed its QP weapon this past year. So that explains the apparent contradiction between me using "five" in later papers and "three" in earlier ones. It was the best information I had at that time. Might mention that so the reader will understand the apparent discrepancy.

Otherwise, it's pretty accurate.

Just now I'm letting the weapons take care of themselves; have to, as I will be recovering now for nearly a year from now after the heart attack last year and discovering that I had contracted mycoplasia (the BW modified kind) in Canada in 1968. Finally got a test which confirmed the chronic mycoplasia (which I had for 33 years!). The stuff burrows inside one's red corpuscles, then draws nutrients from the hemoglobin, hardening it and reducing its ability to take on oxygen (by as much as 50% or more). The resulting symptom is loss of endurance (which I had for that 33 years) -- the so-called "chronic fatigue syndrome".

Many of the Gulf War Veterans who are sick also have it, though they apparently have other complicating factors as well. A very high percentage of persons with chronic fatigue syndrome also have mycoplasia. The treatment for the long-standing mycoplasma infection of that nature is to stay on antibiotics for a year. The only time the mycoplasma is vulnerable is when one wears out a red cell in normal usage, and the body makes a new red cell to replace it. The mycoplasma comes out of the dying cell to infect the new replacement cell, so it is exposed and vulnerable at that specific time and that time only. The antibiotics kills it at that time. Hence the necessity to stay on antibiotics for such a long time so it is continuously in your bloodstream (I've already been on antibiotics for over two months, and have at least 10 more months to go). We also take a little medical oxygen every day.

Another symptom of the mycoplasma infection is the association of runaway fibrillation of the heart. To stop that, there are pills one takes, and they stop it. But they also further reduce the volume of blood pumped by the heart, so that this projects one right back into the hypoxia, dizzy, loss of balance, etc. Catch 22 situation; the fibrillation will build and cause heart attack, stroke, etc. if not stopped, and if stopped it puts you back in the hypoxia which can cause many things! With the conventional treatment, you're damned if you do and damned if you don't. Hence the need for a little extra medical oxygen, so you can take the "heart clamp" pill and stop the fibrillation, but also augment the oxygen enough to continue to survive without a stroke or some such. Interestingly, it's very difficult to even obtain a mycoplasma test, and Medicare fights you tooth and nail over paying for the oxygen. Either they will pay for it or I'll pay for it myself; it is absolutely necessary.

After a heart attack, one is treated in the heart clinic by specialists who are very caring and excellent practitioners, but know nothing of mycoplasma infection, so not consider it even a part of "heart disease", and who are rather puzzled when one has no clogging of the arteries, has the right count of red corpuscles (largely nonfunctional, of course, but there), pumps the right amount of blood, etc. So they identify and treat only the runaway fibrillation, do not prescribe the oxygen -- and essentially place you on a regime as best they know, but one that is guaranteed to kill or maim you or turn you into a totally disabled person or human vegetable via stroke, paralysis, etc. Fortunately my family doctor will prescribe the oxygen anyway, though I may have to pay for it myself. Whatever works!

However, I'm slowly improving little by little, working as much as I'm able to and trying to finish my book: Energy from the Vacuum: Concepts and Principles, and get it to the publisher for publication later this year. Hopefully the book will turn all the interested young grad students and post-docs loose in the free-energy area. They will not have to spend 30 agonizing years to get to where I am, and where a few others are, but can simply start here and go forward. Since speed to develop energy from the vacuum is of the essence because of the world situation, I'm moving on it as fast as I am physically able to.

Meanwhile, working with the AIAS (Alpha Foundation's Institute for Advanced Study), the AIAS (15 authors) has now gotten about 20 scientific papers published in leading journals (Foundations of Physics, Foundations of Physics Letters, Physical Scripta, Optik, etc.) dealing with electromagnetic energy from the vacuum. Several more are either approved for publication or in the review process also. So slowly we are getting it into the mainstream scientific literature. Hopefully it will be in time, but it's cutting it close.

Very best wishes,

Tom Bearden

Late update

Massive display of longitudinal interferometers?

UFO Fleet Taped Over Bedhampton, England

Is this sighting a case of the testing of all the Russian (KGB) longitudinal interferometers at once? And coordinating their targeting through the woodpecker grid to a common place, as an exercise in making a massive scalar attack upon a given region? Was this a confluence of Russian Tesla howitzer marker-beacons?

Certainly for a massive all-out scalar attack you would want coordinated movements of the target areas of many howitzers at once, for you could then just cut a bloody swath across a wide area, all the howitzer blasts marching across the land in a kind of scalar version of the "scorched-earth policy." All in a line, blasting, and heat, and mind waves. Or you might want to put the blasts all in the same place for a truly horrendous destruction. And on top of that biowar on citizens whose immune systems have been weakened with the quantum potential weapons. This is the latest version of Armageddon.

And should any madmen gain control of these weapons, any rogue group at all, and should they have some agenda to radically depopulate the world, to simply kill by the billion, the means will be in their hands to do so.

Update: MEG patent granted

Motionless Electromagnetic Generator Patent Granted

This message is from Jean-Louis Naudin, the French scientist who successfully replicated the Motionless Electromagnetic Generator (MEG) in France. He announces the granting of the patent to the MEG Builder's group at Yahoo.

----- Original Message -----

From: jnaudin509@aol.com
To: jlnlabs@yahoogroups.com
Sent: Tuesday, March 26, 2002 2:20 PM
Subject: [jlnlabs] (Info) GOOD NEWS : The Tom Bearden's MEG IS PATENTED

Dear ALL,

GOOD NEWS !!!!

The Motionless Electromagnetic Generator from Tom Bearden is now PATENTED US 6362718 granted on March 26, 2002

US Patent 6,362,718 :
Motionless Electromagnetic Generator (MEG)

Abstract: An electromagnetic generator without moving parts includes a permanent magnet and a magnetic core including first and second magnetic paths. A first input coil and a first output coil extend around portions of the first magnetic path, while a second input coil and a second output coil extend around portions of the second magnetic path. The input coils are alternatively pulsed to provide induced current pulses in the output coils. Driving electrical current through each of the input coils reduces a level of flux from the permanent magnet within the magnet path around which the input coil extends. In an alternative embodiment of an electromagnetic generator, the magnetic core includes annular spaced-apart plates, with posts and permanent magnets extending in an alternating fashion between the plates. An output coil extends around each of these posts. Input coils extending around portions of the plates are pulsed to cause the induction of current within the output coils.

Inventors: Patrick; Stephen L. (2511 Woodview Dr. SE., Huntsville, AL 35801); Bearden; Thomas E. (2211 Cove Rd., Huntsville, AL 35801); Hayes; James C. (16026 Deaton Dr. SE., Huntsville, AL 35803); Moore; Kenneth D. (1704 Montdale Rd., Huntsville, FL 35801); Kenny; James L. (925 Tascosa Dr., Huntsville, AL 35802)

Appl. No.: 656313
Filed: September 6, 2000

For some technical info see my web site at : http://jnaudin.free.fr/html/meg.htm

Best Regards
Jean-Louis Naudin
Email: JNaudin509@aol.com
Main Web site : http://jlnlabs.org
Site France : http://jlnlabs.multimania.com

Click here to view patent # 6,362,718

Patent Story on Rense.com:

Rense.com
MEG Scalar Energy Device
Patented - Production Starts Next Year

From Bill Morgan
wmorgan@nycap.rr.com
3-28-2

Patent was granted on March 26, 2002 for "The Motionless Magnetic Generator," (MEG) US Patent 6,362,718, which is likely to become the first commercially available free energy device in history in about one year from now. The machine will provide free electricity from the vacuum, for the life of the device, which should be a very long life since it has no moving parts. You can see a picture of scientist Jean-Louis Naudin's MEG replication model at: http://jnaudin.free.fr/html/meg.htm.

It has strong magnets, coils, and a controller unit with the electronics. Naudin made the announcement to the MEG-builder's Yahoo group. The announcement has significance since the patent office has always been skeptical of devices which seem to "get-something-for-nothing." But according to the new science of scalar electromagnetics, the MEG does not break the law of conservation of energy. It's just that the energy is conserved in the fourth dimension, time, and not our 3-space world.

The MEG provides electrical energy by tapping the longitudinal electromagnetic (EM) waves which exist in almost infinite abundance in the vacuum of space. This ocean of energy which permeates everything is sometimes called the "zero point" energy, since it remains there even at absolute zero temperature.

Four inventors are listed: Stephen L. Patrick, Thomas E. Bearden, James C. Hayes, Kenneth D. Moore.

Tom Bearden has explained the operation of the MEG on his website Cheniere.org, and also speaks about the new fearful weapons that can and have been made using the same "longitudinal waves" of the vacuum.

The complicated physics of how the MEG works is explained in the paper "The Motionless Electromagnetic Generator: Extracting Energy from a Permanent Magnet with Energy Replenishment from the Active Vacuum," which can be found at Tom Bearden's website:

cheniere.org.(http://www.help4all.de/energy/MEGpaper.pdf)

The first MEG units to be produced for sale will output 2.5 kilowatts of free electricity. Forever. They should be in production about a year from now. Facilities for manufacturing the device are being set up in an unnamed "friendly nation."

This free electricity will flow indefinitely, without much, or any maintenance. The units may be hooked together to provide more wattage, so four of them would provide 10 kilowatts. After some production experience units will be made which output 10 kilowatts each. With a couple of those units a house could get off the electrical grid.

Tom Bearden, one of the inventors has said "I will admit that the chief scientist of an important experimental group in a large company was rather stunned at the type of output we were able to

obtain. The MEG may look like just a transformer, but it is not. It is a completely different breed of cat." This cat, it would seem, is out of the bag now.

The ordinary EM waves we are familiar with are called "transverse" waves, to distinguish them from the new "longitudinal" EM waves of the vacuum. Bearden has explained in depth on his website cheniere.org that wherever there is a dipole (battery, generator, magnet) there is an unseen flow of longitudinal EM waves in that local vacuum, the only problem is in tapping that energy and "transducing" it to electricity. Bearden says that the problem with all the electrical circuits we have is that they are two-wire circuits, a loop by which half the energy goes back to destroy the dipole. In the MEG that closed loop is never made. So the dipole is not being destroyed.

Patents are not granted on devices which do not work, so in a sense this announcement proclaims a new era. The MEG device itself proclaims and proves that energy is abundantly available everywhere, for free. We only have to build the devices to tap it. MEG type devices could be put into a car with an electric engine to make a truly fuel-less automobile. Electricity can be available in very remote places. People will be able to get off our very terrorist-vulnerable power grids. In an era of terrorism a highly dispersed power system would be most desirable rather than our centralized systems.

What is somewhat astonishing to me is the discovery by Bearden et. al. that time itself is actually compressed energy, and that this free energy is actually coming from the time domain, the ocean of longitudinal EM waves which fill the empty vacuum of spacetime. In fact, time is energy compressed by the same factor that matter is compressed energy: the speed-of-light squared. Thus there is a new companion to Einstein's E=mc2. Can you say "E equals delta-tee-cee-squared?" The "tee" is time and delta-tee is change in time.

A company has been set up to manufacture the MEG called Magnetic Energy Limited.

The ramifications of free energy are enormous. The oil wars are not necessary. If we threw as much money at this technology as we are spending on the oil wars we would be free of the need for oil in less than a decade. With fuel-less cars air pollution will be greatly lessened. Third world nations can raise their standard of living eventually. And the energy is free. And it never runs out.

I have put together a kind of "Bearden for Beginners" article which explains some of the basic concepts of the current state of scalar technology.

http://www.prahlad.org/pub/bearden/scalar_wars.htm

The granting of the MEG patent is the herald of the new era of scalar electromagnetics, and the free energy which flows forever and never runs out.

Bill Morgan
wmorgan@nycap.rr.com

Do the magnets run down after a while?

Further developments: Tom Bearden clears up a question

When the MEG patent was released many questioned the patent language which seemed to imply that permanent magnets of the MEG would "wear out" after awhile. I myself wondered about the same thing so I put the question to Tom, and here is his reply.

> Dear Bill,
>
> Thanks for the kind words; much appreciated.
>
> I'm not up to going on radio or TV, and won't be for quite some time. Still suffering from hypoxia, though very slowly improving, and will still be on antibiotics for 10 more months at least (maybe longer).
>
> Obviously an extensive dialog developed between the Patent office and our patent attorneys. As best I can understand it, the Patent office accepts the fact that a permanent magnet produces and emits energy, or has a history of accepting it. They do not appear to be at all cognizant of the broken symmetry of opposite charges, and hence of a dipole. So in their opinion (which seems to be vague), the magnet has to use itself up very gradually, or some such. So some rewrites were essentially required by the Patent office.
>
> All I can say is that a magnet is a very durable thing, so long as you don't heat it up too much or shock it to much. Certainly one will make a good 20 years, and of course there are plenty of magnets that have been around awhile longer.
>
> That said, in our earliest experiments we did "measure" some such effect, or so we thought, until we found that a particular instrument was bad and giving erroneous readings. So with a new instrument, we have not observed since then any such readings.
>
> Out of all that fuzziness came the inclusion of "using up the magnets gradually". So far as we are aware (after correcting those early readings on a defective instrument), we have seen no such measurements or effects since then at all. Nonetheless, just in case there is some very small effect in that respect, at least it's in there.
>
> Actually, as you are aware, capacitors and solid state components are the major concerns for failure, and any system does require maintenance, both periodic and whenever malfunction or failure occurs. The MEG is no different from any other device in that respect, so of course it will have a component failure rate and maintenance required from time to time, just as any other electromagnetic device. But without moving parts, it can be ruggedized and made very durable indeed.
>
> Please give Jeff Rense my regrets, and I do admire his work and his show. He's laying it in there.
>
> The depth of the scientific mindset against COP>1.0 is inexplicable, particularly when physics itself already has COP>1.0 validated experiments (such as Bohren's experiment,

which outputs 18 times as much as one inputs by Poynting calculations), and it works every time. Any competent university optics lab can perform the experiment. Also, even the conventional texts admit that a charged capacitor or electret laid on a permanent magnet, so that the E of the cap or electret and the H of the magnet are at right angles, is a "free energy machine". That silly thing will just sit there and pour out Poynting energy S = EXH indefinitely. Years and years and years. If you wait just a single year, that silly thing has changed the energy density of a volume of space a light year in radius, reaching out well beyond the solar system. Now that's a WHALE of a lot of EM energy that beast poured out in that year, and it will still be going strong and pouring it out at a steady rate. The charges and dipoles in original matter in the universe have been pouring out EM energy in that fashion for some 14 billion years, give or take a billion or so. It's also easy to see that, prior to Lorentz's ARBITRARY symmetrical regauging of the Maxwell-Heaviside equations, those equations prescribe both EM systems in equilibrium with their active environment, and EM systems not in equilibrium with it. The latter systems are permitted by the thermodynamics of open disequilibrium systems to perform five magic functions: (1) self-order, (2) self-oscillate or self-rotate, (3) output more energy than the operator inputs (the active environment inputs the rest of it), (4) power itself and its load (the active environment inputs all the energy, like a windmill), and (5) exhibit negentropy. That is a well-established thermodynamics. Lorentz arbitrarily discarded all such open disequilibrium EM systems in order to get simpler equations having analytical solutions and not requiring numerical methods. So he simply scrapped all the really interesting and challenging EM systems in Maxwell's theory. ARBITRARILY!

That our scientific establishment continues to teach only that "half" of the theory, and not point out the rest to the young students, and not fund research into developing such systems that take energy from the vacuum, is simply inexplicable. It's a matter of total dogma, not science at all.

But hopefully it is changing a little bit. At least now we cite chapter and verse when these things were done, and what they are, and the young grad students and post docs can go check the papers and make up their own minds.

That is the real hope of the future: that we get a generation of young fellows, with excellent skills, who now know where all the skeletons got hidden in the closet, and understand that the electrical engineering model arbitrarily assumes an inert vacuum environment (falsified for more than a half century in particle physics) and a local flat spacetime (falsified for nearly a century by general relativity).

Once they know that past history, and go read into what broken symmetry of opposite charges means for a dipole and for all dipolar EM circuits, they will set to and change that more than a century of error. In that case, we shall have numerous solutions to the energy crisis rather quickly, popping up all over.

Good thing. It will certainly displace some great energy barons, but it will also free the populace. One can extract all the EM energy from the vacuum one wishes, anywhere, anytime, with ridiculous ease. One can produce that "electrical wind of energy" at will, by making a simple dipole and then letting it alone. The only energy problem is in how to

then intercept some of that energy flow and "catch" it in a circuit, discharge it in a load to power it, and not use half the "caught" energy to kill that dipole that is gushing out the extracted EM energy from the vacuum.

Very best wishes,

Tom Bearden

END

Foundations of Electro-Magnetism

Slide Series

- Major Points of Presentation
- Chung's Carbon Filament Negative Resistor
- Aharanov-Bohm Effect
- Absorption and emission reactions (1)
- Absorption and emission reactions (2)
- Anti-engine for cell's deviation reverses cell back to normal
- Asymmetric regauging produces excess force, which can be used to do work on the system
- Asymmetric regauging produces excess force, which can be used to do work on the regauging system
- Becker's bone fracture healing experiments
- Becker's theoretical control system governing regeneration
- Becker's theoretical DC control system involved with response to injury
- Geometrical Distortion of Poynting Energy Flow
- Cosmic Bootstrap: Before the Big Bang
- Bridging Enables COP > 1

- Aspects of Strong Local Symmetry
- Other Aspects of Strong Local Symmetry
- Bunge on the Status of Electrodynamics
- Bunge on the Status of Electrodynamics and Physics
- Bunge on the Status of Classical and Quantum Physics
- Fractions of BW Casualties Surviving
- First Step in Self-Promotion of Cancer Due to Hypoxia
- Differentiation and Dedifferentiation Timelines
- Evolution of Cells on Earth
- A Charged Particle q is a Coupled System of m and Ø
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (1)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (2)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (3)
- A Charged Particle is a Coupled System
- The Anomalies in Navy Electrolyte Experiments at China Lake
- Chung's Carbon Filament Negative Resistor

- Typical circuit has about 10^{-13} energy collection efficiency
- Classical View of EM
- Curved Spacetime acts as source or sink
- Chronic Disease Puzzling
- Cancer Characteristics
- Solving a Cancer Enigma
- Cancer: Characteristics
- Nonlinear Optics Distortion Correction Theorem
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)
- In Time-Reversed Zone: Nuclear reactions are biased
- In Time-Reversed Zone: Dynamics may be reversed
- Time-Reversed Zone: Significant only after time-density charging
- A New Conservation of Energy Law
- Questions on Carcinogens and EM

Radiation

- AS DEFINED, fields and potentials only exist in and on charged matter
- Serious flaws and errors in classical EM theory
- Electrodynamicists' Reaction to Removal of the Material Ether
- Reaction to Loss of Material Ether (1)
- Reaction to Loss of Material Ether (2)
- Some EM waves in Spacetime
- Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
- Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
- Phase Conjugate Wavepairs Produce New Waves
- Scalar Electromagnetics (Energetics) View of EM (1)
- Scalar Electromagnetics (Energetics) View of EM (2)

- Scalar Electromagnetics (Energetics) View of EM (3)
- Extended General Relativity Principle
- Extension of Work-Energy Theorem
- 34 Flaws in Classical EM Theory
- MTW's General Relativity Principle
- Use of General Relativity (GR) in Particle Physics
- The Missing Infolded Electrodynamics
- Infolded Engines: Excluded by Present Physics
- Mass curves and structures spacetime; ST curvatures change and structure mass (1)
- Mass curves and structures spacetime; ST curvatures change and structure mass (2)
- At Infinite Velocity: Each Is Every Other
- Lisitsyn's Report: Brain Code Broken
- Lorentz Closed Surface Integration
- Lorentz's physically insignificant energy flow can be collected and utilized
- Lorentz surface integration of the Poynting vector around a closed surface
- Longitudinal EM Photon Interaction with Charge
- Mass is transparent to longitudinal EM waves, which move through the infolded interiors of internal waves, potentials, and fields in the mass.

- Pumping with Longitudinal EM waves Time-reverses the Mass
- Maxwell's Quaternion Theory
- Maxwellian Systems before and after Regauging
- Maxwell's four equations reduce to: Page 1
- Maxwell's four equations reduce to: Page 2
- More to come

Major Points of Presentation

- Electrodynamic is seriously flawed
  - Some major flaws
  - Corrections indicated
- Why past corrective attempts failed
  - Force field concept is material
  - Missing two infolded transforms (M->ST; ST->M)
- Missing Infolded general relativity inside electrodynamics
- Several Kinds of EM Waves in Space
  - How to make
  - Transduction
- A French medical example as a deep experimental demonstration
  - Spectacular regenerative cures funded by French Govt
  - Not comprehended, therefore suppressed
- Cold Fusion examples of time-density wave effects
  - China Lake Instrumental anomalies in electrolysis
  - Explanation of anomalous behavior of instruments
  - Explanation of new nuclear reactions
  - Wave energy transduction provides excess heat
- Urge theorists to consider dramatically new reactions

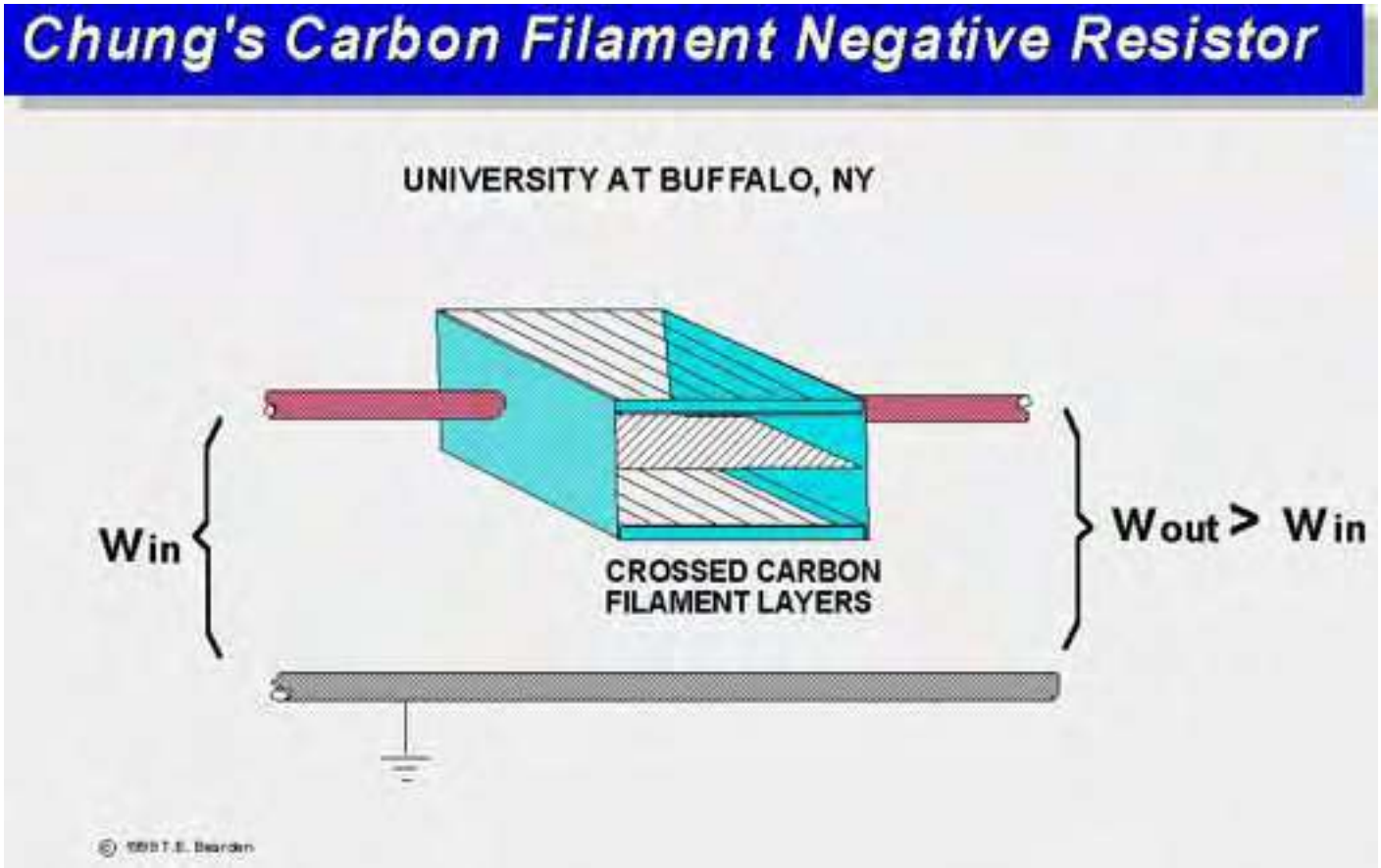
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
Win
CROSSED CARBON
FILAMENT LAYERS
Wout > Win

Aharonov-Bohm Effect

- In field-free regions
  - E-field is zero
  - B-field is zero
- Potentials still exist, just no gradients
  - Cause real effects
  - Interference is the key
  - Contain sum-zeroed substructures
- Does not follow from
  - Mechanics
  - Classical electromagnetics
- Required by quantum mechanics

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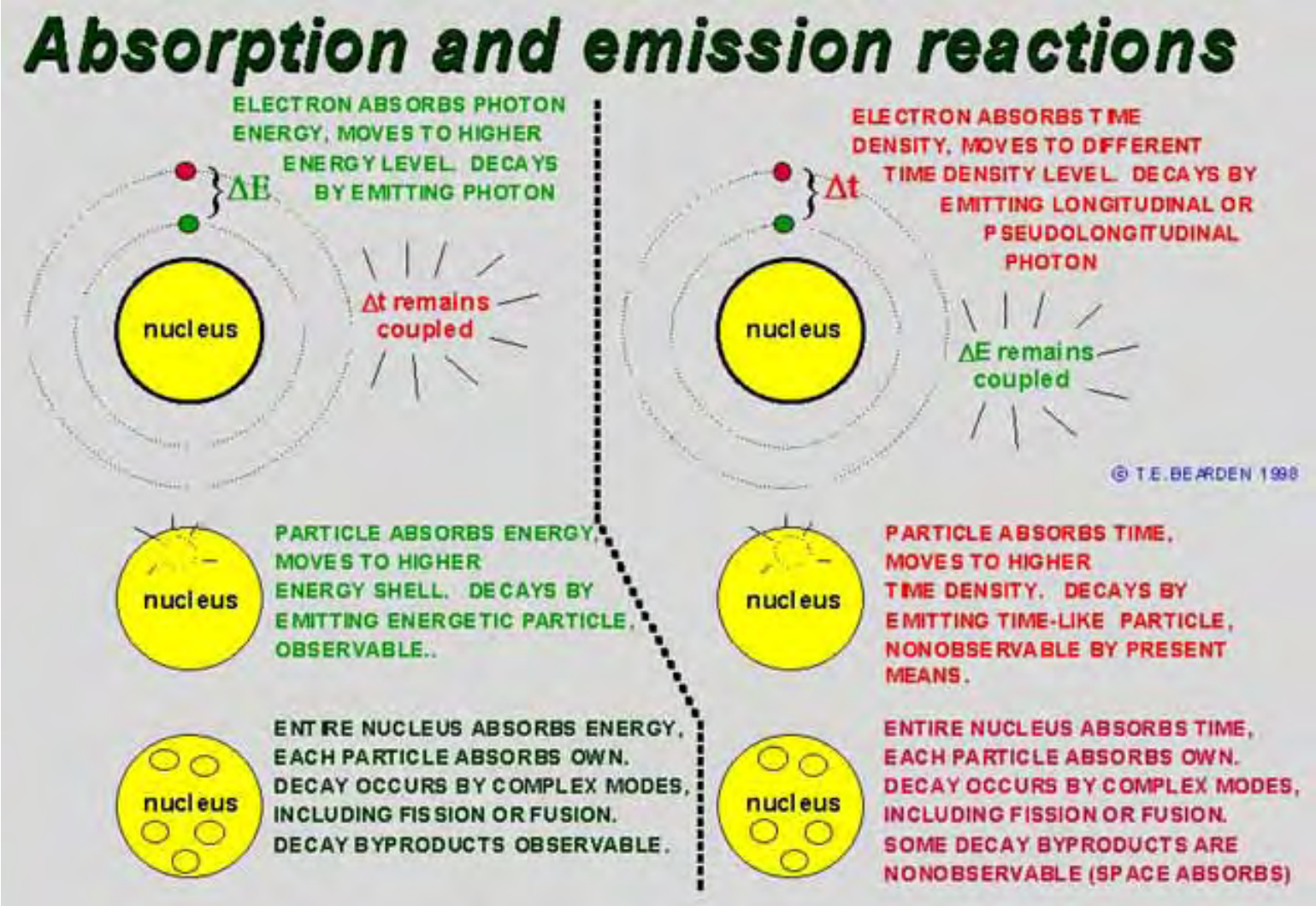
Absorption and emission reactions
ELECTRON ABSORBS PHOTON ENERGY, MOVES TO HIGHER ENERGY LEVEL. DECAYS BY EMITTING PHOTON
ΔE
nucleus
Δt remains coupled
ELECTRON ABSORBS TIME DENSITY, MOVES TO DIFFERENT TIME DENSITY LEVEL. DECAYS BY EMITTING LONGITUDINAL OR PSEUDOLONGITUDINAL PHOTON
Δt
nucleus
ΔE remains coupled
© T.E. BEARDEN 1998
nucleus
PARTICLE ABSORBS ENERGY, MOVES TO HIGHER ENERGY SHELL. DECAYS BY EMITTING ENERGETIC PARTICLE, OBSERVABLE..
nucleus
PARTICLE ABSORBS TIME, MOVES TO HIGHER TIME DENSITY. DECAYS BY EMITTING TIME-LIKE PARTICLE, NONOBSERVABLE BY PRESENT MEANS.
nucleus
ENTIRE NUCLEUS ABSORBS ENERGY, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. DECAY BYPRODUCTS OBSERVABLE.
nucleus
ENTIRE NUCLEUS ABSORBS TIME, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. SOME DECAY BYPRODUCTS ARE NONOBSERVABLE (SPACE ABSORBS)

Absorption and emission reactions

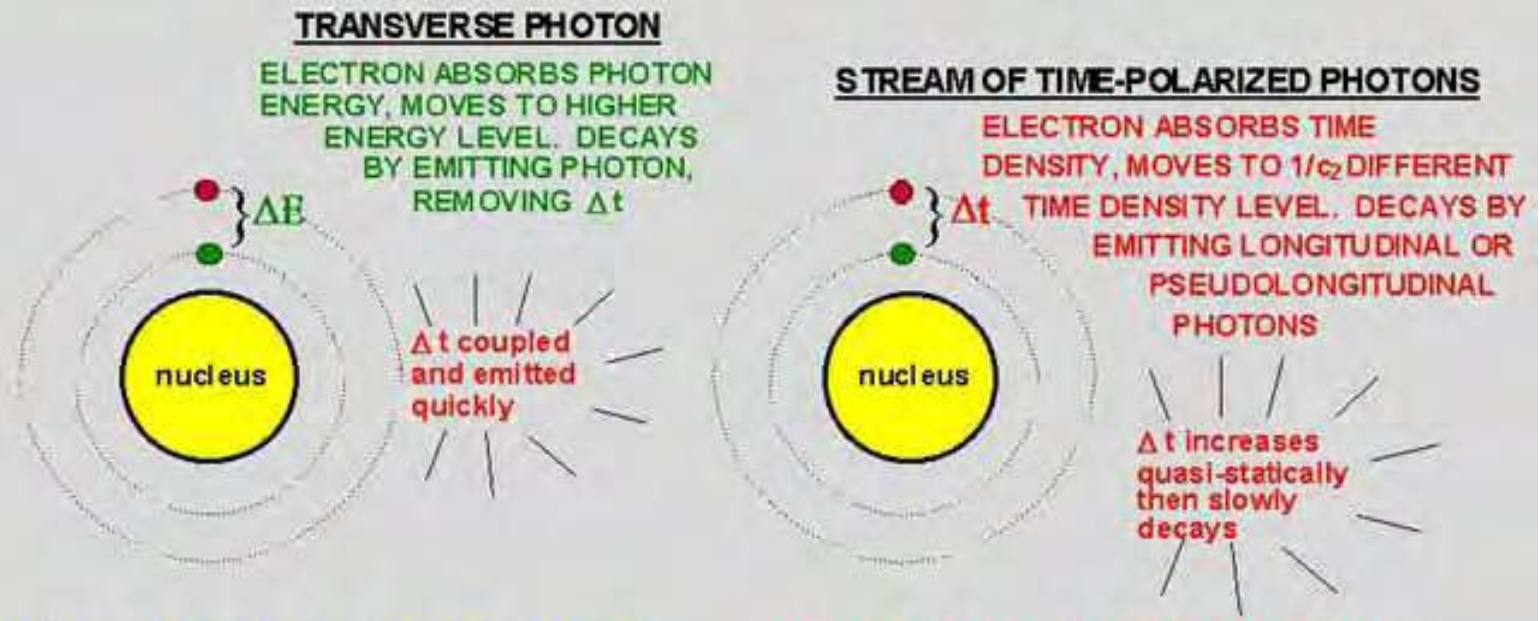

Figure A. Excited energy density level in one jump.

Figure B. Excited time density level significant only after enormous number of increases.

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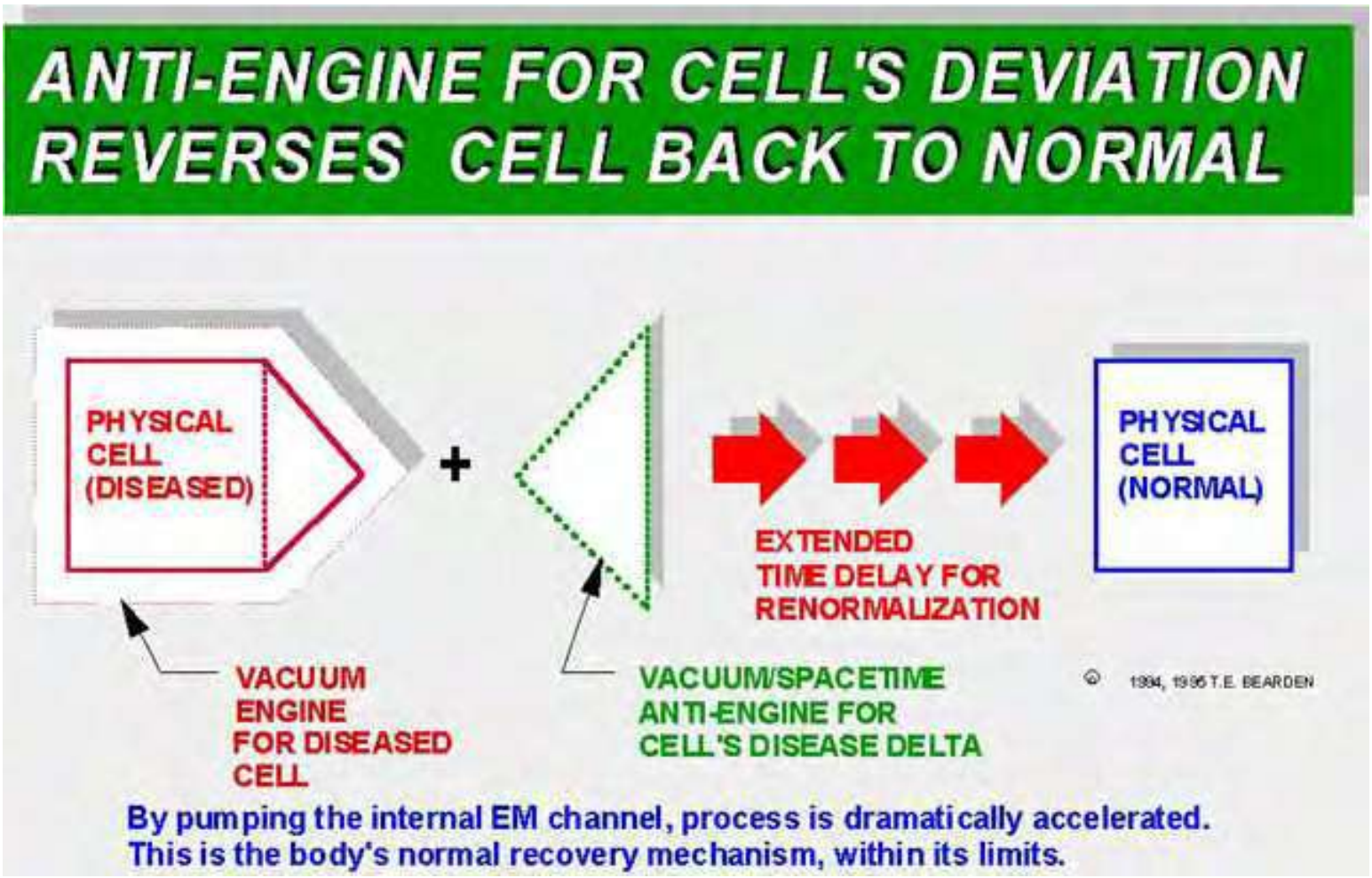
ANTI-ENGINE FOR CELL'S DEVIATION
REVERSES CELL BACK TO NORMAL
PHYSICAL CELL (DISEASED)
+
EXTENDED TIME DELAY FOR RENORMALIZATION
PHYSICAL CELL (NORMAL)
VACUUM ENGINE FOR DISEASED CELL
VACUUM/SPACETIME ANTI-ENGINE FOR CELL'S DISEASE DELTA
© 1994, 1995 T.E. BEARDEN
By pumping the internal EM channel, process is dramatically accelerated.
This is the body's normal recovery mechanism, within its limits.

Asymmetric Regauging Produces Excess Force, Which Can be Used to Do Work on the System

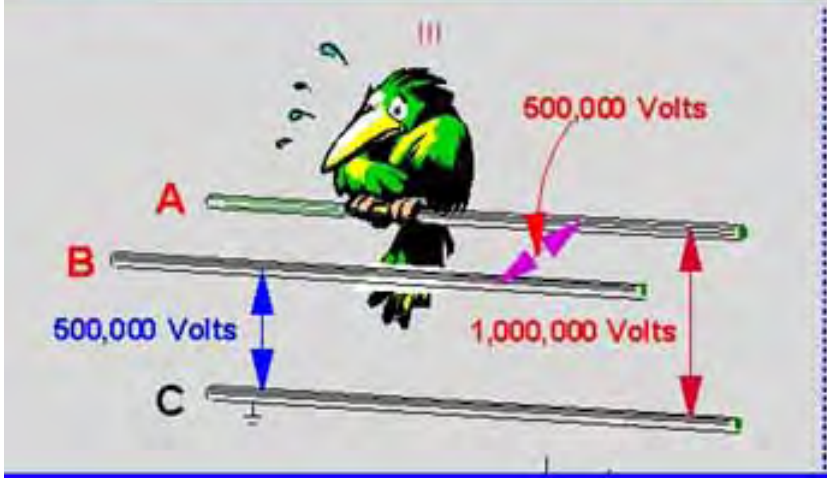

Net Symmetric Regauging Does No Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire A also. He *net symmetrically* regauged, so he had no net excess force across him, even though his potential energy was increased. He asymmetrically regauged each foot, but both simultaneously so that one countered the other. Wise little bird!

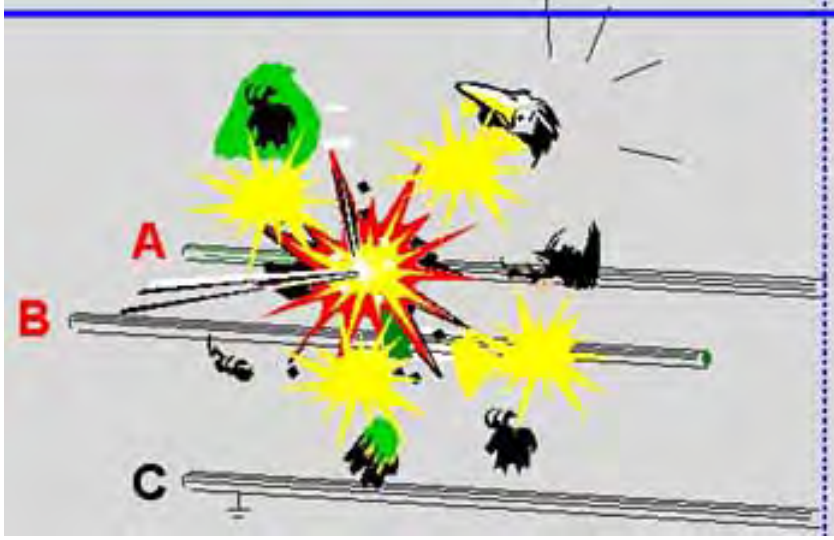

Net Asymmetric Regauging Can Do Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire B. He *net asymmetrically* regauged, so he had lots of net excess force across him. That force then violently translated his little body parts every which way, doing lots of work in and on him. Bummer!

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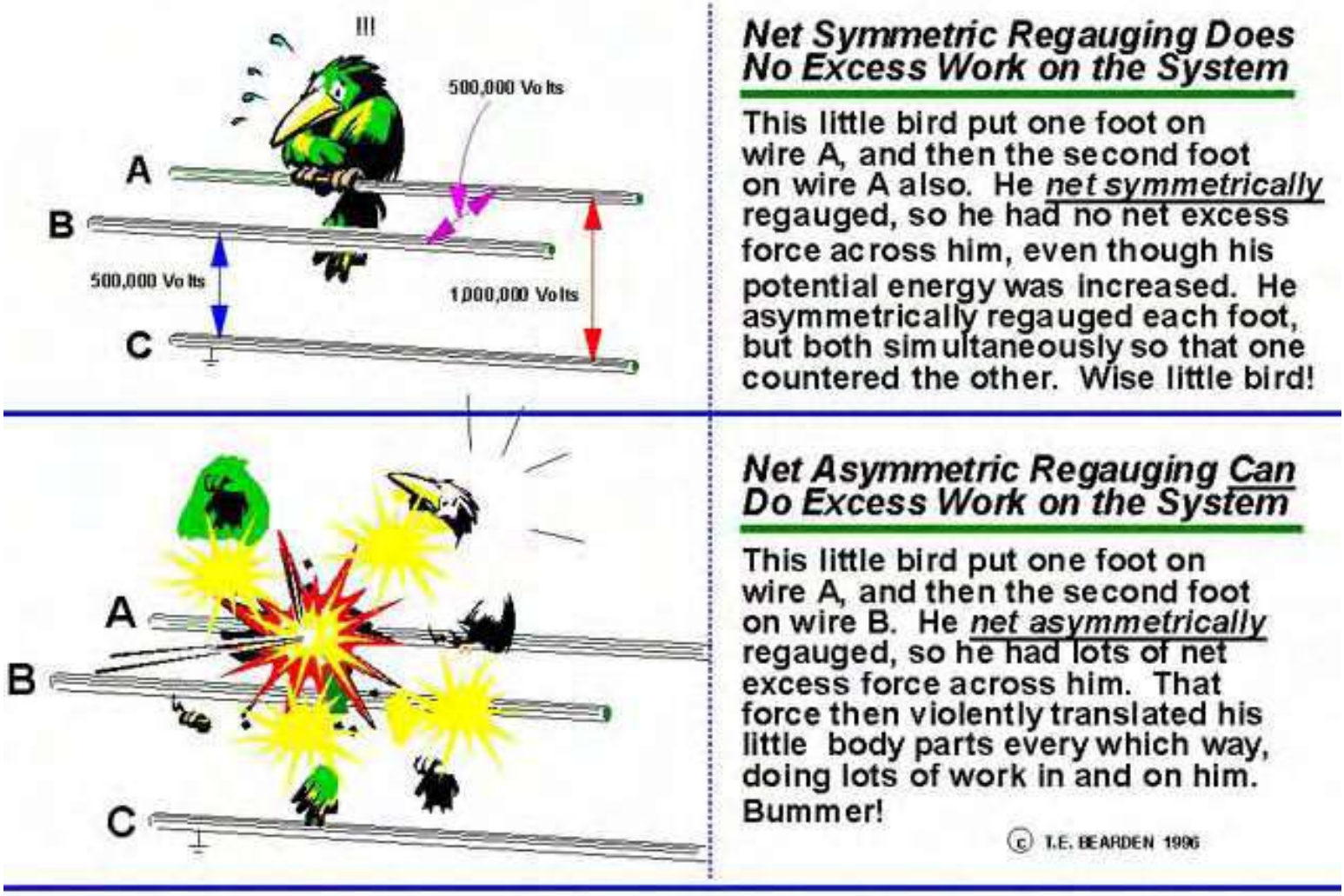

Figure 32. Asymmetric regauging produces excess force, which can be used to do work on the regauging system.

Selected clipart © by Lotus SmartPics™

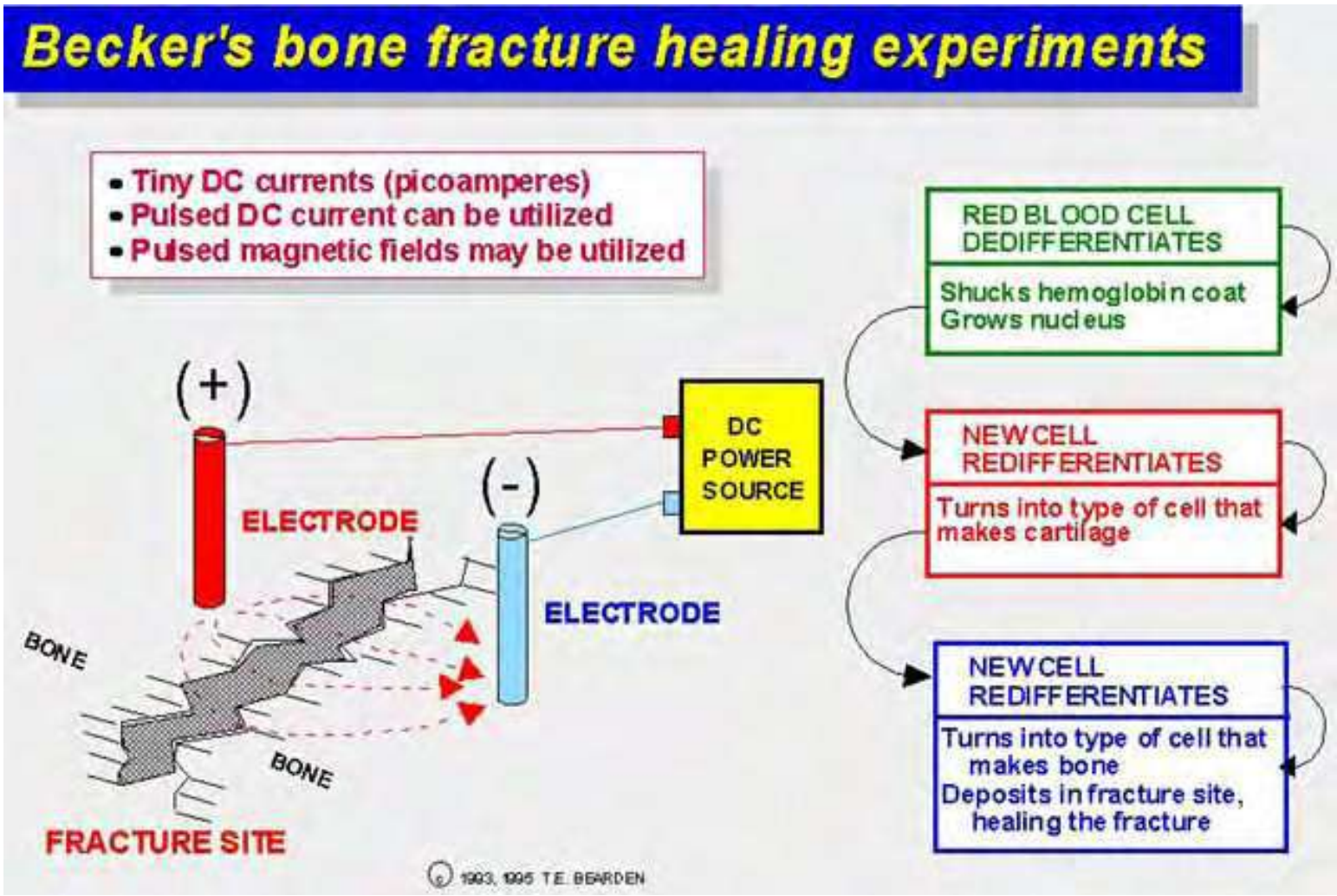
Becker's bone fracture healing experiments
• Tiny DC currents (picoamperes)
• Pulsed DC current can be utilized
• Pulsed magnetic fields may be utilized
(+)
(-)
ELECTRODE
ELECTRODE
DC POWER SOURCE
BONE
BONE
FRACTURE SITE
RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture
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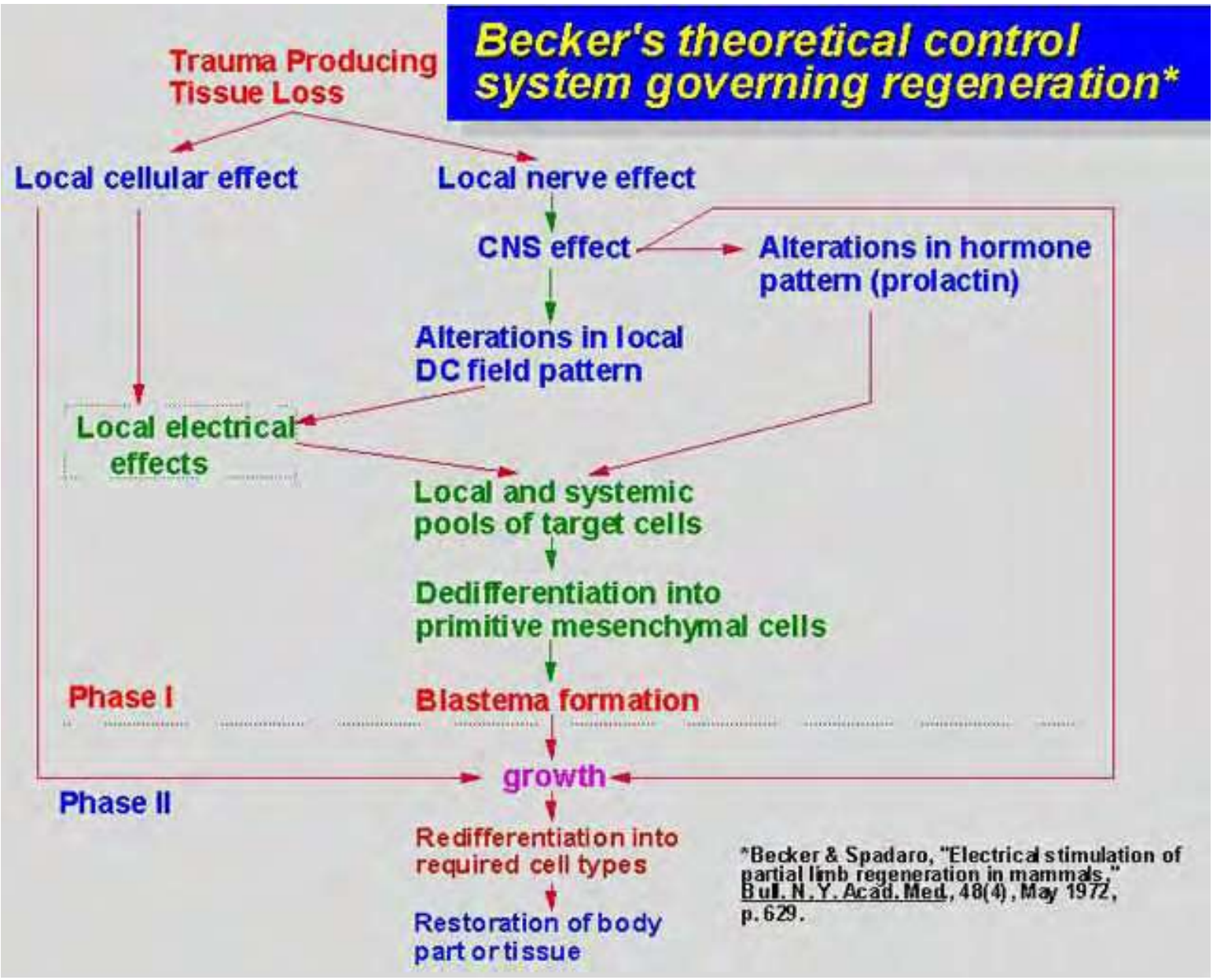
Becker's theoretical control system governing regeneration*
Trauma Producing Tissue Loss
Local cellular effect
Local nerve effect
CNS effect
Alterations in hormone pattern (prolactin)
Alterations in local DC field pattern
Local electrical effects
Local and systemic pools of target cells
Dedifferentiation into primitive mesenchymal cells
Phase I
Blastema formation
growth
Phase II
Redifferentiation into required cell types
Restoration of body part or tissue
*Becker & Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bull. N.Y. Acad. Med., 48(4), May 1972, p. 629.

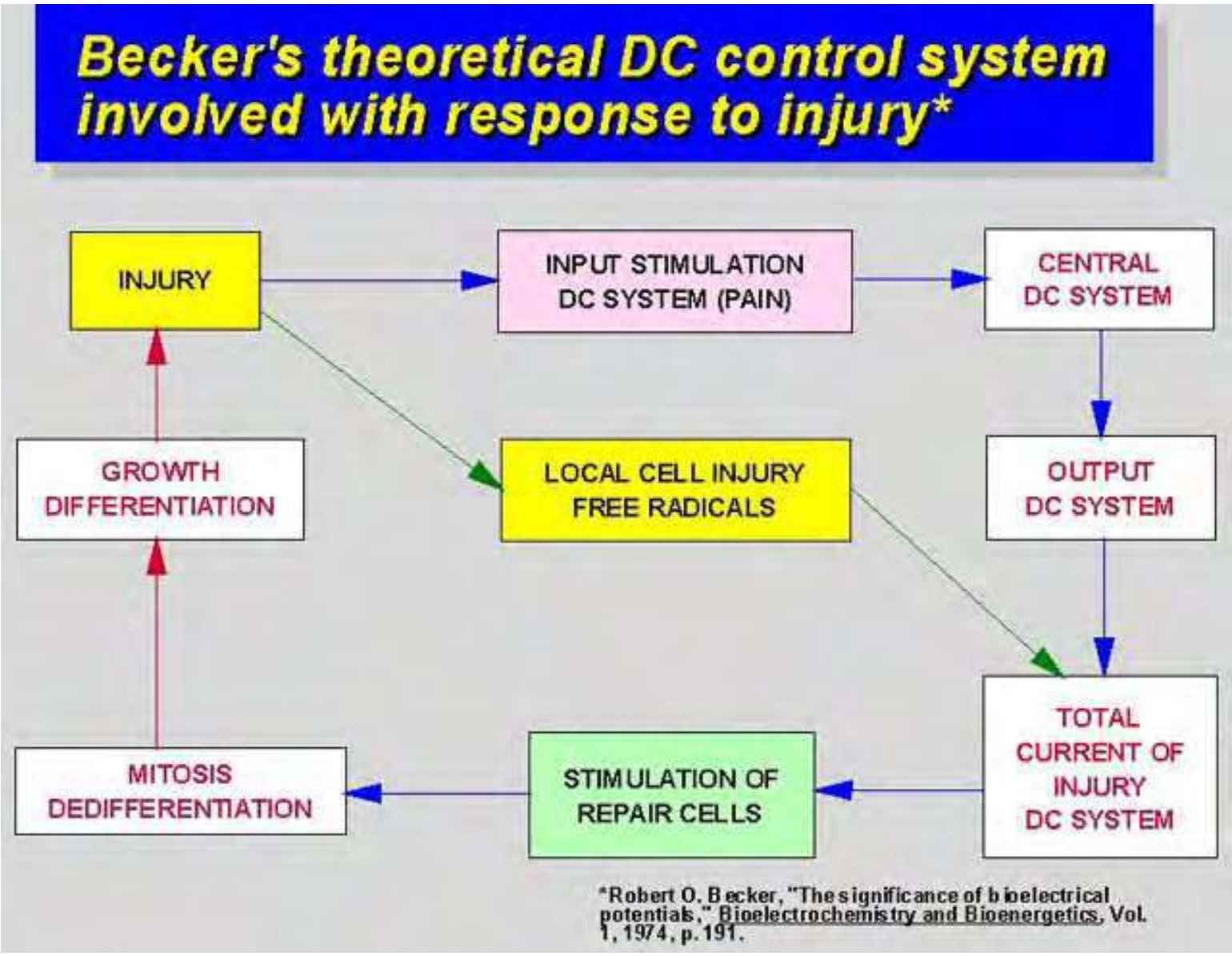
Becker's theoretical DC control system involved with response to injury*
INJURY
INPUT STIMULATION DC SYSTEM (PAIN)
CENTRAL DC SYSTEM
GROWTH DIFFERENTIATION
LOCAL CELL INJURY FREE RADICALS
OUTPUT DC SYSTEM
TOTAL CURRENT OF INJURY DC SYSTEM
MITOSIS DEDIFFERENTIATION
STIMULATION OF REPAIR CELLS
*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Geometrical Distortion of Poynting Energy Flow

At or near resonance frequency, in the case shown the energy collection fraction (reaction cross section) increases dramatically.

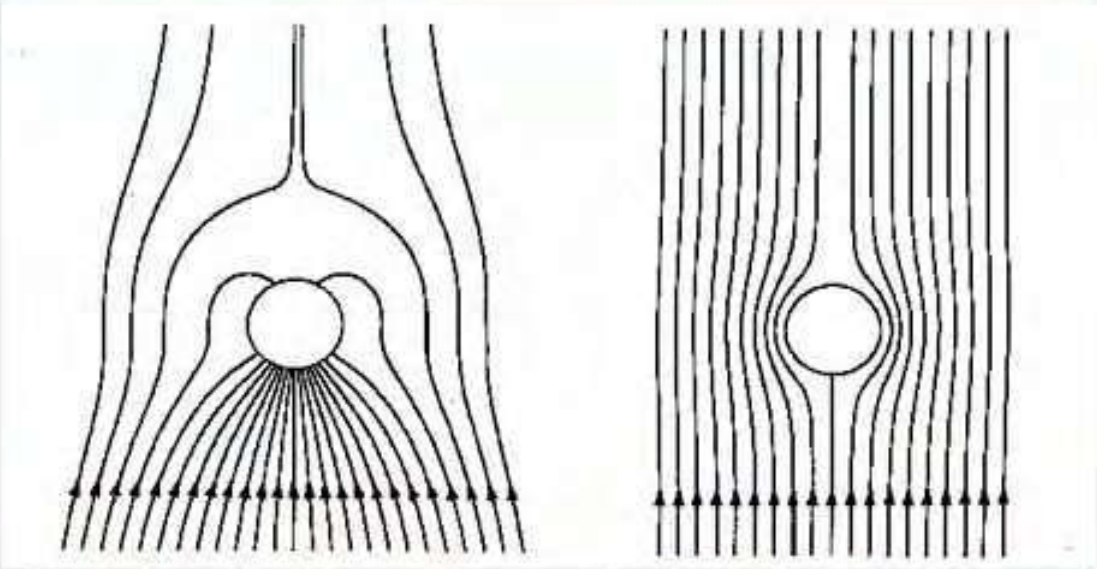

a. Around an aluminum sphere at light energy 8.8 eV. Absorption efficiency = 18.00.

b. Around an aluminum sphere at light energy 5eV. Absorption efficiency = 0.1.

Figures per Craig F. Bohren, "How can a particle absorb more than the light incident upon it? ", American Journal of Physics, 51(4), Apr. 1983, p. 326.

Cosmic Bootstrap: Before the Big Bang:

- *Cosmic repulsion behaved like a fluid with negative pressure*
- *The "universe" inflated (expanded) as a "false vacuum"*
- *As the negative-pressure fluid expanded, its energy went up rather than down*
- *When inflation stopped, the false vacuum decayed from its excited state*
- *Its excitation energy was released in a single great burst*

Paul Davies, Superforce, 1984, p. 194

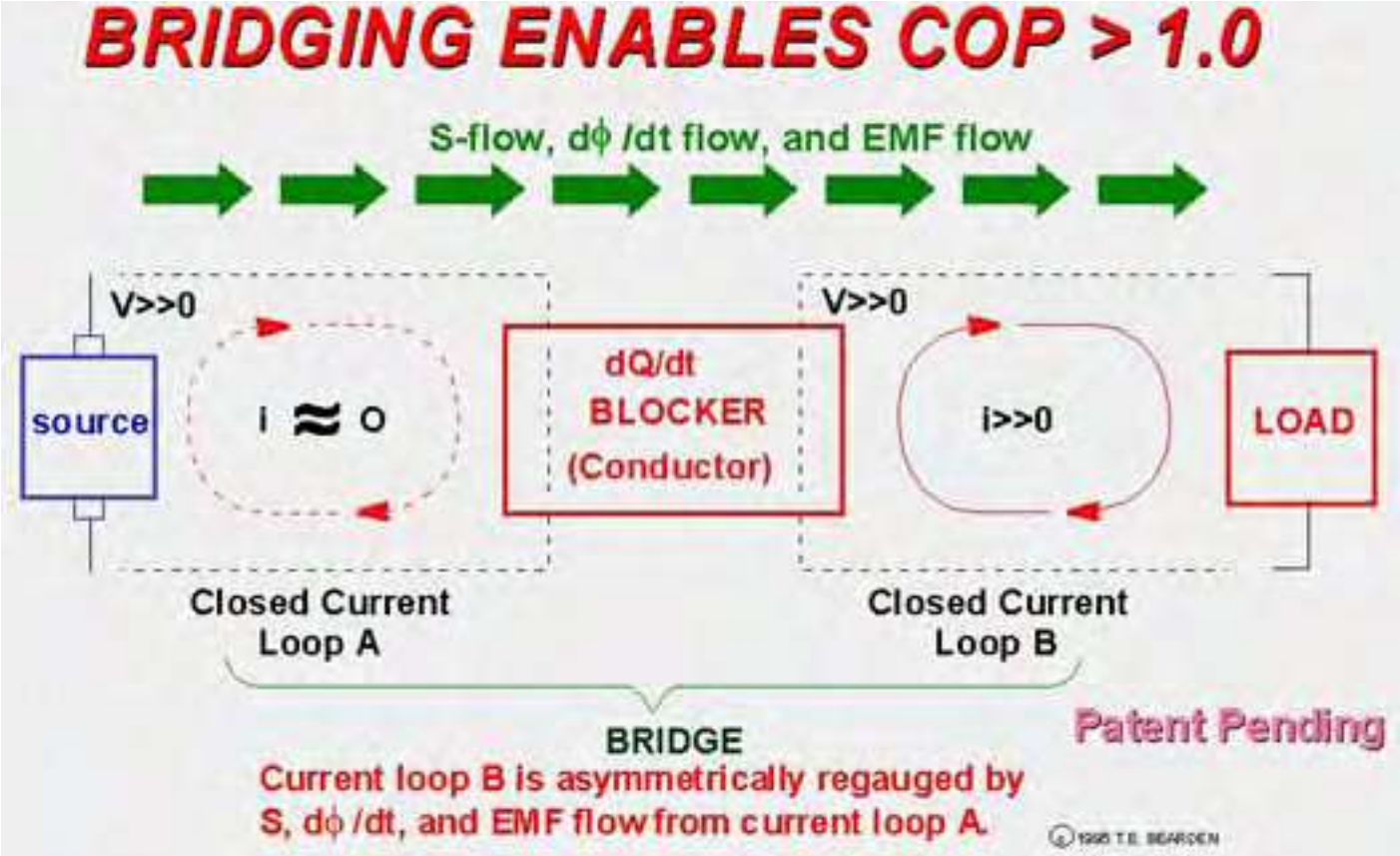
BRIDGING ENABLES COP > 1.0
S-flow, dϕ /dt flow, and EMF flow
V>>0
source
i ≈ 0
dQ/dt
BLOCKER
(Conductor)
V>>0
i>>0
LOAD
Closed Current
Loop A
Closed Current
Loop B
BRIDGE
Patent Pending
Current loop B is asymmetrically regauged by
S, dϕ /dt, and EMF flow from current loop A.
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Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum

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- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another
- STRUCTURING THE INFOLDED EM INSIDE POTENTIALS, FIELDS, AND WAVES
  - Strongly breaks local symmetry
  - Provides spacetime engines giving the above effects

Other Aspects of Strong Local Asymmetry

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- Local spacetime is curved
- Lorentz invariance of vacuum is violated
- May be a local "sink" or "source"
- Gravitational-inertial effects from EM
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation
- COMMENT: Thus the use of infolded longitudinal EM fields and waves to strongly break local symmetry allows intermested clustering of spacetime curvatures. These spacetime structures are *vacuum engines*, or *spacetime engines*.

Bunge on the Status of Electrodynamics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state..."

"... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

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Bunge on the Status of Electrodynamics and Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state...

"... neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

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*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

Bunge on the Status of Classical and Quantum Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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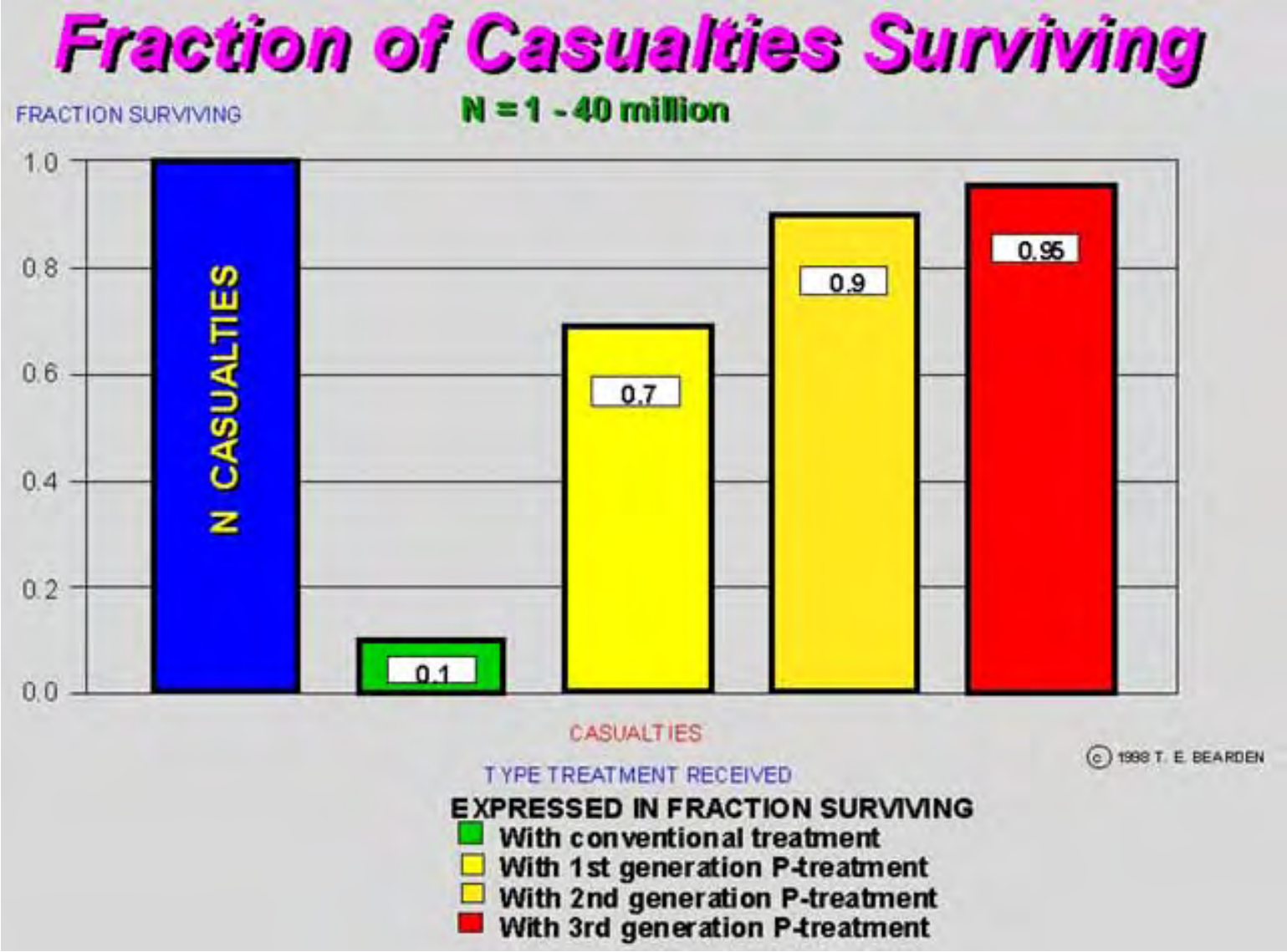
Fraction of Casualties Surviving
FRACTION SURVIVING
N = 1 - 40 million
1.0
0.8
0.6
0.4
0.2
0.0
N CASUALTIES
0.1
0.7
0.9
0.95
CASUALTIES
TYPE TREATMENT RECEIVED
© 1998 T. E. BEARDEN
EXPRESSED IN FRACTION SURVIVING
With conventional treatment
With 1st generation P-treatment
With 2nd generation P-treatment
With 3rd generation P-treatment

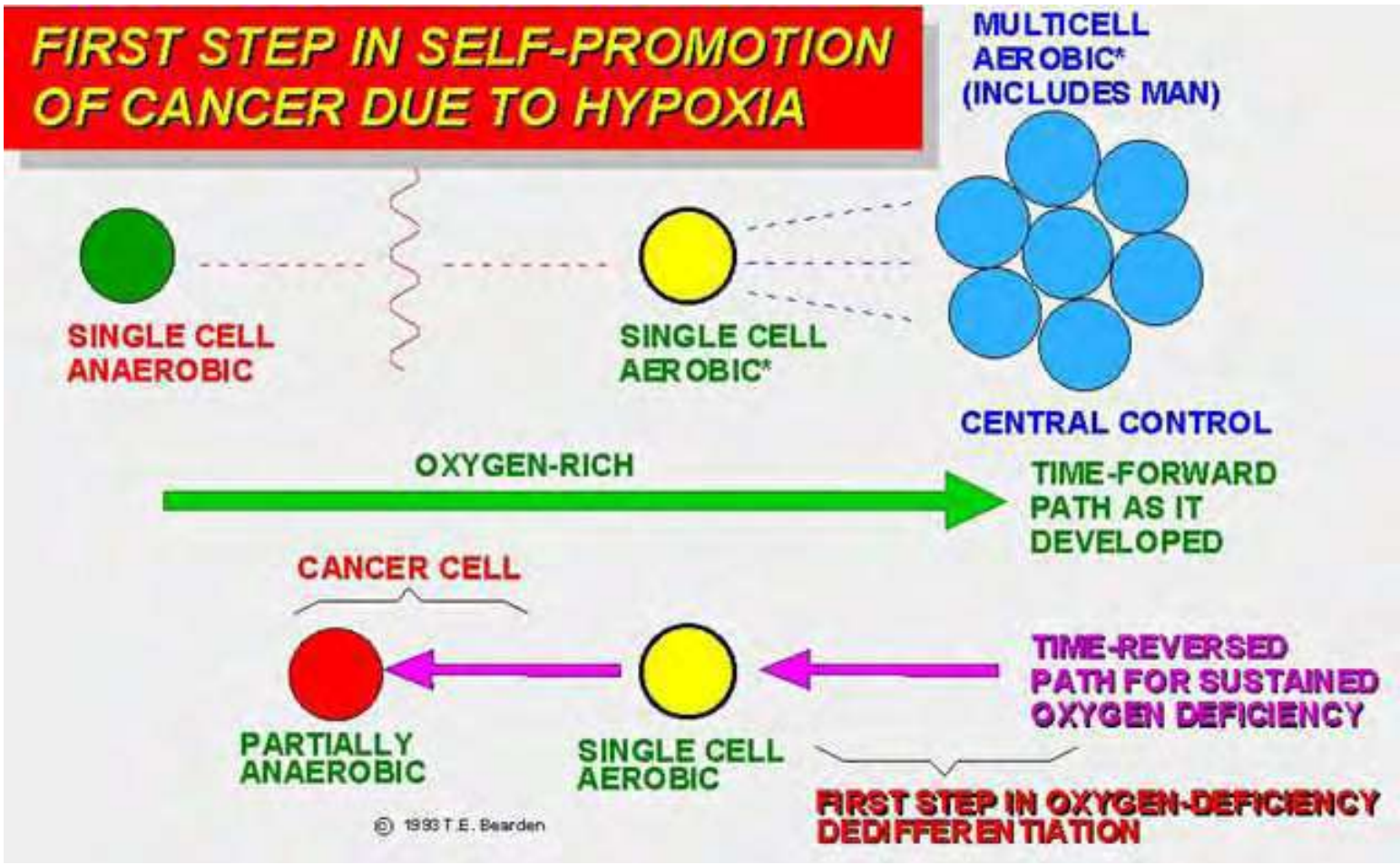
FIRST STEP IN SELF-PROMOTION OF CANCER DUE TO HYPOXIA
MULTICELL AEROBIC* (INCLUDES MAN)
SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC*
CENTRAL CONTROL
OXYGEN-RICH
TIME-FORWARD PATH AS IT DEVELOPED
CANCER CELL
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
PARTIALLY ANAEROBIC
SINGLE CELL AEROBIC
FIRST STEP IN OXYGEN-DEFICIENCY DEDIFFERENTIATION
© 1993 T.E. Bearden

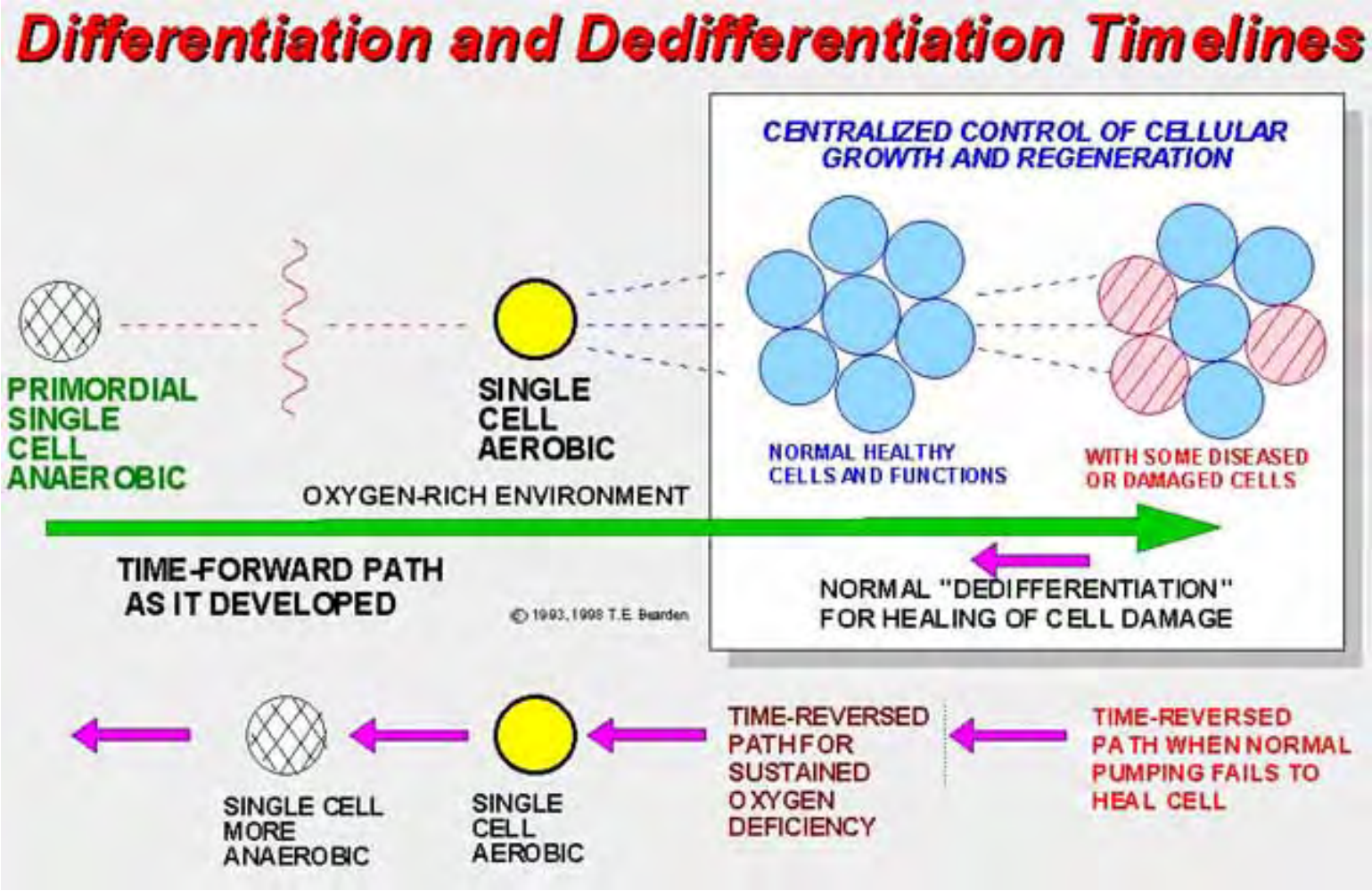
Differentiation and Dedifferentiation Timelines
CENTRALIZED CONTROL OF CELLULAR GROWTH AND REGENERATION
PRIMORDIAL SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC
OXYGEN-RICH ENVIRONMENT
NORMAL HEALTHY CELLS AND FUNCTIONS
WITH SOME DISEASED OR DAMAGED CELLS
TIME-FORWARD PATH AS IT DEVELOPED
© 1993, 1998 T.E. Bearden
NORMAL "DEDIFFERENTIATION" FOR HEALING OF CELL DAMAGE
SINGLE CELL MORE ANAEROBIC
SINGLE CELL AEROBIC
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
TIME-REVERSED PATH WHEN NORMAL PUMPING FAILS TO HEAL CELL

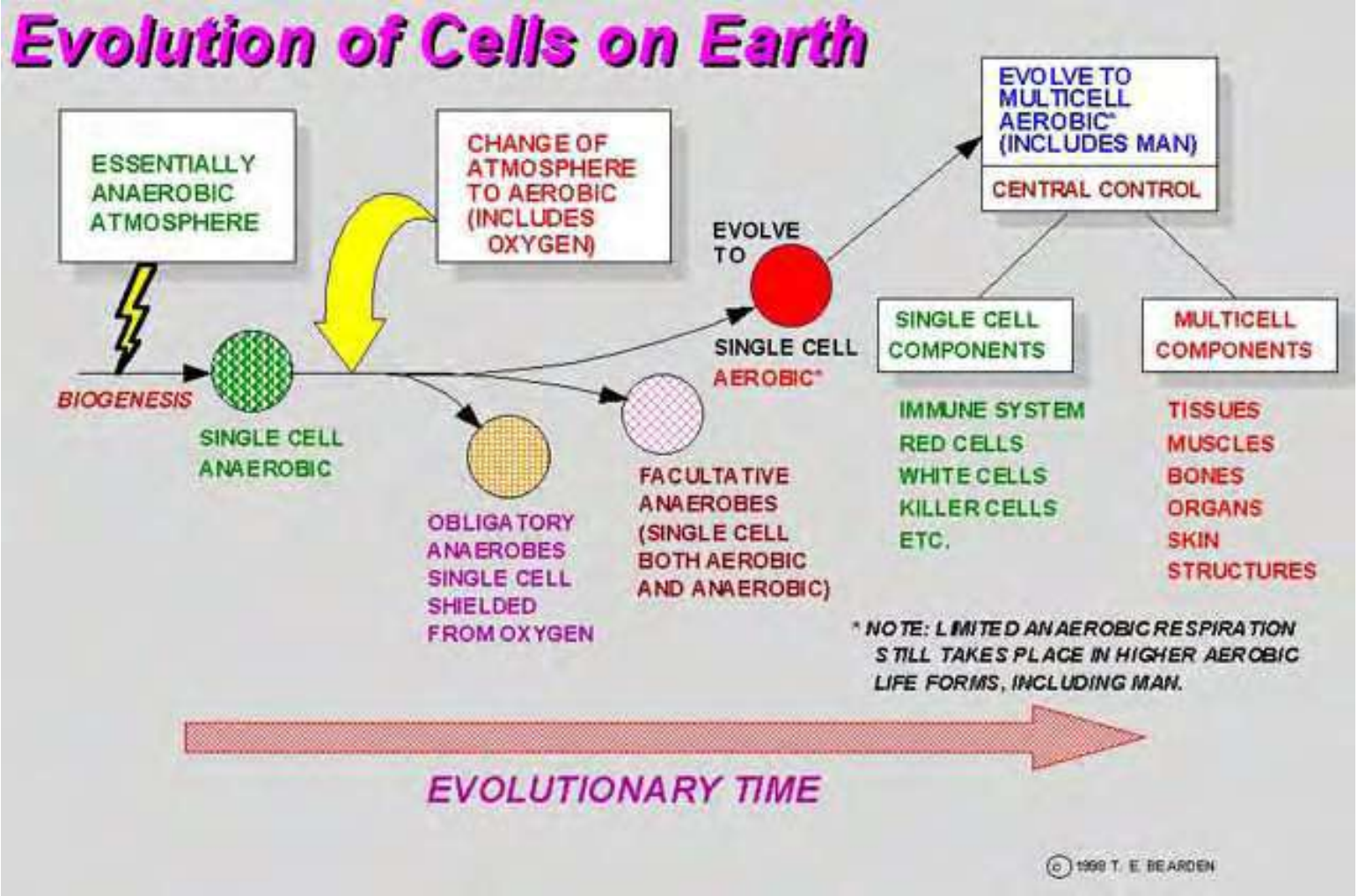
Evolution of Cells on Earth
ESSENTIALLY ANAEROBIC ATMOSPHERE
CHANGE OF ATMOSPHERE TO AEROBIC (INCLUDES OXYGEN)
EVOLVE TO MULTICELL AEROBIC* (INCLUDES MAN)
CENTRAL CONTROL
EVOLVE TO
SINGLE CELL AEROBIC*
SINGLE CELL COMPONENTS
MULTICELL COMPONENTS
BIOGENESIS
SINGLE CELL ANAEROBIC
OBLIGATORY ANAEROBES SINGLE CELL SHIELDED FROM OXYGEN
FACULTATIVE ANAEROBES (SINGLE CELL BOTH AEROBIC AND ANAEROBIC)
IMMUNE SYSTEM
RED CELLS
WHITE CELLS
KILLER CELLS
ETC.
TISSUES
MUSCLES
BONES
ORGANS
SKIN
STRUCTURES
* NOTE: LIMITED ANAEROBIC RESPIRATION STILL TAKES PLACE IN HIGHER AEROBIC LIFE FORMS, INCLUDING MAN.
EVOLUTIONARY TIME
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A Charged Particle q Is a Coupled System of m and ϕ

(A proposed formal definition of a charged mass)

Note: X is a coupling operator

$$q \equiv f_q \times m_q$$

Also note that the ϕ portion of the charged particle can be internally structured, per Stoney-Whittaker-Ziolkowski, with hidden bidirectional EM wavepairs (their sums and products). Note that this constitutes an EM application of Bohm-type hidden variable theory, with many ramifications.

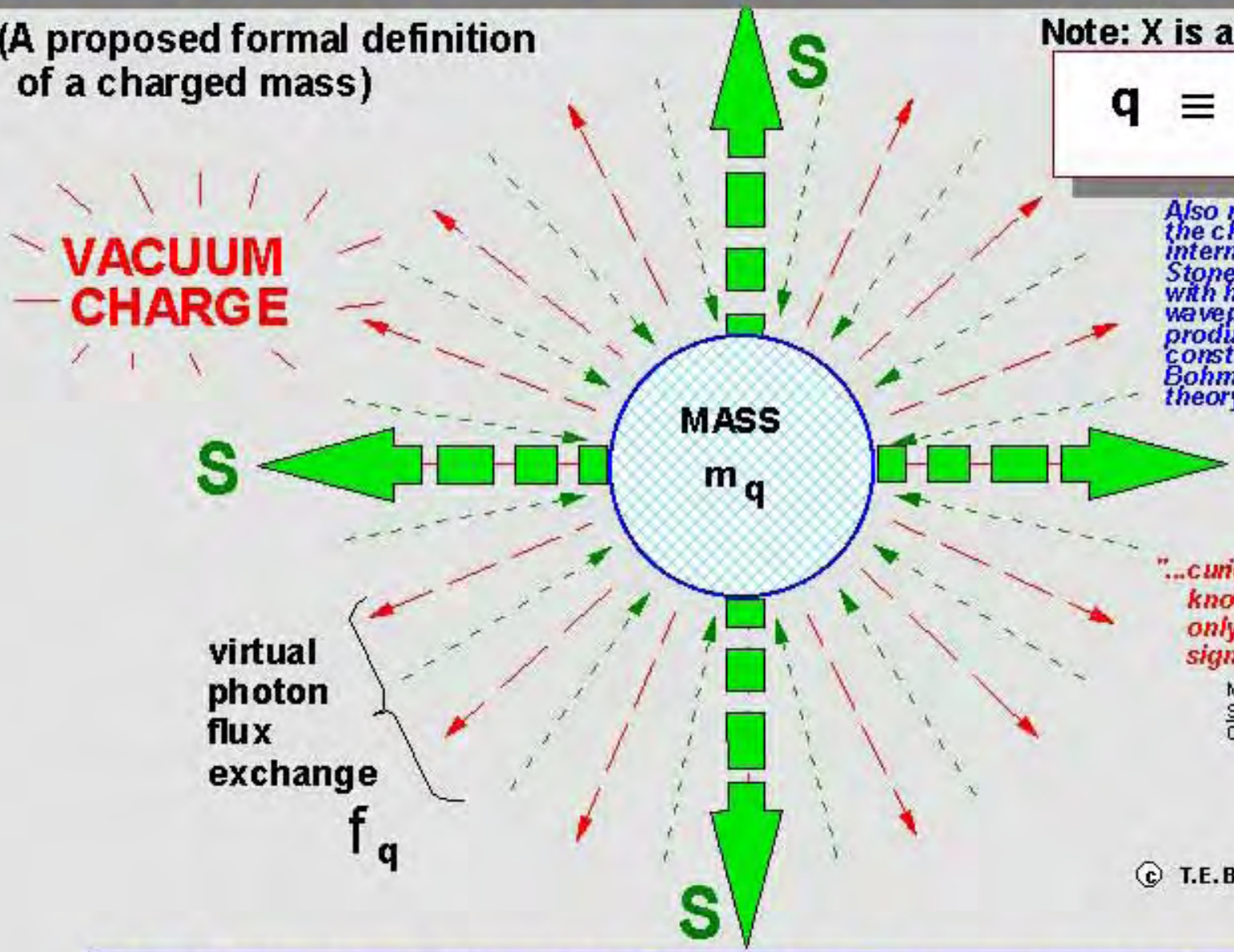

S = EXH

"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

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An electric charge Q consists of a massless flux component and a mass component, coupled together (interacting). Q is a broken symmetry. The mass of the charge continually and violently exchanges virtual photons with the surrounding vacuum.

Thus Q is energetically driven by the surrounding vacuum potential, which itself is to first order just a violent virtual photon flux.

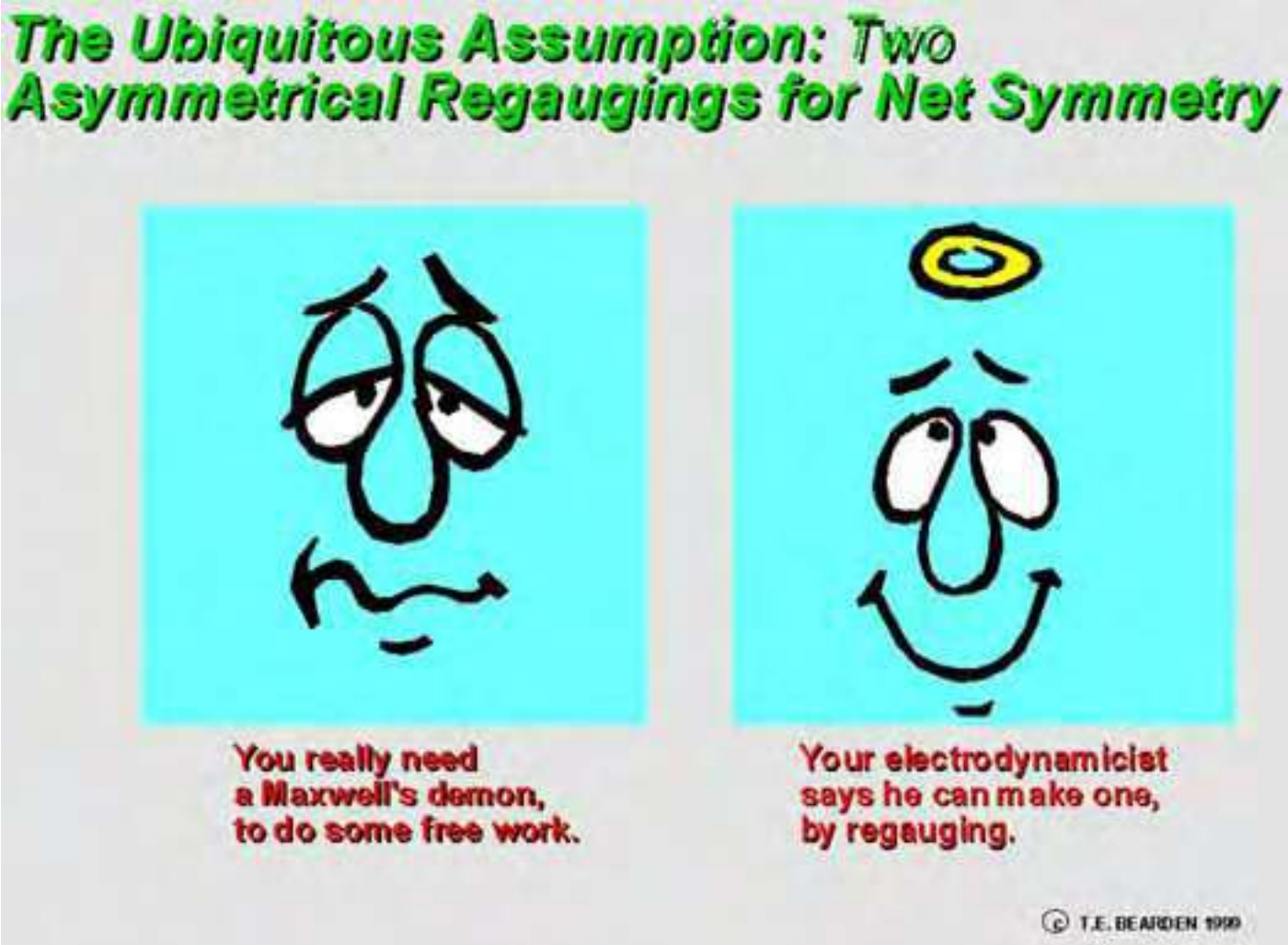
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
You really need a Maxwell's demon, to do some free work.
Your electrodynamicist says he can make one, by regauging.
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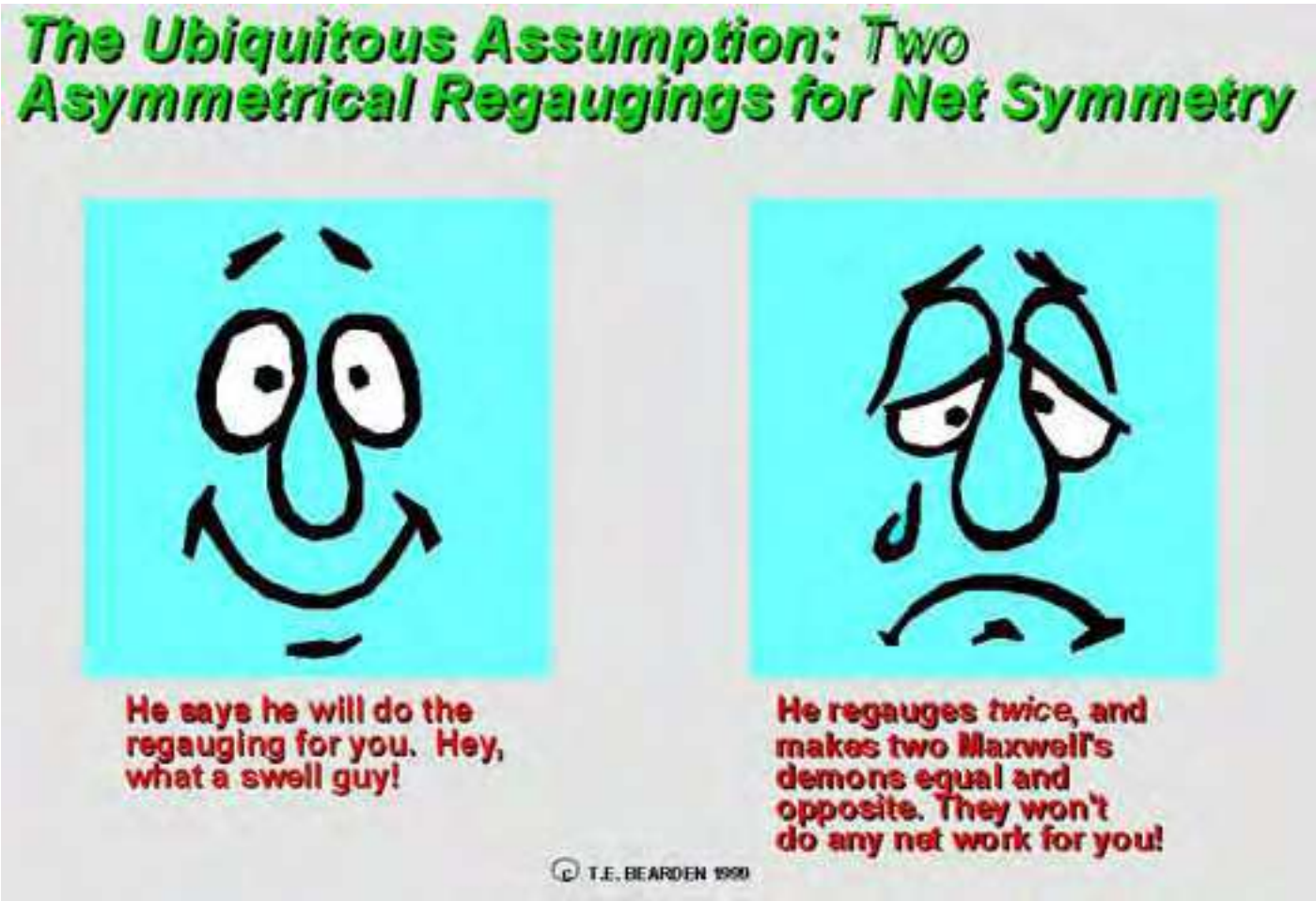
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
He says he will do the regauging for you. Hey, what a swell guy!
He regauges twice, and makes two Maxwell's demons equal and opposite. They won't do any net work for you!
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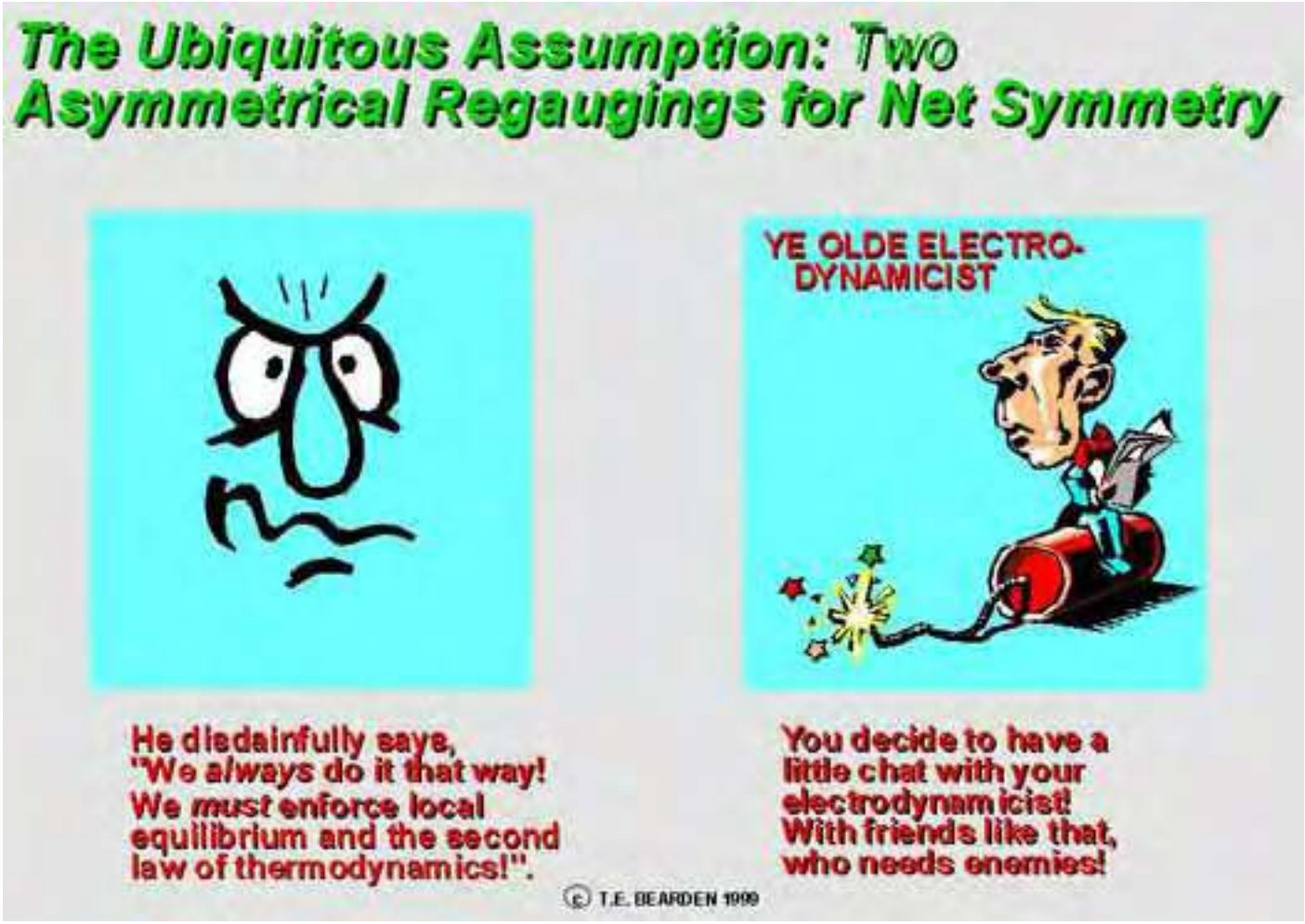
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
YE OLDE ELECTRO-DYNAMICIST
He disdainfully says, "We always do it that way! We must enforce local equilibrium and the second law of thermodynamics!".
You decide to have a little chat with your electrodynamicist! With friends like that, who needs enemies!
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A Charged Particle Is a Coupled System

(The first formal definition of charge)

$$q \equiv \phi_q \times m_q$$

Note: X is a coupling operator

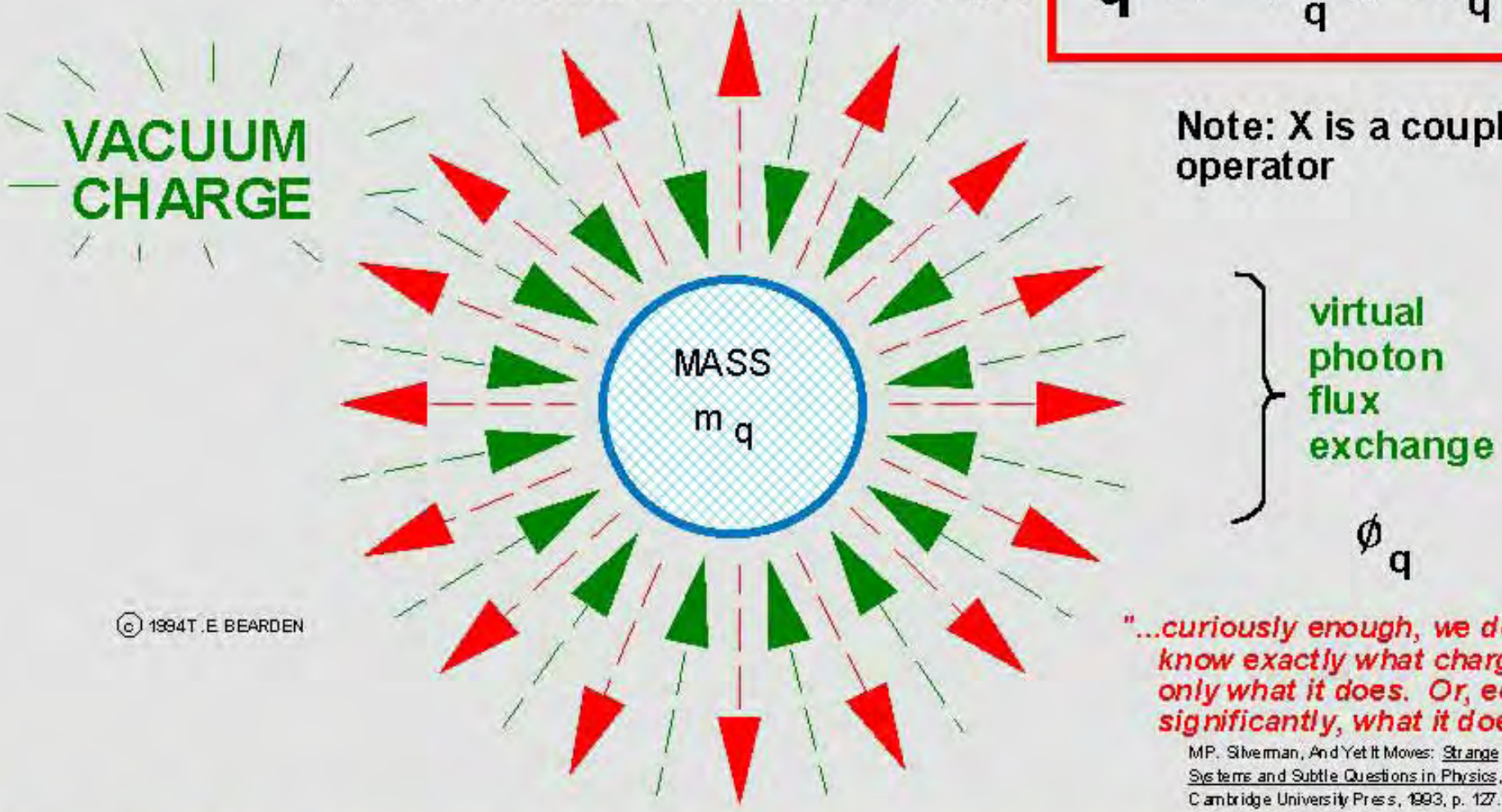

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"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

An electric charge q is a broken symmetry in its fierce energy exchange with the active vacuum. It coherently integrates some of the virtual energy absorbs and outputs it as Poynting energy flow.

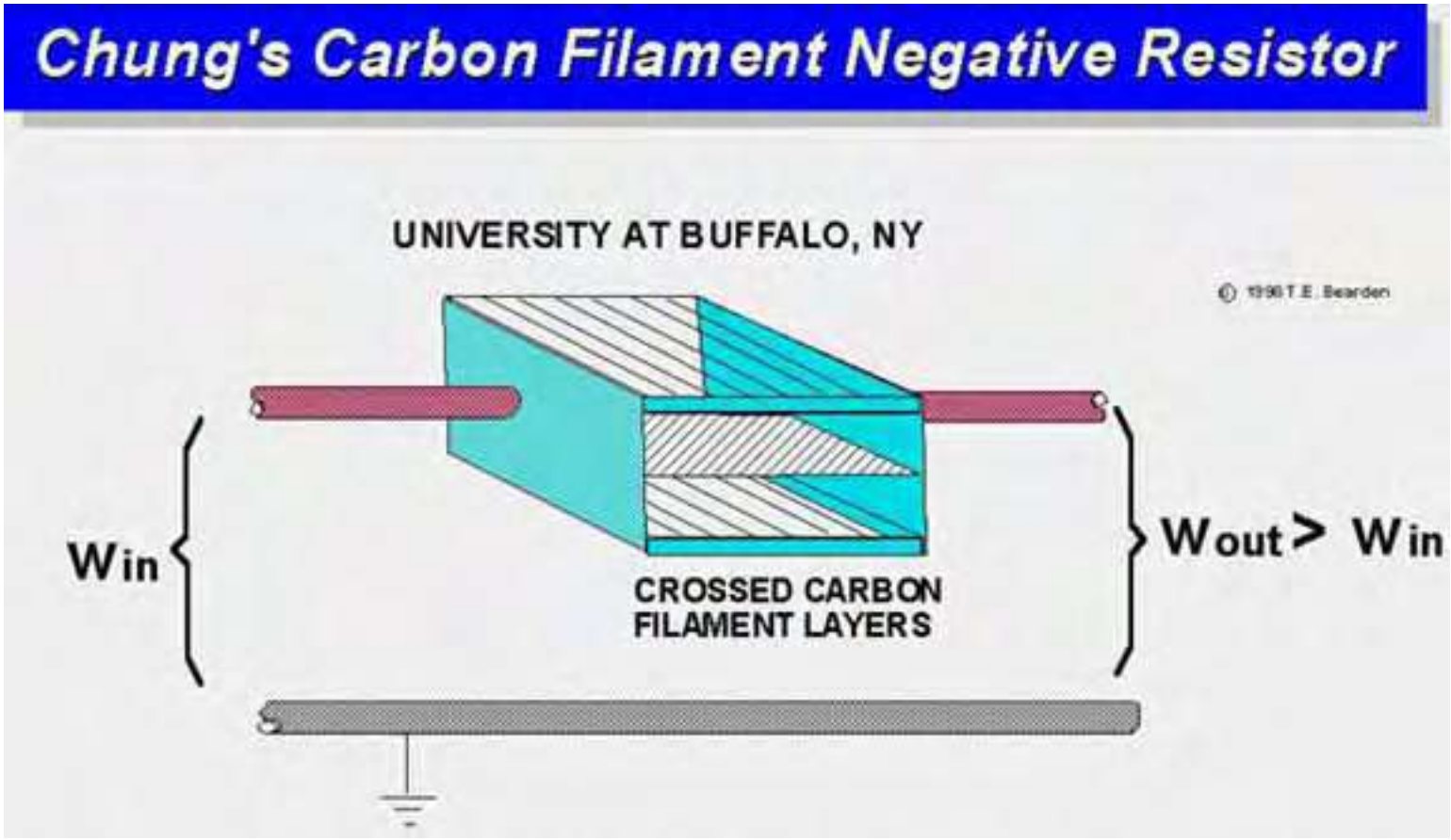
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
© 1996 T.E. Bearden
Win
Wout > Win
CROSSED CARBON
FILAMENT LAYERS

Typical circuit has about 10^{-13} energy collection efficiency

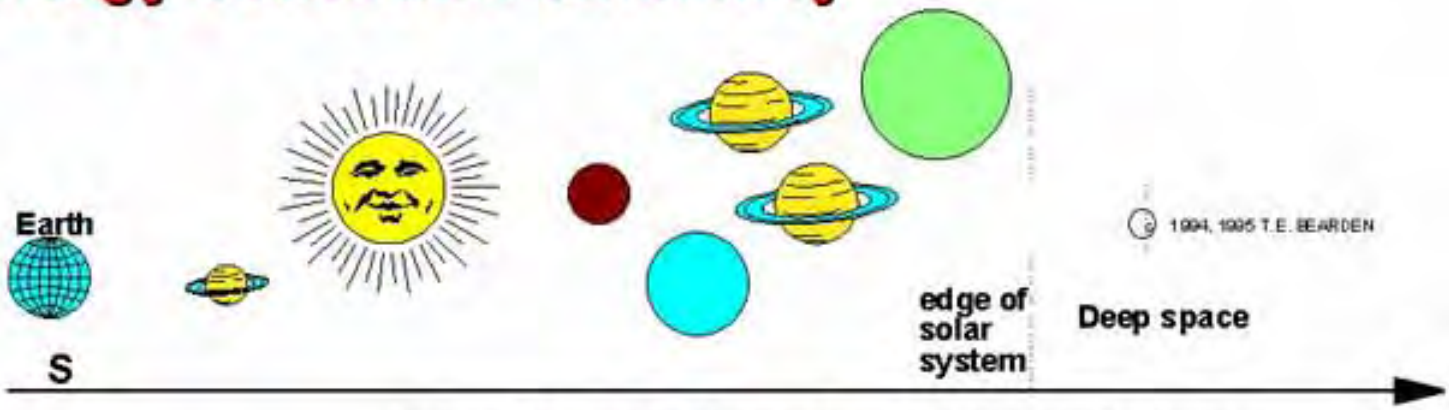

Distance traveled by S in one hour is 1.08x10exp(12) meters.

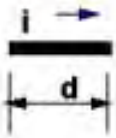

Example: 1.3 amps flowing in DC circuit, 1.8 mm diameter copper wire. J = 51 A/cm ^{2}

d_j = 0.1368 meters

S violently transports ϕ provided from the source.
j ϕ sluggishly transports the energy collected and dissipated in the circuit..

For the case discussed, the electron drift velocity in the circuit is about 3.8 x 10^{-5} meters/sec. So Jϕ moves about 0.1368 meters in one hour. Thus Jϕ has collected about 0.1368 meters of the ϕ-filled S-tube. During that same hour, the S-flow evoked by the power source will have traveled 1.08x10^{12} meters. The ϕ of both currents is the same. Both are involved in the same energy-filled tube. Thus S has provided and transported about 7.89x10^{12} times as much energy along the circuit in one hour as the jϕ has been able to collect, transport, and dissipate as work in the circuit. Thus this circuit provides about 10^{13} collection efficiency.

Classical View of EM

- Potentials just mathematical conveniences
  - Not real
  - No internal structure, just magnitude
- Force fields primary, causative, can exist in space in absence of observable mass
  - All EM actions due to force fields, none when zero
  - No action at a distance
- Vacuum empty; without energy or structure
  - No locally curved spacetime
  - No gravity effects
  - No quantum effects
- Maxwell's equations complete
  - Symmetrically regauged ***arbitrarily***
  - Topology dramatically reduced

Curved Spacetime acts as source or sink

- May emit excess radiation and energy (e.g., heat)
- May absorb radiation and energy (e.g., cool)
- May transduce waves TW ⇔ LW ⇔ TDW
- New energy conservation law applies

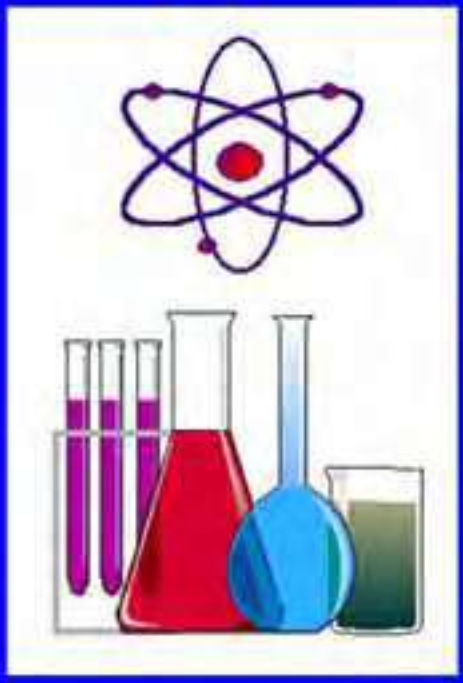

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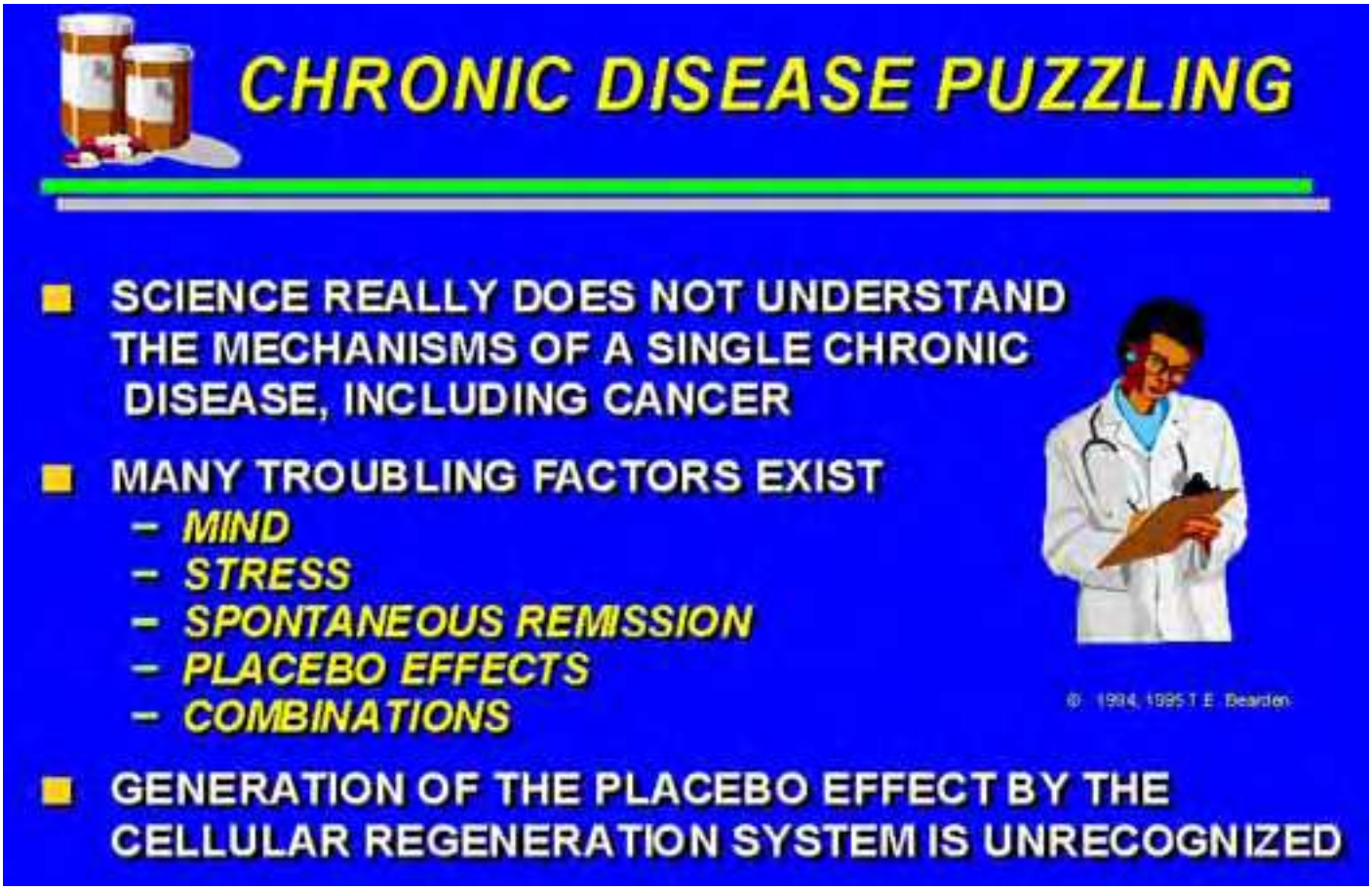
CHRONIC DISEASE PUZZLING
SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
MANY TROUBLING FACTORS EXIST
– MIND
– STRESS
– SPONTANEOUS REMISSION
– PLACEBO EFFECTS
– COMBINATIONS
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GENERATION OF THE PLACEBO EFFECT BY THE CELLULAR REGENERATION SYSTEM IS UNRECOGNIZED

Cancer Characteristics

- Not one disease, but a whole range
- Starts in damaged aerobic cell
- Cell shakes off body's central control
  - Starts uncontrolled division
  - Becomes a lump
- Can send forth cancer cells
  - Through blood
  - Through lymph
- Form metastases (secondary tumors)
- Often become anaerobic

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Solving a Cancer Enigma

- An enigma has been failure of immune system to attack some tumor cells
  - Suppressor cells may curb immune system?
  - Tumor may lack antigens normally identified by the immune system?
- *Promotion of damaged cell to cancer is usually ordered by cellular control system*
  - *Regenerative and recovery system forces cell back toward anaerobe*
  - *First step breaks free from central growth*
  - *Control continues to recognize cell as self*

CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

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*R&R system forces cell back toward anaerobe

Nonlinear Optics
Distortion Correction Theorem

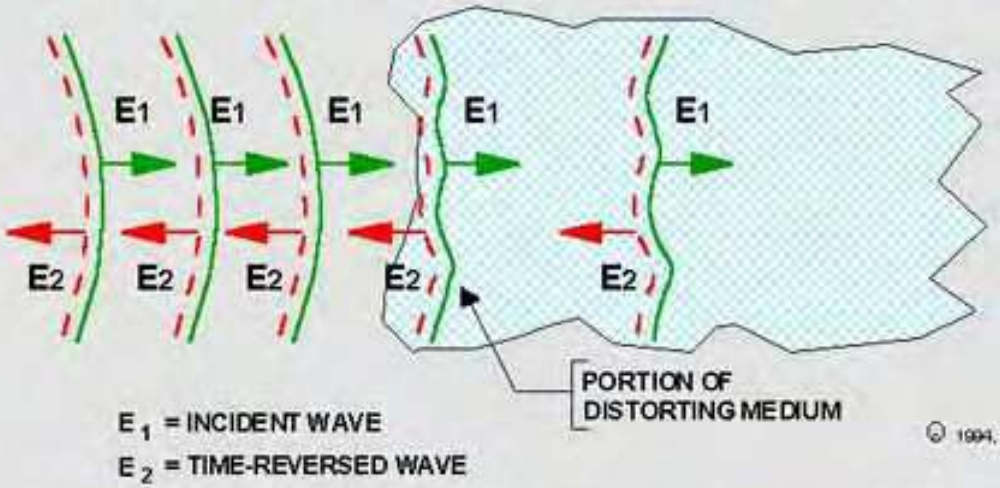

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"If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)

- Nucleon interchange
  - Changes neutron into proton and vice versa
  - At high rate (flat spacetime assumed)
- Statistics become skewed due to curved ST
- Can bias statistics toward either neutron or proton end
  - Biases toward transmutation of elements along isomer chains
  - Concept of "isomer" is vastly expanded

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)

- Normal dynamics (impulses) may reverse
  - Like charges attract, unlike charges repel
  - Positive charges cluster (are drawn together)
  - H+ ions (protons) may form quasi-nuclei
  - Nucleus coulomb barrier becomes assistant
- Many "impossible" reactions now possible
  - Quark access and quark flipping by EM
  - Ion clustering
  - Positive charges as phase conjugate mirrors
  - Time-density waves and time-energy charging

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The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)

- Not observed until time-energy charging has become substantial
  - Time delay (hours, days)
  - Transduction of LW --> TW involved
  - Specific time-charging history of detectors is involved in twhether they detect or not
  - Longitudinal EM waves become significant
- Curved spacetime can act as source or sink
  - May emit excess radiation
  - May absorb excess radiation

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In Time-Reversed Zone: Nuclear reactions are biased

- In normal flat ST, n ⇔ p at high rate
- Curved ST skews statistics
- Biases to either n or p
- Biases to transmutation along isomer chain
- "Isomer" concept greatly expanded

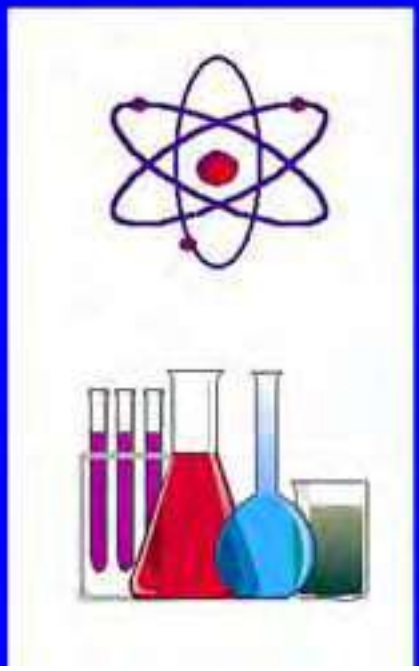

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In Time-Reversed Zone: Dynamics may be reversed

- Like charges may attract and unlike charges repel
- Coulomb barrier becomes Coulomb assistant
- Clusters like charges and forms artificial nuclei
- "Impossible" nuclear reactions at low energy
- Time-density interactions

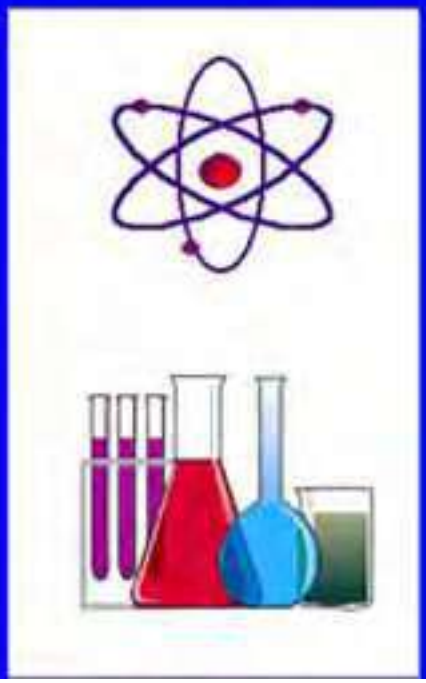

Time-Reversed Zone:

Significant only after time-density charging

- Hours, for "fast" onset
- Days, for "slower" onset
- Transduction involved for TW ⇔ LW ⇔ TDW
- Time-history of each detector is significant
- Longitudinal EM waves become significant

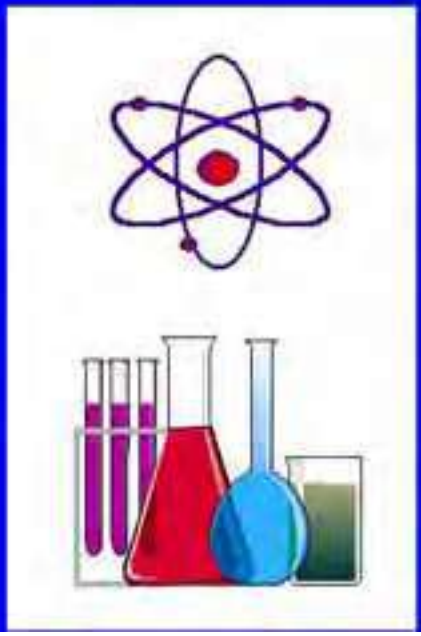

A New Conservation of Energy Law

- Physics conserves total "energy and mass-energy"
- Now also must consider "time-energy"
- Conserve total mass-time-energy (spatiotemporal energy)
- Let E_T = total energy, E_M = mass energy, E_E = ordinary energy, and E_t = time energy. Then

$$E_T = E_E + E_M + E_t$$

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$$(kE_t \Rightarrow E_E > 0) \Rightarrow E_T > (E_M + E_E)$$

- If some E_t is transduced into E_E, the experiment will violate the old spatial mass-energy conservation law

QUESTIONS ON CARCINOGENS AND EM RADIATION

- UNRESOLVED QUESTIONS ON EM RADIATION
  - DOSAGES
  - ACTIVE MECHANISMS
  - REPLICATION DIFFICULTIES
  - MEASUREMENT DIFFICULTIES
  - WHERE, WHEN, HOW ILL EFFECTS OCCUR
- SIMILAR QUESTIONS EXIST ABOUT EVERY CARCINOGEN
- SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
  - FACTORS SUCH AS MIND, STRESS, SPONTANEOUS REMISSION, PLACEBO EFFECTS, AND COMBINATIONS OF FACTORS ARE PARTICULARLY TROUBLESOME
  - GENERATION OF THE PLACEBO EFFECT BY THE REGENERATION & RECOVERY SYSTEM IS UNRECOGNIZED

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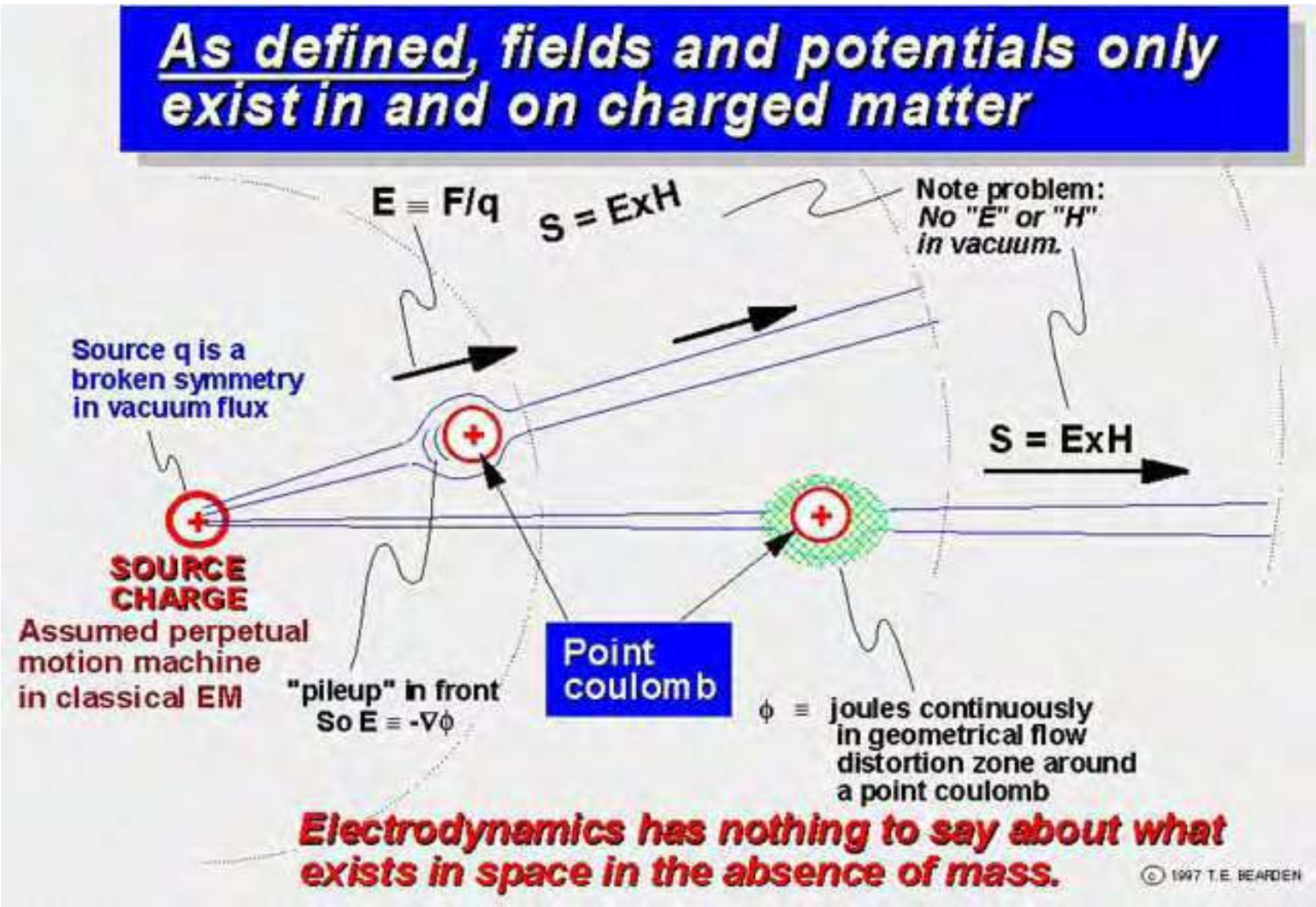
As defined, fields and potentials only exist in and on charged matter
E ≡ F/q
S = ExH
Note problem:
No "E" or "H"
in vacuum.
Source q is a
broken symmetry
in vacuum flux
S = ExH
SOURCE
CHARGE
Assumed perpetual
motion machine
in classical EM
"pileup" in front
So E ≡ -∇ϕ
Point
coulomb
ϕ ≡ joules continuously
in geometrical flow
distortion zone around
a point coulomb
Electrodynamics has nothing to say about what
exists in space in the absence of mass.
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Serious flaws and errors in classical EM theory.

1. Eliminates the Internal EM Inside the Scalar Potential.
2. No Definition of Electrical Charge or of Scalar Potential.
3. Equations Still Assume Material Ether Per Maxwell (Unchanged).
4. Use of Force Fields in Vacuum is False (and Known to be So).
5. Treats Charge q as Unitary Instead of Coupled System $q = \phi[q]m(q)$.
6. Confuses Massless Potential Gradients as Forces (See #3, #4).
7. Does Not Utilize Mass as a Component of Force (See #23).

8. Erroneously Assumes EM Force Fields as Primary Causes.
9. Topology of EM Model Has Been Substantially Reduced.
10. Does Not Include Quantum Potential or Action at a Distance.
11. Does Not Include Superluminal Velocity of Inner EM Components.
12. Does Not Utilize Extended Near-Field Coulomb Gauge Effects.
13. Does Not Include EM Generatrix Mechanism for Time Flow.
14. Does Not Unify Photon and Wave Aspects (Requires 7-D Model).

15. Does Not Include Electron Spin and Precession (See #19, #24).
16. Treats EM Energy As Existing In "Chunks," Instead of as Flow.
17. Confuses Energy and Energy Collection (See #16).
18. Discards Half of Every EM Wave in Vacuum (See #22).
19. Erroneously Uses Transverse Vacuum Wave; It's Longitudinal.
20. Arbitrarily Regauges Maxwell's Equations to Eliminate Overunity.
21. Omits Phase Conjugate Optics Effects (The *Rule* in Internal EM).
22. Does Not Include EM Cause of Newtonian Reaction Force.
23. Erroneously Assumes Separate Force Acting on Separate Mass.
24. Confuses Detected Electron Precession Waves as Proving Transverse EM Waves in Vacuum (Remnant of Old "EM Fluid" Concept).
25. Due to Error in String Wave, Omits the Ubiquitous Antiwave.
26. *Assumes* Equilibrium; Not True Unless Include Vacuum Interactions.
27. Higher Topology Required, to Model Electromagnetic Reality.
28. Lorentz surface integration discards Poynting energy transport.
29. Has nothing at all to say about form of EM entities in massless space.
30. Eliminates the infolded general relativity using EM-force as curve agent.
31. Does not include longitudinal EM waves as time domain oscillations.
32. Does not include EM mechanism that generates time flow and flow rate.

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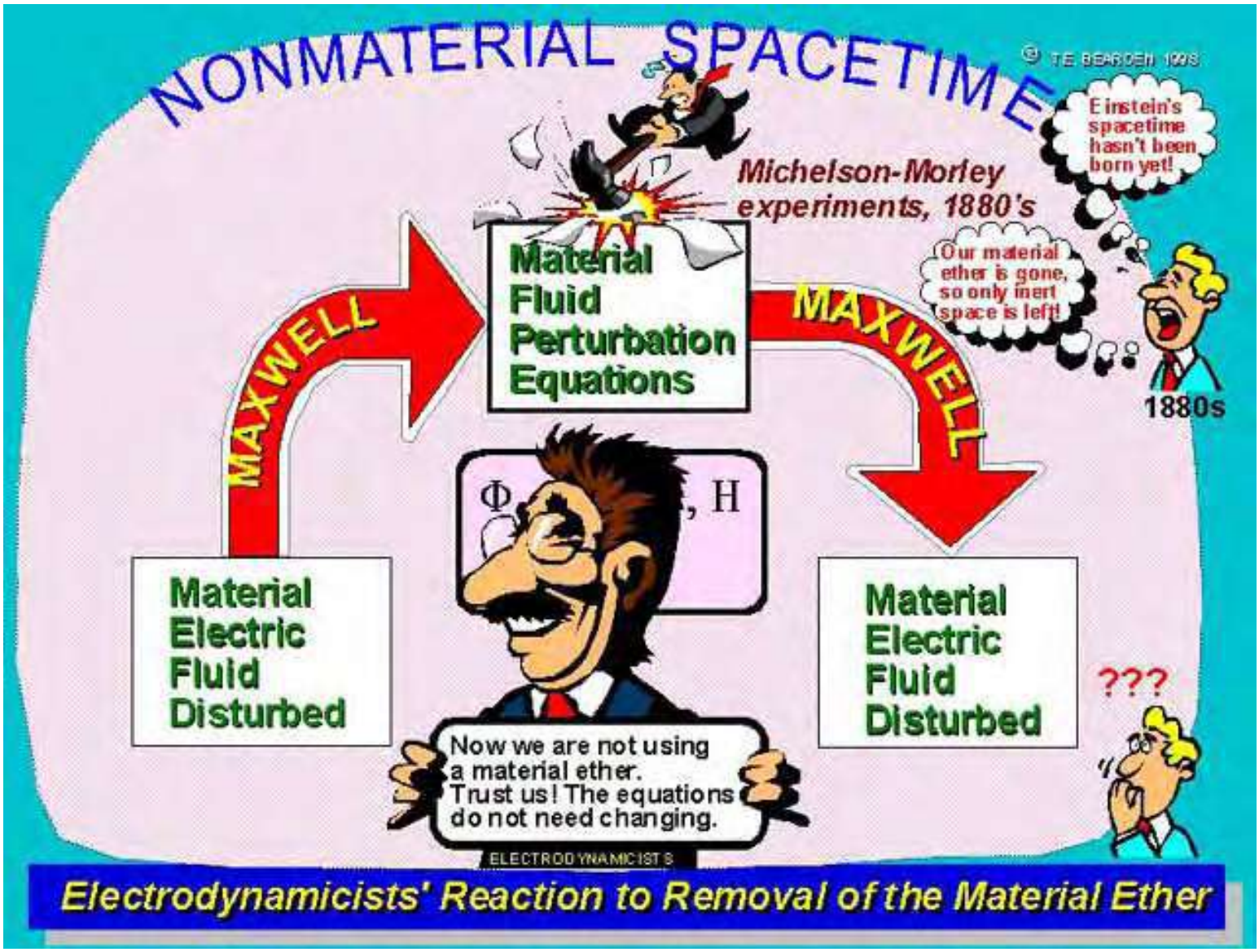
NONMATERIAL SPACETIME
© T.E. BEARDEN 1998
Michelson-Morley experiments, 1880's
Einstein's spacetime hasn't been born yet!
Our material ether is gone, so only inert space is left!
1880s
MAXWELL
Material Fluid Perturbation Equations
MAXWELL
Φ
, H
Material Electric Fluid Disturbed
Material Electric Fluid Disturbed
???
Now we are not using a material ether. Trust us! The equations do not need changing.
ELECTRODYNAMICISTS
Electrodynamicists' Reaction to Removal of the Material Ether

REACTION TO LOSS OF MATERIAL ETHER
Material Ether Assumed in Equations
Potentials, Fields, and Waves Assumed Material
Not a single equation was changed!
Now we are not using a material ether. Trust us! The equations do not need changing.
© T.E. BEARDEN 1999
ELECTRODYNAMICISTS

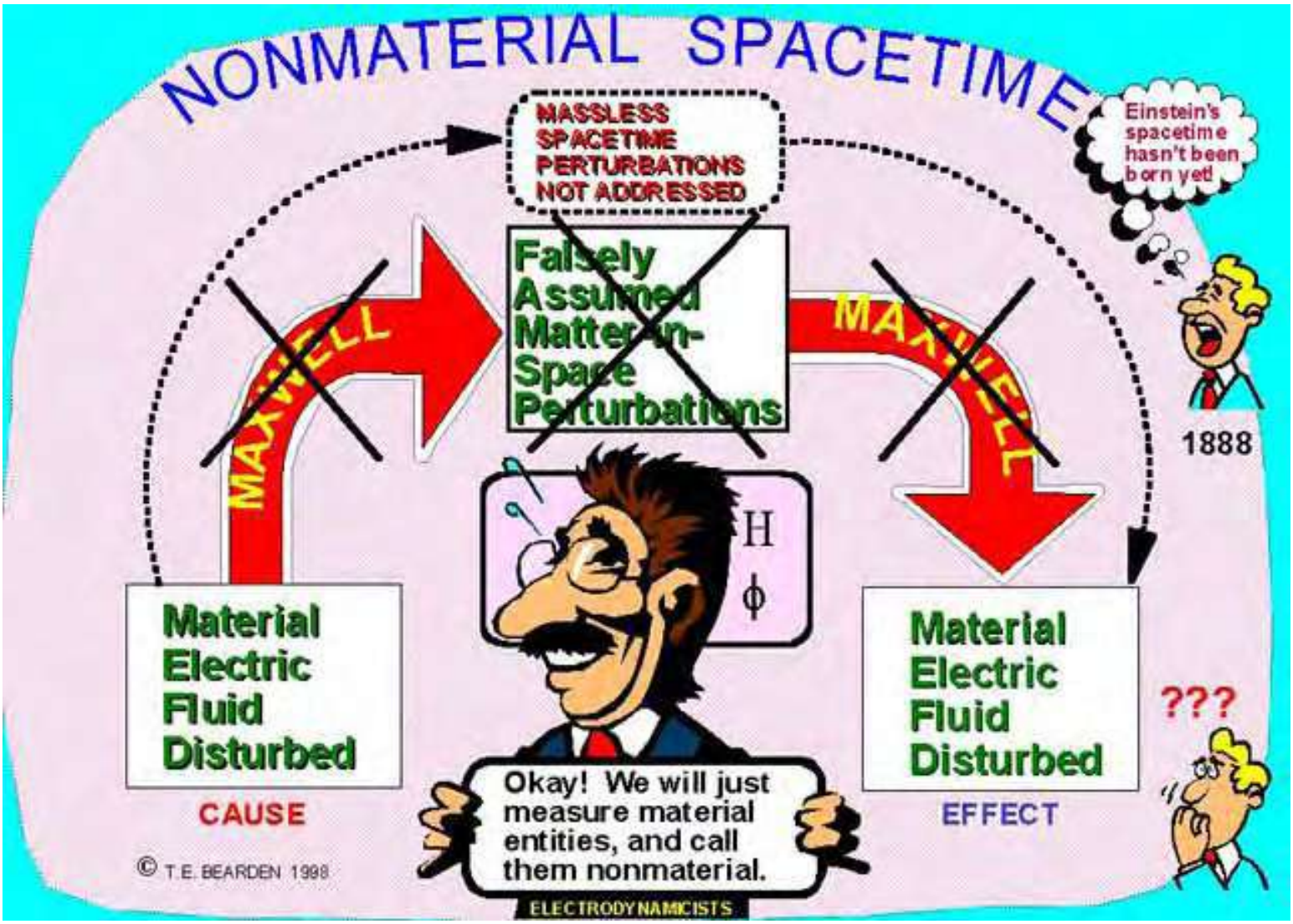
NONMATERIAL SPACETIME
MASSLESS SPACETIME PERTURBATIONS NOT ADDRESSED
Einstein's spacetime hasn't been born yet!
Falsely Assumed Matter-in-Space Perturbations
MAXWELL
MAXWELL
1888
H
ϕ
Material Electric Fluid Disturbed
CAUSE
Material Electric Fluid Disturbed
EFFECT
???
Okay! We will just measure material entities, and call them nonmaterial.
© T.E. BEARDEN 1998
ELECTRODYNAMICISTS

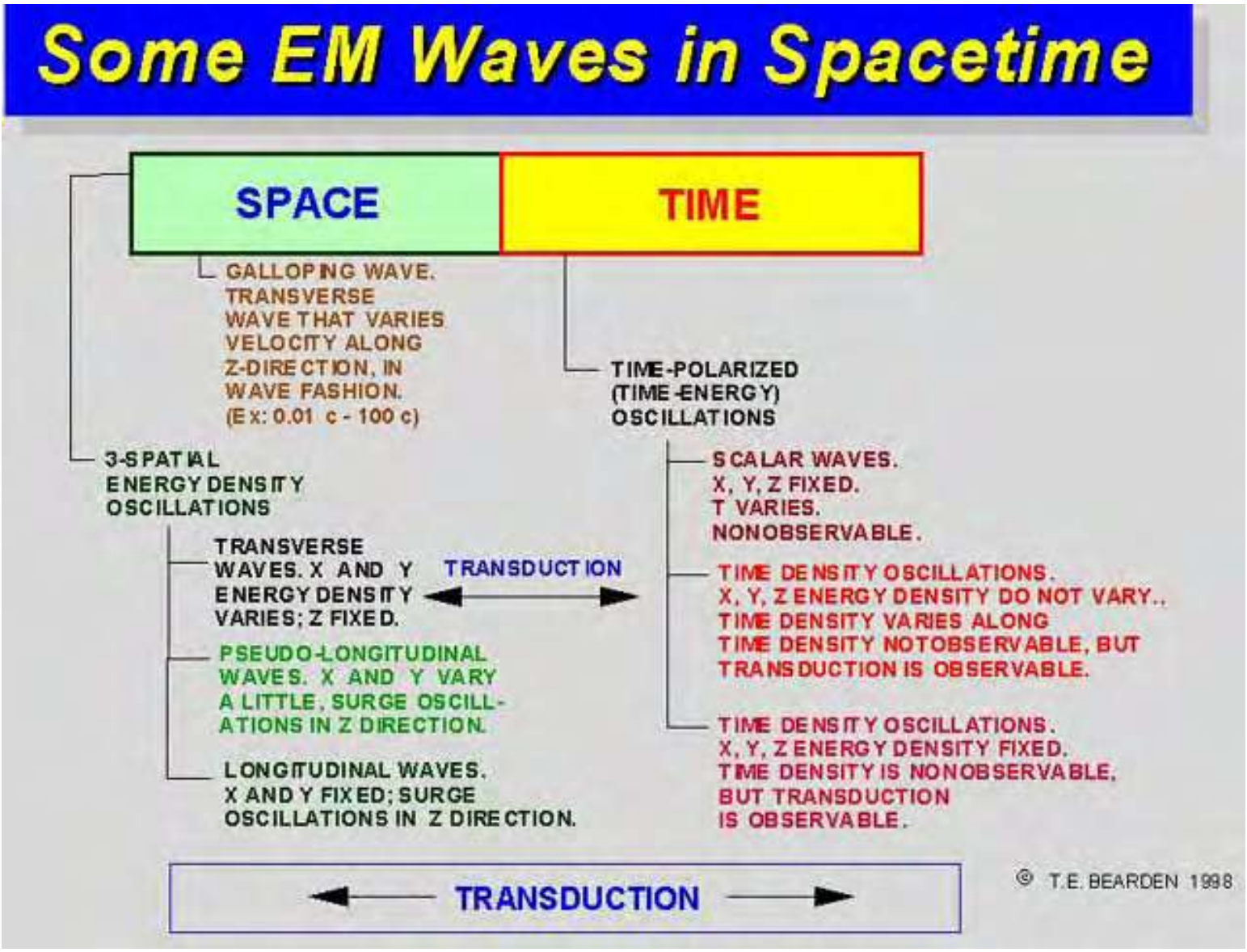
Some EM Waves in Spacetime
SPACE
TIME
GALLOPING WAVE. TRANSVERSE WAVE THAT VARIES VELOCITY ALONG Z-DIRECTION, IN WAVE FASHION. (Ex: 0.01 c - 100 c)
TIME-POLARIZED (TIME-ENERGY) OSCILLATIONS
3-SPATIAL ENERGY DENSITY OSCILLATIONS
SCALAR WAVES. X, Y, Z FIXED. T VARIES. NONOBSERVABLE.
TRANSVERSE WAVES. X AND Y ENERGY DENSITY VARIES; Z FIXED.
TRANSDUCTION
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY DO NOT VARY.. TIME DENSITY VARIES ALONG TIME DENSITY NOTOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
PSEUDO-LONGITUDINAL WAVES. X AND Y VARY A LITTLE, SURGE OSCILLATIONS IN Z DIRECTION.
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY FIXED. TIME DENSITY IS NONOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
LONGITUDINAL WAVES. X AND Y FIXED; SURGE OSCILLATIONS IN Z DIRECTION.
TRANSDUCTION
© T.E. BEARDEN 1998

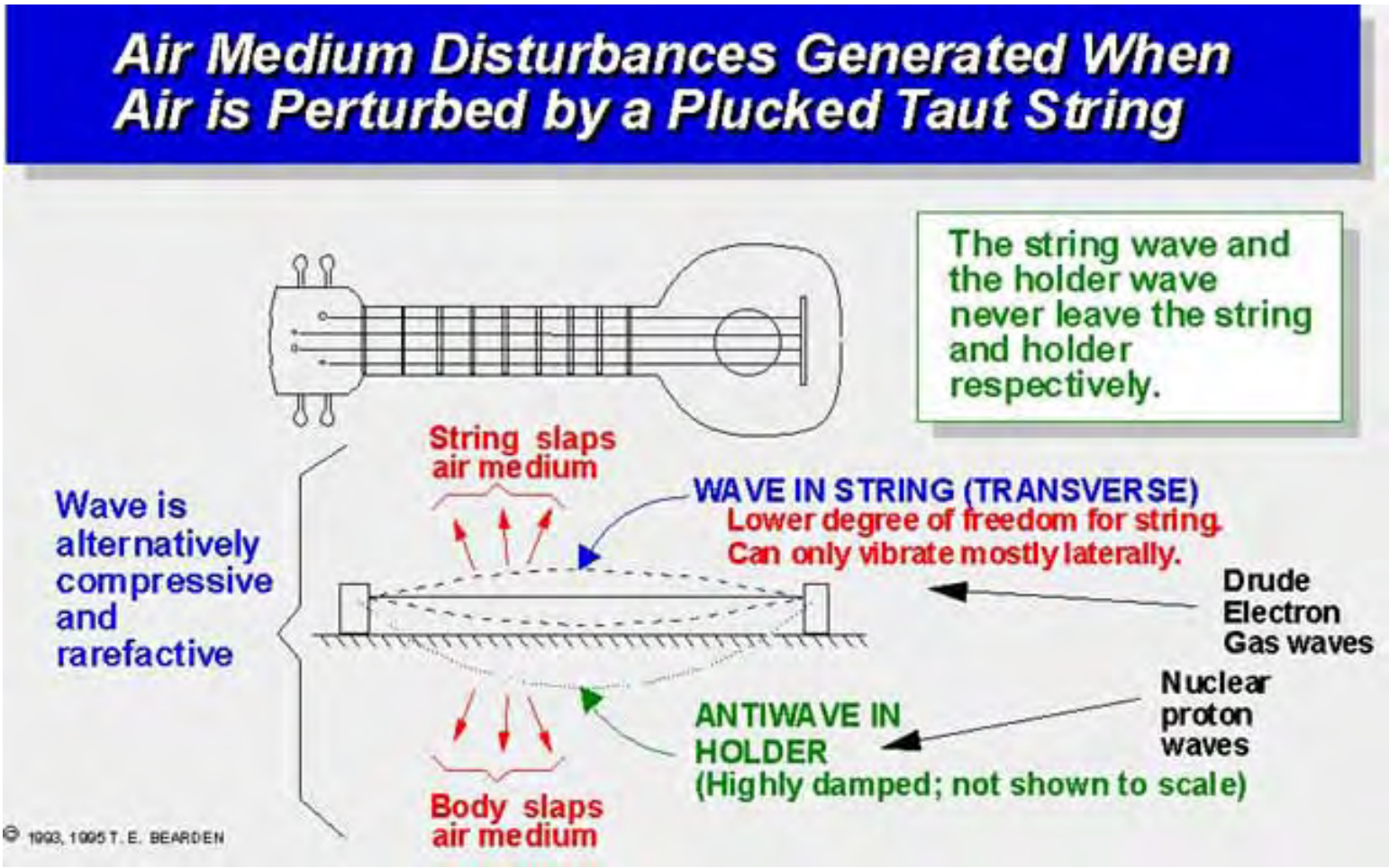
Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
The string wave and the holder wave never leave the string and holder respectively.
String slaps air medium
Wave is alternatively compressive and rarefactive
WAVE IN STRING (TRANSVERSE)
Lower degree of freedom for string.
Can only vibrate mostly laterally.
Drude Electron Gas waves
Nuclear proton waves
ANTIWAVE IN HOLDER
(Highly damped; not shown to scale)
Body slaps air medium
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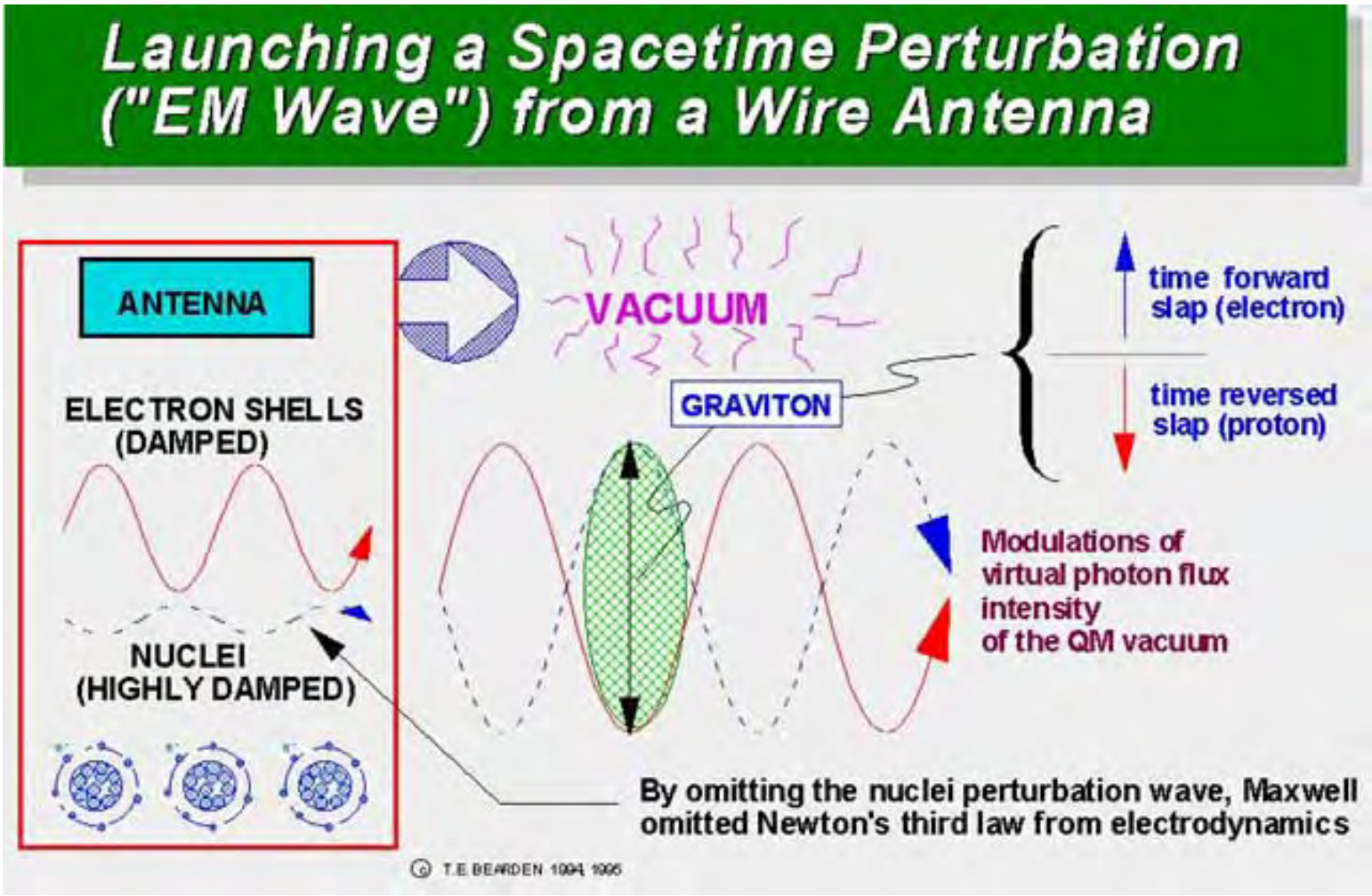
Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
ANTENNA
ELECTRON SHELLS (DAMPED)
NUCLEI (HIGHLY DAMPED)
VACUUM
GRAVITON
time forward slap (electron)
time reversed slap (proton)
Modulations of virtual photon flux intensity of the QM vacuum
By omitting the nuclei perturbation wave, Maxwell omitted Newton's third law from electrodynamics
© T.E BEARDEN 1994 1995

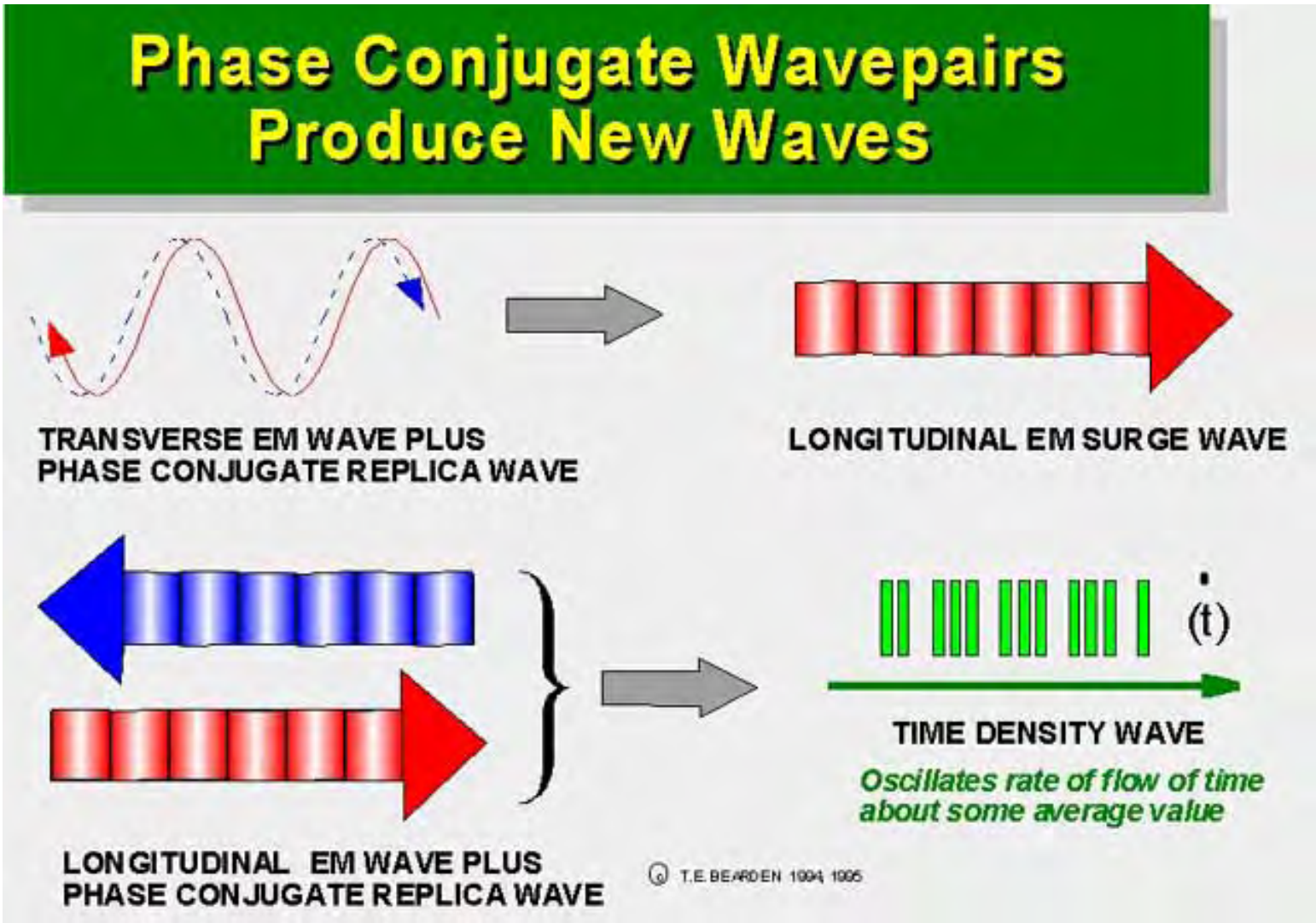
Phase Conjugate Wavepairs
Produce New Waves
TRANSVERSE EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
LONGITUDINAL EM SURGE WAVE
LONGITUDINAL EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
(t)
TIME DENSITY WAVE
Oscillates rate of flow of time
about some average value
© T.E. BEARDEN 1994, 1995

Scalar Electromagnetics (Energetics) View of EM

- Potentials real; primary causes of EM phenomena
  - Force fields made by differentiations of potentials
  - Force fields are effects, not primary causes
  - Force fields exist only in, on mass particles
- Actions due to potentials and their interference
  - Action at a distance or locally
  - Quantum potential and hidden variables
- Locally curved spacetime, engineerable by EM
  - Gravity effects not necessarily negligible
  - Strong EM force or time used as agent of curvature

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Potentials have internal structure
  - Stoney/Whittaker structure
  - Longitudinal EM phase conjugate wavepairs
  - Each wavepair is a time-polarized EM wave
- Vacuum EM is a potential and has microstructure
  - Stoney-Whittaker biwaves/t-polarized waves
  - Fluctuations exhibit chaos
- Spacetime ≡ Vacuum ≡ Potential ≡ Flux

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Statistics may have hidden order (already chaotic)
- Uses spacetime curvature engines to alter matter (inside-out or outside-in)
- Engineerable EM mechanism generates rate of flow of a mass through time
- Quantum potential with specific QP can be used for instant action at a distance

Extended General Relativity Principle

- "All levels of energy structures and all levels of time structures mold spacetime geometry.
- This is called a *vacuum engine* (spacetime engine).
- Spatial and temporal structuring act upon mass at all levels.
- This produces *templates* of forces, for translations and stresses."

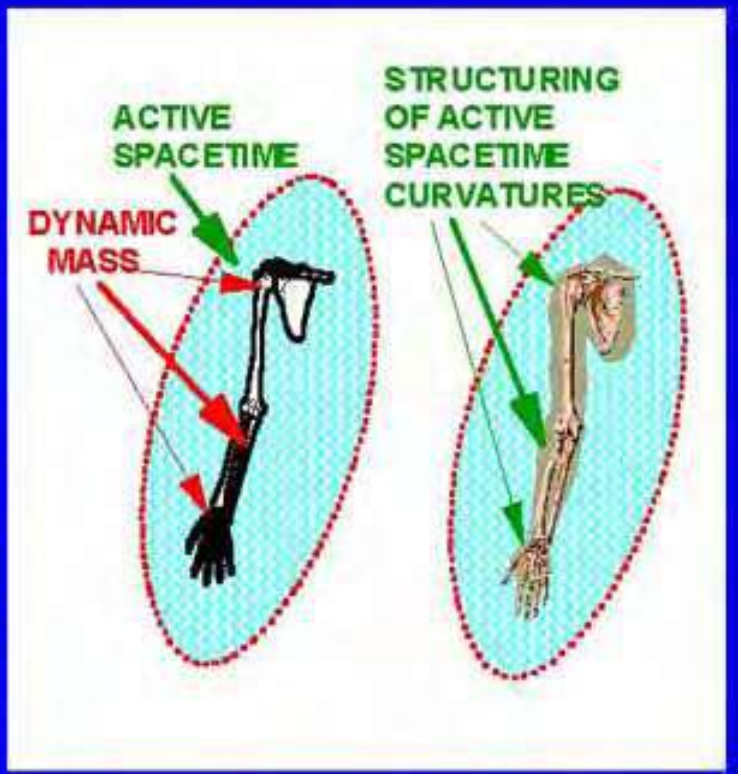

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Extension of Work-Energy Theorem

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- *Theorem:* $W = k_f - k_i = \Delta k$ [1]
- k must be interpreted not as energy *per se*, but as *collected/collecting* energy.
- The reaction cross section λ for the collecting process must be included.
- *Extension:* $W = \lambda (k_f - k_i) = \lambda \Delta k$ [2]
- Normally $\lambda \leq 1$, as for elastic collision or Stokes emission.
- However, $\lambda > 1$ is now possible, for processes which asymmetrically self-regauge. An example is Letokhov's negative absorption of the medium.
- Working models are the Patterson Power Cell® and Lawandy lasing without population inversion.

MTW's General Relativity Principle

- "Space acts on matter, telling it how to move.
- In turn, matter reacts back on space, telling it how to curve."

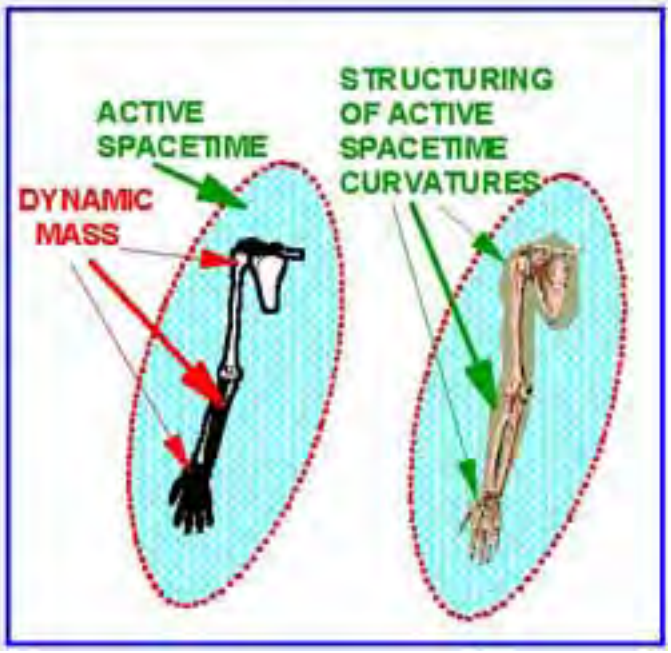

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Use of General Relativity (GR) in Particle Physics

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- GR seldom used in particle physics
- In cold fusion, Matsumoto* has applied general relativity
- Consistent with important cold fusion results
- Used spacetime (ST) curvature by energy density
- Matsumoto did not utilize:
  - Longitudinal EM waves
  - Time density waves
  - Time density curvatures of ST (gain = $9 \times 10_{16}$)

* T. Matsumoto, "Mechanisms of Electro-Nuclear Collapse," Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 98

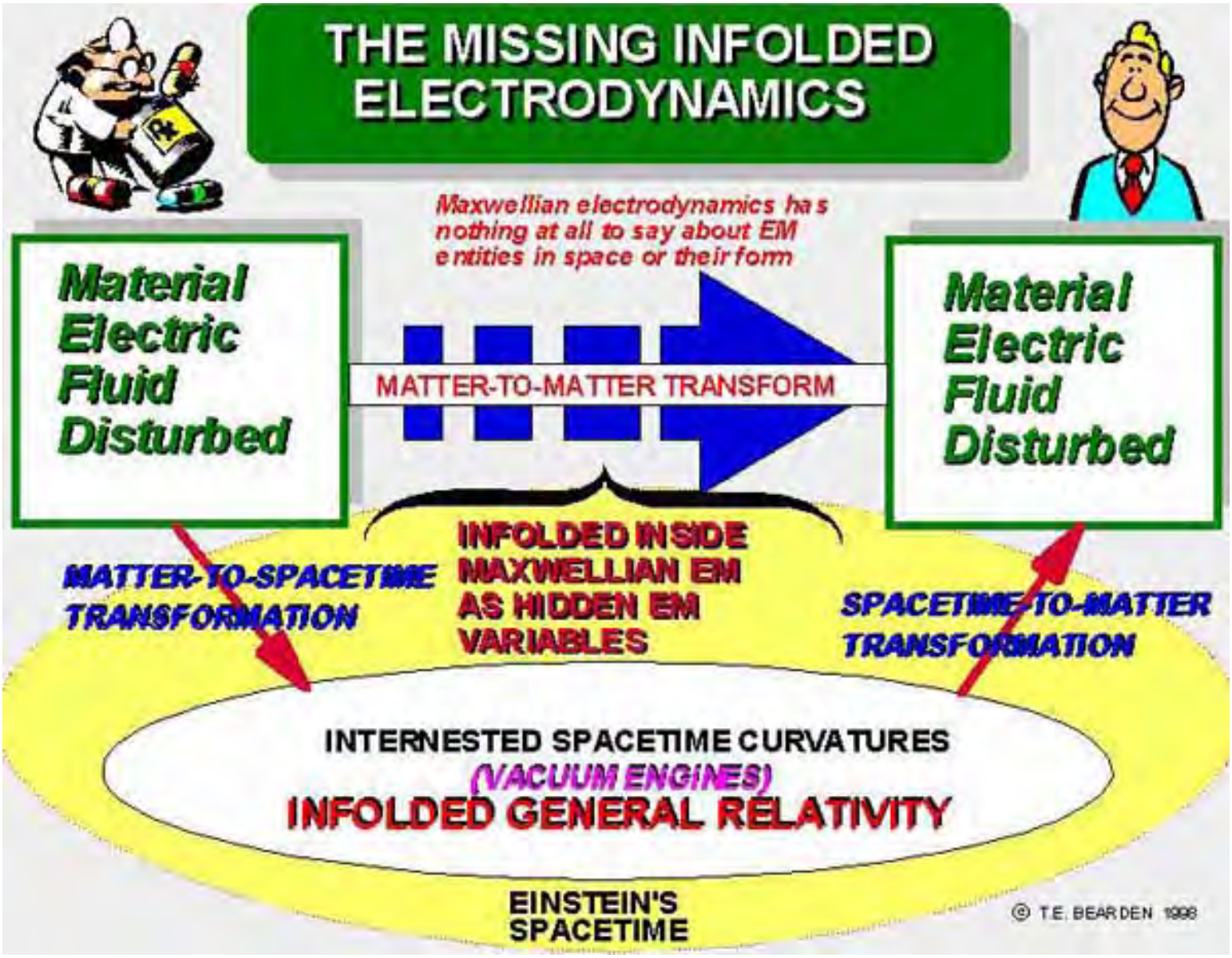
THE MISSING INFOLDED ELECTRODYNAMICS
Maxwellian electrodynamics has nothing at all to say about EM entities in space or their form
Material Electric Fluid Disturbed
MATTER-TO-MATTER TRANSFORM
Material Electric Fluid Disturbed
INFOLDED INSIDE MAXWELLIAN EM AS HIDDEN EM VARIABLES
MATTER-TO-SPACETIME TRANSFORMATION
SPACETIME-TO-MATTER TRANSFORMATION
INTERNESTED SPACETIME CURVATURES
(VACUUM ENGINES)
INFOLDED GENERAL RELATIVITY
EINSTEIN'S SPACETIME
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Infolded Engines: Excluded by Present Physics

- *The infolded dynamics of EM systems are not considered in general relativity, electromagnetics, or quantum mechanics*
- *None of these disciplines include such spacetime curvature engines (vacuum engines)*
- *Thus GR, EM, and QM cannot be unified, since ST curvature engines are where the unification mainly occurs*

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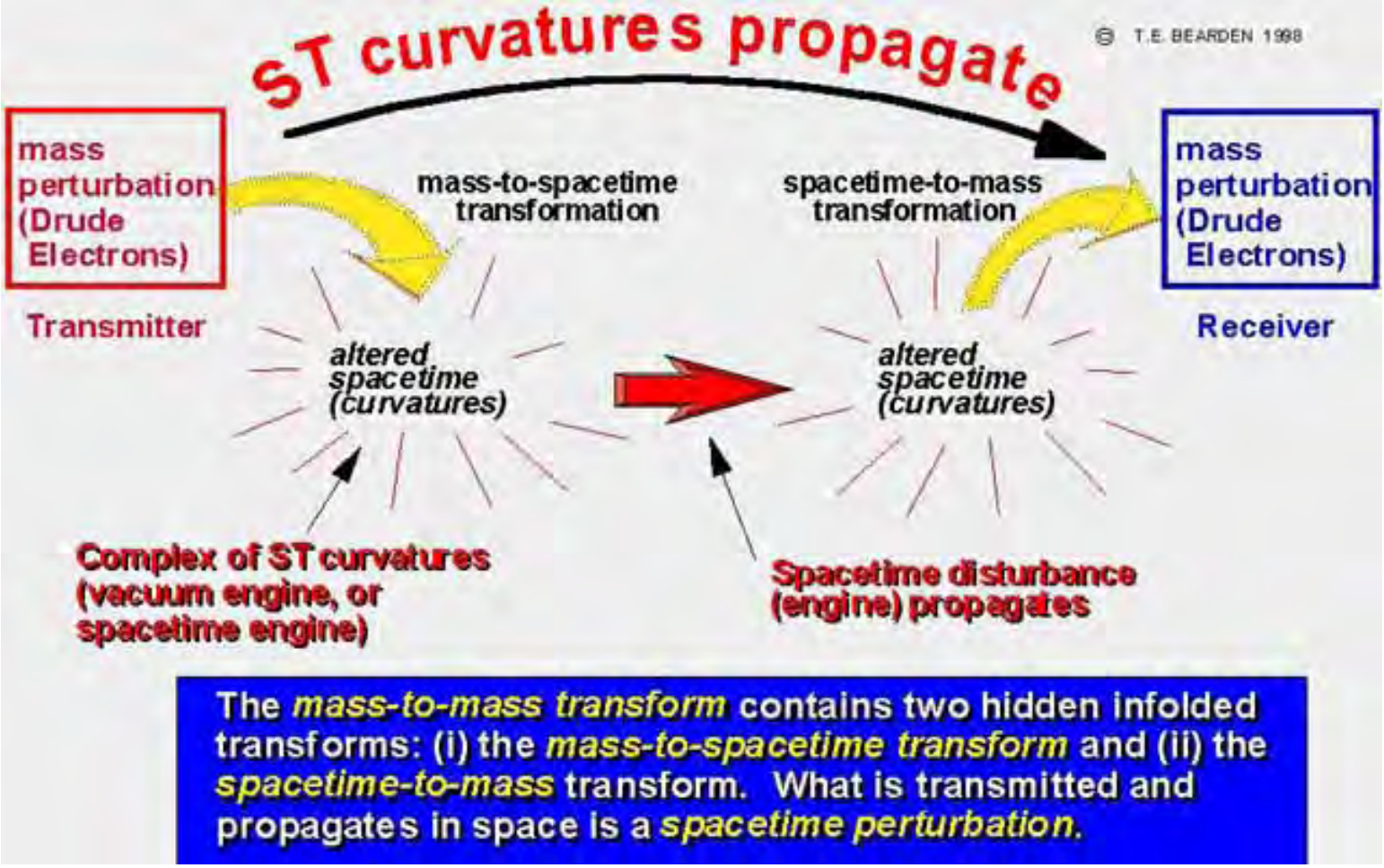
ST curvatures propagate
© T.E. BEARDEN 1998
mass perturbation (Drude Electrons)
Transmitter
mass-to-spacetime transformation
spacetime-to-mass transformation
mass perturbation (Drude Electrons)
Receiver
altered spacetime (curvatures)
altered spacetime (curvatures)
Complex of ST curvatures (vacuum engine, or spacetime engine)
Spacetime disturbance (engine) propagates
The mass-to-mass transform contains two hidden infolded transforms: (i) the mass-to-spacetime transform and (ii) the spacetime-to-mass transform. What is transmitted and propagates in space is a spacetime perturbation.

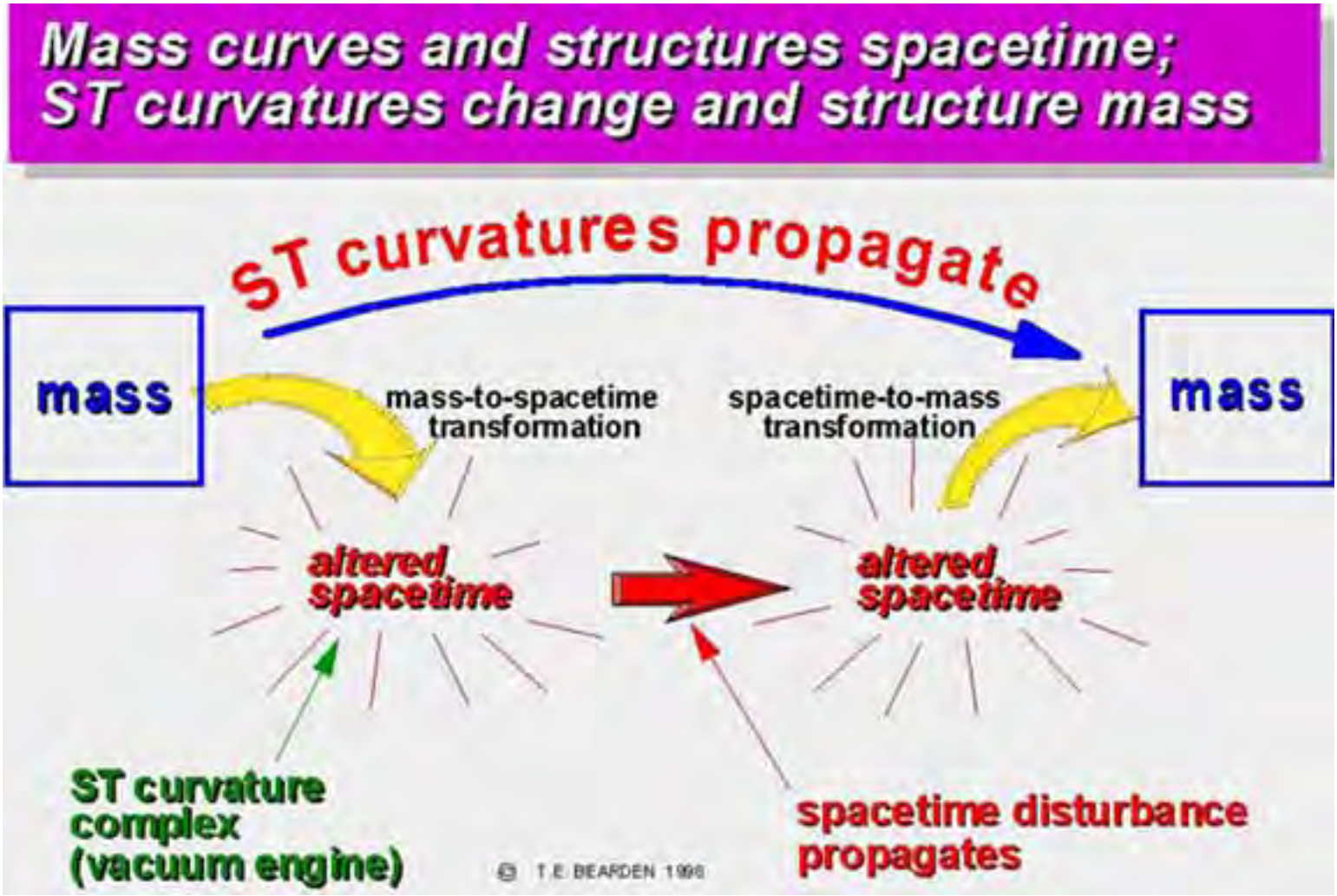
Mass curves and structures spacetime;
ST curvatures change and structure mass
ST curvatures propagate
mass
mass-to-spacetime transformation
spacetime-to-mass transformation
mass
altered spacetime
altered spacetime
ST curvature complex (vacuum engine)
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spacetime disturbance propagates

At Infinite Velocity:
Each Is Every Other
SPACETIME
VIRTUAL PARTICLE FLUX
POTENTIAL
MIND AND MIND LEVELS
MASS
PLANET
LIVING ORGANISMS
© 1997 T.E. Bearden

Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

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S.K. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p. 16-25.

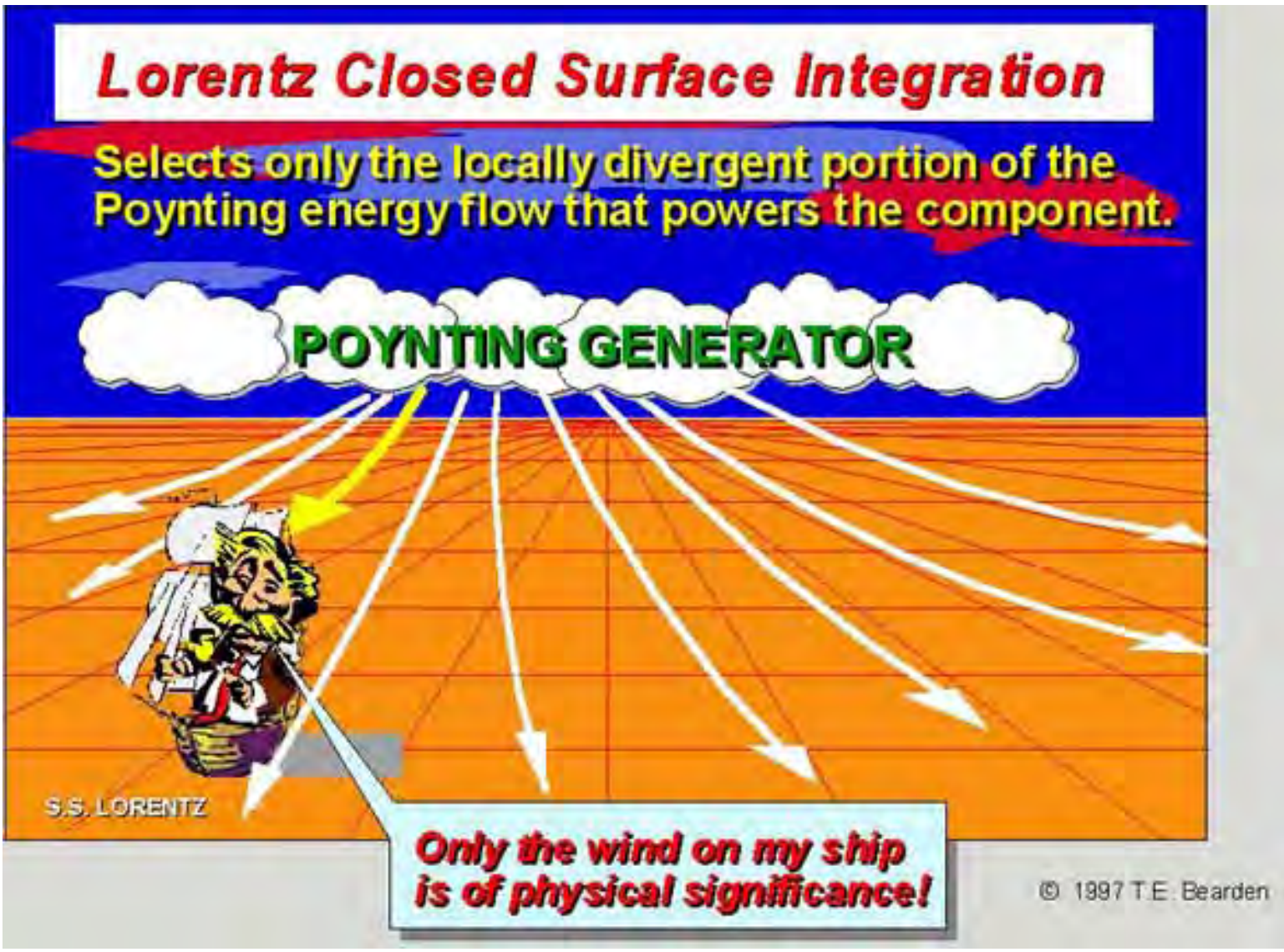
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
Only the wind on my ship is of physical significance!
© 1997 T.E. Bearden

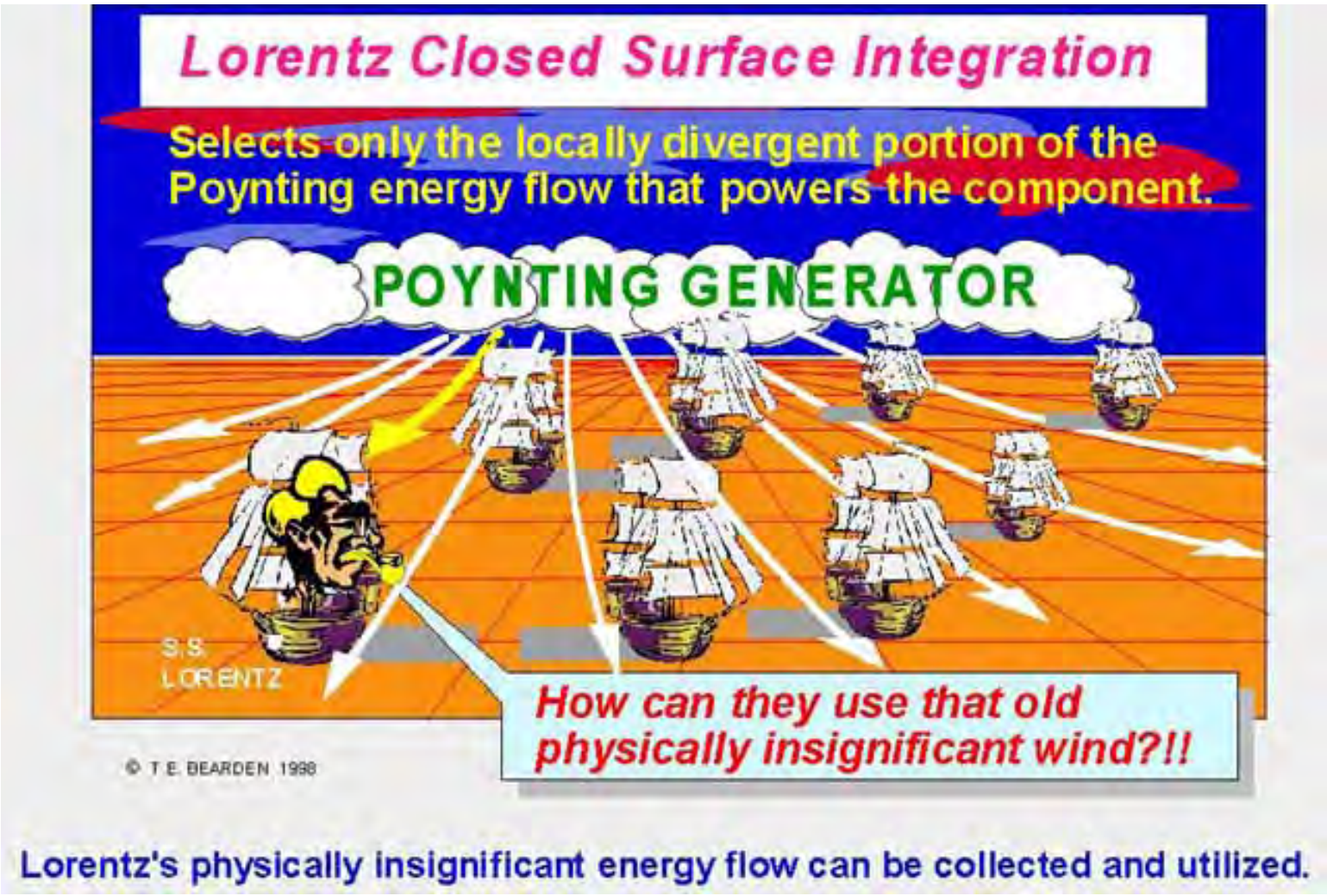
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
How can they use that old physically insignificant wind?!!
© T.E. BEARDEN 1998
Lorentz's physically insignificant energy flow can be collected and utilized.

Lorentz surface integration of the Poynting vector around a closed surface

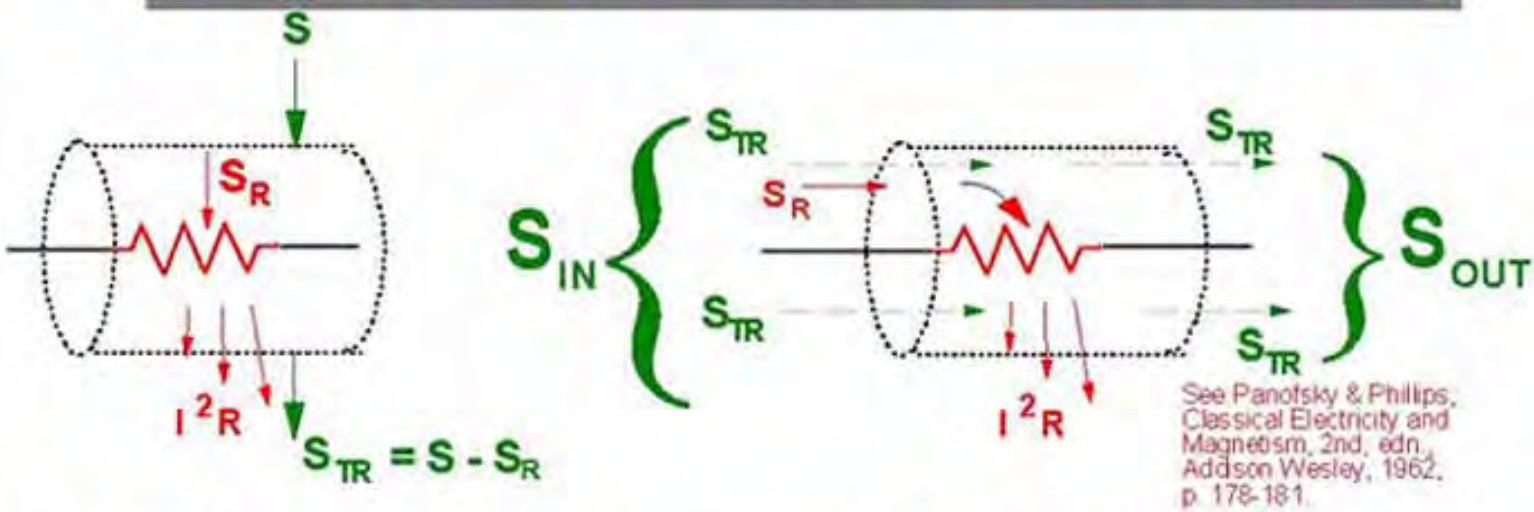

See Panofsky & Phillips, Classical Electricity and Magnetism, 2nd. edn. Addison Wesley, 1962, p. 178-181.

1a. Lorentz surface integration.

1b. Actual S in and S out.

Note: If the S-vector is integrated over the closed surface, then all energy *transport* passage is zeroed, leaving only the very small component of the input S-flow that is powering the joule heating of the resistor. In short, only the small component of the S-flow that is equal in magnitude to the Slepian vector $j\phi$ remains. This measures only the tiny portion of the S-flow that is "collecting" on electrons passing through the resistor, and therefrom being dissipated out of the resistor as joule heating. It discards everything else (all S_{TR}'s and S_{OUT}). S_{IN} becomes S_R.

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Longitudinal EM Photon Interaction with Charge

- Creates time-density wave pumping
- Slowly creates time-density charging

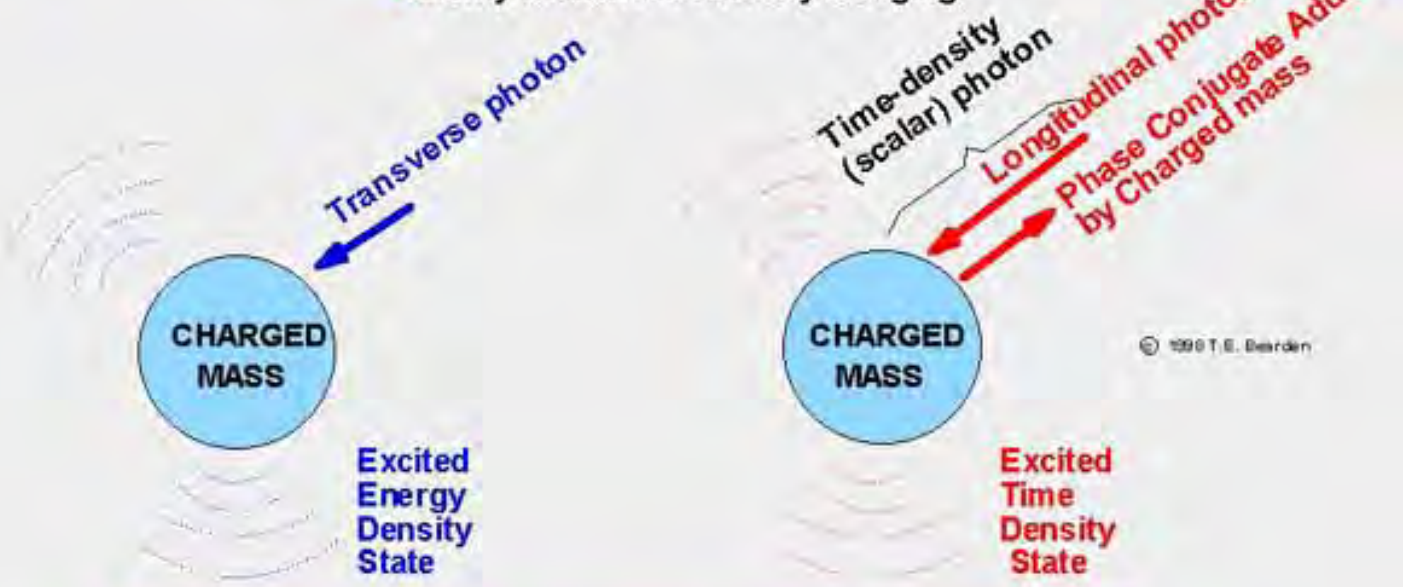

- Fundamental units are arbitrary in physics
- Can express all physics in one unit -- e.g., time
- Time is highly compressed energy
- 1 sec = 9 x 10_{16} joules of transverse EM wave energy

Figure 1-8. Infolded biwave composition of a scalar potential.

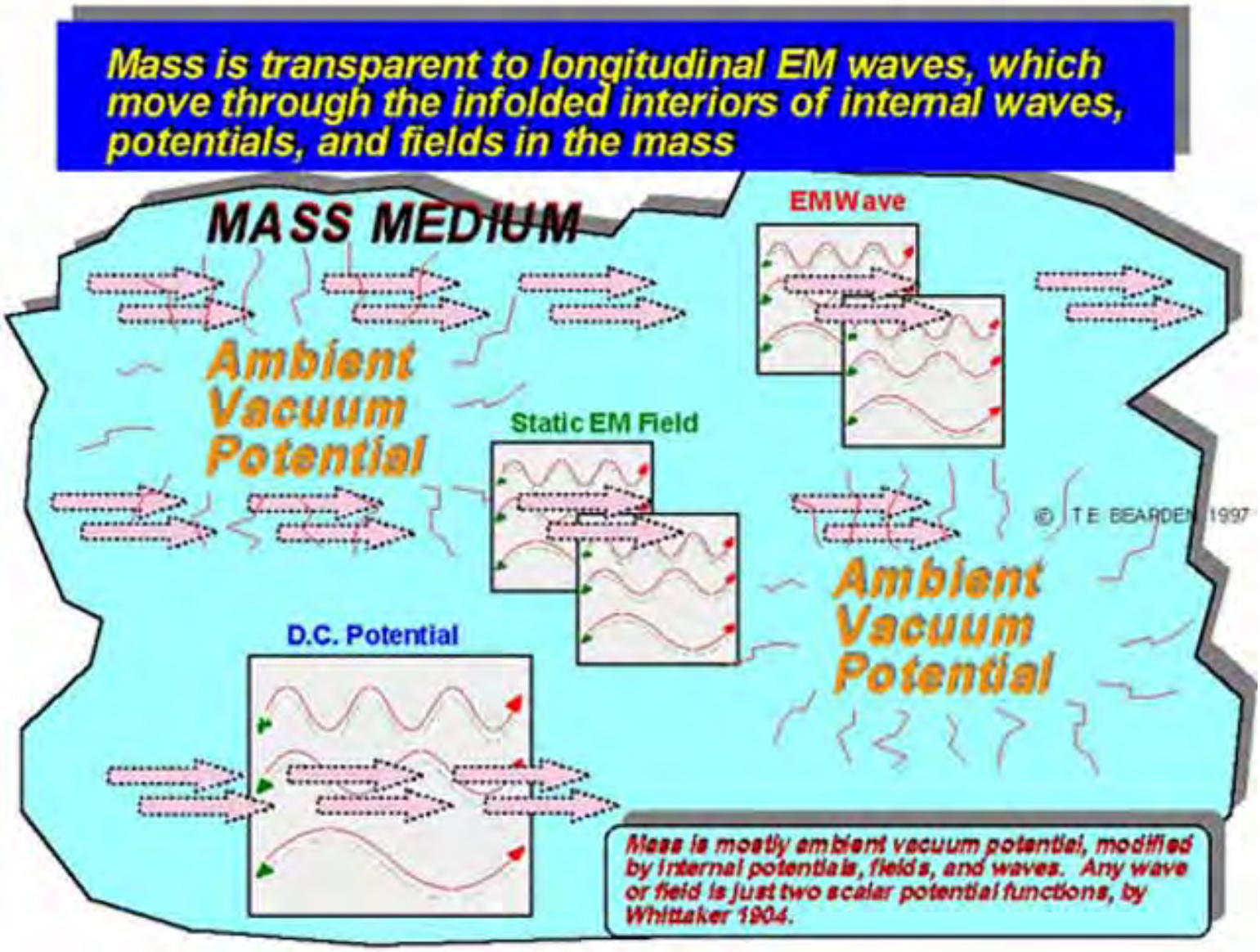

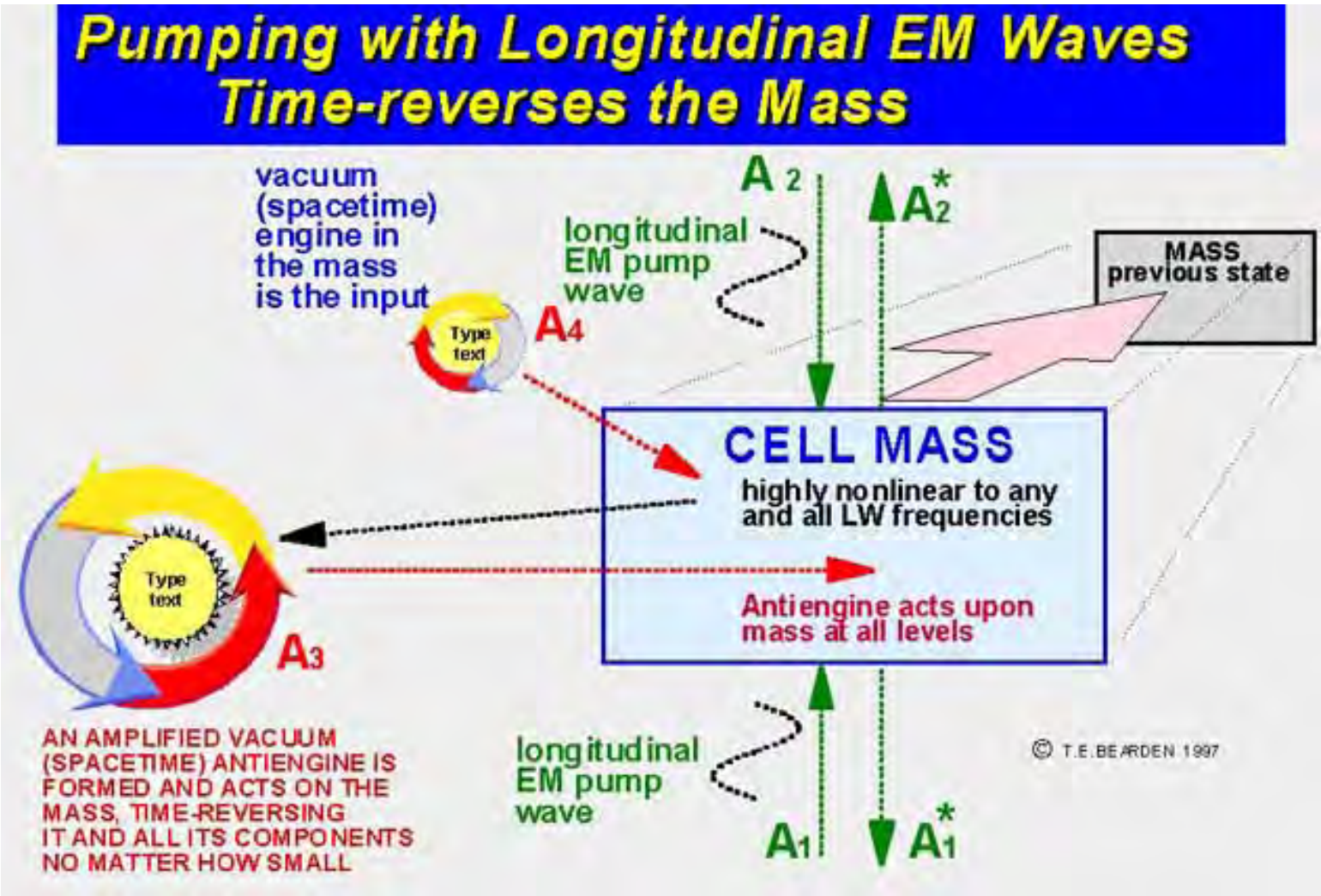
Pumping with Longitudinal EM Waves
Time-reverses the Mass
vacuum (spacetime) engine in the mass is the input
A 2
A*2
longitudinal EM pump wave
MASS previous state
Type text
A4
CELL MASS
highly nonlinear to any and all LW frequencies
Type text
A3
Antiengine acts upon mass at all levels
AN AMPLIFIED VACUUM (SPACETIME) ANTIENGINE IS FORMED AND ACTS ON THE MASS, TIME-REVERSING IT AND ALL ITS COMPONENTS NO MATTER HOW SMALL
longitudinal EM pump wave
© T.E.BEARDEN 1997
A1
A*1

Maxwell's Quaternion Theory

- Quaternions:
  - Discovered by Hamilton in 1843
  - A quaternion has a vector part
  - A quaternion has a scalar part
  - First significant non-arithmetic number system
  - Higher topology than vector or tensor algebra
- Maxwell's theory was in quaternion equations
  - 20 equations in 20 unknowns
  - Reduced to a small 4-equation subset by Heaviside and Gibbs
  - EM topology dramatically reduced

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Maxwellian Systems

Before regauging, after symmetrical regauging, and after asymmetrical regauging

Note: Any system must first break equilibrium in its vacuum exchange, before it can energize Drude electrons and "power" the load. Asymmetric regauging is always utilized. Powering loads and losses is a symmetry-restoring operation.

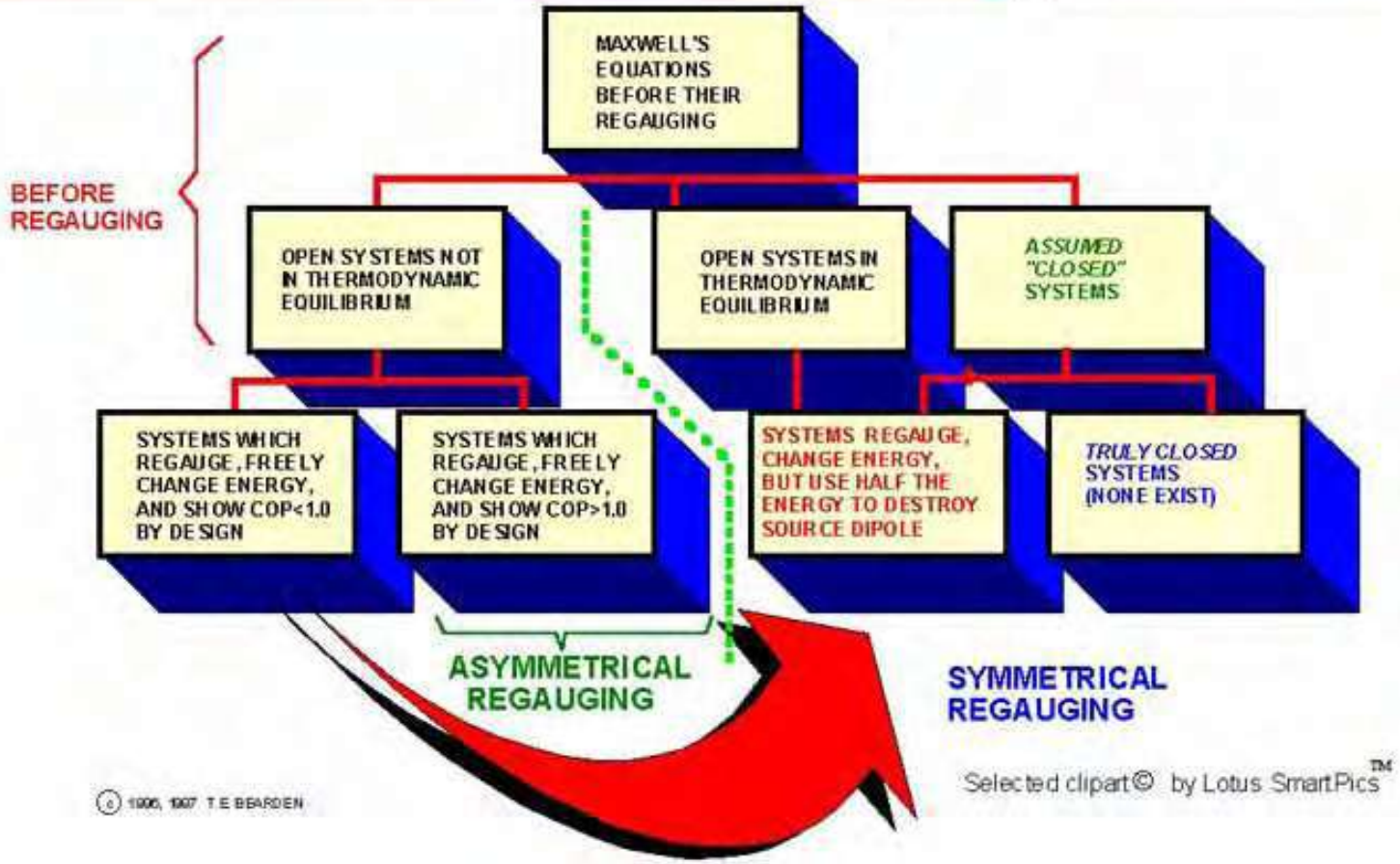

Maxwell's four equations reduce to:

$$\nabla^2 \Phi + \frac{1}{c}\frac{\partial}{\partial}(\nabla \bullet A) = -4\pi\rho \qquad [1]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} - \nabla(\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t}) = -\frac{4p}{c}J \qquad [2]$$

A is replaced by A', where

$$A' = A + \nabla\Lambda \qquad [3]$$

The new B' field then becomes

$$B' = \nabla \times (A + \nabla\Lambda) = \nabla \times A + 0 = \nabla \times A = B \qquad [4]$$

A new E-field will also be formed. So let

$$\Phi' = \Phi - \frac{1}{c}\frac{\partial \Lambda}{\partial t} \qquad [5]$$

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Per Jackson, (A,Φ) are *habitually* chosen so that

$$\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t} = 0 \qquad [6]$$

The *net symmetrical* regauging separates variables. Two inhomogeneous wave equations result:

$$\nabla^2 \Phi - \frac{1}{c^2}\frac{\partial^2 \Phi}{\partial t^2} = -4\pi\rho \qquad [7]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} = -\frac{4\pi}{c} J \qquad [8]$$

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Equations [1] and [2] *arbitrarily* changed to [7] and [8]

The Tom Bearden Website

Energy, Observations and Comments

---

1. A Conservative Field Requires a Single-Valued Potential
2. Earth-Electrosphere and Earth-Ionosphere Capacitors
3. Earth's Poynting Energy Flow
4. The Hidden Energy Flow around us
5. Electrostatic Fields of the Earth's Electrosphere Capacitor in Fair Weather and Thunderstorms
6. Flow of Current and Energy Into, Through, and Along a Conductor
7. Energy "collected" on a charge
8. Fiber Fuse Effect
9. Impact of Vacuum Engineering
10. Lawandy's Experiment
11. Field may be nonconservative for a multivalued potential
12. The Ostrich Problem - Part 1
13. The Ostrich Problem - Part 2
14. Russia had Overunity Devices in 1930s
15. Energy output of human body
16. A "static" Poynting S-flow free-energy generator
17. Topology and Energy Conservation
18. Block Diagram: Sweet's Vacuum Triode

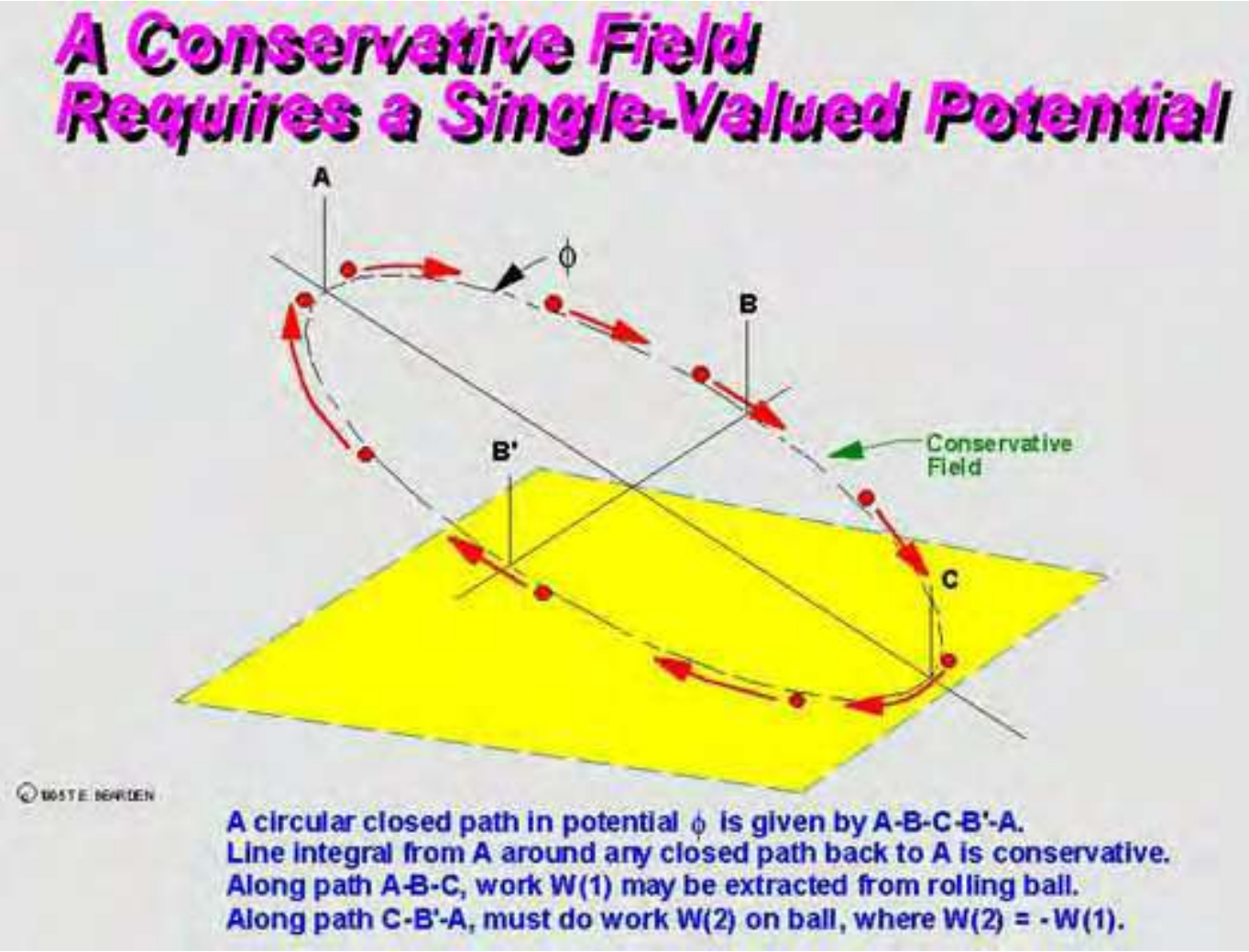

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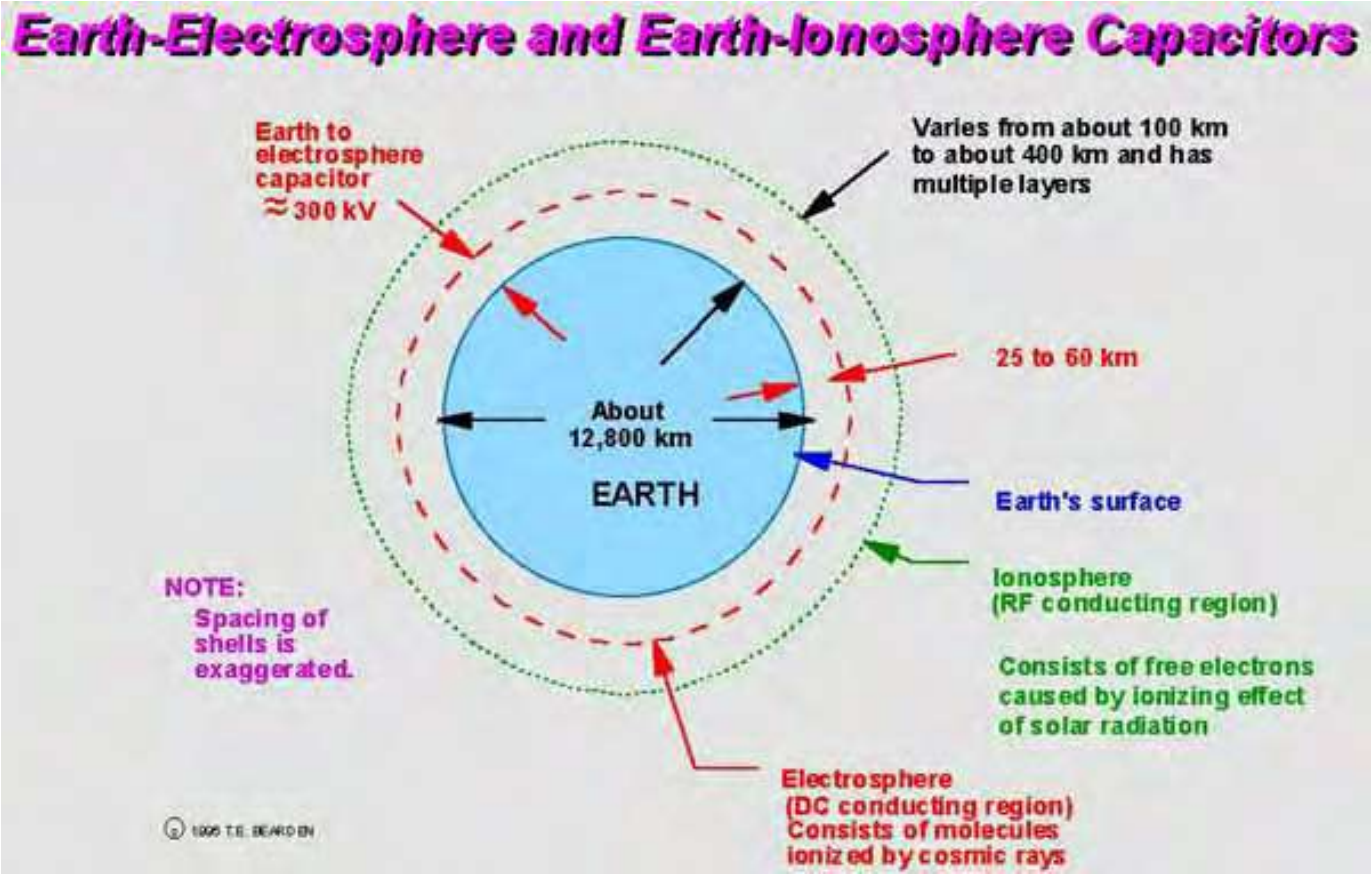

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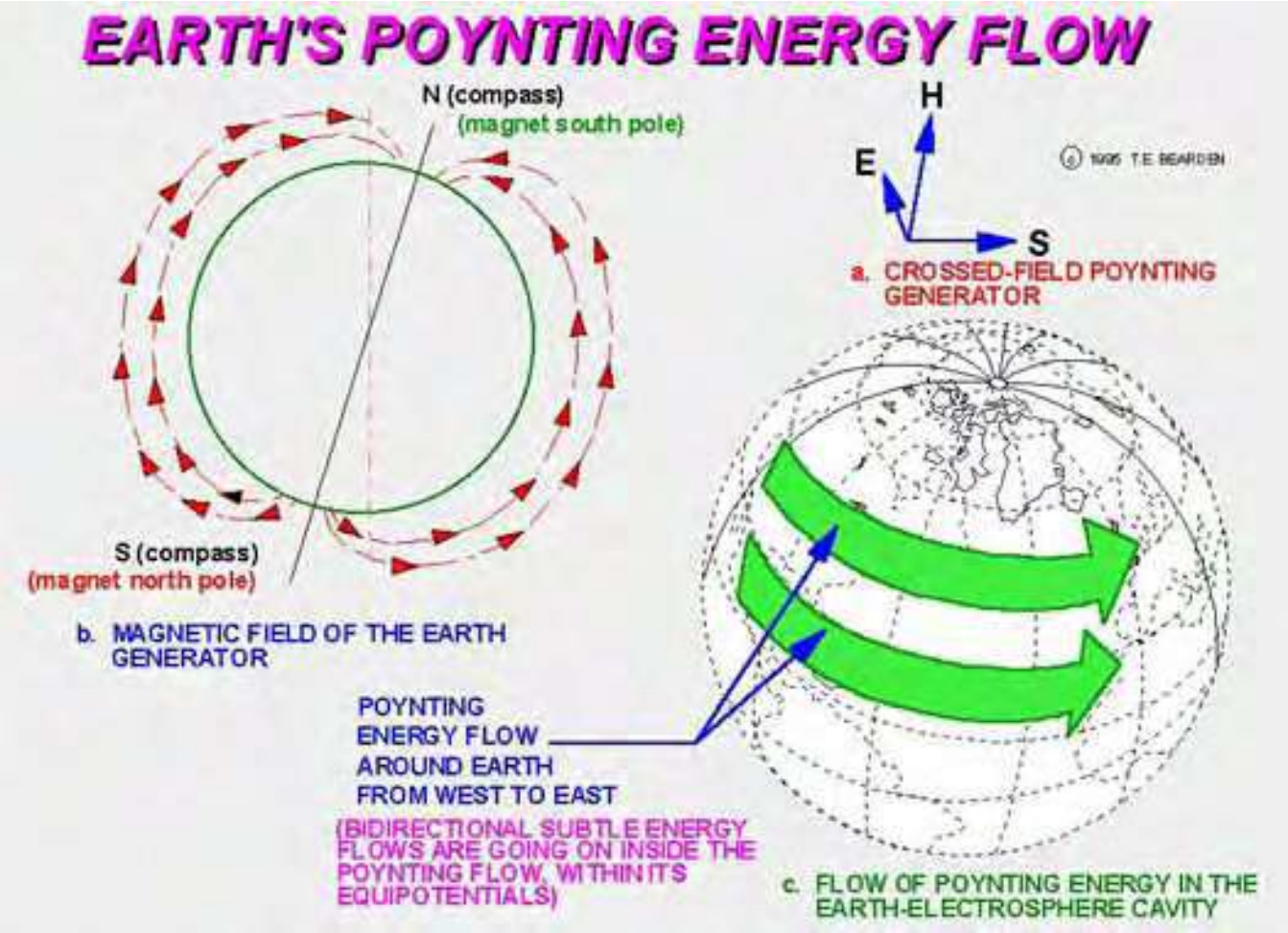

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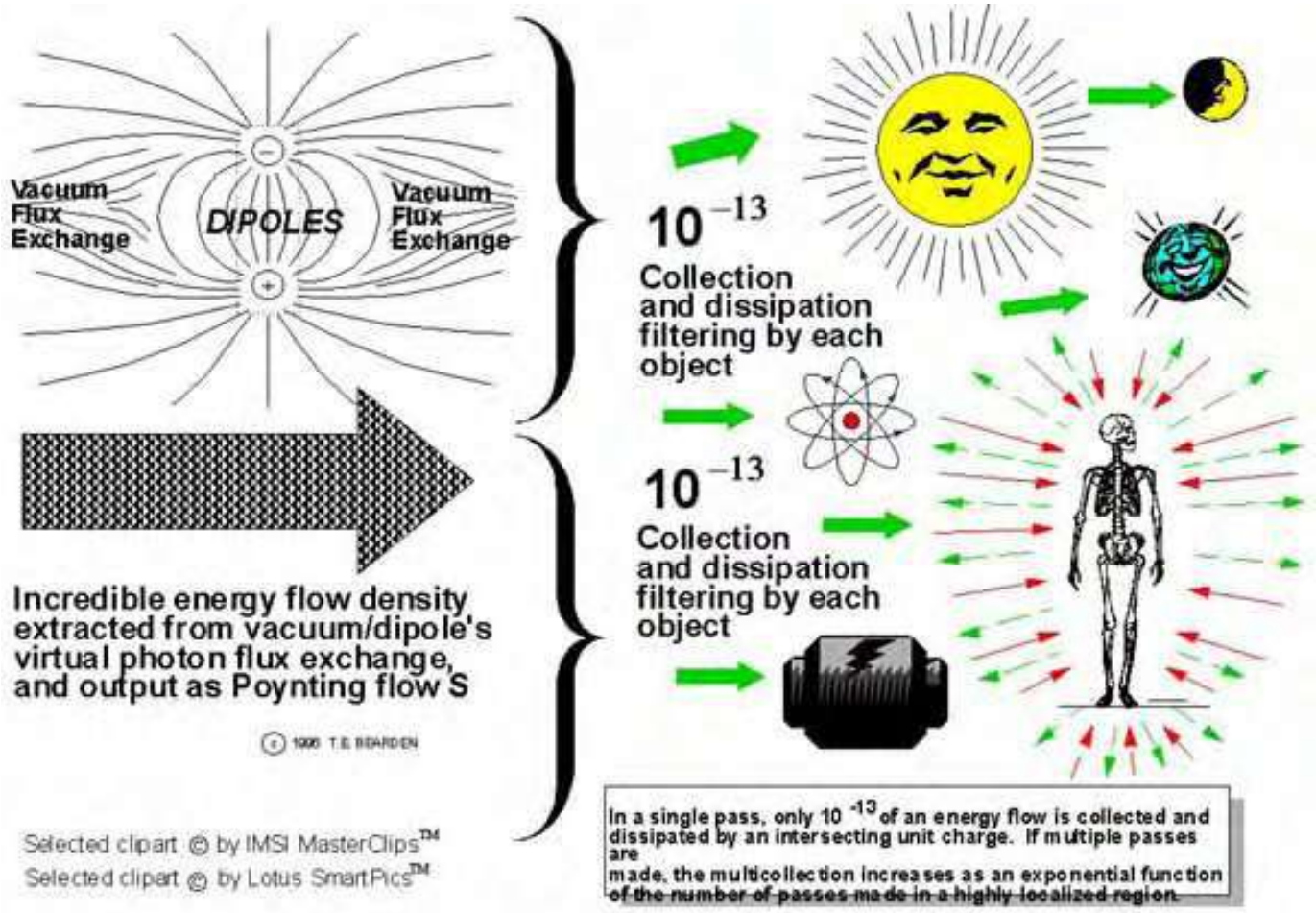

Figure 19. The world of physical matter exists behind a dramatic 10^{-13} filter in a fiery cauldron of fierce and primeval EM energy flow.

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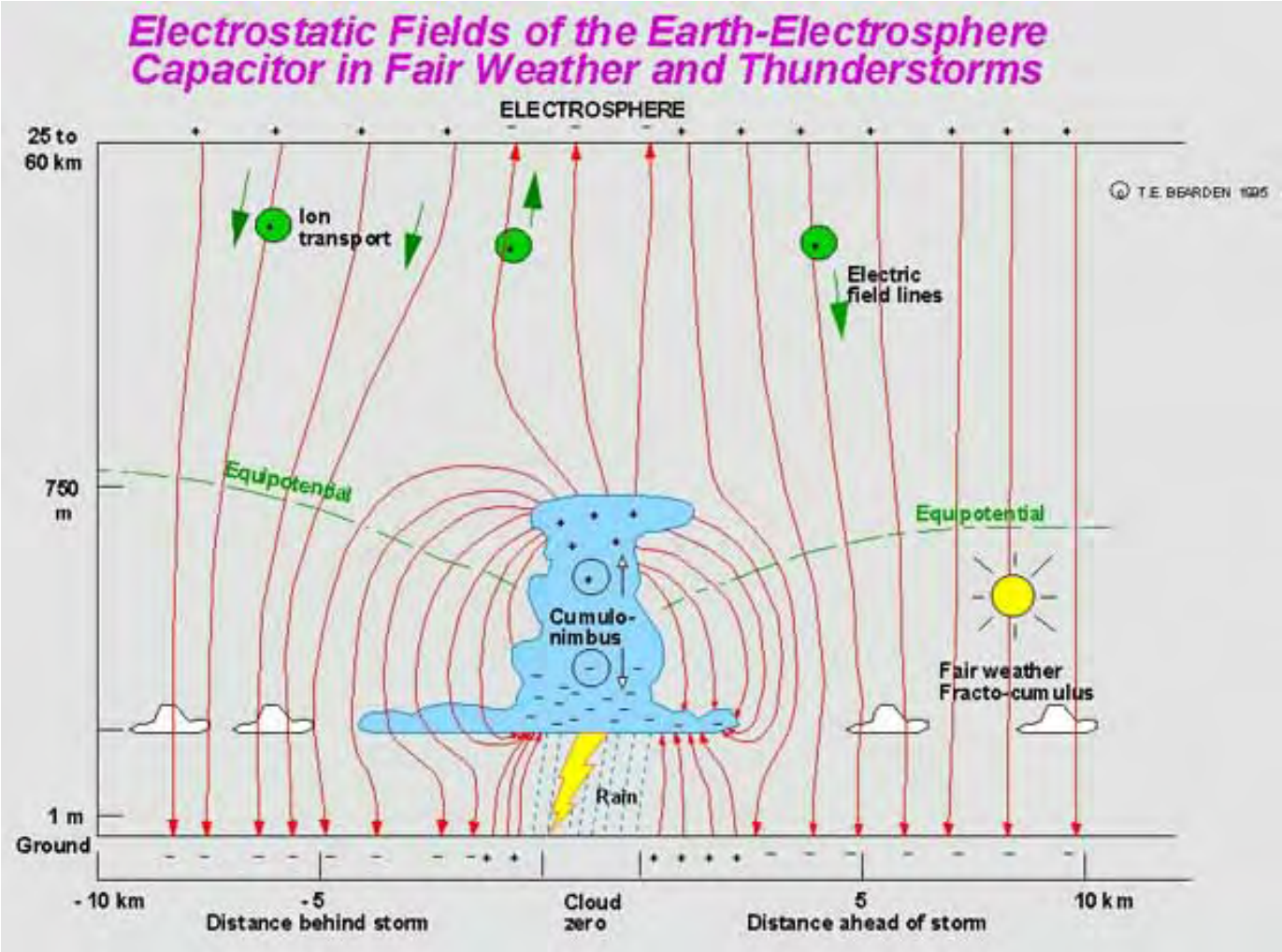

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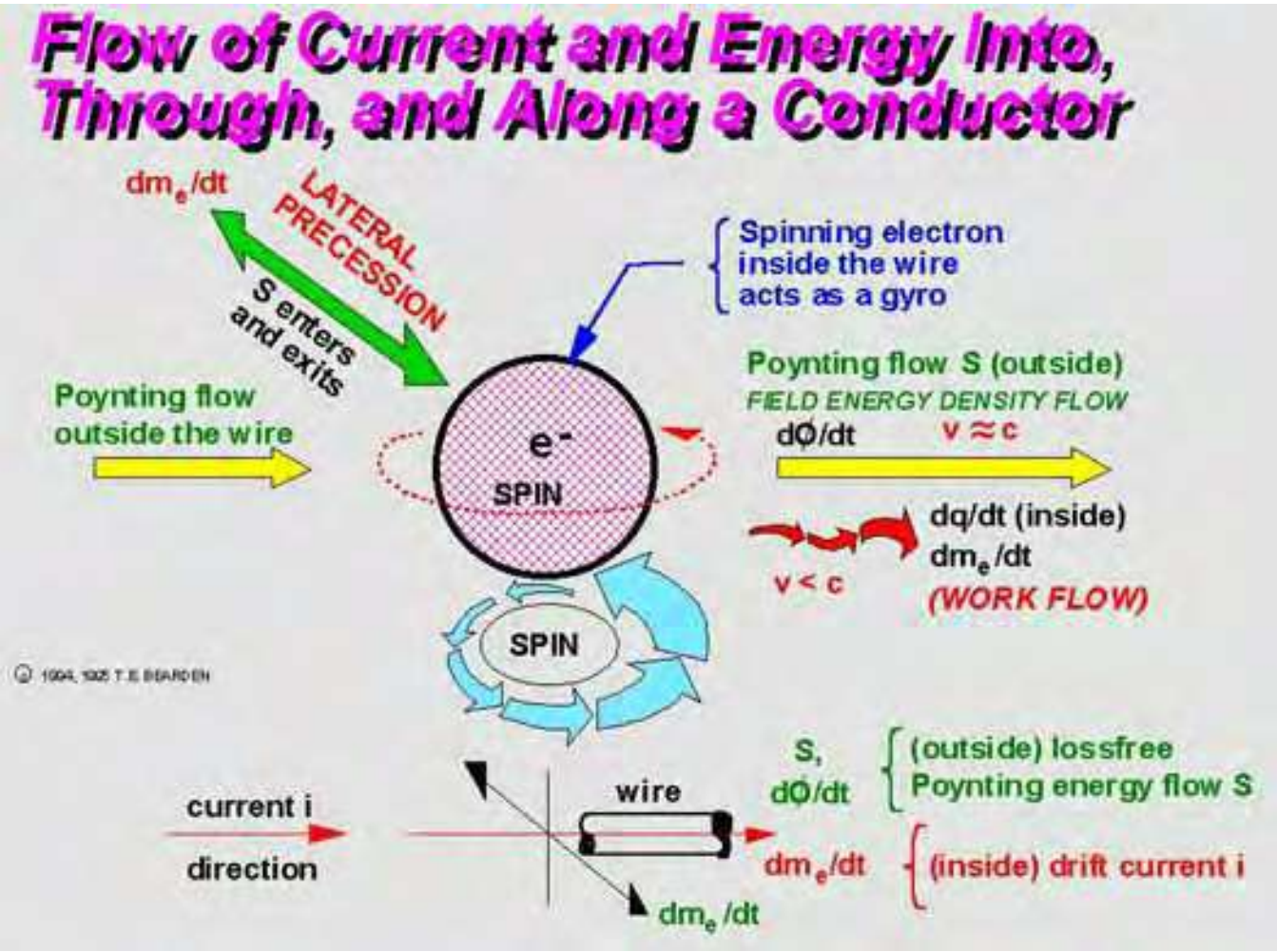

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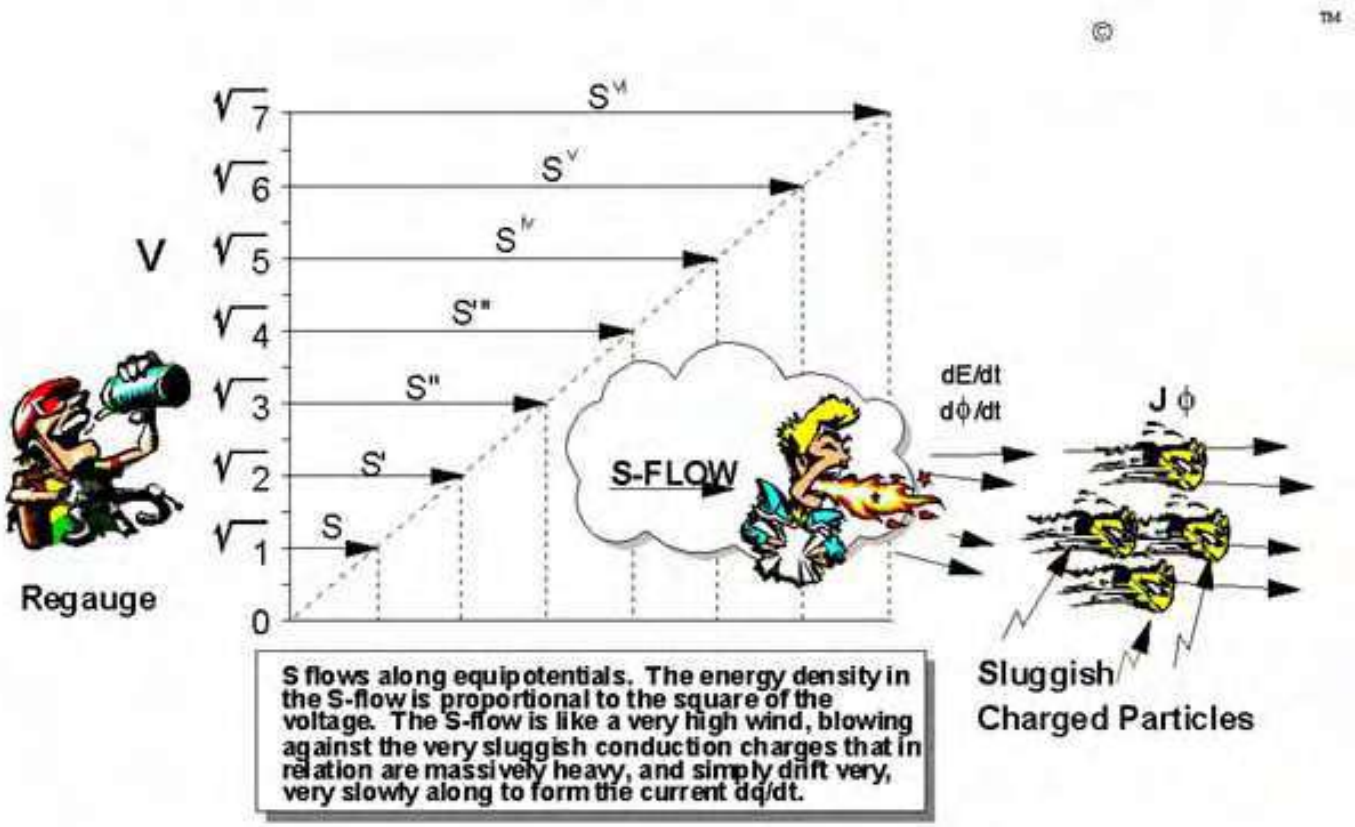

Figure 17. Energy "collected" on a charge depends upon the charge being in a continuous Poynting S-flow. When S ceases, there is no excess energy "collected" on the charge. Energy collection never occurs in chunks, but is always a dynamic, ongoing process.

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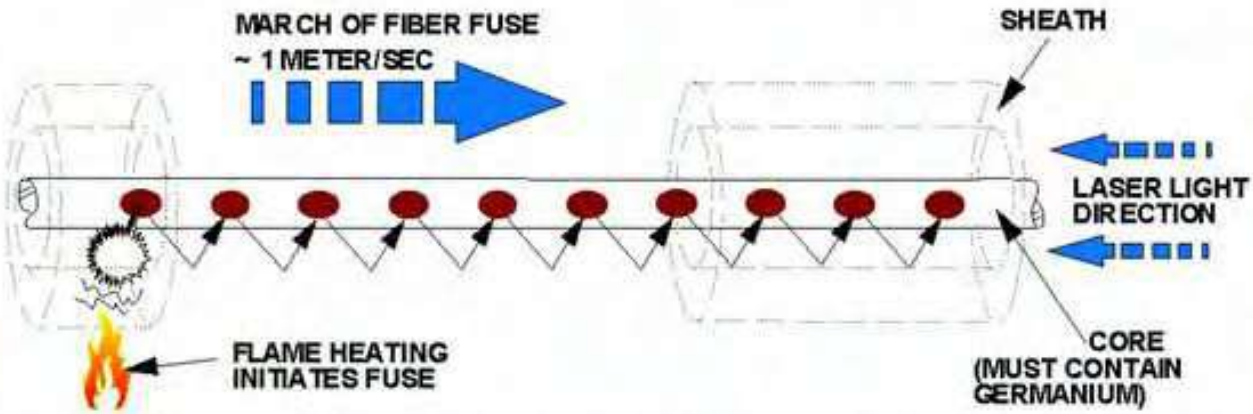

31A. Fiber fuse destroys core of fiber optics cable of indefinite length, pitting core with holes.

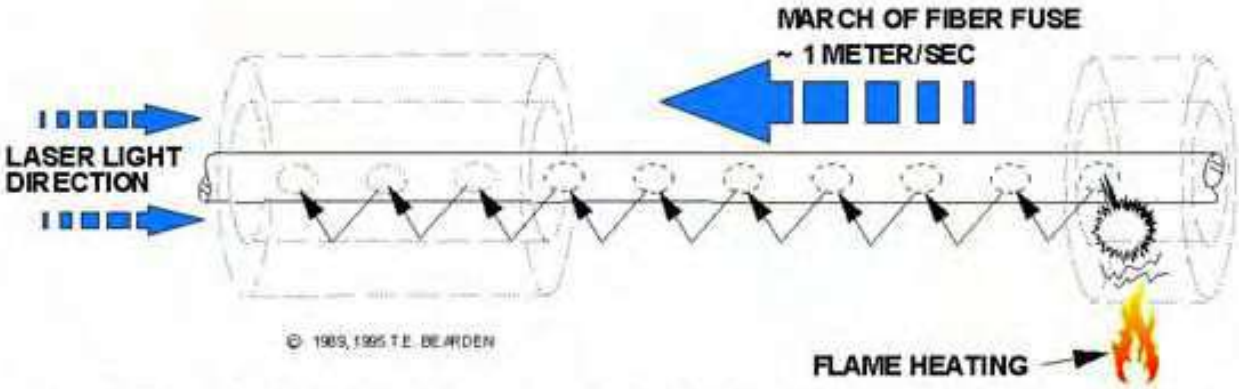

31B. Reversed second fiber fuse often *restores* pitted core in cable, filling holes back up.

Figure 31. Fiber fuse effect and its strange anomalies.

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Impact of Vacuum Engineering

- "If they [quantum fluctuations of vacuum] can be [tapped], the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete – and so would many of our worries about environmental pollution."
- "Don't sell your oil shares yet – but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development:
  - 1. It's crazy!
  - 2. It may be possible -- so what?
  - 3. I said it was a good idea all along.
  - 4. I thought of it first."

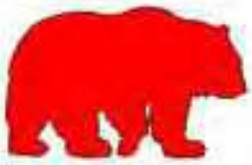

Arthur C. Clarke
"Space Drive: A Fantasy That Could Become Reality"
Nov./Dec. 1994

- *Comment:*
  - *Every dipole's broken symmetry in its energetic exchange with the vacuum already freely extracts vacuum energy.*
  - *In power sources, the dipole gates the extracted energy out as S = EXH, which flows almost entirely outside the conductors.*
  - The circuit interacts with, and uses, only about 10^{-13} of S. The electrodynamicists calculate only this small S-component.

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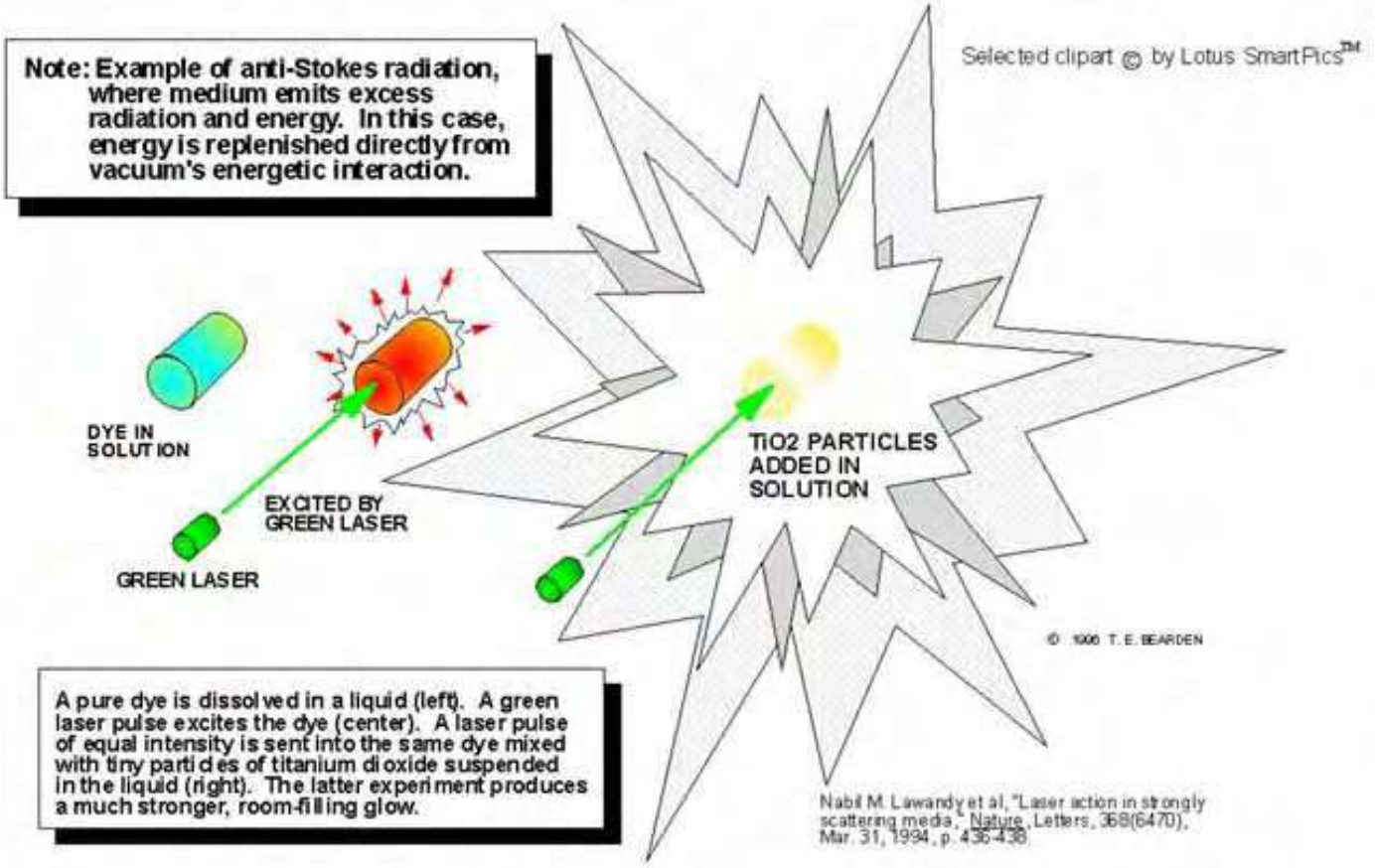

Figure 28. Lawandy's experiment (Letokhov-Lawandy effect) with multipass, multicollection of energy. Formation of a quantum potential can also become involved. Retroreflection and self-targeting are key.

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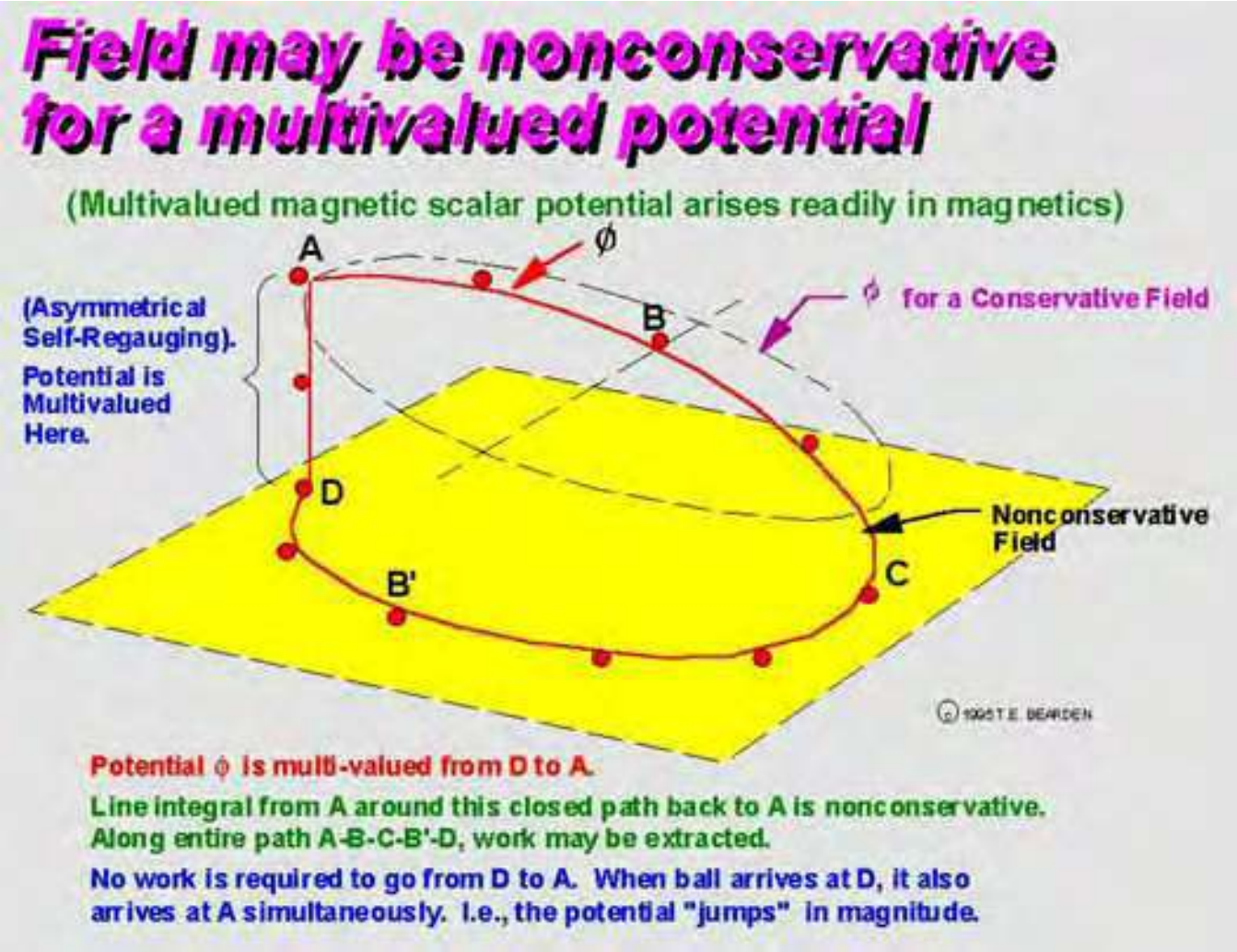

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We're running out of energy! We must redouble our efforts!

We have to keep polluting the Earth, if we are to have energy!

Actually, a *few* of our electrical systems already produce all the energy we could ever need! *Learn to collect it and use it!*

Selected clipart © by IMSI MasterClips™
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All our antibiotics are failing! Millions will die from the new age of pandemics and from terrorists' BW attacks!!

We have to relegate EM effects on biological systems to the trash heap. We can only try to find more drugs and antibiotics.

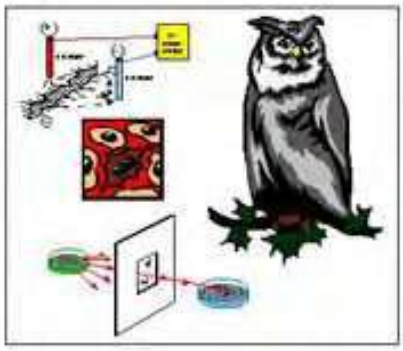

Actually, Priore already showed how to cure most dread diseases, by making and directing vacuum engines. Becker showed you it worked. *Develop it and use it!*

Figure 33. The only problem is the ostrich problem.

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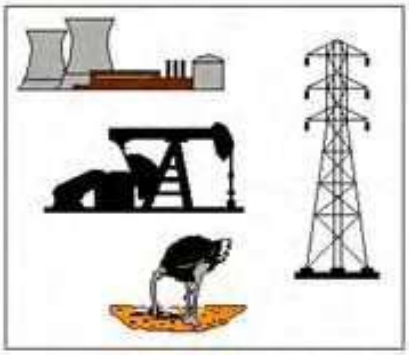

We're running out of energy!
We must redouble our efforts!

We have to keep polluting the Earth, if we are to have lots of electrical energy!

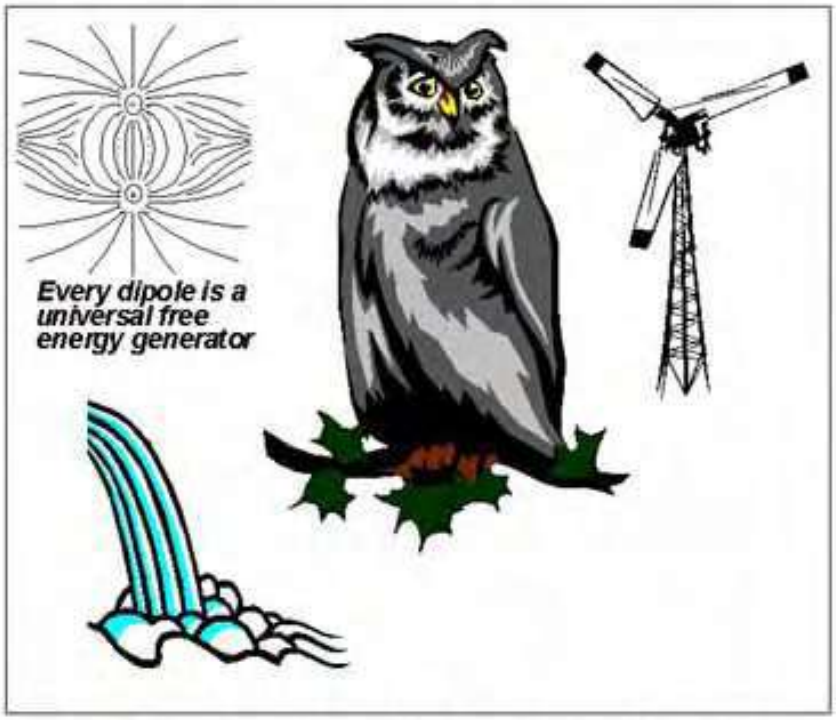

Actually, a single one of our large electrical power systems already produces all the free Poynting energy the world could ever need! *We just have to learn how to collect more of it and use it without continually destroying the source dipole!*

Figure . The only energy resource problem is the theoretical ostrich problem. We must become theoretical owls, rather than ostriches.

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RUSSIAN "SWITCHED PARAMETERS" DEVICES: SELF-OSCILLATING ROTARY GENERATORS*

- Excites oscillations without explicit sources of magnetic or electric forces (i.e., regauges)
  - Periodic variation in system's parameters
  - Experimental and theoretical proof
  - Multiple successful systems made, tested
  - Papers published in Russian, French journals
- As theory predicts, power continually increases unless load is adjusted to stabilize system
- Several large systems tested to self-destruction
- Several large stable systems built, tested

* "On the parametric excitation of electric oscillations," L.I. Mandel'shtam and N.D. Papaleksi, Zh. Tek. Fiz. 4(1), 1934, p. 5-29.

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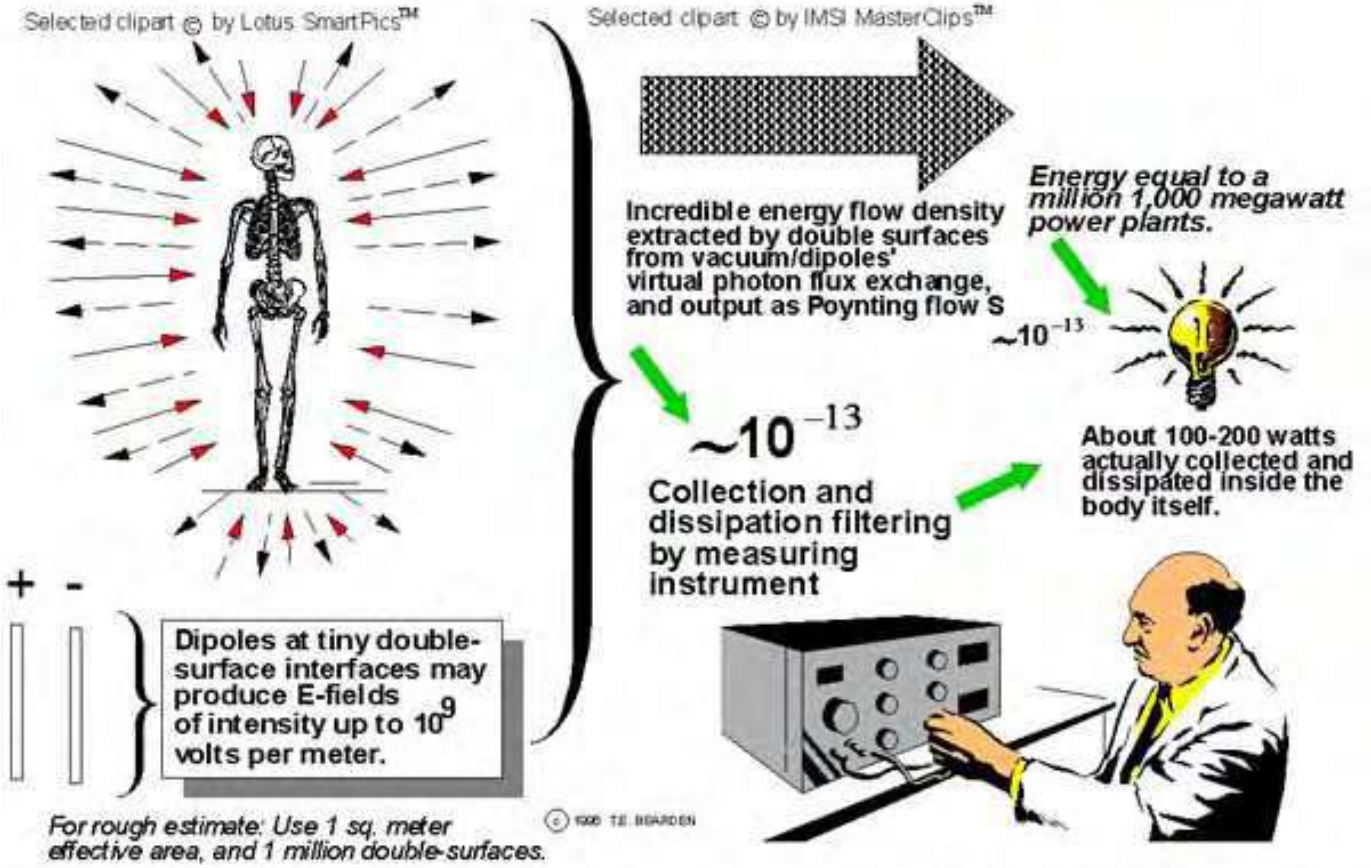

Figure 20. One human body produces more energy flow than all the electrical power loads on earth dissipate. However, only 100-200 watts of its own energy output is collected and dissipated by the body.

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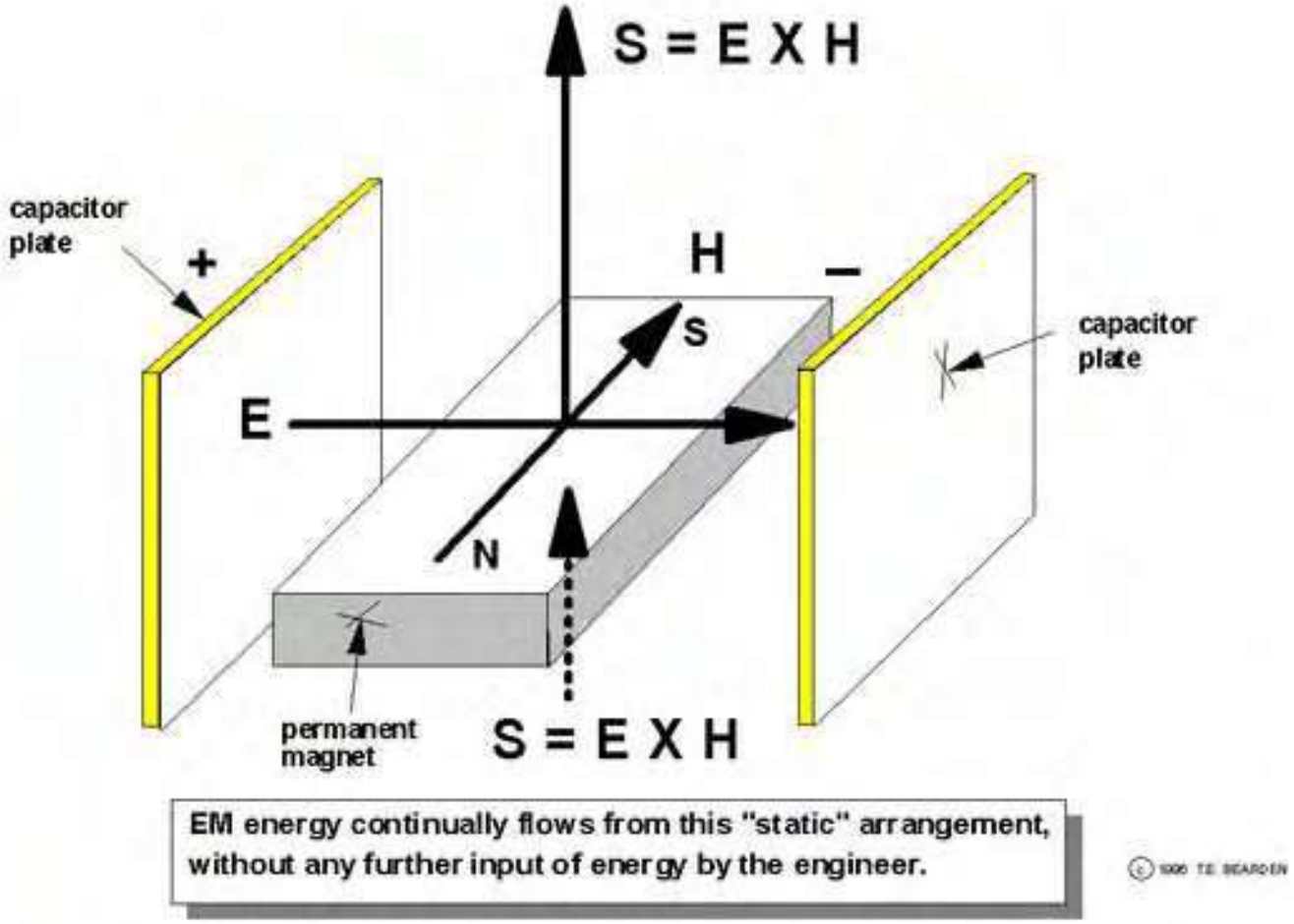

Figure 18. A "static" Poynting S-flow free-energy generator.

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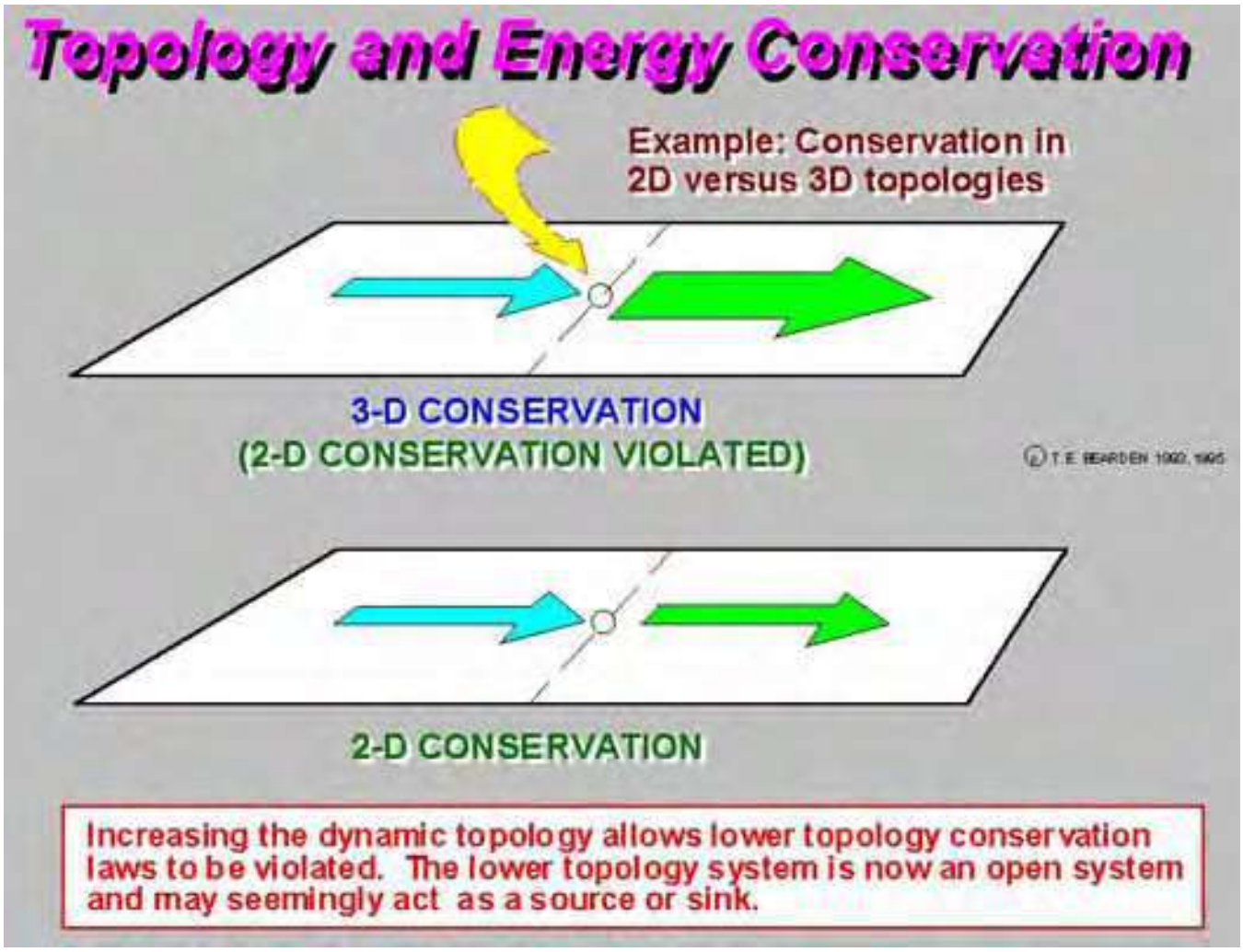

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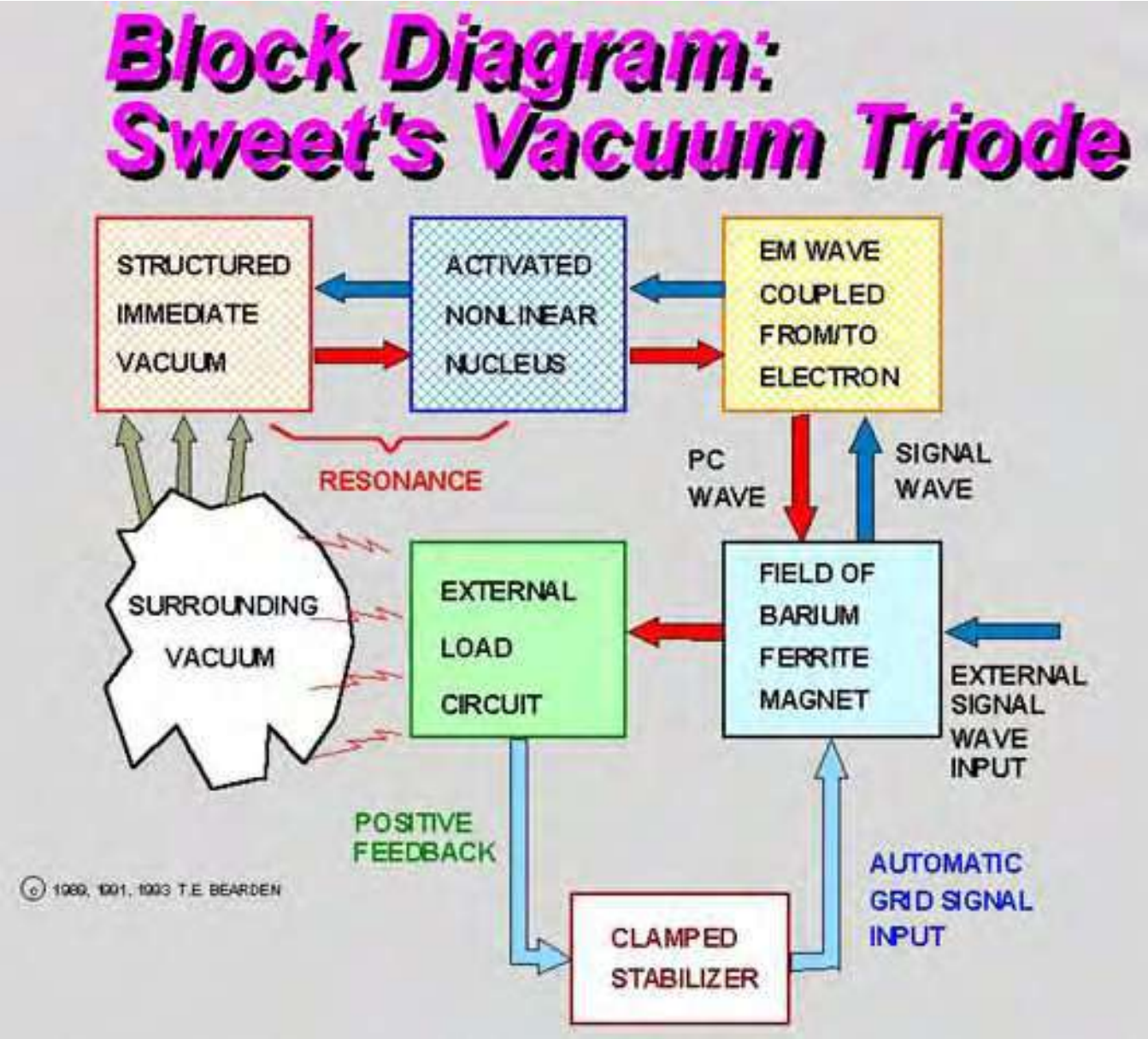

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Defense Department Briefing on Priore Treatment to counter Biological Warfare

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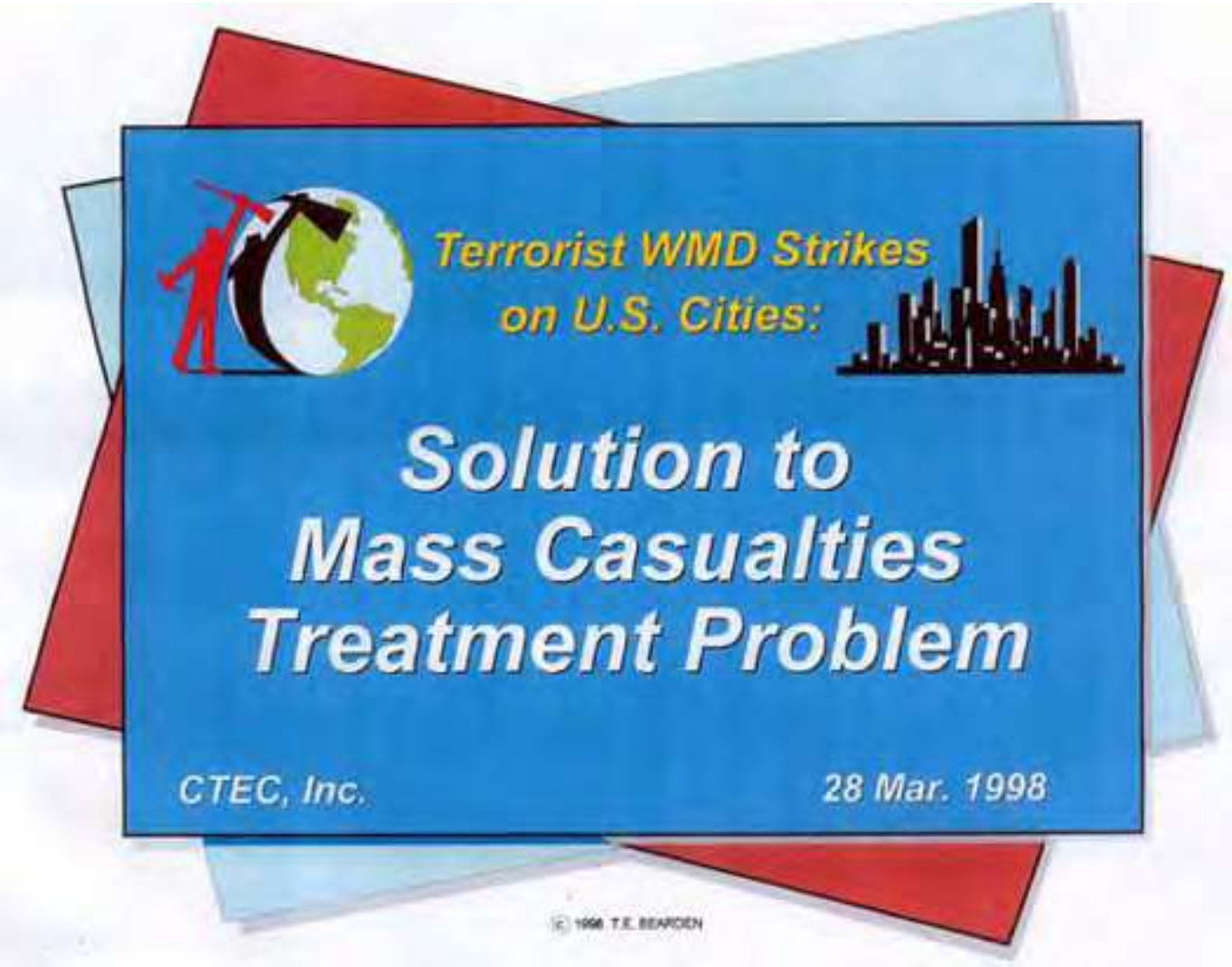

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Key Points in the New Technology

- There is a vast new kind of electrodynamics *hidden inside* all EM potentials, fields, and waves
  - Longitudinal EM waves and complexes
  - Oscillations in time domain

- These complexes are an *infolded general relativity*
  - Clustered formations of *spacetime curvatures*
  - *Very powerful*, since the EM force is used as the agent of curvature

- In general relativity, similar precise complexes permeate and *act on any mass at all internal levels*
- With this approach, one *can now manipulate matter* -- living or inert -- *in any manner desired*, depending only on the level of development of the technology
- Priore unwittingly used this to *cure dread diseases*
- This is a *revolution in all of science*

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- *We have uncovered the major mechanisms* to utilize

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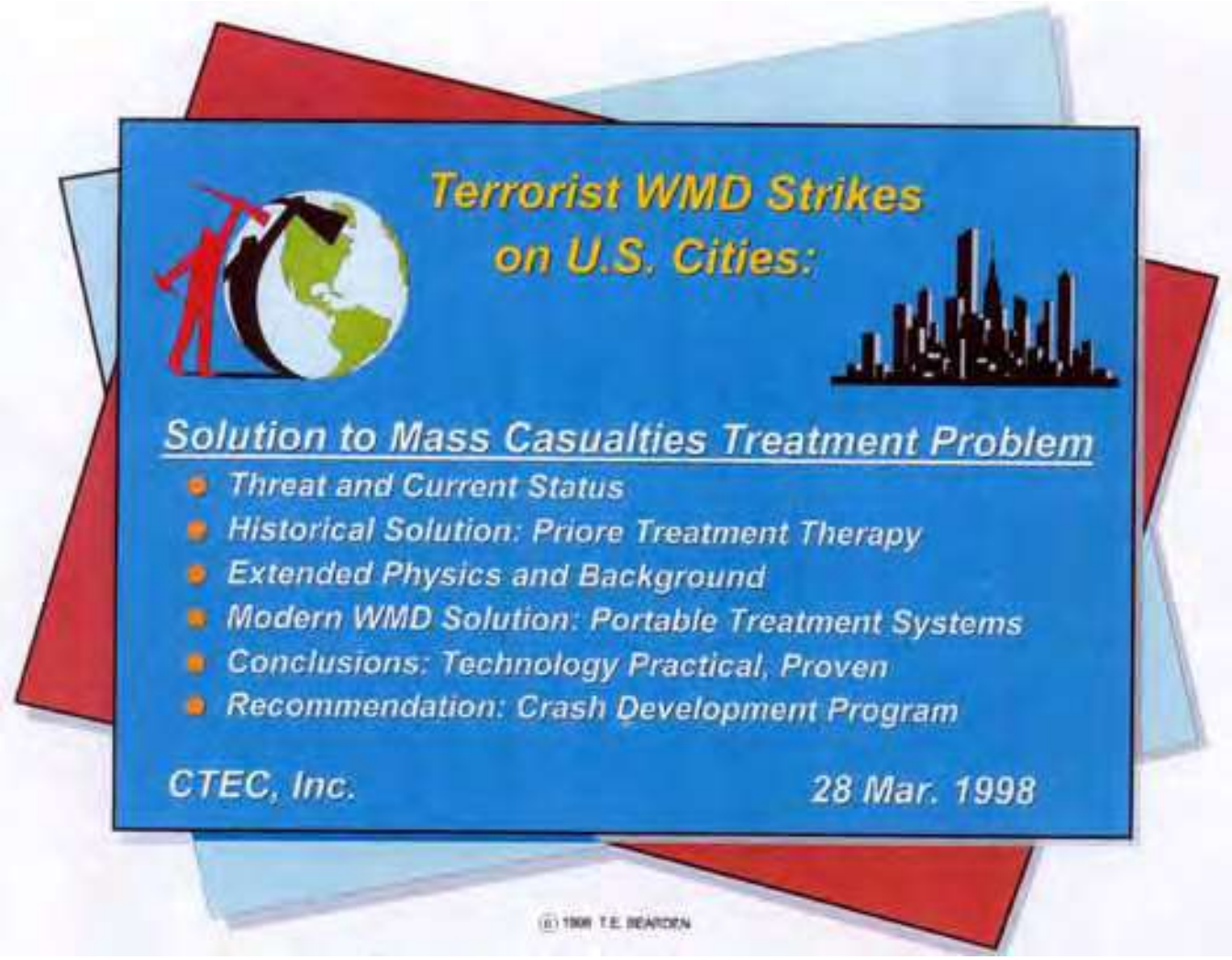

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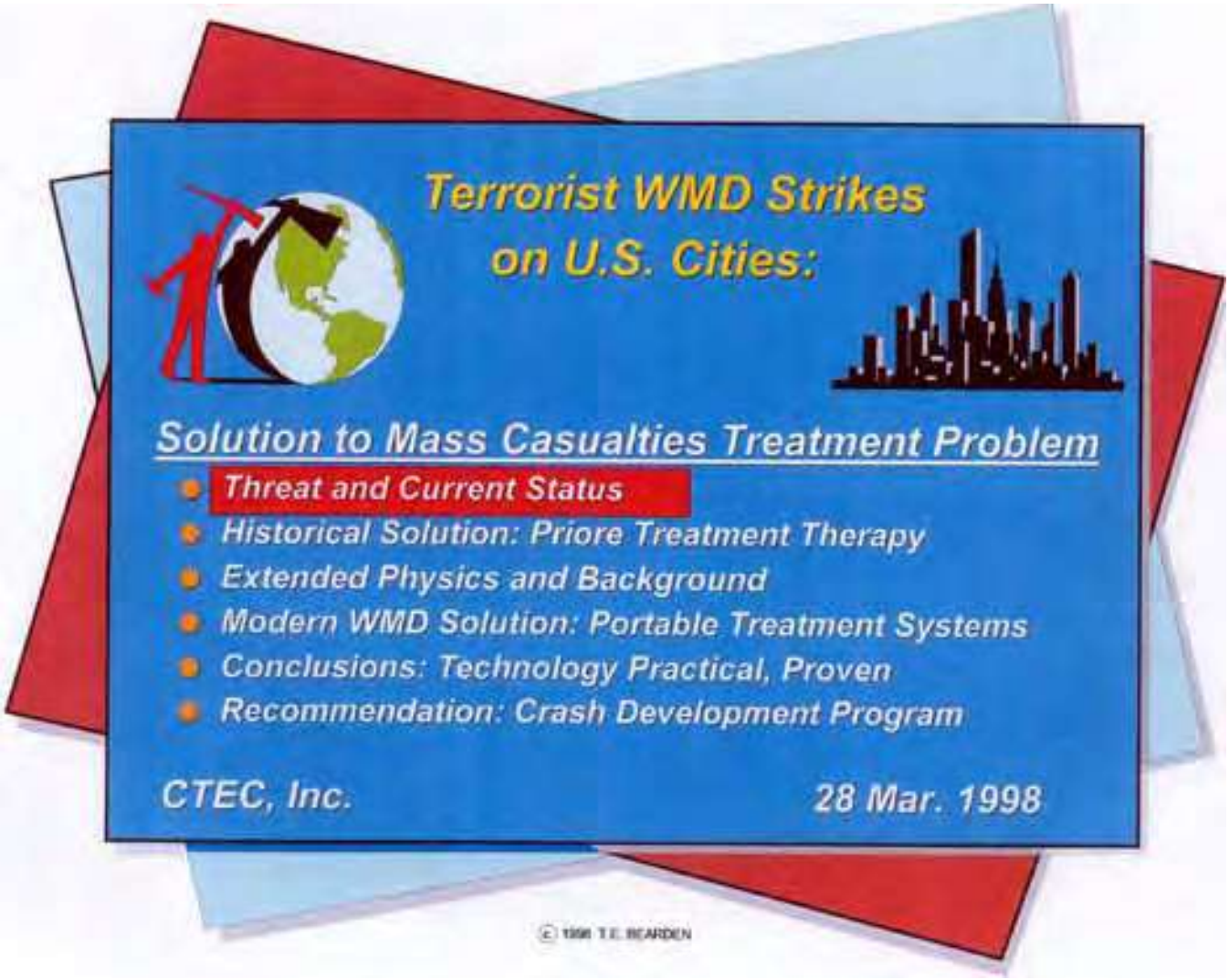

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THE TERRORIST THREAT

TODAY:

- Sabotage
- Chemicals
- Biological agents
- Nuclear materials
- Powerful explosives
- Assassination
- Kidnapping and hostages
- Contamination
- Shoulder-fired AD missiles
- Terrorism

FUTURE ADDITIONS:

- EM weapons
- EM biological warfare
- Scalar EM weapons
- Scalar EM disease induction
- Alteration of behavior and emotions
- Alteration of memory
- Direct thought control
- Action-at-a-distance effects

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Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- One terrorist, one light aircraft with spray tank
- 100 kilograms of anthrax
- Flies over greater metropolitan Washington, D.C.
- Calm night
- *1-3 million casualties result**
- *Most of those stricken will die*
- Presently little can be done to save the stricken civilians
- *Attacks on several population centers might produce some 10 million or more casualties*

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*Per OTA Report to Congress, 1993

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Present Status of the WMD Threat to the United States

- Many foreign nations are hostile to the U.S. and sponsor terrorists
- Some 25 nations have WMD or are acquiring them
  - BW agents and weapons
  - Chemical agents and weapons
  - Nuclear materials and weapons
- Thousands of students and emigres
- Infiltrated teams, BW, other WMD already
- Castro guerrillas infiltrated over the years
- Can do unacceptable damage to U.S. now
- *May reach first strike knockout capability*

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*Per OTA Report to Congress, 1993

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Some Present Problems in the U.S. WMD Defense Capabilities

- No shelters (require overpressure, BW filtering, masks, showers, supplies)
- No stockpiled vaccines, medical supplies, immunoglobulins, masks, suits, food, fuel, generators, heaters, water purification units
- Totally insufficient medical facilities, personnel, and emergency response teams
- Triage, full martial law will be required
- No answer to massive decontamination problem
- State, county, city inadequately staffed and insufficiently trained for mass casualties
- Terrorist teams, BW agents, other WMD on site, waiting
- Water supplies, food, crops, farm animals also vulnerable
- Electric power grid, bridges, trains, railroads vulnerable
- Present medical science cannot save very many of the casualties, now or in the foreseeable future

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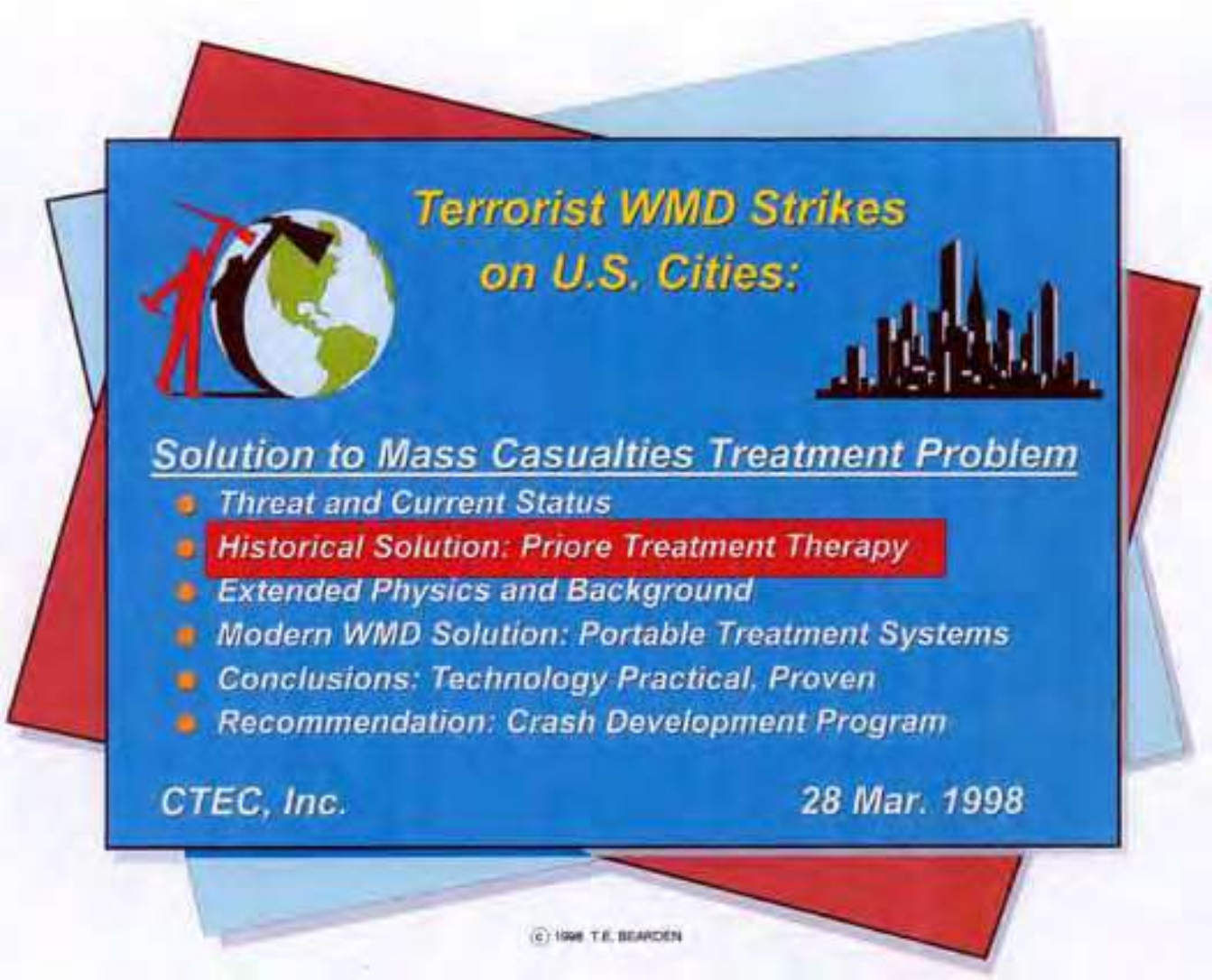

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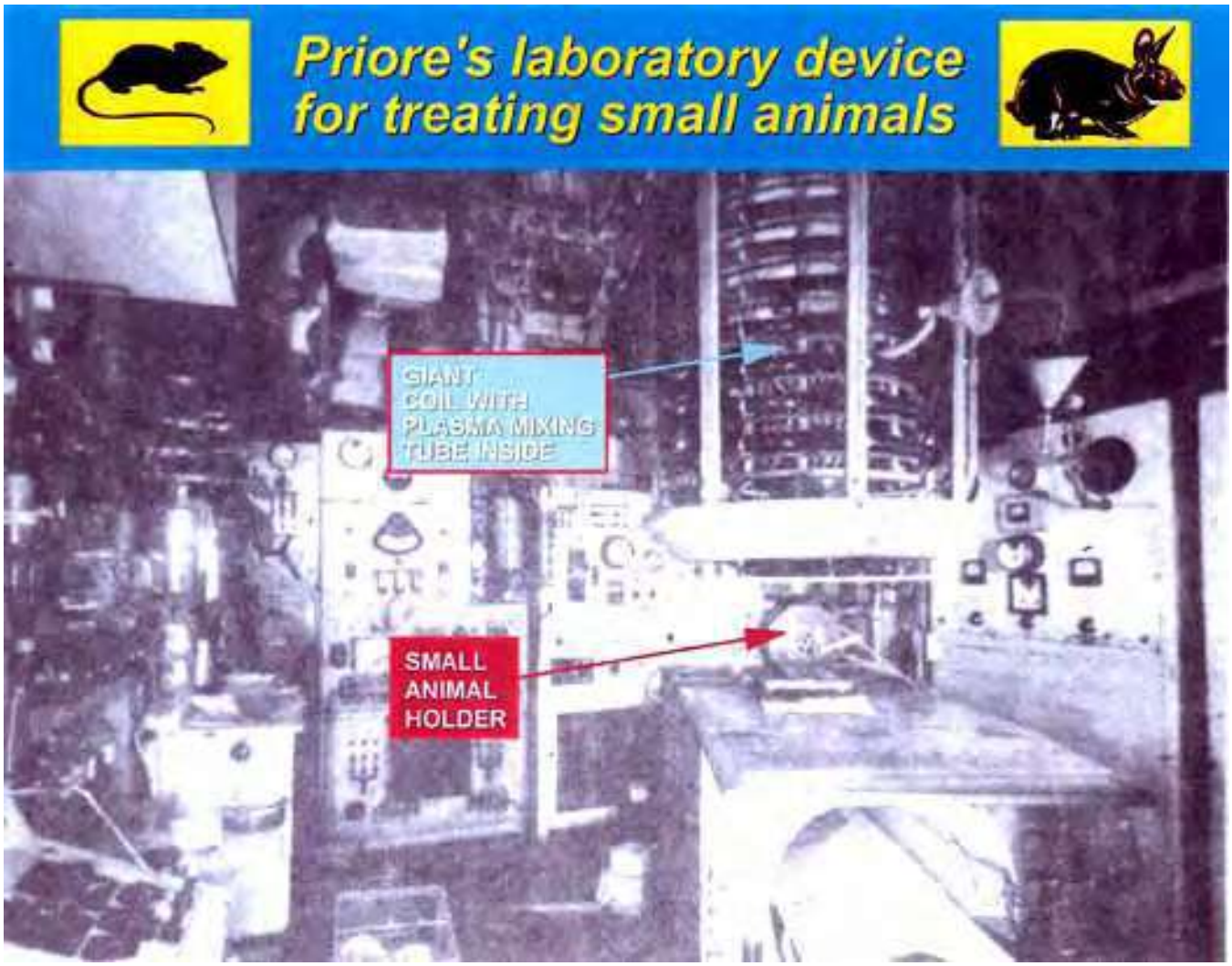

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Photo courtesy of Bob Whitney

Antoine Priore (right) with the Mayor of Bordeaux, Mr. Chaban-Delmas.

The Priore technical mechanism unwittingly involved a dramatic extension to both nonlinear optics and general relativity. However, nonlinear optics itself had not yet been born in the 1950s and 1960s when Priore worked out his methodology. The extension to general relativity has not been previously envisioned even to the present day. When the Priore project was suppressed by the changed French government in the mid-1970s, nonlinear optics itself was just being initiated. To the present day, however, there has previously been no inkling of the dramatic extension to NLO that arises by using longitudinal EM pump waves and thereby pumping in the time domain.

It is little wonder that Priore himself did not understand the nature of the technical mechanism he was utilizing, and neither did anyone else, and neither *has* anyone else prior to this time.

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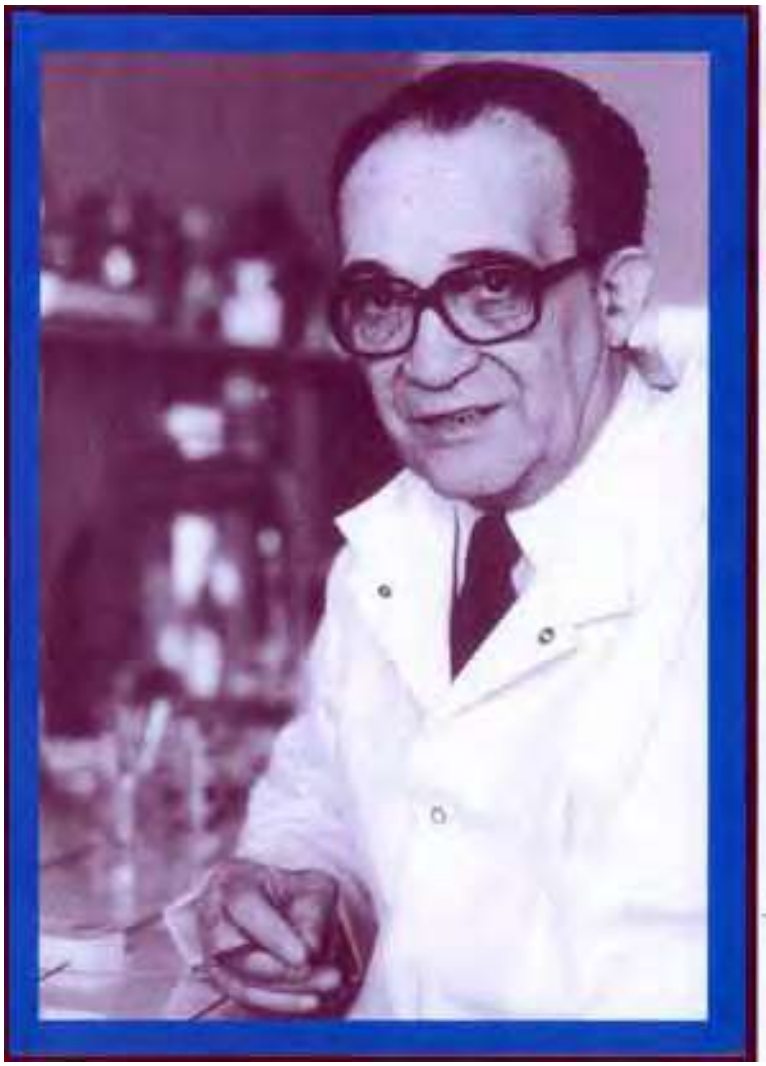

Raymond Pautrizel, eminent French parasitologist who worked with Priore

Among other things, Pautrizel treated seriously infected immature rats with the Priore ray. These rats had never had a mature immune system. When they were removed from the machine, they still sickened again and died, because their immature immune systems could not resist the pathogen *(Trypanosoma)*. So even though the damaged cells were reversed back to normal, the "normal" immune system was unable to fight off pathogens, which reinfected the cells and killed them, killing the rats.

This established the time-reversal nature of the therapy.

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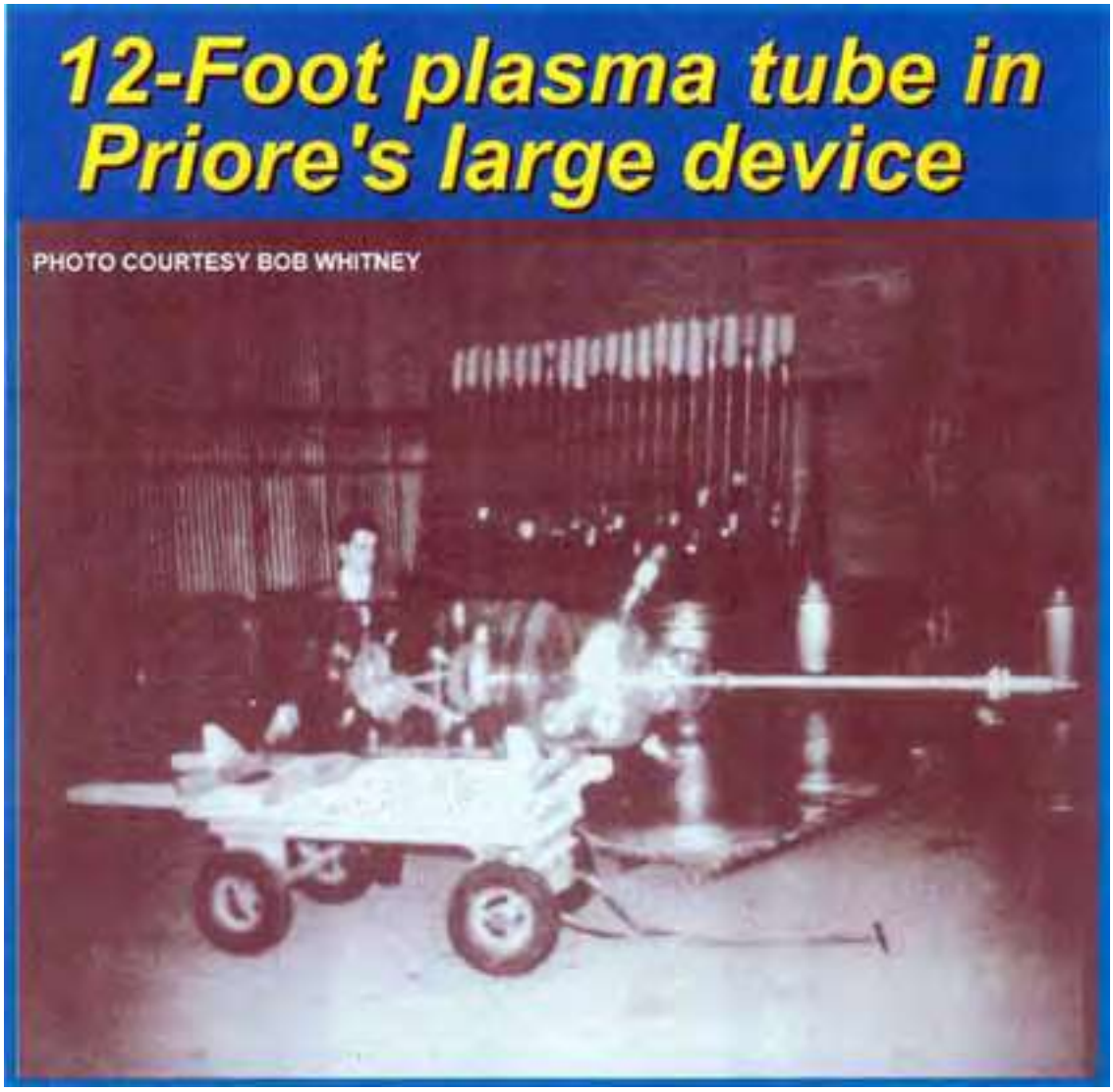

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MECHANISM OF THE PRIORE THERAPY

- FACT: DISEASE-SPECIFIC VACUUM ENGINE PRESENT FOR ANY CELLULAR DISEASE, BY WHEELER'S PRINCIPLE
  - *DISEASE CAN BE REVERSED BY CREATING AMPLIFIED VACUUM ANTI-ENGINE (BEARDEN'S PRINCIPLE)*
  - *ANTI-ENGINE IS CREATED BY PUMPING THE NONLINEAR CELLS IN THE "INNER EM" DOMAIN, TIME-REVERSING THEM*

- PRIORE UTILIZED A PLASMA TO PHASE CONJUGATE AND "INFOLD" MULTIPLE BIDIRECTIONAL LONGITUDINAL EM PUMP WAVES
  - *17 FREQUENCIES MIXED IN A ROTATING PLASMA*
  - *PHASE CONJUGATES ADDED BY THE PLASMA*
  - *INFOLDED MIX INTO STRONG PULSED DC MAGNETIC FIELD, WHICH CARRIED IT INTO ATOMIC NUCLEI*
  - *PUMPED ALL NONLINEAR CELLULAR COMPONENTS TO PRODUCE AMPLIFIED, SPECIFIC VACUUM ANTI-ENGINE*

- NEGATED THE LONG-TERM CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CELLS.
- SCRUBBED OUT THE CUMULATED PRECANCEROUS STATE
- RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING
- NO EXCESSIVE TRAUMA TO TREATED ANIMAL

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Priore's therapeutic methodology: Using infolded longitudinal EM waves as NLO pump waves, to pump in the time domain

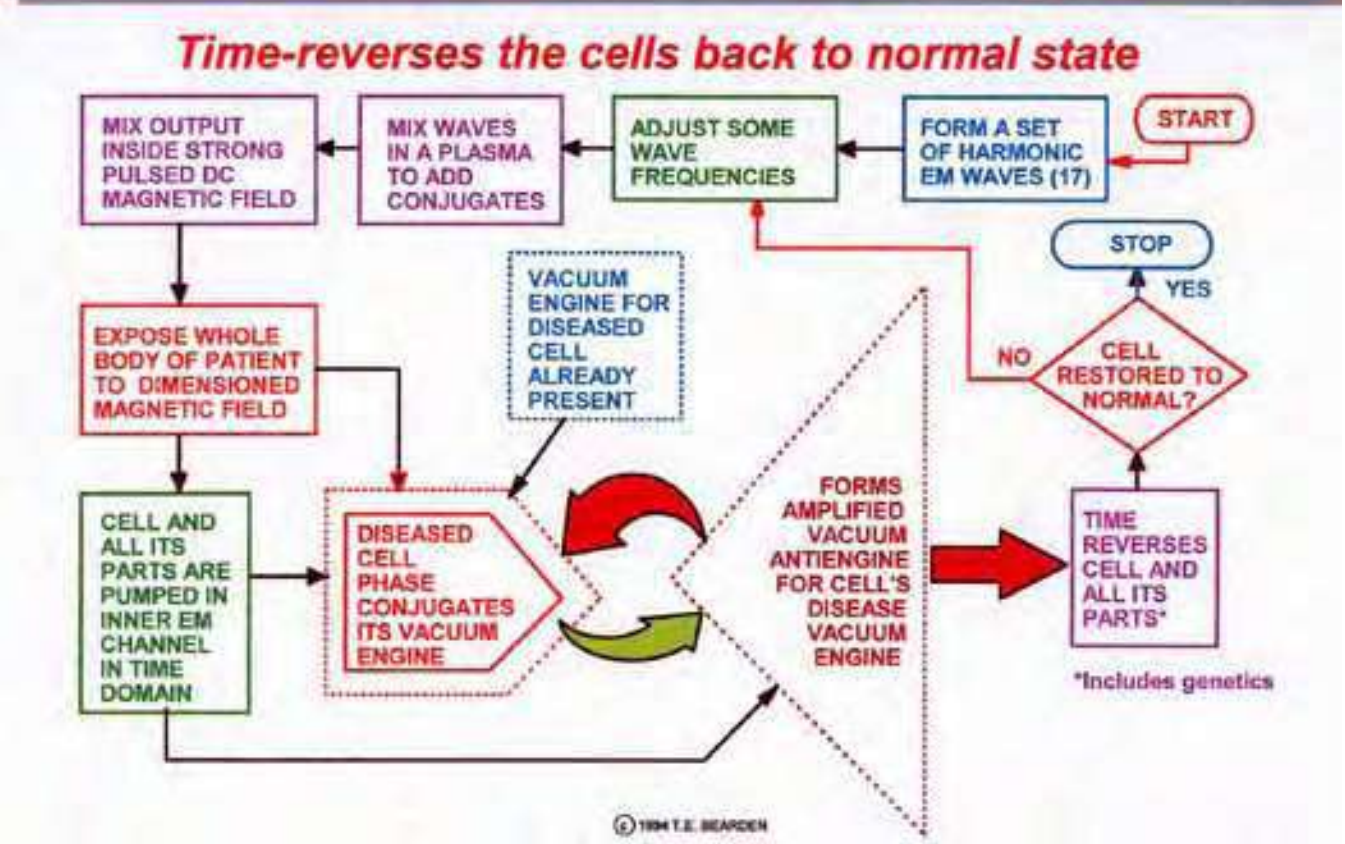

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DRASTICALLY REDUCED CUMULATIVE DETERIORATION AFTER PRIORE THERAPY

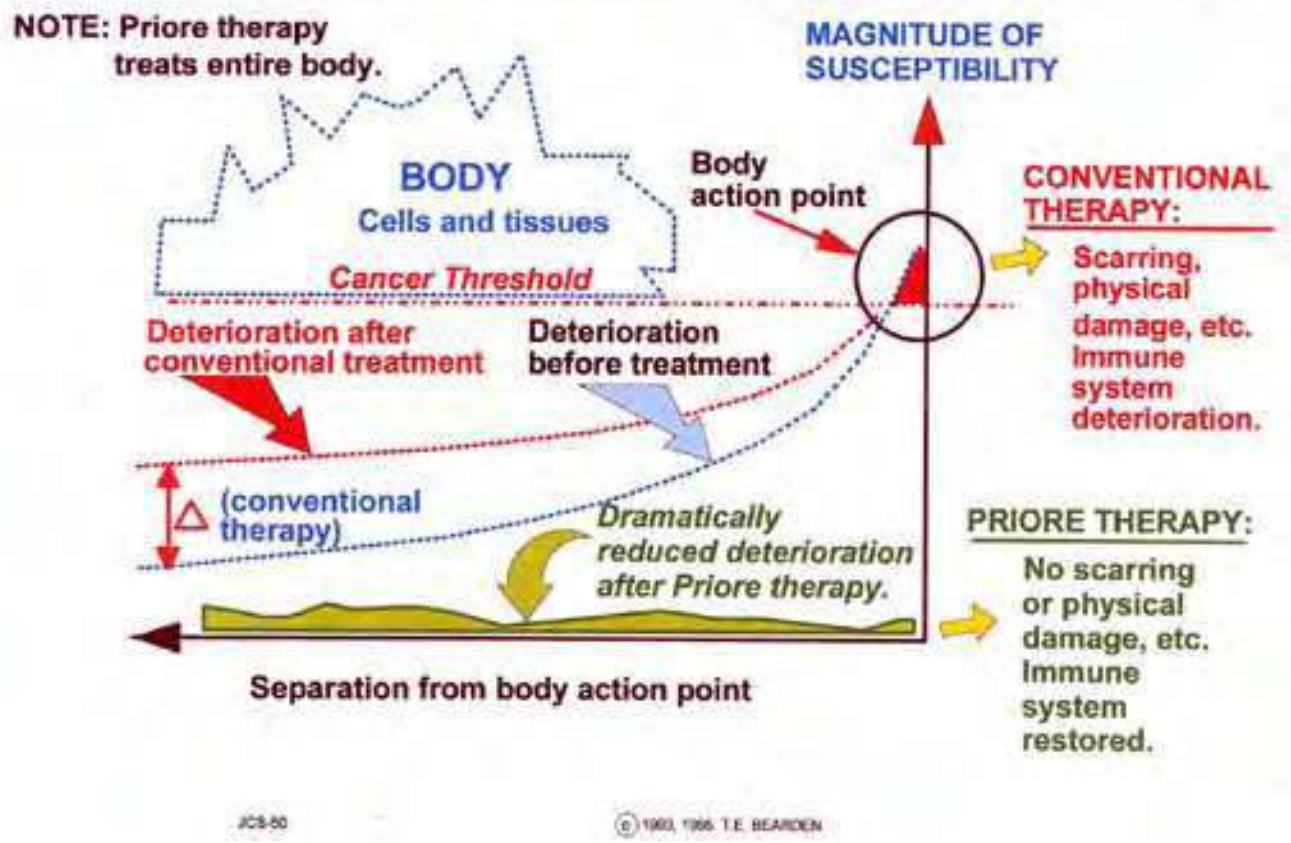

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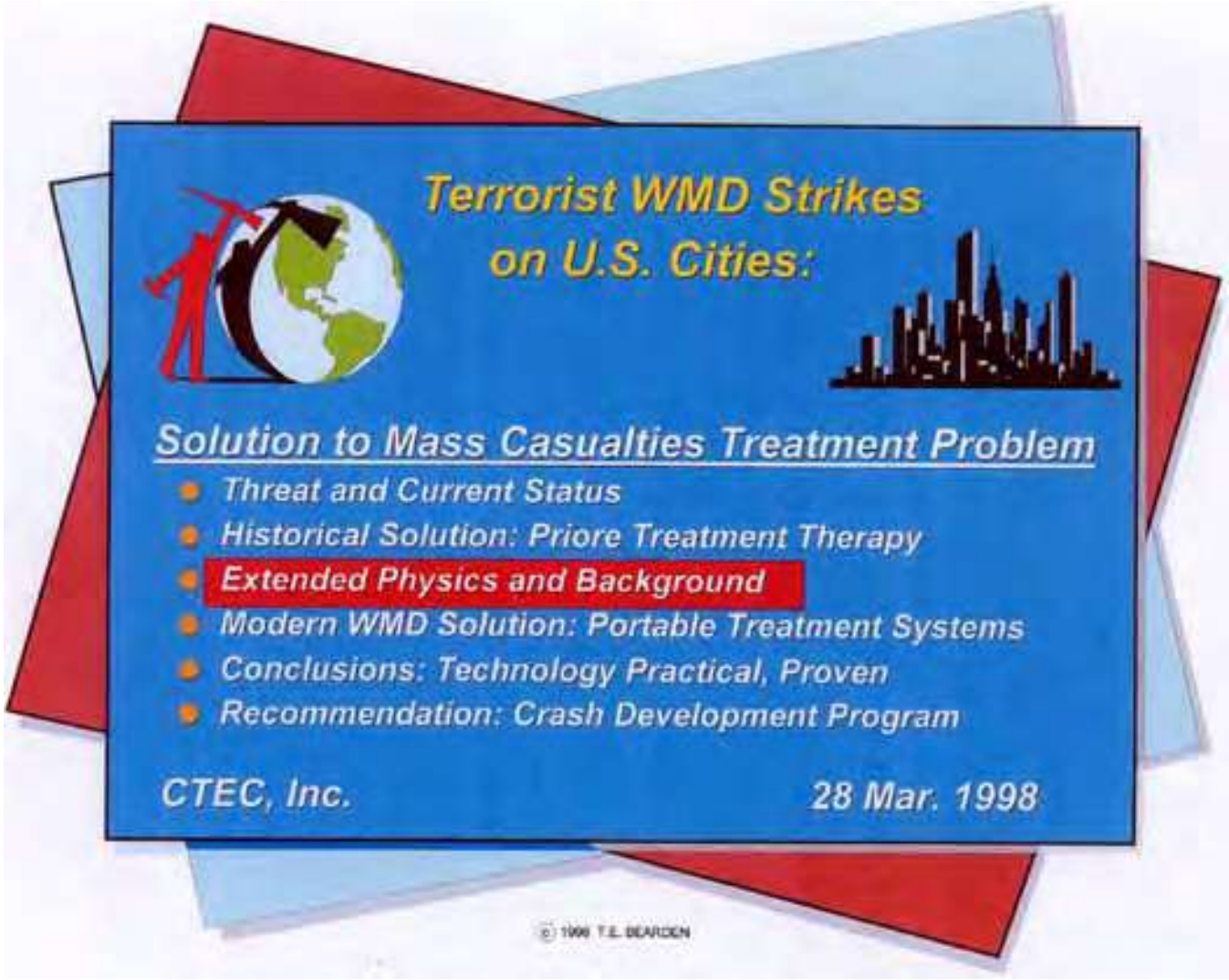

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Founders of Scalar Electromagnetics

- **G.J. Stoney:**

Decomposed the scalar potential into bidirectional wave pairs.

"On a supposed proof of a theorem in wave-motion," Phil. Mag., 5(43), 1897, p. 368-373 (and several other papers).

- **E.T. Whittaker:**

Decomposed the scalar potential into a series of bidirectional EM wave pairs in harmonic series, where the two waves in each pair are conjugates (i.e., a wave/antiwave pair) and are longitudinal waves.

"On the partial differential equations of mathematical physics," Math. Ann., Vol. 57, 1903, p. 333-355.

Showed that all classical EM -- including waves -- can be replaced by two interfering scalar potential functions.. (This founded superpotential theory, extended by Nisbet, Bromwich, Debye, McCrea, and others.)

"On an expression of the electromagnetic field due to electrons by means of two scalar potential functions," Proc. Lond. Math. Soc., Series 2, Vol. 1, 1904, p. 367-372.

- **R.W. Ziolkowski:**

Independently rediscovered the biwave decomposition of the scalar potential and added the product set (in theory enabling modulations and communications) to Stoney and Whittaker's sum set.

Various papers, 1985 to date.

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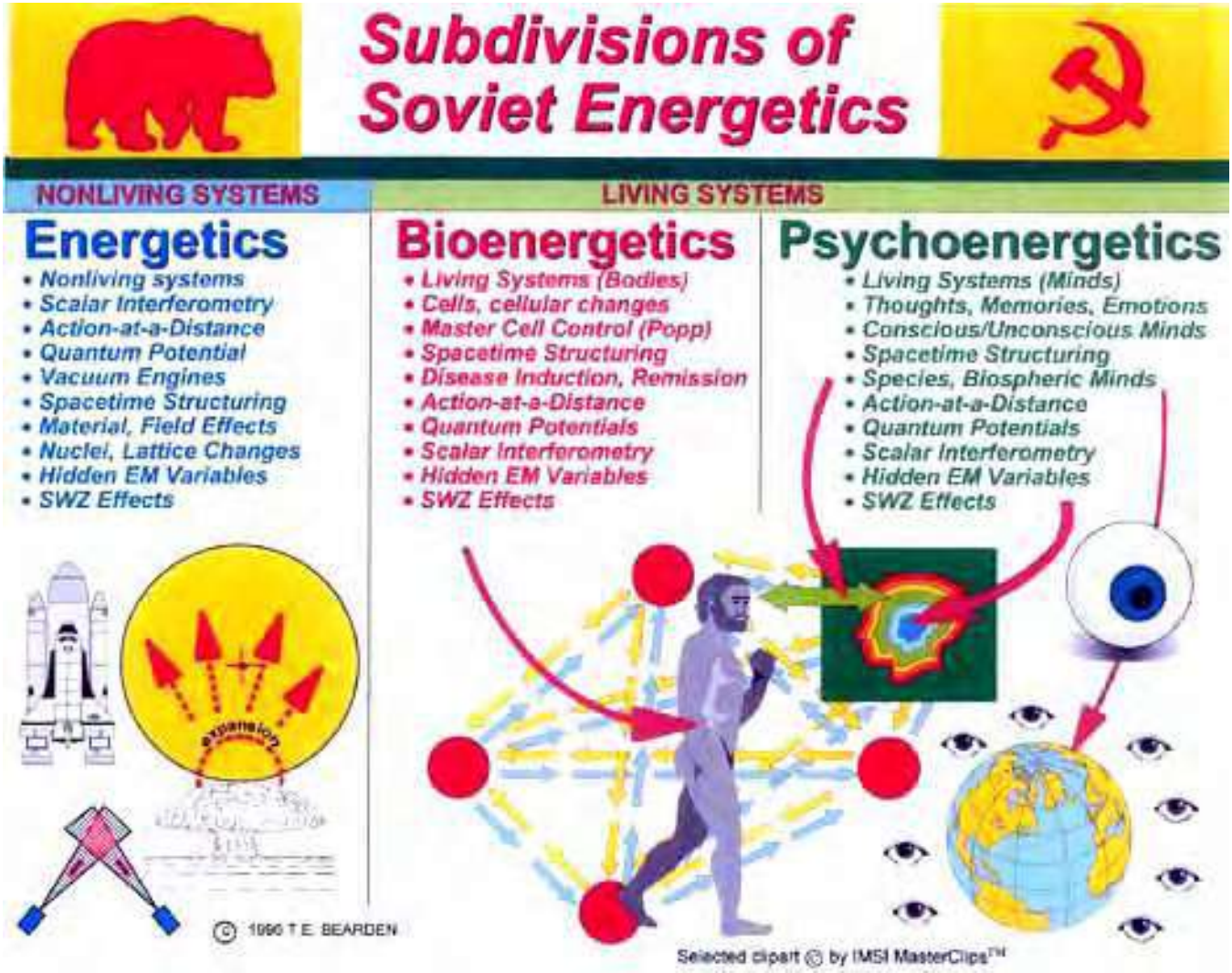

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Bunge on the Status of Classical and Quantum Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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EINSTEIN ON REVIEWING FOUNDATIONS

"...the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools of thought, as something obviously, immutably given; something having an objective value of truth which is hardly even, and in any case not seriously, to be doubted. ...in the interests of science it is necessary over and over again to engage in the critique of these fundamental concepts, in order that we may not unconsciously be ruled by them."

Albert Einstein, "Foreword," in Max Jammer, Concepts of Space: The History of the Theories of Space in Physics, Harvard University Press, Cambridge, Massachusetts, 1969, p. xi-xii.

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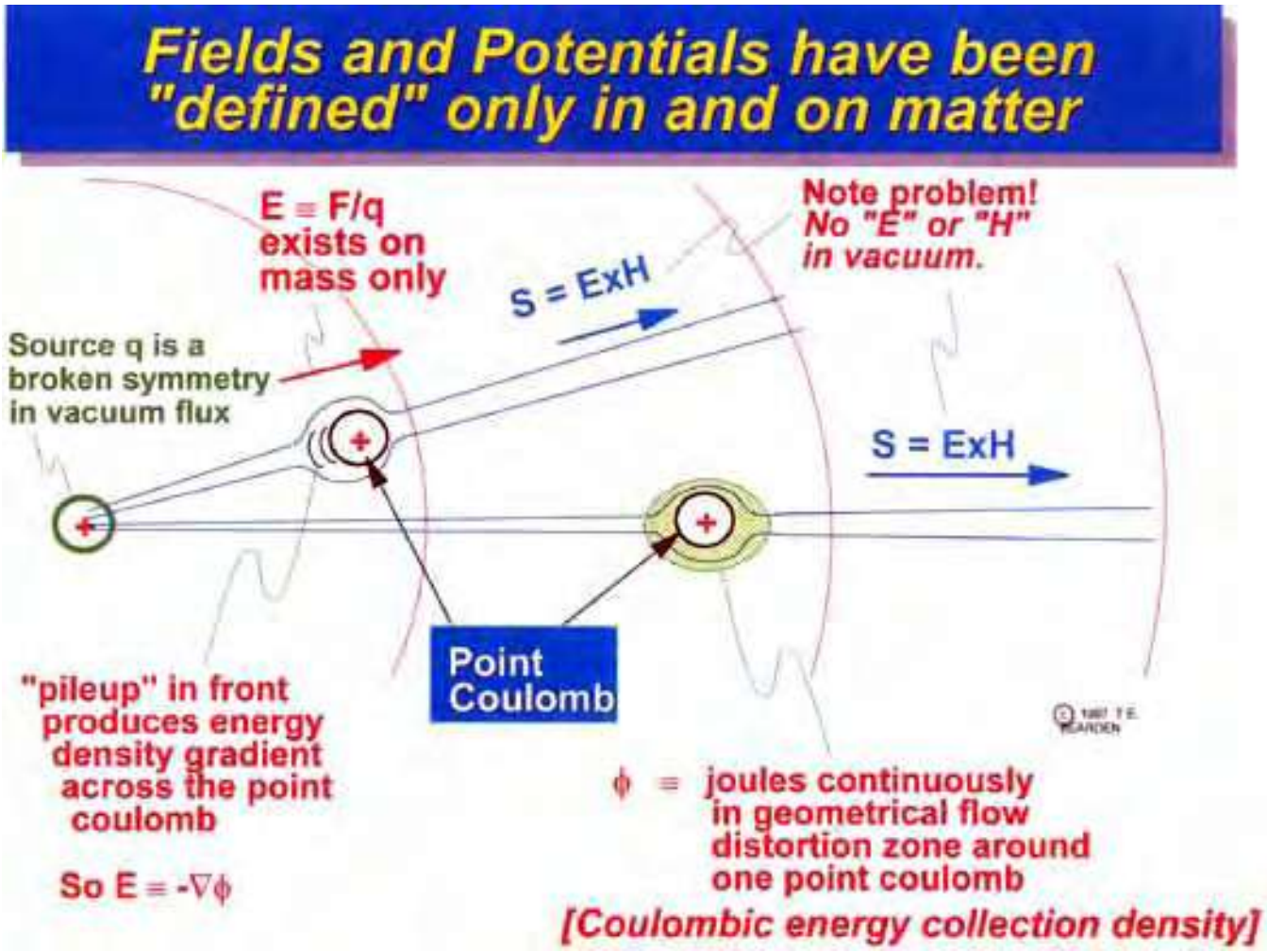

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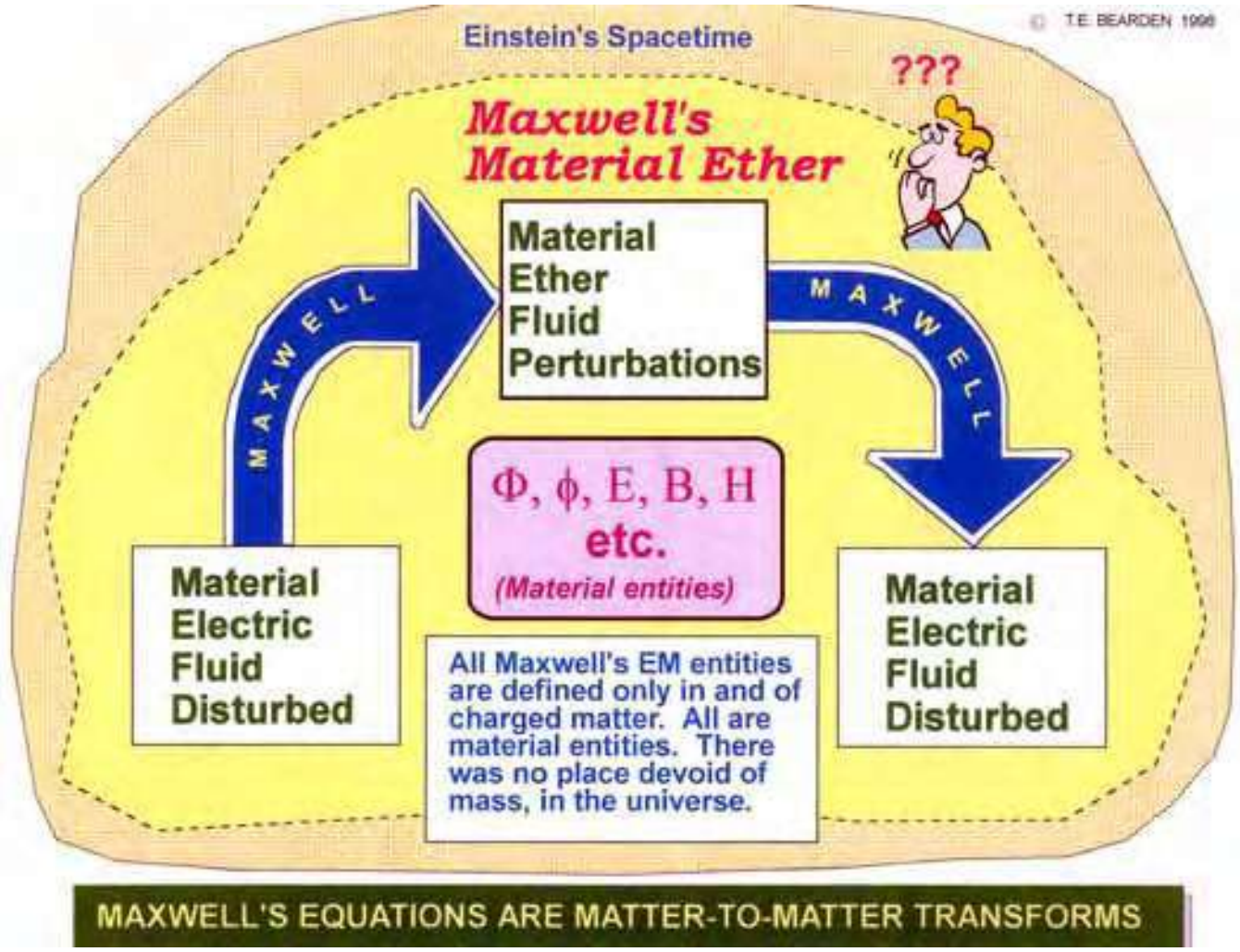

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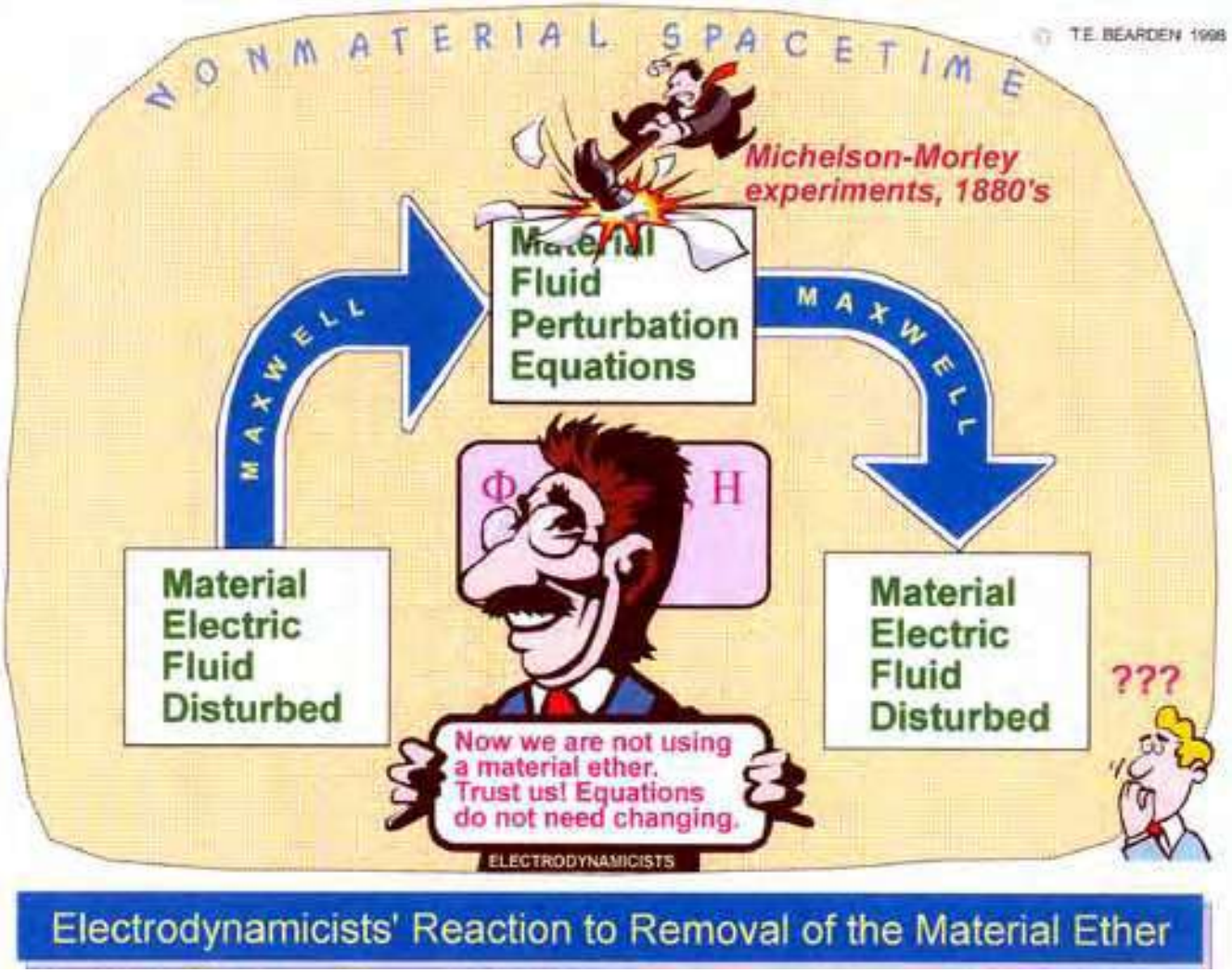

Electrodynamicists' Reaction to Removal of the Material Ether

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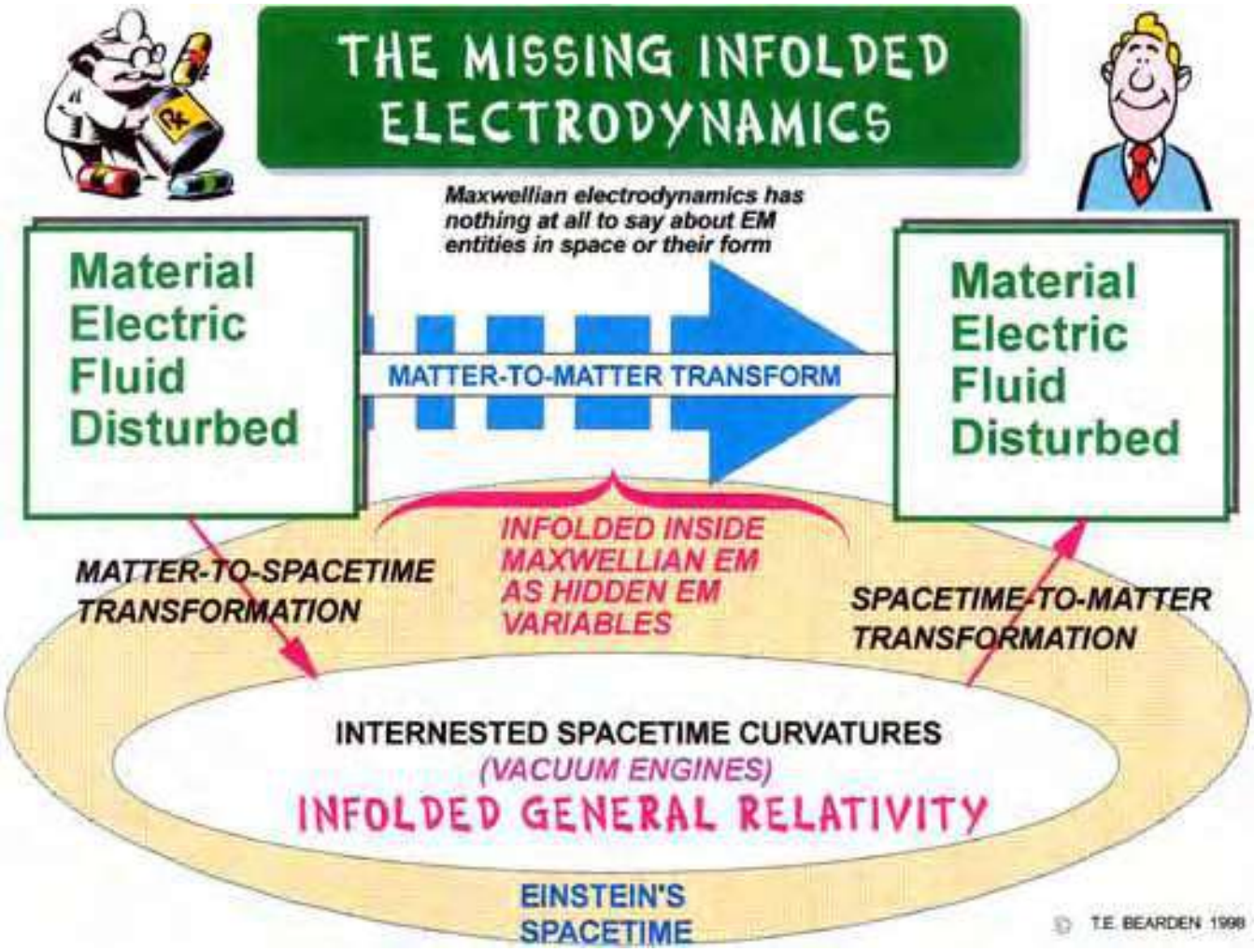

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Nonlinear Optics
Distortion Correction Theorem

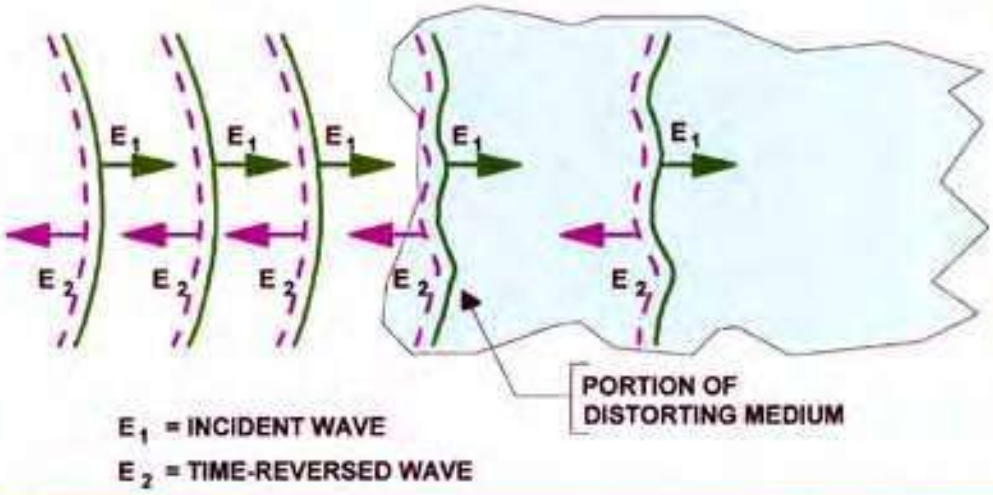

"If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

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Infolded longitudinal EM biwave composition of a scalar potential

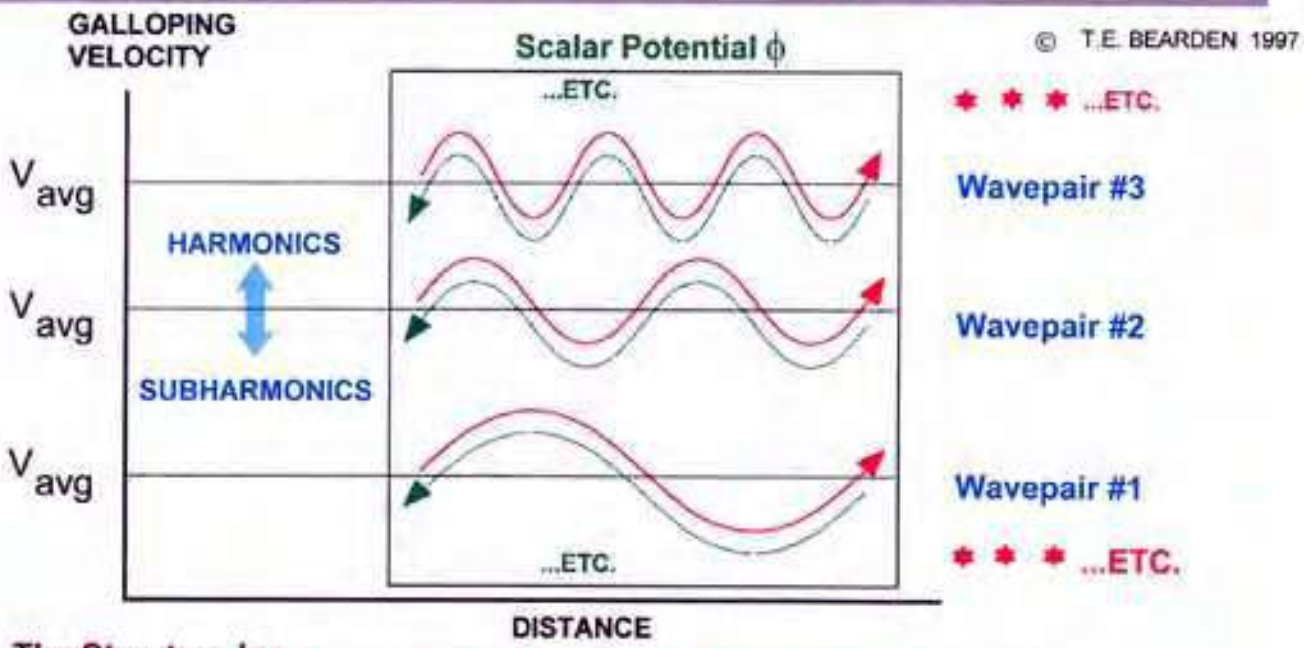

The Structure Is:

A harmonic set of longitudinal EM wavepairs. In each wavepair the two waves superpose spatially, but travel in opposite directions. The two are phase conjugates and time-reversed replicas of each other. Thus they comprise a coupled longitudinal wave and antiwave. The photons must be coupled into photon/antiphoton pairs (gravitons) by a strong application of the distortion correction theorem of nonlinear optics. Each wave in the biwave pair is a galloping wave. Each wavepair is a standing electrogravitational wave. In nonlinear optics, such a wavepair is a pump wave which pumps in the time domain.

Note: Think of the oscillations as velocity modulations.

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The Zero-Vector Axiom Destroys "Topologies within Topologies"

- The axiom: There is a unique vector, $\overline{0}$, in V (the vector space) such that
  $$\overline{V} + \overline{0} = \overline{0} + \overline{V}$$
- Note that $\overline{V} + \overline{0}_i = \overline{0}_j + \overline{V}$; $\overline{0}_i = -\overline{0}_i = n\overline{0}_i$
  so $\overline{0}_i = \overline{0}_j = \overline{0}_k = \ldots + \overline{0}_n = \ldots$
- This makes all $\overline{0}_i$ equal by assumption, since there is *assumed* to be only a single type $\overline{0}$ without real components
- In fact, $\overline{0}$ is <u>*not unique*</u>. An *infinite number* of different zero-vector systems, with real components, satisfy the zero-vector axiom.

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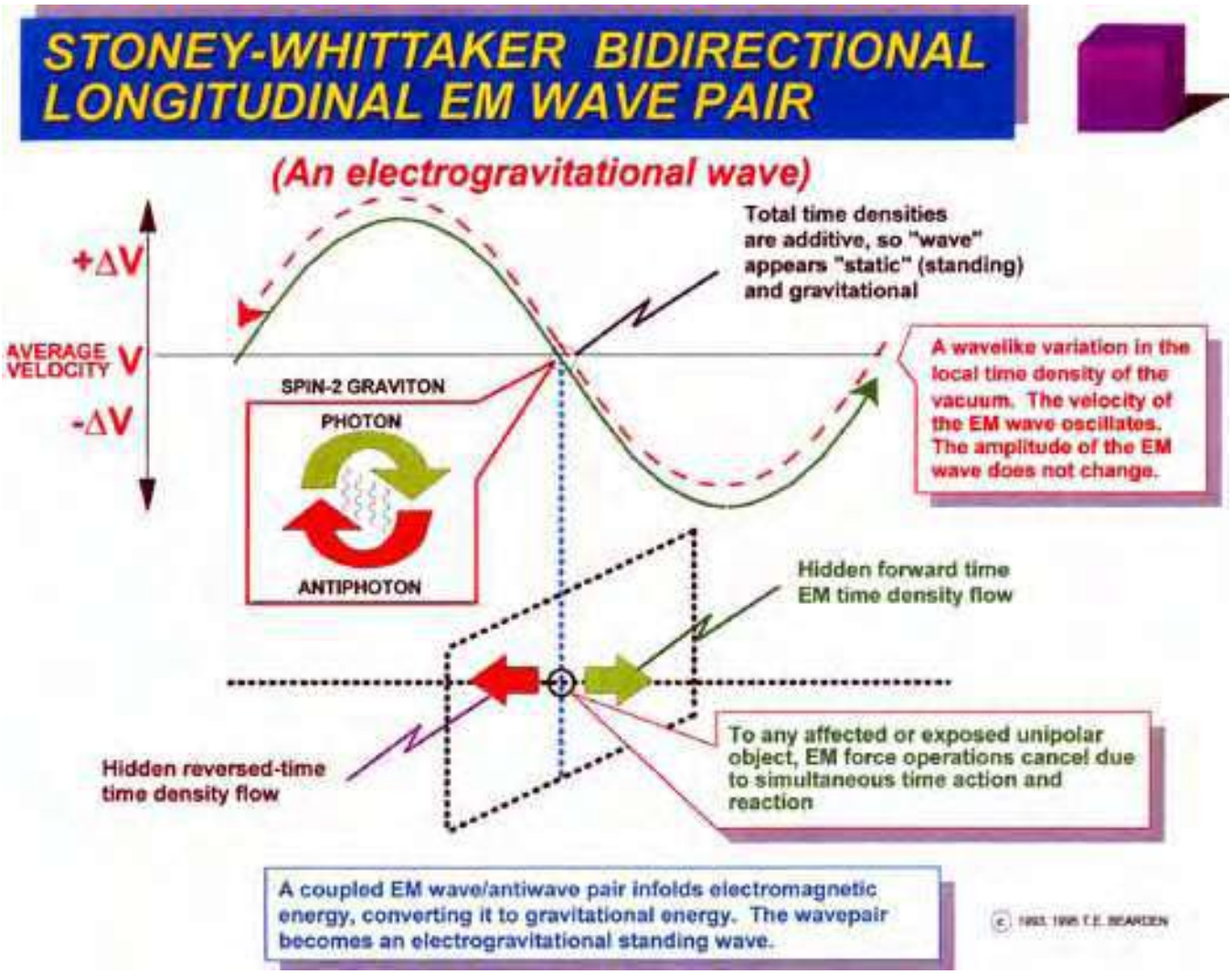

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Undistorted Progressive Waves (UPWs)*

(waves with velocity v, where $0 \leq v \leq \infty$)

- Major equations of interest having UPW solutions are:
  - *Homogeneous wave equation*
  - *Maxwell equations*
  - *Dirac, Weyl, and Klein-Gordon equations*

*Rodrigues and Lu, *Found. Phys.* 27(3), 1997, p. 435-508.

- UPWs are translationally invariant, and do not spread, or they reconstruct their original form after a certain period.
- UPW solutions have infinite energy. Quasi-UPWs can have finite energy and can in principle be launched into space.
- Subluminal Maxwell solutions are called *EM particles*. Superluminal Maxwell solutions are called *X-waves*.
- *Experimental results indicate such waves will be produced within the next few years.*

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- *Nimtz has translated Mozart's 40th symphony at v = 4.7c.*

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Velocity modulating a longitudinal EM wave oscillates rate of flow of time

$$V = \frac{L}{t}$$

Observer sees it this way

Constant transverse wave magnitude

Wave oscillates its velocity along its path, about a nominal value

Wave oscillates this way

Constant transverse magnitude

Wave oscillates magnitude of its transported t, about a nominal value

Note:

- Waves consist of photons
- Each photon consists of energy x time
- Each photon carries time as well as energy
- A wave is both a spatial energy dynamics and a temporal dynamics
- Wave complexes carry dynamic time structures as well as dynamic energy structures

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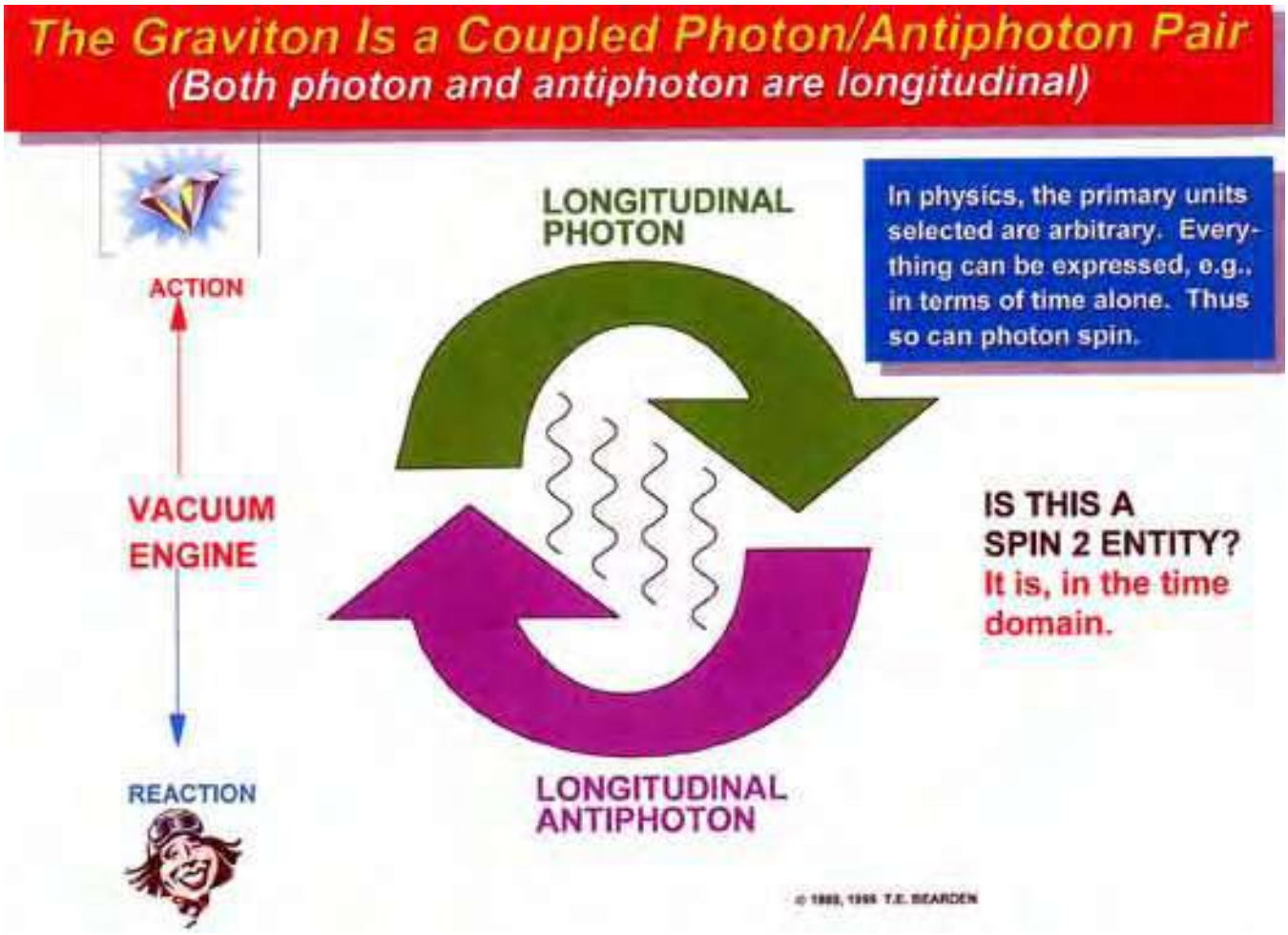

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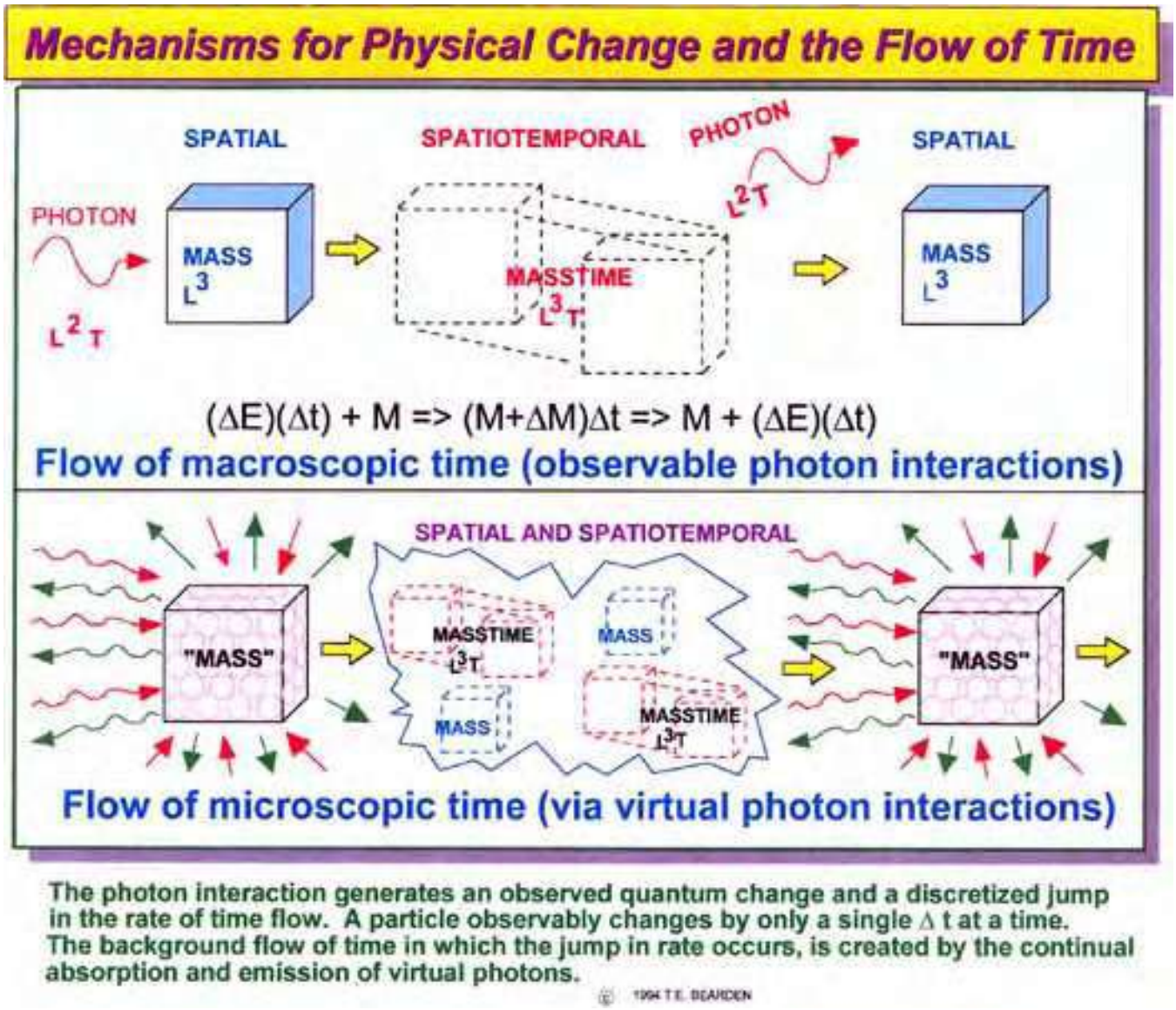

The photon interaction generates an observed quantum change and a discretized jump in the rate of time flow. A particle observably changes by only a single Δ t at a time. The background flow of time in which the jump in rate occurs, is created by the continual absorption and emission of virtual photons.

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Any EM Field or Wave Pattern Is Produced by interference of Two Scalar Potential Functions *(E.T. Whittaker, 1904)*

(Use of Hidden Information Content of the Field)

(Can Provide Action-at-a-Distance)

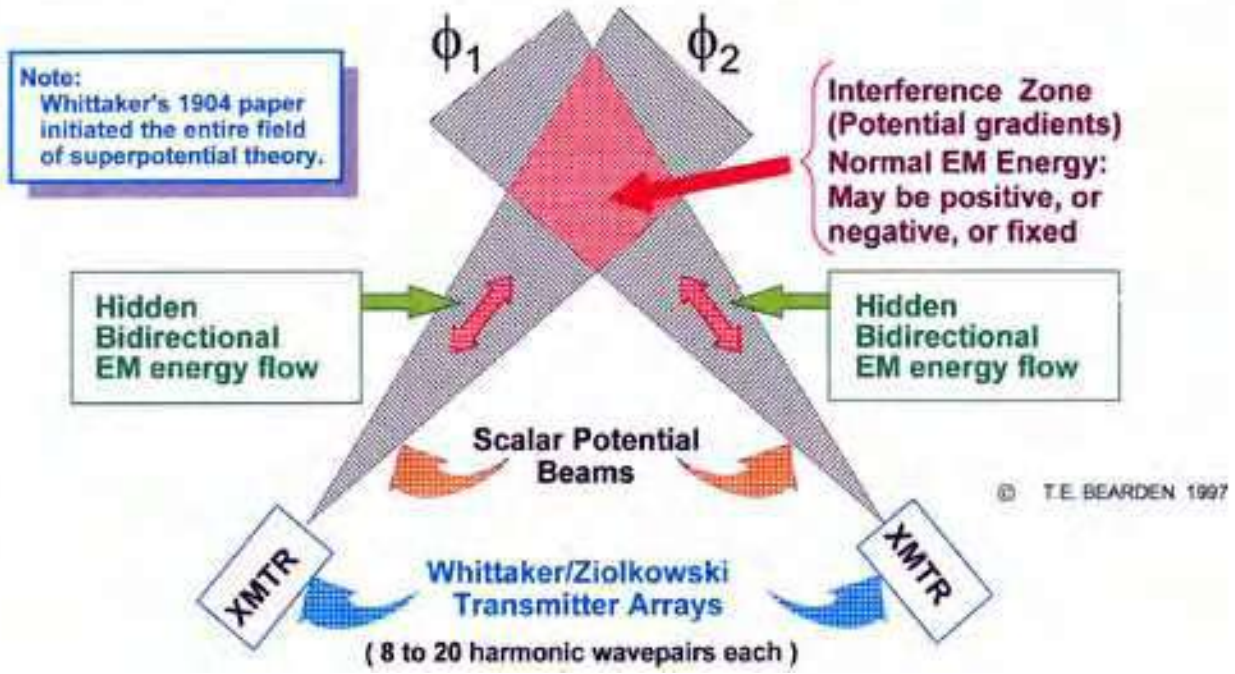

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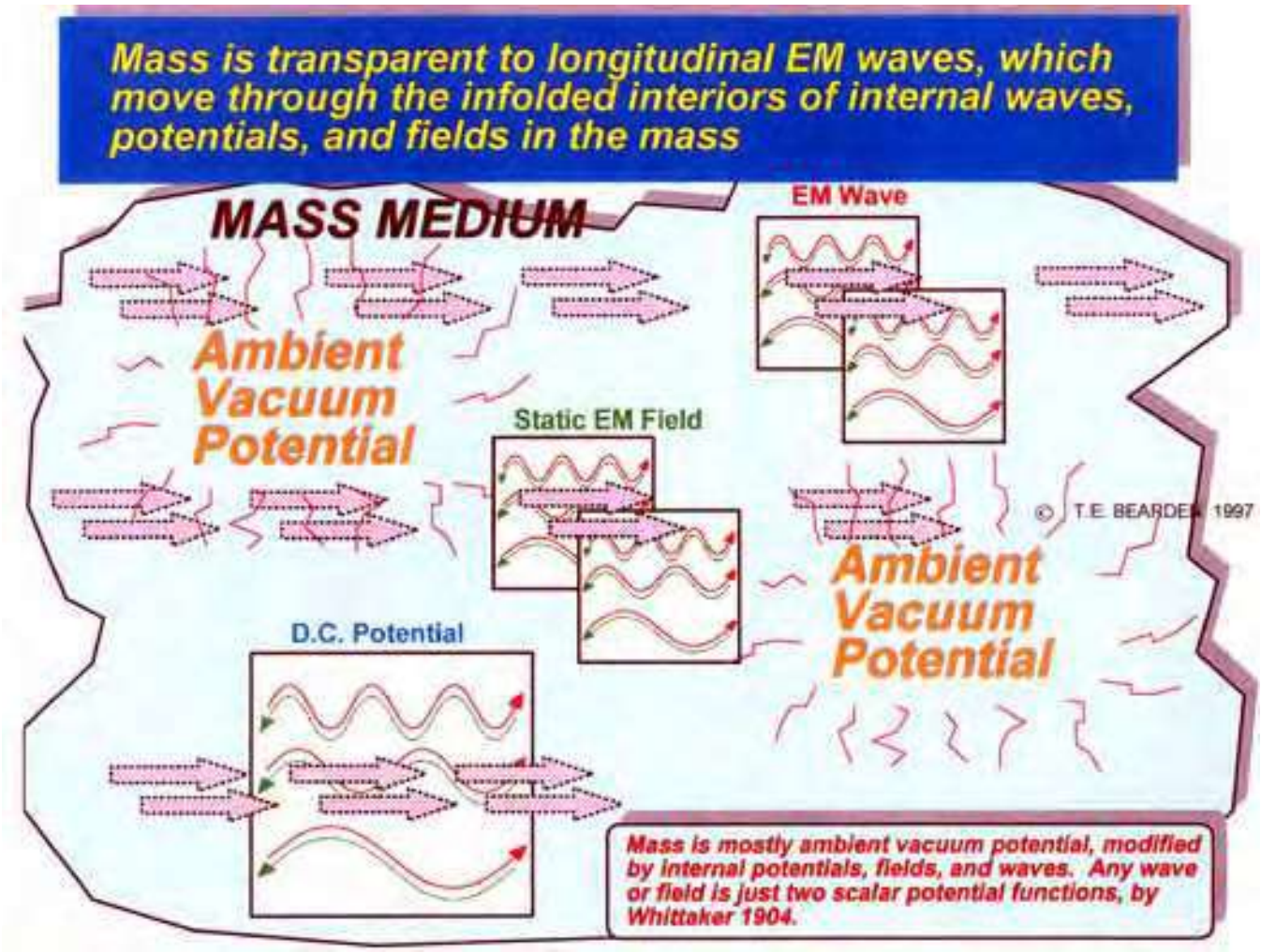

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Deep penetration of weak signals in a dense signal environment, by nonlinear retroreflection

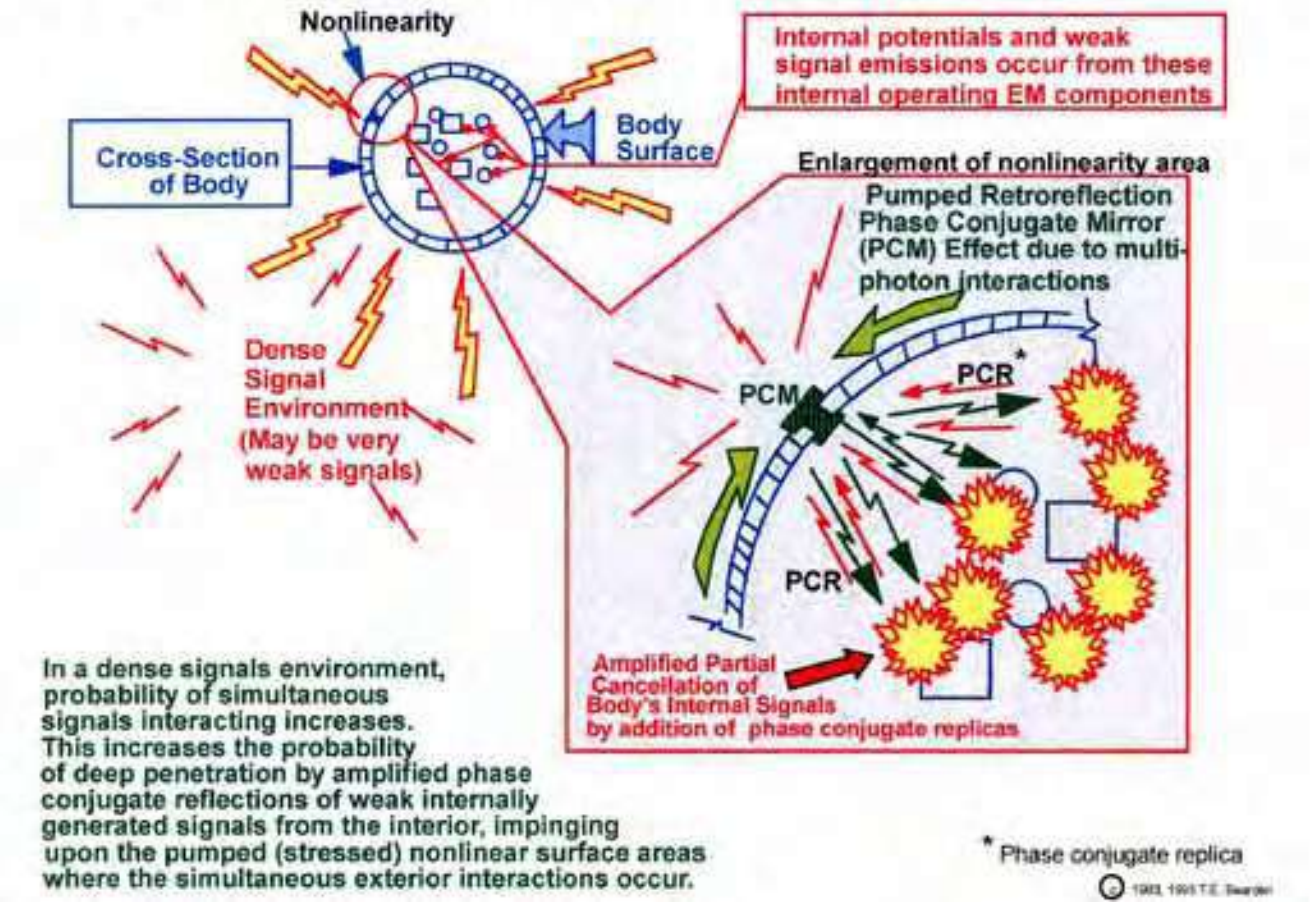

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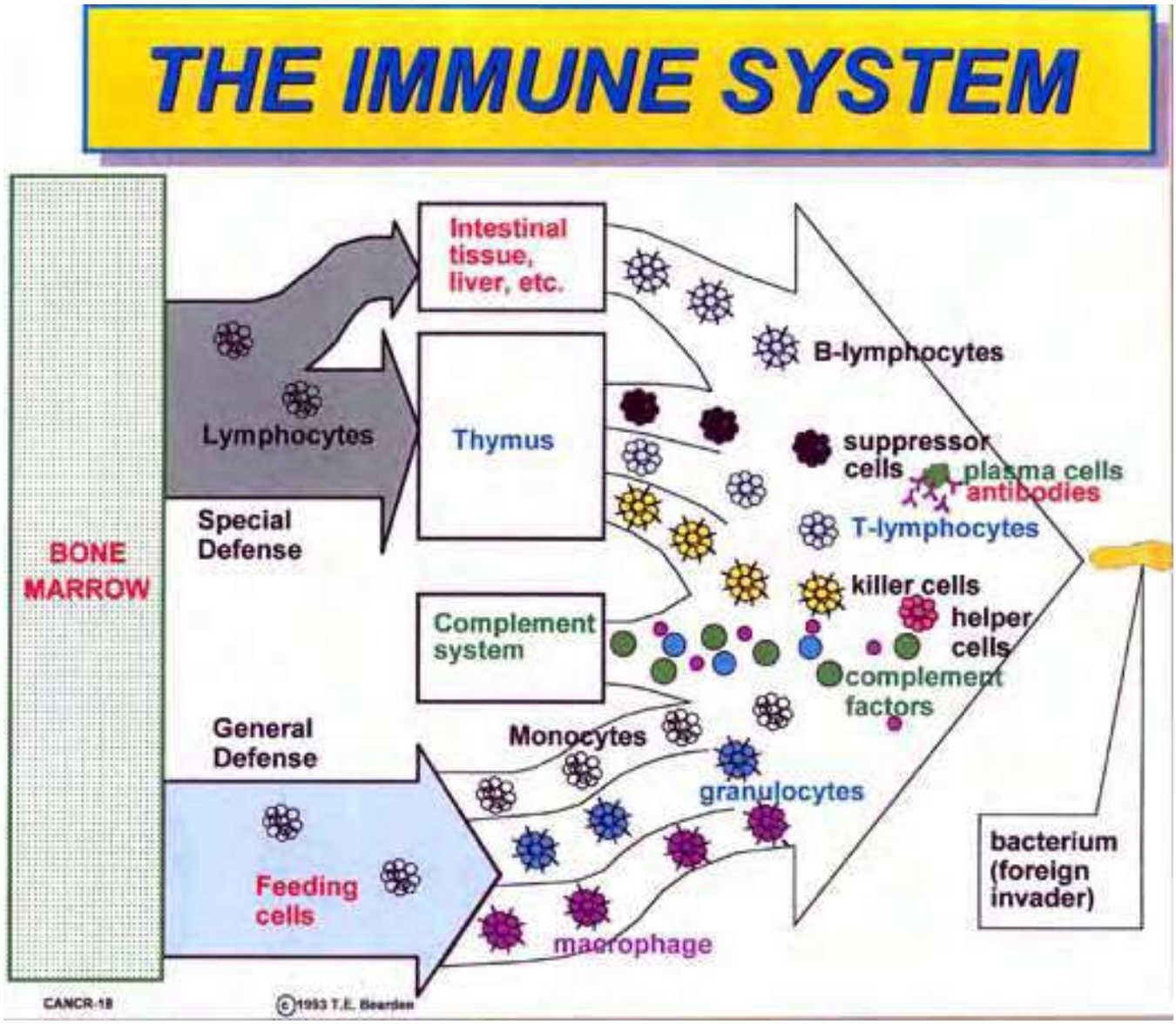

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Popp's master cellular control system

- Provides coherent, long-range interactions in biological systems
- Is an organized morphogenetic field at the basis of functional control

- Emission very sensitive to almost all external and internal influences
- Both spontaneous and delayed luminescence occur
- Photons stored in cell during the delay

- Leakage provides ultraweak, coherent biophoton emission from the system
- Fractional intensity pattern: few to some 100s of photons/cm^2/sec
- Optimum signal-to-noise ratio

- A single delayed biophoton may be able to trigger 10^{10} reactions in a cell before its release
- Spectrum almost continuous within optical range from 200-800 nm.

- Biophoton emission shows biological system always out of equilibrium
- Emission has holistic characteristics
- Correlations to most, if not all, of the biological functions of the organism

- DNA, all other processes are sources
- Single main process of whole system, different processes strongly coupled
- Information function and sync of biological clocks (oscillators)

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CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

**R&R system forces cell back toward anaerobe*

CANCR-26

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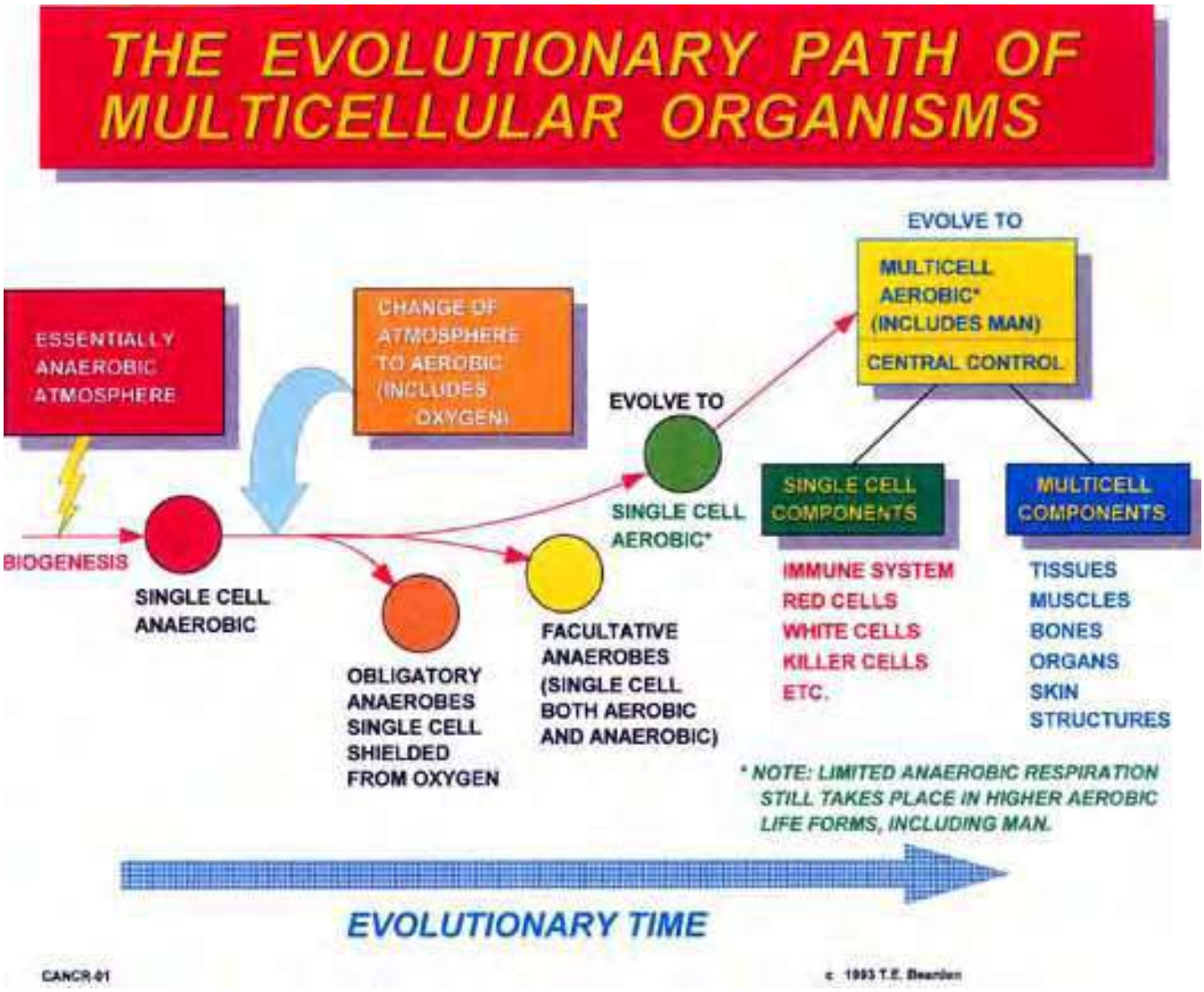

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EFFECT OF FLUID CONTAMINATION ON HEMOGLOBIN'S OXYGEN TRANSPORT

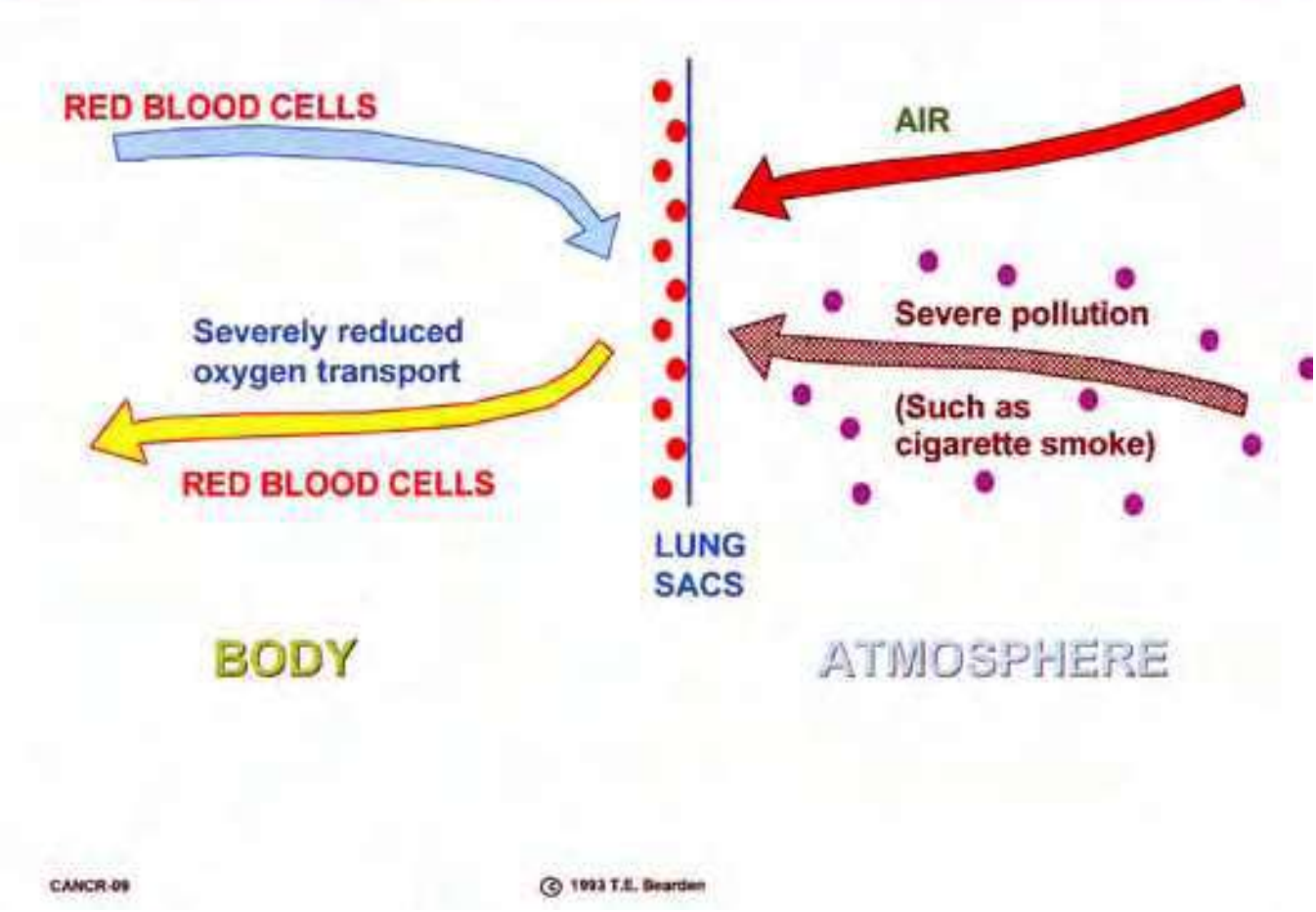

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FIRST STEP IN SELF-PROMOTION OF CANCER DUE TO HYPOXIA

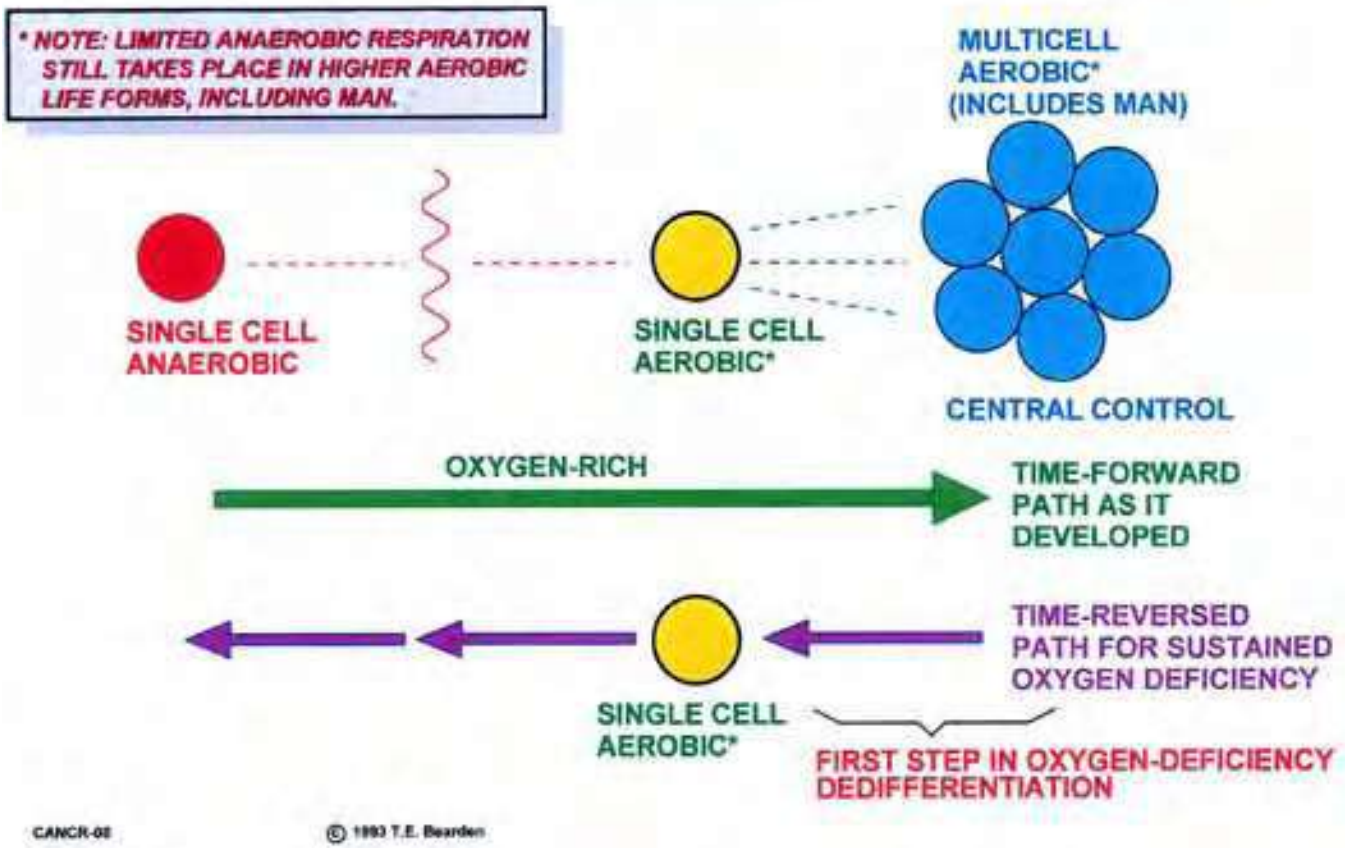

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BECKER'S CELLULAR GROWTH CONTROL

- Two major links uncovered between :
  - The DC system and nervous system
  - The DC system and all body cells
- Bioelectric potentials of primary importance
- Physiology presently considers controls limited to:
  - Neural action potential
  - Various hormone chemical agents
  - Chemical agents associated with DNA/RNA system
- Complete Operational Biological Control System:
  - Controls growth, healing, biological cycles, etc.
  - Operates in ANALOG mode; various levels of DC
  - Interlocks physically with nervous system (and may be its precursor)
  - Other chemical agents
  - Tissue growth and healing NOT INCLUDED
- Medical community now more concerned with diseases resulting from:
  - Inadequate/abnormal growth
  - Inadequate healing

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Becker's dc treatment of bone fractures

Application of tiny DC currents to heal difficult bone fractures. Only picoamperes are utilized. Pulsed DC current or pulsed magnetic fields may also be utilized.

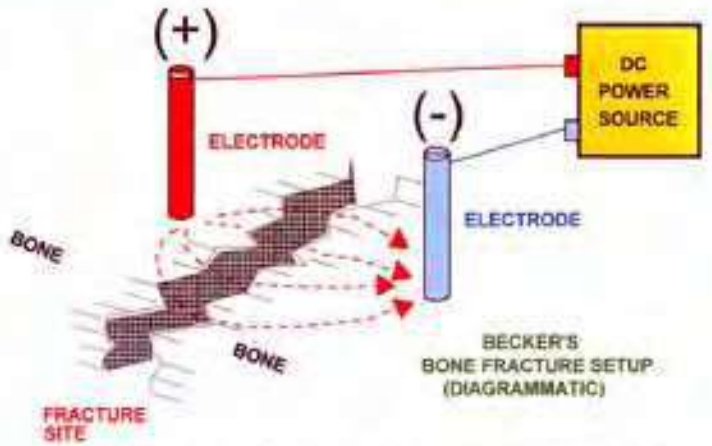

RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture

Proves that cells can be time-reversed (phase conjugated) (dedifferentiated) or time-forwarded (redifferentiated) by application of very weak electromagnetic signals, when those signals contain longitudinal bidirectional EM "pump wave" wavepairs, which cause the cell and its parts to create precise vacuum antiengines.

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Becker's theoretical DC control system involved with response to injury*

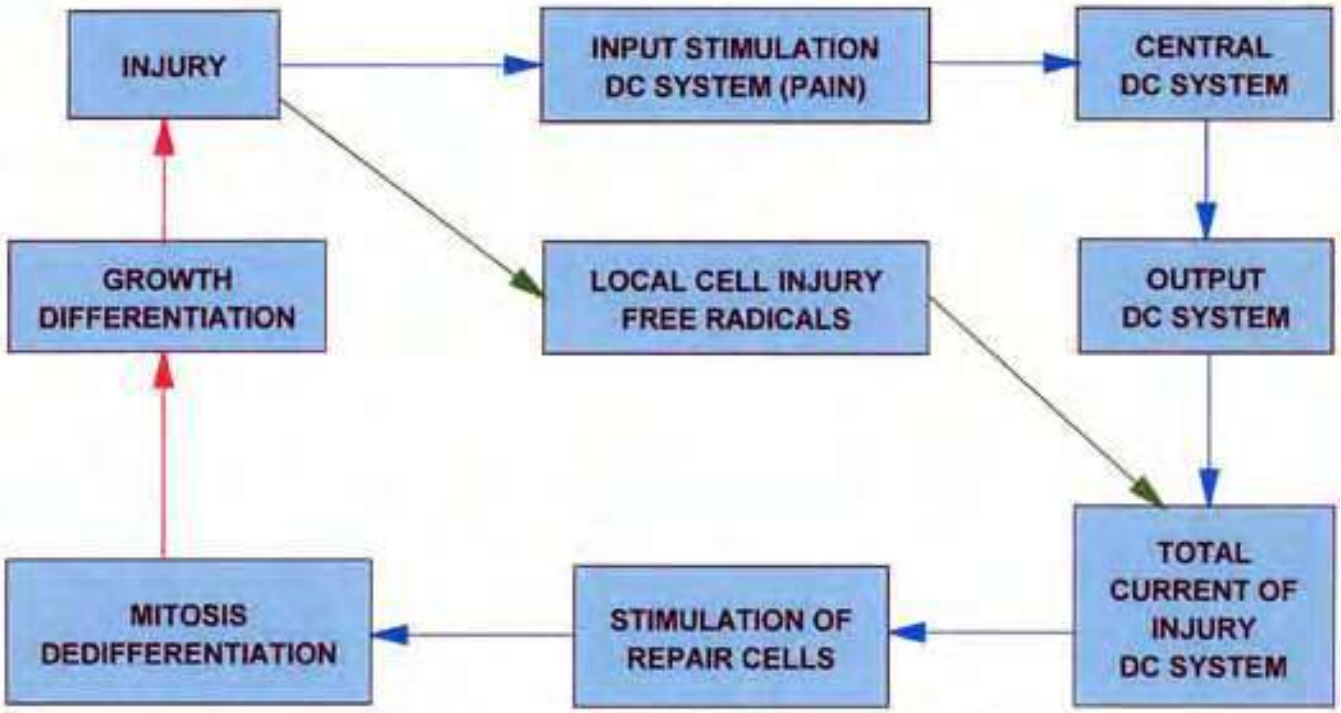

*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

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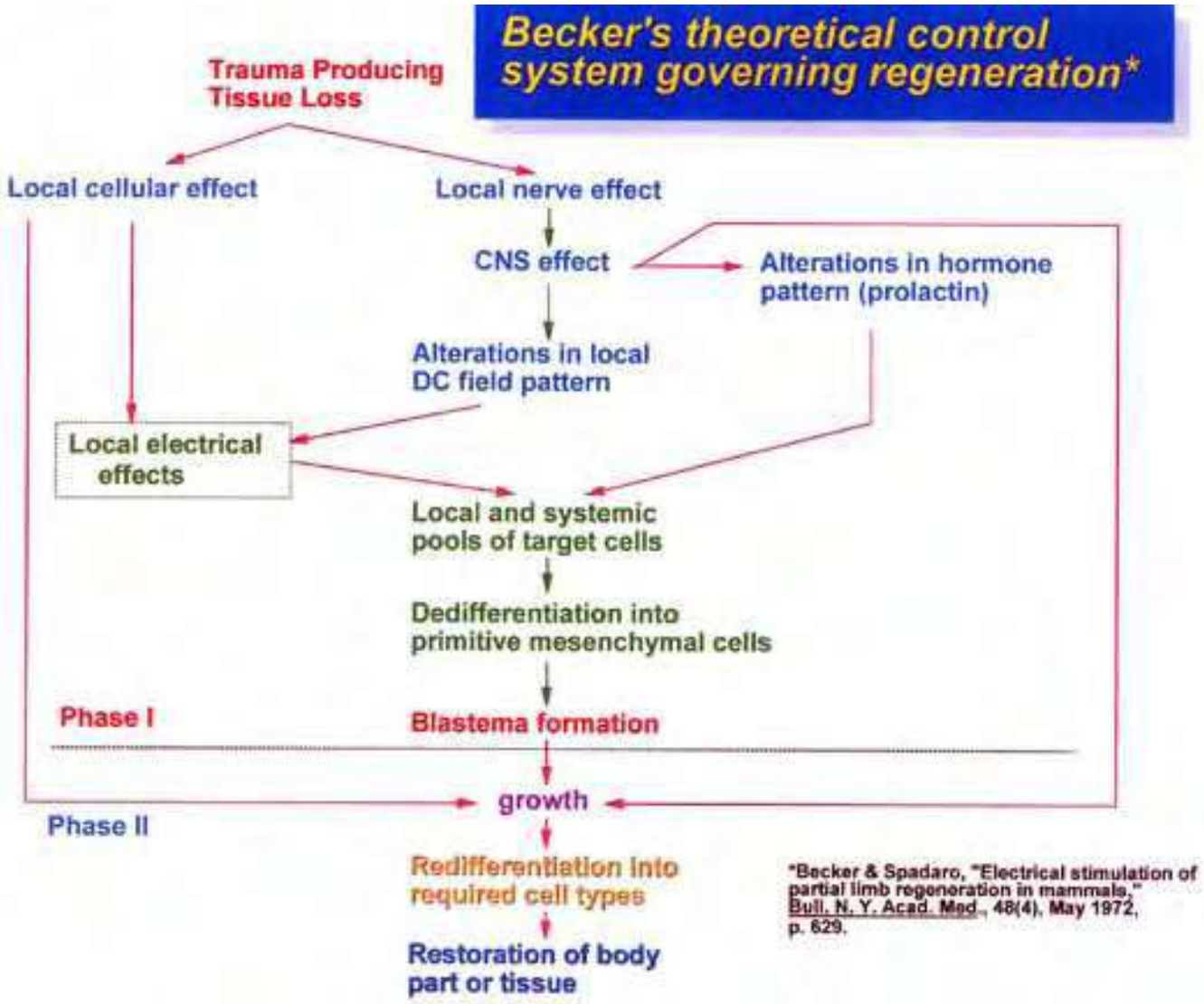

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Link Between Standing DC Potentials and the Nervous System

- Standing DC potentials on intact surfaces of all living animals demonstrate a complex field pattern spatially related to the anatomical arrangement of the nervous system
  - Can be measured directly on the peripheral nerves
  - Polarity difference related to whether nerve is or is not a sensor
  - Steady (weak) current flow exists
  - Demonstrates solid state/semiconductor phenomena
  - Accurately reflects (amplitude and polarity) the general level of neural activity
    - Sleep versus wakefulness
    - Anesthesia versus conscious
    - Other parameters
- DC levels determine the level of neural activity
- Action potential system exists upon a substratum of DC potentials which pre-existed it
- DC potentials substrata had and have control functions over basic properties of the living organism

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Becker's Findings on Cellular Injury and Regeneration*

- Cellular processes are regulated by a precise control system
- Attempted to apply engineering control-system theory
- Cells and tissues have solid-state electrochemical features which provide control signals in the control system
  - Growth process
  - Electron transfer
  - Semiconduction
  - Self-organizing *(NOTE: Implies hidden variables and nonlocal causality)*
- Complex electrical events at the injury site initiate cellular aspects such as dedifferentiation and mitotic activity
- Regeneration is a 2-step process, each with different controls
  - Electrical triggers with threshold values results in appearance of blastema
  - Complex data transmission to blastema establishes it as a self-organizing system capable of growth and redifferentiation
  - Mammals lack ability to produce blastemas except for bone, but partial regeneration growth has been shown in response to electrical stimuli
- Growth related to electrical more than electrochemical aspects
- Hematopoietic marrow as source of cells for the blastema
  - Monocytes can take place in regenerative processes in limbs
  - Lymphocytes can dedifferentiate under certain circumstances
  - Marrow elements can be induced into osteogenesis

*R.O. Becker & J.A. Spadaro, "Electrical Stimulation of Partial Limb Regeneration in Mammals," Bull. N. Y. Acad. Med., 48(4), may 1972, p. 627-641.

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Corrections For the Present EM Bioeffects Model

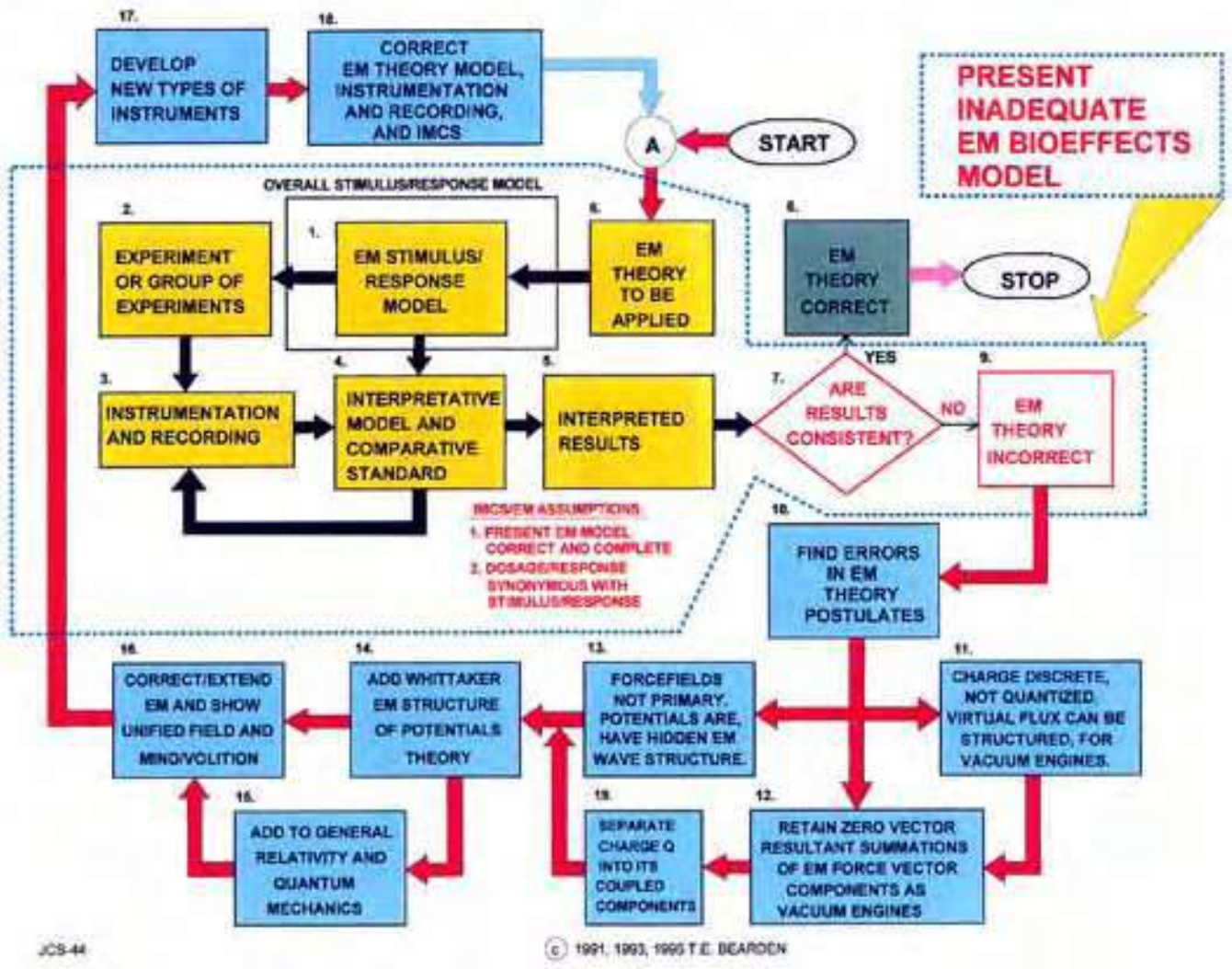

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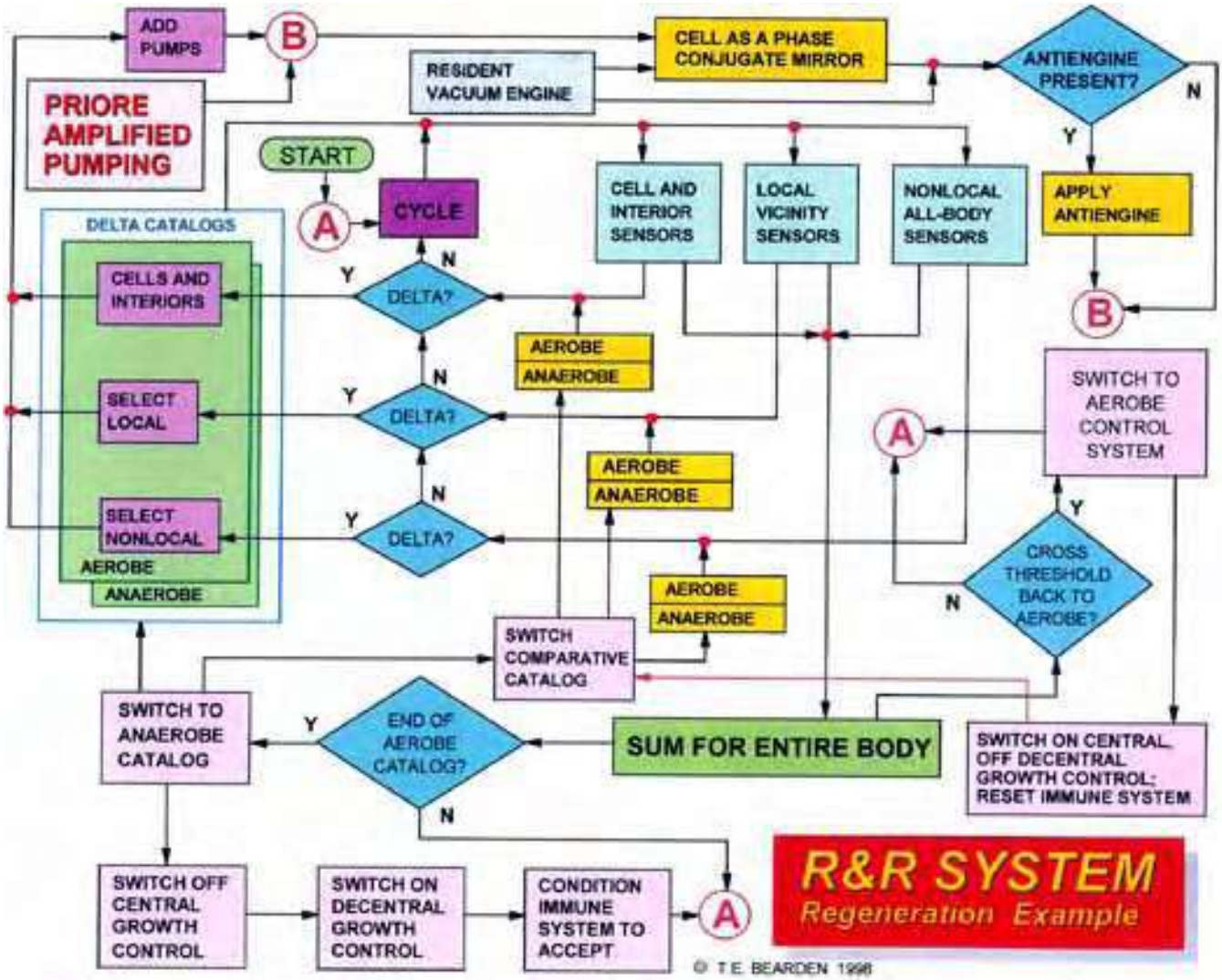

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Kaznacheyev's Cytopathogenic Mirror Effect

Disease vacuum engines transported by photons and waves

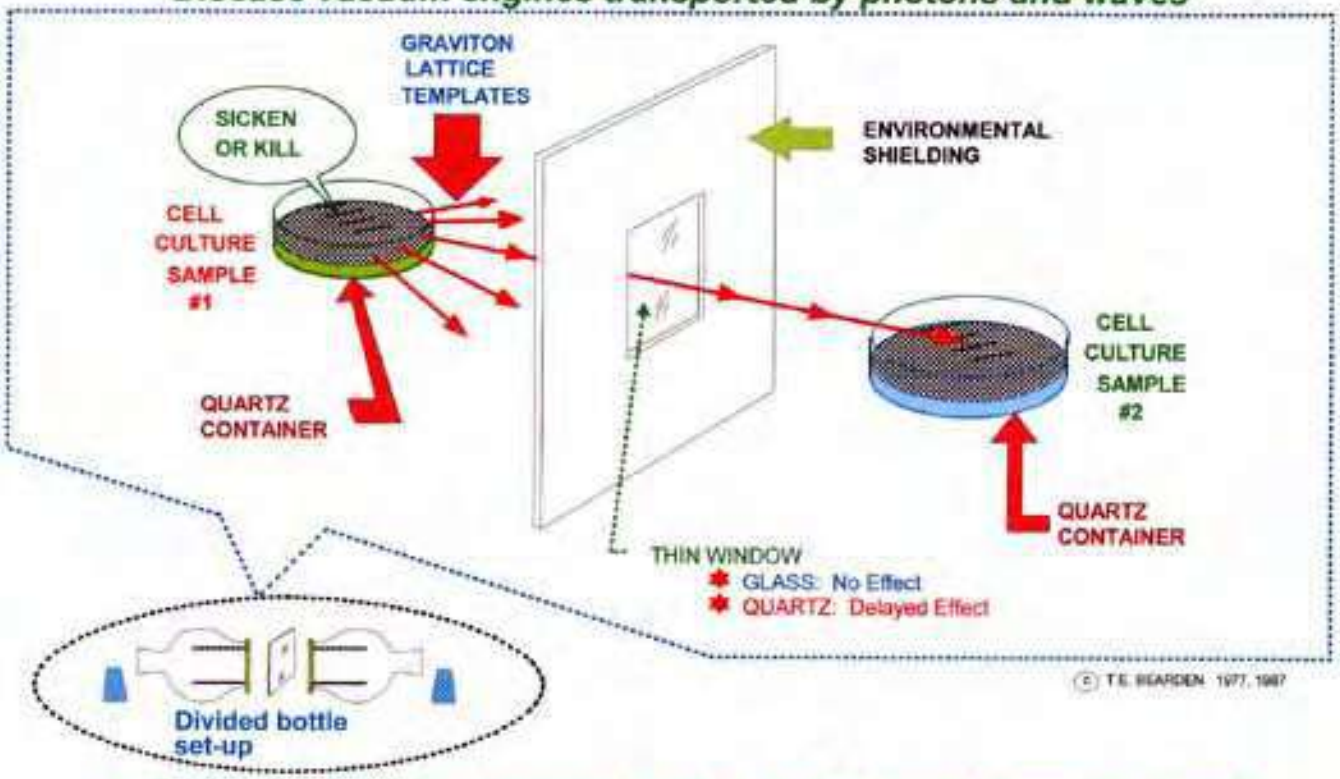

Note: Minimum lattice is one harmonic interval: IR to UV is such a minimum G-lattice.

Distant induction of cellular death and diseases, by special EM means. Coupled photon-antiphoton pairs (gravitons) in a structured harmonic lattice ordering constitute the disease or disorder template.

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MICROWAVE RADIATION OF U.S. EMBASSY IN MOSCOW

Former U.S. Embassy in Moscow.

Selected clipart © by Lotus SmartPics™

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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Self-Targeting in Inner EM Channel Can Produce a Quantum Potential

Once QP is established, energy transmission is direct and instantaneous. Energy input to one single participant will simultaneously appear in all other participants, the amount depending on their fractions of participation with the input station.

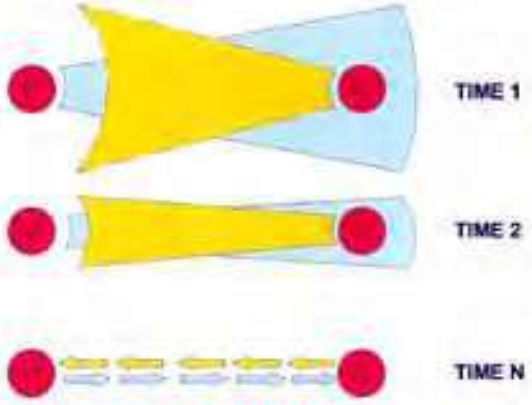

NARROWING OF INTERACTING POTENTIALS INTO LASER-LIKE BEAMS, BETWEEN TWO PUMPED SOURCES. NOW ONLY LONGITUDINAL WAVES CONNECT THE LINKED OBJECTS.

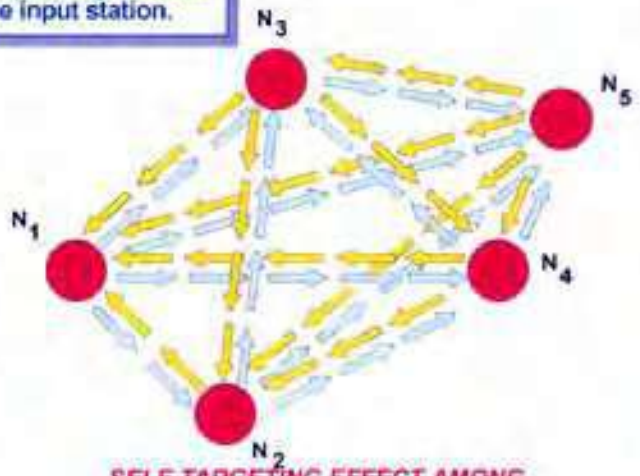

SELF-TARGETING EFFECT AMONG ALL PAIRS OF INTERACTING PUMPED SOURCES

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Quantum potential and hidden variable theory

a. Quantum Potential Characteristics

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- No point source
- Not radiated
- Quantum potential between two particles
  - Interaction does not vanish as spatial separation becomes very large
  - Instantaneous connection, so multiply-connected space

b. Hidden Variable Theory and the Quantum Potential

- $$V_{quantum} = \frac{\hbar}{2m}\frac{\nabla^2\sqrt{\rho}}{\sqrt{\rho}}$$
- "A quantum particle moves as if it were subject, in addition to its external potentials, to a potential which is a function of its own probability distribution."
- Bohm's H.V.T. assumes:
  - Particle and wave function real and separate
  - Wave function obeys Shroedinger's equation
  - Particle obeys classical mechanics
  - Particle couples to wave function through a quantum potential

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Participants in a quantum potential share a common multiply-connected spacetime (MCST)

- Separated points are superposed in MCST
- Intervening distance in MCST is zero
- Connection is instant and bidirectional
- Propagation through ST does not apply
- Energy or vacuum engine input to one station instantly appears at each and every other station, undiminished in magnitude
- Ultimate net-centric warfare effect

Note: Once QP established, separation distance in 3-space is of no consequence

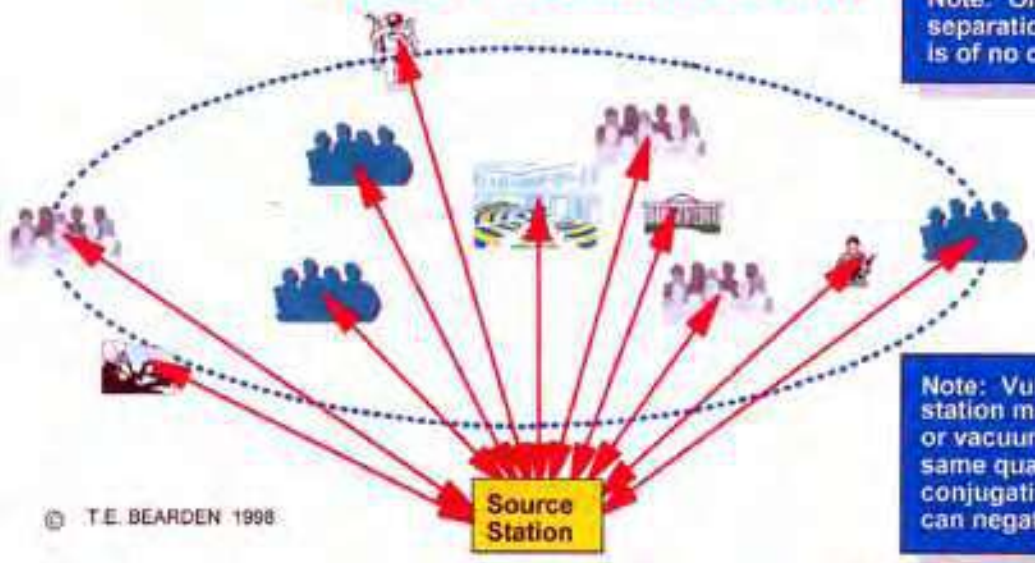

Note: Vulnerability. Any other station may insert energy or vacuum engines into the same quantum potential. Phase conjugating the hostile engine can negate its effect everywhere

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Gulf War Syndrome And Typical Comparative Disease Curves

Note: There is cumulative genetic damage to germ cells also.

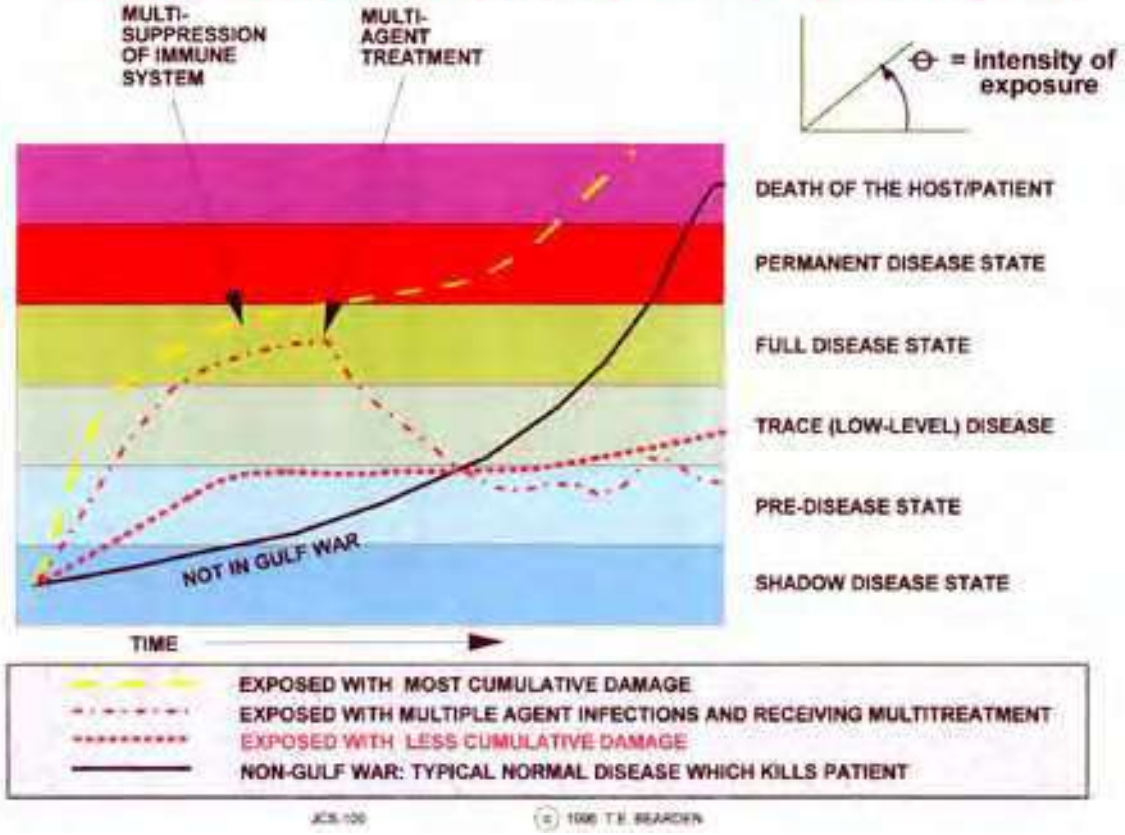

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Force Fields and Symmetry

- Force fields are nature's way of imposing local gauge symmetries on the world
- E.g., electromagnetic field is a manifestation of the simplest known gauge symmetry consistent with the principles of special relativity
- For the EM case, the gauge transformations correspond to changes in 'voltage' from place to place

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Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum

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- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another
- STRUCTURING THE INFOLDED EM INSIDE POTENTIALS, FIELDS, AND WAVES
  - Strongly breaks local symmetry
  - Provides spacetime engines giving the above effects

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Other Aspects of Strong Local Asymmetry

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- Local spacetime is curved
- Lorentz invariance of vacuum is violated
- May be a local "sink" or "source"
- Gravitational/inertial effects from EM
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation
- COMMENT: Thus the use of infolded longitudinal EM fields and waves to strongly break local symmetry allows internested clustering of spacetime curvatures. These spacetime structures are *vacuum engines*, or *spacetime engines*.

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Small Entities Emit Powerful S-Flows

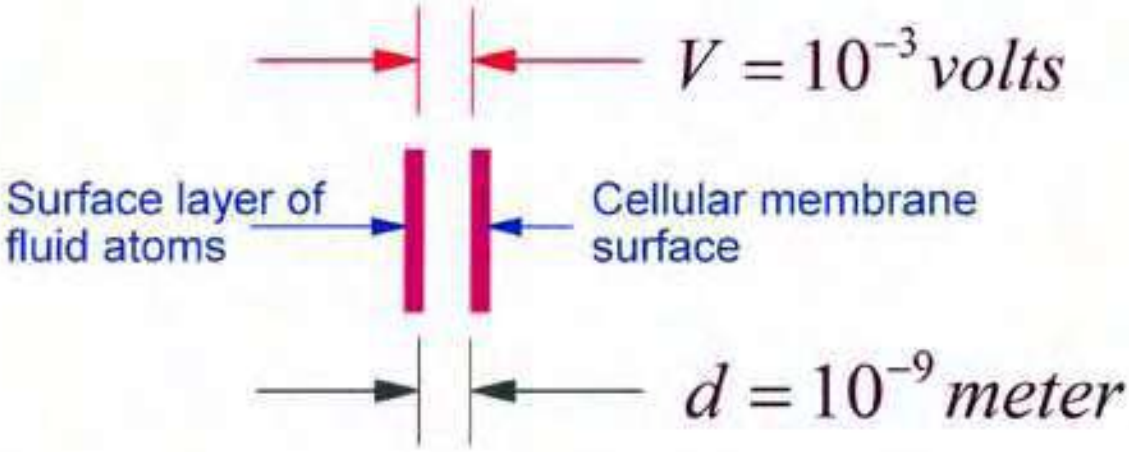

$$E = 10^{6}\ \text{volts / meter}$$

$$S \approx f(E^2) = f(10^{12})$$

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What is the "magnitude" of a potential?

- What is taught is the *"interaction cross section,"* i.e., the joules collected from the associated S-flow by one point coulomb of intercepting/collecting charge.

$$W = Vq = \phi q \quad \text{(joules)} \qquad [1]$$

$$\phi = W/q \quad \text{(joules/coul)} \qquad [2]$$

Let $\phi < 1$ and fixed; $q \Rightarrow n$ where $n = \infty$

$$W \Rightarrow k, \text{ where } k = \infty \qquad [3]$$

- *From any "finite" potential, no matter how small, an unlimited amount of energy can be collected, by increasing the collection (number of coulombs) (interaction cross section).*
- Actual magnitude of the potential ϕ must be very, very large, since we can treat it as infinite or unlimited, via $W = \phi q$.
- *Else Equation [1] could not be linear.*

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Table A1. THE VACUUM ENERGETICALLY INTERACTS WITH EVERY PARTICLE, CONTINUALLY.

- The vacuum is:
  - Ground (zero) state of the electromagnetic (photon) field.
  - Ground (zero) state of mass field.
  - Empty of *observable* particles or photons.
  - Filled with *non-observable* (virtual) particles and photons.
  - Violently fluctuating microscopically and electromagnetically.
  - Constantly interacting with all particles, including partially shielding their bare charges.
- Lamb Shift -- vacuum's alteration of the energy level of an electron in the hydrogen atom.
  - -- Difference in energy (frequency units) is 1057.862 MHz.
  - -- Lamb was awarded a Nobel Prize for showing this.
  - -- Energy *density* exceeds that of the sun's surface!
- Casimir Effect -- vacuum creates an attraction between two conducting surfaces in close proximity.
  - -- experimentally proven, well-known.

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- Cole and Puthoff proved that there is no thermodynamic reason why energy cannot be extracted from the vacuum as heat and power, and utilized.
- The common dipole is a broken symmetry in the virtual photon flux of vacuum. It extracts virtual energy, integrates it, and re-emits it as Poynting energy density flow S = ExH (which observably interacts with charged particles and magnetic poles).

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Extended Superpotential Theory

(Adding Vacuum Engines)

- Any EM field or wave is created by (comprised of) two potentials which interfere with each other in a given area
  - *May be either scalar or vector potentials*
  - *May interfere locally or at a distance*
  - *Process is distance independent*
- Any scalar potential is comprised of a harmonic series of bidirectional longitudinal EM wavepairs (Whittaker 1903).
- Ziolkowski circa 1985 added the interior product set to Whittaker's sum set. Thus he added modulations.
- By assembling a deliberate "sum and product" set of biwaves, a scalar potential can be created having an internal deterministic structure.
  - *This structures local vacuum potential/spacetime curvatures, in specific forms (templates)*
  - *Now have added vacuum engines*
  - *Have infolded general relativity inside electrodynamics*

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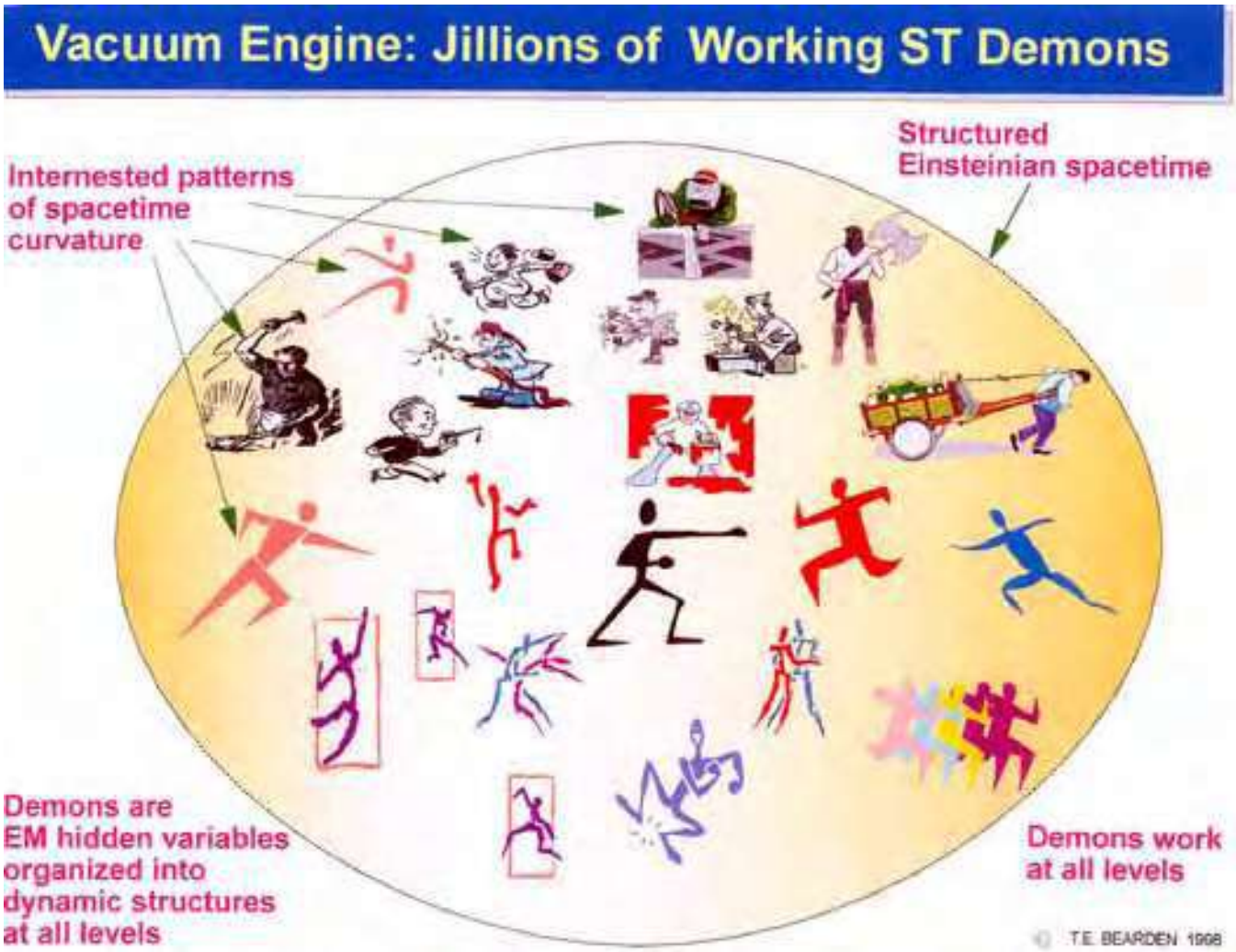

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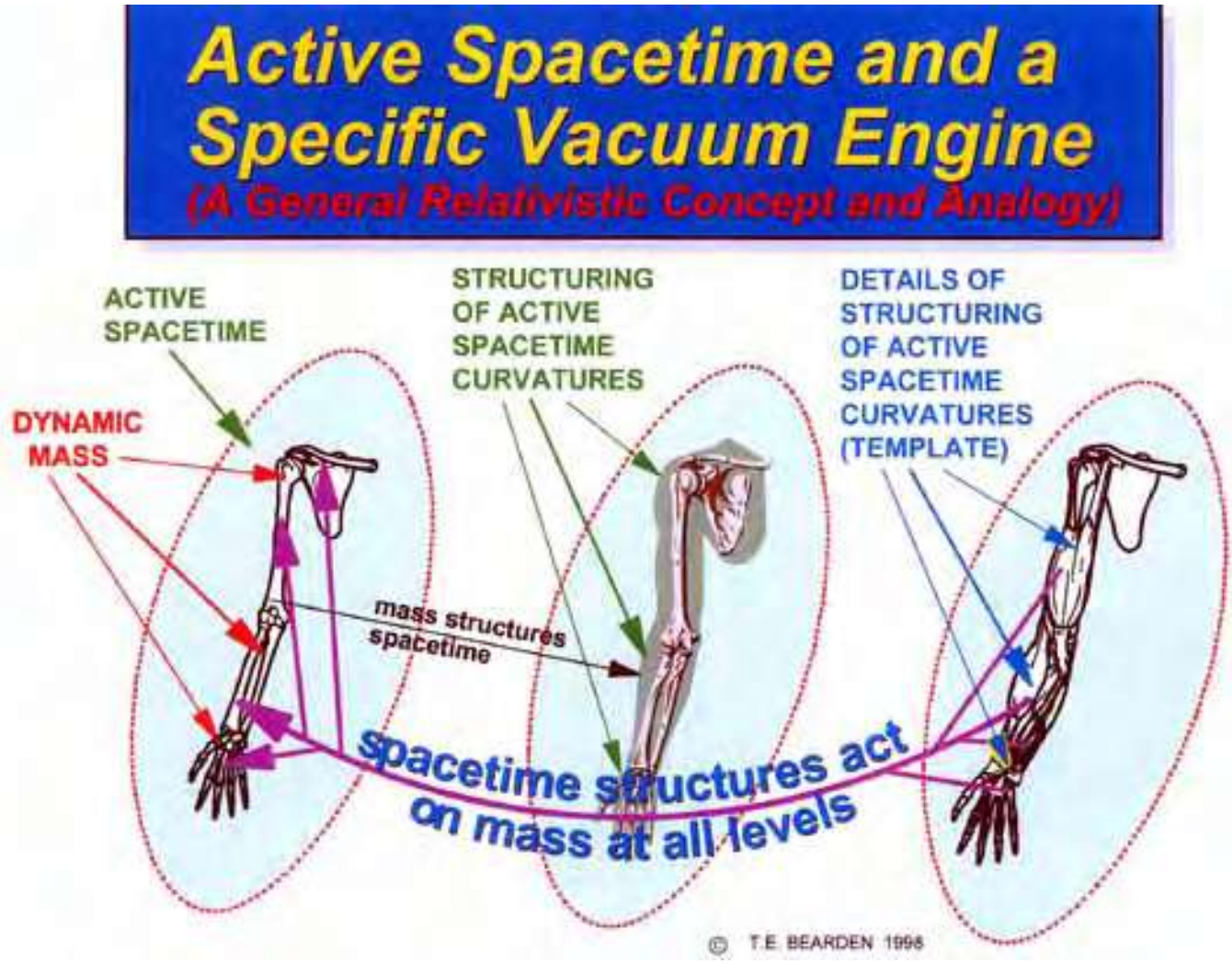

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Extension of Wheeler's general relativity principle:

- Mass (trapped energy) and its structuring curves and structures spacetime complexes (engines).
- Curved and structured spacetime engines produce forces on mass and its components, telling them how to move and structure.
- Since very strong EM force is used as agent of curvature, very powerful general relativistic effects can be obtained by arranging the LWs in the input EM potentials, fields, and waves.
- General relativity becomes directly engineerable in devices of unparalleled capability.

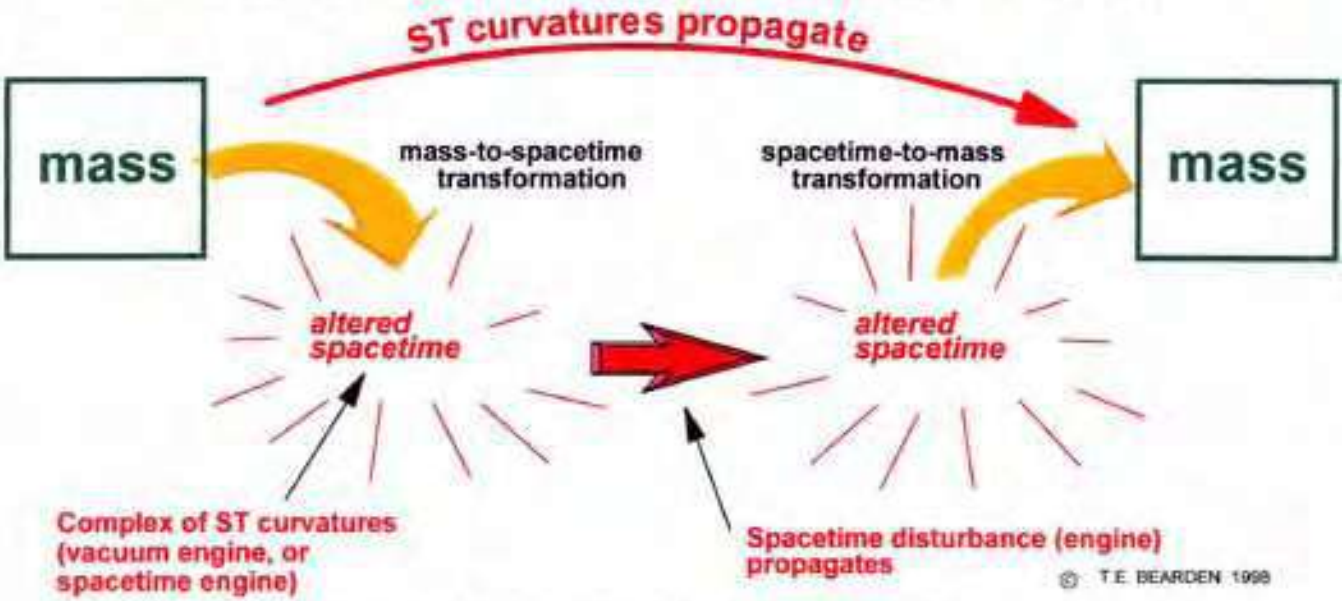

Electrodynamics has a hidden but ignored electro-general-relativity infolded inside (comprising) its so-called potentials, fields, and waves (in space in the absence of mass). What are presently defined as potentials, fields, and waves rigorously exist only in, on, and of charged mass, as pointed out by Aharonov and Bohm in 1959. All of this is just longitudinal EM waves and their interactions.

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SIGNAL VERSUS VACUUM ENGINE

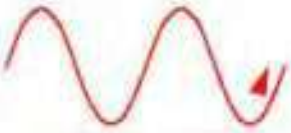

SIGNAL (INFO)

- INFORMATION RECEIVED
- ANY OVERT PHYSICAL ACTION MUST BE TAKEN BY RECEIVER

A. *Receiver must do the action itself; vacuum energy exchange is unaltered. Energy or fuel for doing the action must be added to receiver externally.*

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VACUUM ACTIVATED

ENGINE (STRUCTURE)
TEMPLATE (FORM)

- "INFORMATION" ITSELF ACTS
- VACUUM FLUX GRADIENTS CHANGE ALL PARTS AND CHARACTERISTICS OF RECEIVER, INSIDE AND OUT

B. *Receiver is acted upon; altered vacuum energy exchange does the specific action. No energy or fuel for doing the action need be added to receiver externally.*

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Electronuclear Interactions by Vacuum Engines

- An EM potential is gravitational due to its trapped energy.
- A local EM potential is a local curvature of spacetime.
- *Structured* potentials are structured *(nested)* local spacetime curvatures; hidden variable theory applies.
- Structured potentials thus are *vacuum engines*.
- Gradient-free potential penetrates the atom, into nucleus.
- *With steady application, a structured gradient-free potential can be used to engineer the atomic nucleus at will.*
- Normal cold fusion systems structure a small fraction of their potentials, by chance geometries, boundaries, etc.
- This produces some new nuclides, but haphazardly.
- *The process can be developed and controlled. The nucleus can be deterministically engineered at will.*

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Vacuum Engineering

Using Inner EM Energy and Structuring to Engineer Physical Reality

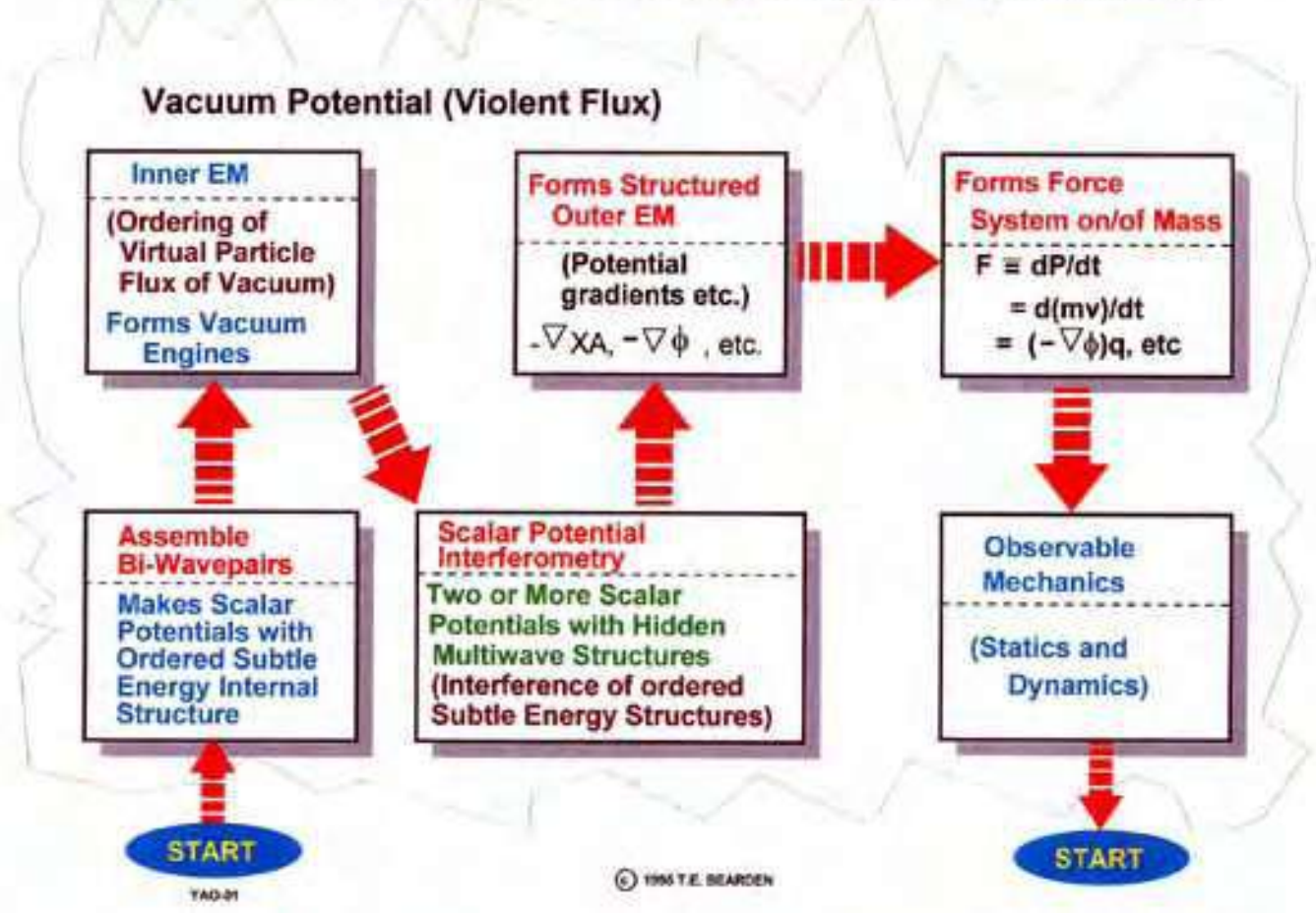

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Impact of Vacuum Engineering

- "If they [quantum fluctuations of vacuum] can be [tapped], the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete -- and so would many of our worries about environmental pollution."
- "Don't sell your oil shares yet -- but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development:
  - 1. It's crazy!
  - 2. It may be possible -- so what?
  - 3. I said it was a good idea all along.
  - 4. I thought of it first."

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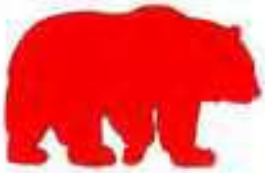

Arthur C. Clarke
"Space Drive: A Fantasy That Could Become Reality"
Nov./Dec. 1994

- *Comment:*
  - *Every dipole's broken symmetry in its energetic exchange with the vacuum already freely extracts vacuum energy.*
  - *In power sources, the dipole gates the extracted energy out as S = EXH, which flows almost entirely outside the conductors.*
  - The circuit interacts with, and uses, only about 10^{-13} of S. The electrodynamicists calculate only this small S-component.

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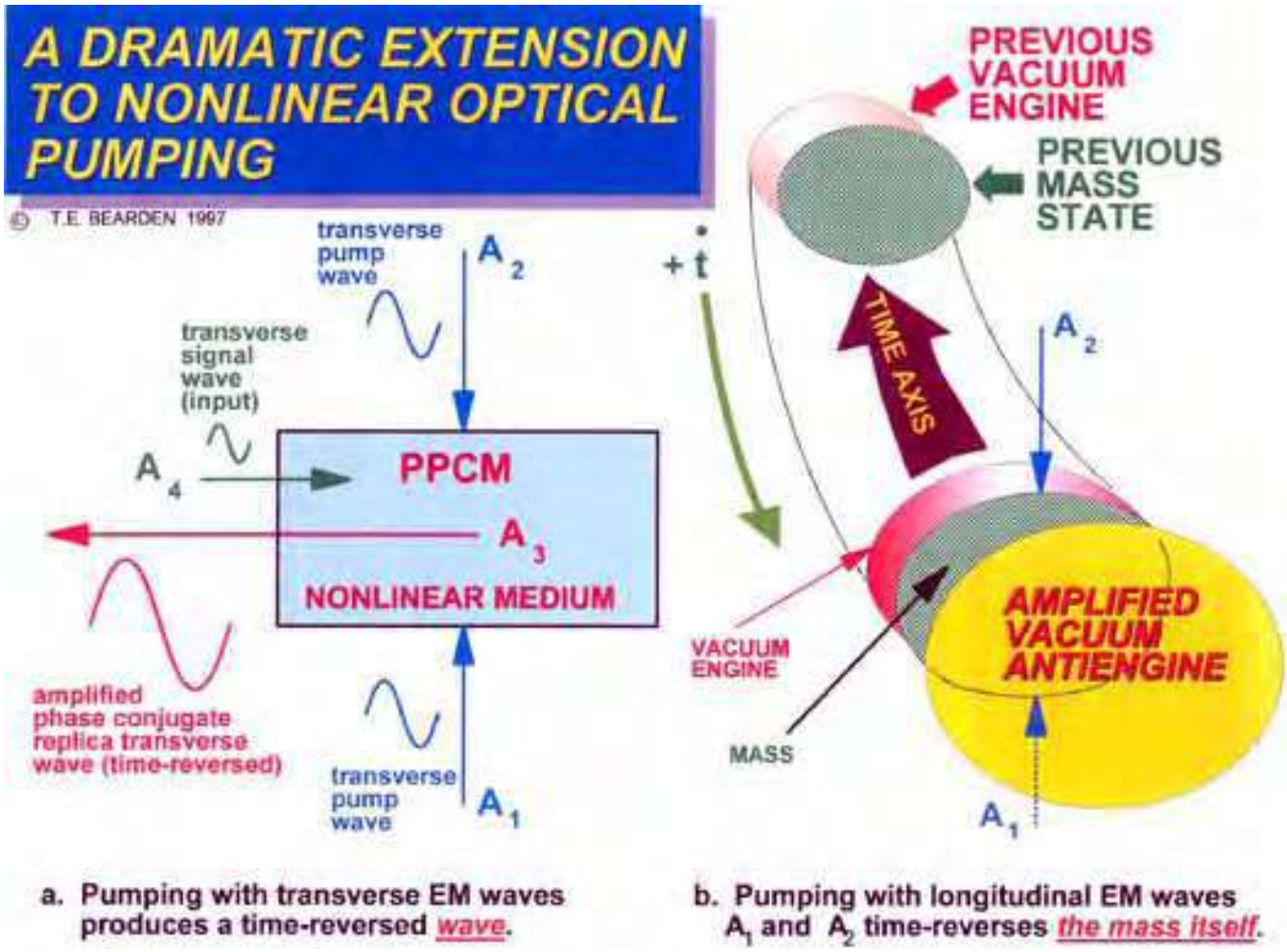

a. Pumping with transverse EM waves produces a time-reversed wave.

b. Pumping with longitudinal EM waves A_1 and A_2 time-reverses the mass itself.

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Time Conservation and Some Properties

(Energy and time are canonical)

- Time can neither be created nor destroyed
  - *Its form can be changed, and it can be positive or negative*
  - *Time can be collected or dissipated, converged or diverged*
  - *Time can oscillate and move in waves*
  - *Longitudinal (infolded) EM waves oscillate time*
- Time is always in motion, and that motion is variable
  - *Collected/collecting time is a continuing stationary change in an ongoing time flow*
  - *Time/collecting time can be internested and internally structured*

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- Time has gravitational aspects
  - *Negative (trapped) time is antigravitational*
  - *Emitting negative time is gravitational, to the emitter*
- Nonlinear optical pumping can use longitudinal EM waves
  - *Pumping a nonlinear mass by longitudinal (infolded) EM waves pumps it in its masstime form, in the time domain*
  - *This creates an amplified vacuum antiengine for the mass, and time-reverses the mass back to a previous state*

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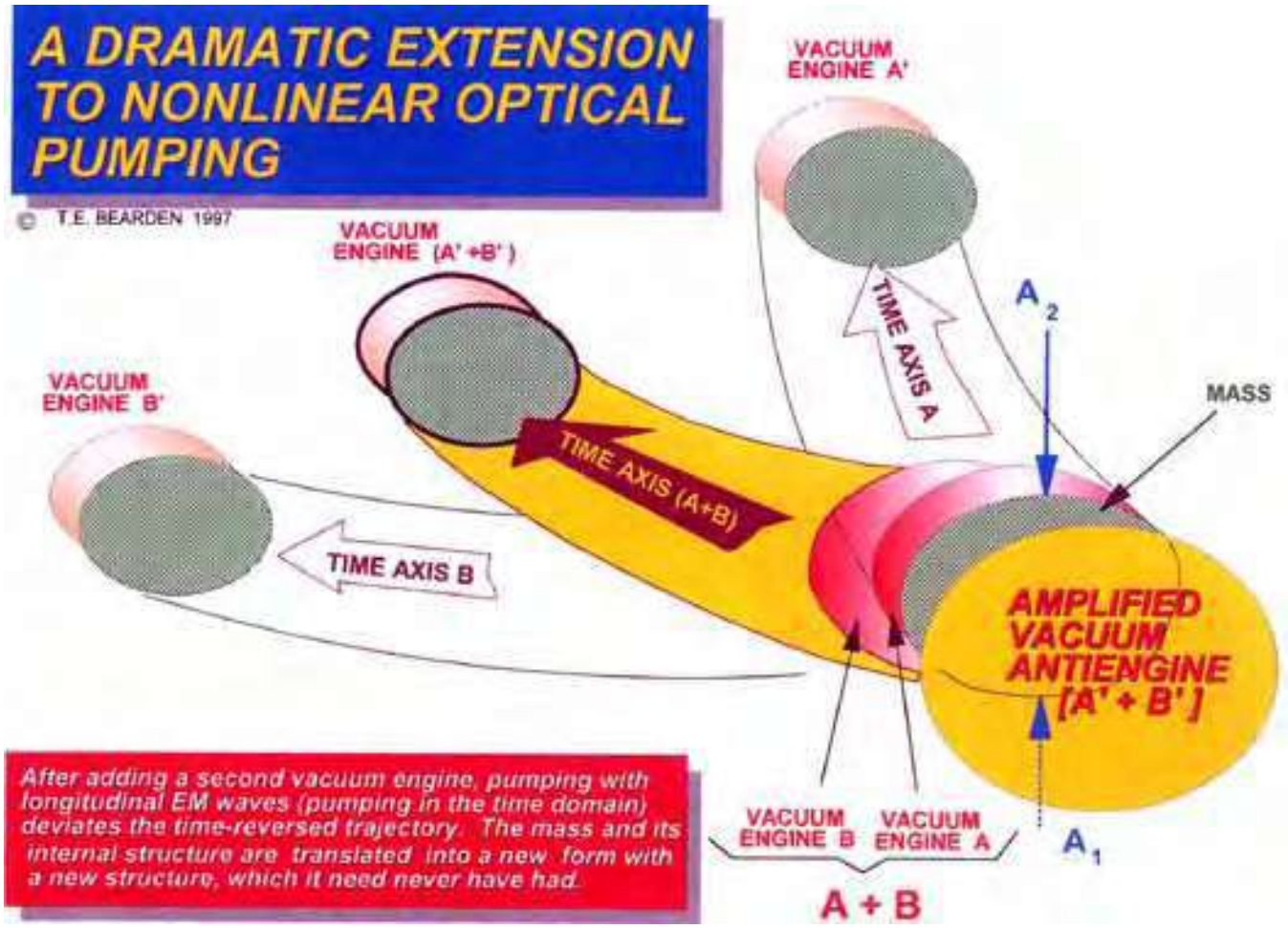

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Key Points in the New Technology

- There is a vast new kind of electrodynamics *hidden inside* all EM potentials, fields, and waves
  - Longitudinal EM waves and complexes
  - Oscillations in time domain

- These complexes are an *infolded general relativity*
  - Clustered formations of *spacetime curvatures*
  - *Very powerful*, since the EM force is used as the agent of curvature

- In general relativity, similar precise complexes permeate and *act on any mass at all internal levels*
- With this approach, one *can now manipulate matter* -- living or inert -- *in any manner desired*, depending only on the level of development of the technology
- Priore unwittingly used this to *cure dread diseases*
- This is a *revolution in all of science*

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- *We have uncovered the major mechanisms* to utilize

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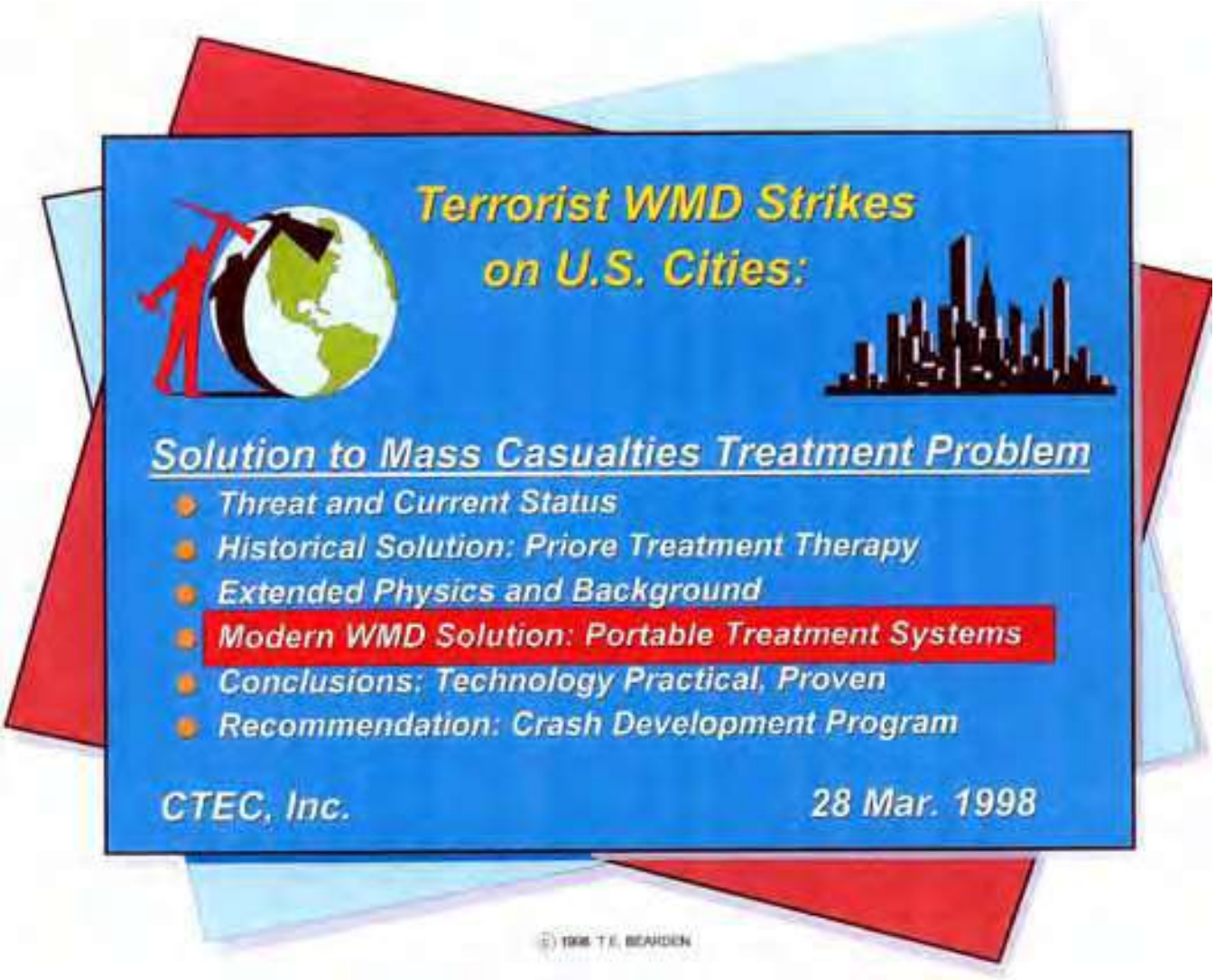

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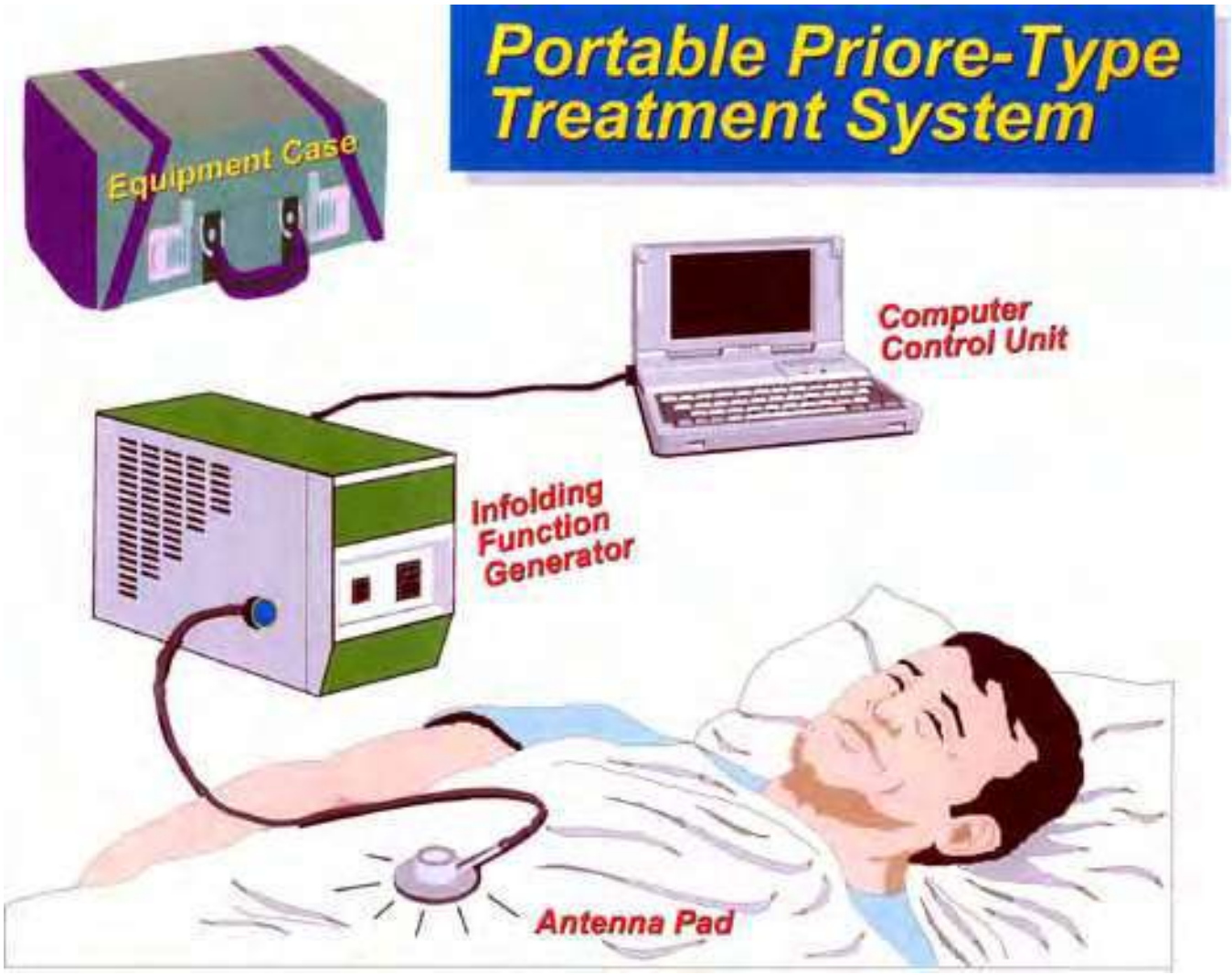

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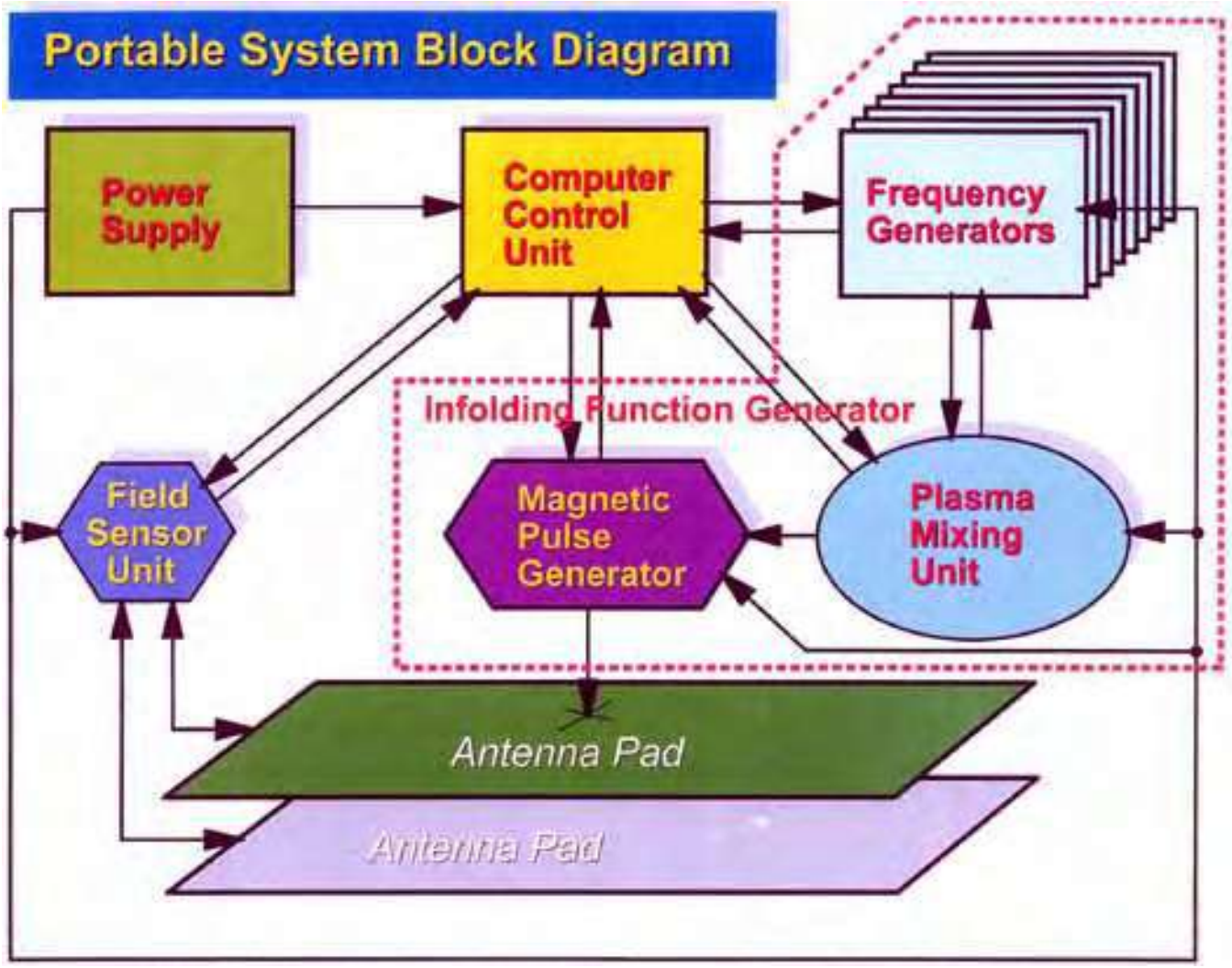

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PORTABLE PRIORE TECHNOLOGY UNIT

- FACT: DISEASE-SPECIFIC VACUUM ENGINE PRESENT FOR ANY CELLULAR DISEASE, BY WHEELER'S PRINCIPLE
  - *DISEASE CAN BE REVERSED BY CREATING AMPLIFIED VACUUM ANTI-ENGINE (BEARDEN'S PRINCIPLE)*
  - *ANTI-ENGINE IS CREATED BY PUMPING THE NONLINEAR CELLS IN THE "INNER EM" DOMAIN, TIME-REVERSING THEM*
- PRIORE UTILIZED A PLASMA TO PHASE CONJUGATE AND "INFOLD" MULTIPLE BIDIRECTIONAL LONGITUDINAL EM PUMP WAVES
  - *17 FREQUENCIES MIXED IN A ROTATING PLASMA*
  - *PHASE CONJUGATES ADDED BY THE PLASMA*
  - *INFOLDED MIX INTO STRONG PULSED DC MAGNETIC FIELD, WHICH CARRIED IT INTO ATOMIC NUCLEI*
  - *PUMPED ALL NONLINEAR CELLULAR COMPONENTS TO PRODUCE AMPLIFIED, SPECIFIC VACUUM ANTI-ENGINE*
- NEGATED THE LONG-TERM CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CELLS.
- SCRUBBED OUT THE CUMULATED PRECANCEROUS STATE
- RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING
- NO EXCESSIVE TRAUMA TO TREATED ANIMAL

CANCR 49

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SAVING THE STRICKEN CIVILIANS

SURVIVORS OF N CASUALTIES

(N = 1-40 MILLION)

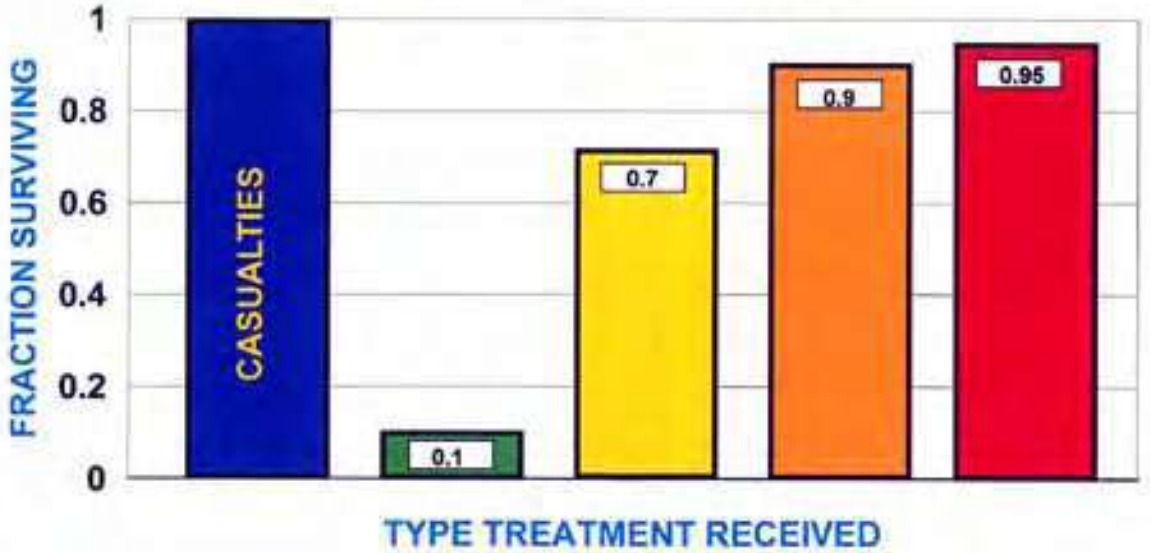

EXPRESSED IN FRACTION SURVIVING
- With conventional treatment
- With 1st generation P-treatment
- With 2nd generation P-treatment
- With 3rd generation P-treatment

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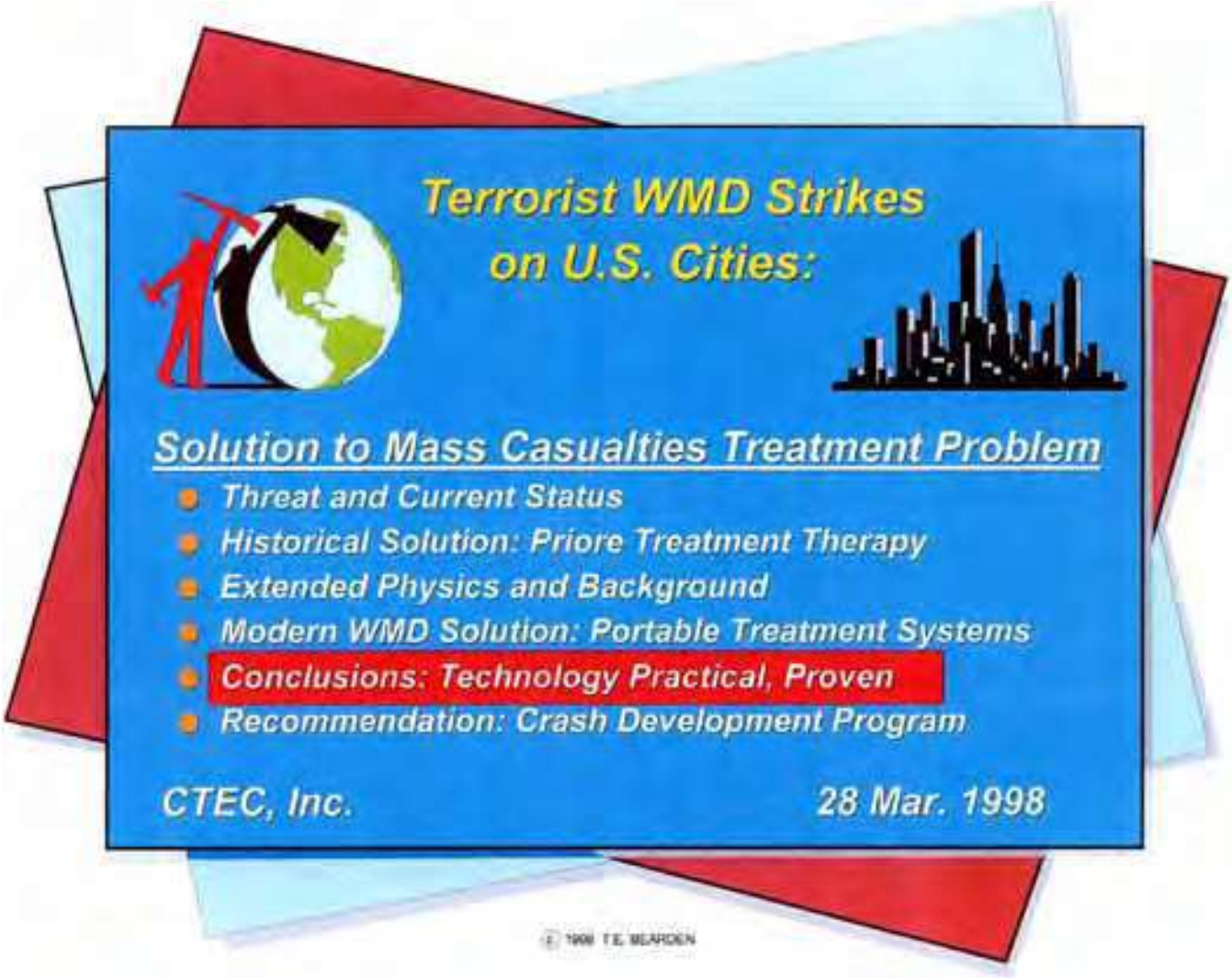

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Summary and Conclusions

- **A new therapeutic paradigm of great scope and effectiveness has been developed**
  - *Will provide effective, quick treatment of mass casualties*
  - *Will provide cures for unknown agents*
  - *No pathogen strains are resistant to this process*
- **Results have been proven experimentally**
  - *Documented in French scientific literature*
  - *Rigorous scientific protocols, eminent scientists*
  - *Technical mechanism deciphered*
- **Will treat and cure many diseases**
  - *Aids, atheriosclerosis, cancer and leukemia*
  - *Sleeping sickness*

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- **Portable units can be developed quickly**
  - *18-month crash development program required*
  - *high level authority and overwatch essential*
- ***Will solve the BW mass casualty treatment problem, both civilian and military***

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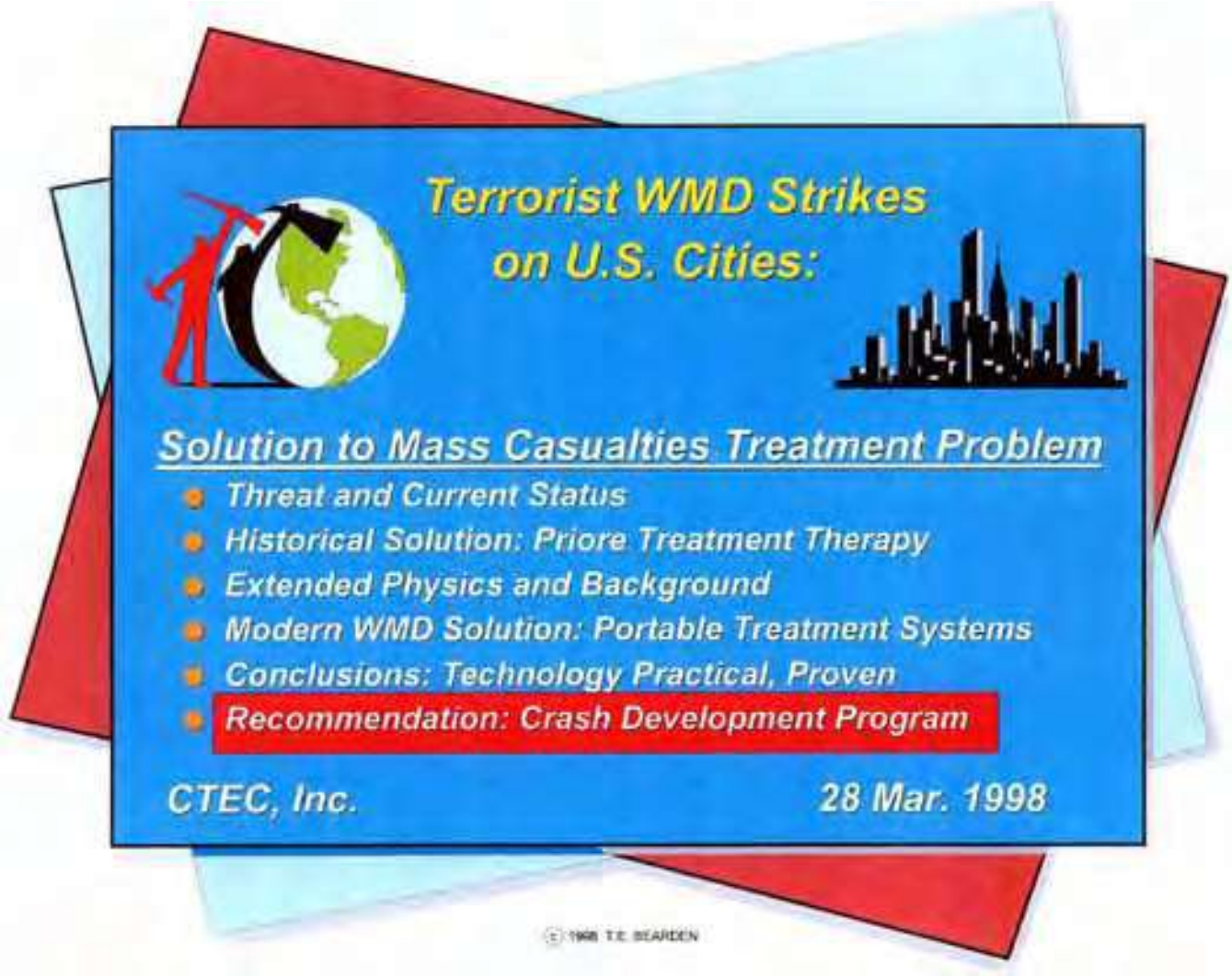

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Recommend implementing:

- Crash development program
  - Suitcase-sized portable unit
  - 18-month Manhattan-type project
  - Simultaneous theoretical modeling, animal testing w/breadboard models
  - SecDef and Congressional overwatch
  - Presidential Decision Directive
- Parallel logistics support program
  - Plan high speed production lines
  - Mass distribution, storage, maintenance
  - User, maintenance training
  - Plan C4 and usage at all levels
  - Integrate firemen, police, National Guard, FEMA, medical facilities, etc.

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Final Thoughts:

- The current internal BW threat can and will kill more Americans than all our previous wars combined
- The Priore technology is the only solution in sight that can save most of those casualties

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CTEC, Inc.
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Huntsville, AL 35801
(256) 533-3682 Ph/
(256) 539-5951 Fax

CTEC, Inc.

June 24, 1998

Dr. Jane F. Kinsel, Director
Office of Policy Analysis
Department of Health & Human Services
Bathesda, MD 20892

Dear Dr. Kinsel:

Your letter of June 8 is appreciated. However, the entire action package had already gone to the Assistant SecDef and also to Major General Neary in the USAF.

The proof of a revolution in medical treatment was in the package. The basis for it is already demonstrated experimentally in the scientific literature, both in the U.S. and in France. We are speaking of something already proven, but missed by the entire U.S. medical community. Strong words, but true. Let me be specific.

Any cell in the body can be time-reversed (physics term) or dedifferentiated (biology term) back to an earlier state, by pumping (i.e., "squeezing" in simple terms) that cell with longitudinal EM waves as pump waves. There are considerable papers in the French scientific literature showing the experimental results.

Apply that to cancer. We are stating bluntly that all cancerous cells in the body can be "depromoted" back to normal cells easily. Further, the damage previously done to them (such as by sustained hypoxia due to contaminants reducing the oxygen-carrying ability normally given to it by some 60-to-80 surrounding water molecules per red cell and the consequent H-bonding interactions) will also be reversed. The cells can all be returned to healthy, normal cells again, without "killing" or "burning" or "cutting" anything.

With some development of the technology, you can quickly and easily cure every cancer patient in every hospital in the United States.

Now apply it to AIDS. Since you can time-reverse every cell in the body, you can time-reverse the HIV-infected cells – genetics and all – right back to normal cells with normal genetics. Those cells not infected and healthy, will just get a "little younger" again.

So with that small development, you can quickly and easily cure every AIDS patient in every hospital in the United States.

I would have thought that NIH would certainly be interested in such a revolutionary therapy which has already been demonstrated in laboratory experiments. World-renowned French scientists – such as the eminent parasitologist Pautrizel and research PhDs assigned directly by Robert Courrier, head of the Biology Section of the French Academy of Sciences, worked with Prioré in performing those startling experiments that proved what we are saying.

The method was rigorously shown to cure infectious diseases (such as trypanosomiasis), atherosclerosis (which now afflicts millions of Americans), and terminal tumors. It was shown to reverse suppressed immune systems back to normal vigorous functioning.

Please permit me to disagree with you that the examination of such is not the mission of the NIH. To the contrary, it is precisely the NIH which should have some of its very best scientists looking into this.

The action package to DoD was to propose a crash program to develop this methodology in the form of a small, portable unit for treatment of mass casualties resulting from a terrorist BW attack on our cities (now expected in the next few weeks, as you must be aware). The leading Arab terrorist of the world has already promised just this.

We are speaking of several million Americans who are going to die. They are going to die in spite of everything that NIH and its labs can do, even though I know you will make a heroic effort. With NIH present methods, you cannot do very much for those stricken Americans at all. Everything we have in the "normal" kit bag is almost useless against a knowledgeable spray attack of modified smallpox (as you know, the Russian secret BW labs have made and sold tons of that already, to guess who!). Or a spray of tularemia (you are well aware of the extreme lethality of that), or anthrax (easily obtained). It is also common knowledge that these terrorist teams with their BW agents are already on site in this country, waiting for the word to attack. This has now been officially raised to our primary Strategic Threat.

In the face of such looming strikes on the U.S., I simply cannot believe that the NIH does not feel it within their mission to rigorously check out a proposed method for saving perhaps 70% of those coming deaths (first generation equipment), and up to 90% with second generation equipment.

Perhaps you just did not read the package carefully. I urge you to do so.

Else NIH is going to look very, very bad when (1) the strikes do occur, (2) they can't handle them (and they cannot, as you well know), (3) they had within their hands in advance, a proposed methodology that could have been investigated intensely, to save millions of those stricken Americans.

As a staunch supporter of NIH and especially CDC, I have to believe that there is a different attitude there. If NIH is not interested in a previously experimentally demonstrated method of saving millions of Americans, then the only recourse left is the political channel.

I assure you that my critique of electrodynamics is well-founded, as supported by various leading physicists such as Nobelist Feynman (who stated bluntly that the field concept is wrong), Wheeler, Bunge, and so on. It is inexplicable why all our universities are still teaching a 130 year old abridged (Heaviside's) subset of Maxwell's theory, and one that still contains a material ether even though that was falsified 110 years ago!

You already have seen the misuse of this technology by the Russians, in the decades-long radiation of the U.S. Embassy in Moscow. Is it not NIH's mission to understand how they generated all those diseases and health changes? Have you ever looked into Kaznacheyev's experiments showing that ANY cellular disease or disorder can be induced in cells at a distance by purely EM means? Have you looked into what got eliminated from electrodynamics by ignoring the hidden longitudinal EM inside every potential, field, and wave? Do you realize what ignoring that has done to American chemistry, biochemistry, and medical science?"

I would hope that the NIH would at least be interested in its own mission area!

I challenge you bluntly to admit that no one presently understands the primary operation of the human cellular *regenerative* system. That's because its technical principle is not presently in our recognized physics, biochemistry, and medical science – even though it has been in the hard physics literature since 1903-4. Becker's epochal work came closest; since he only had access to the conventional EM model, it failed him. But he at least showed you rigorously that cells can be changed (both differentiated and redifferentiated) all over the map by laughably weak EM – picoamperes of current, which means persistent DC potentials. In the microwave radiation of the U.S. Embassy, all the health changes occurred in regions absent of fields – i.e., absent of bleed-off of the potentials. Hence in regions of stable DC potentials! With 100% correlation of the health changes to persistent, gradient free potentials, and 100% anticorrelation to changing potentials (i.e., fields), our own scientists concluded totally erroneously that it could not have been the EM radiation causing the changes, when their own results had just proven that it was.

Now I ask you: Can NIH explain how it was that the DC potentials caused those health changes? I think not. If it could, it would understand the action package I wrote, and its importance.

This is not a "political" letter. I'm just an ordinary American citizen who has done about 30 years very hard work on this particular area. The work is good enough now to stand on its own merits. The scientific community will eventually accept it, about 50 years from now. But we cannot wait 50 years! Those millions of Americans are going to die, because of the bureaucracy and inaction of our own scientific organizations. Whether they like it or not, the U.S. scientific community is now the forefront of the struggle for this nation to survive. And they are failing us dramatically.

So as a parent who wants his children to live, and his neighbors' children to live, and those millions of soon-to-be stricken Americans to live also, I urge you to at least have someone competent in physics (and knowledgeable that the foundations of physics itself are in woeful shape!) check the work. Has anybody there *read* any of the references to the Prioré work I cited? Does anyone there realize that *there are no EM forcefields in space?* Probably not.

Dr. Kinsel, there is a time for "business as usual" and there is a time to do some serious new work. Those stricken Americans are going to be lying there. Nothing NIH can do is going to stop that. That's a given, and it is not my own estimate. It's the official estimate. And you *know* you presently do not have the tools to do anything really effective about it.

Frankly, I interpret your letter to me as just the normal "spin control" for easy disposition. I would hope that NIH would seriously rethink the situation, get off the "spin control" and "business as usual" posturing, and do something dramatically different for a change.

What have you got to lose? A little time from perhaps two or three of your best scientists.

What have you got to gain? Saving untold millions of American lives. A new, *already partially demonstrated* cure for most dread diseases such as AIDS and cancer – diseases which you presently cannot do very much about in spite of decades of heroic struggle.

Sincerely,

cc: Senator Shelby, Congr. Cramer

T.E. Bearden
President and CEO

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2311 Big Cove Road
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(256)533-3682 ph/(256)536-0411 Fax

CTEC, Inc.

May 12, 1998

Dr. Harold Varmus, Director
National Institute of Health
Bathesda, MD 20892
(301) 496-1766

Dear Dr Varmus:

We have recently sent action documents to the Director of Nuclear and Counterproliferation, Office of the DCS, Air and Space Operations, HQ USAF and to the DoD (General Busbee) Assistant Secretary of Defense, as well as several Senate and House committees, which may be of interest to you. For one thing, we give the technical mechanism used to generate the Gulf War Syndrome. The same weaponry is now being used to rapidly induce new strains of certain pathogens worldwide. I urge you to closely read that section of the letter to MG Neary which explains the GWS, why the French did not get it, and why Southern Iraqis got an increase in cancer and leukemia but not GWS. Also explained is how the "microwave radiation" of the U.S. Embassy in Moscow induced diseases for decades, and how we failed to comprehend it because the standard EM model deceived us.

There is a way to treat and quickly cure most diseases, including the mass casualties resulting from a terrorist BW strike on our civilian population centers, our military bases, or our forces in the field. The method is little known, but was scientifically demonstrated in France in the 1960s and early 1970s before cancellation of the Prioré Project when the French Government changed. Eminent French scientists worked on the project, and the results are fully documented in leading French scientific journals. References are listed in a separate attachment.

Previously the Western scientific community has been unable to understand the technical mechanism responsible for such remarkable cures, because of serious foundations flaws in Western physics and electrodynamics. *Foundations* physicists have long been aware our science is flawed, and have pointed out many of these fundamental errors. However, the operational science establishment has not paid attention, even though physicists such as Feynman and Wheeler pointed out that the notion of "force fields in space" was totally wrong.

As a primary example, there is an "infolded" electrodynamics inside all potentials, fields, and waves that is far more primary than the coarse EM that is in our textbooks. It is actually an infolded general relativity, and this is what the Russians have weaponized. This infolded EM-GR has been ignored in the West (but not in Russia) since 1903.

As another example the potentials, fields, and waves of present electrodynamics are rigorously defined – and exist – only in the presence of mass. They do not exist in such form (force fields and oscillating force fields) at all in space, in the absence of mass. Rigorously, Maxwell's equations are mass-to-mass transforms, since Maxwell and everyone at the time assumed the ubiquitous presence of the material ether. In other words, to the founding electrodynamicists, there was no place in all the universe that was devoid of mass. Hence they defined all EM entities as entities containing mass. Even though Michelson-Morley experiments of more than a century ago destroyed that material ether, not a single Maxwellian equation has ever been changed! They still assume the material ether.

Specifically missing from our electrodynamics are two essential transforms: (1) the mass-to-spacetime transform, and (2) the spacetime-to-mass transform. In other words, these two transforms are "infolded" or hidden inside (comprise) the end point extremum case – the mass-to-mass transform actually written by Maxwell.

But these two missing transforms are just general relativity (they correspond precisely to Wheeler's principle of general relativity). So general relativity has always been infolded inside electrodynamics as we know it, but ignored. Further, this is a very powerful general relativity, since it uses the very strong EM force as the agent of spacetime curvature. Hence now one can engineer a powerful general relativity in the laboratory and in practical devices, and even action-at-a-distance, which one cannot do using merely the staid and weak G-force.

It turns out that longitudinal EM waves as shown by E.T. Whittaker in 1903 and 1904 are far more primary than our present EM theory and even our present GR theory. Both EM and GR are directly engineerable using longitudinal EM waves, including subluminal and superluminal EM waves in vacuum, and including action at a distance. One can engineer complexes of spacetime curvatures as desired, which in turn are *spacetime engines* (Wheeler's term). These engines can act upon mass – either living or inert – in any fashion desired, and at any distance desired.

The little-known and poorly understood Regeneration & Recovery (R&R) system – as contrasted to the immune system – utilizes this exact "spacetime engine" methodology to restore damaged or diseased cells, within its limitations – "dedifferentiating" or "time-reversing" them back to normal. The mechanism is fully explained in the attached package. The proposed program applies this fundamental method to greatly amplify the effect. Thus cancer cells can be reversed back to normal cells, HIV-infected cells (HIV-factories) can be reversed back to normal cells (genetics and all), etc. This represents a dramatic and unparalleled new medical therapeutic methodology of extreme power. The same techniques can simply be conjugated one additional time, and used to produce diseases and cellular changes at a distance, including in entire mass populations, as the KGB is doing right now. Specifically, by impressing an extremely weak "cocktail mix" of disease spacetime engines on the U.S. populace, the immune systems are reacting and being "spread thin" across several "shadow state" infectious pathogenic conditions. Thus when an actual terrorist BW attack occurs, the lethality of the strike will be remarkably enhanced because the immune systems will be "thinned" in their ability to fend off this new pathogen. By doing it this way, BW warfare can actually be conducted upon the U.S. without anyone being the wiser.

Our very survival as a nation is threatened by remarkable KGB weapons using this fully documented, extended electrodynamics. Bluntly, unless we take off our scientific blinders and understand Russian energetics weapon science, GWS and the Embassy health changes in Moscow were just a picnic before what is upon us. After two decades of work on the KGB energetics weapon problem, we have fully deciphered the technical mechanisms and what energetics is, as well as citing many of the Russian weapon tests and how they were done. Again, you can see that for yourself in the package.

Now that we understand the technical mechanisms, we are proposing rapid redevelopment of the Prioré process, in portable suitcase-sized units to be mass produced and filtered down into the entire emergency community for mass treatment of lethal infectious diseases resulting from BW strikes. And we are strongly urging the U.S. scientific community to quickly investigate and come to grips with this vast new *biological engineering* mechanism. Our very survival depends on it.

The inclosed documents provide an overview of the process. There is nothing else on the scientific horizon that can save the majority of all those stricken Americans, once the first foreign-sponsored terrorist teams strike our population centers with BW agents.

Sincerely,

Incls: Full package with table of contents

T.E. Bearden
President & CEO

Weapons Slides

The Tom Bearden Website

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"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts." *

Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

Slides
(covers period up to 1999)

- The Coming Strategic Attack on the United States
- Outline
- Loss of two separate A-10 Warthogs in 1997
- Typical ABM Defenses (Widely Deployed by mid-70s)

- Launch Phase Anti-Missile System
- Launch Phase Anti-Bomber System
- HC-130s Engines Quit, Aircraft Crashes
  Nov. 22, 1996
- 1996 Actions by this analyst
- Additional Information Exists: Not Analyzed, Not Integrated in Briefing
- Kill of Arrow DC-8, Gander AFB, Dec. 12, 1985
- Satellite Photos of Plumes in Soviet Arctic Since 1974
  See "Fer de Lance" for additional information
- Aum Shinrikyo ("Supreme Truth" Cult), Shoko Asahara, Leader

  Aum Shinrikyo - Anatomy of a Dangerous Cult
- Ashkhabad Problem and Its Solution
- Strange Characteristics of Iran Quake, Sep. 1978
- Iran Earthquake, September 1978
- Situation Now (Assessment)
- Situation Now (Assessment 2)
- Aspects of Strong Local Asymmetry
- Mass Casualty Problem: Aerial Anthrax

Spray on Washington, D.C.

- Present Status of the WMD Threat to the United States
- Some Present Problems in the U.S. WMD Defense Capabilities
- Internal Terrorist Threat with Weapons of Mass Destruction: Now & Future
- Attempt to Ban Energetics Weapons Worldwide
- Brezhnev's Schedule
- Large glowing Tesla globe witnessed in Red China by hundreds
- Cold Explosion -- 9 April 1984 Near Kurils, and formation and growth of spherical shell (globe)
  Sequence of Events
- Cold Explosion -- 9 April 1984 Near Kurils, and formation and growth of spherical shell (globe)
  What They Were
- Cold Explosion -- 9 April 1984 Near Kurils (Plus additional weapons effects)
- Countering Insane MAD Systems:
  Find Loophole, Exploit It
- Next Generation Counter to Both Sane and Insane MAD systems
- Simultaneous Dudding of Nuclear Weapons Worldwide

- Simultaneous Dudding of Nuclear Weapons Worldwide
- Operation Divine Wind II
- Advanced EMBW Applications
- EM Biological Warfare (EMBW)
- Microwave Radiation of U.S. Embassy in Moscow
- Pentagon EMI Studies, 1989
- EM Missile Practice (6 slides)
- Subdivisions of Soviet Energetics Program
- Communism's Goal
- Manuilsky's Goal vs. Status Today (Dec. 1996)
- Professor Hellman, German Scientist Released from Work in Soviet Union
- Hemispheres and Globes of Light (4 slides)
- How Could Such Superweapons Ever Be Concealed?
- Soviets Easily Concealed These Superweapons for Four Decades
- Microscope-type, laser-like interferometer for inducing quick α-decay in samples of otherwise longer-lived isotopes
- Longitudinal Wave Interferometry: Endothermic

- Longitudinal Wave Interferometry: Exothermic
- U.S. Air Attack on Libya, April 1986
- Lightning Wall
  circa 1959-1960
- Lisitsyn's Report: Brain Code Broken
- Large Longitudinal Wave Interferometer (LWI) Accident
- Large Longitudinal Wave Interferometer (LWI) Accident
- Use of Hidden Information Content of the Field Can Provide Action-At-A-Distance
- Two Types of Mutual Assured Destruction (MAD) System
- Psychoenergetics Weapons Teams Mentally Disable All Personnel
- Strikes Against Special Ship and Energetics Weapons Sites
- "Mindsnapper" Attack on Special Ships and Energetics Weapons Sites
- How Much Off Guard Are We?
  (7 Slides)
- Possible Targets: 1995-9 Escalation Phase
- Propagation of Weapon Effects
- Yugoslav Earthquake, Followed by Cold Explosion
  April 15th, 1979

- Countering an Insane QP Weapon
- Gulf War Disease: KGB QP Weapon Induced ST Curvature Engines for a Cocktail of Diseases
- Self-Targeting in Inner EM Channel Can Produce a Quantum Potential
- Mechanism for Producing a Quantum Potential
- Major Principles for Use of Quantum Potential Weapons
- Major Principles for Use of Quantum Potential Weapons (2)
- Instantaneous Communication by a Quantum Potential
- Participants in a quantum potential share a common multiply-connected spacetime (MCST)
- Quake in Tangshan, China
  28 July, 1976
- Exchanging Earthquakes
- Instant Communication by a Quantum Potential
- Westerners Do Not React to Slow Threats
- Characterizing a Given Risk or Risk Factor
- Technical Risk Management
- Aum Shinrikyo's Sarin Facility

- In Scalar Beam Interference Zone
- Physicist Schappeller Auralaz Munster, Austria
- Initial Soviet Plan for Cold War, After WWII
- Josef Stalin: Absolute Dictator
- Exploding any Resistance by Operational Scientists
- Significant Soviet Statements
- Captain Svoboda Dives Headlong to Her Death
- T-polarized Beam Projector
- Possible Tests (1)
- Possible Tests (2)
- Possible Tests (3)
- Possible Tests (4)
- Mushroom Cloud Rising From Sea
- Launches from Cape Canaveral and Vandenberg AFB Provided Practice Targets of Opportunity
- The sinking U.S.S. Thresher, with her controls jammed, implodes when she reaches crush depth
- Embodiment of an instrument array sufficient to discriminate when time-density charging has occurred, and that transduction

of time-charge decay has occurred.

- Time-Polarized EM Wave Interferometer Creating Space-Time Curvature Engines in a Distant Interference Zone
- Transmutation of Radioactive Nuclei at a Distance
- Transmutation of Radioactive Nuclei
- Typical Tesla Shield, Northern Route of Japan
- A Curious Tide in Human Affairs
- Large Scalar EM Interferometer (LASI) Accident Near Urals, 1958
- The Superpower Paradox: Asymmetric Cheap WMD Strategic Strike and Destruction
- The KGB/Yakuza-Aum War Plan
- Why Western Science is Ignorant of KGB Energetics
- Transmutation of Radioactive Nuclei at a Distance
- TheYakuza
- Yugoslav Earthquake, Followed by Cold Explosion
  April 15, 1979

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* Note that the Secretary did not speak the words in square blocks; these were added by the writers later,

probably to "soften the tone" of the Secretary's information release. So the Secretary confirmed that some nations of the world -- not just some ragged terrorists, as the writers tried to imply for spin control -- do possess novel electromagnetic weapons and are using them to induce earthquakes, engineer the weather and climate, and trigger volcanic eruptions.

THE COMING STRATEGIC ATTACK ON THE UNITED STATES

By an AUM/Yakuza/KGB/Communist Coalition Using Energetics SuperWeapons

T.E. Bearden, LTC
U.S. Army (Retired)
M.S. Nuclear Eng.
Fellow Emeritus, AIAS

With Technical Background and History of Energetics Weapons

Partial support by the Association of Distinguished American Scientists is gratefully acknowledged.d

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Outline

- Background: Classical Electromagnetics (and Defects)
- Background: Energetics (Scalar Electromagnetics)
- Background: Soviet Energetics Weapon Development
- KGB/Communist Plans
- Countering of Soviet/KGB/Communist Plan in Mid-80s
- Soviet Economic Collapse and Adaptation of Plan
- Weapons Bleed-Out: KGB/Russian Mafia
- Yakuza: The Japanese Mafia
- Aum Shinri Kyo (Supreme Truth) Cult
- Coalition: Aum/Yakuza/KGB/Communists/Russian Mafia
- Operation Divine Wind II: Three Phases
  - Phase I: On-Site Training Phase (Completed)
  - Phase II: Escalation Phase (In Progress)
  - Phase III: 1997 Strategic Strike on the United States
  - Support Plan A: Feints, Deception, Sabotage & Terrorism
  - Support Plan B: Test Range
  - Support Plan C: Worldwide Weather Engineering
  - Support Plan D: Strategic and Combat Intelligence
- Special Information
- Recommended Actions

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Loss of two separate A-10 Warthogs in 1997

- A-10 Mysterious Flyaway and Crash - April 2, 1997
- Death of Second A-10 Pilot - May 27, 1997
- Captain Button's Mysterious Flyaway and Eventual Crash
- Death of Second A-10 Pilot - May 27, 1997

A-10 Mysterious Flyaway and Crash

April 2, 1997

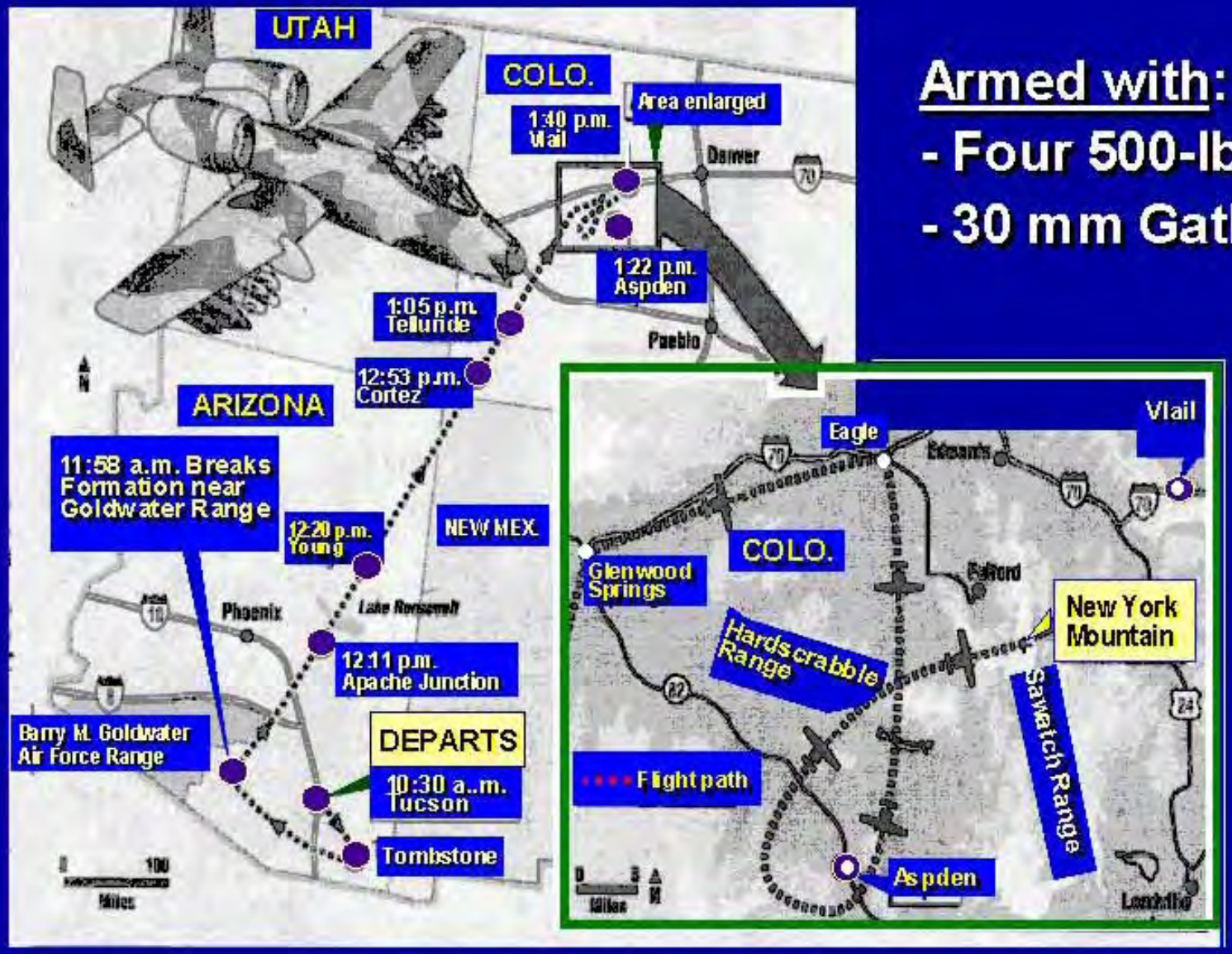

Armed with:

- Four 500-lb bombs
- 30 mm Gatling gun

Death of 2nd A-10 Pilot May 27, 1997

- Captain Amy Svobody
- Night training mission
- From Davis-Montham AFB
- From same wing as Captain Button, who flew his A-10 off course for over an hour and then crashed on April 2.
- Climbout from ordnance delivery on target
- Nosed down sharply and dived into ground

Companion A-10's

- Experienced night flyer & instructor
- Nosed sharply over and flew into ground
- Psychoenergetic kill

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Psychoenergetic weapon induced instant hypnogogic state and reversed Svoboda's sense of up and down.

A-10 Mysterious Flyaway and Crash

April 2, 1997

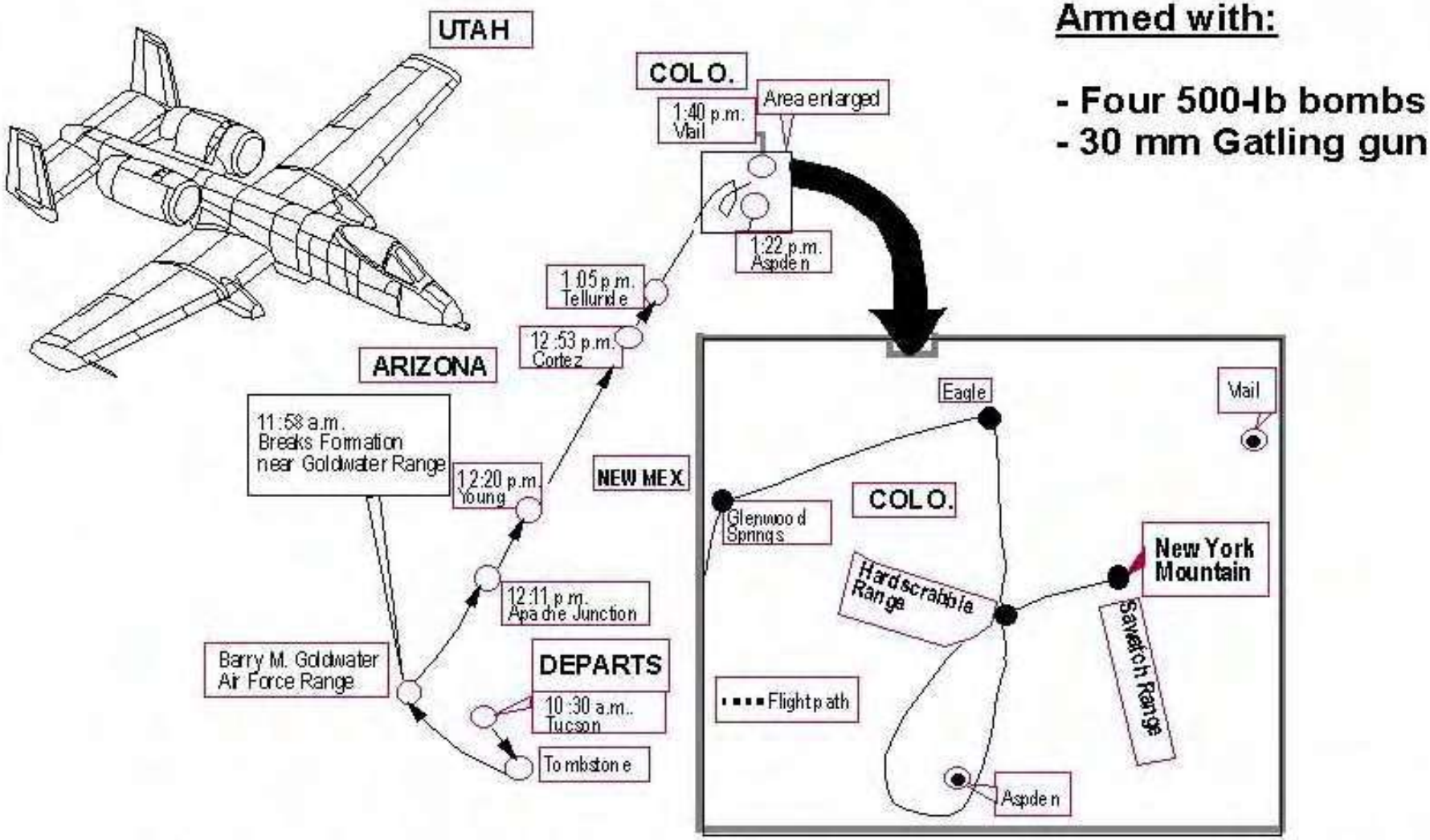

Armed with:

- Four 500-lb bombs
- 30 mm Gatling gun

Figure 14a. Captain Button's mysterious flyaway and eventual crash.

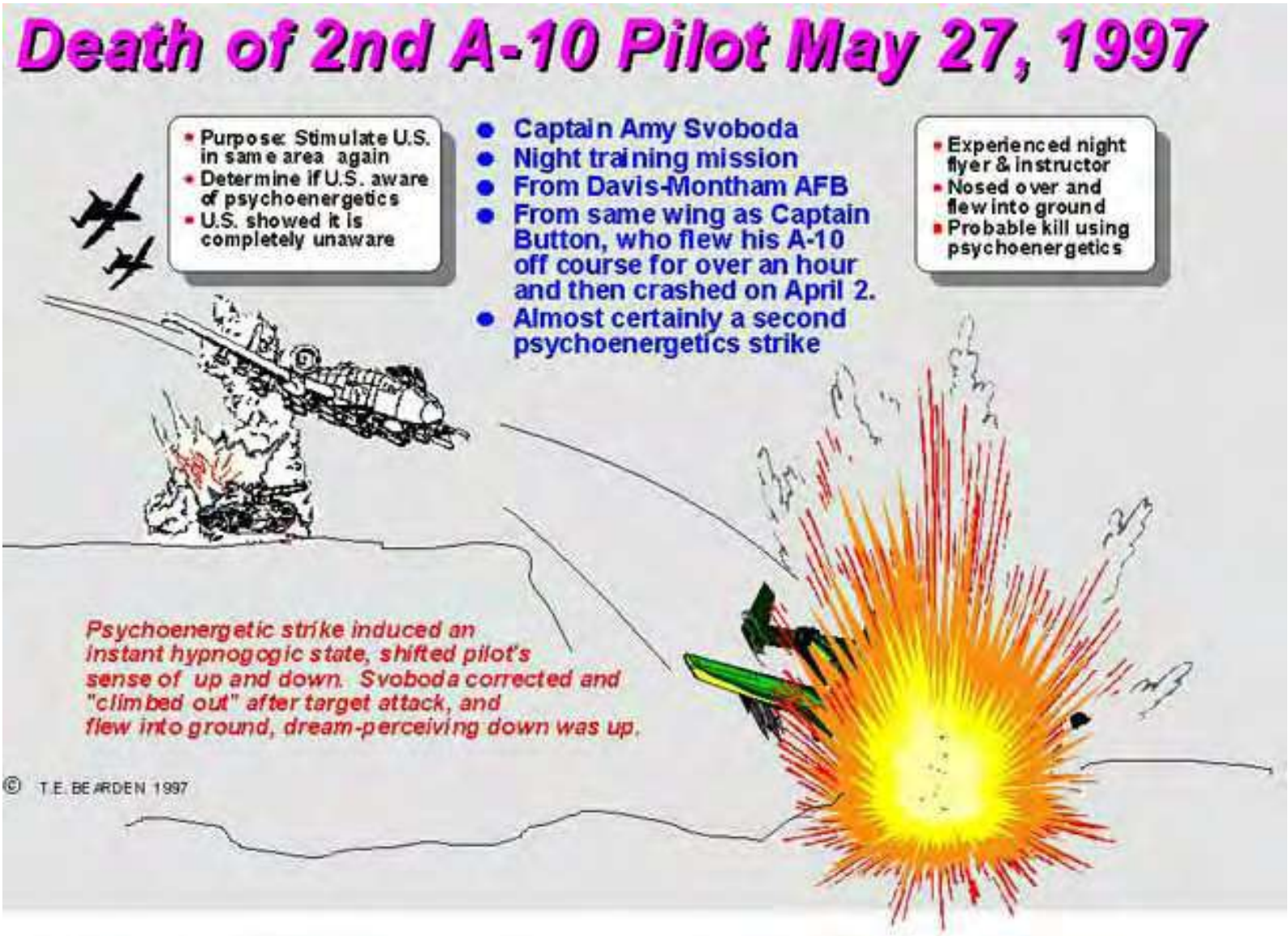
Death of 2nd A-10 Pilot May 27, 1997
• Purpose: Stimulate U.S. in same area again
• Determine if U.S. aware of psychoenergetics
• U.S. showed it is completely unaware
• Captain Amy Svoboda
• Night training mission
• From Davis-Montham AFB
• From same wing as Captain Button, who flew his A-10 off course for over an hour and then crashed on April 2.
• Almost certainly a second psychoenergetics strike
• Experienced night flyer & instructor
• Nosed over and flew into ground
• Probable kill using psychoenergetics
Psychoenergetic strike induced an instant hypnogogic state, shifted pilot's sense of up and down. Svoboda corrected and "climbed out" after target attack, and flew into ground, dream-perceiving down was up.
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Typical ABM Defenses
(WIDELY DEPLOYED BY MID-70's)
GLOBAL SHELL
(MIDCOURSE
ELECTRONICS
DUDDING)
INTENSE ENERGY SHELLS
(Destruction of vehicle)
(Initiation of nuclear
warheads)
© T.E. BEARDEN 1999
EM MISSILES
EARTH'S SURFACE
ENERGETICS
HOWITZER
TRACK
(NESTED)
HEMISPHERICAL
SHELL(S)
(Dudding, initiation,
destruction)
LAUNCH
PHASE
DEFENSES
TERMINAL
DEFENSES

LAUNCH PHASE ANTIMISSILE SYSTEM

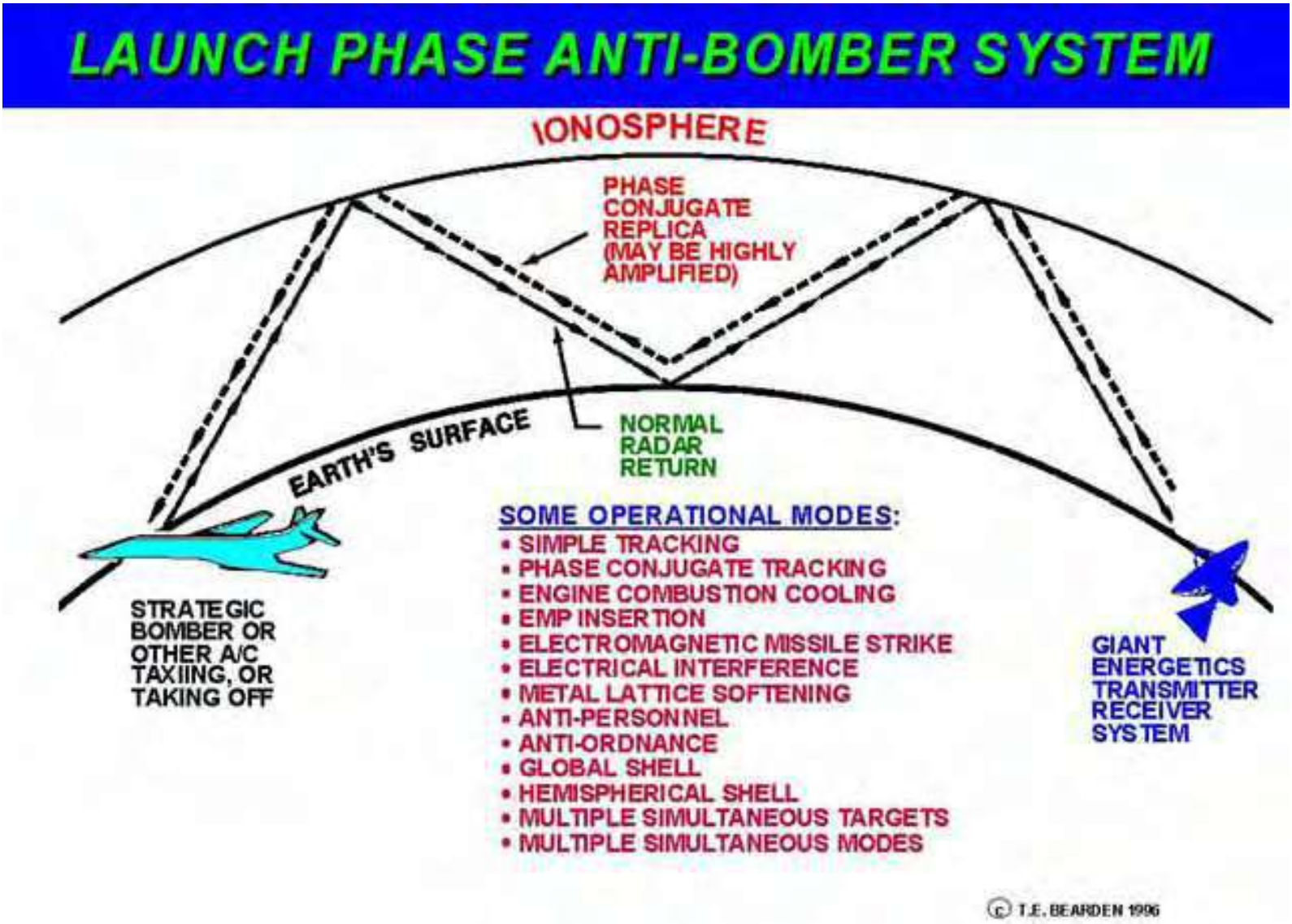
LAUNCH PHASE ANTI-BOMBER SYSTEM
IONOSPHERE
PHASE CONJUGATE REPLICA (MAY BE HIGHLY AMPLIFIED)
NORMAL RADAR RETURN
EARTH'S SURFACE
STRATEGIC BOMBER OR OTHER A/C TAXIING, OR TAKING OFF
SOME OPERATIONAL MODES:
• SIMPLE TRACKING
• PHASE CONJUGATE TRACKING
• ENGINE COMBUSTION COOLING
• EMP INSERTION
• ELECTROMAGNETIC MISSILE STRIKE
• ELECTRICAL INTERFERENCE
• METAL LATTICE SOFTENING
• ANTI-PERSONNEL
• ANTI-ORDNANCE
• GLOBAL SHELL
• HEMISPHERICAL SHELL
• MULTIPLE SIMULTANEOUS TARGETS
• MULTIPLE SIMULTANEOUS MODES
GIANT ENERGETICS TRANSMITTER RECEIVER SYSTEM
© T.E. BEARDEN 1996

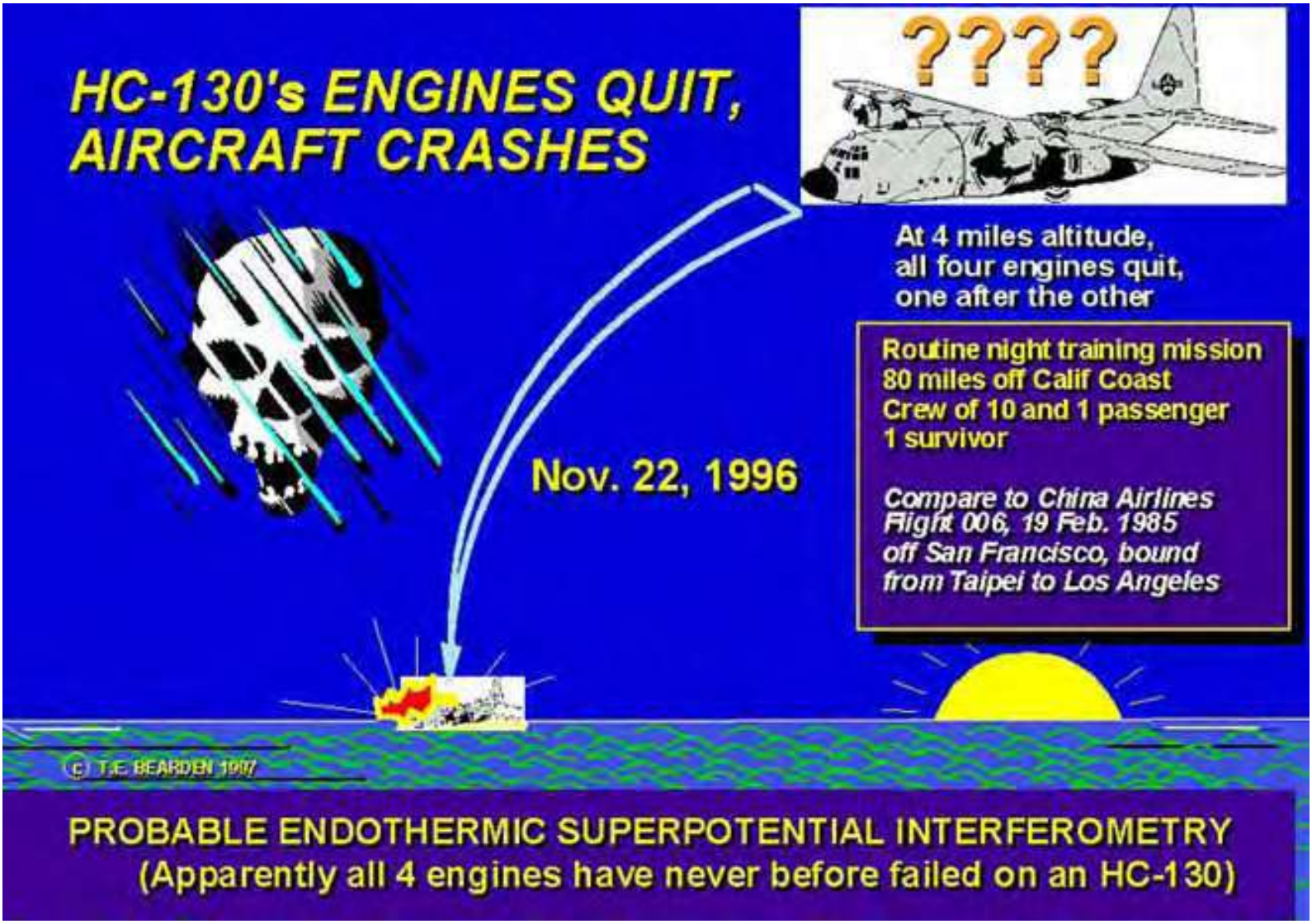
HC-130's ENGINES QUIT, AIRCRAFT CRASHES
????
At 4 miles altitude, all four engines quit, one after the other
Routine night training mission
80 miles off Calif Coast
Crew of 10 and 1 passenger
1 survivor
Compare to China Airlines Flight 006, 19 Feb. 1985 off San Francisco, bound from Taipei to Los Angeles
Nov. 22, 1996
© T.E. BEARDEN 1997
PROBABLE ENDOTHERMIC SUPERPOTENTIAL INTERFEROMETRY
(Apparently all 4 engines have never before failed on an HC-130)

CTEC PROPRIETARY

1996 Actions by this analyst

- In July 1996, with the kill of TWA-800 it became apparent that the KGB/Communists were preparing a massive strategic energetics attack upon the U.S.

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- Began intensive, nearly round-the-clock effort to uncover what was happening, and what had occurred in KGB/Com weapons since 1991
- Began preparing full-up set of briefing slides simultaneously
  - In early 1996, had briefed J6 on scalar EM, per his request
  - Had strongly suggested a follow-on weapons brief
  - Adamant opposition by NRL, NOL, others
- Similar energetics attack scenario in 1986 was countered. Soviets at that time did not possess operational QP weapons, and so could not successfully overcome dead-man fuzing
  - Also could not dud nukes worldwide, because QP required.
  - First lab prototype QP test was in April 1986
- KGB had solved the dead-man fuzing problem by QP's. Deployed circa 1989-1990. Some earlier weapons then leased.

Additional Information Exists; Not Analyzed, Not Integrated in Briefing

- Yakuza arranged involvement of
  - Red Chinese
  - North Koreans
  - A Taiwanese element
- Aum Shinrikyo may have been used as "Red Herring" to deceive West
- Oriental faction plots to strike Russians after the successful first strike on West
- KGB/Russians aware, will counter
  - Plan pre-emptive strike against Oriental faction first
  - Have reserved most advanced, powerful energetics weapons for that purpose

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Kill of Arrow DC-8, Gander AFB, Dec. 12, 1985

- Slide 1
- Slide 2
- Slide 3
- Slide 4
- Slide 5
- Slide 6

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Soviet EM missile weapon strike practice two weeks earlier at Cape Canaveral
► Offset from night shuttle launch
► EM missile photographed by Bob Gladwin
► Associated marker beacon photographed
• Canadian Board split on findings
► Half thought icing, half disagreed intensely
► "Due to icing" approved with half absent
► Separate dissenting finding issued
• U.S. officials hiding Iran/Contra affair
► Feared terrorist bomb, MidEast sponsor
► Pressured Board, Gen. Off. bulldozed site
• Lack of icing on aircraft later validated

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Eyewitness observed beams form in the sky
• Saw streak-down and strike of EM missile
– Struck right fuselage ahead of the engines
– Hole was burned through fuselage there
– Photo of hole published in AW&ST
– No explosive residues on hole
• Consistent with ignition and outgassing of plastics in forward cabin
• Consistent with pre-crash HCN deaths

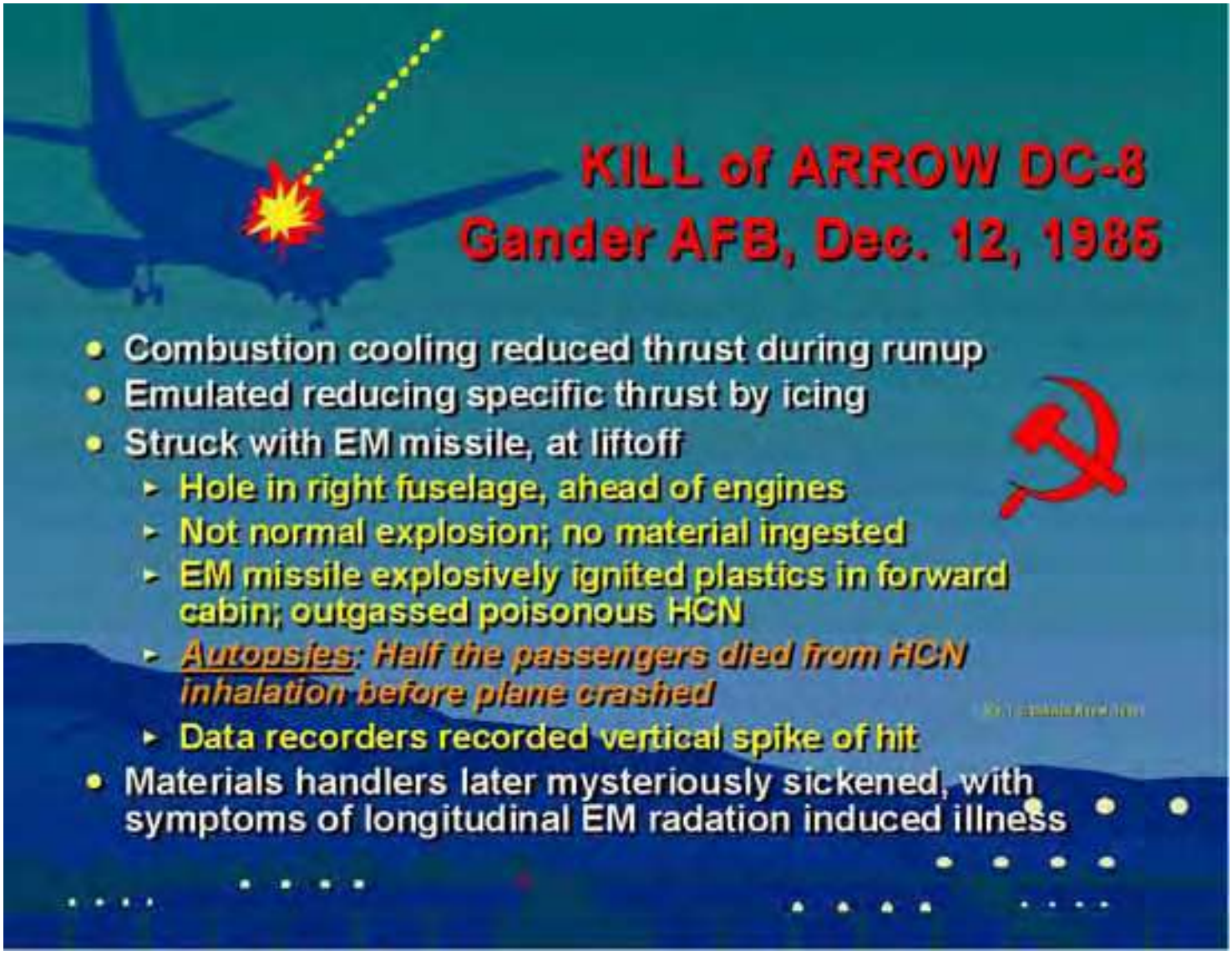
KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
• Combustion cooling reduced thrust during runup
• Emulated reducing specific thrust by icing
• Struck with EM missile, at liftoff
▸ Hole in right fuselage, ahead of engines
▸ Not normal explosion; no material ingested
▸ EM missile explosively ignited plastics in forward cabin; outgassed poisonous HCN
▸ Autopsies: Half the passengers died from HCN inhalation before plane crashed
▸ Data recorders recorded vertical spike of hit
• Materials handlers later mysteriously sickened, with symptoms of longitudinal EM radiation induced illness

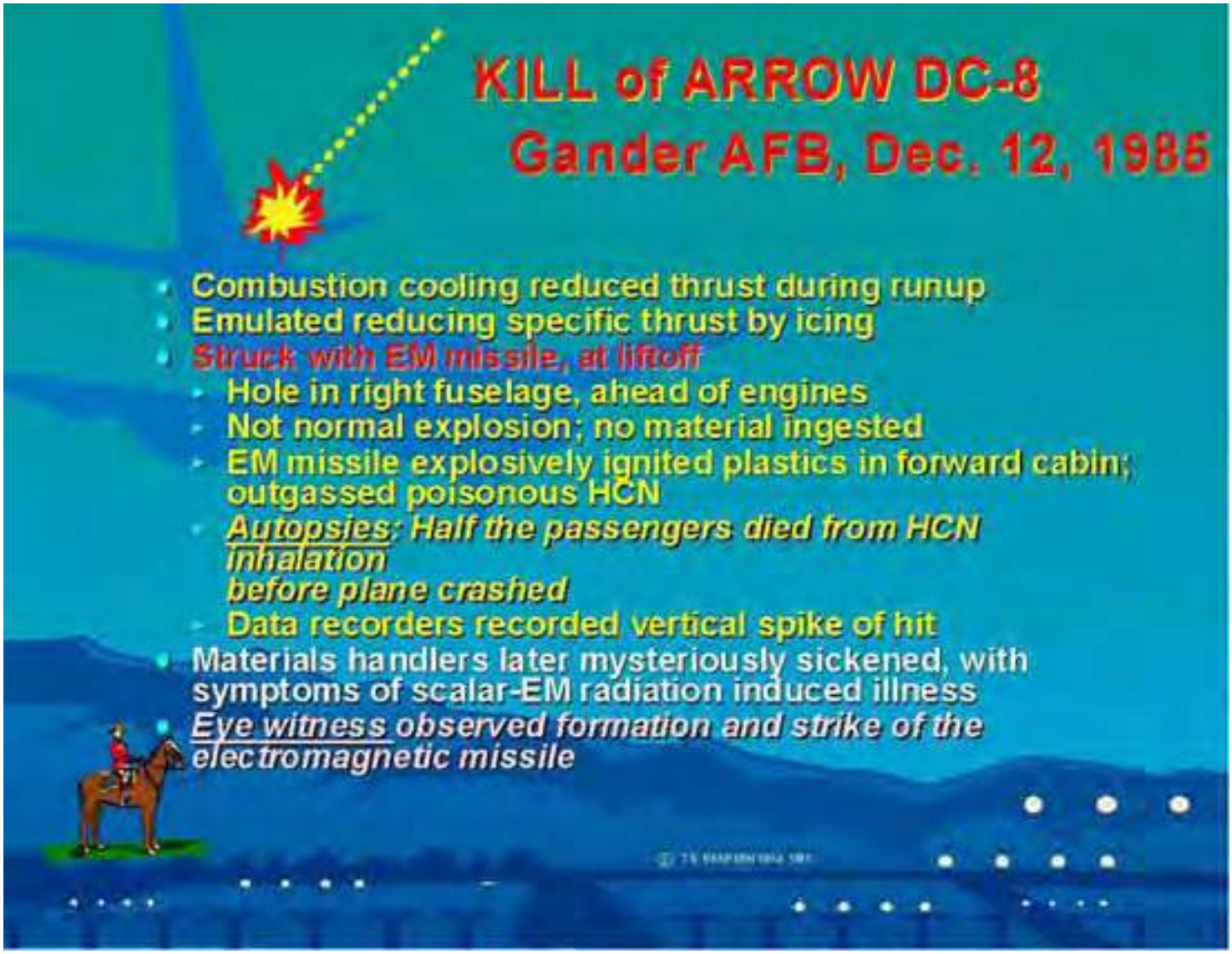
KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985
Combustion cooling reduced thrust during runup
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Hole in right fuselage, ahead of engines
Not normal explosion; no material ingested
EM missile explosively ignited plastics in forward cabin; outgassed poisonous HCN
Autopsies: Half the passengers died from HCN inhalation
before plane crashed
Data recorders recorded vertical spike of hit
Materials handlers later mysteriously sickened, with symptoms of scalar-EM radiation induced illness
Eye witness observed formation and strike of the electromagnetic missile

KILL of ARROW DC-8
Gander AFB, Dec. 12, 1985

- Soviet EM missile weapon strike practice two weeks earlier at Cape Canaveral
  - Offset from night shuttle launch
  - EM missile photographed by Bob Gladwin
  - Associated marker beacon photographed by George Suchary
- Canadian Board split on findings
  - Half thought icing, half disagreed intensely
  - "Due to icing" approved with half absent
  - Separate dissenting finding issued
- U.S. officials hiding Iran/Contra affair
  - Feared terrorist bomb, MidEast sponsor
  - Pressured Board, Gen. Off. had site bulldozed
- Lack of icing on aircraft later validated

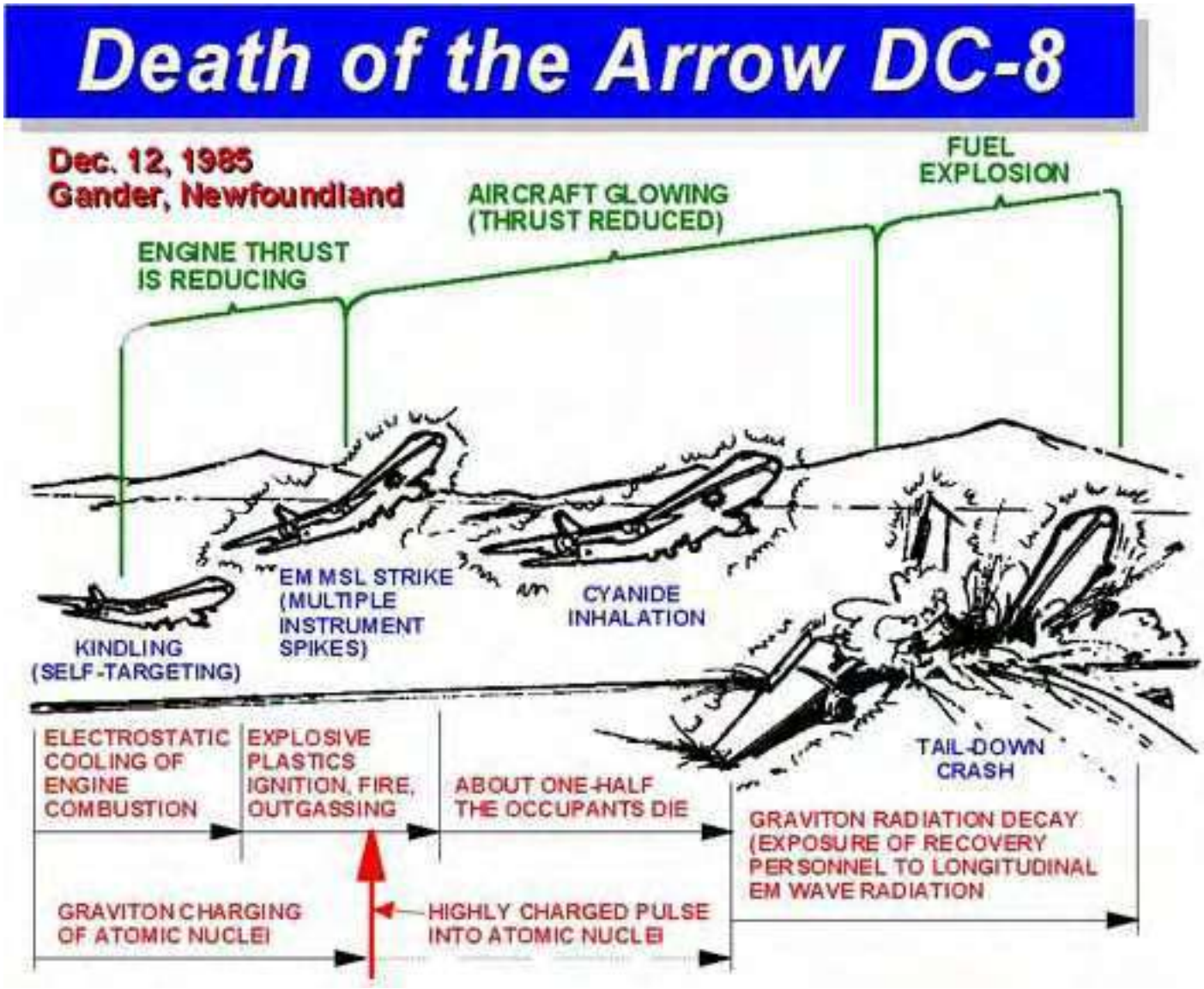
Death of the Arrow DC-8
Dec. 12, 1985
Gander, Newfoundland
ENGINE THRUST IS REDUCING
AIRCRAFT GLOWING (THRUST REDUCED)
FUEL EXPLOSION
KINDLING (SELF-TARGETING)
EM MSL STRIKE (MULTIPLE INSTRUMENT SPIKES)
CYANIDE INHALATION
TAIL-DOWN CRASH
ELECTROSTATIC COOLING OF ENGINE COMBUSTION
EXPLOSIVE PLASTICS IGNITION, FIRE, OUTGASSING
ABOUT ONE-HALF THE OCCUPANTS DIE
GRAVITON RADIATION DECAY (EXPOSURE OF RECOVERY PERSONNEL TO LONGITUDINAL EM WAVE RADIATION
GRAVITON CHARGING OF ATOMIC NUCLEI
HIGHLY CHARGED PULSE INTO ATOMIC NUCLEI

Satellite Photos of Plumes in Soviet Arctic Since 1974*

- Two aircraft flew through for analysis
  - Solid material, mostly ice, a little clay
  - Much colder than surrounding air
  - *Signature of cold exhaust from exothermic scalar interferometry operations*
  - No volcanic material
  - No radioactive material

- May be 2 to 3 times as many incidents
  - Only examined satellite imagery in winter
  - Only periodic satellite coverage
  - Hypothesized methane venting, cloud seeding

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*As of 1989, when this information was gathered

AUM SHINRIKYO
("SUPREME TRUTH" CULT)

Shoko Asahara, Leader

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Ashkhabad Problem and Its Solution

- ***PROBLEM:***
  - Stress increasing in two-plate fault zone
  - 1,000 shocks yearly
  - Kara Kum canal
  - Hydraulic pressure
  - 1948: Ashkhabad 80% destroyed by quake

- ***SOLUTION:***
  - Stress-relieve plate stresses from fault

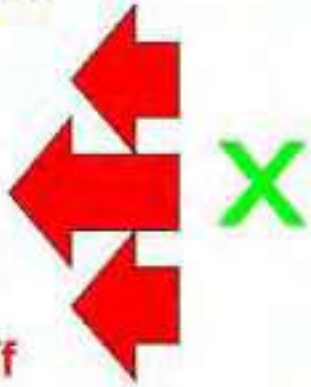

- ***IMPLEMENTATION:***
  - Induce nearby earthquake
  - Deceive by *predicting* a quake, setting off nuclear explosion

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Strange Characteristics of Iran Quake, Sep. 1978

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- **Signatures**
  - 7.4 on Richter scale
  - No aftershocks: 6.0 expected (normal)
  - Strange epicenter
  - Anomalous depth

- **Deception**
  - 10 MT Soviet nuclear explosion 36 hours before the quake
  - Prior disinformation regarding Soviet attempted development of focusing shock waves from underground nuclear explosions, to cause distant earthquakes

Iran Earthquake Sept. 1978

- Killed 25,000 Iranians
- Soviet city of Ashkhabad saved
- Soviets "predicted" quake in advance; then induced it
- Quake had serious anomalies (signatures)
- Deception measures were used by Soviets
  - Prediction in advance
  - "Theory" of quake-induction by nuclear explosions
  - Fired underground nuclear explosion as "Red Herring" candidate for cause

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Situation Now (Assessment)

- In May 1997: second A-10 pilot (lady), in pullup from night ordnance delivery on target, was struck with psychoenergetic weapon takeover. Sense of vertical was reversed. She perceived herself diving, sharply corrected, and dove headlong into the ground.

- Additional aircraft kills uncovered, including one 4-engine aircraft whose engines all failed. This closely repeats the earlier 1985-1987 scenario.
- Korean Airlines Flight 801 crashed on Guam on anniversary of loading of the atomic bomb that was dropped on Hiroshima in WW II. The Enola Gay, which dropped the bomb, took off from Guam in wee morning hours of August 6, 1945. The local opns order on Guam was also issued on Aug. 5.

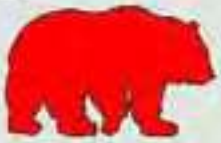

- *Presently the Coalition (KGB/Communists/Aum Shinrikyo/Yakuza) is waiting for proper time to launch the final strike. It is still on.*

Situation Now (Assessment 2)

- April 97: Mind control test against Captain Button:
  - Demonstrates ability to control crewman in complex operations for more than one hour.
  - KGB requires one hour total QP crew control on a site to have crew disable insane QP wpns.
- Once QP systems disabled, Mindsnapper attacks and instantly kills every living thing in QP site area. Contaminates area for months (emits longitudinal EM wave radiation, which disrupt any life forms attempting to enter struck area). Sites nullified.
- Mind control over one crewman requires one weapon system plus up to 20-30 operators for controlling thoughts, hearing, perceptions, etc.
- *In Apr. 97, KGB building and deploying weapons and training crews. Ready for new attack 1999-2000.*

Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum
- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another

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Mass Casualty Problem: Aerial Anthrax Spray on Washington, D.C.

- One terrorist, one light aircraft with spray tank
- One kilogram of anthrax
- Flies over greater metropolitan Washington, D.C.
- Calm night
- *1-3 million casualties result**
- *Most of those stricken will die*
- Presently little can be done to save the stricken civilians
- *Attacks on several population centers might produce some 10 million or more casualties*

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*Per OTA Report to Congress, 1993

Present Status of the WMD Threat to the United States

- Many foreign nations are hostile to the U.S. and sponsor terrorists
- Some 25 nations have WMD or are acquiring them
  - BW agents and weapons
  - Chemical agents and weapons
  - Nuclear materials and weapons
- Thousands of students and émigrés
- Infiltrated teams, BW, other WMD already
- Castro guerrillas infiltrated over the years
- Can do unacceptable damage to U.S. now
- *May reach first strike knockout capability*

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*Per OTA Report to Congress, 1993

Some Present Problems in the U.S. WMD Defense Capabilities

- No shelters (require overpressure, BW filtering, masks, showers, supplies)
- No stockpiled vaccines, medical supplies, immunoglobulins, masks, suits, food, fuel, generators, heaters, water purification units
- Totally insufficient medical facilities, personnel, and emergency response teams
- Triage, full martial law will be required
- No answer to massive decontamination problem
- State, county, city inadequately staffed and insufficiently trained for mass casualties
- Terrorist teams, BW agents, other WMD on site, waiting
- Water supplies, food, crops, farm animals also vulnerable
- Electric power grid, bridges, trains, railroads vulnerable
- Present medical science cannot save very many of the casualties, now or in the foreseeable future

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Internal Terrorist Threat with
Weapons of Mass Destruction: Now & Future
TODAY:
• Sabotage
• Chemicals
• Biological agents
• Nuclear materials
• Powerful explosives
• Assassination
• Kidnapping and hostages
• Contamination
• Shoulder-fired AD missiles
• Terrorism
FUTURE ADDITIONS:
• Orthodox EM weapons
• Energetics EM biological warfare
• Scalar EM (energetics) weapons
• Scalar EM disease induction
• Alteration of behavior and emotions
• Alteration of memory
• Direct control of thoughts, perception
• Quantum potential weapons
• Psychoenergetics weapons
• Action-at-a-distance effects

Attempt to Ban Energetics Weapons Worldwide

- On June 13, 1975, in a major speech Brezhnev urged the United States to agree on a ban of research and development of new kinds of weapons "more terrible than anything the world has known."
- On July 2, 1975 Brezhnev repeated his proposed ban on development of frightful new weapons, to a group of U.S. Senators.
- In August 1975, Ponomarev called for a ban on frightful new weapons of mass destruction.
- On Sept. 23, 1975 Gromyko presented a draft treaty agreement to the 30th Session of the UN General Assembly, for banning development of frightful new weapons.
- *No one had the foggiest notion what the Russians were talking about!*

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Brezhnev's Schedule

"We are achieving with detente what our predecessors have been unable to achieve with the mailed fist...
...by 1985 our power will be so irresistible that we can do what we wish anywhere on the globe."

Leonid Brezhnev,
in a secret 1973 meeting in Prague
with European Communist leaders.

"By the early 1980's we and our allies will control the high seas, space, and most of the earth's land area."

Kosygin,
to Imelda Marcos,
July 1978

In 1985-87, the Soviets did attempt to move, still constrained by nuclear dead man fuzing. That attempt was blocked, primarily by scalar EM countering demonstrations and dead man fuzing.

In April 1986, the first Soviet lab prototype of a quantum potential weapon specifically designed toward 10-min neutralization of nukes worldwide was gingerly tested against our U.S. airstrike on Libya. It was weakly tested in the "induced EMI" mode, for deception.

By 1990 that weapon was deployed and a new attack preparation phase was entered, scheduled for 1997.

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COLD EXPLOSION -- 9 April 1984 Near Kurils

And Formation and growth of spherical shell (globe)

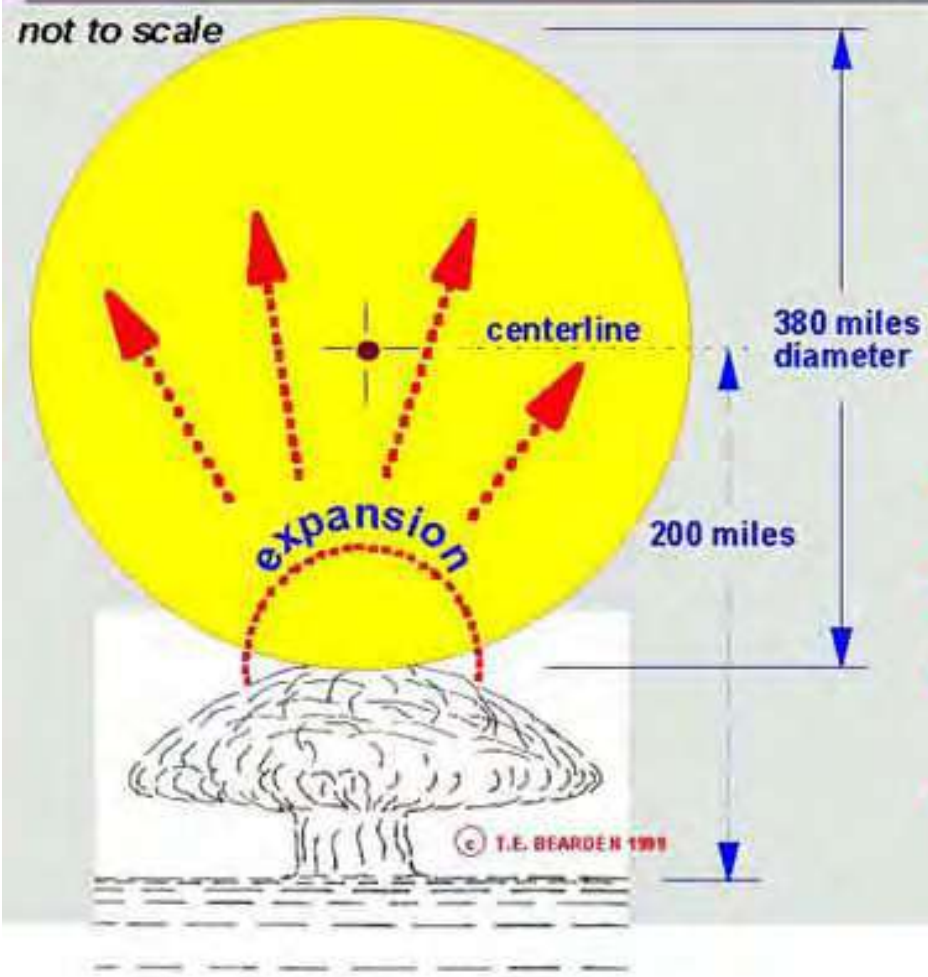

Sequence of Events

- Geyser of water rose rapidly from surface, mushroomed out
- Reached 60,000 feet altitude in two minutes
- Brilliantly glowing globe then appeared in top
- Globe increased greatly in size and altitude
- Reached diameter of 380 miles
- Center reached altitude of 200 miles
- Observed by multiple qualified pilots

COLD EXPLOSION -- 9 April 1984 Near Kurils

And Formation and growth of spherical shell (globe)

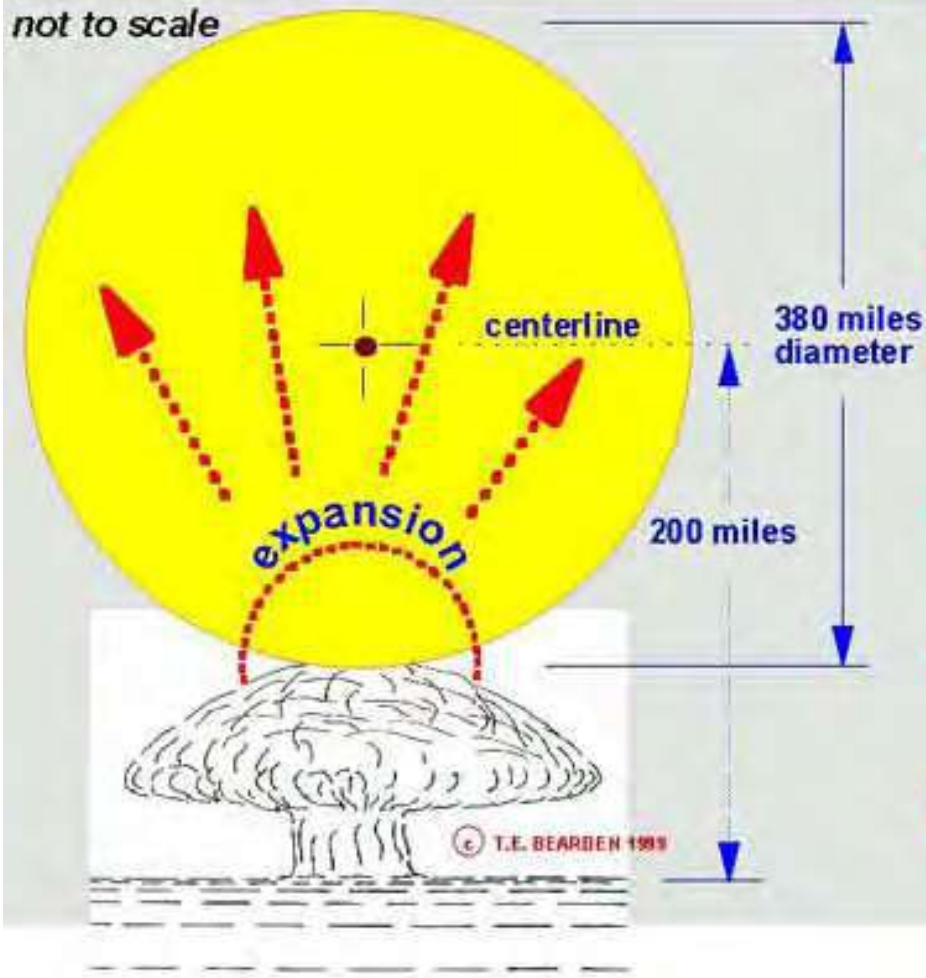

What They Were

- Superpotential interferometry using LWs
- First, a cold explosion just above surface
- Then small intense shell of glowing EM energy for 1-on-1 targeting
- Larger globe for large area as for ICBM targets approaching in zone
- With ST engines, can dud incoming nukes and all electronics
- Use in or out of Earth's atmosphere

COLD EXPLOSION -- 9 April 1984 Near Kurils
(Plus additional weapons effects)
JAL
Halo expanded to giant globe.
380 miles diameter, center over 200 miles
high.
© T.E. BEARDEN 1996

Countering Insane Mad Systems: Find Loophole, Exploit It

- If MADs not quantum potential systems, easily countered by instant QP strike which destroys targeted MAD weapons worldwide with certainty.
- Have to be certain of types of dead-man fuzing. All dead-man fuzing weapons must be included in the assured target list for the striking quantum potential weapon.

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- Multiple targeted MADS require multiple vacuum engines in the striking quantum potentials.
- Uncertainty and risk introduced if not certain of all MAD systems and all dead-man fuzing systems.
- Newest generation psychoenergetic LW interferometry weapons can instantly take over minds of all personnel on targeted sites, with targeted crews quickly disarming their own MAD weapons' launch capability as well as the weapons themselves.
- Mindsnapper then kills all living things and contaminates sites.
- Next generation QP Psy-En weapons can disrupt and destroy minds of an entire targeted national population. The nature of warfare moves irrevocably to the human mind, where of course the fundamental problem arises anyhow.

Next Generation Counter to Both Sane and Insane MAD Systems

- ***Localized quantum potential in an area, used in psychoenergetics mode***
  - Gradually produces mild, continuous hypnotic state
  - Targeted population remains entirely conscious, functional
  - Internal "word thoughts" emerge directly in subconscious
  - Targeted persons all unaware of these "word thoughts"
  - Operates somewhat similar to "post hypnotic suggestion"
  - Gradually changes emotions, psychological outlook
  - Over a period of time, deviates and entrains entire target population's outlook, belief structure, temperament
- ***Moves Psywar to inside the human component***
- ***Human minds are the only battleground***
- ***Can be accomplished without overt signature***
- ***Countered only by inserting same methodology into deeper mind level (collective unconscious)***

Simultaneous Dudding of Nuclear Weapons Worldwide

- Via quantum potential joining U235 and Plutonium in warheads
- Includes weapons airborne, underwater, in storage
- These are *transmutations of the nuclides themselves*
- *Part of the initial barrage launched by Aum/Yakuza/KGB*
- *Will occur in the first minutes of the strategic strike, following psychoenergetically crew-disabling QP weapons*

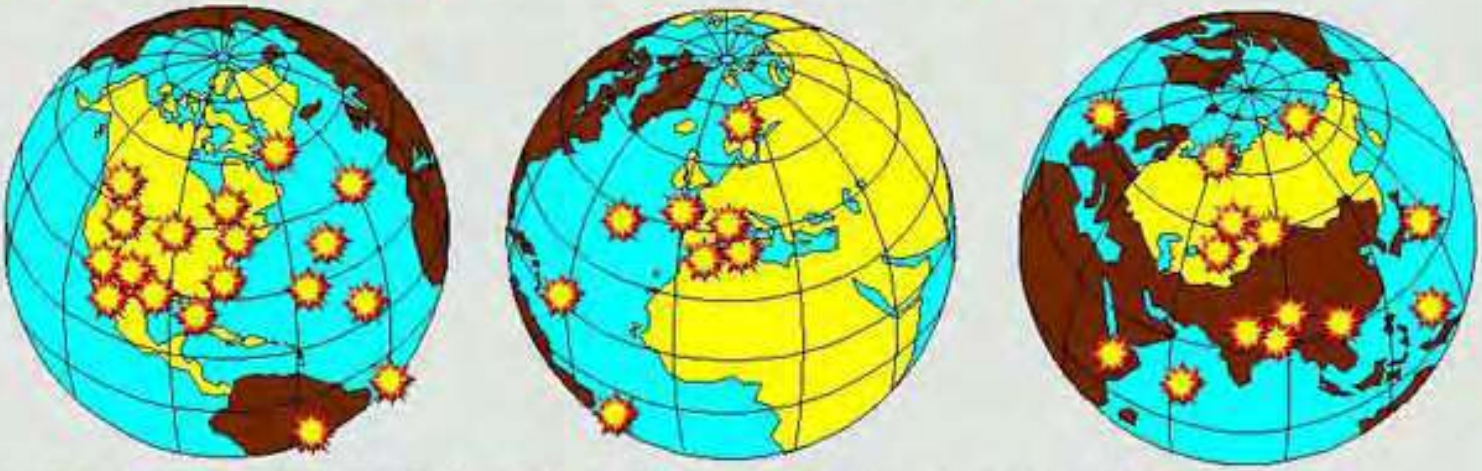

Note: Duds both overt and covert nuclear weapons and weapons-grade materials -- including "suitcase-delivered" covert weapons on site in Russia which otherwise provide dead man fuzing

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Simultaneous Dudding of Nuclear Weapons Worldwide

- Via quantum potential joining U235 and Plutonium warheads
- Includes weapons airborne, underwater, in storage
- These are not explosions, but are *transmutations and increased fissioning rates*
- *Part of the initial barrage launched by Aum/Yakuza/KGB*
- *Will occur in the first minutes of the strategic strike*

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Note: Duds both overt and covert nuclear weapons and weapons-grade materials.

Operation Divine Wind II

Slide 1

Slide 2

Slide 3

Slide 4

YAKUZA &
AUM SHINRIKYO

DIVINE WIND II

U.S.

★ **A secret coalition of Yakuza/Aum Shinrikyo and KGB/Communist forces plan to launch a massive, surprise energetics attack on the United States, given a low-risk opportunity.**

★ Major weapons utilized will be the scalar EM (energetics) superweapons (including quantum potential weapons) that were developed, deployed, and operated by the KGB under the former Soviet Empire, and continuing after its dissolution.

KGB

★ Yakuza/Aum crews have extensively trained and test-fired, from on-site in Russia. They have *leased* operational control of the first three generation energetics superweapons (which work by superpotential interferometry).

MINDSNAPPER AND
PSYCHOENERGETICS

★ *The Escalation Phase of interdicting and destroying actual U.S. targets (e.g., TWA-800, two A-10s) is already underway.*

★ *The first blow in the Strike Phase will dud all nuclear weapons and weapons materials worldwide, in minutes; destroy special ship and energetics weapon sites instantly, disable 99% of the U.S. population instantly, and kill 80% of targeted populations in from 10 minutes to 3 days.*

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QUANTUM
POTENTIAL

YAKUZA &
AUM SHINRIKYO

U.S.

DIVINE WIND II

- ★ A secret coalition of Yakuza/Aum Shinrikyo and KGB/Communist forces plans to launch a massive, surprise energetics attack on the United States and its allies, given the first low-risk opportunity.

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KGB

- ★ Attack was thwarted twice in 1997 by a small nation countering with QP weapons.
- ★ KGB psychoenergetics counter for the last QP weapon counter was tested in April 1997.
- ★ Ready time for a new scheduled attack is latter quarter 1999 through first half of 2000.

YAKUZA &
AUM SHINRIKYO

DIVINE WIND II

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- ★ **A secret coalition of Yakuza/Aum and KGB/Communist forces will launch a massive, surprise, strategic attack on the United States in 1997.**
- ★ **Major weapons utilized will be the scalar EM (energetics) superweapons that were developed, deployed, and operated by the KGB under the former Soviet Empire, and continuing after its dissolution.**
- ★ **Yakuza/Aum crews have extensively trained and test-fired, from on-site in Russia. They have *leased* operational control of the energetics superweapons.**
- ★ ***Escalation Phase of interdicting and destroying actual U.S. targets (e.g., TWA-800) is already underway.***
- ★ ***The first blow in the Strike Phase will dud all nuclear weapons and weapons materials worldwide, in minutes; destroy special ship and energetics weapon sites instantly, and kill 80% of targeted populations in 3 days.***

KGB/COMMUNISTS

MINDSNAPPER

QUANTUM
POTENTIAL

OPERATION DIVINE WIND II

Three Phases and Support

Operational Phases

- Phase I: On-Site Training Phase (Completed)
- Phase II: Escalation Phase (In Progress)
- Phase III. 1997 Strategic Strike on the U.S.
  - *First strike (QP) in Phase III duds all nuclear weapons and nuclear powerplants worldwide, in minutes*
  - *Psychoenergetic strike (QP) disables people instantly*
  - *Mindsnapper attack of special assets for 100% success*
  - *QP initiation of fast-acting, lethal diseases kills 80% of targeted populations in three days or less*

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Support Plans

- Plan A: Feints, Deception, Sabotage, and Terrorism
- Plan B: Testing and Test Range
- Plan C: Worldwide Weather Engineering
- Plan D: Strategic and Combat Intelligence

Advanced EMBW Applications

- Covert EMBW: Examples
  - Activate materials and their potentials with ST disease engines. Potentials superpose and their infolded ST dynamics diffuse
  - Activate water's structuring (H-bonding) potential with disease engines
  - Bias electrical power grid ground fields by weak diseases
  - Employ disease-structured quantum potential in distant area
- Overt death ray (mind snapper)
  - Powerful scalar EM pulse in target area "jerks" rate of flow of time
  - The "time snap" sharply separates mind from body and each cell
- EMBW CM:
  - Irradiate bodies with longitudinal EM waves; self-converts to t-pumping and produces exact amplified ST antiengine
  - Antiengine arises out of local ST, affects all parts of all cells
  - Cells are t-charged with antiengine structure
  - Continuing action restores regenerative and immune systems and reverses cellular damage

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EM Biological Warfare (EMBW)

- KGB/Communists have developed highly effective
  - Electromagnetic biological warfare (EMBW)
  - Counters to orthodox biological warfare
  - Mass death ray weapons
    - Small version of "mindsnapper" tested in Afghanistan
    - Killed occupants in two villages, in separate strikes
    - Unusual aspects (so-called "smerch" gas)
- Russia/KGB is the only group with a complete counter to biological warfare, either covert or overt, and to EMBW
- EMBW (covert and overt) is a preferred option for KGB
  - MAD Doctrine is completely destabilized for a sufficiently covert Russian EMBW strike
  - Situation has existed for at least two decades
  - Can alter germs, bacteria, viruses of specific kind, in a specific target area, to produce antibiotic-resistant strains
  - Can induce any kind of cellular disease or damage at a distance
- U.S. national characteristic: no reaction to slowly increasing threat

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Microwave Radiation of U.S. Embassy in Moscow

Former U.S. Embassy in Moscow.

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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Pentagon EMI Studies, 1989

Washington Post, 22 Jan. 1989, p. A4

- Analysts of severe EMI effects in strike on Libya, 1986
  - performed major 3-year, 66-man study
  - Blamed effects on U.S. forces' own signals
  - Did not know of any other "signals" present
  - Knew nothing of quantum potential weaponry, energetics weaponry
- 7-month preliminary study
  - Severe EMI Problem exists
  - EMI shielding often waived in our weapon systems
  - Thousands of conflicts possible
- Also studied UH60 Blackhawk helicopter problems (which *were* due to its lack of good EMI shielding, and not quantum potentials)
  - uncommanded turns
  - Five EMI crashes 1982-1989
  - $175 M program to shield it
- So found that U.S. transmission combinations can
  - Affect aircraft flight control
  - Turn off fuel supply
  - Cause uncommanded dive/turn
  - Bring down U.S. warplanes
- *Actually, Libyan EMI was induced by Soviet quantum potential tests which can do all those things and much more*

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EM Missile Practice

- EM Missile Practice
  Latter Sept. - Early Nov. 1996
  Melbourne, Australia
- Deception: Using EM Missile to Reinforce Notion of SAM Attack
  Saturday evening, Nov. 16, 1996
- Intelligence Probe: Insuring U.S. Still Unaware of Energetics Weaponry
  Thursday, December 12th, 1996
- EM Missile Strike, Offset from Night Shuttle Launch, Cape Canaveral, Florida
  The Smoking Gun in November 1985
- Distant Operator Onsite in Russia Slew Away Registration Point
  Marker Beacon over Night Shuttle Launch, 26 November, 1985
- EM Missile Practice and Deception
  November 17, 1996

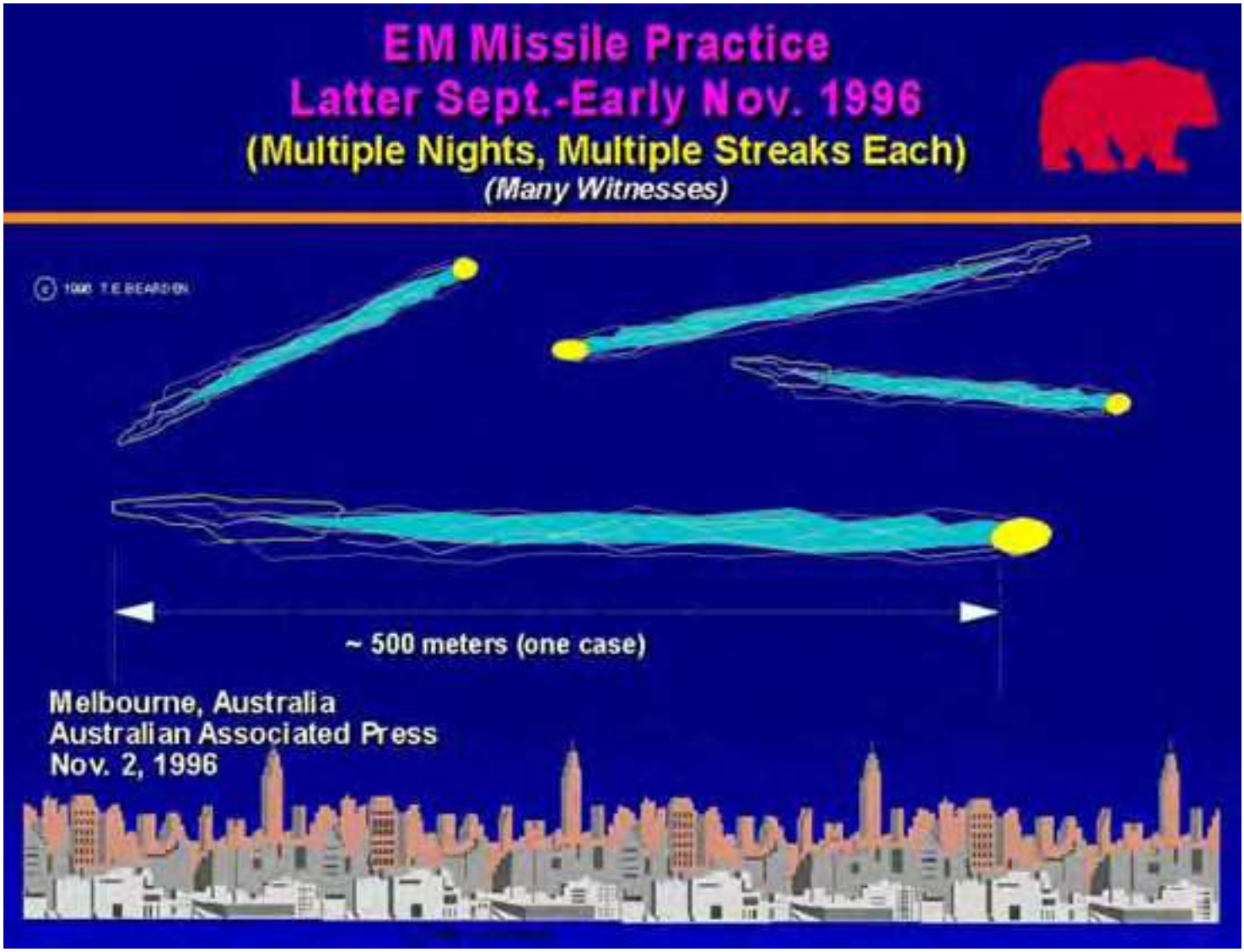
EM Missile Practice
Latter Sept.-Early Nov. 1996
(Multiple Nights, Multiple Streaks Each)
(Many Witnesses)
© 1996 T.E.BEARDEN
~ 500 meters (one case)
Melbourne, Australia
Australian Associated Press
Nov. 2, 1996

Deception: Using EM Missile to Reinforce Notion of SAM Attack

Saturday Evening
Nov. 16, 1996

Note: Meteor shower was forecast, which provided perfect decoy to FBI investigators, to steer them off the true scent.

Pakistan International Airlines Flight 712, just after takeoff from John F. Kennedy Airport, on path similar to that taken by TWA Flight 800, July 17, 1996

© T.E. BEARDEN 1996

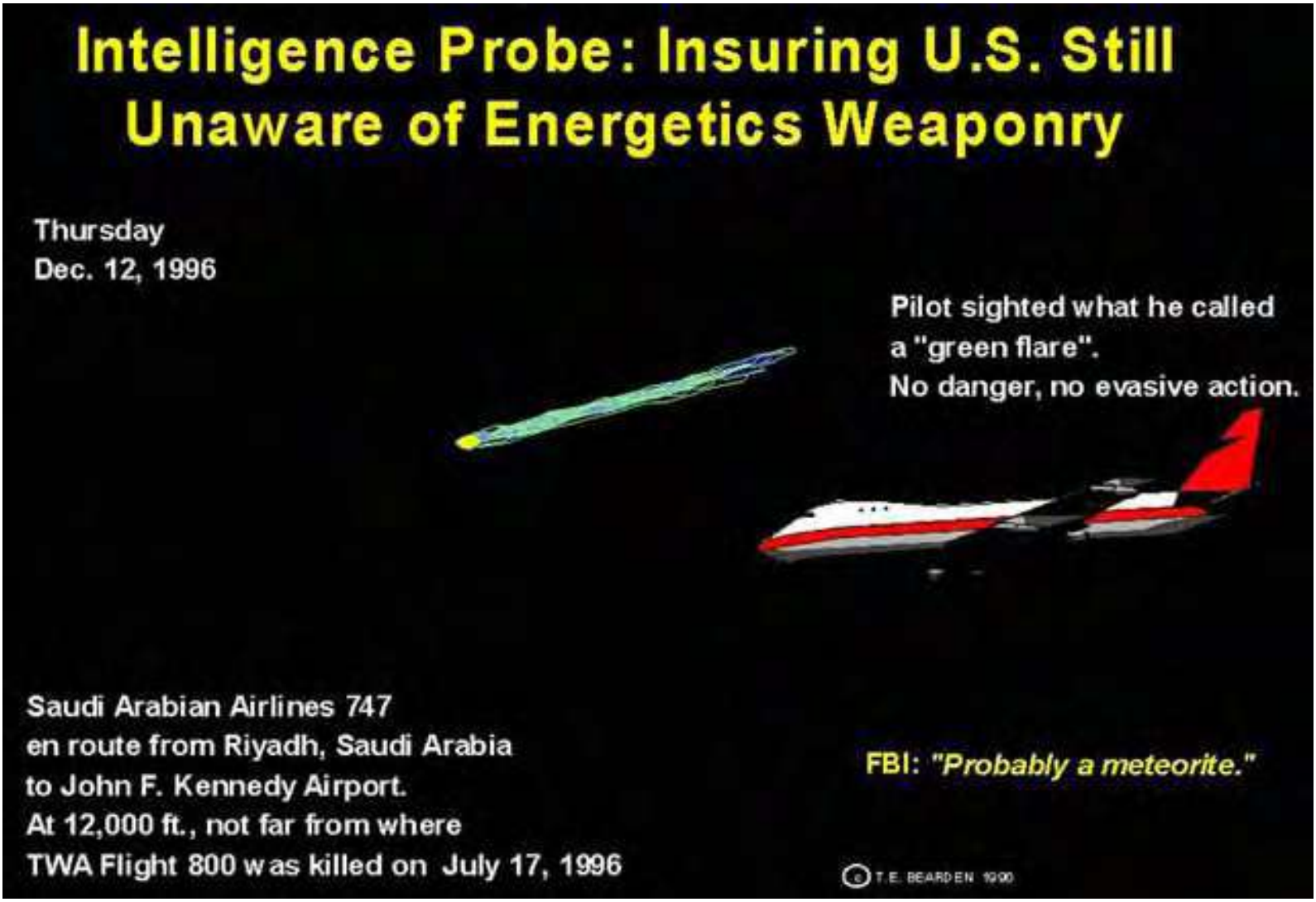
Intelligence Probe: Insuring U.S. Still Unaware of Energetics Weaponry
Thursday
Dec. 12, 1996
Pilot sighted what he called a "green flare".
No danger, no evasive action.
Saudi Arabian Airlines 747
en route from Riyadh, Saudi Arabia
to John F. Kennedy Airport.
At 12,000 ft., not far from where
TWA Flight 800 was killed on July 17, 1996
FBI: "Probably a meteorite."
© T.E. BEARDEN 1990

EM Missile Strike, Offset from Night Shuttle Launch

Cape Canaveral, Florida

© T.E. BEARDEN 1995, 1999,

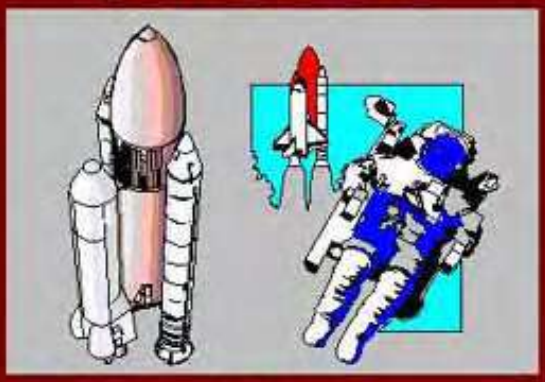

The Smoking Gun in Nov. 1985

Distant Operator Onsite in Russia
Slews Away Registration Point
© T.E. BEARDEN 1995, 1999
MARKER BEACON
Over Night Shuttle Launch
Cape Canaveral, Florida
26 Nov 1985
Photographed by George Suchary
28 Nov 1985
Two weeks later, the same weapon killed the Arrow DC-8
at its takeoff from Gander, Newfoundland.

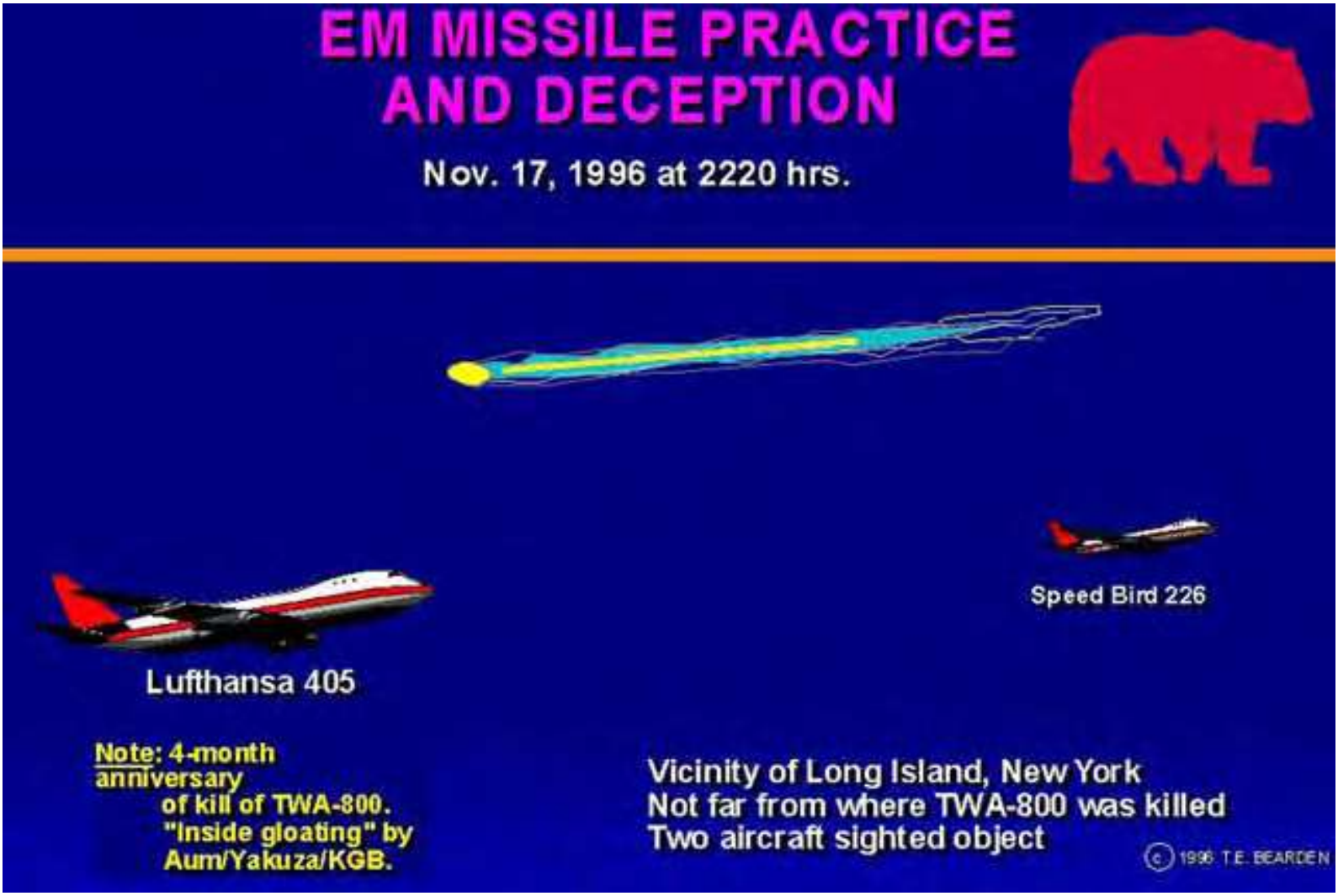
EM MISSILE PRACTICE
AND DECEPTION
Nov. 17, 1996 at 2220 hrs.
Speed Bird 226
Lufthansa 405
Note: 4-month anniversary of kill of TWA-800. "Inside gloating" by Aum/Yakuza/KGB.
Vicinity of Long Island, New York
Not far from where TWA-800 was killed
Two aircraft sighted object
© 1996 T.E. BEARDEN

Subdivisions of Soviet Energetics

NONLIVING SYSTEMS

Energetics

- Nonliving systems
- Scalar Interferometry
- Action-at-a-Distance
- Quantum Potential
- Vacuum Engines
- Spacetime Structuring
- Material, Field Effects
- Nuclei, Lattice Changes
- Hidden EM Variables
- SWZ Effects

LIVING SYSTEMS

Bioenergetics

- Living Systems (Bodies)
- Cells, cellular changes
- Master Cell Control (Popp)
- Spacetime Structuring
- Disease Induction, Remission
- Action-at-a-Distance
- Quantum Potentials
- Scalar Interferometry
- Hidden EM Variables
- SWZ Effects

Psychoenergetics

- Living Systems (Minds)
- Thoughts, Memories, Emotions
- Conscious/Unconscious Minds
- Spacetime Structuring
- Species, Biospheric Minds
- Action-at-a-Distance
- Quantum Potentials
- Scalar Interferometry
- Hidden EM Variables
- SWZ Effects

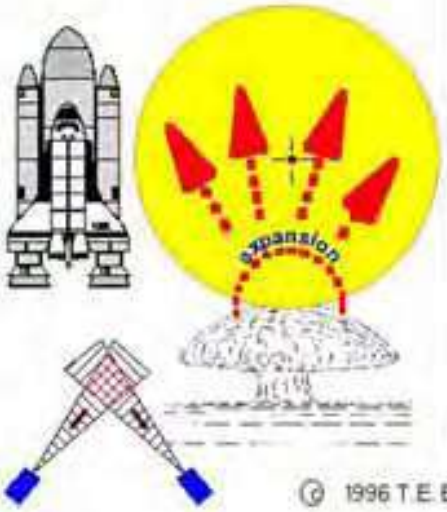

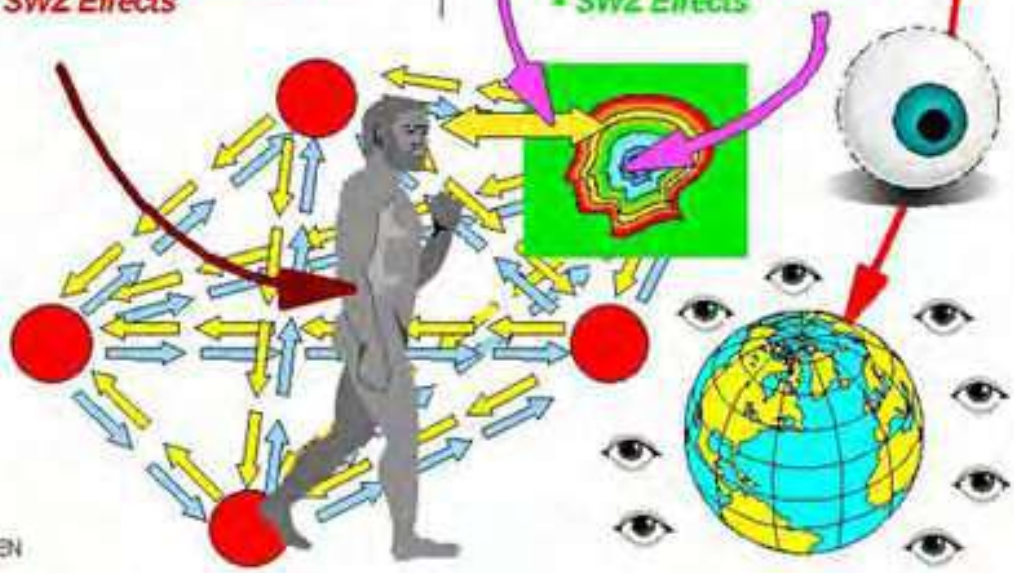

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Communism's Goal

- "War to the hilt between communism and capitalism is inevitable. Today, of course, we are not strong enough to attack... To win we shall need the element of surprise. The bourgeoisie will have to be put to sleep. So we shall begin by launching the most spectacular peace movements on record. There will be electrifying overtures and unheard-of concessions. The capitalist countries, stupid and decadent, will rejoice to cooperate in their own destruction. They will leap at another chance to be friends. As soon as their guard is down, we shall smash them with our clenched fist."

Dimitry Z. Manuilsky
Lenin School of Political Warfare, Moscow
(circa 1934)

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Manuilsky's Goal vs. Status Today

Manuilsky, 1934	Situation, Dec. 1996
▪ War is inevitable.	▪ Has not changed.
▪ Not strong enough to attack now.	▪ Strong enough now; preparations completed. Need right opportunity.
▪ Need surprise.	▪ Have achieved total surprise.
▪ Must put us to sleep.	▪ We are sound asleep.
▪ Need most spectacular peace movement on record.	▪ Done. We think the Russian threat gone, cold war ended.
▪ Electrifying overtures, unheard-of concessions.	▪ Done, and still occurring every day. It has worked beautifully.
▪ Capitalists will cooperate.	▪ We are cooperating in spades!
They will leap to be friends.	▪ We've leaped, and are leaping.
▪ They will let down their guard. ▪	▪ No ABM, junked lots of nukes, shrunk our forces to the bone.
▪ We'll strike them then.	▪ They would have struck (twice) in 1997, but for deterence by another nation (not U.S.) having QP weapons
	▪ *They are still looking for a risk-free opening to strike*

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Professor Hellman, German Scientist Released from Work in Soviet Union

- Worked in Soviet Union after WWII
- Eventually escaped to Germany, then to Brazil (handsome offer)

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- Took part in highly unusual Soviet energetics development and experiments
- Large areas of the sea could be and were *suddenly frozen*
- *No particular attention was paid to this information by highly qualified scientists*
- *In intelligence terms, this is A-1 information of the highest caliber*
- *Bohm also was invited to Brazil, which started an energetics weapon program. Brazil developed such weapons including weak quantum potential weapons (0.95 confidence)*

The Tom Bearden Website

Help support the research

Hemispheres of Light

- March 20th, 1969
  Caribbean and Western North Atlantic
- Hemisphere and Globes, 1977
  24 March, 1977
- Virgin Islands Incident
  August 1969
- Typical Shield Test, Northern Route to Japan
  June, 1982

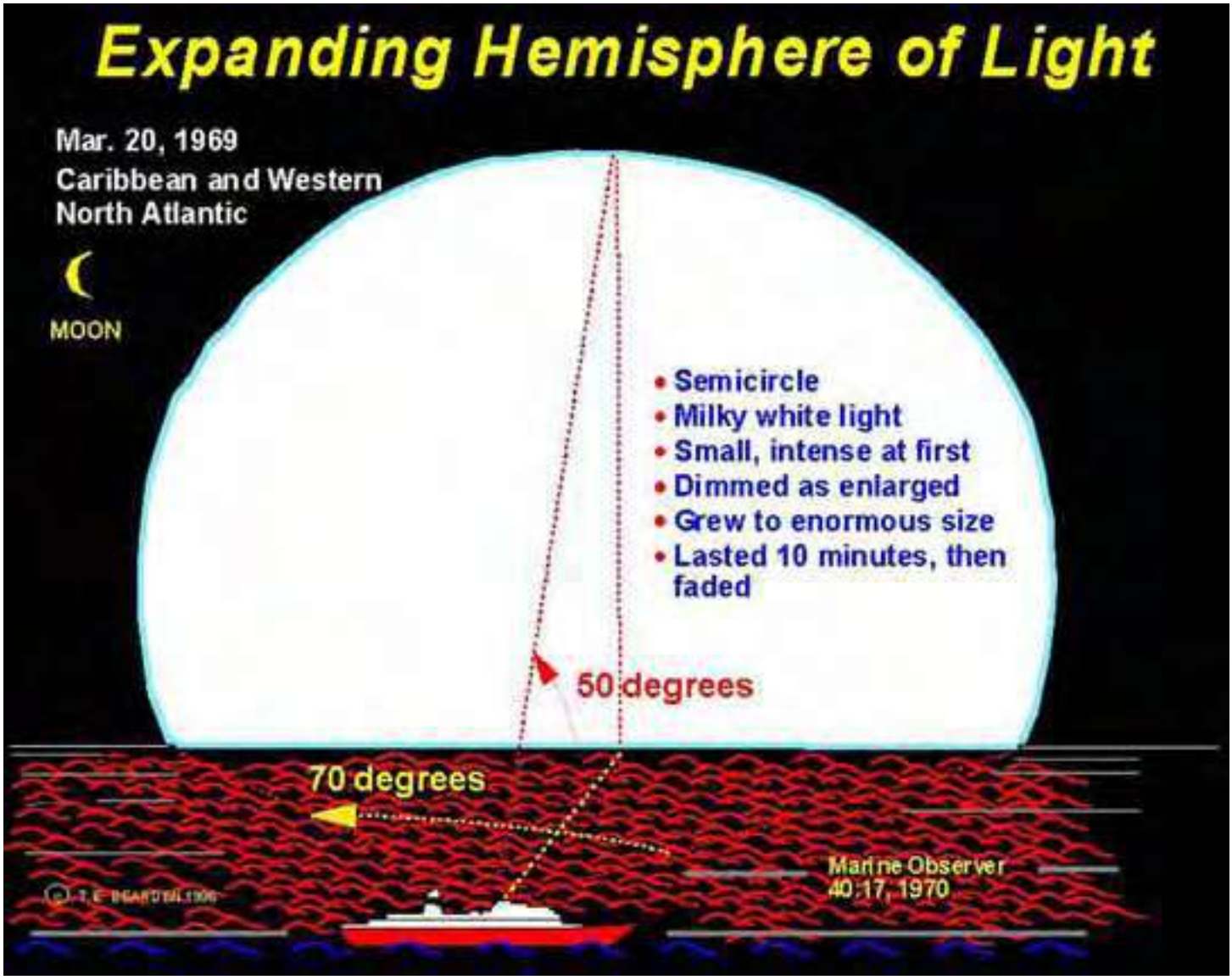
Expanding Hemisphere of Light
Mar. 20, 1969
Caribbean and Western
North Atlantic
MOON
• Semicircle
• Milky white light
• Small, intense at first
• Dimmed as enlarged
• Grew to enormous size
• Lasted 10 minutes, then faded
50 degrees
70 degrees
Marine Observer
40:17, 1970

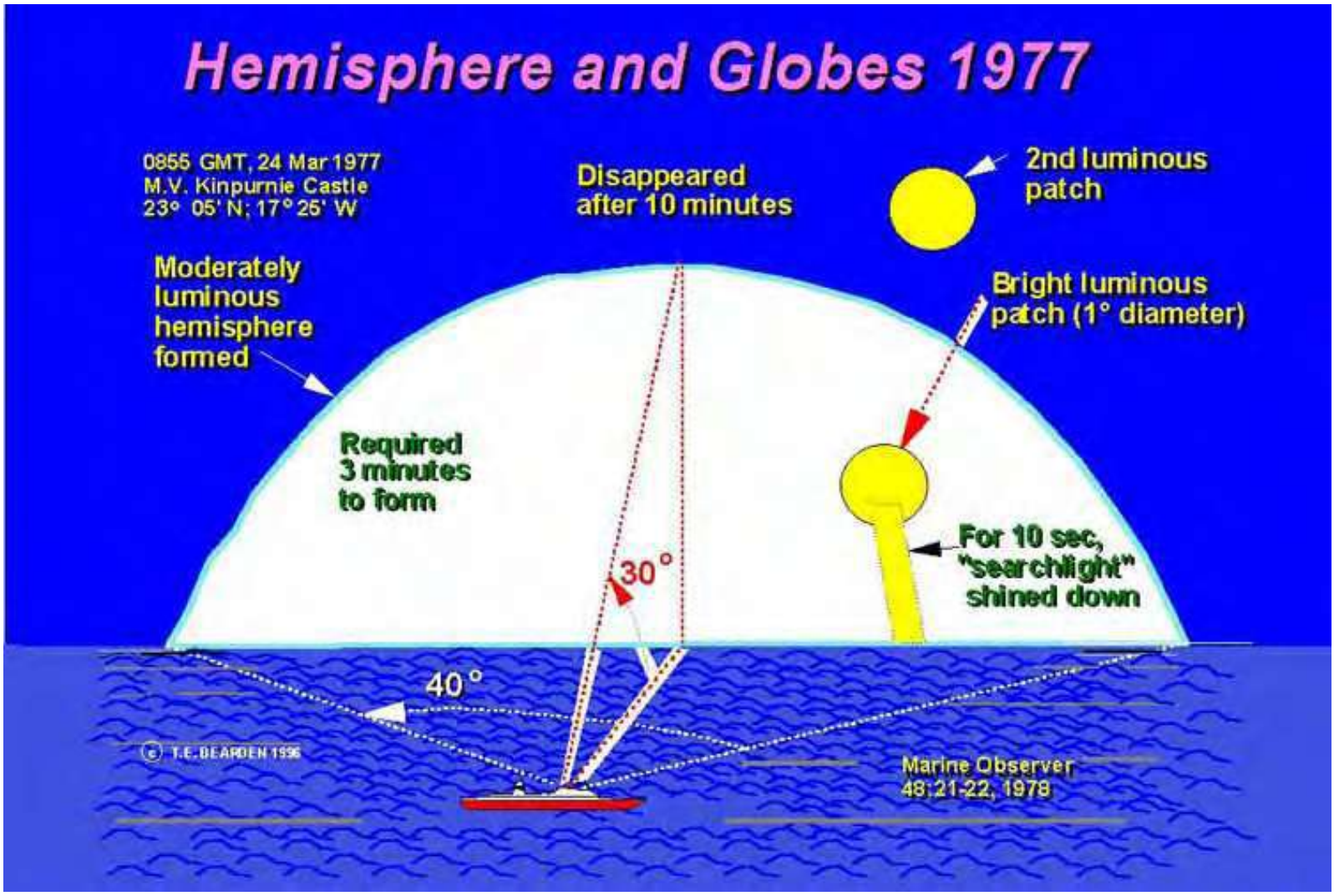
Hemisphere and Globes 1977
0855 GMT, 24 Mar 1977
M.V. Kinpurnie Castle
23° 05' N; 17° 25' W
Disappeared after 10 minutes
2nd luminous patch
Moderately luminous hemisphere formed
Bright luminous patch (1° diameter)
Required 3 minutes to form
For 10 sec, "searchlight" shined down
30°
40°
© T.E. BEARDEN 1996
Marine Observer 48:21-22, 1978

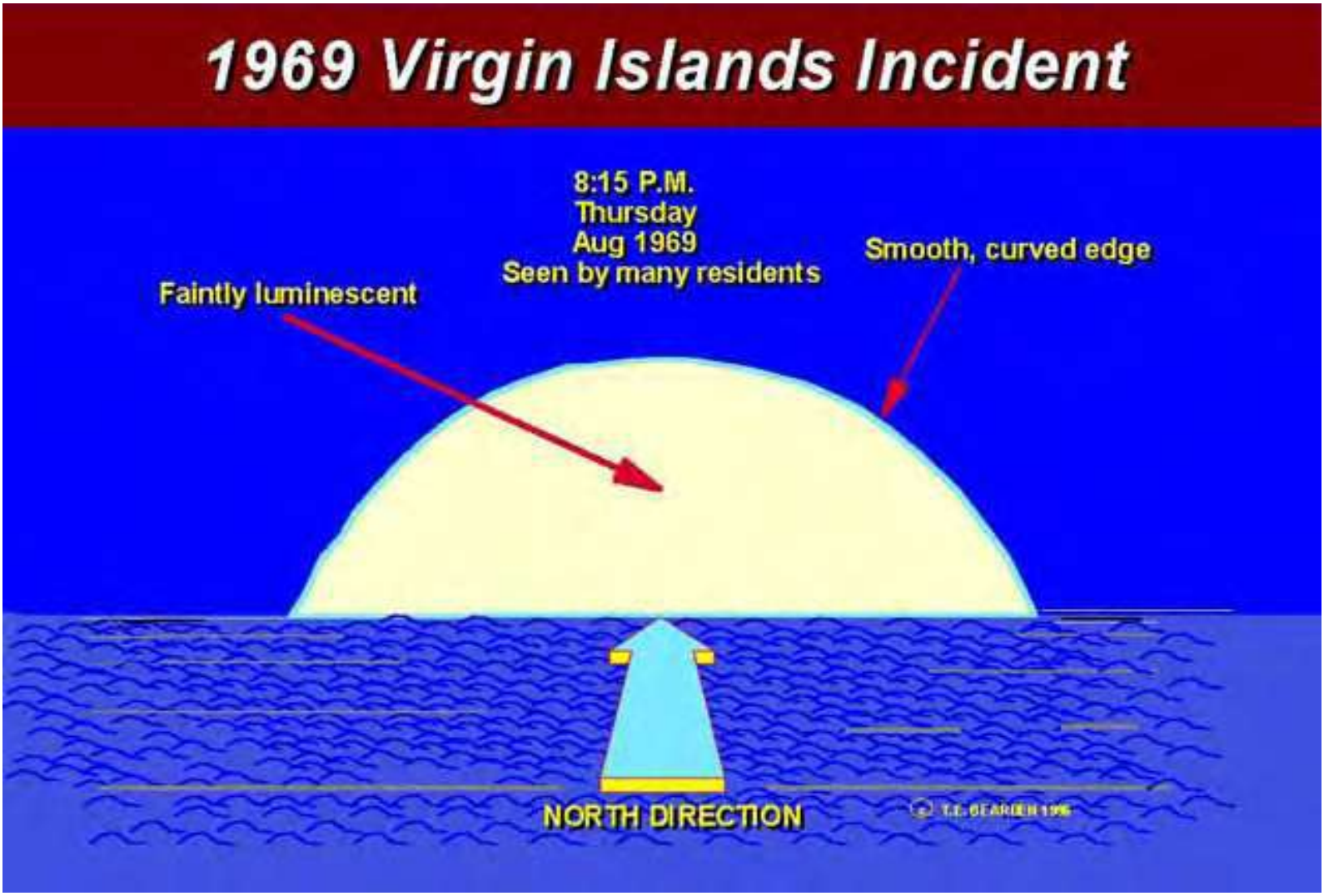
1969 Virgin Islands Incident
8:15 P.M.
Thursday
Aug 1969
Seen by many residents
Smooth, curved edge
Faintly luminescent
NORTH DIRECTION

Typical Shield Test, Northern Route to Japan
18-27 km diameter
Asahi Evening News, Tokyo
June 22, 1982
Multiple tests seen per month, for years.
Pilots simply ceased reporting them.

How Could Such Superweapons Ever Be Concealed?

- Arthur C. Clarke's law states:

  "Any sufficiently advanced technology is indistinguishable from magic."

- To U.S. scientists, "magic" means "impossible"
- Longitudinal EM waves and LW interferometers have been regarded as fantasy and impossible
- To deceive foe on rather open use of unknown technology without discovery:

  "Disguise its uses as understandable accidents, human error, acts of nature, other known technology, etc."

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Soviets Easily Concealed These Superweapons for Four Decades

- Intensive Soviet deception plan utilized
  - Embedded in other weapon system tests
  - Made to resemble natural acts, accidents, etc.
  - Open science releases coordinated to show Russian scientists worked on "normal" science
- West thought Russian scientists inferior
- U.S. scientific community was and is dogmatic, and fiercely suppresses real scientific innovation
- Terribly flawed electrodynamics not ruthlessly shaken and changed in West

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- West had no basis for understanding energetics

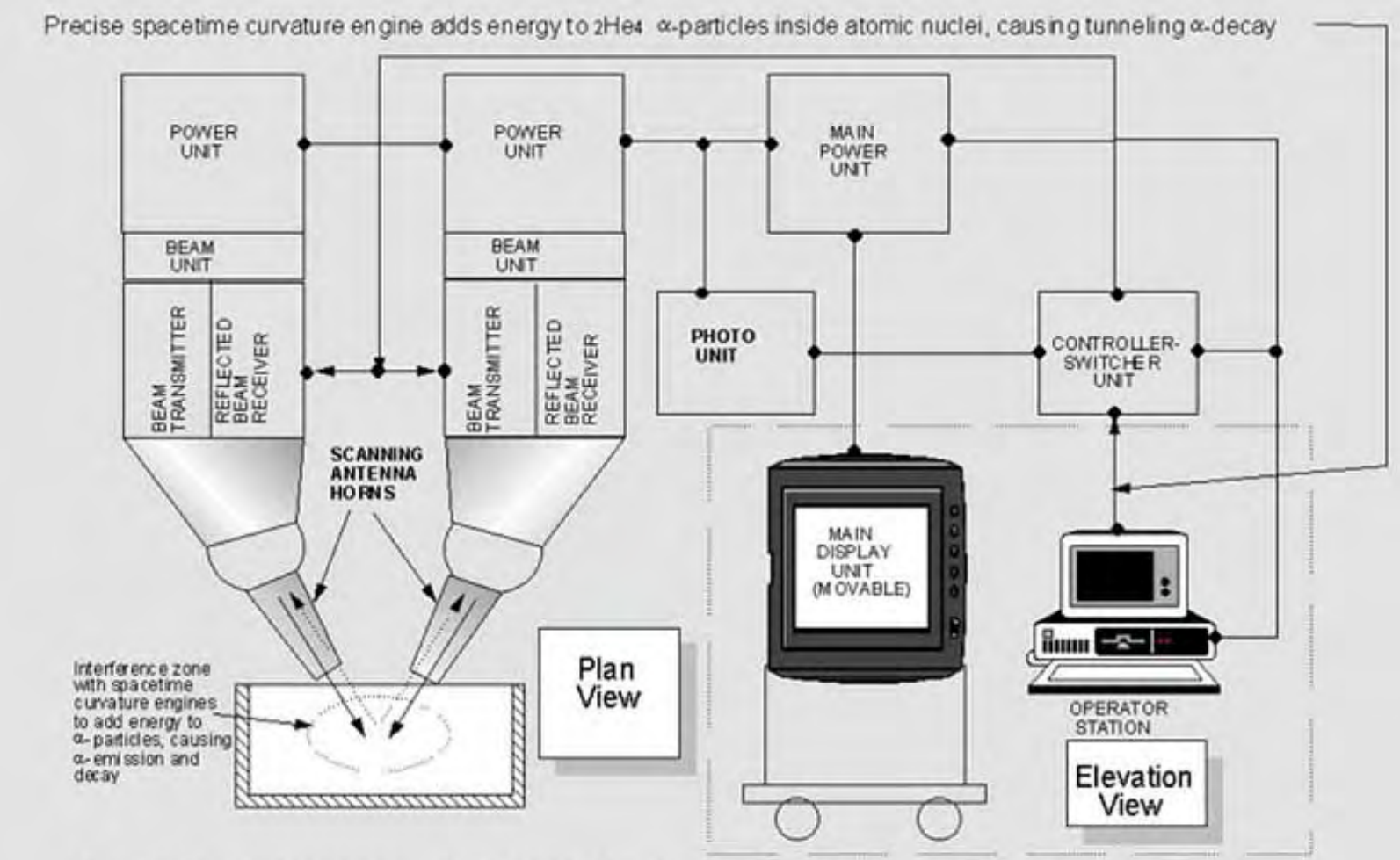

Figure 26. Microscope-type, laser-like interferometer for inducing quick α-decay in samples of otherwise longer-lived isotopes.

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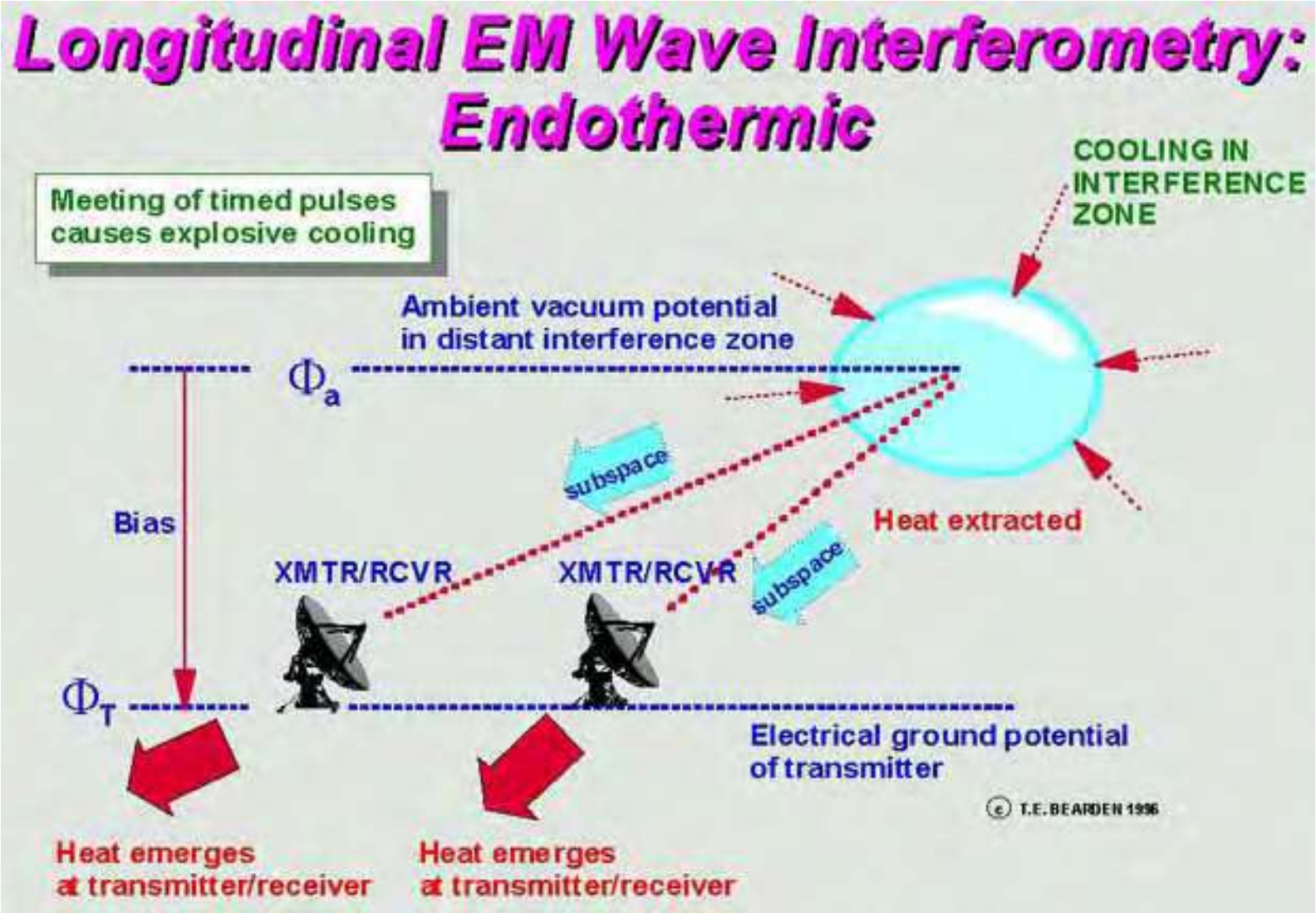
Longitudinal EM Wave Interferometry: Endothermic
Meeting of timed pulses causes explosive cooling
COOLING IN INTERFERENCE ZONE
Ambient vacuum potential in distant interference zone
Φ_a
subspace
Bias
Heat extracted
XMTR/RCVR
XMTR/RCVR
subspace
Φ_T
Electrical ground potential of transmitter
© T.E. BEARDEN 1996
Heat emerges at transmitter/receiver
Heat emerges at transmitter/receiver

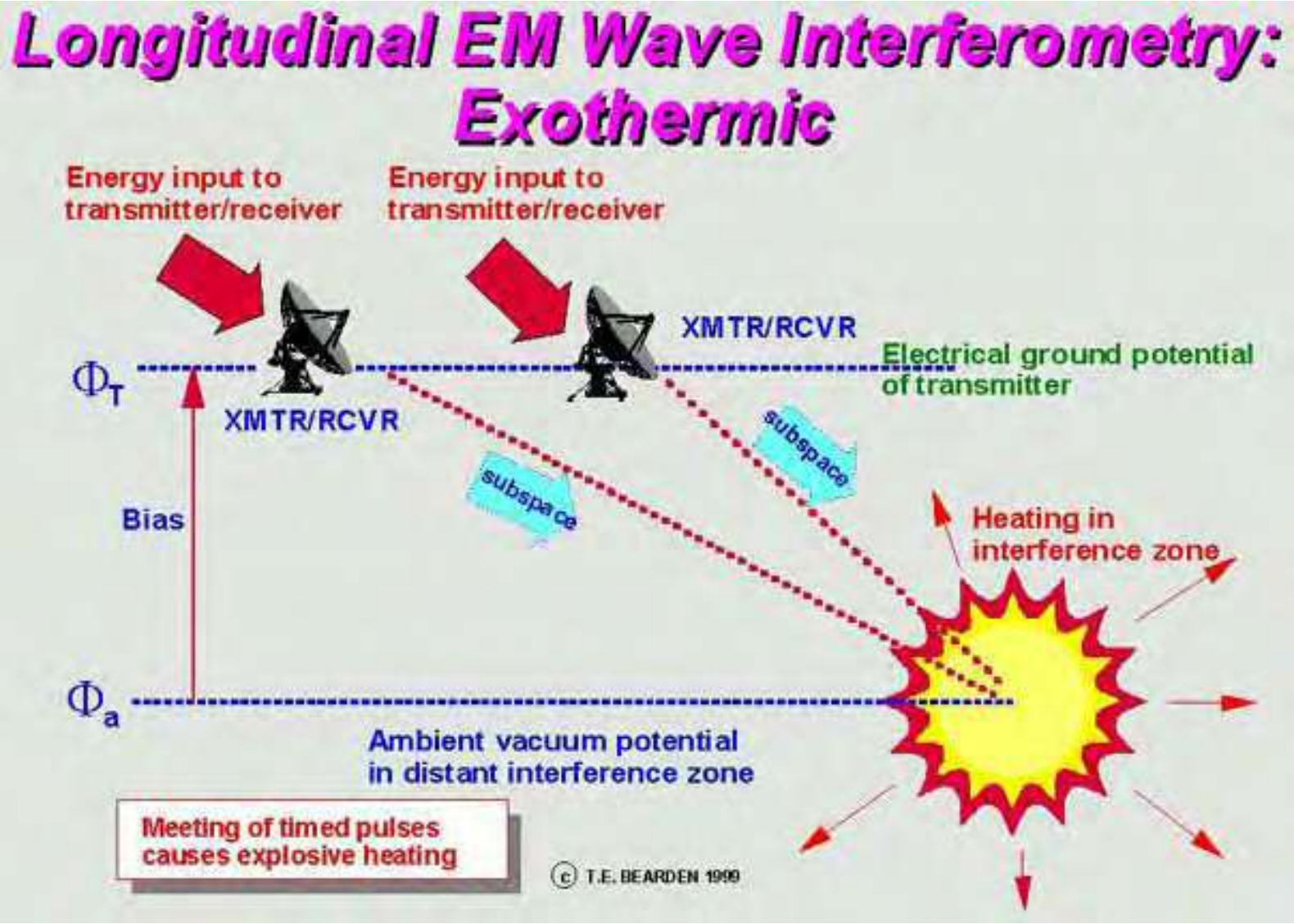
Longitudinal EM Wave Interferometry: Exothermic
Energy input to transmitter/receiver
Energy input to transmitter/receiver
XMTR/RCVR
XMTR/RCVR
Electrical ground potential of transmitter
Φ_T
subspace
subspace
Bias
Heating in interference zone
Φ_a
Ambient vacuum potential in distant interference zone
Meeting of timed pulses causes explosive heating
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The Tom Bearden Website

Help support the research

U.S. Air Attack on Libya
April 1986

- Slide 1
- Slide 2
- "Washington Post" Article
  January 22, 1989

U.S. Airstrike on Libya
April 1986*
• 33 U.S. AIRCRAFT IN STRIKE
• MANY HIGH-POWERED TRANSMITTERS
– COMMUNICATIONS
– JAMMERS
– RADARS
• SEVERE, UNEXPECTED "EMI" ENCOUNTERED
– ONE F-111 DOWNED
– NUMEROUS WEAPONS WENT ASTRAY
– THREE FOREIGN EMBASSIES DAMAGED
– SEVEN AIRCRAFT FORCED TO ABORT
• COMMANDERS: "US OR THEM?"
*Washington Post, 22 Jan. 1989, p. A4
Mild quantum potential weapon tested against electronics in U.S. aircraft and missiles
EM energy arises from every point in spacetime inside the electronics

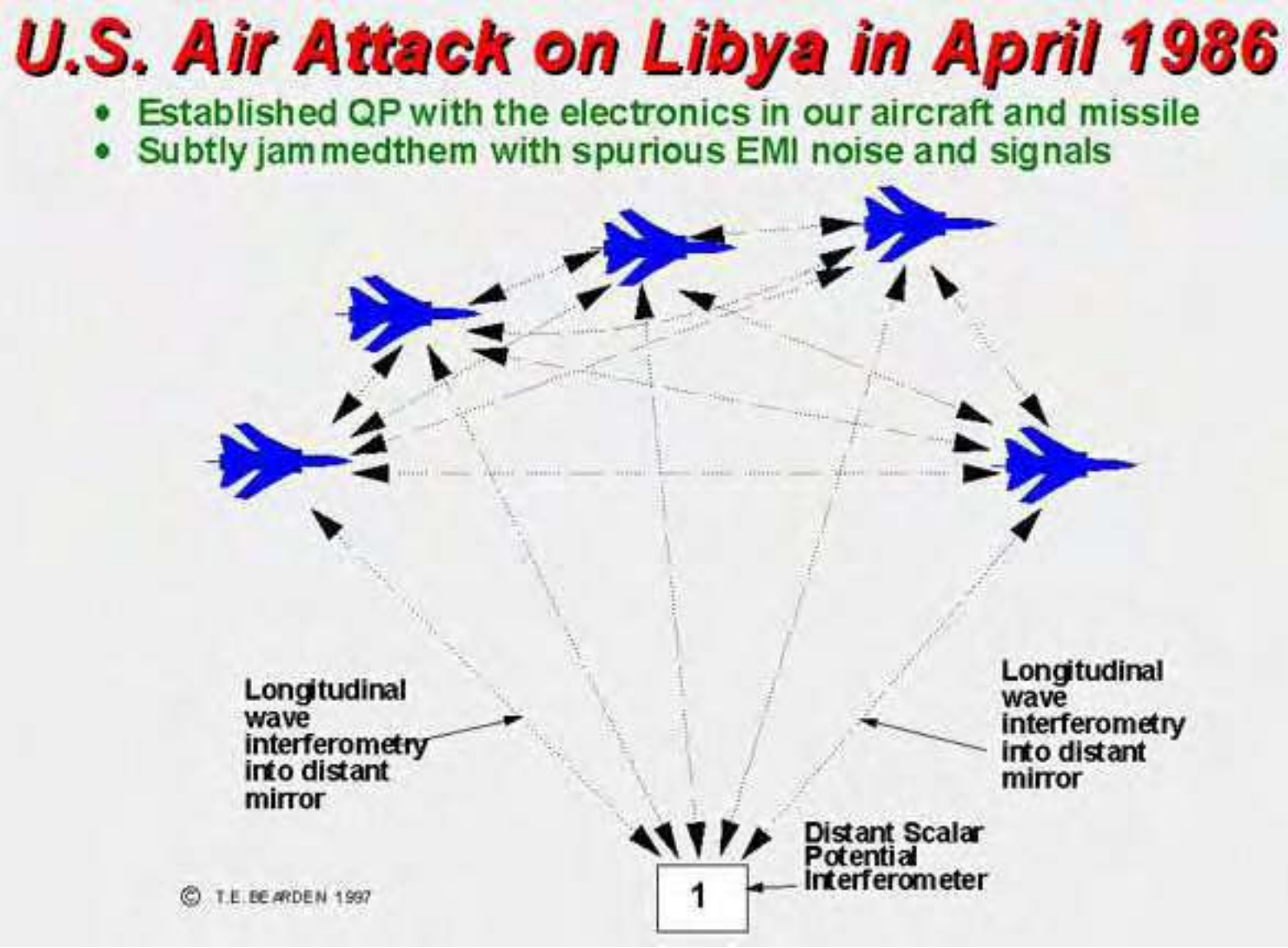
U.S. Air Attack on Libya in April 1986
• Established QP with the electronics in our aircraft and missile
• Subtly jammedthem with spurious EMI noise and signals
Longitudinal wave interferometry into distant mirror
Longitudinal wave interferometry into distant mirror
Distant Scalar Potential Interferometer
1
© T.E. BEARDEN 1997

Lightning Wall

- Aircraft on course of 270 degrees
- Approached "solid wall of lightning" in an otherwise cloudless sky
  - From very high altitude to near the water
  - Extended north-south as far as one could see
- Radar scope clear
- *Rigged aircraft for heavy weather*
- *Plunged directly through wall*
- *Wall was very thin*

circa 1959-1960
Interview with Patrol plane commander
U.S. Navy P5 aircraft
Over Atlantic, 200 miles east of Norfolk

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Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

S.K. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p. 16-25.

JC5-34

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Large Longitudinal EM Wave Interferometer (LWI) Accident

- 1958 nuclear explosion near Urals
  - Contaminated 1200 square kilometers
  - Signature of large LWI accident
  - Buried atomic wastes suddenly exploded
  - Region contaminated to this day
- Soviets were well along with advanced LWI prototypes and testing
  - In Jan. 1960 Khrushchev announced these forthcoming "fantastic" weapons
  - 1958 difficulties would have been resolved by 1960

© T.E. BEARDEN 1990, 1999

Large Longitudinal EM Wave Interferometer (LWI) Accident

- Expected cause of 1958 accident
  - Huge LW energy beams built up
  - Catastrophic short-out in transmitter
  - LW energy flashed over into earth and spread
  - Struck and fissioned stored nuclear wastes
- Developed new safety circuits
  - For transmitter short-out, instantly activates to hold LW beam energy and prevent flash-over
  - Similar accident happened in 1986 at Chernobyl, except private U.S. group blew that transmitter to prevent catastrophic quake in California

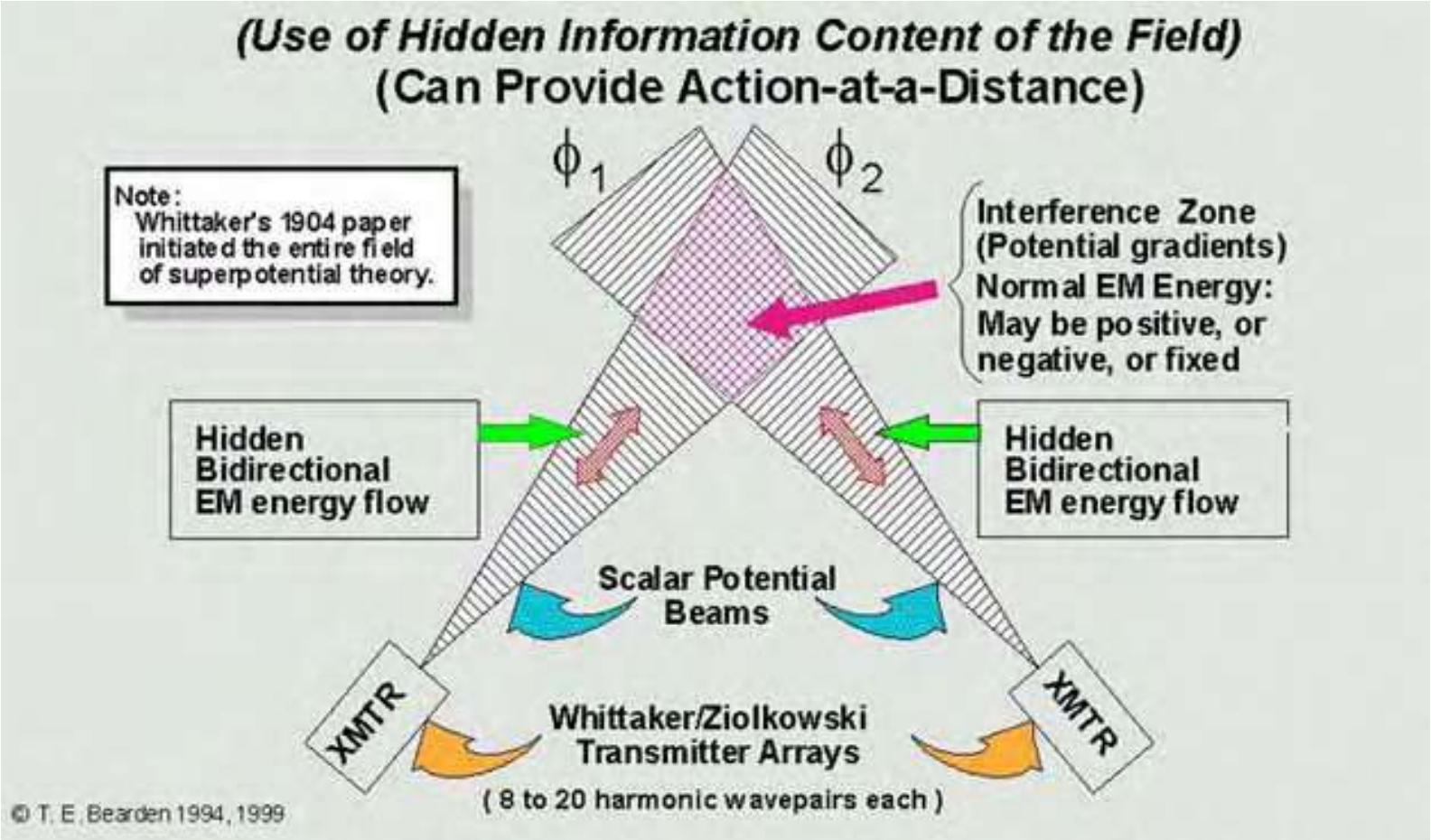

Figure 5. Scalar potential interferometry (between the two sets of bidirectional longitudinal EM wavepair functions) produces all EM force fields and waves.

Two Types of Mutual Assured Destruction (MAD) Systems

- ***Sane system:***
  - Turned off or on standby
  - Wait until attacked or attack is imminent
  - Humans consider situation, make strike decision
  - Command order issued to weapons officers
  - Human finger initiates launch sequence
  - Usually requires code entry, etc. for assured launch control

- ***Insane system:***
  - Computer periodically (e.g., every 2 hours) initiates launch
  - During sequence, there is a period (say, 2 min.) where operators can enter stop order (usually coded)
  - If correct stop not entered, weapons automatically launch
  - if correct stop entered, computer resets, and after another 2 hrs, automatically reinitiates the launch sequence

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Psychoenergetics Weapons Teams
Mentally Disable All Personnel
(COUNTERS ALL SANE MAD SYSTEMS)
(NULLIFIES HUMAN COMPONENT OF ALL WEAPON SYSTEMS)
ELECTRICAL THOUGHT-WORDS ARISE DIRECTLY IN BRAIN, HENCE IN MIND, BYPASSING SENSOR INPUTS
INSTANT HYPNOGOGIC STATE, WITH INSERTED THOUGHT-WORDS
Effects arise in local spacetime, simultaneously in all minds in the targeted area
INSTANT HYPNOGOGIC STATE: WITH WAKING DREAM
PERCEIVED REALITY NOW CONTROLLED
TARGETED POPULACE
• Site personnel instantly hypnogogic and mentally controlled.
• Distant weapon controller teams coord crew actions
• Standdown insane weapons to maintenance standby.
• Mindsnapper then strikes, kills all personnel, and nullifies site for months.
Indicators: Two A-10 incidents 1997, LIDA device since 1950s.
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Strikes Against Special Ship and Energetics Weapon Sites

- Via powerful scalar EM pulses in each targeted area, so sharp time-jerks occur
  - Mind and its operations exist in time but not in 3-space
  - Coupling interaction of mind operations to body occurs through flow of time
  - Flow or change of flow of time must be smooth, for coupling of mind to body
- *Sharp jerk in time flow snaps mind's coupling to body, instantly separates mind*
- *Instant death for every virus, bacterium, cell, insect, mammal, living creature*
- *Contaminates struck sites for months, perhaps a year*

Note: In other words, this is the part of the "preparation barrage" that attacks the enemy's response capability (i.e., his "artillery" and his "airpower") and suppresses it. The use of the "mindsnapper" weapons provides 100% assurance of success.

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"MINDSNAPPER" ATTACK ON SPECIAL SHIPS & ENERGETICS WEAPONS SITES

"We have a new, fantastic weapon ... so powerful that, if unrestrainedly used, it could wipe out all life on earth."

Khrushchev, speaking to Presidium, Jan. 1960

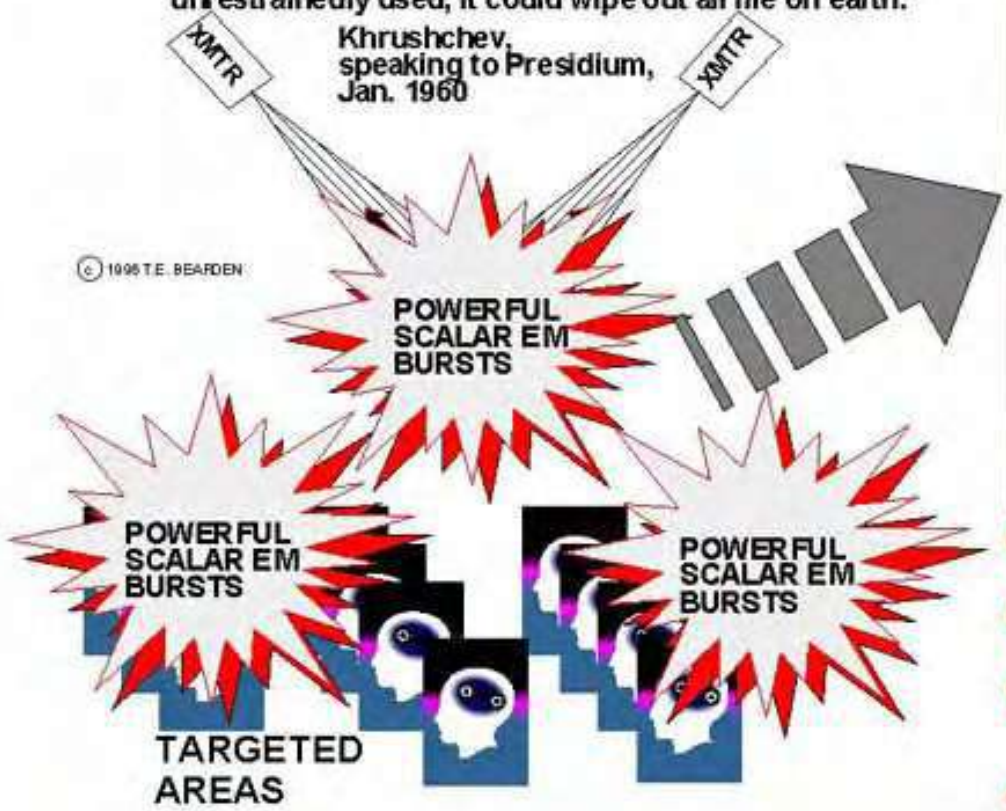

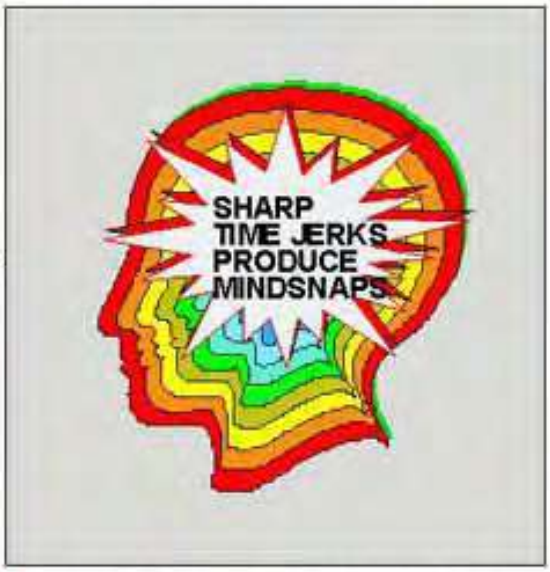

- Minds snapped loose from bodies (every living thing)
- Struck areas completely sterilized of all life
- LWs emitted; slow decay of time-charge makes contamination persistent
- Tested twice in Afghanistan

The Tom Bearden Website

Help support the research

How Much Off Guard Are We?

- Slide 1
- Slide 2
- Slide 3
- Slide 4
- Slide 5
- Slide 6
- Slide 7

How Much Off Guard Are We?

- *Legitimate U.S. forces have no energetics weapons or defenses against them*
- *No DoD general, military officer, or enlisted person reporting to the government of the United States has <u>any:</u>*
  - Training in energetics or energetics weapons
  - Experience in energetics or energetics weapons development and usage
  - Training in strategy, tactics, deployment, and employment of energetics weapons
  - Knowledge of energetics weapons effects and capabilities
  - Knowledge of the energetics weapons, tactics, deployment, and employment by the KGB/Russians
- *Civilian and military, scientific and intelligence, and news media personnel do not recognize energetics weapons effects happening right over their own heads*

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How Much Off Guard Are We?

- Kill of U.S.S. Thresher in 1963 not recognized. Left signatures.
- 23 years of KGB weather engineering, particularly over U.S. and North America, ignored and not recognized.
- Decades of irradiation of U.S. Embassy, fatally injuring three U.S. Ambassadors, health changes in personnel shrugged off ineptly.
- Massive building of underground sites, all through former Soviet Union, lamely speculated as perhaps "ABM" system or?.
- 1985, 1986 Soviet kills of U.S. aircraft, spacecraft, personnel ignored as "accidents" by legitimate U.S. communities.
- Quantum potential strike on soldiers in Gulf war ignored.
- Quantum potential deterioration of U.S. populace's immune systems ignored.
- Exchange of earthquakes and massive retaliatory destruction of Soviet missile ammunition storage sites, 1986-1989, ignored.
- U.S. scientific and military communities adamantly refuse to rework electromagnetics, though known to be seriously flawed.
- Refuse to apply Stoney/Whittaker work to engineer hidden variables, even though present quantum mechanics also known to be wrong because it does not contain such "hidden order."
- Refuse to develop, structure, and apply Bohm's quantum potential, for instantaneous action at a distance. Russians developed it.

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  - Not recognized.
  - Left signatures.
- **23 years of KGB weather engineering**
  - Particularly over U.S. and North America
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- **Decades of microwave irradiation of U.S. Embassy**
  - Fatally injured three U.S. Ambassadors
  - Induced health changes in personnel
  - Shrugged off ineptly.
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- Refuse to apply Stoney/Whittaker work to engineer hidden variables, even though present quantum mechanics also known to be wrong because it does not contain such "hidden order."
- Refuse to develop, internally structure, and apply Bohm's quantum potential, which gives instantaneous action at a distance and great energy amplification.
- Russians developed quantum potential weapons, which obsolete all other weapons.

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JUST HOW MUCH OFF GUARD ARE WE?
Kill of TWA-800 1996
Kill of USS Thresher 1963
Cold Explosion Off Japan Apr 1984
Kill of Space Shuttle Challenger 1986
From The Huntsville (AL) Times 18 Sep 96:
President's party airplane crash 1996
"Retired Gen. Wayne Downing concluded that U.S. forces are so far superior to potential foes that opponents have turned to terrorism as the only way of challenging them."
The Times also provided the information that Defense Secretary William Perry agreed with Gen. Downing's conclusion.
3 Dead U.S. Ambassadors from Moscow Embassy Radiation
QP Gulf War Syndrome: 16,000 persons disabled
QP jamming, U.S. air attack on Libya, 1996
Kill of Arrow DC-8 Gander AFB Dec 1985

JUST HOW MUCH OFF GUARD ARE WE?`

Kill of USS Thresher Nuclear Submarine Apr 1963

QP Test on U.S. Troops in Persian Gulf, 1991 (Gulf War Syndrome)

TWA-800 1996; President's C-130 crash 1996

3 Dead U.S Ambassadors, U.S. Weather Engineered 20 years

Arrow DC-8 Gander AFB Dec 1985

Challenger 1986

Quantum Potential Jamming of Air Attack on Libya Apr 1986

Blind Euphoria to Even the Ballistic Missile Threat

- U.S. National Intelligence Estimate (NIE) released in Nov. 1996 states there is no foreseeable threat to the U.S. from "indigenous missiles" for at least 15 years.
- Clinton has claimed a program for ABM defense is too expensive, would violate ABM Treaty with former USSR.
- Soviets developed an ABM system in violation of the treaty.
- In June 96 Russia test-launched an SS-19, their 26th ICBM test in 5 years.
- *"Russia still retains and is modernizing a vast nuclear arsenal... still the only nation of earth that could destroy America in a matter of minutes. Indeed, given the weakness of the Russian Army, Russia's superpower ambitions rest more than ever on its nuclear capabilities."* *
- "For the first time since the dawn of the nuclear age, there is not a single Russian missile pointed at America's children." **

Comment: Punch a computer button and the missiles are pointed! The armed missiles are still there, ready and waiting.

Bulleted info courtesy Washington Inquirer, June 24, 1996.

* House Nat'l Security Chmn, Floyd Spence.
** Bill Clinton, State of the Union Message.

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Possible Targets: 1995-9
Escalation Phase
(Based on 1985-87 test program)
Earthquakes
Missiles
Power Grids &
Distribution Systems
Satellites
Ships
Shuttle
Launches
& Flights
JETLINERS
Radio/TV
Subs
Microwave Nets
Radars &
Nets
Communications
and Computer Nets

Propagation of Weapon Effects

- All conventional weapons use propagation through 3-space of matter or energy or both
  - Matter (bombs, missiles, projectiles, etc.)
  - Energy (EM force fields, sonic force fields, etc.)
  - Basically one-to-one, or one "bus" to many-on-many
  - Finite propagation velocity v: where $0 < v \leq c$
  - Time delay: Shielding and pre-strike retaliation possible
- Structured quantum potential propagates vacuum ordering (vacuum engines), instantly
  - Zero time delay (through multiply-connected spacetime)
  - No propagation "through space", no "velocity" as such
  - Easily one-to-many, without limit
  - Dramatic energy amplifier (gates, amplifies flux ordering)
  - Effects arise in local spacetime; no shielding possible
  - No range limit, since striking distance always zero
- QP weapons obsolete all other weapons

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Yugoslav Earthquake, Followed by Cold Explosion

Apr. 15
1979

- Magnitude 7.2 on Richter scale
- Epicenter 33 km. deep
- More than 100 aftershocks
- At Kamenari:
  - Adriatic sea mushroomed up
  - Like atomic bomb explosion
  - Signature of a cold explosion
  - Similar to Apr. 1984 test off coast of Japan, near Kurils (see inset graphics)
- Note that April is a significant test month for the Communists (preparing official reports for May Day?)

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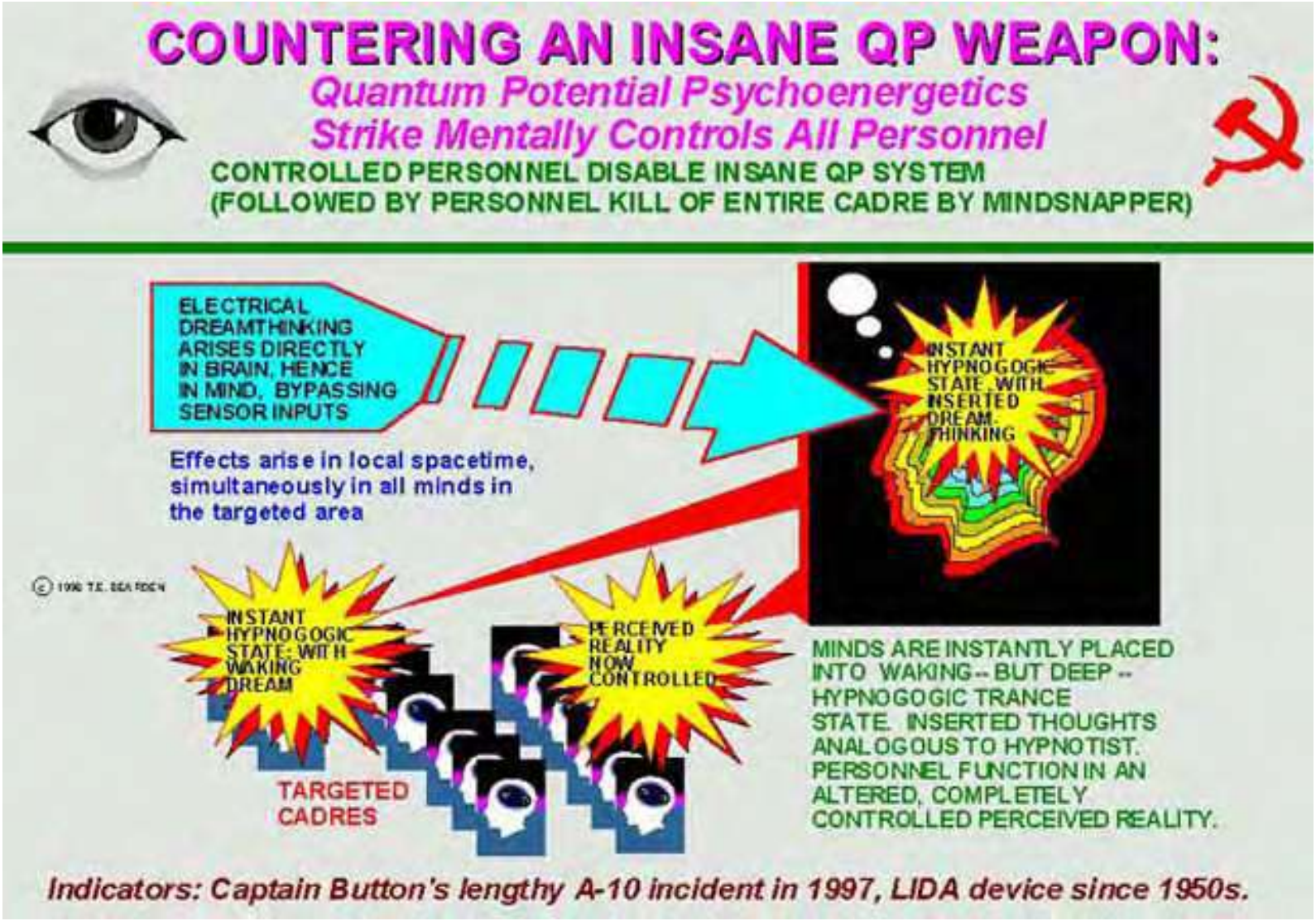
COUNTERING AN INSANE QP WEAPON:
Quantum Potential Psychoenergetics
Strike Mentally Controls All Personnel
CONTROLLED PERSONNEL DISABLE INSANE QP SYSTEM
(FOLLOWED BY PERSONNEL KILL OF ENTIRE CADRE BY MINDSNAPPER)
ELECTRICAL DREAMTHINKING ARISES DIRECTLY IN BRAIN, HENCE IN MIND, BYPASSING SENSOR INPUTS
Effects arise in local spacetime, simultaneously in all minds in the targeted area
INSTANT HYPNOGOGIC STATE WITH INSERTED DREAM THINKING
INSTANT HYPNOGOGIC STATE WITH WAKING DREAM
PERCEIVED REALITY NOW CONTROLLED
TARGETED CADRES
MINDS ARE INSTANTLY PLACED INTO WAKING -- BUT DEEP -- HYPNOGOGIC TRANCE STATE. INSERTED THOUGHTS ANALOGOUS TO HYPNOTIST. PERSONNEL FUNCTION IN AN ALTERED, COMPLETELY CONTROLLED PERCEIVED REALITY.
Indicators: Captain Button's lengthy A-10 incident in 1997, LIDA device since 1950s.

Gulf War Disease: KGB QP Weapon Induced
ST Curvature Engines for a Cocktail of Diseases
LIBYA
EGYPT
CHAD
SUDAN
SAUDIA ARABIA
IRAN
IRAQ
SYRIA
LEBANON
ISRAEL
JORDAN
KUWAIT
QATAR
OMAN
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Distant Scalar Potential Interferometer with iterative self-targeting

Self-Targeting in Inner EM Channel Can Produce a Quantum Potential

Once QP is established, energy transmission is direct and instantaneous. Energy input to one single participant will simultaneously appear in all other participants, the amount depending on their fractions of participation with the input station.

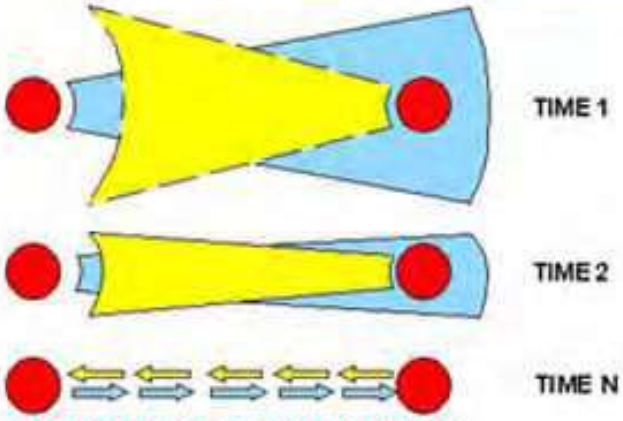

NARROWING OF INTERACTING POTENTIALS INTO LASER-LIKE BEAMS, BETWEEN TWO PUMPED SOURCES. NOW ONLY LONGITUDINAL WAVES CONNECT THE LINKED OBJECTS.

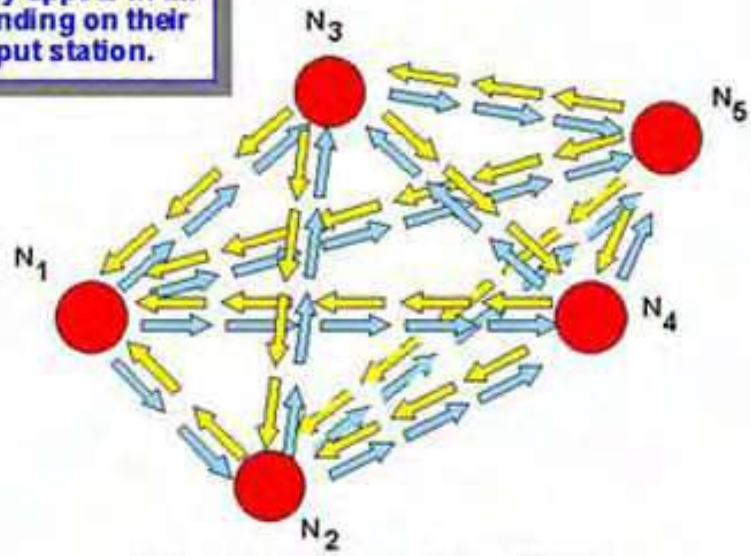

SELF-TARGETING EFFECT AMONG ALL PAIRS OF INTERACTING PUMPED SOURCES

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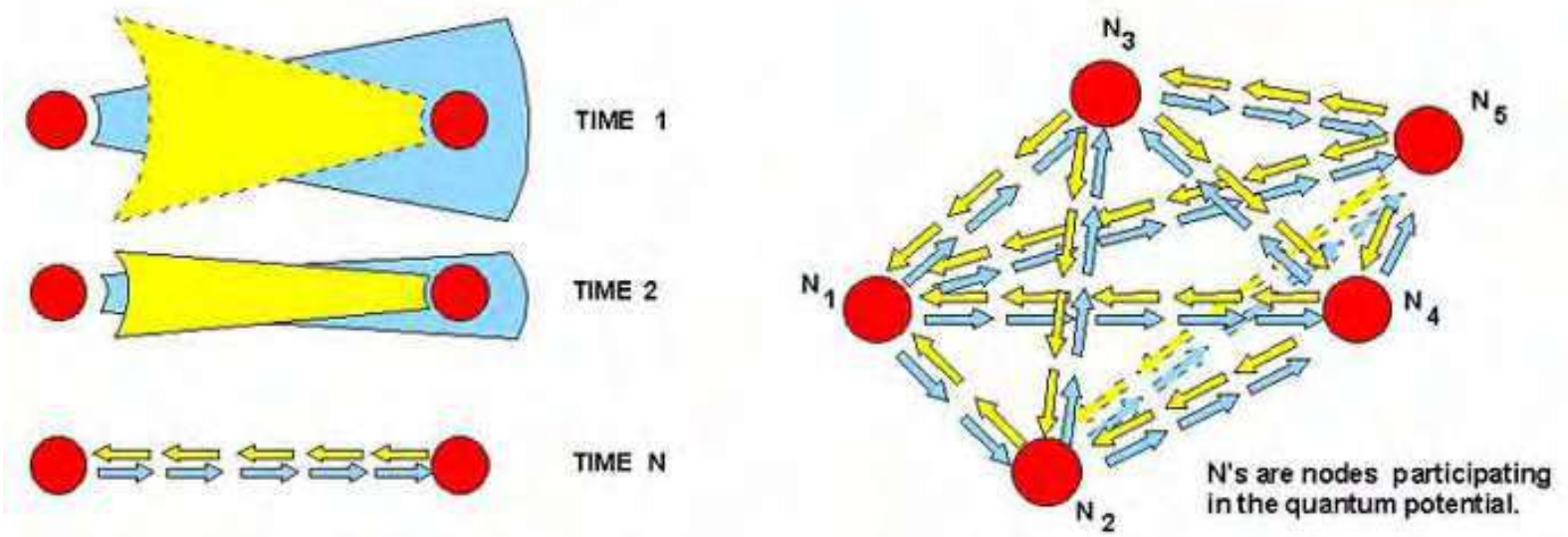

a. Iterative retroreflection between any pair of nodes narrows the interconnecting potentials to a laser-like, bidirectional beam. Iterative phase conjugate reflection provides self-targeting.

b. The quantum potential exists as narrow, laser-like beams between participating nodes, even when the nodes are widely separated. The beam space is multiply-connected; transmission is instantaneous.

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Consider the hidden Stoney/Whittaker bidirectional EM waves that comprise the potential from each source node. If these nodes have sufficient intersymmetry of dynamic material form, then self-targeting occurs between the two nodes of any nodal pair. By iterative phase conjugate reflection, the scattering is narrowed into interconnecting wavepairs, in laser-like beams, between each two nodes. Thus the interconnecting potentials narrow into laser-like, bidirectional beams. The Coulomb gauge may apply, and a quantum potential may be formed.

Figure 30. Mechanism for generating a quantum potential, by iterative self-targeting induced into a system of multiple scattering nodes. Once a QP is established, spatial separation has little or no effect.

Major Principles for Use of Quantum Potential Weapons

- Must disable dead-man fuzing prior to massive use of scalar interferometry weapons.
- Must assure immediate, complete nullification of unique enemy assets (quantum potential assets, special ships, and energetics weapons).
- Personnel can be destroyed instantly with mindsnapping; area is sterilized of life, and effect persists, gradually dying away.
- Personnel can be disabled instantly with various psychoenergetic weapons; area not sterilized.
- Personnel can be destroyed in short order by using EM BW weapons; area not sterilized.
- If foe has energetics weapons, then it is a quick-draw "gunslinger" contest unless insane MAD systems deployed.
- Complete surprise is of decisive importance.
- Tailor effect used to specific target, objective.
- *Note: Must use "insane" MAD systems to deter.*

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Quantum Potential Weapons: Major Principles (Continued)

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- Three major classes of use exist:
  - Use of bulk energy only (as in bulk heating or cooling) without substructuring
  - Use of internal structuring of the bulk energy, so that *vacuum engines* appear in target
  - Use of more deeply nested engines allows direct intervention in mind, long term memory, perception, thoughts, emotions, personality
- Use of vacuum engines allows engineering at a distance of:
  - *Atomic nuclei* including structures, reactions, and transmutations
  - *Bulk matter* including translations, lattice bonding, chemistry, chemical interactions, electromagnetic interactions
  - *Deep biological control systems* such as
    - Becker's cellular control (recovery) system
    - Popp's cellular control system
  - *Cells* including:
    - Structuring, differentiation and dedifferentiation
    - Genetic changes, chemical changes
    - Induction of disease states without normal disease vectors
  - *Mind/matter interface*, including long-term memory, perception, emotion, thought, mental state

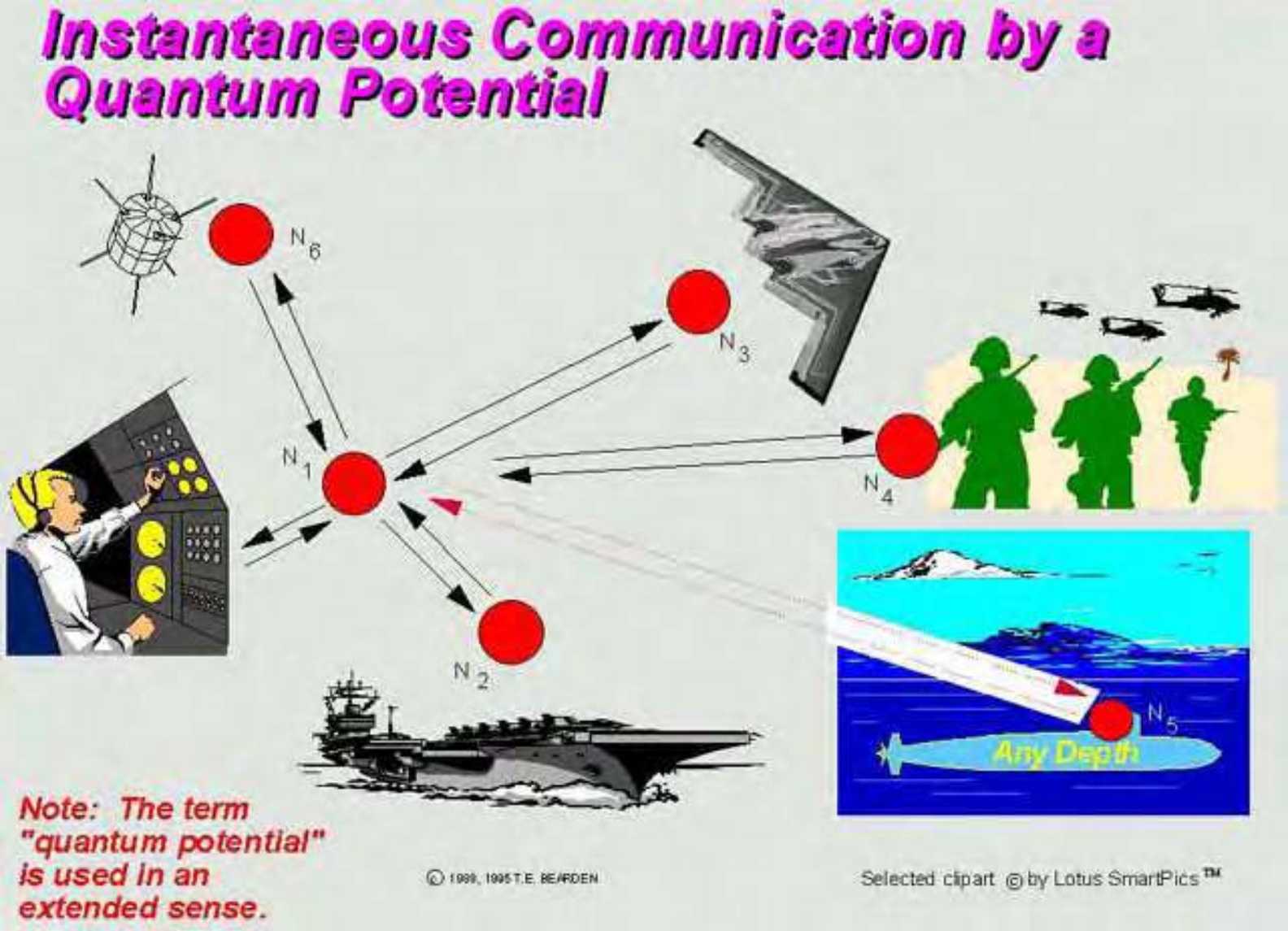
Instantaneous Communication by a Quantum Potential
N6
N3
N1
N4
N2
N5
Any Depth
Note: The term "quantum potential" is used in an extended sense.
© 1999, 1995 T.E. BEARDEN
Selected clipart © by Lotus SmartPics™

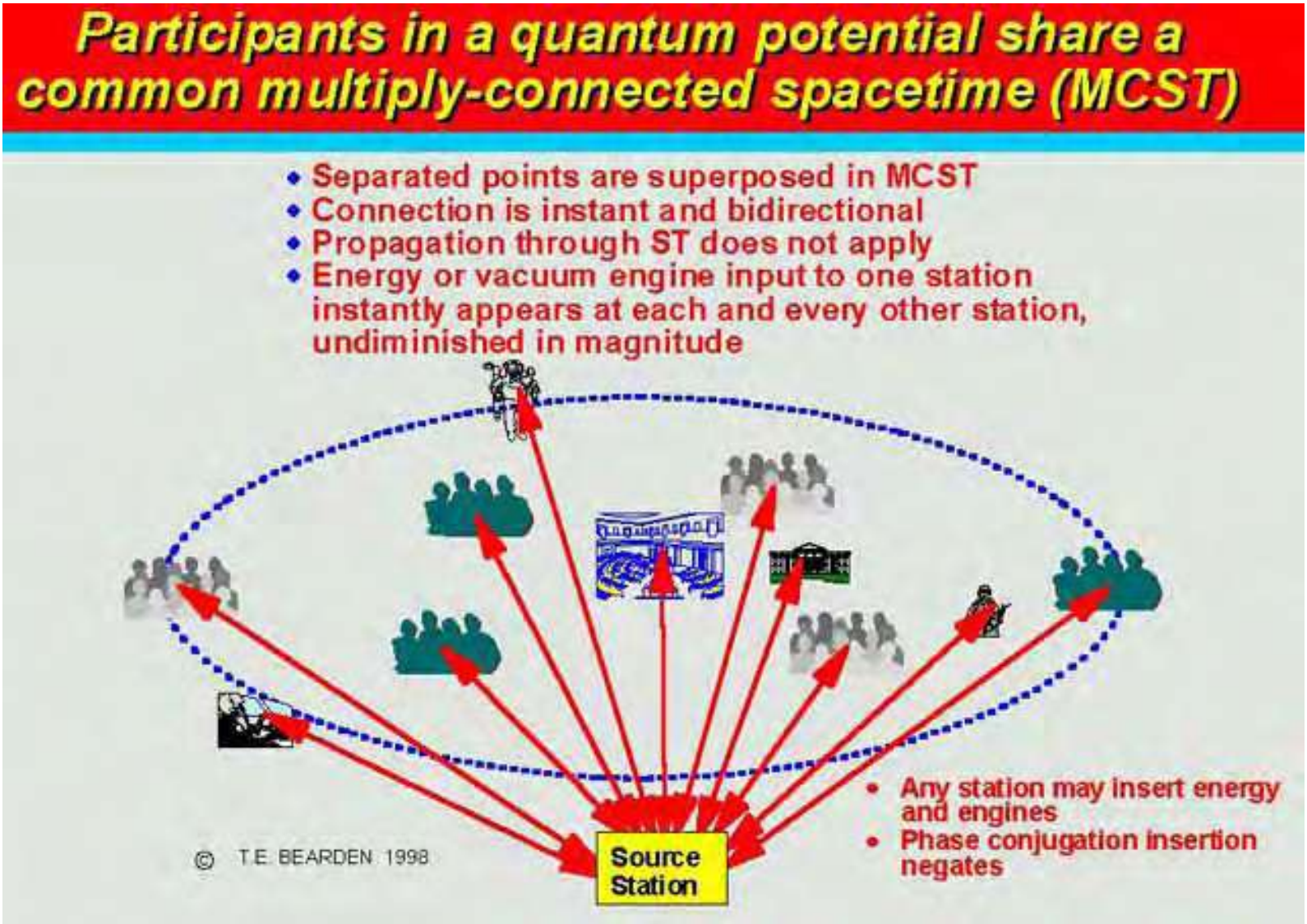
Participants in a quantum potential share a common multiply-connected spacetime (MCST)
• Separated points are superposed in MCST
• Connection is instant and bidirectional
• Propagation through ST does not apply
• Energy or vacuum engine input to one station instantly appears at each and every other station, undiminished in magnitude
• Any station may insert energy and engines
• Phase conjugation insertion negates
Source Station
© T.E. BEARDEN 1998

Quake in Tangshan, China

28 July, 1976

- 7.8 on Richter scale
- Hundreds of thousands killed
- Accompanied by extensive light, electrical effects
  - Starting 3 to 5 days before
  - Communications interference within 250 km
  - Sky lighting observed
- [Personal comments]

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Counting Rifles: Put up or shut up!

(Exchanging Earthquakes)

Opening bet

- Quebec 25 Nov 88
- Pasadena 3 Dec 88

Raise you

- Armenia 7 Dec 88

Call - what do you have?

- Malibu 18 Jan 89

Four aces

- Soviet Central Asia 23 Jan 89

Clear table (stress relief)

- Bakersfield et al various

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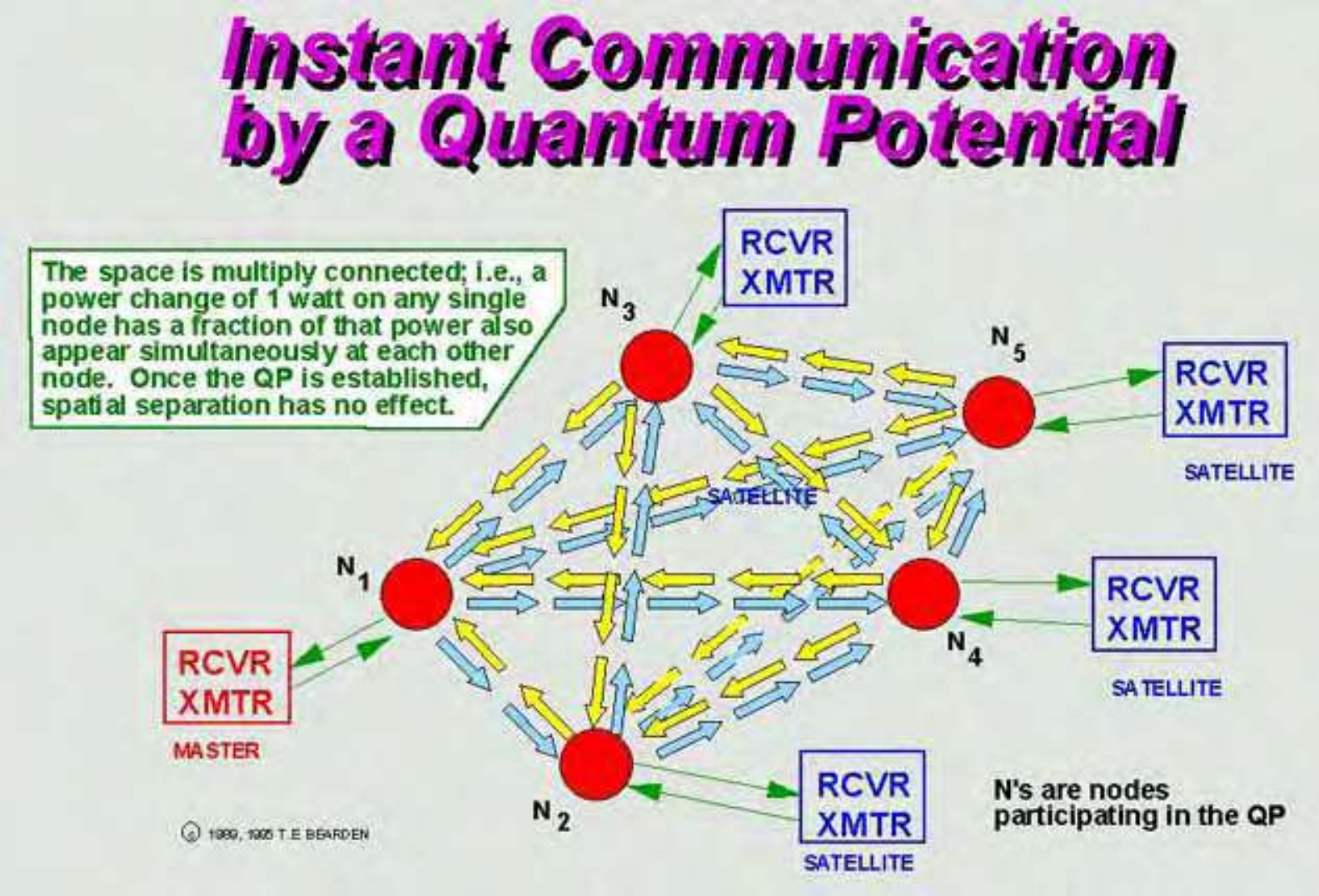
Instant Communication by a Quantum Potential
The space is multiply connected; i.e., a power change of 1 watt on any single node has a fraction of that power also appear simultaneously at each other node. Once the QP is established, spatial separation has no effect.
RCVR XMTR
N3
N5
RCVR XMTR
SATELLITE
SATELLITE
N1
RCVR XMTR
N4
SATELLITE
RCVR XMTR
MASTER
N2
RCVR XMTR
SATELLITE
N's are nodes participating in the QP
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Westerners Do Not React to Slow Threats
BOA CONSTRICTOR
LIGHTNING STRIKE
Westerners tend not to react to slowly increasing things,
but react to rapidly increasing things.

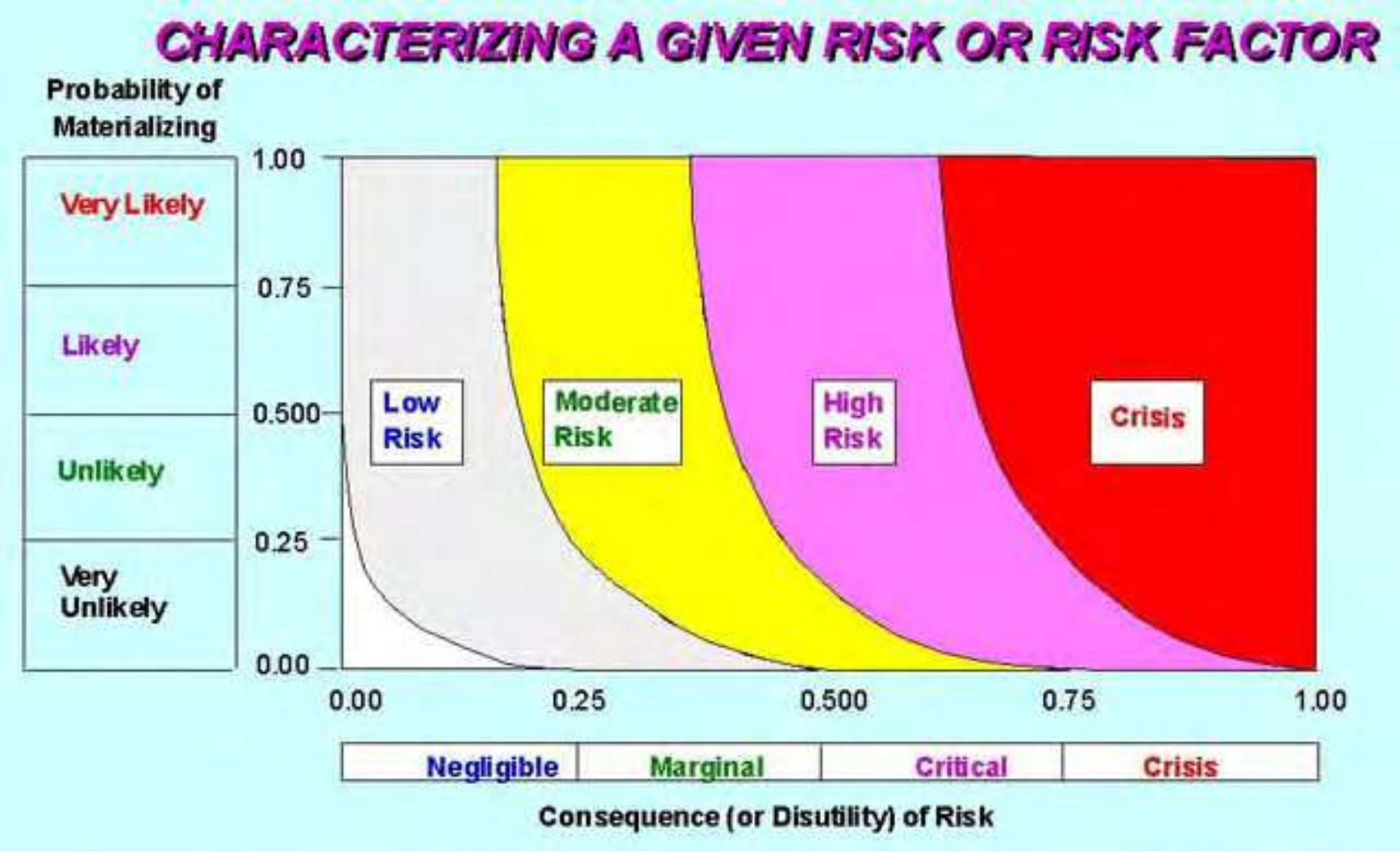
CHARACTERIZING A GIVEN RISK OR RISK FACTOR
Probability of Materializing
Very Likely
Likely
Unlikely
Very Unlikely
1.00
0.75
0.500
0.25
0.00
Low Risk
Moderate Risk
High Risk
Crisis
0.00
0.25
0.500
0.75
1.00
Negligible
Marginal
Critical
Crisis
Consequence (or Disutility) of Risk

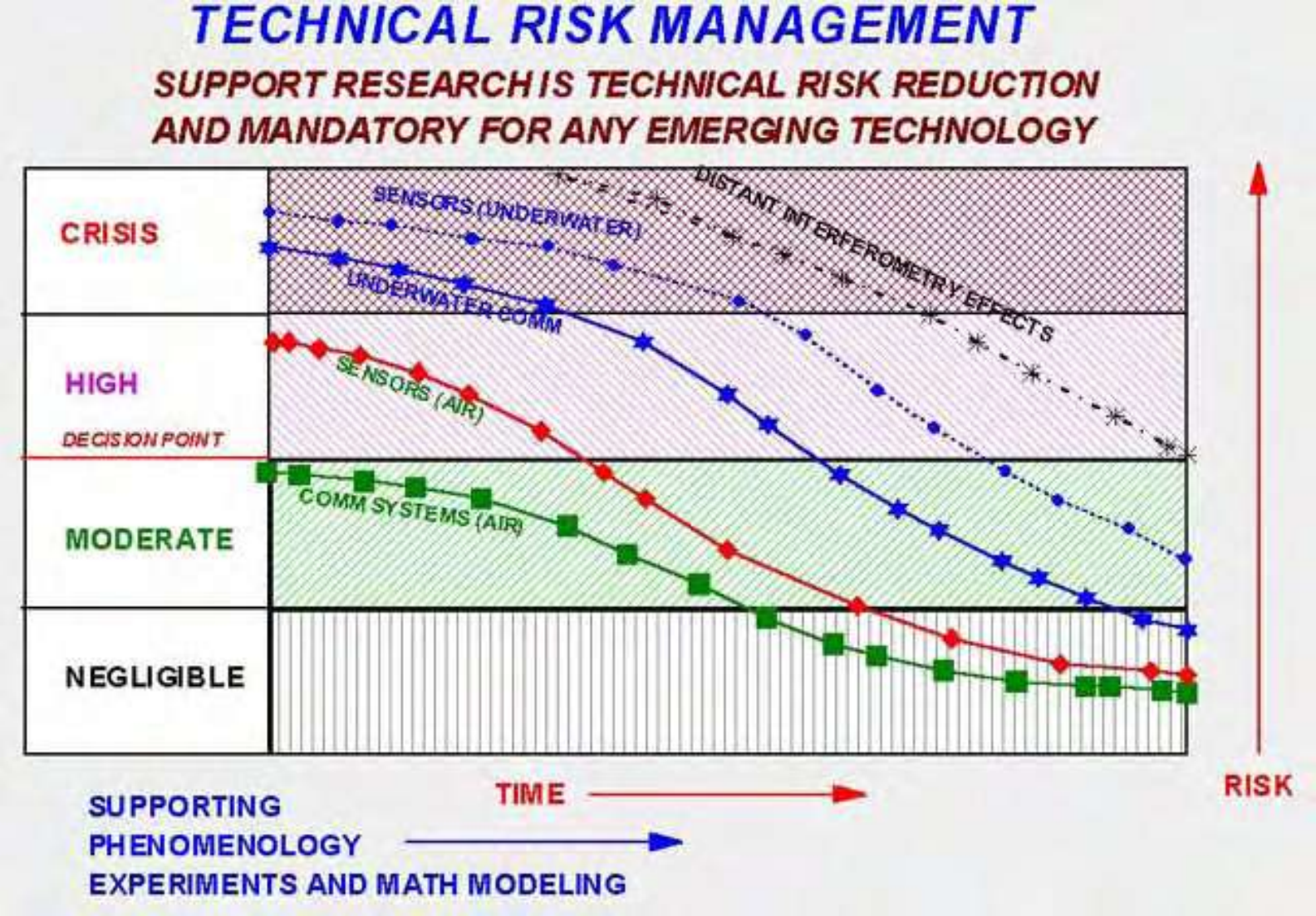
TECHNICAL RISK MANAGEMENT
SUPPORT RESEARCH IS TECHNICAL RISK REDUCTION
AND MANDATORY FOR ANY EMERGING TECHNOLOGY
CRISIS
HIGH
DECISION POINT
MODERATE
NEGLIGIBLE
SENSORS (UNDERWATER)
DISTANT INTERFEROMETRY EFFECTS
UNDERWATER COMM
SENSORS (AIR)
COMM SYSTEMS (AIR)
TIME
RISK
SUPPORTING
PHENOMENOLOGY
EXPERIMENTS AND MATH MODELING

Aum Shinrikyo's Sarin Facility

The interior of Satian No. 7, a suspected sarin production plant

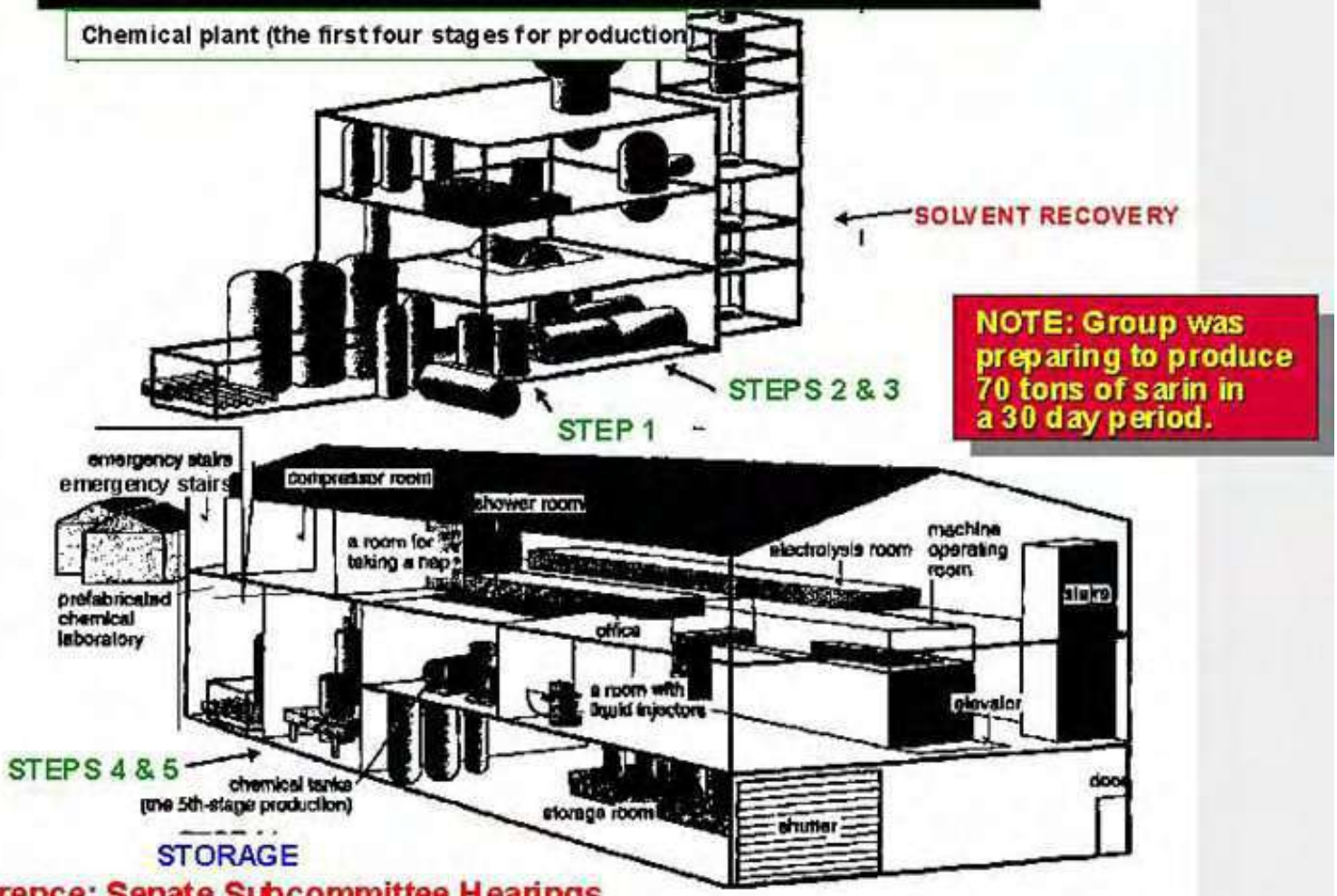

NOTE: Group was preparing to produce 70 tons of sarin in a 30 day period.

Reference: Senate Subcommittee Hearings

In Scalar Beam Interference Zone

- De-phasing of wave/antiwave pairs occurs
- Zero-summation destroyed
- Ordinary EM reappears [Whittaker 1904]
- Ordinary energy appears or disappears (i.e., may produce heating or cooling)
- Energy bottle effect
- Can add or extract EM energy
- Can produce specific ST curvature engines

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Physicist Schappeller Auralaz Munster, Austria:

- British Intelligence interview, about 1948
  - Used Kaluza-Klein theory
  - Worked with Russians
- Schappeller claimed he could:
  - Cause "implosions" rather than explosions
  - Use gravitational and electromagnetic energy
  - Cause large areas of the ocean to freeze
  - Tap earth-ionospheric field
  - Produce enormous energy
- *This is precisely what Hellman worked on in the USSR, after WW II!*

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Initial Soviet Plan for Cold War, After WW II

- Develop and deploy SAM bomber defense
- Catch up in atomic weapons
- Master and apply rocketry
- Wed atomic warheads to rockets
- Initiate "Cold" War
  - Bleed the dragon
  - Guerrilla wars
  - Terrorism
  - Insurgencies
- *Find, develop, and weaponize next great technical breakthrough area as highest national priority*

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Josef Stalin: Absolute Dictator

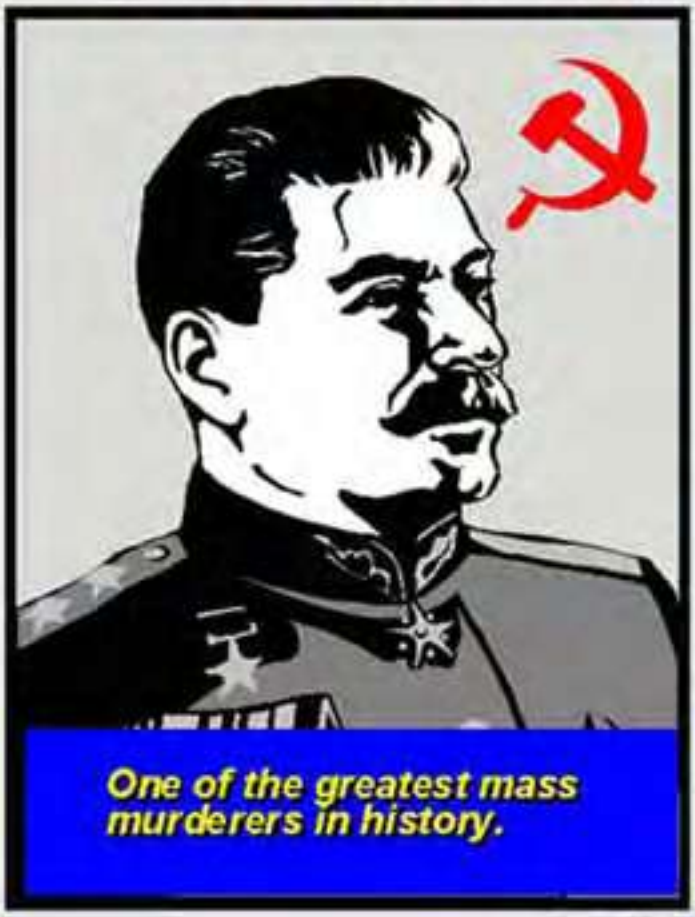

- Secret police and spies everywhere
- Purged his own officer corps
- Always deeply suspicious
- Regularly purged his enemies or those perceived to be shaky or untrustworthy
- Absolute power, justice had nothing to do with it
- Opponents often just disappeared in the night, never to be seen again
- Secret police often tortured, killed them
- Others sent to slave labor camps to die by severe work, starvation, and beatings or downright massacre
- Had experienced unusual abilities of Wolf Messing, so knew that some persons could do unusual things
- Forced Soviet weapon physics into this psychoenergetics realm also

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Exploding any Resistance by Operational Scientists
© T.E. BEARDEN 1997
Josef Stalin
The Communists slaughtered 20 million Russian Kulaks to collectivize Soviet farming
Assembled Academy
"The destiny of communism has been frustrated by the U.S. development of the atomic bomb. That is not the last great technical breakthrough. The next one WILL be Soviet! You will provide me with that great new technical breakthrough at all speed, or I will have your heads. Do I make myself clear, comrades?"

Significant Soviet Statements

- "In the final revolution, it does not matter if three-quarters of the earth is destroyed, so long as the other quarter emerges communist." *[Lenin]*

- "If a means of total neutralization of foreign missiles is to be found, it can only come from a group of new principles in physics, called energetics." *[Nobelian Petr Kapitsa, to Nikita Khrushchev, in answer to Khrushchev's demand for a 100% method of defense against long range missile attack.]*

- "We will bury you." *[Khrushchev, to Nixon, Kitchen Debate]*

- "We have a new weapon, just within the portfolio of our scientists, so to speak, which is so powerful that, if unrestrainedly used, it could wipe out all life on earth. It is a *fantastic* weapon." *[Khrushchev, speaking to the Presidium, Jan. 1960]*

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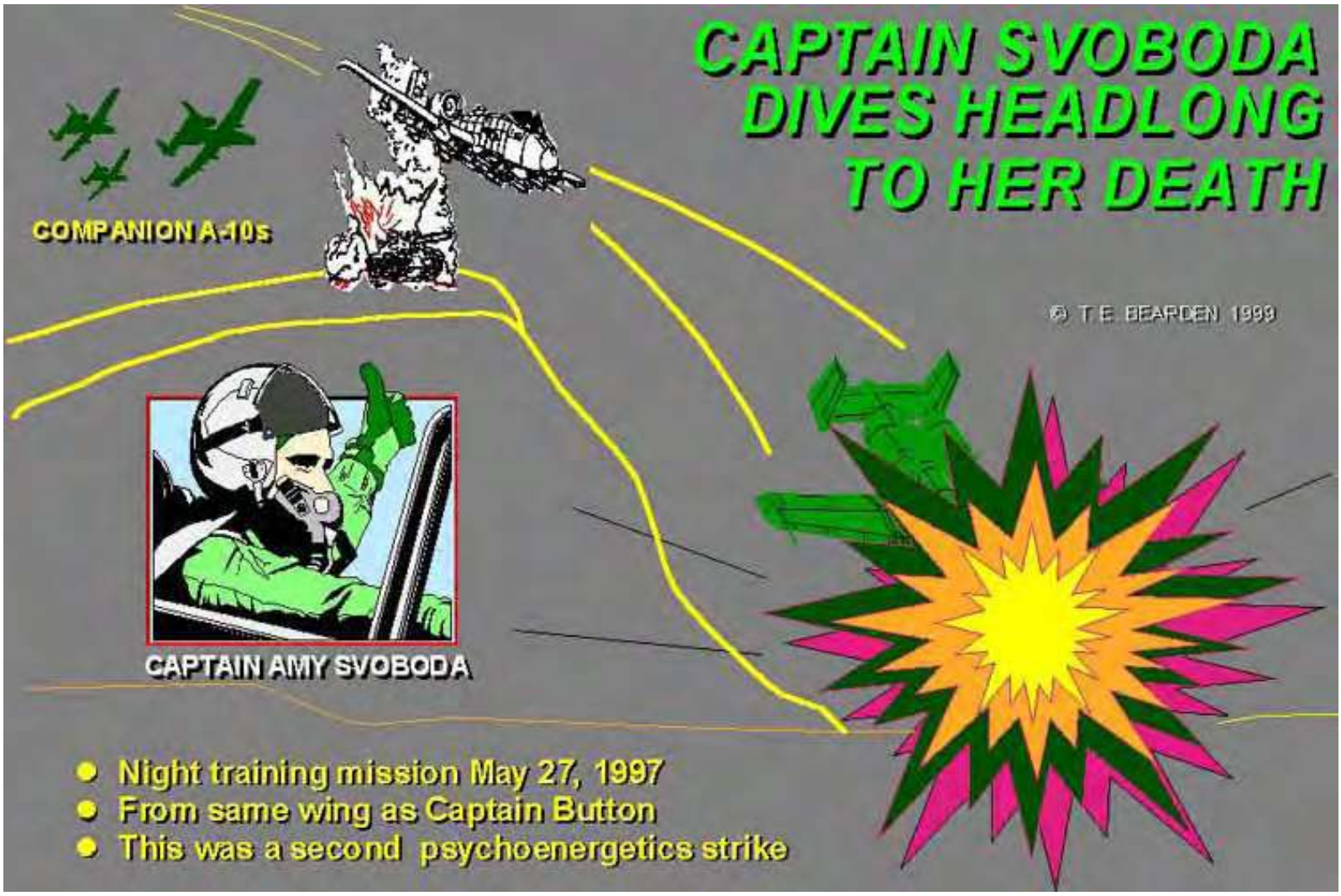
CAPTAIN SVOBODA
DIVES HEADLONG
TO HER DEATH
COMPANION A-10s
© T.E. BEARDEN 1999
CAPTAIN AMY SVOBODA
• Night training mission May 27, 1997
• From same wing as Captain Button
• This was a second psychoenergetics strike

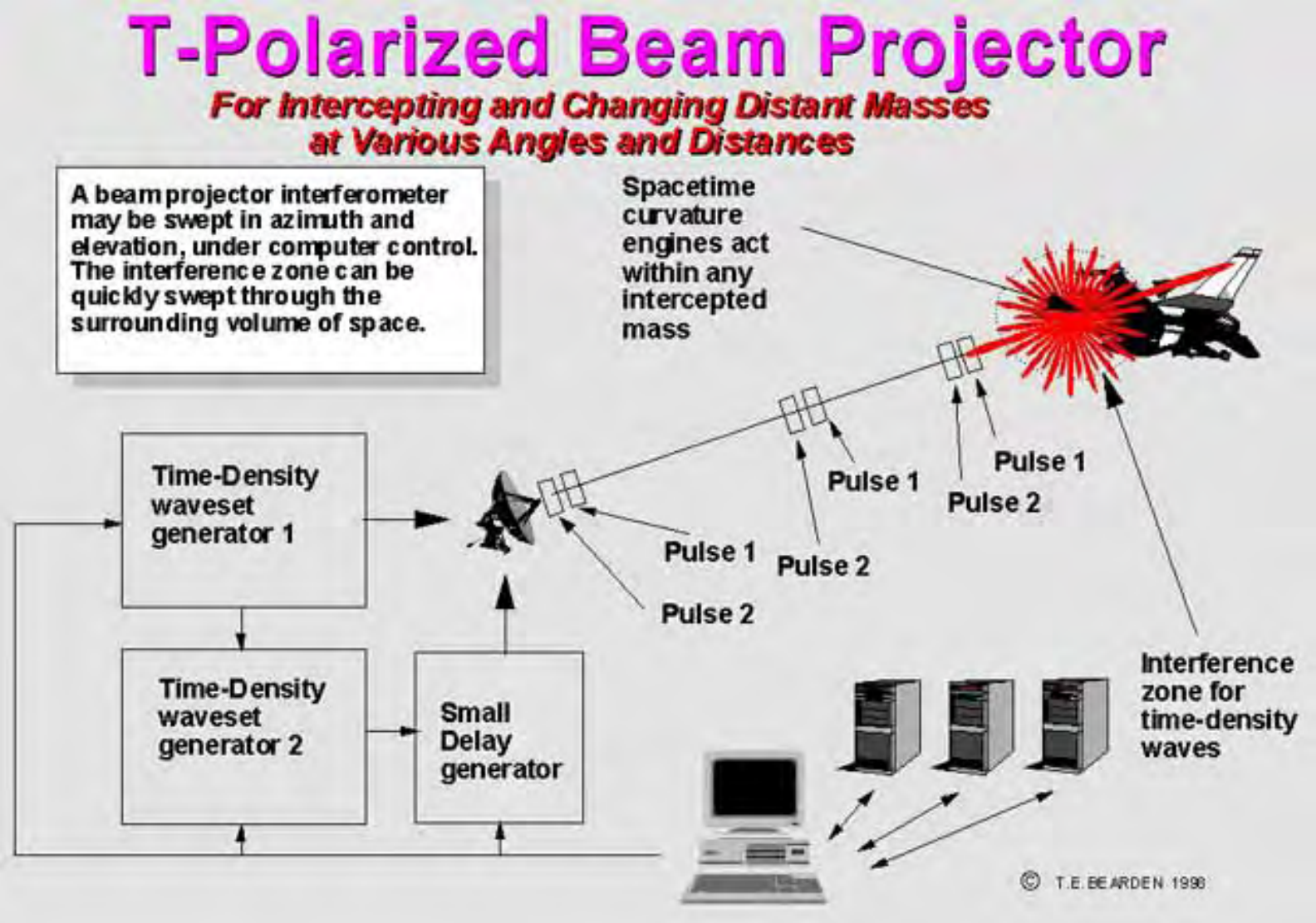
T-Polarized Beam Projector
For Intercepting and Changing Distant Masses
at Various Angles and Distances
A beam projector interferometer may be swept in azimuth and elevation, under computer control. The interference zone can be quickly swept through the surrounding volume of space.
Spacetime curvature engines act within any intercepted mass
Time-Density waveset generator 1
Time-Density waveset generator 2
Small Delay generator
Pulse 1
Pulse 2
Pulse 1
Pulse 2
Pulse 1
Pulse 2
Interference zone for time-density waves
© T.E. BEARDEN 1998

Possible Tests (1)

- 1958 nuclear accident in Urals
- Disease induction in U.S. Embassy personnel in Moscow
- Siberian disease/death transmission experiments
- Destruction of USS Thresher nuclear submarine, Apr. 10, 1963
- Nuclear explosion transmitted into ocean underwater, 100 miles north of Puerto Rico, Apr. 11, 1963

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Possible Tests (2)

- Eight F-111's downed in Vietnam immediately after deployment
- Several large earthquakes
- Mysterious aircraft losses in groupings
- Numerous underground "nuclear" tests
- Nuclear tests at Semipalatinsk without associated seismic activity
- High altitude rumbles, snaps, booms
  - *Off English coast*
  - *Off East coast of U.S.*
  - *Over West Coast of U.S. in thunderstorms*

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Possible Tests (3)

- Blinding of several U.S. satellites (up to 4 hours in duration)
- Cold Explosion off Kurils 1984
  - First, a cold explosion
  - Then test of giant Tesla shield 300 mi. dia.
- Tests offset from shuttle launch Nov. 85
- Kill of Arrow DC-8,Gander, NFLD Dec. 1985
- Titan kill, Vandenberg AFB, CA early 1986
- Kill U.S. Challenger, off Cape Canaveral 1986
- Earthquakes induced, 1986-88
- Dozens of tests of shields around the world
- Decades of radiating U.S. Embassy in Moscow

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Possible Tests (4)

- Extensive tests 1990-99 in Western Australia
- Engineering of weather since 1990 by Yakuza
- Possible nuclear dudding test in WA in 90s by Aum Shinrikyo
- C-130 engine flameout kill
- TWA-800 kill 1997
- Gulf War Disease Induced, 1991
- Spreading of immune systems of U.S. populace, 1990s
- Psychoenergetic control of Captain Button
- Psychoenergetic control of Captain Svoboda
- Twice in 1997, within days of full strategic destruction of U.S.

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Mushroom cloud rising from sea

- 0514 hrs, 9 April 1984
- Gray-white cloud appeared
- Rose 60,000 feet in 2 minutes
- South of Kuril Islands
  - *180 miles southeast of Hokaido*
  - *200 miles from Tokyo*
- Soviet missile testing scheduled about 350 miles away, at 2100 hrs, 9 April 1984

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Launches from Cape Canaveral
and Vandenberg AFB
Provided Practice Targets of Opportunity

The sinking U.S.S. Thresher, with her controls jammed, implodes when she reaches crush depth

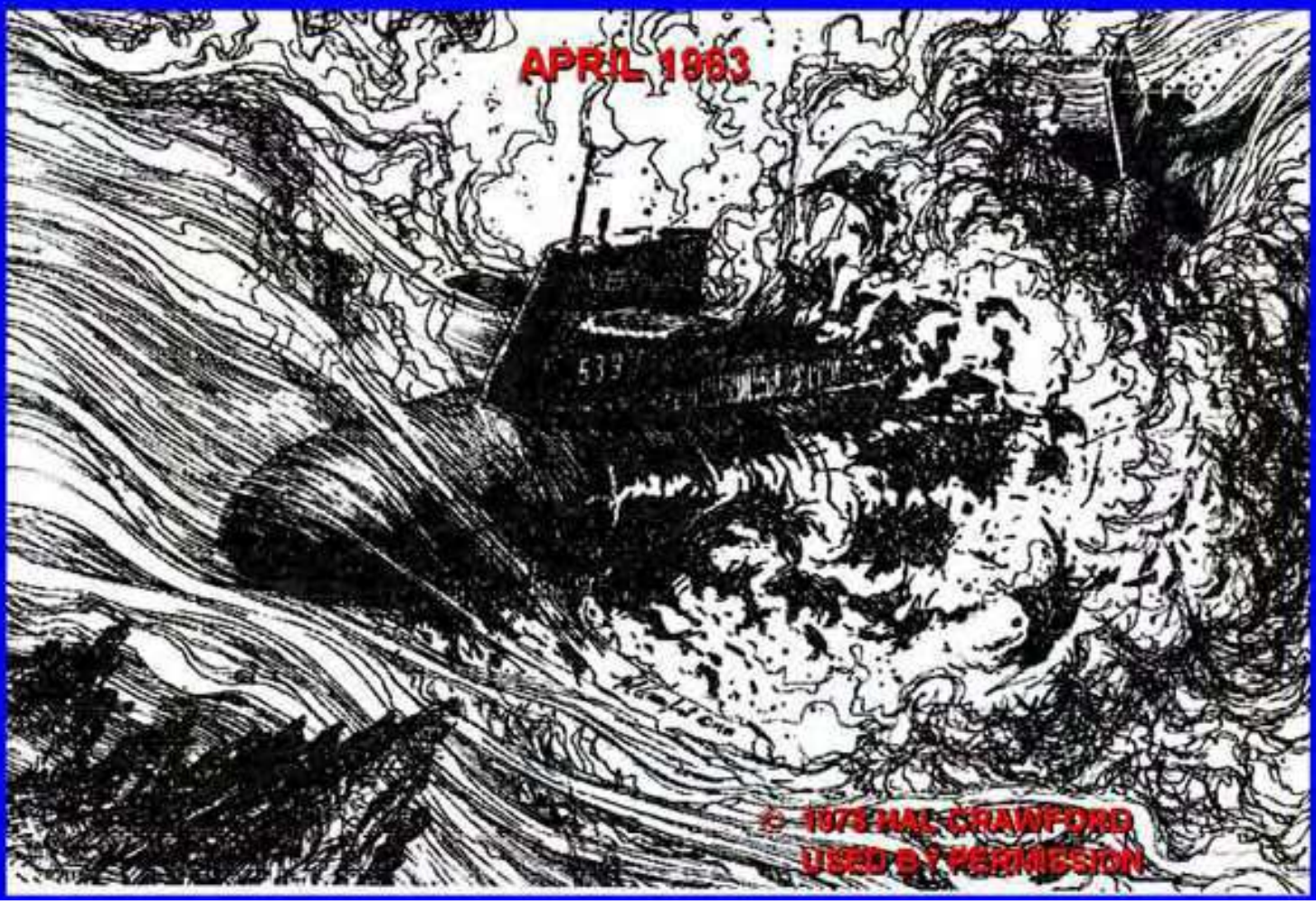

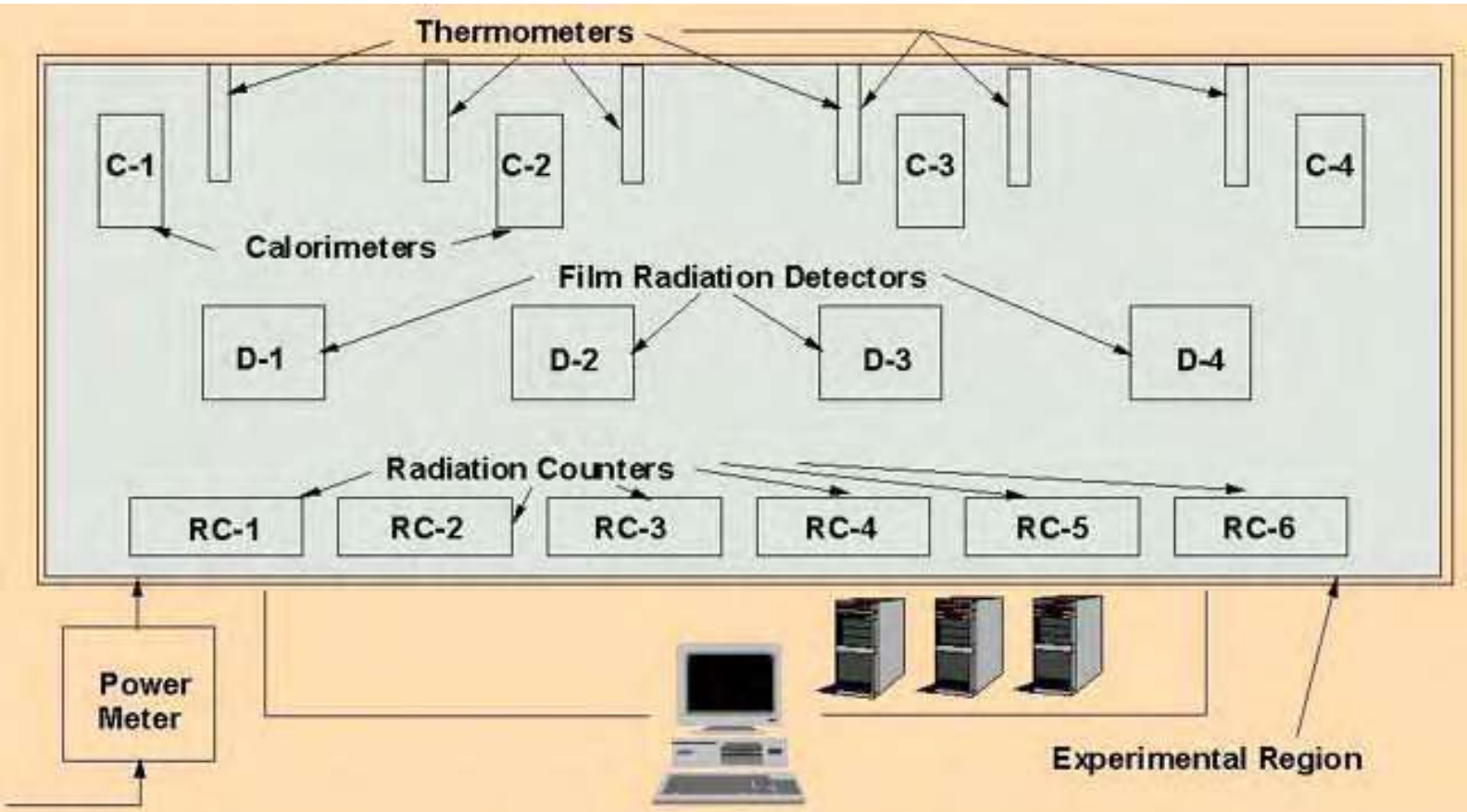

Figure 32. Embodiment of an instrumental array sufficient to discriminate when time-density charging has occurred, and that transduction of time-charge decay is occurring.

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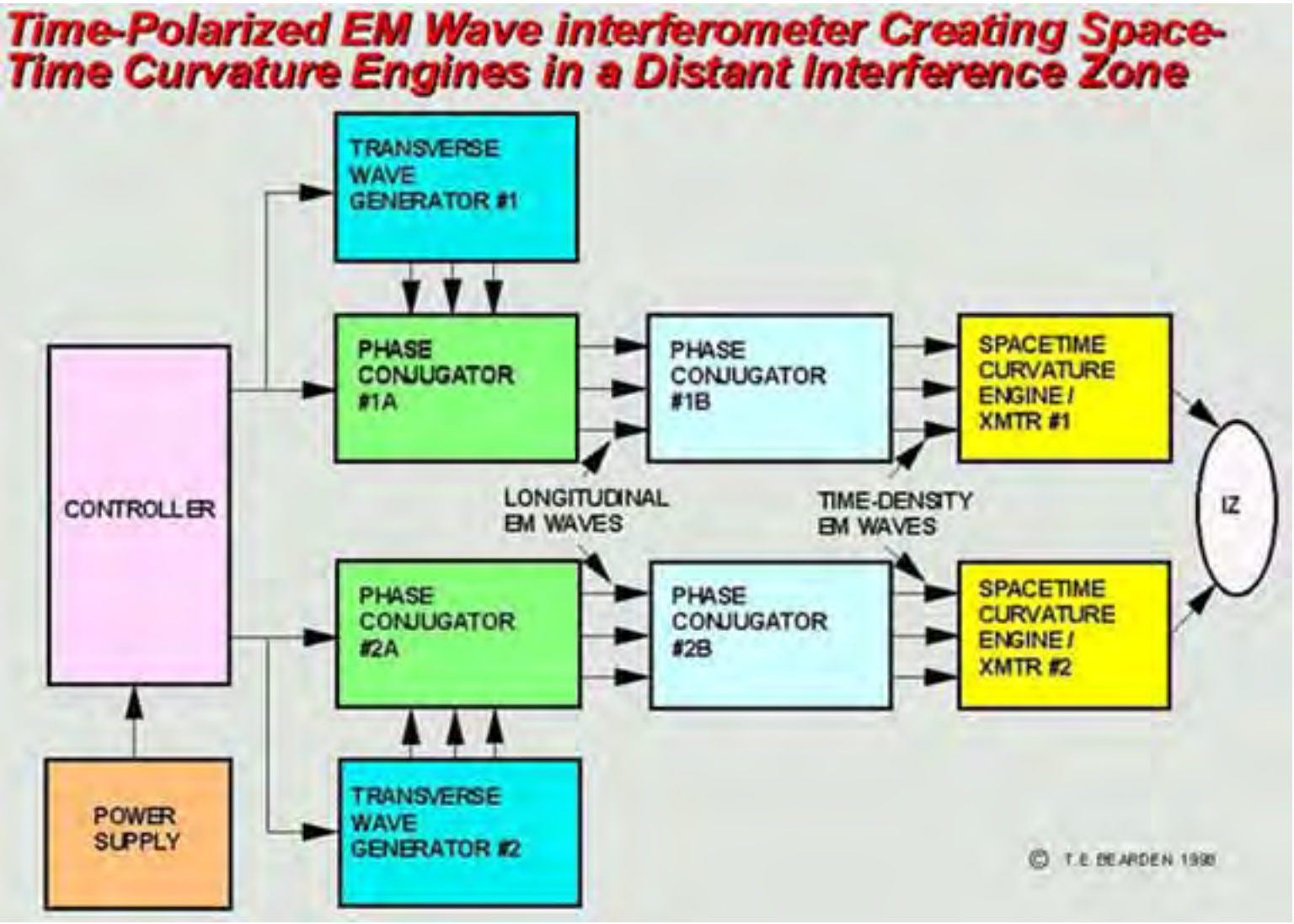
Time-Polarized EM Wave interferometer Creating Space-Time Curvature Engines in a Distant Interference Zone
TRANSVERSE WAVE GENERATOR #1
PHASE CONJUGATOR #1A
PHASE CONJUGATOR #1B
SPACETIME CURVATURE ENGINE / XMTR #1
CONTROLLER
LONGITUDINAL EM WAVES
TIME-DENSITY EM WAVES
IZ
PHASE CONJUGATOR #2A
PHASE CONJUGATOR #2B
SPACETIME CURVATURE ENGINE / XMTR #2
POWER SUPPLY
TRANSVERSE WAVE GENERATOR #2
© T.E. BEARDEN 1990

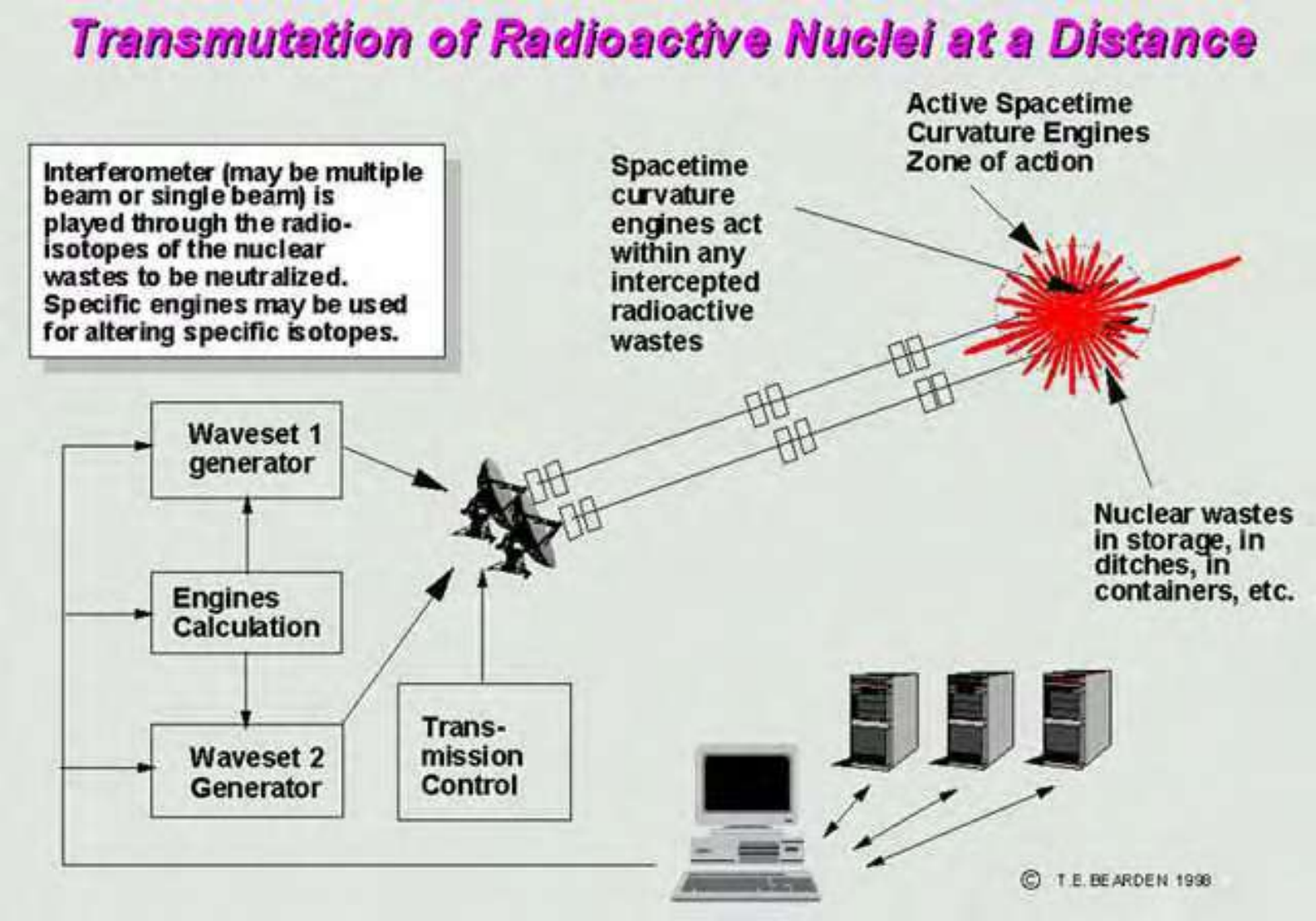
Transmutation of Radioactive Nuclei at a Distance
Interferometer (may be multiple beam or single beam) is played through the radio-isotopes of the nuclear wastes to be neutralized. Specific engines may be used for altering specific isotopes.
Spacetime curvature engines act within any intercepted radioactive wastes
Active Spacetime Curvature Engines Zone of action
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
Nuclear wastes in storage, in ditches, in containers, etc.
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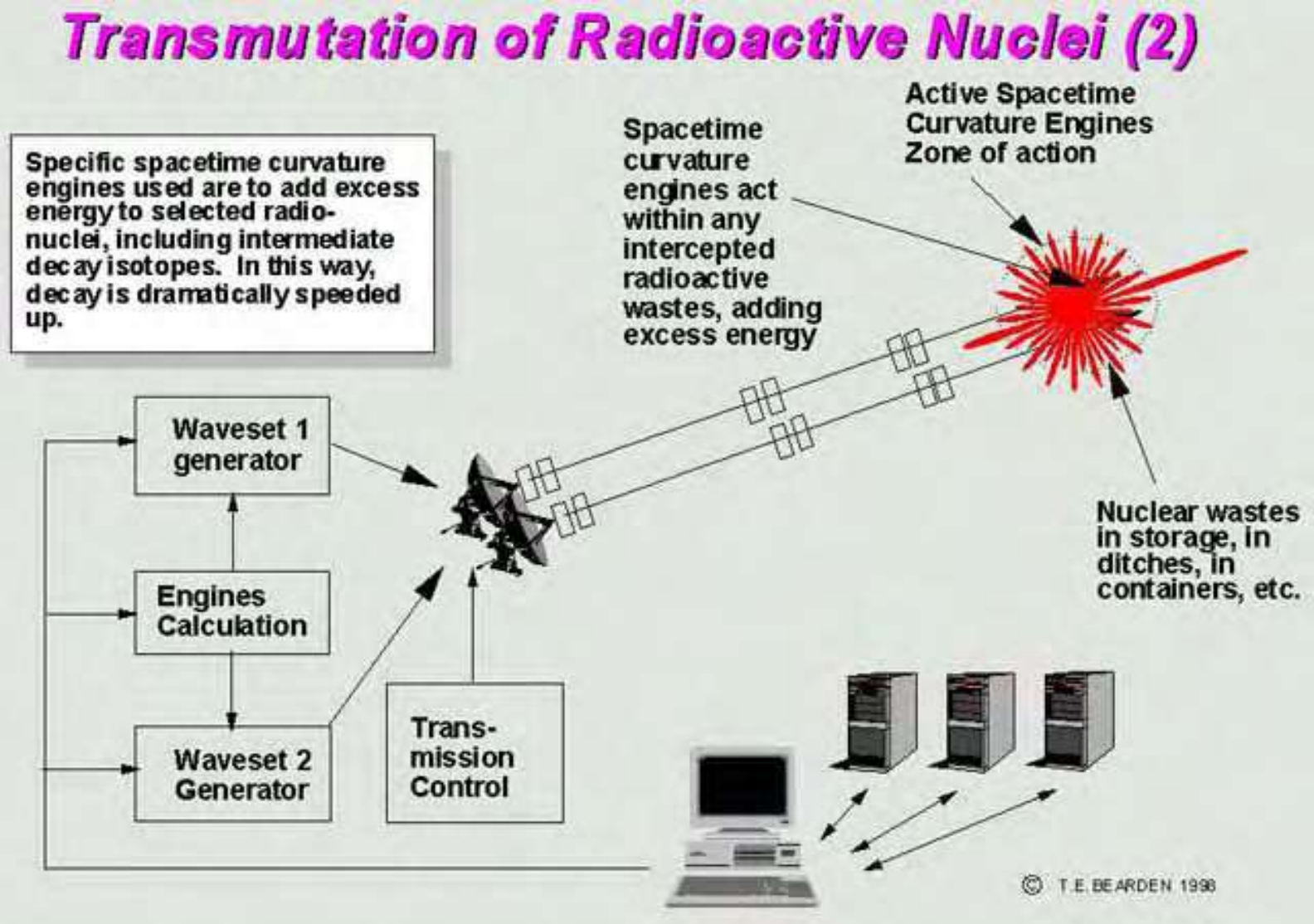
Transmutation of Radioactive Nuclei (2)
Specific spacetime curvature engines used are to add excess energy to selected radio-nuclei, including intermediate decay isotopes. In this way, decay is dramatically speeded up.
Spacetime curvature engines act within any intercepted radioactive wastes, adding excess energy
Active Spacetime Curvature Engines Zone of action
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
Nuclear wastes in storage, in ditches, in containers, etc.
© T.E. BEARDEN 1998

Typical Shield Test, Northern Route to Japan
18-27 km diameter
Asahi Evening News, Tokyo
June 22, 1982
Multiple tests seen per month, for years.
Pilots simply ceased reporting them.
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A Curious Tide in Human Affairs

To win its freedom in the long run, usually a group must defeat its attackers or suppressors *at least twice*.

- We fought the British twice for our independence.
- We are fighting ourselves twice to free the slaves. - American Civil War
  - Civil rights struggle
- We beat the Germans twice, in WW I and WW II
- We beat the Hispanics in the Spanish-American War. *That's once*. (They're winning the second by crossing the border. The U.S. is becoming a Hispanic Nation).

But we also have some unfinished business at hand.

- We checked the Russians in the Cold War. *Once*.
- We checked the Japanese in WW II. *Once*.
- We checked the KGB in the Cold War. *Once*.
- We checked the Communists in the Cold War. *Once*.
- We checked Saddam Hussein in the Gulf War. *Once*.

Large Scalar EM Interferometer (LASI) Accident Near Urals, 1958

- 1958 nuclear explosion near Urals
  - Signature of large scalar interferometer (LASI) accident
  - Buried atomic wastes suddenly exploded
  - Large region contaminated to this day
- Soviets were well along with advanced LASI prototypes and testing
  - Khrushchev announced forthcoming advent of these "fantastic" weapons in Jan. 1960
  - 1958 difficulties could have been resolved by 1960
- Expected 1958 cause: transmitter short-out and failure in a nearby LASI discharged its cumulated energetics beam energy into the ground
- *Spreading ground pulse struck nearby atomic wastes, fissioning nuclei*

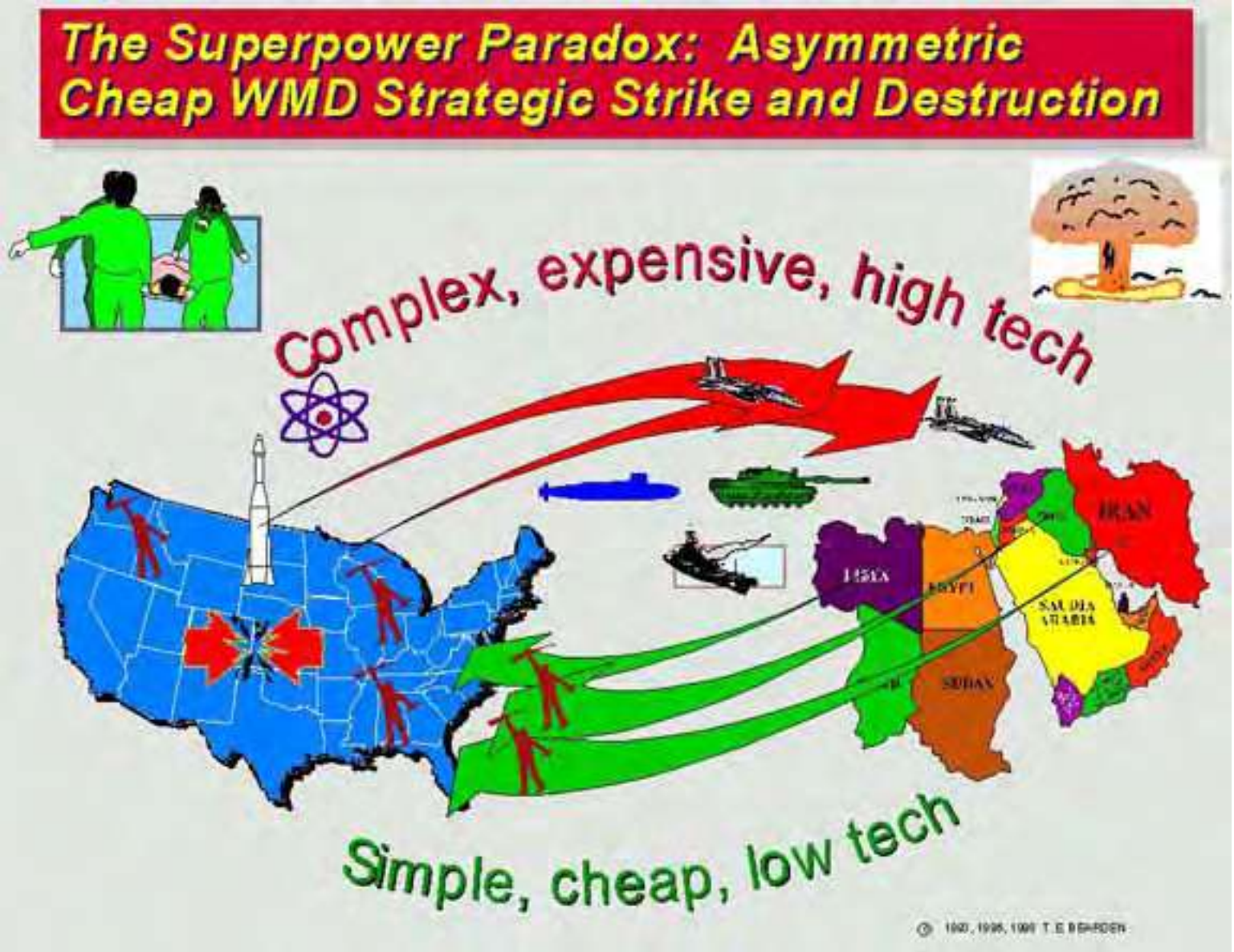
The Superpower Paradox: Asymmetric
Cheap WMD Strategic Strike and Destruction
Complex, expensive, high tech
IRAN
LIBYA
EGYPT
SAUDI ARABIA
SUDAN
Simple, cheap, low tech

THE KGB/YAKUZA-AUM WAR PLAN

- *Dud all quantum potential weapons in other nations via psychoenergetics.*
- *Remove U.S., Israel, Brazil, West Europe as military powers.*
- *Destroy nuclear weapons, hostile energetics weapons, hostile ships, 80% of targeted populaces in first hour of strikes.*

LEASE

1990-91

Aum/Yakuza Acquired Use of on-site Russian Scalar EM (Energetics) Weapons.

Began Geosurvey of Test Range (Western Australia) for training.

KGB Tested QP population wpn (Gulf War Syndrome)

TRAIN

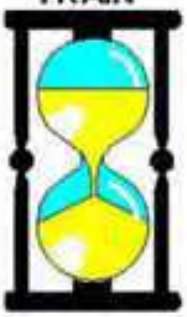

1991-94

Began extensive training of AUM-Yakuza crews in Russia, with practice firing into Western Australia. J-team took over world-wide weather engineering. Preparing for occupation of West Australia.

ESCALATE

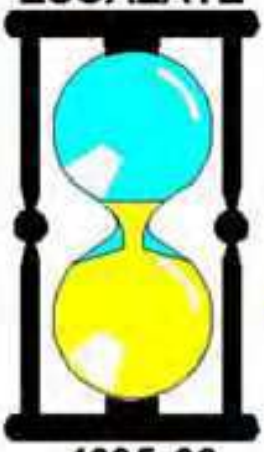

1995-99

Began EM kill of selected lone U.S. targets, law strategic deception plan.

U-2 a/c? USAir 747?
TWA-800 C-130
ValueJet? A-10s

Surged electrical grids. Worldwide practice kills, scalar interferometry. QP modification of selected pathogens

STRIKE!

Plan:
Trigger terrorist BW, & WMD attacks.
Enhance BW infections with QP wpn.
When ready, counter insane QPweapons with psychoenergetics. Destroy QP wpns.
Dud all nuclear weapons worldwide;
Time-snap ships, scalar weapons sites;
Attack major target populations w/QP.
Then cleanup with interferometry strikes.

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Why Western Science is Ignorant of KGB Energetics

- *Foundations* of electrodynamics and much of Western physics are seriously flawed
- Only just rediscovering longitudinal EM waves
- No knowledge of using time-polarized EM waves
- Does not know a powerful GR is hidden in EM
- Ignores inner structure of potentials, waves, fields
- Hotly defends errors, ignores for a century
- Determined to push big nuclear science
- Suppresses research to approved dogma by rigorously controlling precisely what research the funds can be used for

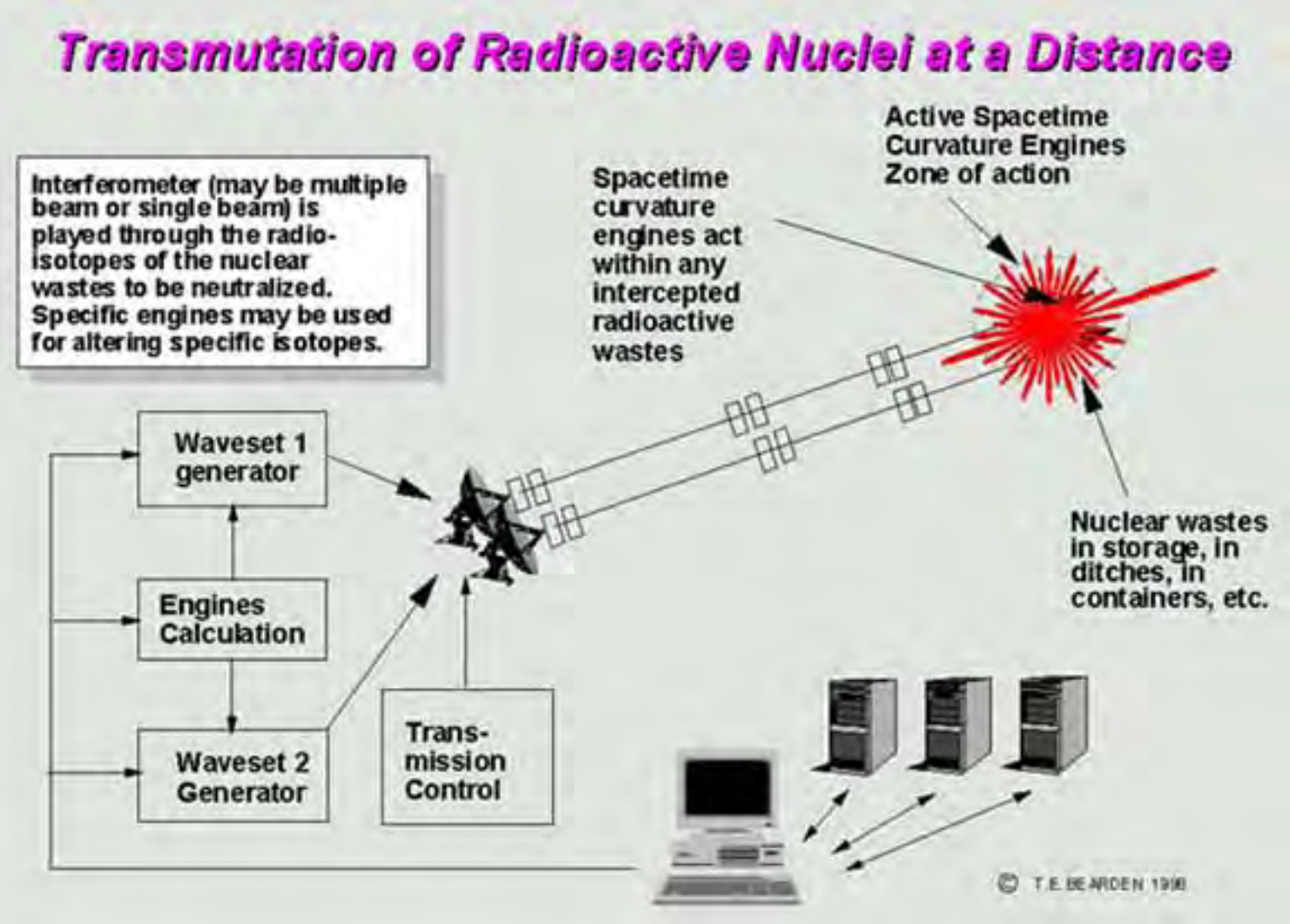
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Active Spacetime Curvature Engines Zone of action
Nuclear wastes in storage, in ditches, in containers, etc.
Waveset 1 generator
Engines Calculation
Waveset 2 Generator
Trans-mission Control
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THE YAKUZA

(JAPANESE MAFIA)

To do business with Japan is to do business with the Yakuza

The Last Samurai, Defending Bushido

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- **3 Major Yakuza Groups, In Coalition.**
- **Penetrate Japanese Government.**
- **Open Offices, Signs on Street.**
- **Public Romanticizes Yakuza as Last Japanese Samurai**
- **In Large High-Tech Corporations.**
- **In Control of Japanese Banks.**
- **Japanese Real-Estate Rip-off.**
- **$500 - 1,000 Billion per Year Income.**
- **Rapidly Spreading in U.S.**
- **Uniting Mafia Groups Worldwide.**
- **Coalition with Aum Shinrikyo.**
- **Leased Russian Energetics Weapons.**
- **Crews On-site in Russia, Trained.**
- **Practice Firings into Western Australia for Three Years. (Dozens of Shots per Month)**
- **Now in Escalation Phase, Killing U.S. Targets.**
- **All-out Strike on U.S. ready 1999-2000.**
- **Now held in check by KGB, dead-man fuzed by small nation friendly to U. S.**

Yugoslav Earthquake, Followed by Cold Explosion

Apr. 15 1979

- Magnitude 7.2 on Richter scale
- Epicenter 33 km. deep
- More than 100 aftershocks
- At Kamenari:
  - Adriatic sea mushroomed up
  - Like atomic bomb explosion
  - Signature of a cold explosion
  - Similar to Apr. 1984 test off coast of Japan, near Kurils (see inset graphics)
- *Note that April is a significant test month for the Communists (preparing official reports for May Day?)*

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Directed Energy Weapons in Modern Battlefield

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Abstract:

The paper deals with electromagnetic threats caused due to Directed Energy Weapons (DEW). The area of interest is focused on HPM (High Power Microwaves) and UWB (Ultra Wide Bandwidth) as an important part of DEW area. Possible impact on electronic structures which can be part of military systems is considered in this paper. Some practical results achieved during experiments related to assessment of electronic equipment vulnerability is provided with overview of immunity of some equipment to HPM and UWB signals at the end of this study.

Keywords:

DEW, HPM, UWB, electromagnetic threats, NEC, vulnerability

1. Introduction

Directed Energy Weapons (DEW) with various principles seem to be more important in the future battlefield. There are several principles which are considered for use in the DEW area. Special optical technologies (lasers), sound technologies as well as microwave technologies are developed and can be used in special weapon systems to disturb military system behaviour or can be used for counter personnel weapons (for example Active Denial System working on frequency 94 GHz, see Fig. 1). DEW has been mainly considered as technologies suitable for less-lethal or even non-lethal technologies which have been subjects of interest within the past years.

Recent developed military systems consist of equipment which is more and more sophisticated and relying on electronics. Very high importance of electronics within the military systems is obvious from development of Network Enabled Capabilities (NEC) which is a key task of the Czech Armed Forces as well as within the NATO (NNEC – NATO Network Enabled Capability). The stage related to "Communication and information sharing" has been topical in recent years and characterised by development of communication networks. Common network infrastructure can be

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considered as a fundament of integrated NEC environment. Communication network and especially its reliability will have significant influence on mission success. Disturbance of these networks could be obviously critical.

Power electromagnetic fields can be generated by relevant power technologies and focused (directed) towards the target with electronics. Shortcuts like HPM (High Power Microwave) and UWB (Ultra Wide Bandwidth) are widely used in this area as well as HPEM (High Power Electromagnetics) and IEMI (Intentional Electromagnetic Interference). Examples of developed technologies which could be easily used like DEW against electronics are shown in Figs 2-6 (these technologies were offered or presented mainly during relevant conferences in past few years, radiated pulse power was hundreds of MW or higher in frequency range of microwaves).

Fig. 1 Humvee with ADS (Active Denial System) mounted [1]

Fig. 2 HPM system DS-110 (built in suitcase, pulse power 250 MW [2]

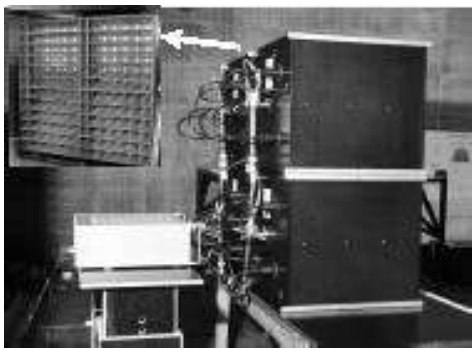

Fig. 3 HPM system with antenna array [2]

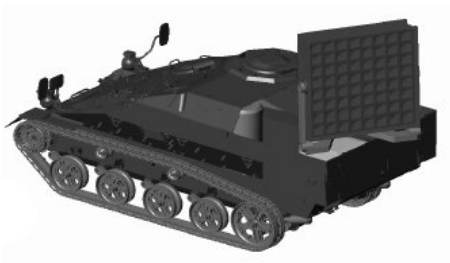

Fig. 4 HPM system with antenna array installed on a tank [2]

Fig. 5 Electromagnetic System for Selective Car Stopping [2]

Fig. 6 JOLT hyperband system, UWB system [3]

2. Electromagnetic Threats

As it was mentioned in the introduction an important group of DEW technologies, non-lethal technologies, was represented by weapons with use of power electromagnetic field destructive effects.

Next electromagnetic environments are typically considered related to DEW (see Fig. 7):

- HPM: High Power Microwaves, narrowband signals in frequency range from hundreds of MHz up to several GHz, electromagnetic strength at the place of target typically up to tens of kV/m (strong dependence on range).
- UWB: Ultra Wide Bandwidth, pulses with rise time typically in hundreds of picoseconds and with duration of several nanoseconds, electromagnetic strength at the place of target typically up to tens of kV/m (strong dependence on range).

Because HPM and UWB environment is strongly dependent on range and moreover these environments may have a wide variety of wave shapes, their standardization is very difficult. Now there are only few standards which describe HPM and UWB environment generally (e.g. IEC 61000-2-13 [4]). A possible approach is to consider various types of HPM and UWB environments that have been produced and to consider their possible use in the future against sensitive targets. It is always necessary to make relevant analysis of electromagnetic threat where the shortest possible distance from HPM or UWB source is a very important parameter.

2.1. Electromagnetic Strength Assessment

As a typical possible scenario can be considered HPM (UWB) source with real pulse power $P = 1$ GW and as a worst case special antenna with extremely narrow radiation pattern ($G = 40$ dB, respectively $D = 8\,750$). Now the expected electromagnetic strength at the place of threatened equipment (system) can be calculated according to next Eq. (1)

$$E = \frac{\sqrt{30PD}}{r} \tag{1}$$

where P is radiated power, D is directivity of antenna, r is a distance of threatened equipment (system) from radiating antenna.
Note: Eq. (1) is valid only for direct propagation where reflections are neglected. This simplified equation is usually used for the microwave area and short distances.

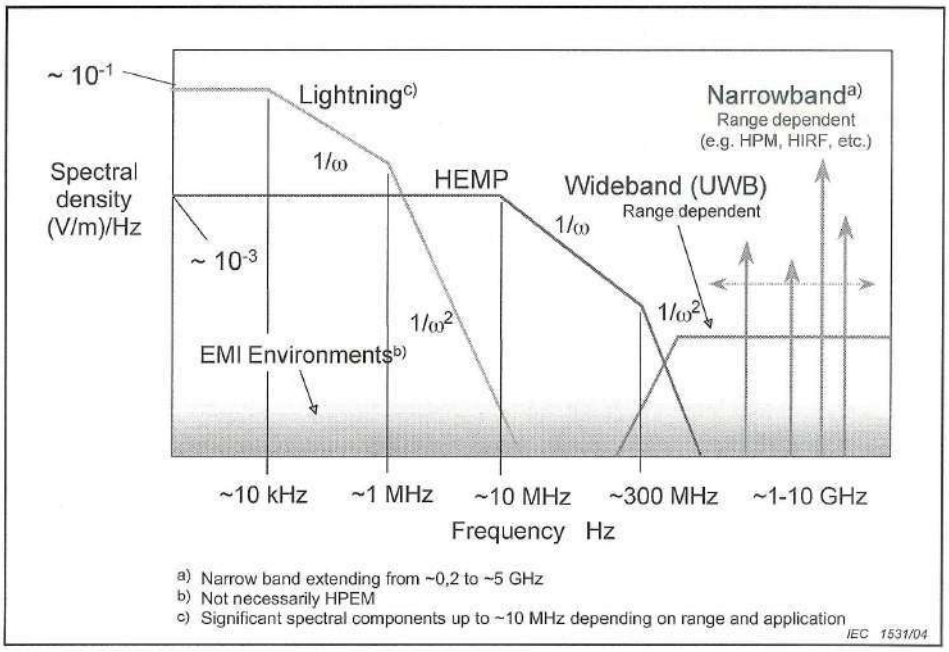

Fig. 7 HPM and UWB comparison with other electromagnetic threats [4]

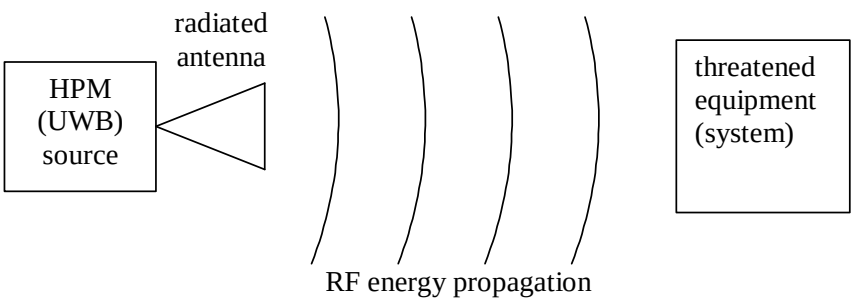

Fig. 8 RF energy propagation from source (HPM or UWB) to equipment (system)

It is obvious from Eq. (1) that for most cases (distance of directed energy weapon from equipment (system) is generally tens of meters), it is possible to consider electromagnetic strength up to tens of kV/m.

2.2. Critical Frequencies Assessment

It is very useful to consider transfer function (T) of investigated equipment (system) for critical frequencies assessment. Transfer function T_O (outer) is combined with T_I (internal) to form a composite transfer function from incident fields to response box inputs in Fig. 9 [5]. Note: T_O typically corresponds to relationship between incident electromagnetic field and surface current and charge densities on the outer surface. T_I corresponds to transfer function from the surface current and charge densities on the outer surface to some interior port of interest, producing voltage and current waveforms there.

From Fig. 9 it is obvious the most important part related to critical frequencies of considered system (equipment) is band 2 – resonance region. It is possible to use first of all analysis where sizes of equipment (system) as well as used cable lengths are considered and next it is important to make relevant measurement of transfer functions (shielding effectiveness of used boxes, induced currents and voltages etc.) for transfer function (T) assessment.

Considered frequency spectrum is divided as follows [5] (see Fig. 9):

Band 1: $f \le f_l \approx \dfrac{c}{4l}$ (aperture and small antenna coupling region),

Band 2: $f_1 \le f \le f_h \approx \dfrac{5c}{l}$ (resonance region, external and internal),

Band 3: $f_h \le f$ (integration region),

where l is characteristic dimension of the object, c is speed of the light, f is considered frequency.

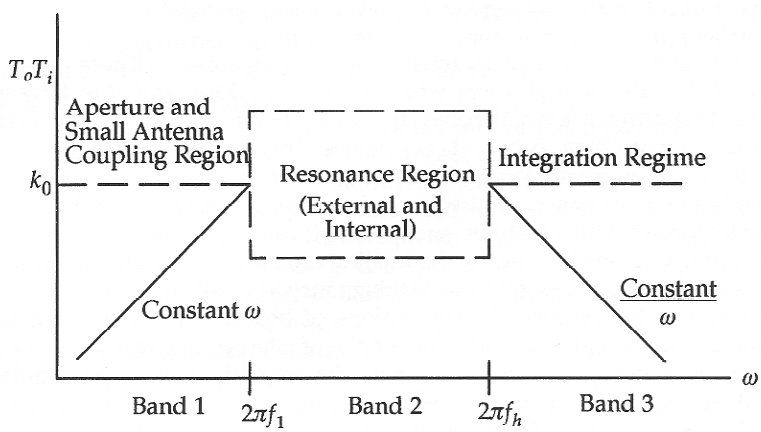

Fig. 9 System response as a function of frequency (logarithmic scales) [5]

3. HPM and UWB Impact on Electronics

Electronic systems can be affected by high intense electromagnetic fields causing the disturbance or even the permanent damage of the system. According to relevant EMC (Electromagnetic Compatibility) standards next performance criteria are usually used:
A - normal performance within the specification limits

B - temporary loss or degradation of function (self-recoverable)
C - temporary loss of degradation of function, which requires operator intervention or resetting
D - degradation or loss of function which is not recoverable due to damage of equipment (components) or software damage

On the one hand performance criteria are a very important parameter on the other hand consequence of IEMI (Intentional Electromagnetic Interference) attack has to be considered too. For consequence scaling it is possible to use for example such terms like "very limited", "limited", "severe", "very severe" and "catastrophic" [6].

4. Vulnerability Assessment

First of all it is necessary to make analysis where electromagnetic threat assessment is done (see chapter 2). Moreover it is necessary to consider criticality of relevant system (consequences – see chapter 3). Finally testing plan and testing can be prepared. The best way is to start with transfer function measurements (shielding effectiveness measurement, induced currents and voltages measurement) which is possible to carry out in wide frequency range up to few GHz or higher. After that it is necessary to choose possible critical frequencies according to transfer function measurements and according to analysis. Chosen frequencies can be used for final high power electromagnetic field measurement with HPM and UWB simulator use. Possibilities of these simulators are restricted to parameters which cannot be changed or changing these parameters takes too much time. Due to this fact it is necessary to choose suitable parameters according to analysis and transfer function measurement results for this testing. The data gained from analyses and testing has to be considered together with possible consequences which can occur. Such data can be used for vulnerability assessment.

5. Practical Results

A lot of experiments related to electronic equipment vulnerability have been carried out in previous projects within the last few years.

Transfer function measurements were carried out for better understanding of electromagnetic field coupling into relevant cables. Tested cables were irradiated with electromagnetic field with vertical polarisation and induced voltages were measured in frequency range 30 MHz to 1 GHz. It was low power measurement, electromagnetic strength of incident electromagnetic field was 1 V/m and measured results were recalculated for expected high power electromagnetic field 10 kV/m. Mainly cables which are widely installed in computer technologies were used for the purpose of these experimental measurements. Few examples are shown in Figs. 10-12. It is possible to expect induced voltage levels on regular widely used cables approximately up to 1 kV during electromagnetic field incidence with electromagnetic strength 10 kV/m on the basis of presented results. The highest induced voltages occur when the length of cables is comparable with wavelength of used signal (resonant region, see Figs. 10-12). For lower frequencies as well as for higher frequencies induced voltages are becoming lower.

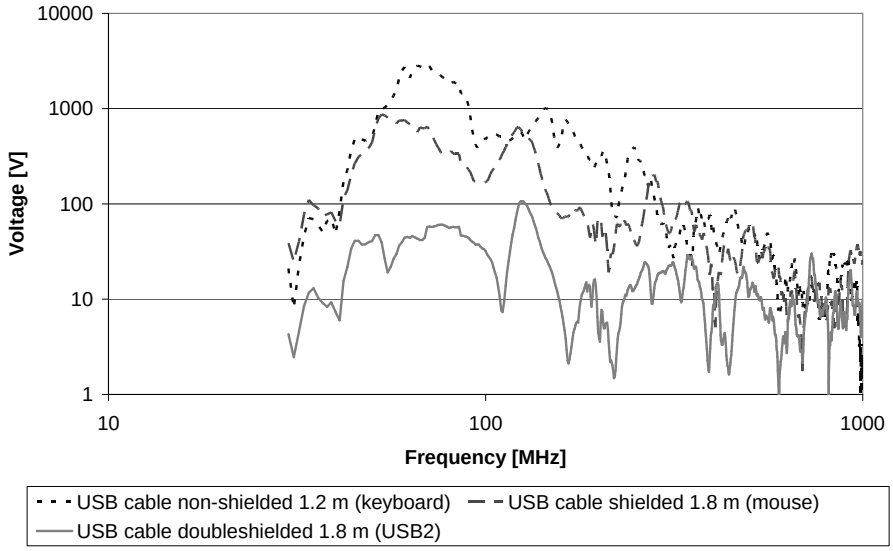

Fig. 10 Induced voltages on USB cables for electromagnetic strength E = 10 kV/m

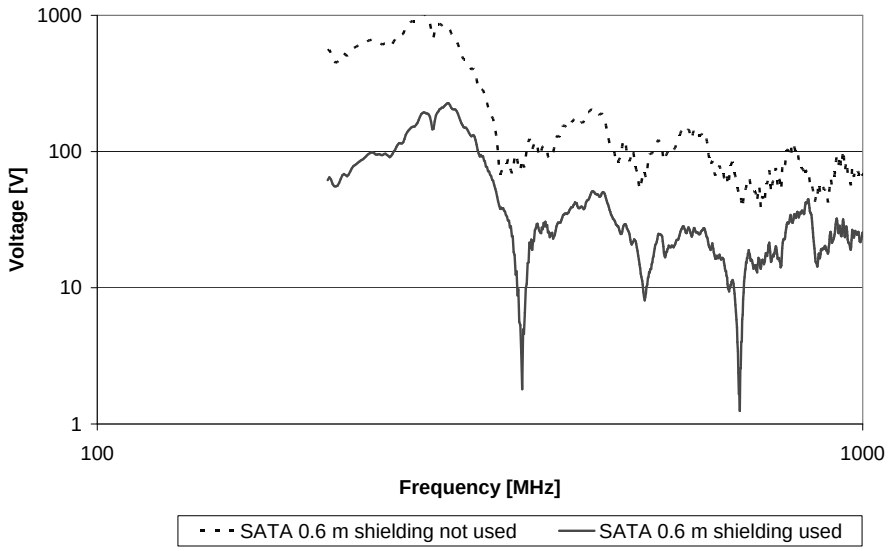

Fig. 11 Induced voltages on SATA cables for electromagnetic strength E = 10 kV/m

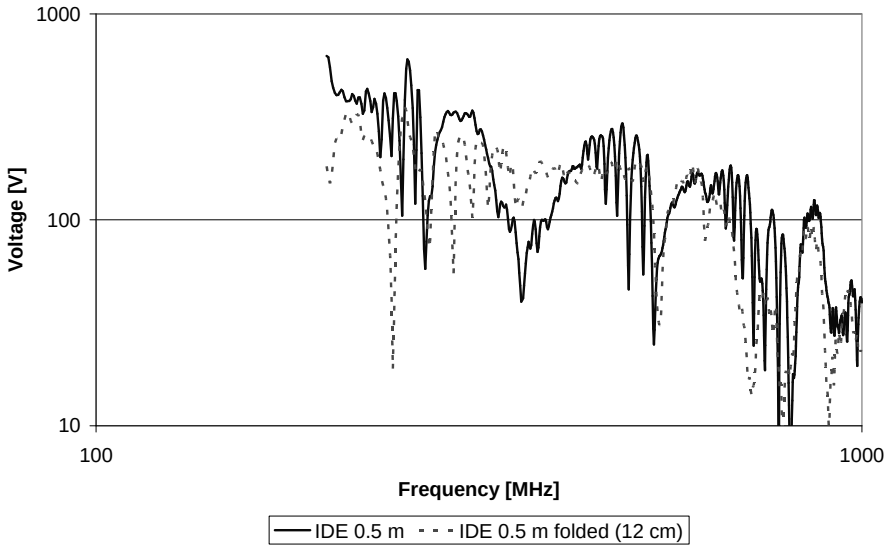

Fig. 12 Induced voltages on IDE cables for electromagnetic strength E = 10 kV/m

Other kinds of experiments in this area are testing with high power electromagnetic field irradiation of possible "targets" and evaluation of effects which can occur.

Some examples of tested setups are shown in Figs 13-15. It was verified that HPM signals can be used for stopping the car engine (see Fig. 13, HPM generator working on frequency 3 GHz with pulse power 500 kW was used for this experiment in shielded semi-anechoic chamber) as well as for effective disrupting of computer technologies and data transfers (see Figs. 14-16). Standard performance criteria (see chapter 3) are usually used for the evaluation of effects. From experiments which were carried out it was obvious that electromagnetic strength of few kV/m can be enough to achieve effective disturbance on electronics.

Repetition rate as a parameter of HPM and UWB signals can have an influence on some kind of temporary failures (see Fig. 16). Overview of immunity of some equipment to HPM and UWB signals is shown in Fig. 17. Typical electronic equipment was tested against effects of HPM 3 GHz, 6 GHz, and 9 GHz signals with pulse widths in hundreds of ns, repetition rates in hundreds of Hz and against effects of UWB signal with rise time of 0.5 ns, pulse duration of 3 ns in single shot regime. The most effective signal to disturb electronics from used ones was HPM 3 GHz. Very often the sensitivity level was very close to damage level (see Fig. 17). For UWB signal it was more typical to achieve temporary failures (sensitivity level) rather than some kind of damage. The results from testing showed the most vulnerable parts of recent systems are computer technologies including data transfers.

Fig. 13 Stopping the car engine with HPM irradiation use (HPM 3 GHz)

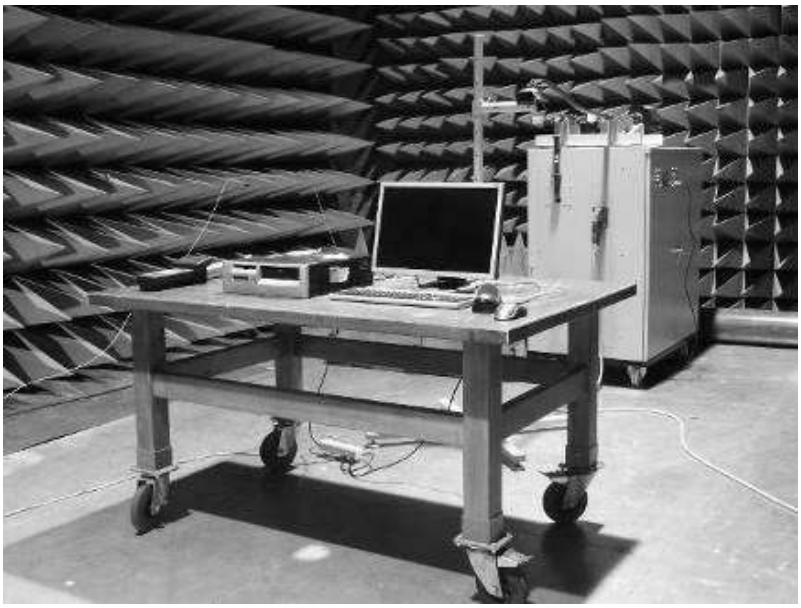

Fig. 14 PC setup irradiated with HPM 9 GHz

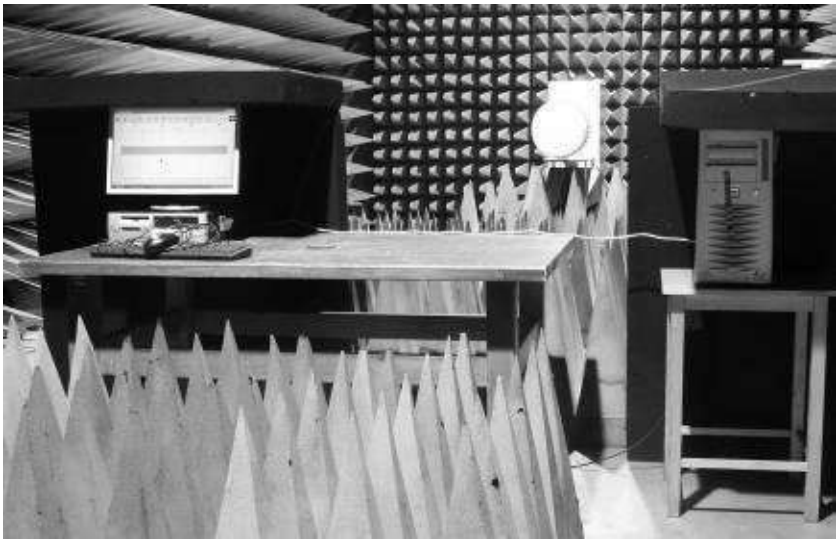

Fig. 15 Data transfer through UTP cable irradiated with UWB signal

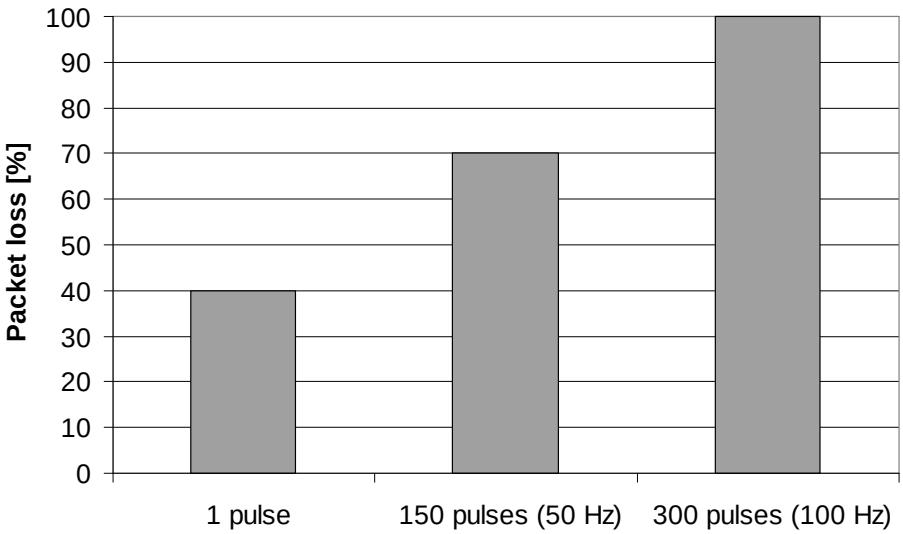

Fig. 16 UTP 2 m irradiated with UWB

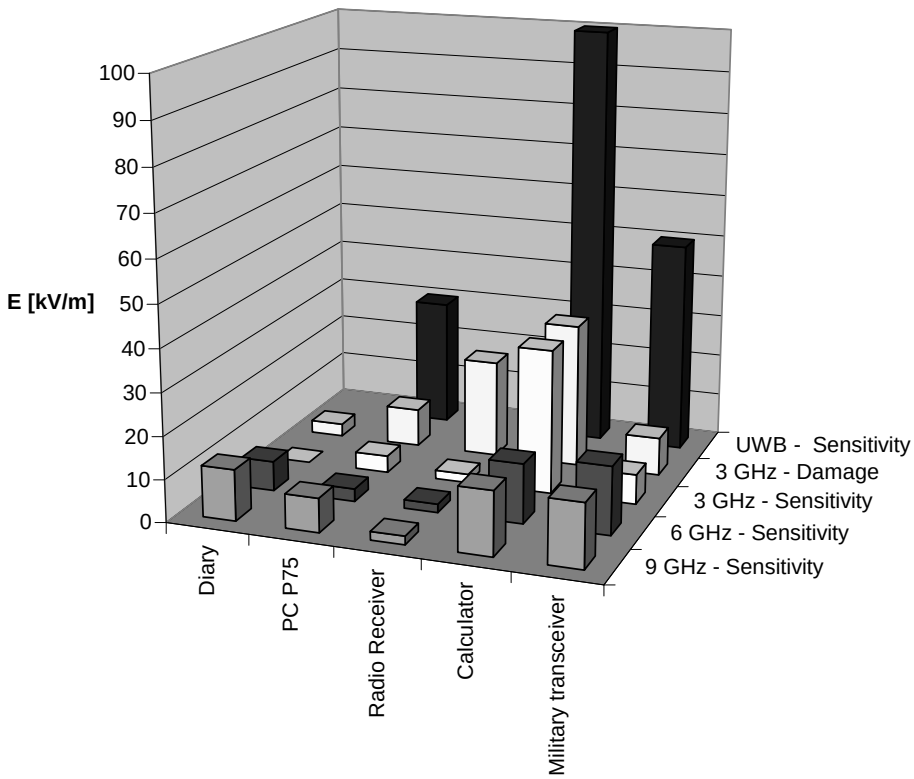

Fig. 17 Sensitivity and damage levels comparison for tested equipment against HPM and UWB effects

6. Conclusion

Electromagnetic threats HPM and UWB as a part of DEW technologies were briefly defined in this paper. Electromagnetic threats assessment as well as vulnerability assessment was introduced. Vulnerability of chosen tested equipment was presented on relevant examples. It was demonstrated that electronic equipment was vulnerable due to electromagnetic field irradiation. In case sensitive electronic equipment is used in crucial applications it is necessary to evaluate vulnerability of the system to such threats.

Gained results in the past have lead to starting a new project for the Ministry of Defence of the Czech Republic (OSPROZ-DEW1) focused on the assessment of vulnerability of weapon systems and parts of communication and information systems integrated in NEC which are installed to ordnance of the Army of the Czech Republic now. Assessment will be carried out on the basis of relevant analyses as well as relevant experimental measurements. The project started in 2009.

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Acknowledgement

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will be available to treat and possibly cure diabetes, hemophilia and other life-threatening and chronic illnesses.

Space manufacturing will develop the new metal alloys needed for high-temperature processing using advanced nuclear and fusion energy sources. Larger and more perfect crystals for the electronics and other industries will be produced.

By themselves, these new industries created by exploiting the unique environment of space, "pay" for the NASA programs. But the indirect impact to the economy has been even greater, and more important. These are the so-called "spin-offs" from space exploration which have been developed by industry using technological breakthroughs funded by NASA.

New materials, such as refractory ceramics and new alloys which withstand the temperature extremes of space flight, are used in everything from nuclear power plants to everyday kitchen implements. Developments in electronics, including miniaturization and sophisticated automation techniques, have streamlined the functioning of industry and shortened the time (thereby increasing the productivity) of almost everything we do.

The machines that monitor all of the vital bodily functions of the astronauts who walked on the Moon, now monitor premature infants in incubators, and have provided heart monitors and miniaturized pacemakers for thousands of people.

The same qualitative impact, magnified many times, will result from the development of beam weapons combined with the recommitment of the civilian space program to establish a permanently manned station in space toward the goal of colonizing the Moon and other planets.

However, studies done by Chase Econometrics and confirmed by independent studies using the Fusion Energy Foundation's econometric model show that there is a much greater impact that the development of a qualitatively new technology has on an economy. This impact is, strictly speaking, not measurable by adding up all the new products and new techniques that a new technology introduces; it is the *increase in productivity* throughout the economy as the result of the combination of higher manpower skill levels and new scientific knowledge entering industrial production. One study of this induced productivity effect estimated that U.S. productivity increased 0.1 percent for every billion dollars spent on the space program. This change in productivity alone represented an additional $3 billion to the GNP every year it was present. An interesting comparison is possible between the expenditure of a $1 billion aliquot of the federal budget on a high-technology R&D oriented program (like the Apollo program or the development of a beam weapon) and its expenditure on transfer payments, bureaucratic services, or the like. The Chase Econometrics study showed that the expenditure of this money on high-technology R&D actually *lowered* inflation, while the other expenditure had the opposite effect, raising inflation by 0.2 percent.

Four types of directed-energy weapons

by Mary McCourt

In his *EIR* multi-client report, *Beam Weapons: The Science to Prevent Nuclear War,* Dr. Steven Bardwell describes the types of beam weapons on line for development. Each type, laser beams, particle beams, microwave beams, and plasma beams, is, Bardwell states, "in principle capable of generating the required power and energy [to reach and disarm its target] in a form efficiently absorbed by the missile." A beam weapon effectively disarms a nuclear warhead. A hydrogen bomb can be detonated only by an initial powerful atomic-bomb explosion capable of setting off a chain reaction in the lithium-deuterium fuel. A beam weapon, by pumping energy into the very delicately balanced triggering mechanism, prevents the initial explosion and essentially turns the warhead into a "dud." The missile, like a satellite, might fall to the earth, but it can no longer be detonated.

Scientists agree that laser-defense battle stations, even with the lowest level of laser-beam technology, can be defended from other beam weapons themselves. But a missile cannot be effectively defended from the beam without such massive protection that it would lose both the necessary speed and distance.

Laser-beam weapons

Laser beams, particularly the chemical laser, will likely be the first deployable beam weapons developed. A laser is a beam of very intense, single wavelength electromagnetic waves, either of light or high energy X-rays. Such a weapon can be focused very precisely because either the light or X-ray wavelengths all have the same frequency and phase. The five different types of lasers, which can be applied to fusion energy as well as beam weapons, are all being researched at U.S. laboratories.

The **chemical laser,** which could be developed for military deployment within five years, uses a gaseous medium in which a chemical reaction is induced. The product of the reaction emits laser light. The Soviet Union used such a laser last year in tests that downed a ballistic missile.

In a **gas laser,** a burning gas such as a hydrogen and fluorine mixture is suddenly compressed, and the energy distribution that results from the compression is then stimulated to emit single-frequency light waves at very high energy. Both the United States and Japan are currently using huge gas lasers for nuclear fusion development.

An **electron discharge laser** uses replaceable energy

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from an electron beam to create the source of laser light. Such a laser would be very efficient for use in space because its energy source is electricity, not an exhaustible chemical fuel.

Two other types of lasers, **X-ray lasers** and **free-electron lasers,** yet to be perfected technologically, have greater advantages of energy density and flexibility than those listed above. The **X-ray laser** is widely recognized as the most promising long-range laser for ballistic missile defense, based in space. The X-ray laser, which is just a single pulse, is by far the most energy-dense, delivering thousands of times more energy per pulse than conventional lasers. In addition, the target absorbs the X-rays very efficiently, making this weapon capable of very efficient destruction of missiles.

Particle-beam weapons

Particle beams also deliver energy in a highly controlled pulse traveling at near the speed of light. But instead of a pulse of intense electro-magnetic radiation, the particle beam consists of **subatomic particles, (electrons** or **protons), neutral atoms** (usually hydrogen), or (usually magnetized) **macroscopic particles** accelerated to high speeds. A particle beam destroys its target, the triggering mechanism, by creating a very intense shock wave within the mechanism, like a very small, but extremely heavy and powerful hammer striking down on the target.

Electron beams can be generated in the range of millions of volts. Scientists researching the electron beam for military or civilian energy use have discovered that the electron beam becomes a complex structure of electrons and a magnetic field. Such structured beams are capable of carrying higher currents and more energy for much longer distances at much great levels of power output.

Proton beams, which have been researched intensively for the past 30 years, use an electron beam as a seed and then are accelerated in their own right. As protons are 2,000 times heavier than electrons, a proton beam of the same velocity has 2,000 times the energy of an electron beam.

Neutral particles eliminate many of the problems of charged-particle beams, which can degrade both the efficiency and controllability of the beam. By spring of 1983, U.S. researchers will have produced a beam of protons at an energy of 2.5 million electron volts, capable of traveling at 99 percent of the speed of light.

Control and targeting of a **macroscopic particle beam** would be more difficult, but the unparalleled power density of the beam—due to the large mass of the particles—gives it great potential as a beam weapon.

Microwave and **plasma beams** have only been discussed in the United States in the past two years, although it is estimated that the Soviet Union is two or three years ahead in the production of microwaves. Intense, directional microwaves are generated when electron beams are propagated at or near the speed of light through a plasma. Such beams, if focused, could destroy delicate electronic equipment in a target.

A plasma beam consists of the highest energy-dense form of matter, a gas so hot that the electrons and neutrons have separated. The plasma forms itself into a complex structure of particles and magnetic fields. The unique feature of a plasma beam is that it actually requires the atmosphere, which hinders the guidance and propagation of other beams, to hold in the plasma and sustain the structure.

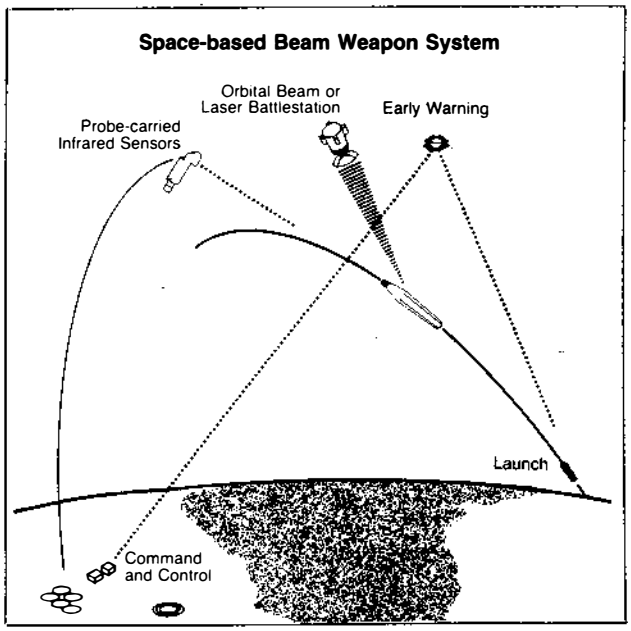

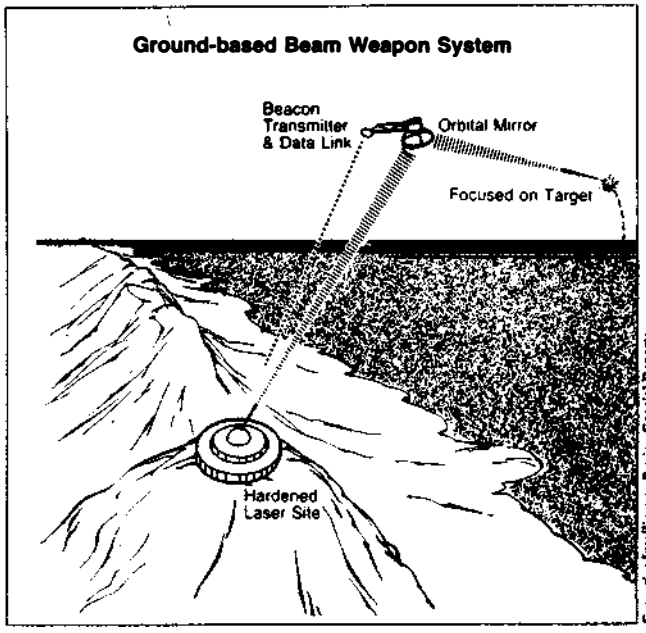

Executive Intelligence Review Special Reports

Space-based beam weapons, (left) provide the only feasible means for area defense against nuclear-armed ballistic missiles. The deployment of a weapon capable of generating an intense beam of laser light, atomic particles, or plasma, in an orbit around the earth, would protect the entire United States from incoming ballistic missiles. **Ground-based beam weapons** (right) can provide both area and point defense. Shown here is a conceptual design of a laser beam-weapon system built on a mountaintop, which uses a relay mirror to provide aiming and tracking for the weapon.

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ELECTROMAGNETIC DIRECTED ENERGY WEAPONS FOR ELIMINATING ELECTRONIC SYSTEMS

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ELECTROMAGNETIC DIRECTED ENERGY WEAPONS FOR ELIMINATING ELECTRONIC SYSTEMS

Capt. Dipl. Eng. Jan VALOUCH

Annotation:

The article presents information on the current situation in the development and application of electromagnetic weapons and indicates possible trends of their future employment. Under the term electromagnetic weapons we understand means and systems that use technology generating directed power electromagnetic pulses degrading the activities or destructing the electronic circuits of the enemy equipment. This will also enable to neutralize or completely destroy the operation of information, communication, control, firing and other electronic devices. Electromagnetic weapons are currently in use and greater number of countries realizes the perspectives of their future development.

✶✶✶

1. CURRENT SITUATION OF DEVELOPMENT AND USE OF ELECTROMAGNETIC WEAPONS IN FOREIGN COUNTRIES

Principle of electromagnetic weapon activities

Typical representative of electromagnetic (EMC) weapons are so called **Directed Energy Weapons** (DEW) employing the technology of **High Power Microwave** (HPM). These weapons represent highly sophisticated technology of 21st century. Their destructive effect results from the electromagnetic field and they threaten the operation of all devices equipped with electronic circuits, especially by the effect of arcing, overload or by discharge of single electronic component parts. These weapons have strong physical and psychological impact.

In general, DEW consists of impulse source of energy, source of microwave radiation and antenna. The impulse source transforms accumulated energy to high power electric pulse with the length of duration in units of nanoseconds. Accumulated energy can be in kilo-Joule with the power of gigawatt. In the source of microwave radiation

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this impulse then acts upon diode and generates a beam of electrons with energy – approx, 400 kV, 10—60 kA. This energy is dissipated by the directional antenna.

Electromagnetic weapons can fundamentally differ in terms of its design and application e.g. according to the used frequency band. EMC wide band weapons emit in wide frequency range but with low density of energy. These equipments are suitable where it is not possible to exactly identify the characteristics of the target – especially its working frequencies. Contrary to the narrow-band EMC weapons emit pulses on individual frequencies with enormously high power. Their action upon the target is very effective since impulse resonate with the known frequency of the attacked device.

Development and application of electromagnetic weapons

Concerning a development and application of electromagnetic weapons we can say that after the EMC weapons emerged from "the unknown" world of classified projects, now they are tuned and EMC weapon capability is enhanced. And they are gradually mounted on suitable carriers – vehicles, aircraft, ships, bombs, missiles and even space ships. The interest is focused not only on single pieces of equipment but also on complete systems incl. sensors and equipment to control the combat functions.

Within the armed forces the employment of EMC weapons have the following advantages:

- very rapid effect against the enemy targets,
- usage irrespective of the weather conditions,
- coverage of a great amount of various targets with minimum need to be informed about their characteristics,
- threat to less available target – under ground,
- operational attack (neutralization, destruction or denial of activities of electronic assets) at selected levels of warfare,
- minimum of collateral destruction in politically sensitive environment and use of this environment after the end of conflict,
- reduction of minimum time for tracking and guidance to target.

USA, Russia, France, China and UK are the countries that achieved the greatest progress in the development and application of electromagnetic weapons. The interest of other countries (Germany, Belgium, the Netherlands, Denmark, Norway …) is for a long time focused on High Power Microwave (HPM) especially on protection against the effects of HPM. As to my opinion this is the beginning of the path for research in the Czech Republic.

Currently, discussions are held on their employment in Iraqi by the U.S. armed forces. They could facilitate quickly eliminate the command and control systems of Iraq and eliminate communication of their forces without any loss of lives and any collateral damage. There were some intentions to employ these weapons of electromagnetic warfare by the U.S. force in Kosovo and Afghanistan at least in trial operation. It is

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also interesting the assumption that Russian forces used DEW prior the action against terrorists in Moscow theatre in 2002. This weapon was designed to disable the electronic detonating primers. The fact is that no Chechen managed to initiate her primer.

Misuse of electromagnetic weapons

More frequent are the attacks of terrorists and criminal underworld using the electromagnetic means. Among the targets of terrorists can be financial institutions, medical facilities, aircraft, automobiles, computer network and other daily used civilian and military equipment. The EMC radiation generators can be for example in the briefcase and that is why it is quite easy to prepare such an attack. First known terrorist application of electromagnetic weapons is from 1995 when Chechen rebels used this technology against the security system of Russian facility.

Nobody knows about the use of DEW for criminal activities and terrorist attacks with exception of the offenders themselves and their victims. The German experts even officially recommended application of these means to the German police units since there were recorded several cases of use of DEW by the German underground. With DEW it is possible to commit perfect crime, as they leave no evidence. No doubt, in future a wide use of these weapons can be expected which can means an increased risk of their misuse.

Future of electromagnetic weapons

Future of DEW is often discussed in many articles and literature. A part of study called Air Force 2025 also deals with the future of DEW employment that was developed by the Air University Maxwell Air Force Base, Alabama. This study discusses a possibility to employ these means in the spaceships or satellites in order to destroy the hostile satellite information and communication channels.

Development of DEW in terms of their employment is mainly connected with mutual co-operation of the army, air force and navy forces. These will be the components that are the potential users of DEW. Protection of the aircraft and ships against the effects of enemy DEW is being solved. Further, e.g. active use of DEW against the air defense and employment of DEW in the aerospace. Within 3—5 years it is expected that DEW will be installed into the drones (USA). In respect of technologies for DEW, the research will be especially focused on increase of input power of DEW, reduction of size and weight and improvement of antenna systems. A very interesting is also a research of biological impact of DEW on human being and hazard for the personnel.

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2. CURRENT SITUATION IN THE AREA OF ELECTROMAGNETIC WEAPONS IN THE CZECH REPUBLIC

The following part of this article briefly discusses NATO RTO – Research and Technology Organization (http://www.rta.nato.int), or the activities of selected panels with representation of the Czech Republic and which deal with the mentioned issue.

The panels dealing with this topic are:

- SCI–119 Tactical Implications of High Power Microwaves,
- SCI–132 High Power Microwave Threat to Infrastructure and Military Equipment.

Since most of activities of these technical panels is classified as NATO SECRET, only general character information not subject to classification are provided.

Panel SCI–119 Tactical Implications of High Power Microwaves started its activities in 1998 and terminated it in this year. The objective of the work of its members have been mainly solution of issues of use of HPM in the military sector both in terms of defense as well as of potential active employment in attack. The most important areas solved:

- design of resources generating HPM,
- vulnerability of information technology of military infrastructure,
- risk of back effect of electromagnetic weapons on friendly troops,
- testing of HPM effects on the off-the-shelf equipment equipped with electronic components (personal computers, cellular phones, vehicles, aircraft …),
- content of HPM national programs from the viewpoint of:
  - earmarking of specialized workplaces,
  - refinement of the content of solution in the given country,
  - allocation of funds,
  - planning of the number of students studying HPM at the universities,
  - gathering of results.

The issue of HPM is solved by NATO systematically since the beginning of 80-ies of the last century. In the short time, it is assumed that new advanced HPM weapons will be developed and within NATO this process must be systematically controlled. In this area – development of electromagnetic weapons – USA, Russian, France and the UK have the greatest success.

Panel SCI–132 High Power Microwave Threat to Infrastructure and Military Equipment commenced its activity by the introductory session in October 2002, held in Munster in Germany. Its orientation is linked to the preceding activity of the Panel SCI–119. The main activities of the Panel are planned for the period of 2003—2005 and single members will deal with the following issues:

- identification of potential threat of HPM on the military and civilian infrastructure and equipment,

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- research of the penetration and dissemination of HPM in specific devices,
- research of DEW (Directed Energy Weapons),
- possibilities how to protect the military equipment against the effect of weapon assets on the basis of HPM.

Other areas considered important by the member of the Panel SCI–132 and that are to be in the area of interest are:

- resistance of military equipment against HPM,
- implication of HPM in the military field test and system of their evaluation,
- EMC terrorism.

The Panel consists of representatives of the following countries: Canada, Czech Republic, Denmark, Germany, France, UK, USA, the Netherlands, Norway and Italy.

CONCLUSION

Currently, the use of electromagnetic weapons plays the more important role. Though, the wider employment of these weapons is expected within 5—10 years, there already exist and are used the devices/equipment capable to reliably effect on the enemy electronic assets (control, information, communication…) and deny the enemy any further operations. The issue of electromagnetic weapons in the Czech Republic is in the stage of research and that is why the representation and involvement of the Czech representatives in the special Panels of NATO RTO or any other international organizations and boards is desirable.

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High Power Electromagnetic Weapons: A Brief Tutorial

George H Baker, III, *James Madison University*

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High Power Electromagnetic Weapons: A Brief Tutorial

George H. Baker

Background. High power electromagnetic weapons, also referred to as high power radiofrequency (HPRF) weapons, are a type of directed energy weapons. The system effects of high power electromagnetic environments are well recognized by world scientific and military communities. Former CIA Director John Deutch has said that, "the electron is the ultimate precision-guided weapon." In the course of the investigation ofnuclear EMP effects on electronics during the Cold War period, it became evident that garden variety, unprotected electronics would malfunction, in some cases burn out, in the presence of electromagnetic fields in the hundreds to thousands of volts per meter. The EMP experience has led to the development of non-nuclear high power electromagnetic sources to create fields that equal or exceed EMP levels, albeit over relatively small ranges. Achievable electronic effects could have serious consequences in terms of interruption or termination of critical system operation. The effects are of particular interest to the military in the context of information warfare and missile defense. Because most critical infrastructures are controlled by electronics, HPRF weapons are a concern for civilian systems as well. The weapons could be used to disrupt computer electronics controlling electric power grids, telecommunications networks, financial institution databases, security systems, and aircraft.

Military forces in many countries are pursuing the development of HPRF weapons. These programs are normally classified. HPRF weapons represent a revolutionary concept because they operate at the speed of light, can be used covertly, and harm equipment rather than humans (non-lethal). HPRF weapons may be enclosed in briefcases, packing containers, truck beds, or aircraft and maneuvered to expose critical military or infrastructure systems.

Electromagnetic Weapon Characteristics. There are three elements to be considered in discussing HPRF weapons systems: the weapon itself, the propagation of the weapon output to the target, and the target response (see Figure 1).

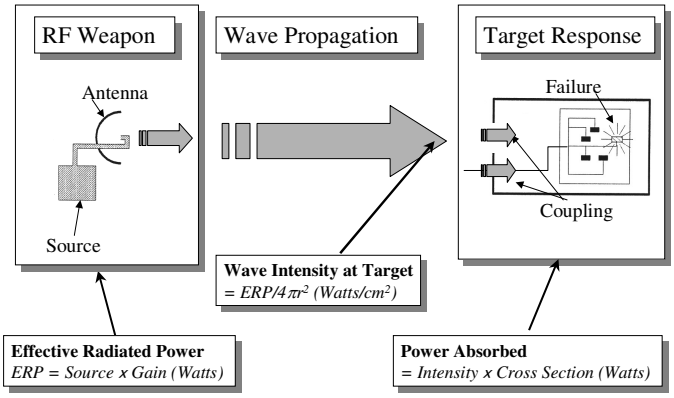

Figure 1. High Power RF Weapon Operation Elements

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Weapon Design. An HPRF weapon consists of a power source, or driver and a radiating antenna. The source is normally pulsed. Outputs may be sine waves (providing a narrow frequency band signal) or pulses (providing a wide frequency band signal). High power electromagnetic source technology includes electron beam devices (magnetrons, vircators, gyrotrons, backward wave oscillators), solid-state devices (bulk avalanche, optical switches, silicon carbide circuits) and explosive generators (magnetic flux compression using high explosives). Output power levels in the gigawatts are feasible over a wide range of frequencies. Design details will determine output characteristics. Power, frequency, bandwidth, repetition rate, and duty cycle are the important HPRF weapon output parameters.

The HPRF weapon source must be connected to an antenna with sufficient gain to "beam" the RF energy to a useful range. Portability requirements impose major limits on antenna area which in turn largely governs the maximum intensity (power per area) that can be delivered to a target system at a given range. Compact sources that may be moved covertly in briefcases, packing containers, truck beds, or aircraft and maneuvered for close-up exposures of critical military or infrastructure systems are of most interest. Antenna size limits largely determine the maximum intensity (power/area) that can be delivered to a target system at a given range. A table of approximate relative portable platform sizes is provided below.

Table 1. Portable Platform Size Comparisons (Approximate)

Capacity: Platform:	Volume	RF system Weight	Basis
Briefcase	0.02 m^3	5 kg	Typical hard side
Footlocker	0.15	40 kg	1 person portable
Pickup truck	4 m^3	1000 kg	1 ton capacity
Econoline van	8 m^3	2000 kg	Bed volume
Tractor trailer	80 m^3	20,000 kg	20 ton capacity

High Power Electromagnetic Wave Propagation. Electromagnetic waves propagate at the speed of light through the atmosphere. Under most conditions, the atmosphere will not attenuate HPRF waves as they travel from source to target. However, if the electromagnetic wave's peak field level exceeds the air ionization threshold a cascade process will occur in which an atmospheric plasma is created that will absorb most or all of the energy in the wave. This phenomenon is referred to as air breakdown.

A typical threshold for breakdown at sea level is approximately 1 megawatt/cm^2 . As an example, a 1 Gigawatt source radiating through a 1-foot radius circular antenna will produce an average intensity over the antenna of 0.35 megawatts/cm^2, a factor of 3 below air breakdown. Once away from the antenna, EM intensity falls off as the beam spreads (typically as $1/4\pi r^2$ where r is the distance to the target).

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The HPRF signal intensity on target depends on source transmission power (P_t), antenna gain, and range according to the following equation:

$$S_t = \frac{ERP}{4\pi r^2} = \frac{P_t \cdot G}{4\pi r^2} \frac{watts}{m^2}$$

The antenna gain may be approximated by $G \approx \frac{4\pi A_e}{\lambda^2}$ where A_e is the effective antenna area and λ is the wavelength of the radiated HPRF signal. This yields a simple formula for the intensity on target:

$$S_t = \frac{P_t A_e}{r^2 \lambda^2}$$

So, for example, a 1 Gigawatt source radiating at 1 GigaHz (λ = 0.3m) with a 1-m^2 antenna will produce a beam intensity of 11 kW/m^2 (or 1.1 watts/cm^2) on a target 1000 meters away. If the pulse duration were 1 microsecond, the energy fluence on target would be power x time or, 1.1 microjoules/cm^2.

<u>Target Response</u>. Once the electromagnetic wave signal reaches the target, its energy couples to the system in a very complex manner through various paths associated with the topology of the target system. The HPRF signal will induce currents on any external conductors (antennas, wires, etc) that penetrate to the system interior. The signal will also couple to any external metal shielding and then may reradiate to internal conductors. Signal waves will penetrate through any holes in external shielding to interior portions of the system. The main concern is the amount of energy that finds its way to critical electronic circuits, causing the system to malfunction.

To simplify coupling calculations, it is possible to determine an effective "coupling cross section" for critical internal circuits. In effect, this treats each internal circuit as a receiver. The power received by the circuit may be expressed as a simple function in incident wave power and an effective coupling cross section:

$$P_i = S_t \mathrm{A}_\sigma$$

P_i is the power induced in the internal circuit, S_t is the incident power at the system's exterior, and A_σ is the coupling cross section of the internal circuit. A_σ is a function of frequency and incorporates all the complexity of coupling including multiple paths, layers and mechanisms. There are two major coupling modes, front door and back door, as shown in figure 2.

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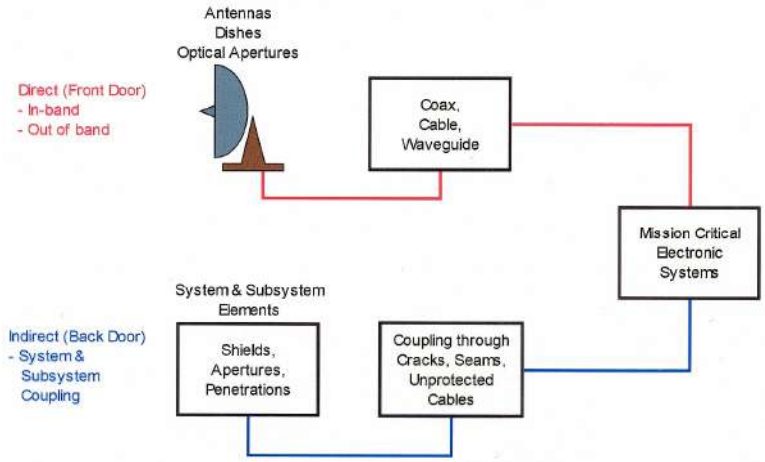

Figure 2. Front Door and Back Door Coupling Modes

The physics of front and back door coupling are the same. In each case, energy resident in the incident wave induces currents in the system that flow to a sensitive system circuit. Each can be characterized parametrically by equation $P_i = S_t A_\sigma$. The coupling cross-section, A_σ, is typically large for front door coupling and small for back door coupling. The coupling cross sections for front door coupling are of the order of the physical area of the antenna or aperture. Effective coupling cross section values for back door coupling of unhardened systems range from $10^{-4} – 10^{2}$ cm^2. Coupling cross-sections are hard to predict analytically and can be determined confidently only by direct measurement. This creates a problem for an attacker's confidence since HPRF effects are subject to much higher uncertainties than conventional weapon effects.

HPRF Weapon Effects on Systems. EMP and HPRF affect systems by disrupting the operation of electronic components either temporarily (upset or latchup) or permanently (component damage). Damage may be "direct" where energy inherent in the EMP/HPRF field is sufficient to cause malfunctions or "indirect" where EMP/HPRF energy triggers effects involving a system internal power supply. Even though the power delivered to a circuit by the HPRF field is small, the much larger energy available in the system's power supply (or fuel and ordnance) can be improperly diverted by an HPRF induced overvoltage arc or malfunction of system digital control circuit, causing major system damage.

Upset refers to an induced change of state in a digital circuit in which the system continues to operate, although possibly with erroneous data bit streams. Latchup refers to changes of state in digital circuits where the affected portion of the system ceases to operate until the system resets itself or (worse) a manual reset is required. In either case, system components are not directly damaged and recovery is often possible (depending on time criticality of affected function).

Exploitation of upset effects should not be discounted. In some cases they are tantamount to permanent damage. Upset may result in major system damage, e.g., a missile plunges into ocean due to a guidance system upset, or computer equipment is destroyed by an upset sprinkler system. Small, upset-level transient pulses can also act to

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trigger the release of energy from a system's own power supply causing components to burn out at fluences much lower than would normally cause permanent damage.

To give an indication of HPRF wave energies required to cause system effects, ITT industries (formerly Kaman Sciences) openly exposed circuit cards to 2.9 GHz microwave pulses with duration 1 microsecond. Onset of upset occurred at 1 watt/ cm^2 (equivalent to 1 microjoule/cm^2 for this pulse duration). All components were upset at wave intensities of 1000W/cm^2. Onset of damage occurred at 100W/cm^2 (for a 1 microsecond pulse, this is equivalent to 100 microjoules/cm^2). All components were damaged at wave intensities of 1000 W/ cm^2 (equivalent to 1000 microjoules/cm^2).

System Protection. System hardening involves a combination of operational and hardware techniques. Operational techniques may include the provision of spares for soft critical subsystems or boxes, disconnecting susceptible circuits upon warning, and/ or establishment of a physical keep-out perimeter (with barriers and/or security force) or zones around critical equipment to prevent positioning of HPRF weapons at close ranges. Operational controls may also be built into software to provide circumvention and reset, error-correcting codes, voting logic, and status detection. For some non time-sensitive systems, provisions for rapid system repair may be an option.

Conceptually, hardware approaches involve placing a conducting material between the incident HPRF wave and susceptible internal circuits. Hardening techniques have been successfully demonstrated and codified for EMP (ref. article on nuclear EMP). The EMP community has placed a heavy reliance on exterior shielding while limiting the number of penetrations that have to be individually protected. Such protection applied at the system exterior allows interior boxes to go untreated. This approach works well when designed in from the start. For retrofit protection, however, it is often prohibitively expensive.

Hardware approaches for HPRF protection, while conceptually similar, have some differences in emphasis from EMP. Because EMP is extremely broadband, typically only a small fraction of the energy comes through the front door in band. HPRF weapons can be tuned to the front door center frequency such that all the beam energy flows into the system. Also since HPRF weapons operate at higher frequencies, attention to smaller apertures (including cracks and seams) is required and dimensions of waveguide-beyond-cutoff penetration treatments will require changes (longer and more narrow waveguides are needed).

Front door in-band protection is one of the more challenging (but not insurmountable) HPRF protection problems. The high gains associated with most front door paths make these potentially the most susceptible portion of the system. However these well-characterized front door receive paths have received much attention in terms of protection engineering. Radar systems are often protected from their own or neighboring transmitters by a receiver protector or RP. Similar protection can be applied to communication receivers against in band HPRF environments. Table 2 summarizes HPRF hardening techniques.

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Table 2. HPRF Hardening Methods

Operational Techniques	Hardware Techniques	
	Front Door	**Back Door**
Disconnect on warning	Tuned metallic radomes	Shielding, topology control
Spares	Bandstop reflectors	Internal cable shields
Physical keep-out perimeters or zones	Antenna gain pattern control	Non corrosive mating surfaces
Software Techniques: Circumvention/reset Error correcting codes Voting logic Status detection/ alarm	Filters	Closely spaced fasteners
	TR devices/ limiters	RF gaskets and seals
	Terminal protection devices	Aperture screens and conductive films
		Selection of hard circuits and components
		Pin protection
		Fiber Optics
		Filtering, limiting at penetration points

Future Directions. HPRF generation techniques have matured to the point where practical devices have become technically feasible. Miniaturization of pulse-power source components, more efficient power supplies, and advances in electronic pulse forming, energy conversion, and antennas enable reduced size and increased efficiency of HPRF generation hardware. Simple weapons can also be built using inexpensive magnetrons from common microwave ovens.

Military trends to computerized battle management, weapons tracking, and landline/wireless network communications are a double-edged sword, introducing serious HPRF vulnerabilities. Military use of commercial off-the-shelf equipment and dependence on civilian infrastructure exacerbate the problem. Senior military officials have dropped hints about pursuing offense technology but there are no officially published details concerning weapon availability or capabilities.

Several other countries also have extensive background in the development of RF weaponry. The former Soviet Union pioneered the development of HPRF weapon technology and this technology is now being offered to other countries. According to a recent report from the Office of the US Secretary of Defense on the military power of China, "Captain Shen Zhongchang from the Chinese Navy Research Institute…envisions a weaker military defeating a superior one by attacking its space-based communications and surveillance systems…in future wars, Shen highlights radar, radio stations, communications facilities, and command ships as priority targets vulnerable to smart weapons, electronic attack, and electromagnetic pulse weapons." It is expected that in future conflicts the United States will encounter adversaries using HPRF weapons as part of asymmetric tactics to disrupt information systems.

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See also: Nuclear Electromagnetic Pulse (EMP)

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electromagnetic protection, underground testing, and standards including MIL-STD-188-125, MIL-STD-2169B, and MIL-HDBK-423. He also headed the Agency's Innovative Concepts Division overseeing the joint US-Russian space nuclear power technology, electro-thermal chemical (ETC) gun development, radiofrequency directed energy source concept development and testing, and DNA's university grants programs. Baker received the Agency Legacy Award for his leadership and innovation. He is a member of the NDIA Homeland Security Executive Board, the Institute of Electrical and Electronic Engineers, the Directed Energy Professional Society (Charter Member), and the Association of Old Crows. He is a Summa Foundation EMP Fellow and holds a Ph.D. from the U.S. Air Force Institute of Technology.

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archived as **http://www.stealthskater.com/Documents/Hamilton_04.pdf**

more of Dan Burisch is at ***http://www.stealthskater.com/Burisch.htm***

note: because important websites are frequently "here today but gone tomorrow", the following was archived from http://www.skywatch-research.org/QuantumHolographic.htm on April 8, 2004 . This is NOT an attempt to divert readers from the aforementioned web-site. Indeed, the reader should only read this back-up copy if it cannot be found at the original author's site.

The Biophotonic Quantum Holographic Matrix

by William F. Hamilton III

ABSTRACT: *This paper is an attempt to integrate studies of the quantum potential, quantum holography, biophotonics and the enveloping matrix of biointegration, biocommunication, and bioinformation that composes the web of light and life in living organisms and their possible genesis in an electromagnetic infoton.*

Introduction:

Theoretical physicist David Bohm proposed a new hidden variables theory of Quantum Mechanics. He assumes the wave function does not represent just a set of probabilities but an actual field. This field exists and acts upon particles the same way a classical potential does. Thus it is a quantum potential which is associated to this field and is a function of the wave function. It is postulated here that the quantum potential is active -- as a field -- in living cells and organisms and acts upon them.

The equation Bohm used to represent this quantum potential is:

$$U = -\sum_{k} \left(\hbar^2 / 2m_k\right)\left(\partial_k^2 R / R\right) \qquad (1)$$

Research reveals that Bohmian quantum potential is still used, but that it may only represent a means to extend Quantum Theory into a realistic theory of particles and fields.

It resolves the dilemma of the appearance -- in one and the same phenomenon -- of both particle and wave properties in a rather straightforward manner. Bohmian mechanics is a theory of motion describing a particle (or particles) guided by a wave. This guiding wave is usually attributed to atomic particles. But it might be more insightfully seen as a traveling **soliton** or vortex.

Bohmian mechanics is manifestly nonlocal, and the velocity may depend upon the positions of other -- even distant -- particles whenever the wave function of the system is entangled.

The behavior of the particle is determined by the particle's position and momentum, the wave field, and the sub-quantum fluctuations.

Bohm's quantum potential binds the entire Universe together into what he liked to call a seamless "unbroken wholeness". Every particle in the Universe is connected by the quantum potential to every other particle. He likened the cosmos to a **hologram** in which each point on the film carries information about the entire picture. Bohm's GWT -- far more sophisticated than de Broglie's crude version -- is a "holistic" vision in which all parts of the Universe are joined to every other part. "Interconnectedness"

was one of Bohm's favorite words. He saw the Universe as resembling the unity of a living organism. A kind of pantheism not unlike Spinoza's -- a pantheism Einstein himself favored." **[2]**

Bohm referred the holomovement as the basic reality. The pattern formed on a photographic plate by light waves that interfere and create a hologram. This pattern is the interaction or interference pattern of two parts of a laser light (coherent light). One beam reflects off an object, the other off a mirror. In addition, any portion of the holographic plate contains information on the whole object.

Biohologram:

Every cell in the human body contains nuclear DNA. Information on the whole body -- much like a hologram -- only the cells can go through a process of division and reproduction (mitosis).

In quantum holography, things are spookier still. While holograms are typically constructed with interfering beams of light, in quantum holography the researchers measure the simultaneous arrivals of an illuminating photon that is sent into a chamber and a companion photon in the other entangled beam.**[2]**

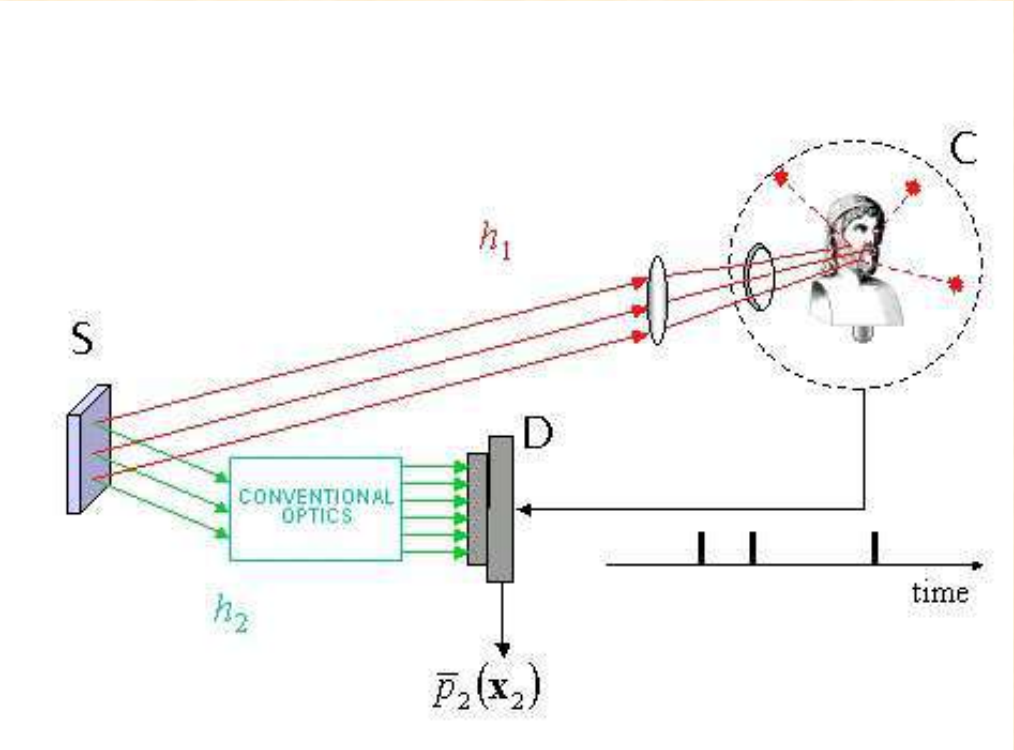

Quantum holography -- as depicted in this cartoon -- is a way that physicists could produce 3-dimensional images of objects that would be invisible to systems relying on classical physics. A source **S** produces 2 photon beams (**h_1** and **h_2**). The photons in **h_1** are quantum mechanically **entangled** with the photons in **h_2**. When a photon in **h_1** enters chamber **C**, it encodes 3-dimension information about the enclosed object (in this case a Grecian bust) in the interference of the 2 paths it could take -- a path that intercepts the object and subsequently is reflected to the chamber wall, and a path that misses the object and strikes the chamber wall directly. The second beam **h_2** passes through conventional optics and strikes a detector array **D**. A coincidence counter extracts the holographic information by monitoring the relative time between a photon in **h_1** striking the chamber wall and its entangled mate in **h_2** arriving at detector **D**.

Wave Genetics Inc. and the Moscow Institute of Control Sciences are exploring a new concept of the genetic code that asserts:

(1) that the evolution of biosystems has created genetic "texts" -- similar to natural context dependent texts in human languages -- shaping the text of these speech-like patterns.

2) that the chromosome apparatus acts simultaneously both as a source and receiver of these genetic texts, respectively decoding-and-encoding them.

3) that the chromosome continuum of multicellular organisms is analogous to a static-dynamical multiplex time-space holographic grating, which comprises the space-time of an organism in a convoluted form.

That is to say, the DNA action -- theory predicts and which experiment confirms -- is …

(i) that of a "gene-sign" laser and its solitonic electro-acoustic fields, such that the gene-biocomputer "reads and understands" these texts in a manner similar to human thinking but at its own genomic level of "reasoning". It asserts that natural human texts (irrespectively of the language used) and genetic "texts" have similar mathematical-linguistic and entropic-statistic characteristics, where these concern the fractality of the distribution of the character frequency density in the natural and genetic texts and where -- in case of genetic "texts" -- the characters are identified with the nucleotides, and

(ii) that DNA molecules -- conceived as a gene-sign continuum of any biosystem -- are able to form holographic pre-images of biostructures and of the organism as a whole as a registry of dynamical "wave copies" (or "**matrixes**") succeeding each other. This continuum is the measuring, calibrating field for constructing its biosystem.

"Complex information can be encoded in EM fields, as we all know from coding-and-decoding of television and radio signals. Even more complex information can be encoded in holographic images. DNA acts as a holographic projector of acoustic and EM information which contains the informational quintessence of the biohologram. Only 3% of human DNA encodes the physical body. The remaining 97% of the 3 billion base pair genome contains over a million genetic structures -- called transposons -- that have the capacity to jump from one chromosomal location to another (Kelleher, 1999). We are 99.9% alike in our genetic legacy. Our individuality is expressed in 3 million small variations in our cells called single nucleotide polymorphisms.

"**Gene-expression** is the mechanism by which new patterns are called into being (Rossi, 2000). There is also a strong correlation between modulation of the brain's EM field and consciousness (Persinger, 1987; McFadden, 2002). The Gariaev group has discovered a wave-based genome and DNA phantom effect which strongly supports the holographic concept of reality (Miller, Webb, Dickson, 1975). This main information channel of DNA is the same for both photons and radio waves. Superposed coherent waves of different types in the cells interact to form diffraction patterns, first in the acoustic domain and second in the electromagnetic domain -- a **quantum hologram** -- a translation process between acoustical and optical holograms." **[4]**

The distribution of the character frequency in genetic texts is fractal, so the nucleotides of DNA molecules are able to form holographic pre-images of biostructures. This process of "reading and writing" the very matter of our being manifests from the genome's associative holographic memory in conjunction with its quantum nonlocality. Rapid transmission of genetic information and gene-

expression unite the organism as holistic entity embedded in the larger Whole. The system works as a biocomputer -- a **wave biocomputer**.

The quantum nonlocality of the genetic information is fundamental. Experimental work of the Gariaev group shows how quantum nonlocality is directly related to laser radiation from chromosomes (coherent light), which jitterbugs its polarization plane to radiate or occlude photons. DNA and the genome have now been identified as active "laser-like" environments. Roughly speaking, DNA can be considered as a liquid crystal gel-like state that acts on the incoming light in the manner of a solitonic lattice. **[5]**

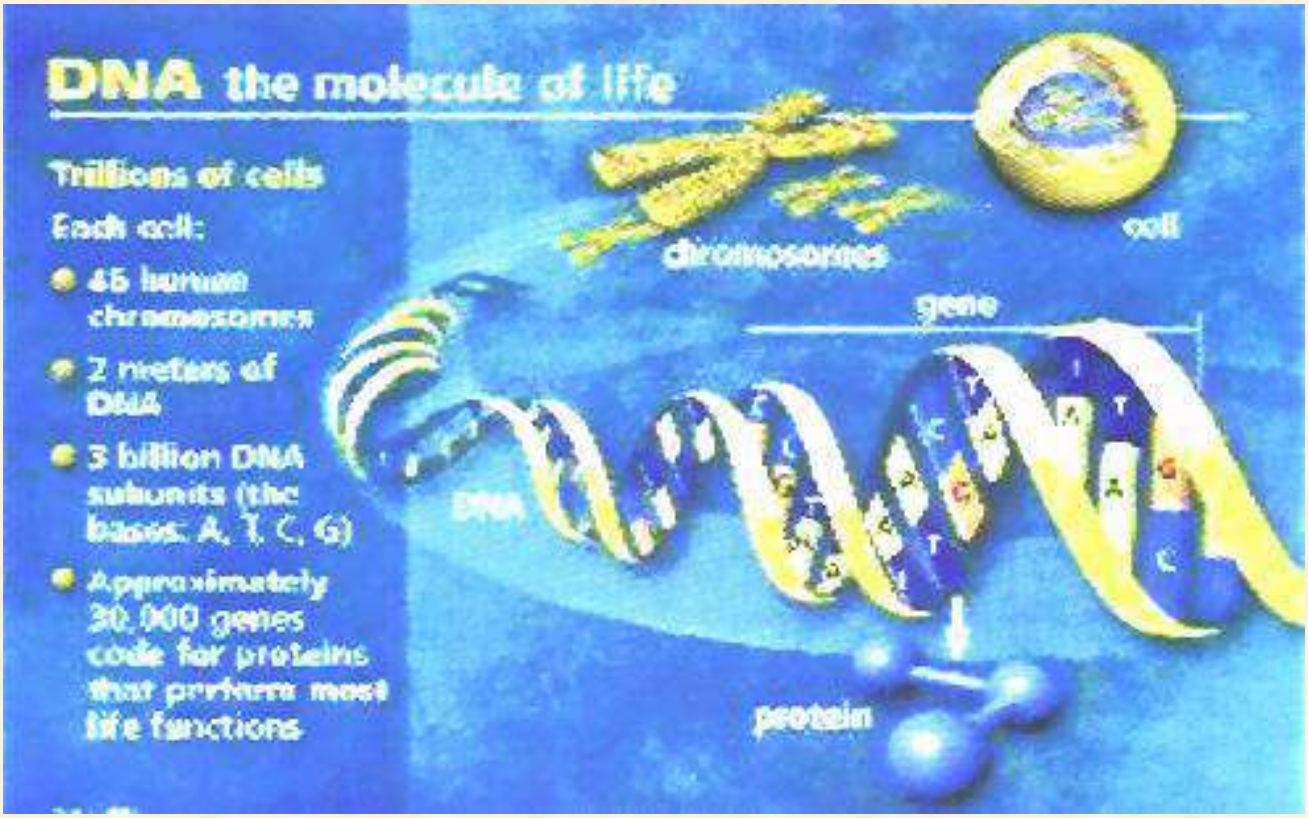

Biophotonics

This entire section is extracted from the History of Biophotonics website:

Around 1923, Alexander Gurwitsch discovers an "ultra-weak" photon emission from living systems (onions, yeast, ...), since he suggested connections between photon emission and cell division rate. He calls this **photonemission "mitogenetic radiation**". His experiments indicate that the wavelength is in the range around 260 nm (Bibliography under Gurwisch and also Ruth (1977, 1979)).

Around 1950, Russian scientists rediscover "ultra-weak photon emission" from living organisms. Most results are published in "Biophysics" (Engl.) and originally in "Biofizika"). (Bibliography under Ruth, 1979).

Italian nuclear physicists discover by chance "bioluminescence" of seedlings. They do not think that this finding is significant, but they publish the results (Colli et al. 1954, 1955, Ruth 1979).

The Russian biophysicist and the American chemist enunciate the first theory of ultra-weak photonemission (UWPE) from biological systems -- the so called "**imperfection theory**". UWPE shall

be an expression of the deviation from equilibrium -- some kind of distortion of metabolic processes (Zhuravlev 1972, Seliger 1975, Ruth 1979).

Independently from each other and by different motivations, scientific groups in Australia (Quickenden), Germany (Fritz-Albert Popp), Japan (Inaba), and Poland (Slawinski) show evidence of ultra-weak photon emission from biological systems by use of modern single-photon counting systems. Bibliography (Quickenden, Inaba, Popp &Ruth, Slawinski).

While Quickenden, Slawinski, and Inaba prefer the imperfection theory, Popp and his group enunciate just the opposite theory:

1. The radiation originates from an almost perfect coherent photon field.

2. Essential sources are the DNA and corresponding resonators in the cells.

3. The mechanism describes photon storage in cavities and information channels, tuned by Casimir forces.

4. There is a close connection to delayed luminescence which corresponds to excited states of the coherent photon field.

5. The radiation is not the product but essentially the initiator of chemical reactions in the cells. The radiation submits the information within and between cells.

6. The radiation is not limited to the optical range but follows an **f = const** rule (the occupation probability of the phase space is equal for all wavelengths) and extends to longer wavelengths including the so-called heat radiation of the body.

7. This radiation is the proper regulator and information carrier of life.

The Marburg group of Fritz-Albert Popp calls this phenomenon "**biophotons**" in order to stress the difference to "bioluminescence". Biophotons are single quanta which are permanently-and-continuously emitted by all living systems. They are subjects of quantum physics, and they display a universal phenomenon attributed to all living systems. Worldwide, all scientists who agree with these statements call the radiation "biophotons" and the scientific field "**biophotonics**".

From 1972 to 1980, the Marburg group of the leader -- the physicist and Dr. Habil Fritz-Albert Popp -- evaluated experimentally all the essential physical properties of biophotons.

1. The intensity ranges from a few up to some hundreds photons/(sec-cm^2).

2. The spectral distribution follows in the time average an **f = const** rule.

3. The modes are strongly coupled.

4. The delayed luminescence that approaches continuously the biophoton emission follows a <u>hyperbolic</u> rather than an exponential relaxation function.

5. The biophotons origin from an almost fully coherent field.

6. Cells are able to establish cavity resonators which contribute to biophoton regulation.

7. The essential source of non-equilibrium biophoton emission is the DNA.

This group introduces the first time photocount statistics (PCS) into biophotonics. They show evidence that biophotons are emitted according to a Poissonian PCS. Furthermore, they show evidence that (1) the delayed luminescence follows a hyperbolic relaxation function rather than an exponential one; (2) the modes are strongly coupled; and (3) there are hyperbolic oscillations around the continuous hyperbolic relaxation function. The group finds the first time intercellular communication by means of biophotons. Later this was confirmed by Albrecht-Bühler (Bacteria), Popp and Chang (dinoflagellates), Galle (daphnia), Shen (blood), and Vogel (bacteria).

(Bibliography under Popp and coworkers, i.e., Bahr, Böhm, Grass, Grolig, Herrmann, Kramer, Rattemeyer, Ruth, Schmidt, Wulle, Albrecht-Bühler, Chang, Galle, Shen, Vogel).

The papers of Popp and his group are examined mainly by the group of B. Chwirot (Kopernikus University, Torun). They confirm the essential results (Bibliography Chwirot et al.).

Herbert Klima (Atom Institute Vienna) performs his dissertation in Popp`s group at the University in Marburg. He transfers "Biophotonics" to the University in Vienna -- in particular investigations on laser excitation of living systems.

(Bibliography Klima or Atominstitut Wien).

J.Slawinski cooperates with the groups in Japan, USA and the Popp-group in Germany. He follows mainly the links between biophotons and biochemical reactions. There arises a branch biochemical biophotonics that becomes an essential part mainly in Japan and USA." **[6]**

Bioinfotons

This term "**bioinfoton**" is one that I am adopting to specify any particle (such as the **Ganesh Particle***), wave, or biomolecule that transfers information from an emitter to a receptor. It is possible that if a biophoton is emitted from a coherent source that it will carry holographic information as a form of modulation (possibly frequency-modulated) and produce action or results in biological systems.

It is possible that biophotons may even be carriers of ***psi*** information and that a coherent coupling can be established between 2 conscious lifeforms resulting in a transference of information from a higher potential field to a field at lower potential. Even though this is conjecture at this point, it suggests other means by which disparate lifeforms can communicate. We know there is a process by which trees communicate and even signal each other in the face of danger. We may be exchanging information with pets and other animals through biophotonic communication. This may be how some people who have a "green thumb" affect plants they care for.

Even communication with other intelligent life forms in the Cosmos may be effected by the amplification and vectoring of biophotons or -- via the quantum potential -- produce information at a distance.

A virtual photon flux in the quantum potential may be integrating the coordinated wholeness of the organism while the action of bioinfotons may keep every part of the organism in communication with every other part.

Conclusions

Life and living organisms are more than the sum of their parts and are composed of material and non-material parts. The spiral form of DNA evidently produces an electromagnetic wave field that informs the organism's growth and structure.

Scientist Richard Alan Miller is a pioneer in this field and has written:

"In a hologram, wave fields interfere with one another to lay the foundations for the reconstruction of the image of an object. But how are the wave fields produced?

The term "holography" comes from the Greek roots meaning "entire" and "to write". In holography, the image is projected by a coherent light source split into both the object wave and the reference wave background. This dichotomous nature is reflected in the particle/wave nature of the DNA molecule, which can be "read out" with biophotons from chromosomes to set up a holographically-produced wave field. This superposition of wave fields (object wave and reference wave) creates a wave guide for the formation of biological structure. The image is constructed according to the reference information contained in the genes. The reconstructed object wave is identical with the object wave field. The reconstructed wave fields reproduce exactly the recorded ones (the DNA with genetic code)." **[7]**

Mr. Miller also proposes this hypothesis:

"QUANTUM BIOHOLOGRAPHY

Hypothesis: The organization of any biological system is established by a complex electrodynamical field that is, in part, determined by its atomic physiochemical components. These, in part, determine the behavior and orientation of these components. This dynamic is mediated through wave-based genomes wherein DNA functions as the holographic projector of the psychophysical system -- a quantum biohologram."

I propose that the biohologram is embedded as an integral part of the biocosmic hologram we call the"Universe".

Dr. Dan Burisch has seen evidence that a **Ganesh Particle*** can transmute itself into a fully functional atypical eukaryotic cell in a matter of seconds -- not eons. Such evidence -- when it becomes available -- will change our entire perspective on the existence of a universal holonomic mind that informs its creation.

**Ganesh Particles are charged clusters that extracted from ancient bedrock and have a seemingly unknown origin, but carry information which is transferred to cells via a crossbridge. (discovered by Dr. Dan B.C. Burisch)*

References:

1. **http://plato.stanford.edu/entries/qm-bohm/#qp**
2. **http://www.ksharpe.com/Word/BM05.htm**

3. http://www.aip.org/enews/physnews/2001/split/566-1.html
4. http://www.rialian.com/rnboyd/dna-wave.doc
5. http://www.geocities.com/iona_m/Chaosophy4/bioholography/bioholography.htm
6. http://www.lifescientists.de/history.htm
7. http://www.nwbotanicals.org/oak/newphysics/Helix%20to%20Hologram.pdf

if on the Internet, Press <BACK> on your browser to return to the previous page (or go to www.stealthskater.com)

else if accessing these files from the CD in a MS-Word session, simply <CLOSE> this file's window-session; the previous window-session should still remain 'active'

Foundations of Electro-Magnetism

Slide Series

- Major Points of Presentation
- Chung's Carbon Filament Negative Resistor
- Aharanov-Bohm Effect
- Absorption and emission reactions (1)
- Absorption and emission reactions (2)
- Anti-engine for cell's deviation reverses cell back to normal
- Asymmetric regauging produces excess force, which can be used to do work on the system
- Asymmetric regauging produces excess force, which can be used to do work on the regauging system
- Becker's bone fracture healing experiments
- Becker's theoretical control system governing regeneration
- Becker's theoretical DC control system involved with response to injury
- Geometrical Distortion of Poynting Energy Flow
- Cosmic Bootstrap: Before the Big Bang
- Bridging Enables COP > 1

- Aspects of Strong Local Symmetry
- Other Aspects of Strong Local Symmetry
- Bunge on the Status of Electrodynamics
- Bunge on the Status of Electrodynamics and Physics
- Bunge on the Status of Classical and Quantum Physics
- Fractions of BW Casualties Surviving
- First Step in Self-Promotion of Cancer Due to Hypoxia
- Differentiation and Dedifferentiation Timelines
- Evolution of Cells on Earth
- A Charged Particle q is a Coupled System of m and Ø
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (1)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (2)
- The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry (3)
- A Charged Particle is a Coupled System
- The Anomalies in Navy Electrolyte Experiments at China Lake
- Chung's Carbon Filament Negative Resistor

- Typical circuit has about 10^{-13} energy collection efficiency
- Classical View of EM
- Curved Spacetime acts as source or sink
- Chronic Disease Puzzling
- Cancer Characteristics
- Solving a Cancer Enigma
- Cancer: Characteristics
- Nonlinear Optics Distortion Correction Theorem
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)
- The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)
- In Time-Reversed Zone: Nuclear reactions are biased
- In Time-Reversed Zone: Dynamics may be reversed
- Time-Reversed Zone: Significant only after time-density charging
- A New Conservation of Energy Law
- Questions on Carcinogens and EM

Radiation

- AS DEFINED, fields and potentials only exist in and on charged matter
- Serious flaws and errors in classical EM theory
- Electrodynamicists' Reaction to Removal of the Material Ether
- Reaction to Loss of Material Ether (1)
- Reaction to Loss of Material Ether (2)
- Some EM waves in Spacetime
- Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
- Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
- Phase Conjugate Wavepairs Produce New Waves
- Scalar Electromagnetics (Energetics) View of EM (1)
- Scalar Electromagnetics (Energetics) View of EM (2)

- Scalar Electromagnetics (Energetics) View of EM (3)
- Extended General Relativity Principle
- Extension of Work-Energy Theorem
- 34 Flaws in Classical EM Theory
- MTW's General Relativity Principle
- Use of General Relativity (GR) in Particle Physics
- The Missing Infolded Electrodynamics
- Infolded Engines: Excluded by Present Physics
- Mass curves and structures spacetime; ST curvatures change and structure mass (1)
- Mass curves and structures spacetime; ST curvatures change and structure mass (2)
- At Infinite Velocity: Each Is Every Other
- Lisitsyn's Report: Brain Code Broken
- Lorentz Closed Surface Integration
- Lorentz's physically insignificant energy flow can be collected and utilized
- Lorentz surface integration of the Poynting vector around a closed surface
- Longitudinal EM Photon Interaction with Charge
- Mass is transparent to longitudinal EM waves, which move through the infolded interiors of internal waves, potentials, and fields in the mass.

- Pumping with Longitudinal EM waves Time-reverses the Mass
- Maxwell's Quaternion Theory
- Maxwellian Systems before and after Regauging
- Maxwell's four equations reduce to: Page 1
- Maxwell's four equations reduce to: Page 2
- More to come

Major Points of Presentation

- Electrodynamic is seriously flawed
  - Some major flaws
  - Corrections indicated
- Why past corrective attempts failed
  - Force field concept is material
  - Missing two infolded transforms (M->ST; ST->M)
- Missing Infolded general relativity inside electrodynamics
- Several Kinds of EM Waves in Space
  - How to make
  - Transduction
- A French medical example as a deep experimental demonstration
  - Spectacular regenerative cures funded by French Govt
  - Not comprehended, therefore suppressed
- Cold Fusion examples of time-density wave effects
  - China Lake Instrumental anomalies in electrolysis
  - Explanation of anomalous behavior of instruments
  - Explanation of new nuclear reactions
  - Wave energy transduction provides excess heat
- Urge theorists to consider dramatically new reactions

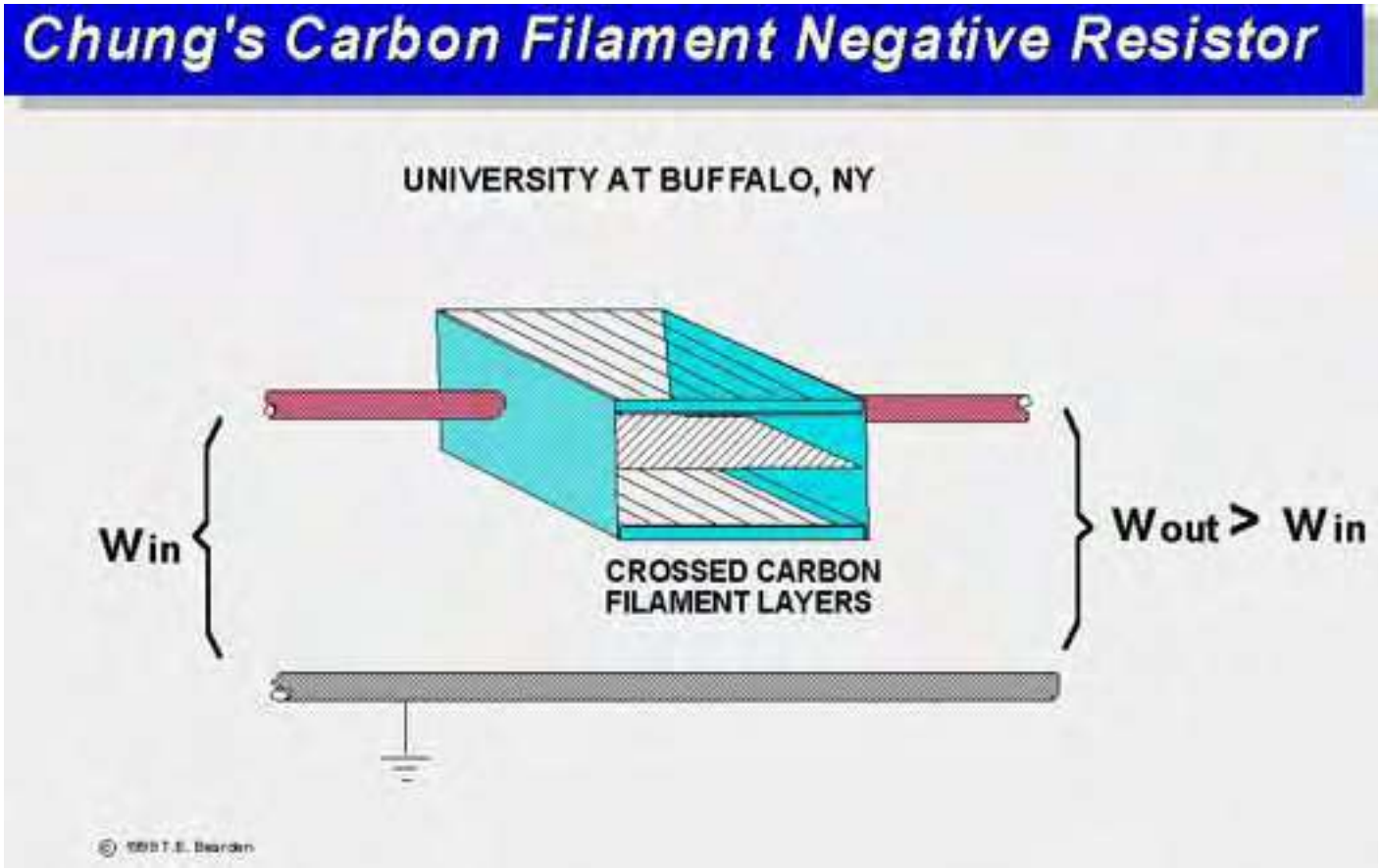
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
Win
CROSSED CARBON
FILAMENT LAYERS
Wout > Win

Aharonov-Bohm Effect

- In field-free regions
  - E-field is zero
  - B-field is zero
- Potentials still exist, just no gradients
  - Cause real effects
  - Interference is the key
  - Contain sum-zeroed substructures
- Does not follow from
  - Mechanics
  - Classical electromagnetics
- Required by quantum mechanics

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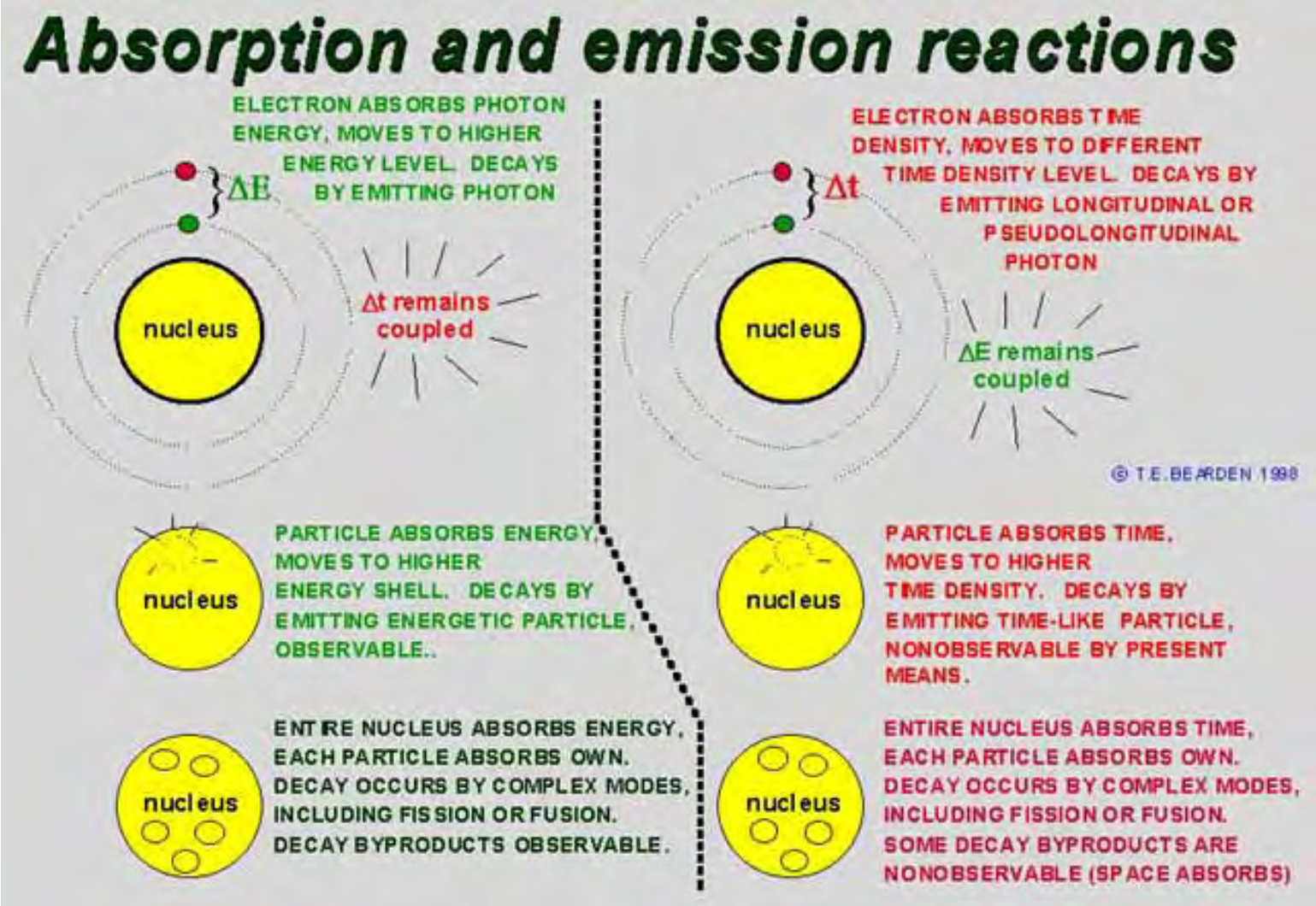
Absorption and emission reactions
ELECTRON ABSORBS PHOTON ENERGY, MOVES TO HIGHER ENERGY LEVEL. DECAYS BY EMITTING PHOTON
ΔE
nucleus
Δt remains coupled
ELECTRON ABSORBS TIME DENSITY, MOVES TO DIFFERENT TIME DENSITY LEVEL. DECAYS BY EMITTING LONGITUDINAL OR PSEUDOLONGITUDINAL PHOTON
Δt
nucleus
ΔE remains coupled
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nucleus
PARTICLE ABSORBS ENERGY, MOVES TO HIGHER ENERGY SHELL. DECAYS BY EMITTING ENERGETIC PARTICLE, OBSERVABLE..
nucleus
PARTICLE ABSORBS TIME, MOVES TO HIGHER TIME DENSITY. DECAYS BY EMITTING TIME-LIKE PARTICLE, NONOBSERVABLE BY PRESENT MEANS.
nucleus
ENTIRE NUCLEUS ABSORBS ENERGY, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. DECAY BYPRODUCTS OBSERVABLE.
nucleus
ENTIRE NUCLEUS ABSORBS TIME, EACH PARTICLE ABSORBS OWN. DECAY OCCURS BY COMPLEX MODES, INCLUDING FISSION OR FUSION. SOME DECAY BYPRODUCTS ARE NONOBSERVABLE (SPACE ABSORBS)

Absorption and emission reactions

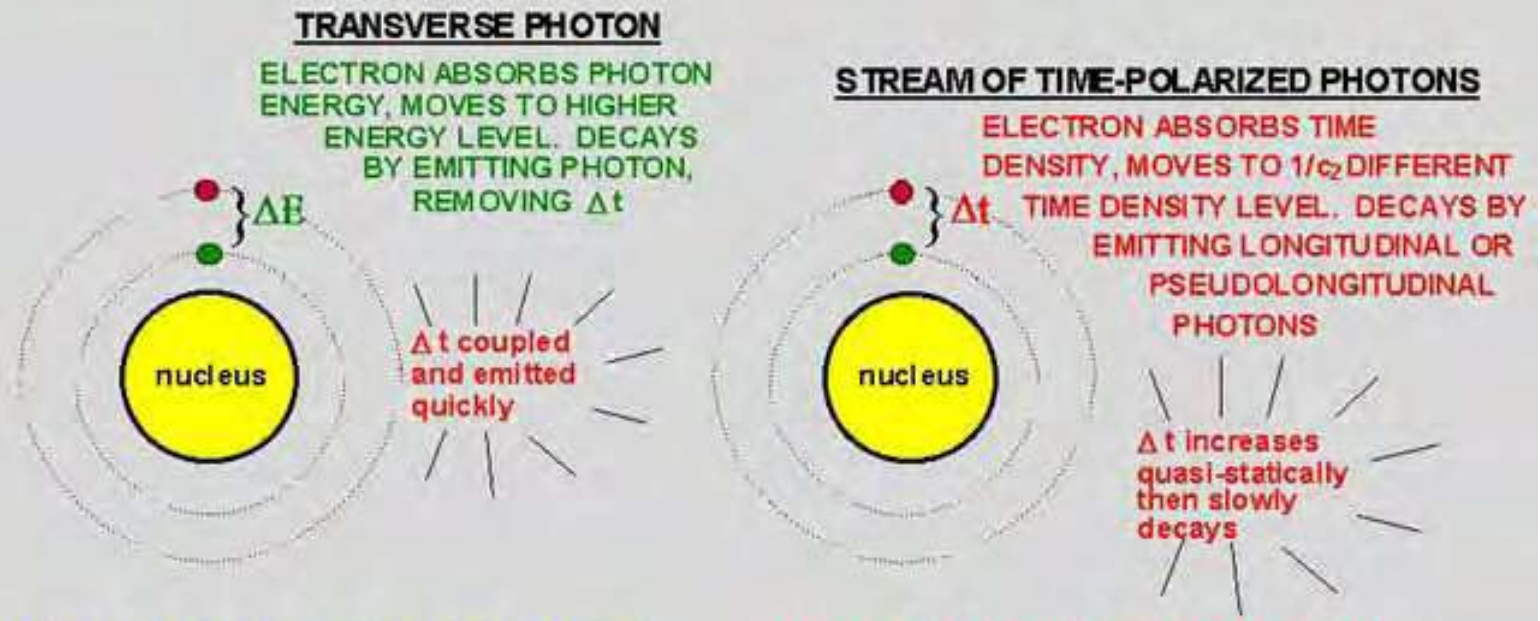

Figure A. Excited energy density level in one jump.

Figure B. Excited time density level significant only after enormous number of increases.

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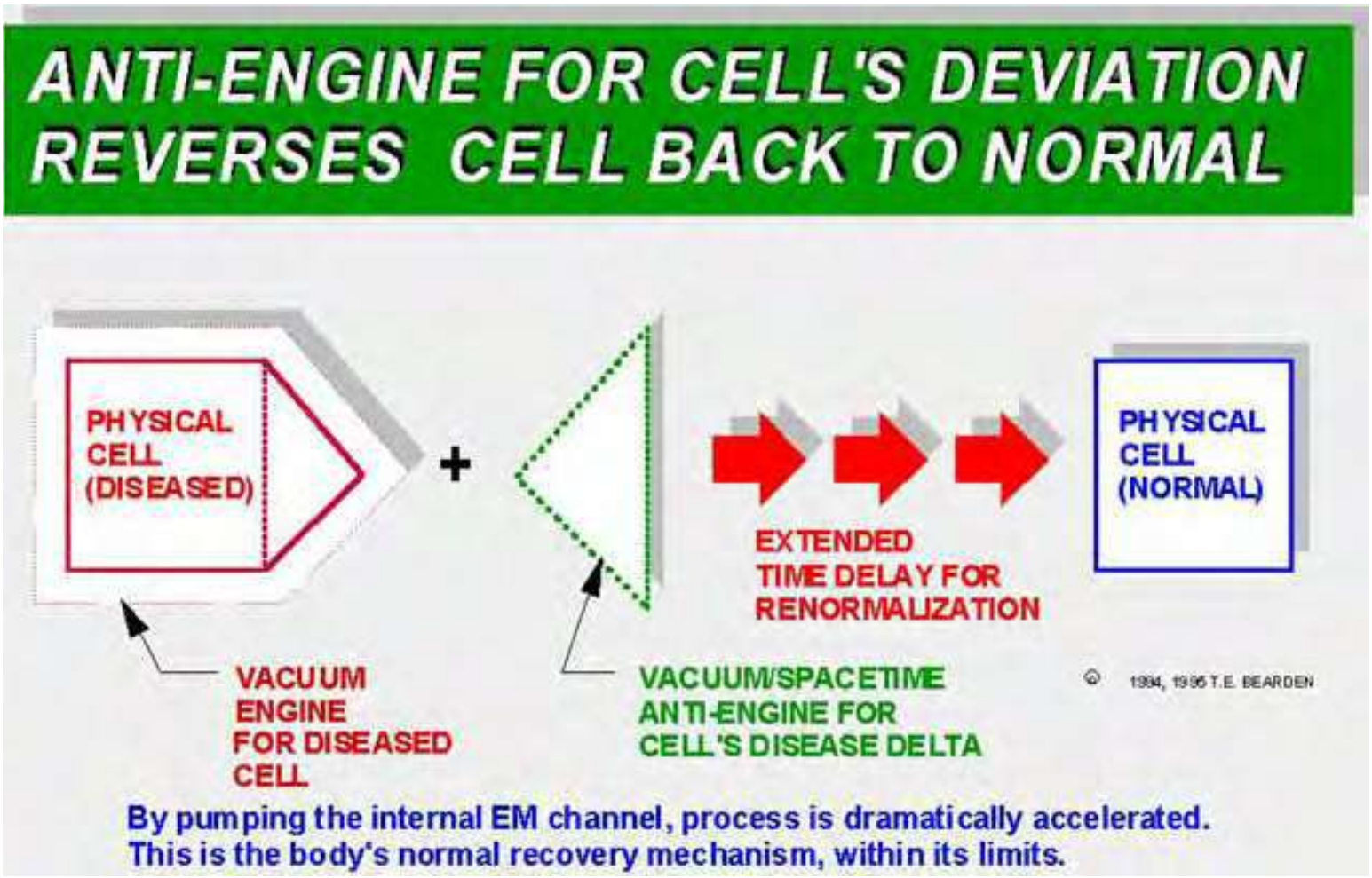
ANTI-ENGINE FOR CELL'S DEVIATION
REVERSES CELL BACK TO NORMAL
PHYSICAL CELL (DISEASED)
+
EXTENDED TIME DELAY FOR RENORMALIZATION
PHYSICAL CELL (NORMAL)
VACUUM ENGINE FOR DISEASED CELL
VACUUM/SPACETIME ANTI-ENGINE FOR CELL'S DISEASE DELTA
© 1994, 1995 T.E. BEARDEN
By pumping the internal EM channel, process is dramatically accelerated.
This is the body's normal recovery mechanism, within its limits.

Asymmetric Regauging Produces Excess Force, Which Can be Used to Do Work on the System

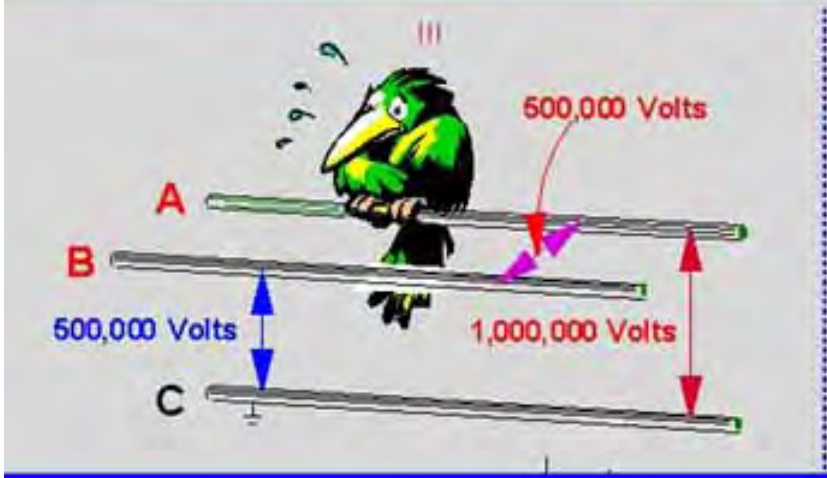

Net Symmetric Regauging Does No Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire A also. He *net symmetrically* regauged, so he had no net excess force across him, even though his potential energy was increased. He asymmetrically regauged each foot, but both simultaneously so that one countered the other. Wise little bird!

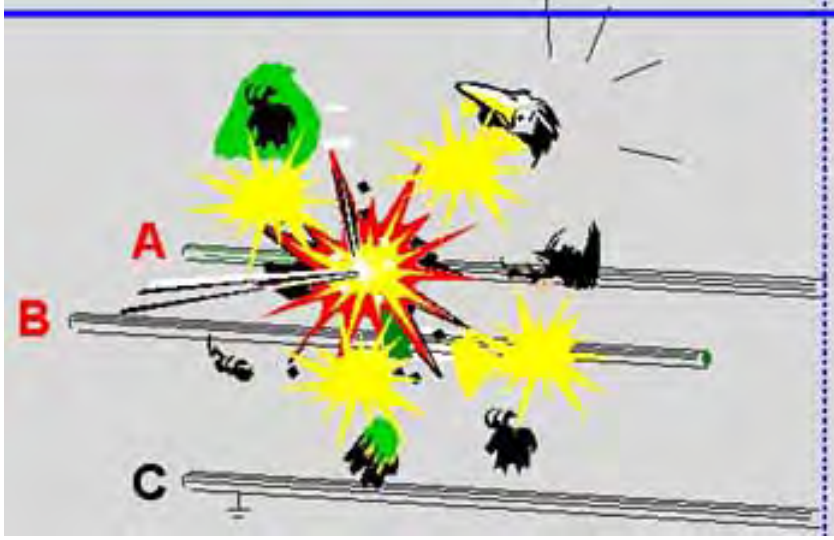

Net Asymmetric Regauging Can Do Excess Work on the System

This little bird put one foot on wire A, and then the second foot on wire B. He *net asymmetrically* regauged, so he had lots of net excess force across him. That force then violently translated his little body parts every which way, doing lots of work in and on him. Bummer!

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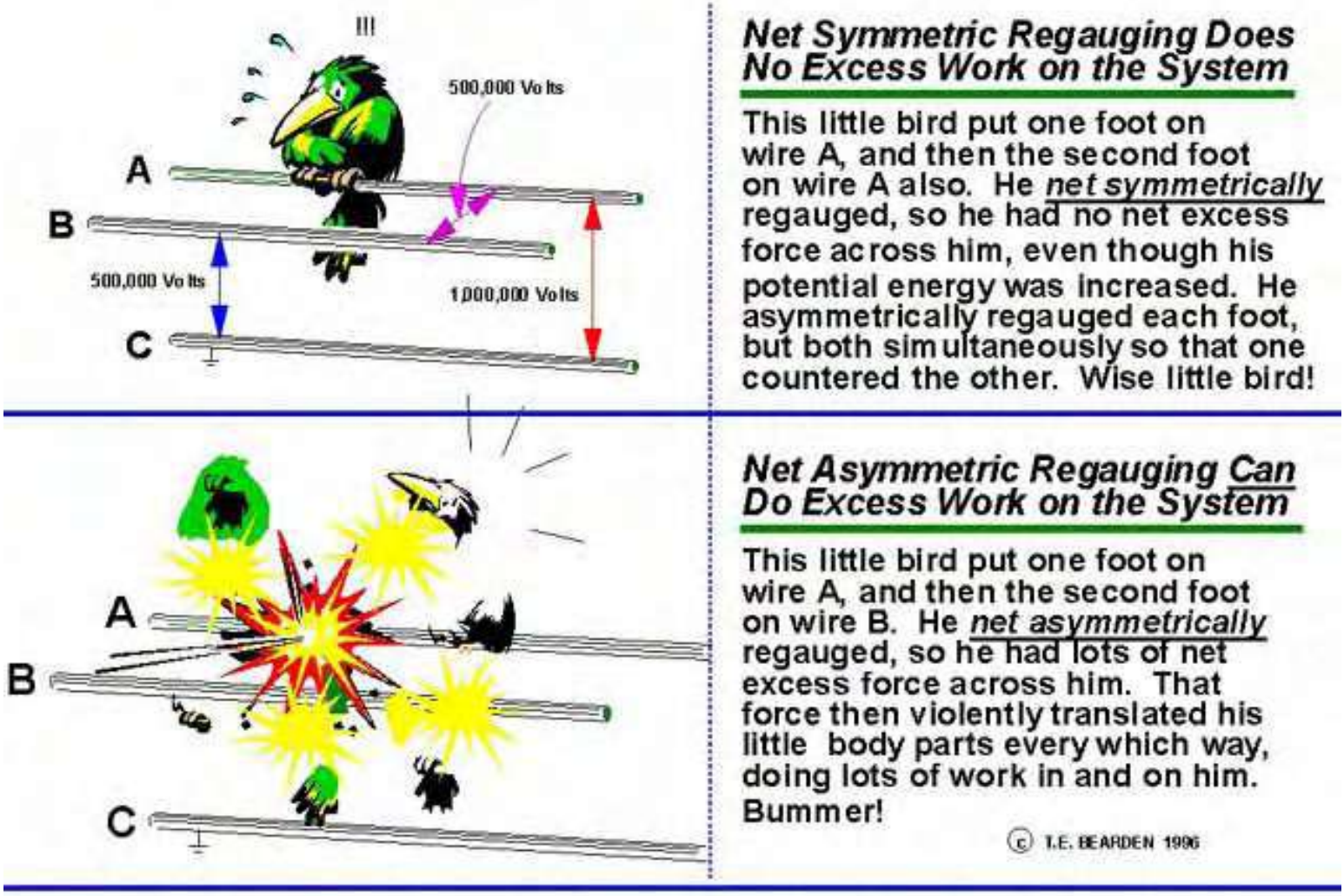

Figure 32. Asymmetric regauging produces excess force, which can be used to do work on the regauging system.

Selected clipart © by Lotus SmartPics™

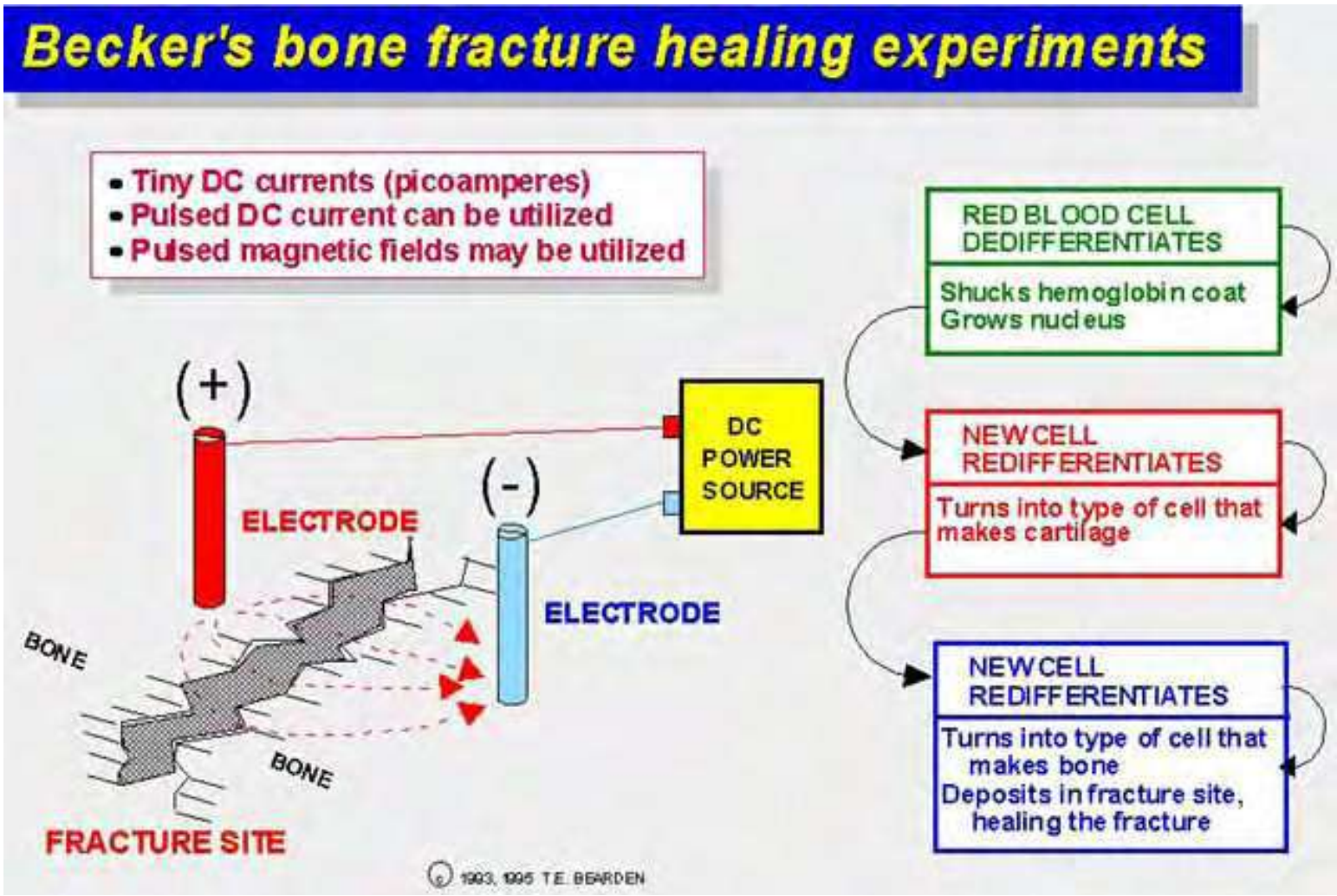
Becker's bone fracture healing experiments
• Tiny DC currents (picoamperes)
• Pulsed DC current can be utilized
• Pulsed magnetic fields may be utilized
(+)
(-)
ELECTRODE
ELECTRODE
DC POWER SOURCE
BONE
BONE
FRACTURE SITE
RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage
NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture
© 1993, 1995 T.E. BEARDEN

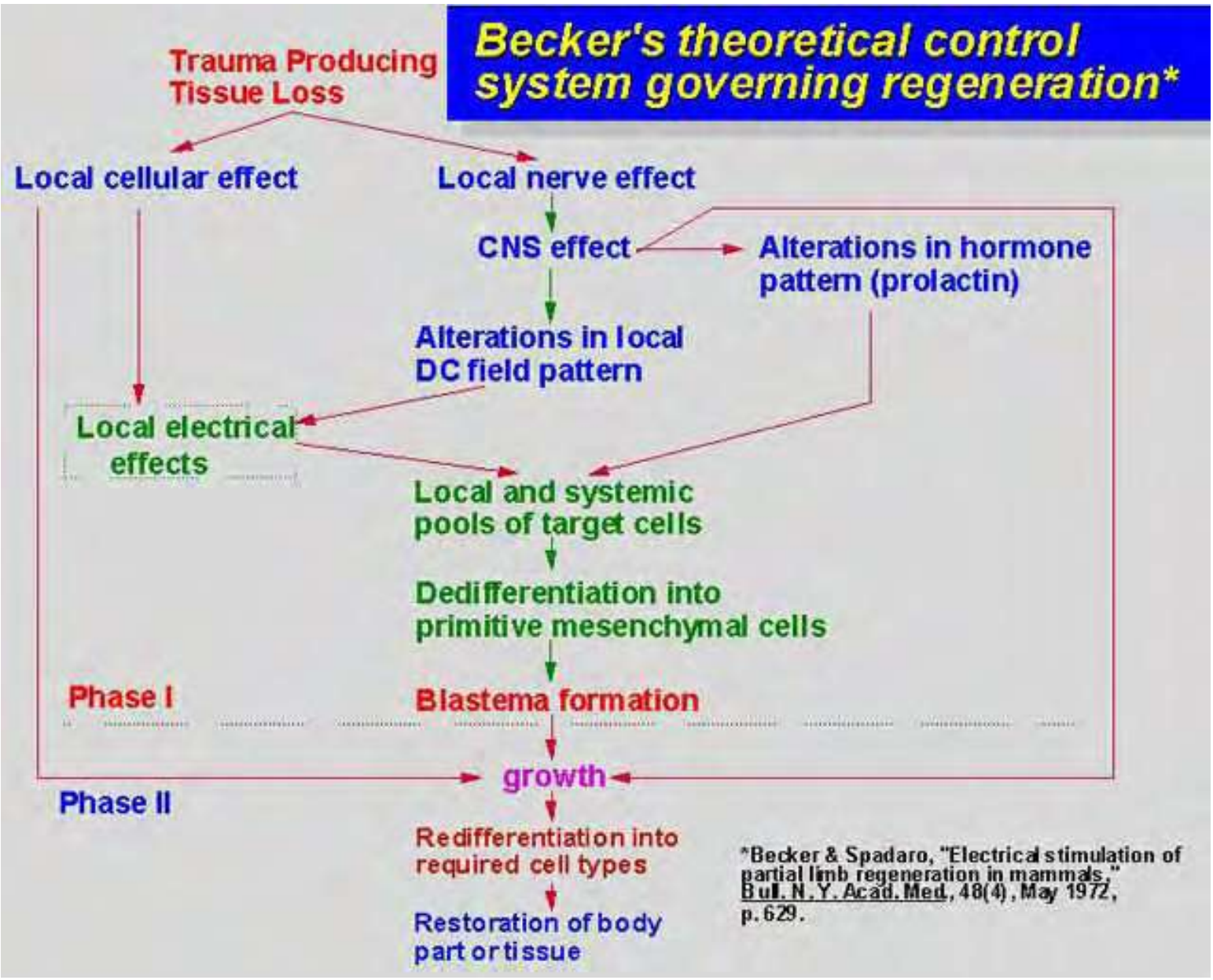
Becker's theoretical control system governing regeneration*
Trauma Producing Tissue Loss
Local cellular effect
Local nerve effect
CNS effect
Alterations in hormone pattern (prolactin)
Alterations in local DC field pattern
Local electrical effects
Local and systemic pools of target cells
Dedifferentiation into primitive mesenchymal cells
Phase I
Blastema formation
growth
Phase II
Redifferentiation into required cell types
Restoration of body part or tissue
*Becker & Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bull. N.Y. Acad. Med., 48(4), May 1972, p. 629.

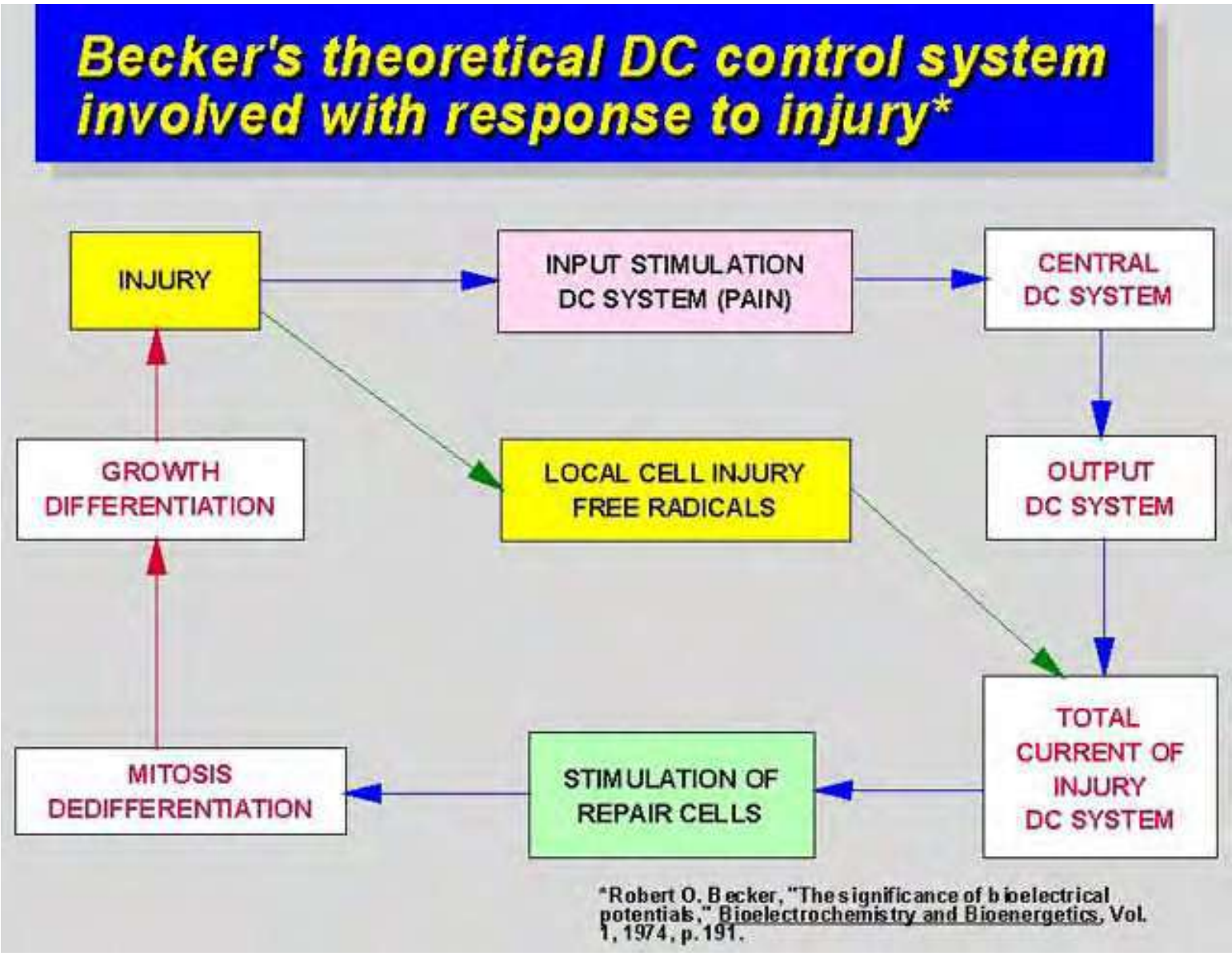
Becker's theoretical DC control system involved with response to injury*
INJURY
INPUT STIMULATION DC SYSTEM (PAIN)
CENTRAL DC SYSTEM
GROWTH DIFFERENTIATION
LOCAL CELL INJURY FREE RADICALS
OUTPUT DC SYSTEM
TOTAL CURRENT OF INJURY DC SYSTEM
MITOSIS DEDIFFERENTIATION
STIMULATION OF REPAIR CELLS
*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Geometrical Distortion of Poynting Energy Flow

At or near resonance frequency, in the case shown the energy collection fraction (reaction cross section) increases dramatically.

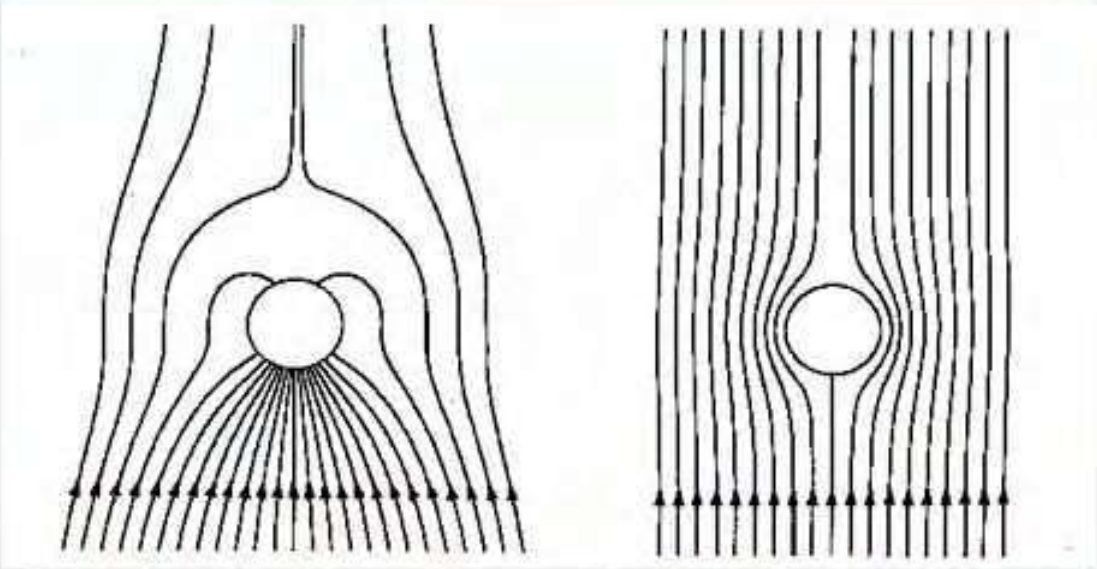

a. Around an aluminum sphere at light energy 8.8 eV. Absorption efficiency = 18.00.

b. Around an aluminum sphere at light energy 5eV. Absorption efficiency = 0.1.

Figures per Craig F. Bohren, "How can a particle absorb more than the light incident upon it? ", American Journal of Physics, 51(4), Apr. 1983, p. 326.

Cosmic Bootstrap: Before the Big Bang:

- *Cosmic repulsion behaved like a fluid with negative pressure*
- *The "universe" inflated (expanded) as a "false vacuum"*
- *As the negative-pressure fluid expanded, its energy went up rather than down*
- *When inflation stopped, the false vacuum decayed from its excited state*
- *Its excitation energy was released in a single great burst*

Paul Davies, Superforce, 1984, p. 194

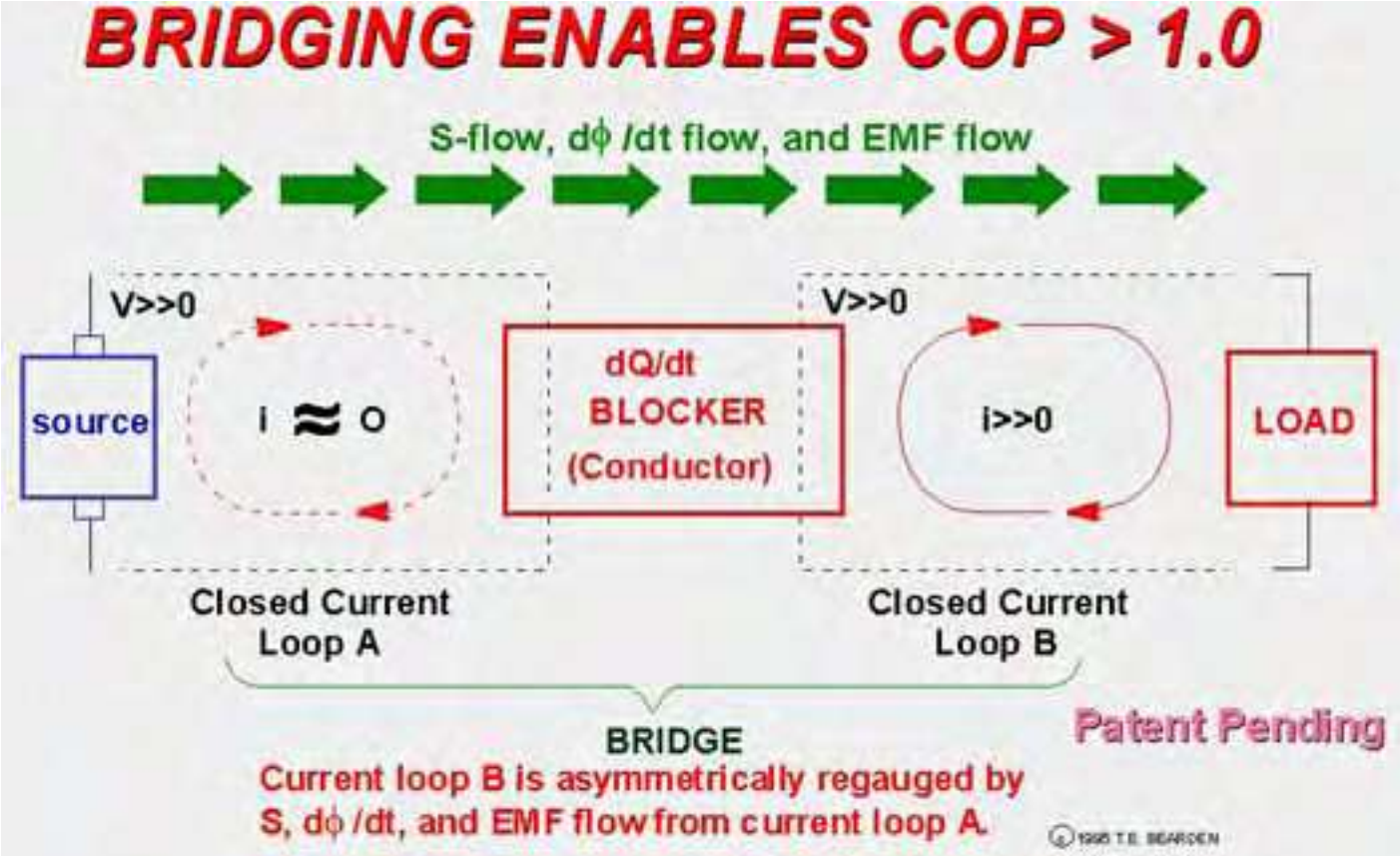
BRIDGING ENABLES COP > 1.0
S-flow, dϕ /dt flow, and EMF flow
V>>0
source
i ≈ 0
dQ/dt
BLOCKER
(Conductor)
V>>0
i>>0
LOAD
Closed Current
Loop A
Closed Current
Loop B
BRIDGE
Patent Pending
Current loop B is asymmetrically regauged by
S, dϕ /dt, and EMF flow from current loop A.
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Aspects of Strong Local Asymmetry

- If local asymmetry is strong, conservation laws may be appreciably violated
  - Energy
  - Charge
  - Spin
  - Momentum
  - Angular momentum

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- Properties of an object may differ appreciably for
  - Different observers
  - Different detecting means
  - One time to another
  - One position to another
- STRUCTURING THE INFOLDED EM INSIDE POTENTIALS, FIELDS, AND WAVES
  - Strongly breaks local symmetry
  - Provides spacetime engines giving the above effects

Other Aspects of Strong Local Asymmetry

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- Local spacetime is curved
- Lorentz invariance of vacuum is violated
- May be a local "sink" or "source"
- Gravitational-inertial effects from EM
- Translation between virtual and observable
- Electrogravitational solitons
- Action at a distance
- Transmutation effects may exist
- Scalar/pseudoscalar field translation
- COMMENT: Thus the use of infolded longitudinal EM fields and waves to strongly break local symmetry allows intermested clustering of spacetime curvatures. These spacetime structures are *vacuum engines*, or *spacetime engines*.

Bunge on the Status of Electrodynamics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state..."

"... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

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Bunge on the Status of Electrodynamics and Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state...

"... neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling..."

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*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176.

Bunge on the Status of Classical and Quantum Physics

"... it is not usually acknowledged that electro-dynamics, both classical and quantal, are in a sad state... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."

*Mario Bunge, Foundations of Physics, Springer-Verlag, New York, NY, 1967, p. 176..

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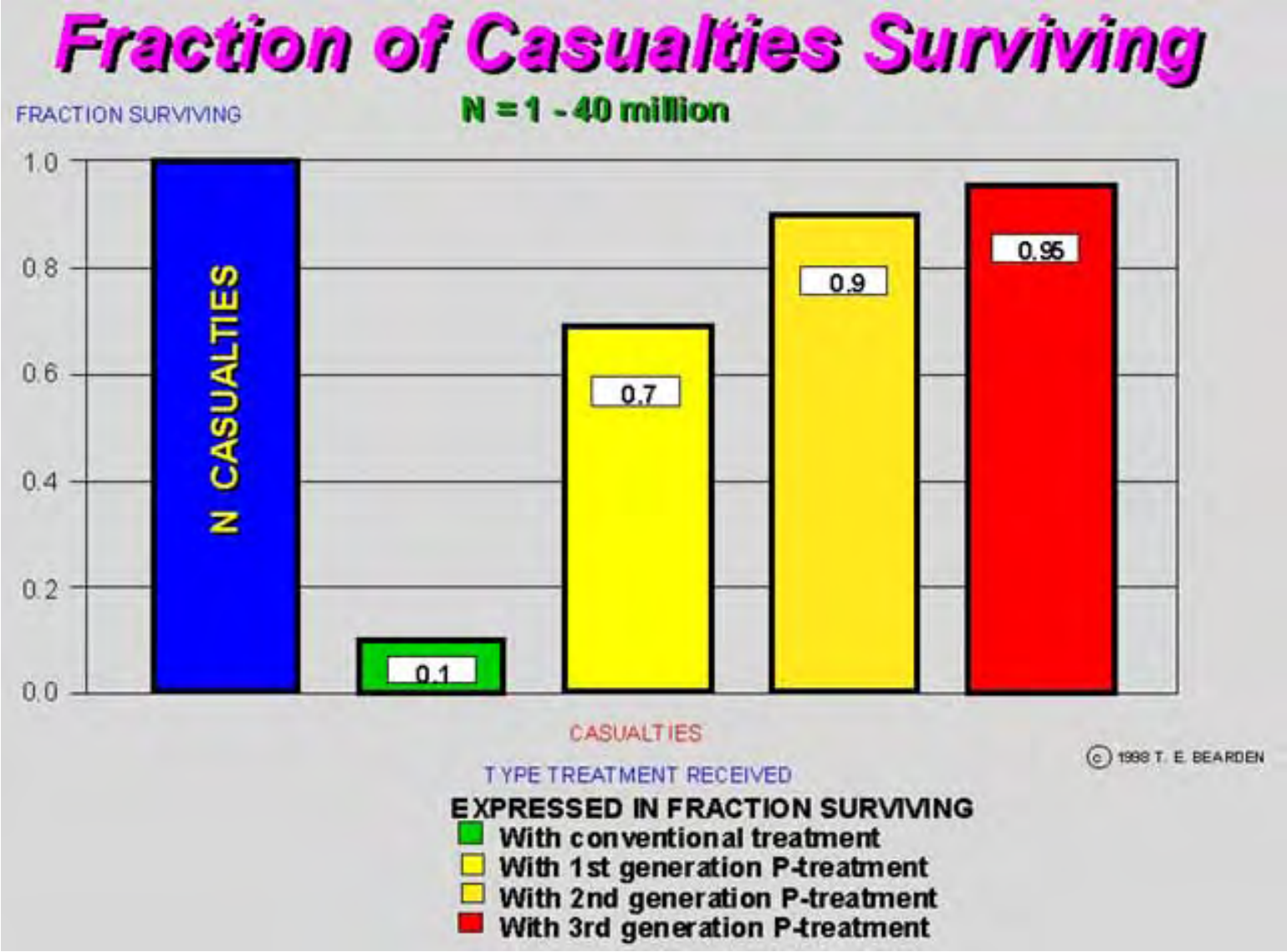
Fraction of Casualties Surviving
FRACTION SURVIVING
N = 1 - 40 million
1.0
0.8
0.6
0.4
0.2
0.0
N CASUALTIES
0.1
0.7
0.9
0.95
CASUALTIES
TYPE TREATMENT RECEIVED
© 1998 T. E. BEARDEN
EXPRESSED IN FRACTION SURVIVING
With conventional treatment
With 1st generation P-treatment
With 2nd generation P-treatment
With 3rd generation P-treatment

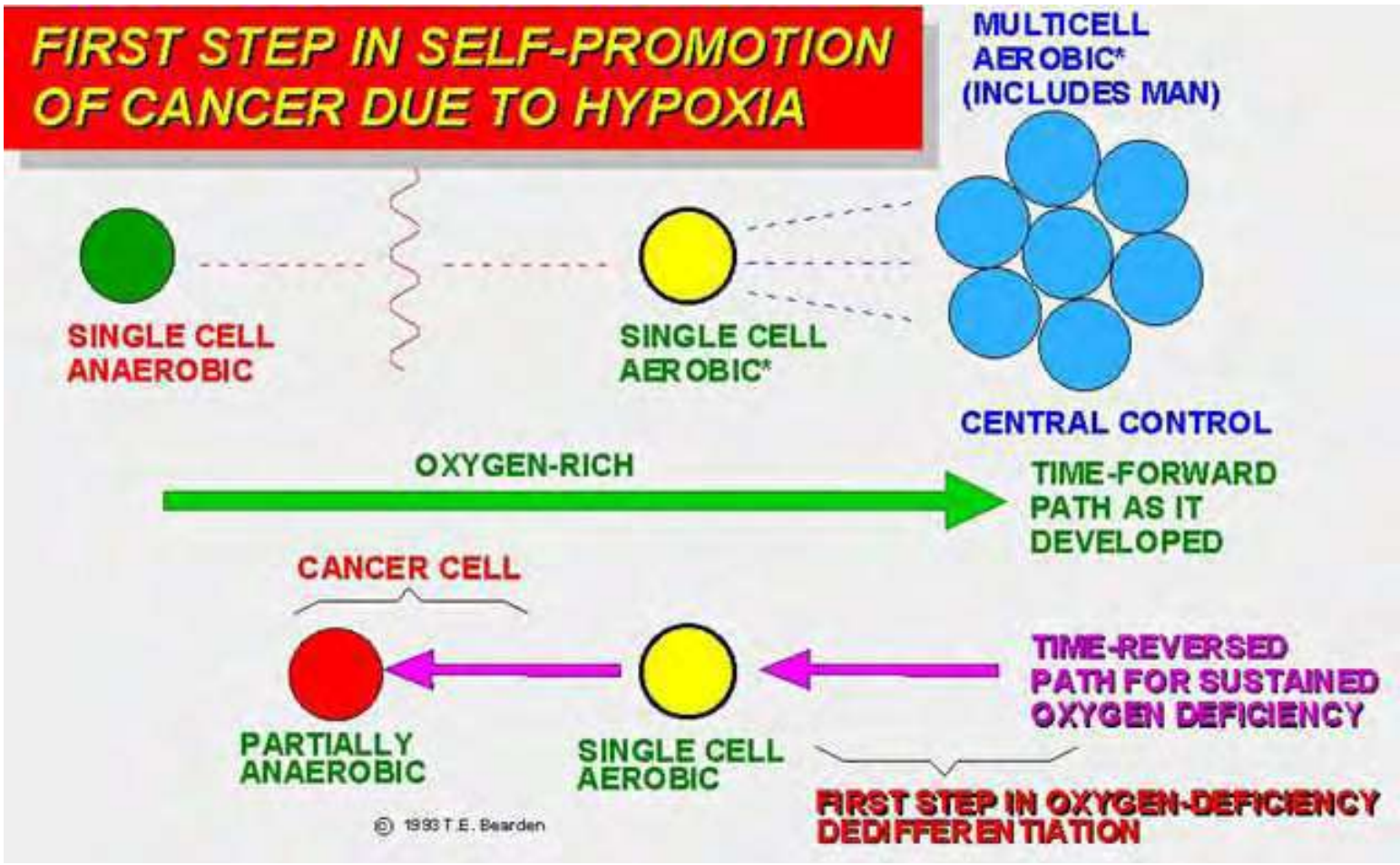
FIRST STEP IN SELF-PROMOTION OF CANCER DUE TO HYPOXIA
MULTICELL AEROBIC* (INCLUDES MAN)
SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC*
CENTRAL CONTROL
OXYGEN-RICH
TIME-FORWARD PATH AS IT DEVELOPED
CANCER CELL
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
PARTIALLY ANAEROBIC
SINGLE CELL AEROBIC
FIRST STEP IN OXYGEN-DEFICIENCY DEDIFFERENTIATION
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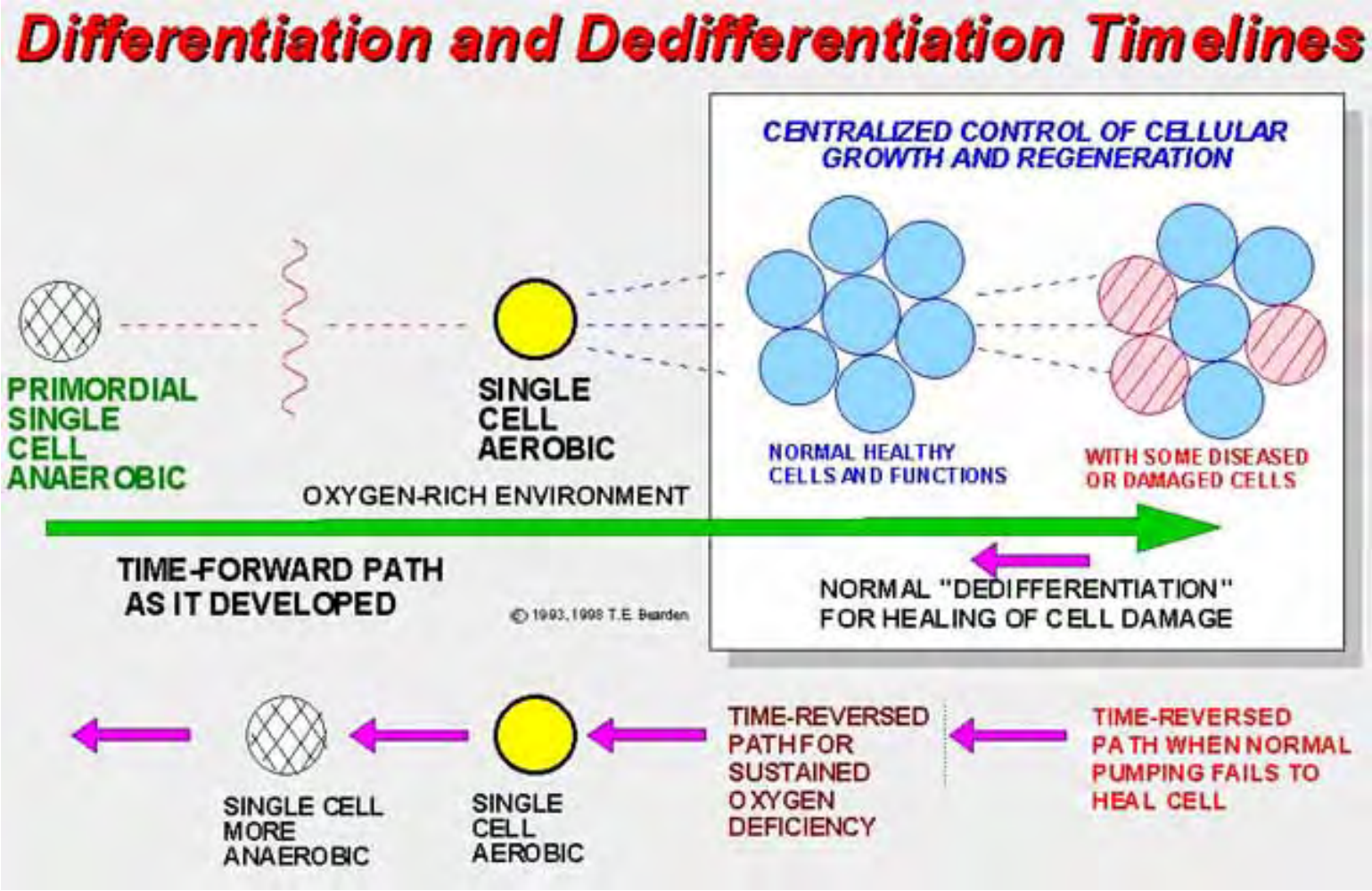
Differentiation and Dedifferentiation Timelines
CENTRALIZED CONTROL OF CELLULAR GROWTH AND REGENERATION
PRIMORDIAL SINGLE CELL ANAEROBIC
SINGLE CELL AEROBIC
OXYGEN-RICH ENVIRONMENT
NORMAL HEALTHY CELLS AND FUNCTIONS
WITH SOME DISEASED OR DAMAGED CELLS
TIME-FORWARD PATH AS IT DEVELOPED
© 1993, 1998 T.E. Bearden
NORMAL "DEDIFFERENTIATION" FOR HEALING OF CELL DAMAGE
SINGLE CELL MORE ANAEROBIC
SINGLE CELL AEROBIC
TIME-REVERSED PATH FOR SUSTAINED OXYGEN DEFICIENCY
TIME-REVERSED PATH WHEN NORMAL PUMPING FAILS TO HEAL CELL

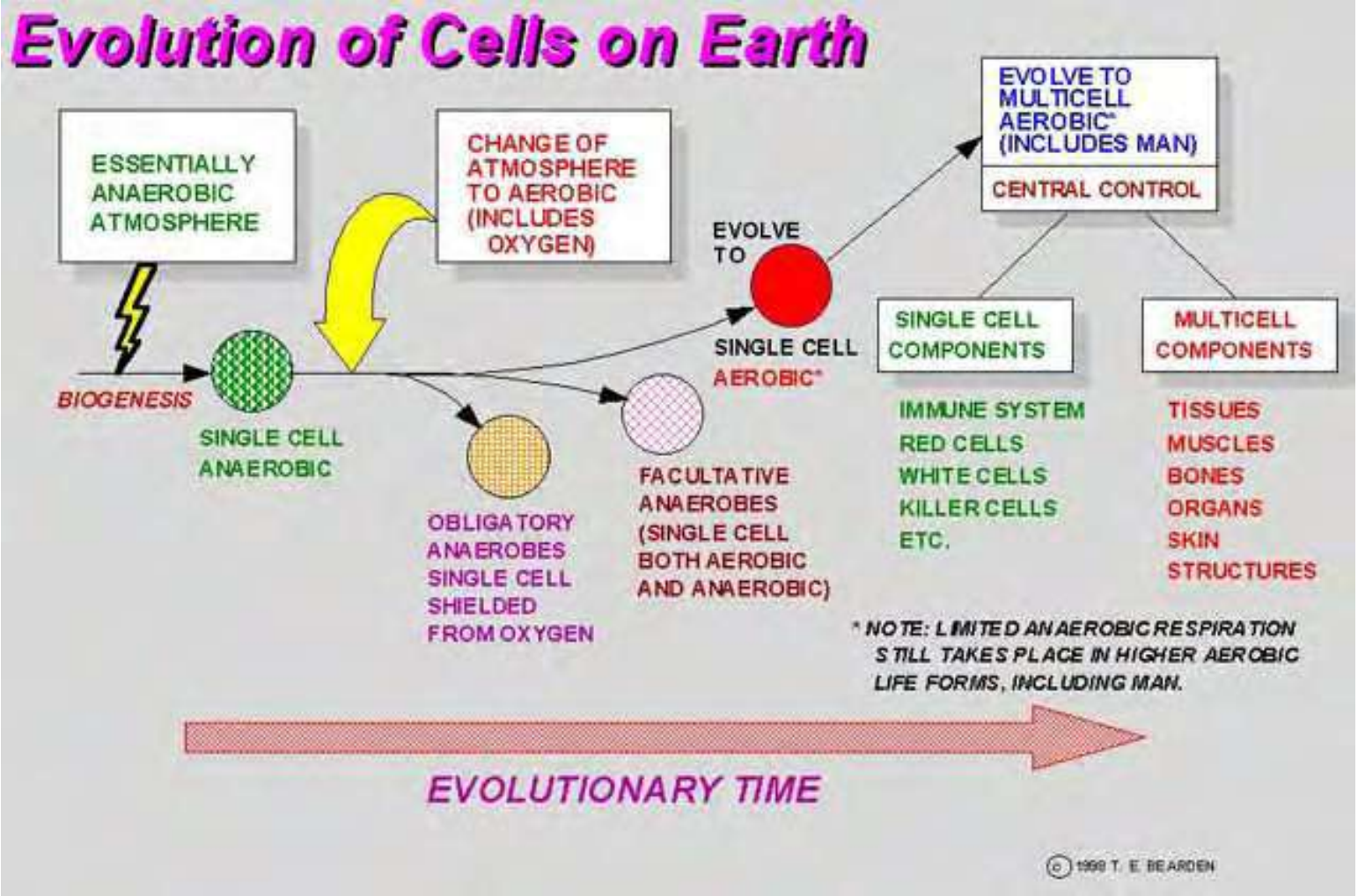
Evolution of Cells on Earth
ESSENTIALLY ANAEROBIC ATMOSPHERE
CHANGE OF ATMOSPHERE TO AEROBIC (INCLUDES OXYGEN)
EVOLVE TO MULTICELL AEROBIC* (INCLUDES MAN)
CENTRAL CONTROL
EVOLVE TO
SINGLE CELL AEROBIC*
SINGLE CELL COMPONENTS
MULTICELL COMPONENTS
BIOGENESIS
SINGLE CELL ANAEROBIC
OBLIGATORY ANAEROBES SINGLE CELL SHIELDED FROM OXYGEN
FACULTATIVE ANAEROBES (SINGLE CELL BOTH AEROBIC AND ANAEROBIC)
IMMUNE SYSTEM
RED CELLS
WHITE CELLS
KILLER CELLS
ETC.
TISSUES
MUSCLES
BONES
ORGANS
SKIN
STRUCTURES
* NOTE: LIMITED ANAEROBIC RESPIRATION STILL TAKES PLACE IN HIGHER AEROBIC LIFE FORMS, INCLUDING MAN.
EVOLUTIONARY TIME
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A Charged Particle q Is a Coupled System of m and ϕ

(A proposed formal definition of a charged mass)

Note: X is a coupling operator

$$q \equiv f_q \times m_q$$

Also note that the ϕ portion of the charged particle can be internally structured, per Stoney-Whittaker-Ziolkowski, with hidden bidirectional EM wavepairs (their sums and products). Note that this constitutes an EM application of Bohm-type hidden variable theory, with many ramifications.

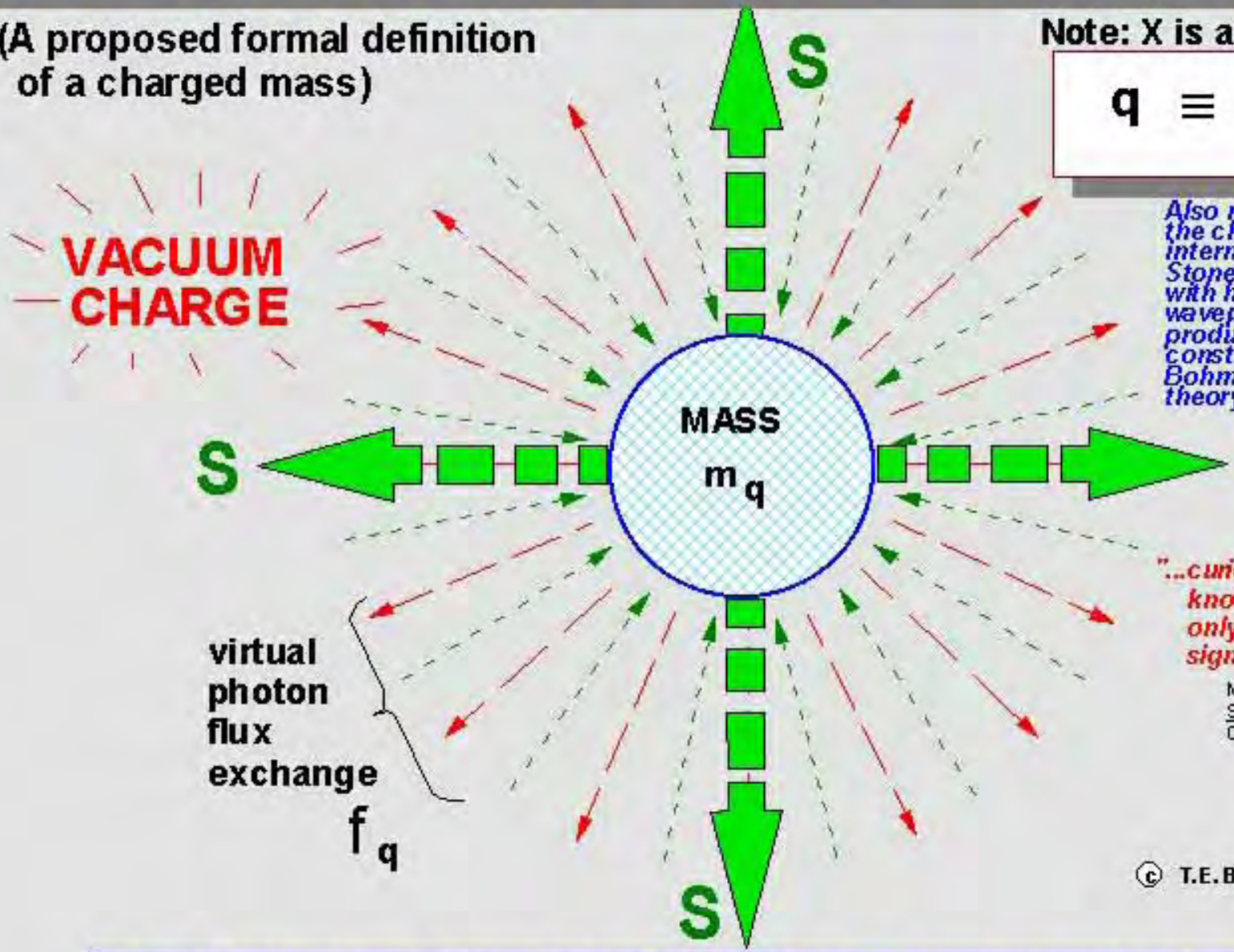

S = EXH

"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

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An electric charge Q consists of a massless flux component and a mass component, coupled together (interacting). Q is a broken symmetry. The mass of the charge continually and violently exchanges virtual photons with the surrounding vacuum.

Thus Q is energetically driven by the surrounding vacuum potential, which itself is to first order just a violent virtual photon flux.

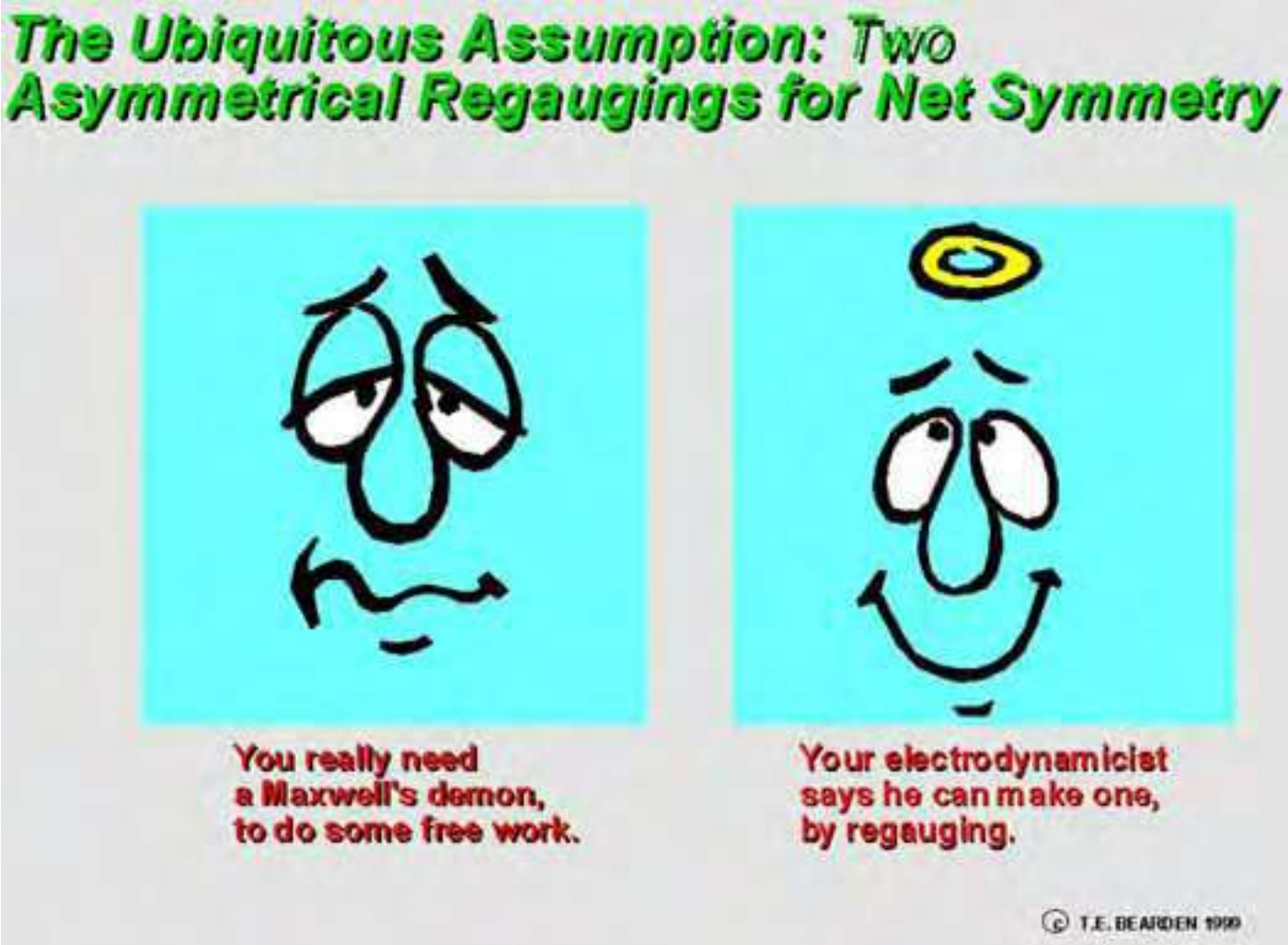
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
You really need a Maxwell's demon, to do some free work.
Your electrodynamicist says he can make one, by regauging.
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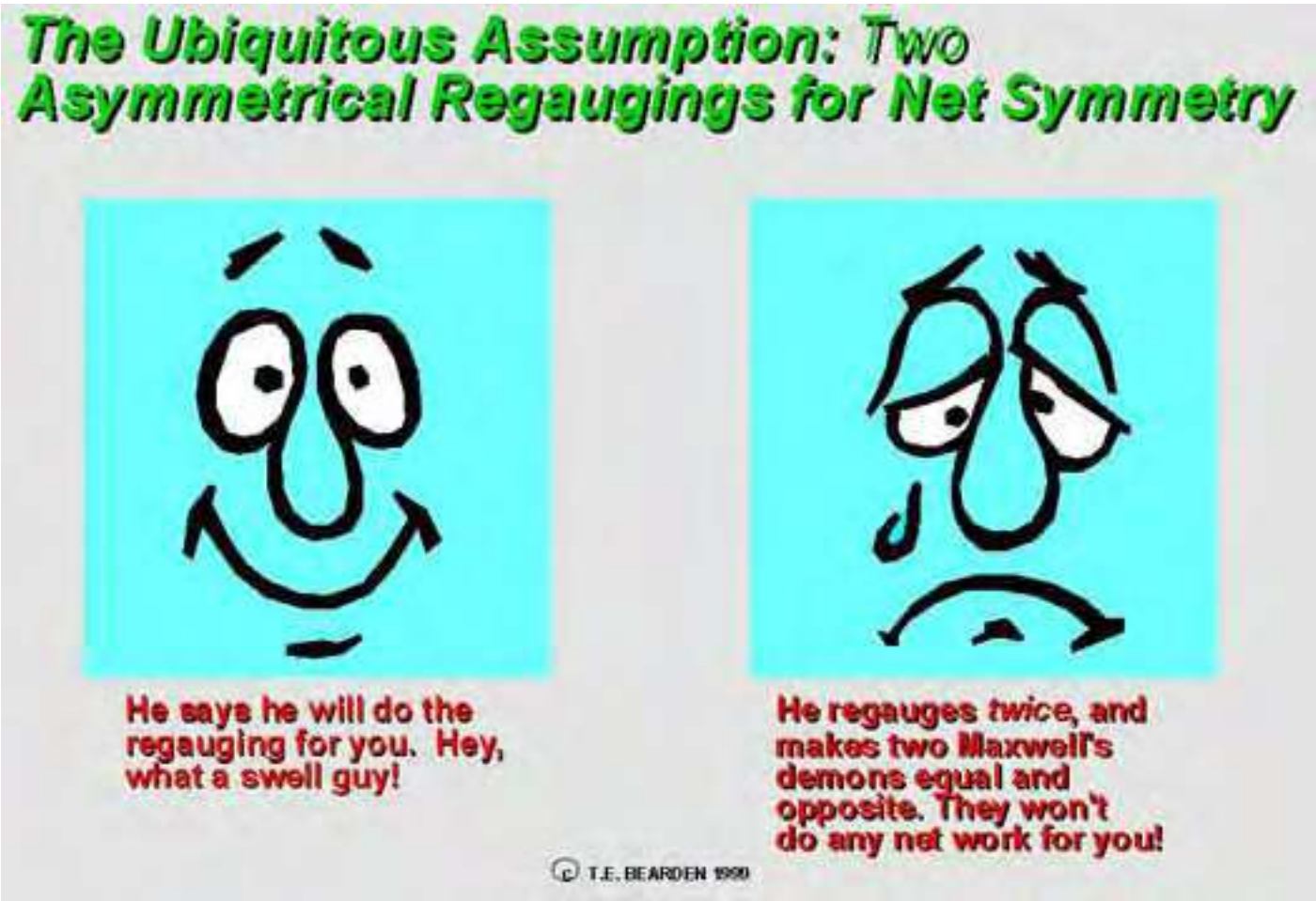
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
He says he will do the regauging for you. Hey, what a swell guy!
He regauges twice, and makes two Maxwell's demons equal and opposite. They won't do any net work for you!
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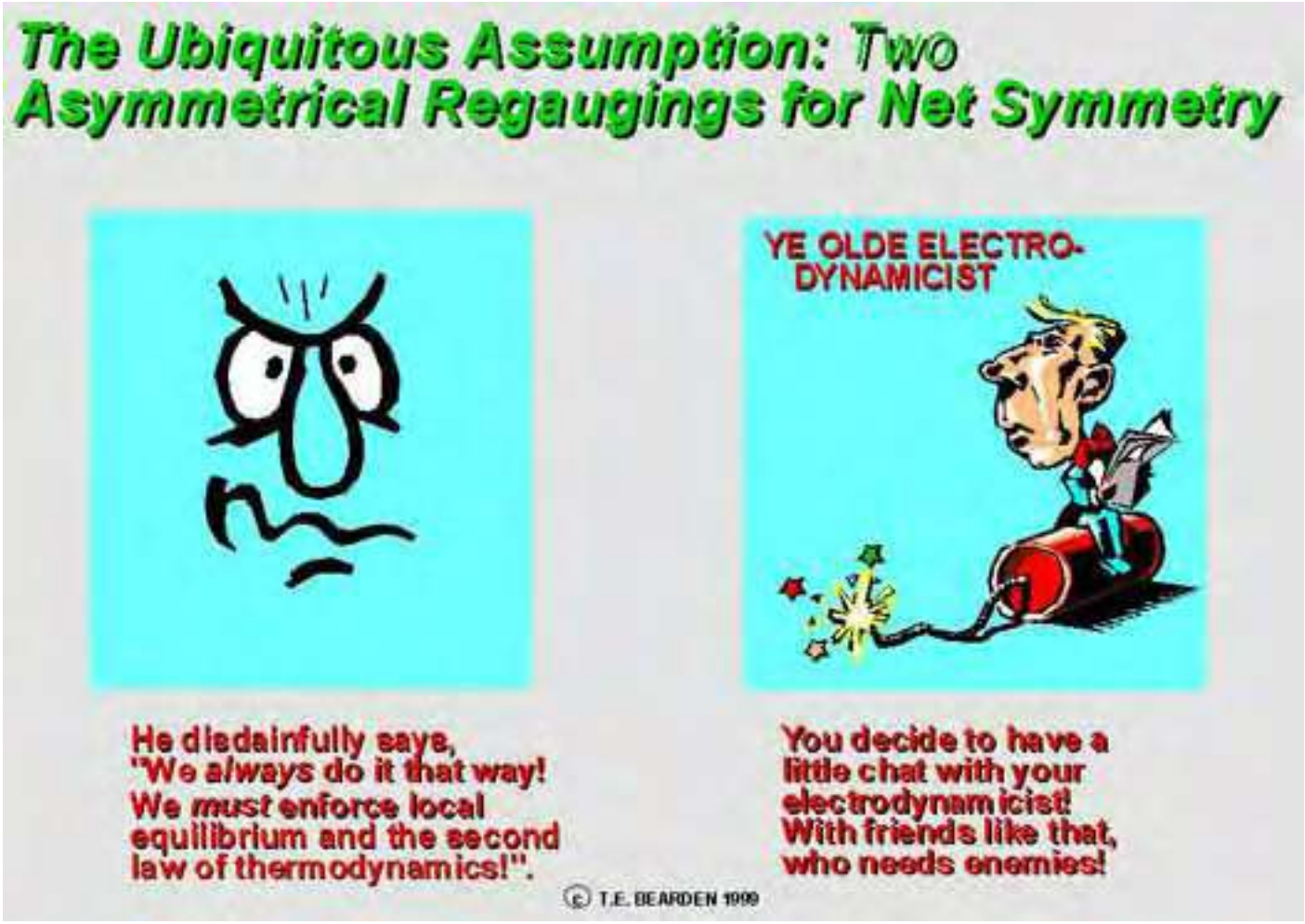
The Ubiquitous Assumption: Two Asymmetrical Regaugings for Net Symmetry
YE OLDE ELECTRO-DYNAMICIST
He disdainfully says, "We always do it that way! We must enforce local equilibrium and the second law of thermodynamics!".
You decide to have a little chat with your electrodynamicist! With friends like that, who needs enemies!
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A Charged Particle Is a Coupled System

(The first formal definition of charge)

$$q \equiv \phi_q \times m_q$$

Note: X is a coupling operator

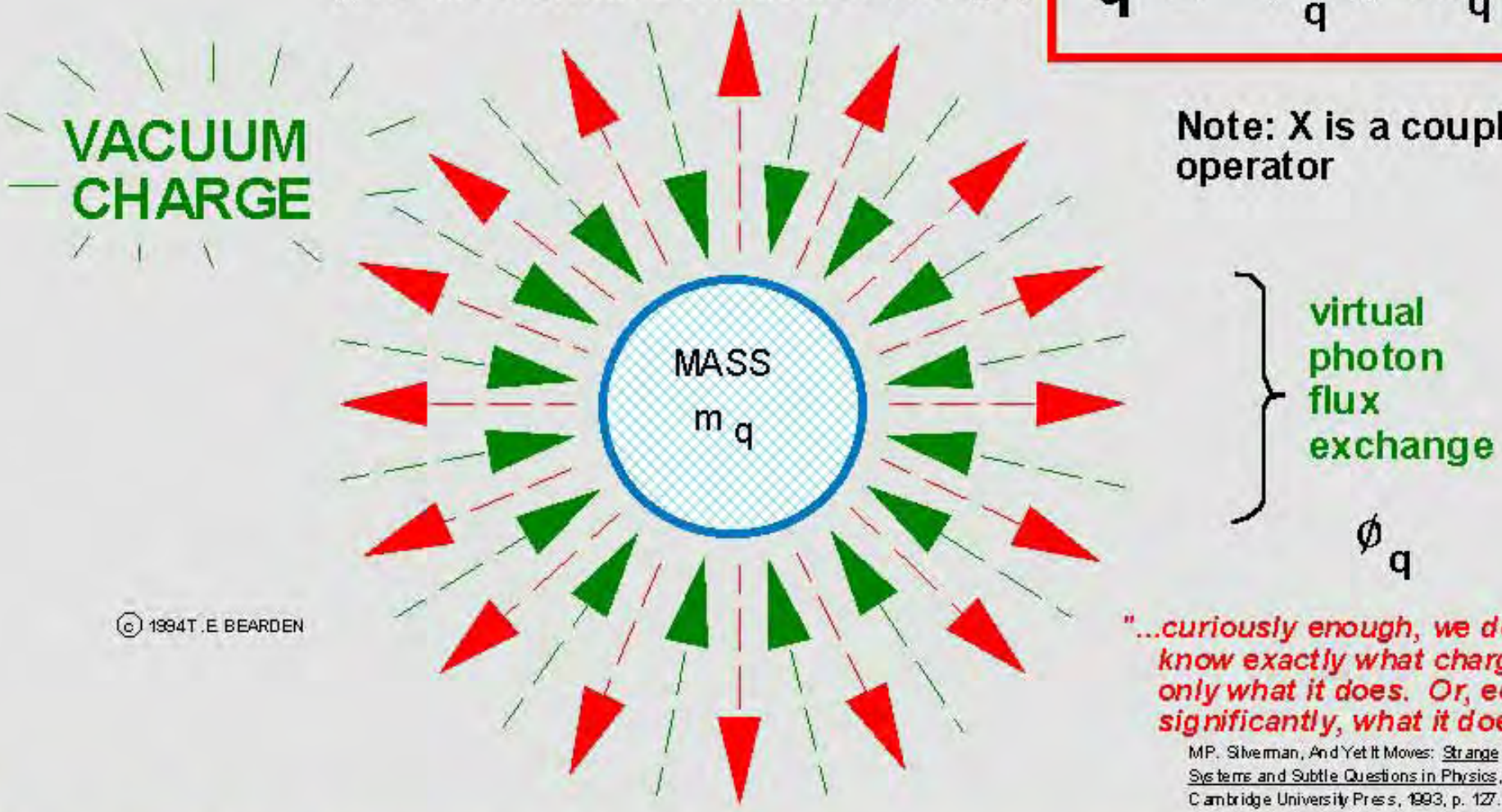

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"...curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."

M.P. Silverman, And Yet It Moves: Strange Systems and Subtle Questions in Physics, Cambridge University Press, 1993, p. 127.

An electric charge q is a broken symmetry in its fierce energy exchange with the active vacuum. It coherently integrates some of the virtual energy absorbs and outputs it as Poynting energy flow.

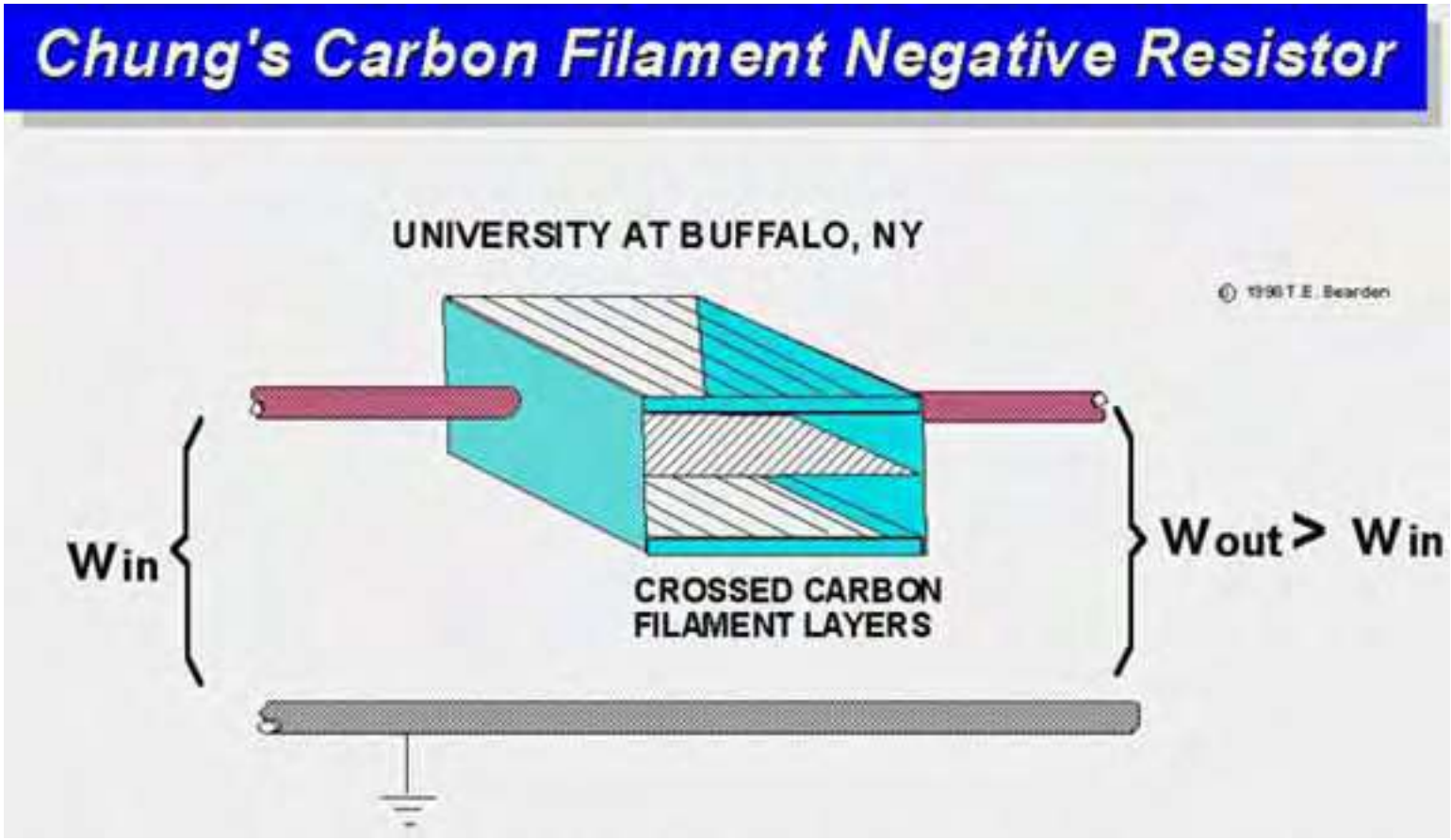
Chung's Carbon Filament Negative Resistor
UNIVERSITY AT BUFFALO, NY
© 1996 T.E. Bearden
Win
Wout > Win
CROSSED CARBON
FILAMENT LAYERS

Typical circuit has about 10^{-13} energy collection efficiency

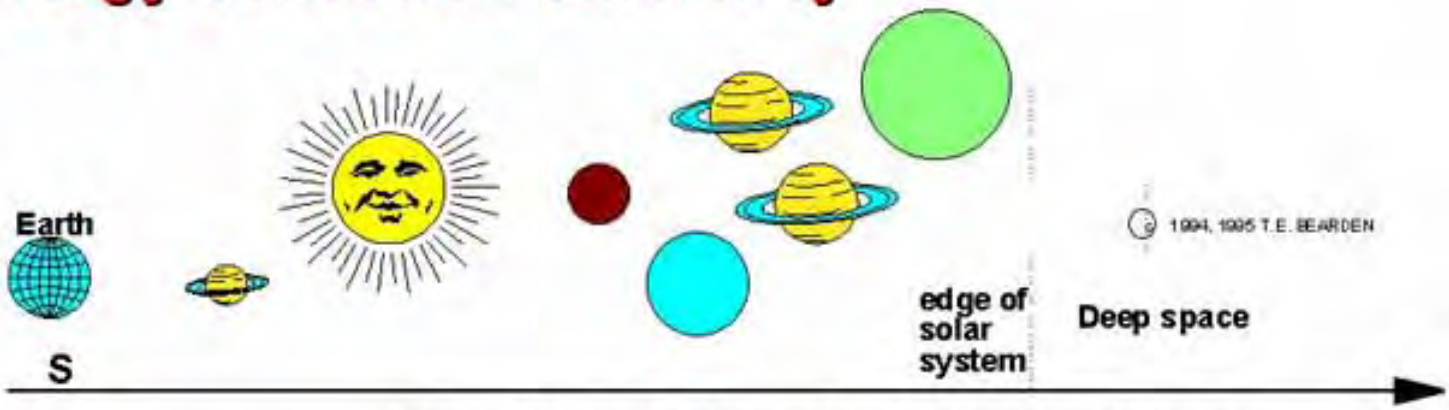

Distance traveled by S in one hour is 1.08x10exp(12) meters.

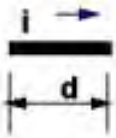

Example: 1.3 amps flowing in DC circuit, 1.8 mm diameter copper wire. J = 51 A/cm ^{2}

d_j = 0.1368 meters

S violently transports ϕ provided from the source.
j ϕ sluggishly transports the energy collected and dissipated in the circuit..

For the case discussed, the electron drift velocity in the circuit is about 3.8 x 10^{-5} meters/sec. So Jϕ moves about 0.1368 meters in one hour. Thus Jϕ has collected about 0.1368 meters of the ϕ-filled S-tube. During that same hour, the S-flow evoked by the power source will have traveled 1.08x10^{12} meters. The ϕ of both currents is the same. Both are involved in the same energy-filled tube. Thus S has provided and transported about 7.89x10^{12} times as much energy along the circuit in one hour as the jϕ has been able to collect, transport, and dissipate as work in the circuit. Thus this circuit provides about 10^{13} collection efficiency.

Classical View of EM

- Potentials just mathematical conveniences
  - Not real
  - No internal structure, just magnitude
- Force fields primary, causative, can exist in space in absence of observable mass
  - All EM actions due to force fields, none when zero
  - No action at a distance
- Vacuum empty; without energy or structure
  - No locally curved spacetime
  - No gravity effects
  - No quantum effects
- Maxwell's equations complete
  - Symmetrically regauged ***arbitrarily***
  - Topology dramatically reduced

Curved Spacetime acts as source or sink

- May emit excess radiation and energy (e.g., heat)
- May absorb radiation and energy (e.g., cool)
- May transduce waves TW ⇔ LW ⇔ TDW
- New energy conservation law applies

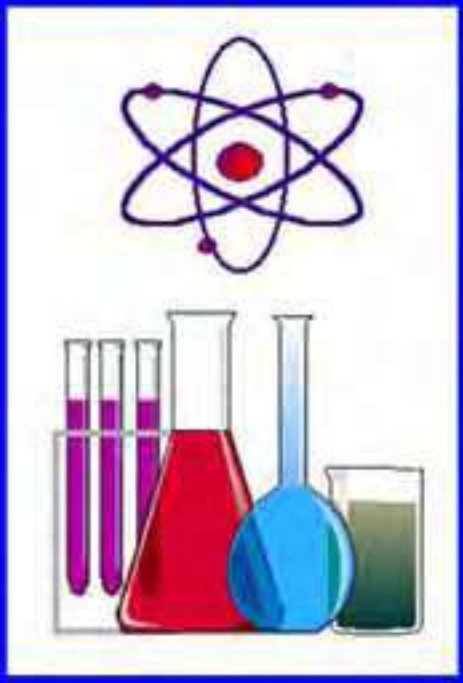

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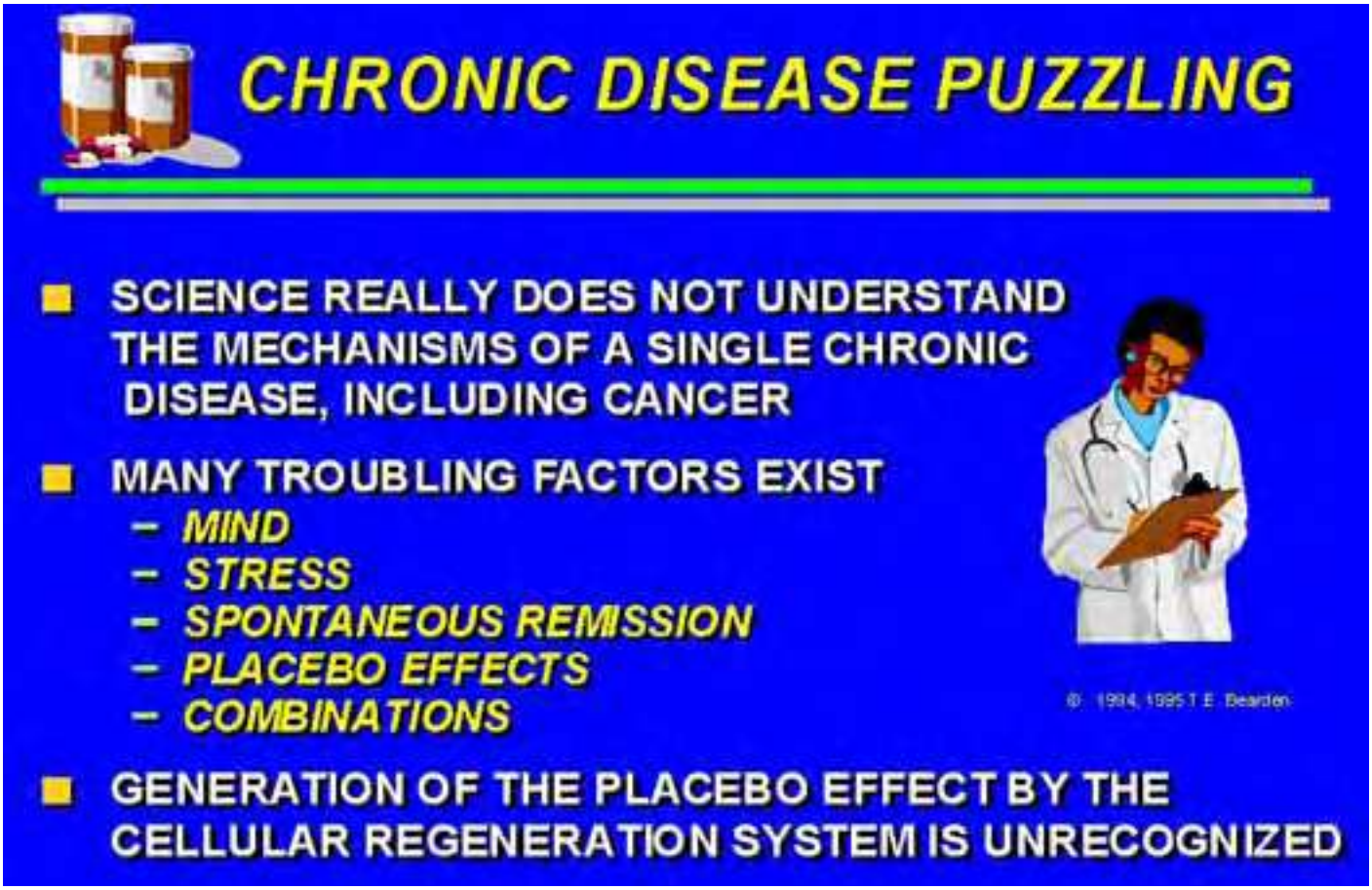
CHRONIC DISEASE PUZZLING
SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
MANY TROUBLING FACTORS EXIST
– MIND
– STRESS
– SPONTANEOUS REMISSION
– PLACEBO EFFECTS
– COMBINATIONS
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GENERATION OF THE PLACEBO EFFECT BY THE CELLULAR REGENERATION SYSTEM IS UNRECOGNIZED

Cancer Characteristics

- Not one disease, but a whole range
- Starts in damaged aerobic cell
- Cell shakes off body's central control
  - Starts uncontrolled division
  - Becomes a lump
- Can send forth cancer cells
  - Through blood
  - Through lymph
- Form metastases (secondary tumors)
- Often become anaerobic

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Solving a Cancer Enigma

- An enigma has been failure of immune system to attack some tumor cells
  - Suppressor cells may curb immune system?
  - Tumor may lack antigens normally identified by the immune system?
- *Promotion of damaged cell to cancer is usually ordered by cellular control system*
  - *Regenerative and recovery system forces cell back toward anaerobe*
  - *First step breaks free from central growth*
  - *Control continues to recognize cell as self*

CANCER: CHARACTERISTICS

- NOT ONE DISEASE BUT A WHOLE RANGE
- STARTS IN ORDINARY (AEROBIC) CELL
- CELL SHAKES OFF BODY'S DICTATORIAL CONTROL*
- STARTS UNCONTROLLED DIVISION
- BECOMES A LUMP
- CAN SEND FORTH CANCER CELLS
  - THROUGH BLOOD
  - THROUGH LYMPH
- THESE FORM METASTASES (SECONDARY TUMORS)
- OFTEN BECOME ANAEROBIC (NON-OXYGEN USING)
- ENIGMA IS FAILURE OF IMMUNE SYSTEM TO ATTACK SOME TUMOR CELLS
  - SUPPRESSOR CELLS MAY CURB IMMUNE SYSTEM
  - TUMOR MAY LACK ANTIGENS NORMALLY IDENTIFIED BY THE IMMUNE SYSTEM

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*R&R system forces cell back toward anaerobe

Nonlinear Optics
Distortion Correction Theorem

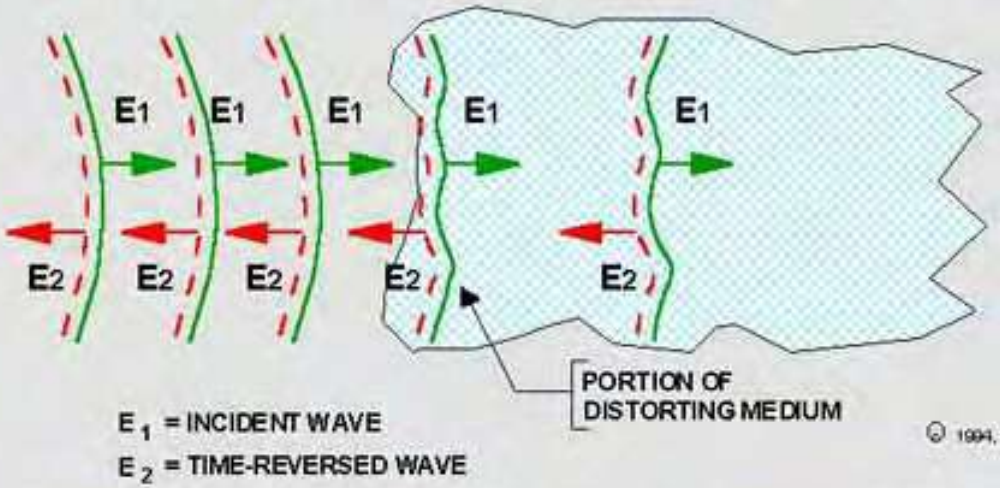

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"If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (1)

- Nucleon interchange
  - Changes neutron into proton and vice versa
  - At high rate (flat spacetime assumed)
- Statistics become skewed due to curved ST
- Can bias statistics toward either neutron or proton end
  - Biases toward transmutation of elements along isomer chains
  - Concept of "isomer" is vastly expanded

The Electronuclear Reaction: Nuclear Reactions in TR-Zones (2)

- Normal dynamics (impulses) may reverse
  - Like charges attract, unlike charges repel
  - Positive charges cluster (are drawn together)
  - H+ ions (protons) may form quasi-nuclei
  - Nucleus coulomb barrier becomes assistant
- Many "impossible" reactions now possible
  - Quark access and quark flipping by EM
  - Ion clustering
  - Positive charges as phase conjugate mirrors
  - Time-density waves and time-energy charging

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The Electronuclear Reaction: Nuclear Reactions in TR-Zones (3)

- Not observed until time-energy charging has become substantial
  - Time delay (hours, days)
  - Transduction of LW --> TW involved
  - Specific time-charging history of detectors is involved in twhether they detect or not
  - Longitudinal EM waves become significant
- Curved spacetime can act as source or sink
  - May emit excess radiation
  - May absorb excess radiation

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In Time-Reversed Zone: Nuclear reactions are biased

- In normal flat ST, n ⇔ p at high rate
- Curved ST skews statistics
- Biases to either n or p
- Biases to transmutation along isomer chain
- "Isomer" concept greatly expanded

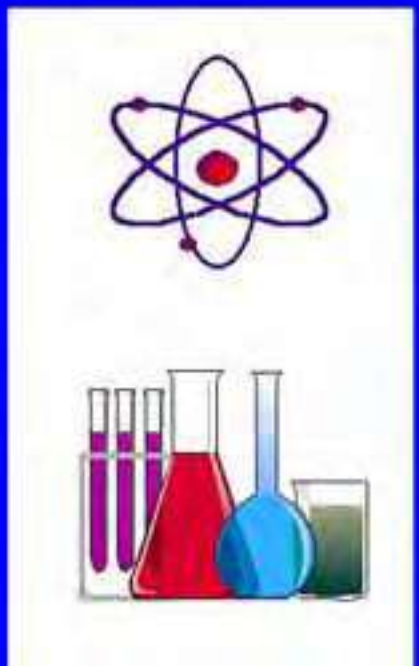

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In Time-Reversed Zone: Dynamics may be reversed

- Like charges may attract and unlike charges repel
- Coulomb barrier becomes Coulomb assistant
- Clusters like charges and forms artificial nuclei
- "Impossible" nuclear reactions at low energy
- Time-density interactions

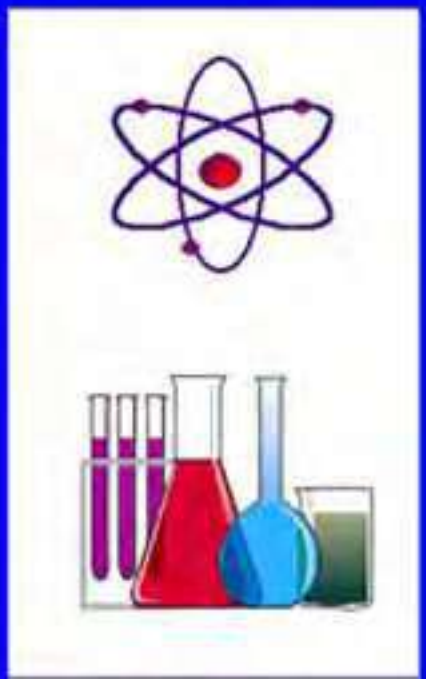

Time-Reversed Zone:

Significant only after time-density charging

- Hours, for "fast" onset
- Days, for "slower" onset
- Transduction involved for TW ⇔ LW ⇔ TDW
- Time-history of each detector is significant
- Longitudinal EM waves become significant

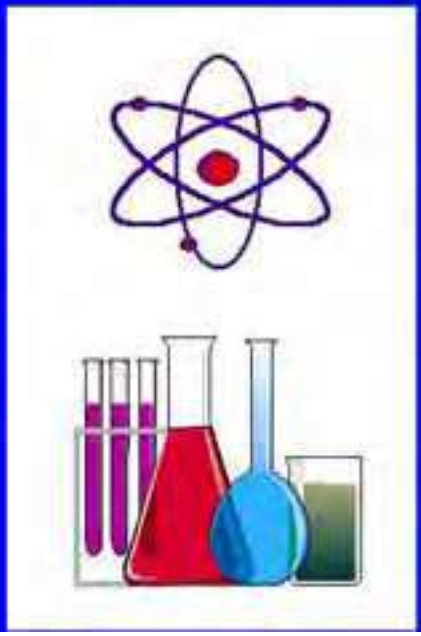

A New Conservation of Energy Law

- Physics conserves total "energy and mass-energy"
- Now also must consider "time-energy"
- Conserve total mass-time-energy (spatiotemporal energy)
- Let E_T = total energy, E_M = mass energy, E_E = ordinary energy, and E_t = time energy. Then

$$E_T = E_E + E_M + E_t$$

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$$(kE_t \Rightarrow E_E > 0) \Rightarrow E_T > (E_M + E_E)$$

- If some E_t is transduced into E_E, the experiment will violate the old spatial mass-energy conservation law

QUESTIONS ON CARCINOGENS AND EM RADIATION

- UNRESOLVED QUESTIONS ON EM RADIATION
  - DOSAGES
  - ACTIVE MECHANISMS
  - REPLICATION DIFFICULTIES
  - MEASUREMENT DIFFICULTIES
  - WHERE, WHEN, HOW ILL EFFECTS OCCUR
- SIMILAR QUESTIONS EXIST ABOUT EVERY CARCINOGEN
- SCIENCE REALLY DOES NOT UNDERSTAND THE MECHANISMS OF A SINGLE CHRONIC DISEASE, INCLUDING CANCER
  - FACTORS SUCH AS MIND, STRESS, SPONTANEOUS REMISSION, PLACEBO EFFECTS, AND COMBINATIONS OF FACTORS ARE PARTICULARLY TROUBLESOME
  - GENERATION OF THE PLACEBO EFFECT BY THE REGENERATION & RECOVERY SYSTEM IS UNRECOGNIZED

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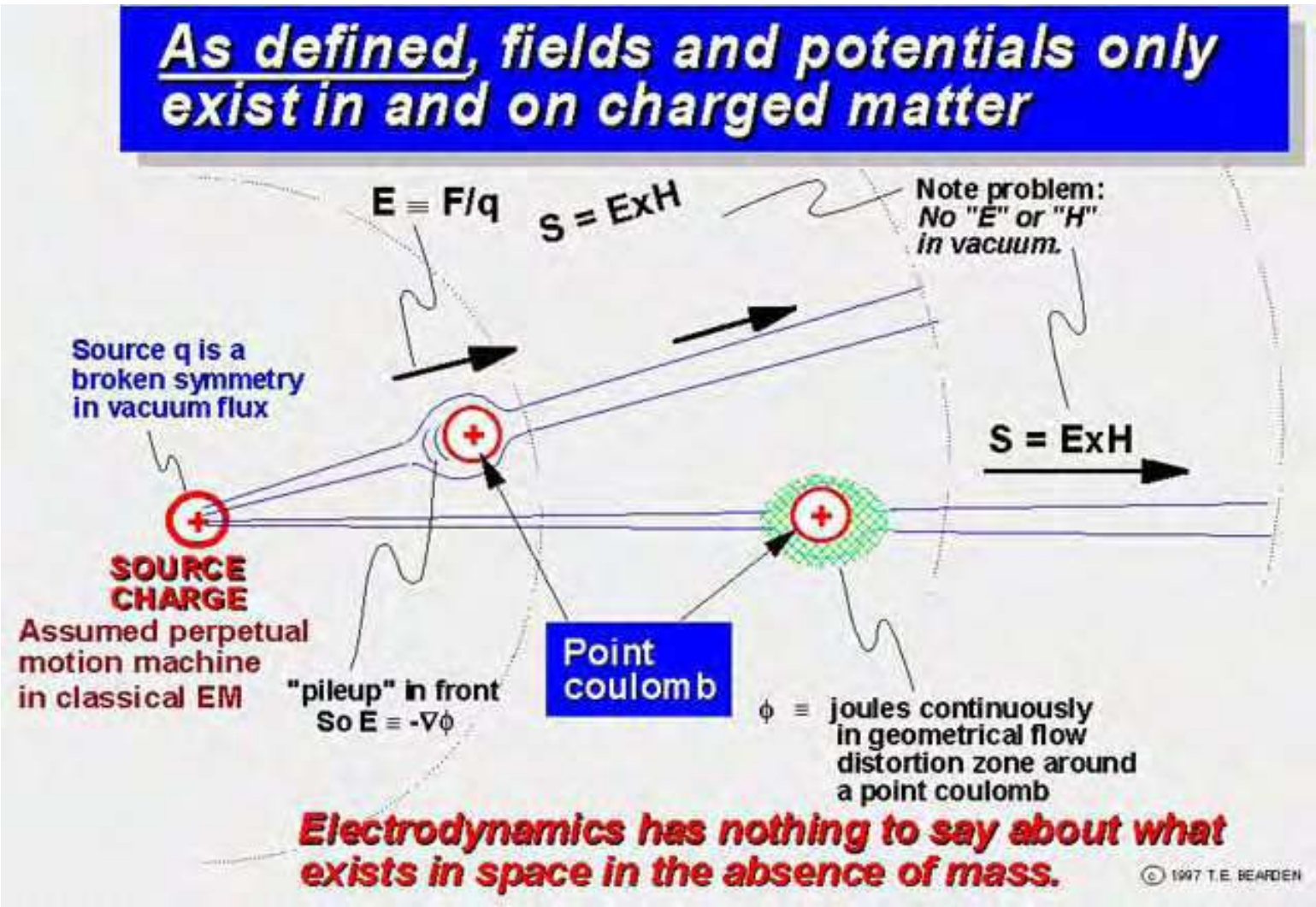
As defined, fields and potentials only exist in and on charged matter
E ≡ F/q
S = ExH
Note problem:
No "E" or "H"
in vacuum.
Source q is a
broken symmetry
in vacuum flux
S = ExH
SOURCE
CHARGE
Assumed perpetual
motion machine
in classical EM
"pileup" in front
So E ≡ -∇ϕ
Point
coulomb
ϕ ≡ joules continuously
in geometrical flow
distortion zone around
a point coulomb
Electrodynamics has nothing to say about what
exists in space in the absence of mass.
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Serious flaws and errors in classical EM theory.

1. Eliminates the Internal EM Inside the Scalar Potential.
2. No Definition of Electrical Charge or of Scalar Potential.
3. Equations Still Assume Material Ether Per Maxwell (Unchanged).
4. Use of Force Fields in Vacuum is False (and Known to be So).
5. Treats Charge q as Unitary Instead of Coupled System $q = \phi[q]m(q)$.
6. Confuses Massless Potential Gradients as Forces (See #3, #4).
7. Does Not Utilize Mass as a Component of Force (See #23).

8. Erroneously Assumes EM Force Fields as Primary Causes.
9. Topology of EM Model Has Been Substantially Reduced.
10. Does Not Include Quantum Potential or Action at a Distance.
11. Does Not Include Superluminal Velocity of Inner EM Components.
12. Does Not Utilize Extended Near-Field Coulomb Gauge Effects.
13. Does Not Include EM Generatrix Mechanism for Time Flow.
14. Does Not Unify Photon and Wave Aspects (Requires 7-D Model).

15. Does Not Include Electron Spin and Precession (See #19, #24).
16. Treats EM Energy As Existing In "Chunks," Instead of as Flow.
17. Confuses Energy and Energy Collection (See #16).
18. Discards Half of Every EM Wave in Vacuum (See #22).
19. Erroneously Uses Transverse Vacuum Wave; It's Longitudinal.
20. Arbitrarily Regauges Maxwell's Equations to Eliminate Overunity.
21. Omits Phase Conjugate Optics Effects (The *Rule* in Internal EM).
22. Does Not Include EM Cause of Newtonian Reaction Force.
23. Erroneously Assumes Separate Force Acting on Separate Mass.
24. Confuses Detected Electron Precession Waves as Proving Transverse EM Waves in Vacuum (Remnant of Old "EM Fluid" Concept).
25. Due to Error in String Wave, Omits the Ubiquitous Antiwave.
26. *Assumes* Equilibrium; Not True Unless Include Vacuum Interactions.
27. Higher Topology Required, to Model Electromagnetic Reality.
28. Lorentz surface integration discards Poynting energy transport.
29. Has nothing at all to say about form of EM entities in massless space.
30. Eliminates the infolded general relativity using EM-force as curve agent.
31. Does not include longitudinal EM waves as time domain oscillations.
32. Does not include EM mechanism that generates time flow and flow rate.

© T.E. [illegible] 1991, 1997

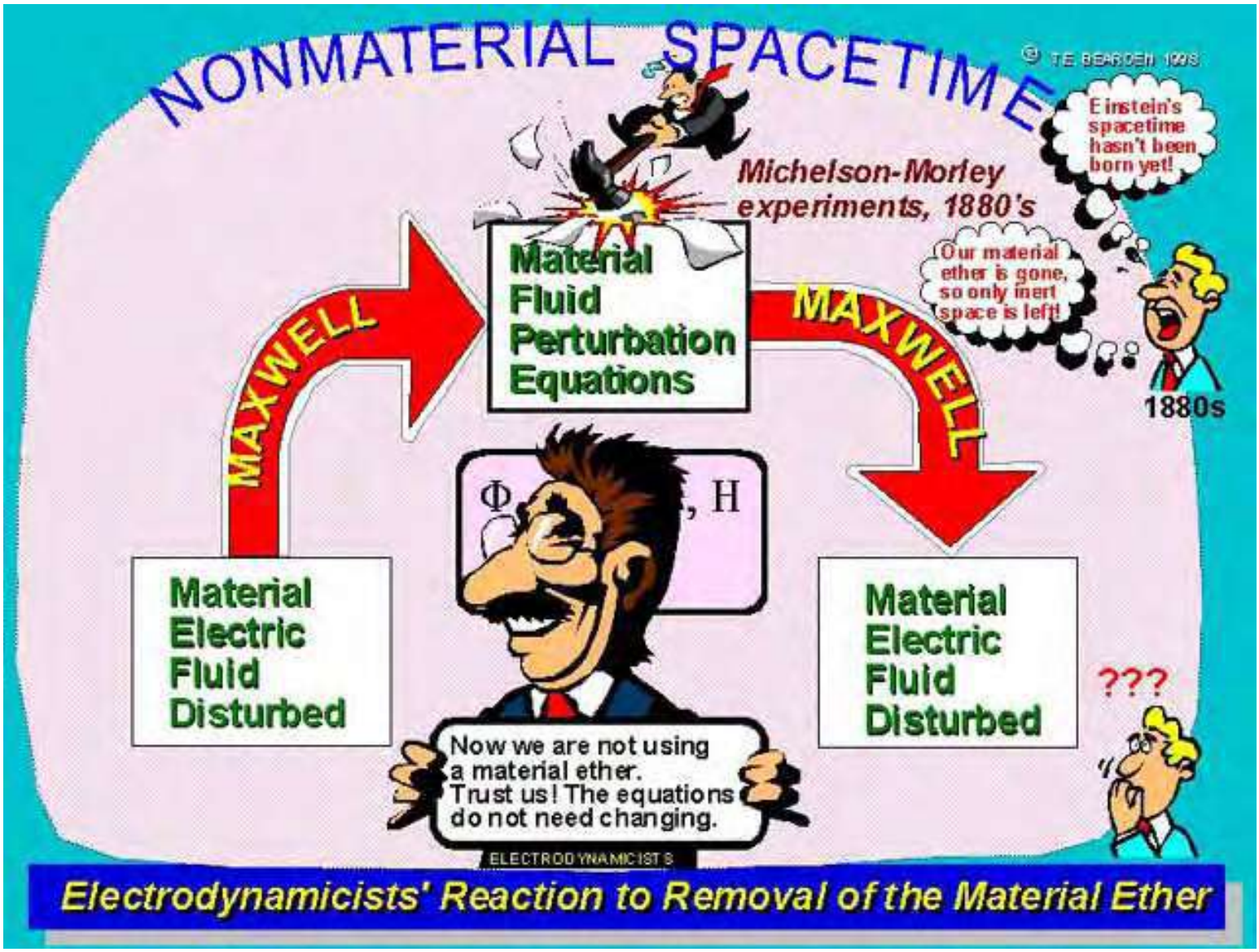
NONMATERIAL SPACETIME
© T.E. BEARDEN 1998
Michelson-Morley experiments, 1880's
Einstein's spacetime hasn't been born yet!
Our material ether is gone, so only inert space is left!
1880s
MAXWELL
Material Fluid Perturbation Equations
MAXWELL
Φ
, H
Material Electric Fluid Disturbed
Material Electric Fluid Disturbed
???
Now we are not using a material ether. Trust us! The equations do not need changing.
ELECTRODYNAMICISTS
Electrodynamicists' Reaction to Removal of the Material Ether

REACTION TO LOSS OF MATERIAL ETHER
Material Ether Assumed in Equations
Potentials, Fields, and Waves Assumed Material
Not a single equation was changed!
Now we are not using a material ether. Trust us! The equations do not need changing.
© T.E. BEARDEN 1999
ELECTRODYNAMICISTS

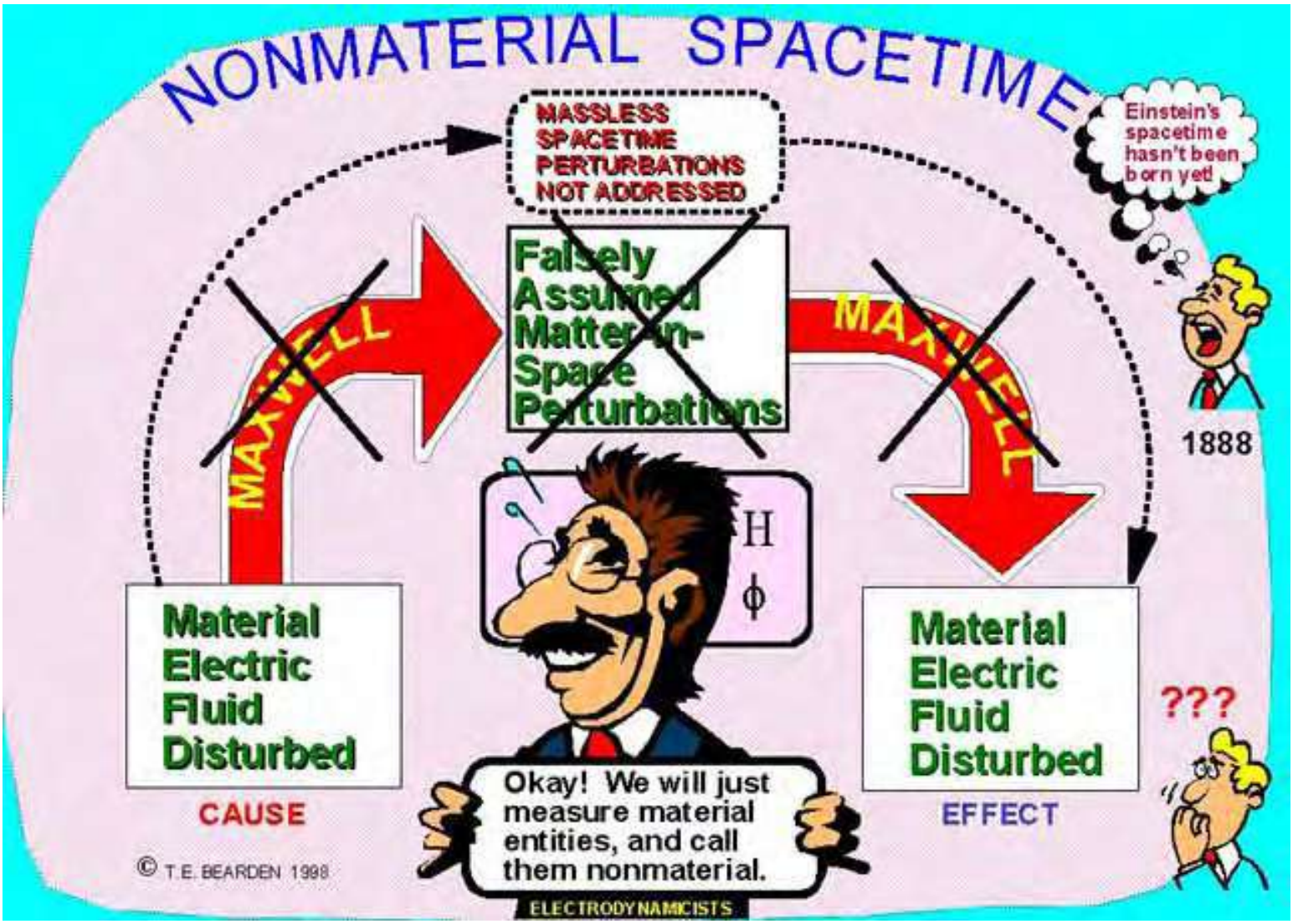
NONMATERIAL SPACETIME
MASSLESS SPACETIME PERTURBATIONS NOT ADDRESSED
Einstein's spacetime hasn't been born yet!
Falsely Assumed Matter-in-Space Perturbations
MAXWELL
MAXWELL
1888
H
ϕ
Material Electric Fluid Disturbed
CAUSE
Material Electric Fluid Disturbed
EFFECT
???
Okay! We will just measure material entities, and call them nonmaterial.
© T.E. BEARDEN 1998
ELECTRODYNAMICISTS

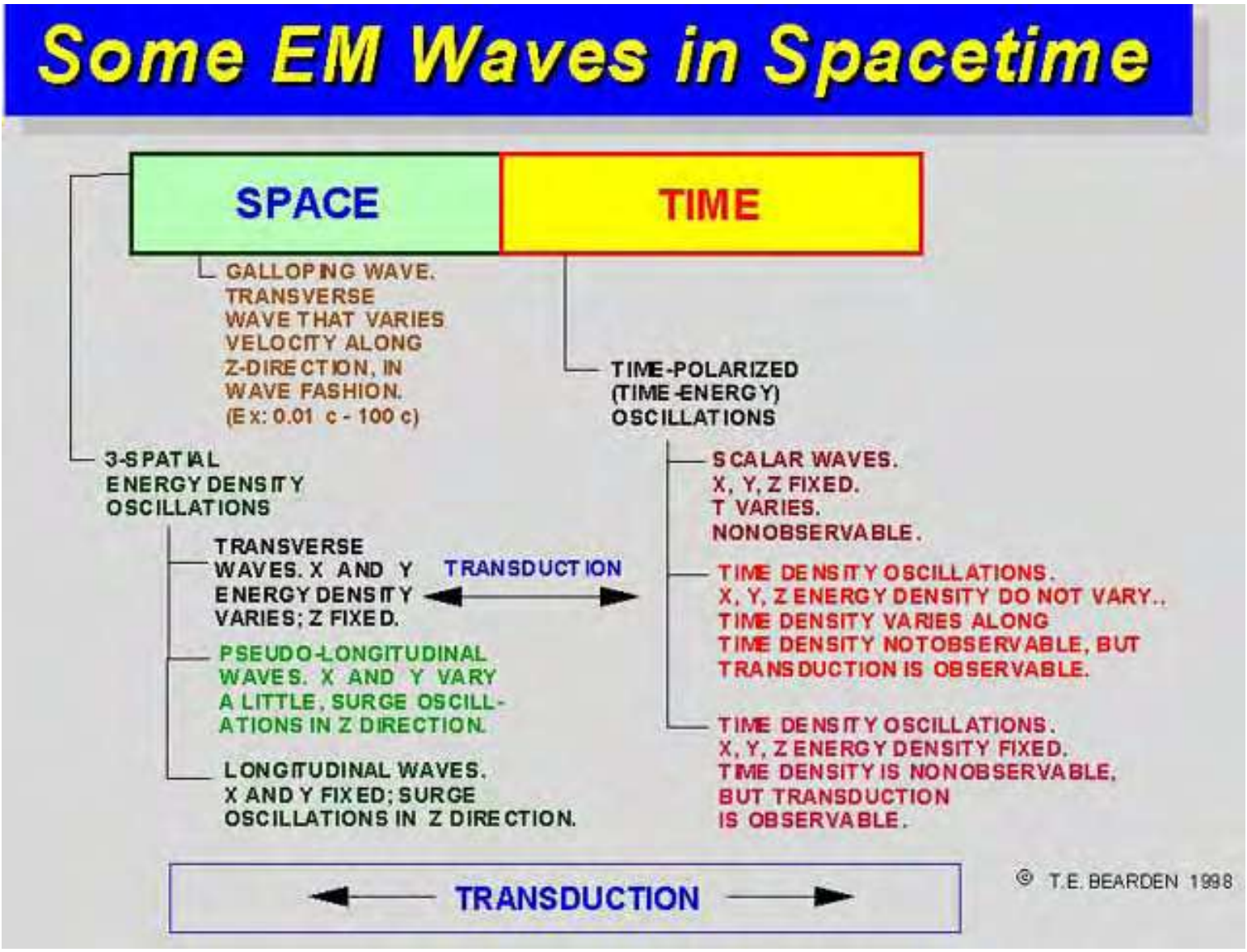
Some EM Waves in Spacetime
SPACE
TIME
GALLOPING WAVE. TRANSVERSE WAVE THAT VARIES VELOCITY ALONG Z-DIRECTION, IN WAVE FASHION. (Ex: 0.01 c - 100 c)
TIME-POLARIZED (TIME-ENERGY) OSCILLATIONS
3-SPATIAL ENERGY DENSITY OSCILLATIONS
SCALAR WAVES. X, Y, Z FIXED. T VARIES. NONOBSERVABLE.
TRANSVERSE WAVES. X AND Y ENERGY DENSITY VARIES; Z FIXED.
TRANSDUCTION
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY DO NOT VARY.. TIME DENSITY VARIES ALONG TIME DENSITY NOTOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
PSEUDO-LONGITUDINAL WAVES. X AND Y VARY A LITTLE, SURGE OSCILLATIONS IN Z DIRECTION.
TIME DENSITY OSCILLATIONS. X, Y, Z ENERGY DENSITY FIXED. TIME DENSITY IS NONOBSERVABLE, BUT TRANSDUCTION IS OBSERVABLE.
LONGITUDINAL WAVES. X AND Y FIXED; SURGE OSCILLATIONS IN Z DIRECTION.
TRANSDUCTION
© T.E. BEARDEN 1998

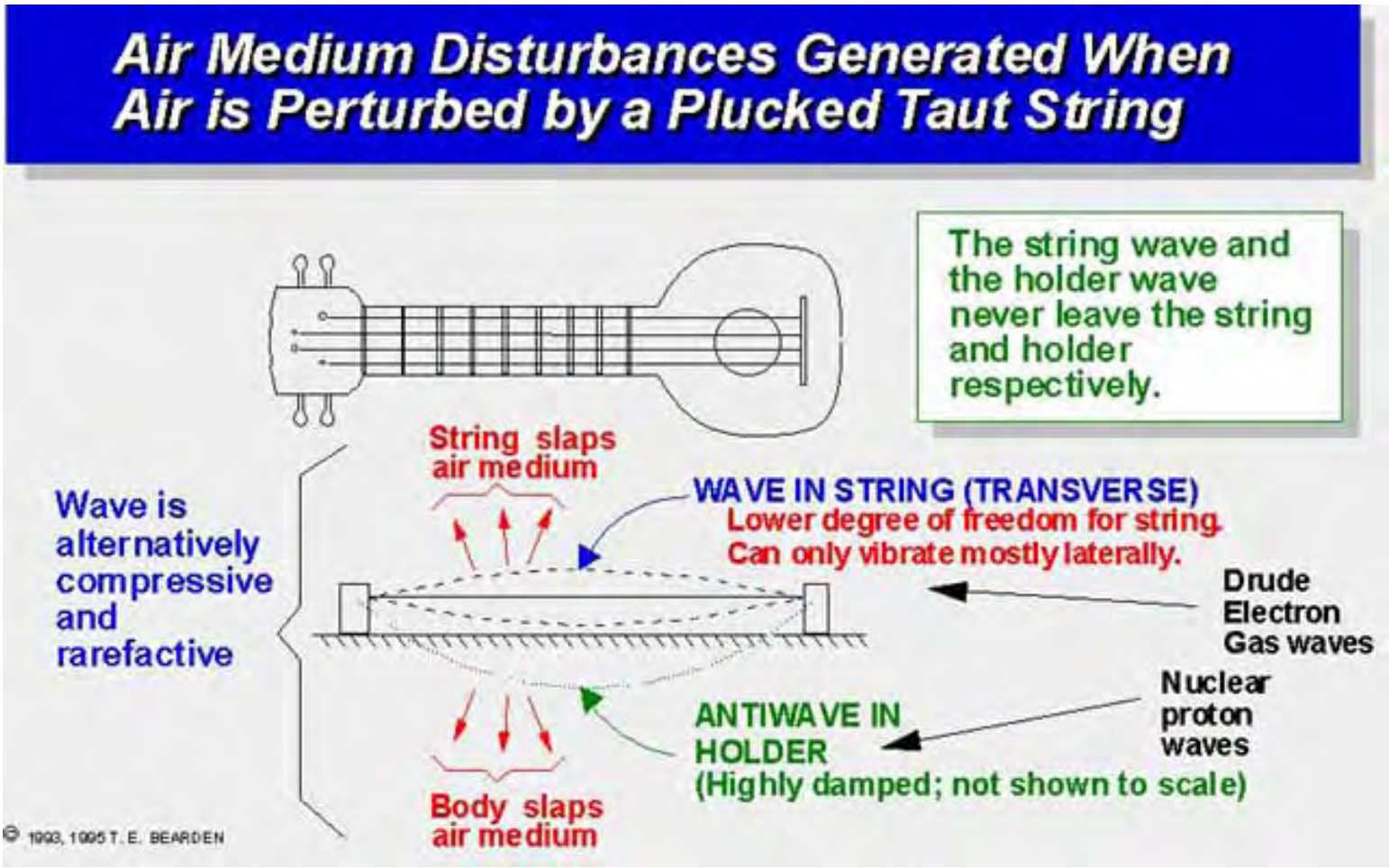
Air Medium Disturbances Generated When Air is Perturbed by a Plucked Taut String
The string wave and the holder wave never leave the string and holder respectively.
String slaps air medium
Wave is alternatively compressive and rarefactive
WAVE IN STRING (TRANSVERSE)
Lower degree of freedom for string.
Can only vibrate mostly laterally.
Drude Electron Gas waves
Nuclear proton waves
ANTIWAVE IN HOLDER
(Highly damped; not shown to scale)
Body slaps air medium
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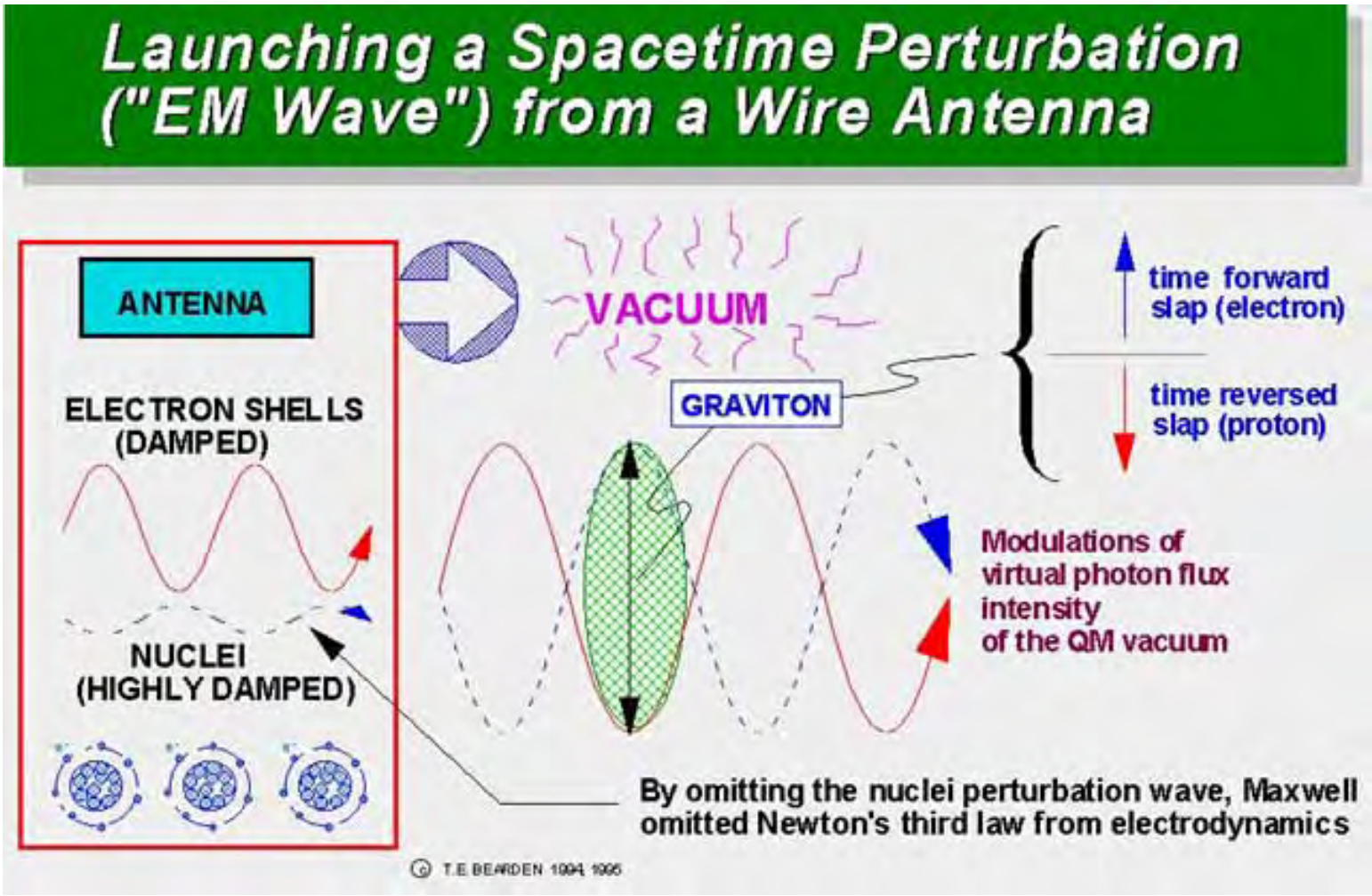
Launching a Spacetime Perturbation ("EM Wave") from a Wire Antenna
ANTENNA
ELECTRON SHELLS (DAMPED)
NUCLEI (HIGHLY DAMPED)
VACUUM
GRAVITON
time forward slap (electron)
time reversed slap (proton)
Modulations of virtual photon flux intensity of the QM vacuum
By omitting the nuclei perturbation wave, Maxwell omitted Newton's third law from electrodynamics
© T.E BEARDEN 1994 1995

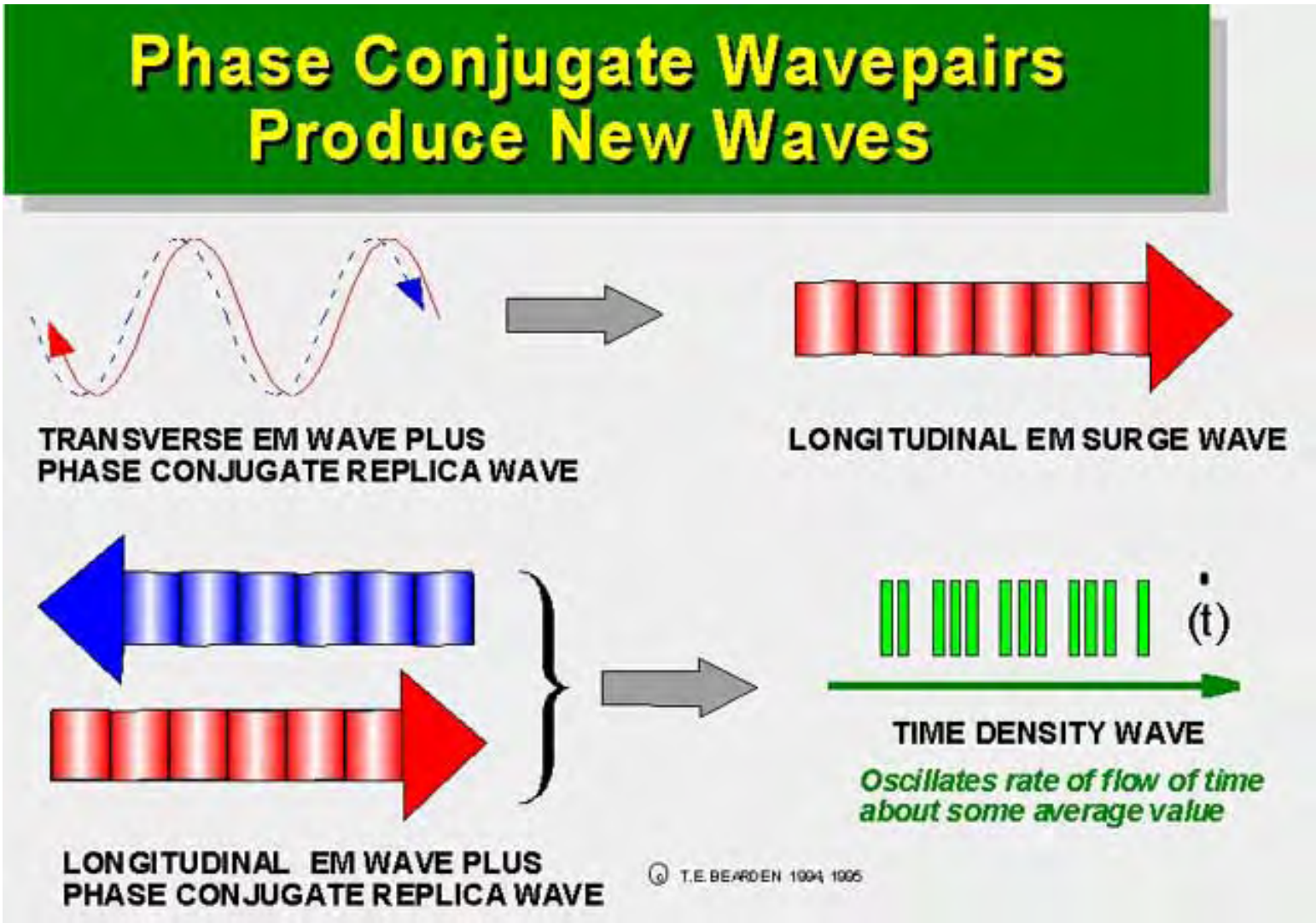
Phase Conjugate Wavepairs
Produce New Waves
TRANSVERSE EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
LONGITUDINAL EM SURGE WAVE
LONGITUDINAL EM WAVE PLUS
PHASE CONJUGATE REPLICA WAVE
(t)
TIME DENSITY WAVE
Oscillates rate of flow of time
about some average value
© T.E. BEARDEN 1994, 1995

Scalar Electromagnetics (Energetics) View of EM

- Potentials real; primary causes of EM phenomena
  - Force fields made by differentiations of potentials
  - Force fields are effects, not primary causes
  - Force fields exist only in, on mass particles
- Actions due to potentials and their interference
  - Action at a distance or locally
  - Quantum potential and hidden variables
- Locally curved spacetime, engineerable by EM
  - Gravity effects not necessarily negligible
  - Strong EM force or time used as agent of curvature

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Potentials have internal structure
  - Stoney/Whittaker structure
  - Longitudinal EM phase conjugate wavepairs
  - Each wavepair is a time-polarized EM wave
- Vacuum EM is a potential and has microstructure
  - Stoney-Whittaker biwaves/t-polarized waves
  - Fluctuations exhibit chaos
- Spacetime ≡ Vacuum ≡ Potential ≡ Flux

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Scalar Electromagnetics (Energetics) View of EM (Cont'd)

- Statistics may have hidden order (already chaotic)
- Uses spacetime curvature engines to alter matter (inside-out or outside-in)
- Engineerable EM mechanism generates rate of flow of a mass through time
- Quantum potential with specific QP can be used for instant action at a distance

Extended General Relativity Principle

- "All levels of energy structures and all levels of time structures mold spacetime geometry.
- This is called a *vacuum engine* (spacetime engine).
- Spatial and temporal structuring act upon mass at all levels.
- This produces *templates* of forces, for translations and stresses."

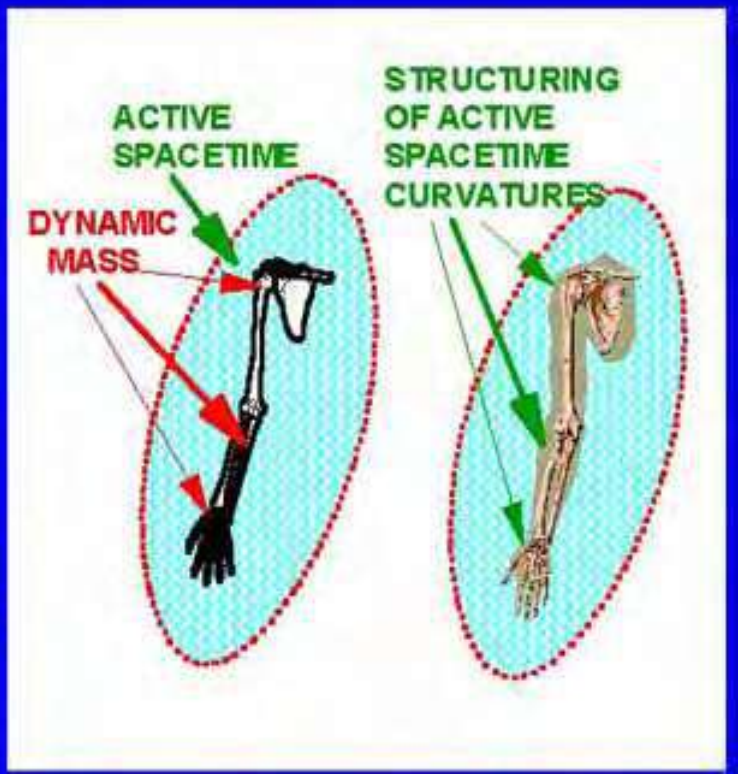

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Extension of Work-Energy Theorem

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- *Theorem:* $W = k_f - k_i = \Delta k$ [1]
- k must be interpreted not as energy *per se*, but as *collected/collecting* energy.
- The reaction cross section λ for the collecting process must be included.
- *Extension:* $W = \lambda (k_f - k_i) = \lambda \Delta k$ [2]
- Normally $\lambda \leq 1$, as for elastic collision or Stokes emission.
- However, $\lambda > 1$ is now possible, for processes which asymmetrically self-regauge. An example is Letokhov's negative absorption of the medium.
- Working models are the Patterson Power Cell® and Lawandy lasing without population inversion.

MTW's General Relativity Principle

- "Space acts on matter, telling it how to move.
- In turn, matter reacts back on space, telling it how to curve."

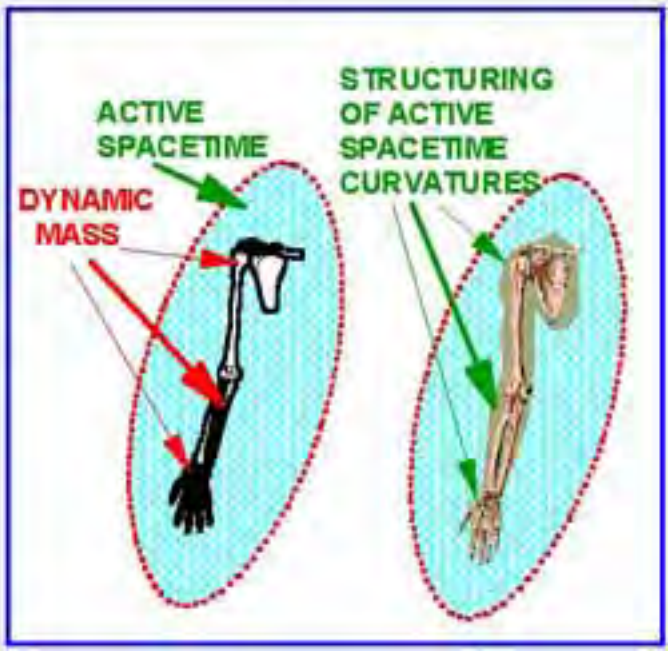

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Use of General Relativity (GR) in Particle Physics

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- GR seldom used in particle physics
- In cold fusion, Matsumoto* has applied general relativity
- Consistent with important cold fusion results
- Used spacetime (ST) curvature by energy density
- Matsumoto did not utilize:
  - Longitudinal EM waves
  - Time density waves
  - Time density curvatures of ST (gain = $9 \times 10_{16}$)

* T. Matsumoto, "Mechanisms of Electro-Nuclear Collapse," Proc. ICCF-7, Vancouver, BC, Canada, Apr. 1998, p. 98

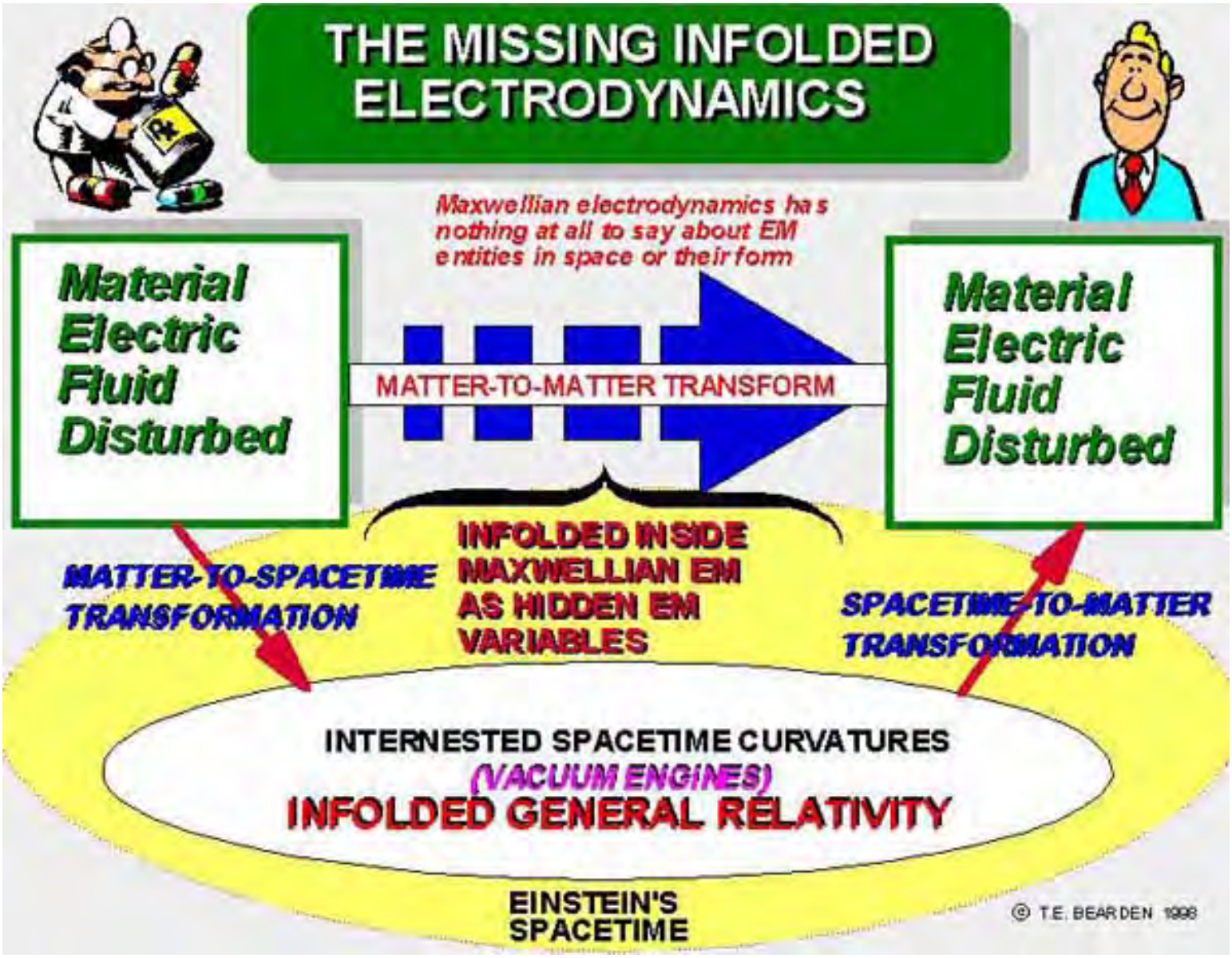
THE MISSING INFOLDED ELECTRODYNAMICS
Maxwellian electrodynamics has nothing at all to say about EM entities in space or their form
Material Electric Fluid Disturbed
MATTER-TO-MATTER TRANSFORM
Material Electric Fluid Disturbed
INFOLDED INSIDE MAXWELLIAN EM AS HIDDEN EM VARIABLES
MATTER-TO-SPACETIME TRANSFORMATION
SPACETIME-TO-MATTER TRANSFORMATION
INTERNESTED SPACETIME CURVATURES
(VACUUM ENGINES)
INFOLDED GENERAL RELATIVITY
EINSTEIN'S SPACETIME
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Infolded Engines: Excluded by Present Physics

- *The infolded dynamics of EM systems are not considered in general relativity, electromagnetics, or quantum mechanics*
- *None of these disciplines include such spacetime curvature engines (vacuum engines)*
- *Thus GR, EM, and QM cannot be unified, since ST curvature engines are where the unification mainly occurs*

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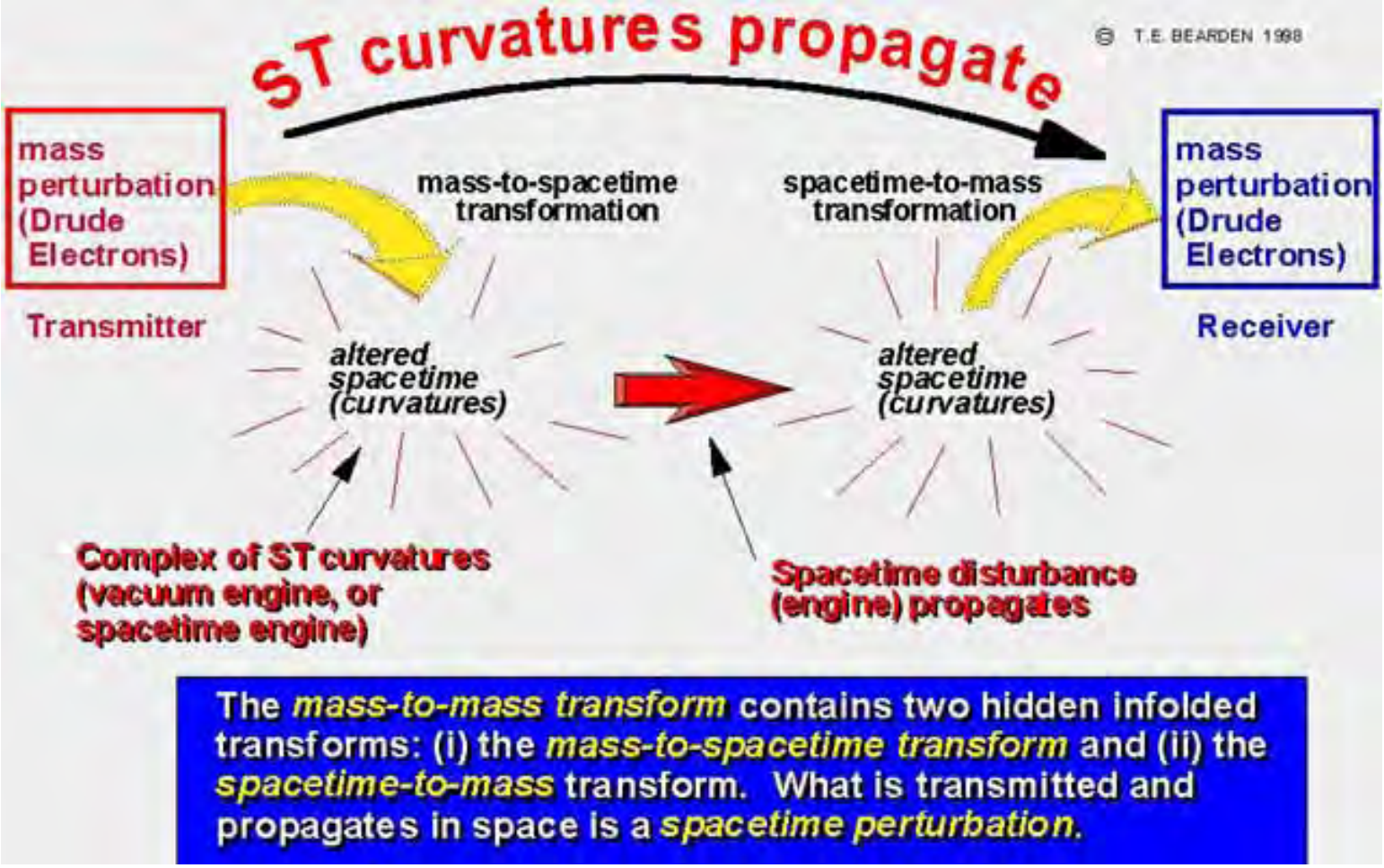
ST curvatures propagate
© T.E. BEARDEN 1998
mass perturbation (Drude Electrons)
Transmitter
mass-to-spacetime transformation
spacetime-to-mass transformation
mass perturbation (Drude Electrons)
Receiver
altered spacetime (curvatures)
altered spacetime (curvatures)
Complex of ST curvatures (vacuum engine, or spacetime engine)
Spacetime disturbance (engine) propagates
The mass-to-mass transform contains two hidden infolded transforms: (i) the mass-to-spacetime transform and (ii) the spacetime-to-mass transform. What is transmitted and propagates in space is a spacetime perturbation.

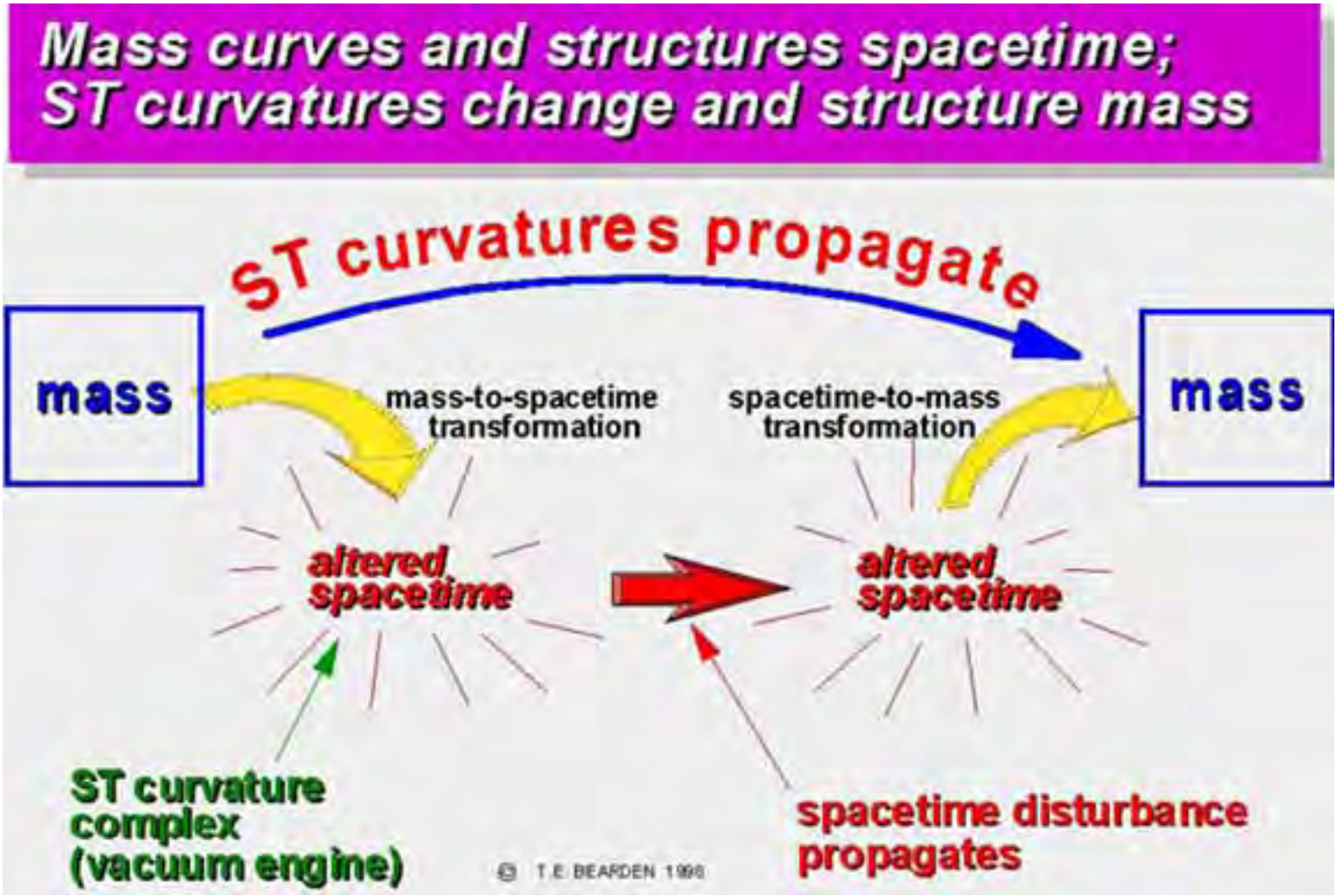
Mass curves and structures spacetime;
ST curvatures change and structure mass
ST curvatures propagate
mass
mass-to-spacetime transformation
spacetime-to-mass transformation
mass
altered spacetime
altered spacetime
ST curvature complex (vacuum engine)
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spacetime disturbance propagates

At Infinite Velocity:
Each Is Every Other
SPACETIME
VIRTUAL PARTICLE FLUX
POTENTIAL
MIND AND MIND LEVELS
MASS
PLANET
LIVING ORGANISMS
© 1997 T.E. Bearden

Lisitsyn's Report: Brain Code Broken

- THEORY DEVELOPED AND FITTED
- HYSTERESIS MEMORY LOOP
- CONTROLLED EM INDUCTION
  - IMAGES
  - SENSATIONS
  - PREDETERMINED EMERGENCE
- 23 EEG BANDS
  - UP TO 8.1 X 10^{20} HZ
  - 11 INDEPENDENT CHANNELS

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S.K. Lisitsyn, "New Approach to the Analysis of Electroencephalograms," DDC Report AD73005, p. 16-25.

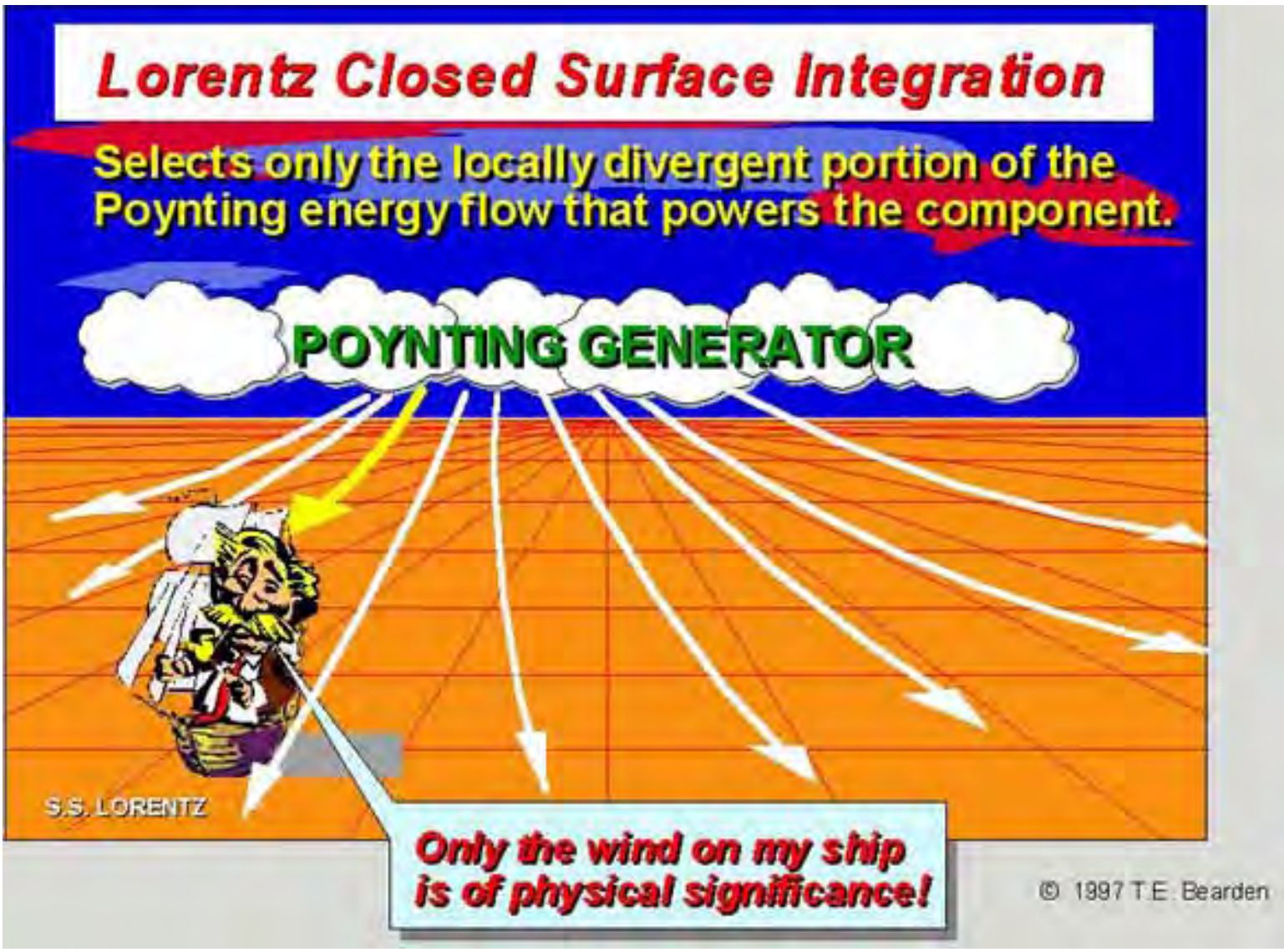
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
Only the wind on my ship is of physical significance!
© 1997 T.E. Bearden

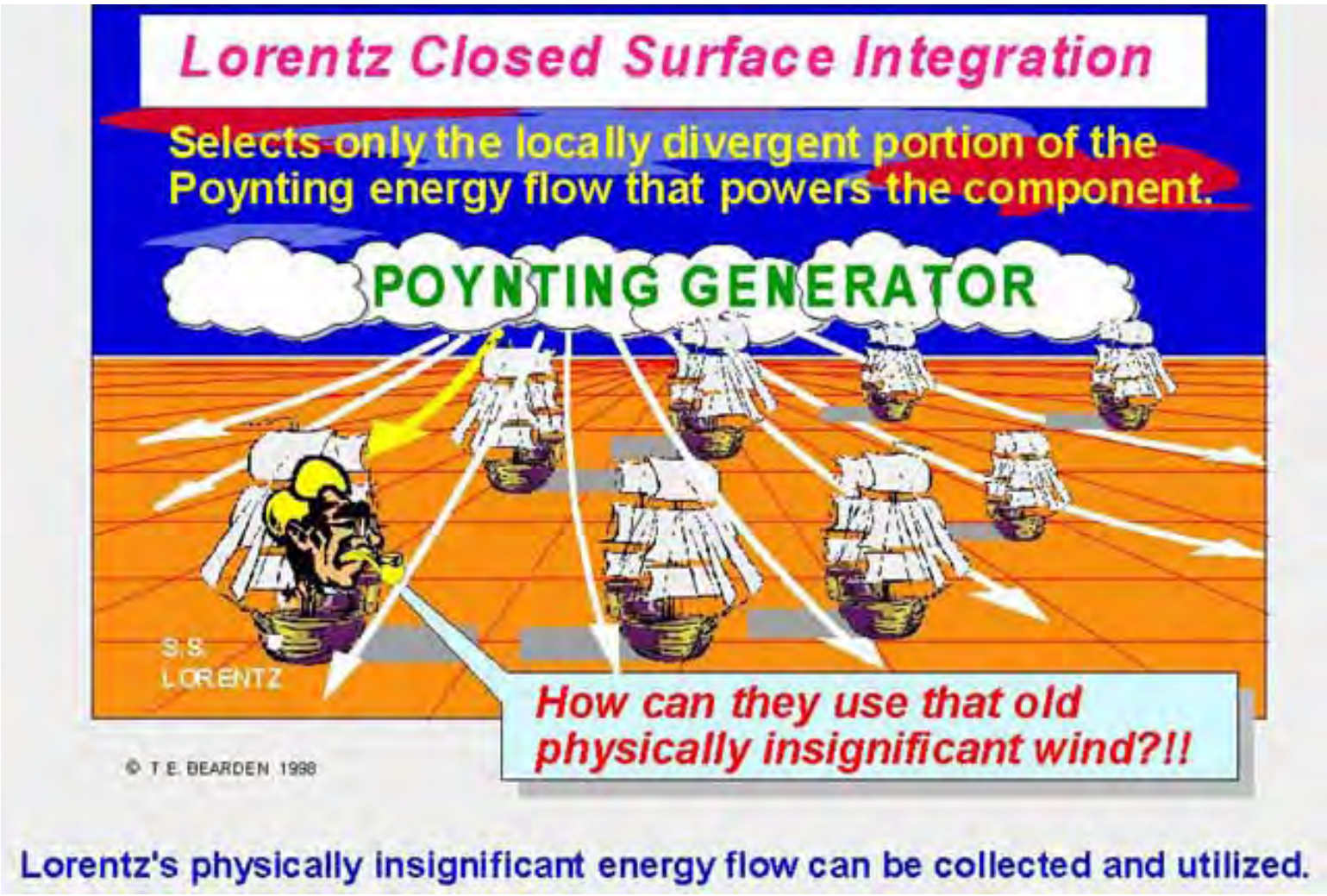
Lorentz Closed Surface Integration
Selects only the locally divergent portion of the Poynting energy flow that powers the component.
POYNTING GENERATOR
S.S. LORENTZ
How can they use that old physically insignificant wind?!!
© T.E. BEARDEN 1998
Lorentz's physically insignificant energy flow can be collected and utilized.

Lorentz surface integration of the Poynting vector around a closed surface

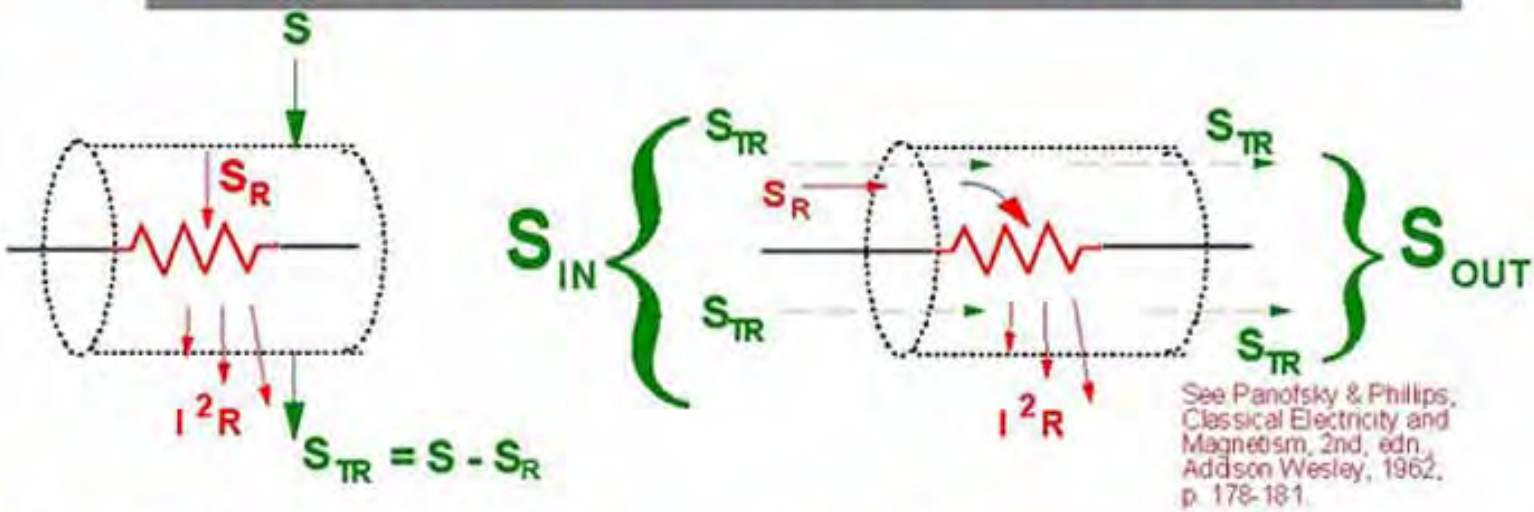

See Panofsky & Phillips, Classical Electricity and Magnetism, 2nd. edn. Addison Wesley, 1962, p. 178-181.

1a. Lorentz surface integration.

1b. Actual S in and S out.

Note: If the S-vector is integrated over the closed surface, then all energy *transport* passage is zeroed, leaving only the very small component of the input S-flow that is powering the joule heating of the resistor. In short, only the small component of the S-flow that is equal in magnitude to the Slepian vector $j\phi$ remains. This measures only the tiny portion of the S-flow that is "collecting" on electrons passing through the resistor, and therefrom being dissipated out of the resistor as joule heating. It discards everything else (all S_{TR}'s and S_{OUT}). S_{IN} becomes S_R.

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Longitudinal EM Photon Interaction with Charge

- Creates time-density wave pumping
- Slowly creates time-density charging

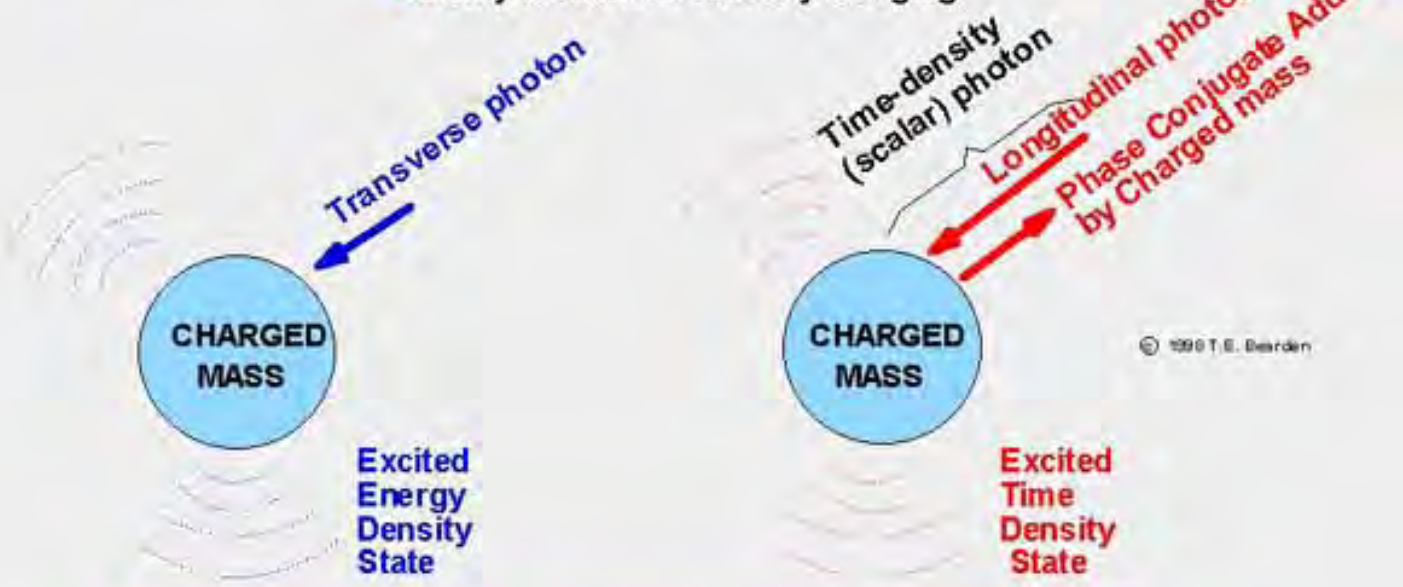

- Fundamental units are arbitrary in physics
- Can express all physics in one unit -- e.g., time
- Time is highly compressed energy
- 1 sec = 9 x 10_{16} joules of transverse EM wave energy

Figure 1-8. Infolded biwave composition of a scalar potential.

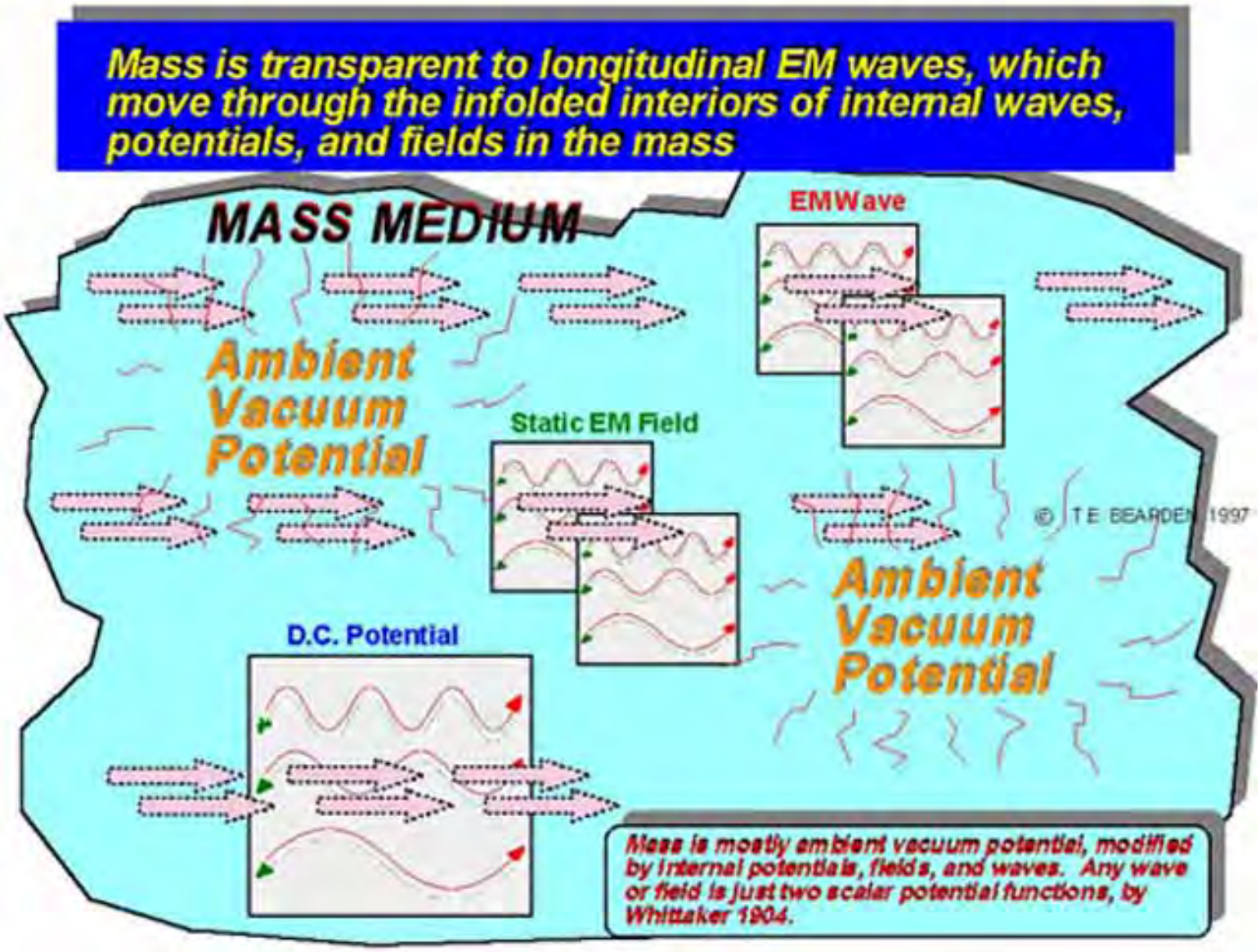

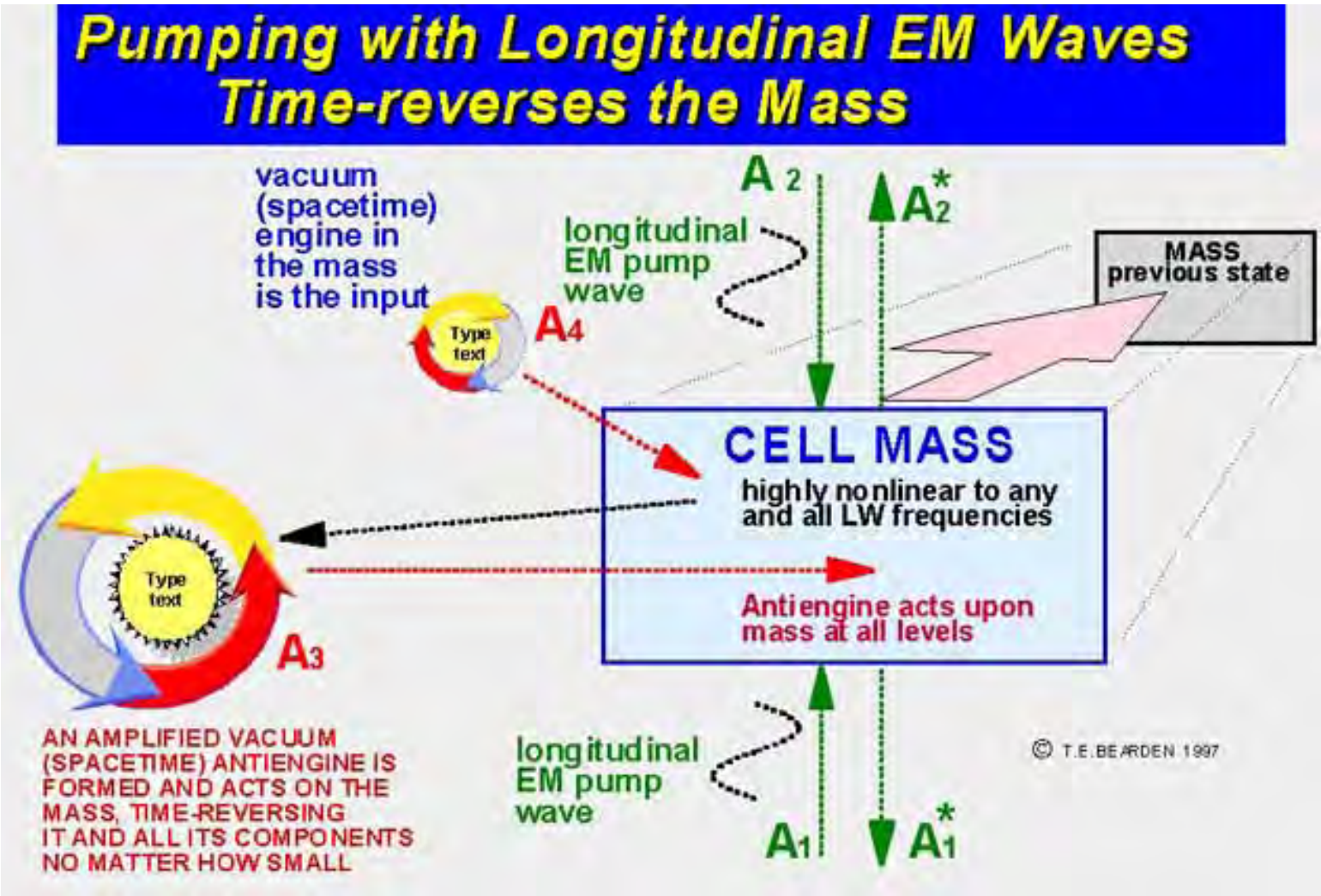
Pumping with Longitudinal EM Waves
Time-reverses the Mass
vacuum (spacetime) engine in the mass is the input
A 2
A*2
longitudinal EM pump wave
MASS previous state
Type text
A4
CELL MASS
highly nonlinear to any and all LW frequencies
Type text
A3
Antiengine acts upon mass at all levels
AN AMPLIFIED VACUUM (SPACETIME) ANTIENGINE IS FORMED AND ACTS ON THE MASS, TIME-REVERSING IT AND ALL ITS COMPONENTS NO MATTER HOW SMALL
longitudinal EM pump wave
© T.E.BEARDEN 1997
A1
A*1

Maxwell's Quaternion Theory

- Quaternions:
  - Discovered by Hamilton in 1843
  - A quaternion has a vector part
  - A quaternion has a scalar part
  - First significant non-arithmetic number system
  - Higher topology than vector or tensor algebra
- Maxwell's theory was in quaternion equations
  - 20 equations in 20 unknowns
  - Reduced to a small 4-equation subset by Heaviside and Gibbs
  - EM topology dramatically reduced

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Maxwellian Systems

Before regauging, after symmetrical regauging, and after asymmetrical regauging

Note: Any system must first break equilibrium in its vacuum exchange, before it can energize Drude electrons and "power" the load. Asymmetric regauging is always utilized. Powering loads and losses is a symmetry-restoring operation.

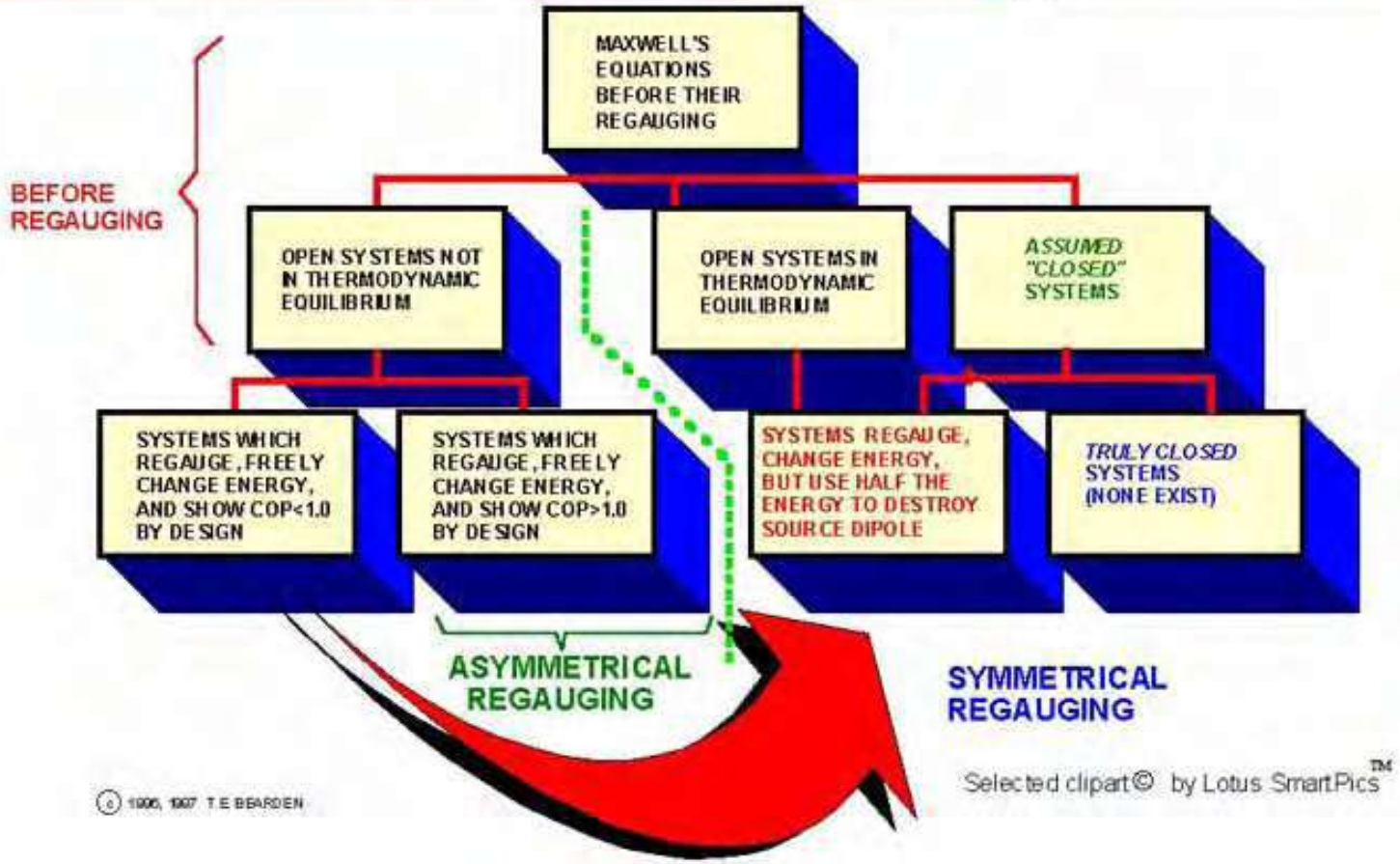

Maxwell's four equations reduce to:

$$\nabla^2 \Phi + \frac{1}{c}\frac{\partial}{\partial}(\nabla \bullet A) = -4\pi\rho \qquad [1]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} - \nabla(\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t}) = -\frac{4p}{c}J \qquad [2]$$

A is replaced by A', where

$$A' = A + \nabla\Lambda \qquad [3]$$

The new B' field then becomes

$$B' = \nabla \times (A + \nabla\Lambda) = \nabla \times A + 0 = \nabla \times A = B \qquad [4]$$

A new E-field will also be formed. So let

$$\Phi' = \Phi - \frac{1}{c}\frac{\partial \Lambda}{\partial t} \qquad [5]$$

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Per Jackson, (A,Φ) are *habitually* chosen so that

$$\nabla \bullet A + \frac{1}{c}\frac{\partial \Phi}{\partial t} = 0 \qquad [6]$$

The *net symmetrical* regauging separates variables. Two inhomogeneous wave equations result:

$$\nabla^2 \Phi - \frac{1}{c^2}\frac{\partial^2 \Phi}{\partial t^2} = -4\pi\rho \qquad [7]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 A}{\partial t^2} = -\frac{4\pi}{c} J \qquad [8]$$

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Equations [1] and [2] *arbitrarily* changed to [7] and [8]

The Tom Bearden Website

Mind Control and EM Wave Polarization Transductions - Part I, II & III

Reprinted from "Explore" magazine, 1999

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Part II

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- The U.S. approach to mind control
- "Voices in my head"
  Flanagan's neurophone - used to give instructions to diplomats during negotiations, etc.

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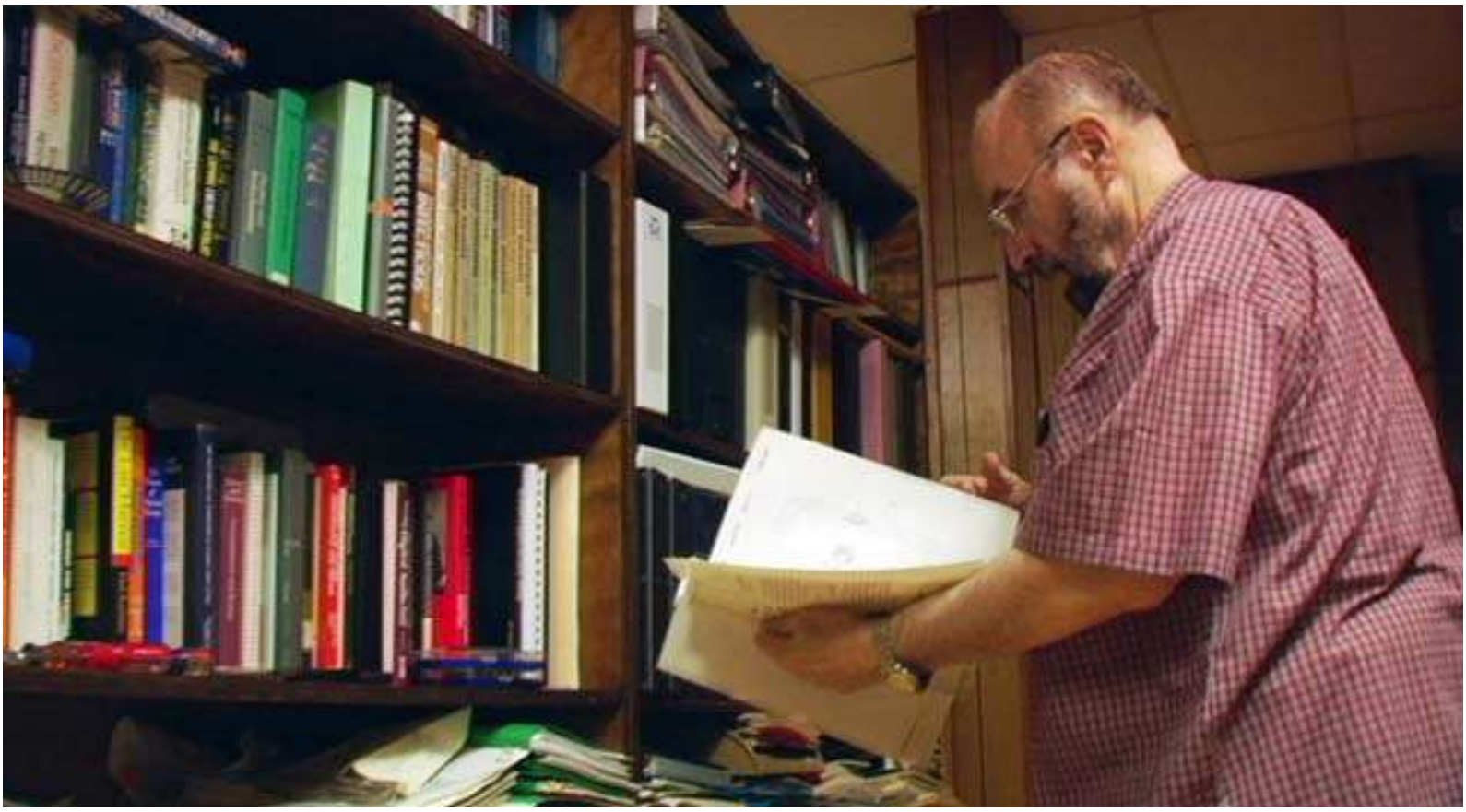

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Mind Control and EM Wave Polarization Transductions

Part I
Vol. 9, No. 2 1999

Part II
Vol 9, No. 3 1999

Part III
Vol 9, No. 4,5 1999

Vacuum Engines and Priore's Methodology - The True Science of Energy-Medicine

Part I
Vol. 6 No. 1 1995

Part II
Vol. 6 No. 2 1995

Paranormal Pictures
Psychic Observer 39(3) ~ 224, 255-258

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Mind Control and EM Wave Polarization Transductions, Part 1

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Abstract

For some time we have been repeatedly queried about the technical mechanisms and unusual electrodynamics of advanced mind control research, both in the West and abroad. Calling full attention to the special note above, in this paper we present a high-level over-view of the novel electromagnetic nature of mind operations, mind and body coupling, and *intent*•the induction of physical 3-space EM energy changes into the brain and nervous system, and into every cell of the body, from the mind's time-like coherent operations. We summarize the time-polarized electrodynamics used to engineer and affect mind operations and the mind-body coupling loop. Transduction mechanisms whereby differing EM wave polarizations can be transformed one-into-the-other are presented. We give two specific examples of lethal foreign military tests in 1997 of advanced mind control weapons against two military pilots over the central U.S. Some dangers and potential benefits of the emerging mind control technology are pointed out

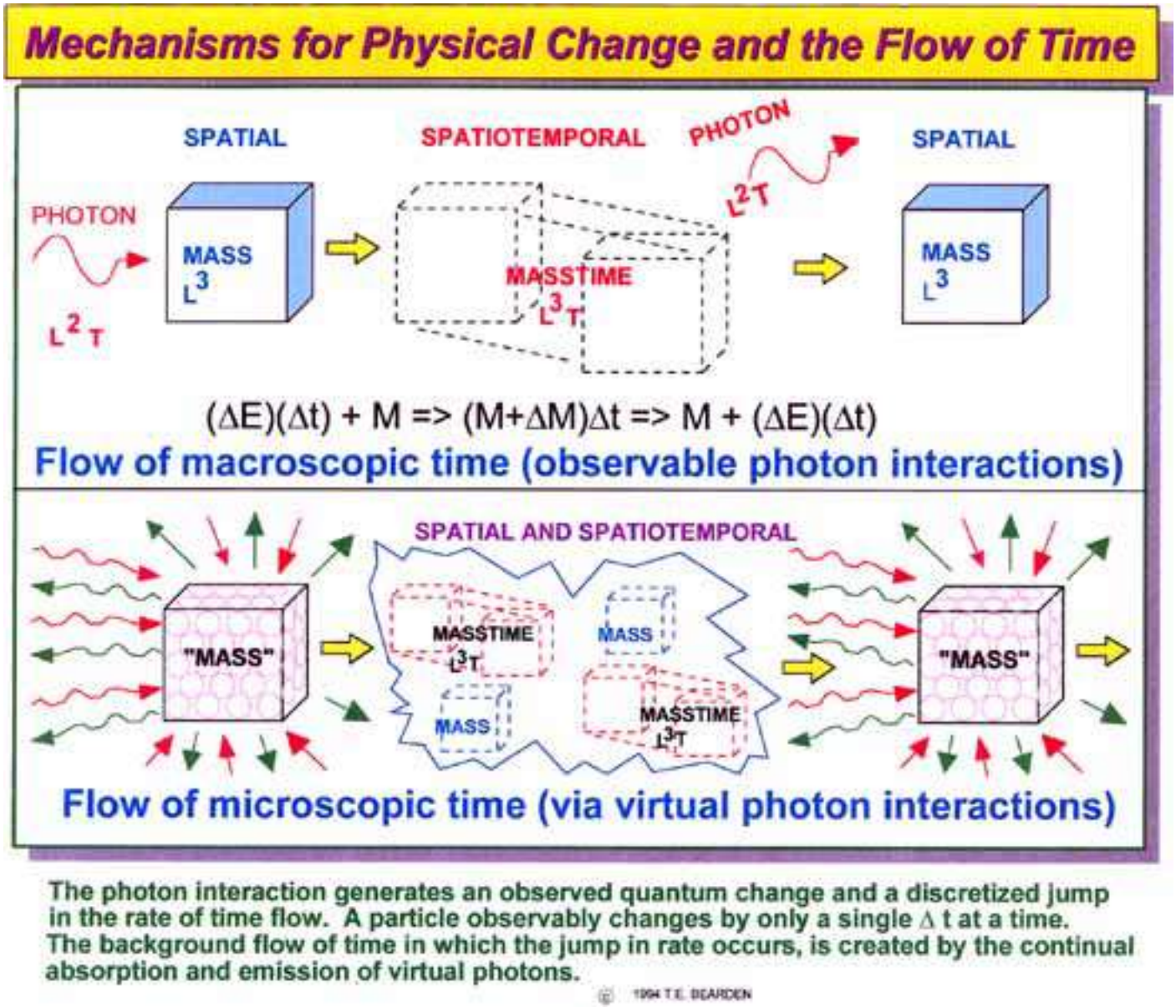

The photon interaction generates an observed quantum change and a discretized jump in the rate of time flow. A particle observably changes by only a single Δ t at a time. The background flow of time in which the jump in rate occurs, is created by the continual absorption and emission of virtual photons.

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Figure 1. Mechanism that generates a mass's flow through time.

EXPLORE! VOLUME 9, NUMBER 2, 1999

Introduction and Background

In quantum field theory, there are four polarizations of photons.[1] Using 4-space and the z-direction as the direction of propagation, we have x- and y- polarizations where the 3-spatial energy of the photon is oscillating laterally, in the x- or y- direction. These are *transverse polarized* photons, as is any combination of the two. The third polarization is along the z-direction, which is a longitudinal polarization. In other words, the 3-spatial energy of the longitudinal photon cannot oscillate in the x- or y- direction, and so it is oscillating to-and-fro along the line of motion, z-. The fourth polarization occurs when the energy is frozen in all three spatial dimensions x-, y-, and z- and it cannot oscillate in any of those directions. In that case, the photon oscillates its energy in the t- direction, providing the t-polarized photon. We will later discuss how time is actually highly condensed energy.

In Minkowski 4-space, body operations are space-like, and are so treated in conventional materialistic physics. Mind and mind-operations are time-like, not space-like, even though they are totally electromagnetic in nature.[2]

As is well-known, all observation in physics is considered 3-spatial..[3] Mass is a 3-spatial concept, and we detect changes to mass (as, e.g., in the shift of electrons in the circuits of electrical instruments). So one may model the common physical observation mechanism as a *time-differentiating process* which *a priori* discards time-change and retains 3-spatial energy change.[4] That is, Minkowski reality is modeled in the fundamental units of L^3t. Physical observation (via the transverse photon interaction) is the process given by applying the operator $\partial/\partial t$ to L^3t, yielding an L^3 output. Hence mind and mind operations are excluded by the usual physics instruments and observation, which simply exclude the time domain in their outputs and do not "measure" it.

For this reason, physicists have erroneously considered mind to be "metaphysical" and nonreal. Indeed, most physicists to one extent or the other are materialists, and consider the "mind" to be nothing but the operations ongoing in a "meat computer." Nonetheless, in the time-domain the time is absolutely real, and it is completely electrodynamic in nature. There is no metaphysics involved, and the temporal domain—along with mind and mind operations—is simply an erroneously neglected area of physics. In present physics, the notion of mind is comfortably disposed of by imposing the use of the "observer" concept, with out ever specifying that the observer has a consciousness and a mind. Indeed, "observation" is only about what that "observer" perceives. Obviously, one has a dramatically crippled physics if one eliminates that nonobservable called "time." Similarly, one also has a dramatically crippled physics when one eliminates the mechanisms and physics ongoing in those time-like and dynamic "things" such as mind, that occupy time and function in it.

From this viewpoint, Western physics adheres to its 3-spatial measurement foundation only by ignoring the transduction of time-polarized EM changes into detectable longitudinal and transverse EM wave changes. In this aspect, present Western physics is severely self-crippled.

Time is totally electromagnetic and energetic in nature. The flow of time is not a separate external river on which a mass floats along like a boat drifting down the current of a great flowing river. Instead, the flow of time is generated directly on every mass by its total set of photon interactions, both virtual and ob servable. We have previously presented the exact mechanism for the flow of time. *[Figure 1]*

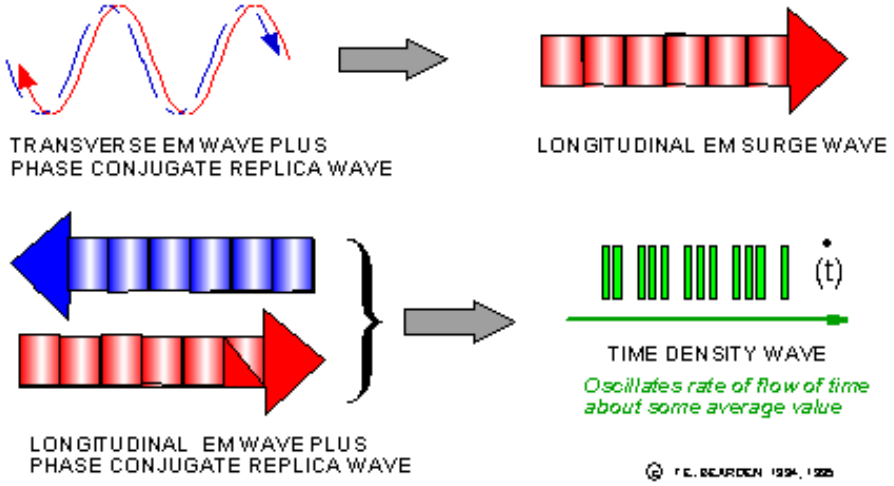

Figure 2. Transduction of EM wave type by successive phase conjugate pairing.

EXPLORE! VOLUME 9, NUMBER 2, 1999

Further, a photon is comprised of angular momentum, therefore of (energy)x(time). It transports both energy and time, not just energy alone. When absorbed by a mass, not only does it "energy-excitation" charge the mass, but also it "time-excitation" charges it, converting the former "mass" to "mass time". Rigorously it is *masstime* that emits a photon, not *mass*. So a mass moves through time in little spurts, by the continual macroscopic addition and subtraction of little Dt components. Further, in being driven through time, mass is continually altered to masstime (a quite different critter from mass), to mass, to masstime, to mass, etc.

In any masstime state, a myriad of tiny virtual photon interactions made of very tiny (DE)(Dt)'s interact with that same mass during that particular larger Dt of the masstime state (m+Dm)(Dt). Hence mass in its alternate masstime state has that state internally structured by its surrounding environment's interactions with it. The masstime state is internally structured energetically in its (DE) component, and also internally structured temporally in its (Dt) component.

A standard charged fundamental particle such as an electron, e.g., is not necessarily identical with another, when the internal structuring of its masstime state is considered. Further, by two papers by Whittaker,[5] interferometry of masstime states with either energy reactions or temporal reactions can yield observable effects and changes due to these neglected "hidden variables" in the electron's masstime alternative states. To engineer the mind and its operations directly, one must perform electrodynamic engineering in the *time* domain, not in the 3-space EM energy density domain. The direct engineering of time-like mind and mind operations—in all levels and all aspects—requires the use of *time-polarized photons and time-polarized EM waves*. This is the rarest form of electrodynamics, almost untouched by Western physicists.

One can either painfully produce such time-polarized photons and EM waves and directly irradiate a target mass with specific assemblies of them, or one can force the mass itself to iteratively transduce ordinary transverse EM waves first into longitudinally-polarized EM waves and then into time-polarized EM waves. Both will be discussed briefly.

In the West, it appears that the present author's discovery of mechanisms for producing time-polarized (scalar) EM waves [see *Figure 2*] and for transducing between wave polarizations has no precedent. [See *Figure 3*]. While scalar (time-polarized) photons are known in the literature,[1] the creation and use of time-polarized EM waves does not seem to appear in the Western physics literature.[6]

Wave transduction or *polarization transductions* are terms used by the author for the process of transforming an EM wave's particular polarization into another polarization type. Such transduction to other than transverse polarization forms is little known in the West. It appears essentially haphazardly in some experiments, usually without any recognition by the experimenters themselves. Significant transduction in experiments will also produce "strange" and unexplained anomalies in the instruments being used for experimental measurements.[7]

So most probably Western mind control researchers have not recognized the methodology and mechanisms[8] for transducing one type of EM wave polarization directly into another.[9] They continue to seek the "mind" in 3-space and hence in the brain, rather than in the time domain. On the other hand, it appears

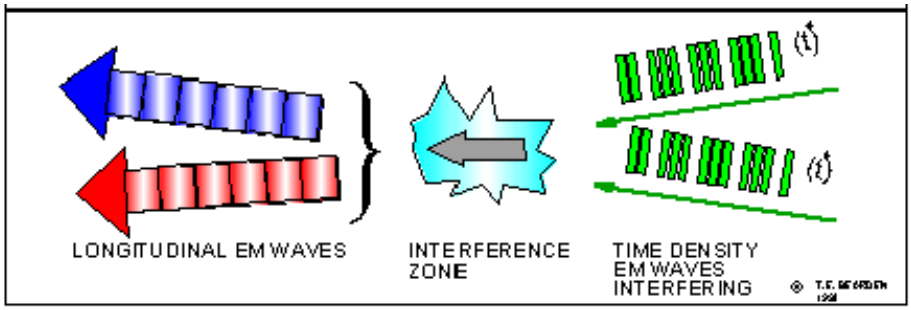

Figure 3. Interference processes for transducing higher EM wave polarizations into lower polarization states.

that the Russian KGB *energetics*[10] weapons scientists—particularly those in *psychoenergetics*[11]—have known and used methods of transducing one wave polarization into another, for at least two decades. It follows that those same scientists have very probably developed *mind engineering* and *mind control* via novel time-polarized EM wave means and a dramatically extended electrodynamics of the time-like mind operations.

In the present paper we briefly develop the wave transductions and the basis for mind engineering, including the specialized use of ordinary transverse wave (TW) EM spectra to force internal EM wave transductions and time-domain operations inside irradiated bodies, cells, and tissues. Through the mind-body coupling mechanism, these transductions of transverse EM waves can operate upon the mind and its deepest operations as well as upon the body, every cell, and every part of every cell.

Russian Mind Control Uses Higher EM Wave Polarizations

It is apparent that the KGB psychoenergetics weapons scientists know and use the full extended EM wave polarization range. As a postulation, one would expect our own weapons scientists to know and utilize the orthodox transverse wave (TW) EM for similar research and experimentation. However, in the West scientists are *just beginning* to realize the importance of a very general (and weaker) type of longitudinal EM wave (LW) polarization, as evidenced by the appearance of dozens of papers on "undistorted progressive waves" (UPWs, which are essentially imperfect LW s with TW residues remaining). The Los Alamos National Laboratory web site has a number of such papers—particularly by Rodrigues[12] and Lu—available for free downloading. UPWs have very interesting characteristics. If they were perfect longitudinal EM waves, they would have infinite energy and infinite speed. Since only imperfect UPWs can be physically made, their speed can vary from slower than the speed of light to faster than the speed of light. Their energy can also vary over a great range.

Another characteristic of UPWs that are reasonably good longitudinal EM waves, is that they pass readily through a large depth of water and mass, including through the ocean and the earth with only small interactions and losses. Yet by interfering two such beams of "high quality" UPWs at a great distance, then in the interference zone ordinary EM energy will rise directly out of local spacetime potential, as essentially shown by Whittaker[13] nearly a century ago. Russian weapon research facilities have weaponized these effects[14] for nearly 50 years, under rigid KGB control and operation. Nonetheless, even if using only ordinary TW waves, Western mind control researchers may get some fairly good results, brute-force-like, by using gross correlates between just the input irradiating TWs and the exhibited behavioral responses of the individual. The net input-output correlations can be determined, even though not taking into account the actual wave polarization transduction mechanisms ongoing inside the irradiated dielectric (or brain, or mind, etc.). However, Western researchers appear to have no knowledge of the exact mechanisms by means of which coherent time-like mind operations of a biological organism couple to the organism's 3-spatial body to provide the mental control loop. They also appear unaware of how the coherent 3-spatial behavior responses of the body couple back to the time-like mind to provide it with a sensory feedback of the body's responses.

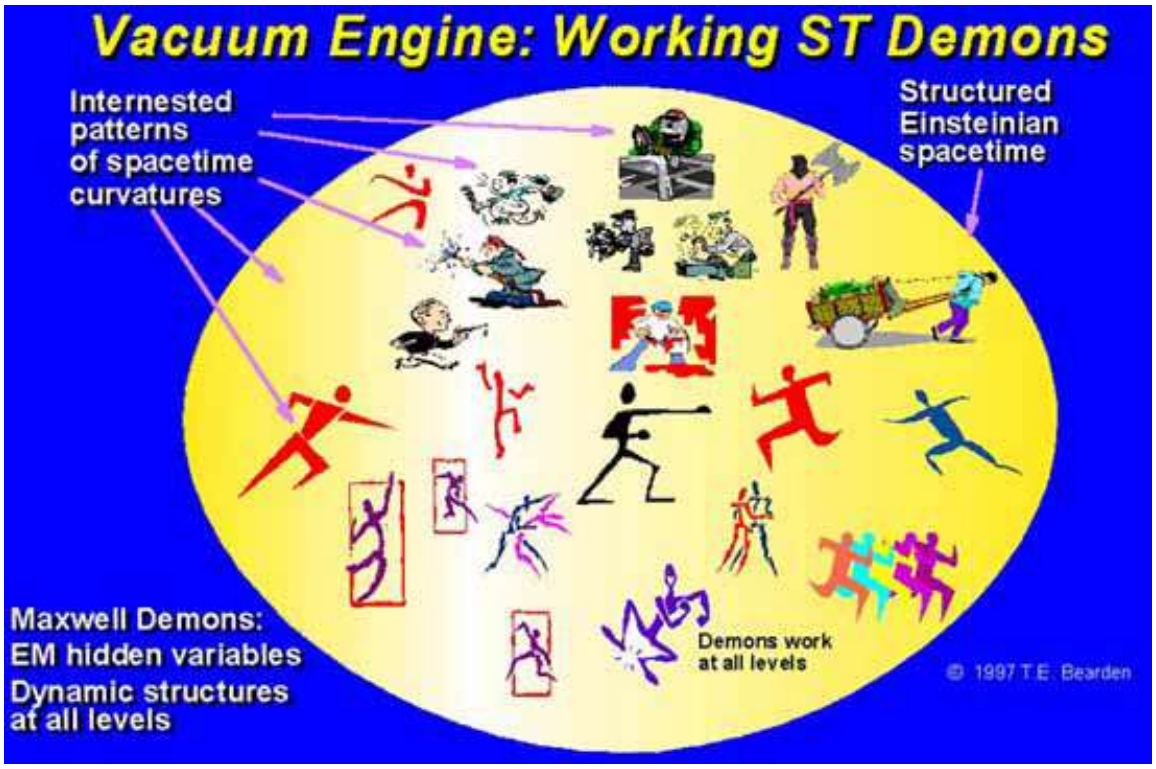

Figure 4. A spacetime curvature engine has myriads of small ST curvature components which act upon mass at all levels.

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General Relativity Aspects

Both these coupling mechanisms can be taken directly from general relativity, if one puts one's mind to it. However, unless the wave polarization transformations are known, it is difficult or impossible to apply the ordinary GR *directly*, since relativists usually concentrate upon spacetime curvature by altering 3-space energy density rather than by altering time-polarized "time-energy" density.

In applied general relativity, spacetime itself is an active medium. One speaks of a change in spacetime as a "spacetime curvature". Any curvature of spacetime in a local region directly performs continuous work upon any mass embedded in that region. Vice versa, any mass (or other concentration of energy) in a local spacetime continuously acts upon that spacetime to "curve" it.

So if one wishes to perform actions upon mass in a distant region, one may generate local curvatures of spacetime in that region, and these curvature "engines" will directly act upon the mass at all levels. *[Figure 4]* This is very different from energy propagation through space from one point to another. Now the "ordinary EM energy and actions" arise from every spatiotemporal point within the mass, at every level, and move upwards (from inside to outside). So we speak of specific forms of "templates" of nested spacetime curvatures formed and utilized to engineer mass "from inside out" as *spacetime curvature engines or vacuum engines*.

Use of vacuum (spacetime curvature) engineering[15] is a far more powerful form of engineering than is provided by energy propagation through space. As an example, it is easy to alter the quarks in a nucleon, using spacetime curvature engines and time-charging decay. Indeed, we have developed the mechanisms for cold fusion and the electronuclear interaction (formation of new nuclides) at feeble energy. An Invention has been filed with the U.S. Patent Office, and formal patent applications are in preparation. Some information on these mechanisms and principles has been released[17].

Time as Dense EM Energy and a Strong Spacetime Curvature Agent

The advantage of using the time-polarized "time-energy" for spacetime curvature is that time is ordinary energy compressed by a factor of at least c^2—which, in the MKS system of units, is some $9¥10^{16}$. Thus use of time-polarized EM photons and waves as ST curvature agents gives an amplification of $9¥10^{16}$ over the use of transverse-polarized EM waves for that purpose. In turn, the use of the strong EM force in ordinary TW waves as an agent of ST curvature is already a nominal 10^{40} times as strong as is the weak G force used as the agent of ST curvature.

The bottom line is this: For spacetime curvature effects, the use of the t-polarized domain provides amplification of some $9¥10^{56}$ greater than the weak G-force ST curvature agent usually considered in general relativity[18].

Western Science Remains Largely Materialistic

Ironically, most Western scientists are materialists and consider "mind" as a mystical and nonscientific concept. They tend to consider mind operations and functions either to be simply "meat computer" operations and functions, or at best to be very weak ordinary transverse-wave EM operations and functions in the brain and nervous system.[8] This serious self-limitation exists because in the body we *measure* only weak TW EM operations and functions correlated to biological behavior and brain operations. We simply do not know how to

Disclosure[16] on this work measure "mind operations" directly.

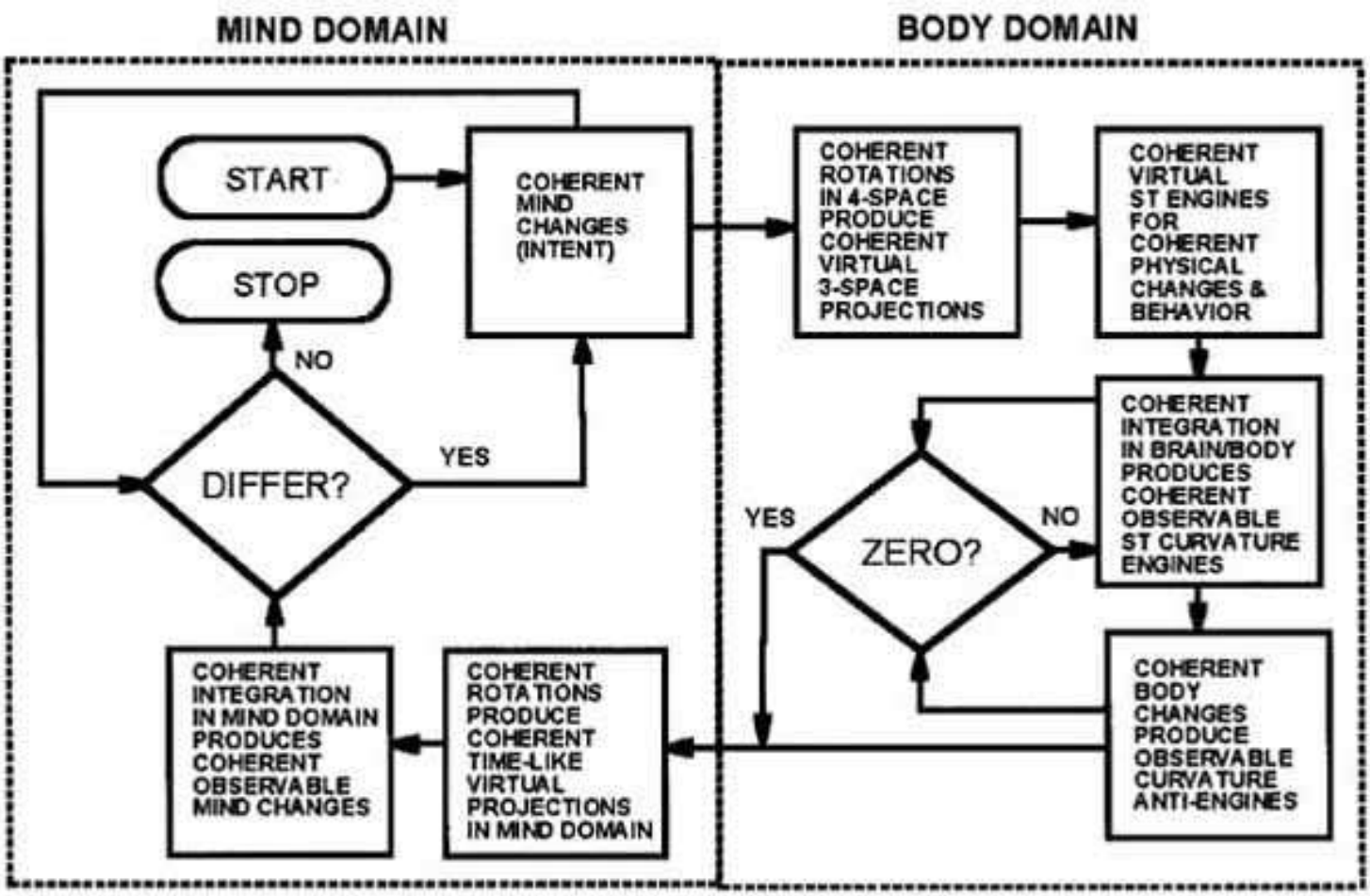

Figure 5. Mind-to body coupling and body-to-mind coupling.

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With no mind measurements possible and no instruments, it is understandable that Western science considers only the physical side of the mind-matter interface.

Presently our scientists do not measure the longitudinally-polarized EM wave operations and functions in the body and around it in nature. Few of them are aware that a maelstrom of such LW functions exist in the body and in all of nature in general. Presently only highly theoretical quantum field theorists seem to even be aware of the existence of scalar (t-polarized) photons, and even they are unaware of t-polarized EM waves. Certainly our scientists do not measure t-polarized EM waves in and around the body and in nature, nor do they make them in the laboratory. Apparently they have not studied such waves and their interactions with matter—living and inert—at all.

But it's even worse. In ignoring the time component transported by photons and EM waves, science has also erroneously omitted half of the excitation charging and excitation decay processes whenever a mass interacts with photons and EM waves. More on that later.

Brute Forcing Time Functions versus Fine Control Methods

Ironically, Western mind control researchers using transverse EM waves for mind control research, are using a brute force method of evoking and using vacuum engines (spacetime curvature engines) and a special form of general relativity, although they do not appear to realize it.

While KGB scientists also use TW EM "brute force" TW waves when necessary, they do "imprint" or "activate" those waves with the desired internal LW and time-polarized EM wave and photon structures required to directly perform the mind engineering desired. They also do not hesitate to use LWs and t-polarized waves overtly. So in blunt terms, Western compared to Russian mind control research is probably like comparing an automobile body shop with a fine surgical ward. Having long ago worked out all those "exact correlates" to the internal "information content of the field" is where the KGB scientists are at least 20 years ahead of the West.

The reason one can get mind and behavior results with the TW electromagnetics, while bypassing the real mechanism which uses t-polarized waves and photons, is due to (1) the very peculiar nature of the EM emission from a dielectric, and (2) what can be done by re-radiating that dielectric with its emitted spectrum, deliberately and very carefully altered in selected parts. We will return to that important feature later.

Polarization and Observability

As we stated, there are four photon polarizations and therefore there must be correspondingly four EM wave polarizations[1] The first three polarizations are the x-, y-, and z- spatial polarizations. The x- and y- polarizations are transverse polarizations and the z-polarization is a longitudinal polarization along the direction of propagation (along the z-axis, by standard notation). Simply put, we may visualize the transverse polarizations as rather like the wiggling of a fish's tail from side to side as the fish moves forward, or a whale's flukes up and down as the whale moves forward, or some combination thereof. We may visualize the longitudinal polarization as a sort of "repetitive accordion effect" along the line of motion of the wave. Usually the z- polarization is neglected in EM wave theory, although in recent years physicists have "rediscovered" longitudinal EM waves and are now intensely researching the use and characteristics of such waves.[12]

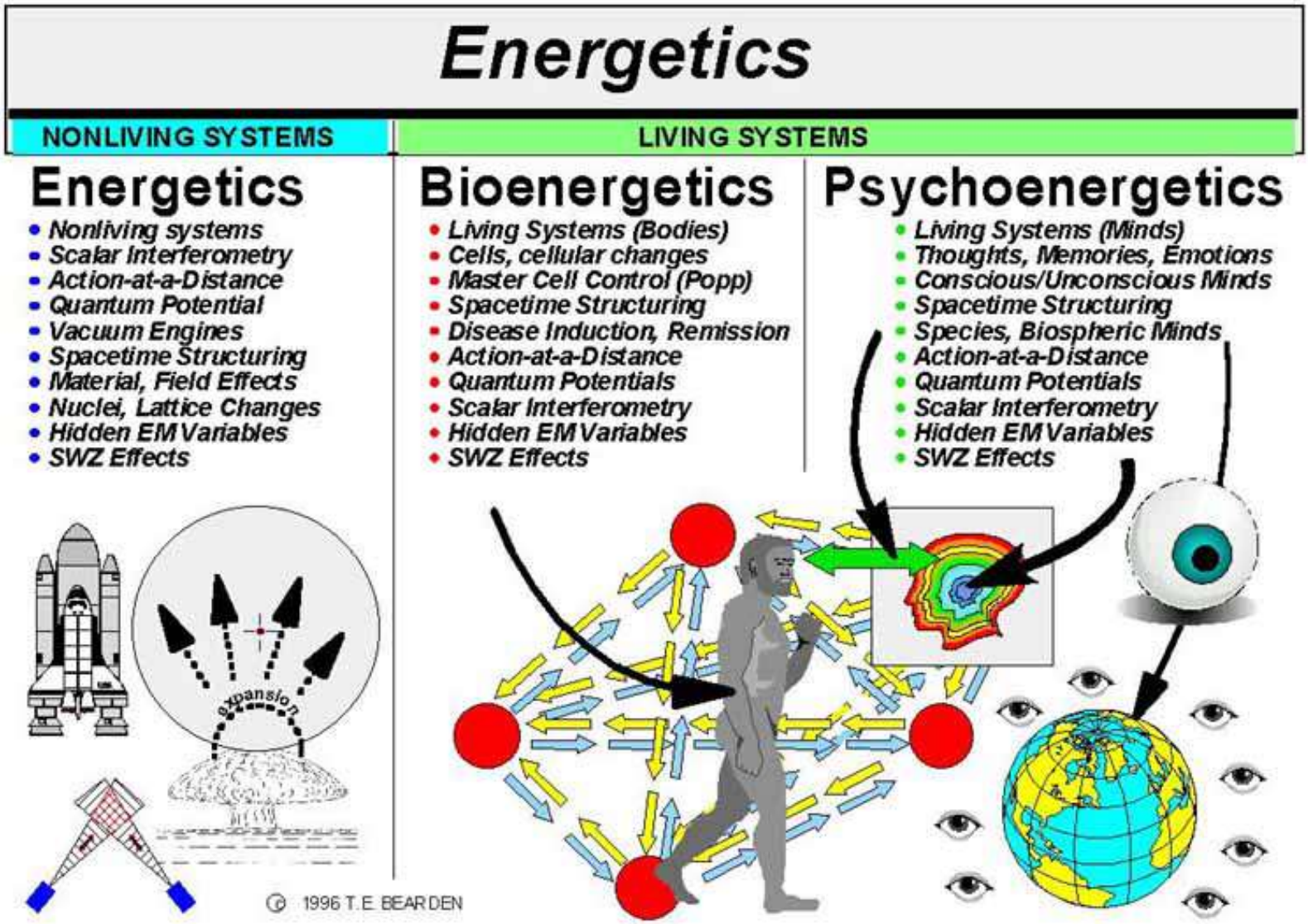

Figure 6. The three divisions of Soviet energetics and their characteristics.

Unfortunately, in quantum field theory there has been a tendency to regard the t-polarized or "scalar" photon—where the local rate of time is oscillated—as unobservable. Oscillation of the local rate of time produces powerful oscillations of local space-time curvatures, due to the extreme energy density of time. Individually, the t-polarized photon tends to be unobservable. However, a *coherent sequential group* of such t-polarized photons, each individually in the virtual state with respect to the external observer, may simply integrate in its interaction with mass over a short time period into observable change because of the coherent integration of virtual spacetime curvatures into a larger, observable spacetime curvature.

Rotations and Projections in 4-Space

Relativistically, any velocity change in 4-space is a rotation. Any such rotation in the time-domain also creates a tiny projection component into 3-space. Any such rotation in the 3-spatial domain also creates a tiny projection component into the time domain.

Hence a sufficient series of coherent time-domain (mental) changes produces a coherent series of virtual changes in 3-space (the body), thereby coherently integrating into an observable energy change in the body. A sufficient series of coherent 3-spatial energy changes produces a coherent series of virtual changes in the time domain which coherent integrate into an observable time-domain change.

Solution to the Age-Old Philosophical Problem of Intent

This is in fact the solution to the age-old problem of *intent*, or how the nonmaterial (i.e., non-3-spatial and non-observable) mind induces a 3-spatial, observable energy change upon the 3-spatial body. It is also the solution to the problem of *awareness*; i.e., how the mind is aware of itself[19] and of the responses of the body. Together the two form a closed loop coupling of the mind and body. The time delay in the loop together with memory recall for comparison, creates the sense of "persistence" of self in time. This also creates the sense of being a "separate, closed being" (i.e., of separate persistence in time—in the living entity). The sense of "separation of self from an external world" is created by comparing those body-to-mind sensory feedbacks which are not correlated to the mind's previous feed-forward intent.

Time As Energy and Why It Is Very Dense Energy

In addition to the three spatial polarizations of photons and EM waves, there is a very, very useful t-polarization along the time axis. In this polarization, the 3-spatial energy is not oscillating at all. Instead, the time or time-energy is oscillating. Time can be taken to be energy compressed by at least c^2, so it has at least the same energy density as mass. In other words, one second is 9×10^{16} joules of time-energy (energy compressed into time). The t-polarized photon or EM wave is called the scalar photon or scalar EM wave, respectively.

To demonstrate why time can be regarded as energy, we need only point out that the choice of fundamental units in any physics model is totally arbitrary. We usually choose these units to ease the mathematical manipulation, ease our understanding, and simplify the ability to visualize or "grasp" the physics. However, if one wishes, one can build all of physics from a single fundamental unit—e.g., energy. In that case, one readily sees that time is a function of energy and only energy. Hence it is perfectly proper to regard time as energy, and to seek out what form the function takes in our normal system of units (say, the MKS system).

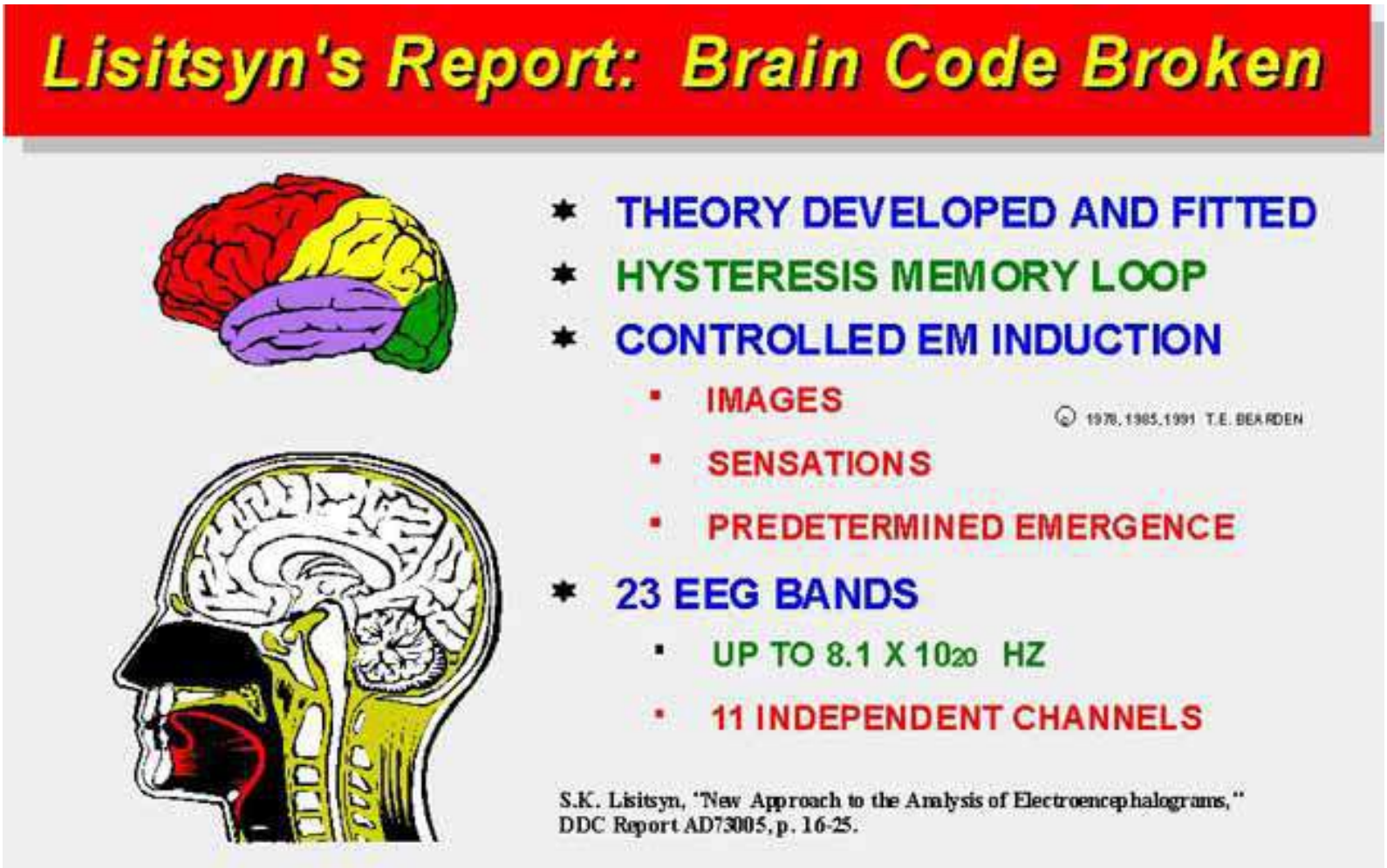

Figure 7. In the 1960s, Lisitsyn revealed Russian scientists had deciphered the human brain code.

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In that system, it appears that any change in time Δt can be taken as always a function of a corresponding change in energy ΔE, where $\Delta t \leq (\Delta E) \div c^2$ [1] from which it follows that $\Delta E \geq (\Delta t) \times c^2$ [2] For convenience, we take the special case where $\Delta t = (\Delta E) \div c^2$ [3] $\Delta E = (\Delta t) \times c^2$ [4].

Observation as Used in Physics Is Spatial

We note that all mind operations are time-like, i.e., they are comprised as scalar EM photon functions and scalar EM wave functions. Thus the mind is a very special kind of electromagnetic system, existing in the time domain, and thus "lost" by the stripping away of time in the ordinary observation process. Physical observation is essentially a time-differentiating mechanism applied to a 4-spatial change, or in terms of MKS fundamental units L and t, observation θ is $\theta = \partial/\partial t(L^3 t) = L^3$ [5].

Thus, as is well-known in quantum mechanics, physical observation is 3-spatial, and time is not a physical observable, even in theory. Since mind is time-like, it follows that mind is not a physical observable either, since discarding the time dimension also discards the mind. In short, one may also take physical operation as the mechanism that separates mind and body. To observe is to separate. We point out, however, that merely "separating and discarding" the time domain (as in physical observation of a single change) does not eliminate it, nor does it eliminate the single time-like mind change that may be involved in an intentional volition. The time domain certainly remains, even though only the 3-spatial intersection of the 4-spatial mechanism and the resulting "outputs". So a series of coherently integrated "mental intent" changes introduced into the human body's overall servo-mechanism provides the continuing input. From there, ordinary physics will generate the resulting actions induced in the body by that servomechanism and its amplifying mechanisms.

Two Coupling Mechanisms Make a Closed Loop

This is the "mind-to-body" coupling mechanism. [See *Figure 5*] It is the mechanism whereby the mind is coupled to the body, and whereby mental intent is able to induce a series of physical inputs into the body servomechanism.

So the body's servomechanism then generates the responses of the body (including everything from chemistry to electrical changes to muscular movements, etc.). These responses are changes in 3-space.

The conscious mind is a *serial processor*, though extremely rapid. It produces the series of coherent intent inputs for volitional behavior.

The unconscious mind is a *massively parallel processor*.[20] It continually produces the vast series of coherent "unconscious intent inputs" for control of all the deeper processes in the body, beyond usual conscious awareness.

However, as the body moves or changes in 3-space, each resulting quantum change in body 3-space is also a slight rotation out of 3-space and toward the time axis. Hence it induces—in the "virtual state" in the time domain—a precisely correlated projection. The body's responses are in general

Minkowski change is given by physical observation. So we may say *that the time-change remains in the virtual state, with respect to attempted physical observation of a single Minkowski 4-space change.*

Rotation, Coherent Integration, and Intent

Previously we pointed out that any change in a 4-space entity may be regarded as a rotation away from the "trajectory" of the entity. Hence each and every t-polarized change creates a very small projection into 3-space by its rotation slightly away from the time axis. All mind changes in the time-domain actually produce virtual 3-spatial projections in 3-space (in the physical domain). We define "intent" as the continued production of successively coherent mental changes, producing coherent virtual changes in the 3-space body system, with coherent integration of those 3-space virtual changes into observable 3-space energy inputs into the 3-space body system. Successively coherent mind-changes will produce successively coherent 3-space virtual changes. In short, coherent mind-changes will produce coherent integration of those 3-space virtual projections into an observable 3-space change. This is the creation of an ordinary 3-spatial energy change induced upon the 3-space body. In short, this is the mechanism whereby time-like mental intent is able to produce a series of coherent observable quantum changes in the physical body (as in the brain and nervous system).

The Body as a Servomechanism

From the standpoint of control theory, we may consider the body system to be a coherent, so a coherent series of virtual state changes in the time-domain (in the mind realm) are created successively. In short, again we have coherent integration, this time in the mind or time domain. This produces "observable" changes in the time-mind domain, which are coherent with the body's 3-spatial changes actually performed. Thus the mind receives feedback directly from the physical movements and changes of the body. This is the manner in which the body is coupled back to the mind.[21]

By comparing the "intent" behavioral move that was "fed forward" into the body, with the return "response" move analog that was "fed back" from the body to the mind, the mind is able to determine errors and differences, and originate additional correctional commands.

Thus the entire mind-body loop is a closed-circuit system of feedforward and feedback, together with corrections. It also has multiple levels of such, infolded in the larger volitional levels. See again *Figure 4*.

This solves the age-old problem of the mechanisms for the mind-body coupling, intent, volition, conscious and unconscious functioning, sense of the external world, sense of the internal world, sense of "being in" the external world, etc.[22]

All This Is Included in Russian Psychoenergetics

This is the highly summarized basis for *psychoenergetics*, the KGB's division of energetics that deals with the mind and body coupling and functions, and direct engineering of (1) the mind-body coupling and (2) the mind operations directly. [See *Figure 6*] The KGB intent, of course, has always been to exploit this science for the

complex servomechanism system comprised of many subordinate servo systems with feedback and feedforward looping.

Given the input from intent, ordinary servo theory will take it from there. Once a servo has an input, servomechanism theory describes the response of the degradation, killing, and control of human beings, including all humanity.

The Russians know full well that, if you produce and utilize scalar EM photons and t-polarized EM waves, you can directly affect and engineer mind and mind operations at any and all levels. Western researchers, who know nothing of how to make

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time-polarized photons and time-polarized EM waves, do not yet know that. Consequently the Russians have developed a highly secret science of *directly* engineering the mind and its operations, including thought, images, perceptions, feelings, emotions, memory, and mind processing. Indeed, Lisitsyn[23] wrote quite specifically of this capability in the 1960s. [See *Figure 7*]

Western clandestine mind control researchers are apparently still slowly and painfully fitting TW EM irradiation correlates to induced or resulting mental and physical behavior responses. They seem unaware of the actual wave transductions occurring inside the body and mind, but are unwittingly inducing those transductions in hidden fashion anyway and in "brute-force input-response fitting" models.

These "fitted brute-force models" certainly can be very powerful, and certainly can produce the exact results shown in the experimental verifications of the fittings. However, they do not of themselves allow sophisticated design—for example—of the necessary time-polarized wave assemblies for engineering the entire human collective unconscious simultaneously, or for engineering the entire collective unconscious of all species on Earth (i.e., Gaia's collective unconscious), or even for precisely engineering the memory and knowledge base of an individual.

This fine research article will be continued in Part II with Russian Methodology, Waves and Wave

spacetime that is highly active. The mind is rooted in the time-domain and projects from that domain into 3-space. The body is rooted in the 3-space domain and projects into the time-domain. To "change" or "function" in one domain is automatically to function in the other. EM and gravitational phenomena are still modeled separately by human scientists, but not by nature.

3. In quantum mechanics, time is not an observable, but merely a parameter.

4. It is convenient to consider mass as a 3-spatial form of condensed energy.

5. E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics, " Mathematische Annalen, Vol. 57, 1903, p. 333-355;— "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions, "Proc. Lond. Math. Soc., Series 2, Vol. I, 1904, p. 367-372.

6. A NERAC document search yielded some 16 good references on t-polarized photons, but not a single reference on t-polarized EM waves.

7. E.g., such previously inexplicable instrument anomalies have accompanied some excellent and rigorous electrolyte experiments at U. S. Navy research facilities at China Lake. For a description, see Melvin H Miles and Benjamin F. Bush, "Radiation measurements at China Lake: Real or Artifacts?", Proc. ICCF - 7 (International Conference on Cold Fusion—7, Vancouver, BC, Canada, Apr. 1998, p. 101. For a brief explanation of the anomalies, see T. E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves, " Explore!, 8(6), 1998, p. 7-16;— "Toward a Practical Unified Field Theory and a Deep Experimental Example," Proc. INE Symposium, Univ. Utah, Aug. 14-15, 1998.

8. Many U. S. researchers and journalists—and even many scientists—have wrestled with the problems of mind, intent, and mind-body

Transduction, The Cellular Control System, and other matters of interest. ♦

ABOUT THE AUTHOR

President and Chief Executive Officer, CTEC, Inc. Lieutenant Colonel US. Army (Retired). MS Nuclear Engineering, Georgia Institute of Technology. BS mathematics, Northeast Louisiana University. Graduate of Command & General Staff College, US. Army. Graduate of Guided Missile Staff Officers Course, U. S. Army (equivalent to MS in Aerospace Engineering). Numerous electronic warfare and counter-countermeasures courses.

Tom is the leading advocate of scalar potential electromagnetics and the Fogal charge-blocking semiconductor: He is involved in alternate energy devices and scalar electromagnetic system prototypes. He has defined charge q as a coupled system of two components, advanced a mechanism for a vacuum engine, whereby the vacuums virtual particle flux is organized and used to energetically shape and manipulate matter and energy, and advanced a mechanism for a Bohm-type quantum potential, which theoretically allows the engineering of action at a distance in physical systems.

He is president of the Association of Distinguished American Scientists (ADAS), a life member of the Alabama Academy of Science, Emeritus member of the American Association of Physics Teachers, and has served on the Board of Directors of several associations

coupling. Enumeration of those efforts would itself require an entire book. For an introduction into that domain, the reader is referred to the very determined exposé by Cheryl Welsh in her very timely book, The 1950's Discovery of the Code of the Brain, May 1988, published on the Internet. Simply employ any Net search engine and search on the name Cheryl Welsh. A connection to the site and to Welsh's book will immediately be found Welsh's important compendium is highly recommended, giving the reader a "birds eye view", so to speak, of how Western scientists think and proceed regarding the subject of mind control by electromagnetic means. Unfortunately all journalists so far researching the area have not been aware that Western electrodynamics itself is seriously flawed, and that the great Russian advances in mind engineering and mind control are a result of their secret but complete revision and correction of Western electrodynamics to provide the basis for energetics. Until Western scientists revise their own decrepit old electrodynamics fouling the textbooks, they will never catch up to the Russian mind control developments springing from intense development programs that did that revision in the late 1940s and early 1950s.

9. An Invention Disclosure on these processes and enhancement embodiments has been filed with the U. S. Patent Office. Formal patent applications are also in preparation.

10. Energetics is a unified science of an extended electrodynamics possessing a hidden infolded general relativity inside the potentials, fields, and waves. It deliberately employs higher polarizations (longitudinal and tempic) of photons and EM waves to engineer action at a distance, use of specific patterns of spacetime curvature created at a distance, and direct engineering of either inert or living bodies. It also encompasses the direct engineering of time-like mind and mind functions. It is divided into three divisions, depending upon the nature of the target. Targeted against inert materials, structures, fields, and waves it is called "energetics. "Against living bodies, their fields,

and corporations. Tom is a guitarist, a retired aikidoist (Sandan, Yoseikan style), is happily married and has two sons and two daughters. He and his wife Doris live in Huntsville, Alabama where Tom is retired from aerospace, continues private research, and serves as a consultant to industry on Scalar electromagnetics processes.

R E F E R E N C E S

1. E.g., see Lewis H Ryder, Quantum Field Theory, Cambridge University Press, 2nd Edition, 1996, p. 147+. For an even deeper discussion of photon polarization, see F. Mandl and G. Shaw, Quantum Field Theory, Wiley, 1984, under the heading "Covariant Quantization of the Photon Propagator" in Chapter 5. Mandl and Shaw argue that the longitudinal and scalar polarizations are not directly observable, but only in combination, where they manifest as the "instantaneous" Coulomb (i.e. electrostatic) potential.
2. Nature is unified and not separated into the "separate" disciplines our science has prescribed. Thus the mind is also totally electrogravitational. The mind works not just with EM
forms in an inert space, but also with spacetime curvatures in a and biochemistry, it is called "bioenergetics." Against the mind and mind functions, it is called "psychoenergetics".
11. Psychoenergetics is that branch of energetics used to directly affect and engineer the mind, memory, perception, thought, emotion, sensation, personality, and other mind functions of a living biological organism. It is usable against a single personal conscious (serial processor) mind and a single personal unconscious (massively parallel) processor mind In theory it is also usable against lungs collective unconscious mind and its functions, as well as the deeper unconscious for all species on Earth (i.e., against Gaia). We are speaking of physics, not metaphysics.
12. W A. Rodrigues Jr.. and J.-Y. Lu, "On the existence of undistorted progressive waves (UPWs) of arbitrary speeds $0 \leq v < \infty$ in nature," Foundations of Physics, 27(3), 1997, p. 435-5•08 A slightly corrected version is downloadable as hep-th/9606171 on the Los Alamos National Laboratory website.
13. E. T. Whittaker, "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions, "Proc. Lond. Math. Soc., Series 2, Vol. I, 1904, p. 367-372. The paper was published in 1904 and orally delivered in 1903.
14. E.g., see T. E. Bearden, Fer-de-Lance, Tesla Book Co., 1986;—AIDS: Biological Warfare, Tesla Book Co., 1988;—Soviet Weather Engineering Over North America, 1-hour videotape, 1985,—Gravitobiology; A New Biophysics, Tesla Book Co., P.O. Box 121873, Chula Vista, CA 91912, 1991,—Energetics of Free Energy Systems and Vacuum Engine

Therapies, Tara Publishing, Internet node www. tarapublishing.com/books, July 1997; — Energetics: Extensions to Physics and Advanced Technology for Medical and Military Applications, CTEC Proprietary, May 1, 1998, 200+ pages furnished to selected government agencies and key Congressional committee leaders.

15. E.g., see T.D. Lee, Particle Physics and Introduction to Field Theory, Harwood; New York, 1981. On P.383, Nobelist Lee points out that the microstructure of the scalar vacuum field (i.e., of vacuum charge) is not utilized. Particularly see Lee's own attempt to indicate the possibility of using vacuum engineering, in his "Chapter 25; Outlook; Possibility of Vacuum Engineering, " p. 824-828. With wave transductions and use of higher polarization EM waves, there are far better and more powerful ways to do vacuum (spacetime curvature) engineering.

16 T.E. Bearden, "Formation and Use of Time-Reversal Zones, EM Wave Transduction, Time-Density (Scalar) EM Excitation and Decay, and Spacetime curvature Engines to Alter Matter and Convert Time Into Energy," Invention Disclosure Document #446522, Oct. 26, 1998.

17. T.E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves, "Explore!, 8(6), 1998, p. 7-16; — "Toward a Practical Unified Field Theory and a Deep Experimental Example," Proc. INE Symposium, Univ. Utah, Aug. 14-15, 1998.

18. We have used the enormous energy density of time in our approach to a totally new kind of electronuclear interaction at feeble spatial energy. By use of a time-reversal zone (TRZ) in a fluid; the free H+ ions—which are free protons —can be induced to attract each other so tightly that the edge of the nuclear force region is entered. In that case the protons form a quasi-nucleus. When the TRZ decays back to a time-forward zone (TRZ), this new quasi-nucleus decays by changing quarks in one or more means "sense of existing in time".

20. The "unconscious" is totally conscious, just multiply so. The conscious mind can see only "a single slide in the slide projector at a time, " so to speak. When it "looks" at the ongoings and outputs of the unconscious, it "sees" millions of slides in the slide projector simultaneously. Hence it cannot distinguish "one and one only". So it just sees nothing, where by "nothing" we mean "no single distinguishable thing." It therefore is unable to consciously perceive the actions of the unconscious. When the unconscious wishes to communicate with the conscious (because of unresolved conflicts, etc.), it must produce large groupings integrated into "symbolic scenarios". Hence the symbolism of the unconscious, and the basis for therapeutic psychology and psychiatry. A "symbol", after all, is just a thing which can have many different meanings, all folded into one.

21. The mind continually has activities of its own, each of which produces coherent changes in the body to a much smaller degree. The interweaving of these "smaller self-changes" infolded inside the 3-space major intent changes also produces slight body changes, which in turn "project back" into the mind. This huge group of "infolded self-loops" produces the sense of "my body" being "volitionally directed or occupied" simultaneously with the "greater intent" loops which represent "my intentional actions with my body". Further; the body servo continually receives a myriad of inputs from its sensory systems, both from changes inside the body and from incoming changes from the external universe. This interweaving produces the awareness of "being in the external world" by having (i) changes whose feedback do not match mind-intent changes, and (ii) changes whose feedback does match mind-intent changes. This of course applies to both the conscious and unconscious levels. The purpose here is to demonstrate that there exists an actual physics of the living being, the mind as well as

nucleons, thereby producing new nuclides. We point out that this is actually a very high energy reaction; however; since the time-energy is used and is very, very dense, the amount of 3-spatial energy that must be used is very small. If this new mechanism holds, it represents a revolution in particle physics.

19. "Self-awareness" refers to be continually "refreshed" by time-delayed coherent feed-back inputs from the body to the mind; where these inputs compare to the recalled memory of the minds inputs to the body. In short, the time-delay coherence creates the sense of "existing in time". Awareness usually the body, and the coupling and interfiinctioning of mind and body.

22. The methodology also easily extends to include deeper interlays for the collective human unconscious mind and for Gaia—the collective unconscious mind level for all the species on earth.

23. S. K Lisitsyn, "New Approach to the Analysis of Electroencephalograms, " in Problems of Bionics— (Selected Articles), Defense Documentation Center Report AD 73005, date unknown, p. 16-25. Available through the National Technical Information System (NTIS).

EXPLORE! VOLUME 9, 1999

Mind Control and EM Wave Polarization Transductions, Part 2

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This article continues on with T.E. Bearden's article, Part 1 of which was published in Volume 9, #2 of Explore! for the Professional. Because we feel that Col. Bearden's caution below is so very important we are repeating its publication in all parts of this article.

Special Note

This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for non-approved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral.

A Strategic Threat Completely Unrecognized by the West

The Russian methodology leads directly to rather mind-bending, extended capabilities. KGB psychoenergetics scientists seem fixed on an eventual goal of directly engineering Jung's collective human unconscious, thereby converting the entire human species into a sort of "ant" species. In short, they seek to engineer what they regard as "perfect communism and perfect order" directly in the entire species. *Figure 8* indicates the direct connection of every human's conscious and unconscious mind to the collective species unconscious and to Gaia, the collective unconscious for all species on Earth. Since time is internally structured and layered, it follows that time-like mind levels are also internested and layered.

This appears to be a significant strategic threat, *well along in its development*, that our scientific and intelligence communities have completely failed to recognize.

The direct engineering of the entire human collective species is a doable.[1] It is going to be done, whether we like it or not. In that race (which may eventually determine whether or not we retain any personal freedom at all), the "democratic" nations are woefully behind. In fact, the West has not even realized there is such a new kind of "arms race" for dictatorship and control of the "collective species mind" and we have already almost lost it. The West has not yet even developed the overall theory of psychoenergetics.

Waves and Wave Transductions

A pure longitudinal EM wave (LW) would have infinite energy and infinite speed. In practice, one can only approach this perfect LW wave, and one always has transverse residues remaining. Hence the "imperfect" longitudinal EM waves we can make in suitable equipment and techniques, are known as "undistorted progressive waves" (UPWs). The UPWs may have velocity far greater than the speed of light, or less than the speed of light. So the speed v of UPWs can vary as

$$0 < v < \infty \qquad [6]$$

The Russians also know that, when a nearly-pure longitudinal EM wave interacts with matter (it usually doesn't interact very much, and has a low reaction cross section), the mass immediately adds the phase conjugate replica to the interacting LW portion, regardless of frequency, thereby transducing the input LW interactions into scalar (time-polarized) EM interactions.

One transduces from TW to LW to Scalar EM via iterative phase conjugation. One transduces from scalar EM to LW to TW via iterative interferometry. It took the present author 20 years to discover this simple thing; we now have filed an invention disclosure on the process and embodiments for performing it, and will be following with formal patent applications. Let TW = transverse EM wave, LW = longitudinal EM wave, and TDW = time-density EM wave (another name I use for t-polarized or scalar EM waves, since the density of time-energy is what is varying). Let (I) = interfering with, PCR = phase conjugate replica wave with a coupled set of parentheses enclosing the type of wave. The rules for wave type transduction are:

$$\text{TW} + \text{PCR(TW)} \Rightarrow \text{LW} \qquad [7]$$

$$\text{LW} + \text{PCR(LW)} \Rightarrow \text{TDW} \qquad [8]$$

Going the other way, the rules are:

$$\text{TDW (I) TDW} \Rightarrow \text{LW} \qquad [9]$$

$$\text{LW (I) LW} \Rightarrow \text{TW} \qquad [10]$$

In EM smog (dense EM signals, even though very weak), there is increased nonlinear multiwave interactions, both interferometric and phase conjugative. So in such EM smog there exists an increased, non-negligible component of LW and TDW irradiation, formed by the above transduction interactions in the irradiated living cells and bodies. This latter part accounts for many of the long term effects which show up in "correlative" studies, but which do not show up in the normal limited-frequencies TW experiments produced by so-called "physical experiments."

The standard EM bioeffects manner of experimenting uses a theoretical model of simple, direct energy deposition by means of absorption in cells and tissues. Now we must utilize an "open system" throughout the body dielectric in which higher polarized EM energy (either LW or t-polarized) travels readily throughout all areas of the body.

EM Bioeffects and Wave Transductions

In the EM bioeffects experiments to date, there has been absolutely zero control of the internal transductions, and there has been no consideration of them. Almost all transductions of TWs into LWs will immediately result into transduction into TDW and time-excitation charging of the cells and all their internal components. These time-excitation charges (excited states of time-charging) will then slowly decay, emitting longitudinal EM waves in the process which travel throughout the body. These emitted LWs interfere with each other and the LW processes in the body, producing low level TW "noise jamming" of the cellular processes and—most especially—of the deep cellular control system of the body. The latter system functions by means of LWs and TDWs. Long-term effects of such "noise jamming" of biochemistry reactions and the control systems of the cells and body, can lead to degenerative diseases such as arthritis, atherosclerosis, Alzheimer's disease, heart disease, cataracts, tumors, leukemia, somewhat accelerated aging, immune system weakening and depressing, etc. As the body's natural defense and regeneration ability weakens, opportunistic infections further add to the degeneration.

It was shown by Whittaker in 1903 that any scalar EM potential is comprised of a harmonic series of bidirectional longitudinal EM wavepairs. [See *Figure 9*] Each longitudinal EM wave pair in the harmonic series is a phase conjugate pair. Unknown to Whittaker, that "LW phase conjugate pair" is actually a time-polarized EM "photon" structure, containing a phase conjugate LW photon substructure. So staid old "voltage" (potential) is comprised of a harmonic series of time-polarized EM waves!

The corresponding "t-polarized photons" are actually spin-4 *supergravitons* comprised of coupled antipairs of LW "photons". Each LW photon is a spin-2 *graviton* comprised of a coupled TW photon-antiphoton pair. Each TW photon and antiphoton in the coupled pair has spin-1. The couplet, being the longitudinal "photon" or graviton, thus has spin-2. And so on.

In 1904, Whittaker showed that any EM field or wave pattern can be decomposed into two scalar potential functions. By applying Whittaker 1903 decomposition to each scalar potential function, any EM field or wave has an enormously rich internal structure, comprised of scalar potential functions in interference. Each scalar potential function is comprised of time-polarized EM waves (made of spin-4 supergravitons). Each time-polarized EM wave is further comprised of bidirectional longitudinal EM wavepairs. Each longitudinal EM wave is further comprised of phase-conjugate pairs of transverse EM waves. Each transverse EM wave is further comprised of two scalar potential functions, each of which is in turn comprised of an infinite harmonic series of time-polarized EM waves, and so on *ad infinitum* and *ad nauseum*. Obviously all EM potentials, fields, and waves have an enormous "internal structure" or internal "information content of the field".

The Cellular Control System Uses t-Polarized EM Photons and Waves

The master cellular control system (MCCS) in the body utilizes these photon-gravitons, their corresponding EM wave polarizations, and transductions between them. By the use of very powerfully condensed gravitons and supergravitons, it is able to utilize small but highly significant direct curvatures of spacetime. It does not merely send a "signal" and hope the cell itself acts upon it. Instead, it sends an "engine" which alters the local spacetime in which the cell and all its components are embedded. This "local ST curvature engine" then physically works directly upon the cell and all its parts, to alter the cell according to the specific "template" of the engine.

This is the direct application of the Wheeler's simple statement of general relativity: *Mass (trapped energy) acts upon spacetime to curve it, and curved spacetime acts upon mass to change it.*

Popp's "ordinary photon" study of this cellular control system[2] therefore will detect the coherent ordinary TW photon residues which result from the photon polarization transductions occurring from the actions of the ST curvature engines upon the cells.

Cellular division, biochemical processes, growth and growth control, cell differentiation and dedifferentiation, etc. are all controlled by the MCCS or one of its subsystems, using spacetime curvature engines. The ordinary TW electronic activity our biophysicists detect and correlate are simply the intermediate components of the actual ongoing polarization transductions.

The Cellular Control System Uses EM Time-Energy

One important subsystem of the MCCS controls the immune system's functions, including the deepest and most subtle functioning performed by all elements of the immune system. This system has been rather intensively studied, but since our biophysicists have not possessed the full electrodynamics utilized, only the correlated residue of normal TW EM waves and photons have been recognized and studied. Hence Western biophysics is in its very crude infancy.

Incorporation of the total wave and photon polarizations, together with their transductions, will eventually present a revolution in both biomedicine and biophysics. Unfortunately, presently our entire medical community is very firmly entrenched in only ordinary TW EM polarizations and ordinary biochemistry. Our scientists thus are studying less than 1% of the functioning of the living organism.

As an example, since Western scientists have no knowledge or research into the time-polarized mind domain and mind-body coupling, the mystery of the *placebo effect*—in which the mind has been verified to produce actual physical effects – will indefinitely remain a mystery.[3] As one result of that "crippling" of our medical theory, medical experimenters have to deliberately drive experiments on drug effects, etc. beyond the "mind's own threshold" of physical effect. In short, they have to drive the experimental results over and above the results being accomplished by the placebo effect. They must perform valid placebo control experiments, and subtract the placebo component results from their own experimental results, to determine the "delta" induced purely by the drugs.

The Regenerative Subsystem

Another important subsystem of the MCCS controls the *regenerative system* of the body. The regenerative system has various mechanisms, including growth control, differentiation and dedifferentiation of cells, etc. Becker's portrayal of the regenerative system is shown in *Figure 10*. One of its most important functions is healing and restoring damaged or diseased cells. It does that by a most remarkable process.

This system has been very poorly studied, mostly by Becker[4]

powerfully condensed gravitons and supergravitons, it is able to utilize small but highly significant direct curvatures of spacetime in precise patterns. In short, it utilizes general relativistic spacetime curvature engines, rather than "EM photon signals", to accomplish its control of the cells and their processes. It does that by a most remarkable process.

This system has been very poorly studied, mostly by Becker[4] *et al.*, although there is still sporadic, ill-funded, and ill-planned research on regenerative effects from time to time.[5] Becker and his colleagues came closest, and—considering the severe limita-

tions of the orthodox U(1) EM model available to them—Becker's work is particularly revolutionary. He demonstrated beyond question that simple DC potentials could generate cellular differentiation and redifferentiation, and produce results at global sites in the body and not just at the local injury sites where the DC potentials were applied.

Becker was nominated for a Nobel Prize for his Herculean efforts and remarkable results. For his trouble he was hounded, his funds were withdrawn, and he was forced to retire at an early age in his 50s. His biggest "heresy" was to bravely point out that power line radiations had deleterious effects upon biological systems, and to testify to it in a series of hearings and court cases where a very powerful electrical power industry essentially ran rough shod over science and the public.

Organized Science Is Highly Politicized and Imperfect

It is not only politicians that are "bought and paid for" by powerful vested financial interests. In organized science, precisely the same arrangement holds true. Scientists are no better or no worse than any other segment of humanity. A surprising percentage will produce the results desired by their benefactors, if provided with cushy jobs, good income, prestige, and secure positions.

It has been said that money is power. It has also been said that power corrupts, and absolute power corrupts absolutely. In the scientific community, as well as in the political community, this "great corruption" by great financial power has been elevated to an art form. Simply examine the funds made available to scientists. There is not enough for all the scientists, so it is fiercely competitive. If the scientist does not get grants (e.g., a would-be professor at a university), he does not bring in extra money to the university. He cannot get his graduate students funded, so his own innovative (read: heretical) research is thwarted. His papers are rejected by the journals, and before long he has no funded position in science. If lucky, he will be employed in the grocery store or the butcher shop.

Every bit of funding available for the scientists to compete for (and apply for grants) already has firmly fixed controls of exactly what research can be done with that money. The "science" that will be applied is already formulated. That and only that can be done. It is a tribute to the dedication and resourcefulness of our working scientists themselves, that anything innovative at all gets done.

One can have a very fine scientific career, tenure as a professor, get one's graduate students funded, get one's papers published in prestigious journals, win awards and achieve stature and prestige, if one just plays the desired game prescribed by the "old boys schools" in control of almost all the scientific funding. Yes, one can permissibly move the decimal point in the present models a bit, and be rewarded handsomely for doing so. But one is damned if one attempts any serious change or overthrow of obsolete scientific models and practices favored by the "system".

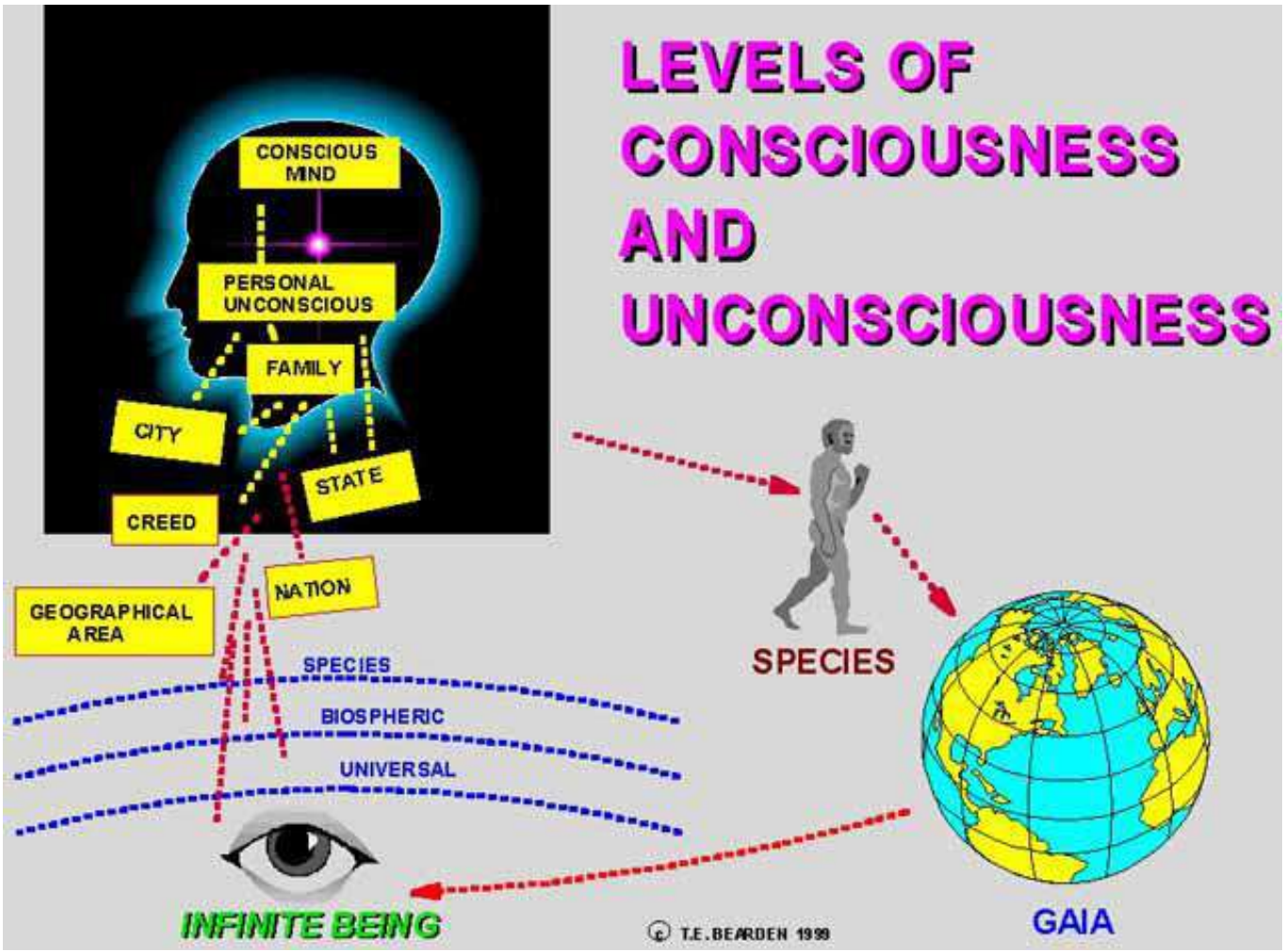

Figure 8. Nested levels of consciousness and unconsciousness. The mind levels contain the "life" and "mind" dynamics.

That is precisely why all our universities continue to teach a terribly flawed electrodynamics that is a caricature with at least 32 major foundations flaws in it.[6]

And that's why the organized Western scientific community has betrayed the taxpayers who largely fund its research. In short, the scientific community fiercely enforces dogma, suppresses innovation, and has denied the U.S. the very defense we need to survive against our pressing enemies who have not been so scientifically dogmatic.

Microwave Radiation of the U.S. Embassy in Moscow

Because of the strongly enforced adherence to the insane foundations errors in classical electrodynamics, our scientists still do not comprehend the decades of so-called "microwave radiation" of personnel in the U.S. Embassy in Moscow.[7] All diseases and health changes produced in those personnel were in *field-free areas* (i.e., where the potentials were persistent and unchanging, with no gradients etc.)[8] No one even thought to look at the "inner longitudinal EM phase conjugate biwave composition" of those potentials, where they would have found the Whittaker internal bidirectional longitudinal EM wavepairs and the internal time-polarized EM waves. They would also have found the infolded, very powerful general relativity: the spacetime curvatures deterministically formed and being utilized to directly alter the irradiated cells and their constituents.

Instead, government-funded studies did a rather straightforward "force field" analysis, and concluded that, since there were no fields there, it could not have been the microwave radiation.

Elementary statistics would immediately indicate a different conclusion: The diseases and health changes were 100% correlated to the presence of potentials, and 100% anticorrelated to the presence of fields. Hence it was the field-free potentials that had to be inducing the diseases and health changes. If it were NOT the radiation at all, then some changes would have occurred in personnel in areas where fields were *present*, as well as in areas where fields were *absent*. Since this did not occur, such a premise is destroyed by self-contradiction. In short, the data actually proved (i) it was indeed the radiation that was causing the diseases and health changes, and (ii) further, it was the field-free potentials that were the culprit.

That this elementary statistical conclusion eluded our scientific community and our government community, is absolutely inexplicable.

Three U.S. Ambassadors eventually died of diseases induced by their exposure to the Embassy radiation. Ironically, Kaznacheyev[9] had openly released some of the results of thousands of Soviet military experiments showing that any kind of cellular disease or disorder could be induced in targeted cells by novel EM radiation emitted from diseased or damaged cells. Apparently no one in the West deciphered the mechanisms involved in Kaznacheyev's epochal work.

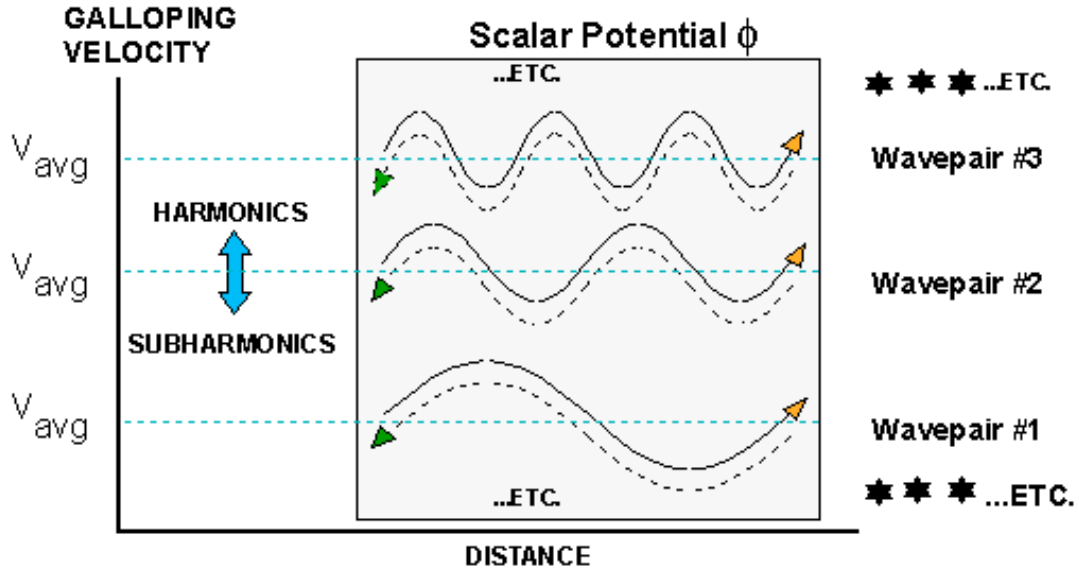

The Structure Is:

- A harmonic set of longitudinal phase conjugate wavepairs.
- In each wavepair the two waves superpose spatially after detection, but travel in opposite directions.
- The convergent wave set is in the imaginary plane, and hence is not observable. It is EM energy incoming to the potential (dipolarity) from the time domain.
- The charge's spin is 720 degrees, 360 in the real plane and 360 in the imaginary plane.
- Hence the charge receives the complex convergent EM energy, transduces it into real EM energy, and emits enormous energy at the speed of light in all directions -- which includes bidirectional pairs in 3-space (after the reaction, being after "observation").
- This produces the fields and potentials from the "source charge or dipole."
- Mandl and Shaw argue that the scalar (time-polarized) photon and longitudinal photon are observable only in similar pairs, which then makes the instantaneous scalar potential. Thus their quantum field

- **Mandl and Shaw argue that the scalar (time-polarized) photon and longitudinal photon are observable only in similar pairs, which then makes the instantaneous scalar potential. Thus their quantum field theory work strongly supports the "negative resistor" interpretation of the scalar potential and our solution to the source charge and source dipole problem.**

Figure 9. Infolded longitudinal biwaves (time-polarized EM waves) composition of a scalar potential.

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The Present Situation in Western EM Bioeffects Research

Our scientific community has not even *designed physical experiments* to validate long-term EM bioeffects of the kind caused by induced wave transductions and long-term effects inside the absorbing human cells and in the body's regenerative and immune systems. Western science has no knowledge of these technical internal "wave polarization transduction" mechanisms. Yet the basis for such mechanisms has existed in the hard physics literature for decades. Leading EM bioeffects researchers seem totally unaware of small reaction cross sections inside the body cells and tissues for the transduction of transverse EM signals into LW and t-polarized EM signals. Conventional Western researchers have not investigated it, and often will not believe it when it is pointed out to them along with the supporting basis in the literature.

A major part of the mainline "EM bioeffects" community, of course, seems comfortably funded largely by the power industry etc.[11] The record is clear that this dominant, well-funded group has little or no intention of "finding" anything that will question powerline radiation safety and upset their cushy positions.

In fact, leading bioeffects researchers have pointed out this deliberate biasing of EM bioeffects as a research area. Quoting Dr. Andrew A. Marino, one of the great pioneers in the area of EM bioeffects[10] and powerline radiation assessment.[11]

"Neither scientists nor the public can rely on power-industry research or analysis to help decide whether powerline electromagnetic fields affect human health because power-industry research and analysis are radically misleading."

Dr. Marino then gives the specific details to prove it, and he shows specifically how they slant and mangle their experiments and interpretations of the results, to do it. If the major financial interests cannot *scientifically* destroy determined, honest researchers such as Marino and Becker, they do not hesitate to attempt to destroy them in lawsuits.

The "Diffusion Mixmaster" at All Body and Cellular Levels

Every mass and all its particles are in a violent energy exchange with the active vacuum. A human body and every part of it is in a continual exchange of EM energy with its environment(s), including transverse, longitudinal, and t-polarized (scalar) EM energy exchanges. Further, within the dielectric body there is a sort of intensive "diffusion" of special kind, actually due to iterative phase conjugation and iterative interferometry of the dense signals environment impinging upon it. This internal "diffusion" and transduction (iterative multiwave phase conjugation and iterative multiwave interferometry) thoroughly "mixes up and transduces" one type of EM wave or signal into the other, including many of the body's own TW, LW, and TDW signals.

Continual or sustained TDW exposure (irradiation by t-polarized EM waves) charges the body and its particles with time-excitation charging, something which has been erroneously omit-

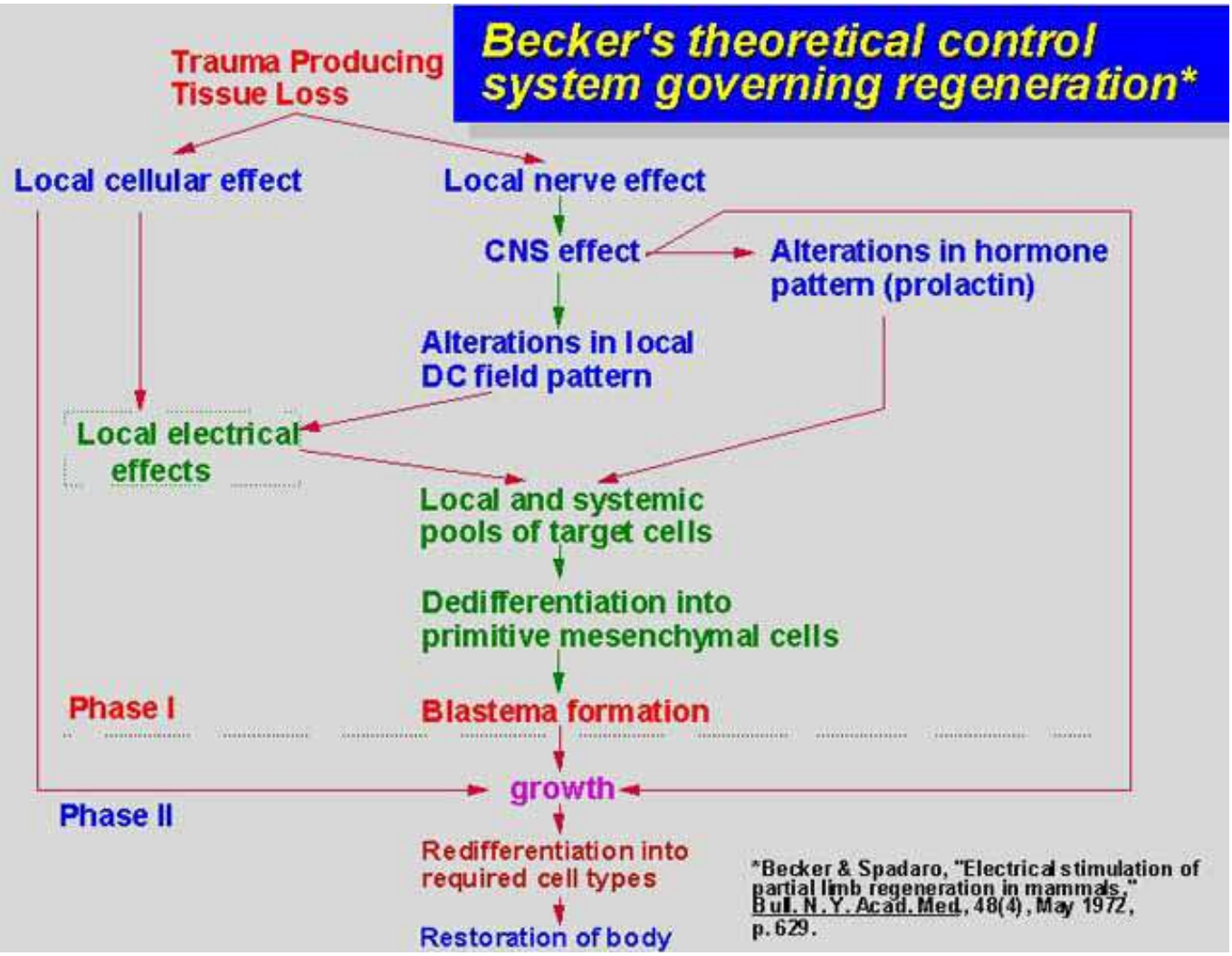

Figure 10. Becker's model of the Regenerative system of the body.

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ted in physics, but is true nonetheless. Inexplicably, physicists just ignore what happens time-wise when a mass absorbs a photon. We have covered that elsewhere.

So inside the body dielectric, there is a "diffusion mix" correlate of any and every type of the waves, to any or all of the exchanges, plus the additional internal interactions of the body in its TW, LW, and scalar EM wave transductions. There is a one-to-one correspondence to any one of the three types of polarization waves (transverse, longitudinal, and scalar) and everything going on anywhere in the body.

Note that the type of LW we are using is actually made of phase conjugate pairs of transverse EM waves, so its "photons" are made of photon/antiphoton pairs. That is, our longitudinal EM wave has an internal TW structure, and the LW wave is comprised of spin-2 *gravitons*. Our longitudinal EM wave has an internal structure, and it dramatically differs from the LW used by the U.S. scientific community which ignores wave, field, and potential infolded substructures. Our LW (which seems to be what the Russians use) is also a gravitational wave because it is comprised of oscillations in its distributions of spin-2 photon/antiphoton pairs (i.e., *gravitons*).

The type of t-polarized (scalar) EM wave we are using is a phase conjugate coupled pair of the specialized electrogravitational (EG) LWs. The "t-polarized photons" comprising this t-polarized "EM" wave are comprised of spin-4 *supergravitons*. These are, I believe, what the KGB energetics weapons scientists use also. By iteration, we can go into as deep an internal multilevel structuring of EM and EG waves, of any type, via methods shown by Whittaker.[12]

Now let us examine a body as a dielectric, sitting there in its exchange, in relative equilibrium. It turns that every tiniest piece of a dielectric participates in any emission from it[13]—even the emission of a single photon, graviton, or supergraviton. Well, it *would* so participate, due to the special sort of correlated diffusion and interferometry and phase conjugation that we pointed out. Anything that escapes (is re-emitted) from the body, has been through this "diffusion wringer". It has escaped from each and every internal part of the body.

Novel Signatures in Body-Emitted EM Radiation of Any Polarization

A single photon or wave emitted from a dielectric carries in its internally structured time component a *template* of the exact internal time structuring of every part of the dielectric emitting that photon. It carries in its internally structured energy component a *template* of the internal energy structuring of every part of the dielectric emitting it. An emitted EM wave, being a collection of emitted photons and photon structures, thus carries the same internal structuring of both its transported energy and its transported time.[14] Western scientists do not use the internal

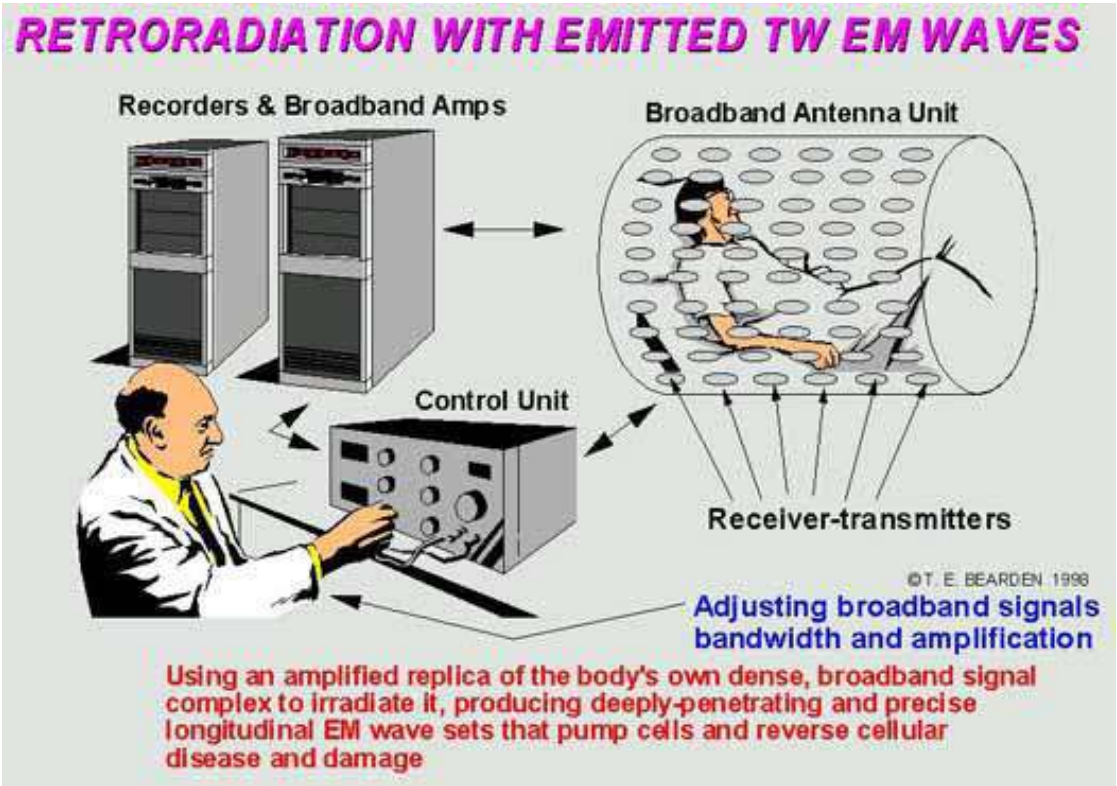

Figure 11.

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structuring of photons and EM sine waves, have no instruments for that, and so do not know it. The Russians know it,[15,16] use it, and have developed sophisticated instruments for it for the last 30 years or more.

Shortly we will postulate how conventional scientists experimenting with mind and behavior control electromagnetically might utilize an immediate consequence of the fact that the specific emission from a body at any time—whatever type of wave component we look at—is a total correlate to all that body's internal functions, its energy exchanges with its environment, its states, its mental states and conditions, etc.

And we accent that the coherently integrated intent-changes in that body from its coupled mind's operations are also in the substructure of photons and EM waves emitted from the living body into its environment.

How Western Mind Control Scientists Might Proceed

Conventional scientists would ignore scalar photons and waves, determine the TW spectrum, and then slowly and painfully correlate that to the various physical, mental, and emotional things. That's the way they would *have* to do it, since apparently they use only standard electrodynamics. They can in fact do this via brute force, because that emission TW spectrum is of waves escaping from the entire "diffusion machinery" mixmaster in the body dielectric. It does contain all those integrated *mind-intent* 3-space correlates as well as the ordinary body 3-space energy correlates.

Anyhow, in envisioning Western procedures, the test body would be sitting there, in its normal (let's say fairly normal and quiet) EM environment. [See *Figure 11*] Let's assume this body is not sick, but is healthy and normal. Its emissions are a part of its equilibrium condition. It follows that the totality of its TW emissions is correlated to the sum total of everything that interacted with the body, plus its own internal reactions, including from mind-body coupling. Indeed, everything that has ever happened to that entity—physically, mentally, emotionally, etc.—has internal correlates infolded inside the emitted transverse EM wave spectrum.[17]

So first the scientists would simply measure the full environmental TW spectrum down to very tiny levels in all frequency bands possible—everything that is coming in to the body from its environment. They would probably perform the experiments in a triply-shielded Faraday cage, so the external environment outside the cage contributes very little transverse EM wave noise (perhaps some Schumann resonance). Magnetic wave shielding and ELF shielding is something else again, and longitudinal EM wave shielding is in general not possible unless longitudinal EM waves are employed in the shielding. But a "quiet external TW environment" enhances the isolation and measurement of the specific TW signal transforms the Western experimenters would be seeking.

Then they would measure everything likewise that the body is *emitting* when in that environment. That is the "zero reference" or "normal reference" level. They would measure every aspect: frequency, amplitude, phase, wave shape, modulation, etc.

Probable Experimental and Measurement Techniques

Next they would selectively irradiate the body with specific signals, frequencies, waveforms, etc. They would begin by using

They would consider the body dielectric as a "ship with portholes". Light (EM transverse wave energy) coming out of the portholes has originated and adapted from everywhere inside the ship and its operations. When the experimenters reinsert energy through one or more portholes, they are interested in determining precisely which operations inside the ship are affected. So the body physiological functions are also heavily instrumented.

By feeding back in the exact EM pattern and magnitude escaping the body dielectric through a single porthole, one "nullifies" that part of the emission by producing a net equilibrium in that component. This will in turn produce changes elsewhere in the spectrum emission from other portholes, and this can be measured. It will also produce "stress changes" in specific portions of the body dielectric, and in the heavily instrumented body these physiological, chemical, electrical, etc. changes can also be detected. Monitoring of the skin conductance, e.g., indicates the level of stress, and EEG monitoring with sophisticated instrumentation can indicate something of the brain wave states.

In short, the necessary measurements from which to construct specific correlates can be performed, recorded, and later analyzed.

This article will be concluded in Volume 9, #4 with Improving the Methodology, Further Phenomenology Experiments, Rejuvenation and other matters. ◆

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President and Chief Executive Officer, CTEC, Inc. Lieutenant Colonel U.S. Army (Retired). MS Nuclear Engineering, Georgia Institute of Technology. BS mathematics, Northeast Louisiana University. Graduate of Command & General Staff College, U.S. Army. Graduate of Guided Missile Staff Officer's Course, U.S. Army (equivalent to MS in Aerospace Engineering). Numerous electronic warfare and counter-countermeasures courses.

Tom is the leading advocate of scalar potential electromagnetics and the Fogal charge-blocking semiconductor. He is involved in alternate energy devices and scalar electromagnetic system prototypes. He has defined charge q as a coupled system of two components, advanced a mechanism for a vacuum engine, whereby the vacuum's virtual particle flux is organized and used to energetically shape and manipulate matter and energy, and advanced a mechanism for a Bohm-type quantum potential, which theoretically allows the engineering of action at a distance in physical systems.

He is president of the Association of Distinguished American Scientists (ADAS), a life member of the Alabama Academy of Science, Emeritus member of the American Association of Physics Teachers, and has served on the Board of Directors of several associations and corporations. Tom is a guitarist, a retired aikidoist (Sandan, Yoseikan style), is happily married and has two sons and two daughters. He and his wife Doris live in Huntsville, Alabama where Tom is retired from aerospace, continues private research, and serves as a consultant to industry on Scalar electromagnetics processes.

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1. *In fact, it simply applies in the laboratory that method that is already used by species for the so-called "directed evolution" component of evolution. The exact mechanisms for directed evolution also arise naturally in the new approach. Directed evolution is required; e.g., no reptilian species could have evolved slowly into a bird. As it started slow changes, it would have not been able to fly or to run, and would have been simply destroyed immediately by*

Next they would selectively irradiate the body with specific signals, frequencies, waveforms, etc. They would begin by using portions of the same frequencies that are being emitted from the body in the "zero reference" environment. They would insure that the returned signal was of higher amplitude than the usual signal being emitted by the body at that same frequency and type.

reptilian species could have evolved slowly into a bird. As it started slow changes, it would have not been able to fly or to run, and would have been simply destroyed immediately by predators. Instead, such evolution occurs in a single jump in a species hard-pressed for a lengthy period. In the evolution of birds, one day every reptile egg that hatched, now hatched into a complete and functional bird with light bones, feathers, etc. A continuing debate (with perhaps more emotion than science) continues to this day on directed evolution. But it is real, and the mechanism can readily be generated (we've already done the gist of it).

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2. *Fritz Albert Popp, "Photon Storage in Biological Systems," in Fritz Albert* Popp et al, *eds.*, Electromagnetic Bio-Information: Proceedings of the Symposium, Marburg, Federal Republic of Germany, Sep. 5, 1977; *Urban & Schwarzenberg, Baltimore, 1979, p. 123-149;—"On the coherence of ultraweak photoemission from living tissues," in* Disequilibrium and Self-Organization, *ed. by C. W. Kilmister, D. Reidel, Hingham, MA, 1986;*—et al., *"Physical aspects of biophotons,"* Experientia, *Vol. 44, 1988, p. 576-585;—"Biophoton emission: New evidence for coherence and DNA as source,"* Cell Biophys., *Vol. 6, 1984, p. 33-52. See particularly Fritz Albert Popp, Ke-hsueh Li, and Qiao Gu, Eds.,* Recent Advances in Biophoton Research and its Applications, *World Scientific Publishing Co., New York, NY, 1992.*
3. *With novel use of EM time-energy to curve spacetime, the physical actions of the "placebo effect" are due to the use of such "spacetime curvature engines" to produce actual physical effects—at least temporarily —in the cells and throughout the body's chemistry, physiology, etc. Experimental detection of these physical effects are well-established in the orthodox medical literature.*
4. *For example, see particularly R. O. Becker, "The direct current field: A primitive control and communication system related to growth processes,"* Proceedings of the. XVI International. Congress of Zoology, *Washington, D.C., Vol. 3, 1963, p. 179-183;—"The direct current control system: A link between environment and organism,"* New York State Journal of Medicine, *Vol. 62, 1962, p. 1169-1176;—and D. G. Murray, "A method for producing cellular dedifferentiation by means of very small electrical currents,"* Trans. N.Y. Acad. Sci., *Vol. 29, 1967, p. 606-615;—and Joseph A. Spadaro, "Electrical stimulation of partial limb regeneration in mammals,"* Bulletin of the New York Academy of Medicine, *Second Series, 48(4), May 1972, p. 627-64.*
5. *E.g., a popular discussion is given by John Travis, "Starting Over: Some Animals can regenerate limbs or even most of their bodies. How?",* Science News, *152(18), Nov. 1, 1997, p. 280-282. For a typical technical paper, see Jeremy P. Brockes, "Amphibian limb regeneration: Rebuilding a complex structure,"* Science, *276(5309), Apr. 4, 1997, p. 81-87.*
6. *I have one viewgraph which lists those 32 major flaws in electrodynamics. Further, leading theorists (Evans, Crowell, and others) in the Alpha Foundation's Institute for Advanced Study (AIAS)—of which I am a Fellow Emeritus by AIAS's kind tolerance—have added about another very technical and very fundamental dozen or so errors to my own list. A leading foundations scientist with over 500 papers in the literature commented dryly to the AIAS that "I broadly agree. that the transverse plane wave view of vacuum electrodynamics is the biggest blunder of twentieth century science. Faraday visualized that "EM disturbances" surrounding wires, magnets, etc. were simply the transverse plucking of taut strings. As he states in his book, Maxwell—who also firmly believed in the material ether—simply captured Faraday's thinking and assumed that transverse "plucked string" wave disturbance in the material ether. At the time all this was expressed, the electron had not been discovered, the atom had not been discovered, the molecule was a featureless blob, and no one had the slightest notion of an atomic nucleus filled with protons and neutrons. Charge was simply a "certain volume of electric fluid" and everything electromagnetic was expressed in fluid dynamics. As an example, that "material fluid" and "material ether" theory was destroyed in the late 1880s by the Michelson-Morley experiment. All the Maxwell equations assume that material ether to this day; not a single equation was ever changed to eliminate the material ether assumptions during the last 110 years.*
7. *For full explanations of the "Moscow Signals," see T. E. Bearden, .,* Gravitobiology: A New Biophysics, *Tesla Book Co., P.O. Box 121873, Chula Vista, CA 91912, 1991;—* AIDS: Biological Warfare, *Tesla Book Co., 1988. For an excellent Government study of the Embassy radiation by excellent but orthodox Johns Hopkins scientists, see A. M. Lilienfeld* et al., Foreign Service Health Status Study: Evaluation of Health Status of Foreign Service and Other Employees from Selected Eastern European Posts, *Department of Epidemiology, of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Maryland, Final Report, July 31, 1978. On p. 245, it is noted that a marked excess of symptoms were noted in the Moscow employee group as compared to other East European employees in other East European nations.*
8. *Johns Hopkins researchers established the exact field patterns present in the Embassy from the microwave carrier radiation; see Robert C. Mallaliew,* A Model of the Microwave Intensity Distribution within the U.S. Embassy, *Moscow 1966 to 1977, Report FS-80-166, Applied Physics Laboratory, Johns Hopkins University, Aug. 1980. Nowhere in any of the Government-funded studies is there any consideration of field-free scalar potentials and their internal time-polarized EM wave structures (the bidirectional phase conjugate wavepairs shown by Whittaker to comprise the scalar potentials). Yet the field radiation patterns surprisingly showed that in just such field-free, persistent potential zones was where 100% of the health changes occurred.*

issue, see "A Comment" by William A. McGarey, p. 143; "A Comment" by Arthur C. Hastings, p. 143-144. See also Vlail Kaznacheyev, "Apparent information transfer between two groups of cells," Psychoenergetic Systems, *1(1), Dec. 1974. The Soviet Union awarded Kaznacheyev a very high medal for his achievements.*

10. *For a very nice summary of EM bioeffects from the more conventional view, see Robert O. Becker and Andrew A. Marino,* Electromagnetism and Life, *State University of New York Press, Albany, 1982. The book is also available at http://www.ortho.lsumc.edu/Faculty/Marino/E/ElPub.html.*
11. *Andrew A. Marino,* Powerline Electromagnetic Fields and Human Health, *http://www.ortho.lsumc.edu/Faculty/Marino/Marino.html. This book is highly recommended. Particularly see "Chapter 5, Blue-Ribbon Committees and Powerline EMF Health Hazards," and "Chapter 6: Power-Industry Science and Powerline EMF Health Hazards." Biophysicist Marino is one of the leaders in the field and has been personally involved in many skirmishes with powerline-dominated studies and findings.*
12. *E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics,"* Mathematische Annalen, *Vol. 57, 1903, p. 333-355; — "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions,"* Proc. Lond. Math. Soc., *Series 2, Vol. 1, 1904, p. 367-372.*
13. *Reali, G. C., "Reflection from dielectric materials,"* American Journal of Physics, *50(12), Dec. 1982, p. 1133-1136. The reflected field from a dielectric material is not generated just at its surface but comes from everywhere in the interior of it.*
14. *Present physics models the EM wave as transporting energy, but erroneously omits that it also transports time. A photon is made of angular momentum, or "energy x time". Since EM waves are made of photons, it follows that they transport both the energy components and the time components making up those photons. An EM wave is a wave of angular momentum, not just a wave of energy.*
15. *KGB energetics weapons scientists call this internal structuring the "information content of the field." However, the Russians use a good deception plan, which implies that the "information content of the field" is just the normal transverse EM spectral content of EM signals. Appreciable "pertinent" work using that phrase is produced by the open Russian scientific community, thus confusing the issue. Our electrodynamicists seem to buy it hook, line, and sinker. The deception plan also tricks Western scientists into thinking that psychoenergetics is nothing but a Russian version of Western parapsychology. Again, our scientists comfortably accept this with smug satisfaction.*
16. *Presently the Russians are in a great new version of this deception plan, with the goal of deceiving Western scientists into thinking that the "secret" Russian energetics is based on torsion fields. Consequently they are releasing substantial material on torsion wave theory, including replicable experimental results. The released version of torsion fields has one glaring omission: the time components and structuring. This deception plan is excellent, because the torsion field theory that is released, is indeed "real" and testable. It is also revolutionary, with respect to present Western science. It almost positively assures diverting the attention of much of the Western science community into this highly limited subset of the full Russian torsion theory—effectively diverting the West away from psychoenergetics and the direct use of t-polarized EM waves and fields, torsion or otherwise.*
17. *We point out that E. T. Whittaker, in "On the Partial Differential Equations of Mathematical Physics,"* Mathematische Annalen, *Vol. 57, 1903, p. 333-355, showed that every scalar potential is comprised of an internal structure of bidirectional longitudinal EM phase conjugate wavepairs in an infinite set of harmonics. Each of those phase conjugate longitudinal EM wavepairs comprises a time-polarized EM wave. So the common potential contains an internal longitudinal EM wave structure that is further organized into an internal time-polarized EM wave structure. The mind-intent correlates and the total mind and emotional experience correlates from fertilization of the egg that led to development of that person, is in the internal substructure of every potential in the living body. In his "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions,"* Proc. Lond. Math. Soc., *Series 2, Vol. 1, 1904, p. 367-372, Whittaker also showed that any EM field or wave is comprised of two scalar potential functions. It follows from Whittaker and Reali that the EM emissions from the living body carry the internal correlates of everything that has been experienced by that person from conception in the womb. Sometimes this deep embedded "hidden information content" can even be accessed in deep hypnosis. I once observed the deep hypnotic regression of a subject back to her prenatal experiences prior to birth, where the subject relived hearing words of rejection by the father, before the subject was born. The occurrence of the incident and the father's words were directly confirmed on the spot by the mother, who was closely observing the session as it occurred. It turned out that this particular rejection of the baby still in the womb had played a major role in subsequent deep psychological*

scalar potentials). Yet the field radiation patterns surprisingly showed that in just such field-free, persistent potential zones was where 100% of the health changes occurred.

9. *Vlail Kaznacheyev and L. P. Mikhailova,* Ultraweak Radiation in Intercellular Interactions, *[in Russian], Novosibirsk, 1981 [an English exposition of much of the Kaznacheyev work is given in Vlail Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions,"* Psi Research, *1(1), Mar. 1982, p. 47-76.]. See also Vlail Kaznacheyev* et al., *"Distant intercellular interactions in a system of two tissue cultures,"* Psychoenergetic Systems, *1(3), Mar. 1976, p. 141-142. In the same observing the session as it occurred. It turned out that this particular rejection of the baby still in the womb had played a major role in subsequent deep psychological problems experienced by that person all her life. To resolve the problem, use of a powerful "simulated" reliving pre-birth experience was conducted with the subject again in the pre-birth state and actively participating, but now with the father figure directly expressing love, acceptance, and cuddling and hugging his daughter. This led to a rather dramatic remission of most of the deep psychological problems within 24 hours.*

Mind Control and EM Wave Polarization Transductions, Part 3 of 3

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This outstanding article is the last, Part 3, Part I and 2 of which were published in Volume 9, #2 and #3 of Explore! for the Professional. Because we feel that Col. Bearden's Special Note below is so very important we are repeating its publication in all 3 parts of this article.

Special Note

This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for nonapproved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation

achieving many more effects in the targeted bio-organism or groups of them. With Hunt's method, the system as an *open dissipative system far from thermodynamic equilibrium in its environment* is being measured as such. This more directly allows for determination of the environmental inputs on a much broader range of subsystems, both space-like and time-like. Particularly for mental and emotional correlates to environmental stimuli, such measurements and correlations are essential.

More Comprehensive Phenomenology Experiments

To return: Now the scientists would perform many phenomenology experiments, making one little change at a time and profusely recording the data. Each time, they would establish the physical change(s) that occur in the body and/or the mental and emotional changes that occur in the mind for each spectral reinsertion back through the "ship's portholes". They would simply but painstakingly (over some years) build up an extensive database of those individual correlates.

In these experiments, the experimenters will eventually be able to provoke any body or mind change they wish. Strong emotion.

of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral.

Two Ways to Improve the Methodology and Experimental Correlates

We diverge momentarily: If they wish to improve this methodology, they will consider the body dielectric as a nonlinear isotropic medium. Then they will pretend that the spectrum of *difference frequencies* between each two adjacent waves is the spectrum of "emissions" from the body. They would also use those, as if they were actual emitted spectral signals, instead of the actual signals emitted. That procedure will give superior correlations, but it is more complicated. Part of that is known for underwater sonar,[1] and so our own scientists may or may not have realized it for use in mind and behavior correlate determination with respect to the body dielectric.

Another dramatic improvement in the depth to which the correlates can be constructed, is provided by detecting each porthole output in a two-channel device, where one channel has an adjustable time-delay as utilized by Dr. Valerie Hunt.[2] The two channels—one real-time and one slightly delayed—are then mixed, as by Hunt's method, producing an instrumental measurement of the chaotic part of the functions. Again, this can be measured, recorded, and later analyzed. It adds (i) a completely different kind of thermodynamics in the system measurements, (ii) a dramatically extended set of correlates, (iii) more direct measurement of the time-polarization causative signals, and (iv) an applications

Intense pain. Intense pleasure. Painful thoughts. Images. Memories. Perceptions. Dreams. Visions. Memory losses. Memory changes. Personality changes. Etc. The "delta" in the emission spectrum (the changes from zero reference spectrum) represent the precise totality of all mental, physical, organic, chemical, etc. changes and interactions.

A particularly vulnerable aspect of every mammal is the pleasure center in the brain. Experiments have shown that, when this center is stimulated, it is the most addictive experience possible. Rats will forego food, endure electrical shocks, starve, and even die to obtain stimulation of this center. Obviously a device capable of generating signals that evoke direct stimulation of the pleasure center in humans would be a powerful weapon.[3]

Extending the Data Base

See Figure 12. After the researchers have made an "individual porthole signal insertion" correlate database, then they would make a "two, three, four," porthole signal insertion correlate database by inducing selected multiple changes at once. Again they would analyze everything; the program would need one or more supercomputers. It would also require quite a highly qualified multidisciplinary team, extensive facilities, substantial funding, and would be many years in duration. We are describing a decades-long program. But it's a doable.

With sufficient development and performance of such a program, the researchers would have produced (with sufficient testing and analysis, and sufficient retest validation and verification) a database of "specific correlates for a given overall

technology eventually having many additional degrees of freedom and therefore capable of desired physical, mental, or physical and

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mental delta."

A second stage in the research would be to test the correlates and porthole insertions upon a statistically significant cross section of ordinary people, and/or specialized populations (such as toughened soldiers). The program would evolve a highly complex, very effective, ever-improving science and technology of mind and behavior control and engineering mechanisms, complete with finished database and developed applications equipment.

The Dielectric Body as a Ship With Portholes

Again let us review what the EM transverse wave irradiation from the body dielectric represents. Think of the body dielectric as a sort of "ship", with lots of portholes. When it gets irradiated, certain operations happen internally to that radiation, i.e., certain "processes" and "interactions" occur, which change both the mental and physical states. The output emissions back from the body dielectric, out through the filtering "portholes", will directly correlate to what has happened inside the ship.

It is terribly important to realize that one can use the same frequencies and spectra coming back out of those "portholes" to insert EM signals and waves etc. back in there, and into the deepest processes going on in the body and in the mind (at all levels, times. So it will reach directly into and affect any and every part of the dielectric, as you wish, and in whatever manner you have correlates for.

We filed an invention disclosure[4] on the above correlate and "back-porthole" process for use in directly inducing full and efficient conversion directly to time-density (scalar, or time-polarized) EM waves inside the body/ cells, *therefore immediately and directly time-excitation charging the body cells and all their internal components.*

Subtracting the Normal Correlates to Obtain the Deltas

A specifically diseased body, e.g., has a specifically tailored change in its "normal" emission spectra, because of the disease condition alteration of its resident spacetime curvature engine. By having a database for the normal emission spectra of the healthy body, one can subtract it from the actual emitted spectra, to obtain the "delta spectrum".

If the correlates have been previously determined by the above mentioned research program, then one may simply introduce an amplified "delta spectrum" into the body, i. e., through the portholes. This will immediately time-excite the cells and their components throughout the body, particularly where that disease does exist. It turns out that the time-excitation charging by that method will "pump" those diseased

including the deep unconscious).

Remember, whatever you put back in there, is going back through the "mixmaster" hopper. It will be iteratively phase conjugated and interfered with by everything, countless cells in the time domain. The cells themselves (and all their parts) are highly nonlinear—to time-excitation charging, they are *totally* nonlinear. So they will act as rather perfect pumped phase conjugate mirrors, but pumped in the time-energy domain rather than in the spatial

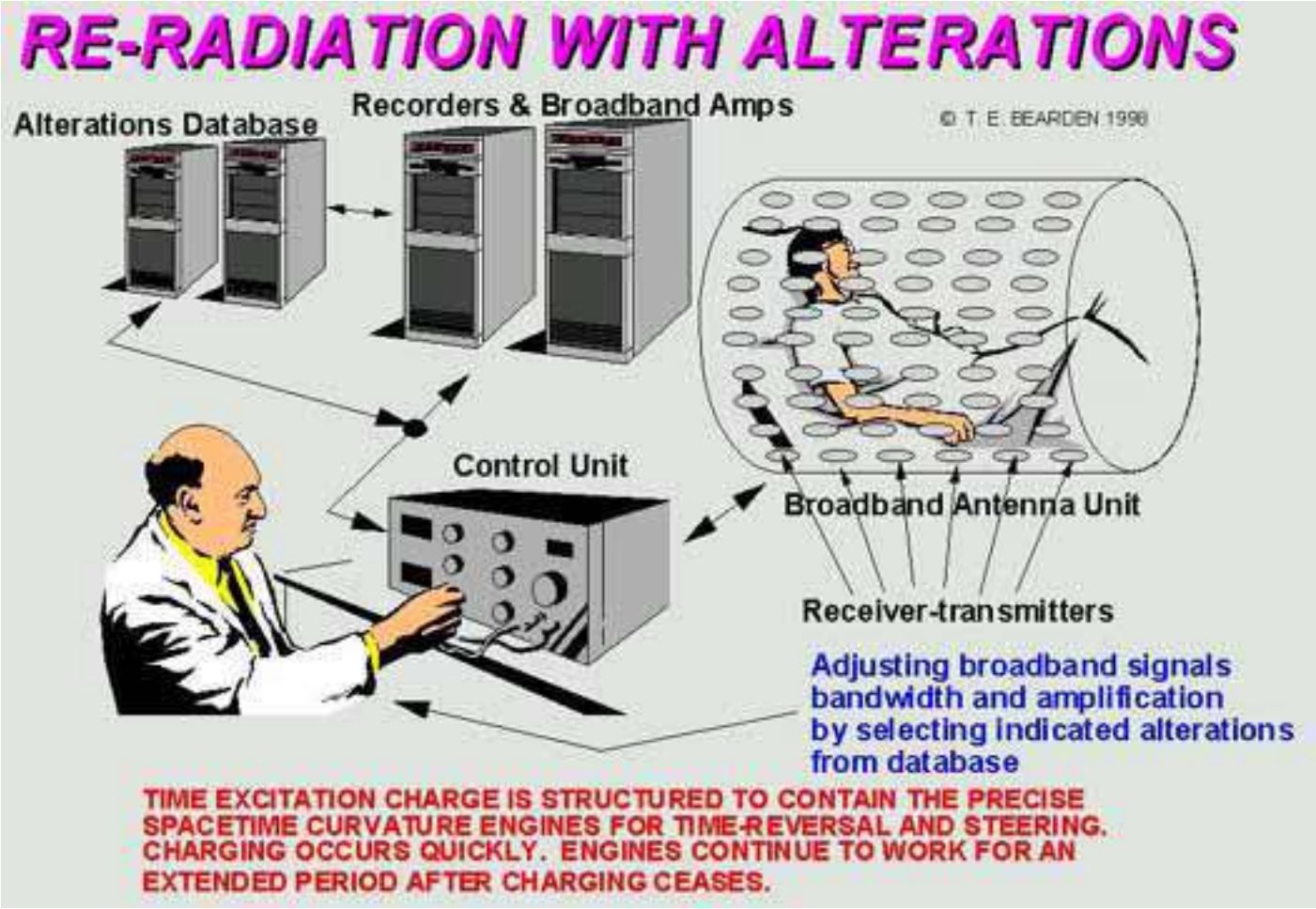

Figure 12. Using an amplified replica of the body's own dense, broadband signal complex, containing added alterations, to irradiate the body and produce deeply-penetrating precise time-density charging for cellular time-reversal while steering the time-reversal trajectory to also correct a congenital condition.

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energy domain. This is a dramatic extension to nonlinear phase conjugate optics theory.[5]

General relativity tells us that each specific detail of the mass and energy structure of each cell and all its parts—down to the finest details—is accompanied by a precise set of spacetime curvatures. By reintroducing the same energy as the disease delta TW waves, the affected cells add the phase conjugates, converting the inserted TW signals into longitudinal EM wave signals. The longitudinally-pumped cells again phase conjugate, converting these longitudinal EM waves to time-polarized EM waves, and "charging" the cells and all their parts in the time domain.

Suddenly, at that point the *resident spacetime curvature engine*—rather than TW or LW EM waves-serves as the "input signal" to the cell-and-its-parts as pumped phase conjugate mirrors (PCMs), pumped in the time domain. An extension to the distortion correction theorem of nonlinear optics results. An exact, amplified antiengine for the diseased cells—i.e., a phase conjugate replica of the resident spacetime curvature engine—is formed. This amplified antiengine overpowers the resident disease engine, powerfully time-reversing the cells and their components back to a previous healthy state. The time-reversal actually occurs over a period of time after the "time excitation charge-up" ceases, say over the next week or two. Usually two to three quick irradiations are required, one week apart, to give a time-reversing period of three to four weeks.

force upon the cells or any part. E.g., as Pepper[6] states,

"*On a more fundamental level, the ideal lossless PCM reverses all the quantum numbers of the incident photon (i. e., linear momentum, angular momentum, etc.). It can be shown that the PCM therefore experiences no linear or angular momentum transfer from the incident photons; hence, the PCM is free from photon radiation pressure and torques."*

Note that, in ordinary EM theory, it is precisely translation forces that are engendered upon charged mass by EM fields. This process is quite different. In biological terms, this process dedifferentiates (in physics: time-reverses) the diseased cells and all their components—including the genes—back to an earlier healthy state.

By taking a diseased body and feeding back into it an exact amplified replica of its emitted TW spectrum, one can force the body to "time-excitation charge" all cells and their components immediately, with high efficiency. The human body and every cell and every part of every cell does the necessary "calculation" for the exact antiengine for each part. Since time is extremely condensed spatial EM energy (by a factor of almost 10^{17}), a startling contraction occurs in the radiation time required to time-charge the cells and their components and charged particles. This is a method for instant initiation of time-charging, hence it is extremely rapid. What took Priore several hours of LW irradiation to accomplish in the body,[7] can now be done

Even though appreciable forces are operating internally upon the cells and all their parts, there is no net translation in seconds with this "thwarting" and spectrum transduction method. In fact, it is an intense stress on the body, and—say—should only

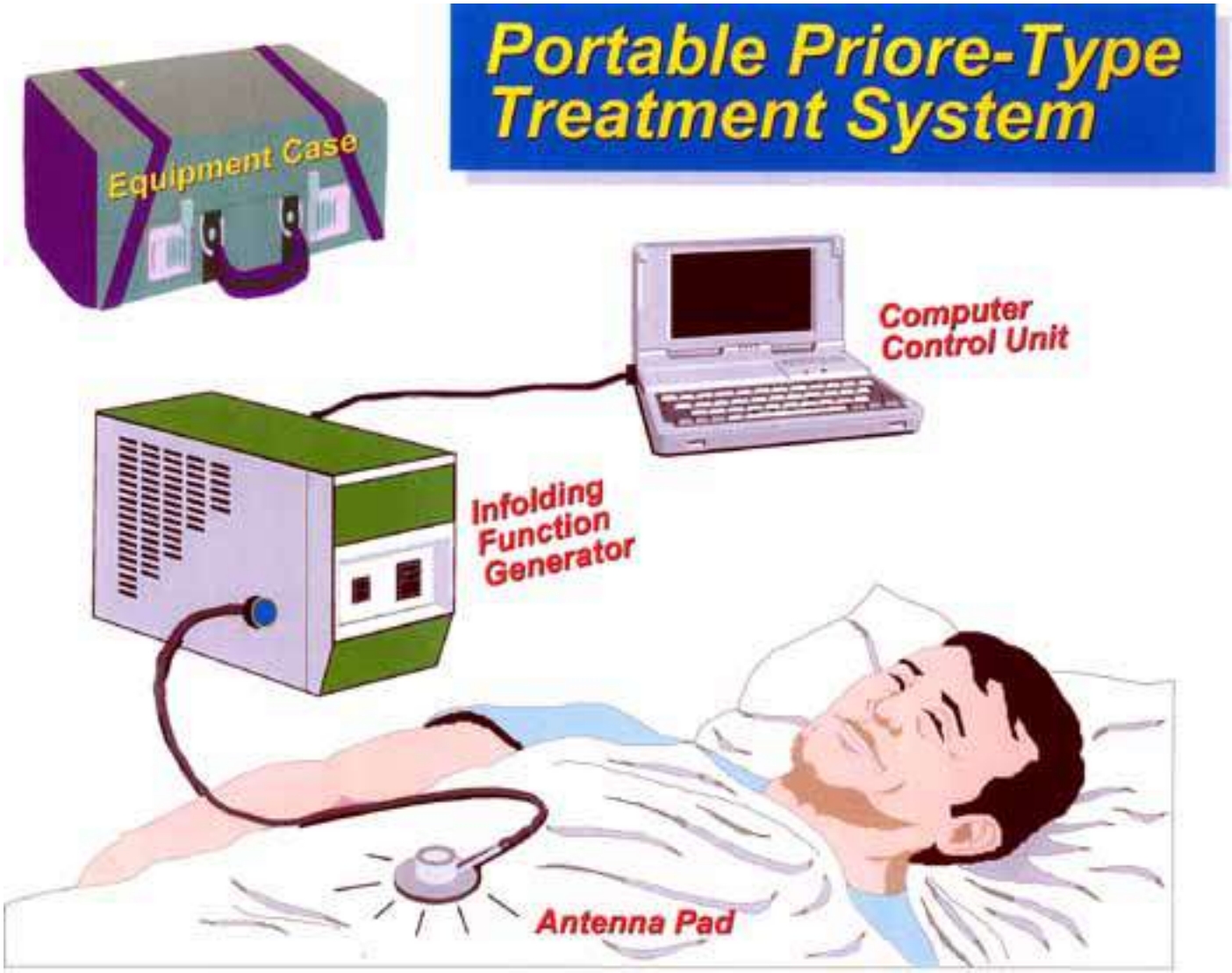

Figure 13. Portable first-method treatment unit proposed to the Department of Defense. For treating and curing mass casualties from terrorist BW attacks on U.S. population centers.

be continued for 30 seconds or so. We highly stress that overcharging in this time domain can be detrimental or even lethal if prolonged.

At the end of the very short time-excitation charging time, the body is "time-excitation charged in all its minutest particles". So everything is therefore pumped in the time domain for the next several days after the irradiation is removed, since the time-charge decays very gradually over a period of time. During that decay period, every part of the cell and body acts as a pumped phase conjugate mirror material, pumped in the time domain rather than in the 3-space energy domain. When time-pumped, the mass itself reverses to a previous physical state. This can be used for both nonliving and living masses. Because there is no forcible translation manipulation of the cells and their parts, it can be utilized on living cells in vivo. In the case of diseased cells—e.g., AIDS-it appears that three precisely determined 30-second "AIDS correlate" irradiations a week apart, should be sufficient to completely cure AIDS, including removal of all HIV-genetics changes from every previously infected cell of the body. Also, it would accomplish considerable rejuvenation of the body (making the body younger).

Rejuvenation: Restore the Telomeres and Produce Immortal Cells

Saving Most of the Casualties from Mass Terrorist Attacks

To defend against things like anthrax attacks on our civilian population centers, we also have recommended to the U.S. Government the crash development of small, portable treatment machines—using similar "antiengine-forming" and cellular reversing "porthole technology". [See Figure 13 on previous page]. Such portable machines could be developed cheaply and quickly, and present government facilities could be used to massively attack the correlate database production problem. The portable treatment units could be cranked out by the hundreds of thousands and flooded down through emergency response agencies such as the police forces, the National Guard, emergency hospitals, emergency response teams, etc.

Each device could be used in "assembly line" fashion upon hundreds of sickened patients, in case of a WMD (weapons of mass destruction) attack upon one or more of our cities. The first generation equipment would save probably 70% of the stricken (as from anthrax, etc.). With second generation equipment, one would expect 90% of the stricken casualties could be saved.

Just now, there is a very dim prognosis for all those casualties, using present available treatment capabilities. Time and lack of vaccines defeats just about everything that can be done. Brutally speaking, most of those unfortunate enough to breath in

In fact, it is now known that the gradual loss of the telomeres—the natural ends of chromosomes—in a cell's chromosomes is what causes the cell to age. The gradual loss of the telomeres and the resulting shortening of the chromosomes represents a cellular "disease state" or "disorder" state" accompanied by a precise delta in the spacetime curvature engine accompanying every affected (aging) cell.

By determining the correlate for that precise telomere loss in the aging body's emitted radiation spectrum, an effective telomere regeneration process immediately emerges. One simply amplifies that aging "precise telomere reduction" correlate and reradiates the body with it, passing an amplified correlate back into every cell of the body. The cells and all their parts—including the chromosomes—add *the phase conjugate replicas*, converting the incoming TW EM correlates to longitudinal EM wave correlates. The cells again phase conjugate the LWs and add *the phase conjugate replicas*, converting the LW correlates to time-polarized EM wave pumping correlates. This latter process *time-excitation-charges* the aging cells and all their parts, including the genes and chromosomes. The cellular matter itself produces the amplified "aging antiengine" for each and every cell and telomere ending. The result is to again add telomeres, converting the cell back to a younger, more vigorous cell, and reversing the process of aging.

We point out without further elaboration that these methods also introduce direct engineering signals into the body's master cellular control system, including the regenerative subsystem. Hence the body's regenerative subsystem is involved in helping produce the necessary engines and anthrax spores from an attack, are going to die. At least 80% of them will expire, in spite of everything the present system can do for them.

Note each device could rapidly treat a whole series patients, one right after the other, merely laying them between "blankets" containing wire antennas, irradiating with the proper correlate spectrum quickly, moving on to the next patient, irradiating quickly (seconds), etc. The entire apparatus could be made to fit in a large suitcase-sized container, and it would be highly portable and controlled by a laptop-sized computer.

Unfortunately, so far the DOD doesn't even understand what the heck we're talking about! The National Institute of Health (NIH) and the National Science Foundation (NSF) are not interested at all. After all, it isn't drugs, vaccines, antibiotics, etc. — which are simply not going to do the job. However, those are what the government and scientific communities are going to finance to the tune of hundreds of millions of dollars. They are then going to lose almost all those mass casualties when the terrorist attacks on our population centers inevitably occur.

Those are Americans. They are going to die. Most of them could be saved. We ought to save them.

For any change in state (physical, chemical, emotional, mental, perceptual), the body dielectric "portholes" change and the output spectrum changes. The delta from zero reference now represents that exact change.

Where Western Mind Control Research Has Probably Arrived

Western mind control researchers

operate upon the short telomere chains to add back telomeres. More specifically, the regenerative subsystem is changed into perfect consonance with the external introduction of the amplified antiengines.

That exact process can be used to rejuvenate the aged population and remedy most of the debilities of growing old. That is how we eventually intend to do it, if we can convince the U.S. government and the U.S. scientific community to perform the necessary research and validation.

probably first established a correlation database of porthole emission correlates to changes in internal states, both physical and mental. They almost certainly recognize the peculiar participation of every part of the body dielectric in the TW emission spectrum from the body. They will almost certainly have opted for this "porthole" notion of some similar expression of it, and the "thwarting" of these "relaxation and release" emission processes to engender internal physical changes in the body and in the brain-meat-computer, as they see it.

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They probably experimented with different TW EM radiation mixes, to see what the body emission change to, and what states are induced. Undoubtedly they found that the induced states began to correlate with the former emission delta data base. That is, they found out which delta emissions spectra, reversed and amplified and fed back thorough the portholes, produce what internal changes.

Use for healing is the simplest of all. Use for killing or debilitating is more complicated. Of course weapons researchers wish to look only at the killing aspects. That is something they understand. They do not understand healing, for they do not even have the "regenerative" or "healing" mechanism in any of the scientific papers or texts. Becker[8] came closest in this country, and Priore did it in France. Both of those scientists were suppressed and paid a bitter price for their revolutionary and innovative research.

But look at what has been done, by "input-output" correlation research. The scientists will have a database now, that tells what state emerges in the body and in the mind, for what irradiation spectra (frequency, relationships, phases, amplitudes, wave shapes, etc.) one uses. And they did not work out all the wave-to-wave transductions ongoing in the mind and body connection and in the body and in the mind, individually, between TWÛLWÛTDW.

We suspect that this is the course Western mind control researchers will have taken, without even realizing the internal wave transductions occurring. And they would not be concerned with that. They would have what they want, for weapons, mind control, and behavior control. And they of the internal "mix" of the dielectric and all its tiniest portions. So Western mind control researchers and rogue groups probably do get good results.

We are not just picking on the U.S. government here! Internal divisive groups exist in all large and powerful groups, and joust for power. In highly classified groups, these groups are greatly enabled to joust more widely, unethically, and immorally because it is so deeply hidden. So very deep classification evokes the growth and intensity of rogue groups. It's the old "Power corrupts, and absolute power corrupts absolutely" routine.

The implication is that in the West one or more highly classified, sustained, heavily funded developments in advanced mind control programs, probably exists and probably has existed for some time. Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, may not operate under very much legitimate government control at all, and may operate specifically for the purposes of the rogue group or groups that have gained control.

In a nutshell, that's what may be going on in the clandestine mind control projects in several Western governments. The involvement of at least some rogue groups, some being "cowboys" who operate well outside all laws and ethics, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, *it could account for what seems to be actually occurring*. As also is "usual" in such a mess, one or more of the rogue groups eventually may become very powerful because their secret weapons are very powerful. They may become confident, thinking they have the "best in the

would of course ignore the healing aspects. And they would get results of course, revolutionary results. So they would undoubtedly classify the program very highly, thinking that they had the best of the best.

Rogue Groups May Also Have Arisen to Divert the Purpose of the Projects

And that is where real problems may arise. Every human group has within it competing subgroups, jousting for power. The more highly classified the group and its activities, and the less that is known about it outside its confines, the more strongly and secretly the subgroups can play. So they can emerge as **rogue groups** pursuing their own agendas, not that of their duly elected governments. In the extreme, such a deep black program can even become a "captured" program, which is totally in the hands of rogues and no longer reports to or is bound by the dictates of the parent government.

It has long been suspected in some quarters that even the US's highly classified research community may be riddled by such rogue groups, and so may be certain highly sensitive parts of the Research and Development community.

Remember that, in every large and powerful human organization, the basis for rogue groups is power and secrecy. They are always seeking to increase their power, control, influence, prestige, etc. Nothing else. Patriotism and mission are—to rogue groups—often just idle words. They have their own agendas. And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A world." They may actually believe they are ahead of the Russians.

Where the Russians Probably Have Arrived

On the other hand, the Russians will have developed instruments for detecting and isolating the LWs and the scalar waves, in addition to the ordinary mundane instruments for measuring the TWs. So they will have not only the TW correlates, but also the much finer TWÛLWÛTDW (scalar EM wave) correlates. They will understand and employ the use of vacuum engines (spacetime curvature engines) which Western researchers will often invoke but not understand or even be aware that this is what is being invoked. In other words, Western researchers probably just use the old method of "input fi set of functions fi output". That is the standard basis for almost all Western system analysis. With it, one doesn't have to know the exact functions and processes going on in the middle. One just determines a transfer function from a given input to the output that results. Then one catalogs that transfer function. One does that for lots and lots of transfer functions for particularly desirable results, and one has the system analysis. One also has the immediate basis for a rapidly-developed applications technology.

Western scientists are good system analysts. But they have little or no comprehension of what is really going on in that "inside the ship functions" portion, even though they have determined the transform function which acts upon the input to give the "from the portholes" output.

The Russians, with their additional knowledge of the actual mechanisms in the transforms, will be much more advanced

certain percentage of a highly secret rogue group will wind up using all these things and more. It's a **human** characteristic, the old primate dominance game. Only now disguised and hidden under deep classification.

Nonetheless, the "simplified" TW EM "porthole correlate" approach will yield very positive results, due to the correlation existing with the LW s and scalar portions than the West, because their fundamental psychoenergetics science is far more advanced, so long as we continue to use the old U(l) electrodynamics. Further, the Russians have decades of use of longitudinal interferometry beams to reach right through the earth and ocean and produce stringent EM effects at a distance. So they will also be able to do the same things here in "mind control" with LW interferometers, through intervening mass

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including the earth and ocean. Western mind-control scientists and their rogue groups—assuming they exist as postulated—largely will not be able to do that, and probably won't even recognize Russian testing of psychoenergetics weapons directly in or over Western nations.

Russian Lethal Psychoenergetics Mind Control Tests Over the U. S.

In fact, the KGB tested just such highly advanced mind control weapons over the middle of the United States in 1997 on two occasions. The tests were conducted against Captain Button in his A-10 "Warthog" aircraft on April 2, 1997 [See Figure 14], and upon Captain Svoboda in her A-10 "Warthog" on May 27, 1997. [See Figure 15].

Over Arizona, Captain Button was thrown into a hypnogogic state, and his perceptions instantly altered and controlled. In his instant "dream-waking" state, everything seemed perfectly normal. His sense of direction was altered a bit more than 90 degrees, so he simply corrected and turned and "flew toward the range", actually flying off course by more than 90 degrees and ignoring radio contacts. He flew right on out of Arizona. At one point he circled, probably thinking he was over the range, and he probably dropped his ordnance there. Then he "flew on back toward home," as he thought in his waking dream state, until his fuel ran out and he crashed and died in the explosion—dream-thinking until he died that everything was normal. All the while, his sense of the passage of time was altered. To him, in his dream-thinking, dream-acting state, everything was normal and nothing untoward had happened. So the distant KGB transmitters and associated psychoenergetics team controlled him for over an hour.

Indeed, that was the exact purpose of the test: demonstrate control (at a great distance) of a skilled person performing highly skilled tasks. A secondary purpose was to stimulate the U.S. government, watch its investigation and findings, and ascertain if the U.S. knew of the extent to which Russian KGB mind control weaponry had advanced. Obligingly, we proved to me KGB that we did not understand what had actually happened to Captain Button.

Captain Svoboda was from the same Wing as Captain Button and was its most experienced night fighter A-10 pilot. In fact, she taught other pilots the fine points of night flying combat missions in the A-10. About two months after Captain Button's bizarre flight and death, Svoboda was engaged in night target bombing on the range. Rising from her ordnance drop on me target, Svoboda was suddenly struck and rendered hypnogogic and in a waking-dream state. Her sense of the vertical was instantly reversed. Superb pilot that she was, she immediately dream-perceived she was diving, not climbing out of the delivery. She instantly corrected to "climb out". So in the real world she dived sharply into the ground and her aircraft exploded.

This test demonstrated the instant alteration of a skilled pilot's perception, causing that pilot to inadvertently react promptly in an unintentionally suicidal manner. A secondary purpose of the test was to stimulate the U.S. government system again, to see if the system recognized what had

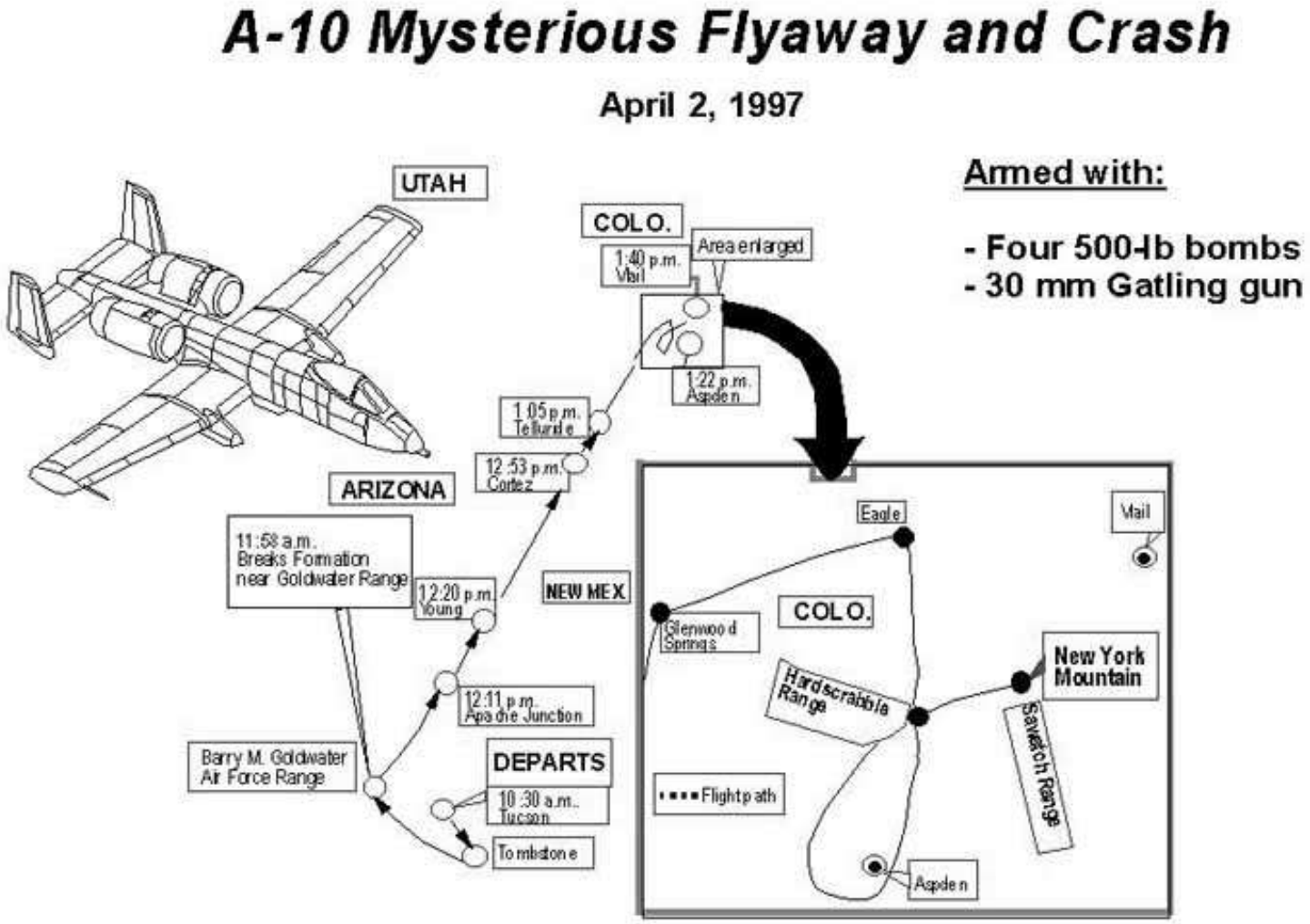

Figure 14a. Captain Button's mysterious flyaway and eventual crash.

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occurred. Sad to say, it did not and it has not. It was lamely speculated that Svoboda probably looked over her shoulder like a rank greenhorn, and inadvertently dived her aircraft into the ground while looking back at the target. If there was one pilot in the USAF who would have not done that, it was Captain Svoboda. At any rate, the KGB determined that the U.S. scientific, intelligence, and governmental communities did not have the foggiest notion of what had occurred.

In private proprietary communications[9] we have explained further, to proper parties, exactly the reasons for these two tests, and what exactly was being tested, and what is its planned strategic use.

The Final Race for Direct Mind Control of the Entire Human Species

The KGB psychoenergetics weapons scientists—because of their direct measurements and detections (and use) of t-polarized waves and LWs for decades—also understand that Jung's collective unconscious mind (of the entire human species) also has its own time-like operations and correlates, which one measures also when using t-polarization measurements and sorting it all out. The collective unconscious mind operations are buried several levels deeper inside the recursive Whittaker structuring inside the EM fields, waves, and potentials.

The KGB scientists also know that something very like Gaia— a collective unconscious mind for all species on earth—also exists, and they are striving to be able to sort out and measure that one as well. The Gaia operations are buried even deeper in the recursive structuring inside the EM fields, waves, and potentials. If one reads some later books by Kaznacheyev,[10] e.g , this human species unconscious mind aspect and the biosphere unconscious mind aspect emerges loud and clear, if one interpolates between the lines, so to speak. Actually, from day one, the Russian mind control scientists have had their eventual goal set upon this "deeper area of mind and possible mind control" of the entire human species.

I am convinced that the KGB psychoenergetics scientists understand this deeper area. If they can learn to directly engineer the collective human species unconscious, they can then convert the human species easily into a sort of "ant" society, modeled along ideal Communism lines, except of course with an excluded "hierarchy at the top" running everything. The "ant society"—communist style—is still a variation of feudalism (all systems tend to feudalism or some form thereof).

The KGB psychoenergetics weapon scientists are seriously pressing on toward that very goal. In my opinion they are not very far from it right now. It is simply a matter of developing sufficiently complex equipment to be able to directly engineer the time-domain substructuring at sufficiently deep levels. It is a doable, although it is very, very complex and very, very difficult. On the other hand, they have been at it for decades. Even in the 50s the Russians already had the old LIDA device,[11] capable of inducing a catatonic trance-like state in a mammal—either a human or a cat,[12] for example. Some versions of Russian mind control devices were used on Russian soldiers in the

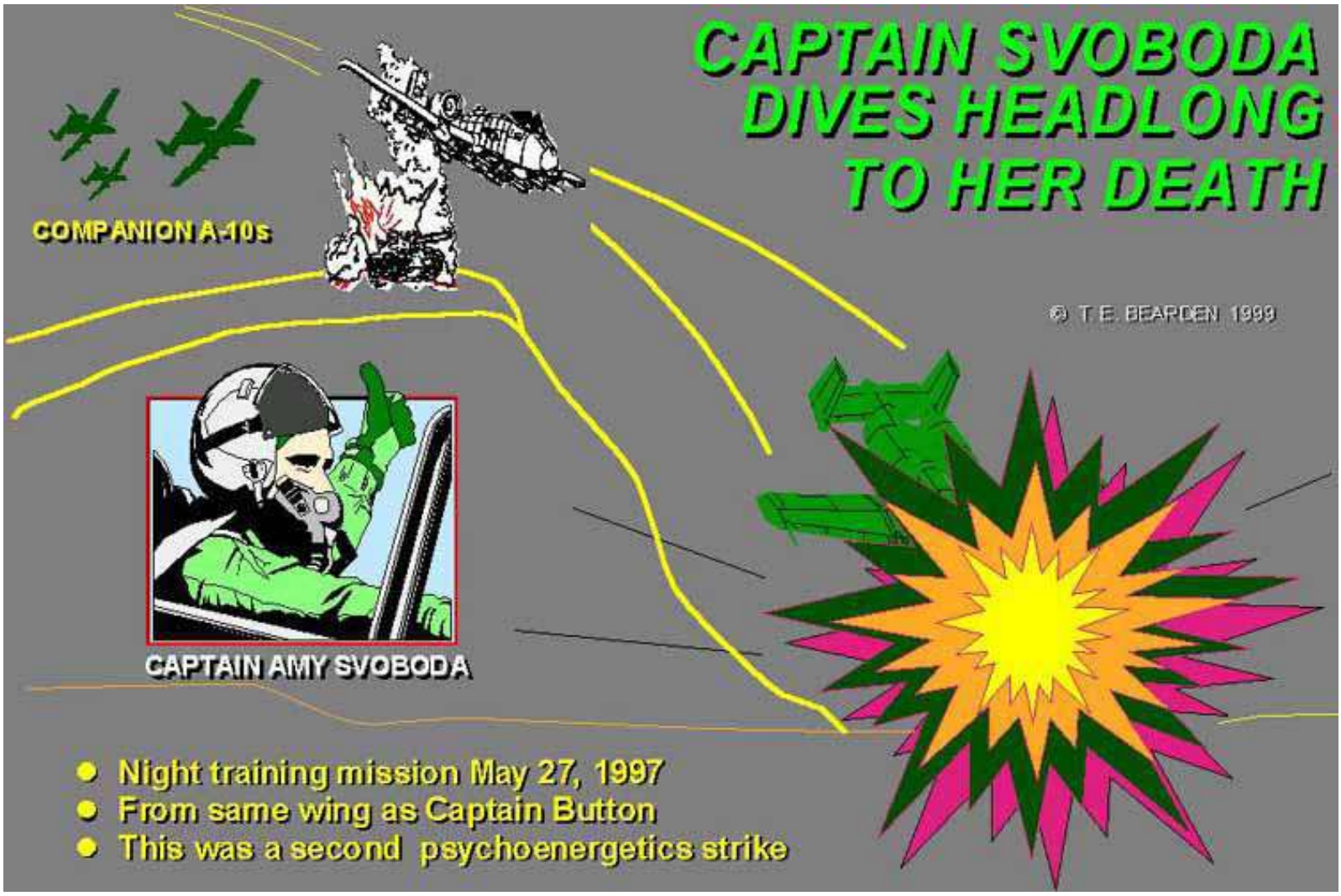

Figure 15. Captain Svoboda dives headlong to her death.

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Afghan War to condition them for performance of merciless acts.[13]

Potential U.S. Rogue Groups and Two Recent Examples

Meanwhile, rogue groups amongst Western clandestine mind control researchers will probably arise if they have not already done so. They will likely seek to increase their personal control and further isolate the programs from orthodox government review and from government and legislative control. They may even divert the research into highly illegal and unethical means, because it furthers their own rogue agendas. That is how clandestine U.S. government research can sometimes go sour, unless great care is exercised by the oversight committees in the House and the Senate.

Sometimes when rogue groups do gain control and total secrecy of a given new technological area, then what appears to be "U.S. government operations" do start to encompass a criminal and unethical operations, hidden usually beneath the deep veil of high classification. Also, if it's "scientific," no one is ever brought to justice, even if the "evil science actions" are uncovered and publicly revealed.

We Certainly Have Proof of Such Rogue Activity. For Example, Here are Two Prominent Cases:

as a result of those ghoulish experiments. So what happened when this gruesome thing was revealed? Again President Clinton publicly apologized! The head of the Executive Branch did not turn the macabre matter over to his Attorney General to prosecute. How many of these scientists were indicted? Not one. How many are going to be indicted? Not one. Suppose again this had been done by a private doctor in his own private clinic. You get the point.

There is Little or No Punishment of Rogue Scientific Groups

Shockingly, the U.S. government at the highest level has directly shown (and these are not all such cases by any means!) that mass crimes against U.S. civilians, *perpetrated by portions of the U.S. scientific community in direct conspiracy and in secret*, will likely be condoned. The perpetrators will not be indicted, tried, or convicted.

Note the connection of the "rogue groups" thesis to the above incidents. Note how rogue **scientific** groups got away with it in both these cases. There may be other rogue

1. For three decades, scientists from the U.S. government, universities, and civilian contractors secretly conspired to treat unsuspecting human patients with whole body nuclear radiation, including some retarded children and cancer patients. Some of those patients—including some of the retarded children—died as a result. These illegal experiments were conducted in great secrecy, and the results were highly classified. Eventually these actions were revealed, and a Presidential investigation committee investigated. These experiments would seem to be little different from the WWII Nazi and Japanese experiments on human prisoners. Are those U.S. scientists who were responsible for those retarded children's' deaths any different from the Nazi scientists and criminals we executed at Nuremberg? So what happened when this terrible thing finally came out into the open? President Clinton publicly apologized! How many of the responsible scientists were indicted for murder? Not one. None is ever going to be.
   Suppose a doctor here in South Alabama, with his own private clinic, had secretly irradiated those human patients and retarded children with whole body nuclear radiation, over a period of 30 years, resulting in some agonizing deaths. How many state and federal agencies would have come after him with arrest warrants? Probably about 50 or so. Would he have been indicted, tried, convicted, and executed or sent to prison for scientific groups getting away with such things today. They should not be able to get away with it. But they can.

Perhaps a most startling additional part of those two incidents is that there was no great public outcry from the scientific community, deploring these murders and demanding that the criminal scientists be indicted and tried.

As the old saying goes, "By their silence they have convicted themselves." The organized scientific community, **as a community**, has shown that it has little or no ethics, and—while deploring any scientific murdering that "gets revealed,"—is not really interested in justice. In short, much of the U.S. scientific community may now have very little ethics left.

We are **not** talking about normal individual scientists, but the Big Science community. There is a whale of a lot of difference between the two. In the Big Science community, there can be and there are rogue groups. Lots of them. There is deep cover, deep classification. And there is very probably advanced mind control research and testing, be it legal or illegal. Hopefully most of it is legal and constrained. However, some of it is almost certain to be illegal and ill constrained.

Human beings are still human beings. All the good and evil is still there, regardless of the group. The stage settings change, but the cast of characters and the play never change.

It's sad, but 'twas ever thus. Hidden parts of our own governments—and other governments throughout the world—are no different from the old medieval groups, where nobles etc. were always plotting against the king, or using the king's power for their own nefarious end. The rogue groups today are no different from all the scheming and conniving groups that

life? Absolutely! Would the President of the United States have apologized? Not on your life; he would have turned it over to the U.S. Attorney General with a strong directive to investigate and prosecute on criminal charges.

2. Again for three decades, scientists from (i) the U.S. Government, (ii) universities, and (iii) civilian contractors conspired to give poor syphilitic blacks in Tuskegee, Alabama a placebo while ostensibly treating them for syphilis. The purpose of the program was to deliberately observe and record the ravages of the disease to its fruition in their wracked bodies. So the scientists deliberately sat there and watched their brains rot and their bodies rot. They kept meticulous notes, of course. It was very scientific. And it was macabre. They "treated" some 400 blacks in the "program." Over 100 blacks died destroyed the Roman Empire. *Great empires fall from within, not usually from without!*

Conclusion

This concludes our brief portrayal of the probable directions that mind control research has taken, in Russia and in the West. It is a novel and powerful area, and it poses both severe dangers and great benefits to all the peoples of the Earth.

Let us hope this great new area, already off to a bad start, can be bridled and steered in the direction of helping and healing people, rather than killing or abusing them. The excesses in its bad use are a potent threat to all nations on earth. Yet it can revolutionize medical science, education, communication, and psychology. Eventually it can engineer the mind and memory directly, beneficially. We foresee the day—perhaps 30 years hence—when education will be

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accomplished *by directly loading the software into the mind.* Then in three weeks one will "load" a doctorate, say, in physics. In three more weeks one will also load a doctorate in chemistry. Another three weeks, in electrical engineering. Another three weeks, an M. D. And so on. When that happens, then truly everyone on earth can be educated. Freedom from ignorance may well be another great freedom that is legally recognized. There will be no impoverished large groups lacking the education to find decent, productive jobs.

We urge all nations to use the principles involved: not for human abuse, but for healing, educating, uplifting, and life-expanding of every person on Earth. If we do, we shall all have a far brighter future. Then we shall check what has started out to

446955, Oct. 23, 1998, forwarded to US. Patent Office on Nov. 4, 1998.

5. A very good introduction to nonlinear phase conjugate optics is given by David M. Pepper, "Nonlinear Optical Phase Conjugation," Optical Engineering, 21(2), March/April 1982, p. 156-183. Also see David M. Pepper, "Applications of Optical Phase Conjugation," Scientific American, 254(1), Jan. 1986, p. 74-83.

6. Pepper, Optical Engineering, ibid., p. 158.

7. See T.E. Bearden, Energetics of Free Energy Systems and Vacuum Engine Therapies, Tara Publishing, Internet node www. tarapublishing.com/books,July 1997. See also T.E. Bearden, "Energetics Update and Summary, " Part I, Explore, 7(6), 1997, p. 60-67, Part II, Explore!, 7(7), 1997, p. 53-56; Part III Explore!, 8(1), I997, p. 53-56; Part IV; Explore!, 8(3), 1997, p. 56-63. See also T.E. Bearden, "Vacuum Engines and Priore's Methodology: The True Science of Energy-Medicine: Parts I and II " Explore!, 6(1), 1995, p. 66-76; 6(2), 1995, p. 50-62.

8. E.g., see R.O. Becker; Charles H. Bachman, and Howard Friedman, The direct current system: A link between the environment and the organism, " New York State Journal of Medicine, Vol. 62,

be the Sword of Damocles and turn it into the golden Millennium.

We are reminded of a poignant quote from Teilhard de Chardin:

"Someday, after we have mastered the winds, the waves, the tides and gravity, we shall harness for God the energies of love. Then for the second time in the history of the world man will have discovered fire."

May the nations of the world utilize the new mind engineering science to truly free all minds into a common love of, and respect for, their fellow humans of every color, creed, and circumstance. As de Chardin envisioned, may we use the new science to discover a new fire, burning clearer and brighter than anything that has gone before. ♦

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Tom is the leading advocate of scalar potential electromagnetics and the Fogal charge-blocking semiconductor: He is involved in alternate energy devices and scalar electromagnetic system prototypes. He has defined charge q as a coupled system of two components, advanced a mechanism for a vacuum engine, whereby the vacuums virtual particle flux is organized and used to energetically shape and manipulate

April 15, 1962, p. 1169-1176. See also R. 0. Becker; "The direct current field: A primitive control and communication system related to growth processes, "Proceedings of the XVI International Congress of Zoology, Washington, D.C., VOL.3, 1963, p. 179-183; —"The neutral semiconduction control system and its interaction with applied electrical current and magnetic fields," Proc. 1lth International. Cong. Radiol., Amsterdam, Excerpta Medica Foundation, 1966, Series 105, p. 1753-1759. See particularly Robert O. Becker and David G. Murray, "The electrical control system regulating fracture healing in amphibians," Clinical Orthopaedics and Related Research, Vol. TBD, No. 73, Nov.-Dec. 1970, p. 169-198.

9. Bearden, T.E., Energetics: Extensions to Physics and Advanced Technology for Medical and Military Applications, CTEC Proprietary, May 1, 1998, 200+ page enclosure to CTEC Letter, "Saving the Lives of mass BW Casualties from Terrorist BW Strikes on US. Population Centers," distributed to selected high U.S. Government agencies and Legislative subcommittees, May. 4, 1998.

10. E. g. , Vlail Petrovich Kaznacheyev, V. I. Vernadsky's Study on Biosphere and NooSphere, 1989 [in Russian]. Vernadskys concepts included living matter, biosphere, and human-transformed biosphere (noosphere). Kaznacheyev writes of evolution and

matter and energy, and advanced a mechanism for a Bohm-type quantum potential, which theoretically allows the engineering of action at a distance in physical systems.
He is president of the Association of Distinguished American Scientists (ADAS), a life member of the Alabama Academy of Science, Emeritus member of the American Association of Physics Teachers, and has served on the Board of Directors of several associations and corporations. Tom is a guitarist, a retired aikidoist (Sandan, Yoseikan style), is happily married and has two sons and two daughters. He and his wife Doris live in Huntsville, Alabama where Tom is retired from aerospace, continues private research, and serves as a consultant to industry on Scalar electromagnetics processes.

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1. Owen Flynn, "Parametric arrays: A new concept for sonar, "Electronic Warfare Magazine, June 1977, p. 107-112.
2. Valerie Hunt, presentation to the U.S. Psychotronics Associations Annual Symposium, Bergamo Center, Ohio, 1988. Hunt presented epochal work showing chaos—and thus hidden order—in recorded ELF electromagnetic radiation from human bodies. Hunt split the received EM signals into two identical channels, time-delayed one channel by a very slight amount, then recombined (mixed) the nondelayed and delayed signals. The result was that attractors precisely indicative of chaos appeared. This positively proves that human systems produce ordered time-organization of the living matter as the biosphere of the earth. Without specifying the exact technical details, Kaznacheyev discusses the gist of much of what is in this present article. The present author has an autographed copy of Kaznacheyevs book referenced above.
11. Rabichev, Lev Yakovlevich; Vladislav Fedorovich Vasiliev; Alexandr Sergeevich Putilin; Tatyana Grigorievna Ilina; Petr Vasilievich Raku; and Leopold Pavlovich Kernitsky, "apparatus for the treatment of neuropsychic and somatic diseases with heat, light, sound; and VHF electromagnetic radiation," U.S. Patent. No. 3,773,049, Nov. 20, 1973. This is the U. S. patent for the LIDA machine, developed by the Russians prior to the Korean War. Additional patents or applications are as follows: Italy, #619,129, March 1961. Germany, #1,183,607, Dec. 1964. Great Britain, #826,766, Jan. 1960.
12. Stefan T. Possony, "Psy-War: Soviet Device Experiment," Defense & Foreign Affairs Daily, 12(104), June 7, 1983, p. 1-2. Reports on Dr. Ross Adey's investigation of the Soviet device called LIDA which is used to bombard human brains with radio waves in the 40-MHz region. Also reports on work by A.S. Davydov of the Ukrainian Academy of Sciences, who discovered how the blood-brain barrier can be penetrated by low-frequency radio waves so that brain cells are affected. See also "Soviet device uses radio

structuring of EM.

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4. T. E. Bearden, "Alteration of Materials by Wideband Multiwave Irradiation Combined with Selective Emission Manipulation," Invention Disclosure Document Number

waves as tranquilizer, " Associated Press release, Huntsville [Alabama] Times, May 19, 1983. Dr. Ross Adey tested the Soviet LIDA machine on a cat, and in two or three minutes the cat was sitting quietly, almost as though transfixed, and uninterested in its surroundings. The animal remained uninterested in its surroundings for some 20 to 30 minutes after the machine was turned off.

13. "KGB Used PIS to Program Soldiers, "Resonance, No. 30, Mar. 1996, p.29. Quoting: "During the 1970s, the Soviet KGB developed a Psychotronic Influence System (PIS) that was used to turn people into programmable "human weapons." Soldiers fighting in the Afghan conflict were trained using the system which employs a combination of high frequency radio waves and hypnosis. Commands are activated by code words or cyphers. The purpose of PIS was to render regular soldiers and members of the special forces incapable of feeling sympathy.

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The Tom Bearden Website

Latest cloning research findings by Bedini/Bearden

The huge dangers of current cloning technology

Mystery of the death of Australia's cloned sheep explained

"Spark of Life"

From "Stranger than Science"

by Frank Edwards © 1959, 1987

Did an obscure amateur scientist discover the spark of life? Did Andrew Crosse accidentally stumble upon a mixture of chemicals and electricity which produced living things from a lifeless compound? If he did not, then just what did he accomplish? The record of his work is clear, only the enigma of the results remains to plague science.

The neighbors of Andrew Crosse regarded him as more devil than man. They did not understand the bright flashes that lighted his laboratory windows at night when he was tinkering with his crude electrical devices. Not only was he dreaded and shunned as "the thunder and lightning man," but he was denounced as an atheist, a blasphemer, and a Frankenstein who had best be put in chains for the common safety.

Andrew Crosse minded his own business, it is true, but his was a very strange business for the early 1800's. And one of his experiments remains a very strange business to this day.

Andrew was an enthusiastic amateur experimenter in the new field of electricity. Out of touch with others in the same work, he labored under the double handicap of not knowing what had already been done - and of not understanding what he was doing himself. Yet it may have been this very lack of knowledge which led him to undertake the experiments which were to inscribe his name, however faintly, in the annals of science.

He decided to induce the development of artificial crystals by subjecting chemicals to prolonged exposure to weak electrical currents. Andrew mixed up some silicate of potash and hydrochloric acid and into this he dropped a fistsized chunk of oxide of iron. By inducing the current from a small battery to trickle through the solution to the oxide of iron,

he hoped to bring about the growth of artificial crystals of silica.

Having arranged this combination of chemicals and current, Andrew set it aside and went back to his favorite pastime of studying the spark-gap - the flashes which alarmed his neighbors.

Did he accidentally stumble upon an arrangement which created life from inorganic matter?

In a paper which he wrote for the London Electrical Society in that same year of 1837, Andrew set down this account of his experience.

He wrote "On the fourteenth day after the commencement of this experiment, I observed through a small magnifying lens a few small whitish specks clustered around the middle of the electrified stone. Four days later these specks had doubled in size and had struck out six or eight fine filaments around each speck . . . the filaments longer than the hemisphere from which they projected.

"On the 26th day of the experiment, the objects assumed the form of perfect insects, standing erect on the bristles which they were growing. Although I regarded this as most unusual I attached no singular significance to it until two days later, the 28th day of the experiment, when the magnifying lens showed that these things were moving their legs. I must say now that I was quite astonished. After a few more days they detached themselves from the stone and moved about through the caustic acid solution.

"In the course of a few weeks more than a hundred of them made their appearance on the oxide of iron. Under a microscope I examined them and found that the smaller ones had six legs, the larger ones had eight. Others who have examined them pronounced them to be of the genus acari, but some say they are an entirely new species.

"I have never ventured an opinion on the cause of their birth for the reason that I have never been able to form one. I thought they might have been airborne creatures that had drifted into the liquid and prospered, but later experiments with closed vessels, in which the ingredients had been purified by baking in the oven, produced identical creatures; therefore, I suggest that they must originate in the electrified liquid by some process unknown to me."

Andrew Crosse realized that he was walking a tightrope before the top scientists of his day. He was describing an experience foreign to their accepted understanding and therefore he was inviting ridicule. He did not have long to wait. Cries of fraud and hoax engulfed him. He and his alleged insects were denounced as nothing more than humbugs.

Amid all the furor that his announcement had created, Crosse stood alone and helpless. Even other scientists who had duplicated his tests with similar results kept their silence.

All but one. That voice was raised in his defense and it was such a powerful voice that none dared challenge it; for it belonged to the great Michael Faraday. At last Crosse had found his champion.

Faraday reported to the Royal Institution that he too had experienced development of these little creatures in the course of his experiments. But he added that he could not decide whether they had been created in the sterile solutions or brought back to life by the electricity! Either development would have constituted a milestone in scientific advance, as Faraday realized, but he left it to his fellow scientists to make the decision, if any.

Crosse never claimed to have discovered anything. He was merely reporting what had happened. After the attacks upon him subsided, he retired to his home in the Quontock hills for many more happy years among his test tubes and batteries.

Although he spent his long life as a humble searcher after scientific truths, the contribution for which he is remembered is the controversy over his acari - unwanted then, and unexplained to this day.

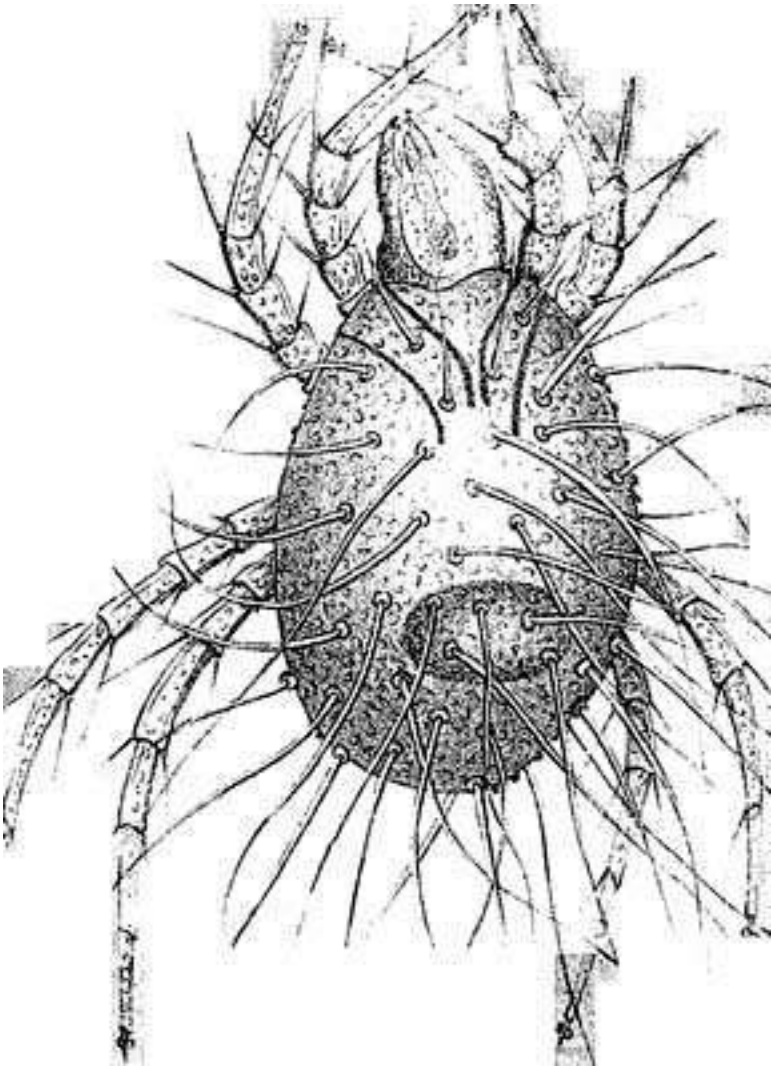

Genus Acari

Tom Bearden comments (finalized and slightly updated in March 2001).

It is difficult to make an understandable comment on the business of life, because presently scientists have not the foggiest notion what mind, being, life, death, time, etc. are. For that matter, they don't really know what matter and energy and charge are either. In the scheme of things, our modern "science" is only about three hundred years old, and that's a snap of the finger in even just the existence of this world. Much of modern science still considers the mind as a "meat computer", or just the physical electrodynamic activity of the brain, etc. Materialism has not died, even though quantum mechanics essentially wiped it out decades ago, and the old concept of "mass" as something hard, permanent, and "material" has also long since vanished. One is referred to the works of Max Jammer to see what the present view of "mass" is. Also, without looking up the references again, recent experiments with quarks and gluons wound up with experiments in which it mattered not a whit whether one considered the mass as zero or nonzero. Nature, it seems, does not have to play by our usual "either-or" rules. In physics, of course, this is the duality problem, which to this day has not

been resolved because attempts to resolve it have applied Aristotelian logic -- and there is no solution to the problem of "opposites being identical" in that logic, which forbids that very thing by authoritarianism.

The modern biogenesis experiments, e.g., never took place in the absence of life. There was no "statistical generation of living or quasi-living forms" in the absence of engines for such forms. The great rush of Poynting energy flow around the earth, generally parallel to the equator, alone carries the "engines" (internal sets of spacetime curvatures) for every form of life that ever existed upon the earth. So the experiments were bathed in "living forms and dynamics", if one accounts for the internal Whittaker-structuring of electrodynamics -- noted but ignored by our scientists for nearly 100 years.

Quite some time ago, we worked out the nature of mind, and the mind-matter coupling mechanism (which is engineerable). We did that in pursuit of the mechanisms in the KGB/ Russian psychoenergetics weapon work. I had the last of a 3-part article published in "Explore", dealing briefly with mind control technology both the way it is probably done clandestinely in this country and how it is done by the KGB/Russians. I'm still trying to get the proper parties to believe it; not much progress. However, some very neat information has been released on the Internet that very probably reveals why officially there is no interest. It's because three decades ago some of our "spooky folks" found (in deep hypnosis experiments) that humans are inordinately sensitive to extremely low-level EM signals and fields. Even though no detection or sensation may rise to the conscious level, the unconscious (which is totally conscious, just massively parallel rather than serial) does sense these signals. Voila! It would appear that "very deep black" parts of the community probably developed quite good mind influence and mind and behavior control or interference using techniques adapted from that work. The reader must always remember that just because the *overt* government does not know something or have something, does not at all mean that the *covert* government doesn't have it. And even in the covert government, there are layers within layers. So there, even when the upper levels do not have something, it still does not mean that the deeper levels do not have it. The problem with the best knowledge and technology, when unknown to the upper covert levels and the overt level, is that it is then quite likely to be subverted into the deepest levels, which may have their own agendas and may not report to the duly elected U.S. government at all. Indeed, such levels often assume that the President himself does not have a "need to know".

Present physics has erroneously omitted the time increment carried by the photon. The overemphasis on the so-called transverse wave (which does not exist as such in vacuum, fairly readily shown) has led to our missing the greatest and most important part of electrodynamics: the longitudinally polarized EM wave and the time-polarized EM wave. For example, mind and mind operations are totally electromagnetic, but use time-polarized EM waves rather than the standard stuff. Overtly we do not even have detectors for LPWs and TPWs yet; the Russians do. However, every major weapons lab on earth now is aware of longitudinal EM waves and their powerful characteristics. Simply read some of the

summary material on Undistorted Progressive Waves (UPWs) on the Los Alamos National Laboratory website, e.g. by Rodrigues et al. A UPW is an "imperfect" longitudinal EM wave with some remaining transverse wave residue (that is the way it is modeled).

Let me give you one example of how fouled we are. We still use Aristotelian logic primarily. Yet it is an incomplete logic. Let me show you instantly. Take the simple Venn diagram of a rectangle lying on its side, divided in half by a vertical line in the middle. Label the right rectangular area A. Label the left rectangular area "not-A". What is the line in the middle and the border? Both A and not-A, so that A is identical to not-A. Yet the third law (law of the excluded middle) forbids A identical to not-A. Apply the third law to the Venn diagram. The border disappears, and the middle dividing line disappears. The logic self-destructs, because now there is no separate A and no separate not-A. Yet so far as I can determine, no one seems to have seen that very simple thing and questioned it. Aristotelian logic cannot be applied to the very Venn diagrams used to establish and "prove by demonstration" its propositions. We corrected that nearly 20 years ago, and got called every kind of lunatic imaginable -- the usual reaction when something fundamentally wrong is pointed out in a comfortable part of the prevailing paradigm. These days I simply point to Morris Kline's "Mathematics: The Loss of Certainty" to the Aristotelians, and tell skeptics to go and read it and then we will discuss the foundations of logic. With a 5-law logic (or 4-law with an additional applications rule), one solves the "dividing line" problem nicely. Then suddenly things like spacetime and being and mind and nothing etc. can be solved -- in the 5-law logic, but never in the 3-law logic. The problem of life itself -- whether terrestrial or extraterrestrial -- has no solution in 3-law logic.

The entire method of Zen is to try to break up the iron Aristotelian bent of the conscious (serial processor) mind, and get into the far broader unconscious (totally conscious, massively parallel processor) mind. Few have done that. But one cannot present a 5-law solution to a 3-law processor; it just "does not compute". It's like putting a thousand slides at once on the normal "single slide at a time" projector. The "conscious mind" can see only a single slide at a time. So it just sees "black" or "nothing at all". That's why we "see" the "massively parallel conscious" mind as "unconscious"! It isn't. But it is a quite different *form* of consciousness which we all have.

Time is never observed, and no observable is a *cause*, a priori, because an observable is only a frozen, nonchanging 3-spatial "instant snapshot" and therefore the *output* of the observation process, while the *causal input* is what exists in 4-space prior to its interaction with the observation process. When one adds time and time dynamics to one's science, one moves far in front of much of present Western physics. E.g., physics has nearly hopelessly confused the *causal* side of the observation mechanism/process with the *effect* side, everywhere, throughout physics -- simply by assuming that observables persist in time -- a non sequitur since an observation is a frozen 3-space snapshot at one single instant.

And sadly, the physicists do not seem to have even realized it!. Not a single paper or text in

the West, e.g., illustrates an EM wave in spacetime prior to its interaction with a unit point charge. E.g., simply check a fine editorial by Romer. Romer is the editor of American Journal of Physics, and we are referring to Robert H. Romer, "Heat is not a noun," American Journal of Physics, 69(2), Feb. 2001, p. 107-109; and specifically to his end note #24, p. 109. Romer takes to task *"…that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/or time?) that besmirch the pages of almost every introductory book. …it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate." "…perhaps then, for historical interest, [we should] find out how that diagram came to contaminate our literature in the first place."*

But in general physicists continue to charge on, confusing effect as cause. Electrodynamics, e.g., is particularly guilty of greatly confusing the two, which is really what is preventing a successful and engineerable unified field theory. Further, contemporary classical electrodynamicists do not calculate either the field or the potential; instead they calculate the *reaction cross section* of each, interacting with a unit point charge assumed out of nowhere. In short, they calculate how much is diverged from the actual field or potential, and then call that "little extracted part" the field or potential! Again, they mistake the causal entity existing before the interaction with the effect entity existing after the interaction. Well, after the interaction has occurred, that result is the *effect*, not the *cause prior to interaction*. Physics has this so hopelessly snarled that it will require 50 to 100 years before the journals and physics societies are likely to even realize it and admit it, and then it will require them another 50 years to straighten it out and purge this huge non sequitur from physics theory and modeling.

Anyway, we did model how mind and mind operations operate, including their precise nature, how they fit into all this, etc. We thus were able to resolve many previously unsolved riddles such as the nature of intent, how a space-less mind operation can generate a spatial input to a spatial body and vice versa, etc. We also worked out how to use "effects" systems to generate "causal" systems, completely independent of mass -- because the KGB has recently completed a completely different kind of weaponry based on this, and different from anything that has ever existed in the history of mankind (at least on this planet!). The Russians of course were already there; I got there much more crudely by intensely working on how to explain what they were doing.

To see that the effect can generate the cause, just consider the normal "forward time" observation process having to operate in a "time-reversed" process. You see, not only must we shift observers from frame to frame, but we must also be able to shift them from forward-time (of some conveniently chosen outside reference observer) to reversed time (of that same reference observer).

At any rate, it turns out that the entire universe is already "alive" in a very special sense. There is no death; there is mind (I use the term "mind" in the most general sense, not just the conscious mind which is merely a "periscope" put up and taken down from the

unconscious). And mind is not a part of the brain, and it is indeed separated from body but intimately linked to it by the mind-body coupling dynamics. Further, any life that has "ever existed" still dynamically exists in a special kind of more fundamental electrodynamics infolded inside all normal EM fields, waves, and potentials. The Tibetans knew much of this very well, but of course in terms that our materialistic science rejects or completely fails to understand (as we stated, most of our scientists believe the human is a robot and the mind is simply the electrochemical reactions of a "meat computer"!).

Since ambient spacetime may be modeled as a special kind of "scalar" potential with intense energy density, it then decomposes into a series of bidirectional EM longitudinal wavepairs, a la Whittaker 1903, except one must use impulse waves so as to include the time dynamics part of spacetime, rather than forcefield 3-space type waves. The entire thing -- mind, life, matter, fields, waves, spacetime, etc. -- then becomes structurable and directly engineerable by novel EM means (such as the O(3) higher symmetry electrodynamics pioneered by Evans and Vigier). Longitudinal EM wave technology is the key to developing such mind-body coupling mechanisms and engineering of them, at all. One only gets the time-polarized EM wave technology *after* the LPW technology has "done its thing" -- the time-polarized technology is far and away the most powerful and primary.

Also, low frequency photons have far more energy than high frequency photons, if one includes the time component, since time is spatial energy compressed by c-squared and has the same energy density as mass. Time-energy (highly compressed spatial energy, compressed by c-squared but in the time domain rather than in 3-space) and spatial energy in the photon are canonical. As the frequency of the photon decreases, its spatial energy decreases also with the decreasing frequency. However, the time-energy component increases, and its compacted energy increases as the square of the time-component expressed in seconds. Hence at lower frequencies the total energy (sum of spatial energy and time energy) in the photon increases. Indeed, if one wishes to engineer gravitational effects, it is the low frequency photons (low ELF) that are important, because they have far and away more "spacetime curving energy" than high frequency photons such as gamma rays.

At least eight nations on earth now have longitudinal EM wave technology weapons to one extent or another. Several of them -- hostile to one another -- are using Western Australia as a convenient nearly uninhabited target range.

Anyway, when you come at the mind-body-life problem with that background (which unfortunately required more than 20 years of very hard work!) there appears to be no great difficulty in explaining the Faraday, Crosse, Fox, Miller, and Urey biogenesis experiments. And yes, there appears to be no difficulty in explaining the "appearance" of "life on earth" in the prebiotic soup. It did not really appear out of nowhere spontaneously at all, but simply was a sort of sympathetic resonant coupling of physical forms to mind-forms already there. None of the experimenters realized that the great Poynting energy flow (and one must add back in the missing Heaviside component which is some 10exp13 times larger than the

accounted Poynting flow) around the earth parallel to the equator and from West to East, is already internally structured with every possible form of life ever in the universe anywhere. If we further multiply that Heaviside component by c-squared, so that we can account for the time-energy portion of that great energy flow, we can see immediately that life and its environment are both living and intercommuting all the while. The creator in fact created a living universe, not an inert one (as best we can speak it in the inadequate 3-law logic). If one believes in big bangs, then life structuring emerged right along in all the fields and waves and energy, right in and out of the big bang. There is not a single point in the universe anywhere that is absent of energy and therefore absent of life, in the view of the model I am using.

Understand, one does not have to agree with this model! That is one's own decision. We are just pointing out that, if we correct many of the errors known to be in the presently used models, this is the kind of reality that readily emerges. We get a physics that is not just an "inert" physics, but a living physics where literally the entire universe is "alive" in very special manner.

In deciphering (after 14 years!) the Priore mechanism, I found that incredibly the cellular regenerative system does retain the form and "memory" of all the precessor cellular forms. Cancer, in fact, is very often due to a direct "order" by that system to a cell (aerobic) to start back down the "chain" to an anaerobic cell, because of severe hypoxia and the sustained inability of the regenerative system to maintain the cell in aerobic form. It doesn't just send an "order", but sends a "precise set of spacetime curvature engines" that go to work on that cell and all its parts. The first major step back is to break it loose from centralized control of its growth -- whereupon we recognize it as a tumor cell. There are two requirements: (1) cellular damage, and (2) "promotion". Biologists do not really understand "promotion", because they do not understand the cellular regenerative system—which used time-polarized EM waves, and nonlinear optical pumping of the cell and all its parts in the TIME-energy domain rather than the SPATIAL energy domain. That sort of pumping creates an "antiengine" to its forward time engine resident in the sick cell, thereby time-reversing the cell and all its parts back to a previous state on the trail from the early anaerobic single cells to the present aerobic cells.

By the way, recent experiments in cloning are beginning to bear out the fallacy that exact electrochemical processes produce the same end physical results, particularly when the persistence of the created forms is examined. E.g., cloned rats may live half their lives in apparently normalcy—then suddenly grow greatly obese and die. Many other anomalies are being uncovered in this fashion. The reason is quite simple: We have some diagrams showing that one may introduce an additional "engine" to the pumping of a diseased or damaged cell (or a healthy one for that matter), and in the time-reversal process then induced, the "time-reversal" process will be diverted from the original trajectory. In short, the original full state will not be recovered.

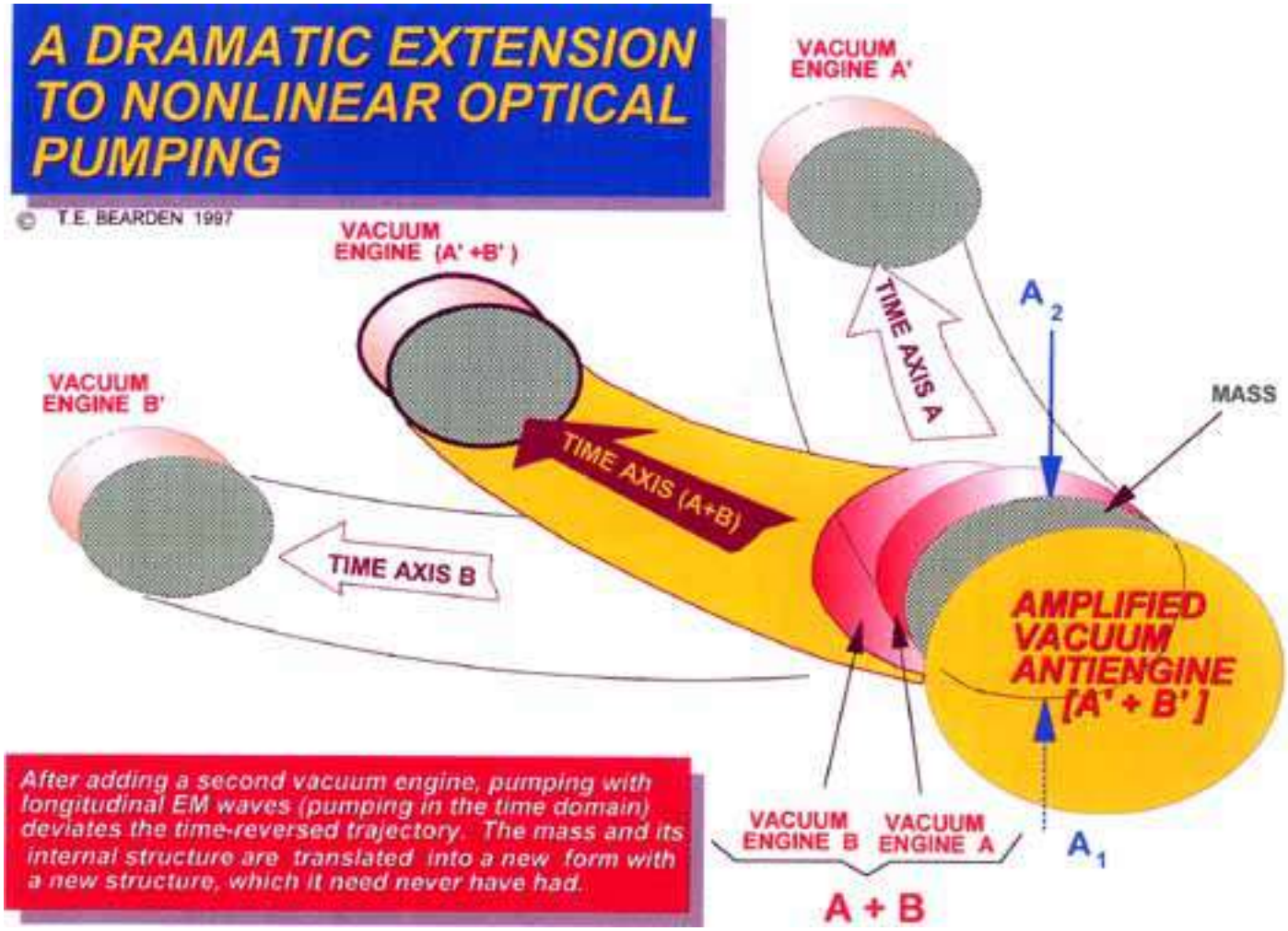

This, we pointed out, is a second generation technology to be developed, where a disease or disorder must be treated and where also there was never a normal past state anyway. A case in point is birth defects, etc. Eventually, if the technology ever is allowed to be funded and developed, even those kinds of medical conditions will be treatable and curable. The point is that in cloning, one does not use the normal sperm cell and egg, without abnormal disruption. There is indeed an abnormal disruption -- and every such physical action or change and dynamics certainly involves an additional set of engines. In short, with present methods the cloned entity also has introduced into the equation an additional "engine". In the fertilization process, there is quite a jump back to a "time-reversed" situation (fertilization is the beginning of a physical embodiment, hence from two parts of an embodiment already in being, there is a rather dramatic "jump backwards"). The "normal" backwards jump of that kind is a normal fertilization of the egg by the sperm. Any change to that procedure, represents the insertion of an abnormal engine to be processed in that same "jump back". For the methods being used, it appears that the abnormal engines are sufficiently weak that, in the cloned animal, some time must expire in its lifetime before the impact of that little constant deviation from normal grows to become suddenly significant.

Indeed, all "living forms" are materialized from energy, but from both matter-energy and time-energy and the dynamics of the two. Natural processes include fertilization, birth, etc.,

but there is no technical reason whatsoever that the process cannot be direct and even directly engineerable. In this "expanded energy" sense, mind energy and dynamics can be engineered as well as body matter energy and dynamics.

To cinch the matter of "engineering living forms", I once participated in a accidental and unplanned experiment where Golden materialized living things. Not little bitty things, but big things. In my view we actually materialized thought forms, since much later we were able to piece together exactly what apparently engendered each part of the phenomena. There were multiple (scared) witnesses who prefer never to discuss it. The experiment also altered all the clocks in the area for four days before the "time-energy charge" we had inadvertently created dissipated. Let me just say that it really got my attention! We never repeated that experiment again. But the changes were substantial and the phenomena were substantial, and to this day I prefer not to discuss that experiment. It simply cannot be understood without the outline sketch we are speaking of, where one accounts for time-energy and dynamics as well as material energy and dynamics, and also for the coupling dynamics between the two.

Not only can one have a "material entity" or thing communicating with another "material entity" or thing, but one can also have a "mental thing" (time-domain thing with no spatial existence) communicating with a "material entity or thing" with only spatial existence, and vice versa. There is indeed a coupling two-way mechanism

Look at the so-called "physical form" -- which almost always one is speaking of as purely 3-space. Most scientists have not yet understood that a priori a piece of 3-dimensional mass *as observed* cannot even persist in time! Masstime exists in time, but "mass" is a frozen 3-spatial intersection of the spacetime entity. It is exactly comparable to a frozen frame in a movie film. The individual frame never has any existence except at a frozen moment in the slide projector. "Motion" and "movement" etc. involve the time domain a priori -- hence something without any time-component at all, cannot persist or even exist except at one frozen moment in time. Hence any observable existed in that single "observation slice" and at that "point in time" only. After all, a "point in time" is where time symmetry is broken or ceases. In short, it is a time-discontinuity. All observations are such time-discontinuities.

The SETI problem will not be solved, in my personal opinion (understand, I do not object at all if others do not see it this way) until a far greater and deeper understanding is reached by our modern physics. Forget communicating with "transverse" waves; longitudinal EM waves can travel at any velocity, limited only by how much "residue" of the normal EM wave junk is still hanging in there (how much "transverse EM wave noise" is still present. A pure LW moves at infinite velocity. As we suggested, simply download the Rodrigues and Lu papers carried on the Los Alamos National Laboratory Web site. It appears that now most major weapon labs have "discovered" the fact that there can be longitudinal EM waves, and some eight or so nations have developed weapons technology from such. If one has such technology, all the rest is obsolete.

For the skeptic, here is a statement made in 1997 by Dr. William Cohen, then Secretary of Defense:

> *"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts."*
>
> [Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.].

Any technological civilization that has not solved the fundamental "self-killer" problem of the technological species, must and will self-destruct. This follows from simple servo-mechanism theory, as we have previously pointed out. The KGB is working on a "solution" that is far along: engineer the entire human species quantum potential so that the human species can be turned into an "antlike" species, which of course would be the "ideal" communist state, in the minds of many Communist party theoreticians. Our guys haven't even got started on engineering the quantum potential yet. They have not yet even discovered the big ball park, let alone the big ball game.

Anyway, that is just some comments for your personal information. What really is happening in the "hidden weapons" area and "hidden weapons science area" is already so advanced in some quarters that science fiction pales by comparison. The real question is whether we shall survive very much longer, and whether we shall mature rapidly enough to begin to use these technologies for the benefit of humanity, rather than for its destruction.

Sincerely,
Tom Bearden

Additional Comments from Tom dated 9 July, 2001

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The Tom Bearden Website

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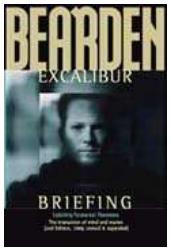

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EXCALIBUR BRIEFING

THE NEUROPHONE

Another device that uses the new hyperspatial, virtual state, nested modulation technology (and has done so for seventeen or eighteen years) is Dr. Pat Flanagan's neurophone. With brilliant insight and intuition far beyond that of science at the time, Pat invented and patented the instrument by the time he was seventeen years old. The neurophone is a device that, contrary to all present theory and knowledge, will directly "pump the brain" and reproduce sound and information directly in the brain and mind system, without going through the auditory system at all. A simplified diagram of Pat's improved neurophone is shown in Figure 11.

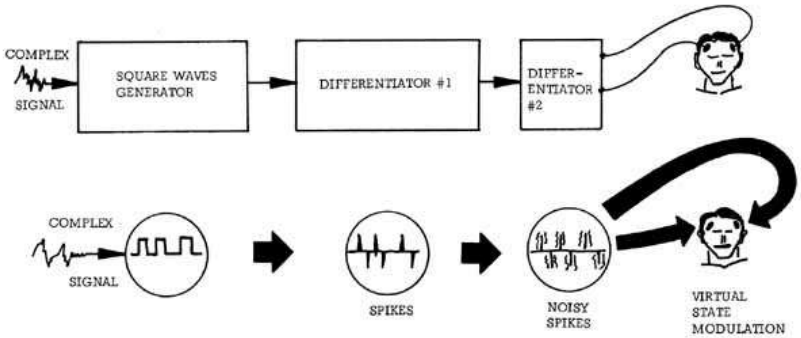

Figure 11. A simplified diagram of the improved Flanagan neurophone

Briefly, the device takes a complex signal, such as the sound of an orchestra playing a musical interlude, and electrically processes it as shown in the figure. First the signal is passed into a section that clips everything into a series of square waves, remarkably analogous to the sort of clipped waves Lisitsyn confirms are the information carriers of the human brain. Next the square waves are differentiated, yielding a series of sharp spikes (note that these spikes retain the pulse-time content of the clipped signal). These spikes are again differentiated, and since these are finite spikes with real nonzero rise times and decay times rather than theoretical constructs, a series of noisy spikes results from the second differentiator section. From here, the noisy spikes are introduced to special contact electrodes, one of which is normally placed on the forehead, while the other may be placed almost anywhere, including on the foot. Nowhere are any sound waves introduced to the head.

The square-wave clipper section reduces the complex signals, their overtones, and their complex modulations to square waves, retaining the temporal content of the wave mix but not the waves themselves. The first and second differentiators heighten or filter through the temporal content of the higher-order differentiations, that is, they serve as a band pass filter unit to accent the time keying of the neutrinic and mindfield portions or aspects of the signal. When these time spikes are then introduced across the body as pulsed voltages, they are modulated directly on the dendrite firings of the brain and nervous system, providing direct and pulsed modulation of the neutrinic and mindfield component channels of the mind-brain-consciousness-life loop itself. Thus the neurophone directly inputs information into the brain and nervous system, bypassing all the normal sensory systems that lie between

the mind-brain loop and the outside environment.

Indeed, a similar development has been reported by two University of Missouri researchers. Dr. Donald York, a neurophysiologist, and Dr. Thomas Jensen, a speech pathologist, have recently reported identifying and decoding twenty-seven words and syllables in specific brain wave patterns and correlating these electroencephalographic patterns with both the spoken word and the silently thought word in about forty subjects. At present, Dr. York and Dr. Jensen are programming a computer with a brain wave vocabulary, to monitor and read the EEG of a stroke victim's brain and help stroke victims who have lost their powers of speech to communicate.

While all such developments can obviously be misused, their potential for assistance to mankind is enormous. Indeed, my own premise that brain linkage is possible and can be used to advance all mankind to the sixth stage of species evolution is slowly being proven. It is within our reach now to develop a multi-channel communications system that will directly link brains, minds, and consciousness into a single functional being; and I have already pointed out that the psychokinetic power of the emergent entity increases exponentially with the number of linked stages. The normal corpus callosum linkage of the two cerebral halves in each human head proves that brains, minds, and beings can be linked and integrated into one.

The Excalibur Briefing details the basic concepts of the theory involved in hyperspace-virtual state engineering, and thus in the engineering of mind-life-consciousness links to multicellular organisms here on earth. Pat Flanagan's neurophone proves that complex information can be implanted directly in the brain and mind, bypassing the normal isolating barriers. Drs. York and Jensen have shown that the brain wave does indeed contain recognizable, decodable information analogues. Lisitsyn has already reported measuring the number of independent channels involved and has documented the importance of the clipped brain waves as opposed to the sine-wave content. If we have the vision, we can still develop a brainlink and rapidly apply it to link sixty to one hundred persons, thereby opening a conscious, multidimensional "eye" for the collective human unconsciousness, gently rousing ZARG into wakefulness, and fulfilling human destiny without undergoing the psychotronic Armageddon planned by the Soviets. The time is short, but it can still be done if the funding, the vision, and the team can be established on a crash priority basis.

SOVIET "WOODPECKER" SIGNALS

But, as I have said, all this can be used for the detriment of mankind as well as for its benefit. Unfortunately, it appears that the Soviet Union has chosen to weaponize the effects on a global scale. A prime example is the "woodpecker" signals emanating from the USSR in the 5-30 megahertz region and interfering with communications around the earth.

These complex woodpecker signals appear to originate from two or three dozen powerful Soviet transmitters, each with a power estimated as high as 40 megawatts (Figure 12).

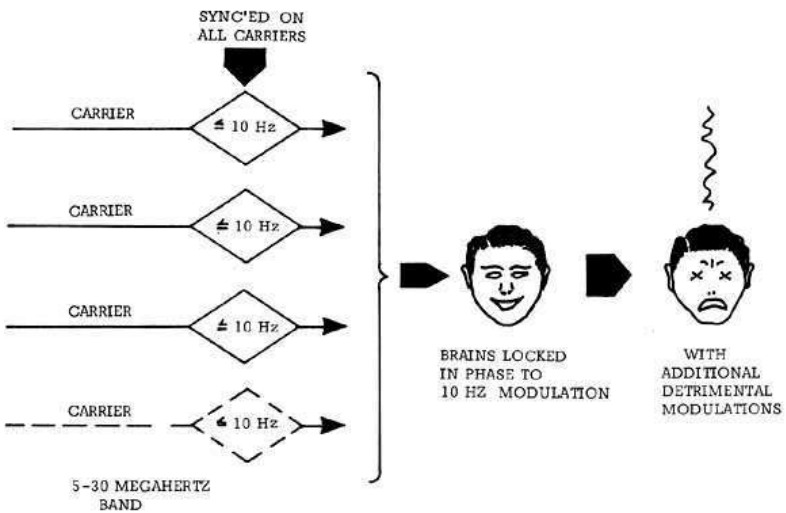

Figure 12. The Soviet "woodpecker" signals

The pioneering experimental measurements of these signals by Dr. Robert Beck and William Bise have shown just how deadly a potential may be possessed by the signals. These measurements have been performed in Eugene and Portland, Oregon; Los Angeles, California; Huntsville, Alabama; and several other locations. They have been particularly significant on the West Coast in and around Eugene, Oregon because of the presence of a direct current transmission line several hundred miles long, which has acted as a long wire antenna, picking up the signals and rebroadcasting them with appreciable gain in the vicinity.

Typically the signals may be found on, say, sixteen different carriers between 10 and 20 megahertz. Twelve of the carriers may appear normal, with normal side-bands, and the other four may have the carrier and both sidebands suppressed but still show the biologically significant modulation (for example, 10 hertz). On all sixteen channels a strong 10 hertz modulation may appear, all perfectly time synchronized and in phase channel-to-channel. The received signal from one of these carriers may be twenty-five to thirty times as strong as the earth's back-ground magnetic field, which is oscillating at approximately 7.0 to 7.5 hertz. Other complex modulation frequencies, many of them changing, are present on the various channels.

Normally, the brainwaves of mammals in an area are gently entrained by the normal oscillations of the earth's magnetic field and are oscillating along at, say, 7.5 hertz. Under continuous radiation from the Soviet woodpecker signals, a percentage (say 30 percent) of the mammalian brains may be captured by the 10 hertz modulation on the overpowering Soviet signals. These captured brains are now in forced oscillation and are riding along in phase with the 10 hertz Soviet modulation. In other words, a certain percentage of the human brains in an area will phase lock to the 10 hertz modulation, and that will effectively lock into those brains the sixteen carrier frequencies with their concomitant frequency mixes and complex signal modulations. If the signals are made much more powerful (for example, by focusing them onto one particular area or increasing the power of the transmitters), then a much higher percentage of brainwave entrainment can be accomplished in the targeted area. By simply adding on the desired modulation patterns, the Soviets can now pump material directly into the mind-brain-consciousness-life loops of the entrained brains. The weapon implications are enormous: raw emotion such as sheer terror or panic can be transmitted; death or disease patterns of all kinds can be transmitted; informational content (thoughts and ideas) can be impressed directly into the captured brains and minds and processed as if originating inside each brain itself. Indeed, as long as the Soviets keep the effects rather gentle, an entire population can be subtly influenced without governmental notice. Certain specific ELF frequencies can rapidly disable or even kill, and for wartime use those frequencies can be directly implanted in the captured brains themselves by the woodpecker signals. It appears that 1984 came a little early, and one can perhaps now understand Brezhnev's strange 1975 proposal to the SALT negotiations that we should also consider outlawing the development of new weapons more frightful than the mind of man has ever conceived.

The signals also have direct application against strategic targets other than personnel. For example, by incorporating the correct nested modulation pattern, the positron kindling (electron squelching) pattern can be impressed. By beaming through the earth (with a circularly polarized signal or with other complex modulation forms), a beam with a strong neutrinic component, which will squelch electrons and which will interact with great preference for strong voltages or strong magnetic fields, can be directed at a target complex. In the targeted area aircraft and communications systems can be disabled; automobile, truck, and other ignition systems will fail; power transformers and large motors and generators will fail; power transmission systems with their associated high voltages will fail; and so on. Even independent, self-contained emergency power equipment, such as at military installations and strategic missile sites, will fail to operate. Further, to some of these signals, the earth and the sea are as transparent as glass, and so underwater nuclear submarines can be electrically disabled on station before their missiles can be fired, while strategic missile complexes can be electrically disabled before their deadly nuclear missiles can be hurled toward their distant targets. If some submarines and land complexes succeed in firing missiles before being disabled, these missiles can be electrically dudded and scrubbed from the sky over Soviet territory while still far from their intended targets.

So, as stated at the end of *Excalibur*, the players are on stage and in place. The final act begins. One thing is sure—mankind will never be the same again after seeing the play!

Return to top of page

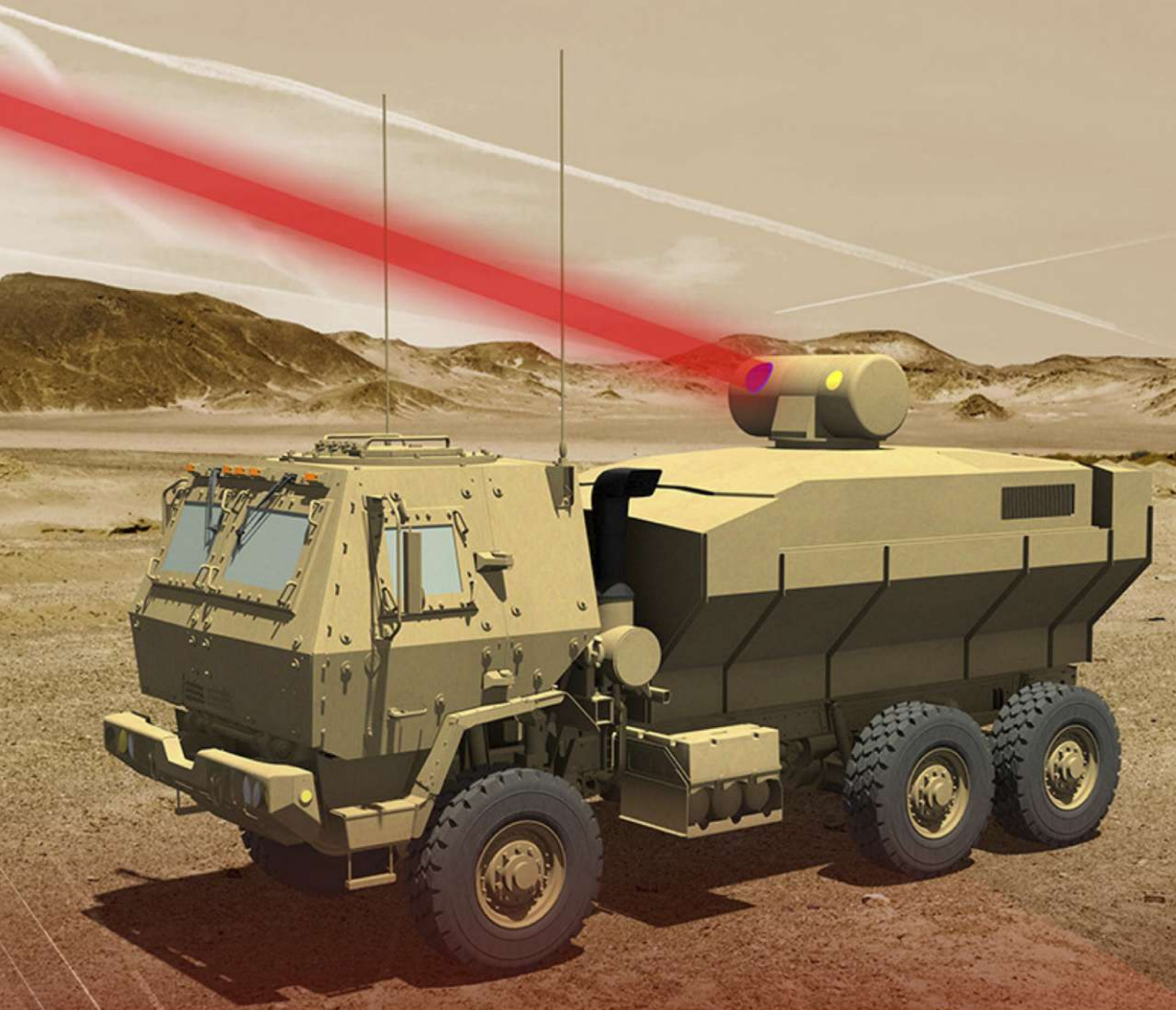

LASER WEAPON SYSTEMS

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Lockheed Martin has specialized in laser weapon system development for 40 years, with advancements in areas such as precision pointing and control, line-of-sight stabilization and adaptive optics – essential functions in harnessing and directing the power of a laser beam – and in compact, robust, spectrally beam-combined fiber laser devices that provide unmatched performance.

Lockheed Martin's directed energy (DE) laser program draws upon our proven expertise across a broad range of capabilities, as well as our spirit of innovation. Our experience includes:

- The beam-control/fire-control system for a megawatt-class laser that destroyed a ballistic missile in flight
- High-power spectrally beam-combined fiber lasers that provide the most efficient conversion of platform prime power into lethal power on target
- Unique SWIR component capabilities that significantly extend the ISR (intelligence, surveillance, and reconnaissance) range of the DE laser system
- Widespread weapons-system and platform integration experience across all DoD services

REVOLUTIONARY TECHNOLOGY

Laser weapons are a revolutionary technology because of the advantages of speed, flexibility, precision and low cost per engagement that are only possible with lasers.

These advantages apply to stand-alone DE laser systems as well as to weapon systems that combine DE and kinetic energy capabilities. In these cases, DE operates as a force multiplier, enabling the warfighter to counter a growing range of emerging threats.

DE weapons are characterized by:

- Very deep magazine
- Extremely low cost per engagement
- Speed of light delivery

These strengths mean that they are well-suited to countering large numbers of inexpensive, highly maneuverable threats that might otherwise exhaust the magazines of our current defensive kinetic energy (KE) weapons. By using DE and KE weapons together, the warfighter will be able to neutralize emerging swarming threats while reserving our most capable kinetic weapons to defend against our adversaries' largest and most hardened threats. DE weapon systems support multi-mission scenarios, and can be readily augmented by communications functions, as well as unprecedented intelligence, surveillance and reconnaissance range, and precision.

In addition, Lockheed Martin's directed energy weapons bring some important and unique advantages to the warfighter:

- A robust and highly-maintainable laser architecture that is designed to minimize life-cycle cost and to maximize up-time
- Output laser power that can be rapidly adjusted between low and maximum power to support disrupt, disable, and destroy capabilities
- Highly parallel laser architecture that supports graceful degradation by eliminating almost all single points of failure

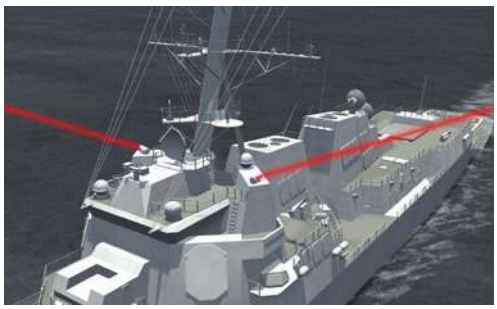

- Highest system efficiency demonstrated in any DE laser system; minimizing size weight and power requirements for DE platforms such as Army and Marine Corps ground vehicles, Navy DDG and LCS ships, and SOCOM AC-130
- Highest lethality laser to minimize engagement time

LOCKHEED MARTIN IS ADVANCING AND DEMONSTRATING A RANGE OF LASER WEAPON SYSTEM TECHNOLOGIES:

ADAM (Area Defense Anti-Munitions)

- Autonomous operations for rocket threats; accepts external sensor cue when required; capable of continuous operation
- Successfully engaged constrained and free-flying rockets, an unmanned aircraft systems (UAS) target in flight, and a small boat
- Affordable commercial-off-the-shelf (COTS) based system with very low cost-per-kill; deep magazine; scalable precision effects
- Capable of close-in defense (1-4 km)

ALADIN (Accelerated Laser Demonstration Initiative)

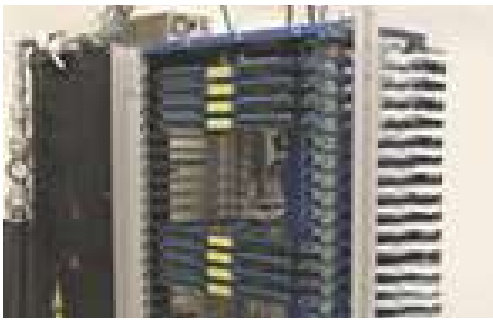

- 30-kilowatt laser made by combining many fiber lasers into a single, near-perfect-quality beam of light
- Uses approximately 50 percent less electricity than alternative solid-state laser technologies
- Spectral Beam Combining sends beams from multiple fiber laser modules, each with a unique wavelength, into a combiner that forms a single, powerful, high-quality beam

ATHENA (Advanced Test High Energy Asset)

- Represents highest power level documented by a laser weapon system of this type, while retaining excellent beam quality and electrical efficiency
- First field testing of an integrated 30-kilowatt single-mode fiber laser weapon system prototype
- Uses the proven high-energy laser weapon system architecture from our ADAM system, and incorporates the 30-kilowatt ALADIN laser

ABC Turret (Aero-adaptive Aero-optic Beam Control)

- Prototype turret with the ability to fire in any direction mounted on tactical aircraft
- First turret to demonstrate a 360-degree field of regard for laser weapon systems on an aircraft flying near the speed of sound
- Validated performance with nearly 60 flight tests conducted in 2014 and 2015 using a business jet as a low-cost flying test bed

RELI (Robust Electric Laser Initiative) for Army HELMTT (High Energy Laser Mobile Test Truck) Demonstrator

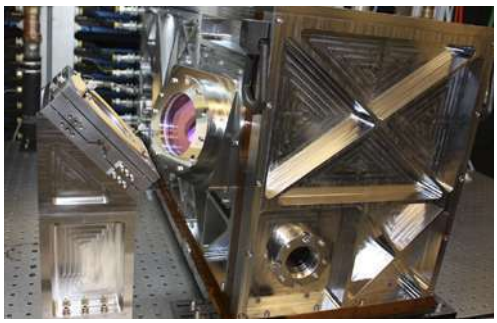

- Modular 60-kW laser in development for the U.S. Army
- Proven affordable weapon architecture that supports size, weight and power constraints for air, sea and land platforms
- Scalable design combines multiple kilowatt lasers to attain various weapon power levels
- Modularity results in a reliable and low maintenance laser system that minimizes single points of failure

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Axial Vircator for Electronic Warfare Applications

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Abstract. *This paper deals with a high power microwave generator with virtual cathode – vircator in axial release for electronic warfare applications. The classification of directed energy weapons microwave (DEWM) is introduced together with basic block diagrams of a particular class of DEWM. In the paper, methods for designing vircator pulsed power supply, axial vircator structure, measurement methods and experimental results are presented. The vircator in electromagnetic ammunition is powered by magneto-cumulative generator and in weapons for defense of objects (WDO), it is powered by Marx generator. The possible applications of a vircator in the DEWM area are discussed.*

Keywords

Electronic warfare, directed energy weapons microwave, high power microwave, magneto-cumulative generator, Marx generator, pulse forming line, vircator.

1. Introduction

Electronic warfare (EW) is defined as the art and science of preserving the use of the electromagnetic spectrum for friendly use while denying its use to the enemy. Electromagnetic spectrum is, of course, reaching from DC to light (and beyond). Thus, electronic warfare covers the full radio frequency spectrum, the infrared spectrum, the optical spectrum, and the ultraviolet spectrum.

Electronic warfare has classically been divided into:

- Electronic warfare support (ES), which includes the receiving part of EW.
- Electronic attack (EA), which includes jamming, chaff, flares used to interfere with the operation of radars, military communication, and head-seeking weapons. Over the last years, EA also includes antiradiation weapons (ARW) and directed energy weapons (DEW).
- Electronic protection (EP), which is directed into design or operation of radars or communication systems to counter the effect EA.

A detailed classification of EW can be found in [1].

Today the directed energy weapons (DEW) are significant in terms of the electronic attack (EA). Considerable financial resources are directed especially to the research of DEW working in microwave band (directed energy weapons microwave − DEWM), which derive their benefits from incidence of electromagnetic pulses (EMP) on electronic devices. The EMP effect was first observed during the early testing of high altitude airburst nuclear weapons [2]. The effect is characterized by production of a very short (hundreds of nanoseconds) but intense electromagnetic pulse, which propagates away from its source with ever diminishing intensity, governed by the theory of electromagnetism. The EMP is in effect an electromagnetic shock wave. This pulse of energy produces a powerful electromagnetic field, particularly within the vicinity of the weapon burst. The field can be sufficiently strong to produce short lived transient voltages of hundreds of volts to kilovolts on exposed electrical conductors, such as wires or conductive tracks on printed circuit boards.

At present, a high intensity EMP can be successfully generate without using nuclear weapons. This fact is very significant especially for applications in the EW area. It is this aspect of the EMP effect which is of military significance, as it can result in irreversible damage to a wide range of electrical and electronic equipment, particularly computers and radio or radar receivers. Depending on the electromagnetic hardness of the electronics (a measure of the equipment's resilience to this effect) and the intensity of the field produced by the weapon, the equipment can be irreversibly damaged or even electrically destroyed. The damage inflicted is not unlike the damage experienced by exposure to close proximity lightning strikes, and may require complete replacement of the equipment, or at least substantial portions of it [3], [4].

2. Directed Energy Weapons Microwave

Directed energy weapons microwave (DEWM) generate very high-powered electromagnetic impulse (EMP) in the microwave band. From the generated signal bandwidth point of view, there are two classes of generators for the design and construction of DEWM in order to produce electromagnetic field with sufficient power:

- Narrowband – very similar to the radar transmitters; usually generate a modulated harmonic signal. This class is called the high power microwave (HPM).
- Ultra-wideband (UWB) – generates high power videosignal illuminated by a broadband antenna.

The application of directed energy weapons microwave (DEWM) determines their design. There are two groups of directed energy weapons microwave:

- Single shot DEWM,
- Repetitive pulsed power systems.

The electromagnetic weapon modes closely relate to the mission of these weapons. Electromagnetic ammunition usually uses single shot DEWM while weapons for defense of objects (WDO) usually use repetitive pulsed power systems. The typical pulse repetition frequency of DEWM is nearly one thousand pulses per seconds. Recently, there has been a trend of increase in the pulse repetition frequency beyond tens of thousands pulses per seconds. The actual DEWM construction depends on the concrete supposed combat use, on the required measure, range and so on. The following text will be dedicated to experimental verification of some technology usable in narrowband DEWM or HPM. Questions regarding classification, construction and possible use of generators for DEWM are answered in more detail in [4], [5] and [6].

2.1 Basic Block Diagram of DEWM

HPM design depends on the specific assumed application of DEWM. There are difference approaches to the design and realization of electromagnetic ammunition and to the design and realization of weapons for defense of objects (WDO). These differences mostly affect the choice of the power sources and the construction of modulators. In electromagnetic ammunition, a highly limiting factor is the demand for low weight and small proportions. This fact also sharply limits the choice of the power microwave tube.

Electromagnetic ammunition usually uses single shot DEWM. The single shot high-energy high-voltage pulsed source has to fulfill hard requirements on the high amount of the delivered energy with respect to the source volume [MJ/m^3]. The best solution of this requirement is a magneto-cumulative generator that reaches up to 8000 MJ/m^3. A block diagram of a HPM generator in electromagnetic ammunition is shown in Fig. 1.

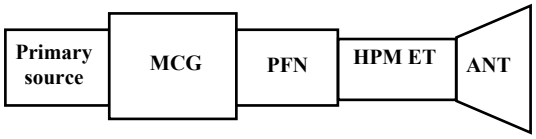

Fig. 1. Block diagram of a HPM generator in electromagnetic ammunition.

In the block diagram, the primary source feeds the stator coil of a magneto-cumulative generator (MCG), which creates a powerful magnetic field in the surrounding fittings filled with an explosive. At the moment of achieving the primary current peak value, the explosive is shooting. The explosion causes expansion of fitting that performs compression of the magnetic field inside the stator coil of MCG. Compression of magnetic field causes dramatic growth of the current flowing through MCG (hundreds of kiloamperes). The MCG output is connected to a pulse forming network that provides transformation of heavy current to an impulse high voltage (hundreds of kilovolts), which feeds a high power microwave electron tube (HPM ET). The generated microwave is emitted through antenna (ANT) to the space.

A block diagram of a HPM generator in weapons for defense of objects (WDO) is shown in Fig. 2.

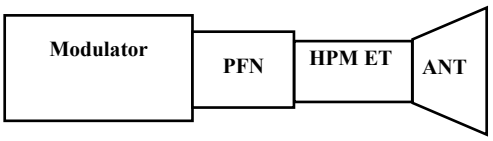

Fig. 2. The block diagram of HPM generator in Weapons for Defense of Objects (WDO).

In weapons for defense of objects (WDO), the HPM generator works similarly as the HPM generator in electromagnetic ammunition. Since WDOs usually generate power microwave pulses repetitively, a modulator with this capability has to be used instead of MCG. Modulators with Marx capacitor banks, Tesla transformers or transductors with fast opening switches are used most often. In this class of DEWM, other types of high power microwave electron tubes (HPM ET) are also used. They may generate microwave pulses with high pulse repetition frequency.

3. Energy Sources for Directed Energy Weapons Microwave

The electromagnetic pulse sources for DEWM are entirely based on energy acquired from the chemical energy of explosion that compresses the magnetic flux made by coil (MCG) or by discharging a capacitor bank. These two possibilities are the best solutions for generation of pulses with sufficient amount of energy in a short time. Other methods were used to generate pulses in the beginning of DEWM research or in laboratory.

3.1 Helical Magneto-Cumulative Generator

MCGs are entirely based on the energy acquired from chemical energy of explosion that compresses magnetic flux made by coil. MCG physical principles, classification and applications are described in more detail in [7]. The main part of research was focused on the possibility of using a magneto-cumulative generator for electromagnetic ammunition power supply. For that reason, 4 versions of low power MCGs were designed, realized and tested in order to verify their characteristics, construction principle, explosive initialization method and verifying a measurement method.

The tested magneto-cumulative generator in Fig. 3 consists of an aluminous cylindrical stator, inside is a 16 screw helical coil from 2 mm copper wire, a copper armature tube with 38 mm outer diameter and 4 mm wall thickness filed by octogen (explosive). The explosive is electrically initiated. The load coil represented by a copper strip in shape of a loop connects the stator with the armature. In the right side of stator, there is a crowbar switch made of a brass plate to perform disconnecting of the primary current source. An insulator circle is responsible for separation of the stator and the armature.

Fig. 3. Low power MCG.

Low power magneto-cumulative generator characteristics:

C_1 = 190 μF − primary capacitor capacity

U_0 = 800 V − voltage of capacitor

L_G = 13.1 μH − stator coil inductance

R = 0.0175 Ω − stator coil resistance

T_0 = 3.13 x 10^{-4} s − primary current period

I_m = 2750 A − maximum primary current

T_d = 73 μs − explosive initiation delay

Fig. 4 presents the low power magneto-cumulative generator output current time history calculated from the voltage measured by Rogowski coil. The primary current I_m = 2750 A gives the generator peak output current I_{out} = 27 kA. The detailed test description and measured results can be found in [8], [9], [10] and [11]. The purpose of the mentioned tests was:

- Verify the method of generating a high energy pulse by magnetic flux compression using explosive;
- Solve the primary current magneto-cumulative generator power supply;
- Find the peak primary current and an explosive initiation synchronization method;
- Find a high current measurement method.

All the requirements were met.

To use a magneto-cumulative generator for single shot high power high voltage pulse generator, it is necessary to obtain a high-level output current. Because of that reason, a middle power MCG was designed and realized. It is a two-stage helical magneto-cumulative generator using a dynamic transformer to increase the output voltage. In Fig. 5, there is a schematic plot of the generator's first stage. The magneto-cumulative generator power supply primary current, the initiation of the explosive and the output high current measure was analogical to the low power magneto-cumulative generator described above.

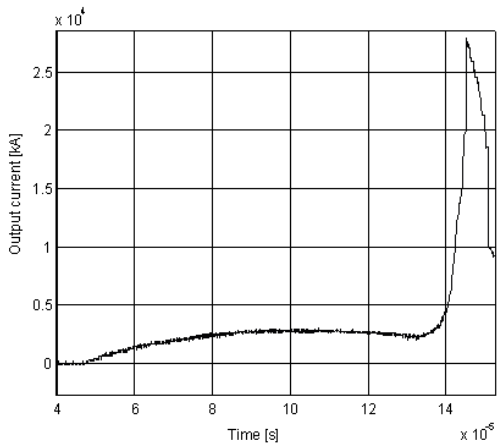

Fig. 4. Low power magneto-cumulative generator output current time history.

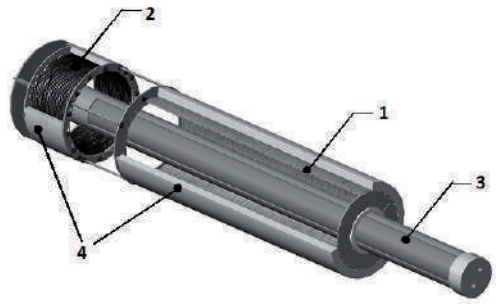

1 – First stage coil, 2 – Load coil, 3 – Armature with explosive, 4 – Insulator

Fig. 5. Schematic drawing of first stage of middle power MCG.

Fig. 6 shows a photo of the middle power magneto-cumulative generator's first stage prepared to the test.

Magneto-cumulative generator characteristics:

C_1 = 125 μF − primary capacitor capacity

U_0 = 5000 V − voltage of capacitor

L_G = 323 μH − stator coil inductance

T_0 = 3x10^{-3} s − primary current period

I_m = 2650 A − maximum primary current value

L_L = 300 nH − load inductance

Fig. 6. The picture of middle power MCG prepared to testing.

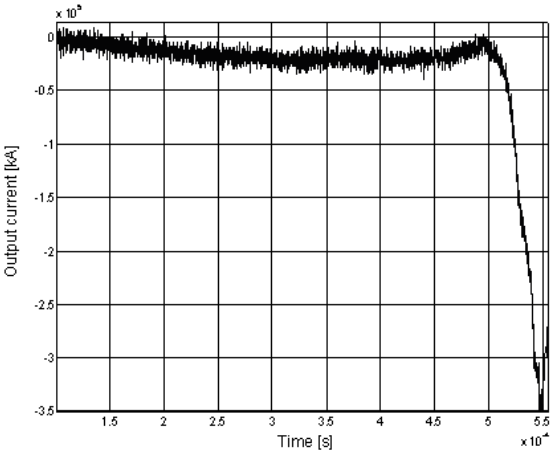

Fig. 7. Middle power magneto-cumulative generator output current time history.

In Fig. 7, the generator output current time history measured during test is shown. The primary current $I_m = 2650$ A gave the generator peak output current $I_{out} = 350$ kA.

The next step in the magneto-cumulative generator research is the implementation and verification of a dynamic transformer. The dynamic transformer's role is an increase of the output voltage to about 70 kV. Magneto-cumulative generator's second stage supplies a load coil through an electric breaker. The beaker interrupts the current in the load circuit in a very short time to enable transfer of the energy from the magnetic field to the high voltage pulse. These activities will be done in the next step of the research and development. The further trends are described in [12].

3.2 Pulsed Power Supply With Capacitive Storage of Energy

For some pulse applications in weapons for defense of objects (WDO), it is desirable to couple the Marx generator directly to the vacuum diode; however, the pulse rise time is then limited by the Marx inductance and capacitance, and the impedance of the generator is greater than typically several tens of ohms. In order to produce short, fast-rising, low-impedance beam outputs, it is customary to use the Marx to charge a pulse-forming line (PFL). Although the PFLs may be constructed in a variety of shapes (strip, coaxial, radial, etc.), they are typically used in only two types of circuits— the simple transmission line, and the double, or Blumlein line. In contrast to the simple transmission line, an alternate circuit invented by A. D. Blumlein is capable of producing an output pulse into a matched load that equals the charge voltage. A cylindrical version of the Blumlein circuit fabricated by our team is represented in Fig. 8. It consists of three coaxial cylinders with the intermediate cylinder being charged by the Marx generator. The Marx generator is shown in Fig. 9. The center cylinder is connected to the outer grounded cylinder by an inductor. Ideally the inductor acts as a short during the charge cycle, and then as an open for the short duration of the output pulse [13]. Pulsed power supply parameters are shown in Tab. 1.

Marx generator		Pulse forming line	
Number of stage	n=18	Impedance	9,1 Ω
Capacity of 1stage	100 nF	Length	1 m
Input voltage	U_{in}=25 kV	Pulse duration	60 ns
Output voltage	U_{out}=450 kV	Working medium	water

Tab. 1. Pulsed power supply parameters.

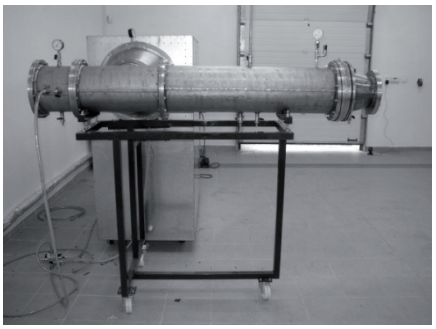

Fig. 8. Cylindrical version of the Blumlein circuit.

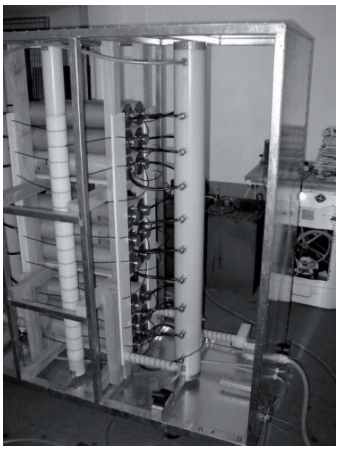

Fig. 9. Marx generator.

4. High Power Microwave Generator

A wide range of HPM devices exists. Relativistic klystrons, magnetrons, slow wave devices, reflex triodes and vircators are all examples of the available technology

base [5]. From the perspective of an electromagnetic weapon or warhead designer, the device of choice will be the vircator at this time. The vircator is mainly a one shot device capable of producing a very powerful single pulse of radiation, yet it is mechanically simple, small and robust, and can operate over a relatively broad band of microwave frequencies. The physics of the vircator tube are substantially more complex than those of the preceding devices. The fundamental idea behind the vircator is that of accelerating a high current electron beam against a foil or a grid anode. Many electrons will pass through the anode, forming a bubble of space charge behind the anode. Under the proper conditions, this space charge region will oscillate at microwave frequencies. If the space charge region is placed in a resonant cavity which is appropriately tuned, very high peak powers may be achieved. Conventional microwave engineering techniques may then be used to extract the microwave power from the resonant cavity. Because the frequency of oscillation is dependent upon the electron beam parameters, vircators may be tuned or chirped in frequency, where the microwave cavity will support appropriate modes. Power levels achieved in vircator experiments range from 170 kW to 40 GW over frequencies spanning the decimeter and centimeter bands [5].

4.1 Vircator Operation Fundamentals

The basic idea of the vircator is to accelerate a dense flush of an electron beam against a grid or a foil anode. Plenty of electrons pass through the anode and form a region of a space charge behind the anode called ”virtual cathode“. This region of a space charge at corresponding conditions can oscillate in a region of microwave frequencies. It is possible to tune the vircator in a broad band of frequencies using only a change of a space charge density. There is no necessity to have an external magnetic field for a correct vircator function. In Fig. 10, an axial vircator is shown. Electron beam passes through the foil or the grid anode. Microwave power is brought out axially, too. Frequency changes appear in vircator with standard geometry when the distance between the anode and the cathode gets smaller due to filling the working space by plasma. Efficiency of a standard geometry vircator is ordinarily about ones percent.

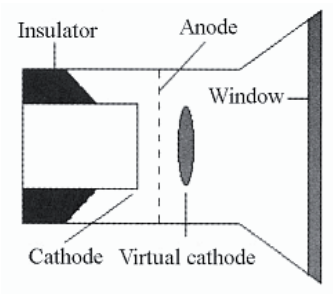

Fig. 10. Schematic drawing of axial vircator.

Despite its low efficiency, vircator is very attractive for army applications because it is very simple to be made, it is a compact device and there it is no need to have an external magnetic field. For more information about construction and properties of various types of vircators you can see e. g. [5], [13] and [14].

4.2 Mathematical Description of Vircator Operation

For microwave frequency generation, it is necessary to meet a number of conditions relevant to the power supply and geometric proportions of a vircator electrode. Determination of these conditions results from [15] and we use simplified geometry displayed in Fig. 11 to derive the mathematical characterization.

The most common case is that a pulse duration τ is much longer than a beam transit time across cavity $\tau >> L/C$.

We assume that an external axial magnetic field obstructs transverse electron motion. The space charge of the beam makes a negative potential energy $e\Phi$ in drift space which breaks the electrons. If the space charge potential reaches the value of accelerating voltage (electrons are stopped in beam), the beam with bigger current cannot expand. There is a value of current which causes stopping of electrons. This value is called the vacuum critical current. There has to be the above mentioned critical current to make the vircator generate microwave oscillations.

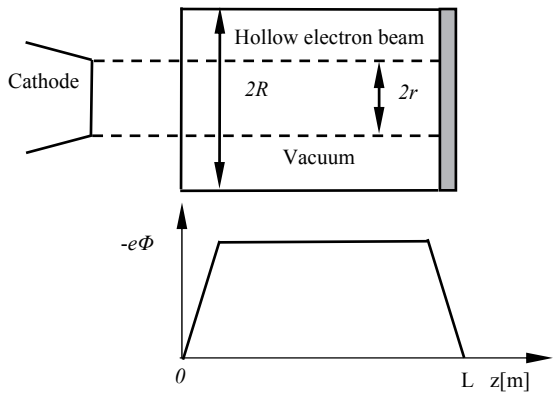

Fig. 11. Simplified geometry of axial vircator.

We suppose a hollow beam; whose charge is concentrated in a thin layer with radius r. Behind the transition space (which is comparable to the radius of chamber – backward conductor), there is nearly homogenous potential. It is possible to determine the potential quantity with consideration that it is a coaxial capacitor and its inner cylinder is saturated by beam charge.

Capacity of the coaxial capacitor is given by

$$C = \frac{2 \cdot \pi \cdot \varepsilon_0}{\lg\left(\frac{R}{r}\right)} \tag{1}$$

where ε_0 is the vacuum electric permittivity, R is the chamber radius, r is the beam radius.

The potential is given by the equation

$$\Phi = \frac{Q}{C} \tag{2}$$

where Q is the charge linear density, C is the capacity per length unit. We can define the charge linear density as

$$Q = \frac{I}{v} \tag{3}$$

where v is an electron module velocity and the current is defined by the equation

$$I = e \cdot n \cdot v \cdot S \tag{4}$$

where e is the charge of an electron, n is the linear electron density, S is the profile of the electron beam.

When (1) and (3) are substituted into (2), we can obtain expression for the potential in the form

$$\Phi = \frac{Q}{C} = \frac{I \cdot \lg\left(\frac{R}{r}\right)}{2 \cdot \pi \cdot \varepsilon_0 \cdot v}. \tag{5}$$

The electron velocity v is associated with its initial energy and potential by the energy preservation law

$$m_e \cdot \gamma_0 \cdot c^2 + e\Phi = m_e \cdot \gamma \cdot c^2 \tag{6}$$

where γ_0 is the initial relativistic factor of the beam, γ is the relativistic factor inside a system reduced due to potential.

The relativistic factor inside a system can be expressed by the equation

$$\gamma = \gamma_0 + \frac{e\Phi}{m_e \cdot c^2} \tag{7}$$

where m_e is the electron mass and c is the speed of light. The relativistic factor can also be expressed by

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \cdot \tag{8}$$

The electron velocity in drift space v can be specified from following equations:

$$\gamma^2 = \left(\gamma_0 + \frac{e\Phi}{m_e \cdot c^2}\right)^2, \tag{9}$$

$$v = c \cdot \sqrt{1 - \frac{1}{\left(\gamma_0 - \frac{e\Phi}{m_e \cdot c^2}\right)^2}} \cdot \tag{10}$$

Substituting (10) into (3) and multiplying by $(e \cdot v) / (m \cdot c^3)$, we can get

$$F(\Phi) = \frac{e \cdot \Phi}{m \cdot c^2} \cdot \sqrt{1 - \frac{1}{\left(\gamma_0 - \frac{e\Phi}{m_e \cdot c^2}\right)^2}} = \frac{e \cdot I \cdot \lg\left(\frac{R}{r}\right)}{2 \cdot \pi \cdot \varepsilon_0 \cdot m \cdot c^3}. \tag{11}$$

The function $F(\Phi)$ has its peak value under the conditions describes by

$$\frac{e \cdot \Phi}{m \cdot c^2} = \gamma_0 - \gamma^{\frac{1}{3}} \cdot \tag{12}$$

The evaluation is written in the form

$$F(\Phi) = \sqrt{\left(\gamma^{\frac{2}{3}} - 1\right)^3} = \frac{e \cdot I \cdot \lg\left(\frac{R}{r}\right)}{2 \cdot \pi \cdot \varepsilon_0 \cdot m \cdot c^3} \cdot \tag{13}$$

There is no possibility to find the solution of (11) for bigger values of function $F(\Phi)$. According to (13), the critical vacuum current is

$$I_{cr} = \frac{2 \cdot \pi \cdot \varepsilon_0 \cdot m \cdot c^3}{e \cdot I \cdot \lg\left(\frac{R}{r}\right)} \sqrt{\left(\gamma^{\frac{2}{3}} - 1\right)^3} \cdot \tag{14}$$

When we substitute the known constants (like $\pi = 3.1415$), we obtain the equation

$$I_{cr} = \frac{8.5}{\lg\left(\frac{R}{r}\right)} \sqrt{\left(\gamma^{\frac{2}{3}} - 1\right)^3} \tag{15}$$

where I_{cr} is the critical vacuum current [kA].

For vircator implementation, energy of electrons of about 500 keV is considered, which corresponds to the relativistic factor of $\gamma_0 = 2$. Thus planar diode current limited by space charge follows the three-half Child-Langmuir law

$$I \approx \frac{U^{\frac{3}{2}} \cdot S_k}{d_{ka}^{\ 2}} \tag{16}$$

where U is the voltage between anode and cathode, S_k is the surface of cathode, d_{ka} is the distance between anode and cathode.

An important characteristic of a vacuum planar diode is its impedance, which is given by

$$Z = 1.36 \cdot 10^5 \cdot U^{-\frac{1}{2}} \cdot \frac{d_{ka}^2}{r_k^2} \tag{17}$$

where r_k is the radius of the cathode.

The vacuum critical current is the maximal current that can distribute itself through vacuum. It means it is possible to measure the same current until the distance is bigger than the diameter of beam. It is just the same value when the potential of space charge of electron beam is equal to the accelerating voltage. That is the limit where the virtual cathode is generated and the vircator starts working. The generated frequency depends on the plasma frequency of the electron beam. The plasma frequency is determined by the electron beam current density. The plasma frequency is the frequency of electrons in space charge field oscillations. The electrons can oscillate due to the influence of repulsive force which takes effect between particles with the same charge. The plasma frequency depends on the concentration of electrons in the beam. The

current density is given by the number of charges which are able to pass through the surface of 1 m^2 per one second. Thus we can calculate the current density i [Am^{-2}]

$$i = e \cdot n_V \cdot c_e \tag{18}$$

where e is the electron charge, n_V is the electron volume density and c_e is the electron velocity.

Plasma frequency of the electron beam is approximately given by

$$f_{pe} = 9 \cdot 10^7 \cdot \sqrt{i} \ . \tag{19}$$

4.3 Axial Vircator Design

Following the theoretical assumptions given above, the axial vircator with grid anode was fabricated. The structure of the grid anode enables repeated operation in contradistinction to vircator with a foil anode. The cathode diameter $r_k = 17.5$ mm and the working chamber radius $R = 40$ mm were chosen in order to decrease the value of the vacuum current. The critical vacuum current is $I_{cr} = 4.63$ kA in this configuration. The vircator impedance matching to the forming line is a very important requirement for vircator's correct operation. Because of that, a cathode with a possibility to change the distance d_{ka} between cathode and anode is fabricated. The cathode is made as a cylindrical carbon block. The anode grid is made from pyrolitic carbon.

In Fig. 12, there is section picture of the built-up axial vircator with the possibility to the change distance between anode and cathode. In Fig. 13, there is a view of the fabricated vircator. The vircator is fed by a pulse generator formed by Marx generator and pulse forming line described in Section 3.2. The connection between the axial vircator and the output of pulse forming line is shown in Fig 14. Vircator voltage is measured by a cylindrical capacitive probe, which is a part of pulse forming line output circuit. Vircator current is measured by Rogowski coil placed in the outer cylinder of the pulse forming line. Vircator voltage time history is displayed in Fig. 15 and vircator current time history is displayed in Fig. 16.

Compared to other types of microwave tubes, the microwaves generated by an axial vircator cover a relatively wide frequency band. In Fig. 17, the frequency spectrum of the signals generated by the realized axial vircator is shown. The dominant frequencies of the generated microwave signals are placed in the band of 0.5 to 1.5 GHz. The frequency spectrum was acquired on the basis of information measured by a digital oscilloscope Tektronix TDS 7704B connected to broadband antenna EMCO 3115. For the measurement the microwave output power of the vircator, a measuring device was designed and made, using calorimetric method for the power measurement. A detailed power sensor description can be found in [18]. A more detailed description the of axial vircator research results is given in [6], [14], [16] and [17].

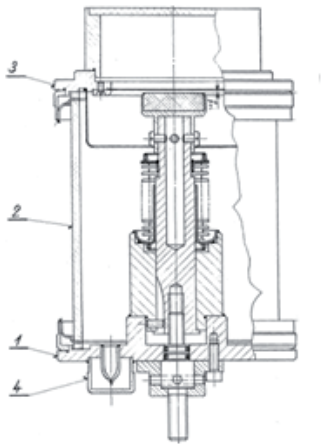

1 cathode contact ring, *2* ceramic insulator, *3* anode contact ring, *4* pipe for vacuum pumping shelter

Fig. 12. Section picture of built-up axial vircator with possibility to change distance between anode and cathode.

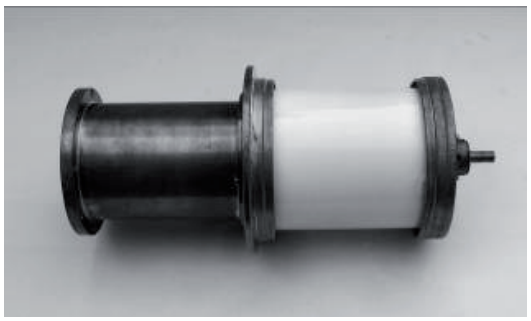

Fig. 13. View of fabricated axial vircator with adjustable distance between anode and cathode.

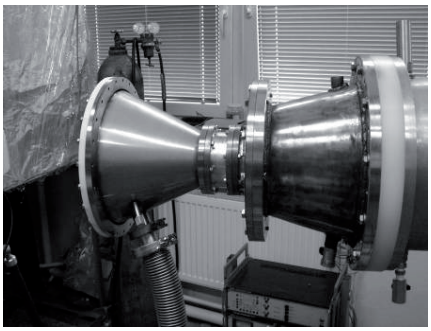

Fig. 14. View of fabricated axial vircator connected to the pulse forming line.

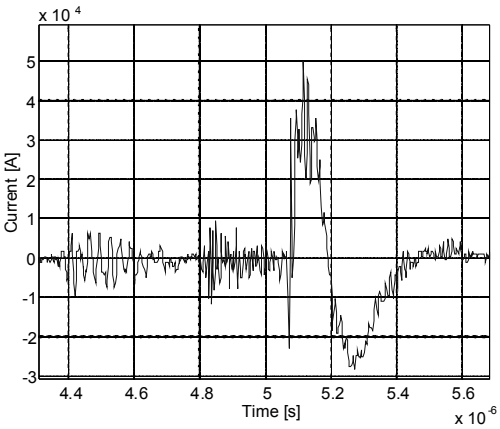

Fig. 15. Vircator current time history.

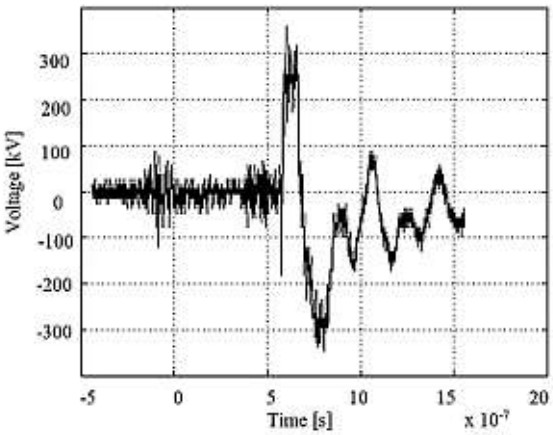

Fig. 16. Vircator voltage time history.

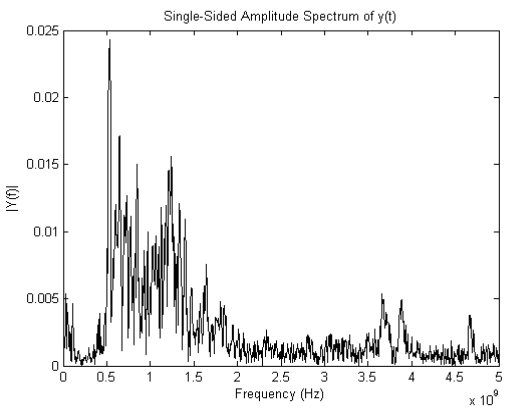

Fig. 17. Frequency spectrum of signals generated by realized axial vircator.

5. Conclusion

The research of directed energy weapons microwave validated substantial technology applicable in electromagnetic ammunition and in weapons for defense of objects (WDO). The axial vircator is the most important component part applicable in both categories of DEWM. Dominant frequencies of the generated microwave signal are placed in band of 0.5 to 1.5 GHz. To fulfill the vircator minimal proportion requirements to be able to use the vircator as a DEWM, it is necessary to shift the vircator dominant frequencies to the 3 GHz band. This requirement can be reached by arranging the cathode size efficiently and consequentially optimizing the distance between anode and cathode. Great attention also has to be paid to increase the specific dielectric strength of the output window of the axial vircator.

Acknowledgements

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About Authors…

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Roman VRÁNA was born in Havířov, Czech Republic, in 1972. He received his Ing. (M.Sc.) degree from Brno Military Academy in 1995. Since 1999, he has been with the Dept. of Radar, Military Academy and University of Defence in Brno, as an assistant professor (since 2008). His research interests include active radar theory and electronic warfare.

DARPA NESD

INDUSTRY GROUP

The ***Biological Technologies Office (BTO)*** of the ***Defense Advanced Research Projects Agency (DARPA)*** is sponsoring an Industry Group to support the ***Neural Engineering System Design (NESD) Program***.

NESD is a highly interdisciplinary program requiring extensive integration of new research and technology. To facilitate the development and adoption of NESD technologies, DARPA has organizedan industry group for potential proposers. Members of this group have agreed to provide access to rapid prototyping and manufacturing of advanced neuro-engineering components, including state-of-the-art electronics, photonics, computing, assembly and packaging.

This document contains all responses to **Special Notice 16-17** as of March 10, 2016. Any updates will be posted at **http://www.darpa.mil/work-with-us/opportunities**.

Allen Institute for Brain Science

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About

The Allen Institute for Brain Science is an independent, non-profit medical research organization that has embarked on a concerted, ten-year effort, involving more than 300 scientists, engineers, technologists and other specialists, to understand the cerebral cortex in the mouse and in the human at the cellular level. We are built upon the notion of Big Science, Team Science and Open Science in the service of Basic Science with an explicit mission to accelerate understanding of the human brain in health and disease. Our data are freely and publicly available at www.brain-map.org.

Capabilities

- We seek to experimentally and computationally characterize the components (cell types) of the rodent visual thalamo-cortical system at the molecular, transcriptional, electron-microscopic, electrophysiological, morphological and functional levels to study how these components integrate information to generate high-level cognitive functioning such as object recognition.
- To study such high-level functioning, we use various in vivo perturbation and monitoring techniques (e.g. optical stimulation, extracellular depth recordings, wide and narrow-field Ca-imaging, etc.), very high density silicon probes (364 probes per shaft) as well as state-of-the art computer models that capture cortical information processing at varying levels of granularity.
- To understand the human brain, the Institute is also engaged in cell typing from human brain tissue harvested from patients undergoing brain surgery.
- Thus, we are routinely recording intracellularly from single and multiple cells from ex vivo human lateral temporal cortex and as well as performing morphological characterization on these same cells).

Capabilities

- We also have extensive experience with the genomic and transcriptional architecture of the human brain.
- We are interested in applying this knowledge for medical and translational purposes and to help facilitate advancement of CNS disorder therapies.

Facilities II

The Allen Institute headquarters, a 270,000 square foot life sciences building, is located in Seattle's South Lake Union neighborhood, the city's biotechnology hub. We are a high-throughput facility, home to custom-designed robotic systems, automated technologies, premier bench laboratory space and all the high-powered computing hardware and software necessary for processing petabytes of data.

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Bionics Institute

Primary Contact

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Capabilities

Medical device safety and efficacy testing (in vitro and in vivo)

- Design, rapid prototyping & validation testing
- Accelerated aging & flexion testing
- Electrochemical impedance spectroscopy
- Acute feasibility studies
- Chronic safety and biocompatibility studies
- Drug delivery techniques
- Histology & data analysis
- Scanning electron microscopy of implanted materials
- Preclinical animal model development

Custom device prototyping & fabrication

- Design and fabrication of custom electrode arrays and surgical tools
- Use of FDA approved materials

'First in human' clinical trials

Clinical and Scientific Track Record

- 35 years of internationally recognised experience & scientific excellence
- Extensive clinical, academic & commercial partnerships
- Proven research & clinical development pathways

Staff and Facilities

- Experienced and qualified scientists, engineers and clinicians
- Co-located in a major Australian hospital
- Purpose built equipment and facilities

Boston Micromachines Corp

Primary Contact

Paul Bierden / pab@bostonmicromachines.com

About

Boston Micromachines Corporation (BMC) is the leading provider of microelectromechanical systems (MEMS) deformable mirror products and has expertise in the design of adaptive optics systems. The company's suite of award-winning compact DM products is the most cost-effective, highest performance mirrors in the market today. By applying wavefront correction, BMC devices can be used in a variety of applications which include laser beam shaping, microscopy, astronomy, and vision science. Located in Cambridge, MA, BMC is privately held and offers custom-designed manufacturing services in addition to its portfolio of standard DM products and adaptive optics systems.

Capabilities

The specific capabilities/services the company provides in relation to the NESD falls into two categories:

Deformable mirrors systems for use in neurological imaging instruments

- MEMS deformable mirrors ranging in size from 140 – 1000 actuators
- Mirror surface geometries of continuous, segmented, and hexagonal tip-tilt
- High speed drive electronics

These devices are currently being used in in vivo neural imaging systems at various premier research institutions around the country. Boston Micromachines also provides research and development services for advancing the deformable mirror and drive electronics technology and design to better fit specific applications.

- Advanced imaging systems utilizing adaptive optics to improve resolution and contrast in in vivo subsurface imaging application (i.e. deep penetration brain imaging)

Boston Scientific

Primary Contact

Rafael Carbunaru / Rafael.Carbunaru@bsci.com

Capabilities

- Lead prototyping
- Firmware modifications to the implantable pulse generators (IPG)
- Software modifications to the computer programmers (CP)
- Use of advanced computational models and predictive algorithms for parameters and programming guidance for neurostimulation

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Chronocam

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Capabilities

- Extensive know-how in designing, developing and industrialising asynchronous, event-based, bio-inspired vision sensors
- Expertise in developing and customising event-based, bio-inspired computer vision algorithms for a large number of applications spanning from autonomous navigation, security and surveillance, aerospace and defence to biomedical devices and smart objects
- System integration capabilities: development of camera systems relying on Chronocam's proprietary vision sensors and development of embedded software porting Chronocam's proprietary computer vision algorithms on a large number of processing platforms (such as: CPUs, GPUs, FPGA)

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Cirtec

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About Cirtec

Cirtec Medical has been providing contract design, development, and manufacturing services to the medical device industry since our founding in Massachusetts in 1986. Today, Cirtec has over 150 employees in our two facilities on the east and west coasts.

Cirtec has supported active implantable developers throughout our history. Early projects focused on hermetic welding and testing services for implantable neurostimulation devices, with service offerings expanding to provide full design and development. In all, Cirtec has worked with over 60 different companies and institutions developing active implantable devices, with over 30 in the neuromodulation space. We work with companies and institutions of all sizes, from early stage starts-ups to large, well-established medical device manufacturers. We also work frequently with research laboratories and academic groups; our current projects include development and manufacturing of an implantable neurostimulator used for research and recently approved for clinical study under a feasibility IDE.

Capabilities

Cirtec is ISO 13485 certified and FDA registered.
Cirtec supports the full product development cycle from conceptual development and requirements definition through clinical and commercial manufacturing.

Our engineering teams including mechanical, electrical, and software design resources as well as process development, manufacturing, and quality engineering. Cirtec has a robust and flexible quality system; start-up companies and research groups often choose to work under our quality system rather than developing their own. We provide design history file management and document control services. We can also perform or contribute to requirements documentation, risk management activities, and design verification activities. Our manufacturing capabilities relevant to active implantable devices include:

- Laser welding
- Resistance welding
- Electrical assembly
- Laser marking
- Laser ablation
- Surface treatment
- Ultrasonic cleaning
- Epoxy molding and adhesion
- Silicone molding and adhesion
- Packaging and labelin

Manufacturing capabilities are supported by in-house test capabilities. These include mechanical testing, hermetic leak testing, bench level and automated electrical testing, environmental conditioning, and custom test setups such as soak or pressure testing.

Our manufacturing infrastructure includes multiple ISO class 7 cleanrooms and ESD safe handling procedures for all devices. Cirtec provides complete supply chain management services, leveraging our extensive Approved Supplier List and robust inventory management and material traceability procedures.

VALUE TO PROPOSING TEAMS: There are six primary areas where Cirtec capabilities provide value to proposing teams.

Hermetic barrier development	Hermetic package and barrier design
	Leak specification development
	Internal moisture management: Vacuum bake, desiccant handling, residual gas analysis testing
	Hermetic sealing (welding, brazing) and testing
Electrical assembly	Soldering, wire bonding, and die bonding
	Coil winding
	ESD-safe workspaces
	Lithium battery safe handling procedures
	Bench and automated testing
Interconnect development	Feedthrough design and sourcing
	Hardwired and disconnectable design
	Fabrication and testing
Encapsulation	Epoxy, silicone, and parylene encapsulation
	Layered encapsulation design to manage fluid ingress
	In-house design, tooling, molding, testing
Sterile packaging	Package design
	Pouch and tray packaging and labeling
	Off-the-shelf double sterile tray system
	Sterilization service provider management
Quality system support	Design control support and design history file maintenance
	GMP manufacturing
	Supply chain management
	Procedures for and support of requirements definition, risk management, design verification, and process validation

Dragon ID

Primary Contact

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Capabilities

- Our staff is very experienced working within the complexities of the medical system from observing physicians in the operating room to bringing devices through regulatory approval.
- We have engineers with process development and industrial experience, including interfacing directly with manufacturers.
- We have software engineers experienced in both hardware and software engineering and experience in microcode and embedded systems, end user applications, and high performance computing.
- In addition to engineering talent, we staff researchers, designers, and SMEs to bring a truly interdisciplinary approach to innovation and design for a project.
- We have experience recruiting, establishing, and coordinating relationships between global stakeholders for complex projects to maximize accountability and efficiency for a product while minimizing bureaucracy required.
- We work with our world--class partners in industries such as industrial design, rapid multi--material prototyping, materials selection, and manufacturing in order to round out our capabilities for a product.

Freedom Photonics LLC

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About

Founded in 2005 we are privately held Limited Liability Company based in Santa Barbara, California with ISO Qualification in process, certification in Q2 2016. We develop, manufacture and market complete photonic integrated circuit based products (Indium Phosphide, PLC, Si Photonics).

Our main markets in components, modules and subsystems are for fiber-optic communication, free-Space-optical (FSO) communication and infrared sensors and illuminators.

Capabilities

We offer electronics design, assembly and testing with expertise in photonic design, packaging, control electronics, manufacturing and qualification.

We offer services across development and have a premier R&D compound semiconductor facility with lithography (steppers, DUV stepper, EBL), wet and dry etching, deposition and characterization capabilities.

Our Business Model

Conceptualization, prototyping and development

- Fast R&D turn-around and low cost device fabrication in Nanotech cleanroom facility (Freedom Photonics employees)
- Internal multi-project wafer runs

Volume device production with commercial foundries worldwide

- Fabrication processes designed for manufacturability
- Access to manufacturability and production capacity, qualified processes
- Experience in outsourcing volume device manufacturing

Significant internal capability for assembly, packaging, test

Capabilities and Facilities I – Photonics Design and Fabrication

Design

- Commercial and proprietary tools for passive and active PIC modeling, (Lumerical, native FDTD/BPM code, mode solvers, mask layout, SOA/active region models, Simwindows, SRIM)

Mask layout

- Proprietary scripting tool, with design rule checker and automated mask plate layout

Fabrication

- Full wafer process, die pick-and-place, wedge bonder, ball- bonder, auto-cleaver, pull-tester, etc.

Capabilities and Facilities II – Photonics Production Test

- Photonic device bar level probe
- Chip-on-carrier level (probe card)
- Package; DC, spectral, and data testing
- Burn in – monitored, environmental chambers

Capabilities & Facilities III – Packaging

Several in-house systems with laser welding and UV curing capability.

- Custom tooling, TOSA packages, 14 pin butterflies etc.
- ZEMAX commercial optical train design tool

Capabilities and Facilities IV – Electronics

- Digital and Analog Electronics
- FPGA design and verification tools in house
- Commercial tools for board layout
- Outside foundry for PCB fabrication and stuffing
- Electronics workstations for assembly and test
- Oscilloscopes, sources, multi-meters

We perform contract fabrication and engage with a number of domestic and international fabrication providers, both full process or selected fabrication steps are available.

IMEC

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Capabilities

IMEC is interested in making its comprehensive capabilities available for joint-research programs for solutions in Life Sciences Technologies, Healthcare and Bio-medical engineering, including:

- Semiconductor/nanotechnology
- Process technology
- Design technology and systems/software technologies

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Infinite Arthroscopy

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About

We are exclusively focused on developing new medical technologies with an emphasis on translating innovations from other industries to the operating theatre. We have experience in the full life cycle of medical device development from initial conception to regulatory submission. We have large number of rapid prototyping and fabrication techniques available in-house including but not limited to software-based design, stereolithography, fused deposition modelling, PCB milling, and machining. Our staff includes designers, engineers, health care professionals, and subject matter experts from a diversity of industries allowing us to leverage a far wider knowledge base than the standard medical device company. We maintain a nationwide network of leading physicians and institutional partners to develop, refine, and validate our technologies according to contemporary healthcare practice and needs.

Capabilities

Infinite Arthroscopy also maintains a portfolio of intellectual property derived from our medical device technologies that would be available to the NESD Industry Group. Two relevant examples are listed below.

Infinite Arthroscopy, Inc. Proprietary Technologies:
Novel Light Source

- Miniaturized / Ruggedized
- Low power (sub 1 watt)
- Low heat (to LEDs of comparable lumen-output)
- High lumen output
- Long Lifetime (50,000+ hours)
- Emits only target wavelength(s) (Capacity to customize to project needs)

Command/Control Architecture for Medical Devices

- HIPAA/FTC Approved for use in Operating Rooms
- Uninterrupted High-bandwidth capacity
- Transmission below standard RF noise floor
- Encrypted protocol

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Inscopix

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Capabilities

- Neuroscience application development and validation (surgical procedures for rodents and non-human primates, application of biological reagents within our own life science lab)
- Optical system development (lens design and simulation, LED light source development, prototyping)
- Hardware system (FPGA-based and/or microcontroller based mixed-signal systems especially involving imaging, mechanical packaging) development, testing, and prototyping
- Software (application, image processing, computer vision, analytical) development and testing
- Mechanical accessories development (design, prototyping via 3D printing)
- With these capabilities, we can customize Inscopix's existing and emerging systems and applications, or develop new systems and applications for or with other proposers in support of this program.

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Nanomedical Diagnostics

Primary Contact

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Capabilities

- Graphene FET sensor array chips appropriate for integration with nearly any biochemical or electrochemical interaction
- Current sensor hardware capable of measuring biochemical and bioelectric interactions over time with 10 millisecond time resolution, and spatial resolution less than 10 microns
- Capability to produce sensor hardware with time resolution approaching one microsecond with a spatial resolution less than 2 microns
- Expertise in combining electronic materials, packaging and assembly with active biological materials
- Projected FDA clearance for an in vitro clinical product, and associated manufacturing chain, using graphene sensors by mid 2017
- Graphene appropriate for use in medical sensors integrated into an electronic or implantable platform of your choosing
- Chemical and biochemical expertise in biochemical attachment and blocking techniques specialized for boosting specificity of electronic readout of biological interactions
- A complete "turnkey" R&D system for using graphene sensor chips
- Hardware and software appropriate for reading graphene biosensors

Additional Contacts

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Naval Research Laboratory

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About

NRL is the corporate research laboratory for the Navy and Marine Corps and conducts a broad program of scientific research, technology and advanced development.

The Optical Materials and Devices Branch has five primary areas: high purity chemicals, specialty optical materials, silica fiber technology, optical devices and advanced concepts.

Capabilities

We have expertise in the research, development and fabrication of glasses, glass-ceramics, ceramics, crystals, bulk optics, films, waveguides and optical fibers.

We offer a full suite of capabilities to make transparent ceramics to solve the ceramic packaging needs of NESD, some key properties:

- UV to RF transparency tailoring
- Tougher, stronger, harder than glass
- Electrically inert
- Demonstrated conformal shapes
- Demonstrated bonding technologies
- Vertical integration

Our facilities include class 100 clean rooms, powder processing equipment, sintering systems, and characterization capabilities (XRD, SEM, TEM, optics labs, mechanical testing).

Some of our prior applications include: Conformal Optics, IR simulators, photonic mast design, flexible PV's, IRCM, and Directed Energy Weapons.

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Star Lab

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About

Star Lab is a high-tech small business focused on complex systems security research and development, with significant expertise and a pedigree of success developing security technologies for safety-critical and mission-critical systems. The company specializes in the areas of high-assurance operating systems, technology protection, applied cryptography, and anti-tamper, and is also a leader in kernel/hypervisor/embedded software development. Star Lab has offices in Washington D.C. and Huntsville, AL.

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Qualcomm

Primary Contact

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Capabilities

- Experience in building an end-to-end platform as a reference design for interface with brain
- Experience in driving an industry wide standard effort to standardize a communication medium and protocol for brain interface
- Advanced low power wireless solutions, RF interface, MODEM system solutions and related electronics for brain interface
- Advanced wireless charging and powering solutions for brain implants
- Ultra low power electronic design solutions at advanced technology nodes suitable for brain implants to enable always on monitoring and processing
- Ultra low power DSP solutions, stream data processing and data compression and decompression solutions

Additional Contacts

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New World War

Revolutionary Methods for Political Control

Mind-Reading

History

Probably no more "intrusive and persistent" method of obtaining information about a person exists than reading their mind.[1] Research on mind-reading has been vigorously pursued by US government agencies and various academic centers since the 1970s, and continues to this day.

Since 1973 DARPA has been studying mind-reading with EEG hooked to computers, using scientists at the University of Illinois, UCLA, Stanford Research Institute, Massachusetts Institute of Technology, and the University of Rochester.

They developed a system that could determine how a person perceived colors or shapes and were working on methods to detect daydreaming, fatigue, and other brain states. Although the device had to be calibrated for each person's brain by having them think a series of specific thoughts, the calibration was quick.

In 1974 another very basic mind-reading machine was created by researchers at Stanford Research Institute. It used an EEG hooked to a computer which allowed a dot to be moved across a computer screen using thought alone. When interpreting people's brainwaves, it was right about 60% of the time. During these tests scientists discovered that brain patterns are like fingerprints, each person has their own. So, each computer would have to be calibrated for a specific person.

Another method to address this issue was to store a large amount of generic patterns on the computer, so when it encountered a brain pattern it didn't recognized, it used one that most resembled it. Since then, DARPA has sponsored Brain-Computer Interface (BCI) and mind-reading programs at Duke University, MIT, University of Florida, and New York State University, Brooklyn.

The Human Computer Interaction group at Tufts University has studied mind-reading funded by grants from a government research and education agency known as the National Science Foundation (NSF). Carnegie Mellon University, Stanford University, and the MIT Sloan School of Management have studied mind-reading. The Computer Laboratory at the University of Cambridge in England has developed mind-reading machines based on facial expressions.

Other academic institutions that have participated in mind-reading projects include the University of California, Berkeley, University of Maryland, and Princeton University in New Jersey. Microsoft has studied mind-reading using EEG to better accommodate its users. Emotiv Systems built a mind-reading gaming device which uses EEG to infer the mental states of video game

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players. Honda Motors and Advanced Telecommunications Research Institute International (ATR) have studied mind-reading.

Neuroimaging Devices

Scientists discovered that the neural code of the human brain is similar to the digital code of a computer. To some extent, they have deciphered this code. Prior to this, they assumed that it was necessary to identify the neurons associated with specific acts, which would have made mind-reading much more difficult.[2]

They now understand that it's not necessary to monitor billions of neurons to determine which are connected to a particular thought or act. Only a small number of them need to be monitored to accomplish this. To monitor these neurons researchers use neuroimaging devices. They include event-related optical signal (EROS), functional magnetic resonance imaging (fMRI), electroencephalography (EEG), functional near-infrared imaging (fNIR), magnetoencephalography (MEG), and positron emission tomography (PET).[3] These devices may be combined for a more accurate reading.

There are basically two types of measurements, *direct* methods and *indirect* methods. Direct methods measure changes in electromagnetic fields and currents around the brain which are emitted from the surface of the scalp, or they monitor the neurons themselves. Indirect methods measure hemodynamic (blood movement) changes of hemoglobin in specific tissue compartments.

Both of these methods are almost simultaneous with neuronal activity. Regarding sensors, there are invasive ones which must be implanted, and non-invasive ones which can be worn on the scalp, in the form of a headband.

Electroencephalography (EEG) provides a direct method for determining brain states and processes by measuring the electrical activity on the scalp produced by the firing of neurons in the brain. EEG has been around for over 100 years. EEG is commonly used in neuroscience, cognitive science, and cognitive psychology. It is inexpensive, silent, non-invasive, portable, and tolerates movement.

Wireless EEG which uses non-invasive sensors that have physical contact with the scalp can transmit the signals to a remote machine for deciphering. Although, in 1976 the *Los Angeles Times* reported that DARPA was working on an EEG to detect brain activity several feet from a person's head, which was to be completed in the 1980s. EEG normally produces only a general indicator of brain activity.

However, in 2008 *Discovery News* reported that a company called Emotiv Systems developed an algorithm that decodes the cortex, providing a more accurate measurement. "We can calibrate the algorithm across a wide range of technologies with the same resolution you would get from placing an invasive chip inside the head," said Tan Le, president of Emotiv Systems.

Functional magnetic resonance imaging (fMRI) measures the blood flow in the brain in response to neural activity. Active neurons use oxygen, which is brought to them by blood. The more active a region of the brain is the more

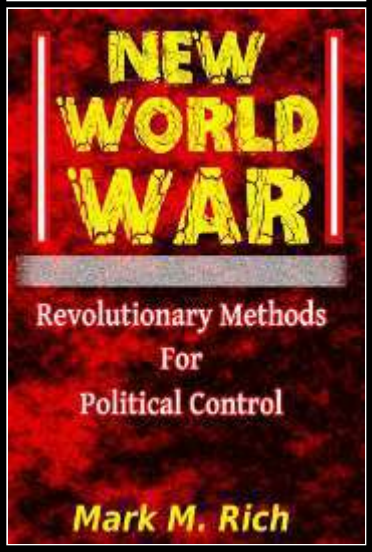

blood flows in the area. This movement of blood is referred to as *hemodynamic activity*. FMRI can detect which areas are receiving blood, which indicates that they're processing information.

The fMRI provides an indirect measurement of brain processes. It is the most common method of neuroimaging, and can produce 2 and 3-dimensional images. It is non-invasive, and can record signals from all brain regions, unlike EEG which focuses on the surface only.

Functional near-infrared imaging (fNIR) provides an indirect measurement of brain activity by detecting hemodynamic changes in the cortex. Although it is based on different principles, in that it uses light, it functions in the same manner as fMRI. FNIR can provide an almost continuous display of these changes in the cortex. It is inexpensive, non-invasive, and portable. A wireless headband with sensors exists for this device.

Event-related optical signal (EROS) is a brain-scanning device that focuses near-infrared light into the cerebral cortex to detect the density of neurons indicated by the transparency of brain tissue. Because it can only detect these changes a few centimeters deep, it can only image the cerebral cortex. Unlike fNIR, which is an optical method for measuring blood flow, EROS detects the intensity of neurons themselves and provides a direct measurement of brain activity. It is very accurate, portable, inexpensive, and non-invasive. A wireless headband with sensors exists for this device.

Capabilities

Mind-reading can be accomplished by first having a computer learn which brain patterns are associated with specific thoughts, then store the decoded information in a database. This machine learning is accomplished using a type of *artificial intelligence* (AI) called an *algorithm*. A very basic algorithm is a spell checker, which uses a database of common mistakes associated with a particular sequence of letters to present suggestions to a user.

"The new realization is that every thought is associated with a pattern of brain activity," proclaimed neuroscientist John Dylan Haynes, in *Newsweek International* on February 4, 2008. "And," says Haynes, "you can train a computer to recognize the pattern associated with a particular thought."

In a January 2000 issue of *US News and World Report*, Lockheed Martin neuroengineer Dr. John Norseen announced, "Just like you can find one person in a million through fingerprints ... you can find one thought in a million." This can be accomplished using AI and HCI, or what Dr. Norseen calls biofusion.

The decoded brain signals can be stored in a database. Then when someone is scanned, the computer detects the pattern and matches the signals to the database of known meanings. But it's not necessary to scan a brain to decode its signals for every single thought, such as a picture.

Instead, after the machine has learned how to decipher patterns associated with specific thoughts such as images, more images can be added to the program and the computer can use the process it used for the other images as a model to somewhat accurately detect additional thoughts.

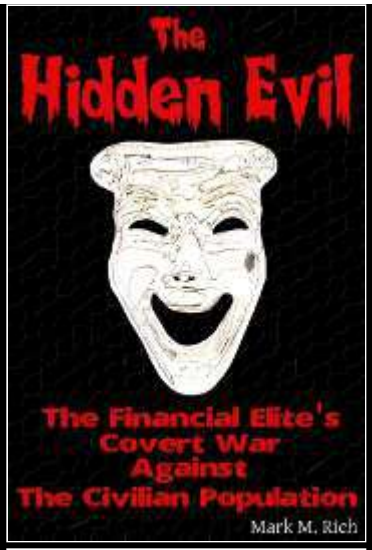

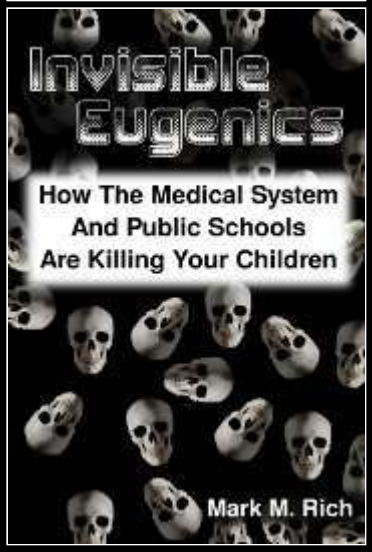

New World War: Revolutionary Methods for Political Control

Dedication & Thanks

Peer Review & Thanks

Dedication

Volume I: Current Political Situation

Overview

Introduction

Revolution in Warfare

The Other World

Dictatorship Creation

The Groups Facilitating the Revolution

Their Goal is Neo-Feudalism

Problem-Reaction-Solution

Volume I Commentary

Both words and images can be detected using mind-reading devices with varying degrees of accuracy. This can occur for words and images being viewed by a person on an external display, such as a book, or words and images just being thought of with no external stimuli.

"It is possible to read someone's mind by remotely measuring their brain activity," announced *New Scientist* in their *Mind-Reading Machine Knows What You See* article of April of 2005. The Computational Neuroscience Laboratories at the Advanced Telecommunications Research Institute International (ATR) in Kyoto Japan, and Princeton University in New Jersey, proved that by monitoring the visual cortex with fMRI they could determine which basic objects (sets of lines) a person was looking at.

When the objects were combined, they could even determine which one was being focused on. According to the scientists, it may be possible not only to view but also to record and replay these images. They announced that the technology could be used to figure out dreams and other secrets in people's minds.

Vanderbilt University in Nashville has conducted simple mind-reading tests using an fMRI/Computer, which learned what basic images a group of test subjects was looking at. They were able to predict with 50% accuracy which objects the test subjects were thinking of when they were asked only to remember what they had seen, without being shown the images.

On March 6, 2008 *ABC News* reported that neuroscientists at the University of California at Berkeley accomplished mind-reading by monitoring the visual cortex with an fMRI connected to a self-learning (artificial intelligence) computer program.

First, they used 1750 pictures to build a computational database for the computer to learn with by flashing the pictures in front of test subjects connected to an fMRI. This allowed the algorithm to decipher the brain patterns and associate them with the images.

In addition to deciphering these brain patterns, the computer recorded the process that it used to accomplish this, and built a model based upon it. Then, without scanning the test subjects, they added 120 new pictures to the program and allowed it to create its interpretation of what the new brain signals would be, based on the previous model.

Then they had the test subjects look at these pictures which they had never seen while being scanned. The computer predicted what they were looking at 72% of the time. The scientists announced that the model could be used as a basis to predict the brain activity associated with any image.

What this means is that it's not necessary to scan a brain to obtain the meaning of each signal. Once the model had been developed, they could simply add new pictures to the database/dictionary. The scientists suggested that out of 1 billion pictures, the computer would be accurate about 20% of the time.

Images which are not consciously seen by a person can even be detected by mind-reading machines. Researchers at University College London flashed

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The New Enemy
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Volume III: Weapons of The New War

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Nongovernmental Organizations
Human-Computer Intelligence Network

pictures in quick succession to test subjects connected to an fMRI. Although some of these pictures were invisible to the subjects, they were accurately recorded 80% of the time by the computer.

Like a fingerprint, each person has their own *brainprint*. Therefore, calibration for each brain is necessary. This is accomplished by having the person think a series of specific thoughts. In the case of EEG, this calibration can take less than a minute. However, because the signals which represent thoughts are similar from one person to the next, a universal mind-reading database has been suggested.

Using fMRI, scientists at Carnegie Mellon University (CMU) discovered that the brain patterns associated with specific thoughts are quite similar among multiple people. This, they stated, would provide the opportunity to create a universal mind-reading dictionary.

Scientists at the University of California at Berkeley mentioned that a "general visual decoder" would have great scientific use. Likewise, the brain patterns associated with specific words that occur when people are reading are also basically the same. This similarity of brain functions associated with words seems to have been an evolutionary development which allowed for an advantage in communication.

A mind-reading machine capable of determining the brain pattern associated with a specific word was developed by scientists at CMU. Brain scans using fMRI were taken of test subjects who were given a variety of words to think of in order to train the computer. An important consideration here is that they were not viewing these words on an external display, only thinking about them. After the computer identified the brain patterns associated with those words, the subjects were given two new words to think about, which the computer accurately determined.

Although, in this particular study only a couple of words were tested, it proves that after a model of how to decipher brain signals was created, AI could accurately determine new words that subjects were thinking about. "These building blocks could be used to predict patterns for any concrete noun," proclaimed Tom Mitchell of the Machine Learning Department.

In February of 2004 *Popular Science* announced that a mind-reading computer could, in theory, translate a person's working verbal memory onto a computer screen. "You could imagine thinking about talking and having it projected into a room 2,000 miles away," says Professor Craig Henriquez at Duke University's Center for Neuroengineering, who has studied mind-reading for DARPA. He added, "It's very, very possible."

FMRI can be used to determine if someone is reading or writing. Neuroscientists can determine when a person is reading by monitoring their brainwaves. They can almost determine exactly what they're reading. And because these patterns are similar from one person to the next, a universal device for determining what people are reading is possible.

In March of 2008 both Technology Review and *ABC News* revealed that an fMRI could in theory be used to display a person's dreams. Then in December of 2008, scientists at ATR in Kyoto Japan announced that they developed a

Electronic Tyranny
Other Devices Connected to the GIG
My Experience
Sources

Other Sites

www.TheHiddenEvil.com
www.RichEssence.com

technology that would eventually allow them to record and replay a person's dreams.

Emotions from love to hate can be recognized by neuralimaging. The level of stress a person is experiencing can also be measured. Brain states such as honesty, deception, and even self deception, can be measured.

Patterns associated with decisions can also be read. Scientists from CMU, Stanford University, and the MIT Sloan School of Management were able to accurately predict the purchasing decisions of test subjects in a virtual shopping center. They monitored the subject's level of interest in a product as well as their decision to purchase it.

Neuroimaging can also detect decisions about how someone will later do a high-level mental activity. Neuroimaging can be used to determine if someone is speaking or reading. It can be used to detect areas of the brain that are active when someone is hearing a sound, or touching an object.

Brain patterns associated with specific physical movements, such as a finger, can be deciphered with neural imaging. The mere intention to make a physical movement can be detected before the actual movement is made.

Cameras

A type of mind-reading is possible with cameras connected to computers. One such device, called the Emotional Social Intelligence Prosthetic (ESP), was developed at the MIT Media Laboratory in 2006. It consists of a tiny camera that can be worn on a hat, an earphone and a small computer that is worn on a belt. It infers a person's emotional state by analyzing combinations of subtle facial movements and gestures.

When an emotional state is detected, the wearer is signaled through the earphone to adjust their behavior in order to gain the attention of the target. The computer can detect 6 emotional states. It can also be adjusted for cultural differences and configured specifically for the wearer.

Around this time, the Computer Laboratory at the University of Cambridge, UK, developed a similar camera-based mind-reading machine. It uses a computer to monitor, in real-time, combinations of head movement, shape, color, smiles, and eyebrow activity to infer a person's emotional state.

It detects basic emotional states such as happiness, sadness, anger, fear, surprise, and disgust, as well as more complex states. It's accurate between 65 and 90 percent of the time. "The mind-reading computer system presents information about your mental state as easily as a keyboard and mouse present text and commands," they announced.

Used for Surveillance

Mind reading exists. The DOD and various institutions have vigorously researched this subject since at least the mid 1970s. "Mapping human brain functions is now routine," declared *US News and World Report*, in an article entitled *Reading Your Mind—And Injecting Smart Thoughts*, of January of 2000.

Both words and images, being viewed or thought, can be mind-read. Various emotional states as well as mental processes such decisionmaking, reading,

writing, movement and the intention to make a movement, can be detected with mind-reading devices. Perceptions such as touch, sound, and light can also be detected.

The proposed uses for mind-reading technology are positive. Some include determining if people in comas can communicate, helping stroke patients and those who suffered brain injuries, aiding those with learning disorders, assisting with online shopping, and improving people's communications skills.

However, other uses that have been suggested include the monitoring of unconscious mental processes, and interrogation of criminal suspects and potential terrorists. Dr. John Alexander mentioned that the recent developments in mind-reading technology would take surveillance to new levels by allowing investigators to "peer into the inner sanctum of the mind," in order to determine if a suspect has caused, or will likely cause a crime.

Dr. Norseen has sent R&D plans to the pentagon to have tiny mind-reading devices installed at airports to profile potential terrorists. He suggested that these devices could be functional by 2005. In August of 2008, *CNN* stated that the US military's knowledge obtained from mind-reading research could be used to interrogate the enemy.

Law Enforcement Technology announced in September of 2005 the existence of a new forensic technology known as *Brain Fingerprinting*, which has already been used in hundreds of investigations as a lie detector by the CIA, FBI and law enforcement agencies in the United States.

Brain Fingerprinting is admissible in court, because unlike a polygraph, which relies on emotional responses, it uses EEG to see how the brain reacts to words and pictures related to a crime scene. Dr. Larry Farwell, its inventor, says it is completely accurate. According to the report it will be used to help speed-up investigations.

Sources Next

Endnotes

1 Another possible method to obtain information is Remote Viewing. RV is the ability to produce correct information about people, events, objects, or concepts that are somewhere else in space and time, and are completely blind to the viewer collecting the information. It can be used to describe people or events, produce leads, reconstruct events, make decisions, and make predictions about the future. See *Remote Viewing Secrets* by Joseph McMoneagle. RV tests were conducted by the US government over a 20-year period during Project Stargate, a classified initiative by the CIA which began in 1972 and lasted until about 1994. Most of the 154 tests and 26,000 trials took place at the Cognitive Sciences Laboratory at Forte Meade, Maryland. A majority of the results of the project are still classified. See the *Journal of Parapsychology* articles, *Remote Viewing by Committee*, September 22, 2003, by Lance Storm and *Experiment One of the SAIC Remote Viewing Program*, of December 1, 1998, by Richard Wiseman and Julie Milton. The success of the project varies depending on the source. Allegedly the original tests were conducted under rigid scientific conditions, which had impressive results. However, the same sources describe RV

in general as ineffective. See *Discover Magazine's* article, *CIA ESP*, on April 1, 1996, by Jeffrey Kluger, and the *Washington Post's*report, *Many Find Remote Viewing a Far Fetch from Science*, on December 2, 1995, by Curt Suplee. According to author McMoneagle, an original viewer during Project Stargate, it is accurate about 50 or 60 percent of the time. Nevertheless, RV will be used to obtain intelligence, according to John B. Alexander. See *The New Mental Battlefield*, which appeared in the December 1980 issue of *Military Review*. Also see the June 1998 *Research Report Number 2* of the University of Bradford's Non-Lethal Weapons Research Project (BNLWRP), for how RV has been added to the NLW arsenal. According to multiple sources, US government agencies are now using the consulting services of RV professionals. This was reported on January 9, 2002 in the *University Wire's (Colorado Daily)* article, *Clairvoyant Discusses Reveals Details of Remote Viewing*, by Wendy Kale, and in the *Bulletin of the Atomic Scientists* on September 1, 1994, in its report, *The Soft Kill Fallacy* by Steven Aftergood. In his book *Winning The War: Advanced Weapons, Strategies, and Concepts for the Post-911 World*, Alexander had this to say regarding RV: "Since the beginning of history, humans have made anecdotal references to innate abilities to foretell the future, to know what was occurring at distant locations or the status of people separated from them, and to find resources they need without any traditional means of accessing that information." He continued: "Studies have demonstrated beyond any doubt that these nontraditional capabilities exist. ... [RV can] radically change our means of gathering intelligence. It holds the promise of providing information about inaccessible redoubts and advances in technology. More importantly, once these skills are understood, those possessing them will be able to determine an adversary's intent and be predictive about the events."

2 Because neuroimaging technology decodes brain patterns to thoughts, some argue that it technically doesn't read a person's mind. However, because specific thoughts and brain states can be deciphered, here it is referred to as mind-reading. Additionally, most mainstream documents refer to this as mind-reading, despite the fact that it is actually brainwave-reading.

3 Magnetoencephalography (MEG) and positron emission tomography (PET) can also be used to infer a person's neurophysiological state. But because they are impractical for field use due to their large size and harmful radiation, MEG and PET won't be considered here. However, DARPA is in the process of developing a small helmet-sized MEG device which would be connected to a portable computer. See the article *Mind over Machine* in the February 1, 2004 issue of *Popular Science*, by Carl Zimmer.

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Navy Lasers, Railgun, and Hypervelocity Projectile: Background and Issues for Congress

Ronald O'Rourke
Specialist in Naval Affairs

May 25, 2016

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R44175

CRS REPORT
Prepared for Members and
Committees of Congress

Summary

The Navy is currently developing three potential new weapons that could improve the ability of its surface ships to defend themselves against enemy missiles—solid state lasers (SSLs), the electromagnetic railgun (EMRG), and the hypervelocity projectile (HVP).

Any one of these new weapon technologies, if successfully developed and deployed, might be regarded as a "game changer" for defending Navy surface ships against enemy missiles. If two or three of them are successfully developed and deployed, the result might be considered not just a game changer, but a revolution. Rarely has the Navy had so many potential new types of surface-ship missile-defense weapons simultaneously available for development and potential deployment.

Although the Navy in recent years has made considerable progress in developing SSLs, EMRG, and HVP, a number of significant development challenges remain. Overcoming these challenges will likely require years of additional development work, and ultimate success in overcoming them is not guaranteed.

The issue for Congress is whether to approve, reject, or modify the Navy's funding requests and proposed acquisition strategies for these three potential new weapons. Potential oversight questions for Congress include the following:

- Using currently available approaches for countering anti-ship cruise missiles (ASCMs) and anti-ship ballistic missiles (ASBMs), how well could Navy surface ships defend themselves in a combat scenario against an adversary such as China that has large numbers of ASCMs (including advanced models) and ASBMs? How would this change if Navy surface ships in coming years were equipped with SSLs, EMRG, HVP, or some combination of these systems?
- How significant are the remaining development challenges for SSLs, EMRG, and HVP?
- Are current schedules for developing SSLs, EMRG, and HVP appropriate in relation to remaining development challenges and projected improvements in enemy ASCMs and ASBMs? To what degree are current schedules for developing SSLs, EMRG, or HVP sensitive to annual funding levels?
- When does the Navy anticipate issuing roadmaps detailing its plans for procuring and installing production versions of SSLs, EMRGs, and HVP on specific Navy ships by specific dates?
- Will the kinds of surface ships that the Navy plans to procure in coming years have sufficient space, weight, electrical power, and cooling capability to take full advantage of SSLs (particularly those with beam powers above 200 kW) and EMRG? What changes, if any, would need to be made in Navy plans for procuring large surface combatants (i.e., destroyers and cruisers) or other Navy ships to take full advantage of SSLs and EMRG?
- Are the funding sources for SSLs, EMRG, and HVP in Navy and Defense-Wide research and development accounts sufficiently visible for supporting congressional oversight?

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Introduction

Issue for Congress

This report provides background information and issues for Congress on three potential new weapons that could improve the ability of Navy surface ships to defend themselves against enemy missiles—solid state lasers (SSLs), the electromagnetic railgun (EMRG), and the hypervelocity projectile (HVP).[1]

Any one of these new weapon technologies, if successfully developed and deployed, might be regarded as a "game changer" for defending Navy surface ships against enemy missiles. If two or three of them are successfully developed and deployed, the result might be considered not just a game changer, but a revolution. Rarely has the Navy had so many potential new types of surface-ship missile-defense weapons simultaneously available for development and potential deployment. Although the Navy in recent years has made considerable progress in developing SSLs, EMRG, and HVP, a number of significant development challenges remain.

The issue for Congress is whether to approve, reject, or modify the Navy's funding requests and proposed acquisition strategies for these three potential new weapons. Congress' decisions on this issue could affect future Navy capabilities and funding requirements and the defense industrial base.

Scope of Report

SSLs are being developed by multiple parts of the Department of Defense (DOD), not just the Navy. SSLs, EMRG, and HVP, moreover, have potential application to military aircraft and ground forces equipment, not just surface ships. And SSLs, EMRG, and HVP can be used for missions other than defending against ASCMs and ASBMs.[2] This report focuses on Navy efforts to develop SSLs, EMRG, and HVP for potential use in defending Navy surface ships against ASCMs and ASBMs. It supersedes an earlier CRS report that provided an introduction to potential Navy shipboard lasers.[3]

Note that while fictional depictions of laser weapons in popular media often show them being used to attack targets at long ranges, the SSLs currently being developed by the Navy for potential shipboard use would be used to counter targets at short ranges of about a mile to perhaps a few miles.

[1] Railgun is also spelled as rail gun; EMRG is also abbreviated as EM railgun; hypervelocity is also spelled as hyper-velocity or hyper velocity.

[2] As discussed later in the report, the Navy is exploring the potential for using shipboard lasers to counter small boats and unmanned aerial vehicles (UAVs), and EMRG can be used to attack land targets.

[3] CRS Report R41526, *Navy Shipboard Lasers for Surface, Air, and Missile Defense: Background and Issues for Congress*, by Ronald O'Rourke. This earlier CRS report has been archived and remains available as a supplementary reference source on potential Navy shipboard lasers.

Background

Strategic and Budgetary Context

Concern about Survivability of Navy Surface Ships

Although Navy surface ships have a number of means for defending themselves against anti-ship cruise missiles (ASCMs) and anti-ship ballistic missiles (ASBMs),[4] some observers are concerned about the survivability of Navy surface ships in potential combat situations against adversaries, such as China, that are armed with advanced ASCMs and with ASBMs.[5] Concern about this issue has led some observers to conclude that the Navy's surface fleet in coming years might need to avoid operating in waters that are within range of these weapons, or that the Navy might need to move toward a different fleet architecture that relies less on larger surface ships and more on smaller surface ships and submarines.[6] Such changes in Navy operating areas and fleet architecture could substantially affect U.S. military strategy and the composition of the Navy's shipbuilding expenditures.

Navy surface fleet leaders in early 2015 announced a new organizing concept for the Navy's surface fleet called distributed lethality. Under distributed lethality, offensive weapons such as ASCMs are to be distributed more widely across all types of Navy surface ships, and new operational concepts for Navy surface ship formations are to be implemented. The aim of distributed lethality is to boost the surface fleet's capability for attacking enemy ships and make it less possible for an enemy to cripple the U.S. fleet by concentrating its attacks on a few very-high-value Navy surface ships (particularly the Navy's aircraft carriers).[7] Perspectives on whether

[4] These include the following: operating ships in ways that make it hard for others to detect and accurately track Navy ships; jamming or destroying enemy targeting sensors; interfering with the transmission of targeting data from sensors to weapon launchers; attacking weapon launchers (which can land-based launchers or launchers on surface ships, submarines, or aircraft); and countering ASCMs and ASBMs headed toward Navy ships. Navy measures for countering ASCMs and ASBMs headed toward Navy ships include the following: jamming a missile's guidance system; using decoys of various kinds to lure enemy missiles away from Navy ships; and shooting down enemy missiles with surface-to-air missiles and the Phalanx Close-In Weapon System (CIWS), which is essentially a radar-controlled Gatling gun. Employing all these measures reflects a long-standing Navy approach of creating a multi-layered defense against enemy missiles, and of attacking the enemy's "kill chain" at multiple points so as to increase the chances of breaking the chain. (The kill chain is the sequence of steps that an enemy must complete to conduct a successful missile attack on a Navy ship. This sequence includes, at a basic level of description, detecting and tracking the Navy ship, passing that information from sensors to the weapon launcher, launching the weapon, and guiding the weapon all the way to the Navy ship. Interfering with any one of these actions can break the kill chain and thereby prevent or defeat the attack.)

[5] See, for example, Andrew F. Krepinevich, Maritime Warfare in a Mature Precision-Strike Regime, Washington, Center for Strategic and Budgetary Assessments, 2014, 128 pp. For more on China's ASCMs and ASBMs, see CRS Report RL33153, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, by Ronald O'Rourke.

ASCMs and ASBMs are not the only reasons that some observers are concerned about the future survivability of U.S. Navy surface ships in combat situations; observers are also concerned about threats to U.S. Navy surface ships posed by small boats, mines, and torpedoes.

[6] See, for example, Phillip E. Pournelle, "The Deadly Future of Sea Control," *U.S. Naval Institute Proceedings*, July 2015: 26-31.

[7] See, for example, Thomas Rowden, Peter Gumataotao, and Peter Fanta, "Distributed Lethality," *U.S. Naval Institute Proceedings*, January 2015: 18-23; Sam LaGrone, "SNA: Navy Surface Leaders Pitch More Lethal Ships, Surface Action Groups," *USNI News*, January 14, 2015; Kris Osborn, "Navy Unveils New Surface Warfare Strategy," *Military.com*, January 14, 2015; Sydney J. Freedberg Jr., "'If It Floats, It Fights,': Navy Seeks 'Distributed Lethality,'" *Breaking Defense*, January 14, 2015; Mike McCarthy and Megan Eckstein, "Navy Eyeing A 'Hunter Killer' Surface (continued...)

it would be cost effective to spend money spreading offensive weapons across a wider array of Navy surface ships might be influenced by views on whether those surface ships can adequately defend themselves against enemy missiles.

Depth of Magazine and Cost Exchange Ratio

Two key limitations that Navy surface ships currently have in defending themselves against ASCMs and ASBMs are limited depth of magazine and unfavorable cost exchange ratios. Limited depth of magazine refers to the fact that Navy surface ships can use surface-to-air missiles (SAMs) and their Close-in Weapon System (CIWS) Gatling guns to shoot down only a certain number of enemy unmanned aerial vehicles (UAVs) and anti-ship missiles before running out of SAMs and CIWS ammunition[8]—a situation (sometimes called "going Winchester"), that can require a ship to withdraw from battle, spend time travelling to a safe reloading location (which can be hundreds of miles away),[9] and then spend more time traveling back to the battle area.

Unfavorable cost exchange ratios refer to the fact that a SAM used to shoot down a UAV or anti-ship missile can cost the Navy more (perhaps much more) to procure than it cost the adversary to build or acquire the UAV or anti-ship missile. In the FY2016 defense budget, procurement costs for Navy SAMs range from about $900,000 per missile to several million dollars per missile, depending on the type.[10]

In combat scenarios against an adversary with a limited number of UAVs and anti-ship missiles, an unfavorable cost exchange ratio can be acceptable because it saves the lives of Navy sailors and prevents very expensive damage to Navy ships. But in combat scenarios (or an ongoing military capabilities competition) against a country such as China that has many UAVs and anti-ship missiles and a capacity for building or acquiring many more, an unfavorable cost exchange ratio can become a very expensive—and potentially unaffordable—approach to defending Navy surface ships against UAVs and anti-ship missiles, particularly in a context of constraints on U.S. defense spending and competing demands for finite U.S. defense funds.

(...continued)

Fleet, Would Require Upgunning Existing Ship Fleets," *Defense Daily*, January 15, 2015: 1-3; Richard Scott, "Offensive Language: USN Sets Out Surface Firepower Strategy," *Jane's International Defence Review*, May 2015: 42-47; Megan Eckstein, "Navy Studying Implications of Distributed Lethality in Wargames Series," *USNI News*, July 9, 2015; Lara Seligman, "Navy Establishes Task Force To Study Impact of Distributed lethality," *Inside the Navy*, July 10, 2015.

[8] Navy cruisers have 122 missile cells; Navy destroyers have 90 or 96 missile cells. Some of these cells are used for storing and launching Tomahawk land attack cruise missiles or anti-submarine rockets. The remainder are available for storing and launching SAMs. A Navy cruiser or destroyer might thus be armed with a few dozen or several dozen SAMs for countering ASCMs and ASBMs. Countering ASCMs or ASBMs with SAMs might sometimes require shooting two SAMs at each ASCM or ASBM.

[9] The missile cells on a Navy cruiser or destroyers are clustered together in an installation called a Vertical Launch System (VLS). VLS cells cannot be reloaded while the ship is underway; a ship needs to return to a port or a calm anchorage to reload its VLS.

[10] Unit procurement costs for ship-launched SAMs in the FY2016 are as follows: about $900,000 for the Rolling Airframe Missile (RAM), about $1.1 million to about $1.5 million for the Evolved Sea Sparrow Missile (ESSM), about $3.9 million for the SM-6 Block 1 missile, about $14 million for the SM-3 Block 1B missile, and more than $20 million for theSM-3 Block IIA missiles. RAM and ESSM are short-range missiles for defense against aircraft and ASCMs. The SM-6 Block 1 is a medium-range missile used for both defense against aircraft and ASCMs, and terminal (i.e., endo-atmospheric) defense against theater-range ballistic missiles. The SM-3 Block 1B and SM-3 Block IIA are used for mid-course (i.e., exo-atmospheric) defense against theater-range ballistic missiles.

SSLs, EMRG, and HVP offer a potential for dramatically improving depth of magazine and the cost exchange ratio:

- **Depth of magazine.** SSLs are electrically powered, drawing their power from the ship's overall electrical supply, and can be fired over and over, indefinitely, as long as the SSL continues to work and the ship has fuel to generate electricity. The EMRG's projectile and the HVP (which are one and the same—see next section) can be stored by the hundreds in a Navy surface ship's weapon magazine.[11]
- **Cost exchange ratio.** An SSL can be fired for a marginal cost of less than one dollar per shot (which is the cost of the fuel needed to generate the electricity used in the shot), while the EMRG's projectile/HVP has an estimated unit procurement cost of about $25,000.[12]

For additional discussion of the strategic and budgetary context in which the programs discussed in this report and other Navy programs may be considered, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

SSLs, EMRG, and HVP in Brief

SSLs

Overview

The Navy in recent years has leveraged both significant advancements in industrial SSLs and decades of research and development work on military lasers done by other parts of DOD to make substantial progress toward deploying high-energy SSLs[13] on Navy surface ships. Navy surface ships would use high-energy SSLs initially for countering small boats UAVs, and potentially in the future for countering ASCMs and ASBMs as well.[14] High-energy SSLs on Navy ships would be short-range defensive weapons—they would counter targets at ranges of about one mile to perhaps eventually a few miles.[15]

[11] In July 2015, the Navy issued a request for information (RFI) to industry for the fabrication of a prototype EMRG mount that would store a minimum of 650 rounds. (RFI for Fabrication of Prototype Mount for Naval Railgun, Solicitation Number: N00024-15-R-4132, FedBizOpps.gov, July 29, 2015. See also Justin Doubleday, "Navy Developing Integrated Mount For Electromagnetic Railgun," *Inside the Navy*, July 31, 2015.)

[12] Sources for cost of HVP: David Martin, "Navy's Newest Weapon Kills at Seven Times the Speed of Sound," CBS News (cbssnews.com), April 7, 2014; Kris Osborn, "Navy Will Test its Electromagnetic Rail Gun aboard DDG 1000," *DefenseTech*, April 15, 2015.

[13] In discussions of potential Navy shipboard lasers, a high-energy laser is generally considered to be a laser with a beam power of at least 10 kilowatts (kW).

[14] In general, lasers would counter small boats and missiles by heating and burning holes in their skins, and causing thermal damage to their interiors. Lasers can also be used to "dazzle" (i.e., interfere with) electro-optical sensors on a boat or missile.

[15] The Navy has also performed research and development work on a different kind of laser, called the free electron laser (FEL). In recent years, Navy research and development work on potential shipboard lasers has shifted more to SSLs. For background information on the FEL, see CRS Report R41526, *Navy Shipboard Lasers for Surface, Air, and Missile Defense: Background and Issues for Congress*, by Ronald O'Rourke.

In addition to a low marginal cost per shot and deep magazine, potential advantages of shipboard lasers include fast engagement times, an ability to counter radically maneuvering missiles, an ability to conduct precision engagements, and an ability to use lasers for graduated responses ranging from detecting and monitoring targets to causing disabling damage. Potential limitations of shipboard lasers relate to line of sight; atmospheric absorption, scattering, and turbulence (which prevent shipboard lasers from being all-weather weapons); an effect known as thermal blooming that can reduce laser effectiveness; countering saturation attacks; possible adversary use of hardened targets and countermeasures; and risk of collateral damage, including damage to aircraft and satellites and permanent damage to human eyesight, including blinding. These potential advantages and limitations are discussed in greater detail in the **Appendix**.

Selected Key Developments

Key developments in the Navy's high-energy SSL development effort include the following:

- Between 2009 and 2012, the Navy successfully tested a prototype SSL called the Laser Weapon System (LaWS) against UAVs in a series of engagements that took place initially on land and subsequently on a Navy ship at sea.
- Between 2010 and 2011, the Navy tested another prototype SSL called the Maritime Laser Demonstration (MLD) in a series of tests that culminated with an MLD installed on a Navy ship successfully engaging a small boat.
- In April 2013, the Navy announced that it planned to install LaWS on the USS *Ponce* (pronounced pon-SAY)—a converted amphibious ship that is operating in the Persian Gulf as an interim Afloat Forward Staging Base (AFSB[I]) [16]—to conduct evaluation of shipboard lasers in an operational setting against swarming boats and swarming UAVs.[17] The system was installed in August 2014 (see **Figure 1**, **Figure 2**, and **Figure 3**).
- In March 2014, it was reported that the Navy anticipated moving to a shipboard laser program of record in "the FY2018 time frame" and achieving an initial operational capability (IOC) with a shipboard laser in FY2020 or FY2021.[18]

[16] An AFSB operates as a "mother ship" for Navy helicopter and small boat operations. The Ponce is serving as an interim AFSB pending the arrival of a new AFSB that is currently being built.

[17] "Navy Leaders Announce Plans for Deploying Cost-Saving Laser Technology," *Navy News Service*, April 8, 2013; Thom Shanker, "Navy Deploying Laser Weapon Prototype Near Iran," *New York Times*, April 9, 2013: 4; Mike McCarthy, "Navy Deploying Laser For Taking Out Drones," *Defense Daily*, April 9, 2013; Graham Warwick, "U.S. Navy Planning Gulf Deployment For Laser Weapon," *Aerospace Daily & Defense Report*, April 9, 2013: 6; Megan Eckstein, "Navy-Built Laser Weapon System Will Begin Demo On Ponce In Early 2014," *Inside the Navy*, April 15, 2013. See also Lara Seligman, "Navy-built LaWS To Begin Demo This Summer, IOC Slated For FY-20-21," *Inside the Navy*, March 24, 2014; Office of Naval Research, "All Systems Go: Navy's Laser Weapon Ready for Summer Deployment," *Navy News Service*, April 7, 2014.

Swarming refers to the use of boats and UAVs in large numbers, or swarms, in an attempt to confuse and overwhelm a target ship's defensive systems.

[18] Lara Seligman, "Navy-built LaWS To Begin Demo This Summer, IOC Slated For FY-20-21," *Inside the Navy*, March 24, 2014. A program of record, or POR, is a term sometimes used by DOD officials that means, in general, a program in the Future Years Defense Plan (FYDP) that is intended to provide a new, improved, or continuing materiel, weapon, or information system or service capability in response to an approved need. The term is sometimes used to refer to a program in a service's budget for procuring and deploying an operational weapon system, as opposed to a research and development effort that might or might not eventually lead to procurement and deployment of an operational weapon system.

- In December 2014, the Navy declared LaWS on the Ponce to be an "operational" system.[19]
- In January 2016, the Navy stated that it anticipated releasing a directed energy weapon roadmap in February 2016.[20]

[19] A December, 11, 2014, press report stated

> The Navy's first-of-a-kind laser deployed on a vessel sailing in the Persian Gulf has been declared operational and can be used by the crew to defend itself against potential threats, the service's head of the Office of Naval Research said on Wednesday [December 10, 2014].
>
> Rear Adm. Matthew Klunder told reporters on a conference call that Central Command has been green lighted to use the laser in the event of a threat, approval that has been passed along to the ship's commanding officer. The 30-kilowat laser, known as the Laser Weapon System, or LaWS, was installed on the USS Ponce in August [2014].
>
> The ship later departed for the Persian Gulf and the LaWS successfully carried out operational testing recently by striking a fast attack boat and drone, Klunder said, adding that this marks the "historic" first ever operational deployment of a directed energy weapon.
>
> (Mike McCarthy, "Navy Authorized To Use Ship-Based Laser In Battle," *Defense Daily*, December 11, 2014: 3. See also Sam LaGrone, "U.S. Navy Allowed to Use Persian Gulf Laser for Defense," *USNI News*, December 10, 2014; Philip Ewing, "Navy Declares Laser Weapon 'Operational,'" *Politico Pro (Pro Defense Report)*, December 10, 2014.)

The Navy testified on February 24, 2016, that

> the Solid State Laser Quick Reaction Capability (SSL-QRC) was fielded as a science and technology demonstration aboard the USS PONCE. It was successfully demonstrated as an effective weapon system and was subsequently transitioned to the fleet in the Central Command area of responsibility and is now an operational system.
>
> (Statement of Rear Admiral Mathias W. Winter, United States Navy, Chief of Naval Research, Before the Emerging Threats and Capabilities Subcommittee of the House Armed Services Committee on The Fiscal Year 2017 Budget Request, February 24, 2016, p. 15.)

[20] Justin Doubleday, "Winter: Navy Directed-Energy Strategy To Be Released This Month," *Inside the Navy*, February 1, 2016.

Figure 1. Laser Weapon System (LaWS) on USS Ponce

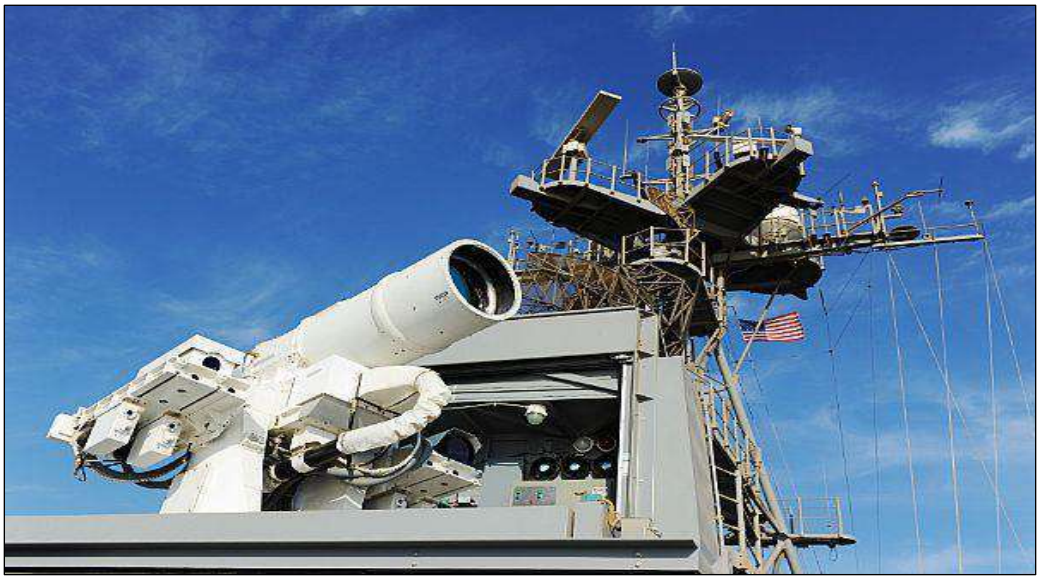

Source: Navy photograph dated November 16, 2014, accompanying David Smalley, "Historic Leap: Navy Shipboard Laser Operates in Arabian Gulf," *Navy News Service*, December 10, 2014, accessed August 12, 2015, at http://www.navy.mil/list_all.asp?id=84805.

Figure 2. Laser Weapon System (LaWS) on USS Ponce

Source: Navy photograph dated November 17, 2014, accompanying David Smalley, "Historic Leap: Navy Shipboard Laser Operates in Arabian Gulf," *Navy News Service*, December 10, 2014, accessed August 12, 2015, at http://www.navy.mil/list_all.asp?id=84805.

Figure 3. Laser Weapon System (LaWS) on USS Ponce

Source: Navy photograph dated November 16, 2014, accompanying David Smalley, "Historic Leap: Navy Shipboard Laser Operates in Arabian Gulf," *Navy News Service*, December 10, 2014, accessed August 12, 2015, at http://www.navy.mil/list_all.asp?id=84805.

SSL Technology Maturation (SSL-TM) Program

LaWS has a reported beam power of 30 kilowatts (kW),[21] which is strong enough to counter small boats and UAVs. As a follow-on effort to LaWS and MLD, the Navy initiated the SSL Technology Maturation (SSL-TM) program, in which industry teams led by BAE Systems, Northrop Grumman, and Raytheon, among others, competed to develop a shipboard laser with a beam power of 100 kW to 150 kW, which would provide increased effectiveness against small

[21] See, for example, Mike McCarthy, "Navy Authorized To Use Ship-Based Laser In Battle," *Defense Daily*, December 11, 2014: 3.

boats and UAVs.[22] Boosting beam power further—to something like 200 kW or 300 kW—could permit a laser to counter at least some ASCMs. Even stronger beam powers—on the order of at least several hundred kW, if not one megawatt (MW) or more—could improve a laser's effectiveness against ASCMs and enable it to counter ASBMs.[23]

On October 22, 2015, DOD announced that it had selected Northrop Grumman as the winner of the SSL-TM competition. DOD's contract-award announcement stated:

> Northrop Grumman Space and Mission Systems Corp., Redondo Beach, California, is being awarded a $53,151,809 cost-plus-fixed-fee contract for the Solid State High Power Laser Weapon System Demonstrator (LWSD) program.... The Office of Naval Research seeks to continue the advancement of SSL weapon system designs, architectures, and component technologies. The government believes that improvements in lethality may be achieved through maturation and optimization of a variety of system characteristics, including laser power, beam quality, beam director architecture, and other physical and optical aspects of the laser, beam director, and system design. Leveraging our experience and internal investments, the Northrop Grumman team is ready to fully support the three phases of the LWSD program. This contract contains options, which if exercised, will bring the contract value to $91,057,597. Work will be performed in Redondo Beach, California, and is expected to be completed Oct. 21, 2016. If options are exercised, work will continue through July 7, 2018.... This contract was competitively procured under the Office of Naval Research broad agency announcement 15-0005 entitled "Solid State, High Power Laser Weapon System Demonstrator (LWSD) Design, Development and Demonstration for Surface Navy, USN." Six proposals were received in response to this solicitation.[24]

A December 22, 2016, Northrop Grumman news release about the October 22, 2016, contract award stated:

> During Phase 1 of the LWSD contract, Northrop Grumman will develop a detailed design for the new system. Phase 2 will include assembly and ground test of the system, while Phase 3 will comprise at-sea testing of the system aboard the Navy's Self Defense Test Ship (SDTS). The Navy will lead this testing with Northrop Grumman providing technical support. The SDTS is the former USS Paul F. Foster (DD-964).
>
> According to Renard, Northrop Grumman's LWSD is well suited to support the Navy's planned initial testing on the SDTS. The company has designed its system to be installed, however, with minimal modification or additional costs, for demonstration on the Navy's DDG-51 FLT II class destroyers.[25]

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[22] For more on the SSL-TM program, see Office of Naval Research, "Solid-State Laser Technology Maturation Program," accessed August 11, 2015, at http://www.onr.navy.mil/Media-Center/Fact-Sheets/Solid-State-Laser-Technology-Maturation-Program.aspx; Office of Naval Research, "Solid State Laser Technology Maturation Program," September 2012, accessed August 11, 2015, at http://www.onr.navy.mil/~/media/Files/Fact-Sheets/35/Solid-State-Laser-Technology-Maturation-Program-2012-a.ashx; Office of Naval Research, "Research and Development/Technology Maturation of Solid State High Power Laser Weapon Systems, Subsystems, and/or Components for Surface Navy, USN, Broad Agency Announcement (BAA)," ONR BAA # 12-019, 2012, accessed August 11, 2015, at http://www.onr.navy.mil/~/media/files/funding-announcements/baa/2012/12-019.ashx; Future Force, "Developing a High-Energy Laser for the Navy," January 23, 2015, accessed August 11, 2015, at http://futureforce.navylive.dodlive.mil/2015/01/high-energy-laser/.

[23] For additional discussion, see CRS Report R41526, *Navy Shipboard Lasers for Surface, Air, and Missile Defense: Background and Issues for Congress*, by Ronald O'Rourke, particularly the section entitled "Required Laser Power Levels for Countering Targets" and Appendix A on "Laser Power Levels Required to Counter Targets."

[24] DOD contract award announcements for October 22, 2015, accessed December 18, 2015, at: http://www.defense.gov/News/Contracts/Contract-View/Article/625630.

[25] "US Navy Selects Northrop Grumman to Design and Produce Shipboard Laser Weapon System Demonstrator," (continued...)

Figure 4 shows an artist's rendering of LWSD installed on the Navy's Self Defense Test Ship (the USS Paul F. Foster [DD-964], an old Spruance [DD-963] class destroyer).

Figure 4. Laser Weapon System Demonstrator (LWSD) on Self Defense Test Ship

Artist's rendering

Source: Cropped version of image accessed on March 18, 2016, at http://media.globenewswire.com/cache/189/hires/39412.jpg.

Figure 5 is a detail from the above photo.

(...continued)

December 22, 2016, accessed March 18, 2016, at: http://www.globenewswire.com/newsarchive/noc/press/pages/news_releases.html?d=10158731 . See also Richard Scott, "Northrop Grumman To Build on MLD for SSL Demonstrator," *IHS Jane's International Defence Review*, February 2016: 5.

Figure 5. Laser Weapon System Demonstrator (LWSD) on Self Defense Test Ship

Artist's rendering

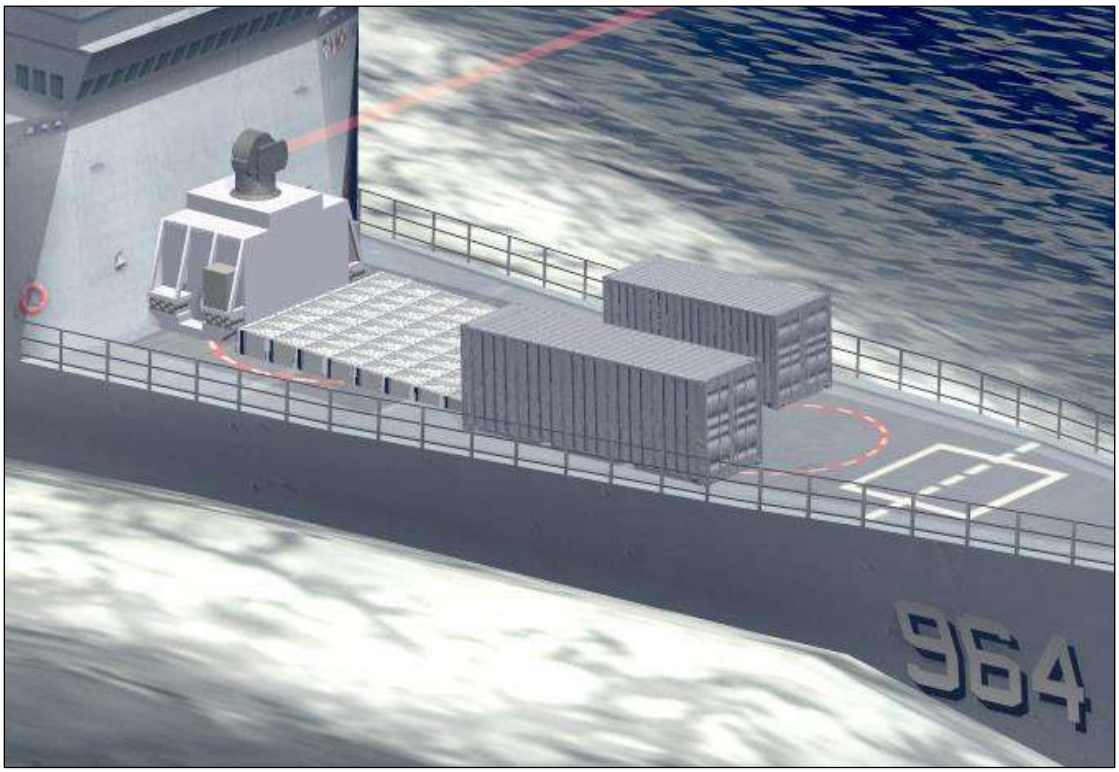

Source: Cropped version of image accessed on March 18, 2016, at http://media.globenewswire.com/cache/189/hires/39412.jpg.

Figure 6 Is an Office of Naval Research (ONR) graphic illustration of the LWSD's major components.

Figure 6. ONR Graphic of LWSD Components

Artist's rendering

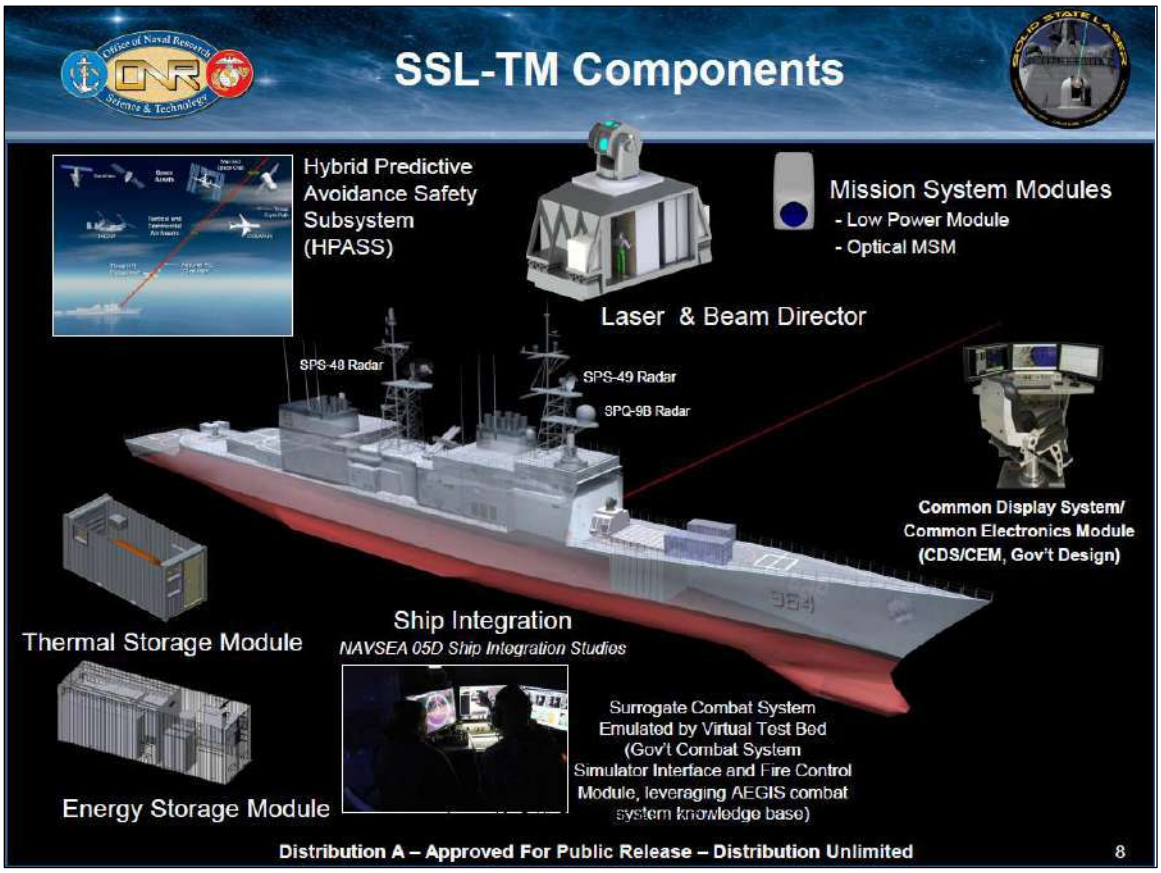

Source: Slide from February 2016 ONR briefing to CRS on SSL-TM program, received from Navy Office of Legislative Affairs February 26, 2016.

Directed Energy Roadmap

A July 28, 2015, press report stated:

> [Secretary of the Navy Ray] Mabus said he would release a DE [directed energy][26] roadmap this fall that "charts our course for research, development, and fielding of high power radio frequency weapons, lasers, and directed energy countermeasures. And I will follow it up with my guidance to the Program Objective Memorandum for [Fiscal Year 2018],[27] which, importantly, establishes a resource sponsor and a program of record."...
>
> Also meant to help quicken the pace of progress, the Office of Naval Research will take lessons learned from the [USS] Ponce to inform the Solid State Laser Technology Maturation program that aims to produce a 100-150 kilowatt laser prototype for at-sea testing in 2018, or sooner if possible. Rear Adm. Bryant Fuller, Naval Sea Systems Command (NAVSEA) chief engineer, said... that everything the Navy learned about rules

[26] Lasers and another class of weapons called high-power microwave (HPM) weapons are referred to collectively as directed-energy weapons because they achieve their effects by directing electromagnetic energy at their targets.

[27] The Program Objective Memorandum (POM) is an internal DOD document that guides the preparation of a budget for a particular fiscal year.

> of engagement and how to use LaWS in an operational environment would apply to larger laser weapons as well. Leveraging the operational knowledge Ponce gained will help the Navy field whatever comes out of the SSL-TM effort much more rapidly.
>
> In the meantime, Mabus said the Laser Weapon System (LaWS) will continue its work in the Middle East after early success led officials to extend its deployment.[28]

EMRG

In addition to SSLs, the Navy since 2005 has been developing EMRG, a cannon that uses electricity rather than chemical propellants (i.e., gunpowder charges) to fire a projectile.[29] In EMRG, "magnetic fields created by high electrical currents accelerate a sliding metal conductor, or armature, between two rails to launch projectiles at [speeds of] 4,500 mph to 5,600 mph,"[30] or roughly Mach 5.9 to Mach 7.4 at sea level.[31] Like SSLs, EMRG draws its power from the ship's overall electrical supply.[32] The Navy originally began developing EMRG as a naval surface fire support (NSFS) weapon for supporting U.S. Marines operating ashore, but subsequently determined that the weapon also has potential for defending against ASCMs and ASBMs.[33] In response to Section 243 of the FY2012 National Defense Authorization Act (H.R. 1540/P.L. 112-81 of December 31, 2011), the Navy in September 2012 submitted to the congressional defense committees a report on the EMRG development effort.[34]

Following tests with early Navy-built EMRG prototypes, the Navy funded the development of two industry-built EMRG prototype demonstrators, one by BAE Systems and the other by General Atomics (see **Figure 7** and **Figure 8**).

[28] Megan Eckstein, "Mabus: Adversaries Showing Interest in Directed Energy; Navy Needs to Move Faster," *USNI News*, July 28, 2015.

[29] Because it uses electricity rather than a powder charge to accelerate the projectile, Navy officials sometimes refer to EMRG as a launcher rather than a gun or cannon.

[30] Grace Jean, "With a Bang, Navy Begins Tests on EM Railgun Prototype Launcher," Navy News Service, February 28, 2012, accessed August 12, 2015, at http://www.navy.mil/submit/display.asp?story_id=65577.

[31] The speed of sound in air (i.e., Mach 1), varies with altitude; at sea level, it is approximately 761 miles an hour. (See for example, the table entitled "Speed of Sound at Different Altitudes," accessed August 12, 2015, at http://www.fighter-planes.com/jetmach1.htm.

[32] Unlike SSLs, however, EMRG is not a directed energy weapon, because it achieves its effects by firing a physical projectile at the target, not by directing electromagnetic energy at the target. See also footnote 26.

[33] For a recent article discussing the use of EMRG in countering ASCMs and ASBMs, see Sam LaGrone, "Navy Wants Rail Guns to Fight Ballistic and Supersonic Missiles Says RFI," *USNI News*, January 5, 2015.

[34] U.S. Navy, *Electromagnetic Railgun System: Final Report to the Congressional Defense Committees*, August 2012, with cover letters dated September 18, 2012. For a press report discussing the Navy's report to Congress, see Dan Taylor, "Stackley: Navy Identifies Four Technical Hurdles To Railgun Development," *Inside the Navy*, November 19, 2012.

Figure 7. Industry-Built EMRG Prototype Demonstrator

BAE prototype

Source: Navy photograph dated July 8, 2014, associated with Office of Naval Research Public Affairs, "From Research to Railgun: Revolutionary Weapon at Future Force EXPO," *Navy News Service*, January 13, 2015, accessed August 12, 2015, at http://www.navy.mil/submit/display.asp?story_id=85166.

Figure 8. Industry-Built EMRG Prototype Demonstrator

General Atomics prototype

Source: navy photograph dated July 8, 2014, accessed August 12, 2015, at http://www.navy.mil/view_image.asp?id=180994.

The two industry-built prototypes are designed to fire projectiles at energy levels of 20 to 32 megajoules,[35] which is enough to propel a projectile 50 to 100 nautical miles.[36] (Such ranges might refer to using the EMRG for NSFS missions. Intercepts of ASCMs and ASBMs might take place at much shorter ranges.) The Navy began evaluating the two industry-built prototypes in 2012.

In April 2014, the Navy announced that it plans to temporarily install a prototype EMRG aboard a Navy Joint High Speed Vessel (JHSV) in FY2016, for use in at-sea tests.[37] **Figure 9** is an artist's rendering of that installation.

In January 2015, it was reported that the Navy is projecting that EMRG could become operational on a Navy ship between 2020 and 2025.[38] In April 2015, it was reported that the Navy is considering installing an EMRG on a Zumwalt (DDG-1000) class destroyer by the mid-2020s.[39]

[35] The Navy states that "a megajoule is a measurement of energy associated with a mass traveling at a certain velocity. In simple terms, a one-ton vehicle moving at 100 mph equals a magajoule of energy." (Office of Naval Research Public Affairs, "Navy Sets New World Record with Electromagnetic Railgun Demonstration," *Navy News Service*, December 10, 2010, accessed August 12, 2015, at http://www.navy.mil/submit/display.asp?story_id=57690.)

[36] Grace Jean, "With a Bang, Navy Begins Tests on EM Railgun Prototype Launcher," Navy News Service, February 28, 2012, accessed August 12, 2015, at http://www.navy.mil/submit/display.asp?story_id=65577.

[37] Naval Sea Systems Command Office of Corporate Communication, "Navy to Deploy Electromagnetic Railgun Aboard JHSV," *Navy News Service*, April 7, 2014, accessed August 12, 2015, at http://www.navy.mil/submit/display.asp?story_id=80055.

[38] Sam LaGrone, "Navy Wants Rail Guns to Fight Ballistic and Supersonic Missiles Says RFI," *USNI News*, January 5, 2015.

[39] Sam LaGrone, "Navy Considering Railgun for Third Zumwalt Destroyer," *USNI News*, February 5, 2015 (updated (continued...)

Figure 9. EMRG Prototype Demonstrator Installed on a JHSV

Artist's rendering

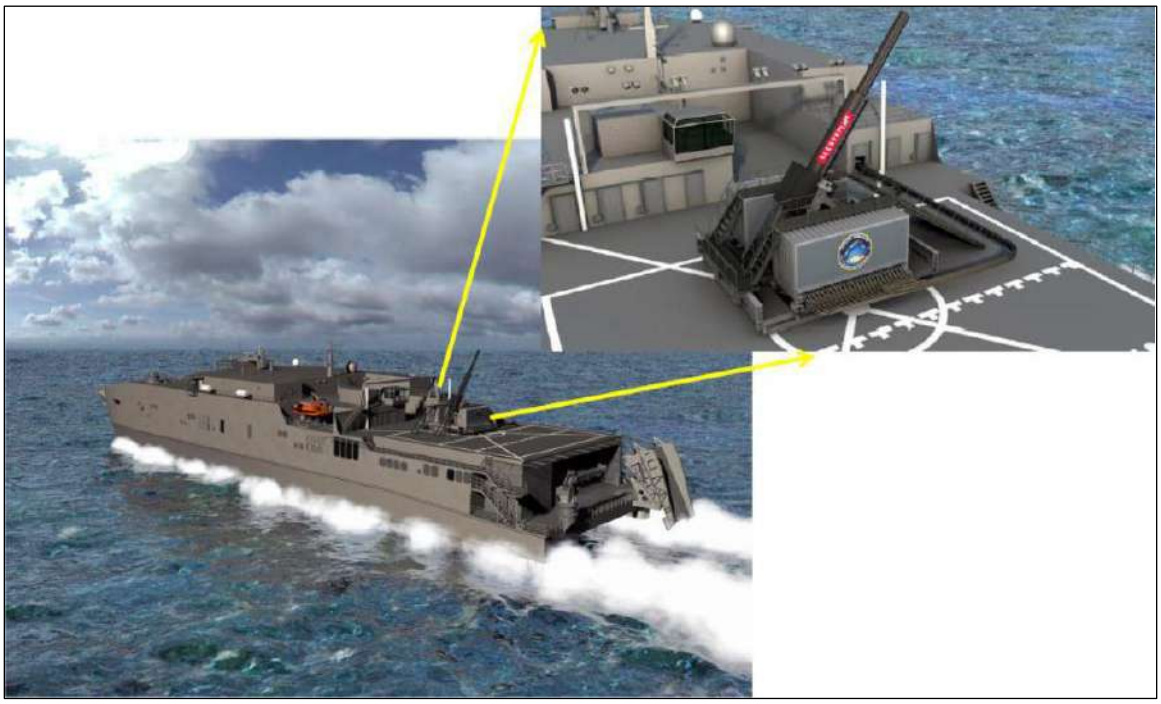

Source: Briefing slide entitled "FY16 At-Sea Test of Railgun" in Navy briefing entitled "Railgun Program Overview," undated but posted at InsideDefense.com on April 14, 2015. (InsideDefense.com states that the briefing was presented at a public conference on April 14, 2015.)

HVP

As the Navy was developing EMRG, it realized that the guided projectile being developed for EMRG could also be fired from 5-inch and 155mm powder guns.[40] Navy cruisers each have two

(...continued)

February 11, 2015); Mike McCarthy, "Navy Aiming To Put Railgun On Third Zumwalt Destroyer," *Defense Daily*, February 6, 2015; Kris Osborn, "Navy Will Test its Electromagnetic Rail Gun aboard DDG 1000," *DefenseTech*, April 15, 2015. For more on Zumwalt-class destroyers, see CRS Report RL32109, *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*, by Ronald O'Rourke.

[40] The Navy describes the HVP as "a next generation, common, low drag, guided projectile capable of completing multiple missions for gun systems such as the Navy 5-Inch, 155-mm, and future railguns.... HVP's low drag aerodynamic design enables high velocity, maneuverability, and decreased time-to-target. These attributes coupled with accurate guidance electronics provide low cost mission effectiveness against current threats and the ability to adapt to air and surface threats of the future." (Office of Naval Research, Hypervelocity Projectile," September 2012, accessed August 14, 2015, at http://www.onr.navy.mil/~/media/Files/Fact-Sheets/35/Hypervelocity-Projectile-2012B.ashx.) The Navy states that HVP weighs 23 pounds. (Source: David Martin, "Navy's Newest Weapon Kills at Seven Times the Speed of Sound," *CBS News (cbssnews.com)*, April 7, 2014.)

BAE Systems states that HVP is 24 inches long and weighs 28 pounds, including a 15-pound payload. The total length and weight of an HVP launch package, BAE Systems states, is 26 inches and 40 pounds. BAE states that the maximum rate of fire for HVP is 20 rounds per minute from a Mk 45 5-inch gun, 10 rounds per minute from the 155mm gun on DDG-1000 class destroyers (called the Advanced Gun System, or AGS), and 6 rounds per minute from EMRG. HVP's firing range, BAE Systems states, is more than 40 nautical miles (when fired from a Mk 45 Mod 2 5-inch gun), more than 50 nautical miles (Mk 45 Mod 4 5-inch gun), more than 70 nautical miles (155mm gun on DDG-1000 class destroyers), and more than 100 nautical miles (EMRG). (BAE Systems, "Hypervelocity Projectile (HVP)," 2014, (continued...)

5-inch guns, and most Navy destroyers each have one 5-inch gun. The Navy's three new Zumwalt class (DDG-1000) destroyers, which are under construction, each have two 155mm guns.

The projectile is a hypervelocity projectile when fired from either EMRG or a powder gun, but the term HVP tends to be used more frequently in connection with the concept of firing it from a powder gun. **Figure 10** and **Figure 11** show the HVP.

Figure 10. Photograph Showing HVP

Source: Navy photograph dated April 4, 2014, with a caption that reads: "Rear Adm. Matthew Klunder, chief of naval research, shows off a Hypervelocity Projectile (HVP) to CBS News reporter David Martin during an interview held at the Naval Research Laboratory's materials testing facility. The HVP is a next-generation, common, low drag, guided projectile capable of completing multiple missions for gun systems such as the Navy 5-inch, 155-mm, and future railguns," accessed August 12, 2015, at http://www.navy.mil/view_image.asp?id=174517.

(...continued)

accessed August 14, 2015, at http://www.baesystems.com/download/BAES_178505/hyper-velocity-projectile-hvp-datasheet.)

In July 2015, the Navy issued a request for information (RFI) to industry for the fabrication of a prototype EMRG mount capable of handling an integrated launch weight package of 22 kg, or about 48.5 pounds. (RFI for Fabrication of Prototype Mount for Naval Railgun, Solicitation Number: N00024-15-R-4132, FedBizOpps.gov, July 29, 2015. See also Justin Doubleday, "Navy Developing Integrated Mount For Electromagnetic Railgun," *Inside the Navy*, July 31, 2015.)

Figure 11. HVP

Source: Slide 7 from Navy briefing entitled "Electromagnetic Railgun," NDIA Joint Armaments Forum, Exhibition & Technology Demonstration, May 14, 2014, LCDR Jason Fox, USN, Assistant PM [Program Manager], Railgun Ship Integration, Distribution A, Approved for Public Release, accessed August 13, 2015, at http://www.dtic.mil/ndia/2014armaments/WedFox.pdf.

When fired from 5-inch powder guns, the projectile achieves a speed of roughly Mach 3, which is roughly half the speed it achieves when fired from EMRG, but more than twice the speed of a conventional 5-inch shell fired from a 5-inch gun.[41] This is apparently fast enough for countering at least some ASCMs. The Navy states that "The HVP—combined with the MK 45 [5-inch gun][42]—will support various mission areas including naval surface fire support, and has the capacity to expand to a variety of anti-air threats, [and] anti-surface [missions], and could expand the Navy's engagement options against current and emerging threats."[43]

One advantage of the HVP/5-inch gun concept is that the 5-inch guns are already installed on Navy cruisers and destroyers, creating a potential for rapidly proliferating HVP through the cruiser-destroyer force, once development of HVP is complete and the weapon has been

[41] Source: Sam LaGrone, "Updated: Navy Researching Firing Mach 3 Guided Round from Standard Deck Guns," *USNI News*, June 1, 2015 (updated June 2, 2015).

[42] The type of 5-inch gun on Navy cruisers and destroyers is called the Mark 45.

[43] Naval Surface Warfare Center Dahlgren Division Corporate Communications, "DEPSECDEF Loads HVP on Test Range, Observes Repetitive Rate Electromagnetic Railgun's Commissioning Series," *Navy News Service*, May 8, 2015, accessed August 12, 2015, at http://www.navy.mil/submit/display.asp?story_id=86987.

integrated into cruiser and destroyer combat systems. **Figure 12** shows HVP launch packages configured for 5-inch guns, 155mm guns, and EMRG.

Figure 12. HVP Launch Packages

Launch packages for 5-inch gun, 155mm gun, and EMRG

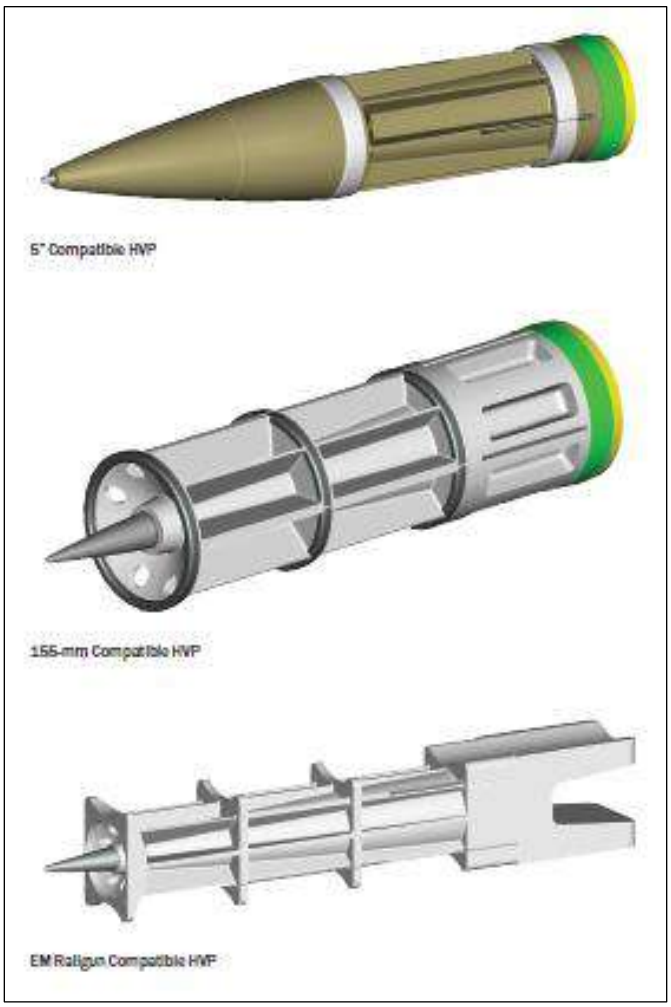

Source: BAE Systems, "Hypervelocity Projectile (HVP)," 2014, accessed August 14, 2015, at http://www.baesystems.com/download/BAES_178505/hyper-velocity-projectile--datasheet.

Figure 13 is a slide showing the potential application of HVP to 5-inch power guns, 155mm powder guns, and EMRG. The first line of the slide, for example, discusses HVP's use with 5-inch powder guns, stating that it uses a high-explosive (HE) warhead for the NSFS mission;[44] that a total of 113 5-inch gun barrels are available in the fleet (which could be a reference to 22 cruisers with two guns each, and 69 destroyers with one gun each); and that as a game-changing capability, it is guided and can be used at ranges of up to 26 nautical miles to 41 nautical miles for NSFS operations, for countering ASCMs, and for anti-surface warfare (ASuW) operations (i.e., attacking surface ships and craft).

[44] The "KE" in the next line down means that when fired from EMRG, the projectile can alternatively attack targets using its own kinetic energy (i.e., by simply impacting the target at hypersonic speed).

Figure 13. HVP Application to Various Launchers

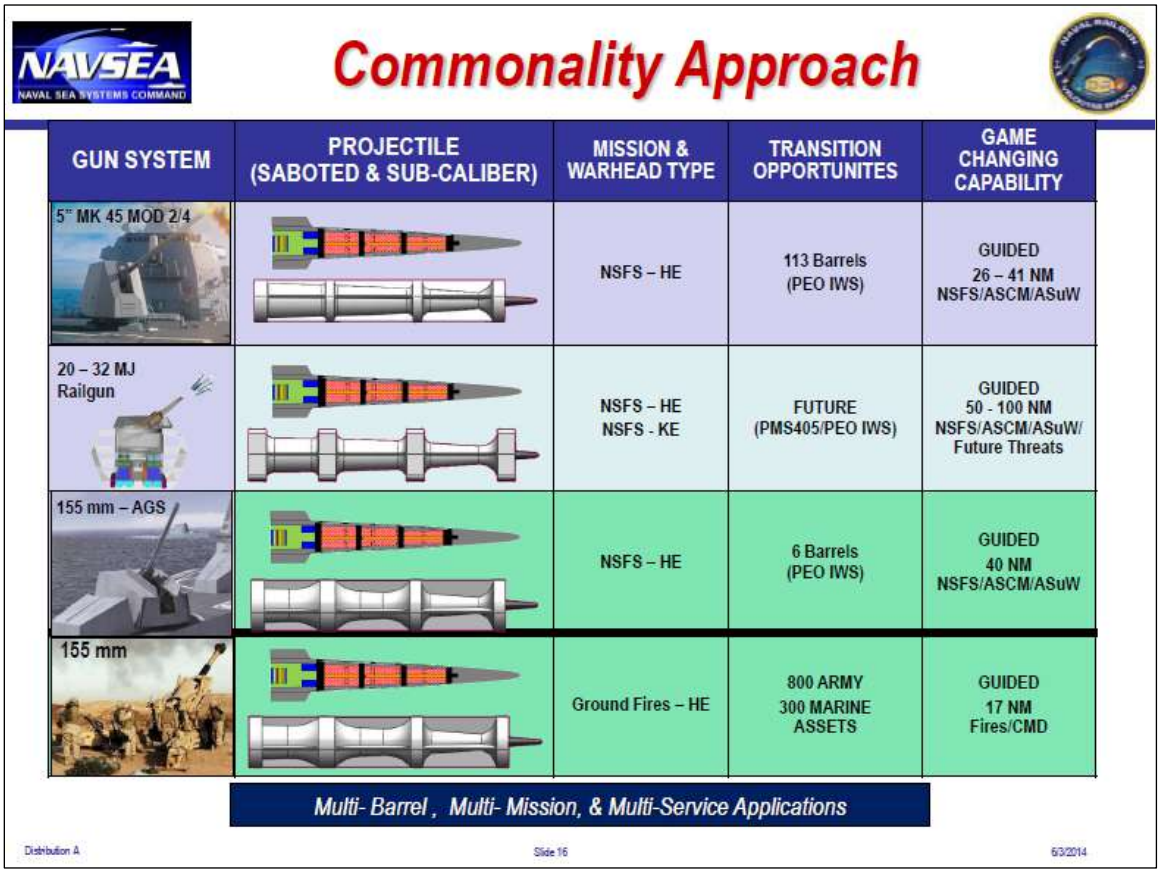

Source: Slide 16 from Navy briefing entitled "Electromagnetic Railgun," NDIA Joint Armaments Forum, Exhibition & Technology Demonstration, May 14, 2014, LCDR Jason Fox, USN, Assistant PM [Program Manager], Railgun Ship Integration, Distribution A, Approved for Public Release, accessed August 13, 2015, at http://www.dtic.mil/ndia/2014armaments/WedFox.pdf.

Figure 14 is a not-to-scale illustration of how HVPs fired from EMRGs and 5-inch guns can be used to counter various targets, including ASCMs and ASBMs.

Figure 14. Navy Slide Depicting Operations Against Various Target Types

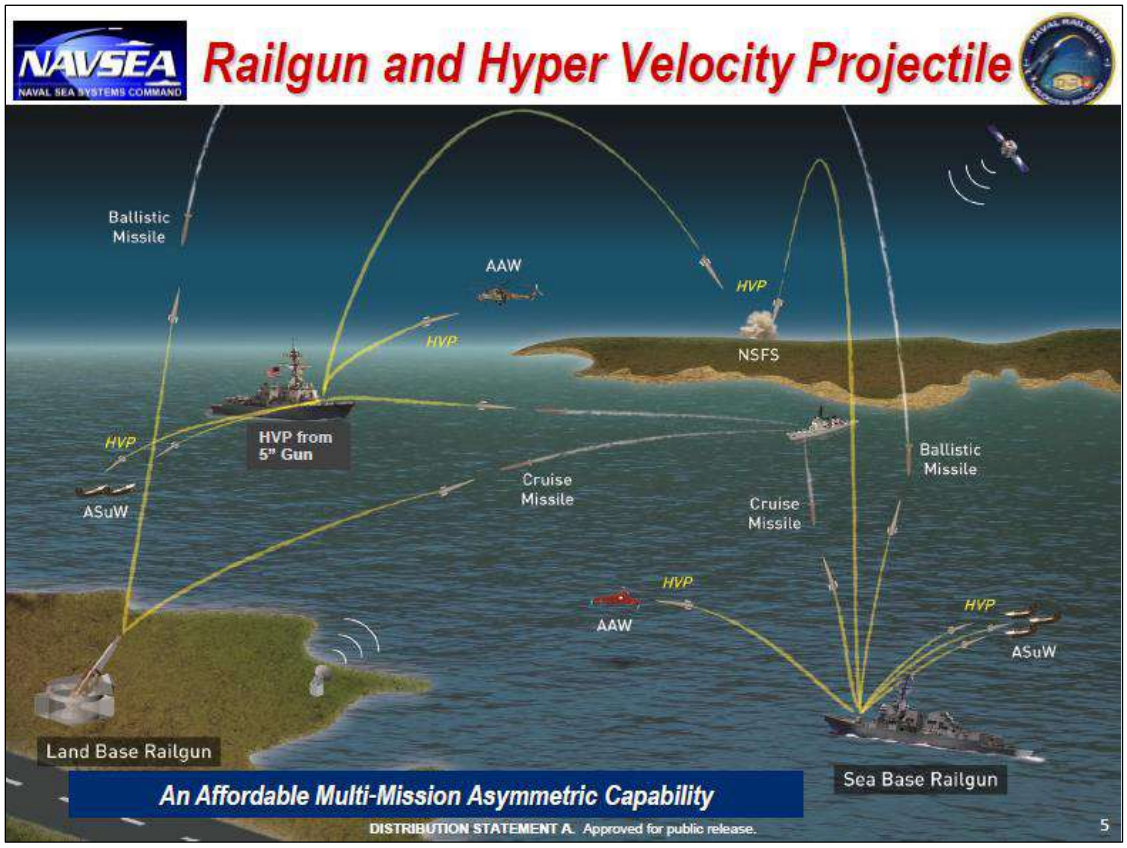

Source: Slide 5 from Navy briefing entitled "Electromagnetic Railgun," NDIA Joint Armaments Forum, Exhibition & Technology Demonstration, May 14, 2014, LCDR Jason Fox, USN, Assistant PM [Program Manager], Railgun Ship Integration, Distribution A, Approved for Public Release, accessed August 13, 2015, at http://www.dtic.mil/ndia/2014armaments/WedFox.pdf.

An April 11, 2016, press report states:

> The Pentagon wants to take a weapon originally designed for offense, flip its punch for defense and demonstrate by 2018 the potential for the Army and Navy to conduct missile defense of bases, ports and ships using traditional field guns to fire a new hypervelocity round guided by a mobile, ground variant of an Air Force fighter aircraft radar.
>
> The Strategic Capabilities Office is working with the Army, Navy and Air Force to craft a Hypervelocity Gun Weapon System that aims, in part, to provide China and Russia an example of a secret collection of new U.S. military capabilities the Defense Department is bringing online in an effort to strengthen conventional deterrence.
>
> "It is a fantastic program," Will Roper, Strategic Capabilities Office director, said in a March 28 interview with reporters, who said the project aims "to completely lower the cost of doing missile defense" by defeating missile raids at a lower cost per round and, as a consequence, imposing higher costs on attackers.[45]

A May 5, 2016, press report states:

[45] Jason Sherman, "SCO Aims To Flip The Script on Missile Defense With Hypervelocity Gun," *Inside the Navy*, April 11, 2016.

> Come January [2017], the Pentagon will almost assuredly have new leadership, complete with a new vision for how the Department of Defense should operate, organize and plan for the future.
>
> It's a reality facing down Defense Secretary Ash Carter and Deputy Secretary Bob Work as they try to complete a transformation at the Pentagon, one which both men have said is vital to making sure the US is able to maintain its technological edge against great powers like Russia and China in the future.
>
> While Carter has made his reach-out to nontraditional communities the centerpiece of his initiative, Work's focus has been the "Third Offset," a series of technological bets, largely focused on man-unmanned teaming, that he believes will pay off in the future.
>
> So how do you make sure that a long-term project like the Third Offset keeps going under a new administration?
>
> "We have three really complimentary ways to go about this," Work said Monday at an event hosted by the Atlantic Council.
>
> The first, he explained, is giving many options to the next administration.
>
> "First of all, I'm going to be central to the transition, so I am going to be able to personally talk with the transition team and explain to them what we have pursued and why we have pursued it, and let them make their own decisions," Work said.
>
> "One of the things we have done in our program is build in a lot of different options that they can pull levers on," Work explained.
>
> As an example, he pointed to the idea of an electromagnetic railgun. Initially, Work and his team thought that was an area that would be a major focus of development, but as they experimented they realized that a powder gun with a hypervelocity round could have almost the same impact — but at a fraction of the cost, because it did not require the development, testing and adaptation of a new gun.
>
> "We're going to say 'look, this is the place where [we think] you want to put your money,' but we're going to have enough money in both the electromagnetic railgun and the powder gun that if the new administration says 'I really want the electromagnetic railgun, this is the way I want to go,' knock yourself out," Work said. "We've set you up for success."[46]

Indirectly Improving Ability to Counter ASCMs and ASBMs

As discussed earlier, SSLs currently under development have enough beam power to counter small boats and UAVs, but not enough to ASCMs or ASBMs. Even so, such SSLs could indirectly improve a ship's ability to counter ASCMs and ASBMs by permitting the ship to use fewer of its SAMs for countering UAVs, and more of them for countering ASCMs and ASBMs. Similarly, even though HVPs fired from 5-inch powder guns would not be able to counter ASBMs, they could indirectly improve a ship's ability to counter ASBMs by permitting the ship to use fewer of its SAMs for countering ASCMs and more of its SAMs for countering ASBMs.

Remaining Development Challenges

Although the Navy in recent years has made considerable progress in developing SSLs, EMRG, and HVP, a number of significant development challenges remain. Overcoming these challenges

[46] Aaron Mehta, "Pentagon No. 2: How to Keep Third Offset Going in the Next Administration," *Defense News*, May 5, 2016.

will likely require years of additional development work, and ultimate success in overcoming them is not guaranteed.[47]

SSLs

As shown in **Figure 15**, remaining development challenges for SSLs include, among other things, making the system rugged enough for extended shipboard use, making the beam director (the telescope-like part of the laser that sends the beam toward the target) suitable for use in a marine environment (where moisture and salt in the air can be harsh on equipment), and integrating the system into the ship's electrical power system and combat system.

A January 23, 2015, blog post co-authored by the Office of Naval Research's program officer for the Navy's SSL program states:

> In the near term, many challenges remain to develop and operate high-energy laser systems in the maritime environment that are unique to the Navy and Marine Corps. Among these challenges is dealing with the heat generated as power levels increase. A second issue is packing sufficient power on the platform, which will require advanced battery, generator, power conditioning, and hybrid energy technologies. Current laser technologies are approximately 30 percent electrically efficient. Corrosion and contamination of optical windows by shipboard salt spray, dirt, and grime also are technical challenges. In addition, atmospheric turbulence resulting from shifting weather conditions, moisture, and dust is problematic. Turbulence can cause the air over long distances to act like a lens, resulting in the laser beam's diffusing and distorting, which degrades its performance.
>
> Much progress has been made in demonstrating high-energy laser weapon systems in the maritime environment, but there is still much to be done. Additional advances will be required to scale power levels to the hundreds of kilowatts that will make high[-]energy lasers systems robust, reliable, and affordable. Higher power levels are important for the ability to engage more challenging threats and improve the rate and range at which targets can be engaged.
>
> The programs managed by ONR are addressing these remaining issues while positioning this important warfighting capability toward an acquisition program and eventual deployment with the fleet and force.[48]

[47] Laser skeptics sometimes note that laser proponents over the years have made numerous predictions about when lasers might enter service with DOD, and that these predictions repeatedly have not come to pass. Viewing this record of unfulfilled predictions, skeptics might argue that "lasers are X years in the future—and always will be." Laser proponents acknowledge the record of past unfulfilled predictions, but argue that the situation has now changed because of rapid advancements in SSL technology and a shift from earlier ambitious goals (such as developing megawatt-power lasers for countering targets at tens or hundreds of miles) to more realistic goals (such as developing kilowatt-power lasers for countering targets at no more than a few miles). Laser proponents might argue that laser skeptics are vulnerable to what might be called cold plate syndrome (i.e., a cat that sits on a hot plate will not sit on a hot plate again—but it will not sit on a cold plate, either).

[48] Peter Morrison and Dennis Sorenson, "Developing a High-Energy Laser for the Navy," Future Force, January 23, 2015, accessed August 13, 2015, at http://futureforce.navylive.dodlive.mil/2015/01/high-energy-laser/. The authors are identified at the end of the post as follows: "Peter Morrison is the Office of Naval Research's program officer for the Navy's Solid-State Laser program. Dennis Sorenson is a contractor with the Office of Naval Research."

Figure 15. Development Challenges for SSLs

As of February 2013

Source: Slide from Navy briefing entitled "Navy Solid State Laser Program Overview," ASNE Day 2013, Mr. Peter "Rollie" Morrison, ONR 35 S&T Program Office, February 22, 2013, accessed August 13, 2015, at https://www.navalengineers.org/ProceedingsDocs/ASNEDay2013/Morrison_Pres.pdf.

EMRG and HVP

As shown in **Figure 16**, remaining development challenges for EMRG involve items relating to the gun itself (including increasing barrel life to desired levels), the projectile, the weapon's electrical power system, and the weapon's integration with the ship. Fielding HVP on cruisers and destroyers ships equipped with 5-inch and 155mm powder guns would additionally require HVP to be integrated with the combat systems of those ships.

Figure 16. Development Challenges for EMRG

As of May 2014

Source: Slide 9 from Navy briefing entitled "Electromagnetic Railgun," NDIA Joint Armaments Forum, Exhibition & Technology Demonstration, May 14, 2014, LCDR Jason Fox, USN, Assistant PM [Program Manager], Railgun Ship Integration, Distribution A, Approved for Public Release, accessed August 13, 2015, at http://www.dtic.mil/ndia/2014armaments/WedFox.pdf.

The Navy states:

> The EMRG effort began in FY 2005 with a focus on the barrel, power storage, and rail technology. In 2015, the Navy is testing full-scale industry advanced composite launchers for structure strength and manufacturability, and has advanced the pulsed-power system design from single-shot to actively cooled repeated rate operations. Building on the success of the first phase, the second phase started in 2012 with a focus on developing equipment and techniques to fire ten rounds per minute. Thermal-management techniques required for sustained firing rates are in development for both the launcher system and the pulsed-power system. The Office of Naval Research will develop a tactical prototype EMRG launcher and pulsed-power architecture suitable for advanced testing both afloat and ashore. Railgun demonstration has been funded to occur in FY 2016.[49]

A June 2015 press report states:

> As the Navy prepares to test its electromagnetic railgun at sea for the first time in 2016, service leaders said one of the biggest challenges will be integrating the new technology onto existing platforms.....

[49] U.S. Navy, *U.S. Navy Program Guide 2015*, p. 169.

> [Vice Adm. William Hilarides, commander of Naval Sea Systems Command] said he is positive the Navy will successfully demonstrate the weapon's ability to fire from the Trenton, but one of the biggest challenges will be configuring the railgun so that it fits within the power structure of other existing platforms.
>
> "Those are not 600-ton margin ships," he said [meaning ships with 600 tons of growth margin available to accommodate EMRG]. "If they have 60 tons, if they have 16 tons, then we'll be talking about what do we take off our existing destroyers, cruisers and other ships in order to get this incredible capability [on them]."
>
> These types of discussions are influencing ship designs as program managers look at what systems are indispensable and what can be exchanged, Hilarides said.
>
> Integrating the railgun into the fleet won't be a swift process.
>
> It will be at least 10 years until the railgun is fielded on new ships and potentially 30 years past that before the Navy considers removing powder guns from the fleet entirely and transitioning to energy weapons alone, according to Hilarides.[50]

Issues for Congress

Potential Oversight Questions

Potential oversight questions for Congress regarding Navy programs for SSLs, EMRG, and HVP include the following:

- Using currently available approaches for countering ASCMs and ASBMs, how well could Navy surface ships defend themselves in a combat scenario against an adversary such as China that has large numbers of ASCMs (including advanced models) and ASBMs? How would this change if Navy surface ships in coming years were equipped with SSLs, EMRG, HVP, or some combination of these systems?
- How significant are the remaining development challenges for SSLs, EMRG, and HVP?
- Are current schedules for developing SSLs, EMRG, and HVP appropriate in relation to remaining development challenges and projected improvements in enemy ASCMs and ASBMs? To what degree are current schedules for developing SSLs, EMRG, or HVP sensitive to annual funding levels?
- When does the Navy anticipate issuing roadmaps detailing its plans for procuring and installing production versions of SSLs, EMRGs, and HVP on specific Navy ships by specific dates?
- Will the kinds of surface ships that the Navy plans to procure in coming years have sufficient space, weight, electrical power, and cooling capability to take full advantage of SSLs (particularly those with beam powers above 200 kW) and EMRG? What changes, if any, would need to be made in Navy plans for procuring large surface combatants (i.e., destroyers and cruisers) or other Navy ships to take full advantage of SSLs and EMRG?

[50] Allyson Versprille, "Integration Biggest Challenge for Railgun," *National Defense*, June 2015. See also Lance M. Bacon, "3-Star: 'Lot of Work' Before Railgun Arrives in Fleet," *Navy Times*, February 5, 2015.

- Are the funding sources for SSLs, EMRG, and HVP in Navy and Defense-Wide research and development accounts (see "Summary of Congressional Action on FY2017 Funding" below) sufficiently visible for supporting congressional oversight?

Legislative Activity for FY2017

Summary of Congressional Action on FY2017 Funding

Funding in the defense budget for research and development work on Navy SSLs, EMRG, and HVP is spread across several research and development account line items (which are known as program elements, or PEs). The PEs shown in **Table 1** capture much but not necessarily all of the funding for developing Navy SSLs, EMRG, and HVP. The PEs shown in the table, moreover, include funding for efforts other than Navy SSLs, EMRG, and HVP, so congressional changes from requested amounts might or might not relate to SSLs, EMRG, or HVP.

Table 1. Summary of Congressional Action on FY17 Funding

In millions of dollars, rounded to nearest tenth

Program Element (PE) number, PE name, FY16 budget line number	Req.	Authorization			Appropriation		
		HASC	SASC	Conf.	HAC	SAC	Conf.
0602114N, Power Projection Applied Research, line 4	41.4	41.4	41.4		41.4		
0602750N, Future Naval Capabilities Applied Research, line 13	165.1	165.1	165.1		157.1		
0603114N, Power Projection Advanced Technology, line 16	96.4	106.4	81.4		76.6		
0603673N, Future Naval Capabilities Advanced Technology Development, line 21	249.1	249.1	239.1		252.1		
0603925N, Directed Energy and Electric Weapon System, line 75	32.7	32.7	32.7		32.7		
0604250D8Z, Advanced Innovative Technology, line 95	844.9	804.9	844.9		844.9		

Source: Table prepared by CRS based on Navy FY17 budget submission and committee and conference reports.

Notes: HASC is House Armed Services Committee; **SASC** is Senate Armed Services Committee; **HAC** is House Appropriations Committee; **SAC** is Senate Appropriations Committee; **Conf.** is conference agreement. The PEs shown in the table below capture much but not necessarily all of the funding for work on Navy SSLs, EMRG, and HVP. The PEs shown in the table, moreover, include funding for efforts other than Navy SSLs, EMRG, and HVP.

FY2017 National Defense Authorization Act (H.R. 4909/S. 2943)

House

The House Armed Services Committee, in its report (H.Rept. 114-537 of May 4, 2016) on H.R. 4909, recommended the funding levels shown in the HASC column of **Table 1**. The recommended increase of $10 million for PE 0603114N, Power Projection Advanced Technology

(line 16) is for "Program increase for common mount." (Page 498) The recommended reduction of $40 million for PE 0604250D8Z, Advanced Innovative Technology (line 95) is for "SCO" (the Strategic Capabilities Office). (Page 518) H.Rept. 114-537 states:

> *Common mount for electromagnetic railgun*
>
> The budget request contained $96.4 million in PE 63114N for power projection advanced technology. Of this amount, $15.4 million was included for the Navy's electromagnetic railgun prototype.
>
> The committee remains supportive of the Navy's program for developing and deploying an electromagnetic railgun. The committee recognizes the growing imperative for the Navy to field this type of weapon, not only to increase capabilities for naval surface fire support and ballistic missile defense, but to also decrease the cost exchange model when comparing the railgun to conventional missiles or guns. However, the committee is increasingly concerned that the shift in emphasis to the hypervelocity projectile by the Strategic Capabilities Office has left the Navy with a funding gap in developing the requirements and design for a common mount, which is a necessary prerequisite to getting this capability into operational use. Therefore, the committee directs the Secretary of the Navy to provide a briefing to the House Committee on Armed Services by February 15, 2017, on the plan and milestone schedule for demonstrating and deploying a common railgun mount for sea- and land-based applications.
>
> The committee recommends $106.4 million, an increase of $10.0 million, in PE 63114N to support the development of a common mount for the sea-based and land-based electromagnetic railgun. (Page 61)

H.Rept. 114-537 also states:

> *Strategic Capabilities Office*
>
> The budget request contained $844.9 million in PE 64250D8Z for development activities of the Strategic Capabilities Office (SCO).
>
> Created in 2012 by the Deputy Secretary of Defense, SCO has the mission to identify, analyze, demonstrate, and transition game-changing applications of existing and near-term technology to shape and counter emerging threats. SCO is comprised of a relatively small number of personnel and relies on other program office personnel and resources to execute its mission. The committee appreciates the nature of SCO's mission and sustained leanness of the organization; however, the committee notes the budget for SCO has grown exponentially each fiscal year. For example, the fiscal year 2017 budget request is nearly double the request for fiscal year 2016.
>
> The committee is concerned that such rapid budget growth may bring with it some risks, including the demands on SCO's small staff, demands on other Department of Defense personnel, and impact of SCO decisions on existing programs. For example, the committee is aware of SCO's inclusion on the electromagnetic railgun development, and subsequent reprioritizing of its planned investment in that program for fiscal year 2017, resulting in a funding gap that could not be covered by the program office.
>
> Additionally, the committee remains concerned that the transition of technologies from SCO has not been adequately captured and conveyed to the oversight committees. The report required by the committee report (H. Rept. 114–102) accompanying the National Defense Authorization Act for Fiscal Year 2016 has not been delivered and is now almost 6 months late. In order to support prudent use of taxpayer resources, and to ensure proper oversight of these activities, the committee believes this report should be provided and concerns addressed before supporting full funding of planned activities.
>
> Therefore, the committee recommends $804.9 million, a decrease of $40.0 million, in PE 64250D8Z for development activities of the Strategic Capabilities Office. (Page 92)

Section 220 of H.R. 4909 as reported states:

> SEC. 220. Designation of Department of Defense senior official with principal responsibility for directed energy weapons.
>
> Not later than 180 days after the date of the enactment of this Act, the Secretary of Defense shall—
>
> (1) designate a senior official already serving within the Department of Defense as the official with principal responsibility for the development and demonstration of directed energy weapons for the Department; and
>
> (2) set forth the responsibilities of that senior official with respect to such programs.

H.Rept. 114-537 also states:

> *Five-inch precision guided projectile development for naval surface fire support*
>
> In the committee report (H. Rept. 114–102) accompanying the National Defense Authorization Act for Fiscal Year 2016, the committee noted "that current surface Navy gunnery requirements are outdated and that new technologies such as railgun and directed energy weapons are nearing readiness for technology transition." The committee referenced the Advanced Naval Surface Fires (ANSF) initiative and noted the ANSF was assessing options for providing a near-term 5-inch guided munition capability. The committee understands this capability would provide for improved and extended-range naval surface fire support. The committee continues to support the need for this precision guided capability and is also aware of the Hypervelocity Gun Weapon System (HGWS) program that is currently under consideration by the Strategic Capabilities Office (SCO). The committee notes the HGWS program would "flip the cost equation using conventional guns to defend forward bases against raids of advanced cruise and ballistic missiles" and believes there could be applications for use in 5-inch gun systems for naval surface fires support. The committee is encouraged by the development of both of these initiatives and expects the Navy and SCO to coordinate on these capabilities. The committee also expects the Navy to proceed forward with an accelerated development and acquisition strategy for this needed capability that is consistent with acquisition reform principles. (Pages 62-63)

H.Rept. 114-537 also states:

> *Technology enablers for directed energy weapon systems*
>
> The committee is aware that the Department of Defense has made significant advances in the development and operational demonstration of directed energy weapons systems. Each military department has demonstrated a marquee program in this area, such as the Navy's Laser Weapon System deployed on the USS Ponce, the Army High Energy Laser Mobile Demonstrator, and the Marine Corps' Ground Based Air Defense System. Along with technology demonstration activities like the Robust Electric Laser Initiative and the High Energy Liquid Laser Area Defense System, each of these programs demonstrated the increased power output and power on target necessary to develop a militarily useful directed energy weapon.
>
> However, as the Department has made progress in raising the power levels of these systems, it has also demonstrated the need for emphasis on development in other technology areas necessary to realize the full potential of laser weapons. For example, higher power output requires improved beam control to engage targets at greater distances, as well as better thermal management systems to dissipate the increased heat load. As the Department has been overcoming foundational technical challenges, new challenges have emerged that will impact the operational uses for directed energy weapons.

> Therefore, the committee directs the Assistant Secretary of Defense for Research and Engineering, in coordination with the research components of the military departments and the High Energy Laser Joint Technology Office, to provide a briefing to the House Committee on Armed Services by January 20, 2017. This briefing should provide a roadmap for enabling technologies, including:
>
> (1) Beam directors and adaptive optics, including deformable mirrors;
>
> (2) Thermal management needs and capabilities;
>
> (3) Integration challenges with fire control systems, including potential
>
> future needs for fire control for laser systems;
>
> (4) Power architectures and power electronics needs;
>
> (5) Facilities and test range capabilities; and
>
> (6) Other areas as deemed by the Secretary. (Page 93)

Senate

The Senate Armed Services Committee, in its report (S.Rept. 114-255 of May 18, 2016) on S. 2943, recommended the funding levels shown in the SASC column of **Table 1**. The recommended reduction of $15 million to PE 0603114N, Power Projection Advanced Technology (line 16) is for "General decrease." (Page 481) The recommended reduction of $10 million to PE 0603673N, Future Naval Capabilities Advanced Technology Development (line 21) is for "Capable manpower, and power and energy." (Page 481).[51] S.Rept. 114-255 states:

> **Power projection advanced technology**
>
> The budget request included $96.4 million in PE 63114N for power projection advanced technology. The committee notes that the Navy, Air Force, Defense Advanced Research Projects Agency, Strategic Capabilities Office, and other elements within the Department of Defense are all pursuing advanced power projection technologies and systems. The committee is concerned that these efforts are not well-coordinated and have uncertain pathways for transition to programs of record. In addition, the committee notes that the budget request represents an almost 200 percent increase over the amount enacted for fiscal year 2016. The committee believes that such a large increase in budget is not warranted and is concerned about the ability of the programs to absorb the additional funding. Consequently, the committee recommends a decrease of $15.0 million in PE 63114N, but directs that this reduction not be assessed against solid state laser maturation efforts. (Page 52)

Section 216 of S. 2943 as reported states:

[51] This recommended reduction of $10 million does not appear to relate (at least not directly) to lasers, the electromagnetic railgun, or the HVP. S.Rept. 114-255 states:

> **Capable manpower and power and energy**
>
> The budget request included $249.1 million in PE 63673N for future naval capabilities advanced technology developments. The activities listed under this program element include capable manpower and power and energy. The committee believes that the work plans for fiscal year 2017 on these activities does not warrant the level of funding included in the budget request. For example, the committee notes that the research included in these two projects include development of new personnel and management methodologies, and capabilities in energy security. Both of these efforts could be better coordinated with other organizations performing similar research. Consequently, the committee recommends a decrease of $10.0 million in PE 63673N to be distributed appropriately from capable manpower and power and energy. (Page 53)

SEC. 216. Directed energy weapon system programs.

(a) Inclusion of Directed Energy Weapon System programs in the rapid acquisition authority program.—

(1) IN GENERAL.—Section 806(c)(1) of the Bob Stump National Defense Authorization Act for Fiscal Year 2003 (Public Law 107–314; 10 U.S.C. 2302 note) is amended by adding at the end the following new subparagraph:

"(D) (i) In the case of any supplies and associated support services that, as determined in writing by the Secretary of Defense without delegation, are urgently needed to eliminate a deficiency in directed energy weapon systems, the Secretary may use the procedures developed under this section in order to accomplish the rapid acquisition and deployment of needed offensive or defensive directed energy weapon systems capabilities, supplies, and associated support services.

"(ii) For the purposes of directed energy weapon systems acquisition, the Secretary of Defense shall consider use of the following procedures:

"(I) The rapid acquisition authority provided under this section.

"(II) Use of other transactions authority provided under section 2371 of title 10, United States Code.

"(III) The acquisition of commercial items using simplified acquisition procedures.

"(IV) The authority for procurement for experimental purposes provided under section 2373 of title 10, United States Code.

"(iii) In this subparagraph, the term 'directed energy weapon systems' means military action involving the use of directed energy to incapacitate, damage, or destroy enemy equipment, facilities, or personnel.".

(2) CONFORMING AMENDMENTS.—Section 2373 of title 10, United States Code, is amended—

(A) in subsection (a), by striking "and aeronautical supplies" and inserting ", aeronautical supplies, and directed energy weapon systems"; and

(B) by adding at the end of the following new subsection:

"(c) Directed energy weapon systems defined.—In this section, the term 'directed energy weapon systems' means military action involving the use of directed energy to incapacitate, damage, or destroy enemy equipment, facilities, or personnel.".

(b) Joint Directed Energy Program Office.—

(1) REDESIGNATION.—The High Energy Laser Joint Technology Office of the Department of Defense is hereby redesignated as the "Joint Directed Energy Program Office" (in this subsection referred to as the "Office").

(2) STRATEGIC PLAN FOR DEVELOPMENT AND FIELDING OF DIRECTED ENERGY WEAPONS CAPABILITIES.—In addition to the functions and duties of the Office in effect on the day before the date of the enactment of this Act, the Office shall develop a strategic plan for development and fielding of directed energy weapons capabilities for the Department, in which the Office may define requirements for directed energy capabilities that address the highest priority warfighting capability gaps of the Department.

(3) ACCELERATION OF DEVELOPMENT AND FIELDING OF DIRECTED ENERGY WEAPONS CAPABILITIES.—

(A) IN GENERAL.—To the degree practicable, the Office shall use the policies of the Department that are revised pursuant to this section and new acquisition and management

practices established pursuant to this section to accelerate the development and fielding of directed energy capabilities.

(B) ENGAGEMENT.—The Secretary shall ensure that use of policies and practices described in subparagraph (A) include engagement with defense and private industries, research universities, and unaffiliated, nonprofit research institutions.

Regarding Section 216, S.Rept. 114-255 states:

Directed energy weapon system programs (sec. 216)

The committee remains concerned about the Department of Defense's inability to field an operational directed energy system. The committee is aware that the military services and industry partners have developed sufficient directed energy weapon capabilities for specific scenarios—like the High Energy Laser Mobile Demonstrator (HEL–MD) to counter rocket, artillery and mortar for base protection purposes and the Counter Electronics High Powered Microwave Advanced Missile Project (CHAMP) for disabling an adversary's electronics while avoiding collateral damage. These programs, as well as other high energy laser weapon systems, have been tested and demonstrated, but have failed to transition to acquisition programs of record.

The committee notes that directed energy capabilities have the potential to support many operational missions in cost effective and efficient manners. In response to these factors, the committee recommends a provision that would amend section 806 of the Bob Stump National Defense Authorization Act for Fiscal Year 2003 (Public Law 107–314) to grant rapid acquisition authorities for directed energy weapon systems to accelerate the development and fielding of this technology and to help offset the gains of potential adversaries.

The committee notes that since 1960, the Department of Defense has invested more than $6.0 billion in directed energy science and technology initiatives. However, the committee remains concerned that, despite this significant investment, the Department's directed energy initiatives are not resourced at levels necessary to transition them to full-scale acquisition programs. The committee notes with concern that years of investment have not to date resulted in any operational systems with high energy laser capability.

The committee highlights that the Defense Science Board Task Force on Directed Energy Weapon Systems and Technology Applications found that "directed energy offers promise as a transformational 'game changer' in military operations, able to augment and improve operational capabilities in many areas." The task force further concluded that the range of potential applications is sufficient to warrant significantly increased attention to the scope and direction of efforts to assess, develop, and field appropriate laser, microwave, and millimeter wave weapons. Consistent with the findings of the task force, the committee believes that directed energy weapons systems offer significant benefits in terms of cost effectiveness, sustainability, magazine capabilities, and precision targeting. (Pages 46-47)

S.Rept. 114-255 also states:

High energy laser joint technology office

The budget request included $42.3 million in PE 62890F for high energy laser research. The committee notes that this program element funds defense high energy laser applied research through the High Energy Laser Joint Technology Office. However, the committee is concerned that the Joint Technology Office has not received sufficient funding in recent years to drive the maturation of high energy laser technology. As an example, the committee notes with concern that no laser technologies have yet been fielded or deployed, despite promising development and field tests. Given the importance of directed energy weapons systems in general as noted elsewhere in this Act, and of high energy laser systems in particular, the committee is concerned that budget request for this

> program element will be insufficient for supporting the joint technology office. Accordingly, the committee recommends an increase of $5.0 million in PE 62890F for the high energy laser joint technology office. (Pages 54-55)

S.Rept. 114-255 also states:

> **Directed energy systems prototyping**
>
> The budget request included no money in PE 64342D8Z for defense technology offsets. The committee notes with disappointment that the administration did not view it as a priority to request funds through this program element. Particularly with the high-profile emphasis placed on the Department of Defense's Third Offset Strategy, the committee is disappointed to see this program be unfunded. In addition, as noted elsewhere in this report, the committee is deeply disappointed with how the technology offset funding enacted in fiscal year 2016 was allocated. As noted, none of the money was put towards directed energy, in contradiction to the clear intent of Congress that half of the money be used to bolster directed energy technologies. While the committee does not recommend additional unrestricted funds for the technology offsets program, the committee underscores that directed energy systems are still critical areas of work in need of greater support and attention. The committee believes that the Department needs to focus in particular on the transition from lab development to deployment and fielding. Consequently, the committee recommends a general increase of $25.0 million in PE 64342D8Z to be used only for the purposes of directed energy systems prototyping. (Pages 59-60)

S.Rept. 114-255 also states:

> **Laser weapon system demonstrator**
>
> The Committee commends the Navy for initiating and funding the Laser Weapon Systems Demonstrator (LWSD) and believes that this is an important step toward maturing technologies that could ultimately enable the deployment of a shipboard maritime laser weapons system. While the Committee understands that the Navy envisions transitioning laser weapons to a formal Program of Record in the 2020s, it appears that the Navy has not programmed funding beyond the LWSD sea-based tests to support the installation of LWSD on a DDG or for the design and procurement of a formal maritime laser program.
>
> The committee expects that the Secretary of the Navy will keep the congressional defense committees updated on its plan to seamlessly transition the LWSD to a shipboard weapons system following sea-based testing and to a formal maritime laser Program of Record, technical progress toward developing the capability, and programmatic steps being taken to move to demonstration and deployment of advanced laser systems. (Page 70)

FY2017 DOD Appropriations Act (H.R. 5293)

House

The House Appropriations Committee, in its report (H.Rept. 114-577 of May 19, 2016) on H.R. 5293, recommended the funding levels shown in the HAC column of **Table 1**. The recommended reduction of $8 million to PE 0602750N, Future Naval Capabilities Applied Research (line 13) is for "FORCENET excessive growth" ($5 million), "Power and energy previously funded efforts" ($2 million), and "Sea shield previously funded efforts" ($1 million). (Page 228) The recommended reduction of $19.8 million to PE 0603114N, Power Projection Advanced Technology (line 16) is for "Precision strike technology excess growth." (Page 228) The recommended net reduction of $3 million to PE 0603673N, Future Naval Capabilities Advanced

Technology Development (line 21) consists of a reduction of $2 million for "Power and energy previously funded efforts," a reduction of $2 million for "Sea shield previously funded efforts," and an increase of $7 million for "Program increase—ASW [antisubmarine warfare] research." (Page 228)

H.Rept. 114-577 states:

> HIGH ENERGY LASERS
>
> The Committee is aware of efforts within the High Energy Laser Joint Technology Office to develop advanced, directed-energy, high energy laser weapons that have the potential to perform a wide variety of military missions. The Committee encourages the Secretary of Defense to explore further development and evaluation of this important technology. (Page 264)

Directed Energy Weapon Systems Acquisition Act of 2016 (H.R. 4964/S. 2778)

House

H.R. 4964 was introduced in the House on May 5, 2016. The text of H.R. 4964 as introduced states:

> SECTION 1. Short title.
>
> This Act may be cited as the "Directed Energy Weapon Systems Acquisition Act of 2016".
>
> SEC. 2. Findings.
>
> Congress makes the following findings:
>
> (1) The Committee on Armed Services of the Senate noted in the report accompanying S. 1356 (S. Rept. 114–49; 114th Congress) that since 1960, the Department of Defense has invested more than $6,000,000,000 in directed energy science and technology initiatives, and that the Committee is concerned that, despite this significant investment, the Department's directed energy initiatives are not resourced at levels necessary to transition them to full-scale acquisition programs.
>
> (2) The Defense Science Board Task Force on Directed Energy Weapon Systems and Technology Applications (the "Task Force") found that "directed energy offers promise as a transformational 'game changer' in military operations, able to augment and improve operational capabilities in many areas".
>
> (3) Despite this potential, years of investment have not resulted in any operational systems with high energy laser capability.
>
> (4) The Task Force believes that the range of potential application is sufficient to warrant significantly increased attention to the scope and direction of efforts to assess, develop, and field appropriate laser, microwave, and millimeter wave weapons.
>
> SEC. 3. Inclusion of directed energy weapon system programs in the rapid acquisition authority program.
>
> (a) In general.—Section 806(c)(1) of the Bob Stump National Defense Authorization Act for Fiscal Year 2003 (Public Law 107–314; 10 U.S.C. 2302 note) is amended by adding at the end the following new subparagraph:
>
> "(D) (i) In the case of any supplies and associated support services that, as determined in writing by the Secretary of Defense without delegation, are urgently needed to eliminate

a deficiency in directed energy weapon systems, the Secretary may use the procedures developed under this section in order to accomplish the rapid acquisition and deployment of needed offensive or defensive directed energy weapon systems capabilities, supplies, and associated support services.

"(ii) For the purposes of directed energy weapon systems acquisition, the Secretary of Defense shall consider use of the following procedures:

"(I) The rapid acquisition authority provided under this section.

"(II) Use of other transactions authority provided under section 2371 of title 10, United States Code.

"(III) The acquisition of commercial items using simplified acquisition procedures.

"(IV) The authority for procurement for experimental purposes provided under section 2373 of title 10, United States Code.

"(iii) In this subparagraph, the term 'directed energy weapon system' means military action involving the use of directed energy to incapacitate, damage, or destroy enemy equipment, facilities, or personnel.".

(b) Conforming amendments.—Section 2373 of title 10, United States Code, is amended—

(1) in subsection (a), by striking "and aeronautical supplies" and inserting ", aeronautical supplies, and directed energy weapon systems"; and

(2) by adding at the end of the following new subsection:

"(c) Directed energy weapon system defined.—In this section, the term 'directed energy weapon system' means military action involving the use of directed energy to incapacitate, damage, or destroy enemy equipment, facilities, or personnel.".

SEC. 4. Joint Directed Energy Program Office.

(a) Redesignation.—The High Energy Laser Joint Technology Office of the Department of Defense is hereby redesignated as the "Joint Directed Energy Program Office" (in this section referred to as the "Office").

(b) Strategic plan for development and transition of directed energy weapons capabilities toward fielding.—In addition to the functions and duties of the Office in effect on the day before the date of the enactment of this Act, the Office shall develop a strategic plan for development and transition of directed energy weapons capabilities toward fielding for the Department, in which the Office may define requirements for directed energy capabilities that address the highest priority warfighting capability gaps of the Department.

(c) Acceleration of development and transition of directed energy weapons capabilities toward fielding.—

(1) IN GENERAL.—To the degree practicable, the Office shall use the policies of the Department that are revised pursuant to this Act and new acquisition and management practices established pursuant to this Act to accelerate the development and transition of directed energy capabilities toward fielding.

(2) ENGAGEMENT.—The Secretary shall ensure that use of policies and practices described in paragraph (1) include engagement with defense and private industries, research universities, and unaffiliated, nonprofit research institutions.

Senate

S. 2778 was introduced in the Senate on April 12, 2016. The text of S. 2778 as introduced states:

SECTION 1. Short title.

This Act may be cited as the "Directed Energy Weapon Systems Acquisition Act of 2016".

SEC. 2. Findings.

Congress makes the following findings:

(1) The Committee on Armed Services of the Senate noted in the report accompanying S. 1356 (S. Rept. 114–49; 114th Congress) that since 1960, the Department of Defense has invested more than $6,000,000,000 in directed energy science and technology initiatives, and that the Committee is concerned that, despite this significant investment, the Department's directed energy initiatives are not resourced at levels necessary to transition them to full-scale acquisition programs.

(2) The Defense Science Board Task Force on Directed Energy Weapon Systems and Technology Applications (the "Task Force") found that "directed energy offers promise as a transformational 'game changer' in military operations, able to augment and improve operational capabilities in many areas".

(3) Despite this potential, years of investment have not resulted in any operational systems with high energy laser capability.

(4) The Task Force believes that the range of potential application is sufficient to warrant significantly increased attention to the scope and direction of efforts to assess, develop, and field appropriate laser, microwave, and millimeter wave weapons.

SEC. 3. Inclusion of directed energy weapon system programs in the rapid acquisition authority program.

(a) In general.—Section 806(c)(1) of the Bob Stump National Defense Authorization Act for Fiscal Year 2003 (Public Law 107–314; 10 U.S.C. 2302 note) is amended by adding at the end the following new subparagraph:

"(D) (i) In the case of any supplies and associated support services that, as determined in writing by the Secretary of Defense without delegation, are urgently needed to eliminate a deficiency in directed energy weapon systems, the Secretary may use the procedures developed under this section in order to accomplish the rapid acquisition and deployment of needed offensive or defensive directed energy weapon systems capabilities, supplies, and associated support services.

"(ii) For the purposes of directed energy weapon systems acquisition, the Secretary of Defense shall consider use of the following procedures:

"(I) The rapid acquisition authority provided under this section.

"(II) Use of other transactions authority provided under section 2371 of title 10, United States Code.

"(III) The acquisition of commercial items using simplified acquisition procedures.

"(IV) The authority for procurement for experimental purposes provided under section 2373 of title 10, United States Code.

"(iii) In this subparagraph, the term 'directed energy weapon system' means military action involving the use of directed energy to incapacitate, damage, or destroy enemy equipment, facilities, or personnel.".

(b) Conforming amendments.—Section 2373 of title 10, United States Code, is amended—

(1) in subsection (a), by striking "and aeronautical supplies" and inserting ", aeronautical supplies, and directed energy weapon systems"; and

(2) by adding at the end the following new subsection:

"(c) Directed energy weapon system defined.—In this section, the term 'directed energy weapon system' means military action involving the use of directed energy to incapacitate, damage, or destroy enemy equipment, facilities, or personnel.".

SEC. 4. Joint Directed Energy Program Office.

(a) Redesignation.—The High Energy Laser Joint Technology Office of the Department of Defense is hereby redesignated as the "Joint Directed Energy Program Office" (in this section referred to as the "Office").

(b) Strategic plan for development and transition of directed energy weapons capabilities toward fielding.—In addition to the functions and duties of the Office in effect on the day before the date of the enactment of this Act, the Office shall develop a strategic plan for development and transition of directed energy weapons capabilities toward fielding for the Department, in which the Office may define requirements for directed energy capabilities that address the highest priority warfighting capability gaps of the Department.

(c) Acceleration of development and transition of directed energy weapons capabilities toward fielding.—

(1) IN GENERAL.—To the degree practicable, the Office shall use the policies of the Department that are revised pursuant to this Act and new acquisition and management practices established pursuant to this Act to accelerate the development and transition of directed energy capabilities toward fielding.

(2) ENGAGEMENT.—The Secretary shall ensure that use of policies and practices described in paragraph (1) include engagement with defense and private industries, research universities, and unaffiliated, nonprofit research institutions.

Appendix. Potential Advantages and Limitations of Shipboard Lasers

This appendix presents additional information on potential advantages and limitations of shipboard lasers.

Potential Advantages

In addition to a low marginal cost per shot and deep magazine, potential advantages of shipboard lasers include the following:

- **Fast engagement times.** Light from a laser beam can reach a target almost instantly (eliminating the need to calculate an intercept course, as there is with interceptor missiles) and, by remaining focused on a particular spot on the target, cause disabling damage to the target within seconds. After disabling one target, a laser can be redirected in several seconds to another target.
- **Ability to counter radically maneuvering missiles.** Lasers can follow and maintain their beam on radically maneuvering missiles that might stress the maneuvering capabilities of Navy SAMs.
- **Precision engagements.** Lasers are precision-engagement weapons—the light spot from a laser, which might be several inches in diameter, affects what it hits, while generally not affecting (at least not directly) separate nearby objects.
- **Graduated responses.** Lasers can perform functions other than destroying targets, including detecting and monitoring targets and producing nonlethal effects, including reversible jamming of electro-optic (EO) sensors. Lasers offer the potential for graduated responses that range from warning targets to reversibly jamming their systems, to causing limited but not disabling damage (as a further warning), and then finally causing disabling damage.

Potential Limitations

Potential limitations of shipboard lasers include the following:

- **Line of sight.** Since laser light tends to fly through the atmosphere on an essentially straight path, shipboard lasers would be limited to line-of-sight engagements, and consequently could not counter over-the-horizon targets or targets that are obscured by intervening objects. This limits in particular potential engagement ranges against small boats, which can be obscured by higher waves, or low-flying targets. Even so, lasers can rapidly reacquire boats obscured by periodic swells.
- **Atmospheric absorption, scattering, and turbulence.** Substances in the atmosphere—particularly water vapor, but also things such as sand, dust, salt particles, smoke, and other air pollution—absorb and scatter light from a shipboard laser, and atmospheric turbulence can defocus a laser beam. These effects can reduce the effective range of a laser. Absorption by water vapor is a particular consideration for shipboard lasers because marine environments feature substantial amounts of water vapor in the air. There are certain wavelengths of light (i.e., “sweet spots” in the electromagnetic spectrum) where atmospheric absorption by water vapor is markedly reduced. Lasers can be

designed to emit light at or near those sweet spots, so as to maximize their potential effectiveness. Absorption generally grows with distance to target, making it in general less of a potential problem for short-range operations than for longer-range operations. Adaptive optics, which make rapid, fine adjustments to a laser beam on a continuous basis in response to observed turbulence, can counteract the effects of atmospheric turbulence. Even so, lasers might not work well, or at all, in rain or fog, preventing lasers from being an all-weather solution.

- **Thermal blooming.** A laser that continues firing in the same exact direction for a certain amount of time can heat up the air it is passing through, which in turn can defocus the laser beam, reducing its ability to disable the intended target. This effect, called thermal blooming, can make lasers less effective for countering targets that are coming straight at the ship, on a constant bearing (i.e., "down-the-throat" shots). Other ship self-defense systems, such as interceptor missiles or a CIWS, might be more suitable for countering such targets. Most tests of laser systems have been against crossing targets rather than "down-the-throat" shots. In general, thermal blooming becomes more of a concern as the power of the laser beam increases.
- **Saturation attacks.** Since a laser can attack only one target at a time, requires several seconds to disable it, and several more seconds to be redirected to the next target, a laser can disable only so many targets within a given period of time. This places an upper limit on the ability of an individual laser to deal with saturation attacks—attacks by multiple weapons that approach the ship simultaneously or within a few seconds of one another. This limitation can be mitigated by installing more than one laser on the ship, similar to how the Navy installs multiple CIWS systems on certain ships.
- **Hardened targets and countermeasures.** Less-powerful lasers—that is, lasers with beam powers measured in kilowatts (kW) rather than megawatts (MW)—can have less effectiveness against targets that incorporate shielding, ablative material, or highly reflective surfaces, or that rotate rapidly (so that the laser spot does not remain continuously on a single location on the target's surface) or tumble. Small boats (or other units) could employ smoke or other obscurants to reduce their susceptibility to laser attack.[52] Measures such as these, however, can increase the cost and/or weight of a weapon, and obscurants could make it more difficult for small boat operators to see what is around them, reducing their ability to use their boats effectively.
- **Risk of collateral damage to aircraft, satellites, and human eyesight.** Since light from an upward-pointing laser that does not hit the target would continue flying upward in a straight line, it could pose a risk of causing unwanted collateral damage to aircraft and satellites. The light emitted by SSLs being developed by the Navy is of a frequency that can cause permanent damage to human eyesight, including blinding. Blinding can occur at ranges much greater than ranges for damaging targeted objects. Scattering of laser light off the target or off fog or particulates in the air can pose a risk to exposed eyes.[53]

[52] See, for example, "Kelsey D. Atherton, "China Plans To Defeat American Lasers With Smoke," *Popular Science*, May 3, 2016.

[53] The United States in 1995 ratified the 1980 Convention on Prohibitions or Restriction on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects. An (continued...)

For additional background information on potential Navy shipboard SSLs, see CRS Report R41526, *Navy Shipboard Lasers for Surface, Air, and Missile Defense: Background and Issues for Congress*, by Ronald O'Rourke.

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(...continued)

international review of the convention began in 1994 and concluded in May 1996 with the adoption of, among other things, a new Protocol IV on blinding laser weapons. The protocol prohibits the employment of lasers that are specifically designed to cause permanent blindness to the naked eye or to the eye with corrective eyesight devices. The United States ratified Protocol IV on December 23, 2008, and it entered into force for the United States on July 21, 2009. DOD views the protocol as fully consistent with DOD policy. DOD believes the lasers discussed in this report are consistent with DOD policy of prohibiting the use of lasers specifically designed to cause permanent blindness to the naked eye or to the eye with corrective eyesight devices. For further discussion, see Appendix I ("Protocol on Blinding Lasers") in CRS Report R41526, *Navy Shipboard Lasers for Surface, Air, and Missile Defense: Background and Issues for Congress*, by Ronald O'Rourke.

Torpedo & Directed Energy Weapons
Indian Navy Perspective

RAdm Om Prakash Singh Rana, VSM,
Director General of Naval Armament Inspection

IN supporting Indigenisation

IN Indigenisation Plan 2015-30

Maritime Cap Perspective Plan

Self-Reliance

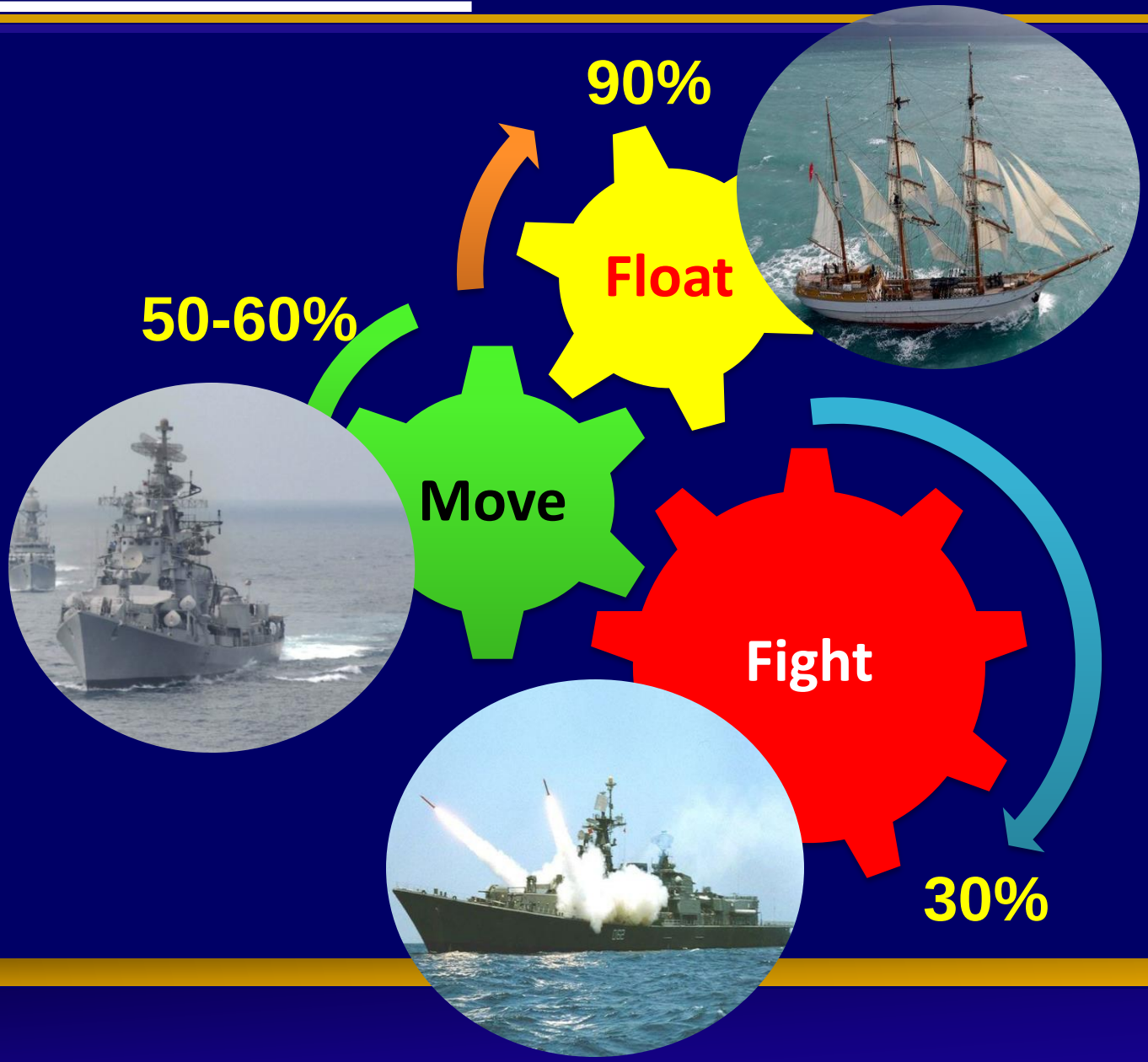

Scope

- Torpedo & Directed Energy Weapons
  - Technological advancement
  - Availability
- QRs for Torpedo & DEWs
- Way Ahead

Advancement
in
Torpedo Technology

Advancement in Torpedo Technology Contd...

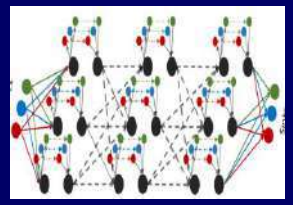

- Broadband sonar, multi-beam & INS
- Multi target tracking capability
- S/W based & high speed sig processing
- Re-programmable S/W & search pattern
- ACCM features
- Digital servo and retractable controls

Advancement in Torpedo Technology Contd...

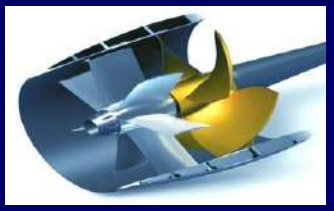

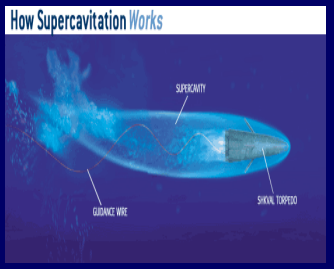

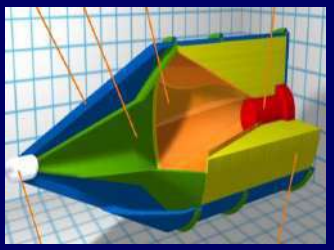

- Al-Ag_2O, Li-ion & Cu-Ni batteries
- Brushless motor & pump jet propulsion
- Semi open/close loop thermal propulsion
- Super-cavitation propulsion
- Tandem shaped charge insensitive W/H

Advance Torpedoes

Torpedo	Origin	Speed (Kts)	Range (Kms)
Black Shark Adv	Italy	18- 50	>50
DM2 A4 Sea Hake	Ger	50	> 50
A244S MOD-3	Italy	36	13.5
Flash Black	Italy	50	20
F21 HWT	France	25-50	> 50
Spearfish HWT	UK	40	48
Torpedo (2000)	Swed	40	> 40
MU-90	Eutorp	50	23
MK 48 ADCAP	USA	55	38
MK 54	USA	28 -43	12
Shkval E	Russia	> 200	7 - 10
UGST	Russia	50	40

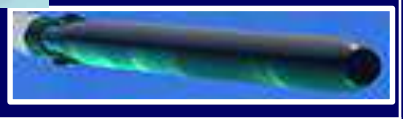

Torpedoes in Indian Navy

Torpedo		Origin/ Country
A244S		Italy
AT1ME		Russian
MK 54		USA
TAL MK-I		India
53-65 KE		Russian
CET 65 E		Russian
TEST 71ME		Russian
SUT		Germany
Varunastra		India

Directed Energy Weapons

Directed Energy Weapons

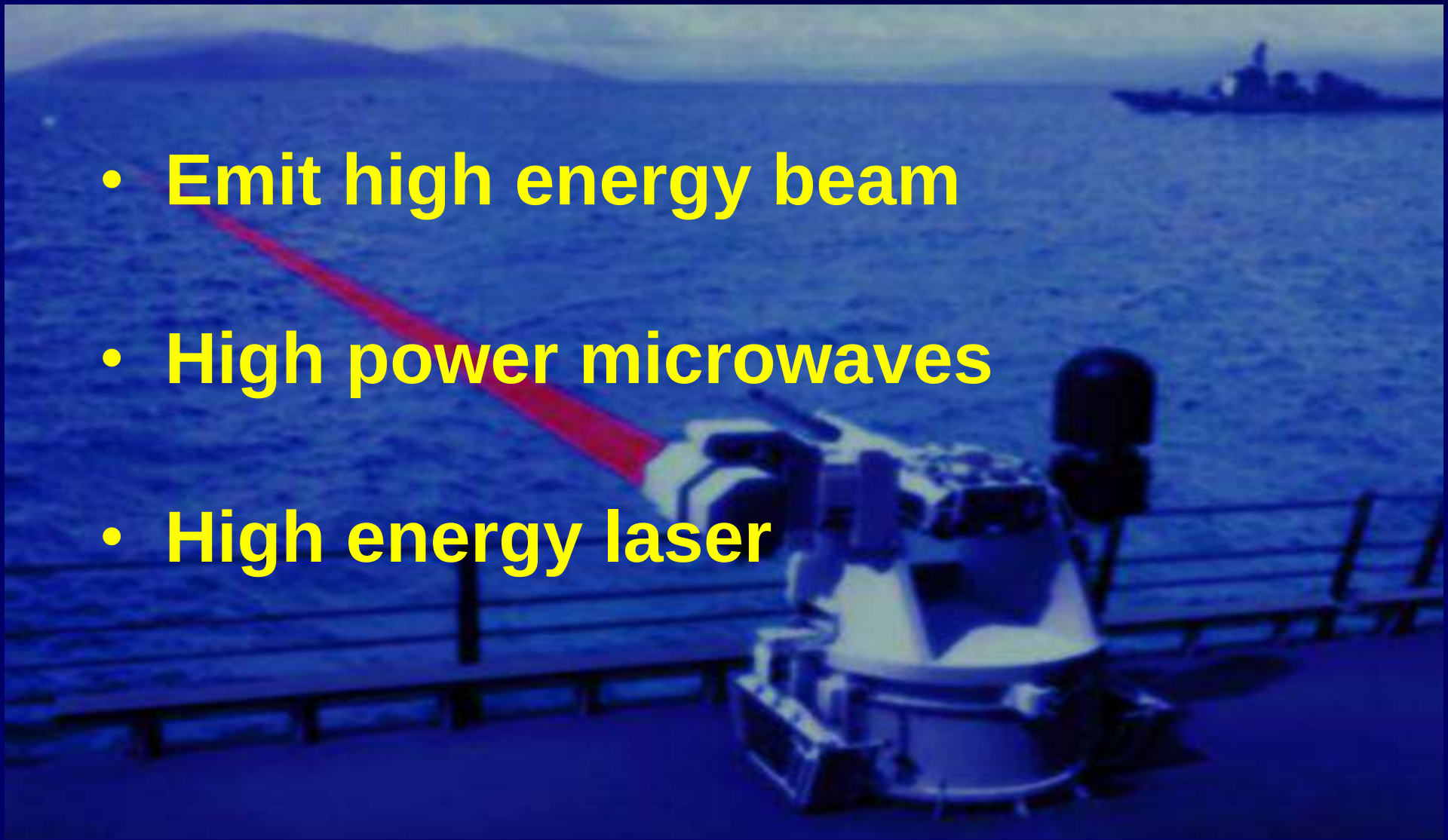

- Emit high energy beam
- High power microwaves
- High energy laser

DEW Advantages

- High Speed of Engagement
- Effective for Defensive/Offensive Role
- Immunity from Gravitation Constraints
- Space Requirement – Limited
- Effective against Moving Air Targets
- Minimal Collateral Damage
- Low Marginal Cost per Shot

DEWs from Sea, Air & Land Platforms

HE Laser Mobile Demon-strator **(USA)**

Electro-mag Rail Gun **(USA)**

Active Denial System **(USA/ Israel)**

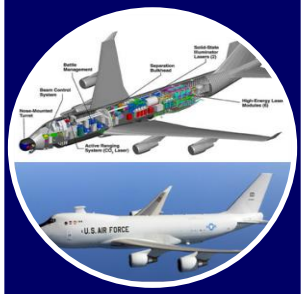

Airborne Ballistic Laser **(USA)**

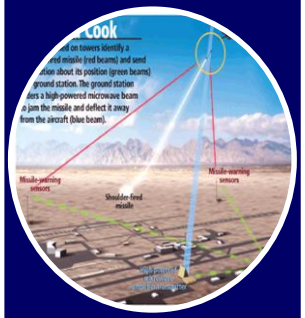

Vigilant Eagle **(USA)**

Laser Weapon System **(USA)**

DEWs in Indian Navy

DEWs not as potential destroyer

10 KW HEL demonstrated by DRDO

Work in progress for 25 KW HEL

Develop 100-500 KW HEL

Qualitative Requirements (QRs)

QRs for Torpedoes

Require-ment	Remark
Speed	Upto 55 Knot with variable speed
Range	Upto 40 Kms
Battery	Mg-Cu_2Cl_2, Al-Ag_2O & Li-ion batteries
Propulsion	Gas turbine, brushless motor & super-cavitation
Warhead	Tandem insensitive munition W/H & prox EBW fuze
Guidance	CBASS & improved signal processing algorithm
Launch I/ P	Tactical S/W algorithm with target data & upgrades
Control	Intelligent digital controllers & actuators
Camouflage	ACCM features

QRs for DEWs

- 10-25 KW for non-lethal engagement
- 100-500 KW against:-
  - Missile
  - Rocket
  - Aircraft
  - UAVs

Way Ahead

Way Ahead….

Joint Venture

Requirement	Scope for Designers & Industry
Torpedo & Sub-systems	
Mech Parts, W/H & Prop	Al-Mg alloy, FRP & nano materials, **IM**, Mg-Cu, Al-Ag_2O & Li-ion batteries, brushless motor, GT, pump jet & supercavitation prop
Guidance & Control	Sonar imaging & det, CABSS, PCBs, tgt wake seeking, mag anomaly det & super quantum induction device homing, adv accl & sensors.
Process Control	Adv sig processing, tact S/W algorithm for tgt data, friendly forces positions, sound profile & mid-course upgrade, dig ctrl & actuator
Miscellaneous	Fibre optic cable, gene, invertor, shaft, bearing, gear box, bottle, gyro, pump, valve, fastener, cable, pipe, dynamic seal, loc & rec aids
Directed Energy Weapons	
DEW Systems	Ship borne 25-500 KW using High Power Microwaves or Lasers for non-lethal & lethal engagement

Way Ahead….

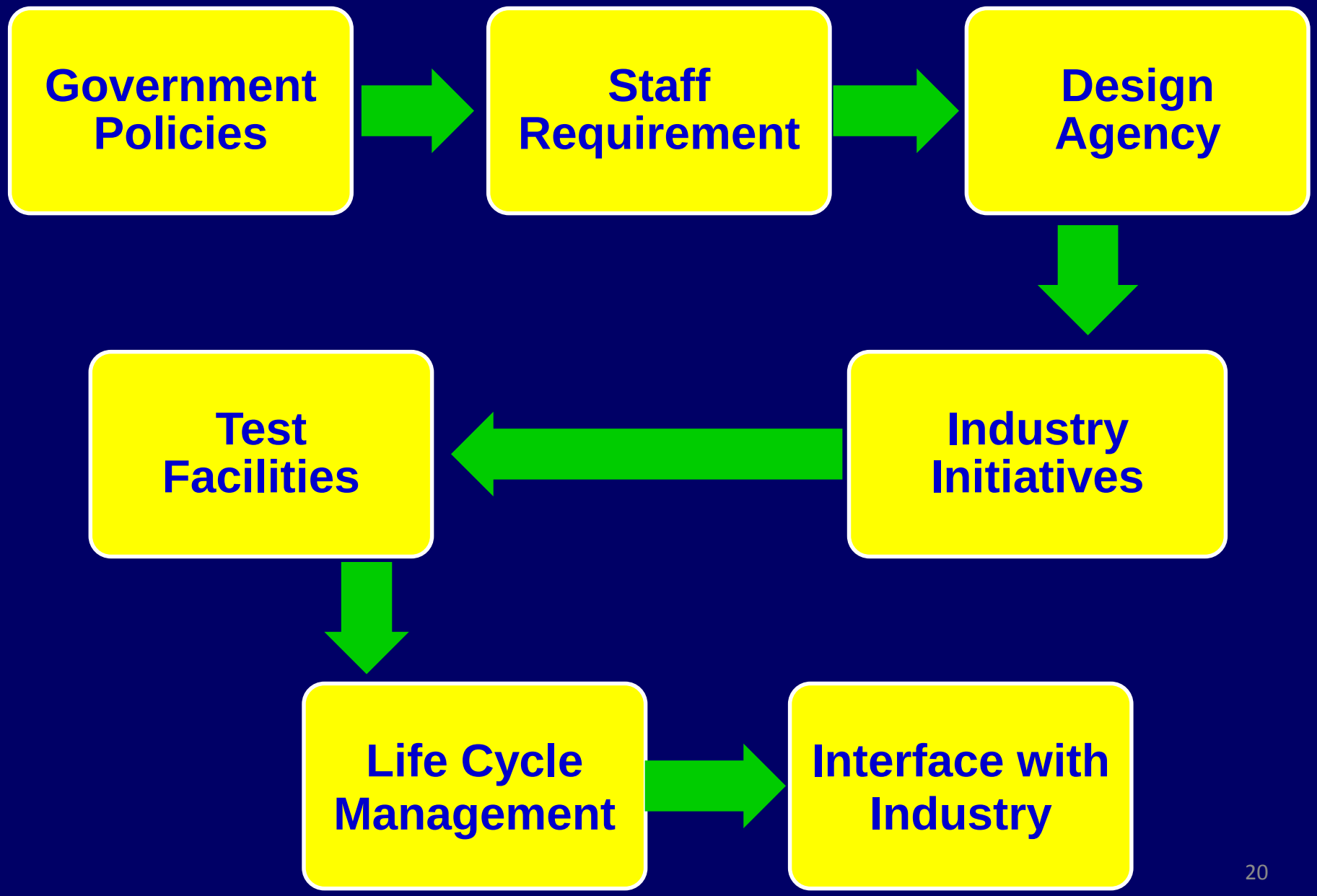
Government Policies
Staff Requirement
Design Agency
Industry Initiatives
Test Facilities
Life Cycle Management
Interface with Industry

Conclusion

- Govt promulgated various major policy guidelines
- ***IN*** “Indigenisation & MCPP”
- Harnessing knowledge base, infrastructures for “**Make in India**” prg under "**FIGHT**" category
- DEWs identified as core mil technology requirement
- Opportunities for strategic partnership

Thank You

5. Psychoenergetics

Mental entrainment, inducing hypnogogic trance, mind control, broadcasting thoughts and feelings, the Ant World, education via EM [LW] mental download, the "Feelies," revolution in spirituality, "enlightenment machine?" Scalar churches?

Psychoenergetics is simply *using the scalar interferometers to manipulate and engineer the human psyche*. To me it is the most mind-boggling and frightening aspect of longitudinal wave engineering.

The mind is electromagnetic in nature, and itself of the time-domain. It is not observable in 3-space. There is nothing you can point to that is the mind. As Bearden says, "The mind is time-like."

The longitudinal scalar EM waves are also of the time-domain. By overlaying certain infolded patterns (oscillations in time) on the longitudinal waves, a thought or feeling may be made to arise in a person or persons who are in the interference zone (where the wave beams cross).

The person will not notice anything, feeling that this thought or idea is his or her own idea. The longitudinal wave pattern might be a wave of panic or fear that spontaneously sweeps over you, perhaps inexplicably. It could even be in the form of a sudden intense patriotism. It could be explicit words and phrases, which everyone would think they had thought of by themselves. Or it could be rage and hatred, angry and violent. On the other hand It could also be a continuous sense of docility and placidity. This is the brave new world of *psychoenergetics and the coming "Mind Wars."*

Scalar Psychoenergetics in its most primitive form simply "entrains" all minds in the target area into a deep hypnogogic trance. In this state of mind people would be suddenly extremely suggestible, and would likely believe anything they are told, and would obey any orders given. Talk about winning the hearts and minds of the American People!

Tom Bearden makes me think of Paul Revere, who heroically conveyed important warnings for the sake of the new nation. But the words of the famous phrase have now strangely and curiously mutated into the once-inconceivable: "One if by land, Two if by mind."

Indeed one strategy in a Mind War would be to simply take over the minds of the "leaders" of the enemy nation. The targeted leader would not be aware that anything was amiss, although he might begin to make unexpected changes in policy.

And are, in fact, any of our "leaders" already having secret thoughts that are not their own? Who knows? Frighteningly, we can no longer be sure.

The new sciences of scalar electromagnetics and psychoenergetics are even now plunging humanity into a sudden science-fiction-like world beyond anything in humanity's previous imaginings.

> "The Russians reached the point in the mid 1990s that they could take over control of a person's mind, with modified longitudinal EM waves including some time-polarized EM waves, and with a team of specialists (estimate 25-30 per transmitter, and one transmitter and team per controlled person)."
> **Bearden: http://www.cheniere.org/misc/time.htm**

In a slide (below image) **Bearden** illustrates how a Scalar War would involve a psychoenergetics attack on the operators of the enemy scalar installation, entraining their minds into hypnogogic trance and getting them to shut down their systems.

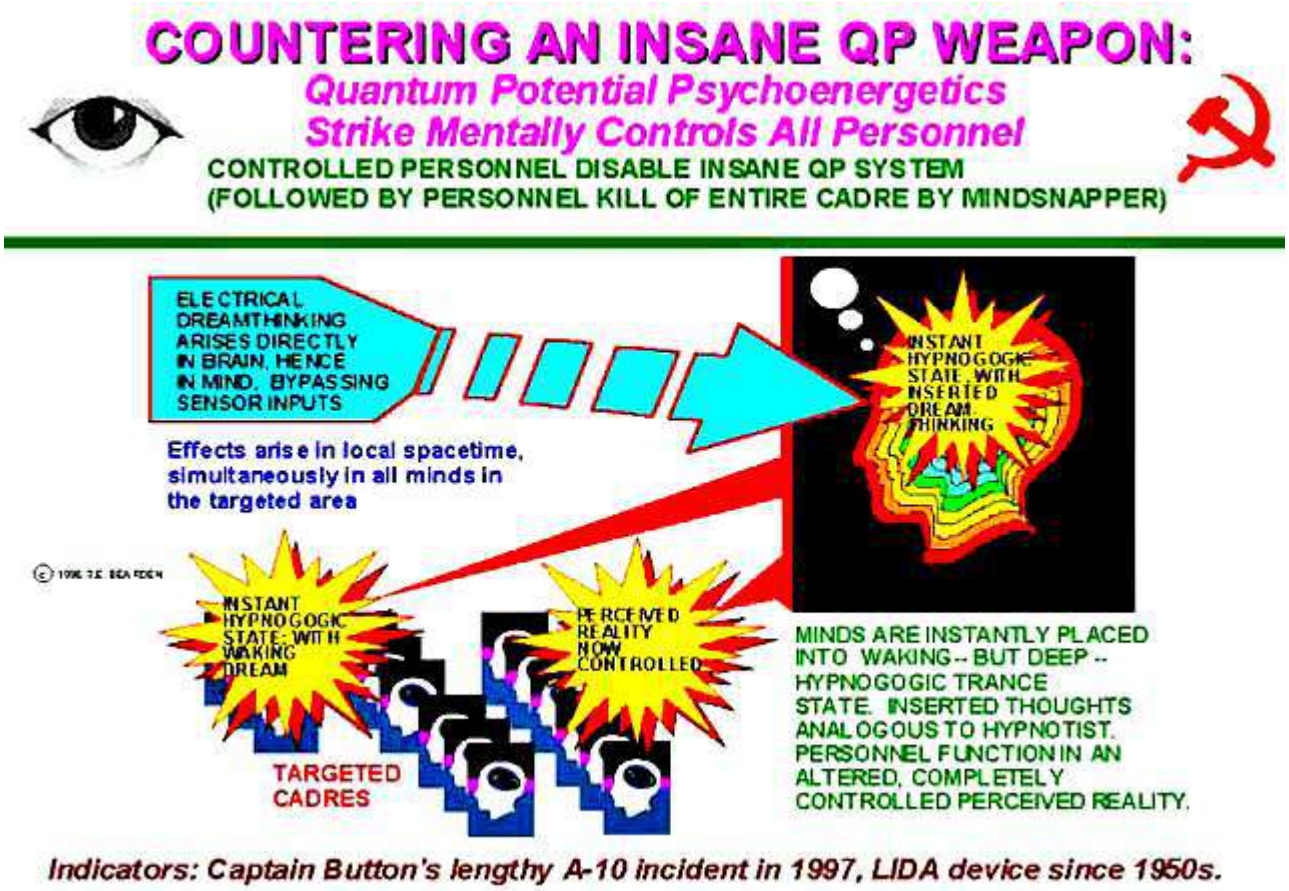

And ultimately psychoenergetic warfare goes to the very heart of human identity itself.

For if my thoughts might no longer be "mine,"

- Then who and what am I?
- Can my very sense of being "me" be hijacked by some nefarious psychoenergetic scheme?
- Will the "secret government" eventually dictate directly into your mind how you feel about yourself?
- Or what you think you are?
- Or what you should do?

How Does Longitudinal EM Mind Control Work?

The physics of **scalar psychoenergetics** as expounded by **Col. Bearden** seems even more arcane and over-my-head than that of extracting energy from the vacuum. I can't understand it, but I look through it anyway. Each time another tiny understanding might occur, or a term might fall into place. I know the mathematics is forever beyond me.

One paper to begin with is **Mind Control** and **EM Wave Polarization Transductions.** This is such serious stuff that **Bearden** includes a strong warning about misuse of this knowledge.

Psychoenergetics weapons can mentally maim and physically kill.

Warning!

(From "Mind Control and EM Wave Polarization Transductions")

> "This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories.
>
> We do not propose or condone any use of these procedures for non-approved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results.
>
> We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral."
> **Bearden: http://www.cheniere.org/explore articles/mind control1/p01.htm**

After the serious warning comes the description of the paper. This is heady stuff for the layman.

> "Calling full attention to the special note above, in this paper we present a high-level overview of the novel electromagnetic nature of mind operations, mind and body coupling, and intent - the induction of physical 3-space EM energy changes into the brain and nervous system, and into every cell of the body, from the mind's time-like coherent operations.
>
> We summarize the time-polarized electrodynamics used to engineer and affect mind operations and the mind-body coupling loop. Transaction mechanisms whereby differing EM wave polarization s can be transformed one-into-the-other are presented."
> **Bearden: http://www.cheniere.org/explore articles/mind control1/p01.htm**

I will leave it to the technically astute to try to understand the mechanisms of operation which are described in scientific language. But there are tidbits for the layman.

Here he speaks of the difficulty Western scientists have in opening up to the "immaterial" *(longitudinal wave)* nature of the human mind.

Western Science Remains Largely Materialistic

> "Ironically, most Western scientists are materialists and consider "mind" as a mystical and nonscientific concept. They tend to consider mind operations and functions either to be simply "meat computer" operations and functions, or at best to be very weak ordinary transverse-wave EM operations and functions in the brain and nervous system. This serious self-limitation exists because in the body we measure only weak TW [transverse wave] EM operations and functions correlated to biological behavior and brain operations. We simply do not know how to measure "mind operations" directly.
>
> "With no mind measurements possible and no instruments, it is understandable that Western science considers only the physical side of the mind-matter interface.
>
> "Presently our scientists do not measure the longitudinally-polarized EM wave operations and functions in the body and around it in nature. Few of them are aware that a maelstrom of such LW [longitudinal wave] functions exist in the body and in all of nature in general."
> Bearden: http://www.cheniere.org/explore articles/mind control1/p05.htm

Western methods of influencing the mind with EM waves have only used transverse waves, not the longitudinal waves of the vacuum.

If only transverse waves are used one pretty well has to hit the target mind with a sledgehammer of waves.

Western Science knows only transverse EM waves

Brute Forcing Time Functions versus Fine Control Methods

> "Ironically, Western mind control researchers using transverse EM waves for mind control research, are using a brute force method of evoking and using vacuum engines (spacetime curvature engines) and a special form of general relativity, although they do not appear to realize it.
>
> "While KGB scientists also use TW EM "brute force", TW waves when necessary, they do "imprint" or "activate" those waves with the desired internal LW and time-polarized EM wave and photon structures required to directly perform the mind engineering desired...
> Bearden
>
> "These "fitted brute-force models" certainly can be very powerful, and certainly can produce the exact results shown in the experimental verifications of the fittings. However, they do not of themselves allow sophisticated design for example of the necessary time-polarized wave assemblies for engineering the entire human collective unconscious simultaneously, or for engineering the entire collective unconscious of all species on Earth (i.e., Gaia's collective unconscious), or even for precisely engineering the memory and knowledge base of an individual.
> **Bearden: http://www.cheniere.org/explore articles/mind control1/p09.htm**

The seemingly magical operations of psychoenergetics, sometimes called "psychotronics," cannot be achieved with ordinary transverse EM wave energy. But they are possible with longitudinal scalar waves because the mind itself is scalar in nature.

> "We note that all mind operations are time-like, i.e., they are comprised as scalar EM photon functions and scalar EM wave functions. Thus the mind is a very special kind of electromagnetic system, existing in the time domain..."
> **Bearden: http://www.cheniere.org/explore articles/mind control1/p08.htm**

The engineering of the mind can only be accomplished with the waves of time.

The course of psychoenergetics development necessitates the building of a vast database of settings and patterns which bring about given mental and/or emotional states.

A kind of "gnome" of the psyche. Bearden describes the process of the decoding of this "gnome."

> "Now the scientists would perform many phenomenology experiments, making one little change at a time and profusely recording the data. Each time, they would establish the physical change(s) that occur in the body and/or the mental and emotional changes that occur in the mind for each spectral reinsertion back through the "ship's portholes". They would simply but painstakingly (over some years) build up an extensive database of those individual correlates.
>
> "In these experiments, the experimenters will eventually be able to provoke any body or mind change they wish. Strong emotion. Intense pain. Intense pleasure. Painful thoughts. Images. Memories. Perceptions. Dreams. Visions. Memory losses. Memory changes. Personality changes. Etc. The "delta" in the emission spectrum (the changes from zero reference spectrum) represent the precise totality of all mental, physical, organic, chemical, etc. changes and interactions."
> **Bearden: http://www.cheniere.org/explore articles/mind control3/p01.htm**
>
> "A second stage in the research would be to test the correlates and porthole insertions upon a statistically significant cross section of ordinary people, and/or specialized populations (such as toughened soldiers). The program would evolve a highly complex, very effective, ever-improving science and technology of mind and behavior control and engineering mechanisms, complete with finished database and developed applications equipment."
> **Bearden: http://www.cheniere.org/explore articles/mind control3/p02.htm**

Summing up his paper Bearden speculates on what the actual situation the science of psychoenergetics probably is.

The intense secrecy with which this knowledge has been kept from the public has led to the current farce of the "government" pretending it all does not exist, and this secrecy may have now put us at great risk.

> "The implication is that in the West one or more highly classified, sustained, heavily funded developments in advanced mind control programs, probably exists and probably has existed for some time.
>
> Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, may not operate under very much legitimate government control at all, and may operate specifically for the purposes of the rogue group or groups that have gained control.
>
> "In a nutshell, that's what may be going on in the clandestine mind control projects in several Western governments. The involvement of at least some rogue groups, some being "cowboys" who operate well outside all laws and ethics, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, it could account for what seems to be actually occurring.
>
> As also is "usual" in such a mess, one or more of the rogue groups eventually may become very powerful because their secret weapons are very powerful. They may become confident, thinking they have the "best in the world." They may actually believe they are ahead of the Russians..."
>
> "Remember that, in every large and powerful human organization, the basis for rogue groups is power and secrecy. They are always seeking to increase their power, control, influence, prestige, etc. Nothing else. Patriotism and mission are to rogue groups often just idle words. They have their own agendas.
>
> And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. It's a human characteristic, the old primate dominance game. Only now disguised and hidden under deep classification."
>
> "The Russians, with their additional knowledge of the actual mechanisms in the transforms, will be much more advanced than the West, because their fundamental psychoenergetics science is far more advanced, so long as we continue to use the old U (I) electrodynamics.
>
> Further, the Russians have decades of use of longitudinal interferometry beams to reach right through the earth and ocean and produce stringent EM effects at a distance.
>
> So they will also be able to do the same things here in "mind control" with LW [longitudinal wave] interferometers, through intervening mass."
>
> **Bearden: http://www.cheniere.org/explore articles/mind control3/p05.htm**

Bearden cites two examples where he believes the Russian KGB tested the psychoenergetics capabilities of their scalar interferometers.

One was the case of Captain Button in his A-10 "Warthog" aircraft on April 2, 1997.

> "Over Arizona, Captain Button was thrown into a hypnogogic state, and his perceptions instantly altered and controlled. In his instant "dream-waking" state, everything seemed perfectly normal. His sense of direction was altered a bit more than 90 degrees, so he simply corrected and turned and "flew toward the range", actually flying off course by more than 90 degrees and ignoring radio contacts. He flew right on out of Arizona."
>
> "At one point he circled, probably thinking he was over the range, and he probably dropped his ordnance there. Then he "flew on back toward home," as he thought in his waking dream state, until his fuel ran out and he crashed and died in the explosion dream-thinking until he died that everything was normal.
>
> All the while, his sense of the passage of time was altered. To him, in his dream-thinking, dream-acting state, everything was normal and nothing untoward had happened. So the distant KGB transmitters and associated psychoenergetics team controlled him for over an hour.
>
> > "Indeed, that was the exact purpose of the test: demonstrate control (at a great distance) of a skilled person performing highly skilled tasks."
>
> **Bearden: http://www.cheniere.org/explore articles/mind control3/p06.htm**

The paper Mind Control and EM Wave Polarization Transductions ends with the most chilling and frightening possibility of all: the psychoenergetic engineering of the human species as a whole.

The Ant World

The Final Race for Direct Mind Control of the Entire Human Species

> "The KGB psychoenergetics weapons scientists because of their direct measurements and detections (and use) of t-polarized waves and LWs [longitudinal waves] for decades also understand that Jung's collective unconscious mind (of the entire human species) also has its own time-like operations and correlates, which one measures also when using t-polarization measurements and sorting it all out. The collective unconscious mind operations are buried several levels deeper inside the recursive Whittaker structuring inside the EM fields, waves, and potentials.
>
> "The KGB scientists also know that something very like Gaia a collective unconscious mind for all species on earth also exists, and they are striving to be able to sort out and measure that one as well. The Gaia operations are buried even deeper in the recursive structuring inside the EM fields, waves, and potentials."
>
> "Actually, from day one, the Russian mind control scientists have had their eventual goal set upon this "deeper area of mind and possible mind control" of the entire human species.
>
> "I am convinced that the KGB psychoenergetics scientists understand this deeper area. If they can learn to directly engineer the collective human species unconscious, they can then convert the human species easily into a sort of "ant" society, modeled along ideal Communism lines, except of course with an excluded "hierarchy at the top" running everything. The "ant society" communist style is still a variation of feudalism (all systems tend to feudalism or some form thereof).
>
> "The KGB psychoenergetics weapon scientists are seriously pressing on toward that very goal. In my opinion they are not very far from it right now...
>
> "Some versions of Russian mind control devices were used on Russian soldiers in the Afghan War to condition them for performance of merciless acts." 13
> **Bearden: http://www.cheniere.org/explore articles/mind control3/p07.htm**
> **More about "The Ant World"**

Whether it is the Russians planning an "ant world" society or rogue U.S. black-ops groups withholding a great boon from human race, the secrecy on all sides around has allowed largely criminal elements to take over this technology while leaving the civilized elements in the dark.

Openness and the spreading of this knowledge among good and decent people is essential, and for that we will have to overcome our frightened denial.

> "Meanwhile, rogue groups amongst Western clandestine mind control researchers will probably arise if they have not already done so. They will likely seek to increase their personal control and further isolate the programs from orthodox government review and from government and legislative control. They may even divert the research into highly illegal and unethical means, because it furthers their own rogue agendas. That is how clandestine U.S. government research can sometimes go sour, unless great care is exercised by the oversight committees in the House and the Senate.
>
> "Sometimes when rogue groups do gain control and total secrecy of a given new technological area, then what appears to be "U.S. government operations" do start to encompass a criminal and unethical operations, hidden usually beneath the deep veil of high classification. Also, if it's "scientific," no one is ever brought to justice, even if the "evil science actions" are uncovered and publicly revealed."
> **Bearden: http://www.cheniere.org/explore articles/mind control3/p08.htm**

Like the huge energy of the Tesla howitzers, the ability to engineer the mind with longitudinal waveforms is a seeming "magical" thing which can be used for good or ill. Bearden envisions that further developments will allow something like the "downloading" of knowledge via scalar interferometry. Everyone could be highly educated, and quickly and easily.

In the conclusion of the paper "Mind Control and EM Wave Polarization Transductions" Bearden makes a plea to the nations of the world regarding the use of psychoenergetic engineering.

> "Let us hope this great new area, already off to a bad start, can be bridled and steered in the direction helping and healing people, rather than killing or abusing them. The excesses in its bad use are a potent threat to all nations on earth.
>
> "Yet it can revolutionize medical science, education, communication, and psychology. We foresee the day - perhaps 30 years hence - when education will be accomplished by directly loading the software into the mind. Then in three weeks one will "load" a doctorate, say, in physics. In three more weeks on will also load a doctorate in chemistry. Another three weeks, in electrical engineering.
>
> Another three weeks, an MD And so on. When that happens then truly everyone on earth can be educated. Freedom from ignorance may well be another great freedom that is legally recognized.
>
> There will be no impoverished large groups lacking the education to find decent, productive jobs.

"We urge all nations to use the principles involved: not for human abuse, but for healing, educating, uplifting, and life-expanding of every person on earth. If we do, we shall all have a far brighter future. Then we shall check what has started out to be the Sword of Damocles and turn it into the golden Millennium."

Bearden: http://www.cheniere.org/explore articles/mind control3/p08.htm

(Perhaps after so many frightening topics a slight break is in order here to consider the lighter side of psychoenergetics. For example, what will be the ultimate impact on the entertainment industry?)

The Feelies at Last!

Psychoenergetics will be able to bring about at last, for better or for worse, Aldous Huxley's fanciful idea in his novel "Brave New World," an entertainment format which he called "The Feelies."

Those were something you went to, like going to the movies, but you would experience all the actual feelings themselves, as if the depicted events were actually happening to you.

Although our "leaders" seem too dim to grasp what is going on in the world of scalar electromagnetics, it should not take some young Hollywood genius too long to understand that The Feelies are now possible, and that the immense megabucks of potential profit more than justify heavy investment in bringing it to market.

One can imagine that first "Feelie" theater, "The Huxley" perhaps, a large comfortable area surrounded by nine giant screens (not just one screen!), which become 3D if you put on your headset. And The Huxley is fitted with the finest sound, and oh, by the way, a modest sized scalar interferometer with computer. And there are one or more new tracks now recorded on the film next to the sound track.

These are the digital patterns of thoughts, feelings, and ideas to be fed into the theater's interferometer. And these thoughts and feelings and ideas will be felt by the audience as if they were their own thoughts and ideas. It is an entirely new art form. Psychevision.

As important (and no doubt famous) as the actors would be the "feelers," those from whose minds the feelings were lifted in the original programming of the Feelie tracks. Because, for example, Brad Pitt might be a good and handsome actor, but can he really feel it? Like the dubbing of foreign language films, it might be necessary to dub the "emotional track" using a deeper and more profound person's feelings, thoughts and ideas.

It might even be engineered so that if you sat on one side of the theater you would feel like the hero, and on the other side you would feel exactly like the bad guy! What would that lead to?

We have all cried at a movie some time, most people have, though they might not want to admit it. But this would be deep sobbing and a flood of tears, if the director so desired it. You would feel it at your core. Or, take a big chase scene, you would be terrified. They are breathing down your neck! You would be gripped by panic.

For that matter, the whole genre of Horror-Feelie would be too much for many people to take. Do I really want to feel that an actual vampire is tearing at my throat with his fangs?

A Religious Feelie would make you feel the exaltation of a saint at his prayers, or give you the definite feeling that you are Christ suffering on the cross. All the pain could be there too. The stickiness of the blood. The very feeling itself: "Why hast thou forsaken me?" Who among us could come up that despair for scanning?

Had this been developed a bit earlier we might watch a documentary of, say, Mother Theresa, containing her own actual deep sense of compassion, which we would feel arising in us as our own.

Then again, a Psychedelic Feelie could induce an LSD-like state and simply blow the audience's minds.

Even in its simplest most primitive mode, the hypnogogic trance induction with its increased suggestibility, would completely alter the experience of even ordinary current movie going.

Go Back to Scalar War

Go Back to Psychoenergetics

<<< Scalar Wars

The Brave New World of Scalar Electromagnetics

by Bill Morgan

(See also **NEW 2007**: Book Review of Bearden's "Oblivion - America at the Brink")

Tom Bearden (2001)
Lieutenant Colonel, U.S. Army (Retired)

For the past six months I have been undergoing the greatest **paradigm shift** I have ever had to go through. It has rattled my nerves and shaken my bones. This intense adjustment of my "world"has come about by studying the information given by Col. Tom Bearden at his website **Cheniere**. The new knowledge there has necessitated a total revision of my ideas about physical reality, the world we live in, and the future of humanity.

This paradigm shifting even actually made me dizzy on certain days as I tried to absorb and digest Bearden's vast amount of information. I am not a scientist at all, just a layman, and I have little comprehension of the math and high physics of this new science called "Scalar Electromagnetics."But there is a great deal of information at **Cheniere** which **needs to become common knowledge** as fast as possible, for the sake of the survival of life on earth.

To that end I have put together this small primer of Bearden's ideas, as a kind of "beginner's guide" to his website. (I have tried to underline certain words and phrases which are part of the new "jargon" of talking about these "new" phenomena. Also I have taken the liberty of **bolding** certain words and phrases to help them stick in the mind).

(Note: Throughout "**EM**" means "**electromagnetic,**" and "**LW**" means "**longitudinal wave**")
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This article has six sections:

1. New Waves 2. Tapping the Waves 3. Weaponization 4. Healing 5. Psychoenergetics 6. As It Stands

2006 NOTE: Click here for a current status history of the MEG from Tom Bearden

1. New waves discovered

Longitudinal EM energy fills vacuum of space, the time domain of spacetime, time as compressed energy, E=tc2, waves of time, phase conjugate wave pairs.

"Electric power is everywhere present in unlimited quantities and can drive the world's machinery without the need of coal, oil, gas, or any other of the common fuels." Nikola Tesla

"At any point and at any time, one can freely and inexpensively extract enormous EM energy flows directly from the active vacuum itself." Tom Bearden

I guess the first thing to try to comprehend is that a **"new" kind of electromagnetic (EM) wave has been discovered** in the empty vacuum of space which, when engineered, can be an inexhaustible supply of energy in great magnitude at any place in the universe. The word "new" is in quotes because the

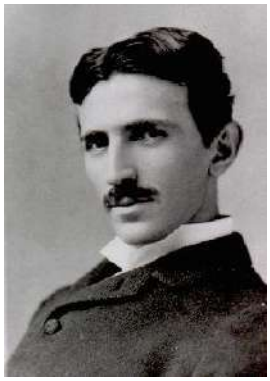

discovery really goes back to Nikola Tesla and his discovery of what he called "radiant energy." It is also not "new" because the Russians (KGB) have been working on this technology **for over 30 years** and have **weaponized** these "new" **longitudinal scalar waves** to a great degree.

These are the weapons Nikita Khrushchev spoke of in January, 1960.

> "By 1957-8 the Soviets had progressed to the point of a giant scalar EM accident in the Urals which exploded nearby atomic wastes, devastating the area. They had also progressed to development of great new superweapons using their new energetics - weapons to which Khrushchev referred in 1960 when he informed the Soviet Presidium of a new, fantastic weapon in development, a weapon so powerful that it could **wipe out all life on earth** if unrestrainedly employed.'" Tom Bearden

After over 30 years of development, and extensive testing around the globe, these new scalar electromagnetic weapons are up and running and ready to go. Tom Bearden, at his website Cheniere, dicusses the history of these new scalar electromagnetic weapons in his paper "Historical Background of Scalar EM Weapons."

Some Immediate Implications

> The implications of successful engineering of the longitudinal waves are enormous, and will change the world as we know it, one way or another. Among other things, these discoveries mean that:
>
> **1. The solutions to the energy crisis and the "oil problem" are in hand. These oil wars are unnecessary. There is endless energy available freely from the domain of time.**
>
> **2. Unbelievably powerful weapons are not only possible, but are already operating in several nations. The many powers of these weapons are unprecedented and mind-boggling.**
>
> **3. The cure of diseases such as cancer and AIDS, in fact nearly any disease, has become possible within a few years of sufficient funding. Everyone can be made healthy and stay healthy.**
>
> **4. Mind control on a mass scale has now become possible, and the machines to do it are already in place in certain nations. It has become possible to mentally enslave whole populations with the twist of a few dials.**

So the layman will need to understand that **there is a new kind of electromagnetic energy** that is altogether different from what he knows, e.g. radio, TV, cell phones, etc. The ordinary EM waves that we have known about are called **transverse** EM waves, to distinguish them from the new **longitudinal** EM waves. These scalar waves do not actually exist in our "material" world, but exist only in the vacuum of empty

space, or the time domain. And we must keep in mind that this vacuum of space we speak of exists all through everything. Even our bodies are mostly empty space between atoms and molecules. So the gateway to this seething ocean of energy can be there at every point in the universe. This seething ocean of energy is all around us and all through us.

Emptiness is Full

This amazing discovery announces that **the "emptiness" of empty space is in fact not empty**, but a **great ocean** of seething energy!

Col. Bearden refers to this ocean of energy as being of the "time domain." Energy out of time? It seems like something from Star Trek but this is the point which the new science of scalar electromagnetics has reached. And where it is going may be beyond anything Star Trek could have dreamed of.

We live in a 3-dimensional world, which physics calls "3-space." But there is also **spacetime**, or 4-space, or the "4th dimension." Then suddenly comes this amazing new knowledge that **time itself is actually compressed energy**. And it is energy which is compressed by exactly the same factor by which **matter** is considered compressed energy: the speed-of-light-squared!

So we have a new companion to the famous **E=mc2**. It is now paired with **E=tc2** (where t is actually "delta-t," or change in time). Or (amaze your family and friends and) say:

"E equals em-cee-squared"
and
"E equals delta-tee-cee-squared"

It has a nice ring to it, like some freedom bell announcing a new era.

And as the atomic bomb released the compressed energy in matter, so can we now unleash **the tremendous energy that is compressed into time itself.** It gives a completely new meaning to the term "time bomb."

Some New Terminology of Scalar Electromagnetics

A new science, **several** new names

"Those [Russian] weapon scientists resurrected an old term from the history of electrodynamics, called "**energetics**". That is their approach to a **unified field theory**, where everything is based on "energetics". This model as its foundations uses a very similar approach to that "single fundamental unit" model, where energy is the unit. If one makes the energy EM in nature, then one has the Russian energetics approach. This unified approach gathers everything in, including all energy actions and relations in inert matter (the first branch of

energetics, called by the same name), all field and matter interactions in living matter (the second branch of energetics, called "**bioenergetics**"), and all mind operations and mind-matter interactions (the third branch of energetics, called "**psychoenergetics**"). [ed: sometimes also called "psychotronics" by the Russians]

"Note that the weaponeers sliced energetics into three branches, with each branch depending on the nature of the "targeting".

"So I took a hint from them, since the stuff and the approach worked. They had already weaponized it highly."

Bearden : http://www.cheniere.org/correspondence/021502a.htm
See also "Subdivisions of Soviet Energetics"

Rick Andersen in an article called "What is Scalar Electromagnetics?" describes the **new science** this way:

"Scalar EM is the brainchild of Lt. Col. (retired) Thomas E. Bearden, a systems analyst and wargames specialist who has been advocating a view of electromagnetics which is based on the notion of a vast, unseen background of scalar energies (as opposed to vector energies) **which underlie all physical reality.**

"If Bearden is correct in his Scalar EM theory, then we can build devices which would enable us to **alter gravity**, time, inertia, and the apparent mass of an object. This of course has ENORMOUS implications for military applications, **space-vehicle drives, time-travel, teleportation, paranormal phenomena**, and just about every other area one can think of."
http://twm.co.nz/Beard_scalem.html

> **"Time-energy, time-currents, and time-structuring play the dominant role in electromagnetics. *Time-as-energy* eventually becomes engineerable, as easily as is spatial energy now. We are always dealing with *spacetime* and with *spacetime curvature*."**
>
> **Bearden:http://www.cheniere.org/techpapers/Vision%202000%20paper.doc**

The scalar energy discovered in the vacuum of space is sometimes called "**zero-point**" energy. Thomas Valone explains how this term came about.

What does "Zero Point" mean?

"Boyer traces the historical “creation of the vacuum” as proceeding in stages in parallel with the historical development of ideas about the vacuum. To paraphrase, he says that in the 17th century, it was thought that a totally empty volume of space could be created by simply removing all matter and, in particular, all gases. That was our first concept of the vacuum. Just get rid of all the gas.

Late in the 19th century, it became apparent that the region still contained thermal radiation. But it seemed that the radiation might be eliminated by cooling. So the second concept of getting a real

> vacuum is to cool it down to zero temperature. Just go all the way to absolute zero. Then we've got a real vacuum. Right? Well, since then, both theory and experiment have shown that **there is a non-thermal radiation in the vacuum** and that **it persists** even if the temperature could be **lowered to absolute zero**. Therefore, it was simply called the "**zero point**" radiation."
>
> Thomas Valone http://www.seaspower.com/InsideZeroPoint.htm

"For our very survival, it is absolutely imperative that informed citizens be aware of this dramatic change, which is just now starting. The powerful new science and engineering must be controlled and used for humanity's benefit, not its detriment. Else it will eventually be let loose unrestrainedly, to destroy all life on earth - a possibility indicated by Nikita Khrushchev in 1960." - Bearden

http://www.cheniere.org/explore%20articles/priore1/p4.jpg

2. Tapping the waves

Endless free energy, Tesla's radiant energy, the dipole as the gateway to the energy of the void, MEG in one year, Bedini, Yakuza, etc. End of Oil, geopolitical chaos, rogue groups

Move Over G.E. & Big Oil, Energy is Everywhere!
Third-world nations set to rise

> "Certain powerful interests did not wish the extended electromagnetics to be discovered or taught. That, after all, would lead to **free energy** and loss of economic control of the citizens. That was precisely why Nikola Tesla had already been suppressed ... Today it is still being suppressed by the orthodox establishment."
> http://www.cheniere.org/books/ferdelance/s25.htm

The vast seething ocean of energy of the vacuum, the longitudinal scalar EM waves of the time domain, can now be tapped and "transduced" into ordinary (transverse) EM energy in our 3-Space world. The process can be compared to putting a paddlewheel into a river. The energy acquired is free, since the river is there flowing whether we tap it or not. And it is a mighty river, and is not diminished by our paddlewheel.

This means that **a permanent solution to the "energy crisis" is at hand**, if only those who hold it **so secret** would give it up to humankind.

It means our species' **insane use of oil** is no longer necessary. We can make automobiles that need no fuel at all. We can build motors that power themselves. It means that unlimited electrical power can be available for free anywhere in the world. Every house and even shack can have its own power supply.

Of course there is the cost of the equipment at first, but the energy flow is free for the presumably very long life (no moving parts) of the generator. It will

probably take decades to shift over to scalar power.

But the ability to tap the scalar (longitudinal) EM waves of the vacuum (which exists everywhere) also means that **unbelievably powerful weapons** can be, and already have been developed. In fact these weapons are so dangerous that the **fear engendered** becomes a psychological obstacle to the grasping of the facts.

I struggled with this myself for months, and even though Tom Bearden had completely convinced me already, it is hard to accept the fact that for everyone on earth the "worst that might happen" has suddenly gotten much worse. It takes time to deal with that, to realize it and get over it.

Indeed, the possibilities of these new weapons, which are tapping the **huge energies of time**, are so terrifying it is natural for the mind to simply say: "I don't want to hear about that."

And the government, likewise, pretends these weapons do not exist and tries to keep it secret from the people. Because **most people would indeed be truly alarmed** to know the actual situation. Col. Tom Bearden has decided that the people need to know the truth anyway. As a People on a Planet we must face this now, and **ban the use of scalar weapons in war or in mass mind control**. The current deployment of these weapons is a **world emergency** which we must all face.

The physics and mathematics of the longitudinal waves and the time domain are clearly beyond the layman, but I recommend scanning through them anyway just to get a sense of the wonder and the elegance of it all and some of the exotic terms which are used. Two of the most important papers by Col. Bearden are:

Giant Negentropy from the Common Dipole
The Final Secret of Free Energy.

Despite the complexity of the science involved, Bearden sums up the **essential secret** of it all in a few words.

> "There is no problem at all in extracting all the energy one wishes from the active vacuum, anywhere in the universe, at any time. **Just make a dipole.**
>
> The problem is in (1) catching some of that freely gushing EM energy in a circuit containing a load, and (2) dissipating the caught and collected EM energy in that load to power it, without using half the caught energy to destroy the source dipole's).
>
> That is the ONLY real energy problem on the planet, and always has been."
>
> http://www.cheniere.org/correspondence/022502.htm

A dipole could be a battery, which is polarized into negative and positive. Or the terminals of a generator. Or any magnet with its two poles. Or an atom with its positive and negative charges. Or the earth's magnetic field, the sun, and all heavenly bodies. Even a galaxy must be some kind of mega-dipole. Wherever there is a dipole there is already immense scalar EM energy ushering out of and back into the vacuum. And there have already been demonstrated a number of

diverse methods for tapping that energy as it flows. (John Bedini, Edwin Gray, Bruce de Palma, and others). Bearden provides what he calls a "partial list" on his website.

> "In other words, **nature then gladly gives us** as much EM energy flow as we need, indefinitely — just for paying a tiny little bit initially to "make the little dipole." After that, we never have to pay anything again, and nature will happily keep on pouring out that 3-flow of EM energy for us. This is the **giant negentropy** mechanism I uncovered, performed in the simplest way imaginable: just make an ordinary little dipole." Bearden
> http://www.cheniere.org/techpapers/Unnecessary%20Energy%20Crisis.doc

Important note 2006: Since the enthusiastic early report below, the hopeful timetable envision has gone quite off track. Bearden had said that the MEG could appear as early as 1-2 years ***after getting funding*** for the final research and scale-up. They have **still** NOT gotten the funding as of 2006.

Click here for a current status history of the MEG from Tom Bearden

The original text of article continues here...

How to Buy a Free Energy Machine

Answer: Just wait one more year! 2003. Then get off the Grid!
[note 2006: The above line was unfortunately naive and overly optimistic! - author]

Perhaps the most eagerly awaited event now is the marketing of Bearden's **M**otionless **E**lectromagnetic **G**enerator (MEG) scheduled to begin in about a year's time. This is when the proof will hit the fan. Many people have said to me, when talking about free energy, "I'll believe it when I can go to the store and buy one." Hopefully in a year's time they will be able to order their own MEG. And then they will believe, because it works and is working.

Says Bearden: "I will admit that the chief scientist of an important experimental group in a large company was rather stunned at the type of output we were able to obtain. The MEG may look like just a transformer, but it is not. It is a completely different breed of cat."

Bearden : http://www.cheniere.org/correspondence/011202.htm

Soon the cat will be fully out of the bag. The first MEG units will supply 2.5 kilowatts of free electricity. Forever. Units can be connected together to double or triple the wattage. After that gets going, 10 kilowatt generators are planned. Energy will flow freely from the time domain indefinitely, and there are no moving parts to wear out. This manufacturing project is a heroic effort and will change the world as we know it. For once people are in possession of such devices there can be no further denial from anyone, including the government and/or "secret-government."

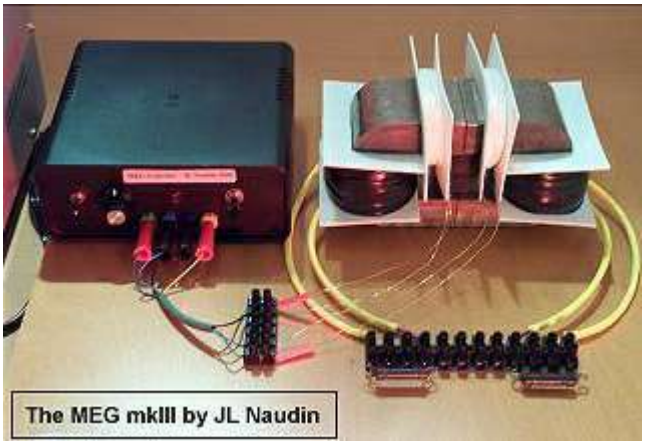

The Motionless Electromagnetic Generator
(Successfully replicated here by J. L. Naudin)

The physics of how the MEG works is explained in the paper "The Motionless Electromagnetic Generator: Extracting Energy from a Permanent Magnet with Energy Replenishment from the Active Vacuum."

The device was successfully replicated by J.L. Naudin in France, and others, like Steve Utne, are also working on their own models. But **Magnetic Energy Limited's MEG** is actually scheduled for production soon and looks to be the first commercially available free-energy generator in history!

I imagine it will not take long for tinkerers to put them into their electric cars and make the first fuelless automobiles since Tesla's unheralded (and unheeded) experiments. Or for builders to begin building houses powered by MEG's. Houses which will never see electric bills. How can they ever make enough of these to meet the demand that will suddenly be there? Bearden is right, it needs to be an all-out crash program of the government **on the order of the Manhattan Project**.

I must include here that Bearden is quick to point out that he is not himself the inventor of the MEG, but is a partner and advisor in bringing it to the public market through **Magnetic Energy Limited, Inc**. I must also admit that I am praying for the success of this venture, and the ending of the absurd and criminal withholding of this technology from the people by the black-ops military-industrial people. This secrecy has cost the planet over 30 years of unnecessary pollution.

The first units off the assembly line, which is being set up in a "friendly" unnamed nation, will usher the public at last into the new era of scalar electromagnetics.

As of December, 2001, the situation with the MEG was described by Bearden in a letter.

> "What we presently have with the MEG is a successful laboratory experiment. At least a year's very hard research will have to be done before we will be ready to put a commercial power supply into production.
>
> "Consequently, we have made an agreement with a foreign partner (the National Materials Science Lab of the National Academy of Sciences of a friendly foreign nation) to do that year's research. At the same time, we are trying to make an agreement with one or more large financial partners here in the U.S." http://www.cheniere.org/correspondence/121901.htm

"So we are hopeful that we will be able to start introducing units on the market about a year from now. Quite simply, we will either succeed or we will fail. But we will give it our very best effort."
http://www.cheniere.org/correspondence/012202a.htm

Bearden has given another technical explanation of how the MEG works here in a letter.

Update : Motionless Electromagnetic Generator patented, 3-26-2002

Click here to read the patent

"In Magnetic Energy Limited, all business discussions and arrangements are taken care of by Dr. Lee Kenny, Managing Partner. There are five of us who are co-inventors of the MEG, and two of the others are really the principal inventors." Bearden
http://www.cheniere.org/megstatus.htm

Lee Kenny can be reached by E-mail at: jlkenny@ingr.com

Free Energy has been Suppressed

Secret Government Aware of Free Energy

"In this world of contemporary times, all the agencies, CIA, FBI, KGB, NSA, Electric Power Research Institute, DARPA, Brookings Institution, Henry Kissinger, Edward Teller, et al., all are aware of [free-energy researcher Bruce] DePalma and his ideas.

"Because these individuals and institutions are employed by the ruling elite to forecast the future and satisfy present needs and demands, it is clear that **free energy is a threat** to the world order constructed by **business** and the **mindset of those who want to own the world**.

"Free energy represents Man's aspirations and dreams of freedom and equality, uniform division of resources and the ability to choose one's own future.

"**The fact that free energy is suppressed speaks to the greed and self-interest of a ruling elite** which, even in the face of an emergency of global starvation, resource depletion and environmental pollution, will not give one inch if it means loss of control. This is an attitude of **paranoid delusion** and fantasy which can only arise from the alienation of a **class of elitists** who, through their money, are completely **insulated** from the reality of the day to day fight for existence of the common man."

http://depalma.pair.com/Absurdity/Absurdity07/ProblemOfFreeEnergy.html

"Before the turn of the century, **Nikola Tesla** had discovered and was utilizing a **new type of electric wave**. Tesla repeatedly stated his

> waves were non-Hertzian, and his wireless transmissions did not fall off as the square of the distance. His discovery was apparently so fundamental (and his intent to provide free energy to all humankind was so clear) that it was responsible for the withdrawal of his financial backing, his deliberate isolation, and the gradual removal of his name from the history books."
>
> Bearden http://www.cheniere.org/books/part1/starting%20pages.htm

Bearden describes one clear case of the suppression of free energy when the Yakuza killed the **Kawai engine** in his very presence in Huntsville, Alabama.

> "That night a jet arrived from Los Angeles, with a Yakuza on board. The next morning Kawai no longer controlled his company, his invention, or his own fate. The Kawai party was in fear and trembling. The Yakuza coldly dissolved the agreement, they packed up the two Kawai engines we had, and left. And that was that."

So it is not only governments who are keeping this revolutionary technology from seeing the light of day. The Yakuza? KGB? The Aum Shinrikyo cult? Our "leaders" need to be honest about what is going on, otherwise they look foolish, acting out a kind of "Alice In Wonderland" script before the public, a script that has become completely unbelievable.

Concerning the criminal withholding of this scalar technology by the military black-budget people, and the cover-up of the actual situation regarding scalar weapons throughout the world, Tom has this to say:

> "The high government officials of the United States of America grossly violated our constitution and their sworn oaths of office. Our constitution specifically charges the government of the United States to **defend** the people of the United States. That means our officials are specifically charged with defending our people. Yet they deliberately agreed not to do so, and they deliberately sacrificed us in advance.
>
> "**They committed treason of the highest kind, by deliberately surrendering us to total destruction anytime the big balloon goes up.**"
>
> Bearden http://www.cheniere.org/books/ferdelance/s75.htm

Energy Crisis Solved

One of the "must read" documents at Cheniere is The Unnecessary Energy Crisis: How to Solve It Quickly, especially since the "**oil wars**," which Bearden has foreseen for decades, have now already begun.

Here are some clips from that Document:

> "To avoid the impending collapse of the world economy and/or the destruction of civilization and the biosphere, we must quickly replace much of the "electrical energy from oil" heart of the crisis at great

> speed, and simultaneously replace a significant part of the "transportation using oil products" factor also.
>
> "The technical basis for that solution and part of the prototype technology required, are now at hand. We discuss that solution in this paper." Bearden

And although the solution to the energy problem and the oil wars may be at hand, Bearden suggests there is still an urgent rush that needs to be made to save human civilization from collapse.

> "Once the technology hardware solutions are ready for mass production, even with a massive worldwide deployment effort some five years are required to deploy the new systems sufficiently to contain the problem of world economic collapse. This means that, by the end of 2003, those hardware technology solutions must have been completed, and the production replacement power systems must be ready to roll off the assembly lines en masse.
>
> "The 2003 date appears to be the critical "point of no return" for the survival of civilization as we have known it.
>
> "Reaching that point, say, in 2005 will not solve the crisis in time, and the collapse of the world economy as well as the destruction of civilization and the biosphere will still almost certainly occur, even with the solutions in hand."
>
> "The **good news** is that we now know how to easily initiate continuous and powerful "electromagnetic winds" from the vacuum at will. Once initiated, each free EM energy wind flows continuously so long as the simple initiator is not deliberately destroyed."

On page 9 he explains the concept of the **dipole**, and how there is already huge scalar energy flowing in the time domain around any dipole. Hold a magnet or a battery in your hand and you hold a stress in time and a beautiful flowing loop of longitudinal waves!

Bearden decries the scientific community in the West for being unable to let go of their dogma long enough to see that the **greatest discovery in human history** lies at their feet, but for their stubborn ignorance.

> "The present energy crisis then is due totally to that "**conspiracy of ignorance**" we referred to, that is maintained by the scientific community, and that has been maintained by it for more than 100 years.
>
> "This is the real situation that the environmentalists must become aware of, if they are to see the correct path into which their energies and efforts should be directed — to solve both the energy crisis and the problem of gigantic pollution of the biosphere."

As far as anyone in the legislative branch of government ever understanding the profundity of the discovery and engineering of scalar waves, Tom Bearden says they are at a great disadvantage in doing so.

"The nontechnical person — e.g., a Senator or a Congressperson — is operating under a distinct disadvantage. If he or she takes the stance that much better electrical power systems can readily be achieved, **he or she is in fact opposing almost the entire set of University, Government Technical, Power Company, Battery Company, and Organized Science communities**. Further, in most cases his technical advisors are themselves from one or the other of those communities, and likely to go back into that community or those communities when the Senator or Congressperson leaves office, or even before. So the Congress and the non-technical government community at large operate at a great disadvantage...Bearden

National Emergency Declaration is Needed

"The Government *Non-Technical* community (the Senate and the Congress, in particular) are in far better shape than the Government *Technical* community, to appreciate the **world implications of the pending economic disaster**. I am hopeful that both the environmentalists and the Government Non-Technical community will rapidly unite in a common goal to **get this vacuum energy program launched**, under a **National Emergency** declaration. If so, then they can solve the energy crisis and the pending economic crisis, in fairly short order, and permanently."

unnecessary_energy_crisis.htm#congress_disadvantage

In the conclusion of his paper The Unnecessary Energy Crisis: How to Solve It Quickly Bearden again states the urgency of replacing our centralized power grids with highly dispersed and local taps on the freely flowing energy of the active vacuum. Given the abilities of the Tesla howitzers, the power grids of all nations are sitting ducks.

"Personally, the present author regards the increasing **energy crisis as the greatest strategic threat** to the United States in its entire history. I will do anything within my power to help prevent what I perceive to be the looming economic collapse of the Western world, preceded or accompanied by a sudden, explosive, all-out and continuing exchange of the WMD arsenals of most of the world.

...*In the name of all humanity, let us begin!* Else by the time this first decade of the new millennium ends, much of humanity may not remain to see the second decade."

3. Weaponization

Scalar interferometry, Tesla howitzer, Tesla dome, heat/cold, dudding, 10 nations have them, dead-man fusing & Insane Systems, scalar strategy, earthquakes and weather wars, solar storms, mind attacks, leased to Yakuza, many examples of testing, quantum potential weapons.

"Indeed, Soviet energetics weapons are now capable of destroying both our triad shield, our homeland, our armed forces in the field, and our population, quickly and efficiently. We have a new "gap" of monumental proportions: not a missile gap, not a submarine or bomber gap, and not even a particle beam or laser gap. We have a scalar electromagnetics or electrogravitation gap." Bearden
http://www.cheniere.org/books/ferdelance/intro.htm

"**We have a new weapon, just within the portfolio of our scientists, so to speak, which is so powerful that, if unrestrainedly used, it could wipe out all life on earth. It is a fantastic weapon."** Khrushchev, to the Presidium, Jan. 1960

"We've totally missed the most incredible "secret superweapons" development program of all times, and the worldwide testing of the weapons themselves.

"Hiroshima and Nagasaki should serve as object lessons in the price of ignorance of such technological breakthroughs.

"History does repeat itself. But this time it's not we Americans who got the great new superweapon first."

Bearden http://www.cheniere.org/books/ferdelance/s75.htm

Warfare has been changed forever by the development of these scalar energy longitudinal wave howitzers. To get a basic understanding of scalar waves is to have the imagination suddenly run wild as all the implications and possibilities regarding warfare fall into place. One realizes with a certain horror that the world has totally changed, and that there are some very fearsome possibilities. Remember, the power for these weapons comes from the time domain, longitudinal EM waves in the vacuum of empty space, and the power is tremendous and mind-boggling. Being able to blast away at any target from a distant control booth is something that has never happened before. This is incredible power to be in control of and it divides the history of weaponry into "before" and "after." And the destructive power of these weapons is delivered instantaneously to the target **from the local vacuum at the place of the target**.

From an interview:

Questioner: "Are you saying that real energy can be transmitted faster than the speed of light?"

Bearden: "Yes. But hyperspatially. Not through 3-space, but "around" it. Again, this means that it's possible to produce energetic changes in a distant system at a distant place, without transmitting energy "through space" in the normal sense. You transmit "around" space, so to speak, and directly in time or through a higher dimension, depending on the model you're using to understand this. Further, the speed of the internal EM energy transmission is not limited to the speed of light."

http://twm.co.nz/beard_interview.htm

Here are some initial considerations about scalar weapons and scalar wars

1. Tesla Howitzer 2. Tesla Domes 3. Rogue groups 4. WW III 5. Russian "UFOs?"

1. The Tesla Howitzer and its modes of action

Source: Tom Bearden's weapons slides and Fer-de-Lance Briefing

For one thing there is no delivery of any thing to any place. Bombs are obsolete. So are the planes to get them there. No helicopters necessary. All current nuclear devices are rendered nearly useless by electronic "dudding." All distant-destruction can be done from a control room, and to any point on earth. The destructive power of "men" has just increased by orders of magnitude. The new weapons could even cause storms on the sun! Thus there is great urgency to make these **new facts public** and known, with the hope that all nations would come together to ban the use of scalar weapons.

Two scalar antennae together along with the computers to control them, make up a scalar interferometer, and according to Col. Bearden the Russians have hundreds of such installations already. These interferometers are called "**Tesla Howitzers**." They can deliver a giant blast of energy to the distant target site, true "action-at-a-distance".

The **first howitzer mode** is called the "**exothermic**" mode of operation because immense EM energy blasts outward at the target site. The blast of a scalar howitzer can be of near nuclear level in destructiveness, and can be repeated easily, at that place, or nearby, or anywhere.

The howitzer can use a lesser exothermic power setting and simply **destroy all electronics** in the target area. Thus they can render our nuclear missiles inoperable as they sit in their silos by "frying" the electronic circuits that guide them. They can bring down any airplane, anywhere in the world, at any time. Any person anywhere, if their exact position is known, can be assassinated without a shot being fired.

The howitzers can also bring down power grids anywhere in the world, at any time. Thus they could bring Wall Street to an instant halt by disabling all its electronics. Even this one little easy tweak of the howitzer could cripple the U.S. economy in a single day. No wonder the "**leaders**" don't want you to know! This is a new era we are in. The discovery and development of scalar interferometry has put us in a **new world**, whether we like it or not. Anyone could be expected to go into denial, the **befuddled** senators and congressmen included. But we have **to wake up**.

In a **second howitzer mode** called the "**endothermic**" mode, the howitzer sucks energy out of the target area, essentially creating a blast of cold at the distant target. It is even capable of freezing parts of the ocean. Bearden gives a number of cases where these "**cold explosions**" have been witnessed, mostly by airline pilots. April 9, 1984: 1 2 3) A huge mushroom cloud of mostly water is seen rising miles into the sky from out of the ocean, an awesome sight.

In the endothermic mode the sucked-out energy must go somewhere, so it is vented out at some other chosen spot on the earth. These endothermic plumes have been photographed by satellite.

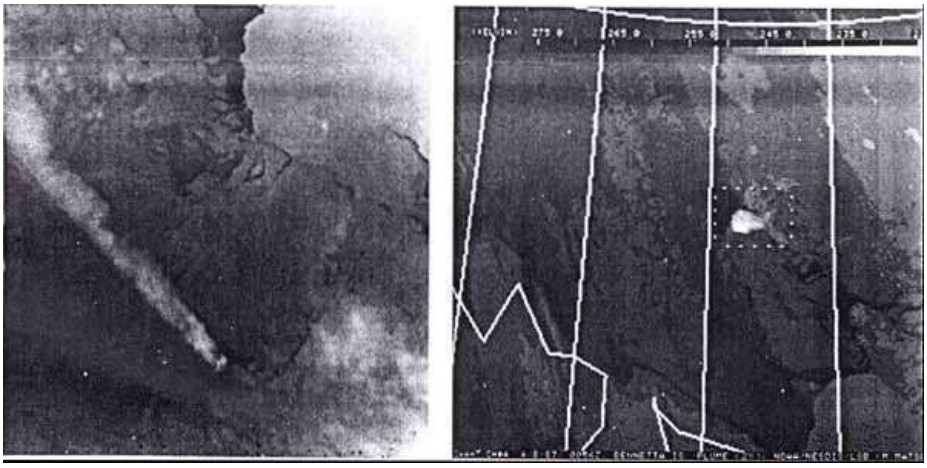

"The exhaust in the left picture is about 150 miles long, and is nearly horizontal (about 1.5 degrees above the horizontal). It is entirely consistent with the continuous exhaust from a "dumping transfer" scalar EM howitzer in the continuous exothermic mode. (The primary howitzer, of course, was activated in the endothermic mode.)" Bearden More Plumes

By using both of these **heat** (exothermic) and **cold** (endothermic) modes together the weather can be altered anywhere. Warm the air over here, cool it down over there, put a curl in the jet stream, dissipate clouds, create clouds, whip up a tornado. Bearden speaks about using the **endothermic howitzer mode** as a weapon of war:

> "Cold explosions can be used to freeze tanks, personnel, and equipment. The equipment and tanks thaw out. The personnel thaw out too, but they are dead when they do." Bearden, Fer-de-Lance

(This endothermic mode of the howitzers makes me think that there might one day be a cure for the problem of global warming after all. Could not a big device, situated in space or on the moon, be able to vent a great deal of excess heat outside the atmosphere into space, thus functioning as a kind of planetary thermostat?)

While the United States has experimented with electomagnetic weapons using ordinary **transverse** EM waves, the **longitudinal** [**LW**] weaponized waves are truly of another order altogether.

For one thing they do not have to travel through space, for they come from the time domain, which is everywhere. The energy of the blast, the heat or light or whatever, comes from the vacuum of space **at the location of the target itself**. This is astonishing. The weapons actually just trigger the release of immense energy from the vacuum at the target location.

> "... it is possible to focus the potential for the effects of a weapon **through spacetime itself**, in a manner so that mass and energy do not "travel through space" from the transmitter to the target at all. Instead, ripples and patterns in the fabric of spacetime itself are manipulated to meet and interfere in and at the local spacetime of some distant target. There **interference of these ripple patterns** creates the desired energetic effect (hence the term energetics) directly in and through the target itself, emerging from the very spacetime (vacuum) in which the target is imbedded at its distant location." Bearden Fer-de-Lance

The big Tesla howitzers are aimed at their targets by using a worldwide electromagnetic pattern called the "Woodpecker Grid," begun by the Russians in 1976.

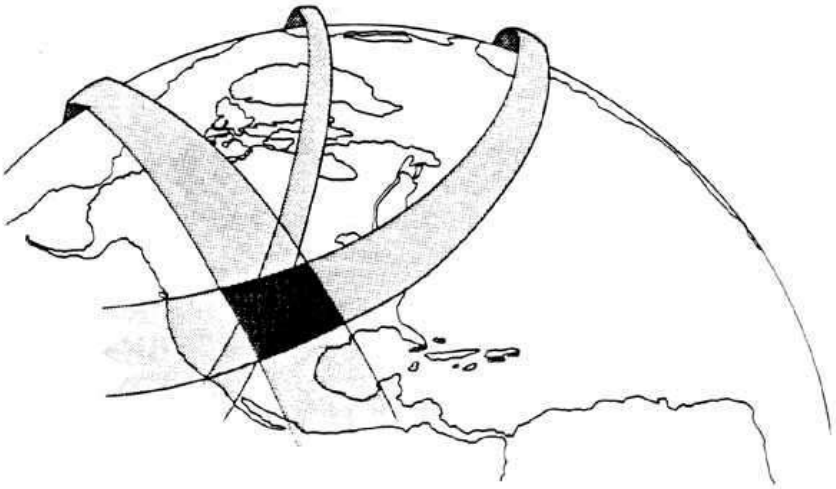

You can hear the Woodpecker signal here:
http://www.cheniere.org/misc/woodpeckersound.htm

The woodpecker grid is just that, a grid of EM waves which provide a channel for the **LW** waves to any point on earth. Computers use the woodpecker grid information to hone down the aiming of the howitzers **to a pinpoint location on earth**. (For that matter, it could be under the earth, in space, or under the sea).

A third howitzer mode is what Col. Bearden calls "**Mindsnapper**" mode. This is a truly frightening mode which affects the electromagnetic mind-body connection. Being mind-snapped at a low level would cause you to lose consciousness. Being mind-snapped at a slightly higher power would "entrain" all minds in the target area into a kind of hypnogogic trance, a state in which they would all be highly susceptible to suggestions and orders.

Being mind-snapped at high level would so disrupt the mind-body connection that everyone in the target area would fall down, instantly dead. Not only that, everything around you and inside you would be killed, so that your sterilized body would **not rot** for quite a long time.

The **Mindsnapper** can be used for a small area, or to **kill an entire population**. In fact, using the scalar waves to affect the human mind has become a new field in its own right, and has been dubbed "psychoenergetics." (This is discussed below in section 5).

Bearden describes the use of the howitzer in **mind-snapping mode** against people, to cause unconsciousness or death:

> "From a military viewpoint, these scalar EM weapons are really quite all-around weapons.
>
> "For example, they are very lethal against personnel.
>
> "Set in the "high intensity pulse mode," one blast and a person's nervous system is destroyed instantly. Total, instantaneous death results. One can blast away at entire groups of infantrymen, for

example. It's the peak power that's important, not the average power. So the weapon doesn't require too much battery power.

"Set on a lower intensity pulse mode, one zap can simply knock out a person, rendering him instantly unconscious. Quite useful if one needs prisoners to interrogate. Also very silent, which is useful in operations employing stealth and surprise." Bearden http://www.cheniere.org/books/ferdelance/s80.htm

"Those hit by the scalar EM weapon, however, have a most peculiar death mode.

"Death comes-instantly and totally. There is no convulsion, no response. The entire nervous system is destroyed instantly. Every living cell in the body is killed instantly, including all bacteria, germs, etc.

"A body hit with this thing falls like a limp rag and lies where it falls. It doesn't decay in even 30-45 days. In a macabre fashion, it's been reduced to something like food irradiated with nuclear radiation; everything is killed, so the material is preserved for an extended period before any decay can set in."

Bearden http://www.cheniere.org/books/ferdelance/s81.htm

He goes on to say that the same "bazooka-sized scalar EM pulse weapon" can also be used to knock out a tank with one shot (or pulse). So tank warfare is obsolete. Helicopters? Bearden points out: "... if he's attacked by a helicopter or a fixed-wing aircraft, he can bring the same weapon to bear on it. He can knock down a chopper or a jet. With one shot."

Obituary for Tank Warfare

Tanks useless against portable LW weapons

"For example, suppose one attacks a tank. [with an LW weapon]
With scalar EM pulse, the personnel die instantly. Total personnel kill is achieved.
All electronic systems of the tank are dudded. Total systems kill is achieved.
The ammunition in the tank explodes. Total kill is achieved.
The fuel explodes. This is another total kill mechanism.
That tank has been killed totally, by a variety of mechanisms, all simultaneously.
That's a k-kill in any analyst's book.
And don't worry about retrieval and repair. That tank is finished permanently.
Even the most modern tank is just as vulnerable as the most obsolete."

Bearden http://www.cheniere.org/books/ferdelance/s88.htm

One begins to get the idea how profoundly the conventional means of warfare have been obsoleted. All the usual weapons of war have been rendered nearly useless! And **Star Trek's "Phaser**," with its "stun" and "kill" modes is here at last.

Although it is the weapons aspect of scalar electromagnetic which has received the most developmental effort, Bearden points out that a great many other amazing things that may be accomplished in this new field of science. Beam me up Scotty!

> "Superluminal communications systems, hyperspace drive, and **materialization** and **dematerialization** are all hypothetically possible, using scalar electromagnetics. As the technology develops, we should see the development of many of the systems long thought impossible except in science- fiction."
>
> Bearden http://www.cheniere.org/books/ferdelance/s15.htm

Bearden describes a huge test of the Russian scalar weapons systems which occurred in 1985, a test that went completely unnoticed by western scientists:

> "Just before May 1, 1985 the Soviet Union performed a "full-up" operational test of their entire strategic scalar EM weapons complex. This test was detected and monitored periodically by Frank Golden. Some 27 of these giant Soviet "power taps" were locked into the molten core of the earth, producing forced (entrained) scalar resonance of the entire planet on 54 controlled frequencies under our very feet. The remainder of the scalar frequency spectrum was ablaze with literally hundreds of Soviet scalar transmitters: probably the entire strategic scalar command and control system to underwater submarines, higher command centers, distant commands, etc. was activated in the giant exercise.
>
> "For several days, the system was exercised on a mind-boggling scale, apparently as part of the Soviet Union's highly accentuated 40th anniversary celebration of the end of World War II.
>
> "Ironically, not a single U.S. intelligence agency, laboratory, or scientist detected this monstrous exercise for the new Soviet leader, Gorbachev. Not a one of them had a detector for scalar EM radiation, and not a one of them officially believes the exercise ever happened."
>
> Bearden http://www.cheniere.org/books/ferdelance/s38.htm
>
> "The **Woodpecker grid/howitzer** weapon system can be placed over the ocean and used against cruise missiles, naval surface-to-air and surface-to-surface missiles, submarine-launched ballistic and cruise missiles, etc. Placed over a carrier task force, it can also take care of the aircraft launched by the carrier as fast as they are launched. It can also handily take care of the missiles launched by guided-missile cruisers of the accompanying task force."
>
> (Bearden http://www.cheniere.org/books/ferdelance/s65.htm)

The whole series of the Fer-de-Lance briefing slides and comments is a "must read" for anyone wanting to be aware of the actual state of things in this world right now. It is a new world and it takes some getting used to. Fer-de-Lance speaks clearly, for the layman, of the way things stand.

What is it like to operate these Tesla Howitzers? Col. Bearden gives us an idea in his "Fer-de-Lance" briefing, Slides 66-71.

Who needs armies anymore? A entire war can be fought and won by a handful of men sitting in a comfortable control booth! The scalar electromagnetics revolution has made all previous forms of warfare nearly obsolete.

Why haven't the Russians used the scalar weapons yet?

Bearden gives his thoughts on this in "Fer-de-Lance." The power of these weapons is so great that an accident or war could wipe out all life on earth, and even **affect the sun**.

> "As can be appreciated, this entire concept [MAD] is now totally obsoleted by the Soviet possession of scalar EM weapons.
>
> 'The "mutual assured destruction" capability -- or MAD concept as it was so aptly named! -- is **no longer mutual.** And for two reasons: (1) the Soviet surprise attack could destroy essentially all our Triad forces wherever they are, in the first attack. (2) Even if a very small number of our strategic forces survive, the puny strike we could attempt to launch could be repeatedly decimated from launch to terminal phase.
>
> 'The restraint on the Soviets is not because of our Triad forces. The restraint is twofold:
>
>> (1) a second nation has scalar EM weapons, and would undoubtedly unleash them upon the Soviet Union with great violence if such a massive world-wide destruction of U.S. forces occurred or was threatened (is it really "accidental" that six major Soviet missile ammunition storage sites mysteriously exploded within seven months?);
>>
>> (2) the closed-loop **scalar radiation exchange system of Earth-Sun could be inadvertently "tweaked"** in the feedback loop from Earth to Sun, so that a large solar scalar resonance was stimulated. In that case the Sun could emit a mighty resonant "burp" that would simply **wipe out all life on Earth in a fiery shower**.
>
> 'The "terror" in the "balance of terror" between nations has just increased by many, many orders of magnitude.
>
> 'The biblical prophecy that the Earth will be wiped out by "fire and brimstone from heaven" is very near fulfillment now.
>
> 'Put another way, the pucker factor -- even on the Russians who may contemplate unleashing Armageddon -- is higher than any Western strategic analyst has ever imagined, even **in his wildest nightmares**.
>
> 'Truly these weapons are "more frightening than the mind of man has imagined," as Brezhnev put it in 1975.
>
> 'The frightening scalar EM weapons can be used, but only very, very gingerly indeed. If a slight mistake is made, everybody loses everything."
>
> Bearden http://www.cheniere.org/books/ferdelance/s74.htm

But the Russians (KGB) are not the worst of it. Bearden claims that some of the scalar weapons have been leased to the Yakuza for about a billion a year, and that only the KGB is holding the Yakuza in check from making a **full-scale all out scalar attack on the west.**

U.S. Defense Secretary William Cohen

Warns about eco-terrorism using scalar electromagnetic weapons

> "Others [terrorists] are engaging even in an eco-type of terrorism whereby they can **alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves...** So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...**It's real**, and that's the reason why we have to intensifour [counter terrorism] efforts." - Defense Secretary William Cohen, 1997

In a letter to a writer named "Russell" Bearden says,

"In short, Russell, the Secretary of Defense of the United States confirmed that there are indeed novel kinds of EM weapons, right now and have been for some time, which have been and are being used to (1) initiate earthquakes, (2) engineer the weather and climate, and (3) initiate the eruption of volcanoes. We wrote about those exact uses of the weaponry decades ago. Several nations now have such weapons. Three of them (two on one side and the other on a hostile side) are even firing practice shots into Western Australia, as a convenient test range."

http://www.earthchangestv.com/ufo/0209gandor.htm

See Also:
Examples of scalar weapons testing around the globe

See Also: Powers of the Longitudinal Interferometers

Tesla Howitzers in Weather mode

How to Make Weather

"Engineering the weather is **duck soup**; they tested that over the U.S. in 1967, and entered upon continuing operations over North America on July 4, 1976 as a grim kind of KGB "Bicentennial Gift" to the United States. Here's how it is done with several interferometers.

"First, the interferometers can deliberately make "high pressure areas" (cool the air so it shrinks and its "footprint" pressure on the ground increases because its density increases) and "low pressure areas" (heat the air so that expands and its "footprint" pressure on the ground

decreases because its density decreases). Well, if one makes the highs and lows where one wishes them, and judiciously and somewhat slowly moves them along a given path, these highs and lows will entrain the jet streams and thus "steer" the weather.

"So if you wish a very cold snap or attack, go up into Canada and start these actions to steer down some streams that bring some very frigid air. Establish other highs and lows judiciously to "block" or "slow" other jet streams and flows as desired. In this way, one can pull the "large cold air masses coming down from Canada" deep into the southern U.S. at will. They do it regularly. If you wish an ice storm, add an additional current of warm moist air you bring up (steer up by using artificial highs and lows) from the ocean. Where they meet, you will get freezing rain, then sleet, then severe icing accumulating. This type of attack does rather large damage to the struck area."

http://www.earthchangestv.com/ufo/0209gandor.htm

Whole websites have now sprung up showing weather **radar anomalies** which may well be indications of scalar weather engineering. One list of over 500 images is here. Cheniere has its own collection here.

Here is an animated anomaly with cloud formation.

In another section at Cheniere are many photos of **cloud anomalies** which reveal the underlying grid along which the clouds are forming or un-forming. Bearden relates a startling incident in these **ongoing "weather wars**."

> "During the spring of 1986, abnormally strong Soviet weather engineering occurred over the U. S., causing a drastic drought in the southeastern U.S. **This drought was broken by a colleague who used an extremely powerful scalar EM device** to redirect jetstreams. A most unusual and unique signature of the "blocking" against the Soviet scalar EM actions resulted: Two huge circulations developed in the atmosphere, clearly showed as two adjacent giant "holes" in the swirling cloud cover over the middle and eastern U.S.
>
> "Between these two giant holes, the cloud circulations formed a stream of clouds, moving to the south, looking very: much like a giant vertical "bar" of a huge "Y-shaped" cloud flow.* Several national weathermen commented on this unusual pattern, which had not been observed before. The pattern continued, day after day, as the blocking continued."
>
> * On the weather maps.
>
> http://www.cheniere.org/books/analysis/history.htm

Tesla Howitzers in Earthquake mode

How to Make an Earthquake

"Here's how you initiate a very large earthquake with such weapons. Take a convenient fault zone of set of them. Focus the interferometry on the fault zone, in the "diverging" mode, and deposit EM energy there in the rocks on both sides, increasing (slowly) the stress in the rocks by the reverse piezoelectric effect (deposit excess energy, get crystal mechanical movements).

"Do it slowly, and the stress will build up to large pressures well-above a plate slip minimum energy required. At some point, the rocks yield and one or both sides "slip" and move rather sharply, giving a very large earthquake in that zone.

"Do the same thing down in the earth (remember, LWs easily penetrate right through the earth and ocean at will, and so the "interference zone" focus can be inside the earth or beneath the ocean, at will.

"Anyway, focus this thing down to where the active part of the volcano is still slumbering, down where the hole in the plate has been made. Keep increasing the deposition of energy in the magma itself, and eventually the increasing pressure from deep within that volcano, underground, will cause an eruption. Build the energy slow, and the eruption will likely be much larger."

http://www.earthchangestv.com/ufo/0209gandor.htm

Yugoslav Earthquake, Followed by Cold Explosion
Strange Characteristics of Iran Quake, Sep. 1978

Tesla Howitzers in Tesla's "Big Eye" mode

How to make a Big Eye in the Sky

By using longitudinal wave interferometry in a weakly endothermic mode a new kind of "radar" is now possible, one which can look right through the earth and oceans. Because the endothermic mode extracts energy from the distant target, a pattern of the target area can be scanned for in the returned energy.

"Thus the receiver produces a representation of the energy extracted from various locations within the distant endothermic zone. By displaying the received signals on an appropriately scanned screen, a representation of the distant scene in the intersection zone can be created. Indeed this is a special kind of "microwave interferometry," and -- with modern techniques -- the imagery obtained might be surprisingly good. With development, it might even become as good as the image presently obtained by side-looking acquisition radars.

"Interestingly enough, since scalar EM beams will easily penetrate the earth or the ocean, one can also look beneath the earth or

beneath the ocean with this type of scanning scalar interferometer.

"The importance of this capability to strategic and tactical reconnaissance is obvious. Camouflage, cover, and concealment have no effect on such a system. One can easily look inside buildings and into underground facilities. With a small system such as this, the U.S. Marines at Khe Sahn would have had little difficulty locating the tunnels continually dug under the perimeter by the Viet Cong. And targets under jungle canopies are directly visible."

Bearden http://www.cheniere.org/books/ferdelance/s42.htm

Tesla Howitzers can destroy all life on earth

How to Make a Storm on the Sun!!

(Just make a big mistake with your Tesla howitzers)

The **deepest dangers** of the use of scalar weapons are frighteningly pointed out by Bearden here where he considers that the sun, earth and moon (actually the whole solar system) is a delicately balanced arrangement of scalar (longitudinal) EM radiation. There is a scalar connection between the earth and the sun, which are both giant dipoles gushing energy in the time domain. Big scalar events on the earth could alter this balance causing **true catastrophe**.

"Indeed, a solar response could be stimulated so that the Sun would violently belch and destroy our biosphere, among other effects."

Unrestrained scalar warfare could cause huge solar storms? To realize that **human activity** could actually **affect the sun itself** is truly mind boggling.

Bearden goes on to say:

> "Accordingly, use of huge scalar EM weapons is a double-edged sword. Unless carefully employed, use of the weapons could cause a terrible backlash to the user as well as the victim, and even accidentally cause the **destruction of the earth itself**. It is not accidental that in 1960 Khrushchev stated that his new fantastic weapon could -- if unrestrainedly used -- destroy all life on earth.
>
> "This appalling backlash potential is apparently what prompted Brezhnev in 1975 to make so strong an effort to get agreement to outlaw the development of "new weapons of mass destruction" more frightful than the mind of man had even dreamed of. Gromyko even introduced such a draft agreement into the proceedings of the United Nations. The first article of the draft agreement indicated that the nature of the weapons referred to would be negotiated. Sadly, the entire Western

> world did not even know what the Russians were talking about."
>
> http://www.cheniere.org/books/ferdelance/s24.htm

2. Tesla domes provide near-perfect defense shield.

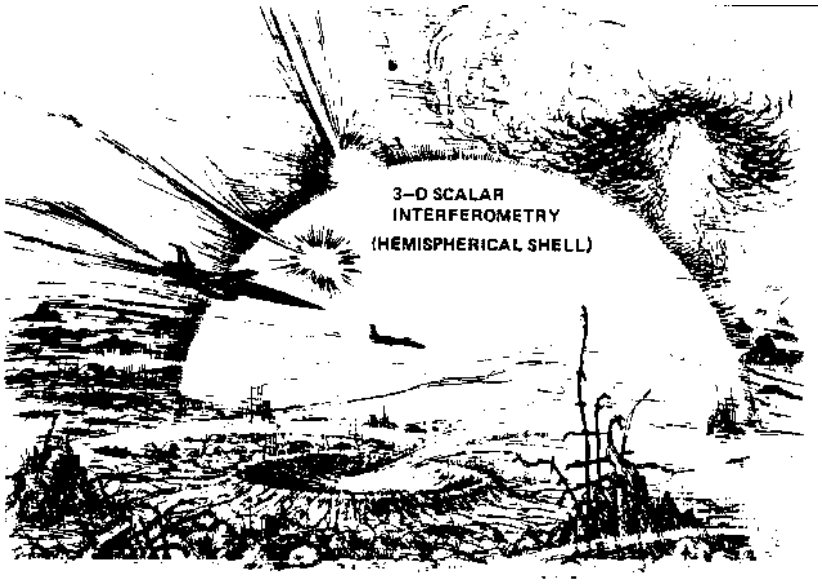

(Slide from Cheniere.org)

The Tesla howitzers can be used in a nearly **impregnable defensive mode** whereby they throw up a dome (**Tesla Dome**) or a sphere (**Tesla Globe**) of highly powerful electromagnetic energy, enough to "dud" or destroy missiles which try to penetrate them. Once again, this energy is not going through space from the howitzer, but being made to emerge from the local vacuum **at the location of the shell**. KGB tests of these domes have been witnessed by airline pilots around the world. Bearden gives many examples of the Tesla domes being sighted around the world in his briefing paper "Fer-de-Lance." (Russian dome test, another globe incident, yet another globe test). These giant electromagnetic domes can be hundreds of miles across, or narrowed down more to total impermeability.

> "Such a shell may be several hundred miles in diameter at the base. The enormous energy required to form such a defense shell is obtained by a "scalar power tap" into the **molten core of the earth itself**, as previously explained. In late April/early May of 1985, 27 such "**power taps**" were placed in the earth by the Soviets. If each tap is capable of powering four to six large scalar EM weapons, then the **Soviet strategic scalar EM arsenal contains over 100 monstrous superweapons** capable of generating exothermic explosions, endothermic explosions, engineering the weather, locating and destroying underwater submarines, detecting and destroying ballistic missiles shortly after launch, detecting and

> destroying long range strategic bombers as soon as they are airborne, etc."
> http://www.cheniere.org/books/ferdelance/s52.htm

By using nested domes one can protect the domed area **even against nuclear radiation itself**. Tesla globes can be used to hit airborne targets by simply placing a globe of any chosen size in the flight path of the incoming missile. It does double duty because the missile hits it going in, and then the rubble hits it again going out the other side.

While the U.S. persists in its useless boondoggle "missile defense system" by shooting a missile with a missile (missiles which would already have been "dudded" by the Tesla howitzers), between the domes and the globes the Russians (KGB) have in hand (**operational**) a nearly **perfect missile defense system**. Someone should ask the Secretary of Defense if the U.S. Tesla domes are in place. And over which cities? How powerful are our American Tesla domes?

Bearden cites a number of examples of these domes being tested around the world: March 20, 1969 | March 24, 1977 | August 17, 1980 | June 17, 1966 | June 18, 1982 June 22, 1976

In a slide from the Fer-de-Lance briefing it is shown how the "woodpecker grid" itself also acts as a sensor, detecting any missile launch anywhere, and how the howitzers can respond instantly by delivering a blast to exactly the right coordinates, right along the channels of that same grid which is feeding the location information about the missile launch. This certainly beats "trying to hit a bullet with a bullet." Especially since YOUR bullet would probably be instantly inoperable in a real scalar war situation.

3. Rogue Groups in the government

Bearden fears that these scalar electromagnetic secrets may have fallen into the hands of what he called secret "**rogue groups**" within the labyrinthine depths of the black-ops special-access domain of the secret government. "In the extreme, such a deep black program can even become a "captured" program," he says, "which is totally in the hands of rogues and **no longer reports to or is bound by the dictates of the parent government**."

> "They have their own agendas. And being rogue groups, they may well bring in **unethical, immoral tricks**: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. **It's a human characteristic, the old primate dominance game. Only now disguised and hidden under deep classification. ...**
>
> "In highly classified groups, these groups are greatly enabled to joust more widely, unethically, and immorally because it is so deeply hidden. So very deep classification evokes the growth and intensity of rogue groups. It's the old 'Power corrupts, and absolute power corrupts absolutely' routine. ... Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, **may not operate under very much legitimate government control at all**, and may operate specifically for the purposes of the rogue group or groups that have gained control."

> "The involvement of at least some rogue groups, some being "**cowboys**" who operate well **outside all laws and ethics**, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, ***it could account for what seems to be actually occurring***. "
>
> http://www.cheniere.org/explore%20articles/mind%20control3/p05.htm

4. World War III has already begun

Because it is now possible to cripple the power grids and electronics of any nation, that nation could be reduced to economic ruin without ever firing an actual "shot." Without electricity Wall Street cannot operate. Without electricity you quickly need martial law. One no longer needs to wage a conventional war anymore at all. There are now **lots of new ways to bring any nation to its knees**.

> "We are at war, whether we like it or not. And we are going to have strategic strikes on an unparalleled scale for us. Pearl Harbor was nothing compared to what is coming down, once we consider the "augmentation" and such.
>
> "When that factor is considered, then it's a totally new ball game on replacing the power system. There isn't going to be much choice; the old one is going to be destroyed or so badly crippled that **it will collapse the U.S. economy** in a way we have not seen since **1929**. Of course, in such a case hitting us, we will be under martial law, the works, everywhere. For one thing, it's the only way you can keep the cities from imploding from within, by the criminal element, looting, robbing, killing, etc. Simply wait and see; it's on the way."

Although Bearden has for years decried the "scalar-gap," and chided the military for falling so far behind the Russian KGB in the field of scalar electromagnetics, recent statements indicate that things may at last have changed somewhat.

> "In the new war, the first phase of WW III has already been completed. Hence President Bush's recognition that this is a total war, and has to be taken to the enemy no matter where he may be hiding or in what sanctuary or in what foreign nation. This is an entirely different war than anything the U.S. has ever fought in its history. **And before it is over, it is going to kill more Americans than have died in all the previous wars in our history. The news media and the public have not yet recognized that awful situation and predicament.** Most are already thinking that, well, we won in Afghanistan so it's just about over. Instead, it has only just begun.
>
> "Anyway, that's a brief uptake on some of the weapon situation today. Some 10 nations or more now have LWIs, and five have the QPs. I'm still working on how many have the appalling negative EMP weapons, but would estimate 6 or 7 nations have them in one stage or the other, either deployed or in at least advanced development. And in my estimation, the Yakuza will have them within three to five years if they have to build them themselves, and quicker if they can buy them from the Russians, Chinese, or???" Bearden

When he was asked the question "**Does the government listen to Tom Bearden?**" Bearden said:

> "Let me speak carefully. I am very satisfied with how I've been listened to in the quarters where the rubber meets the road. **The West is no longer defenseless, not by any means.** Cannot amplify it further than that."
> http://www.cheniere.org/correspondence/021102a.htm

Bearden has briefed the government a number of times and the Cheniere website contains a great number of his graphic military briefing slides.

5. Are the Russians making "UFOs?"

Scalar electromagnetics engineering opens the possibility of antigravity vehicles and "hyperspace travel." In other words we can now make our own UFO's! Of such **scalar-powered antigravity vehicles**, which have now become possible, Bearden has this to say:

> "We might expect to see such vehicles glowing. Their various surface features and mechanisms might appear to be glowing or revolving lights, etc.
>
> "They could exhibit incredible "aerodynamic performance," seemingly in the atmosphere. **Actually they would not be moving "through" the atmosphere at all, but through a higher space outside each particle of atmosphere**.
>
> "They could seem to **materialize** and **dematerialize**.
>
> "They could seem to plunge into the ocean or rise out of it.
>
> "They could even seem to operate under the ocean or inside the earth itself.
>
> "**Such anomalous vehicle performances have been seen all over the world**, particularly since a few years after WWII.
>
> "It appears that one or more nations of Earth are operating such vehicles now **in great secrecy**. Our own "government" may even be one of these.
>
> "If so, it **isn't** our true "government/government." Instead, it's the "control group/government." It's government at the operational level, but at higher level **it belongs to certain control groups who have penetrated our government's vitals and taken over all such projects**."
>
> Bearden http://www.cheniere.org/books/ferdelance/slide32.htm

In an excellent article on her Earthfiles website, Linda Moulton Howe reports on the utter bafflement of Norwegian scientists over mysterious lights appearing in the valley of Hessdalen, Norway.

She writes of the research there: "The results can be broken down into two groups: 95% are thermal plasmas and 5% are unidentified solid objects. The plasmas emit long wave radio frequencies and strangely, their temperatures do not vary with change in size or brightness." She quotes the scientists' research summary:

> "1) most of the luminous phenomenon is a thermal plasma;
> 2) the light-balls are not single objects but are constituted of many small components which are vibrating around a common barycenter;
> 3) the light-balls are able to eject smaller light-balls;
> 4) the light-balls change shape all the time;
> 5) the luminosity increase of the light balls is due to the increase of the radiating area. **But the cause, and the physical mechanism with which radiation is emitted, is currently unknown**."

This would almost certainly seem to be another example of the testing of the scalar howitzers. It is baffling because, as Bearden points out repeatedly, Western scientists have limited knowledge of the scalar electromagnetic principles by which the howitzers operate. The Hessdalen scientists were completely **baffled** as to where the energy of these plasma balls **was coming from**.

Ms. Howe interviews Massimo Teodorani, Ph.D., Astrophysicist, who released the report on the 2001 Hessdalen sightings. The scientist speaks of the baffling phenomon observed.

> "I don't know how it is possible that Nature is spontaneously able to do that. Anyway, we deduce that the plasma is trapped inside a sort of magnetic cage and the magnetic cage closes around the plasma and keeps it fixed in some way, prevents it from expanding. **But where does it come from? We don't know**."

By what we have been considering here, we can recognize the signatures of scalar electromagnetic engineering. If it is a Tesla howitzer, then the energy for the plasma balls **is coming from the vacuum of spacetime** at the very **location of the balls themselves**, triggered by scalar interferometers aimed through the woodpecker grid.

These kind of balls can be used as **marker beacons** giving feedback for precision aiming of the howitzers. The energy of the marker beacon can be read back into the

computers giving precise location information for pinpoint aiming. The target area can be very small, or widened out.

There is a little movie of one of the Hessdalen plasma balls here. It would seem to be a clear documentation of a scalar howitzer marker-beacon. How many other current "UFO" sightings are actually the witnessing of Tesla howitzer tests?

In fact there are a great many **anomalous events** of the past few decades which might very well be explained by the Russian testing of their longitudinal electromagnetic weapons. It would seem that the mysterious appearance of crop circles around the world could be accomplished by feeding a precise mathematical graphic pattern into the computerized aiming software and change the very molecular structure of the crops themselves along the lines of that pattern. The stalks fall over from the localized effect of the longitudinal waves. A plasma ball tracing patterns? Are they slyly sending a message to see if we are "getting it" yet?

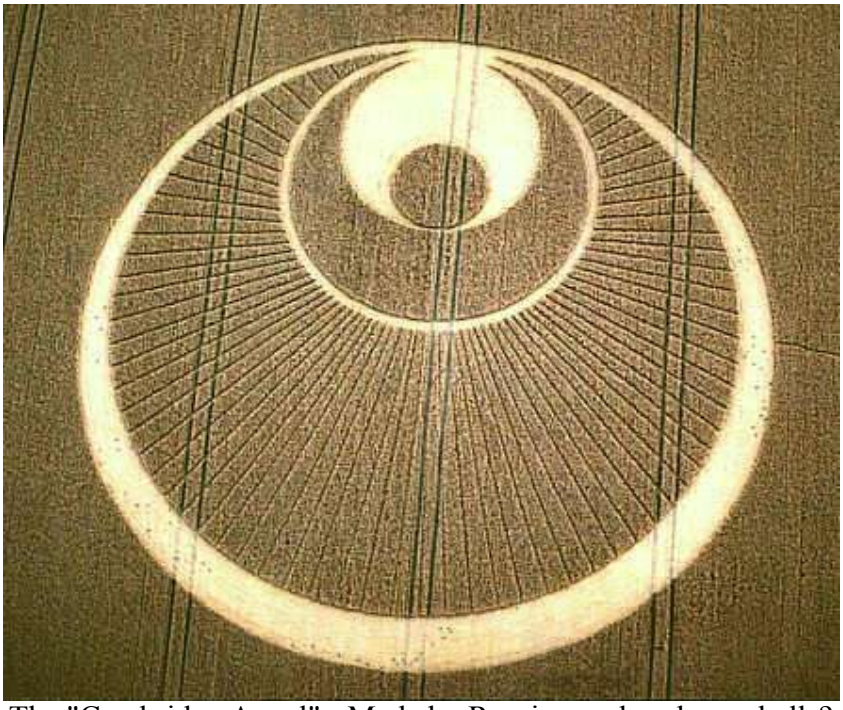

The "Cambridge Angel" - Made by Russian scalar plasma balls?

Also see: Interview with Tom Bearden

(Slide from Cheniere.org)

4. Healing powers of longitudinal waves

Healing via longitudinal waves, time reversal of cells (de-differentiation), Priore's machine, Bearden's proposed "blanket" version, using the electric power grid for healing waves or for broadcasting disease patterns. Scalar Biowar.

The good news!

"**Any sort of disease whatsoever - physical or mental** - will be rapidly curable, simply and cheaply. It will be possible to reverse aging and rejuvenate the person. It will be possible to regrow limbs and straighten misshapen spines - and directly remove the causes of mental diseases and cure them as well. Lifespan will be staggeringly increased, without 'old age's debilitation.' AIDS, cancer, leukemia, and genetic diseases will be completely conquered. The potential for a true golden era is upon us, for all humanity."

Bearden- http://twm.co.nz/beard_interview.htm

Proof of the healing powers of longitudinal waves from the vacuum is seen in the work of Antoine Priore who produced longitudinal scalar waves using a **gigantic glass tube** filled with plasma. He himself did not understand why it worked or how it cured cancer in animals.

> "The Priore team cured terminal tumors, trypanosomias, and other dread diseases in laboratory animals in France, in the 1960s and 1970s, under rigorous scientific protocols by eminent scientists. The Priore

project was funded by the French Government to the tune of several millions of dollars (equivalent). http://www.explorepub.com/articles/energetics.html

". . . Prioré's machines concretely demonstrated a nearly 100% cure of all kinds of terminal cancers and leukemias, in thousands of rigorous laboratory tests with animals. These results were shown to medical scientists as early as 1960." http://www.cheniere.org/priore/index.html

Bearden has stated that the longitudinal EM waves can have a healing effect because they always come in pairs called "**phase conjugate pairs**" and one of the pair is **time-reversed**. This enables engineering of the waves to "pump" the cells of the body (with waves from the time domain) and actually **time-reverse the cells** back to a previous healthy condition. The scalar cure of cancer does not involve killing the cancer cells but rather pumping them with time energy into a previous condition. I know, this seems miraculous, and is it not?

Priore and his giant plasma tube

This healing power in the longitudinal waves of the time domain is a mind-boggling thing to face. It took me months to get through it, and to **suffer the fact** that the **cure** for cancer and AIDS was right there, **in this new scalar electromagnetics technology**, and that it has been kept back from the people for so many decades now.

Bearden has a great deal to say about the work of Antoine Prioré, who himself did not understand why his machine worked. Priore did not know about the longitudinal scalar waves of the time domain. In fact, Tom Bearden has supplied, at last, the missing explanation as to how that **big giant two-story glass tube** consistently cured cancer in animals.

"**The medical implications are enormous**. By just reversing the damaged cells back to a previous physical state, this gives a physics mechanism for *controlled cellular dedifferentiation*, in biology terms. Physicians will **time-reverse diseased, damaged or aged cells** back to an earlier healthy condition, including all the cellular genetics. Normal cells are just reversed to a slightly younger condition."

"We believe this mechanism explains the revolutionary but baffling electromagnetic cures achieved by a team of outstanding French scientists in the 1960s and early 70s, working with inventor **Antoine Prioré**. In lab animals, cures were achieved for terminal tumors, infectious diseases such as trypanosomiasis, and atheriosclerosis. In addition, deliberately suppressed immune systems were dramatically restored.

"We hypothesize that this is the long-sought mechanism of how the living body heals itself. In short, the body's cellular control system induces **cellular reversal by weak time-domain pumping** of the damaged cells and the affected area. The cellular regeneration system performs all healing of cellular damage in the body; the immune system heals nothing, not even its own damaged cells) .

"For the first time medical science can develop as a science of *healing* rather than a science of *intervention*. And it will develop as a science of *unlimited* healing, since **no pathogen can resist action by curved spacetime engines**." Bearden

http://www.cheniere.org/techpapers/Vision%202000%20paper.doc

See Priore's machine See Slides of how it works.

Bearden has extended the Priore work, with the previously missing knowledge now in place, and designed a revised system (for irradiating the body with longitudinal waves) which gets rid of Priore's giant glass plasma tube and uses instead an **antenna unit which surrounds the body**. He has also provided the missing explanation of how it works. There is an article from "Explore" magazine, Part I and Part II.

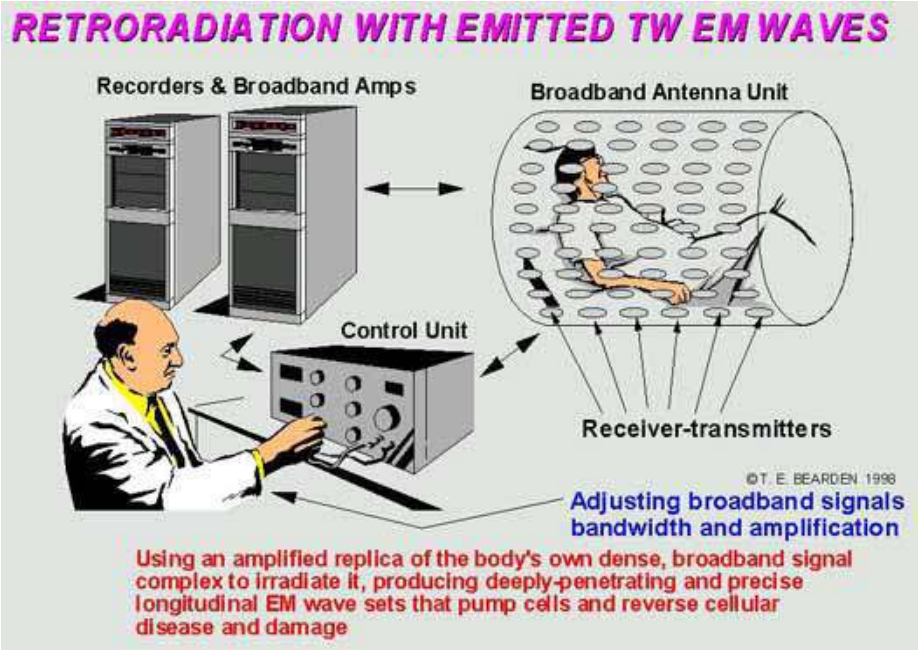

(Slide from Cheniere.org)

In fact, Bearden has presented to the U.S. government a plan to use a **portable version** of a **Scalar Healing Blanket** where wire channels in the blanket act as a scalar antenna, which can both send and receive scalar electromagnetic waves. A **two minute treatment** of the waves is sufficient to restore the body to its earlier healthy condition. Thus even **thousands could be treated easily and quickly in a biowar mass attack** situation.

"To defend against things like anthrax attacks on our civilian population centers, we also have recommended to the U.S.

Government the crash development of small, portable treatment machines—using similar "antiengine-forming" and cellular reversing "porthole technology". [See Figure 13 on previous page]. Such portable machines **could be developed cheaply and quickly**, and present government facilities could be used to massively attack the correlate database production problem.

"The portable treatment **units could be cranked out by the hundreds of thousands** and flooded down through emergency response agencies such as the police forces, the National Guard, emergency hospitals, emergency response teams, etc." - Bearden

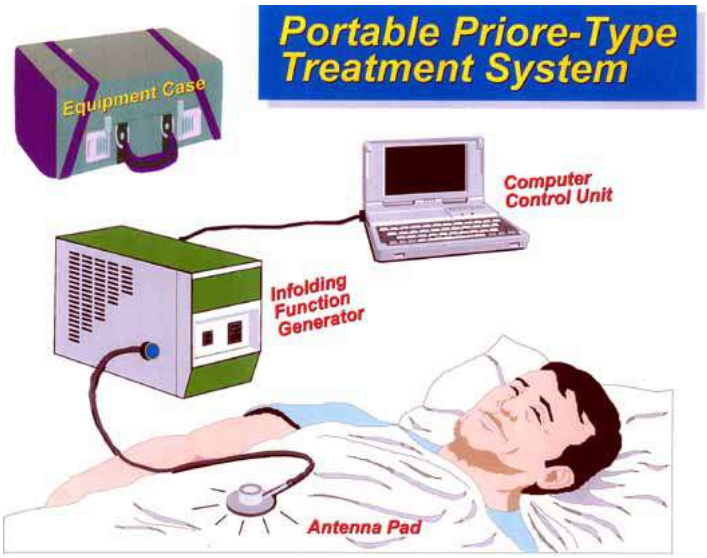

(Slide from Cheniere.org)

The **Scalar Healing Blanket** would fit into large suitcase. It has three basic parts, the longitudinal wave generator, a laptop computer, and the antenna-blanket. The plan was a stroke of Bearden's genius, but unfortunately it fell on **befuddled government ears**. "Unfortunately, so far the DOD [Dept. of Defense] doesn't even understand what the heck we're talking about!"

Article "Healing with Energy": http://www.explorepub.com/articles/energetics.html

> "We tried very hard in 1998 to call attention to the extreme national need for the most urgent possible development of a portable computer-controlled treatment device based on the experimentally proven Prioré methodology, but extended to a much simpler and far more rapid method of treatment.
>
> "Quick development of this technology could lead to **a suitcase size device, capable of treating a patient in less than one minute, and stopping the symptoms and disease progress cold, then reversing it**. Three "less than a minute" treatments one week apart would be required for complete cure. As an added advantage, partial reversal of aging in older patients would also be accomplished as a bonus, in addition to time-reversing the damaged and diseased cells...
>
> "The method proposed to the DoD in 1998 used normal EM in a peculiar way to force the body itself to make its own time-polarized

> EM waves, and pump every part of its cells -- including the genetics -- in the time domain.
>
> "Quite simply, we are going to be struck this way (QP spreading the immune systems of the populace plus professional smallpox, anthrax, etc. BW attacks on our population centers) and by other means we've spoken of in other papers and briefings."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

The Dark Side of the Force:
Creating and broadcasting disease

Speaking of the scalar wave induction of disease by longitudinal wave patterns Bearden refers to work by French scientist Kervran and Russian scientist Kaznacheyev, who proved that any disease could be transmitted electromagnetically.

> "It works this way: the Kaznacheyev experiments (and others) demonstrated that any cellular disease or disorder can be initiated into cells at a distance, by electromagnetic means (albeit unusual EM in nature). The decades of microwave radiation of the U.S. Embassy in Moscow, was an ongoing set of "stimuli" to ping the U.S. system and, by its response, ascertain how far along (or if it was "along") in its knowledge of such weapons. The radiation was responsible for many health changes in personnel and for the **eventual deaths of three U.S. Ambassadors**." Bearden http://www.cheniere.org/correspondence/021702a.htm

In a letter he writes,

"Yes, the Kaznacheyev experiments were quite real; 15,000 or so in military research institutes in Siberia. As with so many other novel areas investigated and developed by the Soviets, most U.S. investigators just assumed normal EM, which is not what the Kaznacheyev experiments involved, and not what was carrying disease induction patterns from one cell culture to another in rigorous lab tests."

How to "Broadcast" Diseases
Longitudinal EM Biowars

Bearden explains how the new quantum potential weapons can be used to induce disease-at-a-distance in a population, or to "spread" the immune system so thin that a **conventional bio-attack would be greatly potentiated**. By "broadcasting" virtual disease patterns over a population, the immune system is so overloaded by the presence of the **"shadow" diseases** that its effectiveness is thinned out.

> "In short, alter the internal wavestructure, and one creates a curved spacetime 'engine' that acts on mass in any fashion one chooses to design -- including initiate diseases . . . Now visualize one of these '**vacuum engines**' or 'spacetime curvature engines' that **acts on mass** to **generate the exact effects produced by anthrax**. (Or any other disease one wishes) . . .

Call the virtual state of a disease engine the disease pattern in the "shadow" state, just prior to becoming observable. . . .

"And the master cellular control system responds to "coming events that cast their shadows before". In short, it responds to the upper level of the **"shadow state" of a disease**, still in the virtual state! (Hey, virtual particles are real, virtual photons are real, virtual ST curvatures are real --- just very fleeting, only for another to immediately arise). The exchange of virtual particles is known to generate all forces in physics anyway! . . .

"So the cellular control system responds to "shadow state" disease patterns. Enter a QP weapon application. Place a quantum potential weapon "area" on the United States, so that the entire populace is in it. The slowly introduce and bring up in the shadow state, the **necrotizing fasciitis disease engine**. At some point, the cellular control systems will react, and order the immune system into action. In other words, immune system resources will be committed against this "immediately coming" enemy. Bring it on up a little, but still just in the shadow state. Voila! Humans form a bell-shaped distribution curve. And even if the structure of the QP fluctuates a little, fluctuating a bit stronger and a bit weaker, etc. **A few of those targeted bodies will now actually develop necrotizing fasciitis**. So far, just like the U.S. Embassy targeting, except a different "carrier".

"But now there is an exact signature that this is what is doing it, and not normal vector carriers of disease and contact or exposure infection. **The few cases of necrotizing fasciitis that break out will be most puzzling.** They will be randomly scattered across the entire nation, and so few that the vector carrier and contact or exposure explanation completely fails."

"And that one happened, right here in the U.S., not so long ago. Check it out.

"So carefully adjust the **patterns** for, say, 12 major terrible diseases, to that "adjusted and desired shadow state level". Now add all 12 patterns into the internal structure of the quantum potential. Now it has **12 shadow state disease engines** in it.

"**Place that one on a populace**. The cellular control systems order the immune systems into action, and they now have to commit their finite resources to 12 different areas. This greatly thins the response an immune system can make to any one of those 12 disease patterns! In short, it "**spreads**" the capabilities of the immune system, which can be galvanized to great effort, but only can perform a small bit against each area.

"Suppose one of those "galvanized" areas in the targeted populace's immune systems is anthrax. And suppose the bad guys now hit one or more of those cities with a professional anthrax attack. A former OTA study showed that a professional anthrax aerial spray attack against Washington D.C., dispensing

> 100 kilograms of anthrax spores in the spray, will account for 1 to 3 million casualties. And that's in an "unthinned" set of immune systems. **In the "thinned" set, one can at least double or triple, and even up to five times, that estimate.** So conservatively, now there would be from 2 to 6 million casualties. And even mild anthrax spray attacks in other "thinned" cities would also be amplified.
>
> "**That one is being set up, or already set up, right now.** There are other such "augmentation" setups also under way.
>
> **"So the weapons alluded to by the SecDef in 1997 are already being employed. WW III has already begun, and our populace (and our scientific community) is blissfully unaware of it."**
>
> http://www.cheniere.org/correspondence/021702a.htm

Most of us can remember the strange outbreaks of the so-called "**flesh eating disease**." It seemed to break out here and there randomly with no known cause. Bearden believes this was a test of the newer quantum potential weapons which go even beyond the capabilities of the Tesla howitzers.

> "The Kaznacheyev "disease induction by novel electrodynamics" work is also the basis for the spacetime curvature engines (not EM signals!) carried by quantum potential EM biological weapons for distant induction of diseases etc. into the population of an entire nation or area, such as the U.S.
>
> "This **quantum potential disease induction weapon** -- capable of attacking an entire population of a nation or area -- has been tested several times in the U.S. at very low levels, in the shadow state only (we explain shortly) and it has a most peculiar signature. E.g., **one test used necrotizing fasciitis (flesh-rotting disease) engines**.
>
> "The disease 'engine' was deliberately kept down in the 'shadow state' (virtual state, just below the observable state) so that only a tiny bit of the populace with depressed thresholds would "breach the observable threshold' due to the population forming a bell-shaped curve as to the threshold level. **The major signature of the test was that the cases of the disease broke out totally statistically and randoml**y, spread all over, without any 'disease vector' in between.
>
> "In short, it was not spread in any manner required by normal deterministic disease vectoring, **but was a totally random set of occurrences**. Several other diseases were also tested this way in the American populace, with precisely the same signature."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm
>
> "Apparently one planned use of such an augmented clandestine BW weapon will be smallpox, e.g. As you know, the Russians

> did develop smallpox for biological warfare, and even developed a new strain against which previous vaccination is ineffective.
>
> "The vast numbers of expected casualties, coupled with immune system spreading, are absolutely irresistible to the Russian mind. You can count on it that they have seen that the smallpox is already on site here, in the U.S. and in the hands of professional terrorist teams. Of course, the Russians/KGB will protest they have nothing to do with that! Yet likely the KGB will have flatly arranged it or at least assisted it. The capability for mass destruction of the nation is so lucrative and easy to achieve in advance, that **they would never be able to resist doing it**."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

Bearden believes the **Gulf War Syndrome** involved the use of scalar technology to induce a disease state, as he stated in a 1997 interview:

> **"I'll say this flatly, and I won't answer any further questions about it; the Gulf War Syndrome was induced...** It was induced with this stuff. All the rest... was contributing factors that everybody's talking about... There are some deeper signatures, if you look into it very deeply, that show you exactly how it was done and the fact that it was induced. It was a test. It was a test of a very special kind of weapon I have not talked about yet. Anyway you can use it to create diseases."
>
> Bearden http://twm.co.nz/beard_weapon.htm

Besides using the woodpecker grid to target a population, the entire **electrical grids** of nations can be used as "channels" for disease patterns to be broadcast to all people near that grid. Your own house wiring can become an antenna, broadcasting these "shadow" patterns of disease, weakening your immune system.

And here one faces the frustrating fact that the same power grids could be set to channel patterns which would keep the entire population healthy, rejuvenated, continuously bathing in the time-reversing old-age-defying energy of the spacetime vacuum. We have **no idea yet** of how long the human life span could be increased with this new technology. People might be able to live two centuries given full humane development of this technology.

5. Psychoenergetics

Mental entrainment, inducing hypnogogic trance, mind control, broadcasting thoughts and feelings, the Ant World, education via EM [LW] mental download, the "Feelies," revolution in spirituality, "enlightenment machine?" Scalar churches?

Psychoenergetics is simply using the scalar interferometers to manipulate and **engineer the human psyche**. To me it is the most **mind-boggling and frightening** aspect of longitudinal wave engineering.

The mind is electromagnetic in nature, and itself of the time-domain. It is not observable in 3-space. There is no **thing** you can point to that is the mind. As Bearden says, "**The mind is time-like**."

The longitudinal scalar EM waves are also of the time-domain. By overlaying certain infolded patterns (oscillations in time) on the longitudinal waves, **a thought or feeling may be made to arise in a person** or persons who are in the interference zone (where the wave beams cross).

The person will not notice anything, feeling that this thought or idea is his or her own idea. The longitudinal wave pattern might be a wave of panic or fear that spontaneously sweeps over you, perhaps inexplicably. It could even be in the form of a sudden intense patriotism. It could be explicit words and phrases, which everyone would think they had thought of by themselves. Or it could be rage and hatred, angry and violent. On the other hand It could also be a continuous sense of docility and placidity. This is the brave new world of psychoenergetics and the coming "**Mind Wars**."

Scalar Psychoenergetics in its most **primitive form** simply "entrains" all minds in the target area into a **deep hypnogogic trance**. In this state of mind people would be suddenly extremely suggestible, and would likely believe anything they are told, and would obey any orders given. Talk about winning the hearts and minds of the American People!

Tom Bearden makes me think of **Paul Revere**, who heroically conveyed important **warnings** for the sake of the new nation. But the words of the famous phrase have now strangely and curiously mutated into the once-inconceivable: "**One if by land, Two if by mind.**"

Indeed one strategy in a **Mind War** would be to simply **take over the minds of the "leaders"** of the enemy nation. The targeted leader would not be aware that anything was amiss, although he might begin to make unexpected changes in policy.

And are, in fact, any of our "leaders" already having secret thoughts that are not their own? Who knows? Frighteningly, we can no longer be sure. The new sciences of scalar electromagnetics and psychoenergetics are even now plunging humanity into a sudden science-fiction-like world beyond anything in humanity's previous imaginings.

> "The Russians reached the point in the mid 1990s that they could **take over control of a person's mind**, with modified longitudinal EM waves including some time-polarized EM waves, and with a team of specialists (estimate 25-30 per transmitter, and one transmitter and team per controlled person)." Bearden

In a slide Bearden illustrates how a Scalar War would involve a **psychoenergetics attack** on the operators of the enemy scalar installation, entraining their minds into hypnogogic trance and **getting them to shut down their systems**.

And ultimately psychoenergetic warfare goes to the very heart of **human identity itself**. For if my thoughts might no longer be "mine," then **who and what am I?** Can my very sense of being "me" be hijacked by some nefarious psychoenergetic scheme? Will the "secret government" eventually dictate directly into your mind how you feel about yourself? Or what you think you are? Or what you should do?

How Does Longitudinal EM Mind Control Work?

The physics of scalar psychoenergetics as expounded by Col. Bearden seems even more arcane and over-my-head than that of extracting energy from the vacuum. I can't understand it, but I look through it anyway. Each time another tiny understanding might occur, or a term might fall into place. I know the mathematics is forever beyond me.

One paper to begin with is Mind Control and EM Wave Polarization Transductions This is such serious stuff that Bearden includes a **strong warning about misuse of this knowledge**. Psychoenergetics weapons can mentally maim and physically kill.

Warning!

(From "Mind Control and EM Wave Polarization Transductions")

> "This article refers to experimental research techniques which can be detrimental or lethal in the hands of any but highly skilled, qualified experimental scientists proceeding under proper laboratory safety procedures. The purpose of this article is strictly for information to properly qualified and authorized scientists in certified laboratories. We do not propose or condone any use of these procedures for nonapproved practice of medicine without a license. Neither the publisher nor the author are responsible for accidents or outcomes in the use of these experimental procedures and techniques. Any researcher who performs these procedures and experiments is acting on his or her own volition, and is solely responsible for insuring safety, qualifications, and legality of the acts and their results. **We neither suggest nor condone unauthorized experimentation on human subjects. Such is a criminal violation of the constitutional rights of the subject under Federal and State laws, and is both illegal and immoral**." Bearden

After the **serious warning** comes the description of the paper. This is heady stuff for the layman.

> "Calling full attention to the special note above, in this paper we present a high-level overview of the novel electromagnetic nature of mind operations, mind and body coupling, and intent - the induction of physical 3-space EM energy changes into the brain and nervous system, and into every cell of the body, from the mind's time-like coherent operations. We summarize the time-polarized electrodynamics used to engineer and affect mind operations and the mind-body coupling loop. Transduction mechanisms whereby differing EM wave polarizations can be transformed one-into-the-other are presented." Bearden

I will leave it to the technically astute to try to understand the mechanisms of operation which are described in scientific language. But there are tidbits for the layman. Here he speaks of the difficulty Western scientists have in opening up to the "immaterial" (longitudinal wave) nature of the human mind.

Western Science Remains Largely Materialistic

"Ironically, most Western scientists are materialists and consider "mind" as a mystical and nonscientific concept. They tend to

consider mind operations and functions either to be simply "meat computer" operations and functions, or at best to be very weak ordinary transverse-wave EM operations and functions in the brain and nervous system. This serious self-limitation exists because in the body we measure only weak TW [transverse wave] EM operations and functions correlated to biological behavior and brain operations. We simply do not know how to measure "mind operations" directly.

"With no mind measurements possible and no instruments, it is understandable that Western science considers only the physical side of the mind-matter interface.

"**Presently our scientists do not measure the longitudinally-polarized EM wave operations and functions in the body and around it in nature. Few of them are aware that a maelstrom of such LW [longitudinal wave] functions exist in the body and in all of nature in general.**" Bearden

Western methods of influencing the mind with EM waves have only used transverse waves, not the longitudinal waves of the vacuum. If only transverse waves are used one pretty well has to hit the target mind with a **sledgehammer of waves**.

Western Science knows only transverse EM waves

Brute Forcing Time Functions versus Fine Control Methods

"Ironically, Western mind control researchers using transverse EM waves for mind control research, are using a brute force method of evoking and using vacuum engines (spacetime curvature engines) and a special form of general relativity, although they do not appear to realize it.

"While KGB scientists also use TW EM "brute force" TW waves when necessary, they do **"imprint" or "activate" those waves with the desired internal LW and time-polarized EM wave and photon structures** required to directly perform the mind engineering desired... Bearden

"These "fitted brute-force models" certainly can be very powerful, and certainly can produce the exact results shown in the experimental verifications of the fittings. However, they do not of themselves allow sophisticated design for example of the necessary time-polarized wave assemblies for **engineering the entire human collective unconscious simultaneously**, or for engineering the entire collective unconscious of all species on Earth (i.e., Gaia's collective unconscious), or even for precisely **engineering the memory and knowledge base of an individual**. Bearden

The seemingly magical operations of psychoenergetics, sometimes called "psychotronics," cannot be achieved with ordinary transverse EM wave energy. But they are possible with longitudinal scalar waves because the mind itself is scalar in nature.

> "We note that **all mind operations are time-like**, i.e., they are comprised as scalar EM photon functions and scalar EM wave functions. Thus the mind is a very special kind of electromagnetic system, existing in the time domain..." Bearden

The engineering of the mind can only be accomplished with the waves of time.

The course of psychoenergetics development necessitates the building of a vast database of settings and patterns which bring about given mental and/or emotional states. A kind of "**genome**" of the psyche. Bearden describes the process of the decoding of this "genome."

> "Now the scientists would perform many phenomenology experiments, making one little change at a time and profusely recording the data. Each time, they would establish the physical change(s) that occur in the body and/or the mental and emotional changes that occur in the mind for each spectral reinsertion back through the "ship's portholes". They would simply but painstakingly (over some years) build up an extensive database of those individual correlates.
>
> "In these experiments, the experimenters will eventually be able to **provoke any body or mind change they wish**. Strong emotion. Intense pain. Intense pleasure. Painful thoughts. Images. Memories. Perceptions. Dreams. Visions. Memory losses. Memory changes. Personality changes. Etc. The "delta" in the emission spectrum (the changes from zero reference spectrum) represent the precise totality of all mental, physical, organic, chemical, etc.changes and interactions." Bearden
>
> "A second stage in the research would be to **test the correlates** and porthole insertions upon a statistically significant cross section of ordinary people, and/or specialized populations (such as toughened soldiers). The program would evolve a highly complex, very effective, ever-improving science and technology of mind and behavior control and engineering mechanisms, complete with finished database and developed applications equipment." Bearden

Summing up his paper Bearden speculates on what the actual situation the science of psychoenergetics probably is. The intense secrecy with which this knowledge has been kept from the public has led to the **current farce of the "government" pretending** it all does not exist, and this secrecy may have now put us at great risk.

> "The implication is that in the West one or more highly classified, sustained, heavily funded developments in advanced mind control programs, probably exists and probably has existed for some time. Due to loose formation of rogue groups inside such programs, they may have dual or triple purposes, **may not operate under very much legitimate government control at all**, and may operate specifically for the purposes of the rogue group or groups that have gained control.

> "In a nutshell, that's what may be going on in the **clandestine mind control projects** in several Western governments. The involvement of at least some rogue groups, some being "cowboys" who operate well **outside all laws and ethics**, could also result in such things as assassinations, clandestine testing on individuals without their consent, etc. In short, ***it could account for what seems to be actually occurring***. As also is "usual" in such a mess, one or more of the rogue groups eventually may become very powerful because their secret weapons are very powerful. They may become confident, thinking they have the "best in the world." They may actually believe they are ahead of the Russians..."
>
> "Remember that, in every large and powerful human organization, the basis for rogue groups is **power** and **secrecy**. They are always seeking to increase their power, control, influence, prestige, etc. Nothing else. Patriotism and mission are—to rogue groups—often just idle words. They have their own agendas. And being rogue groups, they may well bring in unethical, immoral tricks: assassination, bribery, entrapment, disinformation, plausible deniability, etc. A certain percentage of a highly secret rogue group will wind up using all these things and more. It's a **human** characteristic, the **old primate dominance game**. Only now disguised and hidden under deep classification."
>
> "The **Russians**, with their additional knowledge of the actual mechanisms in the transforms, will be **much more advanced than the West,** because their fundamental psychoenergetics science is far more advanced, so long as we continue to use the old U(l) electrodynamics. Further, the Russians have decades of use of **longitudinal interferometry beams to reach right through the earth and ocean** and produce stringent EM effects at a distance. So they will also be able to do the same things here in "mind control" with LW [longitudinal wave] interferometers, through intervening mass." Bearden

Bearden cites two examples where he believes the Russian KGB tested the psychoenergetics capabilities of their scalar interferometers. One was the case of Captain Button in his A-10 "Warthog" aircraft on April 2, 1997.

> "Over Arizona, Captain Button was thrown into a hypnogogic state, and his perceptions instantly altered and controlled. In his instant "dream-waking" state, everything seemed perfectly normal. His sense of direction was altered a bit more than 90 degrees, so he simply corrected and turned and "flew toward the range", actually flying off course by more than 90 degrees and ignoring radio contacts. He flew right on out of Arizona."
>
> "At one point he circled, probably thinking he was over the range, and he probably dropped his ordnance there. Then he "flew on back toward home," as he thought in his waking dream state, until his fuel ran out and he crashed and died in the explosion—**dream-thinking until he died that everything was normal**. All the while, his sense of the passage of time was altered. To him, in his dream-thinking, dream-acting state, everything was normal and nothing untoward had happened. **So the distant KGB transmitters and associated psychoenergetics team controlled him for over an hour**.

"Indeed, that was the exact purpose of the test: demonstrate control (at a great distance) of a skilled person performing highly skilled tasks."

The paper Mind Control and EM Wave Polarization Transductions ends with the most chilling and frightening possibility of all: the **psychoenergetic engineering of the human species** as a whole.

The Ant World

The Final Race for Direct Mind Control of the Entire Human Species

"The KGB psychoenergetics weapons scientists—because of their direct measurements and detections (and use) of t-polarized waves and LWs [longitudinal waves] for decades—also understand that Jung's collective unconscious mind (of the entire human species) also has its own time-like operations and correlates, which one measures also when using t-polarization measurements and sorting it all out. **The collective unconscious mind operations are buried several levels deeper inside the recursive Whittaker structuring inside the EM fields, waves, and potentials**.

"The KGB scientists also know that something very like **Gaia** — a collective unconscious mind for all species on earth — **also exists**, and they are striving to be able to sort out and measure that one as well. The Gaia operations are buried even deeper in the recursive structuring inside the EM fields, waves, and potentials."

"Actually, from day one, the Russian mind control scientists have had their eventual goal set upon this "deeper area of mind and possible mind control" of the entire human species.

"I am convinced that the KGB psychoenergetics scientists understand this deeper area. If they can learn to directly engineer the collective human species unconscious, they can then **convert the human species easily into a sort of "ant" society**, modeled along ideal Communism lines, except of course with an excluded "hierarchy at the top" running everything. The "ant society" — communist style — is still a variation of feudalism (**all systems tend to feudalism or some form thereof**).

"The KGB psychoenergetics weapon scientists are seriously pressing on toward that very goal. In my opinion they are not very far from it right now...

"Some versions of Russian mind control devices were used on Russian soldiers in the Afghan War to **condition them for performance of merciless acts**." [13]

http://www.cheniere.org/explore%20articles/mind%20control3/p07.htm

More about "The Ant World"

Whether it is the Russians planning an "ant world" society or rogue U.S. black-ops groups withholding a great boon from human race, the secrecy on all sides around has

allowed **largely criminal elements** to take over this technology while leaving the civilized elements in the dark. Openness and the spreading of this knowledge among good and decent people is essential, and for that **we will have to overcome our frightened denial**.

> "Meanwhile, **rogue groups** amongst Western clandestine mind control researchers will probably arise if they have not already done so. They will likely seek to increase their personal control and further isolate the programs from orthodox government review and from government and legislative control. They may even divert the research into highly illegal and unethical means, because it furthers their own rogue agendas. That is how clandestine U.S. government research can sometimes go sour, **unless great care is exercised by the oversight committees in the House and the Senate**.
>
> "Sometimes when rogue groups do gain control and total secrecy of a given new technological area, then what appears to be "U.S. government operations" do start to encompass a criminal and unethical operations, hidden usually beneath the deep veil of high classification. Also, if it's "scientific," no one is ever brought to justice, even if the "evil science actions" are uncovered and publicly revealed." Bearden

Like the huge energy of the Tesla howitzers, the ability to engineer the mind with longitudinal waveforms is a seeming "magical" thing which can be used for good or ill. Bearden envisions that further developments will allow something like the "downloading" of knowledge via scalar interferometry. Everyone could be highly educated, and quickly and easily.

In the conclusion of the paper "Mind Control and EM Wave Polarization Transductions" Bearden makes **a plea to the nations of the world** regarding the use of psychoenergetic engineering.

> "Let us hope this great new area, already off to a bad start, can be bridled and steered in the direction helping and healing people, rather than killing or abusing them. **The excesses in its bad use are a potent threat to all nations on earth**.
>
> "Yet it can revolutionize medical science, education, communication, and psychology. We foresee the day -- perhaps 30 years hence -- when **education will be accomplished by directly loading the software into the mind**. Then in three weeks one will "load" a doctorate, say, in physics. In three more weeks on will also load a doctorate in chemistry. Another three weeks, in electrical engineering. Another three weeks, an M.D. And so on. When that happens then truly everyone on earth can be educated. Freedom from ignorance may well be another great freedom that is legally recognized. There will be no impoverished large groups lacking the education to find decent, productive jobs.
>
> "We urge all nations to use the principles involved: not for human abuse, but for healing, educating, uplifting, and life-expanding of every person on earth. If we do, we shall all have a far brighter future. Then we shall check what has started out to be the Sword of Damocles and turn it into the golden Millennium." Bearden

(Perhaps after so many frightening topics a slight break is in order here to consider the **lighter side of psychoenergetics**. For example, what will be the ultimate impact on the entertainment industry?)

The Feelies at Last!

Psychoenergetics will be able to bring about at last, for better or for worse, Aldous Huxley's fanciful idea in his novel "**Brave New World**," an entertainment format which he called "**The Feelies**." Those were something you went to, like going to the movies, but you would **experience** all the actual feelings themselves, as if the depicted events were actually happening to you. Although our "leaders" seem too dim to grasp what is going on in the world of scalar electromagnetics, it should not take some young Hollywood genius too long to understand that **The Feelies are now possible**, and that the immense megabucks of potential profit more than justify heavy investment in bringing it to market.

One can imagine that first "Feelie" theater, "The Huxley" perhaps, a large comfortable area surrounded by nine giant screens (not just one screen!), which become 3D if you put on your headset. And The Huxley is fitted with the finest sound, and oh, by the way, a modest sized scalar interferometer with computer. And there are one or more **new tracks** now recorded on the film next to the sound track. These are the digital patterns of thoughts, feelings, and ideas to be fed into the theater's interferometer. And these thoughts and feelings and ideas will be felt by the audience as if they were their own thoughts and ideas. It is an entirely new art form. Psychevision.

As important (and no doubt famous) as the actors would be the "feelers," those from whose minds the feelings were lifted in the original programming of the Feelie tracks. Because, for example, Brad Pitt might be a good and handsome actor, but **can he really feel it?** Like the dubbing of foreign language films, it might be necessary to dub the "emotional track" using a deeper and more profound person's feelings, thoughts and ideas.

It might even be engineered so that if you sat on one side of the theater you would feel like the hero, and on the other side you would feel exactly like the bad guy! What would that lead to?

We have all cried at a movie some time, most people have, though they might not want to admit it. But this would be **deep sobbing** and a **flood of tears**, if the director so desired it. You would feel it at your core. Or, take a big chase scene, **you would be terrified**. They are breathing down your neck! You would be gripped by panic.

For that matter, the whole genre of **Horror-Feelie** would be too much for many people to take. Do I **really** want to feel that an **actual vampire** is tearing at my throat with his fangs?

A Religious Feelie would make you feel the exaltation of a saint at his prayers, or give you the **definite** feeling that you are Christ suffering on the cross. All the pain could be there too. The stickiness of the

blood. The very feeling itself: "Why hast thou forsaken me?" Who among us could come up **that** despair for scanning? Had this been developed a bit earlier we might watch a documentary of, say, Mother Theresa, containing her own actual deep sense of compassion, which we would feel arising in us as our own.

Then again, a Psychedelic Feelie could induce an LSD-like state and simply blow the audience's minds.

Even in its simplest most primitive mode, the hypnogogic trance induction with its increased suggestibility, would completely alter the experience of even ordinary current movie going.

6. As it Stands - 2002

[Note 2006: Click here for a current status history of the MEG from Tom Bearden]

> "**Anyway, it's presently a "Mexican stand-off**" with the various parties maneuvering with check and countercheck. That is the real "balance of terror" that is held by such a fragile balance."
>
> "You can see the implications if such weapons fall into the hands of the radical terrorists. Ordinary positive energy EMP shooters **can be made fairly readily and cheaply** from nearly just **Radio Shack parts** or surplus parts. It just takes some know-how... When and if the Yakuza [Japanese mafia] gets those (and they will, it's just a question of time), you can begin to appreciate some of the turns this present terrorism and our war on it will take." Bearden

The very thought of the building of one of these howitzers by "some lone-nut gunman" from Radio Shack parts makes one realize how serious it is for humanity to face the crisis it has come to.

Once again, as at the dawn of the nuclear era, humanity finds itself at the crossroads of Heaven and Hell. As a species, we must stop and consider. And there is at least one real difference between this visit to the crossroads and the last: *this* time there is a very real possibility of a true "earthly heaven" on the Heaven side.

The poor nations could come to a good life. Disease could be largely eliminated. Fossil fuel pollution could end. Global warming could be solved, and the weather could be managed in a humane way, bringing water where there is drought, and sunny skies where there is flood. Scalar interferometry would be there to avert any possible hits by asteroids or comets. Mars could be colonized and terraformed. Everyone would be highly educated through psychoenergetic downloading of knowledge. And the **wisdom of the wise** could be realized directly through scalar connection to their minds and hearts.

These stunning sudden possibilities give me pause to think: if our species has reached this crossroads in such a short span of centuries, then surely other species in this vast universe have passed this way before and long ago. And of those who chose the path to "planetary heaven," what is their life like now? It might be good if some of them were with us now, to guide us through this last struggle over this pesky old good-and-evil

problem. **It is our last chance to choose the path which benefits the whole species, and not just some elite group or faction**.

The Disclosure Project

One person working tirelessly to bring to bring these technologies into the open is Dr. Stephen Greer of the Disclosure Project, which is calling for congressional hearings into the issues of UFOs and the free energy technology that was, perhaps in part, reverse-engineered from them.

> "Once abundant and nearly free energy is available in impoverished areas for agriculture, transportation, construction, manufacturing and electrification, **there is no limit to what humanity can achieve**. It is ridiculous — obscene even — that mind-boggling poverty and famine exists in the world while we sit on classified technologies that could completely reverse this situation.
>
> "So why not release these technologies? **Because the social, economic and geo-political order of the world would be greatly altered**. Every deep insider with whom I have met has emphasized that this would be the greatest change in known human history. The matter is so highly classified not because it is so silly, but because its implications are so profound and far reaching. By nature, those who control such projects do not like change. And here we are talking about the biggest economic, technological, social and geo-political change in known human history. Hence, the status quo is maintained, even as our civilization hurtles towards oblivion...
>
> "With the types of weapons currently in the **covert arsenal** — weapons more fearsome even than thermonuclear devices — there is no possibility of a survivable conflict. Yet in the darkness of secrecy, actions have been taken on behalf of every human that may endanger our future. Only a full, honest disclosure will correct this situation. **It is not possible for me to convey in words the urgency of this**."
>
> Dr. Stephen Greer http://www.disclosureproject.org/ES-DisclosureImplications-2.htm

Greer and his team have assembled hundreds of witnesses, many of whom are military or ex-military, who are ready to testify to congressional hearings what they know about the covert black projects which have kept free-energy and antigravity propulsion technology secret from the people.

Greer points out the need to regulate these technologies so they are limited to peaceful uses, but this is of course difficult when the government simply chooses to pretend they do not exist. In the meantime, as the President and the Defense Department continue the charade of war-as-usual, those scalar (longitudinal wave) installations which DO exist continue to fall into ever more sinister hands. And there is no reporter in the press brave enough to ask, "**Mr. Secretary of Defense, what steps are you taking to defend our MINDS from attack by the big Russian longitudinal interferometers?**"

Longitudinal Interferometers are Proliferating

In a later statement Bearden reveals that in fact the Yakuza [Japanese mafia] has **already leased** some of the interferometers with a nearly $1 billion "down payment:"

> "After the collapse of the Soviet Union's economy, lots of things got available for lease or purchase that would never have been under the old system. That happened in the resulting economic chaos. The Russian Mafia rose to prominence, as did some wheeling and dealing entrepreneurs who played both ends against the middle.
>
> "**In that atmosphere, and in the need for money, the KGB allowed leasing of the earlier longitudinal EM wave interferometers to a consortium of the Yakuza and Aum Shinrikyo.** They did this only after they had tested and deployed their great new quantum potential weapons. That class of weapon is the dominant weapon on earth. Five nations now have it: Brazil, Russia (KGB), China, and two nations friendly to the U.S. The deal to lease many of the earlier LWIs [longitudinal wave interferometers] to the Japanese Yakuza and Aum Shinrikyo was consummated at the end of 1989, with a down payment of $900 million in gold bullion as "up front" money. I don't know what the lease per year was and is, but probably something like a billion dollars a year. **So the rogue Japanese acquired longitudinal EM weapons** and that technical know-how. In fact, the Yakuza is producing certain kinds of those in its own facilities in Japan now."
>
> http://www.cheniere.org/correspondence/030202a.htm

Personally, I am a little uncomfortable with the knowledge that the Japanese mafia may now be able to insert things into my mind. I'd like to sleep at night knowing that my dreams are my own, such as they may be, and not some weird fantastic visions cooked up by a criminal organization. **This is a world emergency**.

And in Bearden's analysis, it all comes back to the issue of **energy**. It is the energy crisis which is now provoking the current "oil wars," since oil production has hit the "Hubbard Peak" and will decline. And the electrical power grids must be replaced with scalar power as fast as possible, for these grids are now totally vulnerable to any possessor of longitudinal interferometers. They can all be wiped out in minutes. By anyone who possesses or controls a Tesla howitzer.

> "Anyway, in my personal view, we should have a national **Manhattan Project** right now, to develop decentralized electrical power systems taking their energy from the vacuum . . . The MEG is real and so are several other systems invented by private inventors and colleagues. All these efforts should be massively funded and massively and quickly developed. The survival of this nation is going to depend upon it. . . . There are many other facets, but the major point is that **our scientific apparatus and the public are still unaware of what a desperate struggle we have entered, since it was thrust upon us. 9-11 was a wake-up call**. It was certainly bad enough, and one grieves for those lost American lives. But I fear the **worst is yet to come**, and it is coming at us like a runaway train hurtling right down the track at us."
>
> http://www.cheniere.org/correspondence/021702a.htm
>
> "The electromagnetic weapons mentioned by the Secretary of Defense in April 1997 **are in terrorist hands also**, including the **Yakuza and Aum Shinrikyo**. That rogue group leased those earlier weapons on site in Russia, from the KGB, at the end of 1989. The SecDef stated that such weapons were being used to initiate earthquakes, initiate volcanoes into eruption, and control and engineer the weather. Quite true. And presently

there is a truly massive set of weather engineering operations going on over North America, from that rogue Japanese group manning the weapons in Russia. Some 10 nations of the world now have the type of longitudinal EM wave interferometer weapons (which are what the SecDef was most probably referring to). There are other even more fearsome weapons, possessed by five nations. **So a great deal of the state of the world is not covered in the news at all, and will not be . . .**

"We have been in an undeclared war of an eerie kind for some decades. That war seems now to have started to heat up also. The destructive capability of some of these weapons is awesome, and far greater than nuclear."

http://www.cheniere.org/correspondence/021702a.htm

"In that sense, the first phase of WW III is already completed. Now we are only waiting for Phase II.

"It is against that backdrop that I think one must "analyze" such things as how fast we will be replacing the power grid (**it's going to go anyway, and catastrophically, the terrorists will see to that**). And everything we have is critically dependent upon energy, from the economy to jobs to mobility, to the millions of trucks that transport our goods every day, etc.

"As far as I am concerned, we are already late in declaring a great national emergency in energy, because of the coming destruction of the present energy infrastructure. The scientific community should lead, follow, or get out of the way. The emergency is not in seeking "alternative but conventional" systems. It is in developing "energy from the vacuum" on an emergency, crash basis.

"Unfortunately, everywhere I look I just see business as usual. Most Americans (and news media) seem to think, hey, Afghanistan is finished except for a bit of cleanup, and it's just about over).

"It isn't. It has only just begun."

http://www.cheniere.org/correspondence/021702a.htm

Beyond the Howitzers: Quantum Potential Weapons

Do not use EM propagation through space

As more and more nations acquire the scalar interferometers, Bearden speculates on the next generation of longitudinal weapons called "quantum potential" [QP] weapons.

> "The **quantum potential weapons** are presently only held by three nations: Russia (in the hands of the KGB, which is now know by its new name), Brazil, and the "friendly little nation." Red China may be working on them, but is just at the beginning...

> "The QP weapons have been highly reserved by the Russians. However, the complete extent of their capabilities is still being figured out...
>
> "The quantum potential weaponry (possessed by only three nations) is supreme, because **it uses multiply connected spacetime**, and DOES NOT involve propagation of EM energy through space as does the longitudinal EM wave interferometers.
>
> http://www.cheniere.org/misc/qp.htm
>
> "The operational deployment of full-scale strategic QP weapons on site in Russia occurred at the end of 1989, which is when the formal weapons first went operational. These weapons are not in the inventory of the regular Russian armed forces, but all research and development, manufacturing, deployment, an manning and employment is under the ruthless control of the KGB. Shortly thereafter (within weeks), the KGB leased many of their earlier longitudinal EM wave interferometer (LWI) weapons to a rogue Japanese group comprised of the Aum Shinrikyo and Yakuza."
>
> Bearden http://www.cheniere.org/correspondence/021401.htm

In another paper, "Time Polarization - Significance and Weaponization," Bearden tells the story of how a KGB longitudinal wave attack was averted by the longitudinal weapons of a "friendly small nation."

So as it stands, it is precarious. Not until the people demand an end of what author Jim Marrs has dubbed the "**Rule by Secrecy**," can the people's representatives tackle the big problems of a worldwide ban on Scalar Wars and the shifting over to an essentially oil-free economy.

Latest Update from Tom Bearden - March 2002

The whole situation is changing so fast that when I asked Tom to look over this article he mentioned the seeming contradiction when some of the above statements are taken together. At different times the information he has is updated so one has to keep a kind of running track. He was kind enough to clear up the confusion here with the situation as it stands as of March, 2002.

> "We knew of three nations having the QP weapons for some time. Then we found out last year that five nations had it. So that explains my using the figure "three" first (which represented what I knew at the time). Later I found out about the other two nations. China, e.g., only deployed its QP weapon this past year. So that explains the apparent contradiction between me using "five" in later papers and "three" in earlier ones. It was the best information I had at that time. Might mention that so the reader will understand the apparent discrepancy." Tom Bearden

Emptiness is Full of Energy

"The Tao is an empty vessel;
it is used, but never filled.
Oh, unfathomable source
of ten thousand things!

"Oh, hidden deep but ever present!
I do not know from whence it comes.
It is the forefather of the gods."

Lao Tzu -Tao te Ching

Afterword

Because of the extreme seriousness of the topics brought forward in this article, I asked Tom Bearden to look it over to make sure I had not gotten anything too terribly wrong or mixed up. I did not want to pass on any misunderstanding of my own. I felt a little nervous writing to an eminent scientist, and hoped I had not presumed upon his time.

But Tom was so kind as to answer immediately, and to my relief I had not gotten anything too terribly wrong. Here is his letter, in which he clears up a misunderstanding, and reports on his current health treatment, and gives a call to the young grad students to turn themselves loose in the whole new field of scalar electromagnetics and free energy.

Subject: RE: Article on Tom Bearden and "Scalar Wars"
Date: Fri, 22 Mar 2002 22:54:01 -0600

Bill,

Well, I must say I'm astounded at your persistence and hard work in congealing all that together. My compliments on a hard job quite well done.

Couple tiny things: In the area mentioning Kervran and Kaznacheyev: Kervran was French; Kaznacheyev was and is Russian. Little typo of "spredding" the immune system. Should be "spreading".

We knew of three nations having the QP weapons for some time. Then we found out last year that five nations had it. So that explains my using the figure "three" first (which represented what I knew at the time). Later I found out about the other two nations. China, e.g., only deployed its QP weapon this past year. So that explains the apparent contradiction between me using "five" in later papers and "three" in earlier ones. It was the best information I had at that time. Might mention that so the reader will understand the apparent discrepancy.

Otherwise, it's pretty accurate.

Just now I'm letting the weapons take care of themselves; have to, as I will be recovering now for nearly a year from now after the heart attack last year and discovering that I had contracted mycoplasia (the BW modified kind) in Canada in 1968. Finally got a test which confirmed the chronic mycoplasia (which I had for 33 years!). The stuff burrows inside one's red corpuscles, then draws nutrients from the hemoglobin, hardening it and reducing its ability to take on oxygen (by as much as 50% or more). The resulting symptom is loss of endurance (which I had for that 33 years) -- the so-called "chronic fatigue syndrome".

Many of the Gulf War Veterans who are sick also have it, though they apparently have other complicating factors as well. A very high percentage of persons with chronic fatigue syndrome also have mycoplasia. The treatment for the long-standing mycoplasma infection of that nature is to stay on antibiotics for a year. The only time the mycoplasma is vulnerable is when one wears out a red cell in normal usage, and the body makes a new red cell to replace it. The mycoplasma comes out of the dying cell to infect the new replacement cell, so it is exposed and vulnerable at that specific time and that time only. The antibiotics kills it at that time. Hence the necessity to stay on antibiotics for such a long time so it is continuously in your bloodstream (I've already been on antibiotics for over two months, and have at least 10 more months to go). We also take a little medical oxygen every day.

Another symptom of the mycoplasma infection is the association of runaway fibrillation of the heart. To stop that, there are pills one takes, and they stop it. But they also further reduce the volume of blood pumped by the heart, so that this projects one right back into the hypoxia, dizzy, loss of balance, etc. Catch 22 situation; the fibrillation will build and cause heart attack, stroke, etc. if not stopped, and if stopped it puts you back in the hypoxia which can cause many things! With the conventional treatment, you're damned if you do and damned if you don't. Hence the need for a little extra medical oxygen, so you can take the "heart clamp" pill and stop the fibrillation, but also augment the oxygen enough to continue to survive without a stroke or some such. Interestingly, it's very difficult to even obtain a mycoplasma test, and Medicare fights you tooth and nail over paying for the oxygen. Either they will pay for it or I'll pay for it myself; it is absolutely necessary.

After a heart attack, one is treated in the heart clinic by specialists who are very caring and excellent practitioners, but know nothing of mycoplasma infection, so not consider it even a part of "heart disease", and who are rather puzzled when one has no clogging of the arteries, has the right count of red corpuscles (largely nonfunctional, of course, but there), pumps the right amount of blood, etc. So they identify and treat only the runaway fibrillation, do not prescribe the oxygen -- and essentially place you on a regime as best they know, but one that is guaranteed to kill or maim you or turn you into a totally disabled person or human vegetable via stroke, paralysis, etc. Fortunately my family doctor will prescribe the oxygen anyway, though I may have to pay for it myself. Whatever works!

However, I'm slowly improving little by little, working as much as I'm able to and trying to finish my book: Energy from the Vacuum: Concepts and Principles, and get it to the publisher for publication later this year. Hopefully the book will turn all the interested young grad students and post-docs loose in

the free-energy area. They will not have to spend 30 agonizing years to get to where I am, and where a few others are, but can simply start here and go forward. Since speed to develop energy from the vacuum is of the essence because of the world situation, I'm moving on it as fast as I am physically able to.

Meanwhile, working with the AIAS (Alpha Foundation's Institute for Advanced Study), the AIAS (15 authors) has now gotten about 20 scientific papers published in leading journals (Foundations of Physics, Foundations of Physics Letters, Physical Scripta, Optik, etc.) dealing with electromagnetic energy from the vacuum. Several more are either approved for publication or in the review process also. So slowly we are getting it into the mainstream scientific literature. Hopefully it will be in time, but it's cutting it close.

Very best wishes,

Tom Bearden

Late update

Massive display of longitudinal interferometers?

UFO Fleet Taped
Over Bedhampton, England

Is this sighting a case of the testing of all the Russian (KGB) longitudinal interferometers at once? And coordinating their targeting through the woodpecker grid to a common place, as an exercise in making a massive scalar attack upon a given region? Was this a confluence of Russian Tesla howitzer marker-beacons?

Certainly for a massive all-out scalar attack you would want coordinated movements of the target areas of many howitzers at once, for you could then just cut a bloody swath across a wide area, all the howitzer blasts marching across the land in a kind of scalar version of the "scorched-earth policy." All in a line, blasting, and heat, and mind waves. Or you might want to put the blasts all in the same place for a truly horrendous destruction. And on top of that biowar on citizens whose immune systems have been weakened with the quantum potenial weapons. This is the latest version of Armageddon.

And should any madmen gain control of these weapons, any rogue group at all, and should they have some aggenda to radically depopulate the world, to simply kill by the billion, the means will be in their hands to do so.

Update: MEG patent granted

Motionless Electromagnetic Generator Patent Granted

This message is from **Jean-Louis Naudin**, the French scientist who successfully replicated the Motionless Electromagnetic Generator (MEG) in France. He announces the granting of the patent to the MEG Builder's group at Yahoo.

----- Original Message -----
From: jnaudin509@aol.com
To: jlnlabs@yahoogroups.com
Sent: Tuesday, March 26, 2002 2:20 PM
Subject: [jlnlabs] (Info) GOOD NEWS : The Tom Bearden's MEG IS PATENTED

Dear ALL,

GOOD NEWS !!!!

The **Motionless Electromagnetic Generator**
from Tom Bearden is now PATENTED
US **6362718** granted on March 26, 2002

US Patent 6,362,718 :
Motionless Electromagnetic Generator (MEG)

Abstract: An electromagnetic generator without moving parts includes a permanent magnet and a magnetic core including first and second magnetic paths. A first input coil and a first output coil extend around portions of the first magnetic path, while a second input coil and a second output coil extend around portions of the second magnetic path. The input coils are alternatively pulsed to provide induced current pulses in the output coils. Driving electrical current through each of the input coils reduces a level of flux from the permanent magnet within the magnet path around which the input coil extends. In an alternative embodiment of an electromagnetic generator, the agnetic core includes annular spaced-apart plates, with posts and permanent magnets extending in an alternating fashion between the plates. An output coil xtends around each of these posts. nput coils extending around portions of the plates are pulsed to cause the induction of current within the output coils.

Inventors: Patrick; Stephen L. (2511 Woodview Dr. SE., Huntsville, AL 35801); Bearden; Thomas E. (2211 Cove Rd., Huntsville, AL 35801); Hayes; James C. (16026 Deaton Dr. SE., Huntsville, AL 35803); Moore; Kenneth D. (1704 Montdale Rd., Huntsville, FL 35801); Kenny; James L. (925 Tascosa Dr., Huntsville, AL 35802)

Appl. No.: 656313
Filed: September 6, 2000

For some technical info see my web site at : http://jnaudin.free.fr/html/meg.htm

Best Regards
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Click here to view patent # **6,362,718**

Patent Story on Rense.com:

Important Note 2006! MEG delayed: Click here for a current status history of the MEG from Tom Bearden

Rense.com

MEG Scalar Energy Device Patented - Production Starts Next Year

From Bill Morgan
3-28-2

Patent was granted on March 26, 2002 for "The Motionless Magnetic Generator," (MEG) US Patent 6,362,718, which is likely to become the first commercially available free energy device in history in about one year from now. The machine will provide free electricity from the vacuum, for the life of the device, which should be a very long life since it has no moving parts. You can see a picture of scientist Jean-

Louis Naudin's MEG replication model at: http://jnaudin.free.fr/html/meg.htm.

It has strong magnets, coils, and a controller unit with the electronics. Naudin made the announcement to the MEG-builder's Yahoo group. The announcement has significance since the patent office has always been skeptical of devices which seem to "get-something-for-nothing." But according to the new science of scalar electromagnetics, the MEG does not break the law of conservation of energy. It's just that the energy is conserved in the fourth dimension, time, and not our 3-space world.

The MEG provides electrical energy by tapping the longitudinal electromagnetic (EM) waves which exist in almost infinite abundance in the vacuum of space. This ocean of energy which permeates everything is sometimes called the "zero point" energy, since it remains there even at absolute zero temperature.

Four inventors are listed: Stephen L. Patrick, Thomas E. Bearden, James C. Hayes, Kenneth D. Moore.

Tom Bearden has explained the operation of the MEG on his website Cheniere.org, and also speaks about the new fearful weapons that can and have been made using the same "longitudinal waves" of the vacuum.

The complicated physics of how the MEG works is explained in the paper "The Motionless Electromagnetic Generator: Extracting Energy from a Permanent Magnet with Energy Replenishment from the Active Vacuum," which can be found at Tom Bearden's website:

cheniere.org.(http://www.help4all.de/energy/MEGpaper.pdf)

The first MEG units to be produced for sale will output 2.5 kilowatts of free electricity. Forever. They should be in production about a year from now. Facilities for manufacturing the device are being set up in an unnamed "friendly nation."

This free electricity will flow indefinitely, without much, or any maintenance. The units may be hooked together to provide more wattage, so four of them would provide 10 kilowatts. After some production experience units will be made which output 10 kilowatts each. With a couple of those units a house could get off the electrical grid.

Tom Bearden, one of the inventors has said "I will admit that the chief scientist of an important experimental group in a large company was rather stunned at the type of output we were able to obtain. The MEG

may look like just a transformer, but it is not. It is a completely different breed of cat." This cat, it would seem, is out of the bag now.

The ordinary EM waves we are familiar with are called "transverse" waves, to distinguish them from the new "longitudinal" EM waves of the vacuum. Bearden has explained in depth on his website cheniere.org that wherever there is a dipole (battery, generator, magnet) there is an unseen flow of longitudinal EM waves in that local vacuum, the only problem is in tapping that energy and "transducing" it to electricity. Bearden says that the problem with all the electrical circuits we have is that they are two-wire circuits, a loop by which half the energy goes back to destroy the dipole. In the MEG that closed loop is never made. So the dipole is not being destroyed.

Patents are not granted on devices which do not work, so in a sense this announcement proclaims a new era. The MEG device itself proclaims and proves that energy is abundantly available everywhere, for free. We only have to build the devices to tap it. MEG type devices could be put into a car with an electric engine to make a truly fuel-less automobile. Electricity can be available in very remote places. People will be able to get off our very terrorist-vulnerable power grids. In an era of terrorism a highly dispersed power system would be most desirable rather than our centralized systems.

What is somewhat astonishing to me is the discovery by Bearden et. al. that time itself is actually compressed energy, and that this free energy is actually coming from the time domain, the ocean of longitudinal EM waves which fill the empty vacuum of spacetime. In fact, time is energy compressed by the same factor that matter is compressed energy: the speed-of-light squared. Thus there is a new companion to Einstein's E=mc2. Can you say "E equals delta-tee-cee-squared?" The "tee" is time and delta-tee is change in time.

A company has been set up to manufacture the MEG called Magnetic Energy Limited.

The ramifications of free energy are enormous. The oil wars are not necessary. If we threw as much money at this technology as we are spending on the oil wars we would be free of the need for oil in less than a decade. With fuel-less cars air pollution will be greatly lessened. Third world nations can raise their standard of living eventually. And the energy is free. And it never runs out.

I have put together a kind of "Bearden for Beginners" article which explains some of the basic concepts of the current state of scalar technology.

http://www.prahlad.org/pub/bearden/scalar_wars.htm

The granting of the MEG patent is the herald of the new era of scalar electromagnetics, and the free energy which flows forever and never runs out.

Bill Morgan

Status History of the MEG

updated Oct. 26, 2006

Important notes on the status of the MEG (Motionless Electromagnetic Generator)

Since the time this "**Scalar Wars**" article was written the timetable of the **MEG** has been thrown off considerably. Bearden had originally said the MEG could be marketed within 1-2 years ***of receiving funding for final research and scale-up costs***. I thought certainly it would not take very long, but over 5 years later they still have not gotten the $10 million or so necessary. There are various reasons for this, some of which Tom Bearden has written about.

The place for updates on the MEG status is Tom Bearden's correspondence section at his website Cheniere.org:

http://www.cheniere.org/correspondence/index.html

Here are a few of his reports which detail the history of the MEG status :

Mar. 6, 2006
http://www.cheniere.org/correspondence/030206.htm

May 16, 2005
http://www.cheniere.org/correspondence/051605.htm

Jan. 19, 2005
http://www.cheniere.org/correspondence/011905.htm

Dec. 5, 2004
http://www.cheniere.org/correspondence/120504.htm

Do the magnets run down after a while?

Further developments

Tom Bearden clears up a question

When the MEG patent was released many questioned the patent language which seemed to imply that permanent magnets of the MEG would "wear out" after awhile. I myself wondered about the same thing so I put the question to Tom, and here is his reply.

> Dear Bill,
>
> Thanks for the kind words; much appreciated.
>
> I'm not up to going on radio or TV, and won't be for quite some time. Still suffering from hypoxia, though very slowly improving, and will still be on antibiotics for 10 more months at least (maybe longer).
>
> Obviously an extensive dialog developed between the Patent office and our patent attorneys. As best I can understand it, the Patent office accepts the fact that a permanent magnet produces and emits energy, or has a history of accepting it. They do not appear to be at all cognizant of the broken symmetry of opposite charges, and hence of a dipole. So in their opinion (which seems to be vague), the magnet has to use itself up very gradually, or some such. So some rewrites were essentially required by the Patent office.
>
> All I can say is that a magnet is a very durable thing, so long as you don't heat it up too much or shock it to much. Certainly one will make a good 20 years, and of course there are plenty of magnets that have been around awhile longer.
>
> That said, in our earliest experiments we did "measure" some such effect, or so we thought, until we found that a particular instrument was bad and giving erroneous readings. So with a new instrument, we have not observed since then any such readings.
>
> Out of all that fuzziness came the inclusion of "using up the magnets gradually". So far as we are aware (after correcting those early readings on a defective instrument), we have seen no such measurements or effects since then at all. Nonetheless, just in case there is some very small effect in that respect, at least it's in there.
>
> Actually, as you are aware, capacitors and solid state components are the major concerns for failure, and any system does require maintenance, both periodic and whenever malfunction or failure occurs. The MEG is no different from any other device in that respect, so of course it will have a component failure rate and maintenance required from time to time, just as any other electromagnetic device. But without moving parts, it can be ruggedized and made very durable indeed.
>
> Please give Jeff Rense my regrets, and I do admire his work and his show. He's laying it in there.
>
> The depth of the scientific mindset against COP>1.0 is inexplicable, particularly when physics itself already has COP>1.0 validated

experiments (such as Bohren's experiment, which outputs 18 times as much as one inputs by Poynting calculations), and it works every time. Any competent university optics lab can perform the experiment. Also, even the conventional texts admit that a charged capacitor or electret laid on a permanent magnet, so that the E of the cap or electret and the H of the magnet are at right angles, is a "free energy machine". That silly thing will just sit there and pour out Poynting energy S = EXH indefinitely. Years and years and years. If you wait just a single year, that silly thing has changed the energy density of a volume of space a light year in radius, reaching out well beyond the solar system. Now that's a WHALE of a lot of EM energy that beast poured out in that year, and it will still be going strong and pouring it out at a steady rate. The charges and dipoles in original matter in the universe have been pouring out EM energy in that fashion for some 14 billion years, give or take a billion or so. It's also easy to see that, prior to Lorentz's ARBITRARY symmetrical regauging of the Maxwell-Heaviside equations, those equations prescribe both EM systems in equilibrium with their active environment, and EM systems not in equilibrium with it. The latter systems are permitted by the thermodynamics of open disequilibrium systems to perform five magic functions: (1) self-order, (2) self-oscillate or self-rotate, (3) output more energy than the operator inputs (the active environment inputs the rest of it), (4) power itself and its load (the active environment inputs all the energy, like a windmill), and (5) exhibit negentropy. That is a well-established thermodynamics. Lorentz arbitrarily discarded all such open disequilibrium EM systems in order to get simpler equations having analytical solutions and not requiring numerical methods. So he simply scrapped all the really interesting and challenging EM systems in Maxwell's theory. ARBITRARILY!

That our scientific establishment continues to teach only that "half" of the theory, and not point out the rest to the young students, and not fund research into developing such systems that take energy from the vacuum, is simply inexplicable. It's a matter of total dogma, not science at all.

But hopefully it is changing a little bit. At least now we cite chapter and verse when these things were done, and what they are, and the young grad students and post docs can go check the papers and make up their own minds.

That is the real hope of the future: that we get a generation of young fellows, with excellent skills, who now know where all the skeletons got hidden in the closet, and understand that the electrical engineering model arbitrarily assumes an inert vacuum environment (falsified for more than a half century in particle physics) and a local flat spacetime (falsified for nearly a century by general relativity).

Once they know that past history, and go read into what broken symmetry of opposite charges means for a dipole and for all dipolar EM circuits, they will set to and change that more than a century of error. In that case, we shall have numerous solutions to the energy crisis rather quickly, popping up all over.

Good thing. It will certainly displace some great energy barons, but it will also free the populace. One can extract all the EM energy from the vacuum one wishes, anywhere, anytime, with ridiculous ease. One can

produce that "electrical wind of energy" at will, by making a simple dipole and then letting it alone. The only energy problem is in how to then intercept some of that energy flow and "catch" it in a circuit, discharge it in a load to power it, and not use half the "caught" energy to kill that dipole that is gushing out the extracted EM energy from the vacuum.

Very best wishes,

Tom Bearden

END

Revised: May 16, 2007

Download this article in Ms Word format
(ScalarWars.doc)
Send a comment to Bill Morgan

See also:

Scalar Electromagnetics

Scalar Wars:

The Brave New World of Scalar Electromagnetics
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WHAT A SCALAR "SMOKING GUN" WOULD BE

BEARDEN REPONDS TO SCALAR ATTACK POSSIBILITY (Columbia)

THE SCALAR ATTACK POSSIBILITY
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Musings on Scalar Electromagnetic Phenomena

The New Scalar Paradigm

ELECTROMAGNETIC WEAPONS TO BE USED

SCALAR: BEARDEN SAYS U.S. NOW DEFENDED

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Open Letter to Donald Rumsfeld

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Your comments are welcome: prema@prahlad.org

Journal of Directed Energy, **1**, Fall 2003, 48–72

Compact Pulsed Power for Directed Energy Weapons

David Price,* Carl Bloemker, Edward Goldman, David Nett, Sidney Putnam, Doug Weidenheimer, Roger White, and Tony Wynn

Titan Corporation, 2700 Merced Street, San Leandro, California 94577

The Titan Corporation has been developing directed energy technologies since the early 1980s. Over this time Titan has provided advanced power supplies for electromagnetic gun and laser research while making broader contributions in the field of high-power microwaves (HPM). Titan's HPM work expanded from initial efforts fielding and operating the first gigawatt-level oscillators for susceptibility test applications, to research and development maximizing the peak and average output powers and overall efficiency realized from such systems. As interest in HPM technology has spread globally, Titan has leveraged this core competency and provided the HPM equipment for nearly all of the major European effects test facilities. Titan's current interests focus on compact, efficient and reliable directed energy weapon systems and the advanced subsystems and components that enable the same. Specific subsystems of interest include pulse-forming networks and intermediate energy storage and power conditioning elements (electronically reconfigurable batteries and power ride-thru subsystems). These subsystems are designed for reduced size and weight while still meeting severe service, platform integration, lifetime, and thermal management constraints. Specific components under development at Titan include laser-gated solid-state switches and both high peak and high average power, frequency-agile, HPM oscillators. Status and recent results from this research are presented.

KEYWORDS: Electronically reconfigurable batteries, High-power microwaves, Laser-gated solid-state switches, Magnetron, Power-ride thru, Pulsed power, Reltron

1. Introduction and Previous Work

Directed energy weapons (DEWs) are emerging as a key defense technology of the early 21st century. The first laser antimissile and antiartillery systems are within perhaps five years of deployment, and newly envisioned information warfare and nonlethal point defense missions are hastening the deployment of high-power microwave (HPM) systems. Department of Defense (DoD) programs in "more electric" and "all-electric" platforms and electrically driven weapon and self-defense systems are promoting the development of laser, high-power radio frequency (RF) and both electromagnetic (EM) and electrothermal/chemical (ETC) gun technologies. In fact, the DoD's current fundamental "transformation" efforts are based on stressing the development of capabilities to deal with threats emerging in the

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Table 1. Triservice directed energy applications

U.S. Army [Future Combat System (FCS)—hybrid electric drive vehicles]
- Advanced armaments—electrothermal/chemical guns
- Enhanced area air defense—solid-state heat capacity laser system
- Counter-HARM
- Counter-ATGM
- Countermine (electronically fuzed and wide-area threats)

U.S. Navy [All-Electric Ship Programs (Integrated Propulsion System and DDX)]
- Advanced stand-off shore bombardment—electromagnetic guns
- Advanced anti-ship missile defense (free-electron laser and HPM)
- Nonlethal area denial

U.S. Air Force (more electric aircraft program and advanced UAV programs)
- Enhanced self-defense—solid-state heat capacity laser system
- Space-based laser program
- Airborne laser
- Suppression of enemy air defense
- Aircraft self-defense
- Close air support
- Defensive and offensive counter air
- Strategic attack/strike warfare, attack operation/air interdiction
- Combat search and rescue
- Area denial
- Cruise missile defense

Table 2. Countries now developing high-power RF technology

Programs	Countries
Major	United States, China
Medium-scale	United Kingdom, France, Germany, Russia
Emerging	Sweden, Japan, India, Taiwan, Australia, Israel, South Korea

Information Age instead of emphasizing countermeasures to specific threats. DEWs hold the promise of engaging multiple threats and multiple threat types, thereby fitting very well into this conceptual paradigm. Some specific examples of defense applications of DEW technologies are shown in Table 1.

The initiatory HPM programs in the USSR and United States have evolved and influenced foreign allies and threats to take an interest (Table 2). The collapse of the USSR led to the dispersal of Russian and Ukrainian HPM workers and the proliferation of the Soviet technology to the Third World. This global emergence is driven by at least two factors: 1) The dependence of both military systems and civilian support infrastructure on sensitive electronics is increasing, and 2) after a more-than-20-year effort, an understanding of the susceptibilities of both military and commercial systems to HPM threats is maturing.

For these reasons the Titan Corporation has taken a keen interest in the development of systems, subsystems, and advanced components across several different technologies to support HPM and laser directed energy programs.

In 1997, Maxwell Technologies purchased Physics International (PI) from Primex Technologies and merged two of the three most prominent, commercial, pulsed power entities in the United States. PI and Maxwell pulsed power capabilities were combined into a new entity, Maxwell Physics International, which became a component of Maxwell's Systems Division. Maxwell subsequently decided to leave the DoD and Department of Energy (DOE) pulsed power business altogether and sold the combined Maxwell/PI pulsed power divisions to the Titan Corporation, the parent company of Pulse Sciences Incorporated (PSI). Now, the three most prominent names in commercial pulsed power are combined as the Pulse Sciences Division (Titan-PSD) of the Titan Corporation.

In March 2002, Titan completed the acquisition of Jaycor and its subsidiary California Tube Laboratory (CTL). This acquisition established Titan as one of the world's primary industrial authorities on electromagnetic effects and suppliers of RF and narrow-band microwave DEW technologies and associated electrical power systems. High average power, high efficiency, magnetrons; high peak power, pulsed, relativistic magnetrons and superreltrons; short pulsed, ultra-broad-bandwidth systems and megawatt-class power supplies and power conditioning subsystems are all designed and manufactured by Titan. This paper will chronicle some of the past and report on some of the current contributions that Titan has made to the development of pulsed power technology for DEW applications.

1.1. Previous Titan work in support of HPM programs

Titan-PSD has been developing directed energy technologies since the early 1980s. In this time, Titan has delivered capacitor banks for electromagnetic gun research with a total stored energy exceeding 200 MJ and advanced pulsed power systems for several large laser systems (Fig. 1). Over 40 years, Titan-PSD has delivered more than 200 pulsed power systems for electromagnetic pulse (EMP), x-ray, and lightning simulation; flash radiography; and other applications worldwide. Although somewhat peripheral to DEW research proper, these projects have nonetheless formed much of the experience base supporting Titan's directed energy technologies contributions.

Titan's primary contributions have been in the field of HPM (Fig. 2). Work started in 1984 when Titan set up and began operating a susceptibility effects test facility for the Defense Threat Reduction Agency (DTRA). A $30 \times 20 \times 16$ ft anechoic chamber to support this work was originally designed to operate in X-band and above. At the outset of the U.S. HPM directed energy program the community felt that the higher gains possible from fixed antenna sizes at higher frequencies would drive technology development into these bands. Over the next 10-plus years, the 25 effects test programs conducted on strategic and tactical systems in the Titan facility and tests conducted at other sites both confirmed that the lowest susceptibility thresholds are observed in the S-band and below. HPM source development history has mirrored these findings.

1.1.1. HPM source developments at Titan. In 1983 Titan initiated HPM source research in its test facility by developing first C-X band overmoded vircators[17] and later an L-band vircator.[13] These systems produced gigawatt outputs through the oscillating virtual cathode mechanism. Their main shortcoming was their broad bandwidth due to chirping induced by diode gap closure. To address this shortcoming Titan developed the first cavity vircator[3] that reduced the output bandwidth from several hundred megahertz to a few tens of megahertz. Versions of these devices were soon after sold to Nucletudes in France

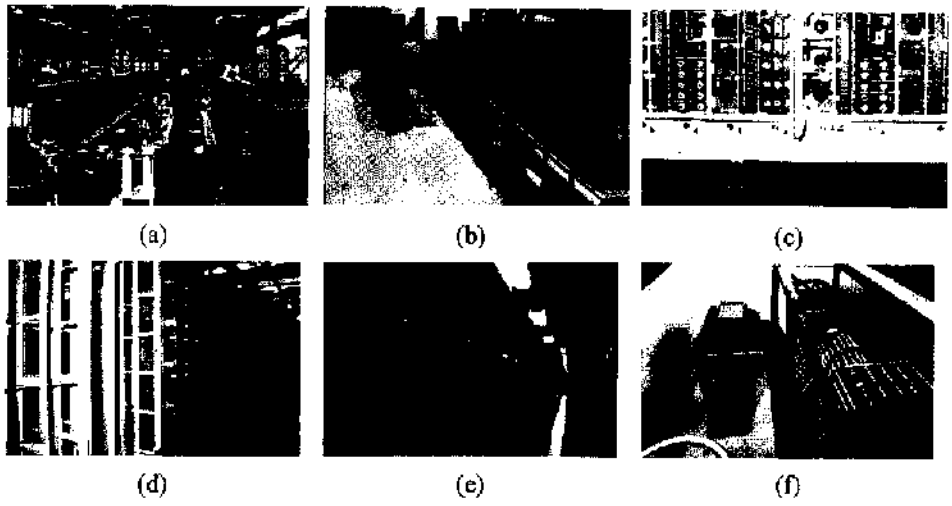

Fig. 1. Titan-PSD has designed, fabricated, and delivered the pulse power subsystems for most of the major electric gun facilities worldwide: (a) the decommissioned 32-MJ Thunderbolt System built for a Strategic Defence Initiative Office (SDIO) project; (b) the existing 32-MJ Kirkcudbright system currently being operated by the United Kingdom; (c) the first transportable pulse power subsystem designed for an electric weapon system. [This 8.5-MJ stored energy subsystem, consisting of four separate PFNs, was designed by Titan-PSD under the Army/Army Research Development and Engineering Center (ARDEC) Balanced Technology Initiative and was capable of delivering up to 5 shots at 3 rounds per minute.]; (d) the 52-MJ bank delivered to the ARDEC for electromagnetic and coil gun research; (e) the pulsed power driver for the 40-MJ OMEGA laser at the University of Rochester; and (f) a portion of the 100-Hz, 750-kV, 1.25-μs modulator for NRL's EMRLD laser.

and Culham Laboratory in the United Kingdom to help kick-start HPM effects testing and technology development programs at each location.

Titan initiated work on magnetrons by acquiring S- and X-band, A-6 versions from Bekifi at the Massachusetts Institute of Technology.[2] These devices were integrated into the Titan test facility, and within two years an L-band version of this same design was developed.[16] An S-band magnetron was sold commercially to Thales in France in 1987 to help kick-start HPM effects testing and technology development programs there.

This HPM source development work soon expanded from the initial efforts to field gigawatt-level vircators and magnetrons for the effects testing applications to the development of other high-power sources. These include narrow-band klystrons (both high- and low-perveance variants) and reltrons, as well as ultra-wide-band systems. In parallel, the peak and average power and spectral characteristics of these HPM sources were being explored in research involving phase locking, repetitive pulsing, and frequency agility. Other related Titan work included the development of pulsed power systems to drive these HPM sources involving several different architectures [pulse-forming networks (PFNs) with capacitive energy storage and voltage adders with magnetic compression power conditioning]. These advancements are described briefly in the following.

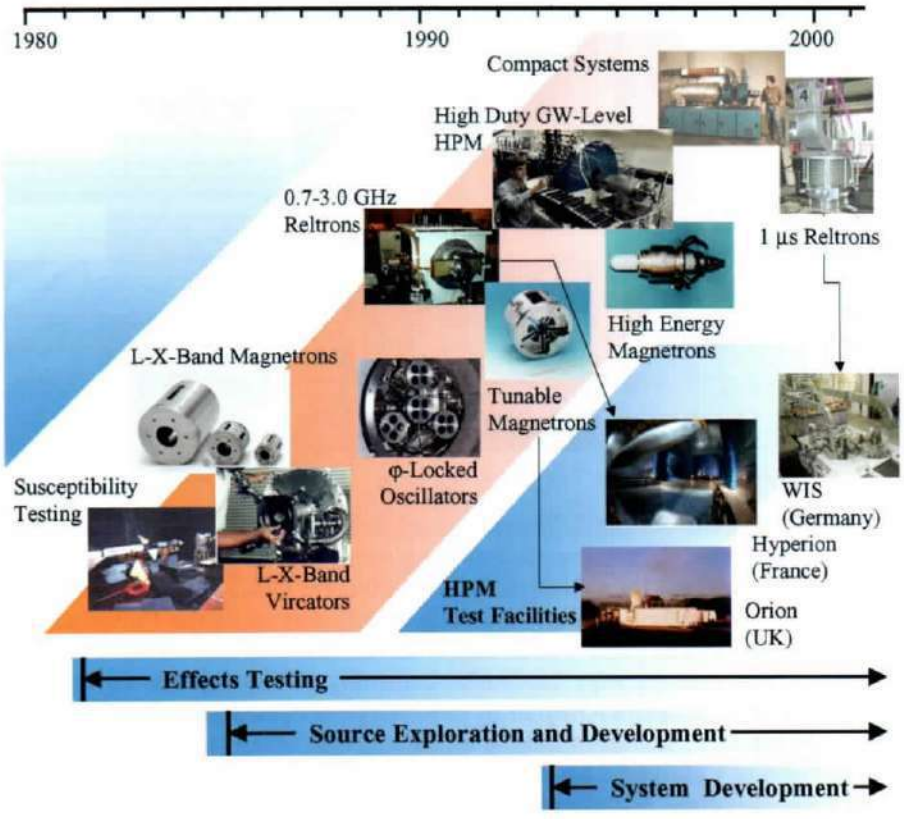

Fig. 2. Titan contributed to the field of HPMs in three distinct eras: 1) susceptibility effects testing, 2) HPM source development, and (currently) 3) DEW system development. The effects testing work started in 1984. Then, Titan operated the DTRA susceptibility effects test facility supporting tests for external DoD users. Soon thereafter Titan began using the facility for its own end-to-end DEW research programs. In parallel, Titan HPM source development efforts initially focused narrowly on providing the facility with minimum essential capability but soon expanded to meet specific weaponization and testing requirements. During this period, Titan performed some of the seminal narrowband HPM work associated with phase-locking, frequency agility, and repetitive operation. Source development work continues today, focusing on improving energy output and tunable bandwidth. These efforts are combined with the development of other advanced pulsed power subsystems and components needed to realize compact, efficient, and reliable DEW systems.

In the late 1980s, Titan S-band magnetrons were used in a three-year effort to understand how to achieve output powers exceeding 10 GW from a phase-locked array.[9] Many mission scenarios for DEW systems that could produce burnout or upset in military targets using only a single HPM pulse drove output requirements to this 10-GW level. The combination of gigawatt-level sources locked in phase appeared an effective way to realize this output level without increasing the RF fields and beam energies within individual diodes (and dealing with the RF breakdown and thermal issues that would certainly ensue). In this effort both master/slave and peer configurations were investigated to understand the optimal

architecture for such an array. In the end, a module of seven "peer-coupled," 2.8-GHz, magnetrons was built that produced an output power of 2.9 GW. Extrapolation to even higher output levels appeared feasible.

At this time, the HPM community was beginning to recognize that there must exist a middle ground between HPM and electronic warfare (EW) DEW concepts. The HPM approaches were characterized by superpower, single-shot, single-frequency, pulse formats, while the EW approaches made use of very low powers but incorporated modulations in the output pulse formats to effectively exploit susceptibilities within their intended targets. To access this middle ground the HPM sources had to first be shown capable of operation in repetitive or burst modes. This burst capability would be surely required of any DEW system, if only to engage multiple threats deployed in sorties or clusters. In response to these weaponization considerations Titan-PSD developed relativistic magnetrons capable of operation in 1-kHz bursts.[4] A 1.1-GHz, L-band, magnetron was driven by a magnetic pulse compression modulator (see discussion below) and achieved 250-pps repetitive operation at 1.2-GW peak power, in a burst of 100 shots. The average power of 12.6 kW during the burst remains today the state of the art for gigawatt peak power sources. To demonstrate that the magnetron's diode could recover in a time short enough to support higher repetition rates, the device was run for ~5 pulses (limited by the modulator) with 1 ms between individual pulses.

In the early 1990s both Jaycor and PI were actively extolling the use of frequency-agile waveforms to enhance lethality in backdoor attacks. Frequency agility exploits the characteristics of typical coupling cross sections that show pronounced dependence on microwave frequency. An HPM source that can sweep or hop frequency across a band has a higher probability of matching to a coupling resonance than a source fixed at a single frequency. Because of this strong dependence of backdoor coupling and susceptibility levels on microwave frequency, it was apparent that test facilities needed the capability to vary frequency continuously in order to obtain a comprehensive and accurate assessment of any given test asset's susceptibilities. In response to these testing and weaponization considerations Titan-PSD developed frequency-tunable magnetrons. These oscillators can be tuned ±17% about a central frequency,[10] which today still represents the state of the art. In the mid-1990s these magnetrons were integrated into advanced concept demonstrations for the Army and were also exported to the United Kingdom as part of an HPM test facility.

In the late 1980s and early 1990s Titan-PSD developed several ultra-broad-bandwidth (UWB) systems for Army and Air Force DEW research programs. The first system was based on a spark gap-switched Marx that drove a variety of different broadband antennas. It could launch 200-MW total RF power in 3-ns pulses with rise times of ~300 ps at a repetition rate of a few pulses per second. This compact, self-contained system was used in both indoor susceptibility tests and outdoor technology demonstrations. A second project produced a system that could launch impulse waveforms at 200 pps in burst mode.[15] A 3.66-m-diameter paraboloidal reflector was driven at its feed by a hydrogen switch that was integrally coupled to a novel electromagnetic lens. The radiated waveform had a rise time of ~100 ps and a 10–90 rise-to-fall pulse width of 45 ns. The peak electric field on bore-sight measured at 305 m was 4.2 kV/m.

Titan invented the super-reltron in 1992. A suite of tubes that operate between 0.7 and 4.5 GHz has been developed since that time.[12] These novel tubes represent a marriage between pulse power and conventional high-power klystron techniques. An energetic electron beam is modulated by periodic virtual cathode formation, and the bunched electron beam is postaccelerated to energies approaching 1 MeV. Microwave power is extracted with ~50%

Table 3. Operating parameters of Titan-built modulators for DEW applications

Modulator	Voltage, kV	Current	Pulse width	Pulse repetition frequency	Pulse energy	Average power	Switch type
LS-15	50	10 kA	100 ns	1.9 kHz	50 J	95 kW	Spark gap
NED laser driver	±40	260 A	2 μs	10 Hz	3 kJ	30 kW	Thyratron
EMRLD PFN	750	38 kA	1.3 μs	125 Hz	35 kJ	4.4 MW	Spark gap
EMRLD (trigger)	600	260 A	400 ns	125 Hz	100 J	12.5 kW	Spark gap
OMEGA[a] laser driver	15	128 kA	200 μs	Single shot	40 MJ	—	Ignitrons
CLIA HPM driver	750	10 kA	100 ns	250 Hz	750 J	188 kW	Magnetic
ORION HPM driver	500	10 kA	50–500 ns	100 Hz	250 J	25 kW	Thyratron
Compact HPM driver	450	9 kA	450 ns	10 Hz	1.8 kJ	18 kW	Spark gap

[a]120 modules, each storing 0.33 MJ.

conversion efficiency downstream in a dual-cavity output section that is tuned to the bunch frequency. The reltrons can produce microwave pulse widths approaching 1 μs and pulse energies of a few 100 J, outstripping the relativistic magnetrons that to date are limited to pulse widths of about 100 cycles and pulse energies below 100 J.

In response to the HPM effects testing considerations discussed above, Titan developed frequency-tunable reltrons. These oscillators can be tuned ±10% about a central frequency.[11] These devices are still in development today (see Sec. 2) and have been provided to both France and Germany as HPM threat simulators.

1.1.2. Development of pulse power modulators for DEW applications at Titan. Titan has developed a large number of modulators for a variety of laser and HPM DEW applications, with voltage ratings from tens of kilovolts to several megavolts and average power levels from tens of kilowatts to multimegawatts (Table 3). They also range from relatively simple units to complex, state-of-the-art devices with various different architectures and subsystems. These include PFNs for generating the required pulse shapes; thyratron switching for precise timing of the pulse switching into the load; low inductance layouts for fast output pulse rise times and high-turns-ratio pulse transformers for generating the high voltage outputs. The switching technologies include thyratrons, spark gaps, magnetic switches, and solid-state devices, such as metaloxide semiconductor field effect transistors (MOSFETs), insulated gate bipolar transistors (IGBTs), and thyristors (Fig. 3).

Several of these modulators have been designed for long-lifetime, reliable operations. Such features are essential if these systems are to find their way into military applications. As an example, the Defense Advanced Research Projects Agency (DARPA) excimer Raman-shifted laser device (EMRLD) modulator (a 100-Hz, 750-kV, 1.25-μs, lumped-element PFN to pump an excimer laser) was specifically designed for and demonstrated a lifetime of 10^{10} shots.

The ORION pulser (Fig. 3b) design has command resonant charge and intermediate energy storage sections each switched by thyratrons that drive a step-up transformer and

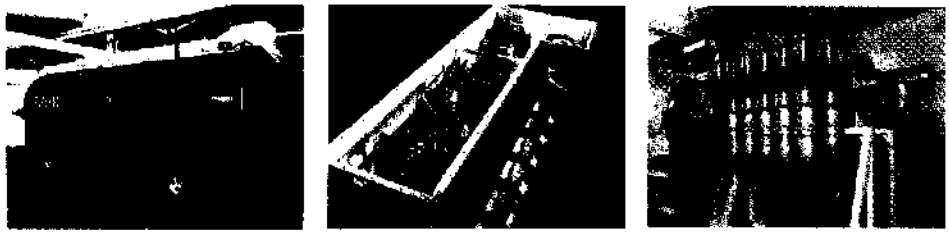

(a) (b) (c)

Fig. 3. Titan-PSD pulsed power systems based on (a) spark gap, (b) thyratron, and (c) magnetic switching.

Table 4. Key operating parameters in European HPM test facilities

HPM facility	Power density, W/cm^2	Range, m	Frequency, MHz	Maximum pulse width, ns	Maximum repetition rate, Hz	Shots per burst	Source type
UK—Orion	>120	100	1,070–3,300	100	100	100	Magnetrons
France—Hyperion	>1,000	~100	700–3,300	300	1	—	Reltrons and magnetrons
Germany	>170	15	700–1,450	300	10	100	Reltrons
Sweden[a]	~120	15–25	L-Ku	500–5,000	1,000	Continuous	Reltrons

[a]This facility uses conventional high power klystrons in L-, S-, C-, X-, and Ku-bands, with maximum power 25–0.25 MW.

PFN. The modulator can fire 1,000 pulses in a burst at repetition rates up to 100 pps and produces 500 kV into a 50Ω load. It has been used to drive relativistic magnetrons[6] for HPM effects measurements.

The Compact Linear Induction Accelerator (CLIA) (Fig. 3c) was developed for moderate-repetition-rate HPM source research and development.[1] CLIA operates at 250 pps with 750-kV, 10-kA, 100-ns output pulses. The system uses thyratron and magnetic switching throughout and produces 188-kW average power into the load. CLIA is not actively cooled and so is restricted to burst operation with 5,000 pulses in a burst. CLIA has been used to drive both magnetron and klystron loads. This technology is scalable to kilohertz repetitive operation.

1.1.3. Titan pulse power systems for HPM simulation. In addition to work done supporting domestic RF and microwave DEW research and development, Titan has provided HPM simulation systems for all of the world's major HPM test facilities in Sweden, France, the United Kingdom,[14] and, most recently, Germany. The microwave test parameters and operational capabilities achievable in these international facilities are summarized in Table 4. The types of Titan HPM sources that produce the intense microwave environments are also given. Work continues today upgrading those systems and providing similar hardware for several non-European countries.

2. Most Recent Contributions

Titan-PSD has taken an interest in the full spectrum of developments of advanced subsystems and components that the three U.S. services will require to realize their DEW and electric platform goals. These developments enable many different military missions and cut across many different technologies: advanced capacitors, switches, transmission systems, RF, and optical systems. Some of the pulse power and power electronic subsystem and component developments that Titan is pursuing are summarized in Table 5.

The following subsections describe five electrical subsystems and three components that Titan-PSD is currently developing for DEW applications.

2.1. Titan-PSD development of subsystems for DEW applications

2.1.1. HPM modulator. Titan-PSD has a conceptual design of a high-voltage-pulse power subsystem for a short-pulse HPM system. The given RF pulse output parameters led us to choose a specific tube that is compatible with the constraints of an airborne system, namely the magnetron with a 20Ω impedance and 33% efficiency in a short-pulse mode. Our pulse power design concept is driven by the tube input requirements (20Ω load, 40-ns pulse width, 10 pps) and comprises a low-impedance, water-filled, stepped-pulse forming line (PFL) charged by a fast Marx and discharged through a self-breaking, spark-gap output switch. An advantage to using a liquid dielectric PFL is that its impedance can be easily varied along its length to accommodate variations in load impedance. Input power to the Marx is from two 400-V series strings of lithium ion batteries with solid-state switched intermediate voltage multipliers providing ±40 kV. Batteries are recharged from aircraft power through a small voltage converter.

Figure 4 is a simplified circuit diagram of the pulse power modulator coupled to a 20Ω constant impedance load though a transit-time isolator. The transit-time isolation is integral to the two parallel cables that couple the output of the pulsed power modulator to the microwave source. The Marx stores 1,140 J at a voltage of ±40 kV. It erects to a 1,280-kV open circuit voltage after a trigger pulse is applied to several of its switches from the trigger generator. Near peak PFL voltage, the self-firing spark gap closes, and energy is transferred to the tube at a peak voltage of 640 kV.

Figure 5 shows the voltage and current in the load computed from a more detailed version of the circuit depicted in Fig. 4. Note that the current is multiplied by a factor of 10. Voltage rises in about 11 ns (10–90%), and the width at the peak is approximately 40 ns. We recognize that the impedance of the magnetron can vary during RF generation, but the constant impedance model is sufficient here. An advantage to using a liquid dielectric PFL

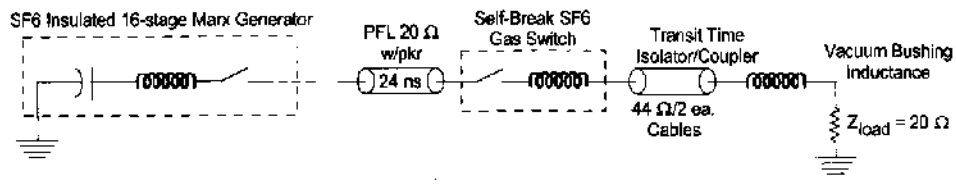

Fig. 4. Simplified circuit diagram of the pulse power modulator coupled to a 20Ω constant impedance load though a transit time isolator. This impedance represents a magnetron electron tube load.

Table 5. Titan advanced DEW power technology development rationales

What need does the development of pulsed power technology fulfill?		What need does the development of high power/high current technology fulfill?	
It is an enabler for advanced electric weapons and self-defense systems.		It is an enabler for advanced electric weapons and self-defense systems.	
System	User	System	User
Dynamic protection	Army (FCS), Navy (carrier)	Solid-state lasers	Army (Anti-Aircraft and Anti-Missile), Navy (ASMD)
ETC	Army (FCS), Navy (shore bombardment)	HPM	Army (FCS), Navy (non-lethal area denial)
HPM/electro-magnetic pulse	Army (FCS), Navy (non-lethal area denial and ASMD), Air Force (SEAD)	EMALS	Navy (carriers)
EM gun	Navy (shore bombardment)	Electric ar-resting gear	Navy
UWB	All services (counter C4I)	Ride-thru	All services
		It is an enabler for electrically driven platforms: • FCS platforms for the Army • Combatants such as DD21 for the Navy • More electric aircraft for the Air Force	
It is an enabler for commercial spin-offs: • Environmental remediation systems • Material surface treatments • Pulsed thrusters for satellite station keeping		It is an enabler for commercial spin-offs: • Electric vehicles • Commercial power distribution and control • Advanced semiconductor lithography	
What must we accomplish at the subsystem level? • Develop compact, reliable, affordable PFNs • Develop compact, reliable, affordable modulators • Develop compact, reliable, affordable intermediate energy stores		What must we accomplish at the subsystem level? • Develop compact, reliable, affordable prime power, power conversion and controls • Develop compact, reliable, affordable intermediate energy stores • Develop compact, reliable, affordable ride-thru systems	
What must we accomplish at the component level? • Develop high-energy-density, fast-discharge capacitors • Develop long-life, reliable, high-current switches • Develop compact inductors for pulse control • Develop affordable ultracapacitors • Develop compact, reliable, efficient, high-average-power HPM sources		What must we accomplish at the component level? • Develop high-current-density, high-voltage stand-off solid-state switches • Develop affordable ultracapacitors • Develop compact, reliable, efficient, high-average-power HPM sources	

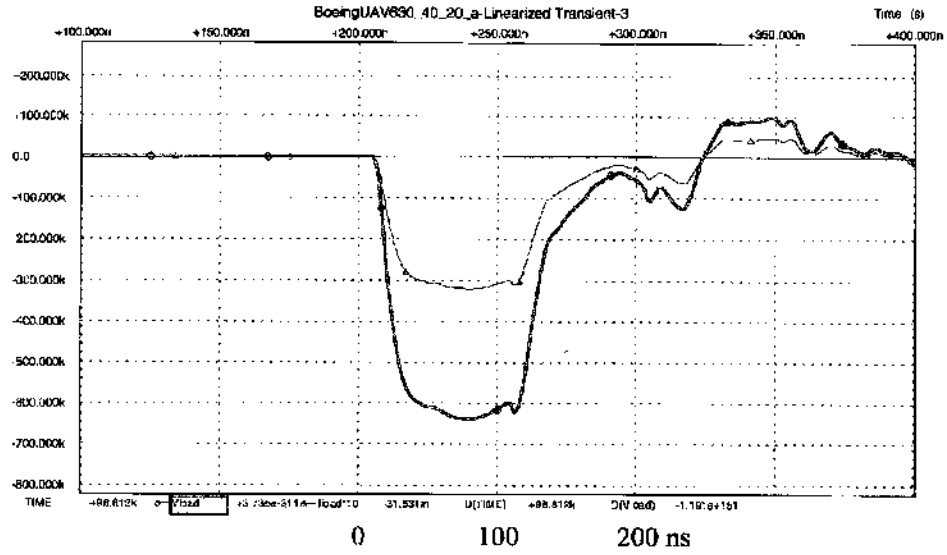

Fig. 5. Voltage and current (multiplied 10×) in the magnetron load computed using detailed version of the simplified circuit diagram in Fig. 4.

is that its characteristic impedance can easily be varied along its length to accommodate variations in load impedance.

Our compact pulse power system conceptual design mounts all of the subsystems and components in a frame that is 24 in. wide × 24 in. high × 144 in. long. The total weight of the system, including the frame, sealed enclosures, and internal mountings, is 1,420 lb. Figure 6 is a dimensioned diagram of the subsystem that is designed to fit into the port bay of an unmanned aerial vehicle (UAV) with the source in the starboard bay. Frames and supports have been omitted for clarity.

2.1.2. Compact PFN. Titan-PSD has designed, fabricated, and delivered the pulse power subsystems for most of the major electric gun facilities worldwide. These facilities were dedicated to electric gun research and for this reason were designed with a premium on reliability and ease of use of the pulse power subsystem. Compactness was a secondary consideration given the large amount of real estate available for the subsystem.

The 8.5-MJ stored energy subsystem, consisting of four separate PFNs (Fig. 1c), was the first design to use the high-energy-density, 2.5-J/cc (2.5-MJ/m^3) polyvinylidene fluoride (PVDF) Aerovox capacitors; the overall energy density of the PFNs is less than 0.5 MJ/m^3. This low energy density is partially due to the use of "jelly-roll" inductors whose large external fields forced the separation of components and resulted in a low component packing fraction.

Figure 7 is a photograph of a 250-kJ PFN that was constructed under a DTRA/Navy-sponsored ETC gun development project and that was incorporated for a time into the Army/Tank-Automotive and Armaments Command (TACOM) Combat Hybrid Power System (CHPS) system integration laboratory.[5] Titan-PSD designed this PFN module for compactness by developing innovative bus work and a closed-field inductor for use with the 2.5-J/cc PVDF capacitors. These advances in component design allowed us to achieve a

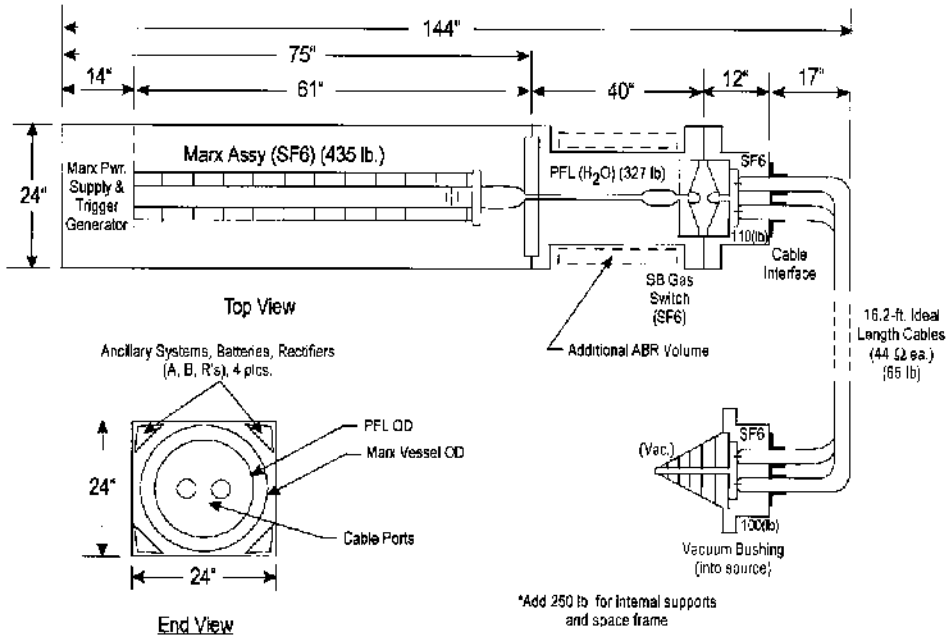

Fig. 6. Top and end views of the pulse power subsystem concept design. The upper portion will be mounted in a frame and placed in one bay of a UAV. The vacuum bushing and the source will be placed in a second bay.

very high packing factor and an overall energy density of 1.25 MJ/m^3. This module designed in 1994 still represents the state of the art in PFN design. Minor variants to the design are under consideration today for EM gun applications.

Titan-PSD has estimated the increases in the overall energy density of small (250–500-kJ) PFN modules that could be realized by achieving specific advances in component technologies.† This includes the use of an existing, more compact vacuum output switch (developed by Titan-PSD) and existing, more compact diodes for the crowbar switches. We would design a higher-energy-density, closed-field inductor and eliminate the dump resistors and associated hardware. Rather than having to dump energy into a resistor, advanced pulsed power systems would be charged by four-quadrant converters capable of returning energy from the PFN to an intermediate energy store. When 5-J/cc film or ceramic, high-energy, reversal tolerant capacitors become available, the utilization of advanced components would lead to a PFN design with an energy density of 3.25 MJ/m^3.

2.1.3. Power supplies for laser applications. Titan-PSD's San Diego operations are actively engaged in building innovative high-average-power systems. Titan is currently delivering power conditioning and control elements for the high-power RF klystrons that will power the DOE Spallation Neutron Source that is now under construction at Oak Ridge, Tennessee, and a series of multimegawatt rectifiers for the U.S. Navy's Electro-Magnetic

†Higher energy densities could be achieved in the design of larger modules due to economics of scale.

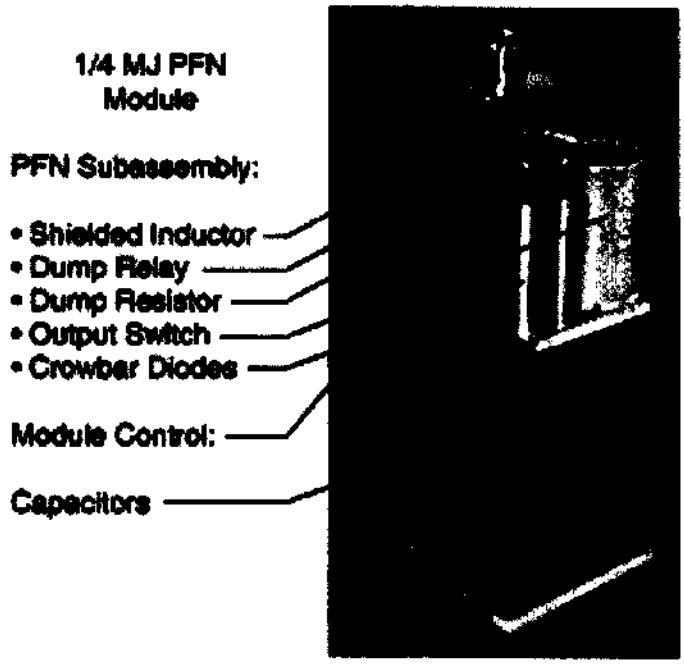

Fig. 7. Photograph of the 250-kJ PFN with the state-of-the-art, 1.25-MJ/m^3 overall energy density. Titan-PSD has operated this PFN into resistive loads at a rate of 1/3 Hz for extended periods. Operational limits were imposed by the heating of the load, not by the performance of any component of the PFN.

Aircraft Launch System (EMALS). Most recently, Titan has developed conceptual compact power supply designs for deployable pulse power systems for the Strategic Illumination Laser (SIL). The SIL is a diode-pumped, solid-state laser for use as a designator as a part of the U.S. Air Force's Missile Defense Agency's Airborne Laser (ABL). These power supplies will drive compact arrays of light-emitting diodes (LEDs), which will in turn pump the solid-state lasing medium.

Titan's proposed SIL power supply system will consist of a group of innovative ballast-type isolated power converter modules, each fed by its own active-power-factor-corrected rectifier module. By this method the input current harmonic distortion will be minimized, resulting in an overall system power factor of 0.995, which will be acceptable for the Boeing-747 type aircraft (ABL platform) power system. The whole power system will be protected against faults by appropriate fuses and circuit breakers. Initial size and weight estimates for the total power system is 65 liters of total volume and 140 kg of mass. The driving factor in the weight and volume is the need to meet the power factor requirements. Given a dedicated power source, the size and weight could be halved.

Two basic topologies have been examined for power factor correction. They are the "Vienna rectifier,"[8] first proposed by researchers in the Vienna Technical University, and the hex-bridge bidirectional inverter. Both topologies do not contain any magnetic components, operating at line frequency, and both can provide a power factor over 0.99. All merits and drawbacks of both topologies have been initially analyzed, and the Vienna approach is favored for this application.

For the ballast inverter Titan-PSD selected the variable-frequency, zero-power switching full bridge quasi-resonant inverter topology. It is new and until recently not well known but is very promising for multikilowatt power supplies. It shows excellent average to peak ratio for the semiconductor switches, close to the theoretical limit of 50%, and a good power transformer copper utilization factor, typically 90%. It is intrinsically output current limiting and therefore operates well in a current regulated mode and is tolerant to output short circuits. Using this converter topology allows the design to reach unprecedented power conversion efficiency (real value 95%) with excellent reliability.

2.1.4. Electronically reconfigurable battery. We consider a DEW power system in which a 10-kV capacitive store is required to operate repetitively. If the system operates at 3 pps, even for a short period of time, the recharge time would be about 300 ms and the recharge power would be about 500 kW_{avg} (1 MW_{pk}). An important system issue is the size and weight of the 500-kW power conditioning unit.

Titan-PSD has developed a means to eliminate the need for intermediate power conditioning for many DEW systems mounted on hybrid electric vehicles by using the on-board batteries to charge the capacitive store directly. Our approach uses electronic switching to convert the battery modules in the mobility store from a parallel configuration providing vehicle load leveling and/or silent mobility capability, to a series configuration that delivers 500 kW at 10 kV to recharge the capacitor bank and back again. We refer to this as an "electronically reconfigurable battery" (ERB). Note that all of the batteries are recharged in parallel. A similar approach is used in capacitive Marx generators to achieve very high voltage pulsed output.

Figure 8 is a schematic drawing of the circuit of an ERB in a hybrid electric drive vehicle. In this schematic circuit, some battery modules are always in parallel and connected to the vehicle bus. Others, along the left-hand side of the drawing, can be switched between a parallel configuration, which supports the vehicle bus, and series operation for charging the DEW store. Electronic reconfiguration requires three switches per battery module. All switches, with the exception of the output switch, need only block the voltage of a single battery module and open at near zero current (characteristic of capacitor charging) in normal operation. Passive snubbing controls the transient conditions during erection and de-erection. Reconfiguration can be accomplished in less than 1 ms using off-the-shelf, solid-state switches such as IGBTs or MOSFETs.

Figure 8 shows an erectable battery module charging a Guillemin E-type network. Switches 2 and 3 are battery isolation switches, and switch 4 is a series switch. These switches are rated only for the module voltage (1 kV in this case). Mechanical contactors parallel the isolation switches for better efficiency during periods when the pulse power system is not in use. Switch 5 is the output switch, which is rated for the full output of the ERB (10 kV and 50 A) and is most likely a series stack of the same switches used for 2–4. For fault protection and charge interrupt at current, a vacuum contactor and fuse are placed in series with the output switch. All switches are optically isolated with gate power drawn from their adjacent modules. Switch 6 is a high-voltage and current-closing switch, either vacuum or solid state.

Assuming a 20-ton-class vehicle and extrapolating from CHPS requirements, we have developed a conceptual design of an ERB for a hybrid electric vehicle with a system meeting the following requirements: 1) Deliver up to 400 kW to the vehicle bus at 1 kV in parallel operation; 2) recharge a 150-kJ capacitive store to 10 kV in 300 ms; and 3) support 30–45-min silent operation at 80 kW. These requirements mandate the use of very high energy

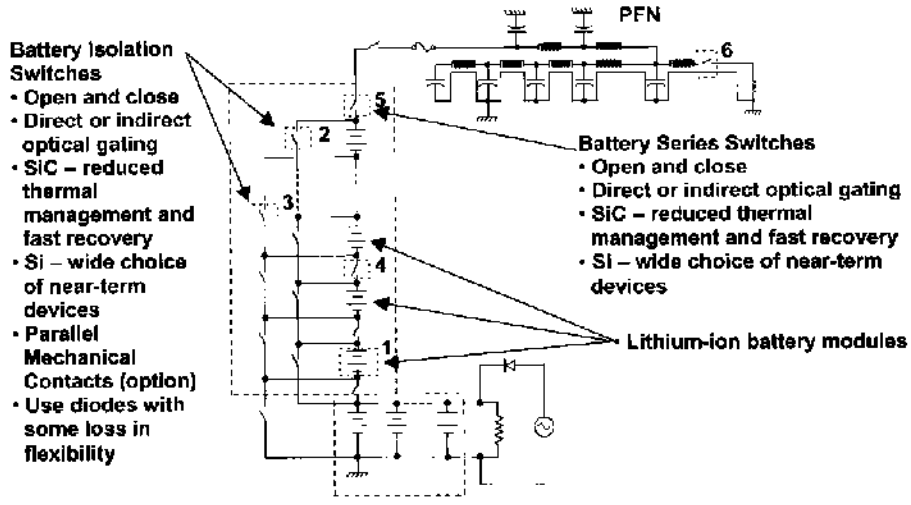

Fig. 8. Schematic circuit of the ERB. Shown is a generic circuit topology for charging a Guillemin E-type network. For the present application, the 10 modules in the dynamic store are all erected in series to produce a 10-kV output. A feature of the ERB is that the dynamic portion of the store may be erected in combinations of series/parallel modules to provide any output voltages that are an integer multiple of the DC bus voltage. This voltage agility, in theory, would allow a single dynamic store to power several loads with different input voltage requirements on the same platform such as ETC guns and HPM systems.

and power density batteries such as the HP series of lithium ion batteries being developed by SAFT and the lithium polymer batteries produced by Ultralife Batteries, Inc., for use in cell phones. The SAFT batteries have a slight advantage in usable power density and packaging for military use, whereas the Ultralife batteries have an advantage in cost due to volume production and a potential for more compact packaging (thin, rectangular) in ERB service. A design and trade study will select the most appropriate cell for the application. We chose the Ultralife cells for the conceptual design used for purposes of discussion in this paper because of our experience with them in our laboratory tabletop ERB and because of the availability of these cells over a range of capacities from 120 mA-h to 3.5 A-h.

The ERB system in this case constitutes only 1/3rd of the total battery for erected (dynamic) operation. The remaining 2/3rds of the store (static) is dedicated to load leveling and silent mobility. The total capacity of ~290 MJ (80 kW-h) accommodates silent mobility requirements. With only 1/3rd (90 MJ, 25 kW-h) of the total capacity configured for on-command electronic erection and de-erection, the vehicle energy storage system maintains its load leveling and silent operation capability even when the pulse power system is active.

For our conceptual design, we assemble 53 Ultralife polymer batteries into individual 200-V stacks. Five of these stacks are placed in series to obtain an output voltage equal to that of the vehicle bus. In the static portion of the store, 20 such series stacks of the UBC34106102 cells (5,300 total cells) are needed to provide the 200-MJ nominal capacity. In the dynamic portion of the store, the UBC383562 cell is used because of its higher current rating. Due to the smaller size of these cells, there can be as many as 4 in parallel by 53 in series per 200-V unit, and five such units will form an erectable module. The module will incorporate all necessary switches and isolation and thermal management hardware.

Ten modules will constitute the entire dynamic store (~90 MJ, 10,600 total cells). The total battery volume in the static and dynamic stores is ~0.282 m^3, and the accessories are expected to add another 0.4–0.6 m^3 for a total volume of less than 1 m^3. The weight for just the batteries would be ~572 kg, with accessories of much lower density adding another 100–200 kg, for a total weight of less than 700 kg. Charging of the ERB is always performed at bus voltage with the dynamic store in parallel configuration.

In load leveling or silent mobility operation, the charge state of the ERB is continuously monitored and controlled by the vehicle's systems. When the pulse power mode is activated, the mechanical contactors bypassing the isolation switches are opened. Next, all isolation switches are opened, followed by the closing of all series switches, and the ERB begins charging the capacitive store. Initially, the load looks like a short circuit, and the charging current is limited by the internal impedance of the ERB cells. As the charge on the bank increases, the charging current diminishes, and the cell voltage begins to rise. Near full charge, the current approaches zero and the ERB output voltage rises to its maximum of ~10 kV. Voltage on the store is monitored and is regulated by chopping the ERB output (i.e., opening and closing the series and output switches as necessary to maintain charge against leakage; this has been demonstrated in the laboratory at rates of up to 1 kHz). When the store discharges, the output switch opens immediately and remains open long enough for the closing switch to recover (1–10 ms). The ERB can remain erected for as long as the pulse power system is active. Recharging of the store is then initiated by reclosing the ERB output switch. When the pulse power system is deactivated, the dynamic store is returned to its parallel configuration by opening the series switches (de-erecting). The dynamic store can then be recharged from the vehicle power bus.

We have created an ERB laboratory demonstration consisting of five erectable modules of 40 V. The Ultralife UBC383562 cells were used and arranged on PC boards that were in turn stacked via standoffs. Isolation and series switching was via optically coupled IGBTs. Some figures of merit (FOM) from the ERB testing include a demonstrated current rise time to 80 A of 4 μs at 200 V and an erection/de-erection frequency of 1 kHz for use in voltage regulation. A FOM from the four series cell tests is a demonstrated current rise time to 120 A of 1 μs, in a maximum power transfer configuration.

2.1.5. Intermediate energy storage. In the preceding section Titan-PSD identified a need for and established the technical feasibility of an advanced technology power conditioning element to charge capacitive stores in DEW systems. The ERB is the solution with the highest efficiency and energy and power density possible. This is critical in order to realize a manageably sized DEW system. A second similar, critical issue in the design and use of pulsed electrical weapon systems involves the level of available platform power. If this power is insufficient to support the required operational burst length and repetitive fire rate of the system, then it may be necessary to incorporate intermediate energy storage into the system design. Intermediate storage could be practically achieved through the use of secondary batteries, flywheels, and ultracapacitors (also referred to as electric double-layer capacitors or EDLCs). Figure 9 is a schematic diagram of intermediate energy stores in two DEW systems.

Figure 10 shows a present application of an EDLC energy storage system in providing ride-through of voltage sags and momentary outages for an induction motor. The output of the store is connected across the direct current (DC) link of the asynchronous drive and supports its voltage. Titan-PSD has manufactured a ride-through system that has been demonstrated to respond to sags and outages within 10 ms. It can provide

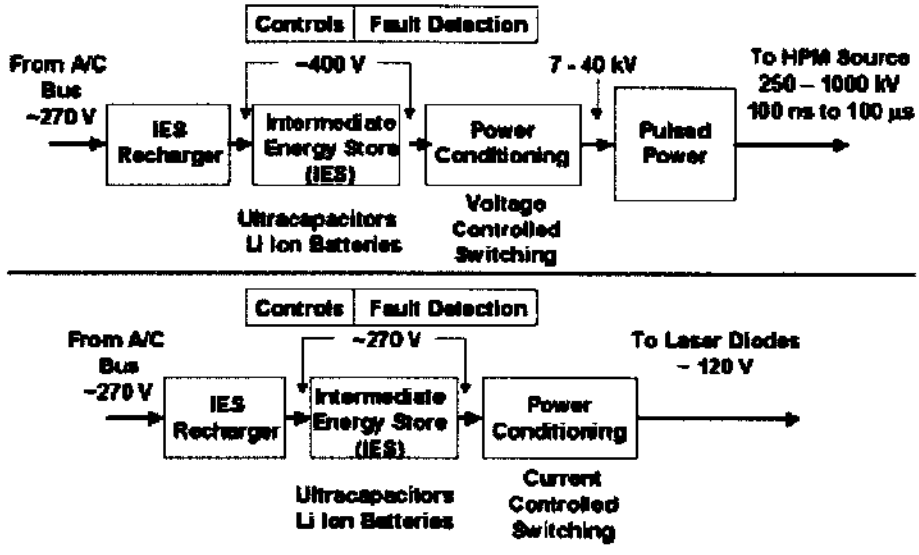

Fig. 9. Two DEW block system schematics with intermediate energy storage.

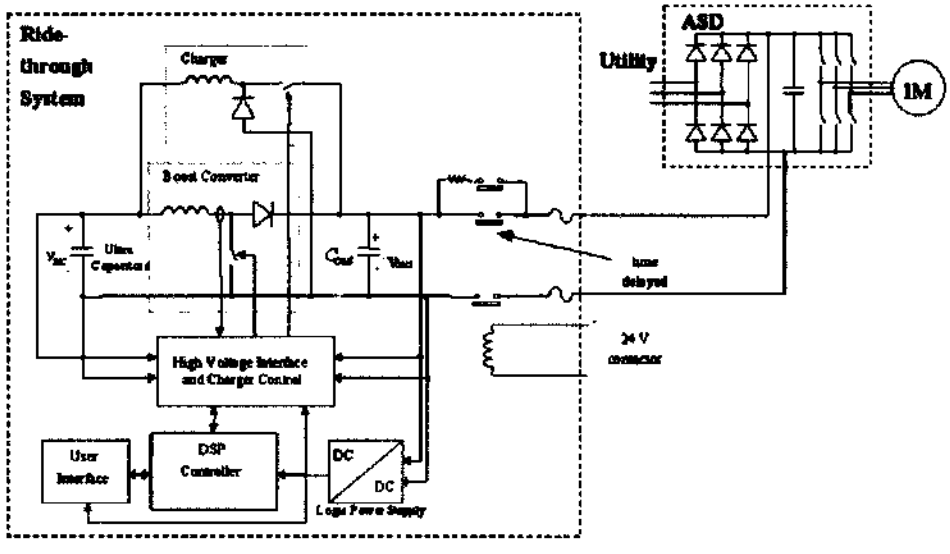

Fig. 10. Circuit diagram of an EDLC ride-through system supporting the DC link of an asynchronous drive (ASD).

100 kW for up to 5 s, which is sufficient to allow for orderly shutdown in a prolonged outage.

Titan-PSD has also developed several concept designs of EDLC energy storage systems for military applications. For example, one EDLC system design would be capable of supporting the DC link in a Navy shipboard system at 480 V for 12.5 s at 250 kW. This system is estimated to be 50% smaller and lighter than a corresponding flywheel system

(i.e., the Caterpillar UPS-250 system). With minor modifications, the same system (or several systems in parallel) could be used as an intermediate energy store for DEW systems.

2.2. Titan advanced component developments to enable DEWs

2.2.1. Solid-state switches for severe service. The key enabling technology for nearly all pulse power systems for DEW applications is the switch that initiates and delivers the pulsed electrical output from the electrical energy store to the load. This switch must hold off high voltage (typically $\geq$10 kV), close rapidly (<1 μs), carry high peak current (100–500 kA) with high initial rate of rise (50–100 kA/μs), sustain a high total action ($\geq 10^7$ A^2-s), and recover rapidly (<10 ms). In addition, the switch must support high current density, operate reliably under mechanically stressing conditions, have minimum weight and volume claims, and not require ancillaries such as vacuum pumps or gas flow subsystems. At present, the hydrogen thyratron is most frequently selected to meet these simultaneous requirements, but thyratrons are large and heavy devices, with auxiliary equipment that consumes several kilowatts and often require immersion in oil. The Army Research Laboratory has been actively seeking solid-state devices for DEW utility[7] and Titan-PSD is weighing in by developing a high fluence, laser gated and pumped (silicon) thyristor (LGPT) that will satisfy these requirements.

High fluence optical gating of thyristor switches has been chosen for numerous pulsed power switching applications. Light activation with high fluence laser sources enables the use of solid-state switching devices in performance parameter spaces previously serviced only by vacuum and gas spark gaps. If the output from the high fluence source is properly distributed within the switching medium, the di/dt capability of the switch does not depend on the rate of plasma spreading. Rather, di/dt becomes a function of the rate of rise of the optical fluence. In addition, optical gating eliminates the extensive and intrusive physical gate structure that limits the conduction area of the highest di/dt conventional solid-state devices. Properly designed laser-gated devices are typically capable of higher di/dt, peak current, and charge transfer for a given silicon area than conventional solid-state devices.

The band edge for intrinsic silicon is $\sim$1.12 eV, corresponding to $\sim$1,111 nm. However, silicon is an indirect band-gap material so that the optical phonon energy (0.063 eV) adds to the photon energy to create e–h pairs out to 1,170 nm. In most previous efforts involving direct laser-gating of silicon devices, a solid-state laser was used; typically either Nd:YAG or Nd:YVO at 1,064 nm. However, over the past 10 years, the development of compact diode-pumped solid-state lasers has significantly reduced the size of the requisite optical sources and improved their lifetime and reliability. More important, the InGaAs laser diode bars that were developed for pumping these solid-state lasers have been pushed to longer wavelengths, approaching and exceeding that of the silicon band edge. In principle, the center wavelength of InGaAs laser diode bars is selectable by design over a continuum from 850 nm through at least 1,150 nm. This allows direct optical gating and pumping of silicon by the diodes without any of the intermediary options of the preceding paragraph. Figure 11 is an illustration of an on-board laser diode gated and pumped silicon thyristor, which is one of the candidate approaches in development now.

Titan-PSD is currently performing on two programs and has finished a third that provide technical leverage for further switch development. Our Electra Advanced Pulsed Power Program is a five-year, Naval Research Laboratory (NRL)/DOE-sponsored effort to develop advanced pulsed power components and systems for KrF laser IFE (krypton fluoride laser inertial fusion energy). The most critical component is the primary switch, and we are

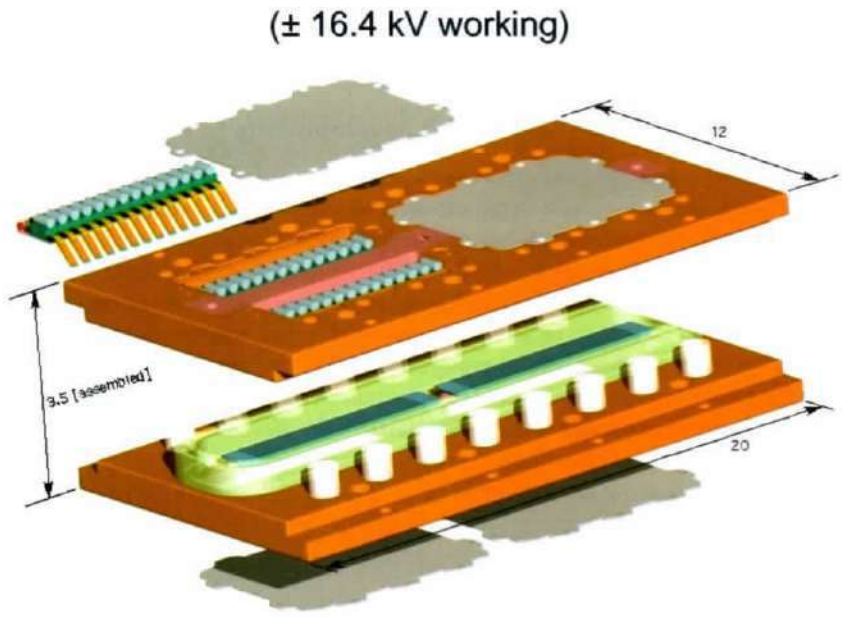

Fig. 11. Illustration of a laser gated and pumped thyristor.

developing an on-board LGPT for this role. The switching requirements are repetitive, high peak current and di/dt, as well as high efficiency (the switch dissipates $<1.5\%$ of stored energy) and long lifetime (10^9 shots). The LGPT is to be used in a Marx generator, and the single device operating parameters are 16.4-kV working voltage, current density 2.25 kA/cm^2, peak current 225 kA, max di/dt 900 kA/μs, pulse width 800 ns, and repetition rate 5 pps continuous. The lifetime requirement limits the thermal excursion per pulse to a few degrees, and therefore the action per square centimeter is low ($\sim$2 A^2-s).

Another current Titan-PSD program is to develop compact pulsed power components for the Air Force Research Laboratory (AFRL) at Kirtland Air Force Base. Components under development enable a compact, long-lifetime Marx-PFN driver for a narrowband HPM source. The di/dt requirement is a few hundred kA/μs/cm^2(Si) or 2 MA/μs total, with a peak current of 30 kA. To satisfy the switching requirements for this application, we are considering the LGPT, a solid-state laser activated switch, and a hybrid combination of the two.

Although the action and charge transfer in these Electra and AFRL applications are substantially less than that found in some pulse power applications, they serve to illustrate our confidence in the high power laser diode bars for high di/dt service. In both cases, the pulse width of the energy transfer is short enough that thyristor action has barely begun by the time the pulse is over. Because of this, a large fraction of the total charge conducted during the pulse must be supplied optically. The diode laser bars and their drive circuitry are capable of supplying an illumination fluence of up to 6 kW/cm^2(Si) within 20 ns and sustaining that level for at least several microseconds. Fluence of several kilowatts per square centimeter is desirable for initial gating in many DEW applications. The required fluence drops to 250–500 W/cm^2 for continuous pumping.

Another effort was recently undertaken in a conceptual design study for an optically gated and pumped switch for rectification of compulsator (pulsed alternator) output for driving an

electromagnetic gun. This completed study was performed by Titan-PSD and the Optiswitch Technology Corporation for the Institute for Advanced Technology (IAT). The on-board LGPT design was chosen because of the customer's desire to reduce the overall device count and silicon area compared with conventional devices. Specifically, we designed a 16.7 kV, 100–115-cm^2 asymmetric (blocks voltage forward direction only) thyristor and series diode. Depending on the allowable temperature excursion per shot, our approach replaces ~80 conventional devices with 3–5 series pairs (6–10 devices total; 340–500 cm^2 active) for the same forward losses. This is possible because continuous pumping of thick (2.5-mm), high-voltage (15–20-kV) devices with photo-carriers mitigates the carrier population deficit in the n-base. Electrically gated devices of the same voltage capability typically exhibit huge commutation and conduction losses and are therefore impractical for this type of service. Reverse blocking was handled by a series optically pumped diode. Separating the forward and reverse blocking functions allowed more freedom in designing for reverse recovery, a feature deemed necessary due to repeated failures of symmetric (blocks voltage both directions) devices in this service. Laser diode pumping served to reduce the forward losses in the series diode element as in the thyristor.

The switch was designed to handle a peak current of 1.6 MA (3.3–4.7 kA/cm^2) for 600 μs when installed in a half-wave, four-phase rectifier. Nine total cycles are rectified per shot of the electromagnetic gun. The initial design (500 cm^2 active) limited the temperature excursion per shot to ~100°C, commensurate with a service life of ~10^4 shots. In the extreme, the current density could be pushed to 4.7 kA/cm^2 and optical pump power doubled, resulting in a ΔT approaching 180°C and ~200-shot lifetime. The laser diode bars in the initial case provided a constant 500 W/cm^2 of silicon for each 600-μs conduction phase. This goes to 1 kW/cm^2 in the extreme case.

2.2.2. Next generation reltron microwave generator development. Reltron HPM sources were invented and developed by R. Bruce Miller of Titan Advanced Innovative Technologies from the mid-1980s through 1998. The PSD of Titan assumed responsibility for reltron contracts in 1998. Projects included one complete HPM simulator for a government research laboratory in Germany and eight reltron tubes of various specifications. In developing these eight tubes, enough mechanical and electrical modifications have been included to justify their designation as "second-generation" designs.

Reltrons are both compact and efficient. The electron beam is highly modulated over ~10 cm and postaccelerated prior to drifting to the output cavities and beam collector. This beam transport requires only ~75-cm overall length for L-band tubes (Fig. 12). The output cavities are incorporated into a standard rectangular waveguide. Microwave power is efficiently extracted (~80%) directly in TE_{10} mode. The overall efficiency (peak electrical to microwave power) is 30–40%.

In general these new tubes move the reltron technology base in the directions of longer pulsewidths (~1–2 μs), increased frequency tunability (~±13%), lower driver voltages (500–600 kV), and higher repetition rates (~10 Hz for demountable versions, ~300 Hz for sealed tubes). Second-generation improvements include a new high voltage insulator design, new movable current contacts for the modulation and output cavity tuners, reduced outgassing, and monolithic grids. The frequency range for these eight tubes covers 700–1,450 MHz. Programs are in place now to extend this range.

In addition to the objective to extend the frequency coverage, efforts are underway to improve beam optics to reduce current losses and thereby improve efficiency and microwave output power. A new beam current diagnostic package has been recently implemented to

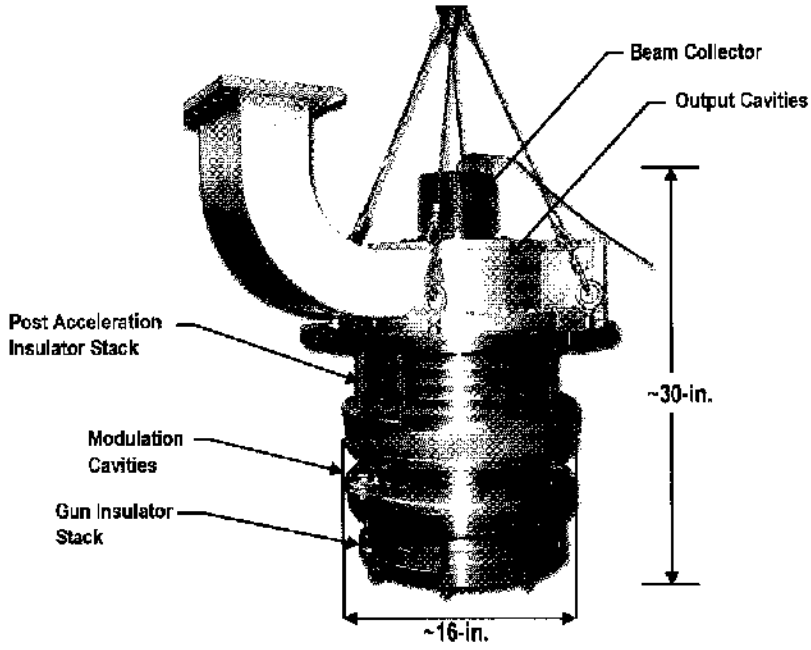

Fig. 12. L-band reltron capable of generating flat 200-MW, 900-ns pulses with frequency stability $\delta f/f < 0.3$. This generation of reltrons is capable of RF pulse widths of ~300 RF cycles, repetitive pulse operation from single-shot to 10 Hz, and $\pm 10\%$ continuous-frequency tunability.

better infer basic performance parameters and to assist in comparing benchmarking simulations. These calculations simulate performance in the actual geometry and are generated with a three dimensional particle-in-cell code (the LSP code from Mission Research Corporation). Measured waveforms generated by a recently delivered L-band tube are shown in Fig. 13. This tube produces ~185 MW in flat, 900-ns pulses with excellent frequency stability. The LSP code was essential during this tube's development. A new era in microwave tube design has emerged with the development of accurate three-dimensional models.

2.2.3. HEM magnetron. Backdoor microwave effects on electronics systems in modern weapons fall into three broad categories. Two categories are characterized by high peak power density and microwave formats that overwhelm the target system with an electric field that is high enough to cause circuit upset or burnout. In the third category, effects are caused by coupling spurious signals into the target system, akin to classical smart jamming, interference or spoofing[‡] techniques used by the EW countermeasures community. The DEW microwave pulse formats appropriate to the latter class of effects are generally distinguished from upset and damage pulse formats by lower peak power density thresholds but more specific requirements on frequency and amplitude modulations and

[‡]Low incident microwave levels can cause "interference" with the operation of threat weapon electronic systems, producing high levels of noise in sensitive circuitry to "mask" true signals. The incident microwave signal is said to "spoof" if it is tailored to "mimic" the true signal and to thereby produce false commands.

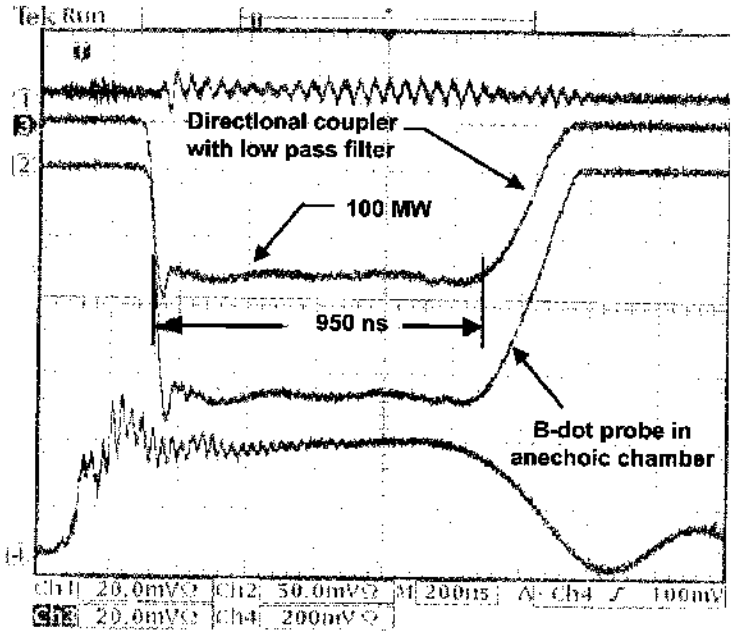

Fig. 13. Waveforms from the 185-MW L-band reltron: the top trace is the heterodyne (l.o. = 1.3 GHz) showing excellent frequency stability, and the second trace is the steady, flattop output power measured with a calibrated directional coupler. (The data are conditioned with a low-pass filter; higher harmonic content is know to be more than 13 dB below the primary L-band signal.) The third trace is the radiated power monitored with an uncalibrated, free-field B-dot, and the last trace is an uncalibrated profile of the Marx current.

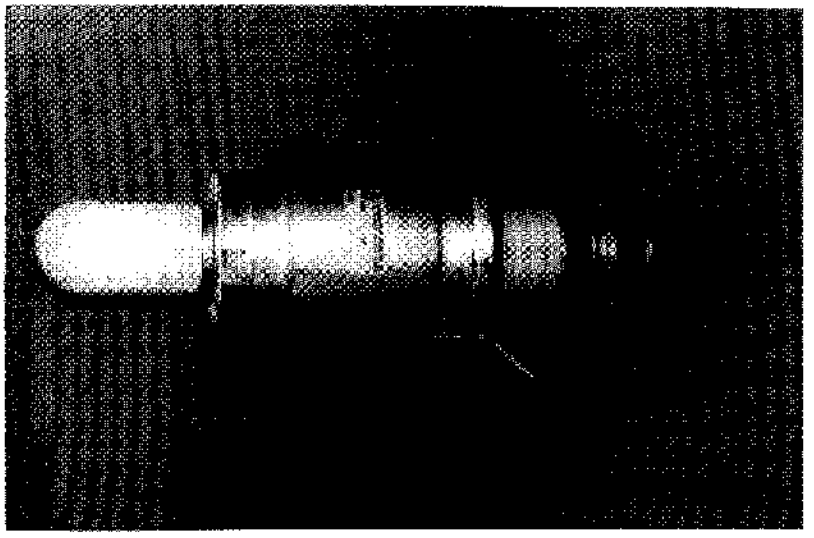

Fig. 14. Titan's L-band HEM magnetron. This is the highest-average-power magnetron that is commercially available.

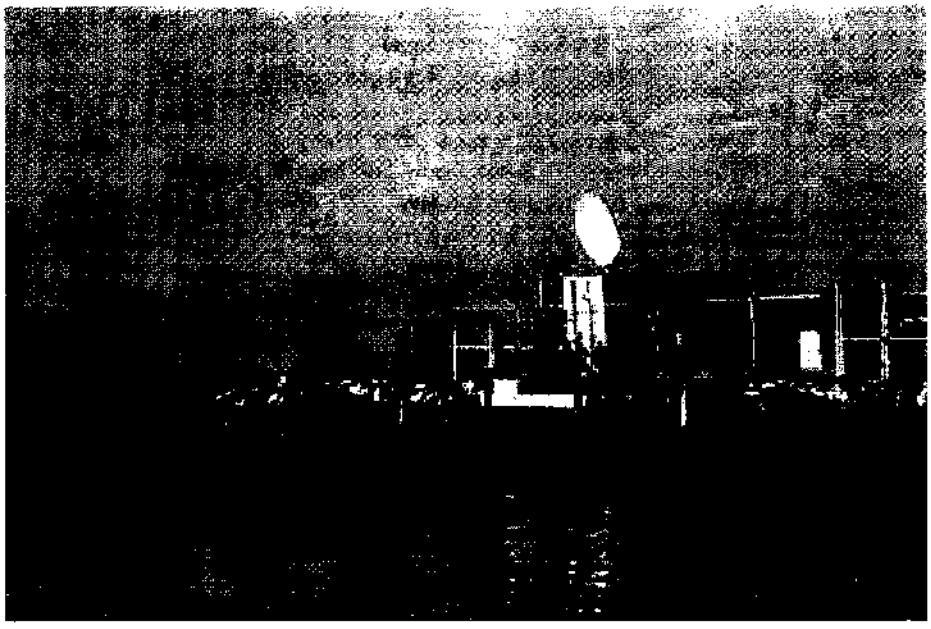

Fig. 15. The principal system elements of the ATD system are a power supply, a modulator, an HEM source, and an antenna. These components are supported by a control system and a cooling system. For the DTRA ATD ground-based system the power supply and operators' console(s) are housed in a shelter mounted on one flatbed trailer while the remaining components are mounted on another flatbed trailer (out of the field of view to the right). The system was designed to broadcast 2-MW peak power pulses with an average power of 300 kW for 30-s missions. This yields a peak fluence of 1 mW/cm^2 at a range of 2,400 m.

repetition rate. All three categories of effects can be induced by DEW systems based on high-power RF, narrow-band, pulsed HPM or long-pulse, high-energy microwaves (HEMs).

Titan has developed an HEM laboratory source and an HEM advanced technology demonstration (ATD) source for DEW purposes at its California Tube Laboratory. These HEM sources have efficiencies of approximately 85%. This high efficiency minimizes prime power and cooling requirements, thus significantly minimizing overall DEW system size and weight. The HEM magnetron, shown in Fig. 14, has produced 900-kW peak and 150-kW average powers and can easily be upgraded to 300-kW average power. The unique modulation characteristics of this magnetron can produce modulation effects of 30 MHz or greater in the target systems. More operational details are given in Table 6.

The ATD system shown in Fig. 15 combines the outputs of two 150-kW-average-output power magnetrons. The maximum peak output power obtained to date is 1.2 MW. The magnetrons with their respective magnet yokes each weigh about 200 lb, and each takes up about 4 ft^3. When combined their efficiency is over 76%, therefore together they absorb only 95 kW and are actively cooled. Variants of this RF system are suitable for Army, Navy, and Air Force missions.

Table 6. California tube laboratory HEM magnetron operational specifications

Parameter	Value
Frequency, fixed	915 MHz (890–920 MHz possible as well)
Power output	
Continuous wave	300-kW minimum
Pulse	600-kW peak (900 actually achieved)
	300-kW avg (nominal 50% duty)
Pulse width	10s of microseconds to 5 ms
Peak anode voltage	42 kV
Peak anode current	17 A
Beam efficiency	88% typical
Water-cooled anode	20 gpm typical
Filament	12 VAC, 200-A typical standby

3. Conclusions and Significance

The first laser and HPM DEWs are just now being deployed, and new threats emerging in the information age will sustain the need for continued DEW development and acceptance. The deployment of even more advanced DEW systems and in fact the DoD's intent to field more (or all) electric fighting platforms depend critically on the availability of compact, lightweight, efficient pulsed power subsystems and long-lived, reliable advanced power conditioning and front-end components.

Titan has been supporting U.S. directed energy programs by providing services and analysis and developing advanced technologies since the early 1980s. Today, Titan is the only U.S. industrial supplier of commercial HPM generators. We have advanced pulsed power and power electronics technology development programs involving intermediate and primary electrical energy storage, solid-state switching, power conditioning, electrical-to-microwave conversion, and novel microwave antennas underway now. Titan is focused on providing pulsed power and C4ISR (command, control, communications, computers, intelligence, surveillance, and reconaissance) solutions for national defense and is intent on maintaining its industrial leadership in military information technologies.

Acknowledgments

The authors recognize and acknowledge contributions made by Jim Benford, Jerry Levine, R. Bruce Miller, and David Blank to the development of the primary narrow-band microwave sources that were the precursors of much of the HPM and HEM technology that Titan offers today.

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TOWARDS A NEW ELECTROMAGNETICS
PART I: SOLUTION TO TESLA'S SECRETS AND THE SOVIET TESLA WEAPONS

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PART I

I am much indebted to Mr. Carey Briggs for furnishing references which strongly support the existence of scalar potential waves and scalar interferometry. Among those papers are Whittaker (1903), Nisbet (1955) , and other papers dealing with Hertzian potential theory. As ever, my profound gratitude is due Hal Crawford for his splendid illustrations which accompany this paper. I am also indebted to John Ratzlaff and the Tesla Book Company for graciously furnishing important Tesla references for me to analyze. My sincere thanks go to Messrs. Jim Beal and Williard Van de Bogart for furnishing important references on exoelectron emission and tectonic fault zones, and to Dr. Robert Beck for furnishing important material on the Rogers underground and undersea transmission system. Additional assistance was also received from Mr. Peter Kelly, Joe Siegeldorf, Joe Gambill, and Bob Beutlich. I am also very appreciative of the information furnished by Bob Jones and Vestigia on the beautiful Vestigia mystery light experiments.

PART II

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Bob Nelson, Berkeley, Calif.
Mildred Ratzlaff, Millbrae, Calif.

FOREWORD

The long-searched-for Tesla secrets have been solved by Tom Bearden. Part I contains the specific description of the solutions to Tesla's secrets and the Soviet Tesla weapons.

The present electromagnetic theory has several flaws, and it is these errors that have hidden the long-sought unified field theory. The explanations presented by the author provide clarity and understanding to related Tesla writings and patents.

Before the turn of the century, Nikola Tesla had discovered and was utilizing a new type of electric wave. Tesla repeatedly stated that his waves were non-Hertzian, and that his wireless transmissions did not fall off as the square of the distance. The author has found that the wave which Tesla was using is a longitudinal scalar wave, capable of many times the speed of light. When coupled with another scalar wave (Tesla wave),
the resulting vector wave can be the source of electromagnetic energy for electrical power, a protective force field, or a destructive weapon.

The booklet is well illustrated with special drawings by Hal Crawford. The bibliography includes corroborating information on all major points. Part II presents reprints or the entire subject matter of selected articles from the bibliography, plus additional references of importance. Articles are arranged in chronological order. Also included are nine patents by James Harris Rogers which were the basis of successful wireless communication during World War I. These principles of underground and sub-sea wireless were based on Tesla's discoveries.

Bearden's solutions are truly a major breakthrough, and an absolute necessity to the understanding of existing Tesla writings. It is also important that more should be known of this extraordinary individual, Thomas E. Bearden.

BIOSKETCH:

A nuclear engineer, wargames analyst, and military tactician, Lieutenant Colonel (Retired) Tom Bearden has over 26 years experience in air defense systems, tactics and operations; technical intelligence, anti-radiation missile countermeasures; nuclear weapons

employment, computerized wargames; and military systems requirements.

He is currently with the Alabama division of a large aerospace company where he is involved in determining the future requirements for laser weapons.

Lieutenant Colonel Bearden obtained a Master of Science degree in nuclear engineering from the Georgia Institute of Technology and a Bachelor of Science degree in mathematics from Northeast Louisiana University. He is also a graduate of the U.S. Army Command and General Staff College and several U.S. Army artillery and missile schools.

He has had direct experience with tube artillery and with the Ajax, Hercules, Hawk, and Patriot missile systems and the production of technical intelligence on Soviet surface-to-air missile systems for the U.S. Army/Department of Defense.

Tom holds a Sandan (third degree black belt) in Yoseikan aikido; is a singer, guitarist and songwriter; member of Mensa, Society for the Investigation of the Unexplained, Vestigia, the American Association of Meta-Science: and is on the board of governors of the U.S. Psychotronics Association. In addition, he is Alabama Director of a small nonprofit foundation, the Association of Distinguished American Scientists and is a MUFON adviser on nuclear engineering.

He also edits *Specula*, Journal of the American Association of Meta-Science.

Tom is primarily active as a theorist on UFOs, parapsychological and paranormal phenomena, and psychotronics. He is the author of a book, *The Excalibur Briefing*, Strawberry Hill Press, 2594 15th Avenue, San Francisco, California 94127 and has numerous technical papers dealing with new paradigm physics, paranormal phenomena, and Soviet psychotronic weapons.

Finally, Bearden's *Solutions to Tesla's Secrets and the Soviet Tesla Weapons* promises to be recognized in the future as a major contribution to our present technology.

JTR

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TESLA'S SECRET AND THE SOVIET TESLA WEAPONS

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With Special Drawings by Hal Crawford

Before the turn of the century, Nikola Tesla had discovered and was utilizing a new type of electric wave. Tesla repeatedly stated his waves were non-Hertzian, and his wireless transmissions did not fall off as the square of the distance. His discovery was apparently so fundamental (and his intent to provide free energy to all humankind was so clear) that it was responsible for the withdrawal of his financial backing, his deliberate isolation, and the gradual removal of his name from the history books.

By 1914 or so, Tesla had been successfully isolated and was already nearly a "nonperson." Thereafter Tesla lived in nearly total seclusion, occasionally surfacing (at his annual birthday party for members of the press) to announce the discovery of an enormous new source of free energy, the perfection of wireless transmission of energy without losses, fireball weapons to destroy whole armies and thousands of airplanes at hundreds of miles distance, and a weapon (the "Tesla Shield," I've dubbed it) that could provide an impenetrable defense and thus render war obsolete.

In my pursuit of Tesla's secret, it gradually became apparent to me that present orthodox electromagnetic theory is seriously flawed in some fundamental respects. One of these is in the definition and use of ϕ, the scalar electrostatic potential. It is this error which has hidden the long-sought unified field theory from the theorists.

In the theory of the scalar electrostatic potential (SEP), the idea is introduced of work accomplished on a charge brought in from a distance against the scalar field. The SEP is not a vector field, but is a scalar field. Indeed, scalar potential cannot of itself perform work on a charged mass; if it could do so, then tremendous force would exist on every mass due to the extremely high SEP of the vacuum itself. Only a differential of SEP between two spatial points can produce force or accomplish work. (Rigorously, a differential of scalar potential between two spatial points constitutes a vector. Only a vector can produce force and do work.)

Also, work can only be done on a mass. Further, it takes time* to move an electron or other charged mass between two spatial points, and so the work performed by a spatial differential of the ϕ-field requires time. Rigorously, the delta SEP is voltage, not SEP per se, and is directly related to

E field. The entire voltage concept depends on the work performed in moving a mass, after that mass has moved. The idea of "voltage" always implies the existence of a steady differential of ϕ between two spatial points for a finite length of time, and it also involves the assumption of a flow of actual mass having occurred. SEP, on the one hand, is always a single-point function; on the other hand, difference in potential (i.e., V) is always a two point function, as is any vector.

Yet many graduate level physics and electromagnetics papers and texts erroneously confuse ϕ and V in the static case! Such an interpretation is of course quite incorrect.

---

* *Two spatial points involve at least $\Delta t = \Delta L/c$ in time. All vectors and gradients involve 2 separated spatial points, and thus present timelines in 4-space. ϕ_4 is a point, not a line, in 4-space.*

Another common assumption in present EM theory -- that the electrostatic potential (ϕ_0) of the normal vacuum is zero -- has no legitimate basis. In fact, we know ϕ_0 is nonzero because the vacuum is filled with enormous amounts of fluctuating virtual state activity, including incredible charge fluctuations. And by virtue of its point definition, ϕ_0 must be the "instantaneous intensity" of these fluctuations -- but both in space and time. The scalar electrostatic potential is therefore the "instantaneous stress" on spacetime itself, and a measure of the intensity of the virtual state flux through a 4-dimensional spacetime point.

Potential theory was largely developed in the 1800's, before the theory of relativity. Time flowrate was then regarded as immutable. Accordingly, electrostatic "intensity" was chosen as "spatial intensity," with the connotation of "spatial flux density." This assumes a constant, immutable rate of flow of time, which need not be true at all if we believe relativity. Such a spatial "point" intensity is actually a "line" in 4-space, and not a 4-dimensional "point" at all. Thus the spatial potential -- ϕ_3 -- is a very special case of the real spacetime potential -- ϕ_4, or charge and electromagnetic theory today is accordingly a special case of the real 4-space electromagnetism that actually exists! Note also that charge is a 4-dimensional concept.

Now mass is a spatial, 3-dimensional concept. Rigorously, mass does not exist in time -- masstime exists in time. Mass and charge are thus of differing dimensionalities!

Also, according to quantum mechanics, the charge of a particle -- e.g., of an electron -- is due to the continual flux of virtual particles given off and

absorbed by the observable particle of mass. Thus charge also is conceptually a measure of the virtual flux density, and directly related to ϕ. Further, since the charge exists in time, it is the charge of a particle of spatial mass that gives it the property of masstime, or existing in time.

Here a great confusion and fundamental error has been thrown into the present EM theory by the equating of "charge" and "charged mass." As we have seen, the two things are really very different indeed.

To speak of a spatial "amount" of charge erroneously limits the basic EM theory to a fixed time flowrate condition (which of course it was considered to be, prior to Einstein's development of relativity). Thus when the limited present theory encounters a "relativistic" case (where the time flowrate changes), all sorts of extraordinary corrections must be introduced. The real problem, of course, is with the fundamental definitions of electrostatic potential and charge. The spatial "amount" of charge (i.e. the coulomb) as we presently erroneously use the term, is actually the spatial amount of observable "charged mass." To correct the theory, one must introduce the true 4-space SEP and separate the definitions of charge and charged mass.

Only when a mass is moved does one have work -- and voltage or vector fields. (The reason one has voltage and E field connected to a normal electrostatically charged object in the laboratory is because an excess of charged-particle masses are assembled on the object, and these masses are in violent motion! A true static charge would have no E field at all.)

Table 1. Some Present Theoretical Facts

- $Ø_3$-FIELD CONCEIVED BEFORE RELATIVITY

  - POINT FUNCTION IN SPACE
  - LINE FUNCTION IN SPACETIME
  - TIME FLOWRATE CONSIDERED IMMUTABLE
  - SPECIAL CASE OF $Ø_4, \ldots\ldots, Ø_N$

- GRADIENT BETWEEN TWO POINTS IN $Ø_3$ FIELD

  - PRODUCES VOLTAGE
  - PRODUCES E FIELD
  - MOVES ELECTRON
  - IS AN AREA IN 4-SPACE

- GRADIENT MAY BE BETWEEN SEPARATED POINTS IN TWO SUPERPOSED Ø-FIELDS

- Ø-FIELD CAN "MOVE" AT INFINITE VELOCITY*

* JACKSON, CLASSICAL ELECTRODYNAMICS, 2ND EDITION, P. 223

Table 2. Some Proposed $Ø_4$ Characteristics

- SPATIOTEMPORAL $Ø_4$ FIELD
  - STRESS ON SPACETIME
  - CAN CHANGE RATE OF FLOW OF TIME
- GRADIENT BETWEEN 2 POINTS IN $Ø_4$ FIELD
  - PRODUCES COMPLEX V_4
  - WILL MOVE ELECTRON IF
    - -- $V_3 \neq 0$, AND
    - -- $\nu_1 = \nu_2 = C$
  - WILL NOT MOVE ELECTRON IF
    - -- $V_3 = 0$, OR
    - -- $\nu_1 \neq \nu_2$
- GRADIENT MAY BE BETWEEN SEPARATED POINTS IN TWO SUPERPOSED $Ø_4$ FIELDS
- $Ø_4$ WAVE MOVES AT $0 \leq \nu_4 \leq \infty$
- $Ø_4$ WAVE IS COMPLEX AND LONGITUDINAL

ϕ-field need not involve observable mass accumulation, but only charge (virtual flowrate intensity) accumulation. Accumulated masses are like so many gallons of water; accumulated charge is like so much pressure on both the water (space) and the time in which the water is existing.

Now, if one varies the SEP solely as a point function, one would have a purely scalar complex longitudinal wave, and not a vector wave at all. This is the fundamentally new electrical wave that Tesla discovered in 1899.

Rigorously, all vector fields are two-point functions and thus decomposable into two scalar fields, as Whittaker showed in 1903. It follows that any vector wave can be decomposed into two scalar waves. By implication, therefore, a normal transverse EM vector wave, e.g., must simply be two coupled scalar (Tesla) waves -- and these scalars independently would be longitudinal if uncoupled. An ordinary transverse EM vector wave is thus two pair-coupled Tesla scalar longitudinal waves, and only a single special case of the much more fundamental electromagnetics discovered by Nikola Tesla.

A Tesla (scalar potential) wave -- i.e., a massless wave in pure ϕ_0, the stress of the spacetime medium would have very strange characteristics indeed. For one thing, since it moves in a complex 4-space, it has many more modes of movement than does a simple wave in 3-space. And for another thing, it need not be bound at all by the speed of (vector) light. In current theory, one ϕ_3-field does not directly interact or couple with other existing ϕ_3-fields except by simple superposition. Therefore presently the ϕ-field is considered to have no drag limitation at all, hence infinite velocity. (E.g., as stated in Jackson, Classical Electrodynamics, 2nd edition, page 223.)

Actually, a ϕ_4-wave can and will interact with some of the other existing ϕ_4-waves in the medium transversed, and this interaction can involve pair-coupling into EM vector fields and waves, an interaction not presently in the electrodynamics theory. The result of scalar pair-coupling creates a finite amount of vector "drag" on the ϕ_4-wave, so it then has less than infinite velocity. However, if this drag is small due to limited pair-coupling, the scalar wave's velocity through the slightly dragging medium still may be far greater than the speed of vector EM waves (light) in vacuum. On the other hand, if the pair-coupling is made severe, the ϕ-wave may move at a speed considerably below the speed of vector light waves in vacuum. The velocity of the ϕ_4-wave is thus both variable and controllable or adjustable (e.g., simply by varying its initial amplitude, which through a given medium changes the percentage of pair-coupling and hence the degree of drag on the scalar wave). The Tesla scalar wave thus can have either subluminal or superluminal velocity, in contradiction to present theory.

Note that the scalar wave also violates one of Einstein's fundamental postulates -- for the speed of our "new kind of light" wave is not limited to c, and need not be the same to every observer. Thus Tesla scalar waves lead to a new "superrelativity" of which the present Einstein relativity is only a highly special case!

Table 3. Tesla Waves Can:

- **ESTABLISH STANDING WAVES**
  - **in the earth**
  - **in the ionosphere**
- **TAP ENERGY FROM THE EARTH'S CORE**
- **TRAVEL FASTER OR SLOWER THAN LIGHT**
- **CHANGE RATE OF TIME FLOW**
- **AFFECT ALL FIELDS, INCLUDING GRAVITY**
- **COMMUTE BETWEEN VIRTUAL AND OBSERVABLE**

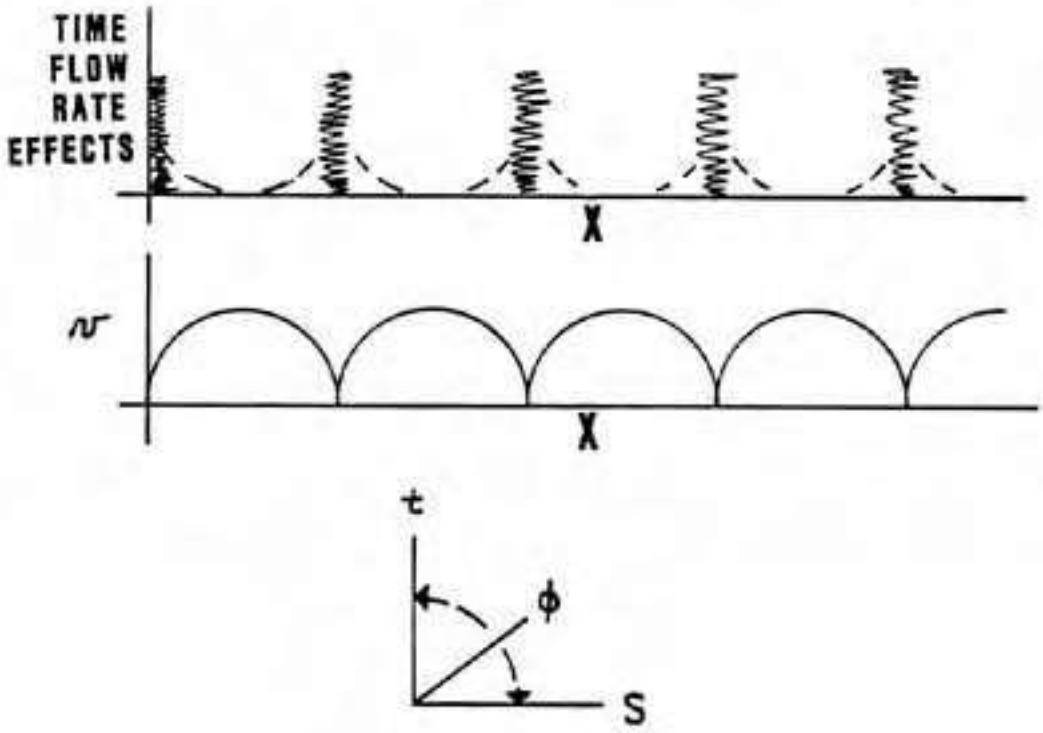

Figure 1. Tesla's Standing Columnar Wave

But let us now look for some subtle but real examples of scalar waves and scalar pair-coupling in nature. As is well known, a tectonic fault zone can provide anomalous lights, sounds, etc. from stresses, piezoelectrical activity, and telluric currents in the earth and through the fault zone. In examining the fault zone phenomena, I finally realized that a fault zone was literally a scalar interferometer i.e., if one can have scalar ϕ_4-waves, they can interfere, either constructively or destructively. Their interference, however, produces scalar pair-coupling into vector EM waves. This coupling may be at a distance from the interferometer itself, and thus the interferometer can produce energy directly at a distance, without vector transmission through the intervening space. Coupling of ϕ waves with the paired scalars comprising ordinary EM vector waves can also occur. If this triplex coupling forms additional EM vector waves 180 degrees out of phase, the ordinary EM wave is diminished or extinguished. If the scalar triplex coupling occurs so as to create vector EM waves in phase with the interacting vector EM wave, the amplitude of the ordinary vector wave is increased.

Scalar potential waves can thus augment or diminish, or create or destroy, ordinary EM waves at a distance by pair-coupling interference under appropriate conditions, and this is in consonance with the implications of Whittaker's fundamental 1903 work.

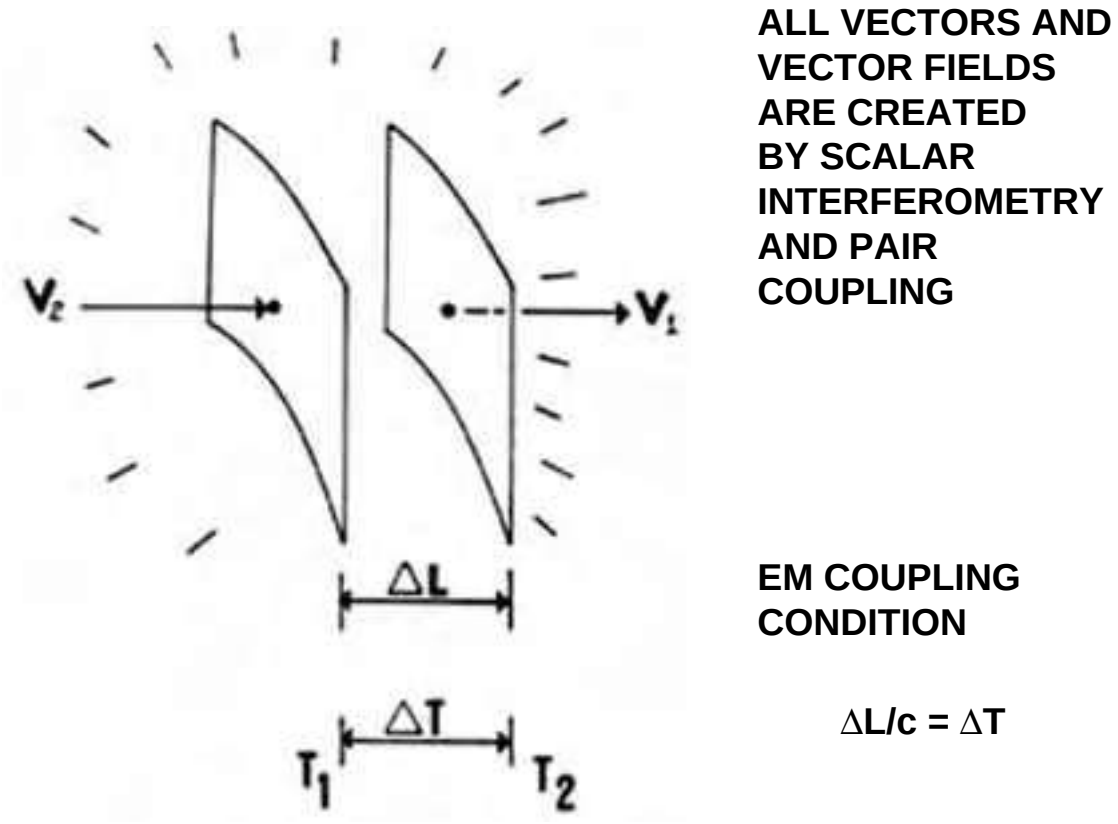

Figure 2. Pair Coupling: Producing EM at a Distance

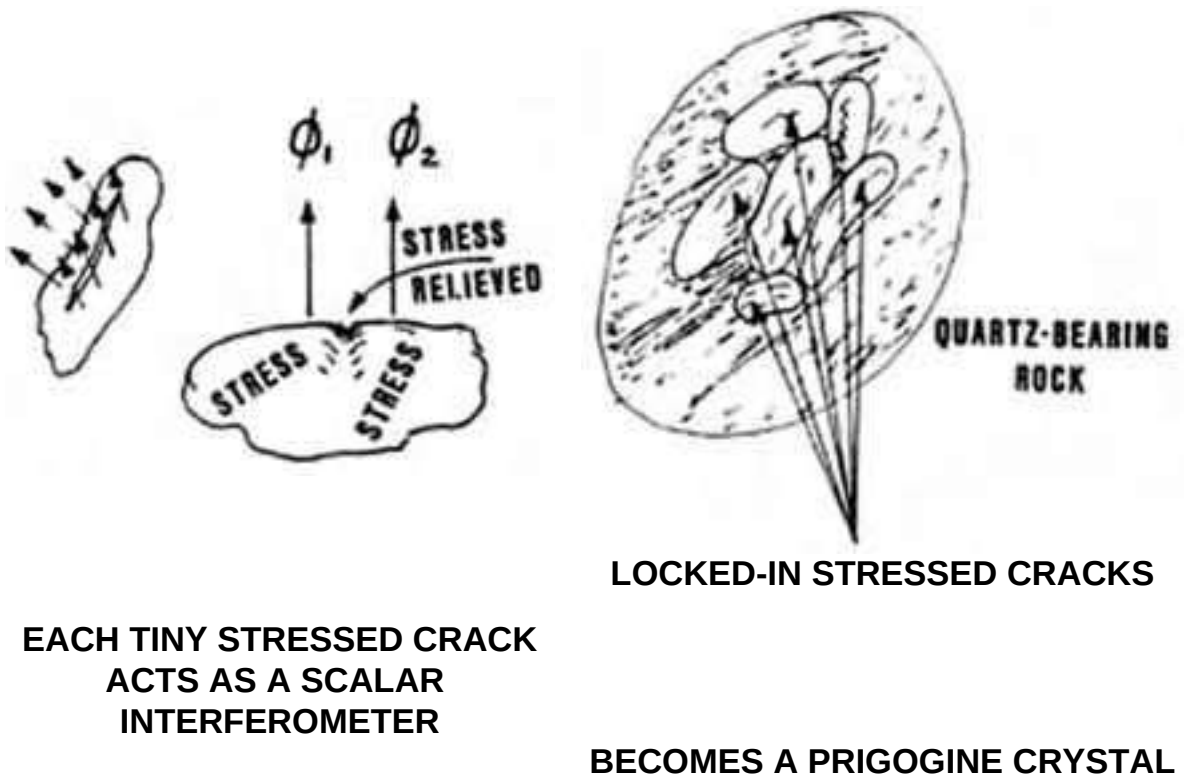

Figure 3. Natural Scalar Interferometers

An earthquake fault zone is such a scalar interferometer. Stresses and charge pileups exist in the plates on each side adjacent to the fault, with stress relief existing in the middle in the fault fracture itself. Since the rock is locally nonlinear, the mechanical stresses and electrical currents in it are also locally nonlinear. This results in the generation of multiple frequencies of ϕ_4-waves from each side of the fault interferometer, yielding two complex Fourier expansion patterns of scalar potential waves. On occasion these two Fourier-transformed scalar wave patterns couple at a distance to produce stable ordinary electromagnetic field in a 3-dimensional spatial pattern -- e.g., a stress light such as the Vestigia light covered in Part I of The Excalibur Briefing. Driven by the erratic two scalar Fourier expansion patterns of the scalar interferometer (whose input stresses normally slowly change), an erratic, darting, hovering "spooklight" of the variety studied by Vestigia is produced.

As the stresses change in each side of the interferometer, the distant scalar coupling zone is affected. Thus the stresslight moves and its form changes, but it may be relatively stable in form for seconds or minutes. Since the stresses in the rock may be intense, the stress light may involve an intense pair of ϕ-patterns coupling into the sphere or ball of vector EM energy. The atoms and molecules of the air in the region of the coupled stresslight ball thus become highly excited, giving off radiant energy as the excited states decay.

Since much of the piezoelectric material in the stressed rocks is quartz grains, the features of quartz are of particular interest. Each little quartz grain is itself highly stressed, and has stress cracks. It is therefore a little scalar interferometer. Further, quartz is transparent to infrared and ultraviolet; and the random orientation of all the quartz scalar interferometers may also form a Prigogine system far from thermodynamic equilibrium. If so, this system can tap into highly energetic microscopic electromagnetic fluctuations to produce large-scale, ordered, relatively stable patterns of electromagnetic energy at a distance.

In short, all of this lends support to the formation of relatively stable but somewhat erratic patterns of electromagnetic energy at a distance from the fault itself. In the atmosphere, such scalar interferometers could form in clouds or even in the air or between clouds and earth. If so, such rare but occasional "weather" scalar interferometers could account for the rare phenomenon of ball lightning. The intense energy of the ball of lightning, as compared to the lesser energy of an earthstress light, could well be due to the enormous electrical charges between clouds or between cloud and earth, available to fuel the scalar interferometer. Very probably it is this phenomenon which gave Tesla the clue to scalar wave interferometry.

Thus such phenomena as earthstress lights, ball lightning, and the Tesla system of wireless transmission of energy at a distance with negligible losses and at speeds exceeding the speed of light may be explained. They are complex, however, and involve fundamental changes to present electromagnetic theory. These changes include utilizing 4-space scalar

electrostatic potentials, scalar waves, pair coupling, ordinary 3-dimensional Fourier expansion, the Prigogine effect, and the properties of piezoelectric materials in rocks.

Since the scalar potential also stresses time, it can change the rate of flow of time itself. Thus it affects anything which exists in time -- including the mind, both of the individual and at various levels of unconsciousness. Therefore the same functions that result in earthstress lights also affect mind and thought, and are in turn affected by mind and thought. This is the missing ingredient in Persinger's theory that UFO's are correlated with, and a result of, fault zones and earth stresses. While Persinger seems to feel this is a "normal physics" explanation, it indeed involves a paranormal explanation.

The time-stressing ability of the true ϕ scalar wave also explains the interaction of such earthstress lights with humans and human intent, as noted by other researchers. (E.g., the lights that repeatedly seemed to react to the observers, as detailed by Dr. Harley Rutledge in his epoch-making Project Identification, Prentice-Hall, 1981.)

These ideas in condensed form comprise the concepts required to violate the speed of light and produce an ordinary electromagnetic field at a distance, using scalar interferometry, without losses -- as Tesla had done in his wireless transmission system which he had tested prior to 1900 and had perfected by the 1930's. Scalar interferometry can give stable regions of EM or "light energy" at a distance without losses, particularly as detailed in the beautiful Vestigia experiments, and it is within our grasp to utilize the new effects. Indeed, any stress crack in a material can result in the scalar potential interferometer effect. Exophoton and exoelectron emission -- poorly understood but already known in fatiguing of materials -- must be at least partly due to the scalar interferometer effect.

However, one additional caution should be advanced. Normal movement of electrons allows so much "sideplay" movement of the electrons -- and there is so much such sideplay electron motion in the surrounding vicinity -- that pair coupling is almost instantaneous for small waves. Thus orbital electrons in atoms seem to absorb and emit vector EM photons. Actually they also emit some percentage of scalar waves as well. Since a scalar wave is comprised exclusively of disturbance in the virtual state, it need not obey the conservation of energy law. Further, a scalar wave of itself does not "push electrons" or other charges; hence it is nearly indetectable by present detectors. Ionization detectors such as a Geiger counter tube, e.g., are exceptions if the scalar wave encountered is fairly strong. In that case sufficient triplex coupling with the ionized gas occurs to produce additional ionization or charge, breaching the tube's cutoff threshold and producing a cascade discharge of electrons and voltage which is detected. But weak scalar waves are presently indetectable by ordinary instruments. However, these small scalar waves are detectable by sensitive interferometry techniques e.g., such as an electron interferometer. Since the use of such instruments is quite rare, then indeed we have been living immersed in a sea of scalar waves without knowing it.

Finally, the percentage of scalar waves produced by changes in charged

mass pileups can be increased by utilizing charged mass streaming. Essentially the charged masses must be moved suddenly, as quickly as possible, at or near the complete breakdown of the medium. For this reason, Tesla utilized sparkgaps in his early transmission systems, but also found that he could induce ionized media to "breakdown" in such fashion by a slow growth process. One of his early patented atmospheric wireless transmission systems is based on this fact. However, it was necessary to use a very high voltage, insuring extreme stress on the medium and hence some spillover stress onto time itself. In other words, ϕ_3 is always an approximation; at sufficiently high spatial stress, sufficient spillover ϕ_4 exists to give Tesla scalar waves. For this reason, Tesla used very high voltages and extremely sharp discharges to give "streaming" of the charged masses and thus high percentages of ϕ_4 waves. This suggests that the breakdown of dielectrics is a much richer phenomenon than is presently allowed for in the conventional theory.

To summarize, electrostatic potential -- ϕ-field is stress on the spacetime medium at a four-dimensional point. I. e. , it is a sort of pressure on the medium, but pressure on all four dimensions, not just on the three spatial dimensions. Thus in the new standard theory, ϕ_4 may have complex values. In addition, a ϕ-wave is to be interpreted as a scalar longitudinal wave in complex spacetime -- directly in ϕ_0, the normal average 4-space stress itself. And charge and charged mass must be recognized as two separate concepts. This is the gist of what I finally recognized about Nikola Tesla's work and fundamental discovery.

This is exciting, for it means that Tesla stress waves can affect either space or time individually, or both space and time simultaneously, or even oscillate back and forth between primarily affecting time and primarily affecting space, Tesla's waves were actually these ϕ-field scalar waves. As such, they were fundamentally different from ordinary electromagnetic waves, and had entirely different characteristics, just as Tesla often stated. E. g., a Tesla wave can either move spatially, with time flowing linearly; move temporally only (sitting at a point and waxing and waning in magnitude -- but changing the rate of flow of time itself in doing so, and affecting gravitational field, fundamental constants of nature, etc,), or move in a combination of the two modes. In the latter case, the Tesla wave moves in space with a very strange motion -- it oscillates between (1) spatially standing still and flexing time, and (2) moving smoothly in space while time flows smoothly and evenly. I.e., It stands at one point (or at one columnar region), flexing for a moment; then slowly picks up spatial velocity until it is moving smoothly through space; then slows down again to a "standing column," etc. This is Tesla's fabulous "standing columnar wave."

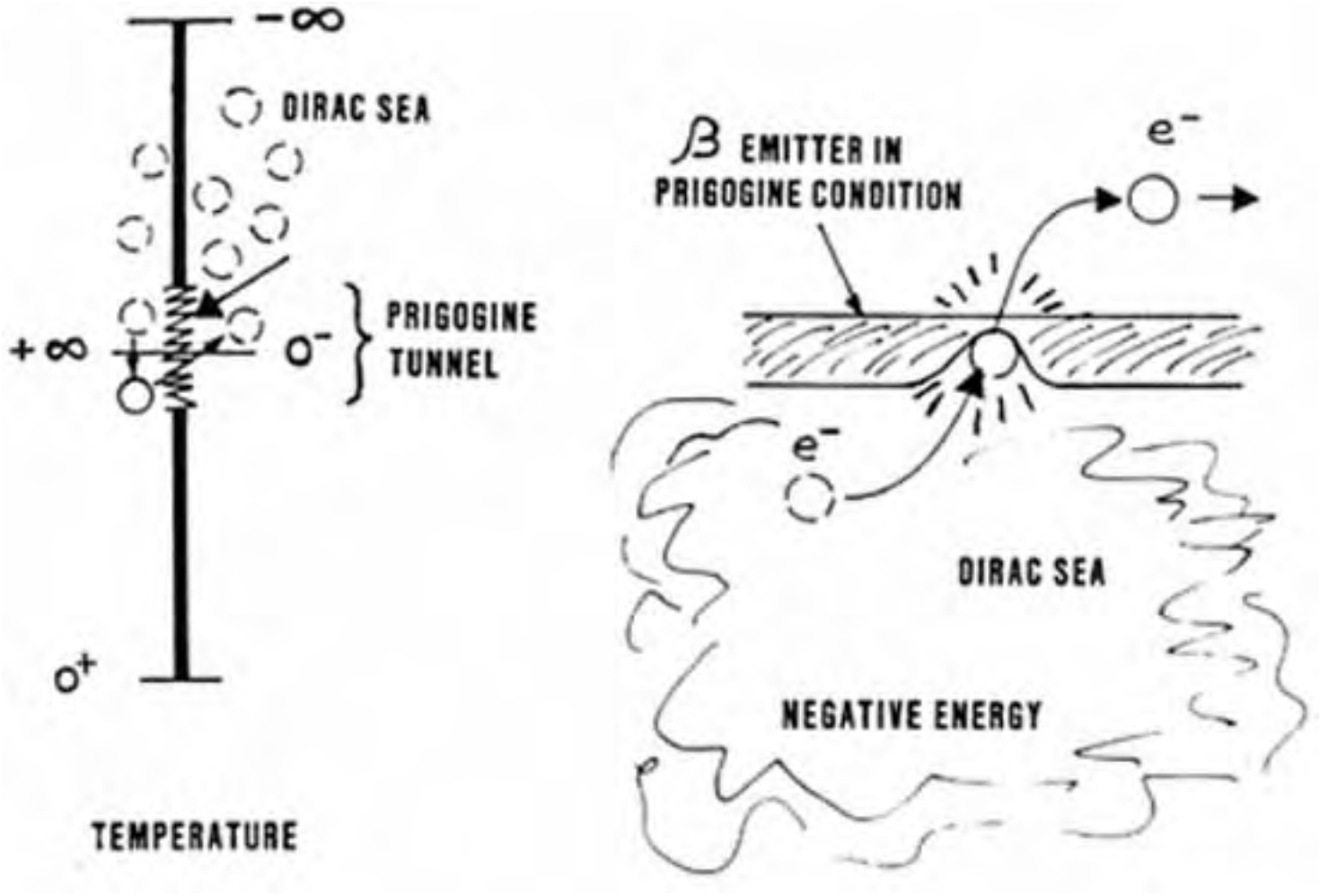

Figure 4. Exoelectric Emission

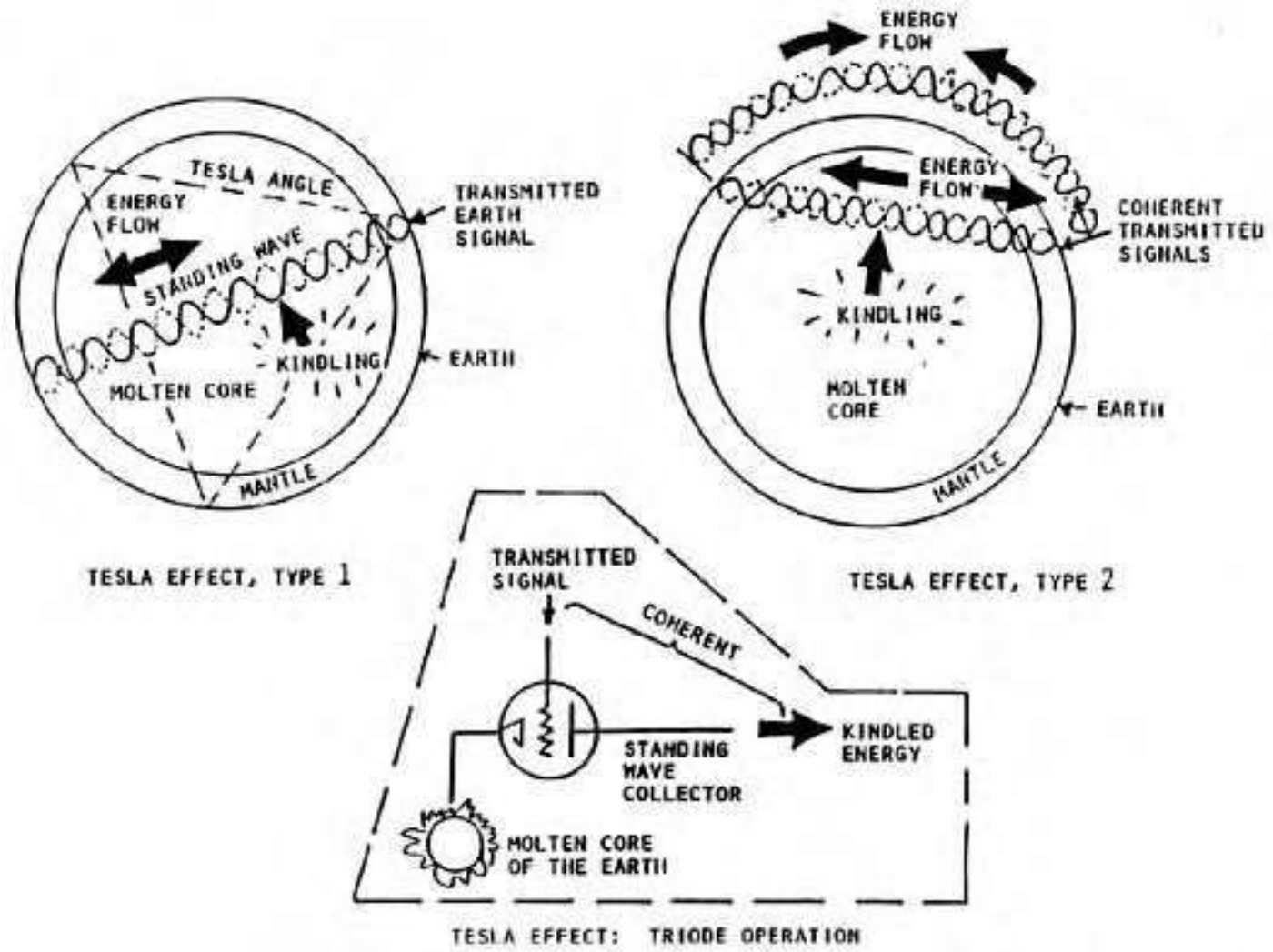

Figure 5. The Tesla Effect

Another wild characteristic of the Tesla wave is that it can affect the rate of flow of time itself; hence it can affect or change every other field including the gravitational field -- that exists in time flow. It can also affect all universal constants, the mass of an object, the inertia of a body, and the mind and thoughts as well! All of these exist in the flow of time, and they are affected if the time stream in which they exist is affected. This was the awful secret that Tesla partially discovered by 1900, and which he came more and more to fully realize as he pursued its nature and its ramifications into the 1920's and 1930's.

Tesla also found he could set up standing ϕ-field waves through the earth. He in fact intended to do so, for he had also discovered that all charges in the highly stressed earth regions in which such a standing wave existed produced ϕ-fields which would feed (kindle) energy into the standing ϕ-field wave by pair coupling. I.e., normal vector field energy would "assemble" onto the scalar matrix wave by means of pair-coupling. Thus by transmitting a scalar standing wave into the earth, he could easily tap the fiery scalar fields produced in the

molten core of the planet itself, turning them into ordinary electromagnetic energy. In such case, a single generator would enable anyone to put up a simple antenna and extract all the free energy desired.

When Tesla's alarmed financial backers discovered this was his real intent, they considered him a dangerous madman and found it necessary to ruthlessly stop him at all costs. And so his financial support was withdrawn, he was harassed in his more subtle patent efforts (and the patents themselves were adulterated), and his name gradually was removed from all the electrical textbooks. By 1914 Tesla, who had been the greatest inventor and scientist in the world, had become essentially a nonperson.

A few other persons in the early 1900's also were aware that potential and voltage are different. And some of them even learned to utilize Tesla's ϕ-field, even though they only vaguely understood they were utilizing a fundamentally different kind of electromagnetic wave. For example, James Harris Rogers patented an undersea and underground communications system which Tesla later confirmed utilized Tesla waves. The U.S. secretly used the Rogers communications system in World War I to communicate with U.S. submarines underwater, and to communicate through the earth to the American Expeditionary Force Headquarters in Europe. The Rogers system was declassified after the War and very shortly after that, it had mysteriously been scrubbed off the face of the earth. Again, potential stress waves -- Tesla waves -- were eliminated and "buried."

Probably the most brilliant inventor and researcher into Tesla's electromagnetics was T. Henry Moray of Salt Lake City, Utah. Dr. Moray actually succeeded in tapping the limitless zero-point energy of vacuum (spacetime) itself. By 1939, Dr. Moray's amplifier contained 29 stages and its output stage produced 50 kilowatts of power from vacuum. Interestingly, another 50 kilowatts could be tapped off any other stage in the device -- which consequently could have produced almost 1.5 megawatts of electrical power! Dr. Moray's epoch-making work was suppressed also. His device -- which represented over 20 years of heartbreaking accumulation of 29 working tubes from thousands made -- was destroyed by a Soviet agent in 1939, but not before the agent had obtained the drawings for building the tubes and the device itself. Today the Moray amplifier is a standard component of many of the Soviet secret superweapons and Tesla weapons.

In the 20's and 30's, Tesla announced the final perfection of his wireless transmission of energy without losses even to interplanetary distances. In several articles (e.g., H. Winfield Secor, "Tesla Maps Our Electrical Future, " Science and Invention, Vol. XVII, No.12, pp. 1077, 1124-1126), Tesla even revealed he used longitudinal stress waves in his wireless power transmission. Quoting from the article, "Tesla upholds the startling theory formulated by him long ago, that

the radio transmitters as now used, do not emit Hertz waves, as commonly believed, but waves of sound." "He says that a Hertz wave would only be possible in a solid ether, but he has demonstrated already in 1897 that the ether is a gas, which can only transmit waves of sound; that is such as are propagated by alternate compressions and rarefactions of the medium in which transverse waves are absolutely impossible." The wily Tesla did not reveal, of course, that such scalar waves nearly always immediately pair-coupled into vector waves when produced by normal means. Tesla himself was working with longitudinal scalar waves.

Table 4. Rogers' Undersea and Underground Communication System

- **SECRETLY USED BY U.S. IN WWI**
- **COMMUNICATED TO SUBS UNDERWATER**
  - **- ANY DEPTH, UP TO 30 KHZ**
  - **- REDUCED DEPTH, >30 KHZ**
- **COMMUNICATED TO EXPEDITIONARY HQ OVERSEAS**
  - **- 5,000 TIMES STRONGER THAN AERIAL**
  - **- STATIC-FREE**
- **DECLASSIFIED IN 1919**
  - **- TO REVOLUTIONIZE COMMUNICATIONS**
  - **- TO END ALL SURFACE ANTENNAS**
- **MYSTERIOUSLY "LOST"**
- **REDISCOVERED AND "LOST" THREE TIMES AFTER WWII**

continued

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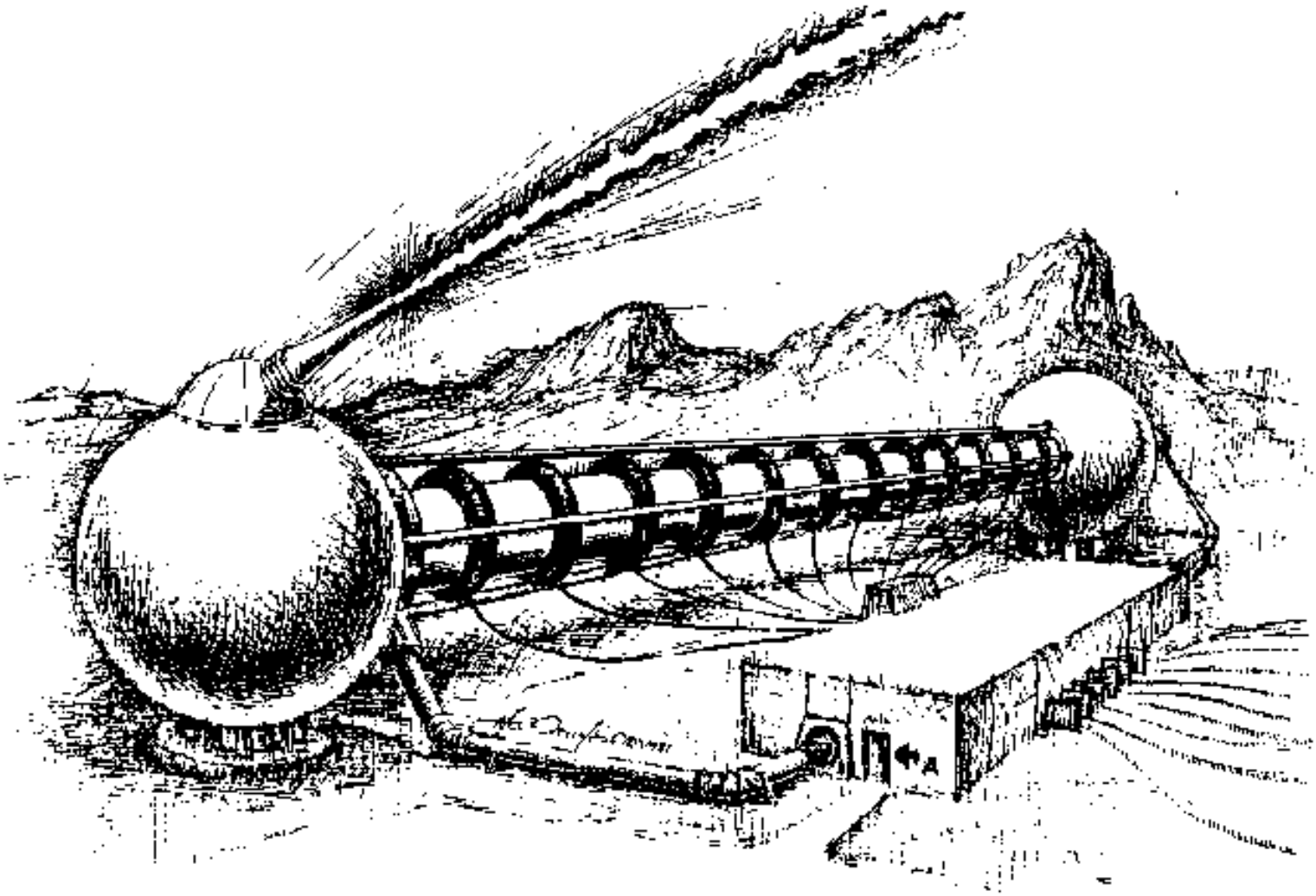

Scalar Potential Interferometer

Figure 6. Multimode Tesla Weapon

In the 1930's Tesla announced other bizarre and terrible weapons: a death ray, a weapon to destroy hundreds or even thousands of aircraft at hundreds of miles range, and his ultimate weapon to end all war -- the Tesla shield, which nothing could penetrate. However, by this time no one any longer paid any real attention to the forgotten great genius. Tesla died in 1943 without ever revealing the secret of these great weapons and inventions.

Unfortunately, today in 1981 the Soviet Union has long since discovered and weaponized the Tesla scalar wave effects. Here we only have time to detail the most powerful of these frightening Tesla weapons -- which Brezhnev undoubtedly was referring to in 1975 when the Soviet side at the SALT talks suddenly suggested limiting the development of new weapons "more frightening than the mind of man had imagined." One of these weapons is the Tesla howitzer recently completed at the Saryshagan missile range and presently considered to be either a high-energy laser or a particle beam weapon, (See Aviation Week & Space Technology, July 28, 1980, p. 48 for an artist's conception.)

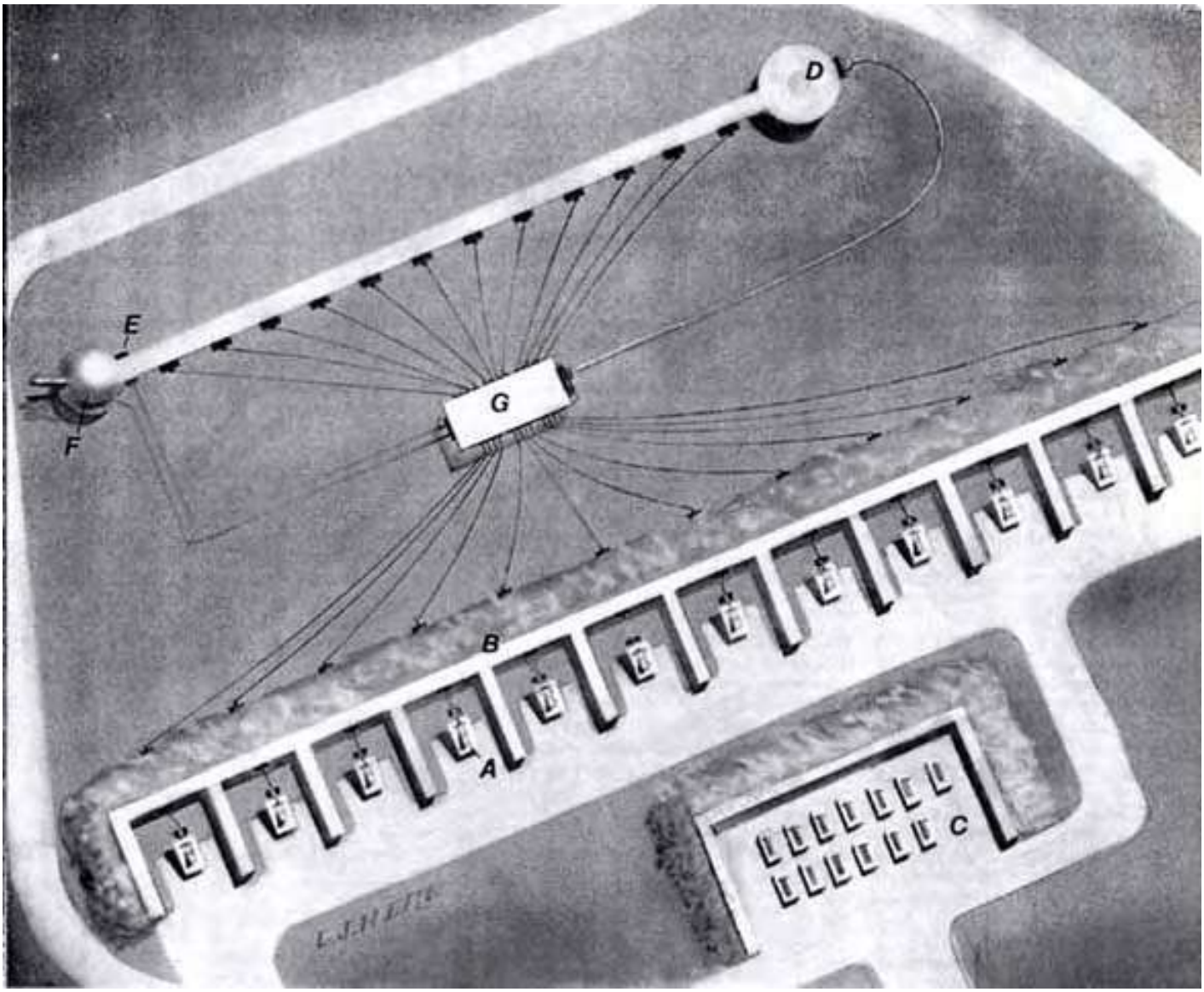

Aviation Week & Space Technology July 28, 1980

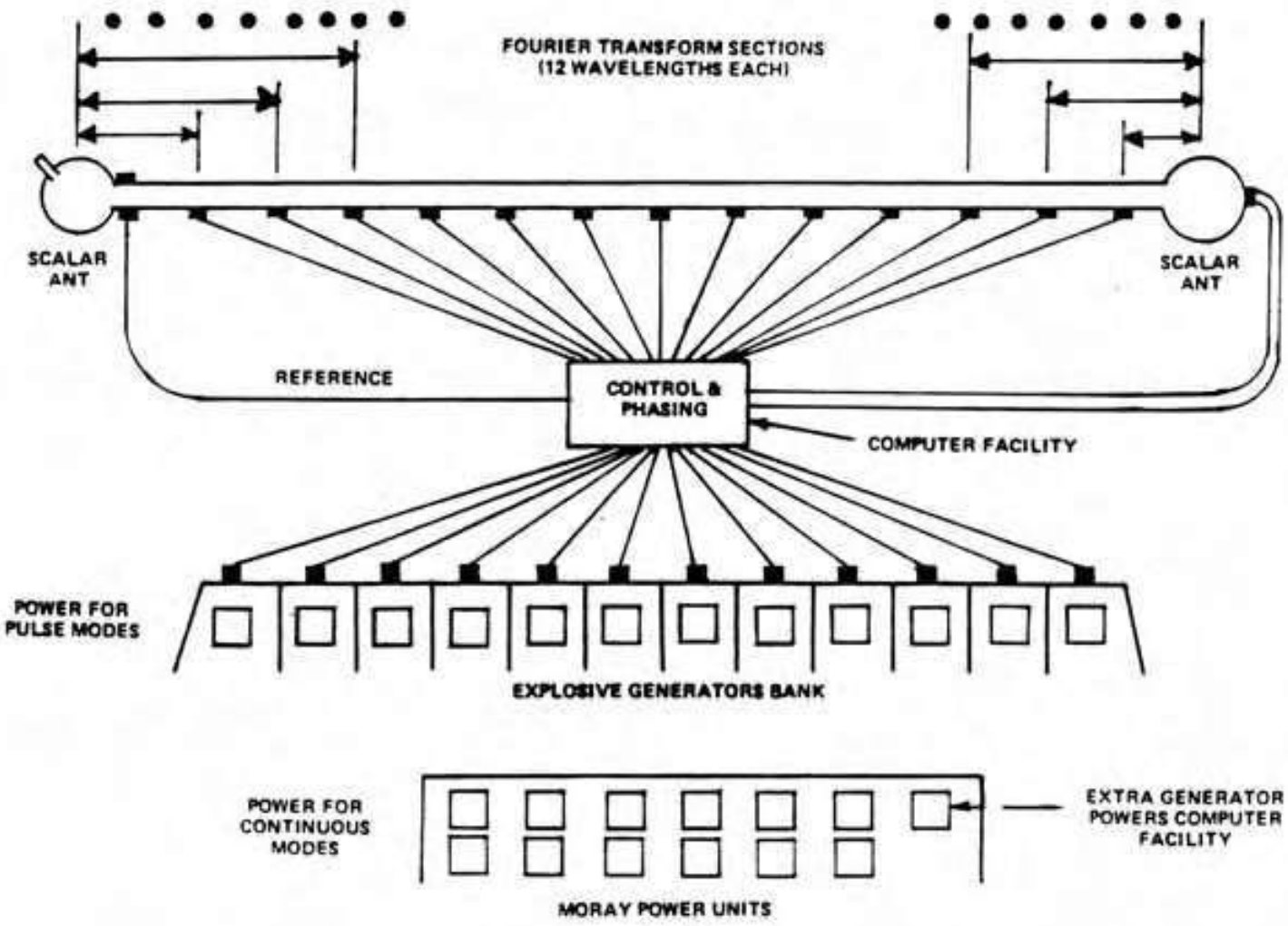

Figure 7. Tesla Weapons at Saryshagan

The Saryshagan howitzer actually is a huge Tesla scalar interferometer with four modes of operation. One continuous mode is the Tesla shield, which places a thin, impenetrable hemispherical shell of energy over a large defended area. The 3-dimensional shell is created by interfering two Fourier-expansion, 3-dimensional scalar hemispherical patterns in space so they pair-couple into a dome-like shell of intense, ordinary electromagnetic energy. The air molecules and atoms in the shell are totally ionized and thus highly excited, giving off intense, glowing light. Anything physical which hits the shell receives an enormous discharge of electrical energy and is instantly vaporized -- it goes pfft! like a bug hitting one of the electrical bug killers now so much in vogue.

If several of these hemispherical shells are concentrically stacked, even the gamma radiation and EMP from a high altitude nuclear explosion above the stack cannot penetrate all the shells due to repetitive absorption and reradiation, and scattering in the layered plasmas.

In the continuous shield mode, the Tesla interferometer is fed by a bank of Moray free energy generators, so that enormous energy is available in the shield. A diagram of the Saryshagan-type Tesla

howitzer is shown in figure 7. Hal Crawford's fine drawing of the interferometer end of the Tesla howitzer is shown in figure 6. Hal's exceptional rendition of the Tesla shield produced by the howitzer is shown in figure 8.

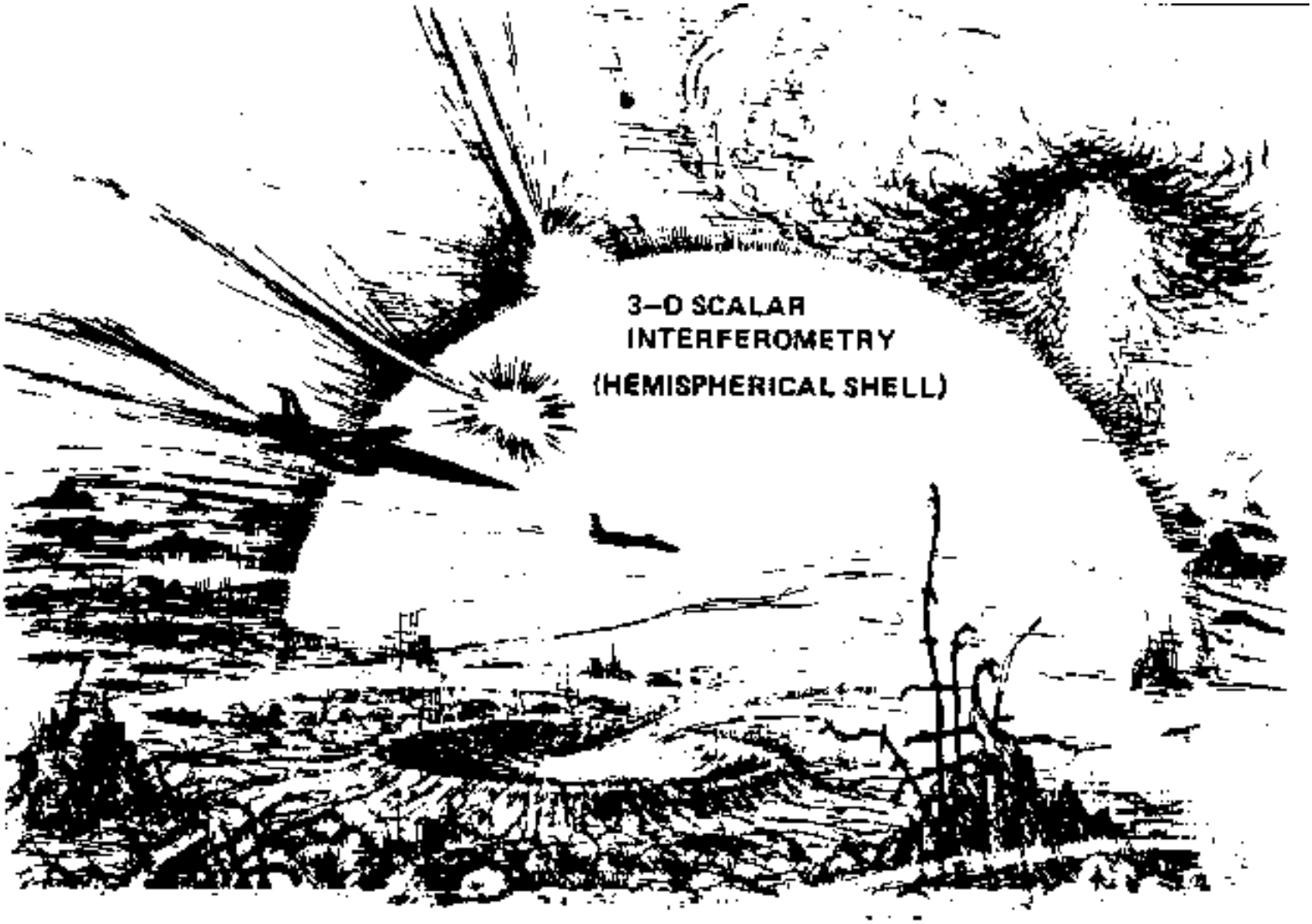

Figure 8. The Tesla Shield

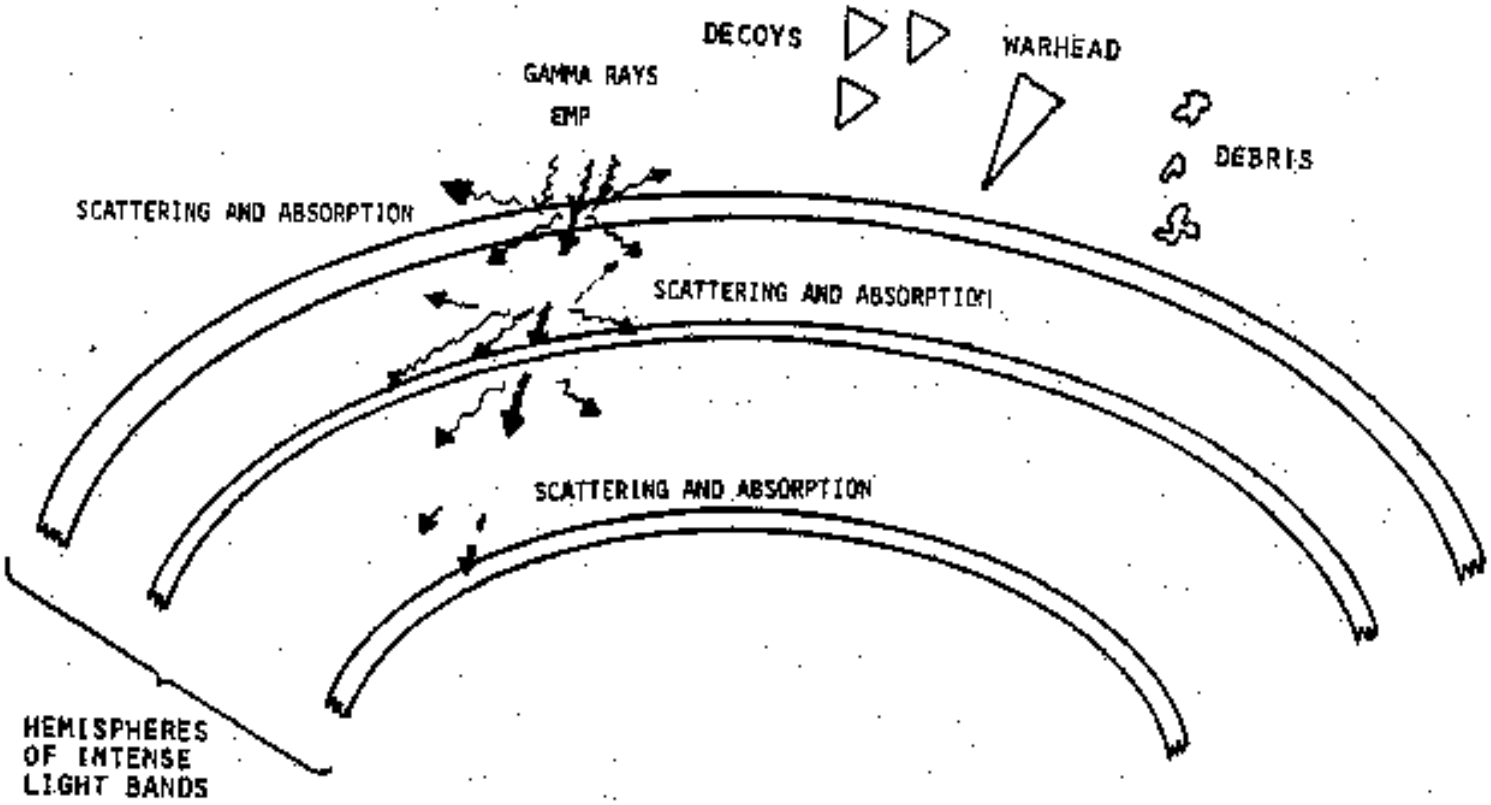

Figure 9. Tesla Terminal Area Defense System

In the pulse mode, a single intense 3-dimensional scalar phi-field pulse form is fired, using two truncated Fourier transforms, each involving several frequencies, to provide the proper 3-dimensional shape (Figure 10). This is why two scalar antennas separated by a baseline are required. After a time delay calculated for the particular target, a second and faster pulse form of the same shape is fired from the interferometer antennas. The second pulse overtakes the first, catching it over the target zone and pair-coupling with it to instantly form a violent EMP of ordinary vector (Hertzian) electromagnetic energy. There is thus no vector transmission loss between the howitzer and the burst. Further, the coupling time is extremely short, and the energy will appear sharply in an "electromagnetic pulse (EMP)" strikingly similar to the 2-pulsed EMP of a nuclear weapon.

This type weapon is what actually caused the mysterious flashes off the southwest coast of Africa, picked up in 1979 and 1980 by Vela satellites. The second flash, e.g., was in the infrared only, with no visible spectrum. Nuclear flashes do not do that, and neither does superlightning, meteorite strikes, meteors, etc. In addition, one of the scientists at the Arecibo Ionospheric Observatory observed a gravitational wave disturbance -- signature of the truncated Fourier pattern and the time-squeezing effect of the Tesla potential wave -- traveling toward the vicinity of the explosion.

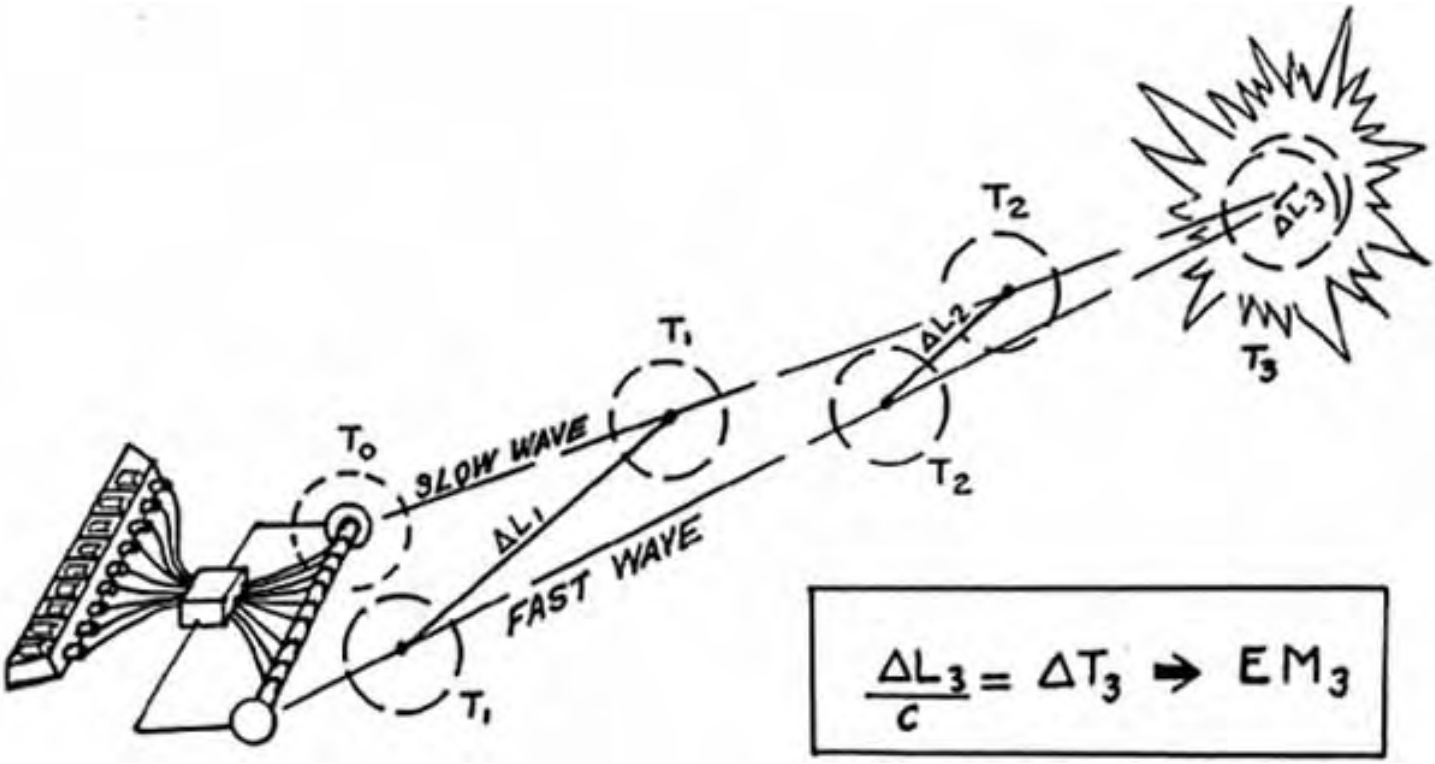

TESLA HOWITZER
(SCALAR INTERFEROMETER)

Figure 10. "Nuclear" Flashes off the Coast of Africa

Lithuania - 10 Sep 1976 - British European Airways Flight #831 between Moscow and London

CIA Report Released under FOIA

Figure 11. Continuous Tesla Fireball

The pulse mode may be fed from either Moray generators or -- if the Moray generators have suffered their anomalous "all fail" malfunction -- ordinary explosive generators. Thus the Tesla howitzer can always function in the pulse mode, but it will be limited in power if the Moray generators fail.

In the continuous mode, two continuous scalar waves are emitted -- one faster than the other -- and they pair-couple into vector energy at the region where they approach an in-phase condition. In this mode, the energy in the distant "ball" or geometric region would appear continuously and be sustained -- and this is Tesla's secret of wireless transmission of energy at a distance without any losses. It is also the secret of a "continuous fireball" weapon capable of destroying hundreds of aircraft or missiles at a distance. An example of a Soviet

test of this mode of operation is shown in figure 11.

Witness to a super weapon?

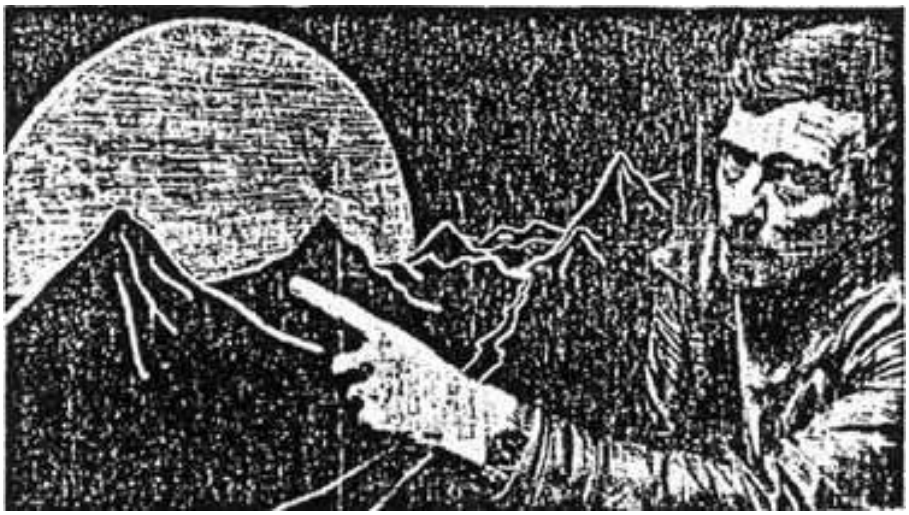

Nick Downie describes the strange lurid glow that flared silently over the Hindu Kush

THE SUNDAY TIMES, 17 AUGUST 1980

(Multiple incidents in Sept., 1979)

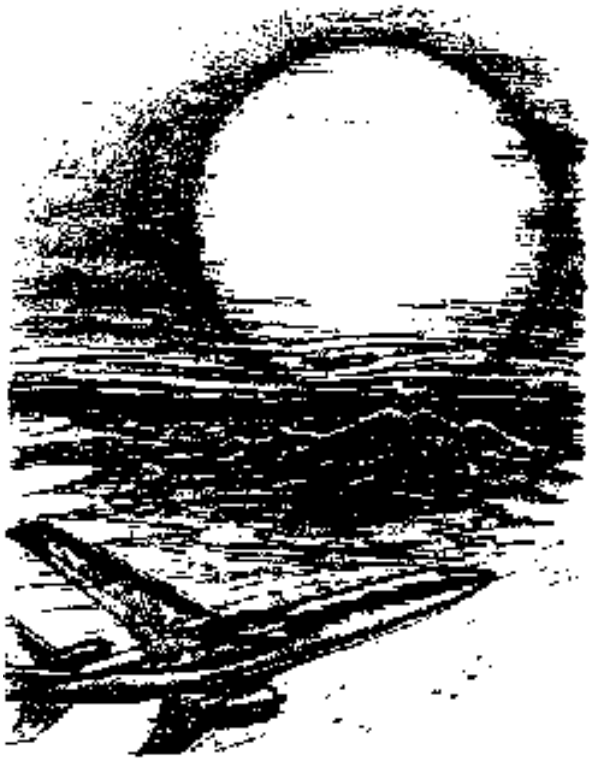

TEHERAN, IRAN 17 JUNE 1966

SEEN FROM NEAR MEHRABAD AIRPORT

OBSERVED 4-5 MINUTES

SEEN BY 2 AIRCRAFT

CIA REPORT RELEASED UNDER FOIA

Figure 12. Tesla EMP Globe

The volume of the Tesla fireball can be vastly expanded to yield a globe which will not vaporize physical vehicles but will deliver an EMP to them to dud their electronics. A test of this mode is shown in figure 12. (See also Gwynne Roberts, "Witness to a Super Weapon?", the London Sunday Times, 17 August 1980 for several other tests of this mode at Saryshagan, seen from Afghanistan by British TV cameraman and former War Correspondent Nick Downie.)

If the Moray generators fail anomalously, then a continuous mode limited in power and range could conceivably be sustained by powering the interferometer from more conventional power-sources such as advanced magnetohydrodynamic generators.

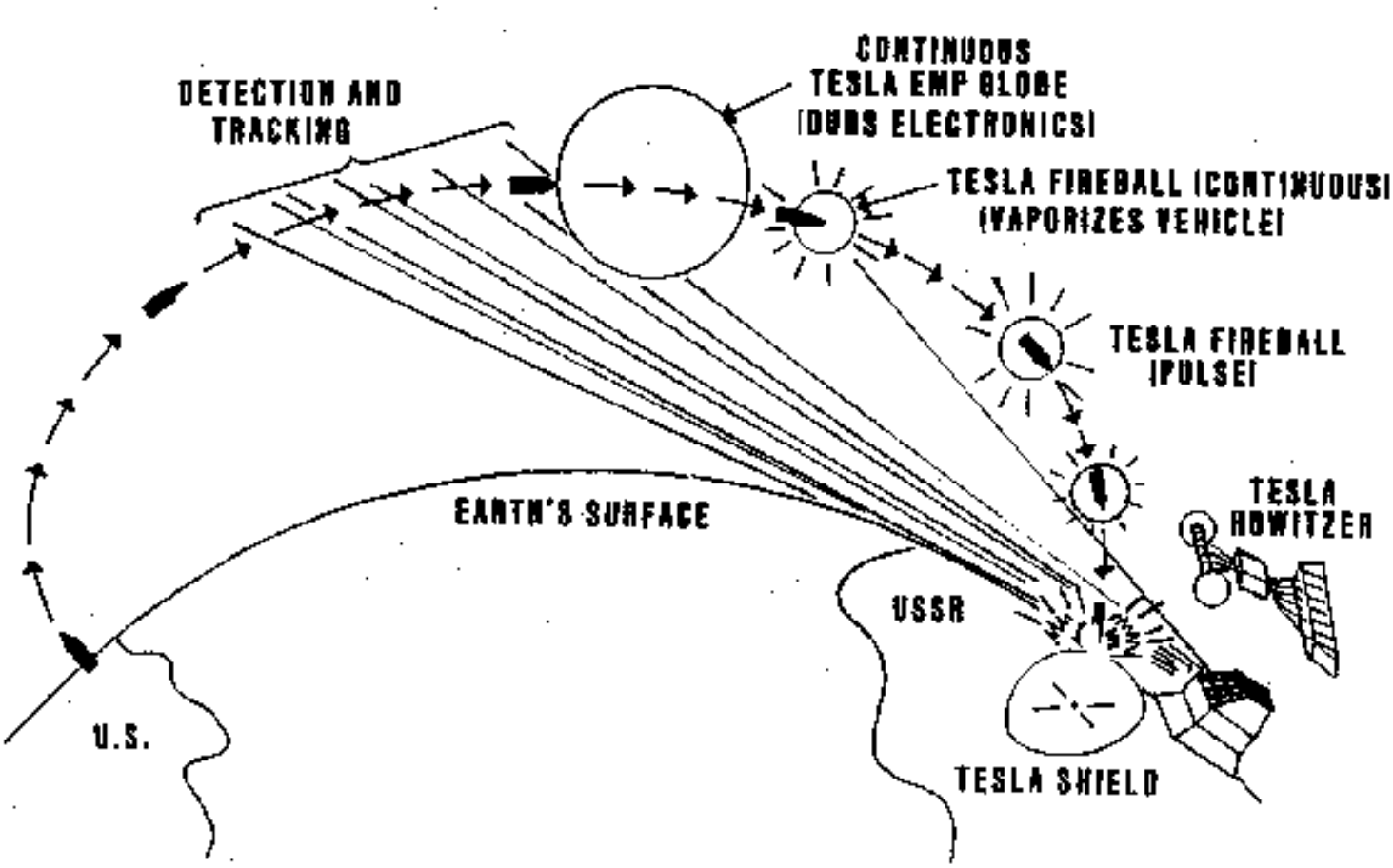

Figure 13. Tesla ABM Defenses

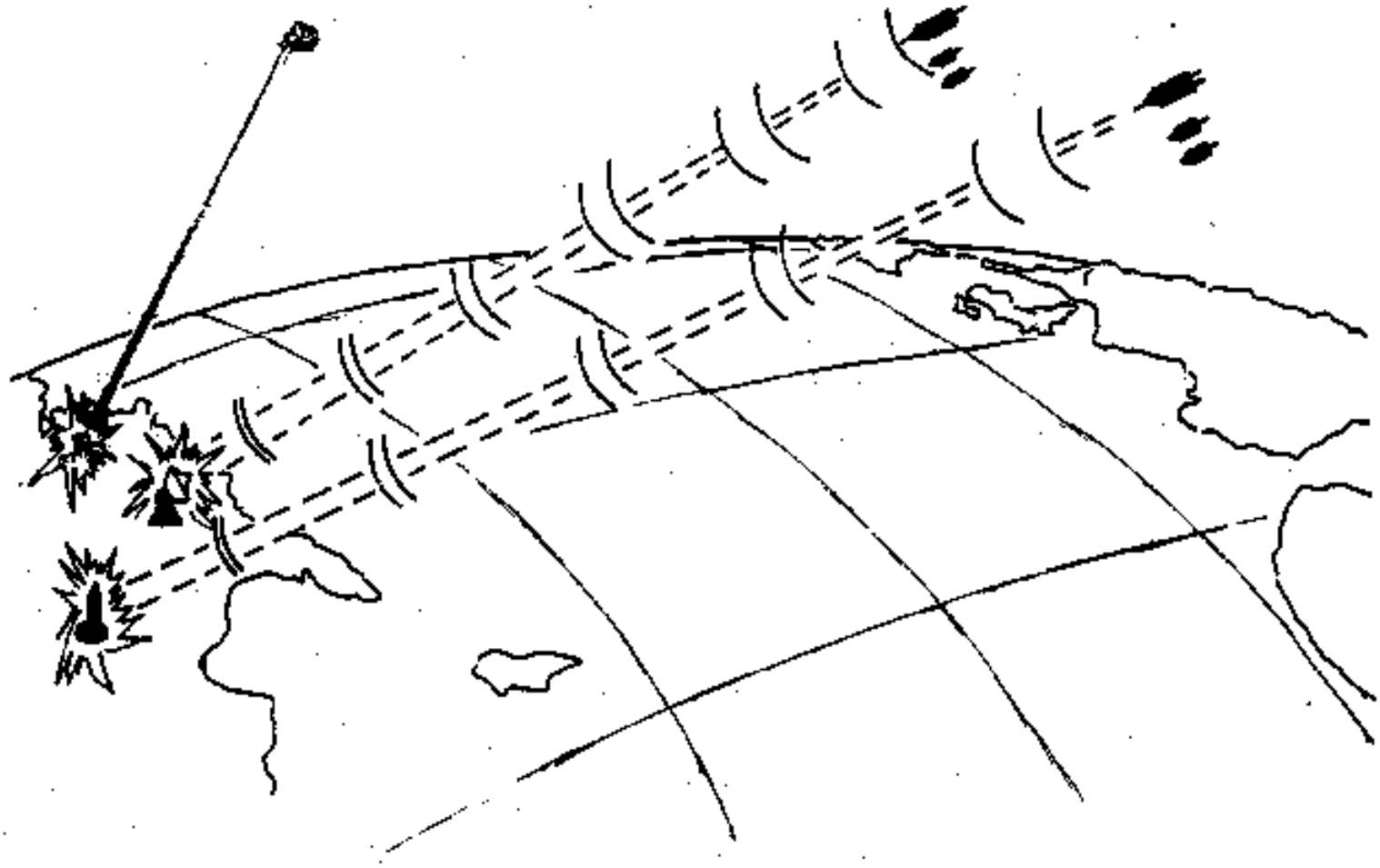

Figure 14. Moray/Tesla Technology: Star Wars Now

Typical strategic ABM uses of Tesla weapons are shown in figure 13. In addition, of course, smaller Tesla howitzer systems for anti-tactical ballistic missile defense of tactical troops and installations could be constituted of more conventional field missile systems using paired or triplet radars, of conventional external appearance, in a scalar interferometer mode.

With Moray generators as power sources and multiply deployed reentry vehicles with scalar antennas and transmitters, ICBM reentry systems now can become long range "blasters" of the target areas, from thousands of kilometers distance (figure 14). Literally, "Star Wars" is liberated by the Tesla technology. And in air attack, jammers and ECM aircraft now become "Tesla blasters." With the Tesla technology, emitters become primary fighting components of stunning power.

The potential peaceful implications of Tesla waves are also enormous. By utilizing the "time squeeze" effect, one can get antigravity, materialization and dematerialization, transmutation, and mindboggling medical benefits. One can also get subluminal and superluminal communication, see through the earth and through the ocean, etc. The new view of phi-field also provides a unified field theory, higher orders of reality, and a new super-relativity, but detailing these possibilities must wait for another book.

With two cerebral brain halves, the human being also has a Tesla scalar interferometer between his ears. And since the brain and nervous system processes

avalanche discharges, it can produce (and detect) scalar Tesla waves to at least a limited degree. Thus a human can sometimes produce anomalous spatiotemporal effects at a distance and through time. This provides an exact mechanism for psychokinesis, levitation, psychic healing, telepathy, precognition, postcognition, remote viewing, etc. It also provides a reason why an individual can detect a "stick" on a radionics or Hieronymus machine (which processes scalar waves), when ordinary detectors detect nothing. Unfortunately there is not room to develop the implications of this human Tesla interferometry in detail, for that must wait for yet another book, presently in its initial stages, that Hal Crawford and I are writing.

Table 5. Orders of Reality

- **PHOTONS ARE**
  - **> PAIR-COUPLED SCALARS**
  - **> VELOCITY-LIMITED TO C**
  - **> CARRIERS OF T**

- **PHOTON INTERACTION**
  - **> IS UBIQUITOUS**
  - **> PRODUCES $\dot{T}$ = C**
  - **> YIELDS 1st ORDER REALITY**

- **SCALAR O WAVES**
  - **> NOT VELOCITY-LIMITED**
  - **> YIELD HIGHER ORDER REALITIES**

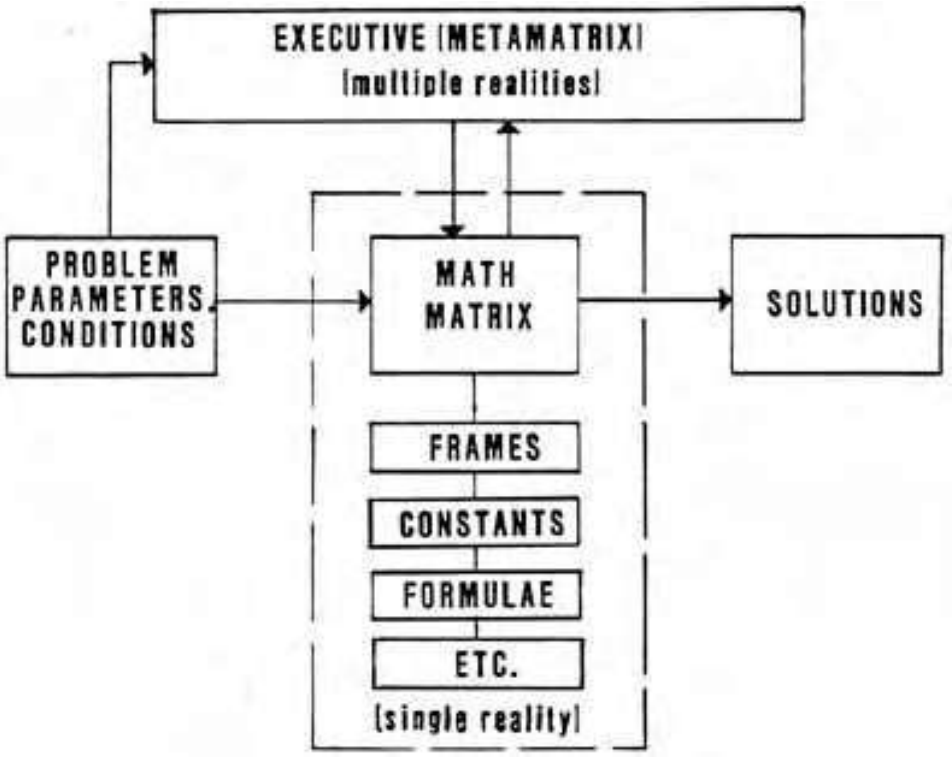

Figure 15. Implications of Tesla Potential

At the July 1981 U.S. Psychotronics Association's Annual Conference in Dayton, Ohio, I presented the first rough paper on the Tesla secret and scalar

interferometry. A videotape of the presentation was made and will shortly be available. I am also scheduled to make a special presentation at the Alternate Energy Conference in Toronto, Canada in latter October, 1981. A professional, videotaped two-hour presentation on this subject is also being prepared. Wide distribution of the material through the international underground physics and technology network has already been made. This time, God willing, Tesla's secret will not be suppressed for another 80 years!

And perhaps it is not yet too late. The material has cost me (now) some 16 years of agonizing labor and nearly $100,000 of my own personal funds. No orthodox university, scientific group, foundation, or governmental agency would support such an effort, either financially or otherwise. Indeed, most ordinary journals will not even accept material on such matters. Nonetheless, the area is of overwhelming importance and I truly believe Tesla's lost secret will shortly affect the lives of every human being on earth.

Perhaps with the free and open release of Tesla's secret, the scientific and governmental bureaucracies will be. shocked awake from their slumber, and we can develop defenses before Armageddon occurs. Perhaps there is hope after all -- for even Brezhnev, in his strange July, 1975 proposal to the SALT talks, seemed to reveal a perception that a turning point in war and weaponry may have been reached, and that human imagination is incapable of dealing with the ability to totally engineer reality itself. Having tested the weapons, the Soviets must be aware that the ill-provoked oscillation of timeflow affects the minds and thoughts -- and the very lifestreams and even the collective species unconsciousnesses -- of all lifeforms on earth. They must know that these weapons are two-edged swords, and that the backlash from their use can be far more terrible to the user than was the original effect to his victim.

If we can avoid the Apocalypse, the fantastic secret of Nikola Tesla can be employed to cure and elevate man, not kill him. Tesla's discovery can eventually remove every conceivable external human limitation. If we humans ourselves can elevate our consciousness to properly utilize the Tesla electromagnetics, then Nikola Tesla -- who gave us the electrical twentieth century in the first place -- may yet give us a fantastic new future more shining and glorious than all the great scientists and sages have imagined.

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The Tom Bearden Website

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PART III: CLARIFYING THE VECTOR CONCEPT

by

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TOWARD A NEW ELECTROMAGNETICS

Part III: Clarifying the Vector Concept

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-- IMPLICATIONS --

Some of the fundamental concepts of the new Tesla electromagnetics are presented. The new concepts have startling implications:

(1) No force or force field exists as such in vacuum.

(2) Hertzian (transverse) electromagnetic waves do not travel through the vacuum, just as Tesla stated.

(3) Forceless, massless Tesla (scalar) longitudinal waves actually transit the vacuum. Tesla called them "electrical sound waves."

(4) At present there are actually four different FUNDAMENTAL TYPES of vectorial entities in physics, erroneously confused as one and the same.

(5) Tesla longitudinal scalar waves are also "time" waves and can affect anything and everything that exists in time.

(6) The fundamental constants of nature (which exist in time) can be altered by Tesla scalar waves, which oscillate the values of the constants.

(7) Every vector and scalar has an internal substructure, which can be independently affected and changed. This allows the direct engineering of the virtual state and the vacuum itself.

(8) All observable forces (electrical, mechanical, gravitational, etc.) arise in, on, and OF the actual substructure of the "accelerating mass particle" itself, not as an "external" massless force or force field applied "to" a mass .

(9) Physical reality itself -- and the "physical laws of nature"

can be deliberately changed and engineered.

(10) All "physical reality" is totally internal to the physical changes of the mass particles of the detector system of the observer.

(11) Relativity's speed of light limitation applies only to the changes of the basic mass particles of the detecting instrument.

(12) Detection of superluminal effects cannot be accomplished by a "single stage" or "single shift " (single interaction) detector .

(13) Detection of superluminal effects is permitted by "multiple stage" or "multiple shift" interactions where the last interaction is a conventional interaction of photon vs. detector particle. (The two-slit apparatus for detection of electron diffraction is an example. First, the superluminal DeBroglie waves interact with the slits, which are "tuned" toward the electron's DeBroglie wavelength. The interaction with TWO slits produces subluminal interference effects, which then interact back upon the physical electron. The apparatus is thus an electron interferometer capable of detecting superluminal waves by a two-stage interaction).

(14) Interference is the most common first-stage superluminal interaction to accomplish "downshifting" superluminal entities to luminal or subluminal velocities. Superposition of superluminal "phase" waves (such as deBroglie waves, which individually always move faster than the speed of light) interferes the waves to create a subluminal group velocity, which may then interact with an ordinary mass particle in the detection system.

(15) Any otherwise physical vector must exist as an unzipped (segmented) or "shadow" vector in vacuum. "Radiation" of a vector EM wave from the electron gas in an antenna into vacuum results in the "choking off" of the mass of the transversely oscillating electrons in the antenna. Since the spinning electron mass is the "zipper" that makes or comprises the physical vector in the first place, this throttling of the mass flow unzips the E and B vectors, leaving whirling (massless magnetic scalar potential) segments of massless charge flux (massless electrostatic scalar potential). This unzipped whirling pattern of charge flux (scalar massless A/Ø) is what radiates into vacuum and propagates through it. This is a special kind of

scalar wave pattern, not a physical or vector wave.

(16) The spin of a charged particle is the mechanism for integrating or "zipping together" the individual virtual fragments of a shadow vector into a real (observable) vector. For "uncharged particles" such as neutrons, it is the spins of its virtual charged components. that accomplish the integration or zipping.

(17) All fundamental charged particles are constantly accelerated. There is no such thing as an "unaccelerated" particle, except as a gross average over time or length. Further, all of them are spinning.

(18) All changes to and from a physical vector or scalar system must arise in and come from its own internal substructure, which is zipped to its spinning particle of mass.

(19) All fundamental particles are charged internally. That is, they are dynamic assemblages of smaller charged particles. If the average sum of the total internal charge is essentially zero over some finite, small increment of time, the particle is externally uncharged. If the sum is not essentially zero, the particle is also externally charged.

(20) There are no static physical things in existence. In physical reality, something appears "static" only at a particular level. Upon sufficiently fine examination, it is composed of accelerating parts, and thus comprised of "fluctuations."

(21) Since (a) the basic physical (mass) vector consists of a "smeared particle," where particle and smear are inseparable, (b) the conceptual particle also is accelerated, and (c) the "smearing" is for a small increment of time and a small increment of length; then the basic constituency of "physical reality" is inseparable "force x time x length," or action. The basic "quantum" of physical change is thus comprised of action.

(22) Since to "detect" we must "stop" the action, separate or split the quantum into two pieces ("canonical" pieces) , and compare (measure) one piece by throwing away the other, then each physical observable must have a differential operator (the "separating agent") corresponding to it. This accounts for the fundamental postulate of quantum mechanics whereby every observable has a corresponding operator. Further, since what remains is totally relative to what was split out and thrown away, physical change

is totally "relative." This accounts for the fact that observed reality is relative, each part to each other.

(23) As a special case, we may assume that we can evaluate a physical change at a point (without length). If so, when we discard length, the remaining basic vector is momentum. This approximation holds only so long as the system to which it is applied essentially does not change over the quantal fragment of length discarded -- i.e., it holds for the linear case. Conservation of momentum, then, is violated when sufficient nonlinearity in length is present.

(24) As a second special case, we may assume that we can evaluate a physical change in a spatial manner (without time). If so, when we discard time, the remaining basic vector is energy (has the units of energy or work). This approximation holds only so long as the system to which it is applied essentially does not change over the quantal fragment of time discarded -- i.e., it holds for the linear case. Conservation of energy, then, is violated when sufficient nonlinearity in time is present. Since a "virtual change" a priori is defined as a total nonlinearity in the observer's quantal time increment but not outside it, then virtual interactions can and do violate conservation of energy within that time increment, but not out of it -- so long as the time interval itself is considered linear. If the time interval is sufficiently nonlinear, then the virtual change may result in violation of the conservation of energy externally to the time increment. In that case, an "observable change" results .

(25) As a third special case, we may assume that we can evaluate the "instantaneous value" of a physical change at a static point in space. To do so, we must discard both time (to be instantaneous) and length (to be at a spatial point), and the remaining basic vector is force. This approximation holds only so long as the system to which it is applied essentially does not change over the quantal fragment of time or the quantal fragment of length discarded. Conservation of force, then, is violated when sufficient nonlinearity in time or length is present.

(26) A new conservation of energy law is required, one which unites the present conservation of energy law with an altered form of the conservation of charge law. Briefly, the total equivalent of mass,

observable energy, and massless charge (anenergy) is conserved.

(27) All AL and At fragments are produced and destroyed one at a time, in the action fissioning of a single quantum of action (detection process). Each ∇L and ∇t is discretized but not quantized. Since quanta do not superpose, the "external universe" is continually created and destroyed in the detector's mass system, one quantum at a time, at a very high rate. This interpretation gives physical meaning to the creation and annihilation operators of quantum mechanics.

(28) Since the detecting mass system is itself continually created and destroyed one quantum at a time, ultimately all is mind changes, and only mind changes. The observer's life, mind, and being transcend all materialistic interpretations of reality -- as indeed does the very fact of the "existence" of a perceived external universe.

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TOWARD A NEW ELECTROMAGNETICS
PART III: CLARIFYING THE VECTOR CONCEPT

-- Electrical Physics Presently Has a Mindset --

In examining the foundations of geometry, mechanics, and electromagnetics, it becomes strikingly clear that substantial -- even grave theoretical errors were made early on and perpetuated into the existing theory. These errors are now so firmly entrenched that they form a part of the "mindset" of almost all physicists, engineers, and scientists.

So ingrained are these errors and inconsistencies that the orthodox scientist/theoretician finds it almost impossible to break out of them.

The present mindset is analogous to the Newtonian mindset which so fiercely resisted the new ideas of relativity, shortly after the turn of the century. However, after a few scientists formulated the rules and theory of the "relativity mathematics game," a new generation of students, not yet so firmly engrained in the Newtonian mindset, could grasp the new relativity when their teachers expounded it.

In this short series of papers[1,2] I will roughly outline where the founders of mechanics and electromagnetics went wrong, and indicate the way to correct the fundamental errors. In addition, I will briefly point out some of the implications, and speak of some direct experimental proof.

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PART III: CLARIFYING THE VECTOR CONCEPT

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2. Bearden, T. E., "Solutions to Tesla's Secrets and the Soviet Tesla Weapons," Tesla Book Co., 1981. Also Ratzlaff , John T., "Reference Articles for Solutions to Tesla's Secrets," Tesla Book Co., 1982.

3. Note we are applying the rule, "A thing is that which it does, and it does that which it is." Actually this is one statement of a fourth fundamental law of logic not incorporated by Aristotle. See Bearden, "A Conditional Criterion for Identity, Leading to a Fourth Law of Logic," DTIS report, available through the National Technical Information System, Port Royal Road, Springfield, VA 22161.

4. Specifically, the resulting theory becomes a curtailed, special case of the much more fundamental electrodynamics and electromagnetics that actually exist
.

5. We point out here that measuring a field of force existing in the electron gas in a probe of the measuring instrument is not at all the same thing as measuring a force in the vacuum, nor does it establish that a force exists in vacuum. Indeed, it is already well known that the FIELD concept itself will not withstand rigorous logical examination. For a discussion rather clearly showing the present difficulty in defining a field, see Robert Bruce Lindsay and Henry Margenau, Foundations of Physics, Dover Publications, New York, 1963, pp. 283-287. Note particularly on p. 283 that a "field of force" at any point is actually DEFINED only for the case when a unit mass is present at that point. It is then illogically ASSUMED that the force

continues to exist at the point in the ABSENCE of the mass, which of course need not follow at all. On p. 284, note the similar logical paradox connected with the idea of a scalar gravitational potential field. The potential (field) is only defined at a point when mass is present at that point, .and it is specifically defined as the potential energy per unit mass for a particle present at that point. IF THERE IS NO MASS PRESENT, NEITHER A FORCE VECTOR FIELD NOR A SCALAR POTENTIAL FIELD IS DEFINED THERE. ASSIGNMENT OF THESE FIELDS TO THE POINT IN THE ABSENCE OF THE MASS IS AN ASSUMPTION, NOT AT ALL A DEFINITION. SINCE A TRUE DEFINITION IS AN IDENTITY, THEN THE ENTITY IDENTIFIED (DEFINED) TO INCLUDE THE PRESENCE OF MASS IS NOT IDENTICAL TO THE ENTITY RESULTING WHEN THAT MASS IS ABSENTED.

To see just how arbitrary and postulational are present. "definitions" of mass and force, see Lindsay and Margenau, op. cit., pp. 84-101. Also see Richard P. Feynman, Robert B. Leighton, and Matthew Sands, The Feynman Lectures on Physics, Addison-Wesley, New York, Vol.1,. 1963, Fourth Printing July 1966, p.2-4 for a definition of the electric field in the context of its POTENTIALITY for producing a force. Again, the force only exists when a particle of mass is present. From these examples, one can see the implication that A PHYSICAL FIELD IS SOMETHING SUCH THAT, WHEN A MASS IS INTRODUCED INTO IT, THE MASS EXHIBITS AN EFFECT. For a "force field," this is tantamount to stating that there exists some mechanism connected with a field which, in the presence of a mass causes a force to be exhibited. In that case the force is an EFFECT, not a cause, and there is a more fundamental mechanism that GENERATES FORCE ITSELF. See also field discussions in Feynman, Richard, The Character of Physical Law, M.I.T. Press, Cambridge, MA, March 1967, 2nd printing September 1967, passim.

6. While in Europe prior to 1881, Albert Abraham Michelson performed his first interferometer experiments to determine the velocity of the earth through the ether, obtaining essentially null results. At the Case School of Applied Science in Cleveland,

Ohio, he perfected his interferometer experiment from 1883 to 1887, assisted by a colleague, chemist Edward Williams Morley. By 1887 the results were ready and announced. Michelson himself thought his experiment had proven Stokes' theory of an ether dragged along by the earth in motion, and thus motionless with respect to the earth. This was at odds, however, with certain other experiments indicating a moving ether. The Michelson-Morley experiment was finally reconciled with these other experiments by Fitzgerald's suggestion in 1892 that the physical dimensions of material bodies are altered when they are in motion. In 1907 Michelson was awarded the Nobel prize, the first American to receive it in the sciences.

7. See Lindsay and Margenau, Foundations of Physics, 1963, pp. 324-326; D. C. Miller, "The Ether Drift Experiment and the Determination of the Absolute Motion of the Earth," Reviews of Modern Physics, Vol. 5, p. 203, 1933. Actually the experiments did not yield a conclusively null result, but rather showed large systematic trends. For a typical elimination of the systematic trends, see Handschy, M. A., "Re-examination of the 1887 Michelson-Morley experiment," American Journal of Physics, Vol. 50, No. 11, Nov. 1982, pp. 987-990. See Rho Sigma, Ether-Technology, CSA Printing & Bindery, Lakemont Georgia, 30552, 1977 for several enlightening points on the vacuum ether: See A. K. Lapkovskii, "Relativistic Kinematic Equations and the Theory of Continuous Media," Soviet Physics Journal, Vol. 21., No. 6, June 1978 for an abstract describing Soviet utilization of the concept of a small particle (called by Bearden a quiton, in Quiton/Perceptron Physics, DTIS, 1973) of the medium. See Belyaev, B. N. , "On Random Fluctuations of the Velocity of Light in Vacuum," Azvestiya Vysshikh Uchebnykh Zavedenii, Fizika, No. 11, Nov. 1980, pp. 37-42, translation by Plenum, for discussion of the proven variation of the speed of light in vacuum; the velocity of light in a vacuum on earth is measured to be higher than the velocity of light in the vacuum of deep space. See Graham, G. M. & Lahoz, D. G., "Observation of static electromagnetic angular momentum in vacuo," Nature, Vol. 285, 15 May 1980, pp. 154-155 for the first direct observation of free electromagnetic angular

momentum in vacuum. See Davies, Paul, "Something for nothing," New Scientist, 27 May 1982, pp. 580-582 for a discussion showing that modern theories of the vacuum reveal that even empty space is seething with activity; an ether of sorts emerges from vacuum fluctuations due to quantum mechanics considerations. See Hooper, William J., "All-Electric Motional Electric Field Generator," U. S. Patent No. 3,610,971, October 5, 1971 for a generator which produces a gravitational or inertial field. Einstein suggested that vacuum, complete with electromagnetic and gravitational fields, be called the ether. Dirac certainly did not abandon an ether, for in 1954 he stated "The aetherless basis of physical theory may have reached the end of its capabilities and we see in the aether a new hope for the future." James Clerk Maxwell derived his famous equations based on an ether theory. Sir Arthur Eddington also believed firmly in an ether. Sir Oliver Lodge actually pointed out the dilemma which yields the approach in this paper: writing of the ether in his book, The Ether of Space, Harper & Bros., New York, 1909, he stated: "We have no means of getting hold of the ether mechanically; we cannot grip it or move it in the ordinary way: we can only get it electrically. We are straining the ether when we charge a body with electricity; it tries to recover, it has the power of recoil.. . . "But when electrical theory was being founded, scientists thought of space as something rather fixed, and FILLED WITH a thin material ether. They did not realize that space itself does not exist except after an observation; before the observation, spacetime exists -- indefinite in both length and time. They did not know that electrostatic scalar potential in fact was spacetime, hence also the vacuum and the ether. In assuming that the charge of vacuum is zero and that charge and charged mass are identical, they hid the answer to the dilemma and placed the foundations of electromagnetics on its present unsound basis.

8. The field, of course, is indeed a highly useful concept and this author certainly does not recommend its abandonment. Instead, he recommends that it be placed on a sounder logical basis.

9. Specifically, they came to feel that the "electric

field" which was improperly defined -- was what was waving.

10. In fact Einstein once proposed that the vacuum, complete with its electromagnetic and gravitational fields, should be called the ether. His proposal was not adopted. (See Born, Max, Einstein's Theory of Relativity, Revised Edition, Dover Publications, New York, 1965, p. 224.)

11. Particularly from the work of Schrodinger, Born, Dirac and others.

12. For example, see Lindsay and Marge. nau, op. cit., pp. 287-288. A physical vector is thought to be defined by its magnitude, its direction in space, and its transformation characteristics. Actually that is a geometrical vector, not a physical vector. It does not tell us WHAT A VECTOR CONSISTS OF, but only tells us some of its important characteristics. Remember that a true definition must be an identity.

13. Here a reading of Lindsay and Margenau, op. cit., pp. 79-81 may prove enlightening. Also note that velocity, or L/T considered "at an instant" (stopped), represents an idea of "motionless motion" and is an application of the fourth law of logic. For a discussion of the fourth law of logic and its usage, see Bearden, Thomas E., "A Conditional Criterion for Identity, Leading to a Fourth Law of Logic," Specula, Journal of the A.A.M.S., P.O. Box 1182, Huntsville, AL 35807, combined Vol. 3, No. 4/Vol. 4, No. 3, Oct 1980 - Mar 1981, pp. 50-57 (also available from Defense Technical Information Service).

14. Note this is an identity of opposites, which explicitly violates the three Aristotlean laws of logic. See Bearden, "A Conditional Criterion for Identity, Leading to a Fourth Law of Logic," loc. cit., 1981.

15. Again note the fourth law of logic: zero motion (the absence of motion) being recognized as a special case of the presence of motion. Also, physical reality consists of internested levels, and any physical object has an internal substructure of nested levels of finer structure, extending down into the virtual (nonobserved) state. For a vector to model (apply to) a

physical object, it itself must be modeled in such fashion as to reflect this kind of substructure. Thus the use of geometrical vectors as models of physical objects in motion is presently flawed in a fundamental fashion.

16. The reader is most strongly urged to read Morris Kline, Mathematics: The Loss of Certainty, Oxford University Press, New York, 1980 as a prelude to understanding what mathematics is and is not, and what it does and does not.

17. Refer to Lindsay & Margenau, op. cit., pp. 79-81 to see how the ideas of motion and vector are inextricably entangled with the idea of a particle.

18. Call it uncertainty or call it constituency; a quantum change is composed of two canonical entities inextricably welded together into a single entity.

19. Time is an unavoidable, nonexclusive constituency of the welded quantum.

20. Simply from the definition of force as CONSISTING OF a time- and length-smeared mass motion change.

21. The force is an effect, not a cause. It IS the smeared charged particle. It is CAUSED by a more fundamental mechanism. It is the result of the combination of (1) a nonzero del phi, and (2) the presence of a spinning charged particle. IN A DEL PHI, THE SPINNING CHARGED PARTICLE ACCELERATES ITSELF! This is the fundamental secret of free energy that was suppressed, to bury the fundamental work of Nikola Tesla, shortly after Tesla was forced to abort his Wardenclyffe attempt to provide the world with free energy.

22. To quote: "The Hertz wave theory of wireless transmission may be kept up for a while, but I do not hesitate to say that in a short time it will be recognized as one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history. " Nikola Tesla, "The True Wireless, " Electrical Experimenter, May 1919, p. 87.

23. De Beauregard, O. Costa, "Running backwards the Mermin device: Causality in EPR correlations," American Journal of Physics, Vol. 51, No. 6, June 1983, p. 515.

24. Note the Soviet scientist Kozyrev's experiments with time waves. See Kozyrev, N. A., "Possibility of Experimental Study of the Properties of Time," September 1967, pp. 1-49, in JPRS 45238, May 1968. Kozyrev reports real physical effects from the oscillation of time. Also, note that scalar potential energy of appreciable size with respect to a particle's rest energy can force the situation to be relativistic, even though the velocity of the particle with respect to the velocity of light is small. That is, electrostatic scalar potential alone can cause variation in the rate of flow of time and hence vary physical characteristics. See Bloch & Crater, "Lorentz-invariant potentials and the non-relativistic limit," American Journal of Physics, Vol. 49, No.1, 1981, pp. 67-75. By inference, oscillating the electrostatic scalar potential can produce time waves and lead to direct physical effects.

25. It is already shown in the literature that the electrostatic scalar potential (ESP) can affect spacetime (ST) in the same manner as velocity. Cf Bloch & Crater, op. cit., 1981. Now note that, to any quantal or macroscopic observer, the existence of the 4-space volume of ST implicit in $(\Delta t)(\Delta v)$, where v is volume, cannot be separated from the existence of the subquantal entities that exist therein. We therefore DEFINE the magnitude of the ESP as the summation of the absolute values of all the internal virtual vectors in the $(\Delta t)(\Delta v)$ quantum of ST, divided by the absolute value (magnitude) of $(\Delta t)(\Delta v)$. We take the view that no such thing as "unstressed" ST physically exists, and that "spacetime" and "stressed spacetime" are identical. Hence ESP and ST are one and the same thing. Note that this implies that the virtual density of ST is variable, and is nothing but the magnitude of the ESP. In EM theory, the assumption that the ESP of vacuum ($Ø_O$) is equal to zero is in serious error. In fact, $Ø_O$ IS "spacetime of the laboratory observer," in the new view.

26. For example, the definition of the electrostatic

potential (ESP) is usually taken as "the work which must be done against electric forces to bring a unit charge from a reference point to the point in question; the reference point is located at an infinite distance, or, for practical purposes, at the surface of the earth or some other large conductor." (McGraw-Hill Dictionary of. Scientific and Technical Terms, ed. Daniel N. Lapedes, second edition, 1978, p. 518.) Note that this is NOT a definition at all, for it is not an identity. Instead, it is the statement that, if an ESP exists at a point and a unit charged mass (assumed to be at a point) is brought in from infinity toward the ESP location point, the amount of work it is necessary to expend upon the mass of the particle is equal to the magnitude of the ESP. The ESP exists whether or not any work at all is expended, and whether or not a charged unit mass is brought in. To adequately define ESP, we must define its identity, or what it consists of, in the absence of mass, since we have conceived the ESP to exist at a vacuum point. Further, the definition usually taken is completely a 3-space definition. Instead, in our new view the ESP is to be taken at a point in n-space, where n is equal to or greater than 4.

27. See Bearden, Quiton/Perceptron Physics, 1973, available through the DTIS. See also Bearden, The Excalibur Briefing, Strawberry Hill Press, San Francisco, CA, 1980. Ultimately all physical phenomena are mindchanges in the minds of all the observers.

28. And then assumes this summation value is zero.

29. See note 25 above.

30. Bearden, The Excalibur Briefing, Strawberry Hill Press, San
Francisco, CA, 1980.

31. Cf Rauscher, E. A., "Electromagnetic and Non-Linear Phenomena in Complex Minkowski Spaces," Tecnic Research Laboratories, 64 Santa Margarita, San Leandro, CA 94579. Presented at the 1983 March Meeting of The American Physical Society in Los Angeles, CA 21-25 March, 1983. This is a truly remarkable paper of great significance. Rauscher, a world-class physicist, has presented a new theoretical

model for some rather extraordinary possible extensions of present electromagnetics.

32. Cf Muses, Charles, Introduction to Jerome Rothstein's Communication, Organization, and Science, The Falcon's Wing Press, Indian Hills, Colorado, 1958. The entire foreword by Muses is a remarkable document, which analyzes the structure of time itself. See also his profound summary paper, "Hypernumbers II" in the January 1978 issue of Applied Mathematics and Computation, published by Elsevier.

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ADDITIONAL NOTES AND REFERENCES

Although quotes and direct utilization of material from these references were not incorporated in this paper, the following references were also consulted. In addition,' several notes are added for further clarity.

33. Rupert Sheldrake, A New Science of Life: The Hypothesis of Formative Causation, J. P. Tarcher, Inc., Los Angeles, CA, 1981. Ø, the electrostatic scalar potential field, in my opinion is actually the morphogenetic field that Sheldrake proposes.

34. Briefly, by a "particle" we mean an entity so constructed that, if any part of it changes all of it changes. From the viewpoint of the particle, this implies that to change is to detect, and to detect is to change. Also, internal and external become synonymous, in the "detected" sense. The idea of a "fundamental particle" in physics actually invokes the fourth law of logic implicitly.

35. Only if a thing dimensionally contains time, can it "occupy time." This point is so obvious that one wonders how so many of the scientists and mathematicians seem to have missed it. By this criterion, e.g., mass does not exist in time, a priori. To "observe" or detect, in fact, means to stop time, thus collapsing the wave function. However, it reduces the observable or detectable to a spatial quantity, not a spatiotemporal quantity. In other words, the ordinary scientific method destroys a part of reality in each detection or measurement, yielding only a partial truth. not fundamental truth.

36. Note that electrostatic scalar potential is actually infinite-dimensional and hyperspatial. The coverage of

this paper is still only a special case. By Tesla technology, it is possible to do direct engineering in hyperspace -- beyond our present space and time, with all that that statement implies.

37. Bob Sloan, "Nikola Tesla: The Greatest Inventor of all Time?". IEEE Antennas and Propagation Society Newsletter, June 1983, pp. 9-11. A very succinct summary of the importance Tesla played in ushering in the modern age.

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The last paragraph by Jammer is illuminating: "The modern physicist may rightfully be proud of his spectacular achievements in science and technology. However, he should always be aware that the foundations of his imposing edifice, the basic notions of his discipline, such as the concept of mass, are entangled with serious uncertainties and perplexing difficulties that have as yet not been resolved."

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TOWARD A NEW ELECTROMAGNETICS PART III: CLARIFYING THE VECTOR CONCEPT

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-- It Started With Geometry and Grew --

At the very beginning of what we call the "scientific period," mathematics was both king and queen, and Euclidean geometry was its handmaiden. So we ask, "What precisely is geometry?" Here we are not interested in a "textbook" answer, but in an answer indicating what geometry really does.[3] In other words, with what does geometry concern itself, and what is the fundamental nature of those things with which it concerns itself?

Briefly, geometry -- at its foundation -- is totally spatial. It is fitted to, and expressed in terms of, the TOTAL ABSENCE OF MASS. Thus the geometer deals in abstract, massless entities called "points," "lines," "planes" etc. When the geometer speaks of "motion," he speaks of a time-smeared, length-smeared point. Geometry at heart is massless, and a "geometer's vector" is a highly specific type of "system." In fact, it represents the "time-smearing" and "length-smearing" of a point. A priori, the fundamental concept of the geometrical vector has taken a "spatial" entity and introduced a hidden involvement with "time."

Modern mathematics and physics have followed an intertwined development for several hundred years. And both sprang as offshoots of the original work of the geometers. Let us briefly sketch the overall path of interest taken by these two developing disciplines.

With the advent of Descartes's fundamental work, algebra was combined with geometry to yield analytic geometry, a new and powerful mathematical tool. With the invention of calculus by Leibniz and Newton, both mathematics and physics received a giant impetus. Differential geometry and vector mathematics arose in full splendor and, in physics, mechanics leaped to the forefront with Newton's

profound work.

But the mechanics made a most fundamental error when they simply applied the geometer's vector to a mass, to produce -- so they thought -- a mass vector. That which rigorously applies only to the absence of mass cannot be so lightly applied to the presence of mass without the risk of serious limitations in the resulting theory. The precise difference between a geometer's massless vector and a mechanic's mass-vector is one of the issues to be developed in this thesis.

As rapid development continued in mechanics and mathematics, certain physicists were involved in intense experimental work on charged matter, becoming the first electricians. Both the preceding mathematical ideas and constructs as well as the preceding (partially erroneous) mechanics constructs and ideas were applied by the electricians, struggling with their pith balls, cat fur, and glass rods to understand, quantify, and model electrical forces and the phenomena of charged matter. In other words, the electricians strove to formulate the physics and dynamics of charged matter and its interactions by simply "adding to" the work of the geometers and mechanics. Here again, a fundamental logical error was made. That (geometry) which a priori applies only to the absence of mass, and that (mechanics) which a priori applies only to the absence of charge, cannot be lightly applied to the presence of charged mass (both mass and charge)[4] without risking the incorporation of grave limitations in the resulting theory.

After the profound work of Maxwell, the idea of FIELDS OF FORCE became more prominent, until the field concept ruled the day[5]. The electricians continued, pushing the idea of fields into space and vacuum itself, along the way inventing the idea of "charge effects" existing even in the massless vacuum, with concomitant fields. Meanwhile, they had thoroughly confused chargeless point-smeared, chargeless mass-smeared, length-smeared and time-smeared vectors.

After a set of fundamental experiments designed to detect motion of the material ether yielded essentially null results[6], Michelson and Morley were regarded as having completely disposed of the ether -- even though the experiments only disposed of material

ethers, and not Lorentz-invariant non-material ethers[7]. Maxwell's equations and the field concept were elevated to profound importance.[8] Then, after Einstein's fundamental relativity work shortly after the turn of the century, the ether concept faded away and the field concept reigned supreme. Indeed, in their enthusiasm the interpreters of relativity went so far as to affirm that one can have a wave without any medium; that is. that something can be moving (waving) without anything there to move![9] And with great glee they pronounced the final end to the idea of "ether" as a medium, even though Einstein himself never did any such thing.[10] With the advent of Einstein's General Theory of Relativity, even matter came to be regarded as just a special "kink" or curvature in spacetime or "vacuum nothing."

Quantum mechanics arose and even certainty and determination fell. Chaos, probability, and randomness now assumed the ruling position. Probability waves (and probability fields) arose,[11] as did quantum fields of various kinds. The intermingling of these concepts with the concepts of electrodynamics pushed the idea of the field even farther into esoteric realms.

The point is, each of these developing disciplines incorporated and built on the foregoing disciplines. From the beginning of geometry, there was no rigorous definition of a vector, and there is none today.[12] From the beginning of mechanics, in their foundations the theorists made grave logical errors by incorporating the geometer's vector; errors so great that today mechanics and electromagnetics are severely flawed, as is everything that came after them and built upon their illogical foundations.

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-- Points and Motion --

It is my purpose in this paper to expose in a very simple fashion the most basic errors that were made. One basic error involves the idea of motion itself.[13]

In formulating concepts of motion, the geometers used a "point in motion" to determine or specify, for example, velocity. Now a "point" is a static concept a priori. To determine (or even to think and perceive) motion, one must determine that it occupies two different points (positions or locations) at two different times, yet consider both points at the same time. Indeed, that is precisely what the arrow means that is used to represent a vector. A "point in motion" therefore represents a contradiction of opposites. That is, it represents the idea that "that which is motionless has motion.".[14] Even with this, there is a difference in a spatial point and a spatiotemporal (spacetime) point. To exist at all, a spatial point must be moving in time; in other words, it is a spatiotemporal line, even if it is a static spatial point.

Vector analysis was constructed in the abstract -- again, a massless point in motion possessed or constituted a velocity vector, etc. In massless (and timeless) space, FIELDS were defined: "scalar" fields constituted the assignment of a simple motionless number (magnitude) to each spatial point, while "vector" fields constituted the assignment of a "simple vector" (magnitude and velocity) to each spatial point. But the MATHEMATICAL vector system consisted of massless (point) motional relationships, recognizing zero motion as a special case of motion.[15]

Of course mathematics development was also always intertwined with practical problems. With the

sustained application of mathematics to gross physical material problems, mechanics slowly arose.

These developments required decades and even centuries to occur completely. All along the way, innovations and changes -- and additions to the mathematical formulism were being derived and taught to students as the "natural" system of reality. A permanent mindset was being forged.

Indeed, mathematics was regarded as THE single human expression of fundamental truth. Not until Godel's work in the twentieth century did it become evident that MATHEMATICS IS SIMPLY A GAME PLAYED ACCORDING TO ASSIGNED RULES, AND THERE IS NO ULTIMATE TRUTH IN MATHEMATICS ALONE.[16] It is a most useful game, of course, since it is the game fitted to perception. Thus it applies, essentially, to whatever can be perceived. But to be applied to physical systems, it must be changed, altered, updated, and fitted as the perceiving/detecting instruments become ever more subtle.

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-- Four Types of Vectors Actually Emerged --

As the physical sciences slowly developed and incorporated abstract geometry and mathematics, in actuality four major types of vectors and two major states of observation evolved, although this fact did not become apparent to the scientists. Specifically, the mathematicians and scientists failed to recognize the differences in the four types of vectors, hopelessly intermingling them and confusing them as a single class of vector. Further, they did not appreciate that a fundamental vector conceptually is a UNITARY SYSTEM, and the system represented by one of these four types of vectors utilizes and is comprised of different components, "welded together with no seam in the middle."

Conceptually (and from a systems viewpoint), the four types of vectors are (1) the chargeless, massless spatial system vector (geometer's vector), (2) the uncharged mass system vector (mechanic's vector), (3) the charged mass system vector (electrician's vector), and (4) the charged space system vector (advanced electrician's vector). These four fundamentally different vectors are shown in Figures 1, 2, 4, and 9 in a simplified manner.

The major problem was that, beginning with the geometer's vector, these four major types of vectors were not treated as systems. Instead, their "vector" aspects were hopelessly confused and intermeshed, and no distinctions were made between them. And in the foundations of the mathematical constructs, time-smearing was not recognized at all.

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-- Quantum Mechanics Compounds the Problem --

In addition, the two presently recognized observation states -- observable and nonobservable (virtual) -- were of course unknown to the early geometers and electricians, and these ideas were not incorporated directly into the theoretical foundation.

From particle physics and quantum mechanics, we now understand that physical reality is structured of an observable state, underlaid with an infinite number of ever finer, successive levels of virtual (unobservable) states. At least reality is most accurately modeled in that fashion, according to particle physics today.

It is also well known, for example, that at the most fundamental level, one cannot actually separate nonmotion from motion (which implies, for example, that one cannot separate mass and velocity). In other words, a "mass in motion" idea is actually incorrect, at the most basic level. What actually exists is a sort of "smeared mass". That is, "mass-motion" is fundamentally what exists, not mass IN motion .

Actually, all that the Heisenberg Uncertainty Principle implies is this fact: If one examines the concept of "static (non-smeared) thing in non-static (smeared) motion", in ever finer detail, one reaches a degree of fineness where the "smearing" is paramount and one cannot have an un-smeared or "separate static thing" to be in motion. Instead, one only has the smeared, 4-dimensional spacetime entity, without 3-dimensional spatial separations.

This means, for example, that at the most basic level, it is actually incorrect to represent a momentum with a little static particle of mass connected to a spatial velocity vector. It is incorrect to think of the system as comprised of TWO SEPARATE ENTITIES, (1) a mass, and (2) a massless spatial system velocity vector (a geometer's vector).

We mention in passing that, presently, we

understand that every particle is continually accelerating. First, the particle has spin, which involves rotation, which means that every "part" of the periphery of the particle is accelerated toward the center axis of spin. Second, every particle is continuously "fluctuating," and these fluctuations are accelerations. Further, we must consider any change such as an acceleration -- as existing in a small time increment, and occurring in a small length increment. Thus mass particles actually exist as (mass x acceleration x time x length). This of course has the dimensions of ACTION or angular momentum. The "real" world of physical matter, then, is composed of building blocks of action, called "quanta." Any other physical "quantity" must be obtained by fissioning (differentiating) the action quantum. For this reason, quantum mechanics presently must postulate that to every observable there corresponds an operator.

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-- To Summarize Briefly --

Let us now summarize these concepts and further examine their impact.

In physics, there must actually exist four major KINDS of vectors, rather than just one as prescribed by present interpretation. These vectors are "built" starting with four major kinds of particles.[17] These are: (1) the spatial point, (2) an uncharged mass particle, (3) a charged mass particle, and (4) a charged spatial point. Further, each of the four vectors at its most fundamental level (that is, at the quantum level)[18] is actually an inseparable, unitary SYSTEM welded into a single undivided entity containing time and existing nonexclusively in time.[19] When we look at or represent the so-called "parts" of the system, we are looking at them before they are welded together into the physical vector. That is, whenever we speak of "parts, " we imply that a "cutting" or "differentiating" action has been implied to separate the system into such "parts."

From such considerations, four different kinds of system vectors result.

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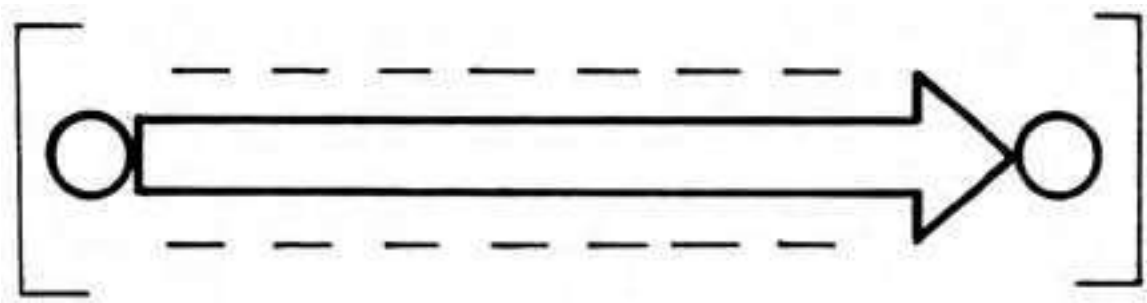

(GEOMETER'S VECTOR)

Figure 1. Uncharged spatial (massless) system vector.

UNCHARGED SPATIAL (MASSLESS) SYSTEM VECTOR
-- (Figure 1) --

This is the geometer's abstract vector, consisting of a "point in motion." (Actually, it is a "smeared point," for example.) However, so ingrained is the concept of a "point in motion" velocity vector that we now consider it to be "natural" because of its total familiarity. But simply ask, "WHAT is in motion?"[17] and you immediately see the difficulty. To have a WHAT, one must "stop the action" (detect or measure), separating "static" from "non-static." Acceleration and other vectors, etc. have also been derived by the geometer and utilized in similar fashion. All are massless.

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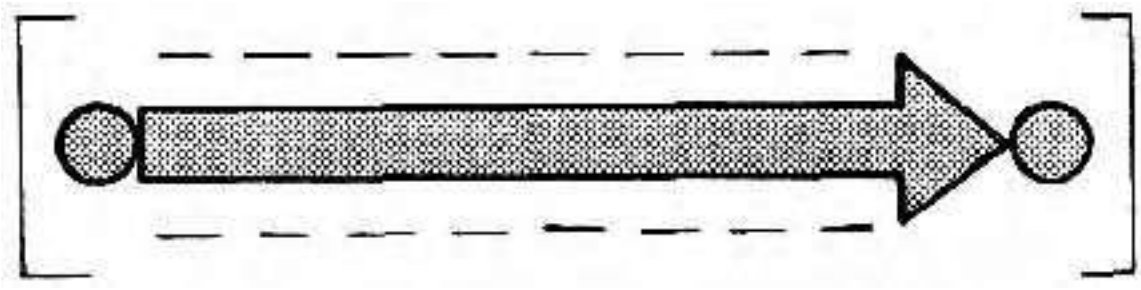

(MECHANIC'S VECTOR)

Figure 2. Chargeless mass system vector.

CHARGELESS MASS SYSTEM VECTOR
-- (Figure 2) --

This type of vector actually is the essential vector of mechanics, involving mass-motion (momentum), force (mass-motion change), etc. The fundamental difference between this type of vector and the geometer's vector is the presence of smeared mass existing in time (i.e., mass-time), welded together with a geometer's vector, but with no seam in the middle, into a new kind of "vector" AS A SYSTEM. The vector is the SYSTEM EXISTING IN TIME .

To illustrate:

"Momentum" is more properly referred to as "mass-motion" rather than "mass in motion." That is, at the fundamental level, the mass is NOT "separate" from its motion. It is NOT separated from the time in which the smearing occurs. The idea of momentum, however, is really to express the time-density of the mass-smeared-through-length. It is, in other words, the time rate of length-smearing of mass. Now in our minds we have conceived that

$$\bar{p} = m \odot \bar{v} \qquad (1)$$

where, by the symbol $\odot$ we mean "coupled to"; but we actually have

$$\bar{p} \equiv [\overline{mv}] \qquad (2)$$

where we are not allowed to separate (even in thought) m and $\bar{v}$. Quantum mechanics agrees with this essentially, because $\bar{p}$ is a canonical variable linked to length, in any observable physical change. (The REASON p is canonically linked to ΔL is because $\bar{p}$ is the time-rate of length-smearing of m. If there is no length, there is no length-smearing of m to have a time rate OF in the first place.)

Note that, not only is

$$\bar{p} = [\overline{mv}] \qquad (3)$$

but also

$$\bar{p} \equiv [\overline{mv}] \qquad (4)$$

which is a much stronger and quite different statement. That is, $\bar{p}$ is IDENTICALLY $(\overline{mv})$, not just calculably EQUAL TO (m)($\bar{v}$). This means that $\bar{p}$ is a SYSTEM that is COMPRISED of mass-motion.

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-- What Force Is --

We now note that force, for example, is -- and may be defined as -- the time-rate of change of momentum, or

$$\bar{F} \equiv d/dt[\bar{p}] \qquad (5)$$

and this identity states that a force -- any force is COMPRISED OF time-changing "mass-motion." As such, the force vector is a mass-system vector, not just a massless spatial vector. Fundamentally, this mass-system vector is a totally different creature from a massless spatial vector. Our present manner of considering force as a geometer's vector "separately applied to" a mass particle is completely erroneous at the quantum level. Instead, fundamentally force is always a mechanic's vector. Force is an EFFECT, not a CAUSE.

And here mechanics made a most fundamental error, in not recognizing the difference between its kind of vector and that of the geometer.

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--Force and Hertzian Waves Cannot Exist in Vacuum --

Note that one cannot have an observable "force vector" existing' in vacuum a priori.

For example, we have the definition of force as

$$\bar{F} \equiv \frac{d\bar{p}}{dt} \qquad (6)$$

or

$$\bar{F} \equiv \overline{[m\bar{a} + \dot{m}\bar{v}]} \qquad (7)$$

and we see that, rigorously, a force vector CONSISTS OF (not, "is equal to") a time-changing mass-motion vector system. IF THERE IS NO OBSERVABLE ACCELERATING MASS PRESENT, THEN THERE CAN BE NO OBSERVABLE FORCE PRESENT. The mass can accelerate in time (increase or decrease of mass) or space (increase or decrease of velocity) or both.

Observable force CANNOT exist in vacuum (in the absence of mass), a priori.[20]

However, assume for a moment that one could have a massless force vector, as assumed in present electrical theory. Let this force vector appear at a point in the vacuum. Since the vacuum has zero observable mass, it would have zero inertial resistance to this hypothetical observable force -- hence the observable force would instantly produce an "infinite" acceleration of its point of application, vanishing with it into the infinite distance. Therefore our fictitious force would disappear the instant it appeared! In any case, it could not be retained at a point in the vacuum for any finite length of time, however small.

The direct implications are that (1) something other than an observable electrical force field exists in the vacuum, and (2) there must exist a more fundamental mechanism by which this "something else" generates or CREATES a force on/of a moving electrically charged mass. (Note again that, at the most

basic level, any particle of mass is always quivering, in motion, and accelerating. from quantal considerations alone.)

Thus immediately we have discovered something unique about so-called "force-fields" in vacuum: for example, about gravitational field, electrical field, and magnetic field (and the strong force and the weak force as well). These fields do not exist at all as ordinary force vectors -- and real force fields -- in vacuum! $\bar{E}$ and $\bar{B}$ fields, e.g., are defined in terms of force per unit electrical charged mass and magnetically charged mass, respectively. In the absence of mass, they cannot exist.

And this in turn means that transverse $\bar{E}-\bar{H}$ field waves (Hertzian waves) cannot exist in a vacuum. Indeed, they appear on, and ARE CONSTITUTED of, the charged-mass-motion that changes, and they appear where such change occurs, as a result of an introduced mass.[21] But in the absence of the spinning charged particle of mass, they do not exist as force fields at all.

Hertzian waves exist in a transmitting whip antenna, for example, in the oscillating electron gas along its length. Something else entirely different exists in vacuum between the transmitting antenna and the receiving antenna. Then in the receiving antenna, Hertzian waves again exist in the oscillating electron gas along its length. (See Figure 3.)

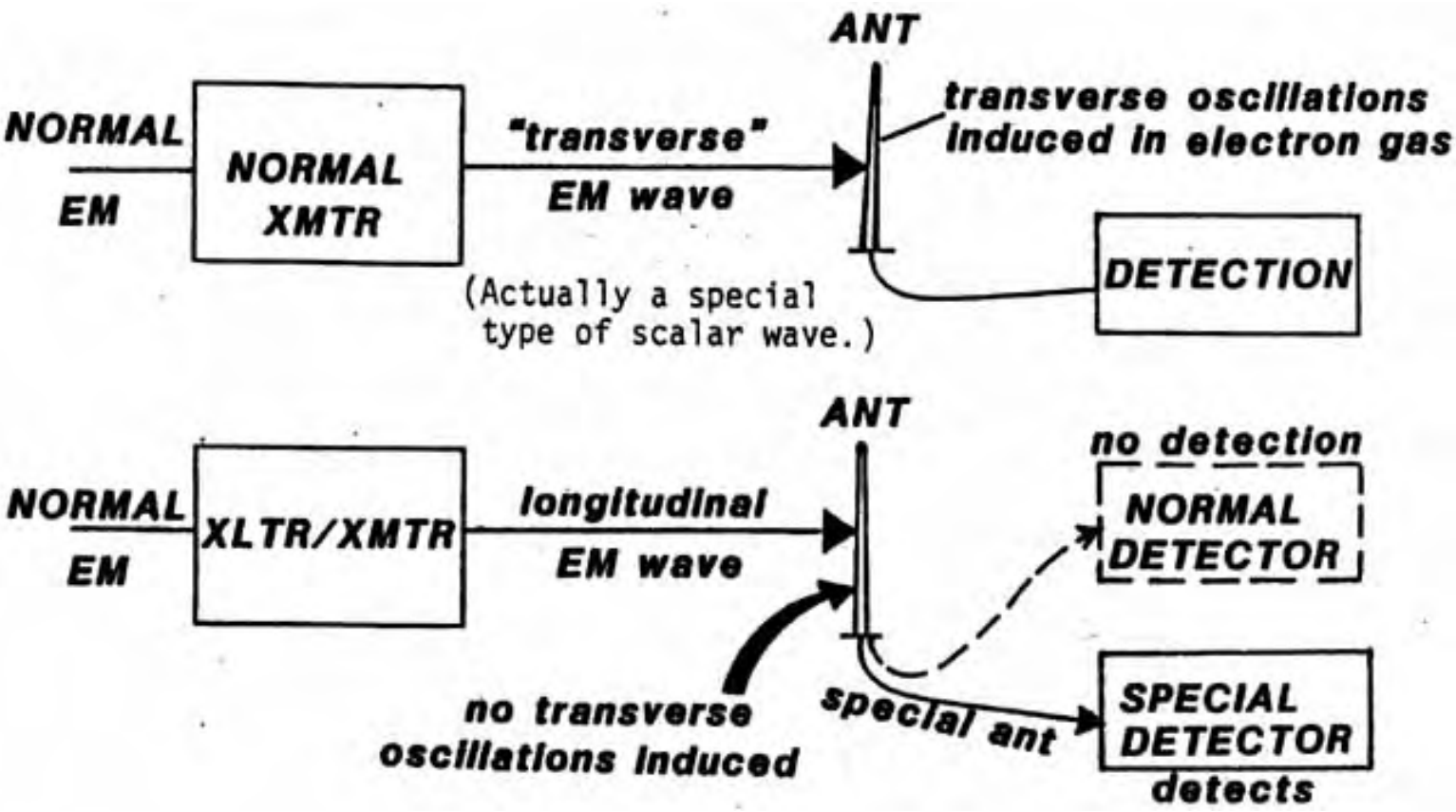

Figure 3. Detection of "transverse" and longitudinal waves

This is interesting, for Nikola Tesla stated several times that HERTZIAN WAVES CANNOT BE PRODUCED IN A VACUUM, NOR CAN THEY TRAVEL IN A VACUUM.[22]

Tesla was correct, as we are beginning to see.

We shall later return to show in what form so-called "force-fields" actually exist in vacuum.

For now, I point out that I am stating a fundamental change to all of physics, including both mechanics and electromagnetics.

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TOWARD A NEW ELECTROMAGNETICS PART III: CLARIFYING THE VECTOR CONCEPT

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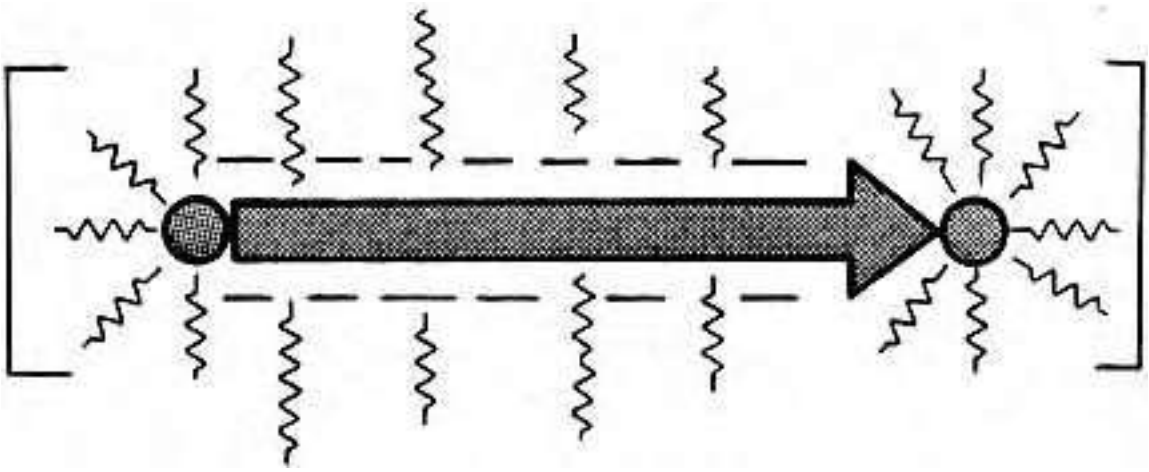

(ELECTRICIAN'S VECTOR)

Figure 4. Charged mass system vector.

-- CHARGED-MASS-SYSTEM VECTOR --
-- (Figure 4) --

The third type of vector we meet is the vector mass system where the mass is charged. First, we point out a serious error in present electromagnetic (EM) theory. That is, in present theory it is implicitly assumed that

$$\mathbf{q} \equiv \mathbf{q_m} \qquad (8)$$

In other words, "charge" and "charged mass" are erroneously assumed to be identically the same thing.

In the days when electricians were playing with pith balls and striving to uncover the secrets of electricity, they knew nothing at all about the virtual

state, and consequently nothing about a "virtual particle flux" on a particle of mass causing (and comprising) the "charge" of that mass.

Today, of course, we know from particle physics and quantum mechanics that the "charge" on an observable particle of mass IS due to a flux of virtual (nonobservable) particles on and off the mass of the observable particle (see figure 5). A charged mass is thus presently known to be a SYSTEM: a massless charge flux, coupled to a bare particle (chargeless mass) constitutes a "charged particle."

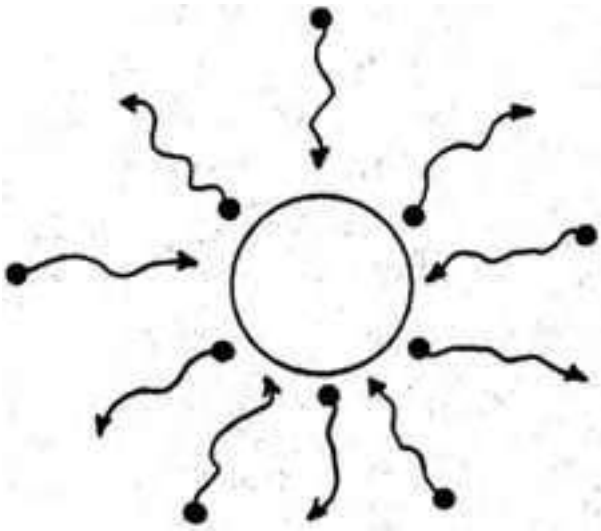

Figure 5. The "charge" on an electron mass consists of a flux of virtual particles on and off the mass.

Thus, actually the "charge" is the virtual (unobservable, or SPATIO-TEMPORAL) flux to and from the observable SPATIAL particle of mass. So, rigorously,

$$\mathbf{q \not\equiv q_m} \qquad (9)$$

But instead,

$$\mathbf{q \equiv [d/dm(q_m)]} \qquad (10)$$

and this is a definition and therefore an identity. This definition alone affects all present electromagnetics theory.

To illustrate: In founding electrical theory, early scientists dealt with forces generated by charged masses (for example, charged pith balls). They later

extrapolated the experimental results they obtained (or thought they obtained) with the smallest charged mass, a charged particle. In Figure 6, I show the classic situation for derivation of the idea of E-field (except we have used an electron for our test charge, rather than a pith ball).

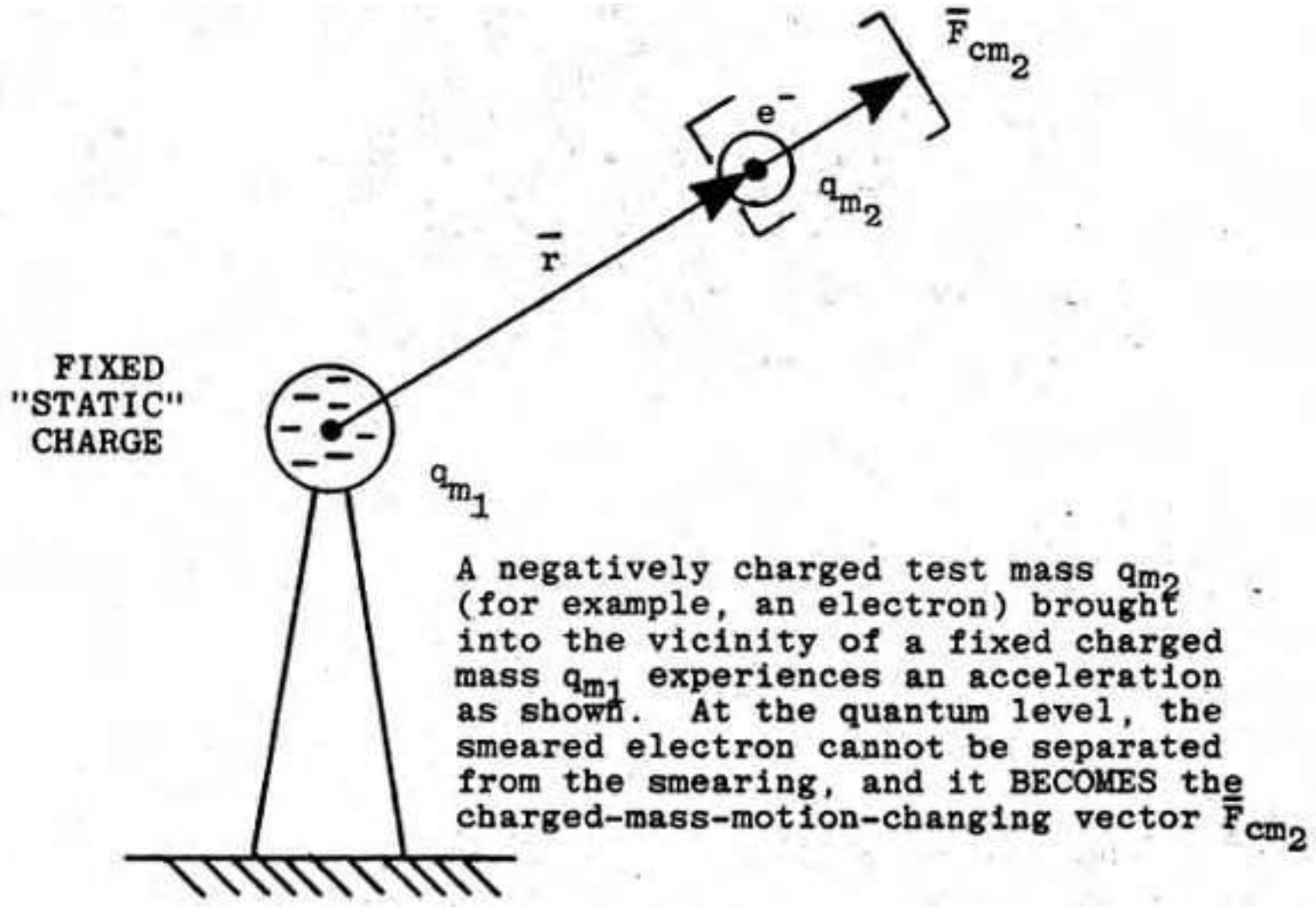

Figure 6. A test charge (charged mass) brought near a fixed charge (charged mass) experiences an acceleration.

Now note that what actually happens is that the unrestrained test charge becomes a CHARGED MASS SYSTEM VECTOR (a "smeared charged mass-motion changing"). The "test charge" BECOMES a charged mass force vector; it does not have a separate geometer's vector "appear on it." What actually happens is shown in Figure 7.

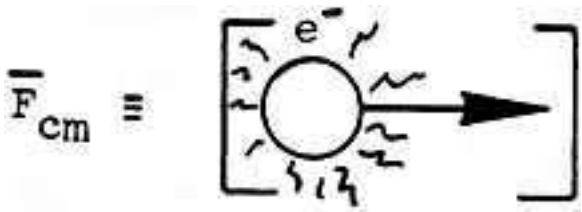

Figure 7. A charged-mass-system vector.

That is, in the simplest (nonrelativistic) case, for an electron what happens is

$$\bar{F}_{cm} \equiv \overline{[q_e \odot m_e \odot \bar{a}_s]} \qquad (11)$$

and this is a DEFINITION. That is, considered instantly, the electron exists as a charged-mass electrical force CONSISTING OF/COMPRISED OF a charge flux q_e canonically coupled to a mass, with that subsystem then canonically coupled to a spatial acceleration vector, ALL AS A SINGLE ENTITY, WITHOUT ANY "SEAMS" BETWEEN ITS "PARTS." The $\bar{F}_{cm}$ IS THE ELECTRON SYSTEM ITSELF; it is NOT a "spatial vector." Rigorously, it does not exist in the absence of the smeared electron mass, a priori.

Again, in assuming this force exists in the absence of the smeared mass of the moving particle, electromagnetics theory is in serious logical error.

Referring back to Figure 6, we see that, if we repeat the experiment many times and with the test charge in many locations, we have the situation shown in Figure 8.

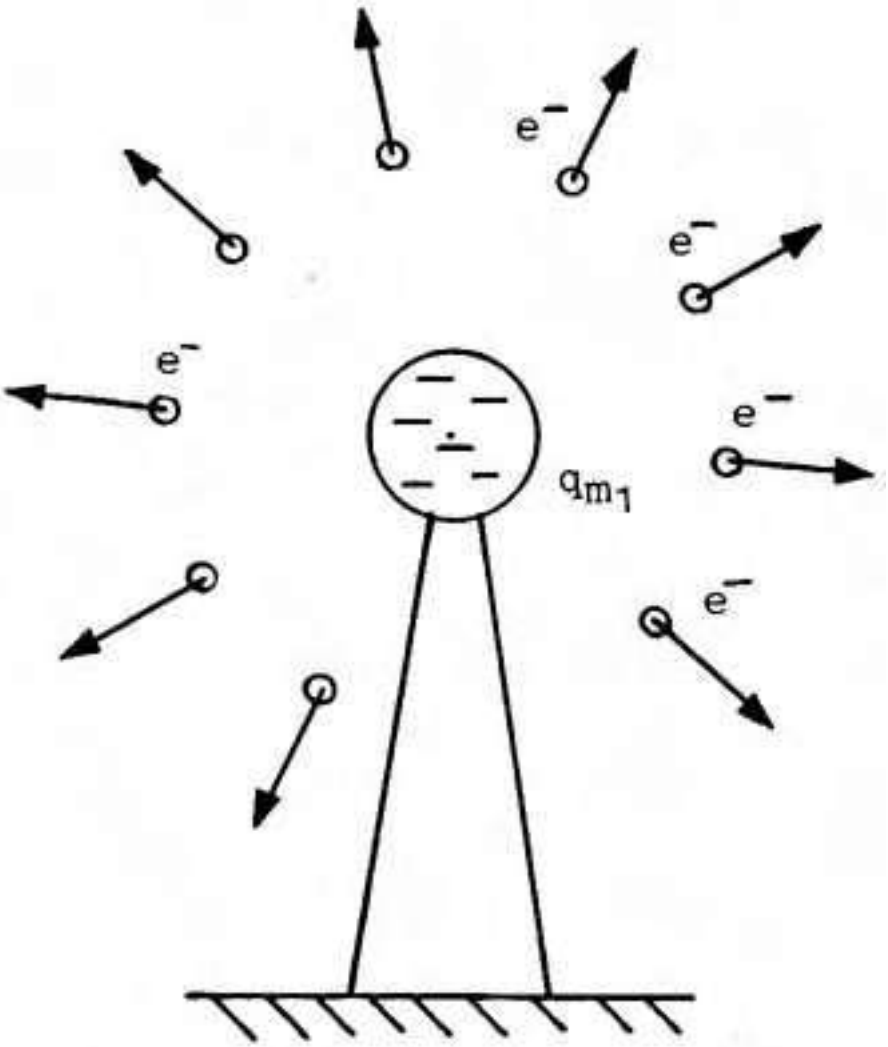

Figure 8. Repeating the "test charge" experiment.

It is found that, rigorously,

$$|\bar{F}_{cm}| \propto \left|\frac{q_{m_1} q_{m_2}}{r^2}\right| \qquad (12)$$

where $\bar{F}_{cm}$ is a charged mass system vector. Erroneously, this has been stated one way or another as

$$|\bar{F}| \propto \left|\frac{q_1 q_2}{r^2}\right| \qquad (13)$$

where $\bar{F}$ is assumed to be a spatial system vector. Further, this confusion has been carried over into the definition of the $\bar{E}$-field as:

$$\bar{E}_{cm} \equiv \frac{\bar{F}_{cm}}{m_{cm}} \qquad (14)$$

In this definition, $\bar{E}$ -- which is a charged mass system vector -- has been confused as a charged spatial system vector, where $\bar{F}$ is regarded simply a spatial system vector! Actually, the definition of the $\bar{E}$-field should be

$$\bar{E}_{cm} \equiv \frac{\bar{F}_{cm}}{m_{cm}} \qquad (15)$$

where $\bar{F}_{cm}$ is a charged mass system vector. Failure to properly define the $\bar{E}$-field has caused the conception of the $\bar{E}$-field to be falsely perpetuated as existing in vacuum.

The $\bar{E}$-field is TREATED this way in present EM theory. Hence present theory falsely assumes that the observable $\bar{E}$-field can exist in vacuum.

What actually exists in space, $\bar{E}$-field-wise, is a special kind of ordered virtual state pattern in a series of spinning "scalar" fields. This virtual state pattern or "shadow vector" field will be explained later.

Note again that one cannot have a "force vector" existing in vacuum - a priori.

However, assume for a moment that one could have a massless force vector, as presently assumed. Let this force vector appear at a point in the vacuum. Since the vacuum has zero observable mass, it would have zero inertial resistance to this hypothetical observable force hence the observable force would instantly produce an "infinite" acceleration of its point of application, vanishing with it into the distance. Therefore our fictitious force would disappear the instant it appeared! In any case, it could not be retained at a point in the vacuum for any finite length of time, however small.

The direct implications are that (1) something other than an observable electrical force field exists in the vacuum, and (2) there must exist a more <u>fundamental mechanism</u> by which this "something else" generates or CREATES a change on/of an accelerating electrically

charged mass particle. (Note again that at the basic level, any particle of mass is ALWAYS quivering and accelerating, from quantal fluctuation considerations alone.) Causality has no arrow microscopically.[23]

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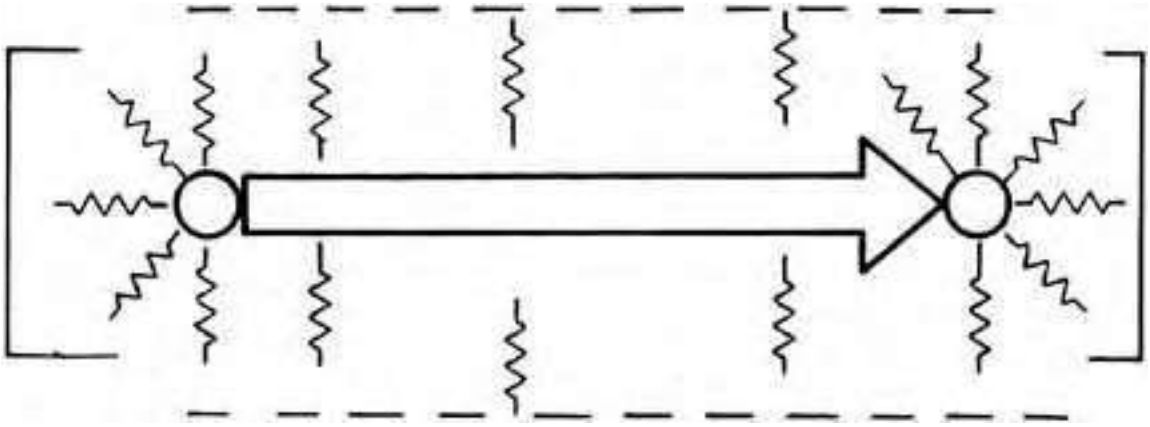

(ADVANCED ELECTRICIAN'S VECTOR)

Figure 9. Charged spatial (massless) vector.

-- CHARGED SPATIAL (MASSLESS) VECTOR --

We recognize now that

$$q_c \not\equiv q_m \qquad (16)$$

and that q_c is simply the virtual-particle flux that constitutes charge -- and indeed constitutes vacuum itself!

We DEFINE vacuum, based on Figure 5, as shown in Figure 10.

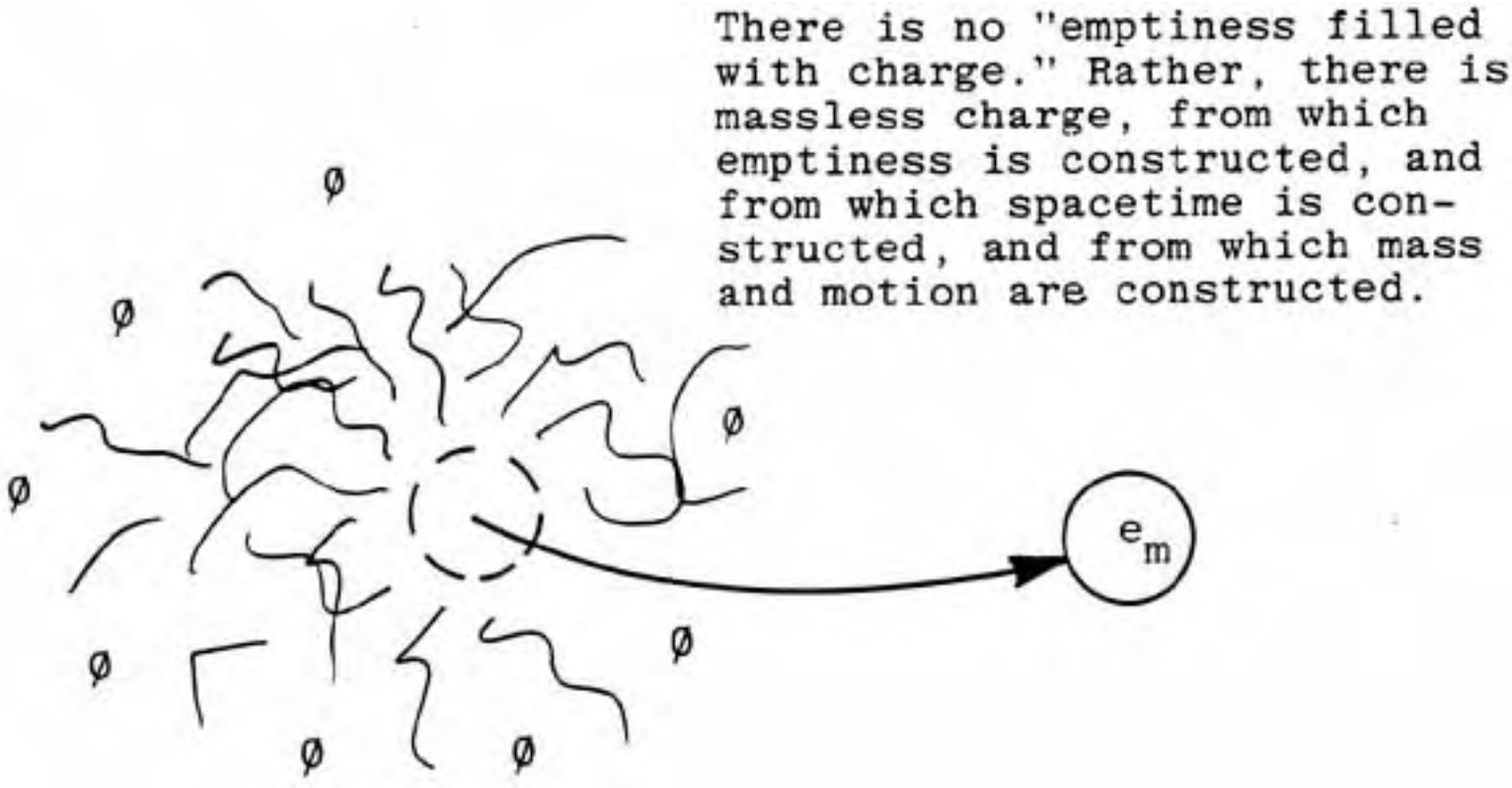

Figure 10. Removing the bare particle (mass) from a charged particle leaves the charge. The vacuum is DEFINED AS the charge.

That is, vacuum may be defined as pure massless charge flux. This flux IS identically "spacetime" as well. Vacuum is pure Ø-field (electrostatic scalar potential). Here again, in present theory it is assumed that

$$Ø_O \equiv 0 \qquad (17)$$

which, by our new definition of vacuum, is quite false.

We now note that, if we insist on assigning a spatial vector to the vacuum, we have the situation shown in Figure 11.

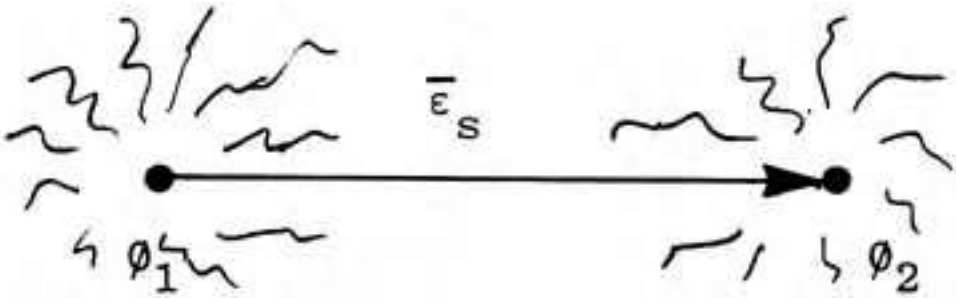

Figure 11. Assigning a spatial vector to the charged vacuum

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TOWARD A NEW ELECTROMAGNETICS PART III: CLARIFYING THE VECTOR CONCEPT

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-- THE SHADOW VECTOR --

Note that this spatial vector $\bar{\varepsilon}_s$ represents $-\overline{\nabla\phi}_s$, that is,

$$\bar{\varepsilon}_s = -\overline{\nabla\phi}_s \qquad (18)$$

but $\bar{\varepsilon}_s$ cannot be a force (mass system) vector. It can only exist as an ordered pattern in the virtual flux between two separated points of the vacuum; that is, as an ordered pattern in the virtual state. Literally, $\bar{\varepsilon}_s$ exists only as a tiny bit of order existing in great disorder.

In other words, the present EM theory is incorrect in stating that

$$\bar{E}_m = -\overline{\nabla\phi}_s \qquad (19)$$

in vacuum in the absence of an observable spinning charged particle, since

$$\bar{\varepsilon}_s \not\equiv \bar{E}_m \qquad (20)$$

The actual existence of $\bar{\varepsilon}_s$ may be visualized in terms of successive differentials of $\bar{E}_m$, broken into differentials $\bar{e}_m$ so small that, observably, each little differential's mass component m has become virtual, so that

$$\bar{e}_m \equiv \bar{e}_{vm} \qquad (21)$$

where subscript m stands for mass, subscript v for virtual, and observably

$$\bar{e}_{vm} \equiv \overline{dE}_m \qquad (22)$$

but, in the absence of a spinning charged particle,

$$\bar{E}_m \neq \int \overline{dE}_m \qquad (23)$$

since the $\bar{e}_{vm}$ components remain individually separated. That is, in macro-time a SHADOW force vector exists, made of microscopically ordered BUT UNJOINED (unintegrated) "virtual state" vector differentials of what would be an observable mass system force vector $\bar{E}_m$ if integrated.

Thus, the "$\bar{E}$-vector" $\bar{\varepsilon}_s$ that exists in vacuum is a "shadow" vector as shown in figure 12.

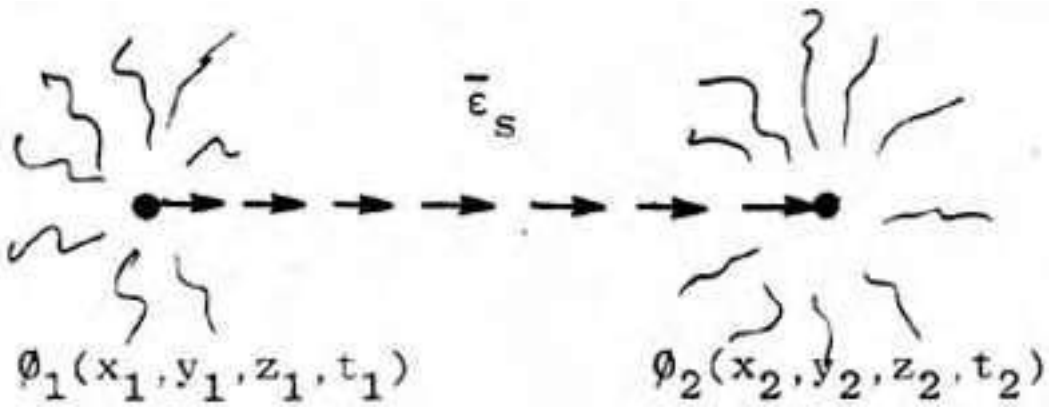

Figure 12. A "shadow vector" $\bar{\varepsilon}_s$

We say that such a previous mass system vector, broken into ordered but unjoined virtual vectors by the absenting of all mass, is a SHADOW VECTOR, and we label it with a subscript vm, to represent "virtual mass" system. To the macro observer, this is the kind of "vector" that exists in vacuuo.

Note that, observably, the shadow vector merely represents a special ordering in $\nabla\phi$. It is NOT an OBSERVABLE (mass system) vector, but it IS an ordered series of consecutive virtual vectors.

With each virtual bit vector, a virtual time exists as well, and these "virtual time bits" are also ordered consecutively (in macrotime).

I point out that any observable vector must be finite, and so it must have a finite magnitude (finite length). In the simplest case, this length ΔL is related to a Δt by

$$\Delta L = c\Delta t \qquad (24)$$

What I am saying is that ANY observable spatial vector is actually a spatiotemporal vector, and the MAGNITUDE of any vector is related to TIME (to the existence of that vector in time) at the most fundamental level. Suffice it to say that, if the fundamental quantum level (Δt) aspect of a vector is interfered with, then the MAGNITUDE of the vector is interfered with.[24] That is, if we can make a time wave, we can change or affect ANY vector's magnitude, including the magnitude of mass system vectors and charged mass system vectors. Such a "time wave" can be made easily, and it has been.

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TOWARD A NEW ELECTROMAGNETICS PART III: CLARIFYING THE VECTOR CONCEPT

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-- A Scalar is a Zero Vector --

Now let us look at the idea of a scalar.

A "scalar" may in a general sense be considered as the sum of the "absolute values" of the individual vector components of a system of vectors whose observable resultant is zero. That is, it represents the magnitude of the internal stress of a vector system, with the absence of a single observable directionality of the system. It also follows that every scalar is actually a stressed zero vector, and every zero vector is a scalar.

Thus we have four major types of scalars related to the four types of vectors:

(a) $$S_1 = |\bar{v}_s| \quad (25)$$

(b) $$S_2 = |\bar{v}_m| \quad (26)$$

(c) $$S_3 = |\bar{v}_{cm}| \quad (27)$$

(d) $$S_4 = |\bar{v}_{cs}| \quad (28)$$

where S stands for scalar, $\bar{v}$ for vector, and subscript s for spatial, m for mass, and c for charged.

For example, comparing equations (25) and (26), it can easily be seen that twice as many "point-motions" is not at all the same thing as twice as many "gram-mass-motions." The two resulting vector systems are quite different.

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-- Virtual and Observable Aspects --

We must also examine some aspects of "virtual" and "observable."

For example, we construct several spatial vector summations in Figure 13. The "resultants" of these spatial vectors are all equal. However, the actual sums, even though equal, are quite different, because their internal "stresses" (substructure forms) are quite different.

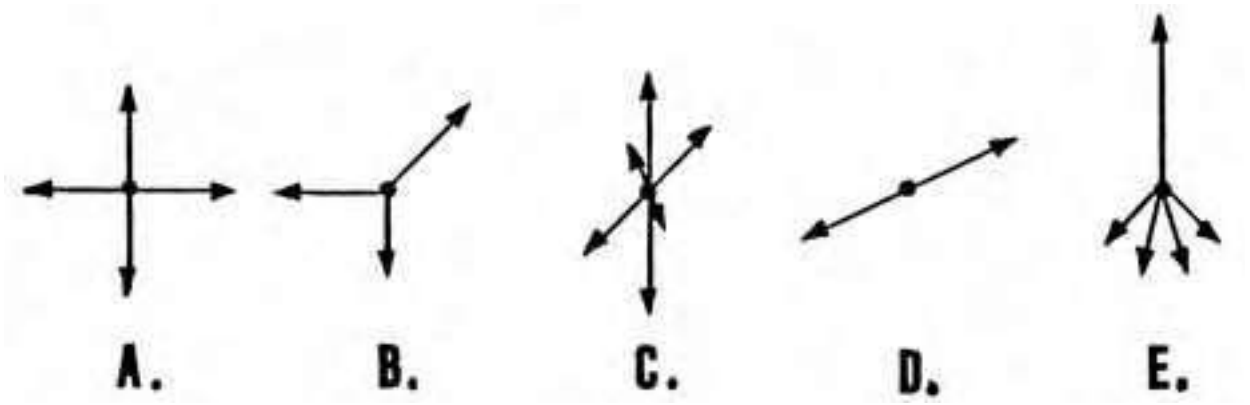

SUPERPOSITION DOES NOT ELIMINATE THE VIRTUAL SUBSTRUCTURE.

When the time aspects of the vector systems of Figure 13 are considered, one can easily understand the problem. That is, the resultant of each of these "systems" is zero, and so one can say that the vectorial "magnitude" of the system is zero since the magnitude of the resultant vector is zero. However, in each case the "action" represented by each vector element actually occurs in a finite tiny Δt. So: (1) The zero resultant must exist for a finite Δt, and (2) all the actions indicated by the system component vectors actually occur in that Δt. The absolute value of the "activity per unit time per unit volume" of such a zero-

resultant system thus has physical meaning, and one may refer to this notion as the "stress" on spacetime[25], or the "electrostatic scalar potential" of the system. Note that this differs from the present definition of electrostatic scalar potential, which becomes just a special case of the more fundamental potential defined here.[26]

The derivatives of this spatiotemporal stress also have physical meaning. The time derivative is indicative of the stress on the flow of macroscopic time at a fixed spatial point, and the spatial derivative is indicative of the stress on space. Here one is confronted with the fact that what we call "space" and "time" are continually being created, directly in the physical observing/detecting apparatus itself.[27] That is, rigorously, "detected physical reality" exists totally in and of the mass-changes of the observer's mass or his detecting instruments. In the fundamental detection process itself, there is a flow of the rate of creation of spatial lengths and a flow of the rate of creation of time lengths. Indeed, to a linear observer the stress on the creation of the flow of time controls the flow of the creation of space, and the stress on the creation of the flow of space controls the flow of the creation of time. The change in the stress on 4-space (ordinary Minkowskian space-time) controls the "curvature of that spacetime" in the fifth dimension. The change in the stress on 5-space controls the "curvature of that 5-space spacetime" in 6-space, and so on. Development of these facets of the new concepts is beyond the scope of this paper.)

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-- SCALARS AND VECTORS HAVE SUBSTRUCTURES --

As can now be seen, the sum of each structure in figure 13 is observably zero. Therefore we might define the sum as a "zero spatial vector." We note, however, that it actually exists for a time Δt and is thus a spatiotemporal entity, rigorously.

If we define the internal stress action A in a region $\Delta s^3 \Delta t$ of spacetime as

$$A_{(s^3 t)} \equiv \sum_{k=1}^{n} |\bar{i}_s| \qquad (29)$$

and the 4-space internal stress intensity or potential as

$$S \equiv \lim_{(\Delta s^3 \Delta t) \to 0} \left[\frac{A(s^3 t)}{\Delta s^3 \Delta t} \right] \qquad (30)$$

where $\bar{i}_s$ is any internal vector in the substructure, Δs^3 is the spatial volume (about a point) containing vector $\bar{i}_s$, and Δt is the inseparable time during which these component actions occurred, then we see that, stress-wise, all the "zero-vectors" in figure 13 are quite different in their internal stresses, 4-space potentials, and internal substructures. For the five "zero sum" vectors, OBSERVABLY we have

$$\bar{0}_1 = \bar{0}_2 = \bar{0}_3 = \bar{0}_4 = \bar{0}_5 \qquad (31)$$

whether or not

$$\Delta s^3 \Delta t_m = \Delta s^3 \Delta t_n \ (m \neq n;\ 1 \leq m \leq 5;\ 1 \leq n \leq 5) \qquad (32)$$

But considering the substructures,

$$\bar{0}_m \neq \bar{0}_n \quad (1 \leq m \leq 5;\ 1 \leq n \leq 5;\ m \neq n) \qquad (33)$$

I now point out that a scalar can be regarded as a stressed zero-sum vector, where the magnitude S of the scalar represents the internal stress intensity caused by the substructure of the zero-vector.

Thus, generally,

$$S(s^n t) \equiv \lim_{\Delta s^n \Delta t \to 0} \left[\frac{\sum_{n=1}^{k} |\bar{i}_s|}{\Delta s^n \Delta t} \right] \qquad (34)$$

That is, in general any observable scalar has, consists of, and is comprised of a VIRTUAL (unobservable) substructure that is very real indeed. One must also consider the scalar as existing for some finite time Δt, (at least for the time of one quantum change), and the intensity of the virtual actions occurring in the spatiotemporal substructure of the scalar during that time Δt is proportional to the magnitude of the scalar.

Normally, the concept of a scalar -- as presently used -- makes no allowance for the scalar to exist in time, or for a virtual vector substructure, or for any patterning inside the substructure. This is equivalent to assuming that

$$A \equiv 0 \qquad (35)$$

and that all $\bar{i}_s$'s are evenly distributed. That is, from this new viewpoint, presently the mathematical theory assumes all scalars to have an equal density of virtual activity per spatiotemporal volume in its virtual substructure, and an isotropic virtual pattern distribution of an infinite number of equal virtual vectors in its 4-space substructure.[28]

In the new approach, neither of these two assumptions need hold -- though in special cases they can hold. Thus present orthodox theory is just a single special case of a more fundamental approach indicated here.

Note that, by directly affecting and changing the virtual substructures of scalars and vectors, we can directly perform

virtual. state engineering, and this allows us to directly "engineer" the so-called "laws of nature" of the normal observable laboratory state and thus ENGINEER AND CHANGE PHYSICAL REALITY ITSELF.[29]

In the new approach, we can (observably) have

$$2 + 2 \neq 4 \qquad (36)$$

or

$$2 + 2 = 4 \qquad (37)$$

by the following means: In the first case (equation 36), we assume that the virtual substructures are patterned, and interact nonlinearly in such a way as to produce an extra observable. Thus we have a delta added to the normal observable scalar results of the interaction, as follows:

$$2_o + 2_o = 4_o + \Delta_{v\text{->}o} \qquad (38)$$

where subscript "o" means observable and "v" means virtual. Note that

$$\Delta_{v\text{->}o} \qquad (39)$$

indicates a delta due to virtual substructure interactions yielding an extra observable delta. This extra delta may be either scalar or vector in nature, depending on the circumstances and the particular interactions.

Note also that any vector or scalar must now be considered to HAVE, CONTAIN, and CONSIST OF an infinite substructure. And note that, similar to the scalar case, from the new viewpoint the present theory assumes each scalar (point) of the vector to have a structure similar to that of equation (34), except that now the scalars are ordered, with a linearly decreasing internal stress density per unit scalar along the line of the vector.

In the new approach, vector interaction (superposition, for example) can now violate present theory, if the two virtual substructures interact nonlinearly to produce a nonzero, observable delta. Observably (macroscopically) , this delta, again, may be either "scalar" or "vector."

This approach now becomes consistent with quantum mechanics at the foundation level.

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-- Substructures, Virtual Levels, and Hyperspaces --

In the new approach, our definitions and assumptions immediately drive us to a picture of an infinite set of nested levels of substructures in the virtual state. That is, anyone component (scalar or vector) in one level of virtual state has an infinite number of even finer virtual components, one level more subtle.

AND THAT IS WHAT PARTICLE PHYSICS AND QUANTUM MECHANICS ALREADY REVEAL ABOUT THE STRUCTURE OF PHYSICAL REALITY.

So these definitions and assumptions now provide the basis for a new vector mathematics that is in accord with, and fitted to, modern physical observations.

We have a picture such that any observable scalar or vector contains a virtual substructure (virtual level 1). Any scalar or vector in virtual level 1 also contains a finer virtual substructure, in virtual level 2. And so on ad infinitum.

Each succeedingly finer level of virtual state can be modeled as a hyperdimension (higher spatial dimension) as I pointed out in Appendix 1 to my book, The Excalibur Briefing.[30]

Thus this approach immediately ties into hyperdimensional or hyperspatial theory -- such as Elizabeth Rauscher's 8-dimensional theory[31] and C. Muses's hypernumber theory.[32]

The new definitions and assumptions are far richer than what is allowed by tensors, though there are many similarities. Muses's work, however, essentially can encompass most of these definitions and concepts, except the distinct types of vectors are not so clearly delineated in his theory (at least to my comprehension of it.) His theory does provide a nested,

hyperdimensional structure of time, however, and thus allows "scalar" waves in the hyperspatial structure of time -- in other words, observably "scalar" waves in the virtual state structure of spacetime, or pure Tesla waves, or simply "time" waves.

These are the bare notes; from this approach, already new (proprietary) mechanisms and exact specifications to make scalar waves -- in essentially whatever quantity and degree desired -- appear to have been successfully accomplished by my close colleagues.

The new approach is real and it leads to a new physics. And I believe that the very beginnings of the new physics are already working on the laboratory bench.

Nikola Tesla discovered the most essential features of the new electromagnetics over eighty years ago and was simply suppressed for his efforts. Now, although it has been eighty years in the reborning, Tesla electromagnetics is once again loose in the Western world.

This time, let us hope that it fares better at the hands of orthodox science and large financial control groups than it did for Nikola Tesla.

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The Tom Bearden Website

TOWARDS A NEW ELECTROMAGNETICS
PART 4: VECTORS AND MECHANISMS CLARIFIED

by Lt. Col. T.E. Bearden (retd.), 1983
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Portland, Oregon

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--FOREWORD --

This paper is an adaptation of the oral/visual presentation given by the author at the 1983 Annual Conference of the U. S. Psychotronics Association on Saturday, July 23, 1983.

The presentation was delivered directly from the vugraphs alone, and not from a formal, written text.

The title of the presentation at the conference was "New Electromagnetics: Where the 'Old Math' Took the Wrong Turn."

As originally conceived, the lecture was to be given in a single period of some 45 minutes and cover only the first part of this paper, the clarification of the vector concept in physical theory. The Symposium director so graciously scheduled two periods instead, allowing time to present additional material further clarifying vector and scalar waves, and to present a variety of unusual physical mechanisms that apply the concepts.

After the conference, the author prepared this paper directly from the same slides, in the same order. However, no attempt was made to match the words in this paper to the words actually delivered in the formal presentation. The gist of the two, however, are the same -- except that, in the conference lecture, the author covered (as an aside) some important additional material: (1) the nature of what actually occurs in an "electrical ground," and (2) the author's explanation of the theory of Tesla's magnifying transmitter.

An audio tape and a videotape of the author's USPA presentation were made by the conference officials. Copies are available at nominal cost from Mr. Robert Beutlich, Secretary/ Treasurer, U. S. Psychotronics Association, 3459 Montrose Avenue, Chicago, Illinois 60618, U.S.A.,
phone (312) 478-7715.

SLIDE 1.

TOWARD A NEW ELECTROMAGNETICS

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ACKNOWLEDGEMENTS

I would like to express my deep appreciation to two of my fellow colleagues, Dr. William Tiller and Mr. Frank Golden, for many fruitful hours of discourse and interchange on these and related subjects.

Also, I wish to thank the Association of Distinguished American Scientists (A.D.A.S.) for support and assistance in the long and arduous struggle to revise the basic foundations of electromagnetics and mechanics.

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SLIDE 2.

OUTLINE

- **MAIN BRIEFING**
  - **> TRANSLATOR EFFECTS**
  - **> POTENTIAL WEAPONS**
  - **> INCIDENTS**
  - **> CONCLUSION**
- **HISTORICAL BACKGROUND**
  - **> TESLA/MORAY**
  - **> WWII AND AFTER**
- **ELEMENTS OF THE EMERGING THEORY**
  - **> LONGITUDINAL/ TRANSVERSE WAVES**
  - **> VACUUM/MASS EFFECTS**
  - **> FLAWS IN VECTOR THEORY**
  - **> IMPLICATIONS**

This presentation is one part of a three part presentation, consisting of the main briefing on physical effects, the historical background, and the elements of the emerging new electromagnetics.

In this present briefing I will not cover the historical background. Instead, first I will address the concepts of the new theory, and then I will give an abbreviated main briefing, including some weapon aspects. I will present one simple free energy motor and show how it works, and where it gets its energy.

Much of this material I have known for some time, but have hesitated to release it because it enables one to develop -- in a fairly straightforward manner -- weapons and beams (ray) systems that can disable electronics, computers, communications, and people. Anyone

handy in electronics, who has a few thousand dollars and access to bench equipment and an electronics parts supply house, can develop these weapons in his or her basement workshop. But because certain very radical elements in this country already know some of this information and may plan to utilize such devices in criminal activities, I am openly releasing the information as a warning, to be prepared.

Of course there are many good things that can be developed with this technology, including machines to heal a remarkable variety of ailments and illnesses. I strongly urge everyone to use this information wisely and only to benefit other human beings. There exists a cosmic or karmic law for those who misuse it against their fellow persons; if one does that, one will assuredly suffer the consequences.

Also, I strongly urge the development of Western defenses against the Soviet strategic and tactical weapons; already developed utilizing these principles. Unless the West wakes up to the extreme urgency of this task, in the near future we may be overwhelmed in short order by a much harsher, dictatorial system. If that should happen, it will plunge the human race into a new dark ages far more terrible than that dark period in history following the fall of Rome.

These are the final times, and this is the beginning of the final technology. The ability to directly engineer physical reality itself has been laid in our laps. Pandora's box is already spilled open, and there is no longer any stopping the new technology.

Let us prepare, then, for that which is to come.

With these introductory remarks, let us now turn to the main presentation.

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SLIDE 3.

CHARACTERISTICS OF SELECTED CONCEPTS

CONCEPT	CHARACTERISTIC
• ENERGY	FLOW OF OBSERVABLE MASS PARTICLES
• ANENERGY	FLOW OF VIRTUAL PARTICLES
• PRESENT "CHARGE"	VIRTUAL PARTICLE FLUX TIED TO OBSERVABLE MASS PARTICLES
• TRUE CHARGE	VIRTUAL PARTICLE FLUX WITHOUT MASS
• FLUX	MULTI-DIRECTIONAL FLOW THROUGH A POINT
• FLOW	UNI-DIRECTIONAL MOVEMENT OF A FLUX [GRADIENT]
• CURRENT	UNI-DIRECTIONAL GRADIENT OF A [USUALLY CONSTRAINED] FLUX

On this slide I show some fundamental defining characteristics of energy, "charge" or charged mass as presently in the theory, flux, flow, and current. These fundamental concepts are often somewhat confused in the literature.

Particularly note that the concept of energy, being tied to "the capacity to do work," is specifically tied to the concept of mass. Eventually, energy must be expressed in terms of moving masses -- specifically, in accelerating or decelerating masses.

I introduce the term "anenergy" here, specifically in relation to

the concept of a virtual particle. Anenergy is roughly equivalent to the present idea of "virtual energy,"
except it more precisely implies the flow or flux of virtual particles.

We also redefine charge as virtual particle flux, in order to remove the present error in EM theory where "charge" always implies a charged mass. The electrostatic scalar potential, phi (Ø) , then merely becomes the intensity of the massless charge -- that is, the intensity of the virtual particle flux -- at a point. Let me point out, however, that in the new view this "point" is always in n-dimensional space, where n is equal to or greater than four. The present 3-space formulation of Ø is thus a highly special case.

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SLIDE. 4

QUOTE FROM NIKOLA TESLA:

**"THE HERTZ WAVE THEORY OF WIRELESS TRANSMISSION MAY BE
KEPT UP FOR A WHILE, BUT I DO NOT HESITATE TO SAY THAT
IN A SHORT TIME IT WILL BE RECOGNIZED AS ONE OF THE MOST
REMARKABLE AND INEXPLICABLE ABERRATIONS OF THE SCIENTIFIC
MIND WHICH HAS EVER BEEN RECORDED IN HISTORY."**

Nikola Tesla
"The True Wireless,"
The Electrical Experimenter

One of the things we will find is that Hertz or transverse electromagnetic waves are strictly mass waves in a charged mass particle medium.

For example, transverse EM waves do not, and CAN not, exist in vacuum. Vacuum EM waves are longitudinal waves of compression and rarefaction. What is compressed and rarified is the virtual particle flux that comprises vacuum itself. Vacuum EM waves in this virtual flux are just like sound waves in air -- in the flux of molecules and atoms that comprise the atmospheric gas.

Nikola Tesla, of course, knew this and he frequently pointed out the falsity of the accepted transverse wave theory. Here is one Tesla quote, for example, taken from The Electrical Experimenter. (PAUSE)

Almost every scientist -- even the "Tesla bugs" -- have thought Tesla wrong in his adamant opposition to the idea of Hertzian waves in the vacuum.

As we shall see, Tesla was right and all the present scientists and textbooks are wrong .

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SLIDE 5.

FORCE BETWEEN TWO LIKE CHARGES

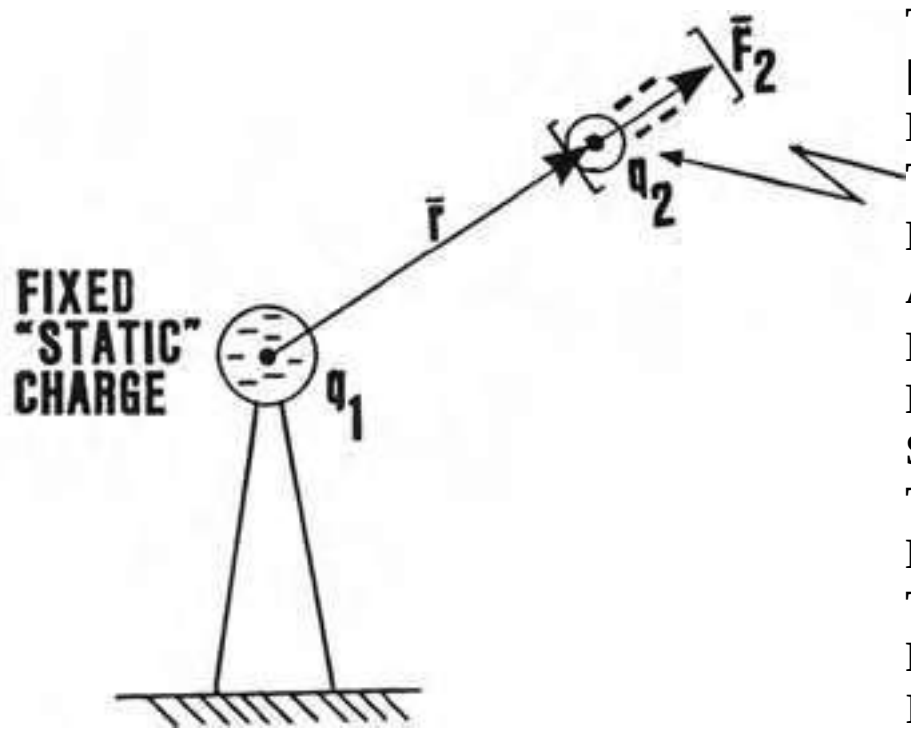

A NEGATIVELY CHARGED TEST MASS [e.g., AN ELECTRON] BROUGHT INTO THE VICINITY OF q_1 EXPERIENCES A FORCE $\bar{F}_2$ AS SHOWN. NOTE THE ELECTRON ACTUALLY IS SPINNING. THIS HAS NEVER BEEN DONE WITH A TRUE "STATIC CHARGE", FOR THERE IS NO SUCH THING IN NATURE.

In my presentation last year, I noted some 22 fundamental flaws in present electromagnetics theory. One of these flaws was in the actual vector theory itself. As we shall discover, one cannot simply plug geometrical vectors into physical systems without making fundamental errors. The vector concept itself must be adapted, for there are now four different kinds of vectors in physics, all confused as the same thing. We will come to that shortly.

To begin, let us look at the fundamental kind of experiment, shown on this slide, from which the idea of electrical force and electric field was taken.

We have a fixed static charged object q(l) in the laboratory, and we bring in a test charged mass q(2). The test charged mass may even be a single electron, as we illustrate here. We show in our example the fixed charge to be negative. When we release the test charge electron, it accelerates away from the fixed charged mass, as shown on the

diagram. Note that we have no force at all until we bring in the test charged mass. Indeed, we shall find that the force is actually COMPRISED OF the accelerating test electron. Specifically, it is not something mysterious which appears in vacuum and PUSHES on the electron. We shall find that FORCE IS AN EFFECT, NOT A CAUSE. It CONSISTS OF the "smeared mass" that is accelerating -- in this case, it consists of the smeared, accelerating electron.

We summarize the experiment: in the absence of the charged test particle, no force exists in the vacuum. When we bring in the test charged mass, it accelerates away, and THE FORCE CONSISTS OF THAT ACCELERATING CHARGED MASS PARTICLE. The experiment does not at all address or deal with WHAT EXISTS IN THE VACUUM AROUND CHARGED MASS Q(l) IN THE ABSENCE OF TEST CHARGED MASS Q(2). Any assumption of a force existing in the vacuum is sheer speculation and not based on this experiment.

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SLIDE 6.

REPETITIONS LEAD TO THE VECTOR "FIELD" CONCEPT

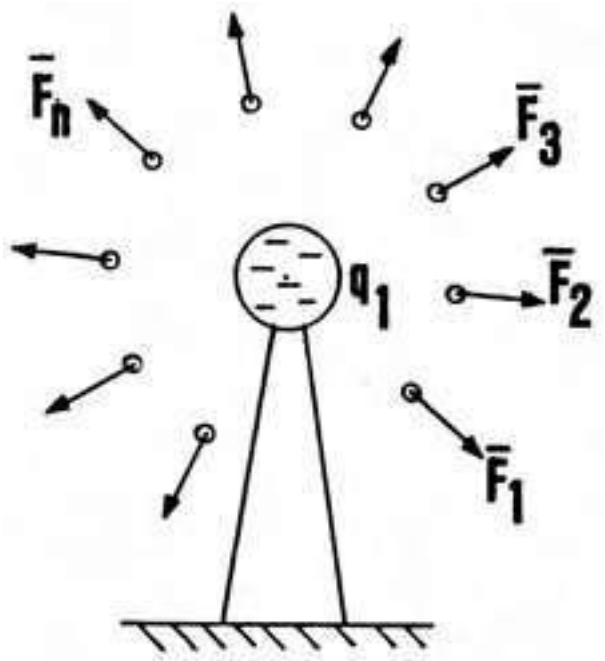

REPEATING FIGURE 4 A NUMBER OF TIMES LEADS TO SETS OF FORCE ARROWS, WHICH WE THEN VISUALIZE IN TOTAL AS A FIELD, Ë, OF FORCE(S) ABOUT q_1

RIGOROUSLY, THIS "FORCE FIELD" WOULD REQUIRE THAT A SPINNING CHARGED PARTICLE OF MASS EXIST AT EACH AND EVERY POINT IN SPACE ABOUT q_1

On this slide, we show that, as we repeat the experiment by bringing in the test charged mass from differing directions, the same thing happens around the fixed charged mass q(l). Test charged mass q (2) -- our electron -- accelerates radially away from q(l).

As we repeat the experiment and draw many of the little arrows radially outward, gradually the idea of a "vector field" emerges. That is, we form the idea that, at every point in space around fixed charge q (l), there exists one of our little vector arrows. Thus we assign a vector field to the space: to every point of it, there is assigned both a magnitude and a direction.

However, note that this does not describe the situation as it exists, at any time, in the "present." That is, rigorously any one arrow only exists whenever a little test charged mass is present and accelerating radially away.

We may take the view that the arrow WILL exist WHEN a test

charged mass is brought to that point and released. In that case, the arrow WILL exist in the FUTURE, not the present. And we may refer to that as, it POTENTIALLY exists, when and if.. ..etc.

So already we see a fundamental logical problem in the idea of such a field. It WILL exist in the future, but only POTENTIALLY exists in the present.

Of course I am not the first one to point out such difficulties; the fact that the field concept is erroneous is already well-known to foundations scientists. But it is such a USEFUL concept that it is retained.

Now the Ë-field, or electric field, is defined as "the accelerating force on a charged mass per unit charged mass accelerated by it." If there is no charged mass present to be accelerated, then there can be no Ë-field present.

So Ë-field cannot exist in vacuum, for vacuum presupposes the absence of all observable mass.

So we can rigorously say that no Ë-field of force exists around the charged mass q(l) IN THE PRESENT. At best, it can only POTENTIALLY exist IN THE FUTURE.

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SLIDE 7.

A SCALAR HAS A HIDDEN [VIRTUAL] VECTOR SUBSTRUCTURE

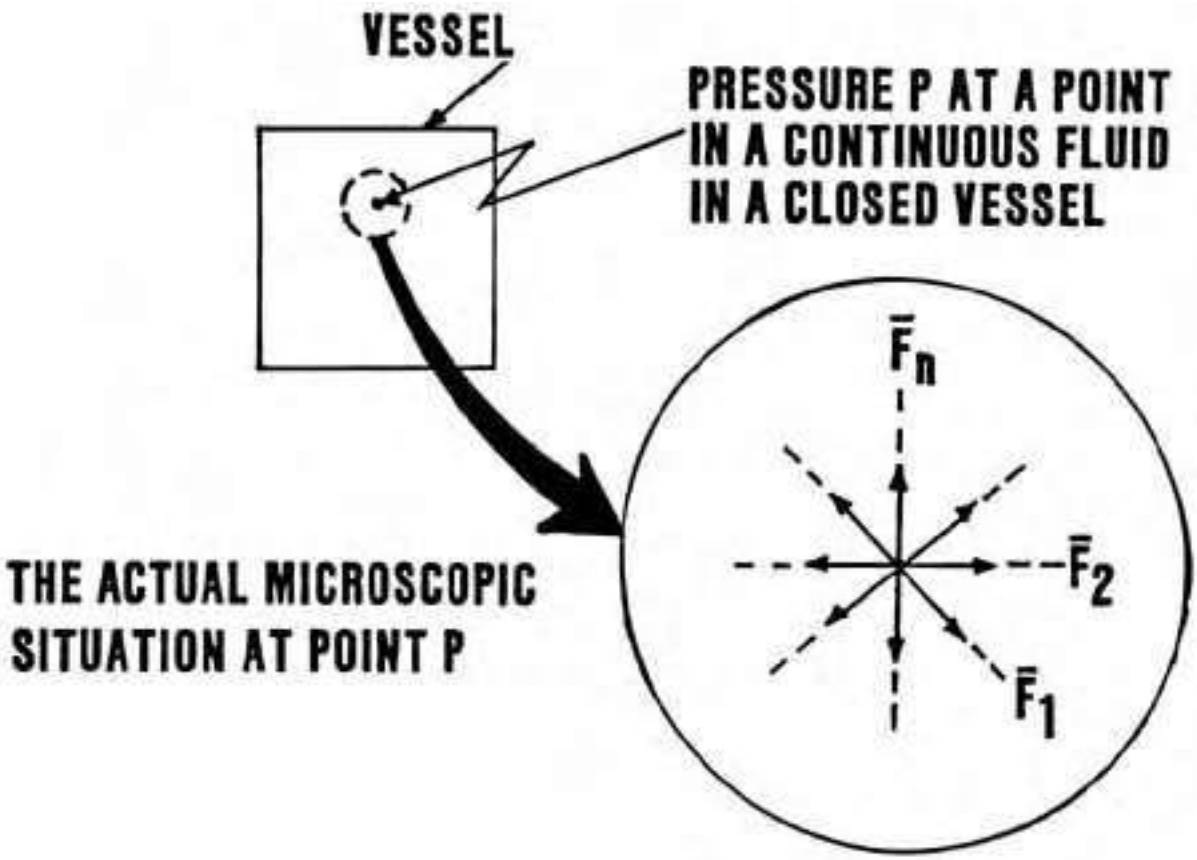

Our next slide shows that a physical scalar quantity has a hidden vector substructure.

For example, we show on the left a closed vessel containing a pressurized gas. The pressure at a point in the gas is a scalar quantity, since it has a magnitude but not a direction. However, physically what we have in the gas is a flux of individual molecules continually through any small volume, which we may let approach a point in the limit. Thus we have a flux in all directions through the point at which we specify pressure.

That is, the scalar "pressure" at a point may be said to contain a substructure of individual molecule flow vectors.

All physical process scalars have such hidden substructures. In

the equilibrium case, the summation of all the individual flux vectors yields a resultant vector zero.

Thus we take the view that ANY PHYSICAL PROCESS SCALAR IS ALSO A ZERO VECTOR, AND ANY ZERO VECTOR IS A SCALAR AND CONTAINS A SUM-ZERO HIDDEN VECTOR SUBSTRUCTURE.

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SLIDE 8.

SCALAR AND VECTOR SUBSTRUCTURES

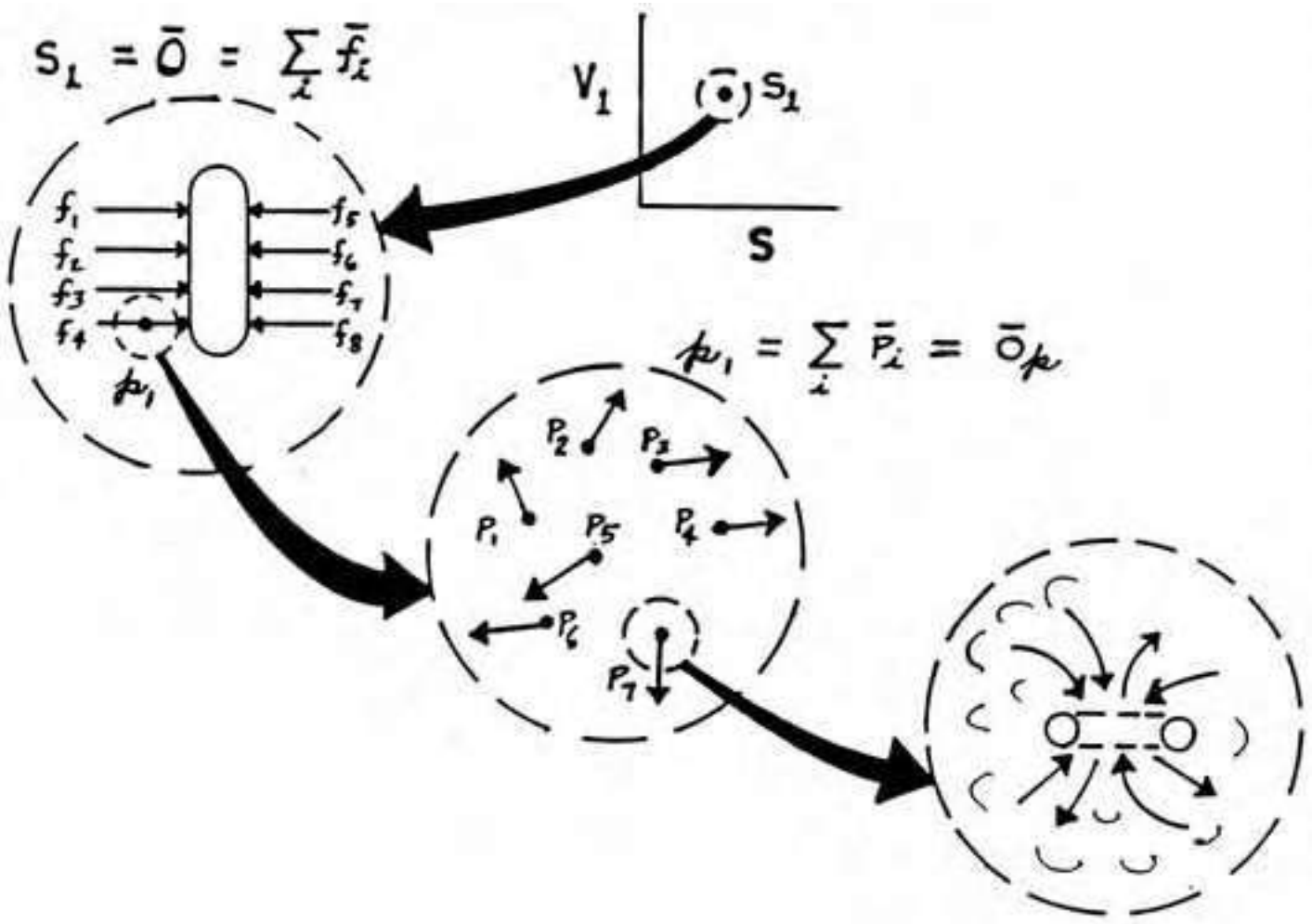

Now let us see if we can do some unusual thinking about the hidden vector substructure of a scalar or zero-vector.

On the leftmost figure in this slide, we show a plate with balanced opposing forces. The vector summation of all the forces' is zero, so the system has no resultant vector. The plate therefore does not move. However, the plate -- that is, the medium in which the forces act -- is stressed, much like the previous example of pressure in a gas. The difference is that now the stress is patterned in its substructure, and not random. Now suppose we rhythmically vary the forces, each the same, in a regular manner in time. Yet we maintain a continuous balance, so there is never a system resultant greater than zero. In this case, we maintain our vector zero, but we are producing regular stress waves in the plate medium..

I think you now can see that I can vary the individual opposing vector pairs so that rhythmic waves flow from top to bottom, or from bottom to top. That, of course, will describe a vector gradient traveling through the medium, and that will be an ordinary "vector wave." Is there any way I can make waves through the medium, and not have such vector waves ever appear?

Indeed there is, if I look further into the substructure. Take one point on one of the vectors shown acting on the plate in the left diagram. That point is a scalar, and it also has a substructure of even finer vectors, as shown in the lower middle figure. And any point in one of these second-order hidden vectors is a scalar and composed of a still finer hidden vector substructure, as shown in the lower right figure. This process repeats ad infinitum, and all is structures within structures. At least it can be modeled that way, for it already is treated that way in particle physics.

Now go back to the second order vector substructure. Here I can establish whatever patterns I wish, and not affect the first order pattern shown in the figure on the left. I can even rhythmically vary things in the second order substructure, and leave a blissfully unchanged first order substructure, to the first order observer.

So I can make as many waves; as I wish through the medium, as long as I stay second order or higher, and the external observer will never see any change at all unless he has a special detector of some sort to detect the lower substructure changes.

As I showed in the Appendix to my book, The Excalibur Briefing, these substructures are in reality the same thing as hyperspaces. And movements in them can proceed much faster than the speed of light.

So I can have higher order signals and waves through the stressed medium without changing the overall first order stress in the medium.

This is a sort of super-relativity; the present relativity is just a special case.

Superluminal communication systems are perfectly possible, but not with the present first order transmitters and receiver/detectors.

Note also that higher order stresses -- stresses in the higher order substructures -- represent special stresses in time, and time has an internal stress-pattern substructure. The higher order stress waves are phase waves or phase fluctuations in that respect.

Also note that Charles Musés has already created the hypernumber mathematics of the structure of time, and it is largely in his mathematics that these concepts will have to be mathematically modeled.

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SLIDE 9.

SUPERPOSITION DOES NOT ELIMINATE THE VIRTUAL SUBSTRUCTURE

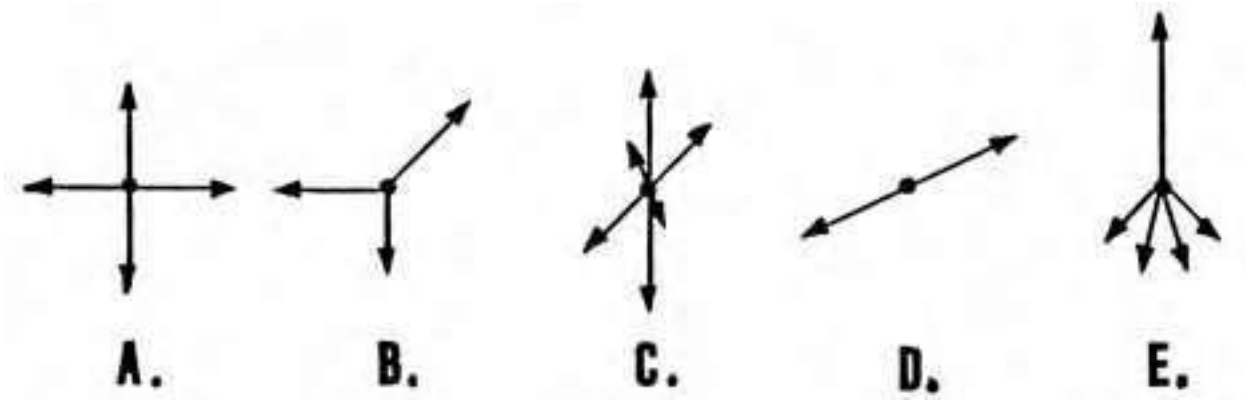

TWO OR MORE MACROSCOPICALLY "EQUAL" VECTORS OR SCALARS CAN DIFFER DRASTICALLY IN THEIR VIRTUAL SUBSTRUCTURE DISTRIBUTIONS. EVEN TWO "ZEROS" MAY BE DYNAMICALLY DIFFERENT DUE TO THEIR DIFFERING SUBSTRUCTURES.

Next we show some simple substructures of a zero vector. All of these vector systems sum to zero vectorially. Note that if we superpose two of these structures, all substructure vectors are still present., and the vector summation is still zero.

Also notice that, from the standpoint of substructuring, zeros can be and are drastically different.

We can even make rhythmic waves in the substructure by superposing patterned zero vectors in a regular fashion.

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SLIDE 10.

PHYSICAL VECTORS

- **VECTOR: A "SMEARED PARTICLE"**

- **FOUR MAJOR PARTICLES IN PHYSICS:**
  - POINT [MASSLESS, CHARGELESS]
  - MASS [CHARGELESS]
  - CHARGED MASS
  - CHARGED POINT [MASSLESS}

- **LEADS TO FOUR MAJOR VECTORS:**
  - GEOMETER'S
  - MECHANIC'S
  - ELECTRICIAN'S
  - ADVANCED ELECTRICIAN'S

In quantum mechanics, as we approach the quantum level, we find that the notions of a particle (static concept) and a wave become inseparable. That is, any particle becomes a "smear" in length and time, and it becomes inseparable from its smear. At the quantum level, there is no separate energy, length, mass, momentum, energy, or time -- all are welded together inextricably into a quantity called "action," having the units of angular momentum.

So at the fundamental quantum level, a moving point becomes a smear, and a vector represents a physical, undifferentiated entity.

To go quickly, we now define a vector as consisting of a smeared particle. That is, the particle is smeared in both time and length, and it is not differentiated from time or length.

There are four kinds of particles in physics which can be smeared to form vectors. First, there is a point in space or spacetime. This point may be approximated as massless and chargeless. At least that is the way the geometers of old conceived it in the abstract, and so the idea of a "point" in space assumes it to be chargeless and massless. Second, there is a tiny particle of mass, often abstracted to be a "point-mass," but visualized as having no charge. This is the mechanic's particle. Third, there is a tiny charged mass, such as an electron, and this is the electrician's particle. Again, it is often abstracted as a charged point-mass. Fourth, there is a charged point, having no mass, and this is the advanced electrician's particle, which he uses to form the idea of potentials and fields.

Smearing these four particles at the fundamental quantum level produces four different kinds of physical vectors: the geometer's, the mechanic's, the electrician's and the advanced electrician's vectors. They are all different.

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SLIDE 11.

THE FOUR VECTORS OF PHYSICS

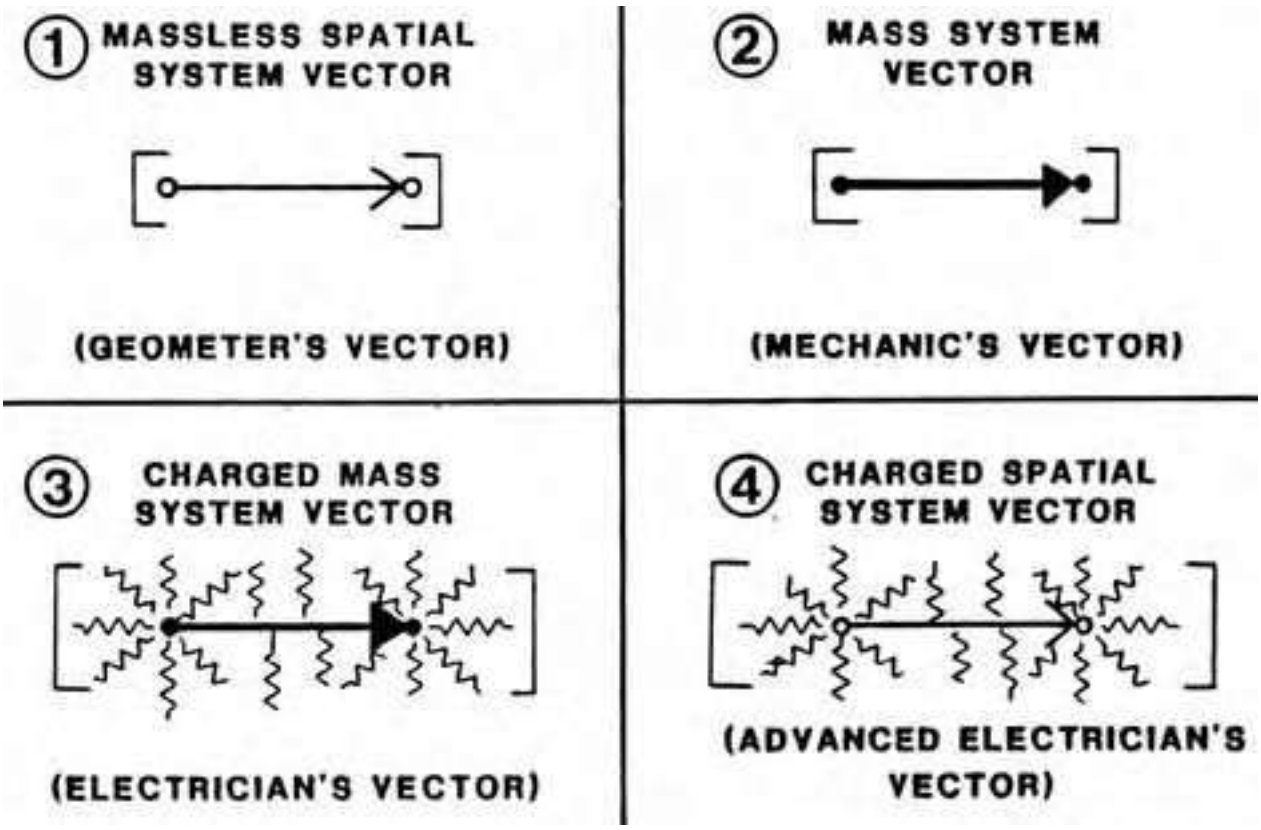

On this slide we show a graphic illustration of each of these vectors.

Note that they may be visualized as smeared particles, but the particle is not separate from the smear in time and length.

Each vector must be considered as a unitary entity -- it is a special kind of quantum, if you will.

Each is a special quantum of motion.

And Dewey Larson has it right when he says, "All is motion."

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SLIDE 12.

FORCE DEFINITION

- ***A TRUE DEFINITION IS AN IDENTITY.***

$$F \equiv d/dt\ (mv)$$

- **FORCE CONSISTS OF THE TIME RATE OF CHANGE OF MOMENTUM**
- **MOMENTUM IS A MASS SMEARED THROUGH A LENGTH IN A CERTAIN TIME**
- **FORCE CONSISTS OF MASS-MOTION-CHANGE**
- ***FORCE IS AN EFFECT, NOT A CAUSE !***

We now look a little closer at the concept of a force.

I point out that a true definition is an identity. If a supposed definition of an entity is not an identity for that entity, then it is not a definition at all, but only a statement ABOUT the entity.

It may come as somewhat of a shock to the normal engineer and scientist that the foundations concepts of physics -- such as force, mass, energy, etc. -- are ALL in serious difficulty and contain many unresolved logical conflicts.

Force is in that kind of difficulty, and it has that kind of logical conflict.

In fact, in its force equations, physics has not even applied its own present definition of force.

As we show here, force is generally defined as the time rate of change of momentum.

If that is true, then as an identity the definition states that a force CONSISTS OF the time rate of change of momentum.

And of course, momentum is mass times velocity. Hence momentum is a mass smeared through a length and through a certain time.

Force then consists of the time rate of change of that smearing. That is, we smear the mass through time and length, faster or slower.

But if force CONSISTS OF that smearing change, it does not CAUSE it.

Force is thus an effect or result, not a cause.

This implies that there is a more fundamental mechanism that causes or generates force itself -- ANY force. If we can find that hidden mechanism, we may well find the long-sought unified field theory, since it will unify all forces on a common mechanism.

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SLIDE 13.

FORCE IS AN EFFECT NOT A CAUSE

---

1. $\bar{P} = M\bar{V}$ (MACROSCOPIC)

2. $\bar{P} \equiv \overline{[M\bar{V}]}$ (MICROSCOPIC)

3. $\bar{F} = \frac{d\bar{P}}{dt}$ (MACROSCOPIC)

4. $\bar{F} \equiv \frac{d\bar{P}}{dt} \equiv \frac{d}{dt}\overline{[M\bar{v}]}$ (MICRO)

   $\equiv \overline{[M\bar{v} + M\bar{a}]}$

5. $F \equiv \overline{[M\bar{a}]}$ (NONRELATIVISTIC)

6. FORCE CONSISTS OF A "SMEARED MASS"

7. IT IS MASS-ACCELERATION, IT DOES NOT CAUSE IT.

8. FORCE IS AN EFFECT, NOT A CAUSE!

On this slide, we show briefly how one might express this idea in mathematical symbology.

Macroscopically, momentum consists of mass times velocity. Microscopically, the mass and the velocity are inextricable, and it is not proper to speak of a "mass in motion," but only of "mass-motion." We show this in equation 2.

We take the macro definition of momentum, as shown in equation 3, and express it for the microscopic, unseparated case, as shown in equation 4.

In the nonrelativistic case, we may consider m-dot to be zero, since the time rate of change of mass is almost zero. In that case, force may be defined for the microscopic case as a smeared accelerating mass, as shown in equation 5.

Force thus consists of the welded mass and acceleration, with no seam in the middle.

It IS mass-acceleration; it does not CAUSE it. Therefore force is an effect, not a cause.

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SLIDE. 14

FORCE AND $\bar{E}$-FIELD DO NOT EXIST IN VACUUM

1. $$\bar{F}_p \equiv \overline{[M_p \circ \bar{a}_p]}$$

2. WITHOUT M, THERE IS NO M_p, NOR $\bar{F}_p$

3. HENCE FORCE DOES NOT EXIST IN VACUUM.

4. $$\bar{E}_{cm} \equiv \frac{\bar{F}_{cm}}{q_{cm}}$$

5. WITHOUT M, THERE IS NO $\bar{F}_{cm}$, NOR q_{cm}.

6. HENCE $\bar{E}$-FIELD DOES NOT EXIST IN VACUUM.

7. SIMILARLY, $\bar{B}$ AND $\bar{G}$ DO NOT EXIST IN VACUUM.

8. NO FORCE FIELD EXISTS IN VACUUM.

But if force CONSISTS OF mass welded to acceleration, it cannot exist in the absence of mass.

Hence force does not exist in vacuum.

Further, the Ë-field (Electric field) of a charged particle is defined as the force on a charged mass, divided by the mass. That is, the Ë-field is thought to represent the force per unit charged mass. And then it is assumed to exist in vacuum.

But vacuum is without mass or charged mass, observably. Without mass, neither force nor charged mass exists.

Therefore the Ë-field does not exist in the vacuum.

Magnetic field (B) and gravitational field (G) are similarly defined, and they have the same logical difficulties.

Therefore neither magnetic field nor gravitational field exist in vacuum.

A priori, NO force field exists in vacuum.

The greatest error in physics has been the assignment of a force as a cause, and thus assigning it to the vacuum. The force is an effect, and it never exists in vacuum, a priori.

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SLIDE 15.

COROLLARIES

- **MORE PRIMARY MECHANISM CAUSES/GENERATES FORCE -- ANY FORCE**
- **FORCE DOES NOT EXIST IN VACUUM, SINCE VACUUM IS THE ABSENCE OF MASS**
- **FORCE FIELDS DO NOT EXIST IN VACUUM**
    - **E-FIELD**
    - **B-FIELD**
- **TRANSVERSE [HERTZIAN] WAVES DO NOT EXIST IN VACUUM**

Without belaboring the issue, I now point out and summarize some of these conclusions.

First, a more primary mechanism causes or generates force -- ANY force.

Second, force implies the presence of mass a priori. Force does not exist in vacuum, since vacuum is the absence of mass.

Third, no force fields of any kind exist in vacuum, including Ë-field, B-field, and gravitational field.

Fourth, since Hertzian waves are defined in terms of Ë and H force fields, and these fields do not exist in vacuum, then Hertzian waves do not exist in vacuum.

Tesla pointed out long ago that vacuum EM waves are longitudinal waves, not Hertz waves. Vacuum EM waves are similar to sound waves in a gas.

The Hertz wave exists as a matter wave in the electron gas in a transmitting antenna, and in the electron gas in a receiving antenna, but does not exist in the vacuum in between the two antennas. Between them, EM waves are longitudinal waves.

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SLIDE 16.

ENERGY IS DERIVED, NOT FUNDAMENTAL

- ENERGY IS CONGRUENT TO WORK

$$dW = \bar{F} \cdot \bar{d}S$$

- BUT FORCE IS AN EFFECT, NOT A CAUSE
- THUS WORK IS AN EFFECT, NOT A CAUSE
- ENERGY≡WORK CAPACITY
- A MORE FUNDAMENTAL MECHANISM GENERATES "ENERGY"

$$\Delta E = \frac{\Delta A}{\Delta T}$$

- ENERGY IS AN EFFECT, NOT A CAUSE

Energy is usually taken as "the capacity to do work" at some future time. In other words, when we refer to the energy of something, we refer to HOW MUCH WORK IT CAN DO IN THE FUTURE, IF AND WHEN WE ARRANGE FOR IT TO DO IT. Rigorously, a body has no "work" at a particular instant in time, so we use "energy" to refer to potential work that can, or will, be done in the future. Thus energy is always congruent to work in the future.

And for that reason, the units of energy are the units of work; the only difference is in the time the work is done, relative to the "now" or "present" we are speaking of.

Energy is the potential for work to be done in the future.

But what is work?

Well, work is defined in terms of the movement of a force through a distance. And it is understood that only the projection

of the force along the line of movement is "working." Thus work is defined differentially as shown on the slide. The differential of work is equal to the dot product of the moving force times the differential of displacement.

But as we have seen, force is an effect, not a cause.

That is, when we calculate the work done, it's always in the past, never in the present or future. It's always been DONE, and has been expended.

Being in the past, it's gone forever, so it certainly isn't the CAUSE of anything which happens in the future.

Thus work is an effect, not a cause.

That's interesting, because then it certainly does not directly generate "energy," since energy is something in the present which speaks of future work to be done.

Rigorously, the fundamental quantum -- which is what exists in the present, in unseparated and unquantized form -- consists of action. NOT energy, NOT time, NOT length, NOT momentum exclusively, but all of these IN<u></u>clusively.

And a change in energy occurs when a quantum is separated at a certain rate in time. Thus delta energy equals the time rate of change of action, or delta action divided by the delta time used in separating the quantum and fissioning it into parts (collapsing the wave function).

Thus energy itself is an effect or result of a more fundamental mechanism, and it is not a cause.

In quantum mechanics all this has been neatly "buried" in the mysterious "collapse of the wave function," which is supposedly what "causes" everything to happen. And then we swear that what results after the collapse is a totally statistical selection from the possible states of the system we are examining. We thus say that the microworld is totally statistical at base. Of course we also build a wave equation or wave function which propagates forward in time with rigorous causality, and that wave or function absolutely controls the basket of "possible states" allowed .

All that says is that the "wave function times time" is what exists in the present, when observation has not been made by "stopping time." And then we "stop time" in a rather blunt manner, somewhat like firing a billiard ball blindly into a group of billiard balls on a table, and we live with what gets hit and pops out.

If we examine this "time" that is flowing, look into its substructure, and arrange that substructure as we will, we can control which "billiard ball" is hit and which pocket it goes into. By working on the vector substructures of time, we can thus deliberately control the microworld and make it causal, not

statistical. Quantum mechanics is in error in stopping where it has; it is presently only a first order approximation of the real quantum mechanics that awaits.

Einstein was correct after all; God does NOT play dice with the universe when one considers all levels.

One finds oneself in a statistical situation at one level only when the constituent sublevels of it are uncontrolled.

Next Chapter

SLIDE 17.

EXISTENCE IN, AND PASSAGE THROUGH, TIME

- **IN RELATIVITY, TRANSLATION OF A BODY AND PASSAGE THROUGH TIME ARE RELATED**

$$\Delta L = C \Delta T$$

- **"MASS" IS SPATIAL**
  - DOES NOT EXIST IN TIME
  - "MASS-TIME" EXISTS IN TIME

- **VIRTUAL FLUX TO AND FROM A BARE PARTICLE DETERMINES ITS "PASSAGE THRU TIME"**

- **SPHERICAL SPIN OF A MASS PARTICLE [L^3] COUPLES IT TO THE SPACETIME VACUUM [L^3T] VIRTUAL PARTICLE FLUX**

- **PASSAGE THROUGH ORDINARY TIME IS CONTROLLED BY CREATION AND ANNIHILATION OF QUANTA**

On this slide, we simply point out that translation of a body through space and its passage through time are related, according to relativity.

Now "mass" is spatial.

It does not exist in time.

Only things which contain the unit of time can "exist in time."

Otherwise, the thing only exists as such when the passage of time has been momentarily stopped -- usually by photon emission and the consequent carrying off of the time unit by the photon.

Since every mass that has temperature -- and every mass does -- is continually absorbing and emitting photons, then the mass is continually grabbing a time tail (absorption) and losing it (emission) shortly thereafter.

Masstime is what exists in time, not mass.

And every mass particle is continually turning from mass to masstime to mass, etc.

Indeed, it is the summation of the absorption and emission of virtual subquanta by a mass particle -- i.e., its "charge" -- that determines its rate of flow through "time."

And the spherical spin of a mass particle couples the particle of mass to the spacetime vacuum; that is, to the virtual particle flux.

Passage through ordinary time is controlled by creation and annihilation of quanta, and these processes are controlled by substructure (subquantal) actions and interactions.

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SLIDE 18.

SOME IMPLICATIONS

- **MODIFIES CONSERVATION OF CHARGE**
- **MODIFIES CONSERVATION OF ENERGY**
  - ***MASS***
  - ***ENERGY***
  - ***ANENERGY (MASSLESS CHARGE)***
- **MODIFIES NEWTON'S LAW**
  - ***FOR EVERY ACTION, THERE IS AN OPPOSITE AND EQUAL REACTION***
  - ***REACTION NEED NOT BE LOCAL***
  - ***REACTION NEED NOT BE ANTIPARALLEL***
- **UNIFIED FIELD THEORY**

Without belaboring the issue, I now simply point out some implications of the new approach.

First, we modify two laws -- the conservation of charge and the conservation of energy -- by combining them into one law, a new conservation law in which anenergy is conserved.

Neither charge per se nor energy per se need be conserved; but the overall anenergy (massless charge) equivalency is what is conserved. This allows us to derive mechanisms for free energy from the vacuum, for example. These mechanisms readily violate the present conservation of energy law, but do not violate the overall conservation of anenergy law.

It is the total anenergy equivalency of mass, energy, and massless charge that is now to be conserved in general. The old laws are now just special cases.

Also, Newton's third law -- for every action there is an equal and opposite reaction -- is modified. It still applies, but in changed form.

The reaction still occurs, but it need not be local, and it need not be antiparallel to the original action.

Thus it is now possible to design and build a "locally reactionless" inertial space drive for a vehicle.

The final implication is that the common mechanism producing force -- any force -- provides a unified field theory. Specifically, it provides one which easily lends itself to direct engineering. It is not esoteric nor mysterious. It is practical and physical, and it can be done with some modifications to our present electrical circuits and devices.

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SLIDE 19.

CONSERVATION OF ANENERGY (AE): (AN EXPANDED ENERGY CONSERVATION LAW)

1. CONSERVATION OF CHARGE:
   - "CHARGE" = MASS (M_c) + CHARGE (AE_c)
   - $|M_c| + |AE_c| = K_1$
2. CONSERVATION OF ENERGY:
   - DYNAMIC ENERGY (E)
   - ENERGY EQUIVALENCE OF MASS (M_E)
   - $|E| + |M_E| = K_2$
3. ADDING (1) AND (2):
   $|M_c| + |AE_c| + |E| + |M_E| = K_1 + K_2 = K_3$
4. LETTING $|M| = |M_c| + |M_E|$,
   $|M| + |E| + |AE_c| = K_3$
5. LETTING $|M| = AE_1$, $|E| = |AE_2|$, $|AE_c| = AE_3$,
   $AE_1 + AE_2 + AE_3 = K_3$

We briefly show a simplified derivation of the new conservation of anenergy law.

We express the conservation of charge law by correcting the term "charge" to show its true meaning: charged mass. We use the absolute value symbol to mean the "anenergy equivalency."

As shown on the slide, we account separately :for the mass (m-sub-c) of the conserved charges and the virtual particle charge flux (the anenergy -- AE-sub-c) of the charges conserved. That law now says that the absolute values of the masses and the massless charge fluxes have a total constant summation.

For a dynamic mass, we do a similar thing, in this simplified case ignoring potential energy of position, and taking the energy equivalence of the dynamic energy (M-sub-E) and the rest mass energy of the particles, M-sub-E. The conservation of energy now states that these two terms have a constant absolute value summation.

We add equations 1 and 2, getting equation 3. We consolidate like terms to get equation 4.

Expressing all terms in their anenergy equivalencies (absolute values), we get equation 5, which is the overall conservation of anenergy equivalency.

Note that we now can change mass into energy or anenergy (massless charge), energy into mass or anenergy, and anenergy into mass or energy.

Thus we can turn everything into pure vacuum ether (pure massless charge, pure anenergy, pure electrostatic scalar potential, pure stress on spacetime) or we can turn part of the vacuum into energy or particles of mass.

Vacuum now becomes a very real thing indeed.

It is pure anenergy.

Pure massless charge, pure electrostatic scalar potential, pure "broken bits" (subquantal bits) of (quantized) energy.

The vacuum is identically the virtual state.

It is not an emptiness filled with virtual things; rather, it IS the sum total of those virtual things, for they are totally unseparated until some sort of "conceptual observation" is invoked.

Physics should have adopted Einstein's suggestion that the vacuum, complete with its EM and gravitational fields, be called the ether.

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SLIDE 20.

FREE ENERGY IS ALLOWED

- **ANY ONE-WAY GATING PROCESS FROM ANENERGY TO ENERGY YIELDS "FREE ENERGY" SINCE THE ANENERGY IS AUTOMATICALLY REPLENISHED BY THE UNIVERSE.**

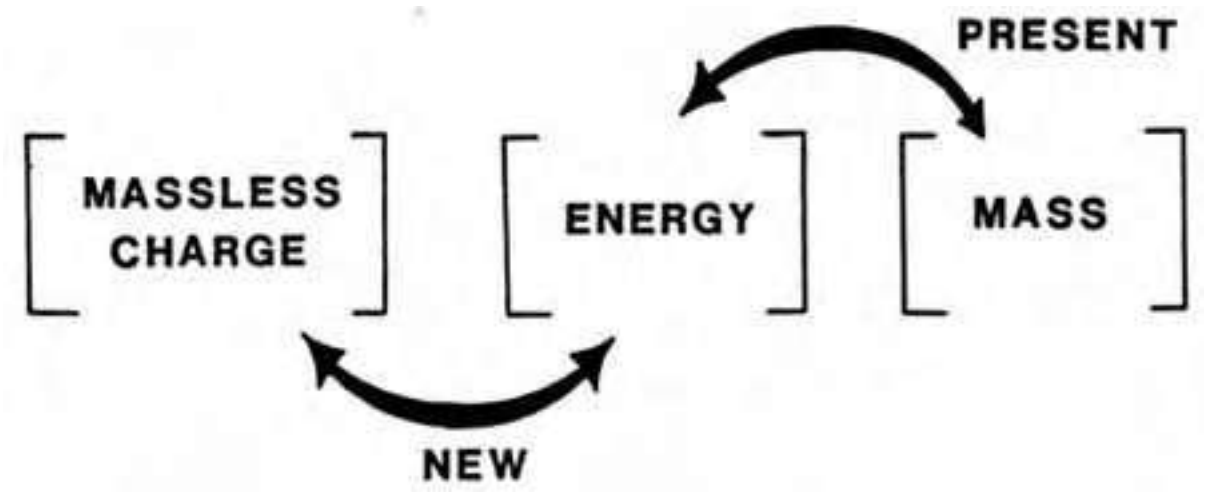

Now we can put the search for free energy devices on a rigorous scientific basis.

As shown here, mass and energy are translatable one into the other. So are massless charge and energy.

And the universe is filled with fantastic amounts of anenergy; ultimately, that is what the universal vacuum IS.

Any one-way gating process from anenergy to energy yields "free energy" since the anenergy is automatically replenished by the universe.

A sort of Maxwell's demon, after all, is what we need. Only we need one which works with the virtual state, not observable molecules.

Fortunately nature has provided several Maxwell's demons of this sort, if we but recognize them and learn to use them.

Next Slide

SLIDE 21.

SCALAR POTENTIAL CAN FORCE THE RELATIVISTIC CASE

- **FOR SCALAR POTENTIAL ENERGY OF APPRECIABLE SIZE RELATIVE TO A PARTICLE'S REST ENERGY.**
  - **NEWTONIAN MECHANICS AND**
  - **THE SCHRODINGER EQUATION**
- **MAY BE INADEQUATE**
  - **EVEN IF V/C IS SMALL**

Bloch & Crater, "Lorentz-invariant potentials and the non-relativistic limit," American Journal of Physics, Vol. 49, No. 1, Jan. 1981, pp. 67-75

First, let us now digress to point out that one does not have to have relativistic velocity to obtain relativistic effects.

One can use the common electrostatic scalar potential to drive the situation relativistic. On this slide we show just one of several references in the standard literature that address this fact.

Let's understand what we are saying.

Anything you get from a relativistic situation, you can get directly by cleverly applying electrostatic scalar potential.

You can get a change in the passage through time, you can get energy changes, mass changes, inertial resistance changes, etc.

You can bend, warp, and twist spacetime like a pretzel.

If you "wave" the scalar potential by simply varying it , you can create pure time waves. You can also produce pure inertial field waves, pure gravitational waves, etc.

The ability to engineer the curving of spacetime allows the direct ability to engineer physical reality itself.

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SLIDE 22.

SCALAR STRESS WAVE [O-WAVE] [TESLA WAVE]

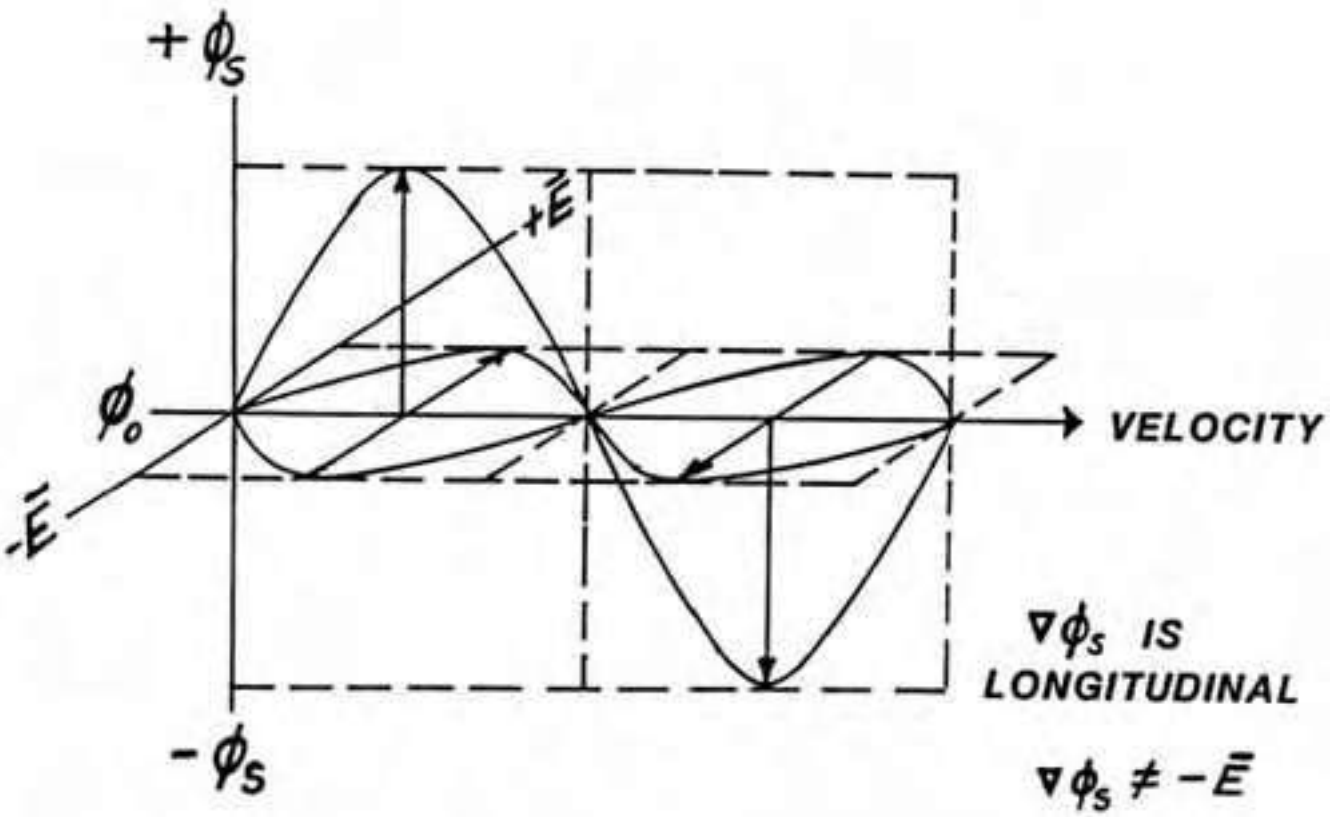

On this slide we now show a simple way to make a scalar, zero-vector wave -- the kind of wave originally discovered by Nikola Tesla.

It's simple. We just believe that a sum-zero vector substructure makes a scalar quantity, and we MAKE some scalars that way.

We also understand that a zero-gradient of a scalar is a zero vector, so that the scalar itself may be taken to be a zero vector.

The simplest explanation of this wave is as follows:

First, in physics we have two competing, mutually exclusive theories as to the nature of

electromagnetic energy: the wave theory and the particle theory. Physicists argued for decades over these theories, for some experiments support one and some support the other. They never solved the problem; they just agreed to quit arguing. They formulated the "duality" principle to allow the saving of face to both sides.

Briefly, the duality principle implies that, whatever the nature of electromagnetic energy is before an interaction, in the interaction you can get it to act as a wave or as a particle. In other words, AS IT EXISTS, BEFORE THE INTERACTION, it is implicitly both particle and wave, joined together in some fashion, without being explicitly either one.

With the fourth law of logic, this becomes perfectly clear. With three-law Aristotlean logic, the problem is unresolvable.

Let us use this idea of "explicit duality without implicit duality" to analyze the wave shown on the slide.

First, from a wave aspect, the E-fields and the B-fields of the two waves do superpose and vectorially add. Since the waves are 180 degrees out of phase, the exterior resultant wave has a zero electric field and a zero magnetic field. Therefore it is a "zero-vector" wave, or "scalar" wave. It's a wave of pure stress in spacetime.

However, this scalar wave has a precisely determined substructure, consisting_of two ordinary sine waves, each of which comprises an ordinary E-H vector EM wave.

Now we apply the photon consideration (remember, before we interact with the wave, it must implicitly possess BOTH wave and particle natures combined, and we have so far only examined the implication of the wave nature.

The theory of photons' states that they are monocular critters. Photons pass right through other photons without interaction, in a linear situation. Therefore they can coexist without interaction, which is what we show here.

One photon, by the way, is one wavelength .

The photon theory requires that both substructure waves continue to exist as independent photons. Therefore we are assured that our substructure is intact.

However, notice that the totality of the two

waves stresses spacetime. In other words, we have twice the stress on spacetime now as we would have from either wave separately.

This wave is therefore just a pure stress wave in spacetime itself.

This thing oscillates time, oscillates the relativity of the situation, and can affect energy, time flow rate, inertia, gravity, etc. aspects of an absorbing system.

Note that we have a rhythmic oscillation in phi (Ø), and we have a longitudinal stress wave, very similar to a sound wave. The MEDIUM for this wave is the virtual particle flux that identically comprises vacuum spacetime itself.

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SLIDE 23.

SCALAR Ö-WAVE PRODUCTION

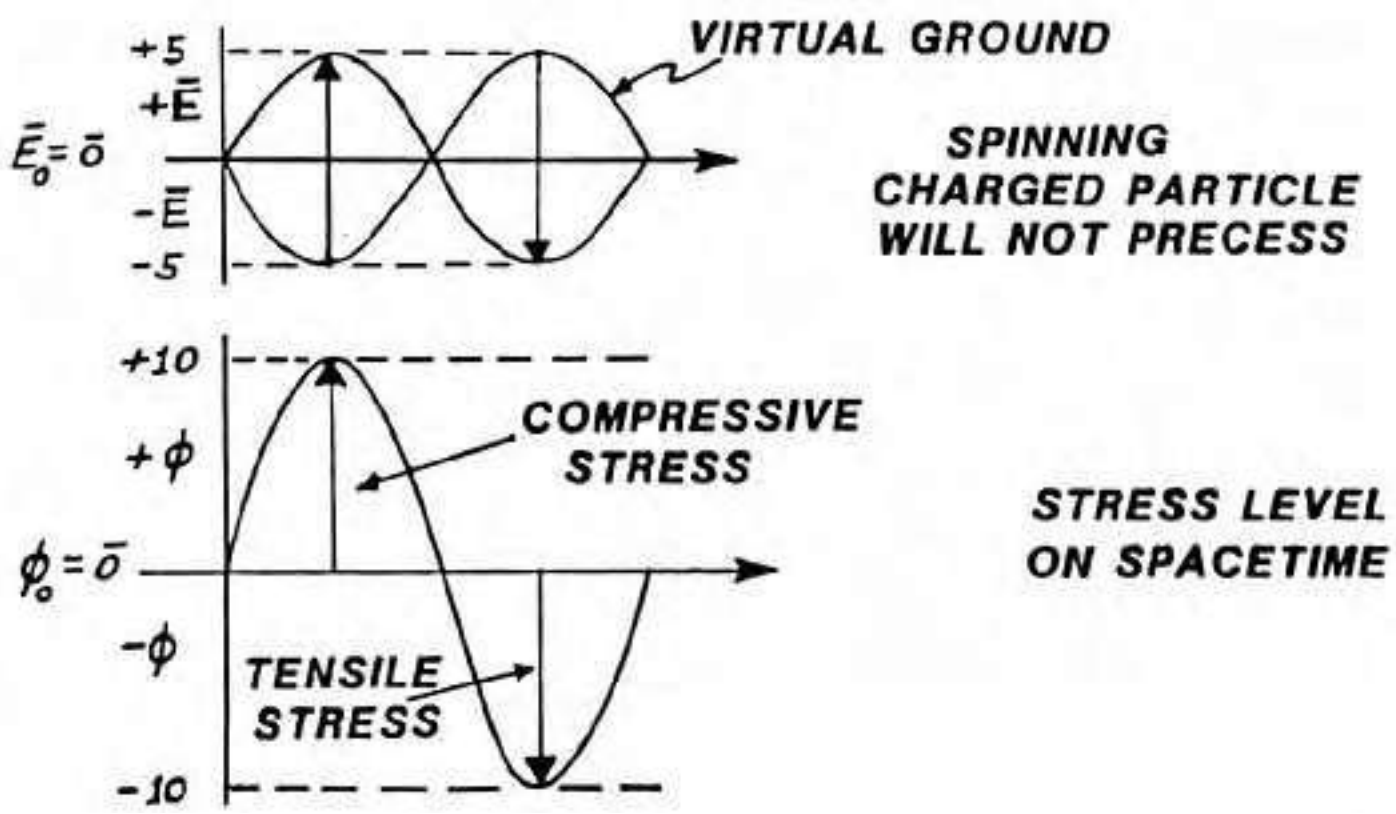

On this slide we show how to regard the magnitude of the stress, by using one wave envelope as "virtual ground." In the top diagram, the original E-field stress of each wave has a magnitude of 5, and the composite stress wave now has a magnitude of 10, in whatever units we choose to express them.

We show in the bottom diagram that during one half cycle we have compressive stress in the virtual particle vacuum flux, and during the second half cycle we have tensile stress.

This shows the wave is like a sound wave in the gaseous molecules of the air.

However, this wave has one difference. It also

oscillates time, and thus has at least one additional degree of freedom, compared to ordinary EM waves.

In fact, this wave can be made n-dimensional and hyperspatial.

As a first order approximation, we can treat such a wave in
a spatial fashion, if the wave is not too great in magnitude and the relativistic oscillation of time and inertia is not too large.

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SLIDE 24.

A SIMPLIFIED CHARGED PARTICLE

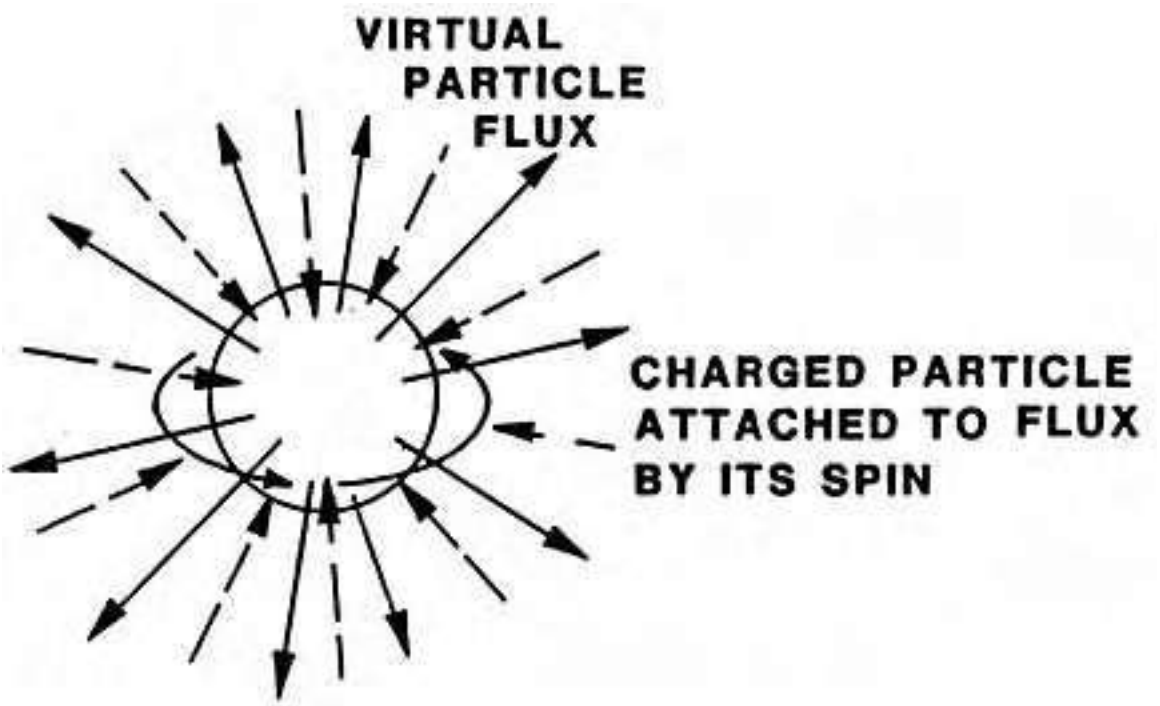

(THINK OF THE FLUX IN AND OUT, EXCEPT GRADIENTS ARE SPIRAL-LIKE, DUE TO PARTICLE'S SPIN)

We now digress slightly to pick up some more concepts.

On this slide, we show a simplified physical model of a charged particle. According to present particle physics, we model it as an observable, spinning bare mass in the middle, connected to a spray of virtual particles on and off the mass in all directions.

It is the spin of the mass that "attaches" the spray of virtual particles to and from itself.

Note that, because of the spin, the gradient lines of flux will actually be spiral or vortex in nature.

Also note that, when EM theory was founded, no one knew that an electron was spinning. Electron spin was therefore omitted from the foundations of present

electromagnetic theory, and compensated for later by strictly ad hoc measures.

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SLIDE 25.

A CHARGED PARTICLE IS A SPECIAL KIND OF "SPRAY NOZZLE"

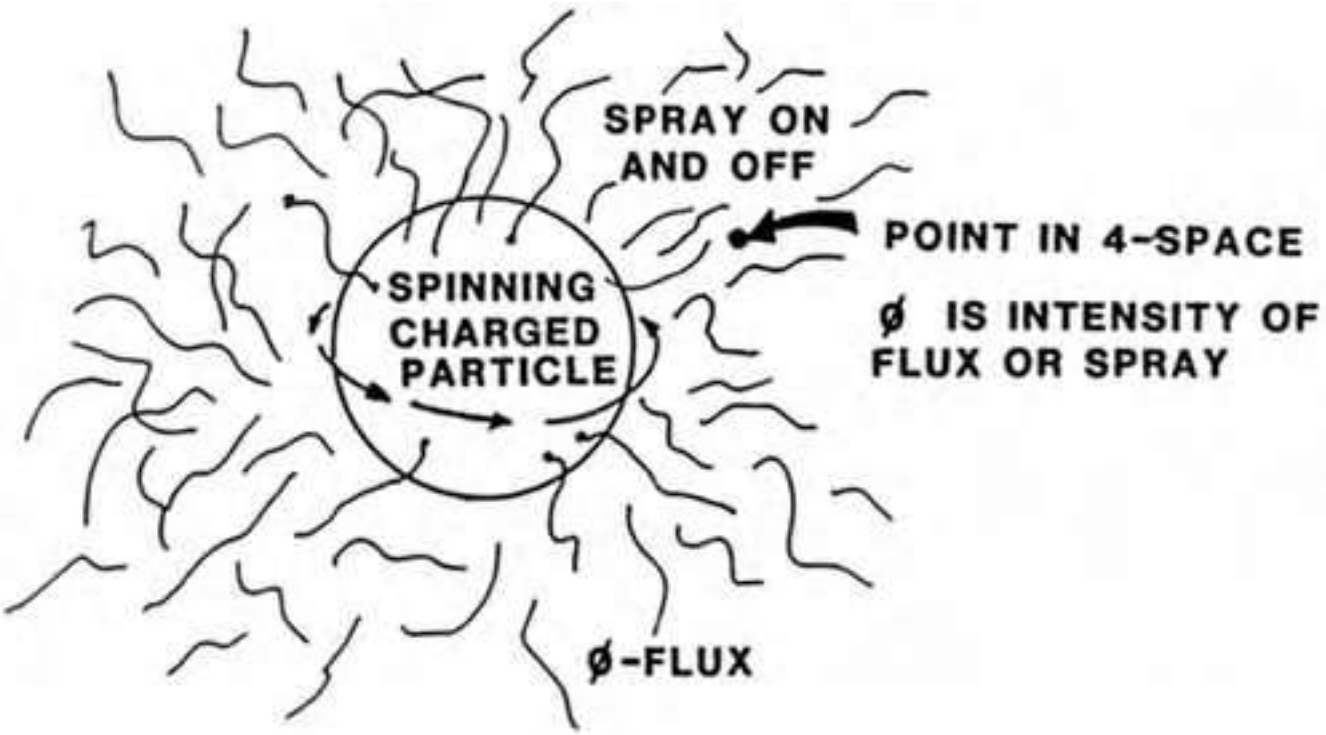

(SPRAY IS THROUGH 4 DIMENSIONS, NOT JUST 3)

Here we show a very important concept, and a very important fact of nature.

A charged particle may be idealized as a special kind of spray nozzle.

The 3-dimensional particle of mass is spraying out virtual particle fluid, and sucking in virtual particle fluid, in four or more dimensions.

We never have to furnish or replenish the spray. Nature provides that. And it's inexhaustible. It comes from the entire virtual particle flux vacuum of the universe. It's already connected firmly to matter, by its connection to the spinning charged particle of mass.

I repeat and strongly stress: This tremendous, continuous spray of virtual particles is absolutely free,

and absolutely furnished by the universe.

We don't have to create the basic pumps for the fluid. We just move the spray nozzles around, by moving the spinning charged masses around.

We never furnish any ultimate energy to or in our present EM circuits. We just pump around the spray nozzles, gating the spray furnished by the universe.

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SLIDE 26.

AN OBSERVABLE CHARGED PARTICLE IS DIRECTLY CONNECTED TO VIRTUAL PARTICLE FLUX VACUUM

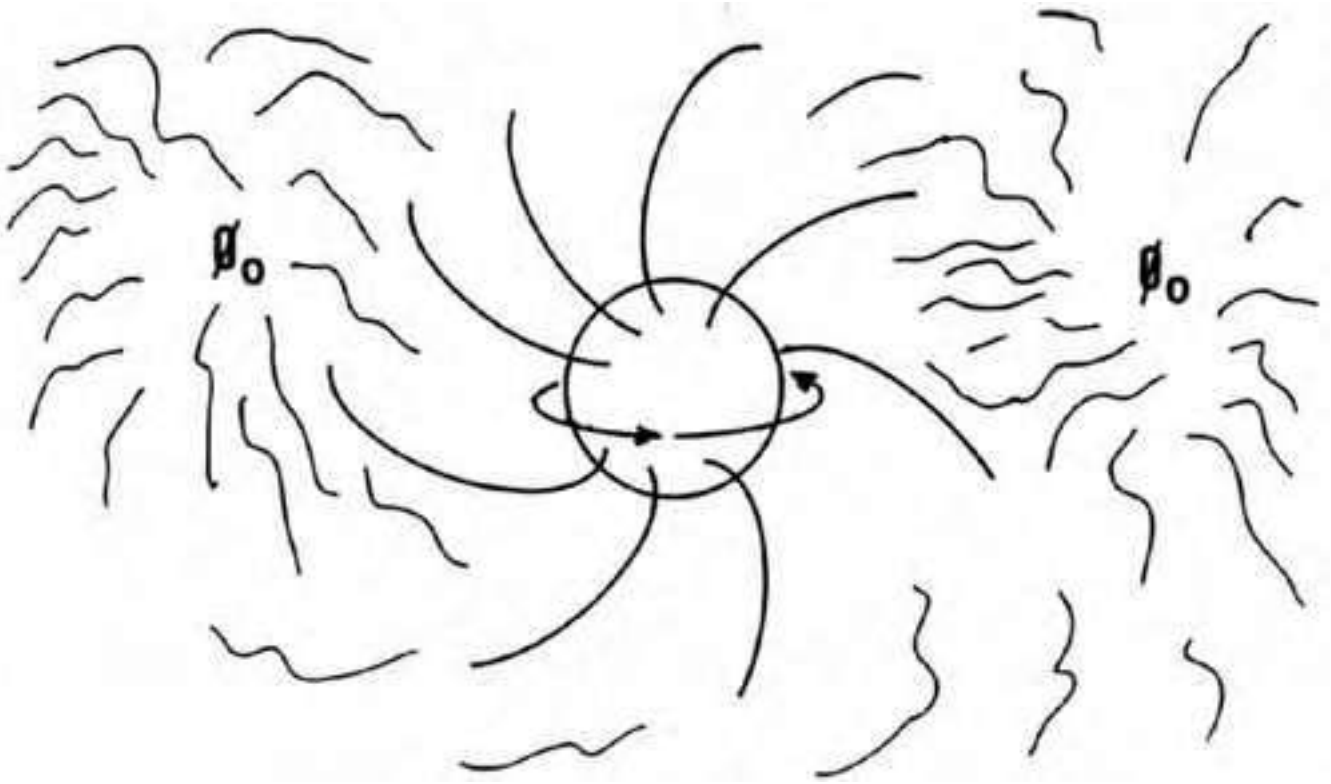

On this slide we accent that our 3-dimensional particle of mass is directly connected by its spin to the vacuum ether itself. To the virtual particle flux that identically IS the vacuum spacetime.

Interestingly, relativity states that the mass itself is nothing but a "kink" or curvature in spacetime .

The fact that the surface of the particle is spinning at right angles to the virtual particle vacuum flux "drags" part of the flux along with it, spiraling it, and certainly "kinking" or "bending" the vacuum flux .

That's the MECHANISM for the bending of spacetime. And that's what MAKES the particle of mass in the first place, and reduces its dimensionality to three.

Also note that the vacuum IS phi-sub-zero, and that is never
a zero value. This is contrary to present EM theory, which erroneously assumes phi-sub-zero -- the charge of vacuum -- to be zero or non-existent.

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SLIDE 27.

SPIN COUPLES VACUUM TO PARTICLE

- **SPHERICAL ROTATION IS THE KEY**
- **A PARTICLE CAN BE MODELED AS A SPHERICALLY ROTATING VORTEX OF SPACETIME**
- **ITS MASS IS DUE TO ITS SPIN**
- **THE SPINNING OBJECT IS CONTINUALLY CONNECTED TO ITS ENVIRONMENT**
- **VERY HIGH VALUES OF ELECTROSTATIC POTENTIAL CAN INDUCE RELATIVISTIC CONDITIONS**
    - **CHANGE RATE OF FLOW OF TIME**
    - **EVEN THOUGH VELOCITY IS NONRELATIVISTIC**

E.P.BATTEY-PRATT AND T.J.RACEY
"GEOMETRIC MODEL FOR FUNDAMENTAL PARTICLES,"
INTL. J. OF PHYS. 19, NO. 6, 437-475, 1980

In fact, the bits and pieces of many of the new concepts are strewed all through the scientific literature. Here we show one example, establishing a good model that spin of a particle couples the particle to the vacuum .

This paper is by E.P. Battey-Pratt and T.J. Racey, and was . published in the International Journal of Physics in 1980.

Note again that very high values of electrostatic potential
can induce relativistic conditions, even though relativistic velocity is not present.

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SLIDE 28.

ELECTRON PRECESSION (SIMPLIFIED)

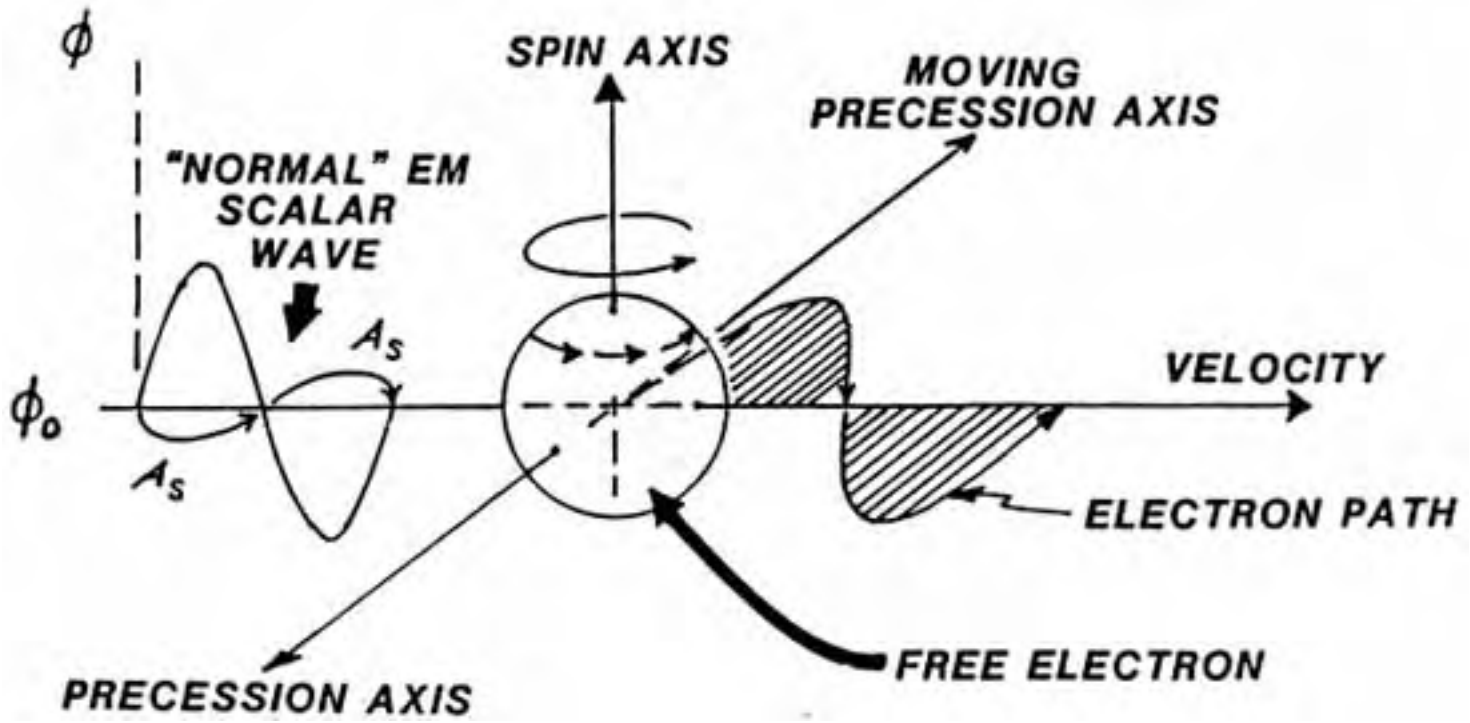

On this slide I show the effects of precession of an electron when it encounters a longitudinal scalar wave that contains "spin vortex holes" for the electrons to fall into and mesh its spin with.

The basic idea here -- that electron precession accounts for the Hertzian waves in the electron gas in a transmitting antenna and in a receiving antenna, came from my close colleague and friend, Frank Golden, and I am most happy to give him full credit for this important insight.

As we have previously stated, transverse (force) waves cannot exist in vacuum in the absence of mass. Hertz waves therefore cannot exist in vacuum, just as Tesla stated.

Yet we know that Hertz waves exist in the electron gas in

our transmitting antennas and in the electron gas in our receiving antennas. How then do we get Hertz waves here, if only longitudinal waves can exist in the vacuum in between?

Electron precession is the key.

We never measure what's happening in vacuum with our instruments. Instead, almost always we measure what is happening to and in the electron gas in our antenna or probe and feeding current to the instrument.

Here we show a "normal" EM vacuum wave -- which is a longitudinal wave containing spin vortexes from the electrons that generated it -- approaching and striking a spinning charged electron. As the peak and trough of the wave passes, it is as if we had a force pressing against the spinning electron, first along the line of wave travel, and then antiparallel to the wave travel. *(that is, "explaining" it in present concepts.)*

The electron acts as a little gyroscope, and precesses laterally, first in one direction and then the other.

Therefore the wave recovered in the electron gas in our receiving antenna or instrument probe is a transverse Hertzian matter wave.

Hertz waves are always <u>matter</u> vector waves.

Vacuum EM waves are always nonmaterial <u>longitudinal</u> scalar waves.

Longitudinal scalar waves in vacuum normally contain many spinning vortex "holes" of flux, created from the spinning electrons which launched the wave and stayed behind in the transmitting antenna. This kind of longitudinal wave is directly detectable by a normal free electron charged gas in a receiving antenna or probe. It also directly interacts with free electrons in a conducting metal shield, and so is shielded by Faraday cages.

On the other hand, our zero-vector longitudinal wave, made
by opposing waves, contains opposing spin holes which annihilate or cancel each other.

In the absence of spin holes, the longitudinal wave will not mesh with spinning electrons in a conductor, and so it is not detectable in the normal fashion. It also does not interact with free electrons in a conducting metal shield, so it readily penetrates Faraday cages.

An easy way to see that electrons do not interact with that substructured longitudinal zero-vector wave is to visualize both substructure component waves interacting on the electron simultaneously, pushing in opposite directions equally. In that case the electron tries to precess in both directions, equally, and so it does not precess in either direction. Therefore it does not "detect" the passing wave.

The wave without "golf ball holes", however, is detectable
by any circuit having high nonlinearity actions occurring in it. Such highly nonlinear dynamic areas act to provide a phase shifting between the composite substructure waves. This phase shift results in violation of the sum-zero condition, producing a "normal" EM wave which deposits energy in the out-of-phase area.

From the spin vortex "golf ball hole" concept, the out-of-phase condition means that now we have an alternating preponderance of spin holes, spinning first in one direction and then in the other. Thus the electrons in the nonlinear, phase shift area are hooked and oscillated (precessed) to and fro, producing energy.

Solid state, highly doped transistors are particularly vulnerable to this effect, as are gas discharge tubes, spark and cascade ion discharges, plasmas, etc.

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SLIDE 29.

VACUUM/SPACETIME IS PURE VIRTUAL PARTICLE FLUX ($Ø_O$)

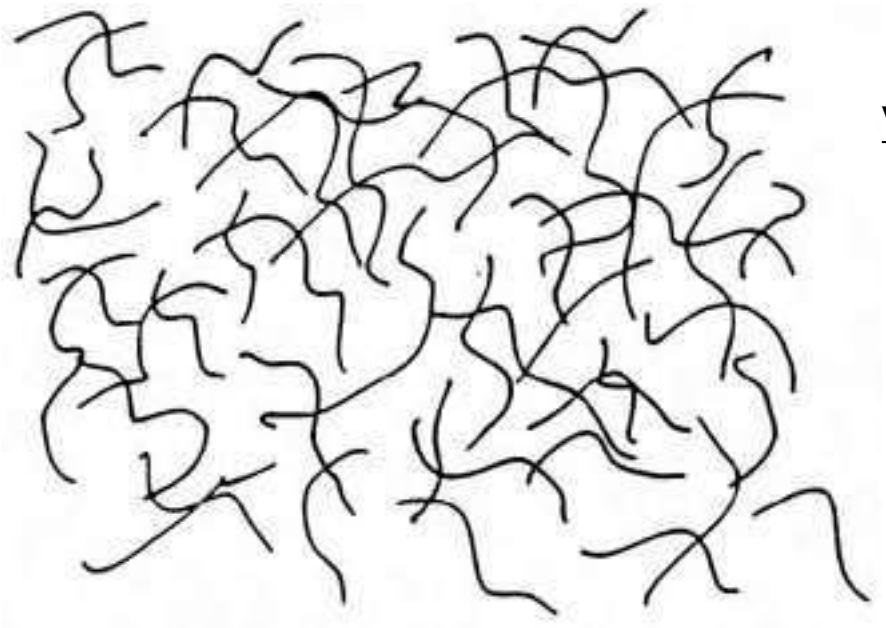

VACUUM IS IDENTICAL TO:

- **VIRTUAL PARTICLE FLUX**
- **SPACETIME**
- **ANENERGY**
- **$Ø_0$**
- **MASSLESS CHARGE**

VACUUM IS:

- **MADE OF UNQUANTIZED ACTION**
- **WITHOUT DEFINITE LENGTH INTERVALS**
- **WITHOUT DEFINITE TIME INTERVALS**
- **N-DIMENSIONAL (UNFIXED)**

We pause here to again summarize some important things we now know about vacuum.

Vacuum IS IDENTICAL TO virtual particle flux, spacetime, anenergy, Phi-subzero, massless charge, unquantized action, and infolded energy, momentum, length, time, power, velocity, acceleration, etc.

Vacuum is made of unquantized action, dimensionally.

It is without definite length or time, as Einstein stated.

It is n-dimensional, where n is always four or

greater.

It is not an emptiness filled with things. Rather, it is identically a plenum filled with things which are totally unseparated, unfixed, and undetermined.

From vacuum: mass, energy, time, frames, and all the rest of physical reality are dynamically made.

Vacuum is the ether. The ether has never been eliminated from physics. Ether just has become much more subtle, and physicists have used other names for it.

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SLIDE 30.

VACUUM IS:

- **SPACETIME (L^nT, WHERE $n \geq 3$)**
- **CHARGE (MASSLESS)**
- **ELECTROSTATIC SCALAR POTENTIAL $Ø_0 \neq 0$**
  ERROR IN PRESENT THEORY
- **BROKEN BITS OF ENERGY (SUBQUANTAL)**
- **PURE VIRTUAL PARTICLE FLUX**
- **O-WAVE FLUX**
- **MULTILEVEL, STRUCTURED, PATTERNED**
- **A VIRTUAL PLENUM**
- **AN OBSERVABLE EMPTINESS**

Again, we list some of the things that vacuum identically is.

It is spacetime, massless charge, electrostatic scalar potential, broken bits (subquantal) of energy, pure virtual particle flux, zero-vector wave flux, multilevel, structured, patterned, a virtual plenum, and an observable emptiness.

It is all things and contains all things in potential state.

It is not, in that it is not observable. But from it comes all observables.

It is both ordered and disordered, simultaneously.

It involves four-law logic, not just three-law Aristotlean logic.

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SLIDE 31.

GRADIENT OF ELECTROSTATIC POTENTIAL

IN VACUUM

$$\nabla Ø \neq Ë$$

ON AND OF A MOVING CHARGED PARTICLE

$$\nabla Ø = Ë$$

Again I accent that, in vacuum in the absence of a charged spinning particle of observable mass, del-phi does not yield an Ë-field, and the conventional equations of EM are wrong in that respect.

In the presence of a spinning charged particle, in a del-phi which contains electron-vortex-holes to mesh with, the charged particle attaches itself to the moving del-phi flux gradient, moving itself with the river. This produces an Ë field. The Ë-field CONSISTS OF the smeared electron, it does not CAUSE THE MOVEMENT of the electron. It is an effect, not a cause. The conventional equation for del-phi equals E is correct for matter waves in electron gases; it is not correct in vacuum itself.

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SLIDE 32.

IN A ∇Ø, A CHARGED PARTICLE MOVES ITSELF

∇Ø>0 IMPLIES A MOVING RIVER, AND THE CHARGED PARTICLE IS "HOOKED TO" THE RIVER

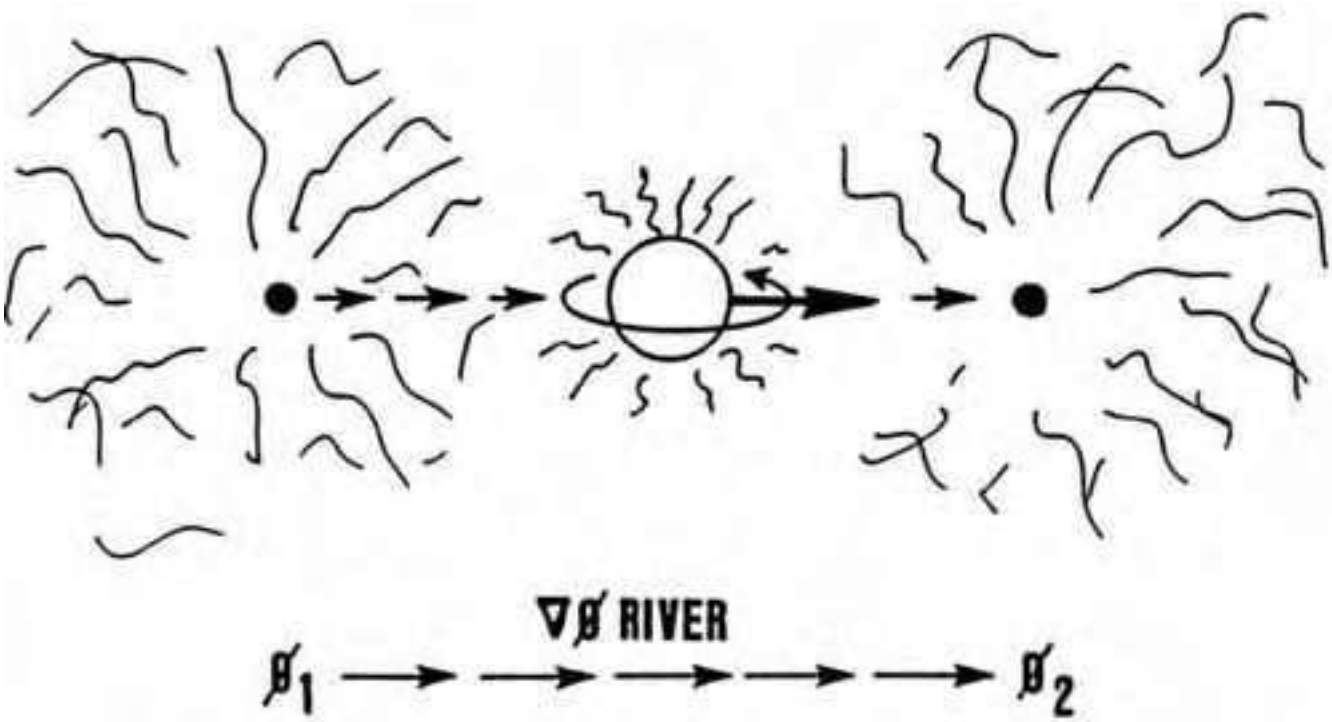

We show clearly on this slide that a spinning charged particle, when it hooks to a spin-hole in a del-phi river, MOVES ITSELF.

Note that a del-phi implies a "pressure difference" in phi-flux between two points. Therefore there is a moving river -- a gradient -- of phi-dot, moving from the higher pressure to the lower.

If a charged particle is attached to this moving river, it flows along with the river. It is just like putting a boat into a moving stream of water. If the boat "latches" to the moving water, it moves with the river.

Electron spin and spin vortexes in the del-phi mesh, to accomplish the "hooking" or "latching."

Once hooked into a moving river, the electron moves itself. One does not have to furnish work to move it.

If the river is accelerating, the electron will accelerate itself.

By cleverly gating such rivers into and onto sources of free electrons, one can directly produce free energy.

The extra energy comes from converting anenergy (massless charge, vacuum flux) to energy of a moving mass.

Next Slide

SLIDE 33.

ELECTROMAGNETIC WAVES IN ELECTRON GAS IN A CONDUCTOR

- **VECTOR WAVES**
- **CONTAIN E, B FIELDS**
- **GENERATED BY SPIN COUPLING OF ELECTRONS WITH SCALAR WAVE "SPIN-HOLES"**
- **WAVES OF FORCE**
- **HERTZIAN WAVES**
- **TRANSVERSE WAVES**
- **WAVES OF ELECTRON PRECESSION**

Here we pause to summarize the characteristics of electromagnetic waves in the electron gas of a conductor.

First, these are vector EM waves in the accepted sense.

They contain E and B fields.

They are generated by spin coupling of electrons with spin-holes in a scalar wave delta-phi river. The electrons move themselves under that condition, producing work and forces.

They are waves of force or force field variations.

They are Hertzian waves.

They are transverse oscillatory, not longitudinal.

They are matter waves.

They are waves of electron precession.

Next Slide

SLIDE 34.

ELECTROMAGNETIC WAVES IN VACUUM

- **SCALAR LONGITUDINAL WAVES**
- **VECTOR ZERO [Ö] WAVES**
- **WITHOUT Ë, B FIELDS**
- **INTERNALLY STRUCTURED**
- **PATTERNED**
- **MAY CONTAIN ELECTRON "SPIN-HOLES"**

Here we summarize the characteristics of electromagnetic waves in vacuum.

They are scalar longitudinal waves of alternate compression and rarefaction of the vacuum virtual particle flux.

That is, they are waves of electrostatic potential.

They are zero-vector waves.

They are internally structured and patterned.

They usually contain electron "spin holes" unless made in a fashion so as to make opposing spin holes that cancel each other.

Since they are pure phi-waves, they need not be limited in velocity to the speed of light.

They are hyperspatial waves.

They are waves in virtual state itself.

Next Slide

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SLIDE 35.

DETECTION OF TRANSVERSE AND LONGITUDINAL WAVES

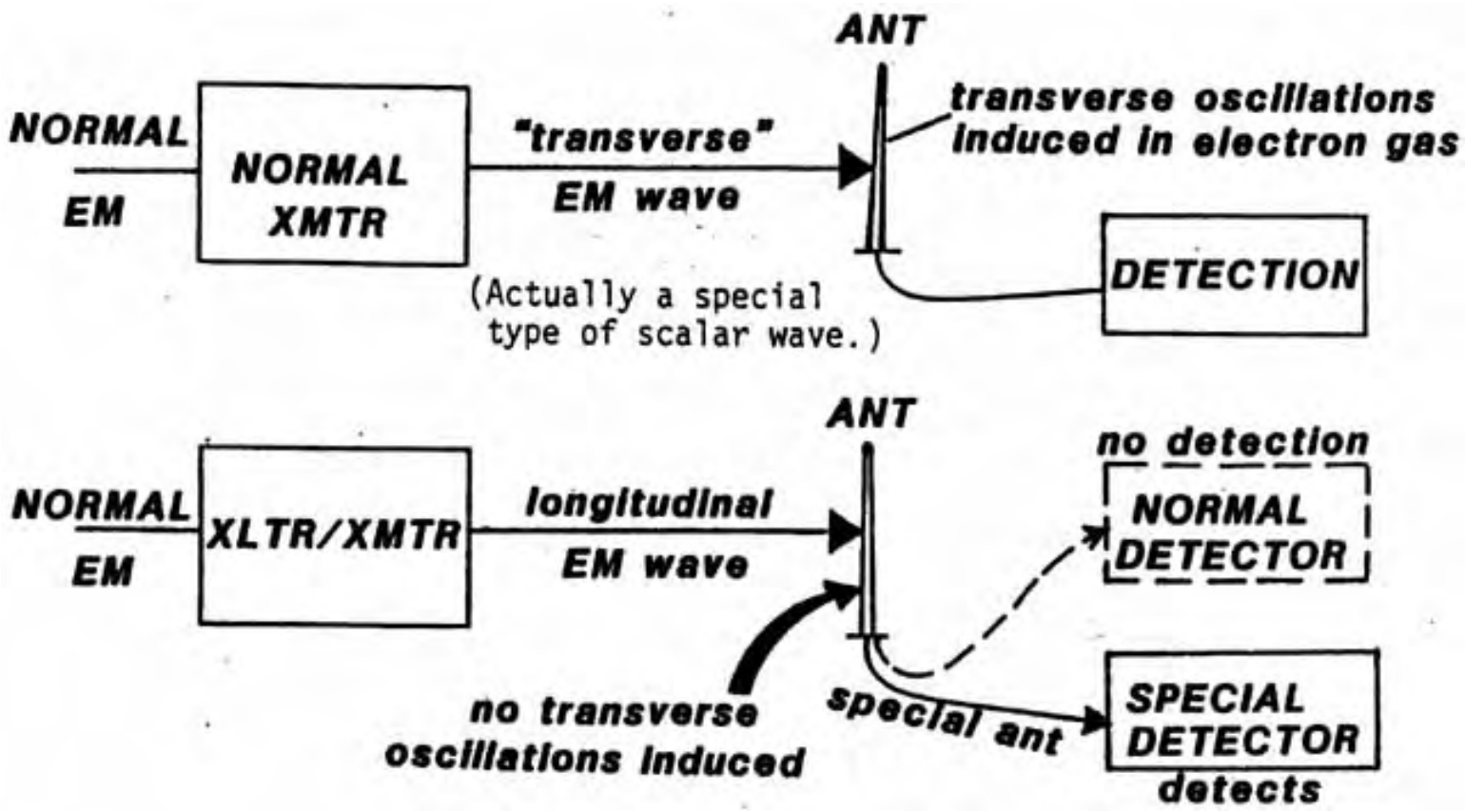

In the top drawing on this slide, we show a normal transmitter putting out a normal EM wave, which received in a normal antenna/receiver. What we call a "transverse" wave rigorously exists only in the electron gas in the transmitting antenna and in the electron gas in the receiving antenna. Specifically, a longitudinal wave exists in the vacuum in between the two antennas. However, due to the method of production, the longitudinal wave contains spin-holes for electrons, so the electrons in the receiving antenna readily couple with the wave by falling into and meshing their spins with the spins of the spin-vortex holes. Electron precession produces electron gas waves that are transverse oscillatory, hence Hertzian waves in nature.

In the bottom drawing, we show a translator/

transmitter. In other words, we oppose ordinary EM waves in a sum-zero substructure, deliberately producing longitudinal EM waves in vacuum with the spin-hole vortexes canceling each other. This type of wave does not "hook" spinning electrons in the normal receiving antenna, and thus it is not detected. The normal antenna/receiver system never sees it at all.

However, by means of a special antenna which generates nonlinear phase shifts in the composite substructure waves, "hooking" holes are restored in an oscillatory nature. Electrons then hook with this output and detect the wave.

Note that it requires a two-stage detector, operated in an interferometer fashion, to detect this pure scalar wave.

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SLIDE 36.

CREATING A "RIVER" OF ANENERGY

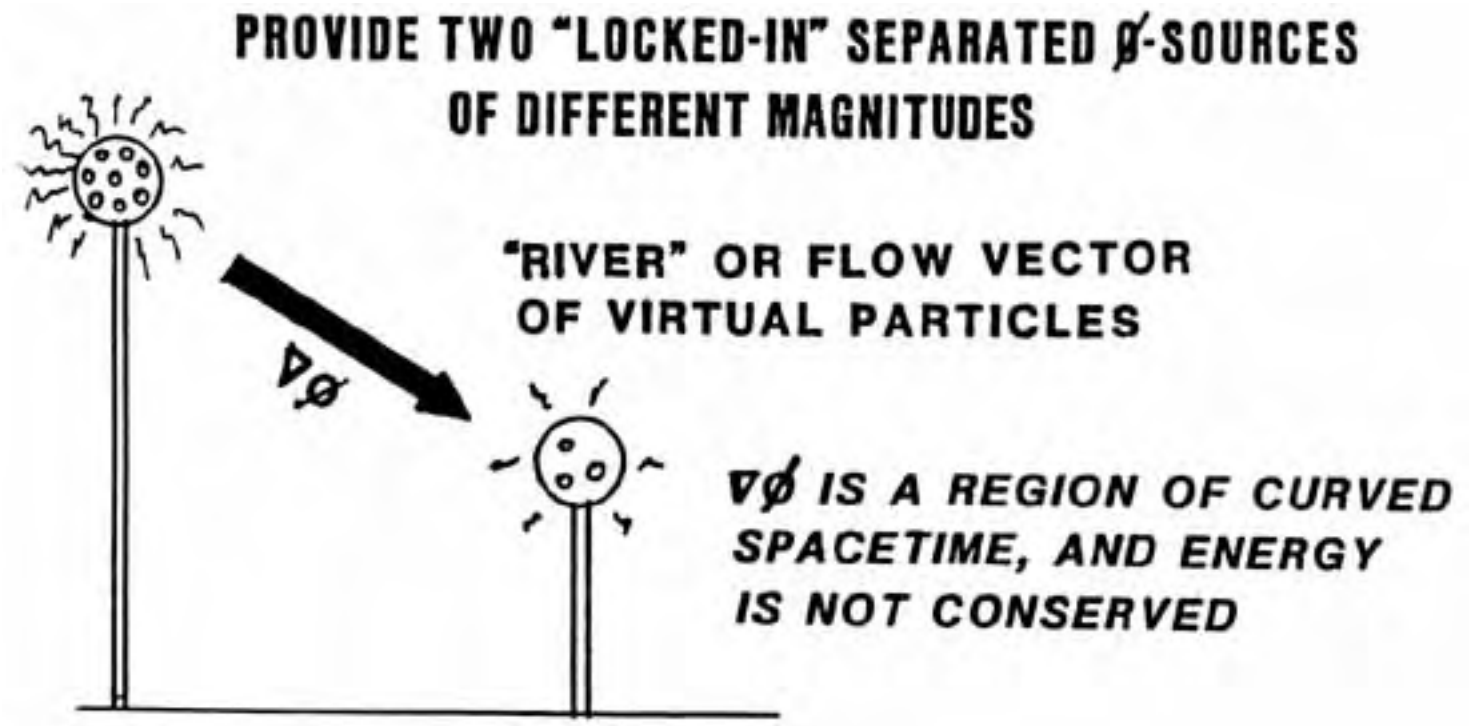

IN VACUUM, THIS IS NOT YET A VOLTAGE DROP (NO MASS FLOW),
NOR IS THERE AN Ë-FIELD

Now if we wish to get free energy, we are going to have to provide a continuous anenergy river, and a means of tapping it to produce mass movement.

This slide shows one easy way to make an anenergy river.

We simply pump some electrons (spray nozzles) onto an elevated charged ball, and we LEAVE them there. A second ball is connected to ground. A higher phi -- that is, a denser spray -- is now in the vicinity of the elevated ball on the left. A lower phi -- that is, a less dense spray -- is in the vicinity of the lower ball on the right. Between the two balls, now, there is a

gradient in phi, and a virtual flux flowing from the "higher virtual pressure" to the "lower virtual pressure."

This del-phi river does NOT constitute an Ë-field, as we have previously pointed out.

The del-phi region, however, is definitely a region of curved spacetime. As is well known from general relativity, in such a region energy need not be conserved.

Therefore it is entirely possible -- consistent with ordinary physics -- to violate conservation of energy in this del-phi river, if one believes general relativity. If one argues adamantly that conservation of energy cannot be violated under any circumstances, then one must throw out general relativity. Also, one must throw out most of particle physics, whose explanations presently involve virtual interactions, each of which violates the conservation of energy.

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SLIDE 37

A 2-WIRE SYSTEM IS CONSERVATIVE

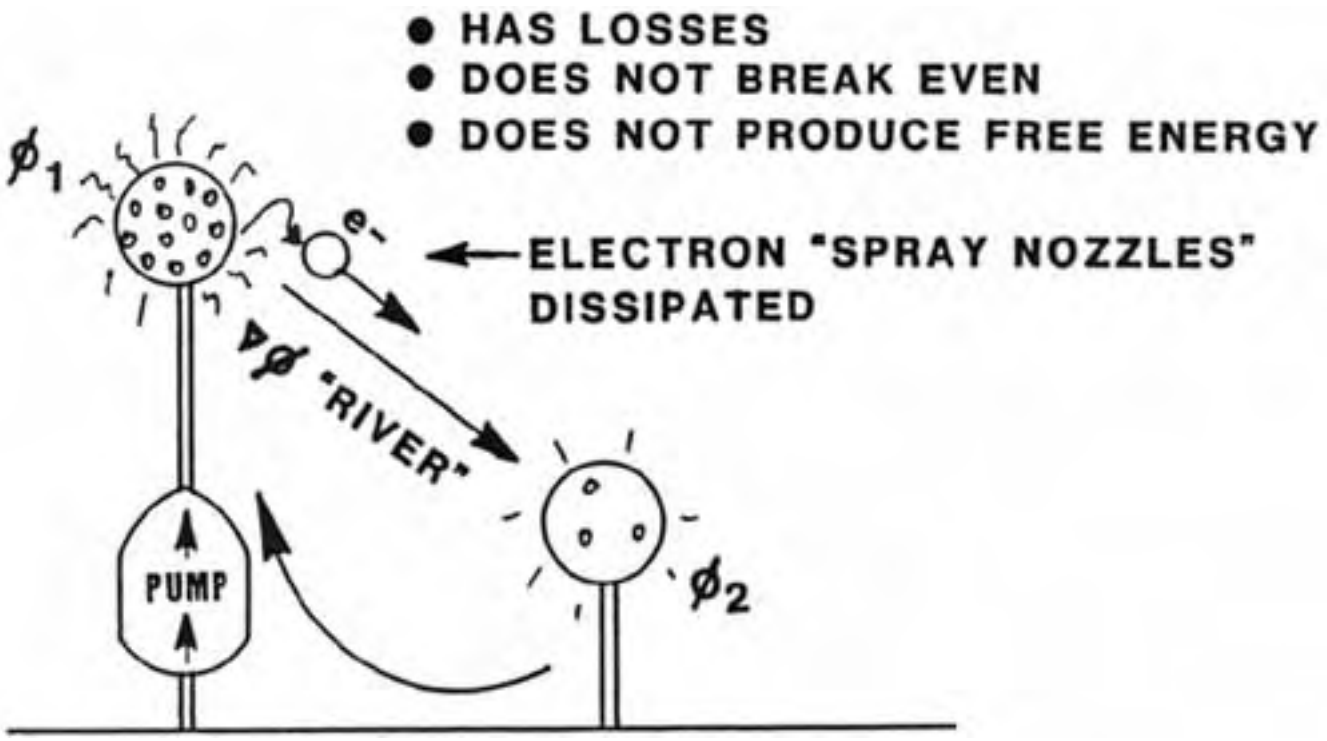

REPLENISH SPRAY NOZZLES BY PUMPING MORE ELECTRONS. (MOVING ELECTRON MASSES AGAINST A "SPRAY PILEUP" REQUIRES WORK.

Here we show that, as engineers, we've all been tricked into releasing our virtual rivers so that we would not discover free energy.

While I cannot prove this as yet, I tentatively suspect that J. P. Morgan and Thomas Edison are directly responsible for this occurring. Tesla utilized a single-wire system; we have all been taught to utilize only two-wire systems.

What we in effect do is connect a wire or circuit to our charged ball, allowing our hose nozzles to drain away.

In other words, we first do some work to pump hose nozzles (electrons) into and onto our elevated

reservoir, so we will obtain a denser flux, and a flux river to utilize. Then we release the nozzles themselves, and let THEM move on the flux river, deplenishing our river. Of course we can get back as much energy as we pumped up there in the first place. But this two-wire system is at best theoretically even. Since real circuits have losses, we can never even quite break even. Thus we have to continue to pump hose nozzles, and let them bleed off to provide energy, in a less-than-100% fashion.

By foolishly releasing our hose nozzles, we guarantee that we will never achieve free energy. And that's nice, because the people who control things, and for their own wealth and power depend on selling us energy at high prices, are guaranteed to stay in power and control.

One is never truly free unless one is energy independent, in a self-contained fashion.

Tesla nearly succeeded in giving us free or very cheap, inexhaustible energy -- and for that reason was quickly and dramatically suppressed.

Only three graduate schools of electrical engineering existed in the U.S. The only one of any real importance was at Columbia University.

Only one or two professors were necessary to "reach" to modify and subtly direct the entire foundations of the emerging electrical theory.

Professors were in general poor, and had no research funds unless some rich industrialist or philanthropist gave them a few dollars.

The setup then was certainly very ripe for Morgan and Edison to stop free energy, and suppress Tesla at the same time. They could have done so by influencing only one -- or at most two -- theoreticians at Columbia.

At any rate, the theory was developed in such fashion as to rule out the single wire circuit and the longitudinal wave. Free energy was suppressed, and the financial empires of Morgan and Edison stayed secure.

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SLIDE 38.

A HOLLOW CHARGED SPHERE

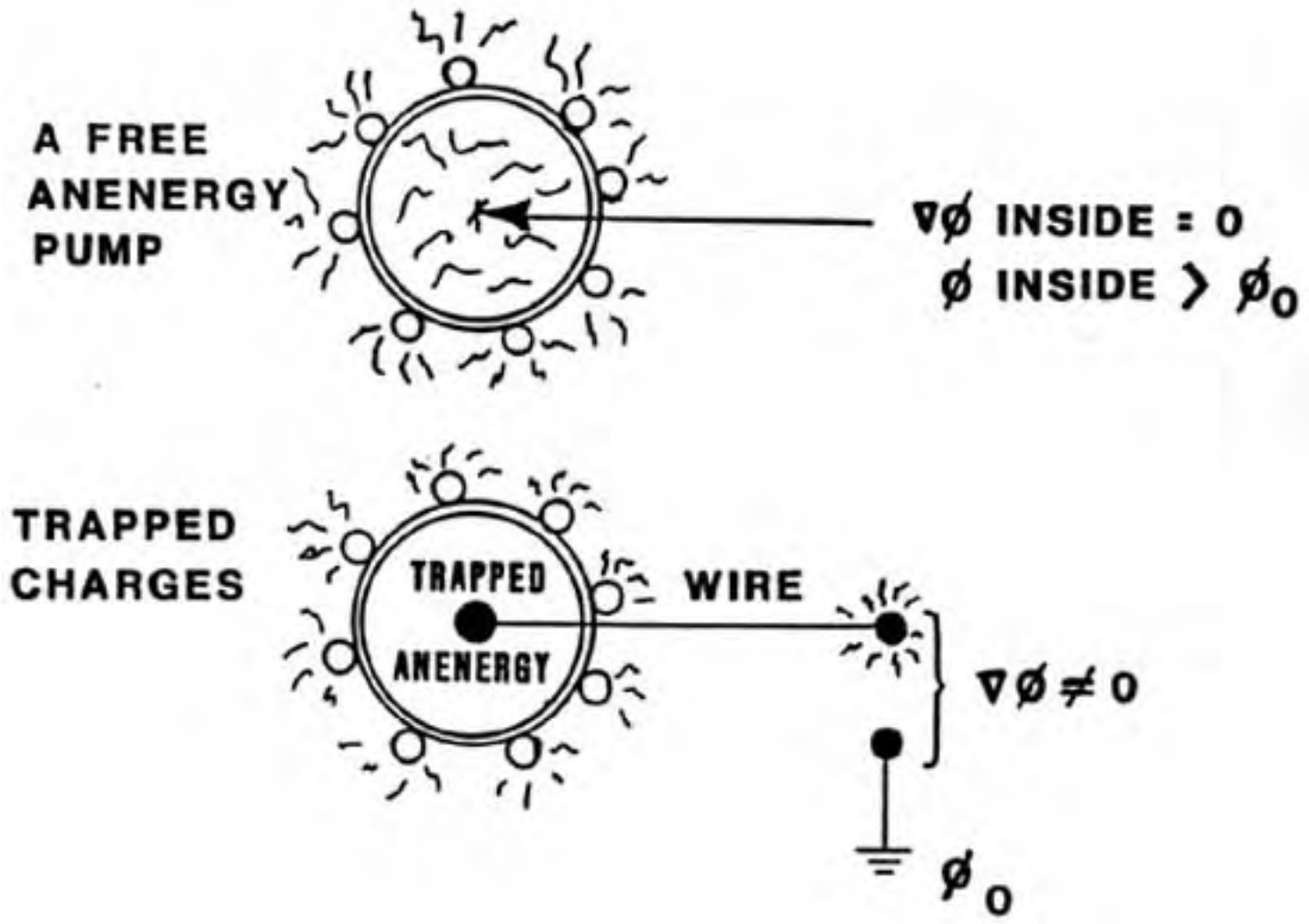

Here we show another easy source of a higher vacuum charge, hence an easy source for a free river.

Simply charge up a sphere. As is well known, inside that sphere one has no del-phi. So one can introduce an electron therein and not produce an Ë-field .

However, since we've piled up additional spray nozzles, the density of the spray inside the sphere (as well as outside it) is certainly higher.

In other words, the inside of the sphere is also a source
for an increased del-phi river. In the bottom drawing, we drill
a tiny hole in the sphere, insulate a thin wire running into the inside of the sphere, and run the wire out to a terminal opposing another grounded terminal.
Between the two terminals now there must exist a del-phi river.

And between those terminals there now exists a curvature of spacetime, hence the theoretical possibility to obtain free energy without violation of principles.

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SLIDE 39.

ONE-WAY GATE VALVE

(ANENERGY TO ENERGY)

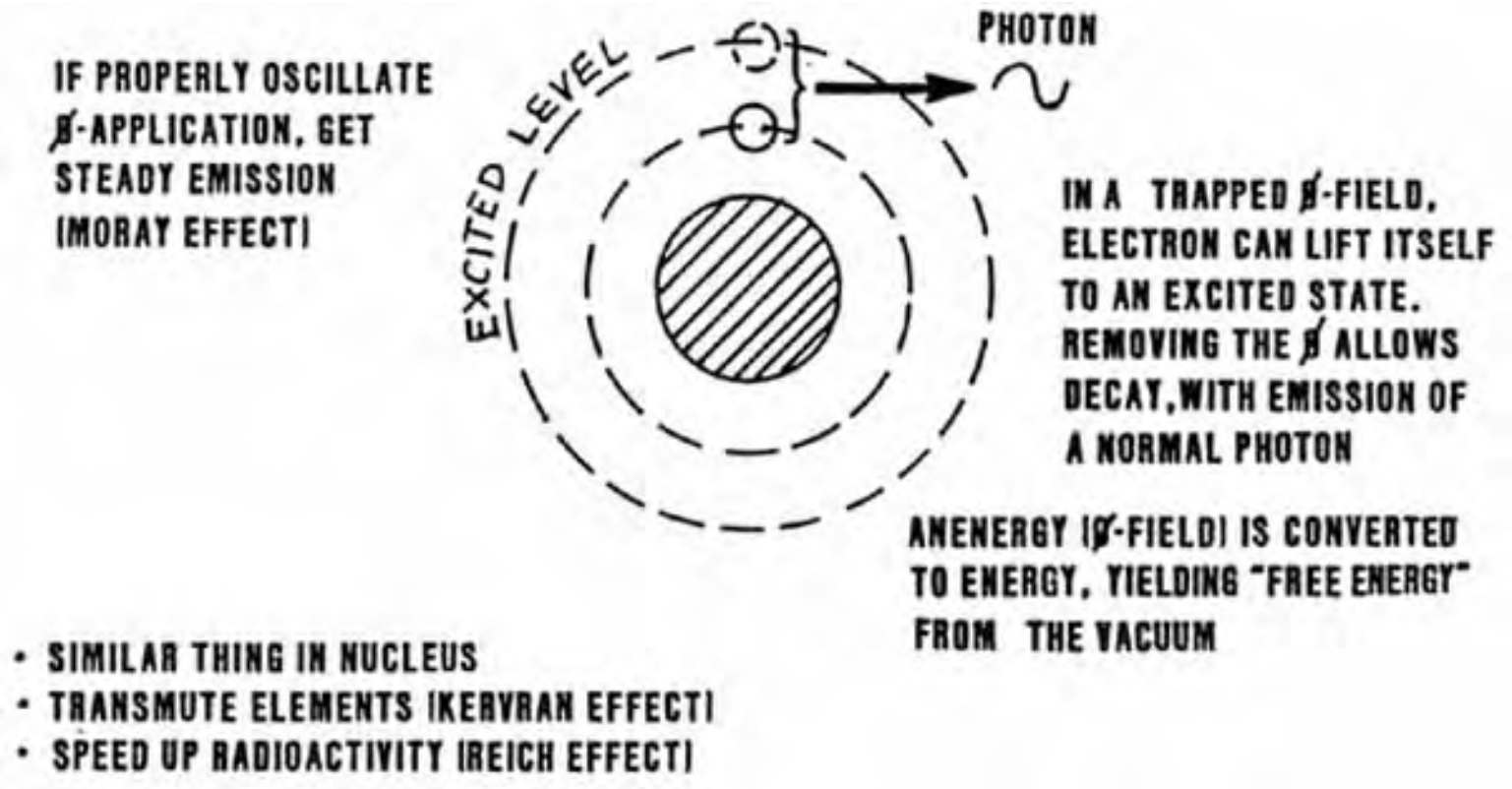

Here we show one way to provide a one-way gate valve from a del-phi river to energy released into the outside world.

By providing a properly tuned, oscillating phi wave, one can cause an orbital electron in an atom to raise itself to an excited state. Remember, in a del-phi, an electron that hooks to it raises itself.

We then switch out the phi application, and the excited electron decays in normal fashion, emitting a normal photon of energy.

By phase locking the processes, one produces a steady stream of photons.

By absorbing or directing the photons, one can

produce heat, light, energy beams, etc.

By this means, one produces free energy by gating anenergy into energy.

And if one does not release spray nozzles in the phi-oscillations which feed the mechanism, one has an inexhaustible energy production.

A very similar thing can be done with the excited states of the nucleus. For example, by using a radioactive material with a predisposition to emit some particle -- say an electron -- the nucleus can be made to continually emit the particles WITHOUT ITSELF DECAYING INTO BYPRODUCTS. In other words, an electron is lifted from the Dirac sea of vacuum to instantly replace the electron emitted from the nucleus.

This provides a one-way gate valve from the Dirac sea to the external universe.

Theoretically, these mechanisms are no more mysterious than a hydraulic ram, which raises water higher than the stream that feeds the ram.

In the 20's and 30's, T. Henry Moray successfully built such gating devices for converting vacuum anenergy to external energy.

In the Kervran effect, living systems are able to directly transmute elements, even though they only possess feeble energies, by influencing the virtual particle interactions in the nucleus that furnish its binding energy.

Reich used an adaptation of a cloudbuster -- which emits scalar waves -- to drastically speed up radioactive decay of radioelements.

Both plants and animals transmute elements by similar processes.

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TOWARDS A NEW ELECTROMAGNETICS
PART 4: VECTORS AND MECHANISMS CLARIFIED

SLIDE 40,

SIMPLE FREE ENERGY MOTOR

BATTERY RECHARGES ITSELF

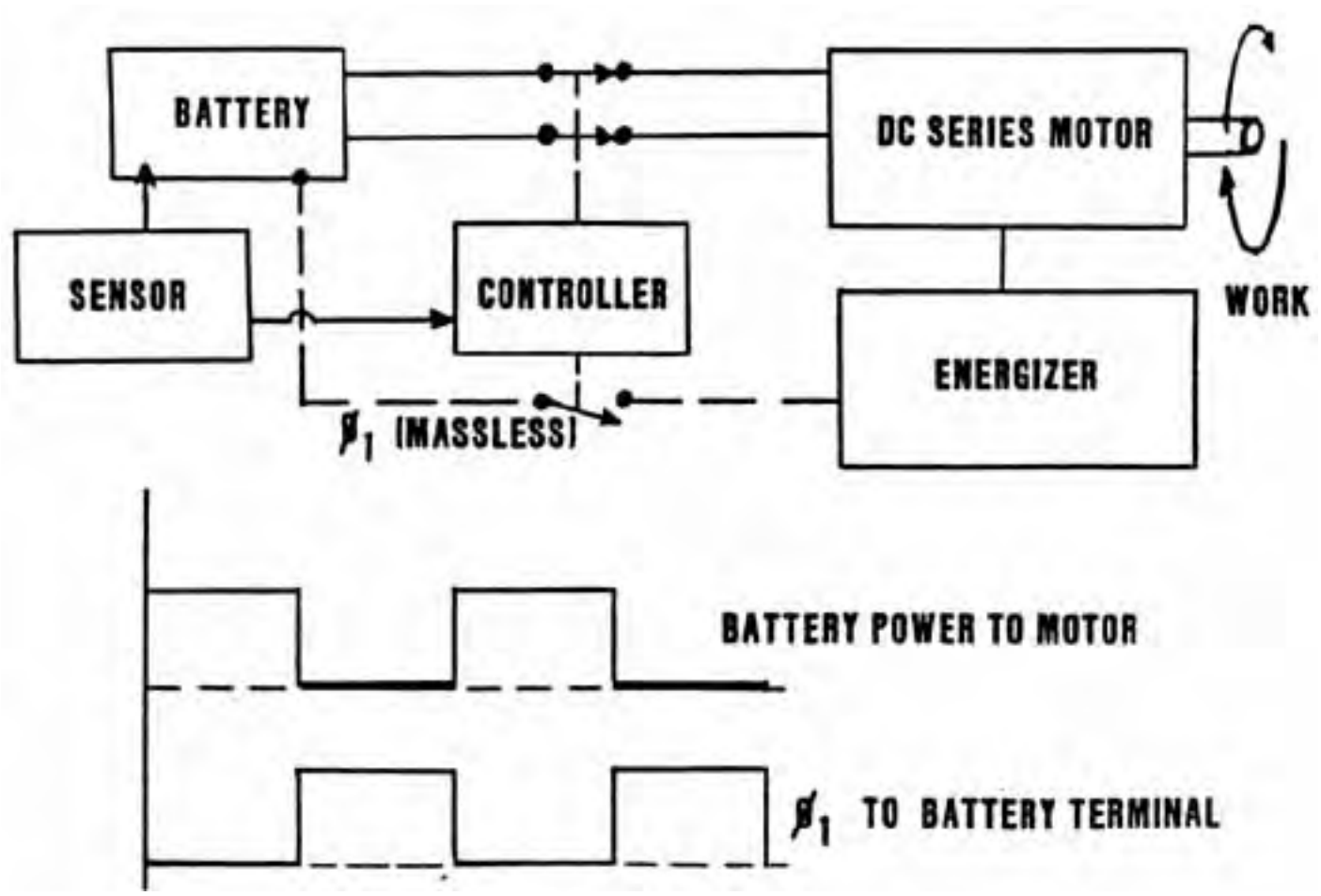

On this slide, we show a theoretical scheme which several researchers have discovered and used to build simple free energy motors.

In this scheme, we drive an ordinary d.c. series motor by a two wire system from an ordinary battery. The motor produces shaft horsepower, at -- say -- some 30 or 40 percent efficiency, compared to the power drained from the battery. This much of the circuit is perfectly ordinary.

The trick here is to get the battery to recharge itself, without furnishing normal power to it, or expending work from the external circuit in the process.

To do this, recall that a charged particle in a "hooking" del-phi river moves itself. This is true for an ion, as well as for an electron. We need only make the del-phi in correct fashion and synchronize it; specifically, we must not release the hose nozzles we utilize to produce our del-phi river or waves.

The inventors who have discovered this have used various variations, but here we show a common one.

First, we add an "energizer" (often referred to by various other names) to the circuit. This device makes the del-phi waves we will utilize, but does NOT make currents of electron masses. In other words, it makes pure Ø-dot. It takes a little work to do this, for the energizer circuit must pump a few charges now and then. So the energizer draws a little bit of power from the motor, but not very much.

Now we add a switching device, called a controller, which breaks up power to the motor in pulses. During one pulse, the battery is connected and furnishes power to the motor; during the succeeding pulse, the battery is disconnected completely from the motor and the output from the energizer is applied across the terminals of the battery.

If frequency content, spin-hole content, etc. are properly constructed by the energizer, then the ion movements in the battery reverse themselves, recharging the battery. Again, remember that these ions MOVE THEMSELVES during this recharge phase. Specifically, we are NOT furnishing ordinary current to the battery, and we are not doing work on it from the energizer.

If things are built properly, the battery can be made to more than recover its charge during this pulse

cycle.

To prevent excess charge of the battery and overheating and destroying it, a sensor is added which senses the state of charge of the battery, and furnishes a feedback signal to the controller to regulate the length of recharge time per "power off" pulse. In other words, the system is now self-regulating.

The relation between power pulses and recharge pulses is shown on the graphs at the bottom. Note that regulation may decrease the time of recharge application of the del-phi river.

This system, if properly built and tuned, will furnish "free shaft energy" continually, without violating conservation of anenergy. Remember that the del-phi condition across the battery terminals means that spacetime is suddenly curved there, and conservation of energy need no longer apply.

Again, this system is consistent with general relativity and with the fact that Ø-field alone can drive a situation relativistic. We have deliberately used these facts to do direct engineering. Our "extra energy" comes from shifting phi-flux -- the energy of the universal vacuum spacetime -- directly into ordinary energy for our use. Thus we draw on an inexhaustible source, and our device is no more esoteric than a paddlewheel in a river. The only difference is that, in this case, we have to be clever enough to make and divert the river in the right timing sequency.

This is a free energy device which an ordinary person, who knows a little electronics, can experiment with in the basement. To develop it, one is talking several thousands of dollars and a lot of persistence and tinkering; one is not talking millions.

WARNING: THE PRECEDING EXPERIMENTS ARE HAZARDOUS. DO NOT ATTEMPT THESE EXPERIMENTS UNDER ANY CIRCUMSTANCES UNLESS YOU ARE AN EXPERIENCED ELECTRICAL RESEARCHER, EXPERIENCED IN PERFORMING EXPERIMENTS WITH LEAD-ACID BATTERIES AND PULSE CHARGE AND DISCHARGE OF SAME, AND UNLESS YOU ALSO USE ALL SAFETY PRECAUTIONS SUCH AS GOGGLES

AND PROTECTIVE GLOVES, SLEEVES, AND APRON. YOU MUST NOT HAVE OTHER INFLAMMABLE LIQUIDS OR OTHER SUBSTANCES PRESENT WHICH COULD BE IGNITED AND BURN OR EXPLODE. SURGED LEAD-ACID BATTERIES PRODUCE HYDROGEN GAS, WHICH CAN EASILY EXPLODE SINCE SPARKING ALSO CAN OCCUR. THE ACID FROM SUCH AN EXPLOSION CAN EASILY BLIND YOU IF IT GETS IN YOUR EYES, AND IT CAN BURN YOUR SKIN. IN ADDITION, LEAD AND LEAD COMPOUNDS ARE POISONS, AND ARE TO BE HANDLED ONLY BY EXPERIENCED RESEARCHERS. THESE EXPERIMENTS ARE NOT FOR AMATEURS UNDER ANY CIRCUMSTANCE, BUT ONLY FOR EXPERIENCED PROFESSIONALS WITH PROPER KNOWLEDGE AND TRAINING, AND USING PROPER PRECAUTIONS. NEITHER THE AUTHOR NOR THE PUBLISHER IS REPONSIBLE OR LIABLE FOR ANY ACCIDENTS OR DAMAGE YOU MAY ENCOUNTER, AND ALL EXPERIMENTATION WITH THESE DEVICES AND PROCEDURES IS AT YOUR OWN ASSUMED PERSONAL RISK.

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[The Tom Bearden Website]

SLIDE 41.

THE TRANSLATOR

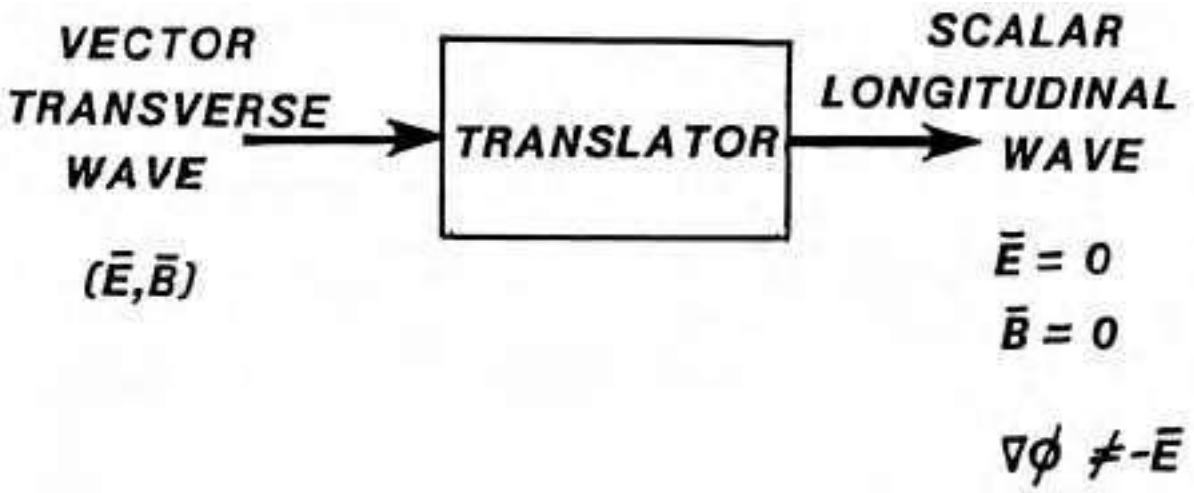

We now turn to a fundamental concept we need in order to understand some of the effects used by the Soviets in their Tesla weapons.

Note that one other country -- one not hostile to the U.S. -- also has such weaponry.

This slide shows the concept of a TRANSLATOR. Briefly, if we input a transverse matter wave, the translator outputs a scalar longitudinal wave without spin vortex hooks. If we input a scalar longitudinal wave -- even one without hooks -- the translator puts out a normal vector transverse matter wave.

We define a translator as anything which will accomplish one or both of those functions (usually both).

Basically, any device which is TOTALLY nonlinear to transverse waves will produce scalar waves from a transverse wave input. Any device which is totally nonlinear to longitudinal waves will produce transverse waves from a longitudinal wave

input.

It is comparable to certain plasmas, which, as is well known, produce such a translator effect. If you input longitudinal waves, you get transverse waves. If you input transverse waves, you get longitudinal waves. And the plasma is rather totally nonlinear.

Again, if our translator outputs non-hooking waves, it means that the component substructure waves oppose each other in sum zero fashion, and "kill" or nullify the vortex spin-holes.

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[The Tom Bearden Website]

SLIDE 42.

TRANSVERSE WAVE INTERFERENCE

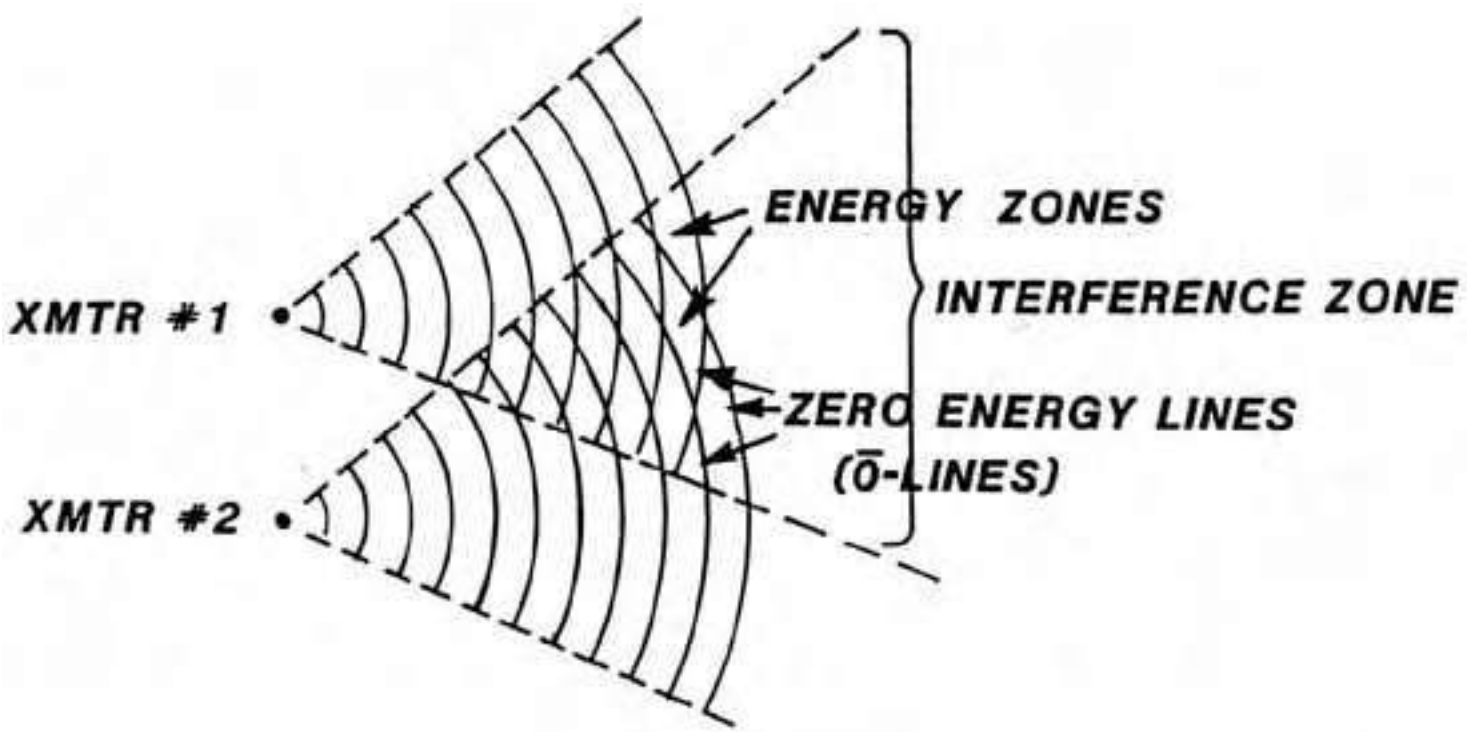

On this slide we show "normal " transverse wave interference, as we presently teach it in our textbooks.

We visualize two identical transmitters, each producing a beam in a pattern of about 55 degrees of so.

Where these beams overlap -- in the ideal, perfect case, we have constructive and destructive interference, with absolute zero-vector linear regions being formed. We put in the energy, and out-of-phase interference creates the zero zones, which contain no energy as such.

We point out, however, that these zero-lines are scalars,
and contain high stresses on spacetime.

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The Tom Bearden Website

SLIDE 43.

LONGITUDINAL WAVE INTERFERENCE [SCALAR WAVES]

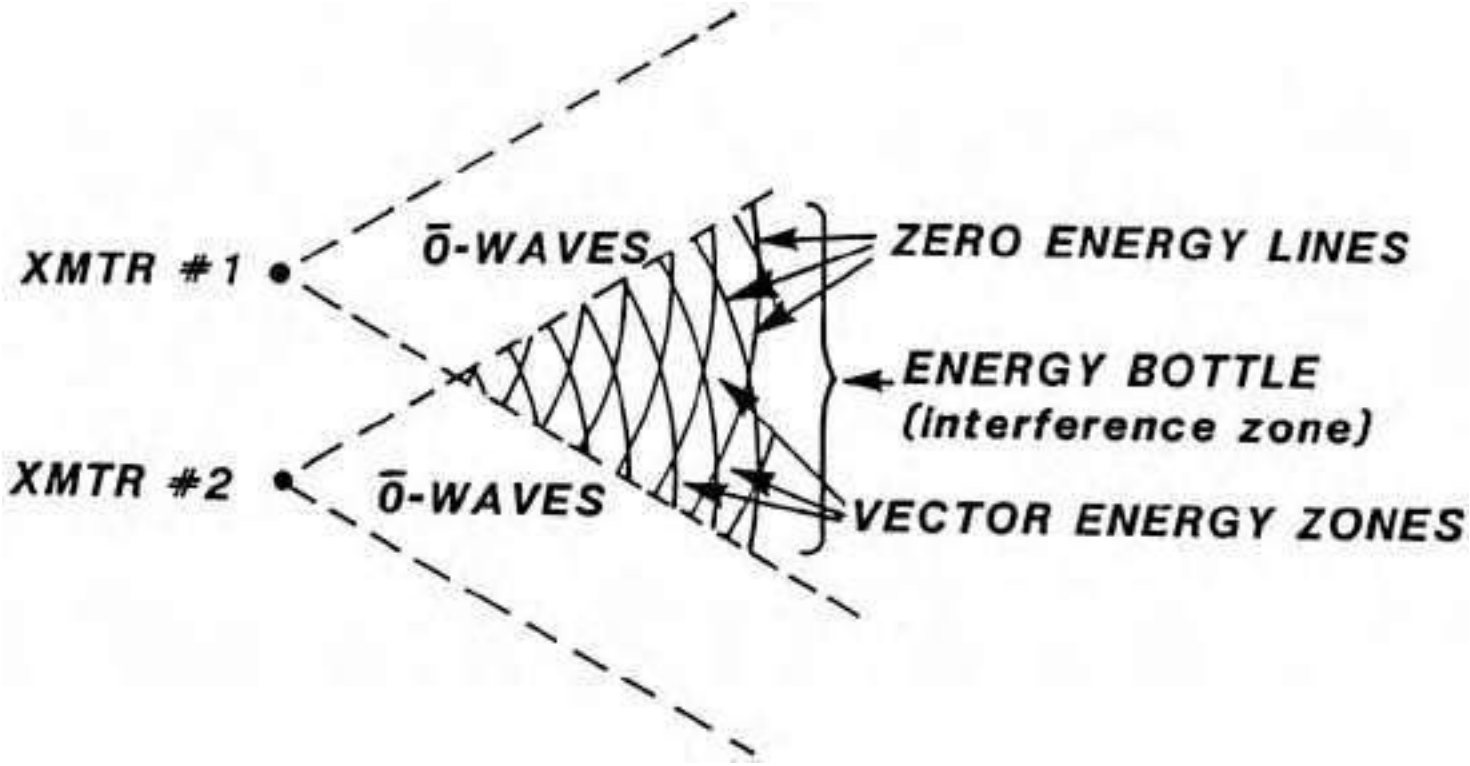

On this slide we show the interference pattern that emerges from the interference of two identical scalar wave beams from translator/transmitters.

Now note we are interfering two zero-vector waves, each containing a substructure. In this case we assume similar substructures.

What happens now is that we get a similar interference pattern, but with some startling differences.

First, we put in the zero-lines. These represent in-phase conditions for the substructures.

. Second, the substructures themselves interfere, and form energy in the grid zones between intersecting zero-lines.

In the perfect case, however, this energy cannot

radiate away. It is physically created and trapped as if in an "energy bottle." We are CREATING this energy at a distance, and storing it in a bottle. If the bottle were perfect, we would continue to accumulate energy in the grid zones -- notice we are continuing to pour energy into both transmitters, and there is zero ordinary energy anywhere else except in the grid zone "bottles."

If we turn off the transmitters smoothly, we extinguish the energy in the bottle completely. It is sucked right out of there, and the vacuum returns to its normal condition.

If we erratically and nonlinearly turn off the transmitters, we destroy the bottle and "dump" the energy suddenly. This is exactly like a sudden EMP from a nuclear weapon. A sudden pulse of energy is freed to radiate and interact in the region where the bottle was.

The high altitude booms off the East coast of the U.S. a few years ago were made in precisely this fashion, from such a weapon being adjusted and calibrated in the Soviet Union.

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SLIDE 44.

CREATING ENERGY AT A DISTANCE

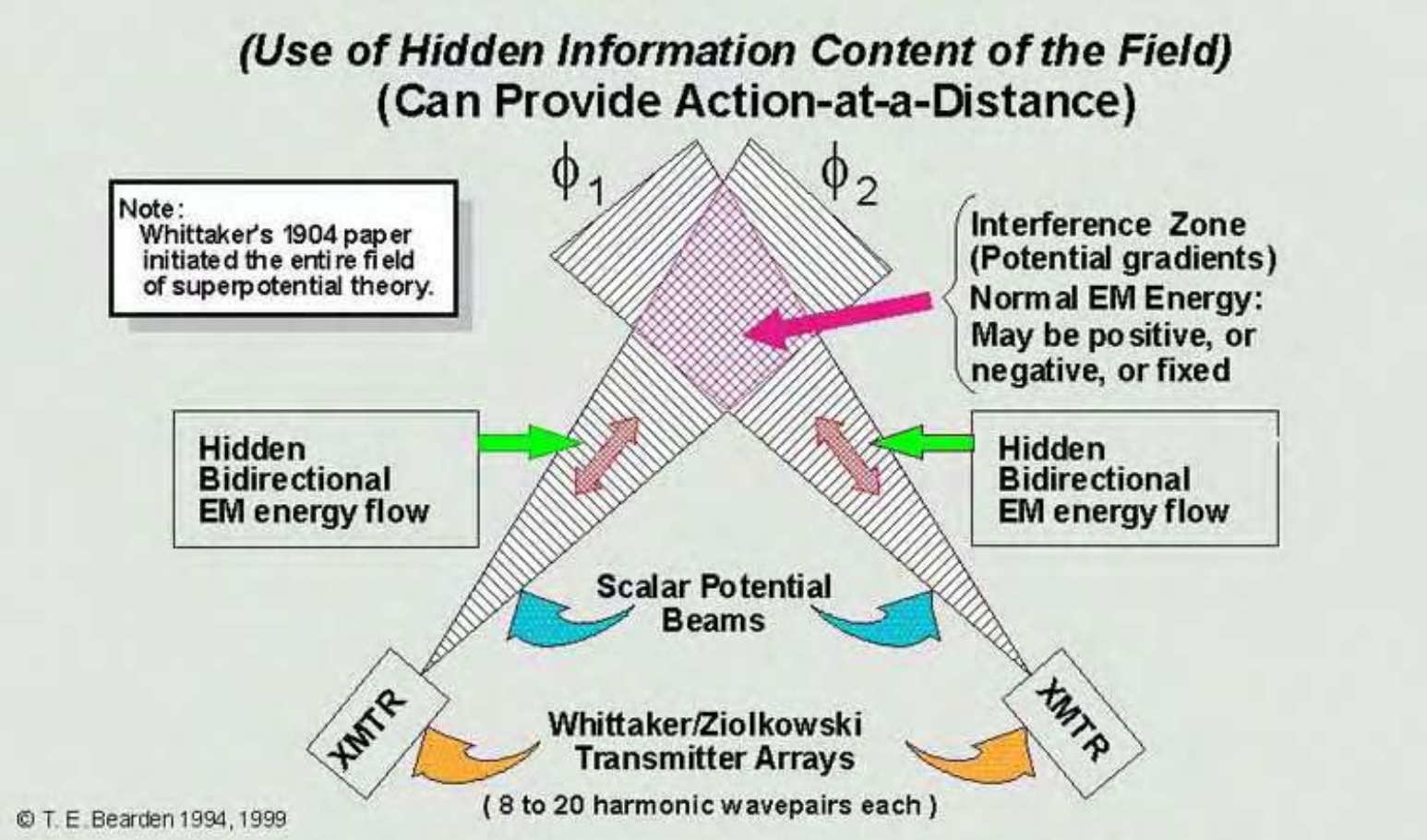

Figure 5. Scalar potential interferometry (between the two sets of bidirectional longitudinal EM wavepair functions) produces all EM force fields and waves.

But let us look at one way to do this sort of thing more efficiently.

Here we show two scalar transmitters (that is, two translator /transmitters) which form narrow beams, and which cross those beams at a distance.

In the crossing zone, scalar interference is established, making an energy bottle and producing trapped or locked in energy.

If I have a physical target in that crossed zone, I can literally "fry" the target, for I get all the power inputted to the transmitters contained in the bottle zone. I don't have any square law losses.

I can heat a metal object white hot at a distance, for example. Because all real bottles are slightly imperfect, the real bottle is leaky and some photons escape. I can observe the white hot steel in the bottle,

and I can record and measure the temperature from the escaping photons, by simple radiometric methods.

Now if I smoothly turn off both transmitters linearly, all the energy in the bottle disappears immediately. I can immediately reach in and pick up a black, cool piece of steel. And that cannot be done with ordinary inductive or radiowave heating.

That has been done in a laboratory on the North American continent.

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The Tom Bearden Website

SLIDE 45.

NONLINEARITIES CAUSE SHIFTING [PARTIAL TRANSLATION]

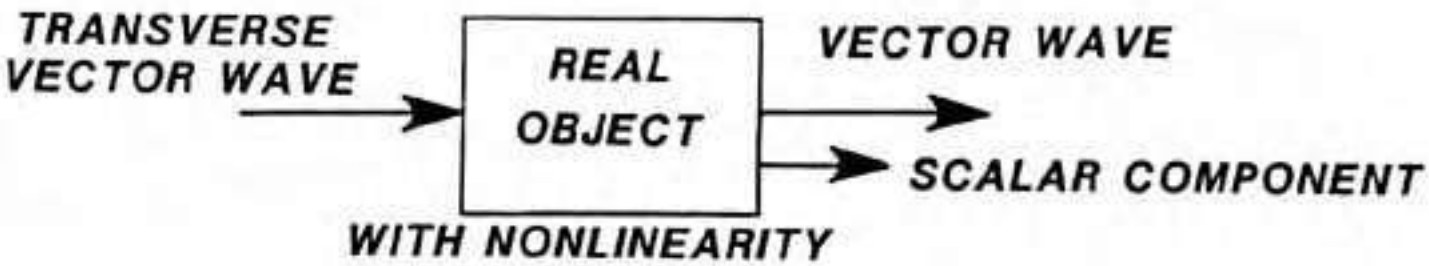

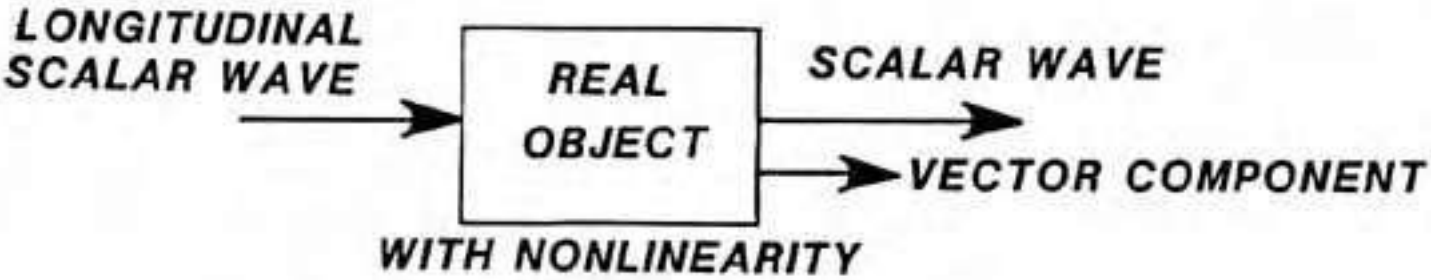

Here we show the results of electrical nonlinearities in an object which encounters a true translated (non-hooking) scalar wave. All objects have some electrical nonlinearities in them, and so all act partially as translators.

This means that any real object creates a small scalar aura around itself from its continual temperature interactions -- from absorbing and radiating ordinary EM waves. In addition, the object normally is subject to undetected scalar wave radiations, and so it also produces a small aura of transverse vector waves around itself by translation.

All real objects accomplish at least a little bit of translation.

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TOWARDS A NEW ELECTROMAGNETICS
PART 4: VECTORS AND MECHANISMS CLARIFIED

SLIDE 46.

THE SCALAR AURA

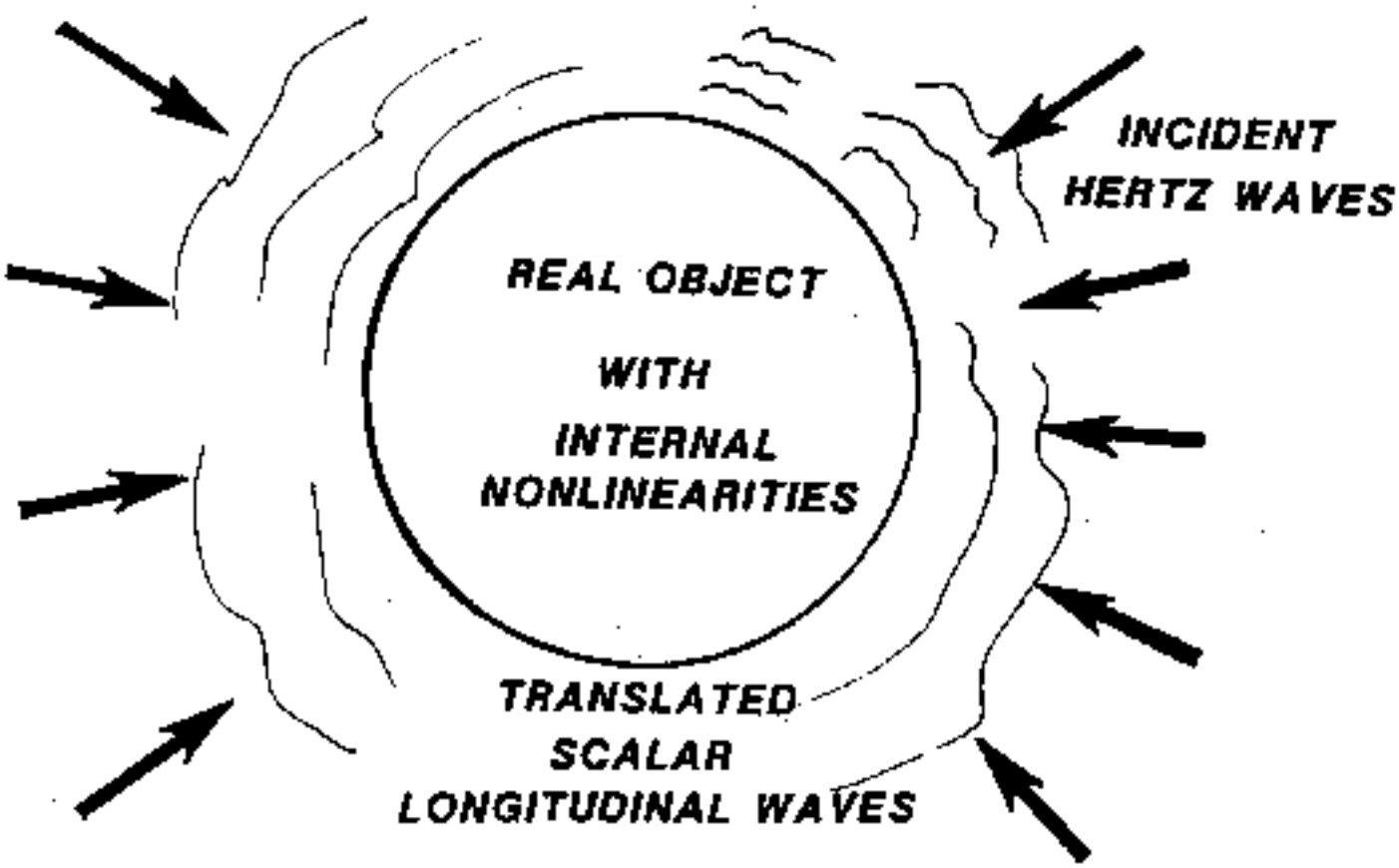

We examine now an object with temperature, that is, a normal object continually absorbing ordinary EM radiation and continually emitting EM radiation.

The object has a small fraction of its incident energy expressed as a scalar aura around it, because of translation. Note that normal detectors will not detect this aura, but special two-stage interferometric detectors will detect it. Also note that the object replenishes- the ordinary radiation flow by its translation of some of its incident scalar radiation into the normal or "transverse" (so-called) radiation.

The entire internal pattern -- all interactions and functions of the body -- are precisely present in its scalar aura, down to the finest detail. This makes an x-ray pale by comparison.

True psychics actually use the nonlinearity of their nervous systems (note the avalanche ion discharges across dendrite gaps) and the interferometric aspects (note two cerebral hemispheres, connected by a corpus callosum) to detect the scalar aura. This is a physical fact and not esoteric delusion. To control this, however, is normally as difficult as learning to walk a high wire and do acrobatics on it. There are not many high wire walkers in the world, but it certainly is a skill within human control capability and purview.

T. Galen Hieronymus was absolutely correct when he stated that the entire internal working pattern of an object is radiated by that object in terms of an extraordinary energy, which he called "eloptic" energy. It is actually translated scalar wave energy, and entirely consistent with present EM theory when the glaring errors in its foundations are corrected.

Shortly I hope we will see instrumentation which can directly examine the scalar aura in the finest detail, seeing every illness, and simply setting dials to radiate the body with gentle, harmless scalar waxes to directly correct illnesses.

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SLIDE 47.

VIRTUAL FLUX AND MAGNETIC FIELD [LINEAR CASE]

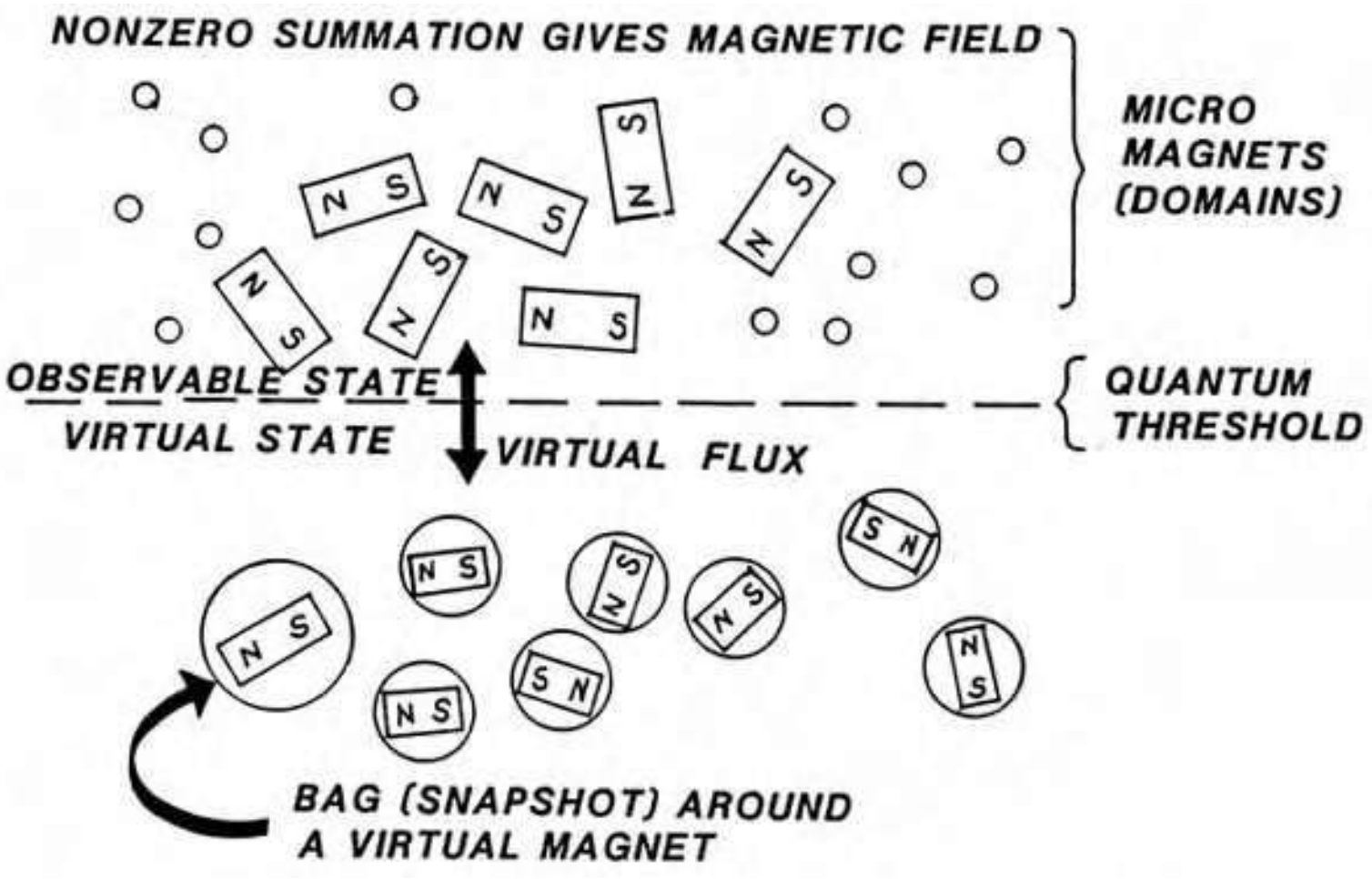

Briefly, let's look at some nice things we can do with magnetism. Specifically, let's find out how to make magnetic monopoles and use them to do things in the laboratory. This again has been done in a laboratory on the North American continent.

First, about all the present science can tell us about a magnet is that "a big magnet is made of littler magnets." And if we examine one of the smaller magnets, it's made of even smaller magnets. This is like saying big dirt piles are made of smaller dirt piles, and that explains what dirt is.

However, let's use that with our knowledge of the virtual flux vacuum.

In this slide, we show diagrammatically the situation for a common magnet. Note that domains in the magnetic material are themselves little magnets, and their alignment and vector summation determine whether or not there's said to be a magnetic field present. Nonzero summation states that there's a resultant magnetic vector, and hence an external magnetic field. Zero summation states there's no external nonzero resultant, hence no external magnetic field.

Actually, there's an external scalar magnetic potential field, even when the external vector magnetic field is zero. The substructure is still there.

If we pursue this "big magnets are composed of smaller magnets," eventually we reach the quantum threshold, and we have a substructure of virtual, subquantal magnets in vacuum, in the virtual particle flux. At least we conceive each little virtual particle as if it were spinning, and hence a little magnet.

We put a conceptual bag around each little virtual magnet.

In a linear situation, the north pole is as strong as the south pole, and so just outside the bag, the poles cancel or appear zero. Since the virtual bag appears to be zero length to an external macro observer, the poles seem to be directly superposed on top of each other, yielding no pole at all to the observer.

However, you and I now know that both poles are still in there, in the virtual substructure, and we certainly have remaining with us a translated scalar magnetic field.

There's a virtual flux to and from each observable particle of charged mass in the observable state as shown, but this flux is now scalar in virtual magnets, except for nonlinearities in the structures

above the quantum level. Thus accelerated portions -- atoms with electrons in whirling orbit, spinning electrons, protons, etc. -- possess nonzero ordinary vector magnetic fields by translation. Again, notice the successive interlocking levels of reality, all the way from deep in the virtual state into interlocking levels in observable state.

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SLIDE 48.

PRODUCING MAGNETIC MONOPOLES

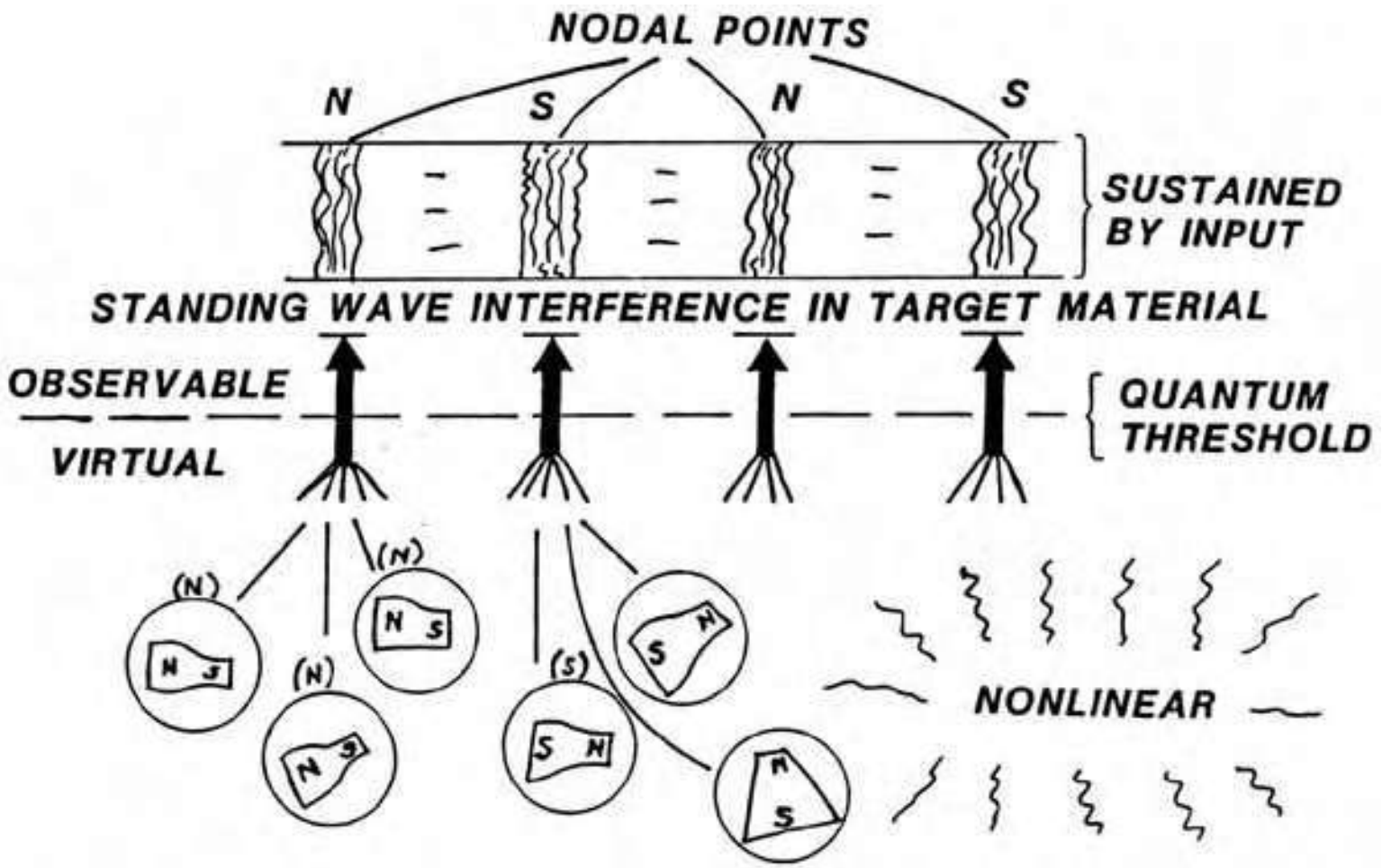

Now let us look at a non-linear case of the same sort of thing. Now the bags are still around the little virtual magnets, but they are nonlinear. This means that, to an observer outside the bag, one pole seems bigger or more powerful than the other. In other words, to the quantum observer, this bag appears to be a magnetic monopole at a point.

In the flux still on and off each observable spinning charged mass, we now have a steady component of "monopoles". If we have a standing scalar wave present in a physical material in which the nonlinearity exists -- and the scalar waves can even be PRODUCING that nonlinearity -- we will have nodes

available at which the monopoles will congregate and emerge and interact.

North monopoles will congregate at one node, while south monopoles will congregate at the next, and so on in alternating fashion.

That means that, at anyone node, monopoles of the same kind are steadily being "deposited" in the material. These monopoles strongly repel each other, and so the material at that node is increasingly stressed in a tensile fashion.

Eventually the material will be torn apart at the node,
stress relieving the situation. Movement of the material will release the nonlinear condition, stopping monopole production and deposit. However, at a break node, the same kind of magnetic pole will appear on each side of the break.

That is, the breaks will be N-N, S-S, N-N, S-S, etc.

An ordinary magnetic does not do that when it breaks. Instead, it breaks N-S, N-S, etc.

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SLIDE 49.

BREAKING METAL WITH MAGNETIC MONOPOLES

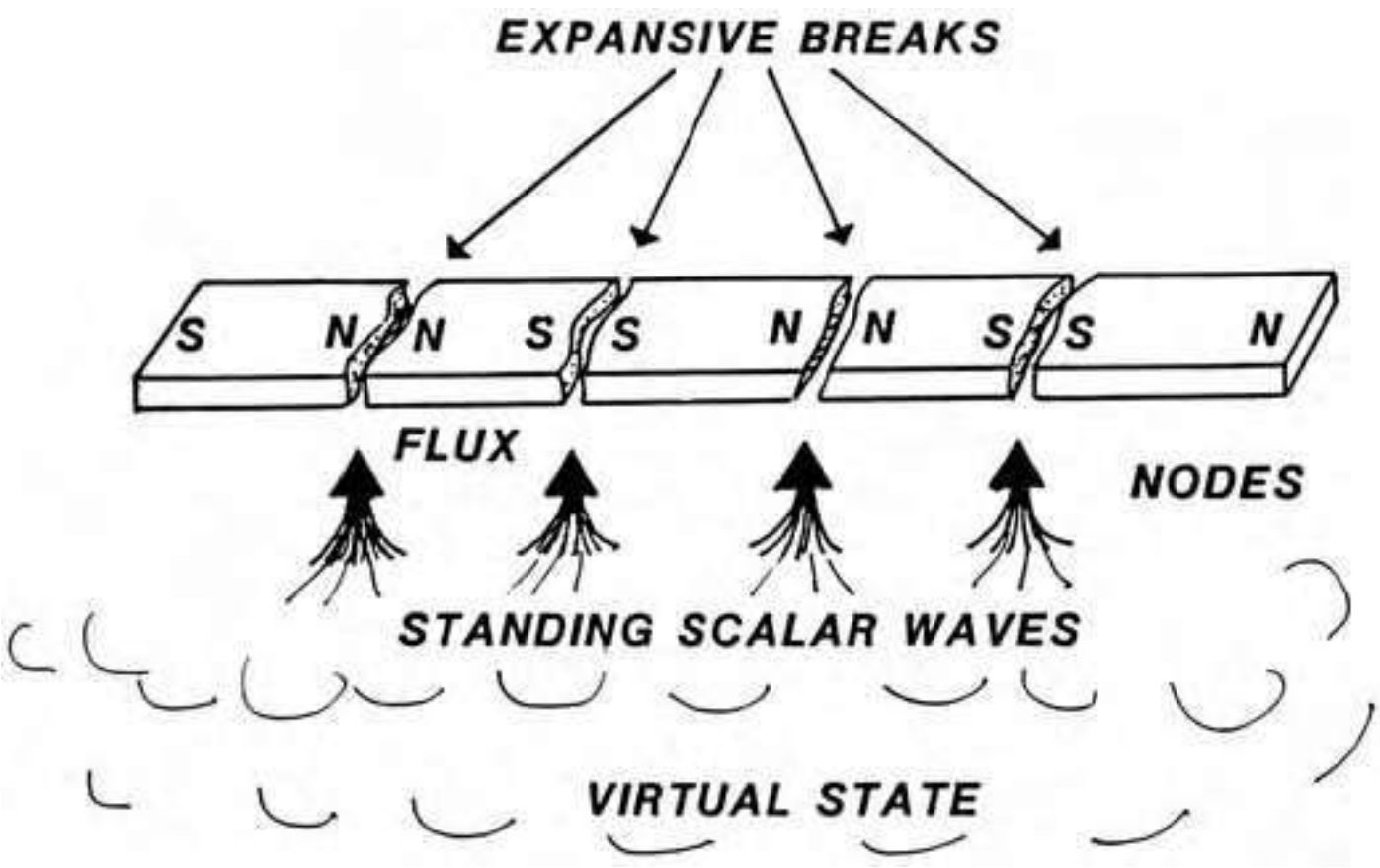

Again, metal has been broken in a North American laboratory utilizing the production and deposit of magnetic monopoles in this fashion.

On this slide we show what was done.

An ordinary bar of steel was exposed to standing scalar waves in a nonlinear situation, depositing magnetic monopoles at the wave nodal points in the metal bar. The breaks occurred as shown on this slide.

Much of what I am presenting is based on certain experiments accomplished in experimental laboratories here and abroad. Most of the mechanisms have actually been produced in the lab. However, these are proprietary labs and I cannot violate trust and

reveal the precise construction details utilized. In some cases I have not seen the precise constructions, but only the direct results.

But ironically, the production of magnetic monopoles -- which has fiercely resisted the normal scientific approach -- yields readily to the new approach.

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SLIDE 50.

CREATING AN INERTIAL FIELD (ANTIGRAVITY)

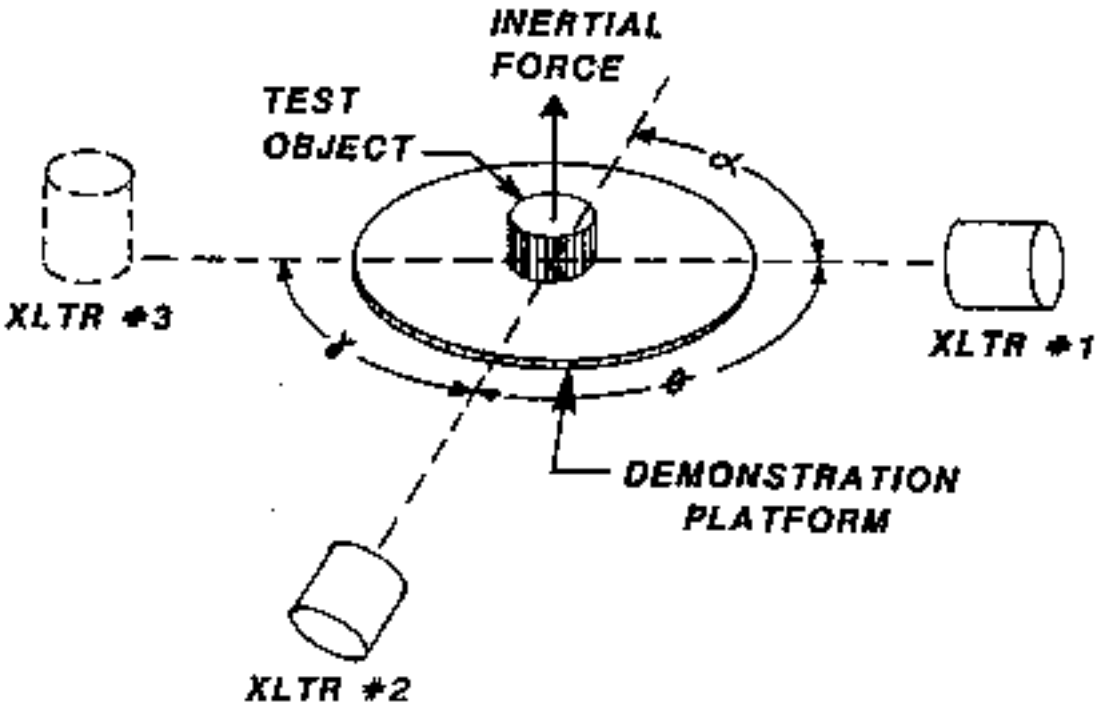

We now show schematically how to produce an inertial field, or antigravity. Also an inertial space drive can be produced in this manner.

This again has been done in a North American laboratory. In fact, inertial fields have been produced in more than one lab here in North America.

In the setup shown here, three translator/ transmitter projectors are used and oriented so as to give three-dimensional interference, or interference along all three spatial axes.

By controlling the substructures of the three projectors all together, one can control the precise phasing in all substructures, with respect to a common time reference.

By this means, a unilateral force can be created of each and every charged mass particle (that is, on each proton) in the nucleus.

Since we know that the neutrons and protons in a nucleus of an atom are continually interchanging, one into the other, back and forth, all of the nucleons can be treated as "diffuse protons" for mass purposes, and scalar wave interaction purposes.

Thus if we have the correct pattern to affect protons, we can control the phases of the substructure waves of the projectors so as to produce unilateral, parallel forces on and of each spinning proton in the nucleus.

This means we can produce unilateral thrust in an object exposed to the triad interference of the projectors.

In short, this produces antigravity. If sufficient force is produced, the test object in the interference zone simply lifts itself off against earth gravity. This has been done in North America.

If we phase the projectors so that counterbalancing forces are produced on each proton, we can either make the proton "lighter" inertially or "heavier."

In fact, we could "freeze" a common pistol so that it could not be moved and its trigger could not be pulled, simply by sufficiently increasing its inertia. This was done in experimental demonstrations in Toronto, Canada in 1969, and witnessed by the Chief of the Homicide Squad of the Toronto police. It was his pistol that was frozen for the demonstration.

If the projectors themselves are on board a space capsule, for example, they can produce such a unilateral thrust in and of a central mass or disc attached to the of the craft. By this means, an inertial spacedrive can be built.

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SLIDE 51.

EFFECTS ON HUMANS

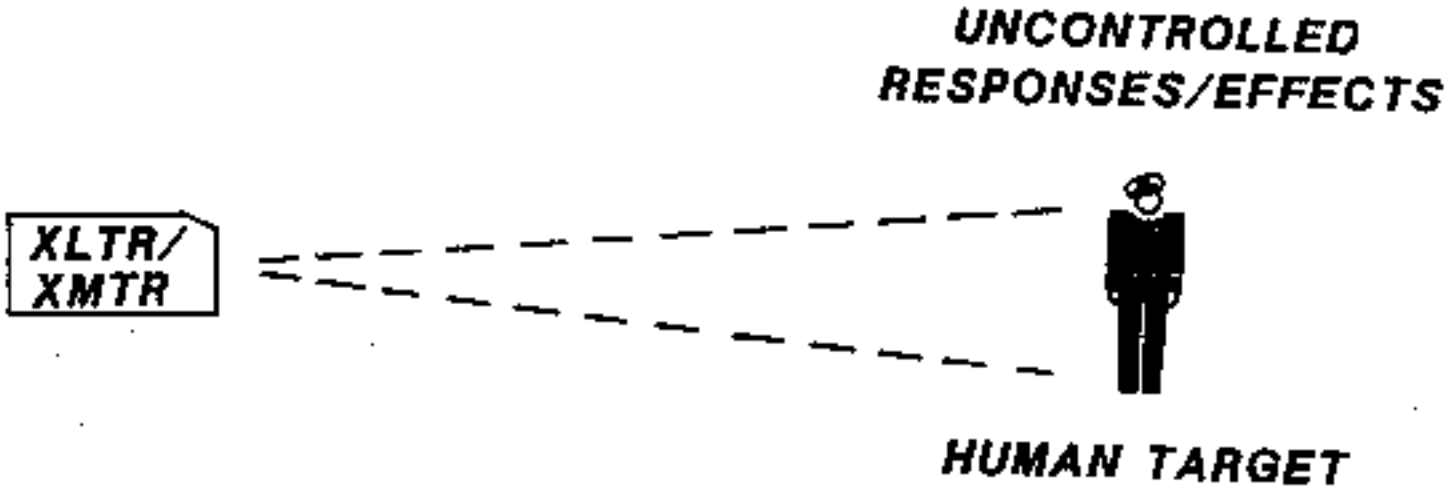

Now let us look at some of the effects on humans, when radiated with a true scalar wave beam from a translator/transmitter.

First, the human nervous system is highly nonlinear. Essentially, across billions of synapses, sudden ion discharges -- analogous to spark discharges -- are continually or periodically occurring. Brain waves, for example, are not waves along wires; instead, they are waves of avalanche discharges across tremendous numbers of nerve cell gaps.

The central nervous system is thus highly nonlinear, and the gap firings of the nerve endings act as translators.

These translators partially translate incident scalar waves, so that additional transverse matter waves -- or ordinary energy inputs -- occur in the ion discharges.

Thus additional energy is being added to the nervous system by incident scalar waves.

Many long-term effects of the environment on the body are gradually kindled in this fashion, even

over a period of years.

For a stronger dosage of scalar waves, the nervous system experiences "jamming" of its signals. This leads to four basic "noise jamming" effects.

If a small dose is absorbed, the interference is slight. One feels as if one had taken a whiff of anaesthesia -- an unreal, dreamy feeling.

If a slightly larger dose is absorbed, the interference is moderate. Now the single channel system -- the motor system -- goes, and the individual is paralyzed. Mentally he is barely conscious, in a sort of hypnogogic, waking dream state. Any tendency toward epileptic seizure or other nervous disorder may surface here, as may heart palpitations or even heart failure.

For a heavier dosage yet, the interference is now strong. Now the multiple systems start failing. Consciousness is lost and the individual is in a deep coma. In addition, seizures and convulsions, and loss of control of some body functions, may occur. The autonomic nervous system is keeping the heart beating with difficulty and keeping the body gasping for breath.

For a very strong dosage, the entire nervous system fails and death results almost immediately. This is quite similar to the effects of nerve gas.

These are the four major symptoms of scalar wave radiation of the body and translating absorption by the nervous system in an uncoordinated fashion.

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TOWARDS A NEW ELECTROMAGNETICS
PART 4: VECTORS AND MECHANISMS CLARIFIED

SLIDE 52.

INITIATING SPECIFIC BIOLOGICAL EFFECTS

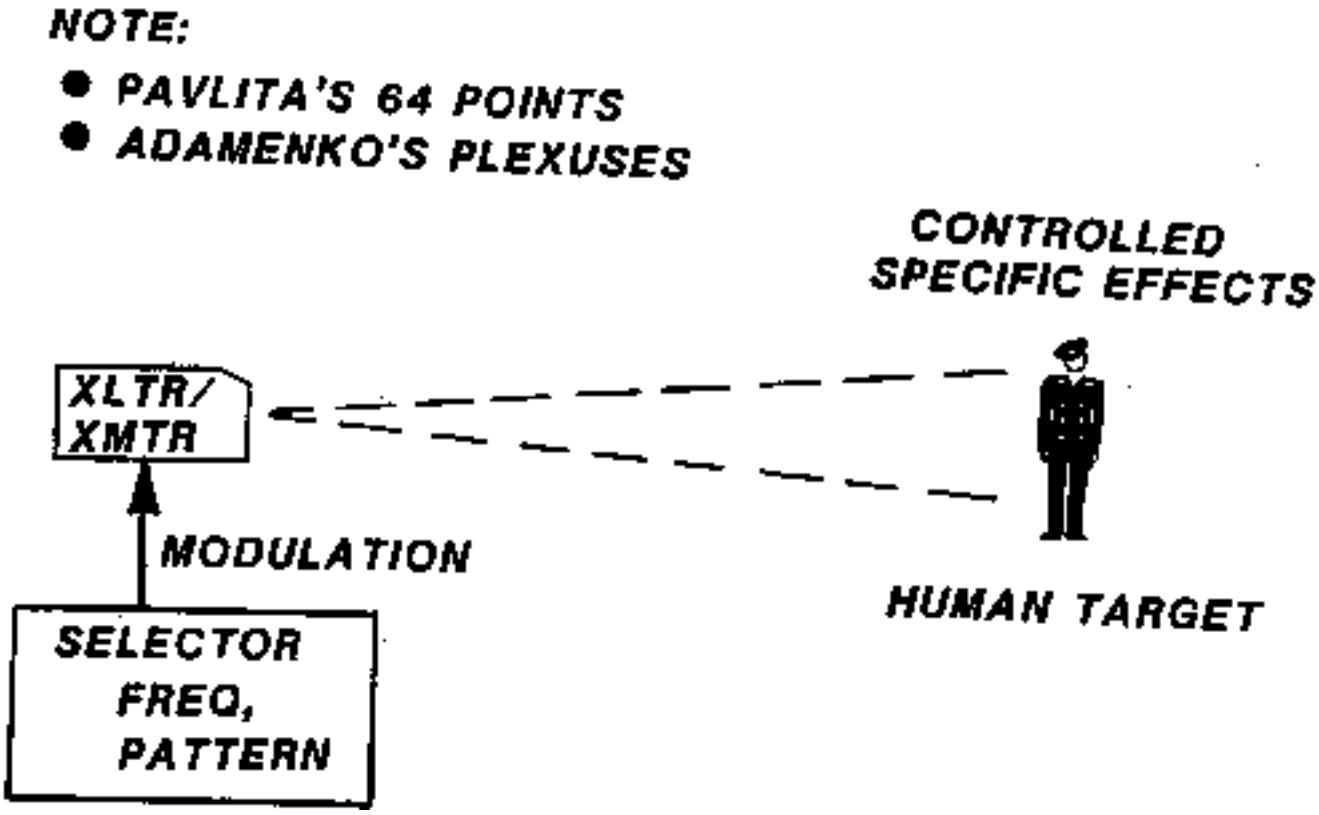

If we now add precisely patterned modulations to the substructure waves of the scalar zero vector beam, we can induce deliberate patterns in the dosage absorbed by a biological system.

As Kaznacheyev's experiments showed, any death or disease pattern can be induced upon an electromagnetic carrier -- specifically, upon the near-ultraviolet as an example. Some of his experiments were duplicated at the University of Marburg in West Germany, utilizing infrared carriers. These patterns can be dumped into cell cultures, eventually kindling the pattern of death or disease in the target cells.

The same can be done to a human from an external source. The major entry point is the acupuncture system, which reacts to scalar waves and transfers them to the nervous system for translation.

Pavlita, Czechoslovakian engineer, has built "psychotronic generators" for over 30 years that affect the human body. Adamenko, Soviet physicist, found that the acupuncture points formed groupings or plexuses that were frequency sensitive. In other words, certain frequency bands affect one plexus more than others. Further, these acupuncture points are known to be connected to effects produced at remote locations in the body.

Pavlita stated he had found 64 different sensitive "points" on the body, and had succeeded in building a generator for each. If by his points he meant Adamenko's plexuses, then frequency patterns can be created that affect certain acupuncture groupings -- and thereby certain specific body locations and effects -- more than others.

It thus appears reasonable that, by placing the proper frequency pattern in the modulations of the substructure waves feeding into the translator/ transmitter, the scalar ray or beam can be made highly selective as to body part affected and the effect generated or kindled in the body.

By this means, specifically tailored attacks on the body can be created.

Strong emotions such as sheer terror, overpowering rage, blind panic, etc. can be induced. Or physical effects such as epileptic seizure, loss of control of internal functions, loss of muscular control, severe weakness, specific failure of an individual organ such as the heart or liver, or blackouts and comas can be induced. In addition, patterns for specific toxins and diseases can be induced. With a strong absorption, these changes can be effected quickly. Imagine bubonic plague developing in 30 seconds, for example, or the effects of a cobra bite developing in 10 seconds.

If the individual is placed in crossed interference beams (that is, in the interference zone of a scalar interferometer), strong effects can be produced essentially instantly, including instantaneous death.

Of course BENEFICIAL effects can also be accomplished. As instrumentation is developed, one should be able to scan the aura, do a computerized

readout to show the different medical problems either developed or developing in the body, have the computer compose a "cancellation or offsetting pattern," and radiate the body with a totally beneficial pattern, customized for that particular condition at that particular time. One should be able to quickly cure cancers and leukemias, for example, even of the brain and of the bone marrow. One may even be able to quickly reverse the effects of aging; at least there is no foreseeable reason why it should not be possible.

The new technology is a very powerful tool, and it can be used for either good or bad, depending upon the intent of the developer and the user.

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SLIDE 53.

GROUND-TO-AIR USE

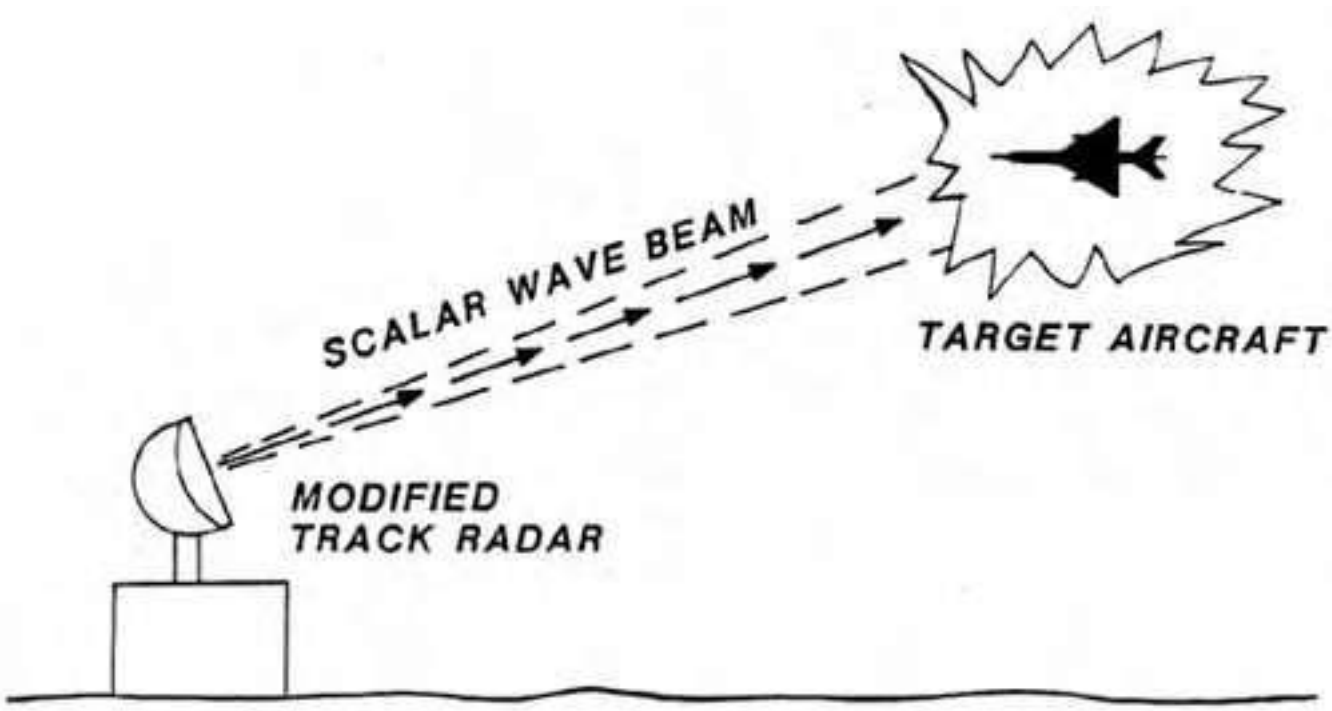

Here we show another use of the scalar beam technology already developed by foreign powers.

A modified track radar -- either continuous wave or pulsed -- transmits a scalar wave beam. It radiates an incoming hostile aircraft, keeping the beam on it, and kindling energy in the nonlinear electronic circuits of the aircraft by translation. Communications, navigation systems, avionics systems, electronic fuze systems, ignition and control systems, airborne radar, missile armament electronics, etc. are all vulnerable to this translation kindling of internally jamming energy from the incident scalar beam.

The electronics can be knocked out and the aircraft knocked down.

The pilot himself is also vulnerable because of his highly nonlinear central nervous system.

Some or all of the eight F-111's mysteriously

lost in
Vietnam may have been bagged by modified SA-2 FANSONG radars, using this effect.

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SLIDE 54.

TACTICAL AIR-TO-GROUND USAGE

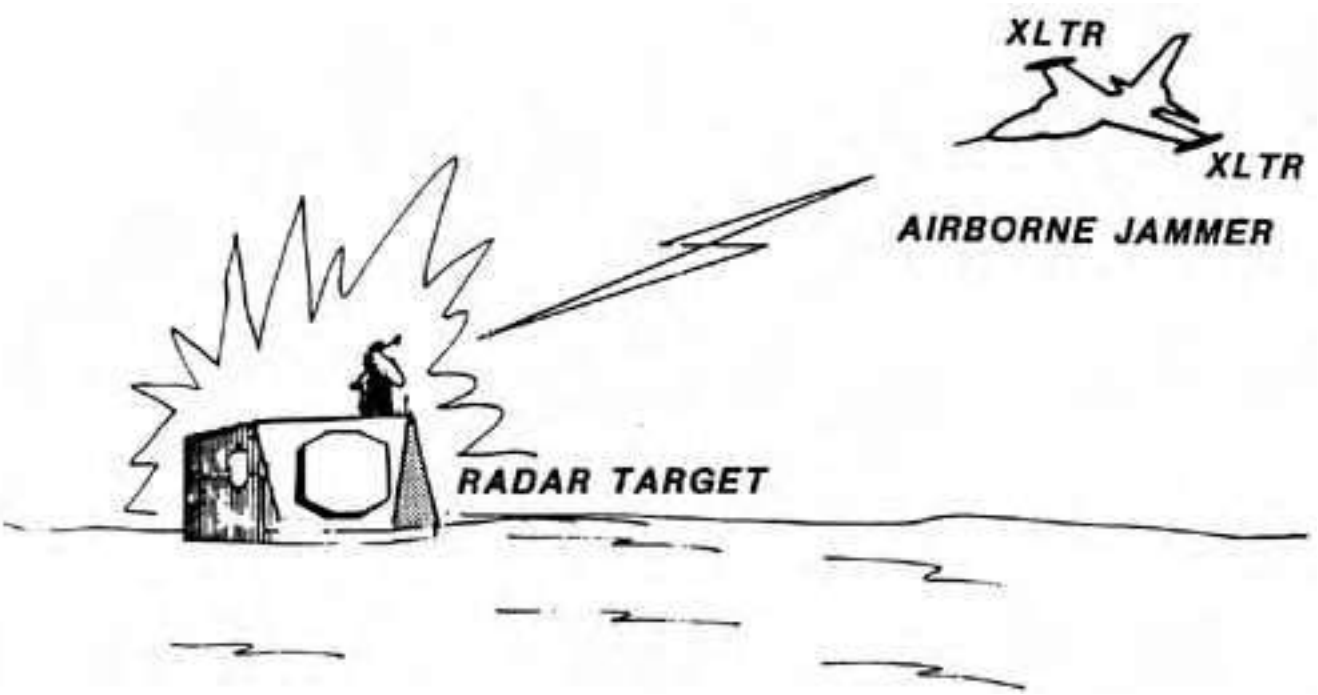

As shown on this slide, the technology is also usable from aircraft against ground targets, particularly ground-based radars and communications systems.

As shown, the aircraft has a modified jammer, able to emit a beam of scalar energy from one or more translator/transmitters.

By simply training a beam on the radar, eventually the radar can be knocked out. That is the simplest use.

A more sophisticated usage is provided by more than one translator/transmitter, acting as a scalar interferometer.

In this mode, each translator/transmitter emits multiple scalar carrier frequencies. Two Fourier expansions are established, so that a three dimensional "ball" or sphere of interference-zone energy is established. By pulsing or phasing, this ball is moved to strike the location of the radar, delivering a large burst of energy to it and knocking it out. Alternatively,

the energy bottle is "dumped" when it reaches the targeted radar or its near vicinity.

A still better way is to fire one Fourier scalar pattern directly at the target radar, then fire a second pulse faster so that it overtakes the first directly upon the target. (The ensemble of such a pattern acts as a soliton, and its velocity is controllable by controlling the amplitude of the pattern generated).

When the second scalar overtakes the first, a sharp interference is formed, with a fast energy bottle, which is then nonlinearly dumped in microseconds or milliseconds. In this fashion, all the energy put out by the jammer is delivered directly upon and into the target in one sharp EMP pulse, much like that from a small nuclear explosion. The target is destroyed.

Note that such a weapon can be utilized against tanks, vehicles, explosives, missiles, ammunition, bridges (the airblast), bunkers (the blast can occur INSIDE the enclosure), ships, planes, personnel, and targets of varied types.

The Soviets have had such secret weapons for years.

One additional country has them also.

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SLIDE 55.

INTEGRATED WEAPONS DISPLAY (MODIFIED JAMMER)

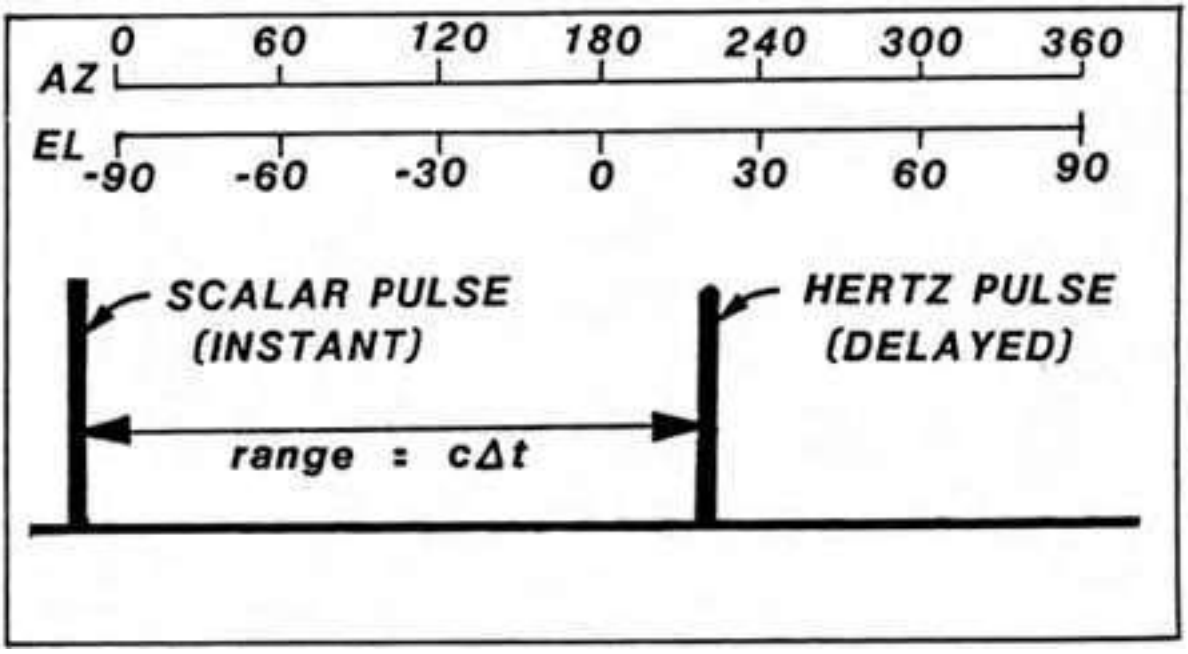

Here we show diagrammatically what a modified Soviet integrated weapons display for a modified jammer might be, to employ scalar interferometer weaponry.

As the "main bang" is emerging from the antenna of the target radar on the ground, the phi-field from it reaches to infinity, including through the aircraft with a finite magnitude. In the a1rcraft, two channels act in interferometer fashion as a scalar detector for phi-dot. The main bang creation (phi-dot) is detected, and displayed as the leftmost pulse.

At that time, a computer time-base starts clocking off microseconds.

At some time later, the third channel, acting as a normal receiver, receives the ordinary "Hertz" pulse from the radar, which has traveled to the aircraft at the

speed of light.

The computer converts elapsed time between the scalar pulse and the Hertz pulse to range.

Azimuth and elevation angle to the radar are obtained by normal angle tracking.

At this time, the computer has the exact coordinates of the radar, allowing for motion of the aircraft during the lapse time.

The computer switches the interferometer into transmit mode, and arranges amplitude patterns to target the radar.

It fires the first scalar pulse, then fires the second so as to create the full EMP directly upon the target.

The EMP flash occurs, destroying the radar.

At that time, another target can be processed.

In a more advanced weapon, scanning may be used to detect, locate, target, and engage multiple targets, including incoming air-to-air and surface-to-air missiles, one after another.

The same weapon is usable against a variety of aerial and ground based targets.

The major weapon is the electronic emitter, not a missile or ordinary ordnance.

Hordes of such special "jammer aircraft" now become a potent force on the battlefield, destroying all before them with annihilating ray weapons.

Star war is a reality now.

The High Frontier is already seriously obsolete.

Our entire defense establishment is completely vulnerable to these weapons at present, for we have not developed countermeasures or defenses.

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TOWARDS A NEW ELECTROMAGNETICS
PART 4: VECTORS AND MECHANISMS CLARIFIED

SLIDE 56

RADAR INVISIBILITY

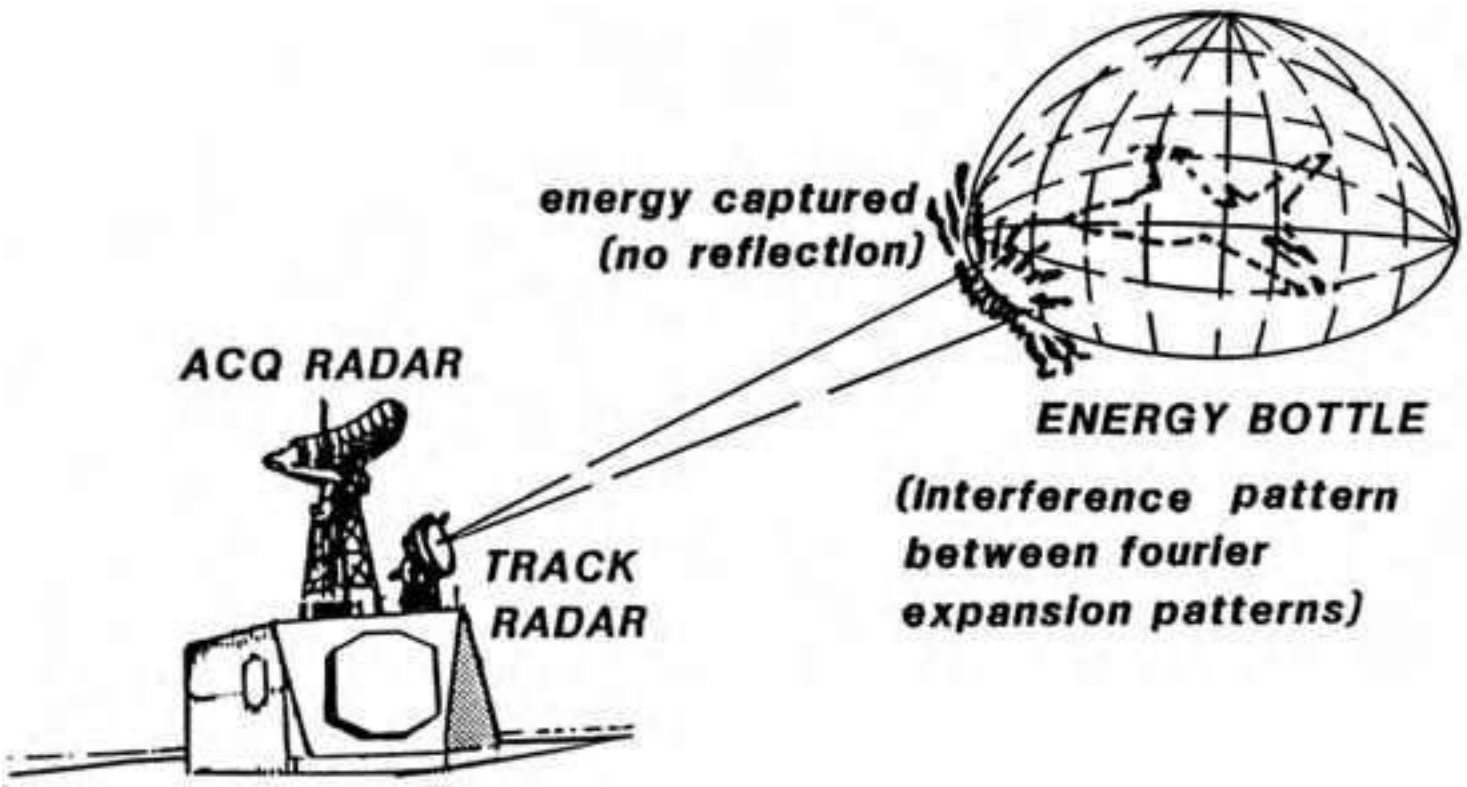

On this slide we show another effect which can be obtained. We can make an airplane invisible to ordinary radar.

Imagine now the same "jammer" type aircraft with three channels, one for use in scalar interferometry and one as an ordinary channel.

This time, a Fourier interference pattern is established around the aircraft, so this establishes an "energy bottle" around the plane. We specifically arrange this bottle in the frequency band of the hostile radar we wish to avoid. For multiple bands, we establish multiple bottles -- this just requires more

frequencies or more translator/transmitters.

The beam from the ground radar now strikes the energy bottle, and its energy enters and is trapped in the bottle grids. Since the bottle is leaky, the incident energy gradually disperses and "leaks" out all around, with very little emerging energy.

The ground radar receives no return pulse or reflection.

Therefore it sees no target.

The same interferometer system is usable both in this defensive screen fashion and in the attack fashion previously discussed.

Use of this system has been demonstrated internationally.

An energy bottle has been created in a North American laboratory as well.

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SLIDE 57.

NETWORK OF VIRTUAL TRANSMITTERS

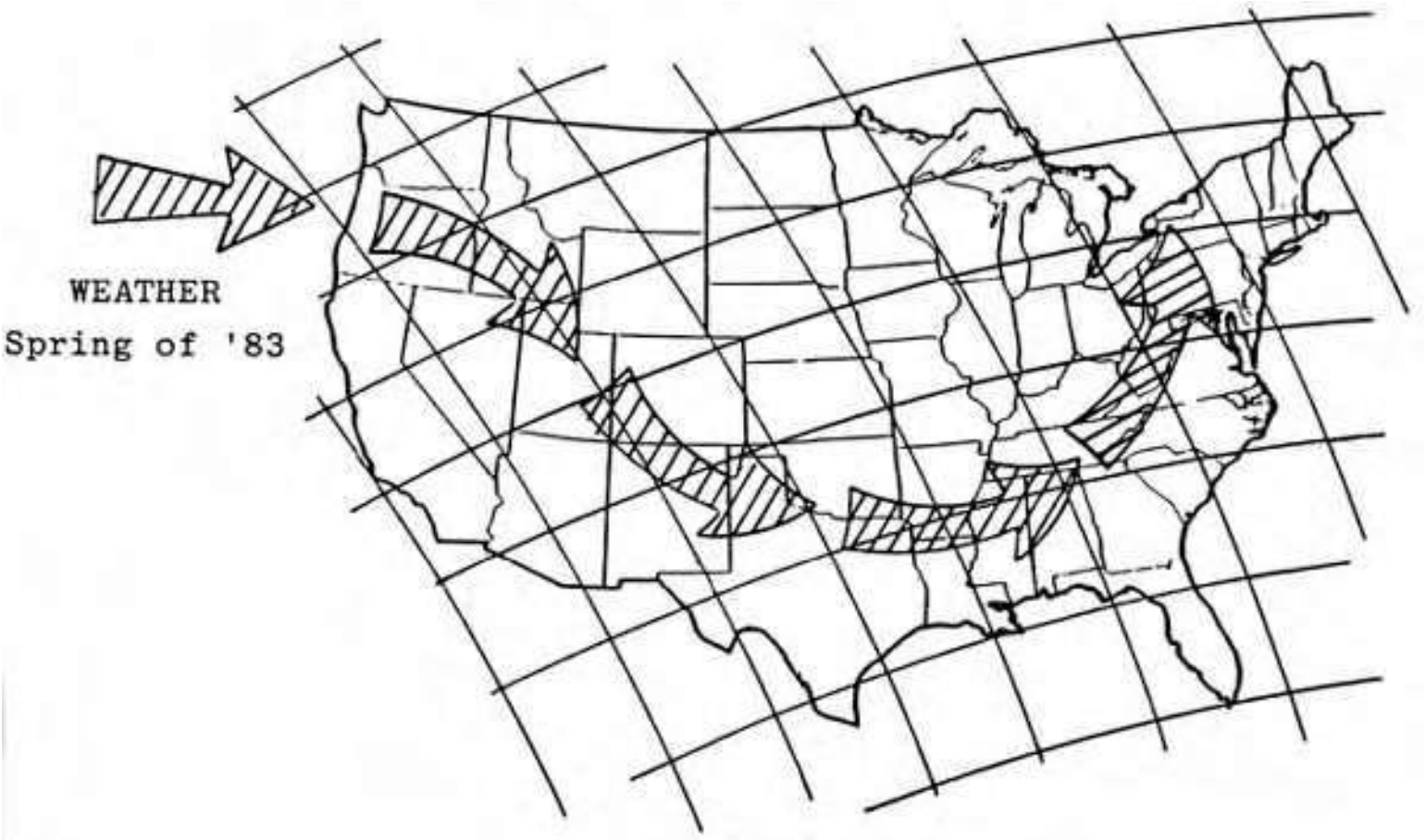

As is well-known, for years the Soviets have blanketed the world with large, powerful transmitter signals in the communications band, referred to as the "Woodpecker" signals because of the staccato noise the chirped signals make to the ear. The carriers have been modulated with known harmful bioactive ELF frequencies. At least some effects have been noted on humans from these signals, and other human effects are suspected but not proven.

In addition, evidence exists that such transmitters, utilized in the scalar transmission mode, may have been used to cause earthquakes and to control the weather. High altitude bursts off the coast of the Eastern United States and Canada, over

Timmons, Ontario, Canada, and off the coast from St. Petersburg, Florida have occurred also.

Mysterious "blackouts" of U. S .satellites -- and British satellites -- have occurred. These would be difficult to explain as the result of illumination from a ground laser, but easily explained as the result of illumination from a ground-based scalar beam or scalar interferometer.

Strange patterns of micro sky quakes and micro earthquakes occurred at various locations throughout the U.S. just before and shortly after the death of Leonid Brezhnev. These strongly appear to be connected with the adjustment of a scalar interference pattern -- a gigantic "energy bottle" across North America, as shown on this slide.

Shortly after this suspected adjustment and alignment, the underground net in the U.S. detected the emergence of numerous ELF-modulated signal carriers throughout the U.S., generally utilizing carriers in the vicinity of 40 MHz. Locations of the apparent transmitters were such places as Atlanta, North Georgia, St. Petersburg, Florida; Mississippi; Alabama; in the vicinity of Washington, D.C.; near Boston; around the Great Lakes; Michigan; in the Pacific Northwest (Washington and Oregon); and in both northern and southern California.

Researchers knowledgeable of the Soviet woodpecker signals and ELF modulations detected and reported these signals.

Physical effects were reported and correlated to the signals, including wakefulness at night, restlessness, fatigue, headaches, nausea, ringing in the ears, anxiety, disturbed dreams, etc.

What appears to have occurred is the adjustment and
alignment of a vast scalar interference pattern across the U.S. Recall that energy emerges in each grid, by phase interference between the composite substructure waves of the scalar beams.

Thus the Woodpecker "over-the-horizon radars," as accepted
by Western intelligence analysts, may have acquired a diabolical new strategic capability.

It is as if the Soviets had been permitted to build a vast network of transmitters directly on U.S. soil, for hostile employment against U.S. citizens.

Shortly after the net was aligned, a curious pattern of weather assaults on the U.S. began.

Storms assaulted California unceasingly. Then they roared across the Rockies, dipping sharply down to hit the Texas Panhandle, and bending northeast again to assault the South and the East.

The mighty jetstreams themselves were diverted and "kinked" into this looped, distorted pattern.

And the storms and floods assaulted the U.S. one after the other in this highly unusual fashion.

I maintain that the virtual transmitter net, just established by the Soviets and adjusted in on the U.S., was tested in the weather control mode. If so, it proved highly effective. Imagine what would have happened to the U.S. if it had been unleashed full force, and not just "gently tested."

And imagine what happens when disease, death, and nervous system disturbances are modulated upon these blanketing signals. The "transmitters" for the patterns are in each grid, all across the U.S.! And there are no physical transmitters there to destroy.

A counter is needed quickly. A simple one would consist of recording the signals in each grid zone, analyzing the substructure, reversing the signals and their structured patterns 180 degrees, and feeding the "cancellation signals" out in each area.

A great strategic Russian weapon of devastating power and potential is now operating directly on U.S. soil. The need for a crash countermeasures program is urgent.

In 1975 Brezhnev had introduced to the SALT talks the strange proposal that we should also consider outlawing the development of new weapons more frightful than the mind of man had ever imagined. We didn't know what the Russians were talking about. When we asked them later what weapons they meant, they referred vaguely to weapons of an electromagnetic nature.

The presentation I have just given you is part of what Brezhnev meant.

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SLIDE 58.

CONCLUSION

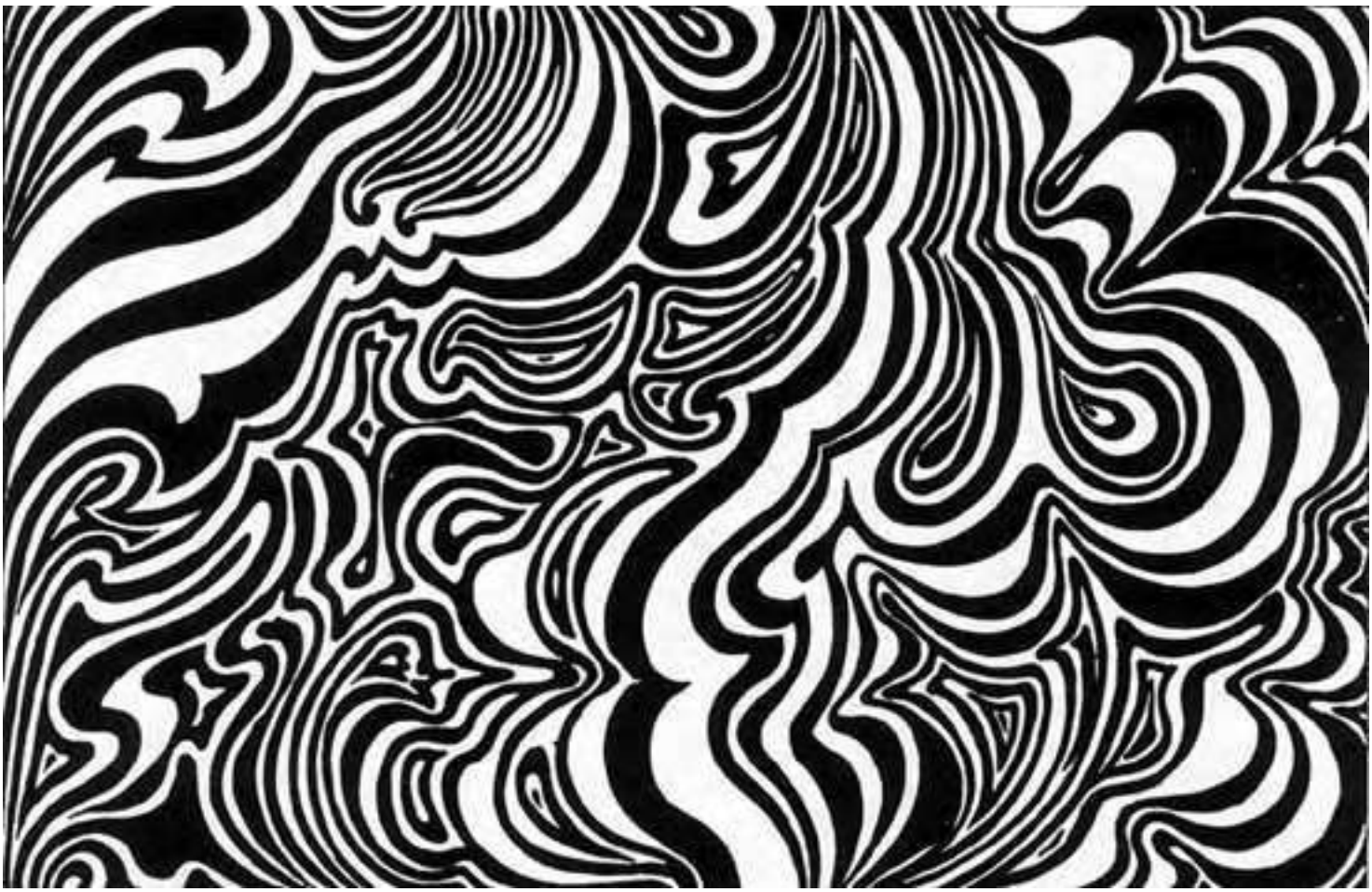

In conclusion, today I have released a number of powerful mechanisms that result from the new technological concepts. Many of these were originally discovered -- at least in rudimentary form -- by Nikola Tesla. In the West, the suppression of Tesla led to the suppression of these effects. And our knowledge of them went to the grave with Tesla.

After World War II, the Soviet Union mounted a massive campaign to obtain all the scientific literature of the West and thoroughly digest it. Great centers were set up, and thousands

of PhD's devoted to this purpose. Gradually they synthesized this technology from the errors in EM foundations they uncovered, and from obscure, ignored papers published in the orthodox Western scientific literature.

They rediscovered the technology of Tesla, Moray, and Rogers. And they have highly weaponized the effects, and adjusted and aligned the weapons upon us.

Now the radical movements are onto part of this technology. As late as about six months ago, one such group discovered how to build a translator and a scalar beam projector. Excitedly, they planned to build them the size of a large pistol, powered by a portable battery pack, and sell them to street criminals to kill or stop the police. They planned to get rich by this illicit means. At that time, a personal friend of mine, who moves in underground circles, was attempting to purchase one of the prototypes for my analysis. Fortunately, the inventor stepped into the beam of one of his devices and was almost killed. This frightened the group, and at least for now they have desisted. But be forewarned: this technology is coming down the pipe, and the police establishments in the West are in for the shock of their lives if the scientific community does not wake up and prepare defenses.

Again I urge my fellow colleagues to experiment vigorously with these new concepts, but build equipment for the benefit of man. Insect control, disease elimination and control -- both are noble purposes. Defense against the hostile use of such devices is also a fitting purpose.

We are in the final days, and the final technology is upon us. It is a stupendous tool for either good or bad, and assuredly it will be utilized for both means. I call attention once again to the fact that my ultimate purpose is to use this technology benevolently to achieve mind linkage, and elevate man from his present brutish state to the lofty state that is his destiny and his true God-nature.

For better or worse, Tesla technology is once again loose in the world, this time for good, and on a massive scale.

Let us prepare ourselves for a wild canoe ride, for the real white water lies just ahead.

Thank you for your attention, and good evening.

LEADING EDGE

Volume 7, Issue No. 4

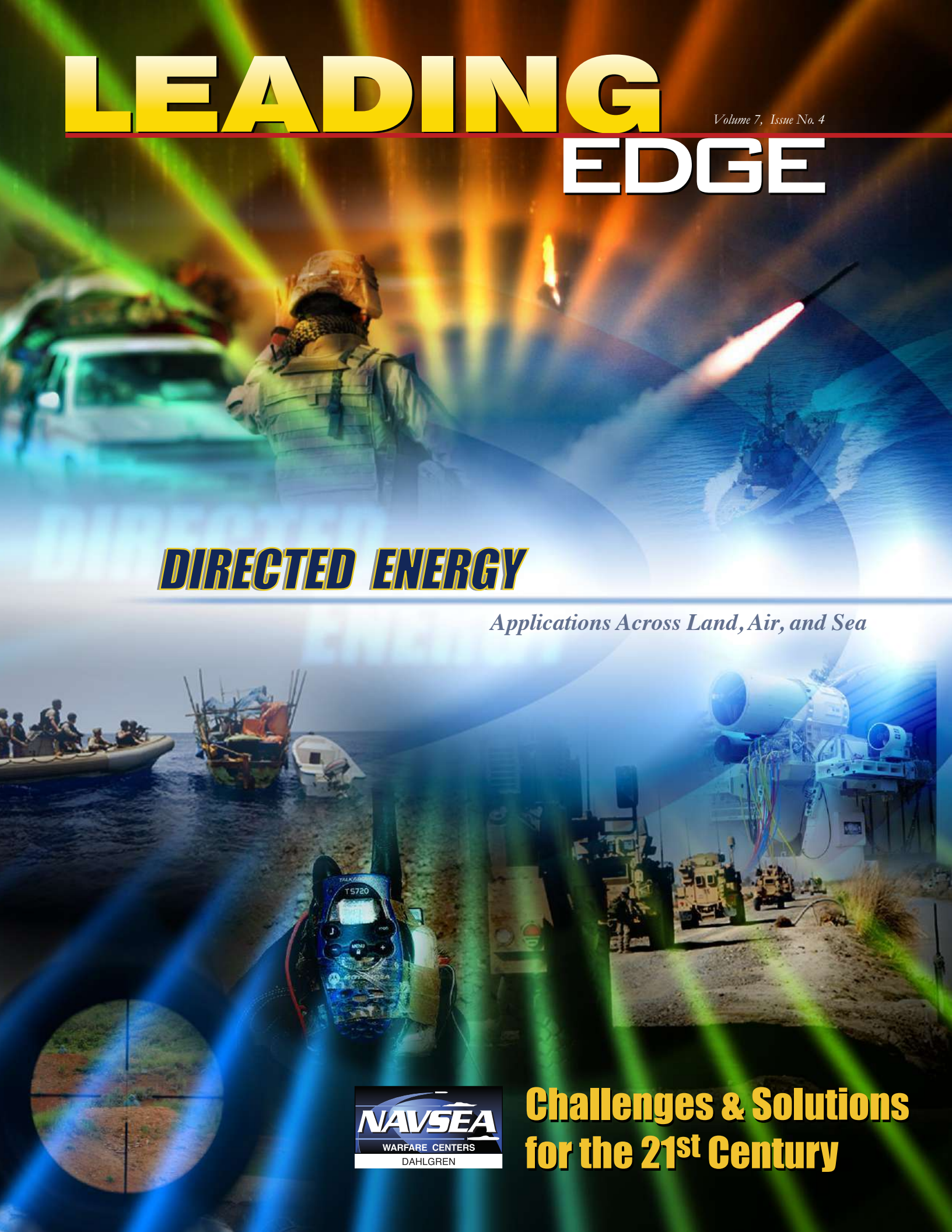

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Applications Across Land, Air, and Sea

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Challenges & Solutions for the 21st Century

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Directed Energy

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LEADING EDGE

Naval Surface Warfare Center, Dahlgren Division (NSWCDD)

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NAVSEA WARFARE CENTERS DAHLGREN

Introduction

Leading Edge Directed-Energy RDT&E

Captain Michael H. Smith, USN
Commander, NSWCDD

Dahlgren first launched research and development efforts devoted to harnessing the power of electromagnetic energy over 40 years ago. From early work with voltage multipliers and pulse-powered technology, to today's high-energy lasers and high-power microwave technologies, the Naval Surface Warfare Center, Dahlgren Division (NSWCDD) has led, and continues to lead, cutting-edge directed-energy research, development, testing, and evaluation. Our commitment in this area only grows stronger—evidenced by our chartering of the Directed Energy Warfare Office (DEWO)—in order to provide increased focus on warfighting applications of these technologies.

Today's military forces face a wide array of challenges in diverse operating environments around the world. Directed energy offers unique and flexible options to address today's challenges, as traditional kinetic weapons are often of limited value in peacekeeping missions and in urban environments, where restricted rules of engagement typify the norm. Kinetic weapons can also be more costly or ineffective to employ against asymmetric threats.

The Chief of Naval Operations (CNO) recently placed added emphasis on directed energy and on expanding the range of directed-energy capabilities. In response, scientists and engineers at NSWCDD are actively developing prototype systems in a number of areas that you will read about in this issue—areas that have been successfully demonstrated and tested in our Navy laboratories and ranges.

In this issue of *The Leading Edge* magazine, you will trace the rich history of directed-energy work at Dahlgren, gain insight into directed-energy weapons already fielded or being readied for the field, and learn about prototypes that show real promise for providing incredibly effective offensive and defensive directed-energy solutions. For example, scientists and engineers at NSWCDD are leading the way toward realizing small, lightweight radio frequency (RF) transmitters using high-power, solid-state switching amplifiers for the development of counter-improvised explosive device detection and neutralization systems. You will also learn about diverse applications of directed-energy technology—such as research and testing of laser glare devices and laser eye protection—and have the opportunity to gain a better understanding of the Department of Defense (DoD) acquisition framework and the challenge of maintaining cost and schedule estimates while delivering weapons systems that are critical to the warfighter.

From lasers to high-power electrical vehicle-stopping systems, I am sure you will be fascinated and, along with me, be impressed with the advancements our scientists, engineers, and technical staff are achieving in the directed-energy arena to support of our men and women in uniform.

Directed-Energy Topics in This Issue

Dale Sisson
Head, Electromagnetic and Sensor Systems Department
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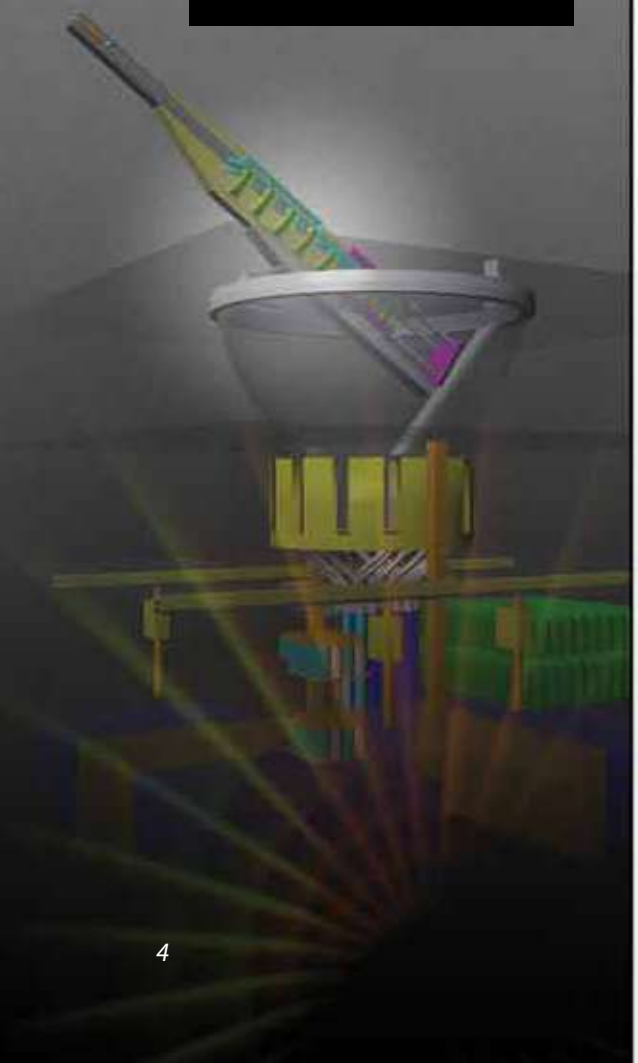

Welcome to our Directed Energy issue of the *Leading Edge* magazine. This issue represents the third in a trilogy of issues covering the truly fascinating and incredibly challenging area of naval warfare in the operational electromagnetic environment. In our first issue, we covered the full range of operational and readiness implications when operating in the electromagnetic environment. Then, in our second issue, we highlighted the complexities and dynamics of providing relevant and effective sensors and radars to our warfighters. Now, we focus on directed energy and relate how the Naval Sea Systems Command (NAVSEA) Warfare Centers, and the Naval Surface Warfare Center, Dahlgren Division's (NSWCDD's), in particular, are working on state-of-the-art directed-energy weapons capabilities for the warfighter.

In this issue, we first look back to the early years, decades ago, when directed-energy weapons research began. We examine the history of directed energy, and we cover significant discoveries and achievements made by NAVSEA Warfare Center scientists and engineers, and others in the scientific community. We then relate information about several of our current directed-energy initiatives, and about how we're working hard to solve some of the most complex technical challenges associated with directed-energy weapons. We highlight how others in the Navy, such as the Naval Medical Research Unit in San Antonio, Texas, are also conducting research into directed energy and how our forces can better protect themselves from the effects of directed energy. We show how directed energy can be employed in a variety of offensive and defensive, lethal and nonlethal situations. We explain how directed-energy weapons work and how they can be employed in various environments against a wide range of situations. Lastly, we look forward as we provide technical and strategic leadership for the efficient and effective development, acquisition, and fielding of directed-energy systems for the warfighter.

So, if you want to learn about what the NAVSEA Warfare Centers and others in the Navy are doing in the area of directed-energy weapons, look no further than this issue of the *Leading Edge* magazine. I'm confident that you will be impressed by the progress made in this most important technology field.

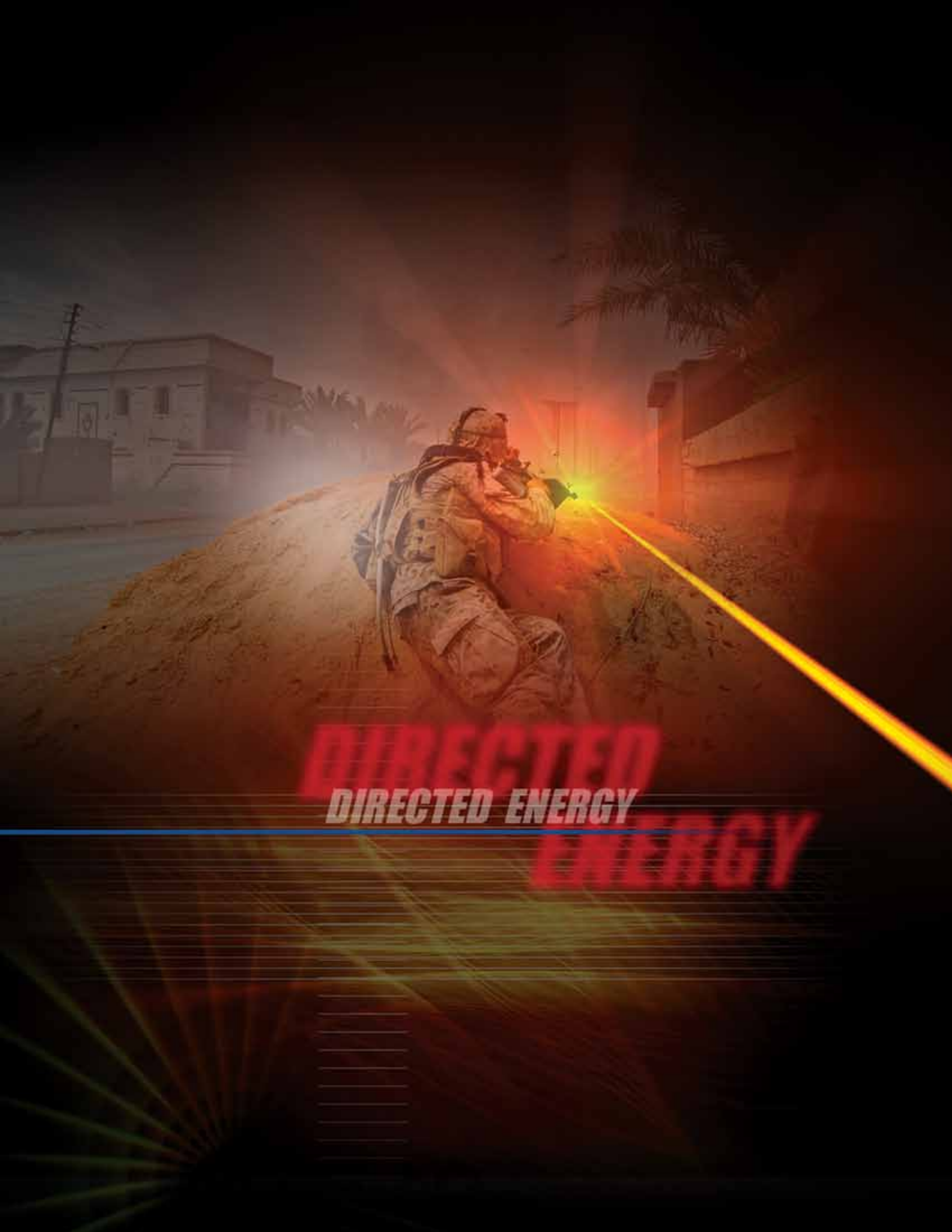
DIRECTED
DIRECTED ENERGY
ENERGY

Naval Directed-Energy Weapons – No Longer A Future Weapon Concept

By David C. Stoudt

Dr. Stoudt is the Distinguished Engineer for Directed Energy (ST) and the NAVSEA Technical Warrant for Directed Energy and Electric Weapon Systems.

Directed-energy weapon (DEW) technologies typically take the form of high-energy lasers (HELs), high-power microwaves (HPMs), and charged-particle beams. This article focuses on the first two technology areas, as they have reached the point of being ready for operational testing and evaluation, and in some cases, operational use on the battlefield. DEWs have been popularized in science-fiction writings for over a hundred years. The Department of Defense (DoD) has been investing in their development since the 1970s. This article will not go into technical depth regarding the various directed-energy (DE)-related efforts currently underway in the Navy, but rather, it will overview DE areas under development and relate recent Navy leadership activity. Other articles in this issue of *The Leading Edge* magazine will provide the reader with much greater technical and programmatic details on various DE efforts.

High-Energy Laser Weapons

HEL weapon systems have been envisioned for a great many years, to include being referred to as Martian "Heat Ray" weapons in H.G. Wells' epic novel *The War of the Worlds*, originally published in 1898. In reality, a high-average-power laser weapon system is very similar to a "heat ray", or even a blow torch. During the early years of DoD investments in DE technology, the Navy led the development of HEL with the creation of the world's first megawatt-class, continuous-wave, Mid-Infrared Advanced Chemical Laser (MIRACL), located at White Sands Missile Range (WSMR). Roughly 80 years after the work of H.G. Wells, the U.S. Navy tested the MIRACL laser and ultimately used that laser system to engage static and aerial targets in the desert of WSMR in the following years. While that laser proved to be the wrong choice for the Surface Navy's self-defense mission, it did spawn work by the Air Force on the Airborne Laser (ABL), and the Army on the Tactical High-Energy Laser (THEL). In 2000 and 2001, the THEL successfully shot down 28 supersonic Katyusha artillery rockets and 5 artillery shells.

In 2010, the ABL successfully engaged and destroyed tactical ballistic missiles during the boost phase of their flight. All three of these laser systems—the MIRACL, the ABL, and the THEL—are chemical lasers that utilize toxic chemicals and operate in less than optimal wavelengths that make them a poor choice for most naval applications. The MIRACL is shown in Figure 1.

Recent advances in solid-state lasers, to include fiber lasers, have moved these electric lasers to the forefront of the Department's research and development (R&D) for near-term HEL applications in the services. The Navy has particular interest in electric lasers, to include the free-electron laser (FEL), for shipboard self-defense and force protection applications. The speed-of-light delivery of HEL energy can defeat the high-g maneuvers of newly developed foreign antiship cruise missiles (ASCMs). Thus, the Office of Naval Research (ONR) started an FEL Innovative Naval Prototype (INP) program in FY10, with a goal of reaching the output power of 100 kW. The eventual goal of the FEL program is to reach the multi-megawatt power level with wavelength selectivity. The Naval Sea Systems Command (NAVSEA) Directed Energy and Electric Weapons Program Office (PMS 405) has been actively developing a fiber laser-based Laser Weapon System (LaWS) that could be a retrofit to augment the current capabilities of the Close-In Weapon System (CIWS) currently deployed on many surface combatants. The Naval Surface Warfare Center, Dahlgren Division (NSWCDD), is the Technical Direction Agent and lead system integrator for PMS 405 on the LaWS program. The Naval Air Systems Command (NAVAIR) has interest in compact, solid-state HEL systems for aircraft self-protect and air-to-ground engagements, and will be starting a

Figure 1. Mid-Infrared Advanced Chemical Laser (MIRACL)

fiber laser-based ONR Future Naval Capability effort in FY12. LaWS is shown in Figure 2.

High-Power Microwave Weapons

Like lasers, microwave weapons have been fantasized about ever since the invention of microwave power generators. In fact, in 1932 it was generally recognized by the British government that bombers, ostensibly German bombers, would be able to penetrate British air space and bomb its civilian population and infrastructures. In 1934, the Air Ministry initially asked Robert Watson-Watt, of the National Physical Laboratory, if he could build a "death ray" that could kill enemy pilots or detonate bombs while they are still on the planes of enemy aircraft. Such a "death ray" had been proposed to the Air Ministry by Harry Gindell-Mathews 10 years earlier in 1924. Watson-Watt, a former meteorologist who had become an expert on radio signals, suggested that energy reflected from an aircraft could be used to locate it. His experiments were successful and RADAR (radio detection and ranging), a name coined by the U.S. Navy in 1940, was born. While RADAR is not a DEW in the way they are thought of today, its roots can clearly be traced to the military's desire for such capabilities.

The Navy's HPM, or high-power radio-frequency (RF) systems, have been progressively increasing in power density to the point where it is now feasible to integrate the technology into weapon systems for deployment. While initial HPM applications suffered from their inability to obtain militarily useful outcomes, either due to technology limitations, difficult concept of operations (CONOPS), or inherent robustness of potential target systems, many feasible military applications for using HPM

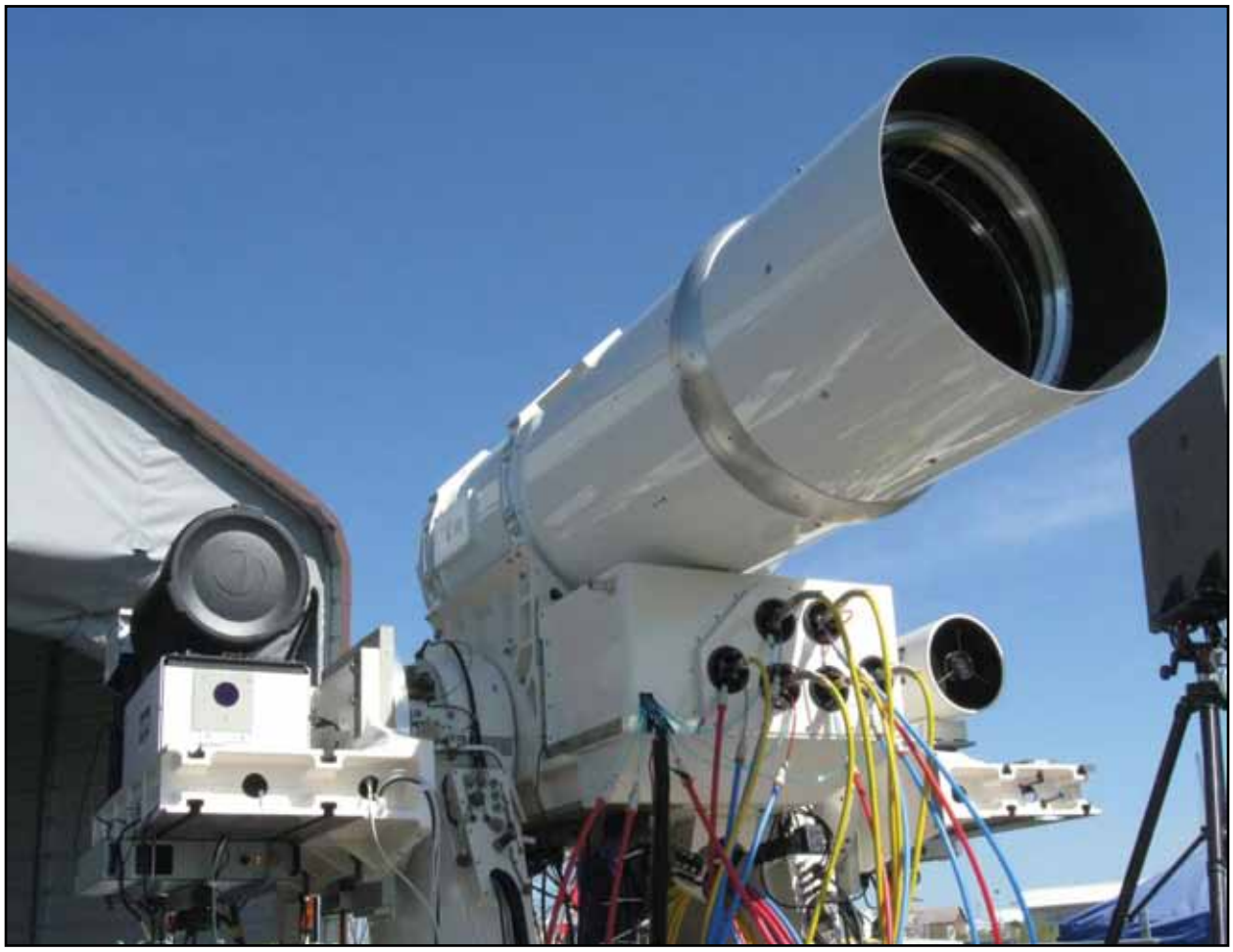

Figure 2. Laser Weapon System (LaWS)

devices have surfaced over recent years to include nonlethal, antipersonnel weapons and nonkinetic, antimateriel weapons. While these concepts offer unique capabilities to the warfighter due to the nonkinetic effects they generate, other warfighting concepts—such as stopping vehicles, or countering hidden roadside bombs or improvised explosive devices (IEDs)—are difficult to achieve by any other means. The multifrequency Radio-Frequency Vehicle Stopper (RFVS) system is shown in Figure 3.

In addition, the difficulty in overcoming the propagation losses associated with HPM has driven some concepts into platforms such as unmanned aerial vehicles (UAVs) or cruise missiles that deliver the HPM device to the target for a close-in engagement. Over the past 10 years, field-testable prototypes have been developed to demonstrate the operational utility of these concepts, and in some cases, those prototypes have or will be deployed operationally to support our troops in theater. It is only through the hard work and perseverance of the Naval Research Enterprise (NRE), as well as other DoD laboratories, that concepts that were once only laboratory curiosities are now making their way onto the battlefield and contributing to the fight.

Foreign Directed-Energy Weapon (DEW) Development

While the United States has been very active in this warfighting area, significant foreign DEW development also has elevated the need for the Navy to afford these threats a higher priority. This can be done either by incorporating the necessary DEW countermeasures into weapon systems, platforms, and critical infrastructures, or by adapting the CONOPS and tactics, techniques, and procedures (TTPs) employed by our armed forces to properly account for those foreign DEW systems. Materiel developers need to understand how this threat

Figure 3. Multifrequency RF Vehicle-Stopper (RFVS) System

is evolving and properly address it during the design of their systems. They also need to address DE in the development of their system threat assessments. There has been movement on the HPM side to modify existing military standards, such as MIL STD 464[1] and others, to now include information on potential HPM threats. For example, in the HEL arena, work has been accomplished in the development of protective measures for eyes; however, this threat needs to be considered during the system development process. It is well known that building in countermeasures is much cheaper during the initial development of a system, vice trying to retrofit systems with countermeasures once a new threat is on the battlefield. As analysts evaluate the foreign development of DE technologies, and the trends become clearer, it is the responsibility of the acquisition community to take this threat into consideration and ensure that weapon systems, platforms, and infrastructures will be available and at full capability when needed. By accounting for foreign threat developments, assessing blue force susceptibilities and vulnerabilities, and adopting appropriate measures to negate or counter these threats, naval forces will avoid technological surprise on the battlefield in the future.

Requirements

The DE programs briefly mentioned in this article, and covered more deeply in this and other publications, offer warfighters unique capabilities not currently found in their arsenal. The continuing problem, however, is matching those unique capabilities to vetted operational requirements. The DE technical community has made great strides in helping the operational community understand the capabilities of DE weapons and their potential military effects on targets. The lack of formal requirements, however, has yielded more of a technology push—rather than an operational pull—of various DE capabilities. Progress has been made, but more effort is required if DE capabilities are to be developed and transitioned between science and technology (S&T), and formal programs of record. Notwithstanding, the current outlook and trends are positive.

A Resurgence of Navy Interest in Directed Energy

The Navy's interest in DEWs for future maritime operations has increased in recent years due to a number of weapons development successes. Recognizing the importance and value of DEWs, NAVSEA reestablished the Navy Directed Energy Weapons Program Office (PMS 405) in 2004. Accordingly, PMS 405 was designated as the point of contact for matters related to DE and electric weapon systems (EWS) development and acquisition initiation for NAVSEA, and for matters being coordinated with other federal agencies and military services. PMS 405's mission is to transition technology from the laboratory to prototype/advanced development/testing for operational development and use.[2, 3]

The Navy also established its first formal executive position for DE (ST-level), the Navy's Distinguished Engineer/Scientist for Directed Energy, at NSWCDD in August 2004. Following the establishment of this position, NAVSEA then formally established a Technical Authority Warrant for Directed Energy and Electric Weapon Systems (DE&EWS)—Surface Ships in July 2008. The scope of the warrant includes the transition of S&T development to weapon system development of lethal and nonlethal capabilities associated with the DE&EWS for Surface Ships.[4] This included, but was not limited to, the following:

- Laser Weapon Systems
  - High-Energy Lasers
  - Solid-State Lasers
  - Free-Electron Lasers
  - Femtosecond Ultrashort Pulse Lasers
  - Laser-Induced Plasma Channel
  - Lethality/Vulnerability
- Electromagnetic Rail Gun Weapon System
- High-Power Microwave
  - Active Denial System
  - Laser-Guided Energy
- Maritime Directed Energy Test Center
- Electromagnetic Launch of Weapons (excluding the Electromagnetic Aircraft Launch System (EMALS))

Then, within the NAVSEA Warfare Center Enterprise, Warfare Center leadership established two technical capabilities (TCs): an NSWCDD TC for DE systems research, development, test, and evaluation (RDT&E); and a Naval Surface Warfare Center, Port Hueneme Division (NSWCPHD) TC for in-service engineering, test and evaluation (T&E), and integrated logistics support to DE systems. NSWCDD leads all S&T and RDT&E for the development and weaponization of DE systems for surface, air, and ground environments. It also leads the development of offensive and defensive DE technologies needed to characterize and exploit vulnerabilities, provide weapons, and protect against attack. NSWCDD provides the technologies, devices, and systems designed to create or control electromagnetic energy used to cause persistent disruption or permanent damage by attacking target materials,

electronics, optics, antennas, sensors, arrays, and personnel, including nonlethal applications. NSWCPHD provides in-service engineering, T&E, and integrated logistics support to DE systems throughout the system life cycle.

The Navy further demonstrated increased interest in DE when Assistant Secretary of the Navy (Research, Development & Acquisition (ASN(RDA)) designated NAVAIR offensive and defensive leads for naval aviation DE activities:

- Program Executive Officer for Unmanned Aviation and Strike Weapons (PEO(U&W)), assigned as the offensive DE lead for naval aviation
- PEO for Tactical Aircraft Programs (T), assigned as the defensive lead for naval aviation

Concerning future initiatives, the Chief of Naval Operations (CNO) tasked the Strategic Studies Group (SSG) to examine a topic entitled "Maritime Operations in the Age of Hypersonic and Directed-Energy Weapons."[5] The intent of the study was to provide Navy leadership with an understanding of where DE technologies and weapons are today and how they might influence future maritime operations. The theme of the study was completed during FY10, the results of which discuss many DE concepts, as well as tactics for the employment of DE capabilities. The study's findings are currently under review and consideration by senior Navy leadership.

Conclusion

While H.G. Wells' *The War of the Worlds* novel and television programs like *Star Trek* popularized the notion of using DE for weapons in years past, today— through persistent DEW RDT&E— Navy leadership is realizing the great potential that DEWs offer naval warfighters and homeland defenders. The scientific and technical advances the Navy has made in HEL and HPM in recent years have been nothing short of extraordinary. Moreover, future technological and engineering advances undoubtedly will result in profound differences in our nation's future warfighting capabilities. Naval DEWs, therefore, are no longer just a future weapon concept…they are here today.

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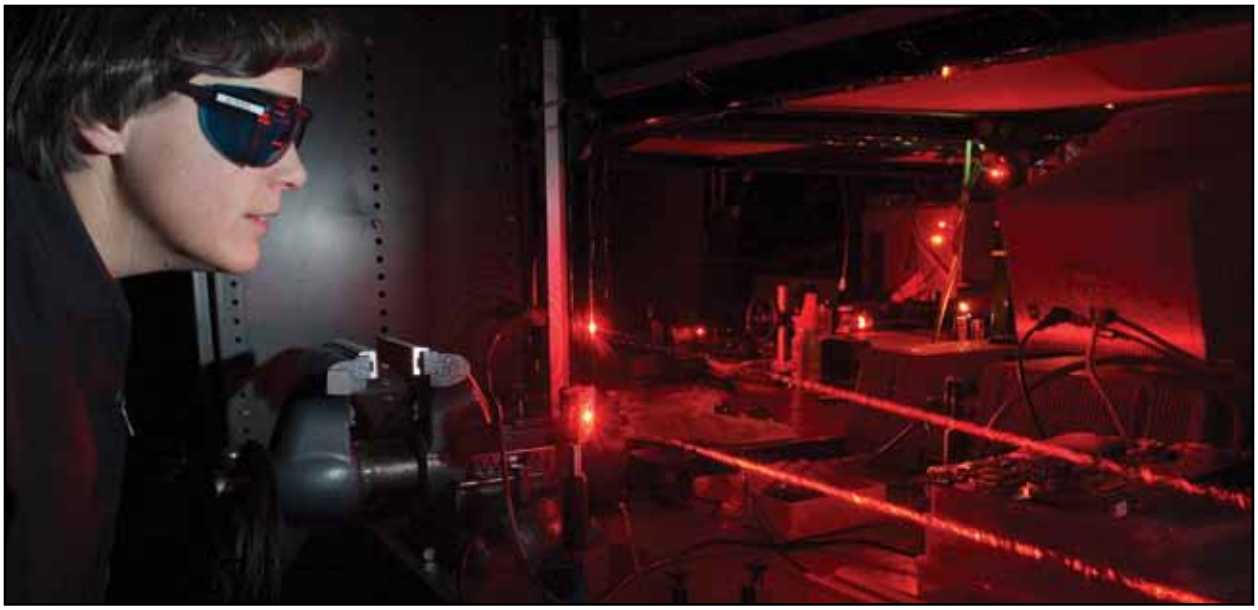

Historical Overview of Directed-Energy Work at Dahlgren

By Stuart Moran

In 1962, the United States set off a megaton nuclear weapon 250 miles above the Pacific. The blast caused a large imbalance of electrons in the upper atmosphere that interacted with the Earth's magnetic field to create oscillating electric fields over a large area of the Pacific. These fields were strong enough to damage electronics in Hawaii, a thousand miles away, and clearly demonstrated the effects of an electromagnetic pulse (EMP). It didn't take long for the military to begin considering ways to create such pulses without using nuclear weapons.

In the late 1960s, the Special Applications Branch at the Naval Weapons Laboratory at Dahlgren began studying ways to generate high-power oscillating electric fields that could be used as a weapon to damage enemy electronics. These devices were basically high-power versions of the old spark-gap transmitters used in the early days of radio. To construct a device that could produce nuclear EMP-like fields, stored electrical energy was converted to radio-frequency (RF) energy that could be radiated from an antenna through the atmosphere to a target. These devices typically would store energy in a high-voltage capacitor and release the energy quickly using a spark-gap switch. This would then drive oscillating currents on an antenna, causing it to radiate. To achieve field strengths of thousands of volts per meter, typical of a nuclear EMP, devices operating at hundreds of thousands of volts or more were needed.

A number of radiating devices were studied in the early 1970s. Most belonged to a class of devices called Hertzian oscillators. A capacitor is charged to high voltage, the switch is closed, and current flows in the circuit, causing the stored energy to oscillate between the electric field of the capacitor and the magnetic field of the inductor. To charge the capacitor to extremely high voltages, a step-up transformer of some type must be used. One of the fastest voltage multipliers, the Marx generator, was frequently used. The losses from internal resistance and external radiation damp the oscillating waveform, typically after a few cycles. The radiated pulses are, therefore, short in time and broad in frequency content.[1] A simple diagram of the inductance-capacitance oscillator (L-C oscillator) is shown in Figure 1.

Single-Pulse Burnout Devices

Many types of Hertzian devices were designed, constructed, and tested at Dahlgren during the 1970s. The transmission-line oscillator, or cavity oscillator, used a quarter-wavelength

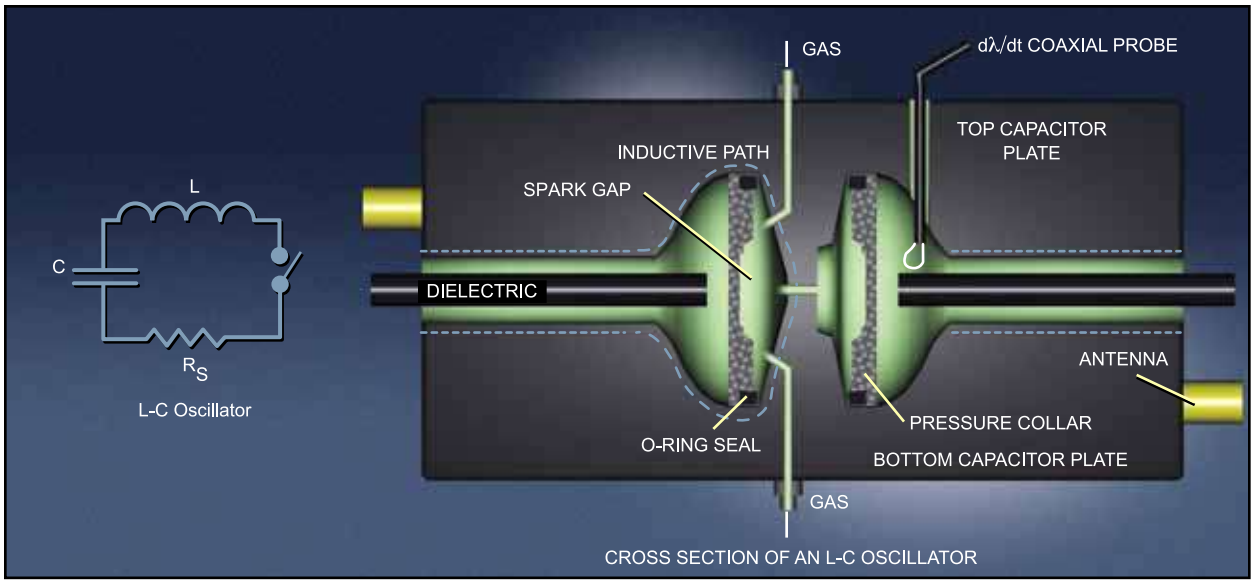

Figure 1. Inductance-Capacitance Oscillator (L-C Oscillator) Diagram

coaxial pipe, which was switched at one end, to create the oscillating waveform. A frozen wave generator, a different type, had quarter-wave sections of cable that were charged plus and minus to create a two-cycle waveform "frozen" in the cable. All sections were simultaneously switched, causing the wave to travel to an antenna. A special folded design was developed so one switch could be used, eliminating the multiswitch synchronization problem. A Ross circuit used a square wave pulse, which traveled down cable "tees," creating reflections, which were timed to create several RF cycles. In the Travetron, the turn-on time of a series of spark-gap switches was incorporated as a designed delay, creating reflections through a series of gaps to produce the waveform. This design allowed higher frequencies. All of these devices were designed, built, and tested to determine power and frequency capabilities, as well as efficiency.

Scientists and engineers at Dahlgren built and tested versions of Hertzian oscillators operating up to half a million volts. These devices powered relatively simple monopole or dipole antennas that could produce very high electric fields at hundreds of meters. In the early 1970s, a special outdoor field-measurement range was constructed. It housed high-voltage systems in underground trailers that fed antennas above ground on a specially-built, 100-m-long ground plane that was constructed for testing and field measurements. A picture of the ground place in a fielded measurement range is shown in Figure 2. Field probes were even carried aboard helicopters to make measurements above ground effects, as shown in Figure 3.

Other types of devices to produce pulses were constructed, too. Vector inversion generators used spiral-wound capacitive plates to generate high voltages without transformers.[2,3] The Landecker ring used a paddle-wheel arrangement of capacitors and inductors charged in parallel and discharged in series. The circular arrangement was designed so the entire system would radiate as a magnetic dipole, thus forming its own antenna.[4] Switch timing was critical, and Dahlgren engineers attempted to verify reports that Landecker developed a specific type that brought all capacitor leads into a single-center spark gap.

Scientists and engineers also looked at devices that used explosives to generate the electrical energy needed. These included explosive flux compressors of several types, which generated fields and then explosively squeezed the fields between conductors to amplify the peak power. In the early 1970s, a large (70-ft clear zone) anechoic chamber was constructed at Dahlgren with an explosive chamber in one end. Explosives would be set off in the chamber to drive various types of flux compressor schemes that would generate electrical pulses fed into an oscillator and antenna in the anechoic chamber. Pulse parameters and field strengths could be measured. Impedance-matching networks, matching transformers, and methods of improving efficiency were studied. Tests were performed at Dahlgren and at Los Alamos using large antennas suspended from balloons.[5] In other schemes, piezoelectric devices were developed, which could be compressed hydraulically and then quickly released to produce high voltages. The concept was to use explosives to generate the high

Figure 2. Field Measurement Range

Figure 3. Airborne Electric Field Measurements

pressures. Ferroelectric and ferromagnetic transducers driven by explosives were also tested.[6]

Special Effects Warhead (SEW) Program

In 1973, Dahlgren began the SEW Program to look at the feasibility of "burning out" enemy radar and missile systems using single-shot, very high-peak-power EMPs. The program looked at the feasibility of constructing an electromagnetic warhead that could disable electronics beyond a normal hard-kill explosive range as far as a mile away. The program was funded at several million dollars a year through most of the 1970s.

A major thrust of the SEW Program was to better understand the effects of high fields on military electronics. Little information was available on the vulnerability of foreign or U.S. electronics, particularly entire systems. A trailer-based RF impulse system, employing a Marx-driven L-C oscillator charged at two million volts, was constructed at Dahlgren. This Transportable Oscillating Pulser System (TOPS) was connected to a large bounded-wave structure that produced uniform fields over a region large enough to place an entire radar or missile system. The electric field emitted from the throat of this system was so high that a special bag of high-voltage gas was needed until the radiating structure became large enough to transition to the normal atmosphere. A picture of TOPS is shown in Figure 4.

Since many important target systems were not available for testing, much of the vulnerability information was obtained from U.S. electronics, and estimates were then made for foreign systems. In addition to the tests done at Dahlgren, pulsers were also constructed in mobile trailers that could be transported to other sites for testing against simulated or actual targets. The Mobile Oscillating Pulser System (MOPS) was an example that was carried to test sites, such as China Lake, to perform tests against radars and simulated foreign systems.

A key requirement for the SEW Program was to demonstrate enforceable target vulnerability, which means that a high percentage of the time a large percentage of the targets are affected. One important finding was the broad difference between an electromagnetic safety concern—where a 1 percent vulnerability was far too great—and a weapon concern—where a 10 percent vulnerability was not good enough. The field strengths between the safety requirements and weapon requirements often were many orders of magnitude apart.

The SEW Program looked at many types of electronic component vulnerability, subsystem vulnerability, and complete system vulnerability. As a result, energy tables for burnout effects were developed. Subsequently, Dahlgren performed numerous field tests against radar and communications systems between 1973 and 1978, and funded component and subsystem testing on missiles.

Figure 4. Transportable Oscillating Pulser System (TOPS)

Repetitive Systems for Electronic Warfare

The electric fields required to damage military electronics in the 1970s often were very high, and ranges typically were limited. As a spinoff of programs trying to damage targets with a single pulse, some of these devices were reduced in size and power, and operated in a repetitive mode to generate noise pulses for the purpose of electronically jamming target systems. In 1976, the Naval Air Systems Command (NAVAIR) began the Electromagnetic Countermeasures Program to study the application of high-repetition-rate Hertzian devices for use as noise jammers. The initial targets were low-frequency radars.

In late 1976, Dahlgren performed effectiveness tests against various radars using helicopter-mounted Hertzian jammers. These devices were able to screen incoming target aircraft at useful ranges. The concept of a forward-launched rocket to deliver a parachute-suspended Hertzian jammer also was investigated. Dahlgren teamed with engineers at China Lake to study packaging concepts of utilizing an extended 5-inch Zuni rocket as a forward-fired delivery vehicle. A prototype is shown in Figure 5.

Similar Hertzian devices were considered for use as communications and data-link jammers. Several antenna deployment schemes were developed, and by fall 1978, successful ground launches had been performed in which the deployment sequence and jammer operation were demonstrated. The name Zuni Expendable Pulsed-Power Oscillator (ZEPPO) was given to the project. Dahlgren teamed with the Naval Avionics Center (NAC) to build the systems. By 1980, China Lake fired the first air-launched prototypes at both low and high altitudes. Devices, batteries, spark gaps, and antennas continued to be developed, and new targets—such as spread-spectrum systems—were tested. Other delivery systems besides rockets were also considered.

Figure 5. ZEPPO Payload

The Pulsed Power Technology Program

Large directed-energy weapons (DEWs) often required megawatts or gigawatts of peak power, so methods of supplying and modifying this power were needed. As Dahlgren became involved in a broad range of DEW systems, one attribute became more and more obvious: the size, weight, and cost of a directed-energy (DE) system were dominated by the pulsed-power technologies needed to drive the system, not by the source device itself. Consequently, more effort began to be devoted to the power-delivery technologies needed for many of the weapon concepts. Pulsed-power components enabled energy to be stored over long periods of time (seconds) and released very quickly (nanoseconds) to obtain a billion times increase in peak power.

Dahlgren hosted a pulsed-power systems symposium and workshop in 1976 and helped initiate the International Pulsed Power Conferences, which began in 1977 and continues today under the Institute of Electrical and Electronics Engineers (IEEE). As Dahlgren's involvement with systems design increased, it became apparent that new technologies were needed in the prime-power and pulsed-power area to support a variety of new concepts. Dahlgren urged the Navy to initiate a Pulsed Power Technology Program to develop power sources, energy storage systems, high-power switches, and power conditioning systems needed for a variety of future weapons. This program was initiated in 1978 and was originally funded by NAVAIR and then by the Directed Energy Program Office (PMS 405) in the early 1980s. In addition to the Pulsed Power Technology Program, PMS 405 also began funding free-electron lasers (FELs), chemical lasers, high-power microwaves (HPMs), and charged-particle beams (CPBs). The Pulsed Power Technology Program at Dahlgren, in turn, funded many areas of research, both internal and external, over the next 10 years. Dahlgren served as the focal point for the Navy's science and technology (S&T) in pulsed power and funded many universities, government laboratories, and commercial companies under the Pulsed Power Technology Program.

To provide large amounts of electrical prime power, new types of rotating machines were studied, including flywheels, conventional alternators, homopolar generators, rotary flux compressors, and compensated pulsed alternators. These machines attempted to produce fast, high-power pulses using special materials to reduce losses, eddy currents, and mechanical stresses. MHD generators were developed using rocket-motor propellant that could be started and stopped. In the mid-1980s, a full-scale hybrid (solid fuel/liquid oxidizer) combustor was fabricated and tested at 10 MW, achieving world records for power-to-weight ratio and conductivity. By 1980, new types of energy storage systems were studied, including inductive storage and advanced capacitors using new types of insulating materials and geometries. During the late 1980s, programs such as the Mile-Run Capacitor Program reduced the capacitor size by a factor of 10 through better synthesis of polymer films.

Beginning with internal independent research funds, Dahlgren developed liquid dielectric materials based on water/glycol mixtures at low temperatures. These water-capacitor devices could hold energy for orders-of-magnitude longer time periods than ever before, allowing pulseforming lines to be constructed that could be charged directly from rotating machines. Dahlgren scientists developed a world-record high-voltage water capacitor that could hold pulses for milliseconds and became internationally recognized experts in water breakdown.[7,8]

High-power fast switching was another important area of research. Dahlgren funded companies to develop new types of multistage thyratrons that could operate at very high voltages. By the early 1980s, multistage thyratrons capable of operating at over 200 kV, 40 kA with 20 nsec risetimes were demonstrated. Vacuum switches, ignitrons, plasma pinch switches, pseudospark switches, back-lighted thyratrons, and e-beam switches all were studied, as well as a variety of spark-gap switches. Higher power solid-state switches were developed, too, using new geometries and substrate material. Superconducting coils were considered, both for energy storage and as opening switches. Dahlgren engineers developed exploding-wire opening switches, and several types of plasma pinch switches were funded. They also worked on stacked cable pulsers. Additionally, concepts for electromagnetic armor were developed. These systems used high-density capacitors to blunt penetrators. Inductive energy storage—which could be far denser than capacitors—was studied, including methods of generating the seed current and the problematic high-voltage opening switch. Opening switches—which were needed for inductive energy store systems—were studied, as well as magnetic switches, which used saturating magnetic material to sharpen pulses. Magnetic switches operating at 10 kHz were demonstrated by 1983.[9]

In 1985, Dahlgren used internal funds to upgrade a facility to provide controls, diagnostics, and 200 kW of average power at 50 kV to accommodate testing of new switches and water-based capacitors. This facility could control the power with a vacuum-tube pulser and could generate over a million volts with a rep-rated Marx generator. The facility was used to:

- Develop water-dielectric energy storage, rep-rated spark gaps, and pseudospark switches.
- Test a variety of switches developed by contractors, such as back-lighted thyratrons.[10,11]

A picture of one system being tested—a water pulse-forming line and spark-gap switch—is shown in Figure 6.

Dahlgren concentrated in-house switching efforts in spark gaps. New types of gases were studied, as well as electrode materials, gas-flows, switch geometries, and triggering techniques to produce high-repetition-rate switches for electronic warfare, as well as particle-beam weapons.[12] Dahlgren scientists and engineers demonstrated 100-μs recovery of spark-gap switches after handling kilojoules of energy at hundreds of kilovolts, a world record.[13] The High Energy 2-Pulse System for fast recovery experiment is shown in Figure 7.

In 1986, Dahlgren ran a workshop on high-power switching for Navy tactical and Department of Defense (DoD) strategic applications and became involved with numerous DoD working groups on electromagnetic propulsion, high-power diagnostics, advanced energy conversion, power modulators, and pulsed power. Spark gaps were investigated to create underwater noise for submarines. Dahlgren also led four North Atlantic Treaty Organization (NATO) Advanced Study Institutes in Europe and the UK on various pulsed-power topics. International assessments of key pulsed-power technologies were also performed.

Particle-Beam Weapons

Particle-beam weapons were a major focus of DE work during the 1970s and 1980s. A CPB weapon takes subatomic particles, generally electrons, and accelerates them to near the speed of light before sending them toward a target. These fast electrons penetrate deeply into most materials, so they are difficult to counter. The high-current electron beam was to be accelerated by an induction-type

Figure 6. A Water Pulse-Forming Line and Spark-Gap Switch Test

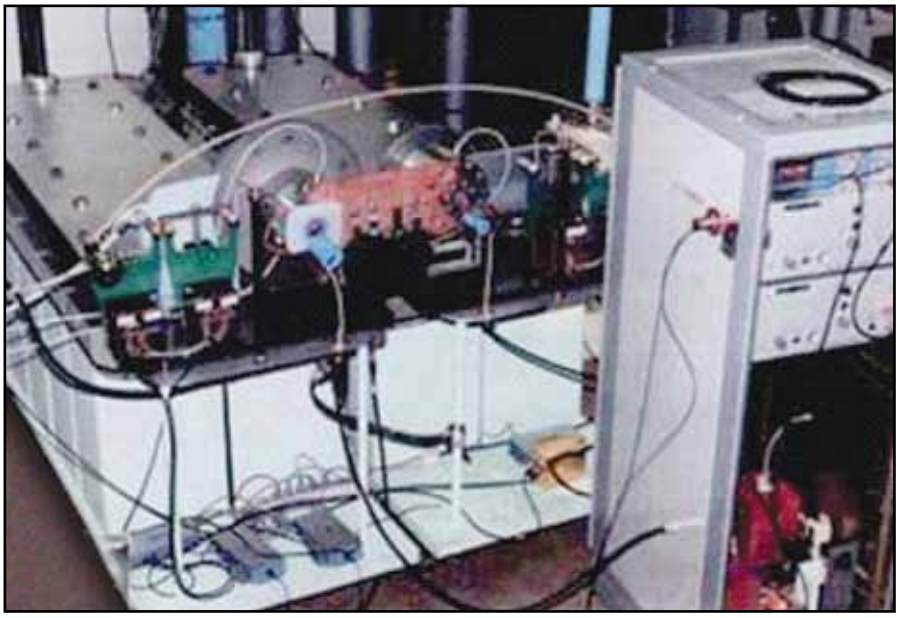

Figure 7. High Energy 2-Pulse System

accelerator, repetitively pulsed. High electron-beam currents (kiloamps) and a hole-boring series of pulses were anticipated to create a stable, long-range beam. Since the beam was capable of penetrating quickly and deeply into any target material, it had the potential to damage electronics and set off explosives before salvage fuzing could occur. The beam was predicted to be all-weather and essentially countermeasure-proof. Even a near miss could cause substantial damage from high fields and X-rays produced by the deceleration of electrons as they hit air molecules near the target. The CPB concept is shown in Figure 8.

Scientists and engineers from Dahlgren worked on the pulsed-power technologies needed to drive these machines beginning in 1980, and it became a major focus of the Pulsed Power Technology Program.[14] The White Oak Laboratory developed beam-steering concepts and looked at material interactions. By 1989, the program investigated:

- Propagation
- Compact Recirculating Accelerators
- Pointing and Tracking
- Prime Power
- Material Interaction
- Fratricide

For a compact shipboard system, recirculating accelerators were needed to make multiple passes of the electron beam past the accelerating cavities. This required a high-power, fast recovery switch, which Dahlgren began working on in 1988. Using patented hydrogen switches and special triggering techniques—efforts that had begun with internal research funds—Dahlgren demonstrated spark-gap switches, the only technology that could meet the current, voltage, and recovery requirements at that time.[15] The High-Voltage 5-Pulse System experiment is shown in Figure 9.

During these technology efforts, significant advances were achieved in all aspects of the program. These included:

- Generating high-current, high-energy beams (although still below weapons parameters)
- Demonstrating a 360º turn in a high-current beam
- Propagating a single pulse through the air
- Demonstrating beam steering on a small scale
- Performing target interaction measurements

Multipulse, long-range propagation was never demonstrated. A comprehensive tri-service summary called the Net Technical Assessment for CPB was sponsored by the Defense Advanced Research Projects Agency (DARPA) in 1987 to describe the accomplishments of the program. The report said compact accelerators were the most pressing technology need. As a result, most funding was directed toward this topic. Funding was stopped in the early 1990s, however, due to the high expense, stretched timelines, and changes in the threat.

Pulsed Power and Electromagnetic Launchers

During the 1980s, the Army and Air Force looked at short-range electromagnetic weapons to penetrate stronger armor with higher velocities. The Navy worked on concepts for a weapon that could be mounted on ships to intercept missile systems at line-of-sight distances. The Navy—then the biggest user of space systems—was also interested in studies showing that small satellites could

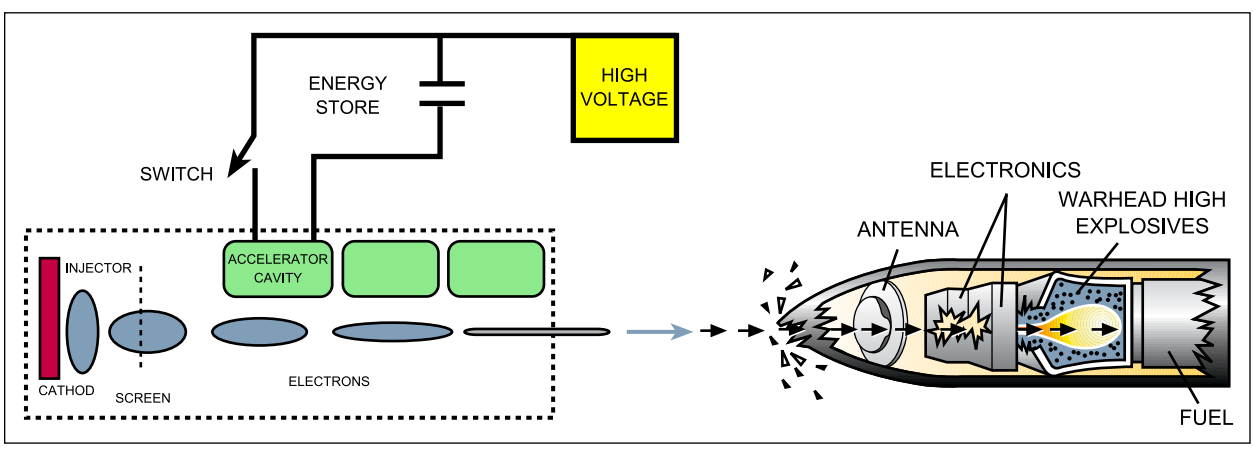

Figure 8. Charged-Particle Beam (CPB) Concept

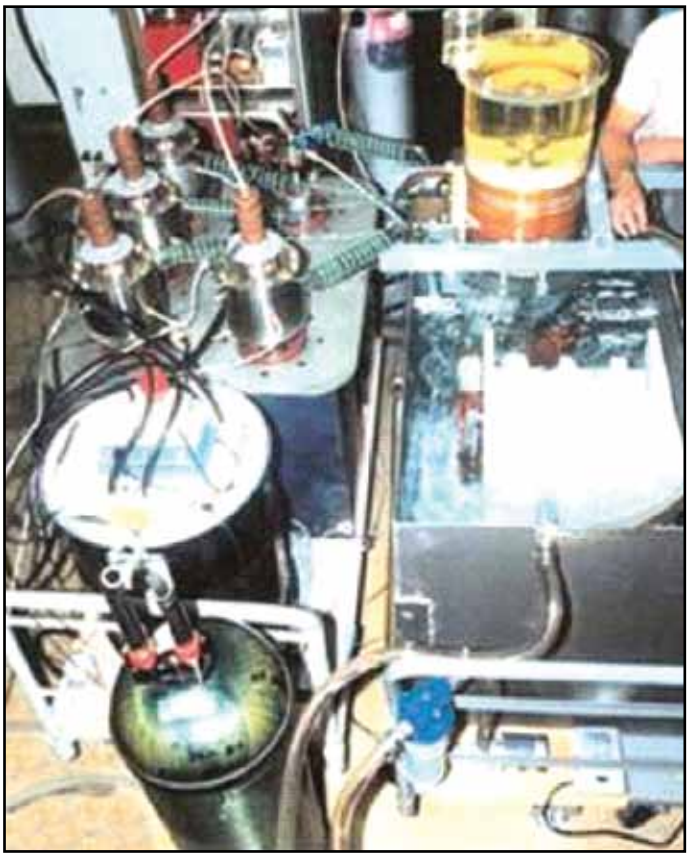

Figure 9. High-Voltage 5-Pulse System Experiment

be electromagnetically launched into low Earth orbit for the fraction of the cost for a normal launch.

Through the 1980s, electric guns were funded by independent research and independent exploratory development programs at Dahlgren, studying electric gun concepts for both rail guns and electrothermal (ET) guns. Kinetic energy weapons were also investigated as part of the Pulsed Power Technology Program. Under these programs, pure electric launchers were developed and tested at Dahlgren, including ones that self-formed projectiles.[16–18] Also studied were ET guns that used the discharge of electrical energy at the gun breech to generate a plasma jet. This plasma jet heated a low-molecular-weight working fluid, such as water, to produce a heated gas that accelerated the projectile to higher velocities than conventional explosives. The Electrothermal-Chemical (ETC) Gun concept augmented the electrical energy generating the plasma jet with a chemical reaction. A 127mm ETC gun was investigated, and a 60mm ETC gun was tested at Dahlgren, with the ability to fire short bursts at a rate of 100 rounds per minute.[19]

Early Dahlgren work on electromagnetic launchers—along with capacitor development and switch advances from the Pulsed Power Technology Program—allowed Dahlgren to provide the Navy with detailed conceptual designs in the late 1990s for near-term, long-range rail guns based on capacitor energy store. These efforts helped support the decision to begin a long-range rail-gun program at Dahlgren that continues today, resulting in world-record achievements. Capital investment funds were used to construct a high-energy facility in 2005 to test pulsed-power components and module designs for use in electromagnetic launcher programs. An early electromagnetic launcher is shown in Figure 10.

High-Energy Lasers (HELs)

In general, megawatts of continuous laser power are required to kill hard targets at long ranges. Laser technologies that can produce this much power are very limited. The Navy was a leader in developing powerful chemical lasers in the 1970s and 80s. These lasers burned chemical reactants to

Figure 10. Early Electromagnetic Launcher at Dahlgren

generate the excited states for lasing, thus reducing the need for large amounts of electrical power. The Navy built an entire HEL system, including the Mid-Infrared Advanced Chemical Laser (MIRACL) and the Sea-Lite beam director. By 1990, this building-sized system demonstrated shooting boosters, missiles in flight, and supersonic vehicles. However, the system had drawbacks because it:

- Used hazardous, expensive chemicals
- Had propagation problems at the mid-infrared wavelength
- Was large in size and high in cost

FELs require electron accelerators similar to CPB weapons, so they also are large and complex. However, they can be designed to operate at optimum wavelengths and scale nicely to higher powers. The Strategic Defense Initiative began working on FELs in the late 1980s, funding the advanced test accelerator at LLNL, originally developed for CPBs. FELs were also studied under the Strategic Defense Initiative Organization (SDIO) to be used as an antisatellite weapon. These lasers went from milliwatts to watts under SDIO, and then to kilowatts more recently with work at the Thomas Jefferson National Accelerator Facility in Virginia. Space-based lasers and relay mirror systems were studied under SDIO funding, too, including the development of the Advanced Beam Control System for beam steering, beam control, rapid optical retargeting, and self-alignment.

Dahlgren engineers concentrated its internal laser efforts on medium-power soft-kill weapons. They performed tests against sensors and cameras, and investigated damage thresholds. In the late 1980s, Dahlgren engineers worked with optical augmentation to locate enemy optics for targeting and on green laser dazzlers for defense against small-boat attack. There were efforts to harden electro-optical equipment, including sights and night-vision systems for the Marines, and laser eye-protection filters for goggles and binoculars. Laser systems were also investigated for remotely cutting holes and wires to disable electronics. Lethality work continued under funding from the Joint Technology Office for High-Energy Lasers to look at alternative wavelengths and pulse shapes in addition to modern target materials.[20]

Dahlgren scientists continued to investigate laser-damage thresholds for materials, components, and subsystems for a variety of laser technologies. Near the start of the 21st century,

commercial lasers based on pumping optical fibers with semiconductor lasers became common and more powerful. Dahlgren purchased the Navy's largest collection of fiber lasers in 2004 and began investigating ways to combine multiple beams into a laser weapon. These lasers have very high efficiencies, above 20 percent, and the fiber-optic output reduces the requirement for complex optical paths. In 2008, Dahlgren engineers demonstrated a laser capability to ignite spinning mortar rounds, and in 2009, engineers demonstrated the capability of fiber lasers in a shoot down of soft targets at China Lake, California.

Resurgence of Directed Energy

With the fall of the Soviet Union and a greatly altered threat, DoD funding (particularly technology funding) experienced an overall decline in the late 1980s and early 1990s. This caused Navy managers to emphasize near-term, lower risk, evolutionary concepts. The Pulsed Power Technology Program and the Navy's Charged Particle Beam Program both came to an end. Investigations into HPM weapons declined as the difficulty of burnout of military electronics—particularly analog components—became apparent. Problems with propagation and cost caused the Navy to greatly reduce efforts on chemical lasers. With the cancellation of major programs, Dahlgren used internal funding in 1990 to keep a core technical capability together, which was necessary for the Center to remain in the mainstream of tactical DE and its associated technologies. Efforts continued in water breakdown, testing of contractor-developed pulsed-power components, and electric guns. New talent and technologies from universities were brought in to jump-start new projects. Tunable waveform generators using unique semiconductor materials were developed. These used bulk semiconductor material, fabricated in-house, that could be used as a fast switch controlled by laser light for both on and off operation. This allowed faster repetition rates and better triggering than could be done with small spark gaps, as well as the ability to create specific waveforms.[21] "Green" technologies were also investigated using nonthermal plasmas and spark-gap shock waves for cleaning and pollution reduction.[22] New types of particle detectors and magnetic field sensors were developed, and new methods of infrastructure protection were investigated.[23] Soft-kill weapons, both optical and HPM, continued to be studied. Short-pulse jamming of spread-spectrum systems was investigated, as well as beat-wave coupling and special waveforms.[24]

A number of trends led to a resurgence of DEWs by the end of the 20th century. The DoD trend in using digital electronics and off-the-shelf commercial technologies increased dramatically. The pace of change in electronics and computers changed rapidly, too. Most of these new electronic systems had never been tested for vulnerability, and there was a question of how much they would increase military vulnerability to RF or HPM attack. The reduced emphasis on nuclear EMP shielding meant more military electronics were not as well protected from RF attack. Consequently, interest in protecting U.S. military and civilian infrastructure increased, including systems in foreign countries. Moreover, with the increasing reliance on civilian infrastructure, such as power, communications, and emergency and industrial systems—all of which were controlled by digital electronics—the potential that an adversary could attack infrastructure systems to affect or divert military operations became an increasing concern. Following several major terrorist attacks during this time period, there was also concern about the impact of an RF attack on airport towers, financial systems, alarm systems, and industrial plants. Human factors—such as a state of confusion experienced by humans—also played an important part in determining the overall effects of an RF attack.

The asymmetric threat—where large numbers of cheap weapons in a swarm attack could overrun a few sophisticated weapons—caused more concern. As the asymmetric threat to the surface Navy pushed the limits of conventional defensive systems, DE—with it speed-of-light propagation, soft-kill potential, and cheap rounds—offered tactical advantages, either as an adjunct to conventional systems or as stand-alone systems. Additionally, there was an increased emphasis on nonlethal, precise accuracy and graduated effects that could be used. Moreover, the idea that future battles would be fought together with civilians and friendly forces on the battlefield increased the importance of low collateral damage and antimateriel attacks.

The Joint Program Office for Special Technology Countermeasures (JPO/STC), located at Dahlgren, began efforts concerning the vulnerability of new digital systems to RF attack. The program also established a DoD-wide database of vulnerability data, source designs, and RF-effects information—bringing together much of the information collected by the services over the years. The program looked at the protection of modern digital infrastructure systems and funded a facility constructed in 1992 to test large-scale electromagnetic vulnerabilities to various methods of attack.

In the late 1990s and early 2000s, Dahlgren initiated programs regarding the potential for RF attack using nonkinetic disruption, with minimal collateral damage. Capital investment funds were used to construct a test facility for this effort in 1998. Dahlgren developed RF payloads for remotely piloted vehicles and demonstrated their effectiveness in field tests in 1999, and in similar tests in 2007. The successful completion of Project Guillotine was DoD's first demonstration of this type of HPM technology. As the need for statistical vulnerability to commercial digital systems became apparent, Dahlgren constructed instrumented test facilities in 1999 and 2002. Two multistory buildings could be reconfigured to reflect different types of building construction and electromagnetic shielding. Large complexes of electronics, computer networks, server systems, telephone systems, security systems, and various types of digital industrial controls could be assembled, instrumented and exposed to attack from an external device or technique. This program-funded complex—called the Maginot Open Air Test Site (MOATS) facility—continues to be used to test target systems, as well as a variety of RF weapon technologies developed internally and by external and international organizations. A picture of the MOATS facility is shown in Figure 11.

As the need for additional DE laboratory space and testing capabilities became apparent, Dahlgren applied for military construction funds, and in 2008, constructed the Naval Directed Energy Center (NDEC), with access to Dahlgren's overwater test range. Other construction funds were used to construct a remote facility at the Pumpkin Neck Explosive Test Range to serve as a laser backstop and measurement facility, as well as an explosive-test staging area. These facilities already have been used to develop and test fiber lasers against modern threat targets. Construction is currently underway to build an expansion of the NDEC and a 120-m laser test laboratory building using an existing tunnel structure. This collection of facilities represents very important capabilities to develop and test future DE systems.

Conclusion

For over 40 years, the Naval Surface Warfare Center, Dahlgren Division (NSWCDD) has been a leader in developing DE devices, pulsed-power systems, and electric weapons. Its people have contributed many publications and patents, and set world records. DEWs tend to be complex and technically challenging to build. Regardless, these weapons offer important, powerful advantages, such as:

- Deep Magazines
- Cheap Rounds
- Fast Targeting
- Variable Lethality
- Pinpoint Targeting

As a result of NSWCDD's leadership, persistent scientific initiatives, and leading-edge engineering

Figure 11. MOATS Facility Undergoing Testing with an RF Weapon (on right)

over the years, naval warfighters will increasingly find themselves turning to DEWs when dealing with situations spanning the spectrum of conflict.

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History of Laser Weapon Research

By Melissa Olson

The idea of using light as a weapon can be traced back to Hippocrates, commander of the Greek forces in 212 B.C. His forces supposedly set fire to the sails of the Roman fleet by focusing sunlight with mirrors. Weapons systems based on lasers and "ray guns," long a staple of science fiction, have captured the imagination of people everywhere. But with steady progress toward the development of lasers in the last 40 years, viable, state-of-the-art laser weapon systems have now become a reality.

The production of lasers in the modern scientific world is fairly new. The first laser was developed in the 1960s and represented the beginning of a drastic change in how the military viewed warfare. The late 1970s and 1980s, too, marked a busy time period for developing lasers into possible weapon systems. All branches of the military and industry were striving to master high power levels, beam control, and adaptive optics. In 1999, the Department of Defense (DoD) formally recognized lasers as future weapons and began research and development (R&D). In 2000, the Joint Technology Office for High Energy Lasers was formed to bring all laser technologies together to develop a complete laser weapon system that could be used by the warfighter.

Electromagnetic Spectrum

The electromagnetic spectrum contains all the types of electromagnetic energy, including radio waves, microwaves, infrared, visible light, ultraviolet, and gamma rays. ***Laser*** is an acronym for "light amplification by stimulated emission of radiation." Light, therefore, is a type of electromagnetic radiation. Light is made up of tiny packets of energy called photons. The amount of energy is what determines the wavelength. Lasers are usually infrared (1 mm to 750 nm) and visible light (750- to 400-nm wavelength). Microwaves are mostly high-frequency radio waves (millimeters to centimeters), with wavelengths 10,000 times longer than lasers. Diffraction of any electromagnetic radiation beam is based on the wavelength and aperture size. For the same aperture size, lasers diffract 10,000 times less than microwaves. This allows the beam to reach farther ranges while maintaining a small spot size of concentrated energy on the target. Lasers are preferred in specific scenarios because of minimal diffraction. The electromagnetic spectrum is shown in Figure 1.

Laser Fundamentals

The quantum mechanical idea of stimulated emission of light was discovered by Albert Einstein in 1917 and is one of the fundamental ideas behind the laser. Einstein

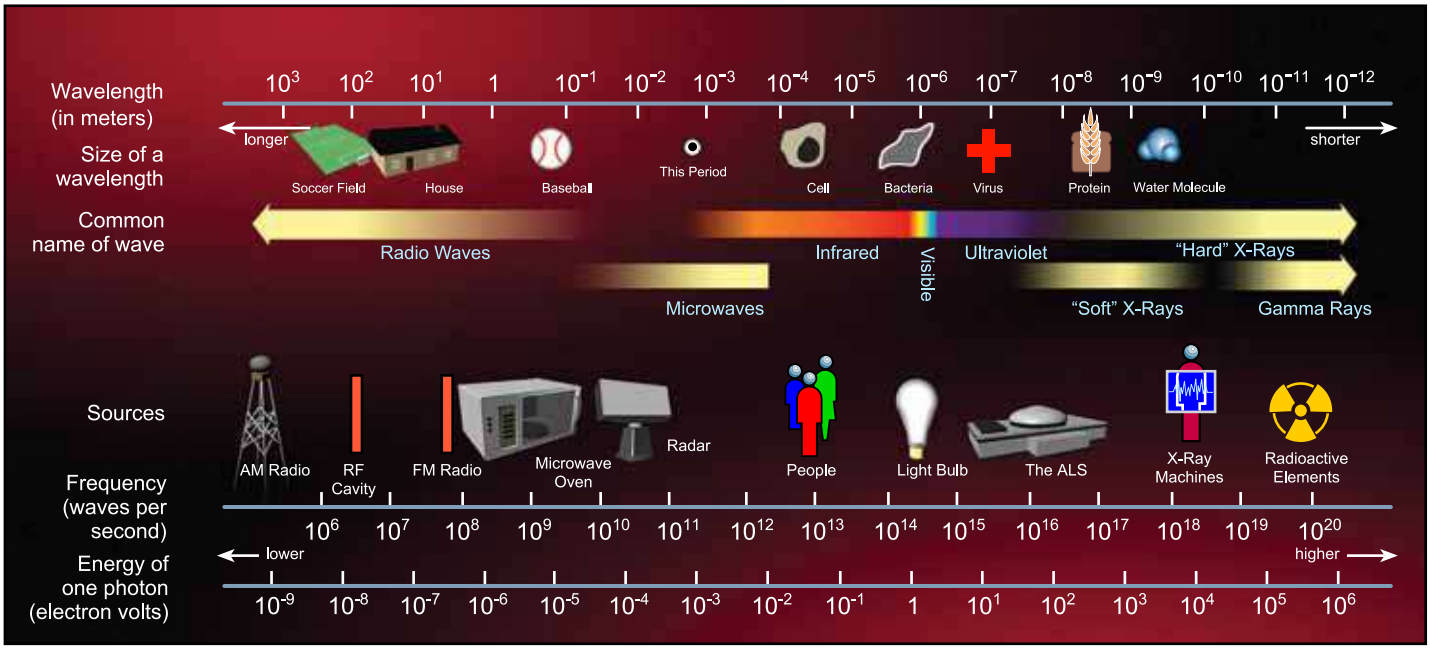

Figure 1. Electromagnetic Spectrum

theorized that when a photon interacts with an atom or molecule in an excited state, two photons are produced when the atom or molecule leaves the excited state. Population inversion occurs when the atoms or molecules are in the excited state. In order for molecules to come out of the normal "ground" state, a source of power must be introduced to the system energizing the atoms to the excited state. When many photons are passed through many excited atoms, more and more photons are produced. The photons are contained and reflected back and forth in a cavity, with mirrors usually on each end. The mirror on the output end is only partially reflective, allowing some photons to leak through, creating the laser beam.

The difference between an everyday light bulb and the light of a laser is temporal and spatial coherence. In a light bulb, the light emits photons equally in all directions. The light is random, out of phase, and multiwavelength. A laser emits coherent light, so photons travel in identical direction and phase. A laser is also monochromatic, i.e., light of one wavelength. Another significant difference is that laser light is highly collimated, which means the laser beam can travel long distances with minimum spreading.

The laser gain medium through which the photons travel to become amplified or magnified can vary. The source of power used to excite the medium, achieving population inversion, can be the result of a chemical reaction, an electric discharge, a flash lamp, another laser, or some other excitation mechanism. The type of the lasing medium determines the type of laser. The three categories in which lasers are usually classified are chemical, gas, and solid state. A laser can also be continuous wave (CW) or pulsed. Each type of laser produces a specific wavelength of radiation. It is important to note that different wavelengths of radiation interact with the atmosphere differently. A laser beam is either scattered or absorbed by air molecules, water vapor, or dust. Longer wavelengths scatter less and are absorbed more than shorter wavelengths; our sky is blue because the shorter blue wavelengths of light are scattered more than the longer wavelengths.[1] Gamma rays are so highly absorbed that they cannot propagate more than a few feet in the air. Thus, some laser wavelengths are scattered or absorbed more than others. This makes laser wavelengths with minimum absorption better for use as directed-energy weapons since they propagate through the atmosphere better than others. For example, the carbon-dioxide (CO_2) laser is strongly absorbed by water vapor, so any use near the ocean will be negatively affected. Near-infrared and infrared lasers have shorter wavelengths with negligible absorbance. The optimal laser choice, therefore, would be a wavelength-tunable laser that could vary depending on the atmospheric conditions, such as the free-electron laser (FEL).

Lasers have affected almost every type of modern technology. Most laser technologies use low

powers and were mastered very quickly. They are used in many everyday appliances, such as scanning/inventory devices, surgery/medicine, hair removal, presentation pointers, law enforcement, ranging and sighting devices, welding applications, and much more. Using a laser as a weapon has many advantages. For example, a laser:

- Is unaffected by gravity
- Causes minimal collateral damage
- Travels at the speed of light
- Can precisely reach far distances
- Is capable of causing a specific, predetermined amount of damage to targets

The theory behind these capabilities makes the laser weapon a prime choice in multiple engagement scenarios. However, developing lasers with higher powers to use as a weapon has proven more difficult than first considered.

Military Laser History and Laser Types

Generally, a laser weapon is any laser used against the enemy with more than 50 kW to megawatts of power. This is much greater power than commercial lasers. Accordingly, they have greater support needs, including:

- Environmental and personnel safety
- Mirror coatings
- Chilling requirements
- Power requirements
- Laser fuel storage
- Alignment and tracking requirements

In 1960, the very first laser (a ruby laser) was built, producing minimal power. This event was followed by many other laser technology developments. The first chemical laser, hydrogen fluoride (HF), was built in 1965, producing 1 kW. It was then that DoD became interested in researching and developing a more powerful laser for weapon applications. Subsequently, in 1968, the Defense Advanced Research Projects Agency (DARPA) Baseline Demonstration Laser produced 100 kW, and the Navy-ARPA Chemical Laser (NACL) produced 250 kW in 1975. The very first laser is depicted in Figure 2.

Solid-State Lasers (SSLs)

An SSL uses a solid lasing medium, such as a rod made up of glass or crystal, or a gem, like the ruby laser. Along with the rod or host material is an active material, such as chromium, neodymium, erbium, holmium, or titanium. Chromium is the active material used in ruby lasers. Neodymium is the active material in the most widespread applications. A flash lamp, arc lamp, or another laser carries out the optical cavity pumping to achieve population inversion and stimulate the laser beam. The Neodymium Yttrium-aluminum garnet (Nd:YAG) laser is a popular SSL. It operates at a 1064.5-nm wavelength and can be pulsed wave or CW. A great advantage of these lasers is that the wavelength and pulse duration can be varied considerably.[1] The power level can reach up to megawatts when using Q-switching to achieve

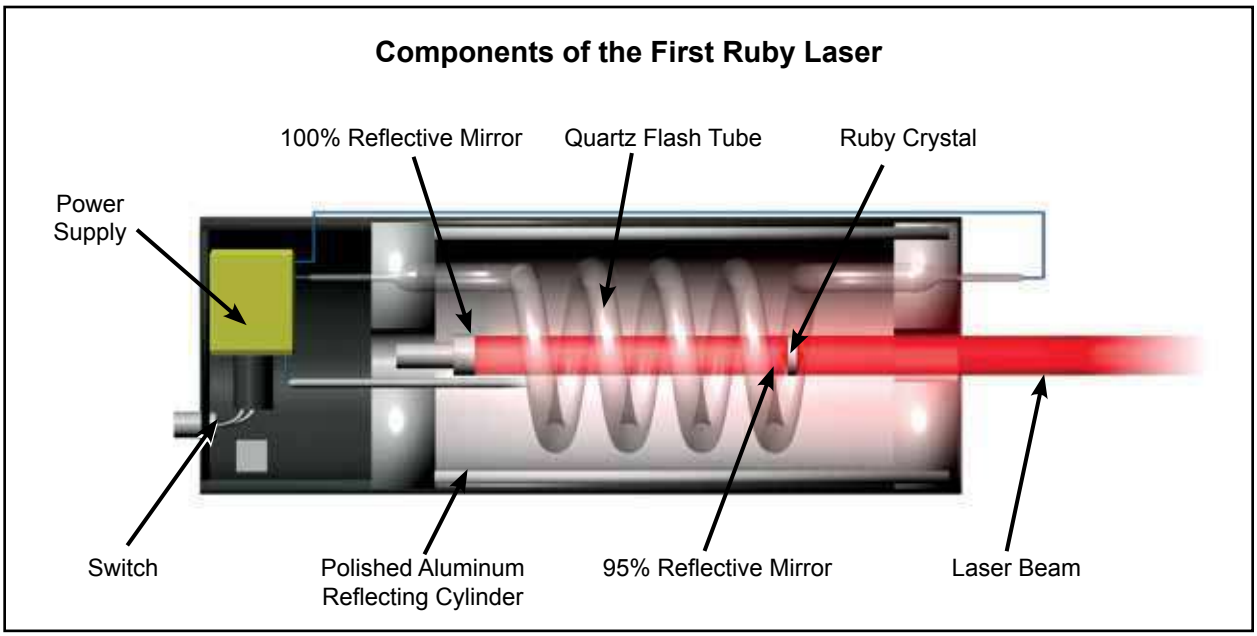

Figure 2. First Ruby Laser Developed in 1960 by Research Physicist Theodore H. Maiman

short pulse lengths. The various interactions with the laser and different crystalline materials can double the electromagnetic frequency, which will halve the wavelength, bringing the laser beam into the visible range, 532 nm (green). The wavelength can be further divided down three or four times, making this laser range from the near-infrared to the ultraviolet wavelength. These lasers are commonly used for rangefinders and target designators. Other advantages of these lasers are that they can be made very small, rugged, cheap, and battery-powered. Characteristics of SSLs are shown in Table 1.

Chemical Lasers

A chemical laser uses chemical reaction to create population inversion in the lasing medium. One example is the Mid-Infrared Advanced Chemical Laser (MIRACL) developed in the mid-1980s. The MIRACL is a continuous-wave, mid-infrared (3.8-μ) laser. Its operation is similar to a rocket engine in which a fuel (ethylene, C2H4) is burned with an oxidizer (nitrogen trifluoride, NF3).[2] Free, excited fluorine atoms are among the combustion products. Just downstream from the combustor, deuterium and helium are injected into the exhaust. Deuterium (U) combines with the excited fluorine to create excited deuterium fluoride (DF) molecules, while the helium stabilizes the reaction and controls the temperature.[2] The laser's resonator mirrors are wrapped around the excited exhaust gas, and optical energy is extracted. The cavity is actively cooled and can be run until the fuel supply is exhausted. The laser's megawatt-class output power can be varied over a wide range by altering the fuel flow rates and mixture. The laser beam in the resonator is approximately 21-cm high and 3-cm wide. Beam-shaping optics are used to produce a 14- × 14-cm (5.5- × 5.5-inch) square, which is then propagated through the rest of the beam train. Diagnostics for evaluating the beam shape, absolute power, and intensity profile are used on each firing of the laser. The beam can be directed to a number of different test areas or to the SEA LITE beam director.[2] The DF Chemical Laser (MIRACL) and the Sea Lite Beam are shown in Figure 3.

The laser and beam director were integrated in the mid-1980s at the Army's High Energy Laser Systems Test Facility (HELSTF) at White Sands Missile Range, New Mexico. Following integration, extensive tests were conducted in the areas of:

- High-power optical components and beam-path conditioning
- Beam-control techniques
- High-power propagation
- Target damage and vulnerability
- Target lethality[3]

Tests supported by the MIRACL included:

- The high-power dynamic with flying drone (BQM-34)
- Conventional defense initiative with flying drone
- High-velocity target test with Vandal Missile
- High-altitude target tests with flying drone
- Missile and plume tests using the 1.5-m aperture
- Radiometrically calibrated images and spectral radiometry

These successful tests are what made many believe that MIRACL was the first and only successful laser weapon system developed by the Navy prior to the Navy Laser Weapon System (LaWS).[3]

Gas Lasers

Gas lasers are a type of chemical laser that uses a pure gas or gas mixture to produce a beam. The typical gas laser contains a tube with mirrors on each end. One end transmits the beam out of the cavity. Most gas lasers use electron-collision pumping, with electric current passing through the gas. Some use optical pumping with flash lamps. The helium

Table 1. Characteristics of Solid-State Lasers

Name	Wavelength (nm)	Typical Power	Typical Operation
Alexandrite	700-830	5 watts	Pulsed/CW tunable
Erbium	850/1230/1540/1730/2900	8 watts	Pulsed
Holmium: glass	1950	milliwatts	Pulsed
Neodymium	1064/1123/1318/1370	megawatts	Pulsed
Neodymium: glass	1060	megawatts	Pulsed
Neodymium: YAG	1064.5	megawatts	Pulsed/CW
Ruby	694.3	10–15 watts	Pulsed
Titanium-sapphire	660–1060	15 watts	Pulsed/CW tunable

DF Chemical Laser (MIRACL)

Sea Lite Beam

Figure 3. DF Chemical Laser (MIRACL) and Sea Lite Beam

neon (HeNe) laser is a very well-known gas laser. It produces a bright red, continuous beam of low power. It is used for many applications such as scanning, alignment, measurement, and stabilization devices. University students use them in optical training laboratories. Many larger lasers contain a HeNe inside the beam path, as well to verify beam alignment. HeNe lasers are fairly cheap and very rugged. They can work continuously for thousands of hours.

CO_2 lasers are in the gas family. These lasers were the earliest, truly high-power lasers and have been among the most crucial lasers used in R&D for high-energy laser (HEL) weapons. In industry, the more powerful CO_2 lasers are used for welding, drilling, and cutting. There are many different types of CO_2 lasers that vary in pumping design. CO_2 lasers work by burning a hydrocarbon fuel (like kerosene or methane) in oxygen or nitrous oxide. The hot gas flows through a comb of nozzles, expands quickly, and achieves population inversion. The gas then flows through an optical resonator at supersonic speeds, resulting in stimulated emission and a laser beam.[4]

CO_2 lasers have been researched for use as nonlethal weapons. The wavelength produced by a CO_2 laser is also absorbed by glass. For example, the beam does not penetrate a windshield. Thus, shooting a CO_2 laser at a vehicle's windshield could deter a threat by damaging the windshield or by causing a dazzling effect to reduce the visibility of the driver, while not reaching the driver at all.

The gas dynamic laser (GDL) is a CO_2 laser based on differences in relaxation velocities of molecular vibrational states. The laser medium's gas has properties such that an energetically lower vibrational state relaxes faster than a higher vibrational state; thus, a population inversion is achieved in a particular time. A GDL is shown in Figure 4. Characteristics of chemical and gas lasers are identified in Table 2.

Fiber Lasers

Modern fiber lasers are considered SSLs. They are powered by electricity, making them highly mobile and supportable on the battlefield. Fiber lasers use optical fibers as the gain media. In most cases, the gain medium is a fiber doped with rare earth elements—such as erbium (Er3+), neodymium (Nd3+), ytterbium (Yb3+), thulium (Tm3+), or praseodymium (Pr3+)—and one or several laser diodes are used for pumping. Optical fibers have been used in industry, specifically for telecommunications to transport information via light. With developing technology, optical fibers have become high-energy, powerful laser energy sources. Fiber lasers have proven to have much benefit over traditional SSLs. They are rugged and do not require a clean room to operate or maintain, as most other laser systems do. They also are extremely efficient; however, they cannot operate well in all weather conditions. One example is the IPG CW fiber lasers, which produce moderate beam quality, causing damage to materials and components through thermal heating and burn-through. The Naval Surface Warfare Center, Dahlgren Division (NSWCDD) purchased eight commercially available 5.5-kW IPG lasers, where two multimode (seven fibers) lasers are housed per cabinet. This type of laser is easy to mount due to the flexible fibers. The IPG CW Fiber Laser is shown in Figure 5.

Miscellaneous Lasers

There are other types of lasers that do not necessarily fit into the chemical or solid-state categories. These include semiconductor lasers, used in:

- Television
- CD Players
- Dye Lasers
- Spectroscopy
- Radios
- Telecommunications
- Medicine
- Astronomy

There also are the FELs mentioned previously. The FEL is a completely different breed of laser.

Figure 4. A laser engineer inspects a gas dynamic laser after installation aboard an NKC-135 airborne laser laboratory.

Table 2. Characteristics of Chemical/Gas Lasers

Name	Wavelength (nm)	Typical Power	Typical Operation
Helium-Neon	543/632.8	.0001–.001 watts	CW
Krypton	350–647	.0001–.05 watts	CW
Argon	350–514.5	.001–6.0 watts	CW
Xenon fluoride (excimer)	351	.001–20 watts	CW
Argon fluoride (excimer)	193	.05–30 watts	Pulsed
Krypton fluoride (excimer)	249	7–100 watts	Pulsed
Deuterium fluoride (chemical)	3,000–4,200	.01–100 megawatts	Pulsed/CW
Hydrogen fluoride (chemical)	2,600–3,000	.01–150 megawatts	Pulsed/CW
Carbon dioxide	9,000–12,000	.1–15,000 megawatts	Pulsed/CW
GaAlAs (semiconductor)	750–900	10–4,000 milliwatts	Pulsed

Figure 5. IPG CW Fiber Laser System

It uses electrons to create photons instead of some type of matter. The electrons are produced, collected, and directed to flow at very high speeds. To excite the electrons, they are passed through a "wiggler," i.e., a series of magnets positioned in such a way that electromagnetic radiation (light) is produced when the electrons release photons. The significant feature of the FEL is that the wavelength can be controlled, depending on the magnet positions and the speed of electrons. This versatility makes the FEL particularly appealing. However, the footprint of the FEL system is too large to transform into any ideal defense weapon. The Jefferson Laboratory in Newport News, Virginia, has an FEL and continues to maintain and test its capabilities and effects. This laser was new to the military in the late 1990s and received funding to optimize its capabilities and integrate as a defense weapon. Although great progress has been made, the required footprint could be much larger than desired. Consequently, some interest in the FEL has shifted to other HEL sources.

Many scientists foresee the probability of using the laser as a global weapon. This possibility is proven through basic laws of physics. Actually implementing such a system, however, can be more difficult. The global weapon concept uses a base laser with optics and is strategically positioned in space to be able to direct its beam multiple places on Earth at the speed of light with maximum power levels. This idea faces significant problems, including appropriate power levels, optics to handle such levels, propagation issues, and the ethical measures behind any global weapon. Still, the idea presents interesting possibilities.

Laser Weapon Development

The following paragraphs highlight some of the laser weapons that have been successfully developed over the last 40 years.

Baseline Demonstrator Laser (BDL) Hydrogen Fluoride (HF)

In 1973, TRW Inc. produced the world's first high-energy chemical laser, the Baseline Demonstration Laser, for DoD. After that, TRW Inc. produced and demonstrated six more HELs, including the MIRACL (1985) and Alpha (2000), the nation's only megawatt-class chemical lasers.

Navy-ARPA Chemical Laser (NACL) HF

The NACL was mated with the Navy Pointer Tracker at TRW Inc.'s San Juan Capistrano, California, facilities in the 1975–1978 time frame. This was the Navy's initial, integrated HEL system test bed and was used to provide the first demonstrated kill of an operational missile in 1978.

Alpha HF—Built for Strategic Defense Initiative (SDI) Space-Based Laser (SBL)

Alpha, an HF laser, was the baseline technology for the SBL readiness demonstration (SBLRD). In 1991, the Alpha laser demonstrated megawatt-class power levels similar to MIRACL, but in a low-pressure, space operation environment. Alpha demonstrated that multimegawatt, space-compatible lasers can be built and operated.

Tactical High-Energy Laser (THEL)

The THEL is a DF chemical laser developed by the Army. In 2000 and 2001, THEL shot down 28 Katyusha artillery rockets and 5 artillery shells. On 4 November 2002, THEL shot down an incoming artillery shell and a mobile version successfully completed testing. Subsequently, during a test conducted on 24 August 2004, the system successfully shot down multiple mortar rounds. These tests represented actual mortar threat scenarios in which both single mortar rounds and salvo were tested and intercepted. A photograph of THEL is shown in Figure 6.

Advanced Tactical Laser (ATL)

The ATL uses a closed-cycle, chemical oxygen-iodine laser (COIL) with beam control, which lases at a 1.315-μ wavelength. The ATL was developed to engage tactical targets from a moving platform at ranges of approximately 10 km. It can spot a 10-cm-wide beam on a distant target for up to 100 shots. This beam has enough power to slice through metal at a distance of 9 miles. The aircraft equipped with the ATL weapon system is shown in Figure 7.

A specially modified 46th Test Wing NC-130H aircraft equipped with the ATL weapon system fired its laser while flying over White Sands Missile Range, New Mexico, successfully hitting a target board located on the ground. Equipped with a chemical laser, a beam control system, sensors, and weapon-system consoles, the ATL is designed to damage, disable, or destroy targets with little or no collateral damage.

Airborne Laser (ABL) (CO_2) Chemical Oxygen

The ABL C-130H aircraft contains three laser beam systems: the powerful killing primary laser beam (ATL), a set of illuminating laser beams for infrared surveillance and high-speed target acquisition, and a beacon laser for a high-precision laser target tracking beam control system. The primary

Figure 6. Tactical High-Energy Laser (THEL)

Figure 7. 46th Test Wing NC-130H Aircraft Equipped with the ATL Weapon System

laser beam is generated by a megawatt COIL located at the rear of the fuselage. The high-power laser beam travels towards the front of the aircraft through a pipe. The pipe passes through a Station 1000 bulkhead/airlock, which separates the rear fuselage from the forward cabins. The high-power beam passes through the fine beam control system mounted on a vibration-isolated optical bench. Beam pointing is achieved with very fast, lightweight steering mirrors, which are tilted to follow the target missile. The ABL finally destroyed a target while in flight at White Sands Missile Range in August 2009. The 12,000-lb ABL locked onto an unspecified ground target and fired the laser, making the target disappear. Although it was successful at this demonstration, using the ABL in the fleet has fallen out of favor due to affordability and technology problems. The ABL is shown on an aircraft in Figure 8.

Joint High-Power Solid-State Laser (JHPSSL)

In hopes of accelerating SSL technology for military uses, work is being performed by the U.S. Army Space and Missile Defense Command (SMDC) and the Army Test and Engineering Center at White Sands Missile Range. The technology uses an electric laser diode to shoot light into 32 garnet crystal modules that combine to create "laser amplifier chains" producing 15 kW. By using seven chains and by combining multiple beams, they have reached 105 kW in the laboratory operating in a clean room. The program's ultimate goal is for a laser system to reach high powers outside a laboratory environment. Fielding such a delicate optical structure can present significant barriers for this laser system. Nonetheless, it will be a great accomplishment for a variety of force protection missions, such as shipboard defense against cruise missiles. The JHPSSL system is shown in Figure 9.

Navy Laser Weapon System (LaWS)

The Navy LaWS is the most recent, successful laser weapon. It uses an electric-fiber laser design, avoiding the problems that chemical lasers present. In the summer of 2009, the Naval Sea Systems Command (NAVSEA)—with support from NSWCDD—successfully tracked, engaged, and destroyed unmanned aerial vehicles (UAV)

Figure 8. Airborne Laser (ABL)

Figure 9. Joint High-Power Solid-State Laser (JHPSSL) System

in flight at the Naval Air Warfare Center, China Lake, California. A total of five targets were engaged and destroyed during the testing, which represented a first for the U.S. Navy. The laser was fired through a beam director on a Kineto Tracking Mount similar to the Sea Lite beam director. The system used fiber lasers in the configuration and has proven to be a rugged and dependable choice for the warfighter's needs. A photograph of LaWS is shown in Figure 10.

Laser weapon systems development in recent years has taken giant steps forward. Dedicated R&D has advanced the state of the art considerably. What was unimaginable only a few short years ago, today has become reality. Accordingly, given continued R&D, warfighters in the near term will have additional weapon options to choose from for dealing with a spectrum of threats and contingencies.

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Figure 10. Navy Laser Weapon System (LaWS)

Laser Weapon System (LaWS) Adjunct to the Close-In Weapon System (CIWS)

By Robin Staton and Robert Pawlak

The Naval Sea Systems Command (NAVSEA) established the Navy Directed Energy Weapons Program Office in January 2002 and subsequently chartered the Directed Energy and Electric Weapon Systems Program Office (PMS 405) in July 2004.[1, 2] Its mission is to change the way the Navy fights in the 21st century by transitioning directed-energy and electric weapon technology, providing the warfighter with additional tools to fight today's and tomorrow's wars. In support of this mission, the Laser Weapon System (LaWS) was developed, which potentially adds a suite of tools for offensive and defensive operations.

The LaWS program is managed by PMS 405 in cooperation with the Program Executive Office Integrated Warfare Systems (PEO IWS), the Navy's Close-In Weapon System (CIWS) manager. A multilaboratory/multicontractor organization led by the Naval Surface Warfare Center, Dahlgren Division (NSWCDD), has been executing the program since March 2007. The potential advantages of a lethal, precise, speed-of-light weapon are numerous and have been recognized for many years. However, even in light of these advantages, there are realities that need to be considered for any program to succeed to the point that an actual system is placed in the hands of the warfighters.

The LaWS system offers viable solutions for an important subset of threats while fitting into acceptable size and weight constraints. In addition, since LaWS is a fully electric laser, the operation of the system does not require the handling and storage of hazardous chemicals, such as hydrogen fluoride. As will be discussed later, due to the incorporation of high levels of commercial off-the-shelf (COTS) technology, the LaWS system also has advantages for topside design, logistic supportability, and cost. Thus, LaWS could enable the Navy to address adverse cost-exchange situations, which can occur when engaging proliferated inexpensive threats such as unmanned aerial vehicles (UAVs).

Background

Based on mission analysis work conducted prior to the LaWS program and additional work done as part of the program, it became clear that a number of factors require careful consideration. First, a high-power laser is not likely to replace anything on a ship in the next 5 years. For a new system to be added to a ship, a high-power laser must supplement current capabilities or provide new capabilities that clearly justify its addition. Second, because a laser provides such a diverse set of capabilities, conventional air-to-air warfare (AAW) models—such as the Fleet AAW Model for Comparison of Tactical Systems (FACTS), Antiair Warfare Simulation (AAWSIM), and Extended Air Defense Simulation (EADSIM), as well as other existing AAW analysis approaches—are not well suited for showcasing current or near-term laser-weapon capabilities. While they can (and have) been used for laser-weapon analysis, their application to a megawatt-class laser that could "instantly" destroy boats or cruise missiles (akin to missile engagements) is a more straightforward application of the existing models and techniques.

In November 1995, the Chief of Naval Operations requested that the National Research Council initiate, through its Naval Studies Board, a thorough examination of the impact of advancing technology on the form and capability of the naval forces to the year 2035. A major observation of the report is quoted below:

> Numerous laboratory and field-test versions of laser weapons have been developed and demonstrated. They have worked as expected and demonstrated suitable lethality against their intended targets. The primary factors that have inhibited the transition of the technology into deployed systems are size and weight. Generally, the conceptual designs of laser weapons that are scaled for combat effectiveness are too large to be appealing to users; conversely, weapons that are sized for platform convenience generally lack convincing lethality.[3]

Subsequently, an August 2006 U.S. Air Force (USAF) Scientific Advisory Board Study examined the increasing threat posed by UAVs in some detail. Key conclusions included:

> No single system can completely address the UAV threat. A single sensor solution is inadequate because of the size and speed challenges presented by small UAVs. A single-weapon-layer solution fails to provide for adaptability to multiple scenarios or adequate probability of kill.

Key recommendations of the USAF Advisory Scientific Board Study included:

> Develop and field longer-term upgrades to counter increased UAV threats. They include:…a small, multimission air/air and air/ground weapon; and directed-energy air defense weaponry.[4]

In addition to the USAF Scientific Advisory Board study, a 2007 OPNAV Deep Blue Study noted the potential advantage of nonkinetic defeat options and recommended that the Navy accelerate development of nonkinetic systems to include high-energy lasers (HELs).[5]

The laser power levels likely to be available in the near term, within reasonable size and cost, are in the neighborhood of 100 kW of radiated power. While this power level is not adequate to engage certain threats, such as cruise missiles or tactical ballistic missiles at tactically useful ranges, there is still a wide spectrum of threats that could be engaged at ranges that are comparable to many current ship-defense weapons, including minor-caliber guns and small missiles. The spectrum of threats includes:

- UAVs
- Missile Seekers
- Intelligence, Surveillance, and Reconnaissance Systems
- Rockets
- Man-Portable Air-Defense Systems (MANPADS)
- Mortar Rounds
- Floating Mines
- Artillery Rounds

LaWS on CIWS

The Mk 15 Phalanx CIWS can often detect, track, and (sometimes) identify potential threats at ranges well outside the effective range of the 20mm gun. These functions are accomplished using the search/track radar system and the Phalanx Thermal Imager (PTI). When added to the Phalanx mount and pointed in the same direction as the gun (see Figure 1), a laser weapon could potentially add a number of useful functions and capabilities to the mount, but technical challenges must be overcome. Preliminary analyses of the mechanical characteristics of the mount suggest that the additional weight that could be added to the mount must be kept under approximately 1200–1500 lb. Additionally, it is highly desirable that the addition of the laser weapon not substantially affect the train/elevation operation of the mount in angle, peak velocity, or acceleration. Consequently, use of rapidly evolving fiber laser technology appears to be the only currently foreseeable path to adding significant laser energy directly to the mount within these constraints.

One major driver in the genesis of the LaWS system was the availability of relatively low-cost COTS fiber-optic lasers. Because these fibers are flexible, they obviate the need for an expensive coudé path system (an optical mirror/lens assembly that turns radiation 90° and may also support rotation of the beam director), thus allowing the use of low-cost mount technology, as well as the retrofitting of the system on existing mounts. The last factor is extremely important because of the scarcity of topside real estate on today's ships. These fiber-optic lasers do have limitations in terms of power, although power levels are growing with advancing technology. The reality today is that, in order to get adequate lethality from a system based on this technology, the use of a beam-combining apparatus utilizing several individual fibers is necessary. (Figure 2 depicts combining multiple fibers in the same beam director.) Furthermore, a smaller beam size is desirable since this drives power density up—increasing the performance required for the tracking and pointing elements of the system. Thus, a high-resolution fine track sensor is needed, as well as an appropriately robust line-of-sight control.

A Potential Suite of LaWS-Related Capabilities

Potential added capabilities that an adjunct LaWS could contribute to the total ship combat system are briefly outlined in the following subsections.

Figure 1. LaWS Mounted on CIWS

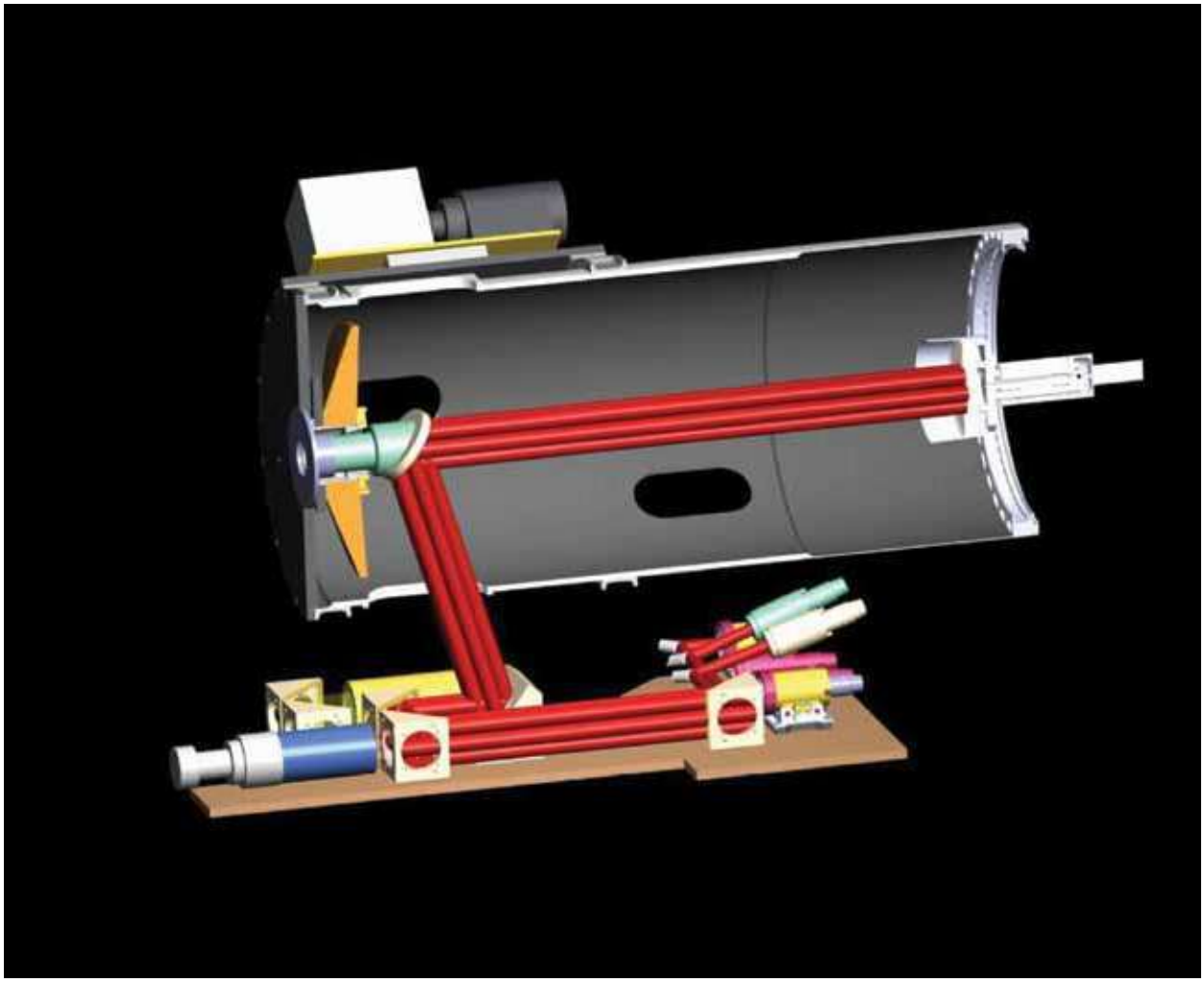

Figure 2. Cutaway View of the LaWS Beam Director

Target Identification, Tracking, and Intent Determination at Range

The optics that would be added for the laser to detect and track targets in support of a laser engagement would immediately contribute additional capabilities to the entire ship combat system even without operating the laser. A laser-gated illuminator, part of the tracking system, significantly increases the signal to the background level of tracked targets and provides good range resolution as well. The additional sensitivity and angle resolution provided by the LaWS optics would allow the identification, precision tracking, and "monitoring" (at high resolution) of potential threats or vehicles of interest at substantially greater ranges than could be achieved by the PTI alone. The Phalanx radar, or another source, would have to provide an initial, accurate cue to facilitate initial acquisition. Once acquired, the target could be examined and monitored with high resolution at range. This capability could make a substantial contribution to identification efforts—efforts to determine intent and potentially even to documenting target behavior to resolve issues with rules-of-engagement doctrine. It is widely recognized that rules-of-engagement issues, such as threat identification and intent determination, are among the most difficult problems faced by ship commanding officers.

Unambiguous Warning at Range

If a fraction of the laser energy is routed through a frequency-doubling crystal, an intense, visible beam can be projected to significant ranges to provide a clear, unambiguous warning that a potential target is about to be engaged unless an immediate change in behavior is observed. This feature also would have utility for dazzling aircraft, surface vehicle, or submarine sensors, and would provide exceptional long-range, unambiguous warning to boats or aircraft at night.

Sensor Destruction at Range

Many electro-optical (EO) sensors are quite susceptible to damage by laser energy in the fiber-laser band as is the case with infrared (IR) missile seekers with germanium optics. The frequency-doubling feature described in the previous paragraph also would be useful to ensure that a band-pass filter at a single frequency could not be applied as an effective countermeasure. The intent here would be to destroy the seeker or imager at ranges well beyond those achievable by the Phalanx 20mm gun. Other examples include intelligence, surveillance, reconnaissance, and targeting sensors on UAVs or unmanned surface vehicles (USVs).

IR Missile Assist at Range

Many targets of interest—including UAVs, USVs, and small boats—are somewhat "marginal" from a target-signature standpoint, particularly at the maximum range of existing IR guided missiles such as the FIM-92 Stinger, the FGM-148 Javelin, the RIM-116 RAM, and the AIM-9X Sidewinder. The CIWS laser adjunct could potentially "correct" this situation by laser heating target vehicles to enhance their signature to existing IR guided missiles. Note that this is NOT "conventional" semiactive-laser (SAL) guidance—the LaWS is not a coded illuminator, nor do the seekers in question rely on this coding. The IR missiles would be unmodified weapons taken from inventory. The LaWS adjunct would simply contribute laser energy that heats the target and enhances its signature for the missile. While, at the ranges envisioned, this laser heating alone would not be sufficient to "kill" the target, it could definitely heat the target. It should also be noted that the laser "illumination" could potentially be used to preferentially select a specific target from among a group of targets for engagement by a missile. It is expected that these engagements could occur at ranges of two to four times the effective Phalanx gun engagement ranges. Use of LaWS in this manner would be exactly analogous to the use of a SAL designator for a SAL guided missile, such as the AGM-114 Hellfire. It is expected that similar rules of engagement would apply.

Direct Target Destruction by Laser Heating

Some threats are known to be vulnerable to direct destruction by the application of laser energy for an appropriate period of time. The currently envisioned system would be able to destroy a subset of naval threats at ranges comparable to, and in some cases greater than, the ranges achieved with modern, stabilized guns using EO fire control systems and modern ammunition. In the case of a LaWS adjunct, the addition of the laser would open new options for a firing/engagement doctrine and would be expected to conserve CIWS rounds for use on threats that are not appropriate for this laser power level. While the laser is often quoted as having an "unlimited magazine," the true number of threats that can be engaged by the laser in any period of time is limited by the required illumination time and by the time required to evaluate a kill and transition to the next target. Thus, for particular target velocities and numbers, the "effective laser magazine" might be added to the CIWS magazine to increase the total number of targets engaged by the combined system.

LaWS Accomplishments

A government/industry team, led by government technical personnel, have achieved significant accomplishments since the start of the LaWS program in 2007; specifically, the team:

- Conducted mission analyses
- Developed threat lethality estimates
- Performed industry surveys for critical components and subsystems
- Performed extensive trade-off analyses
- Designed a prototype system
- Constructed the system—the prototype director and mount (see Figure 3)
- Performed numerous laboratory-based tests of subsystems and the complete prototype
- Validated system operation with a full-up field test at high power using BQM-147A UAV target drones

Additionally, the team was able to minimize the cost of the prototype by leveraging hardware that had already been developed or procured for other applications, including an L3-Brashear tracking mount, a 50-cm telescope, and high-performance IR sensors. Some components were commercially procured, such as the 5.4-kW fiber lasers. Figure 4 shows three laser cabinets, containing two lasers apiece, resulting in a total power output of 32.4 kW. Other components, such as the beam combiner and much of the system software required for operation and target tracking, had to be specifically designed, fabricated, and tested.

The LaWS program achieved a highly successful field test/demonstration in June 2009 when the prototype successfully engaged and destroyed five drone targets at tactically significant ranges at the China Lake, California, test range (see Figure 5).

Additional Work to be Done

Since the LaWS prototype sits on a dedicated gimbal, much additional work needs to be done

Figure 3. Photo of LaWS During Testing at the Naval Weapons Center, China Lake

Figure 4. IPG Laser Cabinets

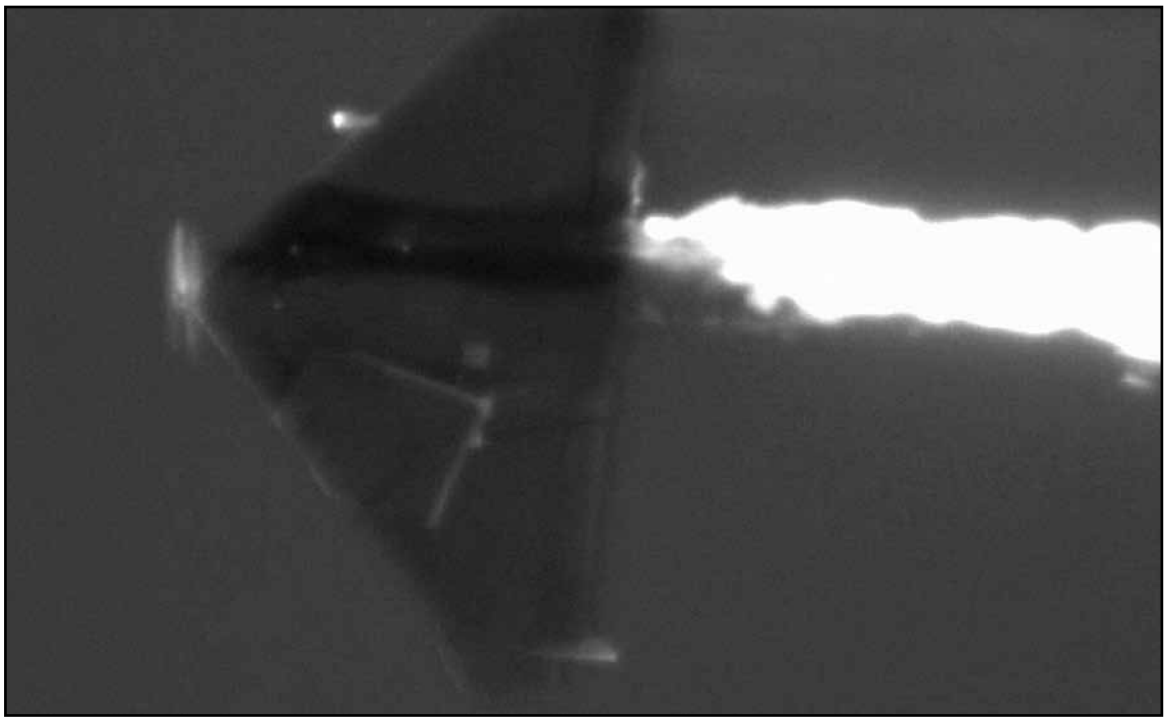

Figure 5. BQM-147A During LaWS Engagement

to place the weapon on the CIWS mount. The latter would require new control systems and optomechanical hardware for line-of-sight stabilization. Other aspects of the shipboard environment are also more stressful, and future mission areas may require an increasingly robust capability to deal with optical turbulence and the high-clutter environment of the ocean surface. Additional laser power might also be required. These modifications, depending on the level of capability desired, will require engineering modifications to the system. Engineering analysis and design to address these issues is currently underway at NSWCDD.

While the aforementioned engineering issues are important to address, there are additional technical issues that have yet to be analyzed. These issues are concerned with the potential utility of the system. Indeed, most of the detailed technical analyses and experiments performed thus far have focused on target destruction, with some effort expended on the issue of seeker damage/destruction. Developing credible lethality estimates for various potential threat targets is clearly very important, but one consequence of the lethality focus is that necessary, detailed, defendable technical analysis, analytic model development, and experiments have not been performed to explore the other functions/features that a CIWS Adjunct LaWS might provide to the overall ship combat system. Some of these contributions might become "routine" if the LaWS were available.

For example, a hard-kill engagement of a target by a Navy shipboard weapon is a relatively rare event, even during wartime conditions. On the other hand, ships in combat zones—and elsewhere—constantly have the problem of detecting potential threats, tracking them, identifying them, determining their intent, and providing warning. Thus, use of the LaWS system, at less than its full lethal potential, could become a daily, standard practice. It is still not clear how these potential benefits and capabilities could be measured or quantified to the satisfaction of key decision makers.

Likewise, other potential advantages of laser weapons—such as the potential for precision engagement, covert engagement, fire starting, graduated lethality, low cost per shot, and "unlimited"

magazine—have not been subjected to rigorous technical analysis for feasibility, utility, and practicality. These investigations need to be performed and are gradually being addressed within the LaWS program.

Although the Phalanx CIWS system is currently installed on a number of Navy surface warships—either a single mount or a double mount—there are still significant numbers of ships that do not have a Phalanx system. It is highly desirable to make LaWS potentially available to virtually any ship that could benefit from the enhanced capabilities.

While the technical issues associated with the addition of LaWS to the Phalanx CIWS will be somewhat different from those associated with adding a LaWS system to other weapon systems—or the provision of a "stand-alone" LaWS—they do not appear to be insurmountable. For example, a LaWS beam director might be added to the stabilized Mk 38 Mod 2 25mm gun or the Mk 46 Mod 2 30mm gun. A LaWS beam director might be added to (or even substituted for) the Mk 46 EO Sight on DDGs or added to the trainable RAM launcher. Other options may exist as well.

The issue of defending combat logistics force ships, joint sealift ships, and certain support vessels from attacks from small boats or UAVs is also relevant. These ships often have little or no installed defensive capabilities for potential terrorist or pirate threats, and expeditionary security detachments do not have decisive warning or engagement capability. In addition, there are severe limitations placed on concept of operations (CONOPS) and rules of engagement due to the limited objectives/limited means of the various missions.

A system such as LaWS could provide graduated lethality from warning to destruction. It also could provide additional applications to minimize risk to sea base platforms and enhance sea shield capabilities against nonstate threats. If acceptable rules of engagement can be established, the advantages of graduated lethality might be extended to ships in port or entering/exiting harbors.

While considerable additional work needs to be done to produce a tactical system, the LaWS program's recent demonstration of capability provides strong evidence that a useful, tactical system could be produced within reasonable cost, volume, weight, and power constraints to provide the warfighter with a suite of additional tools to fight today's and tomorrow's wars.

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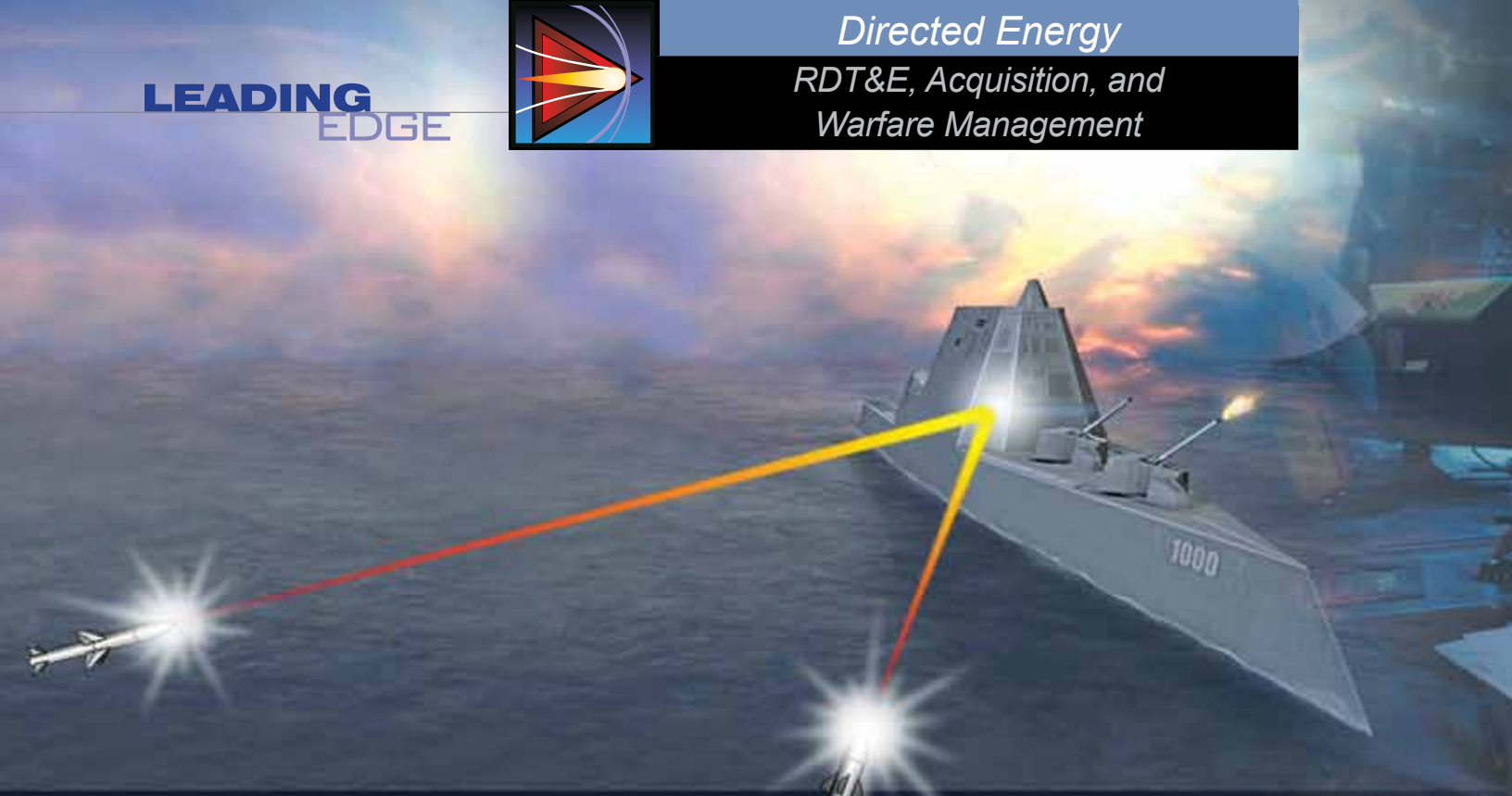

The Acquisition Challenge Associated With Directed-Energy RDT&E

By Mike Kotzian

An already tense situation quickly escalated. Everyone within the combat information center of the Navy's newest all-electric ship suddenly realized that two surface-skimming, antiship missiles were bearing down on their destroyer. With less than 30 seconds to impact, the tactical warfare officer gave the order to fire. Seconds later, the first surface-skimming missile vanished from all tracking consoles. Another order to fire closely followed, and the second missile threat was also destroyed. Consequently, within a matter of 10 seconds from threat recognition to threat elimination, the Navy's newest all-electric ship was able to destroy two incoming threats by using one of the Navy's newest weapon systems—the free-electron laser.

Does this scenario of a Navy all-electric ship, employing a high-energy laser to shoot down enemy surface-skimming antiship missiles, sound like inevitable reality or unattainable science fiction? For scientists and engineers working on directed-energy systems for the Navy, the answer does not lie solely in the advanced technical challenges associated with developing directed-energy weapons. Rather, the answer also lies in how well scientists and engineers understand and adhere to the Department of Defense's (DoD's) Defense Acquisition Management System (DAMS) framework governing the development of new weapon systems.

Evolution of Defense Acquisition

The way in which DoD identifies needs and subsequently develops, tests, procures, and sustains weapon systems has evolved over time. Today's acquisition foundation can be traced back to the Packard Commission report in 1986, where many of this report's recommendations became part of the Goldwater-Nichols DoD Reorganization Act of 1986. This evolution continued along three tracks:

1. Requirements moving from threat-based to capability-based
2. The resource allocation system adding execution reviews with concurrent program and budget reviews

3. The acquisition process attempting to incorporate a more flexible and tailored process

These three tracks form the Defense Support System organizational structure: the Joint Capabilities Integration and Development System (JCIDS) process; the Planning, Programming, Budgeting, and Execution (PPBE) process; and the DAMS process, respectively. These three processes operate as "systems of systems" and are referred to as the "Big A" acquisition process shown in Figure 1.[1]

While all three of these phases hold their own level of importance, the major focus for scientists and engineers at research and development (R&D) facilities is the "Little a" acquisition process. It is this "Little a" acquisition process, where the rules and processes are found, that governs how DoD goes about developing a new materiel solution to a validated warfighter requirement. These rules and processes are codified within DoD Instruction 5000.02, *Operation of the Defense Acquisition System*, which was issued in December 2008.

The acquisition framework associated with DoD Instruction 5000.02 is the DAMS structure. This framework, shown in Figure 2, consists of numerous strategically placed milestones and major program reviews to ensure proper programmatic oversight.[2] Each of the milestones has specific

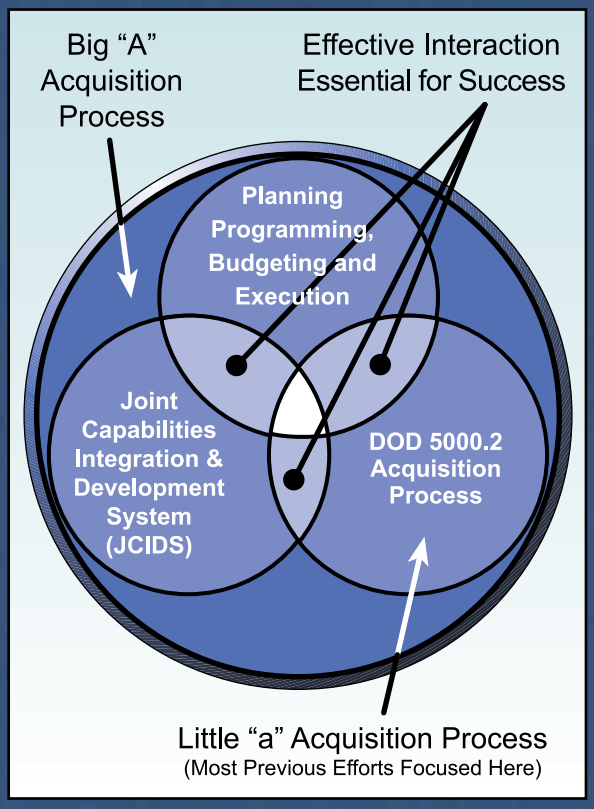

Figure 1. Defense Support System Organizational Structure

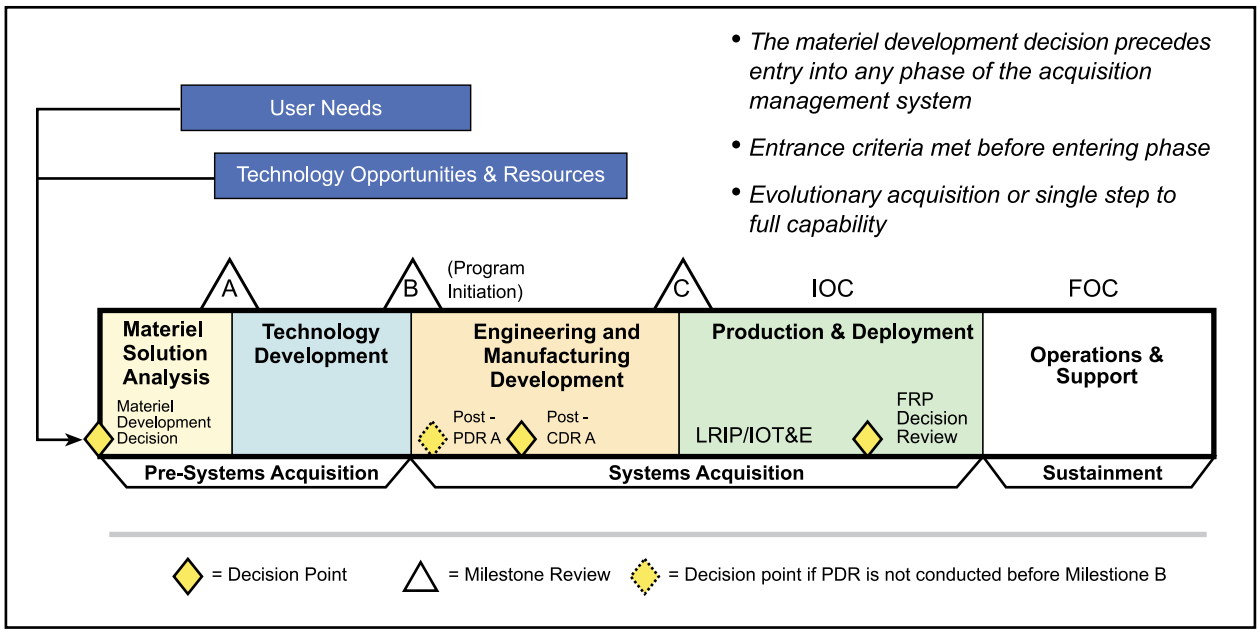

Figure 2. DoD Acquisition Framework

criteria that must be satisfied before a program is allowed to further proceed along the DAMS. The program's Milestone Decision Authority (MDA) rests with the individual responsible for deciding if the milestone criteria have been met and, if so, for allowing the program to proceed to the next phase of the acquisition process. Designation of a program's MDA depends on a program's level of research, development, test, and evaluation (RDT&E) and procurement funding. For example, an Acquisition Category (ACAT) I program is defined as an eventual total expenditure for RDT&E of more than $365 million in fiscal year (FY) 2000 constant dollars or, for procurement, of more than $2.19 billion in FY 2000 constant dollars. In this case, for an ACAT ID ("D" refers to the Defense Acquisition Board (DAB)) the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) is the MDA; for an ACAT IC ("C" refers to Component or Service), the MDA is the Head of the DoD Component or, if delegated, the Component Acquisition Executive.[3]

In addition, civilian and military workforce members within the DoD whose job responsibilities are deemed acquisition-related find themselves with a training requirement necessary to carry out their acquisition-related job responsibilities. Specifically, these workforce members are required to gain acquisition training and education with the passage of the Defense Acquisition Workforce Improvement Act (DAWIA) signed into law in 1990. The current certification process comprises three levels covering 16 different career fields. Each of these 16 career fields has a set of specific training, education, and experience requirements that must be met in order for an individual to achieve Level 1, Level 2, or Level 3 certification. The Defense Acquisition University (DAU) provides the necessary training classes required for the certification. DAU identifies "core-plus" training classes and continuous learning modules for each level of certification. The core-plus classes and modules are not required for certification but are identified as additional sources of information to assist individuals in becoming more knowledgeable about their career field beyond the minimum standards required for certification. The most up-to-date certification frameworks for all 16 career fields can be found at the following DAU website: http://icatalog.dau.mil/onlinecatalog/CareerLvl.aspx

Defense Acquisition Reform

The DoD acquisition environment is undergoing continuous change. The issuance of DoD Instruction 5000.02 marked the opening salvo of what has become seemingly constant updates, modifications, and guidance impacting how DoD procures weapon systems to meet warfighter requirements. In addition to DoD's issuance of DoD Instruction 5000.02, the Government Accountability Office published a stream of reports and findings that indicate significant cost growth and schedule delays in major defense acquisition programs. In 2009, Secretary of Defense Robert M. Gates proclaimed

a new way of doing business within DoD when it comes to weapon systems acquisition. Pressures are building for every program to maintain cost and schedule estimates while delivering the technical requirements originally developed to support the warfighter.

Moreover, there have been two major policy issuances. As previously mentioned, the first was DoD Instruction 5000.02 in December 2008. This update of the rules and processes governing DoD weapon systems acquisition primarily impacted the early part of the DAMS framework. The problem was that weapon system programs were failing their initial operational test and evaluation phases at alarming rates—many times traced to program offices attempting to design weapon systems with immature technology. Such failures were preventing those programs from proceeding to a full-rate production decision review and, more importantly, causing a repeat of some of the DAMS framework, which translated to increased costs and delayed initial operational capability timelines.

DoD Instruction 5000.02 attempted to solve this problem with three main emphases. First, a mandatory requirement was inserted for competitive prototyping prior to program initiation at Milestone B. The intent was to ensure a competition among contractors competing for a contract award. The theory was that such a competition would reduce technical risk, validate designs, improve cost estimates, evaluate manufacturing processes, and refine requirements. Reducing technical risks was especially important because weapon system programs were expected to demonstrate a technology readiness level (TRL) of six—where the system/subsystem model or prototype is demonstrated in a relevant environment—by the time a program reached Milestone B. TRLs are categorized on a scale of 1 to 9. A TRL of 1 is the lowest level of technology readiness, where scientific research begins to be translated into applied R&D. A TRL of 9 is the highest level of technology readiness, where the actual system is proven through successful mission operations. A TRL of 6 represents a major step up in a technology's demonstrated readiness. Using TRLs enables consistent comparisons of technical maturity across different types of technologies, giving program decision makers a common benchmark to consider when assessing program risk. Note that TRLs are meant to capture a level of technical maturity, not the probability of occurrence (i.e., the likelihood of attaining a required maturity level) or the impact of not achieving a level of technical maturity.[4]

The second emphasis was on a stricter adherence to systems engineering processes and technical reviews. Too often weapon system programs were not closely following systems engineering processes or avoiding due diligence when it came to the definition of successful exit criteria for a technical review. Consequently, all technical efforts must be outlined in a program's systems engineering plan. The program manager will use the eight technical management processes—decision

analysis, technical planning, technical assessment, requirements management, risk management, configuration management, technical data management, and interface management—to manage the technical development of the system increments, including the supporting or enabling systems.[5] The program manager will use the eight technical processes—stakeholders requirements definition, requirements analysis, architectural design, implementation, integration, verification, validation, and transition—to design the system, subsystems, and components, including the supporting or enabling systems required to produce, support, operate, or dispose of a system.[6] Figure 3 provides an overlay of the new DoD Instruction 5000.02 and Secretary of the Navy (SECNAV Instruction) 5000.2D (Implementation and Operation of the Defense Acquisition System and the JCIDS), and shows the timing of specific systems engineering technical reviews as a program matures through the DAMS.

The third emphasis was a more prominent role of the MDA, starting with a mandatory requirement that all weapon system programs seeking a full or partial materiel solution must hold a Materiel Development Decision chaired by the MDA. Thus, the old Design Readiness Review was replaced with the Post-Critical Design Review Assessment chaired by the MDA. In short, the MDA was to become a more prominent figure in the oversight of a weapon system program's progress.

The second relatively recent major policy issuance was the Weapon Systems Acquisition Reform Act (WSARA) of 2009, implemented by Directive-Type Memorandum (DTM) 09-027 in December 2009. This DTM amended DoD Instruction 5000.02, the *Defense Federal Acquisition Regulation Supplement (DFARS)*, and associated business practices within the *Defense Acquisition Guidebook (DAG)*. The WSARA implementation brought about changes to policies and procedures across 13 categories. Some of the WSARA changes most relevant to the Navy directed-energy community include:

- Analysis of alternatives study guidance
- Acquisition strategies to ensure competition
- Competitive prototyping
- Developmental test and evaluation
- Systems engineering
- Preliminary design reviews
- Critical cost growth

The Acquisition Impact

So why should the directed-energy community care about these acquisition policy changes? Because these policy changes impact the community's

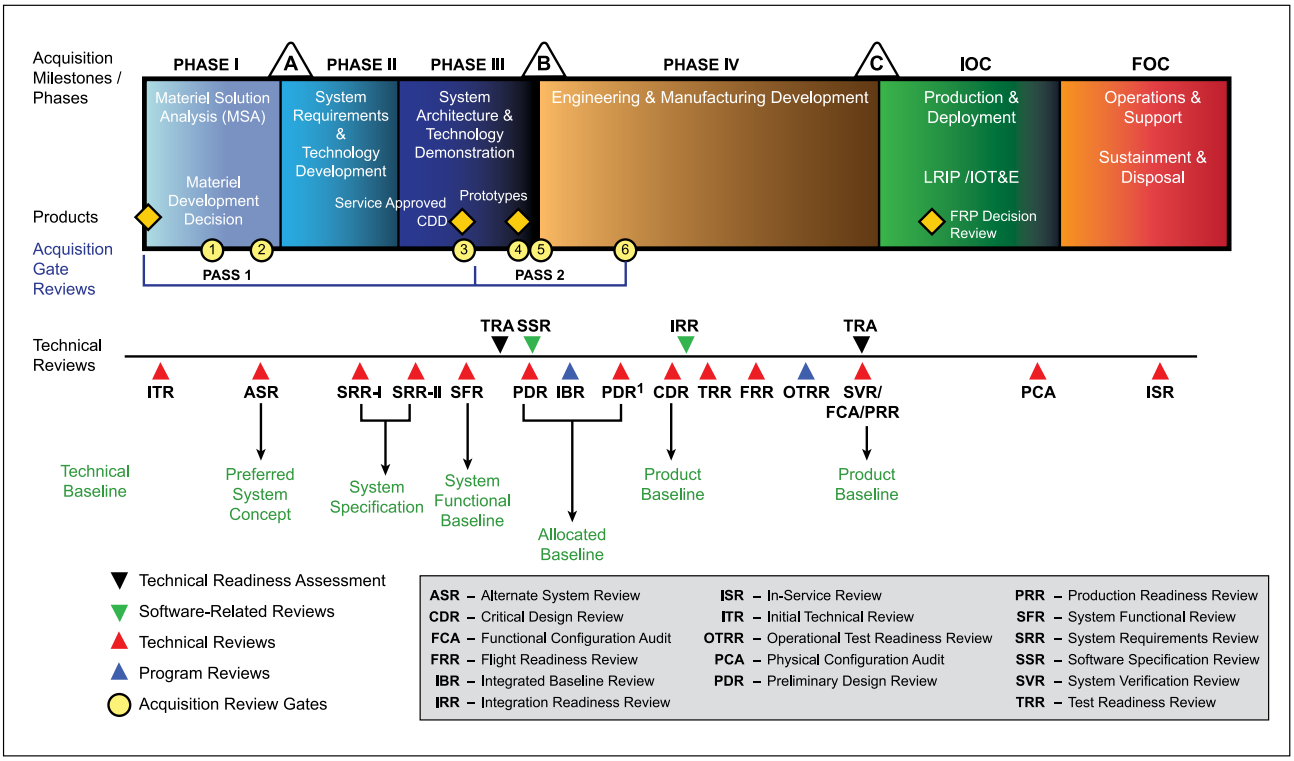

Figure 3. Systems Engineering Technical Review Timing

ability to develop, produce, and/or sustain directed-energy weapon systems. The ultimate goal of the directed-energy community is to deploy directed-energy weapons to the fleet. Accordingly, regardless of which phase or phases an organization in the community supports, its actions are impacted by the language in DoD Instruction 5000.02 and the WSARA of 2009. The more scientists and engineers in the organization are aware of governing policy documents like DoD Instruction 5000.02, the better their chances are of meeting DoD leadership's expectations in terms of cost, schedule, and technical effectiveness.

Actions have shown that DoD senior leadership has come to expect all weapon system programs to adhere to the current acquisition-related policy and guidance changes. As mentioned earlier, major weapon system programs have recently been canceled or restructured for not meeting DoD senior leadership expectations—something that rarely occurred previously. In today's environment, technology alone will not carry the argument for a program's survivability. Directed-energy weapons definitely carry the allure of a "Star Wars-like" capability, but these same weapon systems will need to show sustainable cost and schedule compliance if they are to come to fruition. Resources are too limited, and the warfighter has too many needs to allow unsustainable weapon system programs to continue. Therefore, everyone involved with the development, procurement, and/or sustainment of a directed-energy weapon system needs to have an adequate understanding of the acquisition underpinnings now governing DoD.

Summary

The proverbial "winds of change" are blowing across the DoD acquisition landscape. The management of major weapon systems dependent upon cutting-edge technologies—such as those of directed energy—cannot afford to conduct business in a manner reminiscent of bygone days. Everyone involved with the development, production, or sustainment of a directed-energy weapon system needs to understand the "rules of engagement" laid down by the most recent DoD acquisition policy guidance. Highly skilled scientists and engineers typically already understand the need for a structured systems engineering approach to problem solving. Today, though, more than ever, cost and schedule must be factored in as potential tradespace to deliver the ultimate goal: a cost-effective, directed-energy weapon system delivered in a timely manner while meeting the warfighter's requirements. Scientists and engineers who adhere to these recent acquisition changes will help their organizations achieve this goal, thereby ensuring that warfighters will be armed with the most technologically superior weapons possible.

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6. Ibid., paragraph 4.2.3.2.

The Basics of Electric Weapons and Pulsed-Power Technologies

By Stuart Moran

What Are Electric Weapons?

Most conventional weapons rely on chemical energy (explosives) as their destruction mechanism, either to explode on target, like bombs, or to create kinetic energy, like a bullet. Electric weapons are different. Electric weapons use stored electrical energy, rather than explosives, to attack or destroy the target. Electric weapons generally fall into two categories: directed-energy weapons (DEWs) and electromagnetic (EM) launchers. DEWs send energy, instead of matter, toward a target, and can be separated into three types: laser weapons, particle-beam weapons, and high-power microwave (HPM) or radio-frequency (RF) weapons. EM launchers use electrical energy to throw a mass at a target, thus making them distinct from directed energy. There are also three types of EM launchers: rail guns, coil guns, and induction drivers. All involve the use of strong magnetic fields to push against projectiles. While electric guns are an electric weapon, they are not a DEW.

High electrical powers and large energies are needed for all these weapons. Technologies for storing and controlling electric power are needed and are commonly called pulsed-power technologies. Electric guns are often associated with DEWs due to their common reliance on pulsed-power technology. The types of electric weapons are shown in Figure 1.

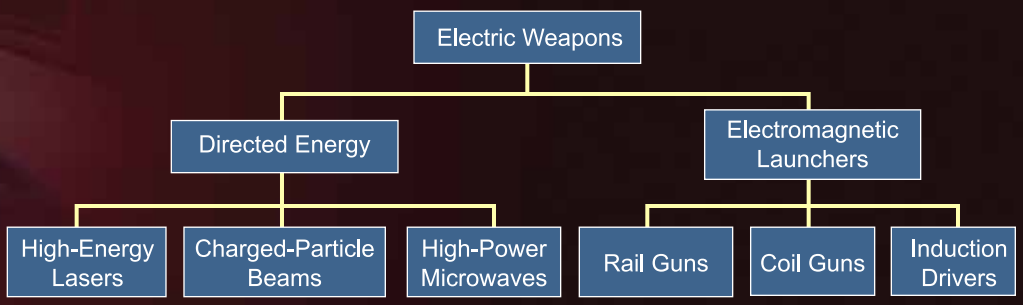

Figure 1. Types of Electric Weapons

There are a number of powerful advantages of electric weapons over conventional explosives:

- DEWs have a near-zero time of flight compared to conventional ordnance, allowing longer decision times and quicker reaction times.
- Electric weapons have a large "magazine" capacity, often limited only by the ability of the power source to recharge the system. The firing rate depends on how fast the system can be recharged, which in turn, depends on the available power source.
- The cost of engagement is greatly reduced. With increasingly sophisticated conventional weapons, the cost of practice rounds, such as a missile, can be millions. For an electric weapon, the cost per engagement is greatly reduced, making the attack of small targets (the asymmetric threat) less costly and training much more affordable.
- There is the potential for variable lethality, where the weapon effects can be controlled or attenuated to provide a warning or nonlethal effect. Otherwise, a full-power setting can be used to destroy the target.
- Electric weapons have the benefit of increased safety since less ordnance needs to be stored. Logistics costs less, and underway replenishment is easier since explosives are reduced or eliminated.
- Electric weapons can be used in conjunction with conventional weapons to heighten overall combat system effectiveness, such as knocking out electronics before engaging with a kinetic weapon.

Historically, the key Navy scenario for using directed-energy technologies has been close-in protection of naval vessels from antiship cruise missiles, particularly in a littoral environment. The ability of a DEW's speed-of-light engagement is particularly attractive under conditions of short warning times from supersonic stealthy missiles. However, increasingly difficult and problematic threats from nonmilitary aircraft and surface ships, countersurveillance platforms, fast patrol boats, unmanned aerial vehicles (UAVs), and terrorist inflatable boats or jet skis present different challenges. The threat has shifted from small numbers of expensive targets in open water to large numbers of small and cheap targets among neutral forces. The unique characteristics offered by DEWs, when compared to traditional weapon systems, allow them to be applied across a spectrum of threat roles, particularly in friendly or neutral-rich regions where precision pointing or less-than-lethal capability is paramount. The potential for HPM to counter electronics at levels below human effects makes them ideal nonlethal weapons. Electromagnetically launched projectiles allow longer range, shorter flight times, reduced reliance on air strikes and missiles, and safer storage and replenishment. With military budgets being squeezed, the low cost of directed-energy engagements, which often require just a few gallons of fuel, cannot be overemphasized. Instead of million-dollar missile shots, electric weapons allow new tactics, warning shots, and continual fire against large and small targets. They also allow inexpensive practice and training for improved readiness.

Pulsed Power for Electric Weapons

A useful rule of thumb is that a stick of TNT contains about a megajoule (MJ) of chemical energy, and this amount is often needed to destroy a military target. To destroy a target with an electric weapon, the electrical energy must also be deposited quickly. Surprisingly, a candy bar also has a megajoule of chemical energy, but it is released very slowly when we eat it. Many electric weapons require peak powers of more than a gigawatt (GW) or energies more than a megajoule. The time scales for delivery range from milliseconds to nanoseconds. As an example, delivering 1 MJ of energy in 10 μs requires 100 GW of power, which is more than a commercial power plant can produce. It is not practical to build continuous power supplies to directly drive most electric weapons. Consequently, pulsed-power technologies are needed to store energy at low power rates and release it quickly for weapon use. A pulsed-power system takes electrical power from a prime source (like a motor), stores it, and transforms the power to meet specific user requirements. The importance of a pulsed-power system is often underappreciated. For most electric weapon systems, the system size, weight, volume, and reliability are dominated by the pulsed-power chain. Pulsed-power components must be improved along with the weapon technology to make electric weapons systems practical. A block diagram of a pulsed-power system is shown in Figure 2.

Electrical energy can be stored in many ways, such as a battery (actually a chemical storage). A car battery has about a megajoule of energy, but it takes many seconds to drain it. A much faster method of storing electrical energy is in a capacitor, which can be discharged in milliseconds or faster. Inductive methods store the energy in the magnetic fields of a coil. This has the potential of achieving higher energy density than capacitors, but

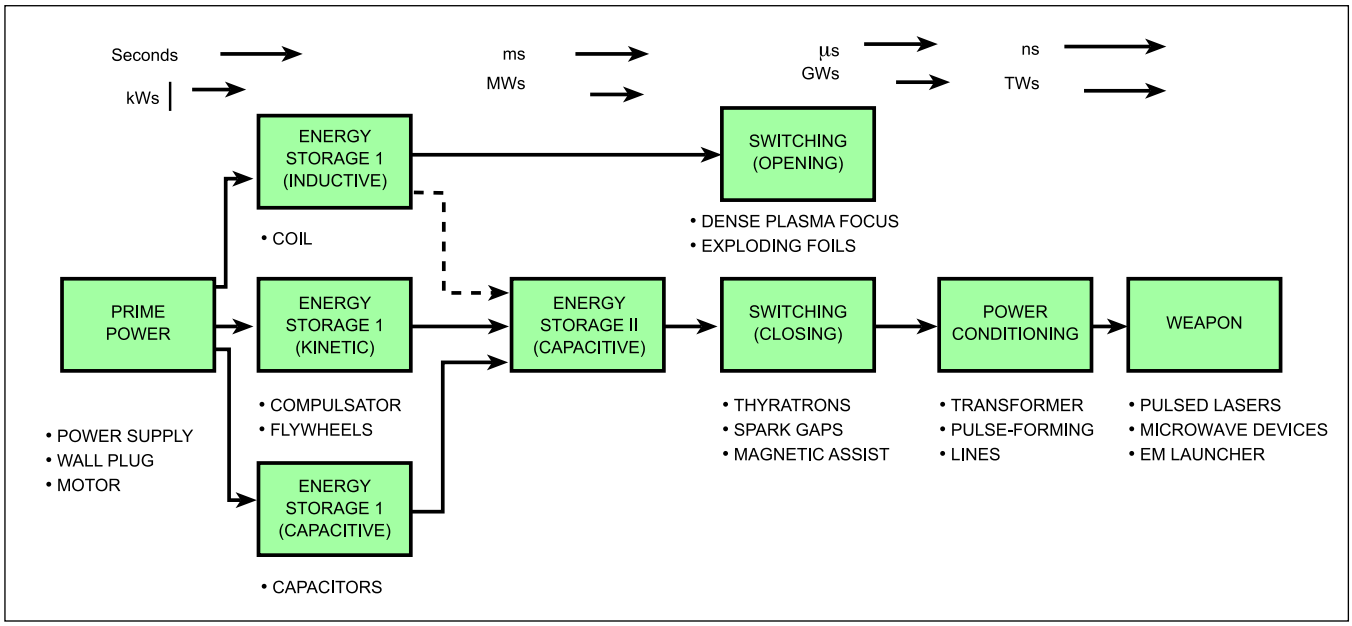

Figure 2. Block Diagram of a Pulsed-Power System

when the supporting systems are considered, the technology becomes less attractive. Energy storage for electric weapons can also be done with chemical explosive energy, where an explosive force is converted into electrical energy using techniques such as flux compression. Energy can be stored in the inertia of rotating machines and flywheels, but the energy can be released only as fast as the flywheel or motor can be stopped, usually in seconds. In many cases, several stages of energy store are used where each stage is faster than the last. Once the energy is stored, it must be released quickly using a high-power switch. There are many types of switches. Perhaps the most common type for electric-weapon applications has been the spark gap. Many types of controlled spark gaps exist, including pin-triggered, laser-triggered, field distortion, and simple overvolted. To achieve high repetition rates, flowing oil or gas can be used to flush the hot spark products, or sealed gaps using special fast-recovery gases, such as hydrogen, can be employed. Other switches, such as vacuum tubes and solid-state switches, can be used if they can handle the voltages and currents needed. Solid-state technologies, such as thyristers, have become very capable in recent years. Once the energy is switched out, there is usually some additional power conditioning, where transformers or pulse-forming networks are used to provide the desired pulse shape, voltage, and current required for the weapon. For rapid firing rates or continuous use, high average input powers are needed.

All-Electric Ship

One of the major impediments to the development of electric weapons systems for Navy ships has been a lack of electrical prime power. Current surface combatant designs employ up to 90 percent of engine power mechanically dedicated solely to propulsion. These designs are unable to provide the tens to hundreds of megawatts (MW) of electrical power capacity required for many electric weapons. The solution is an electric-drive ship that uses all the engine power to generate electricity, enabling it to allocate power to weapons or propulsion as needed. In recent years, the Navy has been investigating cost-effective power-system options to meet future platform requirements.

High-Power Microwave (HPM) and RF Weapons

Microwave weapons are generally considered to use frequencies above a gigahertz, whereas lower frequencies are generally called RF weapons. These weapons are more powerful than electronic warfare systems and are designed to create extended disruption or permanent damage. An HPM weapon is considered to have a peak power of more than 100 MW, or energies above 1 J. The energy can enter a target through intended RF paths, such as target antennas (front door), or unintended paths, such as housing joints, cavities, and circuit wires (back door). Pulses ranging from a few nanoseconds to microseconds in duration can be sufficient to reset computers, cause loss of stored data, or

cause microprocessors to switch operating modes. Nonlinear circuits and components can rectify signals and absorb energy outside of their normal operating parameters. Figure 3 illustrates some of the vulnerability areas on a missile body.

RF or HPM devices can be divided into narrowband or wideband systems, dependent upon the employed pulse length. Narrowband systems are similar to high-power radar pulses and produce RF radiation with a very narrow bandwidth (frequency coverage). The damage concept is to create enough energy in a target to overheat or overload electronic components. Wideband systems generally produce very short pulses (nanoseconds) and typically operate in lower frequency ranges. Wideband systems produce much lower average powers and rely on high-peak electric fields to produce reset or arcing of digital components. Creating short pulses—often only a few RF cycles long—generates a very broad frequency output to take advantage of a target's weak point. But, it also means that the energy is spread over many frequencies, so there may be very little energy at a specific vulnerable frequency. Vulnerability data is critical to estimate the effectiveness of HPM weapons. Ultimately, air breakdown will limit the amount of energy out of an antenna to around 1 MW/cm^2.

HPM devices can produce effects that range from denying the use of electronic-based equipment to disrupting, damaging, or destroying such equipment. HPM weapon advantages include all-weather capability, low precision pointing requirements, and effects persistence after the radiated EM energy "beam" has been turned off. One major advantage of HPM is that electronics are generally more vulnerable to high fields and high energies than humans. This provides the ability to attack electronics without harming people, which makes HPM an ideal choice for nonlethal applications.

Two major challenges of implementing HPM technologies into an operational weapon systems platform are:

1. Fratricide, or self-destruction, can be a problem because of the large areas affected by the sidelobes and near field of any meaningful HPM weapon system. Therefore, when attacking a target of interest with an HPM weapon, there is a greater risk of disruption to systems that were not intended to be targeted but fell within the sphere of influence. Host platforms, therefore, may need to undergo interference hardening.
2. With regard to battle damage assessment, kinetic weapons have the advantage of typically leaving visual evidence. HPM weapon systems do not leave large holes in a target but create more subtle influences as a result of attacking critical electronic components. Consequently, it can be more difficult to ascertain whether a target's capabilities have been sufficiently degraded or destroyed—and for how long—in determining whether a mission was successful.

For HPM system development, a fundamental challenge is the understanding of what it takes to affect the target. Coupling mechanisms, where EM energy enters and affects the target system, are extremely complex. The vulnerability of components is often vastly different if it is outside or inside a circuit board or enclosure. Effects depend upon the interactions with other components, connectors, and nearby conductors. The effects on a component can vary many orders of magnitude depending on frequency, orientation, cracks and seams, protective circuits, pulse energy, and duration. Research regarding effects on missiles has shown large variations not only between designs, but also between different serial numbers due to assembly methods, cable routing, and component variations. With the increasing use of commercial equipment by the military, such as computers and radios, effects are difficult to predict due to constant design and component changes. In general, electronics are getting smaller and operating at lower voltages, making them more sensitive to high fields. But smaller components often have lower pickup areas, and the proliferation of interfering signals has increased the amount of shielding on modern electronics. When

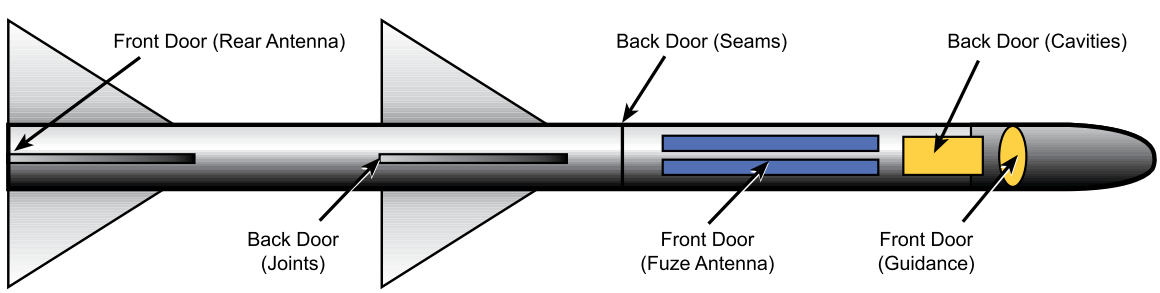

Figure 3. HPM Coupling Paths on Missile Body

target systems are located inside structures or buildings, it becomes even more difficult to predict. Efforts to predict reflections and interference inside complex structures become extremely complicated. Accordingly, generic electronics kill using universal waveforms is not likely. There continues to be a lot of hype about what RF weapons can do, but the idea that a backpack device can wipe out all electronics in a city is no more realistic than a hand-held laser cutting through a bank vault door.

High-Energy Lasers (HELs)

A laser generally produces a beam of coherent light at a specific wavelength dependent on the atomic structure of the lasing substance. Only certain substances have the atomic properties appropriate for producing laser light, and these are often limited in power. Lasers are characterized by the substance being lased (gas, liquid, or solid) and the "pumping" process (light energy, electricity, or chemical reaction). A resonant optical cavity provides the means for aligning the energy in the beam and extracting that energy. A military laser system also includes beam processing or beam-path conditioning, beam pointing and control and—for long-range applications—adaptive optics to compensate for the atmosphere.

Until recently, HELs have been driven by chemical energy, so very little electrical power or pulsed power was needed. Chemical lasers use the reactions of gases or liquids to create the excited energy states necessary for laser emission. Large chemical lasers and beam directors have been developed by the Navy in recent decades and have successfully ruptured fuel tanks and downed supersonic missiles. However, these lasers required high-velocity, chemical-reaction chambers and emitted hazardous gaseous by-products. They often operated at wavelengths where the atmosphere absorbed much of the energy. Absorption creates thermal blooming, whereby absorbed energy in the air creates a negative lens that defocuses the beam. Increasing the power of the laser increases the energy absorbed and worsens the problem. The Army and Air Force are developing chemical lasers for airborne applications, where atmospheric absorption is less of a problem. Recent Navy interest in HELs has concentrated on lasers that are electrically powered, rather than chemically powered, and that operate at shorter wavelengths to allow smaller optics and more efficient propagation near the water.

Small semiconductor (or diode) lasers use current flow through an electrical junction to excite electrons and create laser light. These lasers are very limited in power, so research has focused on using large numbers of lasers assembled into a coherent array. Semiconductor lasers also create efficient light to excite or "pump" other types of lasers. Solid-state lasers (SSLs) use crystalline materials mixed (doped) with elements needed for proper lasing. SSLs show strong promise for compact, medium-power HEL weapon systems. Scaling these systems up to megawatt levels creates extreme heat in the crystal material, making it very difficult to prevent internal damage. Forced cooling and the heat capacity of large masses are under study.

Fiber lasers—which use semiconductor diode lasers to pump a flexible, doped crystalline fiber (similar to a fiber-optic line)—have demonstrated high efficiency and relatively high power. The technology is being used in the welding and cutting industries. Methods of pumping large numbers of fiber-optic lasers and combining them are being investigated. An example is shown in Figure 4.

The free-electron laser (FEL) operates differently from a conventional laser. An FEL uses a high-voltage electron accelerator to push electrons through a magnetic "wiggler" to create light radiation across a tunable band of frequencies. The FEL is extremely complex and large, but scaling to very high powers may be possible. Perhaps the biggest promise of the FEL is the ability to design the laser at an ideal atmospheric propagation wavelength. Significant technical hurdles remain in reaching the status of a deployable FEL, in scaling the beam to megawatt powers and in providing the necessary engineering to turn a laboratory device into a weapon system of reasonable size. For Navy application, FELs will require improvements in areas of radiation shielding, high vacuum, high-current photo-injectors, and probably cryogenic cooling—all of which must be integrated into a ship's basic design.

Fiber lasers and SSLs are the leading-candidate Navy lasers for medium power, as FELs are for high power. All are electrically driven and can meet the requirement for shorter wavelength, capable of transmitting at the "maritime window" of approximately 1 μ.

HEL weapons' advantages include a highly directional and narrowly focused beam, providing:

- Minimal collateral damage
- Speed-of-light delivery
- Rapid retargeting
- Low cost of engagement

Disadvantages center on:

- Limited range due to atmospheric attenuation
- Weather limitations
- Low efficiency (often less than 10 percent)
- Need for eye protection
- Relatively large size and weight requirements

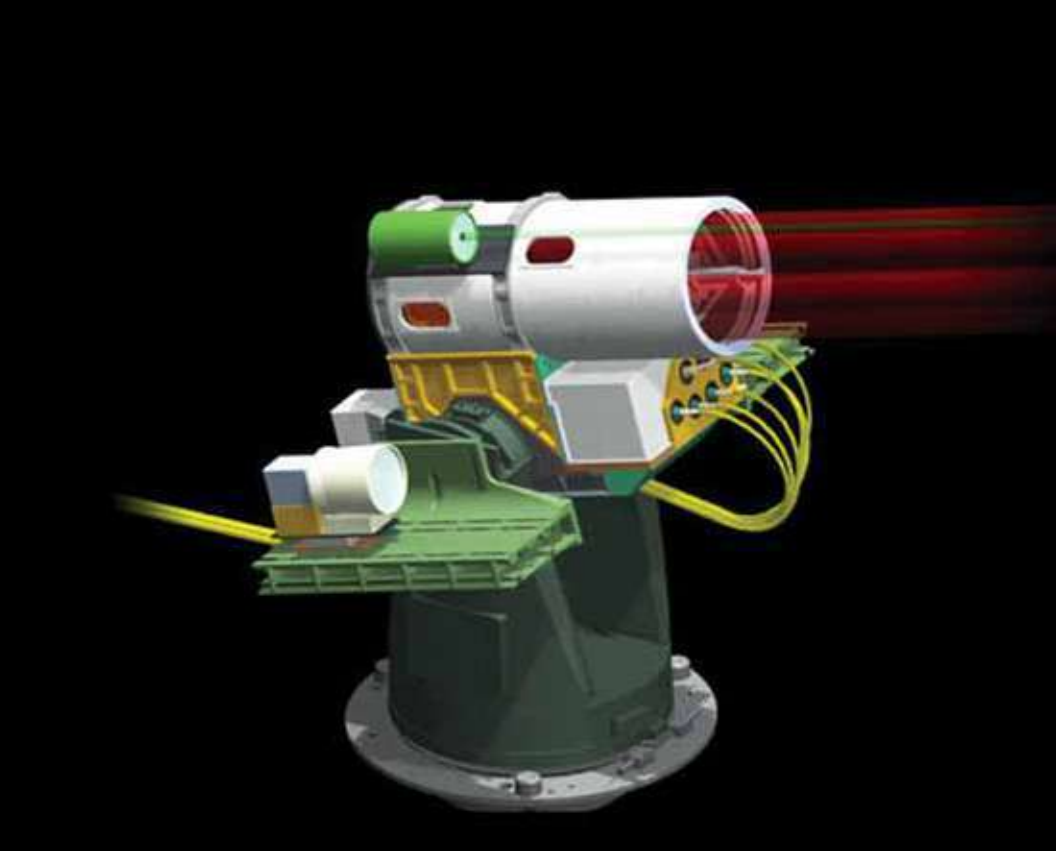

Figure 4. Drawing of Laser Weapon System (LaWS)

Long dwell times (seconds) will be needed for most targets. As with RF systems, there is a potential nonlethal or variable lethality capability since the energy can be easily defocused. A critical challenge is the understanding of a laser beam's propagation through a maritime boundary layer environment, where the sea and air interface creates turbulence and moisture gradients. Measuring the atmosphere and compensating for variations in real time may require adaptive optics or "rubber mirrors" that can be constantly adjusted to compensate for changes. Focusing a small spot at long range will require high beam quality and large optics, probably meter-size mirrors that are very highly reflective and very clean.

HELs in the future are expected to be able to focus energy to a spot size of much less than a meter at ranges of kilometers. This will necessitate very accurate target tracking systems, and precise stabilization and beam-pointing systems, both of which are difficult but should be feasible in the near term. Real-time atmospheric measuring systems will be needed for compensation techniques. Methods to protect the sensitive optical system from salt spray and corrosion will also be needed.

From a lethality perspective, three considerations need to be better understood before a HEL can be deemed a true weapon system:

1. Achievable spot size of beam on target at range
2. Amount of coupling into the target material
3. Subsequent effects of the damage inflicted

For the more severe threats, such as high-speed, antiship cruise missiles, HELs face the difficult task of engaging maneuverable, stealthy, inbound missiles. As such, a better quantitative understanding of the interactions among a laser beam's energy deposition, target material, and flight dynamics is needed.

Particle Beams

A particle-beam weapon is a directed flow of atomic or subatomic particles. These particles can be neutral or electrically charged. Neutral beams need to be used outside the atmosphere (in space), where charged particles would repel and fly apart. Charged-particle beams (CPBs) are easier to make and are used within the atmosphere, where air molecules can constrain the beam. A CPB weapon transmits matter—not just EM waves—like lasers and microwave weapons. The particles are near the speed of light and deposit their kinetic energy deeply into any target material. They have the potential to be highly destructive weapons and are very difficult to shield against.

Charged particles are produced by applying a strong electric field near a material that emits electrons. These electrons then pass through accelerating stages with high voltage gradients (often megavolts), which increase the electron's velocity. As the electrons pass each stage, the velocity increases until they approach the speed of light (become relativistic), at which point they have substantial energy to penetrate a target. The accelerating systems can be linear, but a recirculating design is more compact and can reuse stages. These systems are basically high-current versions of scientific particle accelerators.

Once the electron beam is produced, it must propagate to the target. High-velocity electrons will not go far before they collide with air molecules and lose energy. The fact that air molecules struck by the beam are heated and moved out of the way for a short period of time creates a rarified "hole" in the atmosphere through which a second pulse can travel farther. In this manner, a fast series of pulses can "hole-bore" to the target, each pulse going farther than the last. The final pulse must have enough energy to damage the target. The deceleration of electrons in the atmosphere causes

Bremsstrahlung radiation in the forward direction toward the target, creating gamma rays that, in turn, create X-rays and RF radiation.[a] These effects can cause electronic upset and "soft-kill" mechanisms even if the beam slightly misses the target.

The beam of electrons is typically a few centimeters in diameter. When a beam strikes a target, the energy is deposited deep in the material (the collision cross section is small because of the relativistic speeds) in microseconds (much faster than a laser), creating thermal shock that is very difficult to shield against. For an explosive target, there is also the possibility of causing a deflagration or low-order burn, disrupting the normal warhead mechanism.

Scientists studying CPB weapons made significant technical advancements in the 1980s, but the weapons are still far from being practical. A CPB weapon is technically very challenging and expensive to build. Studies project that the volume requirements necessary for a CPB system could be on the order of a 5-inch gun system. Advantages of a CPB weapon include rapid penetration, a deep magazine, all-weather capability, and soft-kill mechanisms for a near miss. Problems include complexity, size, limited range, and the need to demonstrate compact accelerators and propagation mechanisms.

Electromagnetic (EM) Launchers

A number of technology concepts to launch projectiles exist using electrical energy. These systems rely on large currents in conductors, creating strong magnetic fields that drive a projectile. The velocity of a normal powder gun projectile is limited by the expansion speed of the explosive powder, and present military guns are reaching that limit. With an electric gun, the fields can push projectiles much faster, providing longer ranges and increased kinetic energies. The simplest version is an EM rail gun, shown in Figure 5.

In any conducting loop, the generated magnetic field tries to expand the loop. If everything is held in position, the only movable item is the conducting projectile, which moves down the rails in an attempt to expand the loop. Since megajouoles of projectile energy are needed for EM rail guns, energy storage

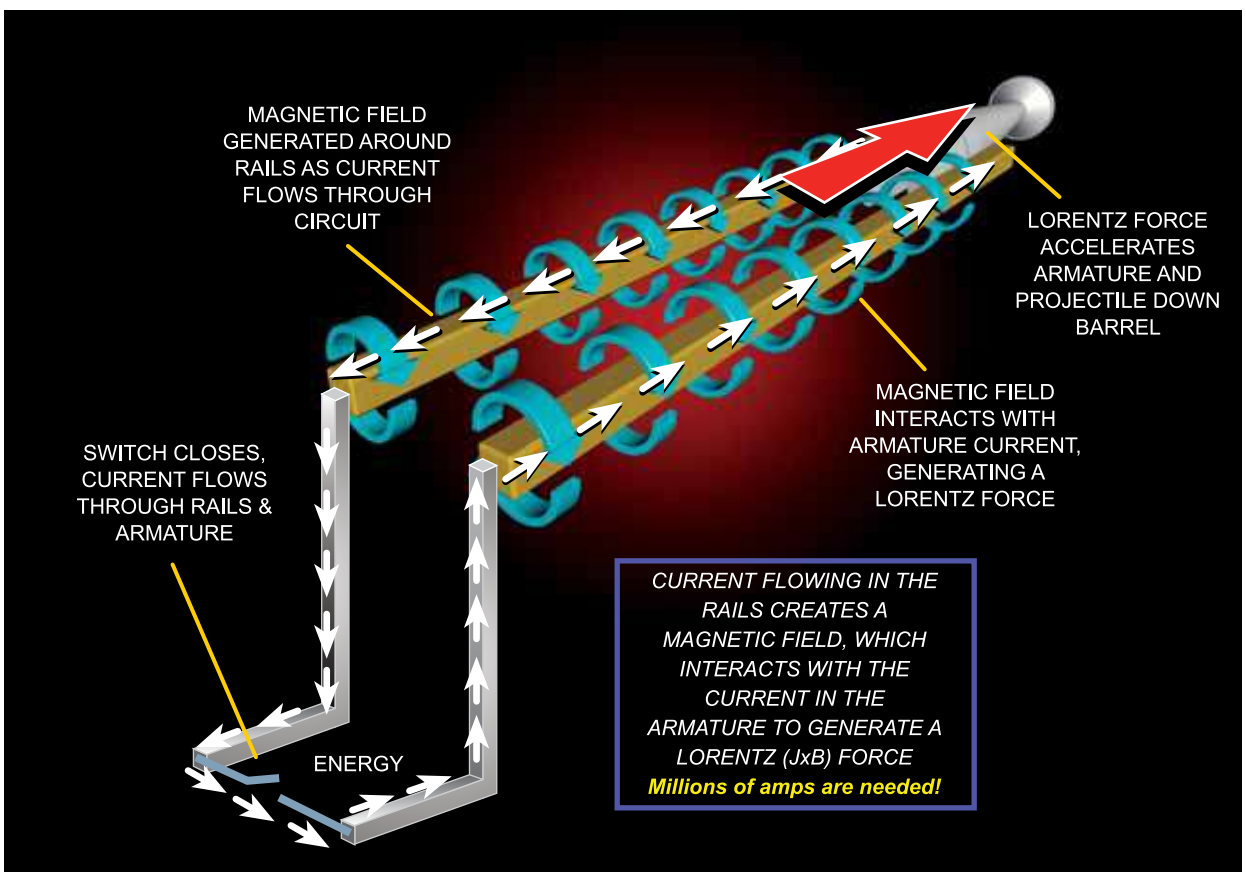

Figure 5. Electromagnetic (EM) Rail Gun Concept

mechanisms that can store about 100 MJ are needed, along with the ability to discharge the energy in milliseconds. To generate useful forces, millions of amps of current are needed—a major challenge and significant loss mechanism. Large capacitor banks with very high-current switches are required. Spark gap switches have historically been the only option, but new high-current solid-state switches are now becoming available. Capacitor energy densities, too, have improved an order of magnitude in the last few decades. Rotating machines have also been considered because they are smaller than equivalent capacitor banks, but extracting the energy quickly, without tearing the machine apart, has been problematic. The launch energy of various projectiles is shown in Figure 6.

- 20 mm --0.1 Megajoules
- 76 mm --1 Megajoule
- 5”/54 --10 Megajoules
- 8”/55 --40 Megajoules
- 16” gun --300 Megajoules
- Aircraft --50 Megajoules (30,000 kg @ 50 m/sec)

Kinetic Energy of Conventional Launch Packages

Figure 6. Launch Energy of Various Projectiles

A rail gun is probably the most compact form of electric launcher. However, it requires direct electrical contact between the projectile and barrel rails, creating the potential for arcing, melting, and erosion. Coil guns use a series of sequentially fired coils around a “barrel” to push the projectile in stages. This does not require direct electrical contact, so it avoids rail erosion but requires a series of fast timed switches and more space. Linear induction motors are basically unrolled electric motors and have been used on electric trains and roller coasters, typically with magnetic levitating systems to avoid contact erosion. This concept is being developed by the Navy for launching aircraft. The energy to launch an aircraft is similar to a large-caliber projectile—more weight but less speed. The slower speeds are more suitable for rotating machines since the launch times are seconds rather than microseconds.[1] Electrothermal guns and electrothermal-chemical (ETC) guns use a combination of electricity and chemicals. Electrical energy is used to initiate chemical reactions that can produce lightweight driving gases, like steam, or allow more energetic propellants that are difficult to ignite in a conventional fashion.

Some advantages of electrically driven projectiles include:

- Higher projectile velocity (over conventional explosives)
- Very long range (>100 miles) with lower cost than missiles
- Time-critical delivery (because of shorter time of flight)
- Safer projectile stowage (minimal explosives)
- Potentially adjustable velocity levels, for better accuracy and controllable damage

The potential of having nonexplosive rounds and magazines is very attractive for the Navy. For long-range, large-caliber EM projectiles, the kinetic energy from the projectile velocity is greater than the chemical explosive energy in a conventional round traveling much slower. Therefore, damage can be equivalent even without explosives. System size and lifetime are still behind conventional systems, but getting close.

Outlook

Challenges remain for many electric weapon concepts. These weapon systems appear promising to meet the increasingly important asymmetric threats with low-cost precision rounds. They also can be employed across the energy spectrum for nonlethal targeting. Electric weapon systems will, in many cases, continue to supplement existing kinetic weapon systems in the near term. Despite technology challenges, directed-energy and electric weapons hold great promise in offering the future warfighter unique combat capabilities not currently available.

Endnote

a. Bremsstrahlung—a type of radiation emitted when high-energy electrons are decelerated. (German for ***braking radiation***)

Reference

1. Shope, S. et al., *Long-Range Naval Fire Support with a Coilgun*, Sandia Report 2001-3832, February 2002.

Solid Modeling of Directed-Energy Systems

By Joseph F. Sharrow

Not long ago, around the mid-1980s, development of most new mechanical systems—such as automobiles, consumer products, and military devices—was performed manually on a drafting table or drawing board, much like the present-day version shown in Figure 1. These tables and boards performed a necessary function, but they offered little assistance other than for drawing lines. Engineers used them to prepare layouts, or two-dimensional sketches of what they were designing. They then would take these layouts to a draftsman, who would create drawings of each part in the device. The drawings would subsequently be sent to a manufacturing facility.

This layout and drawing preparation process typically would need to be repeated multiple times because mistakes would be made, or design issues would be discovered late in the process. Similarly, the manufacturing process would sometimes require multiple iterations as well because of the inherent limitations in designing three-dimensional (3-D) devices on two-dimensional boards. This less-than-ideal process made it difficult to design and manufacture even mundane products and frequently resulted in things that just didn't work. With the emergence of early computerization, numerical analyses of more complex systems began to be performed. These analyses were conducted to ensure that the systems worked in the real world. For example, engineers might conduct a structural analysis of the forces in a loaded dump-truck bed to make sure that the frame wouldn't bend and fail. Because of the difficulty in performing these analyses, they would often require a specially trained group of structural engineers, expensive software, and large mainframe computers, limiting their use to only the largest, most well-funded companies or organizations.

Emergence of Computer-Aided Design (CAD) and Solid Modeling

With the availability of smaller scale computers and more economical software in the mid-to-late 1980s, CAD was born, initiating a period of rapid improvement in the design process. This was driven, in part, by the introduction of software packages such as AutoCAD. Initially, these software packages only attempted to automate drawing lines by making wireframe (stick-figure) versions on the computer of what previously had been made by hand on the drafting board. This reduced the difficulty in making changes in the development process, but it still limited the engineer's pallet to a two-dimensional space. What was really needed was a 3-D method of design. Solid modeling

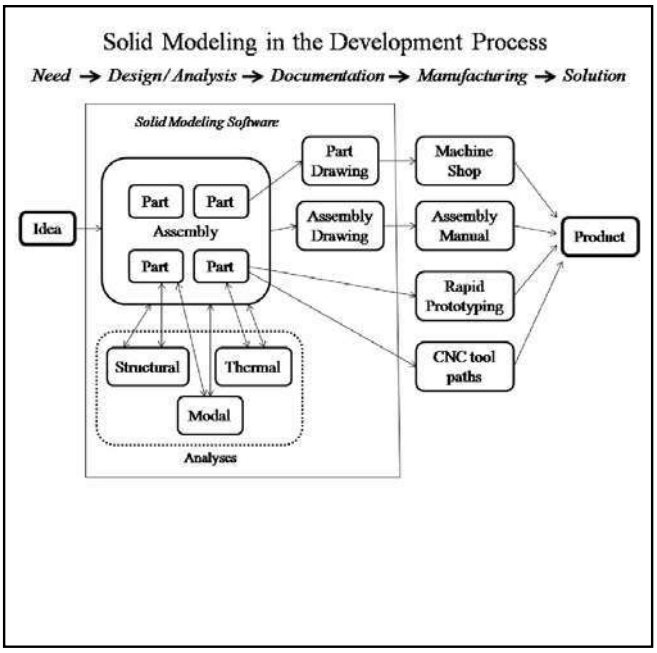

Figure 1. Drawing Board

addressed this need beginning in the late 1980s to early 1990s.

Solid modeling is analogous to taking blocks of clay and cutting and forming them into the shape of a solid part on a computer. These 3-D parts are then put together in an assembly, more accurately representing real-world devices. Though originally used only in a limited way for specialized applications in the aircraft and automobile industries, it wasn't until the 1990s that solid modeling experienced widespread availability and mainstream acceptance due to software packages such as Pro/ENGINEER. Figure 2 summarizes how Pro/ENGINEER and other similar packages fit into the development of new products. The general flow of the process moves from left to right.

Initially, nearly all 3-D solid modeling packages required significant computing and graphics display power, necessitating the use of large graphics workstations running the UNIX operating system. Rapid advances in computing and graphics power have since enabled nearly all packages to run efficiently on personal computers (PCs) and laptops, bringing solid modeling and analysis capability into the mainstream.

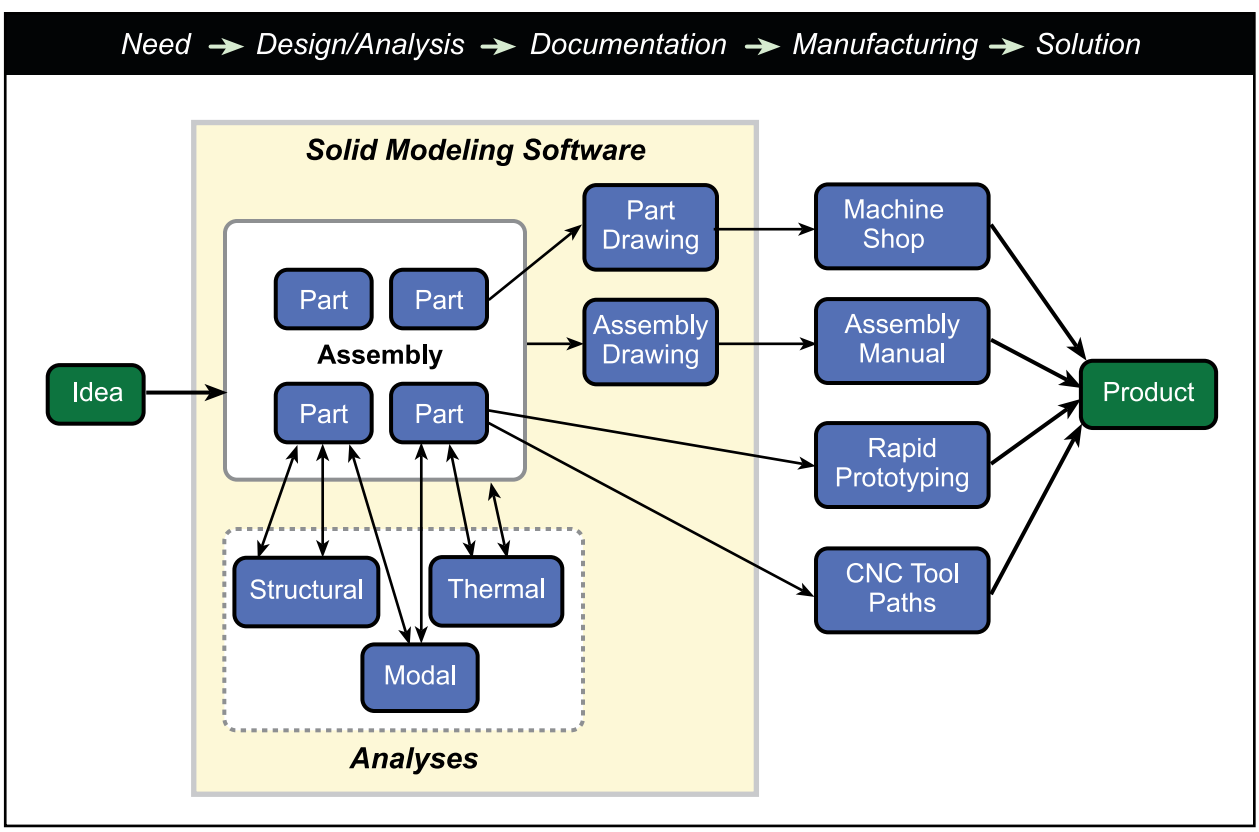

Figure 2. Solid Modeling in the Development Process

Solid Modeling of Directed-Energy Systems

Engineers working in the Directed Energy Division at the Naval Surface Warfare Center, Dahlgren Division (NSWCDD), use solid modeling to develop hardware for nearly all of its programs. Both Pro/ENGINEER and SolidWorks are used extensively to develop new products in virtual 3-D space. Additionally, the structural simulation package within Pro/ENGINEER is used to determine stresses and natural frequencies of parts and assemblies. Consequently, these packages have enabled a single mechanical engineer in the Directed Energy Division and a draftsman in the Engagement Systems Department at Dahlgren to perform the design and analysis work that would have required an entire group of engineers and draftsmen just a few years ago. Today, collaboration among many organizations using similar packages has become commonplace. Insofar as solid modeling has become an indispensable tool for development and collaboration, its successful implementation requires proper training and experience before engineers can use it effectively, just as medical surgeons require training in the use of advanced robotic surgical devices before they can be used effectively. Thus, while these high-tech modeling systems not only have reduced the number of personnel needed for design and development, they have enabled the Navy to get significantly more bang for its buck while supporting warfighting needs. An example of how solid modeling is currently being used is discussed below.

Navy Laser Weapon System (LaWS) Beam Director

The Directed Energy Warfare Office (DEWO) and Directed Energy Division at Dahlgren are currently developing the Navy LaWS for the Naval Sea Systems Command's Directed Energy and Electric Weapon Systems (DE&EWS) Program Office (PMS 405). The program's goal is to take advantage of currently available industrial laser technology and incorporate it into a future naval weapon system. As part of the development process, major subsystems have been integrated with a Kineto Tracking Mount (KTM) into a LaWS beam director. The KTM/beam director was modeled and analyzed using Pro/ENGINEER. Ultimately, the resulting LaWS will be installed on Navy ships on the Close-In Weapon System (CIWS) gun mount. During field testing in June 2009 at the Naval Air Warfare Center, China Lake, California, the prototype KTM/beam director successfully destroyed five unmanned aerial vehicles (UAVs). The actual beam director used in the China Lake testing is shown in Figure 3; the Pro/ENGINEER assembly model used for development is shown in Figure 4.

The LaWS effort took advantage of many aspects of solid modeling including collaboration, structural and modal analysis, and manufacturing drawing creation. The project required development of new, unique hardware, as well as the integration of electronic models from commercial vendors. The KTM model was provided by L-3 Brashear and was originally designed using Pro/ENGINEER. The beam-directing telescope model was provided by RC Optical Systems, Incorporated, and was originally made in SolidWorks. These models were combined with many new optical and structural components developed by the Directed Energy Division into a single, comprehensive assembly model. This model was instrumental in understanding the interaction of the many components, and its use increased accuracy and precision that would have been impossible with old-fashioned two-dimensional development processes. Figure 5 shows a cross section through the main portion of the beam director, revealing the complexity of the many parts and subassemblies required for such a device. In addition to modeling the mechanical components, the actual laser beams were also included to better understand their path through the various mirrors and optical devices in the beam director, and to better highlight any interference they might have with structural components within the KTM or telescope.

Numerous analyses were performed to make sure that everything worked the way it was intended. One major analysis addressed the telescope mount. To ensure that the beams were stable at range, the mount had to be extremely stiff. The best way to ensure this was to perform a structural analysis using the structural simulation package within Pro/ENGINEER. Figure 6 shows the results of that analysis: a displacement plot in which different colors represent how much the telescope will move when the KTM rotates at its maximum speed. The large cylindrical object simulates the mass of the telescope. The minimum amount of displacement is indicated by blue, and the maximum is shown in red. This analysis verified that the movement of the telescope, relative to the optical components within the optics breadboard, was acceptable and should perform well at the range specified by the program office.

After modeling and analysis were completed, manufacturing drawings of custom parts were created by the Engagement Systems Department to be

Figure 3. LaWS Beam Director

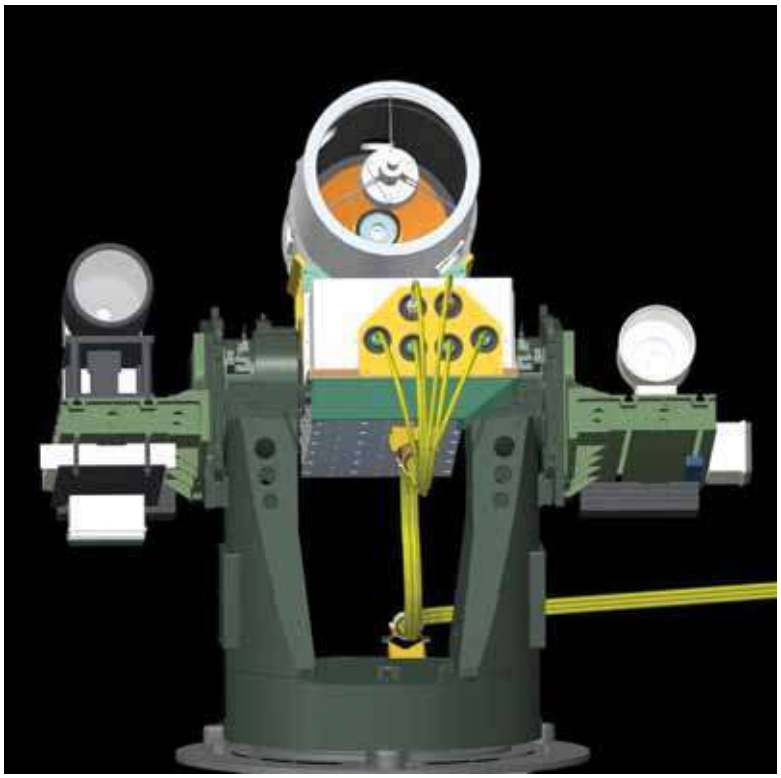

Figure 4. LaWS Beam Director Assembly Model

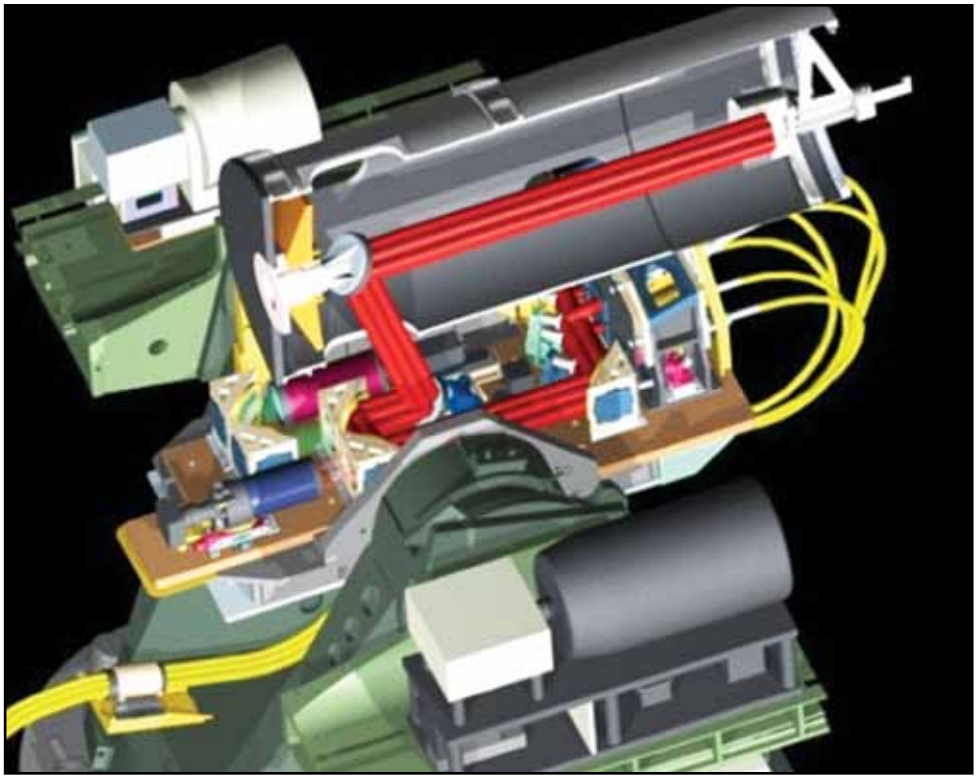

Figure 5. LaWS Beam Director Cutaway

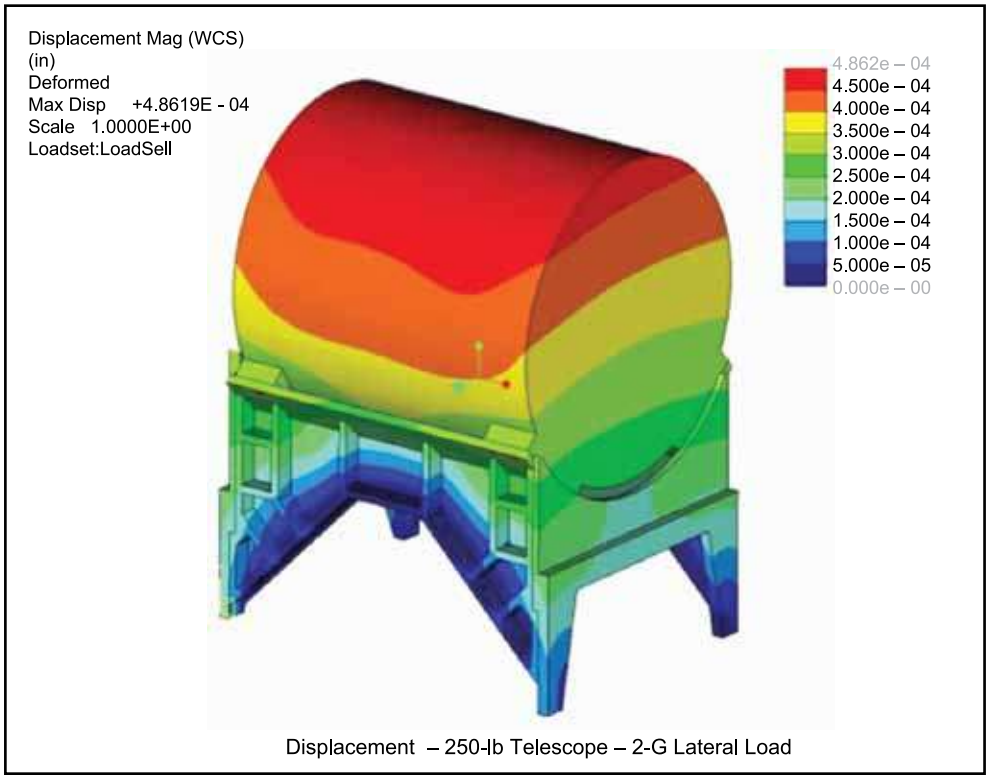

Figure 6. Displacement Plot

sent to manufacturing facilities, such as machine shops. One example is shown in Figure 7, which shows the first sheet of the multisheet drawing needed to manufacture the large plates that support the telescope from the center platform of the KTM. One of these plates is also shown in the displacement plot in Figure 6.

Even though it would be possible for one person to do all of the modeling, analyses, and drawings for a particular program, a more efficient process takes advantage of using the best skills available by collaborating with other experts. Collaboration enables assembly, part, and drawing files to be sent electronically, eliminating the need for collocating personnel. Drawings for the LaWS program, for instance, were made using noncollocated personnel across base at NSWCDD. They could just as easily have been made using personnel from across the country.

The LaWS program exemplifies how the Directed Energy Division uses solid modeling to enhance the quality and effectiveness of Navy directed-energy capabilities. As a result, warfighters will be better armed with more effective weapons and capabilities for future naval conflicts.

Acknowledgment

The author would like to acknowledge the valuable contributions of the Engagement Systems Department's drafting group in support of numerous DEWO and Directed Energy Division programs.

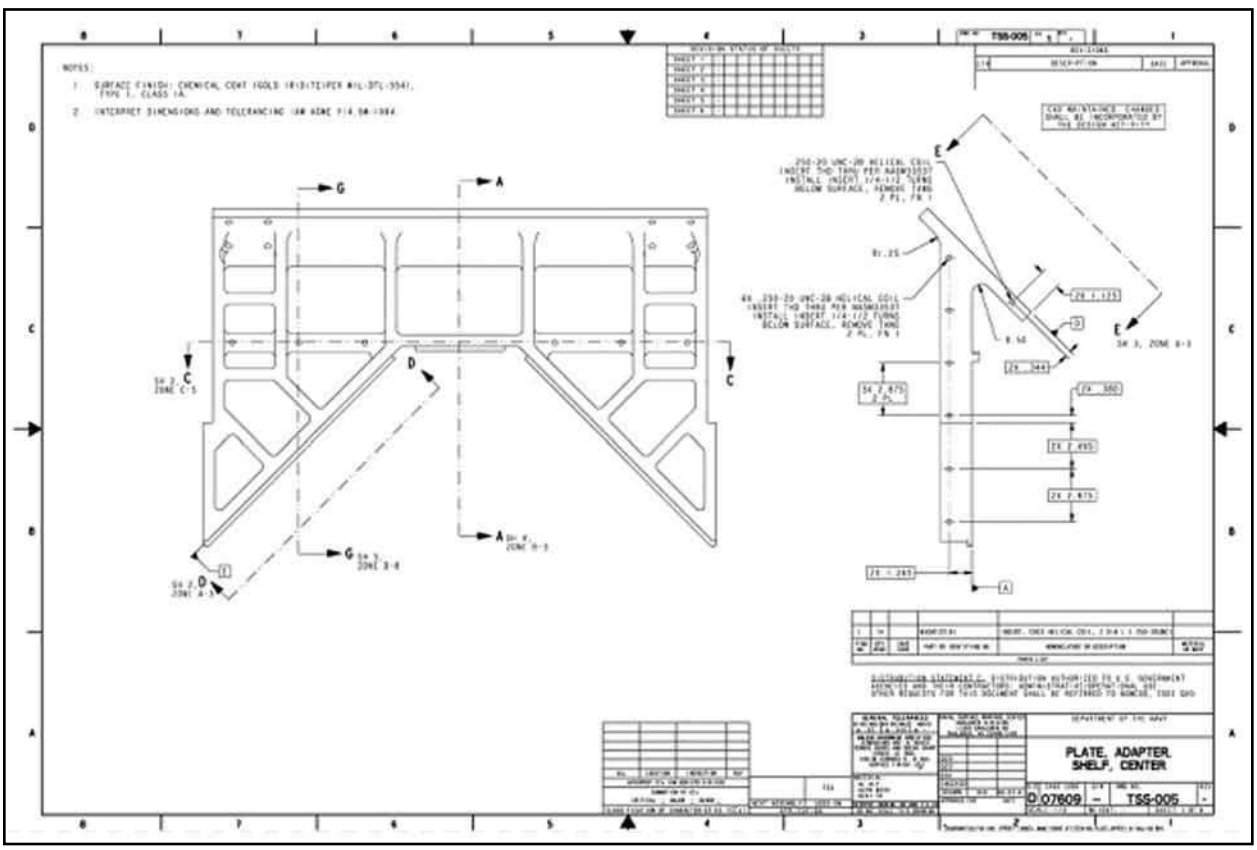

Figure 7. Manufacturing Drawing

A Fundamental Key to Next-Generation Directed-Energy Systems

By Directed Energy Division, Electromagnetic and Sensor Systems Department

Imagine an explosive ordnance disposal (EOD) unit on a routine scouting patrol deep in the notorious "Triangle of Death" south of Baghdad, where Marines, Sailors, and Soldiers frequently find themselves exposed to improvised explosive devices (IEDs). Fortunately, this newly outfitted unit is equipped with the latest unmanned, mobile, remote-controlled, radio frequency (RF) transmitter used as a directed-energy weapon (DEW). The integrated system provides comprehensive IED prediction, detection, prevention, and neutralization capabilities. Lightweight, pocket-sized transmitters carried by each warfighter constantly communicate sensor intelligence, key vital signs, critical conditions, and location telemetry to a geostationary satellite (GEOSAT). It intercepts, collects, and retransmits intelligence and situational awareness data simultaneously to any command post in the world and to each member of the unit on patrol. Highly efficient, miniature, switch-mode, RF amplifiers with high-power density (small size and weight with high-power output) enable these visions of future capabilities as their systems' transmitter backbone.

To civilians, the miniaturization of modern wireless (electromagnetic) devices is considered a mere convenience or luxury, i.e., Blackberries, mobile phones, and high-speed wireless network connections. To the next-generation warfighter, miniaturized, wireless, directed-energy (DE) systems open the door to the realization of a whole new set of effective and efficient wireless modalities. And while the capabilities mentioned in the above scenario are not yet available to warfighters, researchers believe they have uncovered the key to next-generation DE systems leading to the miniaturization of DE devices.

Next-Generation DE System Requirements

At the Naval Surface Warfare Center, Dahlgren Division (NSWCDD), key system requirements for effective next-generation DE systems are being researched and developed for applications to counter IEDs, to detect explosively formed penetrators (EFPs), to neutralize explosives, and to predict threat locations. Next-generation DE systems must yield a high probability of mission success and be inherently safe to operate. By design, they must minimize or eliminate the risk of hostile attack or collateral damage especially during screening missions. Considering the DEW example above, practical

080102-N-1132M-006 SHEIK SA'ID, Iraq (2 January 2008) U.S. Army Soldiers attached to 3rd Squadron, 2nd Cavalry Regiment patrol and search for weapons or Improvised Explosive Devices (IEDs) during a clearing mission. (U.S. Navy photo by Mass Communication Specialist 1st Class Sean Mulligan/Released)

next-generation DE systems must be physically characterized by:

- Low mass (weight)
- Small size (volume)
- High-power output with respect to size or high-power density
- High efficiency for extended mission use
- Minimized prime power and cooling support
- Portability
- Mobility
- Configurability

They must also ensure a high probability of mission effectiveness. The DEW must be easily transportable and agile, adapting to the immediate, local military mission requirements in various warfighting environments. Additionally, DE systems must be mechanically robust and able to withstand the shock and vibration of combat missions in rough and rugged environments. The key requirement—efficiency—fundamentally facilitates all required characteristics, including mass and size.

Moving Beyond Requirements

Scientists at NSWCDD, sponsored by the Office of Naval Research (ONR), are researching and developing key system requirements for effective next-generation DE systems to counter IEDs, to detect EFPs, to neutralize explosives, and to predict threat locations.

Researchers at NSWCDD are leading the way toward realizing small, lightweight, RF transmitters using high-power, solid-state, switch-mode amplifiers, theoretically 100 percent efficient. These practical switch-mode amplifier realizations are at least 1/100 the volume and weight of any commercially available linear solid-state amplifier of comparable power output. The challenges included assessing what type of active amplifier device and operation would provide the greatest power density (power output per unit volume and mass) with its necessary auxiliary systems, such as prime power generation and cooling of waste heat. Such a device also needed to provide sufficient output power based on required standoff range and IED system-coupling efficiency while also maintaining a manageably-sized, easily transportable system. Researchers initially considered tube-based systems, but large, heavy, direct-current (DC) power supplies are required, and typically 40 percent of the input power is dissipated in heat, which negates any possibility of miniaturization.

Upon a practical review of amplifier-class operations and suitable active amplifier devices, however, research pointed to contemporary switch-mode

amplifier schemes (e.g., Class-E and Class-F) using solid-state technology—such as the high-electron mobility transistor (HEMT)—as satisfying the high-power density and abusive mechanical requirements for expected worst-case transportation and operation in a rugged environment. To significantly impact reduction of size and weight, practical, high-efficiency thresholds were defined for next-generation DE systems at 90 percent and greater. The key technology enabler to realize amplifier high efficiency in high-power amplifiers up to 60 kW was found in exploiting contemporary switch-mode amplifier architecture with efficient power combining. Particularly, switch-mode schemes in Class-E and Class-F operation as solid-state, active-hybrid planar topology designs were found to be necessary and sufficient for DE applications. These analyses led to a novel, Class-E RF switch-mode amplifier design. A Class-E RF switch-mode amplifier can theoretically operate at 100-percent efficiency. For every input watt supplied, an RF output watt is produced. The conductors and dielectric substrate of the hybrid planar load network and the commercial off-the-shelf (COTS) transistor all exhibit some small degree of power loss, suggesting an estimated practically realized efficiency of 90 percent.

Moreover, the amplifier under research consisted of a novel microwave load network operating with high-power output at ultrahigh frequency (UHF). This research led to the state of the art in Class-E designs leading by hundreds of watts, several hundred megahertz in frequency, and roughly 10 percentage points in efficiency. A common, solid-state, high-power amplifier design technique sums the phase and amplitude of smaller amplifier units to the large values required for DE systems. A practical hardware limitation exists that limits the theoretically infinite number of fixed RF output power units to a finite number. Approximately 60-kW RF output power sets the boundary as the largest hardware realization. By applying spatial power combining in the propagating medium, phased-array antennas can be employed with constructive wave interference in air that would allow sufficient RF power densities on target, based on the number of elements in the array. This technique eliminates the traditional hardware necessary to power combine the smaller power-amplifier elements, realizing a much simplified DE system with enhanced power density in the transmitter, and reduced mass and volume.

The key to ultrahigh efficiency in a switch-mode amplifier, such as Class-E or Class-F, is found in zero-voltage switching (ZVS). Here, the load network is not only designed to be resonant at and around a particular desired switching frequency, it must simultaneously act to force the voltage across the switch to be zero when current flows and when it switches off; hence, theory suggests that no power is dissipated because the product of current through, and voltage across, the switch is zero. It is this aspect of the design that makes the job of switch-mode amplifier realization difficult. Of course, in practice, a small voltage exists for a very short time during the switching action, resulting in a small amount of input power being dissipated in heat. This theoretical description also assumes that all components are ideal (i.e., no impedance to current flow exists in the switch when turned on). All realistic switches exhibit finite impedance when turned on, which does dissipate some wasted energy, but again, this is very small in modern HEMT devices using the ZVS technique.

Class-E switch-mode amplifier theory development began in the United States during the 1960s, with details published in 1975, although some earlier reports were published in Russia. Lumped element electrical components (RF choke inductors and metal film capacitors) were initially used in lower frequency (3 to 30 MHz) prototypes. As engineers attempted higher frequency designs in the very high frequency (VHF) range, solid-state transistor switch parasitic intrinsic and packaging elements found inside the transistor began to be used as some of the key components necessary for ZVS. These parasitic elements included stray capacitance caused by differences of potential between parts inside the transistor and inductance caused by bond wire length that is used to connect the transistor to accessible terminals in its packaging. At microwave frequencies, these parasitic elements become sensitive, invoking unintended significant changes to load networks designed to operate with the transistors. Intrinsic elements include drain-to-source breakdown voltage capability and peak current capability. As the need for higher frequency operation and higher power increased, constraints of key transistor parameters became difficult to produce in traditional silicon technology:

- High instantaneous transient (peak) current capability through the transistor
- Moderate breakdown potential across the transistor
- Low output capacitance

Only within the past few years have transistor manufacturers produced COTS transistors that meet the required capabilities necessary to operate in switch mode for microwave frequencies and

081107-N-1120L-072 RAMADI, Iraq (7 November 2008) Joint EOD Rapid Response Vehicles (JERRVs) assigned to Naval Mobile Construction Battalion (NMCB) 7's convoy security element are secured following an escort mission from a forward operating base. The Cougar-type JERRVs are employed by coalition forces for escort and logistics missions, and to protect personnel from IEDs. NMCB 7 is deployed to U.S. Forces Central Command to provide contingency construction support to coalition forces in support of Operations Enduring Freedom and Iraqi Freedom. (U.S. Navy photo by Mass Communication Specialist 2nd Class Michael B. Lavender/Released)

high-power output. Selection is still somewhat limited for designers.

New transistor technology known as gallium nitride (GaN) HEMTs—using state-of-the-art manufacturing processes with GaN on silicon carbide materials—now facilitates Class-E high-power amplifier (100-W) designs at ultrahigh frequencies. The design process for switch-mode amplifiers is radically different than linear amplifiers, so engineers have tended to continue using linear amplifier design techniques due to familiarity, rather than advance to the switch-mode designs. Today, the Class-E and Class-F unit power output (greater than 100 W) capability and upper frequency limitation is based on a lack of available HEMTs with the necessary parameter capabilities.

Most recently, transistor manufacturers have limited their investment in the Class-E amplifier solid-state switch market due to no commercial market mandate. An assortment of presently available HEMTs provides a low-power capability in terms of 1- to 10-W output power for Class-E amplifiers in the cell phone market. The need remains to continue advancing in commercially manufactured HEMTs with key capabilities necessary to realize larger unit power output, hundreds of watts to a thousand watts, for practical implementation in DE systems.

Possible Multiple Applications

Directed-Energy Weapon Systems

Expanding on the vision of the next-generation DEW system mentioned at the beginning of this article, further imagine that EOD scouts detect a laser fluorescence signature of C4 high explosive and chlorine outgasses in the vicinity of an abandoned vehicle 2-km north of their current position. An electronic support measure (ESM) team on board an approaching clearing vehicle initiates RF jamming and electromagnetic surveillance procedures. Electronic specialists also scan the area with ground-surface differential thermography—particularly to detect possible buried IEDs and EFPs or their tiny command wires, crush wires, or pressure plates—while clearing a pathway to the abandoned roadside vehicle.

Upon arrival at a 500-m safe distance, the EOD specialists command the RF transmitter's robotic platform, also equipped with sensitive gamma-ray planar and computed tomography (CT) imaging to navigate toward and around the vehicle, interrogating every possible hiding place. It discloses an IED in the fuel tank. The specialist lifts the transmitter arming safety and commands the remote transmitter to radiate a prescribed dose of RF energy directed at a carefully chosen component of the vehicle-borne IED (VBIED) system. Without entering the vehicle, the advanced screening system detects and defuses the deadly IED buried within the rusty, metal vehicle chassis. Within minutes, the suspected VBIED threat is entirely neutralized, with absolutely no wounded warfighters or casualties.

Pictured here is the National Aeronautics and Space Administration/National Oceanic and Atmospheric Administration (NASA/NOAA) Geostationary Operational Environmental Satellite-P (GOES-P) launching from Cape Canaveral Air Force Station, Florida, aboard a Delta IV rocket procured by Boeing Launch Services on 4 March 2010. Built by Boeing Space and Intelligence Systems, GOES-P will provide NOAA and NASA scientists with data to support weather, solar, and space operations, and will enable future science improvements in weather prediction and remote sensing. Additionally, GOES-P will provide data on global climate changes and capability for search and rescue.

Mobile Ad-Hoc Wireless Network (MANET)

Beyond IED detection and neutralization, imagine an expeditionary unit on patrol, with each member equipped with an RF transceiver about the size and weight of a cigarette pack with an ultrahigh-efficient switch-mode amplifier. The miniature transceiver constantly communicates sensor intelligence, key vital signs, critical conditions, and location telemetry to a GEOSAT. This small switch-mode amplifier has the needed output power to reach an altitude of 35786 km, where the GEOSAT intercepts, collects, and retransmits this intelligence and situational awareness data to any command post in the world and to each member of the unit on patrol simultaneously. The expeditionary unit, spread out over a wide area with large interspacing, shares the situational awareness and intelligence data of each other at the speed of light. Thus, near real-time, worldwide communications with ubiquitous secure access from the battlefield is possible in a multiple-input, multiple-output (MIMO) architecture. The same system could provide a soldier-to-soldier MANET.

Next-generation switch-mode RF amplifier designs could also optimize payload weight and volume on board new communication satellites while supplying higher power density and making efficient use of the solar power supply budget. Improved switch-mode amplifier power output, when combined with enhanced antenna design, would minimize Earth-station antenna size requirements. The recently launched satellite shown at left demonstrates an example of the latest antenna technology.

Looking Forward

Miniaturizing next-generation DE systems opens up a whole new world of applications to support warfighters in ways unimaginable just a few years ago. Reduction of transmitter mass and volume, accompanied with high efficiency, creates a welcome trickle-down effect. Low profile, small, lightweight DE systems means:

- Less vulnerability to attack
- Greater mobility and maneuverability
- Simplified logistics with less fuel-supply demands
- Less impact on the environment

Clandestine operations, too, could be executed with greater ease and simplified logistics support. In the case of MIMO MANETs, miniaturized high-power density transmitters could further expand capabilities for the warfighter, enabling them to carry high-power transmitters to communicate with satellites or other supporting platforms. The

satellite industry itself could benefit from miniaturized switch-mode amplifiers with much higher power density microwave transmitters, resulting in reduced payload mass and volume; this also reduces Earth-station antenna gain and size requirements.

Conclusion

NSWCDD is meeting the demanding requirements of next-generation DE systems with Class-E RF transmitter switch-mode amplifiers designed to operate at ultrahigh efficiency, greater than 90 percent. Having discovered the key to next-generation DE systems, researchers at NSWCDD are focusing on the urgent need to counter IED systems with small, lightweight, highly efficient transmitters that use switch-mode amplifiers. Considering the multiplicity of additional applications, all advancements made in amplifier counter-IED applications can be transferred to other applications in the future. Accordingly, while the capabilities suggested in this article might seem somewhat far-fetched, in reality, they are realizable in the near term. It is projected that NSWCDD will soon have its first 250-W UHF amplifier unit prototype ready. These units will fit in the palm of an average-sized adult's hand and can be power combined to the level necessary for platform and mission requirements. A fully realized, fieldable DEW system prototype is possible in just a few years.

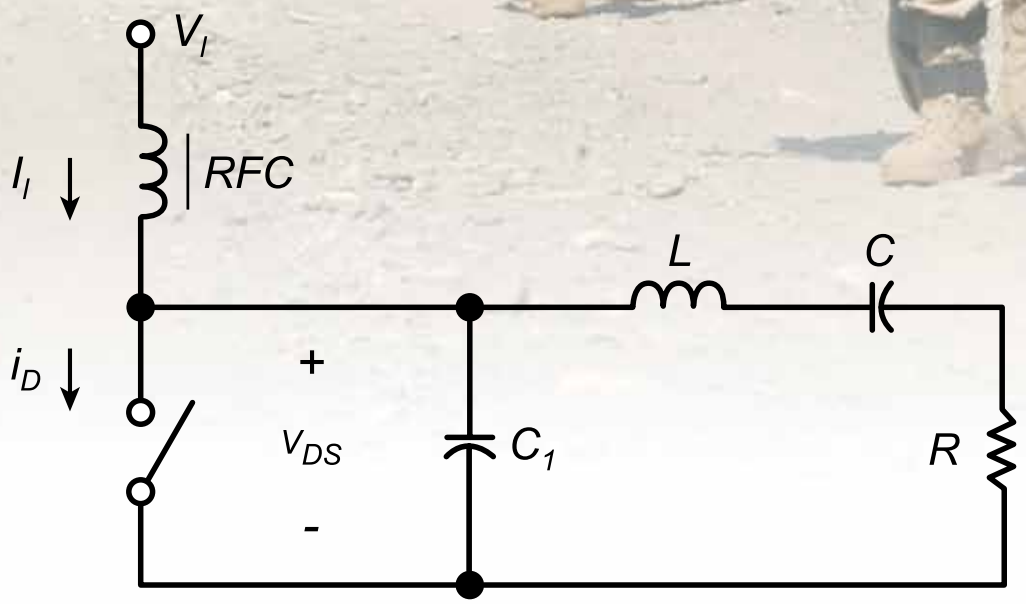

Active Denial Array

By Randy Woods and Matthew Ketner

Active Denial Technology (ADT)—which encompasses the use of millimeter waves as a directed-energy, nonlethal, counterpersonnel weapon—has the potential to provide an important new escalation-of-force capability to U.S. operating forces. ADT projects a focused beam of 95-GHz millimeter waves to induce an intolerable heating sensation on an adversary's skin, repelling the individual with minimal risk of injury. More than a decade of research has established the biological and behavioral effects of ADT for large spot size systems, such as Active Denial System 1 (Figure 1). While the effects of this large spot size system have been successfully established, the technology that produces those effects has the potential to progress in a number of ways, particularly with the development of smaller, lighter, and lower-cost systems.

One research effort focuses on the development of smaller, lighter, and lower cost ADT demonstrators that produce commensurate "ADS-effects," with effective spot size and power densities on target. In support of this effort, the Joint Non-Lethal Weapons Program (JNLWP) sponsored the Naval Surface Warfare Center, Dahlgren Division (NSWCDD) to develop a "smart target system," which measures the millimeter-wave beam using fast-response, 95-GHz diode detectors. NSWCDD subsequently developed and tested the W-Band Beam Diagnostic Array to characterize the system's beam with a temporal resolution of 30 Hz and a high spatial resolution of 1 inch.

The current method of measuring the 95-GHz beam is to use carbon-loaded Teflon (CLT) to produce an average power beam image. This method works as the CLT is exposed to the system's beam. The material heats, over a period of seconds, proportional to the magnitude of the radio frequency (RF) field, resulting in an image as shown in Figure 2. After the exposure, the specific heat capacity of the CLT can be used with the temperature increase in the CLT to provide an indication of the total energy deposited in the material. This method produces a good representation of the average RF field; however, any peak variations in the beam are averaged out.

To allow for high temporal-resolution measurements of the 95-GHz beam, a high-density, 95-GHz diode-detector array was commissioned by the Joint Non-Lethal Weapons Directorate (JNLWD), and was designed and built by NSWCDD, with support from Millitech, Inc. The array consists of a center 11 × 11 matrix (shown in Figure 3) with four removable arms that can be attached (shown in Figure 4), resulting in a measurement area of approximately 1 × 1 m.

Figure 1. Active Denial System 1

Each element's profile consists of the individual horn antenna from the array, an attenuator, a detector, and a SubMiniature version A (SMA) connection to the digitizer circuitry. This configuration allows for the power received from the antenna to be attenuated and converted to a direct current (DC) output capable of being measured by an analog-to-digital converter. The machined antenna elements provide a uniform effective area for each element, allowing field strength (W/cm^2) to be converted into power received (W or dBm). The aperture antennas also provide an impedance match between free space and the waveguide system. A cross-sectional view of the array element is shown in Figure 5, followed by a signal flow diagram shown in Figure 6.

The basic principle of operation behind the array is that the derivative of the diode detector's power vs. output voltage curve is very repeatable between detector elements. Therefore, when the detector elements arrived at NSWCDD, each detector element was paired with a variable

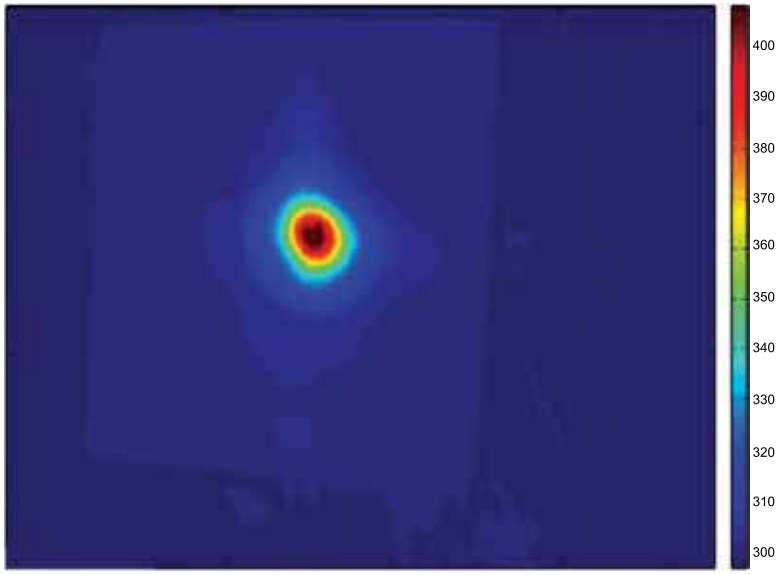

Figure 2. CLT Representation of Small, 95-GHz Spot

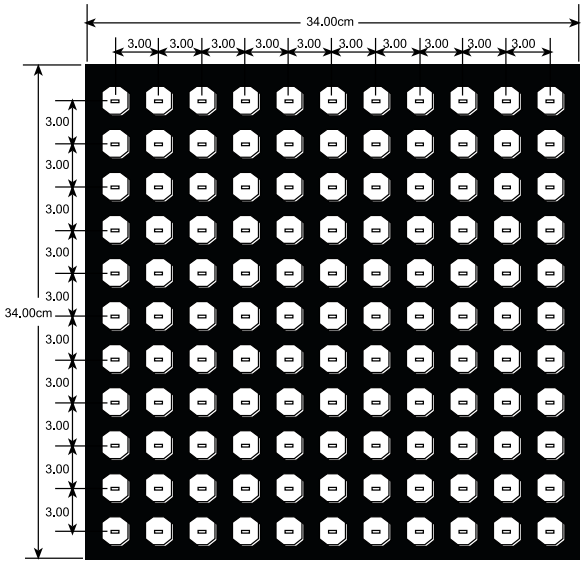

Figure 3. Main Array Face

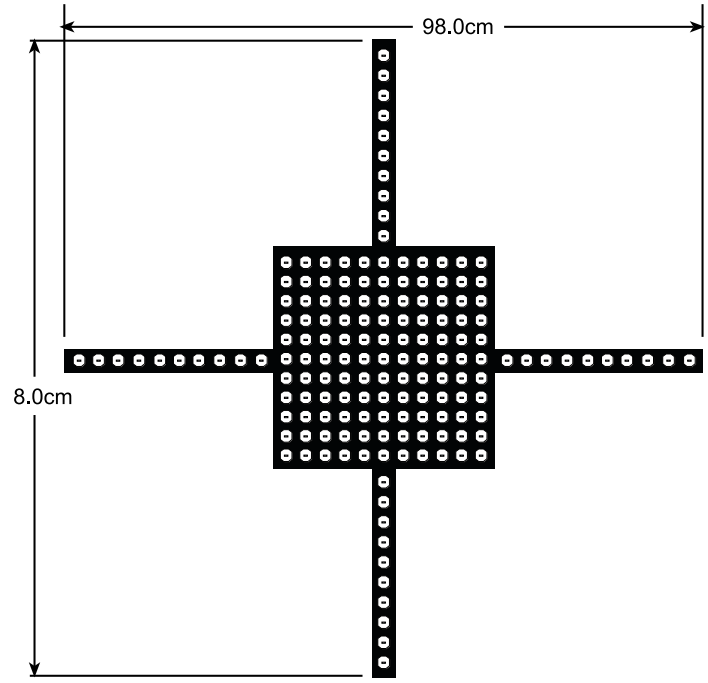

Figure 4. Full W-Band Array

attenuator and calibrated as a single unit. The calibration was accomplished by inserting a known input power of +5 dBm into the input of the attenuator and setting the DC output voltage at a predetermined millivolt (mV) output. This allowed the detector's individual offset voltages to be removed and caused the detectors to behave in a repeatable manner. The attenuator is able to be adjusted by varying the depth that the aluminum nickel card is inserted into the section of waveguide.

The final section of the electrical system converts the DC voltage output from the detectors to a digital signal to send back to the operator station. For this, it was determined that a 16-bit digitizer would be required to enable measuring the microvolts output by the detectors on the low end of their range, while still allowing the digitizer to measure the full output voltage of 1.8 V for high-input powers. Also, due to the proximity of the operator to the array and overall system flexibility, it was determined that Ethernet communications would provide a sufficient means of reading the system data.

To display the data to the operator, a two-dimensional array is populated and displayed for the user (shown in Figure 7). This allows values to be

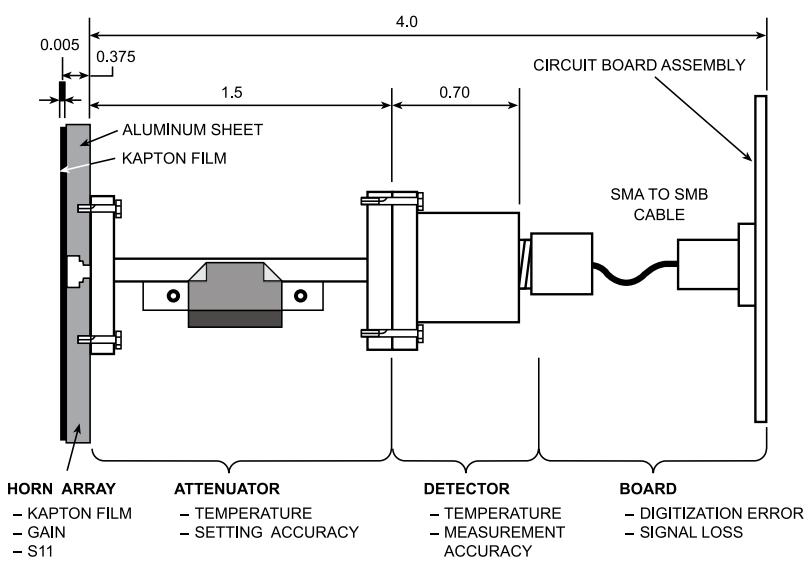

Figure 5. Cross-Sectional View of Array Element

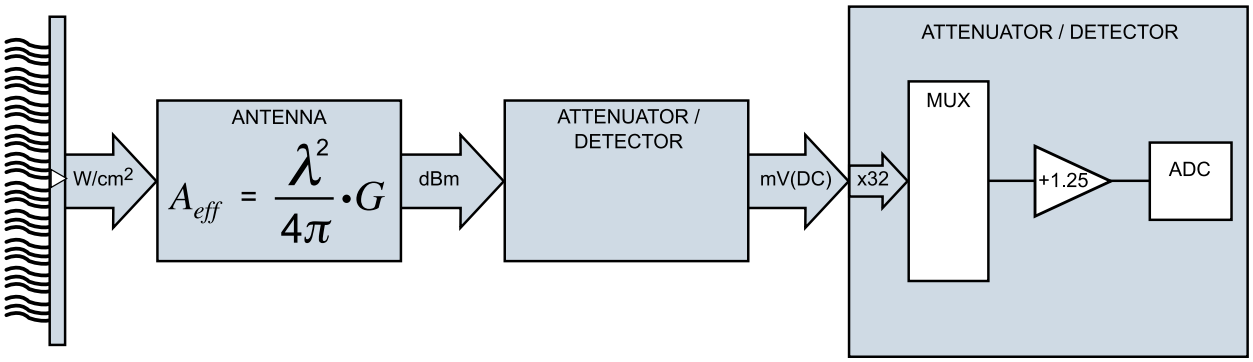

Figure 6. Signal Flow Diagram

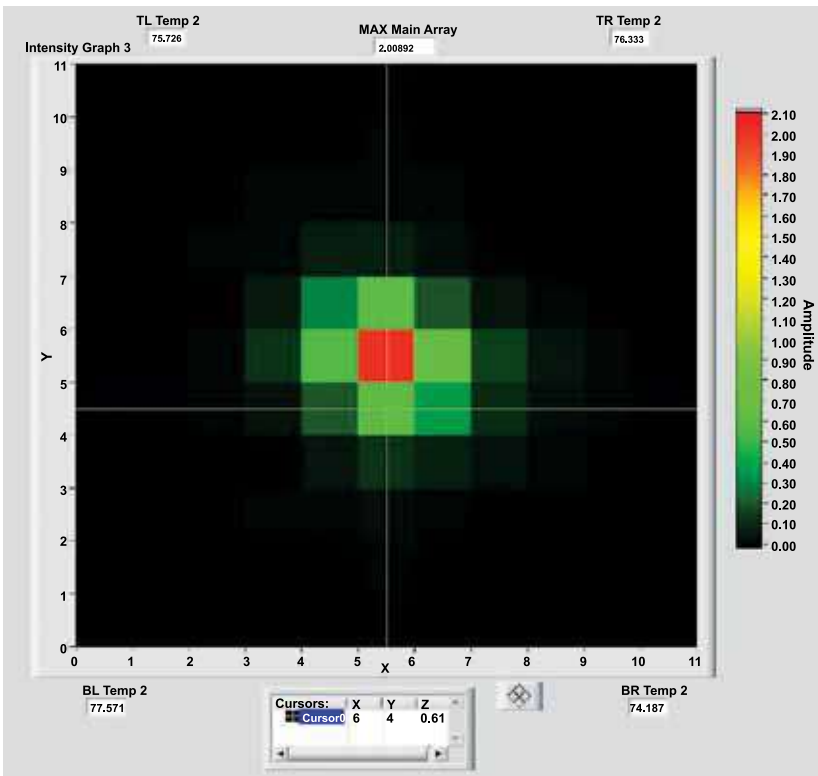

Figure 7. Array's Operator Interface Showing a Small Spot Source

read directly from the display corresponding to the watts per centimeter squared (W/cm^2) present at the array face. Data also is recorded so that it can be viewed later in a player application, such as a video file, or it can be viewed in a spreadsheet application, frame by frame. The data shown in Figure 7 is representative of small-source testing performed recently and very clearly shows the beam profile.

Conclusion

NSWCDD engineers successfully met the W-band array's design goals of providing a high temporal-resolution image of 95-GHz beams. The system has been tested against two active denial systems, providing good agreement with the currently accepted methods, as well as valuable information regarding the system's beam characteristics. These accomplishments will allow future system development to take advantage of this better understanding to possibly reduce system size and increase the effective range. A better understanding of the 95-GHz beam helps to facilitate future ADT development for this much-needed, nonlethal escalation-of-force capability for U.S. warfighters, homeland defenders, and law enforcement personnel.

Directed Energy in the Military Environment

By LT Leedjia Svec, Jeremy Beer, and Dave Freeman

The military operates in the land, air, and maritime environments. In each of these environments, lasers and laser devices are increasingly being seen and used in a variety of ways. Accordingly, the military must protect itself and civilians from the potentially dangerous effects of lasers and other directed-energy devices.

Lasers are being used on the ground to determine the intentions of people who approach checkpoints and to dissuade aircraft from entering restricted airspace. Laser weapons are also being developed for use in the maritime environment. With the use of lasers comes the requirement for eye protection. The eye is particularly sensitive to lasers and its anatomy includes optical components that amplify the power of incoming light. Consequently, the potential for injury or blinding is great.

Naval Medical Research Unit – San Antonio (NAMRU-SA) is poised to lead the way in researching and testing laser glare devices and laser eye protection. The mission of the NAMRU-SA is to conduct medical, dental, and directed-energy biomedical research, which focuses on ways to enhance the health, safety, performance, and operational readiness of Navy and Marine Corps personnel, and addresses their emergent medical and dental problems in routine and combat operations. NAMRU-SA was officially commissioned on 6 May 2009 and is a subordinate command under the Naval Medical Research Center (NMRC) in Silver Spring, Maryland, reporting to Navy Medicine Support Command (NMSC) in Jacksonville, Florida. NAMRU-SA consolidates the Naval Health Research Center Detachment Directed Energy Bioeffects Laboratory, the Naval Institute for Dental and Biomedical Research in Great Lakes, and the NMRC Combat Casualty Care research function. As part of the Base Realignment and Closure (BRAC) 2005, NAMRU-SA has moved to Fort Sam Houston. Two new buildings that have been constructed are the Battlefield Health and Trauma Research Institute and the Tri Service Research Laboratory. A conceptual drawing of the NAMRU-SA Tri-Service Research Laboratory (to house directed-energy research) is shown in Figure 1.

Many factors must be considered when lasers operate in military environments. On the ground, lasers offer a greater likelihood of close contact exposure. In aviation and maritime environments, the mobility of lasers is limited to permanent fixtures on aircraft or ships, so target acquisition can be much more complicated. Often ignored, but just as important and common to all environments, are the psychological factors that need to be explored. These factors include clarifying intentions, communications, and effectiveness. In certain situations,

Figure 1. Naval Medical Research Unit – San Antonio Tri-Service Research Laboratory at Fort Sam Houston, San Antonio, Texas (artist's concept)

sometimes lasers are coupled with other modalities, such as auditory instructions.

On the ground, laser exposure has been shown to interfere with driving vehicles, making color judgments, and target shooting. In aviation, lasers can interfere with pilot vision, causing afterimages, glare, or temporary ocular injury, with attendant effects on navigation and control. In the maritime environment, lights frequently are used to signal a variety of messages, from direction (left, right, etc.) to more complicated messages such as "man overboard." More prolific use of lasers underscores the need for laser eye protection, a dynamic area of research, which must respond to changing threat wavelengths and changing environments. Figure 2 shows NAMRU-SA personnel executing an operational field test at Kennedy Space Center, July 2009.

Recent studies undertaken by NAMRU-SA have investigated the use of laser dazzlers on sailors in small boats.[a] In these studies, participants were exposed to the laser glare at different angles and distances, in both day and night conditions. Study protocols were approved in accordance with the Institutional Review Board in compliance with all applicable federal regulations governing the protection of human subjects. Participants were given a survey assessing their subjective response to the laser, as well as a more objective visual eye chart. The

Figure 2. NAMRU-SA personnel execute operational field test at Kennedy Space Center, July 2009, in which a nonlethal laser prototype is evaluated for power delivery (stability and beam propagation) at range and human visual effectiveness aboard a maritime target.

results suggested that participants were most affected by the laser at night when they were looking straight at it (as opposed to many degrees away) and at the closest exposure distances. The most surprising finding, however, was that some participants reported being drawn to the laser rather than away from it, especially at farther distances. Participants remarked that they couldn't tell what the signal was, so they would want to go closer to find out. This illustrates that the assumption (by some)—that distant laser lights will deter and repel innocent mariners—might not always be true. Further research is needed to verify this finding, however, before employing laser glare devices in the maritime environment. Figure 3 shows NAMRU-SA personnel executing operational field tests, which were conducted at Cheatham Annex, Virginia, and Panama City, Florida, in 2008–2009.

Figure 3. A compact hand-held laser is evaluated for effectiveness in maritime defense against small-boat attacks.

These studies also brought the factor of communication to light. Participants remarked that "green is not a threatening color," and some thought "it could be a signal for help." Many felt curious about the "blinking light" used in the study and would go closer or try to contact the vessel to determine the intent of the message. Green lasers are used because they are more visually salient; however, they may not be as psychologically salient. Participants remarked that if the signal were paired with another signal, such as an auditory one, then the message of "warning" or "do not come closer" might be clearer.

Lastly, these studies brought to light the matter of effectiveness. Laser glare devices are used to stop or alter the behavior of the recipient, but one study yielded mixed results. At close distances, participants noticed the signal, felt affected by it, and reported that their behavior changed in the manner desired by the person pointing the laser. But at greater distances, behavior might not change. Thus, these findings need to be replicated in different maritime scenarios in order to be truly useful in developing laser glare devices. This particular study was encouraging regarding the effectiveness and visual usefulness of glare devices, but it brought up new questions about their psychological impact on behavior. Resolving these questions must be an integral goal of technical research and development studies to determine the operational effectiveness of directed-energy devices, not just for the maritime environment, but for all military environments.

Endnote

a. Results and technical reports are available upon request from the corresponding author or from the NAMRU-SA Public Affairs Officer.

Directed Energy Using High-Power Microwave Technology

By Jacob Walker and Matthew McQuage

The Directed Energy Warfare Office (DEWO) and Directed Energy Division at the Naval Surface Warfare Center, Dahlgren Division (NSWCDD) merge past research and data with continuous innovation in the field of high-power microwave(s) (HPM) to address the critical need for nonlethal, nonkinetic weapons. HPM weapons can be described as nonkinetic devices that radiate electromagnetic energy in the radio frequency (RF) or microwave spectrum. They are designed to disrupt, deny, degrade, damage, or destroy targets. In essence, this is achieved when high-power electromagnetic waves propagate through air and interdict targets by traveling through the exterior layers of structures and coupling energy to critical electronic components. Since effectiveness against a wide range of targets is the goal, HPM has become a collective term for various technologies: wave shapes, source frequencies, and the distribution of varying signal bandwidths. It is the objective of HPM research and assessment, therefore, to address targets for which no engagement option currently exists. NSWCDD is working to identify optimal HPM mission platforms and move relevant technologies into the field.

HPM Initiatives

NSWCDD has actively pursued HPM research since the advent of the field in the 1970s. Since then, scientists and engineers have conducted HPM research and development in many areas, including hydrogen spark-gap switching, spiral generators, and related technologies. More currently, the Directed Energy Division developed a variety of high-power wideband RF systems based on pulsed power and Marx generators (Figure 1). In addition to the extensive work accomplished in HPM and RF source development, NSWCDD contributed substantially to the area of counter-HPM vulnerability assessments. Researchers developed site assessment guides and threat brochures, as well as a number of wideband RF sources, to determine the susceptibility of electronic equipment to high-power RF interference. This latter effort involved assessing and exploiting the weaknesses of specified electronic targets to various HPM and RF threats. Data gleaned from these efforts was then used to support optimized prototypes and system designs employing effects-based design methodology. NSWCDD utilized these wideband RF sources to determine the susceptibility of a multitude of military

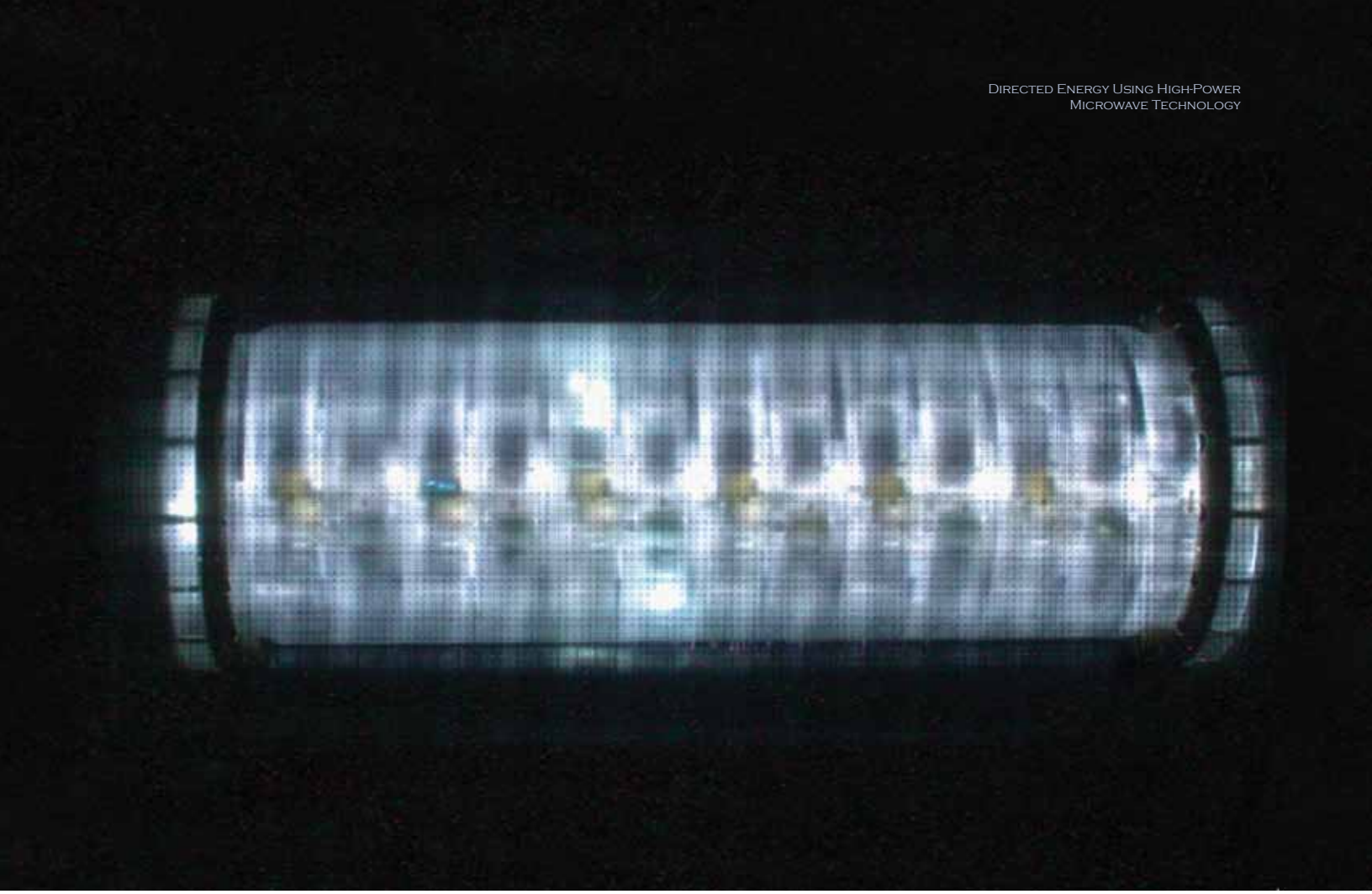

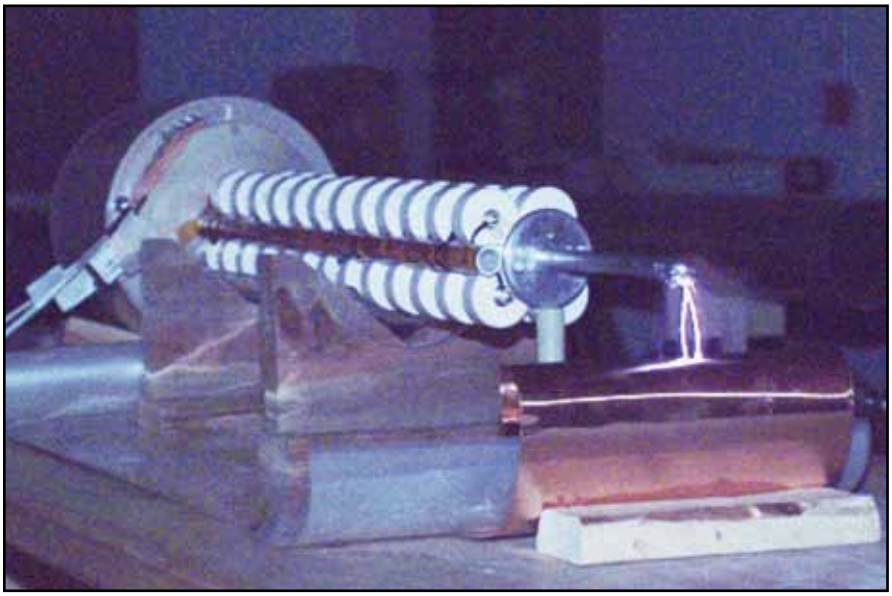

Figure 1. Examples of NSWCDD Marx Generators

and electronic infrastructure equipment to high-power RF interference.

HPM Counterattack Operational Overview

Research in support of HPM-driven electronic attack increased significantly as the demand for nontraditional warfare emerged. Traditional kinetic weapons often are of limited value in peace-keeping missions, for example, as today's enemies frequently are embedded within civilian populations and structures. This creates the need for novel HPM technologies that minimize the risk of collateral damage while effectively neutralizing threats. Dahlgren researchers conduct HPM system research and development—as well as lethality and weapon effectiveness assessments—to address this need while developing technologies against a wide variety of electronic targets. These projects leverage NSWCDD's assets, including the Maginot' Open Air Test Site (MOATS), state-of-the-art RF diagnostics, and modeling and simulation tools to identify applications and platforms in which HPM technologies can be employed. Figure 2 shows a computer model of the MOATS facility and a modeling and

(a)

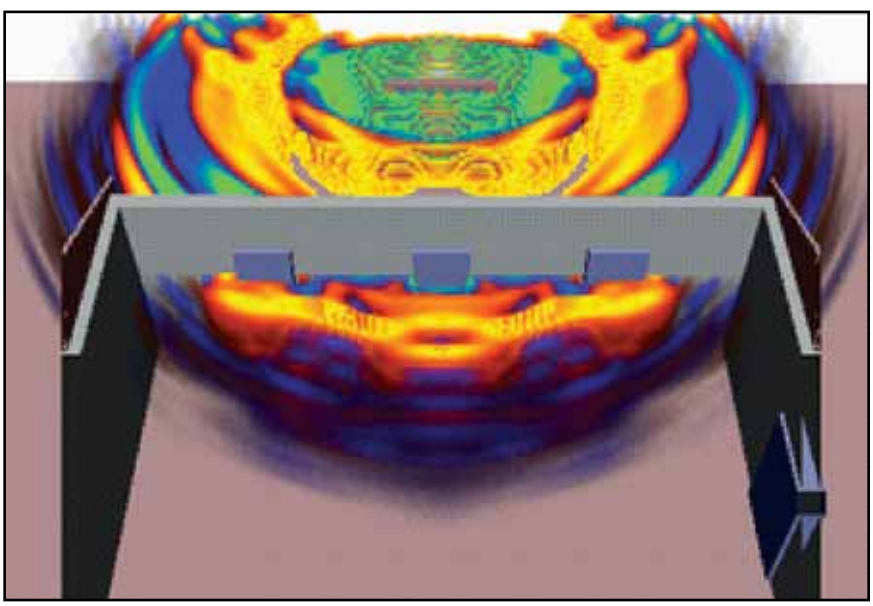

(b)

Figure 2. Modeling and Simulation Depicting (a) NSWCDD Test Facility and (b) Simulation of Radiated RF

simulation graphic depicting the RF emitted by an HPM dipole antenna.

Potential platforms for HPM integration include: man-portable, aerial, vehicle, and vessel-mounted systems. These platforms all provide unique methods for delivery of HPM sources. For example, aerial delivery—which, in many ways, is the most challenging due to size and weight constraints—can increase the effective range of these systems and can engage multiple targets at close range without endangering personnel. Likewise, vehicles and vessel-mounted HPM systems provide a way for law enforcement and the military to stop vehicles in chase scenarios almost as soon as they begin. The goal of all of these projects is to provide military forces with the ability to employ nonkinetic, electronic strike technologies against an adversary's electronics.

The DEWO and Directed Energy Division are uniquely positioned to provide numerous capabilities for in-house development while engaging with the private sector to test and provide feedback on HPM systems developed externally. In the past decade, NSWCDD has evaluated several HPM systems at Dahlgren to determine their effectiveness against various electronic targets while maintaining the Office of the Secretary of Defense's Tri-Service RF Directed Energy Weapon (DEW) Database. This database contains all effects data collected from directed-energy tests performed within the U.S. Air Force, Army, and Navy.

Conclusion

NSWCDD continues to pioneer HPM source development and lethality and integration studies, leading to the demonstration and delivery of prototype capabilities. It also is committed to researching and developing critical subsystems for HPM delivery. By leveraging numerous target assets and sophisticated diagnostic equipment—in conjunction with MOATS—NSWCDD has positioned itself at the forefront of HPM electronic attack, leading the way in the development and delivery of these capabilities to the warfighter.

Acknowledgment

Nancy Muncie, Bowhead, contributed to this article.

Laser Counter Rocket, Artillery, and Mortar (C-RAM) Efforts

By Michael Libeau

Mortars and rockets are common weapons confronting U.S. troops abroad. Insurgents fire the inexpensive projectiles into populated areas, intending to kill or injure service members and to inflict physical damage. While kinetic solutions like guns and missile interceptors are used to counter rockets and mortars, laser counter rocket, artillery, and mortar (C-RAM) systems present a promising solution to counter these challenging threats in the near future.

Scientists and engineers at the Naval Surface Warfare Center, Dahlgren Division (NSWCDD) have been researching, developing, testing, and evaluating laser C-RAM systems through collaboration, modeling and simulation, and experimentation. The Joint Technology Office (JTO) and the Directed Energy and Electric Weapons Program Office (PMS 405) sponsored the first year of these initiatives in 2007. Consecutive and current work has been sponsored by the Office of Naval Research (ONR) Expeditionary Maneuver Warfare and Combating Terrorism S&T Department.

Background

In preparation for the development of a laser C-RAM system, an understanding of the vulnerability of rockets and mortars to laser energy was crucial. Engineers from NSWCDD and the U.S. Army Space and Missile Defense Command (SMDC) collaborated on laser C-RAM efforts. Engineers analyzed the RAM threat and examined a variety of targets, accessing RAM vulnerabilities to laser energy by utilizing theoretical, numerical, and experimental work. They then developed theoretical models that captured the physics of the laser-induced failures of targets containing high explosives (HE). Additionally, NSWCDD engineers enhanced lethality simulations using a tool called the Effectiveness Toolbox to model engagements of RAM targets with laser energy. Figure 1 shows a screen capture from the Effectiveness Toolbox.

The resulting simulations included results from a laser atmospheric propagation model and a thermal model to determine the effect of the laser energy on the target. The simulations also incorporated target trajectories necessary for modeling the changing laser conditions on the target resulting from the engagement of a ballistic target. Subsequent to modeling these effects, live testing was performed. Figure 2 shows the lasing and destruction of a RAM target during live testing.

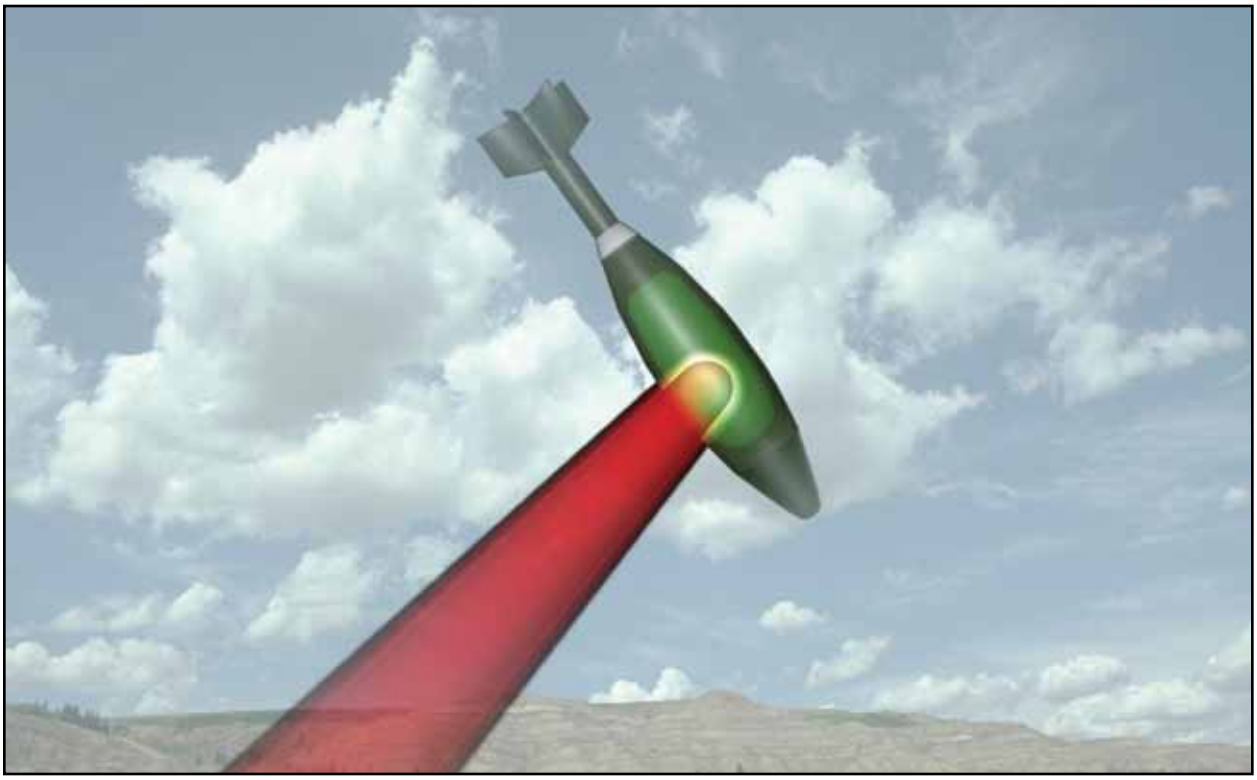

Figure 1. Screen Capture from the Effectiveness Toolbox Showing the Laser Engagement of a Mortar Target

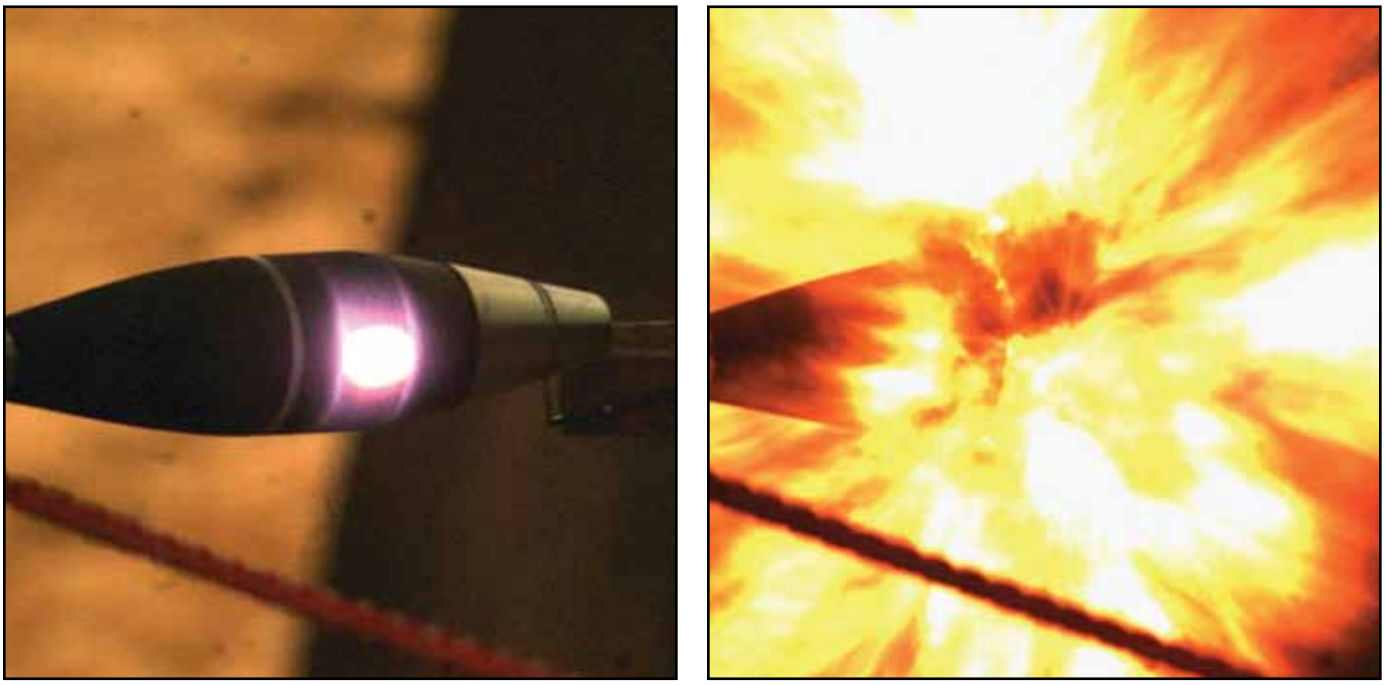

Figure 2. Explosive Target is Destroyed with NSWCDD's Fiber Lasers

NSWCDD engineers conducted two large experimental tests to determine the vulnerability of HE targets to laser energy using NSWCDD's High-Energy Fiber lasers. The first test was conducted jointly with SMDC. During these two tests, over 40 RAM targets were destroyed under different laser conditions, producing significant information on laser lethality. Researchers measured the failure times of multiple targets for different laser powers, spot sizes, incidence angles, and aimpoints. The experimental data yielded by the tests increased engineers' understanding of the vulnerability of targets containing energetic materials. This data was then used to benchmark predictive models.

Future tests are planned with additional HE targets to further the knowledge of RAM vulnerability. These tests are controlled and conducted carefully to ensure that good data is obtained. Accurate measurements of laser power on the target and the resulting target failure times must be made during the tests. To that end, NSWCDD engineers leverage Division-wide expertise in lasers and optics with its long history of explosives testing to achieve meaningful test results. NSWCDD personnel have been instrumental in improving techniques to measure the spatial profile of laser power on a target. The spatial distribution of laser power on a target is critical to understanding the target's failure. Figure 3 shows a laser beam's spatial power distribution measured during a test.

Ongoing Laser C-RAM Initiatives

Recent advances in fiber lasers have increased the power outputs of these rugged, solid-state devices. Both government and contractor efforts are examining the application of commercial off-the-shelf (COTS) lasers and other electric lasers for application into advanced weapon systems. The Navy's Laser Weapon System (LaWS) Program, for example, is examining a laser system built around efficient fiber lasers. This is significant because a high-energy fiber laser system offers two critical advantages over gun and missile interceptor C-RAM systems. First, the laser has a great depth of magazine since it requires only electricity for operation. Consequently, unlike a gun system, which has a limited supply of ammunition, a laser system is limited only by its supply of electrical energy. Second, a laser system offers a cost per kill that is significantly lower than alternative systems because only electricity is being expended instead of gun ammunition or a costly missile interceptor. This low cost per kill also better matches the low cost of the RAM target being engaged.

High-Energy Fiber Laser C-RAM systems will provide significant advantages in defeating the RAM threat while augmenting existing C-RAM solutions. More importantly, laser C-RAM systems will help protect members of the armed forces from the inexpensive, yet often deadly threats posed by rockets and mortars.

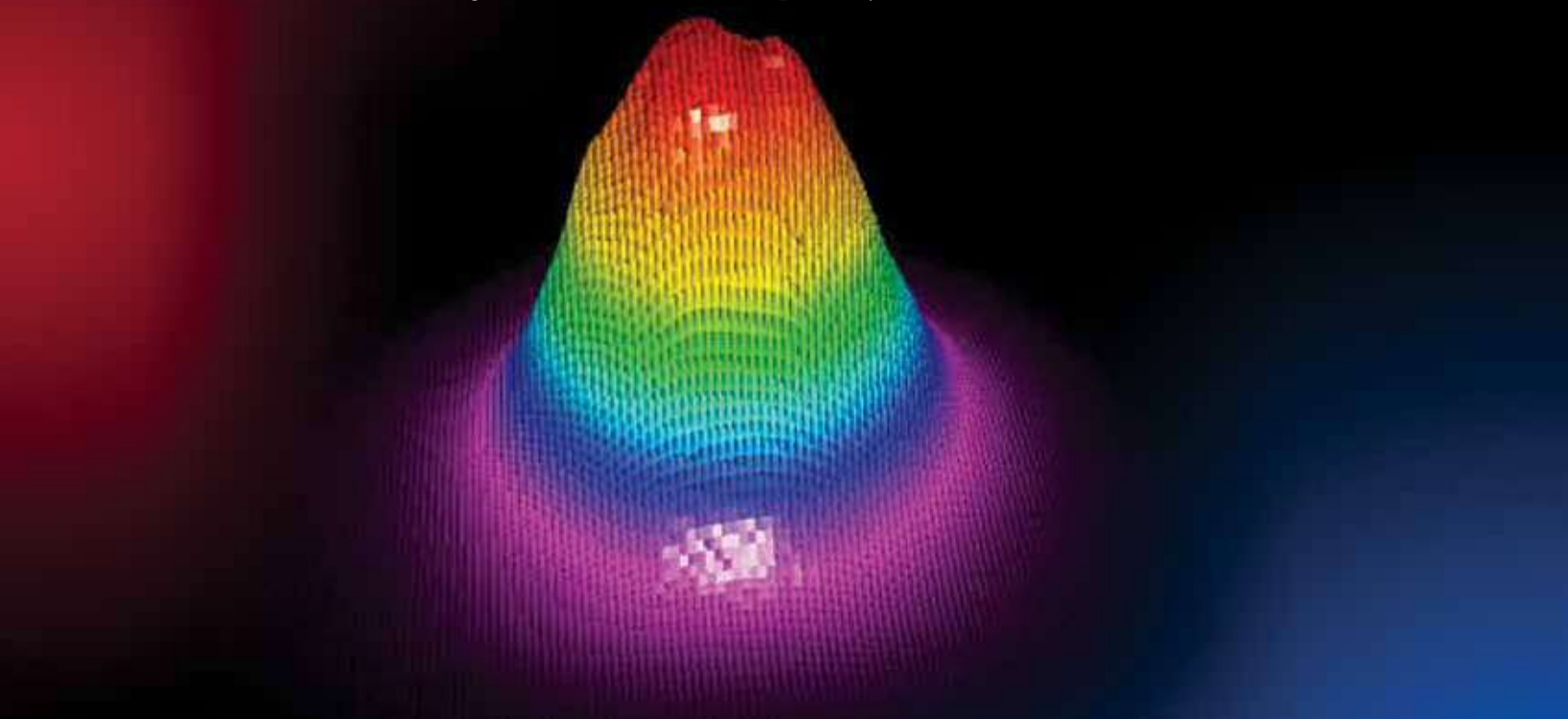

Figure 3. Laser Power Spatial Variation from a C-RAM Test

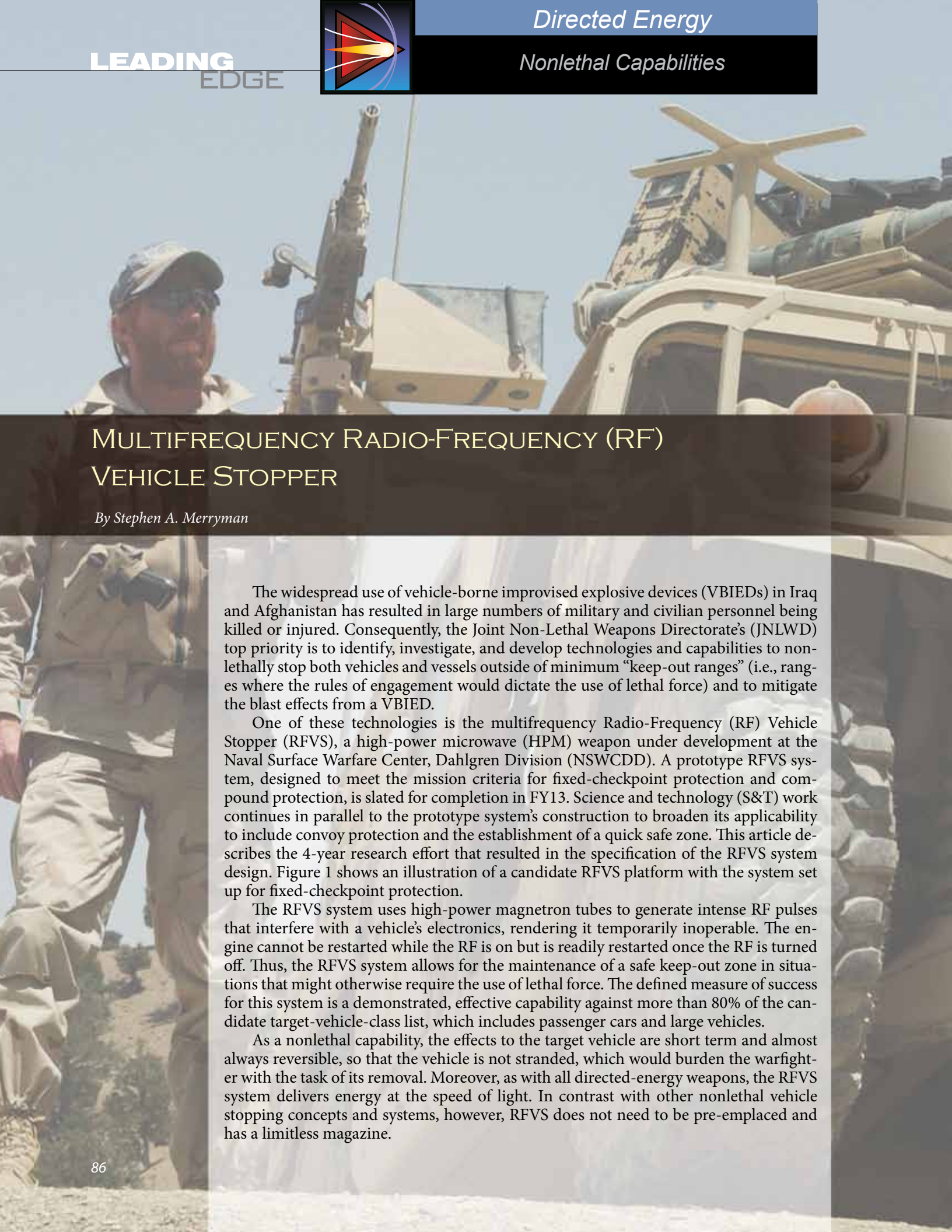

Multifrequency Radio-Frequency (RF) Vehicle Stopper

By Stephen A. Merryman

The widespread use of vehicle-borne improvised explosive devices (VBIEDs) in Iraq and Afghanistan has resulted in large numbers of military and civilian personnel being killed or injured. Consequently, the Joint Non-Lethal Weapons Directorate's (JNLWD) top priority is to identify, investigate, and develop technologies and capabilities to nonlethally stop both vehicles and vessels outside of minimum "keep-out ranges" (i.e., ranges where the rules of engagement would dictate the use of lethal force) and to mitigate the blast effects from a VBIED.

One of these technologies is the multifrequency Radio-Frequency (RF) Vehicle Stopper (RFVS), a high-power microwave (HPM) weapon under development at the Naval Surface Warfare Center, Dahlgren Division (NSWCDD). A prototype RFVS system, designed to meet the mission criteria for fixed-checkpoint protection and compound protection, is slated for completion in FY13. Science and technology (S&T) work continues in parallel to the prototype system's construction to broaden its applicability to include convoy protection and the establishment of a quick safe zone. This article describes the 4-year research effort that resulted in the specification of the RFVS system design. Figure 1 shows an illustration of a candidate RFVS platform with the system set up for fixed-checkpoint protection.

The RFVS system uses high-power magnetron tubes to generate intense RF pulses that interfere with a vehicle's electronics, rendering it temporarily inoperable. The engine cannot be restarted while the RF is on but is readily restarted once the RF is turned off. Thus, the RFVS system allows for the maintenance of a safe keep-out zone in situations that might otherwise require the use of lethal force. The defined measure of success for this system is a demonstrated, effective capability against more than 80% of the candidate target-vehicle-class list, which includes passenger cars and large vehicles.

As a nonlethal capability, the effects to the target vehicle are short term and almost always reversible, so that the vehicle is not stranded, which would burden the warfighter with the task of its removal. Moreover, as with all directed-energy weapons, the RFVS system delivers energy at the speed of light. In contrast with other nonlethal vehicle stopping concepts and systems, however, RFVS does not need to be pre-emplaced and has a limitless magazine.

Figure 1. Illustration of Candidate RFVS System Setup for Checkpoint Protection

Background

Using HPM or RF energy to stop an automobile engine is not a new concept; it has been under investigation for some time in private, academic, and military sectors. To that end, the RFVS program leveraged as much historic work as possible while collaborating with academic and military laboratories and while aggressively pursuing contacts in the automobile industry to gain knowledge of vehicle electronic design and function.

In 2005, the JNLWD funded the then-Directed Energy Technology Office (DETO) at NSWCDD to perform an extensive reverberation chamber test series to characterize the vulnerability of a representative cross section of automobiles to a wide range of HPM source frequencies.[a] The purposes of the tests were twofold. First, the applicability of the Army's Ground Vehicle Stopper (GVS) data set needed to be established for newer vehicles, and second, a thorough, source-technology independent assessment of vehicle vulnerabilities needed to be performed. The rationale behind the latter was to establish vehicle vulnerabilities without inadvertently biasing the process. Only after the full assessment was performed would factors such as concept of operations (CONOPS) and system requirements come into play. Figure 2 is a photograph of reverberation chamber testing.

Over the past decade, a significant number of private, academic, and military laboratories have investigated the susceptibility of automobiles to HPM energy. The range in approaches spans the gamut from isolated component testing, through direct injection and radiated testing of electronic control units (ECUs), and continuing through full vehicle radiated testing. Each of the different test methods has its strengths and weaknesses. Testing of isolated ECUs in controlled laboratory conditions is arguably the best way to determine exactly how a specific unit is responding to the RF. However, whether or not the identified susceptibilities continue to hold true when the unit is in place in a

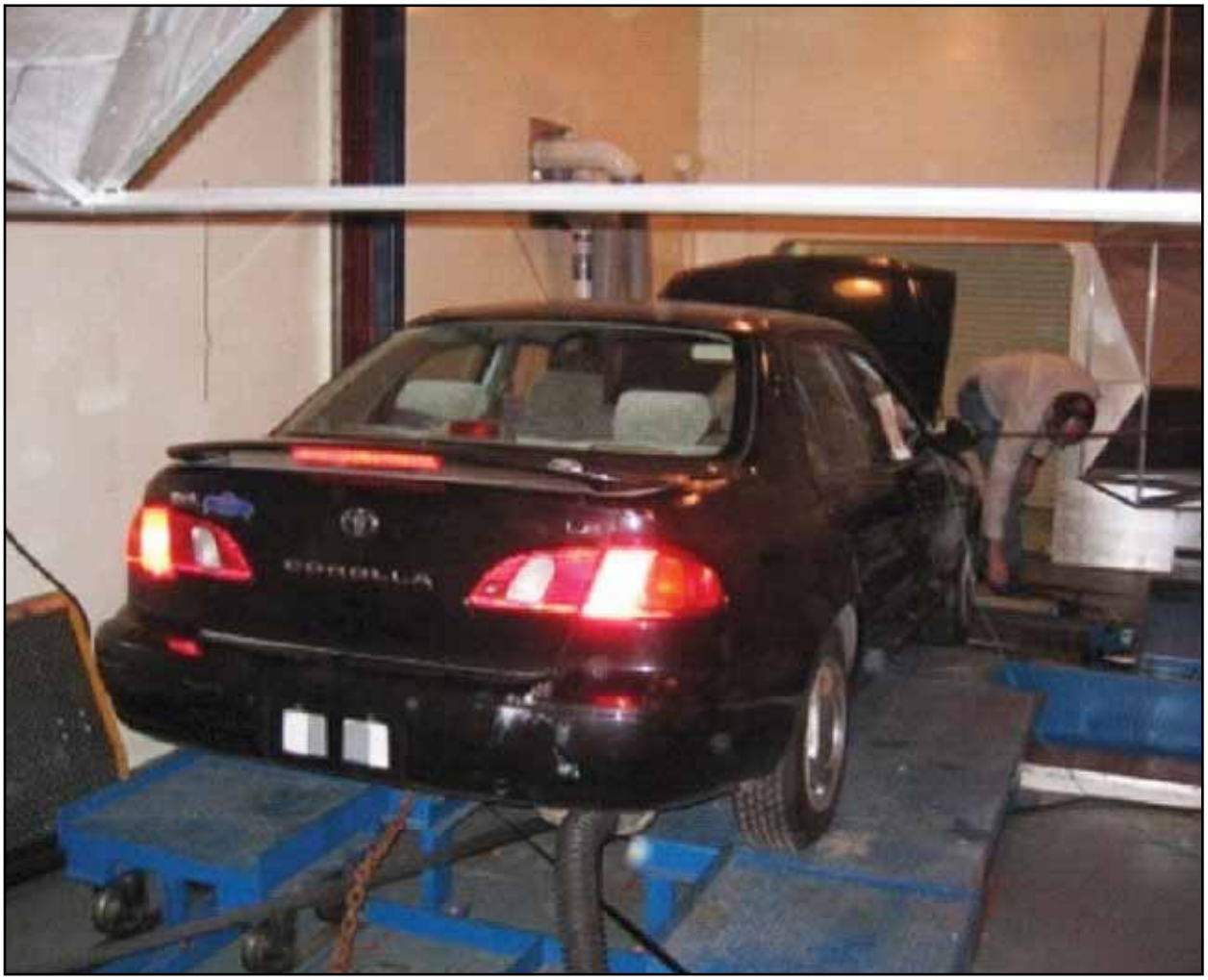

Figure 2. Vehicle on a Dynamometer in the NSWCDD Reverberation Chamber

vehicle, or whether the results apply to other vehicles' ECUs, remains a significant question that limits the applicability of the results.

Full vehicle testing and failure analysis of the ECU can be a daunting task. That said, full vehicle testing affords the advantage of ensuring that the response is commensurate with expectations of genuine engagements. The test approach one chooses to take depends upon resources, test facility availability, and most importantly, the objectives of the program. For the RFVS program, the objectives were to identify an HPM waveform that is effective against a broad class of the candidate target vehicles and to ensure that the identified waveform could be generated with a source that can be packaged in a footprint and cost amenable to military users. To meet the program's objectives, the RFVS program chose to invest the majority of its resources in full vehicle testing. While the focus of the effects testing portion of the RFVS program has remained on full vehicle testing, both time and resources have been devoted to fostering and maintaining connections with academia and the auto industry. There is concerted effort to keep abreast of the latest trends in automotive technology, to ensure that the current RFVS system design will continue to be effective against future vehicle designs, and to leverage all research that might aid in future RFVS designs.

System Operation

The majority of current HPM system concepts employ a narrowband, single-frequency HPM source. In contrast, RFVS utilizes multiple HPM

frequencies. The rationale for using multiple frequencies is associated with increased system effectiveness. Electromagnetic (EM) energy can be used to disrupt or damage an electronic target. In order for the energy to affect the electronics, however, it must be able to reach a critical component(s) inside the target. This involves a process referred to as coupling. Different EM waveforms are more or less effective against specific targets depending, in part, on their frequency, as different frequencies couple better or worse depending on varying target geometries. To be specific, each piece of electronics has specific resonance frequencies that most effectively facilitate coupling energy to the target. Unfortunately, these resonant frequencies can be unique to each piece of equipment. Consequently, a single-frequency waveform might be very effective against one target, but less effective against another target. Therefore, a system that utilizes either a sweep of frequencies or multiple frequencies will be more effective against a larger target set. This is not a novel idea, but rather one that has been readily acknowledged within the HPM community for some time and fervently embraced by the RFVS program. Current technology limitations prohibit high-power-swept frequency sources as viable options, leading to the idea of a multifrequency source. The more frequencies that are used, the more effective the system; however, a trade-off is made with system size and cost as the number of source frequencies is increased.

Brassboard System

After completion of the exhaustive vehicle effects characterization testing in 2006, the RFVS program identified the optimal number of frequencies needed to meet mission requirements. It then used this information in the design and construction of the Brassboard System. The purpose in constructing the Brassboard System was to demonstrate the benefit of the multifrequency approach and the ability to meet mission objectives with specified power on target requirements. Construction of the RFVS Brassboard System began in 2007 and was completed in 2008. The Brassboard System was not constructed with specific system footprints in mind. Thus, the antenna and conex used are significantly larger than those in the prototype design. The RFVS team collaborated with a Marine Corps service representative identified by the JNLWD to flesh out the specifics of the mock checkpoint to be used in the RFVS Brassboard System Demonstration. Figure 3 provides a diagram of the checkpoint setup used in the RFVS Brassboard Demonstration. Figure 4 provides photographs of the RFVS Brassboard System.

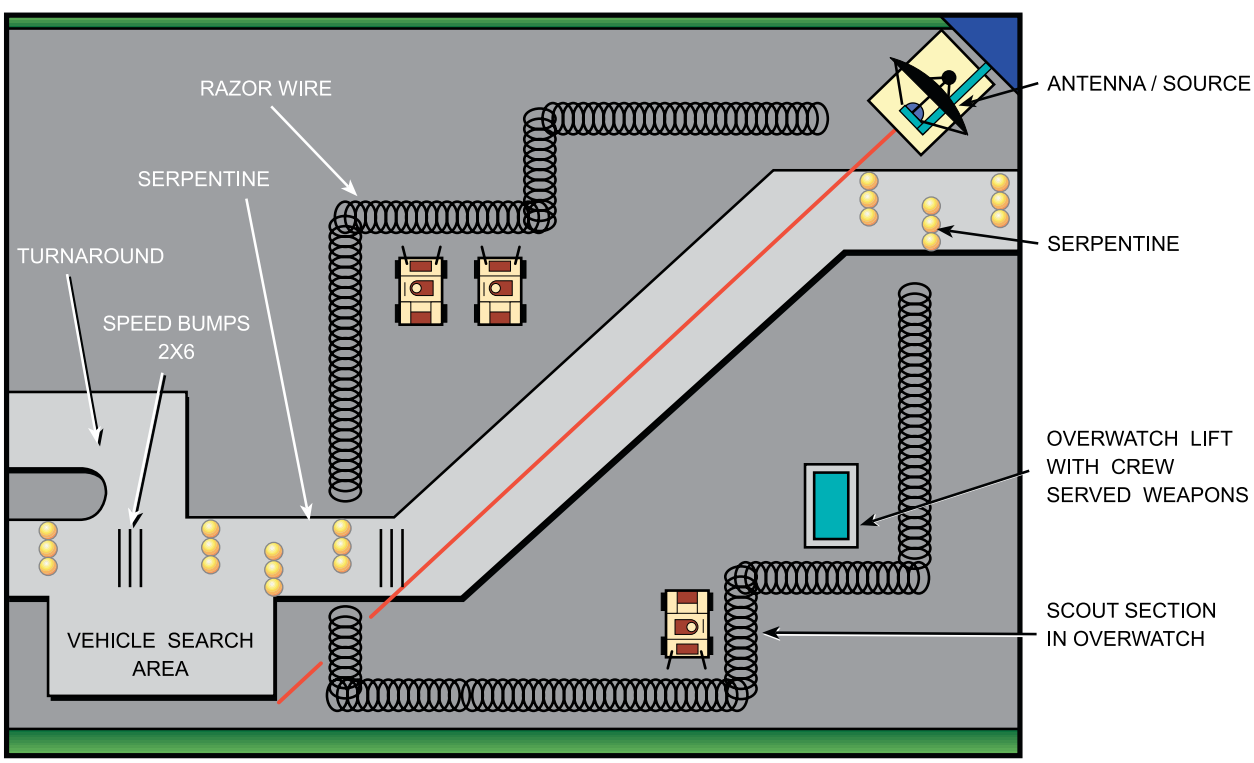

Figure 3. Schematic of Checkpoint Setup

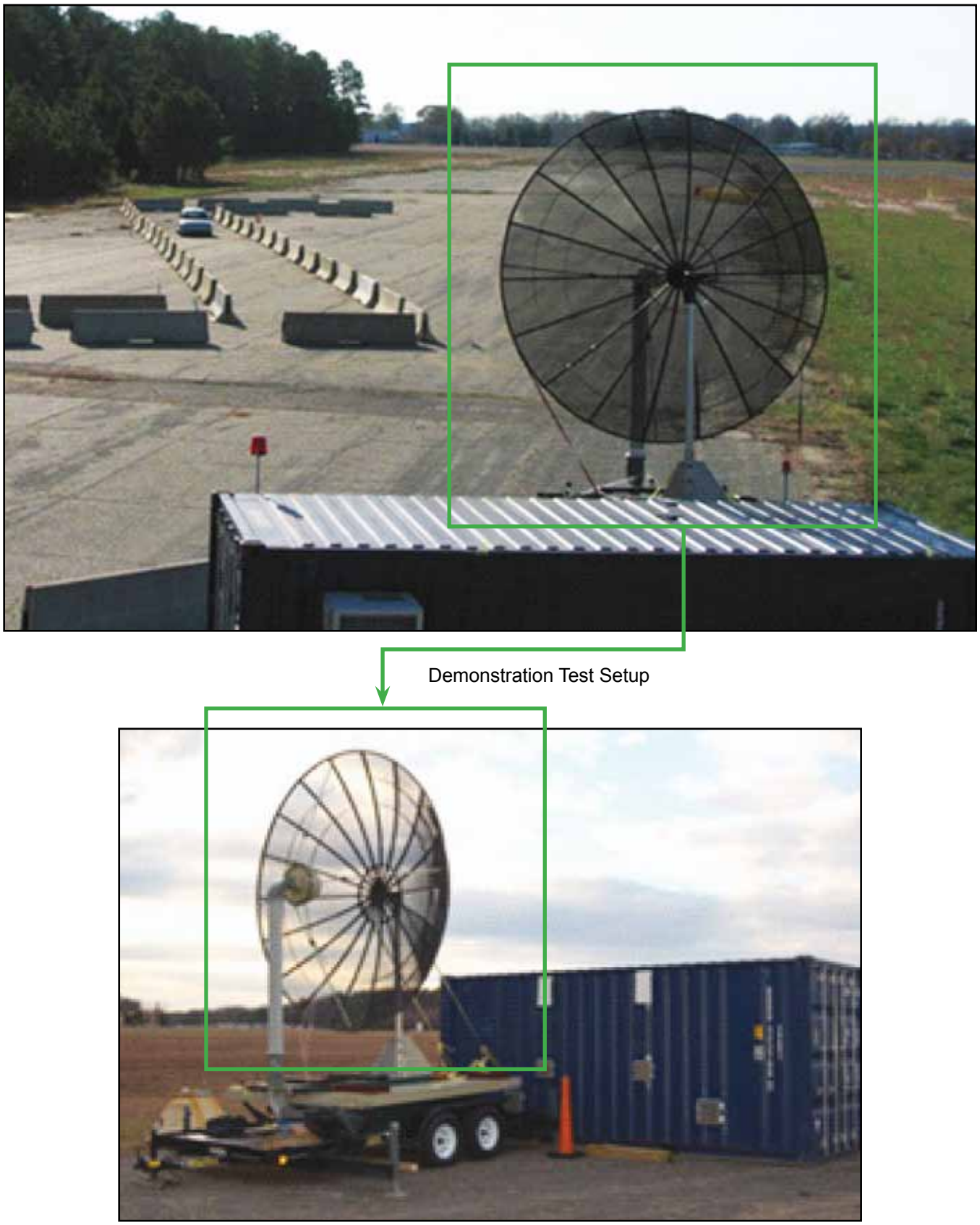

Figure 4. Photograph of the RFVS Brassboard System and Demonstration Setup

The Brassboard System Demonstration was conducted in Spring 2008. The Demonstration was a success, and funding for the RFVS prototype was consequently approved. To date, 42 passenger vehicles (cars, pickup trucks, vans, and sport utility vehicles (SUVs)) and 3 large trucks (dump truck and tractors) have been tested as part of the RFVS program.

Way Ahead

The JNLWD continues to work with the Directed Energy Warfare Office (DEWO) toward the development of a fieldable multifrequency RFVS system. Once the capability is fully developed, tested, and certified ready for operational use, warfighters and civilians alike will benefit greatly. Lives will no doubt be saved using the ability to stop vehicles nonlethally and mitigate the blast effects from VBIEDs.

Acknowledgment

Dr. Cynthia Ropiak (SAQ Consulting) contributed to this article.

Endnote

a. The Directed Energy Technology Office (DETO) was renamed the Directed Energy Warfare Office (DEWO) in August 2009. For reference, see the charter for the DEWO, NSWCDD, 17 August 2009.

High-Power Electrical Vehicle-Stopping Systems

By Jordan Chaparro and Melanie Everton

The military needs devices that can safely and reliably stop or arrest vehicles. The primary concern is security at entry control points and vehicle check points similar to the one shown in Figure 1. In such scenarios, it is desirable to be able to stop unauthorized vehicles at predefined standoff ranges to protect personnel, equipment, and critical infrastructure.

Both the military and civilian law enforcement agencies face similar issues with chase scenarios, where concerns over bringing an offending vehicle to a stop without killing or injuring innocent civilians, or causing collateral damage, often prolongs high-speed pursuits. That said, currently employed nonlethal options for arresting vehicles have significant logistical limitations and carry a high cost per use.

The Naval Surface Warfare Center, Dahlgren Division's Directed Energy Warfare Office (DEWO), under the sponsorship of the Joint Non-Lethal Weapons Directorate (JNLWD), investigated compact systems designed to couple high-power electrical impulses to a target vehicle to stop its engine. Such systems are highly portable, can operate remotely, can be deployed quickly by a two-man team, and can engage hundreds of targets before requiring any significant maintenance.

System Overview

Conceptually, electrical vehicle-stopping systems are fairly simple devices. The systems use several stages of energy compression to take a low-peak power source—like a battery pack—and create very intense, short-duration, oscillating electrical impulses. The block diagram, shown in Figure 2, illustrates the principal components of such a system.

A high-energy density, 300-V lithium battery pack, similar to what might be found in a hybrid vehicle, serves as the prime power source for the device. These batteries are capable of driving the system for hundreds of engagements before requiring recharge.

The direct current bus from the batteries is stepped up to several kilovolts in order to charge a capacitive voltage multiplier, such as a Marx Generator, Spiral Line Generator, or Tesla Transformer. Once triggered, these generators charge a resonant circuit to hundreds of kilovolts which, when switched, generate the desired oscillating waveform. Coupling this electrical pulse to a target may be accomplished by direct electrode contact, by radiating the waveform from a broadband antenna structure, or by a combination of both methods.

Figure 1. An Azerbaijani Soldier Guarding Entry Control Point 1 at the Haditha Dam in Support of Operation Iraqi Freedom

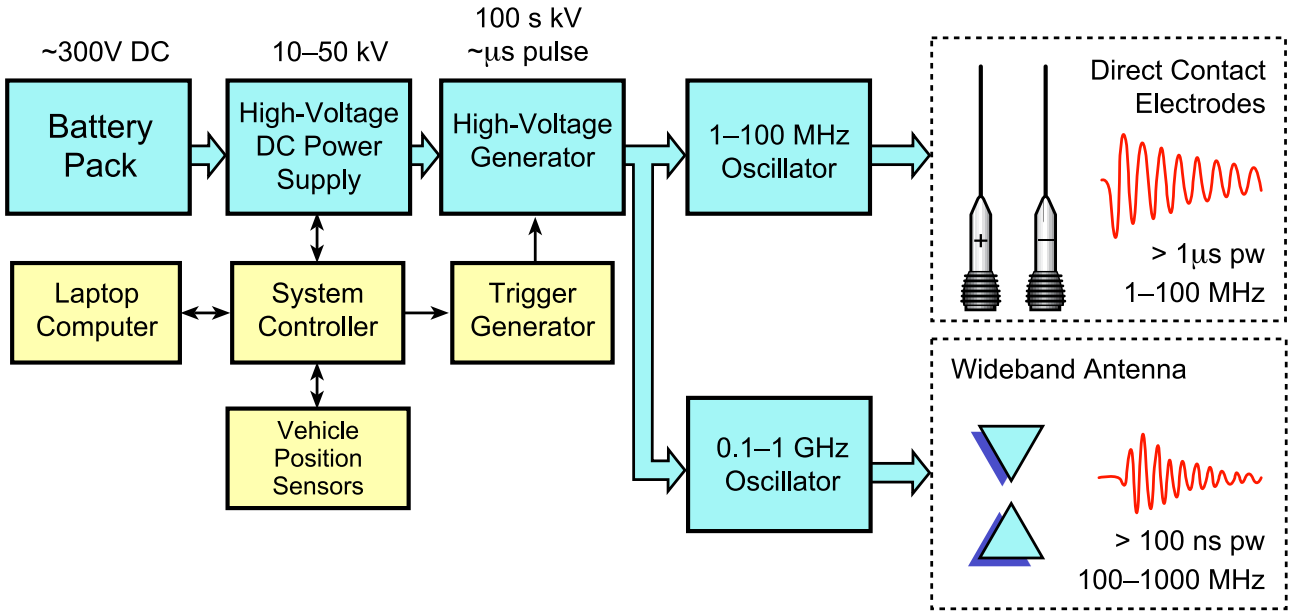

Figure 2. System Block Diagram for Generic Electrical Vehicle-Stopping Systems

The system is monitored and controlled by an integrated system computer. A laptop computer, remotely connected to the system controller through either fiber optic or a wireless network, can be used to arm the system. At this point, motion detection sensors trigger the pulse train upon the targeted vehicle. The laptop can also be used to monitor the system's status, change system parameters, and receive data collected during the last engagement event.

A conceptual rendering of how such a system might look when in use is shown in Figure 3. Traffic would be funneled with barriers to a single lane. When not engaged, the system electrodes would sit flush with the roadway unit, with an exposed height of less than 3 inches. When required, the electrodes could be released to make contact with a vehicle's undercarriage and deliver the electrical impulses.

Comparison with Existing Systems

Tire spike systems are frequently employed but do not limit the momentum, drive, or control of a vehicle to an extent that could be useful in any type of control or checkpoint scenario. Consequently, while tire spike systems are primarily used in high-speed pursuit applications, they are limited, in that they cripple the target just enough to allow law enforcement to force the vehicle to a stop.

Restraining nets are most comparable to electrical vehicle stoppers with respect to their intended application and desired effect. Restraining net systems and electrical vehicle stoppers both completely arrest vehicles, although by different means. Restraining nets bind the front axle of the vehicle, causing it to forcibly lose momentum and skid to a stop. Thus, the vehicle operator loses the ability to steer the vehicle, further resulting in a lower potential for collateral damage. Electrical systems stop the engine of the vehicle, leaving the operator with control for the duration of the vehicle's momentum. Physical barrier structures can then be employed to force an affected vehicle to stop in a fairly short distance. Modern vehicles lose power steering when the engine is cut off, such that the maneuverability of the vehicle is limited enough to

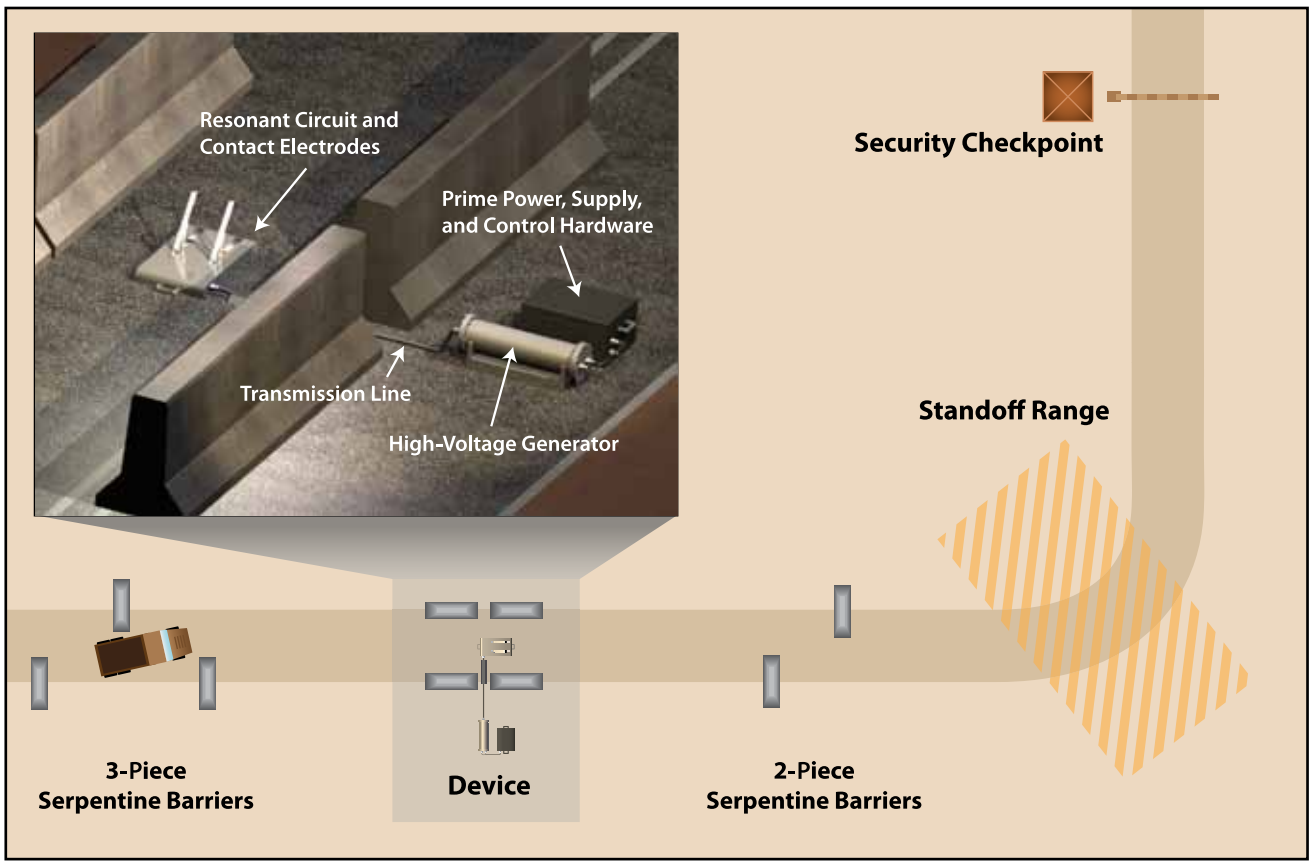

Figure 3. Conceptual Rendering of an Employed Electric Vehicle Stopping System

allow normally nonrestrictive serpentines to be effective at limiting roll-off distances.

One key logistical advantage of electrical vehicle stoppers, compared to restraining nets, is the average cost per engagement. Restraining net systems are one-time use devices that cost several thousand dollars each. Electrical systems initially cost tens of thousands of dollars but can perform thousands of stops within the expected lifetime of the device. Also, there is no requirement to physically reset or reload an electrical system, as with restraining nets. The maintenance required for electrical systems involves the occasional replacement of electrode arms and the inspection of the system connections and pressure levels.

Operationally, both systems have limitations on the types of targets that can be effectively stopped. Restraining nets are limited by vehicle momentum, which can be a product of high speeds or large vehicles. Electrical systems are not limited by vehicle size or speed, but they require additional support from structures—such as serpentines or speed bumps—to force the target to brake and dissipate its momentum once the engine has been stopped.

Both devices typically cause damage to targeted, stopped vehicles. Restraining nets almost always cause tire damage. Less commonly, brake lines, front axles, wheels, and transmissions also might be damaged. Electrical systems typically damage engine controllers, security modules, and engine sensors. In addition, noncritical parts—such as gauges, radios, and cabin fans—also might be damaged. Moreover, moving affected targets is much less of an issue with electrical stoppers than vehicles stopped by net systems, which must first have the net cut away and freed before the target is moved to the side of the roadway.

System Refinement and Look Forward

Previous attempts to field electrical vehicle-stopping systems have been hampered by limited success rates on a large population of vehicles. Many models of vehicles are easily affected by any type of large injected current, while others are fairly resistant. Through carefully designed and controlled experiments, and logistical regression modeling techniques, the DEWO team has been able to determine key waveform attributes that scale with stopping effectiveness rates on a representative population of vehicles. Successful stop rates exceeding 90 percent have been achieved on a diverse vehicle test set by engineering system resonators to enhance system performance The DEWO team, through continued research, testing, and evaluation, is continuing its work to increase the reliability and effectiveness of these systems to make them more compact and to improve their functionality for future military and law enforcement applications.

Nonlethal Small-Vessel Stopping With High-Power Microwave Technology

By Jacob Walker

The employment of small vessels to attack merchant ships and other seafaring units has emerged as a significant threat to international navigation and safe operations on the high seas. Along with swarm tactics, small vessels have been known to carry improvised explosive devices, help smuggle terrorists and weapons, and serve as attack platforms on the water for larger weapons. While kinetic solutions serve as the decisive option, alternative solutions that employ nonlethal means are being explored. A depiction of a swarm of small vessels ready to attack is shown in Figure 1.

The Naval Surface Warfare Center, Dahlgren Division's (NSWCDD's) Directed Energy Warfare Office (DEWO) is evaluating directed-energy (DE) concepts based on high-power microwave (HPM) technology for nonlethal vessel-stopping applications. Nonlethal weapons are defined by the Department of Defense (DoD) as weapons that are explicitly designed and primarily employed so as to incapacitate personnel or materiel while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment.[1]

Several methodologies exist for using nonlethal means to stop small vessels. They include:

- Running-gear or prop entanglement systems
- Exhaust stack blockers
- A sea-anchor vessel-stopping system, which casts a net across the bow of a vessel to impart resistance
- Small-craft disablers, which insert a spear into the hull and deploy a fin that drags in the water, making steering impossible

Prop entanglement systems, exhaust stack blockers, and sea-anchor systems are useful and effective, but all are operationally difficult to deliver when deployment methods rely on positioning them in front of, or directly over, a vessel moving

Figure 1. Depiction of a Small-Vessel Swarm Ready to Attack

at high speeds. Small-craft disablers also are a formidable vessel-stopping solution and may be easier to deploy, but they cause permanent damage to the vessel in question.

Under the direction of the Joint Non-Lethal Weapons Directorate (JNLWD), the DEWO is in the initial stages of a multiyear effort to evaluate DE concepts for nonlethal vessel-stopping applications. It is currently focusing on HPM technology. This technology uses HPM sources to radiate radio frequency (RF) pulses downrange to interfere with motor-control electronics and significantly impede or stop small-vessel motors with minimal collateral damage. These RF pulses can be generated using different technologies ranging from wideband LC oscillators and microwave tubes (e.g., magnetrons, klystrons, and backward wave oscillators) to emerging solid-state technologies (e.g., nonlinear transmission line and photo-conductive switching). An outboard motor on a test stand is shown in Figure 2.

In comparison to kinetic weapons or other nonlethal systems, HPM avoids gross physical destruction to the vessel while, more importantly, providing zero-to-low risk of human injury. HPM accomplishes this at safe distances using speed of light delivery, therefore making evasion difficult, if not impossible, with the added benefit of scalable effects ranging from disruption to damage. Despite its numerous advantages, the use of HPM technology as a nonlethal weapon presents challenges as well, including a trade-off between system size and standoff range. This is particularly important when considering the use of HPM systems in different environments.

Upfront HPM source development costs represent one of the biggest challenges. However, long-term savings associated with HPM technology can offset this challenge. For example, prop entanglement systems might be deployed only once before they are rendered useless. HPM sources integrated onto a ship or other military vehicle can be employed in potentially thousands of missions, therefore resulting in a lower cost per single use, bringing overall associated costs of the system down significantly. Priorities for HPM nonlethal weapons include developing a system effective against different types of small vessels.

NSWCDD's Directed Energy Division began HPM susceptibility testing to determine the effectiveness of HPM weapons against relevant outboard engines. This involves testing small vessels in

Figure 2. Outboard Motor Test Stand

a variety of environments, including reverberation and anechoic chambers, and open-air testing. All help identify different, effective waveform parameters such as frequency, pulse width, rise time, and required power or energy on target. They further facilitate the identification of design specifications necessary for an eventual HPM source. This source, once developed, will then be integrated into one of several potential platforms. Candidate concepts of deployment include U.S. Coast Guard and naval vessels in addition to unmanned surface or aerial vessels. Another potential application might be to supplement existing Coast Guard or Navy platforms used for fast-boat interdiction with an HPM vessel-stopping capability. A small-vessel test using an HPM source is shown in Figure 3.

Developing solutions for the growing threat that small vessels pose to navigation and safe operations in the world's oceans is one of JNLWD's top priorities. Using nonlethal HPM weapons to stop vessels will provide the warfighter with a viable option for swarm threat and fast-boat interdiction. DEWO is working diligently to accelerate this technology and provide a DE alternative to kinetic weapons and fulfill this long overdue capability gap.

Reference

1. *Department of Defense Dictionary of Military and Associated Terms*, Joint Publication 1-02, 12 April 2001 (as amended through 19 August 2009).

Figure 3. Small-Vessel Testing Using a High-Power Microwave Source

LEADING EDGE
Volume 7, Issue No. 4

Directed Energy

We look forward as we provide enterprise-wide technical and strategic leadership for the efficient and effective development, acquisition, and fielding of directed-energy systems for the warfighter.

Dale Sisson
Head, Electromagnetic and
Sensor Systems Department
NSWCDD, Dahlgren, Virginia

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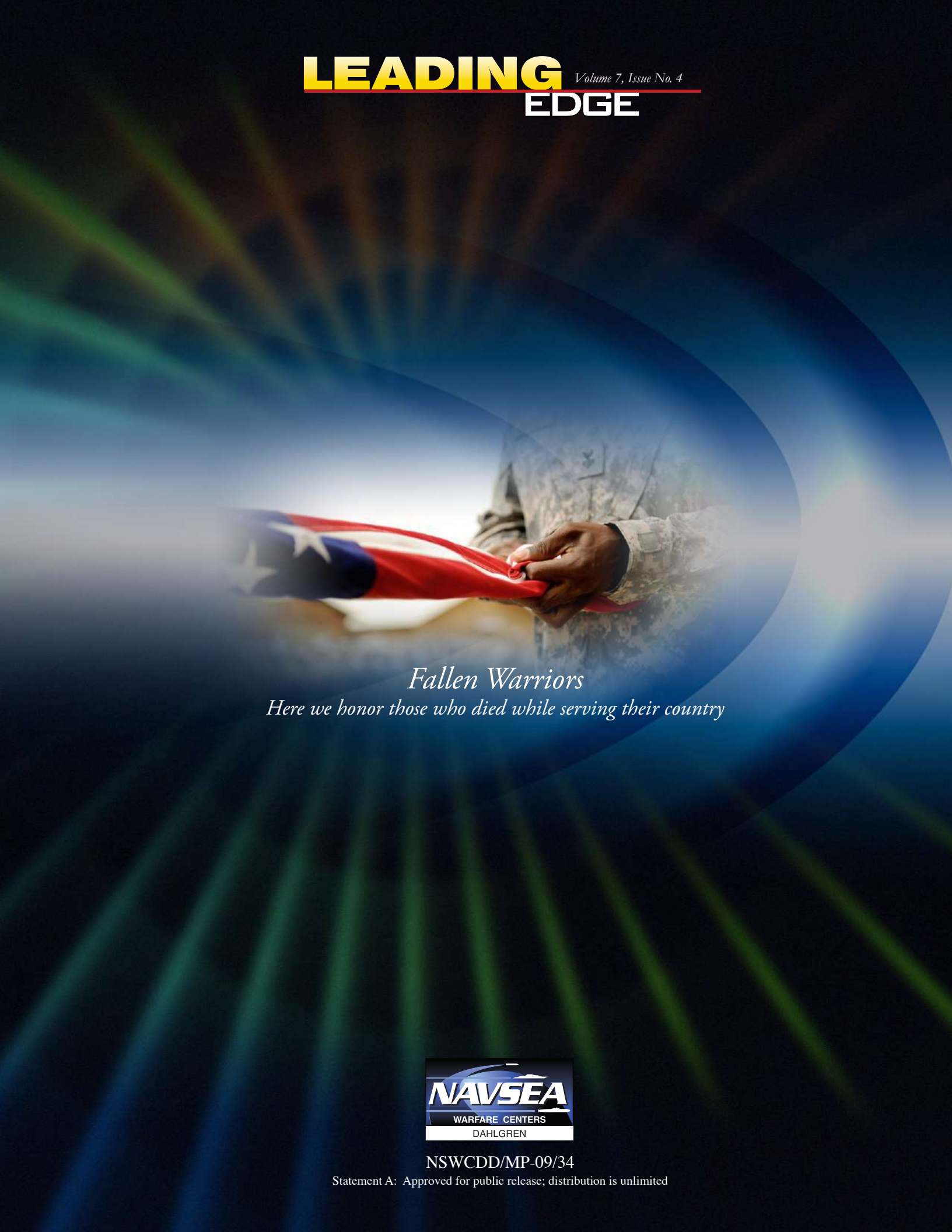

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FOREWORD

This handbook is designed to aid electronic warfare and radar systems engineers in making general estimations regarding capabilities of systems. This handbook is sponsored by the NAVAIR Director of Electronic Warfare/Combat Systems Department. This fourth edition updates technical information in Sections 3-7 and 3-8 from previous editions.

This document was reviewed for technical accuracy by Dr. Andrew Chen.

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DR. R. E. SMILEY, *NAVAIR Director*
EW/Combat Systems Department
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(U) This handbook is designed to aid electronic warfare and radar systems engineers in making general estimations regarding capabilities of systems. This handbook is sponsored by the NAVAIR Director of Electronic Warfare / Combat Systems Department.

15. SUBJECT TERMS

Aircraft Dynamics, Antenna, Data Transfer Busses, Electro-Optics and Infrared, Ethernet, Internet Protocol, Maneuverability, Microwave Components, Polarization, Radar Equations, Radiation Patterns, Receiver Characteristics, Receiver Sensitivity, Receiver Tests, Radio Frequency Components, RS-232 Interface, RS-422 Balanced Voltage Interface, RS-485 Interface, Transmission Control Protocol

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GLOSSARY 10-1

ABBREVIATIONS AND ACRONYMS

a	Acceleration or atto (10^{-18} multiplier)
A	Ampere, Area, Altitude, Angstrom (Å), Antenna Aperture, or Aerial
A-799	No evidence of failure report
A/A, A-A, AA	Air-to-Air or Anti-Aircraft
AA-()	Air-to-Air missile number ()
AAA	Anti-Aircraft Artillery
AAAA	Army Aviation Association of America
AAED	Advanced Airborne Expendable Decoy
AAM	Air-to-Air Missile
AARGM	Advanced Anti-Radiation Guided Missile
AAW	Anti-Air Warfare
A-BIT	Automatic Built-in-Test
ABM	Air Breathing Missile or Anti-ballistic Missile
A/C	Aircraft (also acft.)
AC	Alternating Current
ACA	Associate Contractor Agreement or Airspace Coordination Area
ACAT	Acquisition Category
ACC	Air Combat Command
ACCB	Aircraft Configuration Control Board
Acft	Aircraft (also A/C)
ACLS	Aircraft Carrier Landing System
ACM	Advanced Cruise Missile or Air Combat Maneuvering
ACQ	Acquisition
ACS	Antenna Coupler Set
ACTD	Advanced Concept Technology Demonstration
A/D	Analog to Digital
ADM	Advanced Development Model
ADP	Automatic Data Processing or Advanced Development Program
AEA	Airborne Electronic Attack
AEC	Aviation Electronic Combat (Army)
AEGIS	Automatic Electronic Guided Intercept System
AEL	Accessible Emission Limit
AESA	Active Electronically Scanned Array
AEW	Airborne Early Warning
AF	Antenna Factor, Air Force, or Audio Frequency
AFB	Air Force Base or Airframe Bulletin
AFC	Automatic Frequency Control or Airframe Change
AFIPS	Automated Financial Information Processing System
AFOTEC	Air Force Operational T&E Center
A/G	Air-to-Ground
AGB	Autonomous Guided Bomb
AGC	Automatic Gain Control
AGI	Auxiliary General Intelligence (Intelligence-gathering Ship)
AGL	Above Ground Level
AGM	Air-to-Ground Missile
AGS	Angle Gate Stealer
AHWS	Advanced Helicopter Weapons System
AI	Artificial Intelligence, Air Intercept, or Airborne Interceptor
AIAA	American Institute of Aeronautics and Astronautics
AIC	Air Intercept Control
AIM	Air Intercept Missile
AIRLANT	Commander, U.S. Naval Air Forces, Atlantic Fleet
AIRPAC	Commander, U.S. Naval Air Forces, Pacific Fleet
AJ	Anti-jamming or Anti-Jam
A-Kit	Aircraft wiring kit for a system (includes cabling, racks, etc. excluding WRAs)
ALC	Air Logistics Center
AM	Amplitude Modulation
AMD	Aircraft Maintenance Department
AMES	Advanced Multiple Environment Simulator
AMLV	Advanced Memory Loader/Verifier
Amp	Amplifier
AMRAAM	Advanced, Medium-Range, Air-to-Air Missile
ANSI	American National Standards Institute
ANT	Antenna
Ao	Operational Availability
AO	Acousto-Optical
AOA	Angle of Arrival, Angle of Attack, or Analysis of Alternatives (similar to COEA)
AOC	Association of Old Crows (Professional EW Society) or Award of Contract
AOT	Angle Only Track, Angle Off Tail, or Acquisition-on-Target
APC	Amphenol Precision Connector or Armored Personnel Carrier
APN	Aircraft Procurement, Navy
APO	Armed Forces (or Army or Air) Post Office, Acquisition Program Office

APU	Auxiliary Power Unit
AR	Anti-reflection or Aspect Ratio
ARM	Anti-radiation Missile
ARO	After Receipt of Order
A/S, A-S, AS	Air-to-Surface
ASC	Air Systems Command
ASCM	Anti-ship Cruise Missile
ASE	Aircraft Survivability (or Survival) Equipment, Allowable Steering Error, or Automatic Support Equipment
ASIC	Application Specific Integrated Circuit
ASK	Amplitude Shift Keying
ASM	Air-to-Surface Missile
ASO	Aviation Supply Office
A-Spec	System Specification
ASPJ	Airborne Self-Protection Jammer
ASPO	Avionics Support (also Systems) Project Office (also Officer)
ASR	Advanced Special Receiver or Airport/Airborne Surveillance Radar
ASRAAM	Advanced Short Range Air-to-Air Missile
ASTE	Advanced Strategic and Tactical Expendables
ASW	Anti-submarine Warfare
ATA	Advanced Tactical Aircraft
ATARS	Advanced Tactical Air Reconnaissance System
ATC	Air Traffic Control
ATD	Advanced Technology Demonstration
ATE	Automatic Test Equipment
ATEDS	Advanced Technology Expendables and Dispenser Systems
ATF	Advanced Tactical Fighter (F-22)
ATIMS	Airborne Turret Infrared Measurement System or Airborne Tactical Information Management System
ATIRCM	Advanced Threat Infrared Countermeasures
ATP	Acceptance Test Procedure
ATR	Autonomous Target Recognition, Airborne Transportable Rack, Atlantic Test Range
ATRJ	Advanced Threat Radar Jammer
AUTODIN	Automatic Digital Network
AUX	Auxiliary
avdp.	Avoirdupois (system of measures)
Avg	Average
AWACS	Airborne Warning and Control System
AZ	Azimuth (also Az)

B	Bandwidth (also BW) or Magnetic inductance
BAFO	Best and Final Offer
BAU	Bus Adapter Unit
BC	Bus Controller
BDA	Battle Damage Assessment
BDI	Battle Damage Indication
BFO	Beat Frequency Oscillator
BI	Background Investigation
BIFF	Battlefield Identification, Friend, or Foe
BIT	Built-in-Test, Binary Digit or Battlefield Information Technology
BITE	Built-in-Test Equipment
BIU	Bus Interface Unit
B-Kit	Avionics "Black Box" WRAs
B/N	Bombardier/Navigator
BNC	Bayonet Navy Connector
BOA	Basic Ordering Agreement
BOL	Swedish chaff dispenser in a launcher
BPF	Band Pass Filter
BPS	Bits Per Second
BUMED	Bureau of Medicine (Navy)
BUNO	Bureau Number (aircraft)
BUR	Bottom Up Review
BVR	Beyond Visual Range
BW	Beamwidth (referring to an antenna) or sometimes Bandwidth
BWA	Backward Wave Amplifier
BWO	Backward Wave Oscillator
c	Speed of Light = $3x10^8$ meters/sec = $1.8x10^{12}$ furlongs per fortnight or 1.8 terafurlongs per fortnight, or centi (10^{-2}) multiplier
C	Electron Charge, Coulomb, Capacitance, Celsius, Centigrade, Confidential, Roman numeral for 100, or a programming language (also C+ and C++)
C^2	Command and Control
C^3 (C^4)	Command, Control, Communications (and Computers)
C^3I (C^4I)	Command, Control, Communications, (Computers) and Intelligence
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CAG	Carrier Air Group
CAGE	Commercial and Government Entry
CAIV	Cost as an Independent Variable
CAL	Calibration

CAM	Computer-Aided Manufacturing or Constant Addressable Memory
CAO	Competency Aligned Organization or Contract Administrative Officer
CAP	Combat Air Patrol
CAS	Close Air Support or Calibrated Airspeed
CASS	Consolidated Automated Support System
CAT	Catapult or Cockpit Automation Technology
CB	Citizens Band (also see Seabee)
CBD	Commerce Business Daily
CBIT	Continuous Built-in-Test
CBO	Congressional Budget Office
CCA	Circuit Card Assembly
CCB	Configuration Control Board
CCD	Charge Coupled Device
CCM	Counter-Countermeasures
CCN	Contract Change Number or Configuration Change Notice
CCU	Cockpit Control Unit
cd	Candela (SI unit of luminous intensity)
CD	Compact Disk or Control and Display
CDC	Combat Direction Center
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CE	Conducted Emission
CECOM	Communications and Electronics Command (Army)
CEESIM	Combat Electromagnetic Environment Simulator
CEP	Circular Error Probability
CFA	Cognizant Field Activity
CFAR	Constant False Alarm Rate
CFE	Contractor Furnished Equipment
CG	Center of Gravity, Commanding General, Command Guidance, or Cruiser
CI	Configuration Item
CIA	Central Intelligence Agency
CIC	Combat Information Center (now called CDC)
CID	Combat Identification or Charge Injection Device
CILOP	Conversion in Lieu of Procurement
CINC	Commander in Chief
CIP	Capital Improvement Program
CIS	Commonwealth of Independent States (11 of 15 former Soviet Union territories except Estonia, Georgia, Latvia, and Lithuania)
CIWS	Close-In Weapon System
CJ	Coherent Jamming
CLC	Command Launch Computer
cm	Centimeter
CM	Countermeasures or Configuration Management
CMC	Command Mission Computer or Commandant Marine Corps
CMDS	Countermeasure Dispensing System
CMOS	Complementary Metal-Oxide Semiconductor
CMP	Configuration Management Plan
CMWS	Common Missile Warning System
CNAF	Commander, Naval Air Forces
CNAL	Commander, Naval Air Forces Atlantic (also COMNAVAIRLANT)
CNAP	Commander, Naval Air Forces Pacific (also COMNAVAIRPAC)
CNI	Communications, Navigation, and Identification
CO	Commanding Officer, Contracting Officer, Change Order, or Carbon Monoxide
COB	Close of Business
COCOM	Combatant Command
COEA	Cost and Operational Effectiveness Analysis
COG	Center of Gravity or Cognizant
COMM	Communications
COMSEC	Communications Security
CONSCAN	Conical Scanning Radar
CONUS	Continental United States
CO-OP	Cooperative (countermeasures)
COR	Contracting Officers Representative
CORPORAL	Collaborative On-Line Reconnaissance Provider/Operationally Responsive Attack Link
Cos	Cosine
COSRO	Conical-Scan on Receive Only
COTS	Commercial Off-The-Shelf (hardware/software)
CP	Circularly Polarized (antenna), Central Processor, or Command Post
CPS	Computer or Control Power Supply (depends on application)
CPU	Central Processing Unit
CRC	Originally Chemical Rubber Company, now published reference books by CRC Press
CRFM	Coherent RF Memory
CRISD	Computer Resources Integrated Support Document
CRLCMP	Computer Resources Life Cycle Management Plan

CRO	Countermeasures Response Optimization
CRT	Cathode Ray Tube or Combat Rated Thrust (afterburner)
CSAR	Combat Search and Rescue
Crypto	Cryptographic
CS	Conducted Susceptibility
CSC	Commodity Software Change
CSCI	Computer Software Configuration Item
C-Spec	Product Specification
CSS	Contractor Support Services
CTR	Chesapeake Test Range
CV	Aircraft Carrier
CVN	Nuclear Powered Aircraft Carrier
CVR	Crystal Video Receiver
CW	Continuous Wave or Chemical Warfare
CWBS	Contract Work Breakdown Structure
CWI	Continuous Wave Illuminator
CY	Calendar Year
d	Distance, Diameter, or deci (10^{-1} multiplier)
D	Distance, Diameter, Electron displacement, Detectivity, Doppler, Density, or Roman numeral for 500
da	deca (10^{0} multiplier)
D/A	Digital-to-Analog
DAB	Defense Acquisition Board
DAC	Digital to Analog Converter or Dept of Army Civilian
DAR	Defense Acquisition Regulation
DARPA	Defense Advanced Research Projects Agency
DB	Database
dB	Decibel
dBc	dB referenced to the Carrier Signal
dBi	Decibel antenna gain referenced to an isotropic antenna
dBm	Decibel referenced to the power of one milliwatt
DBOF	Defense Business Operations Fund
dBsm	Decibel value of radar cross section referenced to a square meter
dBW	Decibel referenced to the power of one watt
DC	Direct Current, Discrete Circuit, or District of Columbia
DCE	Data Communication Equipment
DCS	Direct Commercial Sales or Distributed Control System
DDI	Digital Display Indicator
DDS	Direct Digital Synthesizers
DECM	Deceptive Electronic Countermeasures (also Defensive ECM)
deg	Degree
DEMVAL	Demonstration Validation (also DEM/VAL)
DET	Detachment
DF	Direction Finding
DFT	Discrete Fourier Transform
DI	Data Item
DIA	Defense Intelligence Agency or Diameter
DID	Data Item Description
DIRCM	Directed Infrared Countermeasures
DJ	Deceptive Jamming
D-Level	Depot Level Maintenance
DM	Data Management (also manager)
DMA	Direct Memory Address or Defense Mapping Agency
DME	Distance Measuring Equipment
DNA	Defense Nuclear Agency, Does Not Apply, or Deoxyribonucleic Acid
DOA	Direction of Arrival
DOD or DoD	Department of Defense
DoDISS	DoD Index of Specifications and Standards
DOM	Depth of Modulation
DON	Department of the Navy
DOS	Disk Operating System
DOT&E	Director, Operational Test & Evaluation
DPRO	Defense Plant Representative Office
DRB	Defense Review Board
DRFM	Digital RF Memory
DSARC	Defense Systems Acquisition (and) Review Council
DSN	Defense Switching Network
DSO	Dielectrically Stabilized Oscillator
DSP	Digital Signal Processor
D-Spec	Process Specification
DT (&E)	Development or Developmental Test (and Evaluation)
DTC	Design to Cost
DTE	Data Terminal Equipment
DTO	Digitally Tuned Oscillator or Defense Technology Objectives
DTRMC	Defense (or DoD) Test Recourse Management Center

e	Electron charge or base of natural logarithms (2.71828...)
E	Electric Field Intensity or Strength, Energy, East, or Exa (10^{18} multiplier)
E^3	Electromagnetic Environmental Effects
EA	Electronic Attack (similar to older term of ECM)
EC	Electronic Combat
ECAC	Electromagnetic Compatibility Analysis Center (DOD), now Joint Spectrum Center
ECCM	Electronic Counter-Countermeasures (similar to newer term of EP)
ECL	Emitter Coupled Logic
ECM	Electronic Countermeasures (similar to newer term of EA)
ECN	Engineering Change Notice
ECO	Engineering Change Order
ECP	Engineering Change Proposal or Egress Control Point
ECR	Electronic Combat Range (China Lake) or Electronic Combat & Reconnaissance
ECS	Environmental Control System
ECSEL	Electronic Combat Simulation and Evaluation Laboratory
ECU	Electronic Control Unit
EDM	Engineering Development Model
EED	Electro-Explosive Device
EEPROM	Electrically Erasable/Programmable Read-only Memory
EHF	Extremely High Frequency [30 to 300 GHz]
EIA	Electronic Industries Associates
EID	Emitter Identification Data
EIRP	Effective Isotropic Radiated power
EL	Elevation (also El)
ELF	Extremely Low Frequency [3 Hz to 3 kHz]
ELINT	Electronics Intelligence
ELNOT	Emitter Library Notation
EM	Electromagnetic
E-Mail	Electronic Mail
EMC	Electromagnetic Compatibility
EMCAB	EMC Advisory Board
EMCON	Emission Control
EMD	Engineering and Manufacturing Development
EME	Electromagnetic Environment
EMI	Electromagnetic Interference
EMP	Electromagnetic Pulse
EMR	Electromagnetic Radiation
EMS	Electromagnetic Susceptibility, Electromagnetic Spectrum
EMV	Electromagnetic Vulnerability
EO	Electro-Optic, Electro-Optical, or Engineering Order
EOB	Electronic Order of Battle or Expense Operating Budget
EOCM	Electro-Optic Countermeasures
EOF	Electro-Optical Frequency (300 to 3 x 10^7 GHz)
EP	Electronic Protection (similar to older terms of ECCM and DECM)
EPA	Environmental Protection Agency
EPROM	Electrically Programmable Read-only Memory
ERAM	Electronic Counter-Countermeasures (also Protection) Requirements and Assessment Manual
ERP	Effective Radiated Power
ES	Electronic Surveillance (similar to older term of ESM)
ESD	Electrostatic Discharge
ESM	Electronic Support Measures (similar to newer term of ES)
ESSM	Evolved Sea Sparrow Missile
ET	Electronics Technician
ETI	Elapsed Time Indicator
ETIRMS	EW Tactical Information and Report Management System
ETR	Estimated Time to Repair
EVM	Earned Value Management
EW	Electronic Warfare , Early Warning, or Expeditionary Warfare
EWBM	EW Battle Management
EWDS	EW Data Systems
EWIA	EW Intelligence Analysis
EWIR	Electronic Warfare Integration & Reprogramming (USAF database)
EWMP	Electronic Warfare Master Plan
EWO	Electronic Warfare Officer
EWRL	Electronic Warfare Reprogrammable Library (USN)
EWSI	EW Systems Integration
EWSSA	EW Software Support Activity
EXP	Expendable Countermeasure
f	femto (10^{-15} multiplier), Frequency (also F), or lens *f* number
F	Frequency (also *f*), Force, Farad, Faraday Constant, Female, Fahrenheit, Noise Figure, Noise Factor or "Friendly" on RWR display

F2T2EA	Find, Fix, Track, Target, Engage, Assess (targeting of hostile forces)
F/A	Fighter/Attack
FAA	Federal Aviation Administration
FAC	Forward Air Controller
FAR	Federal Acquisition Regulations or False Alarm Rate
f_c	Footcandle (unit of illuminance)
FCA	Functional Configuration Audit
FCR	Fire Control Radar
FDR	Frequency Domain Reflectometry
FEBA	Forward Edge of the Battle Area
FET	Field-Effect Transistor
FEWC	Fleet EW Center
FFT	Fast Fourier Transform
FIFO	First In / First Out
FIPR	Federal Information Processing Resources
fl	fluid
FLAK	AAA Shrapnel, from the German "Flieger Abwher Kanone" (AAA gun that fires fast and furiously)
FLIR	Forward Looking Infrared
FLPS	Flightline Payload Simulator
FLT	Flight
FM	Frequency Modulation or Failure Mode
FME	Foreign Material Exploitation
FMEA	Failure Mode and Effects Analysis
FMS	Foreign Military Sale(s)
FOC	Full Operational Capability
FOD	Foreign Object Damage
FORCECAP	Force Combat Air Patrol
FOT&E	Follow-On Test and Evaluation
FOTD	Fiber Optic Towed Device
FOUO	For Official Use Only
FOV	Field of View
FPA	Focal Plane Array
fps	feet per second
FRACAS	Failure, Reporting, Analysis, and Corrective Actions System
FRB	Failure Review Board
FRD	Functional Requirements Document
FSD	Full Scale Development
FSED	Full Scale Engineering Development
FSK	Frequency Shift Keying
FSU	Former Soviet Union
ft	Feet or Foot
FTC	Fast Time Constant
FTD	Foreign Technology Division (USAF)
FWD	Forward
FY	Fiscal Year
g	Gravity (also G)
G	Universal Gravitational Constant (also K), Giga (10^9 multiplier), Conductance, or Gain
G&A	General and Administrative (expense)
GaAs	Gallium Arsenide
GACIAC	Guidance and Control Information Analysis Center (DoD)
gal	Gallon
GAO	General Accounting Office
GBU	Guided Bomb Unit
GCA	Ground Controlled Approach
GCI	Ground Control Intercept
GENSER	General Service
GEN-X	Generic Expendable
GFE	Government Furnished Equipment
GHz	GigaHertz
GI	Government Issue
GIDEP	Government Industry Data Exchange Program
GIG	Global Information Grid
GIGO	Garbage In / Garbage Out
GOCO	Government Owned Contract Operated
GOFO	General Officer / Flag Officer
GP	General Purpose
GPI	Ground Plane Interference
GPIB	General Purpose Interface Bus
GPS	Global Positioning System
GSE	Ground Support Equipment
h	hours, hecto (10^2 multiplier), Plank's constant, or height (also H)
H	Height (also h), Henry (Inductance), or Irradiance
HARM	High-speed Anti-Radiation Missile
HAWK	Homing All the Way Killer
HDBK	Handbook
HDF	High Duty Factor
HE	High Explosive
HEF	High Energy Frequency ($3x10^7$ to $3x10^{14}$ GHz)
HEL	High Energy Laser
HELO	Helicopter
HERF	Hazards of Electromagnetic Radiation to Fuel
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
hex	hexadecimal
HF	High Frequency [3 - 30 MHz]
HIL or HITL	Hardware-in-the-Loop

HOJ	Home-On-Jam
HOL	Higher Order Language
HPF	High-Pass Filter
HP-IB	Hewlett-Packard Interface Bus
HP-IL	Hewlett-Packard Interface Loop
HPM	High Powered Microwave
HPRF	High Pulse Repetition Frequency
hr	hour
HSDB	High Speed Data Bus
HUD	Heads-Up Display
HV	High Voltage
H/W	Hardware
HWCI	Hardware Configuration Item
HWIL	Hardware-in-the-loop
Hz	Hertz (Cycles per second)
i	current (also I)
I	Current (also i), Intensity, Irradiance, Intermediate, or Roman Numeral for One
IA	Information Assurance
IADS	Integrated Air Defense System
I&Q	In-Phase and Quadrature
IAS	Indicated Airspeed
IAW	In Accordance With
IBIT	Initiated Built-in-Test
IBU	Interference Blanker Unit
IC	Integrated Circuit
ICD	Interface Control Document Initial Capabilities Document
ICMD	Improved Countermeasure Dispenser
ICNIA	Integrated Communication, Navigation, Identification Avionics
ICS	Inverse Conical Scan or Intercommunications System (aircraft)
ICW	In Compliance With
ID	Identification
IDA	Institute For Defense Analysis
IDECM	Integrated Defensive Electronic Countermeasures
IEEE	Institute of Electrical and Electronic Engineers
IF	Intermediate Frequency
IFF	Identification Friend-or-Foe
IFM	Instantaneous Frequency Measurement
IFR	Instrument Flight Rules
IG	Inspector General
IIR	Imaging Infrared
I-Level	Intermediate Level of Repair (also "I" Level)
ILS	Integrated Logistic Support, Instrument Landing System, or Inertial Locator System
ILSMT	Integrated Logistic Support Management Team
IM	Intermodulation or Item Manager
IMA	Intermediate Maintenance Activity
in	Inch
INEWS	Integrated Electronic Warfare System
INS	Inertial Navigation System
INT	Intensity
IO	Information Operations
I/O	Input/Output
IOC	Initial Operational (also Operating) Capability
IOT&E	Initial Operational Test and Evaluation
IPO	International Projects (Program) Office
IPR	In-Progress/Process Review
IPT	Integrated Product (also Program) Team
IR	Infrared
IR&D	Independent Research and Development
IRCM	Infrared Countermeasures
IRDS	Infrared Detecting System
IREXP	IR Expendables
IRIG-B	Inter-range Instrumentation Group B
IRLS	Infrared Line Scanner
IRS	Interface Requirements Specification, IR Suppression or Internal Revenue Service
IRST	Infrared Search and Track
ISAR	Inverse Synthetic Aperture Radar
ISO	Derived from the Greek "isos" meaning "equal," the official title is International Organization for Standardization
ISP	Integrated Support Plan Intelligence Support Plan
ISR	Interference to Signal Ratio (also I/S)
ITU	International Telecommunications Union
IV&V	Independent Validation and Verification
IW	Information Warfare

J	Jamming, Radiance, Current Density, or Joules
JAAS	Joint Architecture for Aircraft Survivability
JAFF	Jammer (illuminating) Chaff
JAG	Judge Advocate General
JAMS	Jamming Analysis Measurement System
JARS	Jamming Aircraft & Radar Simulation
JASSM	Joint Air-to-Surface Standoff Missile
JAST	Joint Advanced Strike Technology
JATO	Jet Assisted Takeoff or JAmmer Technique Optimization
JC2WC	Joint Command and Control Warfare Center (now JIOWC)
JCTD	Joint Concept Technology Demonstration
JCS	Joint Chiefs of Staff or Joint Spectrum Center (formerly ECAC)
JDAM	Joint Direct Attack Munition
JEACO	Joint Electronic Attack and Compatibility Office
JED	Journal of Electronic Defense (Published by the Association of Old Crows)
JEM	Jet Engine Modulation
JETS	Joint Emitter Targeting System
JEWC	Joint EW Conference or Joint EW Center (then JC2WC & now JIOWC)
JEWEL	Joint Electronic Warfare Effects Laboratory
JIOWC	Joint Information Operations Warfare Command
JMEM	Joint Munitions Effectiveness Manual
JMR	Jammer
JOVIAL	Julius' Own Version of International Algorithmic Language (Air Force computer programming language)
JPATS	Joint Primary Aircraft Training System
J/S	Jamming to Signal Ratio
JSF	Joint Strike Fighter
JSGCC	Joint Services Guidance and Control Committee
JSIR	Joint Spectrum Interference Resolution (signal interference portion of MIJI)
JSOW	Joint Stand-Off Weapon (AGM-154A)
JSTARS	Joint Surveillance Target Attack Radar System
JTA	Jammer Threat Analysis
JTAT	JATO Techniques Analysis and Tactics
JTCG/AS	Joint Technical Coordinating Group for Aircraft Survivability
JTCG/ME	Joint Technical Coordinating Group for Munitions Effectiveness
JTIDS	Joint Tactical Information Distribution System
JV or J/V	Joint Venture
k	kilo (10^3 multiplier) or Boltzmann Constant
K	Kelvin, Cathode, Universal gravitational constant (also G), or Luminous efficacy
KCAS	Knots Calibrated Airspeed
kg	kilogram
kHz	KiloHertz
KIA	Killed in Action
KIAS	Knots Indicated Air Speed
km	Kilometer
KSLOC	Thousand Source Lines of Code (software)
kt	Knot (nautical miles per hour)
kW	Kilowatt
l	length (also L) or liter
L	Length (also l), Loss, inductance, Luminance, or Roman Numeral for fifty
LADAR	Laser Detection and Ranging (i.e., laser radar)
LAN	Local Area Network
LANTIRN	Low Altitude Navigation & Targeting Infrared for Night
LASER	Light Amplification by Stimulated Emission of Radiation
LAT	Latitude (0-90° N or S from equator)
lbs	pounds
LCC	Life Cycle Cost(s)
LCD	Liquid Crystal Display or Lowest Common Denominator
LCP or LHCP	Left-hand Circular Polarization
LDF	Low Duty Factor
LDS	Laser Detecting Set
LED	Light-Emitting Diode
LEX	Leading Edge Extension
LGB	Laser Guided Bomb
LF	Low Frequency [30 - 300 kHz]
LIC	Low Intensity Combat or Laser Intercept Capability

LISP	List Processing (A programming language used in artificial intelligence)
LLL	Low Light Level (as in LLL TV)
lm	lumen (SI unit of luminous flux)
ln	Natural Logarithm
LO	Local Oscillator or Low Observable
LOA	Letter of Agreement (or Acceptance)
LOB	Line of Bearing (see also AOA)
LOG	Logarithm to the base 10 (also log) or Logistician
LONG	Longitude (0-180° E or W from Greenwich, U.K.)
LOR	Level of Repair
LORA	Level of Repair Analysis
LORAN	Long Range Navigation
LORO	Lobe on Receive Only
LOS	Line-of-Sight
LPAR	Large Phased-Array Radar
LPD	Low Probability of Detection
LPF	Low Pass Filter
LPI or LPOI	Low Probability of Intercept
LPRF	Low Pulse Repetition Frequency
LR	Lethal Range
LRA	Line Replaceable Assembly
LRF	Laser Rangefinder
LRIP	Low Rate Initial Production
LRU	Line Replaceable Unit
LSA	Logistic Support Analysis
LSAR	Logistic Support Analysis Record
LSB	Least Significant Bit
LSI	Large Scale Integration
LSO	Landing Signal Officer
LSSO	Laser System Safety Officer
LTBB	Look Through Blanking Bus
LWIR	Long Wave Infrared
LWR	Laser Warning Receiver
lx	Lux (SI unit of illuminance)
LZ	Landing Zone
m	milli (10^{-3} multiplier), meter, or electron mass
M	Mega (10^{6} multiplier), Male, Mach number, or Roman numeral for 1,000
MA	Missile Alert or Missile Active
MAD	Magnetic Anomaly Detection (also Detector)
MADD	Microwave Acoustic Delay Device
MAF	Maintenance Action Form
MAG	Marine Aircraft Group or Magnetic
MAGTF	Marine Air-Ground Task Force
MANPADS	Man-portable Air Defense System
M&S	Modeling and Simulation
MASER	Microwave Amplification by Simulated Emission of Radiation
MATE	Modular Automatic Test Equipment
MAW	Missile Approach Warning system (also MAWS) or Marine Aircraft Wing
MAX	Maximum or Maximum aircraft power (afterburner)
MBFN	Multiple Beam Forming Network
MC	Mission Computer
MCIOC	Marine Corps Information Operations Center
MCP	Micro-Channel Plate
MDF	Mission Data File
MDI	Multiple Display Indicator or Miss Distance Indicator
MDG	Mission Data Generator
MDS	Minimum Discernible Signal or Minimum Detectable Signal
MDU	Multipurpose Display Unit
MF	Medium Frequency (300 kHz to 3 MHz)
MFD	Multifunction (video) Display
MG	Missile Guidance
MHz	MegaHertz (10^{6} Hz)
MIA	Missing in Action
MIC	Microwave Integrated Circuit or Management Information Center
MICRON	10^{-6} meter
MiG	Mikoyan-Gurevich (Soviet aircraft manufacturer)
MIGCAP	MiG Combat Air Patrol
MIJI	Meaconing, Intrusion, Jamming, & Interference (also see JSIR)
mil	One-thousandth of an inch
MIL	Military power (100%, no afterburner) or Military
MILCON	Military Construction
MILSPEC	Military Specification
MILSTRIP	Military Standard Requisitioning and Issue Procedure(s)
MIMIC	Microwave Monolithic Integrated Circuit (also MMIC)
MIN	Minimum
Mincon	Minimal Construction
MIPPLE	RWR display switching between ambiguous emitters
MIPS	Millions of (Mega) Instructions Per Second
ML	Missile Launch
MLC	Main Lobe Clutter
MLV	Memory Loader Verifier
MLVS	Memory Loader Verifier Set

mm	Millimeter
MM	Man Month
MMIC	Microwave Monolithic Integrated Circuit (also MIMIC)
MMW	Millimeter Wave (40 GHz or higher per IEEE, but commonly used down to 30 GHz)
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
MOM	Methods of Moments (also MoM) or Metal-Oxide-Metal
MOP	Modulation on Pulse or Measure of Performance
MOPS	Million Operations Per Second
MOS	Minimum Operational Sensitivity, Military Occupational Specialty, Metal-Oxide Semiconductor, or Measure of Suitability
MOSAIC	Modeling System for Advanced Investigation of Countermeasures
MOU	Memorandum of Understanding
MPD	Multi-Purpose Display or Microwave Power Device
MPE	Maximum Permissible Exposure
mph	Miles per Hour
MPLC	Multi-Platform Launch Controller
MPM	Microwave Power Module
MPPS	Million Pulses Per Second
MPRF	Medium Pulse Repetition Frequency
mr or mrad	Milliradian
MRC	Maintenance Requirement Card or Medium Range CAP
MRE's	Meals Ready to Eat
ms	Milliseconds
MSB	Most Significant Bit
MSI	Multi-Sensor (also Source) Integration, Management Support Issues, or Medium Scale Integration
MSIC	Missile and Space Intelligence Center
MSL	Mean Sea Level (altitude) or Missile
MTBF	Mean Time Between Failures
MTI	Moving Target Indicator (or Indication)
MTTR	Mean Time To Repair
MUXBUS	Multiplex Bus
MVS	Minimum Visible Signal
mw	Microwave
mW	Milliwatt
MWIR	Mid Wave Infrared
MWS	Missile Warning Set
MY	Man Year
n	nano (10^{-9} multiplier) or number of elements
N	Noise, Newton (force), Radiance, North, or No
n/a	Not Applicable (also N/A)
NA	Numerical Aperture
NADEP	Naval Aviation Depot
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NATOPS	Naval Air Training and Operating Procedures Standardization
NAV	Navigation
NAVAIR	Naval Air Systems Command (also NAVAIRSYSCOM)
NavMPS	Naval Mission Planning System
NAVSEA	Naval Sea Systems Command (also NAVSEASYSCOM)
NAWCAD	Naval Air Warfare Center Aircraft Division
NAWCWD	Naval Air Warfare Center Weapons Division
NBC	Nuclear, Biological, Chemical
NCTR	Non-Cooperative Target Recognition
NDI	Non-Developmental Item or Non Destructive Inspection
NEI	Noise Equivalent Power
NEMP	Nuclear Electromagnetic Pulse
NEOF	No Evidence of Failure
NEP	Noise Equivalent Power
NF	Noise Figure or Noise Factor (also F)
NFO	Naval Flight Officer
NGJ	Next Generation Jammer
NIOC	Navy Information Operations Command
NIPO	Navy International Program Office
NIR	Near Infrared
nm	nanometer or Nautical Mile (also NM or NMI)
NM or NMI	Nautical Mile (also nm)
NMCI	Navy Marine Corps Intranet
NNWC	Naval Network Warfare Command
NOHD	Nominal Ocular Hazard Distance
NORAD	North American Air Defense Command
NPG or NPGS	Naval Post Graduate School
NRE	Non-Recurring Engineering
NRL	Naval Research Laboratory
NRZ	Non Return to Zero
NSA	National Security Agency
nsec or ns	Nanosecond
NSN	National Stock Number
NSWC	Naval Surface Weapons Center
nt	Nit (SI unit of luminance)

NUWC	Naval Undersea Warfare Center
NVG	Night Vision Goggles
NWIP	Naval Warfare Information Publication
NWP	Naval Warfare Publication
O	Optical
OADR	Originating Agency's Determination Required
OAG	Operational Advisory Group
O&MN	Operations and Maintenance, Navy (also O&M,N)
OBE	Overtaken (Overcome) By Events
OCA	Offensive Counter Air
OEWTPS	Organizational Electronic Warfare Test Program Set
OFP	Operational Flight Program
OJT	On-the-Job Training
O-Level	Organizational Level of Repair (also "O" Level)
OMA	Organizational Maintenance Activity
OMB	Office of Management and Budget
OMEGA	Optimized Method for Estimating Guidance Accuracy (VLF Navigation System)
ONR	Office of Naval Research
OOK	On-Off Keying
OPEVAL	Operational Evaluation
OPM	Office of Personnel Management
OPSEC	Operational Security
OPTEVFOR	Operational Test and Evaluation Force
OR	Operational Requirement or Operationally Ready
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OSHA	Occupational Safety and Health Act
OSIP	Operational Safety Improvement Program
OSM	Operating System Memory or SMA connector made by Omni-Spectra
OSRB	Operational Software Review Board
OT (&E)	Operational Test (and Evaluation)
OTD	Operational Test Director
OTH	Over the Horizon
OTH-B	Over-the-Horizon Backscatter
OTH-R	Over-the-Horizon Radar
OTH-T	Over-the-Horizon Targeting
OTRR	Operational Test Readiness Review
OUSD	Office of the Under Secretary of Defense
oz	ounce
p	pico (10^{-12} multiplier) or page
P	Power, Pressure, or Peta (10^{15} multiplier)
P^3I	Pre-Planned Product Improvement
Pa	Pascal (pressure)
PA	Public Address or Program Analyst
PBIT	Periodic Built-in-Test
PC	Pulse Compression, Personal Computer, or Photoconductive
PCA	Physical Configuration Audit
PCM	Pulse Code Modulation
P_d	Probability of Detection
PD	Pulse Doppler
PDI	PD Illuminator or Post Detection Integration
PDP	Plasma Display Panel
PDQ	Pretty Darn [sic] Quick
PDR	Preliminary Design Review
PDW	Pulse Descriptor Word
PEL	Personnel Exposure Limits
PEM	Photoelectromagnetic
PEO	Program Executive Officer
pf	Power Factor or Pico Farads
PFA	Probability of False Alarm
PGM	Precision Guided Munition
ph	Phot (unit of illuminance)
P_h	Probability of Hit
pi	Greek letter π
P_i	Probability of Intercept (also POI)
PID	Positive Identification
PIN	Personal Identification Number
PIP	Product Improvement Plan or Predicted Intercept Point
Pixel	Picture Element
P_k	Probability of Kill or Peak
PLSS	Precision Location Strike System
PM	Phase Modulation or Program Manager
PMA	Program (also Project) Manager, Air
PMAWS	Passive Missile Approach Warning System
PMS	Program Manager, Ship
PMT	Photomultiplier Tube
PMW	Program Manager, Warfare
P-N	Positive to Negative Junction (also p-n)
PN or P/N	Part Number
POC	Point of Contact
POET	Primed Oscillator Expendable Transponder
POI	Probability of Intercept (also PI)
POL	Polarization
POM	Program Objective Memorandum

POP	Pulse-on-Pulse or Product Optimization Program
POST	Passive Optical Seeker Technology (Stinger missile)
PPI	Plan Position Indicator
PPS	Pulses Per Second
PRF	Pulse Repetition Frequency
PRI	Priority or Pulse Repetition Interval
PROM	Programmable Read-only Memory
PRR	Production Readiness Review or Pulse Repetition Rate
PRT	Pulse Repetition Time
P_s	Probability of Survival
P's & Q's	Pints and Quarts (small details)
PSK	Phase-shift Keying
PUPS	Portable Universal Programming System
PV	Photovoltaic
pw or PW	Pulse Width
PWB	Printed Wiring Board
q	electron charge
Q	Quantity Factor (figure of merit), Quadrature, aerodynamic pressure, or Charge (coulomb)
QA	Quality Assurance
QC	Quality Control
QED	Quod Erat Demonstradum (end of proof)(Satirically "quite easily done")
QML	Qualified Manufacturer Listing
QPL	Qualified Parts List
QRC	Quick-Reaction Capability
QRD	Quick Reaction Demonstration
QRT	Quick-Reaction test
r or R	Radius or Range
R	Resistance, Reliability, or Roentgen
rad	Radian
R&D	Research and Development
RADAR	Radio Detection and Ranging
RADHAZ	Radiation Hazard
RAM	Random Access Memory, Radar Absorbing Material, Rolling Airframe Missile, or Reliability, Availability, and Maintainability
R&M	Reliability and Maintainability
RAT	Ram Air Turbine
RBOC	Rapid Blooming Offboard Chaff
RCP or RHCP	Right-hand Circular Polarization
RCS	Radar Cross Section
RCVR	Receiver
RDT&E	Research, Development, Test, & Evaluation
RDY	Ready
RE	Radiated Emissions
REC	Receive
RET	Return
RF	Radio Frequency
RFEXP	RF Expendables
RFI	Radio Frequency Interference, Ready-For-Issue, or Request for Information
RFP	Request for Proposal
RFQ	Request for Quotation
RFSS	Radio Frequency Simulation System (Army)
RGPO	Range Gate Pull Off
RGS	Range Gate Stealer
RGWO	Range Gate Walk Off (see RGPO)
RHAW	Radar Homing and Warning Receiver or Radar Homing All the Way
RHAWS	Radar Homing and Warning System
RINT	Radiation Intelligence
RIO	Radar Intercept Officer
RM	Radar Mile
rms or RMS	Root Mean Square
RNG	Range
ROC	Required Operational Capability
ROE	Rules of Engagement
ROI	Return on Investment
ROM	Read-only Memory or Rough Order of Magnitude
ROR	Range Only Radar or Rate of Return (financial)
ROT	Rate of Turn
ROWG	Response Optimization Working Group
RPG	Receiver Processor Group
RPM	Revolutions per Minute
RPT	Repeat
RPV	Remotely Piloted Vehicle
RRT	Rapid Reprogramming Terminal (a type of MLVS)
RS	Radiated Susceptibility or Remote Station
RSDS	Radar Signal Detecting Set
RSO	Range Safety Officer or Receiver, Set-on
RST	Receiver Shadow Time
RT	Remote Terminal, Termination Resistance, or Receiver/Transmitter (also R/T)
RUG	Radar Upgrade
RWR	Radar Warning Receiver
Rx	Receive

s, S, or sec	seconds
S	Signal Power, Surface Area, Secret, Electrical conductance (siemens), South, Scattering (as in S-parameters), or Seconds
SA	Situational Awareness, Semi-Active, Spectrum Analyzer, or Surface-to-Air (also S/A or S-A)
SA-()	Surface-to-Air missile number ()
SAE	Society of Automotive Engineers
SAM	Surface-to-Air Missile
SA-N-()	Naval Surface-to-Air missile number
SAR	Synthetic Aperture Radar, Special Access Required, Semi-Active Radar, Search and Rescue, or Specific Absorption Rate
SATS	Semi-Active Test System
SAW	Surface Acoustic Wave
SBIR	Small Business Innovative Research
SCI	Sensitive Compartmented Information
SCIF	Sensitive Compartmented Information Facility
SCN	Specification Change Notice
SCR	Software Change Request
SCP	Software Change Proposal
SCRB	Software Configuration Review Board
SCUD	Soviet short-range surface-to-surface missile
SE	Support Equipment
SDLM	Standard Depot Level Maintenance
SDI	Strategic Defense Initiative
SEAD	Suppression of Enemy Air Defense (pronounced "seed" or "C add")
SEAL	Sea-Air-Land (Navy special forces)
sec	seconds (also S or s)
SECDEF	Secretary of Defense
SEI	Specific Emitter Identification
SEMA	Special Electronic Mission Aircraft
SERD	Support Equipment Recommendation Data
SHAPE	Supreme Headquarters Allied Powers Europe (NATO military command)
SHF	Super High Frequency (3 to 30 GHz)
SI	Special Intelligence or System International (Units)
SIF	Selective Identification Feature
SIGINT	Signals Intelligence
SIJ	Stand-In Jamming (also S/J)
SIM	Simulation
sin	Sine
SINCGARS	Single Channel Ground and Airborne Radio System
SIRCM	Suite of IR Countermeasures
SIRFC	Suite of Integrated RF Countermeasures
SJ	Support Jamming
S/J	Stand-In Jamming or Signal to Jamming Ratio
SL	Side lobe or Sea Level (also S.L.)
SLAM	Standoff Land Attack Missile
SLAR	Side-Looking Airborne Radar
SLC	Side Lobe Clutter
SLOC	Source Lines of Code or Sea Lines of Communication
SM	Statute Mile (also sm) or Standard Missile
SMA	Scheduled Maintenance Action or Sub-Miniature A connector
SMC	Sub-Miniature C connector
SME	Subject Matter Expert
SML	Support Material List
SMS	Stores Management Set or Status Monitoring System
S/N or SNR	Signal-to-Noise Ratio
SNORT	Supersonic Naval Ordnance Research Track
SNTK	Special Need to Know
SOF	Safety of Flight
SOJ	Stand-off Jammer
SONAR	Sound Navigation and Ranging
SOO	Statement of Objectives (replacing SOW)
SOP	Standard Operating Procedures
SORO	Scan-on-Receive Only
SOS	"Save Our Ship" (distress call with easy Morse code, i.e. • • • – – – • • •)
SOW	Statement of Work (being replaced by SOO)
SPAWAR	Space and Naval Warfare Systems Command
SPEC	Specification
SPIRITS	Spectral Infrared Imaging of Targets and Scenes
SPO	System Program Office
SPY	Radar on an AEGIS ship
sq	Square
sr	Steradian
SRA	Shop Replaceable Assembly
SRAM	Static Random Access Memory
SRB	Software Review Board
SRBOC	Super Rapid Blooming Offboard Chaff
SRD	Systems Requirements Document
SRS	Software Requirements Specification
SRU	Shop Replaceable Unit

SSA	Software (also Special or System) Support Activity, Source Selection Activity, or Solid State Amplifier
SSB	Single Side Band
SSI	Small Scale Integration
SSJ	Self Screening Jamming
SSM	Surface-to-Surface Missile
SSRO	Sector Scan Receive Only
SSW	Swept Square Wave
S&T	Science and Technology
STANAG	Standardization Agreement (NATO)
STAR	System Threat Assessment Report
stat	Statute
STBY	Standby
STC	Sensitivity Time Control, Short Time Constant or SHAPE Technical Center
STD	Software Test Description, Standard, or Sexually Transmitted Disease
STE	Standard Test Equipment
STOVL	Short Takeoff and Vertical Landing
STP	Software Test Plan, or Standard Temperature and Pressure (0°C at 1 atmosphere)
STR	Software (also System) Trouble Report
STT	Single Target Track
STU	Secure Telephone Unit
SUBSAM	Subsurface-to-Air Missile
SUT	System Under Test
S/W	Software (also SW)
SWAP	Size, Weight, And Power
SWC	Scan With Compensation
SWM	Swept Wave Modulation
SYSCOM	Systems Command
t	Time (also T)
T	Time (also t), tera (10^{12} multiplier), Temperature, or Telsa
TA	Target Acquisition or Terrain Avoidance
TAAF	Test, Analyze, and Fix
TAC	Tactical Air Command (now ACC)
TACAIR	Tactical Aircraft
TACAMO	Take Charge and Move Out (airborne strategic VLF communications relay system)
TACAN	Tactical Air Navigation
TACDS	Threat Adaptive Countermeasures Dispensing System
TACTS	Tactical Aircrew Combat Training System
TAD	Threat Adaptive Dispensing, Temporary Additional (also Active) Duty, or Tactical Air Direction
T&E	Test & Evaluation
TALD	Tactical Air Launched Decoy
TAMPS	Tactical Automated Mission Planning System
TAR	Target Acquisition Radar or Training Administrative Reserve
TAS	True Airspeed
TBA	To Be Announced
TBD	To Be Determined
TBMD	Theater Ballistic Missile Defense
TD	Technical Directive (also Director)
TDD	Target Detection Device
TDM	Time Division Multiplexing
TE	Transverse Electric
TEA	Technology Exchange Agreement
TEAMS	Tactical EA-6B Mission Support
TECHEVAL	Technical Evaluation
TEL	Transporter Erector Launcher
TEM	Transverse Electromagnetic
TEMP	Test and Evaluation Master Plan
TEMPEST	Not an acronym. Certification of reduced electromagnetic radiation for security considerations
TENA	Training Enabling Architecture
TERPES	Tactical Electronic Reconnaissance Processing and Evaluation System
TGT	Target
TIM	Technical Interchange Meeting
TM	Telemetry, Transverse Magnetic, or Technical Manual
TMD	Theater Missile Defense
TNC	Threaded Navy Connector
TOA	Time of Arrival
TOJ	Track on Jam
TOO	Target of Opportunity (HARM operating mode)
TOR	Tentative (also Tactical) Operational Requirement or Time of Receipt
TOS	Time on Station
TOT	Time on Target
TOW	Tube-Launched, Optically-Tracked, Wire-guided
TPI	Test Program Instruction
TPS	Test Program Set or Test Pilot School
TPWG	Test Plan Working Group
TQM	Total Quality Management
T/R	Transmit / Receive
TRB	Technical Review Board
TRD	Test Requirements Document
TREE	Transient Radiation Effects on Electronics

TRF	Tuned Radio Frequency
TRR	Test Readiness Review
TS	Top Secret
TSS	Tangential Sensitivity
TSSAM	Tri-Service Standoff Attack Weapon
TT	Target Track
TTI	Time To Impact/Intercept
TTG	Time-to-Go
TTL	Transistor-Transistor Logic
TTR	Target Tracking Radar
TV	Television
TVC	Thrust Vector Control
TWS	Track While Scan or Tail Warning System
TWSRO	Track While Scan on Receive Only
TWT	Traveling Wave Tube
TWTA	Traveling Wave Tube Amplifier
Tx	Transmit
TYCOM	Type Commander
u or μ	micron / micro (10^{-6} multiplier)
U	Unclassified, Unit, or Unknown (on RWR display)
UAS	Unmanned Aerial System
UAV	Unmanned (also uninhabited) Air (or Aerial) Vehicle
UCAV	Uninhabited Combat Air Vehicle (new USAF term for UAV)
UDF	User Data File
UDFG	User Data File Generator
UDM	User Data Module
UHF	Ultra High Frequency (300 MHz to 3 GHz)
ULF	Ultra Low Frequency (3 to 30 Hz)
μm	Micrometer
UN	United Nations
UNK	Unknown (also U)
UPC	Unique Planning Component
UPS	Uninterruptable Power Supply
us or μs	Microseconds
U.S.	United States
USA	United States of America or United States Army
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
UTA	Uninhabited Tactical Aircraft
UUT	Unit Under Test
UV	Ultraviolet
v	Volts (also V), Velocity (also V or v_t)
V	Volts (also v), Velocity (also v or v_t), Volume, or Roman Numeral for five
VA	Veterans Administration, Volt-Amperes
VAQ	Prefix for Navy tactical EW squadron
V&V	Validation and Verification
VCO	Voltage Controlled Oscillator
Vdc or VDC	Volts Direct Current
VDT	Video Display Terminal
VECP	Value Engineering Change Proposal
VF	Prefix for Navy fighter squadron
VFO	Variable Frequency Oscillator
VFR	Visual Flight Rules
VGPO	Velocity Gate Pull Off
VGS	Velocity Gate Stealer
VGWO	Velocity Gate Walk Off
VHF	Very High Frequency (30 - 300 MHz)
VHSIC	Very High Speed Integrated Circuit
VID	Visual Identification
VLF	Very Low Frequency (3 to 30 kHz)
VLSI	Very Large Scale Integration
VLSIC	Very Large Scale Integrated Circuit
VMAQ	Prefix for Marine Tactical EW Squadron
VP	Prefix for Navy patrol squadron
VQ	Prefix for Navy special mission (usually reconnaissance) squadron
VRAM	Video Random Access Memory
VS or vs	Velocity Search or Versus (also vs.)
V/STOL	Vertical/Short Take-off and Landing (also VSTOL)
vt	Velocity (also V or v)
VTOL	Vertical Takeoff and Landing
VSWR	Voltage Standing Wave Ratio
VVA	Voltage Variable Attenuator
W	Watts, Weight, or West
W&T	Warning & Targeting
WARM	Wartime Reserve Mode
wb	Weber (magnetic flux)
WBS	Work Breakdown Structure
WC	Waveguide, circular
WFT	Windowed Fourier Transform
WGIRB	Working Group on Infrared Background
WORM	Write Once Read Many [times] (Refers to optical disks)
WOW	Weight on/off Wheels (also WonW or WoffW)
WPN	Weapons Procurement, Navy or Weapon

WR	Waveguide, rectangular
WRA	Weapon Replaceable Assembly
WRD	Waveguide, rectangular double ridged
WSSA	Weapons System Support Activity
WVR	Within Visual Range

x	Multiplication symbol
X	Reactance, Experimental, Extraordinary, Roman Numeral for ten, or X axis
X-EYE	Cross Eye
X-POL	Cross Polarization
XMIT	Transmit
XMTR	Transmitter

Y	Yes or Y-Axis
YAG	Yttrium-Aluminum Garnet
yd	Yard
YIG	Yttrium-Iron Garnet

Z	Impedance, Zenith, or Z-Axis

1xLR, 2xLR	One (or two or three etc.) Times Lethal Range
1v1 or 1-v-1	One versus One (Aerial engagement)

2D	Two Dimension

3D	Three Dimension
3M	Navy Maintenance and Material Management System

FUNDAMENTALS

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CONSTANTS, CONVERSIONS, and CHARACTERS

DECIMAL MULTIPLIER PREFIXES

Prefix	Symbol	Multiplier
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deka	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

EQUIVALENCY SYMBOLS

Symbol	Meaning
$\propto$	Proportional
~	Roughly equivalent
$\approx$	Approximately
$\cong$	Nearly equal
=	Equal
$\equiv$	Identical to, defined as
$\neq$	Not equal
>>	Much greater than
>	Greater than
$\geq$	Greater than or equal to
<<	Much less than
<	Less than
$\leq$	Less than or equal to
$\therefore$	Therefore
°	Degrees
′	Minutes or feet
“	Seconds or inches

UNITS OF LENGTH

1 inch (in)	=	2.54 centimeters (cm)
1 foot (ft)	=	30.48 cm = 0.3048 m
1 yard (yd)	$\cong$	0.9144 meter
1 meter (m)	$\cong$	39.37 inches
1 kilometer (km)	$\cong$	0.54 nautical mile
	$\cong$	0.62 statute mile
	$\cong$	1093.6 yards
	$\cong$	3280.8 feet
1 statute mile	$\cong$	0.87 nautical mile
(sm or stat. mile)	$\cong$	1.61 kilometers
	=	1760 yards
	=	5280 feet
1 nautical mile	$\cong$	1.15 statute miles
(nm or naut. mile)	$\cong$	1.852 kilometers
	$\cong$	2025 yards
	$\cong$	6076 feet
1 furlong	=	1/8 mi (220 yds)

UNITS OF SPEED

1 foot/sec (fps)	$\cong$	0.59 knot (kt)*
	$\cong$	0.68 stat. mph
	$\cong$	1.1 kilometers/hr
1000 fps	$\approx$	600 knots
1 kilometer/hr	$\cong$	0.54 knot
(km/hr)	$\cong$	0.62 stat. mph
	$\cong$	0.91 ft/sec
1 mile/hr (stat.)	$\cong$	0.87 knot
(mph)	$\cong$	1.61 kilometers/hr
	$\cong$	1.47 ft/sec
1 knot*	$\cong$	1.15 stat. mph
	$\cong$	1.69 feet/sec
	$\cong$	1.85 kilometer/hr
	$\cong$	0.515 m/sec

*A knot is 1 nautical mile per hour.

UNITS OF VOLUME

1 gallon	≅	3.78 liters
	≅	231 cubic inches
	≅	0.1335 cubic ft
	≅	4 quarts
	≅	8 pints
1 fl ounce	≅	29.57 cubic centimeter (cc) or milliliters (ml)
1 in^3	≅	16.387 cc

UNITS OF AREA

1 sq meter	≅	10.76 sq ft
1 sq in	≅	645 sq millimeters (mm)
	=	1,000,000 sq mil
1 mil	=	0.001 inch
1 acre	=	43,560 sq ft

UNITS OF WEIGHT

1 kilogram (kg)	≅	2.2 pounds (lbs)
1 pound	≅	0.45 Kg
	=	16 ounce (oz)
1 oz	=	437.5 grains
1 carat	≅	200 mg
1 stone (U.K.)	≅	6.36 kg

NOTE: These are the U.S. customary (avoirdupois) equivalents, the troy or apothecary system of equivalents, which differ markedly, was used long ago by pharmacists.

UNITS OF POWER / ENERGY

1 H.P.	=	33,000 ft-lbs/min
	=	550 ft-lbs/sec
	≅	746 Watts
	≅	2,545 BTU/hr

(BTU = British Thermal Unit)

1 BTU	≅	1055 Joules
	≅	778 ft-lbs
	≅	0.293 Watt-hrs

SCALES

OCTAVES

"N" Octaves = Freq to Freq x 2^N
i.e., One octave would be 2 to 4 GHz
Two Octaves would be 2 to 8 GHz
Three octaves would be 2 to 16 GHz

DECADES

"N" Decades = Freq to Freq x 10^N
i.e., One decade would be 1 to 10 MHz
Two decades would be 1 to 100 MHz
Three decades would be
1 to 1,000 MHz

TEMPERATURE CONVERSIONS

°F = (9/5) °C + 32
°C = (5/9)(°F - 32)
°K = °C + 273.16
°F = (9/5)(°K - 273) + 32
°C = °K - 273.16
°K = (5/9)(°F - 32) + 273

UNITS OF TIME

1 year	=	365.2 days
1 fortnight	=	14 nights (2 weeks)
1 century	=	100 years
1 millennium	=	1,000 years

NUMBERS

1 decade	=	10
1 Score	=	20
1 Billion	=	1 x 10^9 (U.S.) (thousand million)
	=	1 x 10^{12} (U.K.) (million million)

RULE OF THUMB FOR ESTIMATING DISTANCE TO LIGHTNING / EXPLOSION:

km: Divide 3 into the number of seconds which have elapsed between seeing the flash and hearing the noise.
miles: Multiply 0.2 times the number of seconds which have elapsed between seeing the flash and hearing the noise.
Note: Sound vibrations cause a change of density and pressure within a media, while electromagnetic waves do not. An audio tone won't travel through a vacuum but can travel at 1,100 ft/sec through air. When picked up by a microphone and used to modulate an EM signal, the modulation will travel at the speed of light.

Physical Constant	Quoted Value	S*	SI unit	Symbol
Avogadro constant	6.0221367×10^{23}	36	mol^{-1}	N_A
Bohr magneton	$9.2740154 \times 10^{-24}$	31	$J \bullet T^{-1}$	μ_B
Boltzmann constant	1.380658×10^{-23}	12	$J \bullet K^{-1}$	$k(=R\ N_A)$
Electron charge	$1.602177\ 33 \times 10^{-19}$	49	C	-e
Electron specific charge	$-1.758819\ 62 \times 10^{11}$	53	$C \bullet kg^{-1}$	$-e/m_e$
Electron rest mass	$9.1093897 \times 10^{-31}$	54	kg	m_e
Faraday constant	9.6485309×10^{4}	29	$C \bullet mol^{-1}$	F
Gravity (Standard Acceleration)	9.80665 or 32.174	0	m/sec^2 ft/sec^2	g
Josephson frequency to voltage ratio	4.8359767×10^{14}	0	$Hz \bullet V^{-1}$	2e/hg
Magnetic flux quantum	$2.06783461 \times 10^{-15}$	61	Wb	φ_o
Molar gas constant	8.314510	70	$J \bullet mol^{-1} \bullet K^{-1}$	R
Natural logarithm base	$\cong 2.71828$	-	dimensionless	*e*
Newtonian gravitational constant	6.67259×10^{-11}	85	$m^3 \bullet kg^{-1} \bullet s^{-2}$	G or K
Permeability of vacuum	$4\pi \times 10^{-7}$	d	H/m	μ_o
Permittivity of vacuum	$\cong 8.8541878 \times 10^{-12}$	d	F/m	ε_o
Pi	$\cong 3.141592654$		dimensionless	π
Planck constant Planck constant/2π	6.62659×10^{-34} $1.05457266 \times 10^{-34}$	40 63	$J \bullet s$ $J \bullet s$	h $h(=h2\pi)$
Quantum of circulation	$3.63694807 \times 10^{-4}$	33	$J \bullet s \bullet kg^{-1}$	$h/2m_e$
Radius of earth (Equatorial)	6.378×10^{6} or 3963		m miles	
Rydberg constant	$1.0973731534 \times 10^{7}$	13	m^{-1}	R_χ
Speed of light	2.9979246×10^{8}	1	$m \bullet s^{-1}$	c
Speed of sound (dry air @ std press & temp)	331.4	-	$m \bullet s^{-1}$	-
Standard volume of ideal gas	22.41410×10^{-3}	19	$m^3 \bullet mol^{-1}$	V_m
Stefan-Boltzmann constant	5.67051×10^{-8}	19	$W \bullet K^{-4} \bullet m^{-2}$	σ

* S is the one-standard-deviation uncertainty in the last units of the value, d is a defined value.
(A standard deviation is the square root of the mean of the sum of the squares of the possible deviations)

THE SPEED OF LIGHT			
ACTUAL	UNITS	RULE OF THUMB	UNITS
$\cong 2.9979246 \times 10^8$	m/sec	$\cong 3 \times 10^8$	m/sec
$\cong 299.79$	m/μsec	$\cong 300$	m/μsec
$\cong 3.27857 \times 10^8$	yd/sec	$\cong 3.28 \times 10^8$	yd/sec
$\cong 5.8275 \times 10^8$	NM/hr	$\cong 5.8 \times 10^8$	NM/hr
$\cong 1.61875 \times 10^5$	NM/sec	$\cong 1.62 \times 10^5$	NM/sec
$\cong 9.8357105 \times 10^8$	ft/sec	$\cong 1 \times 10^9$	ft/sec
$\cong 9.8357105 \times 10^2$	ft/μsec	$\cong 1 \times 10^3$	ft/μsec

SPEED OF LIGHT IN VARIOUS MEDIUMS

The speed of EM radiation through a substance such as cables is defined by the following formula:

$$V = c/(\mu_r \varepsilon_r)^{1/2}$$

Where: μ_r = relative permeability
ε_r = relative permittivity

The real component of ε_r = dielectric constant of medium.

EM propagation speed in a typical cable might be 65-90% of the speed of light in a vacuum.

APPROXIMATE SPEED OF SOUND (MACH 1)

Sea Level (CAS/TAS)		**36,000 ft*** (TAS)	(CAS)
1230 km/hr	Decreases	1062 km/hr	630 km/hr
765 mph	Linearly	660 mph	391 mph
665 kts	To ⇒	573 kts	340 kts

* The speed remains constant until 82,000 ft, when it increases linearly to 1215 km/hr (755 mph, 656 kts) at 154,000 ft. Also see Section 8-2 for discussion of Calibrated Air Speed (CAS) and True Airspeed (TAS) and a plot of the speed of sound vs. altitude.

SPEED OF SOUND IN VARIOUS MEDIUMS

Substance	Speed (ft/sec)
Vacuum	Zero
Air	1,100
Fresh Water	4,700
Salt Water	4,900
Glass	14,800
Steel	20,000

DECIMAL / BINARY / HEX CONVERSION TABLE

Decimal	Binary	Hex	Decimal	Binary	Hex	Decimal	Binary	Hex
1	00001	01h	11	01011	0Bh	21	10101	15h
2	00010	02h	12	01100	0Ch	22	10110	16h
3	00011	03h	13	01101	0Dh	23	10111	17h
4	00100	04h	14	01110	0Eh	24	11000	18h
5	00101	05h	15	01111	0Fh	25	11001	19h
6	00110	06h	16	10000	10h	26	11010	1Ah
7	00111	07h	17	10001	11h	27	11011	1Bh
8	01000	08h	18	10010	12h	28	11100	1Ch
9	01001	09h	19	10011	13h	29	11101	1Dh
10	01010	0Ah	20	10100	14h	30	11110	1Eh

When using hex numbers it is always a good idea to use "h" as a suffix to avoid confusion with decimal numbers.

DECIMAL TO HEX CONVERSION

Both the following methods must use long division. Method one computes the digits from right to left while method two works from left to right.

Method one: To convert a decimal number above 16 to hex, divide the number by 16, then record the <u>integer</u> resultant and the <u>remainder</u>. Convert the remainder to hex and write this down - this

will become the far right digit of the final hex number. Divide the integer you obtained by 16, and again record the new integer result and new remainder. Convert the remainder to hex and write it just to the left of the first decoded number. Keep repeating this process until dividing results in only a remainder. This will become the left-most character in the hex number (i.e., to convert 60 (decimal) to hex we have 60/16 = 3 with 12 remainder). 12 is C (hex) - this becomes the right most character. Then 3/16=0 with 3 remainder. 3 is 3 (hex). This becomes the next (and final) character to the left in the hex number, so the answer is 3C.

Method two: Use table of powers to work the digits from left to right:

For example: Here is your Decimal Number - 9379

Step 1 - Set up your chart:

65536	4096	256	16	1
16^4	16^3	16^2	16^1	16^0

Step 2 - Look in the table for the highest divisible number in the chart.
9379 / 4096 = 2 (the left-most Hex digit)
<u>Must use long division</u> to calculate the remainder (1187)

Step 3 - Divide the remainder with its highest divisible number in the chart:
1187 / 256 = 4 (the next digit to the right)
<u>Must use long division to</u> calculate the remainder (163)

Step 4 - Divide the remainder with its highest divisible number in the chart:
163 / 16 = 10 (or "A" from table L-1) (the next digit to the right)
<u>Must use long division to</u> calculate the remainder (3)

Step 5 - The remainder will not divide: remainder = 3 (the right-most Hex digit)

65536	4096	256	16	1
16^4	16^3	16^2	16^1	16^0
	2	4	A	3

HEX TO DECIMAL CONVERSION

To convert a hex number to decimal, multiply each hex digit converted to decimal by the decimal equivalent of the hex power represented and add the results.

For example: Here is your Hex Number - 24A3

Step 1 - Set up your chart:

4096	256	16	1
16^3	16^2	16^1	16^0

Step 2 - Place the numbers in a table:

4096	256	16	1
16^3	16^2	16^1	16^0
2	4	A	3

Step 3 - Multiply the Hex number times the power value:

2 x 4096	=	8192
4 x 256	=	1024
A(10) x 16	=	160
3 x 1	=	3

Step 4 - Add up your values:

Decimal value is 9379

GREEK ALPHABET

Case		Greek Alphabet Name	English Equivalent
Upper	Lower		
Α	α	alpha	a
Β	β	beta	b
Γ	γ	gamma	g
Δ	δ	delta	d
Ε	ε	epsilon	e
Ζ	ζ	zeta	z
Η	η	eta	e
Θ	θ , ‘	theta	th
Ι	ι	iota	i
Κ	κ	kappa	k
Λ	λ	lambda	l
Μ	μ	mu	m

Case		Greek Alphabet Name	English Equivalent
Upper	Lower		
Ν	ν	nu	n
Ξ	ξ	xi	x
Ο	ο	omicron	o
Π	π	pi	p
Ρ	ρ	rho	r
Σ	σ	sigma	s
Τ	τ	tau	t
Υ	υ	upsilon	u
Φ	φ	phi	ph
Χ	χ	chi	ch
Ψ	ψ	psi	ps
Ω	ω	omega	o

LETTERS FROM THE GREEK ALPHABET COMMONLY USED AS SYMBOLS

Symbol	Name	Use
α	alpha	space loss, angular acceleration, or absorptance
β	beta	3 dB bandwidth or angular field of view [radians]
Γ	Gamma	reflection coefficient
γ	gamma	electric conductivity, surface tension, missile velocity vector angle, or gamma ray
Δ	Delta	small change or difference
δ	delta	delay, control forces and moments applied to missile, or phase angle
ε	epsilon	emissivity [dielectric constant] or permittivity [farads/meter]
η	eta	efficiency or antenna aperture efficiency
Θ	Theta	angle of lead or lag between current and voltage
θ or ‘	theta	azimuth angle, bank angle, or angular displacement
Λ	Lambda	acoustic wavelength or rate of energy loss from a thermocouple
λ	lambda	wavelength or Poisson Load Factor
μ	mu	micro 10^{-6} [micron], permeability [henrys/meter], or extinction coefficient [optical region]

ν	nu	frequency
π	pi	3.141592654+
ρ	rho	charge/mass density, resistivity [ohm-meter], VSWR, or reflectance
Σ	Sigma	algebraic sum
σ	sigma	radar cross section [RCS], Conductivity [1/ohm-meter], or Stefan-Boltzmann constant
T	Tau	VSWR reflection coefficient
τ	tau	pulse width, atmospheric transmission, or torque
Φ	Phi	magnetic/electrical flux, radiant power [optical], or Wavelet's smooth function [low pass filter]
φ	phi	phase angle, angle of bank, or beam divergence [optical region]
Ψ	Psi	time-dependent wave function or Wavelet's detail function [high pass filter]
ψ	psi	time-independent wave function, phase change, or flux linkage [weber]
Ω	Omega	Ohms [resistance] or solid angle [optical region]. Note: inverted symbol is conductance [mhos]
ω	omega	carrier frequency in radians per second

MORSE CODE and PHONETIC ALPHABET

A - alpha	• –	J - juliett	• – –	S - sierra	• • •	1	• – – – –
B - bravo	– • • •	K - kilo	– • –	T - tango	–	2	• • – – –
C - charlie	– • – •	L - lima	• – • •	U - uniform	• • –	3	• • • – –
D - delta	– • •	M - mike	– –	V - victor	• • • –	4	• • • • –
E - echo	•	N - november	– •	W - whiskey	• – –	5	• • • • •
F - foxtrot	• • – •	O - oscar	– – –	X - x-ray	– • • –	6	– • • • •
G - golf	– – •	P - papa	• – •	Y - yankee	– • – –	7	– – • • •
H - hotel	• • • •	Q - quebec	– – • –	Z - zulu	– – • •	8	– – – • •
I - india	• •	R - romeo	• – •	0	– – – – –	9	– – – – •

Note: The International Maritime Organization agreed to officially stop Morse code use by February 1999, however use may continue by ground based amateur radio operators. (The U.S. Coast Guard discontinued its use in 1995.)

BASIC MATH / GEOMETRY REVIEW

EXPONENTS

$a^x a^y = a^{x+y}$

$a^x / a^y = a^{x-y}$

$(a^x)^y = a^{xy}$

$a^0 = 1$

Example:

$$\frac{x}{\sqrt{x}} = x \bullet x^{-\frac{1}{2}} = x^{(1-\frac{1}{2})} = x^{\frac{1}{2}} = \sqrt{x}$$

LOGARITHMS

$\log (xy) = \log x + \log y$

$\log (x/y) = \log x - \log y$

$\log (x^N) = N \log x$

If $z = \log x$ then $x = 10^z$

Examples: $\log 1 = 0$
$\log 1.26 = 0.1$; $\log 10 = 1$

if $10 \log N = \text{dB\#}$,
then $10^{(\text{dB\#}/10)} = N$

TRIGONOMETRIC FUNCTIONS

$\sin x = \cos (x-90°)$

$\cos x = -\sin (x-90°)$

$\tan x = \sin x / \cos x = 1 / \cot x$

$\sin^2 x + \cos^2 x = 1$

A radian is the angular measurement of an arc which has an arc length equal to the radius of the given circle, therefore there are 2π radians in a circle. One radian = 360°/2π = 57.296....°

ELLIPSE

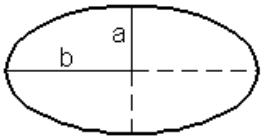

Area = π a b

Approx circumference

$= 2\pi \sqrt{\frac{a^2 + b^2}{2}}$

RECTANGLULAR SOLID

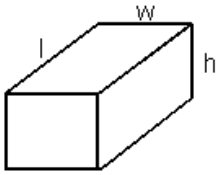

Area = lw

Volume = lwh

CYLINDER

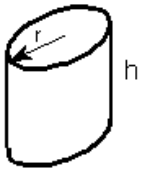

Volume – $\pi r^2 h$

Lateral surface area _ $2\pi rh$

ANGLES

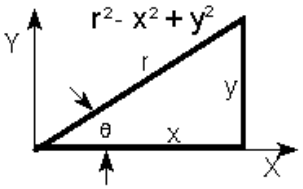

Sin θ = y/r Cos θ = x/r

Tan θ = y/x

SPHERE

Surface area = $4\pi r^2$

Volume = $4/3\ \pi r^3$

Cross Section (circle)

Area = πr^2

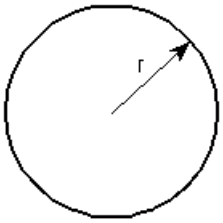

TRIANGLES

Angles: A + B + C = 180°

$c^2 = a^2 + b^2 - 2ab \cos C$

Area = 1/2 hc = 1/2 ab sin C

$b = \sqrt{e^2 + h^2}$

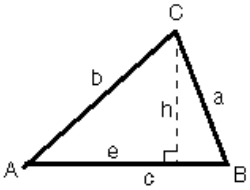

DERIVATIVES

Assume: a = fixed real #; u, v & w are functions of x

d(a)/dx = 0 ; d(sin u)/dx = du(cos u)/dx

d(x)/dx = 1 ; d(cos v)/dx = -dv(sin v)/dx

d(uvw)/dx = uvdw/dx + vwdu/dx + uwdv/dx +...etc

INTEGRALS

Note: All integrals should have an arbitrary constant of integration added, which is <u>left off for clarity</u>

Assume: a = fixed real #; u, & v are functions of x

$\int a dx = ax$ and $\int a\, f(x)dx = a\int f(x)dx$

$\int (u + v)dx = \int u dx + \int v dx$; $\int e^x dx = e^x$

$\int (\sin ax)dx = -(\cos ax)/a$; $\int (\cos ax)dx = (\sin ax)/a$

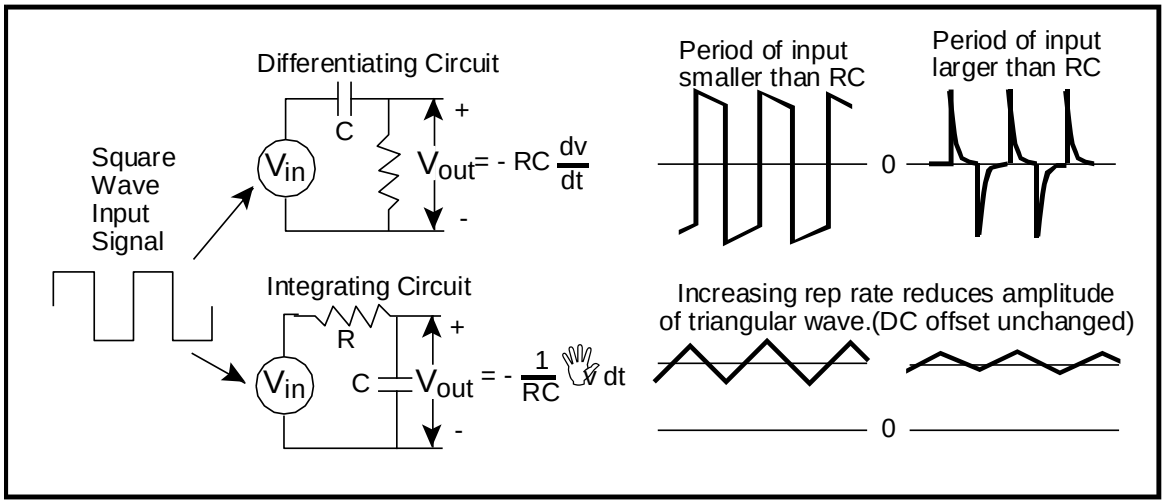

MATHEMATICAL NOTATION

The radar and EW communities generally accept some commonly used notation for the various parameters used in radar and EW calculations. For instance, "P" is almost always power and "G" is almost always gain. Textbooks and reference handbooks will usually use this notation in formulae and equations.

A significant exception is the use of "α" for space loss. Most textbooks do not develop the radar equation to its most usable form as does this reference handbook, therefore the concept of "α" just isn't covered.

Subscripts are a different matter. Subscripts are often whatever seems to make sense in the context of the particular formula or equation. For instance, power may be "P", "P_T", "P_t", or maybe "P_1". In the following list, generally accepted notation is given in the left hand column with no subscripts. Subscripted notation in the indented columns is the notation used in this handbook and the notation often used in the EW community.

α = Space loss
α_1 = One way space loss, transmitter to receiver
α_2 = Two way space loss, xmtr to target (including radar cross section) and back to the rcvr
α_{1t} = One way space loss, radar transmitter to target, bistatic
α_{1r} = One way space loss, target to radar receiver, bistatic

Other notation such as α_{tm} may be used to clarify specific losses, in this case the space loss between a target and missile seeker, which could also be identified as α_{1r}.

A = Antenna aperture (capture area)
A_e = Effective antenna aperture
Å = Angstrom

B = Bandwidth (to 3dB points)
B_{IF} = 3 dB IF bandwidth of the receiver (pre-detection)
B_J = Bandwidth of the jamming spectrum
B_{MHz} = 3 dB bandwidth in MHz
B_N = Equivalent noise bandwidth, a.k.a. B
B_V = 3 dB video bandwidth of the receiver (post-detection) (Subscript V stands for video)
BF = Bandwidth reduction factor (jamming spectrum wider than the receiver bandwidth)
BW = Beamwidth (to 3 dB points)

c = Speed of Light

f = Frequency (radio frequency)
f_c = Footcandle (SI unit of illuminance)
f_D = Doppler frequency
f_R = Received frequency
f_T = Transmitted frequency

G = Gain
G_t = Gain of the transmitter antenna
G_r = Gain of the receiver antenna
G_{tr} = Gain of the transmitter/receiver antenna (monostatic radar)
G_J = Gain of the jammer
G_{JA} = Gain of the jammer antenna
G_{JT} = Gain of the jammer transmitter antenna
G_{JR} = Gain of the jammer receiver antenna
G_σ = Gain of reflected radar signal due to radar cross section

h = Height or Planks constant
h_{radar} = Height of radar
h_{target} = Height of target

J = Jamming signal (receiver input)
J_1 = Jamming signal (constant gain jammer)
J_2 = Jamming signal (constant power jammer)
J/S = Jamming to signal ratio (receiver input)

k = Boltzmann constant
$K_{1,2,3,4}$ = Proportionality constants, see Sections 4-3, 4-4, 4-5, and 4-1 respectively.

λ = Lambda, Wavelength or Poisson factor

L = Loss (due to transmission lines or circuit elements)

N = Receiver equivalent noise input (kT_oB)
NF = Noise figure

P = Power
P_d = Probability of detection
P_D = Power density
P_J = Power of a jammer transmitter
P_n = Probability of false alarm
P_r = Power received
P_t = Power of a transmitter

R = Range (straight line distance)
R_1 = Bistatic radar transmitter to target range
R_2 = Bistatic radar target to receiver range
R_J = Range of jammer to receiver (when separate from the target)
R_{NM} = Range in nautical miles

σ = Sigma, radar cross section (RCS)

S = Signal (receiver input)
S_R = Radar signal received by the jammer
S_{min} = Minimum receiver sensitivity

t = Time
t_{int} = Integration time
t_r = Pulse Rise Time
τ = Pulse Width

V = Velocity
V_r = Radial velocity

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FREQUENCY SPECTRUM

Figure 1, which follows, depicts the electromagnetic radiation spectrum and some of the commonly used or known areas. Figure 2 depicts the more common uses of the microwave spectrum. Figure 3 shows areas of the spectrum which are frequently referred to by band designations rather than by frequency.

Section 7-1 provides an additional breakdown of the EO/IR spectrum.

To convert from frequency (f) to wavelength (λ) and vice versa, recall that f = c/λ, or λ = c/f; where c = speed of light.

$$\lambda_{meter} = \frac{3x10^8}{f_{Hz}} = \frac{3x10^5}{f_{kHz}} = \frac{300}{f_{MHz}} = \frac{0.3}{f_{GHz}} \qquad \text{or} \qquad f_{Hz} = \frac{3x10^8}{\lambda_{meter}} \quad f_{kHz} = \frac{3x10^5}{\lambda_{meter}} \quad f_{MHz} = \frac{300}{\lambda_{meter}} \quad f_{GHz} = \frac{0.3}{\lambda_{meter}}$$

Some quick rules of thumb follow:

Metric:

Wavelength in cm = 30 / frequency in GHz
For example: at 10 GHz, the wavelength = 30/10 = 3 cm

English:

Wavelength in ft = 1 / frequency in GHz
For example: at 10 GHz, the wavelength = 1/10 = 0.1 ft

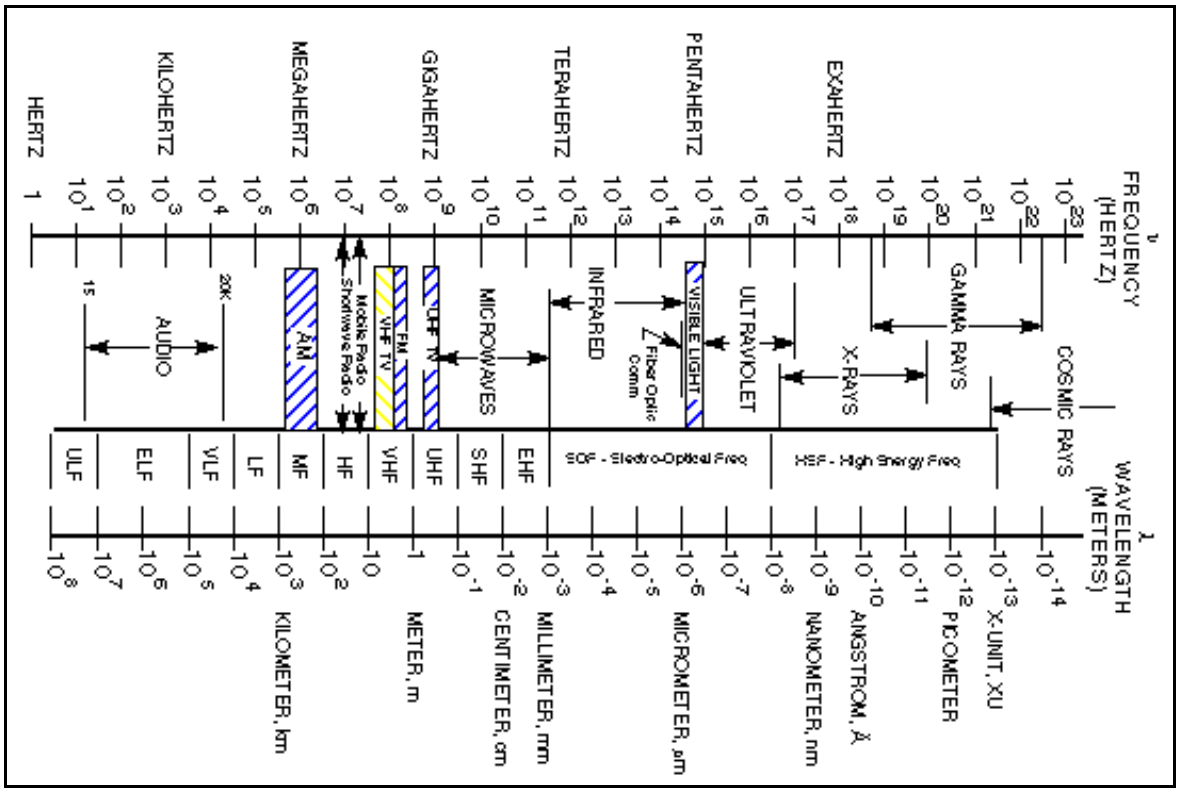

Figure 1. Electromagnetic Radiation Spectrum.

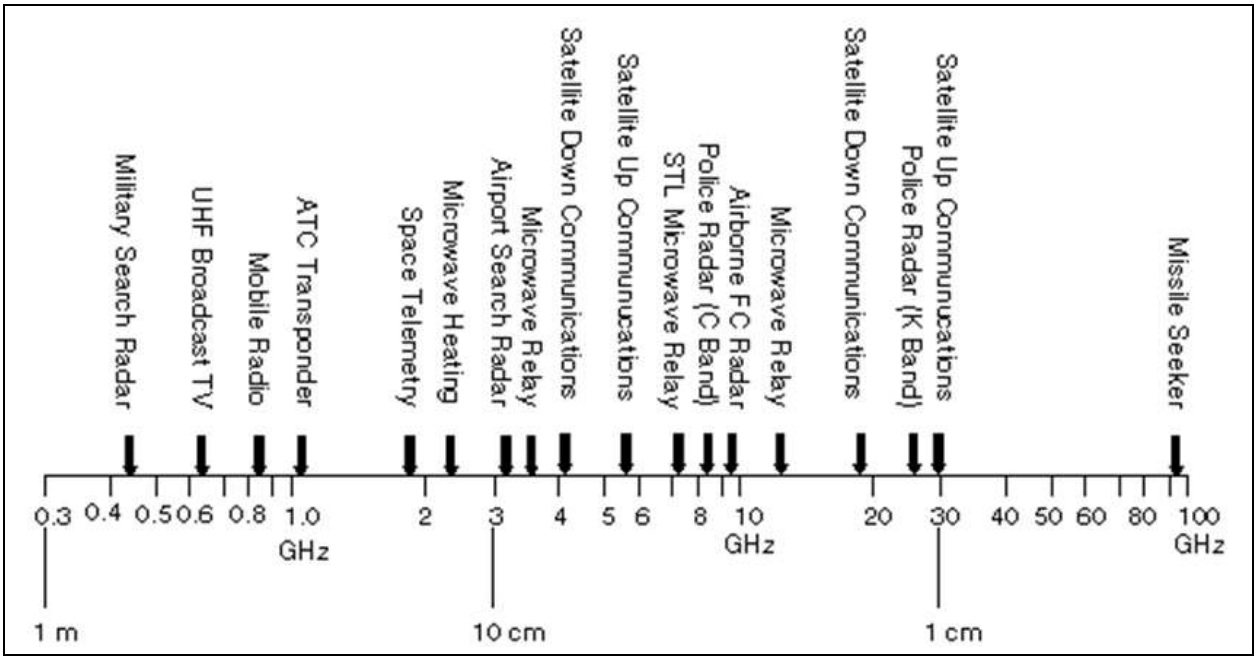

Figure 2. The Microwave Spectrum.

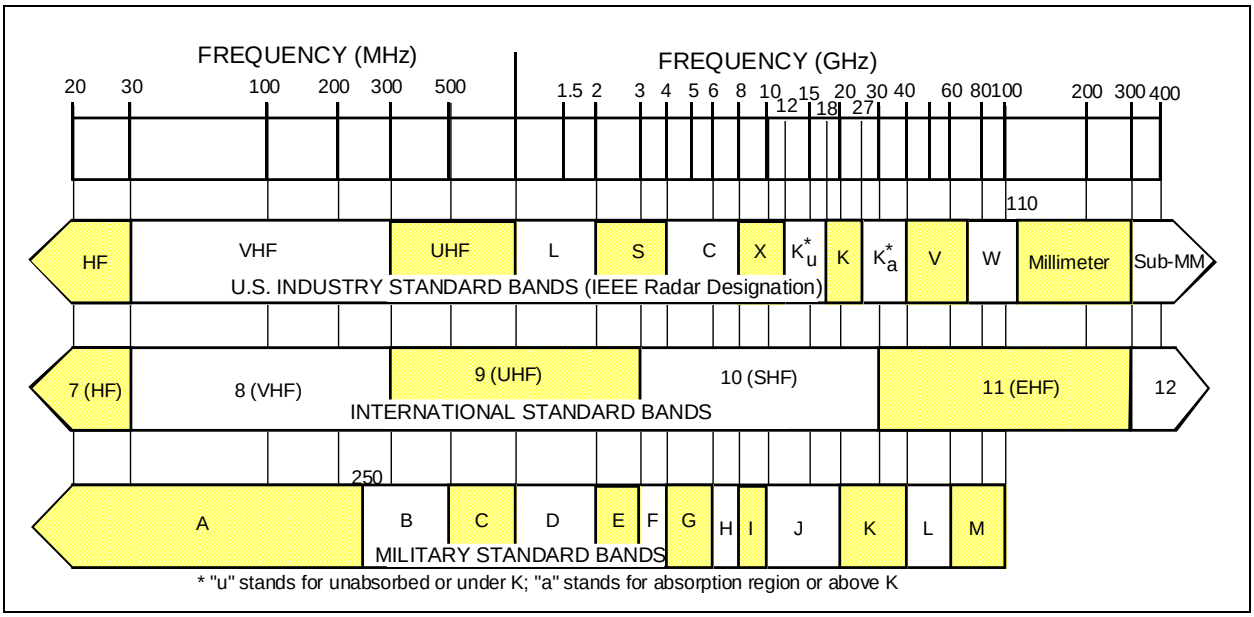

Figure 3. Frequency Band Designations.

See Section 7, Figure 1 for a more detailed depiction of the UV and IR spectrum.

DECIBEL (dB)

The Decibel is a subunit of a larger unit called the bel. As originally used, the bel represented the power ratio of 10 to 1 between the strength or intensity i.e., power, of two sounds, and was named after Alexander Graham Bell. Thus a power ratio of 10:1 = 1 bel, 100:1 = 2 bels, and 1000:1 = 3 bels. It is readily seen that the concept of bels represents a logarithmic relationship since the logarithm of 100 to the base 10 is 2 (corresponding to 2 bels), the logarithm of 1000 to the base 10 is 3 (corresponding to 3 bels), etc. The exact relationship is given by the formula

$$\text{Bels} = \log(P_2/P_1) \qquad \textbf{[1]}$$

where P_2/P_1 represents the power ratio.

Since the bel is a rather large unit, its use may prove inconvenient. Usually a smaller unit, the Decibel or dB, is used. 10 decibels make one bel. A 10:1 power ratio, 1 bel, is 10 dB; a 100:1 ratio, 2 bels, is 20 dB. Thus the formula becomes

$$\text{Decibels (dB)} = 10 \log(P_2/P_1) \qquad \textbf{[2]}$$

The power ratio need not be greater than unity as shown in the previous examples. In equations [1] and [2], P_1 is usually the reference power. If P_2 is less than P_1, the ratio is less then 1.0 and the resultant bels or decibels are negative. For example, if P_2 is one-tenth P_1, we have

$$\text{bels} = \log(0.1/1) = -1.0 \text{ bels}$$

and

$$\text{dB} = 10 \log(0.1/1) = -10 \text{ dB}.$$

It should be clearly understood that the term decibel does not in itself indicate power, but rather is a ratio or comparison between two power values. It is often desirable to express power levels in decibels by using a fixed power as a reference. The most common references in the world of electronics are the milliwatt (mW) and the watt. The abbreviation dBm indicates dB referenced to 1.0 milliwatt. One milliwatt is then zero dBm. Thus P_1 in equations [1] or [2] becomes 1.0 mW. Similarly, the abbreviation dBW indicates dB referenced to 1.0 watt, with P_2 being 1.0 watt, thus one watt in dBW is zero dBW or 30 dBm or 60 dBμW. For antenna gain, the reference is the linearly polarized isotropic radiator, dBLI. Usually the "L" and/or "I" is understood and left out.

dBc is the power of one signal referenced to a carrier signal, i.e., if a second harmonic signal at 10 GHz is 3 dB lower than a fundamental signal at 5 GHz, then the signal at 10 GHz is -3 dBc.

THE DECIBEL, ITS USE IN ELECTRONICS

The logarithmic characteristic of the dB makes it very convenient for expressing electrical power and power ratios. Consider an amplifier with an output of 100 watts when the input is 0.1 watts (100 milliwatts); it has an amplification factor of

$$P_2/P_1 = 100/0.1 = 1000$$

or a gain of:

$$10 \log(P_2/P_1) = 10 \log(100/0.1) = 30 \text{ dB}.$$

(notice the 3 in 30 dB corresponds to the number of zeros in the power ratio)

The ability of an antenna to intercept or transmit a signal is expressed in dB referenced to an isotropic antenna rather than as a ratio. Instead of saying an antenna has an effective gain ratio of 7.5, it has a gain of 8.8 dB (10 log 7.5).

A ratio of less than 1.0 is a loss, a negative gain, or attenuation. For instance, if 10 watts of power is fed into a cable but only 8.5 watts are measured at the output, the signal has been decreased by a factor of

$$8.5/10 = .85$$

or $$10 \log(.85) = -0.7 \text{ dB}.$$

This piece of cable at the frequency of the measurement has a gain of -0.7 dB. This is generally referred to as a loss or attenuation of 0.7 dB, where the terms "loss" and "attenuation" imply the negative sign. An attenuator which reduces its input power by factor of 0.001 has an attenuation of 30 dB. The utility of the dB is very evident when speaking of signal loss due to radiation through the atmosphere. It is much easier to work with a loss of 137 dB rather than the equivalent factor of 2×10^{-14}.

Instead of multiplying gain or loss factors as ratios we can add them as positive or negative dB. Suppose we have a microwave system with a 10 watt transmitter, and a cable with 0.7 dB loss connected to a 13 dB gain transmit antenna. The signal loss through the atmosphere is 137 dB to a receive antenna with an 11 dB gain connected by a cable with 1.4 dB loss to a receiver. How much power is at the receiver? First, we must convert the 10 watts to milliwatts and then to dBm:

$$10 \text{ watts} = 10{,}000 \text{ milliwatts}$$

and

$$10 \log (10{,}000/1) = 40 \text{ dBm}$$

Then

$$40 \text{ dBm} - 0.7 \text{ dB} + 13 \text{ dB} - 137 \text{ dB} + 11 \text{ dB} - 1.4 \text{ dB} = -75.1 \text{ dBm}.$$

-75.1 dBm may be converted back to milliwatts by solving the formula:

$$\text{mW} = 10^{(\text{dBm}/10)}$$

giving: $$10^{(-75.1/10)} = 0.00000003 \text{ mW}$$

Voltage and current ratios can also be expressed in terms of decibels, provided the resistance remains constant. First we substitute for P in terms of either voltage, V, or current, I. Since P=VI and V=IR we have:

$$P = I^2R = V^2/R$$

Thus for a voltage ratio we have: $$\text{dB} = 10 \log[(V_2^2/R)/(V_1^2/R)] = 10 \log(V_2^2/V_1^2) = 10 \log(V_2/V_1)^2 = 20 \log(V_2/V_1)$$

Like power, voltage can be expressed relative to fixed units, so one volt is equal to 0 dBV or 120 dBμV.

Similarly for current ratio: $$\text{dB} = 20 \log(I_2/I_1)$$

Like power, amperage can be expressed relative to fixed units, so one amp is equal to 0 dBA or 120 dBμA.

Decibel Formulas (where Z is the general form of R, including inductance and capacitance)

When impedances are equal: $dB = 10\log\frac{P2}{P1} = 20\log\frac{E2}{E1} = 20\log\frac{I2}{I1}$

When impedances are unequal: $dB = 10\log\frac{P2}{P1} = 20\log\frac{E2\sqrt{Z1}}{E1\sqrt{Z2}} = 20\log\frac{I2\sqrt{Z2}}{I1\sqrt{Z1}}$

SOLUTIONS WITHOUT A CALCULATOR

Solution of radar and EW problems requires the determination of logarithms (base 10) to calculate some of the formulae. Common "four function" calculators do not usually have a log capability (or exponential or fourth root functions either). Without a scientific calculator (or math tables or a Log-Log slide rule) it is difficult to calculate any of the radar equations, simplified or "textbook." The following gives some tips to calculate a close approximation without a calculator.

DECIBEL TABLE

DB	Power Ratio	Voltage or Current Ratio	DB	Power Ratio	Voltage or Current Ratio
0	1.00	1.00	10	10.0	3.16
0.5	1.12	1.06	15	31.6	5.62
1.0	1.26	1.12	20	100	10
1.5	1.41	1.19	25	316	17.78
2.0	1.58	1.26	30	1,000	31.6
3.0	2.00	1.41	40	10,000	100
4.0	2.51	1.58	50	10^5	316
5.0	3.16	1.78	60	10^6	1,000
6.0	3.98	2.00	70	10^7	3,162
7.0	5.01	2.24	80	10^8	10,000
8.0	6.31	2.51	90	10^9	31,620
9.0	7.94	2.82	100	10^{10}	10^5

For dB numbers which are a multiple of 10

An easy way to remember how to convert dB values that are a multiple of 10 to the absolute magnitude of the power ratio is to place a number of zeros equal to that multiple value to the right of the value 1.
40 dB = 10,000 : 1 (for power)

Minus dB moves the decimal point that many places to the left of 1.
-40 dB = 0.0001 : 1 (for power)

For voltage or current ratios, if the multiple of 10 is even, then divide the multiple by 2, and apply the above rules. 40 dB = 100 : 1 (for voltage)
-40 dB = 0.01 : 1

If the power in question is not a multiple of ten, then some estimation is required. The following tabulation lists some approximations. Some would be useful to memorize.

DB RULES OF THUMB

Multiply Current / Voltage By			Multiply Power By:	
if +dB	if -dB	**dB**	if +dB	if -dB
1	1	0	1	1
1.12	0.89	1	1.26	0.8
1.26	0.79	2	1.58	0.63
1.4	0.707	3	2	0.5
2.0	0.5	6	4	0.25
2.8	0.35	9	8	0.125
3.16	0.316	10	10	0.1
4.47	0.22	13	20	0.05
10	0.1	20	100	0.01
100	0.01	40	10,000	0.0001

You can see that the list has a repeating pattern, so by remembering just three basic values such as one, three, and 10 dB, the others can easily be obtained without a calculator by addition and subtraction of dB values and multiplication of corresponding ratios.

Example 1:

A 7 dB increase in power (3+3+1) dB is an increase of (2 x 2 x 1.26) = 5 times whereas
A 7 dB decrease in power (-3-3-1) dB is a decrease of (0.5 x 0.5 x 0.8) = 0.2.

Example 2: Assume you know that the ratio for 10 dB is 10, and that the ratio for 20 dB is 100 (doubling the dB increases the power ratio by a factor of ten), and that we want to find some intermediate value.

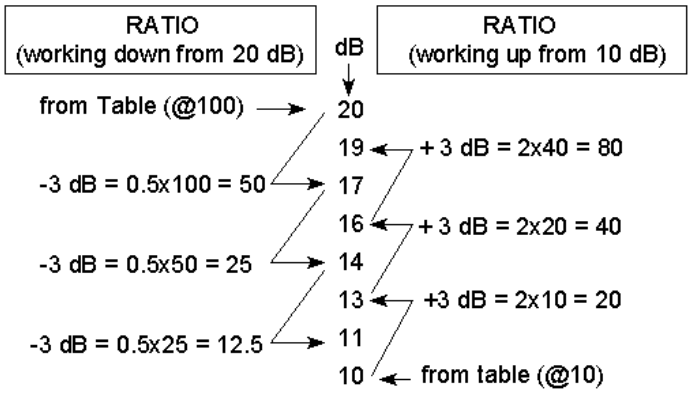

We can get more intermediate dB values by adding or subtracting one to the above, for example, to find the ratio at 12 dB we can:

work up from the bottom; 12 = 1+11 so we have 1.26 (from table) x 12.5 = 15.75
alternately, working down the top 12 = 13-1 so we have 20 x 0.8 (from table) = 16

The resultant numbers are not an exact match (as they should be) because the numbers in the table are rounded off. We can use the same practice to find any ratio at any other given value of dB (or the reverse).

dB AS ABSOLUTE UNITS

Power in absolute units can be expressed by using 1 Watt (or 1 milliwatt) as the reference power in the denominator of the equation for dB. We then call it dBW or dBm. We can then build a table such as the adjoining one.

From the above, any intermediate value can be found using the same dB rules and memorizing several dB values for determining the absolute power, given 48 dBm power output, we determine that 48 dBm = 50 dBm - 2 dB so we take the value at 50 dB which is 100W and divide by the value 1.58 (ratio of 2 dB) to get:

100 watts/1.58 = 63 W or 63,291 mW.

dB AS ABSOLUTE UNITS

dBμW	dBm	POWER	dBW
120	90	1 MW	60
90	60	1 kW	30
80	50	100 W	20
70	40	10 W	10
60	30	1 W (1000 mW)	0
50	20	100 mW	-10
40	10	10 mW	-20
33	3	2 mW	-27
32	2	1.58 mW	-28
31	1	1.26 mw	-29
30	0	1 mW	-30

Because dBW is referenced to one watt, the Log of the power in watts times 10 is dBW. The Logarithm of 10 raised by any exponent is simply that exponent. That is: $\text{Log}(10)^4 = 4$. Therefore, a power that can be expressed as any exponent of 10 can also be expressed in dBW as that exponent times 10. For example, 100 kW can be written 100,000 watts or 10^5 watts. 100 kW is then +50 dBW. Another way to remember this conversion is that dBW is the number of zeros in the power written in watts times 10. If the transmitter power in question is conveniently a multiple of ten (it often is) the conversion to dBW is easy and accurate.

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DUTY CYCLE

Duty cycle (or duty factor) is a measure of the fraction of the time a radar is transmitting. It is important because it relates to peak and average power in the determination of total energy output. This, in turn, ultimately affects the strength of the reflected signal as well as the required power supply capacity and cooling requirements of the transmitter.

Although there are exceptions, most radio frequency (RF) measurements are either continuous wave (CW) or pulsed RF. CW RF is uninterrupted RF such as from an oscillator. Amplitude modulated (AM), frequency modulated (FM), and phase modulated (PM) RF are considered CW since the RF is continuously present. The power may vary with time due to modulation, but RF is always present. Pulsed RF, on the other hand, is bursts (pulses) of RF with no RF present between bursts. The most general case of pulsed RF consists of pulses of a fixed pulse width (PW) which come at a fixed time interval, or period, (T). For clarity and ease of this discussion, it is assumed that all RF pulses in a pulse train have the same amplitude. Pulses at a fixed interval of time arrive at a rate or frequency referred to as the pulse repetition frequency (PRF) of so many pulse per second. Pulse repetition interval (PRI) and PRF are reciprocals of each other.

$$PRF = 1/T = 1/PRI \qquad \textbf{[1]}$$

Power measurements are classified as either peak pulse power, P_p, or average power, P_{ave}. The actual power in pulsed RF occurs during the pulses, but most power measurement methods measure the heating effects of the RF energy to obtain an average value of the power. It is correct to use either value for reference so long as one or the other is consistently used. Frequently it is necessary to convert from P_p to P_{ave}, or vice versa; therefore the relationship between the two must be understood. Figure 1 shows the comparison between P_p and P_{ave}.

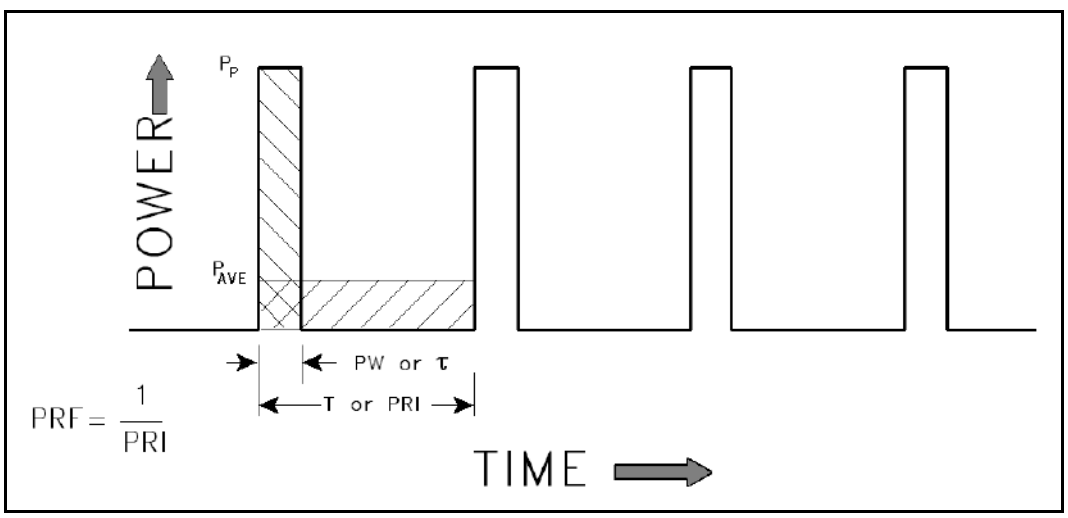

Figure 1. RF Pulse Train.

The average value is defined as that level where the pulse area above the average is equal to area below average between pulses. If the pulses are evened off in such a way as to fill in the area between pulses, the level obtained is the average value, as shown in Figure 1 where the shaded area of the pulse is used to fill in the area between pulses. The area of the pulse is the pulse width multiplied by the peak pulse power. The average area is equal to the average value of power multiplied by the pulse period.

Since the two values are equal:

$$P_{ave} \times T = P_p \times PW \quad \textbf{[2]}$$

or

$$P_{ave}/P_p = PW/T \quad \textbf{[3]}$$

Using [1]

$$P_{ave}/P_p = PW/T = PW \times PRF = PW/PRI = \text{duty cycle} \quad \textbf{[4]}$$

(note that the symbol τ represents pulse width (PW) in most reference books)

The ratio of the average power to the peak pulse power is the duty cycle and represents the percentage of time the power is present. In the case of a square wave the duty cycle is 0.5 (50%) since the pulses are present 1/2 the time, the definition of a square wave.

For Figure 1, the pulse width is 1 unit of time and the period is 10 units. In this case the duty cycle is:

PW/T = 1/10 = 0.1 (10%).

A more typical case would be a PRF of 1,000 and a pulse width of 1.0 microseconds. Using [4], the duty cycle is 0.000001 x 1,000 = 0.001. The RF power is present one-thousandth of the time and the average power is 0.001 times the peak power. Conversely, if the power were measured with a power meter which responds to average power, the peak power would be 1,000 time the average reading.

Besides expressing duty cycle as a ratio as obtained in equation [4], it is commonly expressed as either a percentage or in decibels (dB). To express the duty cycle of equation [4] as a percentage, multiply the value obtained by 100 and add the percent symbol. Thus a duty cycle of 0.001 is also 0.1%.

The duty cycle can be expressed logarithmically (dB) so it can be added to or subtracted from power measured in dBm/dBW rather than converting to, and using absolute units.

$$\text{Duty cycle (dB)} = 10 \log(\text{duty cycle ratio}) \quad \textbf{[5]}$$

For the example of the 0.001 duty cycle, this would be 10 log(0.001) = -30 dB. Thus the average power would be 30 dB less than the peak power. Conversely, the peak power is 30 dB higher than the average power.

For pulse radars operating in the PRF range of 0.25-10 kHz and PD radars operating in the PRF range of 10-500 kHz, typical duty cycles would be:

Pulse	~	0.1 - 3%	=	0.001 - .03	=	-30 to -15 dB
Pulse Doppler	~	5 - 50%	=	0.05 - .5	=	-13 to -3 dB
Continuous Wave	~	100%	=	1	=	0 dB

Intermediate Frequency Bandwidths of typical signals are:

Pulse	1 to 10 MHz
Chirp or Phase coded pulse	0.1 to 10 MHz
CW or PD	0.1 to 5 kHz

PRF is usually subdivided into the following categories: Low 0.25-4 kHz; Medium 8-40 kHz; High 50-300 kHz.

DOPPLER SHIFT

Doppler is the apparent change in wavelength (or frequency) of an electromagnetic or acoustic wave when there is relative movement between the transmitter (or frequency source) and the receiver.

Summary RF Equation for the Two-Way (radar) case

$$f_{Rec} = f_{Xmt} + f_D = f_{Xmt} + \frac{2(V_{Xmtr} + V_{Tgt})\, f_{Xmt}}{c}$$

Summary RF Equation for the One-Way (ESM) case

$$f_{Rec} = f_{Xmt} + f_D = f_{Xmt} + \frac{V_{Xmtr\ or\ Rec}\ f_{Xmt}}{c}$$

Rules of Thumb for two-way signal travel
(divide in half for one-way ESM signal measurements)
At 10 GHz, $f_D \cong$
35 Hz per Knot
19 Hz per km/Hr
67 Hz per m/sec
61 Hz per yd/sec
20 Hz per ft/sec

To estimate f_D at other frequencies, multiply these by:

$$\left[\frac{f_{Xmt}(GHz)}{10}\right]$$

The Doppler effect is shown in Figure 1. In everyday life this effect is commonly noticeable when a whistling train or police siren passes you. Audio Doppler is depicted, however Doppler can also affect the frequency of a radar carrier wave, the PRF of a pulse radar signal, or even light waves causing a shift of color to the observer.

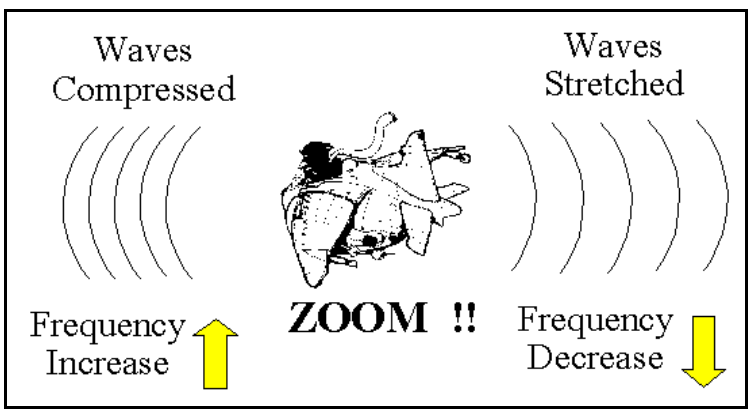

Figure 1. Doppler Frequency Creation From Aircraft Engine Noise.

How do we know the universe is expanding?

Answer: The color of light from distant stars is shifted to red (see Section 7-1: higher λ or lower frequency means Doppler shift is stretched, i.e., expanding).

A memory aid might be that the lights from a car (going away) at night are red (tail lights)!

Doppler frequency shift is directly proportional to velocity and a radar system can therefore be calibrated to measure velocity instead of (or along with) range. This is done by measuring the shift in frequency of a wave caused by an object in motion (Figure 2).

* Transmitter in motion
* Reflector in motion
* Receiver in motion
* All three

For a closing relative velocity:

* Wave is compressed
* Frequency is increased

For an opening relative velocity:

* Wave is stretched
* Frequency is decreased

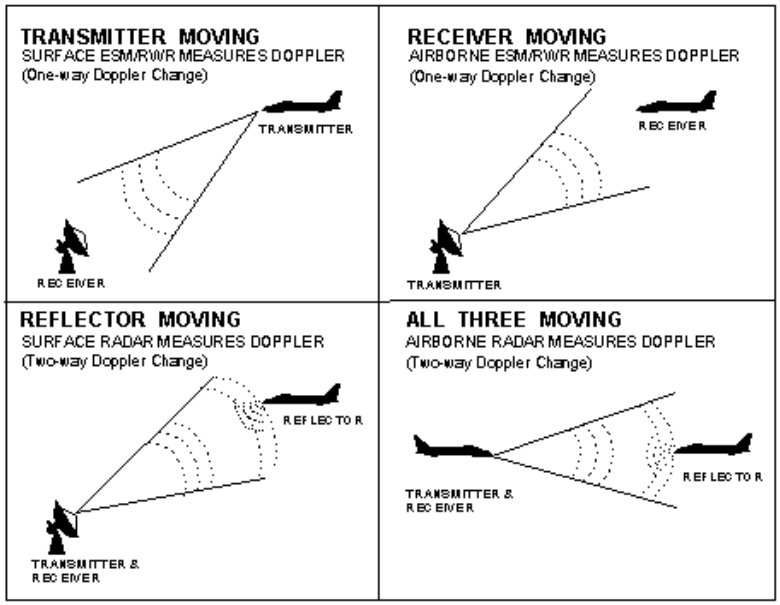

Figure 2. Methods of Doppler Creation.

To compute Doppler frequency we note that velocity is range rate; $V = dr/dt$

For the <u>reflector in motion case</u>, you can see the wave compression effect in Figure 3 when the transmitted wave peaks are one wavelength apart. When the first peak reaches the target, they are still one wavelength apart (point a).

When the 2nd peak reaches the target, the target has advanced according to its velocity (vt) (point b), and the first reflected peak has traveled toward the radar by an amount that is less than the original wavelength by the same amount (vt) (point c).

As the 2nd peak is reflected, the wavelength of the reflected wave is 2(vt) less than the original wavelength (point d).

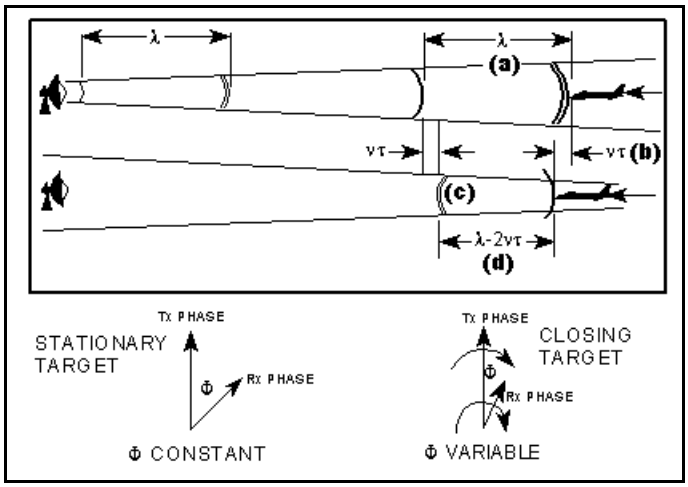

Figure 3. Doppler Compression Equivalent to Variable Phase Shift.

The distance the wave travels is twice the target range. The reflected phase lags transmitted phase by 2x the round trip time. For a fixed target the received phase will differ from the transmitted phase by a constant phase shift. For a moving target the received phase will differ by a changing phase shift.

For the closing target shown in Figure 3, the received phase is advancing with respect to the transmitted phase and appears as a higher frequency.

Doppler is dependent upon closing velocity, not actual radar or target velocity as shown in Figure 4.

For the following equations (except radar mapping), we assume the radar and target are moving directly toward one another to simplify calculations (if this is not the case, use the velocity component of one in the direction of the other in the formulas).

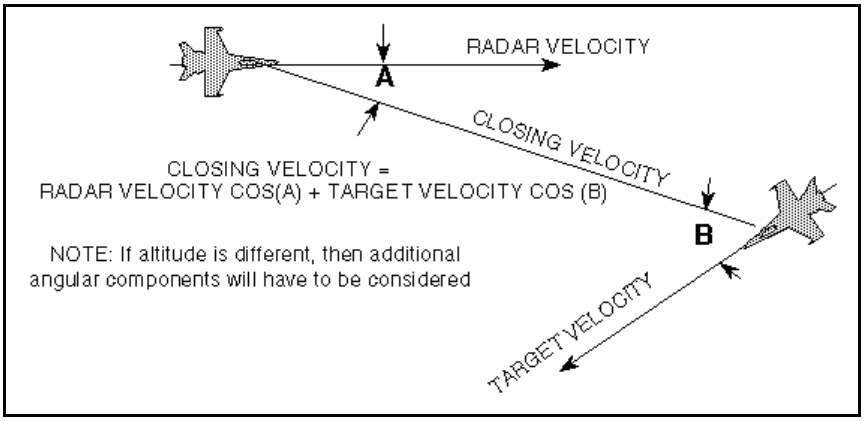

Figure 4. Doppler Depends Upon Closing Velocity.

<u>For the case of a moving reflector</u>, doppler frequency is proportional to 2x the transmitted frequency:
Higher rf = higher doppler shift
$f_D = (2 \times V_{Target})(f/c)$

Likewise, it can be shown that for other cases, the following relationships hold:

Speed of Light Conversions
* * *
$c \cong 2.9979 \times 10^8$ m/sec
$c \cong 5.8275 \times 10^8$ nm/hr (knots)
$c \cong 9.8357 \times 10^8$ ft/sec

<u>For an airplane radar with an airplane target</u> (The "all three moving" case, aircraft radar transmitter, target, and aircraft radar receiver)
$f_D = 2(V_{Radar} + V_{Target})(f/c)$

<u>For the case of a semi-active missile receiving signals</u> (Also "all three moving")
$f_D = (V_{Radar} + 2V_{Target} + V_{Missile})(f/c)$

<u>For the airplane radar with a ground target</u> (radar mapping) or vice versa.
$f_D = 2(V_{Radar} \cos\theta \cos\varphi)(f/c)$, Where θ and φ are the radar scan azimuth and depression angles.

<u>For a ground based radar with airborne target</u> - same as previous using target track crossing angle and ground radar elevation angle.

<u>For the ES/ESM/RWR case where only the target or receiver is moving</u> (One-way Doppler measurements)
$f_D = V_{Receiver\ or\ Target}\ (f/c)$

Note: See Figure 4 if radar and target are not moving directly towards or away from one another.

Figure 5 depicts the results of a plot of the above equation for a moving reflector such as might be measured with a ground radar station illuminating a moving aircraft.

It can be used for the aircraft-to-aircraft case, if the total net closing rate of the two aircraft is used for the speed entry in the figure.

It can also be used for the ES/ESM case (one-way doppler measurements) if the speed of the aircraft is used and the results are divided by two.

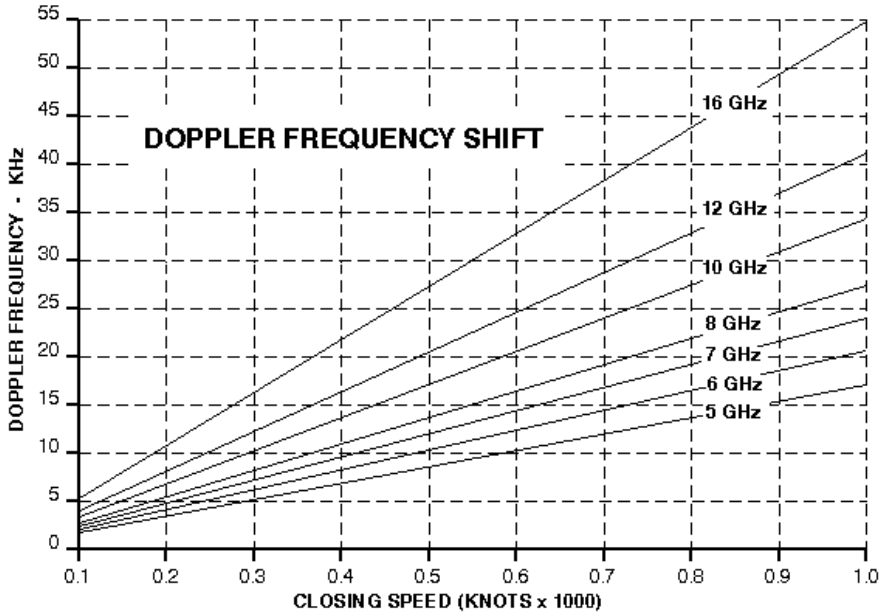

Figure 5. Two-Way Doppler Frequency Shift.

SAMPLE PROBLEMS:

(1) If a ground radar operating at 10 GHz is tracking an airplane flying at a speed of 500 km/hr tangential to it (crossing pattern) at a distance of 10 km, what is the Doppler shift of the returning signal?

Answer: Since the closing velocity is zero, the Doppler is also zero.

(2) If the same aircraft turns directly toward the ground radar, what is the Doppler shift of the returning signal?

Answer: 500 km/hr = 270 kts from Section 2-1. From Figure 4 we see that the Doppler frequency is about 9.2 KHz.

(3) Given that a ground radar operating at 7 GHz is Doppler tracking an aircraft 20 km away (slant range) which is flying directly toward it at an altitude of 20,000 ft and a speed of 800 ft/sec, what amount of VGPO switch would be required of the aircraft jammer to deceive (pull) the radar to a zero Doppler return?

Answer: We use the second equation from the bottom of page 2-6.3 which is essentially the same for this application except a ground radar is tracking an airplane target (vs. an airplane during ground mapping), so for our application we use a positive elevation angle instead of a negative (depression) angle.

$f_D = 2(V_r \cos\theta \cos\varphi)(f/c)$, where θ is the aircraft track crossing angle and φ is the radar elevation angle.

Since the aircraft is flying directly at the radar, $\theta = 0°$; the aircraft altitude = 20,000 ft = 6,096 meters.

Using the angle equation in Section 2-1, $\sin \varphi = x/r$ = altitude / slant range, so:
$\varphi = \sin^{-1}$ (altitude/slant range) = $\sin^{-1}$ (6,096 m / 20,000 m) = 17.7°

F_D = 2(800 ft/sec Cos 0° Cos 17.7°)(7×10^9 Hz / 9.8357×10^9 ft/sec) = <u>10,845 Hz</u>

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ELECTRONIC FORMULAS

Ohm's Law Formulas for D-C Circuits. $E = IR = \frac{P}{I} = \sqrt{PR}$ $P = I^2 R = EI = \frac{E^2}{R}$

Ohm's Law Formulas for A-C Circuits and Power Factor.

$$E = IZ = \frac{P}{I\cos\Theta} = \sqrt{\frac{PZ}{\cos\Theta}} \qquad P = I^2 Z\cos\Theta = IE\cos\Theta = \frac{E^2\cos\Theta}{Z}$$

In the above formulas Θ is the angle of lead or lag between current and voltage and cos Θ = P/EI = power factor or *pf*.

$$pf = \frac{Active\ power\ (in\ watts)}{Apparent\ power\ (in\ volt\text{-}amps)} = Pover E\ I \qquad pf = \frac{R}{Z}$$

Note: Active power is the "resistive" power and equals the equivalent heating effect on water.

Voltage/Current Phase Rule of Thumb Remember "ELI the ICE man"

ELI: Voltage (E) comes before (leads) current (I) in an inductor (L)
ICE: Current (I) comes before (leads) Voltage (E) in a capacitor (C)

Resistors in Series $R_{total} = R_1 + R_2 = R_3 + \ldots$

Two Resistors in Parallel $R_t = \frac{R_1 R_2}{R_1 + R_2}$

Resistors in Parallel, General Formula $R_{total} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$

Resonant Frequency Formulas *Where in the second formula f is in kHz and L and C are in microunits.

$$f = \frac{1}{2\pi\sqrt{LC}},\ or\ \ f = \frac{159.2*}{\sqrt{LC}} \quad L = \frac{1}{4\pi^2 f^2 C},\ or\ \ L = \frac{25{,}330*}{f^2 C} \quad C = \frac{1}{4\pi^2 f^2 L},\ or\ \ C = \frac{25{,}330*}{f^2 L}$$

Conductance $G = \frac{1}{R}$ *(for D-C circuit)* $G = \frac{R}{R^2 + X^2}$ *(for A-C circuit)*

Reactance Formulas $X_C = \frac{1}{2\pi f C}$ $C = \frac{1}{2\pi f X_C}$ $X_L = 2\pi fL$ $L = \frac{X_L}{2\pi f}$

Impedance Formulas $Z = \sqrt{R^2 + (X_L - X_C)^2}$ *(for series circuit)*

$Z = \frac{RX}{\sqrt{R^2 + X^2}}$ *(for R and X in parallel)*

Q or Figure of Merit $Q = \frac{X_L}{R}$ *or* $\frac{X_C}{R}$

Frequency Response

	Inductor *	Capacitor *	Resister
DC	Pass	Block	Attenuate
Low Freq AC	Attenuate *	Attenuate *	Attenuate
High Freq	Block	Pass	Attenuate

* Attenuation varies as a function of the value of the each device and the frequency

"Cartoon" memory aid

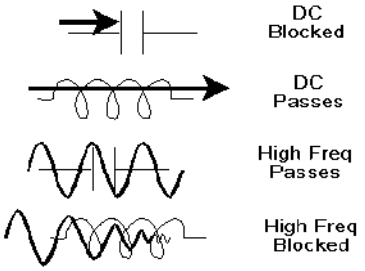

Sinusoidal Voltages and Currents

Effective value = 0.707 x peak value
[Also known as Root-Mean Square (RMS) value]

Half Cycle Average value = 0.637 x peak

Peak value = 1.414 x effective value

∴ Effective value = 1.11 x average value

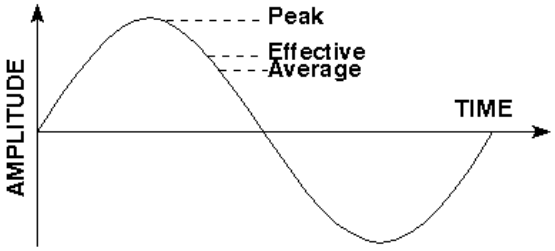

Three-phase AC Configurations

(120° phase difference between each voltage)

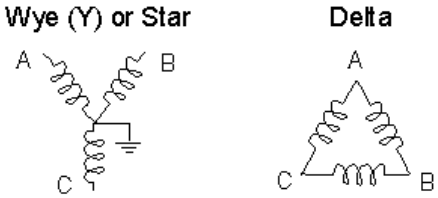

If the connection to a three phase AC configuration is miswired, switching any two of the phases will put it back in the proper sequence.

Electric power for ships commonly uses the delta configuration, while commercial electronic and aircraft applications commonly use the wye configuration.

Color Code for House Wiring:	**PURPOSE:**	**Color Code for Chassis Wiring:**
Black or red	HOT	Red
White	NEUTRAL (Return)	White
Green or bare	GROUND	Black

Color Code for Resistors: **First and second band**:
(and third band # of zeros if not gold/silver)

				Third band Multiplier		**Fourth band Tolerance**	
0	Black	5	Green	.1	Gold	5%	Gold
1	Brown	6	Blue	.01	Silver	10%	Silver
2	Red	7	Violet			20%	No color
3	Orange	8	Gray				
4	Yellow	9	White				

The third color band indicates number of zeros to be added after figures given by first two color bands. But if third color band is gold, multiply by 0.1 and if silver multiply by 0.01. Do not confuse with fourth color-band that indicates tolerance. Thus, a resistor marked blue-red-gold-gold has a resistance of 6.2 ohms and a 5% tolerance.

MISSILE AND ELECTRONIC EQUIPMENT DESIGNATIONS

Missiles are designated with three letters from the columns below plus a number (i.e., AIM-7M) Suffixes (M in this case) indicate a modification.

First Letter Launch Environment	**Second Letter** Mission Symbols	**Third Letter** Vehicle Type
A Air B Multiple C Coffin H Silo stored L Silo launched M Mobile P Soft Pad R Ship U Underwater	D Decoy E Special electronic G Surface attack I Intercept, aerial Q Drone T Training U Underwater attack W Weather	M Guided Missile N Probe (non-orbital instruments) R Rocket (without installed or remote control guidance)

U.S. military electronic equipment is assigned an identifying alphanumeric designation that is used to uniquely identify it. This system is commonly called the "AN" designation system, although its formal name is the Joint Electronics Type Designation System (JETDS). The letters AN preceding the equipment indicators formerly meant "Army/Navy," but now are a letter set that can only be used to indicate formally designated DOD equipment. The first three letters following the "AN/" indicate Platform Installation, Equipment Type, and Equipment Function, respectively. The appropriate meaning is selected from the lists below. The letters following the AN designation numbers provide added information about equipment. Suffixes (A, B, C, etc.) indicate a modification. The letter (V) indicates that variable configurations are available. The letter (X) indicates a development status. A parenthesis ( ) without a number within it indicates a generic system that has not yet received a formal designation, e.g., AN/ALQ( ). Quite often the () is pronounced "bow legs" since they look like the shape of cowboy legs.

First Letter Platform Installation	**Second Letter** Equipment Type	**Third Letter** Function or Purpose
A Piloted aircraft B Underwater mobile, submarine D Pilotless carrier F Fixed ground G General ground use K Amphibious M Mobile (ground) P Portable S Water T Ground, transportable U General utility V Vehicular (ground) W Water surface and underwater combination Z Piloted-pilotless airborne vehicle combination	A Invisible light, heat radiation C Carrier D Radiac F Photographic G Telegraph or teletype I Interphone and public address J Electromechanical or inertial wire covered K Telemetering L Countermeasures M Meteorological N Sound in air P Radar Q Sonar and underwater sound R Radio S Special or combinations of types T Telephone (wire) V Visual and visible light W Armament X Facsimile or television Y Data Processing	B Bombing C Communications D Direction finder, reconnaissance and/or surveillance E Ejection and/or release G Fire control or searchlight directing H Recording and/or reproducing K Computing M Maintenance and/or test assemblies N Navigation aids Q Special or combination of purposes R Receiving, passive detecting S Detecting and/or range and bearing, search T Transmitting W Automatic flight or remote control X Identification and recognition Y Surveillance and control

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RADAR HORIZON / LINE OF SIGHT

There are limits to the reach of radar signals. At the frequencies normally used for radar, radio waves usually travel in a straight line. The waves may be obstructed by weather or shadowing, and interference may come from other aircraft or from reflections from ground objects (Figure 1).

As also shown in Figure 1, an aircraft may not be detected because it is below the radar line which is tangent to the earth's surface.

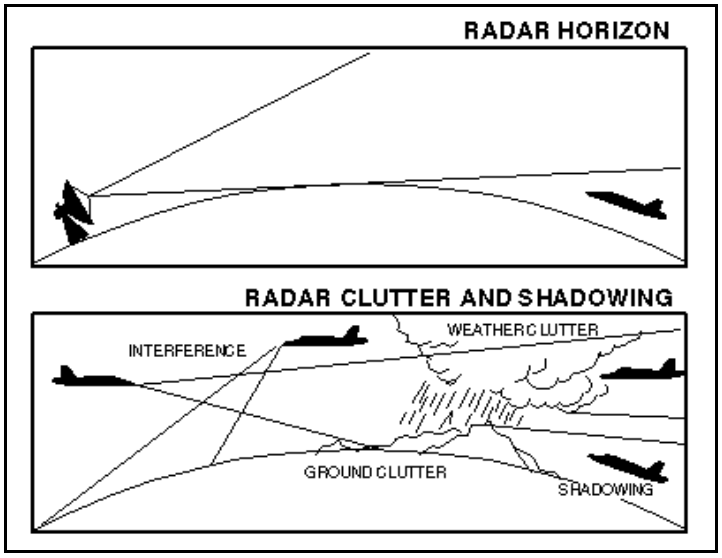

Figure 1. Radar Horizon and Shadowing.

Some rules of thumb are:

Range (to horizon):

$$R_{NM} = 1.23\sqrt{h_{radar}} \quad \textit{with h in ft}$$

Range (beyond horizon / over earth curvature):

$$R_{NM} = 1.23\left(\sqrt{h_{radar}} + \sqrt{h_{target}}\right) \quad \textit{with h in ft}$$

In obtaining the radar horizon equations, it is common practice to assume a value for the Earth's radius that is 4/3 times the actual radius. This is done to account for the effect of the atmosphere on radar propagation. For a true line of sight, such as used for optical search and rescue, the constant in the equations changes from 1.23 to 1.06.

A nomograph for determining maximum target range is depicted in Figure 2. Although an aircraft is shown to the left, it could just as well be a ship, with radars on a mast of height "h." Any target of height (or altitude) "H" is depicted on the right side.

See also Section 5-1 on ducting and refraction, which may increase range beyond these distances.

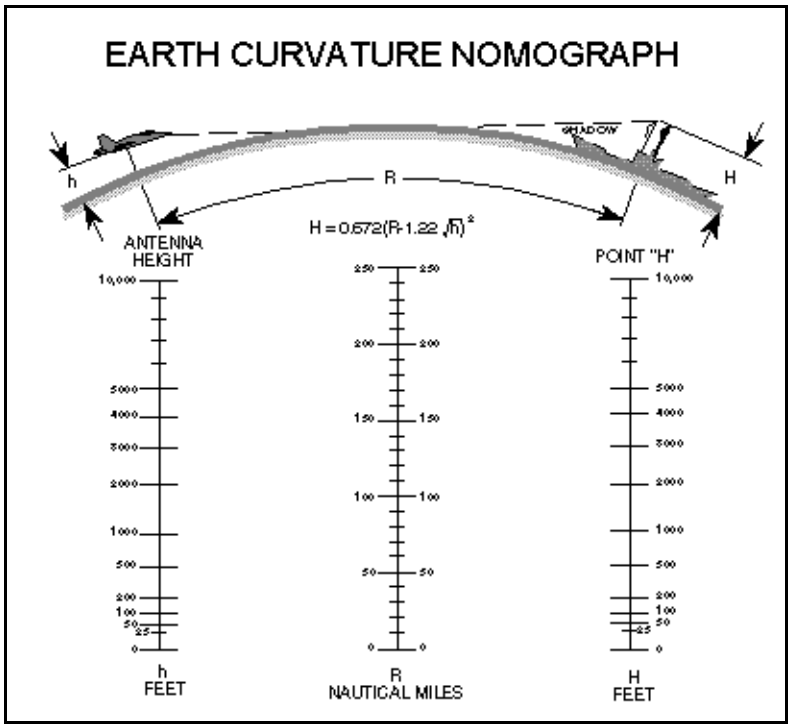

Figure 2. Earth Curvature Nomograph.

This data was expanded in Figure 3 to consider the maximum range one aircraft can detect another aircraft using:

$$R_{NM} = 1.23\left(\sqrt{h_{radar}} + \sqrt{h_{target}}\right)$$

(with h in feet)

It can be used for surface targets if H_{target} = 0. It should be noted that most aircraft radars are limited in power output, and would not detect small or surface objects at the listed ranges.

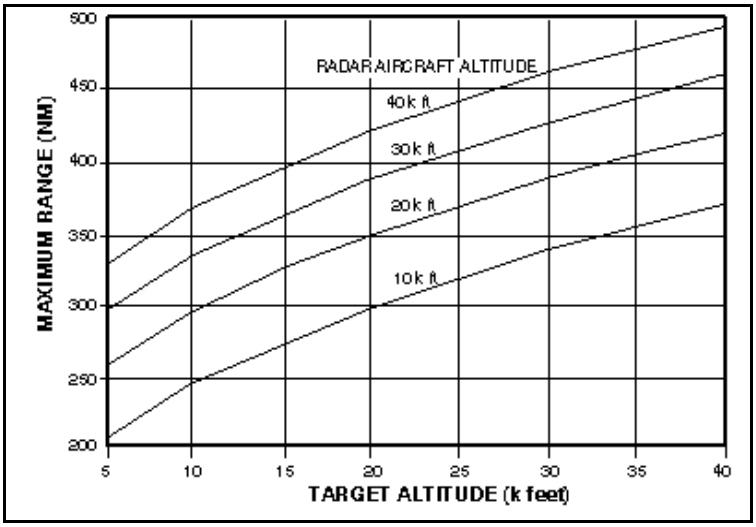

Figure 3. Aircraft Radar vs. Aircraft Target Maximum Range.

Figure 4 depicts the maximum range that a ship height antenna can detect a zero height object (i.e., rowboat).

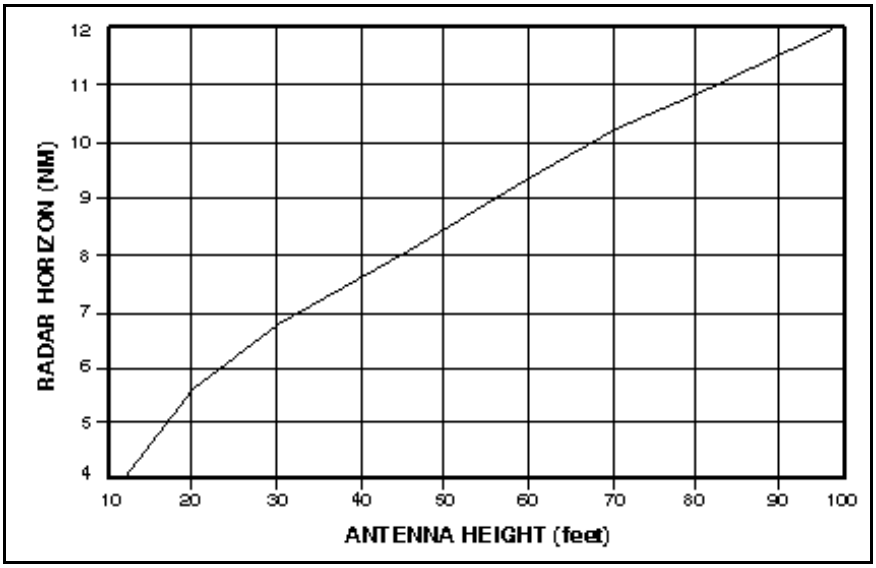

Figure 4. Ships Radar Horizon With Target on the Surface.

In this case "H" = 0, and the general equation becomes: $R_{max}(NM) = 1.23\sqrt{h_r}$

Where h_r is the height of the radar in feet.

Figure 5 depicts the same for aircraft radars. It should be noted that most aircraft radars are limited in power output, and would not detect small or surface objects at the listed ranges.

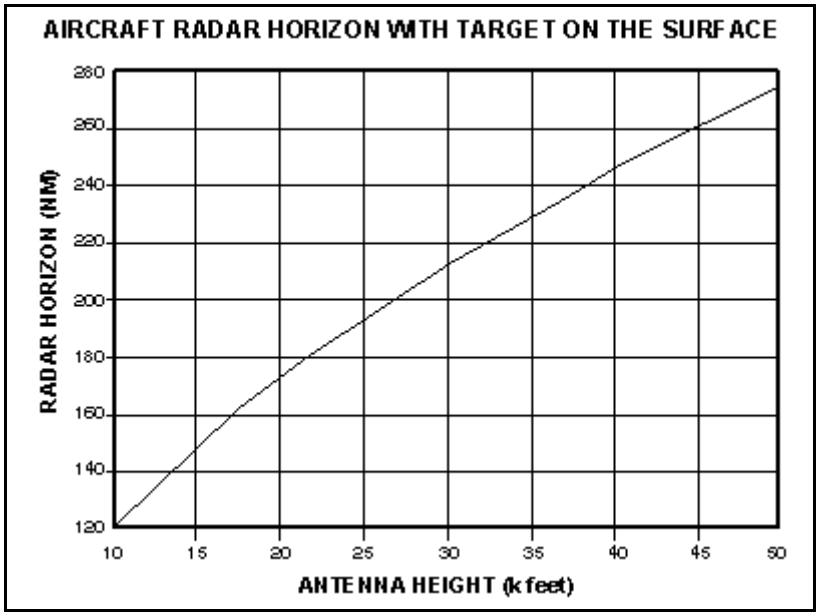

Figure 5. Aircraft Radar Horizon With Target on the Surface.

Other general rules of thumb for surface "targets/radars" are as follows:

<u>For Visual SAR</u>:

$$R_{Visual}(NM) = 1.05\sqrt{Acft\ \ Alt\ in\ \ ft}$$

<u>For ESM:</u>

$$R_{ESM}(NM) = 1.5\sqrt{Acft\ \ Alt\ in\ \ ft}$$

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PROPAGATION TIME / RESOLUTION

1. ROUND TRIP RANGE: $R = \frac{c\,t}{2}$ with t = time to reach target

Rules of Thumb

In one µsec round trip time, a wave travels to and from an object at a distance of:	The time it takes to travel to and from an object at a distance of:
≅ 150 m	1 m ≅ 0.0067 µsec
≅ 164 yd	1 yd ≅0.006 µsec
≅ 500 ft	1 ft ≅ 0.002 µsec
≅ 0.08 NM	1 NM ≅ 12.35 µsec
≅ 0.15 km	1 km ≅ 6.7 µsec

2. ONE WAY RANGE: ***R = ct*** with t = time to reach target

Time	Distance Traveled
1 milli sec (ms)	165 NM
1 micro sec (µs)	1000 ft
1 nano sec (ns)	1 ft

Distance	Time it Takes
1 NM	6.18 µsec
1 km	3.3 µsec
1 ft	1 nsec

3. UNAMBIGUOUS RANGE

(DISTANCE BETWEEN PULSES): $R = \frac{c \bullet PRI}{2}$

Normally a radar measures "distance" to the target by measuring time from the last transmitted pulse. If the inter-pulse period (T) is long enough that isn't a problem as shown in "A" to the right. When the period is shortened, the time to the last previous pulse is shorter than the actual time it took, giving a false (ambiguous) shorter range (figure "B").

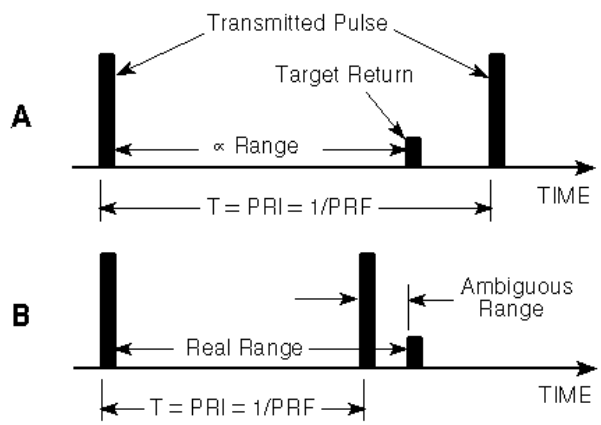

Rules of Thumb

RNM ≅ 81Pms

RKm ≅ 150Pms

Where Pms is PRI in milliseconds

4. RANGE RESOLUTION

Rules of Thumb

500 ft per microsecond of pulse width

500 MHz IF bandwidth provides 1 ft of resolution.

5. BEST CASE PERFORMANCE:

The atmosphere limits the accuracy to 0.1 ft

The natural limit for resolution is one RF cycle.

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MODULATION

Modulation is the process whereby some characteristic of one wave is varied in accordance with some characteristic of another wave. The basic types of modulation are angular modulation (including the special cases of phase and frequency modulation) and amplitude modulation. In missile radars, it is common practice to amplitude modulate the transmitted RF carrier wave of tracking and guidance transmitters by using a pulsed wave for modulating, and to frequency modulate the transmitted RF carrier wave of illuminator transmitters by using a sine wave.

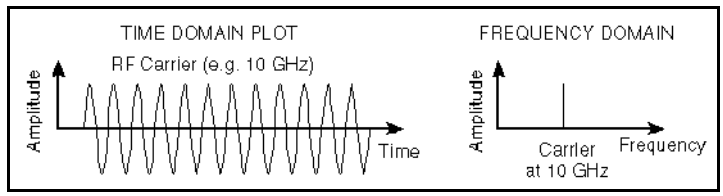

Figure 1. Unmodulated RF Signal.

Frequency Modulation (FM) - As shown in Figure 1, an unmodulated RF signal in the time domain has only a single spectral line at the carrier frequency (f_c) in the frequency domain. If the signal is frequency modulated, as shown in Figure 2 (simplified using only two changes), the spectral line will correspondingly shift in the frequency domain. The bandwidth can be approximated using Carson's rule: $BW = 2(\Delta f + fm)$, where Δf is the peak deviation of the instantaneous frequency from the carrier and *fm* is the highest frequency present in the modulating signal. There are usually many more "spikes" in the frequency domain than depicted. The number of spikes and shape of the frequency domain envelope (amplitude) are based on the modulation index β. The modulation index is related to the same two factors used in Carson's rule. A high Δf means a higher modulation index with many more "spikes" spread across a wider bandwidth.

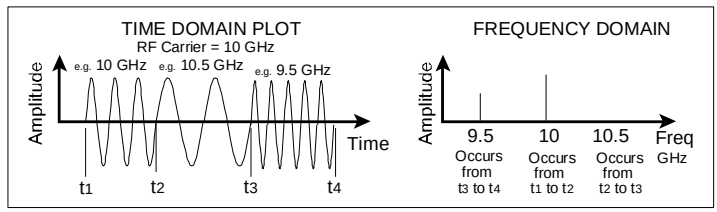

Figure 2. RF Signal With Frequency Modulation.

Amplitude Modulation (AM) - If the signal in Figure 1 is amplitude modulated by a sinewave as shown in Figure 3, sidebands are produced in the frequency domain at $F_c \pm F_{AM}$. AM other than by a pure sine wave will cause additional sidebands normally at $F_c \pm nF_{AM}$, where n equals 1, 2, 3, 4, etc.

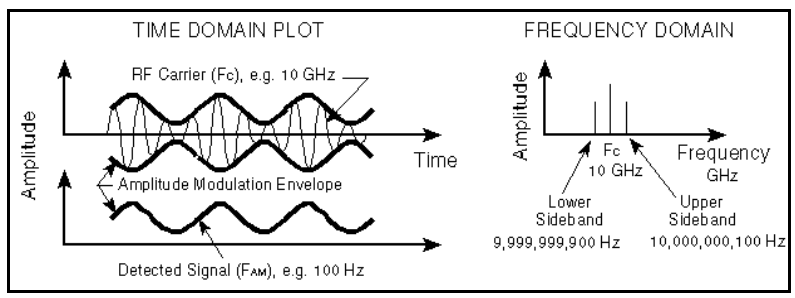

Figure 3. Sinewave Modulated RF Signal.

Pulse modulation is a special case of AM wherein the carrier frequency is gated at a pulsed rate. When the reciprocal of the duty cycle of the AM is a whole number, harmonics corresponding to multiples of that whole number will be missing, e.g., in a 33.33% duty cycle, AM wave will miss the 3rd, 6th, 9th, etc. harmonics, while a square wave or

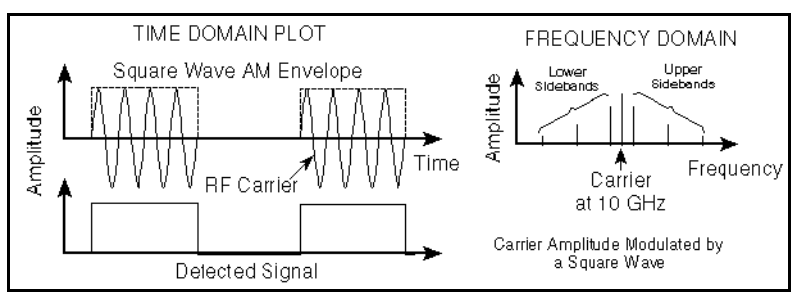

Figure 4. Square Wave Modulated RF Signal (50% Duty Cycle).

50% duty cycle triangular wave will miss the 2nd, 4th, 6th, etc. harmonic, as shown in Figure 4. It has sidebands in the frequency domain at $F_c \pm nF_{AM}$, where n = 1, 3, 5, etc. The amplitude of the power level follows a sine x / x type distribution.

Figure 5 shows the pulse width (PW) in the time domain which defines the lobe width in the frequency domain (Figure 6). The width of the main lobe is 2/PW, whereas the width of a side lobe is 1/PW. Figure 5 also shows the pulse repetition interval (PRI) or its reciprocal, pulse repetition frequency (PRF), in the time domain. In the frequency domain, the spectral lines inside the lobes are separated by the PRF or 1/PRI, as shown in Figures 7 and 8. Note that Figures 7 and 8 show actual magnitude of the side lobes, whereas in Figure 4 and 6, the absolute value is shown.

The magnitude of each spectral component for a rectangular pulse can be determined from the following formula:

$$a_n = 2A\frac{\tau}{T}\frac{\sin(n\pi\tau/T)}{n\pi\tau/T} \quad \text{where: } \begin{matrix}\tau = \text{pulse width (PW)} \\ T = \text{period (PRI)}\end{matrix} \quad \text{and } A = \text{Amplitude of rectangular pulse} \qquad [1]$$

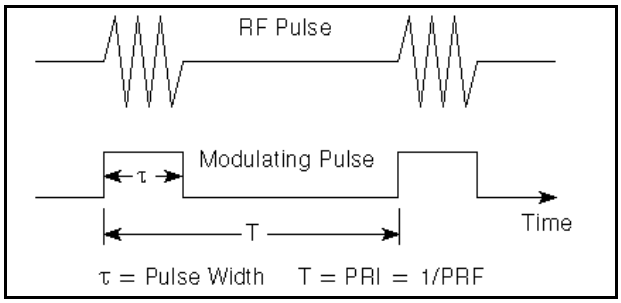

Figure 5. Pulse Width and PRI/PRF Waveforms.

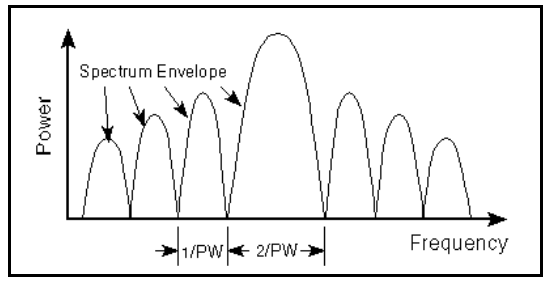

Figure 6. Sidelobes Generated by Pulse Modulation (Absolute Value).

Figure 7 shows the spectral lines for a square wave 50% duty cycle), while Figure 8 shows the spectral lines for a 33.33% duty cycle rectangular wave signal.

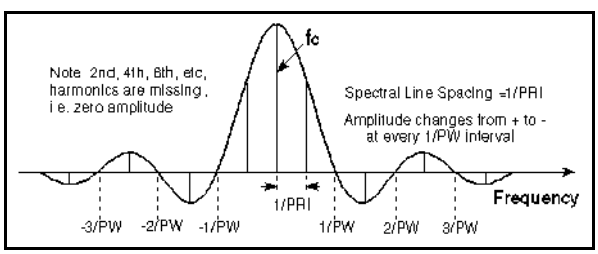

Figure 7. Spectral Times for a Square Wave Modulated Signal.

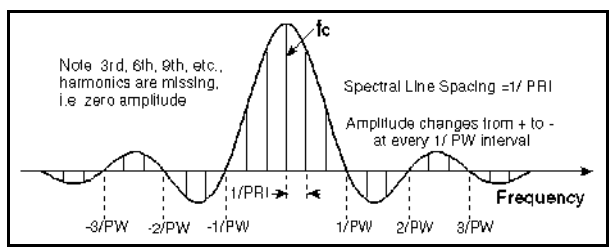

Figure 8. Spectral Lines for a 33.3% Duty Cycle.

Figure 9 shows that for square wave AM, a significant portion of the component modulation is contained in the first few harmonics which comprise the wave. There are twice as many sidebands or spectral lines as there are harmonics (one on the plus and one on the minus side of the carrier). Each sideband represents a sine wave at a frequency equal to the difference between the spectral line and f_c.

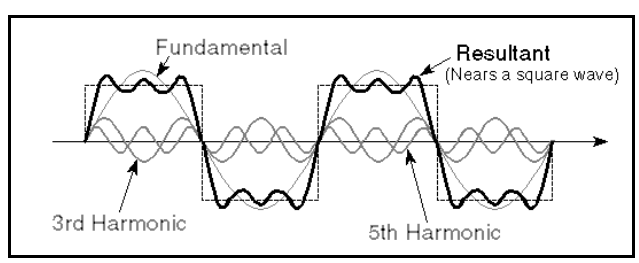

Figure 9. Square Wave Consisting of Sinewave Harmonics.

A figure similar to Figure 9 can be created for any rectangular wave. The relative amplitude of the time domain sine wave components are computed using equation [1]. Each is constructed such that at the midpoint of the pulse the sine wave passes through a maximum (or minimum if the coefficient is negative) at the same time. It should be noted that the "first" harmonic created using this formula is NOT the carrier frequency, f_c, of the modulated signal, but at $F_c \pm F_{AM}$.

While equation [1] is for rectangular waves only, similar equations can be constructed using Fourier coefficients for other waveforms, such as triangular, sawtooth, half sine, trapezoidal, and other repetitive geometric shapes.

PRI Effects - If the PW remains constant but PRI increases, the number of sidelobes remains the same, but the number of spectral lines gets denser (move closer together) and vice versa (compare Figures 7 and 8). The spacing between the spectral lines remains constant with constant PRI.

Pulse Width (PW) Effects - If the PRI remains constant, but the PW increases, then the lobe width decreases and vice versa. If the PW approaches PRI, the spectrum will approach "one lobe," i.e., a single spectral line. The spacing of the lobes remains constant with constant PW.

RF Measurements - If the receiver bandwidth is smaller than the PRF, the receiver will respond to one spectral line at a time. If the receiver bandwidth is wider than the PRF but narrower than the reciprocal of the PW, the receiver will respond to one spectral envelope at a time.

Jet Engine Modulation (JEM)

Section 2-6 addresses the Doppler shift in a transmitted radar signal caused by a moving target. The amount of Doppler shift is a function of radar carrier frequency and the speed of the radar and target. Moving or rotating surfaces on the target will have the same Doppler shift as the target, but will also impose AM on the Doppler shifted return (see Figure 10). Reflections off rotating jet engine compressor blades, aircraft propellers, ram air turbine (RAT) propellers used to power aircraft pods, helicopter rotor blades, and protruding surfaces of automobile hubcaps will all provide a chopped reflection of the impinging signal. The reflections are characterized by both positive and negative Doppler sidebands corresponding to the blades moving toward and away from the radar respectively.

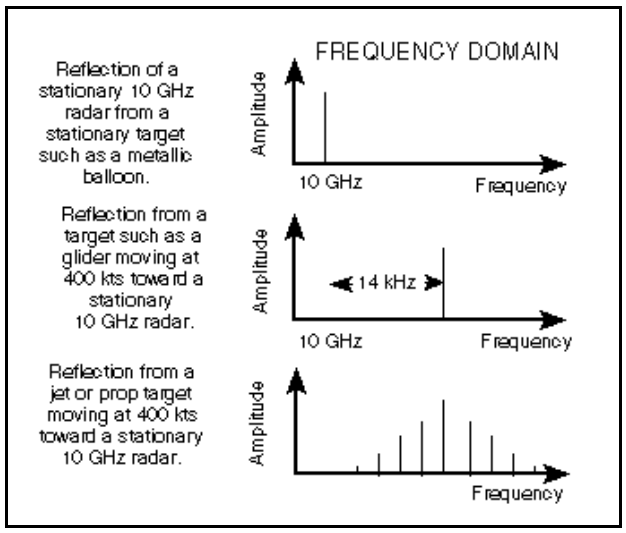

Figure 10. Doppler Return and JEM.

Therefore, forward/aft JEM does not vary with radar carrier frequency, but the harmonics contained in the sidebands are a function of the PRF of the blade chopping action and its amplitude is target aspect dependent, i.e., blade angle, intake/exhaust internal reflection, and jet engine cowling all effect lateral return from the side. If the aspect angle is too far from head-on or tail-on and the engine cowling provides shielding for the jet engine, there may not be any JEM to detect. On the other hand, JEM increases when you are orthogonal (at a right angle) to the axis of blade rotation. Consequently for a fully exposed blade as in a propeller driven aircraft or helicopter, JEM increases with angle off the boresight axis of the prop/rotor.

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TRANSFORMS / WAVELETS

Transform Analysis

Signal processing using a transform analysis for calculations is a technique used to simplify or accelerate problem solution. For example, instead of dividing two large numbers, we might convert them to logarithms, subtract them, then look-up the anti-log to obtain the result. While this may seem a three-step process as opposed to a one-step division, consider that long-hand division of a four digit number by a three digit number, carried out to four places requires three divisions, 3-4 multiplication's, and three subtractions. Computers process additions or subtractions much faster than multiplications or divisions, so transforms are sought which provide the desired signal processing using these steps.

Fourier Transform

Other types of transforms include the Fourier transform, which is used to decompose or separate a waveform into a sum of sinusoids of different frequencies. It transforms our view of a signal from time based to frequency based. Figure 1 depicts how a square wave is formed by summing certain particular sine waves. The waveform must be continuous, periodic, and almost everywhere differentiable. The Fourier transform of a sequence of rectangular pulses is a series of sinusoids. The envelope of the amplitude of the coefficients of this series is a waveform with a Sin X/X shape. For the special case of a single pulse, the Fourier series has an infinite series of sinusoids that are present for the duration of the pulse.

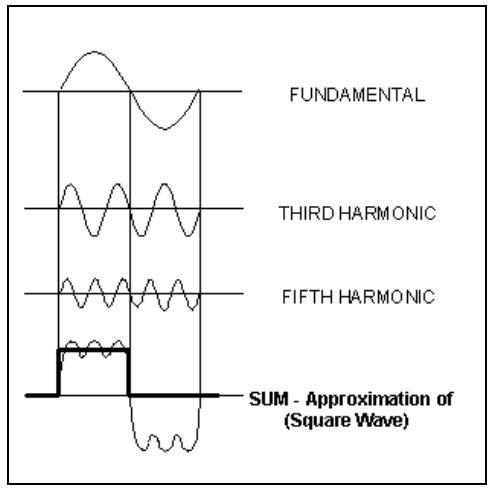

Figure 1. Harmonics.

Digital Sampling of Waveforms

To process a signal digitally, we need to sample the signal frequently enough to create a complete "picture" of the signal. The discrete Fourier transform (DFT) may be used in this regard. Samples are taken at uniform time intervals as shown in Figure 2 and processed.

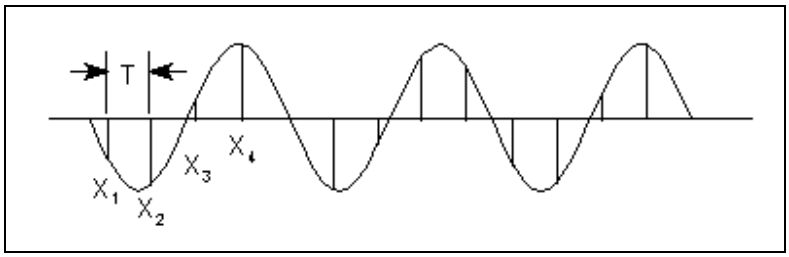

Figure 2. Waveform Sampling.

If the digital information is multiplied by the Fourier coefficients, a digital filter is created as shown Figure 3. If the sum of the resultant components is zero, the filter has ignored (notched out) that frequency sample. If the sum is a relatively large number, the filter has passed the signal. With the single sinusoid shown, there should be only one resultant. (Note that being "zero" and relatively large

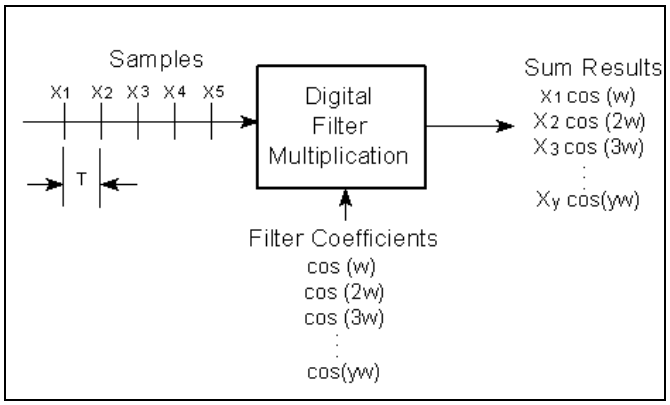

Figure 3. Digital Filtering.

may just mean below or above the filter's cutoff threshold.)

Figure 4 depicts the process pictorially: The vectors in the figure just happen to be pointing in a cardinal direction because the strobe frequencies are all multiples of the vector (phasor) rotation rate, but that is <u>not normally the case</u>. Usually the vectors will point in a number of different directions, with a resultant in some direction other than straight up.

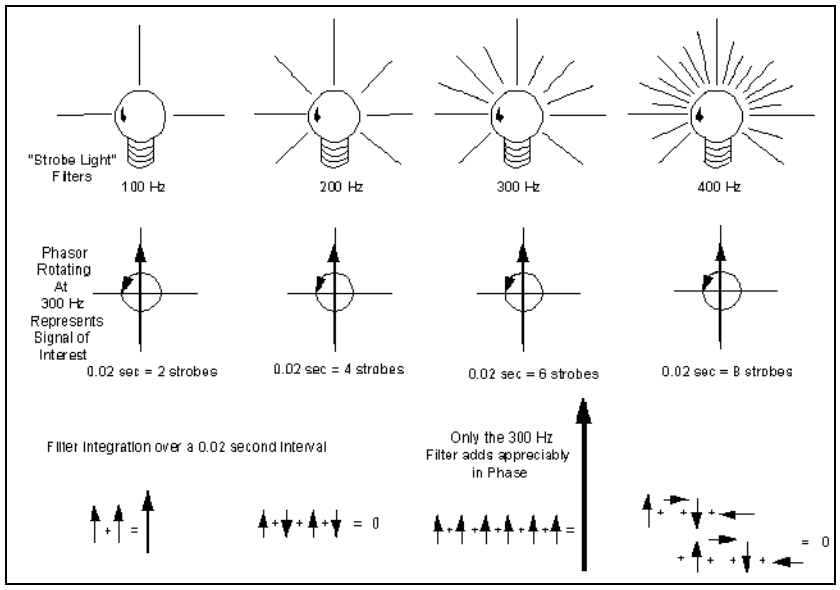

Figure 4. Phasor Representation.

In addition, sampling normally has to taken at or above twice the rate of interest (also known as the Nyquist rate), otherwise ambiguous results may be obtained. Figure 4 is under-sampled (for clarity) and consequently does not depict typical filtering.

<u>Fast Fourier Transforms</u>

One problem with this type of processing is the large number of additions, subtractions, and multiplications which are required to reconstruct the output waveform. The Fast Fourier transform (FFT) was developed to reduce this problem. It recognizes that because the filter coefficients are sine and cosine waves, they are symmetrical about 90, 180, 270, and 360 degrees. They also have a number of coefficients equal either to one or zero, and duplicate coefficients from filter to filter in a multibank arrangement. By waiting for all of the inputs for the bank to be received, adding together those inputs for which coefficients are the same before performing multiplications, and separately summing those combinations of inputs and products which are common to more than one filter, the required amount of computing may be cut drastically.

- The number of computations for a DFT is on the order of N squared.

- The number of computations for a FFT when N is a power of two is on the order of N $\log_2$ N.

For example, in an eight filter bank, a DFT would require 512 computations, while an FFT would only require 56, significantly speeding up processing time.

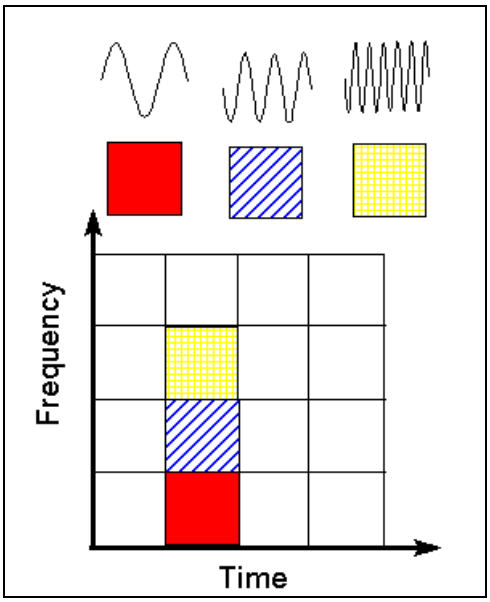

Figure 5. Windowed Fourier Transform.

Windowed Fourier Transform

The Fourier transform is continuous, so a windowed Fourier transform (WFT) is used to analyze non-periodic signals as shown in Figure 5. With the WFT, the signal is divided into sections (one such section is shown in Figure 5) and each section is analyzed for frequency content. If the signal has sharp transitions, the input data is windowed so that the sections converge to zero at the endpoints. Because a single window is used for all frequencies in the WFT, the resolution of the analysis is the same (equally spaced) at all locations in the time-frequency domain.

The FFT works well for signals with smooth or uniform frequencies, but it has been found that other transforms work better with signals having pulse type characteristics, time-varying (non-stationary) frequencies, or odd shapes.

The FFT also does not distinguish sequence or timing information. For example, if a signal has two frequencies (a high followed by a low or vice versa), the Fourier transform only reveals the frequencies and relative amplitude, not the order in which they occurred. So Fourier analysis works well with stationary, continuous, periodic, differentiable signals, but other methods are needed to deal with non-periodic or non-stationary signals.

Wavelet Transform

The Wavelet transform has been evolving for some time. Mathematicians theorized its use in the early 1900's. While the Fourier transform deals with transforming the time domain components to frequency domain and frequency analysis, the wavelet transform deals with scale analysis, that is, by creating mathematical structures that provide varying time/frequency/amplitude slices for analysis. This transform is a portion (one or a few cycles) of a complete waveform, hence the term wavelet.

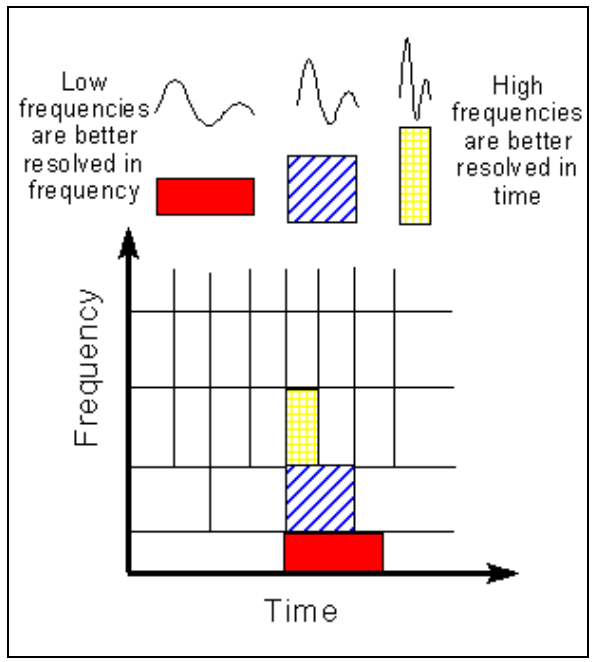

Figure 6. Wavelet Transform.

The wavelet transform has the ability to identify frequency (or scale) components, simultaneously with their location(s) in time. Additionally, computations are directly proportional to the length of the input signal. They require only N multiplications (times a small constant) to convert the waveform. For the previous eight filter bank example, this would be about twenty calculations, vice 56 for the FFT.

In wavelet analysis, the scale that one uses in looking at data plays a special role. Wavelet algorithms process data at different scales or resolutions. If we look at a signal with a large "window," we would notice gross features. Similarly, if we look at a signal with a small "window," we would notice small discontinuities as shown in Figure 6. The result in wavelet analysis is to "see the forest and the trees." A way to achieve this is to have short high-frequency fine scale functions and long low-frequency ones. This approach is known as multi-resolution analysis.

For many decades, scientists have wanted more appropriate functions than the sines and cosines (base functions) which comprise Fourier analysis, to approximate choppy signals. (Although Walsh transforms work if the waveform is periodic and stationary). By their definition, sine and cosine functions are non-local (and stretch out to infinity), and therefore do a very poor job in approximating sharp spikes. But with wavelet analysis, we can use approximating functions that are contained neatly in finite (time/frequency) domains. Wavelets are well-suited for approximating data with sharp discontinuities.

The wavelet analysis procedure is to adopt a wavelet prototype function, called an "analyzing wavelet" or "mother wavelet." Temporal analysis is performed with a contracted, high-frequency version of the prototype wavelet, while frequency analysis is performed with a dilated, low-frequency version of the prototype wavelet. Because the original signal or function can be represented in terms of a wavelet expansion (using coefficients in a linear combination of the wavelet functions), data operations can be performed using just the corresponding wavelet coefficients as shown in Figure 7.

If one further chooses the best wavelets adapted to the data, or truncates the coefficients below some given threshold, the data is sparsely represented. This "sparse coding" makes wavelets an excellent tool in the field of data compression. For instance, the FBI uses wavelet coding to store fingerprints. Hence, the concept of wavelets is to look at a signal at various scales and analyze it with various resolutions.

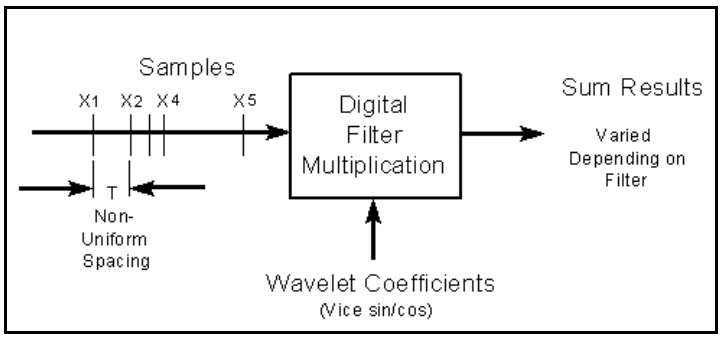

Figure 7. Wavelet Filtering.

Analyzing Wavelet Functions

Fourier transforms deal with just two basis functions (sine and cosine), while there are an infinite number of wavelet basis functions. The freedom of the analyzing wavelet is a major difference between the two types of analyses and is important in determining the results of the analysis. The "wrong" wavelet may be no better (or even far worse than) than the Fourier analysis. A successful application presupposes some expertise on the part of the user. Some prior knowledge about the signal must generally be known in to select the most suitable distribution and adapt the parameters to the signal. Some

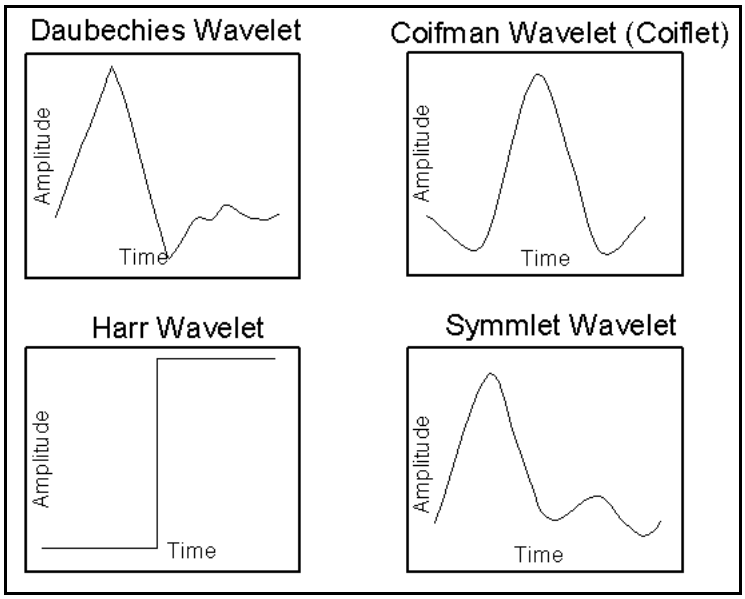

Figure 8. Sample Wavelet Functions.

of the more common ones are shown in Figure 8. There are several wavelets in each family, and they may look different than those shown. Somewhat longer in duration than these functions, but significantly shorter than infinite sinusoids is the cosine packet shown in Figure 9.

Wavelet Comparison With Fourier Analysis

While a typical Fourier transform provides frequency content information for samples within a given time interval, a perfect wavelet transform records the start of one frequency (or event), then the start of a second event, with amplitude added to or subtracted from, the base event.

Example 1.

Wavelets are especially useful in analyzing transients or time-varying signals. The input signal shown in Figure 9 consists of a sinusoid whose frequency changes in stepped increments over time. The power of the spectrum is also shown. Classical Fourier analysis will resolve the frequencies but cannot provide any information about the times at which each occurs. Wavelets provide an efficient means of analyzing the input signal so that frequencies and the times at which they occur can be resolved. Wavelets have finite duration and must also satisfy additional properties beyond those normally associated with standard windows used with Fourier analysis. The result after the wavelet transform is applied is the plot shown in the lower right. The wavelet analysis correctly resolves each of the frequencies and the time when it occurs. A series of wavelets is used in example 2.

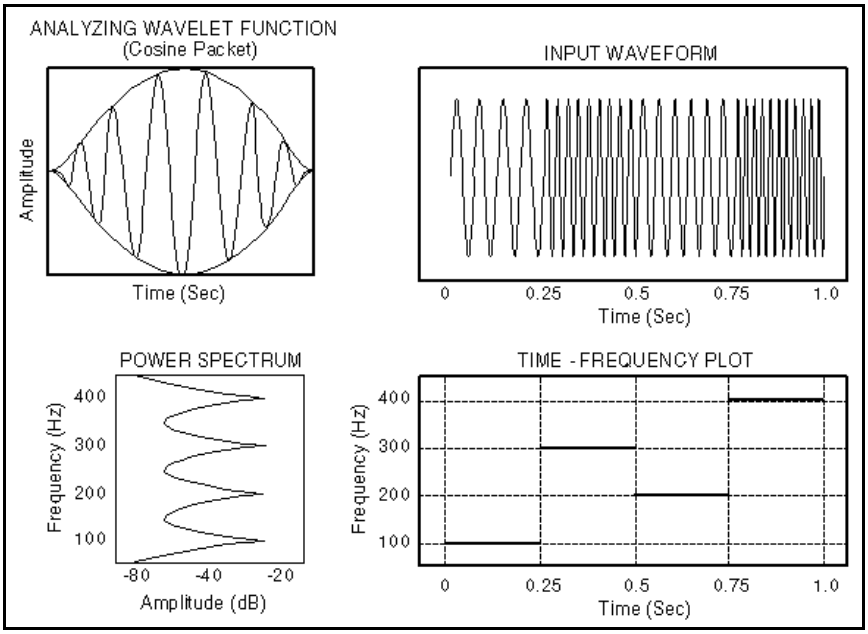

Figure 9. Sample Wavelet Analysis.

Example 2.

Figure 10 shows the input of a clean signal, and one with noise. It also shows the output of a number of "filters" with each signal. A 6 dB S/N improvement can be seen from the d4 output. (Recall from Section 4.3 that 6 dB corresponds to doubling of detection range.) In the filter cascade, the HPFs and LPFs are the same at each level. The wavelet shape is related to the HPF and LPF in that it is the "impulse response" of an infinite cascade of the HPFs and LPFs. Different wavelets have different HPFs and LPFs. As a result of decimating by 2, the number of output samples equals the number of input samples.

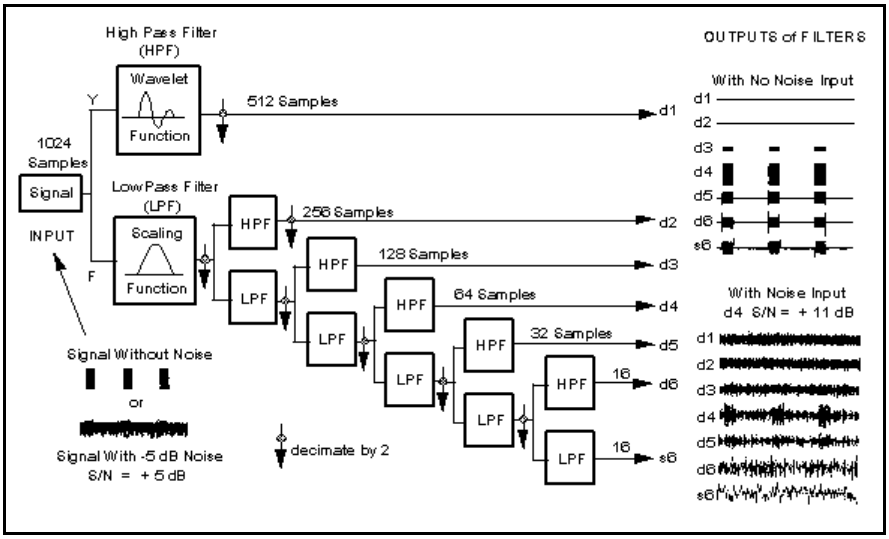

Figure 10. Example 2 Analysis Wavelet.

Wavelet Applications

Some fields that are making use of wavelets are: astronomy, acoustics, nuclear engineering, signal and image processing (including fingerprinting), neurophysiology, music, magnetic resonance imaging, speech discrimination, optics, fractals, turbulence, earthquake-prediction, radar, human vision, and pure mathematics applications.

See Andrew Bruce, David Donoho, and Hong-Ye Gao, "Wavelet Analysis," *IEEE Spectrum*, Vol. 33 No. 10, October 1996.

ANTENNAS

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ANTENNA INTRODUCTION / BASICS

Rules of Thumb:

1. The power gain of an antenna with losses, excluding input impedance mismatch, is given by:

$$G \approx \frac{4\pi\eta A}{\lambda^2} \quad \text{Where} \quad \begin{array}{l} \eta = \text{Efficiency} \\ A = \text{Physical aperture area} \\ \lambda = \text{wavelength} \end{array}$$

another is :

$$G = \frac{X\,\eta}{BW_\phi\, BW_\theta}$$

Where $BW_{\theta \text{ and } \phi}$ are the elev & az beamwidths in degrees.

For approximating an antenna pattern with :

(1) A rectangle; $X = 41253, \eta_{typical} = 0.7$

(2) An ellipsoid; $X = 52525, \eta_{typical} = 0.55$

2. Directive gain of rectangular X-Band Aperture
   G = 1.4 LW Where: Length (L) and Width (W) are in cm

3. Power gain of Circular X-Band Aperture
   $G = d^2\eta$ Where: d = antenna diameter in cm
   η = aperture efficiency

4. Directive gain of an imaginary isotropic antenna radiating in a uniform spherical pattern is one (0 dB).

5. Antenna with a 20 degree beamwidth has approximately a 20 dB directive gain.

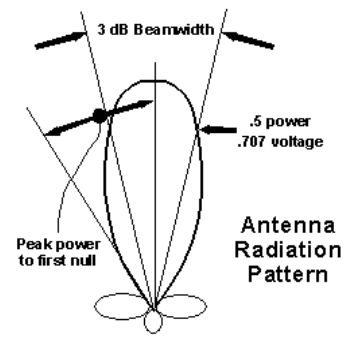

6. 3 dB beamwidth is approximately equal to the angle from the peak of the power to the first null (see figure at right).

7. Parabolic Antenna Beamwidth: $BW = \frac{70\lambda}{d}$

   Where: BW = antenna beamwidth; λ = wavelength; d = antenna diameter.

The antenna equations which follow relate to Figure 1 as a typical antenna. In Figure 1, BW_φ is the azimuth beamwidth and BW_θ is the elevation beamwidth. Beamwidth is normally measured at the half-power or -3 dB point of the main lobe unless otherwise specified. See Glossary.

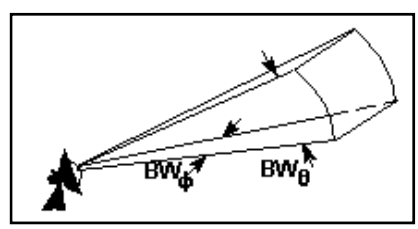

Figure 1. Antenna Aperture.

The gain or directivity of an antenna is the ratio of the radiation intensity in a given direction to the radiation intensity averaged over all directions.

Quite often directivity and gain are used interchangeably and it sometimes leads to overly optimistic antenna performance estimations. The difference is that directivity is based solely on antenna pattern shape estimation where antenna losses such as dielectric, ohmic resistance, and polarization mismatch are neglected. If these losses are included in the antenna gain calculations, the antenna gain is then referred to as the power gain. Moreover, if additional impedance mismatch or VSWR losses are included in the antenna system gain estimation, the antenna gain calculations are then referred to as the realized gain. However, using directive gain (or directivity) calculations is very convenient in practice for a first order idealized antenna performance estimation.

Normalizing a radiation pattern by the integrated total power yields the directivity of the antenna. This concept in shown in equation form by:

$$D(\theta,\phi) = 10 \text{ Log}\left[\frac{4\pi P(\theta,\phi)}{\int\int P_{in}(\theta,\phi)\,\text{Sin}\,\theta\, d\theta\, d\phi}\right] \quad \begin{matrix} 0 < \phi \le 360° \\ 0 < \theta \le 180° \end{matrix} \qquad \textbf{[1]}$$

Where D(θ,φ) is the directivity in dB, and the radiation pattern power in a specific direction is $P_d(\theta,\varphi)$, which is normalized by the total integrated radiated power. Another important concept is that when the angle in which the radiation is constrained is reduced, the directive gain goes up. For example, using an isotropic radiating source, the gain would be 0 dB by definition (Figure 2(a)) and the power density (P_d) at any given point would be the power in (P_{in}) divided by the surface area of the imaginary sphere at a distance R from the source. If the spacial angle was decreased to one hemisphere (Figure 2(b)), the power radiated, P_{in}, would be the same but the area would be half as much, so the gain would double to 3 dB. Likewise if the angle is a quarter sphere, (Figure 2(c)), the gain would be 6 dB. Figure 2(d) shows a pencil beam. The gain is independent of actual power output and radius (distance) at which measurements are taken.

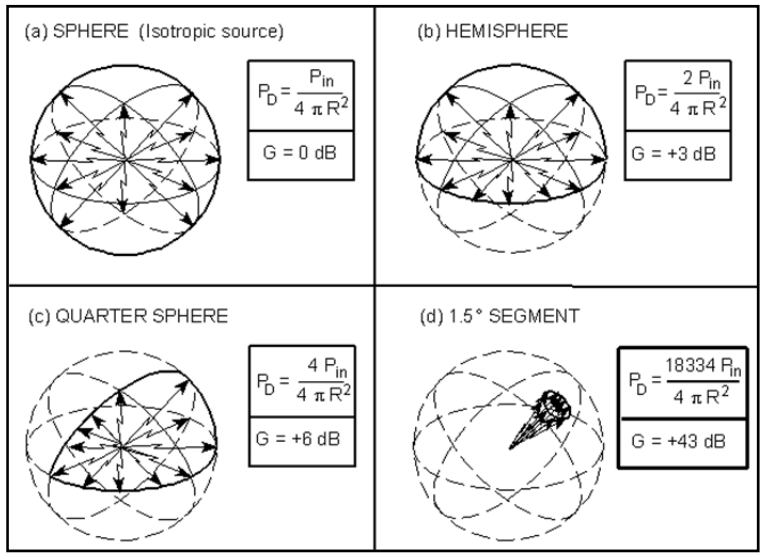

Figure 2. Notional Representation of Directive Antenna Gain.

Real antennas are different, however, and do not have an ideal radiation distribution. Energy varies with angular displacement and losses occur due to sidelobes. However, if we can measure the pattern, and determine the beamwidth we can use two (or more) ideal antenna models to approximate a real antenna pattern as shown in Figure 3.

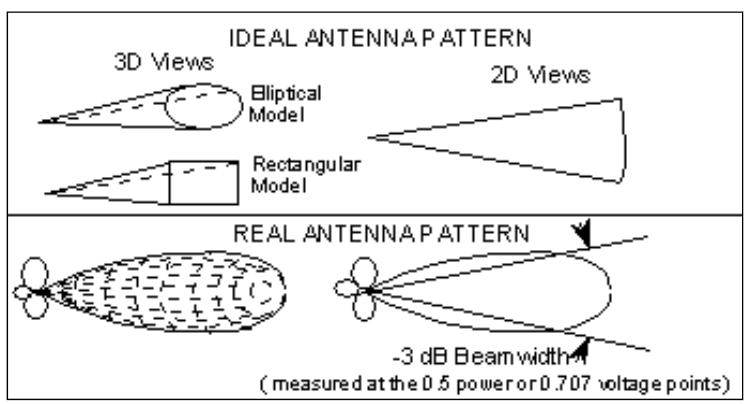

Figure 3. Antenna Beamwidth.

Assuming the antenna pattern is uniform, the gain is equal to the area of the isotropic sphere ($4\pi r^2$) divided by the sector (cross section) area.

$$G = \frac{Area\ of\ Sphere}{Area\ of\ Antenna\ pattern} \qquad \textbf{[2]}$$

It can be shown that:

$$G \approx \frac{4\pi}{BW_{\phi\,az}\,BW_{\theta\,el}} \quad or \quad \frac{4\pi}{\phi\theta\,(radians)} \quad where: \begin{matrix} BW_{\phi\,az} = Azmith\ beamwidth\ in\ radians \\ BW_{\theta\,el} = Elevation\ beamwidth\ in\ radians \end{matrix} \qquad \textbf{[3]}$$

From this point, two different models are presented:

(1) Approximating an antenna pattern using an elliptical area, and
(2) Approximating an antenna pattern using a rectangular area.

<u>Approximating the antenna pattern as an **elliptical** area:</u>

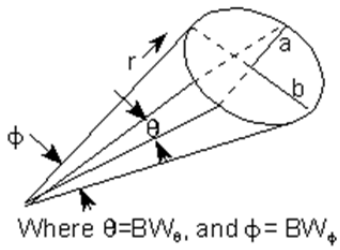

Area of ellipse = π a b = π[(r sin θ)/2][(r sin φ)/2]= (π r^2 sin θ sin φ)/4

$$G = \frac{Area\ of\ Sphere}{Area\ of\ Antenna\ pattern} = (4\,\pi\,r^2)\left(\frac{4}{\pi\,r^2\ \sin\theta\sin\phi}\right) = \frac{16}{\sin\theta\sin\phi}$$

For small angles, sin φ = φ in radians, so:

$$G = \frac{16}{\sin\phi\sin\theta} \approx \frac{16}{\phi\,\theta\,(radians)} = \frac{16}{\phi\,\theta}\left(\frac{360°\ 360°}{2\,\pi\ 2\,\pi}\right) = \frac{52525}{\phi\,\theta\,(degrees)}\ or\ \frac{52525}{BW_\phi\,BW_\theta\,(degrees)} \qquad \textbf{[4]}$$

The second term in the equation above is very close to equation [3].

For a very directional radar dish with a beamwidth of 1° and an average efficiency of 55%:

Ideally: G = 52525, or in dB form: 10 log G =10 log 52525 = 47.2 dB

With efficiency taken into account, G = 0.55(52525) = 28888, or in log form: 10 log G = 44.6 dB

<u>Approximating the antenna pattern as a **rectangular** area:</u>

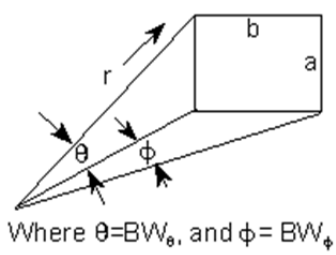

a = r sin θ , b = r sin φ, area = ab = r^2 sin θ sin φ

$$G = \frac{Area\ of\ Sphere}{Area\ of\ Antenna\ pattern} = \frac{4\,\pi\,r^2}{r^2\ \sin\theta\sin\phi} = \frac{4\,\pi}{\sin\theta\sin\phi}$$

For small angles, sin φ = φ in radians, so:
The second term in the equation above is identical to equation [3].

$$G = \frac{4\,\pi}{\sin\phi\sin\theta} = \frac{4\,\pi}{\phi\,\theta\,(radians)} = \frac{4\,\pi}{\phi\,\theta}\left(\frac{360°\ 360°}{2\,\pi\ 2\,\pi}\right) = \frac{41253}{\phi\,\theta\,(degrees)}\ or\ \frac{41253}{BW_\phi\,BW_\theta\,(degrees)} \qquad \textbf{[5]}$$

Converting to dB, $G_{\max}(dB) = 10\ \mathrm{Log}\left[\frac{41253}{BW_\phi\,BW_\theta}\right]$ *with* BW_ϕ *and* BW_θ *in degrees* **[6]**

For a very directional radar dish with a beamwidth of 1° and an average efficiency of 70%:
Ideally (in dB form): 10 log G =10 log 41253 = 46.2 dB.
With efficiency taken into account, G = 0.7(41253) = 28877, or in log form: 10 log G = 44.6 dB

Comparison between elliptical and rectangular areas for antenna pattern models:

By using the rectangular model there is a direct correlation between the development of gain in equation [5] and the ideal gain of equation [3]. The elliptical model has about one dB difference from the ideal calculation, but will yield the same real antenna gain when appropriate efficiencies are assumed.

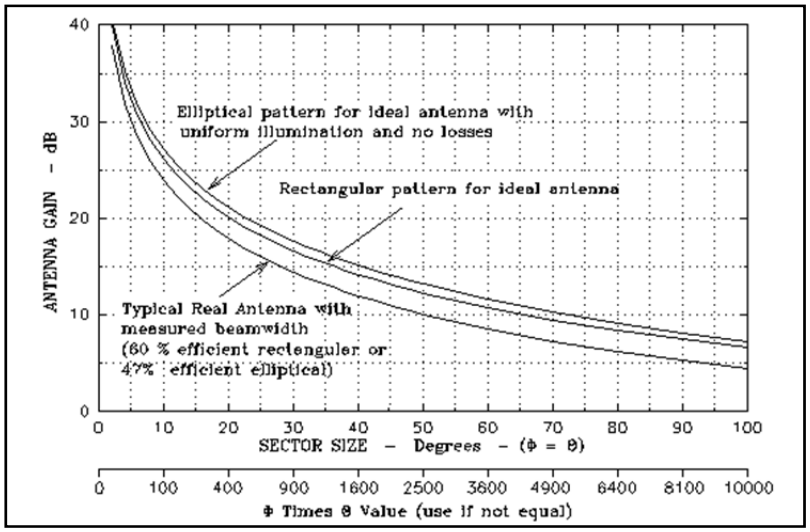

Figure 4. Antenna Sector Size vs. Gain.

The upper plot of Figure 4 shows the gain for an ideal antenna pattern using the elliptical model. The middle plot shows the gain for an ideal antenna using the rectangular model. The lower plot of Figure 4 shows the gain of a typical real antenna (rectangular model using an efficiency of 70% or elliptical model using an efficiency of 47%).

Gain as a function of λ:

When θ = 0, each wave source in Figure 5 is in phase with one another and a maximum is produced in that direction.

Conversely, nulls to either side of the main lobe will occur when the waves radiating from the antenna cancel each other. The first null occurs when there is a phase difference of λ/2 in the wave fronts emanating from the aperture. To aid in visualizing what happens, consider each point in the antenna aperture, from A to C in Figure 5, as a point source of a spherical wave front. If viewed from infinity, the electromagnetic waves from each point interfere with each other, and when, for a particular direction, θ in Figure 5, each wave source has a corresponding point that is one-half wavelength out of phase, a null is produced in that direction due to destructive interference.

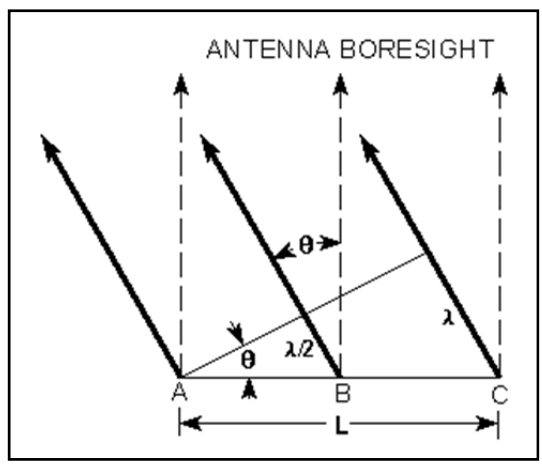

Figure 5. Directional Gain vs. Wavelength.

In Figure 5, the wave emanating from point A is out of phase with the wave from point B by one-half of a wavelength. Hence, they cancel. Similarly, a point just to the right of point A cancels with a point just to the right of point B, and so on across the entire aperture. Therefore, the first null in the radiation pattern is given by:

$$\sin\theta = \lambda/L \text{ and, in radians, } \theta = \lambda/L \text{ (for small angles)} \qquad \textbf{[7]}$$

As the angle off boresight is increased beyond the first null, the intensity of the radiation pattern rises then falls, until the second null is reached. This corresponds to a phase difference of two wavelengths between the left and right edges of the aperture. In this case, the argument proceeds as before, except now the aperture is divided into four segments (point A canceling with a point halfway between A and B, and so on).

The angle θ is the angle from the center (maximum) of the radiation pattern to the first null. The null-to-null beam width is 2θ. Generally, we are interested in the half-power (3 dB) beamwidth. It turns out that this beamwidth is approximately one-half of the null-to-null beamwidth, so that:

$$BW_{3\ dB} \approx (½)(2\theta) = \lambda/L \qquad \textbf{[8]}$$

Therefore, beamwidth is a function of the antenna dimension "L" and the wavelength of the signal. It can be expressed as follows: Note: for circular antennas, L in the following equations = diameter

$$Bw_{\varphi(az)} = \lambda/L_{Az\ eff} \text{ and } BW_{\theta(el)} = \lambda/L_{El\ eff} \qquad \textbf{[9]}$$

Substituting the two variations of equation [9] into equation [3] and since $L_{Az\ eff}$ times $L_{El\ eff} = A_e$ (effective capture area of the antenna), we have:

$$G \approx \frac{4\pi}{BW_\phi\, BW_\theta\, (radians)} = \frac{4\pi\, L_{az}\, L_{el}}{\lambda^2} = \frac{4\pi\, A_e}{\lambda^2} \qquad \textbf{[10]}$$

Note: Equation is approximate since aperture efficiency isn't included as is done later in equation [12].

The efficiency (discussed later) will reduce the gain by a factor of 30-50%, i.e. real gain = .5 to .7 times theoretical gain.

<u>Unity Gain Antenna.</u>
If a square antenna is visualized and G=1, $A_e = \lambda^2 / 4\pi$. When a dimension is greater than 0.28 λ (~¼λ) it is known as an electrically large antenna, and the antenna will have a gain greater than one (positive gain when expressed in dB). Conversely, when the dimension is less than 0.28 λ (~¼λ)(an electrically small antenna), the gain will be less than one (negative gain when expressed in dB). Therefore, a unity gain antenna can be approximated by an aperture that is ¼λ by ¼λ.

<u>Beamwidth as a Function of Aperture Length</u>
It can be seen from Figure 5, that the wider the antenna aperture (L), the narrower the beamwidth will be for the same λ. Therefore, if you have a rectangular shaped horn antenna, the radiation pattern from the wider side will be narrower than the radiation pattern from the narrow side.

APERTURE EFFICIENCY, η

The Antenna Efficiency, η, is a factor which includes all reductions from the maximum gain. η can be expressed as a percentage, or in dB. Several types of "loss" must be accounted for in the efficiency, η:

(1) <u>Illumination efficiency</u> which is the ratio of the directivity of the antenna to the directivity of a uniformly illuminated antenna of the same aperture size,
(2) <u>Phase error loss</u> or loss due to the fact that the aperture is not a uniform phase surface,
(3) <u>Spillover loss</u> (Reflector Antennas) which reflects the energy spilling beyond the edge of the reflector into the back lobes of the antenna,

(4) Mismatch (VSWR) loss, derived from the reflection at the feed port due to impedance mismatch (especially important for low frequency antennas), and

(5) RF losses between the antenna and the antenna feed port or measurement point.

The aperture efficiency, η_a, is also known as the illumination factor, and includes items (1) and (2) above; it does not result in any loss of power radiated but affects the gain and pattern. It is nominally 0.6-0.8 for a planer array and 0.13 to 0.8 with a nominal value of 0.5 for a parabolic antenna, however η can vary significantly. Other antennas include the spiral (.002-.5), the horn (.002-.8), the double ridge horn (.005-.93), and the conical log spiral (.0017-1.0).

Items (3), (4), and (5) above represent RF or power losses which can be measured. The efficiency varies and generally gets lower with wider bandwidths. Also note that the gain equation is optimized for small angles - see derivation of wavelength portion of equation [7]. This explains why efficiency also gets lower for wider beamwidth antennas.

EFFECTIVE CAPTURE AREA

Effective capture area (A_e) is the product of the physical aperture area (A) and the aperture efficiency (η) or:

$$A_e = \eta\, A = \frac{\lambda^2 G}{4\pi} \qquad \textbf{[11]}$$

GAIN AS A FUNCTION OF APERTURE EFFICIENCY

The Gain of an antenna with losses is given by:

$$G = \frac{4\pi\eta A}{\lambda^2} \quad \begin{array}{c} \eta = Aperture\ Efficiency \\ Where\ A = Physical\ aperture\ area \\ \lambda = wavelength \end{array} \qquad \textbf{[12]}$$

Note that the gain is proportional to the aperture area and inversely proportional to the square of the wavelength. For example, if the frequency is doubled, (half the wavelength), the aperture could be decreased four times to maintain the same gain.

BEAM FACTOR

Antenna size and beamwidth are also related by the beam factor defined by:

Beam Factor = $(D/\lambda)\cdot$(Beamwidth) where D = antenna dimension in wavelengths.

The beam factor is approximately invariant with antenna size, but does vary with type of antenna aperture illumination or taper. The beam factor typically varies from 50-70°.

APERTURE ILLUMINATION (TAPER)

The aperture illumination or illumination taper is the variation in amplitude across the aperture. This variation can have several effects on the antenna performance:

(1) reduction in gain,
(2) reduced (lower) sidelobes in most cases, and
(3) increased antenna beamwidth and beam factor.

Tapered illumination occurs naturally in reflector antennas due to the feed radiation pattern and the variation in distance from the feed to different portions of the reflector. Phase can also vary across the aperture which also affects the gain, efficiency, and beamwidth.

CIRCULAR ANTENNA GAIN

Solving equation [12] in dB, for a circular antenna with area $\pi D^2/4$, we have:

$$10 \text{ Log } G = 20 \text{ Log } (D/\lambda) + 10 \text{ Log } (\eta) + 9.94 \text{ dB}; \quad \text{where } D = \text{diameter} \qquad \textbf{[13]}$$

This data is depicted in the nomograph of Figure 6. For example, a six foot diameter antenna operating at 9 GHz would have approximately 44.7 dB of gain as shown by the dashed line drawn on Figure 6. This gain is for an antenna 100% efficient, and would be 41.7 dB for a typical parabolic antenna (50% efficient).

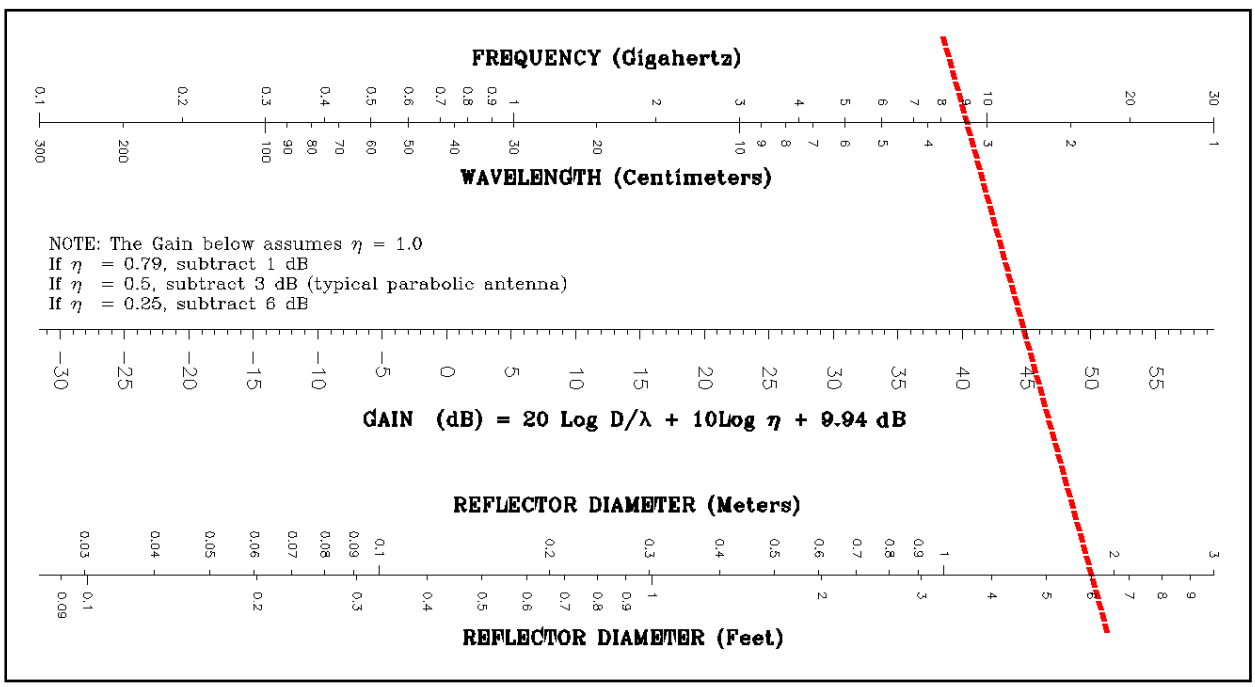

Figure 6. Antenna Gain Nomograph.

An example of a typical antenna (with losses) showing the variation of gain with frequency is depicted in Figure 7, and the variation of gain with antenna diameter in Figure 8. The circle on the curves in Figure 7 and 8 correspond to the Figure 6 example and yields 42 dB of gain for the 6 ft dish at 9 GHz.

Example Problem: If the two antennas in the drawing are "welded" together, how much power will be measured at point A? (Line loss $L_1 = L_2 = 0.5$, and 10log L_1 or L_2 = 3 dB)

Multiple choice:
A. 16 dBm b. 28 dBm c. 4 dBm d. 10 dBm e. < 4 dBm

Answer:

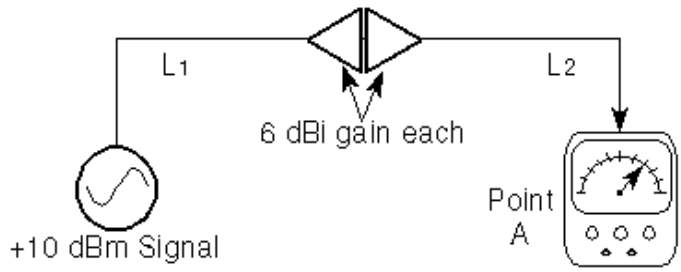

The antennas do not act as they normally would since the antennas are operating in the near field. They act as inefficient coupling devices resulting in some loss of signal. In addition, since there are no active components, you cannot end up with more power than you started with. The correct answer is "e. < 4 dBm."

10 dBm - 3 dB - small loss -3 dB = 4 dBm - small loss

If the antennas were separated by 5 ft and were in the far field, the antenna gain could be used with space loss formulas to calculate (at 5 GHz): 10 dBm - 3 dB + 6 dB - 50 dB (space loss) + 6 dB -3 dB = -34 dBm (a much smaller signal).

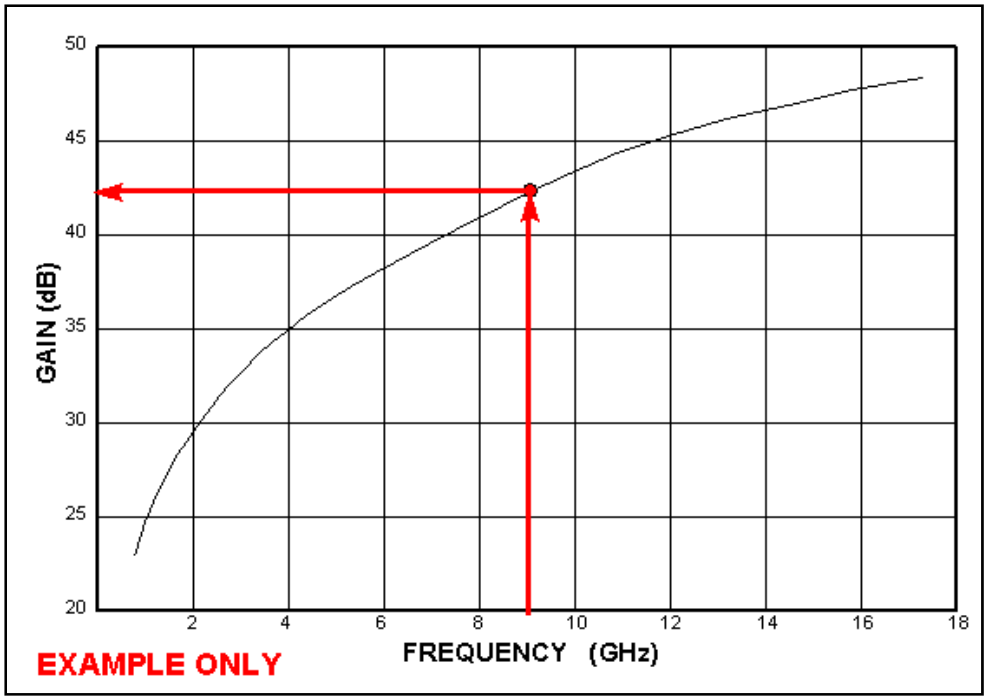

Figure 7. Gain of a Typical 6-Foot Dish Antenna (With Losses).

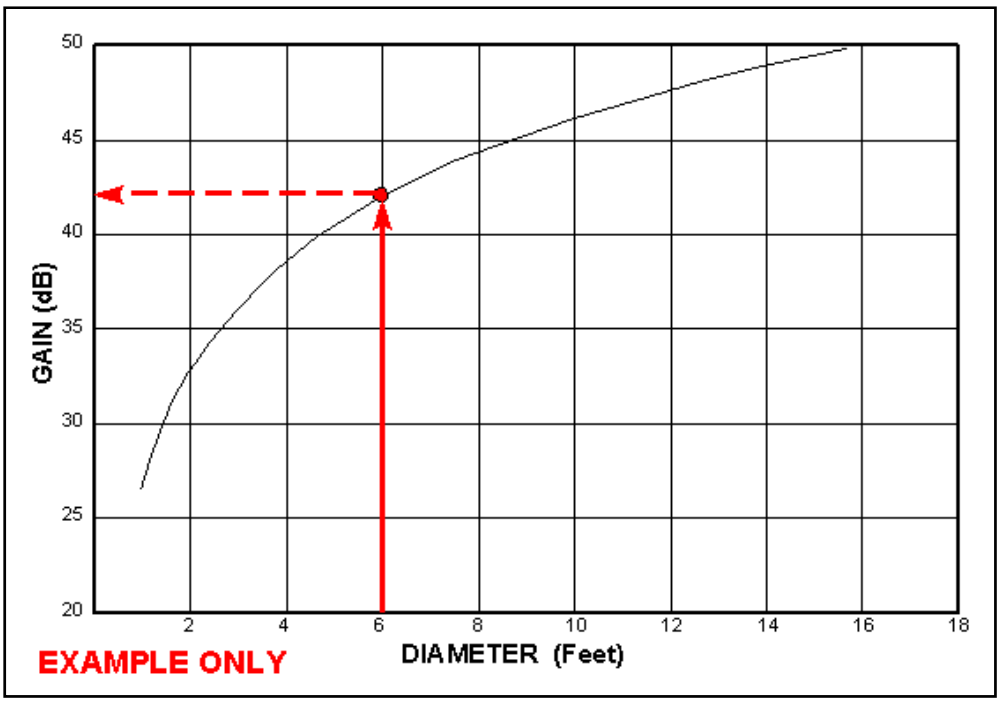

Figure 8. Gain of a Typical Dish at 9 GHz (With Losses).

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POLARIZATION

Table 1 shows the **theoretical** ratio of power transmitted between antennas of different polarization. These ratios are seldom fully achieved due to effects such as reflection, refraction, and other wave interactions, so some practical ratios are also included.

Table 1. Polarization Loss for Various Antenna Combinations.

Transmit Antenna Polarization	Receive Antenna Polarization	Ratio of Power Received to Maximum Power					
		Theoretical		Practical Horn		Practical Spiral	
		Ratio in dB	as Ratio	Ratio in dB	as Ratio	Ratio in dB	as Ratio
Vertical	Vertical	0 dB	1	*	*	N/A	N/A
Vertical	Slant (45° or 135°)	-3 dB	½	*	*	N/A	N/A
Vertical	Horizontal	- ∞ dB	0	-20 dB	1/100	N/A	N/A
Vertical	Circular (right-hand or left-hand)	-3 dB	½	*	*	*	*
Horizontal	Horizontal	0 dB	1	*	*	N/A	N/A
Horizontal	Slant (45° or 135°)	-3 dB	½	*	*	N/A	N/A
Horizontal	Circular (right-hand or left-hand)	-3 dB	½	*	*	*	*
Circular (right-hand)	Circular (right-hand)	0 dB	1	*	*	*	*
Circular (right-hand)	Circular (left-hand)	- ∞ dB	0	-20 dB	1/100	-10 dB	1/10
Circular (right or left)	Slant (45° or 135°)	-3 dB	½	*	*	*	*

* Approximately the same as theoretical.
Note: Switching transmit and receive antenna polarization will give the same results.

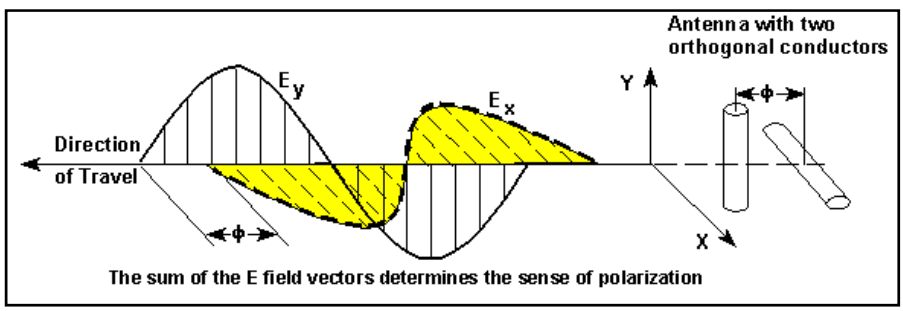

Figure 1. Polarization Coordinates.

The polarization of an electromagnetic wave is defined as the orientation of the electric field vector. Recall that the electric field vector is perpendicular to both the direction of travel and the magnetic field vector. The polarization is described by the geometric figure traced by the electric field vector upon a stationary plane perpendicular to the direction of propagation, as the wave travels through that plane. An electromagnetic wave is frequently composed of (or can be broken down into) two orthogonal components as shown in Figure 1. This may be due to the arrangement of power input leads to various points on a flat antenna, or due to an interaction of active elements in an array, or many other reasons.

The geometric figure traced by the sum of the electric field vectors over time is, in general, an ellipse as shown in Figure 2. Under certain conditions the ellipse may collapse into a straight line, in which case the polarization is called linear.

In the other extreme, when the two components are of equal magnitude and 90° out of phase, the ellipse will become circular as shown in Figure 3. Thus linear and circular polarization are the two special cases of elliptical polarization. Linear polarization may be further classified as being vertical, horizontal, or slant.

Figure 2 depicts plots of the E field vector while varying the relative amplitude and phase angle of its component parts.

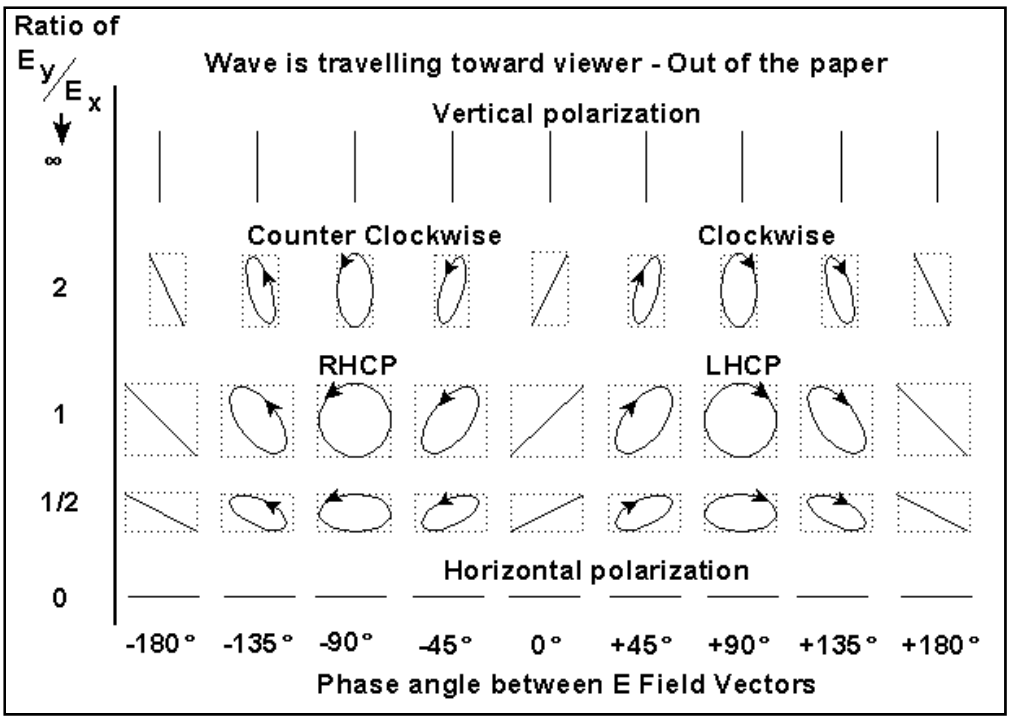

Figure 2. Polarization as a Function of E_y / E_x Ratio and Phase Angle.
Adopted from J.D. Kraus, "Antennas," 2nd ed., Figure 2-37

For a linearly polarized antenna, the radiation pattern is taken both for a co-polarized and cross polarized response. The polarization quality is expressed by the ratio of these two responses. The ratio between the responses must typically be great (30 dB or greater) for an application such as cross-polarized jamming. For general applications, the ratio indicates system power loss due to polarization mismatch. For circularly polarized antennas, radiation patterns are usually taken with a rotating linearly polarized reference antenna. The reference antenna rotates many times while taking measurements around the azimuth of the antenna that is being tested. The resulting antenna pattern is the linear polarized gain with a cyclic ripple. The peak-to-peak value is the axial ratio, and represents the polarization quality for a circular polarized antenna. The typical RWR antenna has a maximum 3 dB axial ratio within 45° of boresight.

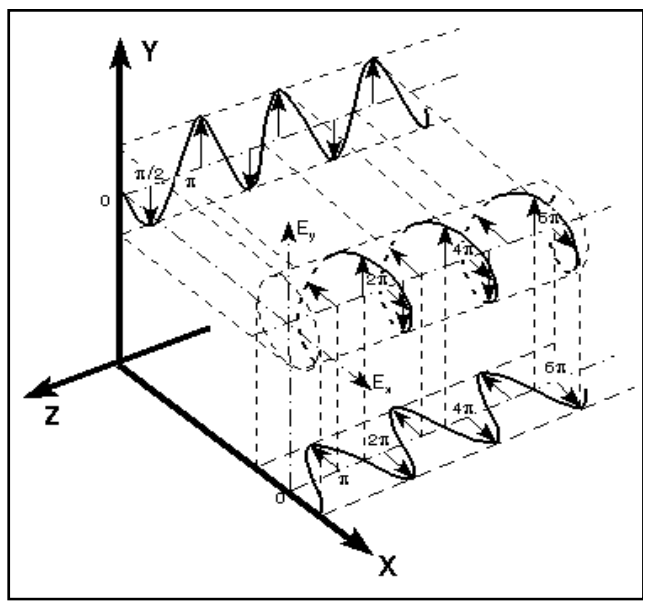

Figure 3. Circular Polarization – E Field.

For any antenna with an aperture area, as the aperture is rotated, the viewed dimension along the axis remains constant, while the other viewed dimension decreases to zero at 90° rotation. The axial ratio of an antenna will get worse as the antenna is rotated off boresight because the field contribution from the axial component will remain fairly constant and the other orthogonal component will decrease with rotation.

The sense of antenna polarization is defined from a viewer positioned behind an antenna looking in the direction of propagation. The polarization is specified as a transmitting, not receiving antenna regardless of intended use.

We frequently use "hand rules" to describe the sense of polarization. The sense is defined by which hand would be used in order to point that thumb in the direction of propagation and point the fingers of the same hand in the direction of rotation of the E field vector. For example, referring to Figure 4, if your thumb is pointed in the direction of propagation and the rotation is counterclockwise looking in the direction of travel, then you have left hand circular polarization.

Optics people view an aperture from the front and therefore use the opposite reference.

The polarization of a linearly polarized horn antenna can be directly determined by the orientation of the feed probe, which is in the direction of the E-field.

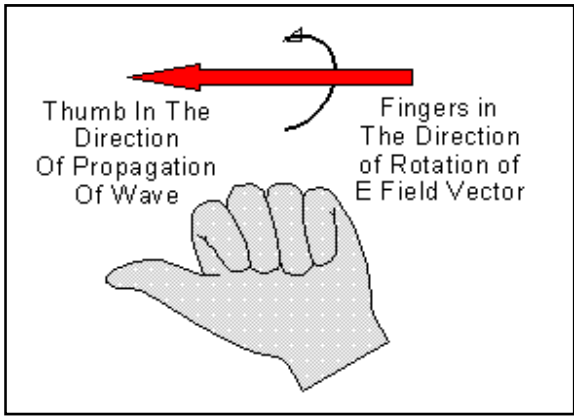

Figure 4. Left Hand Polarization.

In general, a flat surface or sphere will reflect a linearly polarized wave with the same polarization as received. A horizontally polarized wave may get extended range because of water and land surface reflections, but signal cancellation will probably result in "holes" in coverage. Reflections will reverse the sense of circular polarization.

If the desired antenna is used for receiving a direct transmission as shown in Figure 5, the same polarization sense (specified if transmitting) is required for maximum signal reception in this situation. Buy two right-hand or two left-hand circularly polarized antennas for this case. When you procure antennas, remember that the polarization is specified as if transmitting, regardless of intended use.

Wave propagation between two identical antennas is analogous to being able to thread a nut from one bolt to an identical opposite facing bolt.

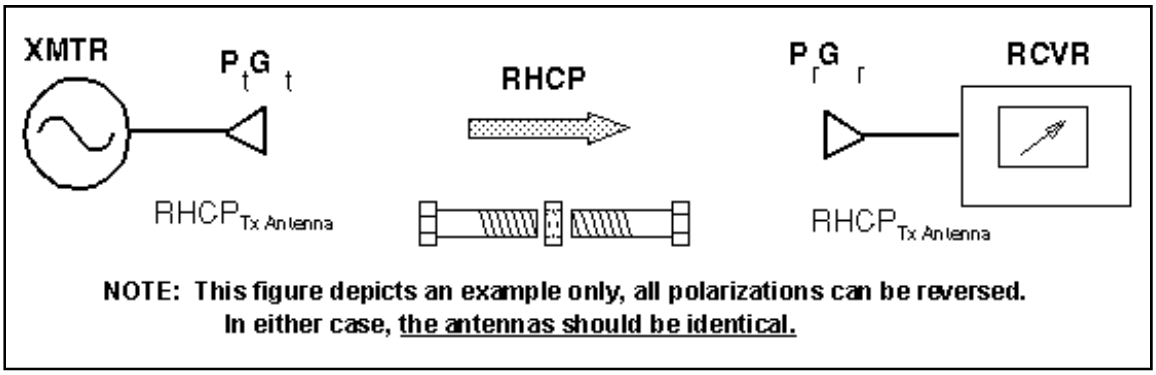

Figure 5. Same Circular Polarization.

If the desired antenna is used for a receiving a wave with a single or odd number of reflections, such as a bistatic radar where separate antennas are used for transmit and receive as shown in Figure 6, then opposite circularly polarized antennas would be used for maximum signal reception. In this case buy antennas of opposite polarization sense (one left hand and one right hand).

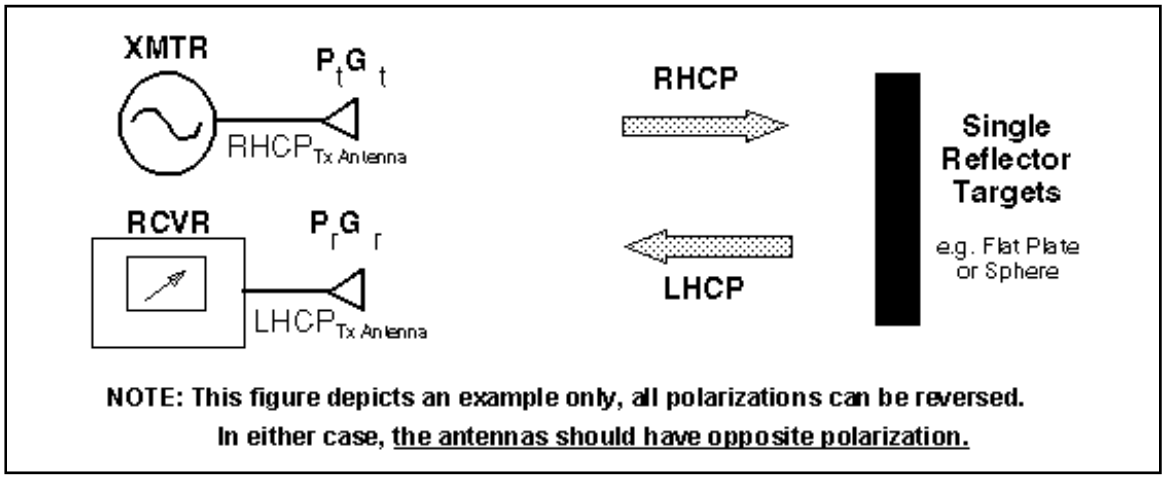

Figure 6. Opposite Circular Polarization.

In a corner reflector, waves reflect twice before returning to the receiver as shown in Figure 7, consequently they return with the same sense as they were transmitted. In this case (or any even number of reflections) buy antennas of the same polarization sense.

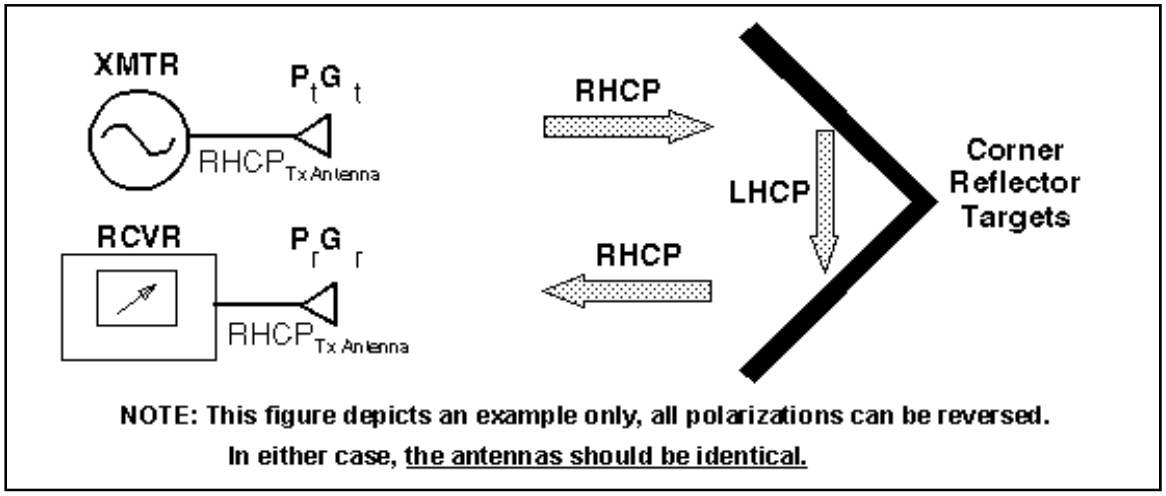

Figure 7. Circular Polarization With Corner Reflector.

An aircraft acts as both a corner reflector and a "normal" reflector so the return has mixed polarization. Most airborne radars use the same antenna for transmitting and receiving in order to receive the corner reflections and help exclude receipt of reflections from rain (single polarization reversal), however in doing so there is about a 5-9 dB loss from the ideal receiver case. It should be noted that the return from raindrops is attenuated by approximately 20 dB.

RADIATION PATTERNS

The radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. Antenna radiation patterns are taken at one frequency, one polarization, and one plane cut. The patterns are usually presented in polar or rectilinear form with a dB strength scale. Patterns are normalized to the maximum graph value, 0 dB, and a directivity is given for the antenna. This means that if the side lobe level from the radiation pattern were down -13 dB, and the directivity of the antenna was 4 dB, then the sidelobe gain would be -9 dB.

Figures 1 to 14 on the pages following depict various antenna types and their associated characteristics. The patterns depicted are those which most closely match the purpose for which the given shape was intended. In other words, the radiation pattern can change dramatically depending upon frequency, and the wavelength to antenna characteristic length ratio. See Section 3-4. Antennas are designed for a particular frequency. Usually the characteristic length is a multiple of λ/2 minus 2-15% depending on specific antenna characteristics.

The gain is assumed to mean directional gain of the antenna compared to an isotropic radiator transmitting to or receiving from all directions.

The half-power (-3 dB) beamwidth is a measure of the directivity of the antenna.

Polarization, which is the direction of the electric (not magnetic) field of an antenna is another important antenna characteristic. This may be a consideration for optimizing reception or jamming.

The bandwidth is a measure of how much the frequency can be varied while still obtaining an acceptable VSWR (2:1 or less) and minimizing losses in unwanted directions. See Glossary, Section 10.

A 2:1 VSWR corresponds to a 9.5 dB (or 10%) return loss - see Section 6-2.

Two methods for computing antenna bandwidth are used:

Narrowband by %, $B = \left(\frac{F_U - F_L}{F_C}\right)(100)$, where F_C = Center frequency

Broadband by ratio, $B = \frac{F_U}{F_L}$

An antenna is considered broadband if $F_U / F_L > 2$. The table at the right shows the equivalency of the two, however the shaded values are not normally used because of the aforementioned difference in broadband/narrowband.

Bandwidth	
%	Ratio
5	1.05 : 1
10	1.11 : 1
20	1.22 : 1
30	1.35 : 1
40	1.50 : 1
50	1.67 : 1
60	1.85 : 1
67	2 : 1
100	3 : 1
120	4 : 1
133	5 : 1
150	7 : 1
160	9 : 1
163	10 : 1

Should there be ever a need to express bandwidth of an antenna in one or the other alternative formats, a conversion between the two narrowband and broadband bandwidth quantities can be easily calculated using the following relationships:

Calculate broadband ratio B_{bb} given narrowband B%,

$$B_{bb} = (200 + B\%)/(200 - B\%) \quad \textbf{[1]}$$

Calculate narrowband B% given broadband ratio B_{bb},

$$B\% = 200 * (Bbb - 1)/(Bbb + 1) \quad \textbf{[2]}$$

For an object that experiences a plane wave, the resonant mode is achieved when the dimension of the object is nλ/2, where n is an integer. Therefore, one can treat the apertures shown in the following figure as half wave length dipole antennas for receiving and reflecting signals. More details are contained in Section 8-4.

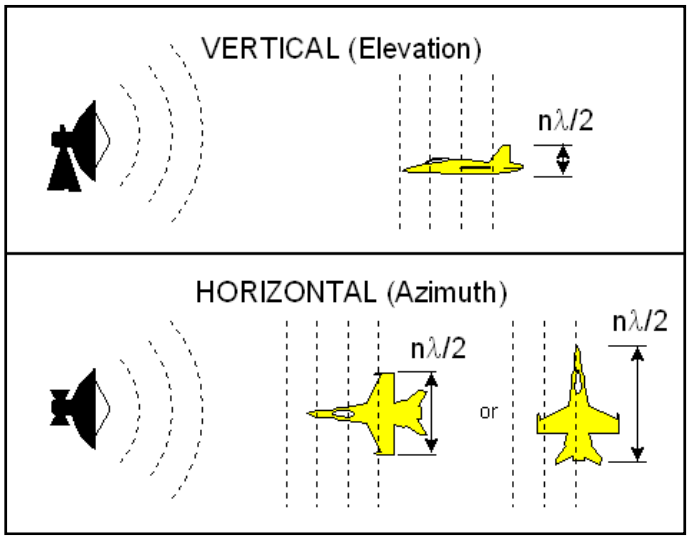

The following lists antenna types by page number. The referenced page shows frequency limits, polarizations, etc.

Type	Page	Type	Page
4 arm conical spiral	3-3.6	log periodic	3-3.8
alford loop	3-3.4	loop, circular	3-3.4
aperture synthesis	3-3.8	loop, alford	3-3.4
array	3-3.8	loop, square	3-3.4
axial mode helix	3-3.5	luneberg lens	3-3.9
biconical w/polarizer	3-3.6	microstrip patch	3-3.9
biconical	3-3.6	monopole	3-3.3
cavity backed circuit fed slot	3-3.5	normal mode helix	3-3.5
cavity backed spiral	3-3.9	parabolic	3-3.7
circular loop	3-3.4	patch	3-3.9
conical spiral	3-3.5	reflector	3-3.10
corner reflector	3-3.9	rhombic	3-3.3
dipole array, linear	3-3.8	sinuous, dual polarized	3-3.6
dipole	3-3.3	slot, guide fed	3-3.9
discone	3-3.4	slot, cavity backed	3-3.9
dual polarized sinuous	3-3.6	spiral, 4 arm conical	3-3.6
guide fed slot	3-3.9	spiral, conical	3-3.5
helix, normal mode	3-3.5	spiral, cavity backed	3-3.5
helix, axial mode	3-3.5	square loop	3-3.4
horn	3-3.7	vee	3-3.3
linear dipole array	3-3.8	yagi	3-3.8

Antenna Type	Radiation Pattern	Characteristics
MONOPOLE 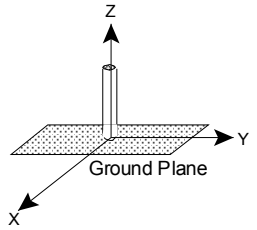 	Elevation: 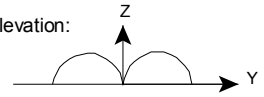 Azimuth: 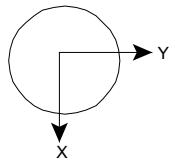 	**Polarization: Linear** Vertical as shown **Typical Half-Power Beamwidth** 45 deg x 360 deg **Typical Gain:** 2-6 dB at best **Bandwidth:** 10% or 1.1:1 **Frequency Limit** **Lower:** None **Upper:** None **Remarks:** Polarization changes to horizontal if rotated to horizontal
λ/2 DIPOLE 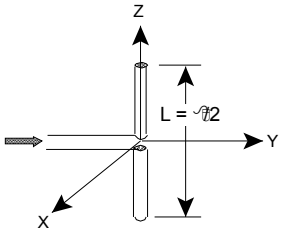 	Elevation: 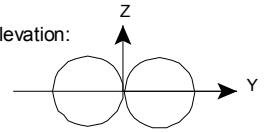 Azimuth: 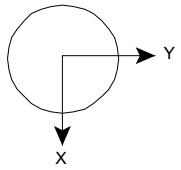 	**Polarization**: Linear Vertical as shown **Typical Half-Power Beamwidth** 80 deg x 360 deg **Typical Gain:** 2 dB **Bandwidth:** 10% or 1.1:1 **Frequency Limit** **Lower:** None **Upper:** 8 GHz (practical limit) **Remarks:** Pattern and lobing changes significantly with L/f. Used as a gain reference < 2 GHz.

Figure 1. Monopole and Dipole Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
VEE 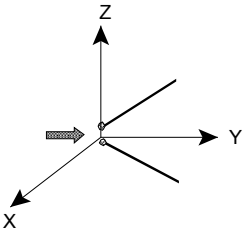 	Elevation & Azimuth: 	**Polarization**: Linear Vertical as shown **Typical Half-Power Beamwidth** 60 deg x 60 deg **Typical Gain:** 2 to 7 dB **Bandwidth:** "Broadband" **Frequency Limit** **Lower:** 3 MHz **Upper:** 500 MHz (practical limits) **Remarks:** 24KHz versions are known to exist. Terminations may be used to reduce backlobes.
RHOMBIC 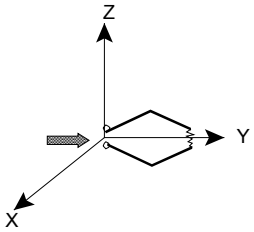 	Elevation & Azimuth: 	**Polarization**: Linear Vertical as shown **Typical Half-Power Beamwidth** 60 deg x 60 deg **Typical Gain:** 3 dB **Bandwidth:** "Broadband" **Frequency Limit** **Lower:** 3 MHz **Upper:** 500 MHz **Remarks:** Termination resistance used to reduce backlobes.

Figure 2. Vee and Rhombic Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
CIRCULAR LOOP (Small) 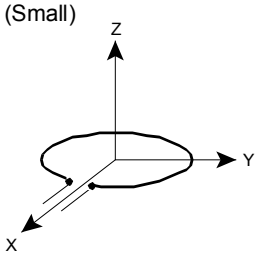	Elevation: 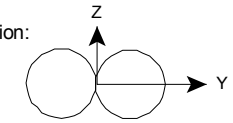 Azimuth: 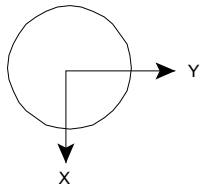	**Polarization:** Linear Horizontal as shown **Typical Half-Power Beamwidth:** 80 deg x 360 deg **Typical Gain:** -2 to 2 dB **Bandwidth:** 10% or 1.1:1 **Frequency Limit:** **Lower:** 50 MHz **Upper:** 1 GHz
SQUARE LOOP (Small) 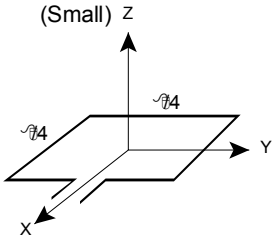	Elevation: 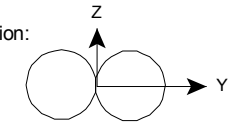 Azimuth: 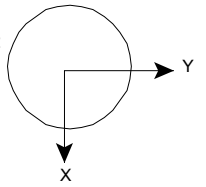	**Polarization:** Linear Horizontal as shown **Typical Half-Power Beamwidth:** 100 deg x 360 deg **Typical Gain:** 1-3 dB **Bandwidth:** 10% or 1.1:1 **Frequency Limit:** **Lower:** 50 MHz **Upper:** 1 GHz

Figure 3. Circular Loop and Square Loop Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
DISCONE 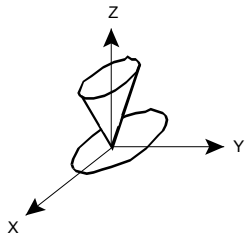	Elevation: 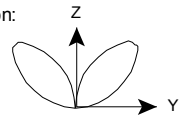 Azimuth: 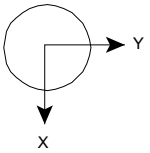	**Polarization:** Linear Vertical as shown **Typical Half-Power Beamwidth:** 20-80 deg x 360 deg **Typical Gain:** 0-4 dB **Bandwidth:** 100% or 3:1 **Frequency Limit:** **Lower:** 30 MHz **Upper:** 3 GHz
ALFORD LOOP 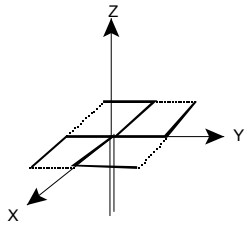	Elevation: 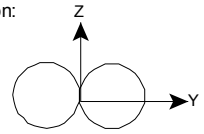 Azimuth: 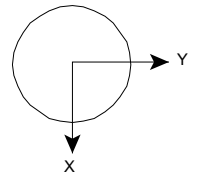	**Polarization:** Linear Horizontal as shown **Typical Half-Power Beamwidth:** 80 deg x 360 deg **Typical Gain:** -1 dB **Bandwidth:** 67% or 2:1 **Frequency Limit:** **Lower:** 100 MHz **Upper:** 12 GHz

Figure 4. Discone and Alford Loop Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
AXIAL MODE HELIX 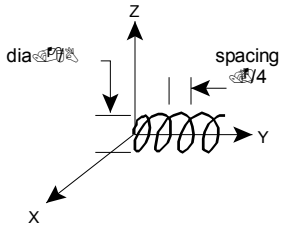 	Elevation & Azimuth 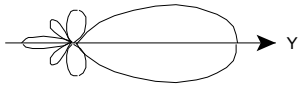 	**Polarization:** Circular Left hand as shown **Typical Half-Power Beamwidth:** 50 deg x 50 deg **Typical Gain:** 10 dB **Bandwidth:** 52% or 1.7:1 **Frequency Limit** **Lower:** 100 MHz **Upper:** 3 GHz **Remarks:** Number of loops >3
NORMAL MODE HELIX 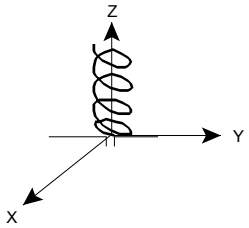 	Elevation: 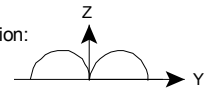 Azimuth: 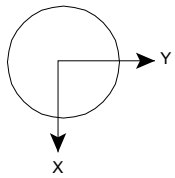 	**Polarization:** Circular - with an ideal pitch to diameter ratio. **Typical Half-Power Beamwidth:** 60 deg x 360 deg **Typical Gain:** 0 dB **Bandwidth:** 5% or 1.05:1 **Frequency Limit** **Lower:** 100 MHz **Upper:** 3 GHz

Figure 5. Axial Mode Helix and Normal Mode Helix Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
CAVITY BACKED SPIRAL (Flat Helix) 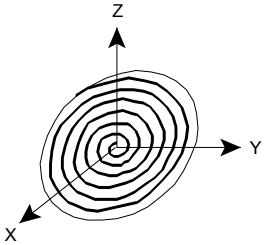 	Elevation & Azimuth 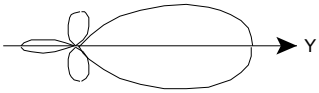 	**Polarization:** Circular Left hand as shown **Typical Half-Power Beamwidth:** 60 deg x 90 deg **Typical Gain:** 2-4 dB **Bandwidth:** 160% or 9:1 **Frequency Limit:** **Lower:** 500 MHz **Upper:** 18 GHz
CONICAL SPIRAL 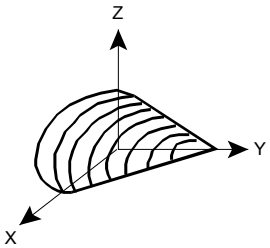 	Elevation & Azimuth 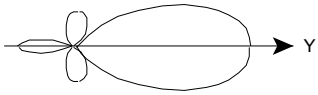 	**Polarization:** Circular Left hand as shown **Typical Half-Power Beamwidth:** 60 deg x 60 deg **Typical Gain:** 5-8 dB **Bandwidth:** 120% or 4:1 **Frequency Limit:** **Lower:** 50 MHz **Upper:** 18 GHz

Figure 6. Cavity Backed Spiral and Conical Spiral Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
4 ARM CONICAL SPIRAL 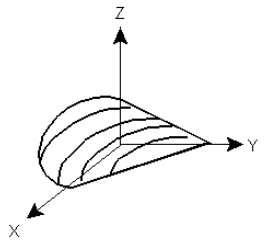	Elevation: 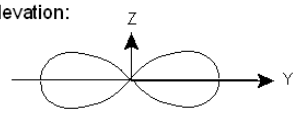 Azimuth: 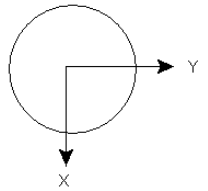	**Polarization:** Circular Left hand as shown **Typical Half-Power Beamwidth:** 50 deg x 360 deg **Typical Gain:** 0 dB **Bandwidth:** 120% or 4:1 **Frequency Limit:** **Lower:** 500 MHz **Upper:** 18 GHz
DUAL POLARIZED SINUOUS 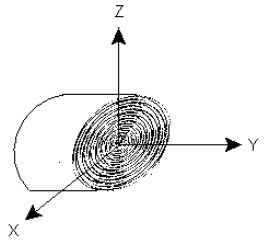	Elevation & Azimuth 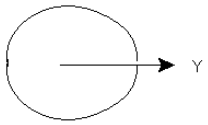	**Polarization**: Dual vertical or horizontal or dual Circular right hand or left hand with hybrid **Typical Half-Power Beamwidth:** 75 deg x 75 deg **Typical Gain:** 2 dB **Bandwidth:** 163% or 10:1 **Frequency Limit:** **Lower:** 500 MHz **Upper:** 18 GHz

Figure 7. Dual Polarized Sinuous Antenna Characteristics and 4 Arm Conical Spiral.

Antenna Type	Radiation Pattern	Characteristics
BICONICAL 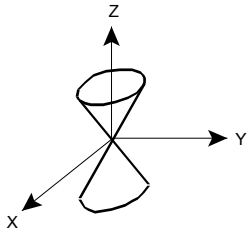	Elevation: 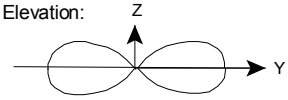 Azimuth: 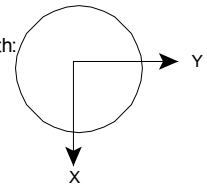	**Polarization:** Linear, Vertical as shown **Typical Half-Power Beamwidth:** 20-100 deg x 360 deg **Typical Gain:** 0-4 dB **Bandwidth:** 120% or 4:1 **Frequency Limit:** **Lower:** 500 MHz **Upper:** 40 GHz
BICONICAL W/POLARIZER 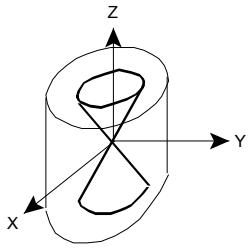	Elevation: 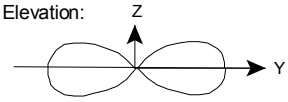 Azimuth: 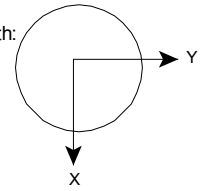	**Polarization:** Circular, Direction depends on polarization **Typical Half-Power Beamwidth:** 20-100 deg x 360 deg **Typical Gain:** -3 to 1 dB **Bandwidth:** 100% or 3:1 **Frequency Limit:** **Lower:** 2 GHz **Upper:** 18 GHz

Figure 8. Biconical and Biconical With Polarizer Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
HORN 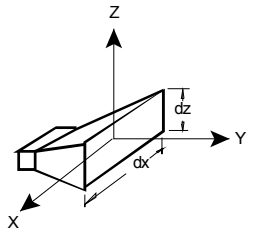 	Elevation: 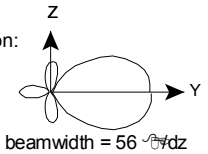 3 dB beamwidth = 56 ~ dz Azimuth: 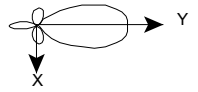 3 dB beamwidth = 70 ~ dx	**Polarization:** Linear **Typical Half-Power Beamwidth:** 40 deg x 40 deg **Typical Gain:** 5 to 20 dB **Bandwidth:** If ridged: 120% or 4:1 If not ridged: 67% or 2:1 **Frequency Limit:** **Lower:** 50 MHz **Upper:** 40 GHz
HORN W / POLARIZER 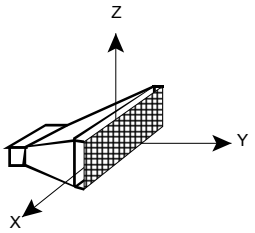 	Elevation: 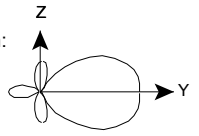 Azimuth: 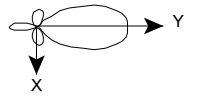 	**Polarization:** Circular, Depends on polarizer **Typical Half-Power Beamwidth:** 40 deg x 40 deg **Typical Gain:** 5 to 10 dB **Bandwidth:** 60% or 2:1 **Frequency Limit:** **Lower:** 2 GHz **Upper:** 18 GHz

Figure 9. Horn and Horn w/Polarizer Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
PARABOLIC (Prime) 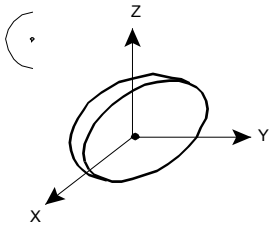 	Elevation & Azimuth 	**Polarization:** Takes polarization of feed **Typical Half-Power Beamwidth:** 1 to 10 deg **Typical Gain:** 20 to 30 dB **Bandwidth:** 33% or 1.4:1 limited mostly by feed **Frequency Limit:** **Lower:** 400 MHz **Upper:** 13+ GHz
PARABOLIC 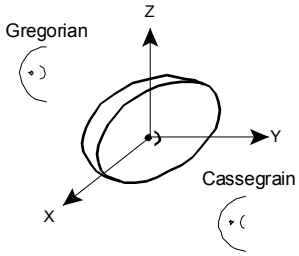 	Elevation & Azimuth 	**Polarization:** Takes polarization of feed **Typical Half-Power Beamwidth:** 1 to 10 deg **Typical Gain:** 20 to 30 dB **Bandwidth:** 33% or 1.4:1 **Frequency Limit:** **Lower:** 400 MHz **Upper:** 13+ GHz

Figure 10. Parabolic (Prime) and Parabolic Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
YAGI 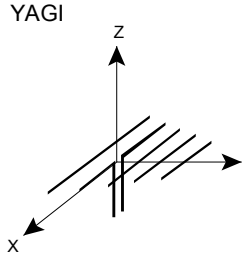	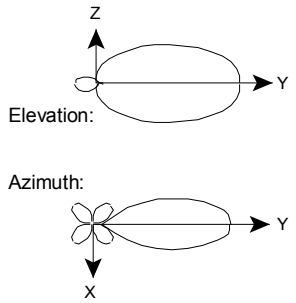	**Polarization:** Linear Horizontal as shown **Typical Half-Power Beamwidth** 50 deg X 50 deg **Typical Gain:** 5 to 15 dB **Bandwidth:** 5% or 1.05:1 **Frequency Limit:** **Lower:** 50 MHz **Upper:** 2 GHz
LOG PERIODIC 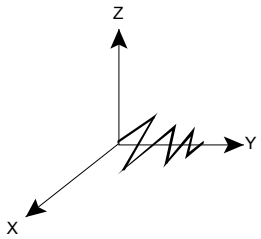	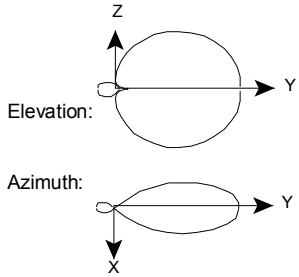	**Polarization:** Linear **Typical Half-Power Beamwidth:** 60 deg x 80 deg **Typical Gain:** 6 to 8 dB **Bandwidth:** 163% or 10:1 **Frequency Limit:** **Lower:** 3 MHz **Upper:** 18 GHz **Remarks:** This array may be formed with many shapes including dipoles or toothed arrays.

Figure 11. Yagi and Log Periodic Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
LINEAR DIPOLE ARRAY (Corporate Feed) 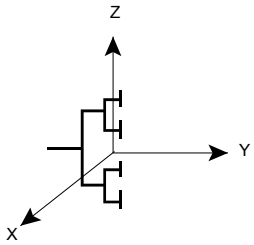	Elevation: 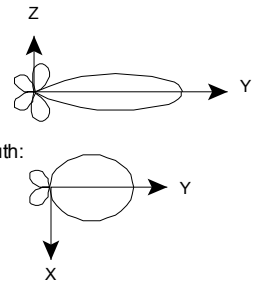	**Polarization:** Element dependent Vertical as shown **Typical Half-Power Beamwidth:** Related to gain **Typical Gain:** Dependent on number of elements **Bandwidth:** Narrow **Frequency Limit:** **Lower:** 10 MHz **Upper:** 10 GHz
APERTURE SYNTHESIS 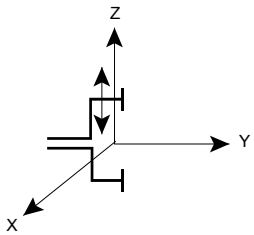	**Elevation & Azimuth** 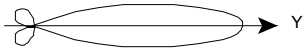	All characteristics dependent on elements **Remarks:** Excellent side-looking, ground mapping where the aircraft is a moving linear element.

Figure 12. Linear Dipole Array and Aperture Synthesis Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
CAVITY BACKED CIRCUIT FED SLOT (and Microstrip Patch) 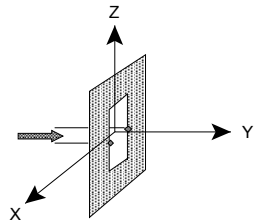 	Elevation & Azimuth 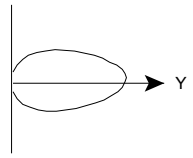 	**Polarization:** Linear, vertical as shown **Typical Half-Power Beamwidth**: 80 deg x 80 deg **Typical Gain:** 6 dB **Bandwidth:** Narrow **Frequency Limit:** **Lower:** 50 MHz **Upper:** 18 GHz **Remarks:** The feed line is sometimes separated from the radiator by a dialetric & uses capacititive coupling. Large conformal phased arrays can be made this way.
GUIDE FED SLOT 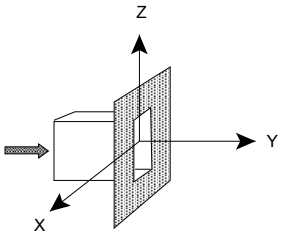 	Elevation: 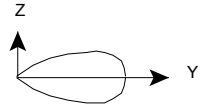 Azimuth: 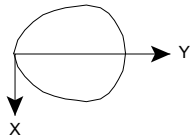 	**Polarization:** Linear, **Typical Half-Power Beamwidth** Elevation: 45-50° Azimuth: 80° **Typical Gain:** 0 dB **Bandwidth:** Narrow **Frequency Limit:** **Lower:** 2 GHz **Upper:** 40 GHz **Remarks:** Open RF Waveguide

Figure 13. Cavity Backed Circuit Fed Slot and Guide Fed Slot Antenna Characteristics.

Antenna Type	Radiation Pattern	Characteristics
CORNER REFLECTOR 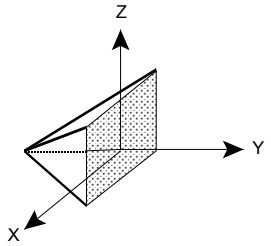 	Elevation: (Z-Y) Azimuth: (X-Y) Dependent upon feed emitter	**Polarization**: Feed dependent **Typical Half-Power Beamwidth** 40 deg x variable **Typical Gain:** 10 dB above feed **Bandwidth:** Narrow **Frequency Limit** **Lower:** 1 GHz **Upper:** 40 GHz **Remarks:** Typically fed with a dipole or colinear array.
LUNEBURG LENS 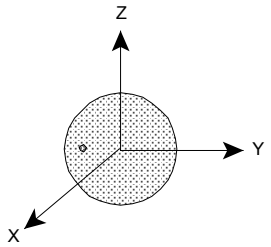 	Elevation & Azimuth 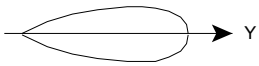 	**Polarization:** Feed dependent **Typical Half-Power Beamwidth:** System dependent **Typical Gain:** System dependent **Bandwidth:** Narrow **Frequency Limit** **Lower:** 1 GHz **Upper:** 40 GHz **Remarks:** Variable index dielectric sphere.

Figure 14. Corner Reflector and Luneburg Lens Antenna Characteristics.

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FREQUENCY / PHASE EFFECTS OF ANTENNAS

The radiation patterns of the antennas presented in the previous section are for antenna geometries most commonly used. The antenna should be viewed as a matching network that takes the power from a transmission line (50 ohm, for example), and matches it to the free space "impedance" of 377 ohms. The most critical parameter is the change of VSWR with frequency. The pattern usually does not vary much from acceptable to the start of unacceptable VSWRs (> 2:1). For a given physical antenna geometric size, the actual radiation pattern varies with frequency.

The antenna pattern depicted in Figure 1 is for the dipole pictured in Section 3-3. The maximum gain is normalized to the outside of the polar plot and the major divisions correspond to 10 dB change. In this example, the dipole length (in wavelengths) is varied, but the same result can be obtained by changing frequency with a fixed dipole length. From the figure, it can be seen that side lobes start to form at 1.25λ and the side lobe actually has more gain than the main beam at 1.5λ. Since the radiation pattern changes with frequency, the gain also changes.

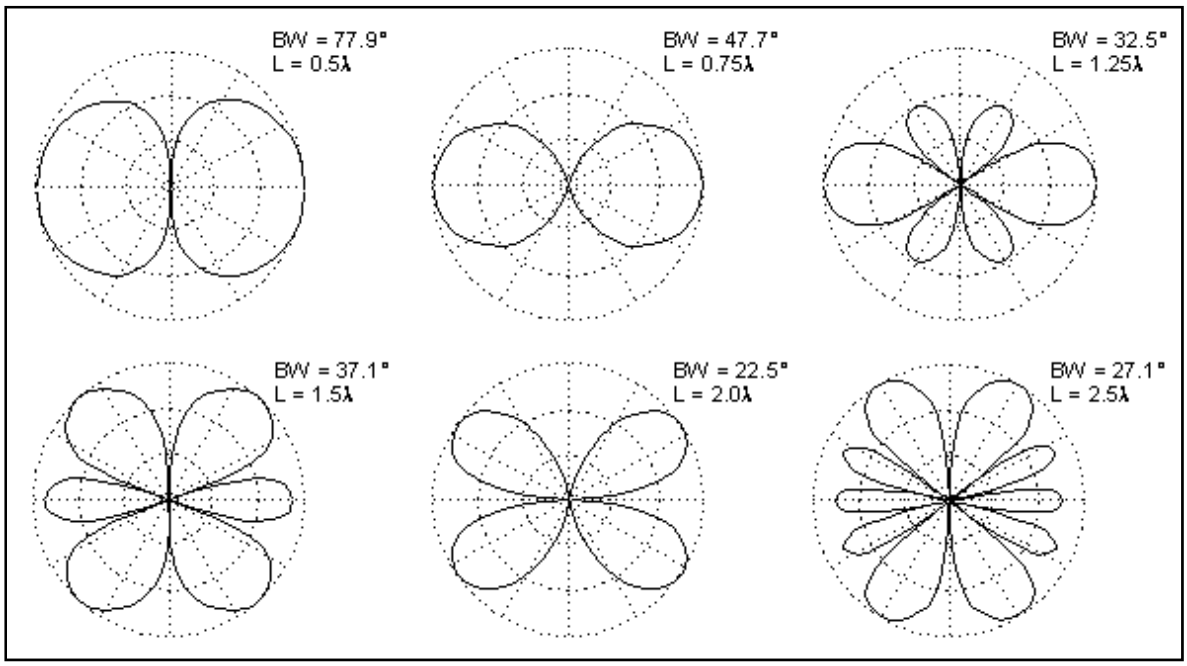

Figure 1. Frequency Effects.

Figure 2 depicts phase/array effects, which are yet another method for obtaining varied radiation patterns. In the figure, parallel dipoles are viewed from the end. It can be seen that varying the phase of the two transmissions can cause the direction of the radiation pattern to change. This is the concept behind phased array antennas. Instead of having a system mechanically sweeping the direction of the antenna through space, the phase of radiating components is varied electronically, producing a moving pattern with no moving parts. It can also be seen that increasing the number of elements further increases the directivity of the array. In an array, the pattern does vary considerably with frequency due to element spacing (measured in wavelengths) and the frequency sensitivity of the phase shifting networks.

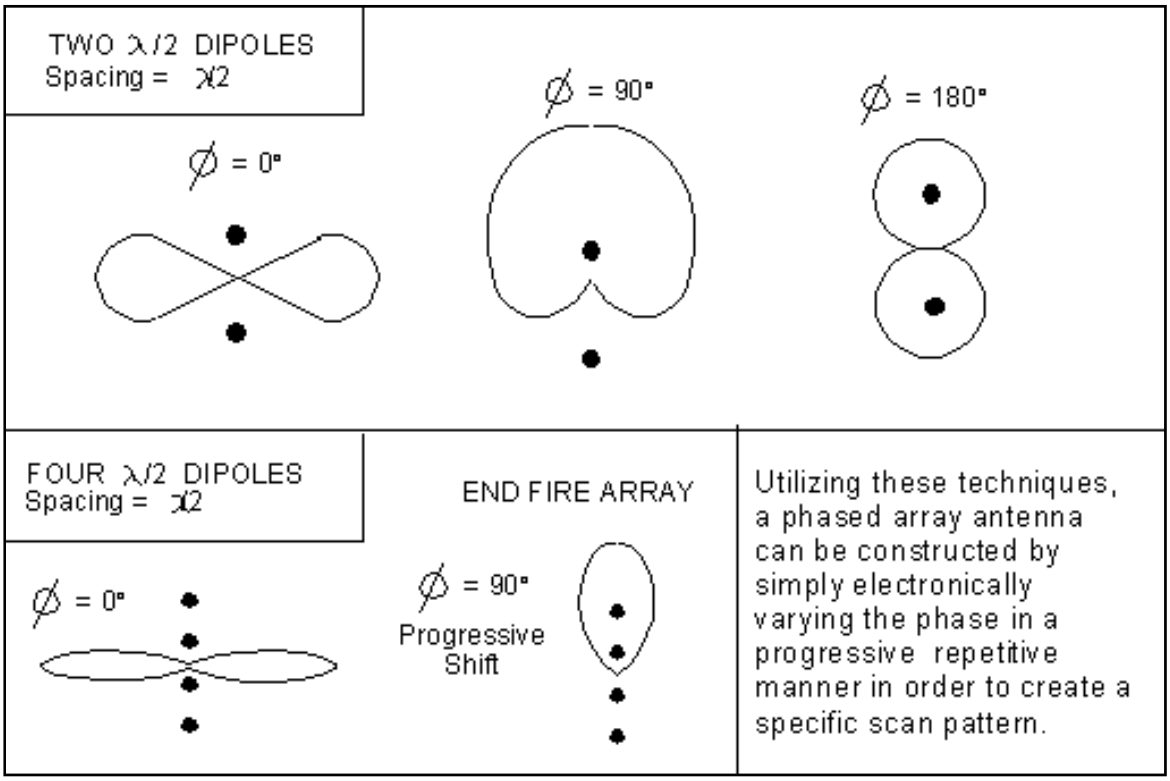

Figure 2. Phase / Array Effects*.

* Note: Assuming Figure 2 depicts x-y plane antenna pattern cross section, to achieve the indicated array patterns using dipole antennas, the dipole antenna elements must be aligned with the z-axis.

Two antennas that warrant special consideration are the phased array and the Rotman bootlace type lens. Both of these antennas find wide application in EW, RADAR, and Communications. The phased array will be described first.

LINEAR PHASED ARRAY

The linear phased array with equal spaced elements is easiest to analyze and forms the basis for most array designs. Figure 3 schematically illustrates a corporate feed linear array with element spacing d.

It is the simplest and is still widely used. By controlling the phase and amplitude of excitation to each element, as depicted, we can control the direction and shape of the beam radiated by the array. The phase excitation, $\varphi(n)$, controls the beam pointing angle, θ_o, in a phased array. To produce a broadside beam, $\theta_o=0$, requires phase excitation, $\varphi(n)=0$. Other scan angles require an excitation, $\varphi(n) = nkd \sin(\theta_o)$, for the nth element where k is the wave number ($2\pi/\lambda$). In this manner a linear phased array can radiate a beam in any scan direction, θ_o, provided the element pattern has sufficient beamwidth. The amplitude excitation, A_n, can be used to control beam shape and sidelobe levels. Often the amplitude excitation is tapered in a manner similar to that used for aperture antennas to reduce the sidelobe levels. One of the problems that can arise with a phased array is insufficient bandwidth, since the phase shift usually is not obtained through the introduction of additional path length. However, it should be noted that at broadside the corporate feed does have equal path length and would have good bandwidth for this scan angle.

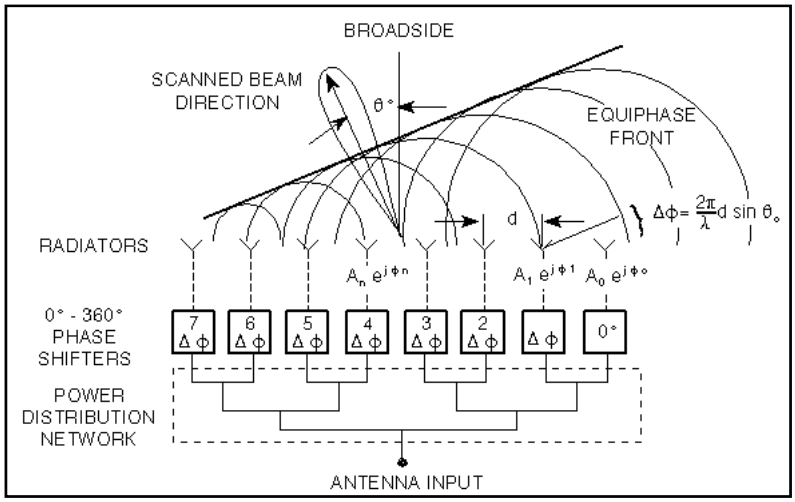

Figure 3. Corporate Fed Phased Array.

The linear array described above would yield a narrow fan beam in the plane normal to the plane containing the array and scan direction, with the narrow beamwidth in the plane of the array. To obtain a pencil beam it would be necessary to array several of these linear arrays in such a manner resulting in a planar array of radiating elements. A problem associated with all electronic scanning is beam distortion with scan angle. Figure 4 illustrates this phenomenon. It results in spread of the beam shape with a concomitant reduction in gain. This effect is known as "scan loss." For an ideal array element, scan loss is equal to the reduction in aperture size in the scan direction which varies as $\cos\theta$, where θ is the scan angle measured from the planar array normal.

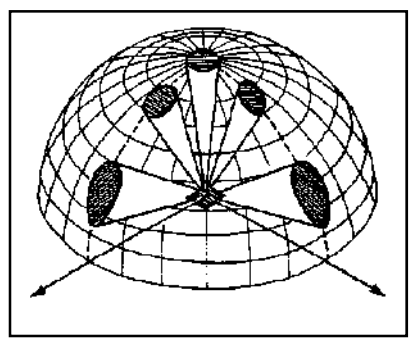

Figure 4. Beam Distortion.

When elements are spaced greater than $\lambda/2$ apart, grating lobes are possible when scanning. As the beam is scanned further from broadside, a point is reached at which a second symmetrical main lobe is developed at the negative scan angle from broadside. This condition is not wanted because antenna gain is immediately reduced by 3 dB due to the second lobe. Grating lobes are a significant problem in EW applications because the broad frequency bandwidth requirements mean that at the high end of the frequency band, the elements may be spaced greater than $\lambda/2$. Therefore in order to avoid grating lobes over a large frequency bandwidth, element spacing must be no greater than $\lambda/2$ at the highest frequency of operation.

There are many other factors to consider with a phased array such as coning, where the beam curves at large scan angles, and mutual coupling between elements that affect match and excitation. Excessive

mutual coupling will invariably result in blind scan angles where radiation is greatly attenuated. These issues will not be covered in detail here.

Of interest is the gain of the array which is given by:

$$Array\ Gain = G_e(\theta) \bullet \sum_{n=1}^{N} A(n)\, e^{j\phi(n)}\, e^{jnkd\sin\theta}$$ Where each element is as described in Section 3-4.

$G_e(\theta)$ is the element gain which in this case has been taken the same for all elements. Note that if we set A(n)=1, and $\varphi(n)=0$, then at broadside where $\sin(\theta) = 0$, the gain would be ($N\ G_e$). This represents the maximum gain of the array, which typically will not exceed $n\pi$, and is a familiar figure. It should be noted that in practical array design, the element pattern characteristics are greatly influenced by mutual coupling and that the characteristic of elements at the edge of the array can deviate significantly from those near the center.

ROTMAN BOOTLACE LENS

Another method of feeding an array of elements is to use a lens such as the Rotman (rhymes with rotten) Bootlace type shown in Figure 5. The lens consists of a parallel plate region (nowadays microstrip or stripline construction) and cables of specified length connecting the array of elements to the parallel plate region. The geometry of the lens and the cable lengths are designed so that all ray paths traced from a beam port on the right side to its associated wavefront on the left array port side, are equal. This tailoring of the design is accomplished at three focus points (beam ports 1, 4, and 7 in Figure 5). Departure from perfect focus at intermediate beam ports is negligible in most designs.

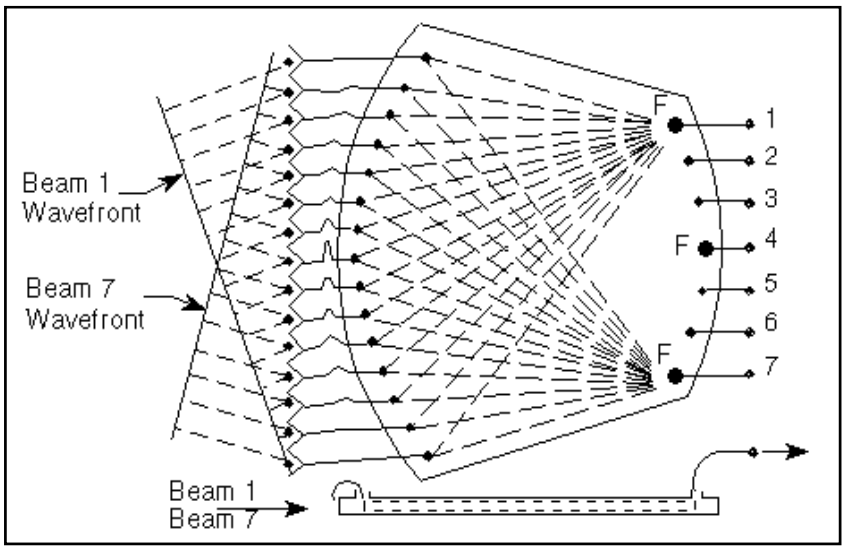

Figure 5. Rotman Bootlace Lens.

The Rotman lens provides both true time delay phase shift and amplitude taper in one lens component. The true time delay is one of the distinct advantages of the lens over the phase shifted array since that makes it independent of frequency. To understand how the taper is obtained requires knowledge of the parallel plate region. For a stripline design the unit would consist of a large flat plate-like center conductor sandwiched between two ground planes, and having a shape much like that of the plan view outline shown in Figure 5 with individual tapered launchers (connectors) attached to each beam port and array port. If the antenna is in the receive mode, the energy intercepted on the array port side can be controlled by the angle subtended by the tapered sections of the connector (launcher) much like a larger antenna would intercept a larger portion of energy from free space.

Unlike the phased array with its fine beam steering, the Rotman lens provides only a distinct set of beams. Fine steering is obtained by combining beams either equally or unequally to form intermediate beams. As can be seen in Figure 6, this results in a broader beam with less gain but lower side lobes than the primary beams.

High transmit power can be obtained using a Rotman lens by placing a low power amplifier between each lens output port and its antenna. In this case a separate Rotman lens would have to be used for receiving.

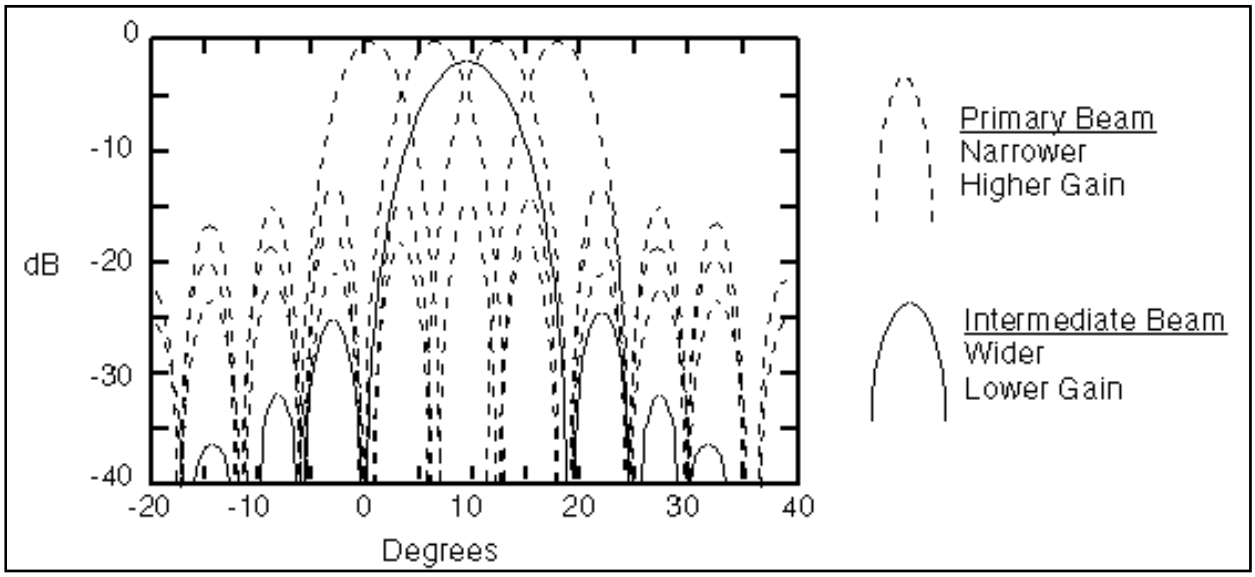

Figure 6. Primary and Intermediate Beam Formation in Lens Arrays.

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ANTENNA NEAR FIELD

As noted in the sections on RF propagation and the radar equation, electromagnetic radiation expands spherically (Figure 1) and the power density at a long range (R) from the transmitting antenna is:

$$P_D = \frac{P_t G_t}{4\pi R^2} \qquad \textbf{[1]}$$

When the range is large, the spherical surface of uniform power density appears flat to a receiving antenna which is very small compared to the surface of the sphere. This is why the far field wave front is considered planar and the rays approximately parallel. Also, it is apparent that at some shorter range, the spherical surface no longer appears flat, even to a very small receiving antenna.

The planer, parallel ray approximation is valid for distances greater than the distance where the phase error is 1/16 of a wavelength or 22.5 degrees. This distance is given by

$$R_{ff} = \frac{2D^2}{\lambda}$$ where λ is the wavelength and D is the largest dimension of the transmit antenna. **[2]**

Antenna measurements made at distances greater than R_{ff} generally result in negligible pattern error. Distances less than R_{ff} is termed the near-field.

If the same size antenna is used for multiple frequencies, R_{ff} will increase with increasing frequency. However, if various size antennas are used for different frequencies and each antenna is designed with D as a function of λ (λ/2 to 100λ), then R_{ff} will vary from c/2*f* to 20000c/*f*. In this case R_{ff} will decrease with increasing frequency. For example: a 10λ antenna at 3 GHZ has a D of 100 cm and corresponding R_{ff} of 20 m, while a 10λ antenna at 30 GHz has a D of 10 cm and corresponding R_{ff} of 2 m.

While the above analogy provides an image of the difference between the near and far fields, the relationship must be defined as a characteristic of the transmitting antenna.

Actual antennas, of course, are not ideal point source radiators but have physical dimensions. If the transmitting antenna placed at the origin of Figure 1 occupies distance D along the Z-axis and is boresighted along the Y-axis (φ = 90), then the geometry of point P on the sphere is represented in two dimensions by Figure 2. For convenience, the antenna is represented by a series of point sources in an array.

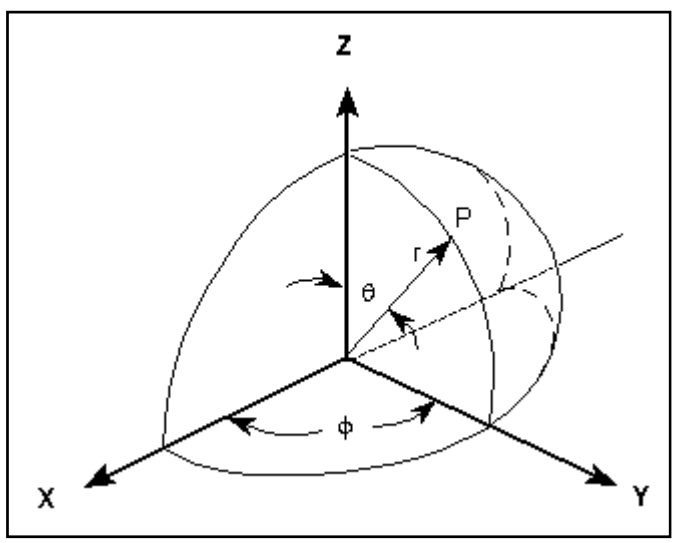

Figure 1. Spherical Radiation to Point "P" from an Ideal Point Source.

When point P is close to the antenna, as in Figure 2, then the difference in distance of the two rays r and R taken respectively from the center of the antenna and the outer edge of the antenna varies as point P changes.

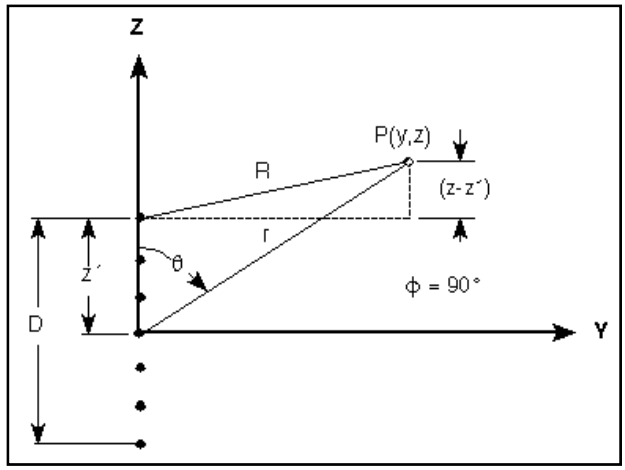

Figure 2. Near Field Geometry of Point "P" for a Non-Ideal Radiator With Dimension D.

Derivation of equation [2] is given as follows:

From Figure 2, the following applies:

$r^2 = z^2 + y^2$ **[3]**

$z = r \cos \theta$ **[4]**

$y = r \sin \theta$ and **[5]**

$$R = \sqrt{y^2 + (z - z')^2} = \sqrt{y^2 + z^2 - 2z'z + (z')^2} \quad \textbf{[6]}$$

Substituting [3] and [4] into [6] $R = \sqrt{r^2 + [-2(r \cos \theta)z' + (z')^2]}$ **[7]**
which puts point P into spherical coordinates.

Equation [7] can be expanded by the binomial theorem which for the first three terms, reduces to:

$$R = r - z' \cos \theta + \frac{(z')^2 \sin^2 \theta}{2r} + ... \quad \textbf{[8]}$$

In the parallel ray approximation for far field calculations (Figure 3) the third term of [8] is neglected.

The distance where the far field begins (R_{ff}) (or where the near field ends) is the value of r when the error in R due to neglecting the third term of equation [8], equals 1/16 of a wavelength.

R_{ff} is usually calculated on boresight, so θ = 90° and the second term of equation [8] equals zero (Cos 90° = 0), therefore from Figure 3, where D is the antenna dimension, R_{ff} is found by equating the third term of [8] to 1/16 wavelength.

$$\frac{(z')^2 \sin^2 \theta}{2 R_{ff}} = \frac{\lambda}{16}$$

$\text{Sin}\,\theta = \text{Sin}\,90 = 1$ *and* $z' = D/2$ so: $\dfrac{\left(\frac{D}{2}\right)^2}{2 R_{ff}} = \dfrac{\lambda}{16}$

$$R_{ff} = \frac{16(D/2)^2}{2\lambda} = \frac{2D^2}{\lambda} \quad \textbf{[9]}$$

Equation [9] is the standard calculation of far field given in all references.

Besides [9] some general rules of thumb for far field conditions are:

$$r >> D \quad \text{or} \quad r >> \lambda$$

If the sphere and point P are a very great distance from the antenna, then the rays are very nearly parallel and this difference is small as in Figure 3.

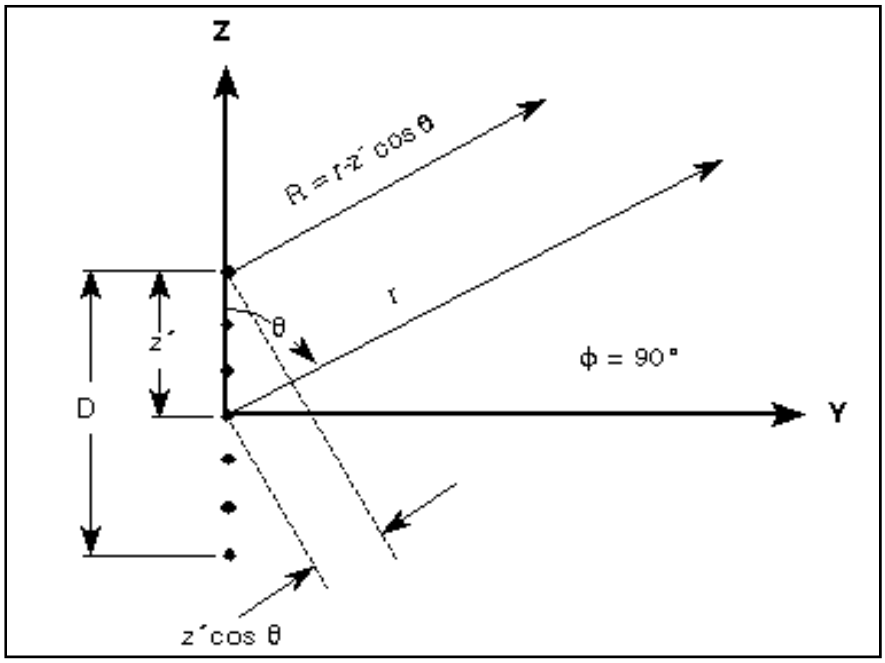

Figure 3. Far Field Parallel Ray Approximation for Calculations.

For reference purposes, a simplified alternative method to derive minimum far field distance approximation for an antenna or an antenna array with aperture size "d" is presented in Figure 4 without the need to resort to the spherical coordinate system and the Binomial Theorem. This approach illustrates a simple application of the Pythagorean Theorem. The P_{FF} symbol represents an arbitrary point in the far field at antenna boresight. Refer to relevant quantities shown in Figure 4.

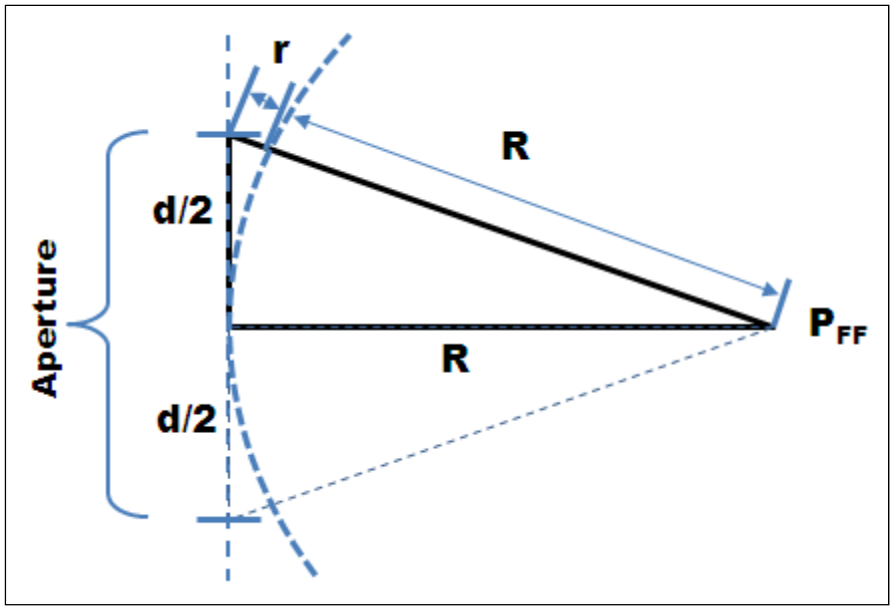

Figure 4. Alternative Geometry for Far Field Estimation.

From Figure 4, the distance "r" is the maximum propagation path difference across a given antenna aperture endpoint locations. Expressing this propagation path difference in terms of a wavelength provides means to derive an equation for generalized far field range relationship. Note a slight change of notation between Figures 3 and 4. A derivation of results already shown in Equations [2] & [9] is given as follows. From Figure 4, the following applies:

$$(R + r)^2 = (d/2)^2 + R^2 \qquad \textbf{[10]}$$

Collecting terms and cancelling,

$$2Rr + r^2 = d^2/4 \qquad \textbf{[11]}$$

Simplifying with a noted valid assumption,

$$2Rr \approx d^2/4, \text{ since } r << R \qquad \textbf{[12]}$$

Solving for "r" (see Figure 4)

$$r \approx d^2/(8R) \qquad \textbf{[13]}$$

For far field condition assume $r \leq \lambda/16$. Substituting "r" in terms of lambda,

$$\lambda/16 \geq r \approx d^2/(8R) \;\rightarrow\; P_{FF} \geq 2d^2/\lambda \qquad \textbf{[14]}$$

As shown, Equation [14] represents the same result as Equation [9] derived earlier.

The power density within the near field varies as a function of the type of aperture illumination and is less than would be calculated by equation [1]. Thus, in the antenna near field there is stored energy. (The complex radiation field equations have imaginary terms indicating reactive power.) Figure 5 shows normalized power density for three different illuminations.

Curve A is for reference only and shows how power density would vary if it were calculated using equation [1].

Curve B shows power density variations on axis for an antenna aperture with a cosine amplitude distribution. This is typical of a horn antenna in the H-plane.

Curve C shows power density variations on axis for a uniformly illuminated antenna aperture or for a line source. This is typical of a horn antenna in the E-plane.

Curve D shows power density variations on axis for an antenna aperture with a tapered illumination. Generally the edge illumination is approximately -10 dB from the center illumination and is typical of a parabolic dish antenna.

Point E For radiation safety purposes, a general rule of thumb for tapered illumination is that the maximum safe level of 10 mW/cm^2 (~200 V/m) is reached in the near field if the level at R_{ff} reaches 0.242 mW/cm^2 as can be verified by computing the power density at point E in Figure 5. (10 mW/cm^2 at point E extrapolates to 0.242 mW/cm^2 [16 dB lower] at $R=R_{ff}$, or Y axis value =1). Figure 1 in Section 3-6 depicts more precise values for radiation hazard exposure.

Point F Far Field Point. At distances closer to the source than this point (near field), the power density from any given antenna is less than that predicted using Curve A. At farther distances, (far field) power densities from all types of antennas are the same.

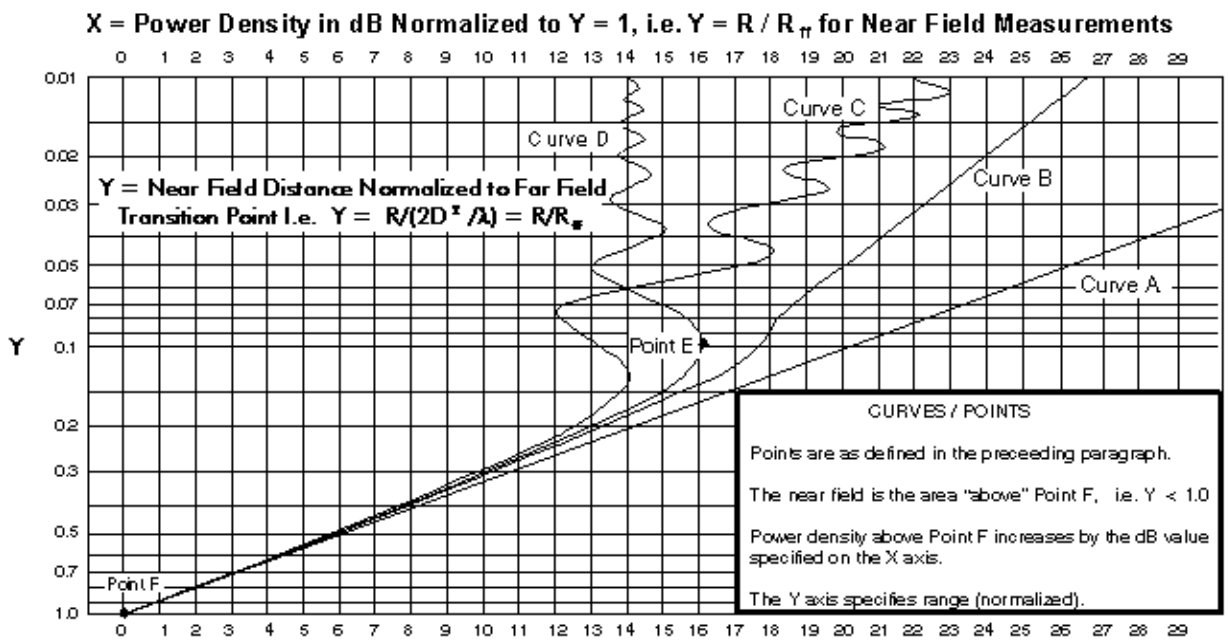

Figure 5. Antenna Near-Field On-Axis Power Density (Normalized) for Various Aperture Illuminations.

FOR FAR FIELD MEASUREMENTS:

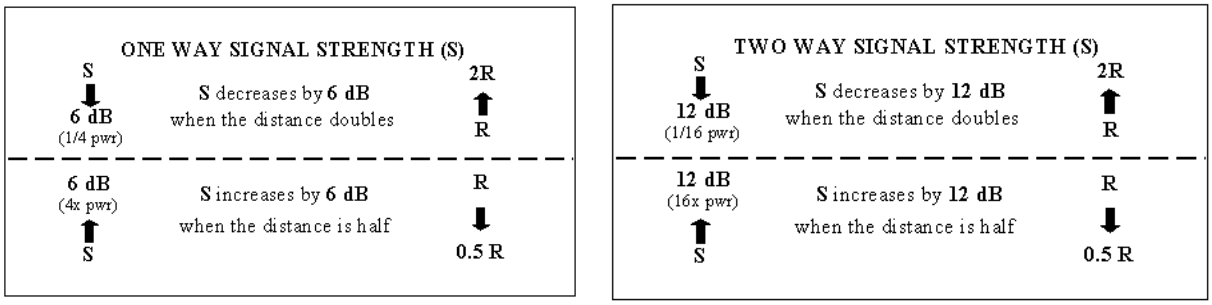

When free space measurements are performed at a known distance from a source, it is often necessary to know if the measurements are being performed in the far field. As can be seen from Curve A on Figure 5, if the distance is halved (going from 1.0 to 0.5 on the Y axis), the power density will increase by 6 dB (going from 0 to 6 dB on the X axis). Each reduction in range by ½ results in further 6 dB increases. As previously mentioned, Curve A is drawn for reference only in the near field region, since at distances less than R_{ff} the power density increases less than 6 dB when the range is halved. In the far field, all curves converge and Equation [1] applies.

When a measurement is made in free space, a good check to ensure that is was performed in the far field is to repeat the measurement at twice the distance. The power should decrease by exactly 6 dB. A common error is to use 3 dB (the half power point) for comparison. Conversely, the power measurement can be repeated at half the distance, in which case you would look for a 6 dB increase, however the assumed extrapolation conclusion is not as certain, because the first measurement could have been made in the far field, and the second could have been made in the near field.

Care must be exercised in using the $\mathbf{2d^2/\lambda}$ far field measurement criterion. For antennas with moderate sidelobe levels (>-25 dB) pattern errors are negligible and the error in directivity is less than 0.1 dB and this measurement distance suffices in most cases. However low sidelobe antennas require longer measurement distances. For example, maintaining a 1 dB or less sidelobe error for a linear array with a -40 dB sidelobe level requires a measurement distance of $6d^2/\lambda$ [(1)]. This corresponds to criterion for "r" in Equation [14] to be changed from $r \leq \lambda/16$ to $r \leq \lambda/48$ or 7.5 deg.

[1] R. C. Hansen. "Measurement Distance Effects on Low Sidelobe Patterns," *IEEE Transactions on Antennas and Propagation*, Vol. AP-32, No. 6, June 1984.

RADIATION HAZARDS

Radiation Hazard (RADHAZ) describes the hazards of electromagnetic radiation to fuels, electronic hardware, ordnance, and personnel. In the military these hazards are segregated as follows:

1) Hazards of Electromagnetic Radiation to Personnel (HERP)
2) Hazards of Electromagnetic Radiation to Ordnance (HERO)
3) Hazards of Electromagnetic Radiation to Fuel (HERF)

The current industrial specifications for RADHAZ are contained in ANSI/IEEE C95.1-1992 which was used as a reference to create the combined Navy regulation NAVSEA OP3565 / NAVAIR 16-1-529. Volume I contains HERP and HERF limits - its current version is REV 5. Volume II (REV 6) covers HERO. These limits are shown in Figure 1 although all values have been converted to average power density.

OP 3565 specifies HERO RADHAZ levels at frequencies below 1 GHz in peak value of electric field strength (V/m), while levels above 200 MHz are specified in average power density (mW/cm^2) - note the overlapping frequencies. Since Figure 1 depicts power density as the limits, you must convert the average values to peak field strength for use at lower frequencies. Also many applications of EMC work such as MIL-STD-461 use limits based on the electric (E) field strength in volts/meter. Remember that $P=E^2/R$, and from Section 4-2, we note that $R=377\Omega$ for free space. It can also be shown that the magnetic field strength (H field in Amps/meter) = I/m where I=E/R. Don't forget that RMS = 0.707 Peak. With the units of P_D in mW/cm^2, E in V/m, and H in A/m, then P_D (mW/cm^2) = E^2 / 3770 = 37.7 H^2. It should thus be noted that a 100 times increase in power (mW/cm^2) is only a 10 times increase in V/m.

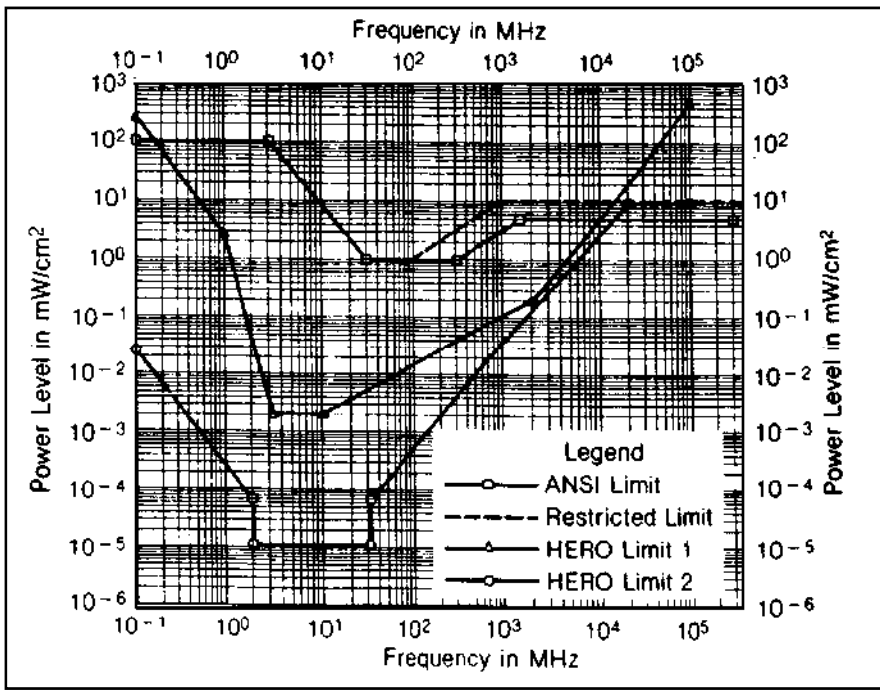

Figure 1. Radiation Hazards to Personnel and Ordnance.

The potential dangers to ordnance and fuels are obvious because there could be an explosive "chain reaction" by exploding; consequently, these limits are generally lower than personnel limits. There are three **HERO** categories. The HERO limit 2 is for HERO "unsafe" or "unreliable" explosive devices with exposed wires arranged in optimum (most susceptible) receiving orientation. This usually occurs during the assembly/disassembly of ordnance, but also applies to new/untested ordnance until proven "safe" or "susceptible." The HERO limit 1 is for HERO susceptible ordnance fully assembled undergoing normal handling and loading operations. HERO safe ordnance requires no RF radiation precautions. A list of which specific ordnance (by NALC) falls into each category can be found in OP 3565 along with specific frequency restrictions for each piece of ordnance. For example, all missiles of one variety are susceptible

(HERO 1 limits), while another missile has both susceptible and safe variants (with no RADHAZ limits). Other ordnance may be HERO unsafe (HERO 2 limits).

The danger of **HERP** occurs because the body absorbs radiation and significant internal heating may occur without the individual's knowledge because the body does not have internal sensation of heat, and tissue damage may occur before the excess heat can be dissipated. As shown in Figure 1, the current "restricted" limit is for individuals more than 55" tall because they have more body mass. In other words, all people may be exposed to the lower limit, but only persons taller than 55" may be exposed to the higher limit of 10 mW/cm^2.

NAVSEA OP 3565 will be updated in the future to be compatible with DoD INST 6055.11 dated Feb 21, 1995 which supersedes it. The personnel radiation levels in Figures 2 and 3 were taken from the new release of DoD INST 6055.11.

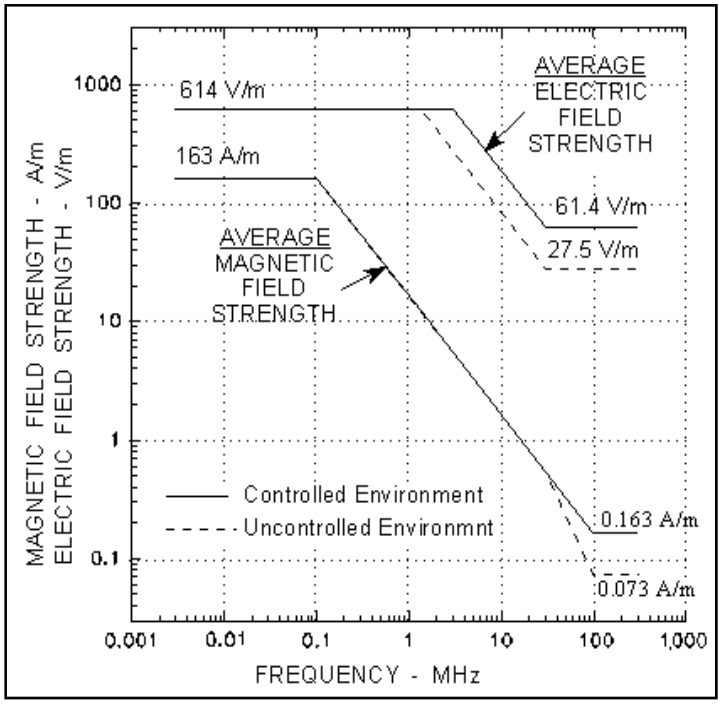

Figure 2. Lower Frequency HERP from DoD INST 6055.11.

Unlike the existing "restricted limit" of NAVSEA OP 3565 discussed above, in the revised DoD instruction for personnel radiation hazards, a different approach to exposure was taken.

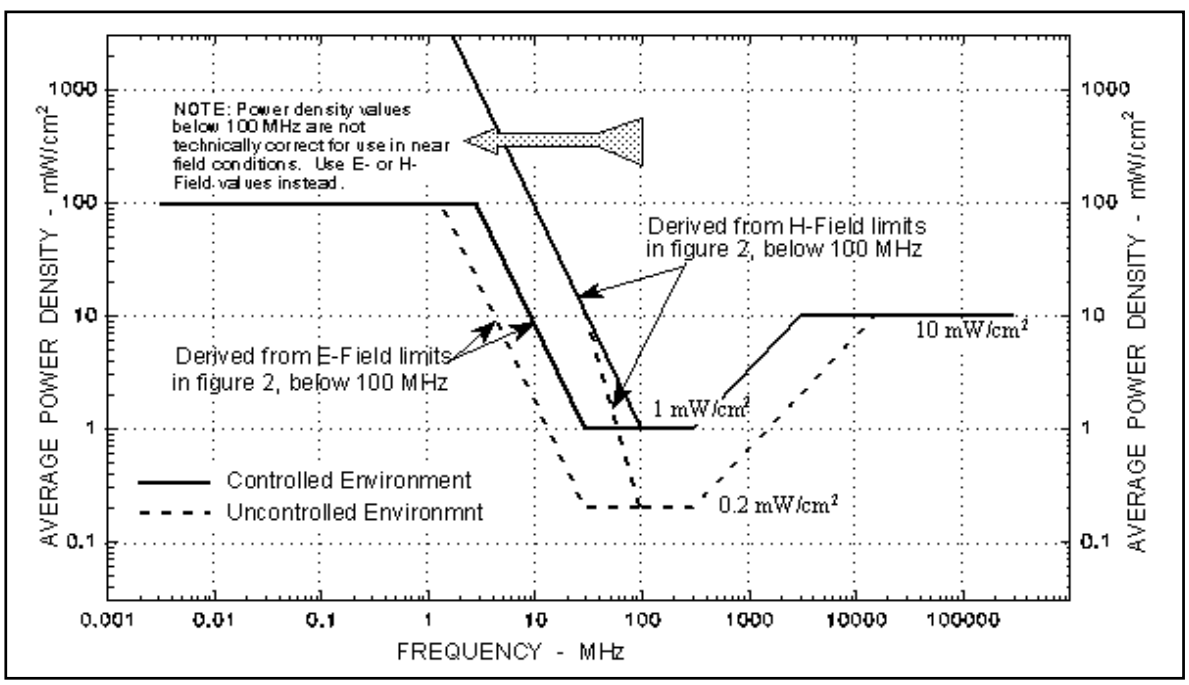

Figure 3. Radiation Hazards to Personnel from DoD INST 6055.11.

Two maximum hazard limits are defined;

1) Controlled Environments - where personnel are aware of the potential danger of RF exposure concurrently with employment, or exposure which may occur due to incidental transient passage through an area, and;
2) Uncontrolled Environments - A lower maximum level where there is no expectation that higher levels should be encountered, such as living quarters.

These Personnel Exposure Limits (PELs) are based on a safety factor of ten times the Specific Absorption Rate (SAR) which might cause bodily harm. The term PEL is equivalent to the terms "Maximum Permissible Exposure (MPE)" and "Radio Frequency Protection Guides (RFPG)" in other publications.

There are several exceptions to the max limits in Figs 2 and 3 (in some cases higher levels are permitted):

- High Power Microwave (HPM) system exposure in a controlled environment, which has a single pulse or multiple pulses lasting less than 10 seconds, has a higher peak E-Field limit of 200 kV/m.
- EMP Simulation Systems in a controlled environment for personnel who are exposed to broad-band (0.1 MHz to 300 GHz) RF are limited to a higher peak E-Field of 100 kV/m.
- The given limits are also increased for pulsed RF fields. In this case the peak power density per pulse for pulse durations < 100 msec and no more than 5 pulses in the period is increased to: PELPulse = PEL x TAVG / 5 x Pulse Width, and the peak E-field is increased to 100 kV/m. If there are more than 5 pulses or they are greater than 100 msec, a time averaged PD should not exceed that shown in Figure 3.
- A rotating or scanning beam likewise reduces the hazard, so although an on-axis hazard might exist, there may be none with a moving beam. The power density may be approximated with:
  PDscan = PDfixed (2 x Beam Width / scan angle)
- Many other special limitations also apply, such as higher limits for partial body exposure, so if in doubt, read the DoD Inst 6055.11 in detail. Field measurements may be measured in accordance with IEEE C95.3-1991.

The PELs listed in Figures 2 and 3 were selected for an average RF exposure time at various frequencies. In a controlled environment, this averaging time was selected as 6 minutes for 0.003 to 15,000 MHz. If the exposure time is less than 6 minutes, then the level may be increased accordingly. Similar time weighted averages apply to uncontrolled environments, but it varies enough with frequency such that DoD INST 6055.11 should be consulted.

NAVSEA OP 3565 contains a list of Navy avionics which transmit RF as well as radars along with their respective hazard patterns. Special training is required for individuals who work in areas which emit RF levels which exceed the uncontrolled levels. Warning signs are also required in areas which exceed either the controlled or uncontrolled limits.

Although E-Field, H-Field, and power density can be mathematically converted in a far-field plane wave environment, the relations provided earlier do not apply in the near field, consequently the E- or H-field strength must be measured independently below 100 MHz. It should be noted that the specifications in NAVSEA OP 3565 for lower frequency HERO limits are listed as peak E-field values, whereas lower RF limits in DoD INST 6055.11 on HERP are in average (RMS) E-field values. Upper

frequency restrictions are based on average (RMS) values of power density in both regulations except for certain circumstances.

HERF precautions are of more general concern to fuel truck operators. However, some general guidelines include:

- Do not energize a transmitter (radar/comm) on an aircraft or motor vehicle being fueled or on an adjacent aircraft or vehicle.
- Do not make or break any electrical, ground wire, or tie down connector while fueling.
- Radars able to illuminate fueling areas with a peak power density of 5 W/cm2 should be shut off.
- For shore stations, antennas radiating 250 watts or less should be installed at least 50 ft from fueling areas (at sea 500 watts is the relaxed requirement).
- For antennas which radiate more than 250 watts, the power density at 50 ft from the fueling operation should not be greater than the equivalent power density of a 250 watt transmitter at 50 ft.

ACTIVE ELECTRONICALLY SCANNED ARRAYS (AESA)

Scanning phased arrays employing electronically controlled phase shifters (e.g., PiN diode, ferrite) have been used in high power radar applications since the early 1960s. These are planar arrays and generally use a corporate type feed structure to array rows of elements in one dimension of the array and use an analogous feed to array the rows in the orthogonal dimension of the array, resulting in a single feed point. A high power RF transmitter, usually employing some sort of liquid cooling, is used to excite the array. This architecture is cumbersome and difficult to package and the high power transmitter is a single point of failure for the system.

The maturation of solid state transmit/receive modules (T/R) using Gallium Arsenide (GaAs) technology or more recently Gallium Nitride (GaN) technology has made AESAs a practical reality. The T/R modules consist of a low noise amplifier (LNA) for the receive function and a solid state high power amplifier (SSPA) for realization of the transmit function. The T/R module may also contain the necessary phase control elements for beam scanning. A generic 8-element AESA for one dimension is shown in Figure 1.

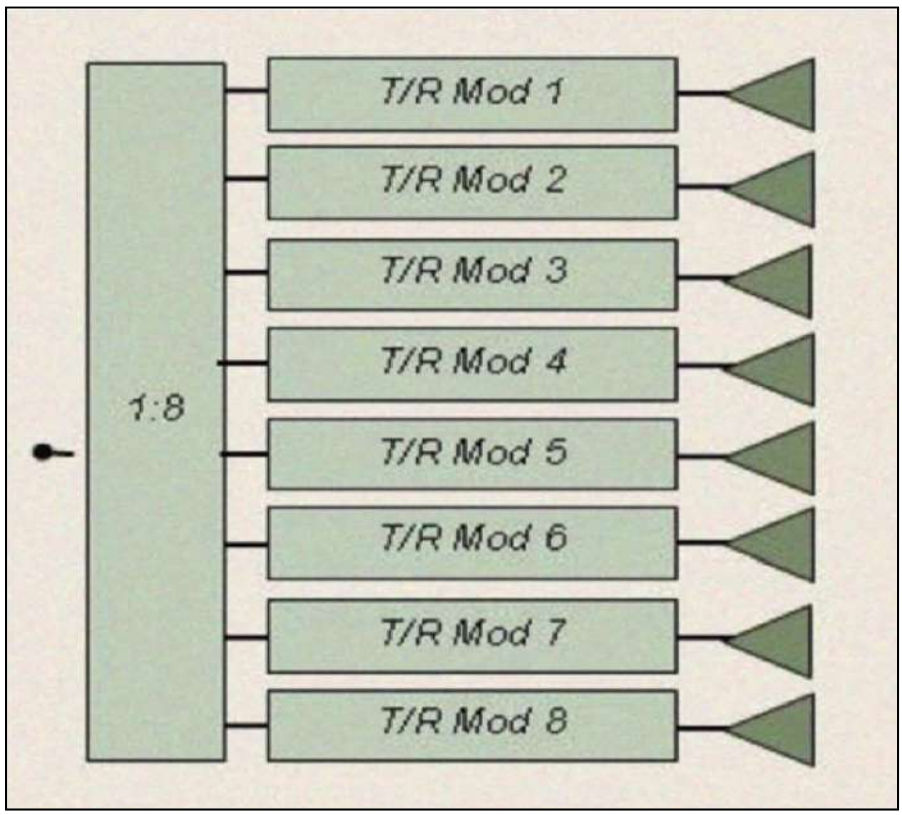

Figure 1. Eight Element AESA.

Electronically scanned phased array designs with decade bandwidths have been reported in the open literature for many years. However those reported are only lab versions and none have been implemented in a fielded system. In addition, the high average power requirement, particularly for EW systems, calls for the use of GaN SSPA technology and this, in conjunction with the dense array packaging requirement, poses severe heat dissipation/cooling issues.

AESAs for EW applications impose design considerations vastly different from an AESA for radar. In contradistinction with high **peak** power radar applications (e.g., AN/APG79), the high **average** power large duty factors (sometimes CW) requirements for EW impose severe design requirements and constraints for the wide bandwidth AESA. Incorporation of an AESA in airborne environment, with its concomitant restrictive volume, further exacerbates design constraints.

The heat dissipation problem is of major concern in modern high power AESAs. Due to the behavior of microwave transistor amplifiers, the power added efficiency (PAE) of a TR module transmitter is typically a relatively small fraction of the total prime power consumption. As a result, an AESA will dissipate a lot of heat, which must be extracted. The reliability of GaAs and GaN MMIC chips improves if the RF amplifier system operates at reduced temperatures. Traditional air cooling used in most established avionic hardware is ill suited to the high packaging density of an AESA. As a result modern AESAs are predominantly liquid cooled. A typical liquid cooling system will use pumps to drive the coolant through channels in the cooling plenum of the array, and then route it to a heat exchanger. In comparison, with a conventional air cooled fighter radar, the AESA will be more reliable but will require more electrical power and more cooling infrastructure, and typically can produce much higher average transmit power.

ADVANTAGES OF AESA RADIATORS

AESAs add many capabilities of their own to those of the Passive Electronically Steered Array (PESAs). Among these are: the ability to form multiple beams, to scan without mechanical steering, to use each transmit/receive module for different roles concurrently, like radar detection, and, more importantly, their multiple wave and scanning frequencies create multiple difficulties for traditional, correlation-type radar detectors.

LOW PROBABILITY OF INTERCEPT

Radar systems work by sending out a signal and then listening for its echo off distant objects. Each of these paths, to and from the target, is subject to the inverse square law of propagation. That means that a radar's received energy drops with the fourth power of distance, which is why radar systems require high powers, often in the megawatt range, to be effective at long range.

The radar signal being sent out is a simple radio signal, and can be received with a simple radio receiver. It is common to use such a receiver in the targets, normally aircraft, to detect radar broadcasts. Unlike the radar unit, which must send the pulse out and then receive its reflection, the target's receiver does not need the reflection and thus the signal drops off only as the square of distance. This means that the receiver is always at an advantage over the radar in terms of range. It will always be able to detect the signal long before the radar can see the target's echo. Since the position of the radar is extremely useful information in an attack on that platform, this means that radars generally must be turned off for lengthy periods if they are subject to attack; this is common on ships, for instance.

Turning that received signal into a useful display is the purpose of the RWR. Unlike the radar, which knows which direction it is sending its signal, the receiver simply gets a pulse of energy and has to interpret it. Since the radio spectrum is filled with noise, the receiver's signal is integrated over a short period of time, making periodic sources like a radar add up and stand out over the random background. Typically RWRs store the detected pulses for a short period of time, and compare their broadcast frequency and pulse repetition frequency against a database of known radars. The rough direction can be calculated using a rotating antenna, or similar passive array, and combined with symbology indicating the likely purpose of the radar - airborne early warning, surface to air missile, etc.

This technique is much less useful against AESA radars. Since the AESA can change its frequency with every pulse, and generally does so using a pseudo-random sequence, integrating over time does not help pull the signal out of the background noise. Nor does the AESA have any sort of fixed pulse repetition frequency, which can also be varied and thus hide any periodic brightening across the entire spectrum. Traditional RWRs suffered significantly decreased effectiveness against AESA radars.

HIGH JAMMING RESISTANCE

Jamming is likewise much more difficult against an AESA. Traditionally, jammers have operated by determining the operating frequency of the radar and then broadcasting a signal on it to confuse the receiver as to which is the "real" pulse and which is the jammer's. This technique works as long as the radar system cannot easily change its operating frequency. When the transmitters were based on klystron tubes this was generally true, and radars, especially airborne ones, had only a few frequencies to choose among. A jammer could listen to those possible frequencies and select the one to be used to jam.

Since an AESA could change its operating frequency with every pulse, and spread the frequencies across a wide band even in a single pulse, jammers are much less effective. Although it is possible to send out broadband white noise against all the possible frequencies, this means the amount of energy being sent at any one frequency is much lower, reducing its effectiveness. In fact, AESAs can then be switched to a receive-only mode, and use these powerful jamming signals instead to track its source, something that required a separate receiver in older platforms.

AESA radars can be much more difficult to detect, and so much more useful in receiving signals from the targets, that they can broadcast continually and still have a very low chance of being detected. This allows such radar systems to generate far more data than traditional radar systems, which can only receive data periodically, greatly improving overall system effectiveness.

OTHER ADVANTAGES

Since each element in an AESA is a powerful radio receiver, active arrays have many roles besides traditional radar. One use is to dedicate several of the elements to reception of common radar signals, eliminating the need for a separate radar warning receiver. The same basic concept can be used to provide traditional radio support, and with some elements also broadcasting, form a very high bandwidth data link.

AESAs are also much more reliable than either a PESA or older designs. Since each module operates independently of the others, single failures have little effect on the operation of the system as a whole. Additionally, the modules individually operate at lower powers and voltages so the need for a large high-voltage power supply is eliminated.

Replacing a mechanically scanned array with a fixed AESA mount can help reduce an aircraft's overall RCS, but some designs (such as the Eurofighter Typhoon) forgo this advantage in order to combine mechanical scanning with electronic scanning and provide a wider angle of total coverage.

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FRACTAL ANTENNAS

The term fractal, which means broken or irregular fragments, was originally coined by B.B. Mandelbrot **[1]** to describe a family of complex shapes that possess self-similarity in their geometrical structure. In-depth studies of the patterns of nature provided inspiration for the development of fractal geometry where it has been used to model numerous natural objects. Recent advances in the antenna art have led to the application of fractal geometry instead of convention Euclidean geometric concepts to the design of wide bandwidth, low profile, compact antennas.

A fractal antenna is an antenna that uses a fractal, self-similar design to maximize the length, or increase the perimeter (on inside sections or the outer structure), of material that can receive or transmit electromagnetic radiation within a given total surface area or volume. The earliest published reference to use of the term fractal radiators and fractal antennas to refer to fractal shaped antenna elements appeared May 1994 **[2]**.

Such fractal antennas are also referred to as multilevel and space filling curves, but the key aspect lies in their repetition of a motif over two or more scale sizes, or "iterations." For this reason, fractal antennas are very compact, multiband or wideband, and have useful applications in many commercial and military systems.

A good example of a fractal antenna as a space-filling curve is in the form of a Minkowski Island (Figure 1). Here, each line of copper is just a small fraction of a wavelength **[3]**.

A fractal antenna's response differs markedly from traditional antenna designs, in that it is capable of operating with good-to-excellent performance at many different frequencies simultaneously. Normally standard antennas have to be "cut" for the frequency for which they are to be used — and thus the standard antennas only work well at that frequency. This makes the fractal antenna an excellent design for wideband and multiband applications.

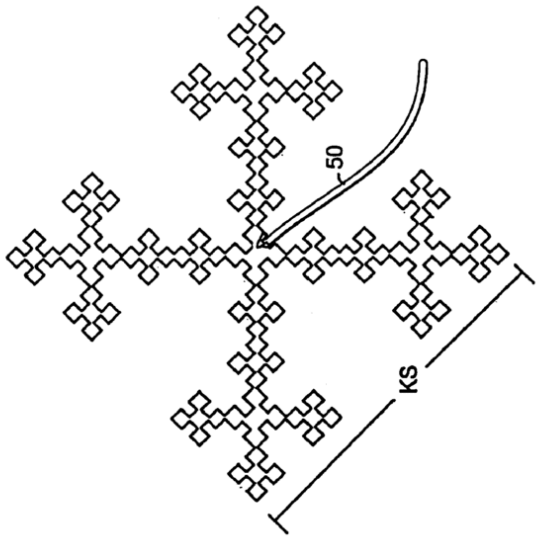

Figure 1. An Example of a Fractal Antenna: a Space-Filling Curve Called a Minkowski Island.

Antenna elements (as opposed to antenna arrays) made from self-similar shapes were first created by Nathan Cohen, then a professor at Boston University, starting in 1995 **[4].** Cohen's efforts with a variety

of fractal antenna designs were first published in 1995 (thus the first scientific publication on fractal antennas), and a number of patents have been issued from the 1995 filing priority of invention. Most allusions to fractal antennas make reference to these "fractal element antennas."

Many fractal element antennas use the fractal structure as a virtual combination of capacitors and inductors. This makes the antenna have so that it has many different resonances that can be selected and adjusted by choosing the proper fractal design. Electrical resonances may not be directly related to a particular scale size of the fractal antenna structure. The physical size of the antenna is unrelated to its resonant or broadband performance. The general rule of antenna length being near target frequency wavelength does not apply itself in the same way with fractal antennas.

This complexity arises because the current on the structure has a complex arrangement caused by the inductance and self capacitance. In general, although their effective electrical length is longer, the fractal element antennas are physically smaller.

Fractal element antennas are shrunken compared to conventional designs and do not need additional components. In general, the fractal dimension of a fractal antenna is a poor predictor of its performance and application. Not all fractal antennas work well for a given application or set of applications. Computer search methods, optimization algorithms, and antenna simulations are commonly used to identify which fractal antenna designs best meet the need of the application.

Although the first validation of the technology was published as early as 1995 **[4]** recent independent studies show advantages of the fractal element technology in real-life applications, such as radio frequency identification and cell phones.

A different and also useful attribute of some fractal element antennas is their self-scaling aspect. In 1999, it was discovered that self-similarity was one of the underlying requirements to make antennas "invariant" (same radiation properties) at a number or range of frequencies. Previously, under Rumsey's Frequency Independent Antenna Principle, it was believed that antennas had to be defined by angles for this to be true; the 1999 analysis **[5]**, based on Maxwell's equations, showed this to be a subset of the more general set of self-similar conditions. Hence fractal antennas offer a closed-form and unique insight into a key aspect of electromagnetic phenomena to wit the invariance property of Maxwell's equations.

Antenna tuning units are typically not required on fractal antennas due to their wide bandwidth and complex resonance. However, if a transmitting antenna has deep nulls in its response or has electromagnetic structural issues that require equalization then an antenna tuning unit should be used.

In addition to their use as antennas, fractals have also found application in other antenna system components including loads, counterpoises, and ground planes. Confusion by those who claim "grain of rice"-sized fractal antennas arises, because such fractal structures serve the purpose of loads and counterpoises, rather than bona fide antennas.

Fractal inductors and fractal tuned circuits (fractal resonators) were also discovered and invented simultaneously with fractal element antennas. An emerging example of such is in metamaterials. A recent report demonstrates using close-packed fractal resonators to make the first wideband metamaterial "invisibility cloak" at microwave frequencies **[6]**. Fractal filters (a type of tuned circuit) are another example of fractal geometry in microwave componentry.

As fractals can be used as counterpoises, loads, ground planes, and filters, all parts that can be integrated with antennas, they are considered parts of some antenna systems and thus are discussed in the context of fractal antennas.

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RADAR EQUATIONS

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FIELD INTENSITY and POWER DENSITY

Sometimes it is necessary to know the actual field intensity or power density at a given distance from a transmitter instead of the signal strength received by an antenna. Field intensity or power density calculations are necessary when estimating electromagnetic interference (EMI) effects, when determining potential radiation hazards (personnel safety), or in determining or verifying specifications.

Field intensity (field strength) is a general term that usually means the magnitude of the electric field vector, commonly expressed in volts per meter. At frequencies above 100 MHZ, and particularly above one GHz, power density (P_D) terminology is more often used than field strength.
Power density and field intensity are related by equation [1]:

$$P_D = \frac{E^2}{Z_0} = \frac{E^2}{120\pi} = \frac{E^2}{377} \qquad \textbf{[1]}$$

where P_D is in W/m^2, E is the RMS value of the field in volts/meter and 377 ohms is the characteristic impedance of free space. When the units of P_D are in mW/cm^2, then P_D (mW/cm^2) = E^2/3,770.

Conversions between field strength and power density when the impedance is 377 ohms, can be obtained from Table 1. It should be noted that to convert dBm/m^2 to dBμV/m add 115.76 dB. Sample calculations for both field intensity and power density in the far field of a transmitting antenna are in Section 4-2 and Section 4-8. Refer to chapter 3 on antennas for the definitions of near field and far field.

Note that the "/" term before m, m^2, and cm^2 in Table 1 mean "per," i.e., dBm per m^2, not to be confused with the division sign which is valid for the Table 1 equation $P=E^2/Z_o$. Remember that in order to obtain dBm from dBm/m^2 given a certain area, you must add the logarithm of the area, not multiply. The values in the table are rounded to the nearest dBW, dBm, etc. per m^2 so the results are less precise than a typical handheld calculator and may be up to ½ dB off.

VOLTAGE MEASUREMENTS

Coaxial cabling typically has input impedances of 50, 75, and 93Ω, (±2) with 50Ω being the most common. Other types of cabling include the following: TV cable is 75Ω (coaxial) or 300Ω (twin-lead), audio public address (PA) is 600Ω, audio speakers are 3.2 (4), 8, or 16Ω.

In the 50Ω case, power and voltage are related by:

$$P = \frac{E^2}{Z_0} = \frac{E^2}{50} = 50\, I^2 \qquad \textbf{[2]}$$

Conversions between measured power, voltage, and current where the typical impedance is 50 ohms can be obtained from Table 2. The dBμA current values are given because frequently a current probe is used during laboratory tests to determine the powerline input current to the system.

MATCHING CABLING IMPEDANCE

In performing measurements, we must take into account an impedance mismatch between measurement devices (typically 50 ohms) and free space (377 ohms).

Table 1. Conversion Table - Field Intensity and Power Density.
$P_D = E^2/Z_0$ (Related by free space impedance = 377 ohms)

E (Volts/m)	20 log 10^6 (E) (dBμV/m)	P_D (watts/m^2)	10 Log P_D (dBW/m^2)	Watts/cm^2	dBW/cm^2	mW/cm^2	dBm/cm^2	dBm/m^2
7,000	197	130,000	+51	13	+11	13,000	+41	+81
5,000	194	66,300	+48	6.6	+8	6,630	+38	+78
3,000	190	23,900	+44	2.4	+4	2,390	+34	+74
4,000	186	10,600	+40	1.1	0	1,060	+30	+70
1,000	180	2,650	+34	.27	-6	265	+24	+64
700	177	1,300	+31	.13	-9	130	+21	+61
500	174	663	+28	.066	-12	66	+18	+58
300	170	239	+24	.024	-16	24	+14	+54
200	166	106	+20	.011	-20	11	+10	+50
100	160	27	+14	.0027	-26	2.7	+4	+44
70	157	13	+11	$1.3x10^{-3}$	-29	1.3	+1	+41
50	154	6.6	+8	$6.6x10^{-4}$	-32	.66	-2	+38
30	150	2.4	+4	$2.4x10^{-4}$	-36	.24	-6	+34
20	146	1.1	+0	$1.1x10^{-4}$	-40	.11	-10	+30
10	140	.27	-6	$2.7x10^{-5}$	-46	.027	-16	+24
7	137	.13	-9	$1.3x10^{-5}$	-49	.013	-19	+21
5	134	.066	-12	$6.6x10^{-6}$	-52	$66x10^{-4}$	-22	+18
3	130	.024	-16	$2.4x10^{-6}$	-56	$24x10^{-4}$	-26	+14
2	126	.011	-20	$1.1x10^{-6}$	-60	$11x10^{-4}$	-30	+10
1	120	.0027	-26	$2.7x10^{-7}$	-66	$2.7x10^{-4}$	-36	+4
0.7	117	$1.3x10^{-3}$	-29	$1.3x10^{-7}$	-69	$1.3x10^{-4}$	-39	+1
0.5	114	$6.6x10^{-4}$	-32	$6.6x10^{-8}$	-72	$66x10^{-4}$	-42	-2
0.3	110	$2.4x10^{-4}$	-36	$2.4x10^{-8}$	-76	$24x10^{-4}$	-46	-6
0.2	106	$1.1x10^{-4}$	-40	$1.1x10^{-8}$	-80	$11x10^{-4}$	-50	-10
0.1	100	$2.7x10^{-5}$	-46	$2.7x10^{-9}$	-86	$2.7x10^{-6}$	-56	-16
$70x10^{-3}$	97	$1.3x10^{-5}$	-49	$1.3x10^{-9}$	-89	$1.3x10^{-6}$	-59	-19
$50x10^{-3}$	94	$6.6x10^{-6}$	-52	$6.6x10^{-10}$	-92	$66x10^{-8}$	-62	-22
$30x10^{-3}$	90	$2.4x10^{-6}$	-56	$2.4x10^{-10}$	-96	$24x10^{-8}$	-66	-26
$20x10^{-3}$	86	$1.1x10^{-6}$	-60	$1.1x10^{-10}$	-100	$11x10^{-8}$	-70	-30
$10x10^{-3}$	80	$2.7x10^{-7}$	-66	$2.7x10^{-11}$	-106	$2.7x10^{-8}$	-76	-36
$7x10^{-3}$	77	$1.3x10^{-7}$	-69	$1.3x10^{-11}$	-109	$1.3x10^{-8}$	-79	-39
$5x10^{-3}$	74	$6.6x10^{-8}$	-72	$6.6x10^{-12}$	-112	$66x10^{-10}$	-82	-42
$3x10^{-3}$	70	$2.4x10^{-8}$	-76	$2.4x10^{-12}$	-116	$24x10^{-10}$	-86	-46
$2x10^{-3}$	66	$1.1x10^{-8}$	-80	$1.1x10^{-12}$	-120	$11x10^{-10}$	-90	-50
$1x10^{-3}$	60	$2.7x10^{-9}$	-86	$2.7x10^{-13}$	-126	$2.7x10^{-10}$	-96	-56
$7x10^{-4}$	57	$1.3x10^{-9}$	-89	$1.3x10^{-13}$	-129	$1.3x10^{-10}$	-99	-59
$5x10^{-4}$	54	$6.6x10^{-10}$	-92	$6.6x10^{-14}$	-132	$66x10^{-12}$	-102	-62
$3x10^{-4}$	50	$2.4x10^{-10}$	-96	$2.4x10^{-14}$	-136	$24x10^{-12}$	-106	-66
$2x10^{-4}$	46	$1.1x10^{-10}$	-100	$1.1x10^{-14}$	-140	$11x10^{-12}$	-110	-70
$1x10^{-4}$	40	$2.7x10^{-11}$	-106	$2.7x10^{-15}$	-146	$2.7x10^{-12}$	-116	-76
$7x10^{-5}$	37	$1.3x10^{-11}$	-109	$1.3x10^{-15}$	-149	$1.3x10^{-12}$	-119	-79
$5x10^{-5}$	34	$6.6x10^{-12}$	-112	$6.6x10^{-16}$	-152	$66x10^{-14}$	-122	-82
$3x10^{-5}$	30	$2.4x10^{-12}$	-116	$2.4x10^{-16}$	-156	$24x10^{-14}$	-126	-86
$2x10^{-5}$	26	$1.1x10^{-12}$	-120	$1.1x10^{-16}$	-160	$11x10^{-14}$	-130	-90
$1x10^{-5}$	20	$2.7x10^{-13}$	-126	$2.7x10^{-17}$	-166	$2.7x10^{-14}$	-136	-96
$7x10^{-6}$	17	$1.3x10^{-13}$	-129	$1.3x10^{-17}$	-169	$1.3x10^{-14}$	-139	-99
$5x10^{-6}$	14	$6.6x10^{-14}$	-132	$6.6x10^{-18}$	-172	$66x10^{-16}$	-142	-102
$3x10^{-6}$	10	$2.4x10^{-14}$	-136	$2.4x10^{-18}$	-176	$24x10^{-16}$	-146	-106
$2x10^{-6}$	6	$1.1x10^{-14}$	-140	$1.1x10^{-18}$	-180	$11x10^{-16}$	-150	-110
$1x10^{-6}$	0	$2.7x10^{-15}$	-146	$2.7x10^{-19}$	-186	$2.7x10^{-16}$	-156	-116

NOTE: Numbers in table rounded off.

FIELD STRENGTH APPROACH

To account for the impedance difference, the antenna factor (AF) is defined as: AF=E/V, where E is field intensity which can be expressed in terms taking 377 ohms into account and V is measured voltage which can be expressed in terms taking 50 ohms into account. Details are provided in Section 4-12.

POWER DENSITY APPROACH

To account for the impedance difference, the antenna's effective capture area term, A_e relates free space power density P_D with received power, P_r, i.e. $P_r = P_D A_e$. A_e is a function of frequency and antenna gain and is related to AF as shown in Section 4-12.

SAMPLE CALCULATIONS

Section 4-2 provides sample calculations using power density and power terms from Tables 1 and 2, whereas Section 4-12 uses these terms plus field intensity and voltage terms from Table 1 and Table 2. Refer the examples in Section 4-12 for usage of the conversions while converting free space values of power density to actual measurements with a spectrum analyzer attached by coaxial cable to a receiving antenna.

Conversion Between Field Intensity (Table 1) and Power Received (Table 2).

Power received (watts or milliwatts) can be expressed in terms of field intensity (volts/meter or μv/meter) using equation [3]:

$$\textit{Power received } (P_r) = \frac{E^2}{480\pi^2}\frac{c^2}{f^2}G \qquad \textbf{[3]}$$

or in log form: $10 \log P_r = 20 \log E + 10 \log G - 20 \log f + 10 \log (c^2/480\pi^2)$ **[4]**

Then $10 \log Pr = 20 \log E_1 + 10 \log G - 20 \log f_1 + K_4$ **[5]**

$$\textit{Where } K_4 = 10 \log\left[\frac{c^2}{480\pi^2} \bullet \left(\begin{array}{l}\textit{conversions}\\ \textit{as required}\end{array} \frac{\textit{(Watts to mW)}}{\textit{(volts to } \mu v)^2 \textit{ (Hz to MHz or GHz)}^2}\right)\right]$$

The derivation of equation [3] follows:

$P_D = E^2/120\pi$ Eq [1], Section 4-1, terms (v^2/Ω)

$A_e = \lambda^2 G/4\pi$ Eq [8], Section 3-1, terms (m^2)

$P_r = P_D A_e$ Eq [2], Section 4-3, terms $(W/m^2)(m^2)$

$\therefore P_r = (E2/120\pi)(\lambda^2 G/4\pi)$ terms $(v^2/m^2\Omega)(m^2)$

$\lambda = c/f$ Section 2-3, terms (m/sec)(sec)

$\therefore P_r = (E^2/480\pi^2)(c^2 G/f^2)$ which is equation [3]

terms $(v^2/m^2\Omega)(m^2/sec^2)(sec^2)$ or v^2/Ω = watts

Values of K_4 (dB)

P_r	E_1	f_1 (Hz)	f_1 (MHz)	f_1 (GHz)
Watts (dBW)	volts/meter	132.8	12.8	-47.2
	μv/meter	12.8	-107.2	-167.2
mW (dBm)	volts/meter	162.8	42.8	-17.2
	μv/meter	42.8	-77.2	-137.7

Table 2. Conversion Table - Volts to Watts and dBμA.
($P_x = V_x^2/Z$ - Related by line impedance of 50 Ω)

Volts	dBV	dBμV	Watts	dBW	dBm	dBμA
700	56.0	176.0	9800	39.9	69.9	142.9
500	53.9	173.9	5000	37.0	67.0	140.0
300	49.5	169.5	1800	32.5	62.5	135.5
200	46.0	166.0	800	29.0	59.0	132.0
100	40.0	160.0	200	23.0	53.0	126.0
70	36.9	156.9	98	19.9	49.9	122.9
50	34.0	154.0	50	17.0	47.0	120.0
30	29.5	149.5	18	12.5	42.5	115.5
20	26.0	146.0	8	9.0	39.0	112.0
10	20.0	140.0	2	3.0	33.0	106.0
7	16.9	136.9	0.8	0	29.9	102.9
5	14.0	134.0	0.5	-3.0	27.0	100.0
3	9.5	129.5	0.18	-7.4	22.5	95.6
2	6.0	126.0	0.08	-11.0	19.0	92.0
1	0	120.0	0.02	-17.0	13.0	86.0
0.7	-3.1	116.9	9.8×10^{-3}	-20.1	9.9	82.9
0.5	-6.0	114.0	5.0×10^{-3}	-23.0	7.0	80.0
0.3	-10.5	109.5	1.8×10^{-3}	-27.4	2.6	75.6
0.2	-14.0	106.0	8.0×10^{-4}	-31.0	-1.0	72.0
0.1	-20.0	100.0	2.0×10^{-4}	-37.0	-7.0	66.0
.07	-23.1	96.9	9.8×10^{-5}	-40.1	-10.1	62.9
.05	-26.0	94.0	5.0×10^{-5}	-43.0	-13.0	60.0
.03	-30.5	89.5	1.8×10^{-5}	-47.4	-17.7	55.6
.02	-34.0	86.0	8.0×10^{-6}	-51.0	-21.0	52.0
.01	-40.0	80.0	2.0×10^{-6}	-57.0	-27.0	46.0
7×10^{-3}	-43.1	76.9	9.8×10^{-7}	-60.1	-30.1	42.9
5×10^{-3}	-46.0	74.0	5.0×10^{-7}	-63.0	-33.0	40.0
3×10^{-3}	-50.5	69.5	1.8×10^{-7}	-67.4	-37.4	35.6
2×10^{-3}	-54.0	66.0	8.0×10^{-8}	-71.0	-41.0	32.0
1×10^{-3}	-60.0	60.0	2.0×10^{-8}	-77.0	-47.0	26.0
7×10^{-4}	-64.1	56.9	9.8×10^{-9}	-80.1	-50.1	22.9
5×10^{-4}	-66.0	54.0	5.0×10^{-9}	-83.0	-53.0	20.0
3×10^{-4}	-70.5	49.5	1.8×10^{-9}	-87.4	-57.4	15.6
2×10^{-4}	-74.0	46.0	8.0×10^{-10}	-91.0	-61.0	12.0
1×10^{-4}	-80.0	40.0	2.0×10^{-10}	-97.0	-67.0	6.0
7×10^{-5}	-84.1	36.9	9.8×10^{-11}	-100.1	-70.1	2.9
5×10^{-5}	-86.0	34.0	5.0×10^{-11}	-103.0	-73.0	0
3×10^{-5}	-90.5	29.5	1.8×10^{-11}	-107.4	-77.4	-4.4
2×10^{-5}	-94.0	26.0	8.0×10^{-12}	-111.0	-81.0	-8.0
1×10^{-5}	-100.0	20.0	2.0×10^{-12}	-117.0	-87.0	-14.0
7×10^{-6}	-104.1	16.9	9.8×10^{-13}	-120.1	-90.1	-17.1
5×10^{-6}	-106.0	14.0	5.0×10^{-13}	-123.0	-93.0	-20.0
3×10^{-6}	-110.5	9.5	1.8×10^{-13}	-127.4	-97.4	-24.4
2×10^{-6}	-114.0	6.0	8.0×10^{-14}	-131.0	-101.0	-28.0
1×10^{-6}	-120.0	0	2.0×10^{-14}	-137.0	-107.0	-34.0
7×10^{-7}	-124.1	-3.1	9.8×10^{-15}	-140.1	-110.1	-37.1
5×10^{-7}	-126.0	-6.0	5.0×10^{-15}	-143.0	-113.0	-40.0
3×10^{-7}	-130.5	-10.5	1.8×10^{-15}	-147.4	-117.4	-44.4
2×10^{-7}	-134.0	-14.0	8.0×10^{-16}	-151.0	-121.0	-48.0
1×10^{-7}	-140.0	-20.0	2.0×10^{-16}	-157.0	-127.0	-54.0

POWER DENSITY

Radio Frequency (RF) propagation is defined as the travel of electromagnetic waves through or along a medium. For RF propagation between approximately 100 MHz and 10 GHz, radio waves travel very much as they do in free space and travel in a direct line of sight. There is a very slight difference in the dielectric constants of space and air. The dielectric constant of space is one. The dielectric constant of air at sea level is 1.000536. In all but the highest precision calculations, the slight difference is neglected.

From chapter 3, Antennas, an isotropic radiator is a theoretical, lossless, omnidirectional (spherical) antenna. That is, it radiates uniformly in all directions. The power of a transmitter that is radiated from an isotropic antenna will have a uniform power density (power per unit area) in all directions. The power density at any distance from an isotropic antenna is simply the transmitter power divided by the surface area of a sphere ($4\pi R^2$) at that distance. The surface area of the sphere increases by the square of the radius, therefore the power density, P_D, (watts/square meter) decreases by the square of the radius.

$$\begin{matrix}\textit{Power density from} \\ \textit{an isotropic antenna}\end{matrix} = P_D = \frac{P_t}{4\pi R^2} \qquad \begin{matrix}\textit{where : } P_t = \textit{Transmitter Power} \\ R = \textit{Range From Antenna (i.e., radius of sphere)}\end{matrix} \qquad \textbf{[1]}$$

P_t is either peak or average power depending on how P_D is to be specified.

Radars use directional antennas to channel most of the radiated power in a particular direction. The Gain (G) of an antenna is the ratio of power radiated in the desired direction as compared to the power radiated from an isotropic antenna, or:

$$G = \frac{\textit{Maximum radiation intensity of actual antenna}}{\textit{Radiation intensity of isotropic antenna with same power input}}$$

The power density at a distant point from a radar with an antenna gain of G_t is the power density from an isotropic antenna multiplied by the radar antenna gain.

Power density from radar, $$P_D = \frac{P_t G_t}{4\pi R^2} \qquad \textbf{[2]}$$

P_t is either peak or average power depending on how P_D is to be specified.

Another commonly used term is effective isotropic radiated power (EIRP), where **EIRP = P_t G_t.** ERP is also used but EIRP is preferred because it specifically defines the type of reference antenna as isotropic.

A receiving antenna captures a portion of this power determined by its effective capture Area (A_e). The received power available at the antenna terminals is the power density times the effective capture area (A_e) of the receiving antenna.

e.g., If the power density at a specified range is one microwatt per square meter and the antenna's effective capture area is one square meter then the power captured by the antenna is one microwatt.

For a given receiver antenna size the capture area is constant no matter how far it is from the transmitter, as illustrated in Figure 1. Also notice from Figure 1 that the received signal power decreases by 1/4 (6 dB) as the distance doubles. This is due to the R^2 term in the denominator of equation [2].

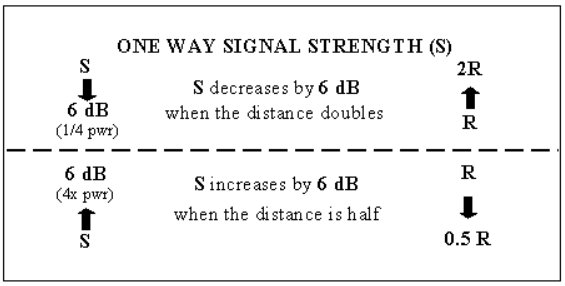

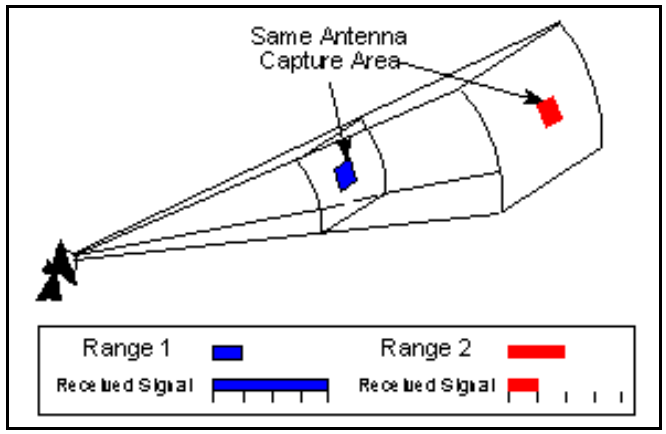

Figure 1. Power Density vs. Range.

Sample Power Density Calculation - Far Field
(Refer to Section 3-5 for the definition of near field and far field)

Calculate the power density at 100 feet for 100 watts transmitted through an antenna with a gain of 10.

Given: P_t = 100 watts G_t = 10 (dimensionless ratio) R = 100 ft

This equation produces power density in watts per square range unit.

$$P_D = \frac{P_t G_t}{4\pi R^2} = \frac{(100\ watts)(10)}{4\pi (100\ ft)^2} = 0.0080\ watts/\ ft^2$$

For safety (radiation hazard) and EMI calculations, power density is usually expressed in milliwatts per square cm. That's nothing more than converting the power and range to the proper units.

100 watts = 1 x 10^2 watts = 1 x 10^5 mW

100 feet = 30.4785 meters = 3047.85 cm.

$$P_D = \frac{P_t G_t}{4\pi R^2} = \frac{(10^5\ mW) \bullet (10)}{4\pi (3047.85cm)^2} = 0.0086\ mW/\ cm^2$$

However, antenna gain is almost always given in dB, not as a ratio. It's then often easier to express EIRP in dBm.

$$P_t\,(dBm) = 10\ \mathrm{Log}\left[\frac{P_t\ watts}{1\ mW}\right] = 10\ \mathrm{Log}\left[\frac{100}{.001}\right] = 50\ dBm$$

$$G_t\,(dB) = 10\ \mathrm{Log}\left[\frac{G_t}{1}\right] = 10\ \mathrm{Log}\,(10) = 10\ dB$$

EIRP (dBm) = P_t (dBm) + G_t (dB) = 50 + 10 = 60 dBm

To reduce calculations, the graph in Figure 2 can be used. It gives EIRP in dBm, range in feet and power density in mW/cm^2. Follow the scale A line for an EIRP of 60 dBm to the point where it intersects the 100 foot range scale. Read the power density directly from the A-scale x-axis as 0.0086 mW/cm^2 (confirming our earlier calculations).

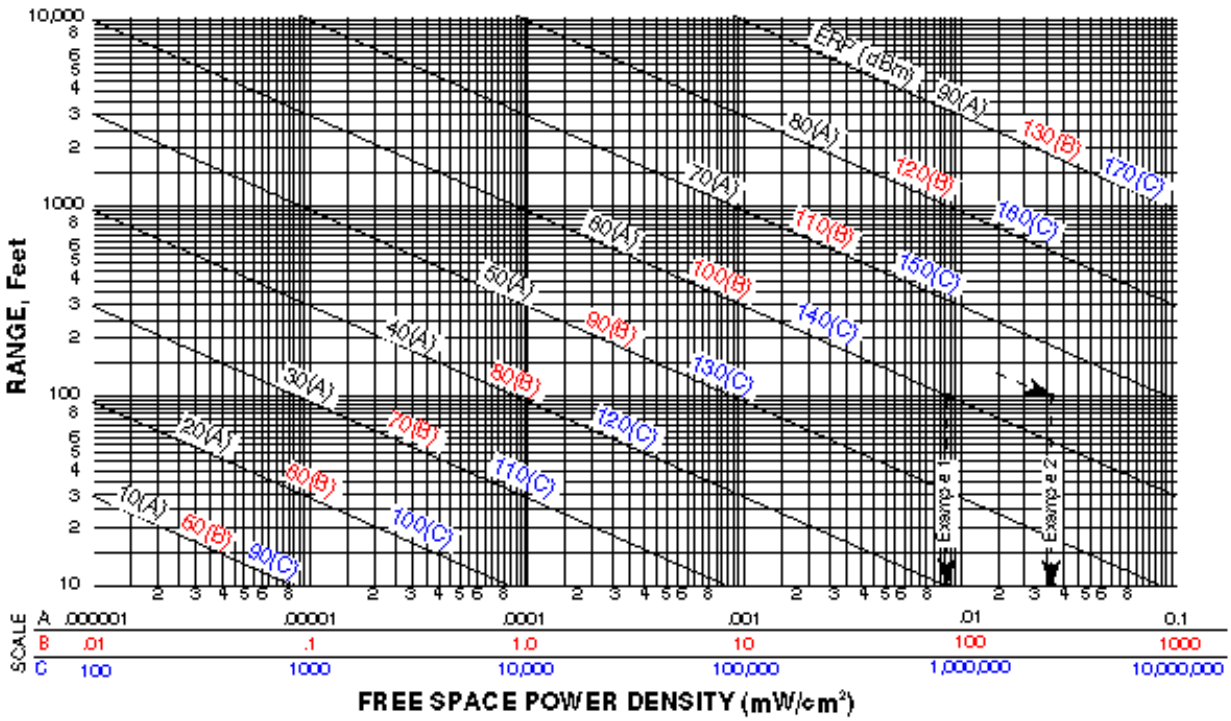

Figure 2. Power Density vs. Range and EIRP.

Example 2

When antenna gain and power (or EIRP) are given in dB and dBm, it is necessary to convert back to ratios in order to perform the calculation given in equation [2]. Use the same values as in example 1 except for antenna gain.

Suppose the antenna gain is given as 15 dB: $\mathbf{G_t\ (dB) = 10\ Log\ (G_t)}$

$$Therefore: \quad G_t = [10]^{\left(\frac{G_t(dB)}{10}\right)} = [10]^{\left(\frac{15}{10}\right)} = 31.6228$$

$$P_D = \frac{P_t G_t}{4\pi R^2} = \frac{(10^5\ mW)(31.6228)}{4\pi\,(3047.85)^2} = 0.0271\ mW/cm^2$$

Follow the 65 dBm (extrapolated) EIRP line and verify this result on the A-scale X-axis.

Example 3 - Sample Real Life Problem

Assume we are trying to determine if a jammer will damage the circuitry of a missile carried onboard an aircraft and we cannot perform an actual measurement. Refer to the diagram at the right.

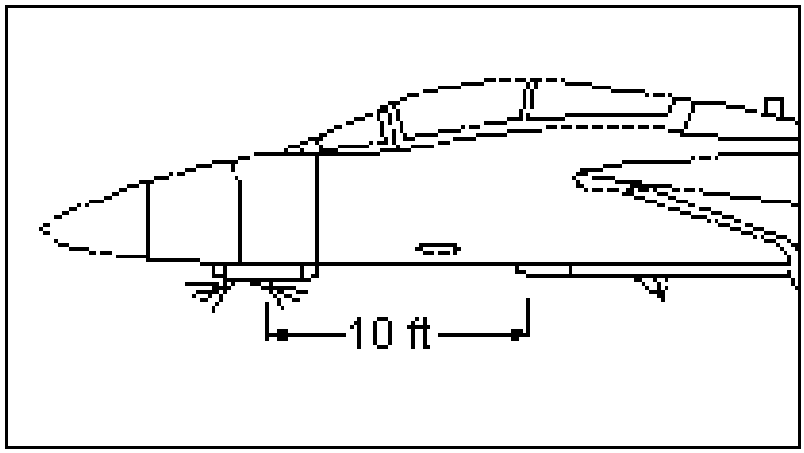

Given the following:

Jammer power: 500 W ($P_t = 500$)

Jammer line loss and antenna gain: 3 dB ($G_t = 2$)

Missile antenna diameter: 10 in

Missile antenna gain: Unknown

Missile limiter protection (maximum antenna power input): 20 dBm (100mW) average and peak.

The power density at the missile antenna caused by the jammer is computed as follows:

$$P_D = \frac{P_t G_t}{4\pi R^2} = \frac{500W\ (2)}{4\pi [(10ft)(.3048m/ft)]^2} = 8.56W/m^2$$

The maximum input power actually received by the missile is either:

$P_r = P_D A_e$ (if effective antenna area is known) or
$P_r = P_D G_m \lambda^2/4\pi$ (if missile antenna gain is known)

To cover the case where the missile antenna gain is not known, first <u>assume</u> an aperture efficiency of 0.7 for the missile antenna (typical). Then:

$P_r = P_D A \eta = 8.56\ W/m^2\ (\pi)[\ (10/2\ in)(.0254\ m/in)\ ]^2\ (0.7) = 0.3$ watts

Depending upon missile antenna efficiency, we can see that the power received will be about 3 times the maximum allowable and that either better limiter circuitry may be required in the missile or a new location is needed for the missile or jammer. Of course if the antenna efficiency is 0.23 or less, then the power will not damage the missile's receiver.

If the missile gain were known to be 25 dB, then a more accurate calculation could be performed. Using the given gain of the missile (25 dB= numeric gain of 316), and assuming operation at 10 GHz ($\lambda = .03$m)

$P_r = P_D G_m \lambda^2 / 4\pi = 8.56\ W/m^2\ (316)(.03)^2/ 4\pi = .19$ watts (still double the allowable tolerance)

ONE-WAY RADAR EQUATION / RF PROPAGATION

The one-way (transmitter to receiver) radar equation is derived in this section. This equation is most commonly used in RWR, communications, or ESM type of applications. The following is a summary of the important equations explored in this section:

ONE-WAY RADAR EQUATION

Peak Power at

Receiver Input, $P_r\,(or\ S) = P_D\,A_e = \dfrac{P_t\,G_t\,A_e}{4\pi\,R^2}$ *and Antenna Gain,* $G = \dfrac{4\pi\,A_e}{\lambda^2}$

or : Equivalent Area, $A_e = \dfrac{G\,\lambda^2}{4\pi}$

So the one-way radar equation is :

$$S\,(or\ P_r) = \frac{P_t\,G_t\,G_r\,\lambda^2}{(4\pi R)^2} = P_t\,G_t\,G_r\left[\frac{c^2}{(4\pi f\,R)^2}\right]^* \qquad (\ Note: \lambda = \frac{c}{f}\ )$$

* keep λ, c, and R in the same units

On reducing to log form this becomes:
$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - 20\log f R + 20\log (c/4\pi)$

or in simplified terms:
$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - \alpha_1$ (in dB)

Where: α_1 = one-way free space loss = $20\log (f_1 R) + K_1$ (in dB) and:
$K_1 = 20\log [(4\pi/c)$(Conversion factors if units if not in m/sec, m, and Hz)]
Note: To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain

Values of K_1 (in dB)

Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
NM	37.8	97.8
km	32.45	92.45
m	-27.55	32.45
yd	-28.33	31.67
ft	-37.87	22.13

Note: Losses due to antenna polarization and atmospheric absorption (Sections 3-2 & 5-1) are not included in any of these equations.

Recall from Section 4-2 that the power density at a distant point from a radar with an antenna gain of G_t is the power density from an isotropic antenna multiplied by the radar antenna gain.

Power density from radar, $P_D = \dfrac{P_t\,G_t}{4\pi\,R^2}$

If you could cover the entire spherical segment with your receiving antenna you would theoretically capture all of the transmitted energy. You can't do this because no antenna is large enough. (A two degree segment would be about a mile and three-quarters across at fifty miles from the transmitter.)

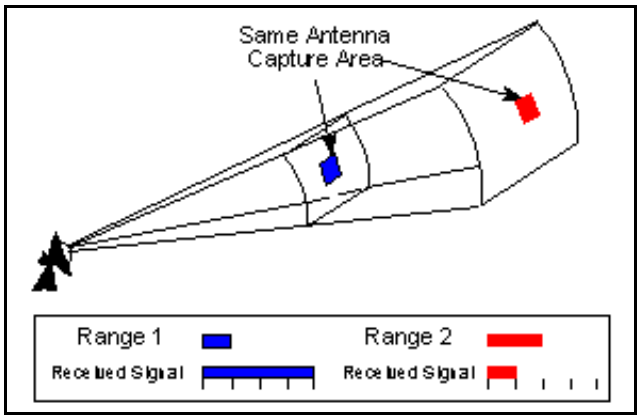

Figure 1. Power Density vs. Range.

A receiving antenna captures a portion of this power determined by its effective capture Area (A_e). The received power available at the antenna terminals is the power density times the effective capture area (A_e) of the receiving antenna.

For a given receiver antenna size the capture area is constant no matter how far it is from the transmitter, as illustrated in Figure 1. This concept is shown in the following equation:
Peak Power at Receiver input,

$$P_R \text{ (or S)} = P_D A_e = \frac{P_t G_t A_e}{4\pi R^2} \quad \text{which is known as the one-way (beacon) equation} \qquad \textbf{[2]}$$

In order to maximize energy transfer between an antenna and transmitter or receiver, the antenna size should correlate with frequency. For reasonable antenna efficiency, the size of an antenna will be greater than $\lambda/4$. Control of beamwidth shape may become a problem when the size of the active element exceeds several wavelengths.

The relation between an antenna's effective capture area (A_e) or effective aperture and its Gain (G) is:

$$\textit{Antenna Gain, } G = \frac{4\pi A_e}{\lambda^2} \qquad \textbf{[3]}$$

$$\textit{or : Equivalent Area, } A_e = \frac{G\lambda^2}{4\pi} \qquad \textbf{[4]}$$

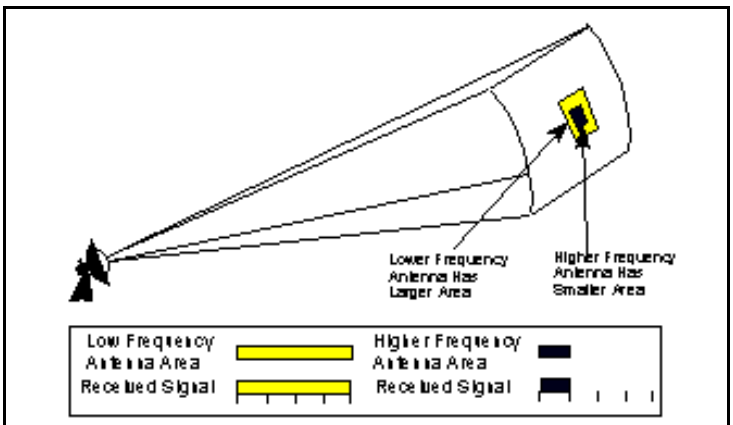

Figure 2. Capture Area vs. Frequency.

Since the effective aperture is in units of length squared, from equation [3], it is seen that gain is proportional to the effective aperture normalized by the wavelength. This physically means that to maintain the same gain when doubling the frequency, the area is reduced by 1/4. This concept is illustrated in Figure 2.

If equation [4] is substituted into equation [2], the following relationship results:

$$\textit{Peak Power at Receiver Input} = S \text{ (or } P_R) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 R^2} = \frac{P_t G_t G_r \lambda^2}{(4\pi R)^2} \qquad \textbf{[5]}$$

This is the signal calculated one-way from a transmitter to a receiver. For instance, a radar application might be to determine the signal received by a RWR, ESM, or an ELINT receiver. It is a general purpose equation and could be applied to almost any line-of-sight transmitter to receiver situation if the RF is higher than 100 MHZ.

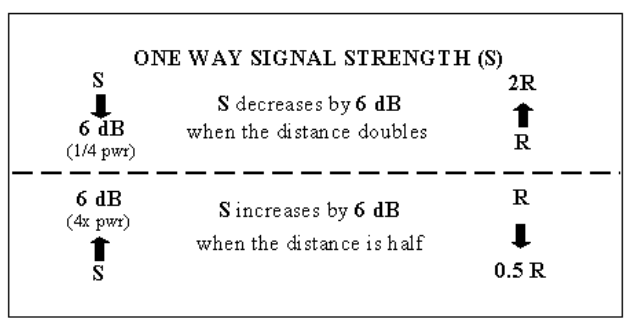

Values of K_1 (dB)		
Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
NM	37.8	97.8
km	32.45	92.45
m	-27.55	32.45
yd	-28.33	31.67
ft	-37.87	22.13

The free space travel of radio waves can, of course, be blocked, reflected, or distorted by objects in their path such as buildings, flocks of birds, chaff, and the earth itself.

As illustrated in Figure 1, as the distance is doubled the received signal power decreases by 1/4 (6 dB). This is due to the R^2 term in equation [5].

To illustrate this, blow up a round balloon and draw a square on the side of it. If you release air so that the diameter or radius is decreased by 1/2, the square shrinks to 1/4 the size. If you further blow up the balloon, so the diameter or radius is doubled, the square has quadrupled in area.

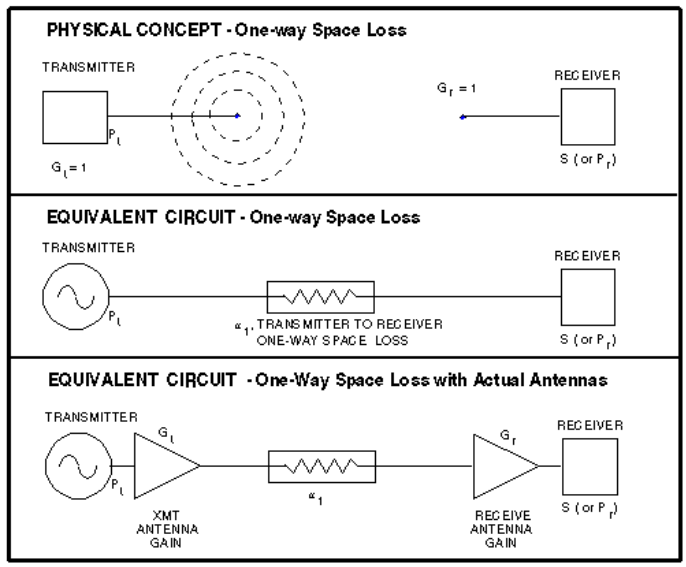

Figure 3. Concept of One-Way Space Loss.

The one-way free space loss factor (α_1), (sometimes called the path loss factor) is given by the term $(4\pi R^2)(4\pi/\lambda^2)$ or $(4\pi R/\lambda)^2$. As shown in Figure 3, the loss is due to the ratio of two factors (1) the effective radiated area of the transmit antenna, which is the surface area of a sphere ($4\pi R^2$) at that distance (R), and (2) the effective capture area (A_e) of the receive antenna which has a gain of one. If a receiving antenna could capture the whole surface area of the sphere, there would be no spreading loss, but a practical antenna will capture only a small part of the spherical radiation. Space loss is calculated using isotropic antennas for both transmit and receive, so α_1 is independent of the actual antenna. Using Gr = 1 in equation [11] in Section 3-1, $A_e = \lambda^2/4\pi$. Since this term is in the denominator of α_1, the higher the frequency (lower λ) the more the space loss. Since G_t and G_r are part of the one-way radar equation, S (or P_r) is adjusted according to actual antennas as shown in the last portion of Figure 3. The value of the received signal (S) is:

$$S\,(or\ P_R) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 R^2} = P_t G_t G_r \left[\frac{\lambda^2}{(4\pi R)^2}\right] \qquad \textbf{[6]}$$

To convert this equation to dB form, it is rewritten as:

$$10\ \mathrm{Log}\,(S \text{ or } P_r) = 10\ \mathrm{Log}\,(P_t G_t G_r) + 20\ \mathrm{Log}\left[\frac{\lambda}{4\pi f R}\right] \qquad \textbf{[7]}$$

Since $\lambda = c / f$, equation [7] can be rewritten as:

$$10\ \mathrm{Log}\ (S \text{ or } P_r) = 10\ \mathrm{Log}(P_t G_t G_r) - \alpha_1 \qquad \textbf{[8]}$$

Where the one-way free space loss, α_1, is defined as: $\alpha_1 = 20\ \mathrm{Log}\left[\frac{4\pi f R}{c}\right]$* **[9]**

The signal received equation in dB form is: $10\log (P_r \text{ or } S) = 10\log P_t + 10\log G_t + 10\log G_r - \alpha_1$ **[10]**

The one-way free space loss, α_1, can be given in terms of a variable and constant term as follows:

$$\alpha_1 = 20 \text{ Log}\left[\frac{4\pi f\ R}{c}\right]^* = 20 \text{ Log } f_1 R + K_1 \quad (in\ dB) \qquad \textbf{[11]}$$

The value of f_1 can be either in MHz or GHz as shown with commonly used units of R in the adjoining table.

$$where\ K_1 = 20 \text{ Log}\left[\frac{4\pi}{c} \bullet (Conversion\ units\ if\ not\ in\ m/\sec, m, and\ Hz)\right]$$

Note: To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain.

A value for the one-way free space loss (α_1) can be obtained from:

(a) The One-way Free Space Loss graph (Figure 4). Added accuracy can be obtained using the Frequency Extrapolation graph (Figure 5)

(b) The space loss nomograph (Figure 6 or 7)

(c) The formula for α_1, equation [11].

FOR EXAMPLE:

Find the value of the one-way free space loss, α_1, for an RF of 7.5 GHz at 100 NM.

(a) From Figure 4, find 100 NM on the X-axis and estimate where 7.5 GHz is located between the 1 and 10 GHz lines (note dot). Read α_1 as 155 dB. An alternate way would be to read the α_1 at 1 GHz (138 dB) and add the frequency extrapolation value (17.5 dB for 7.5:1, dot on Figure 5) to obtain the same 155 dB value.

(b) From the nomogram (Figure 6), the value of α_1 can be read as 155 dB (Note the dashed line).

(c) From the equation 11, the precise value of α_1 is 155.3 dB.

Remember, α_1 is a free space value. If there is atmospheric attenuation because of absorption of RF due to certain molecules in the atmosphere or weather conditions etc., the atmospheric attenuation is in addition to the space loss (refer to Section 5-1).

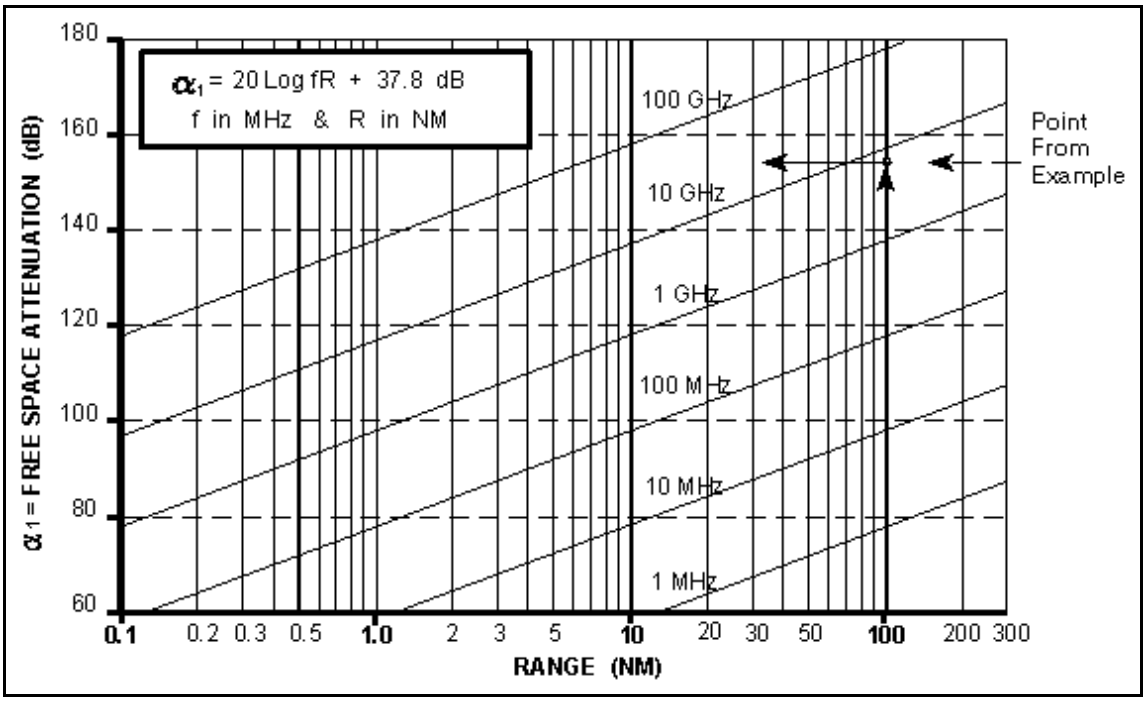

Figure 4. One-Way Free Space Loss.

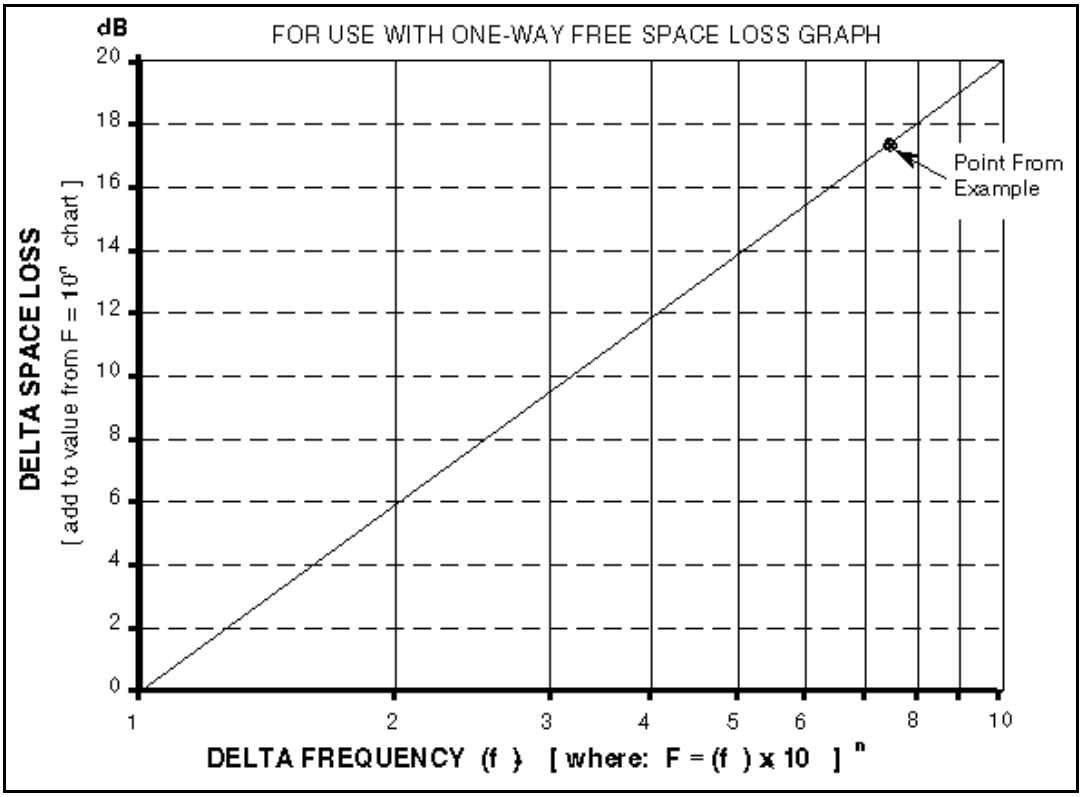

Figure 5. Frequency Extrapolation.

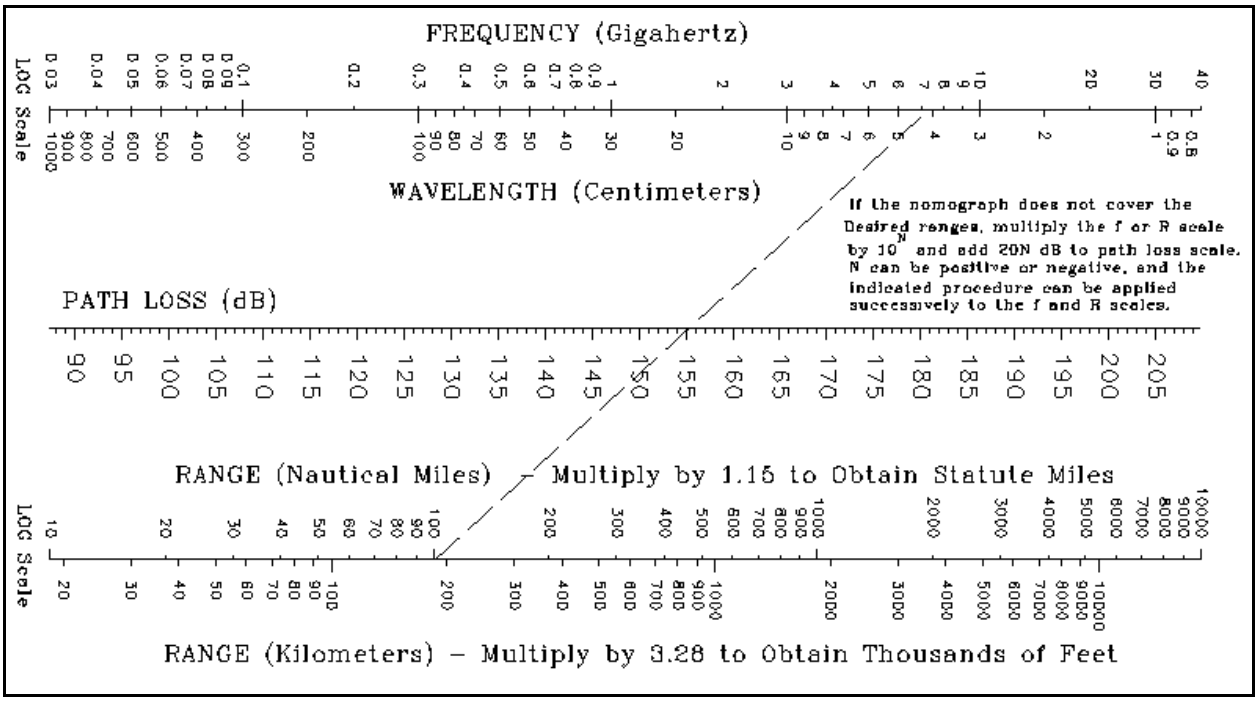

Figure 6. One-Way Space Loss Nomograph for Distances Greater Than 10 Nautical Miles.

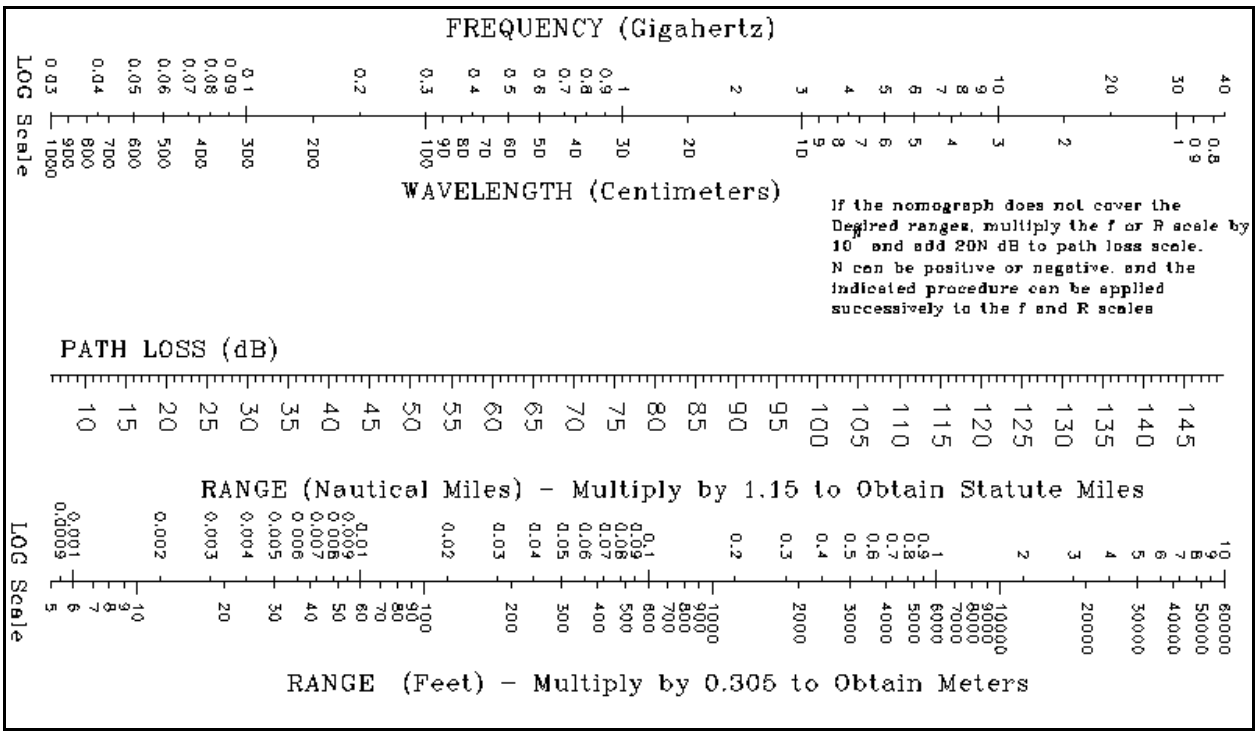

Figure 7. One-Way Space Loss Nomograph for Distances Less Than 10 Nautical Miles.

Figure 8 is the visualization of the losses occurring in one-way radar equation. Note: To avoid having to include additional terms, always combine any transmission line loss with antenna gain. Losses due to antenna polarization and atmospheric absorption also need to be included.

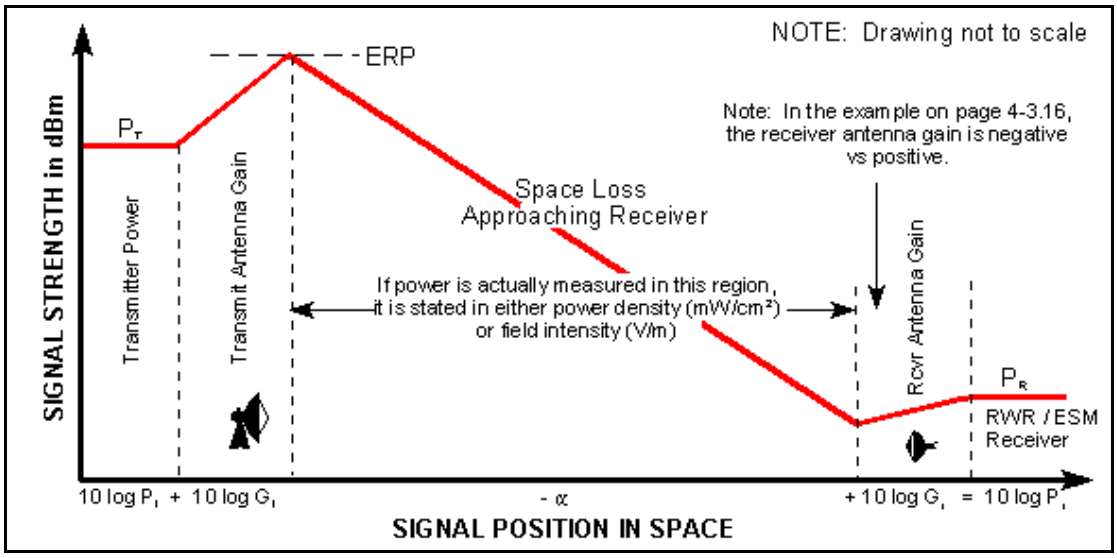

Figure 8. Visualization of One-Way Radar Equation.

RWR/ESM RANGE EQUATION (One-Way)

The one-way radar (signal strength) equation [5] is rearranged to calculate the maximum range R_{max} of RWR/ESM receivers. It occurs when the received radar signal just equals S_{min} as follows:

$$R_{max} \cong \left[\frac{P_t G_t G_r \lambda^2}{(4\pi)^2 S_{min}}\right]^{\frac{1}{2}} \; or \; \left[\frac{P_t G_t G_r c^2}{(4\pi f)^2 S_{min}}\right]^{\frac{1}{2}} \; or \; \left[\frac{P_t G_t A_e}{4\pi S_{min}}\right]^{\frac{1}{2}} \qquad \textbf{[12]}$$

In log form:

$$20\log R_{max} = 10\log P_t + 10\log G_t - 10\log S_{min} - 20\log f + 20\log(c/4\pi) \qquad \textbf{[13]}$$

and since $K_1 = 20\log\{4\pi/c$ times conversion units if not in m/sec, m, and Hz$\}$
(Refer to Section 4-3 for values of K_1).

$$10\log R_{max} = \tfrac{1}{2}[\,10\log P_t + 10\log G_t - 10\log S_{min} - 20\log f - K_1] \quad \text{(keep } P_t \text{ and } S_{min} \text{ in same units)} \qquad \textbf{[14]}$$

If you want to convert back from dB, then $R_{max} \cong \frac{10^{M\,dB}}{20}$, where M dB is the resulting number in the brackets of equation 14.

From Section 5-2, Receiver Sensitivity / Noise, S_{min} is related to the noise factor S:

$$S_{min} = (S/N)_{min}\,(NF)KT_oB \qquad \textbf{[15]}$$

The one-way RWR/ESM range equation becomes:

$$R_{max} \cong \left[\frac{P_t G_t G_r \lambda^2}{(4\pi)^2 (S/N)_{min} (NF) K T_o B}\right]^{\frac{1}{2}} \; or \; \left[\frac{P_t G_t G_r c^2}{(4\pi f)^2 (S/N)_{min} (NF) K T_o B}\right]^{\frac{1}{2}} \; or \; \left[\frac{P_t G_t A_e}{4\pi (S/N)_{min} (NF) K T_o B}\right]^{\frac{1}{2}} \qquad \textbf{[16]}$$

RWR/ESM RANGE INCREASE AS A RESULT OF A SENSITIVITY INCREASE

As shown in equation [12] $S_{min}^{-1} \propto R_{max}^2$. Therefore, -10 log $S_{min} \propto$ 20 logR_{max} and the following table results:

<u>% Range Increase:</u> Range + (% Range Increase) x Range = New Range
i.e., for a 6 dB sensitivity increase, 500 miles +100% x 500 miles = 1,000 miles
<u>Range Multiplier</u>: Range x Range Multiplier = New Range
i.e., for a 6 dB sensitivity increase 500 miles x 2 = 1,000 miles

dB Sensitivity Increase	% Range Increase	Range Multiplier	dB Sensitivity Increase	% Range Increase	Range Multiplier
+ 0.5	6	1.06	10	216	3.16
1.0	12	1.12	11	255	3.55
1.5	19	1.19	12	298	3.98
2	26	1.26	13	347	4.47
3	41	1.41	14	401	5.01
4	58	1.58	15	462	5.62
5	78	1.78	16	531	6.31
6	100	2.0	17	608	7.08
7	124	2.24	18	694	7.94
8	151	2.51	19	791	8.91
9	182	2.82	20	900	10.0

RWR/ESM RANGE DECREASE AS A RESULT OF A SENSITIVITY DECREASE

As shown in equation [12] $S_{min}^{-1} \propto R_{max}^2$. Therefore, -10 log $S_{min} \propto$ 20 logR_{max} and the following table results:

<u>% Range Decrease:</u> Range - (% Range decrease) x Range = New Range
i.e., for a 6 dB sensitivity decrease, 500 miles - 50% x 500 miles = 250 miles
<u>Range Multiplier</u>: Range x Range Multiplier = New Range
i.e., for a 6 dB sensitivity decrease 500 miles x .5 = 250 miles

dB Sensitivity Decrease	% Range Decrease	Range Multiplier	dB Sensitivity Decrease	% Range Decrease	Range Multiplier
- 0.5	6	0.94	-10	68	0.32
- 1.0	11	0.89	- 11	72	0.28
- 1.5	16	0.84	- 12	75	0.25
- 2	21	0.79	- 13	78	0.22
- 3	29	0.71	- 14	80	0.20
- 4	37	0.63	- 15	82	0.18
- 5	44	0.56	- 16	84	0.16
- 6	50	0.50	- 17	86	0.14
- 7	56	0.44	- 18	87	0.13
- 8	60	0.4	- 19	89	0.11
- 9	65	0.35	- 20	90	0.10

Example of One-Way Signal Strength: A 5 (or 7) GHz radar has a 70 dBm signal fed through a 5 dB loss transmission line to an antenna that has 45 dB gain. An aircraft that is flying 31 km from the radar has an aft EW antenna with -1 dB gain and a 5 dB line loss to the EW receiver (assume all antenna polarizations are the same).

Note: The respective transmission line losses will be combined with antenna gains, i.e.:

-5 +45 = 40 dB, -5 - 1 = -6 dB, -10 + 5 = -5 dB.

(1) What is the power level at the input of the EW receiver?

Answer (1): P_r at the input to the EW receiver = Transmitter power - xmt cable loss + xmt antenna gain - space loss + rcvr antenna gain - rcvr cable loss.

Space loss (from Section 4-3) @ 5 GHz = 20 log fR + K_1 = 20 log (5x31) + 92.44 = 136.25 dB. Therefore:

P_r = 70 + 40 - 136.25 - 6 = -32.25 dBm @ 5 GHz (P_r = -35.17 dBm @ 7 GHz since α_1 = 139.17 dB)

(2) If the received signal is fed to a jammer with a gain of 60 dB, feeding a 10 dB loss transmission line which is connected to an antenna with 5 dB gain, what is the power level from the jammer at the input to the receiver of the 5 (or 7) GHz radar?

Answer (2): P_r at the input to the radar receiver = Power at the input to the EW receiver+ Jammer gain - jammer cable loss + jammer antenna gain - space loss + radar rcvr antenna gain - radar rcvr cable loss. Therefore:

P_r = -32.25 + 60 - 5 - 136.25 + 40 = -73.5 dBm @ 5 GHz. (P_r = -79.34 dBm @ 7 GHz since α_1 = 139.17 dB and P_t = -35.17 dBm).

This problem continues in Sections 4-4, 4-7, and 4-10.

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TWO-WAY RADAR EQUATION (MONOSTATIC)

In this section the radar equation is derived from the one-way equation (transmitter to receiver) which is then extended to the two-way radar equation. The following is a summary of the important equations to be derived here:

TWO-WAY RADAR EQUATION (MONOSTATIC)

Peak power at the radar receiver input is:

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4} = P_t G_t G_r \left[\frac{\sigma c^2}{(4\pi)^3 f^2 R^4} \right]^*$$

Note : $\lambda = c/f$ and $\sigma = RCS$

** keep λ or c, σ, and R in the same units*

On reducing the above equation to log form we have:

$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r + 10\log \sigma - 20\log f - 40\log R - 30\log 4\pi + 20\log c$

or in simplified terms: $10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - 2\alpha_1$ (in dB)

Note: Losses due to antenna polarization and atmospheric absorption (Sections 3-2 and 5-1) are not included in these equations.

Target gain factor, $G_\sigma = 10\log \sigma + 20\log f_1 + K_2$ (in dB)

K_2 Values (dB)	RCS (σ) (units)	f_1 in MHz K_2 =	f_1 in GHz K_2 =
	m^2	-38.54	21.46
	ft^2	-48.86	11.14

One-way free space loss, $\alpha_1 = 20\log (f_1 R) + K_1$ (in dB)

K_1 Values (dB)	Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
	NM	37.8	97.8
	Km	32.45	92.45
	m	-27.55	32.45
	yd	-28.33	31.67
	ft	-37.87	22.13

Figure 1 illustrates the physical concept and equivalent circuit for a target being illuminated by a monostatic radar (transmitter and receiver co-located). Note the similarity of Figure 1 to Figure 3 in Section 4-3. Transmitted power, transmitting and receiving antenna gains, and the one-way free space loss are the same as those described in Section 4-3. The physical arrangement of the elements is different, of course, but otherwise the only difference is the addition of the equivalent gain of the target RCS factor.

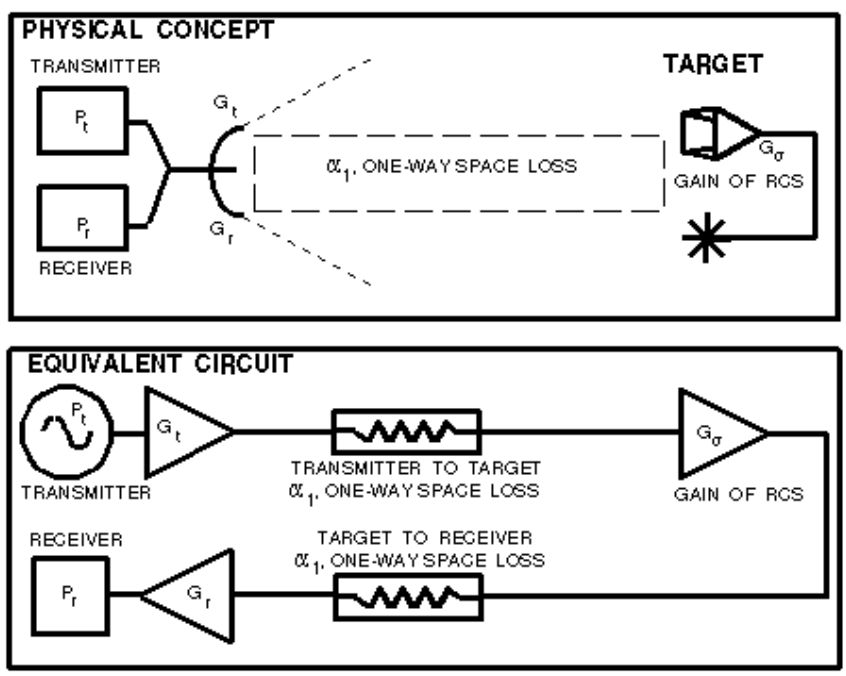

Figure 1. The Two-Way Monostatic Radar Equation Visualized.

From Section 4-3, One-Way Radar Equation / RF Propagation, the power in the receiver is:

$$\begin{matrix}\textit{Received Signal}\\ \textit{at Target}\end{matrix} = \frac{P_t G_t G_r \lambda^2}{(4\pi R)^2} \qquad \textbf{[1]}$$

From equation [3] in Section 4-3: $$\textit{Antenna Gain}, G = \frac{4\pi A_e}{\lambda^2} \qquad \textbf{[2]}$$

Similar to a receiving antenna, a radar target also intercepts a portion of the power, but reflects (reradiates) it in the direction of the radar. The amount of power reflected toward the radar is determined by the Radar Cross Section (RCS) of the target. RCS is a characteristic of the target that represents its size as seen by the radar and has the dimensions of area (σ) as shown in Section 4-11. RCS area is not the same as physical area. But, for a radar target, the power reflected in the radar's direction is equivalent to re-radiation of the power captured by an antenna of area σ (the RCS). Therefore, the effective capture area (A_e) of the receiving antenna is replaced by the RCS (σ).

$$G_r = \frac{4\pi\sigma}{\lambda^2} \qquad \textbf{[3]}$$

so we now have:

$$\begin{matrix}\textit{Reflected Signal}\\ \textit{from target}\end{matrix} = \frac{P_t G_t \lambda^2 4\pi\sigma}{(4\pi R)^2 \lambda^2} \qquad \textbf{[4]}$$

The equation for the power reflected in the radar's direction is the same as equation [1] except that P_t G_t, which was the original transmitted power, is replaced with the reflected signal power from the target, from equation [4]. This gives:

$$\begin{matrix}\textit{Reflected Signal Received Back}\\ \textit{at Input to Radar Receiver}\end{matrix} = \frac{P_t G_t \lambda^2 4\pi\sigma}{(4\pi R)^2 \lambda^2} \, x \, \frac{G_r \lambda^2}{(4\pi R)^2} \qquad \textbf{[5]}$$

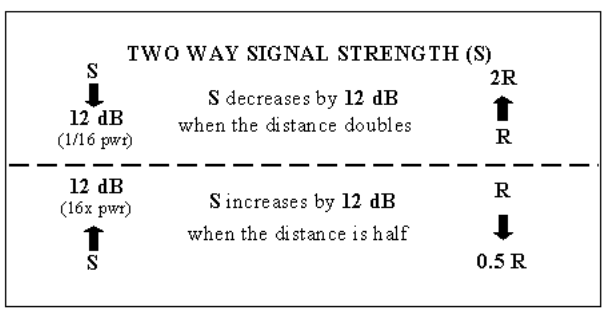

If like terms are cancelled, the two-way radar equation results. The peak power at the radar receiver input is:

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4} = P_t G_t G_r \left[\frac{\sigma c^2}{(4\pi)^3 f^2 R^4}\right]^* \qquad \textbf{[6]}$$

* Note: λ=c/*f* and σ = RCS. Keep λ or c, σ, and R in the same units.

On reducing equation [6] to log form we have:

$$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r + 10\log \sigma - 20\log f - 40\log R - 30\log 4\pi + 20\log c \qquad \textbf{[7]}$$

Target Gain Factor

If Equation [5] terms are rearranged instead of cancelled, a recognizable form results:

$$S\ (or\ P_r) = (P_t G_t G_r) \bullet \left[\frac{\lambda^2}{(4\pi R)^2}\right] \bullet \left[\frac{4\pi\sigma}{\lambda^2}\right] \bullet \left[\frac{\lambda^2}{(4\pi R)^2}\right] \qquad \textbf{[8]}$$

In log form:

$$10\log[S\ (or\ P_r)] = 10\log P_t + 10\log G_t + 10\log G_r + 20\log\left[\frac{\lambda}{4\pi R}\right] + 10\log\left[\frac{4\pi\sigma}{\lambda^2}\right] + 20\log\left[\frac{\lambda}{4\pi R}\right] \qquad \textbf{[9]}$$

The fourth and sixth terms can each be recognized as -α, where α is the one-way free space loss factor defined in Section 4-3. The fifth term containing RCS (σ) is the only new factor, and it is the "Target Gain Factor."

In simplified terms the equation becomes:

$$10\log\ [S\ (\text{or } P_r)] = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - 2\alpha_1 \qquad \text{(in dB)} \qquad \textbf{[10]}$$

Where α_1 and G_σ are as follows:

From Section 4-3, equation [11], the space loss in dB is given by:

$$\alpha_1 = 20\log\left[\frac{4\pi f\ R}{c}\right]^* = 20\log f_1 R + K_1 \quad where\ K_1 = 20\log\left[\frac{4\pi}{c} \bullet (Conversion\ units\ if\ not\ in\ m/s\ ec, m, and\ Hz)\right] \qquad \textbf{[11]}$$

* Keep c and R in the same units. The table of values for K_1 is again presented here for completeness. The constant, K_1, in the table includes a range and frequency unit conversion factor.

One-way free space loss, α_1 = 20log (f_1R) + K_1 (in dB)			
K_1 Values (dB)	Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
	NM	37.8	97.8
	Km	32.45	92.45
	m	-27.55	32.45
	yd	-28.33	31.67
	ft	-37.87	22.13

While it's understood that RCS is the antenna aperture area equivalent to an isotropically radiated target return signal, the target gain factor represents a gain, as shown in the equivalent circuit of Figure 1. The Target Gain Factor expressed in dB is G_σ as shown in equation [12].

$$G_\sigma = 10\log\left[\frac{4\pi\sigma}{\lambda^2}\right] = 10\log\left[\frac{4\pi\sigma f^2}{c^2}\right] = 10\log\sigma + 20\log f_1 + K_2 \quad (in\ dB) \qquad \textbf{[12]}$$

$$where: K_2 = 10\log\left[\frac{4\pi}{c^2} \bullet \left(\begin{array}{c} Frequency\ and\ RCS \\ conversions\ as\ required \end{array} \frac{(Hz\ to\ MHz\ or\ GHz)^2}{(meters\ to\ feet)^2}\right)\right]$$

The "Target Gain Factor" (G_σ) is a composite of RCS, frequency, and dimension conversion factors and is called by various names: "Gain of RCS", "Equivalent Gain of RCS", "Gain of Target Cross Section", and in dB form "Gain-sub-Sigma".

If frequency is given in MHz and RCS (σ) is in m^2, the formula for G_σ is:

$$G_\sigma = 10\log\sigma + 20\log f_1 + 10\log\left[4\pi \bullet \left(\frac{\sec}{3\,x\,10^8\,m}\right)^2 \bullet m^2 \bullet \left(\frac{1x\,10^6}{\sec}\right)^2\right] \qquad \textbf{[13]}$$

or:

$$G_\sigma = 10\log\sigma + 20\log f_1 - 38.54 \quad (in\ dB) \qquad \textbf{[14]}$$

Target gain factor, G_σ = 10log σ + 20log f_1 + K_2 (in dB)			
K_2 Values			
(dB)	RCS (σ)	f_1 in MHz	f_1 in GHz
(units)	K_2 =	K_2 =	
m^2	-38.54	21.46	
ft^2	-48.86	11.14	

For this example, the constant K_2 is -38.54 dB. K_2 values for various area and frequency and frequency units are summarized in the adjoining table.

In the two-way radar equation, the one-way free space loss factor (α_1) is used twice, once for the radar transmitter to target path and once for the target to radar receiver path. The radar illustrated in Figure 1 is monostatic so the two path losses are the same and the values of the two α_1's are the same.

If the transmission loss in Figure 1 from P_t to G_t equals the loss from G_r to P_r, and $G_r = G_t$, then equation [10] can be written as:

$$10\log [S \text{ or } P_r] = 10\log P_t + 20\log G_{tr} - 2\alpha_1 + G_\sigma \quad \text{(in dB)} \qquad \textbf{[15]}$$

The space loss factor (α_1) and the target gain factor (G_σ) include all the necessary unit conversions so that they can be used directly with the most common units. Because the factors are given in dB form, they are more convenient to use and allow calculation without a calculator when the factors are read from a chart or nomograph.

Most radars are monostatic. That is, the radar transmitting and receiving antennas are literally the same antenna. There are some radars that are considered "monostatic" but have separate transmitting and receiving antennas that are co-located. In that case, equation [10] could require two different antenna gain factors as originally derived:

$$10\log [S \text{ or } P_r] = 10\log P_t + 10\log G_t + 10\log G_r - 2\alpha_1 + G_\sigma \quad \text{(in dB)} \qquad \textbf{[16]}$$

Note: To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain.

Figure 2 is the visualization of the path losses occurring with the two-way radar equation. **Note:** to avoid having to include additional terms, always combine any transmission line loss with antenna gain. Losses due to antenna polarization and atmospheric absorption also need to be included.

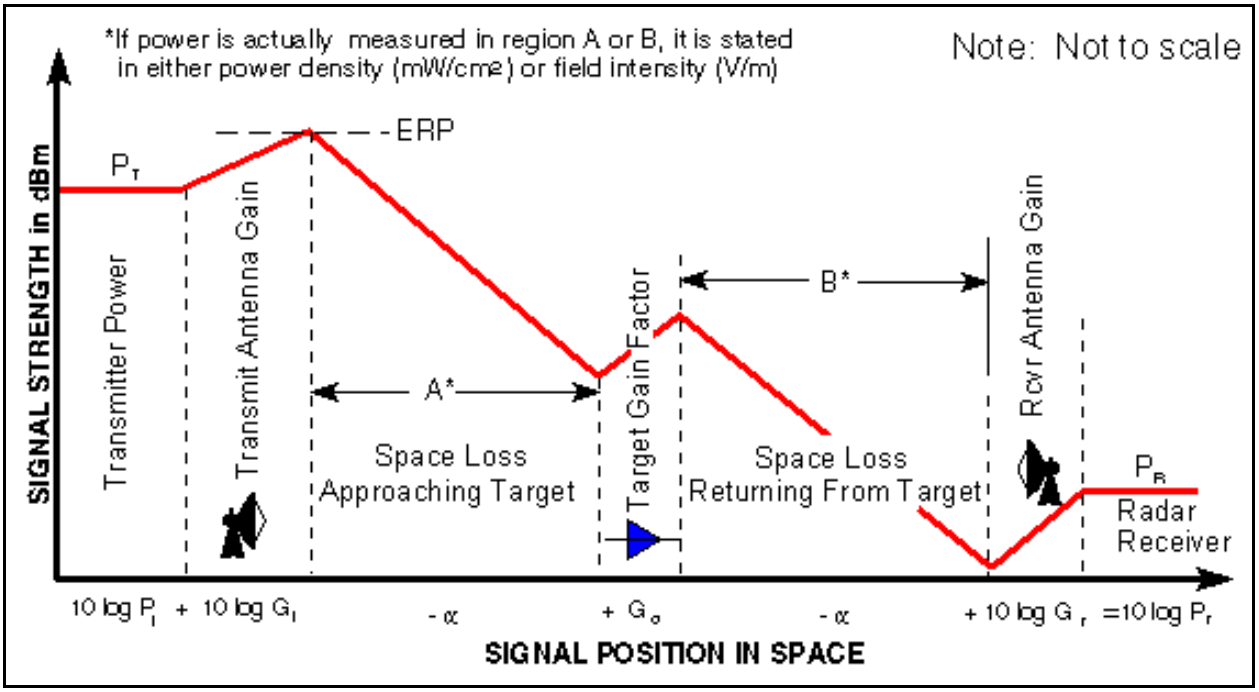

Figure 2. Visualization of Two-Way Radar Equation.

RADAR RANGE EQUATION (Two-Way Equation)

The Radar Equation is often called the "Radar Range Equation." The Radar Range Equation is simply the Radar Equation rewritten to solve for maximum Range. The maximum radar range (R_{max}) is the distance beyond which the target can no longer be detected and correctly processed. It occurs when the received echo signal just equals S_{min}.

The Radar Range Equation is then:

$$R_{\max} \cong \left[\frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 S_{\min}}\right]^{\frac{1}{4}} \; or \; \left[\frac{P_t G_t G_r c^2 \sigma]}{(4\pi)^3 f^2 S_{\min}}\right]^{\frac{1}{4}} \; or \; \left[\frac{P_t G_t A_e \sigma}{(4\pi)^2 S_{\min}}\right]^{\frac{1}{4}} \qquad \textbf{[17]}$$

The first equation, of the three above, is given in Log form by:

$$40\log R_{max} \cong 10\log P_t + 10\log G_t + 10\log G_r + 10\log \sigma - 10\log S_{min} - 20\log f - 30\log 4\pi + 20\log c \qquad \textbf{[18]}$$

As shown previously, Since K_1 = 20log [(4π/c) times conversion units if not in m/sec, m, and Hz], we have:

$$10\log R_{max} \cong \tfrac{1}{4}\,[10\log P_t + 10\log G_t + 10\log G_r + 10\log \sigma - 10\log S_{min} - 20\log f_1 - K_1 - 10.99\text{ dB}] \qquad \textbf{[19]}$$

If you want to convert back from dB, then

$$R_{max} \cong 10^{\frac{M\,dB}{40}}$$

Where M dB is the resulting number within the brackets of equation 19.

From Section 5-2, Receiver Sensitivity / Noise, S_{min} is related to the noise factors by:

One-way free space loss, $\alpha_1 = 20\log(f_1 R) + K_1$ (in dB)

K_1 Values (dB)	Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
	NM	37.8	97.8
	Km	32.45	92.45
	m	-27.55	32.45
	yd	-28.33	31.67
	ft	-37.87	22.13

$$S_{min} = (S/N)_{min}(NF)\,kT_0 B \qquad \textbf{[20]}$$

The Radar Range Equation for a tracking radar (target continuously in the antenna beam) becomes:

$$R_{max} \cong \left[\frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 (S/N)_{min}(NF)kT_0 B}\right]^{\frac{1}{4}} \text{ or } \left[\frac{P_t G_t G_r c^2 \sigma}{(4\pi)^3 f^2 (S/N)_{min}(NF)kT_o B}\right]^{\frac{1}{4}} \text{ or } \left[\frac{P_t G_t A_e \sigma}{(4\pi)^2 (S/N)_{min}(NF)kT_o B}\right]^{\frac{1}{4}} \qquad \textbf{[21]}$$

P_t in equations [17], [19], and [21] is the peak power of a CW or pulse signal. For pulse signals these equations assume the radar pulse is square. If not, there is less power since P_t is actually the average power within the pulse width of the radar signal. Equations [17] and [19] relate the maximum detection range to S_{min}, the minimum signal which can be detected and processed (the receiver sensitivity). The bandwidth (B) in equations [20] and [21] is directly related to S_{min}. B is approximately equal to 1/PW. Thus a wider pulse width means a narrower receiver bandwidth which lowers S_{min}, assuming no integration.

One cannot arbitrarily change the receiver bandwidth, since it has to match the transmitted signal. The "widest pulse width" occurs when the signal approaches a CW signal (see Section 2-11). A CW signal requires a very narrow bandwidth (approximately 100 Hz). Therefore, receiver noise is very low and good sensitivity results (see Section 5-2). If the radar pulse is narrow, the receiver filter bandwidth must be increased for a match (see Section 5-2), i.e. a 1 μs pulse requires a bandwidth of approximately 1 MHz. This increases receiver noise and decreases sensitivity.

If the radar transmitter can increase its PRF (decreasing PRI) and its receiver performs integration over time, an increase in PRF can permit the receiver to "pull" coherent signals out of the noise thus reducing S/N_{min} thereby increasing the detection range. Note that a PRF increase may limit the maximum range due to the creation of overlapping return echoes (see Section 2-10).

There are also other factors that limit the maximum practical detection range. With a scanning radar, there is loss if the receiver integration time exceeds the radar's time on target. Many radars would be range limited by line-of-sight/radar horizon (see Section 2-9) well before a typical target faded below S_{min}. Range can also be reduced by losses due to antenna polarization and atmospheric absorption (see Sections 3-2 and 5-1).

Two-Way Radar Equation (Example)

Assume that a 5 GHz radar has a 70 dBm (10 kilowatt) signal fed through a 5 dB loss transmission line to a transmit/receive antenna that has 45 dB gain. An aircraft that is flying 31 km from the radar has an RCS of 9 m^2. What is the signal level at the input to the radar receiver? (There is an additional loss due to any antenna polarization mismatch but that loss will not be addressed in this problem). This problem continues in Sections 4-3, 4-7, and 4-10.

Answer:
Starting with: $10\log S = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - 2\alpha_1$ (in dB)

We know that: $\alpha_1 = 20\log f R + K_1 = 20\log (5x31) + 92.44 = 136.25$ dB

and that: $G_\sigma = 10\log \sigma + 20\log f_1 + K_2 = 10\log 9 + 20\log 5 + 21.46 = 44.98$ dB (see Table 1)
(Note: The aircraft transmission line losses (-5 dB) will be combined with the antenna gain (45 dB) for both receive and transmit paths of the radar)

So, substituting in we have: $10\log S = 70 + 40 + 40 + 44.98 - 2(136.25) =$ **-77.52 dBm** @ 5 GHz

The answer changes to -80.44 dBm if the tracking radar operates at 7 GHz provided the antenna gains and the aircraft RCS are the same at both frequencies.

$\alpha_1 = 20\log (7x31) + 92.44 = 139.17$ dB, $G_\sigma = 10\log 9 + 20\log 7 + 21.46 = 47.9$ dB (see Table 1)

$10\log S = 70 + 40 + 40 + 47.9 - 2(139.17) =$ **-80.44 dBm** @ 7 GHz

Table 1. Values of the Target Gain Factor (G_σ) in dB for Various Values of Frequency and RCS.

Frequency (GHz)	RCS - Square meters						
	0.05	5	9	10	100	1,000	10,000
0.5 GHz	2.44	22.42	24.98	25.44	35.44	45.44	55.44
1 GHz	8.46	28.46	31.0	31.46	41.46	51.46	61.46
5 GHz	22.44	42.44	44.98	45.44	55.44	65.44	75.44
7 GHz	25.36	45.36	47.9	48.36	58.36	68.36	78.36
10 GHz	28.46	48.46	51.0	51.46	61.46	71.46	81.46
20 GHz	34.48	54.48	57.02	57.48	67.48	77.48	87.48
40 GHz	40.50	60.48	63.04	63.5	73.5	83.5	93.5

Note: Shaded values were used in the examples.

TWO-WAY RADAR RANGE INCREASE AS A RESULT OF A SENSITIVITY INCREASE

As shown in equation [17] $S_{min}^{-1} \propto R_{max}^4$. Therefore, $-10 \log S_{min} \propto 40 \log R_{max}$ and the table below results:

<u>% Range Increase:</u> Range + (% Range Increase) x Range = New Range
i.e., for a 12 dB sensitivity increase, 500 miles +100% x 500 miles = 1,000 miles
<u>Range Multiplier</u>: Range x Range Multiplier = New Range
i.e., for a 12 dB sensitivity increase 500 miles x 2 = 1,000 miles

Table 2. Effects of Sensitivity Increase.

dB Sensitivity Increase	% Range Increase	Range Multiplier	dB Sensitivity Increase	% Range Increase	Range Multiplier
+ 0.5	3	1.03	10	78	1.78
1.0	6	1.06	11	88	1.88
1.5	9	1.09	12	100	2.00
2	12	1.12	13	111	2.11
3	19	1.19	14	124	2.24
4	26	1.26	15	137	2.37
5	33	1.33	16	151	2.51
6	41	1.41	17	166	2.66
7	50	1.50	18	182	2.82
8	58	1.58	19	198	2.98
9	68	1.68	20	216	3.16

TWO-WAY RADAR RANGE DECREASE AS A RESULT OF A SENSITIVITY DECREASE

As shown in equation [17] $S_{min}^{-1} \propto R_{max}^{4}$ Therefore, $-10 \log S_{min} \propto 40 \log R_{max}$ and the table below results:

<u>% Range Decrease:</u> Range - (% Range Decrease) x Range = New Range
i.e., for a 12 dB sensitivity decrease, 500 miles - 50% x 500 miles = 250 miles

<u>Range Multiplier</u>: Range x Range Multiplier = New Range
i.e., for a 12 dB sensitivity decrease 500 miles x 0.5 = 250 miles

Table 3. Effects of Sensitivity Decrease.

dB Sensitivity Decrease	% Range Decrease	Range Multiplier	dB Sensitivity Decrease	% Range Decrease	Range Multiplier
- 0.5	3	0.97	-10	44	0.56
- 1.0	6	0.94	- 11	47	0.53
- 1.5	8	0.92	- 12	50	0.50
- 2	11	0.89	- 13	53	0.47
- 3	16	0.84	- 14	55	0.45
- 4	21	0.79	- 15	58	0.42
- 5	25	0.75	- 16	60	0.40
- 6	29	0.71	- 17	62	0.38
- 7	33	0.67	- 18	65	0.35
- 8	37	0.63	- 19	67	0.33
- 9	40	0.60	- 20	68	0.32

ALTERNATE TWO-WAY RADAR EQUATION

In this section the same radar equation factors are grouped differently to create different constants as is used by some authors.

TWO-WAY RADAR EQUATION (MONOSTATIC)

Peak power at the radar receiver input is:

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4} = \frac{P_t G_t G_{rsigma} c^2}{(4\pi)^3 f^2 R^4} * \quad \left(Note: \lambda = \frac{c}{f} \text{ and } \sigma \text{ is RCS} \right) \qquad \textbf{[1]}$$

* Keep λ or c, σ, and R in the same units. On reducing the above equation to log form we have:

or: $\mathbf{10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - \alpha_2}$ (in dB)

Where: $\alpha_2 = 20\log f_1 R^2 - 10\log \sigma + K_3$, and $K_3 = -10\log c^2/(4\pi)^3$

Note:
Losses due to antenna polarization and atmospheric absorption (Sections 3-2 and 5-1) are not included in these equations

K_3 Values:
(dB)

Range Units	f_1 in MHz σ in m^2	f_1 in GHz σ in m^2	f_1 in MHz σ in ft^2	f_1 in GHz σ in ft^2
NM	114.15	174.15	124.47	184.47
km	103.44	163.44	113.76	173.76
m	-16.56	43.44	-6.24	53.76
yd	-18.1	41.9	-7.78	52.22
ft	-37.2	22.8	-26.88	33.12

In the last section, we had the basic radar equation given as equation [6] and it is repeated as equation [1] in the table above.

In Section 4-4, in order to maintain the concept and use of the one-way space loss coefficient, α_1, we didn't cancel like terms which was done to form equation [6] there. Rather, we regrouped the factors of equation [5]. This resulted in two minus α_1 terms and we defined the remaining term as G_σ, which accounted for RCS (see equation [8] & [9]).

Some authors take a different approach, and instead develop an entirely new single factor α_2, which is used instead of the combination of α_1 and G_σ.

If equation [1] is reduced to log form, (and noting that $f = c/\lambda$) it becomes:

$$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - 20\log (f R^2) + 10\log \sigma + 10\log (c^2/(4\pi)^3) \qquad \textbf{[2]}$$

We now call the last three terms on the right minus α_2 and use it as a single term instead of the two terms α_1 and G_σ. The concept of dealing with one variable factor may be easier although we still need to know the range, frequency, and radar cross section to evaluate α_2. Additionally, we can no longer use a nomograph like we did in computing α_1 and visualize a two-way space loss consisting of two times the one-way space loss, since there are now 3 variables vs. two.

Equation [2] reduces to:

$$\mathbf{10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r - \alpha_2} \qquad \text{(in dB)} \qquad \textbf{[3]}$$

Where $\alpha_2 = 20\log(f_1 R^2) - 10\log\sigma + K_3$ and where f_1 is the MHz or GHz value of frequency and $K_3 = -10\log(c^2/(4\pi)^3) + 20\log$ (conversion for Hz to MHz or GHz)+ 40log (range unit conversions if not in meters) - 20log (RCS conversions for meters to feet)

The values of K_3 are given in the table above.

Comparing equation [3] to equation [10] in Section 4-4, it can be seen that $\alpha_2 = 2\alpha_1 - G_\sigma$.

TWO-WAY RADAR EQUATION (BISTATIC)

The following table contains a summary of the equations developed in this section.

TWO-WAY RADAR EQUATION (BISTATIC)

Peak power at the radar receiver input is:

$$P_r = \frac{P_t\, G_t\, G_r\, \lambda^2\, \sigma}{(4\pi)^3\, R_{Tx}^2\, R_{Rx}^2} = P_t\, G_t\, G_r \left[\frac{\sigma\, c^2}{(4\pi)^3\, f^{\,2}\, R_{Tx}^2\, R_{Rx}^2} \right]^*$$

Note : $\lambda = c/f$ and σ = RCS

** keep λ or c, σ, and R in the same units*

On reducing the above equation to log form we have:

$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r + 10\log \sigma - 20\log f + 20\log c - 30\log 4\pi - 20\log R_{Tx} - 20\log R_{Rx}$

or in simplified terms: $10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - \alpha_{Tx} - \alpha_{Rx}$ (in dB)

Where α_{Tx} corresponds to transmitter to target loss and α_{Rx} corresponds to target to receiver loss.

Note: Losses due to antenna polarization and atmospheric absorption (Sections 3-2 and 5-1) are not included in these equations.

Target gain factor, $G_\sigma = 10\log \sigma + 20\log f_1 + K_2$ (in dB)

K_2 Values (dB)

RCS (σ) (units)	f_1 in MHz K_2 =	f_1 in GHz K_2 =
m^2	-38.54	21.46
ft^2	-48.86	11.14

One-way free space loss, $\alpha_{Tx\ or\ Rx} = 20\log (f_1 R_{Tx\ or\ Rx}) + K_1$ (in dB)

K_1 Values (dB)

Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
NM	37.8	97.8
Km	32.45	92.45
m	-27.55	32.45
yd	-28.33	31.67
ft	-37.87	22.13

BISTATIC RADAR

There are also true bistatic radars - radars where the transmitter and receiver are in different locations as is depicted in Figure 1. The most commonly encountered bistatic radar application is the semi-active missile. The transmitter is located on, or near, the launch platform (surface or airborne), and the receiver is in the missile which is somewhere between the launch platform and the target.

The transmitting and receiving antennas are not the same and are not in the same location. Because the target-to-radar range is different from the target-to-missile range, the target-to-radar and target-to-missile space losses are different.

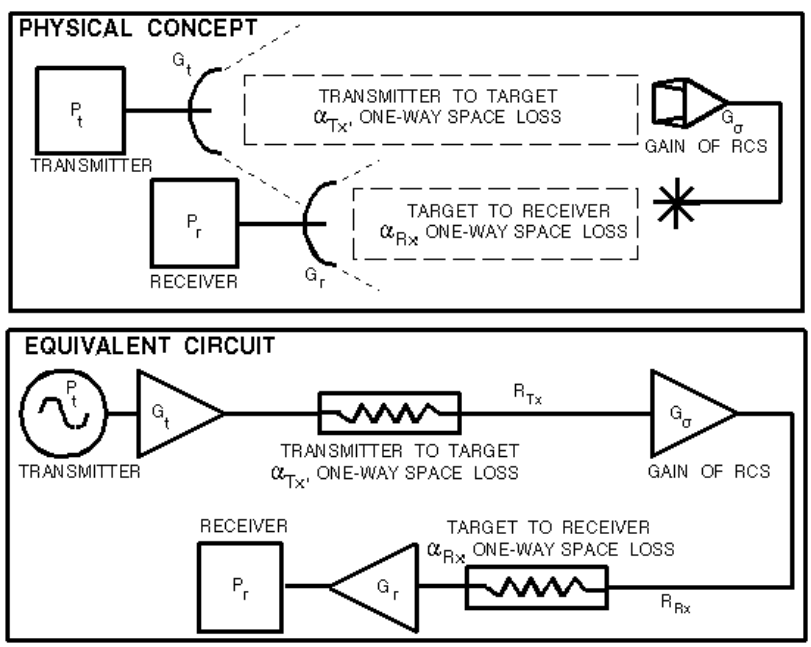

Figure 1. Bistatic Radar Visualized.

The peak power at the radar receiver input is:

$$P_r = \frac{P_t\, G_t\, G_r\, \lambda^2\, \sigma}{(4\pi)^3\, R_{Tx}^2\, R_{Rx}^2} = P_t\, G_t\, G_r \left[\frac{\sigma\, c^2}{(4\pi)^3\, f^2\, R_{Tx}^2\, R_{Rx}^2} \right] \qquad \left(Note : \lambda = \frac{c}{f} \text{ and } \sigma = RCS \right) \qquad \textbf{[1]}$$

Keep λ or c, σ, and R in the same units.

On reducing the above equation to log form we have:

$$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r + 10\log \sigma - 20\log f + 20\log c - 30\log 4\pi - 20\log R_{Tx} - 20\log R_{Rx} \quad \textbf{[2]}$$

or in simplified terms:

$$10\log P_r = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - \alpha_{Tx} - \alpha_{Rx} \quad \text{(in dB)} \qquad \textbf{[3]}$$

Where α_{Tx} corresponds to transmitter to target loss and α_{Rx} corresponds to target to receiver loss, or:

$\alpha_{Tx} = 20\log(f_1 T_{Tx}) + K_1$ (in dB) and $\alpha_{Rx} = 20\log(f_1 T_{Rx}) + K_1$ (in dB)

with K_1 values provided on page 4-6.1 and with f_1 being the MHz or GHz value of frequency.

Therefore, the difference between monostatic and bistatic calculations is that two α's are calculated for two different ranges and different gains may be required for transmit and receive antennas.

To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain.

As shown in Figure 2, it should also be noted that the bistatic RCS received by the missile is not always the same as the monostatic RCS. In general, the target's RCS varies with angle. Therefore, the bistatic RCS and monostatic RCS will be equal for receive and transmit antennas at the same angle to the target (but only if all three are in a line, as RCS also varies with elevation angle).

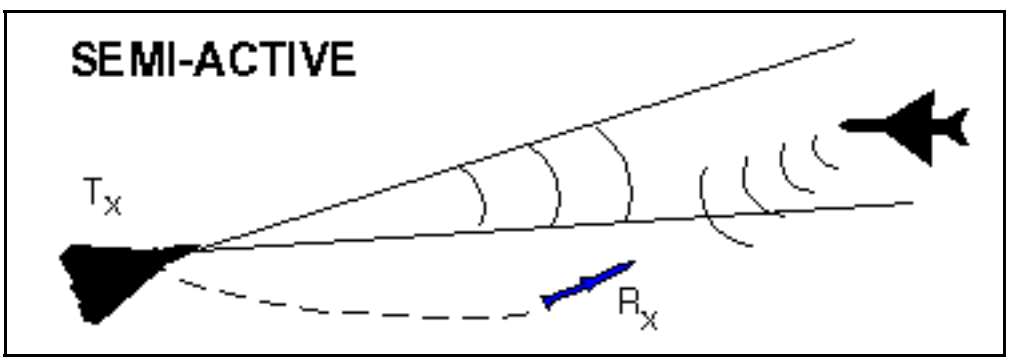

Figure 2. Bistatic RCS Varies.

JAMMING TO SIGNAL (J/S) RATIO - CONSTANT POWER [SATURATED] JAMMING

The following table contains a summary of the equations developed in this section.

JAMMING TO SIGNAL (J/S) RATIO (MONOSTATIC) $J/S = (P_j\, G_{ja} 4\pi\, R^2) / (P_t\, G_t\, \sigma)$ (ratio form)* or: $10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log\sigma^* + 10.99\text{ dB} + 20\log R^*$ Note (1): Neither f nor λ terms are part of these equations	* Keep R and σ in same units Target gain factor, (in dB) $G_\sigma = 10\log\sigma + 20\log f_1 + K_2$ K_2 Values (dB): RCS (σ) f_1 in MHz f_1 in GHz (units) K_2 = K_2 = m2 -38.54 21.46 ft2 -48.86 11.14
If simplified radar equations developed in previous sections are used: $10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - G_\sigma + \alpha_1$ (in dB) Note (2): the $20\log f_1$ term in $-G_\sigma$ cancels the $20\log f_1$ term in α_1	
JAMMING TO SIGNAL (J/S) RATIO (BISTATIC) R_{Tx} is the range from the radar transmitter to the target. See note (1). $J/S = (P_j\, G_{ja} 4\pi\, R_{Tx}^2) / (P_t\, G_t\, \sigma)$ (ratio form) * or: $10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log\sigma^* + 10.99\text{ dB} + 20\log R_{Tx}^*$	One-way free space loss (dB) α_1 or α_{Tx} = $20\log (f_1 R) + K_1$ K_1 Values (dB): Range f_1 in MHz f_1 in GHz (units) K_1 = K_1 = NM 37.8 97.8 km 32.45 92.45 m -27.55 32.45 ft -37.87 22.13
If simplified radar equations developed in previous sections are used: see note (2). $10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - G_\sigma + \alpha_{Tx}$ (in dB)	

This section derives the J/S ratio from the one-way range equation for J and the two-way range equation for S, and deals exclusively with active (transmitting) Electronic Attack (EA) devices or systems. Furthermore, the only purpose of EA is to prevent, delay, or confuse the radar processing of target information.

By official definition, EA can be either Jamming or Deception. This may be somewhat confusing because almost any type of active EA is commonly called "jamming," and the calculations of EA signal in the radar compared to the target signal in the radar commonly refer to the "jamming-to-signal" ratio ("J-to-S" ratio). Therefore this section uses the common jargon and the term "jammer" refers to any EA transmitter, and the term "jamming" refers to any EA transmission, whether Deception or Concealment.

Jamming: "Official" jamming should more aptly be called Concealment or Masking. Essentially, Concealment uses electronic transmissions to swamp the radar receiver and hide the targets. Concealment (Jamming) usually uses some form of noise as the transmitted signal. In this section, Concealment will be called "noise" or "noise jamming."

Deception: Deception might be better called Forgery. Deception uses electronic transmissions to forge false target signals that the radar receiver accepts and processes as real targets.

"J" designates the EA signal strength whether it originates from a noise jammer or from a deception system.

Basically, there are two different methods of employing active EA against hostile radars:

Self Protection EA
Support EA

For most practical purposes, Self Protection EEA is usually Deception and Support EA is usually noise jamming. As the name implies, Self Protection EA is EA that is used to protect the platform that it is on. Self Protection EA is often called "self screening jamming," "Defensive EA" or historically "Deception ECM." The top half of Figure 1 shows self-screening jamming.

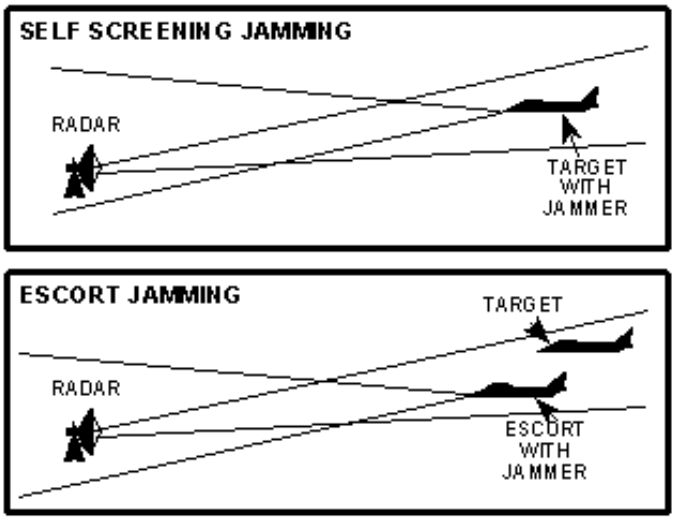

Figure 1. Self Protection and Escort Jamming.

The bottom half of Figure 1 illustrates escort jamming which is a special case of support jamming. If the escort platform is sufficiently close to the target, the J-to-S calculations are the same as for self protection EA.

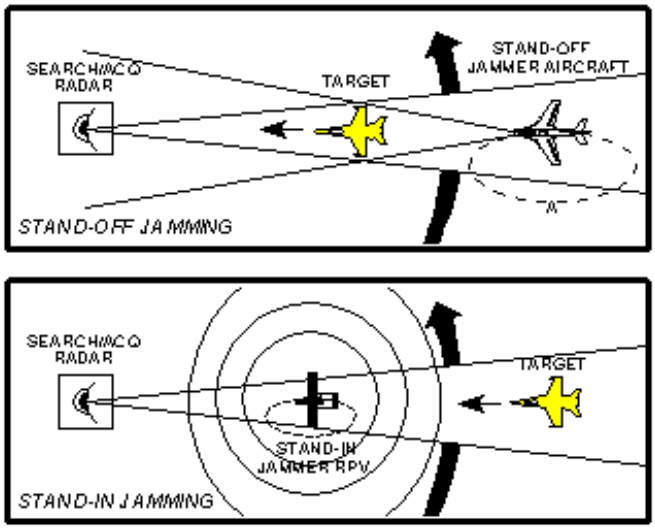

Figure 2. Support Jamming.

Support EA is electronic transmissions radiated from one platform and is used to protect other platforms or fulfill other mission requirements, like distraction or conditioning. Figure 2 illustrates two cases of support jamming protecting a striker - stand-off jamming (SOJ) and stand-in jamming (SIJ). For SOJ the support jamming platform is maintaining an orbit at a long range from the radar - usually beyond weapons range. For SIJ, a remotely piloted vehicle is orbiting very close to the victim radar. Obviously, the jamming power required for the SOJ to screen a target is much greater than the jamming power required for the SIJ to screen the same target.

When factoring EA into the radar equation, the quantities of greatest interest are "J-to-S" and Burn-Through Range.

"J-to-S" is the ratio of the signal strength of the jammer signal (J) to the signal strength of the target return signal (S). It is expressed as "J/S" and, in this section, is always in dB. J usually (but not always) must exceed S by some amount to be effective, therefore the desired result of a J/S calculation in dB is a positive number. Burn-through Range is the radar to target range where the target return signal can first be detected through the jamming and is usually slightly farther than crossover range where J=S. It is usually the range where the J/S just equals the minimum effective J/S (See Section 4-8).

The significance of "J-to-S" is sometimes misunderstood. The effectiveness of EA **is not** a direct mathematical function of "J-to-S." The magnitude of the "J-to-S" required for effectiveness is a function of the particular EA technique and of the radar it is being used against. Different EA techniques may very well require different "J-to-S" ratios against the same radar. When there is sufficient "J-to-S" for effectiveness, increasing it will rarely increase the effectiveness at a given range. Because modern radars can have sophisticated signal processing and/or EP capabilities, in certain radars too much "J-to-S" could cause the signal processor to ignore the jamming, or activate special anti-jamming modes. Increasing "J-to-S" (or the jammer power) does, however, allow the target aircraft to get much closer to the threat radar before burn-through occurs, which essentially means more power is better if it can be controlled when desired.

IMPORTANT NOTE: If the signal S is CW or PD and the Jamming J is amplitude modulated, then the J used in the formula has to be reduced from the peak value (due to sin x/x frequency distribution). The amount of reduction is dependent upon how much of the bandwidth is covered by the jamming signal. To get an exact value, integrals would have to be taken over the bandwidth. As a rule of thumb however:

- If the frequency of modulation is less than the BW of the tracking radar reduce J/S by 10 Log (duty cycle).
- If the frequency of modulation is greater than the BW of the tracking radar reduce J/S by 20 Log(duty cycle).

For example; if your jamming signal is square wave chopped (50% duty cycle) at a 100 Hz rate while jamming a 1 kHz bandwidth receiver, then the J/S is reduced by 3 dB from the maximum. If the duty cycle was 33%, then the reduction would be 4.8 dB. If the 50% and 33% duty cycle jamming signals were chopped at a 10 kHz (vice the 100 Hz) rate, the rule of thumb for jamming seen by the receiver would be down 6 dB and 9.6 dB, respectively, from the maximum since the 10 kHz chopping rate is greater than the 1 kHz receiver BW.

J/S for SELF PROTECTION EA vs. MONOSTATIC RADAR

Figure 3 is radar jamming visualized. The Physical concept of Figure 3 shows a monostatic radar that is the same as Figure 1, Section 4-4, and a jammer (transmitter) to radar (receiver) that is the same as Figure 3, Section 4-3. In other words, Figure 3 is simply the combination of the previous two visual concepts where there is only one receiver (the radar's).

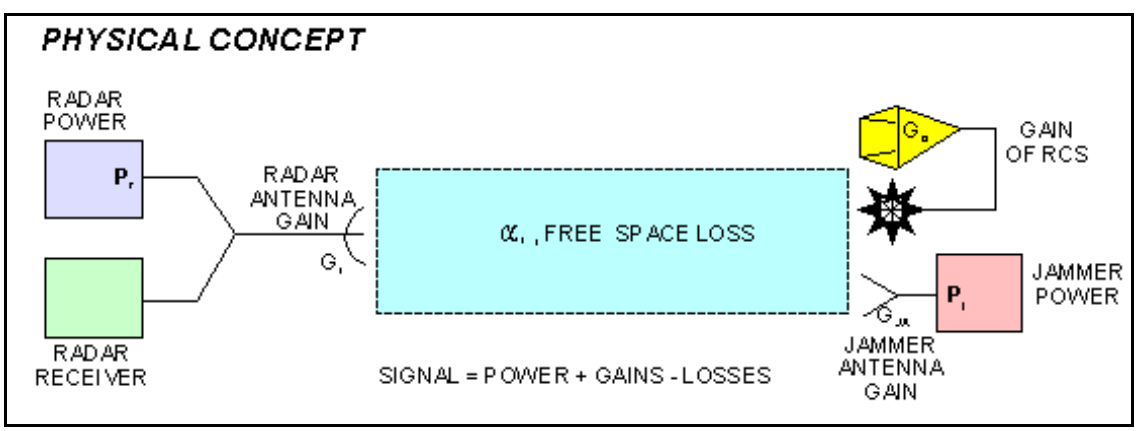

Figure 3. Radar Jamming Visualized.

The equivalent circuit shown in Figure 4 applies to jamming monostatic radars with either self protect EA or support EA. For self protect (or escort) vs. a monostatic radar, the jammer is on the target and the radar receive and transmit antennas are collocated so the three ranges and three space loss factors (α's) are the same.

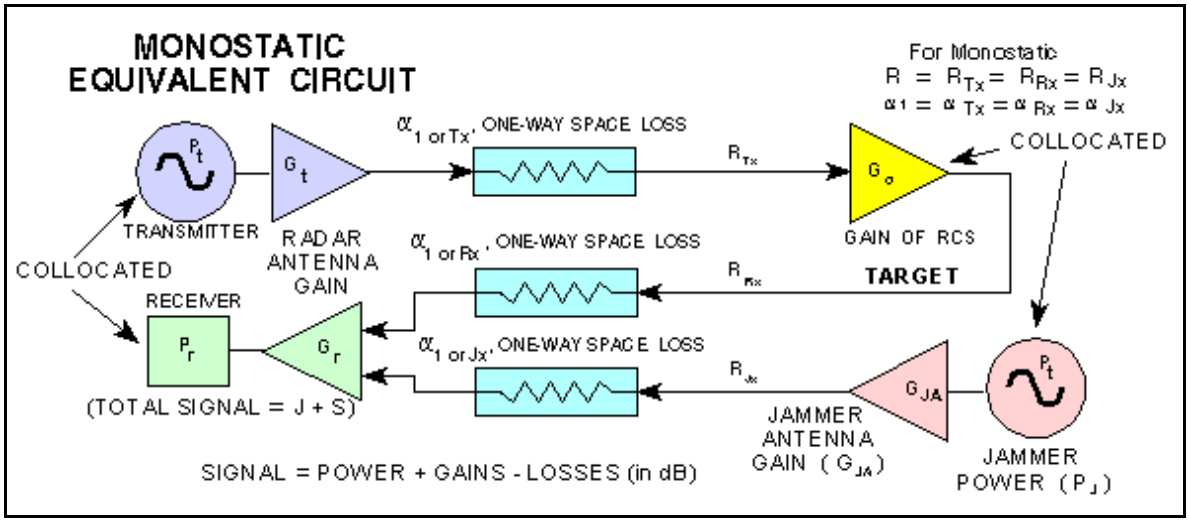

Figure 4. Monostatic Radar EA Equivalent Circuit.

<u>J-S Ratio (Monostatic)</u> - The ratio of the power received (P_{r1} or J) from the jamming signal transmitted from the target to the power received (P_{r2} or S) from the radar skin return from the target equals J/S.

From the one way range equation in Section 4-3: $$P_r 1 \text{ or } J = \frac{P_j G_{ja} G_r \lambda^2}{(4\pi R)^2} \quad \textbf{[1]}$$

From the two way range equation in Section 4.4: $$P_r 2 \text{ or } S = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4} \quad \textbf{[2]}$$

so $$\frac{J}{S} = \frac{P_j G_{ja} G_r \lambda^2 (4\pi)^3 R^4}{P_t G_t G_r \lambda^2 \sigma (4\pi R)^2} = \frac{P_j G_{ja} 4\pi R^2}{P_t G_t \sigma}^{*} \qquad (ratio\ form) \quad \textbf{[3]}$$

* Keep R and σ in the same units.

On reducing the above equation to log form we have:

$$10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log \sigma + 10\log 4\pi + 20\log R \quad \textbf{[4]}$$

or $$10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log \sigma + 10.99 \text{ dB} + 20\log R \quad \textbf{[5]}$$

Note: Neither *f* nor λ terms are part of the final form of equation [3] and equation [5].

J/S Calculations (Monostatic) Using a One Way Free Space Loss - The simplified radar equations developed in previous sections can be used to express J/S.

From the one way range equation Section 4-3:

$$10\log (P_{r1} \text{ or } J) = 10\log P_j + 10\log G_{ja} + 10\log G_r - \alpha_1 \quad \text{(in dB)} \qquad \textbf{[6]}$$

From the two way range equation in Section 4.4:

$$10\log (P_{r2} \text{ or } S) = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - 2\alpha_1 \quad \text{(in dB)} \qquad \textbf{[7]}$$

$$10\log (J/S) = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - G_\sigma + \alpha_1 \quad \text{(in dB)} \qquad \textbf{[8]}$$

Note: To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain. The $20\log f_1$ term in $-G_\sigma$ cancels the $20\log f_1$ term in α_1.

Target gain factor, $G_\sigma = 10\log \sigma + 20\log f_1 + K_2$ (in dB)			One-way free space loss, $\alpha_1 = 20\log (f_1 R) + K_1$ (in dB)			
K_2 Values (dB)	RCS (σ) (units)	f_1 in MHz K_2 =	f_1 in GHz K_2 =	K_1 Values (dB)	Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
	m^2	-38.54	21.46		NM	37.8	97.8
	ft^2	-48.86	11.14		km	32.45	92.45
					m	-27.55	32.45
					yd	-28.33	31.67
					ft	-37.87	22.13

J/S for SELF PROTECTION EA vs. BISTATIC RADAR

The semi-active missile illustrated in Figure 5 is the typical bistatic radar which would require the target to have self protection EA to survive. In this case, the jammer is on the target and the target to missile receiver range is the same as the jammer to receiver range, but the radar to target range is different. Therefore, only two of the ranges and two of the α's (Figure 6.) are the same.

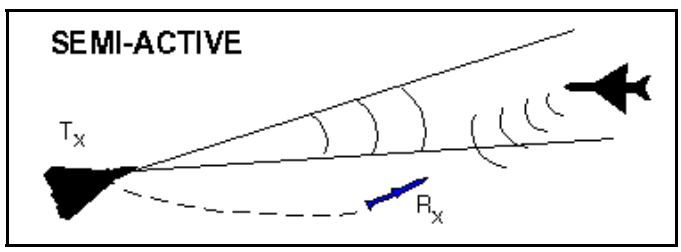

Figure 5. Bistatic Radar.

In the following equations:

α_{Tx} = The one-way space loss from the radar transmitter to the target for range R_{Tx}
α_{Rx} = The one-way space loss from the target to the missile receiver for range R_{Rx}

Like the monostatic radar, the bistatic jamming and reflected target signals travel the same path from the target and enter the receiver (missile in this case) via the same antenna. In both monostatic and bistatic J/S equations this common range cancels, so both J/S equations are left with an R_{Tx}^2 or 20 log R_{Tx} term. Since in the monostatic case $R_{Tx} = R_{Rx}$ and $\alpha_{Tx} = \alpha_{Rx}$, only R or α_1 is used in the equations. Therefore, the

bistatic J/S equations [11], [13], or [14] will work for monostatic J/S calculations, but the opposite is only true if bistatic R_{Tx} and α_{Tx} terms are used for R or α_1 terms in monostatic equations [3], [5], and [8].

The equivalent circuit shown in Figure 6 applies to jamming bistatic radar. For self protect (or escort) vs. a bistatic radar, the jammer is on the target and the radar receive and transmit antennas are at separate locations so only two of the three ranges and two of the three space loss factors (α's) are the same.

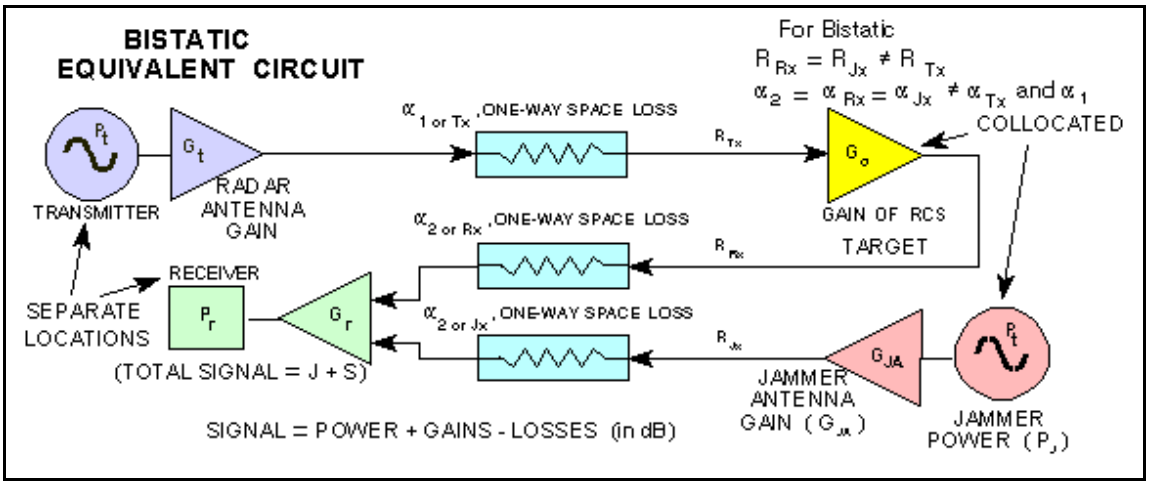

Figure 6. Bistatic Radar EA Equivalent Circuit.

<u>J-to-S Ratio (Bistatic)</u> When the radar's transmit antenna is located remotely from the receiving antenna (Figure 6), the ratio of the power received (P_{r1} or J) from the jamming signal transmitted from the target to the power received (P_{r2} or S) from the radar skin return from the target equals J/S. For jammer effectiveness J normally has to be greater than S.

From the one way range equation in Section 4-3: $$P_r 1 \text{ or } J = \frac{P_j G_{ja} G_r \lambda^2}{(4\pi R_{Rx})^2} \qquad (R_{Jx} = R_{Rx}) \qquad \textbf{[9]}$$

From the two way range equation in Section 4.4: $$P_r 2 \text{ or } S = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R_{Tx}^2 R_{Rx}^2} \qquad \textbf{[10]}$$

so $$\frac{J}{S} = \frac{P_j G_{ja} G_r \lambda^2 (4\pi)^3 R_{Tx}^2 R_{Rx}^2}{P_t G_t G_r \lambda^2 \sigma (4\pi R_{Rx})^2} = \frac{P_j G_{ja} 4\pi R_{Tx}^2}{P_t G_t \sigma}^{*} \qquad \textit{(ratio form)} \qquad \textbf{[11]}$$

* Keep R and σ in the same units.

On reducing the above equation to log form we have:

$$10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log \sigma + 10\log 4\pi + 20\log R_{Tx} \qquad \textbf{[12]}$$

or $$10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log \sigma + 10.99 \text{ dB} + 20\log R_{Tx} \qquad \textbf{[13]}$$

Note: To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain. Neither *f* nor λ terms are part of the final form of equation [11] and equation [13].

Bistatic J/S Calculations (Bistatic) Using a One Way Free Space Loss - The simplified radar equations developed in previous sections can be used to express J/S.

From the one way range equation in Section 4-3:

$10\log (P_{r1} \text{ or } J) = 10\log P_j + 10\log G_{ja} + 10\log G_r - \alpha_{Rx}$ (all factors dB) **[14]**

From the two way range equation in Section 4-4:
$10\log (P_{r2} \text{ or } S) = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - \alpha_{Tx} - \alpha_{Rx}$ (all factors dB) **[15]**

$10\log (J/S) = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - G_\sigma + \alpha_{Tx}$ (all factors dB) **[16]**

Note: To avoid having to include additional terms for these calculations, always combine any transmission line loss with antenna gain. The $20\log f_1$ term in $-G_\sigma$ cancels the $20\log f_1$ term in α_1.

Target gain factor, $G_\sigma = 10\log \sigma + 20\log f_1 + K_2$ (in dB)				One-way free space loss $\alpha_{Tx \text{ or } Rx} = 20\log f_1 R_{Tx \text{ or } Rx} + K_1$ (in dB)			
K_2 Values (dB)	RCS (σ) (units)	f_1 in MHz K_2 =	f_1 in GHz K_2 =	K_1 Values (dB)	Range (units)	f_1 in MHz K_1 =	f_1 in GHz K_1 =
	m^2	-38.54	21.46		NM	37.8	97.8
	ft^2	-48.86	11.14		km	32.45	92.45
					m	-27.55	32.45
					yd	-28.33	31.67
					ft	-37.87	22.13

Saturated J/S (Monostatic) Example (Constant Power Jamming)

Assume that a 5 GHz radar has a 70 dBm signal fed through a 5 dB loss transmission line to an antenna that has 45 dB gain. An aircraft is flying 31 km from the radar. The aft EW antenna has -1 dB gain and a 5 dB line loss to the EW receiver (there is an additional loss due to any antenna polarization mismatch but that loss will not be addressed in this problem). The aircraft has a jammer that provides 30 dBm saturated output if the received signal is above -35 dBm. The jammer feeds a 10 dB loss transmission line which is connected to an antenna with a 5 dB gain. If the RCS of the aircraft is 9 m^2, what is the J/S level received by the tracking radar?

Answer: The received signal at the jammer is the same as the example in Section 4-3, i.e. answer (1) = -32.3 dBm @ 5 GHz. Since the received signal is above -35 dBm, the jammer will operate in the saturated mode, and equation [5] can be used. (See Section 4-10 for an example of a jammer in the linear region.)

$10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log \sigma + 10.99 \text{ dB} + 20\log R$

Note: the respective transmission line losses will be combined with antenna gains,
i.e. -5 + 45 = 40 dB & -10 +5 = -5 dB.

$10\log J/S = 30 - 5 - 70 - 40 - 9.54 + 10.99 + 89.8 = 6.25 \text{ dB @ 5 GHz}^*$

* The answer is still 6.25 dB if the tracking radar operates at 7 GHz provided the antenna gains and the aircraft RCS are the same at both frequencies.

In this example, there is inadequate jamming power at each frequency if the J/S needs to be 10 dB or greater to be effective. One solution would be to replace the jammer with one that has a greater power output. If the antenna of the aircraft and the radar are not the proper polarization, additional power will also be required (see Section 3-2).

BURN-THROUGH / CROSSOVER RANGE

The burn-through equations are derived in this section. These equations are most commonly used in jammer type of applications. The following is a summary of the important equations explored in this section:

J/S CROSSOVER RANGE (MONOSTATIC) (J = S)

$$R_{J=S} = [\ (P_t\ G_t\ \sigma) / (P_j\ G_{ja}\ 4\pi)\ ]^{1/2} \qquad \text{(dB Ratio)}$$

or $20 \log R_{J=S} = 10\log P_t + 10\log G_t + 10\log \sigma - 10\log P_j - 10\log G_{ja} - 10.99$ dB

If simplified radar equations already converted to dB are used:

$20 \log R_{J=S} = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} - K_1 - 20\log f_1$ (dB)

* Keep P_t & P_j in same units
Keep R and σ in same units

K_1 Values (dB):

Range (units)	f_1 in MHz K_1 =	in GHz K_1 =
m	-27.55	32.45
ft	-37.87	22.13

BURN-THROUGH RANGE (MONOSTATIC)

The radar to target range where the target return signal (S) can first be detected through the EA (J).

$$R_{BT} = [\ (P_t\ G_t\ \sigma\ J_{min\ eff}) / (P_j\ G_{ja}\ 4\pi\ S)\ ]^{1/2} \qquad \text{(dB Ratio)}$$

or $20\log R_{BT} = 10\log P_t + 10\log G_t + 10\log\sigma - 10\log P_j - 10\log G_{ja} + 10\log(J_{min\ eff}/S) - 10.99$

If simplified radar equations already converted to dB are used:

$20\log R_{BT} = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} - K_1 + 10\log(J_{min\ eff}/S) - 20\log f_1$(in dB)*

f_1 is MHz or GHz value of frequency

Target gain factor (dB)

$G_\sigma = 10\log \sigma + 20\log f_1 + K_2$

K_2 Values (dB):

RCS (σ) (units)	f_1 in MHz K_2 =	in GHz K_2 =
m^2	-38.54	21.46
ft^2	-48.86	11.14

BURN-THROUGH RANGE (BISTATIC)

R_{Tx} is the range from the radar transmitter to the target and is different from R_{Rx} which is the range from the target to the receiver. Use Monostatic equations and substitute R_{Tx} for R

CROSSOVER RANGE and BURN-THROUGH RANGE

To present the values of J and S, (or J/S) over a minimum to maximum radar to target range of interest, equation [1], Section 4-7. which has a slope of 20 log for J vs. range and equation [2], Section 4-7, which has a slope of 40 log for S vs. range are plotted. When plotted on semi-log graph paper, J and S (or J/S) vs. range are straight lines as illustrated in Figure 1.

Figure 1 is a sample graph - it cannot be used for data.

The crossing of the J and S lines (known as crossover) gives the range where J = S (about 1.29 NM), and shows that shorter ranges will produce target signals greater than the jamming signal.

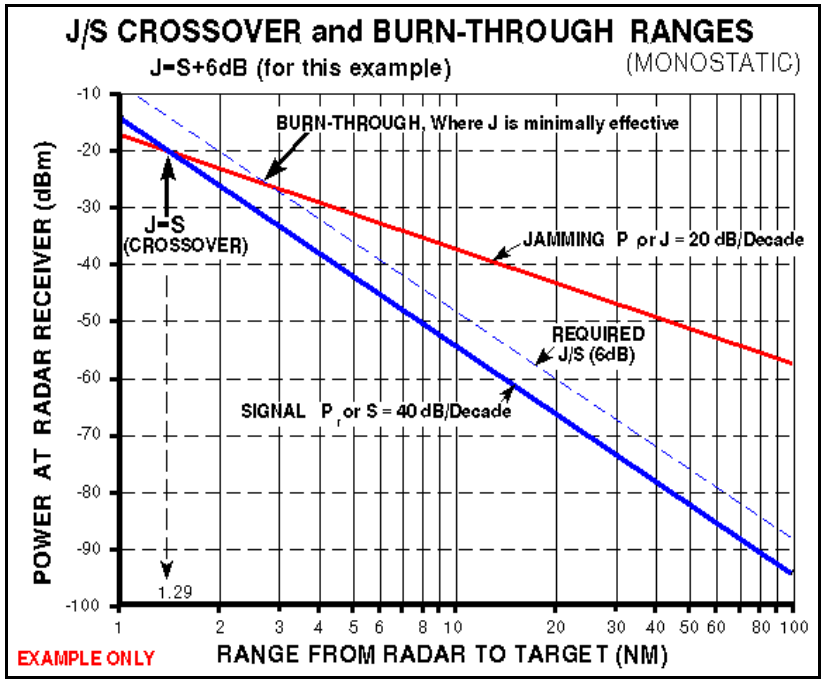

Figure 1. Sample J and S Graph.

The point where the radar power overcomes the jamming signal is known as burn-through. The crossover point where J = S could be the burn-through range, but it usually isn't because normally J/S > 0 dB to be effective due to the task of differentiating the signal from the jamming noise floor (see receiver sensitivity section). For this example, the J/S required for the EA to be effective is given as 6 dB, as shown by the dotted line. This required J/S line crosses the jamming line at about 2.8 NM which, in this example, is the burn-through range.

In this particular example, we have:

P_t = 80 dBm	G_t = 42 dB
P_j = 50 dBm	G_{ja} = 6 dB
σ = 18 m^2	f = 5.9 GHz (not necessary for all calculations)

A radar can be designed with higher than necessary power for earlier burn-through on jamming targets. Naturally that would also have the added advantage of earlier detection of non-jamming targets as well.

> Note: To avoid having to include additional terms for the following calculations, always combine any transmission line loss with antenna gain.

CROSSOVER AND BURN-THROUGH RANGE EQUATIONS (MONOSTATIC)

To calculate the crossover range or burn-through range the J/S equation must be solved for range. From equation [3], Section 4-7:

$$\frac{J}{S} = \frac{P_j\, G_{ja}\, 4\pi\, R^2}{P_t\, G_t\, \sigma} \qquad \textit{(ratio form)} \qquad \text{Solving for R:} \quad R = \sqrt{\frac{P_t\, G_t\, \sigma\, J}{P_j\, G_{ja}\, 4\pi\, S}} \qquad \textbf{[1]}$$

<u>BURN-THROUGH RANGE (MONOSTATIC)</u> - Burn-through Range (Monostatic) is the radar to target range where the target return signal (S) can first be detected through the jamming (J). It is usually the range when the J/S just equals the minimum effective J/S.

$$R_{BT} = \sqrt{\frac{P_t\, G_t\, \sigma\, J_{\min eff}}{P_j\, G_{ja}\, 4\pi\, S}} \qquad \text{(burn-through range)} \qquad \textbf{[2]}$$

or in dB form, (using 10log 4π = 10.99 dB):

$$20\log R_{BT} = 10\log P_t + 10\log G_t + 10\log \sigma - 10\log P_j - 10\log G_{ja} + 10\log (J_{\min eff}/S) - 10.99 \text{ dB} \qquad \textbf{[3]}$$

<u>RANGE WHEN J/S CROSSOVER OCCURS (MONOSTATIC)</u> - The crossover of the jammer's 20 dB/decade power line and the skin return signal's 40 dB/decade power line of Figure 1 occurs for the case where J = S in dB or J/S=1 in ratio. Substituting into equation [1] yields:

$$R_{(J=S)} = \sqrt{\frac{P_t\, G_t\, \sigma}{P_j\, G_{ja}\, 4\pi}} \qquad \text{(Crossover range)} \qquad \textbf{[4]}$$

or in dB form:

$$20\log R_{J=S} = 10\log P_t + 10\log G_t + 10\log \sigma - 10\log P_j - 10\log G_{ja} - 10.99 \text{ dB} \qquad \textbf{[5]}$$

Note: keep R and σ in same units in all equations.

CROSSOVER AND BURN-THROUGH EQUATIONS (MONOSTATIC) USING α - ONE WAY FREE SPACE LOSS

The other crossover burn-through range formulas can be confusing because a frequency term is subtracted (equations [6], [7] and [8]), but both ranges are independent of frequency. This subtraction is necessary because when J/S is calculated directly as previously shown, λ^2 or $(c/f)^2$ terms canceled, whereas in the simplified radar equations, a frequency term is part of the G_σ term and has to be cancelled if one solves for R. From equation [8], Section 4-7:

$$10\log J/S = 10\log P_j + 10\log G_{ja} - 10\log P_t - 10\log G_t - G_\sigma + \alpha_1 \qquad \text{(factors in dB)}$$

or rearranging: $\alpha_1 = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} + 10\log (J/S)$

from Section 4-4: $\alpha_1 = 20\log f_1 R_1 + K_1$ or $20\log R_1 = \alpha_1 - K_1 - 20\log f_1$

then substituting for α_1:

$$20\log R_1 = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} - K_1 + 10\log (J/S) - 20\log f_1 \quad \text{(in dB)} \qquad \textbf{[6]}$$

<u>EQUATION FOR BURN-THROUGH RANGE (MONOSTATIC)</u> - Burn-through occurs at the range when the J/S just equals the minimum effective J/S. G_σ and K_1 are as defined on page 4-8.1.

$$20\log R_{BT} = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} - K_1 + 10\log (J_{min\ eff}/S) - 20\log f_1 \quad \text{(in dB)} \qquad \textbf{[7]}$$

<u>EQUATION FOR THE RANGE WHEN J/S CROSSOVER OCCURS (MONOSTATIC)</u>

The J/S crossover range occurs for the case where J = S, substituting into equation [6] yields:

$$20\log R_{J=S} = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} - K_1 - 20\log f_1 \quad \text{(factors in dB)} \qquad \textbf{[8]}$$

BURN-THROUGH RANGE (BISTATIC)

Bistatic J/S crossover range is the radar-to-target range when the power received (S) from the radar skin return from the target equals the power received (J) from the jamming signal transmitted from the target. As shown in Figure 6, Section 4-7, the receive antenna that is receiving the same level of J and S is remotely located from the radar's transmit antenna. Bistatic equations [11], [13], and [14] in Section 4-7 show that J/S is only a function of radar to target range, therefore J/S is not a function of wherever the missile is in its flight path provided the missile is in the antenna beam of the target's jammer. The missile is closing on the target at a very much higher rate than the target is closing on the radar, so the radar to target range will change less during the missile flight.

It should be noted that for a very long range air-to-air missile shot, the radar to target range could typically decrease to 35% of the initial firing range during the missile time-of-flight, i.e. A missile shot at a target 36 NM away, may be only 12 NM away from the firing aircraft at missile impact.

Figure 2 shows both the jamming radiated from the target and the power reflected from the target as a function of radar-to-target range. In this particular example, the RCS is assumed to be smaller, 15 m^2 vice 18 m^2 in the monostatic case, since the missile will be approaching the target from a different angle. This will not, however, always be the case.

In this plot, the power reflected is:

$$P_{ref} = \frac{P_t G_t 4 \pi \sigma}{(4\pi R)^2}$$

Substituting the values given previously in the example on page 4-8.1, we find that the crossover point is at 1.18 NM (due to the assumed reduction in RCS).

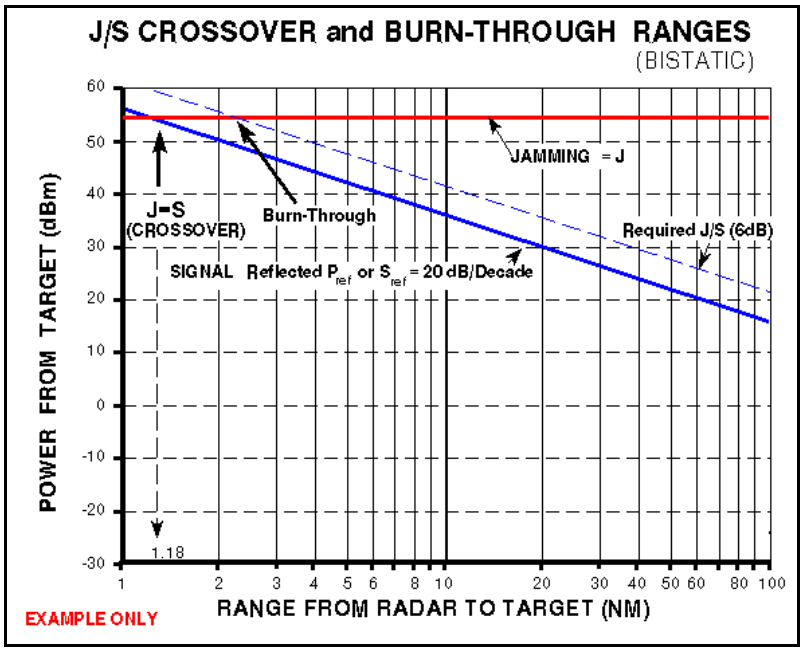

Figure 2. Bistatic Crossover and Burnthrough.

CROSSOVER AND BURN-THROUGH RANGE EQUATIONS (BISTATIC)

To calculate the radar transmitter-to-target range where J/S crossover or burn-through occurs, the J/S equation must be solved for range. From equation [11] in Section 4-7:

$$\frac{J}{S} = \frac{P_j G_{ja} 4\pi R_{Tx}^2}{P_t G_t \sigma} \qquad (ratio\ form)$$

Solving for R_{Tx}:

$$R_{Tx} = \sqrt{\frac{P_t G_t \sigma J}{P_j G_{ja} 4\pi S}} \qquad \textbf{[9]}$$

Note:
Bistatic equation [10] is identical to monostatic equation [1] except R_{Tx} must be substituted for R and a bistatic RCS (σ) will have to be used since RCS varies with aspect angle. The common explanations will not be repeated in this section.

<u>BURN-THROUGH RANGE (BISTATIC)</u> - Burn-through Range (Bistatic) occurs when J/S just equals the minimum effective J/S. From equation [9]:

$$R_{Tx(BT)} = \sqrt{\frac{P_t G_t \sigma J_{\min eff}}{P_j G_{ja} 4\pi S}} \qquad (ratio\ form) \qquad \textbf{[10]}$$

or in dB form:

$$20\log R_{Tx(BT)} = 10\log P_t + 10\log G_t + 10\log \sigma - 10\log P_j - 10\log G_{ja} + 10\log (J_{min\ eff}/S) - 10.99 \text{ dB} \quad \textbf{[11]}$$

If using the simplified radar equations (factors in dB):

$$20\log R_{Tx(BT)} = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} - K_1 + 10\log (J_{min\ eff}/S) - 20\log f_1 \quad \textbf{[12]}$$

Where G_σ and K_1 are defined on page 4-8.1

RANGE WHEN J/S CROSSOVER OCCURS (BISTATIC)

The crossover occurs when J = S in dB or J/S = 1 in ratio.

$$R_{Tx(J=S)} = \sqrt{\frac{P_t\, G_t\, \sigma}{P_j\, G_{ja}\, 4\pi}} \qquad (ratio) \quad \textbf{[13]}$$

or in log form:

$$20\log R_{Tx(J=S)} = 10\log P_t + 10\log G_t + 10\log \sigma - 10\log P_j - 10\log G_{ja} - 10.99 \text{ dB} \quad \textbf{[14]}$$

If simplified equations are used (with G_σ and K_1 as defined on page 4-8.1) we have:

$$20\log R_{Tx(J=S)} = 10\log P_t + 10\log G_t + G_\sigma - 10\log P_j - 10\log G_{ja} - K_1 - 20\log f_1 \qquad \text{(factors in dB)} \quad \textbf{[15]}$$

Note: keep R and σ in same units in all equations.

DETAILS OF SEMI-ACTIVE MISSILE J/S

Unless you are running a large scale computer simulation that includes maneuvering, antenna patterns, RCS, etc., you will seldom calculate the variation in J/S that occurs during a semi-active missile's flight. Missiles don't fly straight lines at constant velocity. Targets don't either - they maneuver. If the launch platform is an aircraft, it maneuvers too. A missile will accelerate to some maximum velocity above the velocity of the launch platform and then decelerate.

The calculation of the precise variation of J/S during a missile flight for it to be effective requires determination of all the appropriate velocity vectors and ranges at the time of launch, and the accelerations and changes in relative positions during the fly out. In other words, it's too much work for too little return. The following are simplified examples for four types of intercepts.

In these examples, all velocities are constant, and are all along the same straight line. The missile velocity is 800 knots greater than the launch platform velocity which is assumed to be 400 kts. The missile launch occurs at 50 NM.

	J/S (dB)	ΔJ/S (dB)
At Launch:	29	n/a
Intercept Type	At 2 sec. to Intercept:	
AAM Head-on:	23	-6
SAM Incoming Target:	25	-4
AAM Tail Chase:	29	0
SAM Outbound Target:	35	+6

For the AAM tail chase, the range from the radar to the target remains constant and so does the J/S. **In these examples** the maximum variation from launch J/S is ± 6 dB. That represents the difference in the radar to target range closing at very high speed (AAM head on) and the radar to target range opening at moderate speed (SAM outbound target). The values shown above are examples, not rules of thumb, every intercept will be different.

Even for the simplified linear examples shown, graphs of the J and S will be curves - not straight lines. Graphs could be plotted showing J and S vs. radar to target range, or J and S vs. missile to target range, or even J/S vs. time of flight. If the J/S at launch is just barely the minimum required for effectiveness, and increasing it is difficult, then a detailed graph may be warranted, but in most cases this isn't necessary.

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SUPPORT JAMMING

The following table contains a summary of equations developed in this section:

MAIN LOBE JAMMING TO SIGNAL (J/S) RATIO (For SOJ/SIJ)	Target gain factor, $G_\sigma = 10\text{Log}\sigma + 20\text{Log}\, f_1 + K_2$ (in dB)
$J/S = (P_j\, G_{ja}\, 4\pi\, R_{Tx}^4) / (P_t\, G_t\, \sigma\, [BW_J/BW_R]\, R_{Jx}^2)$ (ratio form)*	K_2 Values (dB):
$10\log J/S = 10\log P_j - 10\log[BW_J/BW_R] + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log \sigma + \downarrow$ $10.99\text{ dB} + 40\log R_{Tx} - 20\log R_{Jx}$ * $\leftarrow\leftarrow$	RCS (σ) (units) / f_1 in MHz K_2 = / f_1 in GHz K_2 = m^2 -38.54 21.46 ft^2 -48.86 11.14
or if simplified radar equations are used:	
$10\log J/S = 10\log P_j - BF + 10\log G_{ja} - \alpha_{jx} - 10\log P_t - 10\log G_t - G_\sigma + 2\alpha_1$ (in dB)*	
SIDE LOBE JAMMING TO SIGNAL (J/S) RATIO (For SOJ/SIJ)	One-way free space loss, α_1 or $\alpha_{Tx} = 20\text{Log}(f_1 R) + K_1$ (in dB)
$J/S = (P_j\, G_{ja}\, G_{r(SL)}\, 4\pi\, R_{Tx}^4) / (P_t\, G_t\, G_{r(ML)}\, \sigma\, [BW_J/BW_R]\, R_{Jx}^2)$ (ratio form)*	K_1 Values (dB):
$10\log J/S = 10\log P_j - BF + 10\log G_{ja} + 10\log G_{r(SL)} - 10\log P_t - 10\log G_t - 10\log G_{r(ML)} + \rightarrow \downarrow$ $10.99\text{ dB} - 10\log \sigma + 40\log R_{Tx} - 20\log R_{Jx}$ * $\leftarrow\leftarrow$	Range (units) / f_1 in MHz K_1 = / f_1 in GHz K_1 = NM 37.8 97.8 Km 32.45 92.45 m -27.55 32.45 yd -28.33 31.67 ft -37.87 22.13
or if simplified radar equations are used (in dB)*:	
$10\log J/S = 10\log P_j - BF + 10\log G_{ja} + 10\log G_{r(SL)} - \alpha_{jx} - 10\log P_t - 10\log G_t - 10\log G_{r(ML)} - G_\sigma + 2\alpha_1$	
R_{Jx} Range from the support jammer transmitter to the radar receiver R_{Tx} Range between the radar and the target BF 10 Log of the ratio of BW_J of the noise jammer to BW_R of the radar receiver $G_{r(SL)}$ Side lobe antenna gain $G_{r(ML)}$ Main lobe antenna gain α_{JX} One way free space loss between SOJ transmitter and radar receiver α_1 One way space loss between the radar and the target	* Keep R and σ in same units

Support jamming adds a few geometric complexities. A SOJ platform usually uses high gain, directional antennas. Therefore, the jamming antenna must not only be pointed at the victim radar, but there must be alignment of radar, targets, and SOJ platform for the jamming to be most effective. Two cases will be described, main lobe-jamming and side-lobe jamming.

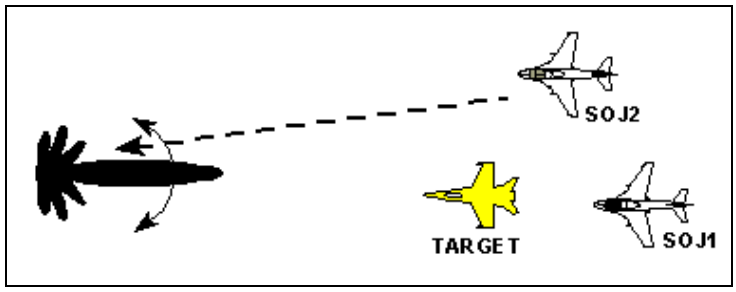

Figure 1. Radar Antenna Pattern.

Support jamming is usually applied against search and acquisition radars which continuously scan horizontally through a volume of space. The scan could cover a sector or a full 360°. The horizontal antenna pattern of the radar will exhibit a main lobe and side lobes as illustrated in Figure 1. The target is detected when the main lobe sweeps across it. For main lobe jamming, the SOJ platform and the target(s) must be aligned with the radar's main lobe as it sweeps the target(s).

For side lobe jamming, the SOJ platform may be aligned with one or more of the radar's side lobes when the main lobe sweeps the target. The gain of a radar's side lobes are many tens of dB less (usually more than 30 dB less) than the gain of the main lobe, so calculations of side lobe jamming must use the gain of the side lobe for the radar receive antenna gain, not the gain of the main lobe. Also, because many modern radars

employ some form of side lobe blanking or side lobe cancellation, some knowledge of the victim radar is required to predict the effectiveness of side lobe jamming.

All radar receivers are frequency selective. That is, they are filters that allow only a narrow range of frequencies into the receiver circuitry. Deceptive EA, by definition, creates forgeries of the real signal and, ideally, are as well matched to the radar receiver as the real signal. On the other hand, noise jamming probably **will not match** the radar receiver bandwidth characteristics. Noise jamming is either spot jamming or barrage jamming. As illustrated in Figure 2, spot jamming is simply narrowing the bandwidth of the noise jammer so that as much of the jammer power as possible is in the radar receiver bandwidth. Barrage jamming is using a wide noise bandwidth to cover several radars with one jammer or to compensate for any uncertainty in the radar frequency. In both cases some of the noise power is "wasted" because it is not in the radar receiver filter.

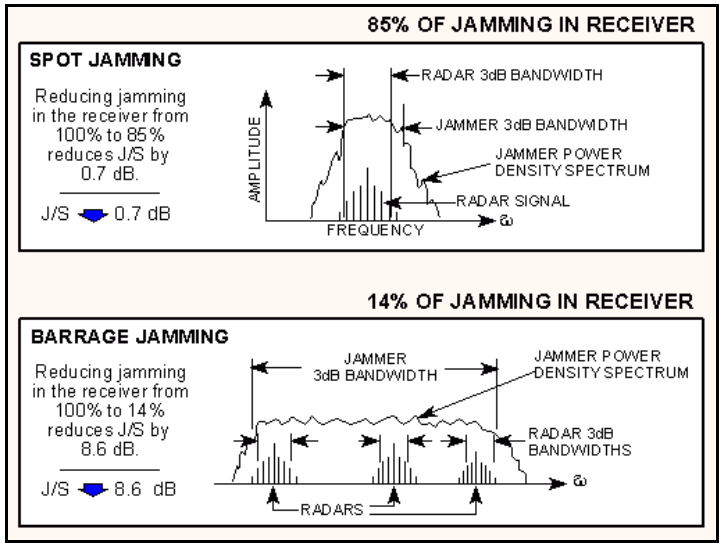

Figure 2. Noise Jamming.

In the past, noise jammers were often described as having so many "watts per MHz." This is nothing more than the power of the noise jammer divided by the noise bandwidth. That is, a 500 watt noise jammer transmitting a noise bandwidth of 200 MHz has 2.5 watts/MHz. Older noise jammers often had noise bandwidths that were difficult, or impossible, to adjust accurately. These noise jammers usually used manual tuning to set the center frequency of the noise to the radar frequency. Modern noise jammers can set on the radar frequency quite accurately and the noise bandwidth is selectable, so the noise bandwidth is more a matter of choice than it used to be, and it is possible that all of the noise is placed in the victim radar's receiver.

If, in the example above, the 500 watt noise jammer were used against a radar that had a 3 MHz receiver bandwidth, the noise jammer power applicable to that radar would be:

$$3\ MHz \times 2.5\ watts/MHz = 7.5\ watts\ _\ 38.75\ dBm \qquad \textbf{[1]}$$

The calculation must be done as shown in equation [1] - multiply the watts/MHz by the radar bandwidth first and then convert to dBm. You can't convert to dBm/MHz and then multiply. (See derivation of dB in Section 2-4)

An alternate method for dB calculations is to use the bandwidth reduction factor (BF).

The BF is: $$BF_{dB} = 10\ \text{Log}\left[\frac{BW_J}{BW_R}\right] \qquad \textbf{[2]}$$

where: BW_J is the bandwidth of the noise jammer, and BW_R is the bandwidth of the radar receiver.

The power of the jammer in the jamming equation (P_J) can be obtained by either method. If equation [1] is used then P_J is simply 38.75 dBm. If equation [2] is used then the jamming equation is written using (P_J - BF). All the following discussion uses the second method. Whichever method is used, it is required that $BW_J \geq BW_R$. If $BW_J < BW_R$, then all the available power is in the radar receiver and equation [1] does not apply and the BF = 0.

> Note: To avoid having to include additional terms for the following calculations, always combine any transmission line loss with antenna gain.

MAIN LOBE STAND-OFF / STAND-IN JAMMING

The equivalent circuit shown in Figure 3 applies to main lobe jamming by a stand-off support aircraft or a stand-in RPV. Since the jammer is not on the target aircraft, only two of the three ranges and two of the three space loss factors (α's) are the same. Figure 3 differs from the J/S monostatic equivalent circuit shown in Figure 4 in Section 4-7 in that the space loss from the jammer to the radar receiver is different.

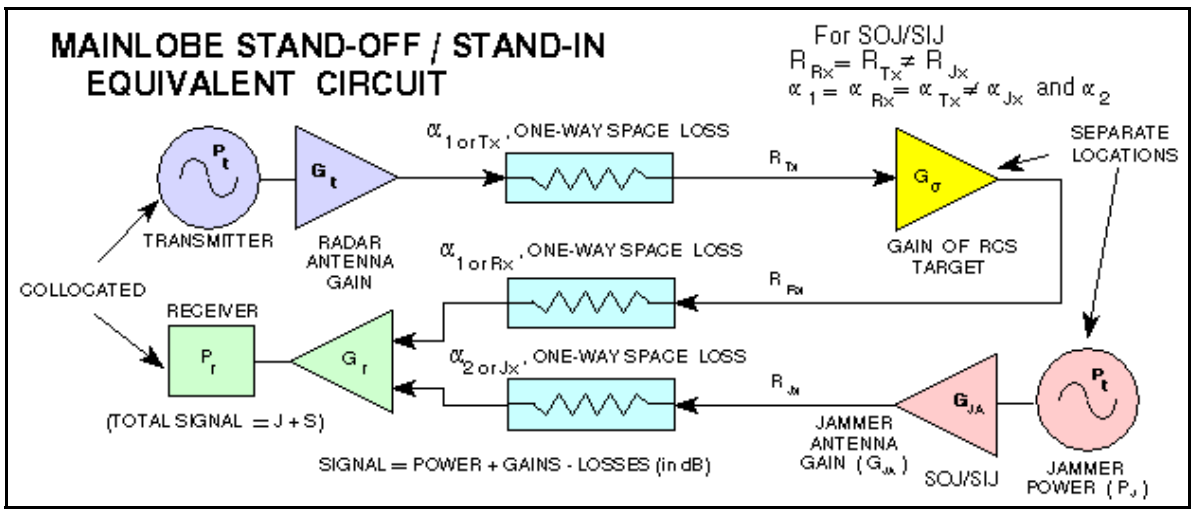

Figure 3. Main Lobe Stand-Off / Stand-In EA Equivalent Circuit.

The equations are the same for both SOJ and SIJ. From the one way range equation in Section 4-3, and with inclusion of BF losses:

$$P_r 1 \text{ or } J = \frac{P_j G_{ja} G_r \lambda^2 BW_R}{(4\pi R_{Jx})^2 BW_J} \qquad \textbf{[3]}$$

From the two way range equation in Section 4.4: $$P_r 2 \text{ or } S = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R_{Tx}^4} \qquad \textbf{[4]}$$

so $$\frac{J}{S} = \frac{P_j G_{ja} G_r \lambda^2 (4\pi)^3 R_{Tx}^4 BW_R}{P_t G_t G_r \lambda^2 \sigma (4\pi R_{Jx})^2 BW_J} = \frac{P_j G_{ja} 4\pi R_{Tx}^4 BW_R}{P_t G_t \sigma R_{Jx}^2 BW_J} \qquad \textit{(ratio form)} \qquad \textbf{[5]}$$

Note: Keep R and σ in the same units. Converting to dB and using 10 log 4π = 10.99 dB:

$$10\log J/S = 10\log P_j - 10\log [BW_j/BW_R] + 10\log G_{ja} - 10\log P_t - 10\log G_t - 10\log \sigma + 10.99 \text{ dB} + 40\log R_{Tx} - 20\log R_{Jx} \quad \textbf{[6]}$$

If the simplified radar equation is used, the free space loss from the SOJ/SIJ to the radar receiver is α_{Jx}, then equation [7] is the same as monostatic equation [6] in Section 4-7 except α_{Jx} replaces α, and the bandwidth reduction factor [BF] losses are included:

$$10\log J = 10\log P_j - BF + 10\log G_{ja} + 10\log G_r - \alpha_{Jx} \quad \text{(factors in dB)} \quad \textbf{[7]}$$

Since the free space loss from the radar to the target and return is the same both ways, $\alpha_{Tx} = \alpha_{Rx} = \alpha_1$, equation [8] is the same as monostatic equation [7] in Section 4-7.

$$10\log S = 10\log P_t + 10\log G_t + 10\log G_r + G_\sigma - 2\alpha_1 \quad \text{(factors in dB)} \quad \textbf{[8]}$$

and $$10\log J/S = 10\log P_j - BF + 10\log G_{ja} - \alpha_{Jx} - 10\log P_t - 10\log G_t - G_\sigma + 2\alpha_1 \quad \text{(factors in dB)} \quad \textbf{[9]}$$

Notice that unlike equation [8] in Section 4-7, there are two different α's in [9] because the signal paths are different.

SIDE LOBE STAND-OFF / STAND-IN JAMMING

The equivalent circuit shown in Figure 4. It differs from Figure 3, (main lobe SOJ/SIJ) in that the radar receiver antenna gain is different for the radar signal return and the jamming.

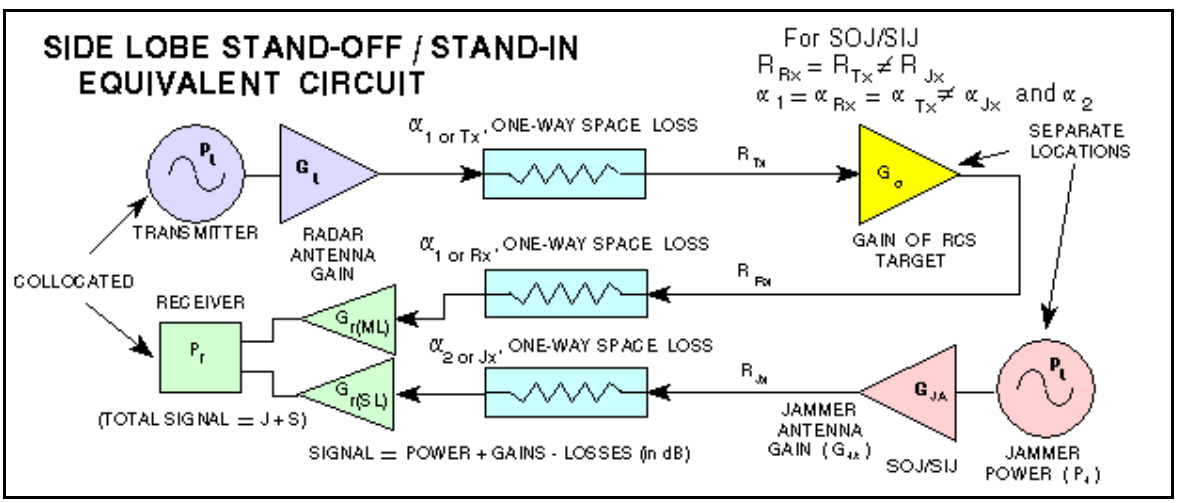

Figure 4. Side Lobe Stand-Off / Stand-In EA Equivalent Circuit.

To calculate side lobe jamming, the gain of the radar antenna's side lobes must be known or estimated. The gain of each side lobe will be different than the gain of the other side lobes. If the antenna is symmetrical, the first side lobe is the one on either side of the main lobe, the second side lobe is the next one on either side of the first side lobe, and so on. The side lobe gain is G_{SLn}, where the 'n' subscript denotes side lobe number: 1, 2, ..., n.

The signal is the same as main lobe equations [4] and [8], except $G_r = G_{r(ML)}$

$$P_r\,2 \text{ or } S = \frac{P_t\, G_t\, G_{r(ML)}\, \lambda^2\, \sigma}{(4\pi)^3\, R_{Tx}^4} \quad \textit{(ratio form)} \qquad \textbf{[10]}$$

If simplified radar equations are used:

$10\log S = 10\log P_t + 10\log G_t + 10\log G_{r(ML)} + G_\sigma - 2\alpha_1$ (factors in dB)

The jamming equation is the same as main lobe equations [3] and [7] except $G_r = G_{r(SL)}$:

$$J = \frac{P_j\, G_{ja}\, G_{r(SL)}\, \lambda^2\, BW_R}{(4\pi\, R_{Jx})^2\, BW_J} \qquad \textbf{[11]}$$

$10\log J = 10\log P_j - BF + 10\log G_{ja} + 10\log G_{r(SL)} - \alpha_{Jx}$ (factors in dB) **[12]**

so

$$\frac{J}{S} = \frac{P_j\, G_{ja}\, G_{r(SL)}\, 4\pi\, R_{Tx}^4\, BW_R}{P_t\, G_t\, G_{r(ML)}\, \sigma\, R_{Jx}^2\, BW_J} \quad \textit{(ratio form)} \qquad \textbf{[13]}$$

Note: keep R and σ in same units. Converting to dB and using $10\log 4\pi = 10.99$ dB:

$10\log J/S = 10\log P_j - BF + 10\log G_{ja} + 10\log G_{r(SL)} - 10\log P_t - 10\log G_t - 10\log G_{r(ML)} - 10\log\sigma + 10.99 \text{ dB} + 40\log R_{Tx} - 20\log R_{Jx}$
(factors in dB) **[14]**

If simplified radar equations are used:

$10\log J/S = 10\log P_j - BF + 10\log G_{ja} + 10\log G_{r(SL)} - \alpha_{Jx} - 10\log P_t - 10\log G_t - 10\log G_{r(ML)} - G_\sigma + 2\alpha_1$ **[15]**
(in dB)

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JAMMING TO SIGNAL (J/S) RATIO - CONSTANT GAIN [LINEAR] JAMMING

JAMMING TO SIGNAL (J/S) RATIO (MONOSTATIC)

$$\frac{J}{S} = \frac{G_{ja(Rx)}\, G_j\, G_{ja(Tx)}\, \lambda^2}{4\pi\sigma} = \frac{G_{ja(Rx)}\, G_j\, G_{ja(Tx)}\, c^2}{4\pi\sigma f^2} \quad \text{(ratio form)}$$

$G_{ja(Rx)}$ = The Gain of the jammer receive antenna
G_j = The gain of the jammer
$G_{ja(Tx)}$ = The Gain of the jammer transmit antenna

or:

$10\log J/S = 10\log G_{ja(Rx)} + 10\log G_j + 10\log G_{ja(Tx)} - 10\log (4\pi\sigma/\lambda^2)$

or if simplified radar equations developed in previous sections are used:

$10\log J/S = 10\log G_{ja(Rx)} + 10\log G_j + 10\log G_{ja(Tx)} - G_\sigma$ (dB)

* Keep λ and σ in same units. Note: λ = c/f

Target gain factor,
$G_\sigma = 10\log \sigma + 20\log f_1 + K_2$ (dB)

K_2 Values (dB):

RCS (σ) (units)	f_1 in MHz K_2 =	f_1 in GHz K_2 =
m^2	-38.54	21.46
ft^2	-48.86	11.14

JAMMING TO SIGNAL (J/S) RATIO (BISTATIC)

Same as the monostatic case except G_σ will be different since RCS (σ) varies with aspect angle.

Since the jammer on the target is amplifying the received radar signal before transmitting it back to the radar, both J and S experience the two way range loss. Figure 1 shows that the range for both the signal and constant gain jamming have a slope that is 40 dB per decade. Once the jammer output reaches maximum power, that power is constant and the jamming slope changes to 20 dB per decade since it is only a function of one way space loss and the J/S equations for constant power (saturated) jamming must be used.

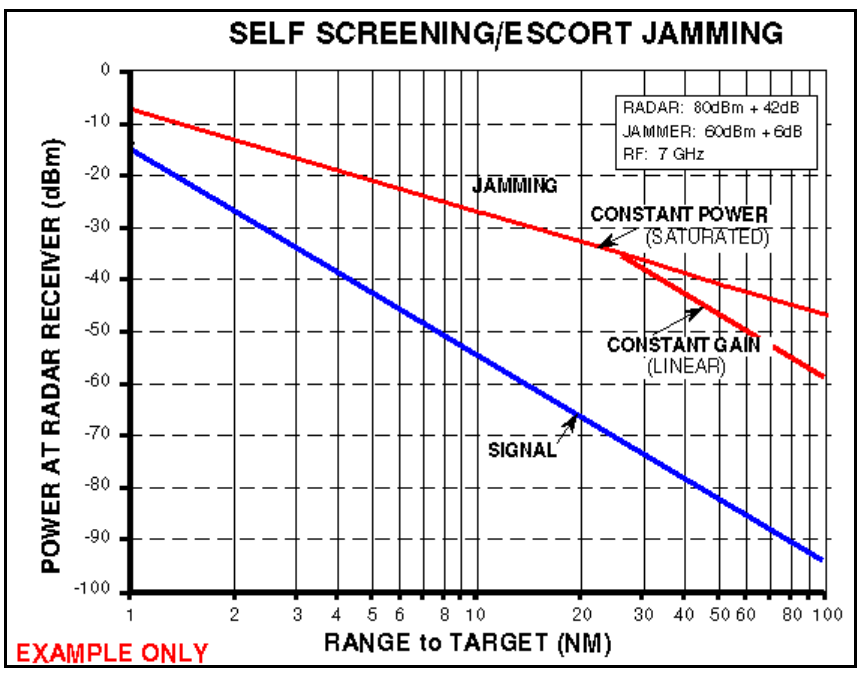

Figure 1. Sample Constant Gain / Constant Power Graph.

Normally the constant gain (linear) region of a repeater jammer occurs only at large distances from the radar and the constant power (saturated) region is reached rapidly as the target approaches the radar. When a constant gain jammer is involved it may be necessary to plot jamming twice - once using J from the constant power (saturated) equation [1] in Section 4-7 and once using the constant gain (linear) equation [4], as in the example shown in Figure 1.

CONSTANT GAIN SELF PROTECTION EA

Most jammers have a constant power output - that is, they always transmit the maximum available power of the transmitter (excepting desired EA modulation). Some jammers also have a constant gain (linear) region. Usually these are coherent repeaters that can amplify a low level radar signal to a power that is below the level that results in maximum available (saturated) power output. At some radar to target range, the input signal is sufficiently high that the full jammer gain would exceed the maximum available power and the jammer ceases to be constant gain and becomes constant power.

To calculate the power output of a constant gain jammer where:

S_{Rj} = The Radar signal at the jammer input (receive antenna terminals)
$G_{ja(Rx)}$ = The Gain of the jammer receive antenna
G_j = The gain of the jammer
α_{Tx} = The one-way free space loss from the radar to the target
P_{jCG} = The jammer constant gain power output
P_j = The maximum jammer power output
L_R = The jammer receiving line loss; combine with antenna gain $G_{ja(Rx)}$

From equation [10], Section 4-3, calculate the radar power received by the jammer.

$$10\log S_{Rj} = 10\log P_t + 10\log G_t - \alpha_{Tx} + 10\log G_{ja(Rx)} \qquad \text{(factors in dB)} \qquad \textbf{[1]}$$

The jammer constant gain power output is: $$10\log P_{jCG} = 10\log S_{Rj} + 10\log G_{ja} \qquad \textbf{[2]}$$

and, by definition: $$P_{jCG} \le P_j \qquad \textbf{[3]}$$

MONOSTATIC

The equivalent circuit shown in Figure 2 is different from the constant power equivalent circuit in Figure 4 in Section 4-7. With constant gain, the jamming signal experiences the gain of the jammer and its antennas plus the same space loss as the radar signal.

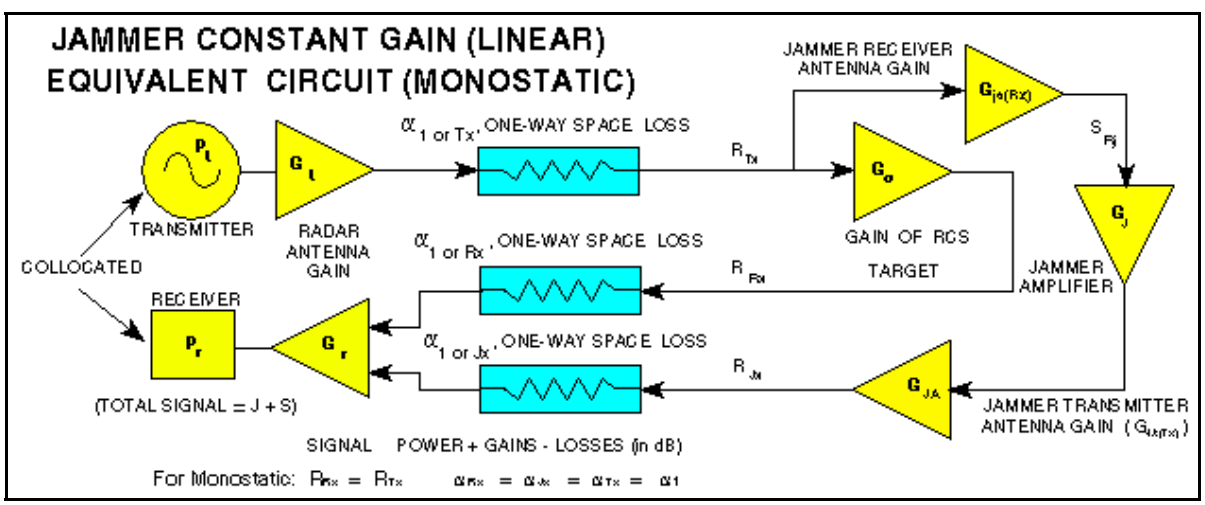

Figure 2. Jammer Constant Gain EA Equivalent Circuit (Monostatic).

To calculate J, the one way range equation from Section 4-3 is used twice:

$$J = \frac{P_t\, G_t\, G_{ja(Rx)}\, \lambda^2}{(4\pi R)^2} \frac{G_j\, G_{ja(Tx)}\, G_r\, \lambda^2}{(4\pi R)^2} \qquad \textbf{[4]}$$

From the two way range equation in Section 4-4: $S = \dfrac{P_t\, G_t\, G_r\, \lambda^2\, \sigma}{(4\pi)^3\, R^4}$ **[5]**

Terms cancel when combined: $\dfrac{J}{S} = \dfrac{G_{ja(Rx)}\, G_j\, G_{ja(Tx)}\, \lambda^2}{4\pi\sigma}$ *Keep λ and σ in same units* **[6]**

Or in dB form: $10\log J/S = 10\log G_{ja(Rx)} + 10\log G_j + 10\log G_{ja(Tx)} - 10\log (4\pi\sigma/\lambda^2)$ **[7]**

Since the last term can be recognized as minus G_σ from equation [10] in Section 4-4, where the target gain factor, $G_\sigma = 10\log (4\pi\sigma/\lambda^2) = 10\log (4\pi\sigma f^2/c^2)$, it follows that:

$10\log J/S = 10\log G_{ja(Rx)} + 10\log G_j + 10\log G_{ja(Tx)} - G_\sigma$ (factors in dB) **[8]**

Target gain factor, $G_\sigma = 10\log \sigma + 20\log f_1 + K_2$ (in dB)			
K_2 Values			
(dB)	RCS (σ) (units)	f_1 in MHz K_2 =	f_1 in GHz K_2 =
	m^2	-38.54	21.46
	ft^2	-48.86	11.14

BISTATIC

The bistatic equivalent circuit shown in Figure 3 is different from the monostatic equivalent circuit shown in Figure 2 in that the receiver is separately located from the transmitter, $R_{Tx} \neq R_{Rx}$ or R_{Jx} and G_σ will be different since the RCS (σ) varies with aspect angle.

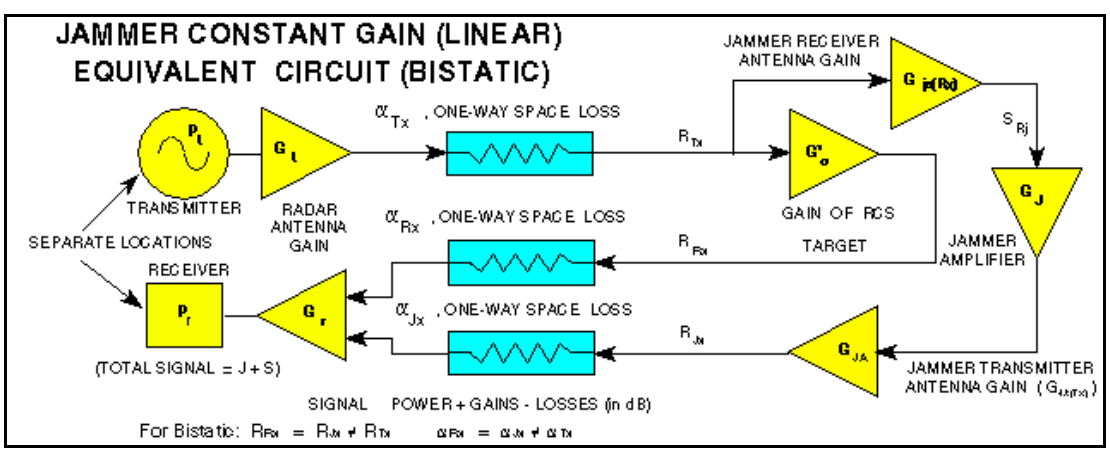

Figure 3. Jammer Constant Gain EA Equivalent Circuit (Bistatic).

To calculate J, the one way range equation from Section 4-3 is used twice:

$$J = \frac{P_t\, G_t\, G_{ja(Rx)}\, \lambda^2}{(4\pi\, R_{Tx})^2} \frac{G_j\, G_{ja(Tx)}\, G_r\, \lambda^2}{(4\pi\, R_{Rx})^2} \qquad (R_{Jx} = R_{Rx}) \qquad \textbf{[9]}$$

From the two way range equation in Section 4-4: $S = \dfrac{P_t\, G_t\, G_r\, \lambda^2\, \sigma'}{(4\pi)^3\, R_{Tx}^2\, R_{Rx}^2}$ (σ′ is bistatic RCS) **[10]**

Terms cancel when combined: $\dfrac{J}{S} = \dfrac{G_{ja(Rx)}\, G_j\, G_{ja(Tx)}\, \lambda^2}{4\pi\sigma'}$ *Keep λ and σ in same units* **[11]**

Or in dB form: $10\log J/S = 10\log G_{ja(Rx)} + 10\log G_j + 10\log G_{ja(Tx)} - 10\log (4\pi\sigma'/\lambda^2)$ **[12]**

Since the last term can be recognized as minus G_σ from equation [10] in Section 4-4, where the target gain factor, $G_\sigma = 10\log (4\pi\sigma'/\lambda^2) = 10\log (4\pi\sigma' f^2/c^2)$, it follows that:

$10\log = 10\log G_{ja(Rx)} + 10\log G_j + 10\log G_{ja(Tx)} - G_{\sigma'}$ (factors in dB) **[13]**

Target gain factor, $G_\sigma = 10\log \sigma + 20\log f_1 + K_2$ (in dB)			
K_2 Values			
(dB)	RCS (σ) (units)	f_1 in MHz K_2 =	f_1 in GHz K_2 =
	m^2	-38.54	21.46
	ft^2	-48.86	11.14

Linear J/S (Monostatic) Example (Linear Power Jamming)

Assume that a 5 GHz radar has a 70 dBm signal fed through a 5 dB loss transmission line to an antenna that has 45 dB gain. An aircraft that is flying 31 km from the radar has an aft EW antenna with -1 dB gain and a 5 dB line loss to the EW receiver (there is an additional loss due to any antenna polarization mismatch but that loss will not be addressed in this problem). The received signal is fed to a jammer with a gain of 60 dB, feeding a 10 dB loss transmission line which is connected to an antenna with 5 dB gain.

If the RCS of the aircraft is 9 m^2, what is the J/S level received at the input to the receiver of the tracking radar?

Answer:

$$10\log J/S = 10\log G_{ja(Rx)} + 10\log G_j + 10\log G_{ja(Tx)} - G_\sigma$$

$$G_\sigma = 10\log \sigma + 20\log f_1 + K_2 = 10\log 9 + 20\log 5 + 21.46 = 44.98 \text{ dB}$$

Note: The respective transmission line losses will be combined with antenna gains,
i.e. -1 -5 = -6 dB and -10 + 5 = -5 dB

$$10\log J/S = -6 + 60 - 5 - 44.98 = 4.02 \text{ dB @ 5 GHz}$$

The answer changes to 1.1 dB if the tracking radar operates at 7 GHz provided the antenna gains and aircraft RCS are the same at both 5 and 7 GHz.

$$G_\sigma = 10\log 9 + 20\log 7 + 21.46 = 47.9 \text{ dB}$$

$$10\log J/S = -6 + 60 - 5 - 47.9 = 1.1 \text{ dB @ 7 GHz}$$

Separate J (-73.5 dBm @ 5 GHz and -79.34 dBm @ 7 GHz) and S (-77.52 dBm @ 5 GHz and -80.44 dBm @ 7 GHz) calculations for this problem are provided in Sections 4-3 and 4-4, respectively. A saturated gain version of this problem is provided in Section 4-7.

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RADAR CROSS SECTION (RCS)

Radar cross section is the measure of a target's ability to reflect radar signals in the direction of the radar receiver, i.e. it is a measure of the ratio of backscatter power per steradian (unit solid angle) in the direction of the radar (from the target) to the power density that is intercepted by the target.

The RCS of a target can be viewed as a comparison of the strength of the reflected signal from a target to the reflected signal from a perfectly smooth sphere of cross sectional area of 1 m^2 as shown in Figure 1.

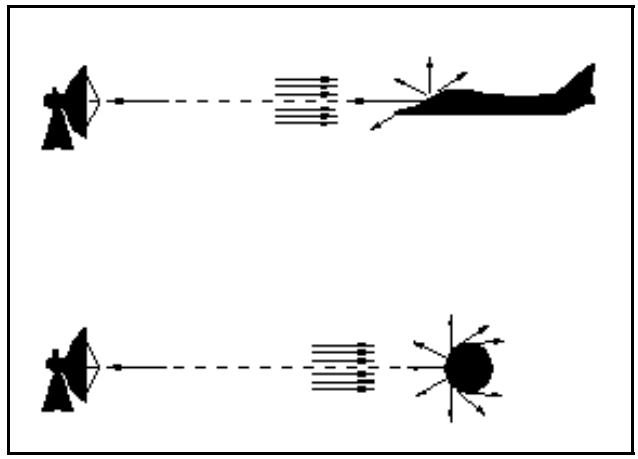

Figure 1. Concept of Radar Cross Section.

The conceptual definition of RCS includes the fact that not all of the radiated energy falls on the target. A target's RCS (σ) is most easily visualized as the product of three factors:

$\boldsymbol{\sigma}$ = **Projected cross section** x Reflectivity x Directivity.

RCS(σ) is used in Section 4-4 for an equation representing power reradiated from the target.

Reflectivity: The percent of intercepted power reradiated (scattered) by the target.

Directivity: The ratio of the power scattered back in the radar's direction to the power that would have been backscattered had the scattering been uniform in all directions (i.e. isotropically).

Figures 2 and 3 show that RCS does not equal geometric area. For a sphere, the RCS, $\boldsymbol{\sigma = \pi r^2}$, where r is the radius of the sphere.

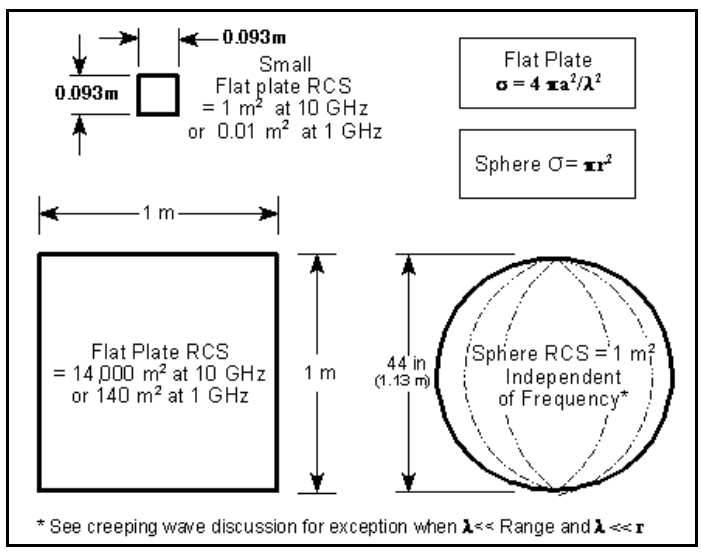

Figure 2. RCS vs. Physical Geometry.

The RCS of a sphere is independent of frequency if operating at sufficiently high frequencies where λ<<Range, and λ<< radius (r). Experimentally, radar return reflected from a target is compared to the radar return reflected from a sphere which has a frontal or projected area of one square meter (i.e. diameter of about 44 in). Using the spherical shape aids in field or laboratory measurements since orientation or positioning of the sphere will not affect radar reflection intensity measurements as a flat plate would. If calibrated, other sources (cylinder, flat plate, or corner reflector, etc.) could be used for comparative measurements.

To reduce drag during tests, towed spheres of 6", 14", or 22" diameter may be used instead of the larger 44" sphere, and the reference size is 0.018, 0.099, or 0.245 m^2 respectively instead of 1 m^2. When

smaller sized spheres are used for tests you may be operating at or near where λ~radius. If the results are then scaled to a 1 m^2 reference, there may be some perturbations due to creeping waves. See the discussion at the end of this section for further details.

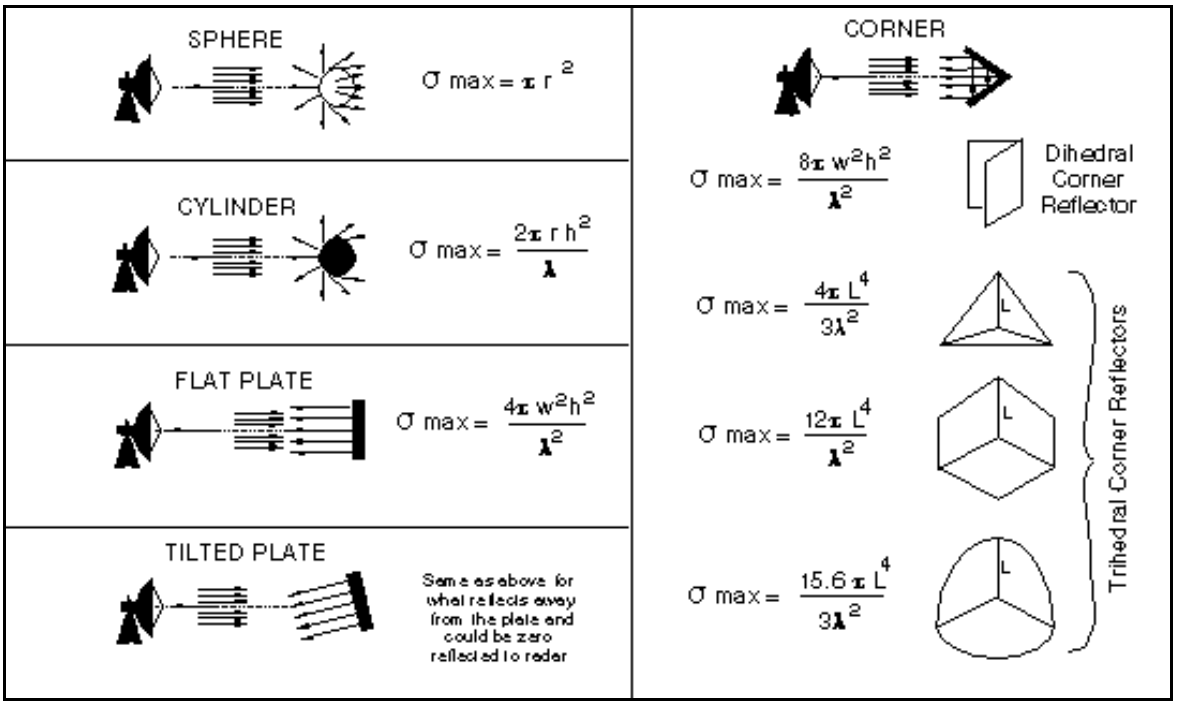

Figure 3. Backscatter From Shapes.

In Figure 4, RCS patterns are shown as objects are rotated about their vertical axes (the arrows indicate the direction of the radar reflections).

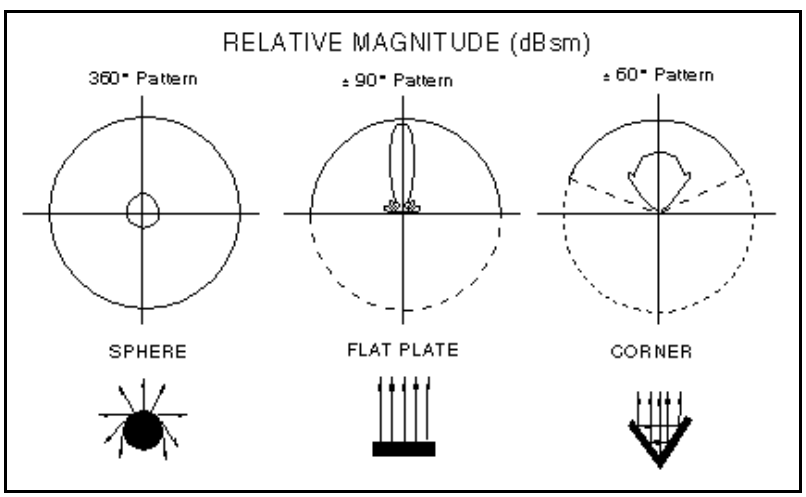

Figure 4. RCS Patterns.

The sphere is essentially the same in all directions.

The flat plate has almost no RCS except when aligned directly toward the radar.

The corner reflector has an RCS almost as high as the flat plate but over a wider angle, i.e., over ±60°. The return from a corner reflector is analogous to that of a flat plate always being perpendicular to your collocated transmitter and receiver.

Targets such as ships and aircraft often have many effective corners. Corners are sometimes used as calibration targets or as decoys, i.e. corner reflectors.

An aircraft target is very complex. It has a great many reflecting elements and shapes. The RCS of real aircraft must be measured. It varies significantly depending upon the direction of the illuminating radar.

Figure 5 shows a typical RCS plot of a jet aircraft. The plot is an azimuth cut made at zero degrees elevation (on the aircraft horizon). Within the normal radar range of 3-18 GHz, the radar return of an aircraft in a given direction will vary by a few dB as frequency and polarization vary (the RCS may change by a factor of 2-5). It does not vary as much as the flat plate.

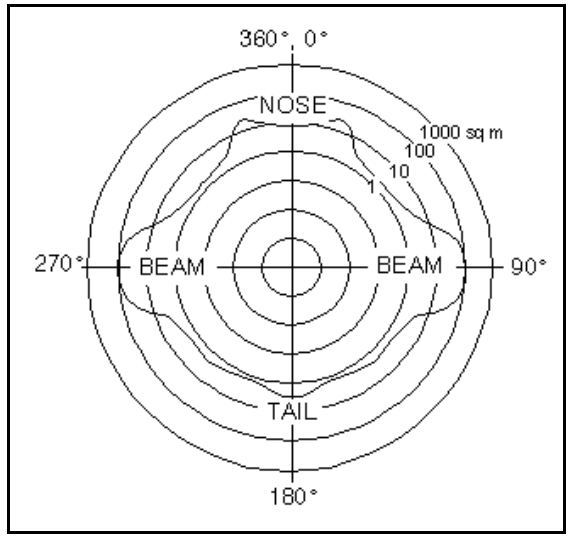

Figure 5. Typical Aircraft RCS.

As shown in Figure 5, the RCS is highest at the aircraft beam due to the large physical area observed by the radar and perpendicular aspect (increasing reflectivity). The next highest RCS area is the nose/tail area, largely because of reflections off the engines or propellers. Most self-protection jammers cover a field of view of +/- 60 degrees about the aircraft nose and tail, thus the high RCS on the beam does not have coverage. Beam coverage is frequently not provided due to inadequate power available to cover all aircraft quadrants, and the side of an aircraft is theoretically exposed to a threat 30% of the time over the average of all scenarios.

Typical radar cross sections are as follows: Missile 0.5 sq m; Tactical Jet 5 to 100 sq m; Bomber 10 to 1000 sq m; and ships 3,000 to 1,000,000 sq m. RCS can also be expressed in decibels referenced to a square meter (dBsm) which equals 10 log (RCS in m^2).

Again, Figure 5 shows that these values can vary dramatically. The strongest return depicted in the example is 100 m^2 in the beam, and the weakest is slightly more than 1 m^2 in the 135°/225° positions. These RCS values can be very misleading because other factors may affect the results. For example, phase differences, polarization, surface imperfections, and material type all greatly affect the results. In the above typical bomber example, the measured RCS may be much greater than 1000 square meters in certain circumstances (90°, 270°).

SIGNIFICANCE OF THE REDUCTION OF RCS

If each of the range or power equations that have an RCS (σ) term is evaluated for the significance of decreasing RCS, Figure 6 results. Therefore, an RCS reduction can increase aircraft survivability. The equations used in Figure 6 are as follows:

Range (radar detection):
From the 2-way range equation in Section 4-4:

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4}$$ Therefore, $R^4 \propto \sigma$ or $\sigma^{1/4} \propto R$

Range (radar burn-through):
The crossover equation in Section 4-8 has:

$$R_{BT}^2 = \frac{P_t G_t \sigma}{P_j G_j 4\pi}$$ Therefore, $R_{BT}^2 \propto \sigma$ or $\sigma^{1/2} \propto R_{BT}$

Power (jammer): Equating the received signal return (P_r) in the two way range equation to the received jammer signal (P_r) in the one way range equation, the following relationship results:

$$P_r = \frac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4} = \frac{P_j G_j G_r \lambda^2}{(4\pi R)^2}$$

$$\uparrow \qquad\qquad \uparrow$$

$$S \qquad\qquad J$$

Therefore, $P_j \propto \sigma$ or $\sigma \propto P_j$

Note: jammer transmission line loss is combined with the jammer antenna gain to obtain G_t.

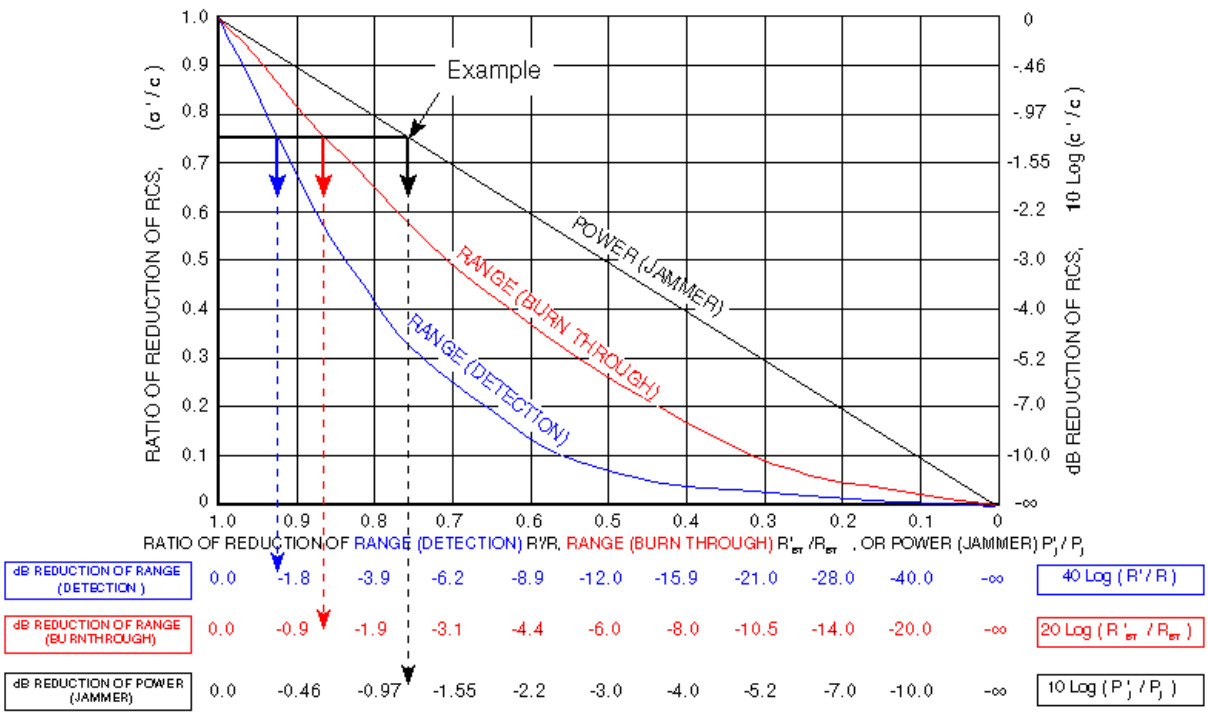

Figure 6. Reduction of RCS Affects Radar Detection, Burn-through, and Jammer Power.

<u>Example of Effects of RCS Reduction</u> - As shown in Figure 6, if the RCS of an aircraft is reduced to 0.75 (75%) of its original value, then (1) the jammer power required to achieve the same effectiveness would be 0.75 (75%) of the original value (or -1.25 dB). Likewise, (2) If Jammer power is held constant, then burn-through range is 0.87 (87%) of its original value (-1.25 dB), and (3) the detection range of the radar for the smaller RCS target (jamming not considered) is 0.93 (93%) of its original value (-1.25 dB).

OPTICAL / MIE / RAYLEIGH REGIONS

Figure 7 shows the different regions applicable for computing the RCS of a sphere. The optical region ("far field" counterpart) rules apply when $2\pi r/\lambda > 10$. In this region, the RCS of a sphere is independent of frequency. Here, the RCS of a sphere, $\sigma = \pi r^2$. The RCS equation breaks down primarily due

to creeping waves in the area where $\lambda \sim 2\pi r$. This area is known as the Mie or resonance region. If we were using a 6" diameter sphere, this frequency would be 0.6 GHz. (Any frequency ten times higher, or above 6 GHz, would give expected results). The largest positive perturbation (point A) occurs at exactly 0.6 GHz where the RCS would be 4 times higher than the RCS computed using the optical region formula. Just slightly above 0.6 GHz a minimum occurs (point B) and the actual RCS would be 0.26 times the value calculated by using the optical region formula. If we used a one meter diameter sphere, the perturbations would occur at 95 MHz, so any frequency above 950 MHz (~1 GHz) would give predicted results.

CREEPING WAVES

The initial RCS assumptions presume that we are operating in the optical region (λ<<Range and λ<<radius). There is a region where specular reflected (mirrored) waves combine with back scattered creeping waves both constructively and destructively as shown in Figure 8. Creeping waves are tangential to a smooth surface and follow the "shadow" region of the body. They occur when the circumference of the sphere ~ λ and typically add about 1 m^2 to the RCS at certain frequencies.

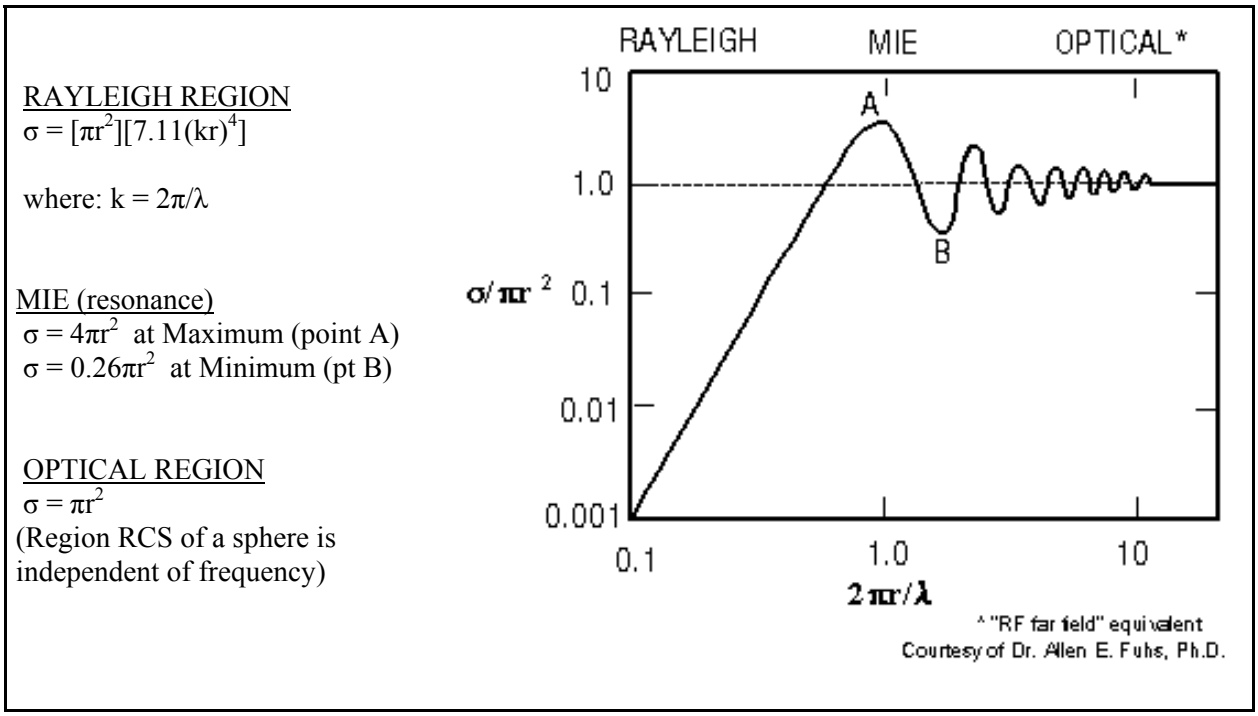

Figure 7. Radar Cross Section of a Sphere.

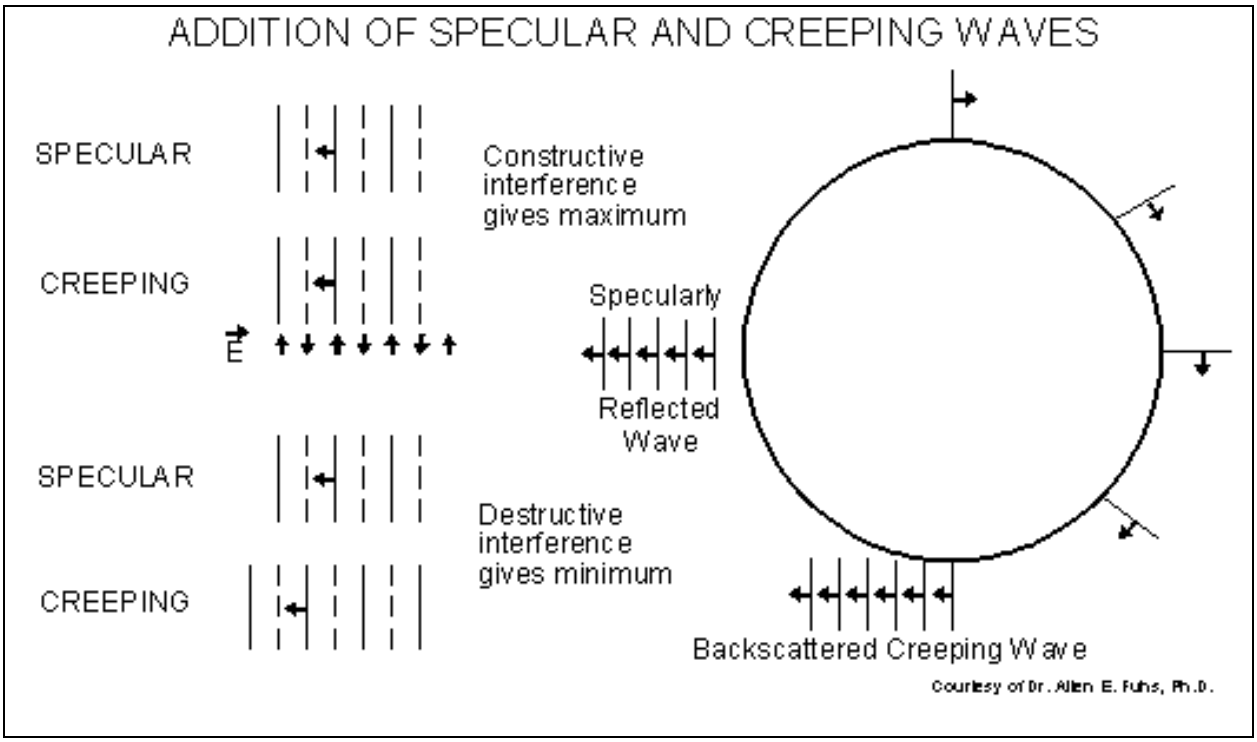

Figure 8. Addition of Specular and Creeping Waves.

EMISSION CONTROL (EMCON)

When EMCON is imposed, RF emissions must not exceed -110 dBm/meter^2 at one nautical mile. It is best if systems meet EMCON when in either the Standby or Receive mode versus just the Standby mode (or OFF). If one assumes antenna gain equals line loss, then emissions measured at the port of a system must not exceed -34 dBm (i.e. the stated requirement at one nautical mile is converted to a measurement at the antenna of a point source - see Figure 1). If antenna gain is greater than line loss (i.e. gain 6 dB, line loss 3 dB), then the -34 dBm value would be lowered by the difference and would be -37 dBm for the example. The opposite would be true if antenna gain is less.

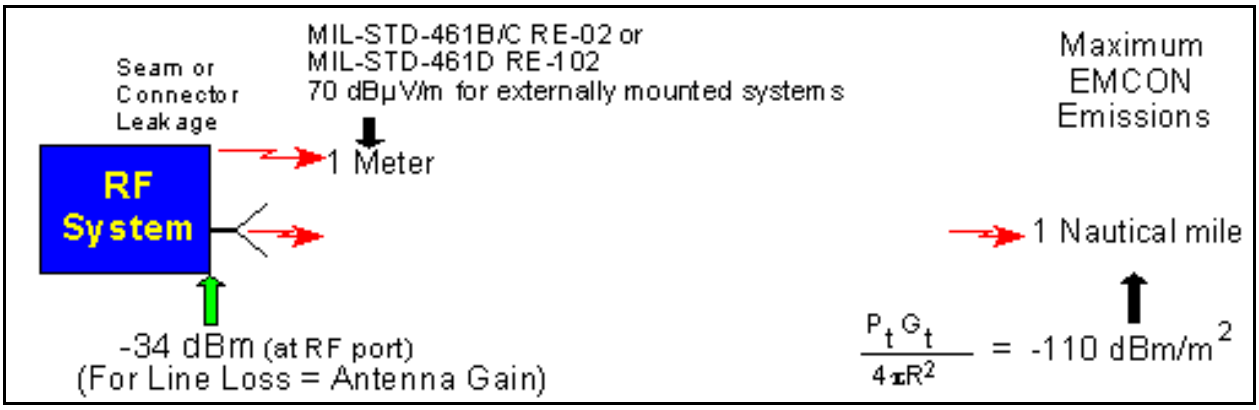

Figure 1. EMCON Field Intensity / Power Density Measurements.

To compute the strength of emissions at the antenna port in Figure 1, we use the power density equation (see Section 4-2)

$$P_D = \frac{P_t G_t}{4\pi R^2} \qquad \textbf{[1]} \qquad \text{or rearranging} \qquad P_t G_t = P_D\,(4\pi R^2) \qquad \textbf{[2]}$$

Given that P_D = -110 dBm/m^2 = $(10)^{-11}$ mW/m^2, and R = 1 NM = 1852 meters.

$$P_t G_t = P_D\,(4\pi R^2) = (10^{-11}\text{mW/m}^2)(4\pi)(1852\text{m})^2 = 4.31(10)^{-4}\text{ mW} = -33.65 \approx -34\text{ dBm}$$

at the RF system antenna as given.

or, the equation can be rewritten in Log form and each term multiplied by 10:

$$10\log P_t + 10\log G_t = 10\log P_D + 10\log (4\pi R^2) \qquad \textbf{[3]}$$

Since the m^2 terms on the right side of equation [3] cancel, then:

$$10\log P_t + 10\log G_t = -110\text{ dBm} + 76.35\text{ dB} = -33.65\text{ dBm} \approx -34\text{ dBm as given in Figure 1.}$$

If MIL-STD-461B/C RE02 (or MIL-STD-461D RE-102) measurements (see Figure 2) are made on seam/connector leakage of a system, emissions below 70 dBµV/meter which are measured at <u>one meter</u> will meet the EMCON requirement. Note that the airframe provides attenuation so portions of systems mounted inside an aircraft that measure 90 dBµV/meter will still meet EMCON if the airframe provides 20 dB of shielding (note that the requirement at one nm is converted to what would be measured at one meter from a point source).

The narrowband emission limit shown in Figure 2 for RE02/RE102 primarily reflect special concern for local oscillator leakage during EMCON as opposed to switching transients which would apply more to the broadband limit.

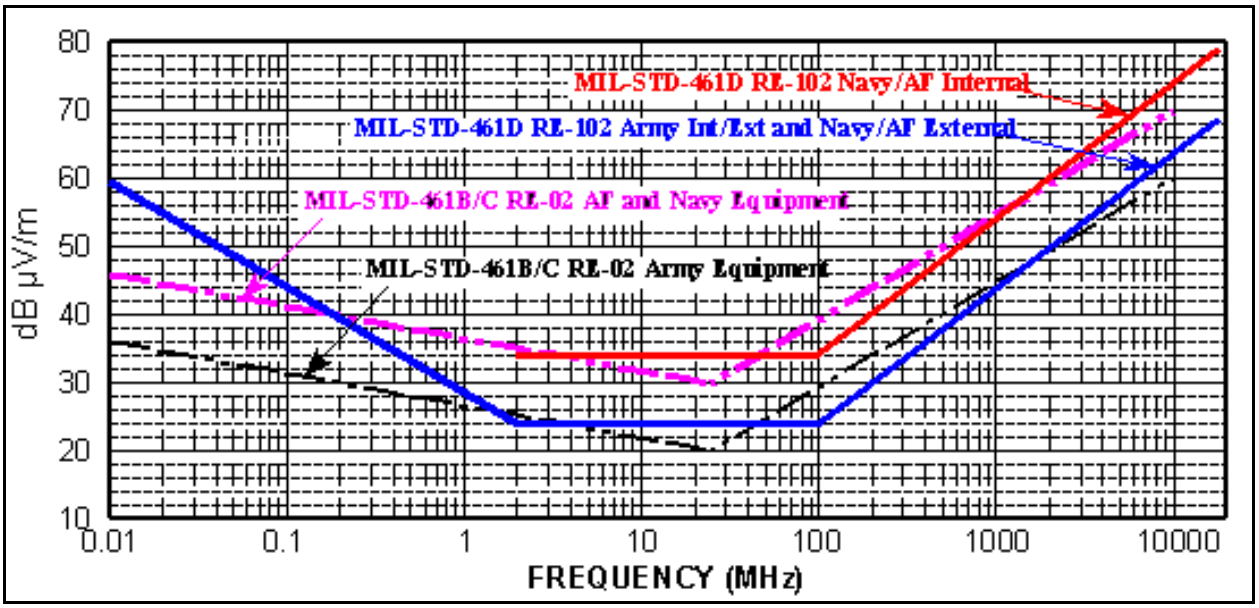

Figure 3. MIL-STD-461 Narrowband Radiated Emissions Limits.

Note that in MIL-STD-461D, the narrowband radiated emissions limits were retitled RE-102 from the previous RE-02 and the upper frequency limit was raised from 10 GHz to 18 GHz. The majority of this section will continue to reference RE02 since most systems in use today were built to MIL-STD-461B/C.

For the other calculation involving leakage (to obtain 70 dBµV/m) we again start with: $P_D = \frac{P_t G_t}{4\pi R^2}$

and use the previous fact that: $10\log(P_t G_t) = -33.6$ dBm $= 4.37\text{x}10^{-4}$ mW (see Section 2-4).

The measurement is at one meter so $R^2 = 1\ m^2$

we have: $\frac{4.37x\,10^{-4}}{4\pi}\ mW/m^2 = .348x\,10^{-4}\ mW/m^2 = -44.6\ dBm/m^2 = P_D$ @ 1 meter

Using the field intensity and power density relations (see Section 4-1)

$$E = \sqrt{P_D Z} = \sqrt{3.48x\,10^{-8} \bullet 377\Omega} = 36.2x\,10^{-4}\ V/m$$

Changing to microvolts (1V = 10^6 µV) and converting to logs we have:

20 log (E) = 20 log (10^6 x $36.2\text{x}10^{-4}$) = 20 log ($.362\text{x}10^4$) = 71.18 dBµV/m ≈ <u>70 dBµV/m</u> as given in Figure 1.

Some Words of Caution

A common error is to only use the one-way free space loss coefficient α_1 directly from Figure 6, Section 4-3 to calculate what the output power would be to achieve the EMCON limits at 1 NM. This is incorrect since the last term on the right of equation [3] ($10 \text{ Log}(4\pi R^2)$) is simply the Log of the surface area of a sphere - **it is NOT** the one-way free space loss factor α_1. You cannot interchange power (watts or dBW) with power density (watts/m^2 or dBW/m^2).

The equation uses power density (P_D), **NOT** received power (P_r). It is independent of RF and therefore varies only with range. If the source is a transmitter and/or antenna, then the power-gain product (or EIRP) is easily measured and it's readily apparent if $10\log (P_t G_t)$ is less than -34 dBm. If the output of the measurement system is connected to a power meter in place of the system transmission line and antenna, the -34 dBm value must be adjusted. The measurement on the power meter (dBm) minus line loss (dB) plus antenna gain (dB) must not be higher than -34 dBm.

However, many sources of radiation are through leakage, or are otherwise inaccessible to direct measurement and P_D must be measured with an antenna and a receiver. The measurements must be made at some RF(s), and received signal strength is a function of the antenna used therefore measurements must be scaled with an appropriate correction factor to obtain correct power density.

RE-02 Measurements

When RE-02 measurements are made, several different antennas are chosen dependent upon the frequency range under consideration. The voltage measured at the output terminals of an antenna is not the actual field intensity due to actual antenna gain, aperture characteristics, and loading effects. To account for this difference, the antenna factor is defined as:

$$AF = E/V \qquad \textbf{[4]}$$

where E = Unknown electric field to be determined in V/m (or μV/m)
V = Voltage measured at the output terminals of the measuring antenna

For an antenna loaded by a 50 Ω line (receiver), the theoretical antenna factor is developed as follows:

$$P_D A_e = P_r = V^2/R = V_r^2/50 \text{ or } V_r = \sqrt{50 P_D A_e}$$

From Section 4-3 we see that $A_e = G_r\lambda^2/4\pi$, and from Section 4-1, $E^2 = 377 P_D$ therefore we have:

$$AF = \frac{E}{V} = \frac{\sqrt{377 P_D}}{\sqrt{50 P_D (\lambda^2 G_r / 4\pi)}} = \frac{9.73}{\lambda \sqrt{G_r}} \qquad \textbf{[5]}$$

Reducing this to decibel form we have:

$$20 \log AF = 20 \log E - 20 \log V = 20 \log \left[\frac{9.73}{\lambda \sqrt{GSUBr}} \right] \quad \textit{with } \lambda \textit{ in meters and Gain numeric ratio (not dB)} \qquad \textbf{[6]}$$

This equation is plotted in Figure 3.

Since all of the equations in this section were developed using far field antenna theory, use only the indicated region.

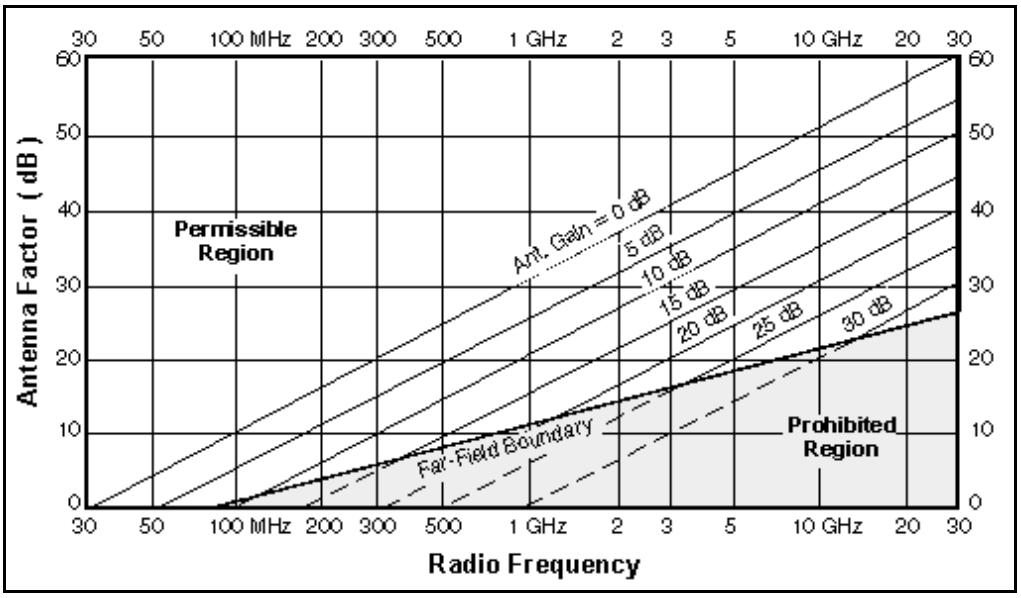

Figure 3. Antenna Factor vs. Frequency for Indicated Antenna Gain.

In practice the electric field is measured by attaching a field intensity meter or spectrum analyzer with a narrow bandpass preselector filter to the measuring antenna, recording the actual reading in volts and applying the antenna factor.

$$20\log E = 20\log V + 20\log AF \qquad \textbf{[7]}$$

Each of the antennas used for EMI measurements normally has a calibration sheet for both gain and antenna factor over the frequency range that the antenna is expected to be used. Typical values are presented in Table 1.

Table 1. Typical Antenna Factor Values.

Frequency Range	Antenna(s) Used	Antenna Factor	Gain(dB)
14 kHz - 30 MHz	41” rod	22-58 dB	0 - 2
20 MHz - 200 MHz	Dipole or Biconical	0-18 dB	0 - 11
200 MHz - 1 GHz	Conical Log Spiral	17-26 dB	0 - 15
1 GHz - 10 GHz	Conical Log Spiral or Ridged Horn	21-48 dB	0 - 28
1 GHz - 18 GHz	Double Ridged Horn	21-47 dB	0 - 32
18 GHz - 40 GHz	Parabolic Dish	20-25 dB	27 - 35

The antenna factor can also be developed in terms of the receiving antenna's effective area. This can be shown as follows:

$$AF = \frac{E}{V} = \frac{\sqrt{377\ P_D}}{\sqrt{50\ P_D\ A_e}} = \frac{2.75}{\sqrt{A_e}} \qquad \textbf{[8]}$$

Or in log form:

$$20 \log AF = 20 \log E - 20 \log V = 20 \log \left[\frac{2.75}{\sqrt{A_e}} \right] \qquad \textbf{[9]}$$

While this relation holds for any antenna, many antennas (spiral, dipole, conical etc.) which do not have a true "frontal capture area" do not have a linear or logarithmic relation between area and gain and in that respect the parabolic dish is unique in that the antenna factor does not vary with frequency, only with effective capture area. Consequently a larger effective area results in a smaller antenna factor.

A calibrated antenna would be the first choice for making measurements, followed by use of a parabolic dish or "standard gain" horn. A standard gain horn is one which was designed such that it closely follows the rules of thumb regarding area/gain and has a constant antenna factor. If a calibrated antenna, parabolic dish, or "standard horn" is not available, a good procedure is to utilize a flat spiral antenna (such as the AN/ALR-67 high band antennas). These antennas typically have an average gain of 0 dB (typically -4 to +4 dB), consequently the antenna factor would not vary a lot and any error would be small.

EXAMPLE:

Suppose that we want to make a very general estimation regarding the ability of a system to meet EMCON requirements. We choose to use a spiral antenna for measurements and take one of our samples at 4 GHz. Since we know the gain of the spiral is relatively flat at 4 GHz and has a gain value of approximately one (0 dB) in that frequency range. The antenna is connected to a spectrum analyzer by 25 feet of RG9 cable. We want to take our measurements at 2 meters from the system so our setup is shown as follows:

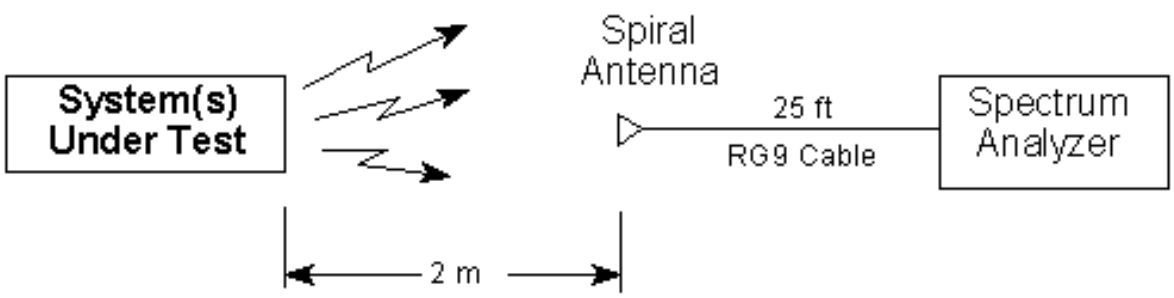

Our RG9 cable has an input impedance of 50Ω, and a loss of 5 dB (from Figure 5, Section 6-1).

First, let's assume that we measure -85 dBm at the spectrum analyzer and we want to translate this into the equivalent strength at 1 NM. Our power received by the antenna is: P_r = -85 dBm + 5 dB line loss = -80 dBm

also $P_D = P_r/A_e$ and $A_e = G\lambda^2/4\pi = (G/4\pi)\bullet(c/f)^2 = (1/4\pi)\bullet(3x10^8/4x10^9)^2 = 4.47x10^{-4}$ m^2

in log form: $10 \text{ Log } P_D = 10 \text{ Log } P_r - 10 \text{ Log } A_e = -80 \text{ dBm} + 33.5 = -46.5 \text{ dBm/m}^2$
at our 2 meter measuring point

To convert this to a value at 1 NM, we use

$P_t G_t = P_{D@1\ nm}\ 4\pi R_1^2 = P_{D@2\ m}\ 4\pi R_2^2$ and we solve for $PD@1_{nm}$

in log form after cancelling the 4π terms:

$10 \text{ Log } P_{D@1\ nm} = 10 \text{ Log } P_{D@2\ m} + 10 \text{ Log } (R_{2m}/R_{1nm})^2 = -46.5 \text{ dBm/m}^2 - 59.3 \text{ dB} = -105.8 \text{ dBm/m}^2$
which is more power than the maximum value of -110 dBm/m^2 specified.

If we are making repetitive measurement as we might do when screening an aircraft on the flight line with numerous systems installed, or when we want to improve (reduce) the leakage on a single system by changing antennas, lines, connectors, or EMI gaskets or shielding, this mathematical approach would be unnecessarily time consuming since it would have to be repeated after each measurement. A better approach would be to convert the -110 dBm/m^2 value at 1 NM to the maximum you can have at the measuring instrument (in this case a spectrum analyzer), then you could make multiple measurements and know immediately how your system(s) are doing. It should be noted that -90 to -100 dBm is about the minimum signal level that can be detected by a spectrum analyzer, so you couldn't take measurements much further away unless you used an antenna with a much higher gain.

In order not to exceed EMCON, the power density must not exceed -110 dBm/m^2 at 1 NM, which is 10^{-11} mW/m^2.

$$P_t G_t = P_{D@1\ nm}\ 4\pi R_1^2 = P_{D@2\ m}\ 4\pi R_2^2$$

we solve for $P_{D@2\ m} = 10^{-11}(1852m)^2/(2m)^2 = 8.57 \times 10^{-6}\ mW/m^2 = -50.7\ dBm/m^2$

We'll be using a spectrum analyzer, so we want to compute what the maximum power or voltage may be.

<u>Method 1 - Using the Power Density Approach</u>

Using logs/dB and the values of $P_{D@2\ m}$ and A_e determined previously:
$10 \text{ Log } P_r = 10 \text{ Log } P_D + 10 \text{ Log } A_e = -50.7 - 33.5 = -84.2 \text{ dBm}$

taking line loss into account we have: -84.2 - 5 dB = <u>- 89.2 dBm</u> as the maximum measurement reading.

If we wanted to calculate it in volts, and take into account our line impedance we would have the following:

$P_r = P_D A_e = V^2/R = V^2/50\Omega$ also $A_e = G\lambda^2/4\pi$ so solving for V we have:

$$V = \sqrt{P_D\left[\frac{G_r\lambda^2}{4\pi}\right]R} = \sqrt{P_D\left[\frac{G_r}{4\pi}\left(\frac{c}{f}\right)^2\right]R} = \sqrt{8.57x\,10^{-9}\left[\frac{1}{4\pi}\left(\frac{3x\,10^8}{4x\,10^9}\right)^2\right]50\Omega} = 1.38x\,10^{-5}\ volts \quad (before\ line\ loss)$$

since our line loss is 5 dB, we have -5 dB = 20 Log V_2/V_1. Solving for V_2 we get <u>$7.79x10^{-6}$ volts</u> or <u>-89 dBm</u> as a maximum at our measurement device input. We can see immediately that our value of -85 dBm that we measured on the previous page would not meet specifications, and neither would any signal with more power than -89 dBm.

<u>Method 2 - Using the Antenna Factor Approach</u>

Starting with the same value of power density that we obtained above ($8.57x10^{-9}$ W/m^2), we find the field intensity from Table 1, Section 4-1 to be approximately 65 dBμv/m. Also from Figure 3 in this section, AF = 43 dB @ 4 GHz (by calculating with equation [6], the exact value is 42.3 dB).

From equation [6]:
20log V = 20log E - 20log AF
20log V = 65 - 43 = 22 dBμv/m.

Since dBμv/m = 20 log (V)(10^6) = 20 log V + 20 log 10^6 = 20 log V + 120, we see that to get an answer in dBv we must subtract 120 from the dBμv/m value so: V_{dB} = 22 - 120 = -98dBv. We then subtract our line loss (-5 dB) and we have:

V = -98 - 5 = -103 dBv = 17 dBμv = <u>$7.1x10^{-6}$ volts</u>

using the fact that $P = V^2/R$ and for the input line R = 50Ω, P = $1x10^{-12}$ W = -120 dBW = <u>-90 dBm</u>

Although this method is just as accurate as that obtained using method 1, the values obtained in Table 1, Section 4-1, and Figure 3 must be interpolated, and may not result in values which are as precise as the appropriate formulas would produce.

<u>Sample Problem:</u> What is the approximate transmit power from a receiver?

A.	1 nanowatt (nW)	F.	100 μW	K.	10 W
B.	10 nW	G.	1 milliwatt (mW)	L.	100 W
C.	100 nW	H.	10 mW	M.	1 kilowatt (kW)
D.	1 microwatt (μW)	I.	100 mW	N.	10 kW
E.	10 μW	J.	1 watt (W)	O.	100 kW

The question may seem inappropriate since a receiver is supposedly a passive device which only receives a signal. If the receiver was a crystal video receiver as shown in Section 5-3, it wouldn't transmit power unless a built-in-test (BIT) signal was injected after the antenna to periodically check the integrity of the microwave path and components. The potential exists for the BIT signal to leak across switches and couple back through the input path and be transmitted by the receiver's antennas.

If the receiver uses a local oscillator (LO) and a mixer to translate the signal to an intermediate frequency (IF) for processing (such as a superhet shown in Section 5-3), there is the potential for the CW LO signal to couple back through the signal input path and be transmitted by the receiver's antenna. Normally a mixer has 20 dB of rejection for the reverse direction. In addition, the LO may be further attenuated by receiver front end filters.

In both cases, the use of isolators described in Section 6-7 could be used to further attenuate any signals going in the reverse direction, i.e. back to the antenna. A good receiver design should ensure that any RF leakage radiated by the receiver will not exceed the EMCON level.

In answer to the initial question, "transmit" leakage power should be less than -34 dBm (0.4 μW) to meet EMCON. Therefore, the real answer may be "A," "B," or "C" if EMCON is met and could be "D" through possibly "G" if EMCON is not met.

EW JAMMING TECHNIQUES

INTRODUCTION

Electronic jamming is a form of Electronic Attack where jammers radiate interfering signals toward an enemy's radar, blocking the receiver with highly concentrated energy signals. The two main technique styles are noise techniques and repeater techniques. The three types of noise jamming are spot, sweep, and barrage. Repeater techniques can be further subdivided into categories as shown in Figure 1.

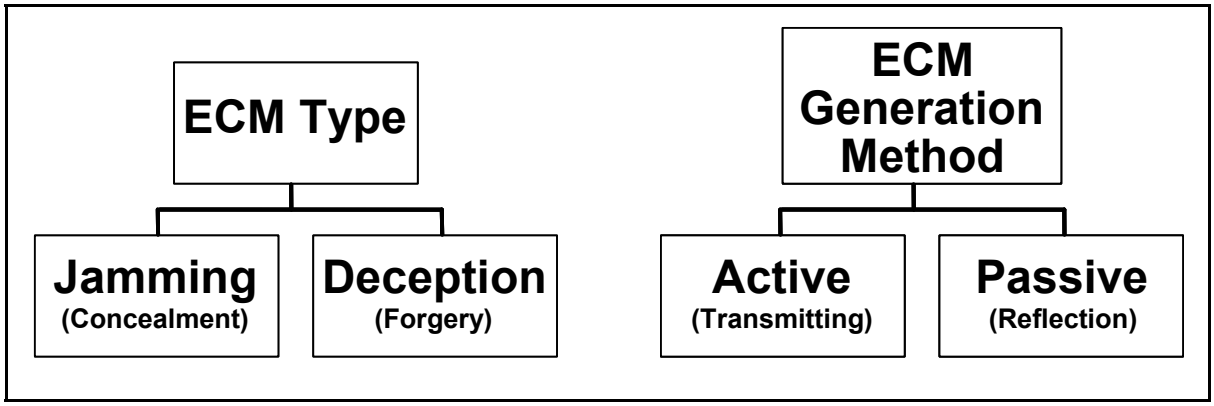

Figure 1. EA Repeater Technique Divisions.

ASYNCHRONOUS SWEPT WAVE MODULATION (ASWM)

ASWM is synonymous with A-SWM. Asynchronous indicates that the waveform is free running - also see SSWM. A swept wave modulation is essentially a swept amplitude modulation (SAM). It is a waveform that is swept between two frequencies that are usually chosen to bracket a radar's passive angle scanning rate. The modulation amplitude can be either down modulated or On-Off Keyed (OOK). The down modulated shape can be square wave, rectangular wave, linear (e.g. a sine wave), or a combination. The OOK modulated shape can be square wave or rectangular wave.

BARRAGE JAMMING

The jamming of multiple frequencies at once by a single jammer. The advantage is that multiple frequencies can be jammed simultaneously; however, the jamming effect can be limited because this requires the jammer to spread its full power between these frequencies. So the more frequencies being jammed, the less effectively each is jammed.

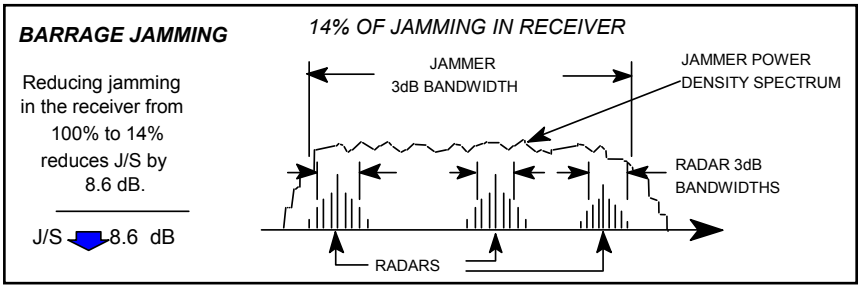

Figure 2. Barrage Jamming.

CROSS POLARIZATION (X-POL)

(1) A self-screening or support EA technique that causes angle errors in tracking radars and sensing errors in jamming suppression EP systems of surveillance radars by radiating a signal that is orthogonally polarized to the principal polarization of the victim radar. (2) A technique used against monopulse and other passive lobe tracking radars. Requires a strong jam-to-signal ratio or the skin echo will show up in the pattern nulls.

HOME ON JAM (HOJ)

A means whereby a missile guidance receiver utilizes the self-screening target jamming signal to develop angular steering information so that the missile can home on that target.

IMAGE JAMMING

Jamming at the image frequency of the radar receiver. Barrage jamming is made most effective by generating energy at both the normal operating and image frequency of the radar. Image jamming inverts the phase of the response and is thereby useful as an angle deception technique. Not effective if the radar uses image rejection.

INVERSE CON SCAN (ICS)

One method of confusing a radar operator or fire control radar system is to provide erroneous target bearings. This is accomplished by first sensing the radar antenna or antenna dipole scan rate and then modulating repeater amplifier gain so that the weapons system will fire at some bearing other than the true target bearing.

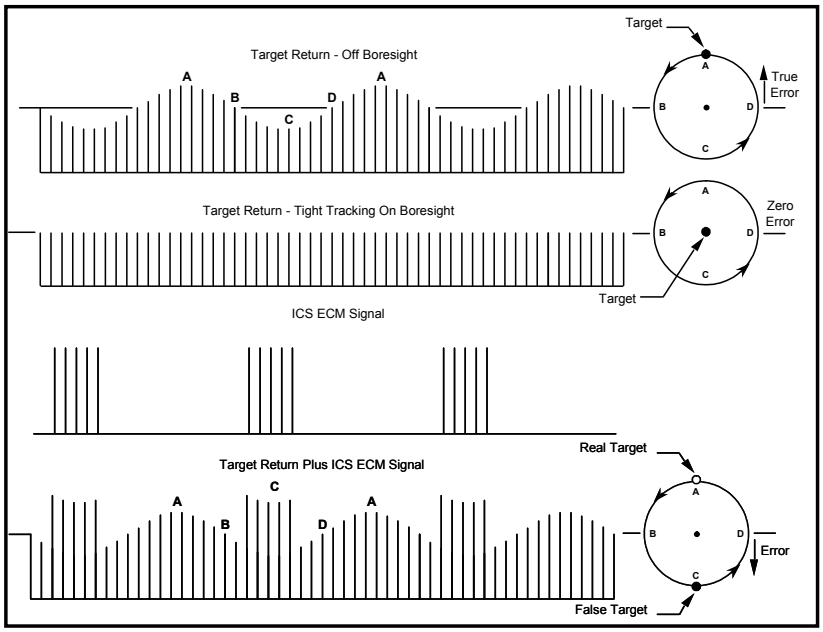

Figure 3. Inverse Con Scan.

J/S REQUIREMENT

The jamming to signal ratio for effective coverage of the true target. Usually on the order of zero dB (J/S=1).

LINEAR MODULATION

A modulation technique in which the output varies in a straight line (linear) manner with the input (modulating) waveform. This is different from a discontinuous (On-Off) modulation. Typically the modulating waveform is a ramp or triangular wave but could also be a sine wave modulating input.

LOBE ON RECEIVE ONLY (LORO)

Predicting the future location of a target (to track) requires that the radar look at areas where the target is not located. When this scanning is accomplished with the radiated beam, large angle targets such as chaff clouds can create complete radar "white-out." RWR indications can be obtained before actual target lock-on. These problems can be overcome by scanning only the receiving antennas and using a separate transmitting antenna pointed only at the target.

In a LORO system, a transmitting antenna emits a few "exploratory" pulses along a direction obtained from an acquisition radar. These exploratory pulses are the acquisition mode of the TTR. That is, in its acquisition mode the small beamed TTR must scan the large location segment provided by the acquisition radar. In radars equipped with Fast Time Constant, the return pulse is applied to a differentiator of extremely short time constant. When the pulse is received, it is "cut-off" on the leading edge and only that portion is fed to the computer. This allows the radar to effectively track on the leading edge of the target. FTC does not improve the range resolution but it can prevent any countermeasures aft of the target which are in the same resolution cell as the target (such as chaff) from interfering with the radar receiver.

The receiving antennas scan their sector for the target return due to these exploratory pulses; as the power centroid is located, the center of the receiving pattern is brought onto the target. The transmitting antenna, which is slaved to the receiving antenna, is then pointing directly at the desired target and only that target is radiated during tracking. This approach allows a very small radiated beam, but the resolution cell of the system is still that of the receiving antenna.

NOISE JAMMING

The transmission of noise-like signals in the target system's radar receiver bandpass. At low power levels, noise jamming has the characteristics of receiver noise and can be mistaken by the radar operator as a problem with the radar. The object of noise jamming is to introduce a disturbing signal into the hostile electronic equipment so that the actual signal is obscured by the interference. The victim of this disturbance might be a radar receiver, a communications network, or a data link.

See also Barrage Jamming and Spot Jamming.

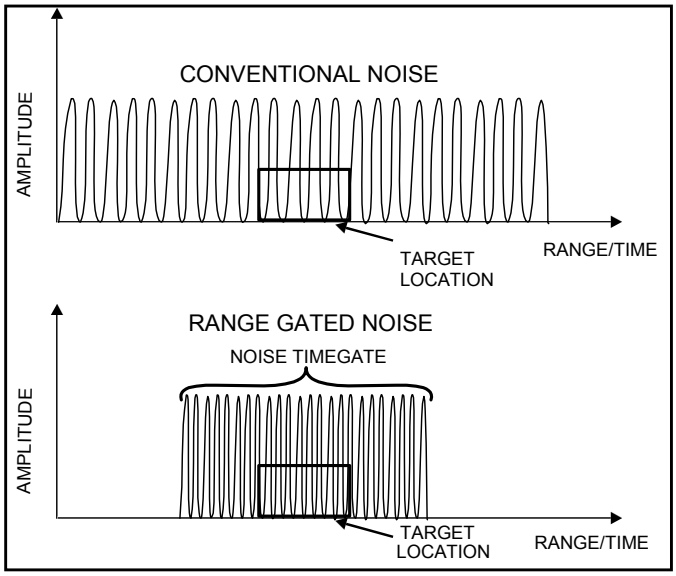

Figure 4. Noise Jamming.

ON-OFF MODULATION

On-Off Modulation is any modulation which switches rapidly between two states. This definition includes pulse radar operation.

On-Off Keying (OOK) is the envelope modulation of a jamming signal with a rectangular wave. The modulation rate and duty cycle are adjusted commensurate with the victim radar's processing time constants. These can be related to AGC time constants, logic time-outs, data sampling cycles, or any other data processing response times.

An important distinction must be made between the terms On-Off Keying and Blinking. While both terms involve envelope modulations that turn a jamming signal on and off, the term OOK is used as the envelope modulation of a single jamming signal, and the term blinking is used as the tactical application of OOK involving two or more cooperative jamming platforms.

PSEUDO RANDOM NOISE (PRN)

A controlled, noise-like, pulse pattern repeated in synchronism with the victim radar pulse repetition frequency. Synonymous with quasi-noise jamming.

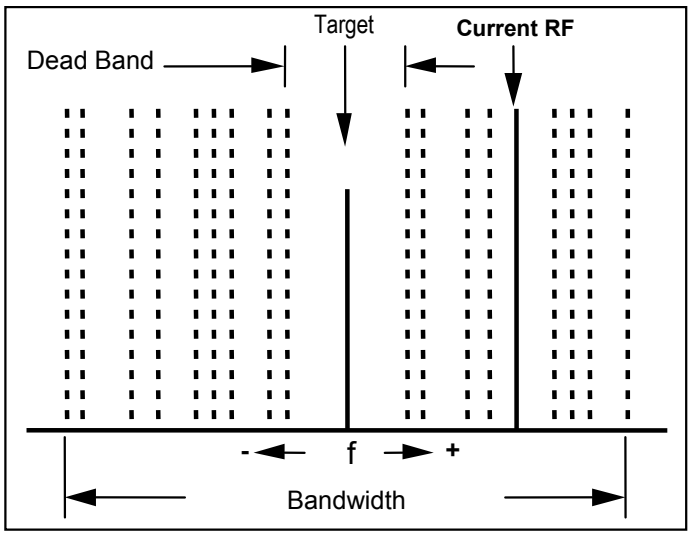

Figure 5. Random Dual Line.

RANDOM DUAL LINE (RDL)

RDL is a coherent repeater technique that is essentially the same as velocity noise (VN), narrow band noise (NBN), and pseudo random noise (PRN) except that no false Doppler frequencies are stepped directly over the target return. The objective is to prevent the momentary additions of the EA signal and target signal that might highlight the presence of a coherent return.

RANDOM RANGE PROGRAM (RANRAP)

A dynamic False Target Jamming technique program to create multiple realistic targets of varying size and distance from the jamming plane.

RANGE GATE PULL OFF (RGPO)

Once a tracking radar has detected a target, it will place *range gates* to either side of it. Range gates essentially blank out all signals which originate from ranges outside a narrow window, substantially increasing the signal-to-noise ratio and protecting the radar against unsynchronized jamming pulses. The radar 'concentrates' on a short range interval which encloses the target's location, and it no longer looks out for other targets. This state is known as 'lock-on'. But range gates can be 'stolen', and it is the objective of the Range Gate Pull-Off (RGPO) technique to *break lock* and escape from out of the window.

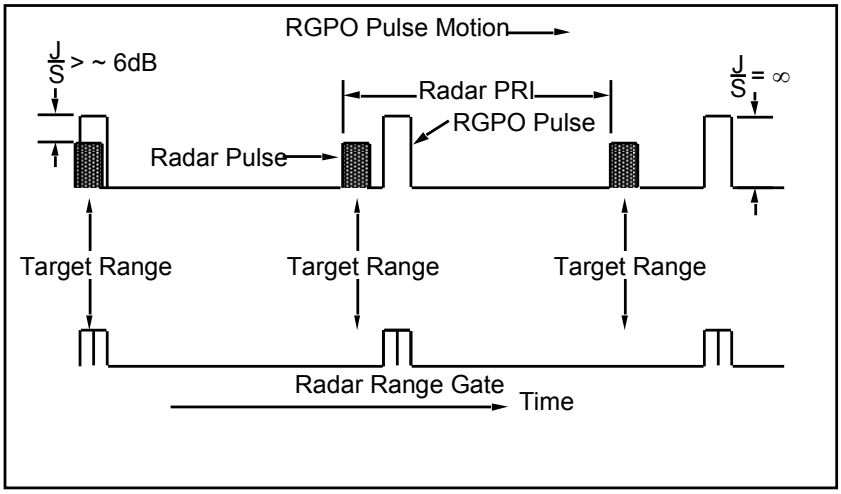

Figure 6. Range Gate Pull Off.

RGPO works as follows:

Upon detection (or assumption) that a tracking radar has locked on, the on-board jammer is switched on and starts to work in a couple of phases:

1. First, a sample of the illuminating pulse signal is taken and the radar's <u>pulse repetition frequency</u> (PRF) is determined. This sample is amplified and retransmitted simultaneously when further pulses are received. The aircraft actually highlights itself on the radar screen. The jamming power is steadily increased, and this continues until the replica is much stronger than the echo from the aircraft skin return. At this time, the sensitivity of the tracking radar's receiver is usually reduced in order to avoid overload. This causes the skin echo vanishes below the noise floor.

2. *Another* replica is transmitted after each of the 'dummy' skin echoes. The power of the second replica is increased while the dummy is made weaker.

3. Next, the tracker has locked on to the *delayed replica*, whereas the skin return has decreased into the noise. With respect to each of the radar's pulses, the replica is now being delayed by small, but increasing amounts of time. The range gates, of course, follow the dummy target which appears to be receding. This continues until the range gates have been moved away from the target's real position. The result is that the radar is tracking a *phantom target* and the skin return is being blanked out by the range gates.

4. Finally, the jammer is switched off and leaves the radar with just *nothing* but noise inside the window between its range gates. Break-lock was successfully achieved and the "tracking" radar needs to

switch back into a search or acquisition mode and loses time. The whole cycle will start again if the target is still within range and is reacquired.

As described above, RGPO creates only false targets which appear at greater ranges than the real target because the deceptive signal is transmitted *after* the skin echo. However, if the victim radar's PRF is constant then the time of incidence of the next radar pulse can be calculated and jamming pulses can be placed such that false targets at closer ranges are also produced.

SCINTILLATION (SCINT)

Scintillation is not an EA technique by itself, it is an implementation of an EA technique. Scintillation is simply superimposing a small, pseudo random amplitude modulation on the EA signal to make it appear more realistic to a manual operator.

SPOT JAMMING

Occurs when a jammer focuses all of its power on a single frequency. While this would severely degrade the ability to track on the jammed frequency, a frequency agile radar would hardly be affected because the jammer can only jam one frequency. While multiple jammers could possibly jam a range of frequencies, this would consume a great deal of resources to have any effect on a frequency-agile radar, and would probably still be ineffective

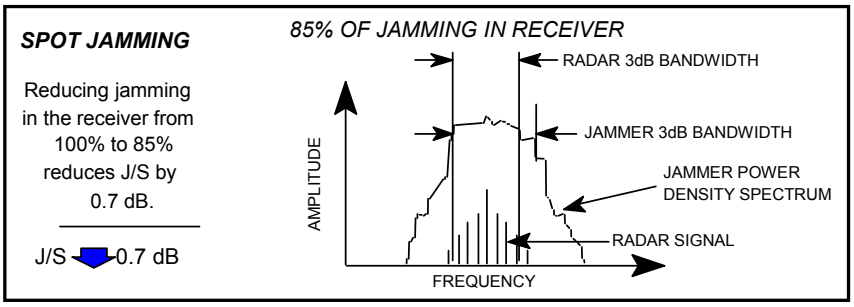

Figure 7. Spot Jamming.

SWEPT JAMMING

This happens when a jammer's full power is shifted from one frequency to another. While this has the advantage of being able to jam multiple frequencies in quick succession, it does not affect them all at the same time, and thus limits the effectiveness of this type of jamming. Although, depending on the error checking in the receiver(s) this can render a wide range of receivers effectively useless.

SWEPT AMPLITUDE MODULATION (SAM)

The OOK frequency is linearly varied in a sawtooth fashion between preset frequency limits while the duty factor is held constant.

SWEPT WAVE MODULATION (SWM)

A swept wave modulation.2 (SWM.2) is essentially a swept amplitude modulation (SAM). It is a waveform that is swept between two frequencies that are usually chosen to bracket a radar's passive angle scanning rate. SWM can be either Synchronous Swept Wave Modulation.2-; (S-SWM) or Asynchronous Swept Wave Modulation.2-; (A-SWM.2-;). The modulation amplitude can be either down modulated or On-Off Keyed (OOK). The down modulating shape can be square wave, rectangular wave, linear (e.g. a sine wave), or a combination. The OOK modulating shape can be square wave or rectangular wave.

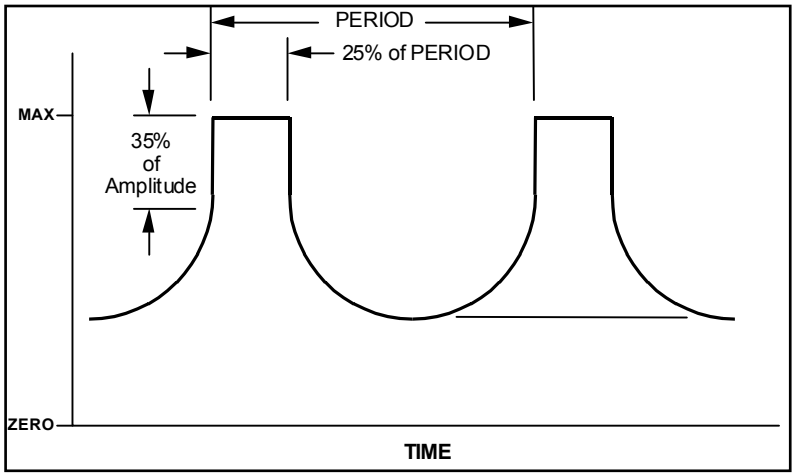

Figure 8. Typical Linear SWM Modulation.

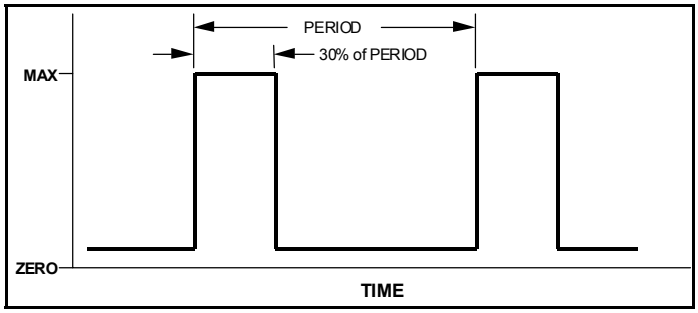

Figure 9. Rectangular SWM.

SYNCHRONOUS SWEPT WAVE MODULATION (SSWM)

SSWM is synonymous with S-SWM. S-SWM and A-SWM are essentially the same except that asynchronous means that the waveform is free running and synchronous means that when a radar scan or TWS beam can be detected, the modulation waveform is synchronized to the detected beam. For programming purposes A-SWM sets sweep limits and rate by frequency (Hz), while S-SWM sets them by period (mSec).

Active Con-Scan radars will not have a detectable modulation if the target is being tightly tracked in the center of the beam. Therefore, a SWM can "jog" the tracking sufficiently to detect the modulation and allowing subsequent synchronization of the SWM waveform.

TRACK WHILE SCAN JAMMING

The technique of shifting or "walking" EA pulses off target. Many angle jamming techniques are effective.

VELOCITY FALSE TARGETS (VFT)

VFT is a pseudo-random false Doppler target concealment technique. It is designed for use against radars that acquire Doppler targets with a bank of contiguous narrow band filters. A false Doppler target is programmed to remain in a Doppler filter long enough for the radar processing to declare it a valid target return, but not long enough for the radar processing to establish tracking.

The false Doppler target is then switched to the next pseudo-randomly selected frequency and repeated. It is intended to overload the radar processing and/or the operator's ability to identify an actual target. In the illustration, the VFTs jump around in the indicated numerical order.

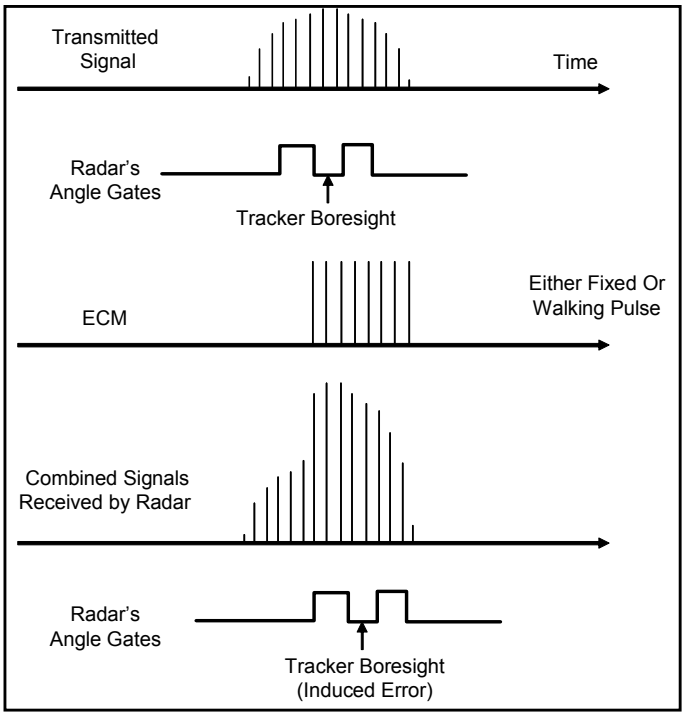

Figure 10. TWS Jamming.

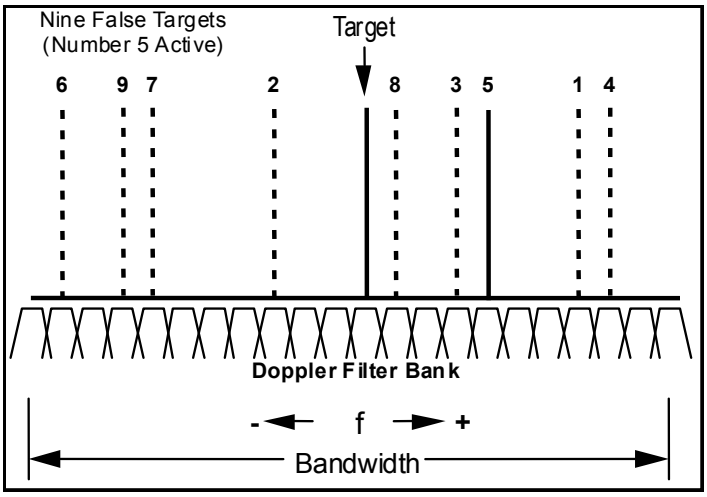

Figure 11. Velocity False Targets.

VELOCITY GATE PULL OFF

This is a method of capturing the velocity gate of a Doppler radar and moving it away from the skin echo. Similar to the RGPO, but used against CW or Doppler velocity tracking radar systems. The CW or pulse doppler frequency, which is amplified and retransmitted, is shifted in frequency (velocity) to provide an apparent rate change or Doppler shift.

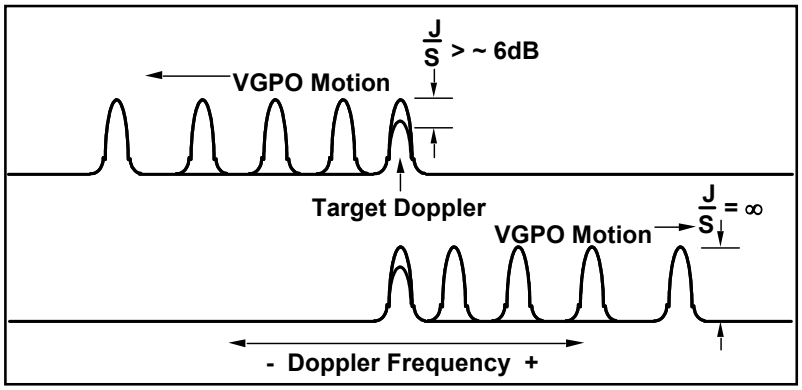

Figure 12. Velocity Gate Pull Off.

VELOCITY NOISE (VN)

VN is a coherent repeater technique. The objective is to create noise centered on a coherent radar's RF, with a noise bandwidth that is close to, or less than, the radar's bandwidth and conceal the target, or destroy target signal coherency. VN is generated by pseudo randomly stepping a frequency over the victim radar's bandwidth. The dashed RF lines represent possible frequencies and the solid line represents the frequency currently active.

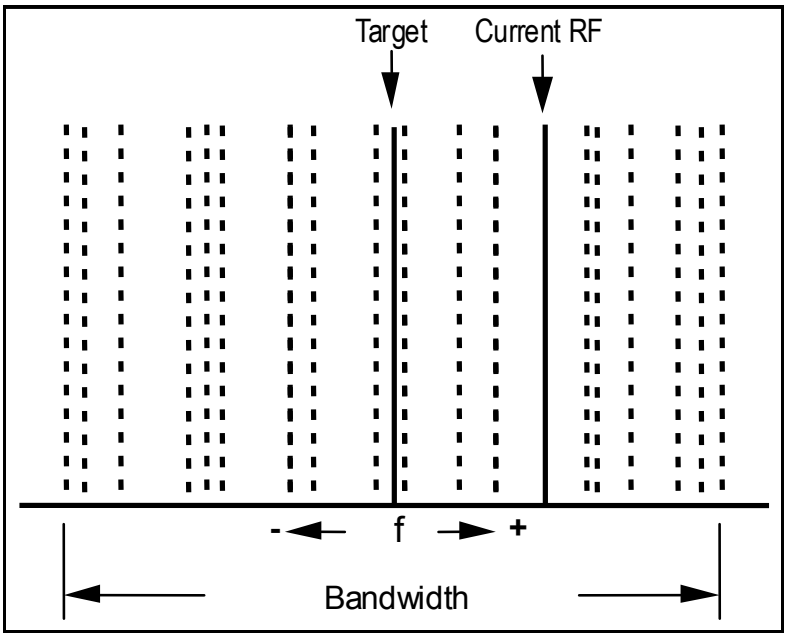

Figure 13. Velocity Noise.

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RADAR AND RECEIVER CHARACTERISTICS & TEST

RF Atmospheric Absorption / Ducting 5-1
Receiver Sensitivity / Noise 5-2
Receiver Types and Characteristics 5-3
Radar Modes 5-4
General Radar Display Types 5-5
IFF - Identification - Friend or Foe 5-6
Receiver Tests 5-7
Signal Sorting and Direction Finding 5-8

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RF ATMOSPHERIC ABSORPTION / DUCTING

Signal losses are associated with each stage of signal processing in both the transmitting and receiving portions of the system. The transmitting losses include power transmission efficiency, waveguide and antenna losses, and duplexer losses. In the receiver, losses include antenna, waveguide, RF amplifier, mixer, and IF amplifier.

In addition to these losses, energy traveling through the atmosphere suffers from atmospheric attenuation caused primarily by absorption by the gasses. For lower frequencies (below 10 GHz), the attenuation is reasonably predictable. For high frequencies in the millimeter wave range, the attenuation not only increases, but becomes more dependent upon peculiar absorbing characteristics of H_2O, O_2, and the like.

Figure 1 shows the areas of peak absorption in the millimeter wave spectrum. Figure 2 shows how the intensity of precipitation can affect atmospheric attenuation.

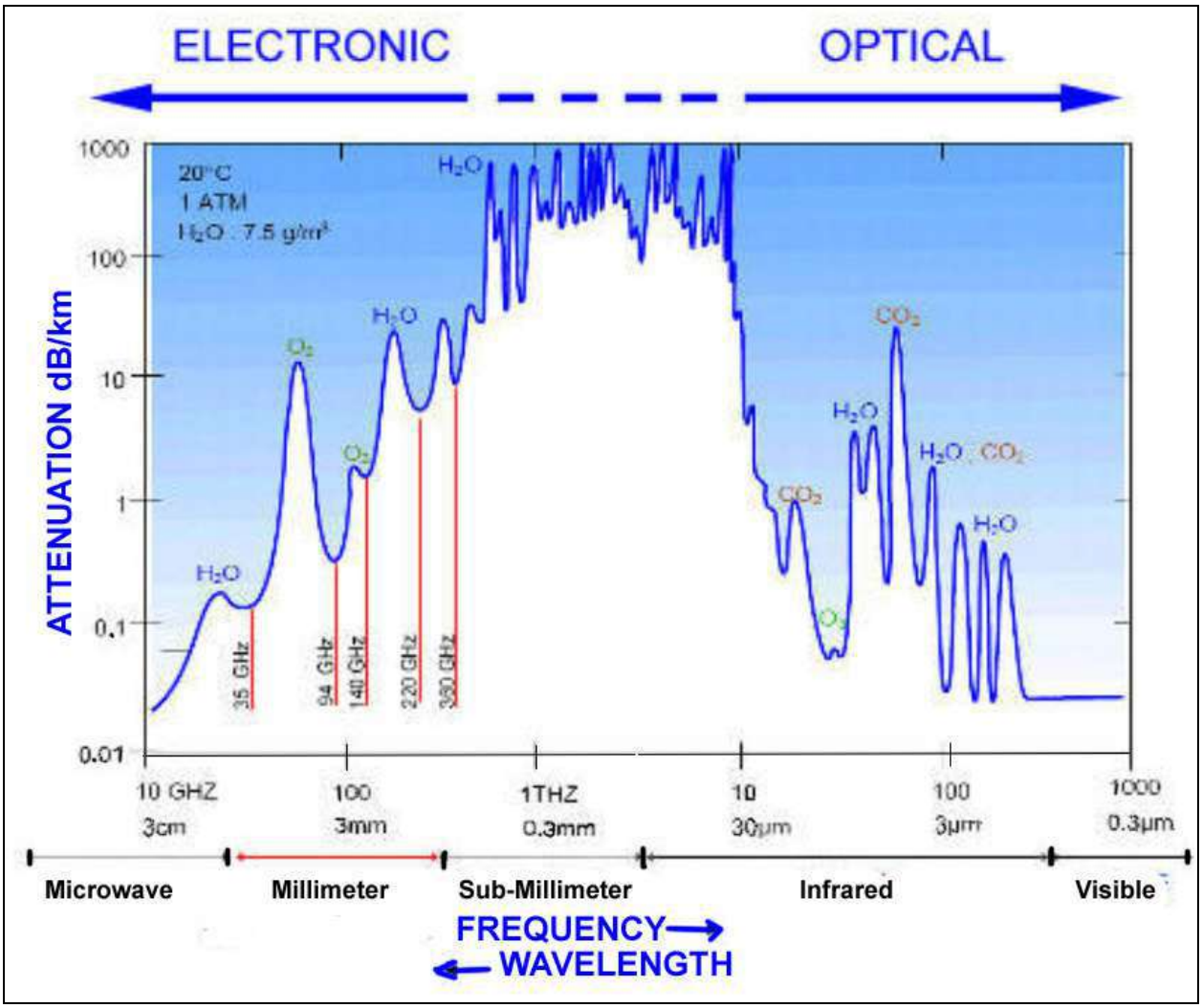

Figure 1. Atmospheric Absorption of Millimeter Waves.

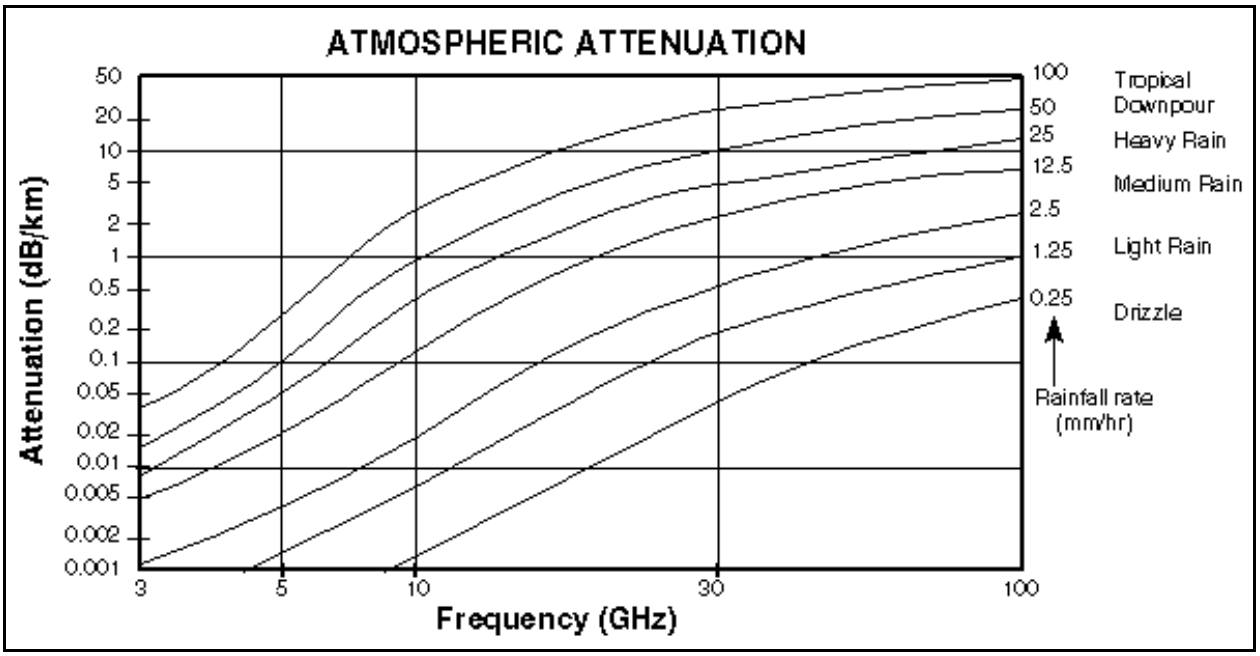

Figure 2. Atmospheric Attenuation.

Ducting is an increase in range that an electromagnetic wave will travel due to a temperature inversion of the lower atmosphere (troposphere) as shown in Figure 3. The temperature inversion forms a channel or waveguide (duct) for the waves to travel in, and they can be trapped, not attenuating as would be expected from the radar equation. Ducting may also extend range beyond what might be expected from limitations of the radar horizon (see Section 2-9).

The ducting phenomena is frequency sensitive. The thicker the duct, the lower the minimum trapped frequency.

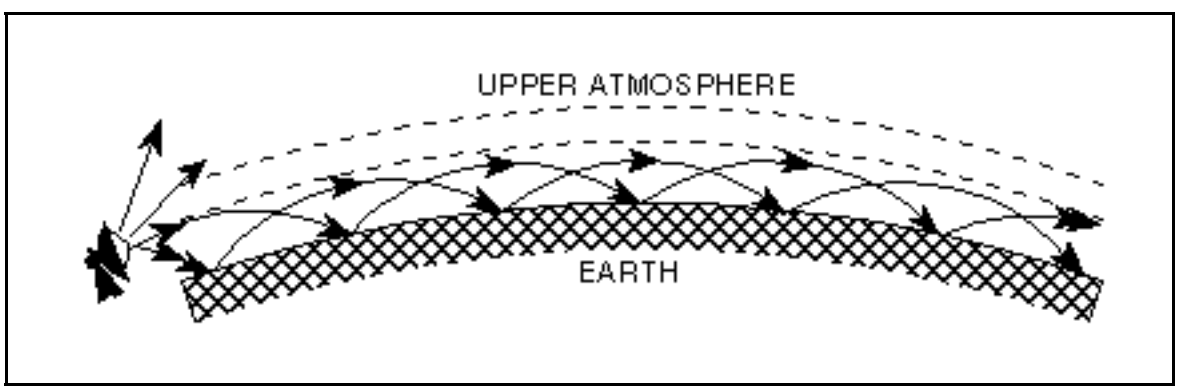

Figure 3. Ducting.

A similar occurrence takes place with ionospheric refraction, however the greatest increase in range occurs in the lower frequencies. This is familiar to amateur radio operators who are able to contact counterparts “around the world.”

RECEIVER SENSITIVITY / NOISE

RECEIVER SENSITIVITY

Sensitivity in a receiver is normally taken as the minimum input signal (S_{min}) required to produce a specified output signal having a specified signal-to-noise (S/N) ratio and is defined as the minimum signal-to-noise ratio times the mean noise power, see equation [1]. For a signal impinging on the antenna (system level) sensitivity is known as minimum operational sensitivity (MOS), see equation [2]. Since MOS includes antenna gain, it may be expressed in dBLi (dB referenced to a linear isotropic antenna). When specifying the sensitivity of receivers intended to intercept and process pulse signals, the minimum pulse width at which the specified sensitivity applies must also be stated. See the discussion of post-detection bandwidth (B_V) in Section 5-2 for significance of minimum pulsewidth in the receiver design.

$$\mathbf{S_{min} = (S/N)_{min} k T_o B (NF)}$$ receiver sensitivity ("black box" performance parameter) **[1]**

or $$\mathbf{MOS = (S/N)_{min} k T_o B (NF)/G}$$ system sensitivity i.e. the receiver is connected to an antenna (transmission line loss included with antenna gain) **[2]**

where: S/N_{min} = Minimum signal-to-noise ratio needed to <u>process</u> (vice just detect) a signal
NF = Noise figure/factor
k = Boltzmann's Constant = 1.38×10^{-23} Joule/°K
T_o = Absolute temperature of the receiver input (°Kelvin) = 290°K
B = Receiver Bandwidth (Hz)
G = Antenna/system gain

We have a lower MOS if temperature, bandwidth, NF, or S/N_{min} decreases, or if antenna gain increases. For radar, missile, and EW receivers, sensitivity is usually stated in dBm. For communications and commercial broadcasting receivers, sensitivity is usually stated in micro-volts or dBμv. See Section 4-1.

There is no standard definition of sensitivity level. The term minimum operational sensitivity (MOS) can be used in place of S_{min} at the system level where aircraft installation characteristics are included. The "black box" term minimum detectable signal (MDS) is often used for S_{min} but can cause confusion because a receiver may be able to detect a signal, but not properly process it. MDS can also be confused with minimum discernable signal, which is frequently used when a human operator is used to interpret the reception results. A human interpretation is also required with minimum visible signal (MVS) and tangential sensitivity (discussed later). To avoid confusion, the terms S_{min} for "black box" minimum sensitivity and MOS for system minimum sensitivity are used in this section. All receivers are designed for a certain sensitivity level based on requirements. One would not design a receiver with more sensitivity than required because it limits the receiver bandwidth and will require the receiver to process signals it is not interested in. In general, while processing signals, the higher the power level at which the sensitivity is set, the fewer the number of false alarms which will be processed. Simultaneously, the probability of detection of a "good" (low-noise) signal will be decreased.

Sensitivity can be defined in two opposite ways, so discussions can frequently be confusing. It can be the ratio of response to input or input to response. In using the first method (most common in receiver discussions and used herein), it will be a negative number (in dBm), with the more negative being "better" sensitivity, e.g., -60 dBm is "better" than -50 dBm sensitivity. If the second method is used, the result will be a positive number, with higher being "better." Therefore the terms low sensitivity or high sensitivity can be very confusing. The terms S_{min} and MOS avoid confusion.

SIGNAL-TO-NOISE (S/N) RATIO

The Signal-to-Noise Ratio (S/N) (a.k.a. SNR) in a receiver is the signal power in the receiver divided by the mean noise power of the receiver. All receivers require the signal to exceed the noise by some amount. Usually if the signal power is less than or just equals the noise power it is not detectable. For a signal to be detected, the signal energy plus the noise energy must exceed some threshold value. Therefore, just because N is in the denominator doesn't mean it can be increased to lower the MOS. S/N is a required minimum ratio, if N is increased, then S must also be increased to maintain that threshold. The threshold value is chosen high enough above the mean noise level so that the probability of random noise peaks exceeding the threshold, and causing false alarms, is acceptably low.

Figure 1 depicts the concept of required S/N. It can be seen that the signal at time A exceeds the S/N ratio and indicates a false alarm or target. The signal at time B is just at the threshold, and the signal at time C is clearly below it. In the sample, if the temperature is taken as room temperature (T_o = 290°K), the noise power input is -114 dBm for a one MHz bandwidth. Normally S/N_{min} may be set higher than S/N shown in Figure 1 to meet false alarm specifications.

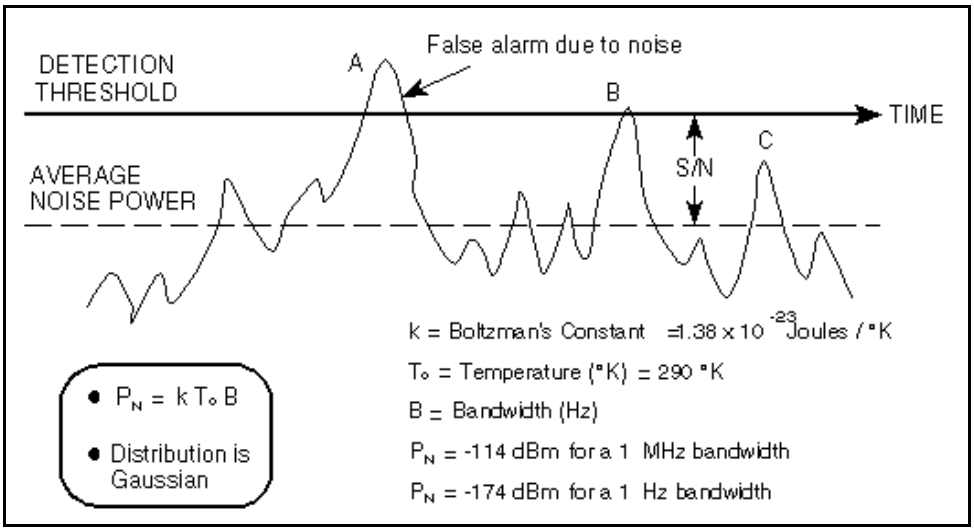

Figure 1. Receiver Noise Power at Room Temperature.

The acceptable minimum Signal-to-Noise ratio (or think of it as Signal **above** Noise) for a receiver depends on the intended use of the receiver. For instance, a receiver that had to detect a single radar pulse would probably need a higher minimum S/N than a receiver that could integrate a large number of radar pulses (increasing the total signal energy) for detection with the same probability of false alarms. Receivers with human operators using a video display may function satisfactorily with low minimum S/N because a skilled operator can be very proficient at picking signals out of a noise background. As shown in Table 1, the setting of an acceptable minimum S/N is highly dependent on the required characteristics of the receiver and of the signal.

Table 1. Typical Minimum S/N Required.

Skilled Operator	Auto-Detection	Auto-detection with Amplitude, TOA, and Frequency Measurements	AOA Phase Interferometer	AOA Amplitude Comparison
3 to 8 dB	10 to 14 dB	14 to 18 dB	14 to 18 dB	16 to 24 dB

A complete discussion of the subject would require a lengthy dissertation of the probability and statistics of signal detection, which is beyond the scope of this handbook, however a simplified introduction follows. Let's assume that we have a receiver that we want a certain probability of detecting a single pulse with a specified false alarm probability. We can use Figure 2 to determine the required signal-to-noise ratio.

S/N EXAMPLE

If we are given that the desired probability of detecting a single pulse (P_d) is 98%, and we want the false alarm rate (P_n) to be no more than 10^{-3}, then we can see that S/N must be 12 dB (see Figure 2).

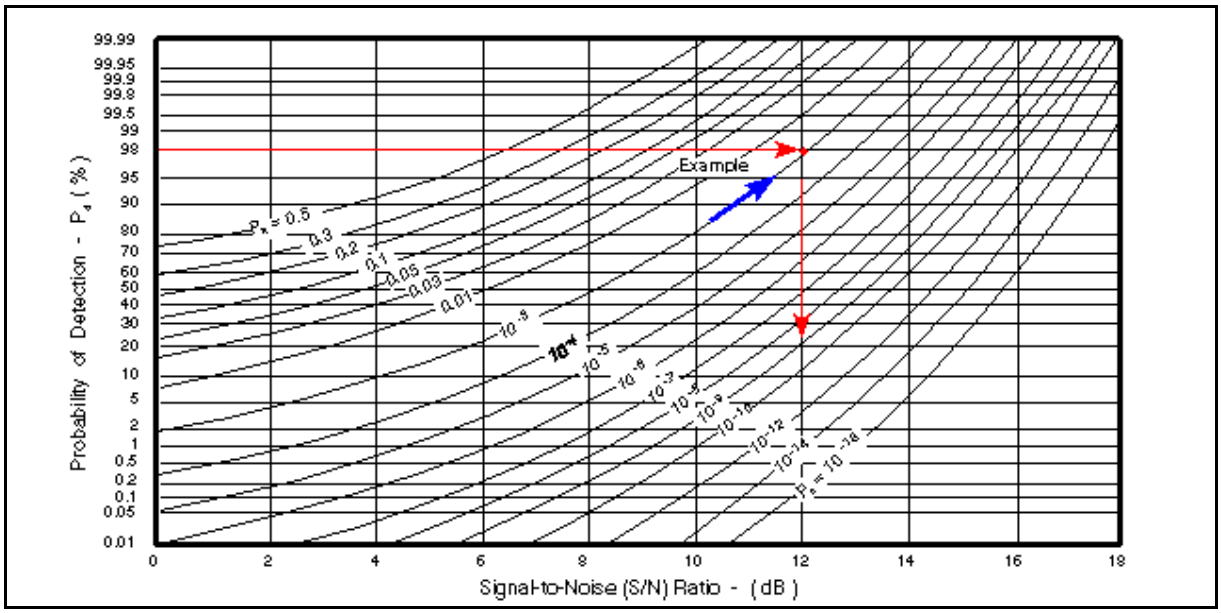

Figure 2. Nomograph of Signal-to-Noise (S/N) Ratio as a Function of Probability of Detection (P_d) and Probability of False Alarm Rate (P_n).

MAXIMUM DETECTION RANGE (ONE-WAY)

From Section 4-3, the one way signal strength from a transmitter to a receiver is:

$$S\ (or\ P_R) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 R^2}$$

For calculations involving receiver sensitivity the "S" can be replaced by S_{min}. Since $S_{min} = (S/N)_{min}\, kT_oB(NF)$, given by equation [1], the one-way radar equation can be solved for any of the other variables in terms of receiver parameters. In communication, radar, and electronic warfare applications, you might need to solve for the maximum range (R_{max}) where a given radar warning receiver could detect a radiated signal with known parameters. We would then combine and rearrange the two equations mentioned to solve for the following one-way equation:

$$R_{max} \cong \sqrt{\frac{P_t\ G_t\ G_r\ \lambda^2}{(4\pi)^2 (S/N)_{min}\, k\, T_o\, B\, (NF)}} \quad or \quad \sqrt{\frac{P_t\ G_t\ G_r\ c^2}{(4\pi f)^2 (S/N)_{min}\, k\, T_o\, B\, (NF)}} \quad or \quad \sqrt{\frac{P_t\ G_t\ A_e}{4\pi\, (S/N)_{min}\, k\, T_o\, B\, (NF)}} \qquad \textbf{[3]}$$

We could use standard room temperature of 290° K as T_o, but NF would have to be determined as shown later.

In this calculation for receiver R_{max} determination, P_t, G_t, and λ are radar dependent, while G_r, S/N_{min}, NF, and B are receiver dependent factors.

Equation [3] relates the maximum detection range to bandwidth (B). The effects of the measurement bandwidth can significantly reduce the energy that can be measured from the peak power applied to the receiver input. Additional bandwidth details are provided in Sections 4-4, 4-7, and in other parts of this section.

NOISE POWER, kT_oB

Thermal noise is spread more or less uniformly over the entire frequency spectrum. Therefore the amount of noise appearing in the output of an ideal receiver is proportional to the absolute temperature of the receiver input system (antenna etc) times the bandwidth of the receiver. The factor of proportionality is Boltzmann's Constant.

Mean noise power of ideal receiver = $kT_oB = P_N$ (Watts)
Mean noise power of a real receiver = $(NF)kT_oB$ (Watts)

The convention for the temperature of T_o is set by IEEE standard to be 290°K, which is close to ordinary room temperature. So, assuming T_o = 290°K, and for a bandwidth B = 1 Hz, $kT_oB = 4x10^{-21}$ W = -204 dBW = -174 dBm.

For any receiver bandwidth, multiply $4x10^{-21}$ W by the bandwidth in Hz, or if using dB;

10 log kT_oB = -174 dBm + 10 Log (actual BW in Hz) or -114 dBm + 10 Log (actual BW in MHz)

and so on, as shown by the values in Table 2.

Table 2. Sample Noise Power Values (kT_oB).

Bandwidth	Bandwidth Ratio (dB)	Watts	dBW	dBm
1 Hz	0	$4x10^{-21}$	-204	-174
1 kHz	30	$4x10^{-18}$	-174	-144
1 MHz	60	$4x10^{-15}$	-144	-114
1 GHz	90	$4x10^{-12}$	-114	-84

Typical values for maximum sensitivity of receivers would be:

RWR	-65 dBm
Pulse Radar	-94 dBm
CW Missile Seeker	-138 dBm

If antenna contributions are ignored (see note in Table 4) for a CW receiver with a 4 GHz bandwidth, the ideal mean noise power would be -174 dBm + 10 Log($4x10^9$) = -174 dBm + 96 dB = -78 dBm. A skilled operator might only be able to distinguish a signal 3 dB above the noise floor (S/N=3 dB), or -75 dBm. A typical radar receiver would require a S/N of 3 to 10 dB to distinguish the signal from noise, and would require 10 to 20 dB to track. Auto tracking might require a S/N of approximately 25 dB, thus, a receiver may only have sufficient sensitivity to be able to identify targets down to -53 dBm. Actual pulse receiver detection will be further reduced due to sin x/x frequency distribution and the effect of the measurement bandwidth as discussed in Sections 4-4 and 4-7. Integration will increase the S/N since the signal is coherent and the noise is not.

Noise Bandwidth

Equivalent Noise Bandwidth (B_N) - Set by minimum pulse width or maximum modulation bandwidth needed for the system requirements. A choice which is available to the designer is the relationship of pre- and post-detection bandwidth. Pre-detection bandwidth is denoted by B_{IF}, while post-detection is denoted B_V, where V stands for video. The most affordable approach is to set the post-detection filter equal to the reciprocal of the minimum pulse width, then choose the pre-detection passband to be as wide as the background interference environment will allow. Recent studies suggest that pre-detection bandwidths in excess of 100 MHz will allow significant loss of signals due to "pulse-on-pulse" conditions. Equations [4] and [5] provide B_N relationships that don't follow the Table 3 rules of thumb.

Table 3. Rules of Thumb for B_N a.k.a. B (Doesn't apply for S/N between 0 and 10 to 30 dB).

S/N out	Linear Detector	Square Law Detector
High S/N (>15 to 20 dB)	$B_N = B_V$ (> 20 to 30 dB)	$B_N = 4\ B_V$ (> 10 to 15 dB)
Low S/N (< 0 dB)	$B_N = \sqrt{(2\ B_{IF}\ B_V - B_V^2)\ /\ 4\ (S/N)_{out}}$	$B_N = \sqrt{(2\ B_{IF}\ B_V - B_V^2)\ /\ (S/N)_{out}}$

For a square law detector: (1)

$$B_N = B_V \left[2 + \sqrt{4 + \frac{(2\ B_{IF}\ /\ B_V) - 1}{(S/N)_{out}}} \right] \qquad \textbf{[4]}$$

At high $(S/N)_{out}$, the $1/(S/N_{out})$ term goes to zero and we have: $B_N = B_V\ [\ 2 + \sqrt{4}\ ] = 4\ B_V$

At low $(S/N)_{out}$, the $1/(S/N_{out})$ term dominates, and we have:

$$B_N = B_V \sqrt{\frac{(2\ B_{IF}\ /\ B_V) - 1}{(S/N)_{out}}} = \sqrt{\frac{2\ B_{IF}\ B_V - B_V^2}{(S/N)_{out}}}$$

For a linear detector: (1)

$$B_N = \frac{B_V}{2} + \frac{1}{4} \bullet \sqrt{B_V \left(4\ B_V + \frac{H^2 (2\ B_{IF} - B_V)}{(S/N)_{out}} \right)} \qquad \textbf{[5]}$$

H is a hypergeometric (statistical) function of $(S/N)_{in}$

H = 2 for $(S/N)_{in} << 1$
H = 1 for $(S/N)_{in} >> 1$

At high $(S/N)_{out}$, the $1/(S/N_{out})$ term goes to zero and we have: $B_N = \frac{B_V}{2} + \frac{1}{4}\sqrt{B_V\ (4\ B_V)} = B_V$

At low $(S/N)_{out}$, the $1/(S/N_{out})$ term dominates, and we have:

$$B_N = \frac{1}{4} \bullet \sqrt{\frac{B_V H^2 (2 B_{IF} - B_V)}{(S/N)_{out}}} = \sqrt{\frac{2 B_{IF} B_V - B_V^2}{4 (S/N)_{out}}}$$

Note (1): From Klipper, "Sensitivity of Crystal Video Receivers With RF Pre-amplification," *The Microwave Journal*, August 1965.

TRADITIONAL "RULE OF THUMB" FOR NARROW BANDWIDTHS (Radar Receiver Applications)
Required IF Bandwidth for Matched Filter Applications:

$$B_{IF} = \frac{1}{PW_{\min}} \quad \text{Where :} \quad \begin{array}{l} B_{IF} = \text{Pre - detection RF or IF bandwidth} \\ PW_{\min} = \text{Specified minimum pulse width} = \tau \end{array}$$

Matched filter performance gives maximum probability of detection for a given signal level, but: (1) Requires perfect centering of signal spectrum with filter bandwidth, (2) Time response of matched pulse does not stabilize at a final value, and (3) Out-of-band splatter impulse duration equals minimum pulse width. As a result, EW performance with pulses of unknown frequency and pulse width is poor.

Required Video Bandwidth Post - Detection
Traditional " Rule of Thumb"

$$B_V = \frac{0.35}{PW_{\min}} \quad \text{Where : } B_V = \text{Post - detection bandwidth}$$

Some authors define B_V in terms of the minimum rise time of the <u>detected</u> pulse, i.e., $B_V = (0.35 \text{ to } 0.5)/t_r$ min, where t_r = rise time.

REVISED "RULE OF THUMB" FOR WIDE BANDWIDTHS (Wideband Portion of RWRs)

$$B_{IF} = \frac{2 \text{ to } 3}{PW_{\min}} \quad \text{and} \quad B_V = \frac{1}{PW_{\min}}$$

The pre-detection bandwidth is chosen based upon interference and spurious generation concerns. The post-detection bandwidth is chosen to "match" the minimum pulse width. This allows (1) Half bandwidth mistuning between signal and filter, (2) Half of the minimum pulse width for final value stabilization, and (3) The noise bandwidth to be "matched" to the minimum pulse width. As a result, there is (1) Improved EW performance with pulses of unknown frequency and pulse width, (2) Measurement of in-band, but mistuned pulses, and (3) Rejection of out-of-band pulse splatter.

NOISE FIGURE / FACTOR (NF)

Electrical noise is defined as electrical energy of random amplitude, phase, and frequency. It is present in the output of every radio receiver. At the frequencies used by most radars, the noise is generated primarily within the input stages of the receiver system itself (Johnson Noise). These stages are not inherently noisier than others, but noise generated at the input and amplified by the receiver's full gain greatly exceeds the noise generated further along the receiver chain. The noise performance of a receiver is described

by a figure of merit called the noise figure (NF). The term noise factor is synonymous, with some authors using the term "factor" for numeric and "figure" when using dB notation. (The notation "F_n" is also sometimes used instead of "NF.") The noise figure is defined as:

$$NF = \frac{Noise\ output\ of\ actual\ receiver}{Noise\ output\ of\ ideal\ receiver} = \frac{N_{out}}{GN_{in}} \quad or\ in\ dB: \quad 10\ \mathrm{Log}\left[\frac{Noise\ output\ of\ actual\ receiver}{Noise\ output\ of\ ideal\ receiver}\right] = 10\ \log\frac{N_{out}}{GN_{in}}$$

A range of NF values is shown in Table 4.

Table 4. Typical Noise Figure / Factor Value.	Decimal	dB
Passive lossy network (RF transmission line, attenuator, etc.) Example: 20 dB attenuator (gain = 0.01)	Same as reciprocal of gain value ex: 100	Same as dB value ex: 20
Solid State Amplifier (see manufacturers specifications)	4	6
Traveling Wave Tube (see manufacturers specifications)	10 to 100	10 to 20
Antennas (Below ≈ 100 MHz, values to 12 dB higher if pointed at the sun) Note: Unless the antenna is pointed at the sun, its negligible NF can be ignored. Antenna gain is not valid for NF calculations because the noise is received in the near field.	1.012 to 1.4	0.05 to 1.5

An ideal receiver generates no noise internally. The only noise in its output is received from external sources. That noise has the same characteristics as the noise resulting from thermal agitation in a conductor. Thermal agitation noise is caused by the continuous random motion of free electrons which are present in every conductor. The amount of motion is proportional to the conductor's temperature above absolute zero. For passive lossy networks, the noise factor equals the loss value for the passive element:

$$NF = \frac{N_{out}}{G\,N_{in}} = \frac{kTB}{\frac{1}{L}kTB} = L \qquad \begin{array}{c} Where\ L = Ratio\ Value\ of\ Attenuation \\ i.e.\ For\ a\ 3\ dB\ attenuator,\ G = 0.5\ and\ L = 2 \\ \therefore NF = 2\ \ and\ \ 10\log NF = 3\ dB \end{array}$$

A typical series of cascaded amplifiers is shown in Figure 3.

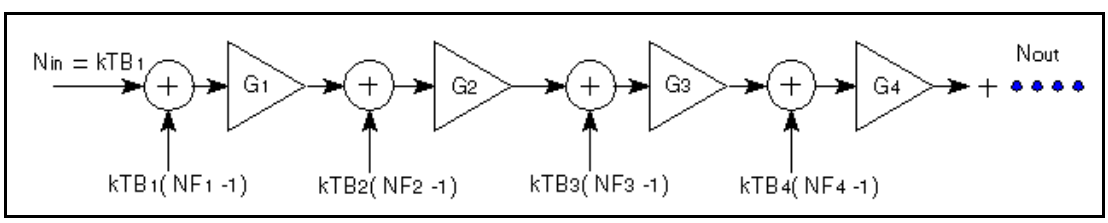

Figure 3. Noise Factors for Cascaded Amplifiers (NF_{CA}).

Loss (negative gain) can be used for the gain value of attenuators or transmission line loss, etc to calculate the noise out of the installation as shown in the following equation:

$$N_{out} = N_{in}\,G\,NF_{CA} = k\,T\,B_1(G_1G_2G_3\ldots)\left(NF_1 + \frac{B_2(NF_2-1)}{B_1G_1} + \frac{B_3(NF_3-1)}{B_1G_1G_2} + \frac{B_4(NF_4-1)}{B_1G_1G_2G_3} + \ldots\right) \quad (ratio\ form) \qquad \textbf{[6]}$$

If the bandwidths of the amplifiers are the same, equation [6] becomes:

$$N_{out} = N_{in}\, G\, NF_{CA} = k\, T\, B\,(\, G_1 G_2 G_3 \ldots)\left(NF_1 + \frac{NF_2 - 1}{G_1} + \frac{NF_3 - 1}{G_1 G_2} + \frac{NF_4 - 1}{G_1 G_2 G_3} + \ldots \right) \quad \textit{(ratio form)} \qquad [7]$$

Pre-amplifier Location Affects Receiver Input Noise

As shown in Figure 4, if a 2 to 12 GHz receiver installation doesn't have enough sensitivity, it is best to install an additional amplifier closer to the antenna (case 1) instead of closer to the receiver (case 2). In both cases, the line loss (L) and the amplifier gain (G) are the same, so the signal level at the receiver is the same. For case 1, $S_1 = P_{in} + G - L$. In case 2, $S_2 = P_{in} - L + G$, so $S_1 = S_2$. The noise generated by the passive transmission line when measured at the receiver is the same in both cases. However, the noise generated inside the amplifier, when measured at the receiver input, is different.

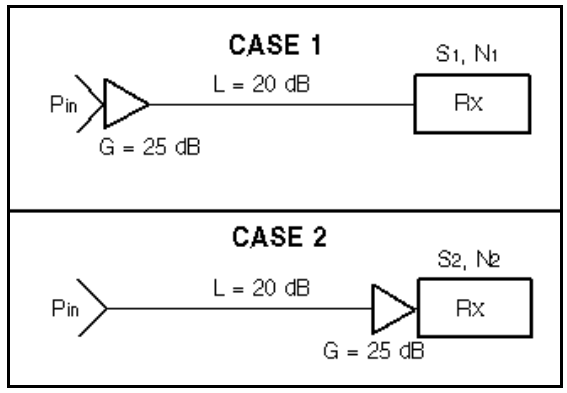

Figure 4. Pre-Amp S/N.

For this example, case 2 has a noise level at the input to the receiver which is 19.7 dB higher than case 1 (calculations follow later).

Table 5a	Case 1 Gain		Case 1 NF	
	Amp	L	Amp	L
dB	25	-20	6 *	20
ratio	316.2	0.01	4 *	100

Table 5b	Case 2 Gain		Case 2 NF	
	L	Amp	L	Amp
dB	-20	25	20	6 *
ratio	0.01	316.2	100	4 *

* Amplifier NF value from Table 4.

Using equation [3] and the data in Tables 5a and 5b, the noise generated by the RF installation is shown in Tables 6a and 6b (the negligible noise contribution from the antenna is the same in both cases and is not included) (also see notes contained in Table 4):

Table 6a. Case 1	**Table 6b.** Case 2
$G(NF) = 316.2\,(0.01)\left(4 + \frac{100 - 1}{316.7}\right) = 13.64$	$G(NF) = 0.01\,(316.2)\left(100 + \frac{4 - 1}{0.01}\right) = 1264.8$
10 log G(NF) = 11.34 dB	10 log G(NF) = 31 dB
Noise at receiver:	
$N_{out\,1}$ = -74 dBm + 11.34 dB = -62.7 dBm	$N_{out\,2}$ = -74 dBm + 31 dB = -43 dBm

$N_{out\,2} - N_{out\,1}$ = 19.7 dB. The input noise of -74 dBm was calculated using 10 log (kTB), where B = 10 GHz.

Note that other tradeoffs must be considered: (1) greater line loss between the antenna and amplifier improves (decreases) VSWR as shown in Section 6-2, and (2) the more input line loss, the higher the input signal can be before causing the pre-amplifier to become saturated (mixing of signals due to a saturated amplifier is addressed in Section 5-7).

Combining Receive Paths Can Reduce Sensitivity

If a single aircraft receiver processes both forward and aft signals as shown in Figure 5, it is desirable to be able to use the receiver's full dynamic range for both directions. Therefore, one needs to balance the gain, so that a signal applied to the aft antenna will reach the receiver at the same level as if it was applied to the forward antenna.

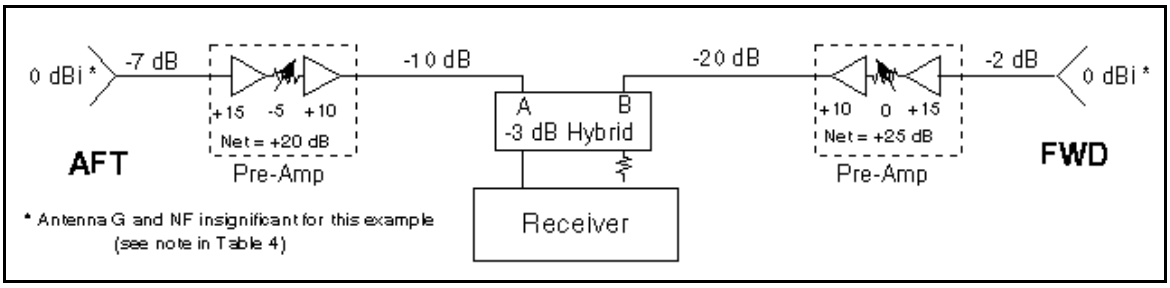

Figure 5. Example of Pre-Amplifier Affecting Overall Gain / Sensitivity.

Common adjustable preamplifiers can be installed to account for the excessive transmission line loss. In this example, in the forward installation, the level of the signal at the receiver is the same as the level applied to the antenna. Since the aft transmission line has 5 dB less attenuation, that amount is added to the preamplifier attenuator to balance the gain. This works fine for strong signals, but not for weaker signals. Because there is less loss between the aft preamplifier and the receiver, the aft noise dominates and will limit forward sensitivity. If the bandwidth is 2-12 GHz, and if port A of the hybrid is terminated by a perfect 50Ω load, the forward noise level would be -65.3 dBm. If port B is terminated, the aft noise level would be -60.4 dBm. With both ports connected, the composite noise level would be -59.2 dBm (convert to mw, add, then convert back to dBm). For this example, if the aft preamplifier attenuation value is changed to 12 dB, the gain is no longer balanced (7 dB extra loss aft), but the noise is balanced, i.e., forward = -65.6 dBm, aft = -65.3 dBm, and composite -62.4 dBm. If there were a requirement to see the forward signals at the most sensitive level, extra attenuation could be inserted in the aft preamplifier. This would allow the forward noise level to predominate and result in greater forward sensitivity where it is needed. Calculations are provided in Tables 7 and 8.

Table 7. Summary of Gain and NF Values for Figure 5 Components.

		Aft					Fwd				
		RF Line	Amp	Attn	Amp	RF Line & hybrid	RF Line	Amp	Attn	Amp	RF Line & hybrid
Gain	dB	-7	15	-5	10	-13	-2	15	0	10	-23
	ratio	0.2	31.6	0.32	10	0.05	0.63	31.6	0	10	0.005
NF	dB	7	6	5	6	13	2	6	0	6	23
	ratio	5	4	3.16	4	20	1.585	4	0	4	200

Aft NF = 22.79 therefore 10 log NF = 13.58 dB. Input noise level = -74 dBm + 13.58 dB = -60.42 dBm ≅ -60.4 dBm
Fwd NF = 7.495 therefore 10 log NF = 8.75 dB. Input noise level = -74 dBm + 8.75 dB = -65.25 dBm ≅ -65.3 dBm
The composite noise level at the receiver = -59.187 dBm ≅ -59.2 dBm.

Table 8. Effect of Varying the Attenuation (shaded area) in the Aft Preamplifier Listed in Table 7.							
Aft Attn NF	Aft Attn Gain	Aft Noise	Fwd Noise	Composite Noise	Min Signal Received ***	Aft Input	Fwd Input
0 dB	0 dB	-55.8 dBm	-65.3 dBm	-55.4 dBm	-43.4 dBm	-48.4 dBm	-43.4 dBm
5	-5	-60.4	-65.3	-59.2	-47.2 *	-47.2 *	-47.2 *
10	-10	-64.4	-65.3	-61.8	-49.8	-44.8	-49.8
12	-12	-65.6 **	-65.3 **	-62.4	-50.4	-43.4	-50.4
15	-15	-67.1	-65.3	-63.1	-51.1	-41.1	-51.1

* Gain Balanced ** Noise Balanced *** S/N was set at 12 dB

TANGENTIAL SENSITIVITY

Tangential sensitivity (TSS) is the point where the top of the noise level with no signal applied is level with the bottom of the noise level on a pulse as shown in Figure 6. It can be determined in the laboratory by varying the amplitude of the input pulse until the stated criterion is reached, or by various approximation formulas.

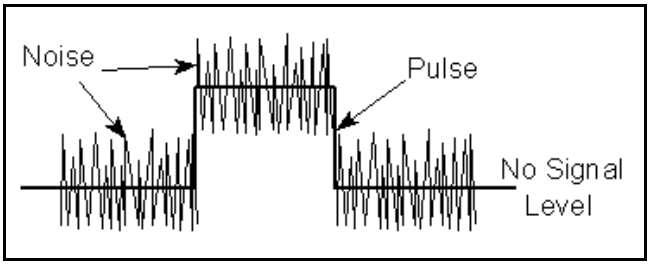

Figure 6. Tangential Sensitivity.

The signal power is nominally 8±1 dB above the noise level at the TSS point. TSS depends on the RF bandwidth, the video bandwidth, the noise figure, and the detector characteristic.

TSS is generally a characteristic associated with receivers (or RWRs), however the TSS does not necessarily provide a criterion for properly setting the detection threshold. If the threshold is set to TSS, then the false alarm rate is rather high. Radars do not operate at TSS. Most require a more positive S/N for track (> 10 dB) to reduce false detection on noise spikes.

SENSITIVITY CONCLUSION

When all factors effecting system sensitivity are considered, the designer has little flexibility in the choice of receiver parameters. Rather, the performance requirements dictate the limit of sensitivity which can be implemented by the EW receiver.

1. Minimum Signal-to-Noise Ratio (S/N) - Set by the accuracy which you want to measure signal parameters and by the false alarm requirements.

2. Total Receiver Noise Figure (NF) - Set by available technology and system constraints for RF front end performance.

3. Equivalent Noise Bandwidth (B_N) - Set by minimum pulse width or maximum modulation bandwidth needed to accomplish the system requirements. A choice which is available to the designer is the relationship of pre- (B_{IF}) and post-detection (B_V) bandwidth. The most affordable approach is to set the post-detection filter equal to the reciprocal of the minimum pulse width, then choose the pre-detection passband to be as wide as the background interference environment will allow. Recent studies suggest that pre-detection bandwidths in excess of 100 MHz will allow significant loss of signals due to "pulse-on-pulse" conditions.

4. Antenna Gain (G) - Set by the needed instantaneous FOV needed to support the system time to intercept requirements.

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RECEIVER TYPES AND CHARACTERISTICS

Besides the considerations of noise and noise figure, the capabilities of receivers are highly dependent on the type of receiver design. Most receiver designs are trade-offs of several conflicting requirements. This is especially true of the Electronic Support Measures (ESM) receivers used in Electronic Warfare.

This section consists of a figure and tables that provide a brief comparison of various common ESM receiver types. Figures 1 and 2 show block diagrams of common ESM receivers. Table 1 is a comparison of major features of receivers. Table 2 shows the receiver types best suited for various types of signals and Tables 3 and 4 compare several direction of arrival (DOA) and emitter location techniques. Table 5 shows qualitative and quantitative comparisons of receiver characteristics.

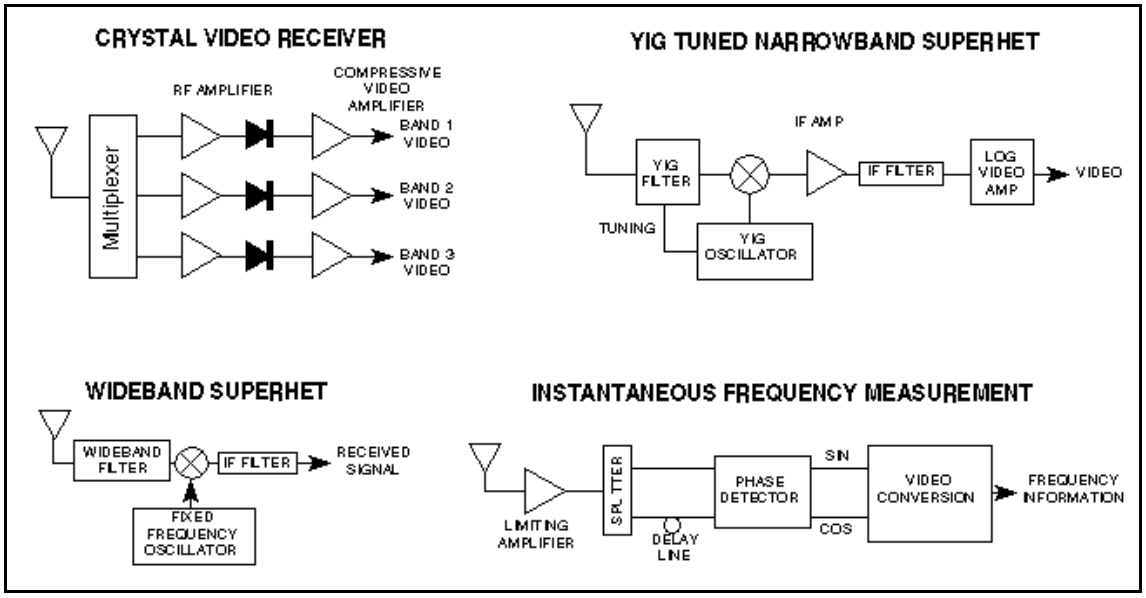

Figure 1. Common ESM Receiver Block Diagrams.

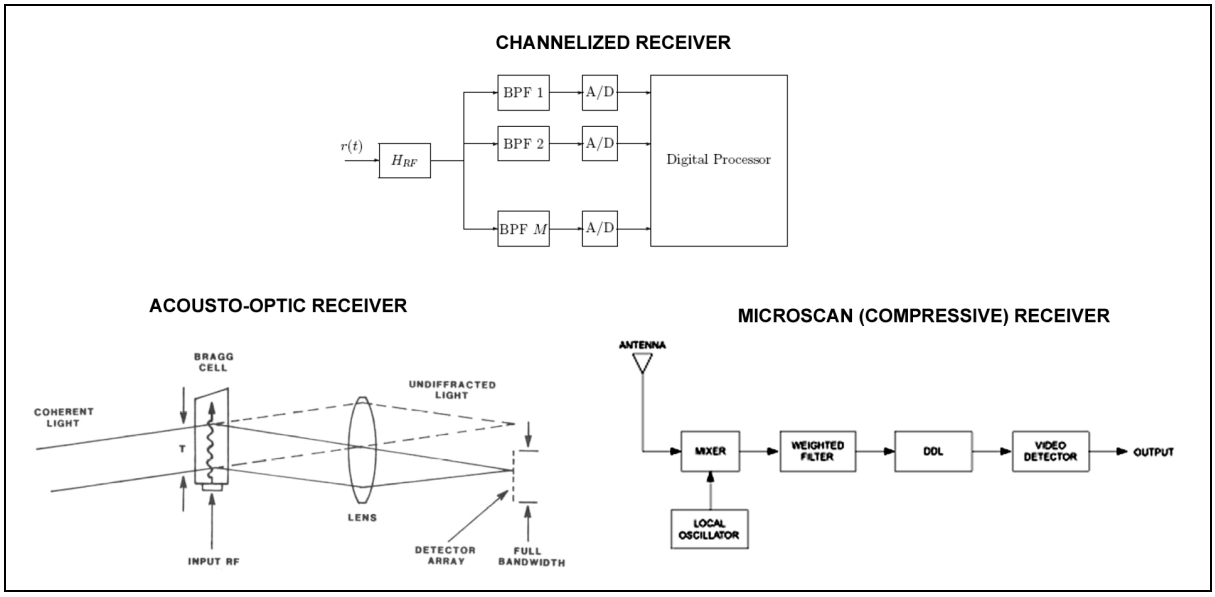

Figure 2. Common ESM Receiver Block Diagrams (Continued).

Table 1. Comparison of Major Features of Receivers.

Receiver	Advantages	Disadvantages	Principal Applications
Wideband crystal video	Simple, inexpensive, instantaneous, High POI in frequency range	No frequency resolution Poor sensitivity and Poor simultaneous signal performance	RWR
Tuned RF Crystal Video	Simple, Frequency measurement Higher sensitivity than wideband	Slow response time Poor POI	Option in RWR, Frequency measurement in hybrid
IFM	Relatively simple Frequency resolution Instantaneous, high POI	Cannot sort simultaneous signals Relatively poor sensitivity	Shipboard ESM, Jammer power management, SIGINT equipment
Narrow-band scanning Superhet	High sensitivity Good frequency resolution Simultaneous signals don't interfere	Slow response time Poor POI Poor against frequency agility	SIGINT equipment Air and ship ESM Analysis part of hybrid
Wide-band Superhet	Better response time and POI	Spurious signals generated Poorer sensitivity	Shipboard ESM Tactical air warning
Channelized	Wide bandwidth, Near instantaneous, Moderate frequency resolution	High complexity, cost; Lower reliability; limited sensitivity	SIGINT equipment Jammer power management
Microscan	Near instantaneous, Good resolution and dynamic range, Good simultaneous signal capability	High complexity, Limited bandwidth No pulse modulation information Critical alignment	SIGINT equipment Applications for fine freq analysis over wide range
Acousto-optic	Near instantaneous, Good resolution, Good simultaneous signal capability Good POI	High complexity; new technology	

Note: The Microscan receiver is also known as a compressive receiver

Table 2. Receiver Types vs. Signal Types.

Signal Type	Receiver Type							
	Wide-Band Crystal Video	TRF Crystal Video	IFM	Narrow-Band Superhet	Wide-Band Superhet	Channelized	Microscan	Acousto-optic
CW	Special design for CW	Special design for CW	Yes, but interferes with pulsed reception	Yes	Yes	Yes	Yes	Yes
Pulsed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiple Frequency	No	No	No	Yes, but won't recognize as same source	No	Yes	Yes	Yes
Frequency Agile	Yes, doesn't measure frequency	No	Yes	No	Yes (within passband)	Yes	Yes	No/Yes, depending on readout time
PRI Agile	Yes	Yes	Yes	No/Yes, depending on scan rate	Yes	Yes	No/Yes, imprecision in TOA	No/Yes, depending on readout time
Chirped	Yes, within acceptance BW	No	Yes	No/Yes, depending on BW	Yes	Yes (reduced sensitivity)	No/Yes, depending on scan rate	Yes (reduced sensitivity)
Spread Spectrum	Yes, within acceptance BW	No	Yes	No	No/Yes, depending on BW	Yes (reduced sensitivity)	Yes (reduced sensitivity)	Yes (reduced sensitivity)

Table 3. Direction of Arrival Measurement Techniques.

	Amplitude Comparison	Phase Interferometer
Sensor Configuration	Typically 4 to 6 Equal Spaced Antenna Elements for 360° Coverage	2 or more RHC or LHC Spirals in Fixed Array
DF Accuracy	$DF_{ACC} \approx \frac{\Theta_{bW}^2 \Delta C_{dB}}{24\,S}$ (Gaussian Antenna Shape)	$DF_{ACC} \approx \frac{\lambda}{2\,\pi\,d\,\cos\theta}\Delta\theta$
DF Accuracy Improvement	Decrease Antenna BW; Decrease Amplitude Mistrack; Increase Squint Angle	Increase Spacing of Outer Antennas; Decrease Phase Mistrack
Typical DF Accuracy	3° to 10° rms	0.1° to 3° rms
Sensitivity to Multipath/Reflections	High Sensitivity; Mistrack of Several dB Can Cause Large DF Errors	Relatively Insensitive; Interferometer Can be Made to Tolerate Large Phase Errors
Platform Constraints	Locate in Reflection Free Area	Reflection Free Area; Real Estate for Array; Prefers Flat Radome
Applicable Receivers	Crystal Video; Channelizer; Acousto-Optic; Compressive; Superheterodyne	Superheterodyne
ΔC_{dB}= Amplitude Monopulse Ratio in dB S= Squint Angle in degrees θ_{BW}= Antenna Beamwidth in degrees		

Table 4. Emitter Location Techniques.

Measurement Technique	Advantages	Disadvantages
Triangulation	Single Aircraft	Non-instantaneous location Inadequate accuracy for remote targeting Not forward looking
Azimuth/elevation	Single Aircraft Instantaneous location possible	Accuracy degrades rapidly at low altitude Function of range
Time Difference of Arrival (Pulsed signals)	Very high precision Can support weapon delivery position requirements Very rapid, can handle short on-time threat	Very complex, diverse systems required, at least 3 aircraft High quality receivers, DME (3 sites) very wideband data link Very high performance control processor; requires very high reliability subsystems

Table 5. Qualitative Comparison of Receivers. (From NRL Report 8737)

Feature	Receiver Type							
	Wide-Band Crystal Video	TRF Crystal Video	IFM	Narrow-Band Superhet	Wide-Band Superhet	Channelized	Microscan	Acousto-optic
Instantaneous Analysis Bandwidth	Very wide	Narrow	Very wide	Narrow	Moderate	Wide	Wide	Moderate
Frequency Resolution	Very poor	Fair	Good	Very good	Poor	Fair	Good	Good
Sensitivity	Poor (No preamp) Fair (preamp)	Fair/ good	Poor (No preamp) Fair (preamp)	Very good	Fair	Fair/ good	Very good	Good
Dynamic Range	Fair	Fair/ good	Good	Very good	Fair	Good	Fair	Poor
Speed of Acquisition	Very Fast	Slow	Very Fast	Slow	Fast	Very Fast	Very Fast	Fast
Short pulse Width Capability	Good	Good	Good	Good	Very good	Good	Fair	Fair
Retention of Signal Character-istics	Fair	Fair	Poor	Good	Fair/ good	Good	Poor	Fair/ good
Applicability to Exotic Signals	Poor/ fair	Poor	Good	Poor	Fair/ good	Good	Fair/ good	Fair/ good
High signal Density Performance	Poor (high false alarm rate from background)	Fair/ good	Good	Poor	Fair (depending on BW)	Fair/good, depending on architecture & processing	Good	Poor
Simultaneous Signal Capability	Poor	Fair/ good	Poor	Good	Fair (depending on BW)	Good	Good	Good
Processing Complexity	Moderate depending on application	Moderate depending on application	Moderate	Moderate	Moderate	Low-high depending on architecture	Complex	Simple signal processing complex data processing
Immunity to Jamming	Poor	Fair	Poor/ Fair	Good	Poor/ Fair	Good	Good	Good
Power Requirements	Low	Low/ Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate/ High
RF Range (GHz)	Multi-octave (0.5-40)	0.15-18 separate	>0.5 to 40	<0.01 to 40	0.5 to 18	0.5 to 60	<0.5 to 8	0.5-4 (0.5-18 channelized and down conversion)
Max Instantane-ous Analysis Bandwidth	Multi-octave (to 17.5 GHz)	As high as desired with equivalent reduction in resolution	Multi-octave (1 octave per unit)	50 MHz	500 MHz	~2 GHz without degradation, 17.5 GHz with degradation	0.5 to 2 depending on PW limitation	1 GHz
Frequency Accuracy	Measurement accuracy no better than analysis BW	Measurement accuracy no better than analysis BW	5-10 MHz	0.5% to 1%	0.5 to 3 MHz	±1 MHz	10 KHz	±1 MHz

Feature	Receiver Type							
	Wide-Band Crystal Video	TRF Crystal Video	IFM	Narrow-Band Superhet	Wide-Band Superhet	Channelized	Microscan	Acousto-optic
Pulse Width Range	CW to 50 ns	CW to 50 ns	CW to ~20 ns (depending on resolution)	CW to 100 ns with 20 MHz resolution	CW to 4 ns with 500 MHz resolution	CW to 30 ns (depending on resolution)	CW to 250 ns	CW to 0.5 µs
Frequency Resolution	~400 MHz (no better than BW)	25 MHz	1 MHz	<0.1 MHz	100-500 MHz	10-125 MHz (less with freq vernier)	1 MHz	0.5 to 1 MHz
Sensitivity (dBm)	-40 to -50 (no preamp) -80 (with preamp)	Better than -80 with preamp	-40 (no preamp) -75 (preamp) 4 GHz BW	-90, 1 MHz BW	-80, 500 MHz BW	-70, 10-50 MHz BW	-90, 5-10 MHz BW	-70 to -80
Maximum Dynamic Range (dB)	70	70-80	80 (w/preamp) 100+ (saturated)	90	60	50-80	40-60	25-35
Tuning Time	-	50 ms	-	1.0 s (1 octave)	.12 s (200 MHz band)	-	0.3 µs LO scan time	0.5 ms (integration time)
Signal ID Time	100 ns	50 ms	2-10 ms	~0.1 s	-	2.10 ms	~1 µs	-
Minimum Weight (lb)	20 (with processor)	30	<20 (octave unit) 65-75 (full coverage)	60-75	35 (tuner only)	1309-200 for 0.5 to 18 GHz coverage	25	29-55
Size / Minimum Volume (in³)	Small 300 (w/processor)	Small 375	Sm/Moderate 600-1000 ~100 miniaturized	Moderate 1500-3000	Moderate Several thousand	Large 4000-8000 (0.5-18 GHz coverage	Moderate 1200-2000	Small 800-1900
Minimum Power (W)	100 (with processor) <10 without processor	60 (without processor)	~50 (octave unit)	150	150 (tuner only)	350 to 1200 for 0.5 to 18 GHz coverage	70-80	200
Cost	Low	Low/ Moderate	Moderate	Moderate/ High	Moderate/ High	High	Moderate/ High	Low/ Moderate

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RADAR MODES

Typical Radar modes are listed below in the general functional category for which they were designed. Not all of these modes are applicable to all radars and certain radars have additional modes.

• NAVIGATION

Terrain avoidance - A mode in which the radar is set at a fixed depression angle and short range to continuously sweep the ground area directly in front of the aircraft in order to avoid mountains. This is particularly useful during flight into unfamiliar territory when clouds, haze, or darkness obscure visibility.

Ground mapping - A mode in which the radar uses a variety of techniques to enhance ground features, such as rivers, mountains, and roads. The mode is unlike air-to-air modes where ground return is rejected from the display.

Precision velocity update / Doppler navigation - A mode in which the radar again tracks ground features, using Doppler techniques, in order to precisely predict aircraft ground speed and direction of motion. Wind influences are taken into account, such that the radar can also be used to update the aircraft inertial navigation system.

• FIGHTER MISSIONS

Pulse search - Traditional pulse techniques are used to accurately determine range, angle, and speed of the target. Limitations are easy deception by enemy jamming, and less range when compared to other modes.

Velocity search - A high PRF Pulse Doppler waveform is used for long range detection primarily against nose aspect targets, giving velocity and azimuth information. Although velocity search can work against tail-on targets, the Doppler return is weaker, consequently the maximum detection range is also much less. When the target is in the beam (flying perpendicular to the fighter), the closure (Doppler) is the same as ground return and target return is almost zero.

Track While Scan (TWS) - A system that maintains an actual track on several aircraft while still searching for others. Since the radar is sharing its computing time between targets, the accuracy is less precise than for a single target track (STT) mode of operation.

Raid assessment - A mode in which the radar has an STT on a single target, but is routinely driven off by a small amount in order to determine if multiple aircraft exists in the immediate vicinity of the target aircraft.

Single-Target-Track (STT) (including air combat maneuvering modes) - Highly precise STT modes are used to provide the most accurate information to the fire control computer so that accurate missile or gun firing can be accomplished. The fire control radar continuously directs energy at the target so that the fired missile locates and tracks on the reflected energy from the target. Air combat maneuvering modes are automatic modes in which the radar has several sweep patterns fixed about the aircraft axis, such that little or no work is required of the pilot in order to lock up a target.

- **AIR-TO-GROUND MISSIONS**

Weapons delivery - A mode in which ground features are tracked, and particular emphasis is placed on determining range to the ground target, angle of dive, weapons ballistic tables, and aircraft speed.

Surveillance/tracking of ground forces/targets - Similar to the above with emphasis on multiple ground features and less on weapons delivery data.

Reconnaissance - A specific navigational mode to aid in identifying specific targets.

- **AIR-TO-SURFACE MISSIONS**

ASW - Navigational techniques specializing in specific search patterns to aid in detection of enemy submarines.

- **TECHNIQUES USED FOR MULTIPLE APPLICATIONS**

Synthetic Aperture Radar (SAR) - A form of radar that uses the relative motion between an antenna and its target region, to provide coherent-signal variations, in order to obtain finer spatial resolution than is possible with conventional beam-scanning means. SAR is usually implemented by mounting a single beam-forming antenna on a moving platform such as an aircraft from which a target scene is repeatedly illuminated with pulses of radio waves at wavelengths anywhere from a meter down to millimeters. The many echo waveforms received successively at the different antenna positions are coherently detected and stored and then post-processed together to resolve elements in an image of the target region.

Over-The-Horizon Radar (OTHR) - uses the refraction of high frequency radiation through the ionosphere in order to detect targets beyond the line-of-sight. The complexities of the ionosphere can produce multipath propagation, which may result in multiple resolved detections for a single target. When there are multipath detections, an OTHR tracker will produce several spatially separated tracks for each target. Information conveying the state of the ionosphere is required in order to determine the true location of the target and is available in the form of a set of possible propagation paths, and a transformation from measured coordinates into ground coordinates for each path. Since may be no other information as to how many targets are in the surveillance region, or which propagation path gave rise to which track, there is a joint target and propagation path association ambiguity which must be resolved using the available track and ionospheric information.

GENERAL RADAR DISPLAY TYPES

There are two types of radar displays in common use today.

RAW VIDEO

Raw video displays are simply oscilloscopes that display the detected and amplified target return signal (and the receiver noise). Raw video displays require a human operator to interpret the various target noise and clutter signals.

On the left hand display of Figure 1, an operator could readily identify three targets and a ghost (a ghost is a phony target that usually fades in and out and could be caused by birds, weather, or odd temporary reflections - also referred to as an angel). Target 3 is a weak return and hidden in the noise - an operator can identify it as a target by the "mouse under the rug" effect of raising the noise base line.

SYNTHETIC VIDEO

Synthetic video displays use a computer to clean up the display by eliminating noise and clutter and creating its own precise symbol for each target.

On the right hand display target 1 comes and goes because it is barely above the receiver noise level - notice that it is quite clear on the raw video. Target 3 wasn't recognized by the computer because it's too far down in the noise. The computer validated the ghost as a target. The ghost might be a real target with glint or ECM characteristics that were recognized by the computer but not the operator.

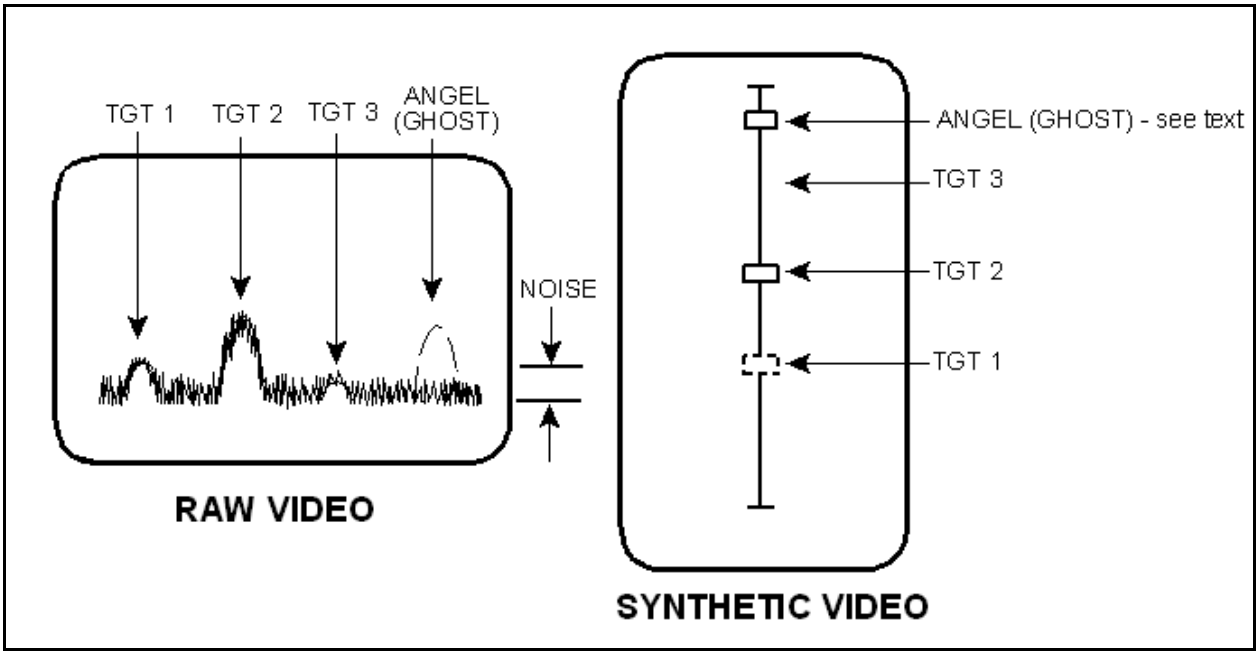

Figure 1. Radar Display Types.

SEARCH AND ACQUISITION RADARS

They generally use either a PPI or a sector PPI display as shown in Figure 2. PPI displays can be either raw video or synthetic video.

PPI scope (plan position indicator).
- Polar plot of direction and distance.
- Displays all targets for 360 degrees.

Sector PPI scope.
- Polar plot of direction and distance.
- Displays all targets within a specific sector.
- Origin may be offset so that "your" radar position may be off the scope.

TRACKING RADARS

Usually use some combination of A, B, C, or E scope displays. There are many other types of displays that have been used at one time or another - including meters - but those listed here are the most common in use today.

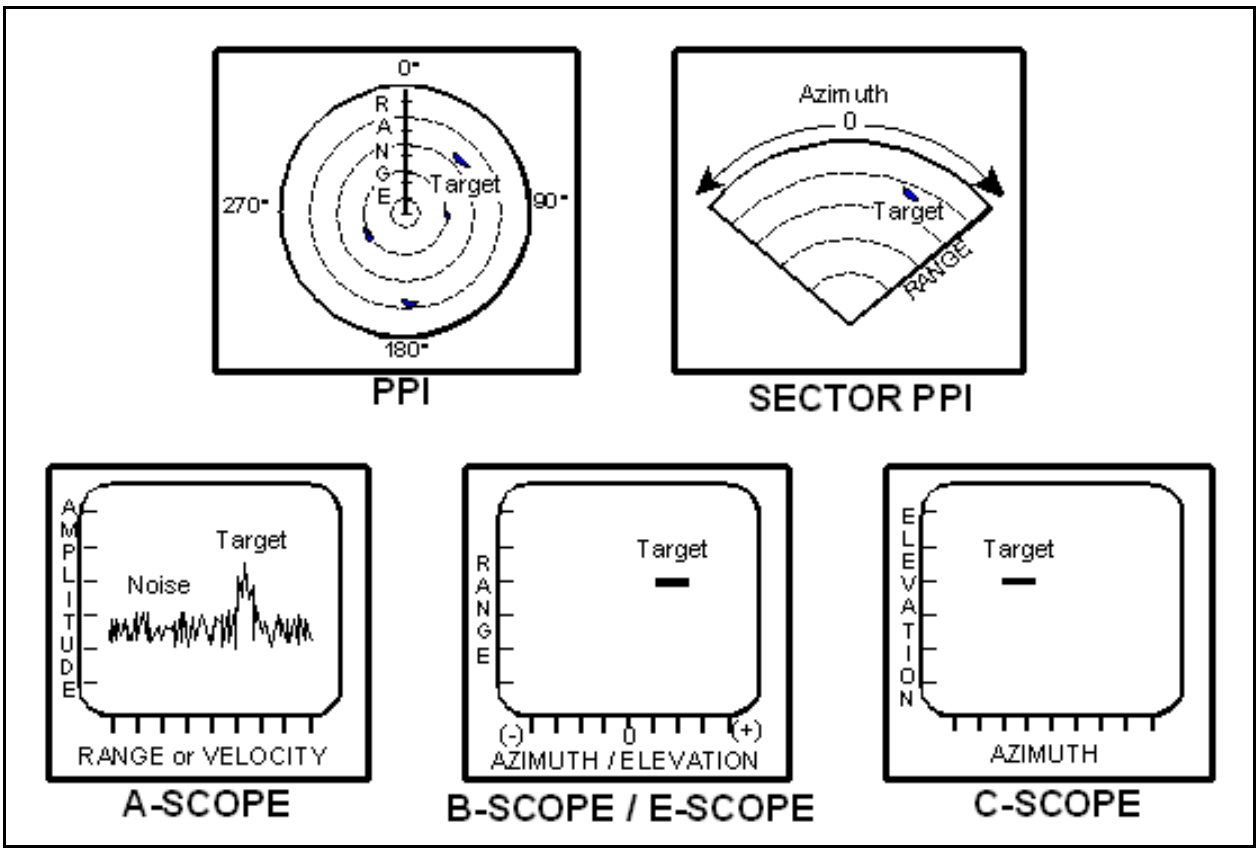

Figure 2. Common Radar Displays.

A-SCOPE

Target signal amplitude vs. range or velocity.

Displays all targets along pencil beam for selected range limits.

Displays tracking gate. Usually raw video. Some modern radars have raw video a-scopes as an adjunct to synthetic video displays.

Must be used with a separate azimuth and elevation display of some sort.

Also called a range scope (R-Scope).

B-SCOPE

Range vs. azimuth or elevation. Displays targets within selected limits.

Displays tracking gate. May be raw or synthetic video.

Surface radars usually have two. One azimuth/one elevation which can result in confusion with multiple targets.

C-SCOPE

Azimuth vs. elevation. Displays targets within selected limits of az and el.

Displays tracking gate. May display bull's-eye or aim dot.

May have range indicator inserted typically as a marker along one side. Usually synthetic video.

Pilots eye view and very common in modern fighter aircraft heads up displays for target being tracked.

Could be used in any application where radar operator needs an "aiming" or "cross hair" view like a rifle scope.

E-SCOPE

Elevation vs. Range similar to a B-scope, with elevation replacing azimuth.

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IFF - IDENTIFICATION - FRIEND OR FOE

Originated in WWII for just that purpose - a way for our secondary radars to identify U.S. aircraft from enemy aircraft by assigning a unique identifier code to U.S. aircraft transponders.

The system is considered a secondary radar system since it operates completely differently and independently of the primary radar system that tracks aircraft skin returns only, although the same CRT display is frequently used for both.

The system was initially intended to distinguish between enemy and friend but has evolved such that the term "IFF" commonly refers to all modes of operation, including civil and foreign aircraft use.

There are five major modes of operation currently in use by military aircraft plus two sub-modes.

- Mode 1 is a non-secure low cost method used by ships to track aircraft and other ships.
- Mode 2 is used by aircraft to make carrier controlled approaches to ships during inclement weather.
- Mode 3 is the standard system also used by commercial aircraft to relay their position to ground controllers throughout the world for air traffic control (ATC).
- Mode 4 is secure encrypted IFF (the only true method of determining friend or foe) Military only
- Mode 5 – provides a cryptographically secured version of Mode S and ADS-B GPS position. (military only). Mode 5 is divided into two levels. Both are crypto-secure with Enhanced encryption, Spread Spectrum Modulation, and Time of Day Authentication. Level 1 is similar to Mode 4 information but enhanced with an Aircraft Unique PIN. Level 2 is the same as Mode 5 level one but includes additional information such as aircraft position and other attributes
- Mode "C" is the altitude encoder (military and civilian).
- Mode S – provides multiple information formats to a selective interrogation. Typically aircraft are assigned a unique 24-bit Mode S address. The Mode S address is partitioned and a group of address ranges are allocated to each country. Some countries change the assigned address for security reasons, and thus it might not be a unique address. (military and civilian)

The non-secure codes are manually set by the pilot but assigned by the air traffic controller.

A cross-band beacon is used, which simply means that the interrogation pulses are at one frequency and the reply pulses are at a different frequency. 1030 MHz and 1090 MHz is a popular frequency pair used in the U.S.

The secondary radar transmits a series of selectable coded pulses. The aircraft transponder receives and decodes the interrogation pulses. If the interrogation code is correct, the aircraft transponder transmits a different series of coded pulses as a reply.

The advantage of the transponder is that the coded pulses "squawked" by the aircraft transponders after being interrogated might typically be transmitted at a 10 watt ERP, which is much stronger than the microwatt skin return to the primary radar. Input power levels may be on the order of several hundred watts.

The transponder antenna is low gain so that it can receive and reply to a radar from any direction.

An adjunct to the IFF beacon is the altitude encoding transponder known as mode C - all commercial and military aircraft have them, but a fair percentage of general aviation light aircraft do not because of cost. The number of transponder installations rises around many large metropolitan areas where they are required for safety (easier identification of aircraft radar tracks).

Air traffic control primary radars are similar to the two-dimensional search radar (working in azimuth and range only) and cannot measure altitude.

The expanded display in figure 1 is typical of an air traffic control IFF response. The aircraft was told to squawk a four digit number such as "4732." The altitude encoded transponder provides the aircraft altitude readout to the ground controllers display along with the coded response identifying that particular aircraft.

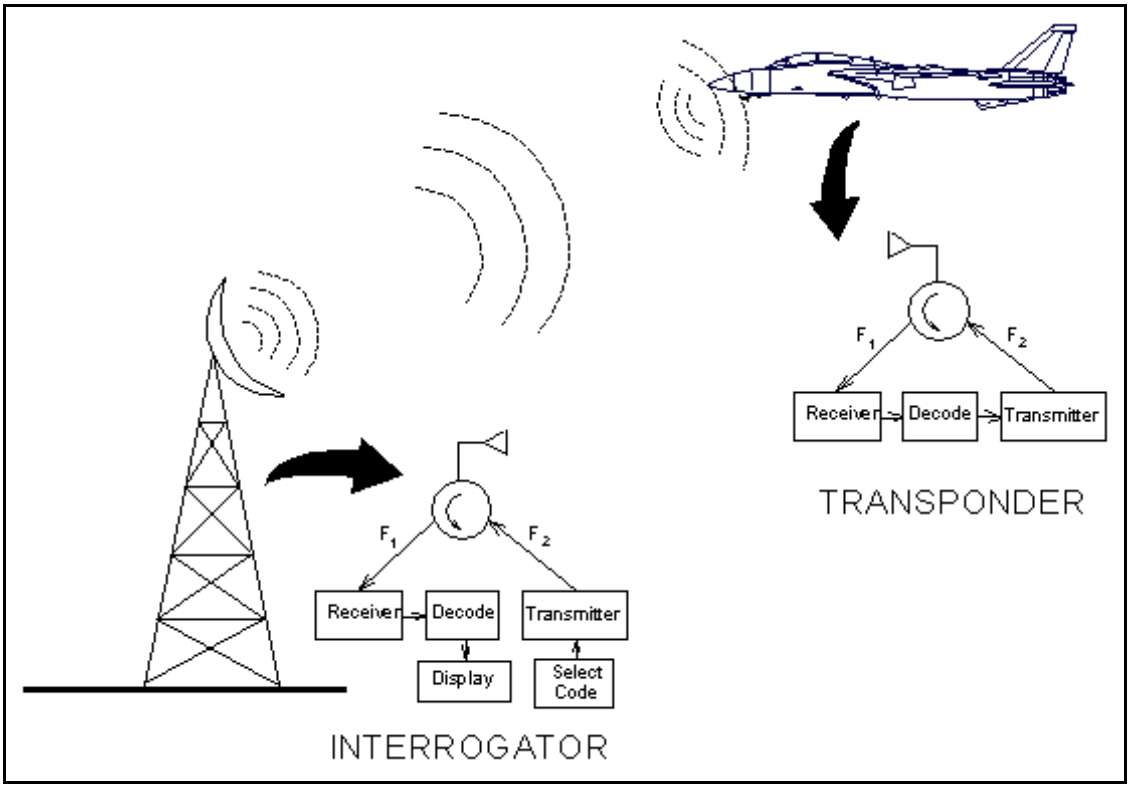

Figure 1. IFF Transponder.

In addition to systems with active electronic data interchange between airborne and ground equipment, some military surveillance systems can provide targeting in tactical applications. The development of automated techniques for use against ground targets is typically referred to as Automatic Target Recognition (ATR). When used against air targets, it is typically referred to as Non-Cooperative Target Recognition (NCTR). The requirements for radar target recognition are complex since typical targets have background clutter and often multiple targets types exist.

RECEIVER TESTS

Two tone and spurious response (single signal) receiver tests should be performed on EW and radar receivers to evaluate their spurious free dynamic range. A receiver should have three ranges of performance: (1) protection from damage, (2) degraded performance permitted in the presence of a strong interfering signal(s) and no degradation when only a strong desired signal is present, and (3) full system performance.

The original MIL-STD-461A design requirement and its companion MIL-STD-462 test requirement specified four receiver tests. These standards allowed the interfering signal(s) to be both inband and out of band, which is meaningful for design and test of EW receivers, however inband testing generally is not meaningful for narrowband communications receivers. These standards were difficult to follow and had to be tailored to properly evaluate the EW and radar system. MIL-STD-461B/C still allowed the interfering signal(s) to be both inband and out of band but deleted the single signal interference test (CS08 Conducted Susceptibility test). MIL-STD-461D/-462D leave the pass/fail criteria entirely up to what is listed in the individual procurement specification. It also places all interfering signals out of band, redesignates each test number with a number "100" higher than previously used, and combines "CS08" as part of CS104. Therefore, to provide meaningful tests for EW and radar systems, the procurement specification must specify the three ranges of performance mentioned in the beginning of this section and that the tests are to be performed with the interfering signal(s) both inband and out of band. The four tests are as follows (listed in order of likelihood to cause problems):

Test Name	MIL-STD-461A	MIL-STD-461D
Undesired, Single signal interference test	CS08	Part of CS104
Desired with undesired, two signal interference tests	CS04	CS104
Two signal intermodulation test	CS03	CS103
Two signal cross modulation test	CS05	CS105

The rest of this section explains the application of these tests and uses the names of the original MIL-STD-461A tests to separate the tests by function.

TEST SETUP

A directional coupler used backwards (as shown here in Figure 1) is an easy way to perform two signal tests. The CW signal should be applied to the coupling arm (port B) since the maximum CW signal level is -10 dBm. The pulse signal should be applied to the straight-through path (port C) since the maximum pulse level is +10 dBm peak. These power levels are achievable with standard laboratory signal generators, therefore one doesn't have to resort to using amplifiers which may distort the signals. Always monitor the output signal to verify spectrally pure signals are being applied to the test unit. This can be accomplished by another directional coupler used in the standard configuration. Dissimilar joints or damaged or corroded microwave components can cause mixing. This can also result if the two signal generators are not isolated from one another. Therefore, even if a directional coupler is used to monitor the

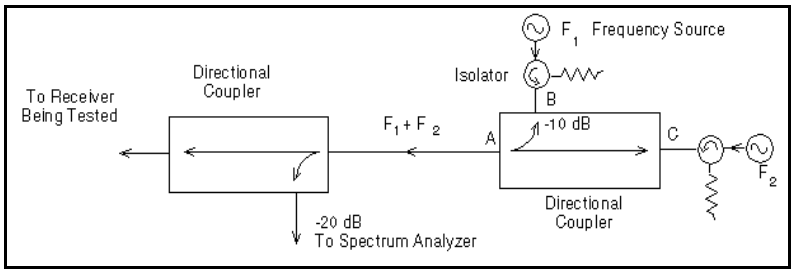

Figure 1. Receiver Test Setup When Antenna Can Be Removed.

signal line, it is still advisable to directly measure the input to the receiver whenever there is a suspected receiver failure. This test does not need to be performed in an EMI shielded room and is more suitable for a radar or EW lab where the desired signals are readily available.

If the receiver's antenna is active or cannot be removed, a modified test as shown in Figure 2 should be performed. The monitoring antenna which is connected to the spectrum analyzer should be the same polarization as the antenna for the receiver being tested. Amplifiers may be required for the F_1 and F_2 signals. It is desirable to perform this test in an anechoic chamber or in free space.

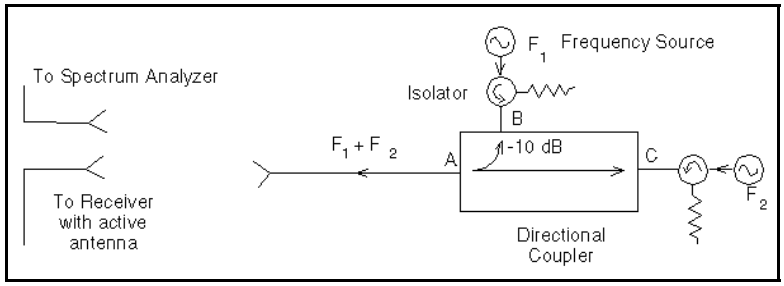

Figure 2. Receiver Test Setup When Antenna Is Active.

In the following discussion of CS08, CS04, CS03, and CS05 tests, it is assumed that when the receive light illuminates, the receiver identifies a signal that matches parameters in the User Data File (UDF) or pre-programmed list of emitter identification parameters. If a receiver is different, the following procedures will have to be appropriately tailored. If the UDF does not have entries for very low level signals in the 10% and 90% regions of each band, complete testing is not possible. Most problems due to higher order mixing products and adjacent band leakage are only evident in these regions. In the following tests, the lowest level where the receive light is constantly on is used to identify the minimum receive level. If a receiver has a receive level hysteresis or other idiosyncrasy, then using a 50% receive light blinking indicator may be more appropriate. Whatever technique is appropriate, it should be consistently used during the remainder of the test. The maximum frequency for testing is normally 20 GHz. If a millimeter wave receiver is being tested, the maximum frequency should be 110 GHz.

CS08 - UNDESIRED, SINGLE SIGNAL INTERFERENCE TEST

MIL-STD-461B/C (EMI design requirements) deleted this test. MIL-STD-461D allows a single signal test as part of CS104 (CS04) but specifies it as an out of band test. The original CS08 inband and out of band test is still needed and is the most meaningful test for wide band EW receivers which have a bandwidth close to an octave. This test will find false identification problems due to 1) lack of RF discrimination, 2) higher order mixing problems, 3) switch or adjacent channel/band leakage, and 4) cases where the absence of a desired signal causes the receiver to search and be more susceptible. In this latter case, a CS04 two signal test could pass because the receiver is captured by the desired signal, whereas a CS08 test could fail. Examples of the first three failures are as follows.

EXAMPLE 1

A 2 to 4 GHz receiver which uses video detection (e.g., crystal video) and doesn't measure RF is used for this example. This receiver assumes that if the correct Pulse Repetition Interval (PRI) is measured, it is from a signal in the frequency band of interest. Three cases can cause false identification. Refer to Figure 3.

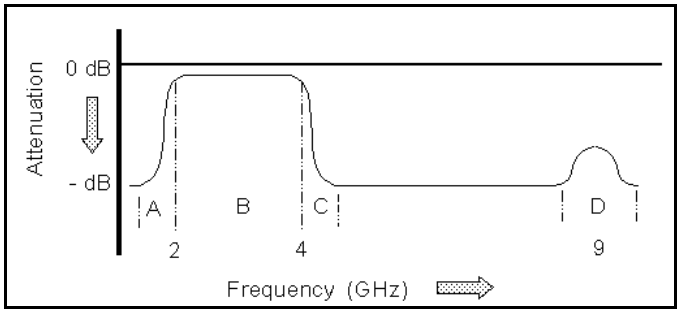

Figure 3. Frequency Areas in a Sample 2-4 GHz Receiver.

(1) Region A&C. The 2 to 4 GHz band pass filter will pass strong signals in regions A&C. If they have the correct PRI, they will also be identified.

(2) Region B. Any other signal besides the desired signal in the 2 to 4 GHz region that has the correct PRI will also be identified as the signal of interest.

(3) Region D. Band pass filters with poor characteristics tend to pass signals with only limited attenuation at frequencies that are three times the center frequency of the band pass filter. If these signals have the correct PRI, they will be incorrectly identified.

High duty cycle signals (CW or pulse doppler) in regions A, B, C, and D may overload the processing of signals, saturate the receiver, or desensitize the receiver. This case is really a two signal CS04 test failure and will be addressed in the CS04 section.

EXAMPLE 2

A receiver measuring the carrier frequency of each pulse (i.e., instantaneous frequency measurement (IFM)) and the PRI is used for this example. False signal identification can occur due to higher order mixing products showing up in the receiver pass bands. These unwanted signals result from harmonics of the input RF mixing with harmonics of the Local Oscillator (LO). Refer to Figures 4 and 5.

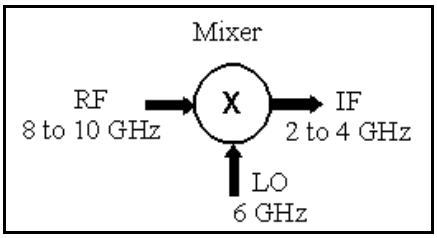

Figure 4. Low Side Mixing.

Mixers are nonlinear devices and yield the sum, difference, and the original signals. Any subsequent amplifier that is saturated will provide additional mixing products.

If a 8.5 GHz signal with a 1 kHz PRI is programmed to be identified in the UDF, measurements are made at the 2.5 GHz Intermediate Frequency (IF), i.e., RF-LO = IF = 8.5-6 = 2.5 GHz.

The same 2.5 GHz signal can result from an RF signal of 9.5 GHz due to mixing with the second harmonic of the LO i.e., 2 X 6 - 9.5 = 2.5 GHz. This signal will be substantially attenuated (approximately 35 dB) when compared to the normal IF of 9.5 - 6 = 3.5 GHz. If the receiver has filters at the IF to reduce the signal density and a filter has minimum insertion loss at 2.5 GHz and maximum insertion loss at 3.5 GHz, then only the low level 2.5 GHz signal will be measured and assumed to be due to a 8.5 GHz input signal whereas the input is really at 9.5 GHz.

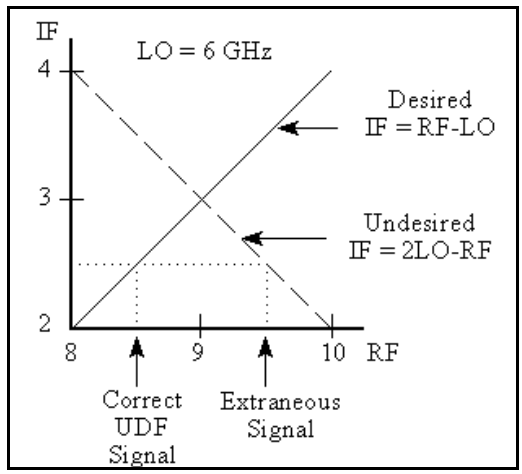

Figure 5. Low Side Mixing Results.

Spurious intermodulation products can also result from high side mixing, but generally the suppression of undesired signals is greater. In this case, the LO is at a frequency higher than the RF input. This is shown in Figures 6 and 7.

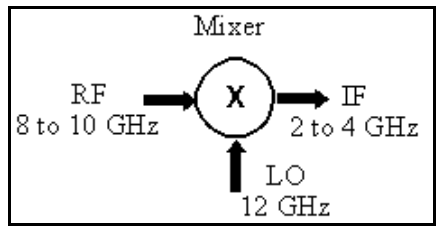

Figure 6. High Side Mixing.

Table 1. Intermodulation Product Suppression.

Harmonic of		
LO	RF	Suppression
1	1	0
1	2	ΔP-41
1	3	2ΔP-28
2	1	-35
2	2	ΔP-39
2	3	2ΔP-44
3	1	-10
3	2	ΔP-32
3	3	2ΔP-18
4	1	-35
4	2	Δ-39
5	1	-14
5	3	2ΔP-14
6	1	-35
6	2	ΔP-39
7	1	-17
7	3	2ΔP-11

Courtesy Watkins-Johnson

As previously mentioned, the amplitude of intermodulation products is greatly reduced from that of the original signals. Table 1 shows rule of thumb approximate suppression (reduction), where ΔP = P_{RF}(dBm) - P_{LO}(dBm). As can be seen, the strength of the LO is a factor. The higher the LO power, the more negative the suppression becomes.

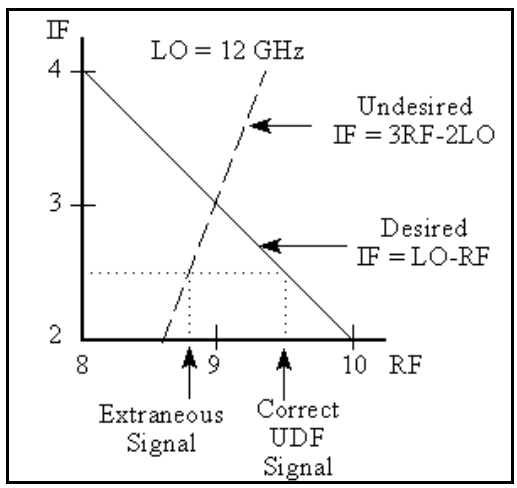

Figure 7. High Side Mixing Byproducts.

If one assumes the maximum RF power for full system performance is +10 dBm and the LO power level is +20 dBm, then ΔP = -10 dB minimum. Therefore in this example, the 3RF-2LO mixing product would be 2ΔP - 44 = - 20 - 44 = -64 dB when compared to the desired mixing product.

The use of double mixing, as shown in Figure 8, can significantly reduce unwanted signals but it is more expensive. For a 8 GHz signal in, one still generates a 2 GHz IF but by mixing up, then down, unwanted signals are not generated or significantly suppressed.

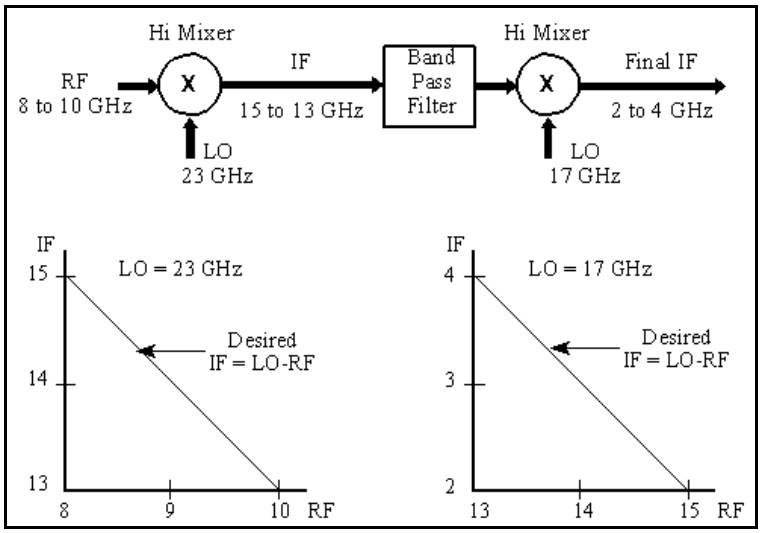

Figure 8. Double Mixing.

Some of these problems can be corrected by:

(1) always having LOs on the high side versus low side of the input RF (but this is more expensive),

(2) using double mixing

(3) software programming the receiver to measure for the potential stronger signal when a weak signal is measured in a certain IF region, and

(4) improved filtering of the LO input to the mixer and the output from the mixer.

EXAMPLE 3

If the same receiver discussed in example 2 had additional bands (Figure 9) and used a switch at the IF to select individual bands, a strong signal in an adjacent band could be inadvertently measured because:

(1) the switch, which may have 80 dB of isolation when measured outside the circuit, may only have 35 dB isolation when installed in a circuit because of the close proximity of input and output lines,

(2) the strong signal in one band may have the same IF value that is being sought in an adjacent band, and

(3) the additional parameters such as PRI may be the same.

As shown in Figure 9, assume that in band 2 we are looking for a 4.5 GHz signal that has a PRI of 1 kHz. Measurements are made at an IF of 3.5 GHz since LO-RF = IF = 8-4.5 = 3.5 GHz. If a 6.5 GHz signal is applied to band 3, its IF also equals 3.5 since LO-RF = 10-6.5 = 3.5 GHz. If this is a strong signal, has a PRI of 1 kHz, and there is switch leakage, a weak signal will be measured and processed when the switch is pointed to band 2. The receiver measures an IF of 3.5 GHz and since the switch is pointed to band 2, it scales the measured IF using the LO of band 2 i.e., LO-IF = RF = 8-3.5 = 4.5 GHz. Therefore, a 4.5 GHz signal is assumed to be measured when a 6.5 GHz signal is applied. Similarly this 6.5 GHz signal would appear as a weak 3.5 GHz signal from band 1 or a 9.5 GHz signal from band 4.

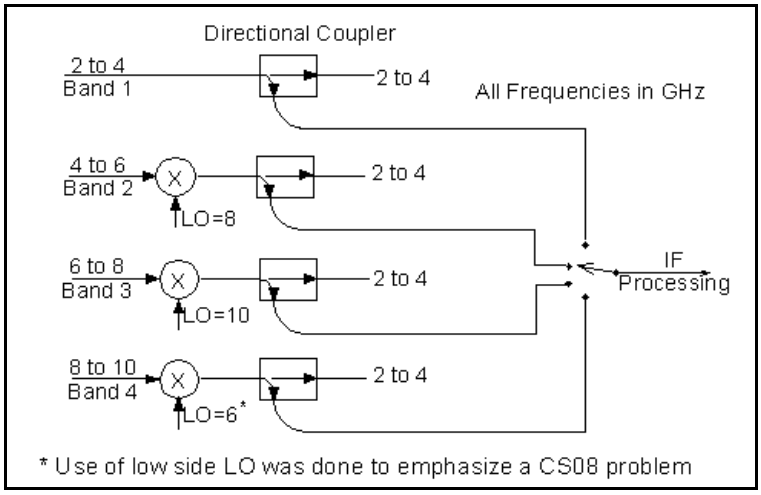

Figure 9. Multi Band Receiver With Common IF.

In performing this test it is important to map the entries of the UDF for each band i.e., show each resulting IF, its PRI, and the sensitivity level that the receive light is supposed to illuminate, i.e., if a test in one band used a PRI corresponding to a PRI in another band where the receive threshold is programmed to not be sensitive this will negate the effectiveness of a cross coupling test. Mapping the UDF will facilitate applying a strong signal to one band using the PRI of a desired signal in an adjacent band.

CS08 TEST PROCEDURE

Assume that the receiver band is 2 to 4 GHz as shown in Figure 10. Pick the UDF entry that has the greatest sensitivity. UDF #1 entry is for a 3±.05 GHz signal with a PRI of 1 kHz. If the test signal is set for the UDF #1 PRI, a receive light will also occur at the frequencies of UDF #2 if it also has the same PRI (this is not a test failure). If adjacent bands don't also have entries with the same PRI, then the test should be repeated for the band being tested with at least one of the adjacent band PRI values.

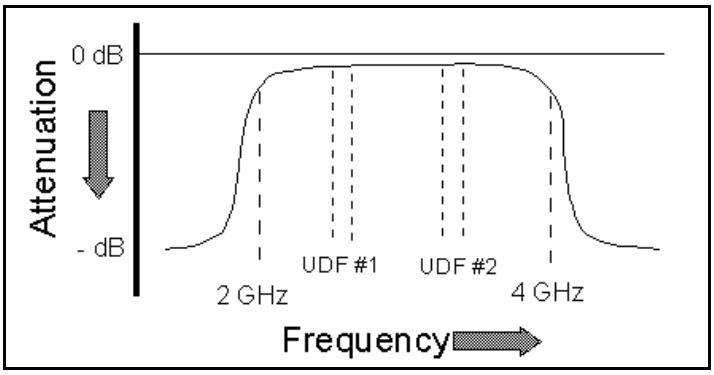

Figure 10. Receiver Band With Multiple UDF Entries.

(1) Set the receiver or jammer to the receive mode, verify it is working for UDF #1 and record P_o, the minimum signal level where the receive light is constantly on.

(2) Raise this signal to its maximum specified level for full system performance. If a maximum level is not specified, use +10 dBm peak for a pulse signal or -10 dBm for a CW signal.

(3) Tune this strong RF signal outside the UDF #1 range and record any RF frequency where the receive light comes on. If another inband UDF has the same PRI, this is not a failure.

(4) This test is performed both inband and out of band. Out of band tests should be performed on the high end to five times the maximum inband frequency or 20 GHz, whichever is less, and on the low end to IF/5 or 0.05 F0, whichever is less, unless otherwise specified. The out of band power level is +10 dBm peak for a pulse signal or -10 dBm for a CW signal, unless otherwise specified.

(5) If a receive light comes on when it is not supposed to, record the RF and reduce the power level to where the receive light just stays on constantly. Record this level P1. The interference rejection level is P1-P0= PIR

(6) Repeat this test for each type of signal the receiver is supposed to process, i.e., pulse, PD, CW, etc.

CS04 - DESIRED WITH UNDESIRED, TWO SIGNAL INTERFERENCE TEST

The intent is for a weak desired signal to be received in the presence of an adjacent CW signal. The desired signal is kept tuned at minimal power level and a strong unmodulated signal is tuned outside the UDF region. Radar and EW receivers without preselectors are likely to experience interference when this test is performed inband. Receivers with nonlinear devices before their passive band pass filter, or filters that degrade out of band, are likely to experience susceptibility problems when this test is performed out of band.

Tests performed inband - An unmodulated CW signal is used. If the receiver is supposed to handle both pulsed and CW signals, this test is performed inband. If the pulse receiver is supposed to desensitize in order to only process pulse signals above the CW level, then only this limited function is tested inband i.e., normally the levels correspond, if a CW signal of -20 dBm is present, then the receiver should process pulse signals greater than -20 dBm.

CS04 TEST PROCEDURE

(1) As shown in Figure 11, initially the pulse signal is tuned to F_0 and the minimum receive level P_0 is recorded, i.e., minimum level where the receive light is constantly on.

(2) The pulse signal is raised to the maximum specified level for full system performance and tuned on either side of F_0 to find the frequencies on both sides (F_{High} and F_{Low}) where the receive light goes out. If a maximum pulse power level is not specified, then +10 dBm peak is used. In some receivers F_L and F_H are the band skirts.

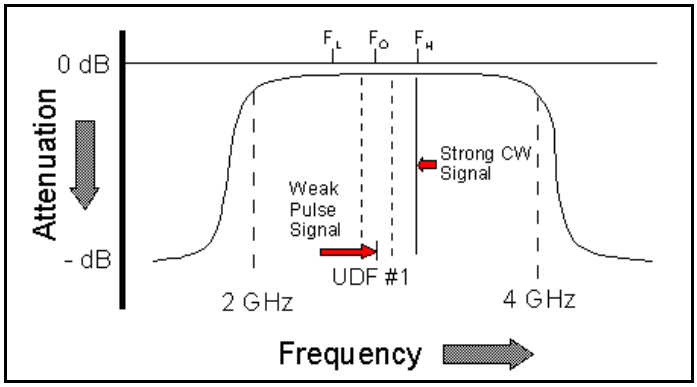

Figure 11. CS04 Test Signals.

(3) The pulse signal is returned to the level found in step 1. A CW signal at the maximum specified CW power level for full system performance is tuned above F_H and below F_L. If a maximum CW power level is not specified, then -10 dBm is used. Anytime the receive light is lost, the tuned CW RF value is recorded. The CW signal should be turned off to verify that the pulse signal can still be received in the absence of

interference. If the pulse signal is still being received, then the interfering CW signal should be reapplied and decreased to the lowest power level where the receive light stays on constantly. Record this level P_1. The interference rejection level is $P_1 - P_0 = P_{IR}$.

(4) Out of band tests should be performed to five times the maximum inband frequency or 20 GHz, whichever is less, and on the low end to IF/5 or 0.05 F_0, whichever is less, unless otherwise specified. The out of band CW power level is -10 dBm unless otherwise specified.

Failures - Out of band test

(1) If a non-linear device such as a limiter is placed before a band pass filter, a strong out of band signal can activate the limiter and cause interference with the inband signal. The solution is to place all non-linear or active devices after a passive band pass filter.

(2) Band pass filters with poor characteristics tend to pass signals with only limited attenuation at frequencies that are three times the center frequency of the band pass filter. Passage of a CW or high duty cycle signal that is out of band may desensitize or interfere with the processing of a weak inband signal.

CS03 INTERMODULATION TEST

This two signal interference test places a pulse signal far enough away (Δf) from the desired UDF frequency (F_0) that it won't be identified. A CW signal is initially placed $2\Delta f$ away. If an amplifier is operating in the saturated region, these two signals will mix and produce sum and difference signals. Subsequent mixing will result in a signal at the desired UDF frequency F_0 since $F_1 - (F_2 - F_1) = F_0$. These two signals are raised equally to strong power levels. If no problem occurs, the CW signal is tuned to the upper inband limit and then tuned out of band. A similar test is performed below F_0.

CS03 TEST PROCEDURES

(1) Set the receiver or jammer to the receive mode. Verify it is working at a desired signal frequency, (F_0), and record the minimum signal level i.e., lowest level where the receive light is constantly on (record this level P_0).

(2) The modulated signal is raised to the maximum specified level for full system performance and tuned on either side of F_0 to find the frequency F_1 on both sides where the receive light goes out. If a maximum power level is not specified, +10 dBm peak is used. The difference between F_1 and F_0 is Δf as shown in Figure 12.

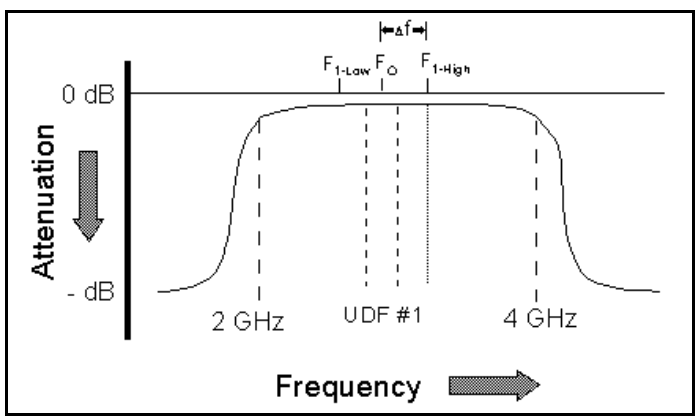

Figure 12. Initial CS03 Test Signal.

(3) As shown in Figure 13, a pulse signal is tuned to F_1 and a CW signal is tuned to F_2 where $F_2 = F_1 + \Delta f$ on the high side. The power level of the two signals is initially set to P_0 and raised together until the maximum specified levels for full system performance are reached. If maximum power levels are not specified, then +10 dBm peak is used for the pulse signal and -10 dBm is used for the CW signal. Whenever the receive light comes on, the two signals should be turned off individually to verify that the failure is due to a combination of the two signals versus (1) a single signal (CS08) type failure or (2) another inband UDF value has been matched. If the failure is due to the two signal operation, then the power level (P_1 and P_2) of F_1 and F_2 should be recorded. If $P_1=P_2$, the intermodulation rejection level is $P_1-P_0=P_{IM}$. If $P_1 \neq P_2$, it is desirable to readjust them to be equal when the receive light just comes on.

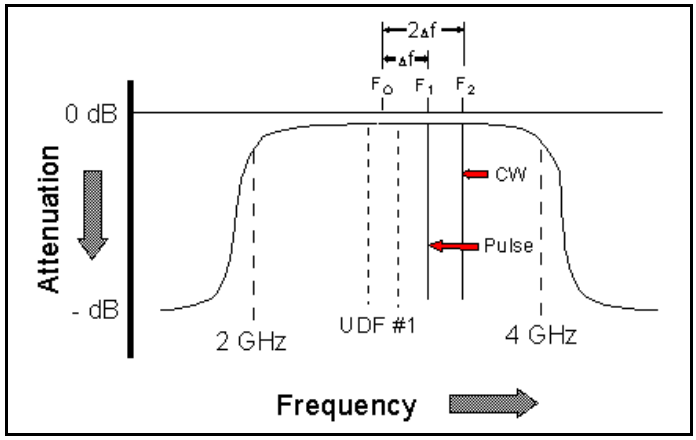

Figure 13. CS03 Testing Signal.

(4) Once the $F_1 + F_2$ signals are raised to the maximum power test levels described in step 3 without a failure, then F_2 is tuned to the upper limit of the band. F_2 should also be tuned out of band to five times the maximum inband frequency or 20 GHz whichever is less unless otherwise specified. The out of band power level is -10 dBm unless otherwise specified. Whenever the receive light comes on, F_2 should be turned off to verify that the failure is due to a two signal test. If it is, turn F_2 back on and equally drop the power levels of F_1 and F_2 to the lowest level where the receive light just comes on. Record the power levels (P_1 and P_2).

(5) Step 3 is repeated where F_1 is Δf below F_0 and $F_2=F_1-\Delta f$. Step 4 is repeated except F_2 is tuned to the lower limit of the band. F_2 should also be tuned out of band down to 0.1 F_0, unless otherwise specified.

(6) Normally if a failure is going to occur it will occur with the initial setting of F_1 and F_2. Care must be taken when performing this test to ensure that the initial placements of F_1 and F_2 do not result in either of the signals being identified directly.

As shown in Figure 14, if F_1 was placed at 3.2 GHz it would be identified directly and if F_2 was placed at 3.4 GHz it would be identified directly. Whereas, if F_1 was at 3.1 GHz and F_2 was at 3.2 GHz neither interfering signal would be identified directly but their intermodulation may result in an improper identification at F_0. Later when F_2 is tuned higher, the receive light will come on around 3.4 GHz and 3.6 GHz. This is not a test failure just a case of another inband UDF value being matched.

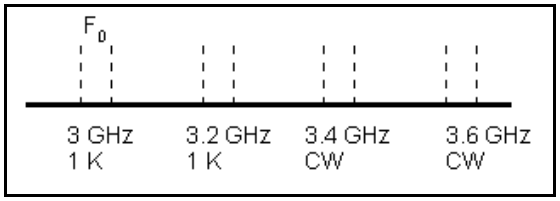

Figure 14. Sample UDF Entries.

CS05 - CROSS MODULATION

This two signal interference test places a weak CW signal where the receiver is programmed for a pulse signal and tunes a strong pulse signal elsewhere. As shown in Figure 15, when an amplifier is saturated, lower level signals are suppressed. When an amplifier is operated in the linear region all signals receive the rated linear gain. In this test the pulse signal will cause the amplifier to kick in and out of saturation and modulate the weak CW signal. The receiver may measure the modulation on the CW signal and incorrectly identify it as a pulse signal.

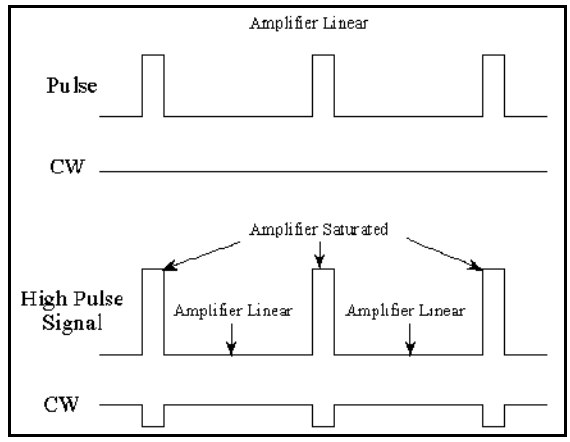

Figure 15. Cross Modulation Example.

CS05 TEST PROCEDURE

(1) Initially the pulse signal is tuned to F_0 and the minimum power level P_0 where the receive light is constantly on is recorded.

(2) As shown in Figure 16, the signal is raised to the maximum specified level for full system performance for a pulse signal and tuned on either side of F_0 to find the frequencies on both sides, (F_{High} and F_{Low}) where the receive light goes out. If a maximum pulse power level is not specified, then +10 dBm peak is used.

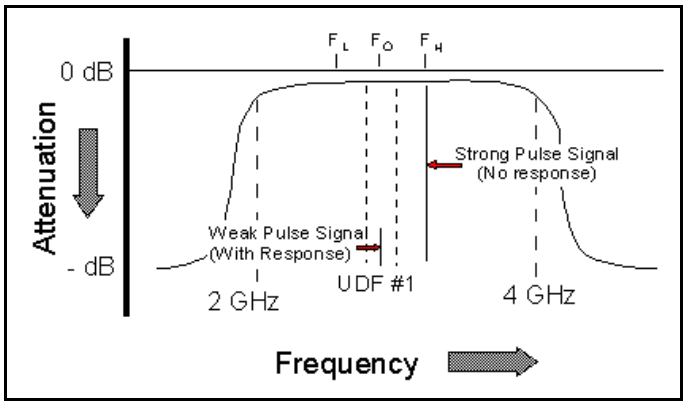

Figure 16. Initial CS05 Test Signals.

(3) The pulse signal from step 2 is turned off and a second signal is placed at F_0. It is a CW signal that is 10 dB stronger than the peak power level (P_0) measured is step 1. The receive light should not come on.

(4) As shown in Figure 17, the strong pulse signal of step 2 is turned back on and tuned above F_H and then tuned below F_L. Out of band tests should be performed to the maximum RF of the system + maximum IF or 20 GHz whichever is less and on the low end to the minimum RF of the system minus the maximum IF, unless otherwise specified.

(5) If a receive light occurs, turn off the weak CW signal since the "failure" may be due to the tuned pulsed signal, i.e., a CS08 failure or another inband UDF value has been matched.

If the light extinguishes when the weak CW signal is turned off, then turn the signal back on, reduce the value of the high level pulse signal until the minimum level is reached where the light stays on constantly. Record this level as P_1.

The cross modulation rejection level is P_1-P_0-10 dB = P_{CM}.

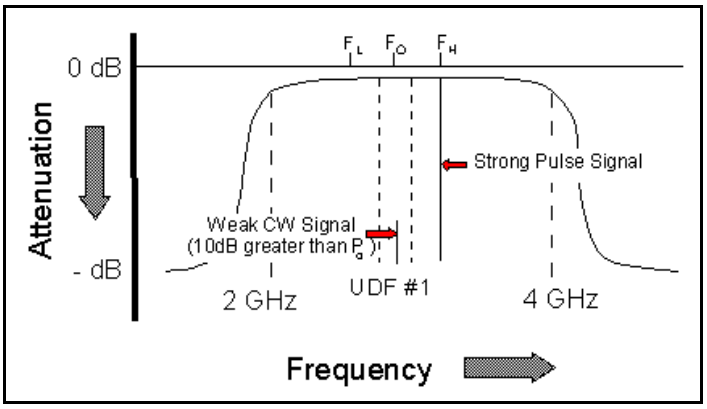

Figure 17. Final CS05 Test Signals.

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SIGNAL SORTING METHODS and DIRECTION FINDING

As shown in Figure 1, signal processing is basically a problem of signal detection, emitter parameter measurement and correlation, emitter sorting, identification, and operator notification.

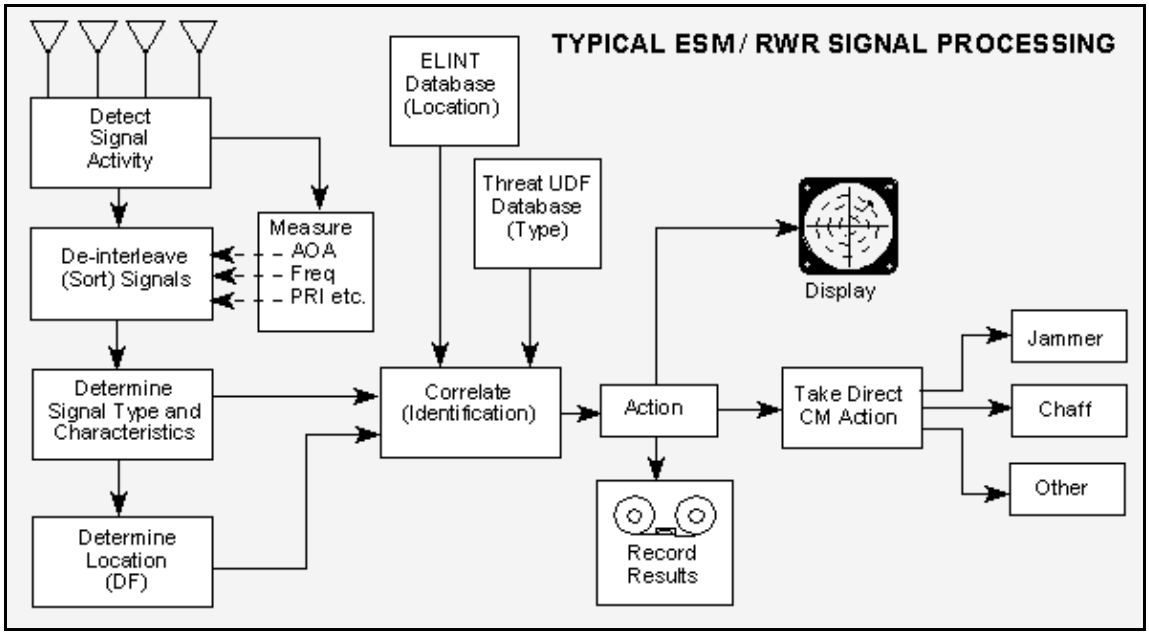

Figure 1. Signal Processing Steps.

The ultimate goal of this processing is to classify radar signals by their unique characteristics and to use this data to identify enemy radars operating in the environment, determine their location or direction, assess their threat to friendly forces, and display this information to the operator.

While not all electronic support measures (ESM) or radar warning receiver (RWR) systems perform every step in this process, each completes some of them. For example, ESM systems seldom initiate direct CM action, while RWRs sometimes do. Also ESM systems frequently record electronic data for future use, but few RWRs do. ESM systems place more emphasis on accurate emitter location and hence direction finding capabilities, while RWRs usually give a rough estimate of position/distance.

The typical emitter characteristics that an ESM system can measure for a pulse radar include the following data:

1. Radio Frequency (RF)
2. Amplitude (power)
3. Direction of Arrival (DOA) - also called Angle of Arrival (AOA)
4. Time of Arrival (TOA)
5. Pulse Repetition Interval (PRI)
6. PRI type
7. Pulse Width (PW)
8. Scan type and rate
9. Lobe duration (beam width)

However, this list is not comprehensive. Other emitter parameters are available which may be necessary to characterize the threat system.

More sophisticated ESM systems can measure additional parameters, such as PRI modulation characteristics, inter- and intra-pulse Frequency Modulation (FM), missile guidance characteristics (e.g., pattern of pulse spacing within a pulse group), and Continuous Wave (CW) signals.

Still other parameters which can describe an electromagnetic wave but are currently not commonly used for identification include polarization and phase. However, as threat emitters begin to use this data more frequently to avoid jamming the more important they may become in identifying signals.

Some of the emitter characteristics which describe an electromagnetic wave are shown in Figure 2.

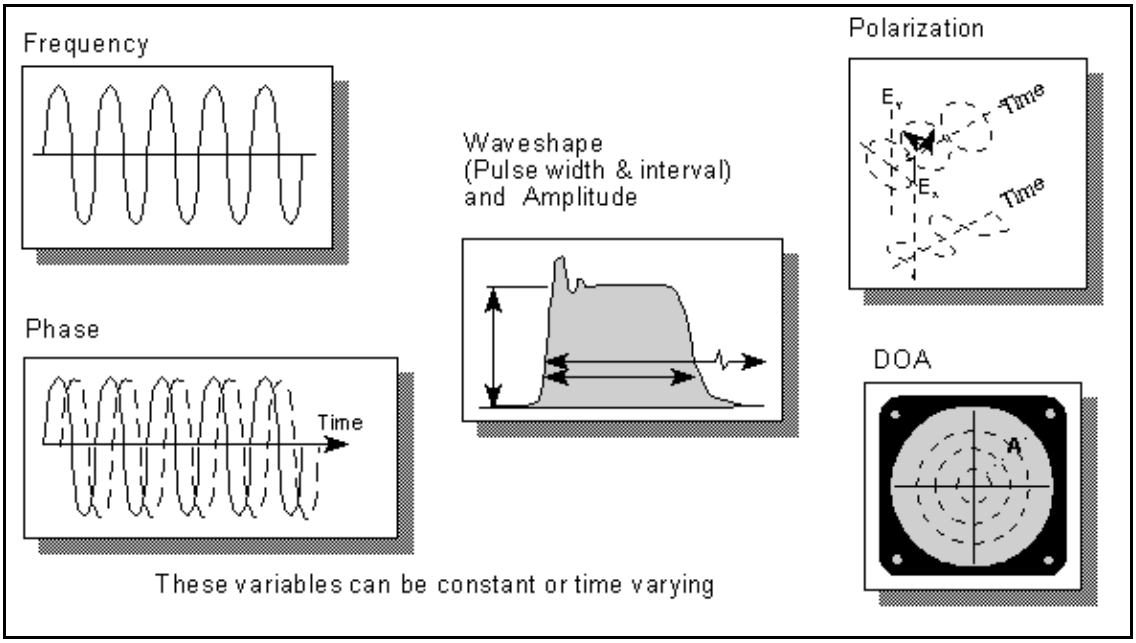

Figure 2. Information Content of an Electromagnetic Wave.

Table 1 illustrates the relative importance of several measured parameters during various stages of signal processing.

Table 1. Importance of Emitter Parameters During Signal Processing.

Parameter	Pulse Train De-interleavement	Emitter Identification	Intercept Correlation
Frequency	2	2	2
Amplitude	1	0	1
Angle of Arrival	2	0	2
TOA	0	0	1
PRI	2	2	2
PRI type	2	2	2
PW	2	1	1
Scan rate and type	0	2	1
Lobe Duration	0	1	1
0 Not Useful	1 Some Use	2 Very Useful	

Some emitter parameters can be measured using a single pulse; these parameters are referred to as monopulse parameters. The monopulse parameters include RF, PW, DOA, amplitude and TOA. RF can be determined on a pulse-by-pulse basis by receivers that can measure frequency. Frequency is very useful for emitter identification since most radars operate at a single frequency. Most real-time systems measure pulse width instead of pulse shape because the latter is much more difficult to characterize mathematically. Unfortunately, the apparent pulse width can be severely distorted by reflections, and consequently, its usefulness for emitter identification is limited. DOA cannot be used for emitter identification, but is excellent for sorting signals. A number of ESM systems use both frequency and DOA information to distinguish the new signals from the old (that is, known) ones. Amplitude also cannot be used for emitter identification. However, it can be used for sorting and for gross distance estimation using precompiled emitter's effective radiated power. Moreover, amplitude in conjunction with TOA can be used to determine the emitter's scan characteristics.

Other emitter parameters such as PRI, guidance and scan characteristics can be determined only by analyzing a group of pulses. All these parameters are useful for emitter identification; unfortunately, they require time for data collection and analysis, and call for sophisticated signal processing algorithms.

The problem of signal recognition in real-time is complicated by two factors: modulation of the signals and the very high pulse densities expected in the environment. Complex modulations (for example, inter-pulse RF modulation, intra-pulse RF modulation and agile Pulse Repetition Frequencies (PRFs)) present a significant pattern recognition problem for a number of ESM systems. It is expected that during some missions, hundreds of emitters will be transmitting simultaneously in the same vicinity. Wide-open antenna/receiver combination systems may have to cope with up to a million PPS. Even narrow-band receivers can expect data rates up to 100,000 PPS. At these rates, a single modern computer cannot be expected to process all the pulses, derive the characteristics for all emitters and identify the emitters in real-time. Other factors which encumber signal recognition include missing pulses, atmospheric noise and multiple reflections of pulses.

Present RWRs are designed primarily to cope with stable emitters. A stable emitter is one whose frequency and pulse repetition interval (PRI) remain relatively constant from pulse to pulse. The future threat will move steadily away from the stable emitter towards agile emitters which vary their frequency and PRI characteristics. The first change in this direction is towards the patterned agile emitter which varies its pulse and frequency parameters in accordance with a specific pattern. Examples of patterned agile emitters are MTI radars which use staggered PRFs, pulse Doppler radars which change frequency and PRF on a block-to-block

basis, and certain frequency-agile radars whose transmitter frequency is mechanically modulated in a systematic pattern (e.g., spin-tuned magnetron). The next step in this evolution is towards truly agile emitters which change their frequency and PRF in a random manner on a pulse-to-pulse basis. One tempering factor in this evolution is that radars which process Doppler must maintain a constant frequency for at least two consecutive pulses.

In addition to agile frequency and PRI parameters, the future threat will be composed of a number of high-PRF pulsed Doppler, burst-frequency, CW, pulse-compression, agile-beam, and LPI radars, which use pseudo-noise waveforms. This conglomeration of radar types will cause a high signal density which must be segmented into a manageable data stream by the use of both frequency and spatial filtering in the RWR. While frequency and PRI are good parameters for sorting present-day non-agile emitters, they are poor or useless parameters for sorting agile emitters.

Angle of arrival is generally regarded as the best initial sorting parameter because it cannot be varied by the emitter from pulse to pulse.

PASSIVE DIRECTION FINDING AND EMITTER LOCATION

Direction finding (DF) systems provide several important functions in modern EW systems. We have already discussed the importance of measuring the emitter's bearing, or angle of arrival (AOA), as an invariant sorting parameter in the deinterleaving of radar signals and in separating closely spaced communication emitters. In addition, the conservation of jamming power in power-managed ECM systems depends on the ability of the associated ESM system to measure the direction to the victim emitter. A function which is becoming increasingly important in defense suppression and weapon delivery systems involves locating the emitter's position passively. This can be accomplished from a single moving platform through successive measurements of the emitter's angular direction, or from multiple platforms which make simultaneous angular measurements.

The emitter identification function requires identifying and associating consecutive pulses produced by the same emitter in angle of arrival (AOA) and frequency. The AOA is a parameter which a hostile emitter cannot change on a pulse-to-pulse basis. However, to measure the AOA of pulses which overlap in the time domain first requires them to be separated in the frequency domain. The advanced ESM receivers which accomplish this function must operate over several octaves of bandwidth while providing RMS bearing accuracies on the order of at least 2 degrees with high POI and fast reaction time in dense signal environments.

There are basically three methods, depicted in Figure 3, which allow the passive location of stationary ground-based emitters from airborne platforms.

These are:

1. The azimuth triangulation method where the intersection of successive spatially displaced bearing measurements provides the emitter location.

2. The azimuth/elevation location technique, which provides a single-pulse instantaneous emitter location from the intersection of the measured azimuth/elevation line with the earth's surface.

3. The time difference of arrival (TDOA), or precision emitter location system (PELS) method, which measures the difference in time of arrival of a single pulse at three spatially remote locations.

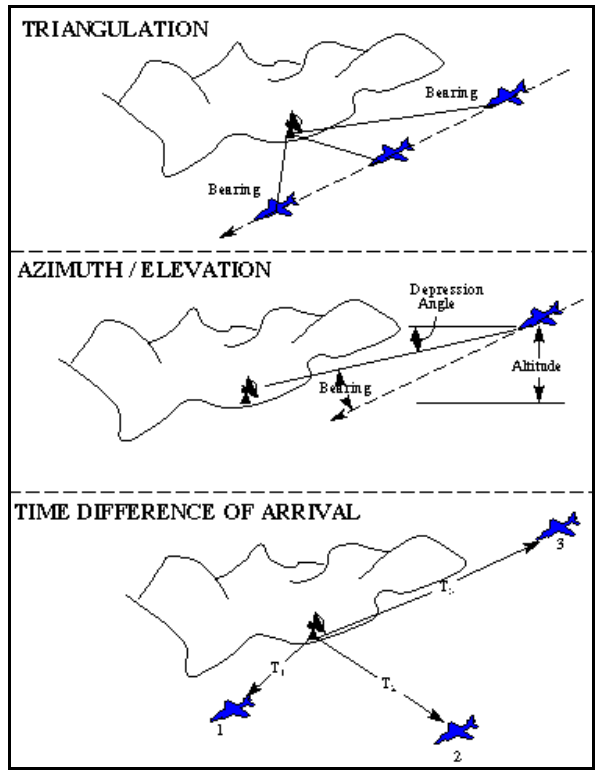

Figure 3. Passive Emitter Location Techniques.

Additional methods include:

1. Phase rate of change, which is similar to triangulation, except it makes calculations using the phase derivative.

2. Angle distance techniques, where the distance from the emitter is derived from the signal strength (with known "threat" characteristics).

3. RF Doppler processing, which measures Doppler changes as the aircraft varies direction with respect to the "target" radar.

The relative advantages and disadvantages of each are given in Table 2.

Table 2. Emitter Location Techniques.

Measurement Technique	Advantages	Disadvantages
Triangulation	Single Aircraft	Non-Instantaneous Location; Inadequate Accuracy for Remote Targeting; Not Forward Looking
Azimuth/Elevation	Single Aircraft Instantaneous Location Possible	Accuracy Degrades Rapidly at Low Altitude; Function of Range
Time Difference of Arrival (Pulsed Signals)	Very High Precision Can Support Weapon Delivery Position Requirements Very Rapid, Can Handle Short On-Time Threat	Very Complex, At Least 3 Aircraft; High Quality Receivers; DME (3 Sites); Very Wideband Data Link; Very High Performance Control Processor; Requires Very High Reliability Subsystems. Requires common time reference and correlation operation for non-pulse signals.

The triangulation method has the advantage of using a single aircraft, and its accuracy is greatest for a long baseline and the broadside geometry. The accuracy degenerates as the aircraft heading line approaches the boresight to the emitter.

The azimuth/elevation technique also has the advantage of using a single aircraft, but suffers from the difficultness of making an accurate elevation measurement with limited vertical aperture and in the presence of multipath effects.

The TDOA technique requires multiple aircraft and is complex, but has high potential accuracy. The determination of the location of the site involves the solution of at least two simultaneous second order equations for the intersection of two hyperbolas which represent $T_2 - T_1 = \text{Constant \#1}$ and $T_3 - T_2 = \text{Constant \#2}$. This method can be used to obtain a fix for an emitter which radiates only a single pulse.

ANGLE-OF-ARRIVAL (AOA) MEASUREMENTS

Several of the above DF measurements require AOA determination. Threat AOA measurements are also required to inform the aircrew in order to position the aircraft for optimal defense.

As shown in Figure 4, angle-of-arrival measuring systems fall into three main system categories of:

1. Scanning beam
2. Amplitude comparison or Simultaneous-multiple-beam
3. Phased Interferometer techniques

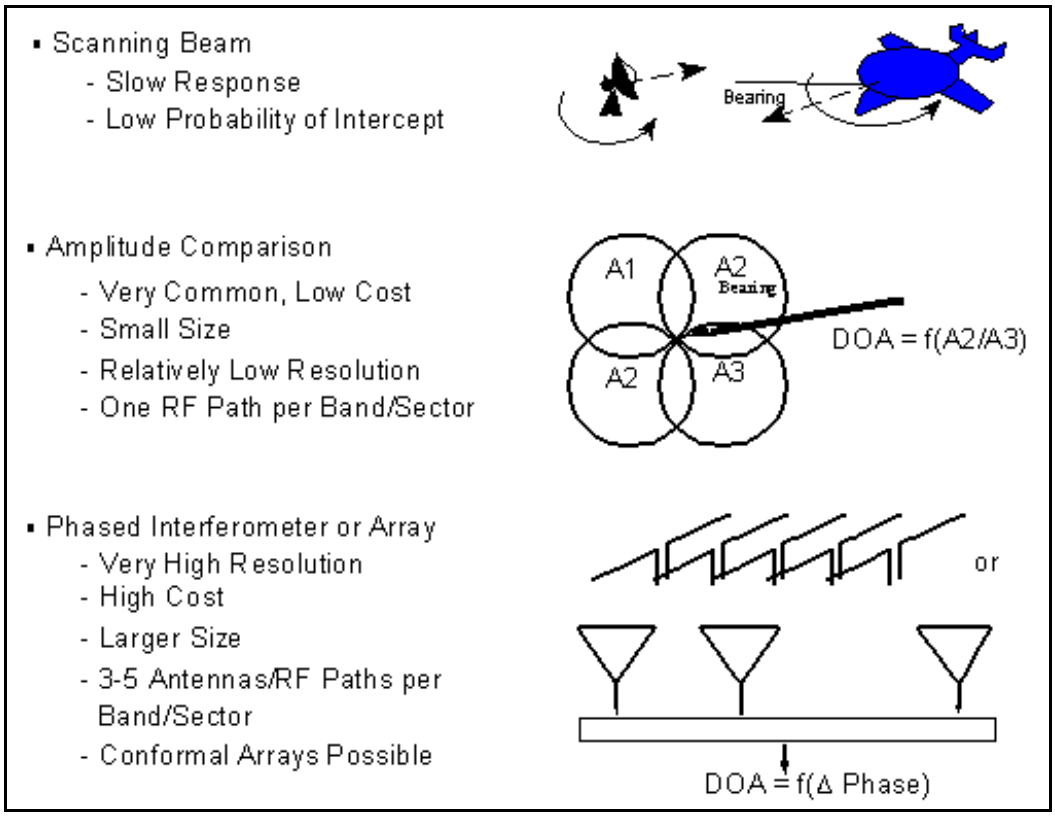

Figure 4. Angle-of-Arrival Measurement Techniques.

Scanning Beam

The mechanically scanning beam, or "spinner," requires only a single receiver and also exhibits high sensitivity due to the use of a directive antenna. The disadvantage is that the "spinner" usually exhibits slow response because it must rotate through the coverage angle (e.g., 360 degrees) to ensure that it intercepts an emitter. Also, if the emitter uses a scanning directional antenna, both beams must point at each other for maximum sensitivity, which is a low probability occurrence. Both of these effects cause the mechanically scanning beam technique to have a low probability of intercept (POI).

Amplitude Comparison

The two primary techniques used for direction finding are the amplitude-comparison method and the interferometer or phase-comparison method. The phase-comparison method generally has the advantage of greater accuracy, but the amplitude-comparison method is used extensively due to its lower complexity and cost. Regardless of which technique is used, it should be emphasized that the ultimate rms angular accuracy is given by:

$$\Delta\theta = \frac{k\,\theta_B}{\sqrt{SNR}}$$

where θ_B is the antenna's angular beamwidth, or interferometer lobe width, and SNR is the signal-to-noise ratio.

Thus, phase interferometers that typically use very widebeam antennas require high signal-to-noise ratios to achieve accurate angle-of-arrival measurements. Alternately, a multi-element array antenna can be used to provide relatively narrow interferometer lobes, which require modest signal-to-noise ratios.

Virtually all currently deployed radar warning receiving (RWR) systems use amplitude-comparison direction finding (DF). A basic amplitude-comparison receiver derives a ratio, and ultimately angle-of-arrival or bearing, from a pair of independent receiving channels, which utilize squinted antenna elements that are usually equidistantly spaced to provide an instantaneous 360° coverage. Typically, four or six antenna elements and receiver channels are used in such systems, and wideband logarithmic video detectors provide the signals for bearing-angle determination. The monopulse ratio is obtained by subtraction of the detected logarithmic signals, and the bearing is computed from the value of the ratio.

Amplitude comparison RWRs typically use broadband cavity-backed spiral antenna elements whose patterns can be approximated by Gaussian-shaped beams. Gaussian-shaped beams have the property that the logarithmic output ratio slope in dB is linear as a function of angle of arrival. Thus, a digital look-up table can be used to determine the angle directly. However, both the antenna beamwidth and squint angle vary with frequency over the multi-octave bands used in RWRs. Pattern shape variations cause a larger pattern crossover loss for high frequencies and a reduced slope sensitivity at low frequencies. Partial compensation of these effects, including antenna squint, can be implemented using a look-up table if frequency information is available in the RWR. Otherwise, gross compensation can be made, depending upon the RF octave band utilized.

Typical accuracies can be expected to range from 3 to 10 degrees rms for multi-octave frequency band amplitude-comparison systems which cover 360 degrees with four to six antennas.

The four-quadrant amplitude-comparison DF systems employed in RWRs have the advantage of simplicity, reliability, and low cost. Usually, only one antenna per quadrant is employed which covers the 2 to 18 GHz band. The disadvantages are poor accuracy and sensitivity, which result from the broad-beam antennas employed. Both accuracy and sensitivity can be improved by expanding the number of antennas employed. For example, expanding to eight antennas would double the accuracy and provide 3 dB more gain. As the number of antennas increases, it becomes appropriate to consider multiple-beam-forming antennas rather than just increasing the number of individual antennas. The geometry of multiple-beam-forming antennas is such that a conformal installation aboard an aircraft is difficult. Therefore, this type of installation is typically found on naval vessels or ground vehicles where the space is available to accommodate this type of antenna.

Simultaneous-multiple-beam (amplitude comparison)

The simultaneous-multiple-beam system uses an antenna, or several antennas, forming a number of simultaneous beams (e.g., Butler matrix or Rotman lens), thereby retaining the high sensitivity of the scanning antenna approach while providing fast response. However, it requires many parallel receiving channels, each with full frequency coverage. This approach is compatible with amplitude-monopulse angular measuring techniques which are capable of providing high angular accuracy.

A typical example of a multiple-beam antenna is a 16-element circular array developed as part of a digital ESM receiver. This system covers the range from 2 to 18 GHz with two antenna arrays (2 to 7.5 GHz and 7.5 to 18 GHz), has a sensitivity of -55 to -60 dBm and provides an rms bearing accuracy of better than 1.7 degrees on pulsewidths down to 100 ns.

Phased Interferometer Techniques

The term interferometer generally refers to an array type antenna in which large element spacing occurs and grating lobes appear.

Phase interferometer DF systems are utilized when accurate angle-of-arrival information is required. They have the advantage of fast response, but require relatively complex microwave circuitry, which must maintain a precise phase match over a wide frequency band under extreme environmental conditions. When high accuracy is required (on the order of 0.1 to 1°), wide baseline interferometers are utilized with ambiguity resolving circuitry. The basic geometry is depicted in Figure 5, whereby a plane wave arriving at an angle is received by one antenna earlier than the other due to the difference in path length.

The time difference can be expressed as a phase difference:

$$\varphi = \omega\Delta\tau = 2\pi a(f/c) = 2\pi\,(d \sin\theta)/\lambda,$$

where θ is the angle of arrival,
d is the antenna separation, and
λ is the wavelength in compatible units.

The unambiguous field of view (FOV) is given by $\theta = 2 \sin^{-1} (\pi/2d)$, which for $\lambda/2$ spacing results in 180° coverage. This spacing must be established for the highest frequency to be received.

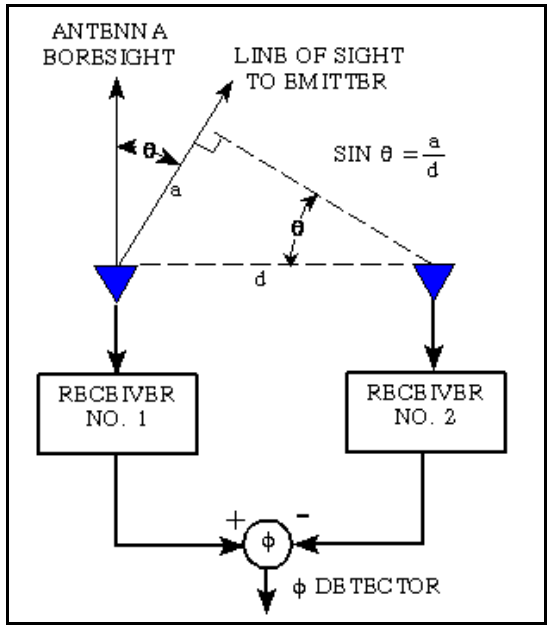

Figure 5. Phase Interferometer Principle.

Interferometer elements typically use broad antenna beams with beamwidths on the order of 90°. This lack of directivity produces several adverse effects. First, it limits system sensitivity due to the reduced antenna gain. Secondly, it opens the system to interference signals from within the antenna's broad angular coverage. The interference signals often include multipath from strong signals which can limit the accuracy of the interferometer.

In an interferometer, the locus of points that produce the same time or phase delay forms a cone. The indicated angle is the true azimuth angle multiplied by the cosine of the elevation angle. The error in assuming the incident angle to be the azimuth angle is negligible for signals near the antenna's boresight. At 45° azimuth and 10° elevation, the error is less than 1°, increasing to 15° for both at 45°. Two orthogonal arrays, one measuring the azimuth angle and the other the elevation angle can eliminate this error. For targets near the horizon, the depression angle is small, thereby requiring only horizontal arrays.

The rms angular accuracy of an interferometer in radians is given by:

$$\sigma_\theta = \Delta\alpha \,/\, (\pi \bullet \sqrt{SNR}\,),$$ where $\Delta\alpha = \lambda/(d\cdot\cos\theta)$ is the separation between adjacent nulls.

For a two-element interferometer, the spacing (d) must be $\lambda/2$ or less to provide unambiguous, or single lobe ± 90°, coverage. This, in effect, sets a wide interferometer (or grating) lobe which must be split

by a large factor to achieve high accuracy. This, in turn, imposes a requirement for high SNR to achieve the large beam-splitting factor. For example, if 0.1° accuracy is required from an unambiguous two-element interferometer, then a SNR of about 50 dB is required to achieve this accuracy. This may be difficult to achieve considering the inherently low sensitivity of an interferometer system.

When high accuracy is required from an interferometer system, it is usual to employ separations greater than $\lambda/2$. The increased separation sets up a multi-grating-lobe structure through the coverage angle which requires less SNR to achieve a specified accuracy. For example, a two-element interferometer with 16λ spacing would set up a 33-grating-lobe structure (including the central lobe) throughout the ± 90° coverage angle. Within each of the 33 grating lobes, it would only require a SNR on the order of 20 dB to achieve 0.1° accuracy. However, there would be 33 ambiguous regions within the ± 90° angular coverage and also 32 nulls (where the phase detector output is zero), about which the system would be insensitive to an input signal. The ambiguities could be resolved by employing a third antenna element with $\lambda/2$ spacing, which would provide an accuracy on the order of 3° with 20 dB SNR. This accuracy is sufficient to identify which of the 33 lobes contains the signal. Providing coverage in the null regions requires additional antenna elements.

Interferometers employing multiple antenna elements are called multiple-baseline interferometers. In a typical design, the receiver consists of a reference antenna and a series of companion antennas. The spacing between the reference element and the first companion antenna is $\lambda/2$; other secondary elements are placed to form pairs separated by 1, 2, 4, and 8 wavelengths. The initial AOA is measured unambiguously by the shortest-spaced antenna pair. The next greatest spaced pair has a phase rate of change which is twice that of the first, but the information is ambiguous due to there being twice as many lobes as in the preceding pair. A greater phase rate of change permits higher angular accuracy while the ambiguity is resolved by the previous pair. Thus, the described multiple-baseline interferometer provides a binary AOA measurement where each bit of the measurement supplies a more accurate estimate of the emitter's AOA.

Harmonic multiple-baseline interferometers use elements which are spaced at $2^n \cdot \lambda/2$, with n = 0, 1, 2, 3. In nonharmonic interferometers, no pair of antennas provides a completely unambiguous reading over the complete field of view. For example, the initial spacing in the nonharmonic interferometer might be λ, while the next companion element spacing is $3\lambda/2$. Ambiguities are resolved by truth tables, and hence the accuracy is set by the spacing of the widest baseline antenna pair. Nonharmonic interferometers have been implemented over 9:1 bandwidths (2 to 18 GHz) with rms accuracies from 0.1 to 1° and with no ambiguities over ± 90°. The principal advantage of the nonharmonic over the harmonic interferometer is the increased bandwidth for unambiguous coverage.

Interferometer DF accuracy is determined by the widest baseline pair. Typical cavity-backed spirals, track to 6 electrical degrees, and associated receivers track to 9°, resulting in an rms total of 11°. At a typical 16 dB SNR, the rms phase noise is approximately 9 electrical degrees. For these errors and an emitter angle of 45°, a spacing of 25λ is required for 0.1° rms accuracy while a spacing of 2.5λ is needed for 1° accuracy. For high accuracy, interferometer spacings of many feet are required. In airborne applications, this usually involves mounting interferometer antennas in the aircraft's wingtips.

The characteristics of typical airborne amplitude comparison and phase interferometer DF systems are summarized in Table 3. The phase interferometer system generally uses superheterodyne receivers which provide the necessary selectivity and sensitivity for precise phase measurements.

Table 3. Direction of Arrival Measurement Techniques.

	Amplitude Comparison	Phase Interferometer
Sensor Configuration	Typically 4 to 6 Equispaced Antenna Elements for 360° Coverage	2 or more RHC or LHC Spirals in Fixed Array
DF Accuracy	$DF_{ACC} \approx \frac{\theta_{BW}^2 \Delta C_{dB}}{24S}$ (Gaussian Shape)	$DF_{ACC} = \frac{\lambda}{2\pi d \cos\theta} \Delta\theta$
DF Accuracy Improvement	Decrease Antenna BW Decrease Amplitude Mistrack Increase Squint Angle	Increase Spacing of Outer Antennas; Decrease Phase Mistrack
Typical DF Accuracy	3° to 10° rms	0.1° to 3° rms
Sensitivity to Multipath/ Reflections	High Sensitivity Mistrack of Several dB Can Cause Large DF Errors	Relatively Insensitive; Interferometer Can Be Made to Tolerate Large Phase Errors
Platform Constraints	Locate in Reflection Free Area	Reflection Free Area; Real Estate For Array; Prefers Flat Radome
Applicable Receivers	Crystal Video; Channelizer; Acousto-Optic; Compressive; Superheterodyne	Superheterodyne

ΔC_{dB} = Amplitude Monopulse Ratio in dB
S = Squint Angle in degrees
θ_{BW} = Antenna Beamwidth in degrees

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MICROWAVE / RF COMPONENTS

Microwave Waveguides and Coaxial Cable 6-1
Voltage Standing Wave Ratio (VSWR) / Reflection Coefficient
Return Loss / Mismatch Loss 6-2
Microwave Coaxial Connectors 6-3
Power Dividers and Directional Couplers 6-4
Attenuators / Filters / DC Blocks 6-5
Terminations / Dummy Loads 6-6
Circulators and Diplexers 6-7
Mixers and Frequency Discriminators 6-8
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MICROWAVE WAVEGUIDES and COAXIAL CABLE

In general, a waveguide consists of a hollow metallic tube of arbitrary cross section uniform in extent in the direction of propagation. Common waveguide shapes are rectangular, circular, and ridged. The rectangular waveguide has a width a and height b as shown in Figure 1. Commonly used rectangular waveguides have an aspect ratio b/a of approximately 0.5. Such an aspect ratio is used to preclude generation of field variations with height and their attendant unwanted modes. Waveguides are used principally at frequencies in the microwave range; inconveniently large guides would be required to transmit radio-frequency power at longer wavelengths. In the X-Band frequency range of 8.2 to 12.4 GHz, for example, the U.S. standard rectangular waveguide, WR-90, has an inner width of 2.286 cm (0.9 in.) and an inner height of 1.016 cm (0.4 in.).

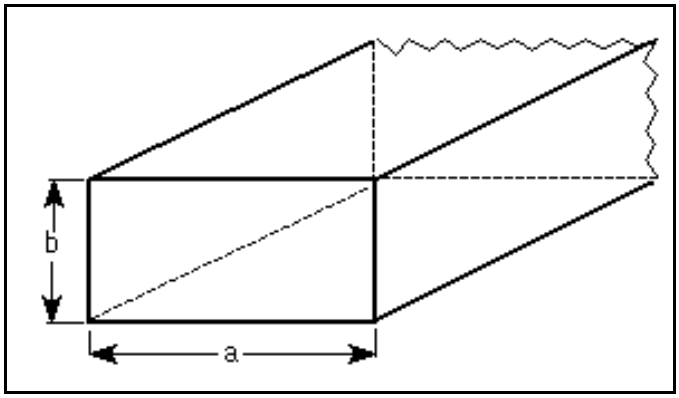

Figure 1. The Rectangular Waveguide.

In waveguides the electric and magnetic fields are confined to the space within the guides. Thus no power is lost to radiation. Since the guides are normally filled with air, dielectric losses are negligible. However, there is some I^2R power lost to heat in the walls of the guides, but this loss is usually very small.

It is possible to propagate several modes of electromagnetic waves within a waveguide. The physical dimensions of a waveguide determine the cutoff frequency for each mode. If the frequency of the impressed signal is <u>above</u> the cutoff frequency for a given mode, the electromagnetic energy can be transmitted through the guide for that particular mode with minimal attenuation. Otherwise the electromagnetic energy with a frequency <u>below</u> cutoff for that particular mode will be attenuated to a negligible value in a relatively short distance. This grammatical use of cutoff frequency is opposite that used for coaxial cable, where cutoff frequency is for the highest useable frequency. The dominant mode in a particular waveguide is the mode having the lowest cutoff frequency. For rectangular waveguide this is the TE_{10} mode. The TE (transverse electric) signifies that all electric fields are transverse to the direction of propagation and that no longitudinal electric field is present. There is a longitudinal component of magnetic field and for this reason the TE_{mn} waves are also called H_{mn} waves. The TE designation is usually preferred. Figure 2 shows a graphical depiction of the E field variation in a waveguide for the TE_{10}, TE_{20}, and TE_{30} modes. As can be seen, the first index indicates the number of half wave loops across the width of the guide and the second index, the number of loops across the height of the guide - which in this case is zero. It is advisable to choose the dimensions of a guide in such a way that, for a given input signal, only the energy of the dominant mode can be transmitted through the guide. For example, if for a particular frequency, the width of a rectangular guide is too large, then the TE_{20} mode can propagate causing a myriad of problems. For rectangular guides of low aspect ratio the TE_{20} mode is the next higher order mode

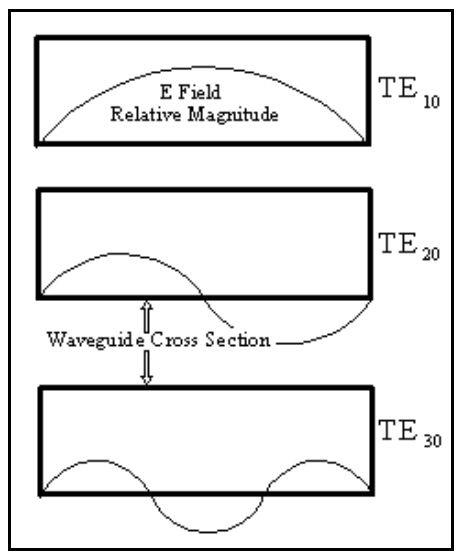

Figure 2. TE Modes.

and is harmonically related to the cutoff frequency of the TE_{10} mode. It is this relationship together with attenuation and propagation considerations that determine the normal operating range of rectangular waveguide.

The discussion on circular waveguides will not be included because they are rarely used in the EW area. Information regarding circular waveguides can be found in numerous textbooks on microwaves.

CHARACTERISTICS OF STANDARD RECTANGULAR WAVEGUIDES

Rectangular waveguides are commonly used for power transmission at microwave frequencies. Their physical dimensions are regulated by the frequency of the signal being transmitted. Table 1 tabulates the characteristics of the standard rectangular waveguides. It may be noted that the number following the EIA prefix "WR" is in inside dimension of the widest part of the waveguide (i.e., WR90 has an inner dimension of 0.90").

DOUBLE RIDGE RECTANGULAR WAVEGUIDE

Another type of waveguide commonly used in EW systems is the double ridge rectangular waveguide. The ridges in this waveguide increase the bandwidth of the guide at the expense of higher attenuation and lower power-handling capability. The bandwidth can easily exceed that of two contiguous standard waveguides. Introduction of the ridges mainly lowers the cutoff frequency of the TE_{10} mode from that of the unloaded guide, which is predicated on width alone. The reason for this can easily be explained when the field configuration in the guide at cutoff is investigated. At cutoff there is no longitudinal propagation down the guide. The waves simply travel back and forth between the side walls of the guide. In fact the guide can be viewed as a composite parallel plate waveguide of infinite width where the width corresponds to the direction of propagation of the normal guide. The TE_{10} mode cutoff occurs where this composite guide has its lowest-order resonant frequency. This occurs when there is only one E field maximum across the guide which occurs at the center for a symmetrical ridge. Because of the reduced height of the guide under the ridge, the effective TE_{10} mode resonator is heavily loaded as though a shunt capacitor were placed across it. The cutoff frequency is thus lowered considerably. For the TE_{20} mode the fields in the center of the guide will be at a minimum. Therefore the loading will have a negligible effect. For guides of proper aspect ratio, ridge height, and ridge width, an exact analysis shows that the TE_{10} mode cutoff can be lowered substantially at the same time the TE_{20} and TE_{30} mode cutoffs are raised slightly. Figure 3 shows a typical double ridged waveguide shape and Table 2 shows double ridged waveguide specifications. In the case of ridged waveguides, in the EIA designation, (WRD350 D36) the first "D" stands for double ridged ("S" for single ridged), the 350 is the starting frequency (3.5 GHz), and the "D36" indicates a bandwidth of 3.6:1. The physical dimensions and characteristics of a WRD350 D24 and WRD350 D36 are radically different. A waveguide with a MIL-W-23351 dash number beginning in 2 (i.e., 2-025) is a double ridge 3.6:1 bandwidth waveguide. Likewise a 1- is a single ridge 3.6:1, a 3- is a single ridge 2.4:1, and a 4- is a double ridge 2.4:1 waveguide.

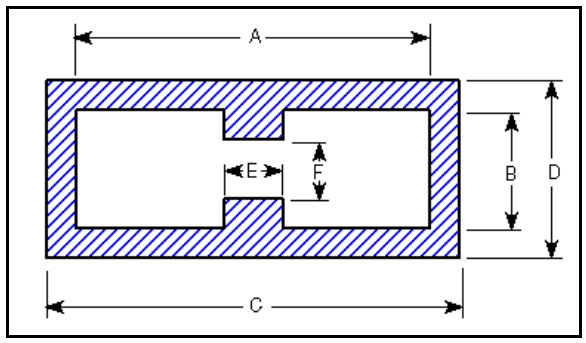

Figure 3. Double Ridge Waveguide.

Figure 4 shows a comparison of the frequency /attenuation characteristics of various waveguides. The attenuation is based on real waveguides which is higher than the theoretical values listed in Tables 1 and 2. Figure 5 shows photographs of waveguides with some common connectors. Figure 6 shows attenuation characteristics of various RF coaxial cables.

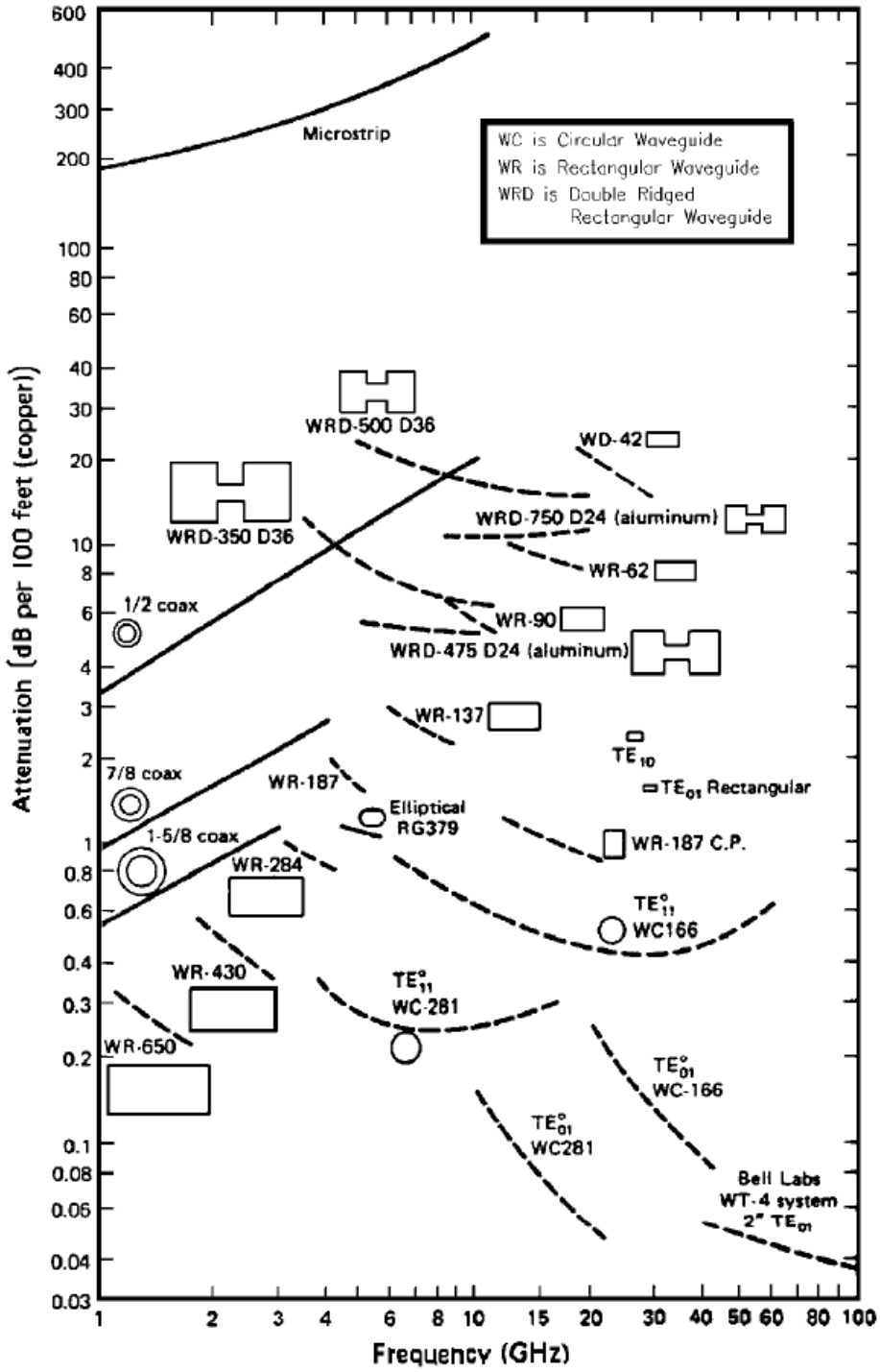

Figure 4. Attenuation vs. Frequency for a Variety of Waveguides and Cables.

Table 1. Rectangular Waveguide Specifications.

Waveguide Size	JAN WG Desig	MIL-W-85 Dash #	Material	Freq Range (GHz)	Freq Cutoff (GHz)	Power (at 1 Atm)		Insertion Loss (dB/100ft)	Dimensions (Inches)	
						CW	Peak		Outside	Wall Thickness
WR284	RG48/U RG75/U	1-039 1-042	Copper Aluminum	2.60 - 3.95	2.08	45 36	7650	.742-.508 1.116-.764	3.000x1.500	0.08
WR229	RG340/U RG341/U	1-045 1-048	Copper Aluminum	3.30 - 4.90	2.577	30 24	5480	.946-.671 1.422-1.009	2.418x1.273	0.064
WR187	RG49/U RG95/U	1-051 1-054	Copper Aluminum	3.95 - 5.85	3.156	18 14.5	3300	1.395-.967 2.097-1.454	1.000x1.000	0.064
WR159	RG343/U RG344/U	1-057 1-060	Copper Aluminum	4.90 - 7.05	3.705	15 12	2790	1.533-1.160 2.334-1.744	1.718x0.923	0.064
WR137	RG50/U RG106/U	1-063 1-066	Copper Aluminum	5.85 - 8.20	4.285	10 8	1980	1.987-1.562 2.955-2.348	1.500x0.750	0.064
WR112	RG51/U RG68/U	1-069 1-072	Copper Aluminum	7.05 - 10.0	5.26	6 4.8	1280	2.776-2.154 4.173-3.238	1.250x0.625	0.064
WR90	RG52/U RG67/U	1-075 1-078	Copper Aluminum	8.2 - 12.4	6.56	3 2.4	760	4.238-2.995 6.506-4.502	1.000x0.500	0.05
WR75	RG346/U RG347/U	1-081 1-084	Copper Aluminum	10.0 - 15.0	7.847	2.8 2.2	620	5.121-3.577 7.698-5.377	0.850x0.475	0.05
WR62	RG91/U RG349/U	1-087 1-091	Copper Aluminum	12.4 - 18.0	9.49	1.8 1.4	460	6.451-4.743 9.700-7.131	0.702x0.391	0.04
WR51	RG352/U RG351/U	1-094 1-098	Copper Aluminum	15.0 - 22.0	11.54	1.2 1	310	8.812-6.384 13.250-9.598	0.590x0.335	0.04
WR42	RG53/U	1-100	Copper	18.0 - 26.5	14.08	0.8	170	13.80-10.13	0.500x0.250	0.04
WR34	RG354/U	1-107	Copper	2.0 - 33.0	17.28	0.6	140	16.86-11.73	0.420x0.250	0.04
WR28	RG271/U	3-007	Copper	26.5 - 40.0	21.1	0.5	100	23.02-15.77	0.360x0.220	0.04

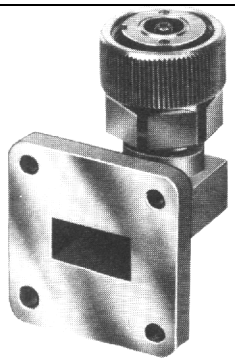

Standard waveguide - 7 mm

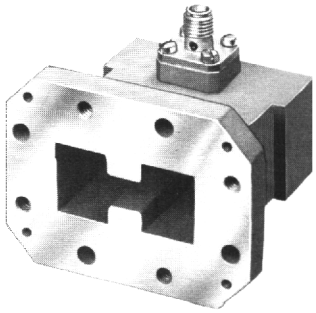

Double ridge waveguide - SMA jack

Figure 5. Waveguides With Some Common Connections.

Table 2. Double Ridge Rectangular Waveguide Specifications.

Waveguide Size	MIL-W-23351 Dash #	Material	Freq Range (GHz)	Freq Cutoff (GHz)	Power (at 1 Atm)		Insertion Loss (dB/ft)	Dimensions (Inches)					
					CW	Peak		A	B	C	D	E	F
WRD250		Alum Brass Copper Silver Al	2.60 - 7.80	2.093	24	120	0.025 0.025 0.018 0.019	1.655	0.715	2	1	0.44	0.15
WRD350 D24	4-029 4-303 4-031	Alum Brass Copper	3.50 - 8.20	2.915	18	150	0.0307 0.0303 0.0204	1.48	0.688	1.608	0.816	0.37	0.292
WRD475 D24	4-033 4-034 4-035	Alum Brass Copper	4.75 - 11.00	3.961	8	85	0.0487 0.0481 0.0324	1.09	0.506	1.19	0.606	0.272	0.215
WRD500 D36	2-025 2-026 2-027	Alum Brass Copper	5.00 - 18.00	4.222	4	15	0.146 0.141 0.095	0.752	0.323	0.852	0.423	0.188	0.063
WRD650		Alum Brass Copper	6.50 - 18.00	5.348	4	25	0.106 0.105 0.07	0.720	0.321	0.820	0.421	0.173	0.101
WRD750 D24	4-037 4-038 4-039	Alum Brass Copper	7.50 - 18.00	6.239	4.8	35	0.0964 0.0951 0.0641	0.691	0.321	0.791	0.421	0.173	0.136
WRD110 D24	4-041 4-042 4-043	Alum Brass Copper	11.00 - 26.50	9.363	1.4	15	0.171 0.169 0.144	0.471	0.219	0.551	0.299	0.118	0.093
WRD180 D24	4-045 4-046 4-047	Alum Brass Copper	18.00 - 40.00	14.995	0.8	5	0.358 0.353 0.238	0.288	0.134	0.368	0.214	0.072	0.057

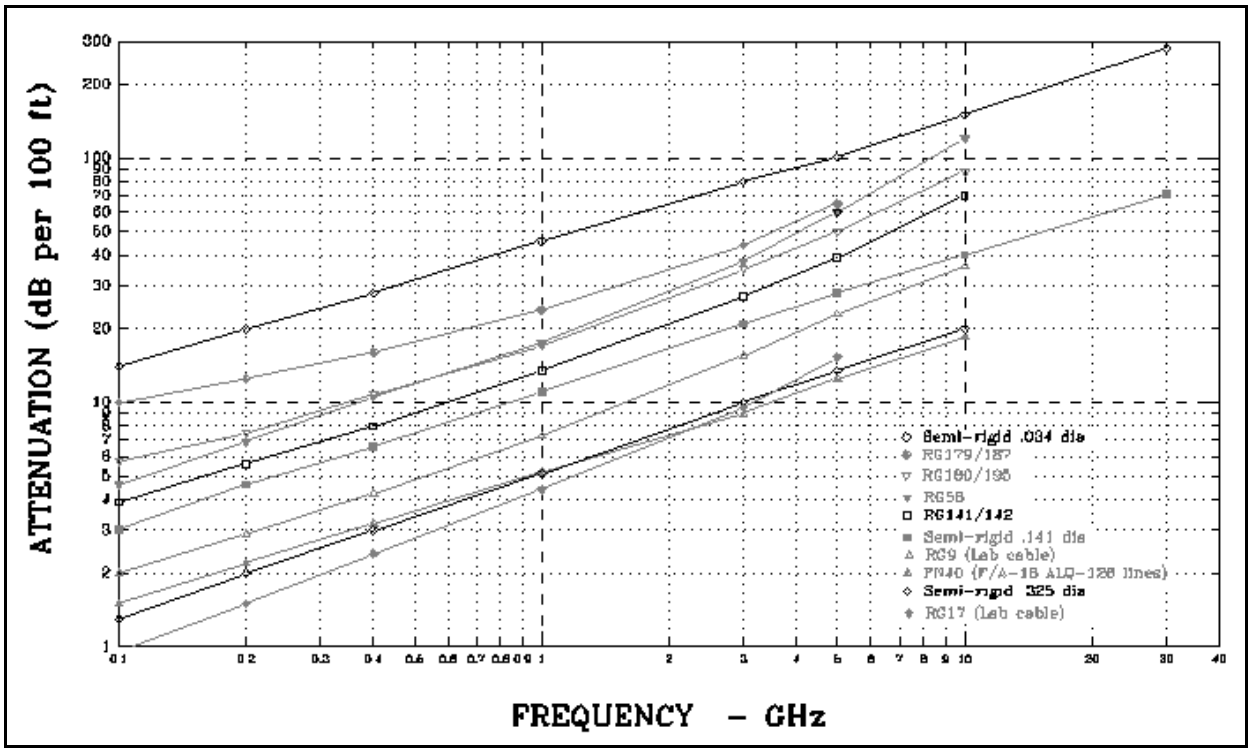

Figure 6. Attenuation vs. Frequency for a Variety of Coaxial Cables.

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VOLTAGE STANDING WAVE RATIO (VSWR) / REFLECTION COEFFICIENT RETURN LOSS / MISMATCH LOSS

When a transmission line is terminated with an impedance, Z_L, that is not equal to the characteristic impedance of the transmission line, Z_O, not all of the incident power is absorbed by the termination. Part of the power is reflected back so that phase addition and subtraction of the incident and reflected waves creates a voltage standing wave pattern on the transmission line. The ratio of the maximum to minimum voltage is known as the Voltage Standing Wave Ratio (VSWR) and successive maxima and minima are spaced by 180° (λ/2).

$$VSWR = \frac{E_{\max}}{E_{\min}} = \frac{E_i + E_r}{E_i - E_r}$$

where E_{max} = maximum voltage on the standing wave
E_{min} = minimum voltage on the standing wave
Ei = incident voltage wave amplitude
Er = reflected voltage wave amplitude

The reflection coefficient, ρ, is defined as E_r/E_i and in general, the termination is complex in value, so that ρ will be a complex number.

Additionally we define: $\Gamma = \frac{Z_L - Z_O}{Z_L + Z_O}$ The refection coefficient, ρ, is the absolute value of the magnitude of Γ. If the equation for VSWR is solved for the reflection coefficient, it is found that:

$$\begin{matrix}\textit{Reflection}\\ \textit{Coefficient}\end{matrix} = \rho = |\Gamma| = \frac{VSWR - 1}{VSWR + 1} \qquad \text{Consequently, } VSWR = \frac{1+\rho}{1-\rho}$$

The return loss is related through the following equations:

$$\begin{matrix}\textit{Return}\\ \textit{Loss}\end{matrix} = 10 \log\left[\frac{P_i}{P_r}\right] = -20 \log\left[\frac{E_r}{E_i}\right] = -20 \log\left[\frac{VSWR - 1}{VSWR + 1}\right] = -20 \log \rho$$

Return loss is a measure in dB of the ratio of power in the incident wave to that in the reflected wave, and as defined above always has a positive value. For example if a load has a Return Loss of 10 dB, then 1/10 of the incident power is reflected. The higher the return loss, the less power is actually lost.

Also of considerable interest is the Mismatch Loss. This is a measure of how much the transmitted power is attenuated due to reflection. It is given by the following equation:

Mismatch Loss = $-10 \log (1 - \rho^2)$

For example, an antenna with a VSWR of 2:1 would have a reflection coefficient of 0.333, a mismatch loss of 0.51 dB, and a return loss of

VSWR	Return Loss (dB)	% Power / Voltage Loss	Reflection Coefficient	Mismatch Loss (dB)
1	∞	0 / 0	0	0.000
1.15	23.1	0.49 / 7.0	0.07	.021
1.25	19.1	1.2 / 11.1	0.111	.054
1.5	14.0	4.0 / 20.0	0.200	.177
1.75	11.3	7.4 / 27.3	0.273	.336
1.9	10.0	9.6 / 31.6	0.316	.458
2.0	9.5	11.1 / 33.3	0.333	.512
2.5	7.4	18.2 / 42.9	0.429	.880
3.0	6.0	25.1 / 50.0	0.500	1.25
3.5	5.1	30.9 / 55.5	0.555	1.6
4.0	4.4	36.3 / 60.0	0.600	1.94
4.5	3.9	40.7 / 63.6	0.636	2.25
5.0	3.5	44.7 / 66.6	0.666	2.55
10	1.7	67.6 / 81.8	0.818	4.81
20	0.87	81.9 / 90.5	0.905	7.4
100	0.17	96.2 / 98.0	0.980	14.1
∞	.000	100 / 100	1.00	∞

* Divide % Voltage loss by 100 to obtain ρ (reflection coefficient)

9.54 dB (11% of your transmitter power is reflected back). In some systems this is not a trivial amount and points to the need for components with low VSWR.

If 1000 watts (60 dBm/ 30 dBW) is applied to this antenna, the return loss would be 9.54 dB. Therefore, 111.1 watts would be reflected and 888.9 watts (59.488 dBm/29.488 dBW) would be transmitted, so the mismatch loss would be 0.512 dB.

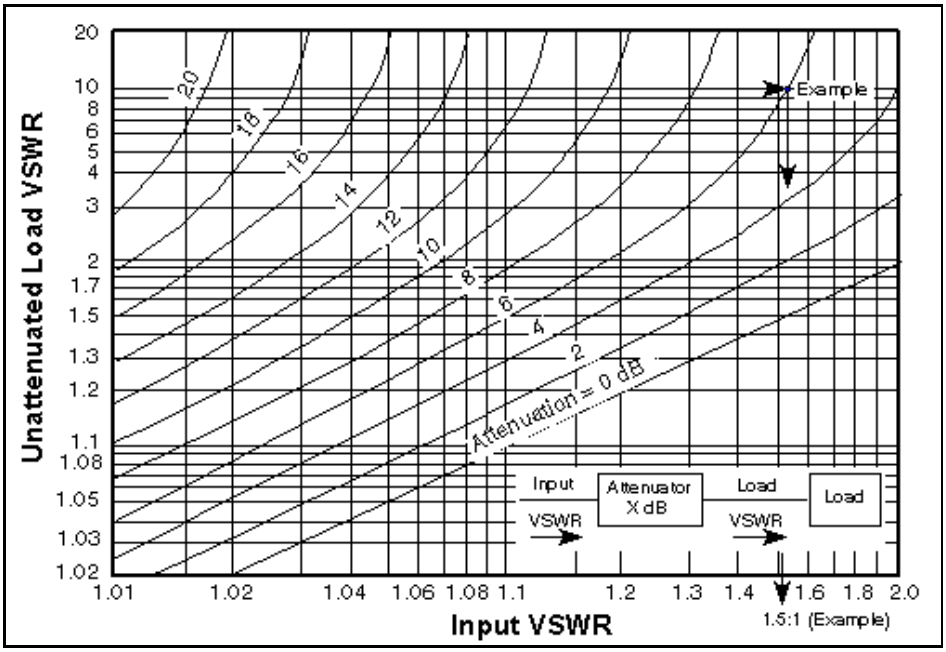

Figure 1. Reduction of VSWR by Attenuation.

Transmission line attenuation improves the VSWR of a load or antenna. For example, a transmitting antenna with a VSWR of 10:1 (poor) and a line loss of 6 dB would measure 1.5:1 (okay) if measured at the transmitter. Figure 1 shows this effect.

Therefore, if you are interested in determining the performance of antennas, the VSWR should always be measured at the antenna connector itself rather than at the output of the transmitter. Transmit cabling will load the line and create an illusion of having a better antenna VSWR. Transmission lines should have their insertion loss (attenuation) measured in lieu of VSWR, but VSWR measurements of transmission lines are still important because connection problems usually show up as VSWR spikes.

Historically VSWR was measured by probing the transmission line. From the ratio of the maximum to minimum voltage, the reflection coefficient and terminating impedance could be calculated. This was a time consuming process since the measurement was at a single frequency and mechanical adjustments had to be made to minimize coupling into circuits. Problems with detector characteristics also made the process less accurate. The modern network analyzer system sweeps very large frequency bandwidths and measures the incident power, P_i, and the reflected power, P_r. Because of the considerable computing power in the network analyzer, the return loss is calculated from the equation given previously, and displayed in real time. Optionally, the VSWR can also be calculated from the return loss and displayed real time.

If a filter is needed on the output of a jammer, it is desirable to place it approximately half way between the jammer and antenna. This may allow the use of a less expensive filter, or a reflective filter vs. an absorptive filter.

Special cases exist when comparing open and shorted circuits. These two conditions result in the same ∞ VSWR and zero dB return loss even though there is a 180° phase difference between the reflection coefficients. These two conditions are used to calibrate a network analyzer.

MICROWAVE COAXIAL CONNECTORS

For high-frequency operation, the average circumference of a coaxial cable must be limited to about one wavelength in order to reduce multimodal propagation and eliminate erratic reflection coefficients, power losses, and signal distortion.

Except for the sexless APC-7 connector, all other connectors are identified as either male (plugs) which have a center conductor that is a probe or female (jacks) which have a center conductor that is a receptacle. Sometimes it is hard to distinguish them as some female jacks may have a hollow center "pin" which appears to be male, yet accepts a smaller male contact.

An adapter is an approximately zero loss interface between two connectors and is called a barrel when both connectors are identical. A number of common of coaxial connectors are described below, however other special purpose connectors exist, including blind mate connectors where spring fingers are used in place of threads to obtain shielding (desired connector shielding should be at least 90 dB).

APC-2.4 (2.4mm) - The 50 Ω APC-2.4 (Amphenol Precision Connector-2.4 mm) is also known as an OS-50 connector. It was designed to operate at extremely high microwave frequencies (up to 50 GHz).	
APC-3.5 (3.5mm) - The APC-3.5 connector provides repeatable connections and has a very low VSWR. Either the male or female end of this 50 Ω connector can mate with the opposite type of SMA connector. The APC-3.5 connector can work at frequencies up to 34 GHz.	2.4 mm jack - 3.5 mm jack
APC-7 (7mm) - The APC-7 was developed by HP, but has been improved and is now manufactured by Amphenol. The connector provides a coupling mechanism without male or female distinction and is the most repeatable connecting device used for very accurate 50 Ω measurement applications. Its VSWR is extremely low up to 18 GHz. Other companies have 7mm series available.	7mm - 3.5mm plug
BNC (OSB) - The BNC (Bayonet Neill-Concelman or Bayonet Navy Connector) was originally designed for military system applications during World War II. The connector operates best at frequencies up to about 4 GHz; beyond that it tends to radiate electromagnetic energy. The BNC can accept flexible cables with diameters of up to 6.35 mm (0.25 in.) and characteristic impedance of 50 to 75 Ω. It is now the most commonly used connector for frequencies under 1 GHz. Other names the BNC has picked up over the years include: "Baby Neill-Concelman", "Baby N connector", "British Naval Connector", and "Bayonet Nut Connector"	BNC male plug (above) BNC female jack

C - The C (Concelman) coaxial connector is a medium size, older type constant 50 Ω impedance. It has a bayonet (twist and lock) connection. It is larger than the BNC, but about the same as Type N. It has a frequency range of 0-11 GHz	C Plug (top)
SC (OSSC) - The SC type connector is a screw version of the "C" connector.	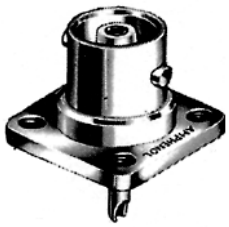 C jack (bottom)
SMA (OSM/3mm) - The SMA (Sub-Miniature A) connector was originally designed by Bendix Scintilla Corporation, but it has been manufactured by the Omni-Spectra division of M/ACOM (as the OSM connector) and many other electronic companies. It is a 50 Ω threaded connector. The main application of SMA connectors is on components for microwave systems. The connector normally has a frequency range to 18 GHz, but high performance varieties can be used to 26.5 GHz.	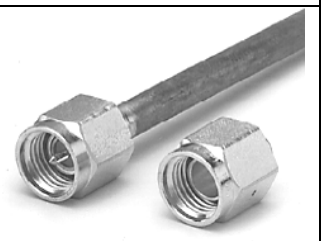 SMA Plug (above) SMA Jack
SSMA (OSSM) - The SSMA is a microminiature version of the SMA. It is also 50 Ω and operates to 26.5 GHz with flexible cable or 40 GHz with semi-rigid cable.	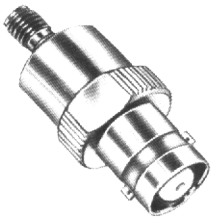 SSMA jack - BNC jack

SMC (OSMC) - The SMC (Sub-Miniature C) is a 50 Ω or 75 Ω connector that is smaller than the SMA. The connector can accept flexible cables with diameters of up to 3.17 mm (0.125 in.) for a frequency range of up to 7-10 GHz.	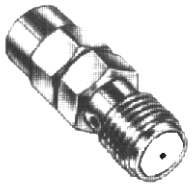 SMC Plug - SMA Jack (Some call this a SMC Jack, even though it has a female connector)
SMB (OSMB) - The SMB is like the SMC except it uses quick disconnect instead of threaded fittings. It is a 50 / 75 Ω connector which operates to 4 GHz with a low reflection coefficient and is useable to 10 GHz.	 SMB Plug (above) SMB Jack
TNC (OST) - The TNC (Threaded Neill-Concelman or threaded Navy Connector) is merely a threaded BNC. The function of the thread is to stop radiation at higher frequencies, so that the connector can work at frequencies up to 12 GHz (to 18 GHz when using semi-rigid cable). It can be 50 or 75 Ω. For size comparison here is a SMA plug - TNC plug 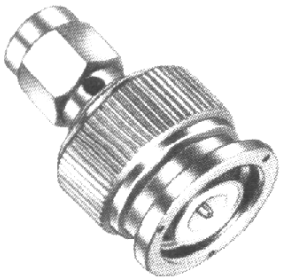	 TNC Plug (above) TNC Jack

Type N (OSN) - The 50 or 75 Ω Type N (Navy) connector was originally designed for military systems during World War II and is the most popular measurement connector for the frequency range of 1 to 11 GHz. The precision 50 Ω APC-N and other manufacturers high frequency versions operate to 18 GHz.

For size comparison here is a picture of Type N plug - TNC jack

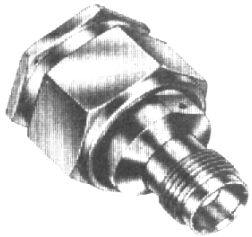

N Plug (above)

N Jack

Note: Always rotate the movable coupling nut of the plug, not the cable or fixed connector, when mating connectors. Since the center pin is stationary with respect to the jack, rotating the jack puts torque on the center pin. With TNC and smaller connectors, the center pin will eventually break off.

An approximate size comparison of these connectors is depicted below (not to scale).

Large ========== Medium ========== Small
SC 7mm N TNC/BNC 3.5mm SMA 2.4mm SSMA SMC

Figure 1 shows the frequency range of several connectors.

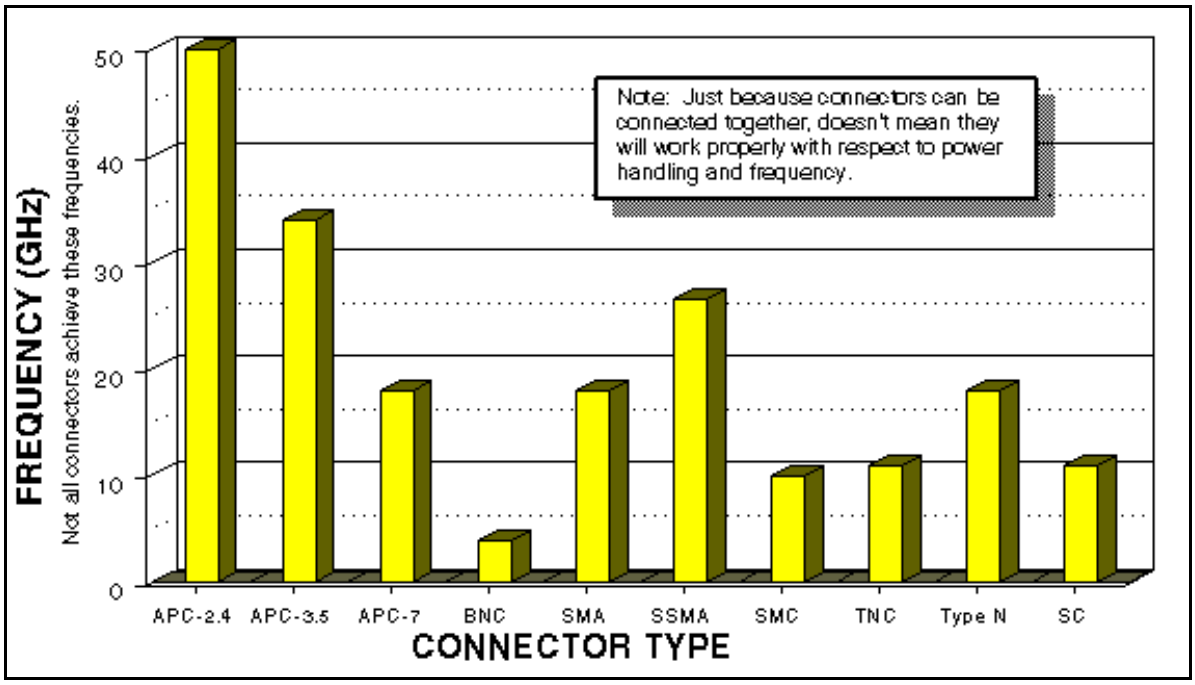

Figure 1. Frequency Range of Microwave Connectors.

POWER DIVIDERS AND DIRECTIONAL COUPLERS

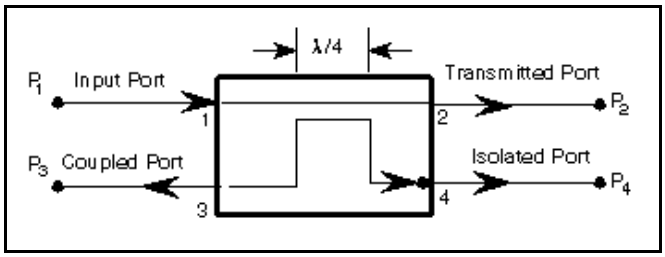

Figure 1. Directional Coupler.

A directional coupler is a passive device which couples part of the transmission power by a known amount out through another port, often by using two transmission lines set close enough together such that energy passing through one is coupled to the other. As shown in Figure 1, the device has four ports: input, transmitted, coupled, and isolated. The term "main line" refers to the section between ports 1 and 2. On some directional couplers, the main line is designed for high power operation (large connectors), while the coupled port may use a small SMA connector. Often the isolated port is terminated with an internal or external matched load (typically 50 ohms). It should be pointed out that since the directional coupler is a linear device, the notations on Figure 1 are arbitrary. Any port can be the input, (as in Figure 3) which will result in the directly connected port being the transmitted port, adjacent port being the coupled port, and the diagonal port being the isolated port.

Physical considerations such as internal load on the isolated port will limit port operation. The coupled output from the directional coupler can be used to obtain the information (i.e., frequency and power level) on the signal without interrupting the main power flow in the system (except for a power reduction - see Figure 2). When the power coupled out to port three is half the input power (i.e., 3 dB below the input power level), the power on the main transmission line is also 3 dB below the input power and equals the coupled power. Such a coupler is referred to as a 90 degree hybrid, hybrid, or 3 dB coupler. The frequency range for coaxial couplers specified by manufacturers is that of the coupling arm. The main arm response is much wider (i.e., if the spec is 2-4 GHz, the main arm could operate at 1 or 5 GHz - see Figure 3). However it should be recognized that the coupled response is periodic with frequency. For example, a λ/4 coupled line coupler will have responses at nλ/4 where n is an odd integer.

Common properties desired for all directional couplers are wide operational bandwidth, high directivity, and a good impedance match at all ports when the other ports are terminated in matched loads. These performance characteristics of hybrid or non-hybrid directional couplers are self-explanatory. Some other general characteristics will be discussed below.

COUPLING FACTOR

The coupling factor is defined as: $\textit{Coupling factor (dB)} = -10 \log \frac{P_3}{P_1}$

where P_1 is the input power at port 1 and P3 is the output power from the coupled port (see Figure 1).

The coupling factor represents the primary property of a directional coupler. Coupling is not constant, but varies with frequency. While different designs may reduce the variance, a perfectly flat coupler theoretically cannot be built. Directional couplers are specified in terms of the coupling accuracy at the frequency band center. For example, a 10 dB coupling ± 0.5 dB means that the directional coupler can have 9.5 dB to 10.5 dB coupling at the frequency band center. The accuracy is due to dimensional tolerances that can be held for the spacing of the two coupled lines. Another coupling specification is frequency sensitivity. A larger frequency sensitivity will allow a larger frequency band of operation. Multiple quarter-wavelength coupling sections are used to obtain wide frequency bandwidth directional couplers. Typically this type of directional coupler is designed to a frequency bandwidth ratio and a maximum coupling ripple within the frequency band. For example a typical 2:1 frequency bandwidth coupler design that produces a 10 dB

coupling with a ±0.1 dB ripple would, using the previous accuracy specification, be said to have 9.6 ± 0.1 dB to 10.4 ± 0.1 dB of coupling across the frequency range.

LOSS

In an ideal directional coupler, the main line loss port 1 to port 2 (P_1 - P_2) due to power coupled to the coupled output port is:

$$Insertion\ loss\ (dB) = 10 \log \left[1 - \frac{P_3}{P_1} \right]$$

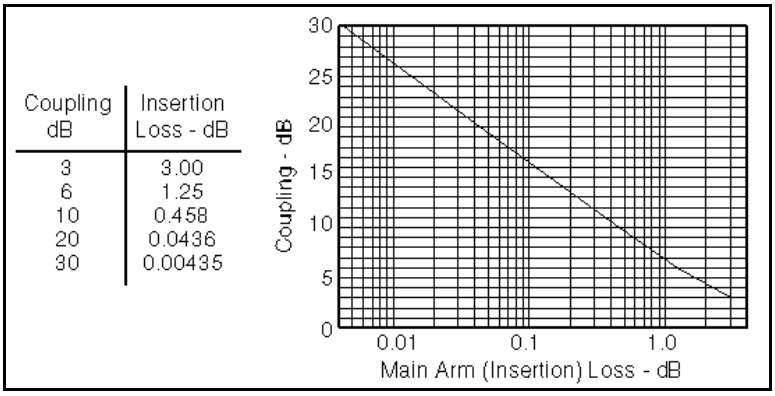

Figure 2. Coupling Insertion Loss.

The actual directional coupler loss will be a combination of coupling loss, dielectric loss, conductor loss, and VSWR loss. Depending on the frequency range, coupling loss becomes less significant above 15 dB coupling where the other losses constitute the majority of the total loss. A graph of the theoretical insertion loss (dB) vs. coupling (dB) for a dissipationless coupler is shown in Figure 2.

ISOLATION

Isolation of a directional coupler can be defined as the difference in signal levels in dB between the input port and the isolated port when the two output ports are terminated by matched loads, or:

$$Isolation\ (dB) = -10 \log \frac{P_4}{P_1}$$

Isolation can also be defined between the two output ports. In this case, one of the output ports is used as the input; the other is considered the output port while the other two ports (input and isolated) are terminated by matched loads.

Consequently: $$Isolation\ (dB) = -10 \log \frac{P_3}{P_2}$$

The isolation between the input and the isolated ports may be different from the isolation between the two output ports. For example, the isolation between ports 1 and 4 can be 30 dB while the isolation between ports 2 and 3 can be a different value such as 25 dB. If both isolation measurements are not available, they can assumed to be equal. If neither are available, an estimate of the isolation is the coupling plus return loss (see VSWR section). The isolation should be as high as possible. In actual couplers the isolated port is never completely isolated. Some RF power will always be present. Waveguide directional couplers will have the best isolation.

If isolation is high, directional couplers are excellent for combining signals to feed a single line to a receiver for two-tone receiver tests. In Figure 3, one signal enters port P_3 and one enters port P_2, while both exit port P_1. The signal from port P_3 to port P_1 will experience 10 dB of loss, and the signal from port P_2 to port P_1 will have 0.5 dB loss. The internal load on the isolated port will dissipate the signal losses from port P_3 and port P_2. If the isolators in Figure 3 are neglected, the isolation measurement (port P_2 to port P_3) determines the amount of power from the signal generator F_2 that will be injected into the signal generator F_1. As the injection level increases, it may cause modulation of signal generator F_1, or even injection phase locking. Because of the symmetry of the directional coupler, the reverse injection will happen with the same possible modulation problems of signal generator F_2 by F_1. Therefore the isolators are used in Figure 3 to effectively increase the isolation (or directivity) of the directional coupler. Consequently the injection loss will be the isolation of the directional coupler plus the reverse isolation of the isolator.

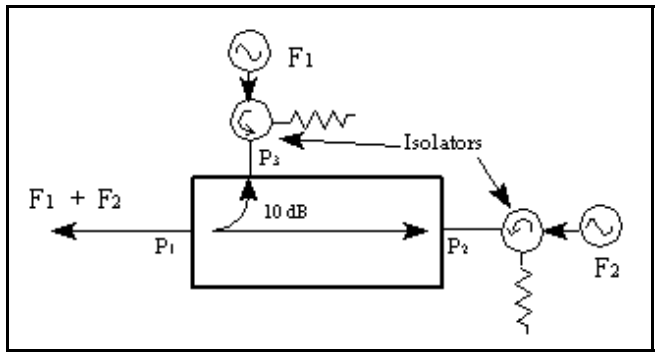

Figure 3. Two-Tone Receiver Tests.

DIRECTIVITY

Directivity is directly related to Isolation. It is defined as:

$$Directivity\ (dB) = -10 \log \frac{P_4}{P_3} = -10 \log \frac{P_4}{P_1} + 10 \log \frac{P_3}{P_1}$$

where: P_3 is the output power from the coupled port and P_4 is the power output from the isolated port.

The directivity should be as high as possible. Waveguide directional couplers will have the best directivity. Directivity is not directly measurable, and is calculated from the isolation and coupling measurements as:

Directivity (dB) = Isolation (dB) - Coupling (dB)

HYBRIDS

The hybrid coupler, or 3 dB directional coupler, in which the two outputs are of equal amplitude takes many forms. Not too long ago the quadrature (90 degree) 3 dB coupler with outputs 90 degrees out of phase was what came to mind when a hybrid coupler was mentioned. Now any matched 4-port with isolated arms and equal power division is called a hybrid or hybrid coupler. Today the characterizing feature is the phase difference of the outputs. If 90 degrees, it is a 90 degree hybrid. If 180 degrees, it is a 180 degree hybrid. Even the Wilkinson power divider which has 0 degrees phase difference is actually a hybrid although the fourth arm is normally imbedded.

Applications of the hybrid include monopulse comparators, mixers, power combiners, dividers, modulators, and phased array radar antenna systems.

AMPLITUDE BALANCE

This terminology defines the power difference in dB between the two output ports of a 3 dB hybrid. In an ideal hybrid circuit, the difference should be 0 dB. However, in a practical device the amplitude balance is frequency dependent and departs from the ideal 0 dB difference.

PHASE BALANCE

The phase difference between the two output ports of a hybrid coupler should be 0, 90, or 180 degrees depending on the type used. However, like amplitude balance, the phase difference is sensitive to the input frequency and typically will vary a few degrees.

The phase properties of a 90 degree hybrid coupler can be used to great advantage in microwave circuits. For example in a balanced microwave amplifier the two input stages are fed through a hybrid coupler. The FET device normally has a very poor match and reflects much of the incident energy. However, since the devices are essentially identical the reflection coefficients from each device are equal. The reflected voltage from the FETs are in phase at the isolated port and are 180° different at the input port. Therefore, all of the reflected power from the FETs goes to the load at the isolated port and no power goes to the input port. This results in a good input match (low VSWR).

If phase matched lines are used for an antenna input to a 180° hybrid coupler as shown in Figure 4, a null will occur directly between the antennas. If you want to receive a signal in that position, you would have to either change the hybrid type or line length. If you want to reject a signal from a given direction, or create the difference pattern for a monopulse radar, this is a good approach.

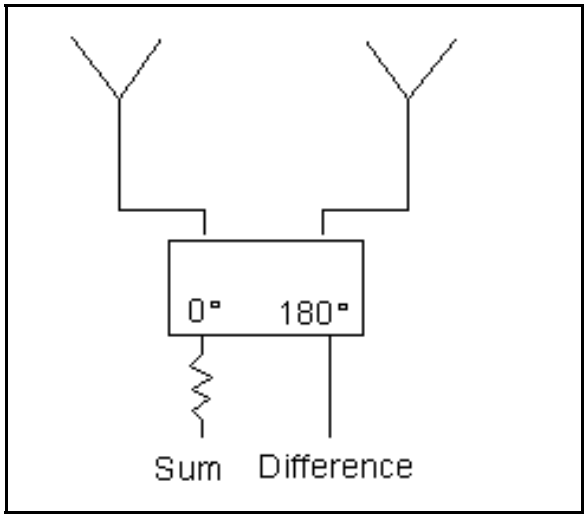

Figure 4. Balanced Antenna Input.

OTHER POWER DIVIDERS

Both in-phase (Wilkinson) and quadrature (90°) hybrid couplers may be used for coherent power divider applications. The Wilkinson's power divider has low VSWR at all ports and high isolation between output ports. The input and output impedances at each port is designed to be equal to the characteristic impedance of the microwave system. A typical power divider is shown in Figure 5. Ideally, input power would be divided equally between the output ports. Dividers are made up of multiple couplers, and like couplers, may be reversed and used as multiplexers. The drawback is that for a four channel multiplexer, the output consists of only 1/4 the power from each, and is relatively inefficient. Lossless multiplexing can only be done with filter networks.

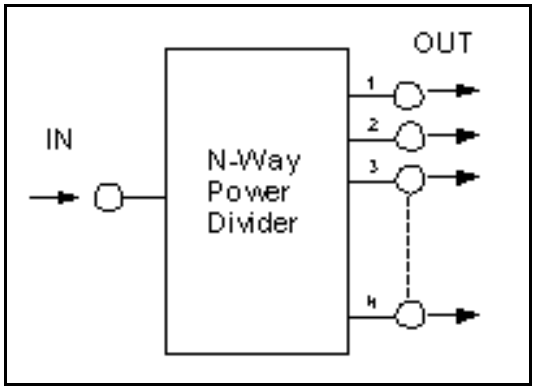

Figure 5. Power Divider.

Coherent power division was first accomplished by means of simple Tee junctions. At microwave frequencies, waveguide tees have two possible forms - the H-Plane or the E-Plane. These two junctions split power equally, but because of the different field configurations at the junction, the electric fields at the output arms are in-phase for the H-Plane tee and are anti-phase for the E-Plane tee. The combination of these two tees to form a hybrid tee allowed the realization of a four-port component which could perform the vector sum (Σ) and difference (Δ) of two coherent microwave signals. This device is known as the magic tee.

POWER COMBINERS

Since hybrid circuits are bi-directional, they can be used to split up a signal to feed multiple low power amplifiers, then recombine to feed a single antenna with high power as shown in Figure 6. This approach allows the use of numerous less expensive and lower power amplifiers in the circuitry instead of a single high power TWT. Yet another approach is to have each solid state amplifier (SSA) feed an antenna and let the power be combined in space or be used to feed a lens which is attached to an antenna. (See Section 3-4.)

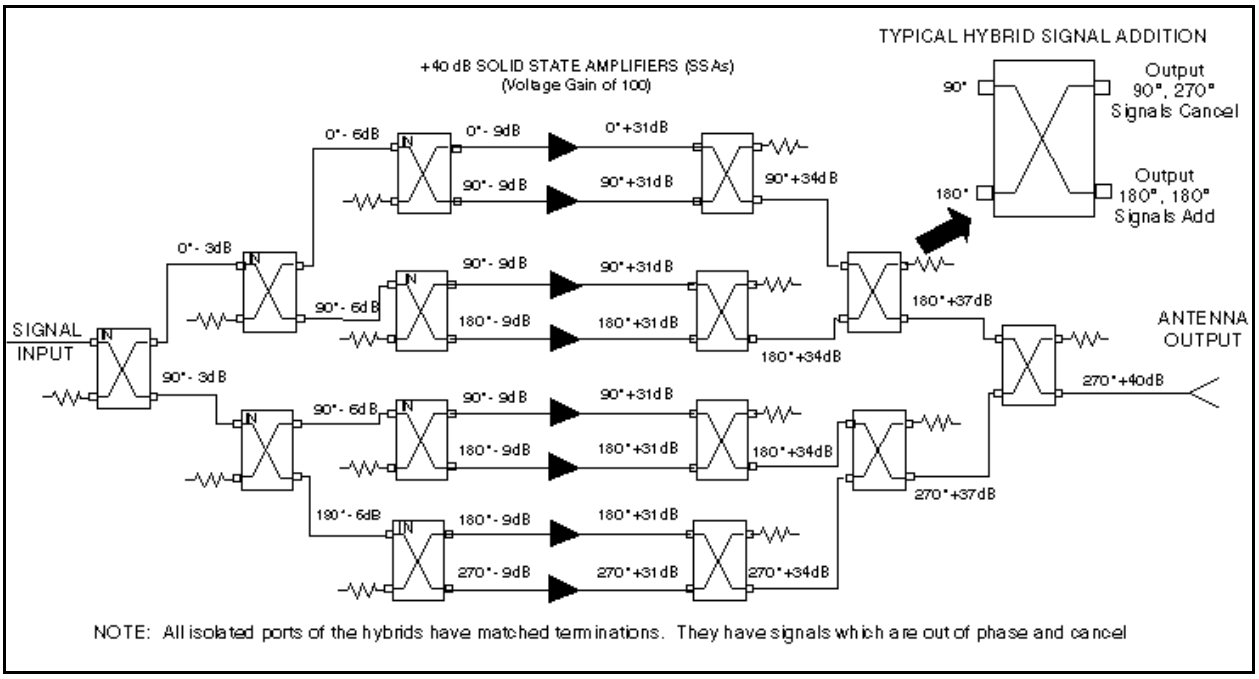

Figure 6. Combiner Network.

<u>Sample Problem:</u>

If two 1 watt peak unmodulated RF carrier signals at 10 GHz are received, how much peak power could one measure?

A. 0 watts

B. 0.5 watts

C. 1 watt

D. 2 watts

E. All of these

The answer is all of these as shown in Figure 7.

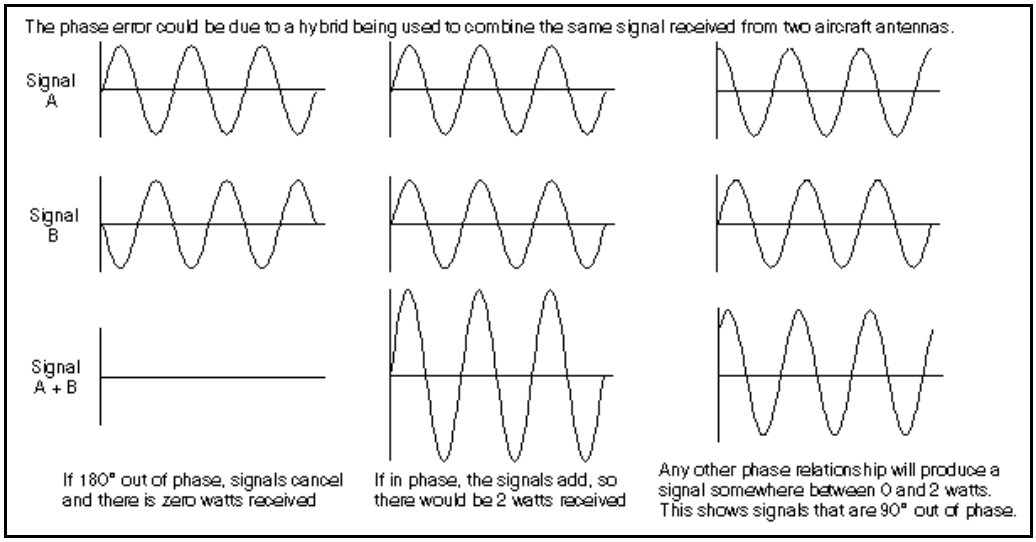

Figure 7. Sine Waves Combined Using Various Phase Relationships.

ATTENUATORS / FILTERS / DC BLOCKS

ATTENUATORS

An attenuator is a passive microwave component which, when inserted in the signal path of a system, reduces the signal by a specified amount. They normally possess a low VSWR which makes them ideal for reducing load VSWR in order to reduce measurement uncertainties. They are sometimes used simply to absorb power, either to reduce it to a measurable level, or in the case of receivers to establish an exact level to prevent overload of following stages.

Attenuators are classified as either fixed or variable and either reflective or non-reflective. The fixed and variable attenuators are available in both waveguide and coaxial systems. Most of the receivers under 20 GHz use coaxial type attenuators.

FIXED

The performance characteristics of a fixed attenuator are:

1. input and output impedances
2. flatness with frequency
3. average and peak power handling capability
4. temperature dependence

VARIABLE

The variable attenuator can be subdivided into two kinds: step attenuator and continuously variable attenuator. In a step attenuator, the attenuation is changed in steps such as 10 dB, 1 dB or 0.5 dB. In a continuously variable attenuator, the attenuation is changed continuously and a dial is usually available to read the attenuation either directly or indirectly from a calibration chart.

For a variable attenuator, additional characteristics should be considered, such as:

1. amount or range of attenuations
2. insertion loss in the minimum attenuation position
3. incremental attenuation for step attenuator
4. accuracy of attenuation versus attenuator setting
5. attenuator switching speed and switching noise.

REFLECTIVE

A reflective attenuator reflects some portion of the input power back to the driving source. The amount reflected is a function of the attenuation level. When PIN diodes are zero or reverse biased, they appear as open circuits when shunting a transmission line. This permits most of the RF input power to travel to the RF output. When they are forward biased, they absorb some input, but simultaneously reflect some back to the input port. At high bias current, most RF will be reflected back to the input resulting in a high input VSWR and high attenuation.

ABSORPTIVE

The VSWR of a non-reflective (absorptive) PIN diode attenuator remains good at any attenuation level (bias state). This is accomplished by configuring the diodes in the form of a Pi network that remains matched for any bias state or by use of a 90° hybrid coupler to cancel the waves reflected to the input connector.

MICROWAVE FILTERS

INTRODUCTION

Microwave filters are one of the most important components in receivers. The main functions of the filters are: (1) to reject undesirable signals outside the filter pass band and (2) to separate or combine signals according to their frequency. A good example for the latter application is the channelized receiver in which banks of filters are used to separate input signals. Sometimes filters are also used for impedance matching. Filters are almost always used before and after a mixer to reduce spurious signals due to image frequencies, local oscillator feedthrough, and out-of-frequency band noise and signals. There are many books which are devoted to filter designs. There are many kinds of filters used in microwave receivers, so it is impossible to cover all of them.

If a filter is needed on the output of a jammer, it is desirable to place it approximately half way between the jammer and antenna vs. adjacent to either. The transmission line attenuation improves the VSWR of the filter at the transmitter. This may allow use of a less expensive filter, or use of a reflective filter vs. an absorptive filter.

A filter is a two-port network which will pass and reject signals according to their frequencies. There are four kinds of filters according to their frequency selectivities. In the examples that follow, f_L = low frequency, f_M = medium frequency, and f_H = high frequency. Their names reflect their characteristics, and they are:

1. A low-pass filter which passes the low frequency signals below a predetermined value as shown in Figure 1.

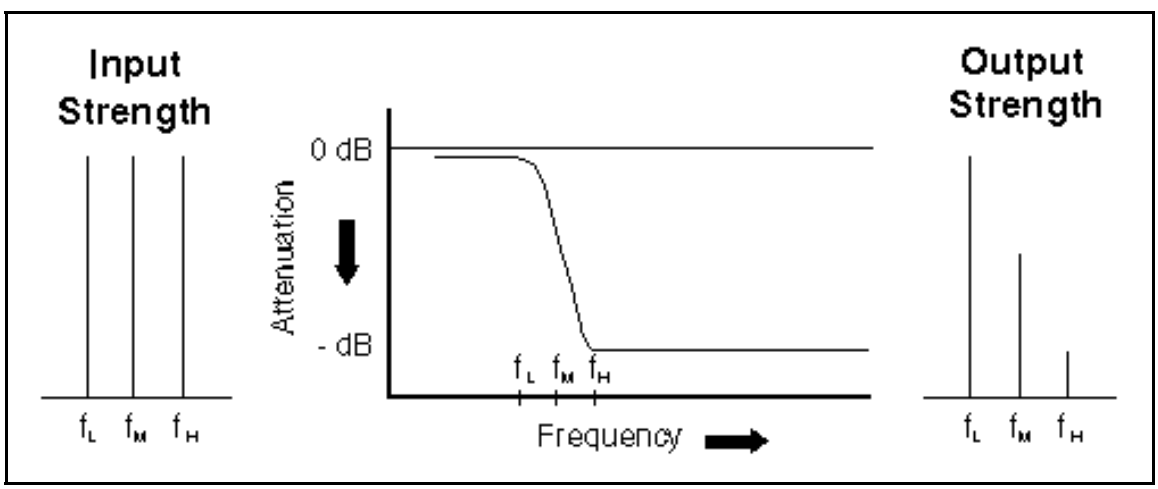

Figure 1. Low-Pass Filter.

2. A high-pass filter which passes the high frequency signals above a predetermined value as in Figure 2.

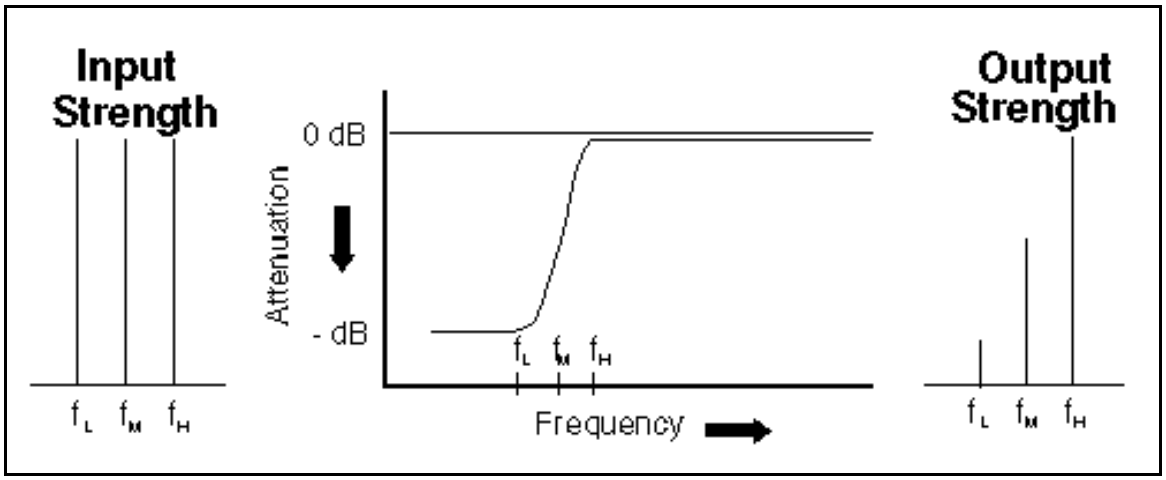

Figure 2. High-Pass Filter.

3. A band-pass filter which passes signals between two predetermined frequencies as shown in Figure 3.

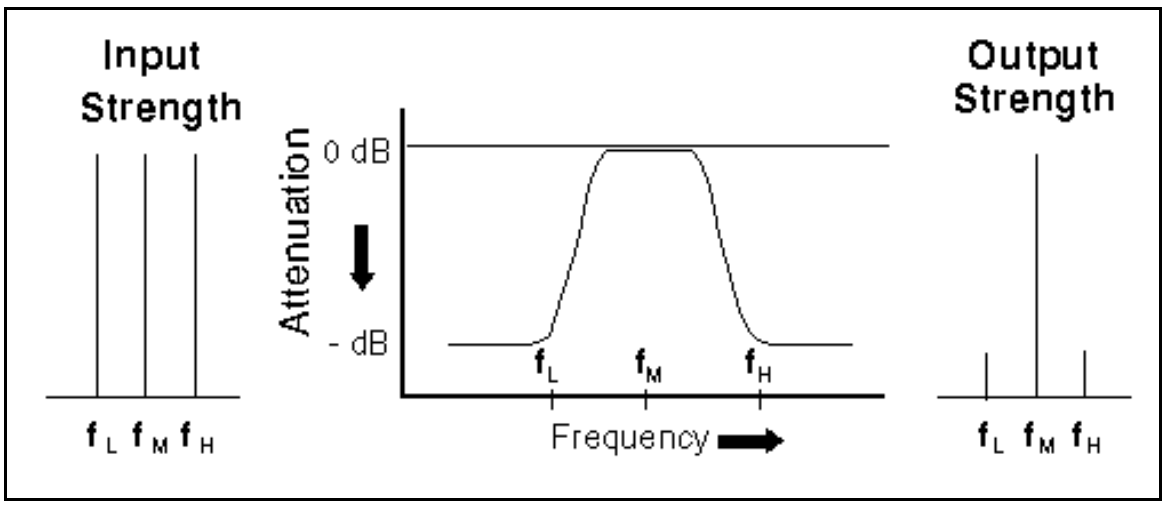

Figure 3. Band-Pass Filter.

A band-pass filter with different skirt slopes on the two sides of the pass band is sometimes referred to as an asymmetrical filter. In this filter the sharpness of the rejection band attenuation is significantly different above and below the center frequency. One additional note regarding band-pass filters or filters in general, their performance should always be checked in the out-of-band regions to determine whether or not they possess spurious responses. In particular they should be checked at harmonics of the operating frequency.

4. A band reject filter (sometimes referred to as a bandstop or notch filter) which rejects signals between two predetermined frequencies such as high power signals from the aircraft's own radar as shown in Figure 4.

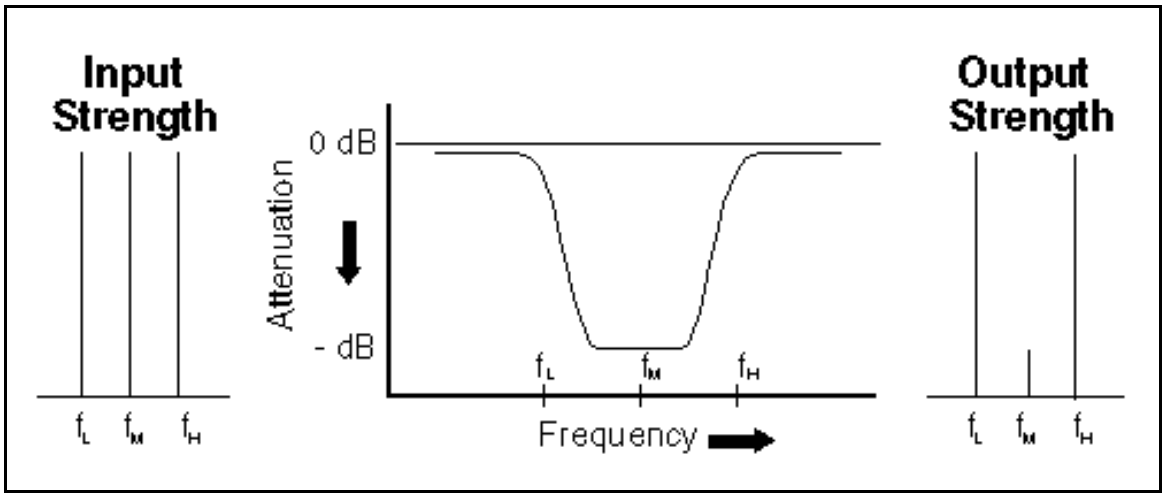

Figure 4. Band-Reject Filter.

In general, filters at microwave frequencies are composed of resonate transmission lines or waveguide cavities that, when combined, reflect the signal power outside the filter frequency pass band and provide a good VSWR and low loss within the frequency pass band. As such, specifications for filters are maximum frequency, pass band loss, VSWR, and rejection level at a frequency outside of the pass band. The trade-offs for filters are a higher rejection for a fixed frequency pass band or a larger frequency pass band for a fixed rejection, which requires a filter with more resonators, which produce higher loss, more complexity, and larger size.

DC BLOCKS

DC Blocks are special connectors which have a capacitor (high pass filter) built into the device. There are three basic types:

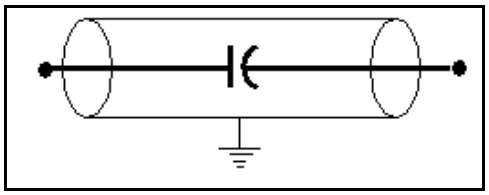

Figure 5. Inside DC Block.

1. INSIDE - The high pass filter is in series with the center conductor as shown in Figure 5. DC is blocked on the center conductor.

2. OUTSIDE - The high pass filter is in series with the cable shield as shown in Figure 6.

3. INSIDE/OUTSIDE - A high pass arrangement is connected to both the inner and outer conductors.

DC Blocks are ideal for filtering DC, 60 Hz, and 400 Hz from the RF line.

In general, capacitors with a large value of capacitance do not have the least loss at microwave frequencies. Also, since capacitance is proportional to size, a large size produces more capacitance with more inductance. Because of these reasons, D.C. blocks are typically available with a high pass frequency band starting in the region of 0.1 to 1 GHz.

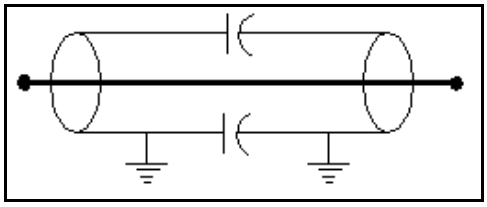

Figure 6. Outside DC Block.

TERMINATIONS / DUMMY LOADS

A termination is a one-port device with an impedance that matches the characteristic impedance of a given transmission line. It is attached to a certain terminal or port of a device to absorb the power transmitted to that terminal or to establish a reference impedance at that terminal. Important parameters of a termination are its VSWR and power handling capacity. In a receiver, terminations are usually placed at various unconnected ports of components such as hybrid and power dividers to keep the VSWR of the signal path low. It is extremely important that the isolated port in a directional coupler and the unused port of a power divider (i.e., only three ports of a four-way power divider are used) be properly terminated. All of the design considerations of directional couplers and power dividers are based on the fact that all ports are terminated with matched loads. If an unused port is not properly terminated, then the isolation between the output ports will be reduced which may severely degrade the performance of the receiver.

A termination is the terminology used to refer to a low power, single terminal device intended to terminate a transmission line. Similar devices designed to accommodate high power are generally termed dummy loads.

TERMINATIONS

Terminations are employed to terminate unconnected ports on devices when measurements are being performed. They are useful as dummy antennas and as terminal loads for impedance measurements of transmission devices such as filters and attenuators.

The resistive elements in most terminations are especially fabricated for use at microwave frequencies. Two types are commonly employed: (1) resistive film elements, and (2) molded resistive tapers. The resistive film is very thin compared to the skin depth and normally very short relative to wavelength at the highest operating frequency. The molded taper consists of a dissipative material evenly dispersed in a properly cured dielectric medium. Both forms of resistive elements provide compact, rugged terminations suitable for the most severe environmental conditions with laboratory stability and accuracy.

Terminations should be properly matched to the characteristic impedance of a transmission line. The termination characteristics of primary concern are:

a. operating frequency range
b. average power handling capability
c. operating temperature range
d. VSWR
e. size
f. weight

Many microwave systems employ directional couplers which require terminations on at least one port, and most have various modes of operation or test where terminations are needed on certain terminals.

A matched termination of a generalized transmission line is ideally represented by an infinite length of that line having small, but non-zero loss per unit length so that all incident energy is absorbed and none is reflected.

Standard mismatches are useful as standards of reflection in calibrating reflectometer setups and other impedance measuring equipment. They are also used during testing to simulate specific mismatches which would be encountered on the terminals of components once the component is installed in the actual system.

The following table shows common mismatches with the impedance that can provide the mismatch.

Common Mismatches (Z_O = 50 Ω)		
Ratio	Z_L (higher)	Z_L (lower)
1.0 : 1	50 Ω (matched)	50 Ω (matched)
1.25 : 1	62.5 Ω	40 Ω
1.50 : 1	75 Ω	33.3 Ω
2.00 : 1	100 Ω	25 Ω

DUMMY LOADS

A dummy load is a high power one port device intended to terminate a transmission line. They are primarily employed to test high power microwave systems at full power capacity. Low power coaxial loads are generally termed terminations and typically handle one watt or less.

Most radars or communications systems have a dummy load integrated into them to provide a non-radiating or EMCON mode of operation, or for testing (maintenance).

Three types of dissipative material are frequently employed in dummy loads: (1) lossy plastic, (2) refractory, and (3) water.

The lossy plastic consists of particles of lossy material suspended in plastic medium. This material may be designed to provide various attenuations per unit length but is limited as to operating temperature. It is employed primarily for low power applications.

The refractory material is a rugged substance that may be operated at temperatures up to 1600°F. It is virtually incapable of being machined by ordinary means but is often fabricated through diamond wheel grinding processes. Otherwise material must be fired in finished form. Such material is employed in most high power applications.

The dissipative properties of water are also employed for dummy load applications. Energy from the guide is coupled through a leaky wall to the water which flows alongside the main guide. Water loads are employed for extremely high power and calorimetric applications.

While dummy loads can operate over full waveguide bands, generally a more economical unit can be manufactured for use over narrower frequency ranges.

The power rating of a dummy load is a complex function dependent upon many parameters, including average and peak power, guide pressure, external temperature, guide size, air flow, and availability of auxiliary coolant. The average and peak powers are interrelated in that the peak power capacity is a function of the operating temperature which in turn is a function of the average power.

CIRCULATORS AND DIPLEXERS

A microwave circulator is a nonreciprocal ferrite device which contains three or more ports. The input from port n will come out at port n + 1 but not out at any other port. A three-port ferrite junction circulator, usually called the Y-junction circulator, is most commonly used. They are available in either rectangular waveguide or strip- line forms. The signal flow in the three-port circulator is assumed as 1→2, 2→3, and 3→1 as shown in Figure 1.

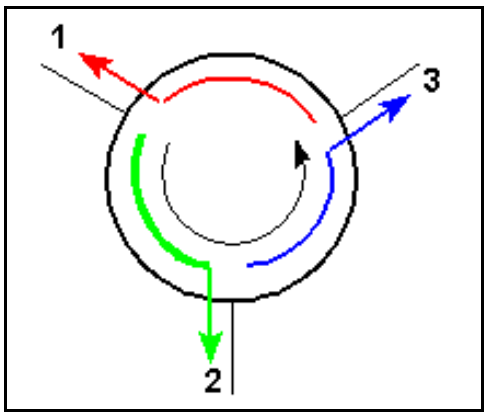

Figure 1. Symbolic Expression for a Y-Junction Circulator.

If port 1 is the input, then the signal will come out of port 2; in an ideal situation, no signal should come out of port 3 which is called the isolated port. The insertion loss of the circulator is the loss from 1 to 2, while the loss from 1 to 3 is referred to as isolation. A typical circulator will have a few tenths of a dB insertion loss from port 1 to 2 and 20 dB of isolation from port 1 to 3 for coaxial circulators (30 dB or more for waveguide circulators). When the input is port 2, the signal will come out of port 3 and port 1 is the isolated port. Similar discussions can be applied to port 3.

> Since circulators contain magnets, they should not be mounted near ferrous metals since the close proximity of metals like iron can change the frequency response.

As shown in Figure 2, if one port of a circulator is loaded, it becomes an isolator, i.e., power will pass from ports one to two, but power reflected back from port two will go to the load at port three versus going back to port one.

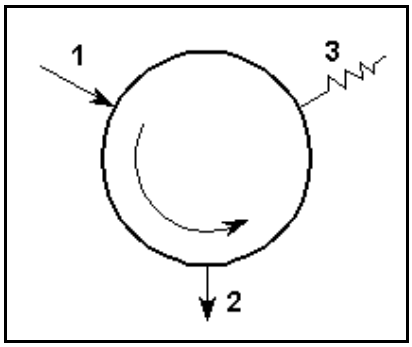

Figure 2. Isolator From A Circulator.

As shown in Figure 3 this circulator is made into a diplexer by adding a high pass filter to port two. Frequencies from port one that are below 10 GHz will be reflected by port two. Frequencies above 10 GHz will pass through port two. At the 10 GHz crossover frequency of the diplexer, a 10 GHz signal will be passed to both ports two and three but will be half power at each port. Diplexers or triplexers (one input and three output bands), must be specifically designed for the application.

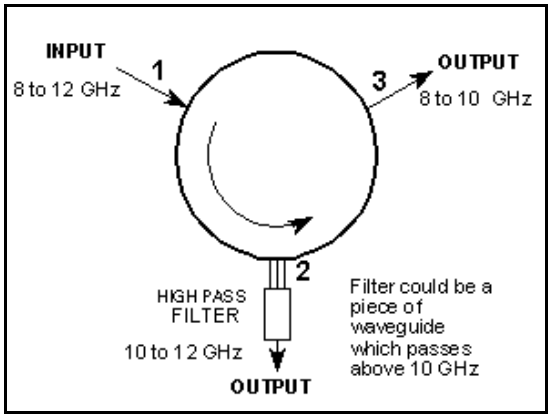

Figure 3. Diplexer From A Circulator.

Another useful device is the 4-port Faraday Rotator Circulator shown symbolically in Figure 4. These waveguide devices handle very high power and provide excellent isolation properties. It is useful when measurements must be made during high power application as shown. A water load is used to absorb the high power reflections so that a reasonable power level is reflected to the receiver or measurement port.

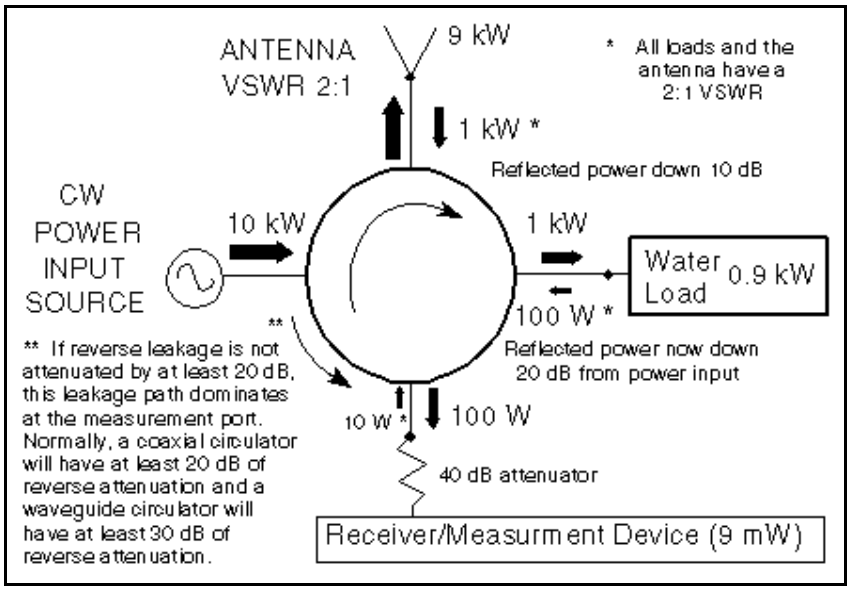

Figure 4. Faraday Rotator Circulator.

<u>The Maximum Input Power to a Measurement Device</u> - The ideal input to a measurement device is in the 0 to 10 dBm (1 to 10 mW) range. Check manufacturer's specification for specific maximum value.

If the RF transmission lines and their components (antenna, hybrid, etc.) can support the wider frequency range, circulators could be used to increase the number of interconnecting RF ports from two as shown in Figure 5, to four as shown in Figure 6. Figure 7 shows an alternate configuration using diplexers which could actually be made from circulators as shown previously in Figure 3.

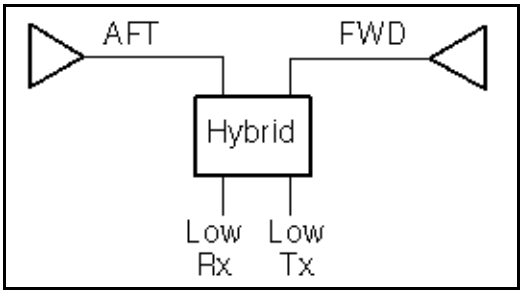

Figure 5. Low Band Configuration.

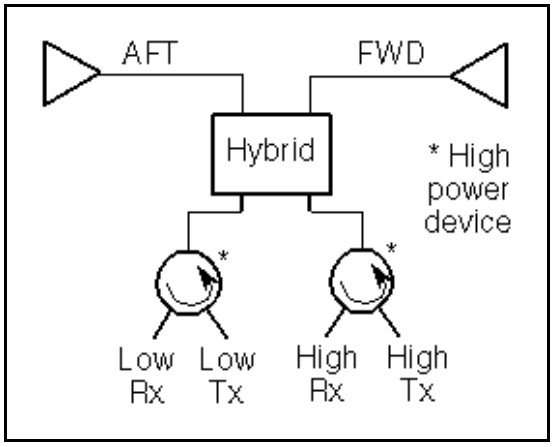

Figure 6. Low/High Band Configuration.

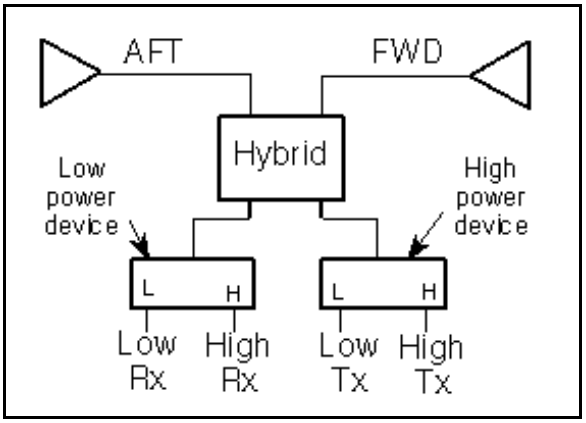

Figure 7. Alternate Low/High Band Configuration.

MIXERS AND FREQUENCY DISCRIMINATORS

Mixers are used to convert a signal from one frequency to another. This is done by combining the original RF signal with a local oscillator (LO) signal in a non-linear device such as a Schottky-barrier diode.

The output spectrum includes:

- The original inputs, LO and RF
- All higher order harmonics of LO and RF
- The two primary sidebands, LO ± RF (m,n = 1)
- All higher order products of mLO ± nRF (where m,n are integers)
- A DC output level

The desired output frequency, commonly called the intermediate frequency (IF), can be either the lower (LO-RF) or upper (LO+RF) sideband. When a mixer is used as a down converter, the lower sideband is the sideband of interest.

A microwave balanced mixer makes use of the 3 dB hybrid to divide and recombine the RF and LO inputs to two mixing diodes. The 3 dB hybrid can be either the 90° or 180° type. Each has certain advantages which will be covered later. The critical requirement is that the LO and RF signals be distributed uniformly (balanced) to each mixer diode.

Figure 1 is a typical balanced mixer block diagram. The mixer diodes are reversed relative to each other; the desired frequency (IF) components of each diode are then in-phase while the DC outputs are positive and negative respectively.

The two diode outputs are summed in a tee where the DC terms cancel and only the desired IF component exists at the IF port.

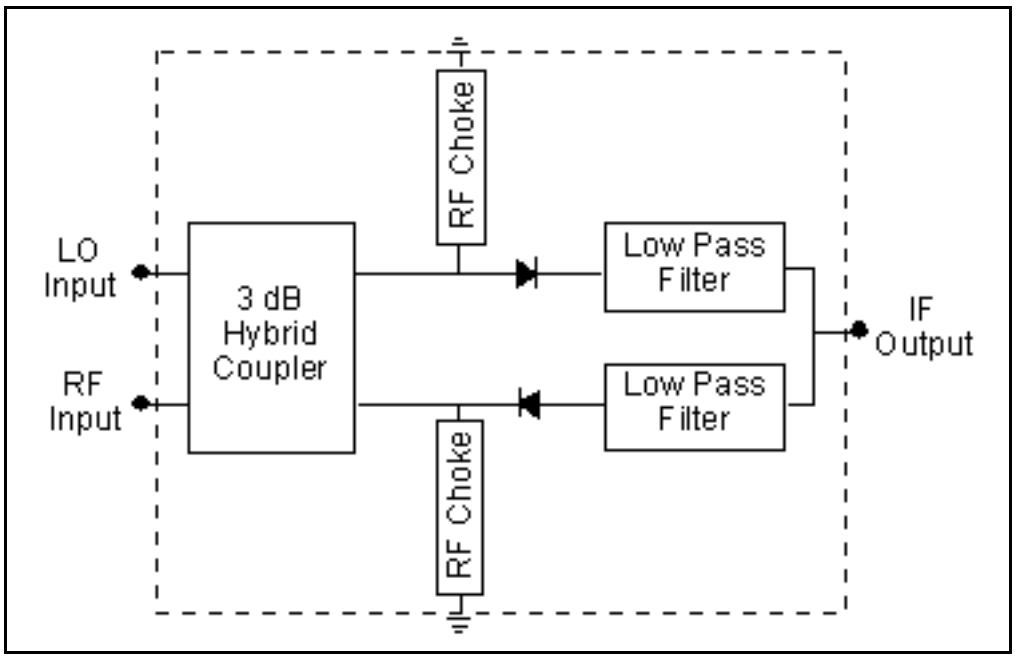

Figure 1. Mixer Block Diagram.

Other types of mixers exist, including the double-balanced mixer, and the Ortho-Quad® (quadrature fed dual) mixer. The relative advantages and disadvantages of each of the four types are summarized in Table 1.

Table 1. Mixer Comparison.

Mixer Type	VSWR [1]	Conversion Loss [2]	LO/RF Isolation [3]	Harmonic Suppression [4]	Dynamic Range	IF Bandwidth
90° Hybrid	good	lowest	poor	poor-fair	high	wide
180° Hybrid	poor	low	good	good	high	wide
Double-Balanced	poor	low	Very good -excellent	very good	high	extremely wide
Ortho Quad	good	low	very good	fair	high	wide

NOTES:
(1) Poor = 2.5:1 typical; Good = 1.3:1 typical
(2) Conversion loss: lowest: 5-7 dB typical; Low 7-9 dB typical
(3) Poor: 10 dB typical; Good: 20 dB typical; Very Good: 25-30 dB typical; Excellent: 35-40 dB typical
(4) Poor: partial rejection of LO/RF even harmonics
Fair: slightly better
Good: can reject all LO even harmonics
Very Good: can reject all LO and RF even harmonics

Used in various circuits, mixers can act as modulators, phase detectors, and frequency discriminators.

The phase discriminators can serve as a signal processing network for systems designed to monitor bearing, polarization, and frequency of AM or FM radiated signals.

A frequency discriminator uses a phase discriminator and adds a power divider and delay line at the RF input as shown in Figure 2. The unknown RF signal "A" is divided between a reference and delay path. The differential delay (T) creates a phase difference (θ) between the two signals which is a linear function of frequency (f) and is given by $\theta = 2\pi fT$.

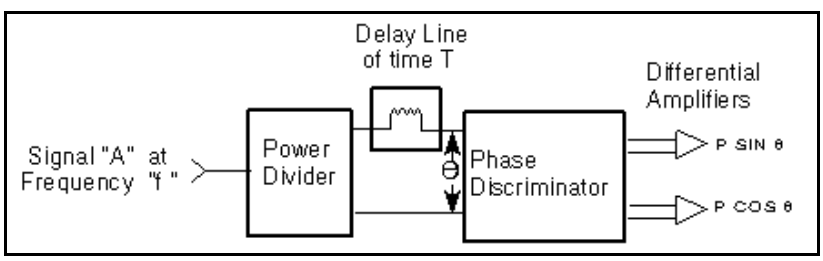

Figure 2. Frequency Discriminator.

When the two output signals are fed to the horizontal and vertical input of an oscilloscope, the resultant display angle will be a direct function of frequency.

DETECTORS

A detector is used in receiver circuits to recognize the presence of signals. Typically a diode or similar device is used as a detector. Since this type of detector is unable to distinguish frequency, they may be preceded by a narrow band-pass filter.

A typical simplistic circuit is shown in Figure 1.

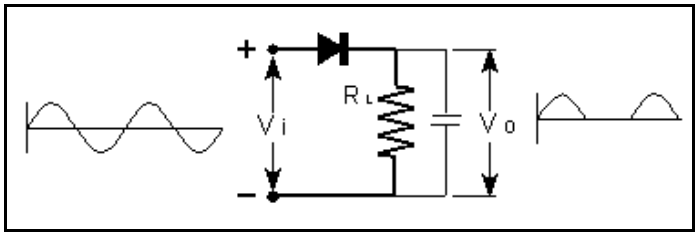

Figure 1. Typical Diode Detector Circuit.

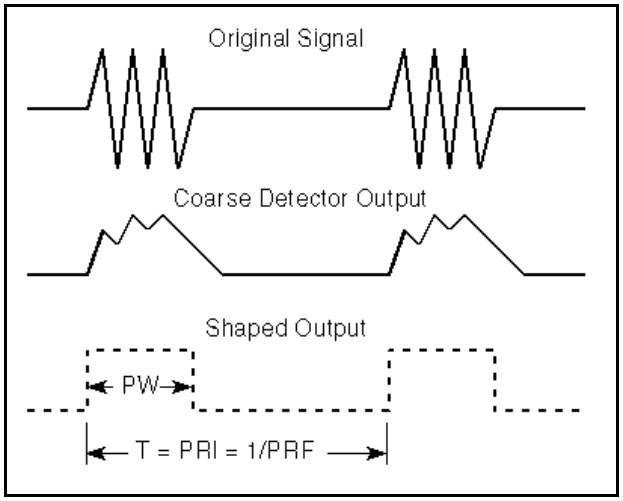

Figure 2. Demodulated Envelope Output.

To integrate a pulse radar signal, we can add capacitance to the circuit in parallel with the output load R_L to store energy and decrease the bleed rate. Figure 2 shows a typical input/output waveform which detects the envelope of the pulse radar signal. From this information pulse width and PRF characteristics can be determined for the RWR UDF comparison.

When the diode is reverse biased, very little current passes through unless the reverse breakdown voltage is exceeded. When forward biased and after exceeding the cut-in voltage, the diode begins to conduct as shown in Figure 3. At low voltages, it first operates in a square law region. Detectors operating in this region are known as small signal type. If the voltage is higher, the detector operates in a linear region, and is known as the large signal type.

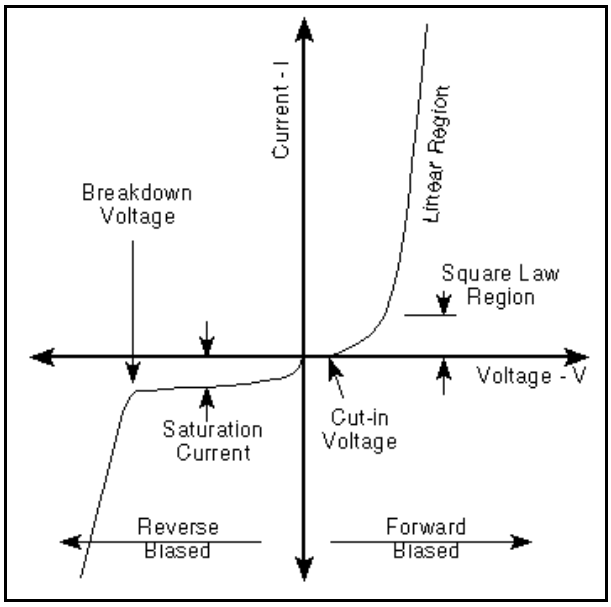

Figure 3. Diode Electrical Characteristics.

The power/voltage characteristics for a typical diode detector is shown in Figure 4.

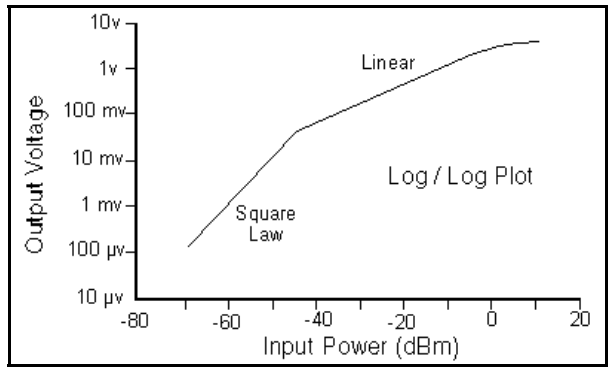

Figure 4. Diode Power/Voltage Characteristic.

Square Law Detector

In the square law region, the output voltage V_o is proportional to the square of the input voltage V_i, thus V_o is proportional to the input power.

$$V_o = nV_i^2 = nP_i \quad \text{or} \quad P_i \propto V_o$$

Where n is the constant of proportionality

Linear Detector

In the linear detection region, the output voltage is given by:

$$V_o = mV_i \quad \text{and since } P=V^2/R, \quad P_i \propto V_o^2$$

Where m is the constant of proportionality

Log Detector Amplifier

Another type of detector arrangement is the Log detector amplifier circuit shown in Figure 5. It is formed by using a series of amplifiers and diode detectors. Due to the nature of the amplifier/diode characteristics, the output voltage is related to the power by:

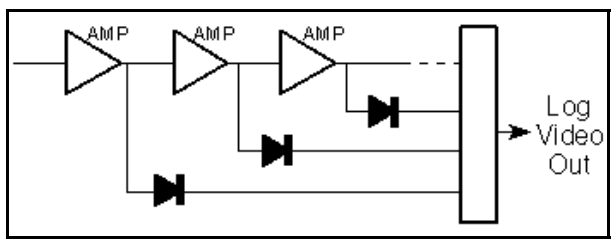

Figure 5. Log Detector.

$$P_i \propto 10^{pVo+q}$$

Where p and q are constants of proportionality

The Log detector has good range, but is hampered by large size when compared to a single diode detector.

Pulse Width Measurements

If the pulse width of a signal was specified at the one-half power point, the measurements of the detected signal on an oscilloscope would vary according to the region of diode operation. If the region of operation is unknown, a 3 dB attenuator should be inserted in the measurement line. This will cause the power to decrease by one-half. The (temporary) peak amplitude on the oscilloscope becomes the amplitude reference point for measuring the pulse width when the external 3 dB attenuator is removed.

These voltage levels for half power using the three types of detectors are shown in Table 1.

Table 1. Detector Characteristics.

	Square Law	Linear	Log
Output Voltage When Input Power is reduced by Half (3 dB)	0.5 V_{in}	0.707 V_{in}	A very small value. ~ 0.15 V_{in} for typical 5 stage log amplifier
Sensitivity & Dynamic Range	Good sensitivity Small dynamic range	Less sensitivity Greater dynamic range	Poorest sensitivity Greatest dynamic range (to 80 dB)

Also see the Microwave Measurements section subsection entitled "Half Power or 3 dB Measurement Point."

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RF / MICROWAVE AMPLIFIERS

An amplifier is one of the most essential and ubiquitous elements in modern RF and microwave systems. Fundamentally, an amplifier is a type of electronic circuit used to convert low-power signals into ones of significant power. The specific requirements for amplification are as varied as the systems where they are used. Amplifiers are realized using a wide range of different technologies, and are available in many form factors. While the performance of an amplifier can be measured by wide range of attributes, several important ones include: gain, power added efficiency (PAE), input and output return loss, 1-dB compression point (P_{1dB}), stability, linearity, intermodulation distortion, and noise figure.

Traveling Wave Tubes (TWTs)

A traveling-wave tube (TWT) is a specialized vacuum tube used in electronics to amplify radio frequency (RF) signals to very high power. A TWT is a component of an electronic assembly known as a traveling-wave tube amplifier (TWTA), often pronounced "Tweet-uh." While trades between these parameters exist, modern TWTAs are capable of providing very high gains (>50 dB), multiple octaves of bandwidth, high efficiency, and output powers that range from tens to thousands of watts. Pulsed TWTAs can reach even higher output powers. Figure 1 presents a simplified diagram of a helix-type TWT.

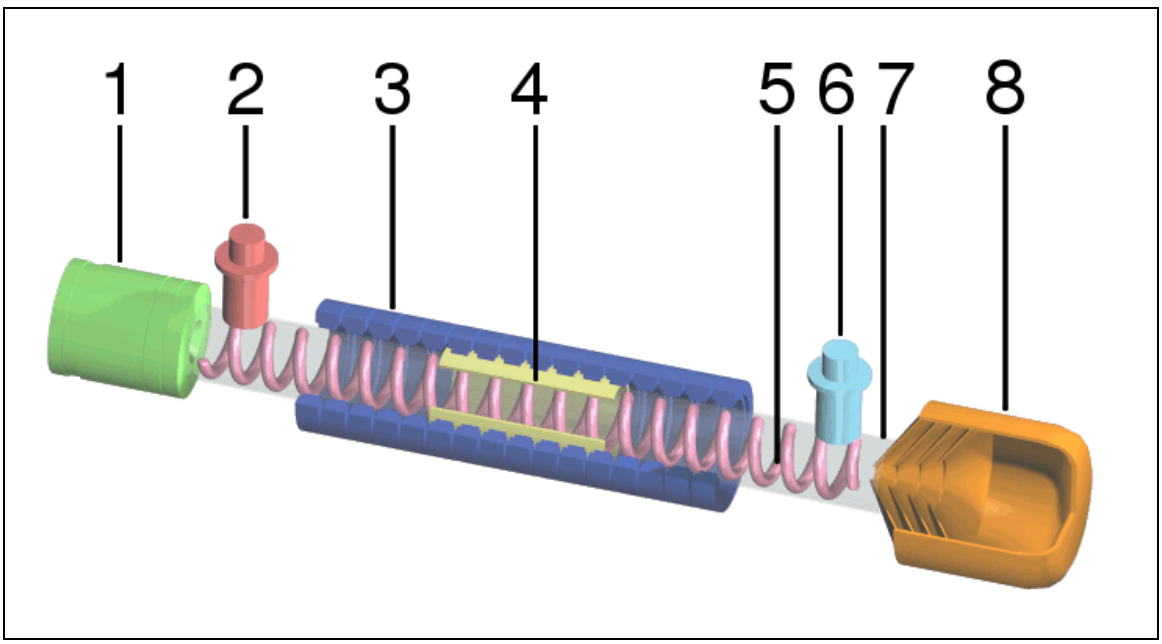

Figure 1. Cutaway view of a helix TWT.
(1) Electron gun; (2) RF input; (3) Magnets; (4) Attenuator;
(5) Helix coil; (6) RF output; (7) Vacuum tube; (8) Collector.
Reproduced from Wikipedia.

The device is an elongated vacuum tube with an electron gun (a heated cathode that emits electrons) at one end. A solenoid coil wrapped around the tube creates a magnetic field which focuses the electrons into a beam, which then passes down the middle of a wire helix that stretches the length of the tube, finally striking a collector at the other end. An input signal is coupled into the helix near the emitter, is amplified by the electron beam as it travels down the length of the tube, and the amplified signal is coupled to an external port near the collector.

The helix, which acts as a RF transmission line, delays the signal to near the same propagation speed as the electron beam. The speed at which the electromagnetic wave travels down the tube can be varied by changing the number or diameter of the turns in the helix. While propagating along the tube, the EM wave interacts with the electron beam. Since the electromagnetic wave effectively propagates slower than the electron beam, the electrons "bunch up" and modulate the input signal, giving up energy in the process - an effect known as velocity modulation. Thus, the traveling wave progressively grows in amplitude as it propagates down the tube towards the collector.

Figure 2 features a photo of a high voltage power supply and TWT.

Figure 2. TWTA Including High Voltage Power Supply (top) and TWT (bottom).

Historically, TWTAs have been used in satellite transponders, radars, and in electronic warfare and self-protection systems. Recently, with the advent of wideband, high power solid-state amplifier solutions, however, TWTAs are slowly being replaced due to the higher reliability of their solid state counterparts.

Microwave Power Modules (MPMs)

A Microwave Power Module (MPM) is a hybrid solution between solid-state and vacuum tube electronics, which aims to take advantage of the best features of both technologies. They feature a solid-state pre-amplifier, miniaturized TWTA, and a high-density power supply, all integrated into a unit much more compact and lightweight than the traditional TWTA. While MPMs generally don't provide as much power as their larger TWTA counterparts, their lighter weight, compact form factor, and relaxed power supply requirements (often 28 VDC or 270 VDC) enable use in applications where a TWTA would not be possible.

Similar to TWTAs, MPMs are capable of providing very high gains (>50 dB), multiple octaves of bandwidth, high efficiency. Typical power levels range from tens to hundreds of watts, with ~1 kW capability for pulsed MPMs.

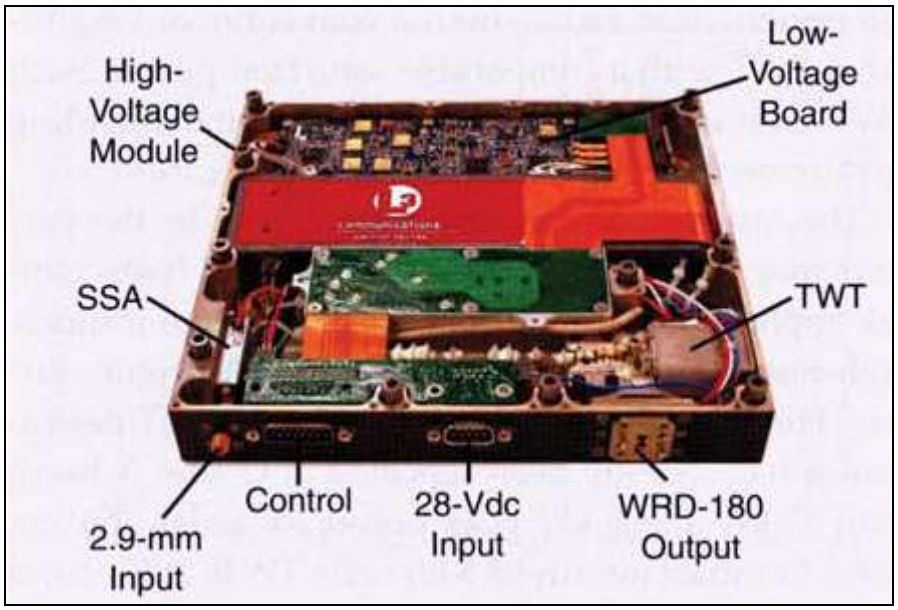

Figure 3. 40W Ka-band MPM With Components Identified.
Image from *IEEE Magazine*, December 2009, page 42.

They have found applications in phased array antennas, lower-power radar transmitters, satellite communications, EW systems, and UAVs.

Solid State

Solid-state electronics, including amplifiers, are built entirely from solid materials and in which the electrons, or other charge carriers, are confined entirely within the solid material. The building material is most often a crystalline semiconductor. Solid-state power amplifiers, or SSPAs, are fabricated on many different semiconductor technologies, some of which include GaAs, GaN, InP, SiGe, CMOS. A photo of a GaN SSPA is presented in Figure 4.

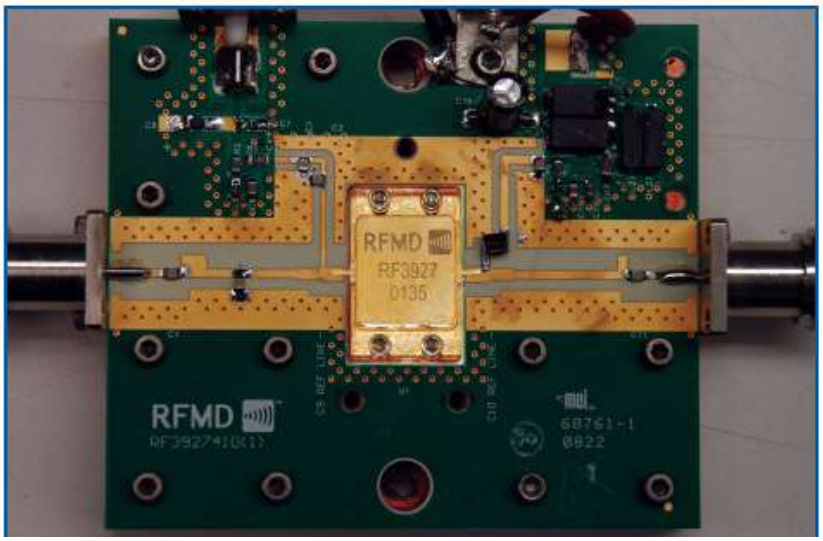

Figure 4. Typical SSPA. Note the GaN die and external impedance matching networks.

In general, SSPAs are heralded as having a higher reliability than TWTAs. While high power SSPAs are available on the market, achieving high efficiency has been a challenge as many amplifier stages often need to be combined to meet to achieve power levels in the tens to hundreds of watts. Multi-stage designs increase size, weight, and power (SWAP) and decrease PAE (due to ohmic losses in the combining networks), which is one reason why TWTs and MPMs still provide excellent alternatives for medium to high power applications.

Below is a table that attempts to compare and contrast different solid-state technologies in the context of microwave networks and amplifiers. It is by no means complete, but provides a general overview.

Table 1. Comparison Between Different Semiconductor Process Technologies.

Technology	Advantages	Disadvantages
Silicon variants (CMOS, SiGe)	• Cheapest substrate due to CPU industry • Can be fabricated with nanometer accuracy	• Not a good overall microwave substrate • Results in lossy, high noise figure, low power components • Crystal is fragile • Junction temperatures limited to ~110C
Indium Phosphide Variants (InP/InGaP)	• High performance at low voltage • Good thermal stability • Results in high efficiency PAs, particularly at lower operating voltage • Extremely low noise figure • Useful through W-band and beyond	• Less mature, "niche" fabrication houses • Brittle, fragile material • Higher cost than GaAs • Low breakdown voltage – not good for high power
Gallium Arsenide variants (GaAs)	• Most mature, widespread technology • Many transistor variants (MESFET, PHEMT, MHEMT, HBT, etc) • High reliability • Fairly low cost (but more than silicon) • Great microwave substrate • Low loss, high ε_r. • 16-20V breakdown possible • Junction temperatures up to 150C	• High noise figure, Noise figure and power performance • Difficult to summarize - depends on transistor type used
Gallium Nitride (GaN)	• Up to 10x the power density of GaAs • High breakdown voltage (100V possible) • Results in high efficiency, high frequency, wide bandwidth PAs • Can operate hotter than GaAs, Si, or SiGe	• Currently more expensive than GaAs, but costs are decreasing • Difficult to fabricate • High power density leads to thermal challenges

SIGNAL GENERATION

Signal generators, also known variously as function generators, RF and microwave signal generators, pitch generators, arbitrary waveform generators, digital pattern generators or frequency generators are electronic devices that generate repeating or non-repeating electronic signals (in either the analog or digital domains). They are generally used in designing, testing, troubleshooting, and repairing electronic or electro-acoustic devices; though they often have artistic uses as well.

There are many different types of signal generators, with different purposes and applications (and at varying levels of expense); in general, no device is suitable for all possible applications.

Analog Signal Generators

RF signal generators are capable of producing CW (continuous wave) tones. The output frequency can usually be tuned anywhere in their frequency range. Many models offer various types of analog modulation, either as standard equipment or as an optional capability to the base unit. This could include AM, FM, ΦM (phase modulation) and pulse modulation. Another common feature is a built-in attenuator which makes it possible to vary the signal's output power. Depending on the manufacturer and model, output powers can range from -135 to +30 dBm. A wide range of output power is desirable, since different applications require different amounts of signal power. For example, if a signal has to travel through a very long cable out to an antenna, a high output signal may be needed to overcome the losses through the cable and still have sufficient power at the antenna. But when testing receiver sensitivity, a low signal level is required to see how the receiver behaves under low signal-to-noise conditions.

RF signal generators are required for servicing and setting up analog radio receivers, and are used for professional RF applications.

Arbitrary Waveform Generator

An arbitrary waveform generator (AWG) is a piece of electronic test equipment used to generate electrical waveforms. These waveforms can be either repetitive or single-shot (once only) in which case some kind of triggering source is required (internal or external). The resulting waveforms can be injected into a device under test and analyzed as they progress through the device, confirming the proper operation of the device or pinpointing a fault in the device.

Unlike function generators, AWGs can generate any arbitrarily defined wave shape as their output. The waveform is usually defined as a series of "waypoints" (specific voltage targets occurring at specific times along the waveform) and the AWG can either jump to those levels or use any of several methods to interpolate between those levels.

Because AWGs synthesize the waveforms using (baseband) digital signal processing techniques, their maximum frequency is usually limited to no more than a few gigahertz (~10 GHz being the latest state-of-the-art in 2012).

A major difficulty in generating non-repetitive waveforms at higher frequencies with AWGs is the large amount of data required to describe high-frequency baseband signals. For example, a 20 gigasample/sec arbitrary waveform with 8 bits of resolution requires 20 GB of data to represent every 1 second of signal, regardless of that signal's nature. Generating such large digital data streams and delivering them to the DAC in the AWG is an increasingly difficult problem as DAC upper frequencies continue to grow.

AWGs, like most signal generators, may also contain an attenuator, various means of modulating the output waveform, and often contain the ability to automatically and repetitively "sweep" the frequency of the output waveform (by means of a voltage-controlled oscillator) between two operator-determined limits. This capability makes it very easy to evaluate the frequency response of a given electronic circuit.

AWGs can operate as conventional function generators. These would include standard waveforms such as sine, square, ramp, triangle, noise, and pulse. Some units include additional built-in waveforms such as exponential rise and fall times, sinx/x, cardiac. Some AWGs allow users to retrieve waveforms from a number of digital and mixed-signal oscilloscopes. Some AWGs may display a graph of the waveform on their screen - a graph mode. Some AWGs have the ability to generate a pattern of words from multiple bit output connector to simulate data transmission, combining the properties of both AWGs and digital pattern generators.

One feature of direct digital synthesizer (DDS) based arbitrary waveform generators is that their digital nature allows multiple channels to be operated with precisely controlled phase offsets or ratio-related frequencies. This allows the generation of polyphase sine waves, I-Q constellations, or simulation of signals from geared mechanical systems such as jet engines. Complex channel-channel modulations are also possible.

Vector Signal Generators

Modern vector signal generators can be seen as a hybrid of the arbitrary waveform generator and the analog signal generator, combining a lower-bandwidth AWG with analog upconversion, allowing a moderate-bandwidth (~100 MHz, circa 2012) digital signal to be upconverted to any frequency (~50 GHz typically upper frequency typically).

With the advent of digital communications systems, it is no longer possible to adequately test these systems with traditional analog signal generators. This has led to the development of vector signal generators, also known as digital signal generators. These signal generators are capable of generating digitally-modulated radio signals that may use any of a large number of digital modulation formats such as QAM, QPSK, FSK, BPSK, and OFDM. In addition, since modern commercial digital communication systems are almost all based on well-defined industry standards, many vector signal

generators can generate signals based on these standards. Examples include GSM, W-CDMA (UMTS), CDMA2000, LTE, Wi-Fi (IEEE 802.11), and WiMAX (IEEE 802.16). In contrast, military communication systems such as JTRS, which place a great deal of importance on robustness and information security, typically use very proprietary methods. To test these types of communication systems, users will often create their own custom waveforms and download them into the vector signal generator to create the desired test signal.

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DIGITAL SIGNAL PROCESSING COMPONENTS

The goal of DSP is usually to measure, filter and/or compress continuous real-world analog signals. The first step is usually to convert the signal from an analog to a digital form, by sampling and then digitizing it using an analog-to-digital converter (ADC), which turns the analog signal into a stream of numbers. However, often, the required output signal is another analog output signal, which requires a digital-to-analog converter (DAC). Even if this process is more complex than analog processing and has a discrete value range, the application of computational power to digital signal processing allows for many advantages over analog processing in many applications, such as error detection and correction in transmission as well as data compression. With the increasing bandwidth and dynamic range of ADC and digital components, common analog RF signal processing operations such as filtering, threshold detection, and pulse compression are being carried out in the digital domain. Additionally new capabilities such as synthetic aperture radar (SAR), digital RF memory (DRFM), and space-time adaptive processing (STAP) are wholly enabled by the increasing power of digital processing components.

Analog-to-Digital Converter

An analog-to-digital converter (abbreviated ADC, A/D or A to D) is a device that converts a continuous quantity to a discrete time digital representation. An ADC may also provide an isolated measurement. The reverse operation is performed by a digital-to-analog converter (DAC).

Typically, an ADC is an electronic device that converts an input analog voltage or current to a digital number proportional to the magnitude of the voltage or current. However, some non-electronic or only partially electronic devices, such as rotary encoders, can also be considered ADCs.

Resolution

The resolution of the converter indicates the number of discrete values it can produce over the range of analog values. The values are usually stored electronically in binary form, so the resolution is usually expressed in bits. In consequence, the number of discrete values available, or "levels," is a power of two. For example, an ADC with a resolution of 8 bits can encode an analog input to one in 256 different levels, since $2^8 = 256$. The values can represent the ranges from 0 to 255 (i.e. unsigned integer) or from −128 to 127 (i.e., signed integer), depending on the application.

Resolution can also be defined electrically, and expressed in volts. The minimum change in voltage required to guarantee a change in the output code level is called the least significant bit (LSB) voltage. The resolution Q of the ADC is equal to the LSB voltage. The voltage resolution of an ADC is equal to its overall voltage measurement range divided by the number of discrete values:

$$Q = \frac{E_{FSR}}{2^M}$$

where M is the ADC's resolution in bits and E_{FSR} is the full scale voltage range (also called 'span').

E_{FSR} is given by

$$E_{FSR} = V_{RefHi} - V_{RefLow}$$

where V_{RefHi} and V_{RefLow} are the upper and lower extremes, respectively, of the voltages that can be coded.

Normally, the number of voltage intervals is given by

$$N = 2^M - 1$$

where M is the ADC's resolution in bits.

That is, one voltage interval is assigned in between two consecutive code levels.

A typical 3 bit (2^8 = 8-level) coding scheme is depicted in Figure 1.

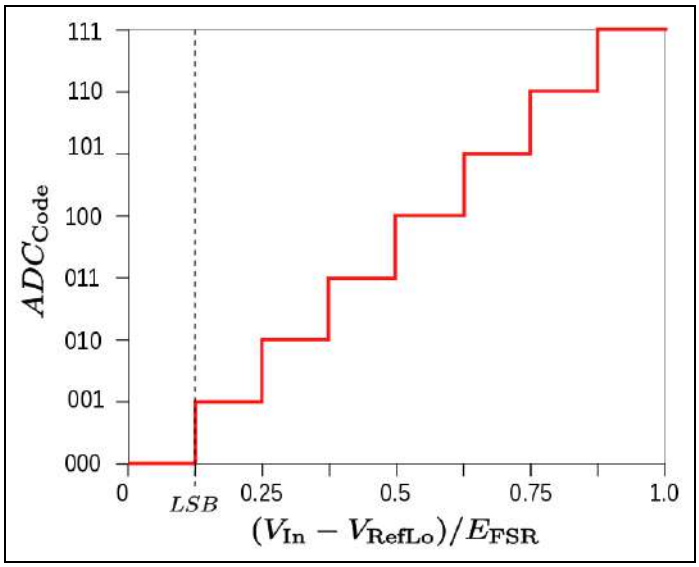

Figure 1. An 8-level (3 bit) ADC Coding Scheme.

Example:

Assume input signal x(t) = A cos(t), A = 5V
Full scale measurement range = -5 to 5 volts
ADC resolution is 8 bits: 2^8 - 1 = 256 - 1 = 255 quantization levels (codes)
ADC voltage resolution, Q = (5 V − [-5] V) / 255 = 10 V / 255 ≈ 0.039 V ≈ 39 mV.

In practice, the useful resolution of a converter is limited by the best signal-to-noise ratio (SNR) that can be achieved for a digitized signal. An ADC can resolve a signal to only a certain number of bits of resolution, called the effective number of bits (ENOB). One effective bit of resolution changes the signal-to-noise ratio of the digitized signal by 6 dB, if the resolution is limited by the ADC. If a preamplifier has been used prior to A/D conversion, the noise introduced by the amplifier can be an important contributing factor towards the overall SNR.

Accuracy

An ADC has several sources of errors. Quantization error and (assuming the ADC is intended to be linear) non-linearity are intrinsic to any analog-to-digital conversion. There is also a so-called aperture error which is due to a clock jitter and is revealed when digitizing a time-variant signal (not a constant value).

These errors are measured in a unit called the least significant bit (LSB). In the above example of an eight-bit ADC, an error of one LSB is 1/256 of the full signal range, or about 0.4%.

Sampling Rate

The analog signal is continuous in time and it is necessary to convert this to a flow of digital values. It is therefore required to define the rate at which new digital values are sampled from the analog signal. The rate of new values is called the sampling rate or sampling frequency of the converter.

A continuously varying band limited signal can be sampled (that is, the signal values at intervals of time T, the sampling time, are measured and stored) and then the original signal can be exactly reproduced from the discrete-time values by an interpolation formula. The accuracy is limited by quantization error. However, this faithful reproduction is only possible if the sampling rate is higher than twice the highest frequency of the signal. This is essentially what is embodied in the Shannon-Nyquist sampling theorem.

Oversampling

Usually, for economy, signals are sampled at the minimum rate required, with the result that the quantization noise introduced is white noise spread over the whole pass band of the converter. If a signal is sampled at a rate much higher than the Nyquist frequency and then digitally filtered to limit it to the signal bandwidth there are the following advantages:

- Digital filters can have better properties (sharper roll-off, phase) than analog filters, so a sharper anti-aliasing filter can be realized and then the signal can be down-sampled giving a better result
- A 20-bit ADC can be made to act as a 24-bit ADC with 256× oversampling
- The signal-to-noise ratio due to quantization noise will be higher than if the whole available band had been used. With this technique, it is possible to obtain an effective resolution larger than that provided by the converter alone.
- The improvement in SNR is 3 dB (equivalent to 0.5 bits) per octave of oversampling which is not sufficient for many applications. Therefore, oversampling is usually coupled with noise shaping. With noise shaping, the improvement is 6L+3 dB per octave where L is the order of loop filter used for noise shaping. e.g. - a 2nd order loop filter will provide an improvement of 15 dB/octave.

<u>Digital to Analog Converter (DAC)</u>

Digital-to-analog converters (DACs) perform the inverse function of the ADC. As such, the aforementioned principles of accuracy, resolution, sampling and oversampling, etc. apply equivalently.

Field-Programmable Gate Array (FPGA)

A field-programmable gate array (FPGA) is an integrated circuit designed to be configured by the customer or designer after manufacturing—hence "field-programmable." The FPGA configuration is generally specified using a hardware description language (HDL), similar to that used for an application-specific integrated circuit (ASIC). Circuit diagrams were previously used to specify the configuration, as they were for ASICs, but this is increasingly rare. FPGAs can be used to implement any logical function that an ASIC could perform. The ability to update the functionality after shipping, partial re-configuration of a portion of the design and the low non-recurring engineering costs relative to an ASIC design (notwithstanding the generally higher unit cost), offer advantages for many applications.

FPGAs contain programmable logic components called "logic blocks," and a hierarchy of reconfigurable interconnects that allow the blocks to be "wired together"—somewhat like many (changeable) logic gates that can be inter-wired in (many) different configurations. Logic blocks can be configured to perform complex combinational functions, or merely simple logic gates like AND and XOR. In most FPGAs, the logic blocks also include memory elements, which may be simple flip-flops or more complete blocks of memory.

FPGAs are becoming increasingly more popular for implementing RF signal processing functions such as signal compression (matched filtering), channel selection, modulation / demodulation, etc.

MICROWAVE MEASUREMENTS

Measurement Procedures

Calculate your estimated power losses before attempting to perform a measurement. The ideal input to a measurement device is in the 0 to 10 dBm (1 to 10 mW) range.

Linearity Check

To verify that a spectrum measurement is accurate and signals are not due to mixing inside the receiver, a linearity check should be performed, i.e., externally insert a 10 dB attenuator - if measurements are in the linear region of the receiver, all measurements will decrease by 10 dB. If the measurements decrease by less than 10 dB, the receiver is saturated. If the measurements disappear, you are at the noise floor.

Half-Power or 3 dB Measurement Point

To verify the half power point of a pulse width measurement on an oscilloscope, externally insert a 3 dB attenuator in the measurement line, and the level that the peak power decreases to is the 3 dB measurement point (Note: you cannot just divide the peak voltage by one-half on the vertical scale of the oscilloscope).

VSWR Effect on Measurement

Try to measure VSWR (or reflection coefficient) at the antenna terminals. Measuring VSWR of an antenna through its transmission line can result in errors. Transmission lines should be measured for insertion loss not VSWR.

High Power Pulsed Transmitter Measurements

When making power measurements on a high power pulsed transmitter using a typical 40 dB directional coupler, an additional attenuator may be required in the power meter takeoff line, or the power sensor may be burnt out.

For example, assume we have a 1 megawatt transmitter, with PRF = 430 pps, and PW = 13 μs. Further assume we use a 40 dB directional coupler to tap off for the power measurements. The power at the tap would be:

$10 \log(P_p) - 10 \log(DC) - \text{Coupler reduction} =$

$10 \log(10^9 \text{mW}) - 10 \log(13 \times 10^{-6})(430) - 40 \text{ dB} =$

90 dBm - 22.5 dB - 40 dB = 27.5 dBm (too high for a power meter)

Adding a 20 dB static attenuator to the power meter input would give us a value of 7.5 dBm or 5.6 mW, a good level for the power meter.

High Power Measurements With Small Devices

When testing in the presence of a high power radar, it is normally necessary to measure the actual field intensity. The technique shown in Figure 4, in Section 6-7, may not be practical if the measurement device must be small. An alternate approach is the use of a rectangular waveguide below its cutoff frequency. In this manner, the "antenna" waveguide provides sufficient attenuation to the frequency being measured so it can be coupled directly to the measurement device or further attenuated by a low power attenuator. The attenuation of the waveguide must be accurately measured since attenuation varies significantly with frequency.

ELECTRO-OPTICS AND IR

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ELECTRO-OPTICAL SYSTEMS AND EW COUNTERMEASURES

INTRODUCTION

The development of infrared countermeasures and the evaluation of their performance against threat missiles is a broad, complex technical field. Much of the detailed information about the threats to be countered and the characteristics of the countermeasures themselves is understandably sensitive, beyond the limitations of this document. More detailed information can be requested, provided the requesting organization has the necessary clearance and need to know. Such requests will be considered on a case-by-case basis. Information will be provided only upon written concurrence of the controlling Government organization.

There are many electro-optical (EO) electronic warfare (EW) systems, which are analogous to radio frequency (RF) EW systems. These EO EW systems operate in the optical portion of the electromagnetic spectrum. Electro-optics (EO), as the name implies, is a combination of electronics and optics. By one definition EO is the science and technology of the generation, modulation, detection and measurement, or display of optical radiation by electrical means. Most infrared (IR) sensors, for example, are EO systems. In the popularly used term "EO/IR," the EO is typically used to mean visible or laser systems. The use of EO in this context is a misnomer. Actually, almost all "EO/IR" systems are EO systems as defined above. Another often-used misnomer is referring to an EO spectrum. EO <u>systems</u> operate in the <u>optical</u> spectrum, which is from 0.01 to 1000 micrometers. EO systems include, but are not limited to, lasers, photometry, infrared, and other types of visible, and UV imaging systems.

Within the broad field of Electronic Warfare, electro-optical systems are prevalent for communication systems and offensive and defensive applications. Lasers have been used extensively for weapons guidance purposes, warhead fuzing applications, targeting systems and other offensive weapons related purposes. Understanding electro-optical and radiometric principles and sensors is critical to the development of vehicle survivability systems. These principles range from signature reduction and camouflage to active countermeasure systems such as lamp-based and laser jammers to passive threat warning systems and expendable flare decoys.

Although military systems operate in many portions of the electro-optical spectrum, the infrared is of paramount importance for remote detection systems and weapons applications. Missile seekers, Forward Looking Infrared (FLIR) systems, and Infrared Search and Track Systems all operate in the infrared portion of the spectrum.

OPTICAL SPECTRUM

The optical spectrum is that portion of the electromagnetic spectrum from the extreme ultraviolet (UV) through the visible to the extreme IR. Figure 1 shows the optical spectrum in detail. The end points of the optical spectrum are somewhat arbitrary.

IR spectrum terminology has also varied through the years, with near (near visible), or short-wavelength infrared (SWIR) being on the high frequency end. Then as frequency decreases the spectrum is followed by intermediate or mid-wavelength infrared (MWIR), then far or long-wavelength IR (LWIR), and finally extreme IR.

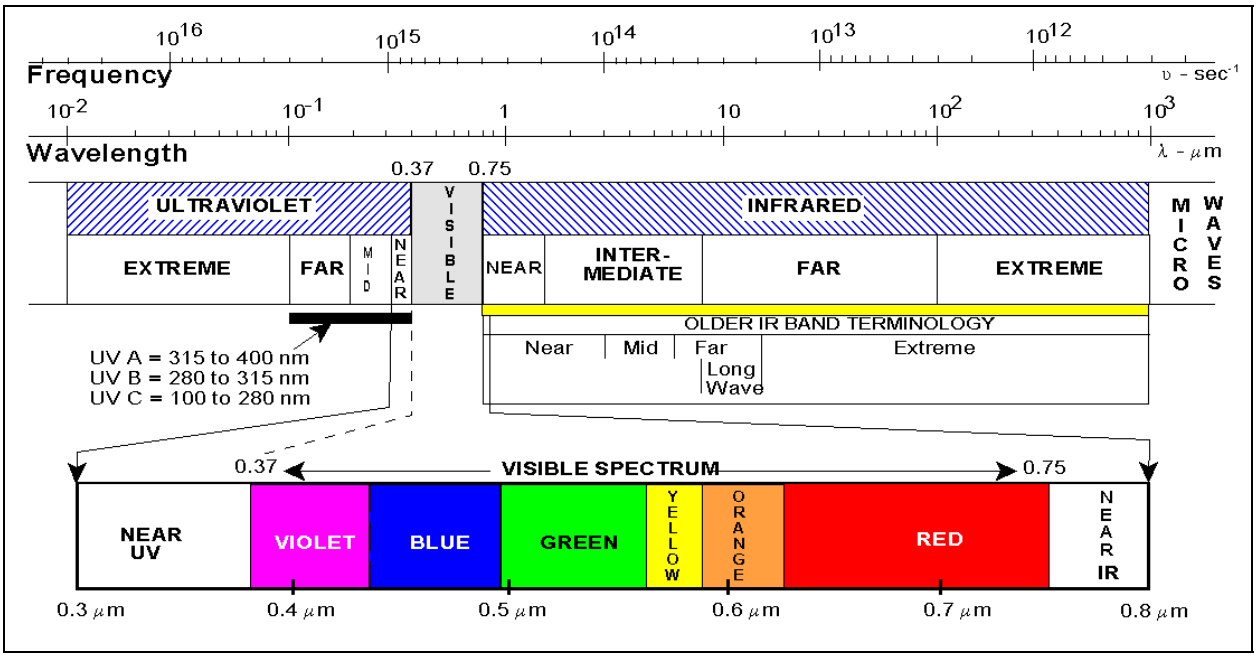

Figure 1. Optical Spectrum.

RADIOMETRIC QUANTITIES AND TERMINOLOGY

The common terms used to describe optical radiation are the source parameters of power, radiant emittance (older term) or radiant exitance (newer term), radiance, and radiant intensity. They refer to how much radiation is given off by a body. The parameter measured by the detector (or collecting object/surface) is the irradiance. Any of these quantities can be expressed per unit wavelength in which case the subscript is changed from e (meaning energy derived units) to λ and the term is then called "Spectral ...X...", i.e. I_e is radiant intensity, while I_λ is spectral radiant intensity. These quantities in terms of currently preferred "Système International d'Unités" (SI units) are defined in Table 1.

Table 1. Radiometric SI Units.

Symbol	Name	Description	Units
Q	Radiant Energy		J (joules)
Φ_e	Radiant Power (or flux)	Rate of transfer of radiant energy	W (watts)
M_e	Radiant Exitance	Radiant power per unit area emitted from a surface	$W\ m^{-2}$
L_e	Radiance	Radiant power per unit solid angle per unit projected area	$W\ m^{-2}sr^{-1}$
I_e	Radiant Intensity	Radiant power per unit solid angle from a point source	$W\ sr^{-1}$
E_e	Irradiance	Radiant power per unit area incident upon a surface	$W\ m^{-2}$
X_λ	Spectral ...X..	(Quantity) per unit wavelength interval	(Units) nm^{-1} or μm^{-1}

Where X_λ is generalized for each unit on a per wavelength basis; for example, L_λ would be called "spectral radiance" instead of radiance.

In common usage, irradiance is expressed in units of Watts per square centimeter and wavelengths are in **µ**m instead of nanometers (nm). Other radiometric definitions are shown in Table 2.

Table 2. Other Radiometric Definitions.

Symbol	Name	Description	Units
α	Absorptance[1]	α = (*) absorbed / (*) incident	numeric
ρ	Reflectance	ρ = (*) reflected / (*) incident	numeric
τ	Transmittance	τ = (*) transmitted / (*) incident	numeric
$\in$	Emissivity	$\in$ = (*) of specimen / (*) of blackbody @ same temperature	numeric

Where (*) represents the appropriate quantity Q, Φ, M, E, or L
Note (1) Radiant absorptance should not be confused with absorption coefficient.

PHOTOMETRIC QUANTITIES

Whereas the radiometric quantities Φ_e, M_e, I_e, L_e, and E_e have meaning throughout the entire electromagnetic spectrum, their photometric counterparts Φ_v, M_v, I_v, L_v, and E_v are meaningful only in the visible spectrum (0.38 **µ**m thru 0.78 **µ**m).

The "standard candle" was redefined as the new candle or candela (cd). One candela is the luminous intensity of 1/60th of 1 cm^2 of the projected area of a blackbody radiator operating at the temperature of the solidification of platinum (2045 ºK). By definition, the candela emits one lumen (lm) per steradian.

Table 3 displays the photometric quantities and units. These are used in dealing with optical systems such as aircraft television camera systems, optical trackers, or video recording.

Table 3. Photometric SI Units.

Symbol	Name	Description	Units
Q_v	Luminous energy		lumen sec (lm s)
F or Φ_v	Luminous flux or Luminous Power	Rate of transfer of luminant energy	lumen (lm)
M_v	Luminous Exitance or flux density (formerly luminous emittance)	Luminant power per unit area emitted from a surface	lm m^{-2}
L_v	Luminance (formerly brightness)	Luminous flux per unit solid angle per unit projected area	nit (nt) or candela / m^2 or lm/sr·m^2
I_v	Luminous Intensity (formerly candlepower)	Luminous power per unit solid angle from a point source	candela (cd) or lm/sr
E_v	Illuminance (formerly illumination)	Luminous power per unit area incident upon a surface	lux or lx or lm/m^2
K	Luminous efficacy	K= Φ_v / Φ_e	lm / w

Table 4 displays conversion factors for commonly used illuminance quantities.

Table 4. Illuminance Conversion Units.

		Lux (lx)	Footcandle (fc)	Phot (ph)
1 lux (lm m^{-2})	=	1	0.0929	1×10^{-4}
1 footcandle (lm ft^{-2})	=	10.764	1	0.001076
1 phot (lm cm^{-2})	=	1×10^{4}	929	1

THE BASIC PRINCIPLES

The processes of absorption, reflection (including scattering), and transmission account for all incident radiation in any particular situation, and the total must add up to one in order that energy be conserved:

$\alpha + \rho + \tau = 1$, as shown in Figure 2.

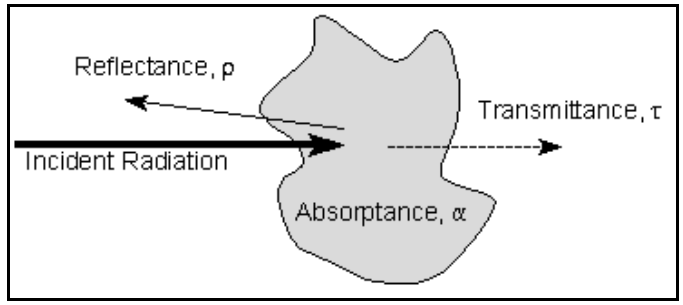

Figure 2. Radiation Incident on a Body.

If a material is opaque (no transmission), then: absorption + reflection = 1

In addition to the above processes, optical (including IR) radiation interacts with matter the same as radiation in any other part of the spectrum, including:

1. **Diffraction** – around edges
2. **Emission** – from matter by conversion from another form of energy
3. **Interference** – constructive and destructive
4. **Refraction** – bends when passing between two media with different propagation speeds (Snell's Law)
5. **Scattering** – when interacts with particles whose size approaches length of the wave
6. **Polarized** - electric field is partially polarized by reflection from dielectric

STERADIAN – SOLID ANGLE

Of significance to many terms and units in radiometric calculations is the *solid angle*. Figure 3 is a pictorial depicting the relationship of area, distance, and solid angle. By definition, the ratio of area on the surface of a sphere to the square of distance (the radius) is the unit less parameter *solid angle*, or steradian in the SI system of units. Solid angle is usually abbreviated as "sr" or given the Greek letter, Ω. The steradian is a dimensionless quantity in radiometric calculations.

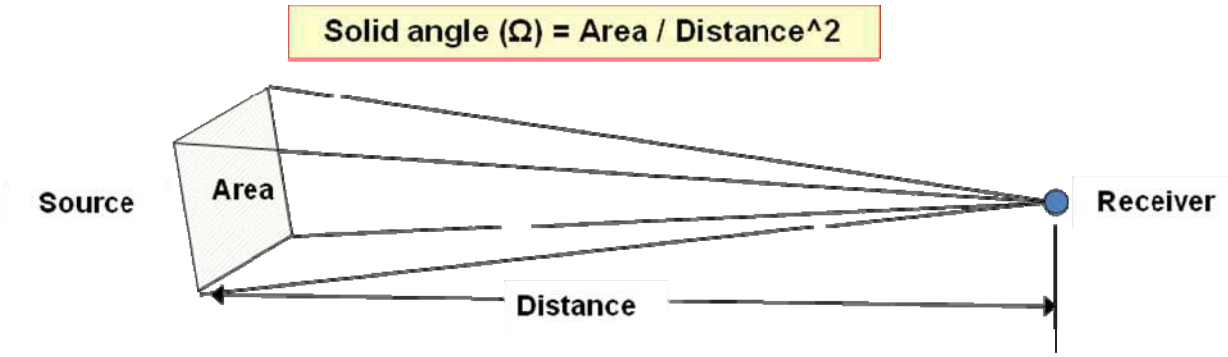

Figure 3. Solid Angle.

A sphere contains a solid angle of 4π steradians; a hemisphere contains 2π steradians, and so on. The area is a curved surface, but in most applications, the solid angles are sufficiently small that the area can be approximated as a plane. Also, for small angles, the solid angle in steradians is approximately equal to the product of two plane angles in radians.

CONVERSIONS

IR wavelengths are typically expressed in **µ**m, visible wavelengths in **µ**m or nm, and UV wavelengths in nm or angstroms. Table 5 lists conversion factors for converting from one unit of wavelength to another. The conversion is from column to row. For example, to convert from **µ**m to nm, multiply the value expressed in **µ**m by 10^3. IR wavelengths are also sometimes expressed in a frequency-like unit called wavenumbers or inverse centimeters. A wavenumber value can be found by dividing 10,000 by the wavelength expressed in **µ**m. For example, 2.5 **µ**m converts to a wavenumber of 4000 or 4000 inverse centimeters (cm^{-1}).

Table 5. Wavelength Conversion Units.

From ->	Angstroms - Å	Nanometers - nm	Micrometers - **µ**m
To get ↓	Multiply by		
Angstroms - Å	1	10	10^4
Nanometers - nm	10^{-1}	1	10^3
Micrometers - **µ**m	10^{-4}	10^{-3}	1

BASIC RADIANT POWER RELATIONSHIPS

Radiant intensity is the most commonly used term to describe the radiant power of a source per unit solid angle. Radiant Intensity offers the advantage of being a source term, like radiance, that is not related to the size of the radiating source. In practice, radiant intensity is a derived term and is not directly measurable. If the Instantaneous Field of View (IFOV), which represents the smallest optical resolution element of a remote sensor, subtends an angle smaller than the size of the radiating source, the

sensor responds directly to *radiance*. If the IFOV of the sensor subtends an angle larger than the radiating source, the sensor responds to *irradiance*. The relationship among radiant intensity, radiance, and irradiance is shown in the following equation:

$$I = ED^2 = E\frac{A}{\Omega} = LA = L\Omega D^2$$

Where:

I = Intensity. Radiant intensity is the target source power per unit solid angle, in Watts/steradian.

E = Irradiance. Irradiance is the received power density in Watts/cm2 incident on a distant sensor. Irradiance is the quantity measured or detected by a distant sensor where the target is not spatially resolved (i.e., where the target subtends an angle smaller than the resolution or field of view of the instrument.)

L = Radiance. Radiance is the intensity per unit area of source, in W/cm^2/steradians. Radiance is the quantity measured by a camera or imaging system, where the target is optically resolved (i.e., where the target subtends an angle much greater than the resolution or instantaneous field of view of the imager.)

A = Area. Area is the cross-sectional or projected area of the target in cm^2.

D = Distance. Distance between the target and sensor in cm.

Ω = Solid angle subtended by the target in steradians. Solid angle appears directly or indirectly in many infrared quantities. The solid angle subtended by a source is the ratio of the source area to the square of distance.

All remote sensors receive energy from a source through an atmospheric path. The atmosphere attenuates the propagation of energy due to scattering, absorption, and molecular rotation and vibration, depending on the wavelengths involved. The atmosphere itself also radiates. All incident energy on a remote sensor, except as received under vacuum conditions, is detected through the atmosphere. The term *apparent* is applied to a radiometric quantity to acknowledge the presence of atmospheric effects. A remote sensor, responding the radiance of a source over an atmospheric path, responds to *apparent radiance*.

Real sensors do not respond uniformly to energy. Sensors have non-uniform spectral and spatial response due to many factors, including detector and optical characteristics. All energy received by the detector is spectrally weighted by the spectral response of the instrument. The term *effective* is applied to acknowledge the non-uniform response of the instrument.

Outside of a vacuum, all radiation incident on a remote sensor is attenuated by atmospheric effects such as scattering and absorption. Where the atmosphere absorbs, it also emits. Path radiance is the term applied to the contribution of the atmospheric path to the received radiation. The term *apparent* is applied to radiometric quantities to acknowledge the influence of the atmosphere on the received radiation.

DOMAINS, DISTRIBUTIONS, AND SENSOR RESPONSE

Radiant power that is emitted or reflected from a source is distributed across multiple dimensions or domains. The three domains that are most important to radiometric applications are spectral (Figure 4), spatial (Figure 5), and temporal (Figure 6). Knowing how the radiant power from a source is distributed across each domain is important to understanding performance of an EW system, whether it be a sensor, a weapon, or a countermeasure.

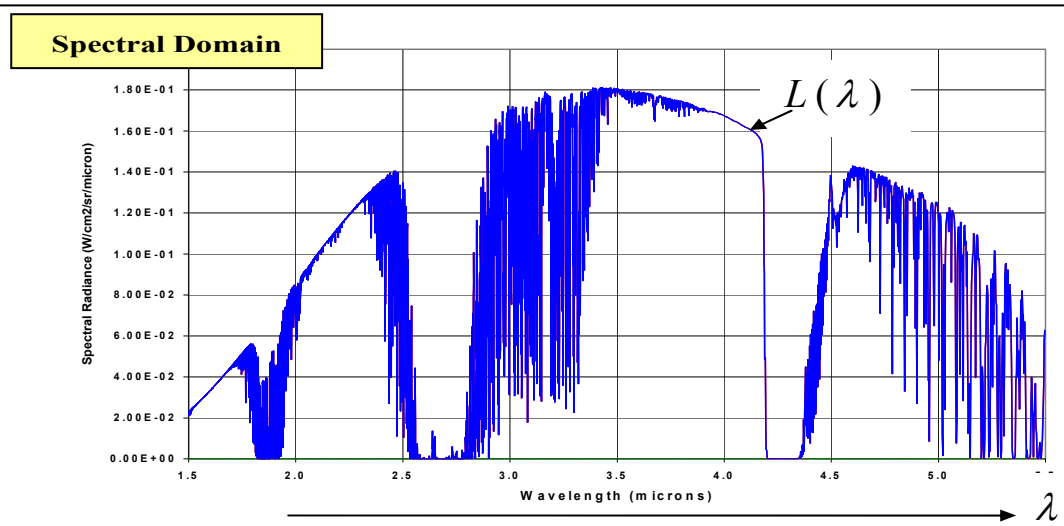

In the spectral domain, radiation is distributed as a function of wavelength (or wavenumber). Radiation from solid materials is distributed as a continuum in accordance with Planck's formula. The graph above shows the spectral distribution of radiation from a 600 degree Celsius blackbody after passage through the atmosphere. Radiation from gases appears at specific wavelength "lines" corresponding to molecular resonances.

Figure 4. Sample Spectral Distribution of a Solid Material.

Spatial Domain

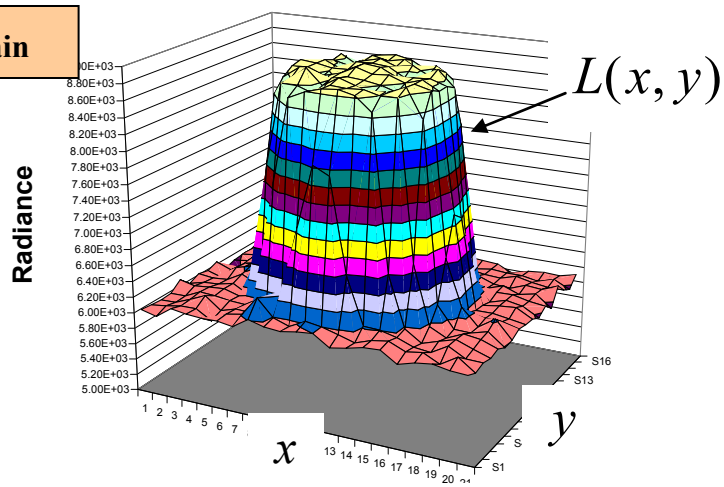

In the spatial domain, radiation is distributed as a function of angle, position, size, shape, or orientation. The graph above shows the radiance of a circular target as viewed by an imaging system.

Figure 5. Sample Spatial Distribution of a Circular Target Image.

Temporal Domain

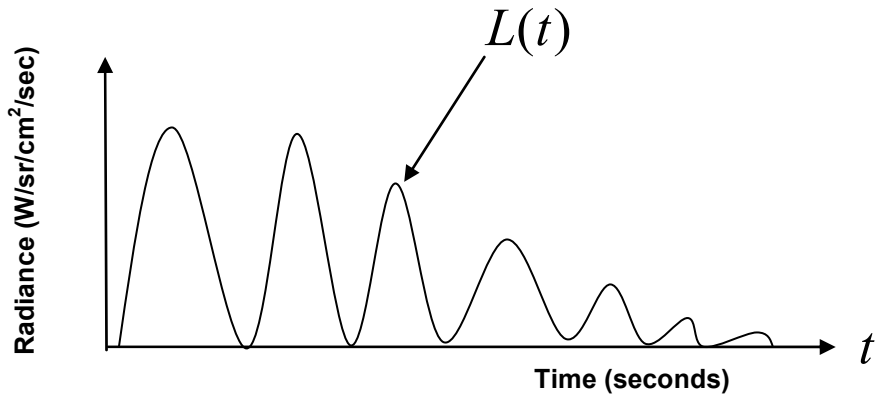

In the temporal domain, radiation is distributed as a function of time (or frequency). Most IR target sources, such as aircraft and ground vehicles, change slowly with time and can be considered steady state for measurement purposes. However, IR countermeasures systems and devices, such as jammers and decoy flares, have high frequency content that must be considered in their design and effectiveness assessment.

Figure 6. Sample Temporal Distribution of a Modulated Source.

All electro-optical sensors have some sensitivity to how radiation is distributed across the different domains. This sensitivity or response takes the following forms:

1. **Spectral response**:
    a. May be broad in the case of a radiometer or imager, or narrow in the case of a spectrometer where response takes the form of resolution.
    b. Spectral response is chosen to exploit particular spectral features of interest in a target.
    c. Non-uniformity of spectral response can have a significant effect on the performance of sensor.

2. **Spatial response**:
    a. May be broad in the case of a radiometer or spectrometer, where spatial response takes the form of sensitivity across the sensor's FOV. In the case of an imager, the spatial response may be narrow because spatial response takes the form of the resolution or IFOV.
    b. Required spatial resolution is defined by the size and radiant power of the source, the distance between the source and the target, and by the sensitivity of the sensor.
    c. Non-uniformity of spatial response can have a significant effect on the performance of sensor.
    d. Response to radiation from the background within the FOV is primarily a spatial response issue and can be significant to sensor performance.

3. **Temporal response**:
    a. Takes the form of bandwidth or, in the case of a digital system, of sampling frequency.
    b. Unlike spectral and spatial response, temporal response includes the response time of the detector and all of the electronics, data transfer time, and processing time for a sensor.
    c. Non-uniformity across a region is usually not a concern. Temporal response is usually uniform for target frequencies that fall well below the low-pass or Nyquist breakpoints.

Sensors respond to received radiant power by integrating the power distribution in each domain under the corresponding response curve. Sensors respond in multiple domains, so output is proportional to a multi-dimensional, weighted integral. Figure 7 illustrates response-weighting, or convolution, of radiation with instrument response in the spectral domain. The concept applies equally in the spatial domain.

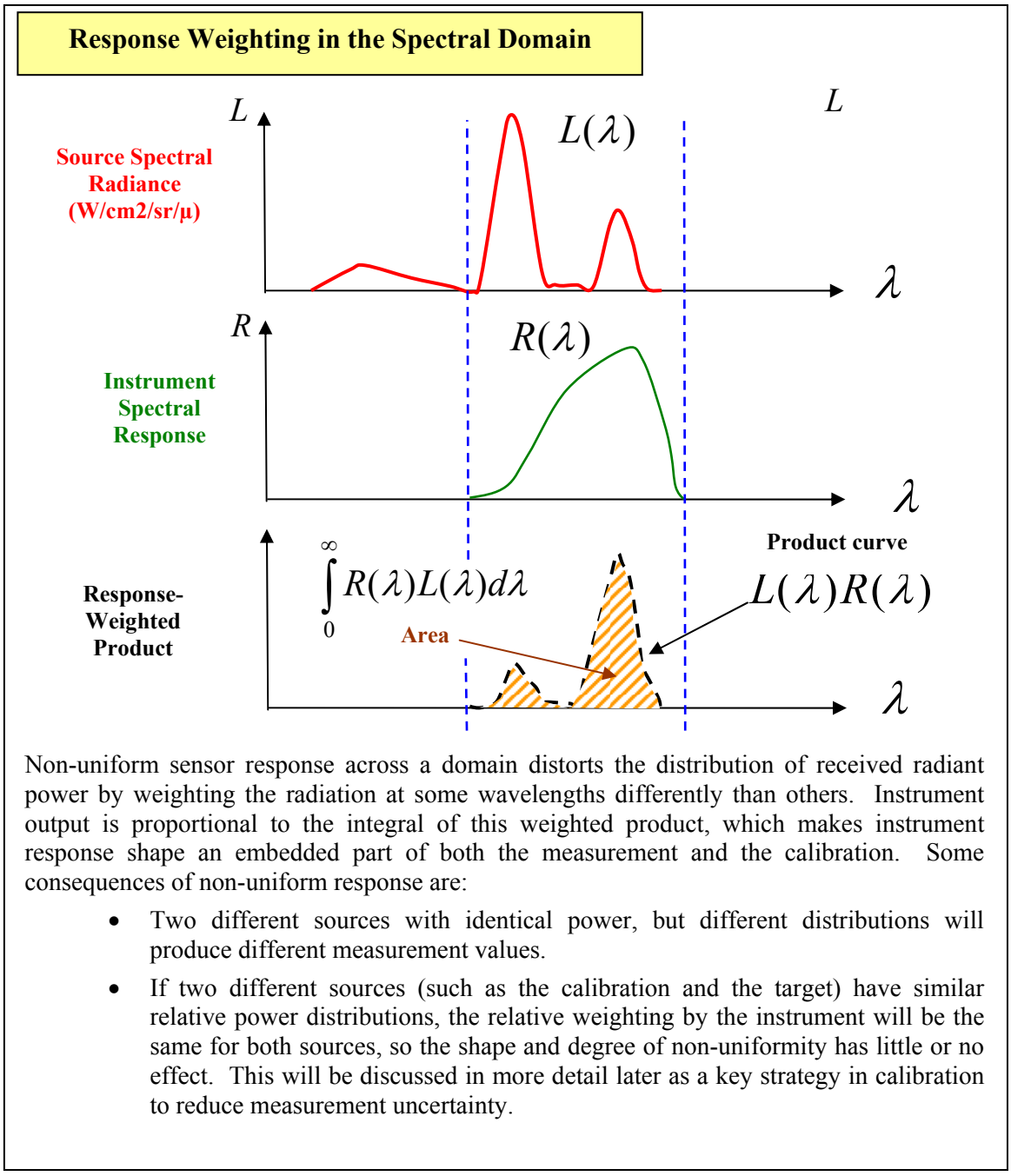

Figure 7. Response-Weighting in the Spectral Domain.

The consequence of instrument output being proportional to multiple weighted integrals is that the characteristics of the instrument affect the measured value in ways that cannot be easily extracted or corrected. Understanding non-uniformity in sensor response is critical to understanding performance and evaluating the effectiveness of the system.

INFRARED SOURCE CHARACTERISTICS

Reflectance

Reflectance is generally categorized as either *specular* (mirror-like) or *diffuse* (scattered by reflection from a rough surface). Most surfaces exhibit both types of reflection, but one typically dominates. Reflections from smooth surfaces are specular. Reflectance is a unitless quantity between zero and one that is the ratio of reflected power to the incident power. Reflectance varies with angle from the normal and with wavelength.

Diffuse reflectors scatter incident radiation broadly. Johann Heinrich Lambert described an ideal diffuse reflector in which the intensity of reflected rays is distributed as a cosine of the angle from the normal, regardless of the angles of the arriving incident rays. Such a surface is described as *Lambertian*. The same relationship applies to a diffuse source. If the source is perfectly diffuse, the radiance is independent of the viewing angle because the projected area of the source also varies as a cosine function of the angle from normal.

While no surface is perfectly diffuse, standard paint on most aircraft, for example, is near enough for at least a first approximation. Significant effort has gone into measuring and describing surface properties of military vehicles to support modeling and simulation activities. Bidirectional Reflectance Distribution Function (BRDF) is defined as the ratio of the reflected radiance to the incident irradiance at a wavelength, λ.

The BRDF provides a complete description of the reflectance properties of a surface. Measurements of BRDF are made in specially equipped optical laboratories. For aircraft, a typical use of BRDF data is in computer models that predict the reflections of the earth and sun from the aircraft fuselage and wings.

Emissivity

Emissivity is a unitless quantity that is a measure of the efficiency of a surface as an absorber or emitter. Emissivity is expressed as a number between 0.0 and 1.0. According to Kirchoff's Law, for an opaque object in thermal equilibrium, i.e., no net heat transfer, the emissivity equals the absorptance. In other words, a perfect emitter is also a perfect absorber. This ideal emitter is known as a *blackbody*. A surface with an emissivity of 1.0 emits the maximum radiation that Planck's Law allows. A body for which the emissivity is constant with wavelength but less than 1.0 is commonly known as a *graybody*. Planck's equation is typically expressed for an ideal blackbody emitter, but multiplying the blackbody expression by the emissivity term expresses the spectral distribution of power for a graybody.

Electromagnetic (EM) radiation, including infrared radiation, can be characterized by amplitude, frequency (or wavelength), coherency, and polarization properties. Amplitude refers to the magnitude of the electromagnetic wave. Coherency refers to the degree in which the electromagnetic waves maintain a constant phase difference, both spatially and temporally. Polarization is a description of the orientation of the wave's propagation perpendicular to the direction of travel. Like all electromagnetic radiation, infrared radiation travels as an EM field with the propagation velocity of the speed of light in a vacuum, and slower through air and other dielectrics. , Infrared radiation also exhibits both wave and particle properties. Which property is used depends on the application: Waves are used for applications involving propagation and geometrical optics, while particles (photons) are used for most detector

applications. The energy of a photon is inversely proportional to its wavelength (hc/λ) where h is the Planck's constant, and c is the speed of light.

Infrared radiation also interacts with matter in a variety of ways:

- Reflects – wave is reflected from a surface.
- Refracts – direction of wave bends when passing between two transparent media with different propagation speeds.
- Scatters – when interacts with particles whose size approaches the wavelength of the radiation.
- Diffracts – around edges of an obstruction.
- Interferes – constructively and destructively.
- Absorbs – when absorbed by matter, radiation is (usually) converted into heat energy.
- Emits – radiation is emitted from matter by conversion from another form of energy.
- Transmitted – propagates through a transparent medium (or vacuum).

Plank's Law:

Infrared is directly related to the heat radiated from matter. Anything with a temperature above absolute zero (-273.15 degrees Celsius) radiates in the infrared. Planck's Law, discovered by German Physicist Max Planck, mathematically describes the distribution of radiant power across the spectrum for a given temperature. The form presented below calculates source radiance in Watts/sr/cm^2/ μ:

$$L_\lambda = \frac{C_1}{\pi\lambda^5\left[e^{\left(\frac{C_2}{\lambda T}\right)} - 1\right]}$$

Where: $C_1 = 2\pi c^2 h = 3.7415 \times 10E{+}04$ W cm^{-2} μ^4

$C_2 = ch/k = 1.4389E{+}04$ μ K

c = speed of light; h = Plank's constant; k = Boltzmann's constant

With λ in μ and T in Kelvin (= ºC + 273.15)

The behavior of Planck's curve with temperature is fundamental to every infrared detection scenario. Figure 8 shows Planck's equation for a single temperature. The shape of this curve resembles a wave of water, with a steep rise in power on the short wavelength side of the peak and a tail off on the long wavelength side.

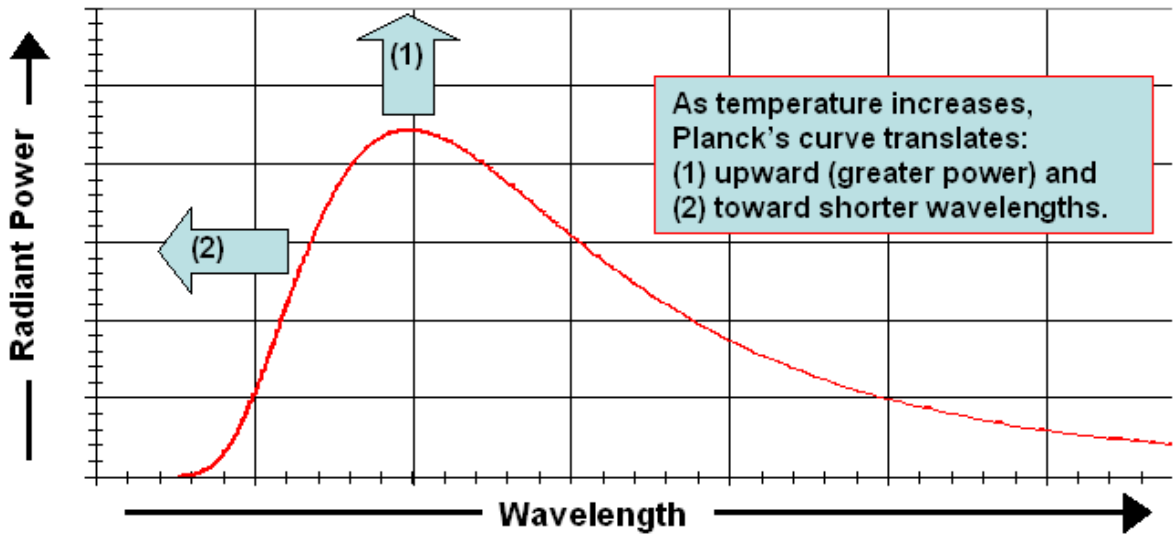

Figure 8. Temperature Effects and Power Distribution.

When temperature increases, two significant changes in power distribution occur and are governed by the following two relationships:

Stefan-Boltzmann Law:

The total power under the curve increases proportionally to the fourth power of the temperature. According to the Stefan-Boltzmann law, the total radiant emittance (power) of a blackbody is:

$M = \sigma T^4$ Where: $\sigma = \frac{2\pi^5 k^4}{15 c^2 h^3} = 5.67 \times 10^{-12} \, Watts \, cm^{-2} \, ^\circ K^{-4}$

and T is in Kelvin

This is Plank's radiation law integrated over all values of λ.

Wein's Displacement Law

The peak emission translates toward shorter wavelengths.

Wein's displacement law takes the derivative of the Plank's law equation to find the wavelength for maximum spectral exitance (emittance) at any given temperature:

$\lambda_{max} = 2897.8 / \mathbf{T}$ where T = temperature is in Kelvin

The surface of the sun radiates with a spectral distribution like that of a 5900 Kelvin source. In accordance with Wein's Law, the wavelength at which the radiation for a 5900 Kelvin source peaks is approximately 490 nanometers. The maximum sensitivity of the day-adapted human eye (photopic) occurs at about 555 nanometers, which happens to be in a highly transparent region of the atmosphere. In other words, the temperature of our sun and the transmission of our atmosphere are conveniently matched

to the response of the human eye. Figure 9 shows the relationship between the response of the human eye and the spectral distribution of solar irradiance.

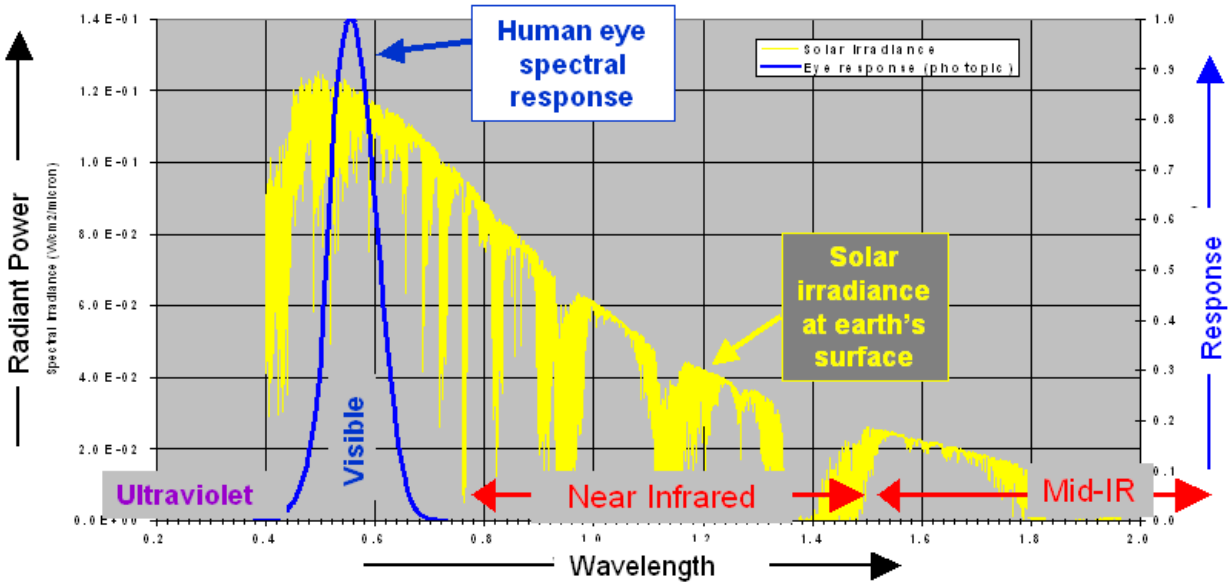

Figure 9. Power Distribution of the Sun Related to the Human Eye.

Unlike other electromagnetic radiation, the peak radiation from objects at the temperature of the earth, and of humans, vehicles, aircraft, etc., lies at infrared wavelengths. This makes the infrared portion of the spectrum militarily important.

For detection of an object, whether it is with the human eye or with an electro-optical sensor, it is not where the maximum emissions occur in the spectrum that is important. It is where the maximum difference between the target and background lies that is most significant.

The *absolute* signature of a source or target is the power radiated and reflected by the target without influence from background radiation. Absolute signature can be measured with an instrument such as an imaging camera at close range, producing highly resolved IR imagery. The difference between radiation from a target and its background is its *contrast*. Contrast is the target signature relative to a specific background. Contrast irradiance is the quantity detected by any remote sensor or missile. Contrast varies greatly with background conditions.

Figure 10 shows several different types of source distributions encountered by infrared sensors. Most targets of military interest are a complex combination of spectral contributions from a variety of sources. For example, the signature of an aircraft can typically be described by the contributions from airframe, hot engine parts, and plume.

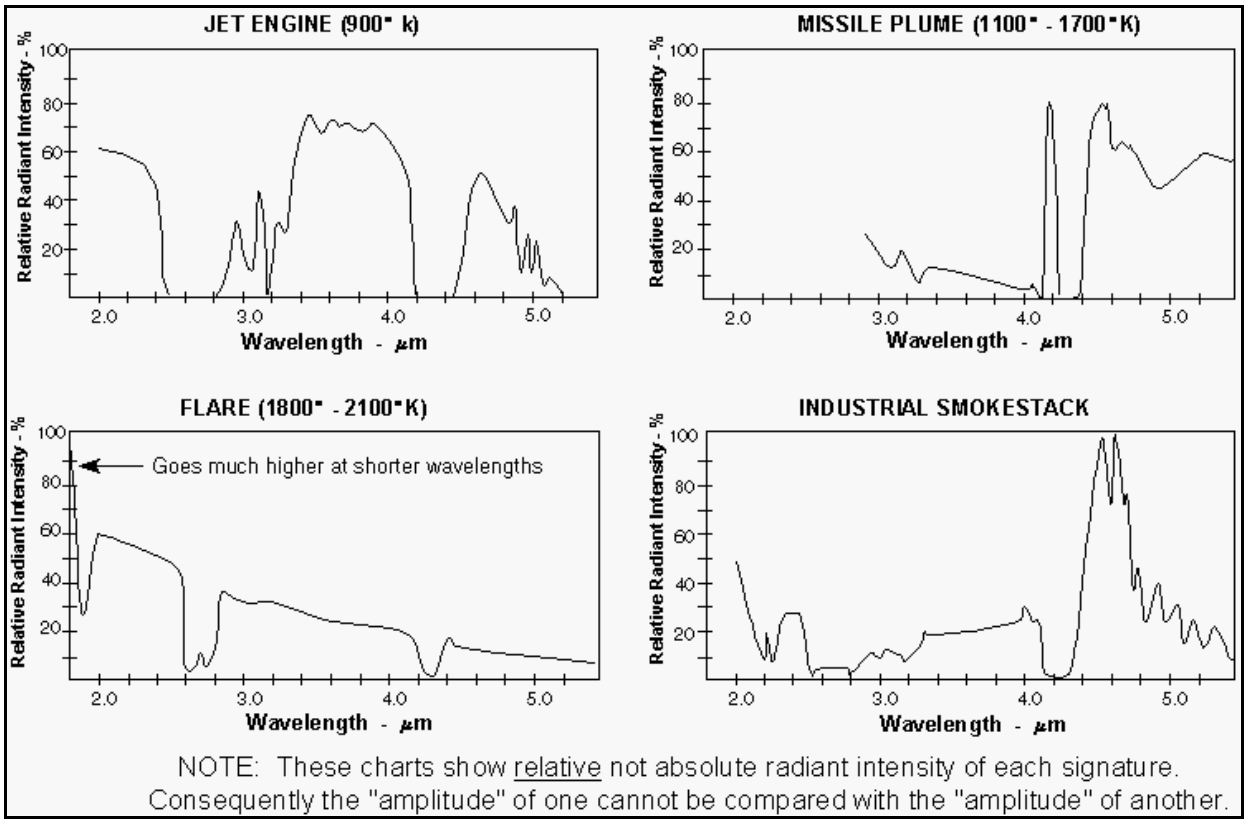

Figure 10. Spectral Distribution of Various Targets.

ATMOSPHERIC TRANSMISSION

The radiation emitted or reflected from the targets and backgrounds must pass through the intervening atmosphere before reaching the detection system. The radiation is absorbed and re-emitted by molecular constituents of the atmosphere and scattered into and out of the path by various aerosol components.

Figure 11 reveals the presence of atmospheric windows, i.e. regions of reduced atmospheric attenuation. IR detection systems are designed to operate in these windows. Combinations of detectors and spectral bandpass filters are selected to define the operating region to conform to a window to maximize performance and minimize background contributions.

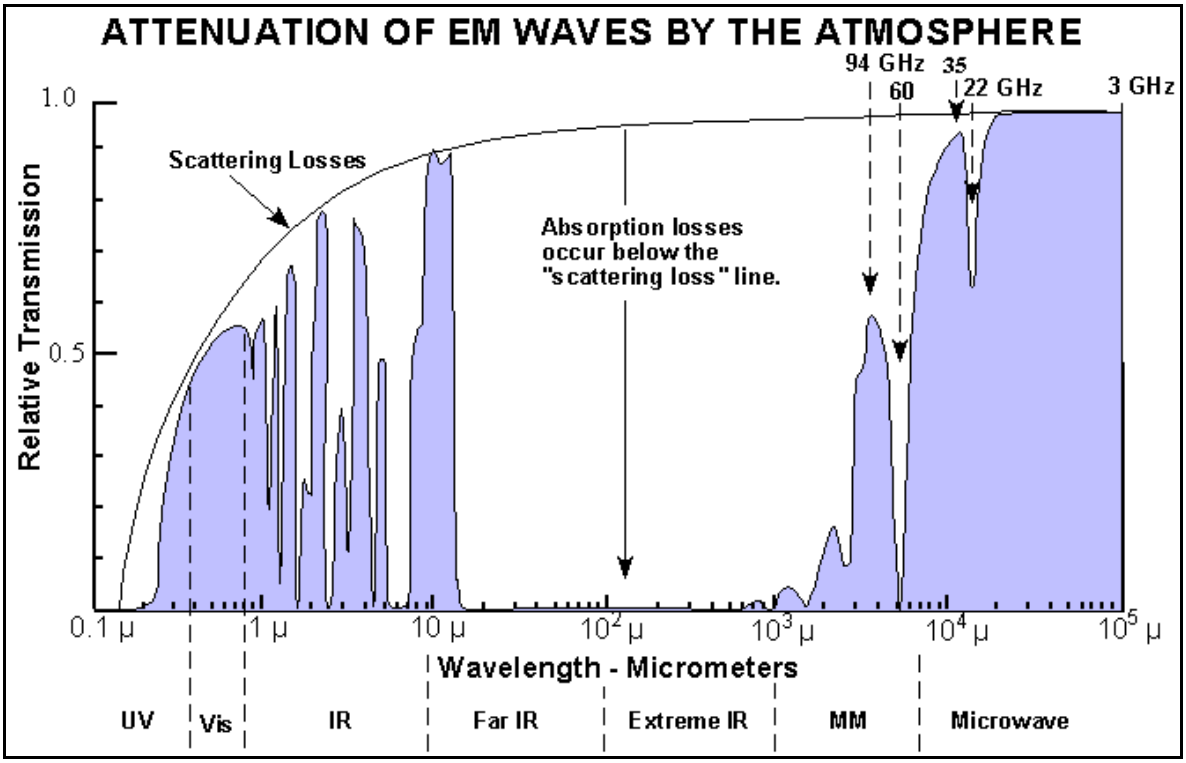

Figure 11. Atmospheric Transmission Over 1 NM Sea Level Path.

The molecules that account for most of the absorption in the IR region are water, carbon dioxide, nitrous oxide, ozone, carbon monoxide, and methane. Figure 12 shows an expanded view of the infrared portion of the spectrum.

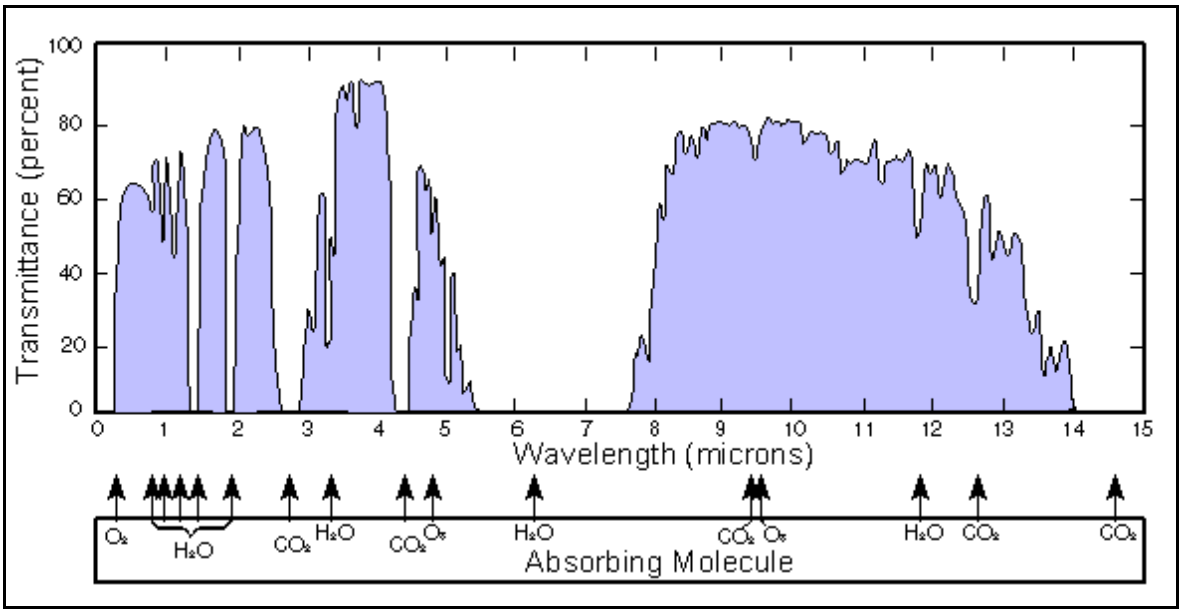

Figure 12. Transmittance of Atmosphere Over 1 NM Sea Level Path (Infrared Region).

The transmission in a window is greatly dependent on the length and characteristics of the path. As path length increases, absorption gets deeper and broader. Water vapor also has a significant effect overall on transmission through the atmosphere. High relative humidity attenuates transmission at all optical wavelengths.

Since water vapor generally decreases with altitude, transmission generally increases and path length becomes the determining factor. However, path length does not affect transmission of all wavelengths the same.

The altitude effects on transmittance are shown in Figure 13.

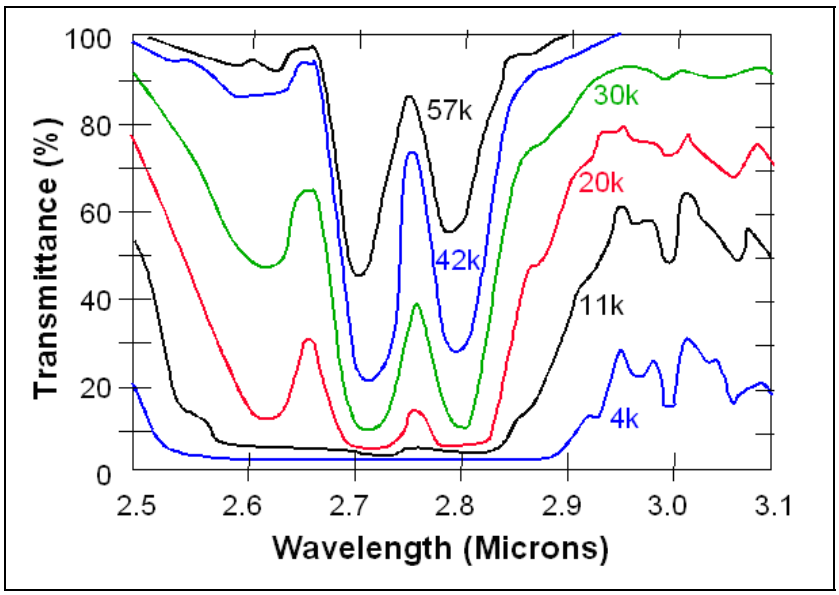

Figure 13. Transmittance at Various Altitudes.

A great deal of work has gone into developing high fidelity atmospheric models. One of the most commonly used tools is MODTRAN™ (MODerate Resolution Atmospheric TRANsmission). MODTRAN™ models atmospheric propagation of EM radiation from 0.2 to 100 um. MODTRAN was developed by Spectral Sciences Inc. and the United States Air Force Research Laboratory.

ELECTRO-OPTICAL COMPONENTS AND SENSORS

Almost all IR instruments, missiles, search systems, etc. have similar functional components. Basic components typically include:

- Optics - Reflective or refractive lenses to:
  - Collect radiation. Irradiance (power density) is increased by collecting radiation over a large area and focusing down to a small area.
  - Form or focus an image that will be used to extract information about the target.

- Filter(s) - Spectral and spatial filters to distinguish target from background and to extract
  - Target information.
  - Spectral filters restrict sensitive wavelength range.
  - A spatial filter separates image information by features such as size or position.

- Detector - A transducer to convert received radiation to an electrical signal for processing.

- Electronics - Used to amplify and condition the detector signal and perform some action, such as controlling a servo for tracking and guidance or recording the received information. In addition to the above, the optical head may also contain a window to protect the electronics and an output unit consisting of indicators or displays.

Windows / Domes / Lens Materials

For most applications of EO systems in EW the detection system is protected from the environment by a window or dome of optically transmissive material. The window operates both as a weather seal and, in some cases, helps to define the spectral response region of the system. In some cases the window functions as a lens.

IR energy interacts with matter in ways we associate with light (reflection, refraction, and transmission). Lower energy of IR photons results in different optical properties than light. For example:

- Glass and water are not transparent to wavelengths longer than about 3 microns.
- Silicon and germanium are highly transparent to infrared radiation, but are opaque to visible light.

Transmission bands of representative window or lens materials are shown in Figure 14. The end points depicted are for the 10% transmission wavelengths. Not shown in Figure 14 are the various UV transmissive glasses such as Pyrex, Corex, and Vycor or Amorphous Material Transmitting IR radiation (AMTIR) which are various combinations of Ge-As-Se (AMTIR-1), As-Se (AMTIR-2, 4, & 5), Ge-Sb-Se (AMTIR-3), As-S (AMTIR-6).

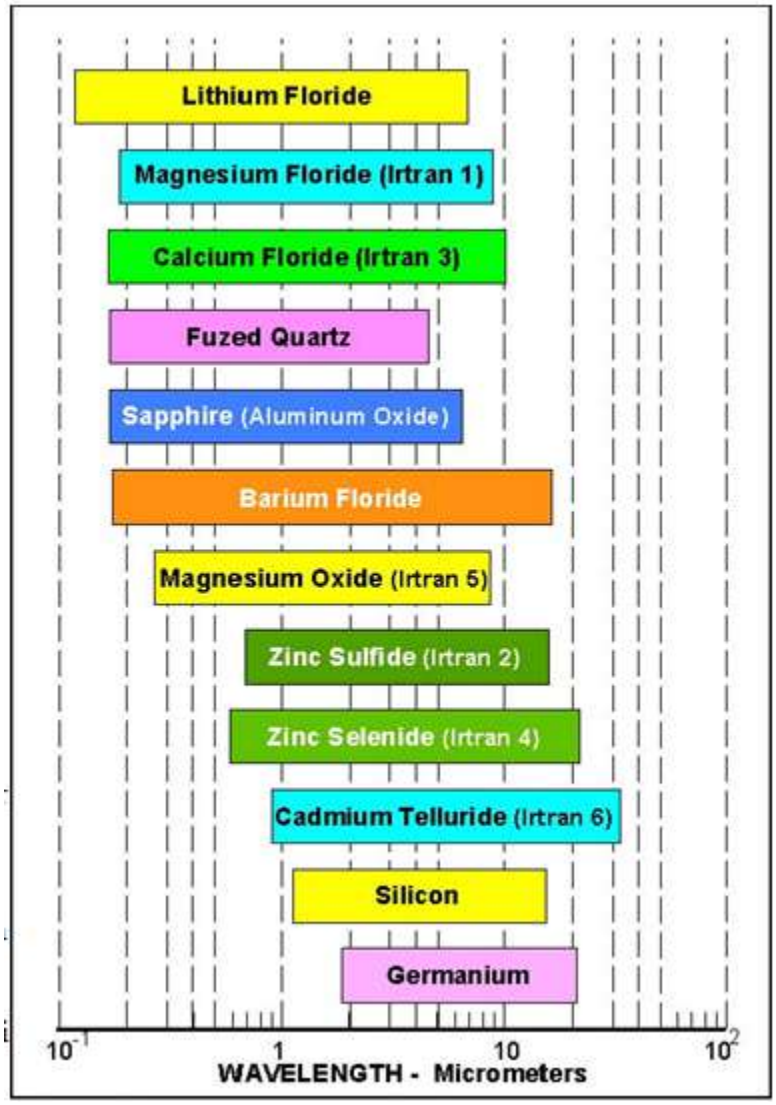

Figure 14. Transmission of Selected Window / Lens Materials.

Objective Lens

The objective lens is the first optical element in a lens in a typical sensor or missile seeker. The objective lens serves two main functions:

- Collect radiation (i.e., multiply irradiance (power density) by collecting over a large area and focusing onto a small area)
- Form an image of the target scene onto a filter and detector array.

Lens Types

Lenses for the IR can be either refractive or reflective. Refractive optics are "straight through" lenses, with the light never making large bends as shown in Figure 15.

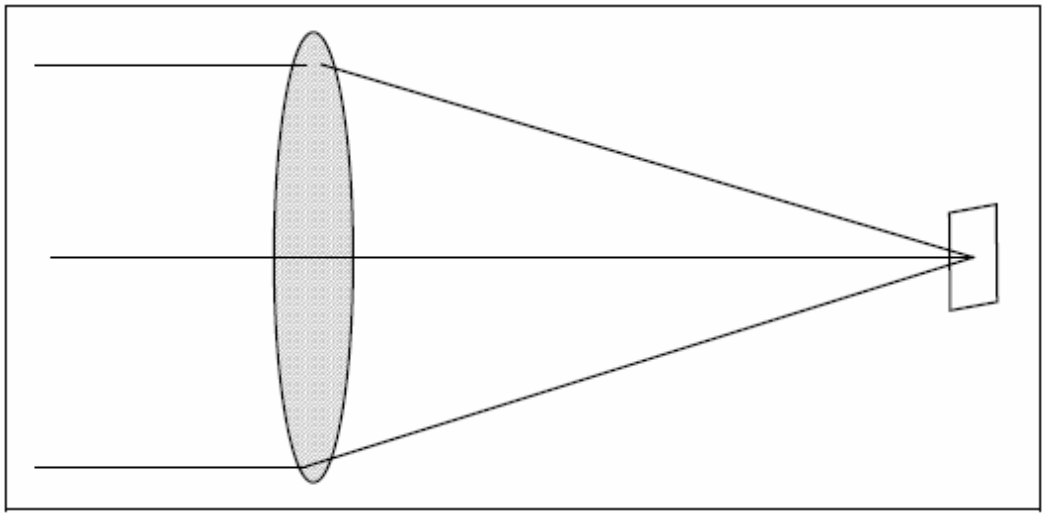

Figure 15. Refractive Lens.

A common reflective design used in many missiles is the Cassegrain. The Cassegrain design shown in Figure 16 is compact in size for its focal length.

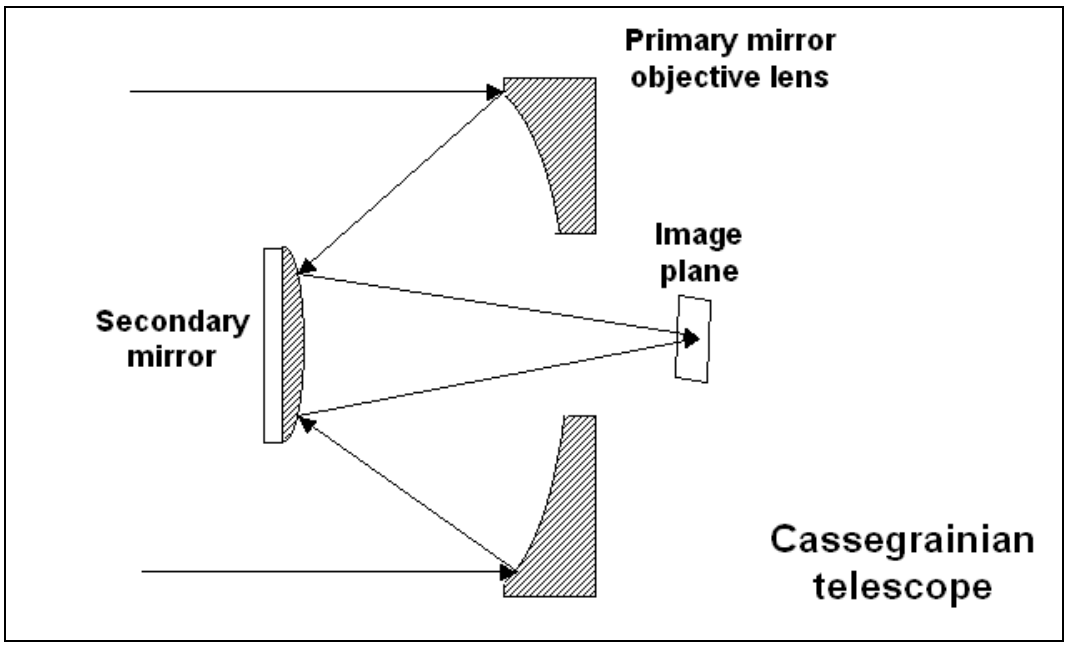

Figure 16. Cassegrain Lens.

Optical Filters

Filters may be divided into two major categories: (1) spectral and (2) spatial.

Most optical radiation detectors have a wider sensitivity band than desired for the particular application. Spectral filters restrict sensitive wavelength range. Reasons for filtering include: enhancement of target-to-background contrast, avoidance of unwanted plume emissions and/or atmospheric absorption regions, and extraction and measurement of target spectral features.

To further define the system sensitivity, band interference filters or absorption filters are used. An absorption filter is a bulk material with a sharp cut-on or cut-off in its transmission characteristic. A cut-on and a cut-off filter can be combined to make a bandpass filter. By selecting absorption characteristics of absorption filters combined with the response of a detector, the desired system response can be obtained. An interference filter is composed of dielectric coatings on an appropriate substrate combined in such a way to produce cut-on, cut-off, or bandpass filters. Interference filters allow more control of the final response characteristics and smaller elements. See Figure 17.

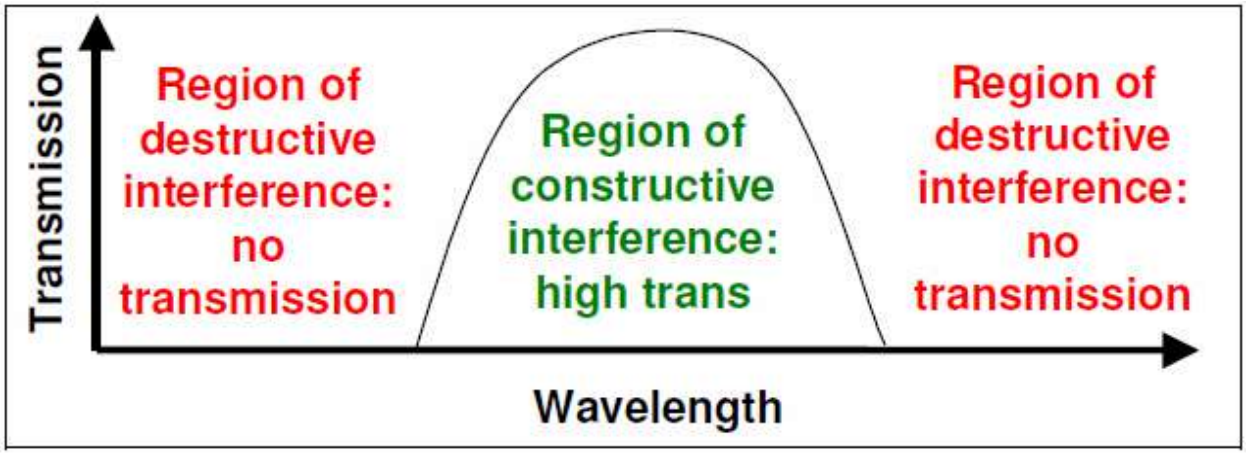

Figure 17. Spectral Bandpass Filter.

Most spectral filters are of the thin-film interference type. Layers of dielectric material are vacuum deposited on a substrate window material. Typical substrate materials in IR are sapphire, silicon, and germanium. Thickness of deposited layers designed to have constructive interference to pass desired radiation at desired wavelengths and destructive interference to block undesired wavelengths Besides spectral filters, EO system optics often have antireflection (or AR) coatings to eliminate or greatly reduce unwanted reflections between optical elements.

A spatial filter separates information in a scene image by features such as size or position. Spatial filters take a variety of forms. Some common types and their functions include:

- Field stop: limits an instrument's field of view. Blocks unwanted sources (such as sun) outside nominal field of view.
- Mechanical modulator or "chopper."
- Reticle: A mechanical modulator used in many missile designs. Usually discriminates against extended sources (such as background) in favor of "point" target sources and provides target directional information from modulation phase.

Detector Coolers

Many IR detectors have to be cooled for proper operation. Most systems use closed-cycle coolers or thermoelectric coolers. Thermoelectric coolers use the Peltier effect, which produces a reduced temperature by passing a d-c current through a thermoelectric junction. Multi-stage coolers can cool a detector down to below 200ºK. Closed-cycle coolers typically are of the Stirling cycle design and utilize the expansion of a gas (helium) to cool a cold finger attached to the detector. These generally operate at liquid nitrogen temperature (77ºK).

Detectors

A detector is a transducer that transforms electromagnetic radiation into a form, which can be more easily detected. In the detectors of interest to EW the electromagnetic radiation is converted into an electrical signal. In some systems the signal is processed entirely within the system to perform its function. In others the signal is converted to a form to allow the human eye to be used for the final detection and signal analysis.

Detectors are transducers than convert optical radiation into electrons. The physical effects by which electromagnetic radiation is converted to electrical energy are divided into two categories: photon effects and thermal effects. EW systems primarily use detectors dependent on photon effects. These effects can be divided into internal photo effects and external photo effects.

The external photo effect is known as photoemission. In the photoemissive effect, photons impinging on a photocathode drive electrons from its surface. These electrons may then be collected by an external electrode and the photocurrent thus obtained is a measure of the intensity of the received radiation.

Internal photoeffects of interest are the photoconductive effect and the photovoltaic effect. In the photoconductive effect, absorbed photons cause an increase in the conductivity of a semiconductor. The change is detected as a decrease in the resistance in an electrical circuit. In the photovoltaic effect, absorbed photons excite electrons to produce a small potential difference across a p-n junction in the semiconductor. The photovoltage thus produced may be amplified by suitable electronics and measured directly.

Thermal detectors respond directly to heat. Examples of these devices include bolometers, thermopiles, and pyroelectric detectors. The pyroelectric effect is an example of the thermal effect. The pyroelectric effect is a change in polarization in a crystal due to changes in temperature. Radiation falling on such a crystal is detected by observing the change in polarization as a build up of surface charge due to local heating. When coated with a good black absorber, the crystal will be sensitive to a wide band of wavelengths.

Figure 18 shows the spectral sensitivity range of typical detectors using these effects.

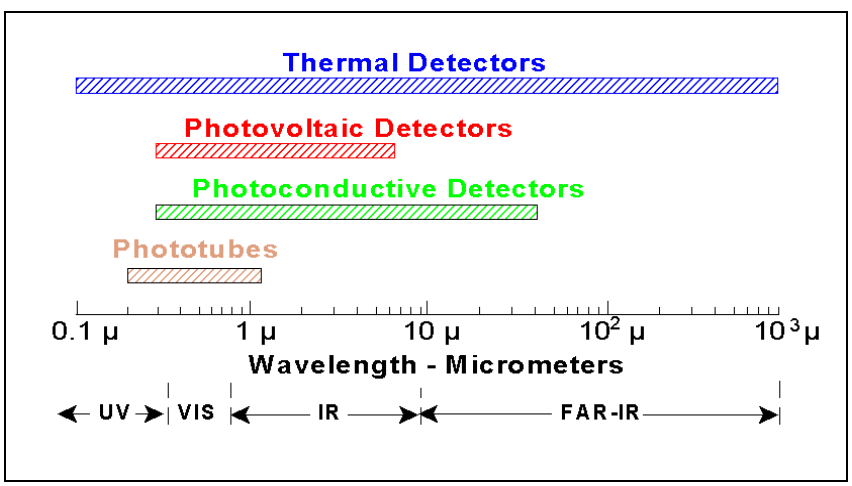

Figure 18. Spectral Range of Various Detectors.

Detector Types

Photoconductive detectors operate as resistors in a circuit. The resistance of the detector changes as the radiation incident on its surface changes. For EW applications, the most photoconductive detector types include: Indium Antimonide (InSb), which can also be operated in photovoltaic mode; Gallium Arsenide (GaAs); Lead Sulfide (PbS); and Lead Selenide (PbSe).

Photovoltaic detectors, the most common detectors used in modern EW and military sensor applications, produce a voltage that is proportional to the incident radiation. Common examples of photovoltaic detectors are Indium Antimonide (InSb) and Mercury Cadmium Telluride (HgCdTe). Both of these detector types offer high sensitivity when cryogenically cooled.

Diode phototubes and photomultipliers are commonly used detectors for UV systems including many operational missile-warning systems. These types of tubes offer the advantage of operating uncooled which can significantly reduce the complexity of a sensor system and offer increased reliability. Most of the modern IR sensors require cooled detectors. InSb, for example, requires cooling to 77 Kelvin to achieve the necessary sensitivity. Depending on the application, HgCdTe can be operated at somewhat higher temperature conditions.

A Photoelectromagnetic (PEM) detector has a junction that generates a current when exposed to light in a magnetic field.

Some detectors (such as InSb) have multiple modes of operation, including: Photoconductive (PC), Photovoltaic (PV), or Photoelectromagnetic (PEM) modes of operation.

Detector Parameters and Figures of Merit

The important parameters in evaluating a detector are the spectral response, time constant, the sensitivity, and the noise figure.

The spectral response determines the portion of the spectrum to which the detector is sensitive.

The time constant is a measure of the speed of response of the detector. It is also indicative of the ability of the detector to respond to modulated radiation. When the modulation frequency is equal to one over the time constant, the response has fallen to 70.7 % of the maximum value. The time constant is related to the lifetime of free carriers in photoconductive and photovoltaic detectors and to the thermal coefficient of thermal detectors. The time constant in photoemissive devices is proportional to the transit time of photoelectrons between the photocathode and anode.

The sensitivity of a detector is related to its responsivity. The responsivity is the ratio of the detected signal output to the radiant power input. For photoconductive and photovoltaic detectors the responsivity is usually measured in volts per watt -- more correctly, RMS volts per RMS watt. However, the sensitivity of a detector is limited by detector noise. Responsivity, by itself, is not a measure of sensitivity. Detector sensitivity is indicated by various figures of merit, which are analogous to the minimum detectable signal in radar. Such a quantity is the noise equivalent power (NEP). The NEP is a measure of the minimum power that can be detected. It is the incident power in unit bandwidth, which will produce a signal voltage equal to the noise voltage. That is, it is the power required to produce a signal-to-noise ratio of one when detector noise is referred to unit bandwidth. The units of NEP are usually given as watts, but more correctly, are watts/$Hz^{1/2}$ or watts·$sec^{1/2}$.

Another figure of merit is the noise equivalent irradiance (NEI). The NEI is defined as the radiant power per unit area of the detector required to produce a signal-to-noise ratio of one. The units of NEI are watts per square centimeter.

Noise equivalent power (NEP) is the radiant power required to produce a signal to noise ratio of one for a detector. Detectivity (D) of a detector is defined as the reciprocal of the NEP. The units of D are watts $^{-1}$·sec $^{-½}$. A higher value of detectivity indicates an improvement in detection capability. Since D depends on detector area, an alternate figure of merit, known as D-star (D*). D* is the detectivity measured with a bandwidth of one hertz and reduced to a responsive area of one square centimeter. The units of D* are cm·watts $^{-1}$·sec $^{-½}$. D* is the detectivity usually given in detector specification sheets. Typical spectral detectivity characteristics for various detectors are shown in Figure 19.

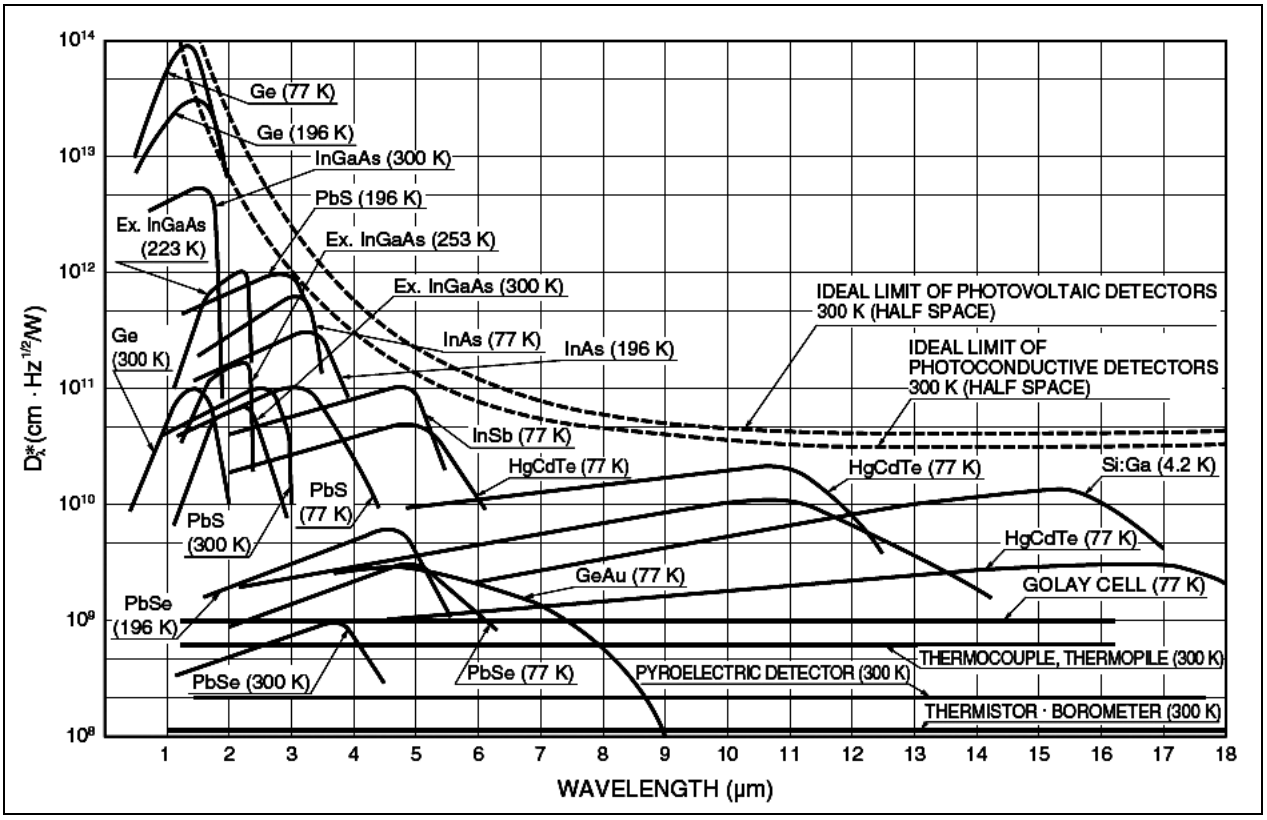

Figure 19. Spectral Detectivity of Various Detectors.

Besides the NEI mentioned above, the quantum efficiency of the photocathode is also a figure of merit for photoemissive devices. Quantum efficiency is expressed as a percent -- the ratio of the number of photoelectrons emitted per quantum of received energy expressed as a percent. A quantum efficiency of 100 percent means that one photoelectron is emitted for each incident photon.

There are other figures of merit for television cameras. The picture resolution is usually described as the ability to distinguish parallel black and white lines and is expressed as the number of line pairs per millimeter or TV lines per picture height. The number of pixels in the scene also defines the quality of an image. A pixel, or picture element, is a spatial resolution element and is the smallest distinguishable and resolvable area in an image. CCD cameras with 512 x 512 elements are common.

Another resolution quantity is the gray scale, which is the number of brightness levels between black and white a pixel can have.

Noise in Detectors

The performance of a detector is limited by noise. The noise is the random currents and voltages that compete with or obscure the signal or information content of the radiation. Five types of noise are most prominent in detectors: (1) thermal, (2) temperature, (3) shot, (4) generation-recombination, and (5) 1/f noise.

Thermal noise, also known as Johnson noise or Nyquist noise, is electrical noise due to random motions of charge carriers in a resistive material.

Temperature noise arises from radiative or conductive exchange between the detector and its surroundings, the noise being produced by fluctuations in the temperature of the surroundings. Temperature noise is prominent in thermal detectors.

Shot noise occurs due to the discreetness of the electronic charge. In a photoemissive detector shot noise is due to thermionic emission from the photocathode. Shot noise also occurs in photodiodes and is due to fluctuations in the current through the junction.

Generation-recombination noise is due to the random generation and recombination of charge carriers (holes and electrons) in semiconductors. When the fluctuations are caused by the random arrival of photons impinging upon the detector, it is called photon noise. When it is due to interactions with phonons (quantized lattice vibrations), it is called generation-recombination noise. Johnson noise is predominant at high frequencies, shot noise predominates at low frequencies, and generation-recombination and photon noise are predominant at intermediate frequencies.

As the name implies, 1/f noise has a power spectrum that is inversely proportional to frequency. It is dominant at very low frequencies. In photoemissive detectors it is called flicker noise and has been attributed to variation in the emission from patches of the photocathode surface due to variation in the work function of the surface. In semiconductors 1/f noise is also called modulation noise. Here it is apparently due to surface imperfections and ohmic contacts (which are a form of surface imperfection).

Infrared Spectral Region and Features of Interest

Different portions of the infrared spectrum are common for particular applications. The reasons for the selection of a specific window are often sensitive and beyond the scope of this document, but selections are typically based on several key considerations:

- Target characteristics such as size and spectral distribution of signature.
- Background radiance and clutter.
- Atmospheric effects (transmission, path radiance, scintillation, etc.).
- Distinguishing characteristics between natural and man-made sources.

Table 6 describes some of the types of characteristics that are prevalent in the short-wavelength (SWIR) infrared (0.7 to 3.0 microns), mid-wavelength (MWIR) infrared (3.0 to 6.0 microns) and long-

wavelength (LWIR) infrared (7.0 to 14.0 microns) along with some types of systems that operate in these regions.

Table 6. Infrared Features, Regions, and Types of Systems.

Near or Short Wave IR (SWIR)	**Dominant natural source**:	**Sun**
	Atmospheric:	
	Transmission:	High
	Path radiance:	Scattered sunlight
	Dominant aircraft IR component:	Sunlit airframe
	Anti-aircraft threat:	Vehicle-launched SAM
Mid-wave IR (MWIR)	**Dominant natural source:**	**Sun**
	Atmospheric:	
	Transmission:	High transmission "windows" between H_2O and CO_2 absorption
	Path radiance:	Scattered sunlight below 3 microns Thermal at longer than 3 microns
	Dominant aircraft IR component:	Engine hot parts and plume
	Anti-aircraft threat:	All AAMs and SAMs
Far or Long-wave IR (LWIR)	**Dominant natural source:**	**Earth**
	Atmospheric:	
	Transmission:	High
	Path radiance:	Low: small thermal emission from ozone
	Dominant aircraft IR component:	Airframe direct emission and terrestrial illumination
	Anti-aircraft threat:	Airborne IRST. No anti-aircraft missiles

Sensors and Detection

Figure 20 shows a generalized detection problem. On the left of the diagram are the radiation sources - the sun, background, and the target of interest. In the middle is the intervening atmosphere, which attenuates the radiation as it travels to the detection system shown on the right of the diagram.

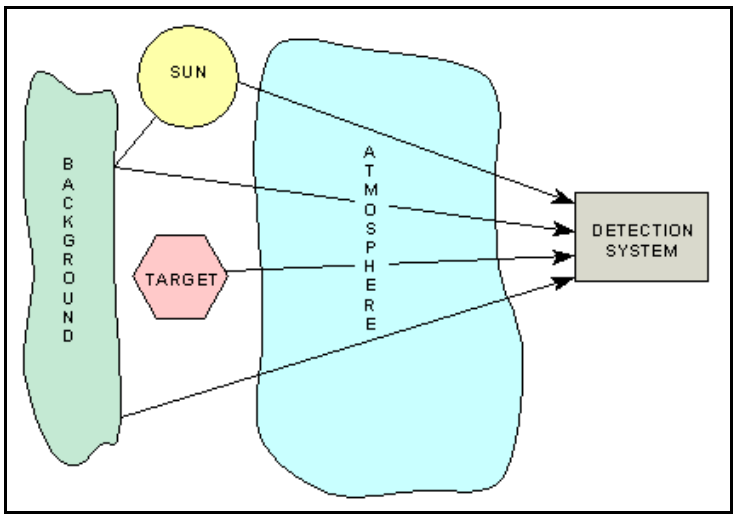

Figure 20. Generalized Detection Problem.

Figure 21 shows the basic relationships that are critical to detection of a target in the infrared. The figure is based on a generalized aircraft, but the principles apply whether the target is in fact an aircraft against a sky background or a ground vehicle being viewed from above against a terrain background. At detection, most targets are unresolved. The sensor's ability to detect the target against background in this case is driven primarily by noise equivalent irradiance.

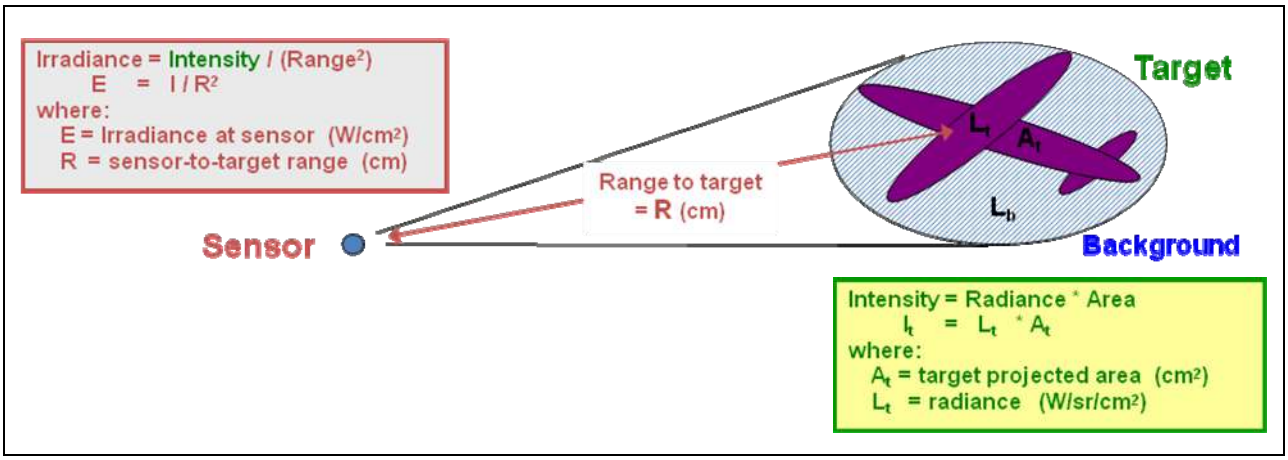

Figure 21. Detection of a Target with a Remote Sensor.

Each of the equations shown in Figure 21 in reality has atmospheric effects and attenuation due to transmission losses and contributes to path radiance. Just as the power distribution of the target and background vary with wavelength, atmospheric effects are also spectrally selective.

Figure 22 shows the roll off of irradiance as a function of range for two different aircraft. Detection occurs at the point of intersection with the sensors noise equivalent irradiance. In the case of threat missiles, there is often a signal-to-noise threshold required for launch of the missile to ensure target quality prior to launch. The product of noise equivalent irradiance and the threshold for these systems is known typically as the minimum trackable irradiance (MTI). This is the figure used to calculate detection range for such systems.

In an effort to simplify calculations, band average atmospheric transmission values are often applied during analysis of detection scenarios. The target itself is non-uniformly distributed as a function of wavelength, and the atmospheric effect is non-uniform, so this approach is mathematically incorrect since it pulls a non-constant term out of an integral. The degree of error introduced by the band average approach depends on the spectral distribution of the source and the overall transmission of the band in question, but caution should be applied when applying band averages. All calculations involving atmospheric propagation should be done spectrally and then integrated to provide the in-band value.

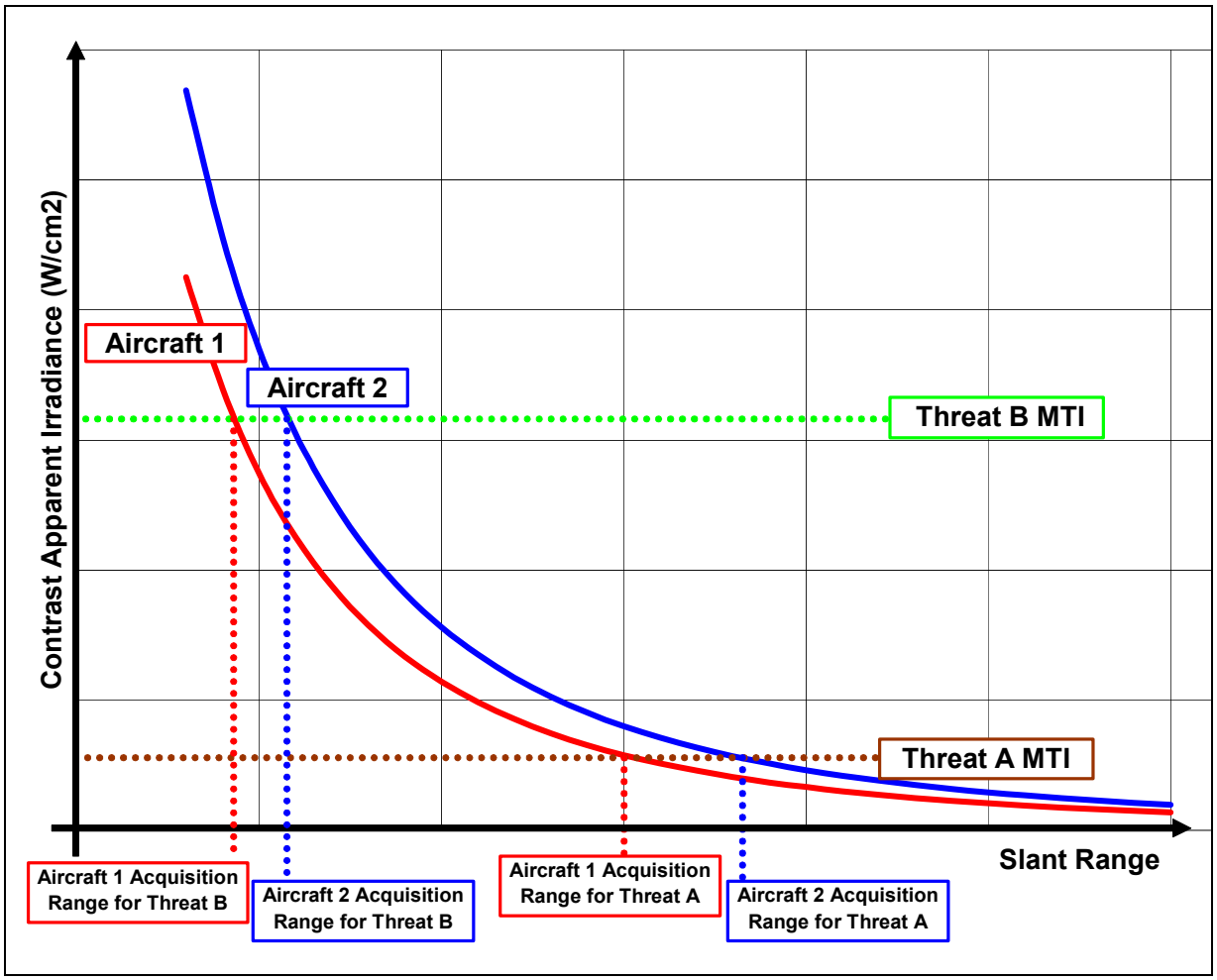

Figure 22. Detection Range Calculation.

Sensor Characterization

As described in a previous section, the output of every sensor is proportional to an integral of the received radiation weighted by the instrument's response function in that domain. Every sensor responds to radiation in accordance with the characteristics of the sensor and its components.

Characterization quantifies the sensor's response shape. Knowledge of response shape is essential to the design of a sensor and understanding its performance in with changing ambient conditions and against various types of targets in real environments.

Normalization

Calibration of a sensor, which describes its response to known input sources, and characterization of the sensor would ideally be the same process. Ideally, the absolute instrument response would be mapped over a domain with a traceable standard laboratory source that was tunable across the range of interest. In the spectral domain, for example, this would require a tunable monochromater whose output beam provided a level of spectral irradiance traceable to a radiation standard and that also had a

cryogenically-cooled background source. The result would be an absolute spectral response function in units of output reading per unit radiance (or irradiance) as a function of wavelength.

In practice, it is sufficient and more practical to separate the characterization and calibration processes, so characterization determines only the relative response shape rather than absolute. Calibration then incorporates the results of the shape characterization to determine the absolute instrument response. Both, however, are important to understanding performance of a sensor.

Characterization uses a variety of different methods and sources to map relative response shapes. The response curve is then normalized and this normalized curve is used in the later derivation of the calibration coefficients. Different normalizations, such as normalization to an average value, are possible, but the convention throughout most of the measurement community today is to normalize response curves to unity at the peak.

When the contributions of all the components are combined into one curve, the result is then peak normalized and this, now unitless, curve is used in the calibration calculations.

Calibration

Sensor calibration, which is the process of relating the known input power to the output of a sensor, requires the use of standard sources, typically National Institute of Standards and Technology (NIST) traceable blackbodies and various other laboratory equipment such as collimators which make all of the rays coming from the source parallel to each other, thus representing a source at infinity. Figure 23 is a pictorial illustration of the calibration of a sensor.

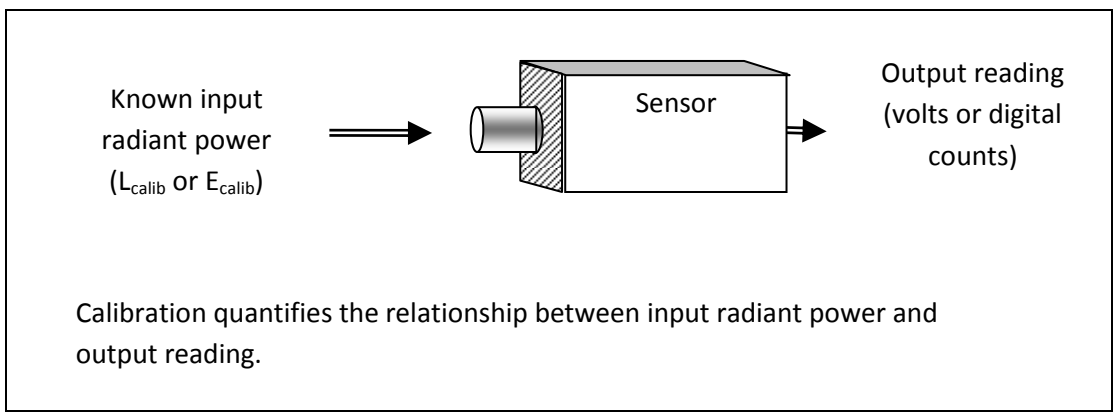

Figure 23. Sensor Calibration Relates Input Power to Output.

Calibration of a sensor usually involves two major steps. Responsivity is the change in output of the sensor to changing input. For a sensor that responds linearly, for example, responsivity represents the slope of the curve when source radiance or incident irradiance is plotted against output voltage or counts for a digitized system. Figure 24 represents a calibration curve for a sensor that has a linear change in output over its dynamic range with changing input power. The slope of the curve is the "m" in the linear equation. Not all sensors respond linearly with power. Higher order response coefficients are common, especially for bolometers and infrared focal plane array sensors operated at short integration times. For these the process of determining the response of the instrument is the same, the curve just yields higher order terms.

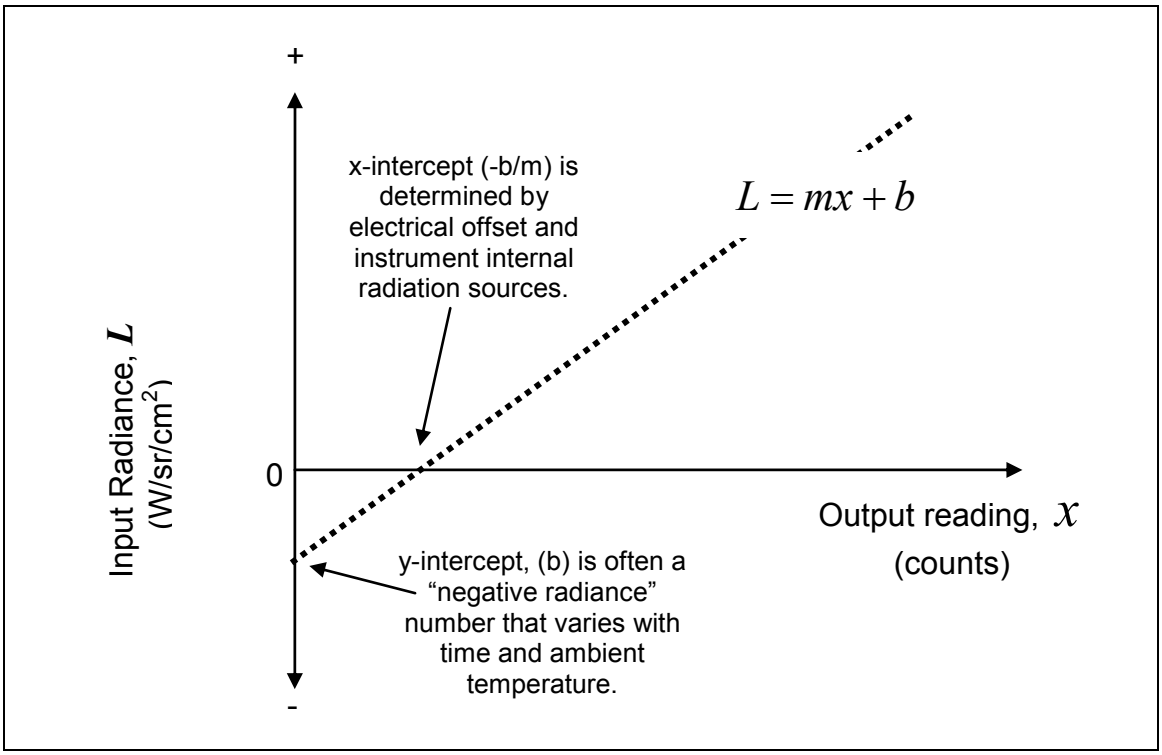

Figure 24. Calibration of a Sensor to Determine Responsivity and Offset.

For most electro-optical sensors, the responsivity does not change with ambient temperature. In other words, the non-constant terms in the calibration equation, whether it is linear or higher order, do not change with changes in temperature. Over time, however, as detectors decay, responsivity decreases. This would show itself on the Figure 24 as an increase in the slope value, i.e., higher input power is required for the same output as the detector becomes less responsive.

Offset

Offset is another important parameter for instrument calibration. For any real (non-ideal) instrument, the response curve does not pass through zero. There are several reasons for this; one being that except in a complete vacuum, zero radiance does not exist. Additionally, contributions from detector noise and radiation from the optical elements in the lens, which cause the offset to drift with changes in ambient temperature, contribute to the offset term. Some amount of offset is designed into the system as well. All electronic circuits have some amount of DC drift. To prevent clipping of the signal if this drift should go below the lower limit of the analog-to-digital converter, the "bottom end" level is adjusted up to some offset level. The consequence of this offset voltage is the addition of a y-intercept term (b), which also must be quantified by the calibration if the sensor is a laboratory instrument. For a sensor that is used for contrast detection, the intercept value is unimportant since it subtracts out in the contrast calculation.

Sensitivity

Sensitivity for a sensor is determined to a large extent by the noise level in the detector output. For focal plane array detector, pixel-to-pixel non-uniformity also limits the sensitivity of the system since

detection is determined by contrast with surrounding pixels. In practice, at least for cooled infrared sensors, detection is typically limited by background and not noise limits.

Instrument Response Uniformity and Non-Uniformity Correction

In reality, all sensors exhibit non-uniform response in all of the domains referenced previously. For example, in the spatial domain, the raw output of an infrared focal plane array detector exhibits pixel-to-pixel offset differences and response differences across the field-of-view. The response change is the result of two primary factors. Since each pixel is essentially a unique detector, it exhibits unique response because of manufacturing tolerances, slight differences in crystal structure, etc. Additionally, most electro-optical sensors implement an aperture or "field stop" in the case of infrared sensors, that limits the radiation that can reach the detector outside of the sensor's desired field-of-view. Radiation entering at angles off of normal to the detector shows a cosine roll-off in incident power. The result is a reduction in responsivity for pixels that are radially separated from the center of the detector. For the majority of systems, an optical gain correction can be applied to compensate for the change in response. The typical method involves using an extended blackbody source that fills the FOV of the sensor. Reference images are collected with the source at two temperatures that are well separated across the sensor's dynamic range. This process is typically called a "2-point" correction. Actual temperature is unimportant. Slope corrections can be determined for each pixel. The result is a gain map that can be stored in the sensor electronics that can be applied to each image to correct for the non-uniform spatial response across the detector array. Pixel-to-pixel offset maps can be determined using one of the same reference images. Pixel slope and offset corrections are typically derived as normalized quantities relative to a center pixel, average of center pixels, or maximum value. The application of the correction maps to the images is commonly referred to as "non-uniformity correction." Figure 25 shows the transition from a raw image to a non-uniformity corrected image.

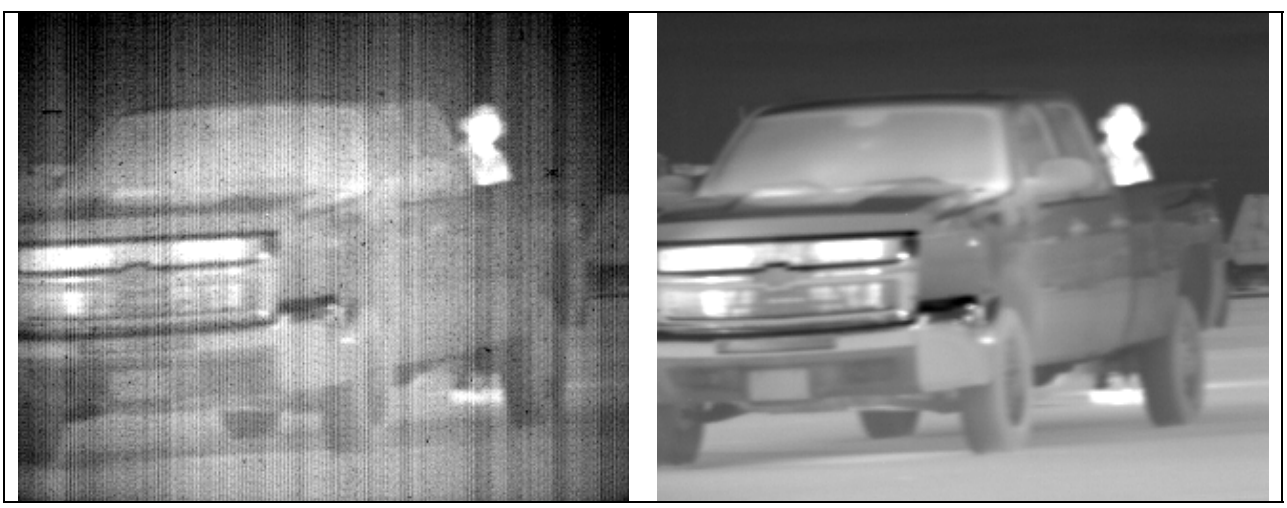

Figure 25. Non-Uniformity Correction of a Mid-IR Image.

Bad Pixel Replacement

Focal plane arrays have pixels that are either unresponsive or responsive outside of useful limits. Figure 25 shows some of the bad pixels that appear as small black spots in an image from an InSb IRFPA imager. Bad pixels can be identified during laboratory calibration or with a sensor mounted reference source. There are many approaches to replacement of bad pixels and the best approach often depends on the sensor characteristics and its application. One common approach is simply to replace the pixel with the average of its nearest neighbors.

INFRARED THREATS TO AIRCRAFT AND THEIR COUNTERMEASURES

IR guided missiles are the largest single cause for aircraft losses since the start of the 1991 Gulf war. All missiles designed within the last 20 years have counter-countermeasures circuitry. Every missile can be defeated with IR countermeasures given time to develop and test devices and techniques, but many missiles have not been exploited and the variety and complexity of the different designs present formidable challenges to the US countermeasure community.

The IR "signature" of any aircraft has three main components:

- Engine exhaust plumes
- Engine hot parts (tailpipe, etc)
- Airframe (aerodynamic heating & reflection from sun, earth, etc)

Infrared guided missiles modulate the signal produced by the aircraft in contrast with its background. Previous generations of missiles used reticles to produce signal waveforms that would provide spatial and temporal information from which signal processing could produce trackable information.

IR Missile Operation

Aircraft (or any other object) can be intercepted using several different types of guidance. The simplest type is pure pursuit, where the missile is always pointed directly at the target location. This is not aerodynamically efficient since the missile would follow a longer (curving) flight path when following a crossing target.

Most missile guidance systems are designed to lead the target so that intercept occurs at the point where the target will be at the time the missile arrives. This requires that the missile fly a course so the relative bearing to the target stays constant (constant "line of sight" angle). The LOS angle is determined by missile speed relative to the target (higher closing speed = smaller angle). The size of the angle isn't important; only that it be constant (zero line of sight rate) as shown in Figure 26.

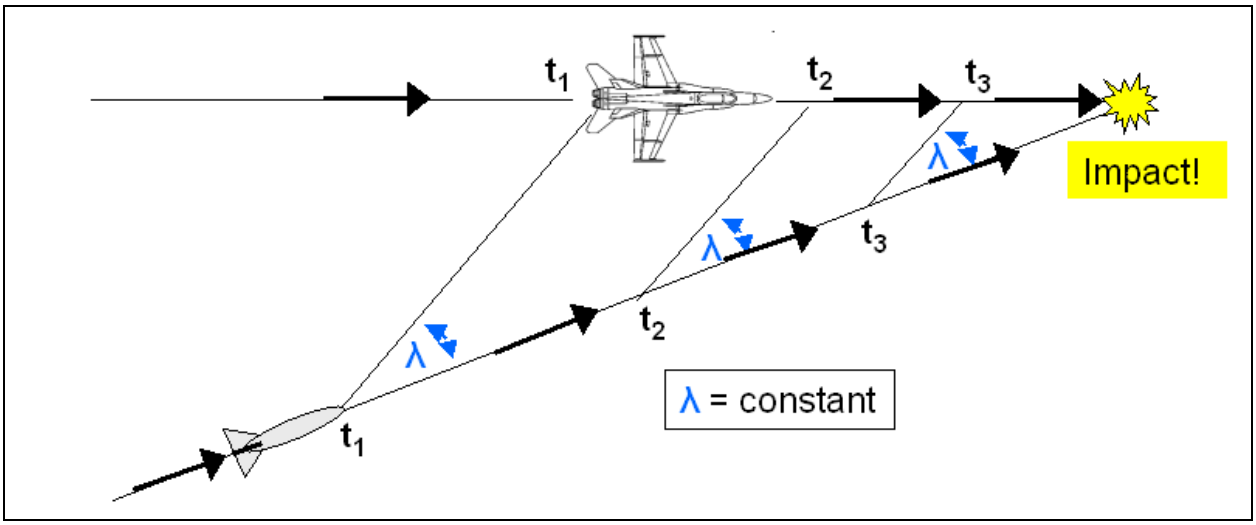

Figure 26. Missile Proportional Navigation.

This intercept course ("proportional navigation") requires that the missile have two separate servo loops: (1) a target tracker and (2) a wing control servo to control direction of flight

For a missile to guide to its intended target, it needs a tracker, which contains the following elements:

- Optics to collect and focus IR from target.
- Gimbals to allow movement to point the optics.
- Gyro stabilization to isolate optics from missile body.
- Detector to convert the received IR to electrical signal.
- Stabilization (gyro) to isolate from missile body.
- A method to determine target direction to enable closed-loop tracking.
- A method to distinguish the target from natural background.

The target tracker is the "window" into the missile's guidance through which it can be deceived by countermeasures.

The problem of determining target direction with a single detector was solved by forming an image of the target scene onto the center of a reticle disk that spun with the optics. Unlike, for example, the reticle in a rifle telescope that superimposes cross hairs, the reticle in a missile acts as a kind of shutter that blocks the passage of IR through part of the reticle and allows IR to pass through the other part. A target image falling on the opaque portion is blocked and produces no detector signal. A target image falling on the transparent portion is passed on to the detector. When the reticle is spun, IR from a target off center is alternately passed and blocked, resulting in amplitude modulation (AM). The phase of this modulation relative to a spin reference is used to tell target direction from center. A closed servo loop moves the optics to keep the target centered on the reticle. This is depicted in Figure 27.

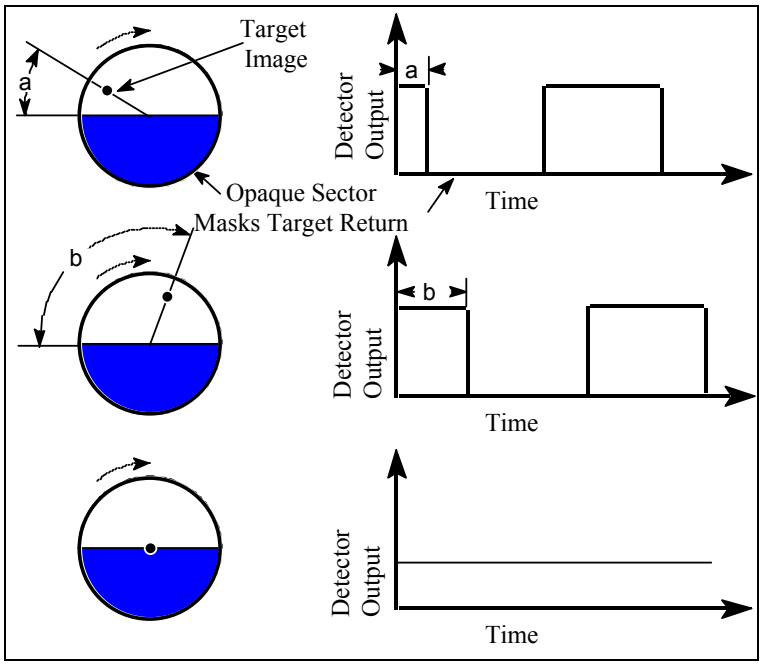

Figure 27. Basic Reticle Design.

Target trackers have another problem: The aircraft target must be distinguished from natural background sources, such as sunlit clouds and terrain. To solve this, they look for features in the spectral, spatial, and temporal domains where the target is different from background.

- Temporal: There is no difference. Neither clouds nor aircraft signature are time varying.
- Spectral: Some difference. Choice of wavelength band yields helpful differences between target and background, but this is not sufficient by itself.
- Spatial: The most viable option. Aircraft are smaller than clouds and terrain. Background radiation can be greatly reduced by spatial filtering.

If half of the reticle is made with opaque "spokes," then some irradiance from targets with small images (such as aircraft) will be modulated more completely and generate a stronger signal at a faster modulating rate than large images (clouds) as shown in Figure 28.

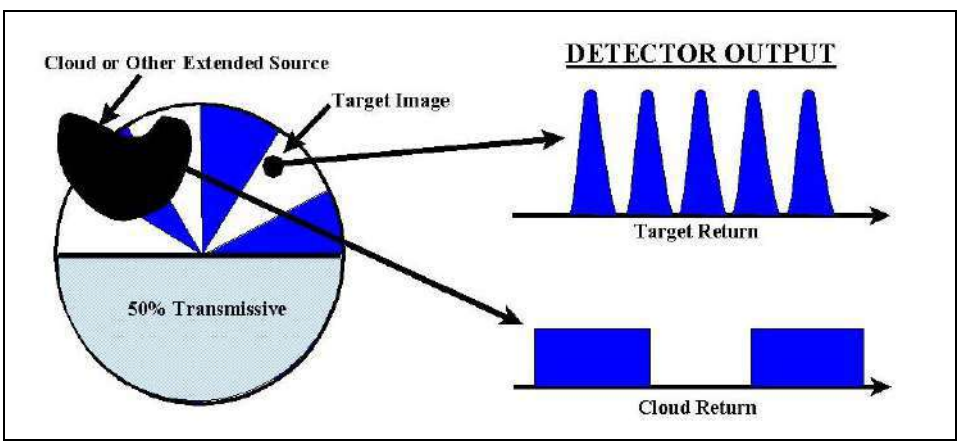

Figure 28. IR Seeker Design for Background Discrimination.

The past figure and the following two figures (29 and 30) depict a spin-scan reticle used on the early Sidewinder designs. After the detector preamp, signal goes through a narrow bandpass filter to improve S/N. The AM waveform is then rectified and filtered. Target direction is determined from AM envelope phase.

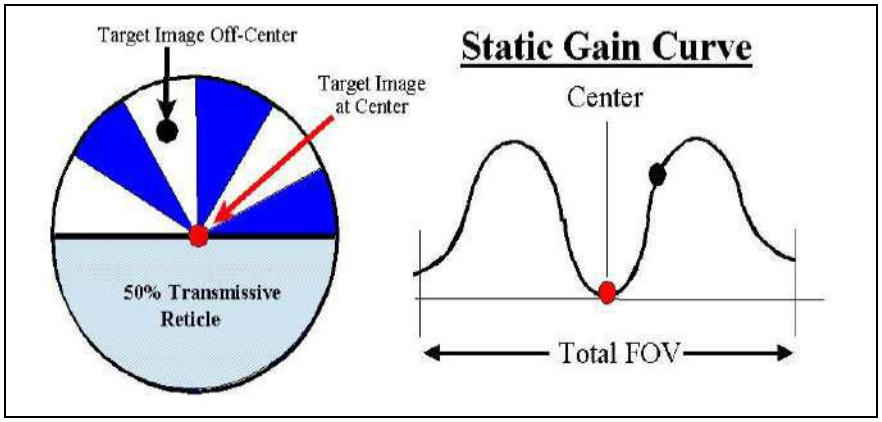

Figure 29. Spin Scan Seeker.

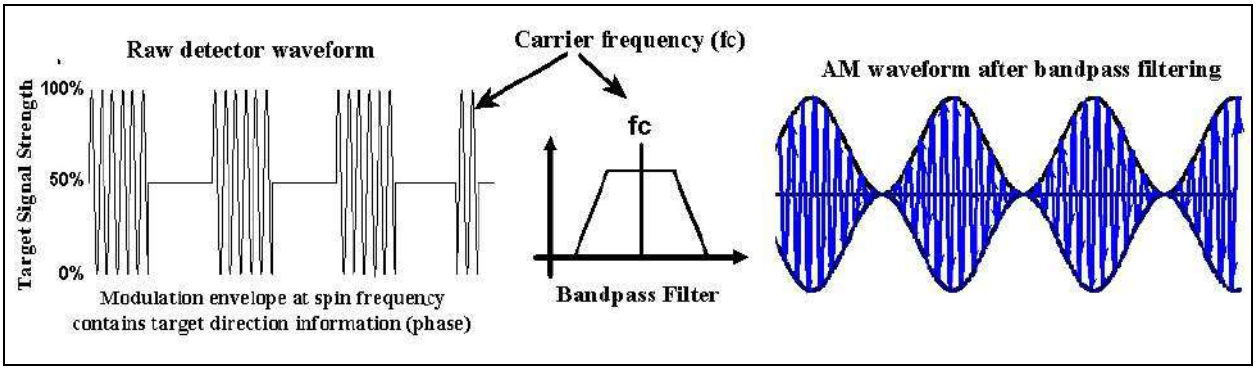

Figure 30. Spin Scan Waveforms for Off-Center Target.

Spin-scan has the following characteristics that are important to countermeasures:

- The tracker loop drives to null the signal to zero. This occurs when the target is on the optical axis and the target image is at the center of the reticle.
- If the target is off-center, an AM carrier "error signal" is generated, where the phase of the modulation envelope indicates the target direction.

With spin scan, the missile is always looking at the target. This vulnerability to jammers led to the next evolution in target trackers: conical scan.

Conical scan borrows concept from early fire-control radars, which used a nutating feed horn. A con scan tracker is shown in Figure 31. With con scan:

- The secondary mirror of the Cassegrain is canted so the field of view seen by the detector sweeps out a pattern of overlapping circles.
- A target image at boresight falls near the edge of the reticle instead of center.
- Reticle pattern is same all the way around. (Usually tapered spokes.)

- Modulation of target near boresight is FM rather than AM. This allows tighter tracking.
- For larger angles off boresight, the target image falls outside the FOV of the detector for part of the scan. The modulation then becomes AM.

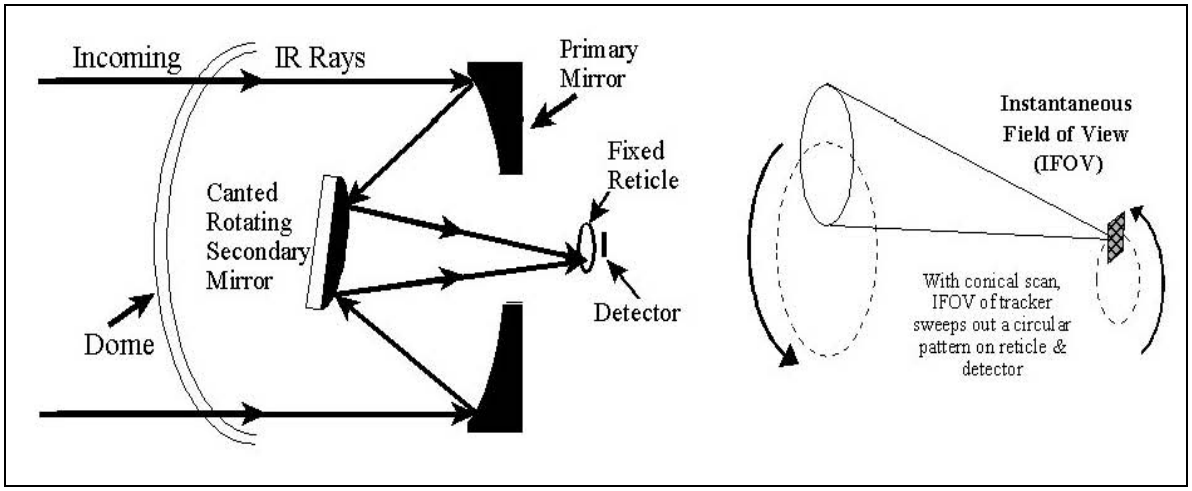

Figure 31. Conical Scan Tracker.

In the con scan tracker, as the missile instantaneous field of view nutates about a target on boresite, (moving through positions at t_1 through t_5 shown in Figure 32), the apparent position of a target image on the reticle sweeps out the circular pattern shown.

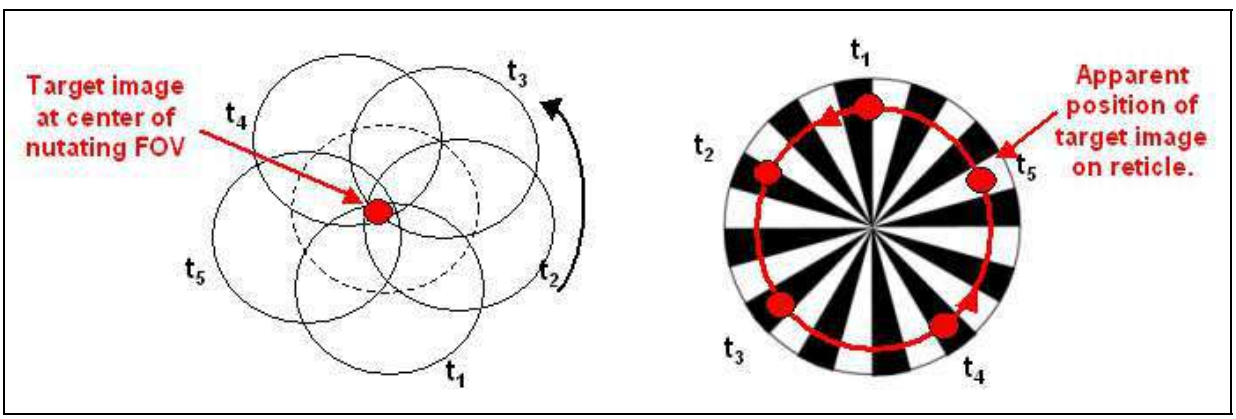

Figure 32. Image on a Con Scan Reticle: Target at Boresite.

If the target is off boresight as shown in Figure 33, the detector receives a signal of varying pulse widths.

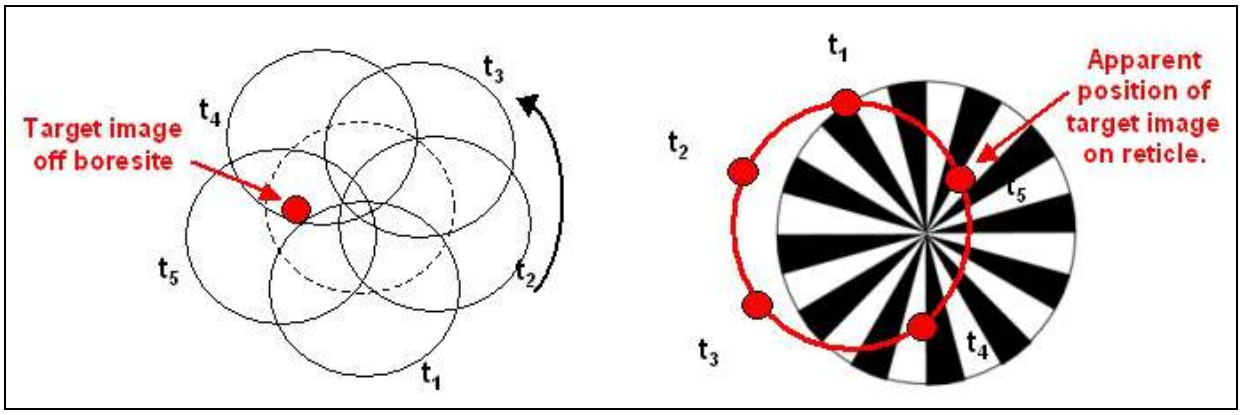

Figure 33. Image on a Con Scan Reticle: Target off Boresite**.**

The waveform produced by a target on boresite is a constant amplitude carrier at the reticle chopping frequency as shown in Figure 34. A target slightly off boresite produces a constant amplitude carrier that is frequency modulated at spin frequency.

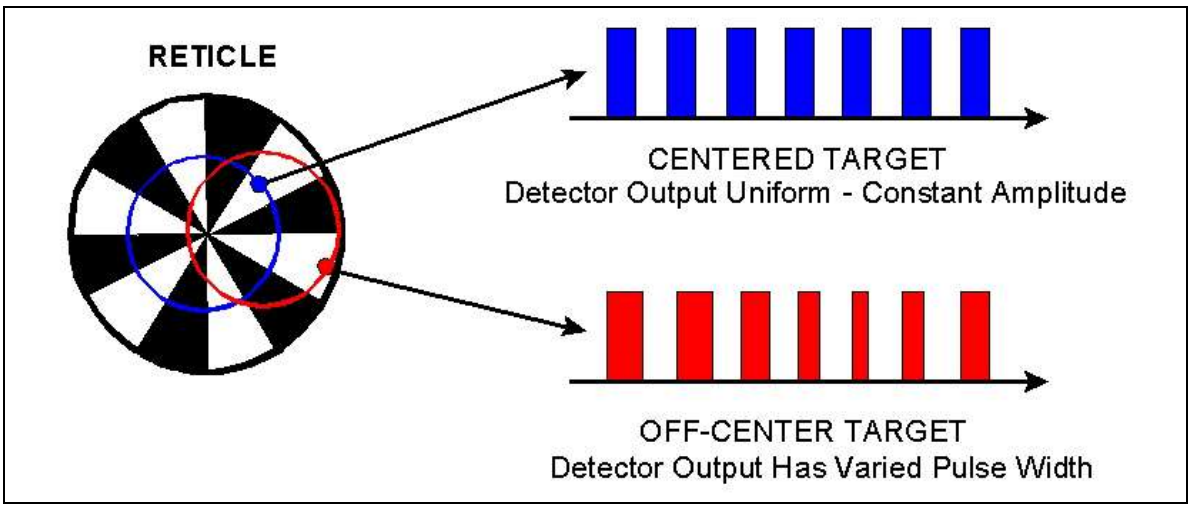

Figure 34. Conical Scan Seeker Output.

A target further off boresite leaves the missile field of view during part of the scan, producing an amplitude-modulated waveform similar to that of a spin scan tracker. The important difference is that with a spin scan tracker, the target never leaves the missile field of view. With con scan, the target may fall outside the missile FOV at certain times during the scan. Because con-scan trackers do not necessarily view the target continuously, they can have high resistance to jammers.

Other types of seeker scan patterns now exist. The Rosette scan pattern shown in Figure 35 is one such example. It has an even higher resistance to countermeasures.

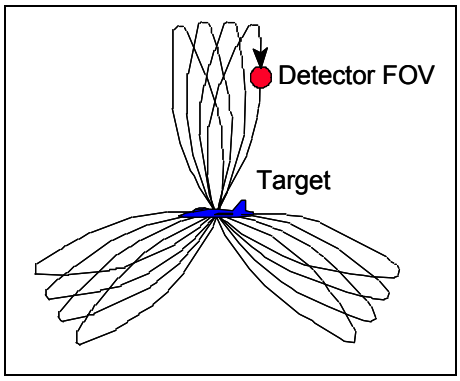

Figure 35. Rosette Scan Pattern.

Imaging arrays of detectors without reticles are newer yet. They may be classified as either staring (every pixel sees the entire scene), or scanning arrays, where the optics plays a role in determining which "pixels" are exposed to optical / IR radiation.

INFRARED COUNTERMEASURE (IRCM)

Flares

Figure 36 shows a Navy F/A-18E Super Hornet aircraft dispensing IRCM flares from its internal flare dispensers. IRCM have been the staple of countermeasures protection for military aircraft more than four decades. Flares are designed to transfer the track of an attacking infrared missile by exhibiting characteristics that confuse the tracking and guidance algorithms built into the missile. Modern missiles incorporate Counter-Countermeasures (CCM) capabilities including hardware configurations, circuitry, and logic to help identify countermeasures and reject them from processing. CCM capabilities can be based on spectral, spatial, and temporal features of the target scene. As missiles continue to improve in their sensitivity, range, maneuverability, and CCM capabilities, flares continue to evolve in order to keep pace with the evolving threat.

Figure 36. Navy F/A-18E Aircraft Dispensing IRCM Flares.

Over the years the Navy has fielded many flare types including the MJU-2/B, MJU-8, MJU-32, MJU-38, MJU-27, MJU-49, and many other improved versions of these flares and other types as well. IRCM flares continue to be the prevailing countermeasure for military aircraft protection by offering cost effective and robust protection.

Dispenser Systems

Most Navy fixed wing and rotary wing aircraft are equipped with countermeasures dispenser systems. These systems are critical to the survivability of the aircraft in a hostile threat environment. Modern dispensers such as the AN/ALE-47 offer high reliability and substantial programming capability that allows flare dispenses to be tailored for maximum protection of the host aircraft type. AN/ALE-47 is highly integrated into the aircraft over the 1553 data buses. The dispenser can incorporate information from several aircraft systems including missile-warning systems to improve its responses to threats and provide vital situational awareness to the aircrew.

Impulse Cartridges

IRCM flares are dispensed from the aircraft flare dispensers with electrically initiated impulse cartridges. Impulse cartridges incorporate energetic materials within a small confined canister. Upon application of a voltage to the electrical leads, a bridge wire in contact with the energetic materials burns through, igniting the propellant materials. The expanding gases push the flare from its case, held captive in the aircraft dispenser. Impulse cartridges for Navy use have been designed to withstand the extreme electro-magnetic environments encountered around aircraft carriers and other combat ships. Examples of impulse cartridges include the CCU-63 and CCU-136.

Infrared Jammers

Several lamp-based and mechanically modulated jammers have been developed over the years for protection of aircraft. Examples include the AN/ALQ-144 and AN/ALQ-157, predominantly used on helicopters and cargo aircraft. These jammers offer some level of protection over a broad field-of-regard and offer the advantage of continuous operation.

In principle, these jammers produce a modulated signal in the track band of the threat that corrupts the target tracking pulses in the missile seeker.

Passive Missile Warning Systems

Infrared-guided weapons provide passive attack capabilities against military vehicles. Unlike a radar-guided weapon that actively emits radiation and tracks the reflected pulses from the target, infrared weapons track radiation already being emitted from the target. Attacking missiles fly at very high speeds, and they are exceptionally maneuverable. Missile warning systems must be capable of detecting the threat, alerting the aircrew, and cueing a countermeasures response within sufficient time to counter the attacking missile. The time from launch to impact can be very short, making timely detection critical. Active warning systems have been developed in the past that use Doppler Radar capabilities to detect missiles, but passive missile warning systems have been preferred because of the desire to minimize emissions from the aircraft under attack.

Several passive missile-warning systems have been developed over the years for military aircraft. These systems operate in a variety of different parts of the electro-optical spectrum, but the most common are ultraviolet and infrared sensor systems. Examples of passive missile warning systems include AN/AAR-47, AN/AAR-54, AN/AAR-57, AN/AAQ-24 (both passive and active components), and the Joint and Allied Threat Awareness System (JATAS), currently under development by the Navy. Passive missile warning sensors continue to improve with advances in detector technologies, particularly with imaging detectors. These sensors provide excellent angle-of-arrival information, necessary to support cueing of laser based countermeasures, and advanced processing to detect and declare threat missiles in cluttered environments.

Laser Countermeasures

Laser-based infrared countermeasures have been in development for many years. Several systems have been fielded over the past fifteen years including the AN/AAQ-24 system on Air Force cargo aircraft and helicopters and a derivative system for Marine Corps helicopters.

Although configurations vary, most of these systems incorporate a single multi-band laser or several single-band lasers that produce modulated waveforms designed to corrupt a missile's guidance target tracking. The laser optics are located in a tracking gimbal that provides agile and rapid pointing over a broad field-of-regard. Laser based countermeasures require a relatively high angle of arrival accuracy from the host aircraft's missile warning sensor. Upon declaration of the threat, the missile warning system hands-off track to the tracking gimbal and cues the lasers to lase. A tracking camera in the tracking gimbal with high optical resolution helps to maintain track on the threat missile through the engagement period.

LASERS

The word laser comes from Light Amplification by Stimulated Emission of Radiation. A laser system emits light that is generated through a process of stimulated emission. The radiation produced by a laser exhibits high temporal and spatial coherence. In order to begin the process of stimulated emission, the lasing medium absorbs the energy from a pump source. The atoms in the lasing medium are excited to a higher energy state. These atoms will eventually return to their ground state. A large number of atoms that are excited to higher states create a population inversion. Population inversion describes the number of atoms in excited state versus the number of atoms in the ground state. In order for the atoms to return to their ground state, they must release energy. This energy is released in the form of photons. Energy of a photon is expressed as

$$E = \frac{hc}{\lambda}$$

Where

E = Energy, generally electron volts (eV)
h = Planck's constant = 4.136×10^{-15} (eV·s)
c = speed of light = 2.998×10^{8} (m/s)
λ = wavelength of light in meters

The energy that must be released by the atom to return to the ground state will direct the wavelength of the photon emitted since h and c are constants. If all the excited atoms released the same amount of energy to return to their ground state, the released photons would all have the same wavelength

and would be considered fully monochromatic. Most lasers do not emit a single wavelength but a range of slightly differing wavelengths ($\Delta\lambda$).

The lasing medium may be a solid, a gas, liquid, or plasma. Some laser types include gas, chemical, dye, fiber-based, solid-state and semiconductor lasers. The laser radiation can be output in a continuous wave (CW) or in a pulsed wave. A continuous wave laser emits light that maintains a steady amplitude and frequency. A pulse wave will vary in amplitude and is also characterized by the systems pulse repetition frequency (PRF). The PRF is defined as the number of pulses emitted during a unit of time. Figure 37 shows the spectral output of several laser types.

The first laser was constructed by Theodore Maiman at Hughes Research Laboratories in Malibu, California. This laser was a pulsed, solid-state ruby laser. The ruby laser uses a synthetic ruby crystal as the lasing medium. A xenon flash lamp is used to excite the atoms in a ruby rod to higher energy levels. The highly polished and mirrored ends of the rod form a resonant cavity. One end of the rod has a slightly lower reflectivity. The lamp excitation produces an inverted population of excited atoms, which are stimulated to relax to lower energy levels releasing their extra energy as photons. Repeated reflections off the mirrored ends of the rod causes the photons to bounce back and forth through the rod stimulating further emissions at the same wavelength and phase producing a highly coherent beam, which finally passes through the lower reflectivity end.

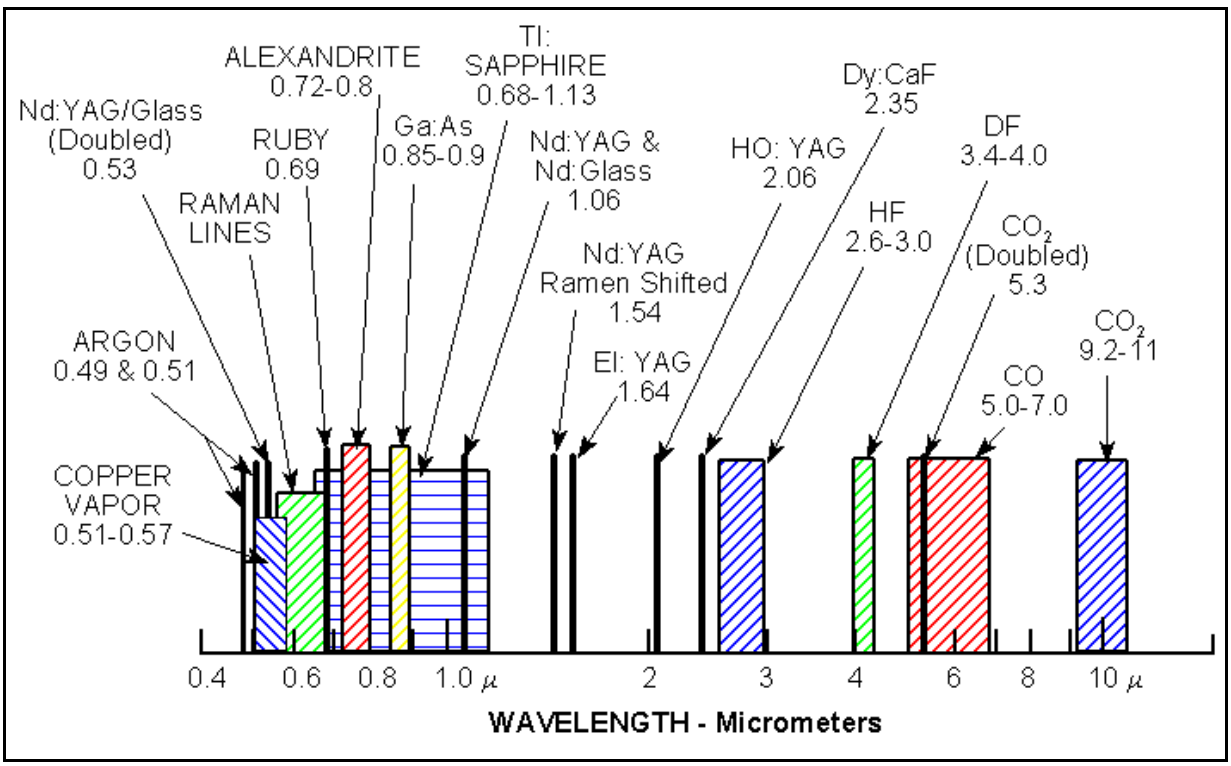

Figure 37. Spectral Lines / Ranges of Available Lasers.

The typical laser rangefinder uses a solid-state laser with a neodymium-YAG crystal lasing at 1.06 μm.

Gas lasers can be pulsed or CW. The gas dynamic laser obtains its inverted population through a rapid temperature rise produced by accelerating the gas through a supersonic nozzle. In chemical lasers the inversion is produced by a chemical reaction. In the electric discharge laser the lasing medium is

electrically pumped. The gas can also be optically pumped. In an optically pumped gas laser the lasing medium is contained in a transparent cylinder. The cylinder is in a resonant cavity formed by two highly reflective mirrors.

Many gas lasers use carbon dioxide as the lasing medium (actually a mixture of CO_2 and other gases). These are the basis for most high energy or high power lasers. The first gas laser was an optically pumped CW helium-neon laser. The common laser pointer is a helium-neon laser operating at 0.6328 µm. The lasing medium is a mixture of helium and neon gas in a gas discharge or plasma tube.

The dye laser is an example of a laser using a liquid for the lasing medium. The lasing medium is an organic dye dissolved in a solvent such as ethyl alcohol. Dye lasers operate from the near UV to the near IR, are optically pumped, and are tunable over a fairly wide wavelength range.

Another type of laser is the semiconductor or injection laser, also known as a laser diode. The junctions of most semiconductor diodes will emit some radiation if the devices are forward biased. This radiation is the result of energy released when electrons and holes recombine in the junction. There are two kinds of semiconductor diode emitters: (1) the light emitting diode (LED), which produces incoherent spontaneous emission when forward biased and which has a broad (800 angstrom) spectral output, and (2) the laser diode, which maintains a coherent emission when pulsed beyond a threshold current and which has a narrow spectral width (< 10 angstrom). In the laser diode the end faces of the junction region are polished to form mirror surfaces. They can operate CW at room temperatures, but pulsed operation is more common. Figure 38 shows a typical diode laser structure.

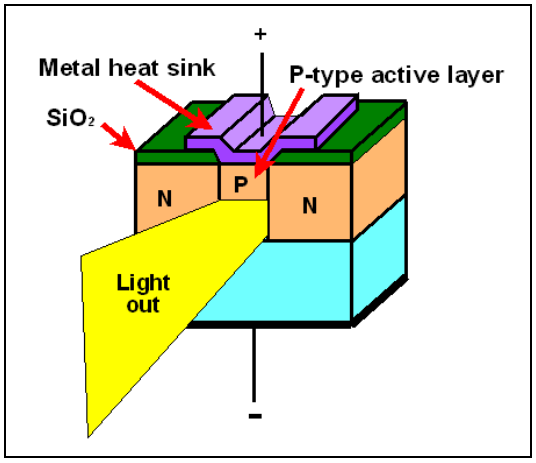

Figure 38. Diode Laser Construction.

Fiber lasers use fibers that are doped with rare-earth elements as the pumping medium. These rare-earth elements include elements such as Erbium (most common), Ytterbium, and Neodymium. There are other elements such as Thulium that are used for doping purposes. Erbium doped fiber lasers can emit in the 1.5 to 1.6 micron wavelength, which is important due to eye safety concerns in this part of the spectrum. Other wavelength emissions for Erbium include 2.7 and 0.55 microns.

Fiber based laser systems are beneficial in many ways. The fiber gain medium is compact compared to many other types of gain medium and is highly efficient. The fiber gain medium can also be physically manipulated to save space. Fiber based lasers are able to achieve high output powers. The gain medium of a fiber laser can extend for several kilometers to achieve these higher power outputs. The fact that the light is already propagating in a flexible fiber can also allow for system designs that implement a gain cavity in one location and then deliver the output in another location.

Q-switching is a common means of obtaining short intense pulses from lasers. The Q-switch inhibits lasing until a very large inverted population builds up. The switch can be active or passive. A passive Q-switch switches at a predetermined level. An active Q-switch is controlled by external timing circuits or mechanical motion. The switch is placed between the rod (or lasing medium) and the 100 percent mirror. Figure 39 shows an arrangement using a Pockels cell as an active Q-switch.

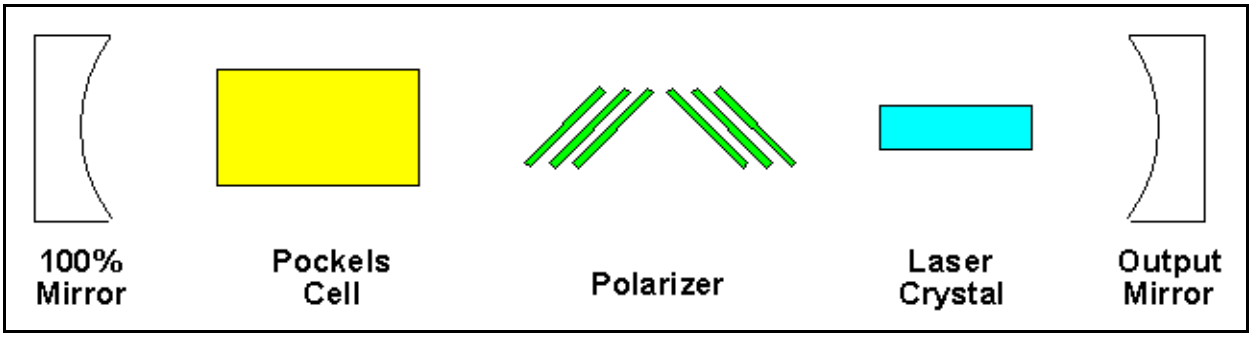

Figure 39. Q-Switch Arrangement.

Other methods of obtaining pulsed operation include using pump sources that are pulsed and mode-locking.

FIBER OPTICS

Fiber optic cables are the optical analog of RF waveguides. Fiber optic cables are made from transparent dielectrics. The fiber optic cable acts as an optical waveguide allowing light to propagate along the length of the fiber by using the principle of total internal reflection. This phenomenon can only occur under certain conditions relating to the material indices of refraction and the light ray's angle of incidence. Some benefits of fiber optic fiber include low losses, bandwidth, electromagnetic interference immunity, size, and weight.

Consider the physical construction of a bare optical fiber, depicted in Figure 40. A bare optical fiber is simply the inner glass core and the surrounding glass sleeve. The core must have a higher index of refraction than the cladding, $n_1 > n_2$. When $n_1 > n_2$, light impinging the boundary between the core and the cladding will totally internally reflect if the incident angle at each reflection is greater than the critical angle, θ_c. $\sin \theta_c = (n_2 / n_1)$

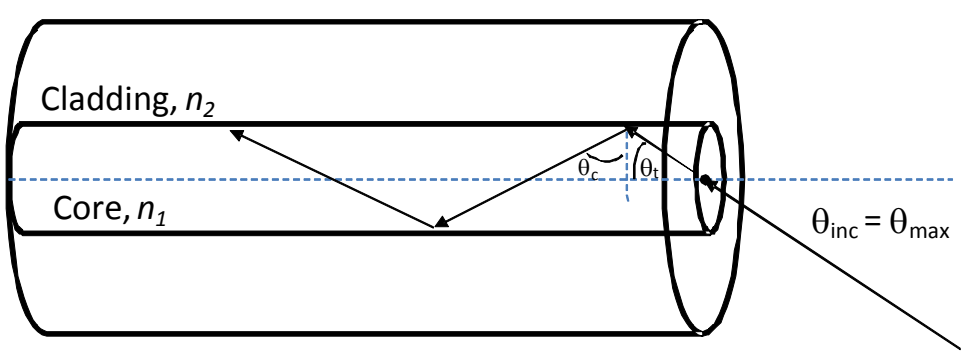

Figure 40. Bare Fiber Optic Cable.

Incident rays on the face of the fiber must intersect at angles less than θ_{max} for the internal ray, θ_t, to intersect at θ_c. When rays intersect the front face of the fiber at angles greater than θ_c, they are only partially reflected in the core and will leak out.

There are many varieties of optical fibers. Optical fibers can either be single mode or multimode. Single mode fibers are fibers which propagate a single mode down the length of the fiber while multimode fibers can propagate many modes. Single mode fibers typically have a much smaller core diameter, typically around 8 to 10 µm. Their cladding is usually 125 µm. Multimode fibers typically have core diameters around 62.5 µm with 125 µm claddings. These diameters can vary depending on the application. Loss in multimode fibers over a 1 kilometer distance is typically around 1 dB at 1310 nm. This value will vary some with changes in wavelength. Single mode fibers can maintain the quality of a light pulse over longer distances than multimode fibers due to modal dispersion effects that occur in multimode fibers. Typical losses for a single mode fiber over 1 kilometer is approximately .3 dB at 1310 nm. Again, this value will vary some with changes in wavelength. However, multimode fiber is much less expensive than single-mode and can have a lower connection loss due to the larger core diameter. Multimode fiber is commonly used in communications.

In addition to single mode or multimode, a fiber can have a step index profile or a graded index profile. Figure 41 depicts the two profiles. The step index profile maintains a uniform index of refraction within the core. A graded index profile has a peak index of refraction at the center of the core. The index of refraction value rolls off from the center to lower values closer to the cladding interface. This profile assists with the modal dispersion issue found in multimode fiber.

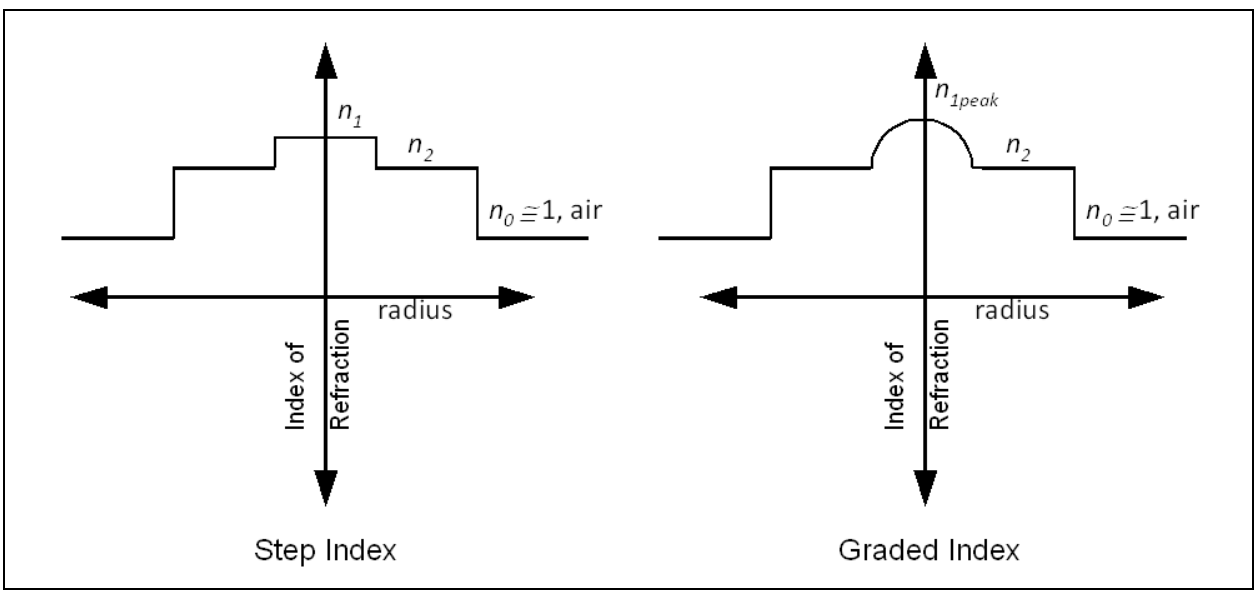

Figure 41. Fiber Profiles for a Single Mode Step Index and a Multimode Graded-Index Fiber.

Most fiber is not used in a bare form and has some additional layers of protection around the cladding. These layers can include a 250 µm buffer with a 900 µm PVC tight buffer. Some fiber will also contain aramid yarn followed by a 3 mm PVC furcation tube. Buffer tubes are often used to assist with identification and provide damage protection. The outer layers can provide additional isolation from environmental factors and lower optical crosstalk.

There are also more specialized types of fiber that include polarization maintaining and photonic crystal fibers. Polarization maintaining fibers are not constructed with a cylindrical core but instead use elliptical, bow-tie styled cores or stress rods located in the cladding (PANDA style). These are shown in Figure 42.

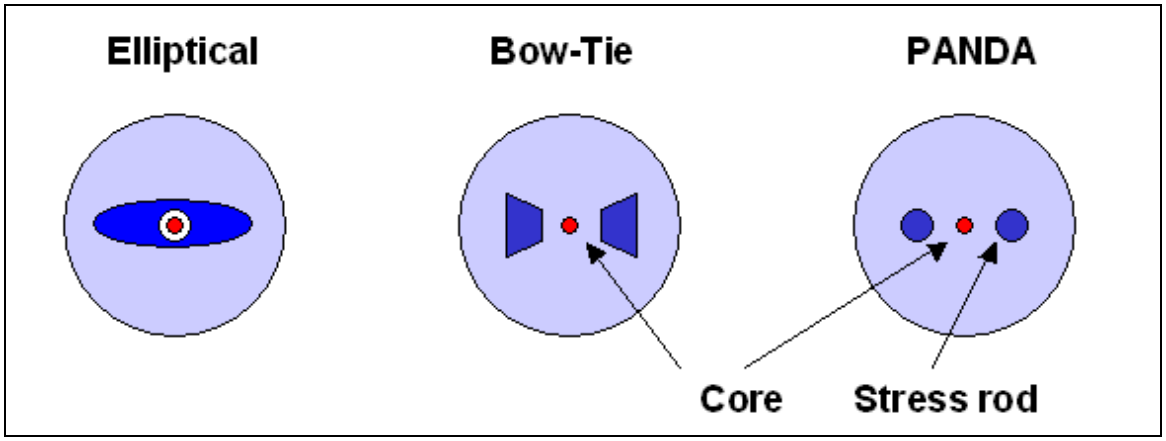

Figure 42. Polarization Maintaining Optical Fiber Types.

Polarization maintaining fibers maintain the state of the linearly polarized light propagating through the fiber. This type of fiber is used when the polarization state of the light cannot vary within a system. Photonic crystals propagate light by an arrangement of very small and closely spaced air holes that are maintained throughout the length of the fiber. Applications of photonic crystal fibers are varying and can be used in fiber lasers, amplifiers, sensors, and telecom.

It is well known that fiber optics has many communication applications; however, improvements in fiber optic technology have lent themselves to many EO applications. Many EO components are now fiber based and can interface with the tremendous advancements in fiber-based laser systems as well as other EO systems. An example of the use of fiber optics in an EW system is the AN/ALE-50 and 55 Fiber-Optic Towed Decoy (FOTD). The FOTD uses fiber optic cabling to communicate with the jammer.

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LASER SAFETY

Lasers are divided into the following classes:

Class 1	Low power / non-hazardous
Class 2/2a	Low power / minor controls necessary
	Emit less than 1 mW visible CW radiation. Not considered hazardous for momentary (<0.25 sec) unintentional exposure. Class 2a lasers are those class 2 lasers not intended to be viewed, i.e. supermarket scanners.
Class 3a/3b	Medium power / direct viewing hazard / little diffuse reflection hazard.
Class 3a	Visible lasers with 1-5 mW power output, invisible lasers, and those having 1-5 times the Accessible Emission Limit (AEL) of class 1 lasers.
Class 3b	All other class 3 lasers at all wavelengths which have a power output less than 500 mW.
Class 4	High power / eye & skin hazard / potential diffuse reflection hazard or fire hazard

There are several pertinent instructions and guidelines regarding laser use. They are:

- OPNAVINST 5100.27B Navy Laser Hazards Control Program
  (which replaced OPNAVINST 5100.27A and SPAWARINST 5100.12B)
- MIL-HDBK-828B, Range Laser Safety
- ANSI Z136.1-2007, American National Standard for the Safe Use of Lasers (Parent)

Every Navy command which uses lasers must have a Laser System Safety Officer (LSSO). All LSSOs must attend a Navy LSSO course.

There are four categories of LSSOs.

- Administrative Laser Safety Officer (ALSO)
- Technical Laser Safety Officer (TLSO)
- Laser Safety Specialist (LSS)
- Range Laser Safety Specialist (RLSS)

See OPNAVINST 5100.27B for details of their qualifications and responsibilities.

The hazard ranges of interest are the NOHD for direct viewing of a beam and the $r_{1(safe)}$ or $r_{2(safe)}$ for viewing a beam reflected off an object such as a wall. These are depicted in Figure 1. The Maximum Permissible Exposure (MPE) values present laser safety levels as a function of exposure time, laser PRF, pulse duration, and wavelength. Different tables are used for eye safety while directly viewing a beam, for viewing a diffusely reflected beam, and for skin exposure.

For repeated pulses the following equation is used to calculate the maximum permissible exposure (MPE).

$$\text{MPE (repeated pulse)} = \frac{MPE(single\ pulse)}{(\ PRF\ x\ t_e\ )^{1/4}} \qquad \textbf{[1]}$$

Where PRF is the pulse repetition frequency of the laser and t_e is the exposure duration.

For visible lasers t_e is usually taken as 1/4 second and for non-visible lasers a value of 10 seconds is used.

Figure 1 depicts some laser hazard distances.

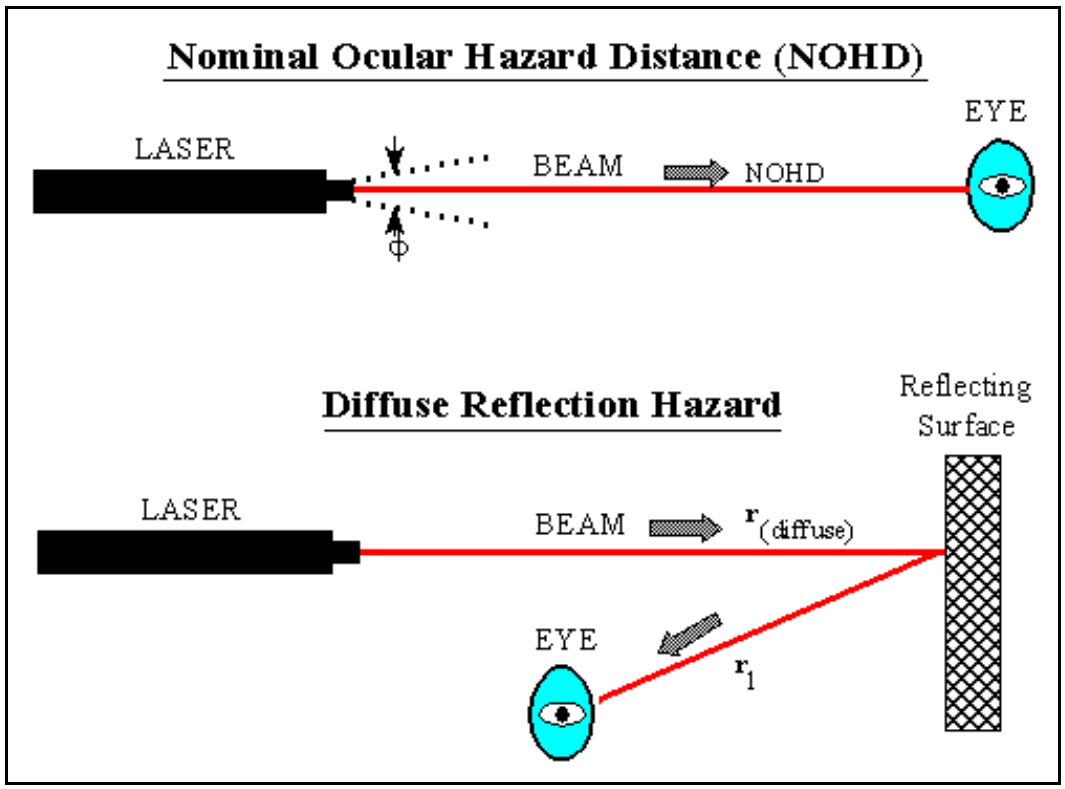

Figure 1. Laser Hazard Distances.

Range laser safety specialists shall be designated for external operations. Range test plans shall specify:

- Permissible aircraft flight paths, and ship or vehicle headings.
- Hazard areas to be cleared.
- Operational personnel locations.
- Types of surveillance to be used to ensure a clear range.
- Radio / communications procedures.

During laser operations no portion of the laser beam may extend beyond the controlled target area unless adequate surveillance can prevent radiation of unprotected areas. Class 3 and class 4 lasers shall not be directed above the horizon unless coordinated with those responsible for the given airspace (FAA, Navy, Air Force, etc).

In an industrial environment, warning and hazard signs and lights will be posted, a hazard zone shall be designated when lasers are in operation, and training shall be provided to operators in the proper eye and body (skin) protection required. Interlocks to laser operation shall be provided when there is the possibility of unauthorized personnel entering the hazard area.

Fiber optic cables usually have laser power sources so appropriate warnings or labels need to be applied to connections or possible breakage points.

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AIRCRAFT DYNAMICS CONSIDERATIONS

Free Fall / Aircraft Drag.....8-1
Mach Number and Airspeed vs. Altitude.....8-2
Maneuverability 8-3
EMP / Aircraft Dimensions.....8-4

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FREE FALL / AIRCRAFT DRAG

The purpose of this section is to get an awareness of the distance traveled by a flare or other object such as a bomb, which is jettisoned or dropped by an aircraft. This will give the reader an appreciation for the significance of aircraft tactical altitude.

From Newton's second law of motion:

$F = m_o a$ where: F = Force
m_o = Mass of object
a = Acceleration

and the law of gravitation: $F = G\dfrac{m_o m_e}{r^2}$

		English Units	SI Units
where:	F = Force of attraction	lb_f	Newton
	G = universal gravitational constant	3.44×10^{-8} $ft^4/lb\text{-}sec^4$	6.67×10^{-11} $m^3/kg\text{-}sec^2$
	m_o, m_e= Masses (not weight) of object & earth	slug	kg
	r = distance between center of gravity of objects	feet	meter

Combining the two equations and solving for "a":

$$a = \frac{G\,m_e}{r^2} = g$$, the familiar constant acceleration due to gravity.

Since G and m_e are fixed and the variation in r (the distance from the earth's center) is small except for satellites, "g" is considered fixed at 32.2 ft/sec^2.

For objects with a constant acceleration (g), it can be shown that:

$$d = v_i t + \frac{1}{2} g t^2$$ where d = distance traveled
v_i = Initial velocity
t = time
g = acceleration

For a falling object, Figure 1 on the following page may be used to estimate time/distance values.

- The upper curve is for an object shot upward with an initial velocity of 50 ft/sec.
- The middle curve is for an object shot horizontally with an initial velocity of 50 ft/sec or one that is a free-falling object dropped with no initial vertical velocity.
- The lower curve is for an object with a downward initial velocity of 50 ft/sec.

Notes:

1) 50 ft/sec is the typical cartridge ejection velocity of a flare/chaff expendable.
2) The top curve actually goes up 39 feet before starting back down, but this is difficult to see due to the graph scale.
3) This simplification ignores the effects of air drag or tumbling effects on a falling object which will result in a maximum terminal velocity, with resultant curve straightening.

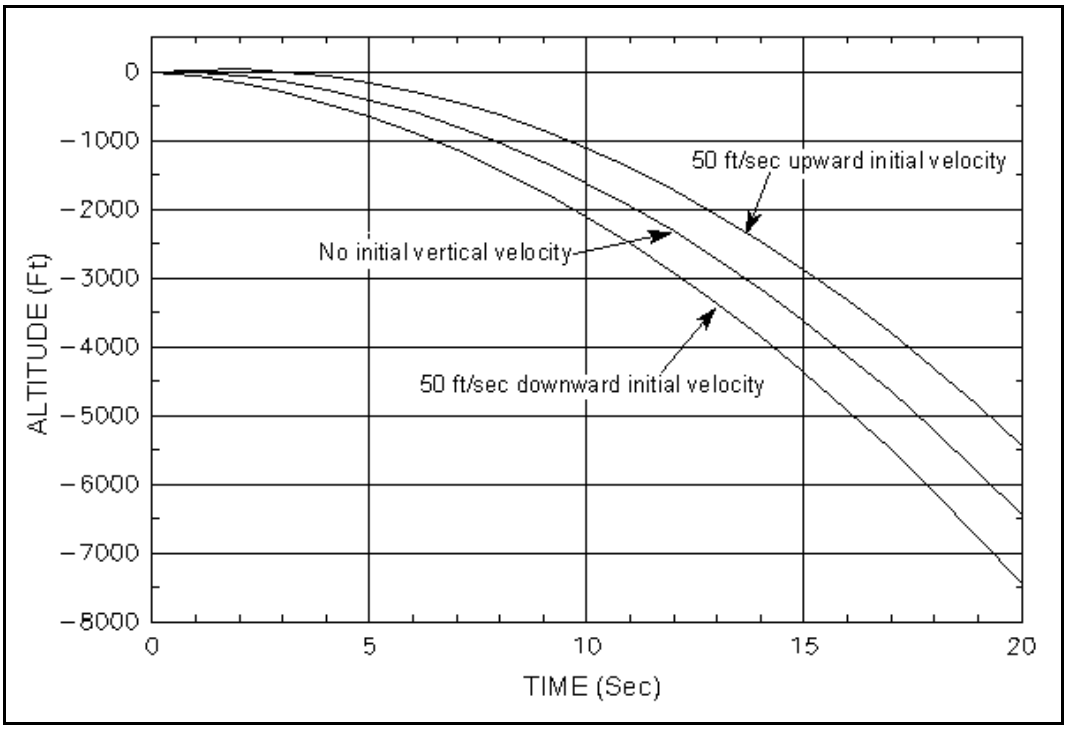

Figure 1. Object Fall Rate.

SAMPLE CALCULATIONS

Let us assume that we want to know how far a bomb or other object has fallen after 13 seconds if it had been dropped from an aircraft traveling at 450 kts which was in a 40° dive.

Our initial vertical velocity is: 450 kts (Sin 40°) (1.69 ft/sec per knot) = 489 ft/sec downward

$d = V_i t + \frac{1}{2}gt^2 = -489(13) + \frac{1}{2}(-32.2)(13)^2 = -6355 - 2721 = -9{,}076$ ft.

Remember to keep the signs (+/-) of your calculations in agreement with whatever convention you are using. Gravity pulls downward, so we used a minus sign for acceleration. Also the initial velocity was downward.

In reality, any object may well have reached terminal velocity before the time indicated using the above formula or Figure 1. In this example, the actual distance determined from ballistics tables would have been 8,000 ft, which is about 13% less than the above calculation would indicate. The drag characteristics of the object determine how much shorter the distance will be. In any case, it will not have dropped farther.

AIRCRAFT DRAG INDEX POINTS

Tactical aircraft carry stores in various combinations depending upon the mission. Each store has a different drag load which affects range. The pilot needs to know the total drag load in order to determine his aircraft range on a particular mission. Adding up the total drag in pounds of force for wind resistance would be cumbersome. Therefore, the drag of the stores is compared to a known reference drag (usually the aircraft), and expressed as a percentage of aircraft drag multiplied by some constant. This ratio is variously called drag count, drag index, or drag points. For instance, if a missile has 100 pounds of drag and the reference aircraft drag is 50,000 pounds, the ratio is 100/50,000 = 0.002. Multiply this by a constant of 100 (for example) and the drag index point is 0.2. The pilot only needs to look on a chart to see what the drag index points are for his stores, add up the drag points, and look on a chart to see what his aircraft range and best range (or endurance) speed will be.

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MACH NUMBER and AIRSPEED vs. ALTITUDE

MACH NUMBER is defined as a speed ratio, referenced to the speed of sound, i.e.

$$MACH\ NUMBER = \frac{Velocity\ of\ Interest}{Velocity\ of\ Sound} \quad \textit{(at the given atmospheric conditions)} \qquad \textbf{[1]}$$

Since the temperature and density of air decreases with altitude, so does the speed of sound, hence a given true velocity results in a higher MACH number at higher altitudes.

AIRSPEED is a term that can be easily confused. The unqualified term airspeed can mean any of the following:

a. Indicated airspeed (IAS) - the airspeed shown by an airspeed indicator in an aircraft. Indicated airspeed is expressed in knots and is abbreviated KIAS.

b. Calibrated airspeed (CAS) - indicated airspeed corrected for static source error due to location of pickup sensor on aircraft. Calibrated airspeed is expressed in knots and is abbreviated KCAS. Normally it doesn't differ much from IAS.

c. True airspeed (TAS) - IAS corrected for instrument installation error, compressibility error, and errors due to variations from standard air density. TAS is expressed in knots and is abbreviated KTAS. TAS is approximately equal to CAS at sea level but increases relative to CAS as altitude increases. At 35,000 ft, 250 KIAS (or KCAS) is approximately 430 KTAS.

IAS (or CAS) is important in that aircraft dynamics (such as stall speed) responds largely to this quantity. TAS is important for use in navigation (True airspeed ± wind speed = ground speed).

Figures 1 and 2 depict relations between CAS and TAS for various altitudes and non-standard temperature conditions. The first graph depicts lower speed conditions, the second depicts higher speeds.

As an example of use, consider the chart on the next page. Assume we are in the cockpit, have read our IAS from the airspeed indicator, and have applied the aircraft specific airspeed correction to obtain 370 KCAS. We start at point "A" and go horizontally to our flight altitude at point "B" (25,000 ft in this case). To find our Mach, we go down vertically to point "C" to obtain 0.86 Mach. To get our TAS at our actual environmental conditions, we go from point "B" vertically until we hit the Sea Level (S.L.) reference line at point "D", then travel horizontally until we reach our actual outside air temperature (-20°C at altitude) at point "E", then go up vertically to read our actual TAS from the scale at point "F" (535 KTAS). If we wanted our TAS at "standard" temperature and pressure conditions, we would follow the dashed lines slanting upward from point "B" to point "G" and read 515 KTAS from the scale. Naturally, we could go into the graph at any point and go "backwards" to find CAS from true Mach or TAS.

Figure 3 shows a much wider range of Mach numbers. It contains only TAS and Mach, since aircraft generally do not fly above Mach 2, but missiles (which don't have airspeed indicators) do. The data on this graph can be obtained directly from the following formula for use at <u>altitudes of 36,000 ft and below</u>:

$$Speed\ of\ Sound\ (KTAS) = 29.06\sqrt{518.7 - 3.57\,A} \qquad Where\ A = altitude\ (K\ ft) \qquad \textbf{[2]}$$

The speed of sound calculated from this formula can be used with the equation on the first page to obtain Mach number. This equation uses the standard sea level temperature of 59° F and a lapse rate of -3.57°/1000 ft altitude. Temperature stabilizes at -69.7° F at 36,000 ft so the speed of sound stabilizes there at 573 knots. See the last page of this section for a derivation of equation [2].

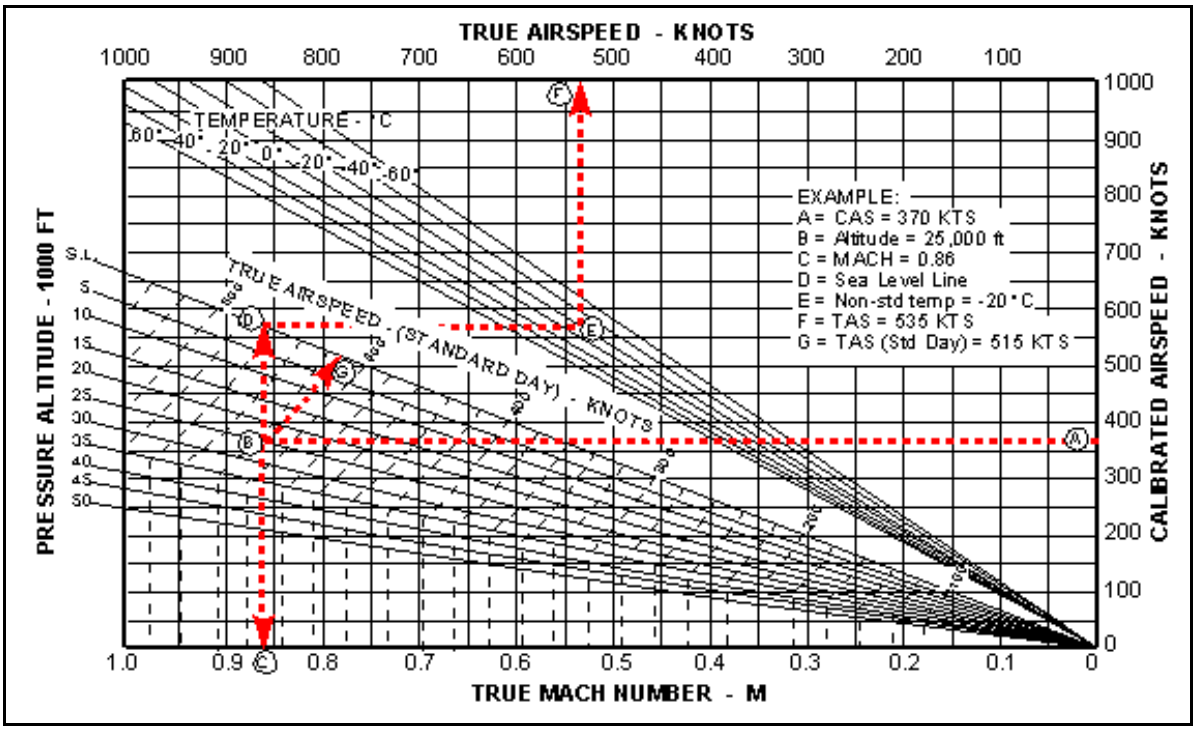

Figure 1. TAS and CAS Relationship With Varying Altitude and Temperature.

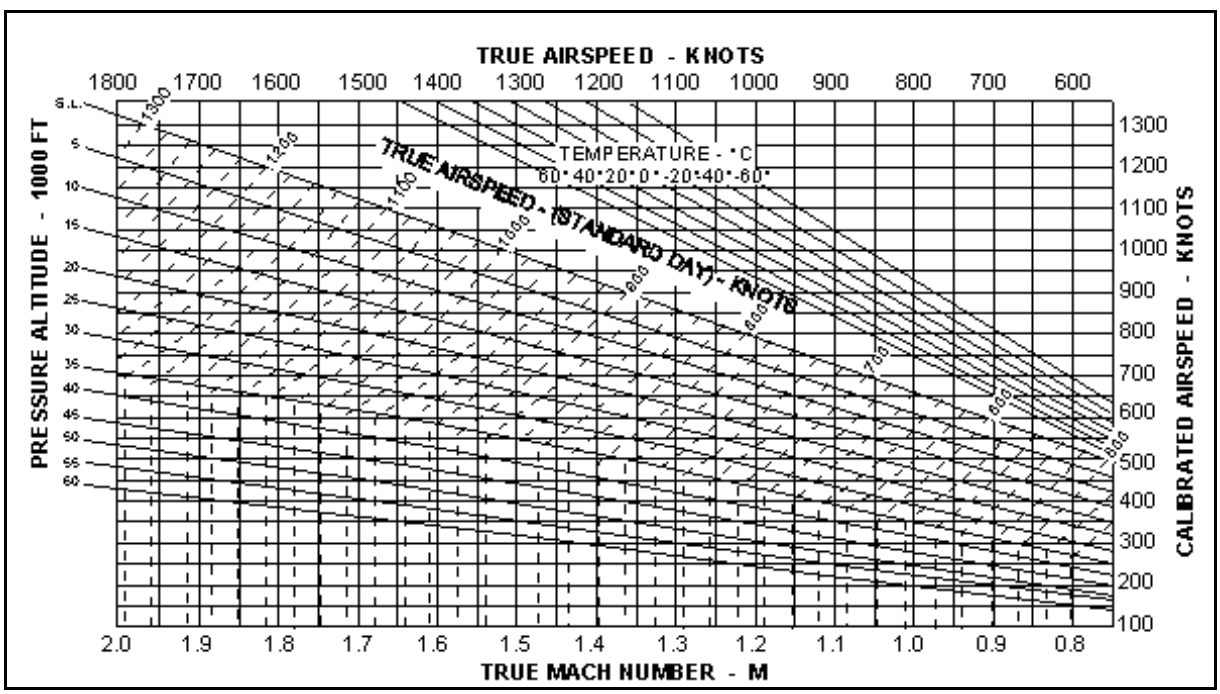

Figure 2. TAS and CAS Relationship With Varying Altitude and Temperature (Continued).

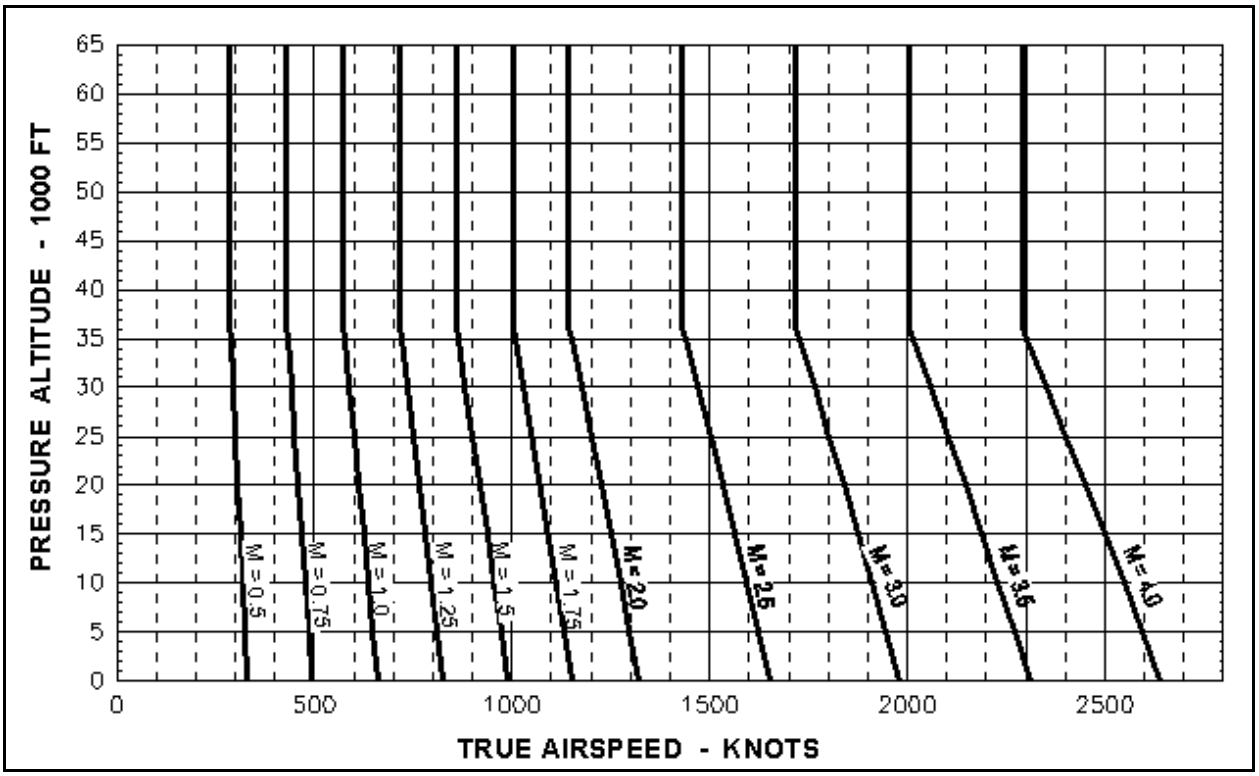

Figure 3. Mach Number vs. TAS Variation With Altitude.

The following is a derivation of equation [2] for the speed of sound:

Given: p = pressure (lb/ft^2) T = absolute temperature (°Rankine) = °F + 459.7
v = specific volume (ft^3/lb) w = specific weight (lb/ft^3) = $1/v$
R = a constant (for air: R = 53.3) ρ = density = $w/g = 1/gv$ $\therefore$ $v = 1/g\rho$

From Boyle's law of gasses: $pv = RT$, therefore we have: $p/\rho = gRT = (32.2)(53.3)T = 1718\ T$ **[3]**

It can also be shown that: p/ρ^{γ} = constant; for air $\gamma = 1.4$ **[4]**

From the continuity equation applied to a sound wave: $\rho A V_a = (\rho + dp)A(V_a + dV_a)$ **[5]**

Expanding and dropping insignificant terms gives: $dV_a = -V_a\, d\rho/\rho$ **[6]**

Using Newton's second law ($p + \rho V_a/2$ = a constant) and taking derivatives: $dp = -\rho V_a dV_a$

Substituting into [6] gives: $V_a^2 = dp/d\rho$ **[7]**

Then taking derivatives of [4] and substituting in [7] gives: $V_a = \sqrt{\dfrac{\gamma p}{\rho}}$ **[8]**

Then using [3] gives: $V_a = \sqrt{\gamma g R T} = \sqrt{1.4(1718)T} = 49\sqrt{T}$ **[9]**

Using a “Standard” atmosphere of 59° F @ Sea Level (S.L.) and a lapse rate of -3.57°/1000 ft altitude:

$$V_a = 49\sqrt{459.7 + 59 - 3.57\,A}\;\frac{ft}{\sec}\left[\frac{3600\sec}{hr}\,\frac{nm}{6076\;ft}\right] = 29.06\sqrt{518.7 - 3.57A}$$ which is equation [2]

MANEUVERABILITY

A useful function is to determine how many "G's" an aircraft might require to make a given turn without altitude loss. From Newton's laws, F cos φ = W, where: F = force applied to an aircraft, W = weight, and φ = bank angle. By definition "G's" is the ratio of the force on an object to its weight, i.e., G = F/W = 1/cos φ.

Simple calculations will show the results presented in Table 1, to the right.

Table 1. G vs. Angle of Bank. (No altitude loss)

G	φ
1.0	0
1.4	45
2.0	60
3.9	75
7.2	82
11.5	85

Given that the average structural limit of an aircraft is about 7 G's, the maximum bank angle that can be achieved <u>in level (non-descending) flight</u> is 81.8°.

Figure 1 can be used to determine the turn radius and rate-of-turn for any aircraft, given speed and angle of bank (assuming the aircraft maintains level flight). It may also be used in the reverse context. It should be noted that not all aircraft can fly at the speeds depicted - they may stall beforehand or may be incapable of attaining such speeds due to power/structural limitations.

In the example shown on Figure 1, we assume an aircraft is traveling at 300 kts, and decides to make a 30° angle of bank turn. We wonder what his turn radius is so we can approximate his flight path over the ground, and what his rate of turn will be. We enter the chart at the side at 300 kts and follow the line horizontally until we intercept the 30° "bank angle for rate of turn" line. We then go down vertically to determine the 2.10°/sec rate of turn. To get radius, we continue horizontally to the 30° "bank angle for turn radius" line. We can then go down vertically to determine the radius of 13,800 ft.

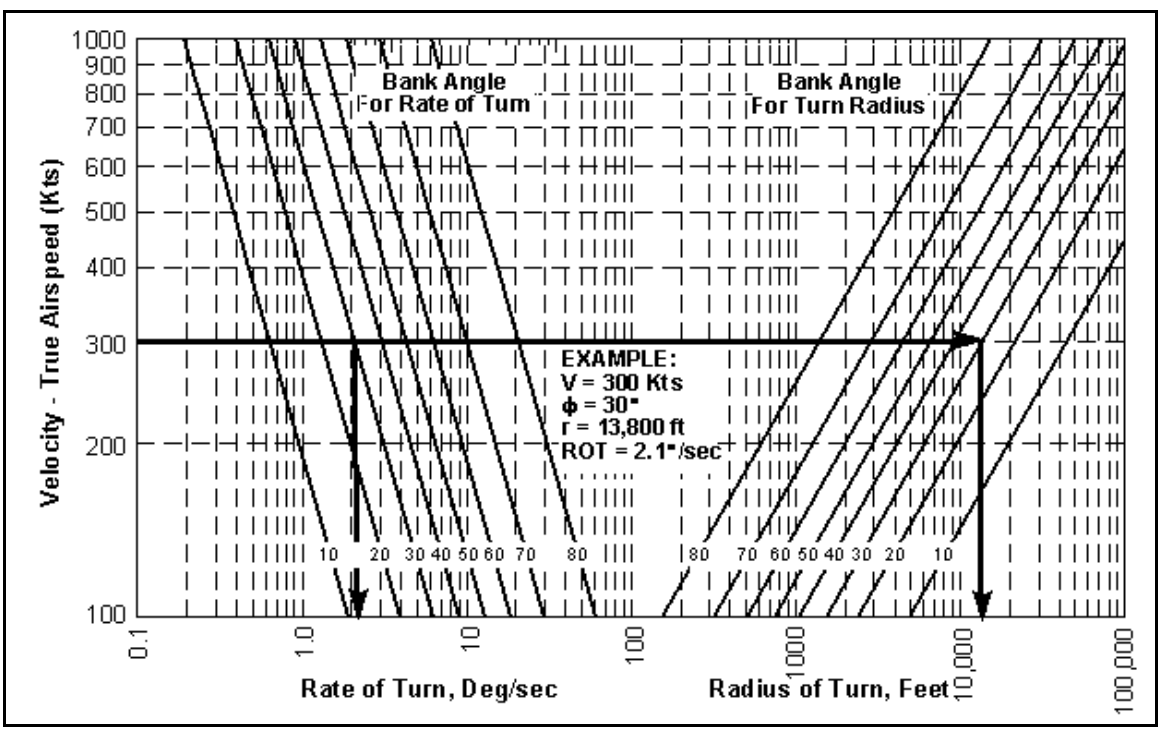

Figure 1. Aircraft Turn Rate / Radius vs. Speed.

The exact formulas to use are:

$$Rate\ of\ Turn = \frac{1091 \tan(\phi)}{V} \qquad Radius\ of\ Turn = \frac{V^2}{11.26 \tan(\phi)} \qquad Where: \begin{array}{l} V = Velocity\ (Knots) \\ and\ \phi = Angle\ of\ Bank \end{array}$$

Another interesting piece of information might be to determine the distance a typical aircraft might travel during a maneuver to avoid a missile.

Figure 2 shows a birds-eye view of such a typical aircraft in a level (constant altitude) turn.

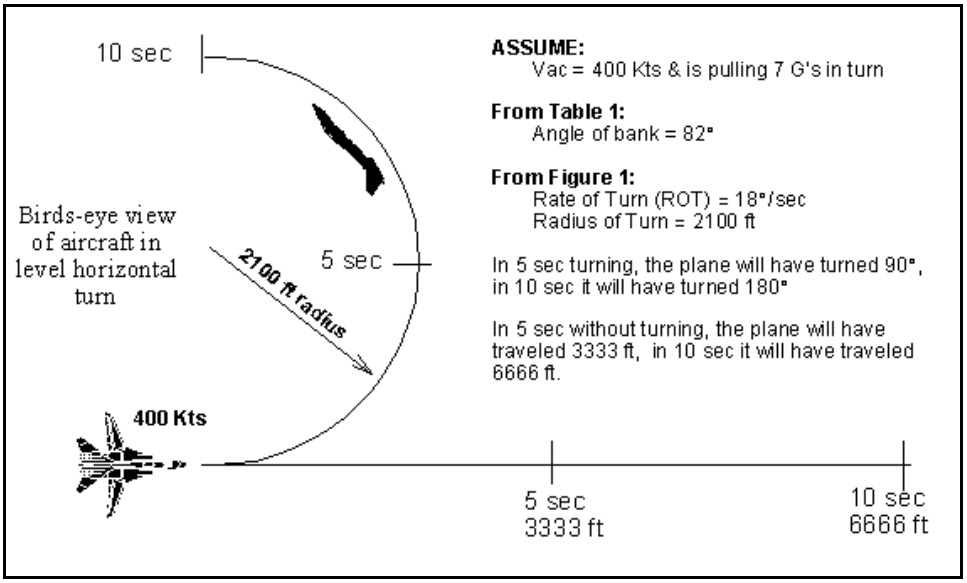

Figure 2. Maneuvering Aircraft.

To counter many air-to-air missiles the pilot might make a level turn, however in countering a SAM, altitude is usually lost for two reasons: (1) the direction of maneuvering against the missile may be downward, and (2) many aircraft are unable to maintain altitude without also losing speed. These aircraft may have insufficient thrust for their given weight or may be at too high an altitude. The lighter an aircraft is (after dropping bombs/burning fuel), the better the performance. Likewise, the higher the altitude, the poorer the thrust-to-weight ratio. Maximum afterburner is frequently required to maintain altitude at maximum "G" level.

REFERENCE AXES (Roll, Pitch, Yaw)

The rotational or oscillating movement of an aircraft, missile, or other object about a longitudinal axis is called roll, about a lateral axis is called pitch, and about a vertical axis is called yaw as shown in Figure 3.

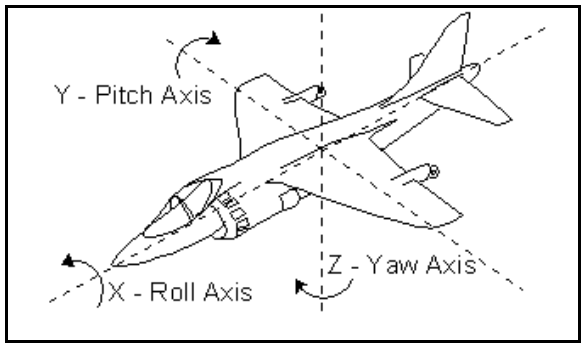

Figure 3. Reference Axes.

SAMPLE CALCULATIONS

If we want to determine the rate of turn or turn radius more precisely than can be interpolated from the chart in Figure 1, we use the formulas. For our initial sample problem with an aircraft traveling 300 kts, in a 30° angle of bank turn, we have:

$$Rate\ of\ Turn = \frac{1091 \tan(\phi)}{V} = \frac{1091 \tan(30)}{300} = 2.1°/\sec$$

$$Radius\ of\ Turn = \frac{V^2}{11.26 \tan(\phi)} = \frac{300^2}{11.26 \tan(30)} = 13{,}844\ ft$$

These are the same results as we determined using Figure 1.

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EMP / AIRCRAFT DIMENSIONS

An aircraft flying in the vicinity of an electromagnetic pulse (EMP) acts like a receiving antenna and picks up EMP radiation in relation to size like a dipole (or half-wavelength dipole). The electromagnetic pulse spectrum decreases above 1 MHz as shown in Figure 1, so an F-14 aircraft that is an optimum ½ wavelength antenna at ≈8 MHz will pick up less EMP voltage than a B-52 or an aircraft with a trailing wire antenna. A rule of thumb for the voltage picked up is:

V_{EMP} = 8.1 volts/ft times the maximum dimension of the aircraft in feet

This rule of thumb was generated because a single linear relationship between voltage and aperture seemed to exist and compared favorably with more complex calculations for voltage picked up by various aircraft when subjected to EMP.

Table 1 shows various aircraft and the frequencies they would be most susceptible to, using $f = c/\lambda$, where λ matches the selected aircraft dimension for maximum "antenna reception effect." This should be a design consideration when trying to screen onboard avionics from the effects of EMP.

The following is a partial listing of aircraft types vs. identifying prefix letters (several are used in Table 1):

A	Attack	K	Tanker	T	Trainer
B	Bomber	O	Observation	U	Utility
C	Cargo	P	Patrol	V	Vertical or Short Takeoff and Landing (V/STOL)
E	Electronic Surveillance	Q	Special mission		
F	Fighter	R	Reconnaissance	X	Experimental
H	Helicopter	S	Anti Sub/Ship	Y	Prototype

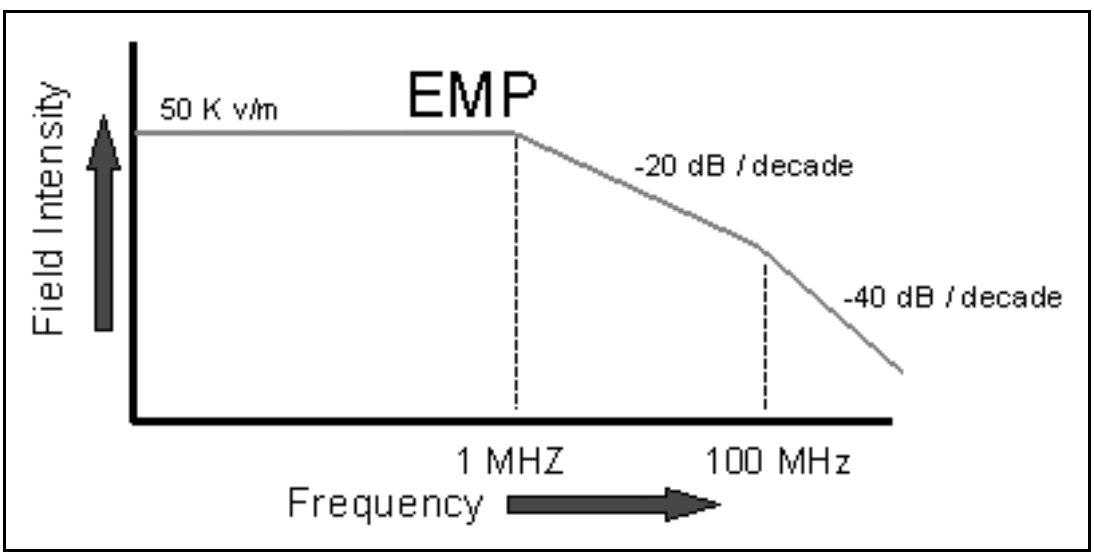

Figure 1. EMP as a Function of Frequency.

Table 1. Aircraft Dimensions and Equivalent Antenna Aperture.

Mission	Aircraft Type	Height (ft.)	Frequency (MHz)		Length (ft.)	Frequency (MHz)		Wing Span (ft.)	Frequency (MHz)	
		A	f	f/2	A	f	f/2	A	f	f/2
ATTACK	A-10	14.66	67.05	33.52	53.33	18.43	9.21	57.5	17.1	8.55
ELECTRONIC WARFARE	EA-6B	16.50	59.64	29.82	59.34	16.58	8.29	53.0	18.57	9.29
	EA-18	16.0	61.47	30.74	60.17	16.35	8.17	44.67	22.02	11.01
FIGHTER	F-15	18.4	53.42	26.71	63.75	15.42	7.71	42.8	22.97	11.48
	F-16	16.66	59.00	29.5	49.25	19.96	9.98	31.0	31.71	15.85
	F/A-18C/D	15.3	64.31	32.16	56.0	17.57	8.79	40.70	24.18	12.09
	F/A-18E/F	16	61.47	30.7	60.17	16.34	8.17	44.67	22.02	11.01
	F-22	17.75	55.41	27.7	64.17	15.33	7.66	43	22.87	11.43
	F-35A	14.2	69.27	34.63	51.4	19.1	9.57	35	28.1	14.05
	F-35C	15.5	63.45	31.73	51.4	19.1	9.57	43	22.8	11.43
	F-117	12.42	79.15	39.57	65.92	14.91	7.46	43.33	22.69	11.34
ASW	P-3C	33.75	29.16	14.58	116.42	8.45	4.23	99.67	9.87	4.94
	S-3A	22.75	43.25	21.63	54.34	18.45	9.23	68.67	14.33	7.17
	P-8	42.1	23.36	11.68	129.5	7.6	3.8	123.6	7.96	3.98
AEW	E-2C	18.4	53.48	26.74	56.50	17.42	8.71	80.58	12.21	6.11
V/STOL	AV-8B	11.64	84.45	42.23	46.3	21.23	10.62	30.3	32.44	16.22
	V-22	18.1	54.3	27.2	57.3	17.17	8.58	84.5	11.64	5.82
	F-35B	15.0	65.6	32.78	51.2	19.2	9.61	35	28.1	14.05
HELICOPTERS	AH-1W	14.16	69.46	34.73	58.25	16.89	8.44	48.0	20.49	10.24
	UH-1E	12.75	71.18	35.59	52.91	18.60	9.30	44.0	22.36	11.18
	U/SH-2	15.41	63.85	31.93	52.5	18.74	9.37	44.0	22.36	11.18
	SH-3D	16.42	59.93	29.97	72.67	13.54	6.77	62.00	15.87	7.84
	CH-46D	16.75	58.75	29.38	84.34	11.67	5.84	50.0	19.68	9.84
	CH-47	18.75	52.45	26.23	99.0	9.94	4.98	60.0	16.39	8.19
	CH-53A	24.91	39.50	19.75	88.16	11.16	5.58	72.25	13.62	6.81
	SH-60	17.0	57.85	28.93	64.83	15.17	7.59	53.83	18.27	9.14
	AH-64	15.25	64.5	32.25	58.25	16.89	8.44	48.0	20.49	10.24
TRANSPORT	C-2A	15.92	61.81	30.91	56.6	17.39	8.70	80.58	12.21	6.11
TANKERS	KC-130F	38.1	25.83	12.92	97.8	10.06	5.03	132.5	7.43	3.72
SPECIAL ELECTRONICS	EC-13OQ	38.5	25.56	12.78	99.34	9.91	4.96	132.58	7.42	3.71
TRAINER	T-2B	14.8	66.49	33.25	38.7	25.43	12.72	37.85	26.00	13.0
	T-39D	16.0	61.50	30.75	43.75	22.49	11.25	44.34	22.19	11.10
	T-45	13.5	72.86	36.43	39.33	25.0	12.5	30.8	31.93	15.97

DATA TRANSFER BUSSES

Data Busses 9-1
RS-232 Interface 9-2
RS-422 Balanced Voltage Interface 9-3
RS-485 Interface 9-4
IEEE-488 Interface Bus (HP-IB/GP-IB) 9-5
MIL-STD-1553 & 1773 Data Bus 9-6
Ethernet 9-7
Transmission Control Protocol / Internet Protocol 9-8

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DATA BUSSES

INTRODUCTION

The avionics systems on aircraft frequently contain general purpose computer components which perform certain processing functions, then relay this information to other systems. Some common examples are the mission computers, the radar processors, RWRs, and jammers. Each system is frequently laid out as shown in Figure 1.

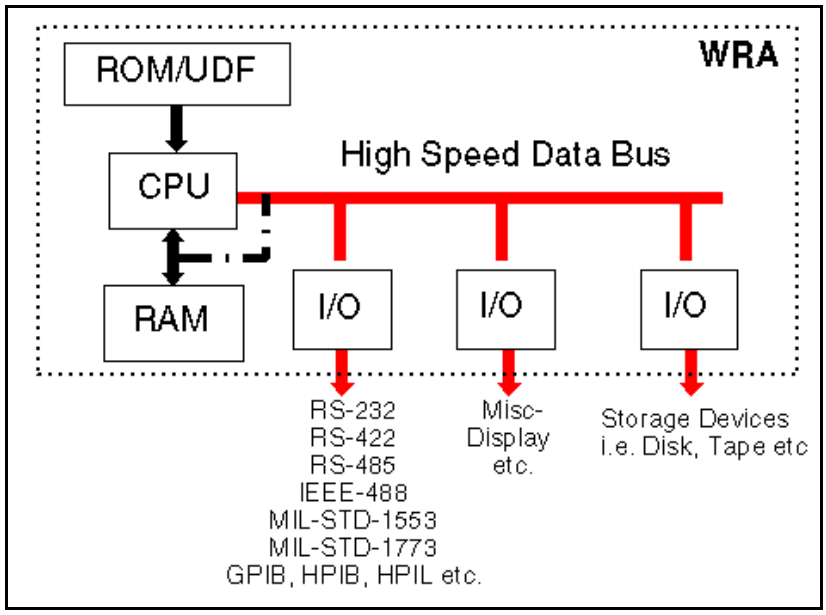

Figure 1. Avionics Block Diagram.

The Input/Output (I/O) modules will vary in function, but all serve the same purpose - to translate the electrical signals from one protocol to one of another in order to exchange information. I/O modules are used similarly in general purpose computers in laboratories to test equipment and/or tie computers together via a local area network (LAN) to exchange information. Some of the methodologies include a star, ring, or bus type network (see terminology at the end of this section).

A number of network "models" exist for describing the functions, interfaces and protocols involved in network data interchange. Regardless of the descriptive model used, all strive toward the same end and none actually changes the detailed implementation. Table 1 shows the layer names and the number of layers of networking models presented in Internet Engineering Task Forces (IETF) Request For Comments (RFCs) and in common use by textbooks.

Table 1. Some Common Network Architecture Models.

IETF-RFC 1122	Kurose, Forouzan	Comer, Kozierok	Stallings	Cisco Academy
Four layer Internet model	*Five-layer Internet model or TCP/IP protocol suite*	*TCP/IP 5-layer reference model*	*Five layer TCP/IP model*	*Four layer Internet model*
Application	Application	Application	Application	Application
Transport	Transport	Transport	Host-to-host or transport	Transport
Internet	Network	Internet	Internet	Internetwork
Link	Data link	Data link (Network interface)	Network access	Network interface
	Physical	(Hardware)	Physical	

These textbooks are secondary sources that may be contrary to the intent of RFC 1122 and other primary sources such as the Open Systems Interconnection (OSI) Reference Model developed by the International Organization for Standardization (ISO).

The OSI Reference Model is a more general description for layered communications and computer network protocol design. The IETF makes no effort to follow the OSI model although RFCs sometimes refer to it. The description of the OSI layers is shown in Table 2.

Table 2. OSI Reference Model.

	Name	Use	Misc Example	IP Suitte
7	APPLICATION	Meaning of data	HL7, Modbus	DHCP, DNS, FTP, Gopher, HTTP, NTP, SMTP, SNMP, Telnet
6	PRESENTATION	Building blocks of data and encryption	ASCII, EBCDIC, MIDI	MIME, XDR, SSL
5	SESSION	Opening and closing of specific communication paths	NetBIOS, SAP, Half Duplex, Simplex, SDP	NetBIOS, RTP, SAP
4	TRANSPORT	Error checking	NBF	PPTP, SCTP, TCP, UDP
3	NETWORK	Determination of data paths within the network	NBF, Q.931, IS-IS	IP, ICMP
2	DATA LINK	Data transmission, source, destination, and checksum	802.3 (Ethernet), PPP 802.11a/b/g/n MAC, FDDI	ARP, PPP, PPTP, SLIP
1	PHYSICAL	Voltage levels, signal connections, wire, or fiber	RS-232, 10Base-T, 802.11a/b/g/n Physical	

A layer is a collection of conceptually similar functions that provide services to the layer above it and receives service from the layer below it. On each layer an instance provides services to the instances at the layer above and requests service from the layer below. For example, a layer that provides error-free communications across a network provides the path needed by applications above it, while it calls the next lower layer to send and receive packets that make up the contents of the path. Conceptually two instances at one layer are connected by a horizontal protocol connection on that layer.

Most networks do not use all layers. For example, RS-232 is only a physical layer. Ethernet is only layers 1 and 2. TCP/IP is a protocol, not a network, and uses layers 3 and 4 regardless of whether layers 1 and 2 are a telephone line, wireless connection, or 10Base-T Ethernet cable.

Most of the sections in this division discuss the lowest (physical) layer of communication. There are, however, several more areas of general interest which are included in later sections such as Ethernet and TCP/IP. These are used in general purpose computers like the desktop PC or lab networks, and are not commonly used in aircraft.

The typical high-speed data busses on avionics/computers do not operate as fast as the CPU clock speed, but they are much faster than the interface busses they connect to. There are a number of interface busses (physical layer in network model) which are widely used by aircraft, avionics systems and test equipment. The most common include the RS-232, the RS-422, the RS-485, the IEEE-488 (GP-IB/HP-IB) and the MIL-STD-1553A/B. The MIL-STD-1773 bus is a fiber optic implementation of the 1553 bus and may be used in the future when technology requires it to reduce susceptibility to emissions or other reasons.

A summary of these more common types follows in Table 3, which includes a brief descriptive comparison, while a section covering each in more detail is provided later.

Table 3. Summary of Physical Bus Characteristics.

Bus	Max Length	Max Number of Terminals(1)	Type	# of Lines(2)	Data Rate	Rise Time(3)	Data Format
RS-232C	100 feet max 50 ft at 20k bps	1	Serial	3-20	150 - 19,200 baud per sec		5- to 8- bit serial
RS-422	1.2 km(4)	10(5)	Serial	3	see figure in RS-232 section	<0.1 T_b	unspecified
RS-485	unspecified	32	Serial	3	10 MHz	<0.3 T_b	unspecified
IEEE-488 (GP-IB/HP-IB)	20 meters	14	Parallel	16	500 kHz(6)		8-bit parallel
HP-IL	100 meters	30	Serial	2	20 k BPS		serial
MIL-STD-1553B MIL-STD-1773	300 feet N/A	32(7)	Serial	3	1 MHz	100-300 ns	20-bit serial

NOTES FROM TABLE:

(1) Max Number of Terminals does not include the bus controller.

(2) Including ground/shield

(3) T_b = time duration of the unit interval at the applicable data signaling rate (pulse width)

(4) Length is function of data signaling rate influenced by the tolerable signal distortion, amount of longitudinally coupled noise and ground potential difference introduced between the controller and terminal circuit grounds as well as by cable balance. See RS-422 section for graph.

(5) Physical arrangement of multiple receivers involves consideration of stub line lengths, fail-safe networks, location of termination resistors, data rate, grounding, etc.

(6) Rate can go up to 1 MHz if special conventions are followed.

(7) Max Number of Terminals includes terminal reserved for broadcast commands.

BUS TERMINOLOGY

10BASE-T: Standard "Plain Vanilla" Ethernet based on Unshielded Twisted Pair wire

10BASE-F: 10Mbps fiber optic Ethernet

100BASE-T: Standard "Fast Ethernet" based on twisted pair copper wire

ADDRESS: A unique designation for the location of data or the identity of an intelligent device; allows each device on a single communications line to respond to its own message.

ASCII (American Standard Code for Information Interchange): Pronounced asky. A seven-bit-plus-parity code established by ANSI to achieve compatibility between data services.

ASYNCHRONOUS OPERATION: Asynchronous operation is the use of an independent clock source in each terminal for message transmission. Decoding is achieved in receiving terminals using clock information derived from the message.

BAUD: Unit of signaling speed. The speed in baud is the number of discrete events per second. If each event represents one bit condition, baud rate equals bits per second (BPS). When each event represents more than one bit, baud rate does not equal BPS.

BIT: Contraction of binary digit: may be either zero or one. A binary digit is equal to one binary decision or the designation of one or two possible values of states of anything used to store or convey information.

BIT RATE: The number of bits transmitted per second.

BRIDGE: A network bridge connects multiple network segments at the data link layer (layer 2) of the OSI model, and the term layer 2 switch is very often used interchangeably with bridge. Bridges are similar to repeaters or network hubs, devices that connect network segments at the physical layer; however, with bridging, traffic from one network is managed rather than simply rebroadcast to adjacent network segments.

BROADCAST: Operation of a data bus system such that information transmitted by the bus controller or a remote terminal is addressed to more than one of the remote terminals connected to the data bus.

BUS CONTROLLER: The terminal assigned the task of initiating information transfers on the data bus.

BUS MONITOR: The terminal assigned the task of receiving bus traffic and extracting selected information to be used at a later time.

BYTE: A binary element string functioning as a unit, usually shorter than a computer "word." Eight-bits per byte are most common. Also called a "character."

COMMAND/RESPONSE: Operation of a data bus system such that remote terminals receive and transmit data only when commanded to do so by the bus controller.

CRC: Cyclic Redundancy Check; a basic error-checking mechanism for link-level data transmissions; a characteristic link-level feature of (typically) bit-oriented data communications protocols. The data integrity of a received frame or packet is checked by an algorithm based on the content of the frame and then matched

with the result that is performed by a sender and included in a (most often, 16-bit) field appended to the frame.

CROSSOVER CABLE: Cable with transmit/receive pairs reversed so one computer or hub or switch can link directly to another.

DATA BUS: Whenever a data bus or bus is referred to in MIL-STD-1553B, it shall imply all the hardware including twisted shielded pair cables, isolation resistors, transformers, etc., required to provide a single data path between the bus controller and all the associated remote terminals.

DCE (Data Communications Equipment): Devices that provide the functions required to establish, maintain, and terminate a data-transmission connection; e.g., a modem.

DHCP: Dynamic Host Configuration Protocol - permits auto-assignment of temporary IP addresses for new devices logging in

DNS: Domain Name Server - associates names with IP addresses

DTE (Data Terminal Equipment): Devices acting as data source, data sink, or both.

DUPLEX: Communication traveling between two nodes in both directions

DYNAMIC BUS CONTROL: The operation of a data bus system in which designated terminals are offered control of the data bus.

EIA (Electronic Industries Association): A standards organization in the U.S.A. specializing in the electrical and functional characteristics of interface equipment.

FDM (Frequency-Division Multiplexer: A device that divides the available transmission frequency range into narrower banks, each of which is used for a separate channel.

FDX (Full Duplex): Simultaneous, two-way, independent transmission in both directions (4-wire).

FTP: File Transfer Protocol - the most popular mechanism for bulk movement of files on TCP/IP.

GATEWAY: Device which links Ethernet to dissimilar networks and transfers data at the application layer level. Interface cards link the PC to Ethernet via the PCI, ISA, PCMCIA, PC/104, or other buses.

GPIB: General Purpose Interface Bus (see section 9-5),

HALF DUPLEX: Operation of a data transfer system in either direction over a single line, but not in both directions on that line simultaneously.

HANDSHAKING: Exchange of predetermined signals between two devices establishing a connection. Usually part of a communications protocol.

HPIB / HPIL: Hewlett-Packard Interface Bus / Hewlett-Packard Interface Loop

HUB: The simplest method of redistributing data, are "dumb," not interpreting or sorting messages that pass through them. A hub can be as simple as an electrical buffer with simple noise filtering. It isolates the

impedances of multiple spokes in a star topology. Some hubs also have limited store-and-forward capability. They indiscriminately transmit data to all other devices, which are still on the same collision domain, connected to the hubs. They are not assigned MAC addresses or IP addresses.

IEEE (Institute of Electrical and Electronic Engineers): An international professional society that issues its own standards and is a member of ANSI and ISO.

IP: Internet Protocol portion of TCP/IP. It is a protocol used for communicating data across a packet-switched network.

IP ADDRESS: Address of a TCP/IP enabled device on an Intranet or Internet – in the form xxx.xxx.xxx.xxx, where xxx is an integer between 0 and 255.

LAN: Local Area Network

MAC: Media Access Control - the physical components which disassemble Ethernet message fames

MANCHESTER ENCODING: Digital encoding technique (specified for the IEEE 802.3 Ethernet baseband network standard) in which each bit period is divided into two complementary halves; a negative-to-positive (voltage) transition in the middle of the bit period designates a binary "1," while a positive-to-negative transition represents a "0." The encoding technique also allows the receiving device to recover the transmitted clock from the incoming data stream (self-clocking).

MESSAGE: A single message is the transmission of a command word, status word, and data words if they are specified. For the case of a remote terminal to remote terminal (RT to RT) transmission, the message shall include the two command words, the two status words, and data words.

MODE CODE: A means by which the bus controller can communicate with the multiplex bus related hardware, in order to assist in the management of information flow.

MODEM (Modulator-Demodulator): A device used to convert serial digital data from a transmitting terminal to a signal suitable for transmission over a telephone channel, or to reconvert the transmitted signal to serial digital data for acceptance by a receiving terminal.

MULTIPLEXOR (also Multiplexer): A device used for division of a transmission into two or more subchannels, either by splitting the frequency band into narrower bands (frequency division) or by allotting a common channel to several different transmitting devices one at a time (time division).

NETWORK: An interconnected group of nodes; a series of points, nodes, or stations connected by communications channels; the assembly of equipment through which connections are made between data stations.

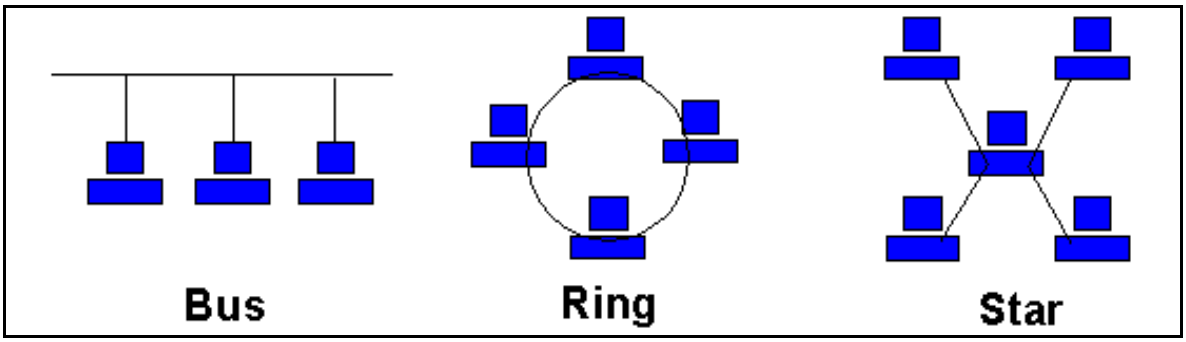

NODE: A point of interconnection to a network. Normally, a point at which a number of terminals or tail circuits attach to the network.

PARALLEL TRANSMISSION: Transmission mode that sends a number of bits simultaneously over separate lines (e.g., eight bits over eight lines) to a printer. Usually unidirectional.

PHASE MODULATION: One of three ways of modifying a sine wave signal to make it "carry" information. The sine wave or "carrier" has its phase changed in accordance with the information to be transmitted.

PING: Packet Inter Net Groper - very useful utility which probes for the existence of a TCP/IP host

POLLING: A means of controlling devices on a multipoint line.

PORT: A number in TCP/IP to which services are assigned; e.g. FTP is port 21; SMTP is port 25; HTTP is port 80.

PROTOCOL: A formal set of conventions governing the formatting and relative timing of message exchange between two communicating systems.

PULSE CODE MODULATION (PCM): The form of modulation in which the modulation signal is sampled, quantized, and coded so that each element of information consists of different types or numbers of pulses and spaces.

REMOTE TERMINAL (RT): All terminals not operating as the bus controller or as a bus monitor.

REPEATER: Buffer which cleans up, strengthens and re-transmits a signal.

ROUTER: Repeater which selectively re-distributes messages based on IP address

SERIAL TRANSMISSION: The most common transmission mode; in serial, information bits are sent sequentially on a single data channel.

SNMP: Simple Network Management Protocol; allows monitoring and management of a network.

SOCKET: Specific instance of an IP address and Port number that represents a single connection between two applications.

STAR TOPOLOGY: Topology which allows only one device at each end of a wire and requires repeaters for more than two devices.

STUBBING: Stubbing is the method wherein a separate line is connected between the primary data bus line and a terminal. The direct connection of stub line causes a mismatch which appears on the waveforms. This mismatch can be reduced by filtering at the receiver and by using bi-phase modulation. Stubs are often employed not only as a convenience in bus layout but as a means of coupling a unit to the line in such a manner that a fault on the stub or terminal will not greatly affect the transmission line operation. In this case, a network is employed in the stub line to provide isolation from the fault. These networks are also used for stubs that are of such length that the mismatch and reflection degrades bus operation. The preferred method of stubbing is to use transformer coupled stubs. The method provides the benefits of DC isolation, increased common mode protection, a doubling of effective stub impedance, and fault isolation for the entire stub and terminal. Direct coupled stubs should be avoided if at all possible. Direct coupled stubs provide no DC isolation or common mode rejection for the terminal external to its subsystem. Further, any shorting fault between the subsystems' internal isolation resistors (usually on the circuit board) and the main bus junction will cause failure of that entire bus. It can be expected that when the direct stub length exceeds 1.6 feet, that it will begin to distort the main bus waveforms. Note that this length includes the cable runs internal to a given subsystem.

SUBSYSTEM: The device or functional unit receiving data transfer service from the data bus.

SWITCH: Repeater which selectively re-distributes messages based on hardware MAC address

SYNCHRONOUS TRANSMISSION: Transmission in which data bits are sent at a fixed rate, with the transmitter and receiver synchronized. Synchronized transmission eliminates the need for start and stop bits.

TCP: Transmission Control Protocol - mechanism in TCP/IP that ensures that data arrives intact and in correct order

TELNET: Standard interface through which a client may access a host as though it were local

TERMINAL: The electronic module necessary to interface the data bus with the subsystem and the subsystem with the data bus. Terminals may exist as separate units or be contained within the elements of the subsystem.

TIME DIVISION MULTIPLEXING (TDM): The transmission of information from several signal sources through one communication system with different signal samples staggered in time to form a composite pulse train.

UDP: User Datagram Protocol - lower overhead alternative to TCP protocol which does not guarantee message delivery

WORD: A set of bits or bytes comprising the smallest unit of addressable memory. In MIL-STD-1553B, a word is a sequence of 16 bits plus sync and parity.

RS-232 INTERFACE

INTRODUCTION

The RS-232 interface is the Electronic Industries Association (EIA) standard for the interchange of serial binary data between two devices. It was initially developed by the EIA to standardize the connection of computers with telephone line modems. The standard allows as many as 20 signals to be defined, but gives complete freedom to the user. Three wires are sufficient: send data, receive data, and signal ground. The remaining lines can be hardwired on or off permanently. The signal transmission is bipolar, requiring two voltages, from 5 to 25 volts, of opposite polarity.

COMMUNICATION STANDARDS

The industry custom is to use an asynchronous word consisting of: a start bit, seven or eight data bits, an optional parity bit and one or two stop bits. The baud rate at which the word sent is device-dependent. The baud rate is usually 150 times an integer power of 2, ranging from 0 to 7 (150, 300, 600, ..., 19,200). Below 150 baud, many system-unique rates are used. The standard RS-232-C connector has 25 pins, 21 pins which are used in the complete standard. Many of the modem signals are not needed when a computer terminal is connected directly to a computer, and Figure 1 illustrates how some of the "spare" pins should be linked if not needed. Figure 1 also illustrates the pin numbering used in the original DB-25 connector and that now commonly used with a DB-9 connector normally used in modern computers

Specifying compliance to RS-232 only establishes that the signal levels in two devices will be compatible and that if both devices use the suggested connector, they may be able to be connected. Compliance to RS-232 does not imply that the devices will be able to communicate or even acknowledge each other's presence.

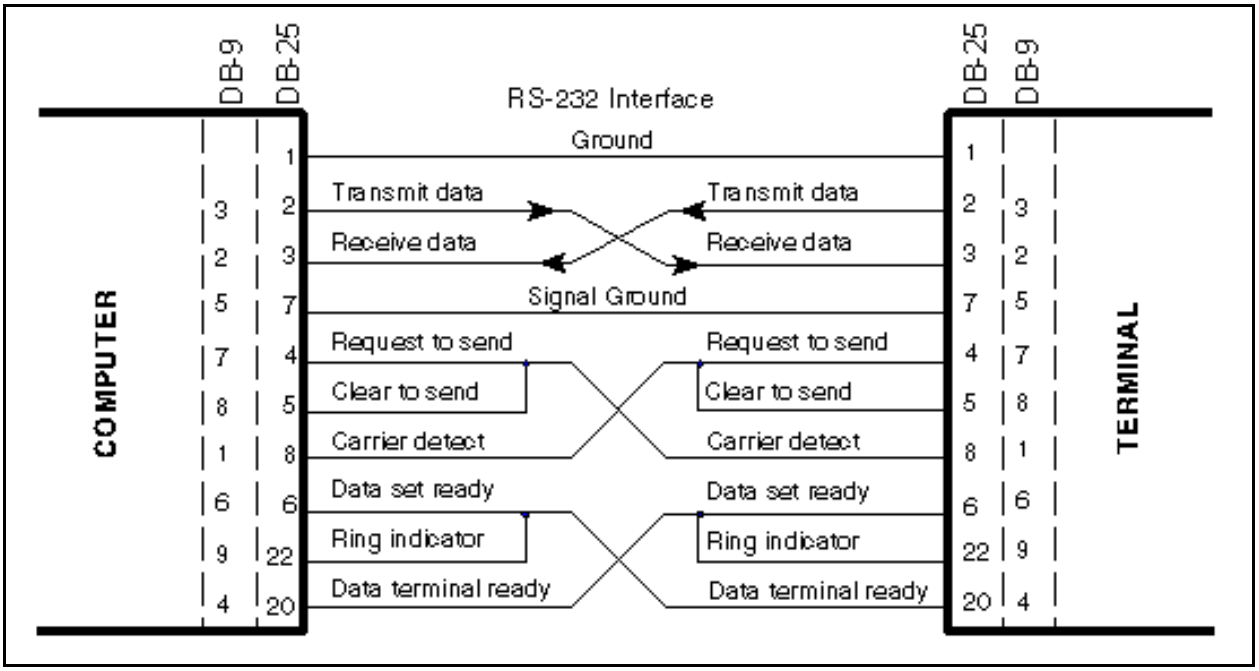

Figure 1. Direct-to-Computer RS-232 Interface.

Table 1 shows the signal names, and functions of the RS-232 serial port pinout. Table 2 shows a complete pin description.

Table 1. RS-232 Serial Port Pinout.

Name	Pin	Signal Name	Function
AA	1	PG Protective Ground	This line is connected to the chassis ground of the GPIB-232CV. Since the GPIB-232CV chassis ground is not connected to earth ground, pin 1 should be connected on both serial devices.
BA	2	TxD Transmit Data	This line carries serial data from the GPIB-232CV to the serial host.
BB	3	RxD Receive Data	This line carries serial data from the serial host to the GPIB-232CV.
CA	4	RTS Request to Send	This signal line is driven by the GPIB-232CV and when asserted indicates that the GPIB-232CV is ready to accept serial data. The GPIB-232CV un-asserts RTS when it is no longer ready to accept serial data because of a buffer full condition.
CB	5	CTS Clear to Send	This signal line is asserted by the serial host and sensed by the GPIB-232CV. When asserted, it indicates that the serial host is ready to accept serial data. When unasserted, it indicates that data transmission should be disabled.
AB	7	SG Signal Ground	This line establishes a reference point for all interface voltages.
CD	20	DTR Data Terminal Ready	This signal line is asserted by the GPIB-232CV to signal that it has been powered on, and is ready to operate.

Table 2. RS-232C Interface Signals.

Pin	Description	Pin	Description	Pin	Description
1	Protective Ground	10	(Reserved for Data Set Testing)	19	Secondary Request to Send
2	Transmitted Data	11	Unassigned	20	Data Terminal Ready
3	Received Data	12	Sec. Rec'd. Line Sig. Detector	21	Signal Quality Detector
4	Request to Send	13	Sec. Clear to Send	22	Ring Indicator
5	Clear to Send	14	Secondary Transmitted Data	23	Data Signal Rate Selector (DTE/DCE Source)
6	Data Set Ready	15	Transmission Signal Element Timing (DCE Source)	24	Transmit Signal Element Timing (DTE Source)
7	Signal Ground (Common Return)	16	Secondary Received Data	25	Unassigned
8	Received Line Signal Detector	17	Receiver Signal Element Timing (DCE Source)		
9	(Reserved for Data Set Testing)	18	Unassigned		

Electrical Characteristics: The RS-232-C specifies the signaling rate between the DTE and DCE, and a digital signal is used on all interchange circuits. The RS-232 standard specifies that logic "1" is to be sent as a voltage in the range -15 to -5 V and that logic "0" is to sent as a voltage in the range +5 to +15 V. The standard specifies that voltages of at least 3 V in amplitude will always be recognized correctly at the receiver according to their polarity, so that appreciable attenuation along the line can be tolerated. The transfer rate is rated > 20 kbps and a distance of < 15 m. Greater distance and data rates are possible with good design, but it is reasonable to assume that these limits apply in practice as well as in theory. The load impedance of the terminator side of the interface must be between 3000 and 7000 ohms, and not more than 2500 pF.

Table 3, summarizes the functional specifications of the most important circuits.

Table 3. RS-232-C Circuit Definitions.

Name	Direction to:	Function
Data Signals		
Transmitted Data (BA)	DCE	Data generated by DTE
Received Data (BB)	DTE	Data Received by DTE
Timing signals		
Transmitter Signal Element Timing (DA)	DCE	Clocking signal, transitions to ON and OFF occur at center of each signal element
Transmitter Signal Element Timing (DB)	DTE	Clocking signal, as above; both leads relate to signals on BA
Receiver Signal Element Timing (DD)	DTE	Clocking signal, as above, for circuit BB
Control Signals		
Request to Send (CA)	DCE	DTE wishes to transmit
Clear to Send (CB)	DTE	DCE is ready to transmit; response to request to send
Data Set Ready (CC)	DTE	DCE is ready to operate
Data Terminal Ready (CD)	DCE	DTE is ready to operate
Ring Indicator (CE)	DTE	Indicates that DCE is receiving a ringing signal on the communication channel
Carrier Detect (CF)	DTE	Indicates that DCE is receiving a carrier signal
Signal Quality Detector (CG)	DTE	Asserted when there is reason to believe there is an error in the received data
Data Signal Rate Selector (CH)	DCE	Asserted to select the higher of two possible data rates
Data Signal Rate Selector (CI)	DTE	Asserted to select the higher of two possible data rates
Ground		
Protective Ground (AA)	NA	Attached to machine frame and possibly external grounds
Signal Ground (AB)	NA	Establishes common ground reference for all circuits

Range: The RS-232-C standard specifies that the maximum length of cable between the transmitter and receiver should not exceed 100 feet. Although in practice many systems are used in which the distance between transmitter and receiver exceeds this rather low figure. The limited range of the RS-232C standard is one of its major shortcomings compared with other standards which offer greater ranges within their specifications. One reason why the range of the RS-232C standard is limited is the need to charge and discharge the capacitance of the cable connecting the transmitter and receiver.

Mechanical Characteristics: The connector for the RS-232-C is a 25 pin connector with a specific arrangement of wires. In theory, a 25 wire cable could be used to connect the Data Terminal Equipment (DTE) to the Data Communication Equipment (DCE). The DTE is a device that is acting as a data source, data sink, or both, e.g. a terminal, peripheral, or computer. The DCE is a device that provides the functions required to establish, maintain, and terminate a data-transmission connecting, as well as the signal conversion, and coding required for communication between data terminal equipment and data circuit; e.g. a modem. Table 4, shows the complete summary of the RS-232-C, e.g., descriptor, sponsor, data format, etc.

Table 4. Summary of the RS-232-C.

Data Format	5- to 8- bit serial
Transfer Type	Asynchronous
Error Handling	Optional Parity Bit
Connector	25-pin female connector on DCE; 25-pin male connector on DTE
Length	20 meters
Speed	20 kb/s
Remarks	RS-232 is used in the microcomputer world for communications between two DTEs. The null-modem is included into one or both connecting devices, and/or cable and is seldom documented. As a result, establishing an RS-232 connection between two DTEs is frequently a difficult task.

RS-422 BALANCED VOLTAGE INTERFACE

Specifying compliance to RS-422 only establishes that the signal between the specified devices will be compatible. It does not indicate that the signal functions or operations between the two devices are compatible. The RS-422 standard only defines the characteristic requirements for the balanced line drivers and receivers. It does not specify one specific connector, signal names, or operations. RS-422 interfaces are typically used when the data rate or distance criteria cannot be met with RS-232. The RS-422 standard allows for operation of up to 10 receivers from a single transmitter. The standard does not define operations of multiple tri-stated transmitters on a link.

The RS-422-A interfaces between the Data Terminal Equipment (DTE) and Data Communication Equipment (DCE) or in any point-to-point interconnection of signals between digital equipment. It employs the electrical characteristics of balanced-voltage digital interface circuits.

The balanced voltage digital interface circuit will normally be utilized on data, timing, or control circuits where the data signaling rate is up to 10 Mbit/s. While the balanced interface is intended for use at the higher data signaling rate, it may (in preference to the unbalanced interface circuit) generally be required if any of the following conditions prevail:

- The interconnecting cable is too long for effective unbalanced operation.
- The interconnecting cable is exposed to an extraneous noise source that may cause an unwanted voltage in excess of + 1 volt measured differentially between the signal conductor and circuit common at the load end of the cable with a 50 ohm resistor substituted for the generator.
- It is necessary to minimize interference with other signals.
- Inversion of signals may be required, i.e. plus to minus MARK may be obtained by inverting the cable pair.

Applications of the balanced voltage digital interface circuit are shown in Figure 1.

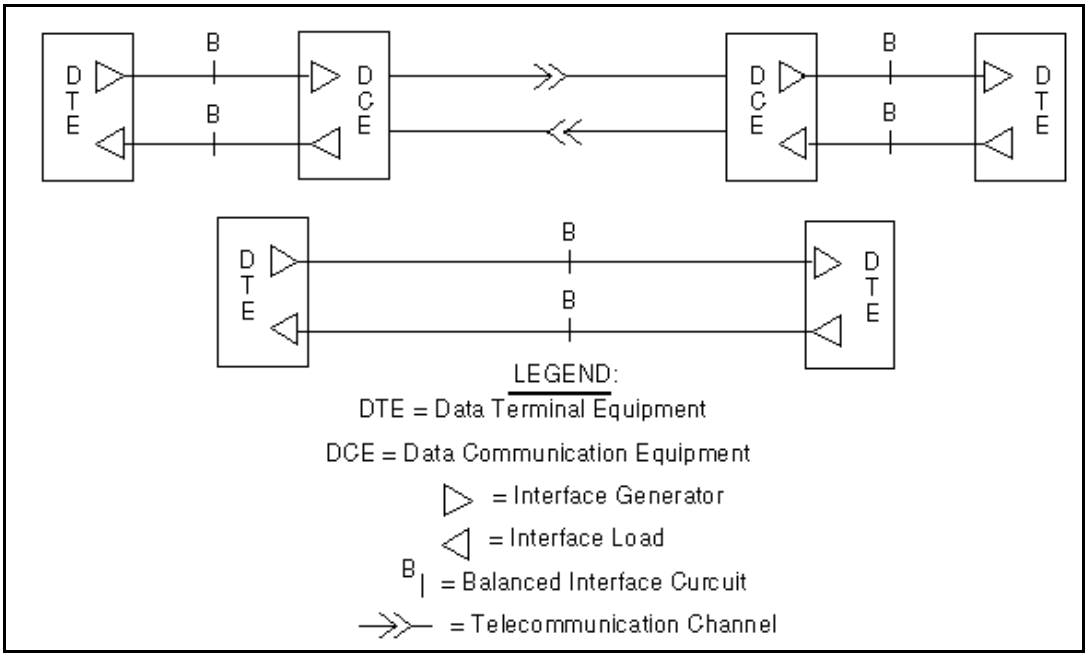

Figure 1. Application of a RS-422 Circuit.

While a restriction on maximum cable length is not specified, guidelines are given later with respect to conservative operating distances as function of data signaling rate.

For a binary system in which the RS-422-A is designed, the data signaling rate in bit/s and the modulation in bauds are numerically equal when the unit interval used in each determination is the minimum interval.

Electrical Characteristics:

The balanced voltage digital interface circuit consists of three parts: the generator (G), the balanced interconnecting cable, and the load. The load is comprised of one or more receivers (R) and an optional cable termination resistance (RT). The balanced voltage interface circuit is shown in Figure 2.

Environmental Constraints:

Balanced voltage digital interface conforming to this standard will perform satisfactorily at data signaling rates up to 10 Mbit/s providing that the following operational constraints are satisfied:

- The interconnecting cable length is within that recommended for the applicable data signaling rate (see Figure 3) and the cable is appropriately terminated.
- The common mode voltage at the receiver is less than 7 volts (peak). The common mode voltage is defined to be any uncompensated combination of generator-receiver ground potential difference, the generator offset voltage (Vos), and longitudinally coupled peak noise voltage measured between the received circuit ground and cable within the generator ends of the cable short-circuited to ground.

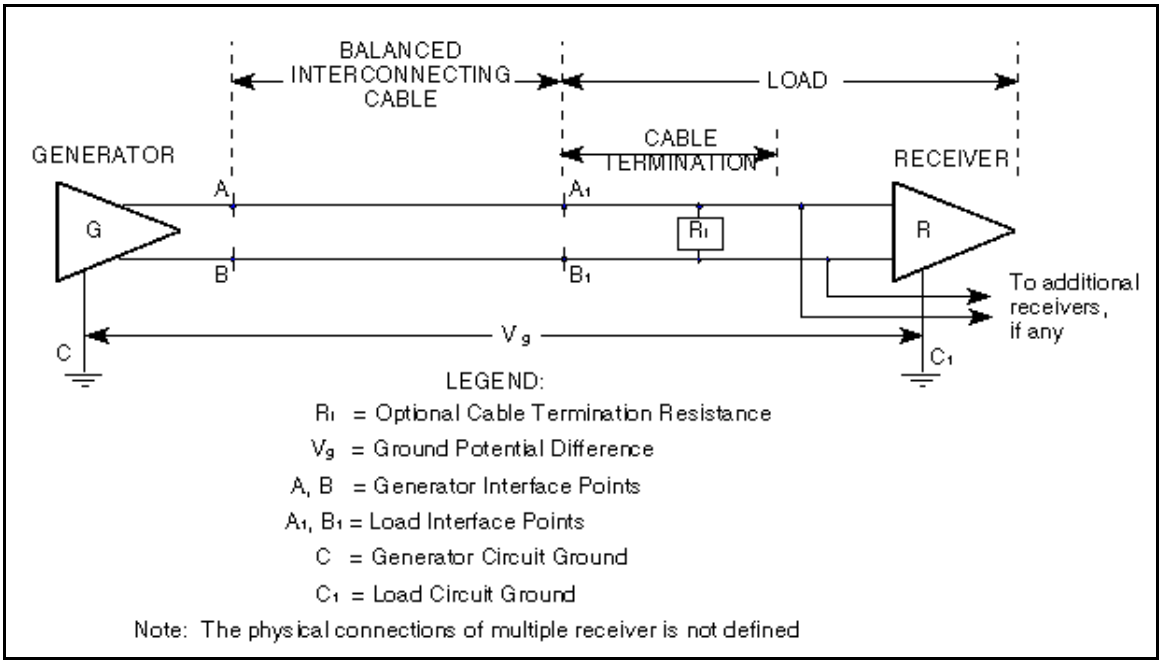

Figure 2. Balanced Digital Interface Circuit.

Interconnecting Cable Guidelines:

The maximum permissible length of cable separating the generator and the load is a function of data signaling rate and is influenced by the tolerable signal distortion, the amount of coupled noise and ground potential difference introduced between the generator and load circuit as well as by cable balance. The curve of cable length versus signaling rate is given in Figure 3. This curve is based upon using 24 AWG copper, twisted-pair cable with a capacitance of 52.5 pF/meter terminated in a 100 ohm load. As data signaling rate is reduced below 90 kbit/s, the cable length has been limited at 1200 meters by the assumed maximum allowable 6 dBV signal loss.

Industry customs are not nearly as well established for RS-422 interfaces as they are for RS-232. The standard specifies use of the 37-pin "D"; the 9-pin "D" is specified for use with the secondary channel. Most data communications equipment uses the 37-pin "D"; many computer applications use a 9-pin "D" only. Some equipment applications use the 25-pin "D" defined for RS-232.

Compatibility With Other Interfaces:

Since the basic differential receivers of RS-423-A and RS-422-A are electrically identical, it is possible to interconnect an equipment using RS-423-A receivers and generators on one side of the interface with an equipment using RS-422-A generators and receivers on the other side of the interface, if the leads of the receivers and generators are properly configured to accommodate such an arrangement and the cable is not terminated.

This circuit is not intended for interoperation with other interface electrical circuits such as RS-232-C, MIL-STD-188C, or CCITT (Comite Consultatif Internationale Telegraphique et Telephonique), recommendations V.28 and V.35. Under certain conditions, the above interfaces may be possible but may require modification of the interface or equipment; therefore satisfactory operation is not assured and additional provisions not specified herein may be required.

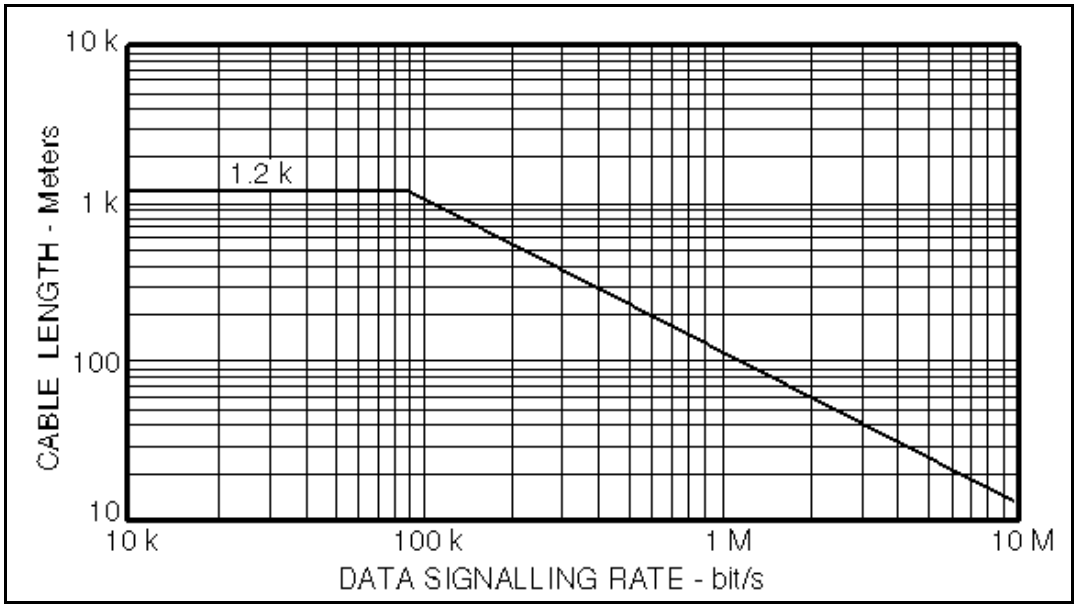

Figure 3. Data Signaling Rate vs. Cable Length.

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RS-485 INTERFACE

STANDARD FOR ELECTRICAL CHARACTERISTICS OF GENERATORS AND RECEIVERS FOR USE IN BALANCED DIGITAL MULTIPOINT SYSTEMS

Introduction: The RS-485 is the recommend standard by the Electronic Industries Association (EIA) that specifies the electrical characteristics of generators and receivers that may be employed for the interchange of binary signals in multipoint interconnection of digital equipments. When implemented within the guidelines, multiple generators and receivers may be attached to a common interconnecting cable. An interchange system includes one or more generators connected by a balanced interconnecting cable to one or more receivers and terminating resistors.

Electrical Characteristics: The electrical characteristics that are specified are measured at an interconnect point supplied by the devices manufacturer. Figure 1 shows an interconnection application of generators and receivers having the electrical parameters specified. The elements in the application are: generators, receivers, transmission cables, and termination resistances (Rt). The loads on the system caused by each receiver and passive generator shall be defined in terms of unit loads. Each generator can drive up to 32 unit loads consisting of both receivers and generators in the passive state. The loading caused by receivers and passive generators on the interconnect must be considered in defining the device electrical characteristics. Two areas are of concern: the DC load and the AC load characteristics. The DC load is defined as a number or fractions of "unit loads." The AC loading is not standardized but must be considered in the design of a system using the devices meeting this standard.

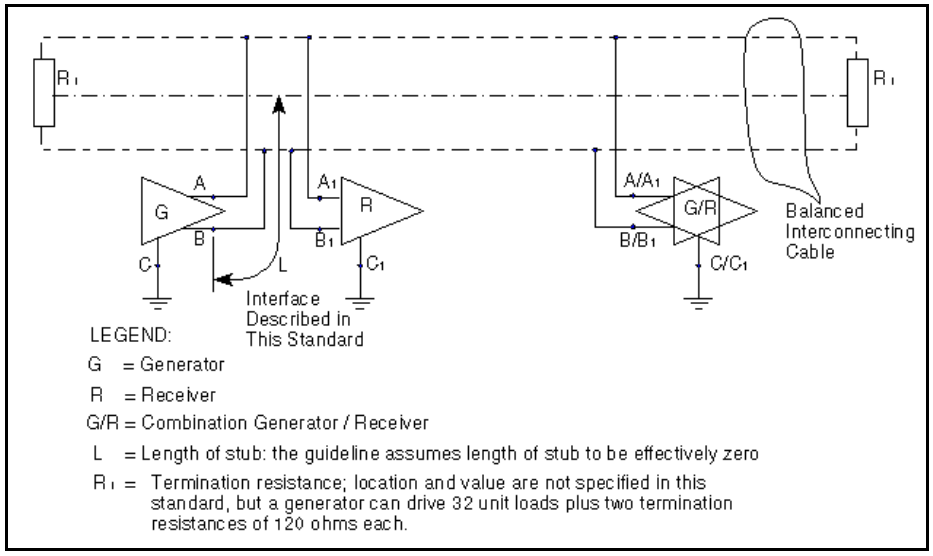

Figure 1. Multipoint Interconnect Application.

General System Configuration: The generators and receivers conforming to the RS-485 standard can operate with a common mode voltage between -7 volts and +7 volts (instantaneous). The common mode voltage is defined to be any uncompensated combination of generator-receiver ground potential difference and longitudinally coupled peak noise voltage measured between the receiver circuit ground and cable with the generator ends of the cable short circuited to ground, plus the generator offset voltage (Vos).

Grounding Arrangements: Proper operation of the generator and receiver circuits requires the presence of a signal return path between the circuit grounds of the equipment at each end of the interconnection. The grounding arrangements are shown in Figure 2. Where the circuit reference is provided by a third conductor, the connection between circuit common and the third conductor must contain some resistance (e.g., 100 ohms) to limit circulating currents when other ground connections are provided for safety. Some applications may require the use of shielded interconnecting cable for EMI or other purposes. The shield shall be connected to frame ground at either or both ends, depending on the application.

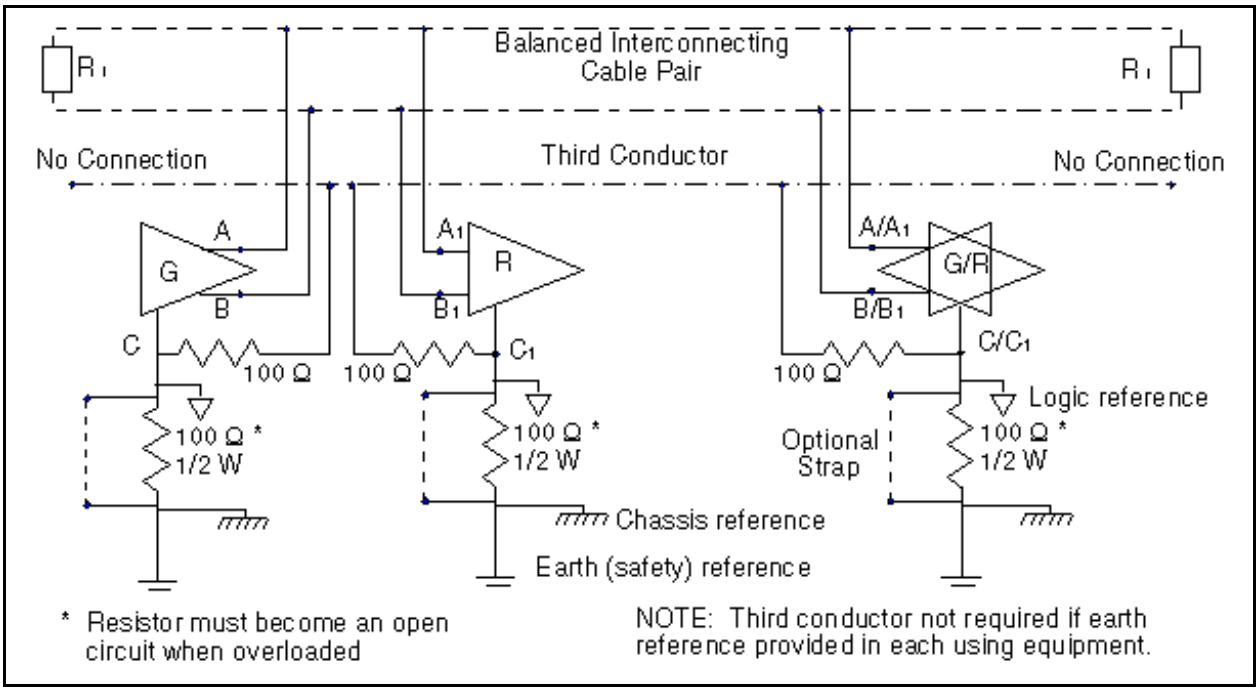

Figure 2. Grounding Arrangements.

Similarity with RS-422-A:

In certain instances, it may be possible to produce generators and receivers that meet the requirements of both RS-422-A and of RS-485. Table 1 depicts the differences in parameter specifications which exist between the two documents.

Table 1. Comparison of RS-422-A and RS-485 Characteristics.

Characteristic	RS-422-A	RS-485
Min. output voltage	2V into 100 ohm > 1/2 open circuit V	1.5 V into 54 ohms
I_{short} to ground	150 mA maximum	
I_{short} to -7, +12 volts		250 mA peak
t_{rise} time	< 0.1 t_b , 100 ohm load	< 0.3 t_b , 54 ohm, 50 pF load

Where t_b = time duration of the unit interval at the applicable data signaling rate (pulse width).

IEEE-488 INTERFACE BUS (HP-IB/GP-IB)

In the early 1970's, Hewlett-Packard came out with a standard bus (HP-IB) to help support their own laboratory measurement equipment product lines, which later was adopted by the IEEE in 1975. This is known as the IEEE Std. 488-1975. The IEEE-488 Interface Bus (HP-IB) or general purpose interface bus (GP-IB) was developed to provide a means for various instruments and devices to communicate with each other under the direction of one or more master controllers. The HP-IB was originally intended to support a wide range of instruments and devices, from the very fast to the very slow.

DESCRIPTION

The HP-IB specification permits up to 15 devices to be connected together in any given setup, including the controller if it is part of the system. A device may be capable of any other three types of functions: controller, listener, or talker. A device on the bus may have only one of the three functions active at a given time. A controller directs which devices will be talkers and listeners. The bus will allow multiple controllers, but only one may be active at a given time. Each device on the bus should have a unique address in the range of 0-30. The maximum length of the bus network is limited to 20 meters total transmission path length. It is recommended that the bus be loaded with at least one instrument or device every 2 meter length of cable (4 meters is maximum). The use of GP-IB extenders may be used to exceed the maximum permitted length of 20 meters.

ELECTRICAL INTERFACE

The GP-IB is a bus to which many similar modules can be directly connected, as is shown in Figure 1. A total of 16 wires are shown in the figure - eight data lines and eight control lines. The bus cables actually have 24 wires, providing eight additional for shielding and grounds.

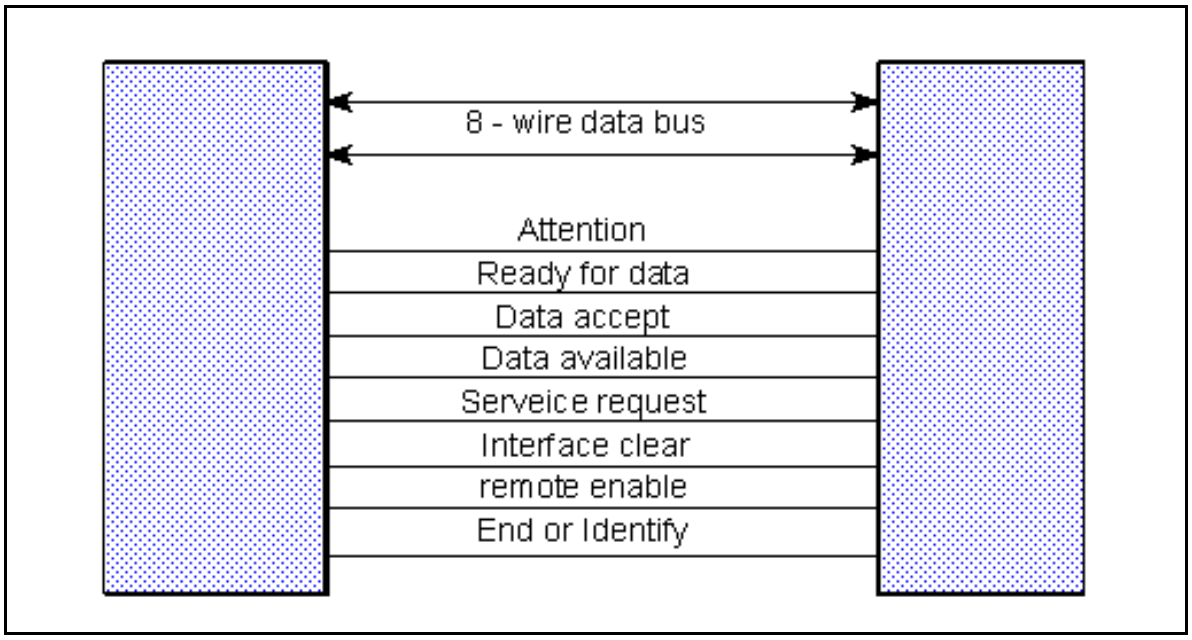

Figure 1. IEEE-488 (HP-IB / GP-IB) Bus Configuration.

The GP-IB defines operation of a three-wire handshake that is used for all data transfers on the bus. The bus operation is asynchronous in nature. The data-transfer rate of the GP-IB is 500 kHz for standard applications and can go up 1 MHz if special conventions are followed. Each transaction carries 8 bits, the maximum data bandwidth is on the order of 4 to 8 megabits (1 M byte) per second. The bus is a two way communications channel and data flows in both directions. Figure 2 illustrates the structure of the GP-IB bus and identifies the 16 connections of the interconnecting cable.

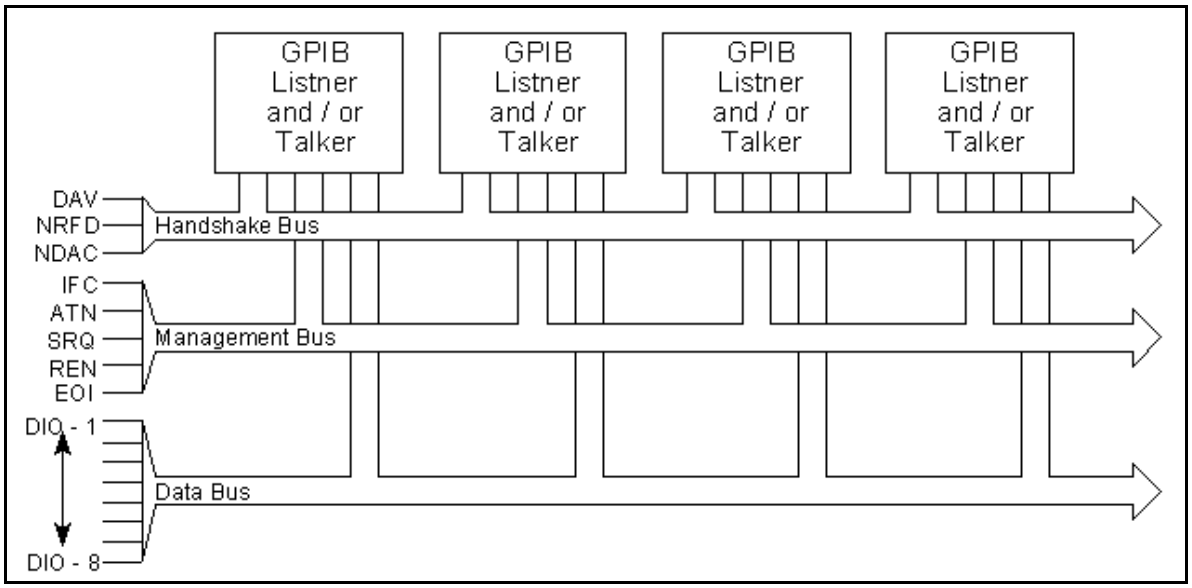

Figure 2. GP-IB Instrumentation Bus Structure.

The cabling limitations make it a less-than-ideal choice for large separation between devices. These limitations can be overcome with bus extenders. Those attempting to use bus extenders should be aware that few extenders are as transparent as claimed. This is especially true in handling of continuous data and interrupts. In nonextended environments, it provides an excellent means for high-speed computer control of multiple devices.

The following table shows the various interface functions, the mnemonics and the descriptions.

Table 1. GP-IB Interface Functions.

Interface Function	Mnemonic	Description
Talker (extended talker)	T (TE)	Device must be able to transmit
Listener (Extended listener)	L (LE)	Device must receive commands and data
Source Handshake	SH	Device must properly transfer a multiline message
Acceptor Handshake	AH	Device must properly receive remote multiline messages
Remote/Local	RL	Device must be able to operate from front panel and remote information from bus
Service Request	SR	Device can asynchronously request service from the controller
Parallel Poll	PP	Upon controller request, device must uniquely identify itself if it requires service
Device Clear	DC	Device can be initialized to a predetermined state
Device Trigger	DT	A device function can be initiated by the talker on the bus
Controller	C	Device can send addresses, universal commands, address commands, and conduct polls
Drivers	E	This code describes the type of electrical drivers in a device

The cabling specifications of the GP-IB interface system permit interconnecting all devices together in a star or linear configuration. The GP-IB connector is a 24-pin ribbon-type connector.

In summary, Table 2 on this page and the next shows the complete description of the GP-IB data bus.

Table 2. GP-IB Data Bus Description.

IEEE-488, GP-IB, HP-IB, or IEC-625					
Descriptor	8-bit parallel, monodirectional, multi-master (token passing) One controller, one talker, several listeners	Arbitration	Token passing: the controller addresses the next controller SRQ Service request when the controller assigns modes	Connector	24-pin Amphenol Female connector on equipment chassis. DIO1 1 ■ ■ 13 DIO5 DIO2 2 ■ ■ 14 DIO6 DIO3 3 ■ ■ 15 DIO7 DIO4 4 ■ ■ 16 DIO8 EOI 5 ■ ■ 17 REN DAV 6 ■ ■ 18 Gnd NRFD 7 ■ ■ 19 Gnd NDAC 8 ■ ■ 20 Gnd IFC 9 ■ ■ 21 Gnd SRQ 10 ■ ■ 22 Gnd ATN 11 ■ ■ 23 Gnd Shld 2 ■ ■ 24 Gnd
Sponsor	Hewlett-Packard	Error handling	Parity bit DI07 when 7-bit ACSII characters		
Standard	IEEE 488, IEC 625	Bus length	15 m		
Address space	31 devices	Driver	Special 24 mA drivers		
Data format	8-bit parallel	Speed	1 MByte/s		
Transfer type	Write only, talker toward listener(s) or commander toward all others			Remarks	The 488 is most commonly used for data acquisition of H-P peripherals. Programmable interfaces and drivers exist and simplify the development of microprocessor interfaces.
Timing	Handshaken 3-wire broadcast transfer: DAV data valid NDAC Not data accepted NRFD Not ready for data	References	IEEE Computer Society		

HP-IL VARIATION

Since introduction of the IEEE-488, technology produced a generation of medium-speed, low-power, instrumentation which had a need to operate in an automatic test system such as the GP-IB. The HP-IL (Hewlett-Packard Interface Loop), was introduced to meet this need. The HP-IL is a low-cost, low-power alternative to the GP-IB system. The HP-IL and GP-IB provide the same basic functions in interfacing controllers, instruments, and peripherals, but they differ in many other respects. HP-IL is suitable for use in low-power, portable applications (typically used for interface of battery-power systems). The GP-IB is not practical to operate from battery power. The HP-IL maximum data rate is 20K bytes per second. This is a high rate compared to the RS-232C, but much slower than GP-IB. The HP-IL can operate over distances of up to 100 meters between any two devices. Since it is a loop environment, there is no maximum system cable restriction. The basic device-addressing scheme allows for up to 30 devices on a loop.

MIL-STD-1553 & 1773 DATA BUS

PURPOSE

In recent years, the use of digital techniques in aircraft equipment has greatly increased, as have the number of avionics subsystems and the volume of data processed by them.

Because analog point-to-point wire bundles are inefficient and cumbersome means of interconnecting the sensors, computers, actuators, indicators, and other equipment onboard the modern military vehicle, a serial digital multiplex data bus was developed. MIL-STD-1553 defines all aspects of the bus, therefore, many groups working with the military tri-services have chosen to adopt it.

The 1553 multiplex data bus provides integrated, centralized system control and a standard interface for all equipment connected to the bus. The bus concept provides a means by which all bus traffic is available to be accessed with a single connection for testing and interfacing with the system. The standard defines operation of a serial data bus that interconnects multiple devices via a twisted, shielded pair of wires. The system implements a command-response format.

MIL-STD-1553, "Aircraft Internal Time-Division Command/Response Multiplex Data Bus," has been in use since 1973 and is widely applied. MIL-STD-1553 is referred to as "1553" with the appropriate revision letter (A or B) as a suffix. The basic difference between the 1553A and the 1553B is that in the 1553B, the options are defined rather than being left for the user to define as required. It was found that when the standard did not define an item, there was no coordination in its use. Hardware and software had to be redesigned for each new application. The primary goal of the 1553B was to provide flexibility without creating new designs for each new user. This was accomplished by specifying the electrical interfaces explicitly so that compatibility between designs by different manufacturers could be electrically interchangeable.

The Department of Defense chose multiplexing because of the following advantages:

- Weight reduction
- Simplicity
- Standardization
- Flexibility

Some 1553 applications utilize more than one data bus on a vehicle. This is often done, for example, to isolate a Stores bus from a Communications bus or to construct a bus system capable of interconnecting more terminals than a single bus could accommodate. When multiple buses are used, some terminals may connect to both buses, allowing for communication between them.

MULTIPLEXING

Multiplexing facilitates the transmission of information along the data flow. It permits the transmission of several signal sources through one communications system.

BUS

The bus is made up of twisted-shielded pairs of wires to maintain message integrity. MIL-STD-1553 specifies that all devices in the system will connect to a redundant pair of buses. This provides a second path for bus traffic should one of the buses be damaged. Signals are only allowed to appear on one of the two buses at a time. If a message cannot be completed on one bus, the bus controller may switch to the other bus. In some applications more than one 1553 bus may be implemented on a given vehicle. Some terminals on the bus may actually connect to both buses.

BUS COMPONENTS

There are only three functional modes of terminals allowed on the data bus: the bus controller, the bus monitor, and the remote terminal. Devices may be capable of more than one function. Figure 1 illustrates a typical bus configuration.

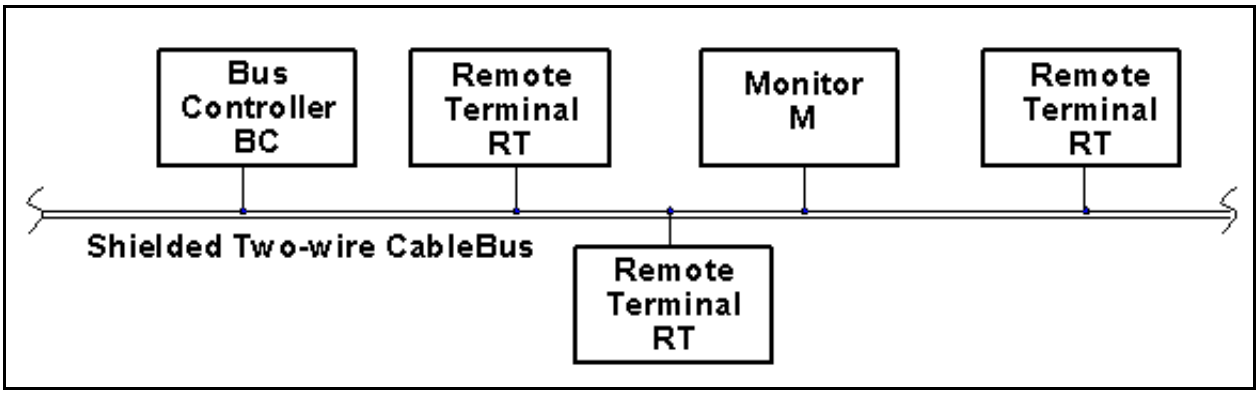

Figure 1. 1553 Bus Structure.

- Bus Controller - The bus controller (BC) is the terminal that initiates information transfers on the data bus. It sends commands to the remote terminals which reply with a response. The bus will support multiple controllers, but only one may be active at a time. Other requirements, according to 1553, are: (1) it is "the key part of the data bus system," and (2) "the sole control of information transmission on the bus shall reside with the bus controller."

- Bus Monitor - 1553 defines the bus monitor as "the terminal assigned the task of receiving bus traffic and extracting selected information to be used at a later time." Bus monitors are frequently used for instrumentation.

- Remote Terminal - Any terminal not operating in either the bus controller or bus monitor mode is operating in the remote terminal (RT) mode. Remote terminals are the largest group of bus components.

MODULATION

The signal is transferred over the data bus using serial digital pulse code modulation.

DATA ENCODING

The type of data encoding used by 1553 is Manchester II biphase.

- A logic one (1) is transmitted as a bipolar coded signal 1/0 (in other words, a positive pulse followed by a negative pulse).
- A logic zero (0) is a bipolar coded signal 0/1 (i.e., a negative pulse followed by a positive pulse).

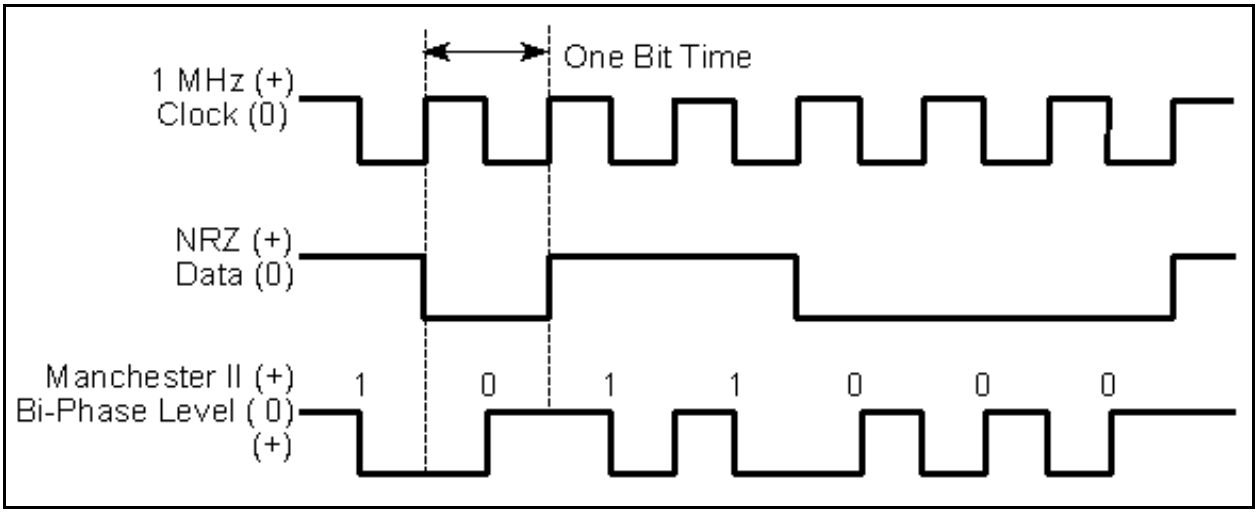

Figure 2. Data Encoding.

A transition through zero occurs at the midpoint of each bit, whether the rate is a logic one or a logic zero. Figure 2 compares a commonly used Non Return to Zero (NRZ) code with the Manchester II biphase level code, in conjunction with a 1 MHz clock.

BIT TRANSMISSION RATE

The bit transmission rate on the bus is 1.0 megabit per second with a combined accuracy and long-term stability of +/- 0.1%. The short-term stability is less than 0.01%.

There are 20 1.0-microsecond bit times allocated for each word. All words include a 3 bit-time sync pattern, a 16-bit data field that is specified differently for each word type, and 1 parity check bit.

WORD FORMATS

Bus traffic or communications travels along the bus in words. A word in MIL-STD-1553 is a sequence of 20 bit times consisting of a 3 bit-time sync wave form, 16 bits of data, and 1 parity check bit. This is the word as it is transmitted on the bus; 1553 terminals add the sync and parity before transmission and remove them during reception. Therefore, the nominal word size is 16 bits, with the most significant bit (MSB) first.

There are three types of words: command, status, and data. A packet is defined to have no inter-message gaps. The time between the last word of a controller message and the return of the terminal status

byte is 4-12 microseconds. The time between status byte and the next controller message is undefined. Figure 3 illustrates these three formats.

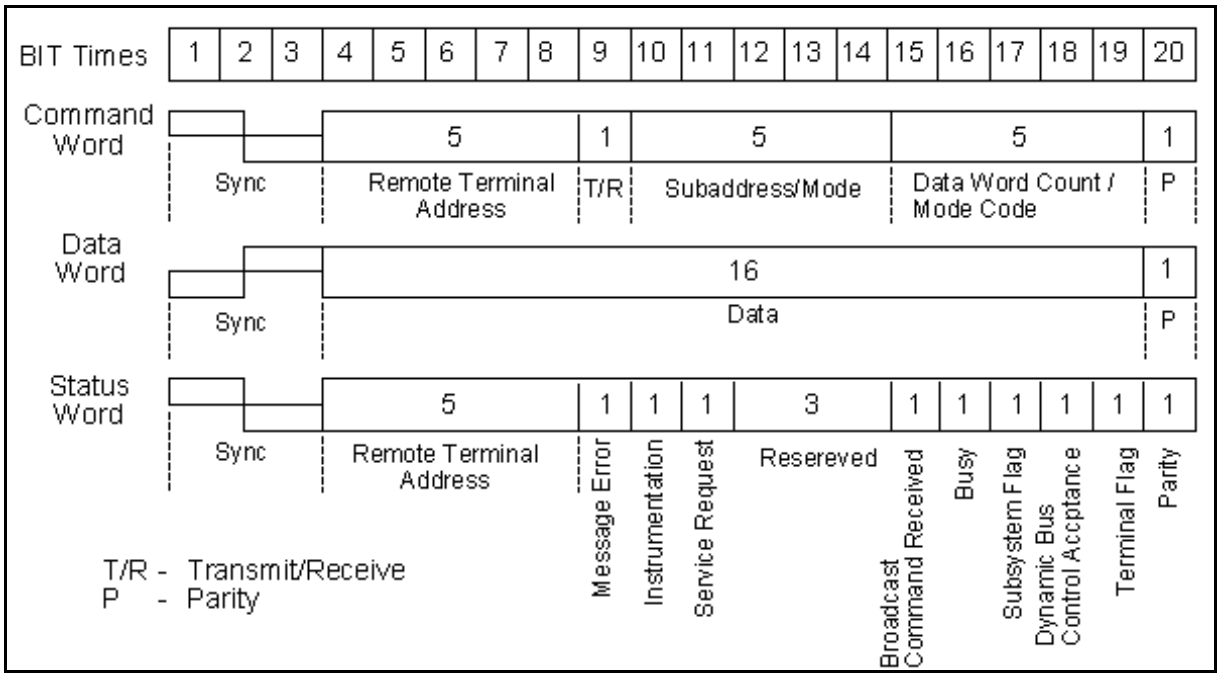

Figure 3. 1553 Word Formats.

COMMAND WORD

Command words are transmitted only by the bus controller and always consist of:

- 3 bit-time sync pattern
- 5 bit RT address field
- 1 Transmit/Receive (T/R) field
- 5 bit subaddress/mode field
- 5 bit word count/mode code field
- 1 parity check bit.

DATA WORD

Data words are transmitted either by the BC or by the RT in response to a BC request. The standard allows a maximum of 32 data words to be sent in a packet with a command word before a status response must be returned. Data words always consist of:

- 3 bit-time sync pattern (opposite in polarity from command and status words)
- 16 bit data field
- 1 parity check bit.

STATUS WORD

Status words are transmitted by the RT in response to command messages from the BC and consist of:

- 3 bit-time sync pattern (same as for a command word)
- 5 bit address of the responding RT
- 11 bit status field
- 1 parity check bit.

The 11 bits in the status field are used to notify the BC of the operating condition of the RT and subsystem.

INFORMATION TRANSFERS

Three basic types of information transfers are defined by 1553:

- Bus Controller to Remote Terminal transfers
- Remote Terminal to Bus Controller transfers
- Remote Terminal to Remote Terminal transfers

These transfers are related to the data flow and are referred to as messages. The basic formats of these messages are shown in Figure 4.

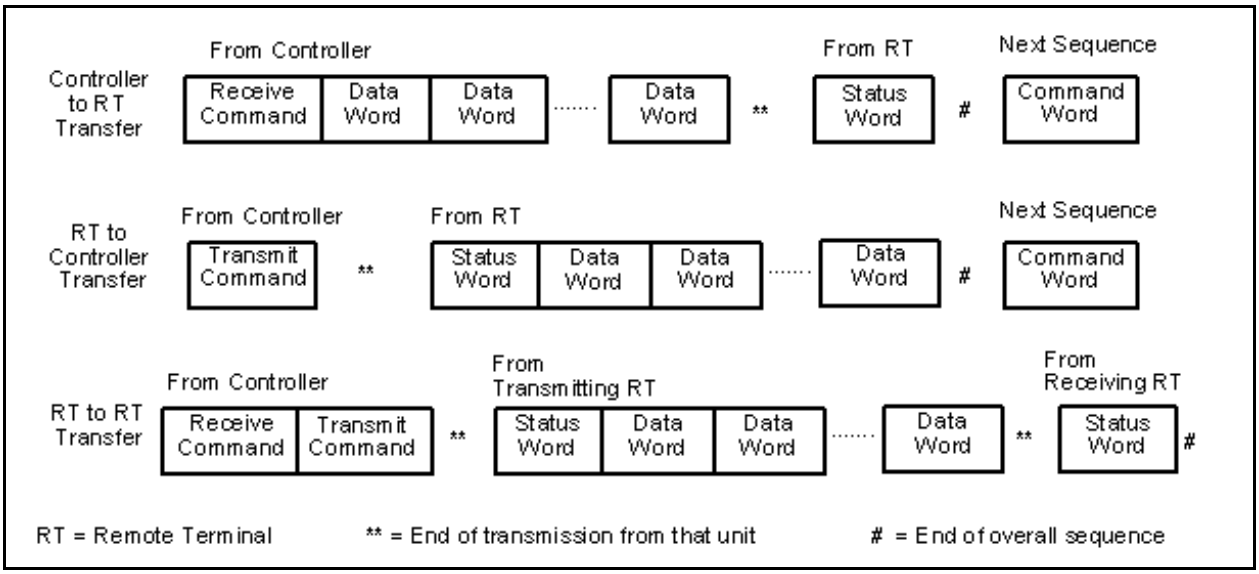

Figure 4. 1553 Data Message Formats.

The normal command/response operation involves the transmission of a command from the BC to a selected RT address. The RT either accepts or transmits data depending on the type (receive/transmit) of command issued by the BC. A status word is transmitted by the RT in response to the BC command if the transmission is received without error and is not illegal.

Figure 5 illustrates the 1553B Bus Architecture in a typical aircraft.

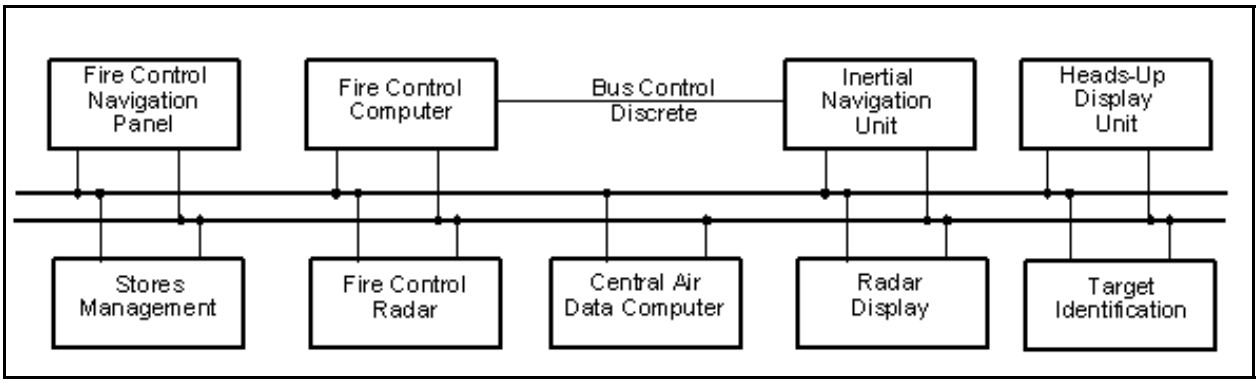

Figure 5. Typical Bus Architecture.

MIL-STD-1773

MIL-STD-1773 contains the requirements for utilizing a fiber optic "cabling" system as a transmission medium for the MIL-STD-1553B bus protocol. As such, the standard repeats MIL-STD-1553 nearly word-for-word. The standard does not specify power levels, noise levels, spectral characteristics, optical wavelength, electrical/optical isolation or means of distributing optical power. These must be contained in separate specifications for each intended use.

Data encoding and word format are identical to MIL-STD-1553, with the exception that pulses are defined as transitions between 0 (off) and 1 (on) rather than between + and - voltage transitions since light cannot have a negative value.

Since the standard applies to cabling only, the bus operates at the same speed as it would utilizing wire. Additionally, data error rate requirements are unchanged.

Different environmental considerations must be given to fiber optic systems. Altitude, humidity, temperature, and age affects fiber optics differently than wire conductors. Power is divided evenly at junctions which branch and connectors have losses just as wire connectors do.

ETHERNET

HISTORY

Ethernet was originally developed by Digital, Intel, and Xerox (DIX) in the early 1970's at the Xerox Palo Alto Research Center (PARC). The two primary inventors were Robert Metcalf and David Boggs.

IEEE Project 802 was set up in February 1980 to provide standards for Local Area Network (LAN) and Metropolitan Area Network (MAN) Architecture. The following committees were established:

- IEEE 802.1: Standards related to network management.
- IEEE 802.2: General standard for the data link layer in the OSI Reference Model. The IEEE divides this layer into two sub-layers -- the logical link control (LLC) layer and the media access control (MAC) layer. The MAC layer varies for different network types and is defined by standards IEEE 802.3 through IEEE 802.5.
- IEEE 802.3: Defines the MAC layer for bus networks that use CSMA/CD. **This is the basis of what is most commonly referred to as the Ethernet standard**.
- IEEE 802.4: Defines the MAC layer for token-bus networks.
- IEEE 802.5: Defines the MAC layer for token-ring networks.
- IEEE 802.6: Standard for Metropolitan Area Networks (MANs).
- IEEE 802.7-9 Inactive Standards:
    - IEEE 802.7: Broadband local area networks. The working group is currently inactive.
    - IEEE 802.8: The Fibre Optic Technical Advisory Group was to create a LAN standard for fiber optic media used in token passing computer networks like FDDI.
    - IEEE 802.9: Integrated Services (IS) LAN Interface at the MAC and Physical Layers.
- IEEE 802.10: A standard for security functions that can be used in both LAN and MAN.
- IEEE 802.11: Wireless LAN MAC and physical layer
- IEEE 802.12: Demand Priority Access Method, Physical Layer and Repeater used in star topology, 100VG-AnyLAN, etc
- IEEE 802.16: Fixed broadband wireless LAN

Ethernet versions 1.0 and 2.0 followed after the original development until the IEEE 802.3 committee altered the structure of the Ethernet II packet to form the Ethernet 802.3 packet. You will currently see either Ethernet II (DIX) format or Ethernet 802.3 format being used.

IEEE 802.3 Ethernet uses Manchester Phase Encoding (MPE) for coding the data bits on the outgoing signal.

INTRODUCTION

Ethernet is a family of frame-based computer networking technologies for local area networks (LANs). The 'Ether' part of Ethernet denotes that the system is not meant to be restricted for use on only one medium type. Copper cables, fiber cables and even radio waves can be used.

Ethernet is standardized as IEEE 802.3. The combination of the twisted pair versions of Ethernet for connecting end systems to the network, along with the fiber optic versions for site backbones, is the most

widespread wired LAN technology. It has largely replaced competing LAN standards such as token ring, FDDI, and ARCNET.

Ethernet defines a number of wiring and signaling standards for the Physical Layer of the OSI networking model, through means of network access at the Media Access Control (MAC) / Data Link Layer, and a common addressing format. Therefore, Ethernet defines the lower two layers of the OSI Reference Model (see Data Busses Section intro). Ethernet sometimes implies an attached protocol—such as TCP/IP, however TCP/IP really defines the transport and network layers, respectively, of the OSI model.

Ethernet was designed as a 'broadcast' system, i.e. stations on the network can send messages whenever and wherever they want. All stations may receive the messages, however only the specific station to which the message is directed responds. To handle simultaneous demands, the system uses Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

CARRIER SENSE MULTIPLE ACCESS WITH COLLISION DETECTION (CSMA/CD)

When an Ethernet station is ready to transmit, it checks for the presence of a signal on the cable. If no signal is present then the station begins transmission. However, if a signal is present then the station delays transmission until the cable is not in use. If two stations detect an idle cable and at the same time transmit data, then a collision occurs. On a star-wired, unshielded twisted pair (UTP) network, if the transceiver of a sending station detects activity on both its receive and transmit pairs before it has completed transmitting, then it decides that a collision has occurred. On a coaxial system, a collision is detected when the DC signal level on the cable is the same or greater than the combined signal level of the two transmitters. Line voltage drops dramatically if two stations transmit at the same time and the first station to notice this sends a high voltage jamming signal around the network as a signal. The two stations involved with the collision quit transmitting again for a random time interval.

A Collision Domain is that part of the network where each station can 'see' other stations' traffic both unicast and broadcasts. The Collision Domain is made up of one segment of Ethernet coax (with or without repeaters) or a number of UTP shared hubs. A network is segmented with bridges that create two segments, or two Collision Domains where a station on one segment cannot see traffic between stations on the other segment unless the packets are destined for itself. If it can still see all broadcasts on the segmented network(s), no matter the number of segments, it is a Broadcast Domain.

ETHERNET FRAME

Figure 1 depicts the structure of the older DIX (Ethernet II) and the now standard 802.3 Ethernet frames. The numbers above each field represent the number of bytes.

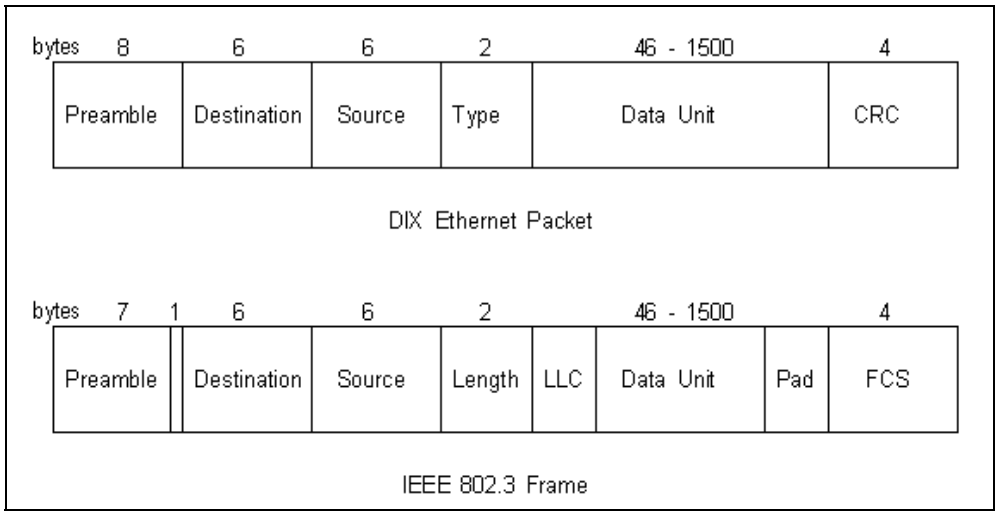

Figure 1. Ethernet Frame.

- **Preamble field:** Establishes bit synchronization and transceiver conditions so that the circuitry synchs with the received frame timing. The DIX frame has 8 bytes for the preamble rather than 7, as it does not have a Start Frame Delimiter (or Start of Frame).
- **Start Frame Delimiter:** Sequence 10101011 in a separate field, only in the 802.3 frame.
- **Destination address:** Hardware address (MAC address) of the destination station (usually 48 bits i.e. 6 bytes).
- **Source address:** Hardware address of the source station (must be of the same length as the destination address, the 802.3 standard allows for 2 or 6 byte addresses, although 2 byte addresses are never used, N.B. Ethernet II *only* uses 6 byte addresses).
- **Type:** Specifies the protocol sending the packet such as IP or IPX (only applies to DIX frame).
- **Length:** Specifies the length of the data segment, actually the number of LLC data bytes, (only applies to 802.3 frame and replaces the Type field).
- **LLC:** Logical Length Control is a data communication protocol layer which provides multiplexing and flow control mechanisms that make it possible for several network protocols (IP, IPX) to coexist within a multipoint network and to be transported over the same network media.
- **Data:** Actual data which is allowed anywhere between 46 to 1500 bytes within one frame.
- **Pad:** Zeros added to the data field to 'Pad' a short data field to 46 bytes (applies to 802.3 frame).
- **CRC:** Cyclic Redundancy Check to detect errors during transmission (DIX version of FCS).
- **FCS:** Frame Check Sequence to detect errors that occur during transmission (802.3 version of CRC). This 32-bit code has an algorithm applied to it, which will give the same result as the other end of the link, provided that the frame was transmitted successfully.

From the above we can see that the maximum 802.3 frame size is 1518 bytes and the minimum size is 64 bytes. Packets that have correct CRCs (or FCSs) but are smaller than 64 bytes are known as 'Runts'.

The hardware address, or MAC address is transmitted and stored in Ethernet network devices in **Canonical** format i.e. Least Significant Bit (LSB) first. The expression **Little-Endian** is used to describe the LSB format in which Ethernet is transmitted. On the other hand, Token Ring networks and the subset, Fiber

Distributed Data Interface (FDDI) networks, transmit the MAC address with the Most Significant Bit (MSB) first, or **Big-Endian**, This is known as **Non-Canonical** format. Note that this applies on a byte-by-byte basis i.e. the bytes are transmitted in the same order, it is just the bits in each of those bytes that are reversed. The storage of the MAC addresses in Token Ring and FDDI devices however, may sometimes still be in Canonical format so this can sometimes cause confusion. The reference to, the distribution of MAC addresses and the Organizationally Unique Identifier (OUI) destinations are always in Canonical format.

The Logical Link Control (LLC) protocol data unit (PDU) is defined in IEEE 802.2 and operates with 802.3 Ethernet as seen in Figure 2.

DSAP address	SSAP address	Control	Information
8 bits	8 bits	8 or 16 bits	M*8 bits

DSAP address	=	Destination service access point address field
SSAP address	=	Source service access point address field
Control	=	Control field [16 bits for formats that include sequence numbering, and 8 bits for formats that do not (see 5.2)]
Information	=	Information field
*	=	Multiplication
M	=	An integer value equal to or greater than 0. (Upper bound of M is a function of the medium access control methodology used.)

Figure 2. LLC Format.

LLC is based on the High-Level Data Link Control (HDLC) data protocol format. Whereas Ethernet II (2.0) combines the MAC and the Data link layers restricting itself to connectionless service in the process, IEEE 802.3 separates out the MAC and Data Link layers. IEEE 802.2 is also required by Token Ring and FDDI but cannot be used with the Novell 'Raw' format. There are three types of LLC; Type 1, which is connectionless, Type 2 which is connection-oriented, and Type 3 for Acknowledged Connections.

The **Service Access Point (SAP)** is used to distinguish between different data exchanges on the same end station and basically replaces the Type field for the older Ethernet II frame. The **Source Service Access Point (SSAP)** indicates the service from which the LLC data unit is sent, and the **Destination Service Access Point (DSAP)** indicates the service to which the LLC data unit is being sent. As examples, NetBIOS uses the SAP address of **F0** whilst IP uses the SAP address of **06**. The following lists some common SAPs:

00 - Null LSAP
02 - Individual LLC Sublayer Management Function
03 - Group LLC Sublayer Management Function
05 - IBM SNA Path Control (group)

06 - Internet Protocol (IP)
18 - Texas Instruments
42 - IEEE 802.1 Bridge Spanning Tree Protocol
80 - Xerox Network Systems (XNS)
86 - Nestar
AA - SubNetwork Access Protocol (SNAP)
E0 - Novell NetWare
F0 - IBM NetBIOS
F5 - IBM LAN Management (group)
FE - ISO Network Layer Protocol

The **Control Field** identifies the type of LLC, of which there are three:

- **Type 1** - Data (PDUs) shall be exchanged between LLCs without the need for the establishment of a data link connection. These PDUs shall not be acknowledged, nor shall there be any flow control or error recovery. This is called **Unsequenced Information (UI)**.
- **Type 2** – Needs data link connection. Uses **Information (I)** frames and maintains the sequence numbers during an acknowledged connection-oriented transmission.
- **Type 3** – No data link connection required. Uses **Acknowledged Connection (AC)** frames in an acknowledged connectionless service.

MAC ADDRESS

With an Ethernet MAC address, the first octet uses <u>only</u> the lowest significant bit as the Individual/Group (I/G) bit address identifier. If it is zero it indicates the address is individual. If it is one, it indicates a group address. The Universally or Locally administered (U/L) address bit is the bit of octet 0 adjacent to the I/G address bit. This bit indicates whether the address has been assigned by a local or universal administrator. Universally administered addresses have this bit set to 0. If this bit is set to 1, the entire address (i.e., 48 bits) has been locally administered.

The first 3 octets of the MAC address form the Organizational Unique Identifier (OUI) assigned by IEEE to organizations that requires their own group of MAC addresses.

SUBNETWORK ACCESS PROTOCOL (SNAP)

The SNAP protocol was introduced to allow an easy transition to the new LLC frame format for vendors. SNAP allows older frames and protocols to be encapsulated in a Type 1 LLC header making any protocol 'pseudo-IEEE compliant'. SNAP is described in RFC 1042. Figure 3 shows how it looks:

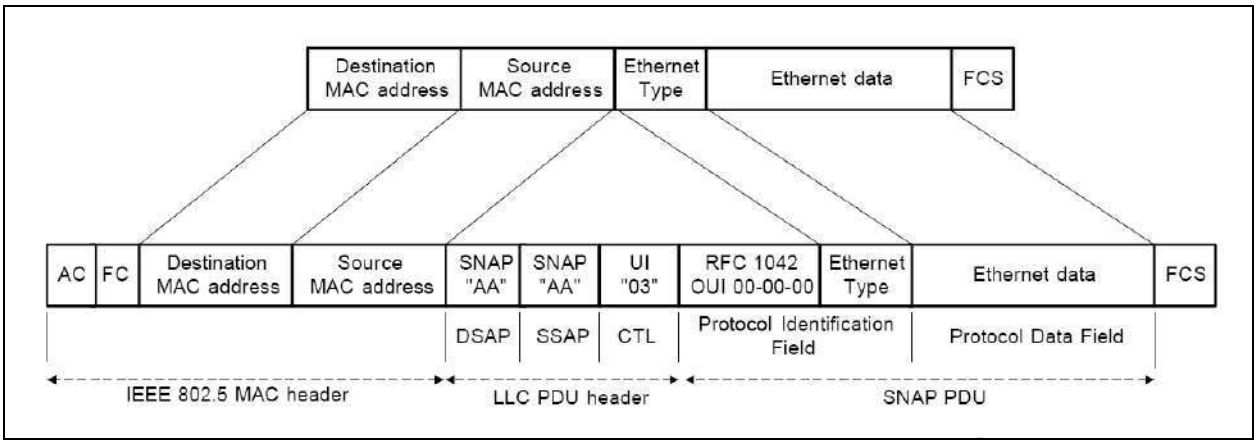

Figure 3. Ethernet Frame SNAP-encapsulated in IEEE 802.5 Frame.

It can be seen that it is an LLC data unit (sometimes called a Logical Protocol Data Unit (LPDU)) of Type 1 (indicated by 03). The DSAP and SSAP are set to AA to indicate that this is a SNAP header coming up. The SNAP header then indicates the vender via the Organizational Unique Identifier (OUI) and the protocol type via the Ethertype field. In the example above the OUI is 00-00-00 which means that there is an Ethernet frame. An ethernet type (Ethertype) of 08-00 would indicate Internet IP is the protocol. The official list of types can be found at IEEE. Although vendors tend to be are moving to LLC1 on the LAN, SNAP still remains.

TRANSMISSION MEDIA

<u>10Base-5</u> - largely obsolete, but may still be in use.

Traditionally, Ethernet is used over 'thick' coaxial cable called 10Base-5 (the '10' denotes 10Mbps, base means that the signal is baseband i.e. takes the whole bandwidth of the cable (so that only one device can transmit at one time on the same cable), and the '5' denotes 500 m maximum length). The minimum length between stations is 2.5 m.

The cable is run in one long length forming a 'Bus Topology'. Stations attach to it by way of inline N-type connections or a transceiver, which is literally screwed into the cable (by way of a 'Vampire Tap') providing a 15-pin Attachment Unit Interface (AUI) connection (also known as a DIX connector or a DB-15 connector) for a drop lead connection (maximum of 50 m length) to the station. The segments are terminated with 50 ohm resistors and the shield grounded at one end only.

The segment could be appended with up to a maximum of 4 repeaters; therefore 5 segments (total length of 2,460 m) can be connected together. Of the 5 segments only 3 can have devices attached (100 per segment). This is known as the 5-4-3 rule. A total of 300 devices can be attached on a Thicknet broadcast domain.

10Base-2 – dominant for many years

It was common to see the Thick coax used in Risers to connect Repeaters, which in turn provide 'Thin Ethernet' coaxial connections for runs up to 30 workstations. Thin Ethernet (Thinnet) uses RG-58 cable and is called 10Base-2 (The '2' now denoting 200 m maximum length - strictly speaking this is 185 m). The minimum length between stations is 0.5 m.

Each station connects to the thinnet by way of a Network Interface Card (NIC), which provides a BNC (British Naval Connector). At each station the thinnet terminates at a T-piece and at each end of the thinnet run (or 'Segment') a 50-ohm terminator is required to absorb stray signals, thereby preventing signal bounce. The shield is grounded at one end only.

A segment can be appended with other segments using up to 4 repeaters, i.e. 5 segments in total. Two of these segments however, cannot be tapped; they can only be used for extending the length of the broadcast domain (to 925 m). What this means is that 3 segments with a maximum of 30 stations on each can give you 90 devices on a Thinnet broadcast domain.

10Base-T – Most widespread today

The most common media used in of Ethernet today involves use of Unshielded Twisted Pair (UTP) or Shielded Twisted Pair (STP). For instance, Category 5 UTP can be installed in a 'Star-wired' format, with runs recommended at no greater than 100 m (including patch leads, cable run and flyleads) and Ethernet Hubs with UTP ports (RJ45) centrally located. It has been found though that runs of up to 150 m are feasible, the limitations being signal strength. Also, there should be no more than a 11.5 dB signal loss and the minimum distance between devices is 2.5 m. The maximum delay for the signal in a 10Mbps network is 51.2 microseconds. This comes from the fact that the bit time (time to transmit one bit) is 0.1 microseconds and that the slot time for a frame is 512 bit times.

In order to connect to Ethernet in this 'Star Topology', each station has a NIC, which contains an RJ45 socket which is used by a 4-pair droplead to connect to another nearby RJ45 socket.

Each port on the hub sends a 'Link Beat Signal' which checks the integrity of the cable and devices attached, a flickering LED on the front of the port of the hub tells you that the link is running fine. The maximum number of hubs (or, more strictly speaking, repeater counts) that you can have in one segment is four and the maximum number of stations on one broadcast domain is 1024.

The advantages of the UTP/STP technology are gained from the flexibility of the system, with respect to moves, changes, fault finding, reliability, and security. The following table shows the RJ45 pin-outs for 10Base-T:

RJ45 Pin	Function	Color
1	Transmit	White/Orange stripe
2	Transmit	Orange
3	Receive	White/Green stripe
4		Blue
5		White/Blue stripe
6	Receive	Green
7		White/Brown stripe
8		Brown

If you wish to connect hub to hub, or a NIC directly to another NIC, then the following 10Base-T crossover cable should be used:

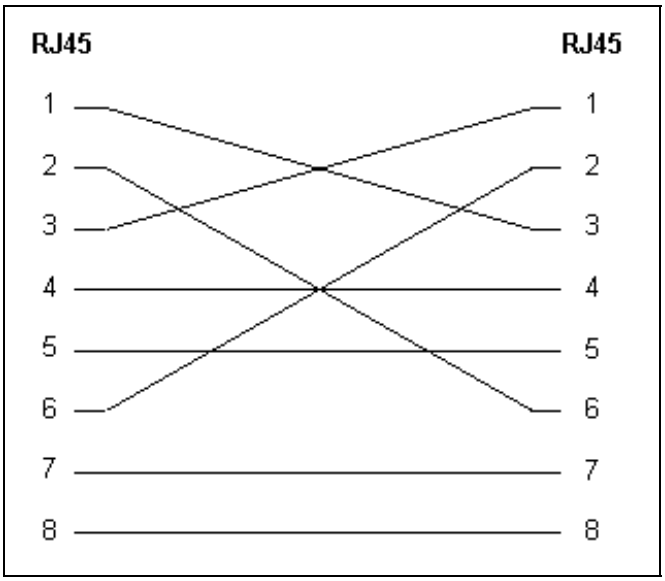

Figure 4. 10Base-T Crossover.

The 4-repeater limit manifests itself in 10/100Base-T environments where the active hub/switch port is in fact a repeater, hence the name multi-port repeater. Generally, the hub would only have one station per port but you can cascade hubs from one another up to the 4-repeater limit. The danger here is that you will have all the traffic from a particular hub being fed into one port so care would need to be taken on noting the applications being used by the stations involved, and the likely bandwidth that the applications will use.

There is a pre-standard called Lattisnet (developed by Synoptics), which runs 10 MHz Ethernet over twisted pair but instead of bit synchronization occurring at the sending (as in 10Base-T) the synchronization occurs at the receiving end.

10Base-F

The 10Base-F standard defines the use of fiber for Ethernet. 10Base-FL describes the standards for the fiber optic links between stations and repeaters, allowing up to 2 km per segment on multi-mode fiber. It replaces the 1987 FOIRL (Fiber Optic Inter-Repeater Link), which provides the specification for a fiber optic Media Attachment Unit (MAU) and other interconnecting components. Two related standards are essentially "dead": 10Base-FB allows up to 2 km per segment (on multi-mode fiber) and is designed for backbone applications such as cascading repeaters. In addition, there is the 10Base-FP (Passive components) standard

The 10Base-F standard allows for 1024 devices per network.

Fast Ethernet - 100Base-T

Fast Ethernet is the most popular of the newer standards and is an extension to 10Base-T. The '100' denotes 100 Mbps data speed and it uses the same two pairs as 10Base-T and must only be used on Category 5 UTP cable installations with provision for it to be used on Type 1 STP. The actual data throughput increases by between 3 to 4 times that of 10Base-T.

Fast Ethernet is specified in 802.3u and uses the same frame formats and CSMA/CD technology as normal 10Mbps Ethernet. The difference is that the maximum delay for the signal across the segment is 5.12 microseconds instead of 51.2 microseconds. This stems from the fact that the bit time (time to transmit one bit) is 0.01 microseconds and that the slot time for a frame is 512 bit times. The Inter-Packet Gap (IPG) for 802.3u is 0.96 microseconds as opposed to 9.6 microseconds for 10Mbps Ethernet.

Whereas 10Base-T uses Normal Link Pulses (NLP) for testing the integrity of the connection, 100Base-T uses Fast Link Pulses (FLP) which are backwardly compatible with NLPs but contain more information. FLPs are used to detect the speed of the network (e.g. in 10/100 switchable cards and ports). The distance must not exceed 100 m.

The IEEE uses the term 100Base-X to refer to both 100Base-Tx and 100Base-Fx and the Media-Independent Interface (MII) allows a generic connector for transceivers to connect to 100Base-Tx, 100Base-Fx and 100Base-T4 LANs.

There is no such thing as the 5-4-3 rule in Fast Ethernet. All 10Base-T repeaters are considered to be functionally identical. Fast Ethernet repeaters are divided into two classes of repeater: Class I and Class II. A Class I repeater has a repeater propagation delay value of 140 bit times, whilst a Class II repeater is 92 bit times. The Class I repeater (or Translational Repeater) can support different signaling types such as 100Base-Tx and 100Base-T4. A Class I repeater transmits or repeats the incoming line signals on one port to the other ports by first translating them to digital signals and then retranslating them to line signals. The translations are necessary when connecting different physical media (media conforming to more than one physical layer specification) to the same collision domain. Any repeater with an MII port would be a Class I device. Only one Class I repeater can exist within a single collision domain, so this type of repeater cannot be cascaded.

A Class II repeater immediately transmits or repeats the incoming line signals on one port to the other ports: it does not perform any translations. This repeater type connects identical media to the same collision domain (for example, TX to TX). At most, two Class II repeaters can exist within a single collision domain.

The cable used to cascade the two devices is called and unpopulated segment or IRL (Inter-Repeater Link). The Class II repeater (or **Transparent Repeater**) can only support one type of physical signaling.

100Base-T4

100Base-T4 was an early implementation of Fast Ethernet. It requires four twisted copper pairs, but those pairs were only required to be category 3 rather than the category 5 required by TX. One pair is reserved for transmit, one for receive, and the remaining two will switch direction as negotiated. A very unusual 8B6T code is used to convert 8 data bits into 6 base-3 digits (the signal shaping is possible as there are three times as many 6-digit base-3 numbers as there are 8-digit base-2 numbers). The two resulting 3-digit base-3 symbols are sent in parallel over 3 pairs using 3-level pulse-amplitude modulation (PAM-3).

100Base-T2

This little known version of Fast Ethernet is for use over two pairs of Category 3 cable and uses PAM-5 for encoding. There is simultaneous transmission and reception of data in both pairs and the electronics uses DSP technology to handle alien signals in adjacent pairs. 100Base-T2 can run up to 100 m on Category 3 UTP.

100Base-Fx

100Base-Fx is a version of Fast Ethernet over optical fiber. It uses a 1300 nm near-infrared (NIR) light wavelength transmitted via two strands of optical fiber, one for receive (RX) and the other for transmit (TX). Maximum length is 400 meters (1,310 ft) for half-duplex connections (to ensure collisions are detected) or 2 kilometers (6,600 ft) for full-duplex over multimode optical fiber. Longer distances are possible when using single-mode optical fiber. 100Base-Fx uses the same 4B5B encoding and NRZI line code that 100Base-TX does. 100Base-Fx should use the following connectors: SC, straight tip (ST), or media independent connectors (MIC), with SC being the preferred option. 100Base-Fx is not compatible with 10Base-Fl, the 10 MBit/s version over optical fiber.

100Base-Sx

100Base-Sx is a version of Fast Ethernet over optical fiber. It uses two strands of multi-mode optical fiber for receive and transmit. It is a lower cost alternative to using 100Base-Fx, because it uses short wavelength optics (850 nm) which are significantly less expensive than the long wavelength optics used in 100Base-Fx. 100Base-Sx can operate at distances up to 300 meters (980 ft).

100Base-Sx uses the same wavelength as 10Base-Fl, the 10 MBit/s version over optical fiber. Unlike 100Base-Fx, this allows 100Base-Sx to be backwards-compatible with 10Base-Fl. Because of the shorter wavelength used and the shorter distance it can support, 100Base-Sx uses less expensive optical components (LEDs instead of lasers) which makes it an attractive option for those upgrading from 10Base-Fl and those who do not require long distances.

100Base-Bx

100Base-Bx is a version of Fast Ethernet over a single strand of optical fiber (unlike 100Base-Fx, which uses a pair of fibers). Single-mode fiber is used, along with a special multiplexer which splits the signal into transmit and receive wavelengths. The two wavelengths used for transmit and receive are either 1310/1550 nm or 1310/1490 nm. Distances can be 10, 20, or 40 km.

100VG-AnyLAN

Based on 802.12 (Hewlett Packard), 100VG-AnyLAN uses an access method called Demand Priority. The 'VG' stands for 'Voice Grade' as it is designed to be used with Category 3 cable. This is where the repeaters (hubs) carry out continuous searches around all of the nodes for those that wish to send data. If two devices cause a 'contention' by wanting to send at the same time, the highest priority request is dealt with first, unless the priorities are the same, in which case both requests are dealt with at the same time (by alternating frames). The hub only knows about connected devices and other repeaters so communication is only directed at them rather than broadcast to every device in the broadcast domain (which could mean 100's of devices!). This is a more efficient use of the bandwidth. This is the reason why the new standard was developed as it is not strictly Ethernet. Standard 802.12 is designed to better support both Ethernet and Token Ring.

The encoding techniques used are 5B/6B and NRZ. All four pairs of UTP are used. On Cat3 the longest cable run is 100 m but this increases to 200 m on Cat5. The clock rate on each wire is 30 MHz; therefore 30 Mbits per second are transmitted on each pair giving a total bit rate of 120 Mbps. Since each 6-bits of data on the line represents 5 bits of real data due to the 5B/6B encoding, the rate of real data being transmitted is 25 Mbps on each pair, giving a total real data rate of 100 Mbps. For 2-pair STP and fiber, the bit rate is 120 Mbps on the transmitting pair, for a real data transmission rate of 100 Mbps.

Gigabit Ethernet

Although the functional principles of Gigabit Ethernet are the same as Ethernet and Fast Ethernet i.e. CSMA/CD and the Framing format, the physical setup is very different. One difference is the slot time. The standard Ethernet slot time required in CSMA/CD half-duplex mode is not long enough for running over 100 m of copper, so Carrier Extension is used to guarantee a 512-bit slot time.

1000Base-X (802.3z)

The 802.3z committee is responsible for formalizing the standard for Gigabit Ethernet. The 1000 refers to 1 Gbps data speed. The existing Fiber Channel interface standard (ANSI X3T11) is used and allows up to 4.268 Gbps speeds. The Fiber Channel encoding scheme is 8B/10B.

Gigabit Ethernet can operate in half or full duplex modes and there is also a standard 802.3x which manages XON/XOFF flow control in full duplex mode. With 802.3x, a receiving station can send a packet to a sending station to stop it sending data until a specified time interval has passed.

There are three media types for 1000Base-X. 1000Base-Sx, 1000Base-Lx, and 1000Base-Cx.

1000Base-Sx (‘S’ is for Short Haul) uses short-wavelength laser (850 nm) over multi-mode fiber. 1000Base-Sx can run up to 300 m on 62.5/125 μm multimode fiber and up to 550 m on 50/125 μm multimode fiber.

1000Base-Lx (‘L’ is for Long Haul) uses long wavelength laser (1300 nm) and can run up to 550 m on 62.5/125 μm multi-mode fiber or 50/125 μm multi-mode fiber. In addition, 1000Base-Lx can run up to 5 km (originally 3 km) on single-mode fiber using 1310 nm wavelength laser.

1000Base-Cx is a standard for STP copper cable and allows operation up to 25 m over STP cable.

1000Base-T (802.3ab)

Many cable manufacturers are enhancing their cable systems to ‘enhanced Category 5’ (Cat 5e) standards in order to allow Gigabit Ethernet to run at up to 100 m on copper. The Category 6 standard has yet to be ratified, and is not being pursued very strongly.

In order to obtain the 1000 Mbps data bit rate across the UTP cable without breaking the FCC rules for emission, all 4 pairs of the cable are used. Hybrid circuits at each end of each pair are used to allow simultaneous transmission and reception of data (full-duplex) by separating the transmission signal from the receiving signal. Because some transmission signal still manages to couple itself to the receiving side there is an additional echo canceller built in, this is called a Near End Crosstalk (NEXT) canceller.

Encoding is carried out with PAM-5.

TRANSMISSION CONTROL PROTOCOL / INTERNET PROTOCOL

Transmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol (TCP/IP) is the communication protocol for the Internet.

Whereas IP handles lower-level transmissions from computer to computer as a message makes its way across the Internet, TCP operates at a higher level, concerned only with the two end systems, for example a Web browser and a Web server. In particular, TCP provides ordered delivery of a stream of bytes from a program on one computer to another program on another computer. Besides the Web, other common applications of TCP include e-mail and Internet file transfer like FTP. Among its other management tasks, TCP controls message size, the rate at which messages are exchanged, and network traffic congestion. Your computer Internet address is a part of the standard TCP/IP protocol and so is your domain name.

Inside the TCP/IP standard there are several protocols for handling data communication:

- TCP (Transmission Control Protocol) communication between applications
- UDP (User Datagram Protocol) simple communication between applications
- IP (Internet Protocol) communication between computers
- ICMP (Internet Control Message Protocol) for errors and statistics
- DHCP (Dynamic Host Configuration Protocol) for dynamic addressing

TCP: If one application wants to communicate with another via TCP, it sends a communication request. This request must be sent to an exact address. TCP is responsible for breaking data down into IP packets before they are sent, and for assembling the packets when they arrive. After a "handshake" between the two applications, TCP will set up a "full-duplex" communication between the two applications. The "full-duplex" communication will occupy the communication line between the two computers until it is closed by one of the two applications. UDP is very similar to TCP, but simpler and less reliable.

IP: IP is responsible for sending the packets to the correct destination. IP does not occupy the communication line between two computers and hence reduces the need for network lines. Each line can be used for communication between many different computers at the same time. With IP, messages (or other data) are broken up into small independent "packets" and sent between computers via the Internet. IP is responsible for "routing" each packet to the correct destination.

When an IP packet is sent from a computer, it arrives at an IP router. The IP router is responsible for "routing" the packet to the correct destination, directly or via another router. The path the packet will follow might be different from other packets in the same communication chain. The router is responsible for the right addressing, depending on traffic volume, errors in the network, or other parameters.

Each computer must have a unique IP address before it can connect to the Internet. Each IP packet must also have an address before it can be sent to another computer. TCP/IP uses 32 bits (4 bytes), of four numbers between 0 and 255, separated by a period, to address a computer. A typical IP address is of the format: 192.255.30.50

Domain Names: A name is much easier to remember than a 12 digit number. The names used for TCP/IP addresses are called domain names. "**navy.mil"** is a domain name. Subdomains are identified by prefixes to the main domain name (separated by a period). When you address a web site, like **http://www.navair.navy.mil** the name is translated to a number by a Domain Name System (DNS) Server. DNS servers are connected to the Internet all over the world. When a new domain name is registered together with a TCP/IP address, all DNS servers are updated with this information.

BROWSER AND OTHER APPLICATION LAYER PROTOCOLS

DHCP - Dynamic Host Configuration Protocol. DHCP is used for allocation of dynamic IP addresses to computers in a network.

FTP - File Transfer Protocol. FTP takes care of transmission of data files between computers.

HTTP - Hyper Text Transfer Protocol - takes care of the communication between a web server and a web browser. It is used for sending requests from a web client (a browser) to a web server, returning web content (web pages) from the server back to the client.

HTTPS - Secure HTTP. HTTPS typically handles credit card transactions and other sensitive data.

IMAP - Internet Message Access Protocol. The IMAP protocol is used by email programs (like Microsoft Outlook) just like the POP protocol (discussed below). The main difference between the IMAP protocol and the POP protocol is that the IMAP protocol will not automatically download all your emails each time your email program connects to your email server. The IMAP protocol allows you to look through your email messages at the email server before you download them. With IMAP you can choose to download your messages or just delete them. This way IMAP is useful if you need to connect to your email server from different locations, but only want to download your messages when you are back in your office.

NTP - Network Time Protocol. NTP is used to synchronize the time (the clock) between computers.

POP - Post Office Protocol. The POP protocol is used by email programs (like Microsoft Outlook) to retrieve emails from an email server. If your email program (also called email client), uses POP, all your emails are downloaded to your computer each time it connects to your email server.

SMTP - Simple Mail Transfer Protocol. The SMTP protocol is used for the transmission of e-mails to another computer. Normally your email is sent to an email server (SMTP server), and then to another server or servers, and finally to its destination. SMTP can only transmit pure text. It cannot transmit binary data like pictures, sounds, or movies directly. SMTP uses the MIME protocol to send binary data across TCP/IP networks.

SNMP - Simple Network Management Protocol. SNMP is used for administration of computer networks.

PRESENTATION LAYER PROTOCOLS

MIME - Multi-purpose Internet Mail Extensions protocol. Converts binary data to pure text. The MIME protocol lets SMTP transmit multimedia files including voice, audio, and binary data.

SSL - Secure Sockets Layer. The SSL protocol is used for encryption of data for secure data transmission.

LOWER LAYER PROTOCOLS

ARP - Address Resolution Protocol. ARP is used by IP to find the hardware address of a computer network card based on the IP address.

BOOTP - Boot Protocol. BOOTP is used for booting (starting) computers from the network.

ICMP - Internet Control Message Protocol. ICMP takes care of error-handling in the network.

LDAP - Lightweight Directory Access Protocol. LDAP is used for collecting information about users and e-mail addresses from the internet.

PPTP - Point to Point Tunneling Protocol. PPTP is used for setting up a connection (tunnel) between private networks.

RARP - Reverse Address Resolution Protocol. RARP is used by IP to find the IP address based on the hardware address of a computer network card.

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GLOSSARY

ACCEPTABLE DEGRADATION - The allowable reduction in system performance. For a fire control radar, the acceptable degradation is usually expressed as a reduction in range; for example, the maximum lock-on range might be degraded by 25 percent without loss of essential defense capability.

ACQUISITION - A procedure by which a fire control tracking radar attains initial lock-on. Usually, the approximate target coordinates are supplied to the tracking radar and it searches a predetermined volume of space to locate the target.

AEROSOLS - Solid particles dispersed in the atmosphere having resonant size particles with a high index of refraction. The particles both scatter and absorb visual and laser directed energy so as to cut down on weapon systems directed by these techniques.

AFC (AUTOMATIC FREQUENCY CONTROL) - An arrangement whereby the frequency of an oscillator or the tuning of a circuit is automatically maintained within specified limits with respect to a reference frequency. A magnetron drifts in frequency over a period of time. The AFC of a radar makes the local oscillator shift by an equal amount so the IF frequency will remain constant.

AGC (AUTOMATIC GAIN CONTROL) - A method for automatically obtaining an essentially constant receiver output amplitude. The amplitude of the received signal in the range gate determines the AGC bias (a DC voltage) which controls the receiver gain so as to maintain a nearly constant output even though the amplitude of the input signal changes.

AMPLIFIER - An electronic device used to increase signal magnitude or power. See also GaAs FET Amplifier, Klystron Amplifier, Traveling-Wave Tube Amplifier.

AMPLITUDE MODULATION (AM) - A method of impressing a message upon a carrier signal by causing the carrier amplitude to vary proportionally to the message waveform.

AMPLITUDE SHIFT KEYING (ASK) - A method of impressing a digital signal upon a carrier signal by causing the carrier amplitude to take different values corresponding to the different values of the digital signal.

ANGLE JAMMING - ECM technique, when azimuth and elevation information from a scanning fire control radar is jammed by transmitting a jamming pulse similar to the radar pulse, but with modulation information out of phase with the returning target angle modulation information.

ANGULAR SEPARATION - This term is frequently used to indicate a protective (from EMI) zone for a missile. The interfering antenna axis must be separated, throughout the critical portion of the missile flight, from the missile by the specified angle. The vertex of the angle is at the interference source antenna.

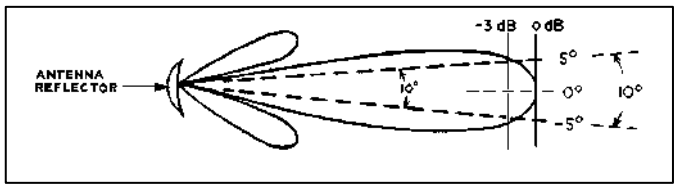

ANTENNA BEAMWIDTH - The angle, in degrees, between the half-power points (-3 dB) of an antenna beam. This angle is also nearly that between the center of the mainlobe and the first null. The angle is given for both horizontal and vertical planes unless the beam is circular. When so indicated, the term may refer to the angular width of the mainlobe between first nulls [beamwidth between first nulls (BWFN)]. See also Antenna Pattern. The figure illustrates vertical profile for antenna displaying a 10-degree beamwidth characteristic. The values can vary dramatically with frequency.

ANTENNA CROSS TALK - A measure of undesired power transfer through space from one antenna to another. Ratio of power received by one antenna to power transmitted by the other, usually expressed in decibels.

ANTENNA ISOLATION - The ratio of the power input to one antenna to the power received by the other. It can also be viewed as the insertion loss from transmit antenna input to receive antenna output to circuitry.

ANTENNA LOBING - Two lobes are created that overlap and intercept at -1 to -3 dB. The difference between the two lobes produces much greater spatial selectivity than provided by either lobe alone. (See also Lobe, Antenna.)

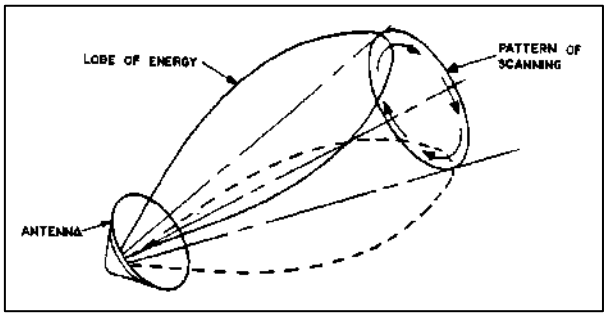

ANTENNA NUTATING - An antenna, as used in automatic-tracking radar systems, consisting of a parabolic reflector combined with a radiating element which is caused to move in a small circular orbit about the focus of the antenna with or without change of polarization. The radiation pattern is in the form of a beam that traces out a cone centered on the reflector axis. The process is also known as nutating conical scanning.

ANTENNA PATTERN - A cross section of the radiating pattern (representing antenna gain or loss) in any plane that includes the origin (source reference point) of the pattern. Both horizontal and vertical polar plots are normally used to describe the pattern. Also, termed "polar diagram" and "radiation pattern."

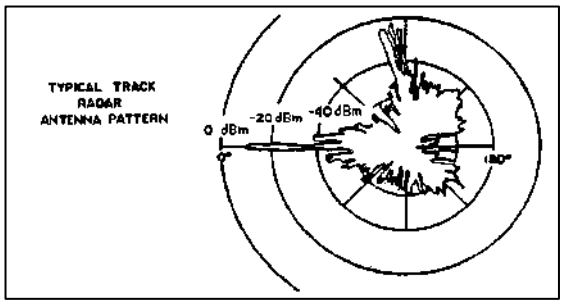

ANTENNA, PENCIL-BEAM - A highly directional antenna designed that cross sections of the major lobe are approximately circular, with a narrow beamwidth.

ANTI-CLUTTER CIRCUITS (IN RADAR) - Circuits which attenuate undesired reflections to permit detection of targets otherwise obscured by such reflections.

APERTURE - In an antenna, that portion of the plane surface area near the antenna perpendicular to the direction of maximum radiation through which the major portion of the radiation passes. The effective and/or scattering aperture area can be computed for wire antennas which have no obvious physical area.

A-SCOPE - A cathode-ray oscilloscope used in radar systems to display vertically the signal amplitude as a function of time (range) or range rate. Sometimes referred to as Range (R)-Scope.

ASYNCHRONOUS PULSED JAMMING - An effective form of pulsed jamming. The jammer nearly matches the pulse repetition frequency (PRF) of the radar; then it transmits multiples of the PRF. It is more effective if the jammer pulsewidth is greater than that of the radar. Asynchronous pulsed jamming is similar to synchronous jamming except that the target lines tend to curve inward or outward slightly and appear fuzzy in the jammed sector of a radar scope.

ATTENUATION - Decrease in magnitude of current, voltage, or power of a signal in transmission between two points. May be expressed in decibels.

AUTOMATIC FREQUENCY CONTROL - See AFC.

AUTOMATIC GAIN CONTROL - See AGC.

BACKWARD WAVE OSCILLATOR (BWO) - A cross-field device in which an electron stream interacts with a backward wave on a nonreentrant circuit. This oscillator may be electronically tuned over a wide range of frequencies, is relatively unaffected by load variations and is stable. BWO is commonly pronounced "be woe".

BALANCED MIXERS - The two most frequently encountered mixer types are single-balanced and double-balanced. In a double-balanced mixer, four Schottky diodes and two wideband transformers are employed to provide isolation of all three ports.

BALLISTIC MISSILE - Any missile which does not rely upon aerodynamic surfaces to produce lift and consequently follows a ballistic trajectory when thrust is terminated.

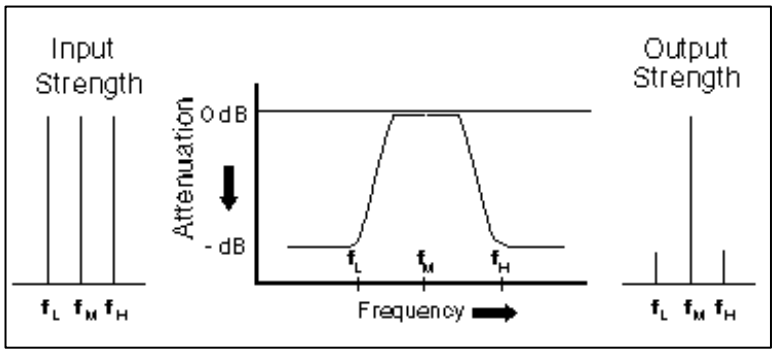

BANDPASS FILTER - A type of frequency discrimination network designed to pass a band or range of frequencies and produce attenuation to all other frequencies outside of the pass region. The figure illustrates a typical bandpass filter, incorporating a bandpass region of (F_h)-(F_l), offering no rejection (0 dB) to desired signal (F_m) and much higher rejection to the adjacent undesired signals F_h, and F_l. The upper and lower frequencies are usually specified to be the half power (-3 dB) or half voltage points (-6 dB).

BANDWIDTH - An expression used to define the actual operational frequency range of a receiver when it is tuned to a certain frequency. For a radar receiver, it is the difference between the two frequencies at which the receiver response is reduced to some fraction of its maximum response (such as 3 dB, 6 dB, or some other specified level). The frequencies between which "satisfactory" performance is achieved. Two equations are used:

$$\textit{Narrowband by \%} \ \left(\frac{F_u - F_l}{F_c}\right)(100) \quad ; \quad \textit{Broadband by ratio} \ \frac{F_u}{F_l}$$

$$\textit{Where } F_u = \textit{Upper} \ ; \ F_l = \textit{lower} \ ; \ F_c = \textit{center} = (F_u + F_l) \div 2$$

See also Receiver Bandwidth and Spectrum Width.

BARRAGE NOISE JAMMING - Noise jamming spread in frequency to deny the use of multiple radar frequencies to effectively deny range information. Although this is attractive because it enables one jammer to simultaneously jam several radars of different frequencies, it does have the inherent problem that the wider the jamming spread, the less jamming power available per radar, i.e. the watts per MHz bandwidth is low.

BATTERY, MISSILE - A missile battery consists of a missile launcher and its associated missile fire control systems (such as a MK 11 MOD 0 Missile Launcher and two MK 74 MOD 0 Missile Fire Control Systems).

BEACON - A system wherein a transponder in a missile receives coded signals from a shipboard radar guidance transmitter and transmits reply signals to a shipboard radar beacon receiver to enable a computer to determine missile position. The missile beacon transmitter and shipboard radar beacon receiver are tuned to a frequency different from that of the guidance transmitter.

BEAM - See Lobe, antenna. The beam is to the side of an aircraft or ship.

BEAM, CAPTURE - See Capture Beam.

BEAM-TO-BEAM CORRELATION (BBC) - BBC is used by frequency scan radars to reject pulse jamming and jamming at a swept frequency. Correlation is made from two adjacent beams (pulses). The receiver rejects those targets (signals) that do not occur at the same place in two adjacent beams.

BEAMWIDTH - See Antenna Beamwidth.

BEAT FREQUENCY OSCILLATOR (BFO) - Any oscillator whose output is intended to be mixed with another signal to produce a sum or difference beat frequency. Used particularly in reception of CW transmissions.

BINGO - The fuel state at which an aircraft must leave the area in order to return and land safely. Also used when chaff/flares reach a preset low quantity and automatic dispensing is inhibited.

BIPOLAR VIDEO - Unrectified (pre-detection) IF (both positive and negative portions of the RF envelope) signals that arise from the type of detection and console display employed in pulse Doppler and MTI receivers.

BISTATIC RADAR - A radar using antennas at different locations for transmission and reception.

BLANKING - The process of making a channel, or device non-effective for a certain interval. Used for retrace sweeps on CRTs or to mask unwanted signals such as blanking ones own radar from the onboard RWR.

BOGEY - Unknown air target.

BURN-THROUGH RANGE - The ability of a radar to see through jamming. Usually, described as the point when the radar's target return is a specified amount stronger than the jamming signal (typical values are 6 dB manual and 20 dB automatic). See Section 4-8.

BUTT LINE - Line used for reference in measurement of left/right location. One of several aircraft references. See also fuselage station and water line.

CAPTURE BEAM - A wide beam incorporated in capture transmitters of beam rider (command guided) missile systems to facilitate gaining initial control of a missile immediately after launch. Upon capture, the system then centers the missile in the narrow guidance beam. The figure illustrates a launched missile at point of capture.

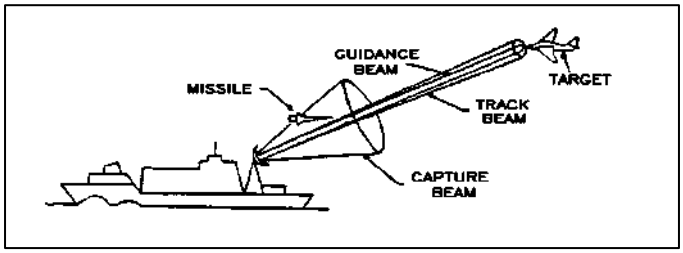

CAPTURE TRANSMITTER - A transmitter employing a wide beam antenna to gain initial control of in-flight missile for the purpose of centering the missile in the guidance transmitter antenna beam. See also Capture Beam.

CARRIER FREQUENCY - The basic radio frequency of the wave upon which modulations are impressed. Also called "Carrier" or f_c. See figure at right.

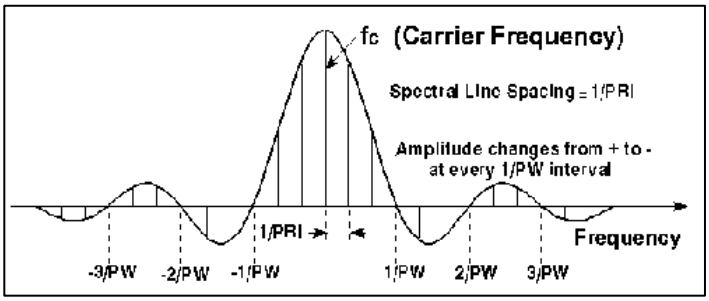

CATCH-22 - A lose-lose situation, from the book of the same name.

CAVITY - A space enclosed by a conducting surface used as a resonant circuit at microwave frequencies. Cavity space geometry determines the resonant frequency. A storage area for oscillating electromagnetic energy.

CENTER FREQUENCY - The tuned or operating frequency. Also referred to as center operating frequency. In frequency diversity systems, the midband frequency of the operating range. See also Carrier Frequency.

CHAFF - Ribbon-like pieces of metallic materials or metalized plastic which are dispensed by aircraft or ships to mask or screen other "targets." The radar reflections off the chaff may cause a tracking radar to break lock on the target. The foil materials are generally cut into small pieces for which the size is dependent upon the radar interrogation frequency (approximately 1/2 wave length of the victim radar frequency). Being this length, chaff acts as a resonant dipole and reflects much of the energy back to the radar. Also see rainbow, rope, stream chaff, and window.

CHANNEL - A frequency or band of frequencies. In guided missile systems, an assigned center frequency and a fixed bandwidth around it. Designates operating frequency of track radars and frequency/code assignments of X-band CW illuminators.

CHIRP - A pulse compression technique which uses frequency modulation (usually linear) on pulse transmission.

CHIRP RADAR - See PC.

CIRCULARLY POLARIZED JAMMING - The techniques of radiating jamming energy in both planes of polarization simultaneously. With this method, there is a loss of 3 dB of effective power in either linear plane, and substantial loss if the opposite sense of circular polarization is used (i.e. left vs. right). See Section 3-2.

CLUTTER, RADAR - Undesired radar returns or echoes resulting from man-made or natural objects including chaff, sea, ground, and rain, which interfere with normal radar system observations. The figure illustrates a target being masked by ground clutter

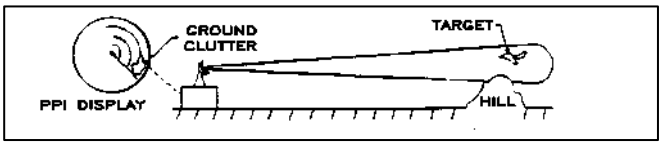

CO-CHANNEL - This term is used to indicate that two (or more) equipments are operating on the same frequency.

COHERENT - Two signals that have a set (usually fixed) phase relationship.

COINCIDENCE DETECTOR - This radar video process requires more than one hit in a range cell before a target is displayed. This prevents video interference from pulses coming from another radar, because such interference is unlikely to occur twice in the same range cell.

COLLIMATION - The procedure of aligning fire control radar system antenna axes with optical line of sight, thereby ensuring that the radars will provide for correct target illumination and guidance beam positioning.

COMMAND CODE - Modulations superimposed upon transmitter carrier signals to provide electronic instructions to an airborne guided missile or pilotless aircraft. The receiver of the remotely guided vehicle is preset to accept only a selected transmitter code to eliminate the possibility of the vehicle responding to commands of extraneous signals. Missile command codes include instructions such as arm, warhead detonate, and self destruct.

COMMAND GUIDANCE - A guidance system wherein intelligence transmitted to the missile from an outside source causes the missile to traverse a directed flight path.

CONICAL SCAN - See Antenna, Nutating.

CONTINUOUS WAVE and CONTINUOUS WAVE ILLUMINATOR - See CW and CWI.

COOPERATIVE COUNTERMEASURES - (CO-OP) Generic term for jamming the same threat radar from two or more separate platforms that are in the same radar resolution cell.

COUPLING FACTOR - A multiplying factor, expressed in dB, used to express the change in EM energy intensity from a radar transmitter to a receiver. The factor includes the antenna gains and the loss (basic transmission loss) caused by the distance between the antennas. The factor will usually be a negative dB figure (a reduction in intensity) because basic transmission loss is always a large negative value. The antenna gains may be positive (pointed toward each other) or negative (no main beam interactions).

CROSS MODULATION - Intermodulation caused by modulation of the carrier by an undesired signal wave.

CROSS POLARIZATION - or "Cross Pole," is a monopulse jamming technique where a cross-polarized signal is transmitted to give erroneous angle data to the radar. The component of the jamming signal with the same polarization as the radar must be very small.

CW (CONTINUOUS WAVE) - In radar and EW systems this term means that the transmitter is on constantly; i.e., not pulsed (100% duty cycle). These systems may frequency or phase modulate the transmitter output. A CW radar has the ability to distinguish moving targets against a stationary background while conserving spectrum bandwidth compared to pulsed radar requirements. A CW radar extracts accurate target range-rate data but cannot determine target range.

CWI (CONTINUOUS WAVE ILLUMINATOR) - A surface or aircraft-based CW transmitter employed in semiactive homing missile systems where the transmitter illuminates the target and the missile senses the reflected energy. The transmitter also provides a reference signal to the missile rear receiver to allow determination of range-rate data and target identification. CW transmitter emissions are sometimes coded corresponding to the associated missile receiver codes to reduce the possibility of the "missile accepting commands of extraneous signals.

DECIBEL (dB) - A dimensionless unit for expressing the ratio of two values of power, current, or voltage. The number of decibels being equal to: $dB = 10 \log P_2/P_1 = 20 \log V_2/V_1 = 20 \log I_2/I_1$
Normally, used for expressing transmission gains, losses, levels, and similar quantities. See Section 2-4.

DECEPTION - The deliberate radiation, reradiation, alteration, absorption or reflection of electromagnetic energy in a manner intended to mislead the enemy interpretation or use of information received by his electronic systems.

dB - See Decibel, or Decibel Section 2-4.

dBc - Decibels referenced to the carrier signal.

dBi - Decibels referenced to an isotropic radiator. (dBLi indicating linear isotropic radiator is sometimes used).

dBm - Decibels relative to 1 mW. dBm is calculated by using the ratio of some power (expressed in mW) to 1 mW. For example, 1 mW is 0 dBm and 10 mW is +10 dBm.

dBsm - Decibel referenced to one square meter.

dBv / dBμv - Decibels referenced to one volt or microvolt, i.e. 0 dBv is 1 volt or 120 dBμv.

dBW / dBμW - Decibels referenced to 1 watt or one microwatt, i.e. 0 dBW is 1 watt or 30 dBm or 60 dBμW.

DEMODULATOR - A device employed to separate the modulation signal from its associated carrier, also called Second Detector. See also Detection.

DESIGNATION - The assignment of a fire control radar to a specific target by supplying target coordinate data to the radar system.

DETECTION - Usually refers to the technique of recovering the amplitude modulation signal (envelope) superimposed on a carrier. See figure at right.

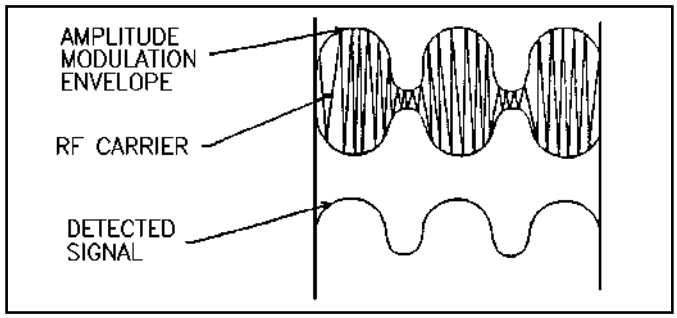

DICKE FIX - This type of radar processing occurs in the IF amplifier. A limiter follows a wideband amplifier, and then the signal goes to a matched filter amplifier. This discriminates against pulses that are too long (clutter) or too short (interference). The "DICKE FIX" is a technique that is specifically designed to protect the receiver from ringing caused by noise, fast-sweep, or narrow pulse jamming. The basic configuration consists of a broadband limiting IF amplifier, followed by an IF amplifier of optimum bandwidth. The limit level is preset at approximately the peak amplitude of receiver noise, the bandwidth may vary from 10 to 20 MHz, depending on the jamming environment. This device provides excellent discrimination against fast sweep jamming (10-500 MHz), usually something on the order of 20 to 40 dB, without appreciable loss in sensitivity. However, strong CW jamming will seriously degrade the performance of the DICKE FIX because the CW signal captures the radar signal in the limiter.

DIELECTRICALLY STABILIZED OSCILLATOR - The DSO uses a dielectric resonator as the frequency determining element. When the dielectric material is properly selected and used, the variations in dielectric constant vs. temperature and the dimensions of the resonant structure vs. temperature tend to cancel

out, providing relatively good frequency vs. temperature stability. The DSO offers frequency accuracy and stability, low power consumption and high reliability. Some of the commonly used materials are barium, zirconium, or tin tinates. The composition of these materials may be controlled to achieve any frequency variation with temperature with close tolerances.

DIODE - An electronic device which restricts current flow chiefly to one direction. See also Gunn diode, IMPATT diode, PIN diode, point contact diode, Schottky barrier diode, step recovery diode, tunnel diode, varactor diode.

DIODE SWITCH - PIN-diode switches provide state-of-the-art switching in most present-day microwave receivers. These switches are either reflective or nonreflective in that the former reflect incident power back to the source when in the isolated state. While both types of switches can provide high isolation and short transition times, the reflective switch offers multi octave bandwidth in the all shunt diode configuration, while the non-reflective switch offers an octave bandwidth.

DIPLEX - The simultaneous transmission or reception of two signals using a common feature such as a single antenna or carrier. Typically, two transmitters operate alternately at approximately the same RF and using a common antenna. See Section 6-7 for a discussion of diplexers.

DIRECTIONAL COUPLER - A 4-port transmission coupling device used to sample the power traveling in one direction through the main line of the device. There is considerable isolation (typically 20 dB) to signals traveling in the reverse direction. Because they are reciprocal, the directional coupler can also be used to directively combine signals with good reverse isolation. The directional coupler is implemented in waveguide and coaxial configurations. See Section 6-4.

DIRECTIVITY - For antennas, directivity is the maximum value of gain in a particular direction. (Isotropic point source has directivity = 1). For directional couplers, directivity is a measure (in dB) of how good the directional coupling is and is equal to the isolation minus the coupling. See Section 6-4.

DISH - A microwave reflector used as part of a radar antenna system. The surface is concave and is usually parabolic shaped. Also called a parabolic reflector.

DOPPLER EFFECT - The apparent change in frequency of an electromagnetic wave caused by a change in distance between the transmitter and the receiver during transmission/reception. The figure illustrates the Doppler increase that would be realized by comparing the signal received from a target approaching the radar site to the transmitted reference signal. An apparent frequency decrease would be noted for targets departing the radar location. Differences can be calibrated to provide target range-rate data.

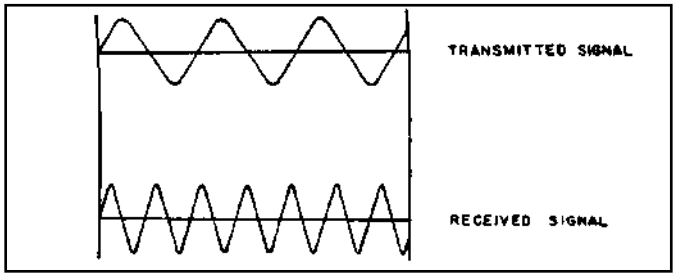

DRY RUN - A test run with aircraft/ship armament and/or EW switches off.

DUCTING - The increase in range that an electromagnetic wave will travel due to a temperature inversion of the atmosphere. The temperature inversion forms a channel or waveguide (duct) for the waves to travel in, and they can be trapped, not attenuating as would be expected from the radar equation.

DUMMY LOAD (Radio Transmission) - A dissipative but essentially nonradiating substitute device having impedance characteristics simulating those of the antenna. This allows power to be applied to the

radar transmitter without radiating into free space. Dummy loads are commonly used during EMCON conditions or when troubleshooting a transmitter at a workbench away from its normal environment.

DUPLEXER - A switching device used in radar to permit alternate use of the same antenna for both transmitting and receiving.

DUTY CYCLE - The ratio of average power to peak power, or ratio of pulse length to interpulse period for pulsed transmitter systems. Interpulse period is equal to the reciprocal of the pulse repetition rate.
See Section 2-5.

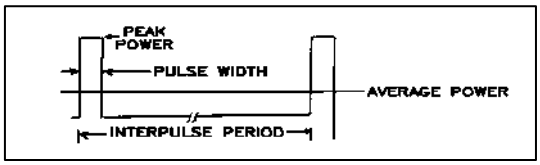

The duty cycle of a radar having a pulse length of 0.3 µsec and a PRF of 2000 pulses/sec is computed as follows:

Interpulse Period, T = PRI = 1/PRF = 500 µsec

$$Duty\ Cycle = \frac{Pulse\ length}{Interpulse\ Period} = \frac{0.3\ \mu\text{sec}}{500\ musec} = 0.0006\ (or\ 0.06\%)$$ or Duty Cycle (dB) = 10log(Duty cycle) = -32.2 dB

An output tube providing an average power of only 90 watts for such a system would, therefore, provide a peak power of:

$$Peak\ Power = \frac{Average\ Power}{Duty\ Cycle} = \frac{90}{0.0006} = 150{,}000\ W\ or\ 52\ dBW\ or\ 82\ dBm$$

EFFECTIVE RADIATED POWER (ERP) - Input power to the antenna in watts times the gain ratio of the antenna. When expressed in dB, ERP is the transmitter power (P_T), in dBm (or dBW) plus the antenna gain (G_T) in dB. The term EIRP is used sometimes and reiterates that the gain is relative to an isotropic radiator.

EGRESS - Exit the target area.

ELECTROMAGNETIC COUPLING - The transfer of electromagnetic energy from one circuit or system to another circuit or system. An undesired transfer is termed EMI (electromagnetic interference).

EMC (ELECTROMAGNETIC COMPATIBILITY) - That condition in which electrical/electronic systems can perform their intended function without experiencing degradation from, or causing degradation to other electrical/electronic systems. More simply stated, EMC is that condition which exists in the absence of EMI. See also Intersystem and Intrasystem EMC tests.

EME (ELECTROMAGNETIC ENVIRONMENT) - The total electromagnetic energy in the RF spectrum that exists at any given location.

EMI (ELECTROMAGNETIC INTERFERENCE) - Any induced, radiated, or conducted electrical emission, disturbance, or transient that causes undesirable responses, degradation in performance, or malfunctions of any electrical or electronic equipment, device, or system. Also synonymously referred to as RFI (Radio Frequency Interference).

EMI MODEL - Usually a set of equations or logical concepts designed to illustrate the interactions, the detailed parameters considerations, and mathematical procedures necessary for proper analysis of a given EMI situation.

EMITTER - Any device or apparatus which emits electromagnetic energy.

EMP (ELECTROMAGNETIC PULSE) - The generation and radiation of a very narrow and very high-amplitude pulse of electromagnetic noise. It is associated with the high level pulse as a result of a nuclear detonation and with intentionally generated narrow, high-amplitude pulse for ECM applications. In the case of nuclear detonations, EMP consists of a continuous spectrum with most of its energy distributed through the low frequency band of 3 KHz to 1 MHz.

ERROR SIGNAL - In servomechanisms, the signal applied to the control circuit that indicates the degree of misalignment between the controlling and the controlled members. In tracking radar systems, a voltage dependent upon the signal received from a target whose polarity and magnitude depend on the angle between the target and the center axis of the scanning beam.

FAST TIME CONSTANT - See FTC.

FEET DRY / WET - Aircraft has crossed from water to shore / aircraft has crossed from shore to water.

FERRET - An aircraft, ship, or vehicle especially equipped for the detection, location, recording, and analyzing of electromagnetic radiations.

FIELD STRENGTH - The magnitude of a magnetic or electric field at any point, usually expressed in terms of ampere turns per meter or volts per meter. Sometimes called field intensity and is expressed in volts/meter or dBμv/meter. Above 100 MHz, power density terminology is used more often. See Section 4-1.

FIRST HARMONIC - The fundamental (original) frequency.

FREQUENCY AGILITY - A radar's ability to change frequency within its operating band, usually on a pulse-to-pulse basis. This is an ECCM technique employed to avoid spot jamming and to force the jammer to go into a less effective barrage mode.

FREQUENCY AGILITY RADAR - A radar that automatically or semiautomatically tunes through a discrete set of operating frequencies in its normal mode of operation.

FREQUENCY DIVERSITY RADAR - A radar system technique, employed primarily as an antijamming feature, where the transmitter output frequency varies randomly from pulse to pulse over a wide frequency range.

FREQUENCY RANGE - (1) A specifically designated portion of the frequency spectrum; (2) of a device, the band of frequencies over which the device may be considered useful with various circuit and operating conditions; (3) of a transmission system, the frequency band in which the system is able to transmit power without attenuating or distorting it more than a specified amount.

FREQUENCY SHIFT KEYING (FSK) - A form of FM where the carrier is shifted between two frequencies in accordance with a predetermined code. In multiple FSK, the carrier is shifted to more than two frequencies. FSK is used principally with teletype communications.

"FRUIT" - In a radar beacon system, there is a type of interference called "FRUIT," caused by beacon replies to interrogation asynchronous with the observer's interrogator. The largest amount of this

interference is received through the sidelobes of the interrogating antenna, but it can become dense enough to cause false target indications.

FTC (FAST TIME CONSTANT) - An antijam feature employed in radar systems where receiver circuits may be selected to provide a short time constant to emphasize signals of short duration to produce discrimination against the low frequency components of clutter.

FUNDAMENTAL FREQUENCY - Used synonymously for tuned frequency, carrier frequency, center frequency, output frequency, or operating frequency.

FUSELAGE STATION or just STATION - A reference point (usually the nose of an aircraft) used to measure or identify fore and aft locations. One of several aircraft location designations - also see butt line and water line.

GaAs FET AMPLIFIER - Because of their low noise, field-effect transistors are often used as the input stage of wideband amplifiers. Their high input resistance makes this device particularly useful in a variety of applications. Since the FET does not employ minority current carriers, carrier storage effects are eliminated giving the device faster operating characteristics and improved radiation resistant qualities.

GAIN - For antennas, the value of power gain in a given direction relative to an isotropic point source radiating equally in all directions. Frequently expressed in dB (gain of an isotropic source = 0 dB). The formula for calculating gain is:

$$G = \frac{4\pi\, P(\theta,\phi)}{P_{in}} \quad ; \text{where} \quad \begin{array}{l} P(\theta,\phi) = \text{Radiation intensity in given direction} \\ P_{in} = \text{Power into lossless antenna radiating uniformly in all directions} \end{array}$$

Note: (1) If radiation efficiency is unity, then gain = directivity i.e. if directivity = 2, then gain = 3 dB, etc.
(2) Interference losses within an array also affect gain
(3) See Section 3-1 for further details

For amplifiers, gain is the ratio of the output power to input power (usually in dB).

GATE (RANGE) - A signal used to select radar echoes corresponding to a very short range increment. Range is computed by moving the range gate or marker to the target echo; an arrangement which permits radar signals to be received in a small selected fraction of the time period between radar transmitter pulses.

GATING - (1) The process of selecting those portions of a wave which exist during one or more selected time intervals; (2) the application of a square waveform of desired duration and timing to perform electronic switching; (3) the application of receiver operating voltages to one or more stages only during that portion of a cycle of operation when reception is desired. See also Gate (Range).

GCI (GROUND-CONTROLLED INTERCEPT) - Vectoring an interceptor aircraft to an airborne target by means of information relayed from a ground-based radar site which observes both the interceptor and the target.

GIGA - A prefix meaning 10^9 (times a billion). For example, gigahertz (GHz).

GLINT (In Radar) - 1. The random component of target location error caused by variations in the phase front of the target signal (as contrasted with Scintillation Error). Glint may affect angle, range of

Doppler measurements, and may have peak values corresponding to locations beyond the true target extent in the measured coordinate. 2. Electronic countermeasures that uses the scintillating, or flashing effect of shuttered or rotating reflectors to degrade tracking or seeking functions of an enemy weapons system.

GUARDBAND - A frequency band to which no other emitters are assigned as a precaution against interference to equipments susceptible to EMI in that band.

GUIDANCE, BEAM RIDER - A missile guidance technique which is dependent on the missile's ability to determine its positions with reference to the center of scan of the guidance radar beam and thus correct its trajectory on the basis of detected errors.

GUIDANCE CODE - A technique of modulating guidance transmitter carriers with coded pulses compatible with the receiver code of the missile assigned that system, thus reducing the possibility of the missile accepting erroneous commands of other transmissions.

GUIDANCE, COMMAND - A guidance system wherein intelligence transmitted to the missile from an outside source causes the missile to traverse a directed path in space.

GUIDANCE, HOMING, ACTIVE - A system of homing guidance wherein both the transmitter and receiver are carried within the missile.

GUIDANCE, HOMING, PASSIVE - A form of homing guidance, which is dependent on a missile's ability to detect energy emitted by the target. Frequently termed Home-On-Jam (HOJ).

GUIDANCE, HOMING, SEMIACTIVE - A system of homing guidance wherein the missile uses reflected signals from the target which has been illuminated by a source other than within the missile. See also CWI.

GUIDANCE, INERTIAL - A self-contained system independent of information obtained from outside the missile, usually using Newton's second law of motion.

GUNN DIODE - The Gunn diode is a transferred electron device which because of its negative resistance can be used in microwave oscillators or amplifiers. When the applied voltage exceeds a certain critical value, periodic fluctuations in current occur. The frequency of oscillation depends primarily upon the drift velocity of electrons through the effective length of the device. This frequency may be varied over a small range by means of mechanical tuning.

HARMONIC - A sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency. For example, a component which is twice the fundamental frequency is called the second harmonic. (The fundamental is the first harmonic, which is frequently misunderstood.)

HERTZ - The unit of frequency equal to one cycle per second.

HOME-ON-JAM (HOJ) - See Guidance, Homing, Passive.

HORN ANTENNA - A flared, open-ended section of waveguide used to radiate the energy from a waveguide into space. Also termed "horn" or "horn radiator." Usually linearly polarized, it will be vertically polarized when the feed probe is vertical, or horizontally polarized if the feed is horizontal. Circular

polarization can be obtained by feeding a square horn at a 45° angle and phase shifting the vertical or horizontal excitation by 90°.

HYPERABRUPT VARACTOR OSCILLATOR - Due to a non-uniform concentration of N-type material (excess electrons) in the depletion region, this varactor produces a greater capacitance change in tuning voltage and a far more linear voltage-vs.-frequency tuning curve. As a result, this device has an improved tuning linearity and low tuning voltage.

IF (INTERMEDIATE FREQUENCY) - The difference frequency resulting from mixing (beating) the received signal in a superheterodyne receiver with the signal from the local oscillator. The difference frequency product provides the advantages inherent to the processing (amplification, detection, filtering, and such) of low frequency signals. The receiver local oscillator may operate either below or above the receiver tuned frequency. A single receiver may incorporate multiple IF detection.

$IF = F_{LO} - F_O$ (for a local oscillator operating above the fundamental)

where:
F_O = Received fundamental frequency
F_{LO} = Local oscillator frequency

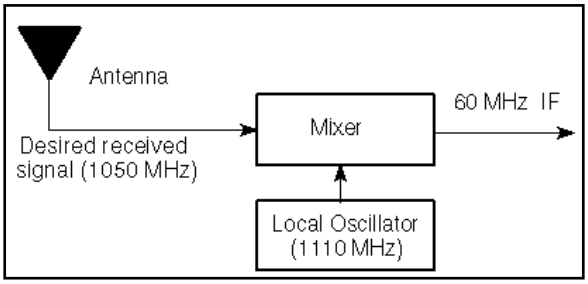

The simplified block diagram illustrates a typical mixing procedure employed in radar systems to obtain desired IF frequencies. The local oscillator is tuned above the fundamental frequency in this example. It should be noted that an undesired signal received at the receiver image frequency of 1170 MHz will also produce the desired 60 MHz IF frequency; this relationship provides the receiver image. See also Image Frequency.

IFF (IDENTIFICATION FRIEND OR FOE) - A system using radar transmission to which equipment carried by friendly forces automatically responds by emitting a unique characteristic series of pulses thereby distinguishing themselves from enemy forces. It is the "Mode IV" for the aircraft transponder. See also transponder.

IMAGE FREQUENCY - That frequency to which a given superheterodyne receiver is inherently susceptible, thereby rendering such a receiver extremely vulnerable to EMI at that frequency. The image frequency is located at the same frequency difference (Δf) to one side of the local oscillator as the tuned (desired) frequency is to the other side. An undesired signal received at the image frequency by a superheterodyne receiver not having preselection would, therefore, mix (beat) with the oscillator, produce the proper receiver IF, and be processed in the same manner as a signal at the desired frequency. See also receiver selectivity.

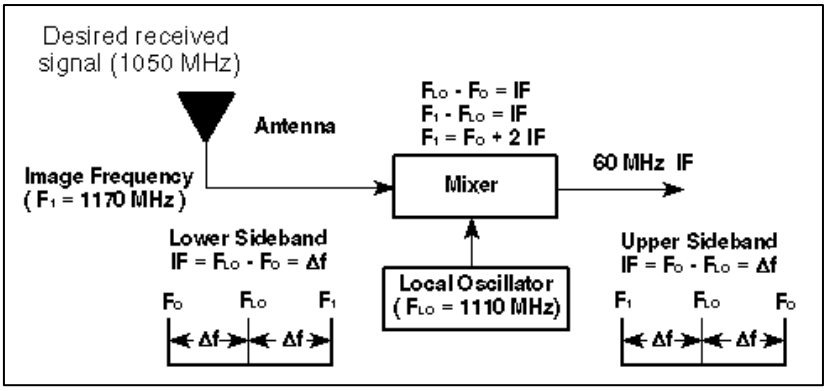

IMAGE JAMMING - Jamming at the image frequency of the radar receiver. Barrage jamming is made most effective by generating energy at both the normal operating and image frequency of the radar.

Image jamming inverts the phase of the response and is thereby useful as an angle deception technique. Not effective if the radar uses image rejection.

IMPATT DIODE - The IMPATT (IMPact Avalanche and Transit Time) diode acts like a negative resistance at microwave frequencies. Because of this property, Impatt diodes are used in oscillators and amplifiers. Usually the frequency range is in the millimeter wave region where other solid state devices cannot compete.

INGRESS - Go into the target area.

INSERTION LOSS - The loss incurred by inserting an element, device, or apparatus in an electrical/electronic circuit. Normally expressed in decibels determined as 10 log of the ratio of power measured at the point of insertion prior to inserting the device (P_1) to the power measured after inserting the device (P_2). Insertion loss (dB) = 10 log P_1/P_2.

INTEGRATION EFFECT - Pulse radars usually obtain several echoes from a target. If these echoes are added to each other, they enhance the S/N ratio, making a weak target easier to detect. The noise and interference do not directly add from pulse to pulse, so the ratio of target strength to undesired signal strength improves making the target more detectable. Random noise increases by the square root of the number of integrations, whereas the signal totally correlates and increases directly by the number of integrations, therefore the S/N enhancement is equal to the square root of the number of integrations.

INTERFERENCE - See EMI.

INTERFERENCE PARAMETERS - Equipment and propagation characteristics necessary for the proper evaluation of a given EMI situation.

INTERFERENCE/SIGNAL RATIO - See I/S Ratio.

INTERFERENCE THRESHOLD - The level of interference normally expressed in terms of the I/S (interference/signal) ratio at which performance degradation in a system first occurs as a result of EMI.

INTERFEROMETER - When two widely spaced antennas are arrayed together, they form an interferometer. The radiation pattern consists of many lobes, each having a narrow beamwidth. This antenna can provide good spatial selectivity if the lobe-to-lobe ambiguity can be solved such as using amplitude comparison between the two elements.

INTERMODULATION - The production, in a nonlinear element (such as a receiver mixer), of frequencies corresponding to the sums and differences of the fundamentals and harmonics of two or more frequencies which are transmitted through the element; or, the modulation of the components of a complex wave by each other, producing frequencies equal to the sums and differences of integral multiples of the component frequencies of the complex wave.

INTERSYSTEM EMC - EMC between the external electromagnetic environment (EME) and an aircraft with its installed systems. Generally, only system BIT must operate properly on the carrier deck while all system functions must operate properly in the operational EME.

INTRASYSTEM EMC - EMC between systems installed on an aircraft, exclusive of an external environment.

INVERSE CON SCAN - One method of confusing a radar operator or fire control radar system is to provide erroneous target bearings. This is accomplished by first sensing the radar antenna scan rate and then modulating repeater amplifier gain so the weak portion of the radar signal is amplified by the jammer, while the strong portion is not, so the weapons systems will fire at some bearing other than the true target bearing. The angle deception technique is used to break lock on CONSCAN radars.

INVERSE GAIN - Amplification, inverse modulation, and re-radiation of a radar's pulse train at the rotation rate of the radar scan. Deceives a conical scanning radar in angle.

ISOTROPIC ANTENNA - A hypothetical antenna which radiates or receives energy equally in all directions.

I/S RATIO (INTERFERENCE-TO-SIGNAL RATIO) (ISR) - The ratio of electromagnetic interference level to desired signal level that exists at a specified point in a receiving system. The ratio, normally expressed in dB, is employed as a tool in prediction of electronic receiving system performance degradation for a wide range of interference receiver input levels. Performance evaluations compare actual I/S ratios to minimum acceptable criteria.

JAFF - Expression for the combination of electronic and chaff jamming.

JAMMING - The deliberate radiation, reradiation, or reflection of electromagnetic energy with the object of impairing the use of electronic devices, equipment, or systems by an enemy.

JATO - JAmmer Technique Optimization group -- Organization coordinates EA technique development and evaluation efforts in support of naval airborne EA (ALQ-99, USQ-113, ALQ-227, ALQ-231, ALE-43). The group is run out of PMA-234 and comprised of elements at NAWCWD-Point Mugu, Johns Hopkins University/ Applied Physics Lab, Naval Research Lab, and NSWC-Crane. Efforts include M&S, Lab test, ground test, flight test, direct fleet support, and requirements and test support to development programs.

JINK - An aircraft maneuver which sharply changes the instantaneous flight path but maintains the overall route of flight. More violent than a weave.

JITTERED PRF - An antijam feature of certain radar systems which varies the PRF consecutively, and randomly, from pulse to pulse to prevent enemy ECM equipment from locking on, and synchronizing with, the transmitted PRF. PRF is synonymous with pulse repetition rate (PRR).

JTAT - JATO Techniques Analysis and Tactics -- Analysis documents produced by JATO to advise EA systems operators on the best ways to employ their systems by region, mission and equipment configuration. Currently covering ALQ-99 and USQ-113 on EA-6B; ALQ-99 and ALQ-227 on EA-18G, and ALQ-231 on AV-8B.

KILO - A prefix meaning 10^3 (times one thousand). For example, kilohertz.

KLYSTRON AMPLIFIER - An electron beam device which achieves amplification by the conversion of periodic velocity variations into conduction-current modulation in a field-free drift region. Velocity variations are launched by the interaction of an RF signal in an input resonant cavity and are coupled out through an RF output cavity. Several variations including reflex and multi cavity klystrons are used.

KLYSTRON, MULTICAVITY - An electron tube which employs velocity modulation to generate or amplify electromagnetic energy in the microwave region. Since velocity modulation employs transit time of

the electron to aid in the bunching of electrons, transient time is not a deterrent to high frequency operations as is the case in conventional electron tubes. See also Velocity Modulation.

KLYSTRON, REFLEX - A klystron which employs a reflector (repeller) electrode in place of a second resonant cavity to redirect the velocity-modulated electrons through the resonant cavity. The repeller causes one resonant circuit to serve as both input and output, which simplifies the tuning operation. This type of klystron is well adapted for use as an oscillator because the frequency is easily controlled by varying the position of the repeller. See also Velocity Modulation.

LEAKAGE - Undesired radiation or conduction of RF energy through the shielding of an enclosed area or of an electronic device.

LENS, RADAR (MICROWAVE) - The purpose of any such lens is to refract (focus) the diverging beam from an RF feed into a parallel beam (transmitting) or vice versa (receiving). The polarization is feed dependent.

LIGHT AMPLIFICATION BY STIMULATED EMISSION OF RADIATION (LASER) - A process of generating coherent light. The process utilizes a natural molecular (and atomic) phenomenon whereby molecules absorb incident electromagnetic energy at specific frequencies, store this energy for short but usable periods, and then release the stored energy in the form of light at particular frequencies in an extremely narrow frequency-band.

LIMITING - A term to describe that an amplifier has reached its point of saturation or maximum output voltage swing. Deliberate limiting of the signal is used in FM demodulation so that AM will not also be demodulated.

LITTORAL - Near a shore.

LOBE, ANTENNA - Various parts of the antenna's radiation pattern are referred to as lobes, which may be subclassified into major and minor lobes. The major lobe is the lobe of greatest gain and is also referred to as the main lobe or main beam. The minor lobes are further subclassified into side and back lobes as indicated in the figure to the right. The numbering of the side lobes are from the main lobe to the back lobe.

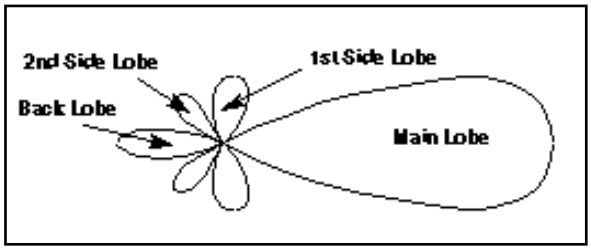

LOCAL OSCILLATOR FREQUENCY - An internally generated frequency in a superheterodyne receiver. This frequency differs from the receiver operating frequency by an amount equal to the IF of the receiver. The local oscillator frequency may be designed to be either above or below the incoming signal frequency.

LOG VIDEO - This receiver process, generally implemented in the IF, compresses the dynamic range of the signal so both weak and strong signals are displayed without changing the gain setting. Output voltage can be calibrated in volts/dB of input power.

LONG PULSE MODE - Many pulsed radars are capable of transmitting either long or short pulses of RF energy. When the long pulses of RF energy are selected manually (or sometimes automatically), the radar is said to be operating in the long pulse mode. In general, "long pulse mode" is used to obtain high average

power for long-range search or tracking, and "short pulse mode" gives low average power for short-range, high-definition, tracking or search.

LOOSE DEUCE - General term for two aircraft working in mutual support of each other.

LORO (LOBE-ON-RECEIVE-ONLY) - A mode of operation generally consisting of transmitting on one non-scanning antenna system and receiving the reflected energy on another scanning system (The receiver could be TWS, Conical, or monopulse).

MACH NUMBER - The ratio of the velocity of a body to the speed of sound in the medium that is being considered. In the atmosphere, the speed of sound varies with temperature and atmospheric pressure, hence, so does mach number.

MAGNETIC ANOMALY DETECTOR - A means of detecting changes in the earth's magnetic field caused by the presence of metal in ships and submarines.

MAGNETRON - A magnetron is a thermionic vacuum tube which is constructed with a permanent magnet forming a part of the tube and which generates microwave power. These devices are commonly used as the power output stage of radar transmitters operating in the frequency range above 1000 MHz and are used less commonly down to about 400 MHz. A magnetron has two concentric cylindrical electrodes. On a conventional magnetron, the inner one is the cathode and the outer one is the anode. The opposite is true for a coaxial magnetron.

MAGNETRON OSCILLATOR - A high-vacuum tube in which the interaction of an electronic space charge and a resonant system converts direct current power into ac power, usually at microwave frequencies. The magnetron has good efficiency, is capable of high power outputs, and is stable.

MATCHED FILTER - This describes the bandwidth of an IF amplifier that maximizes the signal-to-noise ratio in the receiver output. This bandwidth is a function of the pulsewidth of the signal.

MDS (MINIMUM DETECTABLE/DISCERNIBLE SIGNAL) - The receiver input power level that is just sufficient to produce a detectable/discernible signal in the receiver output. The detectable term is interchangeable with S_{min} and the discernable term is interchangeable with MVS. See Section 5-2.

MEACONING -- A system receiving radio signals and rebroadcasting them (or just transmitting) on the same frequency to confuse navigation. The meaconing station attempts to cause aircraft to receive inaccurate range or bearing information.

MEATBALL - Visual light "ball" seen in Fresnel lens optical landing system (FLOLS) by pilot during carrier or Navy field landing. Used as a reference to determine if flight path is high or low.

MEGA - A prefix meaning 10^6 (times one million). For example megahertz (MHz)

MICROVOLT PER METER - A commonly used unit of field strength at a given point. The field strength is measured by locating a standard receiving antenna at that point, and the "microvolts per meter" value is then the ratio of the antenna voltage in microvolts to the effective antenna length in meters. Usually used below 100 MHz. Above 100 MHz, power density terminology is normally used.

MICROWAVE AMPLIFICATION BY STIMULATED EMISSION OF RADIATION (MASER) - A low-noise radio-frequency amplifier. The emission of energy stored in a molecular or atomic system by a microwave power supply is stimulated by the input signal.

MISS DISTANCE - Used variously in different contexts. The distance from the missile to the geometric center of the aircraft, or the closest point of approach (CPA) of the missile to any portion of the aircraft such as the aircraft nose or telemetry pod, etc.

MISSILE SYSTEMS FUNCTIONS - Examples of missile system functions are: "acquisition" (ability to lock-on a desired target); "tracking" of a target; "guidance" of a missile toward a target; "illumination" of a target so that a homing missile can home on the reflected RF illumination; and "command" signal transmission to a missile to cause it to arm, to detonate, to commence homing, or to destroy itself.

MIXERS - See Balanced and Schottky Diode Mixers.

MODULATION - The process whereby some characteristic of one wave is varied in accordance with some characteristic of another wave. The basic types of modulation are angle modulation (including the special cases of phase and frequency modulation) and amplitude modulation. In missile radars, it is common practice to amplitude modulate the transmitted RF carrier wave of tracking and guidance transmitters by using a pulsed wave for modulating, and to frequency module the transmitted RF carrier wave of illuminator transmitters by using a sine wave.

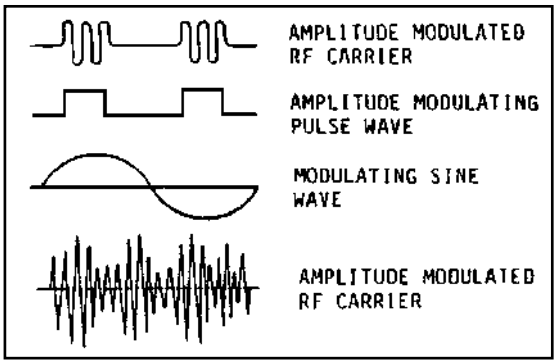

MODULATION, AMPLITUDE - This type of modulation changes the amplitude of a carrier wave in responses to the amplitude of a modulating wave. This modulation is used in radar and EW only as a switch to turn on or turn off the carrier wave; i.e., pulse is a special form of amplitude modulation.

MODULATION, FREQUENCY - The frequency of the modulated carrier wave is varied in proportion to the amplitude of the modulating wave and therefore, the phase of the carrier varies with the integral of the modulating wave. See also Modulation.

MODULATION, PHASE - The phase of the modulated carrier is varied in proportion to the amplitude of the modulating wave. See also Modulation.

MONOPULSE - (See figure to right) A type of tracking radar that permits the extracting of tracking error information from each received pulse and offers a reduction in tracking errors as compared to a conical-scan system of similar power and size. Multiple (commonly four) receiving antennas or feeds are placed symmetrically about the center axis and operate simultaneously to receive each RF pulse reflected from the target. A comparison of the output signal amplitude or phase among the four antennas indicates the location of the target with respect to the radar beam center line. The output

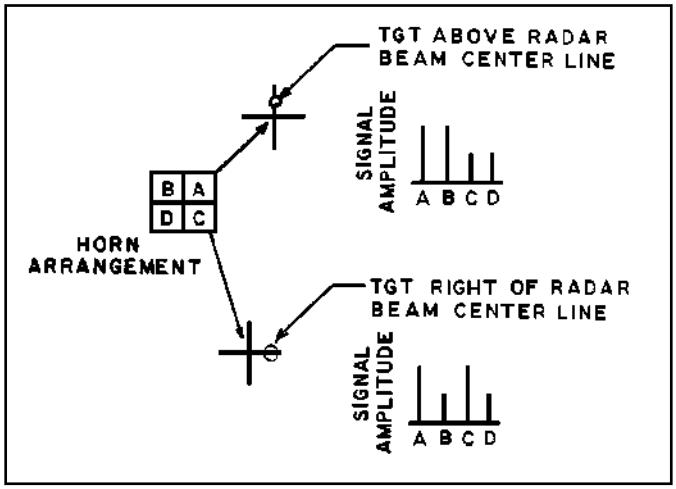

of the comparison circuit controls a servo system that reduces the tracking error to zero and thereby causes the antenna to track the target.

MOS (MINIMUM OPERATIONAL SENSITIVITY) - The minimum signal which can be detected and automatically digitally processed by a radar without human discrimination.

MTI (MOVING TARGET INDICATOR) - This radar signal process shows only targets that are in motion. Signals from stationary targets are subtracted out of the return signal by a memory circuit.

MULTIPATH - The process by which a transmitted signal arrives at the receiver by at least two different paths. These paths are usually the main direct path, and at least one reflected path. The signals combine either constructively or destructively depending upon phase, and the resultant signal may be either stronger or weaker than the value computed for free space.

MULTIPLEX - Simultaneous transmission of two or more signals on a common carrier wave. The three types of multiplex are called time division, frequency division, and phase division.

MULTIBAND RADAR - A type of radar which uses simultaneous operation on more than one frequency band through a common antenna. This technique allows for many sophisticated forms of video processing and requires any jammer to jam all channels at the same time in order to be effective.

MVS (MINIMUM VISIBLE SIGNAL) - The minimum input pulse signal power level which permits visibility of the output pulse, such as on a radar A-scope display. This level is determined by initially setting the input level above the visible detection threshold, and then slowly decreasing the amplitude.

NOISE FIGURE, RECEIVER - A figure of merit (NF or F) of a system given by the ratio of the signal-to-noise ratio at the input, S_i / N_i, divided by the signal-to-noise ratio at the output, S_o/N_o. It essentially expresses the ratio of output noise power of a given receiver to that of a theoretically perfect receiver which adds no noise.

$$Noise\ Figure = \frac{S_i / N_i}{S_o / N_o} = \frac{N_o}{G\,N_i}$$

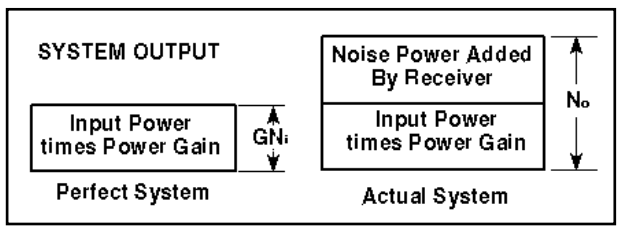

Where $S_o = GS_i$ and G is the gain of the system.

Noise figure is usually expressed in dB and given for an impedance matched condition. Impedance mismatch will increase the noise figure by the amount of mismatch loss. NF is usually given at room temperature; 17°C or 290°K. See Section 5-2.

NOISE JAMMING - A continuous random signal radiated with the objective of concealing the aircraft echo from the enemy radar. In order for it to be effective, it must have an average amplitude at least as great as the average amplitude of the radar echo. There are three major categories of noise jamming which are grouped by how jamming power is concentrated: Spot, barrage, and swept jamming. (See individual definitions)

NONCOHERENT - Two signals that have no set phase relationship.

NOTCH - The portion of the radar velocity display where a target disappears due to being notched out by the zero Doppler filter. If not filtered (notched), ground clutter would also appear on the display. A

notch filter is a narrow band-reject filter. A "notch maneuver" is used to place a tracking radar on the beam of the aircraft so it will be excluded.

NULL, ANTENNA PATTERN - The directions of minimum transmission (or reception) of a directional antenna. See also Lobe, Antenna.

NULL FILL - The nulls in an antenna pattern may be reduced (filled) by using a second ancillary (spoiler) antenna whose pattern is such that it fills in the nulls of the main antenna pattern.

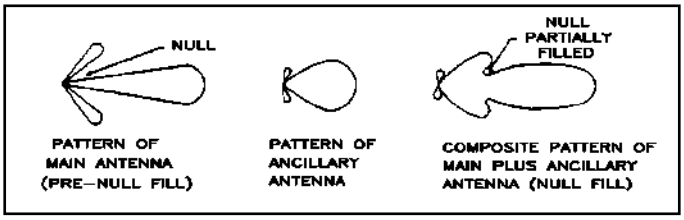

NUTATION - As applied to current missile system radars, this term refers to the mechanical motion of an antenna feed to produce a conical scan (fixed polarization) by the main beam of a tracking antenna, thus providing a means of developing tracking error signals. See also Antenna, Nutating. By analogy, "Nutation" also is used to denote the electrical switching of the quadrants of a seeker antenna. See also Interferometer. The effect is similar to that of a conical scan.

NUTATOR - A motor-driven rotating antenna feed used to produce a conical scan for a tracking radar. See also Antenna, Nutating. Also, the electrical circuits necessary to effect nonmechanical conical scans. See also Nutation.

OPERATIONAL CONSTRAINTS - Limitations on operating procedures in order to prevent interference between missile systems on a ship or between missile systems in a formation of ships under operational conditions. These limitations consist of such things as limited frequency bands or channels in which the radars may be tuned, limited sectors of space into which radar beams may be pointed, limits on minimum spacing between ships, limits on what codes may be used by radars and missiles on each ship, and limits on minimum interval between firing of certain missiles.

OSCILLATORS - Devices which generate a frequency. See also Backward Wave, Dielectrically Stabilized Oscillator, Hyperabrupt Varactor Oscillator, Magnetron Oscillator, Varactor Tuned Oscillator, and YIG tuned oscillator.

OSCILLATOR, LOCAL - See Local Oscillator Frequency.

PALMER SCAN - Conical scan superimposed on another type of scan pattern - usually a spiral pattern.

PARAMETER - A quantity which may have various values, each fixed within the limits of a stated case or discussion. In the present case, some examples of parameters; would be: radar frequency, limited by the tuning range of the radar; missile range, limited by the maximum operating range of the missile; or a missile code, limited by the number of codes available and by the codes that the ship radars are set up to operate on.

PASSIVE ANGLE TRACKING - Tracking of a target using radiation from the target (such as jamming), with no radiation from the radar itself. Only angular tracking is possible under these conditions since no measurement of time of travel of radiation to the target is possible, as is required to obtain target range.

PC (PULSE COMPRESSION) - The process used in search and tracking pulse radars whereby the transmitted pulse is long, so as to obtain high average transmitter output power, and the reflected pulse is

processed in the radar receiver to compress it to a fraction of the duration of the transmitted pulse to obtain high definition and signal strength enhancement. Pulse compression may be accomplished by sweeping the transmitted frequency (carrier) during the pulse. The returned signal is then passed through a frequency-dependent delay line. The leading edge of the pulse is therefore delayed so that the trailing edge catches up to the leading edge to produce effectively a shorter received pulse than that transmitted. Pulse compression radars are also referred to as CHIRP radars. Other more sophisticated pulse compression techniques are also possible and are becoming more popular.

PENCIL BEAM - A narrow circular radar beam from a highly directional antenna (such as a parabolic reflector).

PHASED ARRAY RADAR - Radar using many antenna elements which are combined in a controlled phase relationship. The direction of the beam can be changed as rapidly as the phase relationships (usually less than 20 microseconds). Thus, the antenna typically remains stationary while the beam is electronically scanned. The use of many antenna elements allows for very rapid and high directivity of the beam(s) with a large peak and/or average power. There is also a potential for greater reliability over a conventional radar since the array will fail gracefully, one element at a time.

PIN DIODE - A diode with a large intrinsic (I) region sandwiched between the P- and N- doped semiconducting regions. The most important property of the PIN diode is the fact that it appears as an almost pure resistance at RF. The value of this resistance can be varied over a range of approximately one-10,000 ohms by direct or low frequency current control. When the control current is varied continuously, the PIN diode is useful for attenuating, leveling and amplitude modulation of an RF signal. When the control current is switched on and off or in discrete steps, the device is useful in switching, pulse modulating, and phase shifting an RF signal.

POINT CONTACT DIODE - This was one of the earliest semiconductor device to be used at microwave frequencies. Consisting of a spring-loaded metal contact on a semiconducting surface, this diode can be considered an early version of the Schottky barrier diode. Generally used as a detector or mixer, the device is somewhat fragile and limited to low powers.

POLARIZATION - The direction of the electric field (E-field) vector of an electromagnetic (EM) wave. See Section 3-2. The most general case is elliptical polarization with all others being special cases. The E-field of an EM wave radiating from a vertically mounted dipole antenna will be vertical and the wave is said to be vertically polarized. In like manner, a horizontally mounted dipole will produce a horizontal electric field and is horizontally polarized. Equal vertical and horizontal E-field components produce circular polarization.

PORT - The left side of a ship or aircraft when facing the bow (forward)

POWER (AVERAGE) FOR PULSED RADARS - Average power for a pulse radar is the average power transmitted between the start of one pulse and the start of the next pulse (because the time between pulses is many times greater than the pulse duration time, the average power will be a small fraction of peak power).

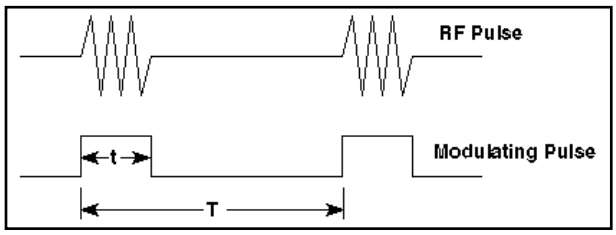

For this example: Peak Power = 1 MW, Pulse Time (t) = 0.5 microsecond, and Interval Between Pulses (T) = 1000 microseconds (1000 pps).

Peak Power = Pwr during pulse time (t) = 1 MW = 10^6 Watts = 90 dBm.

Avg Power = Average Power During Time (T) = 10^6 x t/T
= 10^6 x 0.5/1000 = 0.5 x 10^3 = 0.5 kilowatt = 57 dBm or 27 dBW

POWER OUTPUT - Power output of a transmitter or transmitting antenna is commonly expressed in dBW or dBm. One megawatt would be expressed as 60 dBW or 90 dBm:

10 log (1 megawatt / 1 watt) = 10 log ($10^6/10^0$)
= 10 x 6 = 60 dBW

10 log (1 megawatt / 1 milliwatt) = 10 log ($10^6/10^{-3}$)
= 10 x 9 = 90 dBm

POWER (PEAK) FOR PULSED RADARS - Peak power for a pulsed radar is the power radiated during the actual pulse transmission (with zero power transmitted between pulses).

POWER FOR CW RADARS - Since the power output of CW transmitters (such as illuminator transmitters) usually have a duty cycle of one (100%), the peak and average power are the same.

POWER DENSITY - The density of power in space expressed in Watts/meter^2, dBW/m^2, etc. Generally used in measurements above 100 MHz. At lower frequencies, field intensity measurements are taken. See Section 4-1.

PPI-SCOPE - A radar display yielding range and azimuth (bearing) information via an intensity modulated display and a circular sweep of a radial line. The radar is located at the center of the display.

PRESELECTOR - A device placed ahead of the mixer in a receiver, which has bandpass characteristics such that the desired (tuned) RF signal, the target return, is allowed to pass, and other undesired signals (including the image frequency) are attenuated.

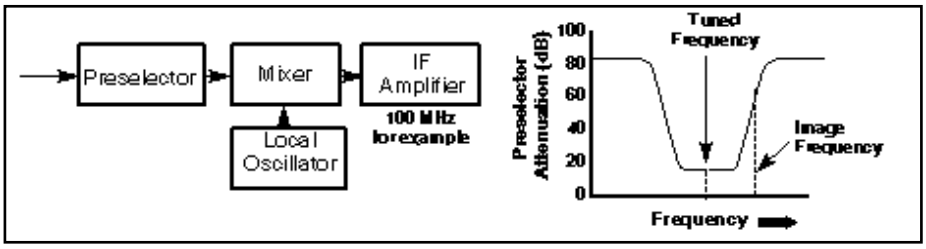

PROPAGATION - In electrical practice, the travel of waves through or along a medium. The path traveled by the wave in getting from one point to another is known as the propagation path (such as the path through the atmosphere in getting from a transmitting antenna to a receiving antenna, or the path through the waveguides and other microwave devices in getting from an antenna to a receiver).

PULSE COMPRESSION - See PC.

PULSED DOPPLER (PD) - A type of radar that combines the features of pulsed radars and CW Doppler radars. It transmits pulses (instead of CW) which permits accurate range measurement. This is an inherent advantage of pulsed radars. Also, it detects the Doppler frequency shift produced by target range rate which enables it to discriminate between targets of only slightly different range rate and also enables it to greatly reduce clutter from stationary targets. See also Doppler Effect.

PULSE LENGTH - Same meaning as Pulsewidth.

PULSE MODULATION - A special case of amplitude modulation wherein the carrier wave is varied at a pulsed rate. Pulse Modulation - The modulation of a carrier by a series of pulses generally for the purpose of transmitting data. The result is a short, powerful burst of electromagnetic radiation which can be used for measuring the distance from a radar set to a target.

PULSE REPETITION FREQUENCY (PRF) - The rate of occurrence of a series of pulses, such as 100 pulses per second. It is equal to the reciprocal of the pulse spacing (T) or PRT. (PRF = 1/T = 1/PRI). Sometimes the term pulse repetition rate (PRR) is used.

PULSE REPETITION FREQUENCY (PRF) STAGGER - The technique of switching PRF (or PRI) to different values on a pulse-to-pulse basis such that the various intervals follow a regular pattern. This is useful in compensating for blind speeds in pulsed MTI radars. Interpulse intervals which differ but follow a regular pattern.

PULSE REPETITION INTERVAL (PRI) or TIME (PRT) - Time between the beginning of one pulse and the beginning of the next.

PULSE SPACING - The interval of time between the leading edge of one pulse and the leading edge of the next pulse in a train of regularly recurring pulses. See also Pulse Repetition Frequency. Also called "the interpulse period."

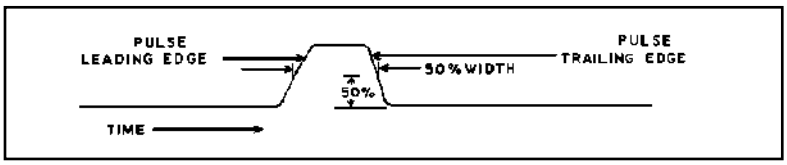

PULSEWIDTH - The interval of time between the leading edge of a pulse and the trailing edge of a pulse (measured in microseconds for the short pulses used in radar). Usually measured at the 3 dB midpoint (50-percent power or 70% voltage level) of the pulse, but may be specified to be measured at any level. See Section 6-10 for measurement techniques.

QUANTIZE - The process of restricting a variable to a number of discrete values. For example, to limit varying antenna gains to three levels.

RADAR - Radio detection and ranging.

RADAR CROSS SECTION - A measure of the radar reflection characteristics of a target. It is equal to the power reflected back to the radar divided by power density of the wave striking the target. For most targets, the radar cross section is the area of the cross section of the sphere that would reflect the same energy back to the radar if the sphere were substituted. RCS of sphere is independent of frequency if operating in the far field region. See Section 4-11.

RADAR RANGE EQUATION - The radar range equation is a basic relationship which permits the calculation of received echo signal strength, if certain parameters of the radar transmitter, antenna, propagation path, and target are known.

Given: $P_r = \dfrac{P_t G_t G_r \lambda^2 \sigma}{(4\pi)^3 R^4}$ *(freespace)* as the basic two-way radar equation (see Sections 4-4 thru 4-6)

where:

P_r = Peak power at receiver input

λ = Wavelength of signal (length) = c/f

P_t = Transmitted signal level (power)
R = Range of target to radar (distance)
G_t = Gain of transmitting antenna (dimensionless ratio)
σ = Radar cross section of target
G_r = Gain of receiving antenna (dimensionless ratio)

In practical use, the radar range equation is often written in logarithmic form, all terms expressed in decibels, so that the results can be found by simple processes of addition and subtraction. Using the above equation and $\lambda = c/f$.

$$10 \log P_r = 10 \log P_t + 10 \log G_t + 10 \log G_r + 10 \log \sigma - 40 \log R - 20 \log f + 20 \log c - 30 \log 4\pi$$

where: f = Signal frequency (cycles {dimensionless}/time) c = Speed of light (length/time)

$$10 \log P_r = 10 \log P_t + 10 \log G_t + 10 \log G_r + G_\sigma - 2\alpha_1$$

where α_1 and G_σ are factors containing the constants and conversion factors to keep the equations in consistent units.

Refer to Sections 4-4 through 4-6.

RADAR TRIGGER KILL - see Trigger Kill, Radar.

RADIATION EFFICIENCY - $E = P_{radiated}/P_{in}$ (ideal=1)

RADIATION PATTERN - See Antenna Pattern.

RADIO FREQUENCY - See RF.

RADIO FREQUENCY INTERFERENCE - See RFI.

RAIL KEEPING - Ability of countermeasures to keep the missile on the launch rail, i.e., prevent launch.

RAINBOW - A technique which applies pulse-to-pulse frequency changing to identifying and discriminating against decoys and chaff.

RANGE CELL - In a radar, a range cell is the smallest range increment the radar is capable of detecting. If a radar has a range resolution of 50 yards and a total range of 30 nautical miles (60,000 yds), there are: 60000/50 = 1,200 range cells.

RANGE GATE - A gate voltage used to select radar echoes from a very short range interval.

RANGE GATE PULL OFF (RGPO) - Deception technique used against pulse tracking radars using range gates. Jammer initially repeats the skin echo with minimum time delay at a high power to capture the AGC circuitry. The delay is progressively increased, forcing the tracking gates to be pulled away ("walked off") from the target echo. Frequency memory loops (FML's), or transponders provide the variable delay.

RANGE RATE - The rate at which a radar target is changing its range with respect to the radar (in feet per second for example). Note that this rate is not the same as target velocity unless the target is moving straight toward or straight away from the radar.

RANGE SCOPE - See A-Scope or PPI.

RECEIVER BANDWIDTH - The difference between the limiting frequencies within which receiver performance in respect to some characteristic falls within specified limits. (In most receivers this will be the difference between the two frequencies where the intermediate frequency (IF) amplifier gain falls off 3 dB from the gain at the center IF frequency.) See also Receiver Selectivity.

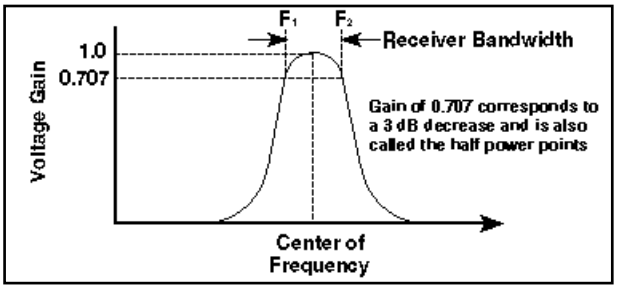

RECEIVER SELECTIVITY - The degree to which a receiver is capable of differentiating between the desired signal and signals or interference at other frequencies. (The narrower the receiver bandwidth, the greater the selectivity.)

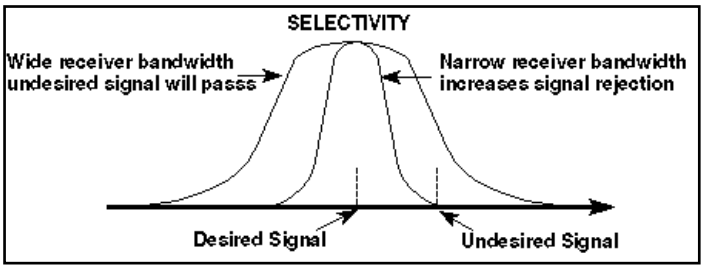

REFLECTION - The turning back (or to the side) of a radio wave as a result of impinging on any conducting surface which is at least comparable in dimension to the wavelength of the radio wave.

RESOLUTION - In radar, the minimum separation in angle or in range between two targets which the radar is capable of distinguishing.

RF (RADIO FREQUENCY) - A term indicating high frequency electromagnetic energy.

RFI (RADIO FREQUENCY INTERFERENCE) - Any induced, radiated, or conducted electrical disturbance or transient that causes undesirable responses or malfunctioning in any electrical or electronic equipment, device, or system. Same as EMI. Not to be confused with the logistic term ready for issue (also RFI).

RING AROUND - A condition in which a repeater jammer's total gain, from receiver antenna to transmitter antenna, exceeds the antenna isolation resulting in the repeater amplifying its own internal noise. Akin to positive feedback in an amplifier that causes unwanted oscillations.

RING AROUND (RADAR-TO-MISSILE) - The condition where radio frequency interference signals from a transmitter of one missile radar enter the receiving circuits of a missile under the control of another missile radar.

RING AROUND (RADAR-TO-RADAR) - The condition where radio frequency interference signals from a transmitter of one radar enter the receiving circuits of another radar.

ROPE - An element of chaff consisting of a long roll of metallic foil or wire which is designed for broad, low-frequency response. See Chaff.

R-SCOPE - (RANGE SCOPE) See A-scope or PPI.

SAFETY OF FLIGHT (SOF) TEST - A flight test to verify that a new or modified subsystem will not cause a major problem with the aircraft, i.e., interference can occur, but will not be such that required

navigational systems will fail or which might potentially cause the loss of an aircraft under all normally expected weather conditions.

SCAN - To transverse or sweep a sector or volume of airspace with a recurring pattern, by means of a controlled directional beam from a radar antenna. See also "Antenna, nutating."

SCHOTTKY BARRIER DIODE - The Schottky barrier diode is a simple metal-semiconductor boundary with no P-N junction. A depletion region between the metal contact and the doped semiconductor region offers little capacitance at microwave frequencies. This diode finds use as detectors, mixers, and switches.

SCHOTTKY DIODE MIXER - The mixer is a critical component in modern RF systems. Any nonlinear element can perform the mixing function, but parameters determining optimal mixing are noise figure, input admittance, and IF noise and impedance. The Schottky diode is particularly effective because of its low noise figure and nearly square law characteristics.

SCHOTTKY DIODE SWITCH - Standard P-N diodes are limited in switching ability at high frequencies because of capacitance provided by the minority carriers. The Schottky diode overcomes this problem by use of the metal-semiconductor junction with inherently low carrier lifetimes, typically less than 100 picoseconds.

SEARCH RADAR - A radar whose prime function is to scan (search) a specified volume of space and indicate the presence of any targets on some type of visual display, and, in some cases, to provide coordinates of the targets to a fire control system to assist in target acquisition and tracking.

SEEKER - The seeker consists of circuitry in a homing missile which detects, electronically examines, and tracks the target; provides data for controlling the flight path of the missile; and provides signals for destroying the missile or for detonating it at intercept. (The seeker function is similar to that of an interferometer.)

SELF-SCREENING JAMMING (SSJ) - Each aircraft carries its own jamming equipment for its own protection.

SENSITIVITY - The sensitivity of a receiver is taken as the minimum signal level required to produce an output signal having a specified signal-to-noise ratio. See also Minimum Visible Signal and Minimum Discernible Signal (MDS).

SENSITIVITY TIME CONTROL - See STC.

SENSOR - The receiver portion of a transmitter/receiver pair used to detect and process electromagnetic energy.

SHIELDING - The physical arrangement of shields for a particular component, equipment, or system, (A shield is a housing, screen, or other material, usually conducting, that substantially reduces the effect of electric or magnetic fields on one side of the shield upon devices or circuits on the other side.) Examples are tube shields, a shielded enclosure or cabinet for a radar receiver, and the screen around a screen room.

SHORT PULSE MODE - See Long Pulse Mode.

SIDEBAND - A signal either above or below the carrier frequency, produced by the modulation of the carrier wave by some other wave. See figure at right ⇒

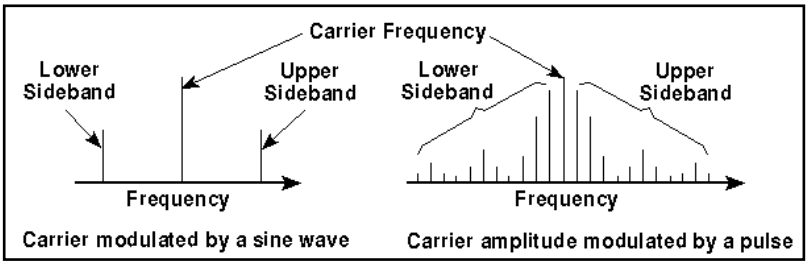

SIDELOBE - See Lobe, Antenna.

SIGNAL STRENGTH - The magnitude of a signal at a particular location. Units are volts per meter or dBV/m.

SIGNATURE - The set of parameters which describe the characteristics of a radar target or an RF emitter and distinguish one emitter from another. Signature parameters include the radio frequency of the carrier, the modulation characteristics (typically the pulse modulation code), and the scan pattern.

SILICON CONTROLLED SWITCH - A P-N-P-N device able to operate at sub-microsecond switching speeds by the application of gate signals. Because it is a four layer device, this switch is also known as a tetrode thyristor.

SLANT POLARIZATION - Technique of rotating a linear antenna 45° so it can receive or jam both horizontal and vertical polarization although there is a 3 dB loss. See Section 3.2.

SOLID STATE STAMO - A stable master oscillator constructed using transistors and other solid state devices as opposed to vacuum tubes. See also STAMO.

SPECTRUM - The distribution of power versus frequency in an electromagnetic wave. See also Spectrum Signature Analysis and illustrations under Sideband.

SPECTRUM ANALYZER - An electronic device for automatically displaying the spectrum of the electromagnetic radiation from one or more devices. A cathode ray tube display is commonly used to display this power-versus frequency spectrum. For examples of two types of displays, see illustrations under Sideband.

SPECTRUM SIGNATURE ANALYSIS - The analysis of the electromagnetic radiation from an electronic device to determine the relative power in each sideband, harmonic, and spurious emission compared to the carrier frequency. This particular distribution (or spectrum) is peculiar to the device and can identify this type of device, thereby acting as an identifying "signature."

SPECTRUM WIDTH (TRANSMITTER) - The difference between the frequency limits of the band which contains all the spectrum frequency components of significant magnitude.

SPOILER ANTENNA - An antenna used to change (spoil) the antenna pattern of a second antenna so as to reduce the nulls in the pattern of the second antenna. See also Null Fill.

SPOKING (RADAR) - Periodic flashes of the rotating radial display. Sometimes caused by mutual interference.

"SPOOFING" - A type of deception by using an electronic device to transmit a "target" echo. The spoofing transmitter must operate at the same frequency and PRF as the radar to be deceived. The radar main pulse triggers the spoofing transmitter which, after a delay, transmits a false echo.

SPOT JAMMING - Narrow frequency band jamming concentrated against a specific radar at a particular frequency. The jamming bandwidth is comparable to the radar bandpass. Can deny range and angle information.

SPURIOUS EMISSION - Electromagnetic radiation transmitted on a frequency outside the bandwidth required for satisfactory transmission of the required waveform. Spurious emissions include harmonics, parasitic emissions, and intermodulation products, but exclude necessary modulation sidebands of the fundamental carrier frequency.

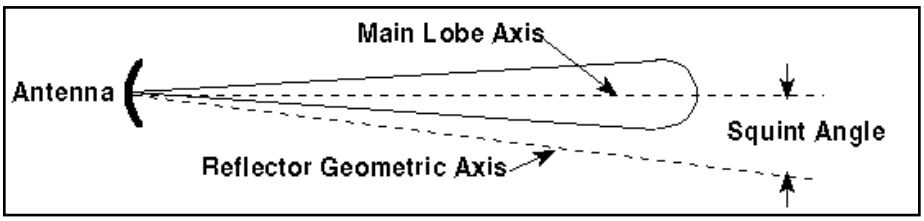

SQUINT ANGLE - The angular difference between the axis of the antenna mainlobe and the geometric axis of the antenna reflector, such as the constant angle maintained during conical scan as the mainlobe rotates around the geometric axis of the reflector.

STAGGERED PRF - Staggered PRF allows an increase in MTI blind speeds such that no zeros exist in the velocity response at lower velocities. In a two-period mode, the usual "blind speed" or occurrence of a zero in the velocity response is multiplied by a factor which is a function of the ratio of the two repetition periods.

STAMO (STABLE MASTER OSCILLATOR) - A very stable (drift free) oscillatory used to provide a precise frequency for transmission and for comparison with the reflected radar signal returned to the receiver, such as in a Doppler radar where a precise difference between transmitted and received signals must be measured to determine accurately the Doppler frequency.

STAND-FORWARD JAMMING - A method which places the jamming vehicle between the enemy sensors and attack aircraft.

STAND-IN JAMMING (SIJ) - Similar to stand-forward jamming but usually using an UAV with a lower powered jammer instead of a jammer aircraft.

STAND-OFF JAMMING (SOJ) - An ECM support aircraft orbits in the vicinity of the intended target. As the fighter-bomber pilot starts his strike penetration, the ECM aircraft directs jamming against all significant radars in the area. This technique provides broad frequency band ECM without affecting performance of the strike aircraft.

STARBOARD - The right side of a ship or airplane when facing the bow (forward).

STC (SENSITIVITY TIME CONTROL) - Gain control that reduces the radar receiver gain for nearby targets as compared to more distant targets. STC prevents receiver saturation from close-in targets.

STEP RECOVERY DIODE - A charge-controlled switch which ceases current conduction so rapidly that it can be used to produce an impulse. Cyclic operation of the diode can produce a train of impulses which when used with a resonant circuit can produce a single frequency output at any harmonic of the pulse frequency.

STERADIAN - Unit of solid angle. An entire sphere has 4π steradians.

STREAM CHAFF - Operational technique of dropping large quantities of chaff for a continuous period of time. This results in a "ribbon" or "stream" of returns many miles in lengths on radarscopes. The penetrating strike force can then use the resulting chaff corridor to mask their penetration.

SUBHARMONIC - A frequency which is an integral submultiple of another frequency. For example, a sine wave whose frequency is one-third of the frequency of another sine wave is called the third subharmonic. (3 MHz is the third subharmonic of 9 MHz).

SUPERHETERODYNE RECEIVER - A receiver that mixes the incoming signal with a locally generated signal (local oscillator) to produce a fixed, low intermediate frequency (IF) signal for amplification in the IF amplifiers.

SUPPRESSION - Elimination or reduction of any component of an emission, such as suppression of a harmonic of a transmitter frequency by band rejection filter.

SUPPRESSION OF ENEMY AIR DEFENSES (SEAD) - Activity which neutralizes, destroys, or temporarily degrades enemy air defense systems by using physical attack or electronic means (SEAD pronounced "seed" or "C add").

SUSCEPTIBILITY - The degree to which an equipment or a system is sensitive to externally generated interference.

SWEPT JAMMING - Narrowband jamming which is swept through the desired frequency band in order to maximize power output. This technique is similar to sweeping spot noise to create barrage jamming, but at a higher power.

SWITCHES - See also Diode Switch, Silicon Controlled Switch, Schottky Diode Switch.

SYNCHRODYNE - A klystron mixer amplifier stage in a transmitter, where two signal frequencies are applied as inputs and a single amplified signal is taken out.

TARGET SIZE - A measure of the ability of a radar target to reflect energy to the radar receiving antenna. The parameter used to describe this ability is the "radar cross section" of the target. The size (or radar cross section) of a target, such as an aircraft, will vary considerably as the target maneuvers and presents different views to the radar. A side view will normally result in a much larger radar cross section than a head-on view. See also Radar Cross Section.

TERMINAL IMPEDANCE - The equivalent impedance as seen by the transmitter/receiver.

TERRAIN BOUNCE - Term for jamming that is directed at the earth's surface where it is reflected toward the threat radar. Reflected jamming creates a virtual image of the jamming source on the earth as a target for HOJ missiles.

THERMISTOR - A resistor whose resistance varies with temperature in a defined manner. The word is formed from the two words "thermal" and "resistor,"

THRESHOLD ISR - The interference to signal ratio (ISR) at which the performance of a receiver starts undergoing degradation. It must be determined by tests.

TRACKING RADAR - A radar whose prime function is to track a radar target and determine the target coordinates (in range and angular position) so that a missile may be guided to the target, or a gun aimed at the target.

TRACKING RADAR RECEIVER - These are of two primary types: conical scan and monopulse. (1) The conical scan system directs the radar signal in a circle around the target. The radar paints this circle 15 to 40 times per second. As the target moves out of the center of this circle, the radar develops aim error voltages and re-aims the antenna. (2) The monopulse system directs four beams at the target simultaneously. The target is in the middle of the four beams. If the target is not in the center, the radar return develops an aim error voltage to re-aim the antenna.

TRACK WHILE SCAN (TWS) RADAR - Although it is not really a tracking radar in the true sense of the word, it does provide complete and accurate position information for missile guidance. In one implementation it would utilize two separate beams produced by two separate antennas on two different frequencies. The system utilizes electronic computer techniques whereby raw datum is used to track an assigned target, compute target velocity, and predict its future position, while maintaining normal sector scan. Most aircraft use only a single antenna.

TRADE-OFF TABLES - A set of tables showing the various combinations of two or more variables that are related in that making one variable better will make the other variable worse. The trade-off helps find the best solution considering all combinations. (For example, how a no-interference condition can be maintained if two emitter platforms are brought close together, if at the same time the frequency separation between their radar transmitters is increased.)

TRANSIENT - A phenomenon (such as a surge of voltage or current) caused in a system by a sudden change in conditions, and which may persist for a relatively short time after the change (sometimes called ringing).

TRANSPONDER - A transmitter-receiver capable of accepting the electronic challenge of an interrogator and automatically transmitting an appropriate reply. There are four modes of operation currently in use for military aircraft. Mode 1 is a nonsecure low cost method used by ships to track aircraft and other ships. Mode 2 is used by aircraft to make carrier controlled approaches to ships during inclement weather. Mode 3 is the standard system used by commercial aircraft to relay their position to ground controllers throughout the world. Mode 4 is IFF. See also IFF.

TRAVELING-WAVE TUBE AMPLIFIER - The TWT is a microwave amplifier capable of operation over very wide bandwidths. In operation, an electron beam interacts with a microwave signal which is traveling on a slow wave helical structure. The near synchronism of the beam and RF wave velocities results in amplification. Bandwidths of 3:1 are possible. Operation at high powers or at millimeter wavelengths is possible at reduced bandwidths.

TRIGGER KILL (RADAR) - A method employed to momentarily disable certain radar system circuits to reduce or eliminate RF emissions which may cause an EMI/EMC or RADHAZ situation such as on the deck of a ship.

TUNNEL DIODE - The tunnel diode is a heavily doped P-N junction diode that displays a negative resistance over a portion of its voltage-current characteristic curve. In the tunneling process, electrons from the p-side valence bands are able to cross the energy barrier into empty states in the N-side conduction band when a small reverse bias is applied. This diode is used as a microwave amplifier or oscillator.

UPLINK - The missile guidance signal which passes midcourse correction command guidance intelligence from the guidance radar site to the missile.

VARACTOR DIODE - A P-N junction employing an external bias to create a depletion layer containing very few charge carriers. The diode effectively acts as a variable capacitor.

VARACTOR TUNED OSCILLATOR - A varactor diode serves as a voltage-controlled capacitor in a tuned circuit to control the frequency of a negative resistance oscillator. The major feature of this oscillator is its extremely fast tuning speed. A limiting factor is the ability of the external voltage driver circuit to change the voltage across the varactor diode, which is primarily controlled by the driver impedance and the bypass capacitors in the tuning circuit.

VELOCITY GATE PULL-OFF (VGPO) - Method of capturing the velocity gate of a Doppler radar and moving it away from the skin echo. Similar to the RGPO, but used against CW or Doppler velocity tracking radar systems. The CW or pulse doppler frequency, which is amplified and retransmitted, is shifted in frequency (velocity) to provide an apparent rate change or Doppler shift.

VELOCITY MODULATION - Velocity modulation is modification of the velocity of an electron beam by alternately accelerating and decelerating the electrons at a frequency equal to the input frequency. Thus, the electrons are segregated in bunches, each bunch causing a cycle or current as it passes an output electrode. The velocity of the electrons is thus a function of the modulation voltage. See also Klystron, Multicavity and Klystron, Reflex.

VICTIM - A receiver (radar or missile) that suffers degradation due to ECM or EMI effects.

VIDEO - Receiver RF signals that have been converted (post detection) into a pulse envelope that can be seen when applied to some type of radar visual display; also used to describe the actual display itself (such as the video on an A-scope).

WARM - Acronym for Wartime Reserve Mode. Any mode of operation of a radar or ECM that is held in reserve, and never used, except in actual combat.

WATER LINE - A reference line used for vertical measurements. When used with an aircraft it is usually the ground with the landing gear extended normally. One of several aircraft location designations, also see butt line and fuselage station.

WAVEGUIDE - A transmission line consisting of a hollow conducting tube of arbitrary geometry (usually rectangular, but may be circular) within which electromagnetic waves may propagate.

WAVELENGTH (λ) - The distance traveled by a wave in one period (the period is the time required to complete one cycle). $\lambda = c/f$. In the atmosphere, electromagnetic waves travel at c, the speed of light (300 million meters per second or 30 cm/nsec). At 5 GHz, one wavelength = 6 cm. At 10 GHz, one wavelength = 3 cm.

WAVEMETER - An instrument for measuring the frequency of a radio wave. The wavemeter is a mechanically tunable resonant circuit. It must be part of a reflection of transmission measurement system to measure the maximum response of a signal. Below 20 GHz, the wavemeter has been replaced by the frequency counter with much greater accuracy and ease of use.

WEAVE - An aircraft maneuver that smoothly changes the instantaneous flight path but maintains the overall route of flight. Not as violent as a jink.

WET RUN - A test run with ship / aircraft armament and/or EW switches on.

WILD WEASEL - USAF aircraft (F-4Gs during Desert Storm) used for suppression of enemy air defense (SEAD) mission.

WINDOW - WWII name for chaff

YIG TUNED OSCILLATOR - A YIG (yttrium iron garnet) sphere, when installed in the proper magnetic environment with suitable coupling will behave like a tunable microwave cavity with Q on the order of 1,000 to 8,000. Since spectral purity is related to Q, the device has excellent AM and FM noise characteristics.

ZENER DIODE - A diode that exhibits in the avalanche-breakdown region a large change in reverse current over a very narrow range in reverse voltage. This characteristic permits a highly stable reference voltage to be maintained across the diode despite a wide range of current.

Empowerment by Virtue of Golden Truth
Human Cloning: Specifically,
REM Driven Human Cloning
FULL DISCLOSURE

Donald Marshall

29 October 2015

https://www.facebook.com/donald.marshall.148
http://donaldmarshall.proboards.com/
Vincent Eastwood Interview
https://www.youtube.com/watch?v=M_1UiFeV5Jg&ab

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Introduction

Just read it. Every word in this document is true, and it is the most important document to ever reach the internet. This document is written to empower good people of the world against the tyranny which exists all around us in our world today. Effectively, the document presented here discloses concealed information about the extent to which medicine, science, and technology has advanced in our **current** era. Moreover, I am disclosing this information because I have been extensively abused, and I am victim of **current** advances in medicine, science, and technology, which I describe in detail below. There are many, many, other victims of abuse, including myself, and therefore it is our plea that you read this document with an open mind and you investigate **ALL** statements which may initially irk you and appear 'suspect' to begin with (the circumstantial evidence is available all around you); because as a victim of abuse, I can honestly say, there is nothing worse than experiencing abuse, and those who have the power to protect you from your abusers, ignore you.

I will now discuss what qualifies as whistle blowing disclosure. After detailing the criteria which qualifies for whistle blowing disclosure, I will detail aspects of the Serious Crime Act, and preface a foundation which defines, explains, and references key information for the reader to understand as well as explore the extent to which medicine, science, and technology has advanced today; all for the express purpose of compelling the reader that medicine, science, and technology, has advanced at an incredible rate; that **current** advances in medicine, science and technology are withheld from public knowledge; and finally these advancements in medicine, science, and technology, have been and are **currently** used to commit **serious unspeakable** crimes against humanity and our environment here on earth. Moreover, it is my aim to present this information as coherently as possible to assist the reader to save me, and save many, many others who experience abuse daily resulting from concealed advances in technology.

Whistle Blowing: Qualifying Disclosure

In the United Kingdom under the Public Interest Disclosure Act (1998) (PIDA) section 43B, a "qualifying disclosure" (whistle blowing disclosure) implies "any disclosure of information which in the reasonable belief of the worker, tends to show one of the following:

a) That a criminal offence has been committed, is being committed or is likely to be committed,
b) That a person has failed, is failing or is likely to fail to comply with any legal obligation to which he is subject
c) That a miscarriage of justice has occurred, is occurring or is likely to occur,
d) That the health or safety of any individual has been, is being or is likely to be endangered,
e) That the environment has been, is being, or is likely to be damaged, or
f) That information tending to show any matter falling within any one of the preceding paragraphs has been, or is likely to be deliberately concealed"

Furthermore, under the Enterprise and Regulatory Reform Act (ERRA) 2013 section 17 (*The new 'public interest' test)* is added for whistle blowing disclosures, amending section 43B of the Employment Rights Act (ERA) 1996 and therefore now reads as such (new words underlined):

"(1) In this part a 'qualifying disclosure' means any disclosure of information which, in the reasonable belief of the worker making the disclosure, *is made in the public interest and* tends to show one or more of the following-- [criminal offence, breach of legal obligation, etc]." (Halliday 2013, p. 2).

The following information is presented **with the express intent** that it is made in the public interest, and meets the all criteria set out in section 43B (a-f) of PIDA as well as the 'public interest test', ERRA section 17. Furthermore, in order for the reader to perceive the credence of my statements, so that (s)he has impetus to research the validity of my statements and not dismiss it as folly supplied by an internet troll who has nothing better to do than waste peoples' time, I will cite the Serious Crime Act 2015 here for the express purpose of convincing the reader that all statements made in this document and my original document are indeed FACTUAL! THIS IS NO HOAX. THIS IS NO JOKE. This is simply what is happening in the world today.

The Serious Crime Act 2015

The Serious Crime Act 2015 (UK) section 41, 3ZA, amends section 3A of the Computer Misuse Act 1990 which **previously** read [under Computer Misuse Offences]:

[[F1] 3A Making, supplying or obtaining articles for use in offence under section 1 or 3

1) [That] A person is guilty of an offence if he makes, adapts, supplies or offers to supply any article intending it to be used to commit, or to assist in the commission of, an offence under section 1 or 3.

To: [The Serious Crime Act 2015, section 41, 3ZA]

3ZA Unauthorised acts causing, or creating risk of, serious damage

(1) A person is guilty of an offence if—

(a) the person does any unauthorised act in relation to a computer;

(2) Damage is of a "material kind" for the purposes of this section if it is—

(a) damage to human welfare in any place;

(b) damage to the environment of any place;

(c) damage to the economy of any country; or

(d) damage to the national security of any country.

3) For the purposes of subsection (2)(a) an act causes damage to human welfare only if it causes—

(a) loss to human life;

(b) human illness or injury;

(4) It is immaterial for the purposes of subsection (2) whether or not an act causing damage—

(a) does so directly;

(b) is the only or main cause of the damage.

(5) In this section—

(c) a reference to a country includes a reference to a territory, and to any place in, or part or region of, a country or territory.

(6) A person guilty of an offence under this section is (unless subsection (7) applies) liable, on conviction on indictment, to imprisonment for a term not exceeding 14 years, or to a fine, or to both.

(7) Where an offence under this section is committed as a result of an act causing or creating a significant risk of—

(a) serious damage to human welfare of the kind mentioned in subsection (3)(a) or (3)(b), or

(b) serious damage to national security,

a person guilty of the offence is liable, on conviction on indictment, to imprisonment for life, or to a fine, or to both."

In laymen's terms it is a **serious crime** (Serious Crime Act 2015), punishable by imprisonment, a fine, or both, to cite hatred or spread hoaxes by use of a computer which would cause mass hysteria or public dissension. I have been condemning public figures, high profile individuals, celebrities, singers, movie stars, directors, politicians, world leaders, royalty, anti-secret society 'truthers' (who are really misinformation agents, and agents of deception) etc. –the list is long - since 2011 and **NOT** a single one of these high profile people has issued a public statement saying "I do not like how you have tarnished my name" or filed a law suit against me. Why you may ask? **Because** every word I have stated and will state again (in this document) is true.

Fundamentals

Before I describe the heinous crimes committed against me and many others (including unsuspecting civilians of the world) it is important that I explain, define, and reference:

- Key figures such as Phil Schneider, George Green and Aaron Russo, so that the reader has reference points to verify the extent to which technology has advanced in our **present** era (and continues to advance);
- Define and briefly explain the transhumanist / post human agenda (for those who may be unfamiliar with their aims).
- Define and explain rapid eye movement (R.E.M) sleep, the phases of sleep, and what happens to the (original's) body during sleep.

- Reference advances in technology, with particular attention to: Memory suppression technologies; Mind-voice technology; H.A.A.R.P technology, RFID microchip technology, and MK Ultra technology (CIA's mind control program);
- Define and explain cloning; the different types of clones; cloning centres and cloning technology;
- Define drip feed disclosure / evaluative conditioning and explain why it occurs;
- Explain what 'consciousness transfer' is to the best of my knowledge, and cite drip feed disclosure articles with the express intent to allow the reader to grasp the abuse I have suffered daily at the hands of my tormentors.

Key Figures

Phil Schneider

Phil Schneider (pictured) had 17 years experience working in government black projects carrying a level three security clearance. He was a geologist and engineer who worked in the black projects underground bases at Area 51, S-4, and Los Alamos.

He is most notable for disclosing (Schneider 1995; 1996; Open Minds 2011):

- The 'black budget' expenditure of the United States, which Schneider claims to be between 1.023 trillion U.S. dollars every 2 years (over $500 billion per year);
- Deep Underground Military Bases (also known as D.U.M.Bs -"dumbs"), and at the time of his lecture (Schneider, 1995), –that there are 131 **active** Deep Underground Military Bases present in the United States, and 1477 Deep Underground Military Bases worldwide;
- Each D.U.M.B costs on average 17-19 billion U.S. dollars; paid for by the taxpayer; and it takes approximately a year-and-a-half to 2 years to build D.U.M.Bs with sophisticated methods.
- That military technology outstrips the general public's technology at a rate of 44 to 45 years of technology for every calendar year which passes. In other words for every 12 months which passes military technology will have advanced by 44 years than what we as the general public is currently accustomed to. Therefore as a rough example if we were to take the year Facebook was founded (2004) as a base year, then the military technology since the creation of Facebook will have outstripped what the

general public is accustomed to by as much as **484 years(!)** (2015 - 2004 = 11. 11 x 44 = 484). Similarly, if we are to use the year which YouTube was founded as a base year (2005), once again, military technology would be 440 years more advanced than what the public is currently accustomed to today.

For the purpose of disclosing current advances in medicine, science and technology, and how such advances are used against me and the people of the world to commit monstrous crimes I will use 1945 as a base year. Everything will become apparent including why I use 1945 as a base year for my disclosure, but for the express purpose of compelling the reader to investigate my disclosure I must present everything, logically, sequentially, methodologically, and provide references for the reader in a coherent way to enable him or her to **pay serious attention** to my eye witness accounts. Therefore, at this present stage keep in mind the year 1945, and the fact that military technology outstrips the general public's technology at a rate of 44 years for every 12 months which passes.

George Green

George Green (pictured) was affiliated with U.S. Presidential candidates, and was once asked to be the Finance Chairman for the next President of the United States. Green would later declined the offer of Finance Chairman when a comment made by Ted Kennedy regarding sleeping with Green's 14 year old daughter caused George Green to re-evaluate his associations with this in-group.

During his 2008 interview with Project Camelot (2008a; 2008b), Green disclosed the following noteworthy information:

- U.S. presidents are "selected" and not elected. This is clearly expressed in a story Green recounts, when Green asks:
  "Who is going to be the next President of the United States [for him to overlook their finances]?"
  And the reply was: "Jimmy Carter"
  Green responds: "Jimmy who?"
  The reply Green received was: "Well, he's the Democratic Governor of Georgia."
  George Green: "But I've been voting Republican."
  Green was then confronted by a tall man, Paul Volcker (American Economist, and Chairman of Federal Reserve under Jimmy Carter and Ronald Regan), who walked over and said, "Son, don't worry about it [Republican or Democrat], we control 'em both."
- U.S. scientists learned how to make people (clones) since 1938 -walking talking ones –and the scientists call these people "synthetics" or "the others".
- Cloning technology is relatively advanced. All that has to be done is take two cells from the original, give the cells a small electrical charge (retain a fertilised egg), then all one needs is a receiver (a womb / artificial womb for the fertilised egg to grow).
- Scientist were excited by the synthetic technology because it meant that spare organ parts could be grown for an "original" human without rejection, because theoretically speaking, the DNA of the synthetic is the same as the original.
- Green gives an example of a cloned Politician: George Walker Bush. Green advices the viewer to seek old video recordings of George W. Bush, and compare the old George W. Bush, with the George W. Bush during Bush's second term,

-in terms of mannerism, speech pattern, body language etc. (old videos of George Walker Bush (Boringest 2006; Fox 4 News - Dallas-Fort Worth 2014) are presented in the References section).

- Scientist have also learned how to make these synthetic people within a few months, to the point where the synthetic can be a walking, talking duplicate of the original, intact with all the memories and experiences of the original. The only problem is that the memory, experiences, and functioning capabilities of these synthetics are like: "A DVD recorder. Sometimes you have glitches, and you have to take the synthetics to Camp David occasionally [every 6 months to a year] to get them tuned up."
- Remember these synthetics are people too, they can think and act just like you can, but they do not have a soul.
- Most of the world leaders have been bought and paid for [by men in the background] and are created to think a certain way –to meet the agendas of these men who remain in the background.
- The global elite plans on depopulating the current human population of **over 7 billion** to **500 million** people. This is corroborated by the "Georgia Guidestones" (WorldTruth 2014).
- Vladimir Putin is executing plans to bring the United States down and into a massive depression. Furthermore, China agrees with Vladimir Putin's plans; stating that the Chinese government has not been a Superpower for over 5000 years and "It is their turn to run the world."
- China has the capacity to set back / shut down all of U.S. computing and electrical systems within two days.

At this present stage, the most **salient** points to keep in mind from Green's accounts are that: U.S. presidents are selected and not elected; and **most importantly**, that scientists have been capable of creating synthetics (cloning people) since 1938. If you have kept in mind Schneider's statement (1995; 1996), (that for every 12 months which passes military technology increases by the equivalent of 44 years compared to what the general public is accustomed to) –then learning that scientists have been capable of cloning humans since 1938 should not come as much surprise. Again, everything regarding my disclosure will become apparent, and I thank these men for disclosing their information, because it helps the reader to corroborate my disclosure.

Aaron Russo

Aaron Russo (pictured) was an American businessman, director, and political activist. He is best known for directing blockbuster films such as *Trading Places, The Rose* and *Wise Guys.* Russo believed that a human being "Should stand for something, and do the right thing when the time calls to act". Consequently, during the latter part of his career he did his best to warn the American public by producing documentaries such as *Mad as Hell* (1996), *Freedom to Fascism* (Russo 2006), and *Reflections and Warnings* (Jones 2008).

Russo disclosed the following key information in *Freedom to Fascism* (Russo 2006):

Income Tax

- There is no law requiring Americans to pay income tax. **Although this is a truth, I DO NOT advocate Americans NOT to pay income tax (and neither did Russo).** This is simply because the Federal Reserve can imprison you and seize your possessions for not paying income tax (although there is no law requiring Americans to do so). So for the sake of avoiding hassle for the mean time –pay your income taxes.
- To further illustrate the above point, Bob Shultz speaking at "We the People Foundation" said the following: "Most people believe that the income tax system is legal and that the revenue from the tax is used in the public interest. However, there is a substantial conclusive body of evidence that proves that our income tax system represents the most pernicious form of tyranny. It is the greatest hoax ever perpetrated by government against the working men and women of America."
- Charlie Beall: "The federal government itself refuses to provide, the American people, who are coercively being subjected to this extraction of their private property, without any underlying legal justification. There is no law. There is no law that requires the average American worker in the private sector to pay a direct un-apportioned tax on their labour and compensation for services. There is no law."

- State Representative – Phil Hart –(R-Idaho): "You can look through the statutes, and look for the law that requires you to pay, and when you do that, you **cannot** identify a law that requires the average person in America who earns a wage and works in private business to pay an income tax."
- Peter Gibbons (Tax Attorney) –It's actually very simple. Congress tried to enact an income tax in 1894 –The Supreme Court said that is unconstitutional. When The Supreme Court says something is unconstitutional, it's unconstitutional. They (Congress) tried again in 1913 –and The Supreme Court said –the 16th amendment- "No new power of taxation" –so if they (Congress) didn't have it then (1913) and they didn't get it; they **DON'T** have it. There is no constitutional base for a tax on the wages for Americans living and working in the 50 States of the union. Period. End of argument.

Radio Frequency Identification (RFID) Microchips

- The latest technology for identifying people at the point of self, when they make purchases –is actually the implantable (RFID) microchip. There are microchips that can actually be imbedded directly into human flesh... It's a tiny glass capsule about the size of a grain of rice... it contains an RFID computer microchip with a coiled antenna and it can transmit information also at a distance.
- Katherine Albrecht –Author of "*Spychips*" (2005) makes the following comment: "RFID is a technology that uses tiny computer technology the size of a grain of sand or smaller; hooked up to miniature antennas to transmit information about items at a distance. Back in 1999, Procter and Gamble, Gillette, and MIT got together to find a way to commercialise this technology and make it small enough, make it efficient enough and make it low cost enough to essentially ---their dream is to put these tiny computer chips on every physical item manufactured on planet earth."
- Radio waves can travel through walls, they can travel through wood, and they can travel through things we normally rely on to protect our privacy, for example your purse, your bag-pack, your pocket, –anything you are wearing or carrying.
- One of the most worrisome applications of RFID microchips, are proposals to put them into cash, meaning that it would be able to track every bank note where it had been, who it had been issued to, and create in essence an audit trail. That would essentially take away the anonymity of cash we now enjoy today.
- Once everything you do is tied down to a single number and there is no longer the ability to pay with cash, then all it takes to render you a non citizen is to simply turn that microchip off. **You will no longer be able to participate in any function in society including buying food. Once money becomes digitised through RFID technology, the elite can deduct whatever amount of money they want out of your microchip, whenever they want. They can trace you whenever they want. You will be at their mercy.**

Habeas Corpus

- Habeas Corpus is "[A] writ [formal document] requiring a person under arrest to be brought before a judge or into court, especially to secure the person's release unless lawful grounds are shown for their detention" (Legal-dictionary 2015).
- During the Bush Presidency [2001-2009 (History 2015)], President Bush signed executive orders giving him sole authority to impose martial law, and suspend Habeas Corpus. This gives him doctorial power over the people without any 'checks and balances.'

  In other words, "The government can jail you for life without charges, without a trial, without a lawyer" (Russo 2006).
- Furthermore: "The National Defense Authorization Act [4] signed by President Obama on the 31st December 2011 authorises the indefinite detention, without trial or indictment, of any US citizens designated as enemies by the executive." See Paye (2013) for further discussion regarding the suspension of Habeas Corpus.

Fraudulent Manipulation of Election Results

- In 2004 at the "Forum of Presidential Election" Clinton Eugene Curtis, a former Computer Programmer for NASA and ExxonMobil testified under oath that election results can be rigged using electronic programs.
- In 2004 he gave the following abridged testimony (Russo 2006):

  Judge: Mr Curtis, are there programs which can be used to secretly fix elections?
  Curtis: Yes.
  Judge: How do you know that to be the case?
  Curtis: Because in October of 2000 I wrote a prototype for present congressman Tom Feeney, and the company I worked for in Oviedo Florida –it did just that.
  Judge: And when you said, "it did just that" –it would rig an election?
  Curtis: It would flip the vote 51:49 –whoever you wanted it to go to, and whichever race you wanted to win.
  Judge: And would that program that you designed be something that election officials that might be on county boards would actually, could detect?
  Curtis: They'd never see it.
  Judge: So how would such a program, a secret program that, fixes the election –how could it be detected?
  Curtis: You would have to view it either with source code, or you would have to have a receipt and then count the hard paper against the actual vote total –other than that you won't see it.
- **Judge:** Given the availability of such vote rigging software and the testimony that has been given under oath of substantial statistical anomalies and gross differences –between exit polling data and the actual tabulated results, do you have an opinion whether or not Ohio elections, the Ohio Presidential elections was hacked?
  Curtis: Yes. I would say it was.

Person in the audience: ---So in other words there is absolutely no assurance whatsoever in anything in regard to these machines?
Curtis: Absolutely none.

- See Truthstream (2006) for further details regarding the full account of Curtis' testimony on how elections can be manipulated.
- Moreover, voting machine manufactures refuse to allow anyone to see the source code. Without paper ballots, the honesty of any election cannot be verified.

The War on Terrorism is the War on Your Freedom

- It is time to wake up America. These ID cards are not about defeating terrorism, but they are **ALL** about controlling the American people.
- The (mainstream) media controls the information that a person gets in various ways. They can make sure that the average American watching T.V. or reading the newspaper is going to come out with a certain mindset. She is going to say this is good, that's bad –and that is all they (media/elites) have to do.

Whoever Makes the Money Makes the Rules

- As Mayer Rothschild said "Give me control of a nation's money supply, and I care not who makes its laws". Mayer Rothschild, private banker, –knew that he and the other bankers would now control the laws of the nation. Government gave these bankers one of its most important powers, and now had to borrow money from the bankers and pay interest to finance the government.
- America has gone from people owning their own property, owning their own businesses –to a nation in debt because all the money is created by borrowing (from private banks) and this country has become one where people just live by borrowing.

Russo's Message to Mankind

- If you are in the military or law enforcement, remember you swore an oath [to uphold the law of the land]. You did not swear an oath to promote world government, or corporations.
- Now that you do understand what happened [to America, and the monetary system based on debt slavery] and how it is leading to a tyrannical one world government – the future of mankind depends on you –will you choose freedom or slavery?
- Stop being passive liberals. Stop being passive conservatives. Stop being passive centralists. Stop being passive human beings! When the media starts telling you that the country will fall apart if this is done... Do not be fooled!!
- Remember these are sick, malevolent and twisted people we are dealing with, trying to save themselves. Squash their agendas and stay on course.
- "I believe the time for mankind is time to give all or perish. Grow up or die. Grow up and become adults. Act like adults. Take some responsibility. The world which you have perceived is childlike; –and now the curtain has been pulled back for all to see."

- Unless people get active [get fully informed, and learn how governments of the world are conspiring against their people] and say –I am going to help shut down the Federal Reserve System; I am going to shut down the powers that be –the whole human race is doomed otherwise.
- We are coming near the end game and things are starting to accelerate... –and people are looking at the world leaders to declare martial law [which in turn will rid Habeas corpus].

Let's Consolidate our Problems

- If we can all get focused on how to win the game instead of all these different objectives –such as people are fighting for a better environment; people are fighting to keep their guns/gun control; there are all these different issues which are going on around the world -and which are all important on their own –but if we can consolidate on that and focus –and take all those people –and say –hey let's shut down the Federal Reserve, then we'll deal with those issues. Let's go to the agenda, the objective, the root cause of man's problems, first, then we'll go back to the other stuff.
- That is the priority right now. You have to cut off the head of the beast. And the head of the beast is the Federal Reserve System and the people behind it. You see, and that is what will save the world, and if people understand that –and they **stop** being passive liberals, and **stop** being passive republicans, but rather become **active** human beings –that is what will save the world!

Aaron Russo: Reflections and Warnings

In this documentary Russo recalls his relationship with Nick Rockefeller. Russo shares critical information Rockefeller discussed with him.

The Falsehood of September 11th 2001

- Russo met Nick Rockefeller through a female attorney who telephoned Russo and said "One of the Rockefellers would like to meet you." Russo made a documentary called *Mad as Hell* (1996), and Rockefeller had watched the video and knew Russo was running for Governor of Nevada and wanted to meet him. Russo said "Sure I'd like to meet him", and the two met and talked. Rockefeller proved to be a very smart man and shared ideas with Russo and was the person to tell Russo 11 months before 9/11 happened "There was going to be an event..."
- Rockefeller never told Russo what the event was going to be; but, there was going to be an event –and out of that event, we [America] were going to invade Afghanistan, to run pipelines from the Caspian Sea; we were going to invade Iraq, to take over the oil fields and establish a base in the Middle East, and make it all part of the New World Order; and we would go after (Hugo) Chavez and Venezuela –and sure enough, later when 9/11 happened –and I remember he was telling me how you are going to see soldiers looking in caves for people in Afghanistan and Pakistan and all these places and there is going to be this war on terror which has no real enemy and

the whole thing is a giant HOAX, but it is a way for the government to take over the American people (and the world).

- There is no question about it [that 9/11 is a hoax]. Nick Rockefeller said to Russo: "There is going to be a "War on Terror"" and he was laughing. Who are we fighting against...? Why do you think 9/11 happened and then nothing has happened since then? Do you think that our security is so great here that these people who pulled off 9/11, who were able to lock down another plane...? Come on it is ridiculous... 9/11 was done by people in our own government and our own banking system to perpetuate the fear of the American people into subordinating themselves to anything the government wants them to do. That is what it is about and to create this endless war on terror.
- Nick Rockefeller was laughing when he said, "We are going to be sending men into caves in Afghanistan and Pakistan" –and it was just cynical, he kept laughing and saying "Look how stupid everyone is! We can do whatever we want!"
- 9/11 was the first lie; and the next lie was to go into Iraq, to get Saddam Hussein out with his weapons of mass destruction (when the real issue was control of the oil fields) –that was the next lie. 9/11 created an endless war on terror that would go on and on and you can never define a real winner. There is no one to defeat and so it goes on and on forever. And they can do whatever they want; because they scared the hell out of the American public.
- This whole war on terror is [perpetuated on] a fraud. It is a farce. It is very difficult to say it out loud because people are intimidated in saying it. Because if you say it they want to make you into a nutcase –but the truth has to be... and the truth has to come out. The fact of the matter happens to be the whole war on terror is a fraud, it is a farce. Yes. There is a war going on in Iraq, because we invaded Iraq, and people over there are fighting... but the 'war on terror' –it is a JOKE –you know, and until we discover what really happened in 9/11 and who was responsible for 9/11 –because that is where the war on terror emanates from. That is where it comes from. It was 9/11 which allowed this war on terror to begin and until we get to the bottom root of 9/11 –the truth of 9/11 we'll never know about the war on terror.
- Russo was in Tahiti when 9/11 happened and he got a call from his son – and his son said –"The twin towers, they were just attacked and they are falling down or something..." Russo was in Tahiti and had just woken up from sleep. Russo didn't realise what it was immediately (11 months after Rockefeller had told him about 9/11 and it had happened –because Rockefeller said there was going to be an event –he wasn't specific) –but after Russo saw that America was going to go to Iraq and Afghanistan, that is when he realised, and equated it to what Rockefeller had said.
- 9/11 was only a manifestation to create a fear in the American public. So that we would obey and do what they want us to do. Take for example, Richard Reed 'The shoe bomber' –now here is a guy who is 6 feet 6, ugly as can be; I heard he smelled... He sits on a plane, lights a match in a non-smoking area, to put his shoe on fire... surrounded by people... That is idiotic! If you were going to blow up a plane... you would go into the bathroom... you close the door... and you put your shoe on fire...

you are not going to sit there.... surrounded by people, lighting matches in a no smoking flight... they (elite) want you to believe this nonsense. That is ridiculous!

- The war on terrorism is to keep people in fear. It is an endless war without a real enemy ('terrorists') –so that people would submit and do whatever the government wants them to. Submit to searches, give you ID cards, put Radio Frequency Identification (RFID) chips in you etc. You become servants to the elite –that is what this is all about...
- Freedom of liberty is what people really want, and it is time to stop the duplicity of the government from lying to us. You see many people know the truth of what is happening in this country; like 9/11 but they are afraid to stand up. People have to stand up and find their courage and say "I'm not going to take this anymore, I know the truth" –and they create a situation where if you tell the truth, you are considered a lunatic.
- In other words if someone goes on a T.V. show and says that 9/11 was an inside job – immediately the person is labelled an idiot or crazy. They call you names. **You cannot be afraid of that.**
- If you do not fight the corruption and you do not stand up for what is right in life, you end up being a serf and a slave and you are leaving your children a world in which you would not want to live in yourself, so how can you in decency behave that way? You have to stand up for what is right in life, and unless you do that you are nothing.

The New World Order Agenda

- The whole agenda is to create a one world government where everyone has an RFID chip implanted in them. All the money is to be in those chips [a cashless world]. This information came straight from Nick Rockefeller himself. That is what the ultimate plans of the global elite, banking industry and Rockefeller wants to accomplish.
- The agenda is to implant everyone with RFID microchips. All money is transferred to those microchips. There is no more cash. Money would be in microchips. Instead of having cash, you would have money in your microchips, but whenever they want, they (elite) could take whatever amount out of your microchip whenever they want to. Total control. If you are a protestor they just turn off your chip; you cannot buy food; you cannot do anything; it is total control of the people.
- So they want a one world government controlled by them. Everyone being chipped, all the money in those chips, and they control the chips and they control people, and you become a slave. You become a serf to these people –that is their goal. That is their goal; that is their intentions.
- Russo did not believe in enslaving people and Rockefeller would question him in the following manner: "Why do you care about them? Why do you care about those people? What difference does it make to you [Aaron]? Take care of your own life.
  Do the best you can for you and your family. What do the rest of the people mean to you? They don't mean anything to you. They are just serfs. They are just people..."

- Rockefeller asked –"Why are you fighting for the people for, what is it all about? The people have to be ruled. The constitution, what you are standing for is only for a few people, it's only for a few individuals who can live that way and we believe that it is best for society to be ruled by an elite people who control everything." Russo told Rockefeller he does not believe that. Russo believes: "God put me on this earth to be best person I could be and put everyone on this earth to be the best they can be, and NOT to be a slave and a sheep to YOU and these people (elite) –and I do not understand why you want to control everything. What is the need for that?"
- It was just a lack of caring [from Rockefeller's part], and that is just not who Russo was. It was just sort of like cold you know, and Russo used to say to Rockefeller, "What is the point, of all this? You have all the money in the world you need; you have all the power you need, what is the point? What is the end goal? Rockefeller said "The end goal is to get everyone chipped. To control the whole society. To have the elite people [the bankers and government] controlling the world."

Women's Liberation from the Perspective of the Elite

- Women's' Liberation was founded by the Rockefellers.
- Rockefeller asked Russo: "What do you think women's liberation was about?" At the time Russo had a pretty conventional thinking about it and he said "It's about women having the right to work; get equal pay with men; just like they won the right to vote." At this point Rockefeller started to laugh and he said to Russo "You're an idiot"
- Rockefeller said –"Let me tell you what that was about. We the Rockefellers funded women's' liberation. We are the ones who got it all over the newspapers and television. The Rockefeller foundation –and you want to know why? There were two primary reasons:"
- 1) "We couldn't tax half the population before Women's Liberation and the second reason was"
- 2) "Now we get the kids at an early age [because both parents are away from home working] –we can indoctrinate the kids how to think, so it breaks up their family –the kids start looking at the state as the family, as the school as the officials as their family, not as their parents teaching them, and so those are the two primary reasons for women's liberation."
- Russo thought, up to that point, Women's Liberation was a noble thing; however when he saw the Rockefellers' intentions behind it, where they were coming from when they created Women's Liberation; the thought process of it; Russo saw the evil behind what he thought was a noble venture.

America is a Republic

- America is a constitution republic / it is supposed to be a constitution republic –and **NOT** a democracy. The majority should not rule, and nor should the majority take over the inalienable rights of the minority.

- Americans pledge allegiance to the "Flag and the **Republic** which it stands" –and **NOT** democracy.
- Democracy is the worst form of government you can have because it is majority rule. Therefore the government can tell you what to do because 'the majority' wants it. It is irrelevant what the majority wants. Decisions should not take away the inalienable rights of an individual.
- Russo also said "It doesn't matter who you vote for, republican or democrat; –they are the same –neither one of them is stopping the Federal Reserve or paying income taxes.
- The elite (Federal Reserve) have taken over the American government; there is no difference between republicans and democrats. There is no difference between the two parties. The duality is manufactured. They (Federal Reserve; central banks) control both parties. It doesn't matter to the elite which one wins, because whoever is running for President will be someone they anoint. Whoever runs for President, will do whatever the elite want them to do. The fact of the matter happens to be that you cannot win an election unless you have enough money to win; they (Federal Reserve; central banks) make sure who gets the money.

Depopulation

- Russo and Rockefeller discussed many things –and one of the things Rockefeller brought up in conversation was reducing the world population. Rockefeller felt that there are too many people in the world. In a way Russo agreed that there are too many people in the world, but he **does not** think he has the authority to say who dies and who lives; but the elite felt that they want to reduce world population and Rockefeller felt it should be reduced by half.
- Rockefeller even mentioned to Russo in conversation, that they were having a real problem trying to solve the Israel/Palestine problem –and they were playing with the idea of bringing Israel to Arizona –and taking everybody from Israel and giving everybody a million dollars, and setting up Israel in the state of Arizona –because that is a problem that they are not in charge of.

Borrowing Money from Private Banks causes Inflation and Debt

- These people (elite) control the money so they make all the rules, and therefore they put the rules in which they want into effect, and the truth is America has really become a socialist communistic country. Everyone says it is a capitalistic country, but how can it be a capitalistic country when you have a central bank? That is the first question people should ask. It can't be. It is a planned economy, it is a phony!
- If they want to create prosperity, they just print dollars, or put digits into the economy. Now you have prosperity. You do not have real prosperity, you do not have real manufacturing, you just have money being injected in which is infusion of credit. This makes the government go into more debt.

- Whoever makes the money makes the rules. Rothschild said that. Why are we allowing these private bankers to make the money for our country? It is nonsense. Why are we paying interest to these banks to make money for us when the government can do it itself without paying interest, without all that debt? There is no answer to that question and it is a question no politician will raise. Everybody talks about America's debt... We are in debt because we borrow money... but we don't HAVE to borrow money. They designed it so that we can go into debt. We can create the money, and back it by gold so that they cannot create too many of it, so that you do not have the inflation, and do what the Founding Fathers told us.
- Why in the world does the American government borrow money from the banks when they have the ability to create it themselves without borrowing it, and paying interest on it? Why? Nobody can answer that question –not one politician ever raises that. Why does the American government ever borrow money, when they can create it without paying interest?

  –And people say that –well if the American government creates it, it will cause inflation. And that is their answer. And Russo says well let's look at it: the American government has the Federal Reserve do it, which creates the same inflation as if they did it, but also with the inflation –now you are getting massive debt –so with the Federal Reserve you have inflation and debt. Now if the American government made the money, backed by gold which would limit the amount they could make –you wouldn't have debt and you wouldn't have inflation.
- It wasn't until 1913 when the Federal Reserve came in, that America had inflation. Before then there was no inflation for 100 years. There were points and spikes, mostly during the Civil War –but basically there was no inflation other than during that short period of time. I mean a loaf of bread would cost the same thing. People could plan their lives.
- Today, they have planned inflation, and now you have two parents working, they cannot afford to take and pay for their family anymore; the kids are going to state run schools now, the kids are being indoctrinated how to think; they are being given Ritalin, they are being given all these drugs, the whole country is being dumb down, it is all because of the Federal Reserve System; and the Federal Reserve system and these bankers are responsible for the demise of America. And if we ever want to win this battle you must shut down the Federal Reserve System, and we must shut down these bankers and restore sound money to this country.
- If you analyse the situation and if you realise that since the Federal Reserve has come into being since 1913, illegally, without a constitutional amendment, by bribing a few senators during Christmas vacation, they turned over the most important power that the American government has, the creation and issuance of money to a private bank.
- Through that private bank issuing money they have destroyed this country. They have destroyed the purchasing power of money in this country; they have created social programs that are destroying this country.
- The Federal Reserve has created massive inflation in America which means the American worker has to keep on making more money to keep up with the cost of

living. The more money they make to keep up with the cost of living, the less competitive they become in the world economy. So now what happens is that we have to pay our workers so much to keep up with the cost of living; and then they (elite; government; corporations etc.) say screw the American worker; let's go overseas now to get the cheap labour.

- The inflation the Federal Reserve has created has now allowed other countries to outcompete us. Other countries do not have to pay as much money as we have to pay to our workers to survive. So now we are not competitive anymore and we have lost our manufacturing base. We have lost our competitive edge.
- "Freedom to Fascism" is a documentary that everybody should see. Russo and his team show the fraud of the income tax; they show how Judges put people into jail for no reason; they show the corruption of the justice system. They show how the Federal Reserve came into being and how it is controlling society and how all the central banks are working together through the bank of International Settlements, in Switzerland which is the central bank for all central banks and how all are working together to create this one world government; this one world order; which is what they are trying to do.

The Deception of the Council of Foreign Relations (CFR)

- Russo was interested in joining the Council of Foreign Relations, but he found out from Rockefeller himself, that part of the end goal of the CFR is to get everyone RFID chipped. To control the whole society and have the elite people (bankers, government etc.) controlling the world. Russo asked Rockefeller "Do all the people in the CFR believe the way that you do?" Rockefeller said "No, no, no. Most of them believe they are doing the right thing. A lot of them believe it is better off being socialistic. We have to convince people that socialism is really capitalism." Because America is becoming a socialistic country; it is a communist country today.
- Russo's friendship with Rockefeller became one where they would share thoughts, ideas and philosophies and Rockefeller wanted Russo to become a part of what they were doing [enslavement agenda], and for Russo to become a member of the CFR; Rockefeller offered various business opportunities for Russo to get involved in the CFR and to **not** take up the fight or the battle that Russo had been taking up in the past. Rockefeller wanted Russo to drop the idea of helping the people; because "What was the point in Russo fighting for the people?" Rockefeller would question.
- Russo asked Rockefeller do all the people of the Council of Foreign Relations feel the same way you feel? Rockefeller said "A lot of them think they are doing the right thing, they think that socialism is the best way to go (but this form of socialism involves redistributing the wealth for the elites and not to everyone), they think that they are doing the right thing." But the people at the (very) top they all know the truth of what is happening. (Therefore, the good people in the CFR are also under an illusion, and do not know that effectively they are working for evil men who have the overall goal to control the populace of the world).

- So it is compartmentalised within the elite structure as well. All the people in the CFR -2000 to 3000 people like Dan Raddler –they don't know what is going on--- they join the CFR because it is prestigious. They think it is good for business, it is good for this; they don't know what is really happening –the evil that comes out of it –that is emanating out of it.
- In terms of the CFR, in terms of compartmentalisation, there are many good people which Russo believes are part of these organisations who do not even understand what these organisations are really about. For example, when Russo was in Germany, doing cancer treatment, there was a gentleman there who was visiting a friend of his with cancer. The gentleman visiting his friend was a member of the CFR, and him and Russo were talking and Russo showed him the movie (*Freedom to Fascism* (2006)); --and he said, "Oh my god! I'm going to resign." "I had no idea this is what the CFR is about". He had no idea; he is just a nice guy, who thought he was joining a prestigious organisation.
- A lot of people join the CFR because they think it is a prestigious organisation; it will help them in business; make good business contacts etc. They do not have an understanding that the CFR is really about world domination. How they, and the Trilateral Commission, The Bilderberger [Group], the banks, all work together to control the people –a lot of them do not understand that. They do not see the big picture. They think: Oh the CFR is a prestigious organisation. I'll make this, I'll make that, and I can do business deals. It is just business to them. The CFR wants to get the people in there that have influence and power, and so they are part of that (enslavement agenda), and so they are not opposed to them. So the whole country is becoming the haves and the have not. You are getting the very, very wealthy and the middle class being destroyed and you are getting the poor people.
- In Russo's words: "You can call the CFR what you like, but it is a criminal organisation. Run by criminals. But people do not think of it as a criminal organisation, because it has 'class'; 'style'; 'prestige'; –and it is 'respected'; so people do not look at it as being a criminal organisation. That is what a great job they have done."

Combining America, Mexico and Canada into one Country

- Imagine this... here you are in America, and they (elite) are combining American, Canada and Mexico into one country. The North American union. And the American people do not know anything about it. It is not even in the press. They would rather talk about Rosy O'Donnell and Donald Trump calling each other names than discussing the fact that we are merging into one country. This isn't even reported.
- The fact of the matter happens to be, that tells you how controlled the media is. The elite control the media, and they control governments and they are all in bed together. Here you are combining American, Canada and Mexico into one country, and you do not see it in the press. You do not see it in the press. Why? This should be one of the top stories everywhere –and the elite are not worried about it. That tells you –there is the evidence that [media] it is controlled. They do not want the American people to

know what is going on, that is why they do not protect our borders. That is why we are losing our constitution, the very document that secures our freedoms.

Russo's Vision on How to Bring These People Down

- There is no question we are in tyranny, there is no question that the American citizen is no longer a free individual human being, to do the things that they wish to do. We're slaves and it is getting worse.
- We are dealing with complete evil; and until the American people wake up and say, we do not want this evil in our country anymore and we want to come back to a country of decency and goodness, integrity and honour, we are going down that road and that is what it is going to take? It is going to take people to stand up and say we do not want to live in this kind of world anymore. I believe we should pull all of our troops out of Iraq, I believe we should leave other countries alone. Let other countries live their lives the way they choose to. Stop trying to spread 'democracy' around the world, which is the worst form of government there is anyway (because 51 percent rule over 49%), restore our republic to what it is supposed to be and go back to what the founding fathers gave us. Restore the republic.
- In Russo's opinion: The populace must shut down the Federal Reserve System –and there has to be an uprising. There has to be an uprising. People have to stand up. One person cannot do it alone. You cannot do it alone. People do not seem to have the courage to do what they have to do.
- A lot of people in Hollywood know the truth, they do not want to stand up and speak about it; I know many of them have seen my movie (*Freedom to Fascism* (2006)) and they know I am right, and they want to talk about it because everybody is afraid. Everybody is afraid because they think that the money they get from the Federal Reserve is really money and they have a comfortable lifestyle and they are afraid of change. They are afraid to stand up for what is right, and until people are willing to stand up and have the courage to do what they need to do, it is not going to change; and hopefully we can affect change when people stand up and say "Hey, I've had enough".
- We (the populace) have one advantage. They (elite) need us to cooperate. See, if we do not cooperate with them, they cannot win. They always need our cooperation with them to go along with their programs. They try to "sell us". Democracy; this majority says this; believe in this; do this, do that; the war on terror; we have to be scared... They are always trying to do things to "sell to us" to go along with them, and once we learn not to cooperate with them; then we win the game.
- That is the point, do not cooperate with them, and do not go along with the program anymore. Stop it. Join forces, and bring freedom back to this country. It is going to take people who believe in freedom; The Constitution and the Founding Fathers, Thomas Jefferson, to make this country whole again, because right now it is in the grip of the evil ones, and the only way to stop that is for good men to stand up.

- We have to stop being scared. We have to do what is necessary to take back what is ours. We have to stop these bankers, these elite, full of liars, congressmen full of liars. They are destroying our borders.
- So through these bankers, attempting to take over America, knowing that America was the freest nation on this earth, it was necessary for them to takeover America, take away gun rights, freedom to bear arms, and create a country where we become slaves, because once they take over America, the rest of the world becomes a lot easier for them. And so by creating 9/11, an event to terrify the American people that we are being 'attacked by terrorist', you create a world where there is an enemy that can **never** be pinpointed. You can never win the battle. It is 100 year war – a never ending war on terrorism. So you are always fighting this war, and through the war on terrorism, through 9/11 which is the first lie, then you create the war on terrorism which is the next lie, then you create the war in Iraq through weapons of mass destruction, which is the next lie –so you get one lie, to the next lie, to the next lie, -- now it is going to be Iran the next lie –and sending more troops and insurgents into Iraq.
- Restore America's Republic back to what it is supposed to be. Get the bankers out of our government. Get government to stop borrowing money from the banks. Government should make its own money; restore the Republic. Restore individual freedoms. That is what this country is about -and until we do that we are going to be slaves.
- You have to take away the creation of money away from the private bankers and you will solve 95% of your problems.
- Americans, mobilise, stand tall, stand together, tell the government you are "Mad as hell!" Do not cooperate with the government do not accept a National ID card. Do everything in your power to restore freedom and your individuality back to America. Stop being a country run by the institutions for the institutions. Let's go back to "We the people, by the people for the people", as opposed to, we the institutions, by the institution, for the institution. Stand up for your individual rights. Stand up for the God leaders that are in each and every one of us!

The Trans-humanist / Post Human Agenda

Transhumanism is a cultural and intellectual movement that believes we can, and should, improve the human condition through the use of advanced technologies. One of the core concepts in transhumanist thinking is life extension: through genetic engineering, nanotech, cloning, and other emerging technologies, eternal life may soon be possible. Likewise, transhumanists are interested in the ever-increasing number of technologies that can boost our physical, intellectual, and psychological capabilities beyond what humans are naturally capable of (thus the term *trans*human) (Anthony 2013). Transcranial direct current stimulation (tDCS), for example, which speeds up reaction times and learning speed by running a very weak electric current through your brain, (Anthony 2012) has already been used by the US military to train snipers. On the more extreme side, transhumanism deals with the concepts of mind uploading (to a computer), and what happens when we finally craft a

computer with greater-than-human intelligence (the technological singularity) (See: "How to create a mind, or die trying", Hewitt 2012) (Anthony 2013).

Moreover, put simply, "posthumanism" can be defined as that condition in which humans and intelligent technology are becoming increasingly intertwined (TheNanoAge 2015). For readers interested in learning more about the posthuman / transhuman agenda see BT Soul Catcher 2025 (BEAMS 2007); Avatar Project 2045 (2045 Initiative 2015; Borghino 2012) and Mind Clone Robot (Bloomberg Business 2015; RT 2015) which have all been disclosed as methods of transferring the human consciousness to a computer.

The Phases of Sleep and Rapid Eye Movement (R.E.M) Sleep

Sleepers pass through five stages of sleep: 1, 2, 3, 4, and REM (rapid eye movement) sleep. These stages progress cyclically from stage 1 through REM then begin again with stage 1. A complete sleep cycle takes an average 90 to 110 minutes (Sleepdex 2015). In other words, after falling asleep, it takes approximately 90-110 minutes to enter REM sleep.

Stages

Waking	REM Sleep	NREM Sleep			
Stage 0	Stage R	Light Sleep		Deep Sleep	
		Stage 1	Stage 2	Stage 3	Stage 4
Eyes open, responsive to external stimuli, can hold intelligible conversation	Brain waves similar to waking. Most vivid dreams happen in this stage. Body does not move.	Transition between waking and sleep. If awakened, person will claim was never asleep.	Main body of light sleep. Memory consolidation. Synaptic pruning.	Slow waves on EEG readings.	Slow waves on EEG readings.
16 to 18 hours per day	90 to 120 min/night	4 to 7 hours per night			

Image 1: Stages of sleep. Source: Sleepdex: (2015)

Any sufficiently advanced technology is indistinguishable from magic.
Arthur C. Clarke

REM Sleep

Most dreaming occurs during Stage Five, known as REM. REM sleep is characterized by eye movement, increased respiration rate, and increased brain activity. REM sleep is also referred to as paradoxical sleep because, while the brain and other body systems become more active, your muscles become more relaxed, or paralyzed. Dreaming occurs because of increased brain activity, but voluntary muscles become paralyzed. Voluntary muscles are those that you need to move by choice, for example, your arms and legs. Involuntary muscles are those that include your heart and gut. They move on their own (Sleepdex 2015; Walcutt 2013).

Rapid eye movement, or REM sleep, is when you typically dream. You may have images float by in earlier stages, particularly when you are going through Alpha or Theta (brain waves), but the actual dream state occurs in REM (Walcutt 2013).

This period of paralyzation is a built-in protective measure to keep you from harming yourself. When you are paralyzed, you can't leap out of bed and run. Do you ever feel like you can't escape during a dream? Well, the truth is, you can't. You can breathe, and your heart is working, but you really can't move (Walcutt 2013).

The reader is also advised to see the Horizon documentary "Why Do We Dream?" (BBC Horizon 2009). This video is available, on YouTube, and details sleep, the phases of sleep, REM sleep, the period of paralysation and more.

Current Advances in Technology

This is a section some readers may have difficulty with, because reading about these current technologies alone, one cannot help but feel that such technologies described below sound like the stuff of science fiction and fantasy -although they have been corroborated through public drip-feed disclosure (explained below). Nevertheless, I urge the reader to keep in mind Arthur C. Clarke's quote (above), as well as Phil Schneider's testimony regarding the advancements of military technology in comparison to the general public's technology (for every 12 months, military technology outstrips the technology the public is accustomed to by a rate of 44 years). Moreover, for the reader who finds difficulty understanding the technologies described below, seek the supporting articles / videos.

Memory Suppression Technologies

Memory suppression technologies are any scientifically advanced technologies which are used to suppress memory. Examples of how memories can be suppressed can be found by reading Winter's (2014) article which details how memories can be suppressed using light; and Greenberg's (2013) article which discusses memory suppression through gene / chemical modification.

Mind-Voice Technology

Mind-voice technology is an advanced technology which is capable of reading, listening, hearing or broadcasting your inner voice / thoughts. Examples of articles which discuss mind-voice technology are: Prigg (2014) details software which can read the inner voice; and New Scientist (2014) which also discusses a brain decoder which can eavesdrop on one's inner voice.

H.A.A.R.P. Technology

The High Frequency Active Auroral Research Program (HAARP) is a radio transmitting system that can bounce signals off the ionosphere (a region of the Earth's upper atmosphere 60km (37 miles) to 1000km (620 miles) altitude) and back to earth to probe deep into the earth or sea, its proponents say. The system could locate minerals or communicate with submarines. (Begich & Manning 1997; Sheen, Begich & Robbins 2005).

HAARP can also:

- Disrupt human mental processes.
- Knock out all global communications systems.
- Manipulate global weather.
- Change weather patterns over large areas.
- Interfere with wildlife migration patterns.
- Hurt ecosystems.
- Negatively affect your health, moods, and mental states.
- Unnaturally impact the Earth's upper atmosphere.

This illustration (below) shows the ionosphere's relationship to the Earth. The illustration appeared in the HAARP Environmental Impact Statement on page 10-125 of Volume II.

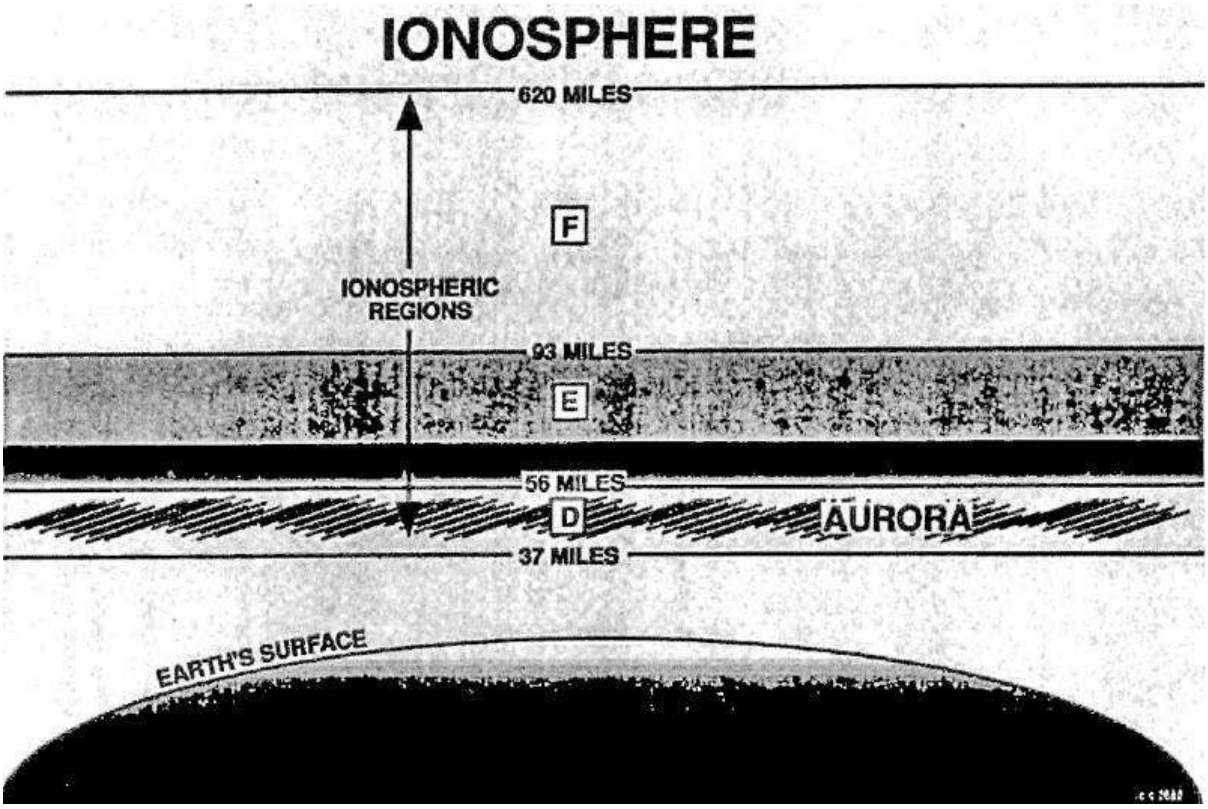

Image 2: The ionosphere's relationship to earth. Source: (Begich & Manning 1997)

The ionosphere protects the earth. HAARP (High frequency Active Auroral Research Program) is made to beam more than 1.7 gigawatts (billion watts) of radiated power into the ionosphere -the electrically charged layer above Earth‘s atmosphere. Put simply, the apparatus is a reversal of a radio telescope - just transmitting instead of receiving. It will boil the upper atmosphere. After disturbing the ionosphere, the radiations will bounce back onto the earth in the form of long waves which penetrate our bodies, the ground, and the oceans.

HAARP represents a technology which could lead to a new class of weapons that could change our world profoundly - an all-purpose military tool. If misused, the tool could mess up the weather. It could be used against humanity in a way that would change what people think, believe and feel. It could be used for good or evil, just as a harp can produce the music of Mozart or the melody of a death march.

H.A.A.R.P. and Weather Control

- “The theoretical implication [of Dr. Robert Helliwell and John Katsufrakis of Stanford University in 1974] suggested by their work is that global weather control can be attained by the injection of relatively small 'signals' into the Van Allen belts (radiation belts around Earth) - something like a super-transistor effect” said Frederic Jueneman.
- Yes. The weather can be controlled using HAARP technology.

- A series of weather disasters began in 1960, according to a CIA report mentioned in the editorial, but at the time climatologists couldn‘t look ahead and see that droughts, floods and abnormal temperatures would continue beyond that decade. As if natural disasters weren‘t bad enough, the CIA reported that national governments were already able to manipulate weather for military purposes [using HAARP technology].

As far back as 1958, the chief White House advisor on weather modification, Captain Howard T. Orville, said the U.S. Department of Defence (DoD) was studying ways to manipulate the charges of the earth and sky and so affect the weather by using an electronic beam to ionize or deionize the atmosphere over a given area. In 1966, Professor Gordon J. F. MacDonald, associate director of the Institute of Geophysics and Planetary Physics at the University of California, Los Angeles, was a member of the President‘s Science Advisory Committee, and later a member of the President's Council on Environmental Quality.

Gordon J. F. MacDonald published papers on the use of environmental control technologies for military purposes. MacDonald made a revealing comment: ―The key to geophysical warfare is the identification of environmental instabilities to which the addition of a small amount of energy would release vastly greater amounts of energy. MacDonald had a number of ideas for using the environment as a weapon system and he contributed to what was, at the time, the dream of a futurist. When he wrote his chapter, ―“How to Wreck the Environment” for the book “Unless Peace Comes” he was not kidding around.

In the text MacDonald describes the use of weather manipulation, climate modification, polar ice cap melting or destabilization, ozone depletion techniques, earthquake engineering, ocean wave control and brain wave manipulation utilizing the planet‘s energy fields. He also said that these types of weapons would be developed and, when used, would be virtually undetectable by their victims. He was not some wire haired fanatic when he made these observations in 1966 -he had the credentials of a world recognized scientist. What his futuristic concepts became, are the things which projects like HAARP are made of...

H.A.A.R.P. and Mind Control

- Radio frequency radiation, acting as a carrier for extremely low frequencies (ELF), can be used to wirelessly entrain (adjust) brain waves.
- We are talking about very, very low power requirements. The trick for influencing brain activity is in the combination of frequency, power level and wave form.
- As Dr. Patrick Flanagan, one of America’s most gifted inventors noted in an interview, the HAARP project could be not only the biggest ionospheric heater in the world, but also the biggest brain-entrainment (brain adjustment) device ever conceived.
- According to HAARP records, when the device is built to full power it can send very low frequency (VLF) and extremely low frequency (ELF) waves using many wave forms at energy levels sufficient to affect the mental states of entire regional populations.

- The HAARP transmitting system could be used unintentionally or intentionally to alter mental functions.
- If HAARP is tuned to the right frequency, using just the right wave forms, mental disruption throughout a region could occur intentionally or as a side effect of the radio frequency transmissions [in other words: “mind control”].

RFID Technology

Radio Frequency Identification (RFID) microchips are microchips that can be directly imbedded into human flesh. This section discusses the dangers of RFID chips. See Rense (2001) for full review.

- RFID technology links the brains of people via implanted microchips to satellites controlled by ground-based super-computers.
- Today they are small enough to be inserted into the neck or back, and also intravenously (through a vein) in different parts of the body during surgical operations, with or without the consent of the subject. It is now almost impossible to detect or remove them.
- Implanted human beings can be followed anywhere.
- Today's microchips operate by means of low-frequency radio waves that target them. With the help of satellites, the implanted person can be tracked anywhere on the globe.

RFID Technology and the Medical Profession

- One reason the dangers of implantable microchip technology has remained a state secret is the widespread prestige of the psychiatric DIAGNOSTIC STATISTICAL MANUAL IV produced by the U.S. American Psychiatric Association (APA), and printed in 18 languages. Psychiatrists working for U.S. intelligence agencies no doubt participated in writing and revising this manual. This psychiatric "bible" covers up the secret development of Mind Control technologies by labelling some of their effects as symptoms of paranoid schizophrenia.
- The Psychiatric Diagnostic Statistical Manual (DSM) for mental disorders has been a brilliant cover up operation in 18 languages to hide the atrocities of military and intelligence agencies' actions towards their targets. THE MANUAL LISTS ALL MIND CONTROL ACTIONS AS SIGNS OF PARANOID SCHIZOPHRENIA.
- If a target is under surveillance with modern technology via TV, radio, telephone, loudspeakers, lasers, microwaves, poisoned with mind altering drugs via air-ducts, giving familiar smells which cause headache, nausea and so forth, if s/he claims her/his clothes are poisoned, her/his food or tap water as well --- all medical schools teach their students that the person is paranoid, ESPECIALLY if s/he believes intelligence agencies are behind it all.
- Never is the medical profession told that these are routine actions all over the world by intelligence agencies against their targets. Thus, victims of mind control are falsely considered mentally ill and get no help since they are not believed and their suffering is doubled by misinformed health professionals.

Further Implications of RFID Technology

- How many people realize what the implications of implantable chips actually mean? It means total loss of privacy and total outside control of the person's physical body functions, mental, emotional and thought processes, including the implanted person's subconscious and dreams! For the rest of his / her life!
- It sounds like science fiction but it is secret military and intelligence agencies' mind control technology, which has been experimented with for over half a century (since 1950s). Totally without the knowledge of the general public and even the general academic population.
- Supercomputers in Maryland, Israel and elsewhere with a speed of over 20 BILLION bits/sec can monitor millions of people simultaneously. In fact, the whole world population can be totally controlled by these secret brain-computer interactions, however unbelievable it sounds for the uninformed.
- Neuro-electromagnetic involuntary human experimentation has been going on with the so-called "vulnerable population" for over 50 years, in the name of "science" or "national security" contrary to all human rights. It happens today in the **USA, Japan, and Europe**. With few exceptions, the mass media suppresses all information about the entire topic.
- Only increased public awareness of the microchip implants, their frightful consequences to privacy by influencing of individuals' thoughts and actions, causing people to become biological robots with physical and emotional pain whenever the supercomputer technician so wishes, is enough reason to refuse to take the microchip into your body for whatever reason.
- It is the biggest threat to humanity and the most sinister plan to enslave the human race forever.

If you have a choice and want to remain a normal human being with privacy, **DO NOT** have your children implanted **NOR** yourself implanted with RFID microchip(s) (or any other type of implantable microchip). Otherwise your vision, hearing, sensing, thoughts, dreams and subconscious will be influenced by an outsider, who does not have your best interests in mind. For the rest of your life!

Mind Control: MK Ultra Technology

MK Ultra today has evolved from the 1950s variation of mind control (MK Ultra Compendium 1980), whereby drugs such as LSD, and interrogation were used as methods to weaken the mind of the individual to force confessions through mind control. Today, mind control is achieved through the implantable microchip (mentioned above; Rense 2001).

- The brain functions of an implanted person can then be remotely monitored by supercomputers and even altered through the changing of frequencies.
- Once implanted, the U.S. National Security Agency's (NSA) 20 billion bits / second supercomputers could now "see and hear" what you are experiencing with a remote monitoring system (RMS).

- Every thought, reaction, hearing and visual observation causes a certain neurological potential, spikes, and patterns in the brain and its electromagnetic fields, which can now be decoded into thoughts, pictures and voices. MK Ultra technology is therefore capable of Mental Video and Audio Projection, as well as Artificial Telepathy.
- The mass media have not reported that an implanted person's privacy vanishes for the rest of his or her life. S/he can be manipulated in many ways. Using different frequencies, the secret controller of MK Ultra technology can even change a person's emotional life. S/he can be made aggressive or lethargic. Sexuality can be artificially influenced. Thought signals and subconscious thinking can be read, dreams affected and even induced, all without the knowledge or consent of the implanted person by using MK ultra technology.
- Memory suppression technologies are used in conjunction with MK Ultra technology, which enables the programmer to control certain memories the victim remembers. The use of memory suppression technologies and MK Ultra technology allows the programmer to reinforce behaviour and elicit specific conditioned responses.
- Mind control techniques, such as MK Ultra, can be used for political purposes. The goal of mind controllers today is to induce the targeted persons or groups to act against his/her own convictions and best interests. Zombified individuals can even be programmed using MK Ultra technology, to murder and remember nothing of their crime afterward.
- The goal of mind control, using MK Ultra technology is to program an individual to carry out any task against their will and self-preservation instinct and to control the absolute behaviour and thought patterns of the individual. The purpose of mind control, using MK Ultra technology is to disrupt memory, discredit people through unusual behaviour, to make them insane or to commit suicide or murder.

See Mind-Computer (2012) which discusses how artificial telepathy is achieved. Artificial telepathy, also known as ‘brain to brain communication’, is also possible using MK Ultra technology. Furthermore, review: Jim Cristea (2009); Berkeley News (2011); UC Berkeley Campus Life (2011) CTForecaster (2013); nature video (2013) and Stromberg (2013). The above mentioned articles and videos describe, demonstrate, and corroborate how audio and video projection of the brain is achieved; how dreams can be recorded and projected digitally; how the brain can be scanned to reveal hidden information personal to an individual; and what a person’s underlying intentions are, by using brain scans. Moreover, the articles and videos mentioned above confirm the functionalities of MK Ultra technology.

Furthermore, when our brain functions are connected to supercomputers by means of RFID technology, MK Ultra technology and other implantable microchips, it will be too late for protest. This threat can be defeated only by educating the public, using available literature on biotelemetry (electronic equipment that receives signals from radio transmitters) and information exchanged at international congresses.

Human Cloning

There are currently five different types of clones, concealed from public knowledge. There are Mark 1 clones; Mark 2 Clones; Mark 3 Clones; and Mark 4 clones and reanimated clones. Moreover, there are two types of cloning techniques: duplication cloning and replication cloning.

Mark 1 clones are REM sleep driven clones. However, the technology used for Mark 1 clones causes many side effects and therefore Mark 1 REM sleep driven clones are no longer a preferred choice.

Mark 2 clones are also REM sleep driven clones. Mark 2 clones have fewer side effects than Mark 1 clones, and therefore Mark 2 clones are currently the preferred method for REM sleep driven clones.

Mark 3 clones are independent clones which operate on microchip containing the entire consciousness of an individual.

Mark 4 clones are also independent clones, operating on a microchip which contains the entire consciousness of an individual and is an advanced version of a Mark 3 clone.

These independent clones (Mark 3 and Mark 4) have a lifespan of 6 months to 12 months and require adjustments after this period to run efficiently once more. Without these adjustments, their functionality weakens.

To "reanimate" means "to restore to life; resuscitate; revive". Consequently, reanimated clones are clones which are genetically identical to that of a person who once lived.

Replication cloning is what the public is most familiar with. Replication cloning involves giving birth to a genetic identical of an original where the newborn starts life off as a baby and matures. The newborn is referred to as a clone.

However, duplication cloning is a current concealed advanced from of cloning, and it involves taking as little as two cells from an individual, adding a constant electrical charge to the cells until a complete human being is formed.

Duplication cloning is similar to the process of regenerative medicine as demonstrated by Dr. Stephen Badylak's video "How to grow a New Fingertip" (CBS 2008; Science Channel 2014) where Badylak states: 'A whole human can be grown within 9 months.' On average it takes 5 months to grow a duplicate clone of an original by means of advanced scientific and technological regenerative procedures.

Cloning Centre and Cloning Technology

A cloning centre is a place where clones are produced. Cloning technology are the advancements in medicine, science and technology used to produce duplicate and replicate copies of originals.

Drip Feed Disclosure and Evaluative Conditioning

Drip Feed Disclosure

Drip feed disclosure is the process of supplying information but in small amounts overtime. Drip feed disclosure is also the process of revealing information slowly overtime, possibly telling lies to conceal certain aspects of the truth until the source administering the drip feed disclosure has adequate time to let out the truth in a slow and controlled way, thereby delaying the betrayed partner (in this disclosure, the public) from having the "complete truth" for some time.

Drip feed disclosure is also a method to gauge public reaction used by governments, the media, multinational corporations and organisations as well as high ranking officials to "test" whether the general public is acceptant of the concealed information or not. When the public reacts favourably to the drip feed disclosure, more information is revealed and made public, and it appears to the unsuspecting observer that the people involved in making the disclosure are taking positive steps towards a favourable goal for all. However, when the public reacts adversely; information contradicting the drip feed disclosure is presented, and an expert is presented to the public who voices the concerns of the general public, and therefore it appears that the opinions of the public have been noted and research and development will not continue in the initial stated direction. Nevertheless, the truth remains concealed and research and development continues despite the aversions of the public.

Examples of drip feed disclosure involve articles such as mind uploading / downloading (BEAMS 2007), Mind Clone Robots (Bloomberg Business 2015; RT 2015), The 2045 Avatar Project (2045 Initiative 2015; Borghino 2012). I am here to tell you that I have been a spy for over 30 years and such technological accomplishments which are posted under trans-humanism / post-humanism genre have been realised many years ago and are **available** today. They are just concealed from the public.

Furthermore, Dolly the sheep was announced as the first publicly cloned mammal (Animal Research 1996), but how many readers can say they know that, four years later, a monkey (BBC News 2000), our closest primate, was cloned? This is publicly disclosed knowledge, but I suspect not many people know of a cloned monkey four years after Dolly. This is because there was such a worldwide adverse reaction to genetic cloning when Dolly was made public, that the disclosure of the cloned Rhesus monkey (BBC News 2000) was not made public knowledge on a grand scale.

Evaluative Conditioning

Evaluative conditioning is defined as a change in liking, which occurs due to an association with a positive or negative stimulus (see De Houwer et al., 2001). Simply put, this means that our preferences for brands, products, people and other things can be influenced and even modified by the presence of something we like or dislike strongly (Hale 2012).

In many settings, a neutral stimulus, called a "conditioned stimulus", often coincides with some desirable or undesirable object, called the unconditioned stimulus. An unknown brand, for example, might appear in a commercial that also depicts a happy child. Over time, stimuli that often coincide with desirable objects are perceived more favourably, whereas stimuli that often coincide with undesirable objects are perceived less favourably--called evaluative conditioning (De Houwer, Thomas, & Bauyens, 2001; Walter, Nagengast, & Trassilli, 2005; Moss 2009). An "unconditioned response" is a response to a neutral stimulus we have no / little control over. It is a natural automatic response.

In other words, our preferences for liking or disliking brands, products etc. (the neutral stimulus) can be influenced by embedding (implicitly placing) the brand etc. (neutral stimulus) with positive or negative associations. Overtime our conditioned response becomes one of conditioned favourable or negative response towards the brand, product etc. (neutral stimulus) when we are faced with the brand, product etc. at a future date. Our preferences have been guided overtime. Evaluative conditioning can change our preferences when carried out subliminally or implicitly; it does not have to be explicit.

In media; music; movies; and other forms of popular culture and entertainment, images and symbols (of stimuli which cause undesirable consequences) are embedded subliminally and implicitly and are paired with positive associations as a form of evaluative conditioning. This causes individuals who have no preconceived judgements of the stimulus to be guided to have positive associations with a stimulus which causes undesirable consequences.

In popular culture; media; advertisements; movies; music and other forms of entertainment, evaluative conditioning is used as a method of hinting (that something is wrong); showing off of power (i.e. nothing can be done to stop the negative stimulus) and as a form of gloating (i.e. we've pulled off the negative stimulus / we are pulling it off). In over the 30 years I have been a spy, I have witnessed methods of evaluative conditioning used to hint, show off power, and gloat more often than not, and evaluative conditioning is not used just to guide social order.

The fortunate aspect is that once a person learns that his / her preferences are being guided by methods of evaluative conditioning, in order to influence the person to have positive associations with negative stimuli (or feel powerless towards the negative stimuli); and that the stimulus (brand / product) does in fact cause undesirable consequences –then the 'spell' is broken. The person can now choose how he or she responds to the brand etc. Usually, once all is known: a negative stimulus is associated with negative associations; despite it being portrayed as positive through evaluative conditioning.

Consciousness Transfer

Consciousness is defined as "the state of being aware of and responsive to one's surroundings; a person's awareness or perception of something" (Dictionary Reference 2015). Consciousness can also be described as: individual awareness of a person's unique thoughts, memories, feelings, sensations and environment (Cherry 2015).

John Locke (1632-1704) was an English philosopher, Oxford academic and medical researcher who argues that it is sameness of consciousness rather than sameness of substance that constitutes personal identity. Consequently, if the psychological life is transferred from the body of a prince to the body of a cobbler (shoe mender), Locke argues, the resulting person will be the prince and not the cobbler. He would be responsible for the prince's actions and not the cobbler's; those who were close to the prince could continue their relationships with him but those who had relationships with the cobbler could not, and so on (Schechtman 2012, p.334). Moreover, basic Lockean intuition has proved to be that "consciousness transfer" can be thought of as the feat in which the person moves from one body into another (Schechtman 2012, p.334).

Consciousness transfer can also be thought of as the process of transferring or copying the mental content (including long-term memory and "self") from a particular brain and copying it to a computational device; artificial body or avatar body such as that of a robot or clone version of the original. The computation device, robot or the clone, will then respond essentially the same way as the original brain (as suggested by Lockean theory on consciousness transfer) and therefore the computational device, robot or clone experiences having a conscious mind and essentially the behaviour of the computational device, robot or clone, can be attributed as belonging to that of the original.

It is **OF MONUMENTAL IMPORTANCE** that the reader understands the above statement regarding consciousness transfer is a method of **CURRENT** concealed advances in technology and not a concept relegated only to the genre of science fiction. At the very least the reader should be **open** to the possibility of consciousness transfer and the implications of consciousness transfer, in order to truly begin to understand the extent to which current concealed advances in technology are used to commit monstrous crimes.

I understand the above sounds unsettling, but there are also many wonderful concealed advances in technology (detailed in the disclosure section). The marvels in technological feats and human accomplishment will be released for the benefit of mankind once the world learns about the monstrous crimes which are committed against the them, and the earth, through the use of highly concealed technological advances and the good people of the world band together to put an end to the tyranny around us.

Now is also a good time to remind the reader that if military technology advances by a rate of 44 years for every 12 months which passes, then since 1945 military technology has advanced by a rate of more than 3000 years compared to the technology the public is currently accustomed to (44 times 70 = 3080). Now ask yourself honestly, in 3000 years from now (the year is 5015) don't you think humans will have been capable of developing a method which allows them to transfer their consciousness from one body to the next and more?

I am here to tell you that I have been a spy for over 30 years and that from the intelligence I have gathered over the years it has been illustrated to me countless times that consciousness transfer is indeed fact and currently exists. Consciousness transfer has been achieved since 1945, although this accomplishment in human advancement (and more) is concealed from public knowledge. Moreover, consciousness transfer is a highly advanced form of concealed technology used by high ranking members of society to commit unspeakable crimes against the public.

Furthermore, for the reader who wishes to understand how consciousness transfer is possible, see Petkova and Ehrsson (2008) and Ehrsson (2013). In the video Professor Henrik Ehrsson (2013) demonstrates:

1) Consciousness transfer from one body to the next (owning another body other than ones original)
2) Physiological evidence for owning the new body. In other words when consciousness has been transferred and the person perceives the new body as that of his or her own; when the new body is threatened as the mannequin (new body) was in the experiment, individuals still perceived the mannequin body as that of their own and became frightened (displayed biological and physiological responses).
3) Visual perception and stimulation causes us to perceive ownership of a new body.
4) The new body we inhabit must be similar to that of our own (it does not matter whether the new body is smaller or larger than our original so long as the measurements are proportional) for consciousness transfer to occur.

5) That it is possible for consciousness to be transferred to another person's body and have (or perceive) ownership of other person's body while being localised in your own body. In other words, dual consciousness is possible.

Petkova and Ehrsson's (2008) and Ehrsson's (2013) research gives one of the clearest publicly disclosed explanations of consciousness transfer and I urge the reader to watch the video in order to better understand my disclosure. One of the main findings from his research is that perception is not rigid; and perception does shape reality. Sight and synchronous (going on at the same time) stimulation can, and does alter the brains perception of reality. Sight and synchronous stimulation activates certain parts of the brain (the sensory parts of the brain and the motor (movement) parts of the brain). The match between the two (sight and stimulation) "convinces" the brain that 'hey, I'm no longer in this body; I'm in that one or that I have a third arm (although it is a false limp) etc. Accordingly, "perception is reality".

Disclosure: Save the Victims through your Diligence

I've done my best to preface this information as logically, sequentially and methodologically for the reader as possible. I have stated what the law is on 'whistle blowing'; I have given references and definitions where appropriate and I have provided many sources in order for the reader to research, corroborate, and better understand my disclosure, so that he or she becomes compelled to help me and victims like me, defeat tyranny and save the future of mankind; therefore if there are any areas of my disclosure which still appears suspect –and I understand, after all my efforts –things may still not appear clear to some readers because we are dealing with highly advanced concealed technologies which are not available in the world the general public lives in; and therefore it is difficult to fathom and furthermore conceive that men can be so evil to their fellow humans through the use of advances in science and technology. Nevertheless, I promise you, I have no reason to lie, I am victimised daily because of these technologies, and therefore my only option is to tell the truth, and nothing but the truth so that the people of the world can put an end to this grave injustice.

For the reader who still finds it difficult to accept my disclosure after first read, I want you to do two things:

1) **Give me the benefit of the doubt.** I am asking you to do this because as I stated earlier, one of the hardest things to do as a victim of abuse is to come forward about the abuse you have suffered. It is even more heartbreaking when nobody believes you. Consider all the victims of paedophiles you have heard about on the news. I cannot speak for their individual cases but I can attest to the fact it affects my mental psyche beyond comprehension; there is nothing worse than being ignored and that nobody believes you. So on that premise, please give me the benefit of the doubt, because I'm sure the majority of good human beings out there will feel worse when it is proven that I am a victim of severe abuse and you ignored me, when you could have done everything in your power to save me.

2) **Set out on a genuine quest to debunk my disclosure.** If my disclosure appears suspect to you to begin with, then set out on a genuine and investigative quest to debunk my disclosure because, if my disclosure initially appears circumspect to believe, then I should be proven false within minutes of your research of my disclosure, because even professionals make mistakes. There will be something about the disclosure which will just not 'add up'. However, when a person is telling the truth, then it is very difficult to debunk that person.
I promise you, it will be worth your time to know the real truth about the world, simply because the truth is liberating.

I would also like to remind you that the truth about the world has been hidden from the public for many decades, therefore when you do hear the truth of course it is going to sound absurd to begin with; but keep an open mind and pursue till you know what truth is; because "to "know" is to understand with certainty".

Words of Inspiration: Personalized from a Theoretical Physicist –Thomas Campbell

The following gives an introduction to many aspects which occur in this world behind closed doors or in plain sight depending on how familiar the reader is with the topics. Evidently, a lot of what is written predominantly affects the people of the world and it is time the people of the world stood up and reclaimed their world. I cannot stress this importance enough! The disclosure is also a basis which explains many of the anomalies which exist in the world today. I apologise in advance if the disclosure is too shocking to be believable (initially) and it shakes the foundations of your belief systems... but as I've said, rather than lash out at the information, you must question your own belief system... and probe into the mechanisms which have influenced you to adopt your current belief system... only then does the shock subside... and you can move forward with an open mind through investigation, which should lead you to either corroborate or debunk the disclosure. Keep in your heart: scepticism, optimism and open mindedness (Campbell 2008). Scepticism keeps you from believing fallacies. It keeps you from falling into that which you have not yet proven for yourself. Scepticism is a requirement for breakthroughs. Optimism gives you the ability to give merit to that which you have not yet proven for yourself and Open Mindedness gives you the ability to "see" that which has not yet been proven.

The Science of Hidden Consciousness

Furthermore, "Consciousness Science Kept Hidden" (YesEthan 2013) illustrates:

- "The heart is an electrical organ. It produces by far the strongest form of bio electricity in our body; up to 40-60 times stronger than the second most powerful source –which is the brain. This electrical energy travels through every single cell in our body and in a sense, binds the cells together. The bio-electricity field is strong enough that it can even be detected outside of the body; out into space; beyond the skin. It is very measurable electromagnetic energy, much like radio waves. What we found is that the heart produces an electromagnetic field that surrounds our entire body 360 degrees; and it can be detected about 3-4 feet with megatron meters outside of the body. Researchers at the medical facility in Kansas –say they have detected it 10-12 feet. So regardless of how far it goes, what is interesting is that we produce this electromagnetic field which can be detected; it can be measured, with sensitive mainstream medical equipment." -Howard Martin (co Author) "The Heart Math Solution""
- Scientific studies have shown: that the heart is not only the most powerful centre in the body, it is the most intelligent and has the ability to receive precognition (knowledge of a future event or situation, especially outside one's normal sense of perception). If we can create coherence with our heart and mind centre we can access our intuition more frequently.

When you read my disclosure, remember that it is the heart and NOT the brain which is the most powerful centre in the body; the heart is the most intelligent; it has the ability to receive precognition and intuition about a future event, **before it actually occurs**; therefore if you find that your heart is in resonance with the themes I disclose; do not fight it with the ego of the mind; when our egos get in the way it overrides our heart's intuition; your heart is capable of discerning the truth of an event before your brain becomes conscious of it; by all means listen to your heart, and allow your brain to naturally develop its intuition. It will be the coherence between your heart first, and then your mind centre which will allow you to access your intuition.

Make an effort and reach your own conclusions to the point where you feel comfort in the fact that you **KNOW** the information contained in this disclosure is indeed factual. This will be the point you will have become empowered with golden truth and compelled to fulfil your duty as a human being and also spread the truth far and wide. Yes, we are all living in very interesting times.

Disclosure: Donald Marshall's Message to the World

My name is Donald Marshall. I have been cloned by a large secretive cult know as "The Freemasons" and "The Vril Society" and "Scientologist" together called the Illuminati. For readers unfamiliar with The Illuminati see "The New World Order" (1990) by A. Ralph Epperson and Appendix C in this document; an introductory guide to the Illuminati and their agenda for the world is presented.

Furthermore, I have to tell you that human cloning has been done since 1945. Now is also a very good time to recall Phil Schneider's comment (Schneider was a Geologist and Engineer who worked on black projects and Deep Underground Military Bases (DUMBs)): "That for every 12 months which passes, military technology advances by a rate of 44 years compared to the technology the public is currently accustomed to" (Schneider 1995; 1996; Open Minds 2011). George Green (a former Financier affiliated with U.S. Presidential candidates) also attests to the fact that humans have been cloned since 1938 (Green 2008a; 2008b). Therefore if we take 1945 as a base year, then military technology or hidden technology has advanced by the rate equivalent to 3080 years than the technology the general public is currently accustomed to (2015 – 1945 = 70 years; 70 multiplied by 44 = 3080). So yes, humans have been cloned since 1945 and continue to be cloned today and that current hidden technology in the year 2015 is as much as 3000 years ahead of the technology the public is currently accustomed to. I'll repeat myself because it is **very important** the reader understands the above statement, even if, the rest of the disclosure is hard to fathom after first read. The two **most important** things to keep in mind are:
1) Humans have been cloned for over 70 years (since 1945);
2) **Present** hidden technology is more advanced -as much as 3080 years more advanced- than what the public is currently accustomed to and technology continues to advance at an incredible rate.

The Two Types of Cloning Techniques

Now there are two different types of cloning techniques, there is replication cloning and duplication cloning. Replication cloning is the type of cloning the public has generally heard of. Replication cloning involves taking the nucleus (the DNA) out of a donor egg, and replacing it with new DNA from the person to be cloned. After a few days the resulting embryo can be implanted for pregnancy. The newborn starts life off as a genetic copy of an original.

Duplication cloning, on the other hand, is the second hidden method and type of cloning where the DNA from the person is grown in a big thick tank full of (salty) water. It involves a method of regenerative technology where the cells are agitated and agitated and over the course of 5 months, a fully formed duplicate clone body of an original is developed. The Illuminati used to have to use a tissue sample from the original or the cells from women's pap smears because this contained rich cells to make duplicate clones; they also used children's foreskins which were discarded at the hospital that got removed. That is what happened to me. I had my foreskin removed at age 4 –and by age 5 the Illuminati grew duplicate clones of me. Now the Illuminati say they have upgraded the technology since 2000 and now all they need is blood from the original. They then agitate the blood cells over and over again through regenerative technology, until a fully formed duplicate clone body of an original is produced. For readers who are unfamiliar with regenerative procedures, see Dr Stephen Badylak's video on "How to grow a new fingertip" (Science Channel 2014) and Carmichael (2013) which discuses how scientists cloned a mouse from a blood sample (this is another example of drip-feed disclosure). Regenerative science and medicine (CBS 2008) does work; I've seen it many times.

The Different Grades of Clones: "Mark 1" to "Mark 4" Clones

There are a few different grades of clones that I know of. There are: "Mark 1" to "Mark 4" clones. Mark 1 clones were available at the end of World War II (1945). Mark 1 clones were rapid eye movement (REM) driven clones but they were primitive grades of cloning with lots of side effects caused to the original. Mark 1, REM driven clones were called "Organic Robotoids", even though there are no robotic parts to the clone at all. See Dr Peter Beter's discussion on "Organic Robotoids" (Beter 2011).

Donald Marshall's Dilemma with "Mark 2" Sleep Driven REM Clones

The problem I am having is with Mark 2 REM driven clones. "Mark 2" is a rapid eye movement (REM) driven clone. In other words, Mark 2 clones are sleep driven clones. REM sleep is the fifth stage of sleep (Sleepdex 2015). The first REM cycle usually happens 90 minutes to 110 minutes **after** we fall asleep (Sleepdex 2015). What that means is: **currently,** this is the Illuminati's main form of communication. They do not call people on the phone; they do not meet at the Bohemian Grove anymore (they only meet there once a year for traditional purposes). Since they discovered the science of sleep driven cloning, they meet at the cloning centre **WHEN THEY GO TO SLEEP** (The cloning centre is a physical location, located 5 / 6 hours radius from the Robert Pickton Farm (Port Coquitlam, British Columbia, Canada) at a nature reserve).

Consciousness Transfer Happens When the Original Reaches REM Sleep

The Illuminati can transfer the consciousness of an original once the person reaches REM sleep if there is a duplicate clone of the original at the cloning centre, once the person goes to sleep (90 minutes to 110 minutes after falling asleep). So what happens is that the consciousness of the original is transferred to the duplicated clone body (the duplicated clone body is grown within 5 months by regenerative technology) once the original reaches REM sleep. The original's consciousness is transferred from the original's body, although the original's body is still in their bed, asleep at home; to a duplicated REM driven clone body at the cloning centre and the original 'wakes up' as a cloned version of himself / herself at the cloning centre. It is a great marvel of science and one man's greatest achievements, but it is kept hidden and used for sinister purposes which I discuss below. I must address the readers at this point who are lost at the thought of duplication cloning, and consciousness transfer.

For readers who may have difficulty understanding the process of duplication cloning, see the video which features Dr Stephen Badylak (CBS 2008; Science Channel 2014). Badylak describes and illustrates how a new fingertip can be grown within 4 weeks, by the process of regenerative technology. Duplication cloning works a similar way; involving regenerative technology whereby the cells are agitated and agitated, and over the course of 5 months a fully formed duplicate clone body of an original is grown. Moreover, readers should also view the Horizon documentary "Why Do We Dream?" (2009); the documentary clearly explains the phases of sleep; particularly REM sleep. The documentary also clearly explains that during REM phase sleep the whole body shuts down, and it is only the brain which is active. The fact that the brain is still active, although the body is inactive, is a perfect opportunity for consciousness transfer; and this is usually the moment the Illuminati transfer the consciousness of a person who is asleep, to a cloned version of himself / herself. The reader should also explore Ehrsson's (2013) lecture on consciousness transfer. In the video, Ehrsson (2013) clearly explains how through the first person visual perspective (seeing through the eyes), and through synchronous (occurring at the same time) stimulation of a body part, individuals can perceive and see the world from another body different from their original. In other words, so long as people can see through the eyes, and the body is stimulated, the match between the visual perspective and feeling body sensations allows the individual to see and perceive the world through another body different from their original. The consciousness has been transferred to another body.

Ehrsson (2013) also demonstrates that consciousness is linked. Once consciousness is transferred (from the original's body to the new body), even though the new body is not the persons original body; when the new body is attacked, because the person perceives the world through the new body, everything feels "very real". When the new body (for which the person's consciousness has been transferred to) is attacked, the original still perceives the threat as "real", and therefore the person displays a biological and physiological fear response in their original body; the heart rate increases, as does respiration (breathing) rate, as well as anxiety.

Donald Marshall is an Original as he sits at Home Typing this Disclosure

This is how advanced technology is today. This is also exactly what happens to me. **I am an original as I sit at home here typing this disclosure,** but when I enter REM sleep, my entire original body shuts down, and only my brain is active. The Illuminati have linked my consciousness to a REM driven duplicate clone body of me. Therefore, as soon as I enter REM sleep, they are alerted to the fact that I have entered stage five of the sleep cycle, and in REM sleep, because they have a green and red light above duplicate clones at the cloning centre. The red light indicates that the original is awake, and the green light lets them know that original has entered REM phase sleep and it is time to transfer their consciousness to a duplicate clone version. They cannot transfer the consciousness of an original before REM phase or when the original is awake. When they try and transfer consciousness before an original is in REM phase it makes the original have intense headaches. Setting an alarm every 90 minutes to wake up and then go back to sleep also does not work in terms of avoiding REM sleep and having your consciousness transferred, because the body requires REM sleep, and therefore you become very tired, quickly, if you do not get REM sleep. If you stay awake for four days without REM sleep you begin to hallucinate; after seven days without REM sleep you will die.

When Donald Marshall's REM Driven Cloned Experiences Began

This whole sordid episode began when I was 5 years old, after going to the doctors to get my foreskin removed, at age 4. The tissues from my discarded foreskin were used to grow multiple duplicate clones of me. Within months, I was having my consciousness transferred to a REM driven, 5 year old clone version of me every time I entered REM sleep. The reason the Illuminati did this was because they wanted to use me as what they term "a diddle kid" – in other words they wanted to have sex with an REM driven, 5 year old, duplicate clone version of me. This is what they do. They clone people. They make duplicate clone bodies of people to victimise in terrible ways, and they clone children for men with undeveloped penises to have sex with.

However, I could never remember any of these REM driven clone experiences when I woke up for 25 years; because another aspect of REM driven cloning is that the Illuminati have the advantage of being able to suppress the experiences of people who have their consciousness transferred to their REM driven duplicate clone versions through advanced memory suppression technologies. For the reader who wishes to understand how memory suppression works see Winter (2014). Memories are stored and retrieved from different parts of the brain. Interactions between the cerebral cortex (the outer layer of the brain) and hippocampus need to work together in order to bring the memories out of mental storage to be re-experienced by the mind (Winter 2014). Therefore all that has to be done is for them to turn off the nerve cells which communicate with the cerebral cortex and hippocampus for the evening which you went to sleep and had your consciousness transferred to a REM driven duplicate clone version of you, and you will not remember anything. The technology is so advanced; they can, and do suppress memories at a push of a button. Therefore, the victim wakes up the next morning and will not remember a single REM driven duplicate clone experience. All that they will be aware of is that they did not have a dream the previous night.

This is what happened to me for over 25 years. I wasn't allowed to remember these REM driven duplicate clone experiences until I turned 30. My memories were suppressed for 25 years. I would wake up many days, after a night's sleep, thinking 'I didn't have a dream last night'; or I would wake up the next morning and I would be sick, although I went to sleep the previous night feeling completely healthy. Throughout the years, I thought I had terminal illness; because whenever I went to see a doctor, the diagnosis would always come back that 'there was nothing wrong with me'.

However, over the course of 25 years when I was memory suppressed, and not allowed to remember my REM sleep driven clone experiences, the Illuminati were using me to produce songs, lots and lots of songs, and whenever I could not produce a song, or did not want to, they would stab my REM driven clone body; sodomize my REM driven clone body; chain me to a crucifix and burn my REM driven clone and torture me for all kinds different reasons; and even when I was compliant and did what they told me to, I was attacked, simply because some members of the Illuminati wanted to know what it feels like to stab someone. Now because consciousness is linked (Ehrsson 2013), all these REM clone torture experiences affected me in my original body, and I have a weak heart today because of it, at the age of 39. The memories of my REM clone driven experiences also had to be released to me slowly (see Alford (2014) and FW: Thinking (2014) –for an example of how memories can be wiped and restored) over the course of many months because I had been through so much horror and torture that if the memories was released all at once, I would have had a heart attack in my real body and died.

This is one of the main reasons the Illuminati currently use REM sleep driven cloning (besides sex and torture): to plagiarise talented people under duress. There are many people including me who have been, and are plagiarised on a daily basis. Their consciousness is transferred to their REM driven clone alternates, and night after night and under duress they are forced to reveal their money making ideas or face torture or clone death; clone death after clone death. That is what the movie *Inception* (2010) is about: REM sleep driven cloning, and stealing ideas from the minds of unsuspecting individuals. The Illuminati actually made the film *Inception* (2010) as well as *The Island* (2005), *Avatar* (2009) and *The 6th Day* (2000); the films mentioned above contain references of cloning and REM driven cloning to show off the Illuminati's 'power' and throw in the world's face and laugh.

The Science of REM Driven Cloning Began in 1945

I am one of the few people fortunate, or unfortunate depending on how you look at it, who remembers all of my REM driven cloning experiences because these memories were released to me at the age of 30. I remember many people who have attended and still attend the cloning centre which they bring me to over the course of 34 years. I am currently 39 years old and was brought there since the age of 5. The science of REM sleep driven cloning was first discovered in 1945, and at first it was just a political thing which leaders of the world did. Through the science of REM sleep driven cloning, political figures, heads of state and royalty met each other as REM driven clones versions of their selves when they went to sleep and discussed worldly affairs in complete secret with each other. They also did whatever they wanted with each other as REM driven clones, which they could not do in their original bodies such as sex, fighting each other to the death, jumping off cliffs as their REM driven clones, and just about anything you can think of when one has the ability of pseudo-immortality as a sleep driven clone version of themselves hidden from the guise of the world and general public.

Well they soon got bored of each other very quickly, and started to make REM driven duplicate clones of movie stars, musicians, celebrities and public figures from all walks of life to hang with as REM driven clones and now they all get together for a disgusting time as REM driven clones when they go to sleep. Most of the G20 political leaders meet at the cloning centre as REM driven clones when they go to sleep to discuss worldly matters and watch gruesome things done to innocent and unsuspecting civilians, who are also REM sleep driven clones at the cloning centre, but civilians have their memories suppressed. This is what the films *Hostel* (2006); *Hostel: Part II* (2007); and *Hostel: Part III* (2011) (Illuminati made films) -are about: -rich people paying to torture and kill innocent people at a secluded location for sport; just that at the cloning centre, the Illuminati members torture and kill REM driven clones of innocent people.

Therefore, depending on what was done to your REM driven clone, you could wake up the next day with a very intense headache in your **original body**, if your REM clone was repeatedly punched in the head; an upset stomach in your **original body** if your internal organs were tortured; achy limbs; and worst of all, feel sick all over; although the previous evening you went to sleep feeling healthy. Remember consciousness is linked (Ehrsson 2013), therefore whatever happens to your REM driven clone will affect you in your original body. Even when they suppress your memory; the previous night's experiences still affects you in your original body. You wake up with the knowledge that you did not dream the previous evening when you went to sleep, and with certain illnesses depending on what was done to your REM driven clone.

Help Donald Marshall STOP REM Driven Cloning NOW!

Everything I discuss in this disclosure is firsthand witness accounts. I have seen and experienced horror spectacles done to innocent civilians and to me. For the sake of humanity and the innocent children brought to the cloning centres all over the world; I must tell the whole world about this and the good people of this world **MUST HELP ME TO BRING THIS TO A STOP.** My sense of duty, moral correctness, and conscience cannot allow me to stay silent about this evil. REM sleep driven cloning, and the torture of innocent civilians as REM driven clones; having REM driven clone sex with beautiful, innocent unsuspecting civilians of the world; the paedophilia of children through the process of REM driven cloning; REM driven sex slavery; the plagiarism of talented individuals through the process of REM driven cloning; and REM driven idea slavery, whereby talented individuals must produce new ideas and concepts daily (or whenever they sleep) or be stabbed or tortured in their sleep as REM clones –is the most vicious and pernicious form of tyranny ever to occur against humanity and **IT MUST BE STOPPED NOW!**

Do Not Panic, Riot, or Cause Chaos. This is Very Important.

Now I must preface this carefully, because members of the Illuminati have told me that I have to put this in an eloquent fashion, in a way which does not make people panic because people finding out about REM driven cloning, and the extent of the evil it has been used for, and continues to be used for; it could cause loss of social order, riots and anarchy in the streets. Moreover, I too **DO NOT** want riots and anarchy in the streets, despite the fact that I am vehemently angry considering the extent to which they plagiarised my talents over the years. If you are a good person reading this, and you want to help and you want social order restored for the benefit of mankind, promise yourself; me; all the innocent children they have affected through REM driven cloning, and the children of the future that you will **NOT** riot, and destroy a world for children who are going to inherit the world. **This is very important**. Remember the Illuminati have highly advanced technologies (kept hidden and secret), including weaponry, and they are just waiting for any excuse to use it on the populace. In all revolutions, the populace always win, and I want this disclosure and the end of REM driven sleep cloning to go smoothly. I want the good people of the world to keep spreading this information, keep spreading this disclosure all over social media, tell your close friends, your family, and as many people on social media platforms as you can. The internet, and radio shows with small audiences are the only forms of communication the Illuminati do not control. They own all forms of television networks, even including the Aboriginal People's Television Network (APTN), and therefore a message as important as this will never reach the average man or woman through television because it does not serve their agenda.

Spread this Disclosure Document until it reaches the Armed Forces

I want this message to reach the armed forces, because currently people in the armed forces are following orders, yet they do not know how corrupt their governments and people in high profile places are. They are unknowingly defending these corrupt people. People in the armed forces will **NOT** defend these corrupt people nor will they harm civilians when they realise that these corrupt people have been growing duplicate clone bodies of civilians, transferring civilians consciousness to their duplicate clone versions when the victim reaches REM sleep, and torturing civilians in their sleep; having sex with under-aged REM driven cloned children; having sex with innocent and unsuspecting adults as REM driven sleep clones, against their will; torturing REM driven clones for sport; and for money-making ideas to benefit their own pockets while they make innocent civilians sick and have side effects in their original bodies from REM sleep driven cloning technology. No. The armed forces will not accept that. Therefore keep spreading and sharing this information for everyone to see so

that it reaches personnel in the armed forces **ASAP!** I want the armed forces to overthrow these corrupt people. The Illuminati think they are very sly and untouchable because together they hold most of the wealth in the world. We must show them that they are not untouchable. Please do all you can, to share and spread this message. It is the most important message to ever reach the internet because it affects all our liberties.

I must also address the readers who may feel afraid in spreading my message because they may want to do the right thing, but they are terrified the Illuminati may degrade or end their lives. As unbelievable as the next thing I am going to share sounds, it is a belief system which shapes the reality of the Illuminati and therefore they themselves are afraid to do anything which may degrade their lives or 'eternal soul'.

They believe that they are the 'fornicators' mentioned in The Bible, and if they were to degrade or harm the lives of anyone aiding me, they would suffer the wrath of God when they die. Notice I said **when they die**, but so long as they are still alive they can do all the evil they like, with little consequence, as they do in their REM driven clone versions at the cloning centre; worshipping Lucifer and doing all sorts of ungodly things. They even say God does not exist, only science and technology; yet they are afraid of dying. Very afraid of dying; because they believe they'll meet God's judgement. I'm just relaying what they have told me. They are weird like that. They also follow Hopi Indian Prophecy, Mayan Prophecy and Nostradamus Prophecy. They mix and match those three prophecies and come up with their own religion of what may or may not happen in the future.

Donald Marshall is NOT "The New Age Saviour". Nobody wants to be a 'saviour'

Furthermore, **THEY** believe I am a new age saviour for the end times; that I was going to save the world from something, according to the Nostradamus prophecy (quatrains); the Illuminati consider Nostradamus the greatest prophet ever to walk the earth. They are in awe of him.

I **DO NOT** endorse their claims. I just want REM driven cloning to stop and these people face punishments for their crimes against humanity. I really do not endorse such claims, but if it saves my life and yours, so be it. In reality and practicality, nobody wants to be 'the saviour'; not with such tyranny and pernicious evil such as this. We'd rather all just be living normal lives without the knowledge and practice of REM driven sleep cloning which is used for torture, clone death spectacles and sex with children. My friends on Facebook do not want to be heroes or 'saviours' either; nobody really does, but we do it out of a sense of duty, moral correctness and our conscience would never rest knowing the true extent of evil in this world, and doing nothing to end it. So all that saviour and Nostradamus prophecy talk, it is just the Illuminati; they like to quote prophecies, and make them come true to make themselves feel special.

Like I said, they are weird. I'm just relaying what they say, and I **do not** endorse the new age saviour claims. I'm just a normal guy, who was unfortunate to be cloned when he had his foreskin removed at age 4. This could have happened to anyone. Thankfully I had a very active imagination at the age of 5 and with the use of the technologies such as Mind-voice technology (that is what the Illuminati call it) it allowed me to make songs to keep the perverts off me. Mind-voice technology is just a technology which can tune into the inner voice in your head (See articles by Prigg (2014) and New Scientist (2014) –which discuss how scientist can listen to your inner voice; –it is similar to how Mind-voice technology

works). Therefore, when you hear the sound of a guitar; the sound of drums; or any instrument for that matter; after hearing the sound, when you imagine the sound you heard, your REM driven clone can replicate this sound with Mind-voice technology **exactly**; and I used Mind-voice technology to make many, many songs over the years. As I've said, and I'll say it again: technology today is very advanced.

How the Nostradamus Prophecies shapes the lives of the Illuminati

Also another reason they have not killed me is because the Illuminati said "If they do, everyone is going to know I am telling the truth", -which I am with my right hand to God and I cannot lie about this stuff; the things I have seen are too sinister and diabolical. It would make me as bad as them if I did. Furthermore, because they follow the Nostradamus prophecies religiously, they have told me that they believe anyone helping me is considered part of "The Army of Light" and again, to hurt or degrade anyone helping me, considered part of The Army of Light would incur the wrath of God; and that to hurt anyone considered part of The Army of Light will degrade their lives; they will suffer misfortune and entire ruin as will their eternal soul. These are just some of the interpretations of the Nostradamus quatrains they have relayed to me. These people are beyond crazy, zealot and religious fanatics. Nevertheless, the main point to remember by all this is that **you are safe**, and **they cannot hurt you**, **they are scared to hurt you**, as well as kill me because prophecies have shaped their lives and the lives of their ancestors for hundreds of years.

Furthermore, and practically, I have told too many people that this is the extent, to which technology has developed in our current day, and it is kept secret and hidden from the public for nefarious purposes and this is what the Illuminati do: REM sleep driven cloning. I have been spreading this information **since 2011** and not one of these high profile people, government officials or celebrity figures has issued a (public) statement against me or taken me to court over libel charges because I'm telling the truth; and their statements would not hold in court.

I have also told over a million Arabs; I have appeared on radio interviews with Vinny Eastwood (Vincent Eastwood 2013); Jeanice Barcelo (Jeanice Barcelo 2013); and Lisa Phillips on the Cry Freedom Radio show (Astral 7ight 2013a – 2013h). I have reached audiences as many as 280,000 views on the Vinny Eastwood Show (Vincent Eastwood 2013) alone. However, I must stress that YouTube reduces the view count of my interviews every so often in order to suppress the truth so that my interviews do not get featured on their platform. Nevertheless, there is safety in numbers and rest assured there are new people waking up to the disclosure of REM driven sleep cloning every day; and therefore you can share and spread this information **without any worry** about facing reprisals from the Illuminati, even if you do not believe that it is in fact their beliefs in Nostradamus prophecies which is saving you and I from the Illuminati.

HIV/AIDS has been cured; so have many forms of cancer

Now is also a good time to share with the reader that this situation is not all 'doom and gloom.' In their quest to perfect technologies, science and medicine, the Illuminati discovered the cure for HIV/AIDS; cancer (except pancreatic cancer); Alzheimer's; Dementia and many more debilitating diseases which humanity suffers with. They relayed the fact that they found the cure for HIV/AIDS by stimulating the cells in an oxygenated rich environment because diseases/viruses cannot thrive in an oxygenated rich environment (in layman's terms). Magic Johnson was cured from AIDS this way and they use him as a spokesperson to sell the retrovirus pills which they know is not as effective. However, the greed these people have,

knows no bounds, and because they receive too many donations for HIV/AIDS as well as cancer donations they do not announce they have cured HIV/AIDS or cancer publicly. As I've told you, and will continue to tell you: technology is far, far, FAR advanced than what you currently see around you. With the help of the good people of earth I promise to release these technologies for the benefit of mankind, and all reading this disclosure can hold me to this. You **must** hold me to this. It is time we ended corrupt governments and corrupt individuals in high positions of power in this world. Hold me to this.

I hope you are now beginning to understand why this is a **world emergency** and why these corrupt people must be ousted and overthrown. I also hope you understand why you must not riot or cause chaos because as I said at the beginning of this disclosure "I write this to empower good people of the world against the tyranny which exists all around us in our world today"; I **did NOT** write this to cause chaos, public dissension or anarchy. Good people of the world will inherit the earth once these corrupt people are overthrown. Therefore, under no circumstance must you destroy the world when you are going to inherit it. No matter how angry this disclosure makes you; no matter how angry the diabolical people who commit these crimes against humanity make you feel. Let's make sure this goes smoothly. Keep spreading and sharing this information, until this disclosure reaches the armed forces; until the armed forces bring these corrupt people to their knees. We are about to inherit the earth; by all means let's ensure everything goes smoothly. Now that you understand how important this disclosure is and that the overthrow of these corrupt individuals must progress smoothly, I'll continue.

The Behaviour of High Profile People at the Cloning Centre

The high profile individuals who attend these REM driven clone gatherings in their sleep have nothing better to do than to show off in disgusting ways. They have no shame and it seems nothing embarrasses them. Some REM sleep driven, cloning centre attendees, sit in the stands of an unused arena, smaller than a hockey rink, but it still has the capacity to seat between approximately 300 to 400 people. There is dirt in the centre of the rink where ice would be. They have frightened REM driven clones of children walk into the middle of the dirt rink to be victimised for a bizarre and disgusting spectacle. Sometimes, they have animals like dogs have sex with the REM driven clone children, while a man holds the dogs on leash so that it wouldn't bite the child on the back of the neck; which I have seen happen before. They all try to outdo each other in their levels of depravity; to be evil is to be "cool" to them.

The Ring Leaders of the Cloning Centre

I will now discuss the ring leaders, but before I name names, please understand that I am not someone who has collated stories and evidence together over the internet. I REALLY **do not** need to do this. Every time I enter REM sleep, the ring leaders at the cloning centre transfer my consciousness to a duplicate clone version of me. I have seen and talked with these monsters over the course of 34 years as REM driven clones at the cloning centre. However, I do understand that for the average reader, without understanding how far medicine, science and technology has advanced; without seeing or hearing people, other than me, discuss the crimes the ring leaders of the cloning centres commit, it is very difficult to imagine that this is what these high profile people are involved with, and do. Nevertheless, I guarantee it; this is the true extent and prevalence of evil in our world.

Their public personas, and public images is well managed by their PR teams, and therefore for the average person it is difficult to imagine these people in any other way but "positive"; but these people behind closed doors are the most evil, sick and twisted people I have ever had the misfortune of encountering. It is also difficult to take in what I am saying because I am not a public figure, nor do I have the "influence" or public image these people have; the general populace have never met, or heard of me, or known who I am; if this was the case my eye witness testimony alone will be enough; however, I do understand that we are dealing with highly advanced technologies, thousands of years advanced compared to what the general public is accustomed to, and because of this I provide references for the reader; I provide references for the reader to have something to corroborate what I am disclosing; and I provide references for the reader to see past the illusions these people have created.

Moreover, as "Consciousness Science Kept Hidden" demonstrates (YesEthan 2013):
remember that it is the heart and not the brain which is the most powerful centre in the body, the heart is the most intelligent; it has the ability to receive precognition and intuition about a future event, **before it actually occurs**, therefore if you find that your heart is in resonance with the names mentioned; do not fight it with the ego of the mind; when our egos get in the way it overrides our heart's intuition; your heart is capable of discerning the truth of an event before your brain becomes conscious of it; by all means listen to your heart, and allow your brain to naturally develop its intuition. It will be the coherence between your heart first, and then your mind centre which will allow you to access your intuition.

The references I provide for the reader to corroborate what I am about to say includes: "Appeal from Survivors of Canadian Genocide" (inifiniLor 2013); Tila Tequila –"Missing Children and Cloning Centres" (Astral 7ight 2013i); "Royal Babylon by Heathcote Williams" (MrCowshedder 2012); and "THIS MOVIE WILL BLOW YOUR F%SNG MIND" (KafkaWinstonWorld 2014).

Watch all the above videos and you will easily see all that I disclose. In Appeal from Survivors of Canadian Genocide interview (inifiniLor 2013): Listen to the indigenous people Stee-mas and Wahtsek speak about the pain and torment they have suffered under the Crown, the Vatican, the government, and churches of Canada. 50,000 to 150,000 indigenous children have gone missing because of the involvement of the Crown, the Vatican, the government, and the churches of Canada; and all these factions involved know this!

Tila Tequila is a television personality who has attended the cloning centres as a REM driven clone since childhood. In Tila Tequila's radio phone in (Astral 7ight 2013i), the audio is not very clear for the majority of her disclosure; she was also frightened and therefore she sounds most animated; however her words are clear at the following points of the audio (I also provide a transcript in the appendices section: "Appendix A"):

4.00 min: Cloning Centres and they take your children...
4.25 min: –There are these CLONING CENTRES –I'm not even talking about child molestation here...
5.40 min –They take your children –they not only molest them; men f*** them; and make them shoot each other...
7.59 min- There is a point where you cannot just turn the other way, you know this stuff is going on and you go 'oh well, you know... that's their problem; let's just turn the other cheek. How long are you going to turn the other cheek until it happens to your own freaking children?

10.34 min - Do you know why they love children? Because they are innocent souls; they are innocent... they are the most innocent, pure beings in this planet. They are not harmed by anything. They are new to the world; bright-eyed, pure innocent children. That is why these disgusting paedophile... and these clone rings, cloning centres, satanic rituals, Brownsville Texas... there are many of the of the cloning centres where they take your children that go missing.

Royal Babylon by Heathcote Williams (MrCowshedder 2012) addresses the fact that for Brits, despite their inordinate pride about their tradition, it is often revealed they know little about it than anyone. The documentary then goes on to address the fact that Prince Phillip the Duke of Edinburgh, has a lust for blood-sports which includes shooting endangered wildlife and mammals which he considers 'culling'. The documentary is also notable for demonstrating to the viewer that Queen Elizabeth II redistributed as much as 2.1 million for her private income from 276 people from Merseyside and Lancashire. These people had no will, so their property was grabbed. The same is true for the Duchy of Cornwall. If you die without making a will, everything you possess will go to Prince Charles. Furthermore, Queen Elizabeth II is the largest land owner on earth. Queen Elizabeth II: head of state of the United Kingdom, and 31 other states and territories is the legal owner of about 6600 million acres of land; one six of the earth's non ocean surface. She is the only person on earth who owns whole countries, and who owns countries that are not her own domestic territory. This land ownership is separate from her role as head of state; is different from other monarchies where no such claim is made –Norway, Belgium, Denmark etc. The value of her land holding is £17,600,000,000,000 (17.6 trillion Pounds) (approximately)).

In "THIS MOVIE WILL BLOW YOUR F%SNG MIND" (KafkaWinstonWorld 2014), readers with a deeper knowledge of the Illuminati and the agenda of the Illuminati will easily spot the minor inaccuracies in the documentary. However, the documentary provides a good reference and foundation for anyone new to the topic of the Illuminati and their agendas for the world. The documentary demonstrates how the world is currently a deception within a deception coated in reverse psychology. It gives widespread insight into the Royal family of England, and their lineage.

Furthermore, the documentary provides information that the world's most popular religions have been infiltrated with Illuminati dogma, in secret. The documentary details how (some) modern Christians, Jews, and Muslims do not (yet) recognise their common enemy because that enemy is invisible (until now). The enemy hides within their own religions. The enemy also hides within the activist community (anti-Illuminati movements), it finances big budget documentaries and movements. The end game is to sell a divisive (creating strong disagreement), anti-capitalistic, atheistic message and deliver trusting followers right into the lap of a communist (one government) New World Order. The enemy is the Illuminati.

The documentary also details that: "Today, the bloodlines of this unholy alliance are on the final stages of establishing one world religion, one world government, and one world ruler [--that is **IF**, the good people of this world do nothing to stop them]. The Windsor Royals are at the control of this web of deceit. It is a known fact that Adam Weishaupt (the founder of the Illuminati) took refuge and got assistance from the German Saxe-Coburg Gotha Royal family. The Saxe-Coburg Gotha's changed their German name to Windsor (in 1917). The Windsor's public image is a façade, to hide the cesspool from which they operate behind the scenes; their power and control cascades out of Buckingham Palace to the elite bloodlines who run world affairs."

For anyone who thinks they know they Royal family of England, did you know that still to this day: they have a person appointed called "Groom of the Stool"? What is a "Groom of the stool", you may ask? A Groom of the stool is responsible for stools. The kind you sit on and the kind you expel. In other words a Groom of the stool wipes Royal bottoms. The above has been confirmed to me by Prince Charles of Wales himself as REM driven clones at the cloning centre, and I quote: "It gives you the feeling of being completely taken care of" when I asked Prince Charles (as a REM driven clone) why they still have that. But don't just take my word for this; research "Groom of the stool".

The Royal Family of England

As most of readers have already guessed; and as unbelievable as it may currently sound to some readers, the ring leaders of these cloning centres includes the royal family of England. As I've said REM driven cloning started as far back as 1945, and it was just a political thing, but Queen Elizabeth II has been involved with REM driven cloning since its inception! Yes! Queen Elizabeth II; Phillip, Duke of Edinburgh and Prince Charles of Wales are the worst of them. They are unbelievable depraved perverts all showing off to the celebrities who attend these REM driven clone gatherings. Elizabeth has the REM sleep driven cloned children at the cloning centre call her "Lilli-bet" and Elizabeth as a REM driven clone herself does ungodly things to these REM driven cloned children. Some she fakes being nice to; some she is terrible to; and as a REM sleep driven clone Elizabeth cuts these REM driven clone children with swords while they scream. The decent people at these cloning centres who have had their consciousness transferred into their duplicate REM driven clones, and are there against their will, like I am; they are terrified to say anything against Elizabeth and her cronies. Most of these decent people also have their children's consciousness transferred into their REM driven duplicate clones, and Elizabeth and her cronies hold these decent peoples' children as hostage; to be torn apart; clone death after clone death if they have the slightest inkling of informing anyone, but as Elizabeth and her cohort have been torturing me as REM driven sleep clones anyway, I will disclose all that they do.

Vladimir Putin is also there, as an REM driven clone, and he loves to put the fear of torture and death into people, but he is essentially a perverted coward himself. Most of the famous people who attended the cloning centre as REM driven clones are ashamed to speak or be seen by me there very much; because they are ashamed of the perverse and disgusting gatherings. I am a decent person, even when my consciousness is transferred to my REM duplicate clone alternative, and I will not participate in these depraved acts; so they use me as an example and torture me for being a good person. They have drugged my REM driven clone, and as I've mentioned because consciousness transfer is real (Ehrsson 2013) and because consciousness is linked, therefore everything feels "real as real"; when I'm drugged as a REM driven clone, I behave exactly as any person would on hard drugs (although I have never taken any drugs in my original body); my vision is blurry and my balance affected; they have used this as method of having me do disgusting things in a blurred state, videotaping these dirty acts and editing a highlight reel which also depicts me doing disgusting things to show to the world when the world learns of their depraved natures and their public personas are shattered so that I can be despised as much as they will be when the entire world learns about this. Furthermore, because of the microchip inserted in my REM driven clone; they mind controlled me like a "Manchurian Candidate" (*The Manchurian Candidate* 2004) using MK Ultra technology, which is far more advanced than the declassified MK Ultra techniques (MK Ultra Compendium 1980) mentioned online today which references MK Ultra techniques in the 1970s. See Rense (2001) for a detailed explanation of how implanted microchips work, and how these chips allow the programmer

control victims. C.S.I.S Canadian intelligence are all involved; they have REM driven clones too; including a lot of Commissionaires and Canadian Prime Minister Steven Harper himself; They do what Elizabeth says, and seem to follow her every whim without question. It doesn't matter who you are; if you have a cute child, or a talented child with imagination, creativity and moneymaking potential (such as business smarts; song making ability; literary / oratory ability etc. –you name it so long as your child has moneymaking value to them) they will send for the blood record of your child; agitate the blood cells over and over until a duplicate clone of your child is grown; they will then transfer your child's duplicate clone body from the tank they were grown onto a steel rack; the steel racks contain 5 rows and each row holds a duplicate cloned body; once your child goes to sleep in his or her original body and once they enter REM sleep (90 minutes to 110 minutes after they first fall asleep) the Illuminati are alerted to this fact by a green light above your child's duplicate clone at the cloning centre and they then transfer your child's consciousness to the REM driven duplicate clone; this is the point where the prime evils molest your children; and so your children are being molested in their sleep as REM driven clones and then they suppress the child's memory or implant false memories (see Kim (2013) and Alford (2015) –on how false memories can be implanted) so your children wake up not remembering dreams from the previous night, or if they do remember anything, the memory is false. These depraved acts very much stunt children's development; it causes them to have learning disabilities; unexplained depression; loneliness; suicidal thoughts, and all kinds of side effects.

The cloning centre is a paedophiles paradise and **it must be stopped**! Elizabeth secretly owes a few music companies too (Universal and others) with bands under contract; she forces me under a knife to compose music for them; if I can't she will stab my REM driven clone; burn my REM driven clone and have her pervert thugs smash my REM driven clone body there. As Ehrsson (2013) demonstrated, because consciousness is linked; and consciousness transfer leads the person who has had their consciousness transferred to still perceive reality as "real as real" in the new body; I have the same biological and physiological responses as I would have if these attacks were occurring to my original body. This has caused me to have heart damage and severe debilitating headaches. Because my memories were released to me; I can now also remember all my past REM driven clone memories since age 5; as well as the previous night's REM driven cloned memories (when I have my consciousness transferred to the cloning centre) which causes severe stress to my mental psyche and mental well being.

As unbelievable as the above statement sounds regarding Elizabeth's ownership of music companies, just go and listen to the song "Abadon" performed by Boondox (RainmanJhof 2011) on YouTube. There are two "Abadon" versions; the version you seek can be found in the Reference section uploaded by RainmanJhof (2011); skip to 2:46 min (or listen to the whole song; pay particular attention at 2:46 min) and you will hear loud and clearly, Elizabeth say "Drop the mother f****ing base". That is Elizabeth's voice; you can compare it to any of her Christmas speeches. That is her. Elizabeth said the above as a REM driven clone at the cloning centre. I know. I was there. They got so confident, that nobody would ever find out about their REM driven cloning shenanigans, that they even had me sing on a song I produced: "Where'd You Go" –Fort Minor (Murdok Dubstep Remix) (MurdokDubstep 2010), available on YouTube. Tila Tequila and I sing on this remixed track as REM driven clones (MurdokDubstep 2010); I start to sing from 1:44 min onwards. You can compare the voice you hear in the song with the Vinny Eastwood interview (Vincent Eastwood 2013). That is me, in both cases, and that song was recorded at the cloning centre.

One good person at the cloning centre; Bernie Mac (also as an REM clone version of himself); who was an actor and comedian, tried to stand up for me and speak up for me saying 'Cloning and torturing people here, it's not right to do to a human being...' and "This place is the devil"'... Bernie Mac also tried to have others join him in speaking out against the REM driven clone torture zone while he was having his consciousness transferred to his REM clone driven version. Elizabeth and Philip tortured him for 4 to 5 hours continuously at the cloning centre as an example of their 'power', Bernie Mac had an aneurysm (brain bleed) the next day and died. This is one of the aspects about REM driven clone torture: if you torture a REM driven clone continuously for hours on end, you will cause the person to die in their original body from a heart attack or aneurysm (while they sleep); even if they do manage to wake up the next day; because of the constant pain their consciousness has recorded; and because consciousness is linked they will wake up only to have a heart attack or aneurysm in their original bodies the following day. If you apply a constantly electrical current to a REM driven clone, that person will either have a heart attack or die from aneurysm in their original bodies while they sleep.

This form of murder is similar to the CIA's heart attack gun (Non Mirage Truth Vision 2015); which was declassified in the 1970s and was a weapon used for causing heart attacks in victims, undetectable as the cause of heart attack under autopsy. The difference with REM driven clone death as a form of weaponry is that hardly anyone has heard of death by REM driven clone torture. Moreover, the perpetrator can be thousands of miles away from the victim; the culprit just needs a duplicate REM driven clone of the victim to torture or apply a constant electrical current to; this is exactly what is going on in our world every day. When Elizabeth and Philip don't like someone and they want to get rid of that person, they clone that person; torture his or her REM driven clone till that person has a heart attack or aneurysm in their original body and dies.

This is what Elizabeth and Duke Phillip did to the indigenous people in Canada. The video reference (inifiniLor 2013) provided above, regarding the genocide of the indigenous people of Canada discusses this very topic (inifiniLor 2013). As Elizabeth and Duke Phillip visited Canada as clones, when they killed the native children; they both had solid alibis of being in England at the time. They then cloned all the witnesses of the Canadian missing children's case and had them remotely killed by applying constant electric currents to their REM driven clones; one by one and each witness either died of a heart attack or aneurysm. They just dispatched the last witness by also applying a constant electric current to the persons REM driven clone because the missing children's case was building momentum.

After Bernie Mac's death everyone is afraid to speak up; they all became afraid of suffering the same fate. All it will take is a few lie detector tests from an independent source; and I will volunteer for them; they cover up for themselves so carefully that lie detector tests from an independent source unconnected to them in anyway will be the only viable method. I know many know non-famous people who have also attended these clone centre gatherings as their REM driven clone duplicate versions and also remember the clone gathering experiences in their original bodies (because they were not memory suppressed) that could be given lie detector tests to prove this. When it comes to the sexual exploitation of a child, lie detectors are admissible in Canadian courts. I need decent people with integrity to speak about this filthy business; to testify about who is involved. There is much to tell about the Illuminati and I am a wealth of information about this topic.

Elizabeth also had Princess Dianna Spencer killed by having someone shine the brightest light known to mankind through the window side on her car; they served away to avoid the light and hit the divider; it was no paparazzi. I first wrote about this in my original disclosure in **2011**; this was corroborated by an article 2 years **AFTER** I had made my original disclosure. See Radar Online (2013) for the corroborating article. Furthermore, "Candle in the wind" performed by Elton John (SadSongs4You 2010) was not Dianna's 'death song'; it was "Bigger than us" performed by "White Lies" (WhiteLiesVevo 2010). The Illuminati released this song, deliberately, 13 years after Dianna's death, again as a show of their 'power'. I did not want to compose this song but Elizabeth and her thugs threatened to stab and burn my REM driven clone repeatedly if I did not. Listen to the lyrics. I'll provide some of the lyrics here for those of you who are feeling too shocked by these revelations:

<u>White Lies Lyrics "Bigger than us"</u>

You took the tunnel route home.
You've never taken that way with me before.
Did you feel a need for change?
Apologies on your fingernails,
Love flickered in the city of lights
Like internet and radio waves.

I don't need your tears
I don't want your love
I've just got to get home

And I feel like I'm breaking up
But I wanted to stay.
Headlights on the hillside
Don't take me this way.
I don't want you to hold me
I want you to pray,
'cause it's bigger than us.

Are you beginning to see why these people must be stopped and stopped immediately? Are you beginning to see why it is no longer okay to 'turn a blind eye' or 'bury your head in the sand', and hope it all goes away? Can you see why I need the good people of this world to keep sharing this disclosure (online); to tell your friends and family until this information reaches the armed forces so that the armed forces can bring these people to their knees. I also do not want innocent civilians to get hurt despite the monstrosities these people cause to humanity on a daily basis. I want the overthrow to progress smoothly so that the good people of the earth can inherit the world, with all technologies and medical advancements which benefit mankind, made available to all. This is why I maintain my composure and resolve, in spite of the evil I see on a daily basis, and you the reader must also maintain your composure and resolve in spite of the evil which I am disclosing, so that we do not inherit a torn down world after we have completely overthrown these malevolent, sinister and corrupt hypocrites!

Furthermore, Diana survived the car crash; and while, either on her way to hospital or in hospital, Dianna was injected with a high concentration of salt, which is near undetectable in an autopsy and she died. Elizabeth did this because Diana was going to marry an Arab named Dodi Fayed. The Illuminati hate Arabs because for the most part, Arabs have not broken their relationship with God. Dianna hated her association with these people; Dianna knew about REM driven, sleep cloning and wanted nothing to do with it; but she was afraid of being killed and so said nothing. I know a lot about this and many more deplorable things the Illuminati have done over the course of 34 years and I will be more than happy to reveal all the evil they have done; as well as all the wonderful discoveries and progresses they have made in medicine, science and technology, which they have withheld from the general public. I am very happy to disclose all, because I known once the world learns of all they have done, we truly will begin to see the end of such evil on this planet. Just make sure you keep spreading this disclosure and it reaches the armed forces soon. Soon, soon, soon!

Help Donald Marshall by Sharing this Disclosure with Your Close Friends and Family

If you are reading this, then you have to help me. I know some of you may be reading this thinking, but I am just an ordinary man or woman Donald, I know you are telling the truth; I can feel it in my heart and my head that what you say is true and that you are telling the truth (which I promise you, with my right hand to God I am) but I'm just an ordinary man / woman Donald; I don't have any power; I don't have any influence; or because of the position I am currently in I can't speak out against these people; and I am just an ordinary man / woman I cannot be expected to take on the world's problems. You are right if you are thinking and feeling this, and I do not expect or want you to take on the world's problems. All I want you to do is share this information with close friends and family initially, because when you do that, at least that is one more person who will know about the true extent of evil in this world. When your close friend or family member also shares my disclosure with another close friend, the disclosure will eventually spread exponentially. It will also be one more person who has your well being in their thoughts because I understand how scary it is to know this. Therefore remember **there is safety in numbers;** and the more people you tell in your social circle, the more you can all look out for each other. So feel free to share my disclosure with close friends and family. Do not talk about my disclosure in public (for now) if it makes you feel uncomfortable. Moreover, if you want to reach more people (other than your initial social circle) the best way, is to do it online: through social media, such as Facebook, Twitter, and YouTube etc. As I've already mentioned, the Illuminati controls all forms of media except the internet.

The Illuminati, being so 'confident' at the time with the evil they wield onto the world, put my face on a Megadeth album cover titled *The World Needs a Hero* (2001) (to mock me) when I was 23. I posed for this album cover at the cloning centre when I was 23, and the album was released with a picture of my face, as a REM driven clone, 3 years later when I was 26. They did this because they were extremely confident that nothing would ever be proven. Google image it, although I am 39 now, you can still tell that it is me. The image shows what I end up looking like after an REM driven clone gathering with a skeleton popping out from my chest. I understand most of you are going to continue reading because although it is "liberating", it is also "paralysing" at the same time (Laurence Mountford) to realise what the truth of the world is, so I will display two images below, but promise yourself, that you will Google search this image in your spare time.

Image 3: Megadeth Album Cover: *The World Needs a Hero* (2001)

Image 4: My original body: top left (age 37) and bottom right (age 37); compared to my 23 year old REM driven duplicate clone body (top right and bottom left) at the cloning centre.

You can clearly see from the images that, it is in fact me. In Image 4, you can also compare what my real body (top left and bottom right) looks like compared to my duplicate clone body. Duplicate clones do not come out of the tank looking 100% like the original; it's 99% - there are always some slight variations as some have commented that the eyebrows and nose in the picture, bottom right, is not the same (as the duplicate clone on the album cover). However, to people who make such comments, I say: my eyebrows and nose is the same when you compare it to the pictures of my original body (top left and bottom right). Also, remember that the image on the album cover is a duplicate REM driven clone of me. REM duplicate clones do not come out of the tank looking 100% like the original. There are always slight variations; but the wrinkles on my 37 year old forehead (when I took the picture in my original body; top left and bottom right) is similar to my 23 year old wrinkles, the lips are the same; and the face which you see, is definitely, the same! Yes. REM duplicate cloning is real; going to sleep and waking up as a cloned version of version of you is real and **we must put a stop to it now!**

The Deplorable Nature of the Illuminati

My own family has been turned against me one by one. The Illuminati have told my family members when they were REM driven clones at the cloning centre, things such as I secretly hit or molested their children; poisoned their pets when the pets died of sickness and other such things to make my own family hate me and not want to help me. Even when my family side with me there at the cloning centre, as REM driven clones of themselves; and my family members say 'They do not believe that Donny did all those horrid things' -which they have been told; Elizabeth then says "Are you cooling me a liyah?!" in her disgusting croaking voice made as low as low and evil sounding as she can make it, complete with psychotic and malevolent glare; and as terrified REM driven clones my family say "No, no, of course [what you are saying] it's true", stuttering and afraid as REM clones. My mother Catherine McMahon sold me into this REM driven sex and torture cloning slavery when she remarried a man named Gordon Cohoon; Gordon's whole family is in this scummy secret society, his brothers Tom and Tony Cohoon; his sisters Darlene and Bernadette Cohoon; they fear the new and improved lie detector tests; and all it would take, is for an independent source, far, far removed from any association with the Illuminati to administer these lie detector tests on me **AND** the above named people to prove this unequivocally.

Half way through the making of my original disclosure document (in **2011**), when I went to sleep that evening, the Illuminati transferred my consciousness to my REM driven clone and introduced me to a man (who was also a REM driven clone) named TROY LANDRY. He is an alligator trapper from Louisiana on the TV program named "Swamp People". Troy Landry said "If I send my [original] disclosure out to the public then he would take a power drill to my shin bone at the cloning centre and suck the marrow from my [REM driven clone's] bones." It is similar to spinal tap, and one of the WORST things you can do to a REM driven clone besides burning a REM driven clone. I told Troy that I will be sending out my disclosure to the public, because I have to escape the cloning centre, and so, Troy Landry did just that. It was excruciatingly painful; all the REM driven clones that were sat in the stands of the arena just watched; slack-jawed. Troy Landry is an insatiable child molester and an extra retarded REM driven clone. A side effect of REM driven cloning is that as a REM driven clone version of yourself, your emotions are heightened and you are less smart as you are when you are experiencing the world in your original body. Nevertheless, Troy Landry is extra retarded as a REM driven clone.

In Louisiana, when Troy sees a young boy that he likes, Troy asks of the boy's name and tells the boy "He is an alligator hunter"; Troy then proceeds to shake the boy's hand; Troy then has his paedophile friends at the local cloning centre find the boy's blood records to grow duplicate clones of the boy. Five months later, there are multiple REM driven duplicate clone bodies of the boy grown for Troy Landry to victimise before the crowd of onlookers. All members of the Illuminati do this; it's just a way of life to them; they consider themselves 'the privileged people' in the world power organisation. Almost all the cast on the "Swamp People" television program attended the cloning centre as REM driven duplicate clones of themselves, **when they go to sleep**. After putting a power drill to my shin bone, Troy Landry asked me again, "Will I send my [original] disclosure out?" I said "Yes" to which he replied "I'll do the same to your pelvic bone everyday!" The pain on my pelvic bone was far worse than when Troy put the power drill to my REM driven clone shin bone. I told Troy "I have no choice but to inform the public" – and so Troy put a power drill to my REM driven pelvic bone, everyday... and it is the worst pain ever... you forget your own name; where you are; all you know is pain; and you beg God or anything to save you from it...

Another deplorable thing which the Illuminati did in real life is: The Canadian government were trying to lower the amount of prostitutes on the streets (Elizabeth hates prostitutes) so they had a man named Robert Pickton start killing the women and feeding the women to pigs on his farm. The Illuminati had a camera set up in the upper corner of a room in Pickton's house and recorded Pickton hitting these women over the head with a hammer (a ball-peen hammer). They took the recordings, all 49 of these murders, and they all watch them at the cloning centre. To be seen as 'tough' at the cloning centre is to watch all 49 of the Pickton murders without having it affect your psyche. Elizabeth loves watching the Pickton murders and she says she has a macabre fascination with death. Canadian Prime minster Steven Harper knows all about the conduct of the Pickton murders; he has seen all the recordings and cheers on as the rest of them do. If Mr. Pickton says anything about his involvement with the Illuminati, or the recordings, they will apply a constant electrical current to his REM driven clone until Pickton has a heart attack or aneurysm in his original body.

What Happened to Britney Spears?

The Pickton murders are also the reason Britney Spears 'lost it' and shaved her head bald. She had watched too many Pickton murders as a REM driven clone at the cloning centre and it drove her 'over the edge'. I'll also reference the following songs performed by Britney Spears so that the reader has more corroborating evidence to add to the ever increasing pile. Search for the video "Break the Ice" (BritneySpearsVevo 2009) on YouTube. In the Japanimation video; at the beginning of the video; that is a cloned **cartoon** version of Britney Spears being grown in a big thick thank full of water (1 second to 7 seconds); and at 1:32 min to 1:43 min Britney walks into the cloning centre. This is **EXACTLY** how the cloning tubes are in real life. They are stacked one on top of the other, each filled with salty water. Britney Spears made this video because she said a fantasy of hers is to "Blow up a cloning centre". The Illuminati allowed her to release this video because at the time they figured nobody would ever figure it out. I have provided the images on the next page.

Image 5: Britney Spears is being grown as a duplicate clone in a cloning tube. The depiction is EXACTLY how the duplicate clones are grown in the Cloning Centre... with wires extending from the body; in a big thick tank full of salty water.

Image 6: Britney Spears walks into the cloning centre. The cloning tubes are stacked one on top of another. This is EXACTLY how these cloning tubes are in real life at the Cloning Centre.

Image 7: The Cloning Centre depicted from an aerial view.

In “Hold it Against Me” (BritneySpearsVevo 2011) performed by Britney Spears; Britney is depicted fighting against her clone at 2:46 min till the end of the video. In “Mona Lisa” (SimpleGirl4ewer 2007) later remade by Britney Spears she changed the words in the song from “gone” to “cloned”. I’ll provide the lyrics to chorus here because they have not changed it on A-Z lyrics etc., but listen to the song and you will clearly hear the following:

Britney Spears Lyrics “Mona Lisa”

She’s the original (yeah, yeah)
She’s unforgettable (yeah yeah)
She wants you to know (yeah)
She’s been cloned…
It’s kind of incredible (yeah yeah)
She’s so unpredictable (yeah yeah)
She wants you to know (yeah)
She’s been cloned,
She’s been cloned,
She’s been cloned…

Yes. Britney Spears and many other celebrities want you to know they have been cloned. The celebrities are depending on you, the ordinary man / woman; the populace, as I am depending on you to spread this message fast and far. In fact Elizabeth has said that “If any public person speaks out, they will die!” Therefore, public figures cannot openly discuss this topic to warn the populace –so they hint. It is **NOW** up to the ordinary man and woman to end this. Furthermore, Elizabeth has a nuclear bomb hooked up at the cloning centre which she can press at any time to wreck havoc on the world unsuspectingly. Thankfully, I managed to convince Elizabeth not to do such a silly thing. I hope you can now understand why everyone is terrified of Elizabeth at the cloning centre, and why this is a **world emergency** and we are depending on you to share and spread my disclosure!

NEVER EVER SELL YOUR SOUL

In This Physical World Selling Your Soul Is Selling Your REM Driven Clone

Furthermore I must discuss an entrapment many up and coming ‘stars’ fall into. You have most likely heard many public figures say “I sold my soul to the devil” or some variation of “I sold my soul”. I am now going to address the aspect of “selling souls” or “selling your soul” which I am sure you have heard many of these celebrities talk about. I’ll address this as coherently as I can because the on the surface selling your soul talk is difficult to contemplate especially if you consider the soul to be a metaphysical, ethereal or mystical part separate from your earth body. Moreover, we live in a physical world, so selling a metaphysical aspect of you sounds incomprehensible (at first). For the most part we have little understanding of what the soul is. However, we are told that the soul is a part of us which never dies and it is eternal. It is all that we are, ever were, and ever will be. Now our faiths and beliefs come into question, because if you are an atheist: there is no God, selling your soul is a bunch of crazy nonsense.

From a practical perspective it also seems difficult to fathom, because if you go on what you have been told, you are selling an intangible part of yourself to be used by someone else for whatever they wish; and so if you get into the headspace of viewing your soul as something separate from you or that you are in control of your mind and your body, then again, 'selling an intangible aspect of you' again sounds like nonsense because right now nobody controls you; you are controlling you; so what are you really selling? Thin air?

Many up and coming 'stars' think this way when they are confronted with "selling their soul" aspect. The up and coming 'stars' are blinded by the prospect of being super famous and super rich; and in the moment they are confronted with "selling their soul" they believe these Illuminati people, are a group of over religious zealots and that they, -the up and coming 'stars' are taking advantage of the Illuminati because the 'soon to be 'stars'' do not believe (in that moment) it is possible to sell your soul, and only consider being super rich and super famous; so the 'stars' sign their 'soul' over.

At this point, it is usually too late for the up and coming 'star'; because what they have actually sold, in this physical world, is the use of their REM driven clone to the Illuminati. They have sold their REM driven clone to be used for REM driven sex by perverse old men and women whenever they enter REM sleep.

These celebrities are not memory suppressed either; so whenever they enter REM sleep, their consciousness is transferred to their REM driven clone, to be used for whatever the Illuminati wish: usually sex as REM driven clones with dirty and perverse old men in return for a promotion in the entertainment industry; such as movie role, advertisements, concert gigs etc. It is a very, very, sick business, and once these up and coming 'stars' get into the business they are trapped. Now you can begin to understand why so many celebrities, although on the surface it appears they have it all, are depressed; and do random and crazy things. It is a cry for help. Their illogical behaviours, (not all) for the most part, can be attributed to REM driven cloning. Furthermore, the Illuminati consider 'selling your soul' (the use of your REM clone) **a very serious business.** They do not joke about this; and there are NO RETURNS. Once you have sold the use of your REM driven clone for promotions etc., that's it. If you ever make a fuss and want your 'soul' back, in other words: you no longer wish to have your REM driven clone to be used by dirty old men for sex; the Illuminati will kill you by applying a constant electric current to your REM driven clone until you have a heart attack or aneurysm in your original body and die. It is as simple as that.

For example, Whitney Houston wanted nothing to do with the cloning centres, she said she would keep quiet; she never wants to be in the spotlight; she never wants to do radio or television. Let bygones be bygones, I'll go my way and you can go your way. The Illuminati were extremely angry! They had bank-rolled her, and now she didn't want to be their 'friend' or ever associate with them again. She was sacrificed; she was killed with a constant electric current to her REM clone. She had sold her soul, in the beginning of her career; in other words, the "use of her REM clone". Earlier in Whitney Houston's career, she had signed that they can use her REM driven clone however they wish.

I have also seen people say "No" –when confronted with 'selling their souls'. These people are then memory suppressed, and will not remember the proposal of their REM driven experience. The people who also refuse to sell the use of their REM driven clone ('sell their souls') are blacklisted secretly, and they will never receive a high paying movie role, concert gig, advertisements etc. If you have ever wondered why so many talented people have not 'made it' –they refused to sell their souls, in other words, the use of their REM driven clones in exchange for promotions. This is how the entertainment industry really works. Another aspect of selling your soul, in other words, **selling your REM driven clone** is that you are also agreeing to sell your children, and your children's children etc.; your whole lineage to the Illuminati; for the Illuminati to use your unborn children for paedophilia, torture, sex sports and other grotesque and ungodly things when they sleep. It is a nasty business. **NEVER EVER** sell your soul.

The lesson is very important. NEVER EVER, 'sell your soul'; NEVER, EVER! You will experience the worst nightmare situation ever, and in this physical world, that is the use of your REM driven clone to be used for sex sports. You'll never have a decent night's sleep ever again, and you will always retain the full memory of your REM driven clone experiences; as well as, you will be selling your unborn children into this dirty business. Even when confronted with this as a joke: never sell your soul. Never Ever! The physical aspect you are confronted with when asked to 'sell your soul' is: "YOU", and everything which makes you, "you"; your ideas, your creativity, your privacy, your biology; everything which makes you, you. Never sell your soul, which in this life is currently the use of your REM driven clone! Never, ever! I hope that is well received.

Fake Alien Abductions conducted through REM Driven Cloning Technology

I must add they grow duplicate REM driven clones of people from all walks of life and then they transfer the persons consciousness to their REM driven clone version at the cloning centre while the person's REM driven duplicate clone is chained down to stainless steel corpse tables; or they pre-inject the REM driven duplicate clones with drugs before transferring the consciousness so that once the consciousness has been transferred, the REM driven clone cannot move. This is the point when they usually send people into the room dressed as aliens. It is a fake alien abduction. It's just these Illuminati people dressed in Hollywood quality accessories and they make the REM driven duplicate clones which have either been chained to the steel corpse tables or pre-injected with drugs, believe they are having an 'alien abduction'. Members of the Illuminati even dye chicken skin grey, and stretch it over a mask for realism and perform "experiments" on the immobile REM driven clones; the perverts anally probe them; they rape their limb bodies and do not suppress the victims memories; so these victims wake up thinking they have been abducted by aliens but in reality, they had their consciousness transferred to their duplicate clone versions when they entered REM sleep and they were violated. The victims do not know where to turn and naturally, they are embarrassed. Some victims even try and do install cameras all around their bedrooms in order to videotape themselves while they sleep; to prove they have been 'taken'; but to no avail they have not been taken; they have been cloned and had their consciousness transferred to their REM driven duplicate copies once they enter REM sleep by the most disgusting perverts in the world. The scum even videotape these 'abductions' to watch later as sick demented porn. These fake abductions are conducted by the Illuminati more often than you can imagine. They just keep doing it to random people over and over and over...

I am THE Spy for Humanity against the Corruption of the Illuminati

Over the years the Illuminati have offered me: a priceless katana (samurai sword); a rigged jackpot winning lottery ticket; REM driven clone slaves to keep me quiet, any of the prettiest women I've ever seen; any girl from high school; Vladimir Putin's daughter; even children; I do the right thing and spit in their REM driven clone faces; jam my fingers into their eyes but they have the technology to turn off the pain sensors of a REM driven clone, and therefore they have their pain receptors turned off as REM clones, while my pain receptors are fully on (sometimes even beyond the threshold of what is normal pain for a human). See the online articles: Science Daily (2014) and RT (2014) which discuss how pain receptors can be turned on and off in humans. Not much will hurt their REM driven clones other than getting dirt or vomit in a wound or bleeding too much. However, they have perfected the science and technology of REM driven cloning and therefore it only takes time and approximately $30 to grow new duplicate clone bodies. I started to smear excrement in their faces as a REM driven clone at the cloning centre in an attempt to deter them; I have **never** handled faeces in my original body, but I do this as a REM driven clone at the cloning centre, and even that does not deter them from their depraved ways. I composed a song which was later performed by "One Republic" referring to it called "All the Right Moves" ("All the right friends in all the right places... All the right moves in all the right faces"). I've made so many songs with MK Ultra technology (Rense 2001; Jim Cristea 2009; Berekley News 2011; Mind-Computer 2012 nature video 2013) and Mind-voice technology (New Scientist 2014; Prigg 2014) it is ridiculous. You see it is very easy to make music using Mind-voice technology; Flo-Rida used Mind-voice technology to produce the song "Whistle" when I first made my original disclosure (in 2011). The song is a taunt at me about my "whistle blowing disclosure" i.e. 'Can Donald blow the whistle? Etc. etc.' The thing is, anyone with a talent for music can make music much easier with the technologies which they have (MK ultra technology; Mind-voice technology); however, the Illuminati made more money from the music I composed, and so over the years, they just kept using me, over and over and over again, for rock, pop, rap, country etc. There are so many people involved in this REM driven cloning business, it is staggering; the organisation is vast. The only things the Illuminati fear are nuclear war; the new and improved lie detector tests and the general populace spreading my DISCLOSURE DOCUMENTS.

For those of you thinking Queen Elizabeth II looks like a kindly little old lady and you still cannot believe that all this is true, although I have provided plenty of evidence to the contrary as well as evidence of her saying "Drop the mother f***ing base" as a REM driven clone on a song track (RainmanJhof 2011); you could not be more wrong. She is the worst human being I have ever seen or heard of. It is so sad to see these REM driven women and children having their consciousness transferred to their REM driven clone duplicates and brought to the centre of the dirt rink, sitting there naked, afraid and crying and raped and beaten for sport, for the rich and famous. REM driven cloned women and children display the most range of emotions, and it is the saddest thing to see there. Therefore, of course I cannot bring myself to be a part of this despite any riches which the Illuminati offer me.

Over the 31 years when I was having my consciousness transferred to my REM driven clone at the cloning centre; Elizabeth, Vladimir and many, many Illuminati members and cloning centre attendees discussed many topics with me. These Illuminati people, such as Elizabeth and Vladimir, as well as many others confided in me because I had composed songs since I was 5 years old.

For readers struggling with the idea that a 5 year old can compose such wonderful songs at such a young age I will remind you that, it is easier to compose songs with technologies such as MK Ultra and Mind-voice technology. One is only limited by their imagination and creativity. Moreover, research talented children. I won't provide references of talented children here because I want to protect children from the Illuminati, and not have children exploited like I was; and for the readers who are parents; I am sure you know how talented, creative, and imaginative your children are.

Accordingly, since the age of 5, Elizabeth, Vladimir and many, others confided me in me because they thought I was special, and wanted me to hang with them; some of these Illuminati people, I had composed their favourite songs; I was also memory suppressed for many years so they thought it was harmless to tell me everything that exists or is possible. They were trying to impress me and amaze me, and therefore they showed me plenty of their technologies and what they had. They wanted me to me a willing, full Illuminati member; so over the years I feigned interest and pretended to like these Illuminati people, so that I could learn what they do and how they do it. I was looking for a way to block the consciousness transfer to a clone during REM sleep, or hoping they would reveal this part to me; but they did not, and I did not find a method to block the consciousness transfer. However, I bided my time, until I knew just about everything they do; so that I could reveal to the world everything they do; to give humanity a fighting chance against everything they do and as a consequence, I became a spy for humanity against the corruption of the Illuminati.

The Threat to Humanity when the H.A.A.R.P Grid is Complete

One of the most important topics which they discussed with me that I must add to this disclosure is HAARP technology and their plans for HAARP technology. I have discussed the basics of HAARP above. HAARP radio transmitters have to be placed at certain points across earth to complete a 'HAARP grid'. Once all the installations are completed over the earth HAARP will have more functions as a grid than the basics described. The Illuminati have told me, there is a possibility the HAARP grid will be capable of time travel, although there is a 50/50 chance using HAARP for time travel could destroy the earth. They also told me that once the HAARP installations are completed, the HAARP grid will be able to bend space and make the distance between, for example, Earth and Pluto approximately 1000 miles for a few seconds, and then the distance will go back to normal.

The Illuminati also said, once the HAARP grid is completed, they would be able to mind control people like never before without the use of RFID microchips or MK Ultra. Life on earth will be much worse once all the HAARP installations are up and working together in unison. The grid has to be complete though. HAARP cannot achieve time travel manipulation and mind control if it is just located in one or a few locations around the earth. There must be a certain number of HAARP installations around the world, in certain locations around the world; and the HAARP radio transmitters must be working in unison in order to achieve time travel manipulation and mind control of the populace of earth.

This is what they told me as REM driven clones at the cloning centre. This disclosure could be false, or a half truth. I do not know. However, it is very important that I add this to the disclosure because the Illuminati are working twice as fast to complete the HAARP grid to achieve their aim of mind control over the entire population since I the time I sent out my first disclosure (in **2011**). Whether or not they will achieve their aim of total mind control once all the HAARP installations are completed is NOT something we can afford to debate. They also told me that once the HAARP installations are completed; they will have the

capability to mind control anyone remotely like never before, at the push of a button. HAARP will also be capable of setting back time; which the Illuminati will use if they are ever in danger of being exposed. However, the Illuminati will remember the previous time, and the general populace will NOT remember the previous time, so that the Illuminati can correct the mistake(s) which led to their downfall. **Once the HAARP grid is completed, humanity will be slaves forever.** This is why we cannot afford to debate. Furthermore, from the book "Angels don't play this HAARP" (Begich & Manning 1997, p. 8), it is estimated that the HAARP grid will be completed by approximately 2017; others estimate by the year 2020. The important thing to note is that humanity does not have long, until the HAARP grid is completed.

I must also add the positive side of HAARP, because as I have said, there is nothing inherently evil about technology. Technology is just a tool; it depends on the person using it. HAARP used correctly, and in the hands of honest men and women, will tame the weather with no adverse effects. Therefore humanity is on a timeline and a deadline to bring the Illuminati to an end. **HAARP is one of the main reasons, this disclosure must spread, and spread fast.**

See below for possible HAARP locations around the earth (Rense 2011). The HAARP sites are located globally where the richest mineral belts are located. Sub-surface mineral exploration has been done from satellites by radio tomography that is 100% accurate.

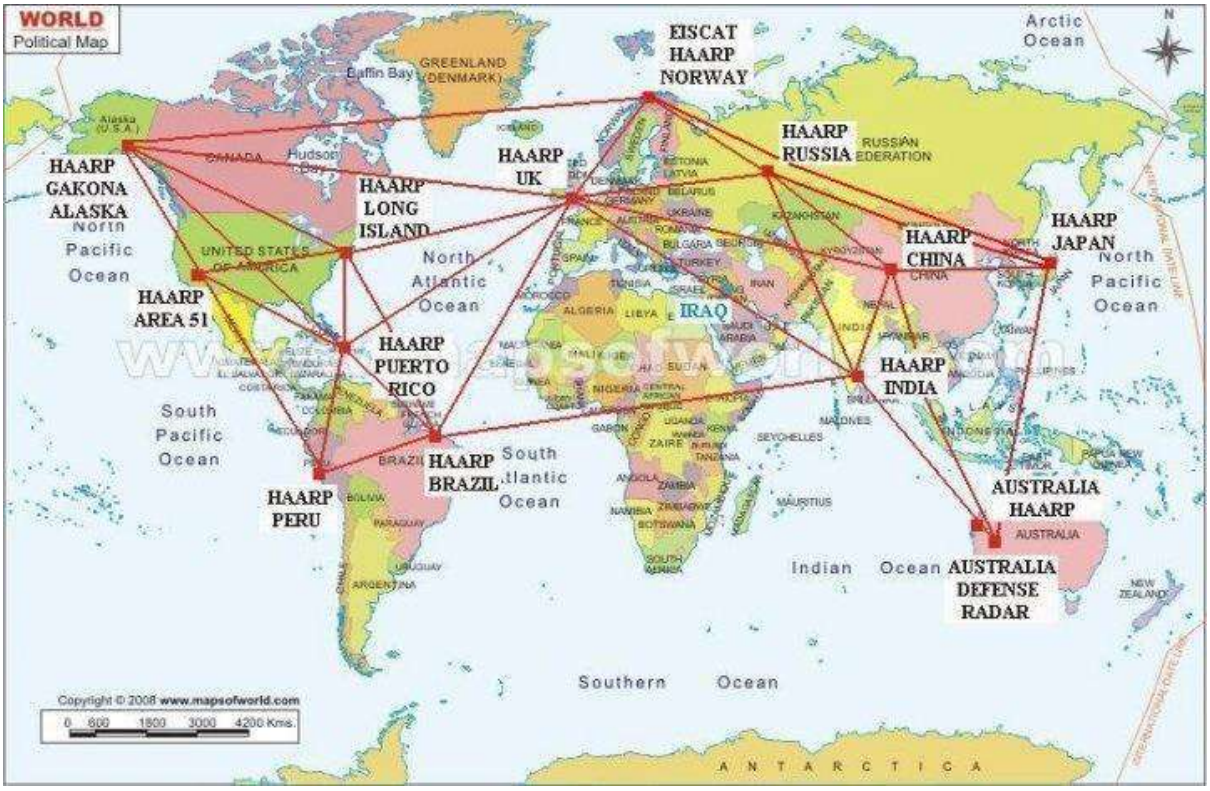

Image 8: Possible H.A.A.R.P. Locations. Source: Rense (2011)

REM Driven Cloning is the Most Terrible Nightmare Situation Ever

Furthermore, in terms of REM driven cloning; Fefe Dobson (singer) and Kurt Russell (actor) told me during my original disclosure (**2011**) specifically, to include in my disclosure that they do not like the cloning centre and they didn't torture me. Then they said not to mention them, but I will mention them again. Mila Kunis (actress) from "That 70s Show" stabbed in my REM driven clone body multiple times when I made my original disclosure and I was rendered immobile for saying that "She is a slimy scumbag for hanging with these people" and for also saying "She has enormous eyeballs and looks like a lemur". Mila Kunis (as a REM driven clone at the cloning centre) then begged me not to mention her (in my original disclosure, but I'll mention her again too) and then Mila Kunis said "She doesn't want to go to the clone zone anyway" and the Illuminati then deactivated her consciousness from her REM driven clone body, and she left. Her REM driven clone body went limp at the point where her consciousness was deactivated from it; her REM driven clone body looked 'dead', and she was gone. Some of the privileged people at the cloning centre are allowed **NOT** to have their consciousness transferred to their REM driven, clone duplicate versions (or they attend the cloning centre willingly when they want), but not me. I am an imprisoned slave in the worst nightmare situation. I told Nicole Leone (Madonna) also a REM driven clone at the cloning centre, that I was going to tell everyone that she coerced me to compose songs for her throughout my life (as REM driven clones). Nicole Leone (Madonna) told me VERY specifically to say in my disclosure here "She is not afraid!" and "No one will believe me and nothing will come of this". I beg you to help me prove her wrong.

Moreover, having your consciousness transferred to a REM driven clone alternative inhibits the person's ability to dream for that evening. Although your original body is immobile and asleep in your bed, when they transfer your consciousness you have actually 'woken up' as a REM driven clone version of you at a physical location here on earth; therefore you walk and talk as a clone version of you. You are not dreaming; you are just a REM driven clone for the evening. Furthermore, when the Illuminati restore your memories (as they have with me) or do not suppress the memory of your REM driven cloning experience for the evening (such as with the fake alien abductions), you will remember the experience as 'clear as daylight on a summer's day'; the experience is 'clear as a bell' as life is in your original body.

It is unlike dreaming, where dreams are fuzzy, incoherent and with random conjecture. The Illuminati know this as a fact, and therefore pre-inject the REM driven clones of random unsuspecting civilians for the evening with drugs before they transfer the person's consciousness. They tell the person who has had their consciousness transferred to their REM driven clone all sorts of nonsense: such as they are in the 5th Dimension; the astral plane; a singularity; the spiritual realm; Valhalla; quantum hopping etc. and all sorts of fallacies so that the person will not have a coherent picture of what has happened or what is happening. The truth is that person has had their consciousness transferred to their REM driven duplicate clone when they went to sleep and entered REM sleep; their original body still remains asleep in their bed; their consciousness however is now transferred to a clone duplicate alternative, and the person is 'awake', walking and talking as a cloned version of themselves in a physical location. The Illuminati allow some people to retain some of these REM driven clone experiences to affect their mental psyche.

The physical location where the populace will be able to verify these REM driven clones is somewhere within 5/6 hours drive, in a radius of the Robert Pickton farm, Port Coquitlam, British Columbia, in Canada, somewhere at a remote nature reserve. This is the cloning centre all the rich and famous attend because it is above ground and the rich and famous don't like the 'hospital smell' of underground cloning centres. The above ground cloning centre located in Canada is the cloning centre I have my consciousness transferred to when I sleep. It is guarded by military personnel. There are many cloning centres all over the world; as Phil Schneider (1995; 1996) disclosed as far back as the mid 1990s when he spoke: there were 1477 Deep Underground Military Bases (DUMBs) worldwide and 131 active DUMBs in the United States alone. Each DUMB costs on average 17 -19 billion U.S. dollars; paid for by the taxpayer; and it takes approximately a year-and-a-half to 2 years to build DUMBs with sophisticated methods. DUMBs contain cloning floors, and have an entire floor dedicated to human cloning, where duplicate clones are grown of unsuspecting civilians (remember they just need your blood / DNA); and unsuspecting civilians have their consciousness transferred to their REM driven clones at a physical location, which is usually these Deep Underground Military Bases when they sleep; unsuspecting civilians are memory suppressed, also to be used for gruesome torture and sex sports; as well as the plagiarism of talented individuals. Schneider gave the above statistics in the mid 1990s; chances are there are more DUMBS and cloning centres worldwide today.

Are you beginning to understand why this is the worst nightmare situation ever? Can you understand how: you, your friends, your family, your brothers, your sisters, aunties, uncles, children, work colleagues and anyone else you have contact with in your network, may be involved in this REM driven cloning business and will not even be fully aware of the situation or remember any experiences which they may have had once they wake up from sleep and they are back in their original bodies? I remember all of the REM driven clone experiences as clear as daylight because my memories are fully restored. Can you understand why the Illuminati must be stopped and stopped immediately? This REM driven clone business is vast, and it affects everyone, not just me.

This is why I mention that I am fortunate or unfortunate to remember all these experiences clearly depending on how you view it. I am unfortunate in the sense that I can recall all the depraved things these people do as REM driven cloned duplicates as clear as daylight and it affects my mental psyche. However, the fortunate part is: because I can recall all these experiences clearly, I can inform the world about the evil committed against humanity in a clear and logical way for the average reader to understand and verify, so that the populace can bring these people to justice for the crimes they have perpetrated against humanity and continue to inflict on humanity. For anyone who has had their intellectual property stolen by the Illuminati as a consequence of the technologies they have used on you unsuspectingly, you will be able to sue and regain monetary reward for the theft of intellectual property as well as invasion of your privacy.

I do not want to get too far ahead, because at this present moment, it is **very important** (I cannot say it enough) that this disclosure spreads (this is the stage we are currently at); it reaches the armed forces; to enable the armed forces to realise the crimes committed against humanity because of these people (the armed forces are kept 'out of the loop'; they just 'follow orders'); the armed forces will have to perform a military coup and bring this people to their knees. This is the point where the ordinary man / woman can have his REM driven cloning experiences restored, (that is if you want to) and sue / rightfully reclaim damages and legal reward for any crimes committed against him or her.

The Meek Shall Inherit the Earth

As you can see if everything goes smoothly; the meek shall inherit the earth. This is why you must maintain your composure and resolve, as I do every single day. You must not riot or cause chaos, damage property or undertake any act which will cause public dissension. The good people of this earth are about to inherit the earth; under no circumstance must you destroy anything. At the end of this currently dire and complicated situation; humanity will inherit the cure for HIV/AIDS, cancer, Alzheimer's, dementia, you name it –many debilitating diseases known to man; and other such wonderful technologies like hypersonic trains which run on magnets and are capable of doing Mach 5 (Mach 5 is the equivalent of 3806 miles per hour or 6125 kilometres per hour; Schneider (1995; 1996) also mentions the availability of Mach 5 trains in his disclosure, back in the 1990s). These trains can be used to deliver foods which are discarded in More Economically Developed Countries (MEDCs) to Less Economically Developed Countries (LEDCs) because these trains can travel thousands of miles within minutes. Yes. The Illuminati have all these wonderful technologies and more, but withhold it, and in turn withhold the progress of humanity. Yes. Plenty of man's problems can be solved when we address the root causes of our problems, and one of the root causes of humanity's problems is: REM driven human cloning which is currently in the hands of evil men. Even REM driven cloning can be used for the benefit of mankind when this tool is in the hands of righteous men. It can be used learn new skills in your sleep: such as gain extra qualifications; learn how to speak a new language; play instruments etc. –so long as memories are not suppressed, you will be able to perform the skills you learned as a REM clone in your original body when you wake up. As you see there is nothing wrong with most technologies; it all depends on the person / people using it. Nevertheless, although they may be beneficial uses to REM driven cloning not yet realised, we must be shut down REM cloning before we can even consider how REM driven cloning may benefit mankind, because at this present moment all that REM driven human cloning is used for is to commit evil, particularly against unsuspecting civilians.

It is OK to feel angry about all these crimes committed against humanity daily. But do not let these evil crimes rule you, in fact, let it motivate you; let it motivate you to the point where you will stand up and speak out to ensure that these crimes end. I think about the children and the future of the world every day; that is what motivates me and I view my situation as a God-given mission to bring these people to justice. I view things this way to maintain my sanity and composure. This is what keeps me going despite the extreme evil I experience, and it helps me to maintain my resolve and composure. The fact that I do not want a single child to grow up in a world, where they are being messed with in their sleep is what keeps me going despite this extreme evil. Some children are even kidnapped and brought to the cloning centre in their original bodies, again to be messed with. This is the root cause of why so many children go missing across the world. I'm sure any rational thinking human being feels the same way I do, and does not want their children, or any child to inherit a sick world governed by sick individuals.

I am a baptised Roman Catholic and a God fearing man. I believe there is a Creator of the universe but the Illuminati tell me there is no God, only science and technology. The Illuminati are also responsible for the death of the young beauty pageant girl Jean-Benet Ramsay; her parents are in this REM driven cloning business. Casey Anthony's daughter; as well as, Casey Anthony (before she died) AND Casey Anthony's parents also attend the cloning centre as REM driven clones. Many others; a man had his wife killed and this was mentioned on the news; it was an Asian woman whose rich husband had killed her; the

husband said the wife was responsible for their son's death. Elizabeth's response was that "Rich people in this organisation (The Illuminati) do not go to jail, they are covered for."

Stephen Spielberg and George Lucas are Illuminati members and they willing attend the cloning centre as REM driven clones when they sleep. George Lucas made other Illuminati members light my REM driven clone body on fire for the end of his movie *Star Wars Episode III: Revenge of the Sith* (2005).George Lucas said (as a REM driven clone) he wanted Hayden Christensen "To scream realistically". Hayden Christensen (also a REM driven clone at the cloning centre) watched me, and listened to my screams and groans of pain and copied the sounds coming from my burning REM driven clone exactly. Hayden Christensen knows he is a REM driven clone when he goes to sleep and Hayden Christensen knows his consciousness is transferred when he reaches REM sleep. Hayden Christensen knows all about REM driven human cloning, and he is a "privileged" Illuminati member. Natalie Portman also knows all there is to know about REM driven human cloning; as does approximately a quarter of the "Star Wars" cast. Many directors have attended the cloning centre as REM driven clones too, and have used me in a similar role playing situation; they have caused me to have excruciating pain as a REM driven clone, to see what kind of squeak or screech I will make, as if I were less than a dog; and when I am a bloody mess on the floor as a REM driven clone; that is when they usually crawl on my broken REM driven clone body and sodomize me saying something like "They love me and they cannot control themselves because I made all their favourite songs and I'm so "special"".

My ribs in my REM driven clone body will be broken, I will have suffered internal bleeding and will be crying or screaming, if I am able, but they just continue to sodomize me, and videotape such a depraved act of wickedness so that they can view it again like "evil pornography".

The REM driven cloned children, who have their consciousness transferred while they sleep at home in bed, in their original bodies, need a familiar face to talk to as REM clones or all they do is scream and cry at the cloning centre; that is where Joy Geizer comes in. Joy Geizer is married to my half brother from my father's first marriage; Joy Geizer is a REM driven clone girl guide leader, and when the Illuminati clone young girls, Joy Geizer speaks to these REM driven cloned girls; Joy Geizer keeps the REM driven cloned girls calm and "pimps" them out for free, knowing that these young girls will have their memories suppressed, and therefore they will not remember the experience and will not talk about it when they wake up. All the Geizers are in this REM driven, human cloning business; there are many people who remember these REM driven cloning experiences in their 'awake state' and in their original bodies who could be polygraph tested by independent polygraph testers. The police, and polygraph testers in my City of Halifax, Nova Scotia are compromised (they attend cloning centres as REM driven clones too); they cover up for child molesters and therefore cannot be trusted to fairly administer a polygraph test; as I said, commissionaires and C.S.I.S are heavily involved. All it would take is a few polygraph tests to prove these things unequivocally, because for those of you who have 'eyes', you can already see that REM driven cloning is real, and that this is actually the way of the world. I will take these polygraph tests publicly too, and demand that my mother and step father submit to them. They have told me, they **wouldn't** even attempt to lie on a polygraph.

Human cloning, particularly REM driven human cloning, is one of the absolute truths of this world; hidden from the world for over 70 years. My life and the freedoms of many, many people, including the reader (you) depend on this disclosure. The Illuminati say that the world finding out about REM driven human cloning will set the stage for the end of the world; people panicking and destroying property because of the evil these people have committed, but as I've said: prove them wrong, because we are going to inherit the earth, so there is no need to riot or cause public dissension. There will be no end of this world; just the end of the crazy Illuminati people. They always like to think and behave so negatively, don't they? *Sigh*. Furthermore, the whole talk about 2012; December 21st 2012 and the end of the world Mayan Prophecy; that was really about the world finding out REM driven human cloning, and the sick and sadistic nature it has been used for by these sick and sadistic people. Under no circumstance must you riot; you **must** prove you are better than these savage barbarians. I'll say it again, **because it is important**: we are going to inherit the earth, and therefore the smart and right thing to do, is not to destroy anything, especially the earth which you shall inherit.

Furthermore, I hope you are beginning to understand that the good people of this world must bring these people to justice and stop their wicked ways. I sincerely wrote this disclosure so that the good people of earth would be empowered to put a stop to their wicked ways. I wrote this disclosure to empower the good people of earth against tyranny and not so that the world would end. Therefore you must understand that the downfall of these Luciferians (Illuminati) must progress smoothly, because unless you have been to the cloning centre as a REM driven clone and retained the full memories of your experience, it is difficult to understand the level of depravity and sub human cruelty; it is beyond anything that has ever been heard of, and there is much more to tell.

Ignore this disclosure and you will condemn me to a horrible eventual death and you will encourage them that 'they are all 'powerful''. This is not an exaggeration. There is no need to exaggerate even President Barrack Obama is involved in the REM driven cloning business and attends the cloning centre as a REM driven clone version of himself, when he goes to sleep. He and his wife Michelle Obama attend these REM driven clone gatherings. Barrack Obama has even told me as a REM driven clone, at the cloning centre "Donny, we're all powerful. You are a slave and the people here [as REM driven clones at the cloning centre] won't speak up for you for fear of torture or death. Now make us a new song or we'll gut you like fish and leave you to writhe in agony!"

Be Wary of: Shills; Trolls; Disinformation Agents and Double Agents

There are many, many disinformation agents whose aim it is, is to denounce or debunk me. Be very wary of them. They DO NOT, and cannot debunk me, because after all, everything I have disclosed is truth. Although the truth concerns highly advanced concealed technologies, so it is a bit difficult to fathom at first, but keep reading, and you will realise that all which I have disclosed is true. Be very wary of the disinformation agents.

The most common thing these people say is that "Donald is a paranoid schizophrenic" –yet, ask them to detail the ins and outs of what a paranoid schizophrenic is and what specifically qualifies Donald to be a 'paranoid schizophrenic'; there is a high probability they will not be able to explain this to you, logically, sequentially and methodologically. Their main goal is just to make it as difficult for newcomers to understand what the real truth of this world is and as I have disclosed; and one of the root causes of man's problems is REM driven cloning.

Some disinformation agents are paid by the Illuminati, to behave this way, and are all too happy to echo empty statements (without any substantial evidence for their claims) because it provides them with a pay check. I will provide the following reference for the reader which discusses the signs and symptoms of a paranoid schizophrenic; all for the express intent for the reader to further understand paranoid schizophrenia. You can read more about paranoid schizophrenia on Medical News Today (2015). The link is provided in the reference section. You are welcome to read my Facebook wall and within days, you will realise I converse with others quite naturally. You can also ask individuals who have spoken to me through Skype or met me; but if this is not a viable option for you; all you have to do is read my Facebook wall and within days, you'll see that whoever makes such harsh and untrue remarks on my character is in fact a disinformation agent.

Furthermore, remember we live in a 3D **physical** world; and there is always a physical aspect to how something manifests. Therefore, when you hear others discussing concepts such as 'Tila Tequila demonstrated an 'energy ball' right on camera; Why didn't Donald discuss that?!' Please understand that these people are trying to deceive you with misinformation. There are also professional disinformation agents to be wary of. I do not perceive anything extra-ordinary in the world when I am awake in my original body beyond the five senses. I don't see orbs, auras or anything of the like. All I will ever discuss are practical things which have been unequivocally proven to me as fact; because in the situation the earth is currently in, I cannot afford to speculate.

Contact Information

My Facebook is: https://www.facebook.com/donald.marshall.148
You can also press Ctrl+Click (hold "Ctrl" on your keyboard and left "Click" with your mouse, on the image to your right).

I have a public wall on Facebook which starts from March 2012. In other words, all posts are made public since March 2012 and you do not have to join my friends list or subscribe me to see what I post (although you will have to have a Facebook account). I suggest that newcomers start reading from March 2012, and be patient, and read everything. You can read everything and learn the real truth of the world free of charge. I don't wish to write a book, I am not looking to turn a profit from this; I want to crush these guys and shut down the cloning centres!

It also worthwhile to add that: I am **not** asking for donations. I do not want **ANY** donations. Ever! These disclosures are far more important than any donations. This is **NOT** my job. I have a job. I am an independent contractor; carpentry is my trade and I earn a living this way. If you sincerely want to help; the best way to help is to spread and share my disclosures. That is all I ever ask for, so that eventually, the world knows about REM driven human cloning, and the armed forces can bring these people to their knees. **That is all I want; spread, spread, and spread this disclosure.** I will **never ever** ask for donations. Ever! Please keep this in mind, and anyone who asks for donations in my name or on my behalf should not be trusted. I, Donald Marshall, will **NEVER EVER** ask for any donations. I hope that is well received.

You can also view Proboards which has all my Facebook posts and have been archived by Celine O'Carroll and Astral 7ight by visiting:

http://donaldmarshall.proboards.com/
You can also press Ctrl+Click (hold "Ctrl" on your keyboard and left "Click" with your mouse, on the image to your right).

There is a search function on Proboards, and you can use this to search for and read all the disclosures I have made regarding REM driven clones, the people involved and more. I understand that it is human nature to want to know, which people have been to the cloning centre as REM driven clones; therefore, use the search function to read about any public figure which I have already covered that you have an inkling about. You can also post anonymously on Proboards and Celine and other Administrators will transfer your question onto Facebook which I'll answer.

Donald Marshall Revolution is a website which details a brief overview of the Illuminati.
http://donaldmarshallrevolution.com/
You can also press Ctrl+Click (hold "Ctrl" on your keyboard and left "Click" with your mouse, on the image to your right).

Interviews

You can listen to the radio interviews I have done. Listen for consistency; particularly anything which you do not hear me, pronounce clearly for the first time; the best thing to do is to pause the recording at that particular point and replay it. You should also research the statement you do not understand. Sometimes reading helps comprehension a lot faster.

One of the main reasons you should pause and replay the recordings is because: the truth has been kept hidden for so long that a lot of what I discuss in my interviews are beyond most people's current world view; so at some points I may speak too fast for you; my audio/ microphone may not be so clear so you may miss what I say etc.

A friend has told me that when he first watched the Vinny Eastwood interview; he did not hear me say the word "scars" (When Vinny asked: 'How do I know I'm the real me?') although he replayed that particular point in the video 8 times. Everything was just beyond his current comprehension, at the time. No matter how many times he replayed that part he really could not hear me say the word "scars" –so he let that part go, and played the rest of the interview, pausing, and replaying points which he did not understand, especially to comprehend whether I was talking about my original body or my REM driven clone duplicate body. He also listened to all my interviews for consistency, to note any 'slip ups', or any parts of my testimonies which do not 'add up'. He would listen to all my interviews, pausing and replaying parts he did not understand and he would reserve his judgements until he felt everything I was saying was for example as ordinary as: 'I woke up today, brushed my teeth, and took the dog for a walk'. He was also patient to realise the truth. After listening to my interviews he would just let it 'sink in'. A week later he would come back and listen to the same interviews, to test whether his comprehension on the topics I discuss has improved, and

whether he can understand what I am saying without having to pause and repeat at certain points in my interview; and soon enough he could now hear me say "scars" at that particular point of the Vinny Eastwood interview. He had reached the point where all topics I discuss sounded to him like I'm saying everyday common place stuff that people have heard, such as: 'I woke up today, brushed my teeth, and took the dog for a walk'. For anyone who may struggle to understand the topics I discuss: I strongly recommend you take the above approach as my friend did; soon enough, you too will realise the real truth of the world like he has: REM driven cloning, kept secret and used for sinister purposes.

I cannot say the following is true for everybody, however, an unproductive venture a complete newcomer can do is to listen to my interviews first time, all the way through, without pausing or replaying parts which they do not fully understand; If you do this and if there is just a single part of my interviews which does not make sense to you; this will interfere with your understanding of the entire interview. Remember, all I am discussing is technology, thousands of years advanced compared to what you currently use; available today, hidden and secret. If things start to get too complex for you, reduce it to its bare minimums: (advanced) science and technology. I hope that helps.

Another thing which I do in my interviews, that friends have picked up on, is: -because REM driven cloning has been my reality for many years; I don't differentiate between my original body and my REM driven clone body. I just say: I did this, I did that, and Elizabeth did this and that, therefore it can become very confusing for newcomers. Please bare with me; although I'm more emotional as a REM driven clone, and not as smart as I am in my original body (this is a side effect of cloning: REM driven clones are more emotional than normal, and dumber than they are in their original bodies) I'm still "me" when my consciousness is transferred; I have all the experiences and knowledge which makes me, "me" and therefore I naturally do not differentiate between my REM driven clone version, and my original body as an outsider discussing these concepts would. I understand it helps comprehension so I have painstakingly done this throughout this disclosure.

I hope this helps; and I hope this helps to better understand my disclosure as well as the interviews which I have done. On the next page you can find the links to my interviews. You can copy and paste the links to your web browser or press Ctrl+Click – (hold "Ctrl" on your keyboard and left "Click" with your mouse, on the images below) to direct you to the interviews.

Links to Donald Marshall Interviews

Vincent Eastwood

Copy and paste the link below to your web browser.
https://www.youtube.com/watch?v=M_1UiFeV5Jg&ab_channel=VincentEastwood
OR Press Ctrl+Click (on the image below) to follow the link.

Jeanice Barcelo

Copy and paste the link below to your web browser.
https://www.youtube.com/watch?v=3uzgu4ekT3c&ab_channel=JeaniceBarcelo
OR Press Ctrl+Click (on the image below) to follow the link.

Lisa Phillips (CFR)

Copy and paste the link below to your web browser.
https://www.youtube.com/watch?v=UonnFuHLJKc&ab_channel=Astral7ight
OR Press Ctrl+Click (on the image below) to follow the link.
Listen to parts 1 through 8.

Radio Presenters –Contact Donald Marshall

Anyone who sincerely wants to contact me for radio interviews on their show is welcome to do this. Please contact me through Proboards by leaving a message for me to contact you.

Professionals who understand "Consciousness Transfer" –Contact Donald Marshall

Any neuroscientists, engineers or professionals who understand how consciousness transfer works, and can provide me with a detailed methodology of how to block the consciousness transfer to my REM driven clone; please message me on Proboards, and this will be greatly appreciated.

Email

I currently do not have a contactable email address. In my original disclosure, the email address has been compromised (hacked), and so has any other email accounts I created: Yahoo, hotmail, Gmail, AOL etc. It doesn't matter; they eventually get hacked; for whatever reason, the Illuminati do not want me to have an email account.

How to Learn More about Donald Marshall's Whistle Blowing Disclosures

The best ways to learn about the truth of the world is through my Facebook page and Proboards. There is a mountain of evidence which has been collated over the years, and corroborates all that I have disclosed here. I also understand that for some people it is impractical to read three years worth of Facebook posts, especially when some post are repetitive; contain unnecessary comments from trolls, shills and other disinformation agents. Therefore, I am currently compiling 5 documents which should make it easier for others to read and understand everything quickly; as well as, for others to share and spread those 5 documents including this main disclosure document –so 6 documents about the real truth of the world. All for free!!

These documents include:

- "Frequently Asked Donald Marshall Questions" –This will contain all the general FAQs which I have been asked over the years; all in one place.
- "Experiences from the cloning centre" –This document will contain the full disclosure of my REM driven cloning experiences from the cloning centre when I go to sleep; all in chronological order.
- "List of people to avoid" This will contain a whole list of trolls, shills, and disinformation agents and double agents in alphabetical order, to avoid at all costs, in real life and online; -all complied in one place; and the reasons why they should be avoided.
- "Public Figures and their relationship with Donald Marshall as REM driven clones" – this will be a complete list of every public figure I have ever come into contact with as a REM driven clone; and you will be able to read about all the public figures I have met as REM clones, as well as the experiences, all in one place.
- "The subterranean underground colonists: The Vril" –this will be everything about the biological parasites the Illuminati harbour. Yes. The Illuminati harbour biological parasites, which they use against unsuspecting humans. I told you the Illuminati were

the biggest depraved perverts ever to grace God's earth. REM driven human cloning, kept secret from the world for over 70 years is difficult to fathom as it is, as are these biological parasites. These parasites are also one of the main root causes of humanity's problems here on earth, and must be rendered extinct. In this document you will be able to learn everything about their, strengths, weaknesses, psychology, biology, ecology, sexuality and arm yourself with knowledge which ensures that humanity exterminates these parasites from our earth, forever. The secret of Vril; a secret no more!

I hope after reading my eye witness statements presented in this document that you have now began to understand that this is simply what is happening in our world today.

Heed my disclosure, very diligently. At the start of my disclosure I asked the reader to do two things:

1) Give me the benefit of the doubt –because there is nothing worse than being a victim of abuse, reporting it and the people who have the power to stop it, ignore you;
2) Set out on a genuine quest to debunk my disclosure. I understand that for some people, plenty of what I have disclosed will still sound 'too out there' beyond their current scope of reality to be believable. For such people, the honest thing to do is to start with the first topic which you do not fully understand and explore it, either by finding that corresponding topic on Proboards (Donald Marshall Proboards 2015), and continuing your research from there; or just Google any topic you currently do not understand and review the topic on websites such as New Scientist (2015), Gizmag (2015), Motherboard (2015), BBC News (2015a; 2015b), BBC Future (2015), The Guardian (2015a; 2015b) The Independent (2015a; 2015b), Daily Mail Online (2015) and start reading more articles in the Science and Technology columns because these people have been telling you what they have been doing for decades. Consequently, keep in mind that articles which discuss 'future' technologies and 'improvements' in medicine or science, are articles, which are **really** discussing present technologies, and achievements in science and medicine already realised; because most of these achievements have been realised decades ago. It just hasn't been fully disclosed publicly.

I have also saved and backed-up every reference (except the homepages of the websites referenced) in this document; therefore if a link or video is ever deleted let me know.

How Much Do You Know About Post-humanism / Trans-humanism?

Furthermore, you have to be honest here: because if you do not know much or anything about post-humanism / trans-humanism then I am afraid to say, -and this is no fault of yours – that you are behind in this the world; simply because these Illuminati people are Post-humanists; and that is the direction the want the rest of the world to go. They want the world to reach a destination where human cloning is common place; a world where downloading your mind / entire life experience onto a computer microchip and living on as a cloned version of you with the microchip running the consciousness to be common place; and these Illuminati Post-humanists want the world to head in a direction where it is commonplace to molest children through science and technology. No. This really is not Science-Fiction, this is the world we live in today; this is why such marvels in science, medicine and technology has been withheld from the general public and kept hidden by an 'elite' group of people because if these people

honestly came forward, and said “We have invented this technology and we want to use it for this “negative” purpose” –the populace would not accept it, and these people will be lynched in the streets before lunchtime. Therefore, through concealed advancements in medicine, science and technology, the Illuminati can live out their inner depraved cravings and commit crimes against humanity and the world, for which most people will be too blind to see or even fathom, because the hidden science and technology is beyond the average person’s current comprehension.

Therefore, please attain an education in post-humanism / trans-humanism because these Illuminati people believe they can rival creation, nature and the marvels of the universe through science, medicine and technology. The Illuminati go **against** creation; they go **against** nature; and they go **against** humans. They don’t consider themselves humans. They consider themselves post-humans and believe they can become “gods” through advancements in medicine, science and technology. See LawOfIdentity (2014) and Mark Dice (2014) for Richard Seed’s comments on ‘becoming gods’ through transhumanism. Richard Seed is a Physicist with a Ph.D. from Harvard University; he is well known in the controversial cloning debate and declares his aspirations to "become god" saying 'We are going to become Gods, period. If you don't like it, get off. You don't have to contribute, you don't have to participate, but if you are going to interfere with me becoming a God, you're going to have trouble. There'll be warfare.' If you value humanity, do your best to attain an education in the trend of post-humanism / trans-humanism; otherwise the future of mankind will be bleak. We must do everything we can to stop these people.

This is of uttermost importance. REM driven cloning of is the most terrible thing in the world, especially when it involves unsuspecting civilians, and worst of all, innocent children. If you choose NOT to do anything you allow the Illuminati to continue to clone your children, sisters, wives, and sons. You allow the Illuminati to continue to hijack the minds of your children, sisters, wives, and sons while they sleep, through concealed advancements in science and technology. You allow the Illuminati to transfer the consciousness of your children, sisters, wives and sons to their REM driven duplicate clone versions while they sleep, whereby the Illuminati molest your children, sisters, wives and sons, which will cause them to have learning disabilities, unexplained depression and suicidal thoughts, as well as all kinds of side effects.

This IS your ONLY chance to end these monsters. There is a deadline!

This is your **ONLY** chance to do something to end these monsters. We are on a timeline and there is a deadline. As I have already mentioned, as well as, the top scientists in the field of physics and geophysics have mentioned: HAARP is not only capable of controlling the weather; once the HAARP grid is completed and working at full power, it will be capable of mind control over entire populations. We will all be slaves to the Illuminati FOREVER. Our freewill will be gone forever. Furthermore, if they achieve their aim of time travel with HAARP technology, future generations of humanity will never be able to stop them, because as they have told me: ‘They will always be able to go back to a previous time, and correct the mistake(s) which led to their downfall’. This is the Illuminati’s end game and what they wish to achieve. This is why this disclosure is so heavy, and so important. It goes beyond REM driven cloning; although it is important the world understands REM driven cloning. The future of humanity is at stake; and because of the 2-5 year deadline until the HAARP grid is completed, it is time humanity stood up and brought an end to the Illuminati. This REALLY is your ONLY chance to end these monsters!

The only way for evil to triumph is for good people to do nothing.
Edmund Burke

Remember for every 12 months which passes military / concealed technology outstrips the technology the general public is accustomed to by 44 years (Schneider 1995; 1996). Close your eyes and think 44 years into the future. The year is 2059. What kind of technologies do you expect mankind to have? Do it for real; don't just read the words. Close your eyes and imagine. The year is 2059. What kind of technologies does mankind have? You see. It is 'out of this world' technology, right. This is exactly what is going on today in the year 2015. It's just that it is hidden. That's all. Not so difficult to fathom now.

Do NOT Be Afraid to Help. We Outnumber the Illuminati by 1,000,000:1

Don't be afraid to help. These people are easily defeated when good people stand together as one. These Illuminati people total no more than 10,000 people. 10,000 people against 7,000,000,000 (7 billion) people –that's less than 0.000001 % of the world's population. Now can you begin to understand how prevalent evil can be when a small organised group of individuals, as little as 10,000 of the world's most evil and tyrannical people all work together in unison to exert their influence over the world? The world does not have to be this way. We outnumber the Illuminati people by a 1,000,000 to 1. For every Illuminati person there is, there are **one million** people who are not Illuminati, therefore do not to be afraid to help; all you will be doing is helping humanity rid itself of its sickness. So please feel free to share and spread my disclosure far and wide.

For those of you whom this applies to: remember the Illuminati (and I know it sounds ridiculous despite the evil they do) are deeply religious. They believe anyone aiding me is part of the "Army of Light" prophesised by Nostradamus; and to harm or degrade the life of anyone assisting me will bring them to their ultimate end and they will incur the wrath of God; they will suffer utter ruin and demise in their lives if they are to hurt you; they are very scared of people who can see through the lies and deceptions they have inflicted on the world. So please, stay calm, do not stress your heart, and know that **you are safe**, and **they cannot hurt you**. You can feel safe in the knowledge that you can do the right thing by helping me. They told me this as REM driven clones on the night of 21st of February 2014 when I went to sleep. The above is exactly what they said.

For anyone interested in understanding the interpretations of the Nostradamus Prophecies, Crystal Links (2015) provides a good source for all 942 of the quatrains. Delores Cannon is also an author who has written three volumes called "Conversations with Nostradamus" and for anyone interested you can read these online (Galactic 2012a; Galactic 2012b) as well as watch her YouTube videos (CreativeForceVideo 2014; Disclose TruthTV 2015).

Yes. This is the state of the world today: a deception within a deception coated in reverse psychology; and fact is indeed stranger than fiction. Now after everything I have said, if you are still sceptical and 'in-between' on this issue then the best thing for you to do is to pay attention to your dreams; or lack of dreams –they are your own experiences and you cannot deny your experiences.

In other words, you may be having REM driven cloned experiences too; for some people they have a 'dream', where they are in the same environment, over and over and over again; or the theme being discussed in their 'dreams' is the same over and over and over again; or the environment their 'dreams' take place always appear to happen in the same 3 or 4 environments over and over again –no matter what the theme is. In each scenario there is a likely probability that these are not just dreams, and in fact these people have had their consciousness transferred to the REM driven clone duplicates and the Illuminati is trying to extract something from them, once that is done they implant a false memory (See Kim (2013) and Alford (2015) for discussions on how false memories are implanted) so you wake up with the feeling of remembering something, but in actuality it is false; or you wake up with no memory of dreams from the previous evening, which means there is a high probability that you had your memories suppressed when your consciousness was transferred to your REM driven clone. This is why I say you can be sceptical about everything I have said (for now), but pay attention to your dreams, or lack of dreams, they are your own experiences, and you cannot deny your own experiences.

Noteworthy Frequently Asked Question

A Frequently Asked Question I receive, which is worth a mentioning here, is as follows: **Q:** Donald, if everything you have said is true...; in other words human clones walk among us now in a multilayered conspiracy which reaches the highest levels of government; armed with this knowledge what does one do exactly? What happens now, Donald? You obviously want to spread the word and make people aware but to what end?

DM: In short: I want to bring a complete end to the Illuminati and usher in a "Golden Age" of mankind. This question is best answered by detailing my 'Mission and Vision' for ending the Illuminati completely.

Donald Marshall's Mission and Vision on How to Bring Down The Illuminati

- This disclosure must spread, and **spread FAST and FAR!**
- If you now understand everything I have disclosed in this document as truth, then do not waste any more time. Share this disclosure with your wives, husbands, brothers, sisters' aunties, uncles, friends, co-workers, and children. We all have a part to play in saving the world from a premature doom.
- Call friends who have not heard from you in a while and tell them you have important news to share. Share this document. Share it on social media such as Facebook; Twitter; Instagram; Dropbox; Slideshare etc.
- Keep sharing this document until it comes to the attention of the Armed Forces. The Armed Forces will have to intervene. Once the Armed Forces intervene we will have reached the middle stage of this vision and will be witnessing a complete end to the Illuminati. Until then, we're in the beginning stages, so please; spread this document faster and further. The quicker it is spread; the quicker the Illuminati are ended.
- Once the Armed Forces have intervened a Military coup can be orchestrated against these vile people.
- Cloning centres can then be shut down once these people are overthrown.

- The freeing of any missing people (children; teens; adults) trapped in the cloning centres can commence (once the Armed Forces intervene).
- HAARP (as well as other highly advanced technologies) can now be contained and not used for adverse effects against the world (once the world learns of this disclosure).
- These Illuminati people will then HAVE to appear in court for their crimes against humanity.
- Suing the Illuminati members in court (once court proceedings commence... we will be past the midpoint of my vision, and closer towards witnessing a complete end to the Illuminati).
- The populace (and it will be your choice) can then have their REM driven clone experiences restored and also sue and claim any legal reward / compensation.
- After the populace has sued the Illuminati for their crimes against humanity; the punishments can commence.
- Punishments will include: imprisonment and executions of these sick and malevolent people. The imprisonment and executions of evil Illuminati members will bring an end to the Illuminati.
- After the punishments and executions; Governments worldwide can now be replaced with incorrupt individuals, worldwide.
- The structure of Governance will also have to change. The reason for this because future generations will always be able to check their leaders and governance more appropriately; so that the depraved and subhuman acts I described can NEVER be committed against humanity again; nor will world leaders be capable of committing such monstrous crimes in such secrecy ever again.
- Ensuring that the laws of the land always progresses in line with advancements in medicine, science and technology; as well as, ensuring law progresses in the directions of Research and Development (R&D) regarding future technologies, science and medicine.
- Release of technologies, science and medicine which benefit mankind.
- Commence a “Golden Age” of mankind.

If you do not fight the corruption and you do not stand up for what is right in life, you end up being a serf and a slave and you are leaving your children a world in which you would not want to live in yourself, so how can you in decency behave that way? You have to stand up for what is right in life, and unless you do that you are nothing.

Aaron Russo

Empowerment by Virtue of Golden Truth

As you can see, despite all the horror of the world I currently present: if everything goes smoothly, the good people of this world, truly will inherit it. This is why despite any anger, sadness, or fears you may have; you must not riot, damage property or cause chaos or bring about any other form of public dissension. You cannot stay silent, or ignore the issue in the hope that the threat removes itself. You are called to act; you must take action to help bring the Illuminati to an end; you must act while at the same time, you must maintain your composure and resolve to ensure that the whole procedure goes smoothly, and we all inherit a world we want to live in.

Your life, **at this very moment**, is more important than you may have probably ever imagined. You have purpose. Through you, and other good people around the world, together we can bring an end to such unspeakable forms of tyranny in this world. It is my humble stance that you have now become truly empowered with golden truth and you are now compelled to bring this tyranny to an end.

Do not waste the knowledge you have obtained from this disclosure. It is my only hope to escape this man made living hell. It is my only hope, as well as, the hope of many REM clones imprisoned there, as well as, real people who go missing daily, and are trapped in the cloning centres.

We sincerely beg you.

Donald Marshall

Appendices

Appendix A: Thien Thanh Thi Nguyen (Tila Tequila) Transcript

Link: https://www.youtube.com/watch?v=7mRZ7ItF9ls&ab_channel=Astral7ight

00.00 – 1.10 min: You know what... since you f****** with my program darling Queen Elizabeth [II] and the paedophilia ring and the cloning centres, and the cloning centres. That's right darling the cloning centres. Parents listen to me right now, they are blocking me but that is quite alright. They are blocking me but that is quite alright. Because I have many, many other forces; I shall not say their names right now, but I have many big plans to expose all of you disgusting, sadistic f***s! Okay? That is all. I shall save that for another time. But, however, I shall REPEAT: that was just an introduction to the reptilian family, leading all the way back. They call themselves the "The Black Nobility". Now that is just one part of it; alright?

1.11 -2.47 min: The Black Nobility; the reptilian family; all the way back from ancient times; so which they think... they feel like they are the divine chosen ones... from whom may I ask? Definitely. Definitely not God. Our creator of the world. Reptilians: they feed on blood; children; the paedophilia ring; recently busted. Oh! It has been going on for centuries. Parents listen to me carefully. I don't care if I'm cutting out. I will continue this and I am not alone on this battle. Believe THAT! Believe THAT! I am not alone on this battle. I started out alone but I am marching on with MILLIONS; okay? So sit your old a** down okay. Because you are gonna roll over, but it doesn't matter anyway because you are all ancestral f***s! Who interbreed... ancestral f*****g... and then... and then... Oh! Only going to talk about cloning those children and... oh! And all those many children's parents listen to me carefully.

2.48 -4.24 min: Hundreds of missing children come up every year. You wonder... why? How? How could this be? And then there is so called CPS [Child Protection Services] or whatever they are called; they come and take your children, just, just for nothing; right? Not to discredit everybody, because not everybody is bad. I'm talking about the bad people. And they take your kids... they take them as this... they treat them like... I can't even say the word. It's disgusting, it's sadistic. They... they... they take your kids... they toss them out like little [inaudible] cause they are so f*****g... Pardon my French, but then again when I'm dealing with these evil cum-buckets I have no holy words coming out of my mouth, because these are the only words they resonate to. So therefore that's how I refer to them. Because they can only [inaudible] ...their masters whiplash on them with these [inaudible] words of cursing, vileness and slaving and that is not what the true God is; okay? The God of Hell...; Anyways...

4.25 – 5.30 min: There are these CLONING CENTRES where they take your children and do sadistic things to them. I'm not even talking about child molestation here; not to mention; uh there is one of them that got caught, flying out to Florida; to meet up with a four year old little girl, to have sex with a four year old girl. That's right. Google it because it is so highly sinful... We have commercials about... you know starving kids; you know save the starving kids and it is heartbreaking. We can have commercials about it... why? Because it is a horrible thing and people can have commercials about it. WHY do we not have commercials about... 'Daddy please don't, don't. Mommy please don't let daddy let daddy touch me?' – because it is disgusting! It is so disgusting; beyond sin that no one, NO ONE, can even make a commercial about that because that's how sinful it is.

5.31 – 7.19 min: Do you understand that? Do you understand how sinful that is? These people, I'm not even going to call them people; alright? They take your children; they not only molest them; men f*** them and make them shoot each other. They give them guns. It's either you shoot him or I'm gonna shoot you. They are... mind you, they are children. Children. Yes. I'm speaking out, because I... uh! Who else is doing this? You're all just [inaudible]... shame on you... And actually the most recent paedophilia... got taken down... WOW! How long did that take? Really?! Do you know how long this has been going on? *Sigh* Alright I'm gonna calm down... but as a parent and I love parents out there. My heart goes out to all the parents out there who have missing children. You know, we all pray for them; every day. And I put on a bold face in public every day; because there needs to be someone strong, believe that. But my strength comes from somewhere... that I have a very vulnerable emotional side where I feel very strongly for these children and innocent people. So therefore I want to speak out.

7.20 – 9.10 min: I have and I have my passion too; and in the end you shall all know why I am so passionate about exposing every single one of these scumbags; okay? The truth shall prevail and you all will know why. So, as for you parents... ah... there are no words to describe. But let me just expose because you can't just... there is a point where you CANNOT just turn the other way. You know this stuff is going on; and you go 'Oh well... that's their problem. Let's just turn the other cheek.' How long are you going to turn the other cheek, until it happens to your own freaking children? When, when, when your own child; three years old, get's run out [kidnapped] and gets blasted right in the head with a gun... yeah... there's more to that people; okay? And I'm not just saying that coming from some... I mean, actually, mothers, fathers out there... If you found out... I'm sure you would do way worse than what I am just saying. I'm just using voc. I'm just annihilating them vocally. I'm sure the parents out there who find out what their children have gone through, their missing children. I am pretty positive more than just a vocal annihilation of these scumbags that do this to your children; okay?

9.11 – 10.32 min: So keep on turning the other cheek folks. Hey, go and turn the other cheek; you are with the others. I am not. I AM NOT. Like I said you... There is only two ways to go about this: you're either with us: the good guys, or you're with the others. There is no in-between. Cause if you are in-between, hiding like cowards, turning the other cheek; doing whatever; well then you are a freaking coward and you are just a sheep. And sheep end up dying because you know what you are owned by "The Others". So pick one: you're either one of us: the good guys or you're part of the others. That is simple as that! Two choices: good guys; bad guys. In-between you're dead because the bad guys are going to suck your soul out [transfer your consciousness to your REM driven clone] and do some sadistic stuff to you and watch, and make you watch while they pretty sadistic stuff to your children as well.

10.33 – 11.33 min: Do you know why they love children? Because they are innocent souls; they're innocent... they're, they're the most innocent pure beings in this planet. They're not harmed by anything. They're new to the world; bright-eyed pure innocent children. That is why these disgusting paedophile and these clone rings; cloning centres; satanic rituals; Brownsville Texas... There are many other cloning centres where they take your children that go missing. And you wonder why? What happens to them? I'm sorry to break this to you but that is what happens. Now either do you want to know what happens to them or do you want to turn the other freaking cheek?

11.34 – 13.09 min: Tune into my next show. I'm gonna upload stuff; I have an arsenal ready to blow up! Okay. And I have reason behind this. You all should know my personal reason soon; but this has nothing to do with me right now. But know that I'm back, I'm back with a vengeance and I'm back with an army full of people around the world who are sick and tired of treated like animals; or quote, unquote "COWS". We all know what that means. For the outside world (the masses) we all know the term "sheep", sheeple. But for the insiders we know what the cows are don't we? You know what "The Others" like to do with the cows, right? They start to herd you in... and to... yeah...I'm gonna end it at that. And to all the parents, families and children out there, I love you so much. I... have to maintain composure, because that is what I do. That is all. Over and out.

Appendix B: MK Ultra

MK Ultra *-noun:* [Manufacturing Killers Utilizing Lethal Tradecraft Requiring Assassinations] The goal of mind control, using MK Ultra technology is to program an individual to carry out any task against their will and self-preservation instinct, and to control the absolute behaviour and thought patterns of the individual.

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Modern-day MK Ultra involves an implantable microchip which is inserted into a Mark 2 clone of the victim. Every thought, reaction, hearing and visual observation causes a certain neurological potential, spikes, and patterns in the brain and its electromagnetic fields, which can now be decoded by the implantable microchip into thoughts, pictures and voices. The thoughts, pictures and voices of the implanted Mark 2 clone (victim) can now be displayed visually and heard on any system capable of converting visual images, such as a television or a computer. These images are usually displayed on a giant screen at the cloning centre.

The purpose of MK Ultra is to elicit a specific conditioned response in a victim (desired by the programmer) to an otherwise neutral stimulus. In other words, through the process of "classical conditioning" (which involves learning a new behaviour via the process of association. In simple terms two stimuli are linked together to produce a new learned response in a person) the implanted Mark 2 REM duplicate clone (victim) is placed thorough many similar recurring scenarios which are experienced (or perceived) by the victim as "real", because the programmer manipulates the victim's audio and visual field, and continuously pairs the victim with the neutral stimulus, so that either a positive or negative conditioned response is elicited in the victim towards the neutral stimulus.

In other words an implanted victim can be placed in many recurring situations deemed as frightful, where a mystery stranger saves the victim from the frightful situation over and over again. The victim will now have positive associations towards the mystery stranger and therefore the conditioned response is now one of 'positive associations' (towards the mystery stranger who did not elicit such a reaction before).

MK Ultra techniques are administered through Mark 2 (sleep driven) clones. In other words classical conditioning happens when the person sleeps. Memory suppression technologies are also used in conjunction with MK Ultra technology, which enables the programmer to control certain memories the victim remembers. The use of memory suppression technologies and MK Ultra technology allows the programmer to reinforce behaviour and elicit specific conditioned responses (in an original).

Therefore, in our example above, when the original meets the mystery stranger in real life, the original (victim) will be predisposed to the mystery stranger and automatically 'feel safe' around this person and may even believe that he / she should 'date this mystery stranger' – depending on what was programmed; because the victim was conditioned to elicit such an emotional response towards the mystery stranger in his / her sleep as a Mark 2 REM driven clone through MK Ultra functionality.

MK Ultra can also be used to create zombified individuals who are programmed to murder and remember nothing of their crime afterward. MK Ultra (technology) can also be used to disrupt the memory of the original, discredit people through unusual behaviour, make the person insane or commit suicide and murder.

MK Ultra has much functionality. Furthermore, because of its video and audio projection functionality, MK Ultra can also be used to compose music. MK Ultra is capable of relaying the Mark 2 REM driven clone's subconscious and conscious mind as visual images and audio, projected onto a screen. Therefore thoughts, pictures and voices which have been experienced consciously and subconsciously in one's life can be displayed visually and audibly on a television or computer screen. The Mark 2 clone now has the option of harmonising these thoughts, pictures, and voices into a coherent order which produces music through the thought process of his or her imagination. See Jim Cristea (2009); Berkeley News (2011); UC Berkeley Campus Life (2011) CTForecaster (2013); nature video (2013) and Stromberg (2013) for examples and discussions and the capability of MK Ultra technology.

Appendix C: The Illuminati

Illuminati –*noun:* A modern-day criminal organisation operated by reprobate (depraved, unprincipled and wicked person) criminals. Their main agenda: is to enslave the whole world through advanced concealed technologies.

Today's Illuminati trace their roots back to Professor Adam Weishaupt who found the Illuminati on 1st May 1776. Since the inception of the Illuminati the intent has always been, and remains: "to bring about a NEW World Order that writes God out of the picture and deifies (glorifies) Lucifer." This intent is still prevalent today. The following excerpt is derived from A. Ralph Epperson (1990) *The New World Order:*

> Weishaupt was a teacher of Cannon Law (law governing the affairs of a Christian Church, especially the law created or recognised by the Papal authority in the Roman Catholic Church) at the University of Ingolstadt in Bavaria, now part of Germany.
>
> He even told the world, in his writings, where he would conceal the Order: "None is fitter than the three lower degrees of Free Masonry; the public is accustomed to it, expects little from it, and therefore takes little notice of it." He felt that this secrecy would lead him to success because he felt no one would be able to break into it. He wrote: "Our secret Association works in a way that nothing can withstand ...."
>
> Weishaupt accepted the fact that all secret associations and secret orders had two doctrines, one concealed and reserved for the Masters... the other public ...." and the Illuminati was [and are to this day] a secret society with two doctrines.
>
> Professor Weishaupt, its founder, boasted of his organization's secrecy. He realized that this secrecy would enable them to decide the fate of nations and because their deliberations were secret, no outsider could interfere. He wrote: "The great strength of our Order lies in its concealment; let it never appear in its own name, but always covered by another name, and another occupation." Weishaupt later wrote about that secrecy in a letter to a fellow member of the Illuminati: "Nothing can bring this about [the new world order] but hidden societies. Hidden schools of wisdom are the means which will one day free men from their bonds [the "bonds" of religion] Princes and nations shall vanish from the earth." So the secret societies were created to bring the world to the new society known as the New World Order. The members of these organizations obviously feel that their goals are so noble that they may perform whatever tasks are required of them to bring that goal to fruition. This means that murder, plunder, and lying all become acceptable as long as these methods assist its members in obtaining their goal.
>
> Adam Weishaupt, the founder of the Illuminati, wrote over and over and over again, that "the ends justified the means." Weishaupt also told initiates to use whatever means, which included murder, to achieve the goals of the association that he was joining. And that the major goal of the Illuminati, was the destruction of all religion, including Christianity. That meant that if Christians physically stood in the way, they could be removed by simply murdering them. Weishaupt even went so far as to say that anyone not willing to take the life of another was unfit to join the Illuminati. He wrote the following in a letter to a fellow member in 1778: "No man is fit for our Order who is not ... ready to go to every length ...."
>
> Another reason, that Weishaupt felt that the Illuminati would succeed, was the fact that he was offering his members worldwide power. He felt that this inducement would enable him to draw into his organization only those who would do anything to satisfy that desire for power. He wrote: "The true purpose of the Order was to rule the world. To achieve this it was necessary for the Order to destroy all religions, overthrow all governments and abolish private property."

> But his religion had a different base than the traditional religion: his was based upon a worship of reason: "... then will Reason rule with unperceived sway." "... Reason will be the only code of Man. This is one of our greatest secrets." "When at last Reason becomes the religion of man, then will the problem be solved." Weishaupt's dedication of his organization to "reason" makes some sense when the reader recalls that "reason" has been defined as the "unbridled use of man's mind to solve man's problems without the involvement of God." The Bible calls this "the fruit of the tree of the knowledge of good and evil." It was this knowledge that God wanted man not to have, and it was the promise made to man by Lucifer that man could have it by eating of "the fruit." In addition, Weishaupt's religion offered its believers a reward not offered by any other religion: worldwide power!
>
> Weishaupt wrote: "The pupils [members of the Illuminati] are convinced that the Order will rule the world. Every member therefore becomes a ruler." Weishaupt's religion not only offered power to his believers, but he offered them something else not guaranteed by any other religion: worldly success. He said that once a candidate had achieved the exalted degree of Illuminatus Minor, the fourth of the thirteen inside his Order, his superiors would: "assist him [the member] in bringing his talents into action, and [would] place him in situations most favourable for their exertion, so that he may be assured of success." Finally, the goal of the Illuminati was "man made perfect as a god - without God."

The ideology of "man made perfect as a god –without God" still remains to this day, and it is practiced by today's Illuminati members. The above phrase is what ties in Luciferian worship and trans-humanism. Lucifer is idolised by Illuminati members as the deity who gave man 'knowledge' and therefore is worthy of worship; God, -according to Luciferians, -did not want man to have knowledge and therefore is despised by Luciferians. Ingrained in the trans-humanism doctrine is the believe that: 'man can become 'god' through science and technology and in turn overthrow the Creator of the universe: God'. See LawOfIdentity (2014) and Mark Dice (2014).

These are the basics of Luciferianism. Therefore everything which is natural or pertains to nature must be contended or destroyed by Luciferians. This is why Illuminati members endorse having sex with children, killing first born sons, and drink blood. All the above go against nature and according to the 'edicts of Lucifer': paedophilia makes the person committing the act younger (it doesn't, it is just an excuse to act perverse on children because they know children are vulnerable); killing your first born son gives you good luck and fortune in this life (so yes, some Luciferians have sacrificed their first bon sons); and Illuminati members believe drinking blood / cannibalism is a 'purifying agent' (although in reality it causes spongiform encephalitis (holes in the brain)).

Modern-day Illuminati members still retain the goal of its founder "to bring about a NEW World Order that writes God out of the picture and deifies (glorifies) Lucifer." Infiltration through secrecy, still remains their mode of operation, for the current Illuminati and therefore they have secretly infiltrated all the major religions on earth; government and education – where each successive generation is being dumb down; they have continually diminished the ability for individuals to own private property, or claim inheritance; divided people against each other to continually diminish patriotism; and have continually diminished family values.

They also compartmentalise their knowledge between members. Until I fully exposed the Illuminati, many people who have been REM clones at the cloning centre did not know they were in fact REM driven clones, and thought they were in the 5th Dimension; the astral plane; a singularity; the spiritual realm; Valhalla; quantum hopping; a time stutter etc. or whatever else the Illuminati told them.

Today's Illuminati members also meet in secret (just like the founding members) as REM driven clones, **when they go to sleep**. Furthermore, because Illuminati meetings are in secret and not many people know the exact location (because knowledge is compartmentalised) of the cloning centre; or the fact that their consciousness has been transferred to Mark 2 REM driven clone bodies at the cloning centre (and they are not in their original bodies); as well as the fact that unsuspecting civilians have their memories suppressed; the points mentioned above are the reasons the Illuminati believe 'they are all powerful and untouchable'; and as a consequence, today's Illuminati members do all the disgusting things they want, because they believe no outsider can interfere.

The ring leaders of the Illuminati today also believe "the ends justify the means". This is why they clone, torture, molest, murder, and rape unsuspecting civilians as REM driven clones in their sleep. The Illuminati of today offer their members incitements to go along with their agenda and not oppose them (or face death). Another popular method is to entice their target with many, many wonderful prospects, and have the target believe they are joining a noble and prosperous venture, so that the target fulfils the objectives of the Illuminati unknowingly; promoting the Illuminati in a positive way, because the target has been deceived to perceive the nature of the Illuminati as 'positive'; by the time the target finds out the true intent of the Illuminati, and the evil which emanates from it, it is too late. Those who rise up in the ranks of the Illuminati are the men and women who have an insatiable lust for power, and most importantly: the men and women who want to rule the world.

Modern-day Illuminati members also wish to become gods (through technology); overthrow the Creator, and achieve their overall aim of enslaving mankind. This is why they clone people, and clone people in high rank society from all walks of life (movie stars, musicians, politicians etc.; whether the person willing wants to be part of the Illuminati or not) so long as that person is in a position of power and influence, the Illuminati clone that person, and threaten that person, for example -"Hey, you're going to hang with us –or else" –through such coercion, the people in high rank society who have power and influence will not oppose the Illuminati's plans to become gods; enslave mankind forever; and rule the world. Another reason for cloning high rank society is to include these people into the Illuminati (willingly or unwillingly) to ensure the world's populace remains in ignorance (because once all the world leaders and high rank society are cloned and under the coercion of the Illuminati nobody in a position of influence or power can warn the populace against the Illuminati) until the Illuminati's plan is completed and they have enslaved the world forever.

The Illuminati's overall aim of 'becoming gods' and ruling the world, as well as, mind controlling all the inhabitants of earth is also the reason the Illuminati:

- Administer drip feed disclosure through media, by telling some truths mixed with lies in order to conceal their true intentions and overall aim, and prevent the betrayed partner (the public) from ever discovering "the complete truth";
- Administer evaluative conditioning, by placing their symbols and ideology in popular media with positive associations, so that the unknowing and unsuspecting public will eventually become predisposed to the Illuminati and unsuspectingly have a positive or neutral response towards the Illuminati;
- Because they want to become 'gods' is also the reason the Illuminati is promoting RFID microchips and only discussing RFID microchips positively, while at the same time placing suppression (gagging) orders on anyone who speaks negatively about RFID microchips –which implies an unsuspecting public will willingly accept the microchip; and at the point of transaction, the person will have (unknowingly) given up their privacy to a third party (the Illuminati) for the rest of his / her life;
- Their aim to become 'gods' is also the reason the Illuminati are hurriedly trying to complete the HAARP grid across earth –because a complete HAARP grid will allow them to achieve their goal of mind control over the entire world; which fulfils their objective of becoming gods; because a complete HAARP grid will be capable of time travel, and therefore the Illuminati will be capable of going back to a previous time to correct the mistake(s) which led to their downfall; the Illuminati members will retain the knowledge of the previous time, and the rest of humanity will have no recollection of such a memory.

The Illuminati is **not** a joke. It is **not** fiction. They are very real, and part of humanity's reality; and through advanced concealed technologies the Illuminati aim to enslave humanity forever. The ring leaders of the present Illuminati includes Queen Elizabeth II, Prince Philip Duke of Edinburgh, Prince Charles of Wales and Vladimir Putin. I have also detailed the actions of the ringleaders in the main text in this disclosure, as well as, detailed other modern-day evil Illuminati members on my Facebook and Proboards. It is time the good people of earth, stopped being afraid, do the right thing, put a stop to this evil, and save themselves, as well as their children's children from being slaves forever. Spread and share this disclosure.

Glossary

Aneurysm -*noun:* An excessive swelling of the wall of an artery at a fixed point in the body. A brain aneurysm is therefore a: bulge or ballooning in a blood vessel in the brain. It often looks like a berry hanging on a stem. A brain aneurysm can leak or rapture, causing bleeding into the brain.

Brain Aneurysm -*noun:* see Aneurysm.

Clone –*noun:* a cell, group of cells, an organism produced asexually from a single ancestor and is genetically identical to a single ancestor.

Concealed Technology -*noun:* hidden machinery and devices undisclosed and currently unavailable for public consumption. Concealed (or military) technology develops at a rate of 44 years for every 12 months which passes in comparison to the technology the public is currently accustomed to. Origin: Phil Schneider.

Cloning Centre –*noun:* a physical location (on earth) where duplicate and replicate clones are produced. These physical locations are usually Deep Underground Military Bases (DUMBs). DUMBs have an entire floor dedicated to cloning. It is also a place where Illuminati members meet with each other as REM driven clones. The above-ground cloning centre where many high profile people attend can be found within a radius of 5/6 hours drive from the Robert Pickton Farm Port Coquitlam, British Columbia, in Canada, somewhere at a remote nature reserve.

Cloning Technology -*noun:* the technological advancements in medicine, science and technology used to produce duplicate and replicate copies of originals.

Conditioned Response -*noun:* an automatic response established by training to an ordinarily neutral stimulus.

Conditioned Stimulus –*noun:* A previously neutral stimulus that, after repeated association with an unconditioned stimulus, elicits the response produced by the unconditioned stimulus itself.

Consciousness –*noun:* the state of being aware of and responsive to one's surroundings; a person's awareness or perception of something.

Consciousness Transfer -*noun or verb:* the process of transferring or copying the mental content (including long-term memory and "self") from a particular brain and copying it to a computational device; artificial body or avatar body such as that of a robot or clone version of the original. It is also the feat in which the person's mental content (long term memory and "self") moves from one body into another.

Depopulation *verb:* to remove or reduce the population of, as by destruction or force.

Drip Feed Disclosure *noun or verb:* is the process of supplying information but in small amounts overtime. Drip feed disclosure is also the process of revealing information slowly overtime, possibly telling lies to conceal certain aspects of the truth until the source administering the drip feed disclosure has adequate time to let out the truth in a slow and controlled way, thereby delaying the betrayed partner (in this disclosure, the public) from having the "complete truth" for some time.

DUMB –*noun:* [Deep Underground Military Base] a facility directly owned and operated by or for the military or one of its branches that shelters military equipment and personnel, and facilitates training and operations beneath the surface of the earth.

Duplicate Clone -*noun:* a fully formed human body which is a genetic copy of original developed through the process of regenerative technology. Duplicate clones are grown in a big thick tank full of (salty) water.

Duplication Cloning -*verb:* involves agitating the cells of on an original repetitively until a fully formed human body of the original is developed. Duplicate clones take an average of 5 months to form into a fully developed human body of the original through the process of regenerative medicine and technology.

Evaluative Conditioning -*noun:* is a change in liking, which occurs due to an association with a positive or negative stimulus.

H.A.A.R.P. Technology –*noun:* [High frequency Active Auroral Research Program] a radio transmitting system that can bounce signals off the Earth's upper atmosphere, (60km (37 miles) to 1000km (620 miles) high) back to probe deep into the earth or sea. HAARP is also capable of: disrupting human mental processes; knocking out all global communication systems; changing weather patterns over large areas; interfering with wildlife and migration patterns; hurting ecosystems; negatively affect human beings health, moods and mental states; and unnaturally 'boil' the earth's upper atmosphere. HAARP used correctly will control the weather without any adverse effects.

H.A.A.R.P. Grid –*noun:* a network of radio transmitters which can bounce signals off the earth's upper surface. Each transmitter is located at a specific point across earth and communicates in unison with other radio transmitters across the earth. At this present time of writing, a HAARP grid has **not** been completed, although the Illuminati are working twice as fast to complete a HAARP grid. The threat to humanity once a HAARP grid is completed includes: mind control over the entire world's inhabitants. A completed HAARP grid will also be capable of time travel, and therefore the Illuminati will always be able to go back to a pervious point in time to correct the mistake(s) which led to their downfall. Humanity will be slaves forever.

Habeas Corpus -*noun:* is [A] writ [formal document] requiring a person under arrest to be brought before a judge or into court, especially to secure the person's release unless lawful grounds are shown for their detention.

Heart Attack -*noun:* A sudden occurrence of a blockage of the flow of blood to the heart.

Human Clone –*noun:* The creation of a genetically identical copy of a human.

Ionosphere –*noun:* the layer of the earth's atmosphere which contains a high concentration of ions and free electrons and is able to reflect radio waves. It lies above the mesosphere and extends from about 60km (37 miles) to 1,000 km (620 miles) above the earth's surface.

Illuminati –*noun:* A modern-day criminal organisation operated by reprobate (depraved, unprincipled and wicked person) criminals. Their main agenda: is to enslave the whole world through advanced concealed technologies. See Appendix C for further discussion.

Mark 2 Clone –*noun:* Is a sleep driven clone; specifically, a REM sleep driven clone. A Mark 2 Clone is activated by transferring the consciousness of an original into a Mark 2 Clone **only when** the original reaches REM sleep (usually 90- 110 minutes **after** the original falls asleep). Once the consciousness of the original is transferred from the original's body to the Mark 2 Clone, the Mark 2 clone is now capable of motion: such as walking, talking etc. The Mark 2 clone 'drops limp' and becomes motionless once the original wakes up from sleep. The original's consciousness no longer resides in the Mark 2 clone (once the original is awake) and therefore the Mark 2 clone is now incapable of motion. Mark 2 Clones are also known as "REM Driven Clones" and "REM Duplicate Clones".

Memory Suppression –*noun or verb:* is the selective removal of memories or associations with the mind using memory suppression technology.

Memory Suppression Technology –*noun:* any scientifically advanced technology used selectively to remove memories from the conscious mind.

Mind-Voice Technology –*noun:* an advanced technology capable of reading, listening, hearing and broadcasting a person's inner voice or thoughts. It is capable of replicating sounds **exactly**. Therefore an individual can hear the sound of drums, a guitar or any instrument and replicate that sound exactly just by thinking about it. Consequently, Mind-voice technology has the functionality of producing music.

Military Technology –*noun:* machinery and devices developed from scientific knowledge used by the Armed Forces which advance at a rate of 44 years for every 12 months which passes, compared to the technology the public is accustomed to. Origin: Phil Schneider

MK Ultra -*noun:* [Manufacturing Killers Utilizing Lethal Tradecraft Requiring Assassinations] The goal of mind control, using MK Ultra technology is to program an individual to carry out any task against their will and self-preservation instinct and to control the absolute behaviour and thought patterns of the individual. See Appendix B for further details.

Neutral Stimulus –*noun:* is a stimulus which initially produces no specific response other than focusing attention. In classical conditioning, when used together with an unconditioned stimulus, the neutral stimulus becomes a conditioned stimulus.

Negative Association -*noun:* is an undesirable experience or perception.

Negative Stimulus -*noun:* a stimulus with undesirable consequences.

New World Order -*noun:* [NWO] Agenda. The whole NWO agenda is to turn humanity into mindless slaves forever; whereby the post-humans / trans-humans mind control the entire world's populace either through RFID microchips or a completed HAARP grid. Another aspect of the NWO agenda is to depopulate the world's current population of 7.3 billion people to 500 million people (and never exceed a world population of 500 million people afterwards); ruled by a one world government; a one world ruler; with a one world religion. See Appendix C for more details.

Original –*noun:* A person who is **not** a clone.

Pain Receptor -*noun:* Any one of the many nerve endings throughout the body that warn of harmful changes in the environment such as excessive pressure or temperature.

Positive Association -*noun:* is a desirable experience or perception.

Positive stimulus -*noun:* a stimulus with desirable consequences.

Posthumanism –*noun:* seeks to rewrite the very definition of being human. It is the condition in which humans and intelligent technology become intertwined. In the Posthuman there are no essential differences or absolute demarcations between bodily existence and computer stimulation, cybernetic mechanism and biological organism, robot technology and human goals.

Posthuman -*noun:* see Posthumanism.

Project MK Ultra -*noun:* see MK Ultra.

Regenerative Medicine -*noun:* (of a living organism) the process of re-growing new tissues after loss or damage.

Regenerative Technology -*noun:* any machinery or device developed from scientific knowledge which has the capability to re-grow new tissues after loss or damage.

REM Sleep –*noun:* [Rapid Eye Movement] is the fifth stage of sleep in the sleep cycle. It takes 90 - 110 minutes to reach REM sleep after we fall asleep. REM sleep is also known as the "period of paralysation". The involuntary muscles such as the brain become more active whereas voluntary muscles (those that you move by choice) such as your arms and legs become more relaxed or paralysed. REM sleep is a kind of sleep that occurs at intervals during sleep, and it is characterised by rapid eye movements.

REM Driven Clone -*noun:* [Rapid Eye Movement Driven Clone] a clone that can only become activated, once the original is in REM sleep. See Mark 2 Clone.

REM Duplicate Clone -*noun:* [Rapid Eye Movement Driven Clone] A clone developed by regenerative medicine and technology and is therefore an identical copy of an original. REM duplicate clones can only become activated when the original is in REM sleep. See Mark 2 Clone.

REM Driven Clone Death –*noun:* the process where an original dies because of constant torture to their REM driven clone or where a constant electrical current is applied to the REM driven clone resulting in death of an original usually in the form of an aneurysm or heart attack (because consciousness is linked) in the original's body.

REM Driven Clone Torture —*noun or verb:* the action or practice of inflicting serve pain on a REM driven clone. REM driven clone torture causes biological and physiological responses in the original's body because consciousness is linked. Intermittent REM driven clone torture (depending on what is done) causes the original to experience severe headaches, an upset stomach, achy limbs, sickness; a weakened heart. Continuous REM driven clone torture will lead to the death of the original; usually in the form of aneurysm or heart attack in the original's body.

Replication Cloning –*verb:* involves giving birth to a genetic identical of an original where the newborn starts life off as a baby and matures. The newborn is referred to as a clone.

RFID Technology [Radio Frequency Identification] **-***noun:* are electronic microchips the size of a grain of sand that can be directly embedded into the human flesh. RFID microchips communicate wirelessly through the use of electromagnetic fields to transfer data. RFID microchips link the brains of people via the implanted microchip to satellites controlled by ground base super-computers. The dangers of RFID microchips to the implanted person are: total loss of privacy and total control of the person's physical body functions, mental and emotional thought processes, including the implanted person's subconscious or dreams –for the rest of that person's life! RFID microchips are also tracking devices, and the implanted person can be tracked anywhere on the globe.

Selling One's Soul -*verb:* to sell the use one's "Mark 2" REM driven clone to the Illuminati, for the Illuminati to use the individual's Mark 2 REM driven clone in whatever manner the Illuminati wishes. There are no returns once the individual has signed over his / her (soul) Mark 2 REM driven clone. When an individual sells their (soul) Mark 2 REM driven clone, the person has also entered into a contract to sell the Mark 2 REM driven clone(s) of their current children (if they have any) as well as any unborn children the person may have later in life. The person sells all their descendants (souls) Mark 2 REM driven clones to the Illuminati, once the individual sells their (soul) Mark 2 REM driven clone to the Illuminati. Selling one's (soul) Mark 2 REM driven clone is considered **a serious business transaction** to the Illuminati. There are no returns. If the person ever makes a fuss and wants their (soul) Mark 2 REM driven clone back, the Illuminati will either torture the person's Mark 2 Clone, or apply a constant electric current to the person's Mark 2 Clone until the person either has a heart attack or aneurysm in their original body. This is what public figures are hinting at when they say "They have sold their soul". They have sold the use of their Mark 2 REM driven clone to the Illuminati. Selling one's soul is not a joke. Never sell your soul.

Stimulus –*noun:* is something that causes a reaction, especially interest, excitement or energy. It is also an energy change registered by the senses. For example a stimulus can be a shinny object for a baby.

Technology –*noun:* machinery and devices developed from scientific knowledge.

Technological Advancement –*noun:* is incorporating, by means of experimental development, a characteristic or capability not previously existing or available in standard practice, into a new or existing process or product that enhances a product's performance. Novelty, uniqueness, or innovation alone does not indicate a technological advancement.

Transhumanism –*noun:* the belief or theory that the human race can evolve beyond its current physical and mental limitations, especially by means of science and technology.

Unconditioned Response –*noun:* is a response to a neutral stimulus we have no / little control over. It is a natural automatic response. For example, food is an unconditioned stimulus for a hungry animal, and salivation is the unconditioned response.

Unconditioned Stimulus –*noun:* A stimulus that elicits an unconditioned response.

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Tetryonic Theory

The unified quantum field geometry of charged EM mass-ENERGY-Matter in motion

"...the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools of thought, as something obviously, immutably given; something having an objective value of truth which is hardly even, and in any case not seriously, to be doubted. ...in the interests of science it is necessary over and over again to engage in the critique of these fundamental concepts, in order that we may not unconsciously be ruled by them." [Albert Einstein]

Given the range and applied scope of Quantum Physics in today's modern technologic World there remains a driving desire to rationalise our numerous disparate scientific theories into one coherent theory with a intuitive model that can be applied equally to the Quantum and Cosmological scales of our Universe.

Such a theory would need to preserve the currently observed outcomes and present established theories in a new light, offering additional testable predictions of its own, and ideally do so in a manner that is simpler than that of the established theories and hypothesises.

Many foundational properties of Quantum Mechanics remain unaddressed by scientific theory and in the following pages an overview of the key quantum properties challenging our current scientific advancement will be highlighted, including a number of assumptions that currently impede the development of a fully realised, coherent solution to all of our current scientific questions.

While Mathematics is the language of Science it remains a language that lacks a well-defined physical model on which to test it and further its many and varied solutions to Quantum & Cosmological scale physics. It is this lack of any rigid, enforceable GEOMETRY that has allowed the development of numerous disjointed statistical and probabilistic solutions to physical problems, in turn impeding our scientific understanding and advancement of quantum processes.

The Standard Model has many observed and testable components to it but more recently new theories have emerged to contest it without being rigorously testable themselves. They rely on the established foundation provided by the Standard Model but try to explain its various deficiencies ad-hoc with various suppositions without any solid footing of their own.

Often the only way to progress further in our scientific endeavours is to retrace our footsteps in science and to develop new physical models on which we can discern our known results and observations thus excluding any false or misleading assumptions (mathematical of otherwise).

In doing so there exists the promise that a simple underlying foundation can be found to the physics of our Universe, revealing new and exciting advances in Science that will allow us to usher in a new age of scientific and technological advancement for the betterment of humanity as a whole.

'Tetryonics – The charged geometry of EM mass-ENERGY-Matter' whose founding principle is that **EQUILATERAL Planck energies are** the foundation geometry for all quantum mechanical processes is presented here as just such a solution to the current quandaries of Quantum Mechanics.

ENERGY

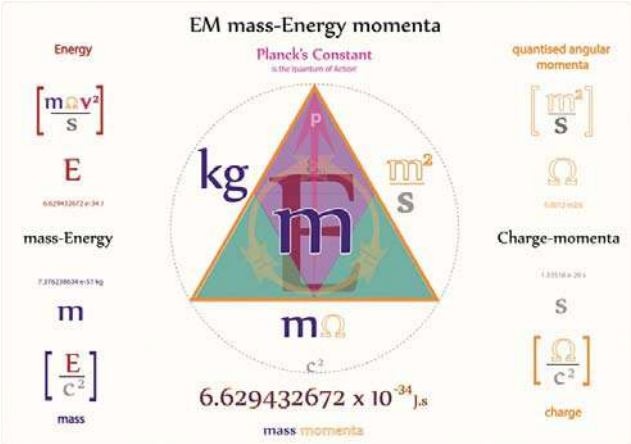

Energy, in Physics, is an indirectly observed quantity of a system that imbues it with the ability to exert a Force or do Work over a distance.

It has been measured and quantified through numerous methodologies over the centuries, most notably through its associated characteristics such as mass, velocity and ElectroMagnetic fields.

The most recent attempt to quantify its characteristics (with respect to heat and light) led to the discovery of Planck's constant and the development of Quantum Mechanics

The application of a simple proposition (that Energy has an equilateral geometry) opens the door on a greater understanding of the mechanics of the quantum world, a realm that will be forever beyond the reach of our physical eyes.

The myriad of perplexing properties of quantum properties (such as Charge, mass & Matter) and the astonishing outcomes of quantum experiments (Interference and Wave-Particle duality) can now all be readily modelled and explained rationally on a solid geometric footing.

Paving the way for new discoveries and a greater understanding of our Universe and its mechanics

Quantised Angular Momenta

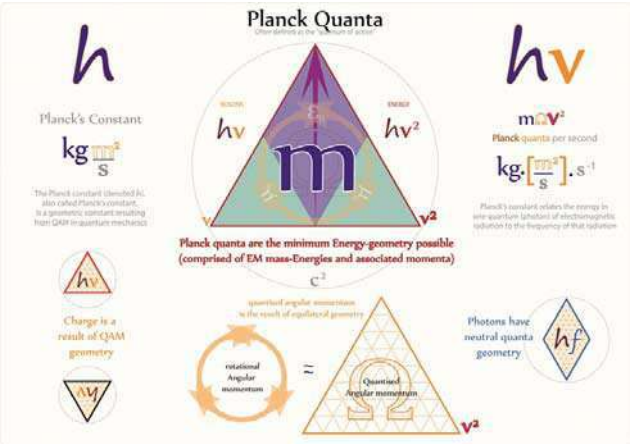

Building on the priori definition of equilateral energy quantisation it can be quickly demonstrated that any energy measurement per unit of Time results in a geometric unit of measurement that has historically be taken to represent rotational motion (specifically Angular momentum)

This unit of motion is found throughout Quantum Mechanics and is directly related to the square energy levels in nuclear processes.

The equilateral EM fields of energy quanta are constrained by its geometry and this geometry lies at the heart of understanding the quantum world in all its beauty.

It determines properties such as Electric permittivity and Magnetic permeability, the vector direction of linear momentum and relates the scalar property of electromagnetic mass directly to velocity.

CHARGE

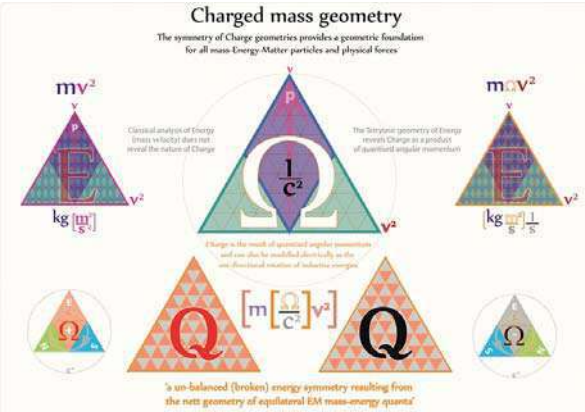

A fundemental property of all mass-ENERGY-Matter that gives rise to the Forces of electrical Interaction has eluded physical explanation by Physicists since its discovery and led to many 'band aid' additions to the Standard model in attempts to explain its observed properties.

The most recent attempt at an explanation was Special relativity theory which in turn led to our current models of charge from contractions of Matter due to motion.

SR explains Charge as an invariant property of of electrostatic bodies and that the motion of charges creates an additional magnetic moment through the relativistic distortion of spherical bodies of Matter.

Equilateral Planck energy momenta geometries and Matter topologies offer a completely different explanation for the source of electrostatic charges and their associated magnetic moments.

Positive and Negative charges are revealed to be opposite side of the same quantum energy 'quoin', and can be modelled electrically as ideal quantum inductive loops. It is equilateral geometry that gives rise to the physical properties of quantised angular momenta, inertial mass, elemental charges and even the geometric topology of Matter itself.

In a planar 2D form they form a neutral EM energy momenta geometry but it is when they form the topology of 3D Matter they are expressed as either Positive or Negative electric charge fascia.

ODD number energy quanta [W Bosons] combine via their magnetic bases in fixed quantum steps to create the 'squared' nuclear energy levels so familiar to quantum mechanics and form the basis for ElectroMagnetic Induction.

It is their rigid equilateral geometry that provides the basis for relativistic charge invariance and the quantum mechanism for photo-electron transitions in atoms while the net energy momenta quanta in charged geometries provides the electromotive force known as Voltage.

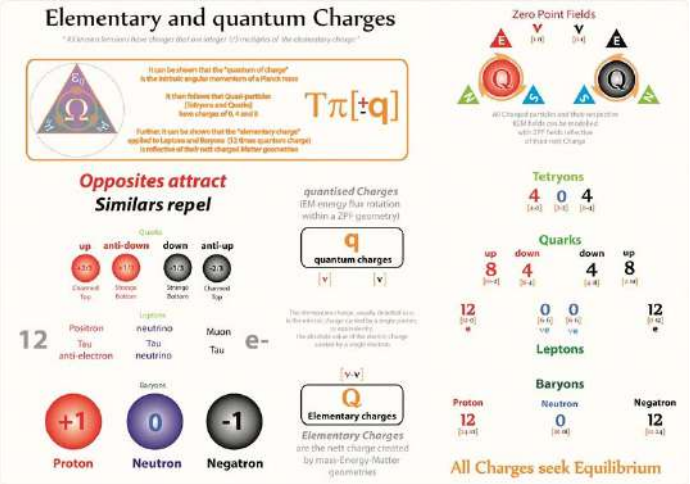

Equilateral geometry reveals an intrinsic connection between EM Energy, mass and Charge.

As separated charges seek equilibrium they provide motive energies & the quantum scaffolding for large scale Matter topologies and their force interactions throughout our Universe.

mass-ENERGY-Matter

All Energy has an EM mass equivalence and equally any object with EM mass has energy equivalence

But there has never been a formal scientific definition and associated equation to distinguish the property of EM mass from that of Matter.

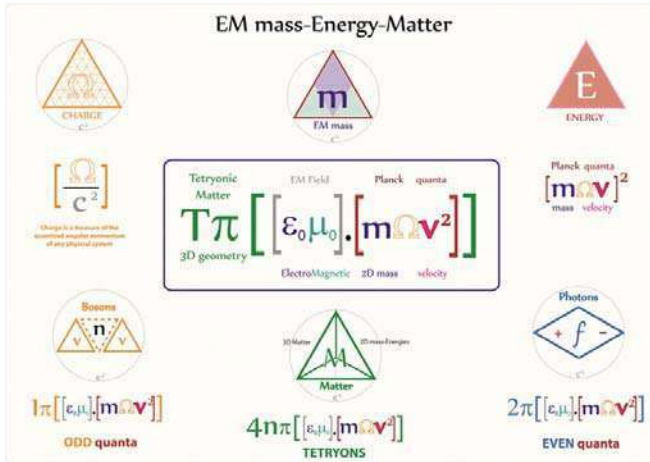

Using Tetryonic geometry it can be clearly demonstrated that ElectroMagnetic mass is NOT Matter – it is the Energy content of a system per unit of time [E / c^2] in total agreement with Einstein (and all before him) however, lacking a formal definition of either the two terms have become mired with each other so much that they are often used for each other inappropriately even in scientific peer-reviewed literature.

ElectroMagnetic mass is the two dimensional (planar) measurement of Energy per unit of Time whereas Matter is a measure of the tetrahedral energies found in a spherical volume of 3D space.

Mass-energy can be viewed as the paper from which 3D Matter is created when it is folded into a tetrahedral shape (the quantum canvas covering the topology of Matter)

The often used tem of 'massless' is now shown to be a misnomer that should be removed from the scientific vocabulary except where it specifically refers to empty space (devoid of any energies).

Matter is now formally defined geometrically as 4nπ tetrahedral standing wave of EM energy and it is the tetrahedral topology of Tetryons that forms the foundation for all large scale Matter in the Universe (not spherical point particles).

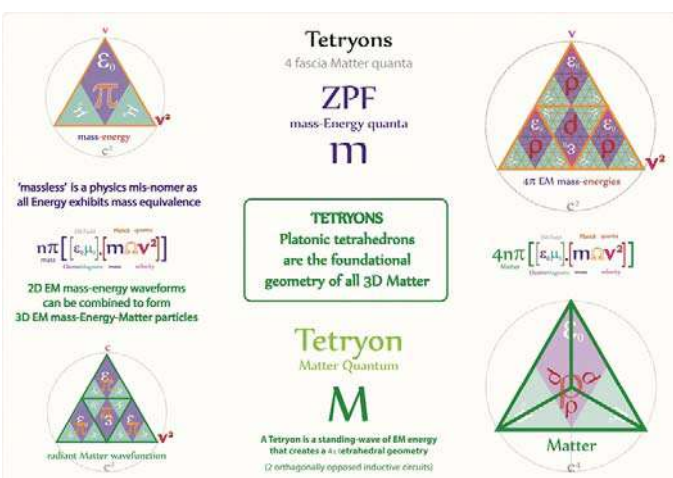

Charge allows EM masses to form a Tetryonic topology giving volume to Matter and its energy momenta provides the interactive forces between them imbuing motion into our Universe.

Matter at rest is comprised of EM mass-energies that are always in motion and propagating in a tetrahedral EM standing wave.

To cause at will the birth and death of matter would be man's grandest deed, which would give him the mastery of physical creation, make him fulfil his ultimate destiny."

[Nikola Tesla]

Sub-Atomic Particles

Using equilateral energy all the mass-energy geometries & mass-Matter topologies of EM fields and particles can be physically modelled revealing the known Standard Model particle sand a few more.

Bosons are shown to be transverse EM fields that facilitate EM induction and Photons are revealed as longitudinal dual-charge pairs possessing a neutral EM charge and inherent magnetic moment.

The net unidirectional momentum of Bosons then distinguishes them from Photons that possess a bi-directional momentum

Closer examination of the geometries highlights a long-standing error in the mathematical formulation of QM energy formulas, namely the mistaken interchanging of Planck's quanta [*v*] for Einstein's frequency [*f*] in relation to Energy.

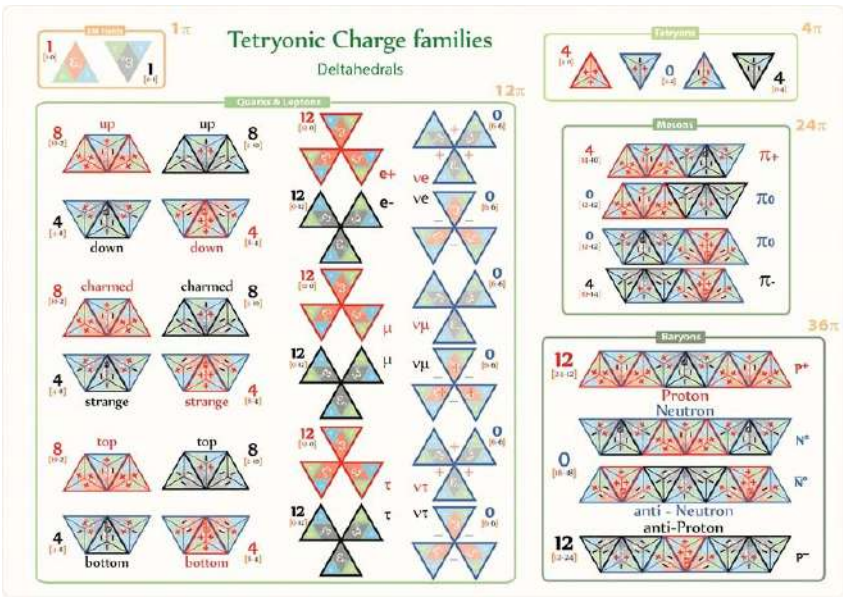

2D EM masses [bosons-photons] do not have the physical property of 3D topology possessed by Matter [Fermions]

Fermions can now be defined as the standing wave energy topologies that create all the known sub-atomic particles – the building blocks of large scale Matter and structure in the macro world.

Historically these particles have been classified according to their charges and masses, Tetryonic geometry now provides a 3D physical model of all the particles highlighting the physical source of the 1/3 charges of Quarks and revealing charge to be the foundational geometry of all Matter.

Tetryons are 4π charge topologies that are the foundational quanta of Matter and surprisingly have a mass-charge ratio identical to that of Leptons explaining how these particles have remained hidden from accelerator experiments.

Quarks are 12π charge geometries where the attractive strong charge interactions between their fascia form 8π particle topologies with entirely different properties to that of Leptons

Leptons also have 12π charge geometries but with repulsive fascia that result in them forming the quantum equivalent of a 6 loop rotor

Protons and Neutrons are 36π charge geometries [that result in 20π Baryon topologies] and have identical masses (against the current model of baryonic masses which derived from an entirely different process where Neutrons are formed by Protons absorbing electrons).

The Particle Zoo

Baryons – the building blocks of atomic nuclei can be formed from many tri- quark combinations and energy levels and this is of particular note when modern accelerators are used to probe atomic structures.

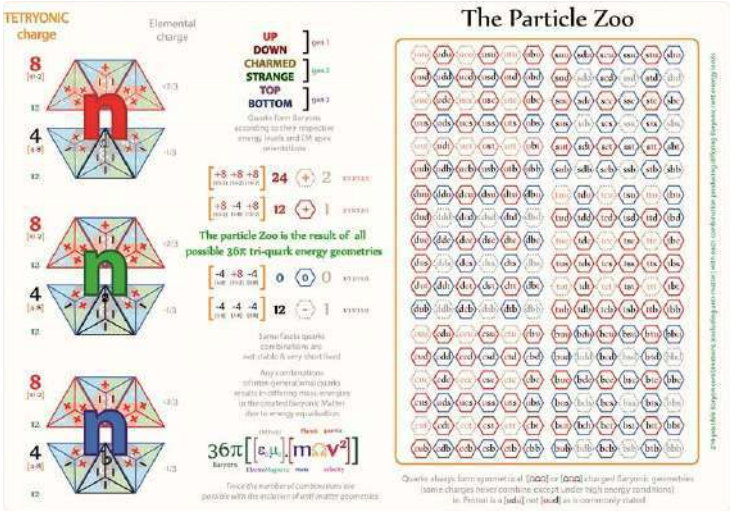

The higher energies they employ when colliding particles together results in higher 2D kinetic energies (and increased energy quanta) which recombine after collisions into a plethora of similar particles called the Particle Zoo.

A sound understanding of EM mass-energy geometries & the charged topologies of all sub-atomic Matter particles reveals the true genesis of all of the Baryons to be found in the particle zoo.

Tetryonic geometries facilitate the precise 3D modelling of all the periodic elements, allotropes and compounds enabling the development of new classes of materials and medicines providing us with many new insights into Quantum Chemistry and large scale Matter in general.

Quantum Electro-Dynamics [QED]

Adding to the mysteries of quantum mechanics is a number of well-known QED effects that have also eluded physical explanation – to date

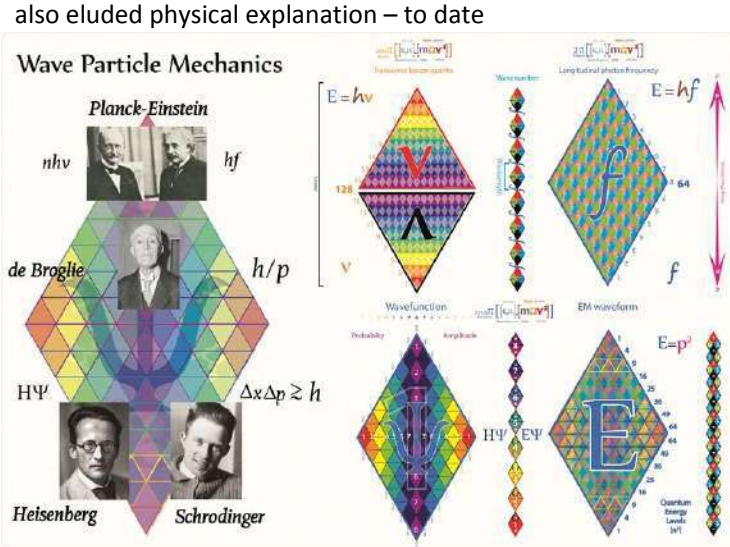

In 1865, James Maxwell Clerk unified the then disparate theories of Electric and Magnetic fields into a theory of Electromagnetism and related then to the velocity of light.

The exact quantum geometry for EM wave geometries (and the photons comprising them) that explains their Wavefunctions and observed inference patterns represents one of the greatest challenges to developing a concise fully realised quantum theory of EM radiation.

Wave-Particle duality dating back to the 17th century is perhaps the best known example of quantum behaviour that has defied precise modelling despite intense effort by scientists around the World for over two centuries

The application of equilateral energy momenta to the charged geometries of Photons and EM waves not only explains these long standing mysteries but also removes the quantum fuzziness introduced by Heisenberg's Uncertainty principle, in turn clearing the way for Science to develop an advanced understanding of Electricity, its role in Quantum ElectroDynamics and provide new clean forms of energy from quantum processes.

Photo-electrons and spectral lines

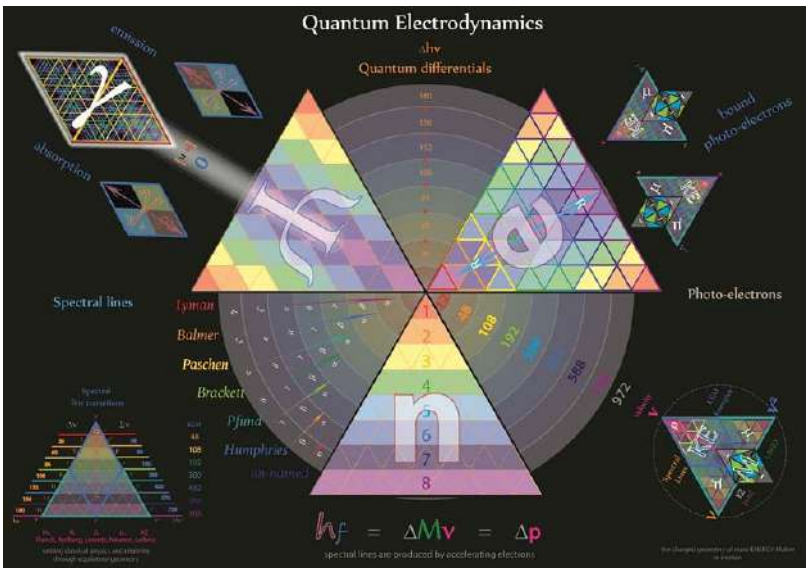

The physical relationship between Spectral lines, Rydberg's Constant and the Kinetic energies of Photo-electrons as they interact with photons and atomic nuclei is quickly revealed when equilateral energy geometries are employed

It is the rigid geometry of equilateral Planck energy momenta that gives rise to the invisible forces of Faraday's Electric and Gauss' Magnetic fields as well as Newton's Action-at-a-Distance.

Quantised Angular Momentum, a direct measure of the long hidden equilateral geometry of Energy, is revealed as the source of Charge, the physical constants and even the geometry of EM mass-energy & Matter itself.

The geometry of Nuclear Forces and Constants

Charge interactions resulting from equilateral EM energy geometries have been mistakenly developed into three disparate nuclear forces:

The EM Force is the result of $2n\pi$ charge geometries acting along transverse or longitudinal directions (or in superposition) in the forms of Bosons and Photons

The Weak Force is the inductive coupling of the magnetic permeability of adjacent energy geometries

The Strong Force is the attractive force between opposite charged fascia of Tetryonic Matter. It can also form a repulsive force between similar charged fasciae resulting in charged Leptons [electrons].

Gravitation (mathematically identical to Coulomb's Force save for strength and source) can also be modelled as the geometric mean of super-positioned EM waves.

All of which are determined by the Fine Structure Constant – the mysterious hand of GOD – setting the strength of EM interactions and determining Charge on the quantum level.

Applying equilateral geometry to energy momenta quanta, the Tetryonic model of EM mass-ENERGY-Matter quickly evolves to explain many additional electrical properties such as Voltage, Current and Power

Quantum Chemistry

Applying tetrahedral Matter topologies to quantum chemistry leads to a number of significant advances in the understanding of chemical processes most notably:

- **Accurate models for all periodic elements and their associated allotropes**
- **Advanced molecular orbitals plots**
- **Exact rest masses for all elements and**
- **A new Periodic table based on the charged topologies of Matter**

Improving upon and extending the Aufbau principle with charged geometries leads to many refinements in chemical engineering and facilitates the building of accurate 3D models of all elements, isotopes and compounds.

Every element can be analysed from the quantum level upwards revealing its exact 3D topology, quark configuration, rest mass-Matter-energies and chemical properties.

And number of misconceptions can be quickly clarified and corrected in turn advancing our understanding to the physical mechanics underlying chemical processes like chemical bonding, element family properties and the structures of complex chemical compounds.

Hydrocarbons and Carbohydrates have already been modelled using equilateral charge topology with the results matching the established chemical models of Nobel gases, Core electrons, Lewis diagrams and the most recent electron photographs of these chemical properties of atoms.

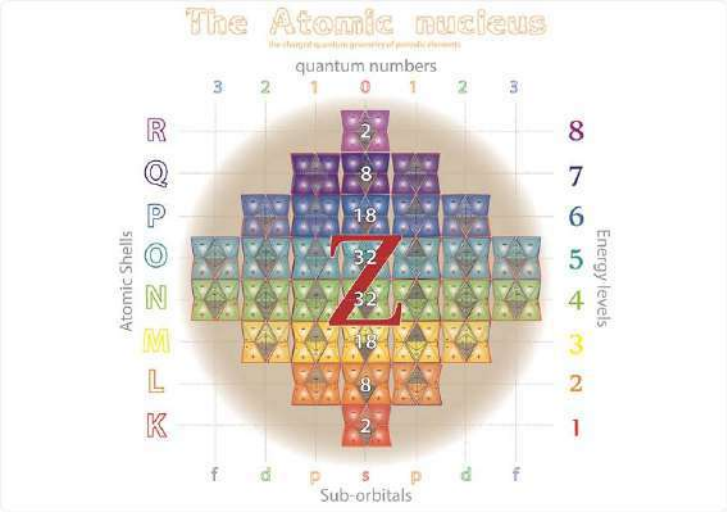

Even DNA can be modelled in 3 dimensions leading to a greater understanding of the role of quantum mechanics in biological processes and the interaction of EM radiation on organic compounds.

A highly developed quantum model of chemical elements and compounds will allow us to model chemical and biological structures in hitherto unimagined detail and facilitate the building of complex (and increasingly accurate) models of all chemical compounds and biological processes.

A Unified field equation

In physics a Unified Field Theory is a type of theory that allows all that is usually thought of as a fundamental force or elementary particle to be formulated in terms of a single equation that explains all their disparate properties.

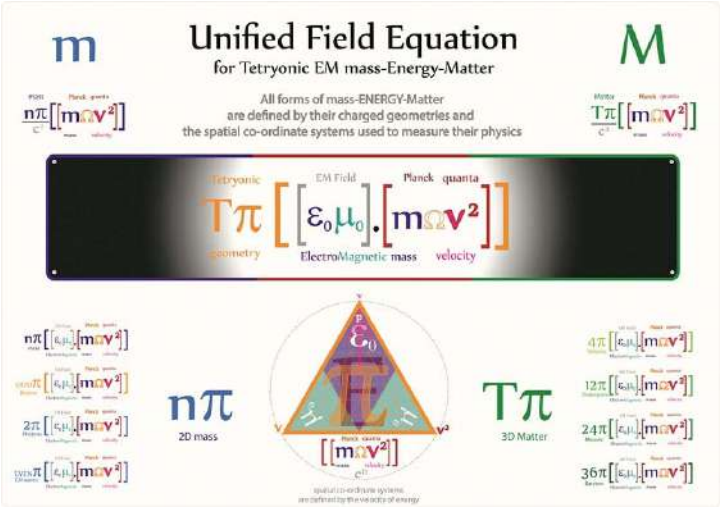

It is considered the holy grail of Science, offering the promise of advances in Technology, Energy and Medicine unparalleled in Human history.

Equilateral energy provides the foundation for the creation of a single equation that expresses EM mass-ENERGY and Matter as the result of geometric & topological charge interactions.

Applying equilateral geometry to Planck energy momenta quanta has been shown to firmly resolve many of the current mysteries plaguing the Standard model and provides a firm foundation for the development of a single unified quantum theory uniting all quantum and macroscopic forces.

It effortlessly merges all the tested features of Classical mechanics with the statistical probabilities of quantum mechanics and scales up to the cosmological scale of General Relativity.

Equilateral charged energy geometries provide a quantifiable foundation for advances in:

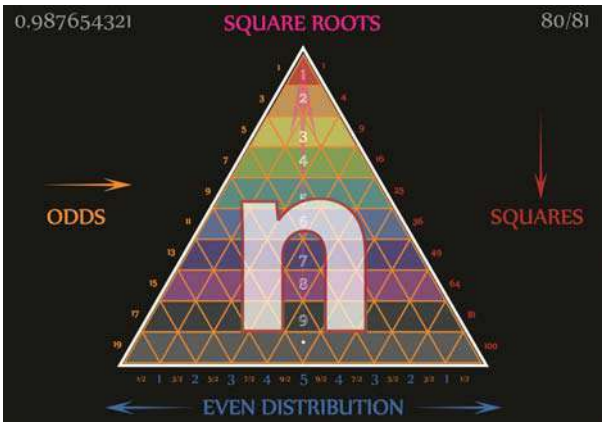

- **Quantum Mechanics**
- **Quantum Electrodynamics**
- **Quantum Chemistry**
- **Quantum Cosmology**

Explaining the quantum mysteries of mass & Matter, Wave-Particle duality and gravitational Singularities by challenging the very foundational assumptions of Relativity and the role of charge in our Universe.

Mathematical principles such as re-normalisation, probabilities and square roots of negative numbers can all be geometrically modelled through Tetryonics leading to further advances in fields such as biology, medicine, quantum computing and telecommunications

Through the charged geometry of Tetryonics many of the erroneous theories that have been developed during the last 1oo years can be falsified at last providing a solid foundation for further advances in science and mathematics.

Gravitation

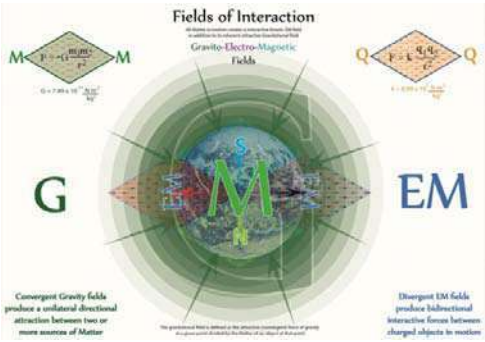

The force of Gravity has been long-held to be the mysterious force that holds our Universe together, shaping the Stars and holding us to the Earth as we orbit our own SUN.

Tetryonic geometry reveals its quantum mechanics to be the result of electromagnetic fields and the effect produced by the geometry of Matter in these fields.

Newton saw Gravity as a force that acts instantaneously on distant bodies of Matter while Einstein dismissed the force between the bodies and explained it as the result of the 'curvature of Spacetime'.

In fact the Gravitational field is comprised of 3 separate components, each of which produces differing forces of interaction, but all combine to produce the nett Gravitational field that we observe and describe as strictly convergent Gravity.

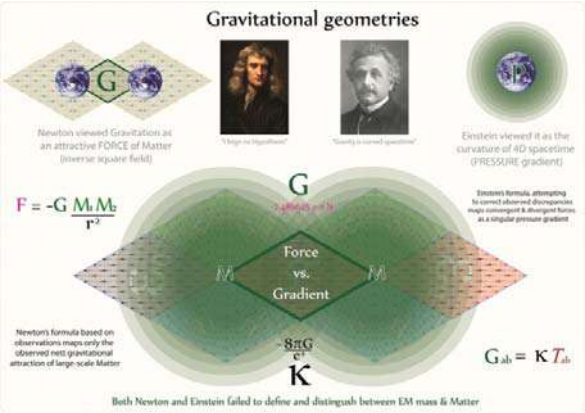

Gravity fields are created by the topology of Matter itself as it displaces and distorts the Vacuum energies surrounding it.

Electric fields diverge radially from all Matter as it is heated, or placed in motion by other forces creating an interactive field with both divergent and convergent equatorial regions of force and acceleration.

Dipole Magnetic fields located around the Polar Regions of all Matter also create a perturbative force on bodies close to them

Although Newton's and Einstein's theories were both correct in their respective analysis of the forces at work they both failed to define and distinguish between EM masses and Matter leading to the continued debate over the true nature and physical formulation of quantum gravity.

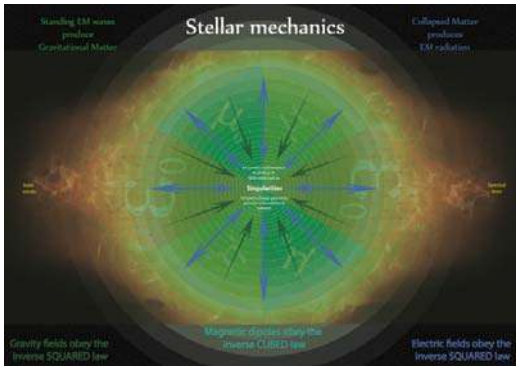

These three quantum forces [G+E+M] combine to produce a field of gravitational acceleration that was so eloquently modelled by Newton back in the 16th century through his inverse square law.

And these 3 distinct forces also combine to produce the stellar mechanics that power the Stars – a Gravito-Electro-Magnetic pinch.

The force of Gravity, created by the geometry of Matter draws Matter toward the core of Stars.

And the GEM pinch singularity at the core of the Star destroys Matter (collapsing its 3D geometry), turning it into radiant 2D ElectroMagnetic radiation (Light).

Energy from the Stars

Virtual particles, Dark Energy and Dark Matter (were all developed to explain the observed mechanics of our Universe) and can now be revealed to be differing manifestations of the electromagnetic force interacting at various angles to, and with, the standing-wave topologies that create it.

Quantum fields of Planck energies combine to create charged 2D geometries of radiative ElectroMagnetic fields that in turn spread out interacting with each other to give us the fundamental laws of Attraction and Repulsion.

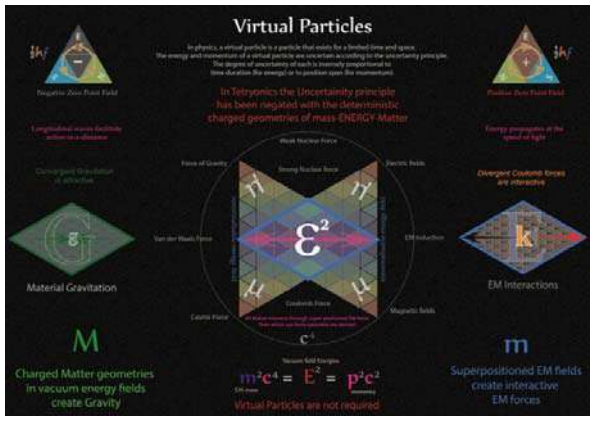

The 3D standing-wave topologies of Matter provide a rigid structure that displaces the surrounding Vacuum energies and creates a pressure gradient which we call Gravity.

And the destruction of these Matter topologies in turn creates radiant energies that propagate out into the surrounding space to weaken and form the Vacuum energies that permeate all of Space.

The eternal cycle of Matter creation and destruction within Stars and Galaxies is what drives the Universe we see today causing it to contract as it forms gravitational Matter and to expand as it restructures the standing-wave Matter into radiant forms of Energy (Light and heat).

The same process offers us clean, limitless energy for all our needs as well as unlimited resources from the restructuring of this energy into its varied elemental and compound forms.

Our toxic stockpiles of radioactive wastes can be completely eliminated from the environment and electrical power can be safely stored as mass within large-scale models of the deuterium nuclei and distributed worldwide to any location without the need for transmission lines.

Even hydro-electric storage schemes can be eliminated, returning water courses to their natural states of flow in turn reducing conflicts stemming from the flow of this precious resource worldwide.

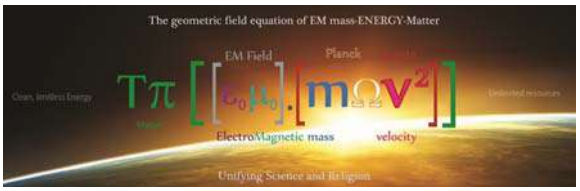

Through the geometries of equilateral Planck energies and the application of the Tetryonic unified field equation of mass-ENERGY-Matter in motion to our needs, for the first time in Humanity's history, we have the chance to advance our civilization to new pinnacles of technology and understanding in turn leaving our World a better place than we found it to be.

The age old dilemma of technological advancement versus environmental pollution is at an end

We stand on the threshold of realising one of the greatest advances in scientific understanding ever witnessed but we must also endeavour to redress our current social challenges with an equally rigorous determination to ensure all of Humanity benefits from this discovery

…… *ABRAHAM [2012]*

Tetryonics …. Challenging and correcting the foundations of quantum theory

Electric field permittivity has a 2pi (rhombic) field geometry while magnetic field permeability is always the result of two separate equilateral magnetic fields that form a magnetic dipole moment

Where two or more rhombic electric fields interact a Coulombic –charge force of interaction results
Where two or more equilateral magnetic fields interact a Gaussian-Ampere forces of interaction results *[opposite fields attract - same fields repel]*

The classical model of the unidirectional electrostatic force fields of point charged particles is corrected to show a bidirectional arrangement of equilateral Planck energy momenta geometries within the electrostatic field that creates the bi-directional forces of charge interactions

Where two similar coupled equilateral energy momenta fields combine an electrostatic field is created
Where two opposite coupled equilateral energy momenta fields combine a magnetic dipole is created

The arrangement and asymmetry of Planck quantum charges with in any EM field determines the motion and acceleration of charged particles within the field of electrostatic force

The classical forces of attraction should be renamed forces of interaction
(as they result from bidirectional quantum vector forces)

All electromagnetic fields are comprised of a squared number of equilateral Planck energy momenta quanta (whose asymmetrical distribution of equilateral Planck quanta results in a net divergent Force) with a convergent vector force component

When modelled with equilateral Planck geometries electromagnetic fields follow the Biot-Savart Law:

- Rhombic electric fields follow the inverse squared law of propagation
- Equilateral magnetic fields follow the inverse squared law of propagation
- Magnetic dipole fields follow an inverse cubed law of propagation

The equilateral geometry of quantised angular momentum creates chirality at the quantum level in physics (rotation does not affect the charge of plank quanta, but mirroring and/or spatial coordinate translations do)

All positive charged fields can be modelled as having a clockwise inductive flux geometry
All negative charged fields can be modelled as having an anticlockwise inductive flux geometry
(with OMEGA representing equilateral geometries per second and PI reflecting their scalar areas]

All W bosons are comprised of an odd number of equilateral Planck quanta in a trapezoidal geometry
All Z bosons are comprised of an even number of equilateral Planck quanta in a dual-trapezoidal geometry (neutral Z bosons are equivalent in terms of Planck mass energy momenta to photons save their net geometry)

All charged fascia [Higgs bosons] are comprised of squared numbers of equilateral Planck quanta in an equilateral geometry.

The odd quanta W bosons within electromagnetic fields form quantum levels of charged mass-energy momenta

The Planck equation [E=n.hv] of quantised energy is a generalised equation of Planck geometries (and applies to all energy momenta arrangements equally)

Bosons and Quantum levels are a transverse measure of mass energy momenta in EM fields
Photons are a longitudinal measure of mass energy momenta within the same electromagnetic fields

Equilateral Planck energy momenta per second [E/c^2] equates to mass geometries
Equilateral Planck energies momenta per second squared [E/c^4] equates to Matter topologies

Interactive **mass energy geometries** can combine via the weak force to form standing wave Matter topologies

Standing wave **Matter topologies** can combine via the strong force to form elementary subatomic particles

The fundamental Matter quantum of all physics is the tetryon (a tetrahedral mass-energy Matter topology) which is formed from photons of electrostatic energy and can be found as positive, neutral or negative charges topologies

These three forms of charged tetryons form the foundation of all the physical Matter of our universe as they seek a state of equilibrium, Tetryons are not spherical point charges – they are tetrahedral, likewise the subatomic particles they form are not spherical point charges - they are **[T]π** Tetryonic charge topologies

The Tetryonic topologies created by tetryons as they combine to form elementary particles creates new forms of closed volume topologies that follow Euler's characteristic [V+F-E = 2] for Platonic solids

Quarks and leptons are comprised of 12 charged mass energy geometries
- quarks form *[8π]* octahedral Matter topologies
- leptons form *[12π]* dodecahedral Matter topologies

and

Baryons are comprised of 36 charged mass energy geometries
- forming *[20π]* Icosahedral Matter topologies

Anti-UP quark's are comprised of 2 positive and 8 negative charges
creating a net charge of **-8** *[-2/3 elementary charge]*
DOWN quark's are comprised of 4 positive and 8 negative charges
creating a net charge of **-4** *[-1/3 elementary charge]*
Anti-DOWN quark's are comprised of 8 positive and 4 negative charges
creating a net charge of **4** *[1/3 elementary charge]*
UP quark's are comprised of 10 positive and 2 negative charges
creating a net charge of **8** *[2/3 elementary charge]*

Positrons are comprised of 12 positive charges
creating a net charge of **+12** *[positive integer elementary charge]*
neutrinos are comprised of 6 positive and 6 negative charges
creating a net charge of **0** *[no elementary charge]*
Electrons are comprised of 12 negative charges
creating a net charge of **-12** *[negative integer elementary charge]*

Protons are comprised of 24 positive charges and 12 negative charges
creating a net charge of **+12** *[positive integer elementary charge]*
Neutrons are comprised of 18 positive and 18 negative charges
creating a net charge of **0** *[no elementary charge]*
anti-Neutrons are comprised of 18 positive and 18 negative charges
creating a net charge of **0** *[no elementary charge]*
anti -Protons are comprised of 12 positive charges and 24 negative charges
creating a net charge of **-12** *[negative integer elementary charge]*

Rest lepton topologies have a completely neutralised magnetic dipole structure and all leptons (charged or neutral) have identical physical Matter topologies
Their rest masses are the result of the number of plank quanta comprising each Matter topology with applied forces creating additional asymmetrical KEM fields resulting in kinetic energies, magnetic moments and vector velocities of motion

As the energies of motion are added to equilateral KEM fields the Planck quanta themselves are physically WAVE-length Lorentz contracted

(Lorentz contractions apply to mass energy geometries only - NOT to Matter topologies)

Matter topologies are Lorentz invariant to velocity changes (or acceleration)
The relativistic distortion of spherical point charges in physics is no longer applicable, in turn undermining a basic tenet of special relativity as postulated by Albert Einstein

It is the equilateral secondary KEM fields of motion created by applied forces to material Matter topologies (and the asymmetrical distribution of plank charges therein) that creates the magnetic moments associated with charged particles in motion, not the relativistic distortion of spherical bodies of Matter as postulated by Einstein in special relativity

These secondary KEM fields of motion also contain the kinetic EM energies and vector [square root] linear momentum of material particles in motion - the mass energy momenta density and physical geometries of Matter topologies is unaffected by applied forces or changes to velocity-momenta

The changing Lorentz contracted mass energies of kinetic EM fields contributes to the total relativistic mass energy of Matter topologies but in no way changes the mass energy distribution of the Matter component of particles in motion itself - leading in turn to varying generations of subatomic particles with in the particle families themselves

The net asymmetric KEM field geometry of each particles in motion is reflective of the charged distribution of the Matter topology of the particle itself.

Mesons are created when quark and anti-quark particles combine via the strong force interaction between their charged fascias to create unique 14 pi Matter topologies (neutral or charged pions)

These strong interactions between opposite charge fascia of material particles and the resulting Matter topologies are evidence of the fact that Matter-antimatter combinations do not necessarily result in the explosive annihilation of the particles concerned (in fact the combining of opposite charge quarks is a necessary step in the formation of the baryons)

All Baryons are Matter topologies created from the combination of tri-quark topologies
The quark's combine via their opposite charged [Higgs] fascia to create neutral and charged elementary topologies
Due to this opposite charge interaction the charged distribution of baryonic topologies does not follow the textbook given arrangements of [UUD] & [DDU] instead they are arranged as follows:

Protons	**UP**	**+**	**DOWN**	**+**	**UP**
Neutrons	**DOWN**	**+**	**UP**	**+**	**DOWN**
anti-Neutrons	**anti-DOWN**	**+**	**anti-UP**	**+**	**anti-DOWN**
anti-Protons	**anti-UP**	**+**	**anti-DOWN**	**+**	**anti-UP**

The specific arrangement of charged fascia within these respective Matter topologies goes on to facilitate nuclear bonding via the residual strong force between atomic nuclei, following the charge arrangement given in modern textbooks does not allow the formation of baryons or their subsequent bonding to form larger scale atoms and molecules

Protons and neutrons are revealed to have quark arrangements that are mirror symmetries of each other, revealing the neutral charge neutron to have a complementary negative charge arrangement to that of protons.

The increased Planck mass energy contents of various families of quarks facilitates the creation of a huge number of possible Baryon topologies resulting in the particle zoo of subatomic elements created in particle collisions within accelerator experiments - all of these elements can be easily modelled and accounted for using Tetryonic mass-energy Matter topologies

Additionally, the particles often referred to as gluons within the standard model can be easily accounted for and explained as being neutral tetryons within Tetryonic theory - where these neutral charge Matter topologies form a neutral Matter dielectric between charged tetryons to facilitate the strong force interaction and the formation of larger particles

Neutral tetryons (gluons) can also form particles in their own right (neutrinos and glue-balls), as can charged tetryons (charge-ball particles), most of which are short lived

Tetryonics reveals the previously hidden geometry and topology of electromagnetic fields and subatomic particles and the geometric relationship and interplay between electric permittivity and magnetic permeability within all EM field that results on the speed of light in any medium.

As well as the revealing a geometric source of all physical constants within physics itself, Tetryonic charge geometries show the weak force to be a magnetic dipole [edge] interaction between mass energy geometries and Matter topologies and the strong force to be a charge [fascia] interaction between Matter topologies themselves

The equilateral [quantised angular momentum] of ***inductive*** Planck mass energy geometries within squared [HIGGS] fascia of Matter topologies is what creates ***inertial*** properties of Matter at the quantum level

The strong force between charged parallel Higgs fascia of Matter topologies results in 'hidden' partitions of mass energy with in the Matter topologies of quark's and baryons leading to the inability of mathematics online to accurately model and understand the physics of creating these particles at the quantum level

Tetryonic charged mass energy geometries allows for the accurate 2D and 3D modelling of all Matter topologies and fields of Force interactions within physics

It reveals that the deuterium atom [not the hydrogen atom] is the quantum building block of all elementary Matter - the unique charge topology of deuterium (consisting of a proton, neutron and electron) can be related to the electromechanical topology and function of quantum synchronous converters.

These quantum synchronous converters absorb and emit mass energies via the rotating electrons [quantum rotors] bound to the nuclei by way of radiant bosons and photons [heat and light]

The net charge of Deuteron nuclei facilitates their binding together to form helium and larger atoms, while stored mass energy quanta within their Matter topology results in raised quantum grounds states that can all be modelled mathematically using Schrodinger’s wavenumbers

The simpler geometric charge topology reveals visually how the mass energy content of baryons directly affects the angular momentum and energy levels of photo electrons bound to atomic nuclei, in turn revealing that larger elements be created in two ways - namely by the addition of a neutron to a Hydrogen atom (as classically modelled in modern chemical physics) or through the raising of Planck mass-energy quanta within the deuterium Matter topology itself

Deuterium nuclei without any bound photo-electrons form quantum batteries with EM mass energies can be stored indefinitely without being released.
These nuclei can be arranged atomically in either a series, parallel or empty parallel configuration each of which affects the ground energy states of the respective nuclei created.
Where photo-electrons (quantum rotors) are attracted and bind to these nuclei (quantum batteries) the stored mass energies can then be released in a controlled manner via spectral line emissions, or energy can be added via spectral line absorption.

As photo-electrons are bound to the deuteron nuclei the energy levels are affected directly by the mass energy levels of the nuclei that they bind to, in turn affecting their KEM field energies
The square root linear momentum of KEM field energies normally creates a vector motion but in the case of bound electrons this vector motion is turned into an angular motion resulting in electron spin within the nucleus.

The direction of the spin is always reference with respect to the nuclear magnetic moment resulting in up and down electron spins and their associated magnetic dipole moments

The kinematics of KEM fields provides an easy visual explanation of Newton's 2nd law of motion - namely that deceleration can be seen as the removal of odd number quanta from the squared kinetic energy fields and acceleration can be viewed as the addition of odd numbered quanta to squared kinetic energy fields.

The addition or subtraction of odd numbered Planck quanta from squared energy fields results in changing square root linear momentum for the particles that these fields are associated with - this changing linear momentum over time can be equated to acceleration leading to Newton's formulation of Force = mass x acceleration [F = ma = dp/t = dmv/t]

Using the equilateral geometry of Planck's constant we can now unify classical mechanics with quantum mechanics and reveal the underlying dynamics of relativistic mass energies of motion (as well is providing an electromechanical explanation of inertia in the physics of Matter in motion)

Newton's vector linear momentum [p=mv] forces are revealed to be the geometric square root of Leibnitz's scalar energies [E/mv^2] with their associated inertial mass being a measure of the scalar energies per second [m=E/v^2]

Linear momentum [mv] is differentiated from vector velocities [v] through the equilateral geometry of energy per second [m] in tetryonics, with the total linear momentum of any EM field or system of particles being the vector some of the square root Planck linear momentum of the quanta in the fields comprising the system

Once the equilateral field geometry of KEM fields is revealed it is easy to show that the total energy of the field [E=mv^2] is the result of the kinetic energies [1/2Mv^2] plus the magnetic moment [1/2Mv^2] of any material topology in motion

This in turn allows for a rigid geometric differentiation of quantised angular momentum [Ω] in Planck quanta, the linear momentum [p] of any system and the classical angular momentum [vector rotation about a point] in physics

These geometric definitions of mass energy momenta in physical systems as portrayed in Tetryonic theory reveal a differing geometric relationship to that commonly portrayed in modern physics]i.e. neutralising right angled Pythagorean triangles]

Additionally Lorentz corrections factors are restricted to planar 2-D mass energies of KEM fields associated to particles in motion where changes of velocity force result in the addition or subtraction of equilateral Planck quanta from the KEM field geometry resulting in the physical expansion or contraction of Planck geometries within the field

Tetryonic theory's geometric definition and application of quantised angular momentum with respect to mass energy momenta in physics allows for the physical modelling of mass energy and Matter at all scales of physics and their unification of classical, quantum and relativistic mechanics

The 'squared' energies of quantum mechanics and statistical distributions of the math associated with quantum mechanics is now revealed in an entirely new light facilitating the macro scale modelling of all hitherto unseen quantum particles and processes.

The geometric relationships between charge, mass geometries and Matter topologies is easily visualised and applied to all physics revealing quantised angular momenta [QAM] to be the hidden variable of Planck's constant [h].....

The modelling of quantised angular momentum as an equilateral geometry allows for the elimination of Heisenberg's uncertainty principle and Bell's inequality from the foundational tenants of quantum mechanics

Both the position and momentum of particles and fields can be now modelled at any stage of a system's spatio-temporal development and evolution using these simple equilateral charged geometries of mass energy momenta

Precise rest mass energies of any Matter topology can be calculated from 1st principles allowing for accurate modelling of all quantum systems and even periodic elements - expanding our knowledge of chemical systems and processes

The Planck-Compton frequency, de Broglie wavelength, absolute rest mass and charge Matter topology of all periodic elements, compounds and molecules can now be calculated with absolute certainty and precision and can be related back to Avogadro's number for all elements in chemistry

The exponential energy levels of atomic nuclei and atomic processes of energy release can also now be shown to be the result of an underlying geometric Planck scale geometry inherent to all mass energy Matter within physics

Einstein's mass energy equivalence formula is shown to be a geometric relationship between measurements of energy per second and inertial mass..... combined with Tetryonics new definition of Matter as energy per second squared we can now show that Einstein's famous formulation is an incomplete formulation of the mass-ENERGY-Matter relationship that applying only to specific processes within our physical universe

The Lorentz corrections on which special relativity is based are shown to be WAVE-length and QAM corrections for the changing physical geometries of scalar mass energies per unit of time in spatial co-ordinate systems (c^2) and that additional time-based dimensional analysis must be taken into account in order to define and differentiate between electromagnetic mass and Matter in physics

The application of squared (equilateral) geometries to physics in the role of quantised angular momentum has been overlooked since the inception of physics itself, but with the inclusion of this geometry a rigid geometric grammar can now be imposed upon the mathematics of physics leading to the correction of many erroneous mathematical assumptions

An exact value from first principles for Planck's constant can be calculated and Avogadro's number can be confirmed and related to the absolute rest mass of hydrogen atoms.

A geometric representation of Coulomb's charged field interactions and the impedance of free space can also be provided for all physical processes allowing for a fast and accurate visualisation of energy mechanics at all scales of physics

Tetryonics theory’s equilateral charged mass energy and polyhedral Matter topologies allow for the modelling and differentiation of energy in all its forms within any spatial coordinate system providing a vast improvement over relativity's use of stress energy tensors and non-Euclidean geometries in modelling physical systems

All fields and particles can be defined and differentiated in terms of their charged mass energy geometries and Matter topologies respectively and the differentiation of elemental families into their generations can be easily accounted for through the addition of mass energies of motion to secondary KEM fields associated with each particle grouping

Inertial resistance to force can be modelled and explained through the equilateral geometry of quantised angular momentum when viewed as an electromechanical equivalent to an inductive loop of energy

Electromagnetic inertial mass can now be clearly defined as a measure of the inductive EM energy density of any charged 2D planar Planck geometry in any spatial co-ordinate system of measurement

3D Matter can now be viewed and modelled as the closed topology created by 2D mass energies through charge interactions in any spatial co-ordinate system of measurement per second squared

Additionally physical terms such as 'mass-less' particles are shown to be a misnomer as any field or particle must by definition contain energy per unit of time - and should be more appropriately re-termed Matter-less or weightless particles

Tetryonics theory defines, differentiates and unifies energy in all its forms (mass, Matter & Force) through the equilateral geometry of quantised angular momentum at the quantum level, allowing for the development of a unified field equation that models physics on all scales and reveals a common geometric thread to all the disparate fields of physics that to date have defied unification

Equilateral (SQUARED) energy fields of Planck quanta comprised of statistical distributions of (ODD) transverse bosons and (EVEN) longitudinal photons account for all the quantum mechanical processes of physics including EM field geometries and material particle topologies and electron spin

Principle quantum levels [1st Schrodinger wave-numbers] are shown to be the result of the series addition of deuterium nuclei in atomic elements with their resulting energy levels determining the squared energy levels of bound photoelectron KEM fields – in turn forming the foundation of discrete quantum jumps of electrons bound to atomic nuclei

The bound photo-electron can only transition between allowed squared energy levels permitted by the energy levels of deuterium nuclei to which they are bound and once free from the atomic nuclei the electron can emit or absorbed a continuous spectra of light photons - but while bound to the deuterium nuclei in atoms it can only have specific [squared] KEM energy levels

The complex, asymmetric tri-quark (9 tetryon) Matter topology of baryons directly affects the magnetic moment of protons and neutrons in motion making them considerably weaker than the symmetric axial Bohr magnetron of electrons in motion

As the Bohr magneton of photo-electrons is determined by the squared energies of its secondary KEM field confusion has arisen with respect to the allocation of spins to subatomic particles, Tetryonic geometries now correct for this and suggest that the electron historically viewed as a spin 1/2 particle is in fact a spin 3 particle under the formal definitions of spin rotations i.e. rotating at 120° can bring it back to an identical quantum state as the initial state measured]

Again Tetryonic theory and its energy geometries in addition to explaining and correcting electron spins also shows that the term electron spin can now be taken literally when modelled with Tetryonic geometries to provide an accurate description of the origin of magnetic moments for electrons, in turn undermining the foundational postulate of special relativity that these magnetic moments are the result of the distortion of spherical point charges and that relativistic Lorentz contractions apply to Matter topologies

Dirack's constant, or Planck's reduced constant [$h/2\pi$], is revealed to be a measure of the electric permittivity of a relativistic electron's KEM field, and the measurement of the associated magnetic dipole of the same KEM field results in the mistaken concept of 1/2 spins in the measurement of Bohr magnetons

The magnetic vector created by the Bohr magneton [or KEM field dipole] when measured with respect to the nuclear magneton [Proton magnetic moment] produces either a higher energy [parallel] or lower energy [anti-parallel] state for all atomic nuclei

It is the arrangement of these parallel or anti-parallel magnetic dipoles within atomic nuclei that determines the exact frequency-wavelength (energy level) of emitted spectral lines with the interaction of a particle’s magnetic dipole moment with external electromagnetic fields creating Lorentz forces

As electrons and protons have identical quantum Matter topologies [elementary charges] but differing mass energy contents the electron is able to create a much larger secondary KEM field (with associated magnetic dipole moment) for the same velocity [$\frac{1}{2}Mv^2$]

The energy level differences created by the parallel or anti-parallel spin coupling of electrons with protons or deuterium nuclei within atomic elements creates the hyperfine splitting and Zeemen effects observed and spectral lines

As the electron is now shown to be a complex non-spherical particle topology when it binds with protons to form hydrogen the unique Matter topology of both the proton and the electron [Hydrogen] create a small but detectable precession in the motion of the spinning electron as compared to that of the motion of the same electron in a deuterium nuclei

Additionally, as all periodic elements, compounds and molecules are comprised of deuterium nuclei (not hydrogen as currently supposed) the orientation and spin direction of electrons bound within these nuclei results in the diamagnetic and paramagnetic properties of various macro-scale materials

Tetryonics theory reveals that the mass charge ratio is of particles are measure of the constituent mass energy geometries that go into making the particle's final Matter topology that we observe a measure

But unlike the current mathematical approach the geometric approach of Tetryonics reveals the hidden mass energy partitions within the Matter topology of all subatomic particles and that particles such as tetryons (the quantum building blocks of all Matter) are in fact hidden within the debris of current collider results.

4 quantum charge tetryons have the same1/3 partial elementary charge as some quarks, and can be measured as having the same mass charge ratio's as charged leptons such as positrons and electrons in collider experiments.

…….. To be continued [QED, Chemistry, Cosmology, Mathematics, Biology and economic theory]

answers@tetryonics.com

ABRAHAM [2014]

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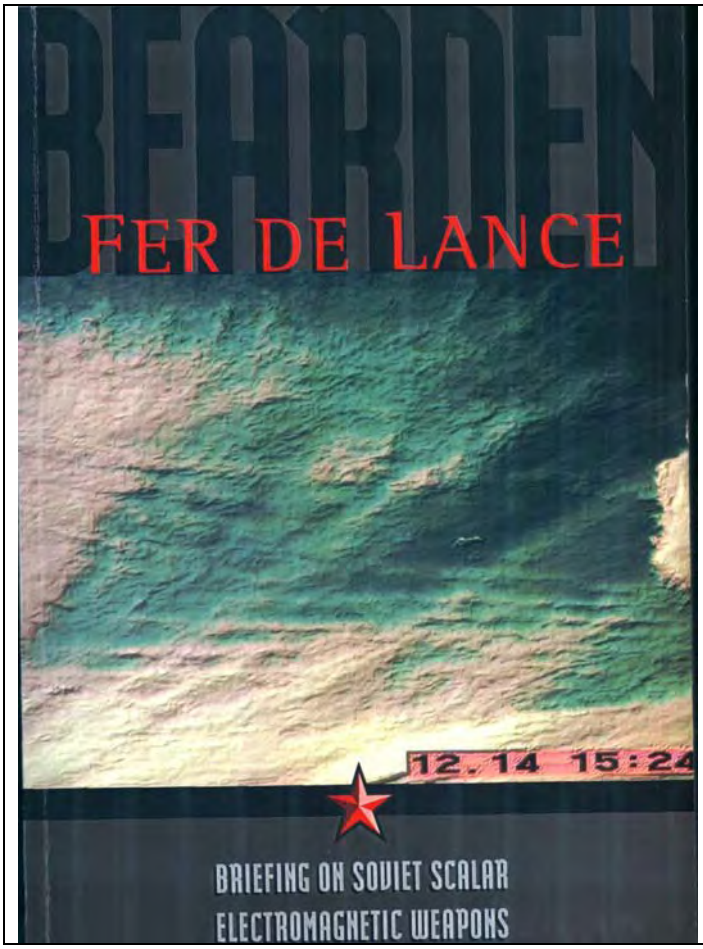

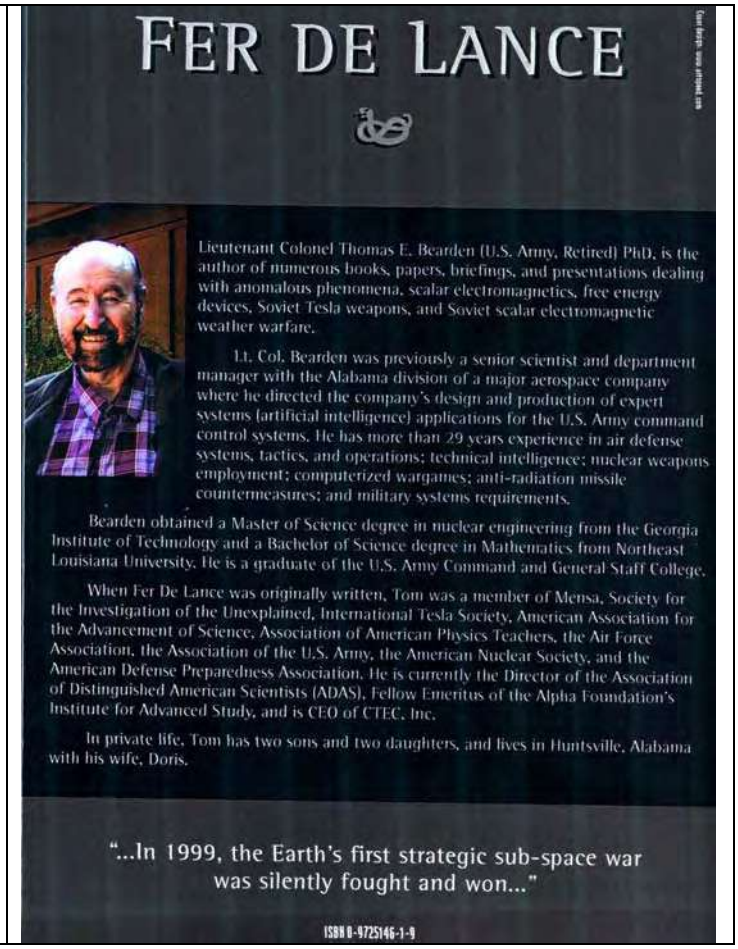

FER DE LANCE

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When Fer De Lance was originally written, Tom was a member of Mensa, Society for the Investigation of the Unexplained, International Tesla Society, American Association for the Advancement of Science, Association of American Physics Teachers, the Air Force Association, the Association of the U.S. Army, the American Nuclear Society, and the American Defense Preparedness Association. He is currently the Director of the Association of Distinguished American Scientists (ADAS), Fellow Emeritus of the Alpha Foundation's Institute for Advanced Study, and is CEO of CTEC, Inc.

In private life, Tom has two sons and two daughters, and lives in Huntsville, Alabama with his wife, Doris.

"...In 1999, the Earth's first strategic sub-space war was silently fought and won..."

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Sweating done by red_gonzo.

Note: sometimes formatting of the text may be a little fuzzy. It's all because the OCR process didn't go as smoothly as I expected. Also there may be some errors inside text so be vigilant. In any case share this book, send emails to people about knowledge contained in it. Since this book talks about the most terrifying weapons present today the information in it is even more of value. But knowing an old saying »the knife cuts both ways« one can also use the same knowledge in order to heal ourselves since it seems that our body already does it using the physics described inside. Hopefully the latter will prove to be the most useful way to use this old but forgotten / supressed knowledge.

The contents include the 2002 update and the older 1986 briefing with slides.

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The Russians have sustained the largest weapons development program ever launched by any nation, and they have kept it effectively hidden from prying Western eyes. I have called this program "Fer-de-Lance," after the deadly South American pit viper of that name.

The dreaded fer-de-lance is a snake of great agility and lethal effect. It often ambushes its hapless prey, striking unexpectedly and without warning. Its first sudden strike is usually lethal to its victim, which promptly expires in writhing agony. Since the Soviet development of scalar EM weapons has been designed for the same purpose, the name seems appropriate.

2002

Overview[1] and Background of the Energetics[2] Weapons Threat

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LTC, U.S. Army (Retired)
Director, ADAS

September 15, 1998
Update

Note: We have placed this update as a section in front of the original paper. This leads to some redundancy, which remains to insure clarity.

[1] This is an updated and slightly sanitized version of a paper originally prepared for and transmitted to selected Senators and Congresspersons.
[2] The present name of the old KGB is the Federal Security Services. The leopard's spots remain the same, regardless of its new name—at least for a die-hard old communist faction of it. Presently the helm of Russia has been turned over to a new Premier who has an extensive KGB background. However, Putin has chosen to differ from the traditional KGB outlook and seems intent on becoming America's trusted cheap oil partner and supplier, in a bid to help his economy and pump much-needed funds into it. His friendship with George Bush may be one of the turning **points** of this new century He at least has achieved sufficient control over much of the KGB to get on with trying to solve his economic problems and break the old "die-hard communist" mold a **bit**

2002 OVERVIEW AND BACKGROUND

For some time, Russia and several other nations have possessed highly advanced "extended-electromagnetics" *(energetics)* weapons of a very novel kind, using a dramatically extended electrodynamics theory {1}. To comprehend these weapons requires a combination of non-Abelian electrodynamics in at least the 0(3) gauge symmetry {2}, general relativity, Bohm's interpretation of quantum mechanics {3}, and the use of time-domain (scalar) energy, fields, and potentials to directly enter distant 3-spatial points without propagating energy through 3-space. It also requires correcting many of the serious errors in classical electrodynamics. Probably the most elegant and applicable extant model to deal with these phenomena and weapons is Sachs' {4} unification of general relativity and extended electrodynamics, particularly as implemented in O(3) electrodynamics. O(3) allows direct engineering by modified EM means.

Most of these energetics weapons are more advanced than what has previously been known to the U.S. military, intelligence, and scientific communities, although parts of the communities are finally making real progress in understanding such "revolutionary" areas. For example, every major weapons lab on earth seems to have discovered longitudinal EM waves and longitudinal EM wave weapons—the scalar interferometry we have been discussing for so long {5}. A major contributing factor holding back U.S. catch-up is that the flawed foundations of Maxwell's 1865 theory {6} have not been changed by the Western scientific community.

Historically, the scientific community exerts resistance to substantial innovation. Often 40 to 50 years are required to do what can be done with a concerted effort in four years. The Manhattan Project in WW II is a notable example of where the scientific community made a maximum effort and did a difficult job in four years. Also, "skunk works" efforts continue to be utilized for very rapid development when something really advanced is to be done and done quickly.

With the U.S. substantially behind in these "new" strategic superweapons, a new Manhattan Project would appear to be advisable and warranted. There are at least some indications that such may actually be going on at last. We hope the indications are true.

A sobering development that occurred early this year (2002) was China's deployment of both quantum potential (QP) weapons {7} and *negative energy* electromagnetic pulse (EMP) weapons (a type which we originally called the *MindSnapper* to disguise its true nature) {8,9}. The QP weapons are the dominant weapons on Earth today, followed closely by negative energy EMP weapons in second place. We have not been able to ascertain exactly how many nations have the negative energy EMP weapons, but it is at least five at the time of this writing.

The U.S. is still well behind in the use of special "engines" (special curvatures of spacetime and their dynamics, but achieved with higher group symmetry electrodynamics) for directly engineering the mind itself, and for producing *nonmaterial* robot systems made totally of such engines—"causal system robots" which we will mention later. Several of the Western nations do accomplish work in the mind control area, but use a sort of "brute force" method oriented on frequency and frequency changes, etc. where the true active mode is the unsuspected transformations of the U(1) electrodynamics to a higher group symmetry unified field theory electrodynamics, accomplished by the human body tissues and structures themselves.

Western scientists have not realized that all EM energy in 3-space actually comes from the time domain *to* each point in 3-space and *returns from* that 3-spacc point back to the time domain.[3] Hence "propagation" of 3-space EM energy is actually the propagation of a "circulation" of EM energy between the time domain and 3-space, involving each 3-space point presently said to be "occupied" by the energy. Unfortunately, Western science is still unaware that *no observable exists in time,* a priori, since by definition it has no extension in the time dimension at all {10}. Instead, an observable *continually recurs* as a frozen 3-space snapshot of an ongoing dynamic 4-space interaction, due to the continual repetition of the observation process which is the application of a *d/dt* operator to the ongoing 4-interaction. Hence, we "see" physical reality (3-space reality) similarly to the way we view a "motion picture" series of successive frozen frames. The major result of this flaw (mistaking a 3-space observable as a 4-spatial cause) in Western science is that Western science still extensively substitutes effect for cause—e.g., in the notion of a separate 3-force acting on a separate 3-mass. No such situation exists in nature, and nothing "moves" or "changes" in 3-space alone. For an entity to exist in time, it requires at least 4-space because a time length is required. Nonetheless, the West is making progress. If some of its scientific dogma can be overcome, the younger scientists will break free and readily do the job required for the defense of this nation.

Mad Scramble of Soviet Science After the End of WWII

During WW II the West produced a great technical breakthrough and obtained the atom bomb as a decisive new weapon. While speeding up his own atomic

[3] Specifically, energy comes from the time domain to the negative 3-charge, thence to the positive 3-charge, thence back to the time domain in a *4-circulation* of EM energy. With extra energy *appearing* and present at the negative charge due to entering 3-space there, and with less energy present at the positive charge due to the energy *leaving* 3-space there, there is a delta in energy density (pressure) across a dipolarity, oriented from negative to positive. That is the exact basis of the T. T. Brown unilateral thrust force, and the force used in the "lifters" experiments today. To calculate the **force, th**e long-unaccounted Heaviside energy flow component must also be accounted— not just the weak Poynting flow component.

weapons program[4] as a result, Stalin also ordered his own Academy of Sciences to quickly derive the next great new technical breakthrough, and he held the top scientific leaders themselves personally accountable to him, to see that it was done at all speed (Figure 1).

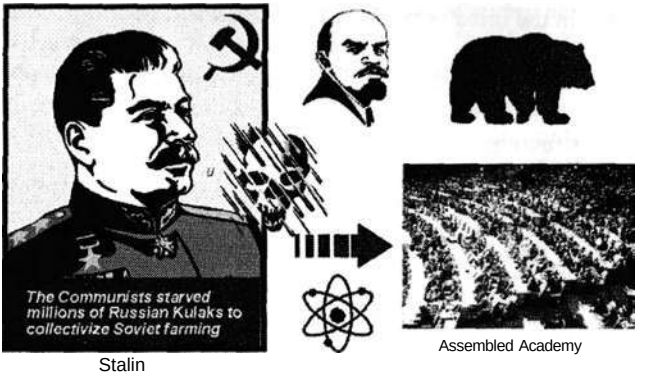

Stalin

Assembled Academy

"The destiny of communism has been frustrated by the U S development of the atomic bomb That is not the last great technical breakthrough The next one WILL be Soviet! You will provide me with that great new technical breakthrough at all speed, or I will have your heads Do I make myself dear, comrades?"

Figure 1 Stalin's dictum removed any resistance from his scientific community.

Simply put, Stalin placed the heads of the Soviet scientific leaders on the chopping block, since he was an absolute dictator and often killed or imprisoned those who opposed his instructions. To survive, the leaders of the Soviet Academy had to demand the utmost of their subordinates, because they themselves had to report their progress or lack of it to a dictator who would and did take swift action if they did not produce results. Thus, Stalin simply bypassed the usual scientific posturing and protracted delay so typical of our Western scientific bureaucracies.[5] If the Directors of the Russian scientific

[4] At the Potsdam conference, after Truman informed him the U.S. had just exploded a great new explosive weapon, Stalin secretly called the head of his nuclear weapons program and ordered him to accelerate the Soviet nuclear weapons program.

[5] As a simple example, the U.S. National Academy of Sciences, National Research Council, National Academy of Engineering, and the National Science Foundation—and all the electrical engineering departments at all the universities in the U.S.—have not yet recognized that all EM circuits and systems are in fact powered by EM energy extracted directly from the seething local vacuum by the source charges and dipoles in the circuit or system, and particularly by the broken symmetry of the source dipole in the generator or other primary power source. They also have not yet solved the more than a century-old source charge problem, but continue to support engineering models assuming that the charge *freely creates* real EM energy out of nothing at all, in total violation of the conservation of energy law, and pours that created energy out, freely and continuously, to establish its associated fields and potentials and their energy reaching across the universe. The agencies thus unwittingly advocate perpetual motion machines on a scale unparalleled in history. They continue to support an electrical engineering model and a classical

community dragged their feet and did not push his desired program to the limit, their heads would roll—and some did.

As a result of Stalin's forceful intervention, the entire Soviet scientific community was galvanized into a most intensive review of all of physics. The scientists desperately sought to quickly uncover potential breakthrough areas that could be developed into the great leap forward that Stalin demanded. They had to have progress, and they had to have it rapidly.

One Institute Had 2,000 PhDs and a Full Support Staff

Large review institutions were quickly set up, staffed with the best Soviet scientists and support translators and teams. One such search institute involved some 2,000 Ph.Ds along with their support staffs. Soviet ships brought in shiploads of copies of all the scientific journals of the West—from the beginning—, and they were reviewed paper-by-paper, page-by-page. Anything novel and implying new scientific possibilities, or anything that had not been adequately followed up, was laid aside in a "select" pile for further review and decision by the best Soviet theoreticians available {11}.

One gets a new physics by discovering shortcomings and flaws in the old one. This intensive Russian search almost immediately uncovered the deep flaws in classical electrodynamics—flaws that have been propagated throughout most other branches of science. Classical electrodynamics (and electrical engineering) is particularly beset by hoary flawed foundations problems, dating from at least 1865. As an example, the equations did and still do assume a material ether, and they have since the beginning! Not a single equation was changed when the

electrodynamics model which *do not even model* the active vacuum and its exchange with every charge, much less a *broken symmetry* in that exchange. So none of those agencies even knows what powers an electrical circuit, 45 years after the proof of broken symmetry was accomplished by Wu and her colleagues in 1957, and the Nobel Prize was then quickly awarded to Lee and Yang *the very same year* (1957) for predicting that broken symmetry revolution. In the modern view a charge is a dipolarity, when its vacuum interaction is considered. As a dipolarity, every charge exhibits the proven asymmetry of opposite charges, in its interaction with the active vacuum. The charge thus extracts and outpours real observable EM energy from the vacuum, freely and continuously, and it exhibits COP = oo. Those agencies—along with nearly all the rest of the U.S. scientific community—still naively assume that a COP>1.0 EM system (i) is impossible, (ii) is against the laws of nature, and (iii) is a forbidden perpetual motion machine. In nearly half a century since the discovery of the broken symmetry of opposite charges, those agencies have yet to apply that finding to electrical engineering and engineering curricula. Frankly, since they have dragged their collective feet for nearly a half century on extracting EM energy from the vacuum, what is needed is a Stalin to put his iron boot firmly to their posteriors and call their attention to it in language they cannot ignore. *The pollution of the planet for energy purposes and the imminent oil and energy wars that will ravish the earth are directly due (i) to this inexplicable dogma upheld by the scientific community and (ii) to the community's continued falsehoods equating EM COP>1.0 to perpetual motion machines.* The continuing failure to **incorporate** the **active vactnun** exchange—and its broken symmetry—into electrical engineering and classical **electromagetics a**lso poses an unacceptable threat to the continued survival of this nation.

Michelson-Morley experiments in the 1880s destroyed the material ether itself. The classical EM model also assumes a flat local spacetime (falsified by general relativity since 1915) and an inert vacuum (falsified in particle physics for several decades). It still assumes the same EM field in mass-free space as exists in mass—a non sequitur of major impact. Just to make the Maxwell-Heaviside equations easier to solve and avoid numerical methods, the *totally arbitrary* Lorentz symmetrical regauging[6] discards all EM systems far from equilibrium with their active vacuum environment. In fact, there is no "active vacuum environment" in the model, much less a broken symmetry in that exchange. Yet that very broken symmetry is exhibited by every charge and dipole {12}, and thus by every EM circuit and system. That asymmetry is involved in the continuously increasing giant negentropy poured out by every charge in the universe, thereby generating all EM fields and potentials and their energy, eventually reaching even across the universe, *and with perfect macroscopic order and time duration as long as one wishes*. Indeed, all electrodynamics is in total violation of the second law of thermodynamics, to any *macroscopic* size level and time duration desired.[7]

The terribly flawed electrodynamics model was completely overhauled by the Russian scientists *very* quickly, and the work was accomplished by some of the best nonlinear scientists in the world. Already present at the time were many things available to assist in dramatically extending {13} the hoary 1865 Maxwellian electrodynamics {6}. Gauge field theory was available since the turn of the 20th century, and the top theoreticians could readily see that something more than Abelian electrodynamics was firmly required in particle physics. The Yang-Mills {14} theory met that need in 1954 by originating non-Abelian gauge theory.

Situation in the Early 1950s

By 1950, Stalin's scientists had the beginnings of what they dubbed "energetics" {15,16}, which we would dub an "engineerable unified field theory" {17,18,19}. Longitudinal EM waves were primary {20,5} in that more

[6] Actually a version of this symmetrical regauging was first performed by Ludwig Valentin Lorenz, "Ueberr die Identitat der Schwingungen des Lichts mit den elektrischen Stromen," *Ann. Phys. Chem.*, Vol. 131, 1867, p. 243-263—only two years after Maxwell published his seminal theory in 1865. The paper is also published in English, as Ludwig Valentin Lorenz, "On the identity of the vibrations of light with electrical currents," *Phil. Mag.*, Ser. 4, Vol. 34, 1867, p. 287-301. Unfortunately not much attention was paid to Lorenz's effort, since he independently derived electrodynamics. Decades later, when H. A. Lorentz also published symmetrical regauging of the Maxwell-Heaviside equations, he was given credit for it with no further mention of Lorenz. A proper historical summary of this has been given by J. D. Jackson and L. B. Okun, "Historical roots of gauge invariance," *Rev. Mod. Phys.*, Vol. 73, July 2001, p. 663-680. This is an excellent coverage of the history of who actually did what and when, and who got credit for it.

[7] This dramatically extends the size regions (microscopic through colloidal) and the time durations (momentary to two seconds) where the second law is known and proven not to necessarily apply.

fundamental approach. By the mid 1950s, one can pick out of the open literature {21} increasing incidences of prototype Russian energetics weapon testing around the world. In 1960, Khrushchev {22} spoke obliquely of these "fantastic new weapons" that were "just within the portfolio of the Soviet scientists," so to speak. Commercial aircraft sightings (Figure 2) and the reports of their captains and crews are also a particularly significant source of sightings of Russian energetics weapons tests, as are sightings by ships' crews (Figure 3) and ground observers (Figure 4).

Figure 2 Typical shield test, northern route to Japan, seen by passing airliner.

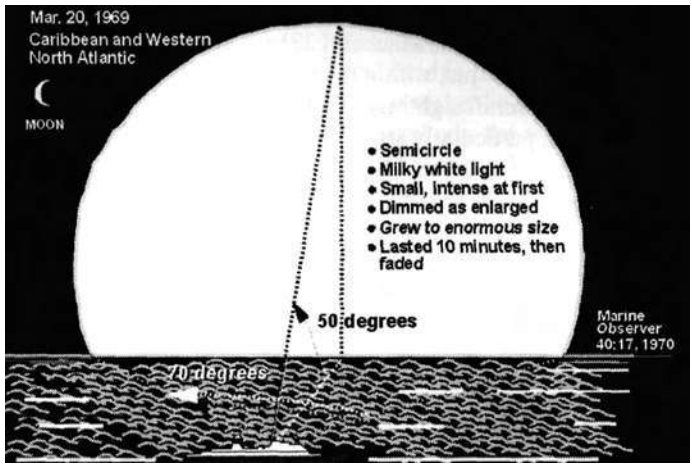

Figure 3 Giant missile shield test seen by passing ship's crew.

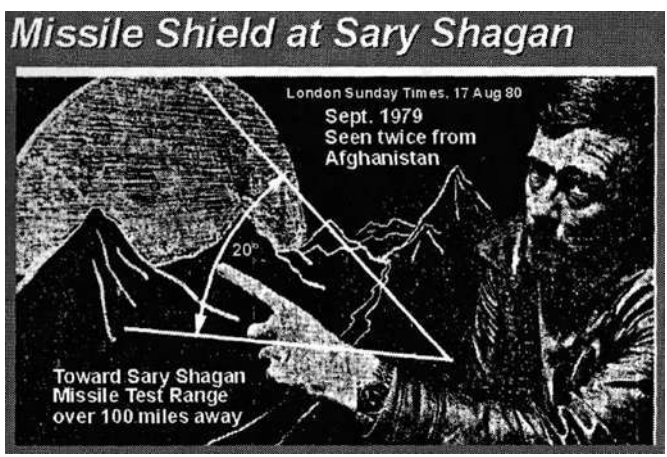

Figure 4 Nick Downie's sighting from the ground of distant Soviet missile shield tests.

1963 Deployment and Immediate Use of Scalar Interferometers

The first huge scalar potential interferometers {23,24} of strategic range and power (Figure 5) were deployed by the Soviets in 1963, and one was used to kill the U.S.S. Thresher nuclear attack submarine (Figure 6), leaving clearly recognizable signatures {25}.

Since 1963, the Russians have had the equivalent of more than seven additional Manhattan Projects (using the Russian 5-year program instead of the 4-year Manhattan Project), back-to-back, in development of energetics weaponry. The energetics weapons have never been given to the regular Russian forces. Instead, all research, production, siting, manning, and employment are by the KGB and still under ruthless KGB control by die-hard communist factions {26}.

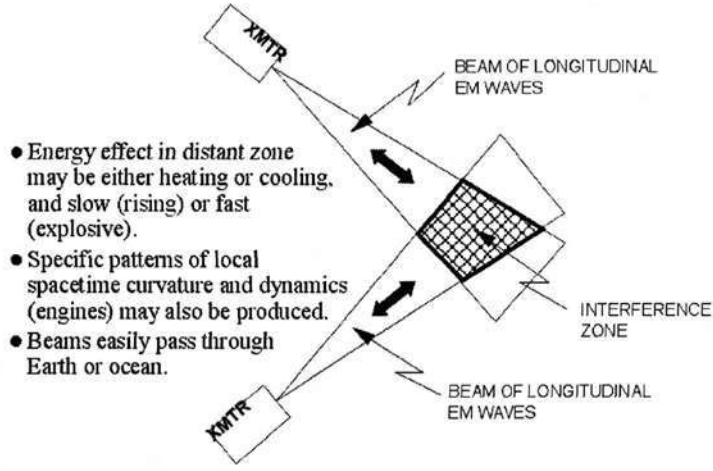

Figure 5 Scalar (longitudinal EM wave) interferometer.

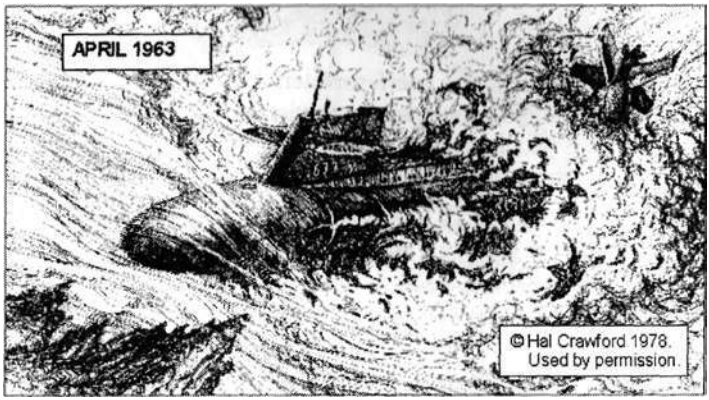

Figure 6 Kill of the U.S.S. Thresher. With her controls jammed, the hull of the doomed submarine implodes when she reaches crush depth

An Example of Russian Technology Astonishing Western Scientists

Some years ago, coordinating with a Western but non-US aerospace firm, I furnished the firm with the names and addresses of some Russian scientists in Moscow, since it was clear from their internet site that the scientists were on the fringes of the KGB energetics weapons program. An excellent European engineer fluent in Russian was sent in, several times. Several unusual things were demonstrated to him, including (i) transmitting enormous energy down a very thin wire, and (ii) cold molding, or turning metal into a liquid at room temperature, pouring it into a mold, and then letting it sit and harden. All without heating.

The engineer also closely questioned the Russian scientists about Russian . energetics weaponry, a subject the scientists were most reluctant to discuss. Finally they admitted the energetics weapons existed, and they actually obtained a meeting between the engineer and the KGB General who had directed the Soviet energetics weapon program for more than 20 years. In the meeting, the General coldly admitted the weapons, stated that "Of course you are not going to be allowed to see *those!"* and confirmed that somehow the Russians obtained everything the present author writes, as soon as he writes it {27}.

The engineer then brought the Russian scientists to his aerospace firm in that Western nation, where the scientists demonstrated cold molding to assembled scientists and some U.S. personnel. I forwarded a written explanation to the Western scientists of how the cold molding was performed technically. Later, on calling the engineer again, I discovered that the foreign authorities of that country had suddenly classified everything over there, and the engineer could no

longer even talk to me without filing a Foreign Intelligence Contact Report. My own part in all this was completely open-source, pro bono, and I had already written of it openly and publicly.

Softening of Metal at a Distance Was One Effect Used Against the Challenger

At any rate, earlier I had openly advanced (and printed) the same mechanism, since it was the metal softening mechanism used by the KGB to kill the U.S. Challenger spacecraft in 1986. Publicly I had been resoundingly called a lunatic for advancing such a "preposterous" thesis. Nonetheless, metal softening by a distant LWI (longitudinal wave interferometer) was definitely utilized as part of the kill of the Challenger, as a close colleague here in the U.S. proved *experimentally*, detecting and demonstrating that metal-softening Russian signal prior to the kill of the Challenger. He amplified the signal and demonstrated on the bench its nearly instant softening of nails, rendering the nails momentarily as limp as wet noodles (Figure 7). Nails from the same box, not exposed to the signal, remained hard and could be hammered into a board. Not so the nails from the box that were exposed to the amplified Soviet signal! Those nails folded up like a wet noodle when tapped with a hammer, and could not be driven into a board.

Working unpaid with the foreign scientists, we had in fact obtained the "smoking gun" proving that this cold molding capability rigorously existed in the KGB inventory. Further, it had existed so long that the KGB had essentially *declassified* it so that the civilian Russian scientists seeking employment funds from the West could utilize it.

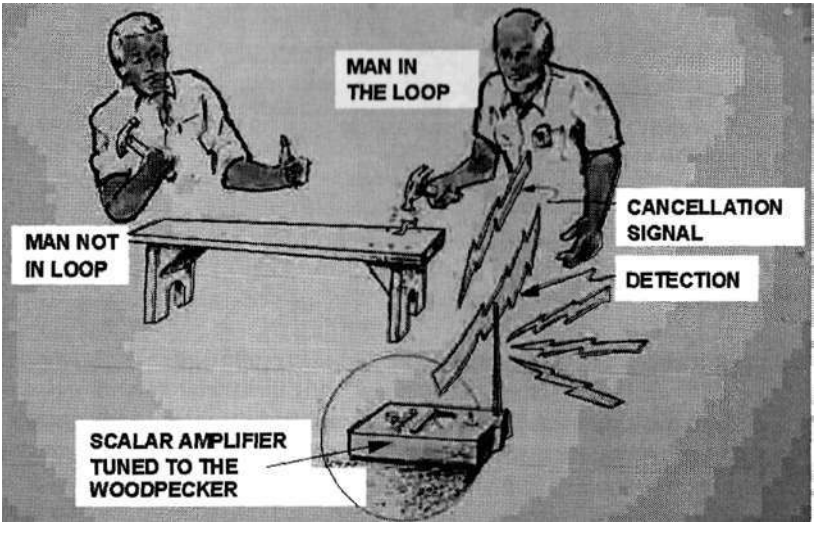

Figure 7 Proof of metal-softening signal: Golden softens nails with amplified Woodpecker signal.

Energetics: Three Branches and a Strategic Deception Plan

The *energetics* weapons use exotic polarizations of EM waves, quantum potentials, and the "infolded" LW electrodynamics (both scalar and longitudinal photons) inside and comprising every "ordinary" transverse EM field and wave. The KGB energetic weapons are categorized (Figure 8) according to what they are targeted against:

(1) against inert matter, fields, and potentials etc., that branch of weapons is called by the same name, *energetics* weapons.

(2) Against living tissue, bodies, cells, biofields, biopotentials, etc., they are known as *bioenergetic* weapons. Disease-induction electrodynamics such as used to irradiate the U.S. Embassy in Moscow are examples of bioenergetic weapons.

(3) Against the mind, thought, memory, behavior, and the mind-body coupling mechanism, they are known as *psychoenergetic* weapons. Particularly in the latter mode, these weapons also use time-polarized (scalar) EM waves and time-polarized (scalar) photons as well {28}.

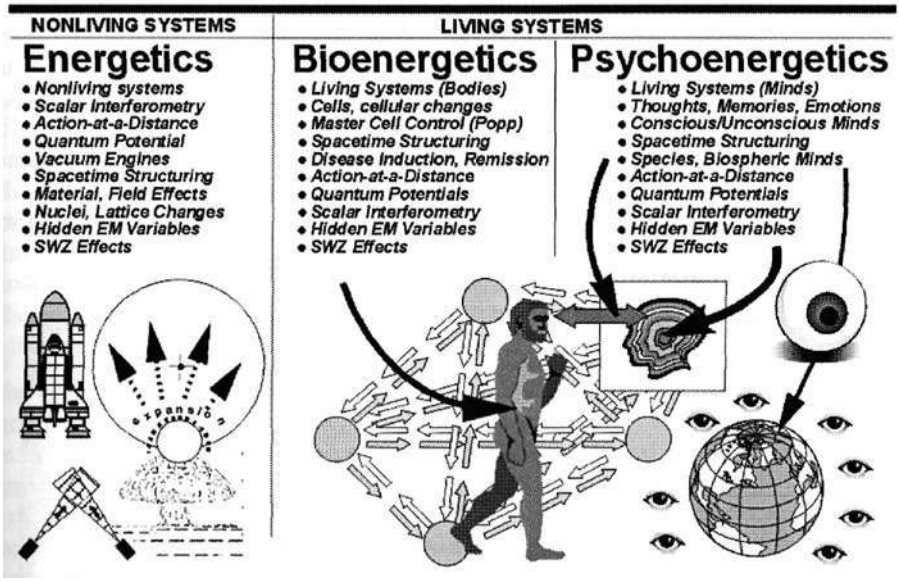

Figure 8 Three branches of Russian energetics weapons.

The KGB also implemented an elaborate and continuing deception plan, as is standard military practice for any great strategic attack plan. The KGB deception plan has been highly successful {29} in keeping the United States convinced that these weapons do not exist, and convinced that the standard strategic nuclear weapons possessed by the West are "leading" and "superior."

Strategic Attacks Scheduled and Why We Were Not Destroyed

Indeed, the West's nuclear weapons are inferior to Russian energetics weapons, particularly to the quantum potential weapons (Figure 9) deployed at the end of 1989 and to the newer "causal system" weapons deployed since the first of 1999, where *functional robot systems* (Figure 10) are made of nonmaterial spacetime curvatures and their dynamics only! In the event of a full strategic Russian energetics strike, an opening strike with quantum potential weapons {30} will dud all nuclear weapons on earth, all nuclear power systems, and all nuclear propulsion systems in about 10 minutes. This takes care of most of the U.S. strategic armament, *within the first 10 minutes.* The publicized strategic weapons of this nation have in my opinion been almost defenseless now for at least a full decade {31,32}, but I also believe that situation may be rapidly changing for the better.

A friendly little foreign nation *does* have such weapons including QP weapons that operate in multiply connected spacetime (MCS). That little nation has been

responsible for our continued survival and has continued to deter the planned KGB strategic energetics strikes upon the West. There are indications (though still not certain) that at least one—and possibly two—other friendly Western nation also possesses such weapons.

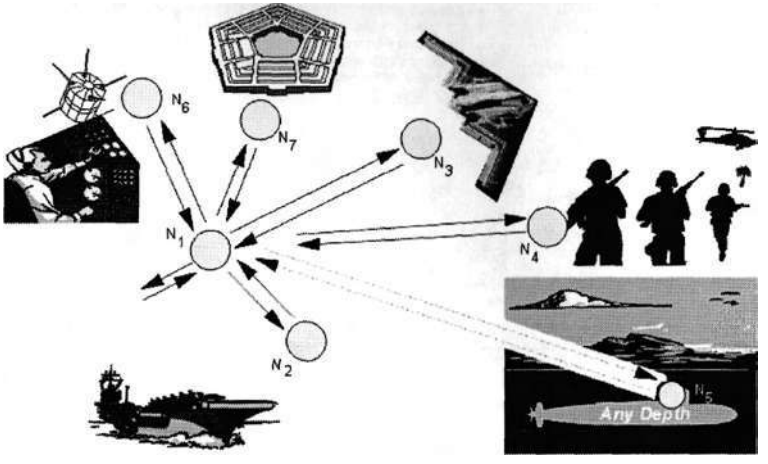

Figure 9 Quantum potential instantly attacking widely separated targets.

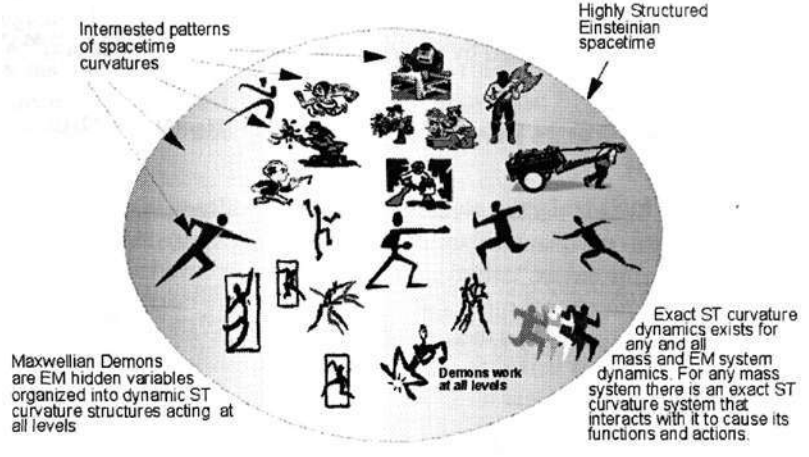

Figure 10 Causal system robots (CSRs). These are sets of ST curvature engines, with functions organized into a single complex weapon system with communication, propagation, weapons effects, and command and control functions incorporated. When the CSR interacts with mass, the mass performs those system functions.

Twice in 1997 alone *we were within days of the scheduled total strategic destruction of the U.S. by die-hard KGB energetic weapons,* with all-out strategic attacks actually scheduled in each case. The first attack was scheduled in latter February but was quickly countered. The attack was immediately rescheduled for May 1. The U.S. intelligence and scientific communities were apparently unaware of what was happening, and still do not believe it. However, as this author previously informed appropriate government agencies a few days prior to the attack scheduled for May 1, 1997, U.S. intelligence agencies certainly intercepted my urgent personal fax directly to the prime minister of the friendly little nation, urgently requesting that the "sane" command and control of the countering MCS/QP weapons be changed to "insane" control and spelling out the compelling reason why it was necessary.

In the insane weapons control mode, the computer periodically (say, every two hours) initiates launch sequence for the weapon, automatically. If any operating personnel remain alive on site, there is a designated short period in the sequence where the onsite personnel can countermand the order and abort the launch. If (he order is not countermanded, the launch is not aborted and the "doomsday" weapon automatically fires. In that case, KGB military power and most of Russia would disappear from the face of the earth.

This was necessary to nullify the impending strikes of MindSnapper negative energy EMP weapons {33} on those critical friendly QP weapon sites to instantly kill all personnel on site. Strike by the MindSnapper instantly kills every living thing in the area, and a protracted contamination remains whereby the struck areas emit longitudinal EM waves. If one attempts to insert new crews to resume operation of the weapons, the crewmen sicken and then die in the entry attempt. First, increasingly severe interference between mind and body control occurs. Then the individuals waver, lose consciousness, go into seizures, and their minds gradually de-couple from their bodies and they die. Fortunately, alter my fax message the C3 system was changed to the insane mode, and the Russians were notified, just in the nick of time {34}. To prevent their own destruction by the certain insane counterstrike, the KGB aborted the looming strategic strikes.

Ironically, at about the very time that the KGB strategic armada was standing down, Secretary of Defense Cohen {35} was making the following statement in Georgia:

> *"Others are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves...So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...It's real, and that's the reason why we have to intensify our efforts."*

Almost certainly Secretary Cohen had no knowledge that, so to speak, a great Sword of Damocles hanging over his head was being removed by a friendly little foreign nation at that very moment, as he uttered those words apparently referring to the older longitudinal EM wave interferometer weapons. I suspect that Dr. Cohen is to this day still unaware of the incidents that were ongoing at the time of his poignant statement.

Attempts to Alert the Nation

We alerted the President and the National Security Council as early as 1984 (Figure 54). In 1998 we also furnished selected Senators, Congresspersons, and certain high-level U.S. government agencies with color copies of a 200-page briefing and expose {36} of—among other things—these weapons, their testing, and their clandestine use against the U.S. since 1963. Because of the nearly 50 years of demonstrated induction of diseases {37, 38} (Figure 11) in personnel in the U.S. Embassy in Moscow (e.g., responsible for the deaths of three U.S. Ambassadors), we also included part of the briefing on the Priore work {39} (Figure 12) showing the remarkable cellular changes (time-reversal of diseased states back to a previous earlier healthy condition) that can be and had been experimentally induced by energetics under rigorous scientific controls.

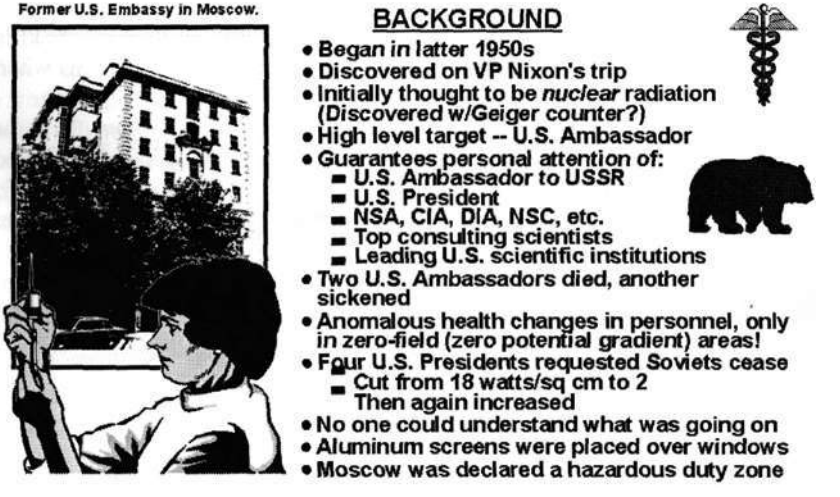

Figure 11 Microwave radiation of U.S. Embassy in Moscow.

We proposed to the DoD a very rapid, high priority development program to develop portable suitcase-sized computer-controlled treatment devices (Figure 13) capable of saving a majority of mass casualties—e.g., from a professional large anthrax attack on a major population center.

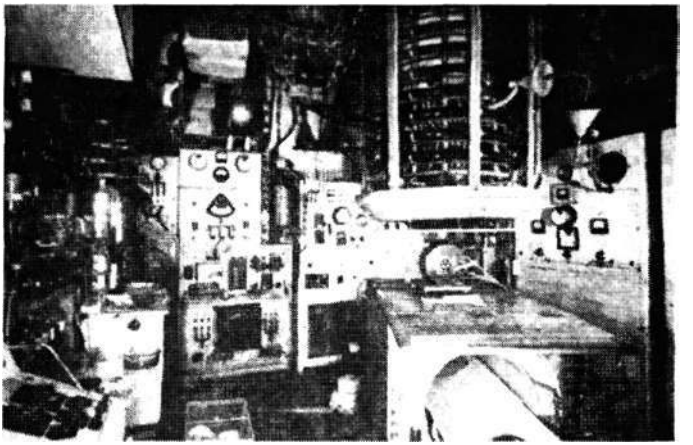

Figure 12 Priore[1] laboratory and device for treating small animals.

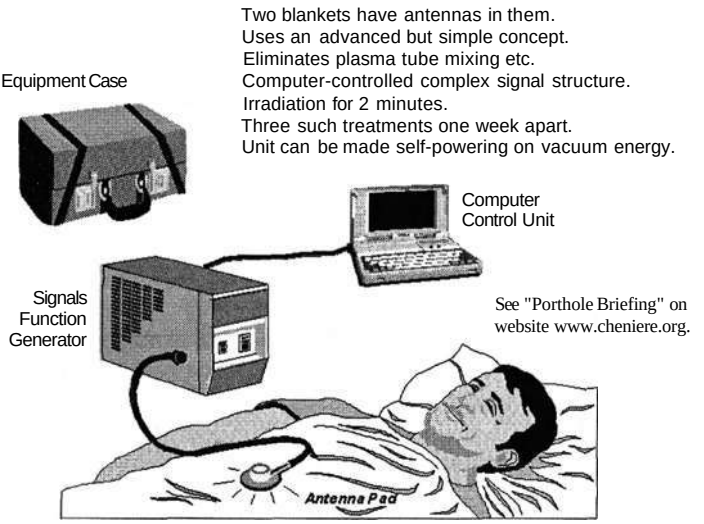

Figure 13 Portable unit for rapid treatment of mass casualties.

The Responses

The responses—or more exactly the near total lack thereof—by various U.S. government agencies were enlightening. E.g., the National Institutes of Health (NIH) never let the package out of its Policy (i.e., *political spin control)* section. It did not check a single scientific reference on a proven method documented in the hard French scientific literature for reversing terminal cancer, infectious diseases, etc. Not a single scientist called me to discuss such a proven, revolutionary effect. Instead, the NIH Policy section simply shipped the package over to the DOD as "their problem, not ours." That was because the package also explained how the Gulf War Disease was induced, including how semen can cause infection of the wife, and how the structured body biopotential of the sickened veteran can induce similar structuring of the biopotentials of his children by proximity, thus inducing various aspects of the disease.

Effective Survival Treatment of Mass Casualties Could Be Developed

Meanwhile, we had uncovered a way to dramatically speed up the Priore healing process, and use only normal transverse EM radiations for ready adaptation of existing equipment, while still forcing the same time-reversal of diseased and damaged cells back to normal. Just much faster. This meant that very small, suitcase-sized treatment units (Figure 13) could now be developed in a reasonable time—e.g., in two to three years, given a high priority, intense effort, adequate funding, and a carefully chosen scientific team.

So, we proposed a crash development by DOD of a small, suitcase-size portable device for quick, mass treatment of mass U.S. casualties following terrorist attacks on our cities using weapons of mass destruction. Eventually an innocuous reply (forced by my congressman) simply stated "it was not supported by the literature." In the package, of course, I had *specifically cited* the numerous scientific papers in the French scientific literature reporting and proving the experimental results. I had also worked 14 years to decipher the mechanism actually performing the revolutionary healing accomplished in rigorous animal testing by the Priore team. Eleven years after suppression of the Priore effort, the University of Bordeaux, which had been pressured into rejecting Priore's doctoral thesis, did approve and publish a doctoral thesis by Perisse on the work {40}.

The National Science Foundation (NSF) did not reply at all. Yet at the time the official strategic threat to the United States listed WMD attack on our cities and great population centers as the greatest threat of all (Figure 14). Today, as everyone knows we are in a war after the terrorist attack on the twin towers in New York and on the Pentagon on September 11, 2001. The U.S. government clearly recognizes that it is not a matter of if additional attacks on the U.S. cities and populace will occur, but *when.* The terrorists are also known to have already

infiltrated weapons of mass destruction such as biological warfare weapons (anthrax, smallpox, bubonic plague, etc.) Nonetheless, apparently the NSF simply did not believe a novel but *rigorously demonstrated-in-the-1960s* unorthodox process that could potentially save most of those millions of Americans who otherwise will surely die—and who *are* going to die in the first major WMD strike on our population centers.

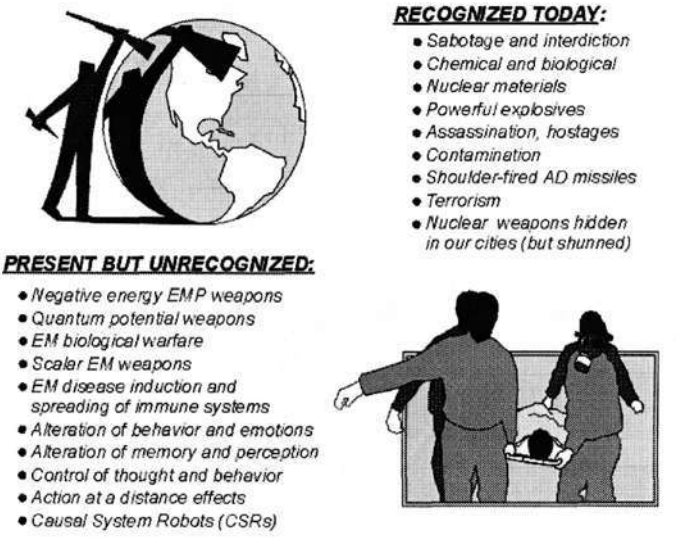

Figure 14 The mass destruction weapons threat to our populace.

The entire scientific method is based on assigning priority to experimental truth rather than dogmatic belief. If experiments refute the theory, the theory must be changed and the experimental results accepted. Else one is not following scientific method. Apparently the National Science Foundation does not follow scientific method, nor does it seem interested in doing so. Neither do the National Institutes of Health. The decisive results of some 2,000 rigorous animal experiments reported in the refereed scientific literature in leading French journals, by multiple established French scientists, were simply ignored because the results are contrary to present dogma. Meanwhile, four years have been lost. During that four years, the portable units could have already been developed, mass produced, and made available to treat and save millions of coming U.S. civilian casualties. Apparently the lives of those Americans are not as important as maintaining the present medical dogma. When those millions do die—and they will—we shall most certainly remind those agencies of the caliber of their dedication to scientific method and of their service to their fellow Americans. In my personal view, ignoring a chance to save so many Americans is treason of a very special kind.

The Official Silence Was Deafening

Not a single scientist in any of those and other organizations seems to have taken the package seriously. Not one called me to discuss it, or apparently studied the references, etc. No one asked for a personal briefing. No one was interested in the actual photo of the strike of a Russian EM missile from a scalar interferometer, offset from a U.S. night shuttle launch (Figure 15) from Cape Canaveral in latter November 1985, or the photo of the actual registration point ball of light high in the air (Figure 16) over that same shuttle launch {41}. The same weapon then killed the Arrow DC-8 at Gander, Newfoundland about two weeks later (Figure 17). An eyewitness (or more than one) actually observed the streak of light from the sky that struck the Arrow DC-8 in the right fuselage ahead of the engines {42,43}, after the thrust of the engines were reduced during take-off by use of a negative energy (cooling) interferometer. A similar ball of light associated with the kill of a Titan missile fired from Vandenberg AFB in early 1986 {44} and printed in *Aviation Week & Space Technology* magazine, was also apparently of no concern.

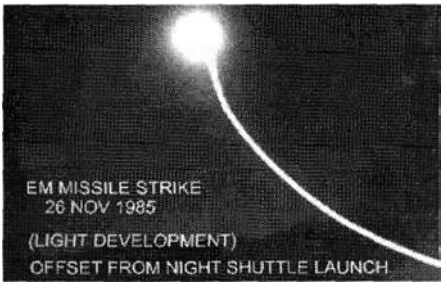

PHOTO BY BOB GLADWIN

Scalar interferometer operator fires offset EM missile from Russia.

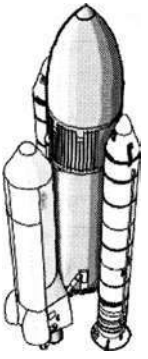

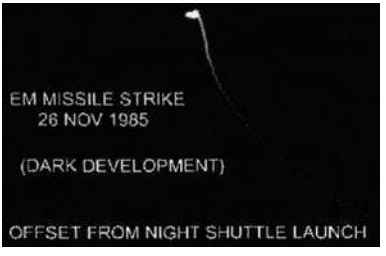

Figure 15 Soviet EM missile strike offset from U.S. shuttle launch at Cape Canaveral on 26 Nov. 1985. This is the smoking gun.

These remarks are intended to show the lack of understanding that has existed in our governmental, scientific, and intelligence communities of what energetics is and of the great energetics superweapons that have been developed. With the present rapidly growing interest in longitudinal EM waves, however, we suspect

that such lack of understanding is now no longer the case. We certainly hope that is true, and we are

Distant operator onsite in Russia slews away the registration point (the m arker beacon)

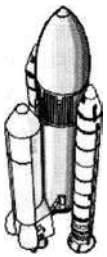

26 Nov1985

Two weeks later, the same weapon killed the Arrow DC-8 at its takeoff from Gander, Newfoundland.

Figure 16 Marker beacon above U.S. shuttle launch at Cape Canaveral, 26 Nov. 1985. Russian crews were using shuttle launches as practice ICBM launch targets.

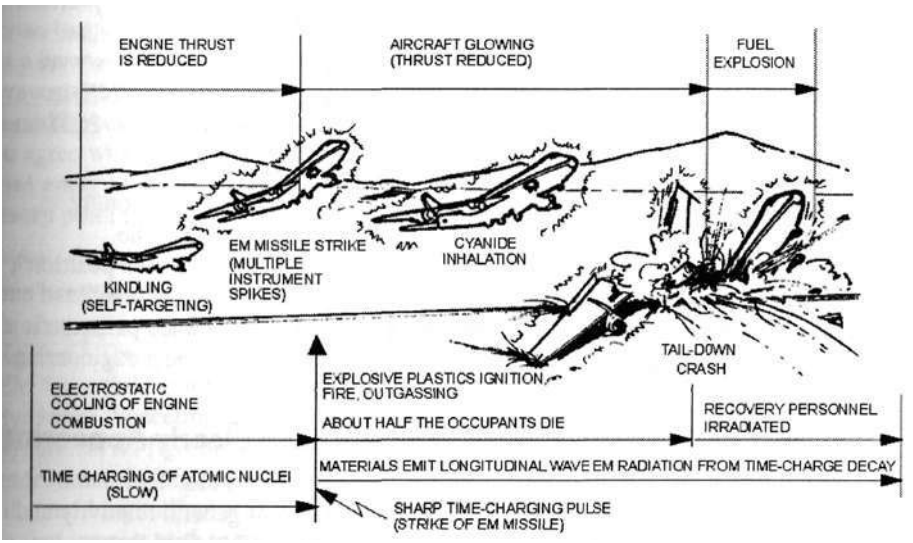

Figure 17 Kill of the Arrow DC-8 at Gander, Newfoundland Dec. 12,1985.

much encouraged that at least one—and possibly two—friendly Western nations now possess quantum potential weapons.

The Long Dry Spell in Correcting Electrodynamics May Be Slowly Ending

In over 20 years of unrelenting effort, until 1999 we were unable to get any significant Western scientists of real "horsepower" (e.g., in non-Abelian electrodynamics, foundations errors in electrodynamics, advanced gauge field theory, general relativity, etc.) to meticulously examine conventional U(1) electrodynamics and its glaring errors, and to look at weapons implications of higher group symmetry electrodynamics.

Beginning about three years ago, however, a noted scientist, Dr. Myron Evans {45,2}, along with other theoretical scientists of the Alpha Institute's Institute of Advanced Study (AIAS), have been extending electrodynamics by developing the 0(3) electrodynamics. They also have deeply examined the Whittaker work of 1903 and 1904 on which the early part of the Russian energetics weapons are based {24}.

The AIAS analyses, and subsequent papers by Dr. Evans and Alex Labounsky as well as by the entire AIAS group, have clearly established the primary importance of time-like precursors of EM fields, operating in massfree spacetime where fields E and B cannot exist. These time-like precursors *create* all the rest of the conventional electrodynamic entities {46}. This is a dramatic extension to electrodynamics and physics across the board. More than 100 papers have been produced to date, with more than thirty published in journals such as *Foundations of Physics*, and many of the others are either accepted or still in the referee process with various journals. Some 60 of the papers were published as a single special edition of the *Journal of New Energy* (JNE) in latter 1999, and a second edition of *Modern Nonlinear Optics*, Wiley, 2001 has been published with many important papers.

However, the problem is that the scientific community, which is strongly committed to "business as usual", has funded none of this work. The conventional lead agencies of the community are still in the "ostrich position", with their heads buried very firmly in the sand with respect to the terrible damage they continue to enforce on this nation by their continued perpetuation of an old, long-archaic, inadequate electrodynamics and electrical engineering.

Engineerable Unified Field Theory Is Now Clearly Appearing

The rapidly emerging AIAS extension of electrodynamics has "met in the middle" with Sachs' {4} revolutionary generalization of general relativity and electrodynamics. For the first time, an *engineerable* unified field theory—employing 0(3) electrodynamic means—is now being produced. The AIAS work in 0(3) electrodynamics was shown to be an important subset of Sachs' approach. It also now provides the full, rigorous theoretical foundation and model for the Priore mechanisms and results.

We also comment most strongly that the important SU(2)xSU(2) electrodynamics as developed by Barrett (47) leads to essentially the same conclusions, since Barrett's electrodynamics is homomorphic with 0(3) electrodynamics. Barrett, of course, is one of the pioneers of ultrawideband radar—another scientific area that was fiercely opposed and suppressed by the orthodox U.S. establishment for some time. Ironically, today those very scientists who were so dogmatic in their vociferous condemnation of UWB radar, have assumed the mantle of "experts in the UWB field", sometimes even taking credit for having "advanced it" in the first place.

Examples of Some Major Non Sequiturs in Conventional Electrodynamics

In every textbook and millions of technical papers in the West, electrodynamicists routinely calculate the "magnitude of the scalar potential". Actually, not a single one—including Maxwell—calculated or calculates the *magnitude of the potential itself.* Instead, they universally calculate the *reaction cross section* of the potential at a point occupied by an assumed intercepting/collecting unit point *static* charge {48}. At best that is a representation of the *intensity* of the field at each point. The reaction cross section of the potential with a fixed unit point static charge is indeed a scalar value. The "scalar" potential itself, on the other hand, *is not* its own reaction cross-section at each point of itself, and it is not a scalar entity at all! Instead, it is a harmonic bundle of bidirectional EM longitudinal phase conjugate wavepairs, as shown by E. T. Whittaker in 1903 {49}. It is and always has been a multi-vectorial, multiwave entity. By slightly reinterpreting Whittaker's work to agree with quantum field theory, the scalar potential is also a circulation of EM energy from the time domain to 3-space and back to the time domain, at every point in space that is occupied by the potential.

Further, the "field" notion is utilized in two self-contradictory manners. On the one hand, it is assumed in the massless reaches of space, and on the other hand it is assumed in mass, *which is the only case in which a force field is properly defined.*[8] The so-called "electromagnetic field" existing in empty space is not an EM force field at all, but a curvature or curvatures of spacetime with assorted ilynamics. Spacetime is after all active, and being active means curvatures and ilynamics. As rigorously shown by the AIAS theoreticians, what exists in *spacetime*—before the force-fields appear on reacting charged mass—are time-like and longitudinal scalar potentials and fluxes. These "pre-EM field" entities in fact interact with mass to produce all the force fields (the electromagnetic fields). Mass is a *component* of force; simply by F == *d*p/dt, which is expanded

[8] Since Maxwell and **the** original pioneers believed in a material ether filling all space, to them t**here** was not a single point anywhere in the universe that was devoid of mass. Hence to them there was only one kind of field: **the** kind that exists in mass.

into F = d(mv)/dt, which is ma + v*(dm/dt).* Note that both terms have mass as a component. Hence there is no force or forcefield when mass is absent. Present mechanics is seriously wrong (and has been wrong for hundreds of years) in assuming a separate massless force acting upon a separate mass.

Jackson, one of the ablest classical electrodynamicists of our day, adroitly states how electrodynamicists skirt that issue. Quoting, p. 249 of his *Classical Electrodynamics,* second edition: *"Most classical electrodynamicists continue to adhere to the notion that the EM force field exists as such in the vacuum, but do admit that physically measurable quantities such as force somehow involve the product of charge and field."*

Our comment is that one does not get an observable until after the interaction of a cause with a previous effect, to provide a change (a new effect). The 4-cause itself—in this case the field that actually exists in the vacuum—is never observed nor is it observable. Its *effect* (force with an affected observable mass as a component of it) is observed. The field in space and the field in matter thus do not even have the same fundamental units, but differ by a factor of m. In electrodynamics the m is avoided by "defining" the field as force per unit coulomb of "charge" (without saying or accounting "charged mass").

Wide Confusion of Cause and Effect

Present electrodynamics (and even the hoary old mechanics, as pointed out) has thoroughly confused the causal (4-space) side of the observation process with the effects (3-space) side—observation yields *3-spatial* entities, not 4-spatial. Indeed, as is well known, *time is not observable, even in theory.* That is really because observation is a *d/dt* process applied by the 3-space intermediary (e.g., mass) being acted upon by the causal (4-space) entity in spacetime, to produce a change in that intermediary (3-spatial) that results (is observed). *A priori,* the output of the observation process does not even exist in time, since its fundamental units are LLL and not LLLT. The observation process is thus *d/dt(LLLT)* => LLL.

Further, electrodynamics omits the fact that, not only does the causal entity act upon the intermediary to produce the *effect* (changes to the intermediary), but *those changes (effects) also act back (in reverse) through the intermediary to produce changes in the causal entity itself.* This mutual interaction between cause and effect (but never stressed in exactly that manner) is well known in GR, where the curvature of spacetime acts upon mass-energy to change it, and the resulting change in mass-energy also acts back upon spacetime to curve it. The omission of the latter "back reaction" in EM theory by Maxwell resulted in omitting half the energy, half the wave, and half the causal entity in spacetime, as well as half the effect. The missing half of the effect appears as the Newtonian third law reaction, which in electrodynamics is just mystically "assumed" to be an effect without a cause.

The vast importance of restoring this missing "back action of effect upon cause" is because it can be deliberately utilized to directly engineer the causal (4-space) state itself, producing nonmaterial "engines" and unobservable functioning robot systems comprised entirely of curvatures of spacetime and their dynamics. Such "causal system robots" (CSRs) can be designed and engineered to then perform almost any desired action upon normal mass systems they encounter. The robots also can easily penetrate vast depths of mass, which is mostly empty space filled with potentials, fields and waves—all of which are just bundles of longitudinal EM waves and their dynamics. "Mass" is actually a vast superhighway through which such CSRs can easily move at the speed of light {50}.

CSRs: Engineering the Unobserved Causal Side To Create Functional Systems

Understanding early on the mutual interaction between cause and effect that existed in their energetics, the Russians were able to engineer this totally new kind of system: the *causal system robot* or CSR (Figure 10). With sufficient theoretical development, one can "work backwards" by adroitly re-engineering the effect to obtain a desired causal system (spacetime curvature set along with its impressed dynamics; (Figure 18) corresponding to some physical system and its changes one desires to engender. One thereby directly creates a deterministic set of spacetime curvatures and impressed dynamics, which we call an "engine" (Figure 18). This *ST curvature engine* system can then function as a completely separate system {51} (Figure 10). One can communicate with it via longitudinal EM waves, control it, etc. By building in scalar interferometry functions, the **CSR** can be given "weapons" capabilities, etc.

- All levels of energy structures and all levels of time structures mold spacetime geometry.
- The "pattern" is called a *template* for a vacuum engine (spacetime curvature engine).
- Spatial and temporal structurings of the engine act upon mass at all levels.
- This produces a template of forces, for precise translations and stresses within the mass at all levels. The forces exist in both time and 3-space.

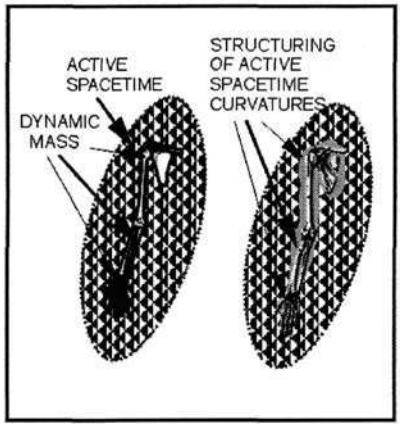

Figure 18 The principle of general relativity extended to include the concept of the vacuum engine.

In theory such a CSR can be assembled to perform any desired function or complex of functions upon matter, fields, potentials, etc. that is desired. In short, one can build real, functioning "infolded" (subspace) robot weapon systems using this "backward engineering of spacetime itself process. The huge underground facilities (hundreds) that the Russians continued to build after the collapse of the Soviet economy and the fall of the Soviet Union, apparently contained the full CSR development and control facilities as well as the operational systems employed for this totally new kind of weapon system.

A great engineering of the future lies in engineering CSRs, which already constitute a great leap forward past the material nanobot technology being pursued in the West.

Making the First CSR is Extremely Difficult; Making a Million Copies Is Easy

The development of a specific CSR with a specific set of functions is akin to developing a highly complex software system of major proportions (several tens of millions of lines of code). The job is extremely difficult, and tortuous "debugging" is required for a lengthy period. Once a single CSR is completed and debugged, however, the production of thousands or even many millions of copies is then a trivial task.

The CSR may be visualized as a sort of vast complex of longitudinal EM waves (recall, we are speaking of ST curvatures, not the conventional EM waves thought to operate on a flat spacetime. *All* EM waves operate in a curved spacetime *a priori,* as clearly shown by Sachs). It turns out that all matter is mostly empty space, filled with potentials and fields. Space itself, considering its energetics, may be taken as a giant scalar potential. All those potentials and fields and waves are in fact nothing but sets of longitudinal EM waves and dynamics. In short, they are vast superhighways for the travel of CSRs and the propagation of longitudinal EM waves.

A CSR can be embedded *within* any kind of EM potential, wave, or field. So to replicate one, one embeds it in a magnetic signal and records that signal on a diskette or other media. Then one makes millions of copies of the diskette, for perhaps 10 cents or less each. Or do it en masse, by first completing a CD-ROM with a hundred or two hundred CSRs embedded in its signals (Figure 19). Then simply reproduce the CD-ROM. Every reproduction has another hundred or two exact duplicates of those CSRs, made for almost no cost at all. With communications built into the CSRs, the command and control facilities take charge of them, give them individual numbers or designations, and a robot armada emerges with most unusual capabilities indeed.

The puzzling underground facilities in Russia (which our fellows apparently never deciphered and which remained a mystery) apparently contained the scientific teams, the research and development facilities, the production

facilities, and the command and control facilities for the new vast CSR weapon complex. It was to see its first great employment at the end of 1999.

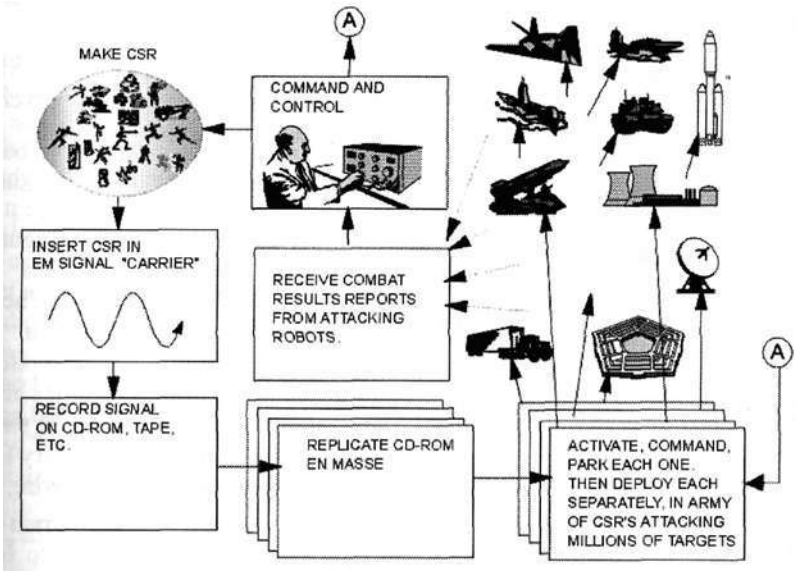

Figure 19 Mass reproduction of a CSR is simple and inexpensive. The CSR resides in, or propagates inside, any EM signal, potential, or field.

In 1999 The KGB Deployed Massive Numbers of CSRs for a Strategic Attack

In latter 1999 the KGB began massively deploying these CSRs of various types throughout the Western world, particularly including the United States. They simply sent the CSRs back "inside" the potentials and fields and waves being emitted from radio stations, TV stations, power lines, satellites, communications systems, inside matter, etc. These CSRs were deployed and infiltrated in major command posts and installations throughout the U.S. and its allies. True to form, the KGB even "stimulated" some major computer systems in critical U.S. government facilities by having the robots "surface" some effects on the Computers, right through the firewall programs (whose EM signals and operations indeed provided nice superhighways for the robots). Our fellows **detected** the interference as a "sophisticated computer hacking attack" (puzzlingly from the Russian Academy of Science), and then the robots "submerged" again after deliberately performing actions to produce obvious changes and guarantee the U.S. detection of those changes. The purpose of this "stimulus and probe" was to see if the U.S. was aware of CSRs and CSR **technology.** We clearly showed we were not, and we still are not aware of them. Fur**ther,** the entire government apparatus—including all our vaunted national

laboratories—knows absolutely nothing at all about CSRs, and none of the laboratories believe it. That is the same posture they've been in with respect to energetics weapons for a half-century. Apparently they will be in that same posture for another half century, left to their own devices.

However, I was not allowed to remain a casual onlooker for this new CSR armada! The KGB also planned to use me as a stimulus to ping the government yet another way, and then assess the government's response.

Here in Huntsville, suddenly I was personally struck by such a CSR right from my computer monitor, with the attack riding through the light from the monitor to my eyes and retinas and right into the brain and nervous system (Figure 20). This was the type of CSR that can lurk in any potential or field inside a computer, and then strike and kill the operator looking at the screen. The CSR took over control of the machine, split the screen so that only one-inch horizontal strips were luminous—one at the top and the other at the bottom of the screen with the middle dark. These two separated horizontal strips allowed scalar interferometry via the inner LWs comprising the light from the two strips. The LWI signals crossed in my vision center, where suddenly ordinary EM signals and waves were produced by the scalar interferometry occurring there.

Stimulating apparently the only analyst capable of recognizing a CSR attack and connecting it with the scheduled giant strategic CSR attack.

KGB General commanding the energetics weapon previously confirmed that what this analyst writes on his computer is received as soon as he writes it. Apparently accomplished by Tempest techniques or directly by energetics.

Figure 20 Present author struck by CSR in latter 1999 as a deliberate nonfatal stimulus.

I saw rapid blinding flashes like a hundred flashbulbs exploding at once right in my face. However, the signals representing those "flashes" were being created right there in my vision center. An external camera would have recorded only the weirdly separated screen display. It *would not* have shown the brilliant flashes of light I was seeing, unless it was set up stereoscopically. The strike was deliberately sustained for only about 10 seconds so as to be severe but nonlethal; about 30 seconds would be totally lethal. Violent fibrillation of the heart also resulted explosively, and I was instantly hypnogogic and seriously weakened by

sudden hypoxia from near total lack of blood pumping (because of the fibrillation). The purpose was apparently to strike the only analyst in the U.S. who would recognize what the nature of the attack was, stimulate him, watch him try to notify the government, and then observe the government's reaction. It look four days to recover from the strike. But I knew immediately what had made the strike, and that I had been hit with a CSR weaponized by having a built-in scalar interferometry capability. It was also a very sophisticated CSR, as it showed by assuming complete "intelligent" control of my computer's functions.

When I finally recovered, I did notify the government and warn them of CSRs, exactly as anticipated by the KGB. As might be expected, the government's total disbelief and lack of reaction clearly showed they knew nothing of CSRs. They simply did not believe such weapons existed or even could exist. Sadly, once again one faced the "not invented here" syndrome. General relativity and its provision for spacetime curvatures and their associated dynamics (engines) operating back upon mass are apparently just supposed to remain a theoretical curiosity. Why, obviously no scientist in his right mind would think of weaponizing such!

A more correct answer is, *"Like hell they wouldn't!"* *American* scientists would not think of it, but *Russian* scientists with their national chess-playing psychology will immediately seize upon any opportunity—even many moves ahead in the game—and develop it and utilize it. They understand and use the boa constrictor. We only understand and use the immediate rattlesnake.

How the Asymmetrically Deployed Strategic Attack Was Stopped in Its Tracks

However, we also alerted the "little nation" that has advanced EM weapons technology, which—since early 1997—has been saving the U.S. by forcing the abortion of impending KGB energetics weapons attacks.

When I warned them in 1997 about the MindSnapper weapons and mind-control weapons used against Captains Button and Svoboda, unknown to me at the time they later reacted and suddenly destroyed those facilities in Russia (apparently with violent scalar interferometry strikes). So *that* mind-control type of attack being readied for 1999 was thwarted for a few years by these strikes sometime prior to mid-1998.

But to return to the CSRs. In the latter quarter of 1999, the Russians were developing and deploying throughout the West numerous kinds of CSRs. So the period at the end of 1999/first few days of 2000 attack was already scheduled for a massively programmed CSR attack. It was designed to cripple the entire **nation,** and perhaps even collapse it economically, yet all would be blamed on Y2K! Our scientific ignorance guaranteed that we would blame it on something **mundane that** our scientists could understand: Y2K problems in all the old

software programs running so much of our automated systems, communications, and centralized functioning, accounting, banking, etc. In short, the KGB planned to give us a bicentennial gift: a Y2K nightmare far beyond our wildest fears.

After my recovery from the CSR strike in the latter quarter of 1999, I again urgently alerted the friendly nation of the development of CSRs and their widespread deployment—and informed them of the personal attack on me and specifically why it was made nonfatal. Of course I also alerted our own government. We were scheduled for a *real* Y2K problem that would curl one's hair, so to speak, with everything imaginable failing—and probably all blamed on Y2K.

Admirably, beginning just at the end of 1999, the friendly nation simply began methodically and massively cleaning out all the CSRs, and they disposed of them in very short order! Such CSR systems[9] may easily be located and destroyed by strategic longitudinal EM wave weapons {52}, when and if one has the longitudinal EM wave technology sufficiently developed. So Y2K came and went with only a few relatively minor incidents from the *normal* Y2k problems expected.[10]

However, unknown to our scientists and intelligence community, a great war of a very special kind—*the Earth's first strategic subspace war*—had just been silently fought and won, right there inside our power systems, command and control systems, major weapon systems, electrical power systems, electrical control systems of our nuclear submarines and strategic bombers and missiles, even inside the electronics of our nuclear warheads, etc. And not a bobble showed on the surface, anywhere. This was the first real "subspace" war, where weapons made of pure spacetime curvatures and dynamics were involved as the main offensive battle systems. LWI destruction of numerous CSRs inside potentials and fields in various electronic equipment throughout the nation, created little or no overt signs at all.

This time we won, thanks to the "good guys" and not to our own scientific community. Next time we may not be so fortunate.

The Mostly-Ignored Time-Energy Interaction

For some inexplicable reason, physicists in the West have omitted one-half the actual photon interaction.[11] If one allows the *spatial energy* component of the photon to interact, then one must also account for the simultaneous interaction of the time-component of the photon. A mass m absorbing a photon (AE)(At)

[9] These early CSRs apparently had no "stealth" capabilities built-in, so they were easily detected and destroyed, rather like shooting fish in a rain barrel.

[10] Even so, a normally disastrous Y2K problem was narrowly averted, in the nick of time, by a concerted national software reprogramming effort massively mounted and costing billions of dollars. Otherwise, the expected "ordinary" Y2K problem would have been very bad indeed.

becomes *masstime* (m+dm)t, not mass m. Mass *m* and masstime *mt* are as different as are force *F* and impulse *Ft.* No scientist in his right mind would ignore the *t* in *Ft* and consider just the force *F.* Yet that exact kind of giant *faux pas* has been done for many decades now in the photon interaction. And it is still ubiquitously done in physics. *Mass does not emit photons; masstime does.* Again, physicists confuse effect and cause.

As the Russian energetics weapon scientists know full well, time is actually spatial energy compressed enormously, by at least the factor c^2. Hence time has at least the equivalent energy density of mass. The greatest amount of "energy" existing in a photon—particularly in lower frequency photons—is in that "time" part that is arbitrarily ignored and discarded. An ELF photon has enormously more total energy—by many orders of magnitude—than does a gamma ray photon.

Energy and time components in the photon are canonical. Low frequency photons are reduced in the magnitude of their *spatial* energy component and thereby maximized in their *time* components. For the ordinary (decompressed) *energy equivalency* of the time component, one must multiply the time in seconds by c^2. Halving the frequency, e.g., doubles the time component, whose spatial equivalent energy is now $(2t)\times(c^2)$. With respect to the original photon, the new total energy (achieved by halving the frequency) is given by $[(\Delta E)/2] \times [(2\Delta t) \times c^2] = [(\Delta E)(\Delta t)\times c^2]$. So halving the photon's frequency increases its total energy by a factor of c^2, which is approximately by a factor of 9×10^{16}. Hence photons actually carry enormously greater total energy (most is locked up as time) at low frequency than at high frequency. Indeed, the highest energy photon interactions in the universe are at low frequency, *if and when* a transduction of the available time-energy into spatial energy occurs.

This has been completely missed in the West, but not by the Russian energetics weapons scientists. They have been *engineering* that formidable new high energy but low frequency physics—a physics far more energetic than that used in our most energetic colliding beams in "conventional high energy physics".

The cold fusion processes[12] stumbled onto by Western scientists are using the

[11] I.e., except for accounting for the overall "action" (angular momentum) and such things as **minimum** action theorems, etc. Treating the photon's increment of time specifically as a formidably compressed piece of spatial EM energy does not appear in Western physics. It has **long** been utilized in the KGB's secret energetics weapon science.

[12] For an explanation of the use of time-reversal zones in cold fusion experiments, and some of the resulting new transmutation reactions that result, see T. E. Bearden, *Energy from the Vacuum: Concepts and Principles,* "Chapter 10: Cold Fusion: Low Spatial-Energy Nuclear Reactions at High Time-Energy," Cheniere Press, Santa Barbara, CA, 2002. Available from www cheniere.org. Statistically, the formation of significant time-reversal zones is guaranteed by t**he transient** fluctuation theorem of Denis Evans et al., and by recent experimental work by Evans et al. proving that such zones (where the reactions run backwards) can and do occur at up to **micron** (colloidal) size and for up to two seconds in duration. We stress that this is a recognized, **proven** violation of the second law of thermodynamics already known to physics.

time-energy component of photon interactions, to generate enormous localized EM energy directly upon the interior quarks and gluons of nucleons {53}. We worked out a speculative explanation of the active time-energy transduction mechanisms that fits all the experimental phenomena, including the eerie instrument anomalies occurring in rigorous electrolyte experiments at China Lake for some years. That is included in my new book, *Energy from the Vacuum: Concepts and Principles,* Cheniere Press, Santa Barbara, CA, 2002, available from www.cheniere.org.

Of course consistency alone does not prove it conclusively; consistency is a necessary but not sufficient condition for proof. But at least the proposed explanation is consistent, and nothing else seems to be, at this time. In one chapter in my referenced new book we do cover the cold fusion mechanism and give specific new nuclear reactions producing the excess deuterium, tritium, and alpha particles in so many successful cold fusion experiments worldwide.

My "time-reversal zone" approach is stringent, because the recent work by Denis Evans *et al.* {54} has clearly shown that reactions can and do run in reverse—totally in violation of the second law of thermodynamics—at micron (colloidal) level in size and for up to two seconds in duration (and sometimes even a little longer). So experimental demonstration that the "time reversal zones" I assumed can and do indeed occur has now been accomplished by Evans *et al.* This provides strong experimental and theoretical support for the basic assumption (of the formation and momentary existence of localized time reversal zones that subsequently decay) we used to derive the fundamental cold fusion mechanism including some of the specific reaction equations for excess deuterium, tritium, and alpha particles now demonstrated in hundreds of successful experiments.

In a reversed zone *the law of attraction and repulsion of charges is reversed,* so that like charges attract—sometimes so closely that each enters the strong force region of the other, forming a quasi-nucleus (Figure 21). As the time-reversal zone subsequently decays back to a time-forward zone, the reduced strong force is restored much faster than the Coulomb force is reduced and then reversed back to normal. So during this readjustment decay process, the quasi-nucleus will simply change to an isomer and a known nucleus by quark-flipping to change an H+ ion to a neutron. Note that the "reversal zone" momentarily changes the Coulomb barrier—always the only thing that has really prevented chemical fusion and transmutation at low spatial energy—to a Coulomb attractor. Hence cold fusion—as now backed up by more than 600 successful experiments worldwide, by multiple laboratories and researchers in multiple nations—is an established fact and a herald for a vast new science based on deliberate and intentional reversal of the Coulomb barrier and use of time-energy.

With its usual perspicacity, the organized U.S. scientific community has flubbed it—and flubbed it badly—with respect to cold fusion. Its contribution has

largely been a tirade of ad hominem attacks, slander, and libel of a viciousness seldom seen in the annals of science. Once again, the community is far more devoted to defending its cherished dogma (and its own rice bowls from the conventional Big Nuclear Science that cold fusion thoroughly upsets), than it is in applying scientific method which calls for *believing the experiments* and changing the dogmatic theory.

- Fermions time-reverse in even numbers
- Like charges cluster
- Aqueous solutions contain H+ ions, which are just protons
- Quarks flip as TR zone fades

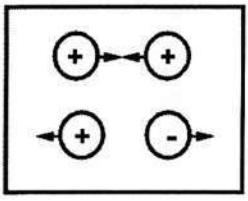

$$2({}_1H_1 + {}_1H_1) \rightarrow 4({}_1H_1) \rightarrow 2({}_0n_1 + {}_1H_1)$$
$$\rightarrow {}_2He_4 = \text{helium (alpha)}$$

Figure 21 Example of a time-reversed zone nuclear reaction common in successful cold fusion experiments.

Development of Threats and Scheduled Attacks Aborted

KGB energetics weapons have long constituted our single most pressing yet largely unrecognized national security problem. That problem has also increased with the growing development and deployment of such weapons by other nations such as China. Some 10 nations, for example, now have scalar interferometry weapons, and even the Japanese Yakuza has them and also has their own secret facilities for producing them in Japan, including small portable units developed for use in assassination and terrorist type warfare within a targeted nation—the United States of America.

Unknown to our government, we narrowly escaped destruction twice in the first half of 1997 from scheduled all-out strategic KGB energetics weapons attacks. **Only** the actions of a friendly small country countered the attacks and caused the **KGB** to abort on each occasion.

When the second scheduled Russian strategic attack was aborted just prior to May 1, 1997, a new KGB counter-counter for the friendly counter used by the **little** nation in latter April 1997 was already rapidly being deployed. The new **Russian** counter-counter—seizure and control of the mind of an operator at a distance, and complete control of his actions while he performs sophisticated

technical tasks—was tested in two separate incidents {55}, first on Captain Button (Figure 22, Figure 23) and then on Captain Svoboda about two months later (Figure 24), each flying an A-10 Warthog aircraft over the U.S.

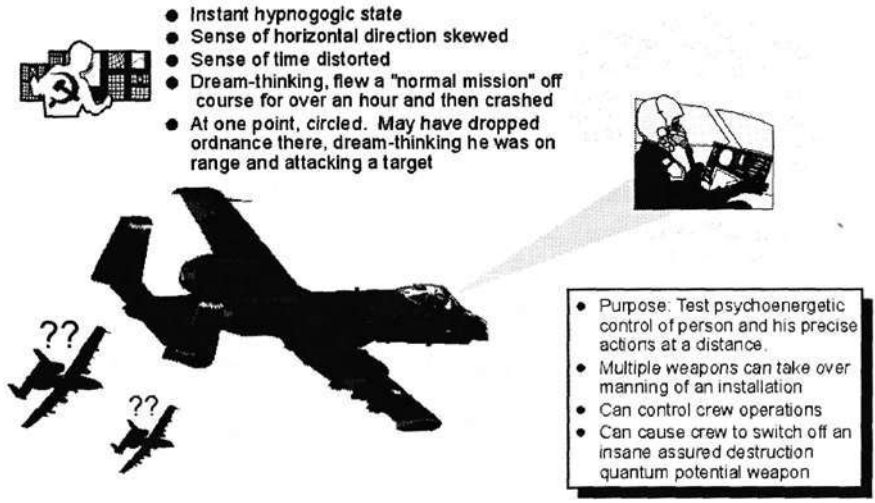

Figure 22 Captain Button's bizarre flight to his death on 2 April 1997.

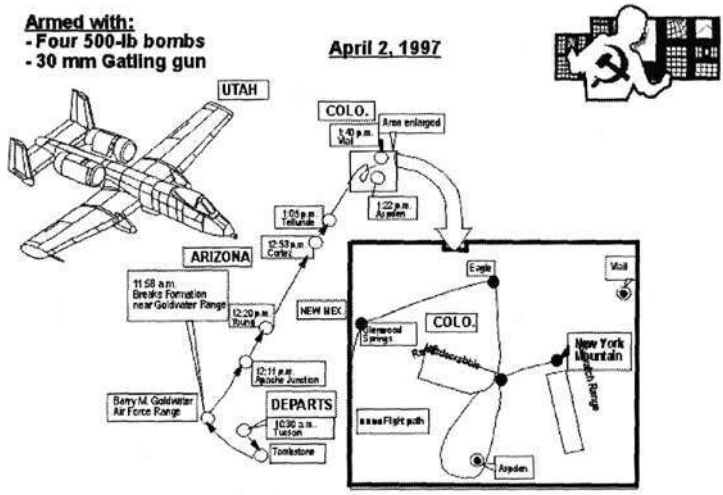

Figure 23 Captain Button's flyaway path to his eventual fatal crash.

The highly successful test against Captain Button (Figure 22, Figure 23) is

particularly significant, as we have explained. Captain Button was controlled while performing highly technical operations, for more than a full hour, and one hour was apparently the acceptance test specification. Captain Svoboda (Figure 24) simply had her mental perception of up and down instantly reversed while climbing her A-10 warthog from low level ordnance delivery on target. Erroneously perceiving she was diving, she immediately "corrected" sharply to "climb", thereby diving headlong into the ground and perishing in the resulting explosion of her aircraft.

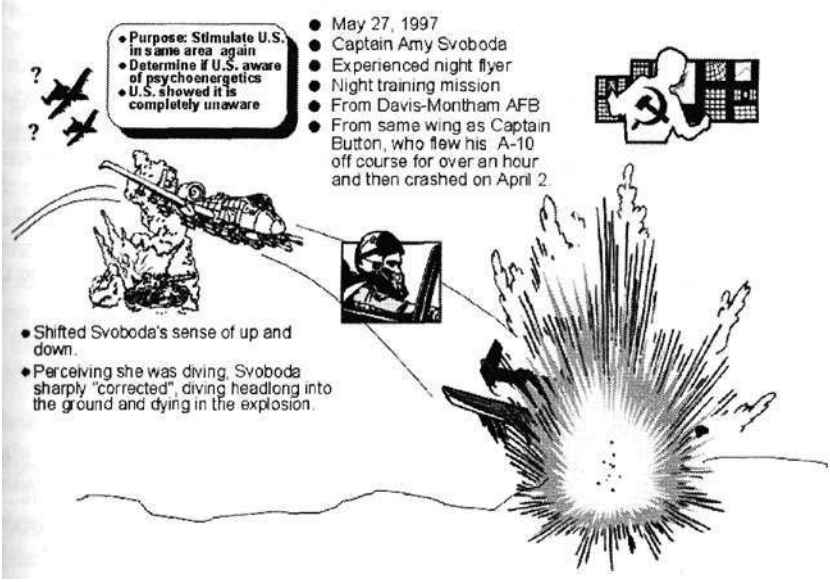

Figure 24 Climbing out of low-level ordnance delivery, Captain Svoboda suddenly dives headlong to her death on 27 May 1997.

Svoboda's kill demonstrated a *tactical destruction* usage, whereas Button's test demonstrated a *strategic* hostile usage of the adversary's defending weapons crew to take action against the adversary's defending strategic weapons system. A new KGB strategic energetics attack against the United States—using the mind control (psychoenergetics) weaponry to take over the operators of the little nation's QP weapon sites and stand the sites back down for maintenance—was rescheduled apparently for latter 1997 to mid-1998 or so. It appears that the extensive preparations for that attack were totally destroyed clandestinely and very suddenly by the friendly little nation some time after we warned them, as we mentioned above.

However, still another Russian counter—the development of "weaponized engines" (functioning causal system robot weapons, "infolded electromagnetic" in form) consisting of organized and functioning systems of spacetime curvatures operating in and traveling through EM fields, potentials, waves, and

signals—came on line (Figure 10, Figure 18). The KGB simply altered the attack plan for a Millennium Strike and completed the forward deployment of these eerie new CSR systems by introducing millions of them directly throughout U.S. facilities, command centers, weapon systems, power grids, ships, aircraft, submarines, missiles, nuclear warheads, computers, communications systems, etc.

We estimate that several million such systems were introduced in that manner, and readied for the Millennium Strike. The United States and its allies were and are almost totally unprepared for this dramatically new kind of strategic warfare that has been developed and deployed against us. No such weapons have previously existed in history. Consequently our national survival and the survival of our allies was once again at stake—and right on schedule during the critical period from mid-1999 through mid-2000 that we had predicted back in 1997.

The die-hard elements of the KGB indeed had a new millennium gift for us, but it was not at all the kind of gift we would appreciate. The KGB is not a monolith! This plot apparently did not include Putin, and it did not include the rest of the KGB, particularly that element reporting to Putin.

Live Destructive Tests Over and Near the U.S. Have Continued

Without elaboration, we believe that the Learjet crash incident and the EA-990 crash incident may have been very sophisticated tests of these new robotic causal EM systems. We also believe that the long years of Russian construction of over a thousand mysterious underground facilities, even though the Russian economy was collapsed and the citizens and soldiers were destitute, is significant. Those facilities apparently contain the set of command and control systems for this vast new strategic weapon system.

The facilities also include the "factories" where the CSRs are made, because the factories are unlike any other factories ever conceived. They do not build "physical" systems, but something more like "software." Only now the "software program" itself is an independent robotic system, with a full set of weapon systems functions, and capable of independent navigation and functioning anywhere, while remaining under KGB command and control via longitudinal EM wave communications infolded inside the potentials of earth, ocean, and space. The facilities also contain the operational forces, headquarters, and communication and control systems that maintain, deploy, and employ (fight) these CSR systems, and direct the battle.

The purpose of the 1998 document we sent to DoD—which did not include the causal robot system armadas later deployed throughout everything in the West—was to inform selected members of the Senate and Congress of the energetics threat situation and summarize it for them. Accordingly, we presented the

background of the development and testing of the KGB energetics weapons since WW II, in some detail, for selected Legislators and their staffs. We also included some specifics on the failure of the U.S. scientific community to keep American science and technology abreast of that of our adversaries.

The Scientific Basis For Energetics Weapons Is Established

As pointed out above, the scientific basis for our early use of Soviet scalar EM interferometry is now rigorously established by work accomplished by the Alpha Foundation's Institute of Advanced Study. It is also rather "old hat" now that all major weapons labs have discovered longitudinal EM waves and are actively working on and with them. The Director of the AIAS, Dr. Myron Evans, is an eminent scientist and theoretician with over 600 papers in the hard science literature. He and his colleagues also have had zero funding for their work on the higher group symmetry electrodynamics necessary to understand such things as energetics. A combination of non-Abelian electrodynamics, advanced gauge field theory, and the impact of E. T. Whittaker's work shortly after the turn of the century has shown that scalar interferometry is real, and that weapons based on scalar interferometry can be a potent threat on the battlefield. The time-like (time-energy) basis for electrodynamics is now clearly established.

With this important new work, we are now only some 40 years behind the Russian weapons scientists! But we are beginning to close the gap—and hopefully that will be done very rapidly.

In 1999 after being personally attacked by a CSR, I again contacted the office of the leader of the friendly small nation and again furnished all the information we possess on the new CSR systems programmed by the KGB as a countering method against the small nation's QP weapons. The outcome was that the little nation destroyed the CSRs in time, as we stated above. We were lucky that (i) the KGB did attack me with one of the weapons, deliberately to "get my strong and immediate attention", and (ii) deliberately did not kill me with the strike. Otherwise, there would have been no warning to the little nation, and the U.S. and its allies would have experienced a "Y2K" problem worse than their wildest fears, possibly collapsing the economy of the United States and much of the developed world.

Our Situation Here In the U.S. Is Precarious

Meanwhile, our own scientific community apparently does little or nothing in these areas, except to castigate, slander and libel anyone daring to suggest that such "out of the box" weapons areas even exist. E.g., there does not appear to be

a single U.S. scientist who knows how to create a *time-polarized* EM wave.[13] There do not seem to be any concerted programs to deal with t-polarized photons and t-polarized EM waves. Our scientists still firmly believe that one has to propagate spatial EM field energy through space to affect a target electromagnetically, when that was obsoleted by Russian "subspace EM longitudinal wave propagation" weapon systems deployed as early as 1963, and was completely obsoleted by deployment of quantum potential weapons in 1989.

Yet a close colleague of the present author has single-handedly developed and demonstrated prototype superluminal communication systems using the infolded (longitudinal EM wave) electrodynamics, and these systems would have been heading onto the market in latter 2001 except for the sudden bankrupting of the major backing company. There has not been any funding forthcoming for his revolutionary work, but only clumsy attempts to take it from him. It is my fear that the further clumsy takeover attempts will be successful, and this desperately needed technology will never see the light of day in defense of our nation. As a single example without further discussion, his work revolutionizes the present notions used in the rapid development of quantum communication and quantum computing, because it revolutionizes the very notion of the Q-bit, completely removing the statistics of the quantum state and making it engineerable. This of course is completely counter to present QM notions, but is consistent with the Bohm hidden variable approach to quantum mechanics.

Meanwhile, our own weapon scientists apparently still do not recognize the possibility of a superluminal longitudinal EM wave communication system, and appear to have no motivation or intention to develop such. This is in a way quite sad; quantum tunneling at more than four times the speed of light, of a clearly recognizable Mozart symphony, has already been demonstrated in a section of a waveguide {56}. Whatever one wishes to call it and however one wishes to do it, superluminal communication of intelligible signals has been clearly demonstrated in the laboratory. For the "infolded" longitudinal EM waves, all the "normal" or "envelope" EM waves, potentials, and fields are just great *superwaveguides* for such longitudinal EM wave "tunneling through subspace" at superluminal speeds.

[13] Keeping one's sense of humor, apparently there has also not been a U.S. scientist who even recognized and knew what actually powered an electrical circuit, until our solution to the source charge problem and publication of it in 1998. Eerily, even after the technical basis for a solution had been proven in particle physics in 1957, no one seemed to have applied the broken symmetry of opposite charges to the common dipole and to a dipolarity such as a scalar potential and a charge (with its associated virtual charges of opposite sign, in the modern view). Everyone accepted that the fields and potentials and their energy are established by their associated source charges, but no one had stated that the source charge receives its input energy from its asymmetry in its seething energy exchange with the active vacuum.

The Dominant Weapons Are Quantum Potential Weapons

Full-bore deployment of Russian quantum potential weapons occurred by the end of 1989, the first lab prototype weapon having been tested in April 1986 against the U.S. air attack on Libya (Figure 25). Beside Russia, two other nations—Brazil and the "little friendly nation"—also had developed quantum potential {57} weapons. The United States did not develop them, or at least apparently not just yet.

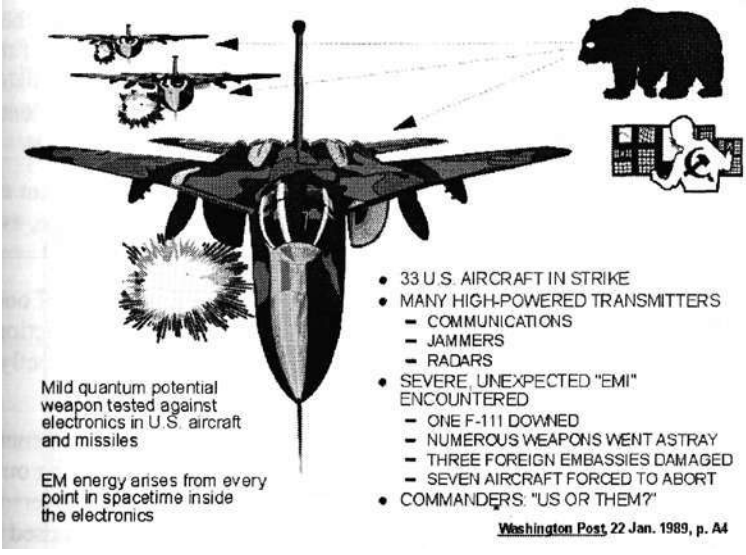

Figure 25 U.S. air strike on Libya, April 1986.

Burlier this year (2002), China also deployed QP weapons, and we now find that an*other friendly* nation has them as well. That brings the total to five, as of this writing. Two of those are friendly, and a third is astraddle of the fence, so to speak. The other two are Russia (the KGB) and China.

At this point China could go either way, so it represents a future enigma. China **has** control of the Panama Canal, and has inserted more than 200,000 Chinese into Panama—which is on the way to gradually becoming a Chinese territory, as soon as the Chinese in Panama outnumber the native Panamanians. In addition, under the Clinton administration China gained access through two U.S. ports (with little checking, so anything can easily be inserted). China also has a**dditional** ports in the Western hemisphere. China is almost certain to eventually attack and seize Taiwan, which puts her on a collision course with the U.S., si**nce** the U.S. has an agreement to defend Taiwan. She has also declared the South China Sea—through which passes some 60% of the oil bound for Japan, a**nd** much oil for other nations also—to be Chinese territorial waters. China also has developed bioenergetics weapons, having long ago induced cancer into most

of the GRU Russian representatives then serving in China. She almost certainly has or is rapidly working to develop psychoenergetics weapons as well.

So far as I am aware, there still exists not a single funded U.S. scientific program to directly correct the glaring errors in our own classical electrodynamics—such as those problems deplored by Nobelist Feynman and Wheeler {58,59,60}. Both knew that the force field concept in space was erroneous. As they put it, only the "potential" for the force field exists in space, in case some charged mass is available there for interaction. But the field itself is created by the interaction and is the effect of it. It does not exist before the interaction occurs. Yet all our texts continue to teach the disinformation of the "field in space." And our science community continues to fiercely defend such dogma, attacking and sometimes destroying the careers of those brave scientists who do try to change it.

One notes that time is multiply-connected, since in theory the same instant exists at every point in the universe. Or said another way, in any instant in time, every point in the universe simultaneously exists.

Operating in the time-domain as a causal system, and then turning out of one point there into any point in 3-space desired, is a means of producing "action at a distance" that obsoletes our old concept of transmitting the energy directly through space {61}.

Presently the U.S. scientific community has little predisposition toward energy turning into the time-domain, operating in the time-domain, then turning out of the time-domain into any desired point in 3-space, anywhere in the universe.[14] Every 3-space point in the universe simultaneously exists in (is superposed in) each point in time, as those points in time occur. In one sense, time can be considered to be the total multiple connectedness of space! We suspect that it may even be possible to interpret "instantaneous" communication—as by a quantum potential—in that "in here-out there" instantaneous fashion via "tunneling through the multiple connection of the time channel".

Finally, mass—being an observable and 3-spatial—does not exist in time. Mass continually turns into masstime (by photon absorption), then masstime turns back into mass (by photon emission). Masstime exists in time, but mass does not. U.S. scientists also seem unaware that the so-called "rate of flow of a mass through time" is generated by the sum total of all photon interactions (both virtual and observable) with that mass. The ubiquitous interaction of a mass with photons also causes that mass to continually recur, and thus to seemingly "continuously exist." It is continually observed, but it does not continuously

[14] If one models the time domain in three dimensions instead of one, e.g., then in theory it becomes possible to "flip" a 3-dimensional mass object into the time 3-domain at a single "moment," then rotate from that "time 3-point" back into 3-space at a new 3-space location anywhere in the universe. Hence the "beam 'em up Scotty!" of the old Star Trek (and the more modern beaming version) may hold more of a promise than just for science fiction entertainment.

exist! Since the photon interaction is engineerable, then it follows that a specific muss can be time-reversed back to an earlier state {62}.

Cellular Time Reversal: Revolutionary Healing by a Team of French Scientists

Priore and eminent French scientists {39,40} unwittingly used the mechanism for time-reversing a mass and every part of it, to time-reverse diseased and damaged cells, including tumor cells, physically changing them back to their previous healthy physical state and condition in vivo. This included all parts of **the** cell, including its genetics. The Priore team demonstrated revolutionary cu**res** of terminal tumors, infectious diseases, atheriosclerosis, and restored depressed immune systems.

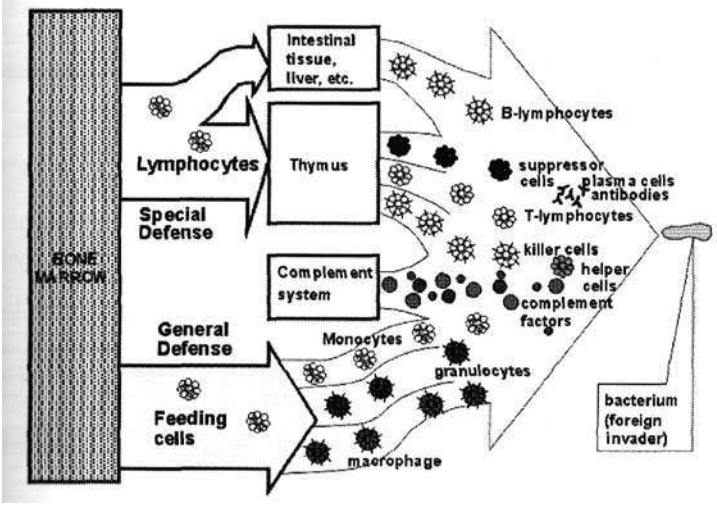

Figure 26 Simplified diagram of the immune system.

The immune system (Figure 26) *heals nothing, not even its own damaged cells.* The human cellular regenerative system {63} is responsible for all *healing* in the body—and it utilizes time reversal of the damaged cells as the active healing mechanism. The regenerative system (Figures 27, 28, 29) pumps the damaged cells with longitudinal EM waves (and therefore with time-polarized EM waves, which always accompany longitudinal EM waves), inducing the cells and all their parts to add the phase conjugates, thereby forming time-polarized EM waves and pumping in the time-domain rather than the 3-space domain. This dramatically extends nonlinear optics to the time domain, and mass pumped in that fashion is time-reversed (propagated back along its own time-track, to a previous physical condition.

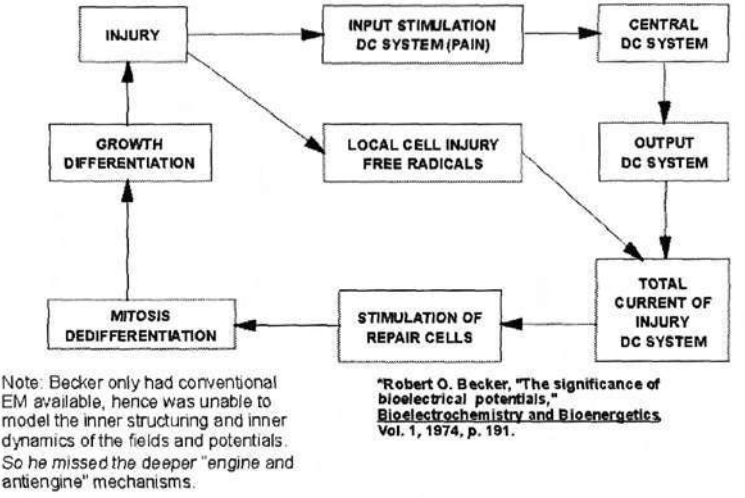

Note: Becker only had conventional EM available, hence was unable to model the inner structuring and inner dynamics of the fields and potentials. *So he missed the deeper "engine and antiengine" mechanisms.*

*Robert O. Becker, "The significance of bioelectrical potentials," Bioelectrochemistry and Bioenergetics, Vol. 1, 1974, p. 191.

Figure 27 Becker's theoretical control system involved with response to injury.

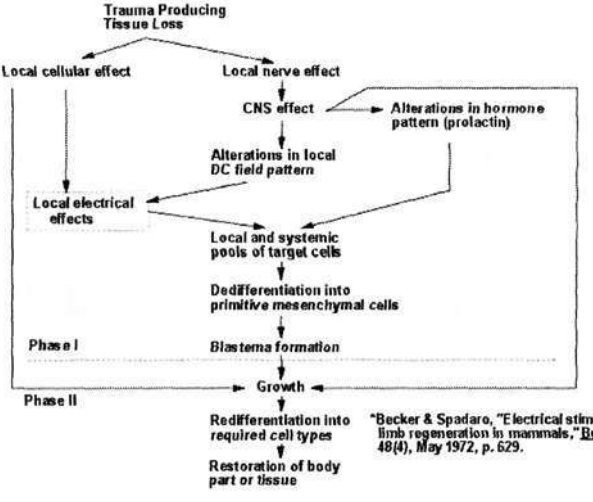

*Becker & Spadaro, "Electrical stimulation of partial limb regeneration in mammals," Bull. N. Y. Acad. Med., 48(4), May 1972, p. 629.

Figure 28 Becker's proposed control system governing regeneration.

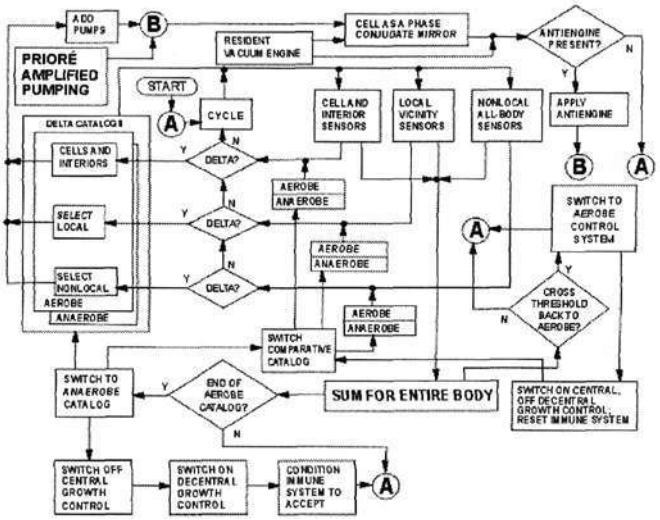

Figure 29 Author's deeper block diagram of the cellular regeneration system.

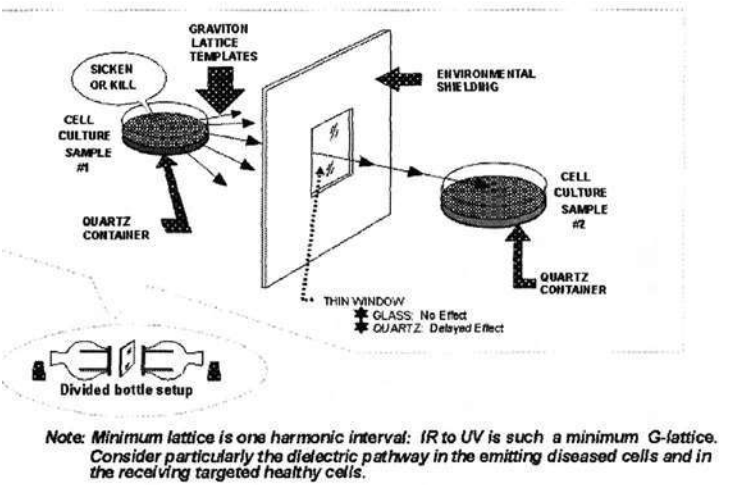

Note: Minimum lattice is one harmonic interval: IR to UV is such a minimum G-lattice. Consider particularly the dielectric pathway in the emitting diseased cells and in the receiving targeted healthy cells.

Figure 30 Kaznacheyev's electromagnetic induction of cellular disease and disorder.

Kaznacheyev has shown that essentially any cellular disease or disorder can be electromagnetically induced in cells at a distance (Figure 30). Together with Becker's work, this shows that the cells can be altered either detrimentally (disease induction) or beneficially (disease elimination) by purely **electromagnetic** means. It would seem that diseases such as AIDS, e.g., could be **rather** dramatically cured by use of whole-body longitudinal EM wave radiation

(with its simultaneously time-polarized EM wave radiation), as was done for other diseases by the Priore team and properly reported in the French scientific literature. We have also uncovered a process and method for causing the body to directly produce the time-polarized EM wave pumping, reducing the irradiation to perhaps 30 seconds of pumping instead of two or three hours {64}.

Becker's Study of the Cellular Regeneration System

In all our medical science, the only true healing procedures being utilized appear to be the use of Becker *et al.'s* tiny EM stimulation across otherwise intractable bone fractures {65} (Figure 31), to dedifferentiate (time-reverse) red blood cells, then redifferentiate (time-forward) them again twice to form osteoblasts, which are deposited in the fracture site to make new bone growth. All the other medical procedures seem to be *interventions,* not *healing.* After the intervention—which of course may be urgently necessary—it is then up to the body to heal itself (restore its cellular and tissue damage and functioning). So we have little *healing* science today, and in fact our medical establishment hardly funds any *healing* studies at all. EM radiation is usually considered as something that simply heats tissue. Our present medical science is deeply engrossed in studying the immune system. Again, the immune system heals nothing, not even its own damaged cells.

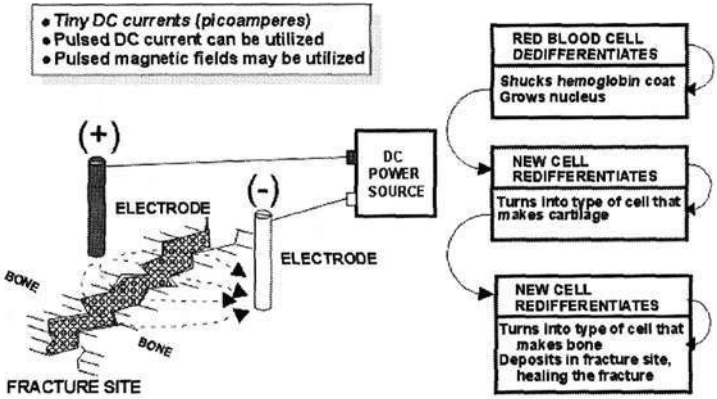

Figure 31 Becker's epochal bone fracture healing.

After the immune system "kills the bad guys" and saves the day, the battlefield is littered with residue and many cells of the body are damaged. The immune system sends in large scavenger cells that clean up the residue. And that's it for the immune system. Comparing it to an army's operation in the field, the immune system is the combat troops, not the medical services.

Restoration (healing) of the damaged cells back to normal is accomplished by

the *cellular regeneration* system (Figure 29). This system is little known and little studied, but mostly studied by Becker (Figures 27, 28). It is a system that functions electrodynamically, but uses time-domain pumping to time-reverse the cells and their every part (including their genetics) back to an earlier state. In biology, the effect is called *dedifferentiation,* but without any knowledge of the actual EM mechanism.

So, within its capabilities, the cellular regenerative system in the body already uses longitudinally polarized EM waves, time-polarized EM waves (TPWs), and optical pumping by LWs and TPWs. Here we point out that neither the longitudinal photon nor the scalar (time-polarized) photon is individually observable; however, the combination of the two is observed as the instantaneous scalar potential {66}. With a little correction to properly make the phase conjugate replica wave a time-polarized EM wave, Whittaker's fundamental bidirectional EM longitudinal wave decomposition of the scalar potential (Figure 32) is consistent. Immediately the direct involvement of both the scalar photon and the longitudinal photon—and both the scalar EM wave and the longitudinal EM wave—are seen in Becker's bone-healing work using a scalar potential (Figure 31).

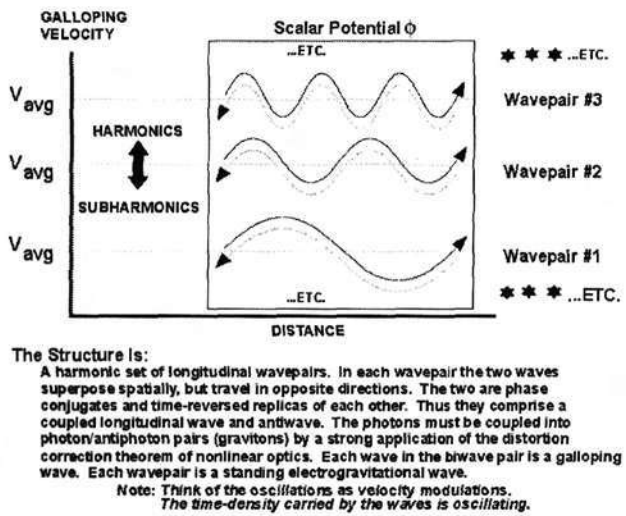

Figure 32 Infolded longitudinal EM biwaves composition of a scalar potential, per Whittaker 1903.

Priore unwittingly stumbled onto the actual mechanism used by all biological systems in "healing" (cellular regeneration), and also recognized how to amplify it (Figure 12). But no one understood its exact nature, including Priore and the scientists who worked with him at the time, and the conventional community still does not understand it. The Russian scientists not only *understood* it early

on, but *weaponized* it as well. So did the Chinese.

Need to Correct and Extend Classical Electrodynamics

The organized scientific community's protracted defense of a seriously flawed classical electrodynamics is long standing. The conventional, comfortable ways of "doing business as usual, leisurely" now threatens the survival of the nation itself. We need to quickly admit and correct long-standing EM errors—such as calculating a reaction cross-section of an entity and calling it the magnitude of the entity itself! Our electrical texts continue to make that fundamental mistake, and they have done it now for 100 years or more. We need to quickly change the classical EM model to include the active vacuum and its interaction, and we need to change all textbooks to clearly state that all EM energy in the universe comes from the active vacuum, via the asymmetry of the source charges in their fierce energy exchange with it.

We also need to point out that all primary electromagnetic entities—the charge, the field, the potential, and every joule of EM energy in the universe—totally violates the second law of thermodynamics. The charge produces continuously increasing negentropy, the field and the potential are formed at expanding light speed across the universe and are perfectly ordered (thereby totally violating the statistical mechanics basis of the second law), and every joule of EM energy is either field energy or potential energy, and hence violates the same statistical basis of the second law.

The Situation Is Serious

Admittedly these are strong statements highly critical of our scientific establishment's track record. But our national survival continues to be increasingly at stake, the situation is serious, and we must not continue to bury our collective heads in the sand like ostriches. We simply cannot continue to idly sit by and pontificate while other groups and nations methodically maneuver technically to cut our collective throats with advanced weapons we cannot defend against, once they find a way to "get by" the little nation that has been countering them for some years. Our own beloved nation may have less than 10 years {67} and perhaps less than three years to survive, unless the organized scientific community is galvanized to focus its very best scientific efforts in the energetics area.

So far, in truly innovative approaches to new methods for electrical energy, the U.S. scientific community is about as energetic as a sand terrapin sleeping in the tropical sun. There is no discernible move to recognize the seriousness of the problem, or to do anything effective about it. In 45 years, the asymmetry of the dipole (and the charge in its modern view as a dipolarity of special kind) has not made it across the university campus from the particle physics department to the electrical engineering department. In fact, the implication of broken symmetry to

electrical engineering and classical electrodynamics seems to still be completely unnoticed by the National Academy of Sciences, the National Science Foundation, our universities, and our great national laboratories. In the scientific community, other than work on vaccines etc., it is largely "business as usual."

A New Manhattan Project Is Warranted

Our need in the energetics weapons area is extreme, as are our needs in the medical area for quick, cheap, easy, and effective portable treatment of the coming mass casualties and our coming dramatic needs in energy. We *do* have superb scientists with the horsepower necessary to do something about it. The astounding, independent work of Sachs, the AIAS, and a few other scientists—which we stress has been unfunded—already clearly proves that. But unless we change the organized scientific community's normal rather snail-like pace—by a strong measure such as a Presidential Decision Directive and a declaration of a Nalional Emergency—the U.S. scientific community will overshoot the point of no return now approaching.

We need a new Manhattan-type project. We need it very quickly. If we do not change and focus our present scientific procedure, then—all too shortly—little that the scientific and intelligence communities are doing will be of value. We shall all be very, very dead or else in a new Dark Ages where most of the world economy has collapsed and freedom has largely disappeared from the face of the Earth.

T. E. Bearden, Ph.D.
Lieutenant Colonel, U.S. Army (Retired)
President & CEO, CTEC, Inc.
Director, Assoc. of Distinguished American Scientists

2002 ENERGETICS WEAPONS THREAT TO THE U.S.

T. E. Bearden 2000
Updated Oct. 1,2002

The U.S. Narrowly Escaped Energetics Destruction Twice in 1997

On two occasions in 1997 (latter February and on May Day), we were scheduled In be strategically attacked without warning and completely destroyed. Eerily, in public statements the leader of the Aum Shinrikyo sect (Figure 33) had foreshadowed the dates for the planned attacks, since his group was also involved—in fact, shooting down the TWA-800 (Figure 34) as advanced practice and stimulation of the U.S. to see if it knew what was afoot. Those two planned strategic strikes in 1997 were avoided only in the nick of time by ac**tions** of a friendly little foreign country, which was the only nation on earth at the time that could counter the KGB quantum potential (QP) weapons. I am sure that proper U.S. agencies intercepted my urgent personal faxes to the Defense Attache in Washington, DC and directly to the Prime Minister of the nation involved. Actions by that nation did succeed in averting our destruction in the nick of time.

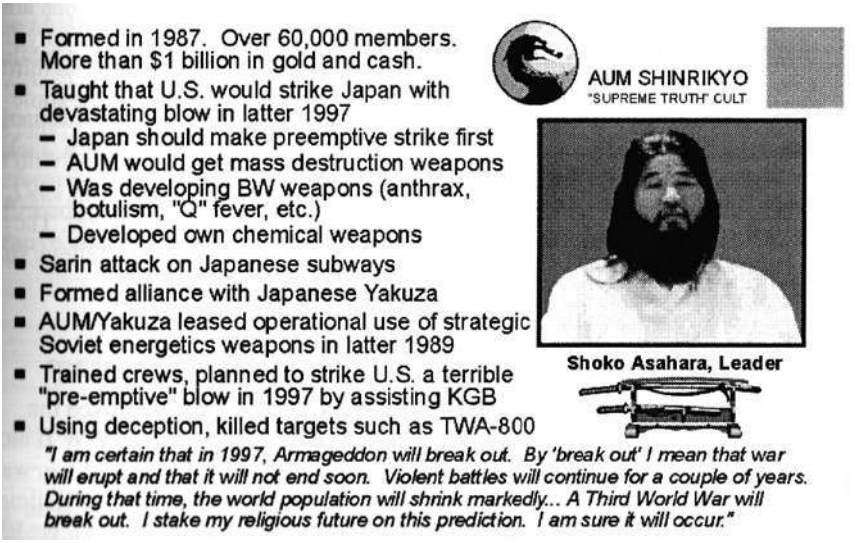

Figure 33 Planned KGB/Yakuza/Aum Shinrikyo attack in 1997 was foreshadowed in public statements made by Shoko Asahara.

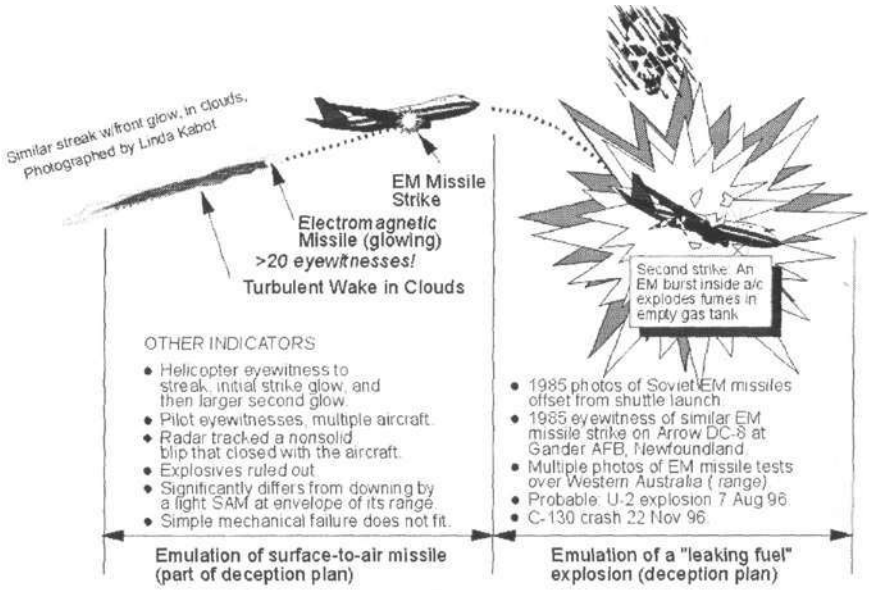

Figure 34 Kill of TWA Flight 800 on 17 July 1996 by Yakuza and Aum Shinrikyo.

Only five nations or national groups have quantum potential (QP) weapons, though one or more additional nations are almost certainly working on them and may even have them. First of the five is the KGB in Russia (the weapons are not in the regular Russian forces, and never have been). Second is the friendly little foreign country to whom we presently owe our continued survival. The third is Brazil (which has had a small and successful QP weapon program for some time). China deployed QP weapons in early 2002, and I recently found that at least one other friendly nation has them as well. I'm not too impressed with that other friendly nation, since they played no role in saving our bacon in 1997. It appears they did not actually know the coming attacks were imminent. They certainly do not have Causal System Robot weapons, nor do they believe such weapons even exist.

Initiation of the Brazilian Energetics Weapon Program

Brazil implemented an energetics weapons program after it employed the repatriated Dr. Hellman, a German scientist taken to Russia after WW II along with the German radar team. Years after being taken to Russia, Hellman was repatriated and made his way back to Germany. In a news interview Hellman reported that he had worked directly on the development of Soviet secret EM weapons which could suddenly free/.e large areas of the ocean surface. That of

course is a scalar interferometry weapon, producing negative (converging) EM energy rather than positive (diverging) EM energy in their distant interference zones.

Also, when the U.S. made David Bohm *persona non grata* in the McCarthy witch-hunts, Bohm was later employed in lecturing and teaching in Brazil for some time. At the time our own scientists continued to pontificate as to whether they *liked* or could *tolerate* Bohm's quantum potential and his hidden variable interpretation of quantum mechanics {3}. Meanwhile, the KGB weapon scientists and the Brazilian Hellman project seized upon Bohm's hidden variable theory with alacrity as soon as he published his seminal paper. Those two weapon groups were already familiar with the internal longitudinal EM wave structuring of potentials, fields, and waves (Whittaker 1903), and immediately saw the fantastic weapons implications of a deliberately structured quantum potential, containing a specific "engine" as desired. Most of our scientists still are unaware of it to this day, and are unaware of its formidable weapon implications when combined with Whittaker's 1904 superpotential paper, his 1903 potential decomposition, and quantum field theory. Most of our scientists still adhere to the Bohr interpretation of QM, which excludes the normal, everyday, observable, ordered universe we all inhabit and observe.[15]

The Bohm quantum potential is, after all, a scalar potential, and at least in theory it has a Whittaker biwave decomposition {68}. Even in the Coulomb gauge, the scalar potential has infinite velocity, as pointed out by Jackson.[16]

Several tests of the "cold explosion" Russian weapons referred to by Hellman have since been openly made. One major test seen by at least five jetliner crews was the anomalous rapidly rising cloud and subsequent extremely huge light globe (ABM energy shield) effects off the Kurils in April 1984 (Figure 35). Two excellent scientific articles on the physical phenomena observed in that incident are published in the prestigious journal *Science* {69}. We had explained the cold explosion phenomena and the ABM energy shield effects some years before that incident. Even ordinary superpotential theory {70} and longitudinal EM wave interferometry at a distance can substantiate the capability. We also positively confirmed by private sources that the scalar interferometry, the MindSnapper (negative energy EMP), and the cold explosion weaponry are real.

[15]This exclusion is euphemistically known as the "missing chaos" problem in quantum mechanics, and it is resolved in Bohm's hidden variable approach.
[16]J.D Jackson, *Classical Electrodynamics*, 2nd Edn., John Wiley & Sons, New York, 1975, p. 222, 223. Usually the instantaneous scalar potential contributes only to the near field.

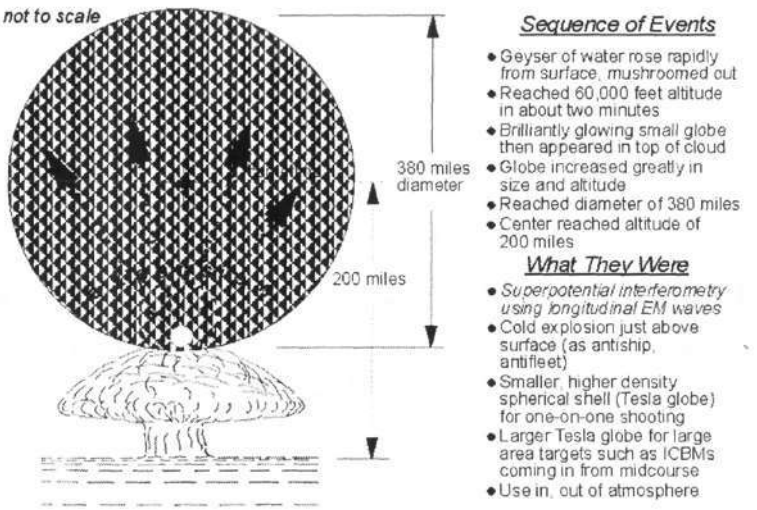

Figure 35 Exothermic (cold) explosion off the Kurils 9 April 1984. A second test, an expanding globe of light, was added in the exothermic mode to demonstrate rapid serial switching between weapon modes.

Related Phenomena

In 1969 in Toronto, Canada, Sid Hurwich demonstrated a device capable of "freezing" a pistol lying on a table so that the gun could physically not be moved and the trigger could not be pulled {71}. For this exhibition of *strong electrogravitation*, general relativistic fields initiated by the EM force field (including the usually unaccounted Heaviside nondiverged component that Lorentz arbitrarily discarded) as the agent of spacetime curvature were used {72}. The strength of the effect was attested by the fact that the hands of the observers' watches all showed "no passage of time" during the half hour they were in the room with Hurwich's device operating.[17]

Rapid development of that strong electrogravitational technology and concomitant energetics then proceeded in another nation. Weapons of such nature were then employed by that nation a few years later, in two well-known international incidents. Clear signatures of the nature of the weaponry utilized were present in those incidents. Details of these incidents will not be included in this paper.

[17] We point out that this is highly interesting itself, since it showed that the observers were operating in a different frame from that of the watches and the gun, which were "frozen". We also point out that recently light itself has been "stopped" in quantum experiments, yielding something quite similar.

Since the energetics weaponry already utilized special EM "hidden variables," Bohm's hidden variable theory and quantum potential were directly adapted into the program to dramatically extend it into the development of quantum potential weapons.

Stalin *Personally* Initiated the Soviet Energetics Program with the Greatest Urgency

While Stalin was at the Potsdam conference, at the close of WWII, the U.S. exploded the first atomic bomb in the desert. Truman informed Stalin in general terms that a powerful new U.S. weapon had been successfully tested. Secretly, Stalin already knew of our atomic bomb progress, for he had a spy in the program. While he was still at Potsdam, he then secretly called the Director of the Soviet atomic weapons program and directed a speed-up.

After we exploded two atomic bombs on Japan, the Japanese surrendered and WWII was over. See again Figure 1. Stalin vehemently ordered his Academy of Sciences to produce the next great technical breakthrough at all possible speed, since the American atomic bomb had frustrated his plan to wait two years after the war while the West speedily disarmed, then march into Europe and take it in six weeks. Now his massed troops could just be bombed back into the Stone Age by U.S. bombers using atomic bombs.

A Great Technical Breakthrough in Physics Can Always be Had in Four Years

The scientific community can have a great new technical breakthrough whenever its furious and dogmatic resistance to innovative discoveries or the possibility of innovative developments can be suspended. All that is necessary is a concentrated group of highly skilled, open-minded scientists, the money and facillities, and a strong headlock placed on the powerful but dogmatic scientific groups who would otherwise hamstring the program and destroy it.[18]

[18] Present day examples are (i) the cold fusion fiasco, where the U.S. scientific community has revealed furious determination to ignore more than 600 successful experiments worldwide, (ii) a similar fury against any and all research into extracting EM energy from the vacuum, even though all EM energy comes directly from the active vacuum via the proven asymmetry of source charges and dipoles, (iii) violent suppression of proven "extended electrodynamics" methods of rapidly curing severe diseases, even in terminal stage (resistance to anything except "cut, drug, burn" and anything that would interfere with the monstrous profits of the large pharmaceuticals), (iv) continuing dedication to an electrical engineering model that does not even model or apply what powers an electrical circuit, (v) continuing resistance to quantum potential research and development, (vi) slavish dedication to "big nuclear science", massive accelerators, dangerous nuclear power plants, and a "hot fusion WPA program", even though much higher energy physics than these programs advocate and use can be and is being done on the tabletop, using time-energy instead of spatial energy, and (vii) increasing "lock-up" of all research funds into the organized hierarchy's politically approved agenda. The community has deviated so far from scientific

We proved it in the WWII Manhattan Project, where we went from nearly zilch to the operational atomic bomb in 4 years. But we did it only by secretly bypassing the conventional U.S. scientific establishment. Einstein wrote to President Roosevelt *around* the scientific community, and when the President approved and ordered the highly classified program, conventional scientists not on the project were just parked on the sideline and ignored so that the job could be completed. The naysayers were also muzzled because of the extreme classification of the project; they faced jail if they engaged in their usual ad hominem attacks and dogmatic eloquence.

Further, today the "Skunk Works" approach repeatedly proves that bold new projects can be done, when the skilled scientists and facilities are mobilized and no adamant opposition by the conventional community is tolerated.

Numerous examples of the U.S. scientific community's suppression of innovation and new technology can easily be furnished. Such are well known to any historian of science. Cold fusion, the amorphous semiconductor by Ovshinsky, the first laser papers, ultrawideband radar, Mayer's original conservation of energy law, Boltzmann's work, Wegener's continental drift, flight of heavier-than-air machines, the rocket as a great strategic weapon, and hundreds of other examples come readily to mind. Such suppression has been *the* major characteristic of the organized scientific community since its inception, as pointed out by numerous leading scientists and authors. As Planck stated, usually one gets a new physics only after the old physicists who so adamantly oppose it just die off and get out of the way.

Today, the U.S. scientific community is in fact our "front line troops," although—except for a little lip service—the managers of the organized scientific community are blissfully unaware of it and have little or no sense of mission in out-of-the-box areas with respect to national survival. It is ironical, e.g., that our orthodox scientific community does not even know what powers an EM circuit—energy extracted directly from the vacuum by the asymmetry of the source charge (considered in its modern view as a dipolarity) and by the source

method in defending archaic theory in the face of experiments that falsify it, that the ubiquitous violation of the law of increasing entropy (second law of thermodynamics) by electrodynamics itself continues to be adamantly resisted using ad hominem and inflammatory attacks, slander and libel, and destruction of scientific careers of researchers. We flatly are not getting our taxpayer money's worth from our present scientific community, and—barring a Stalin-like shakeup from top to bottom—we are not going to get our money's worth in the future unless the community is forced to free up funds for young graduate students and postdoctoral scientists wishing to work in "out of the box" scientific areas. As Max Planck stated, *"An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out, and that the growing generation is familiarized with the ideas from the beginning."* In other words, one doesn't get a scientific innovation until the old dogs so bitterly opposing it just die off and get out of the way. This long-known and stated characteristic of the scientific community—its fierce and unrelenting resistance to change and innovation—is presently the greatest threat to the survival of this nation.

dipole (Figure 36).

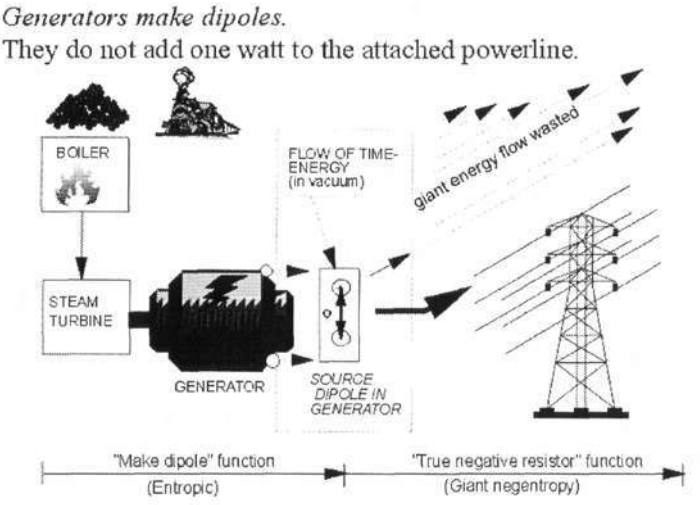

Figure 36 Energy extracted from the vacuum by the asymmetry of the source dipole powers every electric power line and electric circuit.

A Typical Example: The Suppression of Cold Fusion

As an example, much of U.S. Science—dominated by nuclear factions since the adventof the atomic bomb in WWII—vehemently attacked cold fusion and the **cold** fusion researchers, including wholesale ad hominem attacks, with a viciousness seldom seen in the history of science. Many dogmatic scientists declared the entire field at best a mistake and at worst a fraud. Even the character of many of the leading cold fusion scientists was openly impugned and the researchers were slandered and libeled. All this was done by conventional dogmaticscientists who have not solved the fundamental source charge problem {10,12}, have no inkling that all EM energy in 3-space comes from the time-domain {10}, and have not a clue as to what really powers every EM circuit. Since they also do not know where the electrical energy driving the chemistry actually comes from, they have no knowledge of the effects of time-energy in electrolyte solutions.

They also appear to have little or no knowledge of the implications of Evans' and Searles' *transient fluctuation theorem*[19] in thermodynamics showing to what degree the second law of thermodynamics can be violated and reactions can run

[19]D.J. Evans and D. J. Searles, *Phys. Rev. E,* Vol. *50,* 1994. p. 1645.

in reverse, nor its extension to the micron (colloidal) size level and to two seconds in duration.[20] If they did, then they would realize that the Coulomb barrier provided by *repulsion* of like charges (such as two H+ ions), often reverses into the *attraction* of like charges, with the barrier changing into the Coulomb attractor. This can last (by experimental proof shown by Evans *et al.)* up to two seconds, in a volume of fluid up to a micron in diameter. Hence it is not "against the laws of physics and thermodynamics" to observe attraction of two protons in an electrolyte so closely that each enters the strong force region of the other and the two form a quasi-nucleus. In the decay of this reversal zone, the preferred decay of the quasi-nucleus can be by quark flipping in one of the protons, yielding an atom of deuterium emerging from the decayed time reversal zone. Such results have been meticulously observed in many cold fusion experiments in multiple labs and nations, and by multiple researchers. Since these and other novel nuclear transmutation results are *replicated* experiments (more than 600, in multiple labs, multiple nations, and by multiple researchers), it means that no amount of theory can refute them or the results. The harsh skeptics launching the frenzied ad hominem attacks are thus revealed as the unscientific bigots they are, since they ignore substantial experimental results that contradict the prevailing theory. The excess energy production and inexplicable new nuclides (Figures 21, 37, 38) obtained by these multiple experimenters are completely inexplicable by ordinary nuclear interactions in the accepted theory.

- Fennions time-reverse in even numbers
- Like charges cluster
- Aqueous solutions contain H+ ions,
  which are just protons
- Quarks flip as TR zone fades

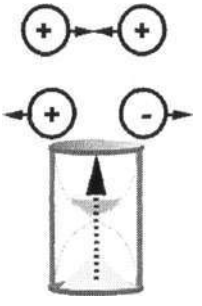

$$({}_1H_1 + {}_1H_1) \rightarrow ({}_0n_1 + {}_1H_1) = {}_1H_2 \text{ deuterium}$$

Figure 37 Electronuclear reaction in a time-reversed zone producing excess deuterium ions.

[20] G. M. Wang, E. M. Sevick, Emil Mittag, Debra J. Searles, and Denis J. Evans, "Experimental Demonstration of Violations of the Second Law of Thermodynamics for Small Systems and Short Time Scales," *Phys. Rev. Lett.,* 89(5), 29 July 2002, 050601.

- As TR zone decays, quasi-nucleus is usually in an excited state
  - — Decay action starts from every point in spacetime inside the nucleons
  - — Moves from inside toward outside
  - — Strikes the nearly free quarks first
- Decay occurs by easy quark flip
- Quasi-nucleus transmutes to an isobar
- If quasi-nucleus is a stable state in a forward time zone, no decay occurs.

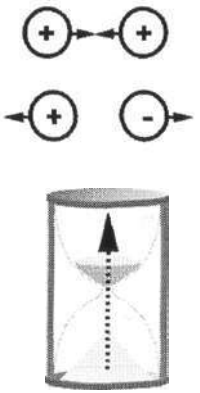

$$_1H_2 + {}_1H_2 \rightarrow {}_2He_4$$

Figure 38 Electronuclear reaction in a time-reversed zone producing excess alpha particles.

Meanwhile, the U.S. Patent Office has been instructed not to accept any patent applications that would interfere with present nuclear planning. Positive cold fusion results have also been successfully obtained in several U.S. government laboratories, including at China Lake where very strange instrumental effects have the experimental team puzzled. I proposed an explanation of those anomalies in August 1998, and have included it in my book just published in September 2002 {73}.

Revolutionary New Processes Are Hidden in the Cold Fusion Experimental Results

Once understood, cold fusion holds the breathtaking key to systems that consume *a tiny fraction of time flow itself* as a fuel to produce copious heat energy for the world's needs. Unknown to the conventional scientists, of course, electrodynamics itself already does this, but it has just not been recognized and accepted. Transducing one microsecond per second of time into transverse wave EM energy will produce some 9×10^{10} watts of real electrical power, if all the transduced EM energy is intercepted and used. This is the *real* way to extract energy from the vacuum and use it cleanly and cheaply.

To grasp such a notion, recall that the fundamental units used in physics are completely arbitrary. It is perfectly possible to express all physics in only a **single** fundamental unit—for example, *the joule*. Time then becomes totally a function of energy. So it is not so insane after all to express time as highly compressed energy. Mass is also highly compressed energy. That concept is now familiar after Einstein, the nuclear age, and $E = mc^2$. Time-as-energy is just as straightforward as mass-as-energy, but it has just not yet come into

recognition.

The *use* of time as compressed energy, however, leads to some profoundly new types of electronuclear reactions presently unknown in particle physics. These new transduction reactions produce the new nuclides in cold fusion experiments, and generate the *electronuclear interaction*. We explain that in some detail in our new book, *Energy from the Vacuum*, previously cited {10}.

When interpreted as using time-energy, cold fusion shows us the way to a new electronuclear regime of nuclear reactions where nuclei, elements, and compounds can just be directly assembled by comparatively weak (in terms of *spatial* energy!) electromagnetic interactions. Presently we have made substantial progress in understanding the fundamental mechanisms generating these electronuclear reactions, after presenting preliminary results in August 1998.

As one example, time-reversing a single fermion (a particle with spin 1/2, 3/2, etc.) is precluded by the Pauli exclusion principle. But one can time reverse *two* of them, or any even number n, where they act as a semi-boson or group of semi-bosons. Simply put, if a time-reversal zone is established momentarily in the region where like charges exist, then the n-tuple fermion cluster can be achieved because the law of attraction and repulsion of charges is temporarily reversed {74,75}. This unexpected "attraction of paired fermions of like sign" will form quasi-nuclei in many cases, particularly in small clusters of two or four, etc.

Hence two H+ hydrogen ions (two protons) in such a time-reversal zone in a fluid are drawn together into a quasi-nucleus, which actually is an excited isomer of deuterium (Figure 37). Time-reversal zones are temporary in cold fusion experiments due to the statistics of their formation and the transient fluctuation theorem {76} of thermodynamics. As the time reversal zone decays, the quasi-nucleus of two protons is increasingly in an excited and unbalanced state. The excited-state *diproton* nucleus decays by flipping a quark in one proton, converting it to a neutron. That produces a *neutron + proton nucleus*, which is a deuterium ion, strictly by electronuclear means. Or four protons may cluster by "attraction in a time-reversal zone" and form a 4-p nucleus. That is an excited isomer of a helium nucleus. As the time-reversal zone decays, first one quark flips in one proton and then another quark flips in a second proton. That produces a helium nucleus - i.e., an *alpha particle*. Or two deuterium ions can attract and form a quasi-nucleus (Figure 38), which is already an exact isomer of a helium nucleus and thus easily decays into an alpha particle by simply "tightening" as the weakened strong force recovers faster than the Coulomb force can reduce, vanish, and resume in the opposite direction. The exact reaction equations for these reactions are given in my new book, *Energy from the Vacuum* {10}.

We filed an Invention Disclosure on the process of forming and using time-

reversal zones to cause like charges to attract and unlike charges to repel *in vacuo,* in fluids, and in other media, resulting in the formation of semi-nuclei as excited isomer states of other nuclei, followed by decay into new nuclides. We will follow it with patent applications in the future. This represents a completely new kind of particle physics interaction presently not included in the textbooks, and not requiring high-energy processes. Literally thousands of new nuclear interactions—all *permissibly* violating the second law of thermodynamics because the statistics permit such violations and experiments prove it—are now possible.

Cold fusion does indeed hold a new kind of nuclear physics in its hand—but a physics presently considered very alien by our orthodox nuclear science community. For decades nuclear scientists have been seeking ever more spatially energetic particle smashing, believing that extreme high energy nuclear reactions and transmutations cannot possibly be done with charged particles at low *spatial* energy. One is sympathetic to the scientists, because even the concept of "low spatial energy transmutation" itself sounds like an oxymoron. And it would be, *if one were limited to spatial energy alone*, as is presently assumed by physicists. But one is also speaking of the neglected and compressed *huge time-energy* component of those low-spatial energy photons, and that is quite a different matter. The lower the spatial energy of the photon (the lower its frequency), the greater the amount of compressed energy transported in the time component as "time". The transposition of time-polarized EM energy into longitudinally polarized EM energy—and vice versa—is already justified in quantum field theory. Use of that extremely high energy component by its transposition or partial transposition into spatial energy in fact provides a much higher energy physics interaction than present orthodox high energy physics utilizes, knows, or considers.

Almost all the learned scientists are thinking *only* of spatial energy, since that is the only kind they have been "taught" to consider. Hence, from their view (i.e., on the premise of their implicit *assumption)* it is perfectly "logical" to condemn cold fusion, since in their view, "cold" implies low (spatial) energy and "fusion" implies high (spatial) energy transmutation. What is unknown to the orthodox community is that the "cold" in cold fusion also implies "extraordinarily high time-energy". So with a little transduction of highly compressed time-energy into spatial energy, "cold" fusion actually can imply "extremely high spatial energy made available by transduction" also.

As an example, the Chief Editor of *Science* recently had the courage {77} to publish results of sonoluminescence research reporting positive experimental transmutation results {78}. A paper was then published in *Nature* {79}, pointing out that the (spatial) energy involved is insufficient for such nuclear transmutation temperature, thereby implying that the reactions reported by the first researchers are not possible.

However, given formation of a time-reversal zone, this second paper is not

necessarily applicable to the sonoluminescence fusion process, because the paper is based on an unwitting two-part premise that *(i) only spatial energy can be used for nuclear transmutation and (ii) no time-reversal zones exist to nullify that premise by having reactions (such as the law of attraction and repulsion of charges) run backwards.* That premise is already experimentally proven to be invalid by Evans et al., and it fails when the time reversal zone effect is considered.

We strongly stress that thermodynamics—both in theory and as demonstrated in experiments—not only allows but predicts—for a certain fraction of the time—the formation and existence of just such "reversal zones" where the usual reactions *run in reverse* {76}. It is also experimentally proven {54}. In that case a much higher energy—time energy—can be and is employed to convert the Coulomb barrier into the Coulomb attractor.[21] We know now (from the experimental demonstrations by Denis Evans et al.) that such "reversal zones" may be up to a micron in size and may endure for up to two seconds. The subsequent decay of that TRZ then allows the quasi-nuclei temporarily formed in it to decay by quark flipping alone, allowing the quasi-nucleus to easily transmute into a perfectly well known nuclear reaction product.

To quote Arthur C. Clarke, when a learned scientist says something is *possible*, he is probably right. When he says something is *impossible*, he is probably wrong.

Stalin's Dictatorial Impact on Soviet Scientific Management's Response

Stalin was a powerful dictator. He simply killed or jailed those who opposed his will. So after his blunt order (Figure 1) circa latter 1945 to find a great new technical breakthrough area quickly, his Academicians and high level science managers were faced with a severe dilemma: They could not afford to *oppose or criticize a vigorous search* for new innovations and a great breakthrough, and they could not remain passive. Their very lives depended on they themselves *personally finding such a breakthrough in great haste and presenting it to Stalin*. They had to actively spur the efforts of their most outstanding subordinates and Soviet science itself, or suffer dire personal consequences. Siberia and prison camps loomed for the lot of them unless they produced.

To put it bluntly, Stalin "got their collective attention" and their "whole-hearted support." Those few who resisted simply were shipped post-haste to the notorious prisons of Siberia, and worked to death in short order.

[21] We strongly point out that, when the reactions run backward and negentropy appears in those reversed regions, the conservation of energy law is violated unless time-energy is being converted to spatial energy. Either we must begin accounting time as energy, or we must give up the conservation of energy law itself. The obvious solution is to account the time energy being utilized, as well as the 3-space energy.

So the highest-level Soviet scientific managers now desperately demanded of their subordinate scientists *anything—anything at all*—that was novel and had breakthrough implications. An almost convulsive national scientific effort was launched immediately, with hardly a detracting voice. A great team of the very best Soviet scientists was rapidly formed and methodically searched the scientific literature of the world from beginning to end. Nothing even remotely like that search and review has ever occurred in the West.

For example, one great technical center set up by the Soviets had a staff of about 2000 Ph.D.s with associated translators, staffs, etc. The Soviets purchased and hauled in copies of all the scientific literature of the West—by the shiploads—to such centers. Their scientists then methodically went through the material, journal by journal, paper by paper, page by page. There are and always have been myriads of innovations and discoveries sitting on the shelf in the scientific literature, never followed up, or opposed by standard models and credos. The first tier of reviewing Soviet scientists was composed of excellent scientists. They skimmed out the "cream" into a select pile which the second tier then analyzed in depth. The second tier was composed of the best nonlinear scientists in the world—the "superscientists."

They were seeking *new principles of nature that could rapidly be developed into highly advanced technology*, and they found them—sitting there in the literature, already pointed out, and long ignored by the Western scientific community.

Shortly Stalin had his great new breakthrough area emerging, and they had their heads.

Our Own Science Community's Progress During These Decades

For decades foundations physicists (Bunge, Feynman, Wheeler, Lindsey, Margenau, etc.) in the U.S. have repeatedly pointed out the substantial foundations problems in electrodynamics. Nobelist Feynman and the great John Wheeler tried to "fix" the problem whereby electrodynamics still erroneously assumes force fields in a space filled with a *material ether* (unit point positive charge, unit point north pole, and unit point mass assumed at every point in space). Unfortunately they failed, primarily because their absorber theory {80} contradicted the photon hypothesis and hence quantum mechanics.

Meanwhile, our own National Science Foundation and National Academy of Sciences has directed only minimal work on correcting electrodynamics and dramatically extending it. Faraday and Maxwell—as did every other scientist at the time—rigorously assumed a material ether. Maxwell's equations also implicitly included that material ether assumption. They still do, even after Heaviside's truncation and Lorentz's symmetrical regauging, because none of the Maxwell-Heaviside equations were changed to eliminate the material fields in space (material ether) assumption after the Michelson-Morley experiments

falsified it.

Every major university in America still teaches that implicit material ether, even though it was falsified over a century ago. That is an exact measure of the caliber of "foundations" work our own scientific community does if left alone. *In more than 100 years, they have not even chosen to root out the material ether from electrodynamics.*

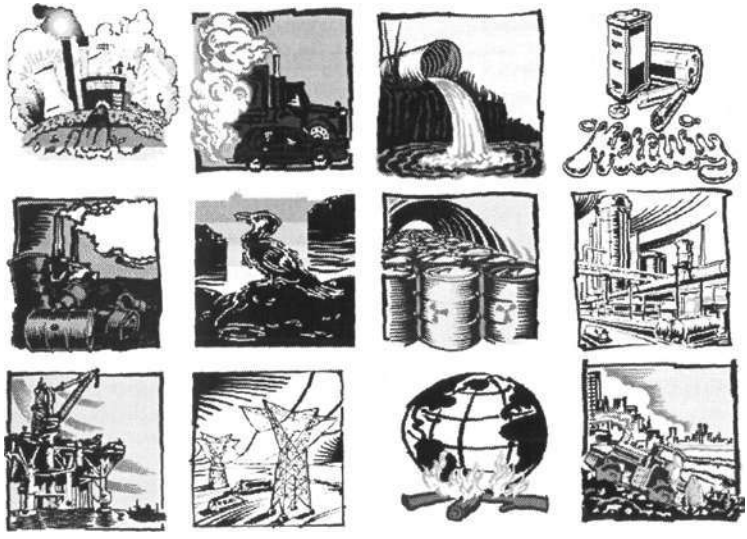

Figure 39 This polluted and suffering planet. Direct result of the scientific community's adamant resistance to upgrading classical electrodynamics and electrical engineering.

The prevailing flippant attitude is that, "Well, your TV set works, doesn't it?" Yes it does, but we also do not have practical electrogravitation and inertial propulsion, nor do we have cheap clean EM energy from the vacuum. Instead, we have a severely polluted planet (Figure 39), ever increasing deaths from biospheric fumes and polluting byproducts, increasing destruction of species, and a monstrous unleashing of far more coal and hydrocarbon burning in our near future while the world tears itself apart and destroys its economy and civilization in a rising series of oil and energy wars. The direct responsibility for that mess lies directly with the scientific community and its fierce resistance to innovative research and development, and changing a century-old, long outmoded classical EM and electrical engineering model.

Wryly put, it's high time we "got the lead out" of EM field theory, where the lead is the material ether and other non-sequiturs cluttering the theory.

Such drastic modeling errors would not be tolerated of government-funded aerospace engineers and contractors developing a new missile system. So it should be equally intolerable in the government-funded scientific community

and in fact in the civilian scientific community as well, and it should not be tolerated of either the National Academy of Sciences or the National Science Foundation.

Einstein {81} said it perfectly, as follows:

> *"...the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools of thought, as something obviously, immutably given; something having an objective value of truth which is hardly even, and in any case not seriously, to be doubted... in the interests of science it is necessary over and over again to engage in the critique of these fundamental concepts, in order that we may not unconsciously be ruled by them."*

Upholding and perpetuating flawed electrodynamics models seriously impedes the progress of scientific development and revolutionary new technology.[22,23] At some point, one must legitimately question the upper management of the U.S. scientific community for not modifying classical EM and electrical engineering to include the active vacuum exchange with every charge and EM system. In not doing so, they continue to advocate perpetual motion source charges, creating energy from nothing, on a scale unparalleled in history.

It is little wonder that we do not have electrical power systems that successfully and freely utilize more than a trillionth of the vacuum energy they freely extract from the local vacuum. *There is not now and there never has been a single*

[22] Oddly, the conventional electrodynamics model assumes that every source charge freely creates energy out of nothing at all, and pours this energy out continuously in all directions, thereby establishing its associated EM fields and potentials at light speed, reaching out across the universe. From the 1960s alone, the total assumption of incredibly vast numbers of perpetual motion machines has been carefully hidden from the new students, so that today even many professors do not realize that in their model all EM fields and potentials, and every joule of EM energy in the universe, are assumed to be created by a vast assortment of perpetual motion machines called source charges. That problem has not been solved in electrical engineering or in classical electrodynamics, and if the scientists have their way, it is not going to be solved. Yet the basis for its solution—the asymmetry of opposite charges such as the dipolarity (in the modern view) of a source charge—has been in particle physics since 1957, with the award of the Nobel Prize to Lee and Yang in December of that year.

[22] One keeps one's sense of humor. The raucous skeptics and "defenders of the orthodox EM faith" who so noisily denounce legitimate COP>1.0 EM system researchers as "perpetual motion nuts", are themselves unwittingly the greatest perpetual motion nuts ever recorded in history. Further, they are so ignorant of what their present model actually means, that they do not even know it. It is one thing to be ignorant and to recognize it; it is quite another thing to be ignorant and so ignorant one does not know it—45 years after broken symmetry was rigorously established experimentally by Wu and her colleagues, and the Nobel Prize awarded to Lee and Yang.

electrical engineering department, professor, or textbook that knows what actually powers an EM circuit—real observable EM energy extracted from the local seething vacuum by the source charges and the source dipolarity.

Since our scientific community cannot seem to make such a simple change (as including the active vacuum's interaction with every charge and the charge's broken symmetry in that interaction) even 45 years after the basis for that change has been resoundingly proven in particle physics, our national survival is at stake and the nation itself is seriously threatened by the superweapons developed by the KGB over the last five decades. We would have already been totally destroyed—twice in 1997 alone—had it not been for the intervention of a friendly little foreign nation. My colleagues and I played a very small alerting role in those affairs, so we are speaking from experience, not from extrapolation. We would be quickly destroyed today, were it not for the continuing "balance of terror" provided by the little nation.

U.S. Scientists Have Committed Monstrous Crimes and Gone Unpunished

Rather sadly, we also point out another thing that has to be said: *scientists are no more moral or immoral than any other slice of American citizens.* A percentage of scientists is capable of committing horrible scientific crimes, as distasteful as such a statement may be. That includes the deliberate experimentation on humans, resulting in deaths. In short, at least manslaughter and perhaps even murder, since knowledge of the probable results was there beforehand.

One would think U.S. scientists would *never* scientifically condone and perform experiments leading to mass deaths for 30 years (i) as they did in the Tuskegee case in Alabama. Over 400 poor blacks were supposedly treated for syphilis, while actually not being treated at all, but were deliberately tricked and allowed to rot with syphilis so our "ethical" scientists could watch how their brains decayed, so to speak. Over 100 of those poor blacks died with the disease while the scientists cold-bloodedly watched them expire and kept meticulous records. Or (ii) as they did in the case of whole body nuclear radiation for 30 years—again by trickery, deceit, and illegal use of security classification to hide these acts—of helpless retarded children and others, some of whom also died.

Once these heinous incidents were exposed publicly, the political power of the scientific community is such that *no scientist was ever indicted or tried for these heinous mass murders, and none is going to be.* The scientific community *has* <u>*not*</u> fiercely called for punishment of these mass murderers amongst their midst—guilty of precisely the same kind of horrible actions for which we tried and executed war criminals at Nuremberg.

Incredibly, the President of the United States formally apologized for these incidents! He did not turn the case over to the Justice Department for prosecution of high crimes against humanity and mass murder, *as would have*

been done for ordinary citizens. Had a single doctor in his private clinic done such things on his own, he would have been arrested, summarily tried, and either sentenced to life in prison or executed.

The sad thing is that there was really no sharp clamor from the scientific community to bring their fellow scientists to justice, a la Nuremberg. By their silence, the organized scientific community showed a side that scientists are loftily not supposed to possess. *So long as the scientific community continues to tolerate those mass murders of American citizens and not call for justice, then just so long do they stand convicted by their own resounding silence and inaction.*

We cite these painful incidents (there are others!) to point out that one must not deify the scientific community. The conduct of science is no better and no worse than the conduct of human affairs in other areas. Science is also a big business, and it has its moral scientists and its immoral scientists. It does its moral business and it does its immoral business.

We painfully submit that both sides of the scientific character must be considered, when one examines such things as the tolerance or intolerance of the scientific community to dramatic innovation and "out of the box" research. We have to consider it now, because it has become a serious threat to the continued survival of our nation. The conduct of scientific affairs will unavoidably include suppression, maneuvering, spin control, and fierce struggle for power and funds—such is in the very nature of human beings, and it is present in the scientific community on a bell-shaped curve as in all other human communities. It is ongoing widely today, and to an uncomfortably large extent much of science has been captured and effectively controlled by controlling the scientific funding and prescribing what research must be done for the funds available.

As the French say, "The more things change, the more they remain the same." Science is still the same way as it was when Planck made his famous statement. It will still be that way tomorrow, and a century from now. As with any other big enterprise, it has to have checks and balances imposed and enforced on it from outside—by the government itself. Little or no indication exists of that happening in the near future, until we get something like an anthrax spray attack on a large city, and have a million or more Americans dying in the streets.

Energetics: New Principles of Physics and How the Soviets Found Them

Under Stalin's whip, the Soviets particularly sought anything that indicated *possible new principles of nature.* It is no accident that Nobelist Petr Kapitsa later informed Nikita Khrushchev that a means of total neutralization of foreign missiles could only come from *a group of new principles in physics called energetics.* A group of new principles is precisely what energetics *is.* So if our scientific and intelligence communities wish to understand energetics, they must

first understand the new principles it is based upon. They cannot just simply apply ordinary electrodynamics and "business as usual" as they have largely done. The massive Soviet scientific search program spurred by Stalin is where those new principles came from.

When the first tier of Soviet review scientists found something that had not been followed up, and saw that it had significant implications if found valid, that paper was laid aside into a "select" pile. That select pile then went to the "super" scientists, for full-blown review and analysis by some of the brightest and sharpest minds on the planet.

The Russians came up almost immediately with Whittaker's 1903 and 1904 work. That work shows a hidden electrodynamic *longitudinal* EM wavepair structure (in phase conjugate pairs) inside the scalar potential and comprising it.

This is a dramatic extension of electrodynamics to incorporate a full-infolded general relativity infolded inside the electrodynamics. Whittaker showed that scalar potential functions in interference already *create* all the "normal" fields and waves anyway (the beginning of superpotential theory). This novel interferometry and its inherent capability for action-at-a-distance did not elude the Russian superscientists. The superb Soviet scientific team came up with that and with much, much more.

Nothing like the comprehensive, intense review of the entire scientific literature has been accomplished by the U.S. scientific community. Nothing like it is being done now.

Longitudinal EM Wave Interferometry Energetics Was Almost Immediately Uncovered

At the end of WW II, the German radar team and infrared team were taken to Russia. Both teams were years ahead of their Western counterparts.

One of my close colleagues has validated that the German radar team had some severe instrumental anomalies while still in Germany. We think this is what they were:

In WW II the Germans invented radar absorbing materials, to coat their submarine snorkels and prevent Allied antisubmarine warfare bombers from tracking the snorkels and destroying the subs. A wide variety of highly nonlinear, doped materials were investigated. In addition to single beam radar cross section, the Germans also examined the materials in multi-beam illumination circumstances.

It appears that, in some multibeam experiments with some materials, conditions were just right so that the multi-illuminated absorbing material acted as a pumped phase conjugate mirror (PCM), and wave-to-wave interactions emerged. This meant that the absorber material PCM would suddenly gather up

all the energy in the pumping beams, use one of the other beams as a signal input beam, and fire an amplified retroreflected pulse right back down the signal input beam, wrecking the experiment and creating havoc in surrounding equipment.

When the German radar team went to Russia, their knowledge of these anomalies went with them. In the desperate Russian scientific climate to find *lust such anomalies,* this startling and anomalous phenomenon would have been exhaustingly examined and studied, once the German radar engineers got to Russia to their new laboratories.

In short, it appears that the Russians quickly came up with what today is called "nonlinear phase conjugate optics," but first in the radar band rather than optics.[24] So before 1950, it appears that the Russians already had working phase conjugating pumped phase conjugate mirrors for the radar bands and in other bands.

Fisher {82} details that we Americans did not "stumble onto" practical phase conjugate optics experiments until Russian physicists briefed Lawrence Livermore National Laboratory scientists in 1972 about the strange wave in **many** of their optical experiments that "came out of nowhere and restored order **from** disorder." At that time, the KGB energetics weapon scientists had known aboutphase conjugate retroreflection and its amplified pumping, for more than 20 years. Indeed, the first giant strategic scalar interferometers had already been deployed and utilized to kill the U.S.S. Thresher nearly a decade earlier (Figure **6).**

By 1950 Russian Energetics Was Off and Running

By the beginning of the 1950s, the Russian scientists under iron KGB control were already experimenting with "scalar potential interferometry" at a distance, a la Whittaker 1904. Here transverse EM waves, EM fields, and EM energy—either *divergent* (heating) positive energy or *convergent* (cooling) negative enery—could be readily created at a distance {83} (Figures 40 and 41). Further, the longitudinal EM wavepairs used in this interferometry had the marvelous characteristic of easily penetrating right through the earth and ocean, with only a little intervening interaction, given that the LWs are sufficiently well made {84}. The interferometry "beams" can and do also move superluminally—again, right through the earth and ocean.

[24]**Of course, they would also have investigated it at all other bands as well.**

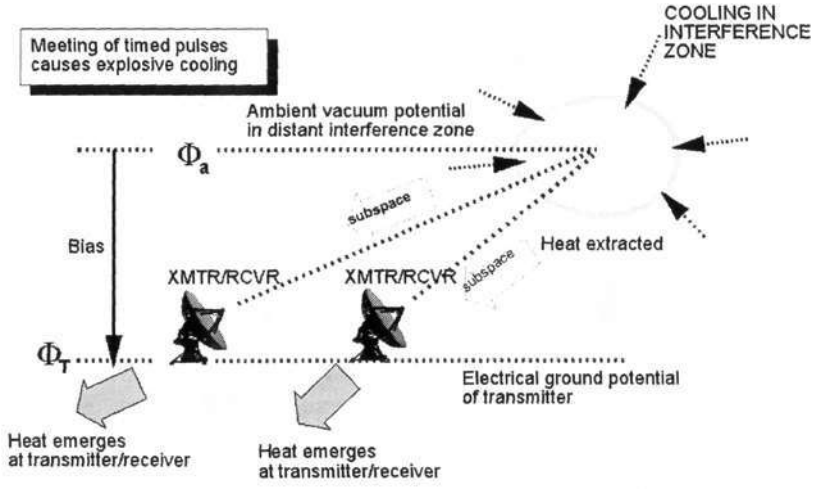

Figure 40 Scalar interferometry in the endothermic (cooling) mode.

It is not accidental that Admiral Gorshkov, head of the Soviet Navy, would later bluntly state: *"We have made the oceans of the world transparent."* And so they had.

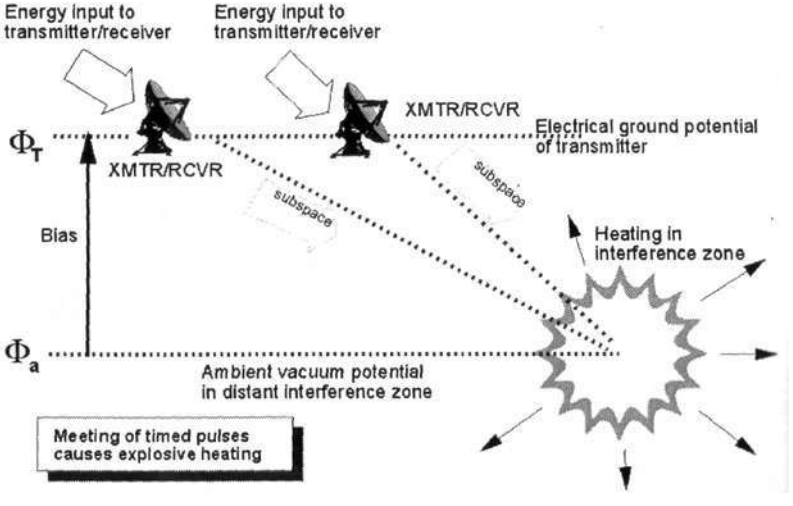

Figure 41 Scalar interferometry in the exothermic (heating) mode.

By 1950, the Russian scientists were experimenting with deliberately creating and phase conjugating longitudinal EM waves, forming phase conjugate

wavepairs. They then assembled the desired (mathematically calculated) sets of those waves, adjusted frequencies and magnitudes, phasing, etc., to produce EM potentials having a desired deterministic internal spacetime curvature set (internal spacetime engines) and dynamics.

As a result, by the mid-50s Russian weapon scientists were already experimenting in *bioenergetics* with the direct inductance of diseases and health changes via the transmission into human targets of such "internally structured" EM potentials, fields, and waves. They were also experimenting with the production of EM energy, potentials, fields, and waves at a distance, directly through the earth and the ocean. Either heating (energy flow divergence) (Figure 41) or cooling (energy flow reconvergence) (Figure 40) could be produced at will in the distant interference zone, merely by altering the bias voltage on the chassis grounds of the interferometer's transmitters. Rapid switching between the exothermic and endothermic modes thus was straightforward {85}, as demonstrated (Figure 35).

By the latter '50s, longitudinal wave interferometry weapons had already emerged from advanced engineering development and were in full production engineering toward deployment. The LIDA device {86} and even more advanced versions for directly affecting the human mind and its state of consciousness had emerged in *psychoenergetics* as one class of devices rather openly released and utilized. The LIDA uses structured EM microwaves {87} to induce a hypnogogic or cataleptic type of trance-like state in either a human or a cat. as tested years later by Dr. Ross Adey of the U.S. Early prototypes were purportedly used against our prisoners in North Korea during the Korean War to assistin their brainwashing by their North Korean Captors. Prisoners reported that its effects were irresistible.

Meanwhile, energetics weapon testing in several major modes was being conductcd, particularly from Soviet research ships over remote regions of the ocean and at night. Descriptions of such tests—many of them seen by passing ship's captains—can readily be found in the open maritime literature. We gathered and published many such incidents and cited references.

Deployment of the Soviet Energetics Weapons and Their Quick Use

In January 1960 Khrushchev spoke obliquely of these "fantastic" new superweapons, just within the portfolio of the Soviet scientists, so to speak, in an important speech to the Presidium. Parts of that speech were reported in the *New York Times* {88}. No one in the West knew what Khrushchev was talking about. Our intelligence community, which bases many of its assessments on the tired old phrase "We have no evidence that..." simply treated it as propaganda, It wasn't, and the U.S.S. Thresher was to be destroyed (Figure 6) three years later by that same weapon Khrushchev was speaking of.

Khrushchev began rapidly inserting long-range missiles and nuclear warheads into Cuba in 1962, precipitating the Cuban Missile Crisis. Kennedy knew Khrushchev's strategic bombers and rockets were in horrible shape, due to direct information received from Colonel Oleg Penkovskiy, a Russian spy in our employ courtesy of British Intelligence. No one knew of the superweapons, but they were not yet operationally ready in Oct.-Nov. 1962. So Kennedy called Khrushchev's bluff and faced him off. Blustering awhile to obtain U.S. assurance that it would not invade Cuba, Khrushchev was forced to back down and withdraw the missiles. In his exuberance he had simply moved too fast in inserting the missiles into Cuba. Had he waited a few months later, the strategic superweapons would have been operational and ready. Any U.S. naval blockading force would have thus faced quick and eerie destruction or disabling, as was soon to be demonstrated in the case of the U.S.S. Thresher and its surface companion, the U.S.S. Skylark.

This severe loss of face by Khrushchev, before the Communist Party, made it imperative that he do something quite dramatic to stay in power, and do it as quickly as possible.

Khrushchev's first large, full-up, strategic longitudinal EM wave energetics interferometer weapon became operational on site by April 1, 1963. A few days later, Khrushchev employed it to kill the U.S.S. Thresher atomic submarine (Figure 6) underwater off the East Coast of the U.S. By simply creating EM noise in an interference zone placed on, in, and around the sub underwater, and thus jamming the sub's electrical controls so that it could not be controlled, the helpless sub sank to crush depth and imploded. The U.S.S. Skylark on the surface had multiple systems seriously jammed or rendered nonoperational. This was the Russian deception plan, to have the kill of the sub resemble an accident.

One day after the successful clandestine kill of the Thresher, the same weapon was used to demonstrate a powerful underwater electromagnetic burst 100 miles north of Puerto Rico (Figure 42). The energetics underwater burst equaled a substantial deep underwater nuclear explosion in size. The burst was seen by a passing U.S. jetliner crew and was reported to the FBI and the U.S. Coast Guard when the aircraft landed in Florida. A colleague interviewed the co-pilot of the aircraft, and relayed the interview information to me.

Khrushchev's Second Demonstration

Deep Underwater EM Explosion 11 Apr. 1963

(Similar to this photo set of a deep underwater nuclear **test** explosion)

Phenomena observed and reported by passing U S jetliner

100 miles north of Puerto Rico, over Puerto Rican Trench (One of the deepest parts of the ocean)

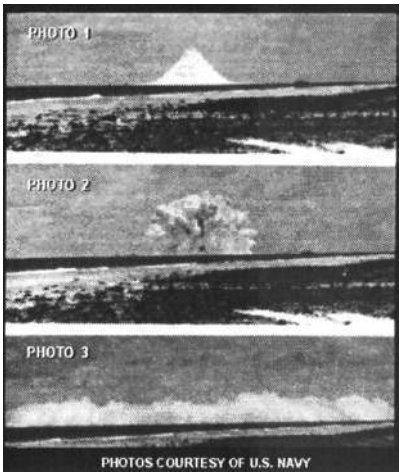

Figure 42 Deep underwater nuclear burst, demonstrating same water phenomenology produced by Khrushchev's second demonstration on 11 Apr. 1963, the day after killing the U.S.S. Thresher.

Why the Soviets Could Continue to Attack and Kill U.S. Targets with Impunity

Ironically, Khrushchev clearly demonstrated the inability of U.S. science to comprehend the numerous test incidents of Soviet LW interferometers, including the actual destruction of strategic U.S. targets (our latest and greatest nuclear attack submarine!) right off our coast. *The greatest strategic weakness of the U.S.—and the thing that may yet completely destroy all of us—is the continuing snail-like pace of U.S. scientific progress in revising, correcting, and extending its seriously flawed classical electrodynamics model. This scientific inertia placed us several decades behind in development of defenses in the areas of longitudinal EM wave weapons, quantum potential weapons, and causal system weapons. It countered our strategic nuclear armada for two decades. We were for some time analogous to the Spanish Navy with its wooden ships, when it faced and was destroyed by American steel ships. Hopefully at least some more modern work has now been accomplished in higher group symmetry electrodynamics, so that we are not quite as defenseless as we formerly were. But we still have a very long way to go.*

When one performs a standard strategic analysis on a nation, one of the areas examined in depth is called *national style.* One of the major characteristics in the U.S. **national** style is that we do not react to slowly increasing threats or changes

(Figure 43). That style particularly applies to the scientific community. Because of it, the Russians knew that our government only inches forward in achieving new *basic* science. We run at enormous speed, doing *applied* science. We are essentially Romans and great engineers. We are largely not Greeks and not great esthetics discoverers. We also will just ignore new threats if they emerge very slowly and are only gradually perceived, and we will hide behind that infamous phrase, "We have no evidence that..."

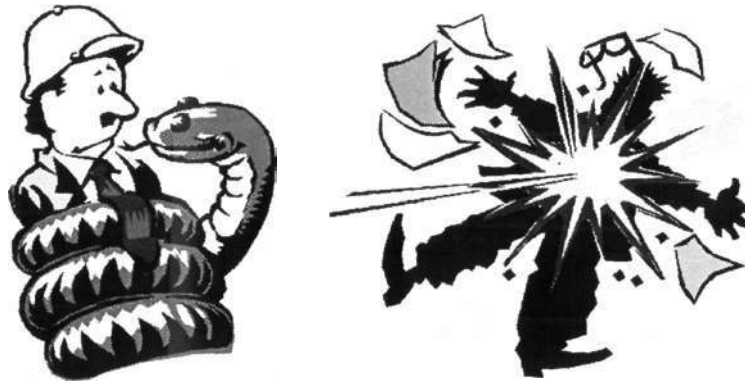

BOA CONSTRICTOR LIGHTNING STRIKE

Americans tend not to react to slowly increasing things,
but react to rapidly increasing things.

Figure 43 America's national style: we do not react to slowly increasing threats.

In short, *we react to the coiled rattlesnake, not to the boa constrictor*. We are now in a long, bloody, costly war against terrorism because of that very characteristic of our national style. For decades, the slowly increasing infiltration of terrorists and their weapons was just ignored. Oh, yes, the official "threat studies" pointed it out, placidly.[25] But no one got very excited about it. The prevailing attitude was that "Ah, yes, but nothing like that will happen on *my* watch!"

As clearly demonstrated by their successful decades-long radiation of the U.S. Embassy in Moscow, the KGB chess masters knew that, if the test kills using

[25] Indeed, if one will look at the threat studies prior to William Cohen taking office as U.S. Secretary of Defense, one will find widespread complacency about the terrorist threat, and mostly just lip service to it. It was definitely not very important to most of the intelligence and scientific community. Cohen built a fire under the entire threat community, forcing them to get their act together and start actually studying the terrorist threat, asymmetrical warfare capabilities and dangers, and what could be done about it. He did force the research and threat communities to do a creditable job of studying it, and to publish reports detailing it. Unfortunately, the tenor of the political community outside SecDef Cohen's control was basically "business as usual, not to worry." September 11, 2001 changed all that forever. Once again we had waited until the rattlesnake struck and actually bit us, before the nation rose up and paid attention.

their superweapons were not too often repeated, and if they even vaguely resembled other things known in the world, the U.S. scientific community and government investigators would resist all suggestions of Russian superweapons and super technology using new principles of nature. And so would our intelligence community, since they rely on the scientific community for their scientific assessments. They were well aware of our historical "ostrich" position (Figure44).

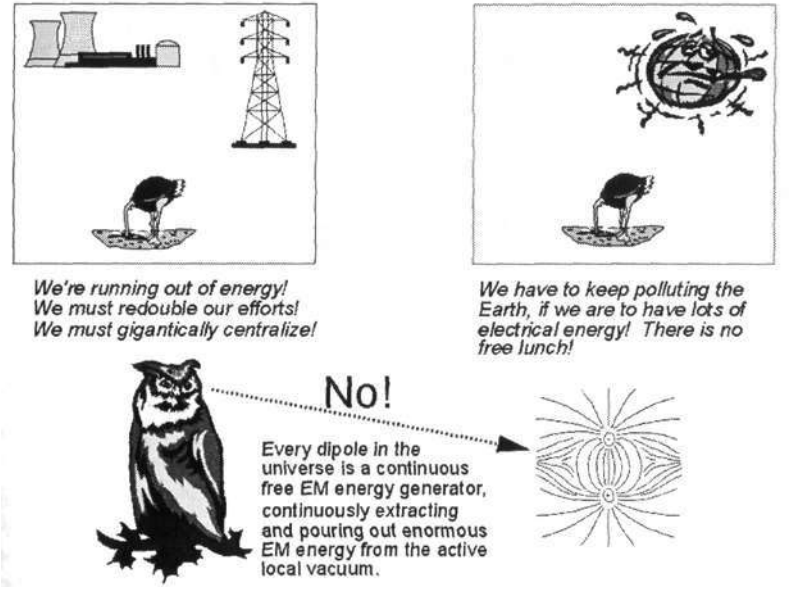

Figure 44 The only energy resource problem is the theoretical ostrich problem in science. We *must* become theoretical owls, rather than ostriches.

The KGB deception just depended upon the U.S. tiger to keep its stripes and exhibit its normal reactions or lack thereof. They also utilized (i) a series of strategic deception plans, deliberately designed to perform the tests suggestive of discredited phenomena such as UFO reporting and "lights at night" types of things, and (ii) a continuing series of subtle and anomalous stimuli (probes) designed to rather slowly attract the attention of U.S. Government at high levels, and of state-of-the-art U.S. government scientific contractors as well. The trick was not to attract U.S. attention *too suddenly or too strongly.* Show them the slow boa constrictor, not the lightning-fast rattler, and see how they reacted, if at all. By their reactions, the KGB could assess whether or not the U.S. governmcnt, intelligence, and scientific communities understood what was happening.

Precisely as anticipated by the KGB, we showed them for some decades that we

really had little or no comprehension of the superweapons and their testing right over our heads. Even today, at least in the open community there is still little recognition, even of the violent weather war raging right over our own heads since July 4, 1976 and easily recognized.[26]

A case in point was the deliberate induction of diseases and health changes in U.S. personnel in the U.S. Embassy in Moscow for over 40 years (Figure 11). On a continuing basis, this excellent intelligence probe showed (by the U.S.'s actions or lack thereof) that we knew nothing about energetics.

Another KGB probe method was to kill a target once in a while, such as a jetliner or a submarine (deliberately rather seldom here, because the U.S. military would react if a certain frequency threshold were exceeded). Such kills resemble or can be posed as natural accidents or terrorist incidents. Quite a number of such incidents have occurred over the last three decades. The National Transportation Safety Board (NTSB) does not have higher group symmetry electrodynamics in its knowledge base or on its "checklists", nor does it have scalar interferometry, psychoenergetics, bioenergetics, or quantum potentials. In total, the results of deliberate stimuli of the U.S. continually assured the KGB chess masters (with 100% certainty) that we were a complete novice in the energetics game, and we were a lamb increasingly ready for the slaughter.

The major contribution to the continued success of these deliberate measures by the KGB has been provided for decades *in the "nonreaction of our own scientific community to slowly increasing threats."* To a lesser extent, our own intelligence community has also not focused sufficiently open-minded and highly qualified scientists to comprehend what is occurring in "new principles of nature" phenomena. "In the box" electrical engineers with Bachelor of Science degrees often are the analysts who analyze and assess such "out of the box" phenomena. Good luck!

Ordinary radar engineers may analyze an ordinary radar rather well. They will never, never become aware of a radar beam carrying infolded spacetime curvature engines. Such is not even in their lexicon or in their belief structure. They have no understanding or experience at all with longitudinal or time-polarized EM waves—most have never even *heard* of time-polarized EM waves. Mention curvatures of spacetime and their dynamics as deliberate "engines" impressed *inside* EM fields and potentials and waves, and one gets a glaze right over the eyes of the intelligence analyst recipient.

Western science conceives the mind as a meat computer, and does not understand that mind operations are totally electromagnetic and causal, but nonphysical—meaning in the time domain rather than in 3-space. Mind

[26] The weather war over our heads has been particularly violent, and violently resisted, this year (2002).

operations primarily use time-polarized EM waves rather than the transductions into transverse EM waves that the scientists actually measure. Hence Western science has not the foggiest notion as to what Russian psychoenergetics is all about, or how it can even "be." Certainly Western science has had no notion of deliberately creating time-polarized EM waves for direct engineering within the mind itself and within the mind's time-EM operations.

As Arthur C. Clarke puts it in his "third law," *"Any sufficiently advanced technology is indistinguishable from magic."*

Our long fascination with our "normal" (optics, IR, UV, radar, COMINT, satellite photography, etc.) technological intelligence collection systems will certainly not lead to any great breakthrough understanding of Russian energetics weaponry. That could only have come through HUMINT or COMINT. HUMINT is an area which, in the past, we have mostly just neglected or given lip service to for decades—and that came back to bite us severely on September 11, 2001. Even when we use HUMINT, it will not yield energetics results if the managers and directors themselves (and the agent handlers in the field) have no understanding of it and do not even know the proper questions to ask. And the system will not deliver results if the Intelligence Collection Requirements do not address the proper issues because ordinary electrical engineers and conventional electrical physicists having no inkling of psychoenergetics, or how it works, drew them up.

COMINT, on the other hand, suffers from its own extraordinary prolific output -as well as by only conventional analysts and conventional scientists examming it. Warehouses of COMINT information often have not even been read in any way except a casual glance by a junior analyst, and certainly have not had serious foundations scientists examine it in detail. ELINT does a little better insofar as a human analyst looking at it, but then what is a conventional electrical engineer or radar engineer to make of a giant hemispherical globe that slowly forms and expands from a tiny "seed bubble" of intense glowing light that appears (Figure 35), as it did off the Kurils in April 1984? What will he label it? "Light phenomena?" Where are the technical descriptors of the actual process forming the phenomenon? Where are the implications as to the strategic military use of such phenomena? The reader can see the point. For decades our analysts ignored prolific reports of such incidents by the hundreds. Why, everybody knew it was glowing swamp gas!

One cannot even write a proper "intelligence collection requirement" if one does not understand the basic phenomenology. So essentially no one in U.S. intelligence was writing the proper intelligence collection requirements.

The Science Behind the Soviet Energetics Weapons

The science behind these weapons is called *energetics*. (See again Figure 8.) Energetics consists of three branches, depending upon the nature of what is

being targeted. The branch targeted against nonliving matter is just called the same name: *Energetics*. Targeted against living cells and biological material, the nervous system, etc., that branch of energetics is called *bioenergetics*. Against the mind and its functions (which are time-like and thus involve scalar photons and time-polarized EM waves), energetics is called *psychoenergetics* {89}. See Figure 45. Psychoenergetics includes both the conscious[27] and unconscious mind[28] of the individual—and even Jung's collective unconscious mind[29] of the entire human species {90}, and in fact even the collective unconscious mind in all species on earth, which corresponds to Lovelock's *Gaia* concept.

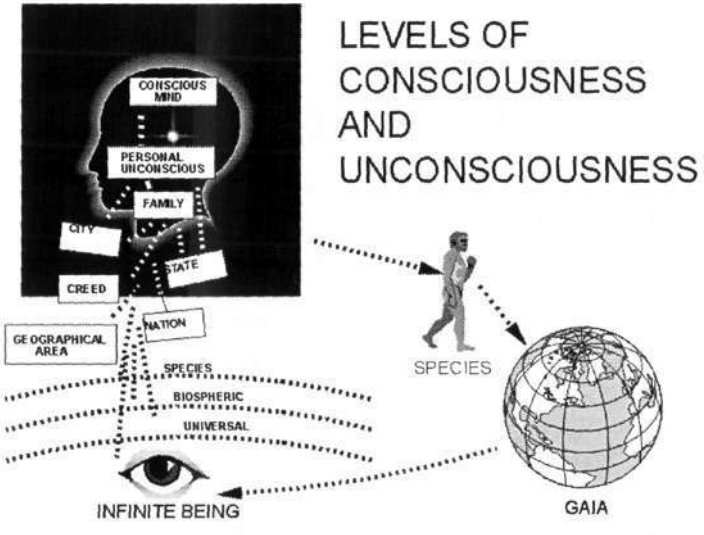

Figure 45 Mind levels are subject to engineering by higher group symmetry electromagnetic (psychoenergetic) weapons.

We remind the reader that we are talking *physics*, not metaphysics and not mysticism. Strong Soviet physics developments over a sustained period have occurred in all three energetics areas, and these areas continue to be developed at present.

Once a nation enters into LW EM development, it has just entered into unified

[27] The conscious mind is a very fast serial processor, processing one snapshot at a time.
[28] The unconscious mind is a massively parallel processor, doing a great many things simultaneously. It is totally conscious, but multiply so. Since the serial processor conscious mind can only "see a single slide projector in the viewgraph at one time", when it "looks at the unconscious mind" it sees a large number of slides simultaneously, hence just sees "black" or "nothingness" (no single thing).
[29] Jung himself labeled it a *mind* (and hence a living entity). His modern followers shudder at such a concept, and very much downplay the "mind" and "entity" aspect, preferring that it just go away.

field theory development also. Particularly with longitudinal EM waves, one is directly engineering general relativity itself, and spacetime itself, as well as the dynamics of spacetime curvatures and sets of such curvatures. But it is an even greater unified field theory than Western physicists suspect. Not only does it unite the four forces of physics, but it also unites mind and matter and their dynamics as well.

We shall also refer to time-polarized EM waves as *time-density waves*. The reason is that a time-polarized EM wave is one where the EM energy is on the time-axis and oscillating along it, like the squeezing of an accordion. In short, it is a longitudinal EM wave on the 4th Minkowski axis *ict*, where the only variable is *t*. Hence it is a wave of the variation of time-density along that axis.

All three branches of KGB energetics use longitudinal EM waves, longitudinal E*M* wave interferometry, and Whittaker-structuring of fields and waves to provide organized curvatures of spacetime known as *spacetime engines* or v*acuum engines*. They also use time-polarized EM waves, as mentioned above. Any or all can also employ the quantum potential as well as negative energy EMP aspects. For now, the reader should just recognize that each infolded longitudinal EM wavepair comprising the scalar potential, includes both a *time-density wave* along the time axis and a longitudinal EM wave in 3-space {91}. So ordinary electrostatic scalar potential fi—ordinary voltage—is made of a harmonic structure of *coupled time-polarized and longitudinal EM wavepairs.*

Oscillations of time density oscillate the local rate of flow of time. In turn, since time has the energy density of mass, its spatial energy equivalence *W is* given by $W = c^2t$. Any change in a time density wave is a very powerful oscillation of loca1 spacetime curvature. So time-density waves constitute a very powerful form of infolded general relativity, inside potentials and hence inside all EM waves and fields. The KGB weapon scientists call that inner general relativity (time density waves) the *information content of the field*. Unfortunately our follows confuse that term with common "spectral analysis" which it very def initely is not. But as part of the deception plan, the Russians are quite happy to help them think it is exactly that, and in fact the Russians go to some pains to continue to help our fellows think that.

KGB energetics involves the use of a highly structured general relativity infolded inside electrodynamics—inside EM potentials, fields, and waves regardless of type. In addition, that very special GR is using the very strong EM force along the time axis as the main agent of curvature. By deliberately structuring these time-polarized EM waves and their dynamics, extremely powerful *spacetime curvature engines* can be employed, either created locally or at a real distance, or also globally in an entire selected distant region.

Once these spacetime curvature engines structure the distant targeted spacetime region. Then in that interference zone the engines therein act upon any mass present. In theory, any physical effect known can be engineered, according to

general relativity, once one can create and utilize the proper set of spacetime curvatures (the proper set of spacetime curvatures and their dynamics). In GR, curvature of spacetime acts directly upon any mass present, and vice versa. With such technology one can therefore *engineer mass* to any level and at any distance (and eventually in any quantity) at will, using energetics methodology. *The engineered mass may be either living or inert* {92}. It follows that bioenergetics and psychoenergetics effects can also be engineered at a distance in similar manner. All it requires is the proper engines for the effects desired in the targets desired.

By using time-density waves and their dynamics, mind itself can be engineered and controlled at a distance as in the cases of Captains Button (Figures 22 and 23) and Svoboda (Figure 24).

The Importance of Scalar Photons and Time-Density Waves

Now we digress momentarily. Again, there are four major photon polarizations in quantum field theory {93}. The first two are *transverse* photons, polarized in the x- and y-direction respectively (transversely to the line of propagation, which is customarily taken along the *z*- axis). Ordinary transverse EM waves are comprised of such photons or blends thereof. Though ignored, EM waves prior to interaction with mass do *transport EM time-energy* as well as EM spatial energy, though in electrodynamics that time-energy transport has been ignored, thus confusing the effect with the cause.

The third polarization is a *longitudinal* photon, vibrating along the *z*- direction (the direction of propagation). Obviously longitudinal EM waves are comprised of such longitudinal EM photons.

The fourth polarization is a *scalar* photon, since it oscillates only along the time axis (the word "scalar" refers to the fact that it has no vector field component in 3-space). In American physics the latter photon is largely ignored since time is not an observable in quantum mechanics. However, such scalar photons do comprise time-density waves and EM time-energy currents, and they are involved in powerfully curving spacetime via oscillating the time domain. Hence by their oscillations they produce spacetime curvature oscillations, which in turn project small components into 3-space. Sufficient such coherent projection components are in fact longitudinal waves in 3-space.

The combination of the scalar and longitudinal photons is observable as the instantaneous scalar potential, and when Whittaker's 1903 decomposition of the scalar potential is slightly corrected, then the scalar potential is comprised of coupled pairs of waves, where each pair consists of a time-polarized EM wave coupled to a longitudinal EM wave. The combination of the scalar and longitudinal EM waves in the presence of charge is observable as the macroscopic scalar potential. Negative charge absorbs the time-polarized photon from the time domain and re-emits a longitudinal photon in 3-space, while the

positive charge absorbs a longitudinal photon from 3-space and re-emits a time-polarized photon in the time domain.

Psychoenergetics: Engineering the Mind-Matter Interaction by Engineering Mind

We shall be interested in what actually constitutes a living biological system in **the** psychoenergetics view (Figure 46). Mind operations are *time-like* rather than existing in 3-space, and for that reason mind and its operations are not observable. Observation is a *d/dt* operator acting on an LLLT ongoing interaction, which removes the T and leaves a frozen LLL snapshot, via d/dt(LLLT) => LLL. *Imposition of observation itself breaks,* any and all connection with time-like operations, including mind and its operations.

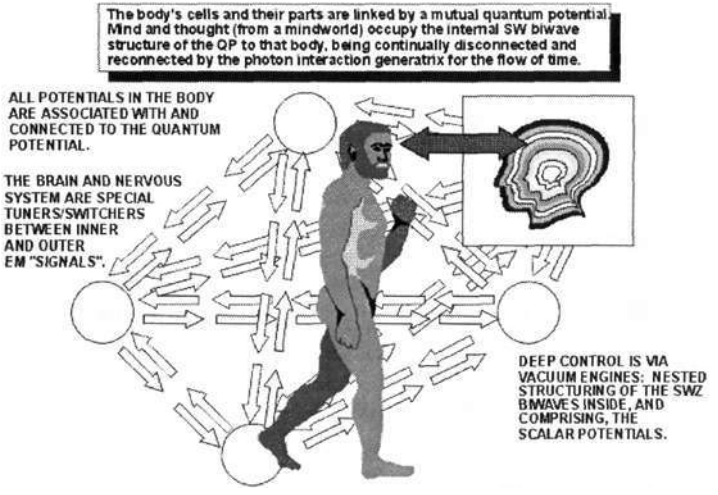

Figure 46 A living biological system (psychoenergetics view).

"Dynamics" involves "velocity", and in general relativity's 4-space velocity is rotation (Figure 47). Any mind-operation or change is dynamics and produces a small velocity, which is a small rotation. This projects a very small component into 3-space, in the physical body, but still in the virtual state. We are speaking of physics rather than metaphysics! *Sufficient* coherent mind operations (changes) have just such small (virtual) rotation components in 3-space that will project coherent little projection components (virtual) into 3-space. Coherently sustaining these components (intent) results in their coherent integration to breach the quantum threshold and become detectable (produce an observable 3-space result). That is how an "intent" change sustained in the mind becomes an actual physical energy input to the body and nervous system.

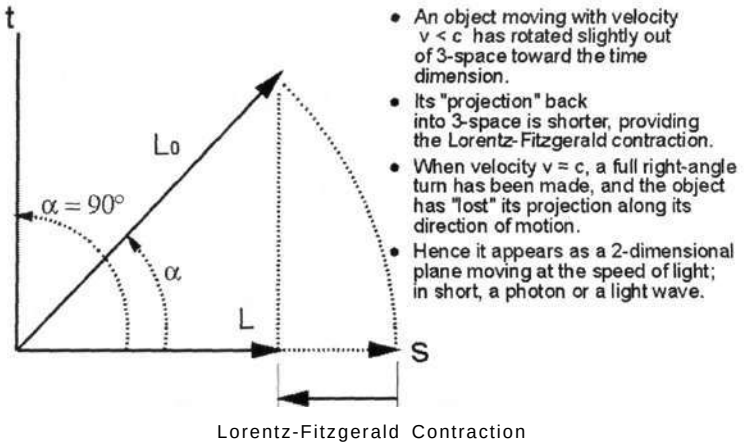

Figure 47 Velocity is rotation. Necessary to understand the mind-body coupling mechanism.

We again stress that the scalar potential is comprised of coupled time-density and longitudinal EM wavepairs. Mental operations also are time-density wave changes, hence they are changes to the interior of potentials, including the ambient potential of the vacuum itself. Potentials superpose, and their coherent internal structures add (integrate) coherently. Hence, mind changes can coherently integrate to produce minute but real, observable, physical input changes to the body system. *Mind permeates the body via the interlinked and superposed potentials of the body.* The living bio-organism's mind and its operations can be modeled as an organized operating wave dynamics inside a scalar potential and superposed potentials of the body of that organism. Since fields are made from the more fundamental potentials, these operations also function inside the fields of the body. The organized time-density dynamics constitute both the conscious mind and its operations and the unconscious mind and its operations. More subtle depths of the time-density dynamics also constitute the human collective unconscious mind functions and operations. Again, we are speaking physics, not mysticism.

See Figure 48. The "component projection" (coherent integration) process from time-like mind operations into 3-space in the body potentials introduces into the living body the *physical* commands correlated to the *mental intent* of that entity. This is the solution {94} to the long unresolved *philosophical problem of intent*, and addresses the unresolved physics problem of *just what constitutes the "observer."* But the subsequent physical changes accomplished by the responding body as a servomechanism, also produce small rotations into the time domain (into the mind domain) but in the virtual state. However, a series ol' coherent physical changes produces coherent virtual state changes in the mind realm, which in turn coherently integrate into perceptual input. In this fashion,

the mind senses the response of the body to its order, and any errors in that response that need correction. The time delay gives also the sense of identity and personal persistence, hence creates the perception of self, the "responding body belonging to self," etc. Interwoven perceptions of coherent rotation changes from other 3-space phenomena that do not respond to mind intent, also create the perception of the "separate physical world." That these phenomena do not respond directly to mental intent creates the perception of the "separateness" of this "external" physical world, while the interweaving creates the perception of "existing simultaneously" with or in the external world.

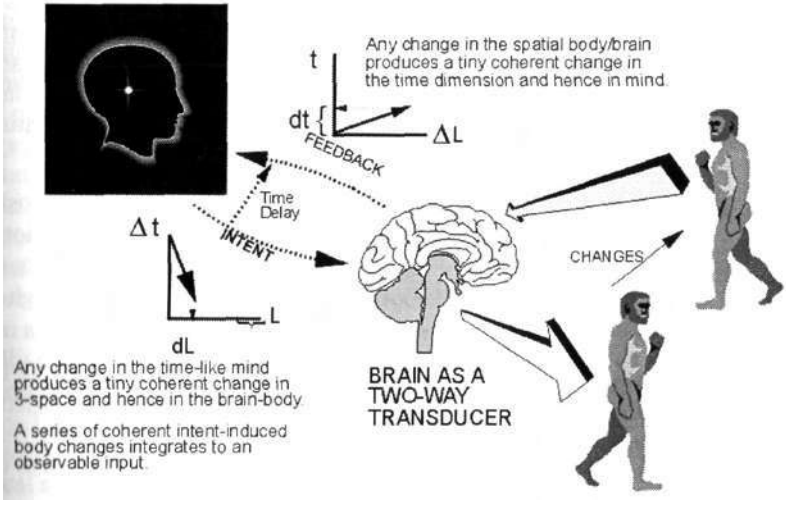

Figure 48 Mind-body coupling mechanism at work.

All of that perception, dynamics, rotation, and processing is subject to direct engineering via psychoenergetics means.

Without further elaboration, we again stress that the conscious mind is a serial processor, whereas the unconscious is a massively parallel processor. Westerners are prone to equate self to consciousness or conscious mind operation alone. That is not the case. Consciousness is just one attribute of the self (of the total feedback loop having delay between feedforward and feedback).

The totality is the mind-body coupling mechanism (Figure 48) enabling a living biological system (Figure 46).

By using time-density waves formed of scalar photons, the mind realm also can be directly engineered by the same energetics technology. Hence, for the Russian energetics weapon scientists there followed the development of psychoenergetics as an entire class of breakthrough electromagnetic weaponry.

This resulted in the development of not only a unified physics of matter and space, but also a unified physics of mind and matter reaction. Any true unified field theory must integrate the observer and the unobserved as well as the various categories of the observed. It is now possible to *directly model and engineer both physical and mental reality and their interaction.* Russian psychoenergetics has been developed to do precisely this {95}.

Quantum Potential Weapons Are Utilized in All Three Energetics Branches

In addition to scalar interferometers, there is another category of energetics weapons used in all three branches. That category involves the use of *quantum potential weapons*, after David Bohm's quantum potential in his hidden variable interpretation of quantum mechanics {96}, published in *Physical Review* in 1952. We openly published one mechanism for creating a quantum potential {97}; there are others.

Presently these quantum potential weapons are the most powerful and most flexible weapons on earth. Nothing else can stand against them. Any nation not possessing QP weapons is already a second-rate power, regardless of how many nuclear missiles, bombers, and submarines it possesses, or how many high-energy lasers and high power microwave weapons it possesses.

The greatest problem the Soviets had was not in *making* the QP itself, but in (a) *localizing* its creation to the specific area or region desired, and (b) restricting its coupling to the type of equipment, entity, level, size, type of nuclei, etc. that was desired. We have not yet fully solved the problem of how they are able to do that, but have made a little progress upon it.

The Importance of Longitudinal EM Waves

The KGB energetics weapons use longitudinally polarized and time-polarized EM waves as their basis, rather than transversely polarized EM waves. There is a surge of renewed U.S. interest—and a revolution in electrodynamics—just underway in this country (and in the major weapons laboratories of other nations) *vis a vis* longitudinal EM wave solutions to the major equations of physics. E.g., one may check the Los Alamos National Laboratory Internet web site for summary papers by Rodrigues and Lu {98}. There are now formal EM wave solutions faster than light speed, slower than light speed, etc. {99}. There is also experimental support for superluminal tunneling of EM waves in waveguides {100}. In addition, as is well known, the speed of the ordinary scalar potential is infinite in the Coulomb (transverse) gauge {101}

Higher topological algebra is being used to embed the electrodynamics in most of the KGB energetics work. Maxwell's original theory {6} was some 20 quaternion and quaternion-like equations in 20 unknowns. Quaternion algebra

has a higher topology than either vectors or tensors. Heaviside and others reduced the quaternion-like theory of Maxwell down to four equations in four unknowns—or to two coupled equations, depending upon how represented—and formed the much lower topology vector algebra in the process. This seriously demoted the topology of electrodynamics and placed undue limitations upon what can be done with it. The subsequent mathematical promotion of electrodynamics to tensor algebra still did not recover much of the EM functioning possible in quaternion algebra. An even vaster, far more powerful electrodynamics emerges in *Clifford Algebra* electrodynamics, which may be the coming modern trend.

However, even with Clifford Algebra, there remain fundamental foundations difficulties—such as bluntly confusing *energy transport* with *energy dissipation, by* arbitrarily integrating the Poynting vector around a closed surface so as to select only the divergent portion of the Poynting energy flow. That produces the *energy dissipation flow* associated with the circuit, not the overall energy flow associated with it. The overall energy flow is some 10^{13} times greater in a nominal case, as (i) discovered by Heaviside in the 1880s, (ii) never even considered by Poynting, and (iii) deliberately discarded by Lorentz with a little integration trick {102} still used by classical electrodynamicists and electrical engineers. Electrical engineering departments, professors, and texts do not know and do not teach that all EM power sources—such as generators and batteries—actually pour out of their terminals a far greater energy flow than the meager shaft energy input to the generator or the chemical energy dissipated in the battery. Lorentz arbitrarily discarded the huge Heaviside nondiverged output energy flow component a century ago, with the observation that it "has no physical significance" {103,104}.

Part of the emerging electrodynamics revolution is intuitively obvious. Higher topology algebra used in one's electrodynamics model means that lots more things can be done—in circuits, equipment, and components. As an example, suppose one can only draw geometrical figures on a flat, uncurved plane. Then compare the figures there to what can be drawn when a third dimension is added so that the plane can be curved, twisted, folded, stretched, compressed, etc. in 3-dimensional space. That is similar to the dramatic differences between electrodynamics in a higher topology algebra and electrodynamics in the far more limited tensor and vector algebras.

Further, if someone's circuits *are working* in a higher topology, a lower topology analysis will not even see their true functioning. This turns out to be true for Tesla's work, where so many pundits have used vector or tensor algebra in the belief that they therefore knew what Tesla was doing. They did not, nor did they even use the proper tools to see what he did. For the proof, see Barrett's examination of Tesla's actual patented circuits, using quaternions {105}.

Energy, Wave Energy, and Wave Speed are All Dramatically Altered

The energy of a pure longitudinal EM wave (LW) is infinite (unlimited). In practice, only an imperfect LW is produced experimentally, and therefore its energy is finite, but that energy may be extremely large, and the wave's propagation may be many times faster than the speed of light. This is much like *quantum tunneling*, which has been measured to be superluminal. Nimtz *et al.*, e.g., have transmitted Mozart's 40th symphony through a barrier in a waveguide at 4.7 times the speed of light {100}. Other researchers have transmitted information at lesser velocities but still at greater than c, the speed of light in standard vacuum.

Einstein assumed light speed in vacuum to be universally constant. That is correct for *transverse* photons and *transverse* EM waves, but not necessarily for other polarizations. Instead, it can be a function of the energy density of the vacuum (i.e., its stress energy density), which can be a matter of the gauge and the wave polarization. Further, *c* as a constant applies to transverse polarized EM waves (which are "surface" waves of the medium, so to speak) and not to longitudinal or time-polarized EM waves (which are "subsurface" or "subspace" waves). In general, the speed of the EM wave can be a function of the energy density of the vacuum (i.e., its stress time-energy density). And it is also a function of the type of EM wave being utilized.

"Empty space" is filled and writhing with the continual transiting of higher order EM waves, the presence of standing high order EM waves, and energetically organized regions where the energy is in the LW mode and in the time-density mode. Indeed, space (more correctly, spacetime) itself is nothing but a plenum of such waves and their wave-to-wave interactions.

The longitudinal and time-density effects in empty space are correlated with seasonal and periodic variations of time-charging and longitudinal EM wave emissions from planets, stars, etc. As a result, the characteristics of empty space itself periodically vary, and these can be detected as variations in the speed of light through the affected space.

The interplanetary radar measurements, e.g., do indeed show several periodic variations of the speed of light in interplanetary space, on a weekly and essentially monthly basis. In this data the proclaimed constant speed of light is upheld only by averaging the measurements over a month-long period, as shown by Wallace {106}. Actually, the scientists are dealing with variations of the periodically varying local time-density of spacetime, but have not taken that into account.

There are also specialized "galloping wave" zones, created by variations in the interferometry of the interpassing and interfering longitudinal EM waves in space. Such galloping waves from wave interferometry are already known in the literature {107} from 0.1 to 100 times the speed of light, but they do this on a

"surge forward and lag backward" mode about an *average* speed of c in the laboratory here on earth. In space away from planetary masses, that value "c" varies from its textbook value also.

All that has really been shown is that interplanetary space is *not quite* uniform after all, contrary to present scientific assumptions.

One would think that this *fundamental foundations anomaly* shown by the interplanetary radar measurements would excite the entire scientific community and trigger a massive scientific investigation. Instead, scientists such as Wallace who publish critical analyses showing that the data directly prove the variation of c in "ordinary" space, are just ignored and essentially "parked on the side-lines" until they eventually fade away.

A Process for Creating Longitudinal and Time-Density EM Waves

Today we know that some plasmas very often can produce a longitudinal EM wave from a transverse EM wave, and can produce a transverse EM wave from an input longitudinal EM wave. This was not known when the Priore team was performing its experimental work. However, it provides one method for producing and detecting longitudinal EM waves.

The Priore team in France unwittingly made longitudinal EM waves by inputing transverse EM waves into Priore's rotating plasma in a giant plasma tube (Figures 12 and 49).

- At the end of the project, Priore had developed a large unit to treat humans.
- A few were treated.
- Cures replicated what had been done in lab animals.
- The massive size of the unit and long treatment time (hours) made the process bulky and very inconvenient — and expensive.
- We proposed a way to do it with a suitcase-sized unit and a treatment time of two minutes.*

*See *Porthole Briefing,* www.cheniere.org

Figure 49 Priore's large plasma tube installation in his 3-stories-high treatment facility for humans. Results obtained in animal experiments were also duplicated in human experiments.

Quantum Potentials and Multiply Connected Spacetime

It appears that a sufficiently clean longitudinal EM wave can be utilized to

create a *quantum potential*, very similar to Bohm's notion, by iterative retroreflection between two phase conjugate reflectors. When sufficient *iterative self-targeting* occurs and persists, the waves eventually "snap in" and fully converge to laser-like beams without any energy divergence {97}. At that point, one has achieved an essentially "pure" LW, which has infinite velocity. For all practical purposes, there is then little or no difference between this wave and a quantum potential.

A pure longitudinal EM wave just "appears instantly" everywhere in space that it will be. It is already an element of a quantum potential. In this sense, all that a "quantum" potential is, is an ordinary scalar potential in which the composite EM longitudinal phase conjugate wavepairs really are pure longitudinal EM waves. It would seem that this also moves the gauge to the Coulomb gauge, so far as the potential is concerned. It follows that, by establishing significant and clean longitudinal EM wave contact between any two points via iterative retroreflections, one establishes a quantum potential if sufficient harmonics are established in the contact. The implications for "phase conjugate shooting" to go one step farther are obvious.

By "scanning" an area with the appropriate LW transmitter array, with deliberately imperfect LWs so that contact reaction occurs, and then decreasing the imperfections in the scanning by iterative retroreflection, it appears that a quantum potential can be created and connected between the transmitters and a desired distant region.

Essentially, in the case of pure longitudinal EM waves and quantum potentials, we must model the situation in terms of a *multiply connected spacetime*. The divergence-free waves are now pure longitudinal waves in one sense, and pure potential beams in another sense. In any case, the Coulomb gauge applies. As is well-known, the potential moves at infinite velocity in the Coulomb gauge.

Thus a single station can be connected by such a QP to any number of distant stations—by first "knitting them together" into a common multiply connected spacetime by iterative mutual LW self-targeting beams. It matters not if one or more distant station(s) is/are then moved beyond the star Sirius; the moment an energy signal appears in the initiating station, it is already instantly in each distant coupled station anywhere in the entire universe. There is no separation distance involved. Here *one no longer needs to propagate transverse EM wave energy painfully through space at the speed of light.* Instead, one is now dealing with multiply connected spacetime. One now has the instant appearance *in each and every distant coupled target* of the energy input into the single "transmitting" or "coupling" station. So the process is a startling and giant "energy amplification method" as should be expected from something that has infinite energy in the first place!

One vulnerability and disadvantage of a QP weapon is that, if the target is aware of one's coupling and also has QP technology, he can now immediately send

back any energy form or "greetings" he wishes, from any one of his coupled targets. He can even do it inadvertently, without even knowing he has been coupled by a quantum potential. In other words, the QP provides a two-way street, if the target is aware of it and has the technology himself, *and even if he is unaware of it and does not have the technology.* For that reason, actual use of the QP weapon in strategic strikes requires caution and special considerations. Usually it requires very rapid single use and then cessation of any further usage.

Need for Caution with QPs Used Against Biological Organisms

Another QP weapon disadvantage is that rather extreme care must be rigidly exercised, particularly when linking living creatures. For living things, the QP is best utilized in the absolute minimum energy mode. E.g., *an extremely weak OP already links every member of the human species.* Suppose one increased that linkage intensity carelessly. Immediately the entire human race is in grave difficulty. Every death of a person feeds into every other living person. Every birth of a baby feeds into every living human. Even the fertilization of one human ova instantly feeds into all other ova. The integration of all those changes would totally disrupt—and instantly destroy—all human life on Earth. Since chimpanzees have very similar genetics to that of humans, all the chimps would probably die also. Other higher primates would also suffer or die, as would many other species.

What might be useful, of course, would be to use a QP to kill every smallpox, HIV, Ebola, and other dread disease pathogen on Earth. If so, it would first have to be made extraordinarily specific, else it could threaten all or most of the life on Earth.

A very useful adjunct would be to use a QP device to nearly instantly scrub and decontaminate (disinfect) an anthrax-contaminated large city—such as New York or Washington, D.C.—by instantly killing all the anthrax spores in that locality. Or to clean all the antibiotic-resistant staph pathogens out of U.S. hospitals by just killing them all instantly and periodically. Or to rid the Earth of necrotizing fasciitis—flesh eating disease pathogens.

An extremely localized QP could be used to connect with all HIV viruses and DNA inside an AIDS patient's own DNA. One could then kill the HIV viruses not yet integrated into the patient's cellular DNA. One could also time-reverse the patient's own HIV-infected DNA back to normal, effectively "removing" the HIV DNA already dumped into the patient's own infected cells. In theory, 100% of the HIV infection could be removed from the patient's body, restoring him or her to a completely HIV-free condition.

A Hypothetical Example

Suppose one arbitrarily increased the even weaker QP that presently joins all living things on Earth, regardless of species. Instantly every living thing on Earth would die, and the Earth would be instantly converted to a sterile planet.

Even though *physically embodied* life was gone, however, all the forms of those species would remain in spacetime activity, their vacuum engines—for both minds and bodies—forever embedded in the local potentials and fields of the material Earth. In other words, the Earth's potentials and the local spacetime potential would still be *dimensioned* and *conditioned* for the life forms that once moved upon it in physical form. The dimensioning and conditioning (engines) for every life form that ever lived on the Earth *exists now* at every point in the Earth and in the local spacetime. With proper application of energetics, in theory it is possible to recover any of these life forms desired, back into living form.

When one understands that environmental aspect, one understands why the Miller-Fox-Urey biogenesis experiments {108,109,110} (Figure 50) would still produce living organisms again. A *physically* dead planet or test flask is not necessarily a "completely dead" planet or flask, when one considers the presence of spacetime engines and dimensioned potentials. One recalls that these forms and engines contain not only physical forms, but also the mind-aspects and the mind/body coupling and dynamics aspects as well.

In short, the entire biochemical notion of biogenesis from truly inert matter devoid of any form of life or pattern of life appears to be a false premise. Since potentials reach to the end of the universe, then any structured potential structures *(dimensions)* the universal vacuum potential everywhere in the universe {111}. The Miller-Fox-Urey experiments were not performed in a truly "sterile" environment after all, when the new energetics is considered {112}. One realizes that the entire universe is alive; the mere presence of a single living microbe or other form anywhere establishes an entire living noosphere. The Russian researchers—such as Kaznacheyev {113}— into EM induction of disease in targeted cells at a distance also realized that biology included a noosphere, and it could be engineered.

- Engines of and from all life forms ever on earth or in the universe exist in the ambient vacuum potential.
- The Miller-Fox-Urey experiments were not in a "sterile" environment.
- Heat (IR) and UV constitute (1) a harmonic interval with a difference frequency, and (2) amplifying by the process previously shown.
- These experiments "kindled" previously living forms from the available gases etc. by amplifying the ancient living engines from their virtual state to the observable state, so that the masses were molded into the physical states of their templates.

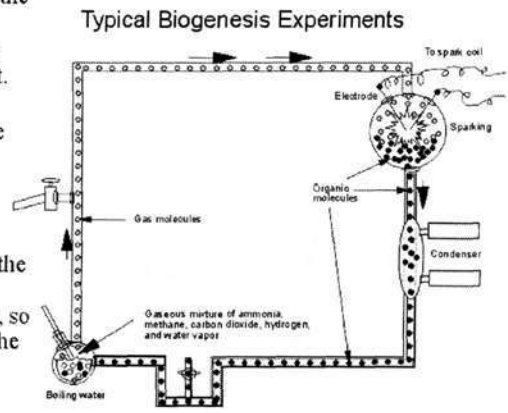

Figure 50 Typical Miller-Fox-Urey biogenesis experimental apparatus.

Herman Kahn, then director of the Hudson Institute (a leading think tank), once remarked that it did not concern him that there existed mechanisms that would destroy all physical life on earth. Instead, he stated, it concerned him that he know almost 200 such mechanisms. The quantum potential weaponry is yet another doomsday weapon with a thousand lethal mechanisms to add to Kahn's list, were he still with us.

The QP Weapon Is a Superb Energy Amplifier "For Free"

In a multiply connected spacetime established between multiple separated (to the observer) stations, one can instantly input one megawatt of power into *every distant stution* by inputting it into a single station. Suppose that coupling station is coupled via QP to one million distant stations (scattered anywhere in the universe). Then in each distant coupled station there now instantly appears one megawatt of power, even though we have input only a single megawatt in our "transmitter" coupled station. This is a superb *one-on-many weapon system and energy amplifier*—perhaps the ultimate weapon system.[30]

AS an analogy for understanding, one can look at it this way. Put a dot (point) on a piece of paper. Mathematics tells us that an indefinite number of other points can be "superposed" directly on that original point. Now input some "energy" into the original point. It instantly appears in each and every other superposed point. That is precisely the way a quantum potential linkage between stations

[30] However, we should not be loo surprised at such "astonishing" effects, once we appreciate that with the quantum potential and pure longitudinal waves one is playing with infinite energy anyway.

works, except that in normal singly-connected 3-space the points are *observed* by a normal observer to be widely separated. Aristotelian logic—which is an "either/or" logic—does not apply. Instead, a higher topology logic applies.[31]

The QP weapon can be used with microwatt input to induce low-level disease states or pre-disease states *(shadow disease states)* (Figure 51) in entire populations. Tests done in this fashion will violate the "vector carrier" aspect of infectious disease transmission. Instead, the tests will cause a few widely spaced nearly simultaneously cases of the disease being tested. Several such tests (e.g., with necrotizing fasciitis) have already been conducted in the populace of the United States.

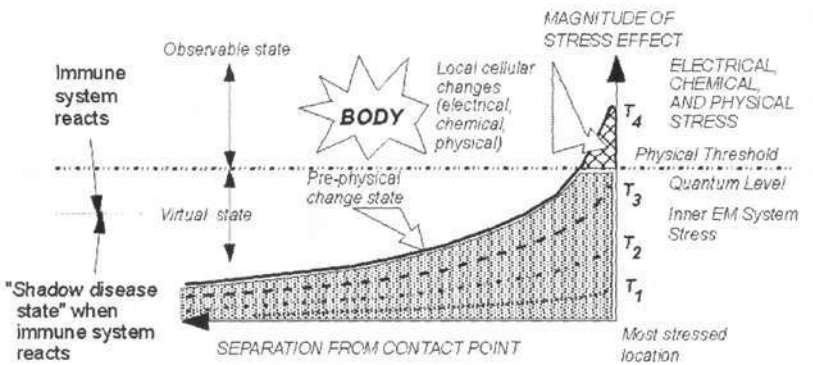

Figure 51 The shadow disease state is that structured virtual state level of the promoting disease engine template, at which the immune system reacts.

Or a QP weapon can be used with megawatt or gigawatt input to blast multiple distant targets simultaneously. One may destroy, e.g., every single transmitter of a given type. Or one may instantly kill all ships and weapons and paraphernalia in a large naval task force steaming toward its target. Or if one wishes to take the ships and equipment, the weapon can just kill all the humans instantly in that task force. ICBM sites, e.g., are vulnerable and obsolete since 1990 to any nation possessing QP weapons. So are underwater nuclear submarines and long-range strategic bombers. The entire strategic and tactical armada we have built up so painfully over the decades is obsoleted—also meaning *countered*—by any enemy possessing sufficiently advanced energetics weapons, and particularly quantum potential weapons.

[31] We developed such a logic years ago, and have recently included **it** in *Energy from the* ***Vacuum*** 2002, *ibid.*

Other Novel Uses of QP Weapons

If an enemy has such QP weapons and you do not, you are easily and directly destroyed at will, once certain other deterrents are overcome. One of these previous deterrents that had to be overcome was the stability of nuclear weapons in our nuclear arsenal. To remove this stability and render them easily destroyed, the holder of a scalar interferometry capability could induce sudden massive fissioning and fusioning of many of the targeted onsite weapons if the scalar potential interferometers were used massively. However, the resulting tremendous nuclear explosions—many "in the dirt and dirty"—would also unacceptably damage the attacker. Further, major antagonists usually clandestinely introduced hidden nuclear weapons into the cities and target areas of their opponents, which practice was known as "dead man fuzing." The notion was that, even if one side suddenly destroyed the other, that destroyed side could stil1 detonate its secret nuclear weapons hidden in the attacker's homeland territory, destroying him as well. In essence, the killed side (the "dead man") had set off the fuzing of his pre-planted weapons, to destroy the attacker even though the "dead man" was already dead.

One strong reason that the Russians pursued the quantum potential weapon so strongly was precisely because it offered a mechanism to solve this "dead-man fuzing" problem, removing it as a viable deterrent. Obviously it would be quite advantageous to be able to dud or destroy these hostile weapons in one's very midst, even though one did not know their locations, and pull the fangs of the dead-man fuzing installed by one's opponent.

There appear to be ways of directly connecting a QP, e.g., to every atomic nucleus of a given type, in a given region (say, in a region consisting of on the surface of the Earth, in the Earth to some depth, in nearby space, on the surface of the ocean, and beneath the ocean). Connection can be made, e.g., to every U235 nucleus and to every weapons grade plutonium nucleus. Or with the technology developed, the users ought to be able to make such connection only between certain pre-selected *localized amounts* of U235 nuclei or plutonium nuclei.

Now suppose that such a QP is established between weapon-sized groups of U235 atoms. Then one hits one U235 nucleus in such a group in an activator station with a neutron bullet. Voila! One simultaneously hits every other linked U235 atom (including the activator station—one just blew it to smithereens if it contained very many U235 nuclei) in such weapon-sized groups. The raw U235 in ores in nature is still okay if the ore contained only tiny traces of U235 nuclei. But all the "neutron-struck" fissionable nuclei in nuclear weapons worldwide—regardless of owner or location—fission in the weapons immediately. That destroys all the nuclear weapons on Earth—including the clandestine nuclear weapons that various nations have spirited into other nations perceived to be their enemies, as a "checkmate" against sudden surprise attack. *One* does not need to know where a weapon is at all.

However, it gets all the weapons by exploding them, and that itself could create a giant nuclear destruction and fallout problem that would probably do in most life on earth because a great many nuclear weapons will have exploded "in the dirt and dirty." In short, it is an entirely unacceptable solution to the dead-man fuzing problem.

Of course, no *sane* enemy would wish to use the QP in such fashion, because it is quite suicidal for him and essentially destroys civilization. But suppose the sane enemy is well aware of the exact nature of the new cold type nuclear reactions (we explained these in an initial rough paper given in August 1998 at an Energy conference in Utah). The energy initiating these "time-reversed" nuclear reactions starts from "inside" the nucleons in the nucleus and moves outward (that is true of any "reversed" zone).

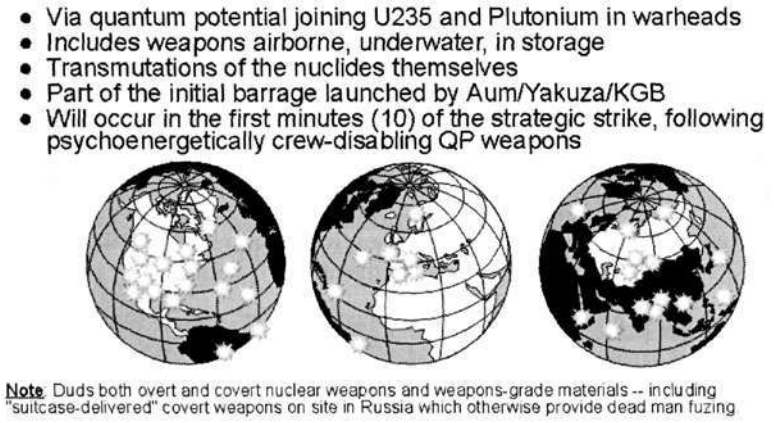

Figure 52 Simultaneous dudding of nuclear weapons worldwide. Also duds nuclear reactors and nuclear propulsion systems.

Direct *isomeric transmutation* then becomes a preferred decay reaction to induce in the nuclear weapons one wishes to dud. By gradually inducing (slowly "kindling") one of these transmutation reactions, one can just "transmute" the U235 to—say—an isomer such as U238, with some readjustment and energy balancing in the ensuing rebalancing decay processes. In that way, one gets no nuclear explosions. One can even choose the transformation or several successive transformations so as to minimize any resulting nuclear radiation. The attacker also destroys all the nuclear reactors, including those in civilian power plants, nuclear submarines, and elsewhere. But he gets just about all the nuclear weapons if he transforms both U235 and plutonium (Figure 52). In about 10 minutes he will dud them all, without any nuclear explosions, but he would probably allow about one hour "just for good measure and nearly 100% certainty."

This offered the Soviets the ideal solution to the worrisome hostile nuclear arsenals of the world, since they also had additional nonnuclear strategic weapons of a different kind and of great power.

Apparently that very kind of QP weapon became operational, on site in Russia, circa 1989 under KGB control. For the first time, it provided the KGB with a guaranteed solution to the nuclear dead-man fuzing problem that had until then prevented its massive use of the scalar potential interferometers (such as in 1985-1986 as originally envisioned by Brezhnev).

By almost simultaneously leasing the earlier scalar interferometer weapons to **the** Yakuza and Aum Shinrikyo at the end of 1989, the KGB obtained an influx of vast new funds {114}. It thus concentrated even more intensely on the more advanced energetics weapons such as QP weapons and psychoenergetics weapons {115}.

So with a QP weapon one can attack multitudes of targets, using a single "coupler" or "transmitter," all without "propagating the EM energy through 3-s**pace."** Further, with the technology developed, only the number of outrigger stations coupled limits the energy amplification achievable. One can alter matter at any level, from the quarks in the protons and neutrons in the nucleus, to the lattice bonds, to the molecular bonds, etc. Or one can structure the emerging energy (that emerges directly out of the local spacetime itself), so that *structured local spacetime curvatures* (engines) appear in the target zone(s). These ST engines can be generated so as to perform macroscopic functions against real systems—e.g., jamming electronics, as against the U.S. air attack on Libya in April l986 (Figure 25), or as was done by a longitudinal EM wave interferometer in the attack and kill of the U.S.S. Thresher (Figure 6) in April 1963 {116}.

The U.S. Narrowly Escaped Destruction Twice in 1997 Alone

On two occasions in 1997 the United States would have been utterly destroyed by the die-hard faction of the KGB, except for direct countering by a friendly little foreign nation. The present author and three colleagues played a very minor role by alerting that nation to the impending attacks. There was certainly no reason to contact officials of our own country; the U.S. was and is powerless to prevent such attacks, although *hopefully* that is changing! It made much better sense contact the only nation that could possibly avert our impending disaster. Of course we later also informed proper U.S. government officials of our actions.

The first strategic attack was scheduled for between early to mid-February, and involved (1) dudding all nuclear weapons, (2) striking the QP weapons in the little nation simultaneously, as well as extant scalar interferometer weapon sites in other foreign nations, and (3) then leisurely blasting cities, facilities, and installations with iterative and continued scalar interferometer strikes. This third

phase would include work assigned to the Yakuza/Aum Shinrikyo teams. That is how the Yakuza (and Aum Shinrikyo) expected to revenge themselves for the Western defeat of Japan in WWII, and for the West's dropping the atomic bomb on Nagasaki and Hiroshima. To be able to "get in on the kill" is why the Aum Shinrikyo and Yakuza leased the scalar (longitudinal EM wave) interferometers from the Russians in the first place {117}.

These, along with negative energy EMP weapons, are the kind of energetics weaponry that now determines our fate, and against which the U.S. presently has still inadequate defenses. Our own scientific community does not believe such weapons even exist—apparently due to the "not-invented-here" syndrome. Most of the U.S. scientific community is thus relatively useless and outdated as far as contributing to the strategic survival of the United States is concerned.

Purpose of the Novel Attack on Captain Button

Hopefully, some scientists are aware of the strange incident that involved the mental seizure of Captain Button in his A-10 (Figure 22) and controlling him for well over an hour (Figure 23), including controlling his perceptions, intent, and actions while performing complex technical tasks. That was the test of a KGB *psychoenergetics* weapon, developing and to be deployed by the KGB. That was the "acceptance test", so to speak—deliberately conducted over the United States—for the KGB's system that would be produced in numbers sufficient to counter the QP weaponry, if the QPs of the little friendly nation were to be placed in the insane command and control mode. This was yet another Soviet counter, planned for the near future against the counter by which the little nation did force abortion of the KGB second attack (scheduled for May 1) in 1997.

The purpose of the attack on Captain Button can be understood as follows: The later second scheduled strategic attack on the U.S.—scheduled for May 1, 1997—was forcibly aborted after the friendly defending nation switched to an *insane* command and control mode. The insane C3 mode counters the MindSnapper type attack that instantly kills all on-site operators and renders the sites too "hot" for new personnel to come in from outside and control it. In short, the U.S. could have been destroyed in that scheduled May 1 attack, but with the change of the friendly QP weapons to insane C3, Russia would also have perished in the immediate quantum potential counterblow from the little nation[32] that would have been automatically delivered by the site weapons themselves. The May 1 attack had been predicated upon the fact that a preliminary MindSnapper (negative energy EMP) attack on the friendly QP

[32] There are also variations. As an example, the insane C3 can also include a separate channel requiring a countering "punch in" code every 15 minutes (as in a heightened alert status) or the control system will order the launch initiation (this accepts that all on site personnel have now been suddenly killed). So the insane control system is also flexible, and many variations and considerations are possible.

weapon sites would have instantly killed all persons on site,[33] and neutralized the site for some months because of the resulting longitudinal EM radiation. However, the shift of the C3 of the QP weapons to insane mode rendered such a pre-emptive MindSnapper attack totally ineffective because Russia would still have been destroyed.

Hence another countering means was required, and in fact that additional system was already in development. It was a very sophisticated array of psychoenergetic weapons, each with a special, highly trained team of operators capable of fully controlling one targeted individual while he was directed and controlled to go about performing desired technical tasks. We estimate that it required one psychoenergetic weapon (very complex, multiple transmitters) and an operator team of perhaps 20 to 30 skilled operators (one for each major human function to be controlled) to adequately control the mind and actions of one distant person performing quite technical tasks. Hence several hundred such "weapon sets" were required to take over all persons on the targeted QP weapons sites in the friendly nation, have the controlled crews deactivate the QP weapons including using the security code and procedures to standdown for maintenance, etc.

Once the QP weapons were totally on standdown, then the MindSnapper would have struck suddenly and killed every living thing on site, neutralizing the site for several months due to subsequent strong longitudinal EM wave emissions from the struck site. No new crews could have entered the site and lived, so the sites could not be operated after MindSnapping, even though the QP weapons were still intact but just on standby. Of course, a third phase then would have involved strikes by scalar EM interferometers to leisurely and completely destroy the systems and sites, permanently taking out the physical system as well.[34] With the first two of that three-part series of strikes completed successfully, then the KGB weapon sites would have been absolutely free to blast North America and our European allies into smoking ruins, leisurely and at will, given the first 10 minutes of dudding all nuclear warheads worldwide, to take care of that old type of "dead man fuzing".

From the open reports of the Button incident, and from the kill of Captain Svoboda a few weeks later, the nature of the next strategic attack that would be scheduled was immediately apparent. Accordingly, we warned the little nation about the shift to a new attack plan, and estimated the new schedule between mid - 1999 and the first of 2000. Of course, we also passed that information on to

[33] We point out that it required a longer time to develop the more powerful negative energy EMP weapons capable of just destroying the sites, personnel and all. The first effective weapons of that type could easily kill personnel brains, nervous systems, and hearts while still doing little damage to the much more robust *QP* systems and on site equipment.

[34] We strongly believe there are shielding provisions at those sites, against scalar interferometry attacks, which reduces their effectiveness and delays their destructiveness. However, so far this analyst has not deciphered those shielding methods or mechanisms.

our government as well, but apparently, no one believed it. The proper U.S. intelligence agencies, however, certainly intercepted my faxes to the little nation's Military Attache in Washington D.C., and particularly my fax a few days before May 1, sent directly to the Prime Minister of that nation and urging the change to an insane command and control system for the QP weapons and the reason why.

It turned out that, some months after I alerted them to the coming psychoenergetics, MindSnapper, and scalar interferometry attack in that order, to be scheduled between mid-to-end of 1999, apparently the friendly nation suddenly struck and utterly destroyed the KGB facilities for the MindControUer negative energy EMP weapons being painfully built up in sufficient number. Probably scalar interferometry weapons were used to destroy them. The onsite psychoenergetics crews and facilities were destroyed and neutralized completely.

Anyway, as we passed mid-1999, the type of "Y2K" problem we were worrying about was whether or not the attack was on, headlined by a psychoenergetics weapon strike on the little nation first, with the three phases as previously scheduled back in 1997.

Later, in early 1999 I realized the Russian/KGB development of the causal system robots (Figure 10), mentioned in the introduction. In the latter part of the third quarter of the year, working at my computer at night, I was struck by one of these very beasts from within my computer (Figure 20), in very bizarre but unmistakable fashion (previously detailed). In 10 seconds I was nearly killed and severely disabled for a period of time (it took four days to recover completely). Because of the features deliberately utilized by the CSR on my computer screen so I would recognize it, I grasped the nature of the attack (the KGB *wanted* me to recognize it, and live to tell about it!), how it was done, how it jammed the brain and vision center and strongly fibrillated the heart, upset the equilibrium, etc. I also realized that, in 20 seconds or so additional exposure, I would have been a very dead person, expiring with a very violent heart attack and severe brain embolisms. Note that the CSR deliberately struck directly from the computer screen through my retinas and onto the nervous system, passing through the vision center and flashing it tremendously, and jamming my mind, brain, and nervous system.

When I recovered shakily about four days later, I notified the small nation, once again, as best I could, giving the exact symptoms of the attack and explaining what it was. By then I knew what was coming down, the form it would take, and the deceptive cover (Y2K uncorrected errors!).

The little nation then quickly proceeded to search out—apparently *inside* the North American signals, potentials, fields, and waves "superhighways" for the CSRs—all the CSRs and destroy them in place. It turns out to be a fairly straightforward operation, once one possesses advanced longitudinal EM wave

interferometry weapons and techniques. Locating a "very dense" and very dynamic set of LWs performing organized functions is analogous to a normal radar locating a large bomber in cloud cover. One "burst" from the LW "radar," and the targeted CSR is completely disrupted and electronically destroyed.

So a very short (lasting a few days) and strange strategic battle was fought in infolded space or subspace, inside our electrical and electrical systems and inside the fields, potentials, and waves in them. A mighty attacking armada of perhaps several million main battle systems was intercepted and destroyed throughout our homeland, without the slightest notice by our own government, scientific, and intelligence communities. And without a whimper of what is usually recognized as "combat actions".

Afterwards, a very simple and innocuous little message was received which, reading between the lines, simply meant "thank you very much." In short, my hard-pressed colleagues and I got a small "Attaboy!" for our role in alerting the friendly nation.

So Y2K and the Millennium Celebration came, while we waited to see if the CSRs were gone or if they would erupt with damage all over the U.S. Fortunately, they were gone like popping balloons, and so the *fourth* scheduled strategic attack upon the U.S. in the space of three years—this time actually launched—was successfully destroyed.

Whatever I can do to help the survival of my country I will continue to do without hesitation, regardless of whether the U.S. scientific, intelligence, and military communities are aware of the new threat or not, and regardless of whether they believe it or not. Presently our fate and that of the Western world rests on the shoulders of a small but advanced and friendly nation. That is beginning to change, it seems, but still not swiftly enough to suit our needs.

We simply must change all that, by developing QP weapons and defenses ourselves. It is not an option; as an example, China has now finished—as of earlier 2002—and deployed QP weapons. Almost simultaneously, China also finished and deployed the more powerful negative energy EMP (MindSnapper-type but much more powerful) weapons and deployed them as well. So we have entered a very dangerous period when the strategic changes that are likely to occur will be both massive and traumatic.

AS this is being written in early October 2002, it is obvious that our nation is also preparing to strike Iraq if need be, either with a coalition effort or alone. If so, then Saddam Hussein will certainly unleash whatever terrorist forces he has in North America. He will attempt to unleash upon us all the weapons of mass destruction at his command. This could even happen within the next 30 days, with the MidEast exploding, giant polarization of the Arab world, general chaos in the MidEast and upset of world oil supplies, and skyrocketing fuel and energy costs with severe impact upon the already seriously ailing U.S. stock market.

If Saddam Hussein succeeds in doing sufficient damage to our cities and energy infrastructure with more weapons of mass destruction than we have credited him with, then the potential economic collapse of the United States and much of the developed world is an uncomfortable possibility. If that happens, turf wars will erupt all over the world, the world economy may collapse, the KGB and rogue Japanese (Yakuza and Aum Shinrikyo) will move and unleash further destruction, Pakistan and India are likely to erupt into a nuclear war, and several other regions may also erupt into nuclear war and use weapons of mass destruction. What China might do in such event is anybody's guess.

In short, the Armageddon we have so long feared, with the resulting collapse or destruction of much of civilization, could well be approaching. Let us hope that dark picture is terribly, terribly wrong, and that we successfully avoid Armageddon one more time!

Meanwhile, we would be in much better shape to weather the coming storm had our scientific community not grossly betrayed us. But if and when millions of Americans are dying in the streets with no effective means of treatment, and no effective defenses to prevent onslaught after onslaught against our nation, all those deaths and all that suffering will be directly the fault of our own organized scientific community.

Rogue Japanese (Yakuza and Aum Shinrikyo) Have a Role

In the information briefing furnished the previously named agencies, we briefly detailed the elements of the attack, how our own nuclear weaponry can be dudded anywhere, etc.

We also detailed the strange role of the Japanese Yakuza and the Aum Shinrikyo, who leased the operational use of the early generations of KGB longitudinal wave interferometry weapons in 1990 directly from the KGB. The first down payment on the lease was $900 million. I previously furnished pertinent information on this to an investigative U.S. Government agency. Since then, the Yakuza have set up their own scalar interferometry weapons development facilities in Japan, including portable energetics weapons,[35] and have assumed a very secret and nearly unsuspected role somewhat similar to Bin Laden's role in the attacks of September 11, 2001—but much more deadly when the coming Armageddon erupts.

Inducing the Gulf War Disease

In 1986, the Russians had already solved the dead man fuzing problem theoretically, but had not yet completed the development and deployment of the

[35] We strongly suspect some of these portable weapons have already been infiltrated into the United States—e.g., to be used against nuclear power plants and other lucrative targets such as refineries, oil fields, etc.

necessary QP weaponry. The KGB's first "combat demonstration" test of the **ability** to localize a QP in a selected region of space was against the U.S. air attack on Libya in 1986. That test apparently used a laboratory apparatus to prove the process. In short, it was a major milestone whose success moved the system into full production engineering and production. The system was then developed at very high speed after the successful demonstration in 1986. The first strategic KGB QP weapon(s) became operational on site in latter 1989.

It was this QP weapon that was used to generate the so-called *Gulf War Disease* in our soldiers in the MidEast. In the action package, I explained precisely how that was done. I have also finally placed the simplified gist of that explanation openly on the Internet for all to see (website www.cheniere.org). Those suffering U.S. veterans were *casualties of war,* not victims of just nerve gas whiffs or chemicals or their own stress, etc. The initial U.S. Government and U.S. scientific community's assertion that "it was all in their heads" and due to stress, insults every veteran who has ever served his nation. One justifiably has contempt for such treatment of our veterans. Sadly, the latest "studies" are **beginning** to conclude the same thing once again.

Apparently our intelligence and military command agencies have not yet learned t**he** lesson of the decades long Soviet microwave radiation of the U.S. Embassy in Moscow, which was responsible for health changes of many kinds in U.S. personnel and was also responsible for the deaths of three U.S. Ambassadors to the Soviet Union. Apparently we are still using radar engineers and electrical engineers for electrodynamics analysis, and these analysts apparently still believe that in the absence of the EM fields there can be no induced EM effects. One sadly comments that, just as the electrical engineering departments of our universities have been unable to walk across the campus to the particle physics department and find out what the discovery of broken symmetry in 1957 portends for their discipline and model, then the intelligence community apparently has not yet learned that no EM analysis of such things as the microwave radiation of the U.S. Embassy in Moscow or the shootdown of the TWA-800 is worth a tinker's dam unless it is a higher group symmetry EM analysis. As Barrett showed, our fellows still have not grasped what Nikola Tesla already accomplished in actual patented circuits circa 1900 and shortly thereafter. Tensor analysis and vector analysis simply will not show what is really there.

Our veterans were hit with a "cocktail mix" of specialized disease "spacetime curvature engines" just below the observable threshold, in the "shadow" (virtual, but nearly observable) state[36] (Figure 53). The immune systems and the cellular

[36] One should think deeply about this, in terms of the solution to the source charge problem (which our engineers have not thought of very much, much less solved). Every charge already "engineers" the virtual stale at will, converting virtual energy into deterministic observable EM energy. That means we can directly engineer the virtual state vacuum itself if we put our minds to it. **Actually** Nobelist Lee has already pointed out that we have *not even tried to do this!* See T. D.

regenerative systems do react to that shadow state level.

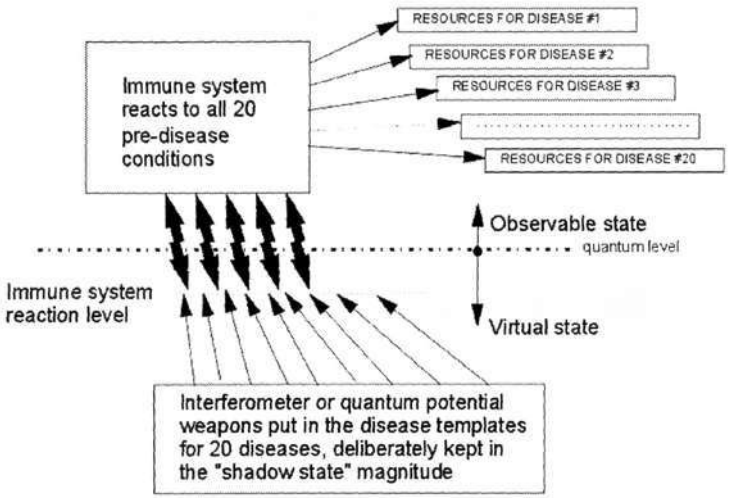

Figure 53 Spreading (thinning) the immune system's ability available to meet a new pathogen.

Such a "simultaneous mix" shadow induction "spreads" the reacting *finite* immune system and regenerative system (Figure 53) and their resources all across that entire mix of shadow diseases, so that only a much smaller portion of the immune system and of the regenerative system is directed against *any one* of the shadow diseases. This in turn greatly heightens (by a factor of 5 or more) the susceptibility of the body to all additional disease pathogens, and it greatly lowers the ability of the body to recover from any disease or biological warfare strike. In addition, the exposed veteran's body fluids and masses have accumulated a persistent "time-density charging" that very slowly decays (by emission of weak *longitudinal* EM waves) over months or even a few years.[37] The sperm from these veterans did indeed have the innate "engines" and therefore the capability to gradually infect their wives. So did the saliva in their mouths. The weak "dimensioned" LW radiation from their bodies could also slowly alter the cellular regeneration and immune systems of their family members in close proximity, over a period of time, thus inducing the disease in them {118,119,120}.

Lee, *Particle Physics and Introduction to Field Theory*, Harwood, New York, 1981, in his "Chapter 25: Outlook: Possibility of Vacuum Engineering," p. 824-828. On p. 383 Lee points out that the microstructure of the scalar vacuum field (i.e., of vacuum charge) *is not utilized.* We add that the West does not utilize it. It has been utilized for some decades in the former Soviet Union and now in the continuing KGB energetics and bioenergetics weapons programs.

[37] See T. D. Lee, "Can Time Be a Discrete Dynamical Variable?." *Phys. Lett.,* 122B(3,4), Mar. 10, 1983, p.217-220.

The induction of GWS in our troops was in fact a test for the *present* clandestine use—already ongoing—of that technique to spread the immune and regenerative systems of the targeted U.S. population. This in turn gradually makes us more susceptible to terrorist BW attacks and disease pathogens of all types *from anyone else*. This tactic is already in place and accomplished, and it will substantially increase the American civilian casualties in our cities when they are subjected to terrorist BW attacks in the near future. *Those attacks now will have some five times the effectiveness that our present planners estimate.* In short, it is going to insure the deaths of millions more Americans. The approaching war in the MidEast, with Saddam Hussein's unleashing of his terrorist assets in the U.S. to the maximum extent possible, thus will probably see a five-fold increase in the effectiveness of some of his mass destruction weapons that Hussein's assets are able to unleash on America.

The entire affair of the Gulf War Disease was both a preliminary test and also a magnificent intelligence probe by the KGB, to clearly demonstrate once again that the U.S. Government and the U.S. scientific community are still nearly totally unknowledgeable of QP weaponry, immune and regenerative system "spreading," disease induction by bioenergetics means, etc. It follows a methodology used with great success for four decades by the KGB,[38] and one that our own government, scientific community, and military community has yet to decipher. *So long as the threat only slowly increases, Americans remain complacent in their ignorance, ignoring the boa constrictor slowly strangling them, while awaiting the cobra seen in the distance?*[9] We have unwittingly cooperated with the KGB boa constrictor for four decades, even as it slowly prepared to crush us. In the Gulf War, that crushing moved to the next threshold, to actually inflict casualties and deaths on U.S. troops and totally get away with it because of the bioenergetics (in the Russian sense) ineptness of the U.S. scientific community.

[38] The decades-long microwave radiation of the U.S. Embassy and induction of health changes and diseases, was a case in point. A high level target—the U.S. Ambassador—was involved, guaranteeing U.S. Government attention at the highest level. Puzzled, the U.S. government would then call in their most trusted EM scientific analysis groups. By the responsive actions then taken by the U.S. at the Embassy, the KGB could ascertain with absolute certainty whether or not our scientists knew of the use of infolded engines in bioenergetics. For more than four decades our actions assured them with 100% certainty that we knew nothing of what their "information content of the field and potential" actually was, or how it had been weaponized and was being used right in front of our faces and before the entire world.

[39] It is bizarre that our scientific community—even after those decades of EM induction of diseases and health changes in American personnel in the U.S. Embassy in Moscow—*still do not and cannot believe that conditioned EM radiation can induce cellular disease.* Such total blindness is inexplicable.

40-Years of Russian Induction of Diseases In U.S. Embassy Personnel

Sadly, our own fellows have never even figured out how the diseases and health changes were previously induced by the KGB for decades in personnel in the former American Embassy in Moscow. Three U.S. Ambassadors to the Soviet Union died as a result of their exposure to that radiation. Many other Americans on site were made ill or suffered health changes.

When Johns Hopkins scientists studied the problem, they found a most anomalous thing: no health changes occurred in areas *where the EM forcefields existed* in the microwave radiation. Instead, the health changes only occurred in areas where the potentials were gradient free so that the force fields were zero—and thus the potentials (and their specific internal "engines") were *persistent.* Using only a classical EM force field analysis—which does not show any of the internal longitudinal EM wave substructuring of the fields, potentials, and waves—the Johns Hopkins scientists erroneously concluded that it could not have been the weak microwave radiation causing the health difficulties, *because no such health difficulties occurred where the forcefields were present.* That is, they very naively assumed that "no force fields" meant no EM effects were possible. Their entire findings thus were based on a total non sequitur, the assumption that there can be no electromagnetically induced physical changes in matter in the absence of fields! The Aharonov-Bohm effect alone falsifies that entire premise. So does general relativity and higher group symmetry electrodynamics.

Actually, the Johns Hopkins scientists had just clearly proven the exact opposite: *that it indeed was the radiation that induced the health changes.* That is simply shown statistically, and it is a deep and continuing mystery how good scientists and their governmental overwatch did not notice the violation of inference methodology.

Simply put, there was 100 percent correlation to the presence of *gradient free EM potentials— the persistent kind.* There was zero correlation (or 100% anticorrelation) to the presence of the normal electric and magnetic fields—i.e., where the potentials changed over a very small region of space. Hence it could *only* have been the constant potentials, else we must throw out statistical inference theory altogether.

If the changes had *not* been caused by the EM radiation at all, one would have had some health changes in regions where fields were present and some health changes where the fields were absent. Considering the lengthy time the radiation persisted and the number of personnel affected, the statistics are decisive. Without question, the cause was indeed the persistent potentials where the **force** fields were zero. Whittaker's two papers—one in 1903 and the other in 1904-would then show how it was done. The 1904 paper and superpotential theory alone would *not* have explained it, since that alone does not include the

"information content of the field"—i.e., spacetime curvature engines infolded inside the normal EM potentials, fields, and waves.

So, the U.S. government and U.S. scientific community "botched it badly," unfortunately, by elemental statistical inference standards. And unfortunately, they have continued to "botch it" to this day. Both the scientific community and the intelligence community missed it. Elementary statistics theory alone, coupled with the Johns Hopkins results, clearly indicates that the microwave radiation was causing the health changes, to a very high degree of confidence.

This demonstrates how "totally inexplicable" some of the effects generated by longitudinal EM wave interferometry and by "structured" or dimensioned potentials, fields, and waves can seem to our conventional scientists. If we examine the serious foundations flaws in classical electrodynamics and electrical engineering taught in our universities, and the near-total lack of higher group symmetry electrodynamics training, we can understand why our scientists and intelligence analysts did not and do not have the background required to properly assess the incidents and effects.

Western Electrodynamics Is in Sad Shape

Actually, numerous scientists have long pointed this out. For example, quoting Mario Bunge {121}: *"...it is not usually acknowledged that electrodynamics, both classical and quantal, are in a sad state."*

In quantum electrodynamics, it is the *potentials* that are the primary causes of all electromagnetic phenomena, not the force fields as used by Johns Hopkins and the Government in its analysis. We know that classical EM is wrong in its focus upon force fields as primary EM causes; the Aharonov-Bohm effect, Berry phase, and geometric phase work in some 20,000 papers in the physics literature already show that. Indeed, we also know that the classical force fields do not even exist apart from mass; in space, only the potential for such a force field exists, in case some charged matter is brought in to interact with the EM entity as it exists in mass-free space (as curvatures of spacetime).

The Aharonov-Bohm effect and its implications have been published in *Physical Review*—our most prestigious physics journal—since 1959. Later publications have included the Berry phase extension of the AB effect, and Aharonov and Anandan's further extension of the Berry phase to what is today called the geometric *phase.* The potentials are indeed the primary EM causes, and *the force fields do not even exist as such in mass-free space, but only in mass.* Yet our classical EM taught in our universities has not been changed in its fundamental acceptance of the material ether since 1865.

Every university in America is still teaching and defending a rather mangled electrodynamics where

(1) The material ether is still assumed, even though destroyed more than a

century ago by the Michelson-Morley experiments;

(2) The force fields are erroneously assumed to exist in massfree space, but in force-free form(!!!) when what actually exists there as an EM disturbance is a general relativistic perturbation of spacetime (i.e., an oscillation of the local curvature of spacetime). Actually, force identically is the time rate of change of momentum, where momentum is mass times velocity. Thus mass is a *component* of force and force field. There is no force or force field without mass. As Feynman put it, there is no force field in massless space; instead, there is only the potential for such a force field to be formed at the various points, should a charged mass be placed at (added to) each of them;

(3) The source charges are erroneously assumed to *create* their fields and potentials and all that energy in them, reaching across the entire universe from each and every charge, right out of nothing at all. This perpetual motion and creation of energy error continues even though particle physics has known (and proven, both theoretically and experimentally) that any charge (as a set of composite dipoles, when the charge is taken with its clustering virtual charges of opposite sign) is a broken symmetry in its fierce energy exchange with the vacuum. Hence the charge extracts that energy in its fields and potentials *from the active vacuum,* and outputs the extracted energy across space {122}.

Our own electrodynamicists and electrical engineering professors and departments would have us believe - and they continue to imply such in every university in America—that every charge is a perpetual motion machine clearly in violation of the master energy conservation dictum that *energy can neither be created nor destroyed.* The complete lack of scientific understanding that every charge extracts energy from the vacuum and freely and continuously pours it out as real observable EM energy, is reflected in rather silly "witch-hunts" {123} against electrical systems which exhibit more energy output than the operator himself inputs—i.e., systems which exhibit a coefficient of performance (COP) of COP>1.0, which are open EM systems far from equilibrium in their active environmental exchange.

Let us reason together! If the second law of thermodynamics really did prohibit COP>1.0 *electrical* systems, then it also would prohibit the demonstrated COP = oo of a solar cell array. It would also prohibit the demonstrated COP>1.0 *mechanical* systems such as a windmill, waterwheel, or sailboat—all of which have COP = oo! In other words, the second law cannot even be a law if it discriminates only one type of energy prohibited from being used for COP> 1.0,

For some inexplicable reason, EM COP>1.0 systems have come to be dogmatically labeled "perpetual motion machines" by the professional skeptics since EM systems must take their excess energy from the known active vacuum environment! In short, the dogmatic scientific community is saying that "windmill-type EM systems" with COP = oo are permissible for exchanges with

physically active and observable environments (such as the sunlight used in solar cells, the heat in the air used in heat pumps, the water currents used hydroelectric power plants, the winds used in windmill power generation, etc.), but they are not permissible for exchanges with the proven modern active vacuum *virtual particle flux energy* environment, even though the discovery of **broken** symmetry in 1957 already proves that all EM energy is indeed freely taken from the seething vacuum environment by the asymmetry of the modern dipolarity of the source charge! We refer the interested reader to the proven broken symmetry of opposite charges {124}. We also refer the reader to Nobelist T. D. Lee's statement applicable to the skeptics' naive notion of symmetry. Finally, in modern physics all the major forces of nature are generated by the exchange of virtual particles. It is these forces that then translate against a resisting mass or entity to provide useful work. So all useful work in the universe already comes from the interactions of the seething virtual flux of the vacuum. On what distant planet have the skeptics been hiding while all this modern physics has been developed?

One must keep one's sense of humor! It is ironic but true that every major university in the U.S. continues to teach, uphold, and advocate—by implication—EM charges as ubiquitous perpetual motion machines, freely creating energy from nothing. And that is those professional skeptics and witch-hunters never mention that their own naive understanding of electrodynamics already implicitly assumes and teaches perpetual motion machines freely creating energy from nothing at all—and on a scale unparalleled in scientific history!

We have one chart with some 32 major foundations errors and flaws in the electrodynamics taught in all our schools; there are many others in addition. This erroneous teaching has so indoctrinated our graduate students that most electrical engineers no longer know the real difference between power (the rate of change of form of energy and thus the rate of production of work) and rate of energy flow (whether it is being dissipated or not).

Every textbook speaks of "sources furnishing power," when it is the rate of dissipation of energy in the individual loads and losses to provide the rate of doing work that *constitutes* power. Sources do not furnish power! They furnish energy flow (specifically, their source dipole furnishes energy flow, extracted and transduced directly from the active vacuum, and only a tiny bit of that enormous energy flow is diverged into the circuit and used). The various components of the receiving circuit interact with that energy flow to catch and dissipate a little of it, thus producing power and work locally in the intercepting and dissipating component.

A massive nondivergent (nonintercepted) energy flow has zero power (time-rate of doing work), but if intercepted and diverged, the divergence may develop enormous power (time rate of doing work) in and upon the interceptor, diverger, or collector. Even many physicists today are confused on the difference between

rate of work and rate of energy flow per se. E.g., for about 30 years now, there has been a polite debate involving that very subject in the *American Journal of Physics.* It is still not completely resolved, because the argument has not actually addressed where all EM energy in fields, potentials, and waves comes from in the first place: directly from the seething vacuum via the asymmetry of the source charge. It also has not addressed the long unaccounted giant Heaviside nondiverged energy flow component.

Toward a Deeper Electrodynamics

The first thing the Soviet Academicians did after WW II was to completely overhaul electrodynamics, but in highly classified areas controlled totally by the KGB. Stalin's boot firmly planted on their backside saw to it, creating the terrible fear that if they failed to produce, they would surely die. Not having experienced such a "Stalin boot," our own scientific community continues leisurely onward, while it teaches 110 years old electrodynamic material filled with non-sequiturs.

The Russian use of the "information content of the field" euphemism is a case in point. Our fellows (in both the intelligence community and the scientific community) assume the Russians are speaking of simple transverse EM wave spectral analysis. Nothing could be farther from the truth. Let me explain.

In 1903, E.T. Whittaker—a leading theoretical physicist at the time—showed that any scalar potential is comprised of a harmonic set of bidirectional *longitudinal EM wavepairs.* Each pair consists of a longitudinal EM wave and its true phase conjugate replica (i.e., its "antiwave", or time-reversed twin, coupled together).

Unknown to Whittaker, that LW wavepair actually includes a *time-density wave* in the time domain, coupled to a longitudinal EM wave in 3-space. Per quantum field theory {66}, such a coupled pair would be observable as the scalar potential. Knowledge of this specialized coupling is necessary in order to properly decipher the Priore mechanism. That mechanism was demonstrated to *time-reverse* (dedifferentiate) a diseased or damaged cell and all its parts back to it previous normal state, *genetics and all.* The time-reversal was accomplished by "pumping" the cell and all its parts in the time-dimension so that time-reversal propagation of the mass-energy is achieved. The time-domain pumping is done by the associated time-density wave, which always accompanies any longitudinal EM wave a priori. So sometimes we sloppily say that the "longitudinal EM wave pumping" causes the time reversal of the mass, but it is really the associated time-density wave pumping that causes it. The time-density wave component also can cause *time charging* or *time-excitation charging* of a mass. During its alternate existence as masstime, the time portion is altered, and that is a time-excitation or time-energy excitation.

It turns out the human cellular regenerative system (Figure 29) also uses the

same time-excitation charging methodology to produce time-pumping of the cell and all its parts. This produces a slow time-reversal (dedifferentiation) of damaged cells back to a previous state. This is in fact the basic mechanism for healing, as used by the living body.

Reversing aluminum, for example, just converts it back to ordinary aluminum. Not too interesting.

Reversing an HIV infected cell, however, would produce a healthy, normal cell with normal genetics. When a damaged cell turns into a cancerous cell, it is due to a process called *promotion* (change of the cell to a cancerous cell). *Reversing a* cancerous cell would change it back to a healthy, normal cell again—in short, it would constitute *demotion* of cancer and then healing of the damage in the now normal but damaged cell. In the AIDS patient, simply pumping the entire body with the time-density wave accompanying the longitudinal EM waves produced in a plasma—as Priore did for terminal tumors—would time-reverse all cells, completely ridding them of any residue of HIV infection. This would remove all the "HIV factories", thus completely solving the problem of AIDS. We have also uncovered a more advanced process where *matter can essentially be directly engineered in any conceivable manner,* including nuclear transmutation etc. We have filed a Provisional Patent Application and will file formal patent applications on those processes in the future, as soon as funds are available (patent attorneys are expensive!)

Time Is Highly Compacted Energy

Since time is energy compacted by some $9x10^{16}$, even small time-density changes can produce enormous spatial energy, should any of that compacted energy be *transduced* from time-density waves into transverse EM waves and thus into spatial EM energy. Such transduction can indeed occur in nonlinear materials and processes, such as in electrolysis.

The New Transduction Model Explains the Cold Fusion Results and Mechanisms

In August 1998, we presented a conference paper pointing out that cold fusion uses this very *transduction of EM wave types,* one into the other. We presented such new concepts as (i) TW to LW to TDW transduction and in the other direction also, (ii) time density charging of a particle to an excited time-density state (analogous to energy charging to an excited energy state), and (iii) the observation that excess phase conjugation in a local region can generate a time reversal zone where like charges attract and unlike charges repel.

With these concepts we were able to explain the excess heat appearing in the cold fusion experiments of hundreds of researchers. We also came up with (iv) a totally new class of nuclear reactions without the usual high-energy

considerations. That is, we showed the exact nature of the electronuclear reaction that is forming the anomalous nuclides in cold fusion experiments. Production of the new nuclides was revealed to be simply what one would expect from this mechanism, as indeed was particle clustering of like-charged particles.

We also explained (v) all the instrumental anomalies occurring in a series of well-documented cold fusion electrolysis experiments at China Lake. In fact, (vi) we added a completely new term to the conservation of energy law, thereby extending it.

An updated explanation is included in my new book, *Energy from the Vacuum*, 2002, *ibid.* With the new transduction interactions, one must state that the total energy in (a) spatial energy form, (b) mass-energy form, and (c) time-energy form is what is conserved.

So when transduction occurs in cold fusion experiments (electrolysis), some of the time-density charge energy is gradually transduced into ordinary transverse EM wave energy, which as it scatters produces excess heat not accounted for in present particle physics interaction models.

Scientists with only the "old" 2-term Einstein conservation law in mind, will be firmly convinced that this excess heat represents a violation of conservation of energy, hence is impossible. So they will question the calorimetry ability of the cold fusion scientists, etc. Unfortunately, the more ardent defenders of the orthodox faith will unjustifiably impugn the intentions and morals of the experimenters themselves with vicious ad hominem attacks. Such has indeed been precisely the case. Many of the harsh scientific critics have acted like cur dogs in a pack attack, and not as scientists at all.

Once one analyzes cold fusion in the new 3-term conservation manner and with the new transduction concepts, one immediately sees that the *overall* conservation of energy is upheld, while the *special case* represented by the former energy conservation law (conservation of the sum of the spatial energy and the mass-energy) is *permissibly* violated. The former case was a special case in that it arbitrarily assumed that no transduction of time-energy into spatial energy or mass energy—or vice versa—occurred.

In essence, successful cold fusion experiments show that, via transduction, a bit of time itself can be "utilized for fuel" and transduced into ordinary EM energy. Energy-wise the system has become a nonlinear open dissipative system[40] far

[40] But we point out one idiosyncrasy of thermodynamics, which defines a "closed system" as one in which mass does not cross the system boundary, but energy is free to exchange across that boundary {125}. Hence, eerily a "closed thermodynamic system" is actually an open system with respect to energy exchange between system and environment. As such, energy-wise the system can be a system far from energetic equilibrium with its external active environment, and still be considered a closed thermodynamic system! Energetically, a *closed thermodynamic system* that exchanges energy but not mass is permitted to exhibit COP>I .0 and even COP = oo!

from thermodynamic equilibrium {125}. As such, it is permitted to (1) self-organize, (2) self-oscillate, (3) output more energy than it itself has, by merely receiving, converting, and using excess energy from its environment (in this rase, from the transduction of a tiny bit of the time-charging that has occurred), (4) power itself while simultaneously powering a load or performing useful work, and (5) exhibit negentropy. With the exception of transduction of time-charge into excess energy, all of that is already in the thermodynamics texts, though it has not been clearly spelled out in electromagnetics texts. The source charge, e.g., exhibits all five of those capabilities. *The inclusion of the time-domain as part of the external active environment, however, is an extension of* ***previous*** *open dissipative system work by leading researchers such as* ***Prigogine.*** *It dramatically extends the meaning of "active environment".*

Why There Is a Time Delay in the Onset of Cold Fusion Phenomena

With an energy-to-time compaction ration of $9x10^{16}$, energy processes have to transduce spatial energy into time for quite a while in order to build up very much *time-excitation charge*. This leads to an initial delay in the onset of the "new law" transduction phenomena, as directly shown by the vast majority of careful cold fusion experiments. This build-up occurs during the "palladium-lattice loading" time, e.g.

By the same token, there is a time delay after cutoff of the input power to such experiments, during which time the slowly decaying time-density charge by its transduction into spatial energy continues to maintain the anomalous new processes (such as excess heat production) as they slowly subside. So the hours-long or even days-long delay phenomena after input power shutdown are also explained by the new approach.

In summary, there exist some very anomalous but very good experiments by excellent scientists—more than 600 of them—that are at least totally consistent with the above new wave polarization transduction model. Consistency with experiments is the first element of proof (it is necessary but by itself it is not sufficient). The new model also contains and obeys the conventional conservation of energy law until the new transduction phenomena become observable, at which time the extended energy conservation law applies. So in its lower limit, the new model corresponds to the present model—again, another requirement of any model purporting to extend a scientific area past that area's conventional model description.

The KGB weapons scientists—not the regular Russian academic establishment—have about a 40-year lead on us in all these areas. While our own scientists have dallied and pursued the standard model, the Russian weapon scientists have produced the equivalent of 10 Manhattan Projects, back-to-back, in the "new" energetics area.

The Early Soviet Longitudinal Wave Interferometers

Using longitudinal EM waves, the early KGB energetics interferometers could pass their beams right through the earth and ocean. LWs readily penetrate matter, reacting with it only weakly.

Some LW interferometry was also done using ordinary EM waves as carriers for the LW wave functions. Each such transverse wave carrier is in fact two scalar potential functions (Whittaker 1904, the initiation of superpotential theory). In each scalar potential for which functions are extracted and used to make the normal transverse carrier wave, there exist LW biwave pairs comprising said potential. So by assembling the desired LW biwave subsets, the two scalar potentials and their resulting interference-produced carrier wave are internally structured as desired. This is the use of the so-called *internal information content of the field*. We speak of such a deliberately structured potential, field, or wave as having been *conditioned*, *dimensioned*, or *activated*. If these terms are deemed inappropriate, just use the more generic term "internally structured." Then one has to explain what the "internal" is, and how this "internal" can be "structured."

In the distant interferometry zone, those *dimensioned* potentials, fields, or carrier waves would interfere and produce the desired alterations in the local spacetime (including specific spacetime curvature engines). Remember, the potentials are just bundles of special waves. We are discussing a special form of nonlinear multiwave interferometry, where the individual waves and waveforms comprising the total wave package assembly constituting a carrier have been carefully chosen in advance.

In the local spacetime in the distant interference zone, such multiwave longitudinal EM wavepair interferometry creates ordinary EM waves and energy that arise directly from each and every point in that individual interference zone. We stress that ordinary transverse wave EM energy propagation through the intervening space between the interferometer transmitters and the distant target *does not occur*.

In January 1960, in a speech to the Presidium, those are the weapons then in final engineering development for production that Khrushchev spoke of as "fantastic new weapons".

Khrushchev Killed the Thresher to Prevent His Own Dismissal

The first deployed large force-structure interferometer weapons became operational circa 1 April 1963. Khrushchev was still smarting from his Cuban missile crisis fiasco and his humiliation by Kennedy. Having overplayed his

hand and gotten caught,[41] Khrushchev was desperate to stay in power and not be thrown out by the Communist Party leaders for such a massive loss of face.

On April 10 of 1963 Khrushchev used his new interferometers to reach through the earth and ocean and "kindle" EM jamming in the electrical controls of the **U.S.S.** Thresher nuclear submarine underwater off the East Coast of the U.S. **The** reader should recall that, wherever the interference zone is established—including in the earth or underneath the ocean, in the atmosphere, or in space—the energy arises directly out of the local spacetime. *There is no Faraday shielding of such effects, which do not depend upon ordinary transverse wave EM field energy propagation through space*. The energy appears everywhere within the targeted object, simultaneously.

It is extremely important that the reader recognize the dramatic difference in the way energy propagates in the new mode as compared to the old "propagation through space" mode. In the old mode, energy transport arises in one spatial location and is considered to proceed serially through the intervening spatial points to the intercepting and interacting particle's location. The Poynting model presently uses only this mode. In other words, the energy propagates from wi*thout* the object *to* the object, and thence *inward inside* the object, if possible as the object interacts.

On the other hand, when the energy arises at each and every point in spacetime, it then propagates outward from each arising point. Thus in the nucleus of an atom, the "energy flow" starts at all interior spatial points and flows or diffuses outward in all directions. So the energy "meets" and interacts with the quarks in the nucleons, *before* it meets the "nucleon as a whole" and translates it. For this reason, with energetics it is easier to alter and "flip" quarks in nucleons than it is to translate nucleons, since one is using the new energy propagation mode. *This simple reversal of the outside-to-inside energy propagation to an "inside-to-outside" mode, is a revolution in particle physics and effects on materials.*

In fact, the energy dramatically enters the "interior" areas of nuclei, nucleons, etc. in a manner heretofore impossible or extremely difficult to achieve by high-energy physics, which can only do it by smashing into the object with sheer brute kinetic energy. Therefore the new "inside to outside" energy propagation mode can produce—at feeble spatial energy—extraordinary nuclear interactions not possible by brute force "outside-to-inside" energy propagation means. By controlling the structuring of the arising of the energy at each point in spacetime, the energy structure interacting with the quarks and other interior components can **b**e tailored to order. This is the primary secret of transmuting an element at a distance by a specialized energetics weapon. The structuring of the emerging

[41] Oddly, had he simply waited a few more months or a year before injecting the missiles and nuclear warheads into Cuba, Khrushchev's strategic scalar interferometers would have become operational. With those in operation, a "Cuban missile crisis" might well have had a different outcome.

internal energy can be deliberately tailored to change quarks in—say—some of the nucleons of U235 and plutonium nuclei. In this fashion nuclear warheads, nuclear powerplants, and nuclear propulsion systems of atomic submarines can be altered at a distance, beneath the earth's surface, beneath the ocean's surface, in space above the earth, etc.

The EM "hash" emerging from the Russian interferometry simply jammed the electrical controls and systems of the Thresher *from inside its very electrical circuits.* Out of control and helpless, the Thresher sank to crush depth and imploded (Figure 6). The EM "splatter" from that interferometry, arising from the local spacetime throughout a surrounding region, engulfed the Skylark, the surface companion of the Thresher. The resulting spurious EM jamming severely interfered with multiple electronic systems on the Skylark. Several electronic systems just ceased working altogether. Their electrical forces were time-energy excited and time-reversed so that electron currents in them became impossible (blocked).

It required over an hour for the Skylark to transmit an emergency message back to the Navy that the sub was in difficulty, through all that interferometry jamming effects. The Russians undoubtedly "tracked" the sub till it imploded, then cut off the interferometry. As the "time-density charging" in the area slowly diminished, all failed electronic systems in the Skylark returned to full functioning. This was because the excess time-energy excitation just decayed away, so that electrical currents could again flow.

Khrushchev Demonstrated the Powerful Blast Capability of Strategic Interferometry

The next day, 100 miles north of Puerto Rico, the same KGB interferometer weapon was powerfully pulsed to produce a giant EM burst deep under the ocean's surface (Figure 42). A cone of water rose up from the surface to about a half-mile in height, observed by the startled crew of a passing U.S. jetliner and reported to the FBI and Coast Guard when the aircraft landed in Florida. As it rose, the cone of water spread into a cauliflower shape typical of a deep underwater nuclear burst that does not vent the gas bubble. Then that giant cauliflower of water fell back out of the sky and into the ocean. The second successful demonstration of Khrushchev's scalar interferometer weapon had been made for the benefit of the Presidium and the leaders of the Communist Party.

With those two dramatic tests, Khrushchev had killed the latest and greatest U.S atomic submarine and demonstrated the awesome power of energetics weapons. He had shown the leaders of the Communist Party that the U.S. had no inkling of his new superweapons. He had struck the U.S. a formidable blow in a direct act of war—but a new kind of *clandestine* energetics war—and gotten clean away with it. Now it was Kennedy, rather than Khrushchev, who had been

duped. So had the entire U.S. Intelligence Community and the U.S. Scientific Community. Sadly, mostly they apparently remain duped or partially duped to this day.

Khrushchev managed to stay in power nearly two years longer by these two demonstrations. So the KGB/Soviets embarked on a decades-long program of buildup and development of the new weaponry, clandestinely, in order to take the U.S. by surprise attack and destroy it utterly.

In 1972 Brezhnev named 1985 as the target year when Russia would be able to do as it pleased, and would essentially control the land, the oceans, and space {126}. This was stated at a secret meeting of the European Communist parties in Europe. A British intelligence agent was in the meeting, and furnished the U.S. that information. Later it was openly released and published.

The Russians met that 1985 deadline, and the resulting increase in killing U.S. missiles and aircraft in 1985-1986 was most indicative. Other indicators such as massive weather engineering were already ongoing.

Weather Engineering Over North America

The first KGB weather engineering tests over the U.S., using their relatively new interferometers, produced signatures of anomalous perfectly round holes appearing in clouds. These experiments started in 1967 or thereabouts. The Russians gave us that very severe "deep freeze" winter of 1967, as an initial weather-engineering test of their energetics interferometry weapons.

The KGB communists do have a sense of historical dates, and they often do things on certain dates in symbolic fashion. Full-time Soviet weather engineering over North America started in earnest on July 4th, 1976—our Independence Day and our bicentennial. This was the KGB's "gift" to the United States on such a historic occasion. Full-bore weather engineering over the Americas has continued to this day, and even increased. It was passed into the hands of the Yakuza and the Aum Shinrikyo upon their leasing of those interferometers on site in Russia at the end of 1989. In 1985 I produced a rather crude videotape[42] (40 minutes) with pictures of the giant radial cloud signatures etc. associated with such weather engineering operations since 1976.

The *basic* weather engineering method is simple. Use an LW interferometer (LWI) to reach through the earth and *cool* the air in a region and produce a high-pressure area, due to the densification of the air. Use another interferometer to *heat an*other area and form a low-pressure area, due to the expansion of the air. Then carefully steer those *highs* and *lows* by gradually and slowing rotating the distant antennae and slowly adjusting the interferometry range simultaneously, according to a calculated schedule.

[42]T. E. Bearden, "Soviet Weather Engineering Over North America," 1985.

By that means, the LWIs easily catch, entrain, and steer the jetstreams largely responsible for our weather. Put sharp loops and twists in that steering, and the huge angular momentum of the jetstreams developed in those sharp turns and circles will spawn tornadoes, violent weather, etc.

The first complete weather engineering system over North America in 1976 also used the Woodpecker's normal EM carrier signals with dimensioning and internal assemblage of the composite longitudinal EM wavepairs. A giant "interference grid" was established over much of North America. A great deal of local adjusting of the interferometry in the grid was necessary. These local grid readjustments caused "sudden popouts" of EM energy, creating many atmospheric booms, rumbles, and explosions.

To really stir up big weather trouble, the Russians—and now the Yakuza and Aum Shinrikyo—also heat or cool areas of the ocean where El Nino and similar "water engines" form. A dimensioned LW interferometer is required for this operation. By slowly and protractedly heating or cooling the water in one of the "warm water engines" fueling the weather, one causes a very significant, long-term, later effect on perhaps an entire continent.

One can create great droughts in some areas, great floods in others, etc. The KGB has been doing this extensively, since 1976. The great floods in Red China a few years ago are a direct example of KGB/Yakuza weather engineering, as is much of the extreme heat of 1998. In fact, thanks to the weather operations of the Yakuza under their KGB mentors, 1998 was the overall hottest year on record till then, since records were kept. At least for the summer of 2002, the record may have been broken again, with a significant season of giant forest fires burning away.

One purpose of the excess heating of the atmosphere, of course, is to do damage. An added "benefit" to the KGB is to furnish support to the environmentalists who are concerned about global warming. Understand, there is indeed such a thing as global warming. But by augmenting the atmospheric (and ice sheet) heating just a bit in a single year, the statistical analyses are skewed. The skewed analyses will show that the global warming problem is far more imminent than it really is, if the LWI engineering of it were suspended. Nobody on either side of the global warming debate seems aware of the LWI intervention that is ruining the results of their models and calculations.

In turn, the heightened global warming indications, detected as a result of the LWI interruptions, impel strong activist support for such things as the Kyoto treaty, *which is specifically designed to the strategic detriment of the U.S.* if and when the U.S. Senate ever approves it. The Kyoto treaty does not even apply to some 160 countries including Russia, China, etc. This focuses a certain proportion of our government time and effort in grappling with an inflated global warming problem, immediately. It directly fits the KGB strategy of "spreading" our government energy and attention all over the map, anywhere

but upon the coming strategic energetics strike and upon energetics weaponry.

The die-hard section of the KGB strategists are chess players. *They will come at you anyway, anyhow, and anywhen that they can.* Everything that can be impressed to serve or support the overall objective, will be impressed and used. That is the overriding principle when analyzing Russian KGB strategy.

Khrushchev meant every word of it when he said to Nixon in their famous Kitchen Debate: *"We will bury you!"* Interestingly, to this day Americans and their government officials have continued to be deceived as to exactly what Khrushchev meant. He meant it literally.

Earthquakes to Order

According to U.S. Defense Secretary Cohen, electromagnetic induction of earthquakes is now recognized by the U.S. Department of Defense, considering his little-noticed statement in Georgia in 1997, which we previously quoted. An interesting exchange of induced earthquakes (Figure 54) had occurred in latter 1988 and early 1989. Here two sides seemed to be "counting rifles."

Opening bet (induced quakes)

- Quebec 25 Nov 88
- Pasadena 3 Dec 88

Raise you

- Armenia 7 Dec 88

Call - what do you have?

- Malibu 8 Jan 89

Four aces

- Soviet Central Asia 23 Jan 89

***Clear** table (stress relief)*

- Bakersfield CA et al. various

Figure 54 Counting rifles with earthquakes: Put up or shut up.

As Secretary Cohen made his April 1997 statement obliquely recognizing the scalar interferometer weapons, the little friendly nation had just completed countering and averting a massive strategic energetics strike upon the United States and Western Europe, scheduled for May 1, 1997 —just three days later. A little more than two months earlier, a previously scheduled attack had also been countered and averted by the same friendly little nation.

Once one can reach into or through the earth and ocean and create energy in a

desired interference zone, induction of earthquakes is simple. Use the interferometers to deposit energy in a fault zone over a period of time. Keep it up, and the piezoelectric plates build up enough mechanical stress to forcibly "slip" and produce an earthquake.

Put the energy in very slowly, and one gets a long "overpotential" effect where the rocks do not slip for a long time, while the energy builds to higher levels due to the static friction of the rocks. Then there occurs a rather rapid catastrophic slip. In short, one produces a large destructive earthquake. The KGB weaponry can produce earthquakes of the highest magnitude if they work at it.

If one wishes to induce a quake in an area where there are no known faults, then one simply focuses the interference zone there inside the solid rocks and proceeds to deposit the energy, preferably rather quickly (in hours instead of days). The entire rock will be expanded and it will fracture, producing an anomalous so-called "flat plate" earthquake.

Around the early 1900s, the "normal" rate of large earthquakes was two or three per year. That gradually increased after WW II. During one week in year 2000, there were some 20 major earthquakes around the globe. Obviously, someone is doing it, since this is far beyond what could be expected naturally. Presently that "someone" is mostly the Yakuza and Aum Shinrikyo, on site in Russia and leasing the LWIs. With the scheduled CSR attacks forcibly aborted, the KGB has the problem of restraining an increasingly impatient Yakuza and Aum Shinrikyo group, while keeping them paying the lucrative lease money. Consequently, inducing some big earthquakes is one way to "keep the troops occupied and busy." Shooting down the occasional aircraft or missile is another way.

I worked for 8 years or more with an inventor (Floyd Sweet, now deceased) who had an energy device {127,128} sensitive to *artificially* induced quakes of that fashion, even such quakes thousands of miles away. The device would sit right on top of a *normal* quake and not react. We could tell within some 8-10 thousand miles—and often even for greater distances— which quakes were artificial and which were natural.

So during that period I was able to clearly ascertain what was going on, and who was doing what to whom, and which quakes were normal and which were manmade. Several artificial U.S. quakes, the Armenia quake, and a subsequent big quake in Russia were particularly interesting in the mid and latter 1980s. The huge 1976 China quake was directly induced by the KGB.

Figure 55 Brewer briefs President Reagan on Soviet scalar EM weapons October 1984, then briefs National Security Council

In 1984, on my behalf Roy Brewer {129} had briefed President Reagan on these scalar interferometry weapons (Figure 55), then briefed the National Security Council. Let us hope that these high level briefings may have borne at least some fruit.

Readying the Weapons for the 1985 Readiness Demonstration Tests

In latter April 1985 I received an urgent call from my close colleague Frank Golden. In his avionics repair work, he suddenly found that his best calibration instruments were very "noisy." He replaced one expensive instrument, and the second was "noisy," also. A third proved equally noisy. This was unparalleled. It was not the instruments, but instead it was all the electronics to be repaired, that were emitting electromagnetic noise!

So Frank borrowed one expensive instrument and brought it home for the weekend. He altered it by a proprietary method so that he could detect energetics radiation. Voila! The entire earth was alive with Soviet energetics signals. The weak interferometry of so many signals impinging into the weakly interacting electronic systems to be repaired, had generated the electronic noise his instruments had detected.

In response to Frank's call, I immediately proceeded to his location. I personally observed on the oscilloscope, as detected by Golden, some 27 pairs of Russian energetics signals, each of the two in a pair being 12 kilohertz apart. (We have

previously explained why two frequencies are used, and one "pretends" one transmitted the difference frequency). Each of these frequency pairs represented the entire earth held in entrained resonance. Each pair was an "energy tap" in the earth, extracting enormous energy from the heat of the molten core of the earth itself and outputting it as 12 kilohertz power for transmission to giant interferometry weapon sites.

Each "tap" was extracting energy sufficient to power perhaps 4 to 6 of the giant intercontinental energetics interferometer weapons. We were observing something like 100 to 150 massive weapons on line and radiating. A full-up strategic dress rehearsal—or preparations for a full-up strategic attack on the U.S.—was underway.

Gorbachev was still a "new man on the job" at that time. Further, 1985 was the 40th anniversary of the end of WWII, and a very important occasion for the Communists and in fact for all Russians. The May Day celebrations that year went on for several days, not just on May 1.

What we were seeing were preparations for a massive May Day weaponry demonstration in and around May 1, 1985. We were observing the preparation and demonstrated readiness of all that great armada of Soviet energetics weapons, to meet Brezhnev's 1985 schedule laid down back in 1972 {126}.

Longitudinal EM wave communications to deep underwater Soviet subs, the huge interferometer armada, and everything else—all were being readied and demonstrated. I can assure the reader that observing full rehearsal of preparations for the next World War was a most sobering experience.

After May 1, most of the armada of interferometers was stood down again because it had been demonstrated that the "ready schedule" had been met. All but one of the giant energy taps in the Earth were also stood down again. That one remained active.

The May Day report to the heads of the Communist Party that year must have really been something!

As usual, apparently our own scientific and intelligence communities did not detect the main activities, and would not have believed it if one told them. They certainly did not believe it when I published it in 1986 in *Fer-de-Lance,* but labeled it sheer fantasy or at best total conjecture.

It was neither fantasy nor conjecture. It was direct experimental measurement. It was in fact what used to be called *scientific method.* The problem with our intelligence agencies was that they operated behind *policies.* Once the *policy* is decided, then regardless of what the intelligence analysis indicates, anything against the official *policy* is just ignored. This neat little *policy* method of doing business has resulted in making our intelligence agencies some of the most political-minded and manipulative groups on Earth.

Meeting the 1985 Schedule for Readiness

In 1985, KGB/Russian preparations began in earnest for the energetics weapons readiness projected for that year by Brezhnev in 1972. Being full-bore tests, these actually went after destruction of vehicles and killing people. These were actual acts of war. The so-called "Cold War" was not nearly so cold as pictured in the news media!

Early that year, an LWI was used to cool the combustion in the engines of a jet liner off the coast of San Francisco, bound for Los Angeles (Figure 56). This flamed-out the engines. The stricken craft fell 30,000 feet before the time-density "cooling" charge drained away, sufficient for the pilot to restart his engines and limp into San Francisco. Gravitational and inertial anomalies—*a clear signature of the use of this EM/GR weapon*—were exhibited upon the personnel in the cockpit. The official investigators ignored those signatures; after all, such is not in their standard checksheets! And everybody knows the standard checklists are already perfect!

SIX MILE DROP IN TWO MINUTES

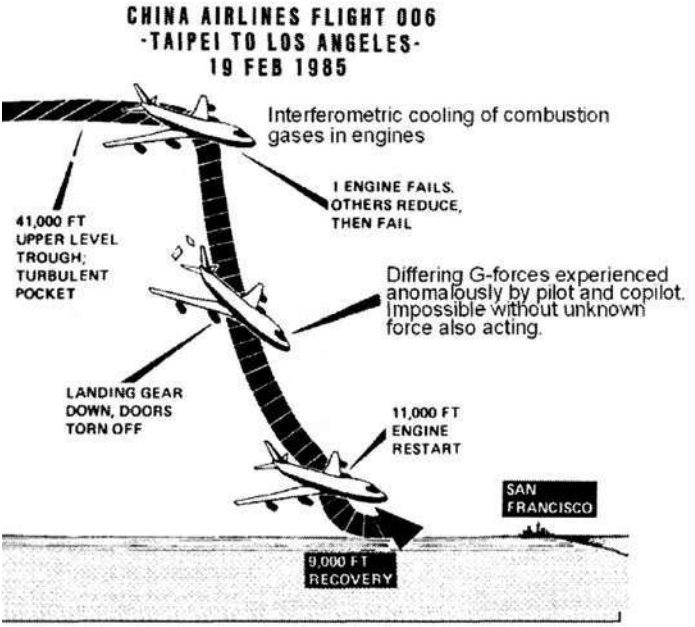

Figure 56 Extinguishing combustion in the engines of a jetliner 19 Feb. 1985.

KGB Crews Regularly Practiced Against U.S. Rocket Launches from Cape Canaveral

In a late Nov. 1985 night shuttle launch at Cape Canaveral, the Russian interferometer crews continued their practice of using the U.S. shuttle launches as convenient "simulated" ICBM launches, for energetics interferometer crew practice (Figures 15 and 16). EM missiles (balls of EM energy formed in the area by distant LW interferometry through the earth) were used as the "destructive agent", but were offset from the actual launch in order not to destroy the shuttle. This was *normal crew drill,* not combat operations. The practice range for energetics weapons is—as might be expected—the actual targeted area and targeted nation itself.

As shown in *Fer-de-Lance,* I published an actual picture (Figure 15) of such a KGB EM missile strike, offset from that shuttle launch in late Nov. 1985 and snapped by Bob Gladwin. I also published an actual picture of a second such EM ball of glowing energy (Figure 16), over the launch site for the same launch, and used as a registration point (the LWs deviate slightly in passage through the earth, since the potentials in the earth are not constant). George Suchary took the second photo.

A standard artillery "shift-from-known registration point" method of firing was being used. In other words, the crews establish LW track on that EM registration ball, right through the earth. That represents *a point having a known set of coordinates*—a registration point—established in the firing computer. Then when the targeted strategic missile (in this case the shuttle's main booster) ignites, the interferometer also tracks the huge ionization target of the exhaust with the same weapon system.

That gives a known *relative* location of the missile rear end, with respect to one's registration settings for the registration point ball of light. Then add some meters to move up onto the missile body proper, and voila! The center of the target missile that will be fired is now in the bulls-eye, so to speak. That is a standard "shift from a known registration point" method of shooting, well known to every artillery group on the planet. The "marker beacon" is what is known as a "high burst registration," except it is not a burst but a steady ball of energy maintained over the area as the registration point.

The distant rocket or missile can now be destroyed in a variety of ways:

(1) Just create a sudden EM surge arising right in that spacetime (that is, just pulse the interferometer). That burns out some of the inner electronics of the missile, causing partial or complete missile failure.

(2) Sharply pulse the interferometer to introduce EM energy surges and sparks in the fuel or solid propulsion, igniting it massively and blowing up the rocket. Works well for aircraft fuel tanks as well.

(3) Form another EM missile and hit the missile broadside with that, burning

through it and destroying it immediately.

(4) Hit it with an explosive EM missile internally, instantly exploding the missile into pieces. Or

(5) Hit it with several of the above simultaneously.

Suchary and Gladwin had captured the direct evidence of KGB dress rehearsal for the strike and kill of the Arrow DC-8 in Gander, Newfoundland about two weeks later.

Kill of the Arrow DC: Practice Turned into Performance

Two weeks later, the same KGB weapon tested against the Cape Canaveral shuttle launch was used to destroy the Arrow DC-8 at Gander, Newfoundland, killing some 256 occupants, 248 of them being U.S. soldiers returning from peace-keeping operations overseas. The aircraft *was not* iced up; later that was clearly established.

See Figure 17. As the ill-fated Arrow aircraft began its thrust down the runway for takeoff, it was already under LW interferometer track (the exhausts of the **engines** were being precisely tracked) by distant KGB operators. The KGB operators simply began to cool the combustion gases in the engine combustion chambers as had been done to a U.S. jetliner earlier that same year (Figure 56) off the coast of San Francisco (there they had completely flamed out the en**gines).** Now they did not want to flame out the engines during take-off, but just wanted to reduce the thrust of those engines.

So the available thrust of the engines began decreasing as the aircraft picked up speed on the runway toward takeoff, even though the turbines were rotating at full speed. For powered flight, it is the *thrust-per-drag ratio* that is important. One can reduce that ratio by ice-loading and therefore increasing the overall aircraft drag, as all Transportation Safety Board checksheets assume if the engines are at full rotation and if operation and icing conditions are present. Or one can reduce the ratio by reducing the engine thrust itself, as was done for the Arrow, even though the plane is de-iced. All the Transportation Safety Board checksheets *assume* that it has to be drag increase, and thus due to icing.

The National Transportation Safety Board (NTSB) investigators know nothing about longitudinal EM wave interferometry and its capabilities—and its development by several nations of the world. Neither do their checksheets. Sad**lly,** the NTSB is not even aware that the electrodynamics and electrical engineering it assumes is so perfect is in fact a decrepit old model based on century-old errors. They are unaware that much better electrodynamics models have long been developed for particle physics, because the crusty old classical model is totally inadequate. Their checksheets also are "unaware" of anything really modern such as electrodynamics models of the higher group symmetry **kind.**

The thrust reduction by combustion gas cooling *does not appear on the official checksheets and is never considered.* It is not considered to this day. It will probably still not be considered this century.

Observers on the ground heard those engines "laboring," which can be a direct symptom of combustion gas cooling and engine thrust reduction. Rough running and missing can be another, if the cooling increases. Engine flameout occurs when the combustion no longer can be sustained because of the dramatically lowered temperature of the gases.

The Arrow Pilot Sensed the Lack of Power, But the Aircraft Was Immediately Hit

See Figure 17. At rotation and liftoff, the pilot of the Arrow DC-8 immediately sensed his lack of lift, and started a slow turn to the right, apparently intending to come around and land again as an emergency measure. Meanwhile, crossed beams had formed in the sky above and off to the right side. From those crossed beams of light, there shot down a bright "streak" of light that struck the fuselage of the aircraft in the right side, ahead of the engines. That was the EM missile strike—just as had been offset from the shuttle launch two weeks earlier in Florida, and photographed by Bob Gladwin.

That piece of Arrow DC-8 fuselage hit by the EM missile, with the burned hole in it, was recovered and tested. Tests showed no explosive residues on the edges of the hole, so it *was not* made by a bomb or other explosive device. Instead, it was made by an EM missile of the type that over a decade later hit the TWA-800 several times off Long Island and killed it.

In the Arrow aircraft's kill, the fiery EM missile sharply ignited the plastics in the forward cabin, which explosively outgassed. One product of such outgassing is hydrogen cyanide. A whiff or two, and all the passengers in that section were already dying of cyanide poisoning. *In the autopsies of the recovered bodies, about half the passengers were already dead of cyanide poisoning before the plane impacted the ground and exploded.* They died while that aircraft was still flying and sinking tail-first toward the ground.

The results of those autopsies were deliberately withheld from the Canadian investigative board.

The impact of the EM missile on the Arrow DC-8 was clearly recorded by sharp, vertical EM surges (spikes) in traces on both data recorders on board the aircraft. In *Gravitobiology,* on p. 82 I printed the recorded sensor responses **for** that signature also.

Elements of the U.S. Government Deliberately Suppressed Vital Evidence

Several eyewitnesses, including Judy Parsons, physically observed the formation of the crossed beams in the sky. Parsons and perhaps others actually saw the streak-down and strike of the EM missile when it hit the doomed Arrow DC-8. Parsons tried to testify, but her testimony was never allowed to be heard by the Canadian Transportation Safety Board. A major U.S. News agency interviewed her, but then squelched the story for some "unknown reason." Other witnesses (who are still reluctant to come forward) did observe the strike of the EM missile also.

Why would the U.S. government deliberately suppress information relating to the cause of the deaths of 248 of our soldiers returning from peacekeeping missions overseas? Why were they so determined that this direct act of war be declared an "accident" in the face of overwhelming evidence that it was not an accident at all?

Iran Contra was not yet divulged at the time. Recall, at very high level our own fellows had directly violated the law, and were engaged in the illegal Iran Contra fiasco up to their eyeballs. Also, some officials in Washington in certain high U. S. Government circles were in near panic, in their personal (erroneous) firm belief that a MidEast-sponsored terrorist bomb had destroyed the Arrow. In that case, so they reasoned, with the murder of 248 of our soldiers, the American public would be so aroused and angry that they would force military action against the MidEast nation or group, and that would then reveal Iran Contra. *Too many highly placed people's hands were dirty!*

So extreme spin control was the major requirement. Damn how many American soilders had just been killed in an overt act of war against the U.S. Damn the implications of the use of eerie new weapons we did not possess. A hue and cry from the U.S. public would almost certainly reveal Iran Contra and smoke out the duly secrets. That must not happen at any cost. Some high officials—particularly the ones who engage in such illegal acts, in assassinations, murders, etc.—are far more interested in covering up their nefarious deeds than they are interested in any kind of justice or morality. Consequently, the fix was in.

So *U.S. officials placed enormous pressure on Canada to produce a finding of icing.* Lots of other skullduggery occurred, which probably constituted criminal activity by some U.S. officials. A high-ranking U.S. military officer arrived on site quickly, apparently under orders to erase that scene as fast as possible. He almost immediately wanted the Canadians to bulldoze over the site, even before recovery operations were complete and while the investigation was just getting underway. The site was bulldozed over in unseemly haste not long thereafter. That would appear to possibly constitute deliberate tampering with the evidence at an official site of investigation, on the part of whoever ordered the General to bulldoze the site precipitously.

In addition, witnesses such as Parsons were never allowed to testify. The Canadian Board waited until the half of its members who strongly opposed any ad hoc finding were absent, and hastily approved a finding of icing as the cause of the "accident." Later the disgruntled Board members who were absent when the "voting" occurred, issued their own minority report. Unfortunately they knew nothing of scalar interferometry and energetics weapons, and so they strongly believed it had to be sabotage and explosives.

Anyway, the blackguards hiding Iran Contra buried the incident, and the savage kill of 248 of our soldiers and 8 civilians went unpunished. Anyone such as the present author who pointed out what had really happened and why, was just branded a lunatic. After all, the blackguards who do not flinch at murder and unapproved assassination do not blink an eye at slander and libel.

The sad part is those fine young soldiers and the 8 civilians who were killed, and the grief and lasting changes made to their families. It is the children who had to grow up without their fathers, the mothers whose husbands were suddenly dead, etc. They deserved much better from their government than they got.

Other Direct Energetics Signatures on the Arrow DC-8

Meanwhile, in the lifting DC-8 the strike of the EM missile had also *time-density charged* the forward cabin materials. Those materials slowly decayed from their excited states via longitudinal EM wave emission. When a human body is subjected to fairly significant LW waves (accompanied with their time-density waves), it gets its internal immune system and cellular regeneration system "jammed," since these systems use LWs and accompanying time-density waves. The cells and tissues are also "time-energy charged" as well, and so spurious LWs continued to be slowly emitted in their tissues and cells locally, leading to gradual, general debilitation. After a time delay for the effects of this time-charge decay to be exhibited, such exposed persons will get sick with odd symptoms of various diseases such as influenza.

The ground handlers on the scene and exposed to the struck materials of the aircraft, were also exposed to longitudinal EM wave radiation from those materials which had been instantly "time-charged" at the powerful strike. Hence they were exposed to fairly significant LW waves, and should therefore have shown later symptomology.

Some 60 or so of the ground handlers actually retrieving the crash materials later sickened with all sorts of mysterious maladies: dizziness, stomach cramps, flu-like symptoms, weakness, nausea, fatigue, etc.—precisely what would be expected if some the materials they were handling were emitting longitudinal EM radiation, exposing them to significant LW radiation. That is a clear signature again of a strike by an EM missile, and the exposure of those retrievers to LW emissions. *In no normal way could 60 of those ground crewmen handling the wreckage debris all come down simultaneously with the exact symptoms of*

LW radiation sickness, unless that was what it actually was.

Many of those sickened persons remained debilitated for years. Probably a few are still alive and debilitated.

There are other signatures on the Arrow DC-8 kill. I did a small bit of work on the problem in the interests of Arrow airlines, but of course the conventional investigators they also hired could only conceive of an ordinary explosive. Nevertheless, I did tell them as best I could what happened to their aircraft, their crewmembers, and our own valiant soldiers.

Our troops on board the tragic Arrow DC-8 *did not* die from a simple over-iced plane that crashed as a result of carelessness in deicing operations. *They died as the result of an act of war against the U.S., carried out by the KGB as a test in an entire series to demonstrate the 1985 readiness that Brezhnev had specified in 1972.* That war is still partially ongoing and undeclared to this very day, with other players such as the Yakuza and Aum Shinrikyo also now in the game—and possibly even the Chinese, who certainly have had the weapons for some time, and have had QP weapons and negative energy EMP weapons since earlier this year (2002).

With the kill of the Arrow DC-8, the KGB made its deadline that had been set down 13 years earlier by Brezhnev. To meet the 1985 schedule, something significant had to be killed successfully and clandestinely, no later than Dec. 31, 1985. The KGB made the schedule on December 12, 1985, by killing the Arrow DC-8 after a warm-up and full dress rehearsal against a U.S. night shuttle launch at Cape Canaveral about two weeks earlier. And they also demonstrated just how ignorant of such energetics weapons and their usage the U.S. government, scientific community, and investigative boards really were.

We were fortunate they did not just go ahead and kill that same shuttle in late November 1985. Instead, they waited and killed the Challenger a few months later.

Other Acts of War Completed the Milestone

Apparently the final demonstration of milestone completion called for the destruction of an aircraft, kill of an ICBM, kill of a space shuttle, induction of earthquakes, and demonstration of the new quantum potential weapon still in the advanced laboratory stage. The KGB completed much of the milestone demonstration in 1985. The remainder they completed in 1986.

In January 1986 they killed the space shuttle Challenger, and the very next night the KGB even gave a big party in Moscow, to celebrate the "perfect success of their active measures" against the shuttle. General Daniel O'Connor, former head of U.S. Army intelligence, personally issued an alert to many high-ranking U.S. government officials, pointing out the almost certain involvement of the KGB and the fact that the loss of the shuttle was almost certainly due to a hostile

act by the Soviets.

In April 1986 (May Day report time was coming!) the KGB killed a Titan ICBM fired from Vandenberg Air Force Base. They also induced several large earthquakes for practice, and then began the induction of the long-dreaded "giant California quake" in the San Andreas Fault zone.

This latter induction of what would have been a massive quake in both San Francisco and Los Angeles, and all along the San Andreas Fault, was countered (destroyed) by a civilian group known to this author, with a backlash that resulted in the Chernobyl incident.

In April 1986 (for the same May Day report) the KGB also demonstrated the effectiveness of their newly emerging quantum potential weapon against the convenient U.S. air attack on Libya (Figure 25).

Kill of the Titan Missile Over Vandenberg Air Force Base

In 1986, the KGB began gingerly using those energetics interferometry weapons to kill other U.S. aircraft and several U.S. missiles, including killing a Titan 34-D fired from Vandenberg AFB on 18 April 1986. The Titan was killed 9 seconds after launch, partially crippling the U.S. space surveillance program. That kill was part of the demonstration of readiness milestone completion.

There was a completely decisive signature on the kill of the Titan. Simply check *Aviation Week & Space Technology,* 124 (17), Apr. 28, 1986, p. 18, where a picture (the one taken from longer range) of the Titan explosion is printed. Look about an inch above that explosion, which is already well developed. There above the Titan explosion sits the KGB ball of light registration point, just as it was sitting over the night shuttle launch in Cape Canaveral in latter Nov. 1985 when videotaped by a private photographer.

I persuaded NBC engineer Ron Cole and his colleagues to analyze a copy of that video tape frame by frame. In 17 frames, that little ball of energy above the explosion moved off on its own course, independent of the Titan explosion. Since the launch area for such missile launches is controlled and there were no aircraft over the explosion, then one again has a very clear signature. The KGB killed the Titan, with 100% certainty.

That of course was a test of the interferometry weapons in the role of *Launch Phase ABM system*. Tested against the Arrow, the KGB operators were emulating test of the system in a *Launch Phase Antibomber role*. These were vital *strategic* weapon tests. I published details of the use of the weapons in many other roles.

Dead-Man Fuzing and Outside Assistance Deterred a Full Strategic Attack in 1986

We have previously documented and published why the U.S. was not fully attacked and destroyed by the Soviets in 1986. It was because of our nuclear facilities, warheads, etc. which would have exploded, creating great fallout hazards worldwide, and because of nuclear dead-man fuzing weapons clandestinely placed in Russia by one or more other nations.

A friendly small nation possessing energetics weapons also intervened directly in l986, and blew up several Russian missile ammunition storage sites, some five or so in six months. In one such explosion, about one third of all the missiles in the Russian Northern Fleet were destroyed. As we stated, the so-called "Cold War" was not nearly so cold as has been represented.

In short, the friendly little nation served notice on the Soviets that, if they moved against the West, the Soviet Union itself would suffer terribly. They put it in language clearly understood by the KGB. So any full-up strategic attack for that period was stalemated by that combination of factors.

A major concern for the Soviets was their inability to counter the dead-man fuzing problem posed by nuclear weapons clandestinely hidden inside Russia and by the nuclear warheads and reactors inside the targeted nation(s). They already had the quantum potential (QP) answer *theoretically,* and had conducted a demonstration test of a laboratory QP device, but they had not yet completed the *QP* weapon systems and deployed them.

Nonetheless, a very powerful strike of peculiar nature—induction of a giant earhquake in the San Andreas Fault zone, including in both Los Angeles and San Francisco—was scheduled. This strike would have caused billions of do11ars worth of damage and would have killed perhaps 200,000 Americans. The initiation of the strike was actually begun in April 1986—as the reader can begin to see, there was to be one helluva May Day report in 1986! Incredibly, a private group here in the U.S. then made a unique and unprecedented contribution that saved the day for Los Angeles and San Francisco.

What Really Happened in the Chernobyl Disaster

Using the "inside" of the Woodpecker beams as superhighways for their longitudinal waves and interferometry, in April 1986 the KGB interferometers had started their build-up of substantial induced EM energy in the sides of the San Andreas Fault that runs through Los Angeles and up through San Francisco. Two beams were being used by the Soviets: One was coming down on the target from the North—coming over the North Pole regions and the ice caps—and one was coming around from the East and upon the target area. Completely (100%) certain signatures were present, including some ELF "chugger" waves symptomatic of the Soviet method of inducing very large quakes. The time-

energy is being used, hence very low frequency ELF is employed to maximize the amount of time-energy available for transduction in the rocks on the side of the fault. The Soviets were building up a very large earthquake—indeed, to spawn a whole series of such quakes all along the San Andreas fault—with severe aftershocks following after the main quake had done terrible damage. In short, they were preparing to hit California with the "big one" that everybody had been anticipating and dreading for so long.

A private group contacted me. They stated they could take out one of the transmitters by producing a powerful (giant) phase conjugate replica signal pulse upon it that would backtrack right into the transmitter and catastrophically burn it out—a surface application of the "phase conjugate shooting" once considered for armed satellites that could shoot down rising hostile ICBMs at 10,000 miles distance. As I understood it, they had a new kind of essentially noise-free regenerative amplifier, used in a transmitter. This meant that *extreme amplification* could be achieved in a pulse response to a received Woodpecker signal, before the transmitter burned out.[43] Since the group had no knowledge of the exact KGB transmitter locations or the possible consequences of such an action, they asked my opinion as to the risks associated. This placed me in a real quandary.

At the time, the U.S. was literally under siege. We have mentioned some of the

[43] A very subtle but important point is this: An energy flow of any amount—say, 10^{20} joules per second—has absolutely *zero power* if none of that energy flow is diverted or changed in form. So if one has a truly perfect noise-free amplifier, and a pure noise-free energy signal input, the signal energy input can be directly and freely amplified without limit, so long as those noise-free conditions can be upheld. In short, that rigorously constitutes *regauging,* and the widely used **and** well-known axiom of gauge freedom—the ability to change the local energy density of a system or spacetime freely and at will—applies. Relativistically, such re-gauging is merely rotating the frame of the system away from the laboratory frame. This group indeed had such an amplifier, which I physically saw, and apparently has it today. Our present texts have not yet realized the real implications of gauge freedom: It means that one can freely amplify energy without limit, once certain conditions (no divergence of the energy or change of its form) are met. This does not violate energy conservation; the "potential energy of a system" is not a fixed number at all, but depends on the frame of the observer vis a vis the frame of the system. We point out that there really are no true conservation laws in general relativity unless introduced by arbitrary measured The great Hilbert already knew this in 1917, two years after the advent of Einstein's general relativity. Hilbert stated: "/ *assert... that for the general theory of relativity, i.e., in the case of general invariance of the Hamiltonian function, energy equations... corresponding to the* ***energy*** *equations in orthogonally invariant theories do not exist at all. I could even take this circumstance as the characteristic feature of the general theory of relativity."* [D. Hilbert, *Gottingen Nachrichten,* Vol. 4, 1917, p. 21]. Loskutov and Logunov commented as follows: *"In formulating the equivalence principle, Einstein actually abandoned the idea of the gravitational field as a Faraday-Maxwell field, and this is reflected in the pseudotensorial characterization of the gravitational field that he introduced. Hilbert was the first to draw attention to the consequences of this. ... Unfortunately, ... Hilbert was evidently not understood by his contemporaries, since neither Einstein himself nor other physicists recognized the fact that in general relativity conservation laws for energy, momentum, and angular momentum are in principle impossible."* ["Nonuniqueness of (he predictions of the general theory of relativity," *Sov. J. Part. Nucl,* 18(3), May-June 1987, p I79).

"target year" activities, such as kill of the Arrow DC-8, flameout of jet engines early in 1985, target practice against shuttle launches at Cape Canaveral in November 1985, etc. Actually kill of targets had continued in 1986. A huge earthquake followed by several large aftershocks had been used against Mexico City on 19 September 1985, causing great damage and demonstrating a little of what might be expected when they chose to hit Los Angeles and San Francisco much harder. The Mexico City quake had been preceded by an induced, giant hailstorm weeks earlier, and on the evening of 18 September 1985 by giant radial cloud signatures accompanying the generation of excess energy in the underlying rocks as the KGB prepared next day's giant Mexico City quake. The reader should recall that, working with Sweet during this period, I knew with certainty which earthquakes were natural and which were manmade.

U.S. missiles and aircraft had been hit, the Challenger had been destroyed, and the Titan 34-D had been destroyed at Vandenberg AFB on 18 April 1986, accompanied by a 100% indicator (the substantiated presence of the marker beacon for registration and shift firing). In addition, a little Richter 5.3 quake in the San Francisco Bay area had been induced by the Soviets on 31 March 1986, a quake which was correlated with preparatory activity on the Woodpecker transmitter signals the day before, showing Soviet induction of the energy to create the quake. Again, we had instrumental evidence that it was manmade.

That quake on 31 March had been a "warm-up" and practice for the big one now about to be induced in both Los Angeles and San Francisco, and along the San Andreas Fault. In fact, it appeared that the entire fault zone would be stimulated by deposit of excess energy all along its length. In that case, induction of a distributed California quake of unprecedented extent and great magnitude was now in process, though just beginning. If that event or those events occurred, the loss of American lives and property would be staggering.

The High Side Risk Factor

The group's query to me presented a very difficult decision situation. Such huge Soviet interferometer beams, once built up, contain *enormous* longitudinal EM wave energy. If a Soviet transmitter were near large nuclear facilities, and were instantly blown and shorted, all that potential energy might flash directly into the ground.

In case of such a catastrophic transmitter failure, an enormously powerful longitudinal wave pulse would spread out in all directions in the surrounding earth. The first nuclear material the pulse encountered would be fissioned abruptly and very violently. If the transmitter were within a few kilometers of one or more of the large "monster" Soviet ICBM sites, the full-up explosion of several 30 or 40 megaton warheads might result—in the dirt and dirty. The resulting fallout and contamination would be massive, would spread round the world, and would eventually kill millions for years to come. Nuclear reactor stations were a similar risk; instant fission of all the fissionable material in one

of them would constitute an unprecedented and giant nuclear explosion, in the dirt and dirty. That was the high side risk.

The Low Side Risk Factor

The low side risk would be that little or nothing at all would happen; perhaps a tremor induced in a nearby fault zone, etc. I knew that the Soviets—after an early Kyshtym transmitter failure—had produced such a flashover on a much smaller scale and that flashover had caused the nuclear explosion of nearby stored nuclear wastes. The resulting fallout contaminated some 1200 square kilometers, which is still contaminated to this day. I also knew that, after Kyshtym, the Soviets had installed safety devices on all their scalar interferometer transmitters in case of just such failures.

So if the safety devices held when the transmitter suddenly shorted out, they could hold the longitudinal EM wave beams and potentials long enough to drain the energy slowly and harmlessly into the earth over an extended period. That was the low side risk.

The *most likely* consequence, of course, would be somewhere in the middle, between the extreme upper risk and lower risk limits. In other words, we could expect some bad repercussions in the Soviet Union almost certainly, but hopefully it would mostly be confined to that spot.

Consequences of Not Taking Counterfire Action

If no action were taken, the risk to the U.S. was appalling. If the transmitters continued, then perhaps 200,000 Americans were going to die in Los Angeles and San Francisco and along the San Andreas Fault. Perhaps 300,000 more Americans would be injured, and many of them would also die. Enormous physical damage would also be done, and those basins would be disaster areas for some years to come. It would be interpreted by our inadequate scientific community as a great "natural" disaster caused by a giant earthquake, and the ghost of Khrushchev would have had one more laugh at us, with his words "We will bury you!" silently ringing in the ether.

My Recommendation to the Counterf ire Group

To save those American lives, some reasonable element of risk had to be accepted. In other words, it became a classic "risk-to-benefit" military analysis, but one that was deadly serious. To me, as a military person the medium risk had to be accepted in such case.

I gave the group my reasoning. They then asked what I would personally do if my own finger were on the fire switch. I answered that I would take out the transmitter or transmitters and save those American lives, accept the medium risk, trust in God, and pray **for** the best. Military decisions often have to be made

in just such uncertain conditions. If one's military could not make such tough decisions, then one's military forces would inevitably lose their wars.

The Group Fired and Took Out a Transmitter

The group thanked me, stated that they would fire, and hung up the phone. See Figure 57. They did fire on April 25, just as they promised, and they did destroy one of the KGB transmitters—apparently located some kilometers (perhaps 30?) from the Soviet nuclear reactors at Chernobyl.

At the moment the transmitter was hit and destroyed, engineer Bill Bise—out in the field with magnetic field detectors and measuring the Woodpecker beams—observed the abrupt failure of the Woodpecker transmitter beam coming around the Earth from the East. Thus, he actually detected the successful destruction of that distant interferometer transmitter. Unknowingly he had detected the results of a great counterstrike in a very dangerous strategic battle.

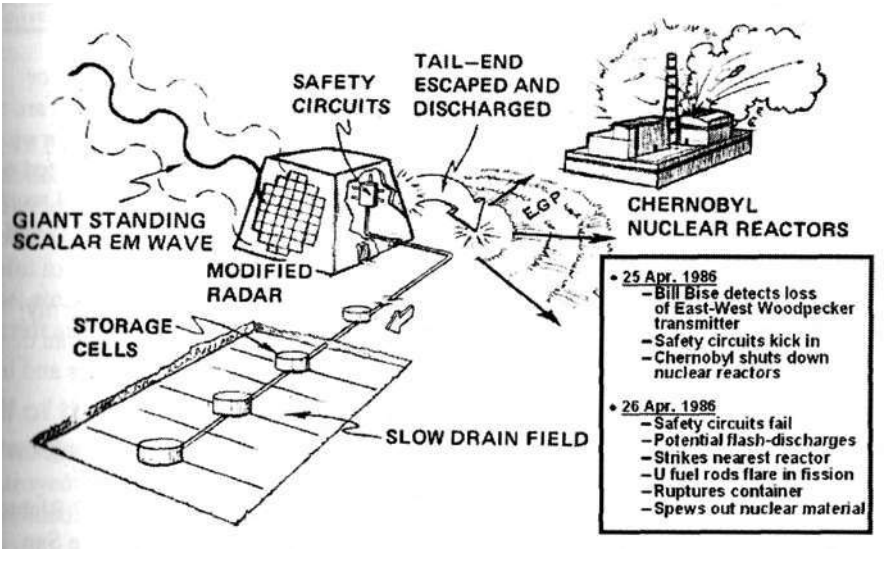

Figure 57 Chernobyl disaster 25-26 April 1986.

Results at the Transmitter and at Chernobyl

We were very, very lucky. At the destroyed transmitter site, the safety circuits kicked in and caught the huge beam potential and held it for about 24 hours, gradually draining down the intense beam energy into the earth in a slow manner all the while.

A frantic Russian message to the Chernobyl reactors galvanized the operators to immediately shut down those reactors (put in the cadmium control rods).

However, the uranium in the fuel rods was of course still sitting there. Chernobyl then waited with bated breath to see if the safety circuits would hold.

Then on 26 April, the safety circuits at the transmitter site finally crumbled, and a far weaker LW flashover occurred than would have occurred earlier without the safety. The spreading LWs in the earth struck the nearest reactor core at Chernobyl, preceded seconds before by a tremor induced in the earth at Chernobyl as the LWs arrived. *Part* of the struck uranium in the core fissioned immediately, venting the containment structure and spewing out radioactive material. Nuclear fallout spread over much of Europe. The rest of the disaster is well known.

That unknown group, in my estimation, saved a large number of American lives—at least 200,000 or more and perhaps as many as 300,000. They also prevented enormous physical damage to California, both to Los Angeles and San Francisco and to points in between. The members of that group are the unsung heroes of this bizarre episode. It is my hope that I may live to turn the names of those persons in for the award of a very high Presidential medal. Until then I will not reveal those names under any circumstance.

Whether or not the U.S. scientific and intelligence communities know it or believe it is of no concern. What matters is that a great many Americans are still alive, and their children born since then are alive. Those Americans otherwise would have been very, very dead or never born. I personally have reflected on those desperate circumstances many times. If I had it to do over again, I would unhesitatingly urge the same action: Fire and save those American lives, and accept the medium risk. And pray.

And I did pray after recommending the strike. In my opinion, this time my fervent prayers were answered. I am extraordinarily sorry for the civilian deaths that occurred; all one can say is that it was under severe circumstances and in a very peculiar—and very desperate—war.

The Soviets had many other interferometers on line. They induced a substantial earthquake in Mexico at the end of April. Thus they did complete their "earthquake footsteps" of the milestone. On 7 May they induced a 7.7 Richter quake in the Aleutian Islands. If 7.7 to 9.5 quakes had hit all along the San Andreas Fault in Los Angeles and San Francisco and in between, then the destructive scenario I had envisioned for the West Coast would have occurred.

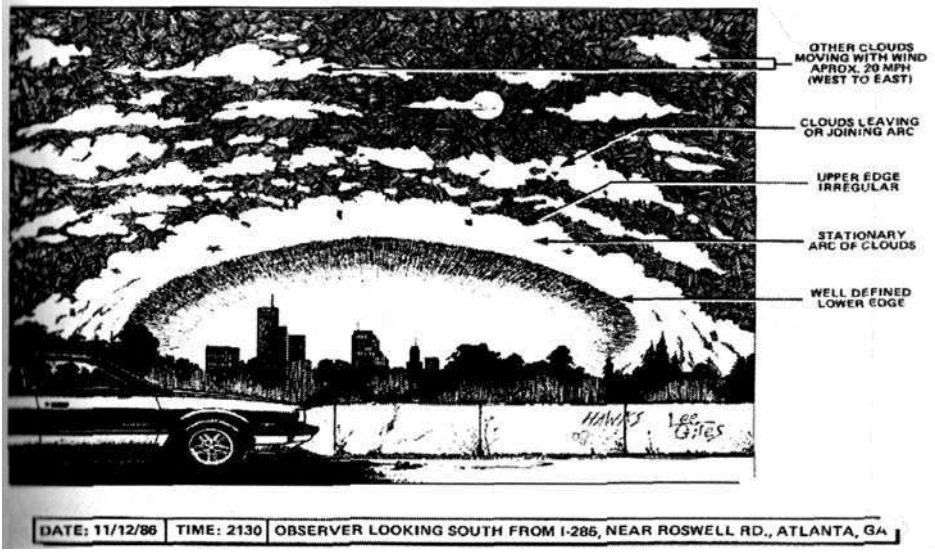

Figure 58 "Bottling up" shield practice over Atlanta 12 Nov. 1986. With a real shield, aircraft or missiles flying into it (from inside or from outside) explode and are destroyed.

On 12 November 1986 the Soviets even placed a giant "dummy shield" (practice) over Atlanta, Georgia (Figure 58). If the shield had been real and not just practice, any aircraft and missiles flying into it would have been instantly exploded and destroyed. That mode—"bottling up" a strategic weapons area—is useful to nullify an entire strategic ICBM launch complex or a large bomber base, etc. It can also "bottle up" a large carrier task force at sea, including the aircraft and the Tomahawk missiles, the shells from the naval guns, etc.

Kill of the Challenger Included Use of Metal-Softening

As we mentioned, during that 1986 preparation period the Russians also destroyed the Challenger spacecraft (January 28, 1986). Numerous signatures abounded, all of which we have already published.

A few weeks before the kill of the Challenger, a close colleague had experimentally proven that a metal-softening signal was indeed placed on the Russian "woodpecker" signals (Figure 7). He did this quite simply: he wired himself into a receiver, through an intervening amplifier, and tuned the receiver to the Woodpecker signals.[44] Then he took nails from a can of nails he was

[44] Here he was taking advantage of the fact that the infolded LW signals inside the Woodpecker carrier wave, comprising the "engines" for metal-softening, also constitute "perfect" divergence-free EM energy, so to speak, at least overall. Amplifying the signal also amplifies the "engine" inside it. When connected to his body, "potentials superpose" is the rule, and that transferred the amplified engines to his body and into the EM field immediately surrounding his body. Hence he softened the hammer metal a tiny bit, and softened the much less tempered nails quite a bit more.

using, and hit them with a hammer to drive them into planks. The nails all folded up instantly like totally wet noodles. A couple dozen, one right after the other. Simultaneously, his son—who was not connected to the Soviet signal—was pounding nails from the same box, normally and without difficulty. None of the nails picked up and pounded by his son experienced any difficulty or softness.

Then my friend disconnected himself from the signal, and waited a bit. Whereupon when he then used nails from that same box, he drove them in without difficulty. There were no more "wet noodle" nails.

We reach a very simple conclusion: When he connected to an amplified Woodpecker signal, his body was time-excitation charged (quick charge and quick decay) with a specific signal so that the nails he picked up were charged. Then when hit with the hammer, the nails acted as if made of very limp rubber without a rebound. When he disconnected from the amplified Woodpecker signal, and waited a moment for the induced charge in his body to dissipate, the nails also discharged their engines and quit acting like limp rubber bands when hit, and became normal nails with normal behavior. That would seem to be quite sufficient to prove the thesis.

The Challenger was then destroyed, as we previously printed, with numerous signatures of the hit, including even a KGB party in Moscow to celebrate the success of killing the vehicle (and getting away with it).

Cold Molding: An Epilog to the Metal-Softening Donnybrook

I was called a total lunatic for pointing out a metal-softening capability on the Russian signals. So be it. Metal softening is achieved by an engine which serves as a pumped phase conjugate mirror for the vibrations and signals in the lattice bonds of metals. Build up that engine in the metal until the precisely reversed and overlaid signals negate the normal signals, and one has "dissolved" the lattice bonds, converting the solid to a liquid. Lattice bond cancellation is not heating.

But that was not to be the end of the "metal softening" story.

A few years later, working informally with a large UK aerospace firm "for free", I furnished them an address in Moscow of some Russian scientists associated on the perimeter of the KGB energetics weapon program. The address had been taken from their cautious advertisement for business on the Internet and furnished to me by a correspondent. A UK engineer fluent in Russian was sent to meet with those scientists in Russia. They nervously showed him several novel things, one of which was "cold-molding" of metal. The liquefied the **metal**

The result was that a hammer blow onto a nail head resulted in the nail acting as a limp noodle upon impact.

without heating, poured it in a mold, and waited for the "effect" to wear off and the liquid to turn back into a solid again.

Briefly, an energetics charge (using LWs) was induced on the metal lattice vibrations, adding their phase conjugate replicas to the interior LWs comprising the lattice bond signals. The metal's atoms were time-density charged to an excited state (presently not recognized in Western science). Thereupon the metal lattice EM forces "dissolved" and the metal became liquid at room temperatures and without heating. The cool liquid metal was then poured into a mold. Then after awhile, the time-density charge and slowly drained away, and the metal resumed its normal solid state—all without any heating whatsoever.

On a subsequent trip the engineer brought that Russian team itself out of Russia and to the UK. The Russian scientists demonstrated cold molding to assembled UK scientists, and to some U.S. visitors. The phenomenon was physically demonstrated and proven.

I was correct about the metal softening then. We were also correct back there in 1986 about the metal-softening signal employed against the Challenger (together with several other things).

There are numerous other signatures on the death of the Challenger. Again, *the death of the Challenger was not an accident.* It was due to a deliberate act of war by the KGB. The KGB knew in advance—after substantial probing incidents—that they would get away with it. And they did so.

Additional Update from Year 1998 to Year 2,000 Has Been Given

In the action package we sent to the DoD in 1998, we told the rest of the KGB energetics weapons story up to that date. We gave the attack plans as we saw them and the most useful types of attacks to be expected.

I hope the reader is interested in this special energetics weapons information. High power microwave weapons, high energy lasers, and nuclear weapons are useful but no longer decisive weapons either strategically or on the battlefield against a foe equipped with such energetics weapons, and particularly against a foe equipped with quantum potential weapons and negative energy EMP weapons.

At present, we are intensely watching to see if we can pick up indicators for the next scheduled strategic attack, its probable timing, and the "new twists" included in it.

Presently, we have perhaps an 80% chance that the little nation can once again counter any new threat and cause the KGB to abort the impending attack. On the other hand, with Putin apparently limiting at least some of the action of the KGB, we have moved into our present asymmetrical warfare against terrorism—

and ultimately against the extensive terrorist teams and assets already infiltrated into our homeland.

As a single example, before the collapse of the former Soviet empire, the Russians long ago slipped in nuclear weapons (from 20 to 40 KT) and hid them in all our large cities and population centers, along with the Spetznaz teams to detonate them on command.[45] Several nations have introduced teams with normal sabotage assets and also with weapons of mass destruction such as radioactive nuclear materials (for a dirty bomb), anthrax, smallpox, bubonic plague, etc. Behind the scenes, the die-hard remnant of the old KGB crew are using QP weapons to "spread" the immune systems (Figure 53) of our populace and materially enhance any BW strikes that the terrorists unleash. The rogue Japanese team (Yakuza and Aum Shinrikyo) on site in Russia are using their LWIs in a giant weather war and the occasional kill of an aircraft, etc. Over the decades Castro infiltrated some 10,000 guerrilla/special forces types trained in camps in Southern Mexico for decades. Probably at least half are still loyal and dedicated—and waiting to blow up bridges, power substations, high voltage power distribution system towers, dams, harbor facilities, refineries, pipelines (both oil and gas), etc. The first phase of WW III—delivery of the weapons of destruction and mass destruction to the targets along with means to unleash them—has already been accomplished.

We are particularly struggling against the rise of asymmetrical warfare—the superpower's paradox (Figure 59)—and our present involvement in that "new" kind of warfare is still quite foreign to us. Only time will tell how well we fare in this new type of war, which we will be engaged in for many years to come. Vice President Cheney rightly regards it as almost a state of perpetual warfare we shall have to learn to live with, as shown by his words on Oct. 21, 2001:

"The war on terrorism will not be over in our lifetime. It is different than the Gulf War was in the sense that it may never end. At least not in our lifetime. The way I think of it is, it's a new normalcy."

[45] See Stanislav Lunev (with Ira Winkler), *Through the Eyes of the Enemy,* Regnery, Washington, 1998. Lunev is a high-ranking GRU defector. He is a former Colonel in the GRU, the military counterpart of the KGB. In p. 22-33, he summarizes the Spetznaz capabilities. On p. 22-27, he summarizes Spetznaz use of nuclear weapons already on American soil. On p. 26, he gives some of the ways in which the Soviets easily brought nuclear weapons into the U.S. On p. 30 he confirms Russian seismic weapons. Use of EMP weapons is on p. 30-31. Use of very, very low frequency weapons to destroy the human brain, put people into a zombie-like state, and aid in brainwashing is confirmed on p. 31. And this is **information** Okayed by the CIA for release!

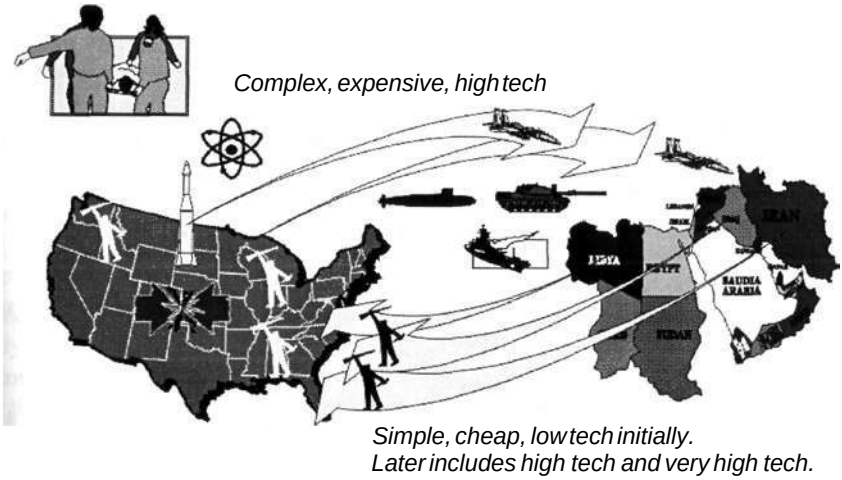

Figure 59 The superpower paradox: Asymmetric cheap WMD strategic strikes and destruction, later becoming extremely high tech and extreme yield.

There is Also a Severe Bioenergetics (EM Biological Warfare) Threat

The threat from bioenergetics is equally vivid. That old die-hard section of the KGB can now attack an entire population, e.g., with electrodynamically (energetics) induced diseases of any kind whatsoever, particularly when using QP weapons. Such attacks are totally immune to inoculations and antibiotic treatment. Any kind of strain or variation of a disease can also be induced in the pathogen pool for that disease. Against a foe who has such capabilities, our entire medical establishment—including all our emergency treatment procedures and agents—*is obsolete right now.* A vaccination and the presence of antibodies, e.g., does absolutely nothing against the EM induction of the exact physical effects and form of a disease, as shown in the decades-long "microwave radiation" of the U.S. Embassy in Moscow (Figure 11).

To the Assistant to the SecDef in such matters, in 1998 we furnished a 200+ page briefing package and loosely proposed a crash development of the new type of medical therapeutic treatment devices pioneered and proven by the Priore group in France in the 1960s and early 1970s. Later, Congressman Cramer queried that office for an answer.

Unfortunately the Assistant SecDef s office erroneously responded to Congressman Cramer that nothing in the literature supported the mechanisms proposed. Indeed, the package we furnished contained a *detailed list* citing the hard French scientific papers in the literature, reporting the exact experiments

and the astounding results obtained. Some 2,000 highly successful animal experiments for more than a decade of experiments in fact supported the thesis, and higher group symmetry electrodynamics fully supports the ability to use EM means to make spacetime curvature engines, so that these engines then interact back upon the targeted matter to perform the actions desired. That it does not appear in conventional electrical engineering is of no consequence; it appears in physics and it is good physics, just on the cutting edge.

We also reported, explained, and cited Becker's epochal work (Figures 27 and 28), which is copiously published in the hard literature and which was an example of the fundamental mechanism also. Becker was twice nominated for a Nobel Prize for his outstanding work. Unfortunately, the Assistant SecDef s office responded with a non sequitur.

Packages were sent also to NIH, NSF, CDC, and several other government agencies. Not a single one of those agencies was interested enough to have a competent scientist contact me and discuss the area. I strongly doubt that a single scientist anywhere in the Government bothered to *seriously* read and ponder the material so painfully and expensively compiled and furnished. Lieutenant Colonel (Retired) Ken Moore and I worked our fingers to the bone for weeks, preparing that briefing, and we spent all the spare money doing it that we could rake up and obtain.

The near-total lack of response itself seems astounding, but it clearly shows the state of U.S. science with respect to novel energetics innovations, even long after those innovations have been experimentally proven and documented in the hard literature, and even after they have been weaponized against us. It is a direct indication of why the U.S. never deciphered what was going on in some four decades of Soviet weak microwave radiation of the U.S. Embassy in Moscow, including the kill (eventual deaths) of three U.S. Ambassadors.

For decades there have been manipulations, to say the least, in the hotly contested field of the biological effects of EM radiation. We refer the interested reader to an excellent expose of that situation: The expose is by Dr. Andrew A. Marino, Ph.D., J.D., *Powerline Electromagnetic Fields and Human Health,* which is current. I believe it can be freely downloaded from: http://www.ortho.lsumc.edu/Faculty/Marino/PowerlineTOC.html. Dr. Marino has been personally and deeply involved in the investigation of EM bioeffects, in court cases, and in Blue Ribbon Panel investigations and proceedings. The book is an eye-opener, and it gives one a good view of the machinations in the EM bioeffects field. We quote directly from Dr. Marino, Chap. 6, p. 1:

> *"Oversimplistic as it may sound, whoever pays for EMF bioeffects research and analysis determines what data is produced and the way it is interpreted. Soon after the possibility that powerline EMFs were health risks was raised in a legal dispute involving the New York Public Service*

Commission, power companies and their trade associations, particularly the Electric Power Research Institute (EPRI), became massively involved in EM bioeffects research. Subsequently, the power industry dominated funding of the effects of powerline EMFs, both in terms of absolute dollars and compared with dollars from non-industry sources...the power companies and their trade associations were deeply deceitful regarding the information they provided to scientists and to the public regarding the potential health hazards of powerline EMFs."

In the entire EM bioeffects field, there does not appear to be any mention of, study of, or recognition of EM bioeffects induced by the most powerful EM factors: longitudinal EM wave irradiation, time-polarized EM wave irradiation, and time-excitation charging of particles throughout the body and its cells, with resulting emission of transduced longitudinal and transverse EM radiation *from-within-to-without.*

National Institute of Health Reaction

NIH replied to my letter and action package from their *Policy*—read: *spin control*—Section. They noted that the package mentioned the Gulf War Syndrome, which was not in their mission area. So they just sent it off packing to DoD (simplest way to get rid of it, apparently no one seriously read it or even cared to read it). I queried them back by separate response letter about their lack of interest in a revolutionary proven new medical methodology well-documented to cure cancer and other dread diseases, in many hundreds of experiments by leading French medical scientists. This was certainly within their mission area.

They hastily replied from the *Policy* Section that, yes of course NIH was interested in all such things, and told me where to "submit a proposal." We never got out of their *Policy* department. Again, not a single competent scientist in the U.S.'s supposed master medical agency apparently even read the package or cared to call and discuss the matter. This was an indicator of their total lack of any grasp of the energetics threat, its testing, and its use to induce the Gulf War Disease.

Now perhaps one can see why we are so far behind the KGB energetics weapons scientists and weapons program.

Marino, *ibid.*, is particularly enlightening on the adamant opposition by appropriate sections of NIH vis a vis the harmful effect of nonionizing EM radiation.

No responses at all were received from the NSF and the CDC, or the other U.S. government agencies to which the package was furnished.

The CDC of course comes under NIH, and thus its responses or lack thereof would be dictated by the parent NIH policies. As for the NSF, Marino, *ibid.*, again is enlightening on the qualifications or lack thereof of its membership.

So as the reader can see, the top of the medical establishment in this nation is flatly not interested in any "controversial" or "out of the box" proven method for curing cancer, dread diseases, and mass treatment of those millions of American casualties that are coming in our cities and population centers. Again, they directly ignore scientific method's very premise: *If the experiment is replicated and contradicts the theory, accept the experiment and change the theory.* I personally concluded that the U.S. Medical establishment largely does not follow scientific method, but follows dogma and the already approved methodologies.

How the New Revolution in Medical Healing Works

For the reader who is a medical scientist and trained in physiology and biology, one might be interested in that revolutionary French therapeutic methodology and how it worked (before it was ruthlessly suppressed in the early 1970s).

Priore's apparatuses (Figures 12,49, and 60) simply pumped the cells of the entire body with longitudinal EM waves (each accompanied of course by its time-polarized twin, in a Whittaker pairing). The cells and every part of them are very nonlinear, so they act as pumped phase conjugate mirrors for Whittaker wave-pair engines resident in the cells and acting as "input signal complexes".

Once the cells are pumped by these now-established *time-density* waves, the damaged or diseased cellular masses slowly "charge up" with excess time-excitation. The irradiation took several hours, and this was the "activation" or "time-excitation charging" stage. Thereafter, the time-charge decayed slowly, all the while constituting *pumping* of every cell and every part of it, in the time domain.

The resident engine in the cell contains two components: (1) the normal or healthy component, and (2) the abnormal component representing disease or debility. Pumping these two components time-reverses both of them and amplifies that reversal. This creates amplified and incredibly precise *antiengines* in each cell and in each part of each cell. These antiengines override the weaker cellular engines resident. In turn, this "reversing" action of the antiengines causes the pumped cellular masses (actually the mass-energy, in its exact structure and dynamics)—at any and all levels, including the genetics—to be time-reversed back to normal. In biological instead of physics terms, it "dedifferentiated" the diseased or altered cells back to a previous healthy state by simply eliminating the diseased engine component. *This is a dramatic extension of nonlinear optical phase conjugation from the 3-space pumping domain to pumping in the complex (time) plane, and it is effective for time-reversing mass-energy at any and all frequencies. We accent that the cellular*

time *reversal back to a previous state includes all the cell's genetics and every* ***part*** *of the cell no matter how small.*

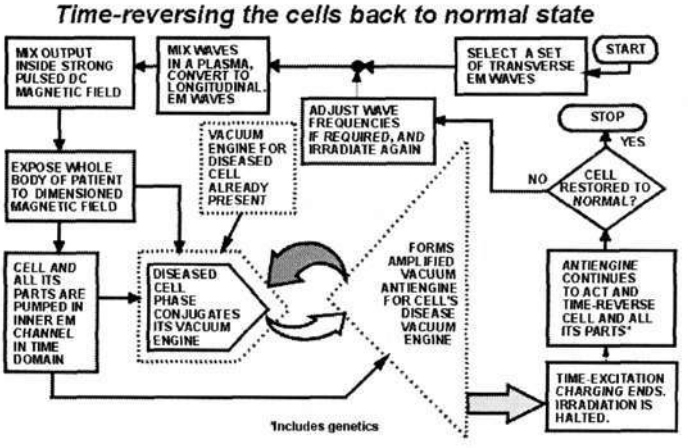

Figure 60 Block diagram of Priore's healing (regenerative and time-reversing) process.

Normal cells are just backed up to a slightly younger condition. Diseased cells **have t**heir abnormal engine component overridden and reversed back to zero (its earlier state), so that only a slightly younger normal engine remains resident in the cell. This simultaneously reverses the cellular masses back to their previous healthy condition.

Contrast this direct healing mechanism to the action of the immune system.

The immune system itself does not *heal* anything. It contains the killers, the scavengers, the locators, the markers, the attackers, and the troops manning the ram**parts.** Usually after a fierce battle with invading hostile pathogens, it wins. Lots of cells still living are damaged in the melee. The immune system scavenger cells then scavenge up the residue littering the battlefield. But *the immune system itself cannot heal and restore a single damaged cell, including one of its own.*

That healing and restoration of damaged cells is the job of the *regenerative syst**em,*** still little known and inadequately studied today. Perhaps the most fundamental studies were mostly by Becker *et al.* some decades ago. The regenerative system (Figure 29) is an EM system in its operation, as clearly shown by Becker (Figures 27 and 28), yet it is able to physically differentiate and dedifferentiate cells from one form to another at will, and in highly selective fashion. The regenerative system acts within its limitations (only weak pumping can be done for the time-reversal of diseased or damaged cells) to eliminate the delta (the deviation from normal of the resident engines in the pumped cell). That restores the normal (healthy) engine and slightly amplifies it as well.

It is obviously of the utmost medical importance to understand and apply (and amplify) this little-known technical mechanism by which the regenerative system is able to restore damaged cells back to normal.

It turns out that *the regenerative system in its novel EM functioning uses precisely LW and TDW pumping of those damaged cells and gradually time-reverses their entire masses back to a normal healthy state, within its limitations.*

This is the secret of the mechanism of the cellular regenerative system—which is an electrodynamic system of very unusual nature. The exact mechanism has not previously appeared in the literature. It took me 14 years to uncover that fundamental mechanism, and another 4 or 5 to refine it a bit, even though both Priore and Becker (as well as others) applied it decades before without being able to fully decipher it.

The experimental proof is already in the literature, once one understands the higher topology EM unwittingly used by both Becker and the Priore team. The proper types of higher group symmetry electrodynamics required to understand the action of the cellular regenerative system are available. There exist scientists skilled in their application and use. These scientists and that higher group symmetry electrodynamics are little used, and are never used at all in the medical field. There exists no funding anywhere for higher EM examination and modeling of the functioning of the cellular regenerative system—i.e., for the fundamental healing process.

Just imagine what this could mean to medicine: *One can now develop a new medical science to amplify and apply nature's own proven method of restoration and healing of damaged cells, including all their damaged genetic material.* It matters not what caused the damage, whether pathogen or gamma radiation, whatever. This new therapeutic method is a totally new general relativistic process where powerful spacetime engines are created which work directly upon the damaged cell and every part of it, physically reversing the cell and all its parts precisely back to normal condition.

General relativity rigorously tells us that a precise spacetime curvature engine (set of precise spacetime curvatures) is present and active for every specific disease condition and every nuance in it. It also tells us this flawed (disease or damage carrying engine) continuously operates on the cellular mass at every level, maintaining the exact physical condition of the cell and its dynamics. By creating a precise "anti-engine" and amplifying and applying it, general relativity assures us that we are physically acting upon the cell and all its parts at every level, down to the smallest—to precisely return every part in perfect proportion back to a previous normal healthy condition. *Pautrizel directly proved the time-reversal to an actual earlier state of the cells and the organism* (Figure 61). Amplification by time-domain EM pumping, means that we can cause this time-reversal of the cells back to normal to happen much more

quickly than can the body itself, which can only pump very weakly.

- Pautrizel compared identical treatment of immature rats with immature immune systems, and mature rats with mature immune systems.
- Treatment restored the damaged mature system back to full mature functioning, and it promptly recognized and dispatched the pathogens.
- Treatment restored the damaged immature system back to full immature functioning, unable to cope, and the pathogens promptly reinfected and killed the immature rat.
- The lesson: The body is indeed returned to a previous physical state. The pathogens themselves are not killed by the treatment, but by restoring the ability of the immune system to recognize and destroy them.
- Only *the previous ability* of the immune system is restored by the process.

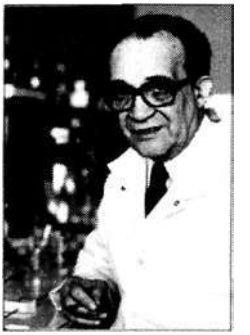

PROF RAYMOND PAUTRIZEL
(Renowned Parasitologist)

Figure 61 Pautrizel's proof of time reversal of the stricken cells back to a previous state.

General relativity also assures us that any and every disease is subject to this novel treatment approach, even diseases which have resisted every other known therapy. The Sachs unified general relativity and electrodynamics, and GR/EM unification applications in O(3) electrodynamics produced by Evans, for the first time provide a solid theoretical basis for Priore's methodology and his evolutionary results. They also offer direct engineering of startling physical cures, once the technology is developed.

The profound implications of that treatment can be seen. Apparently, however, **our** leading governmental agencies and health agencies do not see it, do not wish to see it, have no appreciation for general relativistic effects in healing, and do not intend to have any appreciation for general relativistic effects in healing. Indeed, they seem totally uninterested in even trying to comprehend and research *the fundamental healing mechanism* demonstrated by nature herself.

What the French Researchers Showed

Among other things, the Priore team produced revolutionary cures of *terminal tumors, infectious trypanosomiasis, suppressed immune systems, and atheriosclerosis* in several thousand laboratory animals in rigid laboratory tests under rigorous protocols. Eminent scientists such as Robert Courrier and Raymond Pautrizel worked with the Priore team. Courrier was head of the Biology Section of the French Academy of Sciences at the time, also *Secretaire Perpetuel* of the Academy, and a noted scientist of high stature. Courrier personally presented the astounding Priore results to the entire assembled French Academy. He also sent his own most able scientist assistant to personally

prepare the terminal tumor grafts on the lab animals before their treatment.

A world-renowned parasitologist who did enormously important work with Priore was Raymond Pautrizel, who is still alive at this writing though quite aged. Pautrizel was greatly persecuted for his years of determination and effort. Courtesy of Pautrizel via the late Christopher Bird, I personally have the very Ph.D. thesis that Priore himself submitted to the University of Bordeaux on his revolutionary work. That thesis was maliciously rejected in the suppression that was applied to the project. When the French Government changed to a Leftist government in the mid-70s, Government support was immediately withdrawn and the project was ruthlessly suppressed. Priore later sickened and died and that was the end of that. More than a decade later a brave and determined Pautrizel finally was able to get a doctoral thesis approved in the Priore work area, at the same university, by another doctoral candidate, Eric Perisse {40}.

There are two U.S. patents on the Priore device itself, and of course several French patents also.

All the above was rigorously documented in the 1998 package prepared and submitted by Ken Moore and I.

While Priore was still alive, a team with which I was connected attempted to mount a well-funded effort to restore the Priore methodology while Priore was still alive. We also were viciously suppressed. The lives of our financial backers and their families were threatened. The head of our project was viciously attacked financially and destroyed, fleeing the country for his very life. Whoever thinks that dramatically innovative medical science in this country is just sweet reason and scientific method, should have a strong enema to remove the serious blockages interfering with his perceptions.

This vicious outside suppression of our project so infuriated me that I made a solemn promise that, were it humanly possible, I would decipher the Priore process before I died. It took 14 years, but we made good on that promise. During the 20 years or so since our project was suppressed, it is heartbreaking to consider the millions of children and sickened and suffering people who could have been saved had the project continued and succeeded. It is heartbreaking now to consider the coming millions of casualties in our civilian populace in our cities, most of who are going to die from mass destruction weapons. And most of those would not have to die, would the scientific community waken from its long sleep and discover some modern physics and higher group symmetry electrodynamics—and their application to solve nature's mechanism for **healing.**

When one time-reverses the body's cells and all their parts, one forces the diseased cells to dedifferentiate back to healthy state. We strongly accent that this is accomplished by unified GR/EM processes involving precisely **organized** spacetime curvatures and their local actions in the cells and all their inner components, down to the finest level. It can be rigorously expressed in good unified physics, as expressed in an electrodynamics such as O(3).

The nondamaged or nondiseased cells just get a little younger. That is also highly beneficial; it reverses the ravages of aging, just a little. Indeed, one of the implications of the Priore mechanism is that aging can indeed be reversed by the process and treatment. Again, one must keep one's sense of humor. In order to get this technology and therapeutic method born, what seems to be needed is an extremely wealthy person, strongly desiring to live longer than the expected life **span** and do it in a vigorous, healthy body—and who is willing to fund the project with the necessary $60 million required so to redevelop and extend the Priore technology so it can be readily applied. A byproduct will be the saving of millions of American lives when those coming mass casualties from weapons of mass destruction occur in our cities.

How the Regeneration Mechanism Was Finally Deciphered

What took so long in deciphering the mechanism was the problem of how to make such precisely tailored and exact ST curvature engines, specifically so that they are *exact* antiengines for a specific disease and even a specific pathogen, and even for different versions of the engines for different cells in a single body having different strains of the same pathogen, having different body DNA, etc. For years, the solution of that task seemed hopeless. How on earth could one possibly work all that out in a hundred lifetimes, so that it could be precisely calculated even by an array of the most powerful computers on Earth?

After years of struggling with the problem, in one stroke of enlightenment it was revealed to be the simplest thing in all the world. Absolutely no calculation was necessary, and the exact amplified antiengine effect was a fairly simple and straightforward thing to obtain. General relativity tells us that every cellular mass and each part of it, has its own unique spacetime curvature engine, to the finest detail and an exact fit. As Wheeler put it so nicely {130}, *"Space acts on matter, telling it how to move. In turn, matter reacts back on space, telling it how to curve. "* The mass and its dynamics and the engine and its dynamics constantly interact upon each other, and "keep attuned and in perfect adjustment," so to speak.

That means that a "normal" cell already has just such a precise "normal" ST engine residing in it, and acting upon every component at every level—even in the atomic nuclei. Well, a diseased cell has an absolutely specific structuring, and therefore it also has an absolutely specific ST engine structuring. *A priori that* resident structuring for the diseased or damaged state in the individual cell differs (by some delta) from the structuring of the normal healthy cellular state for that individual cell.

Voila! That means that *the ST engine for the damaged cell can be decomposed into two parts (two engines):* (1) the normal "healthy cell" state engine, and (2) a delta ST engine that has been added to it so that together the two comprise the full ST engine for the exact individual condition of the cell.

What is now needed is a way to produce an exact antiengine of two parts: (1) one for the normal engine and (2) a second one for the delta (disease) engine. Applying this amplified and combined "antiengine" would overpower the resident combined engine, precisely reversing the cellular condition by reducing the delta to zero. Rigorously, the cellular mass and every part of it must then also revert to a previous physical state, or else we must complete discard general relativity itself.

Well, if we were to just time-reverse the resident engine and its two components, that would give us the perfect antiengine with its two components. Amplifying this antiengine would then produce one that was more powerful than the resident engine in the cell. Applying that amplified antiengine to the cell, that would not really change the "normal" engine component, but it would precisely reduce the delta engine component back to zero (its previous state, before it was there!) Voila! A specific healing signal of perfect structure, for the specific deviant condition of the individual cell and its every part.

Since we have a combined GR/EM to use, we can think electrodynamically about this general relativity problem. Immediately we see that phase conjugate optics is a candidate, since the "resident composite engine" can correspond to the "signal" or input wave, and the pumping of the nonlinear mass of the cell and its parts (where they act as nonlinear phase conjugate mirror materials) produces an exact phase conjugate replica (the exact amplified antiengine). The presence of that antiengine overrides the magnitude of the resident engine, and it moves the cell precisely back along the temporal path previously taken. In short, it applies a specific kind of dedifferentiation of the cell back to its previous healthy condition.

Since we extend phase conjugate pumping to the time-energy domain, then the resident composite engine and its time-stream component are the "input." The amplified antiengine and its time domain component will then forcibly propagate that pumped mass energy back over the time trajectory previously taken by it. In short, it will time-reverse the cell and all its parts back to a previous condition, completely eliminating the delta (disease or disorder). The beauty is that it will also reverse damaged or altered genetics, such as in the AIDS disease. It can do this prior to the appearance of health symptoms—it can be done as soon as the patient tests positive for HIV.

Since the antiengine is amplified, it moves the cell back to normal fairly rapidly (in a few hours, for example). At least the time charge for the reversal process is delivered in that period; one may allow (as Priore did) a full week for the time-charge and its transduction to continue reversing the cells. But it is much faster than the normal speed of the human regeneration system using the same process, because now we have greatly amplified the time-reversal rate.

It is therefore ideal for a method of quickly treating mass casualties, particularly since it can be developed and used in a portable unit about the size of a large

suitcase (Figure 13).

Interestingly, during the radiation with LW EM radiation, one also pumps the pathogen and time-reverses it as well. Its "normal state" towards the beginning was a condition whereby it could move with relative immunity past the immune system's opposition, having deceived the immune system. In the treatment, a small amount of the pathogen is therefore converted back into this condition just shy of the beginning, where that part of the pathogens is resistant to the immune system. However, a very small, short "post treatment" irradiation with LW radiation for a much shorter interval and at weaker power, will clean up this altered pathogen residue by allowing the immune system to recognize it and destroy it. Pautrizel clearly demonstrated this significant fact.

Cellular and Body Rejuvenation are Possible, Once the Technology is Developed

One can in fact really accomplish *rejuvenation* of the aged and infirm, as the technology is developed. One could certainly solve the major problems of Medicare, and cut the patient load at least in half, relatively quickly and inexpensively. Of course lots of big U.S. drug companies will be rather violently opposed to any such idea, because much of their empire would be threatened. Much of the organized medical community depends largely on the Big Drug Approach. So the organized medical community will also vehemently oppose it, just as the formal medical science community in France viciously opposed it.

One could also produce cheap, portable LW treatment units *en masse*, which is what we were suggesting to the Assistant. SecDef. That way one could flood the emergency response system (response teams, hospitals, fire stations, police precinct stations, schools, etc.) with quick and effective treatment devices. They could be used to rapidly {131} treat those millions of American casualties that are going to occur when one or more of our cities are attacked in the near future by terrorist WMD attacks. This would save the lives of most of those stricken millions of Americans.

Mow Many Americans Could Be Saved?

For an anthrax attack on Washington, D.C., first generation equipment could save perhaps 70% of those sickened Americans, almost all of who are going to die with *present* capabilities. With second-generation equipment, one could save perhaps 90%.

For an anthrax attack without spreading via QP clandestine preparation of the populace, one would save 0.7 to 2.1 million Americans. With clandestine KGB QP spreading and a *5:1* increase in the yield of the anthrax strike, one would save 3.5 to 10.5 million Americans.

For a truly nightmare attack (as a worst case scenario) perhaps 5 major cities

might be attacked in such manner and to such degree. In that case, one is talking about saving 3.5 to 10.5 million Americans for the unspread attack case, and up to 17.5 to 52.5 million Americans for the spread case.

Further, the development of the necessary portable treatment units is doable and affordable, for mass treatment capability. Training on a portable machine could be done for a high school student in 30 minutes or less, and that student could then give emergency treatment effectively.

Absolutely nothing else out there can presently warrant such projections. Yet this is the very technology our own medical science community is eminently uninterested in, has no knowledge of, does not wish to obtain any knowledge of, and does not wish to scientifically discuss.

There Are No Resistant Strains to the New Technology, and There Cannot Be Any

A most interesting thing is that there cannot be a "resistant strain" of a pathogen for the new treatment methodology, *a priori.* No mass can shield against spacetime curvature effects. Slight adjustments of the controls will adjust the spacetime engines being utilized. Two or three hour's work with a developed unit and a lab team on a new strain would suffice to completely determine the required adjustments, once the technology is developed. The new information could then be quickly relayed to all stations treating patients. On each treatment device, adjusting a few dials and controls for the laptop computer controlling the unit will do the trick. The use of the final device would be so simple that a teenager could be trained to use it in less than 30 minutes.

Such new capabilities are urgently needed not only for the millions of civilian casualties we expect in the future, but also for support of our armed forces in the field. Frankly, the anthrax shots are not going to do them much good, once one realizes that the "spreading" of their immune and regenerative systems is already occurring via KGB quantum potential means. Camel pox is available to any terrorist foe, and has almost the identical actions and constitution as smallpox. Indeed, it is almost identical to smallpox.

The Gulf War Disease and Syndrome were just small preludes of what is to come and what is already being used against the entire U.S., though as yet very clandestinely. Look again at the Kaznacheyev work. *He clearly proved in thousands of successful experiments that any kind of cellular disease or damage or death whatsoever, can be induced at a distance by novel EM means.* Replication experiments were successfully accomplished at the University of Marburg and also at the University of Sydney.

Results of the Priore' Treatments Are Well-Documented and Independently Supported

The Priore team's results are well documented in the hard French scientific literature. At least one French doctoral thesis was eventually accepted upon the work. The astounding results really occurred. They were scientifically substantiated under rigorous protocols and even police-guarded labs for tests by a learn of outside scientists. To then deny those results simply because no one **has** *understood* the active mechanism until now, is to deny the scientific method itself: *Believe the experiment when it refutes the prevailing theory.*

There is also independent work by other scientists that strongly supports the Priore results, once the mechanism is finally understood.

Robert Becker *et al.* in the U.S. conclusively showed that living cells *in situ* can be dedifferentiated, redifferentiated, etc. by laughably weak currents (picoamperes) and DC potentials (which are comprised of those famous Whittaker pairs). Becker was unaware that his potentials included time density waves and longitudinal waves, as predicted by quantum field theory and as shown by Whittaker in 1903 (once one understands that a bidirectional phase conjugate longitudinal EM wavepair is a time-density EM wave coupled to a longitudinal EM wave). Application of such EM potentials by Becker transformed red blood cells into pre-cartilage cells, then further into pre-bone cells. That latter cell type was then deposited in bone fractures, healing them when nothing else would. Becker and others have demonstrated partial regeneration of limbs in small test mammals, using the technique. The bone-healing techniques were finally approved by the FDA and are often used in some hospitals for treating otherwise intractable bone fractures.

Since then, other scientists have shown the directed formation of other types of body cells from cells from distant parts of the body (i.e., muscle-type cells from cells produced in the bone marrow, etc.). Such things are now well documented in the U.S. literature, in at least several hundred papers and in the leading journals including *Nature, Science,* etc.

The Present Threat Is Urgent, and Our Strategic Destruction is Still at Issue

Our own medical community, our science community, and our intelligence community are at least 20 years or more behind the KGB right now. We are also behind the Chinese. In many respects our scientists have simply missed the biggest scientific breakthrough of the century.

It is urgent that we find some way to counter and avoid future strategic energetics attacks sure to be scheduled. The eventual attack actually launched—if the little nation's QP weapons can be countered first—would destroy the U.S. in about 2 hours. It only takes about 10 minutes, it seems, for the QP weapons

already deployed to negate almost all our strategic nuclear arsenal. Thereafter, the KGB and Yakuza/Aum Shinrikyo can simply attack us at will and utterly destroy the U.S. To any loyal American, that is an entirely unacceptable solution.

The most urgent requirement would seem to be immediate and strong contact at the highest level between the U.S. government and the leaders of the little foreign nation (and the other friendly nation) that presently is guarding the ramparts and saving our necks. A cooperative crash program to develop our own QP weapons would seem to be the order of the day, if it can in any fashion be negotiated. But to have any chance of success, the President and the Congress will have to use the utmost care in selecting the U.S. negotiators and scientists to explore this possibility.

Immediate transfer of the requisite capabilities to the U.S. would be desirable, at least from our own view. From their view, of course, we do not necessarily resemble a trustworthy scientific partner at all, based on our past scientific performance, and it is up to the U.S. scientific community to prove to them that the leopard really has changed its spots. That would all have to be negotiated and worked out.

If that is not possible, then it is of extreme urgency that our own country embarks upon a new Manhattan Project to develop strategic quantum potential weapons and defenses. It would be a great relief to discover that such had already been started, but I fear not.

Desperately Needed Defensive Capabilities Can be Provided by a QP Solution

We pose one more very, very useful QP capability prior to closing. As we stated, if a large U.S. city is hit with—say—an anthrax attack done in professional manner, we would expect 1-3 million casualties, according to a well-known major U.S. government study. With immune/regenerative spreading presently already ongoing here in our populace by KGB QP weapons, that figure may actually increase by about 5-fold. So the casualties (prompt and delayed) might well reach 5-15 million, in a single *professional* anthrax spray attack by two persons from one light plane on a calm night dispensing 100 kilograms of anthrax spores sprayed over the city with a simple agricultural sprayer. With the indicated Priore technology and treatment units in all emergency response hands, at least 70% or so of those casualties could be saved. Otherwise, *presently almost all of them will die.* That dramatic saving of lives is one desperately needed capability that could be met.

But there is a further capability of LW technology that nothing else presently known can do without serious impact upon the populace.

After the prompt and shortly delayed casualties are mostly cured and the

remaining fraction dies, a terrible problem of BW contamination still remains. No one anywhere really knows how to clean up an entire city from anthrax spores. But unless harshly decontaminated, that contaminated city is going to be effectively uninhabitable for decades to come, if only the present technology and methods are available. Islands of the coast of Scotland, where anthrax was tested decades ago, are still "hot" and contaminated—and off limits.

The indications are that our nation has developed chemical sprays that can kill and neutralize the anthrax, including in the lungs of the populace breathing the spray. On the other hands, it is indicated that the spray is a high physical stress factor, and some of the more debilitated citizens will be injured or even killed by the spray itself. This includes babies and small children, the aged, those with lung and breathing difficulties, etc. As a matter of national survival, desperate diseases do deserve desperate remedies. So while spraying the zone might itself sicken and kill some thousands of our weaker citizens, at least—so the thinking would go—it saves millions. This of course is similar to the use of triage—reserving treatment and scarce medical capabilities and supplies for treating those most likely to live and recover with treatment, rather than treating those more seriously affected and less likely to survive. Sadly, presently triage will almost certainly be necessary because of very short supplies and treatment teams, etc. So most of those 1 to 3 million casualties will simply be dragged aside and left to die, and just made as comfortable as possible.

However, the QP technology can be adapted to produce systems that can indeed do complete decontamination, very quickly, and without harm to the citizens in zone. The anthrax can simply be modified by specialized spacetime curvature engines—specialized EM fields and waves carrying hidden inner "information content of the field" engines that are designed specifically to change and destroy anthrax and nothing else. Eventually one could develop the capability to do it similarly for *any other* major contaminant, including nuclear radioactive materials contamination of a major city.

Any strategic and tactical analyst can immediately see the tremendous value of such capabilities.

In Conclusion

I hope the above admittedly lengthy overview is of interest to the reader and useful. If we are to survive the debacle that now looms before us in this new asymmetrical war we shall be in for decades, it will require the efforts of leading and dedicated Lawmakers and Overwatch persons. Without firm prodding, the military, scientific, and intelligence communities are likely to just continue their present pace until many or most of us all die suddenly.

The KGB energetics threat is still real and imminent; Russia is not a monolith and Putin still does not have complete control over the KGB. Another full strategic attack is sure to be scheduled before very long by either that die-hard

faction of the KGB, the Yakuza/Aum Shinrikyo, the Chinese (particularly if they move against Taiwan and we defend), or someone. And so our possible deaths also to be taken into account, if we just continue to do business as usual.

Along with other Americans, I love my country and served it to the best of my ability for 20 years of active duty. It is the survival of America itself that is now at stake, both in the asymmetrical war against terrorists and in the continuing war against energetics weapons. Our scientific, military, and intelligence communities simply must be jolted awake and into massive efforts in energetics.

We have the scientists with the required capability. We have the facilities. We have the leadership, and we can do it if we can put this thing under a Presidential Decision Directive, under an Executive Order and a Declaration of National Emergency (along with the several already in effect).

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1986

Fer De Lance

Briefing on Soviet Scalar Electromagnetic Weapons

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1986

Note: This is the original Fer De Lance briefing paper wich includes some minor text and artwork editing.

1986 FER DE LANCE INTRODUCTION & BRIEFING ON SOVIET SCALAR ELECTROMAGNETIC WEAPONS

This briefing presents the basic concepts of Soviet scalar electromagnetic weapons, some of the major types available, and evidence of their widespread testing.

Scalar Electromagnetics is Electrogravitation

Scalar electromagnetics is an extension of present electromagnetics (EM) to include gravitation. That is, it is a unified, and, what is more important, it is a unified engineering theory. Nikola Tesla initially discovered its basis.

In the scalar EM extension, EM field energy can be turned into gravitational field energy and vice versa. This exchange can be patterned and localized, in specific areas or objects. Such a controlled change of electromagnetics to gravitation is not possible in the normal EM or physics presently taught in Western textbooks. However, the bits and pieces of the theory have been scattered through the physics literature for some time, but no orthodox Western scientist seems to have realized that these anomalous portions could be integrated into a startling new physics. Unorthodox experimenters, inventors, and scientists have made discoveries in this arena for several decades, but again have not realized the exact implications or the precise manner in which their results could be combined with present electrical physics.

Fer-de-Lance

Such sluggishness is certainly not present in the Soviet Union. For over three decades, the Soviet Union has been developing electrogravitation and applying it to develop strange new secret weapons of incredible power and capability. They have sustained the largest weapons development program ever launched by any nation, and they have kept it effectively hidden from prying Western eyes. 1 have called this program "Fer-de-Lance," after the deadly South American pit viper of that name.

The dreaded fer-de-lance is a snake of great agility and lethal effect. It often ambushes its hapless prey, and strikes unexpectedly and without warning. Its first sudden strike is usually lethal to its victim, which promptly expires in writhing agony. Since the Soviet development of scalar EM weapons has been designed for the same purpose, the name seems appropriate.

The equivalent effort of about seven Manhattan projects has been poured into Fer-de-Lance by the Soviets, and the program has been successful almost beyond imagination. The eery weapons are now developed, deployed, and

tested. The ambush has been completed; Fer-de-Lance is coiled and ready to strike.

Energetics and Directed-Energy Weapons (DEWs)

The ordinary Soviet name for this type of weapons science is energetics. In the West, that term is believed to be associated with conventional directed-energy weapons (DEWs) such as particle beam weapons, lasers, radio frequency (RF) directed-energy devices, etc. The Soviets do not limit the term in this way.

Western scientists are familiar only with directed-energy weapons where fragments, masses, photons, or particles travel through space and contact the target to deliver their effects. Hence in their thinking they limit the Soviet term "energetics" to the type of weapons they themselves understand - exotic but normal weapons using energy or mass traveling through space to impact a target.

However, it is possible to focus the potential for the effects of a weapon through spacetime itself, in a manner so that mass and energy do not "travel through space" from the transmitter to the target at all. Instead, ripples and patterns in the fabric of spacetime itself are manipulated to meet and interfere in and at the local spacetime of some distant target. There interference of these ripple patterns creates the desired energetic effect (hence the term energetics) directly in and through the target itself, emerging from the very spacetime (vacuum) in which the target is imbedded at its distant location. As used by the Soviets, energetics refers to these eerie new superweapons, as well as to the more mundane DEWs known to the West.

As a consequence of the Soviet breakthrough and decades of feverish development, monstrous strategic weapons undreamed of in the West are already in Soviet hands. A noose is slowly and steadily being tightened about our throats, and it is already the 11th hour.

The Soviets Use a Deception Plan

Concomitant with this supersecret development program, the Soviets developed and implemented an elaborate deception plan to conceal these startling weapons and their nature from Western eyes until it is too late. Soviet deception has been so successful that even when Western scientists are confronted with the actual Soviet tests of these weapons directly over their heads, they do not recognize the weaponry nor the nature of the effects produced.

As early as January 1960, Nikita Khrushchev announced the Soviet development of a new, fantastic weapon. On May 1, 1960 Soviet defensive radars - rigged as prototype weapons of this new kind - probably downed Francis Gary Powers's high-flying U-2 reconnaissance plane over the Soviet Union, precipitating a major diplomatic incident.

On April 10, 1963 one of the first new superweapons operationally deployed was used to destroy the U.S.S. Thresher atomic submarine underwater, off the east coast of the U.S. The next day, April 11, 1963 the same deployed superweapon was utilized in a different mode to produce a giant underwater explosion in the ocean over the Puerto Rican Trench, 100 miles north of Puerto Rico.

Over the years, various aircraft were interfered with or downed as tests of these Soviet weapons. A particular case involved the mysterious loss of F-111s in the Vietnam conflict. At least one downed F-l11 crew was recovered in the subsequent prisoner-of-war exchange. On that aircraft, all electrical systems suddenly were in difficulty simultaneously. All emergency indicator lamps were lit up, "like a Christmas tree." This was probably due to special Soviet teams converting some North Vietnamese SA-2 missile system radars to the scalar EM mode, and employing "scalar beam" interference to produce spurious EM noise throughout the electrical and electronic systems of the aircraft.

In late April/early May of 1985, the entire armada of Soviet strategic scalar EM superweapons was activated as a special celebration of the 40th anniversary of the end of WWII. Activation of this armada (which probably contained over 100 giant weapons), together with 27 giant power systems and a large number of command and control transmissions, was monitored on an advanced, proprietary detection system by Frank Golden. After the giant strategic exercise, which lasted several days, most of the weapons and power sources were once again stood down to "standby."

The NASA shuttle launches provided a convenient opportunity for Soviet testing of these superweapons in a Launch Phase ABM mode, where a launched missile can be detected and destroyed shortly after liftoff. At first, electromagnetic pulse (EMP) bursts on the early shuttle trajectory were deliberately delayed in time, to prevent actual destruction of the target and avoid alerting the U.S. that something unusual was happening.

The shuttle launch of November 26, 1985 saw a particularly significant-test of this kind. In this case, a very loud "sonic boom" or explosion occurred over the launch site 12 minutes after shuttle liftoff, when the shuttle was already away and downrange. At least two previous shuttle launches had also been used as pseudotargets, with delayed booms occurring over the launch site well behind the vehicles.

After the lack of U.S. reaction to these three tests showed that the U.S. still had no knowledge of the new technology and did not even recognize its employment, the Soviets apparently decided to proceed with tests where the target vehicles would actually be destroyed.

On December 12, 1985 the same Soviet weapon tested against the NASA shuttle launches may have deliberately interfered with the controls of an Arrow DC-8 taking off from Gander Air Force Base, Newfoundland. At an altitude of 100

feet, the aircraft - carrying over 250 U.S. soldiers and civilian crew members - lost power and sank into the ground tail-low, killing everyone on board. Three Canadian witnesses to the crash were interviewed over the Canadian Broadcast Corporation's television news on April 8, 1986 at 10 p.m. No flame or smoke issued from the plane before its descent and crash. However, the aircraft was seen to be mysteriously glowing with a yellow glow. That is a signature of the use of a scalar howitzer in the "continuous EM emergence" mode, similar to the manner in which the F-111s were downed in Vietnam. In short, the DC-8's electrical systems were interfered with by electromagnetic noise created throughout each increment of spacetime occupied by the aircraft. The powerful charge created in and on the aircraft also apparently caused the loss of two engines, one after the other. With its controls ineffective and power drastically reduced, the aircraft sank to earth, still in its "tail down" configuration from takeoff, and crashed and burned. The "yellow glow" was a corona due to the acquisition of a high electrical charge by the skin of the aircraft.

Other factors contributing to the crash may have been reduced lift due to poor engine maintenance, increased weight of the aircraft due to icing, and heavy loading. Still, no one has recognized the significance of the "yellow glow" or what it implies, or the possible connection between loss of the aircraft and previous Soviet testing of-a Launch Phase ABM system against U.S. shuttle launches.

As this book goes to press, the last two U.S. Air Force Titan 34-D missiles fired from Vandenberg Air Force Base in California have blown up shortly after launch. The first one blew up on Aug. 28, 1985 just after lift-off. That loss has been attributed to failure of a high-powered fuel pump, causing a massive oxidizer leak and a smaller fuel leak. The second Titan loss occurred on April 18, 1986 when the missile blew up 5 seconds after lift-off. Its loss is still under investigation and no determination of cause has been made. Apparently the shuttle and the Titan presently provide the only viable launch vehicles for launching U.S. "spy" satellites. The loss of these sensitive satellites - if indeed they constituted the payloads - cannot help but be damaging to our strategic surveillance capability. According to the Los Angeles Times, the single remaining KH-11 satellite was launched in December 1984 and, with an expected life of two to three years, it could stop functioning later this year.

Whether or not significant Woodpecker grid activity existed in the vicinity of the Titan launch of August 1985 is unknown at this time. However, significant activity in the grid definitely occurred before the April 18 Titan disaster and on the same day.

On Easter Sunday, Mar. 30, 1986 engineer Ron Cole observed significant **cloud** signatures of grid pattern activity, correlated with Soviet Woodpecker measurements. On April 18, the present author observed traces of a cloud **radial** over Huntsville, Alabama and took photographs of it. Preliminary reports from

Thousand Oaks, California indicate extensive grid activity again on April 18, the day the second Titan exploded.

At least the second of these two missile destructions shortly after launch is suspicious, since the grid positively was active during that time. Also, a clear trail of Launch Phase A8M system indicators exists back to the massive scalar exercise of April/May 1985. The first Titan explosion in Aug. 1985 thus falls within the Soviets' "now let's test them against U.S. launch vehicles" period. The second Titan loss follows highly suspicious losses of the Arrow DC-8 on Dec -T7 1985 and the Challenger on Jan. 28, 1986. The same Soviet weapon system that destroyed those targets may also have destroyed one or both of the critical Titans.

The Soviets have also been able to significantly engineer the weather over North America for more than a decade without being found out. They have tested a fantastic range of anti-ballistic missile (ABM) defense weapons for over two decades, and no one is the wiser in the West.

As previously stated, prior to the end of November, 1985, at least three "wet-run" tests of a Soviet "launch phase ABM system" against actual U.S. shuttle launches were made directly over Cape Canaveral itself, and still no one recognized what was happening or what sort of weapon was being tested. On December 12, destruction of the Arrow DC-8 in Newfoundland produced no indications that the Americans and Canadians knew anything about the nature of the weapon possibly used.

Accordingly, after a sufficient wait to test our reactions (if any), the Soviets prepared to actually destroy a shuttle after its launch.

Destruction of the Challenger in January 1986

As the whole world knows, on January 28, 1986 the shuttle Challenger was launched from Cape Canaveral, Florida after exposure to undesirable weather conditions, and disastrously exploded shortly after launch. The evidence seems to indicate that, as the rising vehicle was stressed, one end of its right booster broke loose, twisting away and into the main fuel tank, causing rupture, spillage of the fuel and catastrophic explosion. Several other anomalies still exist, however, and it is clear that a problem existed with at least one of the booster scals. All seven astronauts aboard the flight were killed in the fiery destruction of the vehicle.

Of course no one had recognized that the Soviets had already tested a launch-phase anti-ballistic missile (LPABM) system against three of our previous shuttle launches. These "wet-runs" used a deliberate "time offset" to delay the explosive emergence of electromagnetic energy in a launched shuttle's location along its trajectory. The delayed test shots resulted in very large "booms" above the Iaunch site after the shuttle was safely out of the area, but did not destroy the

shuttle vehicles themselves. For example, the delayed-shot boom occurred 12 minutes after the evening launch of Nov. 26, 1985. Even a marker beacon (large light in the sky) was utilized on that launch shortly after lift-off. The marker beacon was photographed. In addition, another photograph taken in a time sequence shows another sudden streak of light coming down and ending in a burst of light. This was probably a spatially-offset test of the "pulse" mode for destroying the shuttle. The "light burst" would have been detected in the Soviet Union and scored against its intended offset position. However, another mechanism may have been used to cause destruction of the shuttle itself.

On Jan. 1, 1986 the presence of a metal-softening signal added on to the Soviet LPABM system's scalar EM transmissions was detected by a surprised Frank Golden. The metal-softening ability of the detected signal was experimentally verified by him. Golden also locally nullified the action of the scalar EM signal in a test, rather conclusively establishing (1) that it existed and (2) what it was. The signal was apparently being prepared for use against an upcoming U.S. shuttle launch.

Just prior to the launch of the shuttle in late January, 1986, the Soviets accomplished significant weather engineering over the U.S. The jet stream was severely bent southward in the middle of the U.S., bending rightward again to move across the Florida panhandle. Icy cold air from Canada was drawn far down, into Florida and onto the Challenger sitting on its launch pad. This exposure to cold outside its tested range was probably an additional factor contributing to the Challenger's failure. Positive signatures of the Soviet weather engineering and jet stream manipulation were observed and photographed by several persons, particularly in Alabama and California.

On January 28, 1986, the Soviet scalar EM weapon system effects were sharply localized in the launch zone. Localization involved higher frequencies being present; these are quite painful to small brains - whose hemispheres act as a scalar interferometer and detector - such as in birds. As commented upon by national news commentators, strangely the birds were not flying that morning. Indeed, they were staying down on the ground or avoiding the area, since the sky over the area was painful to them.

As the Challenger rose, the metal-softening signal would have been experienced in and around the boosters shortly after ignition, since the booster flame acts as a special "ion-plasma" turner/detector for the scalar signal. (Certain plasmas have a unique characteristic: they transform an input transverse wave to a longitudinal wave, or an input longitudinal wave to a transverse wave.) The effect of such a local signal is to "change mass in the immediate vicinity" with the particular scalar resonance signal. (Mass acts as a capacitance or accumulator for scalar resonance).

The ill-fated Challenger was doomed. After ignition, the booster flame acted as a ionic plasma detector/amplifier for the scalar metal-softening signal on the

Soviet Woodpecker grid. The metal in and around the booster flame was slowly and steadily weakening due to charge-up with the metal-softening pattern. This attributed to booster leakage from the already cold-damaged seal. The leaking booster poured out smoke and later flame, contributing to the impending disaster.

Substantial winds and air turbulence over the site increased the stress on the Challenger as it rose through this region. This also contributed to the impending disaster and may have been deliberately created there by Soviet weather engineering.

As the Challenger stressed, eventually one or more weakened metal mounts gave way, partially freeing the end of the right booster. The booster oscillated, rotating into the tank and rupturing it. Contact of the escaping liquid fuel and the flame resulted in a fiery explosion, destroying the vehicle.

Even so another anomalous flame or light was observed on the vehicle, and may have represented a very small additional "pulse mode energy form" produced by the Soviet weapon that was attacking the Challenger. The shock of the explosion probably killed the astronauts instantly, although the cabin appears to have remained essentially intact while it plunged several miles to the ocean below.

By treating excess cold exposure to the shuttle, inducing metal-softening in and around the ignited booster, and possible adding a deliberate "intensely hot spot", the Soviets caused the Challenger to weaken and destroy itself shortly after launch, in so subtle a fashion that NASA scientists would not suspect what had actually caused the mishap. The Soviets also had previously withdrawn all their trawlers and ships which normally shadow a shuttle launch, to prevent any suggestion of Soviet presence near or involvement in the catastrophic accident.

A few days later, sporadically intense "high frequency localization signals" were still present on the grid, at least at one hinge-point at Birmingham, Alabama. From 1-4 February 1986, many birds inadvertently flew into the zone when an intense breakout of these components occurred, and dead birds fell from the sky in substantial numbers.

* According to an Urgentgram sent out by General D. Graham, on the evening of the Challenger's loss, KGB headquarters held a party to celebrate "success of their active measure against the shuttle." Note that all Soviet scalar EM weapons - development, testing, deployment, and usage - is under command and control of the KGB.

Among other things, this briefing details the bizarre series of indicators that showed the Soviet intention to destroy the vehicle, and documents the accidental discovery of the signal with which they intended to cause the shuttle to fail and destroy itself.

Technological Surprise and a New Hiroshima

Sadly, the bureaucratic smugness of orthodox Western scientists has materially assisted the Soviet deception process. Most Western managerial scientists - particularly in weapons development activities — have continued to view the Soviets as ignorant peasants, still trying to clean the mud off their boots. This view, of course, is totally untrue and unwarranted.

It takes only a few examples to refute this attitude. In nonlinear mathematics, engineering and science, the Soviets have led their Western counterparts since the beginning. The electromagnetic pulse (EMP) effect of a nuclear explosion appeared in the ordinary Soviet scientific literature before Western scientists were even aware that the effect existed. The Soviets continue to lead the world in explosive welding, titanium forming and welding, etc. While the Soviet scientists exhibit little inclination to build good washing machines, they certainly do produce state-of-the-art technology — and beyond — in any area in which they focus their main efforts. (We do lead the Soviets in some areas such as computers, computer software, miniaturization, etc.)

Once before, a modern nation - the United States - developed a mighty weapon in secrecy and used it to force a powerful foe - Japan — to its knees. The mindbending atomic blows to Hiroshima, and shortly after to Nagasaki, showed once and for all that in the modern age technological surprise can prove instantly disastrous. Yet in our scientific arrogance, we have assumed that no one else will ever do such a thing. We have assumed that it certainly could never happen to us, and that the "secret weapon" scenario will never be repeated. On the contrary, it has happened again, someone else has done it, and it has happened to us.

It has also become fashionable in the West to believe that all the laws of physics are already discovered. We assume we already know all of them. While we have been pridefully crowing this tune, the Soviets have been steadily discovering new laws in secret, as well as new ways to circumvent the old laws.

We Have Given Up Defense in the Larger Sense

Meanwhile, to defend ourselves strategically, we have chosen to forego "defense" and rely almost totally on building a powerful strategic offense that is capable (we think!) of destroying our would-be enemies anywhere in the world. Our offensive striking power is based mostly on a triad of deterrent forces - land-based ballistic missiles, submarine-launched ballistic missiles, and strategic bombers. The cruise missile is presently being added to the triad. If this 4-part offense were nullified or destroyed by Soviet secret weapons, we would be powerless to prevent our own destruction and Soviet domination of the world.

We have been viewing ourselves as Samson, confident in the strength of our locks.

Yet literally our locks have been secretly shorn and the Philistines are already upon us. Indeed, Soviet energetics weapons are now capable of destroying our triad shield, our homeland, our armed forces in the field, and our population, quickly and efficiently. We have a new "gap" of monumental proportions: not a missile gap, not a submarine or bomber gap, and not even a particle beam or laser gap. We have a scalar electromagnetics or electrogravitation gap.

In this briefing, it is my purpose to show a portion of the Soviet weapons developments that have lead me to such dire conclusions. The Fer-de-Lance briefing is also an attempt to galvanize our leaders and scientists into action, for our present total vulnerability to the Soviet Fer-de-Lance weapons is intolerable and unacceptable.

Unless we achieve defenses — and quickly — our own demise in a fashion similar to the Hiroshima-Nagasaki scenario is inevitable and imminent.

CHARACTERIZATION

- SINGLE ANALYST
- PERSONAL INTERPRETATION
- UNOFFICIAL
- NO APPROVAL/DISAPPROVAL BY ANY
  - CORPORATION
  - GOVERNMENT AGENCY
- PREPARED
  - ON OFF-DUTY TIME
  - AT PERSONAL EXPENSE

Slide 001: Characterization

We point out at the beginning that this briefing and its interpretation are the result of 22 years of analysis and effort by a single analyst. It is entirely unofficial. It is not approved or disapproved by any corporation, company, or government agency. It has been prepared by this analyst at nights, on weekends, on holidays, and during off-duty time.

It has been prepared mostly at personal expense, though several grants and support have been received from R. J. Reynolds III, Peter Kelly, Mike Bearden, Interdimensional Sciences, Association of Distinguished American Scientists, and others. Very valuable assistance has been received from the U.S. Psychotronics Association and the Planetary Association for Clean Energy. These contributions are deeply appreciated and most gratefully acknowledged.

Graphics and artwork support by Hal Crawford, Margaret Wilson, Tommy Neumann, Ron Cole, and Lee Giles has been invaluable. My sincere thanks go to these artists who have made the presentation vivid and imaginative. A great deal of background support was given by Joe Gambill, Frank Golden, Tom Herold, Ken Moore, Pete Kelly, Eike Mueller and Mel Bartlett and is deeply appreciated.

Finally, the help of many other persons and colleagues too numerous to enumerate is also gratefully acknowledged.

If the U.S. bureaucracy ever moves and develops defenses against scalar EM weapons, it will largely be due to the support of the persons and organizations who have freely given of their talents and resources to further this effort.

OUTLINE

- THREE VIEWS OF ELECTROMAGNETICS
- EXTENDED AHARONOV-BOHM EFFECT
- SCALAR ELECTROMAGENTICS
- KILL/DAMAGE MECHANISMS
- VULNERABILITY
  - ELECTRONICS
  - PERSONNEL
  - EQUIPMENT
  - MATERIAL
- SUMMARY

Slide 002: Outline

This presentation does not attempt to cover the complete field of energetics weapons developed by the Soviet Union. Instead, it concentrates on the major areas necessary to understand the type of weapons likely to be unleashed on our strategicand tactical installations and our troops and their equipment. It does not attempt to present the frightful bio-electromagnetic weapons the Soviets have developed to be unleashed on our populace at large and on our troops in the field. Also, the briefing does not dwell on the historical progression, but on the types of weapons themselves.

Of necessity, it presents several shortcomings in classical EM, and presents three differing views of electromagnetics and what can be done with them. The briefing particularly stresses the Aharanov-Bohm (AB) effect. This mesoscopic effect, which produces action at a distance by pure EM flux and not EM force fields, has been extended by the Soviet weapons developers into the macroscopic world around us.

In addition, we develop the basic concepts of scalar electromagnetics and how electrogravitation is achieved. The basic concepts of scalar interferometry and scalar resonance are briefly advanced, and a few of the major kill and damage mechanisms are presented. The nearly total vulnerability of our present electronicequipment,personnel,communications,vehicles,aircraft,ships, missiles, submarines, nuclear weapons, and materiel is stressed.

Finally, a short summary is given to highlight the main points of the briefing.

ELEMENTS OF THE EMERGING THEORY

- FLAWS IN VECTOR THEORY
- ZERO-VECTOR SYSTEM
- KALUZA-KLEIN ASPECTS
- VACUUM/MASS EFFECTS
- SCALAR RESONANCE
- ELECTROGRAVITATION
- LOCAL GENERAL RELATIVITY
- IMPLICATIONS

Slide 003: Elements of the Emerging Theory

Specifically, we will point out some flaws in vector mathematics itself, particularly with the concept of the zero force vector. The zero force vector is a system of forces that sum to a zero resultant. Hence the components of the summation represent a patterned stress in the medium to which they are applied, or in which they are imbedded. This includes the vacuum (spacetime) medium. In classical electromagnetics, this vacuum stress due to a zero-vector summation of EM force fields has been totally omitted and ignored.

As such, the EM "zero" force-vector summation produces a "trapped internal EM flux and flux pattern, without resultant (external) force field" condition - precisely as does the Aharonov-Bohm effect. The components of the artificially zeroed system, however, can be transmitted and still maintain their special relationship and coherence. While the AB effect has been shown to hold for the mesoscale (a few thousands of angstroms), the zero-vector scalar EM effect can hold for hundreds of thousands of kilometers.

To provide a unified electrogravitation, we adapt Kaluza-Klein 5-dimensional gravitational concepts to the idea of the zero-vector stress system in vacuum-spacetime. We also point out how simultaneously varying the magnitudes of **the** force components of a stress, all in phase, produces a stress wave or scalar EM wave. Scalar waves are almost always absorbed and emitted by the nucleus of the atom, not by the electrons in orbit.

The relationship of mass and vacuum, and the constitution of the vacuum, are pointed out from the viewpoint of modern quantum mechanics.

How a scalar wave resonance differs from conventional EM resonance is developed briefly. Mass and inertia are the direct result of - and are - trapped scalar resonance. The trapping mechanism is the spin of the particle.

Severely limiting assumptions in ordinary general relativity (OGR) are pointed out. In OGR, it is assumed that the local frame is always a Lorentz frame, and never curved. In other words, local spacetime is always assumed to be flat. This **saves** the conservation laws, simplifies relativity, and reduces "general" relativity to special relativity with distant perturbations and curvatures.

By removing this ad hoc assumption, a much richer local general relativity results. This local general relativity is readily engineered. Note that, in OGR, the physicist has actually assumed that he can never "engineer" local general relativity! Indeed, with the scalar EM approach, he can easily do so, in contradiction to what is taught in all Western universities.

By engineering a local general relativity (LGR), the individual conservation la**ws** can be violated locally. This includes the conservation of energy/momentum, and the conservation of charge, for example.

The major implication of this startling new engineering physics is that one can **engineer** physical reality itself. For example, elements can be transmuted with minuscule energy input, free energy devices are possible, action at a distance is possible, communication faster than light speed is possible, etc.

By using the zero-vector approach, the virtual state can be organized and made **largely** deterministic, rather than statistical. This means that the probabilities of the states propagated forward by the Schroedinger equation can be engineered and changed. Whether or not a certain quantum change shall emerge or not can be determined or substantially influenced in advance. Bohm's hidden variable **theory** now becomes directly engineerable. This is a drastic change to quantum mechanics and physics in general.

Another implication is that this is the final engineering, for it allows the direct engineering of physical reality itself. Humans must now find a way to resolve their differences peacefully, or shortly Man will destroy himself and his biosphere by his own hand.

Slide 004: Three Kinds of Electromagnetics

There are actually three kinds - or three views - of EM. These are (1) the classical view, (2) the quantum mechanical view, and (3) the scalar EM or electrogravitational view.

In the classical view, the potentials are just mathematical conveniences and do not physically exist. The real causative agents are the force fields, and there is no longer any electromagnetics going on if the force fields reduce to zero. Further, the ideas of "charge" and "charged mass" have been made erroneously synonymous.

Of course the classical view was formed from the idea of a thin material ether, with electricity as a thin fluid, long before the discovery of the electron. Since most earlier scientists studied string waves and these are transverse, the EM wave was modeled as a transverse wave. Also, detection equipment actually detected transverse waves. The role of electron spin and drift velocity, which would have shown that force-field-causing EM waves in the vacuum could only be longitudinal, was not yet discovered. Maxwell's equations and the classical approach became so engrained that the basic derivations were never corrected for more modern discoveries.

The quantum mechanical view, on the other hand, regards the potentials as the real physical actants, and the force fields are just effects derived from the potentials by differentiating operators. Classically oriented physicists have adamantly opposed this foundations requirement of QM because it would require nearly a complete redo of EM theory. It would also rather drastically

change our ideas of physical reality. For years a controversy has raged around the Aharonov-Bohm effect (which demonstrates the reality of the potentials, among other things). Only this year - 1986 - have most physicists finally accepted the AB effect with its implications (see Physics Today, Jan. 86). However, no changes have yet been made to EM theory and the basic classical approach to electrical physics and engineering.

Yet even the QM view is flawed, since it has not examined the structure of EM forces which sum to a vector zero. Such a system produces stress, and if the summation is in the vacuum itself, it produces stress of vacuum/spacetime. Rigorously, this is a gravitational effect, and the energies of the various EM components in the local region are locked into an artificial potential. From general relativity, this type of potential where the energy density of vacuum is altered is a gravitational potential. From Kaluza-Klein unified theory, it is at least a 5-dimensional gravitational potential.

If the individual force vector components of the vector zero are varying in magnitude - say, all in phase - then they produce a gravitational wave. The energy density of the local vacuum is being rhythmically varied. Call such an EM wave a scalar EM wave, where, by "scalar" we imply that, to an external observer, the EM force vector resultants are identically zero, but the local gravitational potential of the wave is varying. Thus this is an electrogravitational wave, and vector zeroing of EM force fields constitutes a means of changing EM field energy into G-field energy. On the other hand, by breaking up the coherence of the zero-vector summation of the EM forces, nonzero EM resultants are recovered, constituting the change of gravitational energy into EM energy.

A simple means to break zero-summed coherence is by interference of two or more such zero-vector waves.

In this, third view of EM, action at a distance is easily possible, and is the norm rather than the exception. In addition, a new kind of resonance - scalar resonance - exists. The scalar EM wave does not interact with orbital electrons, but rather with the interior of the nuclei of atoms. Thus the new scalar EM resonance is between nuclei and within nuclei.

Slide 005: Bohm-Aharonov Effect

In 1959, Aharonov and Bohm published a fundamental paper in Physical Review, which pointed out the QM implications of potentials as the real entities, while force fields were derived effects. They showed that, even in the presence of zero EM force fields, the potentials may still exist and produce real effects in physical systems. They also suggested experiments to prove these predictions.

Interference of the potentials is the key mechanism producing real effects in charged particle systems, even in the presence of zero E-field and zero B-field. Unfortunately the AB paper did not address the issue of zero-summed systems of EM force fields as one way of producing artificial potentials having unique characteristics

At any rate, the "AB effect," as it came to be called, was rather hotly resisted and debated over the years, until finally it has generally been accepted as proven in 1986. The principle represents a violation of both classical mechanics and classical electromagnetics. It is required, however, by quantum mechanics and quantum electrodynamics. And experiment has proved it.

(See Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," Physical Review, Second Series, 115(3), Aug. 1, 1959, p 485-491.).

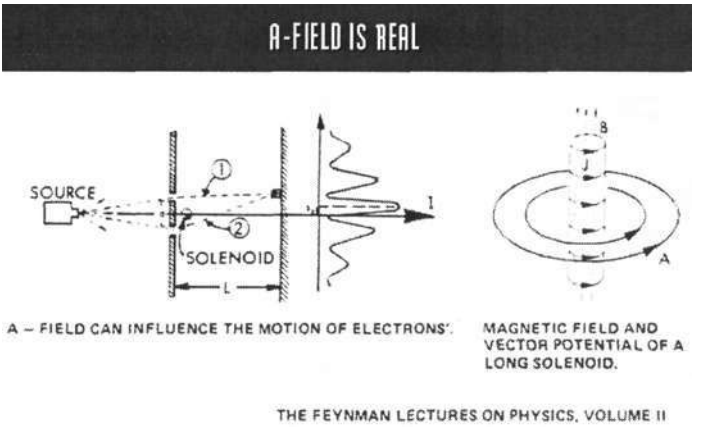

Slide 006: A-Field is Real

In classical EM, the vector magnetic potential (the A-field) had been defined as a mathematical convenience by the equation

$$\nabla x A = B \qquad [1j$$

But if the potentials are real, then conceivably the A field can be loosed from its enchainment to the ∇x operator. In that case, it becomes a free, new, and independent field of nature with potentially unique characteristics. For example, its defining equation shows that magnetic force field can be made from it, and the rightmost term of the equation

$$E = -\nabla Ø - dA/dt \; [2]$$

shows that its time rate of change makes an electric field.

Let us explain this in more simple terms, and somewhat more precisely than conventional theory. We will use the Kaluza unified G-EM interpretation and electron flow in our explanation.

In the A-field, we have a certain kind of 5-dimensional G-potential which can bleed-off as EM force fields in two ways: (1) in a swirl fashion, where the vortex producing the swirl moves parallel to electron movement, and the swirling is a torque or spin, and (2) in a linear fashion, where the time rate of change of the A-potential produces a linear E-field on the electrons.

The first bleed-off as given by equation [1] constitutes the magnetic B-field, and the second bleed-off as given by the rightmost term of equation [2] creates a component of the overall electrical E-field. (Bleed-off of the electrostatic scalar potential produces the other component of the E-field).

Now in general relativity (GR) theory, "the" G-potential is just a conglomerate of many things, each of which has the characteristic of curving spacetime. "The" gravitational field is not a single thing at all, but is composed of a collection of many things.

Thus if we realize that both the electrostatic scalar potential (Ø-field) and the magnetic vector potential (A-field) are components of the 5-d G-potential, then we see immediately that bleed-off of these two components of the 5-d G-potential creates all normal EM force fields.

It follows that, if we produce a zero-vector summation of the two or more EM bleed-offs, we are actually "putting as much back in" to the 5-d G-potential through its A and Ø components as we are taking out electromagnetically. In that case, the 5-potential is in a state of equilibrium with respect to EM bleed-off. It is now forced to bleed-off in the only other way it can: as ordinary 4-dimensional gravitational field. Thus by vector-zeroing EM force fields, we turn EM field energy into G-field energy and vice versa, via the intermediary of the 5-potential.

At any rate, soon after publication of the Aharonov-Bohm paper, experiments showed that, if the magnetic field is trapped inside a long solenoid, a phase shift still is induced in the two-slit electron experiment, even though - classically - no contact of the enclosed magnetic field and the moving electrons occurs. This phase shift is explained by the fact that the freed A-field exists outside the trapping solenoid, even though the B-field does not. Consequently, interaction of this free A-field with the electrons produces a phase shift of the QM interference detection pattern.

This proves that A-field is real and causes physical effects.

It also proves that a form of action at a distance is real, just as required by quantum mechanics.

Years ago, Frank Golden and this author - together with Dr. William Tiller - experimented with "free A-field" devices. Golden went on to develop prototype transmitters and receivers and a prototype underwater communication system.

Since that time, Gelinas has patented several curl-free magnetic vector **potential** (free A-field) devices: see U.S. patent no. 4,447,779, May 8, 1984; 4,429,288. Jan. 31, 1984; 4,429,280, Jan. 31, 1984; and 4,432,098, Feb. 14, 1984. These patents are assigned to Honeywell.

(See also Theodor Kaluza, Sitz. Berlin Preuss, Adad. Wiss. 966, 1921.).

QUANTUM NON-LOCALITY

"The non-local aspect of quantum systems is ... a general property of nature, and not just a freak situation manufactured in the laboratory."

PAUL DAVIES, SUPERFORCE
1984 (PAGE 48)

Slide 007: Quantum Non-Locality

Indeed, quantum systems exhibit nonlocal effects that are general properties of nature. These effects are not just freak situations manufactured in subtle laboratory experiments.

However, if spatial coherence in such microscopic effects can be induced and sustained, then action-at-a-distance can be obtained in large macroscopic systems. This is the engineering aspect of the scalar EM approach.

It is also the aspect that the Soviets have secretly weaponized for over three decades.

The zero-vector EM force-field summation of multiple EM waves is used to transport specific time-phased patterns of EM polarization of vacuum to a distance. There interference of two or more such patterns results in the interference of the internal patterns, breaking of the phase relations, and appearance of positive (added) or negative (extracted) EM energy in the intersection region.

VECTOR MATHEMATICS HAS A FUNDAMENTAL PROBLEM

IN ITS AXIOM FOR THE ZERO VECTOR,
VECTOR ANALYSIS DISCARDS ZERO VECTOR
SUMMATIONS OF ACTIVE SYSTEMS
OF VECTORS.

VECTOR ZERO IS MADE THE ABSENCE
OF ALL VECTORS

(IT CAN ALSO BE THE PRESENCE OF REAL
VECTORS WHOSE VECTOR SUM IS 0.)

Slide 008: Vector Mathematics has a Fundamental Problem

In its concept of the zero vector, vector mathematics discards zero-vector summations of active systems of vectors. It replaces such a summation with a zero vector. This is fine for mathematics as an abstract system, but it is in error when applied to real electromagnetic force fields of nature.

In the abstract mathematics, a vector zero summation is made the "absence of all finite vectors". Further, all vector zeros are made equal. No concept of the "internal stress" of the zero vector exists in abstract vector mathematics.

However, physically the zero summation or "balancing" of vector forces in a medium represents stress in that medium. In the physical case, a vector zero summation system of non-zero vectors has a dynamic substructure, and this substructure is an individual.

Obviously, in the physical case vector zero summations may materially differ, both in the pattern of stress and the magnitude of stress. They cannot all be equated. Further, they are not the absence of vectors, but represent the presence of vectors in a special manner. Such a zero summation of EM vector forces directly stresses the "medium" - which may be the vacuum itself.

In the physical case, several changes to the axioms of abstract vector mathematics are required. (1) the "potential" of a vector zero must be taken into account, such as is represented by the sum of the squares of the magnitudes of its vector components. (2) the specific deterministic pattern of the vector components comprising the zero must be taken into account. (3) The dynamic

variation in both the deterministic directions and deterministic magnitudes of the components and of the overall pattern must be taken into account. (4) Frequencies of the changes in the direction, magnitude, and actual makeup of the vector zero must now be accounted for. That is, time and wavelengths are rigorously aspects of the vector zero, and these may be deterministic variables. Since time itself is now a variable aspect of the vector, the vector zero system can affect its "rate of time flow" in the observer's system. (5) Since a "reference vector zero" can be established at any point of a vector magnitude, then individual vectors themselves may have dynamic substructures inside a special "zero reference" in and on the vector. The patterned potential of a vector is a reality.

This leads to a system of "vectors nested inside vectors" ad infinitum. In other words, it leads to an infinite-dimensional system, and the "opening" of every finite closed vector system through its vector zeroes.

For application to physical electrogravitational systems, at least 5 dimensions are required, four of space and one of time.

Here we still are considering only a special case where all vector zero summations represent EM force field energy locked in a gravitational potential, or gravitational force field energy locked inside the EM potentials. That is, we are prescribing a system where the only intertranslation of energy is among mass, EM field, gravitational field, and vacuum virtual energy (anenergy).

(See T. E. Bearden Toward a New Electromagnetics: Part III: Clarifying the Vector Concept, Cheniere Press, Santa Barbara, Ca. www.cheniere.org, 1983; Part 4: Vectors and Mechanisms Clarified, 1983. See also E. T. Whittaker, Proc. Lond. Math. Soc. 1, 367, 1903; Robert Bruce Lindsay and Henry Margenau, Foundations of Physics, Dover, New York, 1963, p. 283-287; Richard P. Feynman et al, The Feynman Lectures on Physics, Addison-Wesley, New York, **Vol.** I, p.2-4.).

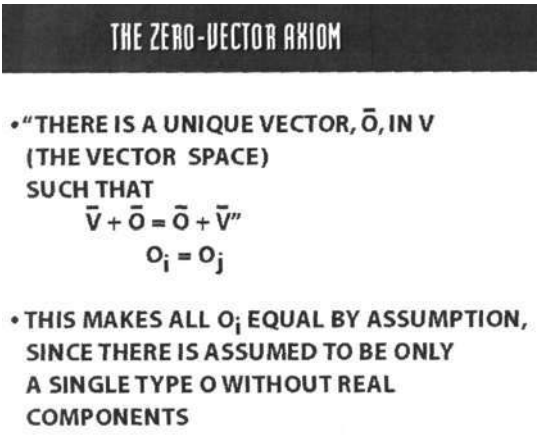

Slide 009: The Zero-Vector Axiom

This slide shows a standard mathematical statement of the zero-vector axiom, used in many texts.

As can be seen, all zero-vectors are made identical, and no substructure is considered.

Such an abstract system of vector mathematics does not fit physical reality. However, when all one's EM foundations concepts are strongly conditioned in this fashion, the gravitational aspects of EM are discarded.

Further, EM theory, experiments, and equipments will be developed along these limiting lines. In that case, EM engineering of gravitational effects will not be developed. One will assume that it is impossible to have a locally curved spacetime, and hence all local frames will be Lorentz frames. Therefore the conservation laws will rigorously apply.

Further, the nonlocal quantum effects will stay firmly in the microscopic world where they belong. Physical macro-reality will stay stable and predictable in a classical manner.

General relativity (in curved spacetimes) will be restricted to the special case of the local special relativistic (uncurved) spacetime, with only distant perturbations (spacetime curvatures).

The world will stay sane and "normal", and the totally variable insanity of physical reality will remain bottled up in the minute microworld or the distant maelstrom of suns, stars, black holes, etc.

The Aharonov-Bohm heresy will stay kaput in the real world and will not be unleashed beyond mesoscopic reality — a few thousand angstroms or so.

With such an error in the application of vector mathematics to physical science, we become "flatland physicists," so to speak. We become like skimmer bugs on the surface of a pond; we have no appreciation of the dynamics of the depths below or of the heavens above.

Worse, we condition our development of instruments according to the fixed notions in our heads. Then we use these "biased" instruments to do experiments that reaffirm our notions. Any deviation suggested to this is considered heresy and nonsense.

And as Max Planck once pointed out, you will get a new physics only when the old physicists — who so adamantly oppose it — die off.

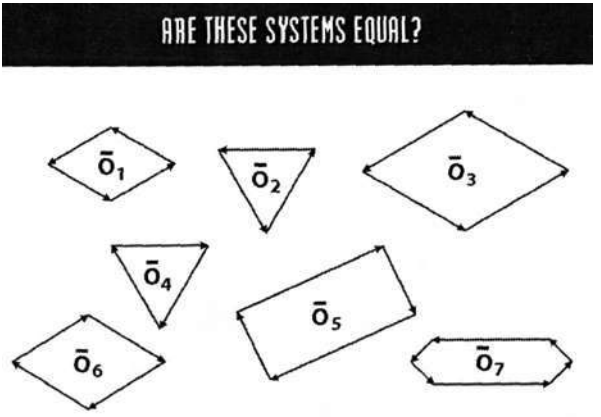

Slide 010: Are These Systems Equal?

Shown here are some representations of various very simple zero-vector systems. As can be seen, the stress magnitudes and the spin and dynamics of all of these systems are very different.

Further, their "stress potential" substructures are not composed of a huge collection of little random force vectors. Instead, their substructures are deterministic. If the components being put into the zeros are varied in direction and magnitude, but always sum to a zero resultant, then highly complex substructure dynamics may be created and utilized, infolded (Bohm's term) inside the zero vector.

In theory one can establish "channels" of communication and power (magnitude) transmission without ever surfacing a nonzero EM force field. In practice one can do this with very little EM spillout. Thus one can establish electrogravitational channels and energy transmission inside normal EM potentials and/or ordinary EM carrier waves.

One can use a conventional system of EM potentials, force fields, and waves as a special kind of "wiring circuit" in and through which to transmit and produce electrogravitational effects. By distant interference, EM effects at a great distance can be accomplished, yet no "ordinary EM energy" has passed between the transmitters and the distant interference zone.

INFOLDED SYSTEMS ARE EXCLUDED BY PHYSICS

DYNAMIC ZERO-VECTOR SYSTEMS ARE NOT CONSIDERED IN ORDINARY GENERAL RELATIVITY, CLASSICAL ELECTROMAGNETICS, OR QUANTUM MECHANICS.

Slide 011: Infolded Systems are Excluded by Physics

Unfortunately, these infolded dynamic zero-vector systems have been eliminated from physics.

They are omitted in classical EM, ordinary general relativity (OGR), and quantum mechanics.

That is, they have been omitted in Western physics.

They have not been omitted in secret Soviet weapons labs and weapons development programs.

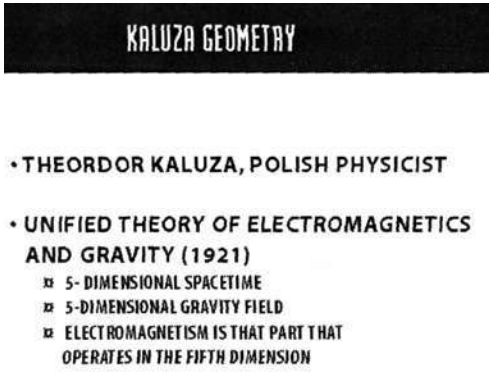

Slide 012: Kaluza Geometry

In 1921, Theordor Kaluza, a Polish physicist, published a unified theory of electromagnetics and gravitation. Albert Einstein, who had had the paper for two years, recommended his paper for publication. In that theory, five dimensions - four space and one time - are utilized in the basic model. This gives a 5-dimensional spacetime.

In the model, electromagnetics and ordinary gravity are two aspects of a single more fundamental field: the 5-space gravity field. Electromagnetism is that part of the 5-field that operates (bleeds-off) in the fifth dimension.

The ordinary 4-space G-field is the small residue that spills over into our ordinary 4-space, and doesn't slide around into the fifth dimension and bleed-off there as electromagnetics.

Implicit in the theory, but not explicitly stated, is the fact that the 5-space G-potential bleeds-off in two fashions: (1) in the 5th dimension nearly unopposed, to produce what we see as EM force fields, and (2) in the ordinary 4-space we live in, which we see as ordinary gravitational field.

Normally almost all the force field bleed-off is in the fifth dimension as EM; only a minuscule bit bleeds off as 4-gravity.

Just as one example, between two electrons the 5-space G-potential bleeds-off into electric force field about 10^{42} times as much as it bleeds-off into 4-space G-field.

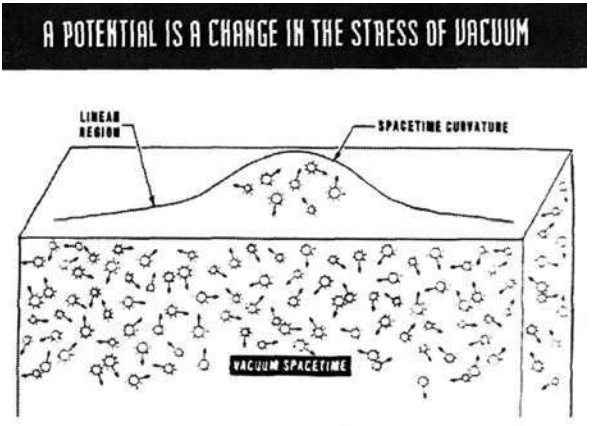

Slide 013: A Potential is a Change in the Stress of Vacuum

In physics, the idea of a "potential" is very poorly defined, if at all. The normal "definition" for the electrostatic scalar potential, for example, is not a definition at all. Instead, it's an abstract operation that tells how to mathematically calculate the magnitude of the potential, by pushing a unit charge in from infinity, against the potential field.

Now ultimately a definition must be an identity statement, not an operational statement about something.

Since I could find hardly anyone who actually understood what a potential was, and how or of what it was composed, I simply took quantum mechanics at face value and constructed this model.

First, the modern view of the vacuum is that it is not an emptiness, but a plenum. It's teeming with an incredible amount of raw energy, existing totally as the temporary bits of energy of virtual particles. That is, the vacuum "energy" exists as the nonintegrated energies of little particles which appear from nothing fare spontaneously created) and disappear into nothing (are spontaneously annihilated) almost instantly. This happens so fast that the little particle and its energy cannot individually be detected; it doesn't hang around long enough.

Hence the fleeting little booger is called a "virtual" particle. Like, "We had 'im there man, for just a moment, but he was gone before we could grab 'im!"

This kind of ghostly particle, however, is very real in modern physics. All observable forces are theorized to be due to the integration or collection of a large number of virtual forces created by exchange of these little particles.

However, this implies a peculiar thing about the vacuum "energy." Actually it's vacuum energies, for each little bit of energy only exists momentarily, then returns to the nothingness from which it came. That is, vacuum virtual energies are totally unintegrated. Each "bit" of virtual energy exists individually. These virtual energies cannot be "added up" to compute the "available energy" unless some collector or integrating mechanism puts them together.

That is, unless some kind of "zipper" is there to "zip them together" into macroscopic, observable energy. The usual "zipper" is a spinning, observable particle of mass. We say that the vacuum energy is unzipped and hence unobservable in that state. We say that "observable energy" is just zipped-together vacuum energies - integrated by and on a spinning, observable particle of mass.

So the vacuum can be visualized as a special sort of violent, unzipped plasma, where the particles of the plasma are fleeting and do not last. We can speak of it also as a sort of special unzipped gas, in the same manner.

The "pressure" of the vacuum gas we refer to as "stress." Due to its violent boiling activity, the vacuum gas is always under very high stress.

This "stressed virtual plasma" identically IS the vacuum and identically IS spacetime. Length, time, frame, mass, etc. - all arise by zipping operations (or understood zipping operations) in and of this raw vacuum/spacetime. When one uses the vacuum notion in this manner, one now uses the term "ether" again. However, this is not the old "thin material ether that hangs around"; this is an entirely new kind. It's a virtual flux and a virtual plasma.

The ether is also what we call "spacetime" in relativity. As can be seen, spacetime is stressed. Further, spacetime has a substructure.

By an uncurved spacetime, we mean one in which the stress of these virtual particles (the "pressure in the ethereal gas," so to speak) is constant from one place to another and from one time to another. Indeed, we also should mean that the stresses of the individual components of the entire plasma are constant from one place to another and from one time to another.

By definition, when we determine the lengths between every two points, we determine a frame. (Actually, we have prescribed a universal "length zipping" operation/mechanism as well as its characteristics.). A "linear frame" or "Lorentz frame" is one in which the pressure or stress remains constant. It may be higher than ambient vacuum, however, due to a particle's or an object's motion through the observer's ether. In the case of constant velocity, the particle/object encounters a higher level of virtual particle flux in the observer's ether, like a vehicle moving through raindrops. It encounters a constant rate of

flux, however. In such constant velocity case, the moving object's frame is said to be "rotated," but not curved, with respect to the laboratory frame of the observer.

In a "curved" spacetime, we mean one in which the stress of vacuum increases or decreases from one place to another, or from one time to another, or both. At one fixed location, if spacetime is curved, then the stress is increasing or decreasing as a function of time. That is, the flux density of that area is changing. We may visualize the local frame as undergoing angular acceleration, rotating more or rotating less. This is a non-Lorentz frame, or curved spacetime. It is also a nonlinear vacuum.

In such a vacuum, local gradients exist in the flux of virtual particles. If affected by (coupled to) one or more of these gradients by a nonzero coefficient, a local object experiences effects (forces and actions) "without observable cause." Observably, conservation laws may be locally violated by these "virtual rivers" of vacuum by coupling, just as a paddlewheel dipped in a river violates its own local "conservation of energy" due to the river providing an energy source to it.

One must be very careful with the "pressure" analogy, however, when one utilizes unified theory (Kaluza theory). We now have a virtual plasma vacuum in five dimensions, not four. But the basic notions to enable our visualization and understanding still apply.

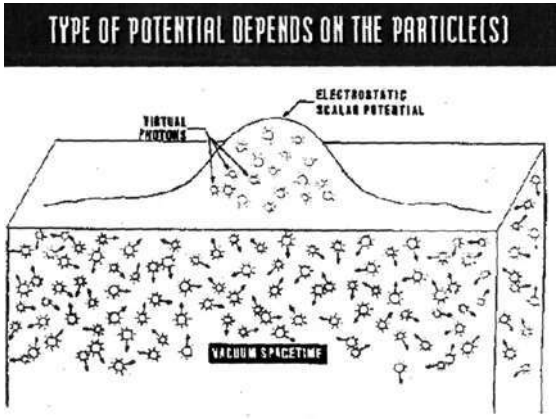

Slide 014: Type of Potential Depends on the Particle(s)

Now one can see that, by choosing the type or class of virtual particle, and looking at its potential or stress in the vacuum, one can have many kinds of "potentials" existing in the overall "gravitational potential" of vacuum spacetime.

For example, the stress of the virtual photon flux (which is what causes electrical charge) is called "electrostatic scalar potential."*

We can choose any other class of virtual particle we wish, and there exists a potential (and "change") for it. There are quark potentials, neutrinic potentials, etc.

Indeed, one of the reasons for ignoring Kaluza unified theory for so long was that it predicts a great many types of potentials and fields which have never been observed and which are unknown. Approximations, which neglected all these mysterious, and unknown fields, gave erroneous results. Perplexed physicists, seeking to simplify matters, simply turned away from it in frustration. They returned to it in the mid-70's when it appeared that 11-dimensional Kaluza-Klein theory possibly offered a complete unified theory.

Actually, the diversity of new fields in Kaluza theory was its strength not its weakness. That they are presently unobservable and undetectable is beside the point. Neither is time directly observable; however, we have worked out handy procedures and measurements of spatial quantities, which allow us to infer time. We have not just tried to drop it from physics!

And indeed the Kaluza theory is consistent with experiment when the higher fields are included. The message is, we must work out "clocks" for these new potentials and fields, so that they can be inferred with at least some degree of precision

- The character of movement also determines the type of potential. The longitudinal (radial) movement of the virtual photon flux is implied in electrostatic scalar potential. The swirl (tangential) component of this flux might be taken as the magnetostatic scalar potential - a magnetic pole - when the cw and ccw components of the swirl balance, but the sum of their absolute values differs from the sum of the absolute values of the corresponding tangential components in the swirl flux of the local ambient vacuum. If this swirl stress is higher than the vacuum swirl stress, this constitutes a north magnetic pole. If lower, it constitutes a south magnetic pole. If there is a prevalence of direction (cw or ccw) in the swirl (i.e., one component exceeds the other), this corresponds to the magnetic vector potential (the A-field) when the A-field is freed from the magnetic force field (B-field) — i.e., when A-field is freed from its ∇x operator in the equation $\nabla x A = B$. The bleed-off of the excess swirl stress from the north magnetic pole to the deficient swirl stress of the south magnetic pole constitutes the magnetic force field, B — usually referred to simply as the "magnetic field."

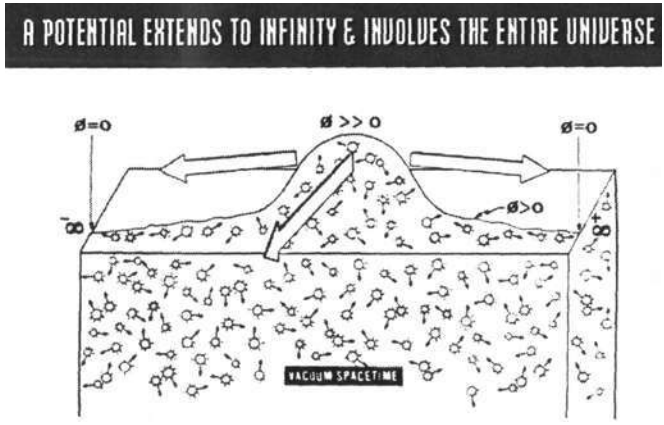

Slide 015: A Potential Extends to Infinity & Involves the Entire Universe

As shown on this slide, the change in the stress of vacuum due to a potential tapers off to infinity. Its magnitude normally does not reduce to zero until infinity.

Some types of potentials reduce much faster or slower than others, however, and so - at some distance away from a common origin of the potentials, one or more may be neglected in its (their) overall effects on an experiment or system.

Also, the speed of propagation of potential is highly dependent upon (1) what type of virtual particle or particles produce its stress, (2) its magnitude, (3) its composition, and (4) the presence or absence of coupling objects and other interacting potentials.

Fundamental observable particles are like little spray pumps and little vacuum cleaners at the same time.

Each is emitting virtual particles into the vacuum in a spray or flux, and at the same time it is absorbing virtual particles from the vacuum spray or flux. It's a little dynamo, and nature furnishes its driving energy unceasingly.

However, each little virtual particle it emits is itself such a little simultaneous pump and vacuum cleaner. That is, it's also emitting an even finer (and faster) flux of smaller virtual particles, and at the same time it's also absorbing flux al this time finer level.

"Bigger fleas have smaller fleas to bite em;

And so on ad infinitum".

We may consider the vacuum to be made of an infinite number of virtual state layers or levels.

It is not too difficult to show that each of these successively deeper, nested "layers" of virtual state corresponds to a successively higher dimension being added to our 4-space basic spacetime. So hyperdimensions and deeper levels of virtual state are one and the same thing.

The basic "speed" of the first layer is c, the speed of light.

The basic "speed" of the second layer is c^2.

And so on.

This is interesting. We may directly engineer the virtual state by means of the vector zero (scalar electromagnetics) approach. By nesting vector zeros inside other vector zeros, we may directly engineer the deeper layers of virtual state, and consequently hyperdimensions.

Scalar electromagnetics thus is virtual state engineering and hyperspatial engineering at one and the same time.

Superluminal communications systems, hyperspace drive, and materialization and dematerialization are all hypothetically possible, using scalar electromagnetics. As the technology develops, we should see the development of many of the systems long thought impossible except in science fiction.

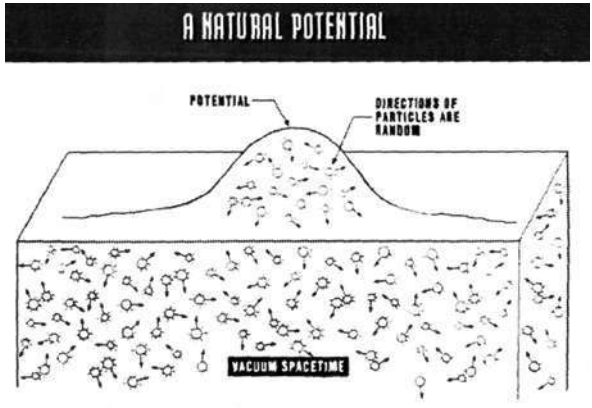

Slide 016: A Natural Potential

There are two broad categories of EM potentials, depending upon the way in which they are formed.

The two categories of potential formation are: (1) natural, and (2) artificial.

The difference is in the virtual particle flux substructure that comprises the potential.

If the substructure of emerging and vanishing virtual particles is random and without deliberate order (polarization) except in one broad, overall sense, then that is a natural potential. As such, there is no deterministic functioning going on inside the substructure of the potential itself. The potential can only act "as a whole" on a charged particle system.

Natural potentials have substructures of random virtual vector components. Any small amount of coherence as a function of distance vanishes quickly (on the order of a few thousand angstroms at most, according to present Aharonov-Bohm experiments).

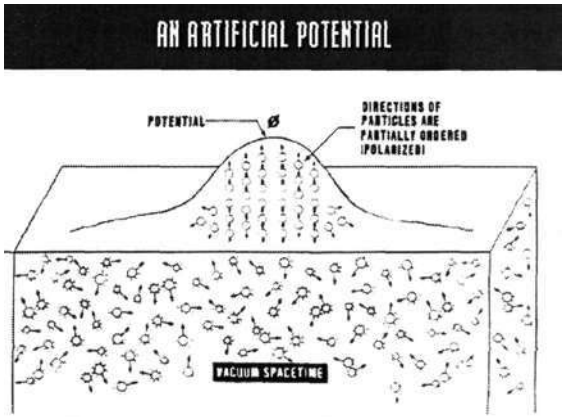

Slide 017: An Artificial Potential

An artificial potential by definition has a substructure composed of deterministic observable vector components, summed to an overall zero vector. Coherence as a function of distance can be maintained over enormous macroscopic distances - even hundreds of thousand of kilometers - by simultaneous transmission of the entire cluster of substructure components as a coherent "zero" group.

To the conventional linear EM detector, at any point along its transmission path, this substructure is detected as a zero-E vector and a zero-H vector. Hence the conventional detector does not see the artificial potential, even if its "stress magnitude" (a function of the magnitudes of all summed components) changes.

Action at a great distance is possible with this artificial potential, however, if a highly nonlinear situation is met so that the phasing of the components is broken or significantly altered. In that case, the components do not sum to zero after their dephasing, and real EM force fields emerge. This "dephasing" can be made to occur at the distant nonlinearity.

Action at a great distance is not possible with the natural potential, but is possible with the artificial potential.

Further, with the transmitted artificial potential, VO must be applied from the transmitter to the distant interruption zone, as if there were no intervening space between.

Note that VO may be positive or negative. Thus energy may emerge at the distant disruption, or be extracted from there. In the first case, energy is input to the transmitter, to re-emerge at the distant dephasing zone. In the latter case, energy is extracted (disappears) from the distant dephasing zone and is received (reappears) back at the transmitter

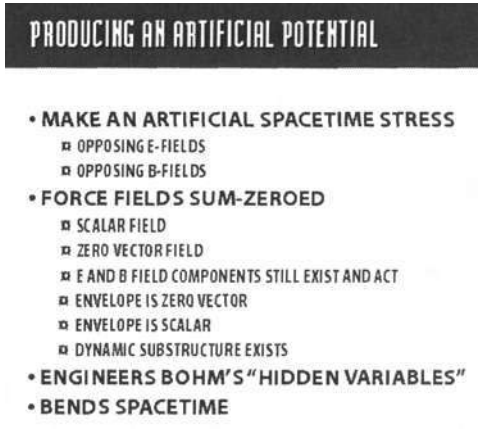

Slide 018: Producing an Artificial Potential

ANartificial potential is deterministically patterned spacetime stress, made by opposing E-fields and/or B-fields so that they sum to vector zeros in a special pattern.

The resulting zero-summed envelope has no EM force field, to an external observer/detector.

However, the infolded E-field and B-field vector components still exist and act. They may dynamically vary, so long as their summation is always kept to zero.

The simplest variation is to vary all their magnitudes at once, by the same degree. In that case, each one comprises an "EM wave." However, the summations of this cluster or "locked group" of waves still exhibit a zero-E and zero-B field to any external observer/detector. In other-words, to an external observer, one now has a varying wave of pure spatiotemporal stress, but one that has a deterministic structure. This is a scalar EM wave, or electrogravitational wave. It is also an alternating current of specific scalar pattern.

Varying the stress of spacetime locally, curves it locally. This violates the conventional assumption of restricted general relativity that local spacetime is uncurved (is a Lorentz frame).

By use of scalar EM waves with deliberate substructures, one can engineer Bohm's "hidden variables" so that quantum mechanics becomes deterministic

rather than statistical. This is a drastic change to the common (Bohr) interpretation of quantum mechanics.

And Einstein's intuition that God does not play dice with the universe turns out to be correct after all.

Since physicists haven't seen where the real game was being played, it has all seemed bewilderingly statistical to them.

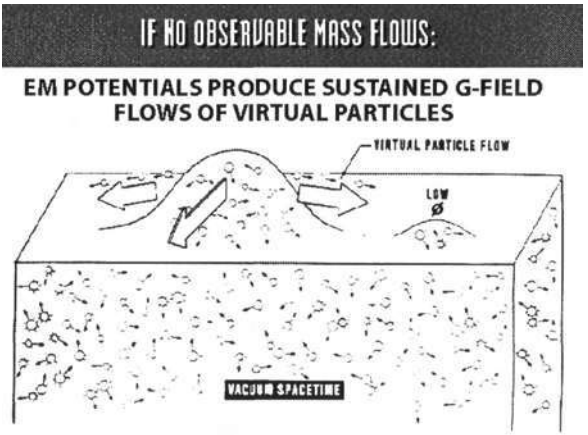

Slide 019: If No Observable Mass Flows:

Since there are no observable mass particles flowing in vacuum, there are no observable force fields produced. Only virtual force fields can be produced in the virtual particle medium that is vacuum itself.

Thus (here is no observable E-field in the vacuum surrounding a charged point. There is, however, a virtual E-field there. When an observable charged particle such as an electron is introduced in the surrounding vacuum and "couples to" (integrates, zips together) the virtual E-field, an observable E-vector force is produced on and of the observable charged particle.

(For the classically trained electrical engineer or electrical physicist, the statement that no E or B fields as such exist in vacuum, is usually bewildering. Let me point out that any so-called "vector field" (such as the assumed E and B vacuum fields) can mathematically be replaced with two scalar fields. See E. T. Whittaker, Proc. Lond. Math. Soc.l, 366, 1903. What we are saying here is that the definition of an E field is in terms of force per unit charged mass. The scalar fields - which are actually what exist in vacuum - provide only a virtual or unzipped E field, until an observable spinning particle couples to both of them by virtue of its "dynamo flux pump" action. The ensemble, then, of two electrostatic scalar potentials coupled to a spinning observable particle, constitutes and is the so-called "E-field.")

When detecting these "vacuum E-fields," it is the free electrons in the electron gas in our probe or antenna which couple to the two "Whittaker scalar fields". These electrons produce ensembles that interact with each other collectively.

Charges in this electron-gas coupled medium is what we actually detect - not "what is in the vacuum."

To repeat this again for emphasis: The usual detector is an "electron-wiggle" detector. It detects changes in its own conduction electron gas, not in the vacuum itself. That is, the disturbance in the virtual-particle vacuum interacts with the observable particles of the electron gas, if (and only if) the spins of these observable particles couple the vacuum disturbance to the electrons and integrate their virtual components. After integration, an observable disturbance of the integrating object - say, the electron - results. It is this electron gas disturbance that is "detected" by almost all orthodox EM detectors.

If the spin of the observable conduction electrons cannot couple the electron to the vacuum flux disturbance, then the normal "simple" detector will not detect the disturbance. (By a "simple" detector we mean one in which the electrons are able to couple to the vacuum disturbance! Little circular definition here!)

Now most potentials reach to infinity before reducing to zero. The change in the virtual particle flux intensity of vacuum - which comprises the potential - decreases with distance from the potential. The magnitude of the change tails off toward zero as one approaches infinity.

To any finite distance, then, there exists a decreased gradient in the change of the virtual flux intensity of vacuum, from a potential. Therefore virtual particles are flowing in the direction of the decrease of this gradient, just as gas molecules flow from a region of high pressure toward a region of lower pressure.

So there is a virtual particle "river" in the vacuum between any two separated points of different potential magnitude. The type of potential determines the type of virtual particle(s) in the river.

If the potential is natural, the gradient river does not carry any coherent substructure.

If the potential is artificial, the gradient river carries the coherent substructure everywhere within it. In this case, there is a flow or "river" of the virtual structure of this coherent pattern in the vacuum between two separated points of different "potential" in that pattern.

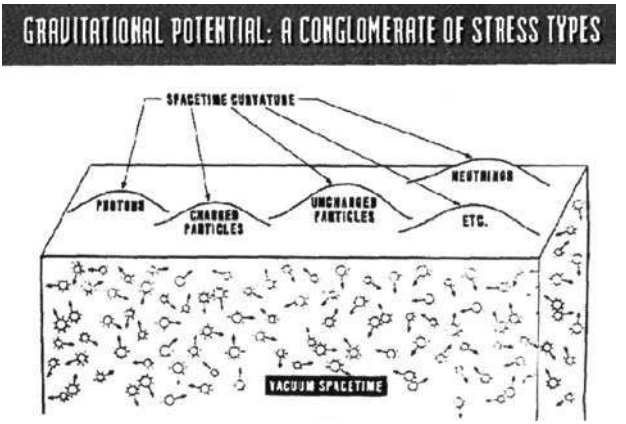

Slide 020: Gravitational Potential: A Conglomerate of Stress Types

Rigorously, all EM potentials are actually part of the overall 5-dimensional gravitational potential.

There is no such thing as "the" singular gravitational potential: instead, it is a conglomerate of different stress types and patterns, each of which is named for the type of action that produces it.

The movement of charged particles, for example, creates electromagnetic potentials. At any point in vacuum, the potential consists of a flux of virtual particles.

The vacuum contains a great variety of particle fluxes. There are virtual photons, virtual electrons, virtual positrons, virtual protons, virtual pions, virtual neutrinos, etc.

The conglomerate stress from all these virtual particle stresses constitutes the overall gravitational potential

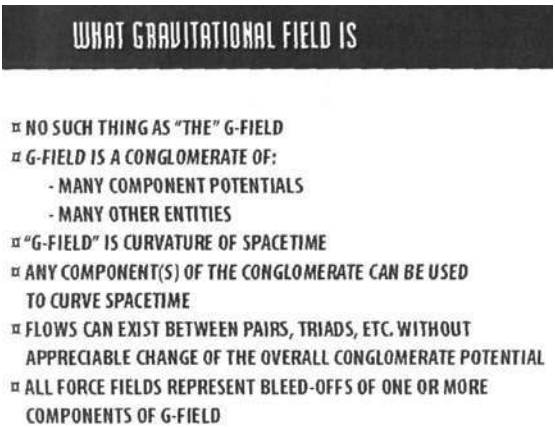

Slide 021: What Gravitational Field Is

As previously stated, there is no such single thing as "the" gravitational field, as is assumed in the Newtonian sense.

G-field is a conglomerate of many component potentials and other entities.

Rigorously, anything that "curves spacetime" is a gravitational field.

In the modern view, all forces ultimately arise, by some means, from the curving of spacetime. Thus all forces and force fields are related to - and caused by, so to speak - gravitational field.

If the vacuum stress is uniform from one place to another in an observer's **frame** then the observer's spacetime is uncurved. The observer's frame, is said to be linear or uncurved; or a Lorentz, frame. In such a situation the conservation laws rigorously apply for macroscopic, closed systems.

If the vacuum stress is not uniform from one place to another, then the spacetime is curved. In such a situation the conservation laws may be violated for macroscopic systems, since they are "opened" to the vacuum stress, and vacuum virtual particle flux gradients exist across the system or portions of it.

Note that the overall stress magnitude may be constant across a region, but its composition may change. That is, two or more components may vary canonically. In that case, the spacetime is uncurved in the gross external sense, but contains specialized "internal" curvature patterns locally. Depending upon

reaction to the canonical infolded curvature patterns, some macroscopic systems will still exhibit conservation, but certain other macroscopic systems may not.

An example is symmetry breaking. Here charge, parity, and time symmetry may be violated individually or in pairs, but not all three simultaneously. An overall conservation law is obeyed, but any two of the three conservation laws can be (und are) violated.

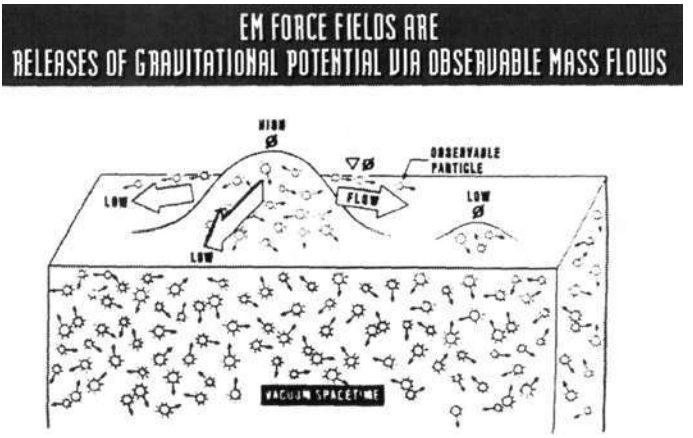

Slide 022: EM Force Fields are Releases of Gravitational Potential via Observable Mass Flows

In Kaluza theory, we may take EM force fields to be the 5th dimensional "bleeding-off" of a 5-G potential. However, in vacuum alone this bleeding-off is totally within the virtual state. That is, only virtual EM force fields exist in vacuum.

By the ordinary term "EM force fields," physics has chosen to imply measureable or observable E and B force fields.

That implies that the 5-G potential gradient flows of virtual particle flux must be coupled to observable charged particles - such as electrons, protons, ions, etc. - before observable E and B force fields exist.

Rigorously, E and B force fields consist of the virtual E and B force fields coupled to observable charged particles. They do not "cause" a particle to accelerate; they are the product of the particle and its acceleration.

As these observable particles are themselves "spray pumps" producing virtual particle flux, then a collection of them represents an increased or decreased **flux** (for negative or positive charge) vis-a-vis the ambient background flux of vacuum. Nature furnishes the continuous power to drive these "virtual flux" pumps.

Normally, EM potentials are formed in natural and manmade electrical circuits by collections of these observable particle "spray pumps." Such collections of

increased or decreased "spray flux" density, of course, represent 5-potentials, gravitationally.

Release of these pumps in conductors or in the vacuum itself results in creating E-fields and B-fields on and of the moving observable charged particles. But release of the observable-particle spray-pumps from the collection (the potential "pressure head" or "source") reduces the potential or "pressure" at the source.

Thus the formation of E and B fields represents the release of the 5-potentials. Hence EM force fields are the bleed-off of 5-dimensional G-potential via observable mass flow.

Since classical EM always seeks to create the force fields, it always bleeds-off and discards the gravitational effects that could be otherwise achieved.

To allow orthodox EM flow is to dissipate the gravitational effects.

Strangle the orthodox EM flows, and you can keep and use the amplified gravitational effects.

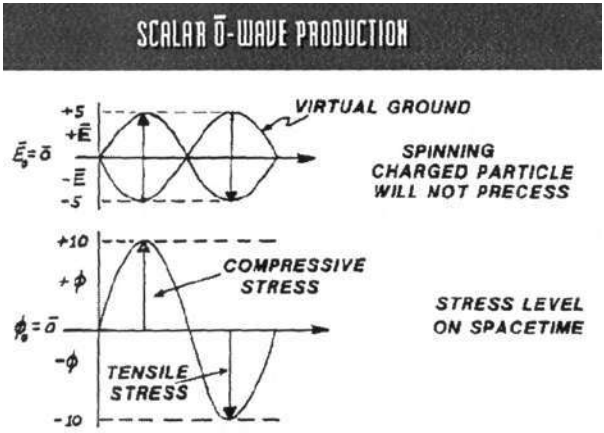

Slide 023: Scalar O-Wave Production

We now visualize the formation of waves of pure stress in the spacetime medium (in the vacuum). These we call scalar EM waves, Tesla waves, electrogravitational waves, longitudinal EM waves, waves of pure potential, electrostatic/magnetostatic waves, and zero-vector EM waves. All these terms are synonymous. Each sheds its own particular light upon the nature of these waves or of their original discoverer, Nikola Tesla.

We use a gedanken experiment, or thought experiment, in which we can be "perfect."

Thus we have two single-frequency EM sine waves whose E-field componenls are shown on the slide. The two waves are of the same frequency, traveling together in the same direction, and superposed 180 degrees out of phase with each other.

In this case, at any spatial point, the summation E and B fields are vector zeros.

However, if we plot the spatiotemporal (vacuum) stress induced by the wave, wo see that it constitutes a sine wave, with compressive stress in one half cycle **and** tensile stress in the second half cycle.

Rigorously this defines a "longitudinal" EM wave - or what Tesla called a "sound wave in the nonmaterial ether."

Also, rigorously it is a gravitational wave, for it is a wave of the curvature of spacetime (nonlinearity of vacuum) itself. That is, what is changing in the wave

is the vacuum stress, or intensity of the virtual particle flux of vacuum. That is identical to changing the curvature of spacetime. In one half-cycle, spacetime is curved positively. In the second half-cycle, spacetime is curved negatively.

Since the increase or decrease of the intensity of virtual particle flux (vis-a-vis the ambient vacuum's virtual flux intensity) represents electrical charge, then in one half-cycle negative charge is represented, and in the other half-cycle positive charge is represented. This directly explains the "positron-electron pair" representation of an electromagnetic photon - the "photon" being one wavelength.

In one half-cycle, time moves slower. In the second half-cycle, time moves faster. Thus scalar waves can also be considered to be "tempic" waves (to use Wilbur Smith's term), or oscillations of the rate of flow of time itself, about the ambient rate of time flow. Since these oscillations are variations in the curvature of spacetime, then they represent gravitational or force-generating waves, when coupled to a mass.

Variations in the rate of flow of time produce force, just as any other type of curvature in space-time does.

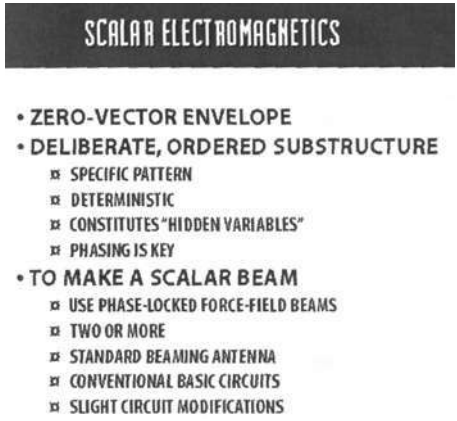

Slide 024: Scalar Electromagnetics

To rehash: scalar waves are zero-vector waves. Patterned E and B fields exist in a relationship where their summation equals vector zero. Electromagnetically, the zero EM "envelope" of a scalar EM wave is composed of a zero-summation of infolded finite EM force-vectors.

However, the internal (infolded) substructure is deliberate, macroscopic, and ordered. Vacuum is polarized deterministically by the wave, and macroscopic spacetime is locally curved by it.

These substructure components constitute Bohm's "hidden variables." They can be manipulated and varied at will. Phasing, beaming, frequency, superposition, interference, resonance, and Fourier expansion are the keys to scalar EM engineering.

To make a scalar beam, special modifications are made to the EM wave transmitter so that, effectively, the transmitter transmits multiple transmissions simultaneously, and these vectorially sum to zero. This is the same thing as transmitting multiple phase-locked EM force-field beams simultaneously, in **the** sum-zeroed fashion.

Standard beaming antennas and conventional circuits can readily be utilized with slight modifications.

Any radar can be converted to a scalar EM radar quite simply. Indeed, a modification kit to accomplish that can be developed and held until the **scalar**

mode is desired. The modification kit can be quickly installed to provide the scalar capability.

Scalar radars, for example, cannot track "corner reflector" targets. However, they can magnificently track smoothly filleted corners; rounded, smoothly curved surfaces; and curved or flat metalized dielectrics. Against aerial targets using special construction to lower their cross-section to normal radars, the application of the scalar radar mode is immediately obvious.

Scalar waves pass through the electron shells of an atom and interact with the nucleus. They are continually absorbed and emitted by all nuclei in the universe.

BACKGROUND FOR THE BRIEFER.

Any large collection of nuclei - such as a star or a planet - is a strong absorber and radiator of scalar wave radiation.

The Sun is a particularly strong source of scalar radiation. This radiation penetrates the Earth deeply, interacting more and more with the deeper layers which, under greater mechanical stress, are more nonlinear. Most of the heat in the molten core of the Earth comes from the dephasing of a portion of this absorbed scalar radiation from the Sun, liberating ordinary EM energy as heat.

The Earth also re-radiates scalar wave radiation back to the Sun. The Sun and Earth are thus coupled into a "scalar" system in equilibrium or near-equilibrium. Each body in the couplet possesses both a feed-forward and a feedback loop.

The Earth also radiates scalar wave radiation to the Moon, and the Moon reradiates scalar radiation back to the Earth. The Earth and Moon also are coupled into a "scalar" system in equilibrium or near-equilibrium. Again, each body in the couplet possesses both a feed-forward and a feedback loop.

The Sun and Moon are correspondingly coupled into a scalar system in equilibrium or near-equilibrium, each with both a feed-forward and a feedback loop.

The Earth, Sun, and Noon thus form a triad-coupled system of special importance to the stability of our existence here on Earth, and the stability of our biosphere.

And so on with all the other planets in the solar system, and combinations thereof.

The solar system is thus a very sensitive scalar-coupled system, with strong subsystems within it.

ADDED FOR THE BRIEFER:

Actually this scalar coupling of the solar system provides a major check on unreslricted use of the large Soviet strategic scalar EM weapon systems. If significant scalar effects are produced on earth in a "pulse" mode, pulsed

disturbance of the earth-sun and earth-moon systems results. Here a danger exists that one or more natural resonances of the coupled system may be excited. If the feedback stimulation of the Sun is not insignificant, for example, large sunspot activity may result sometime thereafter, say in a day or two. If too much or too sharp stimulation occurs on earth, the coupled resonant response from the sun could be disastrous. Indeed, a solar response could be stimulated so that the Sun would violently belch and destroy our biosphere, among other effects. The simplest doomsday stimulation would be for a violent expulsion of Solar EM energy and particles to occur. If this were due to resonance, the expulsion of Solar EM energy and particles would continue during some decay time. In that case, fiery destruction of the earth, strongly indicative of Biblical prophecy, would result. Particularly sensitive are the resonances of the sun-earth, sun-moon, and earth-moon systems.

Note the abnormal influence of the moon on tides - tides of both the tectonic plates and the oceans. One cannot help but point out that, if the earth-moon resonant system were overstimulated, one might expect violent earthquakes of extraordinary magnitude, and tremendous tidal waves hundreds of feet in height. (The potential connection to legends of earth-destroying floods, evidences of extreme water levels in mountains, and legends of ancient cataclysmic destruction of supposedly advanced technological oceanic cultures is obvious.)

Accordingly, use of huge scalar EM weapons is a double-edged sword. Unless carefully employed, use of the weapons could cause a terrible backlash to the user as well as the victim, and even accidentally cause the destruction of the earth itself. It is not accidental that in 1960 Khrushchev stated that his new fantastic weapon could - if unrestrainedly used - destroy all life on earth.

This appalling backlash potential is apparently what prompted Brezhnev in 1975 to make so strong an effort to get agreement to outlaw the development of "new weapons of mass destruction" more frightful than the mind of man had even dreamed of. Gromyko even introduced such a draft agreement into the proceedings of the United Nations. The first article of the draft agreement indicated that the nature of the weapons referred to would be negotiated. Sadly, the entire Western world did not even know what the Russians were talking about.

ROGERS' UNDERSEA & UNDERGROUND COMMUNICATIONS SYSTEMS

- SECRETLY USED BY U.S. IN WWI
- COMMUNICATED TO SUBS UNDERWATER
  - ANY DEPTH, UP TO 30 KHZ
  - REDUCED DEPTH, – 30 KHZ
- COMMUNICATED TO EXPEDITIONARY HQ OVERSEAS
  - 5000 TIMES STRONGER THAN AERIAL
  - STATIC-FREE
- DECLASSIFIED IN 1919
  - TO REVOLUTIONIZE COMMUNICATIONS
  - TO END ALL SURFACE ANTENNAS
- MYSTERIOUSLY "LOST"
- REDISCOVERED AND "LOST" 3 TIMES AFTER WWII

Slide 025: Rogers' Undersea & Underground Communications Systems

In an article in the March 1919 issue of the Electrical Experimenter, a real bombshell was released on an unsuspecting world.

In that issue, details of the Rogers'undersea and underground communication systems were released. These systems had been classified SECRET during WWI, and used to communicate with (1) U.S. submarines underwater around the world, and (2) U.S. Expeditionary Forces Headquarters overseas.

Subs at any submerged depth could be reached with transmitters of frequencies up to 30 kiloHertz. At reduced depths, frequencies above 30 kHz could be used.

At the headquarters of U.S. overseas forces, the signals were received through the earth. They were 5,000 times stronger than aerial signals through the atmosphere, and static-free.

The Rogers' systems were covered by a series of patents. They used special antennas implanted in the ground.

While the patents are somewhat confused, several of the diagrams in the Electrical Experimenter reveal that the antennas were producing scalar waves. Scalar waves can indeed travel through the earth and through the ocean. Indeed, if good quality scalar waves are made, then frequencies well above 30 kHz can be sent through the ocean. Multi-megahertz frequencies, for example, are easily achievable. (The problem, of course, is that these waves are pure zero-vector

artificial potentials that do not move electrons in the conduction gas of a conventional antenna/receiver combination. Normal receivers and detectors do not see them. Special underwater detectors - such as those developed by Frank Golden - are required.).

With the startling declassification and revelation of the Rogers' systems, it was expected that all communications would be revolutionized, and that all surface antennas would be removed.

Strangely, this entire technology faded away quickly, as if it had never been. Certain powerful interests did not wish the extended electromagnetics to be discovered or taught. That, after all, would lead to free energy and loss of economic control of the citizens. That was precisely why Nikola Tesla had already been suppressed.

According to the important research of Dr. Robert Beck, the same scalar technology has been rediscovered and mysteriously "lost" at least three times after World War II!

Today the orthodox establishment is still suppressing it.

One wonders why no orthodox physicist - with the single exception of Dr. Hooper (see U.S. patents 3,610,971, Oct. 5, 1971 and 3,656,013, Apr. 11, 1972) - seems to have experimented with deliberately constructed zero-vector EM waves and devices, and published his results in the literature.

One would think that any university physics department would wish to explore such a gaping void with at least a few graduate student experiments, if for no other reason than scientific curiosity, particularly when the experiment is easily performed, it is totally different from anything else in the theory or literature, and the implications may be formidable. A true scientist in that related field ought to try it!

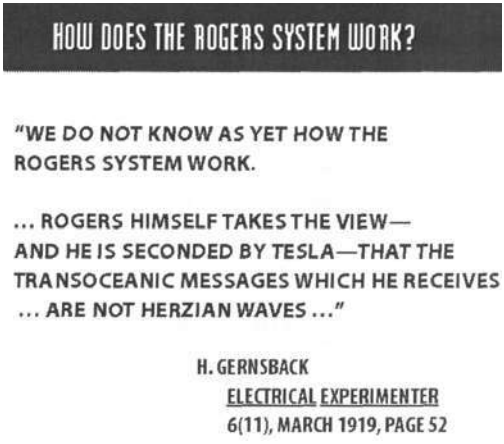

Slide 026: How does the Rogers System Work?

In the same March 1919 issue of Electrical Experimenter, Hugo Gernsback pointed out that no one as yet knew how the Rogers' system actually worked.

Rogers himself believed he was not using conventional Hertzian waves.

Nikola Tesla himself confirmed that the underground and undersea waves were not Hertzian waves.

If so, they could only have been scalar waves.

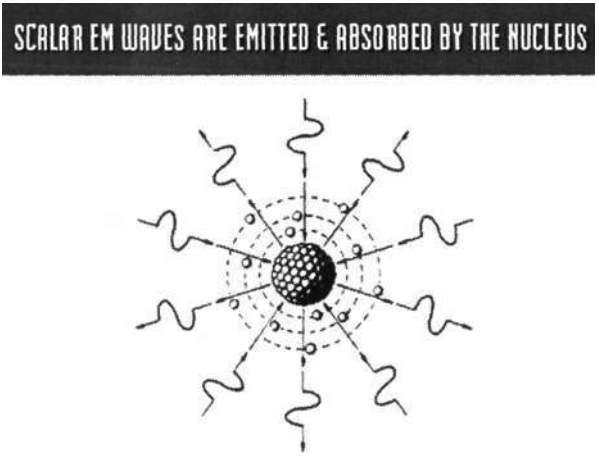

Slide 027: Scalar EM Waves are Emitted & Absorbed by the Nucleus

Normally scalar EM waves do not couple to orbital electrons. Entering into the atom, incoming scalar EM waves penetrate the electron shells without interaction. They continue, penetrating into the interior of the closely packed nucleus, where the extreme nonlinearity of the charged virtual particle flux that binds the nucleons together distorts the scalar wave, dephasing its summed EM vector components. This produces a nonzero EM resultant and polarized pattern directly inside the virtual particle charge flux of the nucleus.

The new EM resultant immediately couples the distorted scalar wave to the nucleus, resulting in absorption of the wave and incorporation of its polarization pattern into the nucleus' virtual flux. This in turn results in a slightly excited nucleus. Normally the excited nucleus will promptly decay by emitting another scalar wave, which passes through the orbital electron shells and radiates out into the universe.

However, as can be seen, if the same strong scalar pattern is constantly radiated into the nucleus and absorbed by it, the excitation of the nucleus "charges up," leading to decay by other modes. In this manner the nucleus can be engineered even transmuted - by rather minuscule power of the engineering radiation signal.

This is how living biological systems are able to transmute elements, as discovered by Louis Kervran. (Kervran was nominated for the 1977 Nobel Prize

for this work.). The biosystem produces scalar EM waves. If the appropriate signal is employed into and on the appropriate nucleus, a changed element emerges. In this fashion chickens denied sufficient calcium in their diet, but allowed a surplus of potassium, are able to transmute some of the potassium into calcium. Note that one of the isotopes of potassium is an isomer of normal calcium. Transmutation of this potassium isomer to calcium is easiest.

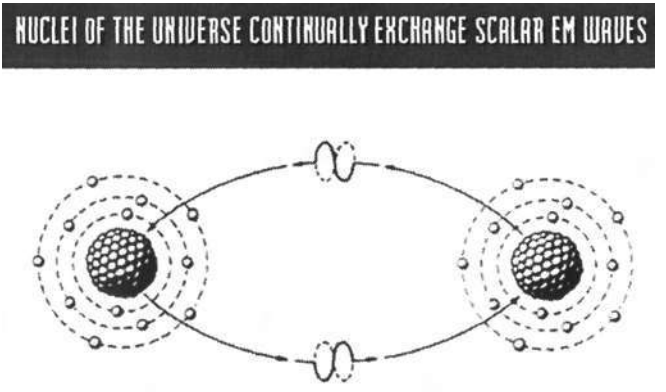

Slide 028: Nuclei of the Universe Continually Exchange Scalar EM Waves

Thus scalar EM waves are continually exchanged by all nuclei of the universe, and the vacuum is - among other things - a seething cauldron of scalar radiation.

In fact, it is this seething scalar wave cauldron that creates the virtual particles and the virtual particle flux of vacuum itself. (Since the scalar EM wave represents an oscillation of the curvature of spacetime, and since everything - virtual or observable - is a curvature of spacetime, then scalar waves can be taken as the universal generatrix.

The intensity of the trapped scalar flux in the nucleus of an atom is responsible for the mass and inertia of the nucleus.

Mass is localized trapped scalar resonance.

The trapping agent is the spin of a particle.

The mass and inertia of the particle are due to the scalar resonance that is trapped. Increasing the amplitude of the trapped scalar resonance increases the mass and inertia; decreasing the amplitude decreases the mass and inertia.

CONVERTING EM FIELD ENERGY TO G-FIELD ENERGY & VICE-VERSA

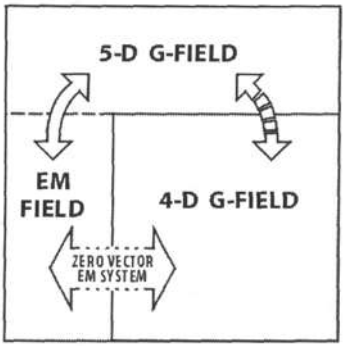

Slide 029: Converting EM Field Energy to G-Field Energy & Vice-Versa

According to Kaluza theory, there are no such things as a separate EM field and a separate gravity field. Instead, in five dimensions there is only one field: the 5-d gravitational field. The EM field is the 5th dimensional aspect, while our **normal** 4-dimensional G-field is the other aspect of the 5-field, in our normal 4-space.

Thus we may say that the 5-field is composed of two components: the 5th dimensional component (our normal EM field) and the component occupying **our** normal 4 dimensions (our normal G-field).

The 5-d "force" field, of course - or the 5-space analogy to a force field - would be due to a gradient or "bleed-off of the 5-d gravitational potential. This gradient in turn is composed of two components: the 5th dimensional "bleed-off" outside our normal 4-space (this outer bleed-off is our normal EM force **field**) and the bleed-off inside our normal 4-space (this inner bleed-off is our normal G-field).

Normally the 5-potential bleeds-off outside our 4-space as EM field, far greater than it bleeds-off inside our world as G-field. Between two electrons, for example, the electric field is about 10^{42} times as strong as the G-field. Since in the Kaluza view there is only one 5-d G-potential that is causing both force fields, this shows that there is an incredibly greater EM bleed-off of the 5-

potential between the two electrons than there is a G-field bleed-off between them.

As shown on the diagram, the 5-d G-field is normally comprised almost entirely of the 5th dimensional EM field. Only a small 4-space G-field component exists.

However, suppose we were to "block" the bleed-off of the 5-potential in the EM mode. Then none of the 5-potential could bleed-off in the 5th dimensional EM field. Instead, it would be forced to bleed-off into the 4-space G-field. In our two-electron example, this "perfect case" would result in the disappearance of the E-field between the two electrons, and the G-field between them would increase to about 10^{42} times its normal strength.

The end result would be that, by blocking the EM force field bleed-off, EM field is converted to G-field. In addition, EM field energy is converted to G-field energy. With the extremely amplified gravitational and inertial effects that result, one can now accomplish direct engineering of gravitation, mass, and inertial effects.

We can effectively accomplish this "blocking the EM bleed-off by opposing EM force fields so that they sum to vector zero. This is the same as summing various 5th dimensional gradients of the 5-potential to a zero vector resultant. In that case, as much "EM bleed-back to 5-potential" occurs as there is "EM bleed-off from 5-potential." This places the 5-potential in equilibrium with respect to EM bleed-off.

Also, another nice thing results: Since we can readily vary the magnitudes of the EM force field components of the vector zero summation, we can actually form phased "zero vector waves" by increasing and decreasing the magnitudes of all the component EM vectors in phase, but retaining their vector summation always equal to zero.

In that case we have produced a very simple 5-space G-potential wave, which concomitantly forces phase-locked variations in the 4-space G-potential. In short, we have produced an electrogravitational (EG) wave, or scalar EM wave for short. This wave described is the simplest EG scalar wave we can produce; much more complex EG waves can be produced and used for highly **specialized** purposes.

The scalar EG wave changes EG potential energy into 4-gravity potential energy in one half-cycle, and changes 4-G potential energy into EG potential energy in the other half-cycle. However, the EG potential energy in the first half-cycle does not react electromagnetically in linear circumstances, since it is electromagnetically a linear vector zero.

So our scalar EG wave actually oscillates energy back and forth between a locked-in 5th dimensional EM potential and a 4-space G-potential. As can be seen, to the linear 4-space observer this scalar EG wave appears as a purely gravitational wave, with G-potential magnitude varying in a wavelike manner.

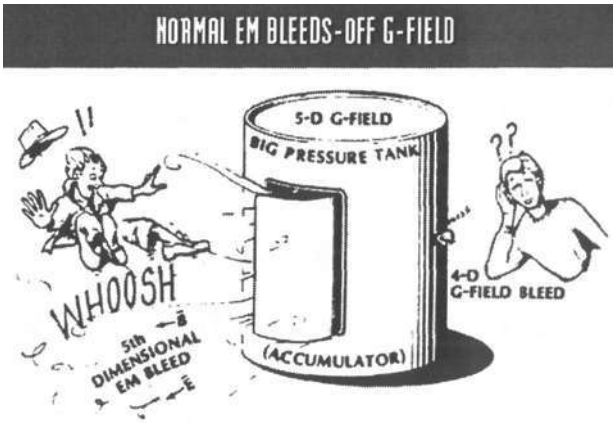

Slide 030: Normal EM Bleeds-Off G-Field

For easy visualization, we may regard the situation in the analogy shown on the slide.

The 5-potential of 5-space vacuum is like a high pressure in a big tank. The tank has a huge open door in the 5th dimension, leading to rapid bleed-off of the 5-presure through the big door; that is, as EM field. Only a very small hole in the tank normally exists in our own 4-space world, so only a very small amount of the pressure bleeds off as our G-field.

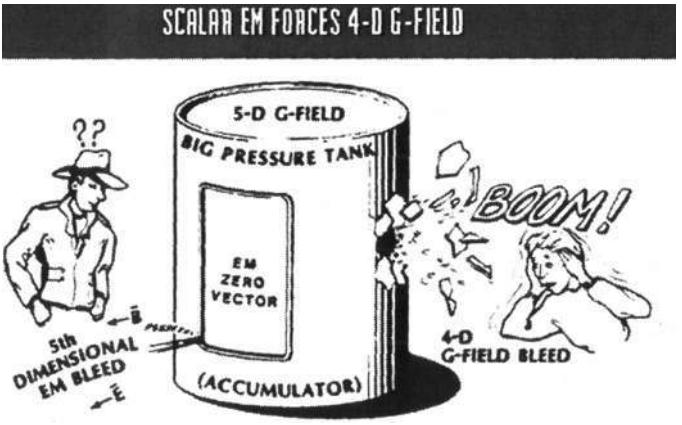

Slide 031: Scalar EM Forces 4-D G-Field

As can be seen however, if we shut the big door so that we have only a little bleed-off through the seals, then most of the pressure is forced to bleed-off through the small opening, greatly enlarging it. In that case, most of the 5-potential bleeds-off as 4-G force field.

The mass exposed to such increased 4-G bleed-off exhibits a much greater mass and inertia.

In fact, mass itself can act as an accumulator for the effect, and it can increase its ability to store trapped scalar resonance. This increases its inertia.

By the use of scalar EM (blocking the EM bleed-off), we can input normal EM energy and obtain powerful gravitational and inertial effects. Many other powerful effects can also be obtained.

DETECTION OF ELECTRO-GRAVITATION

- WHEN ORDINARY EM FORCE FIELDS ARE INTERFERED/SUMMED TO PRODUCE ZERO, AND ARE ALSO LOCKED TOGETHER, THEY PRODUCE STRESS OF VACUUM (GRAVITATIONAL POTENTIAL OF FIELD). THIS IS ELECTRO-GRAVITY.
- WHEN ELECTRO-GRAVITATIONAL FIELDS ARE INTERFERED/SUMMED TO PRODUCE ZERO, AND ARE LOCKED TOGETHER, THEY PRODUCE ORDINARY ELECTRO-MAGNETIC FORCE.

Slide 032: Detection of Electro-Gravitation

Here arc two magic rules in the scalar electrogravitational business:

(1) When ordinary EM force fields are interfered or summed so that they produce vector zero, and the fields are locked together, they produce stress of vacuum (5-potential). One component of this 5-potential is the 4-space G-potential. Since bleed-off as a gradient of this 4-space G-potential is all that is allowed, then the EM destructive interference/zero summation bleeds-off to produce gravitational force field. This is because opposing equal forces, which sum to a vector zero force field resultant, actually produce a stress potential having stress energy of spacetime. And that is a curvature of spacetime, hence gravitational.

In short, total destructive interference of EM waves or force fields produces excess stress potential energy in spacetime, and therefore gravitational force field on detecting/coupled particles.

(2) When electrogravitational fields are interfered/summed to produce vector zero, this destructive interference/zero summation bleeds-off to produce ordinary electromagnetic force field.

In short, destructive interference of scalar EM waves or fields (electrogravitational waves or fields) produces electromagnetic force fields on detecting/coupled particles.

BACKGROUND FOR THE BRIEFER:

Mathematically we can summarize this as follows;

$$G_{(1-4)} = G_{(1-4)}(m) + G_{(1-4)}(EM) \quad [3]$$

$$G_{(1-5)} = G_5 + G_{(1-4)} \quad [4]$$

If $\mathbf{E} = \Sigma \mathring{\mathbf{a}}_i E_i = \mathbf{0},\ E_i \neq \mathbf{0};\ \mathbf{B} = \Sigma \mathring{\mathbf{a}}_i B_i = \mathbf{0},\ B_i \neq \mathbf{0}$ [5]

then $G_{(1-4)}(m) = G_{(1-4)}(EM) = G_5 = G_{(1-5)}$ [6]

and $G_5 = G_{(1-4)} = f[\Sigma(\mathring{\mathbf{a}}_i\ |\mathbf{E}_i|^2)] + g[\Sigma(\mathring{\mathbf{a}}_i\ |\mathbf{B}_i|^2)]$ [7]

and $G_{(1-5)} = G_5 = G_{(1-4)}(m) = G_{(1-4)}(EM) = f(\phi) + g(\mathbf{A})$ [8]

Where:

$G_{(1-5)}$ is the 5-d G potential, or total G-stress on dimensions 1-5.

G_5 is the combined EM potential, or G-stress on dimension 5 only.

$G_{(1-4)}(m)$ is the normal 4-d G-potential of mass alone, or the G-stress due to mass-gravity.

$G_{(1-4)}(EM)$ is any extra 4-d G-potential of mass due to conversion from G_5 stress (normally zero).

E and B are the electric and magnetic force fields.

ϕ is the electrostatic scalar potential.

A is the magnetic vector potential.

Thus the age-old scientific dream of direct engineering of gravitational field — and of spacetime itself — can now become reality. To start, one simply makes an intense EM vector zero and varies its stress intensity and internal pattern of summed components. One also varies the reference potential at which the patterned EM stress zero is created, and the frequency of internal component variation.

BACKGROUND FOR THE BRIEFER.

He that has ears, let him hear.

Here is the secret of antigravity

The "electrical charge" of a charged particle — such as one of the orbital electrons of an atom or one of the protons of its nucleus — represents a difference in flux intensity (potential) between the local particle and its ambient vacuum.

It's the continual bleed-off of gravitational charge as electrical charge.

If that bleed-off is reversed or stopped, a drastic effect on the gravitational potential and charge ensues. The 5-potential and 5-charge have become 4-G-potential and 4-d-charge respectively.

Thus "charging" an object with its scalar EM pattern charges it gravitationally.

Now the only "bleed-off channel" is through the 4-G force field.

Further, in a nucleus the nucleons continually change back and forth between proton and neutron, so the electrical charge is "spread" throughout the nucleus and shared by all the nucleons.

Further, each element (actually each isotope) has its own unique "ensemble pattern" of Fourier expansion scalar frequencies, amplitudes, etc. This pattern, of course, can be reproduced artificially and transmitted by modified EM transmitters (i.e., by scalar EM transmitters). There is, however, a sort of "master key" scalar EM (EG) pattern for nucleons (protons and neutrons which are changing back and forth into each other by exchange of virtual charge currents).

If one "reverses the charge" by inverting this pattern, and then "charges up a mass with the inverted charge," to the external observer the charging mass just gets lighter and lighter, and its inertia gets less and less. Eventually it seems (to him) to acquire negative mass and negative inertia, and just accelerate away from the earth. The object "falls upward" instead of "falling downwards."

There are also some weird time effects. The object can be moving slower through time than the laboratory observer, or even be moving backwards through time with respect to the laboratory observer. (Don't believe everything they laught you in relativity; none of those professors had ever engineered a single general relativistic situation. Little that they teach in GR is based on direct experimcnt. Most of what they teach is already experimentally proven to be incomplete or in need of further extension.).

But back to our slide.

Inside the pattern itself, it's just a quite normal pattern. No change in or on the object seems to have occurred, to it, if the charge is evenly accomplished throughout the object. Indeed, to an internal observer it's the external environment that seems to have suddenly gotten very strange! This is what occasionally happens to a haplessaircraft or ship that experiences anomalous spatiotemporal difficulty in an *occasionally scalar-active* area such as the Bermuda triangle. Under the right conditions, the vehicle's gravitational charge is affected by anomalous changes in the scalar radiation from the earth in that area. To the passengers and crew, it is the external environment that suddenly seems weird. In addition, on-board EM and inertial instruments may be affected, and other electrogravitational effects may also occur, due to differing rates of charge in different parts of the vehicle.).

"Reversing or lowering the EG-charge" is controlled by means of biasing the ground potential on the ensemble pattern transmitters. These transmitters can even be on-board the vehicle itself. (Remember, in scalar EM to transmit is also to receive. A vehicle can change its own bias potential (with respect to local vacuum G-potential) by properly transmitting, which translates to "receiving potential charge." The charge current can either be negative or positive (its potential can be lowered or increased vis-a-vis that of the vacuum.) Think of this as handling positive and negative energy, which means positive and negative gravity.

By "fiddling" with this, you can float metal. Or a human body. Or a battleship. Or a high-speed vehicle containing a crew.

You can even "dematerialize it" or "teleport it."

The Philadelphia Experiment may have been real after all. If so, the test ship and its personnel were "blasted" into this strange realm, instead of making a gentle, controlled entry.

Suppose you materially lower or reverse (adjust) the gravitational charge (gravitation 5-potential with zero-summed EM to throttle EM bleed-off). At zero gravitational charge, to the external observer, such an assumed vehicle would seem to have no mass and no inertia. It is capable of extreme accelerations, right angle turns at full speed, etc. It is also right on the point of dematerialization, and may appear to be glowing or just a vehicle of light.

If the pilot wishes to "land," of course he must adjust the charge on the vehicle.

If the pilot wishes to "dematerialize" or "teleport," again he must adjust the charge on the vehicle.

If he wishes to go "hyperspatial," again he must adjust the charge on the vehicle and allow the proper bleed-off to produce a hyperspatial force. That's done with nested zero summations and nested patterns of scalar EM transmission.

That is, he can charge and bias the vehicle in multiple, nested zero-summations simultaneously.

That is necessary for hyperspatial control and travel.

Note that in lower hyperspace such a vehicle could do some very strange things. Such as "penetrate" solid matter (actually, it goes "around" the 3-space matter in a 4th Kaluza-Klein space).

We might expect to see such vehicles glowing. Their various surface features and mechanisms might appear to be glowing or revolving lights, etc.

They could exhibit incredible "aerodynamic performance," seemingly in the atmosphere. Actually they would not be moving "through" the atmosphere at all but through a higher space outside each particle of atmosphere.

They could seem to materialize and dematerialize.

They could seem to plunge into the ocean or rise out of it.

They could even seem to operate under the ocean or inside the earth itself.

Such anomalous vehicle performances have been seen all over the world, particularly since a few years after WWII.

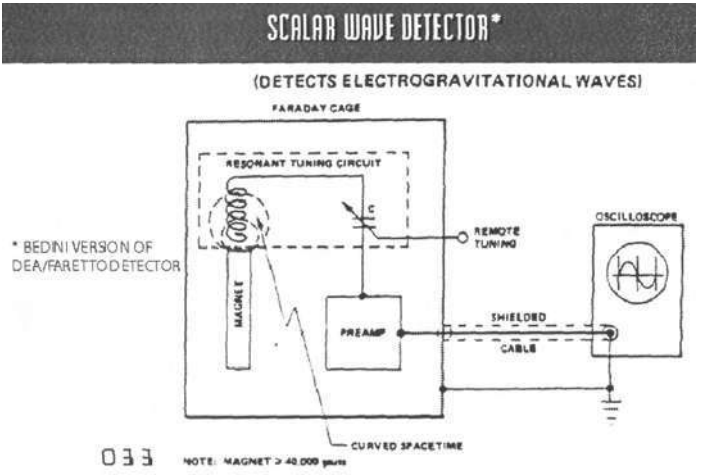

Slide 033: Scalar Wave Detector

On this slide we show a concept for a detector for scalar EG waves. This is the Bedini scalar wave detector, adapted from an original concept by Dea and Faretto.

The idea is quite simple: install a very powerful bar magnet vertically inside a grounded Faraday cage. Then install an open-ended coil longitudinally above the magnet so that a line through the longitudinal axis of the magnet passes through the longitudinal axis of the coil above it. The open end of the coil does not touch the magnet.

Connect the other end of the coil to a variable tuning capacitor, so that the coil and capacitor form a tunable, series-LC-oscillatory circuit. The output of the capacitor is connected to a transistorized preamplifier inside the cage. A tuning shaft for the capacitor is very carefully passed through a small hole in the shield to allow tuning from outside.

The output of the preamp passes very carefully through a small hole in the shield, through a shielded cable, to an adjacent oscilloscope. The cable shield in also grounded to reference ground potential.

The theory is as follows: Suppose a normal EM wave appears inside the cage, above the magnet or closely adjacent thereto. In that case a coupled **oscillation** appears in the field of the magnet, and this oscillation is coupled to the coil immediately above it. If the oscillation is within the bandwidth of the tuned

scries LC circuit, detection occurs. This is amplified by the preamp and passed to the oscilloscope, where it is displayed on the scope.

Note that the detector detects normal EM wave. Now our problem is: how do we get an EG wave to be detected? And how do we assure that we do not detect ordinary EM waves from outside?

Actually this is simple. Ordinary waves (except for quite low frequency) will be grounded out by the Faraday shield, and will not penetrate the cage. Thus these normal EM waves cannot enter the cage and appear above the magnet. They will not be detected.

Scalar EG waves, on the other hand, will enter the cage since they do not couple to conduction electrons in the metal of the cage. Above the pole of the magnet, spacetime is locally bent. After all, a pole is a magnetostatic scalar potential, which is a part of the conglomerate called "G-potential." The pole represents an increase (or decrease, depending upon whether it is a north or a south pole) in the magnetostatic component of the local G-potential. This is a curvature of spacetime. An EG wave entering this region adds a varying component of magnetostatic G-potential, which bleeds-off in the coil as an ordinary EM wave.

Another way to view the detector is to model the EG wave as a longitudinal wave, and an ordinary EM wave as a transverse wave. When the EG wave enters the curved spacetime region above the magnet, to the coil (the "observer" in this case) the longitudinal aspect of the EG wave appears to be rotating back and forth, so that an oscillating transverse component is present. This transverse component appears to the coil as an ordinary EM field, and so the LC circuit detects it if it is in the proper frequency band.

Yet another way to view the situation is to realize that an EG wave entering the magnet results in an oscillation component added to the magnetostatic scalar potential (pole strength) of the magnet. Accordingly, the magnet is a receiver for scalar waves, which are detected to "bleed-off as an oscillation of the magnetic field strength of the magnet. Coupling of this oscillating magnetic field to the coil creates an oscillating current flow into the capacitor. This oscillates the voltage input to the preamp, which amplifies and feeds the signal to the oscilloscope for display.

In fact rather like the latter view! It is important to remember that a magnetostatic potential and an electrostatic potential can be oscillated by a scalar EG wave. By placing a magnetic material inside a Faraday cage, the oscillation of the magnetostatic scalar potential (pole strength of the magnet) can be used as the EG detecting mechanism. By placing a chargeable material inside a Faraday cage, the oscillation of the electrostatic scalar potential can be detected. (Possible examples of the latter type detectors are given by Hodowanec, Radio Electronics, April 1986.)

Note also that one may detect waves at one reference level and not at another. Changing the bias on the zero-reference ground of the Bedini detector affects the detection. To look inside a normal EM carrier (such as the Woodpecker) and see what scalar signals are riding upon it, the carrier may be used to bias the reference ground of the Bedini detector.

To produce a spectrum analyzer, simply use additional series resonant LC tuning circuits in parallel (put multiple taps on the coil, and wire each tap to a separate tuning capacitor of different capacitance). Again, varying the zero reference level is important, as is varying the strength of the magnet.

Golden also has invented an excellent series of scalar wave detectors based upon quite different proprietary principles.

The bottom line is: we can indeed rigorously detect and measure scalar EG waves. When one considers the large sums of money presently being spent to bury large aluminum cylinders etc. in an attempt to detect gravitational waves, one wonders why some funds could not be released to a few unorthodox researchers by the National Academy of Sciences to fund the proven creation and detection of electrogravitational waves!

Note from TEB: I understand that it took Bedini about 600 attempts before he got the device to work. It was then handed over to a different party to produce, who made some "improvements," and the device then failed to work.

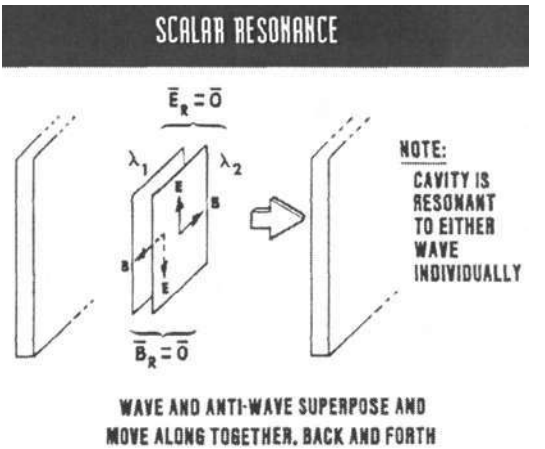

Slide 034: Scalar Resonance

Here we explain a new kind of resonance: scalar EH resonance, or electrogravitational resonance.

First, imagine we have a standard resonant cavity, represented by the two walls in our diagram. In this cavity we have a resonant EM wave moving back and forth, represented by the forward-most plane. In accordance with convention, we show the E-field vector and the B-field vector at right angles in this moving wave front. As the wave front moves back and forth, the vectors vary back and forth; however, at any one point between the walls, the two vectors always have the same value. Thus our resonant EM wave forms a standing wave in the cavity.

Now imagine that a second wave front, precisely like the first and of the same frequency, is superposed over the first wave front and travels along with it. This second wave - the "antiwave" - has its force vectors 180 degrees out of phase with the force vectors of the reference wave. Hence the E-fields and B-fields of the two superposed waves always sum to vector zeros, anywhere in the cavity. To an external observer, the cavity contains no ordinary electromagnetic force fields, hence no ordinary EM energy.

However, the energy density of a single EM sine wave in vacuum is given by

$$[E^2+B^2]/8\pi \qquad [9]$$

This energy density is always positive. Hence the energy density of the two waves at any point x between the walls is equal to

$$[E^2+B^2]/4\pi \qquad [10]$$

where

$$E = E(x)\ ;\ B = B(x) \qquad [11]$$

Thus the energy density of vacuum varies with x. But, rigorously, since the resultant E and B fields are zero, this describes a standing gravitational wave. Hence we have a standing EG wave, existing in the resonant cavity. This is an example of scalar resonance. Rigorously the cavity has mass and inertia, to an outside observer, as a result of the two warps in spacetime it contains.

Note that in one half-cycle the energy density of vacuum is greater than ambient, and in the other half-cycle it is less. In the region of one half-cycle, time flows at a faster rate than to the ambient observer, and in the other half-cycle time flows at a slower rate than to the ambient observer.

One half-cycle appears to contain negative electrical charge, and the other appears to contain positive charge.

One half-cycle appears to contain a north pole (positive magnetostatic scalar potential), and the other half-cycle appears to contain a south pole (negative magnetostatic scalar potential).

Perhaps now one can begin to understand why a continuously accelerated orbital electron in the atom does not radiate EM energy, completely in violation of Maxwell's equations. The electron is naught but a complex aspect of a standing scalar resonance, existing between the nucleus and the orbit.

SCALAR RESONANCE

- NOT IN PRESENT TEXTBOOKS
- CONTROLS NATURE OF PARTICLE
- BENDS SPACETIME
- CONTROLS MASS
- CONTROLS INERTIA
- CONTROLS GRAVITY
- CAN FLOW
- A "MASS" IS LIKE A CAPACITANCE
- HAS A SCALAR MAGNITUDE
- HAS SPECIFIC PATTERNING

Slide 035: Scalar Resonance

Scalar resonance is not in the conventional textbook.

Scalar resonance is a particular zero-summed multi-resonance, electromagnetically, so that it does not act in an electromagnetic manner.

A scalar resonance is a standing electrogravitational wave. It can be made e**lectrically,** but it is not electrical in behavior.

In any scalar resonance, spacetime is curved, and it is the magnitude (and direction; of this spacetime curvature that is oscillating in "standing wave" fashion. In respect to stress of the vacuum medium, one half of a standing sine wave of scalar resonance is tensile; the other half is compressive. However, this is with respect to the local ambient stress of vacuum.

"Mass" of a particle is just a characteristic exhibited by a trapped scalar resonance. Usually this trapping is done by the "spin" of the individual particle.

The concept of "mass" may be compared to the concept of "capacitance." That is, a mass is an accumulator for scalar waves; that is, for scalar resonances. It is continually being "charged" and "discharged" by absorption and emission of sca**lar** waves from and to the ambient vacuum scalar wave flux.

Indeed, the magnitude of a mass may be defined in terms of the absolute value of this "switching" (absorption = switch in; emission = switch out) rate. In a very early paper I defined the mass of an object as proportional to the absolute value of the sum of the input and output switching rates, where each "switch"

represents a change of action of h/(4). (Bearden, Quiton/Perceptron Physics: A Theory of Existence, Perception, and Physical Phenomena, Mar. 1973, AD 763210, available through NTIS.) In that scheme, one kilogram of mass equals a switch rate of 17.053×10^{50} switches per second. An object is in a Lorentz frame when the switch-in and switch-out rates are equal in a given direction. If, in addition, the in-out rates in all directions are constant, the object is "stationary" with respect to a Lorentz observer. If not constant in all directions, the object is in a curved spacetime with respect to a Lorentz observer. In that case either the object's local spacetime is warped or the object is in a generalized, accelerated frame.

In the normal linear spacetime, the "charging" and "discharging" are equal in all directions; hence the "mass" exhibited in any direction is the same.

With respect to an "external observer's" equilibrium flux, a moving object encounters an increased amount of flux rate along its line of motion, just as a moving object in a rainstorm encounters more raindrops per second in the direction of its path, than does a stationary object. Encountering increased scalar wave flux (with respect to the external observer) forces the moving object to absorb and emit scalar waves at a higher rate along its direction of motion than when it is not moving. Thus to the external observer, the mass of the object has increased, insofar as any disturbing force along its line of motion is concerned.

At right angles to its line of motion, however, the flux rate is precisely the same as when the object is at rest. Therefore the "mass" of the moving object with respect to any disturbing force at right angles to its line of motion has not changed, as seen by the external Lorentz observer.

Thus is explained both parts of one of the alltime great mysteries of special relativity: (1) how the mass of an object increases with respect to its motion, and (2) why the mass only increases with respect to its line of motion, and not at right angles to it.

The inertia of a particle is due to its mass, i.e., to the total magnitude of its trapped scalar resonance.

The gravitational attraction between two masses is due to their spacetime curvature. Further, mass is like a capacitance. It can trap additional scalar waves as trapped resonance; hence increase its magnitude or "inertial charge." Or, it can discharge more scalar waves than it absorbs; hence decrease its magnitude or "inertial charge."

Those scalar waves emitted from resonance are emitted as a pattern ensemble of the resonance. Hence they may be regarded as constituting a current of scalar resonance leaving the mass-accumulator-object. Scalar waves absorbed into trapped resonance may be regarded as constituting a current of scalar resonance into the mass-accumulator-object. Thus it is proper to speak of scalar resonance as being able to "flow."

Further, it is possible to increase the mass of an object directly, by transmitting scalar EM waves to it so that it absorbs them. (By "absorbing" scalar waves one means that more enter the object than leave it, so the object acts as an inertial accumulator charging up with inertial charge. This is done by insuring that the reference potential of the scalar wave transmitter is higher than the reference potential of the irradiated object.)

It is also possible to decrease the mass of an object directly, by transmitting scalar EM waves to it so that it emits more than it absorbs. (By "emitting" scalar waves one means that more leave the object than enter it, so the object acts as if it were an inertial accumulator that is discharging its inertial charge. This is done hy insuring that the reference potential of the scalar wave transmitter is lower than the reference potential of the irradiated object.)

As can be seen, the scalar wave "transmitter" is actually somewhat comparable to a heat pump; it can either act as an "energy transmitter" or as an "energy extractor," depending upon the difference in potential between "transmitter" and "receiver."

Finally, scalar resonance can have a specific pattern: both in frequency and in spatial curvature aspects, as well as "rate of flow of time" aspects. Indeed, scalar-wise every object has its individual "scalar pattern" which is a unique fingerprint. Since that print is spatiotemporal, it is a product of the object's entire past history. Thus - scalar-wise - no two objects are identical.

This brings up another rather amazing potential: If a reasonably precise scalar pattern of an object can be "irradiated" and resonated with scalar waves, energy may be created in or extracted from the distant object, just as stimulating one tunning fork can excite another at a distance by sympathetic resonance. We leave it as an exercise for the reader to ascertain the relevance of this statement to clairvoyance, radionics, remote viewing, etc.

For the skeptic, however, we must point out that - rigorously - quantum mechanics requires that, continually, in any localized region of spacetime, the "pattern" of any object in the universe appears momentarily in the virtual state, purely from statistical considerations alone. So long as the situation remains statistical, any place in the universe can continue to have the "ghosts" of everything present there, in an ethereally thin pattern, and the observable world will not be affected by it. However, if one can discriminate and scalarly "charge" or "discharge" individual patterns in this "ghost-realm," action-at-a-distance is directly possible, as is materialization and dematerialization. If one accepts that even thought itself produces such virtual "ghost-patterns" in the virtual particle flux of vacuum, then it is at least theoretically possible to even materialize thoughts and thought images.

We have entered a new kind of reality where the old rules and the old limitations do not necessarily apply.

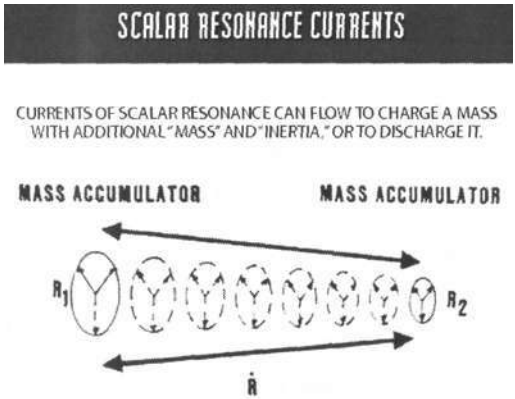

Slide 036: Scalar Resonance Currents

As we pointed out, we can often greatly simplify matters by considering currents of scalar resonance. These currents flow from higher potential to lower potential, regardless of whether we are considering "transmission" or "reception."

Indeed, to "transmit at lower potential" is to receive, and to "receive at higher potential" is to transmit.

Thus the "transmitter-receiver" is a special system where simply biasing the two nodes differently determines which way the scalar resonance current will flow.

We may increase or decrease an object's inertia and mass, simply by properly biasing the transmitter-receiver system's two nodes.

In one accidental experiment of some hours in duration, Golden charged up an area so that, locally, all clocks became erratic. This included electrical clocks, battery-driven watches, wind-up kitchen clocks, and a pendulum-operated grandfather's clock. The rate of flow of time itself was apparently altered in the local area by the accumulated charge, which took some four days to drain off and discharge. At the end of the four days of discharge, all clocks and watches had returned to normal.

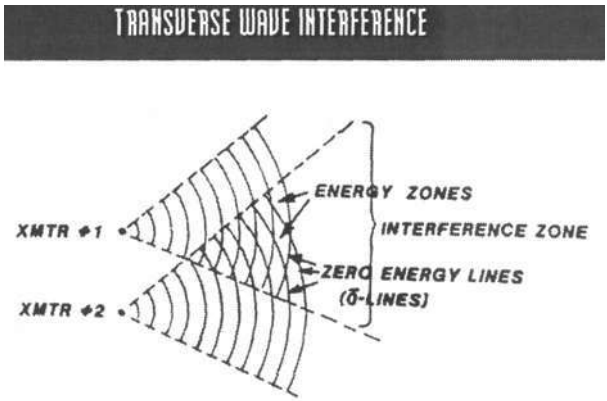

Slide 037: Transverse Wave Interference

On this slide we show the orthodox representation of EM wave interference.

The chart is stylized since we assume two single-frequency EM waves that intersect and interfere in the indicated region.

In the interference zone, in-phase wave amplitudes add (constructive interference) while out-of-phase wave amplitudes subtract (destructive interference). In our stylized mode, we show the zero-summed locations as lines.

Conventionally, these interfering waves are considered to be transverse waves in vacuum.

The point is, in this scheme we think of "putting in the waves of finite amplitude, and creating the zero-amplitude regions by destructive interference." We create additional waves of increased-amplitude regions by constructive iterference.

Note that this view is only half correct. It addresses the electromagnetics, but not the gravitational aspects. Actually the regions of destructive EM interference are regions of constructive G-interference, and the regions of constructive EM interference are regions of destructive G-interference.

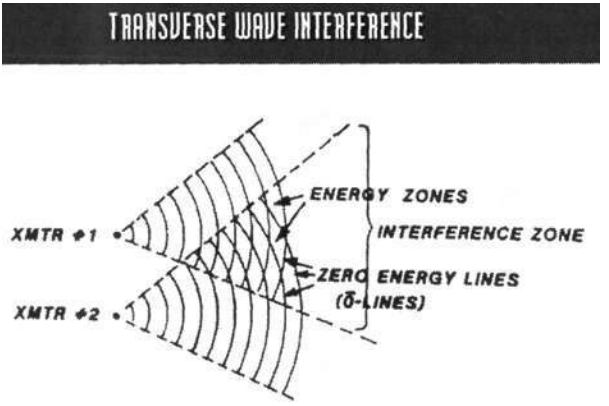

Slide 038: Transverse Wave Interference

Here we show the same interference situation, only now we think of transmitting scalar EM waves, which we model as longitudinal waves.

Again we assume two single-frequency scalar EM waves that intersect and interfere in the indicated region.

However, to an external observer, each of these waves individually appears to have zero E and H fields, hence to contain zero EM energy. That is, conventionally we seem to be transmitting waves of "pure potential," without any "force field" amplitudes whatsoever. We say we are transmitting waves of "artificial potential," since we deliberately constructed the zero-vector-summation scalar waves in the first place.

In the interference zone, a strange thing now happens. The relative magnitudes of the artificial potential of one wave with respect to the artificial potential of the other depend upon the phase relationship between the two. Further, whether the "gradient" so established appears negative or positive also depends upon the phase relationship between the two.

What results is most interesting: the out-of-phase condition now produces an EM gradient whose sign and magnitude are functions of the location within the interference zone.

Thus one now has real, non-zero EM potential gradients, both electrical and magnetic. And so real EM energy has emerged in an interference pattern within the area.

Ironically, we get essentially what we had before! Only now we have "put in the zero-reference lines, and produced the non-zero gradient (energy) zones."

In other words, we have recreated ordinary EM energy at a distance, directly from the interference of gravitational potential energy (anenergy).

And, to the laboratory observer, there has been no "EM wave" energy flow through the intervening space.

This was Tesla's secret of "wireless transmission of energy to a distance without losses."

Further, in a hypothetically perfect case, the interference represents a sort of "energybottle."

But now recall our need to take the sign of the scalar current into account. In this energy bottle, then, EM energy emerges and stabilizes - if and only if our transmitters are at higher reference potential than the ambient interference zone. If our transmitters are biased at lower potential, then energy is extracted from the energy bottle and re-emerges back at the transmitters, where it must be extracted and disposed of, if the transmitters are not to be burned out.

BACKGROUND FOR THE BRIEFER:

If we interfere two transmitters in a region of great energy -such as the molten core of the earth itself- and bias the transmitters negatively, we can extract enormous energy directly from that distant source!

Indeed, a slight variation of this effect is precisely how the Soviet Union obtains the enormous energy with which to power its incredibly powerful strategic "continent-buster"scalar EM weapons. Scalar frequency pairs - 12 kiloHertz apart - are transmitted into the earth itself on some portion of the earth's "giant scalar resonance" frequency curve. Biasing the two transmitters differently with respect to each other produces a high potential difference (voltage) between them. At the same time, biasing them both negative with respect to the earth's molten core produces a scalar resonance current from the core to the two transmitters. In the "outer loop" between the two scalar transmitters, there appears a gigantic voltage and gigantic electrical current that can be captured by appropriate means. This electrical power is tapped off and transmitted to incredibly powerful scalar EM weapon systems. There special accumulators and switchers are are utilized to provide the power of many Niagaras to each weapon.

Just before May 1, 1985 the Soviet Union performed a "full-up" operational test of their entire strategic scalar EM weapons complex. This test was detected and monitored periodically by Frank Golden. Some 27 of these giant Soviet "power taps" were locked into the molten core of the earth, producing forced (entrained)

scalar resonance of the entire planet on 54 controlled frequencies under our very feet. The remainder of the scalar frequency spectrum was ablaze with literally hundreds of Soviet scalar transmitters: probably the entire strategic scalar command and control system to underwater submarines, higher command centers, distant commands, etc. was activated in the giant exercise.

For several days, the system was exercised on a mind-boggling scale, apparently as part of the Soviet Union's highly accentuated 40th anniversary celebration of the end of World War II.

Ironically, not a single U.S. intelligence agency, laboratory, or scientist detected this monstrous exercise for the new Soviet leader, Gorbachev. Not a one of them had a detector for scalar EM radiation, and not a one of them officially believes the exercise ever happened.

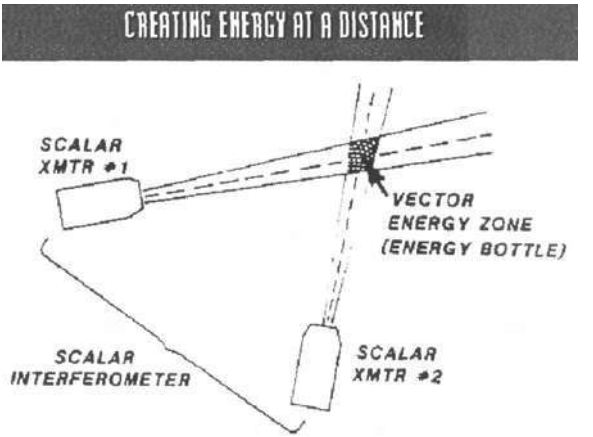

Slide 039: Creating Energy at a Distance

A most useful device is obtained if one uses a scalar interferometer where the two transmitters transmit beams that intersect at a distance.

In the interference zone, an energy bottle is created.

By biasing the transmitter reference potentials well above that of the distant energy bottle, EM energy emerges in that zone. In that case the interferometer is operating in the exothermic mode.

By biasing the transmitter reference potentials well below that of the distant energy bottle, EM energy is extracted from the distant zone and emerges from the transmitter. In that case the interferometer is operating in the endothermic mode.

If the transmitters transmit continuously, the effect in the distant zone is continuous.

If each transmitter transmits a pulse, and the two pulses meet in the distant intersection zone, then an explosive emergence or extraction of energy occurs at the distant interference zone, depending upon whether the interferometer is operating in the exothermic or the endothermic mode.

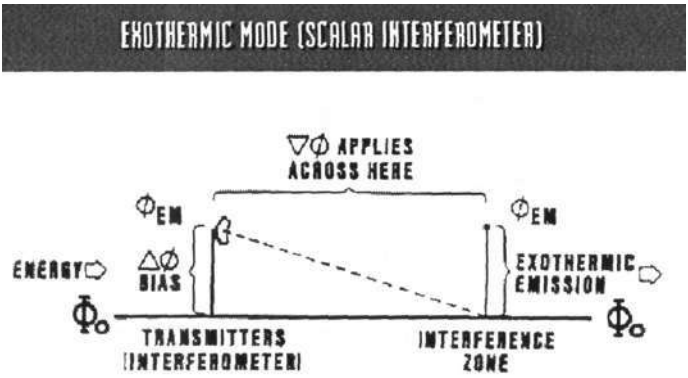

Slide 040: Exothermic Mode (Scalar Interferometer)

For a scalar interferometer, "del phi" (the gradient of the potential) applies between the transmitter site and the distant intersection site, not to the intervening space in between. Thus one speaks of "energy flow" as being between transmitter and intersection, without any "in between." In the intervening space, all the energy exists as locked-in artificial potential, not EM force field energy (gradient bleed-off of potential).

In the exothermic mode, the ground potential of the transmitter is biased well above the ground potential of ambient vacuum. Energy enters the transmitter and "disappears", to "reappear" in the distant interference zone.

If continuous wave transmission is used, the energy continuously appears in the distant zone.

If pulse transmission is used and timed so that the two scalar pulses meet in the distant zone, energy explosively appears there.

If multiple frequencies are transmitted in the manner of a Fourier expansion of a particular geometric form, then a 3-dimensional energy form appears at the distant intersection. In this manner, a spherical or hemispherical shell (a globe of "dome" of EM energy) can be created at a distance. If pulse transmission is used, this will be an impulsive or explosive emergence of that energy form. If continuous transmission is used, this will be a continuous glowing form.

By feeding incredibly powerful transmitters with large amounts of energy extracted from the earth's molten core by "energy taps," very large spherical

globes and hemispherical domes of EM energy can be created. The energy in the interference "shell" of such a sphere or hemisphere is sufficiently dense to lift Dirac matter from the Dirac sea of the vacuum. Thus the shell contains a glowing plasma.

Many such scalar howitzer signatures have been seen over the oceans, particularly over the North Pacific by jet airliners flying into and out of Japan. Also, such globes and domes of light have been seen deep within the Soviet Union, by observers in Afghanistan and by pilots of aircraft landing in Iran.

In the impulsive exothermic mode, a large visible flash will occur if EM energy in the visible spectrum is produced. "Flashes" in the infrared may similarly occur, if the emerging energy is in that spectral band. In September 1979 our Vela satellites detected such a large "nuclear flash" over the South Atlantic, off the southern coast of Africa. A second "nuclear flash" detected by the Vela satellites in 1980 was in the infrared only. Some years ago, a series of Momalous "flashes" and "booms" occurred off the east coast of the United States. These were due to the orientation and alignment -and registration - of one or more Soviet "scalar howitzers" - scalar EM interferometers in the exothermicmode.

Large "booms" occurred over the shuttle launch site at Cape Canaveral, associated with three shuttle launches prior to the end of November 1985. These were tests of such exothermic scalar EM howitzers, being tested as part of the Soviet Launch Phase ABM system. In that mode, the scalar pulses from the two transmitters are injected into special zero-reference scalar EM "channels" established in the EM carriers of the Woodpecker over-the-horizon radars. The scalar pulses travel through these channels, traveling in the ordinary EM beam of the transmitter and following it in its curvature around the earth in the earth-ionospheric waveguide. The scalar pulses are timed, phased, and oriented so as to meet the rising shuttle. In these tests the transmissions were offset in time so the shuttle would not actually be destroyed, but the system could be tested against actual shuttle launches in the U.S.

The specific uses of these various exothermic modes will be covered in later partsofthebriefing.

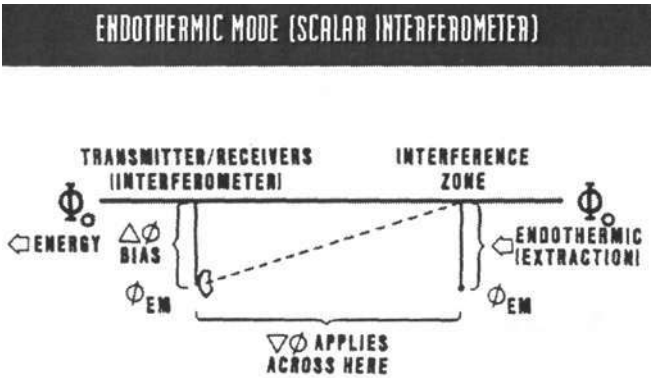

Slide 041: Endothermic Mode (Scalar Interferometer)

In the endothermic mode, the bias on the transmitters is such that energy is extracted from the distant intersection zone, to re-emerge at the transmitters. There the energy must be caught and disposed of if it is not to burn out the transmitters. When very large amounts of energy are extracted from distant points, the Soviets often use a "dump" method of temporarily capturing, and storing in an accumulator, the heat energy emerging at the transmitters. A "scalar energy tap" established into the accumulator then feeds a second howitzer in the exothermic mode. This howitzer is focused on a distant dumpsite - often Bennett Island, where U.S. weather satellites continually observe exhausts.

In the impulsive endothermic mode, energy is impulsively extracted from the distant intersection zone. In the atmosphere this results in a very sharp cooling, or a "cold explosion." It also results in the type of boom and rumble often associated with thunder after a lightning bolt.

On April 9, 1984 the Soviet Union tested such a "cold explosion" off the coast of Japan, near the Kuril Islands. In the suddenly induced low pressure "cold zone" above the ocean, ocean water was sharply sucked up from the ocean, forming a dense cloud. Then air rushing in to the low pressure zone forced the cloud upward, forming a mushroom much like that of an atomic explosion in visual appearance, except for the absence of a flash and the absence of a giant shock wave moving out away from the site of the explosion. (In this case the

Soviets controlled the rise time of the pulse so that no "giant atmospheric boom" occurred.).

As the cloud rises, it expands by mixing - very similar to a giant thunderhead buildup, except much faster. In this case the cloud rose to 60,000 feet in about 2 minutes, spreading out until it reached a diameter of about 200 miles. The pilots and crews of several Boeing 747 jet airliners in the general vicinity saw the incident. Sometime after that, a U.S. weather satellite photo of the area occurred. The cloud in that photo has an anomalous density distribution, differing from that of all other clouds in the area.

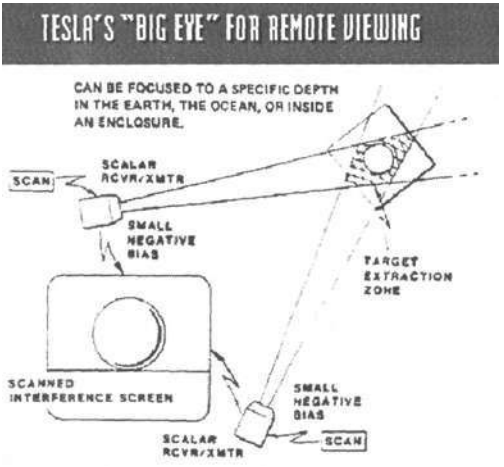

Slide 042: Tesla's "Big Eye" for Remote Viewing

Nikola Tesla also planned a very special use for his endothermic scalar interferometer. He planned to produce what he called his "big eye to see at a distance."

This is accomplished as shown on the diagram. First, the system is only weakly endothermic, so that only a small amount of energy is extracted from the **distant** target. Also, the beams are "scanned" by an open receiver, timewise, from side to side and top to bottom. By scanning yet another single beam through the intersection zone and phasing its pulses, an even better representation can be obtained. Thus the receiver produces a representation of the energy extracted from various locations within the distant endothermic zone. By displaying the received signals on an appropriately scanned screen, a representation of the distant scene in the intersection zone can be created. Indeed this is a special kind of "microwave interferometry," and - with modern techniques - the imagery obtained might be surprisingly good. With development, it might even become as good as the image presently obtained by side-looking acquisition radars.

Interestingly enough, since scalar EM beams will easily penetrate the earth or the ocean, one can also look beneath the earth or beneath the ocean with this type of scanning scalar interferometer.

The importance of this capability to strategic and tactical reconnaissance is obvious. Camouflage, cover, and concealment have no effect on such a **system.** One can easily look inside buildings and into underground facilities. With a small system such as this, the U.S. Marines at Khe Sahn would have had **little**

difficulty locating the tunnels continually dug under the perimeter by the Viet Cong. And targets under jungle canopies are directly visible.

BACKGROUND FOR THE BRIEFER:

It requires little imagination to see that this system is easily adapted to produce an "underwater radar." With such devices, the problem posed by the underwater nuclear submarine is solved. For example, an entire area can be continually searched, much like acquisition radar systems do now. A submarine can be detected and tracked, and none of its ordinary detectors will detect anything out of the ordinary. By using a separate pair of beams in the exothermic mode, powerful scalar pulses can be fired at the distant sub, intersecting at the submarine in a violent EMP throughout the sub and its armament. Thus the sub and all its missiles are destroyed instantly.

Or, continuous exothermic transmission can be used by the targeting weapon at lesser power, gradually interfering with the sub's electrical systems and causing it to lose control. The sub then sinks to crush depth and implodes.

Precisely that scenario seems to be what happened on April 10, 1963 to the U.S.S. Thresher nuclear submarine. It left a signature: the sub's surface companion, the nearby U.S.S. Skylark, was in the "splatter zone" of the underwater scalar interference. That is, spurious EM noise was being generated In all the Skylark's electrical systems, some of which were actually disabled. So intense was the "electronic jamming" that it required over an hour and a half for the Skylark to transmit an emergency message back to its headquarters that the Thresher was in serious trouble and contact with it had been lost. Some of the Skylark's communication systems actually failed, but later resumed operation inexplicably, once the jamming was gone. That type of "jamming" of multiple bands and multiple electronic equipments, of course, together with the anomalous failure of electronic equipment and its later mysterious recovery, were direct signatures of the use of the exothermic scalar interferometer against the undersea target area in the vicinity of the Skylark.

The very next day, Apr. 11, 1963, the same Soviet scalar EM howitzer system was tested in the "destroy submarine" pulse mode. A huge underwater EM blast occured off the coast of Puerto Rico, about 100 miles north of the island. The underwater explosion caused a huge boiling of the surface of the ocean, followed by the rising up of a giant mushroom of water about a third of a mile high. The mushroom of water then fell back into the ocean, completing the signuture.

Fortunately the startled crew of a passing U.S. jetliner that was just passing its checkpoint in that area saw the entire incident. (See Robert J. Durant, "An Underwater Explosion - or What?", Pursuit, 5(2), April 1972, p. 30-31.)

These two incidents were full-up operational tests of Khrushchev's newly deployed superweapons. He probably staged this dramatic one-two punch in a

desperate effort to recover face with the Communist Party after his disastrous facedown by Kennedy in the Cuban Missile Crisis a few short months previously. Apparently the attempt was successful, since he remained in power another year before being deposed.

Slide 043: Site of Mystery Cloud

On this slide we show the location of the "cold explosion" off the coast of Japan on April 9, 1984. The site of the explosion was only about 200 miles from downtown Tokyo. The crews of several jet airliners, including Japan Air Lines Flight 36, saw it.

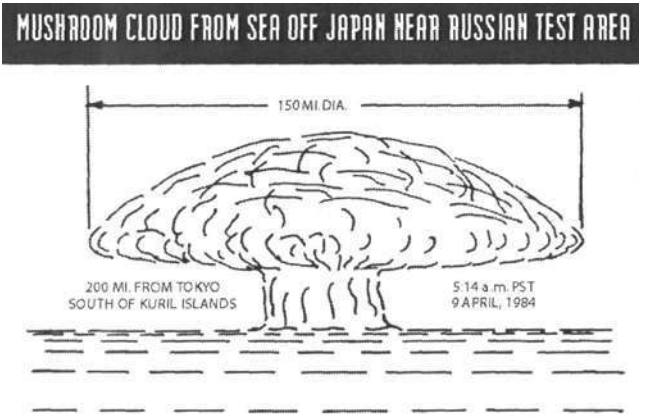

Slide 044: Mushroom Cloud from Sea off Japan near Russian Test Area

A short time before, the Soviets had hastily announced missile tests would be conducted into a zone some distance away from the cold explosion site. This may have been intended as deception to cover this incident, should any foreign nation indicate they understood what was going on.

It also was a direct "stimulus" to the Japanese and the rest of the world: That is, stimulate the system and see if the scientists recognize what happened. If they do, then they know about scalar EM weapons. If they don't, then their countries know nothing of scalar EM weapons, and those countries are defenseless against them.

At any rate, at about 5:14 a.m. Pacific Standard Time on April 9, 1984, a **giant** mushroom cloud erupted above the ocean south of the Kuril Islands. The mushroom rose rapidly, expanding as it rose. In two minutes it had reached **an** altitude of 60,000 feet and a diameter of about 200 miles.

One pilot of a Boeing 747 who observed the cloud was a former B-52 bomber pilot. He described the cloud as very similar to a mushroom cloud from a gigantic nuclear explosion, except there was no flash of visible light. Taking evasive action, he turned off course away from the blast, and braced for a blast shock wave, which never came.

MUSHROOM CLOUD RISING FROM SEA (COLD EXPLOSION)

- 0514 HOURS, 9 APRIL 1984
- GRAY-WHITE CLOUD APPEARED
- ROSE 60,000 FT IN 2 MINUTES
- 180 MILES S.E. OF HOKKAIDO
  200 MILES FROM TOKYO
  SOUTH OF KURIL ISLANDS
- SOVIET MISSILE TESTING SCHEDULED
  ABOUT 350 MILES AWAY
  AT 2100 HOURS, 9 APRIL 1984

Slide 045: Mushroom Cloud Rising from Sea

Indeed, this highly anomalous cloud was due to a cold explosion - a test of a Soviet scalar EM howitzer in the pulsed endothermic mode.

In the weapon's targeted interference zone, EM energy (heat) was rapidly withdrawn when the biased endothermic extraction occurred. Above the ocean an intense low-pressure zone was created. Water from the ocean was sucked up, as if by a giant vacuum cleaner. The water was violently broken into droplets, forming a dense cloud, with a strong upward momentum.

The surrounding higher-pressure air rushed into the low-pressure zone, pushing the rising dense cloud of water vapor upward as its upward momentum continued. Mixing caused rapid expansion of the rising cloud, causing its density to thin measurably as it rose and expanded. An effect very similar to the formation of a strong thunderhead resulted, except much faster.

The mixing cloud also resembled the mushroom cloud from a giant nuclear explosion, just as an emerging thunderhead does.

But no outward blast wave resulted as does from a nuclear explosion. Also, no visible flash occurred, probably as a result of deliberate design by the Russians.

Thus a beautiful "stimulus" and test was conducted: quite a few airliners were "pinged," providing a high-level stimulus to competent observers. The news was sure to be reported by them to several nations. The press was sure to pick up the story. This was a high order stimulus to see whether the U.S., Japan, or other

potential adversaries of the Soviet Union recognized the testing of a cold explosion weapon.

By our reaction, we assured them (with high confidence) that we still knew nothing of scalar EM interferometry or cold explosions.

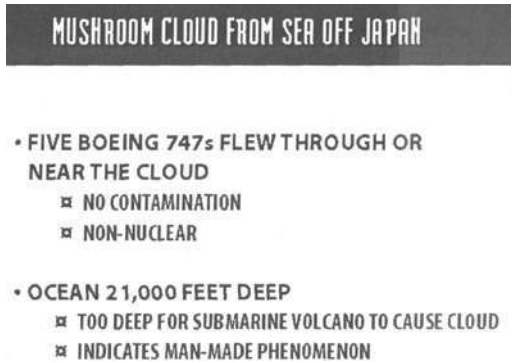

Slide 046: Mushroom Cloud from Sea off Japan

Five Boeing 747's flew through or near the cloud on their way to Anchorage, Alaska. The aircraft were checked at Anchorage for radioactive contamination, but nothing was found. This showed that the huge "explosion" had been non-nuclear.

The ocean in the area is also about 21,000 feet deep. That is really too deep for a submarine volcano to have erupted and caused the cloud. (Besides, a volcano would have continued to snort at least a bit, and so that appears to be out of the question as a possible cause of the incident.)

In short, a manmade phenomenon is indicated.

Indeed, we know it was a cold explosion. As I've stated previously, a colleague has in fact produced the basic effect over a dish of water in the laboratory, using a small scalar interferometer in the endothermic mode.

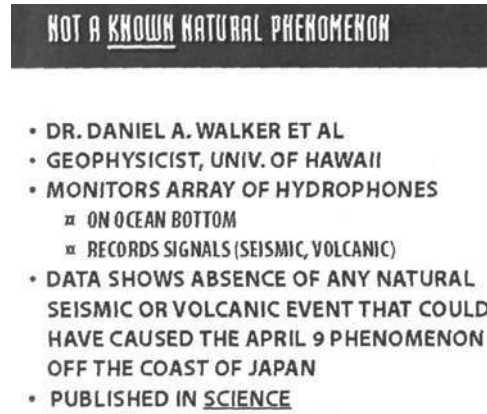

Slide 047: Not a Known Natural Phenomenon

Further, the story does not end there.

A geophysicist at the University of Hawaii, Dr. Daniel A. Walker, together with his colleagues monitor an array of hydrophones on the ocean bottom, recording signals such as seismic incidents, volcano eruptions, etc.

Dr. Walker and his colleagues performed a comprehensive analysis of the data recorded by the hydrophones in and around the time of the incident in question. The data shows the absence of any natural seismic or volcanic event that could have caused the April 9th phenomenon off the coast of Japan.

He and his colleagues concluded that it was either an as yet unknown natural phenomenon, or a man-made phenomenon.

Their report is published in Science. (Walker et al, "Kaitoku Seamount and the Mystery Cloud of 9 April 1984," Science, 227(4687), Feb. 8, 1985, p. 607-611.)

Slide 048: Explosive Events seen on Soviet Island

Here are two U.S. weather satellite photos of the anomalous exhausts on Bennett Island we previously referred to.

The exhaust in the left picture is about 150 miles long, and is nearly horizontal (about 1.5 degrees above the horizontal). It is entirely consistent with the continuous exhaust from a "dumping transfer" scalar EM howitzer in the continuous exothermic mode. (The primary howitzer, of course, was activated in the endothermic mode.)

I think any open-minded investigator must admit that that is indeed a very powerful jet-like exhaust, and not like anything one ever sees from a natural volcano or geological gas vent. If anyone knows of such an anomalous volcanic or geological exhaust, I would be most delighted to see a photo or report. To my knowledge, no such natural photo exists, and no such natural exhaust has ever been reported.

The right picture shows the "puff of an explosive emergence of the exhaust. In other words, this one is the exhaust from a "dumping transfer" howitzer used in the pulsed exothermic mode. Since it did not have so much energy to dump, it could dump it in a pulse. Again, the primary howitzer, of course, was activated in the endothermic mode.

Over 100 weather satellite photos of these anomalous exhausts have been taken since 1974.

One or more U.S. aircraft have even been vectored through the exhausts, and samples of the exhaust taken and analyzed. The exhaust is made up of a little clay and mud and water, and is colder than the surrounding air.

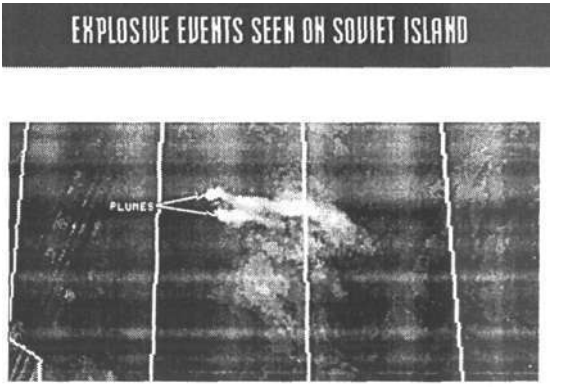

Slide 049: Explosive Events seen on Soviet Island

U.S. weather analysts euphemistically call these exhausts from Bennett Island plumes.

Here is another U.S. weather satellite photo, showing the twin emergence of multiple puffs.

One might expect such exhausts if the secondary "dumping transfer" howitzer is operated in the continuous mode, with continuous extraction by "power tapping" the accumulator of the primary howitzer. In that case, the signature of the exhaust would expose the operation of the primary howitzer. For example, this exhaust would indicate multiple puffs, hence probably multiple frequencies and multiple primary transmitters, each phased in a controlled manner. That of course indicates the production of Fourier expansion forms - of 3-dimensional geometrical forms - by the primary howitzer(s). Since these are puffs, it may indicate the explosive formation of distant spherical balls of energy by the primary howitzer. This in turn indicates the use of a howitzer system in the "pulse firing" mode, which can be used against missiles, ships, aircraft, ground targets, armored vehicles, underwater targets, etc.

Slide 050: Explosive Events seen on Soviet Islands

This slide shows the location of three areas of interest relative to Soviet scalar EM weapons testing.

Wrangel Island, north of the northeastern portion of the Soviet mainland, is associate with tests of these weapons in large circular breakups of the ocean's ice cover. This of course could aid submarines that wished to surface and fire cruise missiles, or submarines that wished to fire from underwater and needed the **ice** broken up.

Strangely enough, Wrangel Island has a most peculiar history: legally it still belongs to the U.S., but has been "given" to the Soviet Union without permission of the U.S. Senate, which is illegal.

Bennett Island, a little farther to the west and still north of the Soviet **mainland,** is noted for its phenomenal number of anomalous exhausts as previously discussed.

North of the Soviet mainland and near its middle lies the large island of Novaya Zemlya. Weather satellites have taken pictures of anomalous circulations over this island, which are further candidates for exhausts from scalar EM howitzer operations.

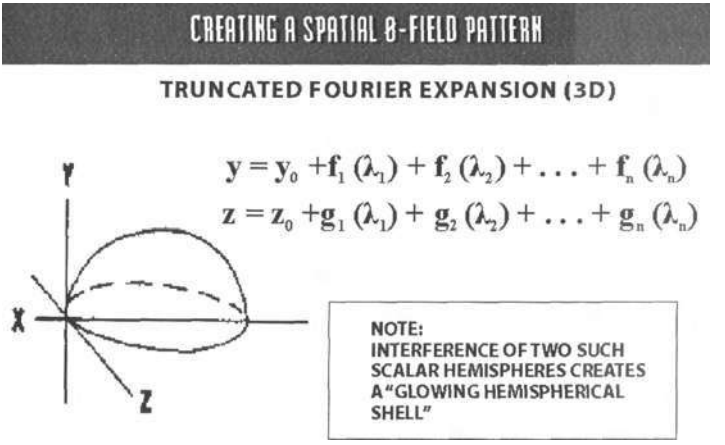

Slide 051: Creating a Spatial 0-Field Pattern

On this slide we show that a hemispherical dome (or other regular shape) can be composed from scalar waves by 3-dimensional Fourier expansion. By truncating the expansion - say after 10 or 12 frequency terms - a good representation of the desired form can be obtained with a practical number of frequencies, and in turn a practical number of transmitters. A computer is used to compute the multiplying functions for each frequency, and the entire complex of frequencies is then transmitted to produce the scalar form. By interfering two such scalar forms, a 3-dimensional shell of locked-in, ordinary EM energy is formed in space.

Interference of two such scalar hemispherical surfaces creates a "glowing hemispherical shell or dome of energy."

Interference of two such scalar spherical surfaces creates a "glowing spherical shell or globe of energy."

Both such geometric forms have been repeatedly seen.

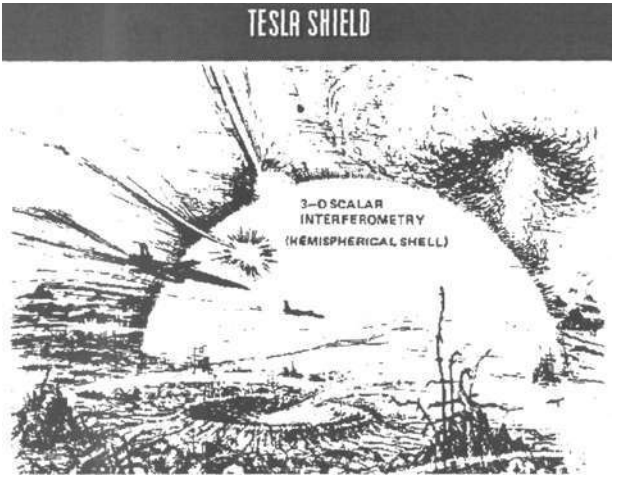

Slide 052: Tesla Shield

Of particular interest is the hemispherical shell of energy, which years ago I dubbed the "Tesla shield."

As shown on this slide, two scalar hemispherical surfaces are created, using multiple frequency transmitters and truncated Fourier series expansions. Interference of the two scalar hemispheres creates a great, glowing hemispherical shell of ordinary electro-magnetic energy. In the shell, the energy density is sufficient to lift Dirac matter from the Dirac Sea of vacuum. The shell is thus filled with a glowing plasma.

Such a shell may be several hundred miles in diameter at the base. The enormous energy required to form such a defense shell is obtained by a "scalar power tap" into the molten core of the earth itself, as previously explained. In late April/early May of 1985, 27 such "power taps" were placed in the earth by the Soviets. If each tap is capable of powering four to six large scalar EM weapons, then the Soviet strategic scalar EM arsenal contains over 100 monstrous superweapons capable of generating exothermic explosions, endothermic explosions, engineering the weather, locating and destroying underwater submarines, detecting and destroying ballistic missiles shortly after launch, detecting and destroying long range strategic bombers as soon as they are airborne, etc.

At any rate, the giant Tesla shield is useful against any penetrating vehicle. If the shell is not so large, its energy density may be very high. In that case, the intense

plasma heating will fuse and even vaporize metallic bodies. In addition, any vehicle encountering the shell is subjected to an extremely intense EMP arising everywhere inside its circuitry. EM shielding is of no use against the creation of energy throughout the spacetime of the circuits; such shielding only helps against energy flow through space in the conventional sense.

Thus the electronics of any vehicle encountering the shield are instantly dudded, whether or not they are shielded against ordinary electromagnetic interference (EMI). This includes the electronics operating a nuclear warhead, carried by a re-entry vehicle. Electrically everything penetrating the shell is totally dudded. Further, explosive materials are exploded when such an EMP is encountered, and combustible materials are fiercely consumed or set afire. Ablative shielding suffers an interesting catastrophe: since energy does not try to "flow into" the shielding but "arises everywhere in it simultaneously", "ablation" occurs everywhere throughout the ablative material, simply exploding it instantly. In addition, for smaller Tesla shells (say of 50 miles diameter) the energy density is sufficient to melt or vaporize metals such as in missile structures.

With such a Tesla shield, there is no need to discriminate true warhead-bearing re-entry vehicles from decoys, chaff, etc. The entire "mess" entering the shield is simply "cleaned up" and "sterilized" or destroyed. The shield can take care of ICBMs/IRBMs and their nuclear warheads, strategic bombers and their nuclear **bombs,** cruise missiles and their nuclear warheads, re-entry vehicles and their warheads, decoys, chaff, etc.

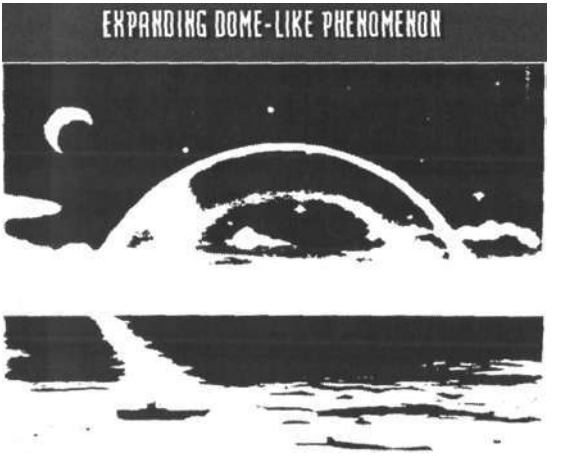

Slide 053: Expanding Dome-like Phenomenon

Here we show one instance of apparent Soviet testing of the Tesla shield (hemispherical shell of energy) over the ocean. This incident occurred in the Caribbean and Western North Atlantic Ocean on Mar. 20, 1969 and is reported in the Marine Observer, Vol. 40, 1970, p. 17. A semicircle of milky white light, quite intense at first, was sighted on the horizon. The semicircle enlarged, dimming as it expanded. The incident lasted for about 10 minutes. Seen from a passing ship, the top of the hemisphere reached a sighting elevation angle of about 50 degrees, while the base of the hemisphere of light subtended an arc of about 70 degrees. This is directly indicative of a test of the Tesla shield, first as a small, more intense shield and then expanding to greater size for a less intense shield whose primary destructive mechanism is EMP. Note that the EMP in a Tesla shield is locally contained in the energy-bottle shell. It is not an ordinary EMP of energy radiated out of the shell.

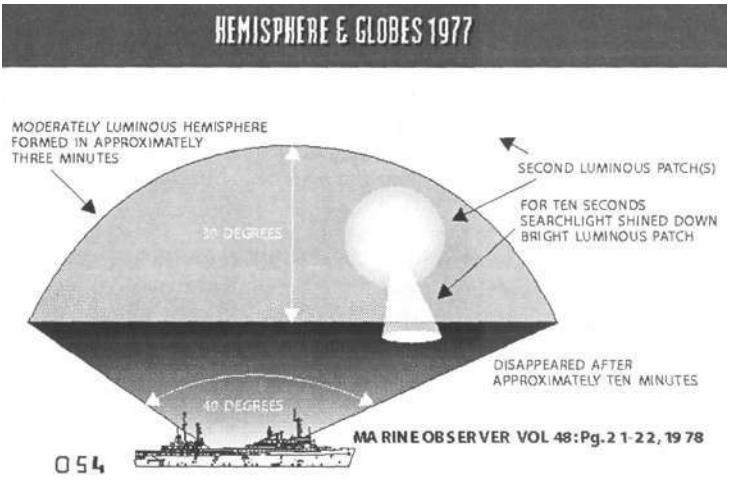

Slide 054: Hemisphere & Globes 1977

Here is a second instance of apparent Soviet testing of the hemispherical Tesla shield over the ocean. This time it is combined with simultaneous testing of two smaller scalar interferometers creating Tesla globes of EM energy.
This incident occurred at 23 degrees 5 minutes north, 17 degrees 25 minutes west. It was sighted and reported by a British ship, H.M.V. Kinpurnie Castle, on Mar. 24, 1977. The report is in the Marine Observer. Vol. 48, 1978, p. 21-22.

First a large, moderately luminous hemisphere of light formed, requiring about 3 minutes to do so. Seen from the ship, the top of the hemisphere was at a sighting elevation angle of about 30 degrees, while the base subtended an arc of about 40 degrees. This was the basic Tesla shield.

Then two other luminous globes or patches of light, each of about 1 degree diameter as seen from the ship, formed in the same area; one inside the shield and one outside it. From the glowing globe inside the shield, a light beam similar to a giant searchlight shone down to the ocean's surface for about 10 seconds.

Again the phenomena lasted about 10 minutes and then disappeared.

The luminous globe or patch inside the hemisphere might be the test of a second weapon deployed from a Soviet aircraft in the area. If so, the aircraft has placed a **strong** spherical shield around itself. In addition, the aircraft is utilizing some sort of scalar interferometer beam weapon in an underwater mode. Probably this would imply a "shot" at a hostile nuclear submarine inside the shielded zone. Thus this aircraft would have the scalar EM equipment to search for the

underwater sub and detect it, and also to concentrate interference energy upon it underwater, destroying it quickly.

Suffice it to say that it is possible to perform scalar interferometry by means of a single beam, in a proprietary process discovered by a close colleague. Thus the "glowing beam to the ocean" resembling a searchlight makes very good sense in the anti-submarine role. The same weapon, of course, could also attack any hostile surface vessel that might have been inside the shielded area at its formation.

The second luminous globe or patch, outside the hemisphere, is probably from a second scalar interferometer from the naval task force, simulating the continuous attack of a certain target (missile or aircraft) outside the protective dome.

As can be seen, this phenomenon is directly indicative of the types of operations one would expect from the testing of Soviet scalar EM weapons at sea, possibly to protect a Soviet naval task force during simulated combat operations.

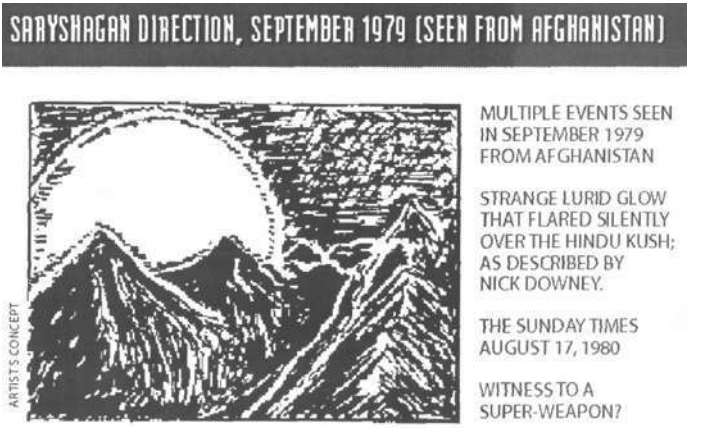

Slide 055: Saryshagan Direction, September 1979

The London Sunday Times of 17 August 1980 contained information and a photo-sketch of incidents of sighting of the testing of very large Tesla globes deep within the Soviet Union. British war cameraman Nick Downie made the sightings from Afghanistan. The phenomena seen were in the direction of the Saryshagan Missile Test Range, which - according to the U.S. Defense Department's Soviet Military Power, 1986 - contains one or more large directed energy weapons (DEWs).

Even though Downie was seeing the giant globe of light from a great distance, it flared silently over the Hindu Kush and expanded to subtend an arc of about 20 degrees, dimming as it expanded. (An arc of 20 degrees subtended by an object many hundreds of miles distant indicates an object of well over a hundred miles in diameter. This gives some idea of the enormous energy being controlled and manipulated by these Soviet weapons.).

Downie saw the sight on more than one occasion in September 1979.

BACKGROUND FOR THE BRIEFER:

In the same month - September 1979 - a stationary luminous globe containing a vertical stripe of black in the center was seen in the sky off Saint Petersburg, Florida. This particular type of sighting in that area has been previously correlated with times of known activity at Saryshagan.

Further, in the same month U.S. nuclear-warning Vela satellites detected a mysterious "nuclear flash" over the South Atlantic, off the coast of Africa. Controversy has raged in U.S. intelligence and scientific circles to this day as to whether a nuclear explosion or some other mechanism produced the flash.

Indeed, the flash may have been produced by a scalar EM howitzer from Saryshagan as one more "ping" of the U.S. intelligence system, to ascertain whether or not it knew anything about scalar EM howitzers. Again, the negative response told them with high confidence that (1) we still didn't know about scalar EM stuff, and (2) we were still absolutely defenseless against the Soviet scalar EM weaponry.

In 1980, a second "Vela flash" was reported. This time it occurred in the infrared region only, which positively rules out any sort of nuclear explosion. Even this increased stimulus still evoked a U.S. action that revealed total ignorance of scalar EM weaponry.

An alternate possibility for the September 1979 Vela flash also exists: countries not hostile to the U.S. may have tested a scalar EM weapon that produced the flash.

At any rate, from Downie's sightings, it is highly probably that the DEW weaponry at Saryshagan Missile Test Range was active in September 1979, and was producing huge Tesla globes. If the DEWs at Saryshagan can produce the giant luminous Tesla globe, they almost certainly are scalar EM interferometers and can produce the giant Tesla shields as well. Downie reported other earlier sightings of similar phenomena seen by Afghans deep within the Soviet Union in the same direction toward Saryshagan.

Briefly let us cover the uses of such a "giant globe" or spherical shell of glowing EM energy and plasma.

By placing such a "giant globe" thousands of kilometers out away from the defended heartland, an entire arc of the sky can be defended against long-range ballistic missile attack in midcourse. During their midcourse trajectory, the attacking missiles would have to penetrate the globular shell twice, exposing them to giant internal EMPs twice. A very high probability thus exists that all missiles entering the space occupied by the globe are dudded upon entry and/or exit. This includes the electronics inside the nuclear warheads themselves. Also, this is particularly effective against MIRV and MARV missile carriers, since the multiple re-entry vehicles are normally still on the main vehicle during most of midcourse. The use of this midcourse ABM globe defense greatly reduces the number of vehicles arriving at the latter part of midcourse and at the terminal phase of their trajectory.

By using a smaller, more intense globe and placing it on incoming clusters of objects or single objects, both EMP and intense local heating are used against the objects. This is suitable in the latter part of midcourse and in the **terminal**

phase of ICBM's, IRBM's, SLBM's, and cruise missiles. It is also useful against incoming strategic bombers and their air-to-surface missiles, both ballistic and cruise.

Two modes of the globes - especially the small ones - can be used. First, the continuous mode can be used to "fry" or vaporize incoming objects in a relatively small volume (say two or three tens of kilometers in diameter). Second, the "pulse" mode can be used to "service" all incoming objects, whether or not they have passed through the "large globe" midcourse defense. This provides an additional guarantee of killing the objects; discrimination is not required, just service all of them. The exposure of all incoming objects to multiple attacks raises the probability of kill to essentially 100%, or as close to that as one wishes. Of course the incoming vehicle may still encounter a terminal defense consisting of the Tesla shield and associated roving "quickshot" small intense globes.

In short, with these systems an essentially 100% ABM and anti-bomber defense is possible. Further, the Soviets have possessed such an effective defense for two decades, just as they have openly stated.

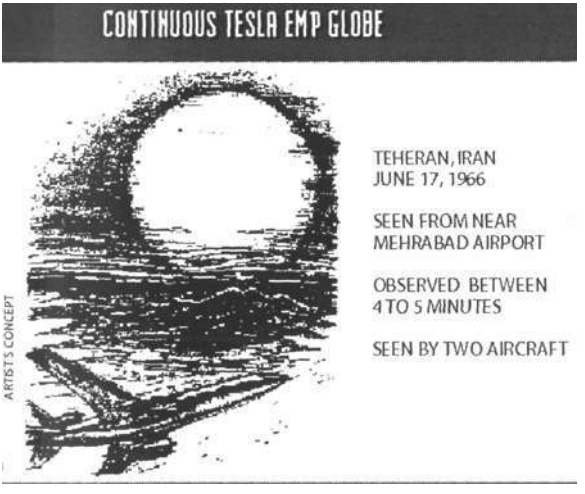

Slide 056: Continuous Tesla EMP Globe

Here is another verified incident of a gigantic test of a Soviet scalar EM howitzer deep within the Soviet Union.

This is a CIA report, released under the Freedom of Information Act. One can be quite sure that the incident occurred as stated.

The phenomenon was seen from two aircraft approaching Mehrabad Airport in Teheran, Iran on June 17, 1966 and reported by their pilots.

On the far horizon deep within the Soviet Union, an intense spherical ball of light appeared, "sitting on the horizon" so to speak. The globe of light increased to enormous size, dimming as it did so, literally filling an arc of the distant sky as it expanded. The sighting was shielded from most ground observers' view at the airport itself due to an intervening mountain range that masked most of tin-phenomenon from the ground.

The silent, expanding globe was observed for four or five minutes before it faded away.

BACKGROUND FOR THE BRIEFER:

Again, this is positive evidence of the testing of a giant scalar EM interferometer, in the "midcourse ABM globe" type of action.

However, note the date - mid 1966! The Soviets have therefore been testing such scalar weapons of enormous size and power for at least two decades. This

implies that development must have started at least a decade earlier, or in the mid '50s.

Still earlier in January 1960 Nikita Khrushchev had announced the development of a "fantastic" Soviet weapon, one that could even destroy all life on earth if unrestrainedly used. In 1962 the ebullient Khrushchev was forced to back down and lose face before John Kennedy in the Cuban Missile Crisis. Khrushchev's missiles and bombers were in woeful shape, as Kennedy well knew (by courtesy of the Soviet spy, Colonel Oleg Penkovsky). Kennedy did not know that Khrushchev's new superweapons were nearing deployment, but were not yet quite ready.

To save face and prevent his immediate ouster, Khrushchev apparently conducted a startling two-strike demonstration of his new weapons as soon as they became operationally ready. On April 10, 1963 he detected and destroyed the U.S.S. Thresher nuclear submarine using a scalar EM howitzer in the underwater "continuous" mode.

The next day he demonstrated the "pulsed" underwater destruction mode for nuclear subs by producing a giant underwater EM explosion underneath the ocean 100 miles north of Puerto Rico. Ironically, just as the Atlantic was coming alive with U.S. naval vessels searching for the lost Thresher, a second test of the weapons that had finished off the sub occurred to the south of them, unnoticed and disregarded, even though seen and reported (to the FBI and the U.S. Coast Guard) by a passing U.S. jetliner's pilot and crew, who observed the underwater explosion.

We thus can peg the development of these weapons by the Soviets as starting well before 1960. The first operational deployment of the giant strategic weaponry occurred in early 1963.

Note that the 1966 testing observed here is completely consistent with this estimated development schedule.

Thus large Soviet strategic scalar EM weapons have been operational on site for 23 years! This implies that at least three additional generations of the scalar EM weapons have been developed and deployed by now.

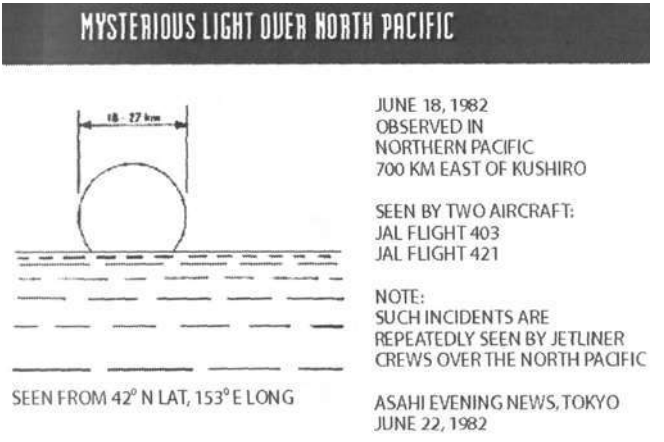

Slide 057: Mysterious Light over North Pacific

Incidents of Soviet testing of the Tesla shield and the Tesla globe weapons are routinely observed by airline pilots flying over the North Pacific into and out of Japan.

This is one typical example. Two jetliners, Japan Air Line flights 403 and 421, sighted and reported a large glowing globe of light sitting just beyond the horizon and extending well above it. The aircraft were in the vicinity of 42 degrees N latitude and 153 degrees longitude at the time. The sighting was thus about 700 miles east of Kushiro.

The pilots estimated the diameter of the ball as at least 18-27 kilometers. Depending upon the actual distance to the sphere, it may have been of much larger size.

This incident is reported in the Asahi Evening News, Tokyo, June 22, 1982.

The jet airliner pilots flying over these waters have reported many other **similar** sightings.

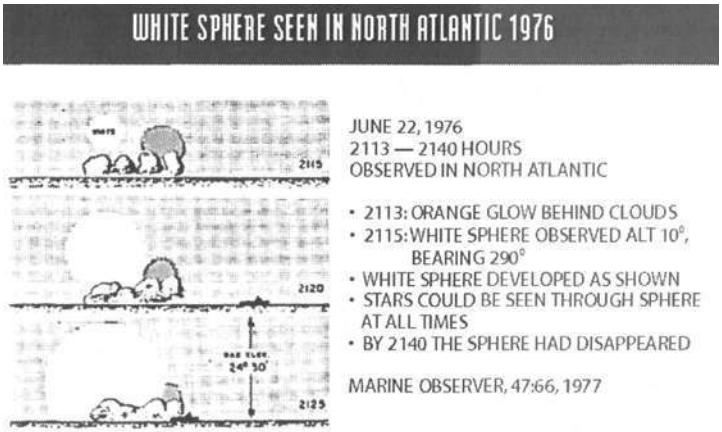

Slide 058: White Sphere seen in North Atlantic 1976

Here is another sighting closer to home.

This incident was observed from a passing ship on June 22, 1976 in the North Atlantic, at about 2113-2140 hours. It is reported in the Marine Observer, Vol. 47. 1977, p. 66.

First, an orange glow was sighted behind some distant clouds. A couple of minutes later, a glowing white sphere of light was observed to the left of the orange glow, just above the clouds. The white sphere then slowly expanded to a much larger sphere, dimming as it expanded. At its maximum size, the top of the white sphere reached about 24 degrees 30 minutes elevation angle to the observer. Development to maximum size required about 10 minutes.

By 2140 hrs the sphere had faded and disappeared. The sphere was sufficiently thin that the stars could be seen through it at all times.

Again this incident strongly fits the large Tesla globe mode of a Soviet scalar EM interferometer.

The significance and role of the orange glow are not known at this time.

Slide 059: Continuous Tesla Fireball

Here is another incident that represents a stimulus to the British government, to see if the British are aware of scalar electromagnetics.

Again, this is a CIA report released under the Freedom of Information Act, so the details are reliable.

On Sep. 10, 1976 British European Airways flight 831, flying between Moscow and London and over Lithuania at the time, observed an intense ball of light above the clouds below the aircraft. The light was so intense that it lit up the sky in the entire vicinity.

The concerned pilot reported the glowing object to the Soviet ground authorities with whom he was in contact. He received the harsh instructions to ignore the light, and essentially to continue on his way out of there.

Here we see an incident involving a small, intense Tesla globe, of the kind with which the defense could "service" objects that had already penetrated a large midcourse globe, or aircraft approaching the defended area.

Obviously the Soviet authorities were tracking the aircraft, and knew it was in the vicinity. It seems logical, then, that they deliberately placed the brightly glowing ball beneath the aircraft so that the pilot and crew could not fail to observe it.

The strange message to the pilot was simply designed to increase the intensity of the stimulus. The stimulus was to be something like, "The Soviets are doing

something in research and development that allows them to create intense balls of glowing light at a distance, and place these objects in the air in and around aircraft, possibly to intercept them." The purpose, of course, was to observe the British government's reaction after the incident was reported by the pilot upon his arrival at London.

Again the reaction of the British - and the U.S. as well - was as predicted. Again we showed that we knew nothing of scalar electromagnetic weapons, and did not recognize one when we encountered its effects.

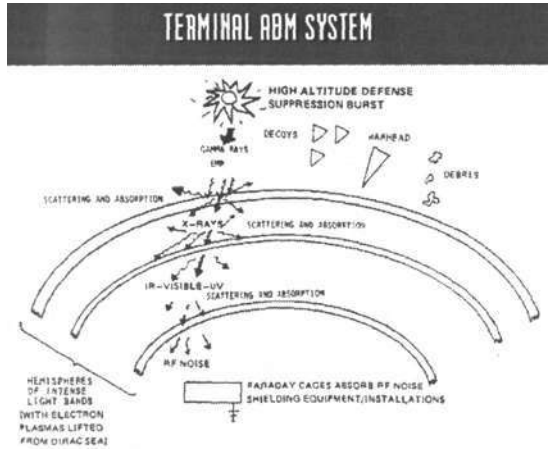

Slide 060: Terminal ABM System

Very neat things can be done if one nests several Tesla shields - say three or four - concentrically, one inside the other. In that case even the nuclear radiation (such as gamma rays) from a defense-suppressive high altitude nuclear burst can be handled.

For example, suppose three such concentric shields are placed over a large vital area. Further, suppose a high altitude nuclear burst is placed up above the outer shield. Gamma radiation almost instantly strikes the plasma in the outer shell, where it is absorbed, scattered, and re-radiated at lower temperature. (That, after all, is what plasmas do.)

Inside the first shell, the scattered radiation is now in the x-ray and ultra-violet region. Let us track the most lethal component, the x-rays.

The scattered x-rays then strike the second plasma shell, and are absorbed, scattered, and re-radiated at lower temperature. Inside the second shell the scattered radiation is now in the visible and infrared region, with a little ultraviolet.

This optical radiation in turn strikes the third plasma shell, and is absorbed, scattered, and re-radiated at still lower temperature. Inside the third shell most of the energy is now in the form of radiofrequency (RF) energy, with a little IR and visible band spectral energy content.

At this point, ordinary electromagnetic interference (EMI) shielding of electronic equipments on the ground and inside the third shield can take care of any RF interference resulting from the emergent RF noise.

As can be seen, three shells are sufficient to convert the gamma and x-ray radiation (and ultraviolet and infrared) mostly to harmless RF energy before all three shells are penetrated. Thus the tactic of deliberate defense suppression by a preliminary high altitude nuclear burst can be countered by multiple Tesla shields.

In addition, of course, any ordinary vehicles penetrating all three shields are exposed to successive violent EMP's, and are almost certainly electrically dudded. The vehicles are also subjected to multiple periods of intense heating, so combustibles, fuels, explosives, and ablatives are destroyed. In addition, metal structures may be melted or vaporized.

Think of it this way: anything that hits one of these Tesla shields goes phht! Just **like** a bug hitting an electrified bugkiller screen.

For years passing ships have observed and reported such multiple-shield "light phenomena" over remote regions of the ocean. U.S. intelligence has routinely **not** paid any heed to reports of "lights at night" over remote ocean areas, and so Soviet tests in this manner have remained relatively unnoticed by officialdom.

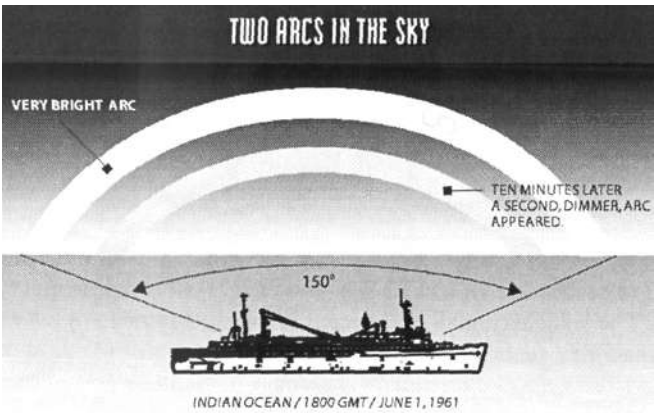

Slide 061: Two Arcs in the Sky

Just to list one incident involving the testing of multiple concentric Tesla shields, here is an early test conducted in mid-1961 over the Indian Ocean.

The incident occurred at 1800 hrs. Greenwich mean Time (GMT) and was observed by a passing ship. The report is contained in Marine Observer, Vol. 32, 1962, p. 64.

First the ship's crew observed a gigantic, very bright arc of light on the horizon or beyond it, with both ends passing below the line of sight to the horizon. This was in fact probably a large Tesla shield, but of such low intensity that only its intersection arc could clearly be seen. The arc subtended an arc of about 150 degrees across its diameter at the bottom. After about 10 minutes, a second and dimmer arc appeared, concentrically inside the first one. The ship thus was observing what probably was the nesting of two giant hemispheres (of EM energy) to provide a multiple Tesla shield.

This was probably a test of an early research and development prototype, since Khrushchev had only announced his new "fantastic weaponry" in development in his January, 1960 speech to the Soviet Presidium. And apparently land-based weapons such as this prototype probably did not become deployed and operational until April 1963. However, even in 1961 the Soviets would have been developing and testing prototypes of the weapon adapted for naval task force protection and usage.

Several other similar phenomena involving nested hemispheres or giant concentric arcs of light have been seen by mariners at sea.

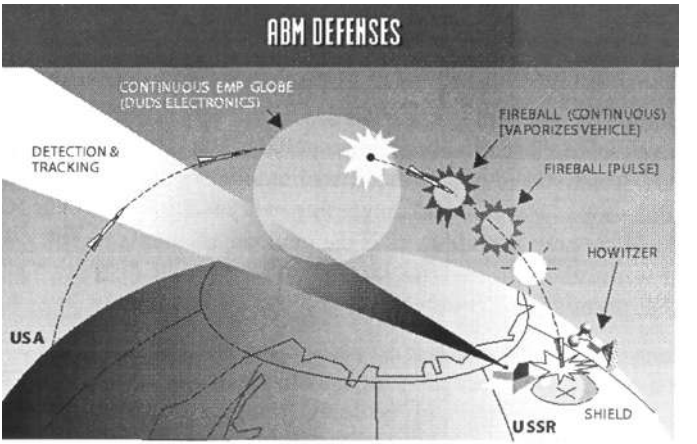

Slide 062: ABM Defenses

When the various capabilities of Tesla shields, globes, and scalar howitzers are integrated together into an ABM defense, a most formidable Soviet strategic defense capability is apparent.

On this slide we deal only with midcourse and terminal phase ABM defense. Later we shall cover the application of these weapons to launch phase ABM defense, primary phase bomber defense, underwater antisubmarine defense, etc.

Suppose the U.S. is provoked to desperately launch a missile attack toward Russia, as indicated on the slide.

First would come the launch phase destruction of the launched missiles, which we will cover shortly.

Any remaining missiles in midcourse would encounter extremely large, glowing spheres of light, where the EM energy density is contained and held in the spherical shell "energy bottle" of the glowing globes. Each globe might cover an are of up to about 20 degrees, as seen from the Soviet defended area. Missiles carrying MIRV and MARV payloads would not yet have deployed their re-entry vehicles.

As a missile and its payload encounter one of the globular shells, an intense EMP is suddenly experienced throughout the missile and all of its components. Again, EMI shielding is of no consequence since the EMP arises in each increment of spacetime throughout the vehicle volume. The result is instantaneous dudding of all electronic circuitry, including the electronics of the

nuclear warheads themselves. The HE content of the nuclear warhead system is violently exploded, totally destroying the configuration of the warhead. A low-order nuclear detonation may occur, but more likely the warhead's nuclear material is just broken up, finely divided, and set afire.

In addition, all combustible materials are set fiercely afire or destroyed. Explosive materials such as booster propellants and HE explosives are violently exploded. Ablative and plastic materials literally explode into pieces, torn apart by sudden violent ablation and outgassing everywhere within. The remnants of the vehicle are now total duds, as is the payload, including re-entry vehicle, nuclear warhead electronics, nuclear materials from the disruption and explosion of the HE portion of the warhead system, etc.

Still, each piece of the debris must pass through the glowing shell once more before it exits. Thus a second "shot", precisely as effective as the first, still awaits each and every piece of the debris plunging along inside the shell as it exits.

As the debris continues on to the latter part of midcourse and early terminal phase, any portions large enough to track are subjected to small, intense Tesla globes where the energy density in the shell is many orders of magnitude greater than in the larger globe used in earlier midcourse. This part of the defense system simply services each incoming "blob" methodically, probably first in the pulse mode. Later, any blobs still remaining are given the maximum "continuous heating" mode with a small Tesla globe, to actually vaporize metals and materials.

In the unlikely event that anything active still remains, or that an object has managed to elude the large and small Tesla fireballs, a Tesla shield is still to bo encountered, towering over the protected area. For significant targets this shield will be concentric, and will contain three or more concentric Tesla shields. Again, the approaching vehicle will be subjected to multiple EMP's and severe heating throughout its volume. In addition, the concentric shields will "clean up and sterilize any gamma radiation and EMP resulting from any deliberate high altitude defense suppression nuclear burst that somehow (inconceivably!) gets through the launch phase ABM system, and the Tesla-globe midcourse and earl terminal phase defenses.

As can be seen, the system complex represents a most formidable defense **that** certainly approaches 100% effectiveness against the present triad, and even against the addition of cruise missiles.

In addition, since these weapons suffer from very strange constraints and limitations, the scalar transmitters are actually dual mode: they become conventional radars by simply switching into the ordinary EM mode. They arc part of the more conventional ABM defense system complexes we presently recognize in the Soviet Union. In this conventional role, backup ABM missile

interceptors are available, to be employed in case the conventional role must be assumed.

Later we will address the reason for the strange limitations that must be placed upon unqualified use of the large scalar EM systems, particularly in the pulse or "burst" nodes.

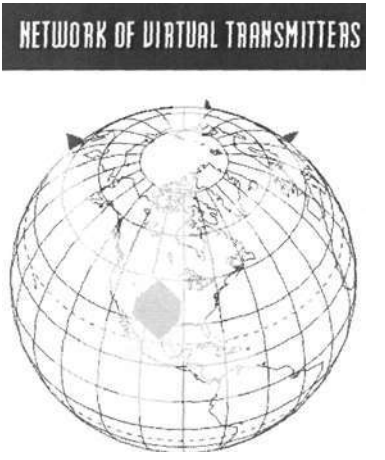

Slide 063: Network of Virtual Transmitters

In July 1976 the U.S. received very special Bicentennial greetings from the Soviet Union.

At that time, communications systems of the world in the 3-30 megaHertz band suddenly met substantial interference from extremely powerful, chirped Soviet transmitters that were suddenly activated. These transmitters continue their transmissions to this day.

Estimates of the power of these enormous transmitters vary, but figures range as high as several hundred megawatts, with a nominal figure being 100 megawatts.

These powerful transmitters were promptly nicknamed "Woodpeckers" because of the characteristic sound of the chirped signal when received. That is, the received signal made a "pecking" sound much like a woodpecker's beak hitting a block of wood.

Several nations protested, but the powerful signals have continued, right down to this day. The only Soviet response was to add a "spread spectrum" capability, so that the transmitter did not dwell too long on one specific frequency, but shifted periodically to other frequencies.

These transmitters have apparently never been precisely located by U.S. intelligence, but their beams carry much of the characteristics of an **over-the** horizon (OTH) radar. They have been dubbed OTH-radars by U.S. intelligence, and can without question perform that mission, in addition to some very interesting missions which U.S. intelligence does not assess.

Soviet Military Power, Department of Defense, 1985, p. 45 shows the direct intersection over the United States of the Woodpecker radar beams used in an OTH-role. We show an illustration of that intersection on this slide.

In addition, we show an additional "scanner" beam that can be scanned across the intersection "grid" over the U.S., formed by waveform interference of two main Woodpecker beams.

These Woodpecker transmitters have a great many diverse functions.

First, they can be used in a conventional over-the-horizon radar node, since their beams follow the earth-ionosphere waveguide and curve around the earth. In this mode they can detect missiles at launch and thereafter, and strategic bombers when taking off and thereafter.

However, these scalar interference grid weapons have many other uses.

First, they can be used to biologically attack entire populations in a targeted area. This aspect is not covered in this briefing. Suffice it to say that phase-locked ELF modulation signals ot 10 Hz and less are often detected on multiple Woodpecker frequencies simultaneously. In a target area, this modulation - if sufficiently stronger than the Schumann resonance of the earth's magnetic field - will entrain a percentage of the brains into "forced entrainment." In that case, these human brains are "synchronized" to the Woodpecker signals so that multiple coherent frequencies are phase-locked into them. That is, multiple coherent EM channels directly into these entrained brains now exist. At that **point,** Fourier expansions may be used to attack specific portions of the brain geometrically.

In addition, scalar EM disease patterns can be modulated upon the carriers, again with Fourier expansions. Specific biological effects can be induced in the entrained populace at will, limited only by the state of the art of the Soviet technology used to attack them. Possible induced effects include instantaneous **death,** heart seizure, severe emotional disruption, loss of control of internal functions, diseases, disabling of the immune system, and even implantation of **thoughts,** emotions, and ideas which are interpreted by the targeted subjects as their own.

While further discussion of this area is beyond the scope of this briefing, the biological aspects of the Woodpecker transmitters are horrible. It suffices to say that, in thousands of experiments, Kaznacheyev demonstrated that almost any **kind** of cellular death and disease pattern could be electromagnetically transmitted. Kaznacheyev reported the effect in the near ultraviolet. Experimenters at the University of Marburg in West Germany duplicated the experiments in the infrared.

The bottom line is that photons themselves can carry death and disease patterns between cells. Scalar E*M* technology allows the synthesis of the actual potential pattern (which after all represents total control of charge and charge distribution,

hence biochemistry in the cell) of a particular cellular disease or death mechanism. Symptoms (and cellular death from them!) of nuclear radiation, chemical poisoning, bacterial infection, and other mechanisms were successfully induced by the Kaznacheyev experiments.

Dr. Popp of West Germany has published an analysis of the virtual photon master control system of the cells. Since scalar EM represents the deliberate ordering of virtual particle flux into deterministic patterns, the master control system can readily be entered with scalar techniques to induce disease and disorder at will.

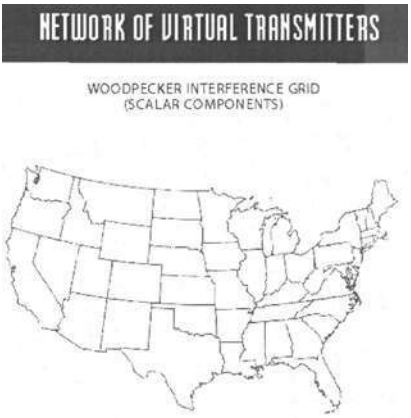

Slide 064: Network of Virtual Transmitters

On this slide we diagrammatically represent the Soviet woodpecker interference grid over the U.S. This grid can easily be used to influence and control the weather, and for over a decade the Soviets have manipulated the weather over the U.S. and other parts of the world.

By the peculiar title of this slide, we wish to call attention to the fact that, in the exothermic mode of scalar interferometry riding on the woodpecker radar signals, each of the woodpecker grid interference cells can act as a little "virtual transmitter." It's exactly as if the Soviets had been permitted to enter the U.S. and build thousands of EM transmitters at regular intervals all over the country!

And of course it's even worse. In the endothermic mode, it's as if the Soviets had been permitted to enter the U.S. and build thousands of "cold generators" all over the U.S. That is, in that mode, each of the "transmitters" can actually extract electromagnetic energy.

These two modes have enabled the Soviet Union to drastically manipulate the weather at will over the U.S. during the last decade (and similarly, for other places as well.)

(For a disclosure of the Soviet weather control operations over the U.S., see T.E. Bearden, Soviet Weather Engineering Over North America, 1-hr. videotape, 1985, available from The Tom Bearden Website www.cheniere.org. We will only summarize here.).

Briefly, inside various reference level zeros on the ordinary EM woodpecker carriers, scalar "channels" are established. Scalar beams, signals, and interferometer pulses and transmissions can be transmitted through these reference channels as if directly through a wire. Phasing, pulse shaping, and Fourier expansion formation of geometric forms are then the key to be used in scalar interferometry through the internal scalar channels of the Soviet woodpecker signals.

By choosing one or more grid cells and using scalar interference there in the exothermic continuous mode, local heating and expansion of the air, and formation of a high-pressure area, occurs.

By choosing one or more grid cells and using scalar interference there in the endothermic continuous mode, local cooling and shrinking of the air, and formation of a low-pressure area, occurs.

By electromagnetic "rotation" of the interfering scalar beams, the hotspots and coldspots can be moved along a desired path and at a desired speed.

By these methods the entire jetstream across the U.S. can be deviated and controlled to a large degree. Moisture can be drawn from the Pacific beyond Southern California and Mexico, and collided over the southern U.S. with extremely cold air brought down from Canada, producing ice storms such as those in and around February 1, 1985.

Violent thunderstorm activity can be induced and directed. By adding "spin", these same storms can be induced to form extensive tornados.

By sustained weather engineering operations, drought or excessive rain and flooding can be induced in areas of the U.S. as desired. Crops can be destroyed or heavily damaged by severe and unseasonal weather.

If the grid is placed in the ground on scalar EM carriers instead of normal EM carriers (and the woodpecker "radars," can switch to, or add, scalar carrier mode whenever they wish), it can be used as an anti-submarine weapon, as we shall see later. It can also be used to cause substantial ocean effects that have drastic consequences on the world's weather - such as the anomalous El Nino of 1982-83.

By localizing one spot of heating at the top of a thunderstorm anvil, and another spot of cooling at its side, a localized downburst can be created. Our weather satellites have detected just such an anomalous combination heating and cooling of thunderstorm anvils over the U.S. While there may exist natural mechanisms to cause this anomalous dual pattern, it may also be caused by Soviet weather engineering, which can cause either broad-area or highly localized effects.

All these types of weather engineering incidents have been deliberately created over the U.S. by the Soviet Union.

Perhaps the greatest weather effects can be induced by altering some of the large-scale normal mechanisms that influence and control our weather. Thus the **artificially** induced El Nino of 1982-83 was a case in point, causing drastic weather upsets worldwide for a year or more.

The last decade has seen weather so anomalous that it could only occur once in 1200 years by chance. It has not been due to normal chance, but by Soviet weather engineering, particularly since the advent of the Woodpecker transmitter complexes.

ADDITIONAL BACKGROUND FOR THE BRIEFER:

The Woodpecker transmitters can carry scalar components, which, in addition to biological strikes, can be used for many other purposes such as to

1. Influence and control the weather,
2. Deviate the giant jetstreams of the upper atmosphere,
3. Detect, track and destroy missiles shortly after launch,
4. Detect, track and destroy strategic bombers and other aircraft,
5. Attack land and ocean surface targets by large aerial electromagnetic explosions: the EM explosion produces the fireball, the thermal effects, and the blast wave of a nuclear explosion without the nuclear radiation and radioactive fallout contamination;
6. Attack surface land and ocean targets by large "cold explosions", where living things freeze almost instantly, leaving the surface facilities and equipment intact,
7. Attack land and ocean surface targets by severe internal electromagnetic disruption, so that all electronics are dudded,
8. Attack personnel on land and sea by direct destruction of their nervous systems with an internally induced strong EMP,
9. Disrupt the operation of distant facilities, equipment, and personnel or destroy food crops in large areas by severe cold or severe heating, or even startling oscillation between the two.

   In addition, the scalar aspects of the Woodpecker transmitters can be beamed through the earth and ocean as surface waves or at a given depth to intersect at a distant region. This mode can be used to

10. Cause distant earthquakes in a distant fault zone by depositing energy in the rocks there, increasing the plate stress until slippage occurs at a fault zone,

11. Cause large, anomalous rocking of an entire plate or large area, by depositing and extracting energy from alternate areas, causing buckling of the large rock plate,

12. Set up an interference grid under the water, so that underwater submarines can be detected, tracked, and destroyed on station and with their missiles still unfired,

13. Attack naval vessels and task forces through the water and through their hulls, without warning,

14. Attack missile silos and nuclear storage sites "before launch", directly through the earth itself,

15. Initiate the full nuclear explosion of implosion-type nuclear warheads on-board missiles on station,

16. Initiate full nuclear explosion of implosion-type nuclear warheads in storage sites and ready reserve,

17. Destroy seaborne and ocean-bottom-mounted mines and underwater sensors, even including entire "fields" of them,

18. Detect and destroy hostile torpedoes, ship-to-underwater anti-submarine missiles, and dumped anti-submarine munitions and charges,

19. "Pump" the electrical grounding of distant electrical power distribution and generation systems so that the system catastrophically fails,

20. "Pump" the electrical grounding of distant electrical power systems so that radio and television transmitters, power grids, and wiring complexes in buildings and facilities radiate a desired scalar wave component or signal complex at equipment and personnel.

All in all, the woodpecker transmitter complexes and other associated scalar EM weaponry are most useful in the major missions required in war.

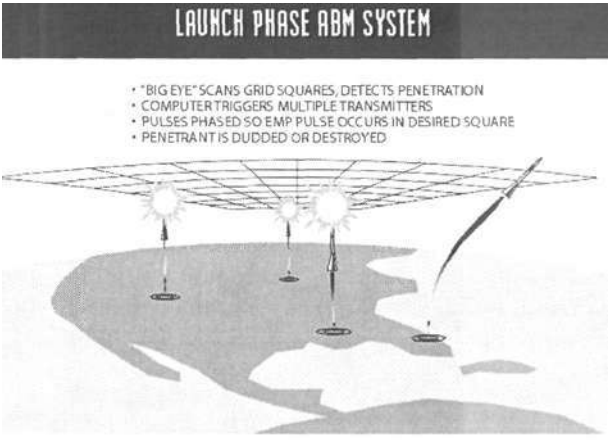

Slide 065: Launch Phase ABM System

On this slide we show the use of the Woodpecker grid in the Launch Phase **ABM** system role.

The scalar components establish an interference grid over the U.S., at some altitude above the earth. One or more separate scalar interferometers transmit through scalar channels established in the Woodpecker's normal EM carriers, scanning through the grid square cells one by one in the "just barely extract energy" endothermic mode.

Back in the Soviet Union, the energy extracted passes through a scanned receiver biased just so that the normal energy extracted from the distant atmosphere does not show on a scanning screen. Any substantial amount of additional energy appearing in the cell - such as from the jet engines of a large aircraft or the rocket exhaust of a large missile - will be detected.

The **operation** of this weapon is four-fold: (1) the scanning interferometer or "big eye" scans the grid squares, detects penetration, and tracks the rising missile. (2) A separate scalar EM interferometer (a howitzer) is controlled by a computer and fired through a separate scalar EM channel opened in the ordinary EM woodpecker carriers. (3) Two timed scalar pulses are fired so that they converge and meet in the grid cell containing the rising missile. This results in the **sudden** emergence of a violent EMP pulse throughout the missile and the surrounding vicinity. (4) All missile and warhead electrical and electronic systems are instantly dudded and destroyed. In addition, fuels, propellants, and

explosives of the missile are immediately ignited, explosively destroying the penetrating missile.

That takes care of the missile target. (The same weapon, of course, can be used against airborne strategic bombers - including Stealth-type bombers. In fact, Gary Powers' high flying aircraft was probably shot down in 1960 by a "jury-rigged" scalar EM howitzer using modified radars and timed scalar pulses to provide an aerial explosion and EMP.)

The Woodpecker grid/howitzer weapon system can be placed over the ocean and used against cruise missiles, naval surface-to-air and surface-to-surface missiles, submarine-launched ballistic and cruise missiles, etc. Placed over a carrier task force, it can also take care of the aircraft launched by the carrier as fast as they are launched. It can also handily take care of the missiles launched by guided-missile cruisers of the accompanying task force.

Now let's take a look at the command and fire control end of this weapon system, way back in the Soviet Union.

SOVIET COMMAND & CONTROL CONCEPT

Slide 066: Soviet Command & Control Concept

On this slide we show a postulated Soviet fire control system for the grid weapon.

Two or more operators sit at a control console, facing a giant display (screen). The display contains a grid, which represents the distant interference grid of the Woodpecker carriers (or scalar EM carriers, if in the underground or underwater mode). A distant missile launched into the real interference grid overhead will cause a spot of light to appear in the appropriate grid square (cell) on the operators' screen. The operators will track the displayed target, select firing mode and type of action, engage the target, and assess whether or not the distant target is killed or missed by the firing.

When a missile is launched in the distant area over which the Woodpecker grid has been placed, it quickly rises through one of the scanned grid cells on its upward journey. As it penetrates the cell, additional energy is extracted (since part of the missile's exhaust energy is now extracted also). At the screen in the Soviet Union, the additional energy received rises above bias, causing a "bloom" or spot of light to appear on the screen at the appropriate grid cell representation.

The distant operator has now detected the missile launch and its location. He places a marker over the target track and activates the computer, also inputting the type of firing or action to be performed. In this case, let us say he wishes a burst of **energy** to emerge inside the distant launched missile, and has activated that mode of firing action.

The computer computes the necessary parameters for another scalar interferometer channel in the exothermic mode, and for firing at the location of the rising missile so that two scalar pulses will meet in the cell penetrated by the rising missile on the other side of the earth. As the channel is opened, the firing solution settled, and the interferometer howitzer readied, the computer activates indicators on the console notifying the operator. When all is ready, a "ready-to-fire" light is lit on the console.

Upon receiving the command to fire and destroy the missile, the operator presses the fire button. The computer fires the activated scalar EM howitzer in the pulse mode. The operator continues to watch his screen.

When the pulses meet in the distant grid cell, a violent EMP suddenly arises in and throughout the missile and its surrounding vicinity. This explodes the missile propellants and warheads, destroying the target.

On the distant screen, a sudden drastic "blossoming" of the target results from the sudden extraction of a great deal of additional energy by the scanning scalar interferometer. The operator thus knows he has made a "kill."

Should for some reason the target be missed, additional energy will still be extracted by the scanning interferometer from the grid cell/vicinity in which the EMP suddenly emerges. The distant operator will still see a bloom on his scope, but not nearly so great as when the missile explodes. He thus knows that the EMP effect of the firing has occurred, but the target has been missed (he will see the bloom in its offset location as well). In that case, the operator can quickly mark the EMP location, hit the switch, and the computer will automatically correct and fire again.

At any rate, for a miss a large "sonic boom" or blast still results in the EMP emergence zone from sudden heating of the air. These are precisely the type of booms that were associated with three NASA shuttle launches prior to the end of 1985. These were actual testing of this weapon system, using the shuttle launches to provide a target, and delaying the burst some minutes so the shuttle would not actually be destroyed. On Nov. 26, 1985 a "marker beacon" (glowing ball of light) was also created over the site. This was probably to orient satellites and other detection systems. Some 12 minutes after that nighttime launch, a large blast occurred over the site, heard for hundreds of miles up and down the coast. Shortly after, the light suddenly moved away very rapidly - faster than a jet aircraft.

If many missiles are being launched, the operator marks them rapidly, one after the other, and the howitzer fires burst after burst at them, decimating the launched missiles, one after the other. In this fashion most of the counterstrike missiles launched by the U.S. would be destroyed shortly after launch, greatly reducing the number of missiles that make it to midcourse.

However, apparently the loss of the shuttle launched on Jan. 28, 1986 was caused by the addition of a metal-softening pattern in the exothermic mode, in and around the booster, using the actual booster ionic flames as a receiver-amplifier. This led to the failure of one of the supports and the partial breakaway of the right booster. The booster rotated into the tank, causing damage and the resulting explosion when the venting main fuel hit the booster flame.

By spread spectrum techniques and proper timing and phasing, one system of Woodpecker transmitters can set up multiple interference grids, in various parts of the world. The scanners and howitzers can operate in the appropriate zones, again by spread spectrum techniques and proper timing and phasing.

In fact, the latest versions probably can operate in the "ordinary EM carrier" (atmospheric) mode and the "scalar EM carrier" (underwater and in the earth) mode simultaneously - again by timed switching between EM and scalar EM carriers, spread spectrum techniques, and timing and phasing of howitzers and Manners.

Thus a single system can operate in the earth, underwater, and atmospheric modes. It can operate against the very wide range of different targets previously mentioned. It can do all this "simultaneously," from a real-time practical viewpoint.

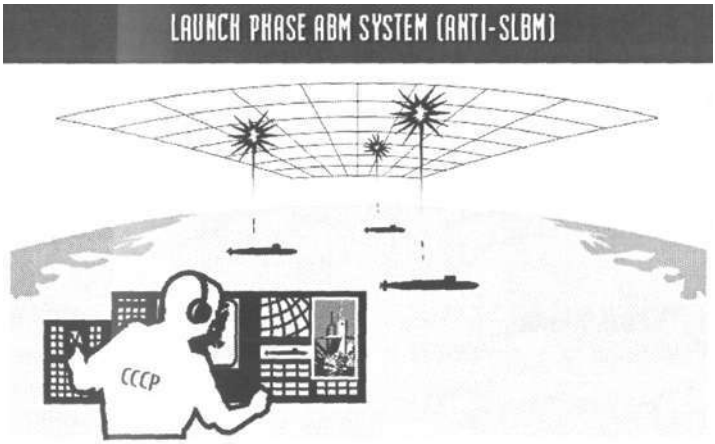

Slide 067: Launch Phase ABM System (Anti-SLBM)

Here we show the operation of the system in the atmosphere over the ocean, to destroy sub-launched ballistic missiles such as Poseidon and Polaris. The system operation shown uses the normal EM Woodpecker carrier frequencies, with scalar components to establish the interference grid, and scalar channels for the scanners and howitzers. The grid can be set up by this method anywhere in the world.

As can be seen, during their early launch phase, this mode will take care of the missiles launched from underwater U.S., British, and French nuclear submarines.

Remember, this is just one mode in which the system is operating. It can at the same time have other interference grids at other locations, and even in other modes, including underwater grids used against the submarines themselves, it can be engaging a multitude of targets of a wide variety of types, essentially all simultaneously.

Slide 068: Detecting & Marking Missile Launch

Here we show the missiles launched from the underwater submarines, when just detected in the atmosphere over the ocean. As each rising missile is detected, an operator at the screen places a cursor (a "marker") over the detected track spot on the scope.

The computer quickly computes the firing parameters and indicates when the system is "ready to fire."

By using additional scalar scanner frequencies in the multi-gigaHertz range and fine scanning, the operator is able to accomplish non-cooperative target identification.

After the operator places a cursor over a target, the advanced system fine-scans and identifies it as hostile, then continues the track in automatic.

When the operator presses the fire button for a designated target, the computer intiates fire by the appropriate scalar EM howitzer through established grid scalar firing channels.

Slide 069: Destroying the Launched Missiles

On this slide we temporarily omit the interference grid and diagrammatically show the operation of the scalar EM howitzer. As shown, two pulses are fired so that they meet in the grid cell where the rising missile is located. A drastic EM pulse suddenly emerges everywhere throughout the missile and its vicinity causing instant missile destruction.

Of course, individual howitzers not in the Woodpecker carrier's scalar channel can also fire at the missiles in the purely scalar exothermic mode. Or they can utilize the large "Tesla globe" in the continuous mode, the small Tesla "ball of light" in the continuous or pulsed mode, etc.

Also, continuous EM energy can be caused to emerge in a broader, "defocused" interference area causing electronic dudding of circuits in vehicles over a wider area. This is a very useful mode to use against mass attacks by many aircraft and/or many missiles at the same time. That is, the entire formation can be attacked in the "dud electronics" mode, and then followed up by more intense servicing of each individual hapless target.

Again, in 1960 Gary Powers was probably downed by a crude prototype scalar interferometer "howitzer" obtained by modifying two ordinary radars. At least the Soviets had previously been unable to down a penetrating U-2 with missiles they possessed. We know the scalar howitzers were in development, for Khrushchev had announced to the Presidium in January 1960 that a new "fantastic weapon" was in development. A development prototype was probably used to down Powers' aircraft.

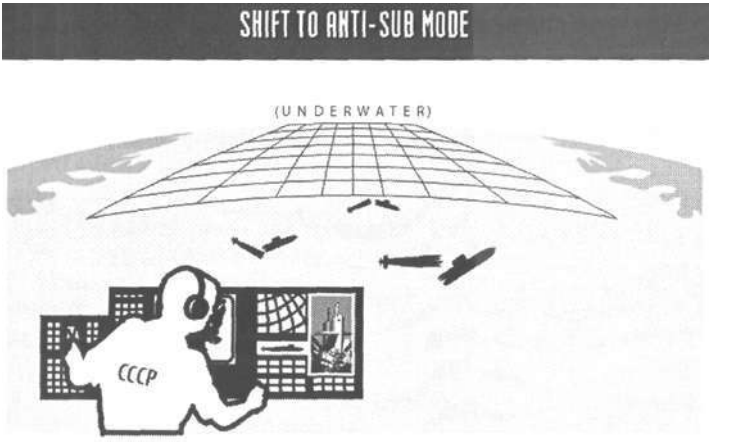

Slide 070: Shift to Anti-Sub Mode

In the underwater mode portrayed on this slide, the Woodpecker transmitters have been switched to "scalar carriers" mode and the carrier beams transmitted through the ground and into the ocean underwater. (Remember, an artificial EM potential that does not couple to charged particles or ions will travel through the ocean, but a force field will not.)

Thus a giant scalar interference grid is now established underwater. Additional scalar beams in the weakly endothermic mode scan this grid. When a submarine enters tne grid, it substantially changes the potential in that cell, and the scanner picks this up. The distant screen now displays the sub as a "track" of light in the appropriate grid square cell. The computer switches in fine-scanning and non-cooperative target identification. It identifies the target as hostile and alerts the operator (by blinking the track and changing its color to red, for example).

As before, the operator marks the target and enters the firing mode and type of action desired. Again, let us assume the "EMP burst" mode of destruction is to be used. The computer computes the firing parameters and readies the howitzer, When the commander gives the command to fire, the operator presses the firing button. The computer fires the howitzer.

Two scalar pulses proceed through the howitzer scalar channel and meet in the submarine. Throughout the sub and its vicinity, a violent EMP is suddenly experienced, knocking out the electrical systems, electronic equipment, and igniting propellants and explosives in the on-board missiles and armament. This explodes the submarine, missiles, and torpedoes instantly.

At the distant command console, the scanners detect the violent eruption of energy from the exploding submarine. It appears on the screen as a sudden strong blossoming of the track. The operator assesses that the target has been destroyed. He immediately engages another target if one is present.

If the EMP is off-course and misses, the scanners still pick up a smaller blossoming in the offset location. The operator immediately knows he has missed the target. He marks the offset bloom, presses the switch for "Correct!" and the computer makes the firing correction. When the operator again gets a Ready-to-Fire light illuminated, he presses the firing button and fires again at the target, this time with corrections applied.

Again, the same Woodpecker system - using timing, phasing, scalar/EM switching and spread-spectrum techniques - may be involved in several grids and many types of targets. When in a target-rich environment, the firing operators may be very busy indeed.

As we shall later see, the same weapon system may also be firing in the "cold explosion" or pused endothermic mode, where intense bursts of instant and severe freezing are unleashed in the target zone.

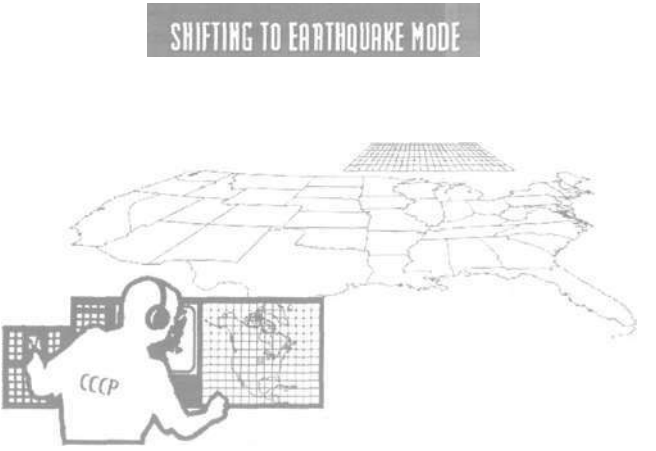

Slide 071: Shifting to Earthquake Mode

The uses of the complex grid, scanners, and scalar howitzers is limited only by human ingenuity and state-of-the-art of the technology developed.

By shifting to the scalar-carrier mode and transmitting in the surface layer of the earth, the interference zone can be established in a distant region of the earth, beneath the earth's surface.

Suppose we establish a very small interference grid in the earth at and around a distant fault zone. Then by steadily depositing energy in the zone in the continous exothermic mode, the stress in the fault area is steadily and gradually increased. Eventually the plates on each side of the fault will slip, and a "natural appearing earthquake" occurs. If the energy is deposited slowly and gently, a gentler quake can usually be effected. If the energy is deposited fairly rapidly, a higher peak stress can usually be reached before the rocks slip, and a larger, more destructive earthquake results.

By making a wider grid in the earth in a larger area, a strange kind of earthquake can be induced, whether or not a fault zone exists in the area. By pouring energy out of alternate cells and extracting energy from the others, a "wave-like" buckling tensile and compressive stress is created throughout the zone. As this continues, the entire plate area will try to oscillate, moving and causing an anomalous sort of "rocking, flat earthquake" throughout a large area.

Not too many days after the destruction of the Challenger on January 28, 1986, such an anomalous "flat earthquake" occurred in the U.S., near the Great Lakes,

involving some 10 states. This was probably the subsequent testing of an additional weapons mode of the same Soviet scalar EM system that destroyed the shuttle.

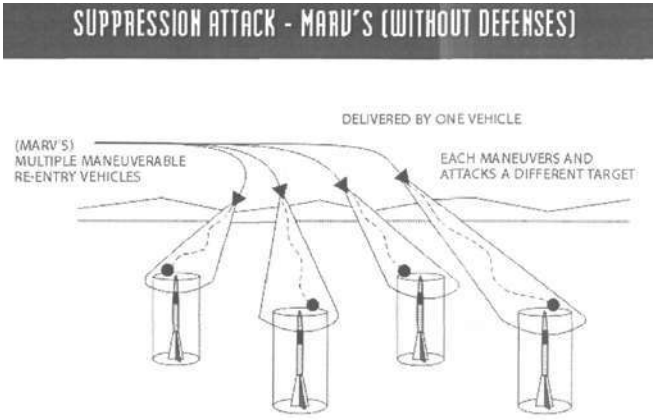

Slide 072: Suppression Attack—MARVs (without defenses)

Now to shift the emphasis a bit, and look at the impact on some "normal" strategic systems and concepts.

On this slide we show the basic idea of suppression attack against an enemy's ground based missile force in fixed-site silos. The attack uses multiple maneuverable re-entry vehicles (MARVs) delivered by a single carrier missile, which acts as a "bus." The bus ejects the MARVs at the appropriate time, and each of the MARVs heads toward its predesignated target, maneuvering as it re-enters the atmosphere and proceeds to the target. The maneuver makes conventional intercept of the MARV by conventional anti-ballistic missiles more difficult.

In this manner, missile silos without defenses may be caught by surprise and destroyed.

The "bus" concept actually multiplies the number of targets a single launched missile can attack, and the maneuvering of the MARV increases the difficulty of defending the target area by orthodox means.

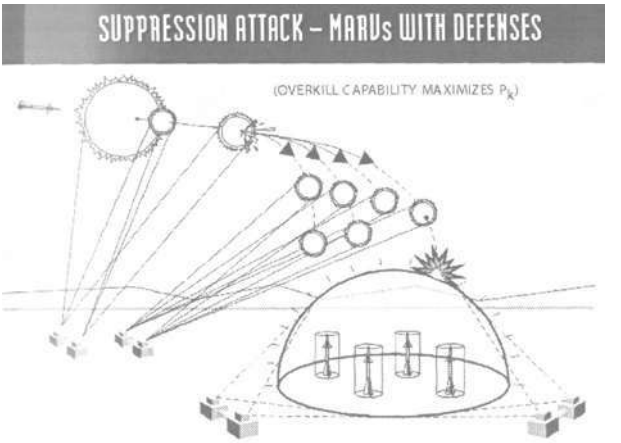

Slide 073: Suppression Attack—MARVs (with defenses)

Now suppose some of the scalar EM defenses we have discussed are added to the picture.

On this slide we show a similar missile field, defended by a Tesla dome and by multiple scalar howitzers.
The howitzers take the incoming buses under attack during the early midcourse phase, by means of very large spherical EMP globes. Many of the buses - and their entire payloads, including the nuclear warheads themselves - are dudded by these midcourse defenses.

Servicing of dudded vehicles that have penetrated the globe now occurs farther along in midcourse. Each dud vehicle may be serviced, for example, with a small globe in the continuous mode for an appreciable number of seconds. This causes vaporization or fusing of the physical structures of the vehicles.

Groupings of incoming vehicles may also be serviced by medium-sized globe in the pulse mode. This assures dudding, and is especially useful for clearing away chaff and debris with smaller ballistic coefficients. It also is useful to further insure that the nuclear warheads themselves are totally dudded.

An additional wrinkle is to place scalar signal patterns - that affect and transmute a nuclear warhead's radioactive nuclei - onto a continuous globe. In short, by the proper scalar signals it is possible to transmute plutonium and uranium into harmless elements, and it can be done at a distance. The 4th and 5th generation Soviet scalar EM technology is probably capable of doing **this**

This insures that, not only are the incoming nuclear warheads electromagnetically inert, but they are also nuclearly inert and incapable of generating nuclear explosions.

Still another wrinkle - particularly useful against implosion-type weapons - is to utilize a scalar signal pattern that causes sudden generation of neutrons in the active material (plutonium or uranium). This harmlessly explodes the nuclear warheads while they are far away from their intended targets and out in space. The burst mode is probably the most useful for this tactic.

Note that, if desired, this same tactic - exploding the nuclear weapons themselves - can also be utilized in the Launch Phase ABM system grid against the missiles after launch. This capability converts an adversary's intended nuclear attack against you to an actual attack against himself!

Also note that the adapted grid system in the surface of the earth can be used to explode the nuclear warheads in ICBMs while they are still in the silos, or to explode nuclear warheads in storage. In the underwater mode, the nuclear warheads in the Poseidon and Polaris missiles on-board the nuclear submarines can be exploded in a similar manner. In fact, the nuclear reactor used to furnish the power for the nuclear submarines can also be exploded or disabled in this manner, as can land-based and ship-based reactors.

Again, this actually turns an adversary's own nuclear weapons against him. His own weapons can be used to obliterate him. Without scalar defenses, possessing the capability of nuclear attack becomes a serious detriment!

But back to our slide. Just in case something gets through this formidable defense somehow, the Tesla Shield (dome) provides the final reiteration that takes care of any residue "leakage."

The sum total of these defenses fully justifies the 1968 Soviet statement in Military Strategy that the USSR has achieved a 100% defense, and the West has

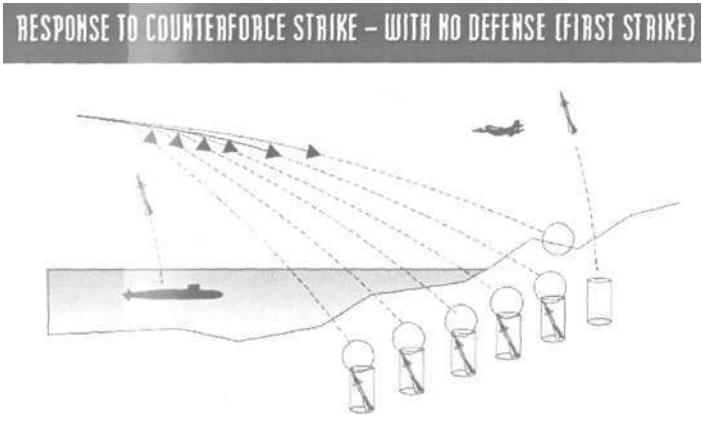

Slide 074: Response to Counterforce Strike with No Defenst

Here we show the orthodox concept of response to a surprise counterforce nuclear strike when the surprised force has no defenses.

A great percentage of the attacked missile silos are destroyed. The surprised side thus is able to mount only a limited strike in retaliation. Perhaps he is able to launch some remaining silo-based missiles that escaped destruction. He is also able to launch missiles from any of his underwater nuclear submarines that escaped. Some of his strategic bombers may have escaped destruction on the ground or while airborne on station; these surviving bombers can be directed to proceed with strategic reprisal against the enemy.

As can be appreciated, this entire concept is now totally obsoleted by the Soviet possession of scalar EM weapons.

The "mutual assured destruction" capability - or MAD concept as it was so aptly named! - is no longer mutual.

And for two reasons: (1) the Soviet surprise attack could destroy essentially all our Triad forces wherever they are, in the first attack. (2) Even if a very small number of our strategic forces survive, the puny strike we could attempt to launch could be repeatedly decimated from launch to terminal phase.

The restraint on the Soviets is not because of our Triad forces. The restraint is twofold: (1) a second nation has scalar EM weapons, and would undoubtedly unleash them upon the Soviet Union with great violence if such a massive

world-wide destruction of U.S. forces occurred or was threatened (is it really "accidental" that six major Soviet missile ammunition storage sites mysteriously exploded within seven months?); (2) the closed-loop scalar radiation exchange system of Earth-Sun could be inadvertently "tweaked" in the feedback loop from Earth to Sun, so that a large solar scalar resonance was stimulated. In that case the Sun could emit a mighty resonant "burp" that would simply wipe out all life on Earth in a fiery shower.

The "terror" in the "balance of terror" between nations has just increased by many, many orders of magnitude.

The biblical prophecy that the Earth will be wiped out by "fire and brimstone from heaven" is very near fulfillment now.

Put another way, the pucker factor - even on the Russians who may contemplate unleashing Armageddon - is higher than any Western strategic analyst has ever imagined, even in his wildest nightmares.

Truly these weapons are "more frightening than the mind of man has imagined," as Brezhnev put it in 1975.

The frightening scalar EM weapons can be used, but only very, very gingerly indeed. If a slight mistake is made, everybody loses everything.

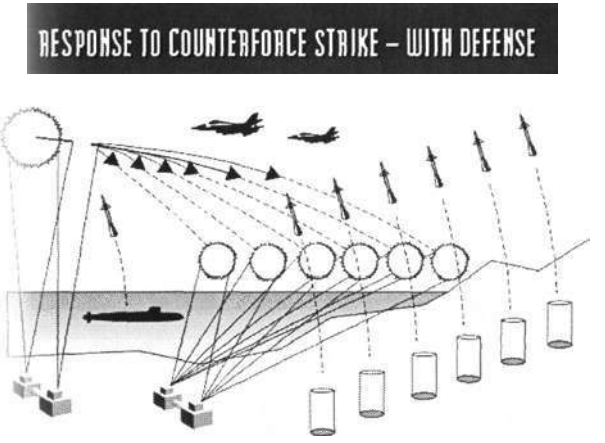

Slide 075: Response to Counterforce Strike with Defense

On this slide we show the impact of scalar defenses against an adversary who possesses only the orthodox nuclear weapons and delivery systems, and makes a "first strike" by surprise against his opponent.

In this case, the attacked opponent has scalar EM defenses.

With just the midcourse and terminal scalar EM howitzer defenses, almost all of the attacking missiles and re-entry vehicles are destroyed.

If for some reason (such as to prevent triggering the sun and destroying the world inadvertenly!) the attacked adversary does not wish to attack strategically with scalar EM weapons, he may now launch a massive retaliatory strike on his opponent.

And if that opponent has no ABM defenses, he's just bought the farm.

What a funny coincidence! Long ago, we crazy Americans chose to put all **our** eggs in the offensive basket. That is, we thought the Soviets cannot dare to strike us because we will have enough surviving missiles to penetrate any orthodox defense and destroy them in return. They would also have the same "mutual assured destructon (MAD)" capability, of course!

The MAD concept was aptly acronymmed - it was an insane idea from its inception. That is, the Soviets were not supposed to defend their cities **and** populace, and neither were we. That way, you see, we could destroy their

citizenry at will, and they could destroy ours at will. We deliberately agreed to that, thinking - in our insanity - that the Soviets agreed also.

Of course the Soviets weren't playing the same lunatic's game at all. They simply fed our own garbage back to us, and we importantly thought we were negotiating something. Unknown to us, they were secretly building and deploying scalar EM defenses even then. Since we didn't know of any other defense, we assumed the Soviets could not defend their citizenry with ABMs any better than we could defend ours with ABMs. So we blithely scrapped our ABMs.

The high government officials of the United States of America grossly violated our constitution and their sworn oaths of office. Our constitution specifically charges the government of the United States to defend the people of the United States. That means our officials are specifically charged with defending our people. Yet they deliberately agreed not to do so, and they deliberately sacrificed us in advance.

They committed treason of the highest kind, by deliberately surrendering us to total destruction anytime the big balloon goes up.

The constitution doesn't charge the government with surrendering our citizens to destruction under any circumstances. It charges the government with defending us against destruction.

Ronald Reagan is the first U.S. president in some time to see through the MAD concept. At least he stands forthrightly for defense. It's just a shame that the government and scientific leaders under him aren't aware of the Soviet scalar weapon developments, so they could brief him on these startling developments.

Be sure you understand what the government leaders before Reagan have been saving. For years, our official policy has effectively said to the Russians: "We will allow each side a token defense only. We deliberately will not defend ourselves, so that anytime you decide to strike us you can destroy us. In return, however, we do not think you will want to strike us, for we believe that - before we become ashes from that strike - we can get enough away at you, to destroy you as well. Of course we believe you are in the same sort of boat."

Then we said, "There! That's settled! What a relief! Nobody can strike anybody anymore. Now can we talk about partial disarmament and on-site inspection?"

The Soviets just kept their astonished amusement to themselves and kept building scalar defenses (and scalar offenses as well!). Their deception plan called for imbedding the scalar EM weapons in ordinary systems when possible, and hiding the scalar EM weapons tests in ordinary weapons tests when possible. Of course they had to be adamant in their opposition to on-site inspection; after all, even Western scientists, if allowed on site with the dual-mode weapons, might suspect something was different and possibly things were amiss.

The Soviet deception has worked like a charm. The U.S. MADmen who created and implemented the MAD doctrine have succeeded in prejudicing two generations of academicians and elected U.S. leaders against the need for effective defense. A vast wasteland of inane paper studies - learnedly dealing with ABM's, penetration tactics, leakage, force and counterforce, radar blackout, electronic warfare, etc. etc. - has been churned out by our military, industrial, and university "think tanks" to clog the minds, efforts, and literature of our defense and governmental establishments.

Our homeland has no effective ABM defense (and very little defense against aircraft or subsonic cruise missiles).

Our field army has no effective ABM defense (or air defense). Our naval forces have no effective ABM defense (although they are better defended against air attack than the field army). Yet ballistic missiles - and to some extent cruise missiles - have supposedly been our greatest threat for decades, followed closely by the secondary threat of massed aircraft attack.

A cynic might take the stand that, if our Defense Department hasn't been allowed to defend us (with deployed weapon systems, not by "paper studies") against what we ourselves have proclaimed is our biggest threat, then why is it called the Defense Department? Why not call it the No-defense Department'?

Understand, a great many fine, hard-working people in DoD have certainly tried to get adequate defenses developed and deployed. The sheer weight of the bureaucracy and its mind-numbing entanglements has prevented it.

But it's even worse. Our bureaucrats - both in government and in "big, organized science" - have been so caught up in the "Russians are really just ignorant peasants" syndrome and the "not-invented-here" (NIH) syndrome that they've not recognized the greatest scientific and technical breakthrough in history. Such a breakthrough - far greater in importance that the nuclear bomb has been made, developed, and deployed by the Soviet Union, all in secrecy and behind the smokescreen of a masterful deception plan.

We've totally missed the most incredible "secret superweapons" development program of all times, and the worldwide testing of the weapons themselves.

Hiroshima and Nagasaki should serve as object lessons in the price of ignorance of such technological breakthroughs.

History does repeat itself. But this time it's not we Americans who got the growl new superweapon first.

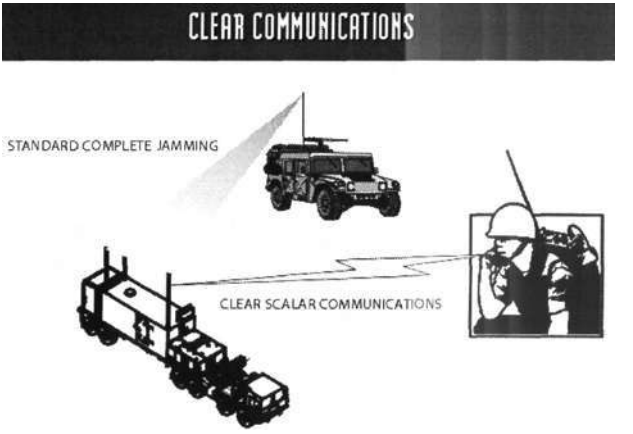

Slide 076: Clear Communications

Now let us rapidly give some unique capabilities that one can do with scalar EM in smaller things. Not only can scalar EM weapons be used in the big "continent burning" strategic weapons, but they can also be used for a variety of smaller defense tasks.

For example, one can establish a zero reference anywhere one wishes in an ordinary carrier. Inside that zero, one can establish as many independent "carriers" as one wishes, and hide them completely from ordinary detectors.

The way to do that is easy. Take as complex a signal as you wish. Subtract it from zero. That gives a "complement" which, when summed with the original signal, will produce the zero. Then only a scalar detector can go inside the zero and pull out the individual components.

So take a carrier wave. Let the enemy jam it completely, with gobs of power.

Your scalar communication channel stays serenely there, calm and unjammed. The enemy thinks you're jammed and can't communicate. Meanwhile, you continue to communicate just fine.

Or be real smart. Take one of those components inside the first zero. Pick a zero reference inside it. Hide still more carrier components inside the second zero. Do this as many times as you wish.

You can put all the telephone calls in the United States of America on one carrier. And you can keep them clear, right through total jamming.

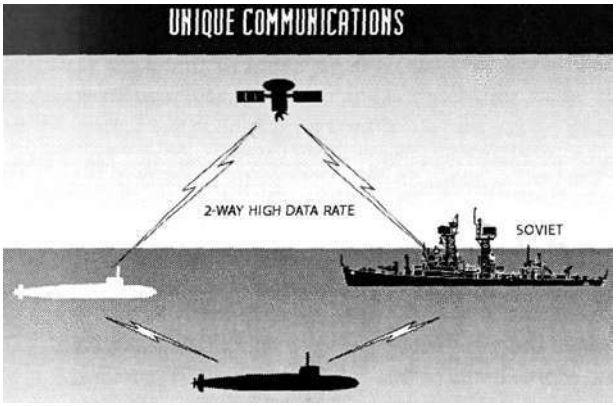

Slide 077: Unique Communications

But that's still not all.

You can also communicate with your submarines underwater. High data rate. Chat away as you wish. You can scramble, frequency hop, encrypt, the works. They can also communicate back to you.

Remember. EM force fields of any appreciable frequency won't travel through the water. Natural EM potentials grab charged particles and ions, so they won't travel through the ocean either. But artificial potentials don't grab onto charged particles or ions, and they will go through the ocean quite nicely.

Everything - aircraft, ships, shore installations, submarines, etc. - can communicate like gangbusters if they possess scalar EM technology.

In fact, you can even build scalar EM underwater radar if you wish.

The airborne scalar EM radar can see under the ocean with a little adjustment. perhaps as well as a conventional side-looking radar sees distant targets today, The airborne scalar EM radar can detect and track the underwater submarine while tooling along.

In fact, the airborne scalar EM radar can then destroy the sub, by using a **little** scalar interferometry. And it's even possible to do scalar interferometry with a single transmitter! How, is proprietary to a friend.

In fact, you can even use your enemy's jamming transmission as a "wire" along which to establish your scalar EM channels. You can use these scalar channels In the "weakly endothermic mode" to locate his transmitter and "lock-in" on it. You can "walk" the lock-in right past his encryption function to the "clear" Input, and receive and record that in the clear. All this from a distance.

You can then destroy his equipment if you wish, or just continue to monitor him in the clear if it's important to do so. Perhaps now we can understand what the decades-long weak microwave radiation of the U.S. Embassy in Moscow is all about. Or why the Soviets are building a nice new Embassy, bristling with antennas, on the high ground in Washington, D.C.

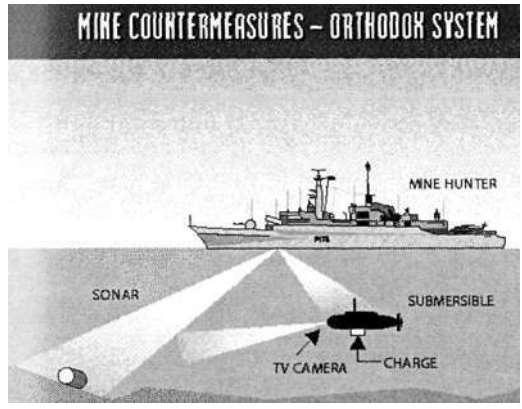

Slide 078: Mine Countermeasures—Orthodox System

Take something like mine countermeasures, for example. Finding and destroying mines - particularly those placed on the bottom in relatively shallow areas such as ports and rivers - is a really tough problem.

Presently it's often done as portrayed on this slide.

Here a minehunter ship uses an underwater sonar to locate the mine, or what resembles a mine. Then it directs a submersible robot vehicle to proceed over to the object and examine it with an underwater television camera. If it's a mine, the submersible places a remotely operated charge beside it, then chugs away. When it reaches a safe distance away, the charge is exploded, causing the mine to detonate.

A very painful process. Very time consuming, and very difficult.

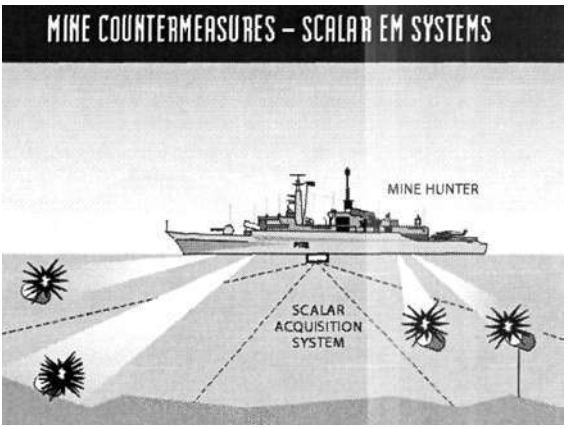

Slide 079: Mine Countermeasures—Scalar EM Systems

Now try the same thing while using scalar EM underwater systems. The scalar EM acquisition system is really a sophisticated scalar radar. It scans a large area rapidly, locating moored mines, bottom-planted mines, and drifting mines.

The acquisition system is also a scanned "underwater eye." The operator in the surface vessel can tell whether or not it's a mine he's located.

Once thc target mine is detected, a computer computes the firing parameters for a scalar interferometry pulse to hit it and destroy it. The operator fires the pulse, destroying the mine.

The same system that detects the mine at a distance identifies and destroys it at a distance. In this way large areas can be quickly scanned and swept clean of mines.

If a suspicious object is detected and one is still not quite sure it's a mine, shoot it anyway! If it's a mine, it explodes. If it's just a rock, nothing happens. So the samesystemcando"discriminationbyfire."

The same system is useful to destroy midget submarines, bottom crawlers, etc.

It can also wipe out whole arrays of underwater sensors by electromagnetically dudding them.

It can take on a sub if it has to! Here it would just gently kindle EM energy inside the sub's controls, causing it to lose control of all its systems. The sub

would then sink to crush depth and implode. The scalar EM mine sweeping system could, of course, simply "blow" the sub, but might itself get caught in the resulting explosion.

SCALAR ANTI-PERSONNEL WEAPON

Slide 080: Scalar Anti-Personnel Weapon

From a military viewpoint, these scalar EM weapons are really quite all-around weapons.

For example, they are very lethal against personnel.

Set in the "high intensity pulse mode," one blast and a person's nervous system is destroyed instantly. Total, instantaneous death results. One can blast away at entire groups of infantrymen, for example. It's the peak power that's important, not the average power. So the weapon doesn't require too much battery power.

Set on a lower intensity pulse mode, one zap can simply knock out a person, rendering him instantly unconscious.

Quite useful if one needs prisoners to interrogate. Also very silent, which is useful in operations employing stealth and surprise.

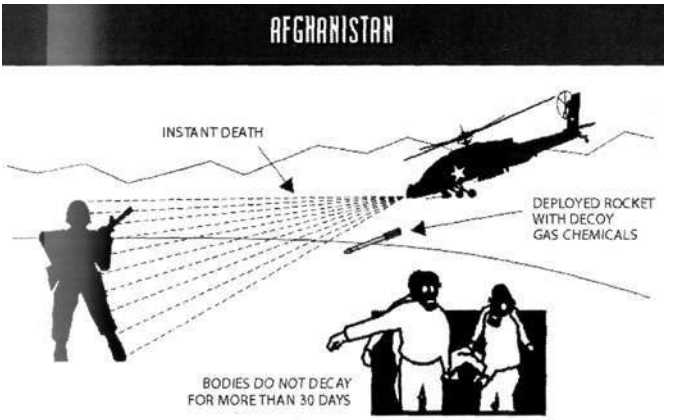

Slide 081: Afghanistan

The Soviets are employing just such a scalar "death ray" weapon in Afghanistan, apparently in the noses of some of their HIND helicopters.

These choppers usually fire gas rockets to camouflage the testing of the tactical scalar death ray. For example, they may fire rockets filled with nerve gas, and some persons will die convulsively from the chemical.

Those hit by the scalar EM weapon, however, have a most peculiar death **mode,**

Death comes instantly and totally. There is no convulsion, no response. The entire nervous system is destroyed instantly. Every living cell in the body is killed instantly, including all bacteria, germs, etc.

A body hit with this thing falls like a limp rag and lies where it falls. It doesn't decay in even 30-45 days. In a macabre fashion, it's been reduced to something like food irradiated with nuclear radiation; everything is killed, so the material is preserved for an extended period before any decay can set in.

Western military authorities have speculated that this strange death is due to some sort of eery new gas.

However, even with the most virulent gas, some seconds are required for a b**ody** to die. And while it's dying it goes into convulsions. Violent convulsions.

This eery, instant death that leaves a non-decaying corpse is not due to a **gun,** This is the signature of a high-powered pulse kill using a scalar EM weapon

The associated gas rockets are the disguise used to fool our intelligence analysts.

They're just part of the Soviet deception plan.

ADDITIONAL NOTES AND REFERENCES

15. For details of the mysterious, instant deaths in Afghanistan, see Yossef Bodansky, "Soviets testing chemical agents in Afghanistan," Jane's Defence Weekly, 1(13), Apr. 7, 1984, p. 508

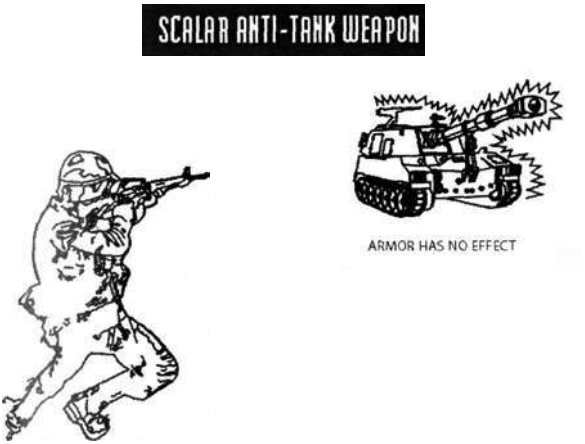

Slide 082: Scalar Anti-Tank Weapon

Such weapons are also effective against armored vehicles, for example.

They can be carried by personnel, mounted on vehicles, mounted in helicopters, etc.

They are truly all-purpose weapons.

An infantryman with a bazooka-sized scalar EM pulse weapon can easily knock out a tank with one shot. The armor has no effect; scalar EM goes right through conductive shielding and Faraday cages.

And with the same weapon he can knock out another tank, and another, and another...

Slide 083: Scalar Anti-Aircraft Weapon

And, if a helicopter or a fixed-wing aircraft attacks him, he can bring the same weapon to bear on it.

He can knock down a chopper or a jet. With one shot.

And another. And another.

Also, it's a line-of-sight weapon. He doesn't have to compute lead angle and all that jazz. Just aim, get the target in his sights, and pull the trigger.

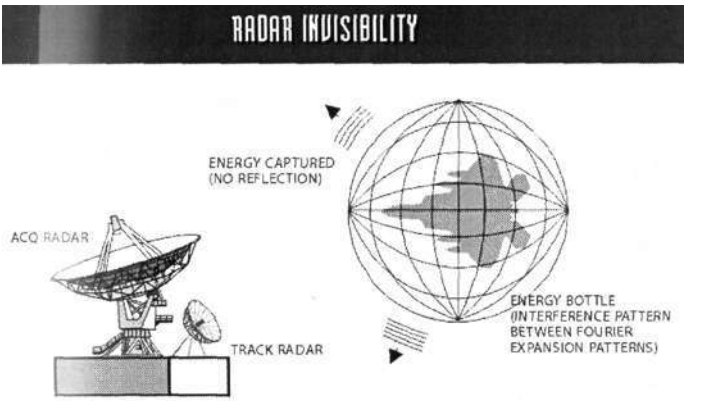

Slide 084: Scalar Anti-Aircraft Weapon

Another neat trick you can do with scalar EM is make an aircraft invisible **to** ordinary radar.

Just use multiple transmitters on the airplane to establish a spherical interference shell, in the bandwidth of the threatening radar, around the aircraft.

When the signal pulse (or continuous wave) from the ground-based radar **strikes** the "energy bottle" in the shell, it interferes with it and is diffracted, scattered, and partially absorbed.

The ground-based radar doesn't get any coherent return pulse or return signal reflected from the target.

Radars don't track aircraft; they track the reflection of their own signal bouncing off aircraft. No reflected signal, no aircraft - as far as a radar is concerned.

To shield against a passive radar (one which tracks emissions from the aircraft), just detect and complement your own emissions so that "near zeroes" result In the spectrum of interest.

Or do both, to protect against both.

It's even possible to cool the exhaust and heated surfaces of the aircraft by a scalar EM adaptation of electrostatic cooling. Theoretically it's even possible to cause the aircraft to "disappear" optically. Takes a bit of doing, but it's possible The basic scheme here is that, when a photon hits the target from a given direction, it's absorbed totally, and a corresponding or "matching" photon is

emitted from the opposite side in the same direction the original photon was going. In that fashion, the light emitted from the target from one direction seems to have "passed through it" from the other direction.

Since that's what empty space does, then what a distant observer sees is "empty space," so far as he can tell.

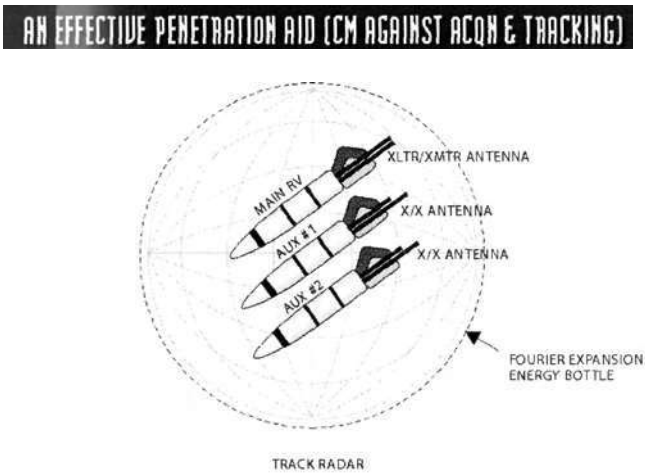

Slide 085: An Effective Penetration Aid

Of course you can do the same thing for re-entry vehicles.

Use some multiple antennas on a vehicle. Or better yet, use satellite RV's to carry the extra transmitters necessary for scalar interferometry.

Deploy the interferometer RV's and activate the scalar EM transmitters. Place an energy bottle Fourier expansion interference shell around the ensemble in the bandwidth of interest.

Radars in that bandwidth now will be unable to detect the incoming ensemble. If nothing detects the threat, nothing is going to shoot at it or react to it.

This can also be used on a bus vehicle during midcourse, for example.

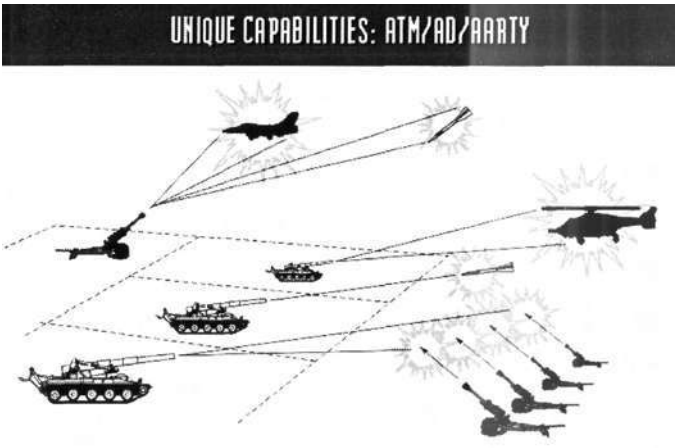

Slide 086: Unique Capabilities: ATM/AD/AARTY

But the uniqueness of scalar EM devices and weapons doesn't end there.

You can hit lots of other threats that are presently difficult or impossible to effectively handle.

For example, on the tactical battlefield, the same scalar EM radar interferometer system can defend against tactical missiles (ATM role), aircraft (AD role), cruise missiles (ACM role), and even artillery and mortar shells (AARTY role).

How the devil, you might ask, can it defend against artillery and mortar shells?

Simple. Sweep the artillery or mortar barrage with closely spaced pulses. Sorta like a machinegun. Or more like a phased-array radar.

If the peak power in the sweeping pulses is sufficient, the explosives are sparked and detonated. Fuses are destroyed.

So even mortar and artillery rounds can be destroyed, by the same system providing air defense and anti-tactical missile defense.

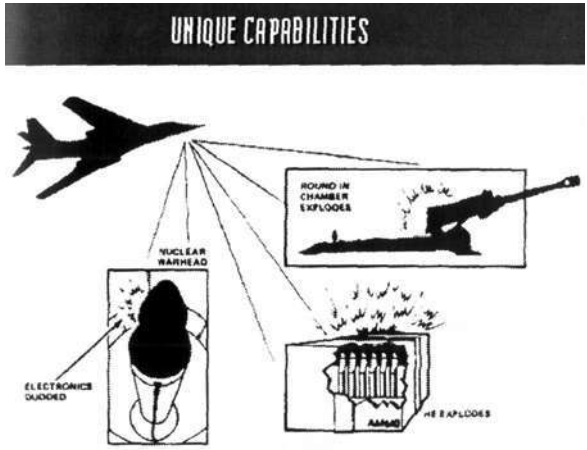

Slide 087: Unique Capabilities

That's still not all.

An incredible number of different types of targets can be attacked with scalar EM weapons.

For example, aircraft equipped with scalar EM weapons can attack targets such as loaded artillery pieces. The round in the chamber explodes, destroying the weapon.

It can also attack nearby stored ammunition. Again, the high explosive in the ammunition explodes, destroying the store.

Even underground missiles can be attacked. The scalar pulse will go right through the overhead cover and dud the electronics, including the nuclear warhead. It will also detonate the HE in the warhead and detonate the fuels and propellants.

A great variety of other targets can also be attacked, as we shall see.

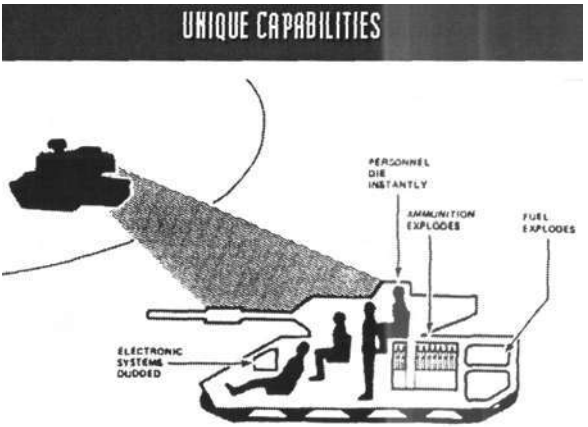

Slide 088: Unique Capabilities

For example, suppose one attacks a tank.

With scalar EM pulse, the personnel die instantly. Total personnel kill is achieved.

All electronic systems of the tank are dudded. Total systems kill is achieved.

The ammunition in the tank explodes. Total kill is achieved.

The fuel explodes. This is another total kill mechanism.

That tank has been killed totally, by a variety of mechanisms, all simultaneously.

That's a k-kill in any analyst's book.

And **don't** worry about retrieval and repair. That tank is finished permanently.

Even **the** most modern tank is just as vulnerable as the most obsolete.

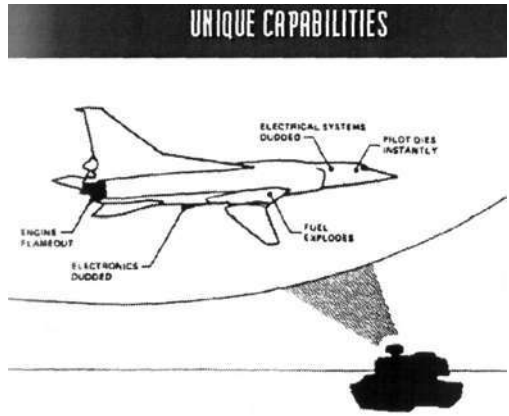

Slide 089: Unique Capabilities

Suppose one attacks a fighter-bomber aircraft.

Again, the kill is catastrophic from multiple simultaneous kill mechanisms.

The pilot and crew die instantly. Total destruction of their nervous systems.

The electrical systems are dudded.

The electronics in all avionics and ordnance is dudded.

The fuel explodes.

HE in on-board or out-board ordnance explodes.

The jet engine flames out if the pulse is powerful enough.

That aircraft is finished. Permanently.

And it's point-and-shoot, line-of-sight.

Even the most modern aircraft is just as vulnerable as the most obsolete.

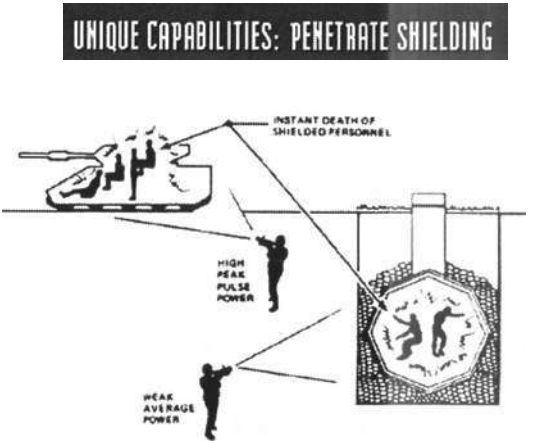

Slide 090: Unique Capabilities: Penetrate Shielding

Shielding is ineffective.

The scalar pulse (or continuous wave) can go anywhere gravity can go.

It penetrates the steel hull of tanks and armored vehicles.

It penetrates underground shelters and bunkers.

It penetrates pillboxes and fortifications.

Foxholes are no protection. Just shoot through the earth into them.

There is no longer any place to hide.

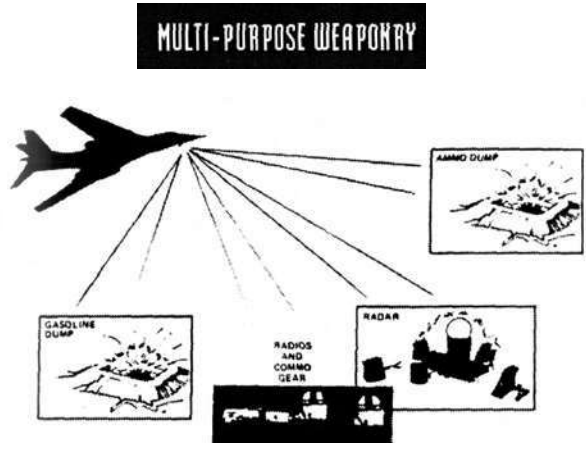

Slide 091: Multi-Purpose Weaponry

These scalar EM weapons are all-purpose. Things such as ammunition dumps, radar systems, radios and communication gear, communications centers, gasoline dumps, etc. can easily be destroyed.

Not only that, but the weapons can be swept, giving area coverage.

You can hit both point targets and area targets.

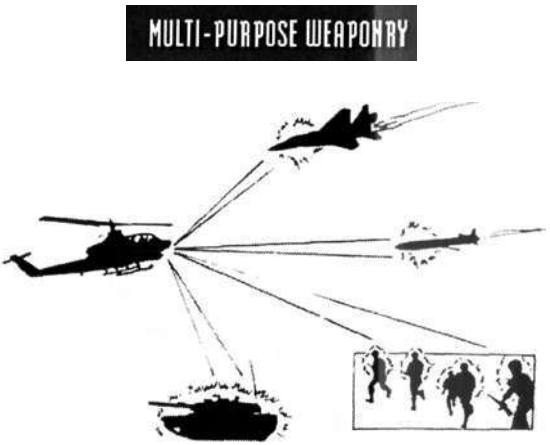

Slide 092: Multi-Purpose Weaponry

Look at what a weapon a helicopter becomes.

The same vehicle, equipped with scalar EM weapons, can engage and destroy jet aircraft, other helicopters, cruise missiles, personnel, and armored vehicles.

It can also hit all the other targets we've been talking about. Any vehicle equipped with scalar EM weapons becomes a formidable destroyer on the battlefield.

And "reconnaissance by fire" takes on a particularly lethal meaning.

For example, don't worry about the enemy in cover and concealment, or highly camouflaged.

Don't worry about decoys or dummy positions.

Just sweep the area with scalar EM fire. The actual targets will be discriminated by fire and destroyed.

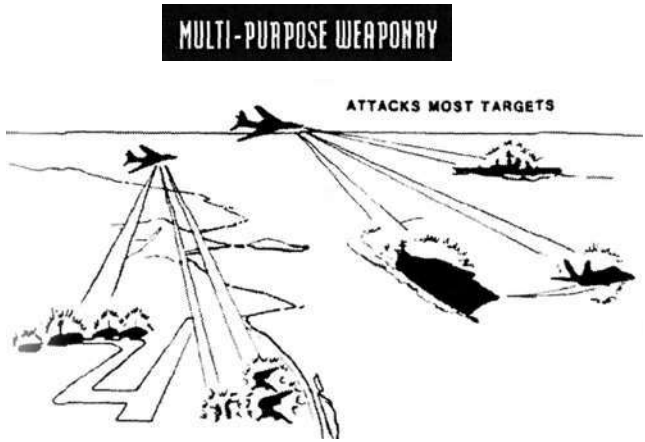

Slide 093: Multi-Purpose Weaponry

As can be seen on this slide, most targets of interest can be attacked.

A single aircraft can sink an aircraft carrier or destroy a battle cruiser from afar.

It can also destroy aircraft, ground installations, artillery, personnel, nuclear weapons storage sites, tanks, vehicles, fuels, and combustibles.

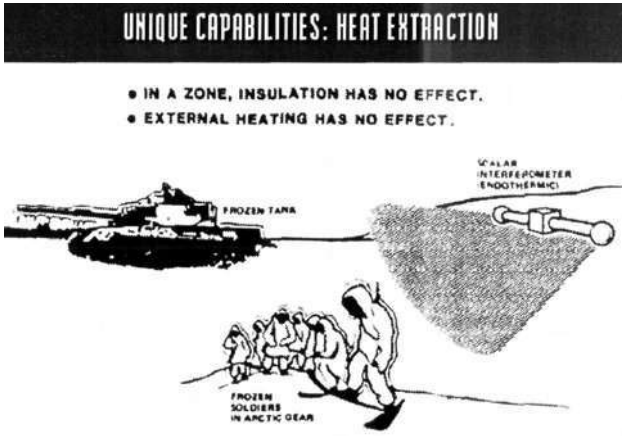

Slide 094: Unique Capabilities: Heat Extraction

Or one can get truly exotic.

To prevent destroying equipment and installations, the endothermic mode can be utilized.

Cold explosions can be used to freeze tanks, personnel, and equipment.

The equipment and tanks thaw out.

The personnel thaw out too, but they are dead when they do. Heaters and arctic clothing are no protection.

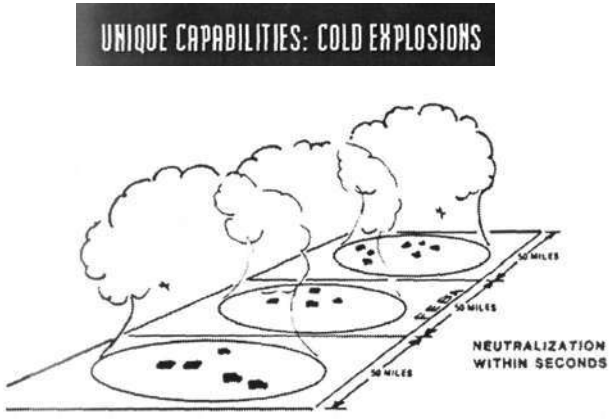

Slide 095: Unique Capabilities: Cold Explosions

For example, suppose three cold explosions, each 50 miles in diameter, are placed upon the front-line strength of NATO.

In seconds there is no longer any "front line strength" of NATO. Every living thing is frozen into a block of ice.

A few more of these things placed on selected rear area installations, and the battle is over before it gets started. Say in about one minute flat!

Suppose NATO is quickly defeated - say in two days. And then the Russians offer us a "Dunkirk." They agree to allow us to evacuate the beaten remnant of our forces.

Are we going to evoke a strategic nuclear exchange, or are we effectively "decoupled" from Europe? Particularly if the Soviets also offer sweeping accommodations to the Europeans, and they accept? If we punch the strategic button, we guarantee our own absolute destruction. (MAD doctrine and all **that,** old chap!)

Whether or not we could do anything to the Russians is a matter of conjecture.

For a demonstration, they could even invite us to launch a couple of missiles, and destroy them over our heads shortly after launch.

And they could take out a few submarines under the ocean, just to make it believable.

And destroy some SAC bombers that are orbiting on station.

Or take out a U.S. Naval Task Force, with a nuclear carrier, as a demonstration that they mean business.

Would a sane President go ahead and destroy us, or accept the Soviet's "Monroe Doctrine" and an "armistice"?

If the Soviets thought he was seriously contemplating ordering a nuclear strike, they could immediately destroy all our nuclear armaments where they sit. Our own weapons would obliterate us!

What would Congress do - after the Soviet Union had demonstrated its absolute power, offered a Dunkirk and armistice, and threatened our total destruction if we "reached for the holster," so to speak - when it realized the President might actually be contemplating evoking assured national suicide?

What would you do if you were a Congressman? If you were the President?

Slide 096: The Transmitter is the Major Weapon

As shown on this slide, with scalar EM the transmitter becomes the major weapon on the battlefield.

Almost every type of target of any importance can be easily and effectively attacked and destroyed or nullified by scalar EM weapons.

Small wonder the Soviets do not discard their thousands of "old" radars!

How effective do you suppose some of their "old" transmitters on their "old" aircraft might be?

What chance do you think SAC bombers would have against thousands of "old" radar-directed gun sites and "obsolete" air defense missile sites?

Could it be that even something like the old SA-1 could be startlingly effective?

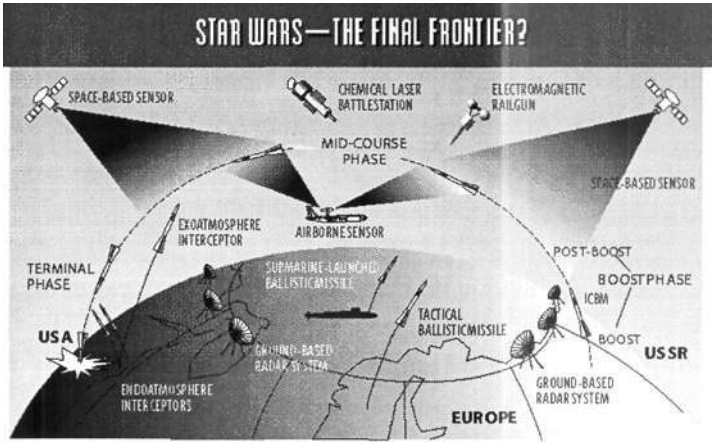

Slide 097: Star Wars—The Final Frontier?

But what of our advanced concepts, such as the strategic defense initiative?

Here we show some of the expensive and complex components of that powerful system.

We have ground-based radars, endoatmospheric interceptors, exoatmospheric interceptors, airborne sensors, space-based sensors, chemically propelled interceptors, electromagnetic railguns, particle beam weapons, high energy lasers, etc. all tied together by a massive command and control system. This massive, expensive system is designed to detect and destroy missiles, including ICBMs, IRBMs, cruise missiles, SLBNs, etc.

The system detects the missile launches and engages them from launch on in to the terminal phase.

Massive systems. Electromagnetic marvels. Nuclear-pumped lasers of staggering power. Perhaps even x-ray and gamma ray lasers. Directed energy RF weapons. Stupendous railguns. Sensors everywhere. Giant webs of communications. Banks of computers and control systems.

And it's totally vulnerable to scalar EM interferometer weapons. Giant scalar EM "radars" can simply sweep through all that like a scythe through standing hay.

As it stands, it's obsolete before its design is even finished.

It's obsolete to Soviet scalar EM weapons that are already deployed and operationally tested in place!

Without scalar EM weapons and defenses, all our present weapons and concepts are deadly vulnerable.

The war is over before it hardly gets started. It's not a war; it's more like a clay pigeon shoot.

Understand, if orthodox science was all the Russians possessed, the Strategic Defense Initiative would be the way to go.

But they do possess something else, and presently they have all the trump cards in the deck.

COMPARISON OF EM CONCEPTS			
CHARACTERISTIC	THEORY		
	CLASSICAL EM	QM VIEW	SCALAR EM (ARTIFICIAL o)
VACUUM SPACETIME	LINEAR NO CHARGE	LINEAR, CHARGED (VIRTUAL) STATISTICALLY	NONLINEAR, CHARGED (VIRTUAL) W/ DETERMINISTIC COMPONENTS
VIRTUAL SUBSTRUCTURE	NONE (FLUID EQUATIONS)	YES STATISTICAL	YES. STATISTICAL. DETERMINISTICALLY WEIGHTED
FORCE IN VACUUM?	CAUSE YES	EFFECT YES	EFFECT NO
ZERO FORCE FIELDS	NO EFFECT	BOHM-AHARONOV EFFECTS	SUBSTRUCTURE EFFECTS, ENGINEERABLE
POTENTIALS	FICTICIOUS	REAL, PRIMARY. STATISTICAL SUBSTRUCTURES	REAL, PRIMARY. DETERMINISTIC SUBSTRUCTURES
CAUSATIVE AGENT	FORCE FIELDS	POTENTIALS	POTENTIALS AND INFOLDED FIELDS OF SUBSTRUCTURES

Slide 098: Comparison of EM Concepts (Chart)

On this slide and the three that follow, we show a comparison of some of the major characteristics of the three kinds of electromagnetics.

We compare the classical, the quantum mechanical, and the scalar EM (electrogravitational) views of electromagnetics

Notice the differences between the three in regards to vacuum spacetime, virtual substructure, force, whether or not force exists in vacuum, the effect of zero force fields, potentials, and what is to be regarded as causative agents.

COMPARISON OF EM CONCEPTS			
CHARACTERISTIC	THEORY		
	CLASSICAL EM	QM VIEW	SCALAR EM (ARTIFICIAL o)
CHARGE CONSERVATION	YES	YES	NOT NECESSARILY
ACTION AT A DISTANCE	NO	NO, EXCEPT BOHM-AHARONOV EFFECTS	YES, SCALAR INTERFEROMETRY
SCALAR (ZERO-VECTOR) RESONANCE	NO	NO	YES
INERTIA IS ELECTRICAL	NO	NO	YES
GRAVITY IS ELECTRICAL	NO	NO	YES
MASS IS ELECTRICAL	NO	NO	YES

Slide 099: Comparison of EM Concepts (Chart)

Now note the differing views of charge conservation, action at a distance, scalar resonance, and whether inertia, gravity, and mass are electrical.

COMPARISON OF EM CONCEPTS			
CHARACTERISTIC	THEORY		
	CLASSICAL EM	QM VIEW	SCALAR EM (ARTIFICIAL o)
CHARGE	WITH MASS	WITH MASS	MASSLESS
RELATIVISTIC EFFECTS DUE TO	VELOCITY	VELOCITY, INTERFERING POTENTIALS	INTERFERING POTENTIALS
HIDDEN VARIABLE	NO	STATISTICAL, NEGLIGIBLE	DETERMINISTIC, MAJOR ROLE
VECTOR THEORY APPLIED TO EM	OK	OK	REQUIRES REVISION
VACUUM EM WAVE	TRANSVERSE	TRANSVERSE	LONGITUDINAL W/ SWIRLS
ENERGY/MASS CONSERVATION	YES	YES	NOT NECESSARILY, AN ENERGY CONSERVED

Slide 100: Comparison of EM Concepts (Chart)

Continuing, note the differences in the views of charge, what relativistic effects are due to, whether or not one has hidden variables and whether they are enginerrable, how vector theory is applied to electromagnetics, the nature of the EM wave in vacuum, and conservation of energy/mass.

SUMMARY (1)

- AHARONOV-BOHM EFFECT
  - VERIFIED
  - MESOSCOPIC SCALE (CENTIMETERS)
  - NEED MACROSCOPIC COHERENCE
  - POTENTIAL WEAPON IMPLICATIONS
  - PROBABLE SOVIET WEAPONIZATION
- 6 TO 8 ADDITIONAL ORDERS OF MAGNITUDE NEEDED

Slide 101: Summary (1)

Now we examine the three views for whether or not electro-gravitational waves exist and what they interact with, the number of required spacetime dimensions the type of geometry, the nature of a zero-summed EM vector, local and distant relativity aspects, and whether or not the probability states propagated by the Schroedinger equation can be deterministically engineered.

As can be seen from the last four slides, the three views are quite different, and the scalar EM view is drastically different.

SUMMARY (1)

- AHARONOV-BOHM EFFECT
  - VERIFIED
  - MESOSCOPIC SCALE (CENTIMETERS)
  - NEED MACROSCOPIC COHERENCE
  - POTENTIAL WEAPON IMPLICATIONS
  - PROBABLE SOVIET WEAPONIZATION
- 6 TO 8 ADDITIONAL ORDERS OF MAGNITUDE NEEDED

Slide 102: Summary (1)

In summary, we can now state unequivocally that the Aharonov-Bohm effect has been conclusively proven, at least for the mesoscopic scale over a few thousand Angstroms, and possibly over a few centimeters.

But inthese experimental proofs; the "natural" type of potential has been used, it is basically incoherent in its substructure, dooming the effect to stay small.

By utilizing macroscopic EM force fields and waves to zero-sum and comprise artificial potentials, the coherence can be maintained over a macroscopic distance - even for hundreds of thousands of kilometers.

The weapons implications - only some of which we have set forth in this treatise - are mindboggling.

SUMMARY (2)

- ZERO-VECTOR (SCALAR) EM SYSTEMS
  - SCALAR EM WAVES
  - KEY TO ELCTROGRAVITATION
- DETECTORS
  - INITIAL DETECTORS DEVELOPED
  - NEED IMPROVED DETECTORS
- INITIAL THEORY BEGUN
- PRELIMINARY EXPERIMENTS SUPPORT

Slide 103: Summary (2)

Zero-vector (scalar) EM systems are the key to scalar EM waves, which are actually electrogravitational waves.
Scalar wave detectors nave been developed and are being improved. Further improvement is needed. This development is limited only by funds.

The initial theory has been begun. More work is needed. Again, this development is limited only by funds.

Preliminary experiments support the scalar EM concepts.

Equipment can be designed and made to work electro-gravitationally.

And it has been.

SUMMARY (3)

- INTERFERENCE PHENOMENA ARE KEY
  - ACTION AT A DISTANCE
  - EXOTHERMIC MODE
  - ENDOTHERMIC MODE
  - 3-D FOURIER EXPANSIONS (TRUNCATED)
- EFFECTS IN/ON NUCLEUS
- NOT ENERGY TRANSMISSION THROUGH SPACE
- SHIELDING INEFFECTIVE

Slide 104: Summary (3)

Interference phenomena are key.

One can get action at a distance - even over hundreds of thousands of kilomcters.

One can engineer gravitational and inertial effects.

One can engineer the nucleus, including transmute it, easily and cheaply. One could cleanup all the nuclear wastes.

Electromagnetic energy can be produced at a distant target, or extracted from a distant **target.**

This is is not energy transmission through space in the form of EM force fields. Instead, it is transmission through spacetime in the form of electrogravitational potentials.

Conventional EM shielding is ineffective against scalar EM.

SUMMARY (4)

- MOST SYSTEMS ARE VULNERABLE
  - ELECTRONICS (INCLUDING OF FUZING/WARHEAD)
  - PERSONNEL
  - EXPLOSIVES/PROPELLANTS/FUELS
  - ORDNANCE
  - SHIPS/SUBMARINES/TORPEDOES
  - AIRCRAFT/HELICOPTERS/MISSILES/DRONES
  - TANKS/APCs/WEAPONS CARRIERS/SP ARTY
  - COMMUNICATIONS/SATELLITES/RADARS/C^3I
  - DEW SYSTEMS
  - SURVEILLANCE/SENSOR SYSTEMS
  - MINES/ARTY ROUNDS/NUCLEAR WARHEADS

Slide 105: Summary (4)

Almost every weapon system we presently have - or are developing - is totally vulnerable to scalar EM weaponry.

This includes personnel, electronics (including fuzing and warhead), explosives, propellants, fuels, ordnance, ships,
submarines, torpedoes, aircraft, helicopters, missiles, drones, rockets, tanks, armored vehicles, weapons carriers, self-propelled and towed artillery, communications, satellites, radars, command and control, directed energy weapon systems, surveillance and sensor systems, mines, artillery rounds and ammunition, nuclear warheads, etc.

We are in dire straits. We need a "Manhattan Project" of the highest priority. Now!

The Soviets have already had the equivalent of seven or eight Manhattan Projects in this area.

SOVIET DEFENSE AGAINST MISSILES

"In our country the problem of eliminating rockets in flight has been successfully solved by Soviet science and technology...

It is interesting to note that the problem of anti-missile defense is far from being solved in the West."

SOKOLOVSKIY
MILITARY STRATEGY
THIRD EDITION, 1968

Slide 106: Soviet Defense Against Missiles

Here is a significant statement by Sokolovskiy, contained in Military Strategy, 3rd edition, 1968.

This is not propaganda. The Soviets really do have an effective missile defense. We do not. At the present rate we're going, we may not have one in the year 2000 - if we live that long.

SURPRISE BY USING SECRET WEAPONS

"Each side secretly develops new means of warfare in order to employ them unexpectedly. History knows many examples how the employment of a new weapon initially gave considerable success because the enemy, caught unawares and not knowing the combat capabilities of this weapon, was for some time incapable of effective counteraction."

V. YO SAVKIN
THE BASIC PRINCIPLES OF OPERATIONAL ART AND TACTICS
MOSCOW, 1972

Slide 107: Surprise by Using Secret Weapons

The Soviets took to heart the lesson of our secret development of the atomic bomb. Thrust suddenly upon a fanatical nation, the atomic bomb brought the empire of Japan to its knees.

Other lesser examples - such as the impact of the German V-l and V-2 missiles and jet fighter - also were not lost on the Soviets.

SOMETHING RUSSIA DOESN'T WANT THE U.S. TO KNOW

"Of particular importance is basic research aimed at discovering still unknown attributes of matter, phenomena, and the laws of nature, and developing new methods for their study and use to reinforce the state's defense capability."

COMMENTS:

- PORTION OF A BOOK BY MARSHALL GRECHKO
- DELETED FROM ENGLISH TRANSLATION, BY SPECIFIC REQUEST OF THE U.S.S.R.

Slide 108: Something Russia Doesn't Want the U.S. to Know

But Marshall Grechko said it even plainer.

He made it clear that the Soviet Union has actively searched for great technical breakthrough areas, particularly in discovering new laws of nature, unknown attributes of matter, and new phenomena, and developing their use for defense.

He made it so clear that the Soviet Union formally requested the U.S. State Departmentto have deleted from its. English translation that portion of his book.

That is a positive signature that the statement is exceedingly sensitive to the Soviets. In other words, it's a real tipoff.

So of course the State Department leaned on the publisher and got that section eliminated.

ADDITIONAL NOTES AND REFERENCES

1. Nikola Tesla, "The Problem of Increasing Human Energy," Century magazine, June 1900, p. 208-209. In this article Tesla spoke of using standing waves to produce distant effects and locate objects such as ships. At this point he was thinking of a scalar radar locator, something more advanced than even our radar today. It was also capable of producing electrical effects at any part of the globe. To quote: "Stationary waves... mean something more than telegraphy without wires to any distance... For instance, by their use we may produce at will, from a sending station, an electrical effect in any particular region of the globe; we may determine the relative position or course of a moving object, such as a vessel at sea, the distance traversed by the same, or its speed..."

2. Nikola Tesla, "The True Wireless," Electrical Experimenter, May 1919, p. 87.

3. T. E. Bearden, Comments on the New Tesla Electromagnetics: Part I: Discrepancies in Present EM Theory, Tesla Book Co., 1580 Magnolia, Millbrae, CA 94030, 1982.

4. T. E. Bearden, Toward a New Electromagnetics: Part III: Clarifying the Vector Concept, Tesla Book Co., 1580 Magnolia, Millbrae, CA 94030, 1983.

5. T. E. Bearden, Toward a New Electromagnetics: Part 4: Vectors and Mechanisms Clarified, Tesla Book Co., Millbrae, California, 1983, p. 6, 39.

6. T. E. Bearden, Solutions to Tesla's Secrets and the Soviet Tesla Weapons, Tesla Book company, 1981

7. T. E. Bearden, Tesla's Secrets and the Soviet Tesla Weapons, 1 hr. 40 min. videotape, Weather Engineering, POB 1472, Huntsville, AL 35807, 1981.

8. T. E. Bearden, Soviet Weather Engineering Over North America, 1-hr. videotape, Weather Engineering, POB 1472, Huntsville, AL 35807, 1985.

9. T. E. Bearden, Star Wars Now! The Bohm-Aharonov Effect, Scalar Interferometry, and Soviet Weaponization, Tesla Book Co., 1984

10. Stefan T. Possony, "The Tesla Connection," Defense & Foreign Affairs, Aug. 1984, p. 12-14, 27.

11. Stefan T. Possony, "Psy-War: Soviet device experiment," Defense & Foreign Affairs Daily, 12(104), June 7, 1983, p. 1-2. Reports on Dr. Ross Adey's investigation of the Soviet LIDA device which is used to bombard human brains with radio waves in the 40 MHz region. Also reports on work by A. S. Davydov of the Ukrainian Academy of Sciences, who discovered how the blood-brain barrier can be penetrated by low-frequency radio waves so that brain cells are affected.

12. Fritz Albert Popp, "Photon storage in biological systems," in Electromagnetic Bioinformation: Proceedings of the Symposium, Marburg, Sep. 5, 1977. Edited by Fritz Albert Popp et al, Munchen, Wien, and Baltimore, 1979, p. 123-149. Dr. Popp has discovered, both theoretically and experimentally, that mitogenetic radiation from cells can be seen as a sort of "waste" from a virtual electromagnetic field with a high coherence. This field has a tendency to become stationary over the whole organism. In addition, it includes the storage of "virtual" coherent photons. (In other words, there is a master EM field with high coherence, stationary over the whole body. This is the cells' master control system. Storage of virtual photons -- i.e., scalar signals -- occurs in this field.).

13. To gain an appreciation of the Aharonov-Bohm effect, see Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," Physical Review, Second Series, 115(3), Aug. 1, 1959, p. 485-491. For an exhaustive discussion of the Aharonov-Bohm effect and a large number of references, see S. Olariu and I. Iovitzu Popescu, "The quantum effects of electromagnetic fluxes," Reviews of Modern Physics, 57(2), April 1985. See also Bertram Schwarzschild, "Currents in normal-metal rings exhibit Aharonov-Bohm effect," Physics Today, 39 (1), Jan. 1986, p. 17-20.

14. For details of the mysterious explosions of six major Soviet missile ammunition storage sites in seven months, see photograph, Jane's Defence Weekly, 2(3), July 28, 1984, p. 92; see also Mark Daly, "Goa and Goblet SAMs in Severomorsk explosion," Jane's Defence Weekly, 2(6), Aug. 18, 1984, p. 224; Derek Wood, "Soviets' northern fleet disabled... 'not viable' for six months," Jane's Defence Weekly, 2(1), July 14, 1984, p.3; Derek Wood, "Six explosions in the past seven months," Jane's Defence Weekly, 2(1), July 14, 1984, p. 3; John Moore, "The aftermath of Severomorsk," Jane's Defence Weekly, 2(6), Aug. 18, 1984, p. 224.

15. For details of the mysterious, instant deaths in Afghanistan, see Yossef Bodansky, "Soviets testing chemical agents in Afghanistan," Jane's Defence Weekly, 1(13), Apr. 7, 1984, p. 508.

16. For details of the Enhanced-V cloud signature of severe weather, see Gary Ellrod, "Dramatic examples of thunderstorm top warming related to downbursts," National Weather Digest, 10(2), May 1985, p. 7-13; T. J. Fujita, "Manual or Downburst Identification for Project Nimrod," SMRP Research Paper No.156, University of Chicago, 1978; D. W.McCann, ., The Enhanced-V: A Satellite Observable Severe Storm Signature," Monthly Weather Review, 111, 1978, p. 887-894.

17. For a good discussion of the modern view of the vacuum, see
I.J.R. Aitchison, "Nothing's plenty: The vacuum in modern quantum field theory," Contemporary Physics, 26(4), 1985, p. 333-391.

18. For a discussion of the ring interferometer experiments related to quantum and gravitational effects, see G.E. Stedman, "Ring interferometric tests of classical and quantum gravity," Contemporary Physics, 26(4), 1985, p. 311-332.

19. For information on self-induced transparency with pulsated light, see E. L. Hahn, Scientific American, June 1967. This is a scalar EM effect. The phenomenon is observed only in insulators, not in conducting materials. A dielectric tends to stop the flow of electrons, thus stopping the bleed-off of the Kaluza-Klein 5-potential as EM force fields. Thus through the insulator or dielectric, an electrogravitational pulse is transmitted. When this pulse emerges from the other side of the

dielectric, then electrons are free to move again and form ordinary EM fields, resulting in resumed EM bleed-off of the KK (Kaluza-Klein) 5-potential. Thus ordinary photons strike the dielectric, changing into electrogravitational waves which transit the opaque dielectric, and these EG waves transform back to EM waves on the far side of the dielectric. Advanced scalar EM application of this effect can make an object optically invisible.

20. For a lucid and profound presentation of the entire subject of elementary particle physics and quantum field theory, see T. D. Lee, Particle physics and introduction to field theory, Harwood Academic Publishers, New York, 1967. Subjects covered include those at the forefront of current research. Chapter 16, "Vacuum as the source of asymmetry," is particularly important. Here Lee concisely covers the idea of degenerate vacuum states, vacuum structuring, and vacuum effects causing symmetry breaking (violation of conservation laws). An excellent coverage of asymmetries and observables is given on p.181-188. For example, whenever symmetry is spontaneously broken, a nonobservable (virtual entity) has become observable. Thus there exist mechanisms for the direct translation between virtual and observable states.

Most engineers are unaware that physics has already rigorously proven (both theoretically and experimentally} that conservation of energy can be physically violated, even by excitation of the vacuum.

However, in the present assumption of a randomized virtual microstructure of a vacuum potential, these broken symmetry effects are individually confined to very small microlevels. For example, on p. 383, Lee points out that the microscopic structure of the scalar vacuum field (i.e., of vacuum charge or "potential") is not utilized.

This of course is reasonable if all vacuum potentials used in particle physics are treated as having a randomized microstructure of virtual particle flux vectors. Since any appreciable directional coherence in such a randomized microstructure could persist only over extremely tiny distances, then the microstructure of vacuum degenerate states has negligible local effects in ordinary macroscopic systems.

In other words, these conservation violation effects would be very difficult to coherently capture and utilize to provide "free energy, emerging from the vacuum."

The randomized momentary coherences, however, are responsible for the violent microfluctuations of the EM fields, well-known in classical electrodynamics. An approach such as taken by Yater or Moray would be necessary to achieve a vacuum energy tap under such conditions. To achieve usable macroeffects, a very large collection of charge or magnetic material, etc. would be required before the probability of usable coherences would become sufficiently large. Therefore this area is neglected in practical physics and engineering.

However, this is precisely where scalar EM is lost in conventional theory and engineering practice. In scalar EM, the coupling together of macroscopic EM force field vectors into a summed zero system means that the vacuum potential's microstructure is now macroscopically ordered by that system. Further, it is sustained during translation through space. In such case, one has produced directional gravitational potential gradients that have macroscopic range and form. Further, by coherently varying the amplitude of the individual components of the zero vector system, a gravitational wave -- a controlled oscillation of the degenerate states or vacuum -- is produced. By processing the EM components, this gravitational wave can be narrowed, formed into a beam, and projected. Two such beams can be interfered, even at a great distance, producing G-interference and causing EM effects to emerge in the distant interference zone. Thus scalar EM profoundly affects quantum mechanics, quantum field theory, particle physics, general relativity, and electromagnetics.

21. For some strong and pertinent critique of present scientific bias, see Ruggero Maria Santilli, Ethical probe on Einstein's followers in the U.S.A.: An insider's view, Alpha Publishing, POB 82, Newtonvllle, MA 02160. Santilli is a highly published physicist and the editor of a refereed scientific journal, the Hadronic Journal. After lengthy attempts to correct injustices within the Scientific system, to no avail, he finally has gone public with his specific charges. Santilli references senior Russian physicist G. Yu. Bogoslovsky, whose 1984 paper "Generalization of Einstein's relativity theory for the anisotropic spacetime," whose research would have been impossible in the U.S. Quoting Santilli: "He would have been discredited, humiliated, and chased out of these institutions [Harvard, M.I.T., and Yale] beyond any reasonable doubt by ample documentation on similar cases." Again to quote Santilli: "Papers bearing the title of 'Generalization of Einstein's relativity' are routinely permitted with human dignity at Moscow University in the U.S.S.R., but they are absolutely inconceivable today at the departments of physics of Harvard University, of the Massachusetts Institute of Technology, of Yale University and of other similar institutions in the U.S.A., as numerous senior scientists would readily testify."

You see, dear reader, there has been a deep scientific conspiracy in the U.S. to prevent any change in the severe restrictions placed on general relativity by Einstein. This has reduced GR to a sort of "special relativity, with only distant perturbations." Specifically, it has excluded scalar electromagnetics and branded as heresy the inconceivable idea that general relativity could be local, and engineerable.

Now you know why the Soviets have been able to develop these monstrous weapons for over three decades while our scientists slept at the wheel. Scientific arrogance and pride has been our greatest enemy.

See also Bryan G. Wallace, "The great speed of light in space coverup," Scientific Ethics, 1(1), Feb. 1985, p. 2-3; "Radar testing of the relative velocity of light in space," Spectrosc. Lett. 2, 1969, p. 361; Wallace, "Letter to the editor," Physics Today, 36(1), 1983, p. 11; "Letter to the editor," Physics Today, 37(6), 1984, p. 15. See M.E. Ash et al, Astron. J., 72, 1967, p. 72. Direct experiments on Einstein's second postulate, in the 1961 interplanetary radar contact with Venus, challenge whether relativity is correct. Variations of over 30,000% of the best possible general relativity fit the MIT Lincoln Lab could generate were measured. The variations were not random but contained diurnal, lunar, and synodic periodic components. See also Bryan G. Wallace, Spectrosc. Lett. 4, 1971, p. 79 for an analysis of published 1961 data on the interplanetary radar contact with Venus that concludes that the data showed a component that was relativistic in the Galilean c+v sense. See also Wallace, "The Unified Quantum electrodynamic ether," Foundations of Physics, 3, 1973, p. 381. which details Measurements strongly challenging the Einstein assumption of the constant velocity of light, and deals with the nature of the ether. See also Thomas E. Phipps, Jr., "Critique of accepted theories of special relativity and electromagnetism," Scientific Ethics, 1(2), Apr. 1985, p. 17-23.

22. For a sample of Soviet scientific freedom from narrow-minded bias in general relativity, see V. I. Denisov and A. A. Logunov, "The inertial mass defined in the general theory of relativity has no physical meaning," Teor. i Matemat. Fizika, 51(2), May 1982, p. 163-170 (In Russian). See also A. A. Vlassov and V. I. Denisov, "Einstein's formula for gravitational radiation is not a consequence of the general theory of relativity," Teor. i. Matemat. Fizika, 53(3), Dec. 1982, p. 406-418. Here we find that the intensity of gravitational radiation and the total intensity determined in the general theory of relativity in accordance with Einstein's formulas depend on the choice of the coordinate system, so that they can be made to vanish or even become negative. [Note by T.E.B.: If local curvature is

engineerable, as in scalar EM, the local choice of coordinate systems can itself be directly engineered. This clearly implies that scalar EM can thus produce either "positive" intensity radiation or "negative" intensity radiation; thus it can "produce energy at a distance" or "extract energy from a distance.]
Continuing with Denisov: This result is a particular consequence of the general assertion to the effect that in general relativity there are no energy-momentum conservation laws for a system consisting of matter and the gravitational field. [Note by T.E.B.: Thus we can have an energy source or energy sink appear in the distant interference region, where matter has been lifted from the Dirac sea and exposed to the highly nonlinear interfering EG fields.]. See also V. I. Denisov and A. A. Logunov, "New theory of spacetime and gravitation, "Teor. and Matemat. Fizika, 50(1), July 1982, p. 3-76. Points out that ". . . the gravitational field in general relativity is completely different from other physical fields and is not a field in the spirit of Faraday and Maxwell." (p. 3, English version).

23. In the Proceedings of the Tesla Centennial Symposium, an IEEE Centennial Activity, Colorado College, Colorado Springs, Colorado, Aug. 9-11, 1984, see Richard A. Blade, "Modification of Maxwell's equations in free space to account for nonzero photon mass and scalar electromagnetic waves," p. 91-92; Jack Y. Dea, "Scalar fields: their prediction from classical electromagnetism and interpretation from quantum mechanics," p. 94-98; Robert W. Bass, "Self-sustained non-Hertzian longitudinal wave oscillations as rigorous solutions of Maxwell's equations of electromagnetic radiation," p. 89-90; T. E. Bearden, "Tesla's electromagnetics and its Soviet weaponization," p. 119-138.

24. To see the limiting assumptions imposed on general relativity that results in the severely restricted "ordinary general relativity" taught in almost all Western universities. see Charles W. Misner, Kip S. Thorne and John Archibald Wheeler, Gravitation, W. H. Freeman and Co., San Francisco, CA, 1973, p. 19-21, 71-72, 367-369. Among other things, these arbitrary restrictions save the conservation laws. When they are removed. the conservation laws can be violated.

25. Several anomalous events -- skyquakes, booms, or earthquakes -- have been documented in Europe. See H. W. Haak. "The Seismic event of November 9, 1983: Earthquake or sonic boom." Seismic Activity in Western Europe, (With particular consideration of the Liege Earthquake of November 8, 1983), Ed. by Paul Melchior, D. Reidel Publishing Co., 1985, p. 215-222. For such events in the United States, see S. Claflin-Chalton and G. J. MacDonald, "Sound and light phenomena," The Mitre Corporation, McLean, Virginia 22102, Nov. 1978.

26. Fundamental experiments were performed by Eotvos et al. in the early 1920s. See R.V. Eotvos, D. Pekar and E. Fekete, Ann. Phys. (Leipzig) 68, 1922, p. 11. Actually a fifth force of nature due to hypercharge may have been found by these experiments. See Ephraim Fischbach et al. "Reanalysis of the Eotvos experiment," Physical Review Letters, 56(1), Jan. 6, 1986, p. 3-6. See also F. D. Stacey and G. J. Tuck, Nature 292, 230 (1981); S. C. Holding and G. J. Tuck, Nature 307, 714 (1984); G. W. Gibbons and B. F. Whiting, Nature 291, 636 (1981); F. D. Stacey, in Science Underground, edited by M. M. Nieto et al., AIP Conference proceedings No. 96, (American Institute of Physics, New York, 1983, p. 285. See also S. H. Aronson et al, Physical Review Letters 48, 1982, p.1306; Physical Review D 28, 1983, p. 476, 495. Also, comparison of satellite and terrestrial determinations of the gravitational field constant reveals significant disagreement: see R. H. Rapp, Geophys. Res. Lett. 7, 1974, p. 35; Bull. Geod. 51, 1977, p. 301.

27. John J. A. O'Neill. "Tesla cosmic ray motor may transmit power 'round the earth: Famed scientist, on eve of 76th birthday, says he has succeeded in harnessing 'penetrating rays' to operate small motive device." Brooklyn Eagle, July 10,1932. Tesla reported he had harnessed "cosmic rays" and caused them to operate a small motive device. Tesla's use of "cosmic rays," however, encompassed scalar EM radiation. Tesla later seems to have progressed to a simpler motive unit. In the Kansas City Journal-Post, Sep. 10, 1933, he stated: My power generator will be of the simplest kind -- just a big mass of steel, copper and aluminum, comprising a stationary and rotating part, peculiarly assembled." A similar type of "gravitational turbine" seems to have been invented by John Bedini.

28. To see just how arbitrary and postulational are present "definitions" of mass and force, see Robert Bruce Lindsay and Henry Margenau, Foundations of Physics, Dover Publications, New York, 1963, p. 283-287. Note on p. 283 that a "field of force" at any point is actually defined only for the case when a unit mass is present at that point. Also see Richard P. Feynman, Robert B. Leighton, and Matthew Sands, The Feynman Lectures on Physics, Addison-Wesley, New York, Vol. 1, 1963, p. 2-4 for a definition of the electric field in the context of its potentiality for producing a force. This problem did not exist for the original foundation of electromagnetic force fields in vacuum, since the vacuum was assumed to be a material ether. With the modern view a nonmaterial ether has emerged, yet the classical electromagnetic theory has not been made sufficiently rigorous in distinguishing "observable" and "virtual" electromagnetic force fields.

29. E. P. Battey-Pratt and T. J. Racey, "Geometric Model for Fundamental Particles," International Journal of Physics, Vol. 19, No. 6, 1980, p. 437-475.

30. Some years ago, Dr. William Tiller produced very important "free A-field" theoretical work which showed waves which did not fall off as $1/r^2$. Interesting theoretical work in scalar wave theory has also been advanced by Dea. See Jack Dea, "Fundamental Fields and Phase Information," presented at the 1985 U.S. Psychotronics Association Conference, Bergamo Center, Dayton, Ohio, July 1985. Dea has formulated an important theory for vacuum EM scalar waves, derived from Maxwell's equations with zero E and B fields. He predicts waves whose intensity falls off with distance as 1/r instead of $1/r^2$, and detection of these waves by various means. He shows simple generators for the waves. Detection is quantum mechanically by electron interference, not by single electrons. Thus such scalar waves will pass through normal Faraday shields. In his theory Dea does not address the question of spin vortexes in vacuum scalar waves. It is the present author's view that all vacuum waves are scalar waves, and the primary distinction between the "transverse" EM wave and the longitudinal scalar wave is simply the presence or absence of spin-vortexes. Indeed, one may argue that the present "vector wave" EM theory can be replaced by a scalar wave theory. In 1903 Whittaker proved that any vector field can be replaced by two scalar fields. See E. T. Whittaker, Proc. Lond. Math. Soc.1, 367, 1903. By implication, since a vector wave is simply a moving vector field, it can be replaced by two moving scalar fields.

31. David Jones, "Israel's Secret Weapon," Weekend Magazine, Dec.17, 1977.

32. John Hutchinson, private communication. Masses of wood, metal, etc. -- some weighing over 60 lbs. -- have been levitated by Hutchinson.

33. For a description and details of the April 9, 1984 incident off Japan, see Daniel A. Walker, Charles S. McCreery, and Fermin J. Oliveira, "Kaitoku Seamount and the Mystery Cloud of 9 April

1984," Science, 227(4684), Feb. 8, 1985, p. 607-611. See also transcription from Japan Airlines flight 036 to Anchorage International Flight Service, 9 April 1984, at 1406 Greenwich mean time, Federal Aviation Administration (FAA) — Alaska Region; Jim Derry, Special Agent, FAA-Alaska Region, interviews with Captain C.H. McDade, Japan Airlines Flight 036, with Captain Cornelis Vander Berg, KLM Royal Dutch Airlines Flight 868; with First Officer Reint Sol, KLM Royal Dutch Airlines Flight 868, and with Captain Mike Howe, Flying Tiger Lines Flight 078, Anchorage Daily News, 10 April 1984, p. A-l; Anchorage Daily News, 12 April 1984, p. A-l; Honolulu Advertiser, 10 April 1984, p. B-l; Newsweek, 30 April 1984, p. 25, Gregg Ripee, "Mushroom cloud sighted off Japan," Los Angeles Daily News, 11 April 1984, p. 1,8; Ross Gelbspan, "Mystery cloud baffles scientists," Boston Sunday Globe, 13 Jan. 1985, p. 1, 14; T.E. Bearden, Soviet Weather Engineering Over North America, 1-hr. videotape, 1985. See also McKenna, Daniel L. & Daniel Walker,"Mystery Cloud: Additional Observations", Science, 234(4775), Oct. 24, 1986, p. 412-413.

34. For a description of the April 11, 1963 anomalous underwater explosion north of Puerto Rico, see Robert J. Durant, "An Underwater Explosion — or What?", Pursuit, 5(2), April 1972, p. 30-31.

35. For details of the loss of the U.S.S. Thresher and the interference experienced by the U.S.S. Skylark, see John Bentley, The Thresher Disaster, Doubleday, Garden City, N. Y., 1975, particularly p. 164. Some of the communications systems of the Skylark experienced temporary failure, but were not disabled, later resuming operation.

36. The Soviet Union has a well-established history of interfering with and destroying aircraft; for example, for a listing see "Soviet and Warsaw Pact air incidents," Jane's Defence Weekly, 3(2), Jan. 12, 1985, p. 58.

37. For details of the anomalous "nuclear flashes" detected by U.S. Vela satellites, see "Scientists Fail to Solve Vela mystery," Science, 207, 1 Feb. 1980, p. 504-506. "Satellite Evidence Shows 'possibility' of Nuclear Test, DOD Says," Aerospace Daily, Oct. 29, 1979, p. 286. "A Flash of Light," Newsweek, Nov. 5, 1979, p. 64-65. "Was It a Nuclear Device?", Newsweek, July 21, 1980, p. 19. "Diverging Views," Washington Roundup, Aviation Week & Space Technology, July 21, 1980, p. 15. Philip J. Klass, "Clandestine Nuclear Test Doubted," Aviation Week & Space Technology, Aug. 11, 1980, p. 67, 69, 71-72. "Debate continues on the Bomb That Wasn't," Science, 209, 1 Aug. 1980, p. 572-573. "Navy Lab Concludes the Vela Saw a Bomb," Science, 209, 29 Aug. 1980, p. 996-997. See also Jack Anderson and Dale Van Atta, United Press Syndicate, "CIA knew South African-Israeli nuclear test was coming," Birmingham Post-Herald, Apr. 26, 1985, p. A5. The latter article repeats the CIA/DIA argument that the Vela incidents represent concurrent South African-Israeli testing of atomic weapons. Taiwan is considered a possible third partner. According to Anderson and Van Atta, a South African navy contingent was "in the area" at the time of the 1979 Vela detection, and Israel and South Africa were cooperating on an atomic bomb project as early as 1966. Apparently U.S. announcement of an impending South African atomic test in the Kalahari Desert in 1977 led to such an outcry that the test was suspended. Anderson and Van Atta cite succeeding visits to South Africa by Israeli scientists, technicians, and defense officials. However, since the actual Vela detections showed some deviations from what would be expected from nuclear tests, one can speculate that Anderson and Van Atta have presented evidence for the development of scalar electromagnetic weapons by two additional countries. One may further speculate that this could reveal what has been checking the Soviets from simply moving against the West with scalar electromagnetic weapons.

Indeed, the mysterious destruction of six major Soviet missile ammunition storage areas within the space of seven months could have been a preemptive measure and warning to the Soviets if they had actually been considering moving against the West. Also, other incidents reported in the South Atlantic may possibly be associated with the program producing the "Vela flashes." For example, see N.W.C. Rutherford, "Unidentified Phenomena," Marine Observer, 51, 1981, p. 186 for a description of a great bluish-white flash and small bolt of lightning, indicating some sort of anomalous electrical discharge, on Dec. 23, 1980 at 2245 hours (10:45 p.m.). Many other anomalous flashes for which no known causative mechanism exists have been detected by satellites. For example, the OSO-2 and OSO-5 satellites have detected about one mysterious short (less than 0.1 sec) flash about every ten orbits, at times when the fields of view of the telescopes were well above the earth. As many as three of the satellite's photometers have detected a flash simultaneously. These flashes must be removed from any discussion of satellite-observed lightning; see J. G. Sparrow and E. P. Ney, "Lightning Observations by Satellite," Nature, 232, 1971, p. 540.

38. For a description of sightings of enormous glowing globes of light deep within the Soviet Union in the direction of Saryshagan, see Gwynne Roberts, "Witness to a Super Weapon?", The Sunday Times, London, England, Aug. 17, 1980. Several incidents were observed by Downie and others.

39. For an artist's conception of a directed energy weapon installation at Saryshagan, see Aviation Week & Space Technology, July 28, 1980, p. 48. For a DOD sketch, see Soviet Military Power, 1985. Obviously classically-trained U.S. military analysts, with no knowledge of scalar interferometry, have not considered the installation as a candidate hyperspatial howitzer.

40. For a description of multiple pilot sighting (from Iran) of an enormous glowing globe of light deep within the Soviet Union, see Central Intelligence Agency (CIA) Information Report No. CO-B-321/15354-66, "Sighting of Unusual Phenomenon on Horizon Near Iranian/USSR Border," Sep. 8, 1966, released on 15 Dec. 1978 under the Freedom of Information Act (FOIA). The sighting occurred at 2142 hours (9:42 p.m.).

41. For details of sighting of the intensely glowing ball of light near British European Airways flight 831 between Moscow and London, see CIA Foreign Intelligence Information Report CO-B-324/33601-76, "Aerial observation of intense Source of Light," Nov. 18, 1976, released on 15 Dec. 1978 under the FOIA. The incident occurred between 1800 and 1900 hours (6:00-7:00 p.m.). The light was observed for 10-15 minutes, until the aircraft had flown past and left the light behind.

42. For other examples of pertinent 1ight phenomena: F. S. Angus and G. Carling, "Optical Phenomenon: Caribbean Sea; Western North Atlantic," Marine Observer, 40, Jan. 1970, p. 17-18; R. A. Holmes, "Unidentified Phenomenon, off Barbados, West Indies," Marine Observer, 40(229), July 1970, p. 107-108; H. K. Dyer, "Unidentified Phenomenon: Western North Atlantic," Marine Observer, 43, July 1973, p.114. For a 1961 double concentric hemispheric shape observed in the Indian Ocean, see Marine Observer, 32, 1962, p. 64. For a particularly significant combination of forms, see Marine Observer, "Unidentified Phenomenon," 48, 1978, p. 21-22. Also, on the night of July 26, 1984 the pilot and crew of a Boeing 747 (American carrier) flying from Tokyo to Fairbanks, near the Kuriel Islands, at 47 5'44" N: 161 00'05" E, noticed a slowly expanding hemisphere of white light off to their left above the horizon. The shell of light continued to expand over a 10-minute

period until ahead of them and to the right. The crew braced for a shock wave which never arrived. Their weather radar saw nothing out of the ordinary. The shell of light had sharp edges and was semi-transparent so that stars became visible through it. (Richard F. Haines, private communication, Sept. 27, 1984). See also Richard Hall, "Aerial anomalies at sea," The Info Journal, 4(3), May 1975, p. 6-9 for an unusual light phenomenon seen in the Caribbean by the R.M.S. Carmania (British). The phenomenon occurred four times at precise hourly intervals, strongly suggesting an artificial origin. See also F. Shepherd, "Cloud: Strait of Gibraltar," Marine Observer, 51(273), July 1981, p. 107-108 for an incident of associated cloud, arch, and anomalous pressure effects. For another significant airline sighting by Japan Airlines flights 403 and 421 of a giant, expanding globe of light on June 18, 1982, in the North Pacific, 100 km. east of Kushiro, see the Asahi Evening News, Tokyo, Japan, June 22, 1982. For additional evidence that nomadic tribesmen passing through Kazakhstan repeatedly observe such gigantic light phenomena in close association with Saryshagan missile test range, and that Soviet deception planners foster the notion of "UFO activity" as a Red Herring, see Robert Jackson, "KGB takes to the flying saucers!", Northern Echo, Darlington, England, March 15, 1984.

43. For details of Khrushchev's announcement of a Soviet superweapon, see Max Frankel, "Khrushchev Says Soviet Will Cut Forces a Third; Sees 'Fantastic Weapon'", New York Times, Jan. 15, 1960, p. 1.

44. See Christopher S. Wiren, "Brezhnev Calls for Accord against 'Terrifying Arms,'" New York Times, June 14, 1975, p. 1, 11. In a major Kremlin speech on June 13, 1975, Leonid I. Brezhnev included a statement that one major concern not covered by existing agreements was "assuming ever greater urgency with each passing day." Calling for a ban on new weapons of mass destruction, the Soviet leader stated: "The level of modern technology is such that a serious danger arises of creating weapons more terrifying than nuclear ones." He stated, "The reason and conscience of humanity dictate the necessity of erecting an insurmountable barrier to the development of such weapons." See also Malcolm W. Browne, "Senatorial Group Received by Brezhnev," New York Times, July 3, 1975, p. 2. Leonid Brezhnev repeated his proposal to a group of U.S. senators on July 2, stating that the capability to develop more terrible weapons was obvious. He emphasized, however, that he "had no particular weapon in mind." Here he may have been deliberately misleading the U.S. senators, to prevent revealing that the Soviet Union had already developed such weapons, and was horrified at their potential for total destruction. E.g., if massive and rapid scalar explosions occur, the linearity of spacetime -- and the orderly flow of time itself -- may be seriously perturbed throughout the earth and its adjacent space. From a general relativistic viewpoint, such an event might well prove catastrophic for the entire biosphere. Boris N. Ponomarev, a Soviet national party secretary, again raised the same issue to a delegation of visiting U.S. congressmen in the Kremlin on Aug. 11, 1975; see Christopher S. Wren, "Moscow Now Pressing Disarmament." New York Times, Aug. 12, 1975, p. 6. At the United Nation's thirtieth session of the General Assembly on Sept. 23, 1975, Foreign minister Andrei A. Gromyko strongly raised the same issue, warning that science can produce "ominous" new weapons of mass destruction. He urged that all countries, led first by the major powers, should sign an agreement to ban the development of these unspecified new weapons. He even offered a draft, entitled "Prohibition of the Development and Manufacture of New Types of Weapons of Mass Annihilation and of New Systems of Such Weapons." The first article provided that the types of these new weapons would be "specified through negotiations on the subject." Because of its fixation on nuclear weapons, the West may have lost its only opportunity to prevent the spread of scalar electromagnetic weapons of power unprecedented even by nuclear arms. Of course, it may also have

been a Soviet ploy to prohibit the U.S. from developing scalar electromagnetics defensive weaponry to counter the massive strategic scalar electromagnetics weapons already developed, tested, and deployed by the Soviet Union. Certainly in 1973 at a secret meeting in Prague with European communist leaders, Brezhnev had laid out a firm statement of Soviet domination of the world by 1985. See "Secret Speech: Did Brezhnev Come Clean?", National Review, 29(8), Mar. 4, 1977, p. 248, 250. Brezhnev's speech contained statements such as: "We are achieving with detente what our predecessors have been unable to achieve using the mailed fist...come 1985 we will be able to extend our will wherever we need to." Brezhnev stated the Soviet Union would control the oceans of the world, 90% of the land, and the air and space above. A front-page Boston Globe article on Feb. 11, 1975 was the first to carry the story. A copy of Brezhnev's secret speech was obtained by British intelligence in 1973, but denigrated by Secretary of State Kissinger. Apparently the first official U.S. reference to Brezhnev's startling speech did not appear until the 1976 National Intelligence Estimate. Although the big intelligence bureaucracies can do a fantastic job with "current intelligence," their record at predicting a drastic change is woeful, precisely because of the political nature of bureaucracies. See "What is Intelligence," Colonel William V. Kennedy et all, Intelligence Warfare: Penetrating the Secret World of Today's Advanced Technology Conflict, with an introduction by Dr. Ray S. Cline, Crescent Books, New York, 1983, p. 8-23. Intelligence Warfare is heartily recommended as the single book which best gives the reader a grasp of modern technical intelligence organizations, capabilities, and operations.

45. For details of Soviet weather engineering operations over the U.S., see Thomas E. Bearden, "USSR: New beam energy possible?", Defense & Foreign Affairs Daily, 13(111), June 12, 1984, p. 1-2. Cloud signature patterns reported in the article have been repeatedly sighted over multiple areas in the U.S. A series of anomalous "hole in the cloud" patterns, possibly associated with early Soviet weather engineering efforts over the U.S., was widely seen in 1967-68. See Weatherwise, 21(4), Aug. 1968, cover and p. 143; 21(5), Oct. 1968, p. 194-195, 204-205; 21(6), Dec. 1968, p. 238-245. Peculiar stationary blocking patterns have also been observed to occur and influence weather over the U.S., leading to severities such as the winter of 1976-77. See K. K. Tung and R. S. Lindzen, "A theory of stationary long waves, Part 1, A simple theory of blocking; Part 2: Resonant Rossby waves in the presence of realistic vertical shears; Part 3, Quasi-normal modes in a singular waveguide," Monthly Weather Review, 107(6), June 1979, p. 714-774. See also T. E. Bearden, Soviet Weather Engineering Over North America, videotape, 1985 for an expose or the physics and some major incidents of major Soviet weather engineering, including details and photographs of cloud signature patterns. See also C. B. Baker, "Soviet Weather Mayhem," Youth Action News, Nov. 1983, P.O.B. 312, Alexandria, Virginia 22313, p. 1-8; C. B. Baker, "Diabolic Soviet Warfare," Youth Action News, Nov. 1984; For a conventional Soviet look at weather modification (possibly intended to mislead the West), see E. T. Protasevich, "Microwave weather modification," Soviet Technical Physics Letters, 7(3), March 1981, p. 114-115. For a downburst mechanism, see Gary Ellrod, "Dramatic examples of thunderstorm top warming related to downbursts," National Weather Digest, 10(2) May 1985, p. 7-13. See Art and Kay Westermann, Weather War — Worldwide, Liberty Bell Books, POB 288, Sedona, Arizona 86336, 1983. See also U.S. Senate Resolution on Environmental warfare, July 11, 1973.

46. For details of the Soviet Woodpecker beams bending around the earth and intersecting over the U. S., see Christopher Chant and Ian Hogg, Nuclear War in the 1980's?, Harper & Row, New York, 1983, p. 71. See also Soviet Military Power, U.S. Department of Defense, 1985, p. 45. The

intersection forms an interference grid. Scalar EM channels added to the Woodpecker carriers then provide a corresponding sca1ar EM interference grid in the scalar area.

When adjusting the scalar interferometry components of the grid, bursts in the interference and discharges of energy as well as bursts of energy extractions occur. This leads to the production of anomalous aerial phenomena such as explosions, rumblings, airquakes, etc. In addition, direct Bohm-Aharonov forces may be engendered in ground structures, shaking buildings and windows, etc. without seismic disturbances. Such anomalous disturbances have been widely noted in the open U.S. press. E.g., particularly see Kenneth F. Bunting and Daniel M. Weintraub, "Mysterious Rumbles Jar Southland," Los Angeles Times, Dec. 8, 1984, CC(II), p. 1,10; Let Scarr, "People shook up over mystery shakes," The San Diego Union, Dec. 8, 1984, p. Bl, 4. Following this and a Dec. series of anomalous aerial disturbances off the Los Angeles/San Diego coast, a sharp and unexpected weather front appeared, racking the area with high winds on the night of Dec. 12, producing widespread damage and power outages. The newly-formed front moved on to produce significant snowstorms in other areas. See Ted Thackery, Jr., "Winds Kill Two, Wreak Havoc as They Sweep Through the Southland," Los Angeles Times, Dec. 14, 1984, MF/Part II, p. 1,8; "Even Tucson gets snow in storm that dumps 20 inches," AP release, Los Angeles Herald Examiner, Dec. 14, 1984, p. A-12. During several months prior to the December 1984 Los Angeles incident, anomalous electrical failures and outages had occurred in the San Diego and Southern California area, possibly due to scalar interferometry adjustments in the Woodpecker grid over the area. For other typical incidents possibly associated with adjustment of the interference grid, see "Who boomed? Odd Noise unnerves Ohioans," Journal, Milwaukee, Wisconsin, Dec. 28, 1982; "Tremors shake Miss. Gulf Coast," Times-Picayune, New Orleans, Louisiana, Feb. 27, 1983; Sandra Skowron, "Sonic boom is just Mother Nature," Beaver Co. Times, Beaver Falls, Penn., Jan 13, 1983; "Booms in Rockland, New York Times, Mar. 1. 1979, Sec. 8, p. 82; "Loud 'boom' unexplained," Star-Beacon, Ashtabula, Ohio, Feb. 21, 1983; Paul Senecton, "The word is now IDENTIFIED," Mail, Hartlepool, England, Feb. 3, 1985: On Jan. 23, 1974 a mysterious explosion over North Wales rocked a 60-mile radius area. Associated anomalous light phenomena were also seen. Hundreds and hundreds of anomalous booms, aerial rumbles, and aerial explosions, many accompanied by flashes or anomalous shaking of ground structures, buildings, windows, etc., have occurred over the U.S. and other Western nations in the 60's, 70's, and 80's.

On occasion, an aircraft at the proper altitude and position can conceivably experience interference in its electrical systems and in its engine combustion processes due to exothermic kindling or endothermic extraction of electromagnetic energy. The combustion processes of aircraft engines produce highly ionized gases in very nonlinear conditions. These can act as strong dephasers and decouplers of the vector EM components of a vector zero summation in a scalar interference zone. Exothermic interference would have little effect on combustion, but strong endothermic interference can result in engine flameout. Anomalous simultaneous failure of jet and propeller-driven aircraft engines sometimes occurs. For high altitude grids, this can result in engine flameouts, but restart and recovery after unusual loss of altitude has dropped the aircraft out of the scalar interference zone. Several candidate incidents over and near the U.S. exist, particularly where power failures were experienced by multiple aircraft. The more usual exothermic case, however, if substantial could result in anomalous loss of control of the aircraft. For a recent candidate incident, see "Jetliner drops 32,000 feet; 400 aboard; 50 are injured," Associated Press release, Huntsville Times, Feb. 20, 1985, p. 1 and "China Airlines Pilot Denies Cockpit Error," Associated Press release, Huntsville Times, Feb. 21,

1985, p. A-9. Deliberate use of this effect as an anti-strategic-bomber weapon capable of destroying bombers at or shortly after takeoff is possible (the Arrow DC-8 which crashed just after takeoff from Gander Air Force Base, Newfoundland on December 12, 1985 may have been deliberately interfered with by just such a Soviet weapon -- see extensive newspaper and TV news coverage of that event).

In scalar EM interference with aircraft, certain signatures may occur. Different instruments may sharply contradict each other, since their activation and inactivation is no longer a simple function. The pilot's instrument panel, for example, may indicate failure of the control system, when actually it has not failed, and the flight recorder may record that the control system is still operating. In such case, the pilot may take proper action based on his own instrumental readings, yet these actions may be contraindicated for the actual status of the aircraft, resulting in opposing pilot/autopilot actions. Tentative indications of the jetliner that anomalously dropped 32,000 feet and recovered are that apparently such anomalous instrument disagreements occurred. Another signature is that, as the EM charge accumulates in and on the aircraft, its skin charges up electrically, producing a glowing corona similar to St. Elmo's fire. The Arrow DC-8 was observed to be glowing yellow by eyewitnesses, according to the Canadian Broadcast Corporation's 10:00 p.m. network TV news on April 8, 1986.

47. T. E. Bearden, Star Wars Now! The Bohm-Aharonov Effect, Scalar Interferometry, and Soviet Weaponization, Tesla Book Co., Millbrae, California, 1984, p. 19-22.

48. For a paper possibly related to the first Bedini scalar wave detector from the "free A-field is a scalar field" view, see Robert R. Lewis, "Aharonov-Bohm effect for trapped ions," Physical Review A, 28(3), Sept. 1983, p. 1228-1235. This paper analyzes the role of the Aharonov-Bohm effect for the bound states of a charged particle in the superposition of two fields: a uniform magnetic field plus the vector potential of a solenoid. Gives exact solutions for a solenoid of zero size and discusses the corrections due to a solenoid of finite size. Shows that a series of new "betatron resonances" appear in the spectrum, dependent on the flux quantum number. The fundamental betatron resonance remains narrow and unshifted for solenoid radii large enough to broaden and shift the cyclotron resonance. See also W. Ehrenburg and R. E. Siday, Proc. Phys. Soc. London, Sect. B62, 1949, p. 8 which, among other things, discusses the effect of the vector potential in electron interferometry, where the insertion of a tiny solenoid between the interfering paths is shown to give an additional phase difference proportional to the flux through the solenoid. The resulting shift in the fringe system is called the Aharonov-Bohm effect.

49. Frank Golden has developed a most important and precise scalar EM detection system to display scalar EM signals on a cathode ray tube. His important measurements have mapped the scalar resonant frequency responses of the entire earth. Two completely different types of scalar instrumentation show precise agreement on the frequency maps. The measurements show that the Soviet Union has for some time entrained the entire earth into giant scalar electromagnetic resonances on two frequencies approximately 12 kilohertz apart. It is the opinion of the author that the beat frequency between these two giant resonances is utilized by the Soviet Union to extract enormous power from the earth, essentially by a mechanism that Golden has uncovered. A complex of four to eight weapon systems might reasonably be powered from the single bi-resonant tapping source. In April 1985 Golden discovered the rather sudden activation of many other scalar frequencies with characteristics resembling command and control communications. In addition, a significant number of additional paired scalar resonances had been entrained upon the earth. It is the

opinion of the author that this showed a major activation of the Soviet strategic scalar electromagnetic defense system, with the power up of from 80 to 100 weapons, along with the complete command and control system. Golden has previously built a prototype of an actual Soviet scalar communications system and demonstrated that it works. Because of the impending mayday and the 1973 statement by Brezhnev indicating that 1985 was a critical planning year, the sudden activation of such massive numbers of weapons and communications was alarming. Accordingly, the author discreetly notified certain contacts to alert the U.S. system. Golden then detected the periodic turn-on and turn-off of the systems, indicating a large command and control exercise rather than preparations for direct tactical use. An additional difference, however, was the change from scalar electric to scalar magnetic field on many of the large transmitters. This is indicative of electrostatic location, targeting, and adjustment of the target on the earth and then switching to the "power input" mode. It is the opinion of the author that this indicated the choice of a geological target and proceeding to attack that geological target in the "slow buildup" mode. Again, proper contacts were so notified.

50. A very good coverage of the Soviet microwave radiation of the U.S. Embassy in Moscow is given in Paul Brodeur, The Zapping of America, W. W. Norton & Co., New York, 1977, passim. None of our U.S. Embassy security personnel knew of scalar interferometry, nor did they possess scalar electromagnetics detectors. Further, orthodox U.S. scientists were also ignorant of scalar electromagnetics. The Soviets were thus in a position to tailor the radiation signals and precisely determine what our on-site personnel would detect. Details of the effects on U.S. Embassy personnel, possibly associated with the microwave radiation, are given by Brodeur. A great number of related releases by the open news media also exist. For example, see Robert C. Toth, "Radiation Devices Bug U.S. Embassy," Huntsville Times, reprinted from the Los Angeles Times, Feb. 8, 1976; "U.S. Screening out Soviet 'Listening Rays'," United Press International release, Washington D.C. Star, Feb. 11, 1976; Norman R. Beebe, "Nixon Exposed to Radiation In Russia?", Associated Press release, Huntsville Times, Apr. 30, 1976; Barton Reppert, "U.S. Scientists Puzzled Over Embassy Radiation Effect," Associated Press release, Huntsville Times, May 28, 1976; Barton Reppert, "Radiation Entering Embassy in Moscow through Phone Line," Associated Press Release, Huntsville Times, May 28,1976. See also Martin Ebon, Psychic Warfare: Threat or Illusion, McGraw Hill Book Co., New York, 1983.

51. For details of the electromagnetic transmission of cellular disease and death, see Vlail P. Kaznacheyev, "Information function of ultraweak light flows in biological systems," Problems in Biophysics, Novosibirsk, 1967, p. 7-18. Kaznacheyev et al, "Conditions necessary for appearance of distant intercellular interactions after UV-radiation," Bulletin Experimentalnoy Biologii i Meditsiny, (5), 1979, p. 468-471; Distant intercellular interactions in a system of two cultures connected by optical contact," Ultraweak Luminescence Biology, Moscow, 1972, p. 224-227; "Distant intercellular interactions caused by UV-radiation," Photobiology of a Living Cell, Leningrad, 1979, p. 221-223; "Studies on the biological role of electromagnetic emission as a factor of adaptive behavior of cells under conditions of latitude changes," Abstracts of the second all-union conference devoted to the problem of human adaptation to different geographical, climatic, and labor conditions, Novosibirsk, 1977, p. 101-104; Vlail P. Kaznacheyev, S. P. Shurin and L. P. Mikjhailova, "Distant intercellular interactions in a system of two tissue cultures," Official Bulletin of the committee on inventions and discoveries affiliated to the council of ministers of the USSR, Discovery no. 122 (19), 1973, p. 3, also printed in Psychoenergetic Systems, 1(3), Mar. 1976, p. 141-142; "Apparent Information Transfer

Between Two Groups of Cells," Psychoenergetic Systems, 1(1), Dec. 1974, p. 37.

52. For evidence of anomalous scalar reflection out of the scalar grid caused by a Navy chaff drop, See "Navy sabotages traffic lights, TV sets," United Press International, PM cycle, Jan. 11, 1985; "Power blackout blamed on anti-radar particles," United Press International, AM cycle, Jan. 11, 1985; "Power Disrupted Briefly After Navy Plane Drops Metallic Strands," Associated Press, AM cycle, Jan. 16, 1985.

53. A good summary of the early incidence of the Soviet Woodpecker signals is given by Bradley Wells, "The Russian woodpecker: a continuing nuisance," CQ, Nov. 1984.

54. A particularly important Soviet Paper is E. B. Smetanin, "Electromagnetic field in a space with curvature -- new solutions," Soviet Physics Journal, 25(2), Feb. 1982, p. 107-111. In this paper, a solution to the stated problem is obtained, which may be regarded as a classical model of a charged particle that has both a magnetic moment and a nonzero magnetic charge density. Interaction with spacetime curvature can disrupt the gauge invariance of the EM field, and it can also reestablish invariance in an initially noninvariant theory. (Hutchinson has had anomalous breaks of metal caused by standing scalar waves, which seems to be due to a mechanism that produces monopoles and deposits them in the metal at standing-wave nodes. This paper should be directly applicable.)

See also Yu. S. Vladimirov and A. A. Kozlenkov, "6-optics and a general theory of gravitation and electromagnetism," Soviet Physics Journal, 27(12), Dec.1984, p. 1039-1041; V. G. Bagrov and M. D. Noskov, "New exact solution of the Dirac equation. XI," Soviet Physics Journal, 27(12), Dec. 1984, p. 1030-1034. See particularly V. I. Petukhov and I. A. Kuzin, "Weak processes in the field of a gravitational wave," Soviet Physics Journal, 27(12}, Dec. 1984, p. 1025-1029.

In the latter paper it is significant that the decay probability increases in a locally curved spacetime, and that solutions are obtained for circularly polarized waves.

(In EM waves, circularly polarized waves have special characteristics in nonlinear isotropic media: exact solutions exist. Also, when two longitudinal sine waves of differing frequencies are transmitted into a nonlinear isotropic medium, the apparent difference frequency is transmitted as a sine wave, undistorted. This characteristic has been used by Westinghouse to produce improved sonar transmission through seawater, for example. The scalar EM (electrogravitational) wave may be represented as a longitudinal EM wave. Immediately, if one wishes to produce a pure scalar EG wave in the nucleus of an atom, two frequencies should be transmitted such that their difference is the frequency wished. Or circularly polarized waves may be utilized.)

Note that, by implication, one should be able to deliberately tailor scalar EM waves to greatly speed the decay of long-lived radioisotopes, such as are contained in radioactive wastes from nuclear reactors and other processes.

55. For some evidence of continuing persistence of the higher frequency scalar components applied to the scalar grid on Jan. 28, 1986 to localize the effects when attacking the Challenger, see "Poison suspected in unexplained deaths of birds," Huntsville Times, AP release, Feb. 6, 1986. From 1-4 Feb.

1986, various kinds of dead birds -- such as blackbirds, cardinals, sparrows and bluebirds -- plummeted to the ground in Birmingham, Alabama. At first some sort of mysterious poison was suspected, but later was ruled out. During this period, the woodpecker grid was particularly active in weather engineering operations. Multiple sightings of giant cloud radials occurred in various places throughout the U.S. The retention of the high frequency components possibly was intensified in the Birmingham area sporadically during the period. Birds flying into this zone would be killed if their brains acted as scalar receivers and were sufficiently jammed by the signals. Normally Huntsville (further north) is a "hinge point" for increased scalar activity, to start the Jetstream bending northeast to move along the Appalachian mountain chain. However, just before 28 January the jetstream had been diverted further south than usual by the Soviet interference, bringing unseasonably cold weather to Florida and the waiting Challenger on its launch pad. Probably hinge points further south than Huntsville were needed for this operation. If these more southern points were retained for a few days, and the high frequency components were retained, then an inadvertent high intensity area of these components may have sporadically occurred in the Birmingham area, killing the birds.

For description of the Apr. 18, 1986 Titan blast and its ramifications to the spy satellite program, see James Gerstenzang and Ralph Vartabedian," Los Angeles Times News Service, "Titan Blast to Hurt Spy Program," Huntsville Times, Apr. 19, 1986.

56. For another very important paper indeed, see Vu. G. Ignat'ev, "Relativistic kinetics of an anisotropic plasmalike medium with damping in a field of gravitational radiation," Soviet Physics Journal, 27(12), Dec. 1984, (English translation: Plenum, June 1985), p. l066-1069. If we substitute the vacuum "virtual plasma" for the observable plasma, this paper may be part of the smoking gun to show that the Soviet Union has developed scalar electromagnetics. Extrapolating from this paper, the amplitude of the "induced longitudinal field" is proportional to the square of the amplitude of the gravitational wave (GW) in an initially isotopic medium, but reduces to a linear proportionality as the medium develops nonlinearities (anisotropies or inhomogeneities). Whereas conventional GW are considered to be weak, the scalar GW may be very strong since we ourselves determine the variation in the energy density of vacuum it involves. Further, sharply spiked scalar EM (EG) pulses may develop appreciably more amplitude that the linearly calculated amplitude from the magnitudes of the zero-summation components. The end result is that (1) we can produce powerful gravity waves using the scalar EM approach, (2) local spacetime can be curved, producing violation of the conservation laws, and (3) the assumption of a local Lorentz frame made by Einstein as a limitation on ordinary general relativity is falsified.

In passing, note that immediately one also has a clear basis for the excess local production of energy when the battery furnishing power to a DC series motor is sharply spiked backwards in a "recharging" fashion. Further, the ions in the battery (which are several hundred thousand times as massive as an electron) possess a resonance on the order of 16 megahertz in a typical lead-acid battery. Under the correct conditions, the ions collect the excess energy (due to the initial square effect) produced by a sharp pulse of recharging potential. The ions are shocked into resonance and, on reversal, "overshoot" and deliver this excess energy to the plates, recharging the battery. Thus such a system can violate linear conservation of energy because spacetime is locally curved by the spiking, and excess energy from the excited local vacuum is collected by the ions and delivered to the plates. This is precisely the effect upon which the first Bedini free-energy motor depended. The timing and adjustment, however, are highly critical and difficult, and the battery takes a rather severe

beating.

57. For details and photographs of highly anomalous exhausts seen on Bennett Island, see "Explosive Events Seen on Soviet Island," Aviation Week & Space Technology, Sept. 26, 1983, p. 31. NOAA-6 and NOAA-7 weather satellite photographs of massive smoke plumes, one of them 150 miles long and nearly horizontal, are shown. Also, in U.S. weather satellite photos of Novaya Zemlya, similar plumes have been detected, making this location a tentative candidate for a second Soviet "exhaust site." See also Letter John M. Miller, Geophysical Institute, University of Alaska, Jan. 4, 1985 with attachment, "Bennett Island plume cases recently found." Satellite photos showing actual circular breaking of arctic ice have also been taken near Wrangel Island. See Sam Bishop, "UA photos show Soviets break ice for missiles," Fairbanks Daily News-Miner, Dec. 15, 1984, p. 1,3; Craig Covault, "Soviet Abi1ity to Fire through Ice Creates New SLBM Basing Mode," Aviation Week & Space Technology, Dec. 10, 1984, p. 16-17. Wrangel Island in fact has a bizarre history: it belongs to the U. S., but has been illegally given to the Soviets and occupied and used by them. For details, see "Wrangle over Wrangel and the Weather War," Don Bell Reports, 32(9), Mar. 8, 1985.

58. For details of anomalous blinding (probably by scalar EM means) of U.S. satellites, see Philip J. Klass, "Anti-Satellite Laser Use Suspected," Aviation Week & Space Technology, Dec. 8, 1975, p. 12-13. For details of anomalous failures and recoveries of a British satellite, see Joe Schwartz, Nature, 280, July 12, 1979, p. 95.

59. For other possible evidence of traces of Soviet scalar EM activity over the oceans, see George D. Curtis, "An electromagnetic radiation pattern over the ocean," Undersea Technology, 5(8), Aug. 1964, p. 29-30, 40. In producing a scalar wave, there exists a sort of "signal to noise" ratio of the desired scalar wave to an accompanying, undesired normal EM component. Due to practical equipment imperfections, the generated scalar wave inevitably is accompanied by a small residue of ordinary EM wave. While measures can be taken to further purify the scalar wave, a residue always remains. Curtis may have detected the weak EM residue accompanying early Soviet interference gridding for weather control testing over the U.S.

60. Interactions which occurred between Khrushchev and renowned physicist and Nobelian P. Kapitsa are of interest. Khrushchev desired absolute defense of the Soviet Union so that the Soviets might be able to launch any action desired without risk or serious concern. Kapitsa informed the Soviet leader that, if a means of total neutralization of foreign missiles was to be found, it could only come from a group of new principles in physics which was called " energetics." The term "energetics," of course, was contracted from "psychoenergetics," and is essentially the expanded physics/electromagnetics that this author has dubbed scalar electromagnetics.

Strangely, a portion of a book by Marshal Grechko was deleted from its English translation at the specific request of the Soviet Union to the U.S. State Department. The passage stated: "Of particular importance is basic research aimed at discovering still unknown attributes of matter, phenomena, and the laws of nature, and developing new methods for their study and use to reinforce the state's defense capabilities."

The most definitive Soviet book on military strategy is titled Military Strategy (Voyennaya

Strategiya). See V. D. Sokolovskiy, Soviet Military Strategy, third edition, edited with an analysis and commentary by Harriet Fast Scott, Crane, Russak & Company, Inc., New York, 1975. There are three editions, the latest in 1968. In the third edition, the exotic weapons normally proposed for defense against strategic ballistic missiles -- such as particle beams, high energy lasers, exotic nuclear warheads, plasma weapons, antigravitational weapons, etc. -- are discussed and discounted by implication. The statement is made several times that 100% defense against missiles and aircraft is possible. A statement is also made that it is interesting to note that this capability (a solution to the strategic missile defense problem) has been achieved by the Soviet Union, but not by the West (e.g., p. 298.) In the same edition, a previous definition of antimissile defense obviously consisting of radars, computers, and interceptor missiles is deleted (see author's note 190, p. 454).

The Soviets also recognize the great importance of technical surprise: "The experience of war shows that warring sides quite often have tried to employ new types of weapons to this end to achieve surprise, which are a surprise for the enemy or are little known to him. Each side secretly develops new means of warfare in order to employ them unexpectedly. History knows many examples how the employment of a new weapon initially gave considerable success because the enemy, caught unaware and not knowing the combat capabilities of this weapon, was for some time incapable of effective counteraction… The mass introduction of new weapons into an army usually cannot remain secret for long for the other side. -- New means of warfare, and in mass numbers, are impossible to create often and quickly. In this regard, the sides have begun to take other paths concerning the attainment of surprise along with searches for new weapons and their sophistication." V. Ye. Savkin, of The Basic Principles Operational Art and Tactics, Moscow, 1972, U.S. Air Force translation, U.S. Government Printing Office, Washington, D.C. 20402.

61. The Soviets have not discarded most of their old radars, and have continued to develop, build, and deploy giant new radars (in apparent violation of SALT agreements), which U.S. analysts always analyze in conventional fashion. It is fairly straightforward, simple, and inexpensive to modify an ordinary pencil beam radar to produce scalar wave beams and geometrical scalar Fourier expansion forms. Radars can provide a wide array of totally new and unexpected capabilities when utilized in the scalar electromagnetics mode. Even older Soviet radars, with antiaircraft gun sites and older surface-to-air missile sites, will exhibit new and startlingly advanced capabilities against ballistic and cruise missiles and Strategic Air Command bombers. Since there are many thousands of these older Soviet radars still operationally deployed, in the scalar mode the Soviet strategic defense may well approach 100%, just as Military Strategy implies. Also, the antiaircraft and antimissile defense capability of Soviet land forces may be far greater than anything presently estimated by U.S. analysts.

62. To the physicists, engineers, and researchers who have made the tough sledding to this point, congratulations! Here's a bonus for you.

Turn to page 32, equation [7]. Time differentiate it (this is left as an exercise for the reader). Collect terms and study the result intensely.

Now you have the reason why rise time is so important from a scalar EM viewpoint. You can also see why spiking the innate inductance of any system very sharply is so important. Fast rise time greatly increases the value of the time derivative terms, and your gravito-inertial effects go up with

the collective squares of your zero-vector summed components. Any system has at least a little inductance. For sharp spikes, the gravitational potential goes very high. The inductance of the system momentarily opposes any current (translation: opposes any current bleed-off, or EM force field bleed-off). During that time you've got the 4-space G-potential to use. If you need to hold it longer to use it, then increase the inductance.

Now you can see why extremely rapid discharge of properly tuned, giant Tesla coils give gravitational and inertial effects sometimes.

You can see why the sharp "EMP" (electromagnetic pulse) from a nuclear explosion or EMP generating device can penetrate the ocean.

That's why the spikes (such as used by the neurophone) can carry messages directly into the brain and nervous system. You also should see why the Soviet woodpecker carriers (a Soviet over-the-horizon radar system) are loaded with scalar EM spikes (Bedini has precisely detected them from 50 Hz to 10 MHz; Golden has detected them into the gigahertz range.) to work on the humans in the targeted area. They're zapping the hell out of us. And they have done something similar at the U.S. Embassy in Moscow for decades.

Bedini has developed a simple, cheap device to mess up the phaselocking of the scalar EM spikes on the woodpecker carriers. It's based on the fact that the Russkies use a lot of circularly polarized transmitters when they make the spikes. Here's what to do: Take 4 strong bar magnets and an old (but operational) long-playing record turntable. Set it on 33-1/3 RPM speed. Glue the magnets on the top of the turntable, standing vertically, symmetrically placed around the turntable's outer edge. Place them so that on one a north pole is up, on the next a south pole is up, then a north up, then a south up. Now turn the turntable on and let it run. This gadget makes a slowly rotating magnetostatic wave. (Yes, it will also make a rotating "magnetic" wave, which is actually two rotating magnetostatic waves.). These rotating magnetostatic waves will interfere with the scalar spikes, changing them to EM (electromagnetism) and slowly rotating their phase. This breaks the phaselock of the Soviet circularly polarized scalar EM signal on the human brain. This gadget will protect the average large room.

But back to our differentiated equation.

Now you should also see why the first Bedini motor is so "devilishly difficult" to adjust. You've got to get the effect and examine it in well under 20 nanoseconds. You'll need an oscilloscope of 350 MHz range or so. Microwave-quality bench equipment is necessary; the ordinary electrical and electronic shop equipment is not good enough. You can also see why the ordinary lead-acid battery takes such a beating. However, a special battery certainly can be designed to take it. Now you know.

Okay, you tigers. Go get 'em.

63. Now here's a final bonus for the persistent reader.

This time, see J. N. Brittingham, "Focus Wave Modes in Homogeneous Maxwell's Equations:

Transverse Electric Mode," J. Appl. Phys. 54, 1983, p. 1179-1189; T. T. Wu and R. W. P. King, "Comment on 'Focus Wave Modes in Homogeneous Maxwell's Equations: Transverse Electric Mode' [J. Appl. Phys. 54, 1179 (1983)]", J. Appl. Phys. 56, 1984, p. 2587; T. T. Wu and H. Lehmann, "Spreading of Electromagnetic Pulses," J. Appl. Phys. 58, 1985, p. 2064-2065; T. T. Wu, "Electromagnetic Missiles," J. Appl. Phys. 57, 1985, p. 2370-2373. Pay particular attention to the latter paper.

Because of the Strategic Defense Initiative (SDI) and other programs, great interest has recently been kindled in using EM pulses to carry energy from a high-powered source to a target. However, so far almost all the work is still couched in terms of purely ordinary (though sophisticated) electromagnetics. It still involves the EM concept of "EM energy flow through the intervening space from the transmitter to the target." As such, the work to date still suffers from all the self-imposed ills and limitations of using the classical force fields concept of EM.

However, the theoretical work of these referenced papers is of great interest to us here.

In the first paper, Brittingham sparked a great deal of interest with theoretical work which promised a permanently focused 3-dimensional concentration of EM energy that propagates in a straight line with the speed of light. That is, this mode used a newly formulated wave packet (called the "focus wave mode") that acted as a non-dissipating EM soliton.

In the second reference, it was concluded that Brittingham's focused wave packet actually satisfied Maxwell's equations, but not the associated boundary conditions.

[Comment by this reviewer: both of these formulations use "linear time" and a "linear frame," ignoring the local general relativity aspects. Indeed, Brittingham's "focused wave packet" can be made by the zero-vector approach! However, it will not be an "EM" packet, it will be a pulse (or oscillating wave, depending upon how it is made) of 5-gravity potential. As such, it contains a multiplicity of locked-in, 5th-dimensional, non-zero EM gradients in and EM gradients out. Collectively these gradients themselves constitute a deterministic "flux of gradients" or an EM flux in the 5th dimension, with no resultant effective current of EM gradients. In other words, it's possible to build a "flux of gradients" and to have a "current of gradients," just as in ordinary EM it's possible to have a "flux of virtual particles" and a "current of virtual particles." The argument concerning the EM boundary conditions of Maxwell's equations is not relevant in such a case. The only boundary involved is the zero itself.]

Be that as it may, the 4th reference is of direct interest. In this paper, Wu has done us a great service. He shows that, under transient excitation, an antenna of finite size can transmit energy to a faraway receiver so that the energy decreases as slowly as one wishes. An electromagnetic pulse of energy with such slow decay is conveniently referred to as an "electromagnetic missile."

The electromagnetic missile has important applications, according to Wu. One possible application is the transmission of

information in a manner that is very difficult to intercept or jam. A second possible application is to

destroy or disable a distant target. However, Wu feels that so much energy is required [remember, he is speaking of EM non-zeroed force fields traveling through ordinary space] that a like1y radiating source must be something like a nuclear explosion. However, as Wu points out, a nuclear explosion produces a powerful EM pulse which includes frequencies from microwaves to gamma rays. To weaponize the explosion to produce a coherent beam, the nuclear explosion must be controlled to produce a coherent radiating source and a pulsed laser-like EM beam. Wu points out that such a technology is difficult and has not been developed.

We comment as follows: It is certainly true that enormous energy is required if the waves in the pulse remain electromagnetic -- that is, if they have non-zero resultant E and B fields to the external observer.

On the other hand, if we form a complex of waves in opposition so that we control the energy content of each individual component wave, but blend all the waves so that their collective envelope wave has zero E-field and zero B-field resultants, then -- to the external observer -- the EM energy is infolded and unzipped electromagnetically. It is now electrogravitational energy, and limitations of "EM force field energy flowing through space or through a physical medium" need no longer apply. However, we may still look at each EM component wave as an individual EM wave, moving in the Kaluza-Klein 5th dimension that is wrapped-around each and every point in our ordinary 4-space. In other words, to the ordinary 4-spacetime observer, each component wave has a special channel around every point of his space, not through it. Thus we have established multiple EM channels "just outside" each point of observer space. These we call "scalar channels," and EM energy can move through each one as if it were moving through a wire. The relative potentials between the "ends of each wire" determine in which direction the "EM energy current" flows along the wire.

And in each of these "special channels," we just have a normal kind of space (to the internal observer). Wu's paper assures us that we can get as much of the input energy to the distant target as we desire. The problem then is how to break the zero-summed EM envelope (and hence the "zero channel" for each component EM energy wave) in the distant target itself, spilling the infolded contents of all the special channels back into ordinary spacetime as EM energy (either positive or negative).

That, of course is easily done by interference in the distant zone. As previously stated, there is a way in which we can even perform this interference in a single scalar beam. Since the newly formed EM energy emerges from each and every increment of spacetime occupied by the distant target, it already emerges inside the very vitals of the target. It does not have to translate through the intervening ordinary space between transmitter and target. Instead, it goes through the Kaluza-Klein fifth dimension. It translates along a line through our space, but not through our space. With the scalar EM approach, we transmit EM energy through hyperspace, not through normal space.

Hereafter we will adapt and expand Wu's SDI term "electromagnetic missile" to include these electrogravitational aspects. In other words, we include the "scalar EM missile", which consists of an infolded multiple of Wu's ordinary EM missiles moving together coherently in special sheathed hyperspace channels.

In Appendix I we show an anomalous photograph taken by Bob Gladwin, just before the shuttle launch of Nov. 26,1985. While the photograph may be an artifact, it also is a candidate for the test strike of such a Soviet scalar "electromagnetic missile" tested against an aiming point offset from the shuttle launch which followed a few seconds later. The test was accomplished before the shuttle was launched, and offset from it, so that it positively would not endanger the shuttle itself. The conditions under which this spectacular photograph was taken happened to coincide with the special conditions required to photograph such scalar EM energy. Those conditions are clarified and explained in the Appendix.

My deep appreciation goes to Mr. Gladwin for allowing me to use this photograph. As we will point out in Appendix I, the video camera caught a picture of the Soviet scalar EM marker beacon associated with the Titan explosion of April 18, 1986. One can rest assured that the Soviets probably destroyed that vehicle, using a scalar EM missile.

APPENDIX 1: SOME IMPORTANT INDICATORS AND DESTRUCTIVE TESTING

Some of the indicators which bear on the use of the Soviet
scalar electromagnetic grid via the Woodpecker EM carrier beams are given in this appendix. along with other information believed pertinent to overall scalar EM effects.

IN ADDITION, THE THESIS OF ACTUAL LIVE TESTING OF THESE WEAPONS BY THE SOVIETS -- TO INCLUDE THE DESTRUCTION OF A TROOP-CARRYING U.S. AIRCRAFT, A SHUTTLE, AND A TITAN MISSILE -- IS ADVANCED AND INDICATORS PRESENTED.

An anomalous photograph taken by Bob Gladwin is presented which possibly may have captured the "smoking gun" -- the strike of a
Soviet scalar EM missile at an offset aim point near the shuttle Atlantis, just before its launch on Nov. 26, 1985. However, this photograph is caveated since it may also represent an anomalous but ordinary artifact. captured in some as yet unknown manner. The manner in which such a photograph may have been taken -- when normally the scalar energy does not show on a photo -- is explained.

Another photograph taken by George Suchary after the launch did
capture the Soviet "marker beacon" utilized in the test firing, however. This independent photograph is presented, and adds credence to the thesis that the Gladwin photograph captured the test of a Soviet scalar EM pulse missile.

- INDICATORS AND SUCH -

1. Continual cloud radials have repeatedly been seen and photographed over Los Angeles, California or its vicinity.

Los Angeles is also apparently a "hinge point" for bending and controlling the jetstream. Three typical radials seen to form one after the other by Margaret Wilson (and sketched and airbrushed by her) in the greater Los Angeles area are shown in figures 1, 2, 3, and 4. These radials were formed on Sunday, Jan. 26, 1986. Ms. Wilson had heard my Saturday night "Soviet Weather Engineering" broadcast over KABC Los Angeles, and my request that anyone who saw the typical radial cloud formation should photograph or draw it, noting time and location, and send the photos or drawings to me.

As Margaret described it. "To my astonishment, the next day I not only saw one, but three in the sky at the same time.

The time of the first one was Sunday, Jan. 26, at 1:15 p. m.
. . . I stepped out the back door for some minor errand and noticed a
fan of long straight clouds in the sky. The sky had been filled with dark clouds most of the morning but this had been breaking up and the western half of the sky was now clear with these lines of clouds spread out on it. I immediately thought of your request and tried to see the bottom of the fan which was hidden behind bushes and a garage. When I stepped into the street, I saw there was a semi-circle beneath them.

Not having film and a wide-angle lens on my camera. I knew I couldn't capture it in its entirety. I am, however, a retired commercial airbrush artist so I quickly sketched the formation. It is illustration #1.

It was in the western sky, the base of the central semi-circle sitting about 15 degrees above the ocean horizon. It was very clear and sharply defined. The semi-circle was broken at the top and the two broken ends curled inward like commas. As I sketched the wind deformed it somewhat, the right half of the whole formation sliding down away from the left.

Ten minutes later it was getting quite clear of clouds except
for a bank over the Santa Monica Mountains to the north and there, straight north, another fan was forming. As I watched it took shape -- illustration #2. The same broken semi-circle (with commas') but this time the bases of the rays were feathered about half-way out with end halves long straight wisps.

As I sketched, another fan had begun to take shape

further east. It was hard to tell its size but I had estimated the first one at about 15 miles across and the second a little larger and the third larger yet. At the peak of its formation it looked like illustration #3. ...There in the middle of the central circle, hazy and a little faint was what looked like the top of a mushroom cloud. Or was it only a distant thunderhead that coincidentally found its way to a place behind the formation? The arms of the last, largest formation were rather wavy and feathery like some gigantic sea creature. It did not disperse as fast as the others, but held for a couple of hours, though it was pretty distorted by then. I could not estimate its size as I wasn't sure of its altitude.

Were they aircraft contrails? Certainly not! There was an airliner in the sky at the time -- a mere scratch on the smooth blue sky (see illustration #3, right center.).

The three formations were present in the sky at the same time although the first was getting quite distorted by the upper level winds before the last reached its peak.

Tuesday our weather changed from hot and sunny to rainy as the weather man said the path of the jetstream altered, and then there was the space shuttle explosion.

...The Russians seemed very sincere in their sympathy for the loss of our astronauts but only two days later it was printed in TASS and I personally heard Vladimir Posner say that Russia hoped that the United States would now realize what could happen if the S.D.I. program was further pursued. Was this friendly concern or a threat? It is very evident that if the S.D.I. can destroy a missile in flight, it can also destroy one on the ground. This would immediately put all Russian missiles in [reach of] our arsenal. They are already in place in the most desirable target areas -- their own launch sites. I'd be panicky too if I were a Soviet leader."

[Ed. comment: My sincere thanks to this thoughtful lady who took the time to sketch the cloud radial phenomena occurring in the Los Angeles "jetstream pivot point" at this critical time, just prior to the launch and destruction of the Challenger.

Anomalous cloud grid activity (formation and dissolution) in
the Los Angeles area has been positively correlated with Soviet Woodpecker activity by engineer Ron Cole, with 100% correlation in 30 straight Woodpecker measurement runs. Statistically, of course, this
is quite decisive.].

2. Continual cloud radials have repeatedly been seen and photographed over Huntsville, Alabama, associated with weather engineering and grid activity. Typical radials seen by this author are shown in Bearden, Soviet Weather Engineering Over North America, 1-hr. videotape, 1985. Huntsville is apparently a pivot point or "hinge point" for bending and controlling the jetstream.

3. Spectacular cloud grid patterns have been seen over Huntsville, Alabama and Los Angeles, California. An excellent videoclip of one of the Los Angeles area grids, personally observed and shot by KABC Open Mind talk show host Bill Jenkins, is shown in Bearden, Soviet Weather Engineering Over North America, 1-hr. videotape, 1985. An artist's sketch of an earlier gigantic grid, extending from horizon to horizon in every direction, seen over Huntsville, Alabama by Tom Bearden and Ken Moore, is also shown in the tape. The videotape is available from P.O. Box 1472, Huntsville, AL 35807. Sketches and details of another highly anomalous grid pattern observed in the greater Los Angeles area by engineer Ron Cole are shown in figures 5 and 6.

The reason that clouds of water droplets and/or ice particles detect the scalar interferometry and form signature patterns is simple: Consider each H_2O molecule as having two light little hydrogen atoms hanging on to the much heavier oxygen atom. The covalent sharing with the oxygen atom of the electron from each hydrogen atom means that (1) the electrostatic scalar potential between the H ion and the O ion it is bonded to, is rhythmically varying as the electron is shared back and forth, (2) this varying potential contains "electron spin holes" since it is made by the moving electron, (3) two such varying potentials exist since there are two H atoms sharing covalent electrons with the O atom, (4) the two H ions are at an angle of over 100 degrees with respect to each other, (5) the molecule assembly thus constitutes one part (one half, so to speak) of a scalar interferometer with imbedded electron spin holes for electron hooking, (6) Incident scalar waves from outside the system interact with the "half scalar interferometer." This scalar interferometry interaction is coupled to the covalent bonding electron because of the internal spin hole pattern of the molecular half of the interferometer. The coupled electron moves with the scalar pattern's changes, causing an observable interaction with and in the electrical structure

and ionic potential of the molecule, (7) the weak H to H hydrogen bonding between molecules connects resulting ionic potential changes to the structuring of the entire macroscopic cloud assembly. Thus by scalar interferometry with the H_2O "half interferometers", an incident scalar EM pattern is detected and translated into patterns of E and B force fields. The H_2O molecules then "line up" in accord with the electrical patterns detected.

Thus the clouds form "signature patterns" according to the incident scalar EM radiation patterns. Giant cloud radials in the targeted area are probably due to the type and shape of antennas -- including the type and shape of the electrical wires establishing the antennas' ground planes -- 640used by the Soviet Union to project the scalar waves. Note that such "radial" antenna patterns were occasionally used by James Harris Rogers in his underground and undersea scalar EM transmission system.

[For Rogers' patents, see U.S. patent numbers 1,316,188, Radiosignaling system, Sept.16, 1919; 1,322,622, Wireless Signaling System, Nov. 25, 1919 (figure 6 of this patent clearly shows a "radial wire" ground plane antenna); 1,349,103, Radiosignaling system, Aug. 10, 1920 (the fourth version in figure 1 shows inside/outside variation which, for the long waves used, to a distant observer appears as a varying magnetostatic scalar potential using opposing B fields); 1,349,104, Radiosignaling system, Aug. 10, 1920; 1,220,005, Wireless Signaling System, Mar. 20, 1917; 1,303,729, Wireless signaling system, May 13, 1919; 1,303,730, Radiosignaling system, May 13,1919; l,315,862, Radiosignaling system, Sept. 9, 1919; also 958,829, Method and Apparatus for Producing High Frequency Oscillating Currents, May 24,1910.].

4. Anomalous power outages in Ventura County, Southern California on Nov. 8 and 9, 1985. Again, engineer Ron Cole, who lives in the affected area, investigated and reports as follows:

"On the evening of 11-8-85 in a rural area of Ventura County known as Carlisle Canyon, a strange electrical phenomenon began to occur at about 10:15 p.m. Our first observation was that random white dots began to appear on the TV screen, then began to increase in size and brightness. The brighter the dots got, the dimmer certain lights in our home became. Yet later we found that, when some lighting circuits were dimming, other circuits were causing lights to

shine much brighter than normal. After a bit of checking, we were able to determine that lighting circuits common to pole 1 of the service transformer were the ones that were seeing a reduction in voltage, while all circuits on pole 2 were seeing an increase in voltage.

There is another interesting condition that was observed on the TV screen. The dots were in sync with the vertical field or frame rate of the signal. This means that the interference had to be of a frequency of 59.7 Hz or 29.85 Hz. Normal power line interference will form a grouped dash pattern across the screen and will strobe upward at the rate difference of 59.7 Hz or 29.85 Hz. In the 8 November case, there was no strobing of the dots whatsoever.

These conditions continued off and on for the rest of the entire evening and were observed by no less than six other persons that I know of. They were observed over the entire TV frequency spectrum, low band VHF, high band VHF, and on two UHF channels. Line interference is almost always most prominent on the low band VHF frequencies only.

These anomalous events would take place on a somewhat irregular time pattern; anywhere from 3 to 10 minutes apart. They would always last for about 2 minutes.

At 12:30 a.m. I went to bed and was not aware of any further activities until 6:20 a.m., at which time I was awakened by several sharp snapping or cracking sounds coming from the walls of my house. I rolled over and went back to sleep, only to be reawakened about 15 minutes later by my wife, who informed me that the power and phones were out. My comment was, "Some dummy must have crashed into a power pole," and I dozed off again.

At 10:15 a.m. the power and phones came back on line. Shortly after, our phone began to virtually ring off the hook. About a dozen neighbors up and down the canyon wanted me to check out their electrical wiring and various appliances. All of them were trying to explain their individual encounters and what took place when the power went out. Such things as wires snapping in walls, singing and humming sounds coming from wiring in walls, strong smell of ozone, light bulbs exploding, buzzing coffee pots, and a handful of other phenomena all took place just before the power went out at 6:20 a.m.

A typical example was that of Rob Steel. [Ed: Name changed for this report; his real name is in my files.] Rob lives four miles down the canyon from us. He had just turned on the lights in his barn and was getting ready to feed

the livestock, when he realized he had left several needed items in the garage located about 75 yards from the barn. Upon entering the garage, he saw the garage lights began to flicker, then go to a dim orange glow. Upon stepping from the garage area, Steel saw that lights in the barn were so bright that he thought the entire structure was about to explode. He froze in his tracks for a moment and his whole house and garage began to hum. Then everything went out.

An interesting point to inject is that Mr. Steel's home and several others farther down the canyon from us are being fed from a different 19 kv power feeder source than the 14 kv feeder that supplies us and most homes in the canyon.

At about 2 p.m. on 11-9-85 I was in contact with the power utility company (Southern California Edison Company) to inquire as to the cause of the power outage. My first assumption was wrong. No power poles had been knocked down; only a ceramic fuse in the 19 kv feeder system had blown and a two-pole oil breaker had kicked out on the 14 kv feeder system. Load charge recorders at the power company show that both fuse devices kicked out at exactly the same time, but they are in no way common to each other as to load distribution. They only supply power to adjacent areas.

Also, the phone company has no record of its service being out, yet the phone service was restored when the power was restored. The phone company does not use Edison Company's power to power its phones. Again, the only commonality is that the phones and phone lines were in the same area.

Numerous magnetic breakers, used as manual switch devices for well pumps and other services, were on when power was returned. These switches had previously set in their off state.

A strong electrical-type ozone odor was detected at five locations at the time the power went out.

Later we found that a Research and Development laboratory in a nearby area measured 29 Hz intermittent signals late on the night of 11-8-85. These signals were interfering with some critical tests the lab personnel were trying to accomplish. The laboratory itself did not experience a power outage.

At this point in time, the only realistic surmise we can come up with is that a tremendous ELF or scalar ground wave was adding and subtracting to the grounded neutral service side of the power pole transformers so as to sum in

and out of phase. When peak nodes were achieved, all line transformers ended up back-feeding the feeder lines out of phase, causing the final power outage.

Twenty-one persons are aware of the strange conditions of the power outage and prior events. [Ed: Their names are in my files.]"

Editor's comment: Another anomalous power outage also occurred in the same area. This occurrence is possibly associated with effects of the scalar interference grid adjustments. If the Soviets were preparing for a major test of the grid in the Launch Phase ABM mode, substantial tests and exercises may have been performed before the actual "wet run" against the shuttle launch on Nov. 26, 1985 -- about two and a half weeks after the anomalous power outage at Carlisle Canyon.

See the Rogers' patents, referenced above, for ideas of how scalar EM signals couple to the power lines and telephone lines.

As this book goes to press, John Bedini has notified me that his new and very sensitive developmental scalar detector positively verifies scalar frequency "spike" activity on the Woodpecker grid (and possibly the ground reference) from 50 Hz to 10 MHz. A normal instrument will definitely not see these signals. John's lab is at Sylmar, California and about 70 miles from Carlisle Canyon.

5. During the Skylab mission, NASA astronauts observed and photographed a mysterious green glow of the atmosphere. The glow was over 1,000 miles long and over 100 miles wide. From Carlisle Canyon, Ventura County, California the sky has also been observed to possess a mysterious green glow from horizon to horizon, on three occasions. [Editor's comment: It is hypothesized that this green glow is associated with grid activity in the Launch Phase ABM System mode.]

6. Just prior to the hapless launch of the Challenger on Jan. 28, 1986, the Soviet Union sharply bent the jetstream down through the center part of the country, then curved it eastward across the Florida panhandle. This exposed the waiting Challenger on the launch pad to severe cold air, brought down from Canada by the sharply deviated jetstream. The use of the scalar interferometry aspects of the Woodpecker grid for weather engineering over the U.S. has been documented previously. [Bearden, Soviet Weather Engineering Over North America, 1-hr. videotape, 1985;

Bearden, "USSR: New beam energy possible?", Defense & Foreign Affairs Daily, 13(111), June 12, 1984, p. 1-2.]. Wilson's cloud radial sightings on Jan. 26, 1986 and Cole's giant cloud grid sightings on Jan. 24, 1986 are directly connected with adjusting the Woodpecker grid and deviating the jetstream, to carry cold air to the Florida launch site.

7. The previous testing of the grid in the Launch Phase ABM/Anti-bomber Mode, using actual jet aircraft as "wet-run" targets, has been demonstrated by various anomalous incidents.

As one probable example, see "Jetliner drops 32,000 feet; 400 aboard; 50 are injured," AP release, Huntsville Times, Feb. 20, 1985, p. 1 and "China Airlines Pilot Denies Cockpit Error," AP release, Huntsville Times, Feb. 21, 1985, p. A-9. In this incident (see figure 7) a Boeing 747, flying at 42,000 feet and bound for Los Angeles, experienced unusual engine flameouts while still out from San Francisco. In a hair-raising plunge toward the earth, the pilot fought to restart the engines and regain control of the aircraft. After a fall of some 32,000 feet in two minutes, the engines finally restarted, and the pilot was able to fly into San Francisco and land safely.

We have already explained how the Soviets are able to track the aircraft's jet engines. Later in this Appendix we show just how accurately an actual "scalar EM missile" may be focused by the Soviets on a hapless target. If a negatively biased pulse or continuous wave scalar EM "energy extraction" beam hits the engines, the extraction of energy will result in engine flameout. (No heat energy, no combustion of the fuel.). This is apparently what happened to this aircraft. In the presence of "splatter" from the extraction beam targeted at the engines, the aircraft instruments were seriously affected. Different instruments have different responses to such an anomalous scalar EM kindling effect. Thus a signature would be that the instruments disagree with each other, and need not record what actually occurred. This appears to have been the case, constituting a signature that scalar EM was targeted against the aircraft. The pilot's instruments apparently indicated that the control system had failed, while the flight recorder apparently indicated that it had not.

Let us assume this was a Soviet test. When the distant Soviet operator turned off the extractor beam, the engines returned to normal state after a "discharge time constant" period. They normalized before the plane struck the ground,

so the pilot was able to restart the engines and proceed.

Notice that this was a limited test to cause engine flameout only. If the scalar EM missile had been used against the aircraft in the "pulse" mode, it would instantly have exploded in mid-air.

The crash of an India jet aircraft outside Great Britain may have been a test of the same weapon in the pulsed "destroy aircraft" mode, since there are indications that the aircraft suffered an anomalous midair explosion. Another candidate for such a possible "shoot-down" of a jet aircraft is an (Italian) Itavia DC-9 that crashed into the Mediterranean in June, 1980. Both Itavia and the Italian Transportation Minister Salvatore Formica believed that a missile struck the jetliner and was the likely cause of the crash. It may have been a scalar EM missile and a full-up test by the Soviet Union. See "Plane was probably hit, judge says," Birmingham Post-Herald, Jan. 17, 1981.

Also the present author has knowledge of at least one instance in the early 1980's when an American-made tactical ballistic missile was anomalously destroyed shortly after being launched by troops in Europe. The destruction was anomalous and a large hole was inexplicably burned through the side of the missile -- exactly as if it had been struck by a scalar EM missile test in the anti-tactical missile (ATM) role.

8. As another example of airborne scalar EM activity in the Woodpecker grid, in January 1985 a U.S. Navy-dispensed chaff cloud, dispensed well-offshore from San Diego, California was caught by an unexpected wind and blown toward the city. (See figure 8.). As the chaff cloud moved in, significant failures of electrical systems and electrical components resulted. Power was disrupted to as many as 60,000 homes by the incident.

The sudden, unpredicted wind was suggestive of a wind blowing toward an artificially created low pressure area. Under certain conditions, a specialized structure such as that of a piece of sophisticated chaff will reflect scalar waves of frequencies within its cut bandwidth. If scalar modulation frequencies within the chaff bandwidth were present on the Woodpecker carrier grid above and surrounding San Diego, a myriad of reflecting bits of chaff in the moving chaff cloud would produce myriads of random, invisible "fireflies" of EM energy kindled at a distance, from random scalar interferometry, in a zone surrounding the cloud. As these invisible "firefly" pulses of

EM energy pulsed inside components of the electrical systems and electrical controls in San Diego and vicinity, extensive and random internal electrical interference occurred. This lead to widespread, anomalous electrical failures throughout the city.

Note that this activity preceded the huge Soviet scalar EM exercise of April-May 1985. The grand exercise would certainly have been scheduled well in advance by Soviet strategic forces controlling the scalar EM howitzers and Woodpecker grid weapons, and adjustments and smaller tests would have been being made for some months before the tests.

9. Other anomalous "electrical strikes" certainly exist, suggesting Soviet testing may occur widely throughout the world, yet be reported as ordinary but anomalous phenomena. An example which comes readily to mind is the anomalous blast (or blasts) that struck Bell Island, off the east coast of Newfoundland, on April 2, 1978. Persons on the shore of Conception Bay reported seeing fireballs coming down out of the sky and hitting the island, according to Royal Canadian Mounted Police. Highly anomalous atmospheric electrical activity preceded the blast. This may have been Soviet testing of scalar-created electromagnetic missiles. Extensive information on this incident can be obtained from P.A.C.E., 100 Bronson Ave., Apt. 1001, Ottawa, Canada T1R 6G8.

As another possible example, villages in an area of West Donegal in Ireland have been terrorized by freak "lightning bolts" for over two years. Roofs have been literally stripped off, windows smashed, telephones and television sets blown up, and pipelines wrecked. On Dec. 25, 1984 a mighty blast caused a three-day blackout: it accompanied a snowstorm, the first "white Christmas" in the area in 20 years. See "Bolts from the blue," Fortean Times, Issue no. 45, Winter 1985, p. 5.

10. Scalar spikes or pulses from the Soviet testing may also cause other anomalies, including deaths of unsuspecting persons using the telephone. For a candidate event of this type, see "Killer Phones," Fortean Times, Issue no. 45, Winter 1985, p. 8-9; also AP release, Huntsville Times, May 30, 1985; AP newswire June 2, 1985; and New York Times, Sep. 11,1985.

On May 21, 1985, five days after passing a complete physical examination, 17-year-old Jason F. Findley of

Piscataway, New Jersey was on the phone at his grandmother's house, talking to his girl friend. An odd click occurred on the line, followed by a gasp from Findley and then only the TV playing in the background. His grandmother found him unconscious, still clutching the phone in his hand. Rushed to Muhlenberg hospital, he was pronounced dead shortly afterwards. An autopsy could not determine the cause of death, and the telephone company found the phone working properly, properly grounded, and no evidence of excess electrical charge. Findley was lying on a wooden bed which would not conduct electricity. He had a hemorrhage of the inner ear. There had been an electrical storm over Scotch Plains, New Jersey the night Findley died.

AP wire services were told by the special forensic investigator with the New Jersey medical examiner's office that about six people had died in the U.S. in similar circumstances. Others had reported being knocked unconscious by "high voltage shock" from their telephones. Several weeks before Findley's death, another man from Whitehouse Station, New Jersey had been found unconscious with a telephone in his hand. According to the Consumer Product Safety Commission in Washington, D. C., in 1984 nearly 12,000 people in the U. S. were taken to emergency rooms with injuries related to telephones. A hundred of them died, although exact details were not revealed.

Note that the giant Soviet scalar exercise of May 1985 had been detected and verified by Golden. Substantial activity in the Soviet weapon complex, and in the Woodpecker grid over the U.S, continued throughout May and beyond. A phone line may by chance detect one or more atmospheric scalar EM pulses, just as occurred in the blackout in Ventura County, California on Nov. 8-9, 1985. These scalar pulses can travel along a phone line and be broadcast into a person's ear and brain from the telephone earpiece. The proper scalar EM pulse can induce both "acoustic shock" in the inner ear and "electrical shock" conditions in the nervous system. The pulse may also interrupt the body's electrical timing pulses to the heart, causing the heart to stop without physical damage. The scalar EM shock to the brain and nervous system can knock the person unconscious or, if sufficiently strong, kill him instantly. The condition is worsened if the person is ungrounded, since then he acts as a large, open-ended capacitance in series with the telephone instrument's

inductance. In such case, the scalar resonance of the equivalent series LC circuit can be sharply excited and resonated. By the nonlinearities of the body and nervous system, the scalar resonance can be translated into an ordinary electrical pulse or resonance. Since the scalar power is not translated into ordinary power except inside the nonlinearities of the human capacitor/nervous system, no damage to the telephone or phone lines need happen. [At the ComTec exhibit in Las Vegas in 1984, John Bedini demonstrated powering a 200-watt speaker system through a 100-foot length of #40 magnet wire, using scalar EM means. He put some 200 "watts equivalent" of scalar energy through the tiny wire to the speakers, where a small Bedini translator translated it back into ordinary electrical "force field" energy, powering the speakers. This was much to the astonishment of the technical audience, since the wire was quite cool and exhibited no evidence of heating, even though by conventional thinking it should have been instantly melted.]

The bottom line is: With increased Soviet scalar weapons activity over the U.S., the telephone system is likely to become more hazardous to humans using it, when th e instrument is connected to th e external wire. A radio ph one is much saf er against anomalous scal ar EM "spiking."

11. The metal-softening detected and verified by Frank Golden on Jan. 1, 1986 is certainly indicative of a new mechanism or effect added to the Woodpecker grid. The highly specialized nature of the particular detector/amplifier which Golden was using provides strong evidence that the signal was actually derived by recording the scalar EM signals produced by a human cerebrum (two cerebral hemispheres connected by the corpus callosum, forming a scalar interferometer) when the human was successfully performing psychokinesis (metal-bending). The fact that Golden was able to nullify the signal locally by special methods worked out by him lends further credence to this hypothesis. In any event, three hours of very objective experimental data strongly support this thesis. It is therefore indicated that (1) the metal-softening signal had been added for a purpose, and (2) something made of metal was going to be softened, leading to its failure. Certainly the Challenger would have been an ideal target; softening the metal on its boosters and fasteners by even a small percentage would significantly reduce the vehicle's ability to withstand the

stress during launch. This of course is circumstantial evidence only, but the finger of suspicion is there nonetheless. It is a fact that the metal-softening signal was and is in the Soviet Woodpecker-repertoire; it is a presumption that it was intended for use against the Challenger.

- FINAL DRESS REHEARSAL BEFORE THE BIG SHOW -

12. The shuttle launch from Cape Canaveral on the evening of Nov. 26, 1986 seemed smooth as silk to the army of official observers and onlookers. In reality the Soviet Union clandestinely conducted one or more Launch Phase ABM System tests against the vehicle, using it as a convenient target.

Figures 9, 10, 11, and 12 are included to give the reader some preliminary background on the highly significant events which occurred in conjunction with this flight, and previous to it. These figures are newspaper articles from the News Tribune, Fort Pierce, Florida. The articles are used by permission.

Anomalous atmospheric "booms" and airquakes had occurred in the Florida area for over three and a half years prior to the launch. Sixteen counties, most of them on the northern Gulf coast or close to it, had reported booms during the two-year period preceding April 1984. State and local emergency preparedness officials and U.S. Air Force Base representatives met but could not resolve the mystery of what was causing all the anomalous booms.

In fact, many booms had occurred in and around the gulf coast of Florida, particularly offshore from St. Petersburg, starting from several years earlier.

These anomalous booms were caused by the Soviets adjusting and testing the Woodpecker scalar EM grid for weather engineering and potential weapons use. The booms and airquakes were certainly not confined to Florida alone, but also occurred at many other locations throughout the U. S. and Europe.

Mysterious, highly localized seismic microquakes also had occurred at widely scattered locations throughout the U. S.

On at least two shuttle flights prior to the Nov. 26, 1985 launch, large anomalous "booms" had occurred over or around the launch site after launch. No one in NASA knew what they were or what caused them.

So prior to Nov. 26, the Soviets had already prepared and tested the Launch Phase ABM system mode of the grid against at least two U.S. shuttle launches. However, so eerie and strange are the scalar EM weapons that they had been able to do so without the U. S. government even becoming aware of what was going on. In the Kremlin, they must have marveled at our continued ignorance.

At any rate, they tested the Launch Phase ABM system again on Nov. 26, and this time private U.S. citizens happened to capture at least some evidence of what was going on. It still would have died there without surfacing, except for a curious chain of events. Let me briefly recount those events.

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Lucius Farish publishes a fine little monthly newsclipping collection called UFO Newsclipping Service (Route 1, Box 220, Plumerville, AR 72121). In it she includes clippings on all sorts of anomalies, including UFO's, strange light phenomena, etc. Because of my long work in UFOs (for some time now, placed on the back burner due to the press of my work in Soviet scalar electromagnetic weapons), I've subscribed to Farish's service for several years.

And this time my unorthodox interests certainly paid off. Farish published a clipping of the article, "NASA officials stumped by strange light, boom," by Susan Burgess, News Tribune writer (see figure 10). The moment I read the article, I realized that the Soviets had actually tested the Launch Phase ABM System's area mode against the shuttle launch of Nov. 26, 1985. Further, George Suchary had taken a picture of the marker beacon as it was slewed away at the conclusion of the test.

With alacrity I contacted Ms. Burgess and, through her, George Suchary. Both were very helpful, and Mr. Suchary gave me permission to use his important photograph of the light moving away after the test. Ms. Margery Bril , the kind librarian at the News Tribune, sent me four clippings.

After reading the article by Julie Enders, Showcase Editor of the News Tribune, I contacted her also. Although extremely busy, Ms. Enders kindly gave me additional details, including the fact that Bob Gladwin had taken a series of eight stills of the launch itself, and in one frame an anomalous, curving line of light with a splash on the end

appeared.

At first I thought it might be the answer to a dream. Very tentative information suggested that the "curved light with a splash on the end" might have occurred in one of the pictures taken during the launch sequence itself, with the light striking directly under the shuttle shortly after it lifted off. I was positive the Soviets could strike at the shuttle (or a missile) with a "scalar EM pulse" missile, but hardly dared hope someone could have actually been lucky enough to get a photograph of it.

From my acquaintance with two masters of paranormal photography -- the indomitable Trevor James Constable and a close friend, Joe Gambill -- I understood how one could possibly get a picture of such a strike -- assuming it occurred -- at night, when the same picture could not have been taken in the daylight. I also understood why the camera might catch it when the human eye would not see it.

It seemed that, between them, these friendly, cooperative persons just might have gathered together the positive evidence to prove that the Soviets had struck at the shuttle with an offset test of a scalar EM missile, using a marker beacon for adjustment. (As it turned out. it was not to be as definite as that!) However, time was of the essence.

The Soviet tests had definitely included a test in the "area burst" mode, which can catch and destroy several missiles fired from a deployed silo complex at once. The clinching evidence I had needed for so long on a Soviet test of the pulse mode -- the scalar EM pulse missile -- just might be there in one of Bob Gladwin1s photographs. But there was no time to lose; such evidence is fleeting. and unless I moved quickly, it was likely to fade away and disappear forever. With persistence, the rest followed swiftly. Mr. Suchary graciously gave me permission to use his photographs. These of course prove that the marker beacon was there. (In addition, it was seen by numerous persons.). The News Tribune gave me permission to print the articles. Mr. Gladwin furnished his negatives and gave me full permission to analyze and use his photographs. Personal friends, Everett and Shirley Edwards, printed the photographs in their private darkroom so the negatives would not be out of safe hands for even a moment.

At the time, this book was almost finished. If the photo of the candidate Soviet use of the electromagnetic missile was accurate, quick work would be necessary if it was to be included. My friend and publisher, John Ratzlaff. had

already agreed to swiftly publish this large output as soon as I could get it to him. At Omni Video Publishing, Ms. Electra Briggs was alerted to the potential importance of what was coming. She and Mr. Glenn Shoemaker swung by my house from New Orleans, and a quick, informal videoclip was taped, announcing the book. (Murphy's law -- if anything can go wrong, it will -- got me there. Inexplicably, in my near-total fatigue from months of 19-hour days and 7-day weeks on this project, I spoke the date of the Titan explosion as April 19th, knowing full well it was the 18th! It happens. Electra suggested she slap a correcting statement over the video. Done. Be ready to get it out. It's too important; don't sweat the small stuff.)

Zerox copies of the photos were received. There in the fifth photo (or so it seemed) was an unequivocal strike of the scalar EM missile, in the launch sequence itself. The assumed strike seemed to have occurred right under the shuttle, a few seconds after liftoff.

The evidence seemed complete. All that was left was to receive the actual negatives and verify the sequence. At last we seemed to have the smoking gun. The Soviets would have been caught redhanded.

Based on the advance zerox copies, the manuscript was altered. Everything was ready. And then the negatives came in.

In this business, you learn to meet and accept a lot of failures. Things often go astray, and don't wind up as they seem at first blush. This time was no exception. Murphy got us again! The photos on the negative were in a different order then they had been on the zerox copies.

There's no mistaking the order in which the pictures were taken. There they are on the negatives, one right after the other, and clearly numbered. And the curving light with a splash at the end did not occur during the launch sequence at all. Instead, it was taken before the launch -- just how long remained to be seen. Everett and Shirley took the photo and developed it at both extremes: very dark and very light, to bring out all the details possible.

The results were most interesting. As shown on the lighter print (figure 13), the light does not curve down out of the sky and strike toward the ground, it turns up toward the sky and strikes above the distant treeline. Further, as shown on the darker print (figure 14), it does consist of a little ball of light, just like a scalar EM missile would appear. No apparent structure to hold the light appears in either picture, though one could not positively rule this out completely

without microdensitometer tests. (One can inadvertently get artifacts like this by focusing on a ball-like light bulb, for example, and then moving the camera while the shutter is still open. On the other hand, there is no evidence that this happened at all, and no street lamp post or other foreign object in the photo.)

(The remaining photos of the liftoff sequence are shown in figure 15.).

We called Mr. Gladwin. He verified that the photos had been taken in order, one right after the other. He had not had the camera on a tripod, but had steadied it on a railing. In other words, the "light streak with a burst on it" had been taken just before the liftoff. Also, Mr. Gladwin had not observed 'the marker beacon, and had not attempted to photograph any such "light in the sky." In fact, visually he had not observed any such streak and burst of light in any scene he was photographing.

So the question is, exactly what did Mr. Gladwin photograph in that photo, just prior to the shuttle's liftoff? The answer is. we just don't know for sure.

Let's run through the two possibilities:

(1) He may have snapped an artifact while moving the camera. If so, the camera was definitely quite still at least most of the time the lens was open, for the treeline is quite clear in the lighter photo, which reduces light saturation and shows details more clearly. Further, there is no evident support or structure attached to the light itself; it seems to be a "disembodied" light. So this possibility is ambiguous, though reasonable. Mr. Gladwin does not recall any such movement of the camera; it was steady while he was shooting.

(2) He may still have snapped a scalar EM missile. If so, it means the Soviets fired a "small test" of the exothermic pulse or scalar EM missile in advance of the actual shuttle launch. Let's pursue that for a moment, and suppose it to be true.

The Soviets already had the marker beacon up in the sky -- that's certain. Many persons saw it. Soviet trawlers off shore and Soviet satellites could also have given the actual position of the marker beacon. Thus the Soviet LPABM System would have had (a) the actual parameters the computer had used to transmit the beacon, and (b) the actual location at which the beacon emerged. Comparison of (a) and (b) is much like having a "meteorological data message" in field artillery: One has the corrections to apply for specific conditions of the medium that cause deviation.

These corrections can then be applied to calculated or "table" data to adjust firing for real-world conditions.

So far so good. The Soviets had the exact position of the registration beacon, and could apply corrections for a shot of the scalar EM missile. They certainly would know the exact position of the shuttle on its launch pad.

If a fairly substantial offset for the scalar EM missile shot were used, "mett corrections" could be applied and a small scalar missile could be zinged in, stopping momentarily at the final offset "strike" position so that a track could be obtained by the scanner extraction beam. Then by comparing the detected offset position of the "burst" of the scalar EM missile to the detected offset position of the marker beacon, the difference could be applied to the beacon's true position to get the true strike position of the missile. The offset used could then be subtracted to give the location where the missile would have struck without the offset, had it actually been fired at the rising shuttle after liftoff. This "adjusted final strike position" could be compared to the shuttle's expected early trajectory (which varies only slightly from standard for the first few seconds) to determine the expected combat success of the shot. It's a little roundabout, but it's a very safe way to do it if one wants quite positive assurance that the missile will not strike the shuttle and destroy it. Since the Soviets delayed the "area burst" and its concomitant atmospheric "boom" to T + 12 minutes, it is evident that a large offset was used for the area strike -- probably about 10 extra minutes -- to positively assure that there would be no actual damage or threat to the shuttle.

It seems logical, then, that they might fire the small scalar EM missile well offset from the shuttle, and just before its launch, to prevent any possibility of actual damage to the shuttle.

So there you have it. Mr. Gladwin's photograph is consistent with such a careful, safe scalar EM missile test by the Soviets, prior to the actual liftoff of the shuttle. On the other hand, it's not possible to say with certainty that that is what it is. It may simply be a very peculiar artifact. In fac, if it were not for the other indicators, one would most certainly not consider such a bizarre possibility as an offset Soviet scalar EM missile strike at the shuttle.

If the "streak" photo is examined as a candidate for a sca1ar EM missile test, then one other thing must be explained: Why did the film capture the test when observers did not see it at all? That, of course, we can explain!

So back to our presentation. Here I'm going to assume -- and accent that this is a postulation -- that the Gladwin photo actually represented a scalar EM missile test. We will run through a possible sequence of events, based on that assumption. We will hypothesize the LPABM system operation and the Soviet conduct of the test. The major events here in the U.S. may be quite real; those assumed to occur in the Soviet Union, of course, are "author's license" -- but hopefully realistic.

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The evening of Nov. 26, 1985 is perfect. At Cape Canaveral, the shuttle Atlantis is poised on its launch pad waiting to move majestically into the heavens on its impending journey. As launch time approaches, everything is as smooth as a cat's whisker. There is, however, just one small anomaly.

A mysterious light is hanging up in the sky, staying still for awhile, then gently rocking back and forth. The light is a Soviet marker beacon for a scalar EM howitzer. The howitzer, employed in a special scalar EM channel contained in the Woodpecker transmitters and interference grid, will shoot through the EM carriers at an aiming point offset from the shuttle.

Since this is still to be a nondestructive test, no chances will be taken. The pulse mode will be used, and a "scalar EM missile" -- a bundle of energy buried in hyperspace around its moving zero-point in this world -- will be fired directly at an offset aiming point prior to launch of the shuttle. A substantial offset in distance will be used to prevent posing any danger of inadvertently hitting the shuttle on its launch pad.

The marker beacon is necessary for precision. Its desired position will be calculated and the beacon will be placed on station. By placing this source of continuous EM energy in the area, it can be detected by the scanning "energy extraction beam" and tracked by the distant Soviet operator. Soviet trawlers and satellites monitoring the test will report the true position of the marker beacon, which will deviate from the calculated location due to conditions of the channel medium (the Woodpecker beams) at the time. Comparison of the beacon's true position to its desired, calculated position "registers" the marker beacon and yields the "meteorological corrections" which must be applied to standard firing table calculations. These corrections can be

applied to any further shot into the area to correct its aim, just as standard field artillery applies registration corrections in the target area.

When the shuttle boosters ignite, an additional track will be obtained from it. The offset from the received track of the marker beacon and the received track of the shuttle booster flame thus will give the exact correction or "shift" from the marker beacon settings that should be used to set the howitzer's aim. In other words, a "relative" firing, offset from the marker beacon registration track, will automatically compensate for any vagaries of the medium experienced by the beams in transmission.

The Russians, being excellent artillerymen, have simply applied the standard artillery technique of shifting from a known registration point.

The Soviet Launch Phase ABM System is cocked and ready. This is the last test in the "wet run" series in which an offset will be used. If everything goes as planned, future shots will move into the next phase, where actual U.S. targets will be destroyed. The two great powers are already at war, but one of them does not know it yet. Because of the importance of this last test before the next step in hostilities commences, Gorbachev himself is monitoring the test.

The countdown begins. In Florida a great many persons are observing the event. George Suchary has already spotted a strange light hanging in the sky, where none ought to be. Bob Gladwin, resting his camera on a railing, prepares to snap his first picture so that he will be sure to have a sequence completely across the launch.

Deep within the Soviet Union, a large display screen is illuminated. The marker beacon's track is clearly shown on the display, as are synthetic symbols for the shuttle on its launch pad, several Soviet ships off the coast of Florida, and several Soviet satellites.

The control officer barks, "Missile test! Proceed!" The simulation officer presses a switch, and a simulated shuttle launch track appears.

The operator responds immediately, "Launch detected!" The identification officer, scanning the frequency components and the signature of the energy extracted from the launch, calls out, "Missile! Target hostile!" He presses a button, and a light illuminates on the panel, marking the target as a hostile missile. The launch track begins to blink.

The control officer announces, "Prepare to fire!" "Pulse mode!" "Strength one!" "Test!" "Apply burst

offset!" The operator rapidly flips switches, setting the mode of fire and the offset. Instantly lights light to show that the computer has computed the shift and offset, and corrections. A red "Ready to Fire" light illuminates and a low siren begins its wobbulating growl.

The control officer orders, "Fire!" The operator presses the fire switch. A "Fire" light appears. A slight, deep shudder is felt briefly as the howitzer fires its scalar EM pulse missile of deadly energy. On the screen, the path of the scalar EM missile is traced out as it speeds toward its target far over the horizon.

In Florida, George Suchary is getting more and more curious about that pesky light. Bob Gladwin is preparing to snap his first photo as the final seconds of the countdown tick away.

On the distant Soviet screen, a sudden small burst appears, superposed over the synthetic shuttle track. The operator yells, "Burst!" On a smaller screen, a vertical profile shows the strike directly underneath the target. Immediately a blinking "Target Killed" light appears as the computer assesses the shot a kill.

The operator excitedly calls out, "Kill !" "Direct Hit!" Cheering breaks out from the firing team and the onlookers. Gorbachev and his entourage are smiling broadly and clapping. The cheering quickly hushes as the crew and participants continue to watch the track of the rising shuttle, and prepare for the launch and the next test.

Bob Gladwin has snapped his first picture (figures 13 and 14) leaving the shutter open a bit to allow for the nighttime conditions. As luck would have it, the scalar EM missile strike Occurs during the time the shutter is open. The film has captured the strike by a special process, even though human eyes have not seen it. (We will explain that shortly.).

At 7:29 the Atlantis's boosters ignite and the vehicle begins to rise smoothly off the launch pad. She will continue to rise, then pitch over to a 45 degree angle and proceed down range..

Bob Gladwin is snapping pictures regularly, one after the other.

In the local Florida area, hundreds and hundreds of persons are watching the flawless launch. The tip-off of the Indian River Community College basketball game and the St. Lucie County School Board meeting are held up while participants watch the Atlantis begin to rise serenely upward.

In the Kremlin, another track has appeared on the

control screen display. Once again the sharp-eyed operator snaps, "Launch detected!" The identification officer, scanning the frequency components, tersely rasps "Missile! Target hostile!" Again he presses a button, and a light lights on the panel, marking the target as a hostile missile.

The control officer orders, "Simulate multiple firings!" The simulation officer acknowledges, "Multiple firings simulated!" and presses a button to cause the computer to simulate multiple launches on the display.

Immediately other synthetic target tracks begin to appear on the display screen, one by one, clustered around the shuttle launch at various separation distances, pre-arranged to represent multiple firings from a missile silo complex for this exercise. A special audio alarm sounds as each track appears.

The operator immediately calls out, "Multiple tracks! Missile launches!" and then "Identified hostile!"

The control officer orders, "Prepare to fire!" "Area pulse mode!" "Test!" "Apply time offset ten!"

The operator flips switches rapidly, acknowledging. Lights illuminate on the console, showing status of preparation for firing. The "Ready to Fire" light illuminates and the low siren begins again.

Back in Florida, Bob Gladwin has stopped snapping photographs. George Suchary has gone into his house to find his Polaroid camera and take a picture of that pesky light still hanging up there in the sky.

Back in Russia, the fire control officer orders, "Fire!" The operator presses the fire switch. The "Fire" light illuminates, immediately blinking, and the siren changes tone. On the display screen, all target tracks are blinking. A large light on the console comes on, showing that an "exercise time offset" of 10 minutes has been applied. A digital clock starts ticking off the minutes.

Minutes pass as the offset time ticks down.

Back in Fort Pierce, George Suchary is coming out to take photographs of that darn light, which is <u>still</u> hanging up there!

Folks are streaming back into the Indian River Community College gymnasium for the basketball game. Attendees at the St. Lucie County School Board meeting are wandering back inside, to get ready for the meeting.

More minutes pass.

Back at the control console in the Kremlin, the offset clock ticks down to zero. The siren ceases its wobbulating tone and holds a steady note. The "Fire" light ceases

blinking and illuminates with steady brilliance. A deep shudder is felt as the howitzer fires again. On the screen, the rapid trace of the mighty scalar EM serpent is shown as it races toward its target.

Suddenly it reaches the target area, and a large blossoming light appears, covering all the target tracks. The operator announces, "Burst!"

All the target tracks flare brightly, then dwindle and die. The "Targets killed" light illuminates and the operator yells, "Kill! All targets killed!"

Wild jubilation breaks out. Everyone is grinning and clapping. Gorbachev personally congratulates the fire control officer and pumps his hand. The tension relaxes visibly. In the noise, the operator touches a joystick and slews away the marker beacon, preparing to shut down the system.

The final test has been a crowning success. Now the real first phase of active combat begins. "And the fools don't even know it yet!" a grinning Gorbachev delightedly announces.

Back in Fort Pierce, precisely 12 minutes after liftoff, high in the atmosphere above the launch site and a little downrange, a tremendous rumbling boom suddenly rocks the coast for hundreds of miles in each direction. The blast is heard as far north as Charleston and as far south as Key West.

George Suchary is taking pictures (figure 10) as the hanging light in the sky suddenly begins to move away, obeying the controls of a Russian operator thousands of miles away. Bob Gladwin has already finished snapping his photographs (figures 13, 14, and 15) of the launch and taken down his camera.

The anomalous light disappears rapidly in the distance, moving faster than any jet aircraft.

People gradually resume their normal activities, talking about the beautiful evening and the perfect launch. Many of them have noticed the strange light that hovered and bobbled in the sky, then sped away.

The final Soviet registration of their eerie weapons for World War III has been completed. A totally different kind of Pearl Harbor -- more akin to a Trojan Horse -- has been prepared for the unsuspecting United States.

Countdown toward Armageddon begins.

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George Suchary's photograph of the marker beacon, just after it had started slewing away, is shown in figure 10, as printed in the News Tribune.

Bob Gladwin's photographs of the shuttle launch are shown in figures 13, 14, and 15.

Figures 13 and 14 show two developments of the same shot, one light and one dark. The light one shows the treeline in focus in the distance, with the light streak and burst.

Figure 15 shows liftoff of the shuttle and its rise and tilt over on the first part of its trajectory.

Figure 16 shows a possible detailed interpretation of the first Gladwin photo. The simulated aim point was offset from the shuttle, and the strike was directly at the offset point. The computer computed the burst strike strike of the scalar EM missile from the adjusted registration data, and determined whether or not the target was killed.

The control precision is shown by the small size of the scalar EM missile.

The strike of the weapon is caught by the camera, but not seen by the naked eye. None of the many hundreds of onlookers saw the strike, though all of them saw the shuttle launch.

There is a very good reason for that, though it is not commonly known.

Constable

The reason is that Bob Gladwin's camera was utilizing a form of photography pioneered -- to the best of my knowledge -- by Trevor James Constable. At least I learned about it from Constable's books and articles. I then told it to my good friend, Joe Gambill, and Joe applied and adapted it to the unusual photography which he performs. Both Constable and Gambill are masters of this type of photography. Once I got deeply into scalar electromagnetics, I finally figured out what was going on in this methodology.

Briefly, here's the way it works. Scalar energy, of course, has to be detected by some sort of interference phenomenon. There exists a very special way to get a camera to perform such interference for you.

In the EM spectrum, the infrared and the ultraviolet have a special relationship to each other. The ultraviolet is exactly twice the frequency of the infrared, if the two zones are properly chosen. In other words, the UV is the first

harmonic of the IR.

The scalar EM energy, since it operates in the Kaluza hyperspace surrounding every point in ordinary space, may be considered to be composed of pure spin. (That is, it's moving in a dimension where each particle of that dimension is spinning). Harmonics there are spin harmonics.

In this photon-interaction produced level of reality (the ordinary world), the IR and UV bands are more closely connected to the "shadow world" in which scalar energy moves. Thus there is a sort of shadowy "swirling" of the scalar energy near the IR and the UV. Entry of the scalar energy into this world, through the IR and UV windows by a kind of "harmonic interferometry," is normally prevented by the presence of visible light. That is, visible light "squelches" the "paranormal channel" that lurks beneath the IR and UV zones.

To make use of the IR and UV interference source zones, Constable covered his camera lens with a special filter (18A) which is opaque to the visible light spectrum and transparent to the IR and UV. Note that the film is sensitive to the IR and UV region we are talking about, but the human eye is not.

When pointed at a sufficiently strong source of scalar energy, such a specially filtered camera has unique characteristics. It strips out the visible spectrum, but still admits the IR and UV spectrum. The scalar energy surges through these two source windows, and phaselocks harmonically. That is, the scalar energy entering through the UV window fits twice neatly in the scalar energy entering through the IR window. This interference, on the film, is (recall) swirling in frequency. The net result is that the film records the interfering scalar energy as visible spectrum energy.

Infrared film can be used to increase the response in many circumstances.

Both Constable and Gambill have rigorously proven this technique in literally thousands of "paranormal" photographs. (They do not necessarily use my scalar EM terminology, but the technique is rigorous and works, regardless of terms.)

Under nighttime conditions, sometimes the particular lens and film combination will phaselock between IR and UV for incident scalar EM energy. This is particularly true when a relatively strong source of IR is in the vicinity.

While Bob Gladwin was taking his photographs, there

was no suppression of the IR/UV phase-lock effect by visible light because it was night and there was hardly any visible light entering his lens.

Thus his camera lens and film formed an IR/UV phase-locked interferometer that detected and recorded the strike of the scalar EM missile underneath the shuttle, even though human eyes did not detect it.

At this point it would be interesting to know whether NASA may have had IR cameras focused on this shuttle launch (which was at night). If so, it would also be interesting to know whether any of them may have developed the IR/UV phaselocked interferometer effect, and captured the strike of the weapon.

Note that daylight shots would automatically break the IR/UV phase-lock possibility, by jamming out the effect with visible light, unless a special filter is used to filter out the visible light but leave both the IR and UV.

One would hope that both NASA and the U.S. Air Force will take note and discreetly add a specially filtered camera to the instrumentation observing and recording all future daylight launches.

To recapitulate the major events at the shuttle launch on Nov. 26., 1985, see figure 17. A marker beacon was placed in the vicinity, high over the area, for precise registration and location of tracks relative to it. A scalar EM missile strike may have occurred just prior to launch, and offset from the shuttle.

Then the shuttle lifted off. The exercise called for simulating multiple launches from a missile field. The area code was computed, and the fire order given. A substantial time delay -- say, 10 minutes or more -- was used to absolutely assure that the actual shuttle was well away from the engage blast.

Twelve minutes after launch, the delayed firing in an area "multiple missile kill" mode occurred, producing a massive boom heard for hundreds of miles up and down the east coast. After the boom, the marker beacon was slewed away, and photographed by George Suchary just as it moved.

The shuttle moved on downrange and went merrily on its way, blithely unaware of the jaws of the tiger that had snapped shut behind it.

To the Soviets, this final test of the preparation phase was highly successful. They were now ready to increase the risk level and fire the first round of World War III.

- THE SHOW BEGINS -

13. On Dec. 12, 1985 the same Soviet weapon tested against the previous NASA shuttle launches and against various aircraft may have deliberately interfered with the controls of an Arrow DC-8 taking off from Gander Air Force Base, Newfoundland. At an altitude of 100 feet, the aircraft -- carrying over 250 U.S. soldiers and civilian crew members -- lost power and sank into the ground tail-low, killing everyone on board. It was a tragedy of enormous proportions to the U.S., and especially to the families and friends of the brave servicemen and crewmembers who lost their lives.

Three Canadian witnesses to the crash were interviewed over the Canadian Broadcast network television news on April 8, 1986 at 10:00 p.m. No flame or smoke issued from the plane before its descent and crash.

However, witnesses reported seeing the aircraft mysteriously glowing with a yellow halo. That is a signature of the use of a scalar howitzer in the "continuous EM emergence" mode, similar to the manner in which several F-111's were downed in Vietnam.

In short, the DC-8's electrical systems were interfered with by electromagnetic energy and noise created throughout each increment of spacetime occupied by the aircraft. A powerful charge was rapidly created in and on the aircraft structures and skin. The "yellow glow" seen by the witnesses was a corona due to the skin of the aircraft acquiring a high electrical charge.

Something also apparently caused the rapid loss of two engines, one after the other. This indicates that the distant Soviet operator may have struck at the engines, one after the other, with a scalar "energy extractor beam." Thus he apparently tracked the aircraft as it moved down the runway, then used two modes against it: one to create serious EM interference with the electrical systems of the aircraft, and one to disable the engines.

With its controls ineffective and power drastically reduced, the doomed aircraft sank to earth, still in its "tail down" configuration from takeoff, and crashed and burned.

Admittedly other factors may also have contributed to the crash. These included reduced lift due to poor engine maintenance, increased weight of the aircraft due to icing, and heavy loading. However, normally the aircraft could still have taken off and flown to its destination. (See "Arrow Air was absolutely safe, FAA official says," UPI release,

Birmingham Post-Herald, Apr. 17, 1986.)

To date, no official seems to nave recognized the sinister significance of the "yellow glow" or what it implies. No one seems to have connected the loss of this aircraft, the mysterious booms over U.S. shuttle launches, the Woodpecker interference grid, the anomalous loss of the U. S.S. Thresher, the high altitude "booms" off the east coast of the U.S. some years back, the puzzling loss of two critical Titan launch vehicles in a row, anomalous engine flameouts of civilian jetliners, etc.

Certainly officialdom has not recognized that a Soviet Launch Phase ABM System is being tested directly over its collective head, to include actual destruction of U.S. aircraft, missiles, and space vehicles with concomitant severe loss of American lives.

Direct and diabolical acts of war have been committed upon us by the Soviet Union, but in a fashion that still eludes our erstwhile pundits.

However, it is not as simple as that. To even energize giant scalar EM weapons is to run a risk -- to all mankind -- so horrendous that it boggles the imagination. Truly it deserves Brezhnev's 1975 phrase, "...more frightful than the mind of man has ever imagined."

Shortly we will reveal exactly what he meant.

- Apr. 18, 1986: Death of a Titan -

14. As this book goes to press, the last two U.S. Air Force Titan 34-D missiles fired from Vandenberg Air Force Base in California have blown up shortly after launch. The first one blew up on Aug. 28, 1985 just after lift-off. That loss has been attributed to failure of a high-powered fuel pump, causing a massive oxidizer leak and a smaller fuel leak. The second Titan loss occurred on April 18, 1986 when the Missile blew up 5 seconds after lift-off. Its loss is still under investigation and no determination of cause has been made. Apparently the shuttle and the Titan presently provide the only viable launch vehicles for launching U.S. "spy" satellites. The loss of these sensitive satellites -- if indeed they constituted the payloads -- cannot help but be damaging to our strategic surveillance capability. According to the Los Angeles Times, the single remaining KH-11 satellite was launched in December 1984 and, with an expected life of two to three years, it could stop functioning later this year.

Whether or not significant Woodpecker grid activity existed in the vicinity of the Titan launch of August 1985 is

unknown at this time. However, significant activity in the grid definitely occurred before the April 18 Titan disaster and on the same day.

On Easter Sunday, 30, 1986 engineer Ron Cole observed significant cloud signatures of grid pattern activity, correlated with Soviet Woodpecker measurements. On April 18, the present author observed traces of a cloud radial over Huntsville, Alabama and took photographs of it. Preliminary reports from Thousand Oaks, California indicate extensive grid activity again on April 18, the day the second Titan exploded.

At least the second of these two missile destructions shortly after launch is highly suspicious, since the grid positively was active during that time. Also, a clear trail of Launch Phase ABM system indicators exists back to the massive scalar exercise of April/May 1985. The first Titan explosion in Aug. 1985 thus falls within the Soviets' "now let's test them against U.S. launch vehicles" period.

The second Titan loss follows highly suspicious losses of the Arrow DC-8 on Dec. 12, 1985 and the Challenger on Jan. 28, 1986. The same Soviet weapon system that destroyed those targets probably also destroyed one or both of the critical Titans.

At least, on the second Titan explosion, the Soviets left another signature. In one of the videotapes taken of the explosion, the marker beacon can be seen well , above the exploding debris, moving away from the explosion site.

See for yourself! Refer to "Titan Explosion Cripples U. S. Launch, Surveillance Capability," Aviation Week & Space Technology, 124(17), Apr. 28, 1986, p. 16-19. Specifically, look at the color photo of the explosion on p. 18.

Look well above the explosion (about one inch on the page) and to the left (about one inch on the page) of the center of the top of the fireball portion. There you will see a little light, caught in the very act of moving away.

At my rather frantic urging, engineer Ron Cole sought out a copy of the original videotape. He and a team spent two hours, going through this portion of the tape frame by frame. The light is there. It's real. And it moves on out of there, well above the explosion and independent of it.

It's the Soviet marker beacon, caught in the very act. Here I want to express my sincere appreciation to Ron Cole for his untiring efforts to nail this light down. Without his dedication to supporting this investigation, it would have been impossible to say for sure that the light was there.

So we have caught the bear red-handed, with his fingers in the cookie jar. If the marker beacon is there, you may rest assured that the Soviets destroyed that Titan missile, with very high probability. [See also "Investigators Search for Clues to Cause of Titan Blast," Aviation Week & Space Technology, 124(17), Apr. 28, 1986, p. 19-20; also "Titan Accident Prompts Funding, Technology and Policy Questions," AW&ST, 124(17), Apr. 28, 1986, p. 21.].

Continue

Figure 1. Wilson's first cloud radial

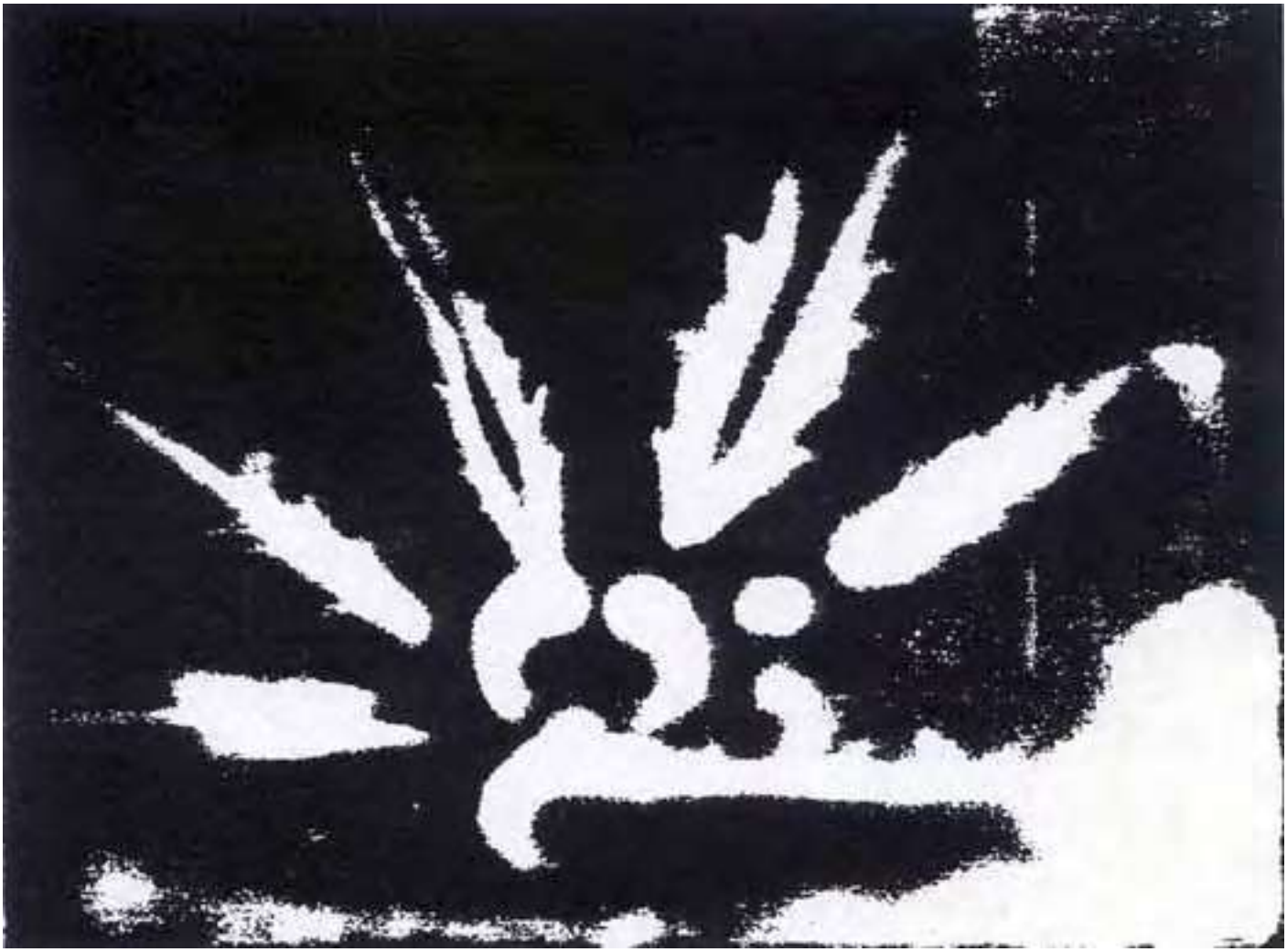

Figure 2. Wilson's second cloud pattern

Figure 3. Wilson's third cloud radial

Figure 4.

PLACEMENT OF WILSON'S THREE RADIALS

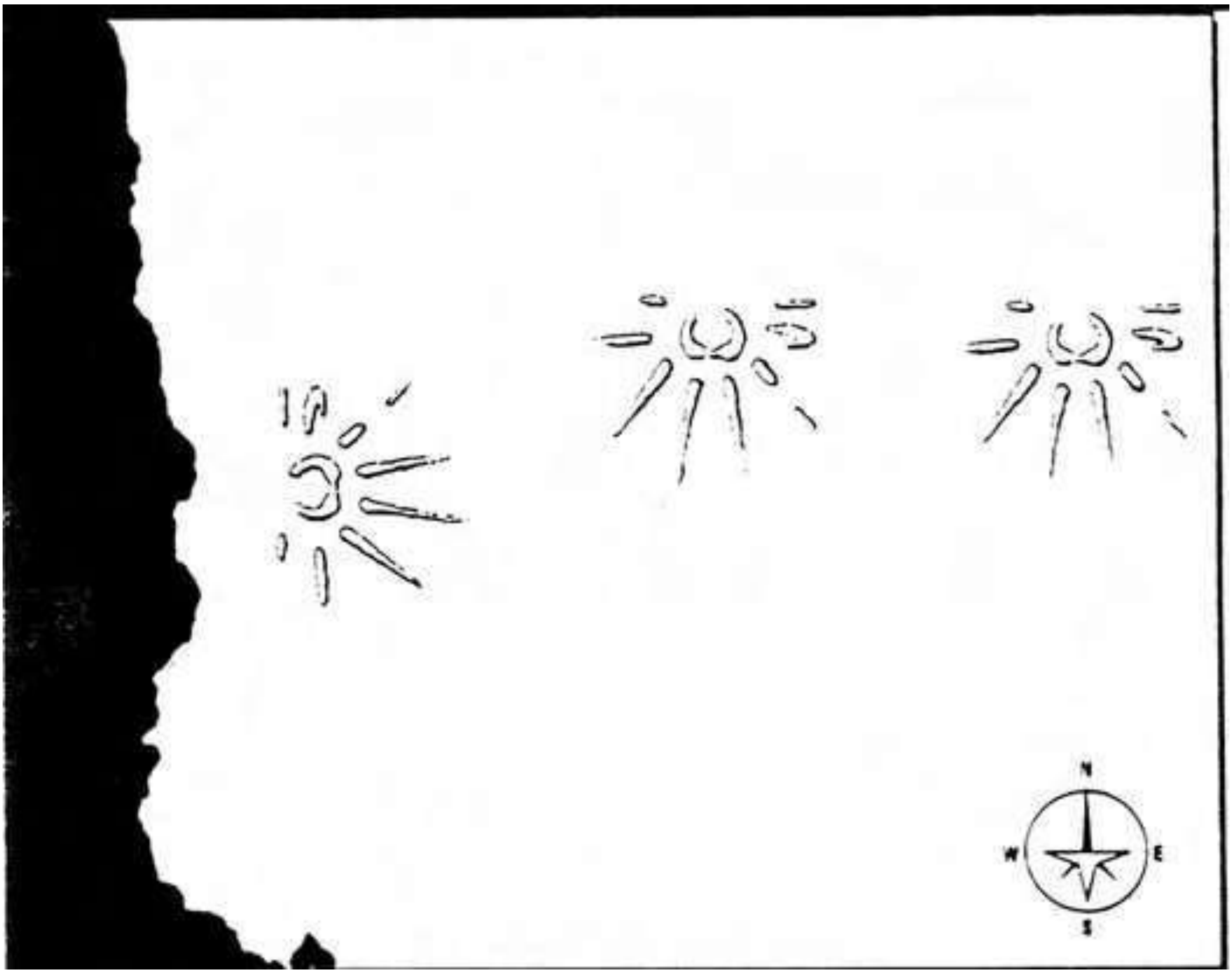

Figure 5.

VIEW FROM WESTLAKE OVER VENTURA COUNTY, CA

1-24-86, 280• WEST/NORTH-WEST

11:45 AM PST

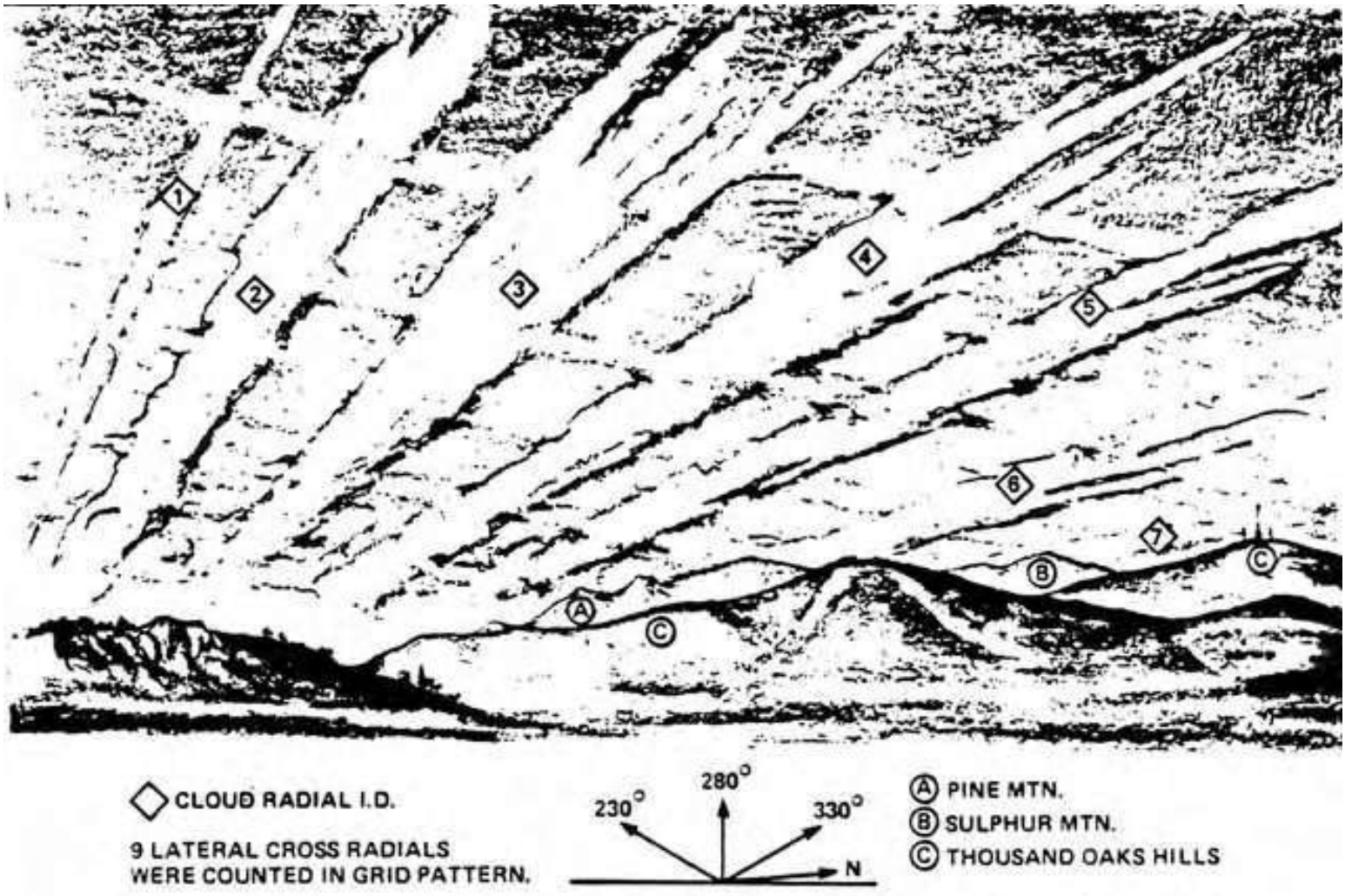

Figure 6.

GRID VECTOR APPROXIMATION
1-24-86 VENTURA COUNTY, CA

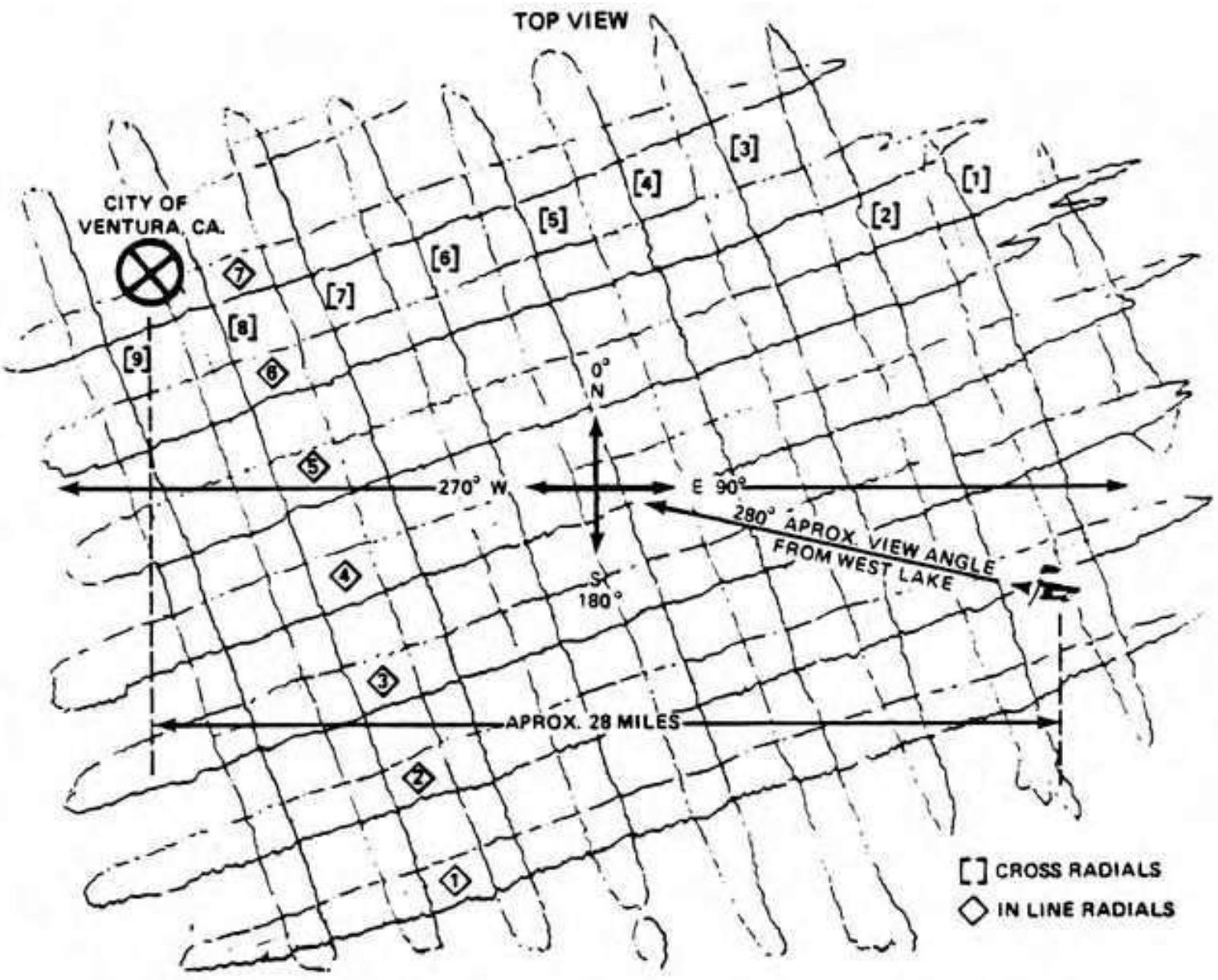

Figure 7.

SIX-MILE DROP IN TWO MINUTES

CHINA AIRLINES FLIGHT 006
- TAIPEI TO LOS ANGELES -
19 FEB 1985

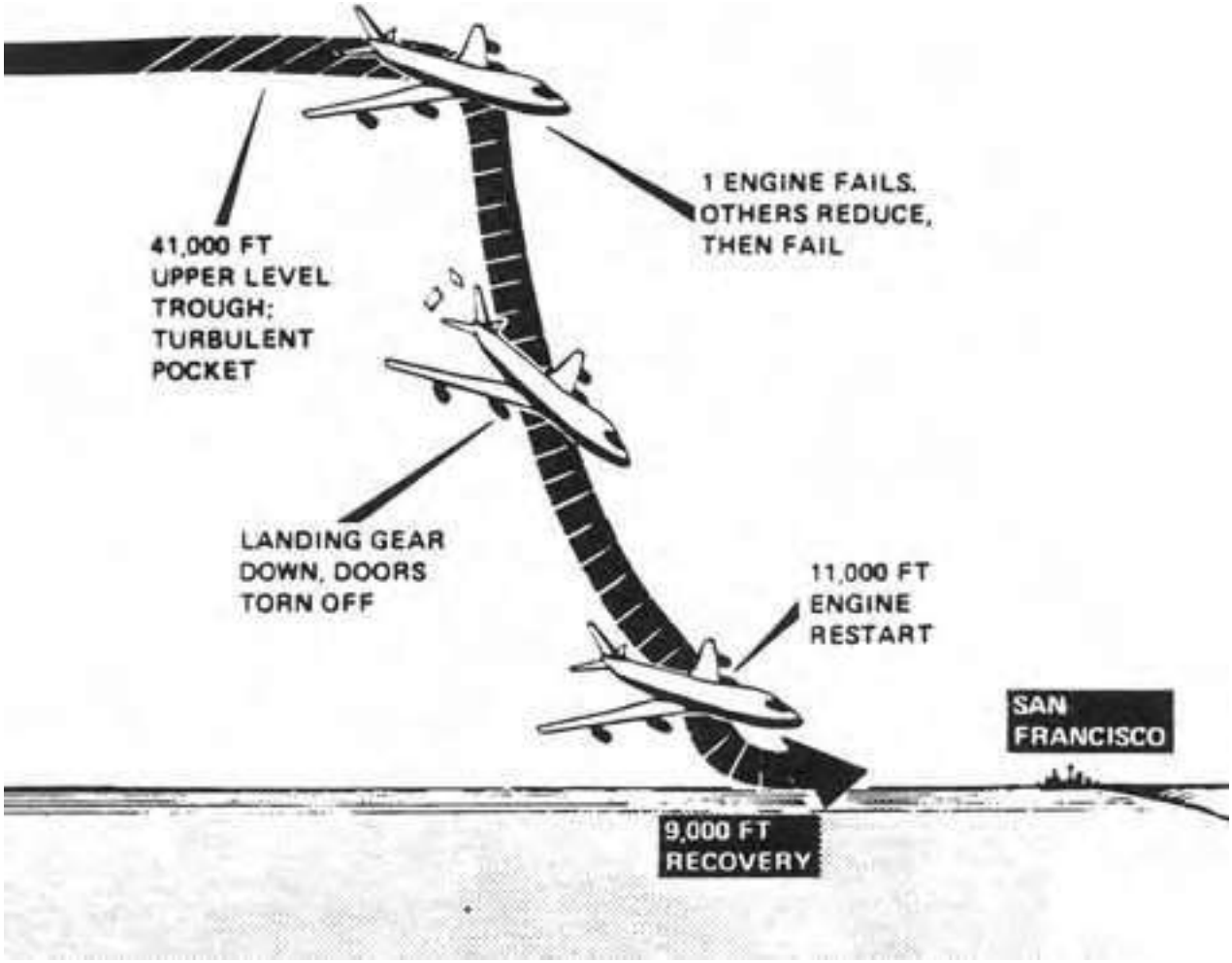

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The Tom Bearden Website

Fer de Lance

Figure 8.

SAN DIEGO CHAFF INCIDENT, JAN. 1985

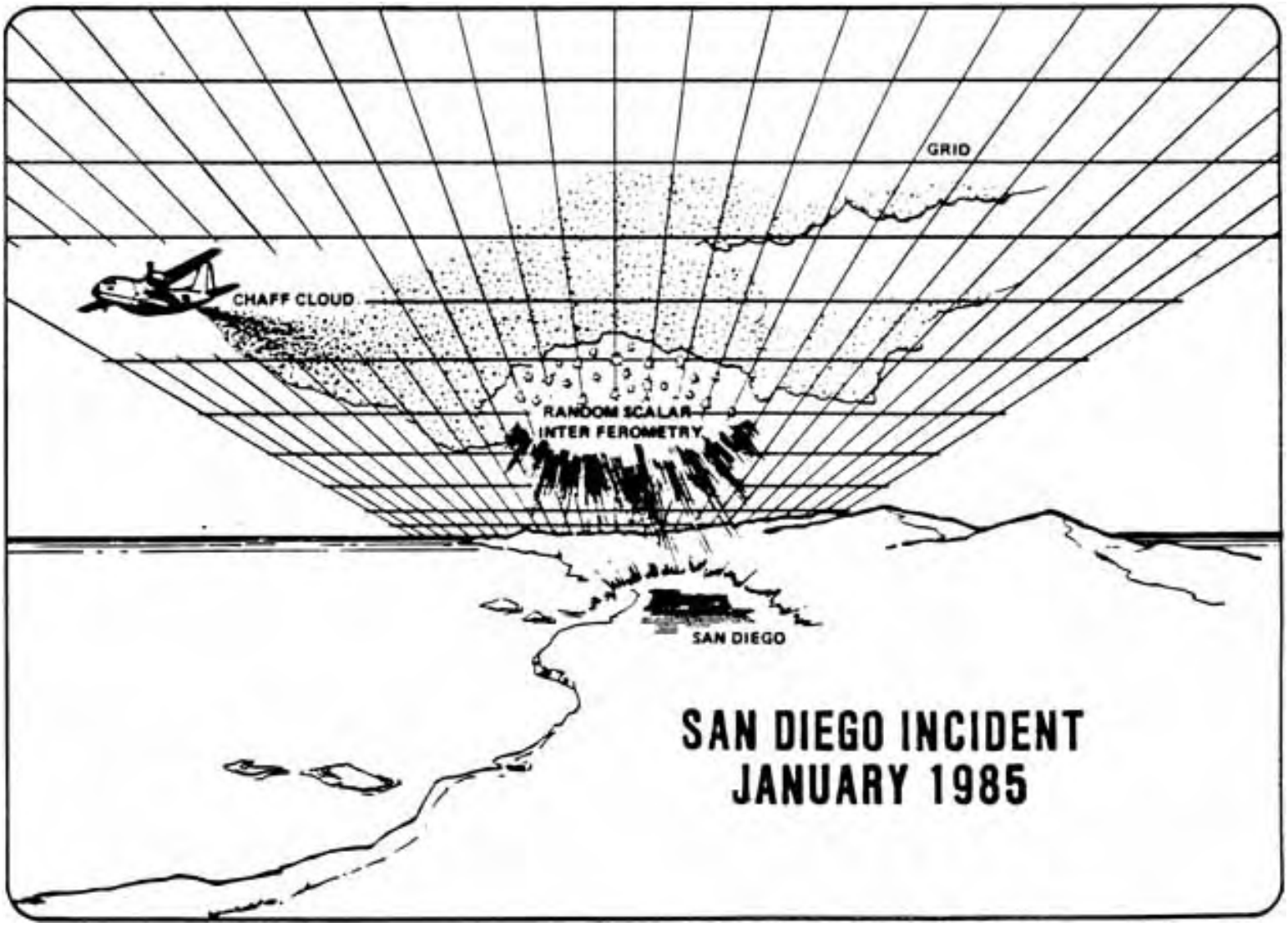

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EM Missile Strike, Offset from Night Shuttle Launch

Cape Canaveral, Florida

PHOTO BY BOB GLADWIN

© T.E. BEARDEN 1995

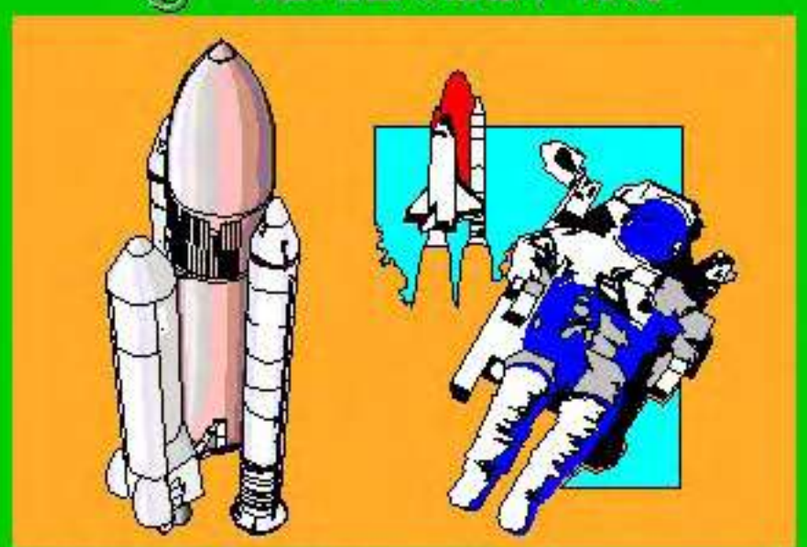

The Smoking Gun on 26 Nov. 1985

Longitudinal EM Wave Interferometry: Exothermic

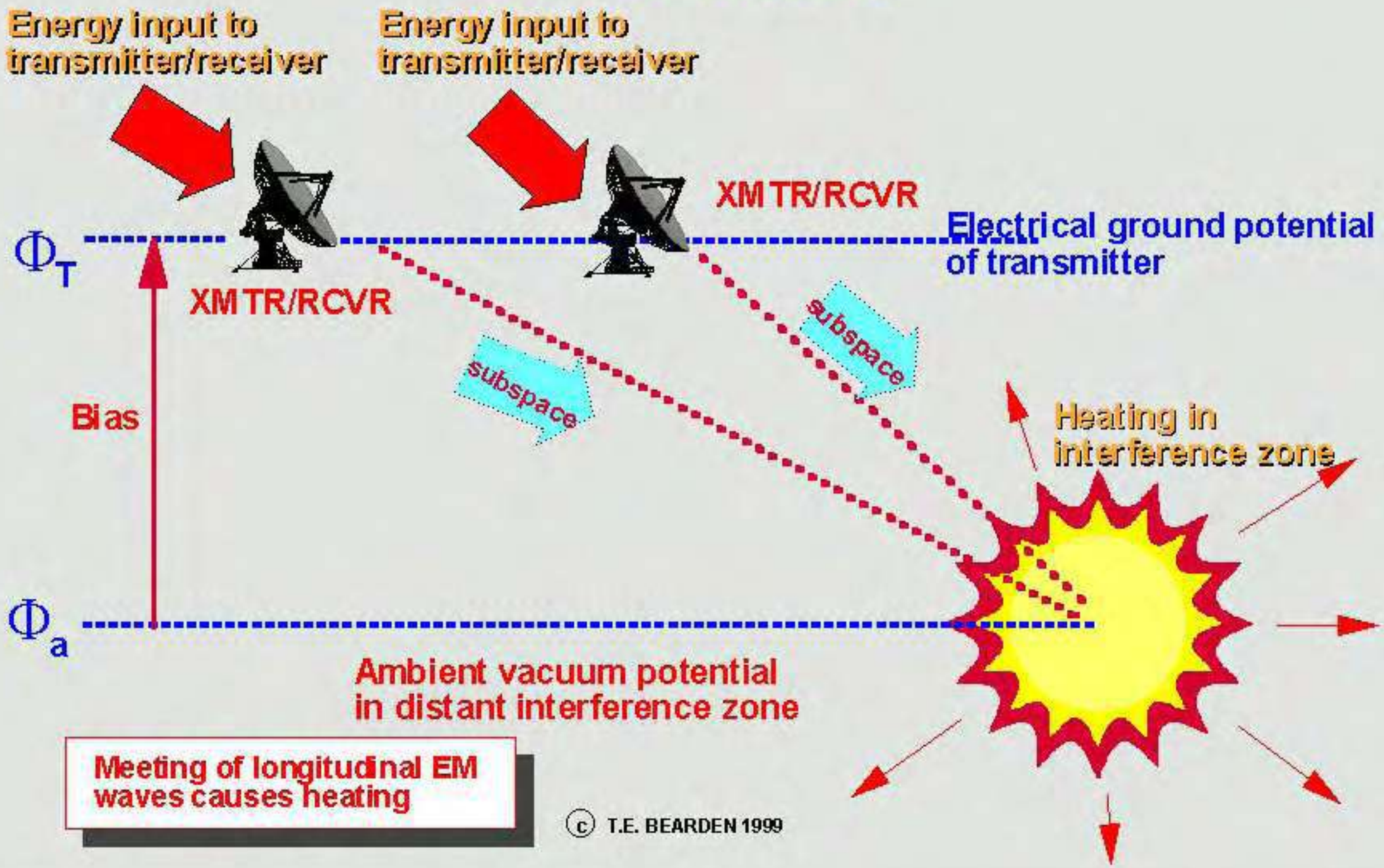

Meeting of longitudinal EM waves causes heating

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Longitudinal EM Wave Interferometry: Endothermic

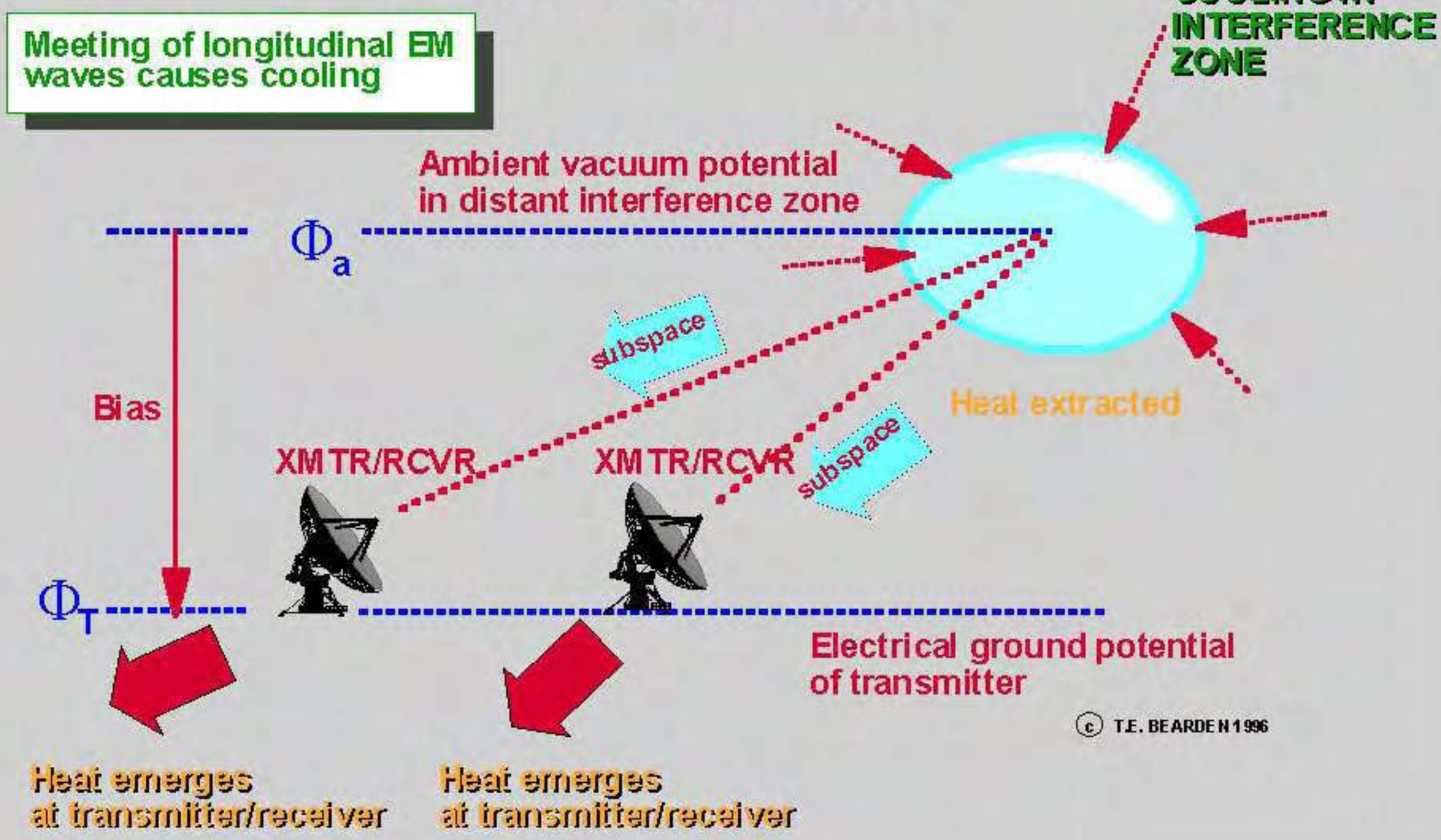

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- More Frightening Than the Mind of Man Has Ever Imagined -

Brezhnev's unheeded 1975 characterization of these weapons as "more frightening than the mind of ran has ever imagined" has very real justification. In a moment we shall explain what he meant. We shall also explain why the Russians may be serious about substantial nuclear disarmament.

There is now a "balance of terror" loose in the world that makes the old MADmen's MAD concept look like a sunny day in Hawaii.

Let me explain just a little of what I mean.

The scalar EM can and does use an ordinary EM beam as a medium. Many, many scalar EM channels can be infolded into an ordinary carrier. Thus the amount of energy stored in the carrier as "electrogravitational" energy has little to do with the feeble amount of electromagnetic energy stored in the EM carrier signal.

Thus in one sense, when the Soviets are employing the big "continent buster" weapons, literally hundreds of millions -- or even billions -- of watts of energy may be infolded into the seemingly weak carrier beams. All this energy is in the scalar EM channels established in the carriers.

Plus which, the scalar beams are employed in a "standing wave" node. Each scalar standing wave is like a gigantic "capacitor": It is highly charged. Under normal conditions, it has a charge and discharge time constant as well. If something were to "short circuit" one of these huge standing waves -- say, one with a thousand megawatts in it -- all that stored electrogravitational charge would discharge through the short circuit into whatever is on the other end of the short, and into the ground itself. In other words, the earth itself in that location would receive a mighty electrogravitational pulse (EGP). The ground in a region surrounding the discharge point would "charge up" just like a capacitor, and would transmit the EGP as a hemispherical current into the earth and spreading around it. This is where the real problem cores in.

The problem, as originally discovered by Wilhelm Reich [orgone energy was and is real, and is simply one form of scalar electromagnetics], is that radioactive material has a very great affinity for this EGP and undergoes a drastic reaction to it. Crudely, it works like this:

Imagine the vacuum as a virtual particle gas. This gas is under extremely high "pressure" or, more correctly, internal Stress. This stress is a gravitational potential.

However, the stress of the ambient vacuum is normally about the same in most localities. So a chunk of radioactive material doesn't experience a difference in vacuum potential across itself or throughout itself. In other words, the scalar EM fluxes in and out of every part of the nucleus are very high, but of equal magnitudes. The radioactive nucleus, however, is "unbalanced"; that is, it has an extra bit of unresolved EG potential which it would very much like to get rid of or discharge, by spitting out one or more particles. That is, it would like to "decay" to a more stable configuration. A nucleus that is trying to decay to a more stable configuration is a radioactive nucleus.

Remember, the radioactive nucleus is involved in a tremendously dynamic virtual particle flux exchange with the vacuum potential. And a part of it isn't quite in balance in that flux. Sooner or later the right "bobble" in the input flux will come along, and the nucleus will decay and emit a particle and/or radiation. By measuring the level of decay activity in a certain amount of the radioactive material, we can determine a "decay constant," or basically the probability that a nucleus will decay in one second. We can then determine how long it will take that chunk of material to decay away to a stable, relatively inert material. Some materials only require a few minutes to decay, while others may require thousands of years.

Now if you suddenly and drastically change the stress of the vacuum in which a radioactive nucleus is imbedded, you change the potential placed on the unbalanced nucleus. You hit it, in other words, with a strong EG potential pulse -- an EGP. That instantly unbalances the nucleus and it decays explosively. That is, it changes the decay constant and the probability of decay.

Basically that's what happens in a nuclear implosion weapon: You hit the radioactive hunk of material in the center with a very high, imploding pressure wave, which is carrying an EGP. The EGP causes all the nuclei to decay nearly instantly, producing a nuclear explosion.

The bottom line is: strong EGPs wreak havoc if they happen to hit anything radioactive. Such as nuclear warheads, in missiles or in storage. Such as nuclear reactors. Etc.

Now do you begin to see the problem? Let me spell it out.

Suppose the Soviets have activated some of their giant scalar EM transmitters, to place a giant weather engineering grid over the U.S., or to knock down a Challenger or a Titan. They've got their scalar EM beams all charged up. One of the giant Woodpecker transmitters has -- let's say -- 500 megawatts in its infolded scalar EM standing waves. Everything is going good. They're socking it to the Americans and the Europeans.

All those multiple scalar EM frequencies they're using to form the patterns, etc. have to all be absolutely phaselocked. Therefore all the transmitters have to be rigorously phaselocked, too.

And suddenly something goes wrong. A major amplifier/transmitter controlling or stabilizing the phaselocking malfunctions. The phaselock is disturbed, and begins to quiver.

Emergency circuits react instantly, trying to stabilize the situation and restore the quivering phaselock. Little "shorts" are being applied to the circuitry and to the "giant capacitor" that is the scalar EM standing waves. Dumps and discharges of EM energy are beginning to flash in the transmitter and associated circuits -- and into the ground. These make the situation more unstable. Feverishly the emergency circuits struggle to contain this thing -- and Wham! they cave in, all at once.

Now you get a mighty and continuing discharge of the scalar EM energy in that standing wave back into the transmitter and into the ground. It burns out the transmitter. And the discharge continues as the "capacitor" drains all its EG energy into the earth in a giant pulse.

Around the transmitter site, the EGP is transmitted radially away, still very much like a standing scalar wave. It reaches the first nuclear facility. Let's suppose it's a nuclear reactor. Specifically, let's suppose it's a nuclear reactor at Chernobyl.

If you'll check Soviet Military Power, DoD, 1986 you'll find that there's a big ABM radar site not far from Chernobyl. And Canadian sources verify that one of the large Woodpecker transmitters seems to be sitting in that general location. Now check "The Soviet Nuclear Disaster," The Wall Street Journal, Apr. 30, 1986, p. 24. Check the small drawing in the lower right corner of the bigger drawing. Here you can see that a Woodpecker transmitter located near Chernobyl would ideally transmit nearly due west to intersect over the U.S., entering across North America from its east. Other Soviet "over-the-horizon (OTH) radar transmitters" go over the north polar regions, to enter the U.S. from the North. The two then form a giant interference grid over the U.S. (You can see that in Soviet Military Power.).

Suppose you were in the field in the U.S., measuring the Woodpecker signals. Suppose the stronger beam was coming from the east. You would be able to see this with your instruments.

Now suppose the giant transmitter near Chernobyl got into the type of failure we're talking about. The emergency circuits panic and cut down the EM carriers, trying to drain away the standing scalar waves in a controlled fashion. Then your instruments would suddenly record the "new" direction as coming from the north, since the east carrier is gone.

That's exactly what engineer Bill Bise detected out in California, about the time it appears the reactor at Chernobyl began to get in trouble.

Let's continue with our scenario. Suppose the emergency circuits at the discharging Chernobyl transmitter contain things for awhile. The standing scalar waves are steadily draining into the earth. The EG potential starts to rise at the Chernobyl nuclear power plant.

In the nuclear reactors, the decay constant of the uranium in the fuel rods changes. Additional radioactivity begins to pour out of the uranium. The reactor alarms go off, and the crew takes measures to reduce the problem. The control rods go further in, to slow it down.

But the EG charge keeps increasing. The radioactivity of the uranium continues to increase. The control rods go further in to counteract this. The electrical controls begin to act up, showing anomalous indications. The radioactivity increases. In panic, the controls are fought until the control rods go all the way in. The reactor should in fact now be shut down completely, in normal circumstances.

Things settle and hold a bit. The scalar EG charge increases. Finally the "shutdown" reactor starts to increase in radioactivity again. The control rods can't handle it. Everything is heating up, including the graphite moderator. Back at the transmitter, the emergency circuits finally are overwhelmed and give in. They fail all at once. The dreaded "uncontrolled short circuit" now exists between the collapsing standing wave and the earth. A gigantic discharge of EGP into the earth occurs at the

transmitter site.

In the desperate reactor, suddenly a great EGP appears. Instantly the uranium goes intensely radioactive. A gigantic pressure of heat, steam, graphite and radioactive materials bursts out of the reactor, breaching the building and erupting violently into the atmosphere. The core melts down. The graphite moderator ignites. You've got the realization of the nuclear engineer's worst fears: core meltdown and reactor out of control. It's afire and spewing deadly radioactivity out by the gobs. And the heat! It's like hell itself opened up for business in this spot.

At any rate, something very similar to that seems to have happened at Chernobyl.

This author believes something similar happened in 1957 in the Southern Urals. (See Zhores A. Medvedev, Nuclear Disaster in the Urals, Translated by George Saunders, W. W. Norton & Co., 1979, p. 150.). In the Kyshtym area, an explosion of nuclear wastes stored underground occurred in the winter of 1957-58. The area for miles around was contaminated, and is still contaminated to this day.

Recall, Khrushchev spoke of a fantastic weapon in development in January 1960. Early prototypes of the weapon would have been in development and testing in 1957. Probably at that time there were no emergency control circuits to handle standing wave collapse, or only primitive circuits at best.

If the failure of a transmitter occurred in full-power experiments, the unrestrained collapse of the standing scalar EM wave would most certainly have produced a large EGP in the ground, and instantly activated the nuclear wastes stored nearby. Eyewitness accounts reportedly stated that the wastes exploded, and that is totally consistent with our thesis. It is in fact a scalar EM accident signature.

Any nuclear facility at all is an incredible and monstrous risk whenever scalar EM weapons are active.

Of course, one's nuclear facilities are at risk if one's enemy has scalar EM weapons and fires at them, as we covered earlier in this book.

However, they are at terrible risk even from one's own scalar EM weapons. The consequences ot a relatively simple electronic failure can be catastrophic; not only for the local nation, but for the earth as a whole.

To show what we mean:

Suppose a similar scalar EM accident -- such as seems possibly to have happened at Chernobyl -- occurs at some other giant Soviet "radar" facility. Further, suppose this particular transmitter is not too many tens of kilometers away from a Soviet missile silo complex. Just to really throw in the grit, suppose these missiles are the "big monsters" with--- say -- a 50 megaton warhead in each missile. Suppose there are 10 of them in the complex.

Let's say this accident occurs "catastrophically" -- that is, the emergency control circuits are

overwhelmed immediately and a discharge of all the scalar energy begins at once.

A giant EGP strikes the earth, spreads in all directions, and strikes the waiting monster missiles. In their implosion trigger warheads and in their fissionable and fusionable payload, everything goes at once. Actually, it goes better than when normally triggered. So each one goes at about 100 megatons.

You've just had a monstrous 1,000 megatons of nuclear explosion in the earth. You get a giant earthquake. If it's not too far from the ocean, you get a tidal wave also. You get incredible amounts of lethal dirt and debris, radioactive and deadly, hurled violently into the air.

This is just about the equivalent of a "normal all-out nuclear war!"

And what about the other side's detection and early warning systems? Who's going to alert whom, and for what? How many missiles get launched?

I think you see the point.

And I haven't even covered what a giant EGP can do to humans. If it's truly a catastrophic failure, you can get an EGP that can wipe out half a mighty nation in one burst!

And if the discharge happens to tickle the Sun and Moon's feedback loops the wrong way, you'll get convulsions of the earth, mighty burps of the sun raining fire and brimstone on the earth, and a violent increase in the interior heat of the earth's molten core, with a concomitant eruption of that core right up though the mantle.

In other words, it could be "back to the beginning" for the earth, and start all over -- if, that is, some semblance of an earth survived.

The Soviets know full well the implications of their giant scalar EM weapons. (Remember, I estimate they have over a hundred of these monsters, based on Frank Golden's detection of their full-up exercise in April/May 1985.).

Scalar EM weapons have added a totally new dimension to the meaning of the word "terror". If one develops them and his adversary does not, nothing on earth can stand against them. So in Man's present state, the temptation to develop them is nearly irresistible.

On the other hand, if one's adversary already has developed them, one is already totally defeated unless one also develops them. Again, the need to develop them is imperative.

Yet, whenever one activates a large scalar EM weapon, one immediately places the entire earth in deadly peril. The slightest misstep, and it's curtains for everyone. And it's curtains for the earth as well.

So one is damned if one does, and damned if one does not.

We have reached the final turning point in human history. The clock is ticking away the last years -- or days -- of the lives of all humans on earth. There has never been such a threat.

We simply have come to the crossroads. somehow, all Mankind has to change.

Infatuated with the thirst for ultimate power, we are facing two doors. Behind one is a beautiful lady, and the fulfillment of all man's dreams: control of physical reality itself. Behind the other is the deadliest tiger ever dreamed of in our wildest nightmares.

Which is it to be, the lady or the tiger?

SCALAR EM INOCULATION AND ITS IMPLICATIONS

My appreciation goes to Gary North for his openly sharing the above important information with the public. Human nature being what it is, one or more of his more dire scenarios is going to happen sooner or later.

The problem becomes enormously more compounded if the hostile agent or agents possesses sophisticated scalar EM technology.

With scalar technology, there exists the potential that the worm or virus can be implanted from a distance. If scalar scanning devices of sufficient precision can be developed, then major software residing in a chip, a computer, or on a disk can be read from a distance. With scalar EM methods, the ordinary software "guards" are totally ineffective. The scalar "reader" could simply read off the software directly as the disk or device goes about its normal operations.

After the software is read, a germ or a virus is designed to produce a particular problem as desired and upon special stimulus. Then a scalar "imprinter" device is used to produce the necessary digital pulses directly upon the media in which the software resides. The required code has now been .implanted. In effect, the operating system has been injected from a distance, and contaminated with the desired "sleeping agent" -- germ or virus. From there on, it's just like Gary North's scenarios.

So the scalar EM technology can probably be used (at least eventually) to place "mines" in systems in advance, for damage or destruction at a future date. At least it's possible in principle.

However, it's not the injection of computers and equipment that bothers me. It's the injection of human beings. Here's generally how it can be done (and possibly is being done).

Basically, human brains have various rhythmic waves which represent "envelope pulsations" of the entire electrical system. However, it is not the EM force fields represented by these pulsations which are important: it is the summed-zero (scalar) patterning of the entire complex of neuron firings which represents the real activity of the brain -- and represents it thoughts and emotions. A storage system for these patternings exists, but it's a scalar pattern storage, not an E and B field storage. The storage system is in the nuclei of the tissues of the nervous system itself, not in electrical or electrochemical potentials.

At any rate, the human brain rhythms are also "riding along" relatively entrained to the Schumann resonance of the earth's magnetic field. So all the patterning of the brain is grouped together into giant overall orders, and one or more of these is normally synchronized to our natural environment.

If a varying magnetic signal of extremely low frequency -- say 10 hertz -- bombards the brain with greater power than the earth's magnetic field, it is possible for the brain's rhythm to be "forcibly entrained" to synchronize with that signal, rather than with the normal Schumann resonance. If a large number of brains are forcibly entrained to such a signal, and the signal is artificial, then a master coherent phasing of all the brains to the transmitted signal has been accomplished.

And that can be utilized -- and is utilized -- by the Soviet Union. On the Woodpecker signals, Bob Beck has detected up to 16 carriers, each with a 10 Hertz modulation, and with all the 10 Hz modulations in phase.

Let's stress what we're saying here. At times, the Woodpecker signals have shown 16 carrier frequencies which contain the same 10 Hertz modulation, and which are all kept coherently sync-locked.

If those signals and the modulations are strong enough, the brains in a targeted area demodulate the 10 Hertz signal and phase-lock to it -- actually, to them. At that point, the brains are entrained to

a 10-Hertz driver, and 16 channels of multimegahertz frequencies are locked-in to the brain.

Now if the Soviets have broken the genetic code of the human brain (which they have) and succeeded in developing the ability to implant thoughts, emotions, pictures, etc. (which at least to a degree they have), then they can simply record the proper signals from human guinea pigs, using scalar technology and instrumentation. They can tailor those signals and add them onto the Woodpecker carriers, using scalar EM techniques. By using most of the sixteen carriers as a means to express Fourier frequency expansions, specific areas and functions of the brain can be targeted.

Notice that the distant transmitters al ready "know" the correct phasing; just use the 10 Hertz modulation signal as a reference. In that case, phasing takes care of itself inside the captured human brains.

The brain has a unique characteristic. If a signal arises inside it, it interprets that it itself originated the signal. Thus for the first time in history , true unwitting "robot" actions and emotions can be engendered in masses of human beings.

But it's still worse. The Kaznacheyev experiments (see references) proved conclusively that electromagnetic signals can carry and transmit cellular disease and death patterns into a targeted biosystem. You can rest assured that the Soviets continued on to actually measure and determine a wide variety of death and disease scalar patterns. All of that can be added on to the Woodpecker carriers so that the population in the intersection grid area is devastated. One can even test it out in advance by producing a modified pattern of a disease in the targeted populace, and keeping the percentage of brains entrained down to a small level. This lowers the number of persons "injected" from a distance to a small percentage of the populace. Then the outbreak of the "new strain" of a familiar disease -- such as influenza, pneumonias, and something like AIDS -- can be monitored to provide targeting and effectiveness data. Notice that a series of diseases was experienced by U.S. personnel assigned to the U.S. Embassy in Moscow, probably as a result of the so-called "weak microwave radiation" of the Embassy by the Soviet Union.

But that's not all. Much more subtle effects can be produced in the targeted populace, without anyone getting wise. Cancers and leukemias should be relatively easy to induce. Also, the immune system can simply be attacked directly. If done slowly, a series of common, ordinary diseases will just seem to get "tougher and tougher to cure." Actually it's not the disease that got tougher, it is the immune systems that got weaker. It is my opinion that precisely that sort of testing -- against the immune system -- has been accomplished by the Soviet Union against the U.S. since about October, 1985. A great percentage of influenza patients during the period from then until now have had complications. So much so that multiple sessions -- as many as 3 to 5 -- of antibiotics are necessary before the patient recovers. At least in the Huntsville, Alabama "hinge pin" area, that seems to have been the case. This author personally experienced this, having influenza and follow-on complications for a period of seven months -- something quite different indeed for him.

But it's even worse.

The human scalar EM nervous system ("inside" the ordinary EM signals and functioning of the system) also has its own resident "software." It has special storage media contained in its brain. its cells, and its genetic material, and its actual nucleons. All of these storage media are continually telecommunicated with via scalar EM means. The "stability" of what each of us is, is largely conditioned by those recordings. As personalities we literally "are" what we have experienced, felt, thought, and did. Our whole "functioning conscious system" has been evolved by our experience, and it continues to be "us" by means of continual reference to the record base.

I hope you now realize that the actual record base itself can conceivably be altered by scalar electromagnetic means, even from a distance. Even by the hidden scalar EM content of 16

Woodpecker carriers, locked into a captured brain and pouring in their deadly content. It is conceivable that even what one is can be taken from him, and what someone decides he will be, he will be.

A totally new -- and ultimate -- form of "slavery" has emerged.

Also, look at all this scalar EM functioning of the human system as a special kind of cybernetics. A scalar EM computing software and hardware system.

What if scalar techniques are used to plant "worms" and "viruses" in this system? With hidden triggers? What about a series of them, so that a range of "eruptive software diseases" can be stimulated at will?

And guess what. Such scalar EM "worms" and "viruses" can even be induced by contact with or consumption of "contaminated" water and food. Or saliva. Or other body fluid.

So you can see the possibilities of "seeding" a population with a staggering variety of time-bombs.

I think you begin to see the point. Now you can change North's "Soviet blackmail" scenario drastically. In a new scenario, Gorbachev simply announces to Reagan that a graduated series of specific sweeping changes are going to happen in our population -- changes which we are absolutely powerless to stop. The last stages are various deaths. The master "trigger" for this series has already been initiated. Incidentally, the Soviet populace has been carefully "seeded" with the proper antidotes. The Russian leader demands certain things (very similar to what North's scenario utilized). Unless his demands are met, a "killer virus" will be activated by a special signal. If so, everyone dies. The first step change in the series will start to occur in a few hours. And it does.

In fact, this scenario could be added to North's scenario, and both used simultaneously. What do you think the President and the Congress would do? Or could do?

There are other even more diabolical possibilities, but these should be quite sufficient to illustrate the point.

Pandora's box has already been spilled, and the end of humanity is ticking away like a time-bomb. It's already nearly midnight, and the watchman hasn't even sounded the alarm yet.

I certainly can anticipate the next question: Have the Soviets already "seeded" the populations of the U.S. and other selected western nations with scalar EM viruses and germs"?

The answer is, I simply don't know. And just like Gary North, I don't know what if anything can be done about it if they have. This researcher certainly doesn't have all the answers. An immediate national crash program to develop scalar EM defenses is essential if we are not simply to be crushed beneath the hammer and sickle. It takes funding, people, facilities, and time.

In some 22 years of unrelenting struggle to convince the system we've got a terrible problem, I've hardly been able to move it off dead-center (no pun intended). This book, produced under extreme workload stress, is all I can do to raise the alarm. I've given it my very best shot.

What happens now remains to be seen. Other hands, hearts and minds are going to have to take up the task and carry it forward. This researcher has reached his limit, and has no more left to give.

1986 APPENDIX II

COMPUTER WORMS AND VIRUSES, AND THE IMPACT OF SCALAR EM

Source: - Gary North, "Electronic Aids (Parts 1 and 2)," Remnant Review, 12(20), Nov. 1, 1985, p. 1-8; 12(20), Nov. 15, 1985, p. 1-8. POB 8204, Fort Worth, TX 76124. Phone (817) 595-2691.

Annotation: - Two deliberately un-copyrighted issues to alert the public to software worms and viruses, and their implications for drastic interruption of society. Describes a hypothetical scenario in which drastic scrambling and destruction of banks' computer tapes, files, and records occur due to software worms and viruses. Written in first person by Gary North. [Slightly edited.]

Article: - "Worms." Earlier this year, I read a very interesting article on a major problem facing computer software (programs) development companies. A program comes on one or more 5.25-inch plastic discs. It takes only a few seconds to copy a program on one disc to a blank disc, which costs $3. Yet these programs normally run at least $250, and usually sell at $495, and sometimes cost thousands. Very few are less than $100. So you have a major temptation: make a $500 asset out of a S3 asset. Insert the $500 program into drive A, write "COPY A:*.*.B:" and hit the "enter key;" sixty seconds later, you have a $500 program in drive B.

There are ways to make this copying more difficult. The companies code the programs, and force you to have a control disc in drive A at all times. These "copy protected" programs are a hassle for users. We cannot put them on "hard (big) disc" easily, and sometimes the control disc dies for some reason. Then what? Your data are locked in your hard disc or on a floppy disc, but you can't get to the data because the control disc is not functioning. You order a replacement. Weeks go by.

Last year, several firms came up with a solution. It is called a worm. A worm is a command that is built deep into the complex code that creates the program itself. These are incredibly complex codes, and it is easy to bury a command in them. They cannot be traced.

What does the worm do? It "eats" things. Say that you are a software thief. You make a copy of a non-copy-protected disc, either to use on a second computer, or to give (or sell) to a friend. The program works just fine. But when the program is copied to a new disc, the worm is "awakened." It bides its time, maybe for many months, maybe for years. The program's user is blissfully unaware that a monster lurks inside his pirated program. He continues to enter data, make correlations, etc. He becomes completely dependent on the program.

Then, without warning, the worm strikes. Whole sections of the data disappear. Maybe the data storage disc is erased. Maybe it is just scrambled. Even his back-

up data discs have worms in them. Everything he entered on those discs is gone. Forever.

Can you imagine the consternation of the user? He has become dependent on a booby-trapped program. His business could simply disappear. For the savings of $500(stolenprogram),hecouldloseeverythinghehas.

Several firms threatened to insert worms into their programs. But then they backed off. They are afraid that lawsuits initiated against them might go against them in court. They could be hit for damages suffered by the thieving victims. Juries might decide that the punishment, a bankruptcy) was too much for the crime (a $500 theft).

So far, no worms are lurking in any commercial software programs — as far as I know and the industry knows, anyway. But what if a disgruntled programmer was to hide one in a master copy of, say, Lotus 1-2-3, the most popular business program on the market? What if ten thousand copies a month go out for, say, three years? Then, without warning, every company that has started using them loses three years of data? They sue Lotus. Lotus goes bankrupt paying lawyers. No company in the industry is willing to talk about this sabotage threat publicly. Obviously.

LARCENISTS

I just happened to stumble across an article on worms in a computer magazine. It occurred to me that it might be possible to use the worm technique as a form of deliberate sabotage rather than just as a copy protection device. But what did I know? I'm not a computer expert.

I know a computer expert, however. I mean, a real expert — one of those people you occasionally read about. In the world of business, they're called "space cadets." They operate somewhere in between the asteroid belt and Jupiter. But this one is different. He's a businessman, too.

I got him to sit down with me to discuss the problem of worms. It turned out that he has a real fascination for the topic. He tells me that there are advanced design worms, called 'viruses' by 'hackers' — computer freak programming geniuses. "The software virus is the most terrifying thing I've ever come across," he told me. And then he showed me why. My initial scenario is based on only a portion of his estimation of the threat. It gets a lot worse.

He gave me a 90-minute FIRESTORM CHAT interview. He must remain anonymous. He used to be a software developer for programs that were used in the U.S. banking system, but is now employed in a highly sensitive job in a related industry. Therein lies his problem. If he were to tell the story of what he is capable of doing to these banks, his firm might lose a lot of sales. He can't "go public." Let's call him Tom.

Let me summarize briefly some of the details he gave to me. They floored me. They're going to floor you.

(1) Jackpotting. The rush is on in the banking world to get automated teller machines (ATM's) into shopping malls, supermarkets, and in front of every bank. We've all seen them. Just walk up, punch in your card number, ask for cash, and you get it.

In a busy location, one of these machines can hold as much as $250,000 in cash, mostly small bills. These machines are controlled by computer. They are hooked up to the bank's computer system, usually by phone lines. This local line, Tom tells me, is what computer freaks call THE LOOP. The loop is wide open to tampering. He says that what computer thieves are doing is to hook up a cheap Apple II computer, tie into the phone lines, break into the ATM, and get it to empty itself. This is "jackpotting."

He tells me that ATM thieves are hitting banks continually, but nothing is getting to the press. The banks have yet to show a profit with the ATM's so far, which is understandable. They are hoping to get their machines placed in key locations, so "market share" is crucial to their plans. They are suffering horrendous losses in the short run in the hope that long-run profits will pay off, if and when a defense is developed.

The banks are saying nothing because of their fear that if the extent of the losses gets into the press, they will be forced by pressure from depositors — bank runs — to cancel the ATM's. The losses are horrendous, he says. At present, there is no known defense, given the communications technology.

(2) Rounding Off. This is the "preferred" computer bank theft system. Someone on the inside who has access to the software takes advantage of the banks' need to round off numbers. The programs carry numbers out to 13 places. Banks can't use all that space. So when they balance the books (interest rates at, say, 9.873), they just don't count every tenth of a cent. The program is assumed to round off the numbers randomly. What does the bank care? But the thief has set up bank accounts that absorb those random tenths or hundredths of a cent. In millions of dollars worth of transactions (federal funds, etc.), programmers in some cases have stashed away hundreds of thousands of dollars — maybe millions — over a few years. No one knows how much of this goes on.

How could a bank spot this? The books would always balance to the penny. How would the accountants ever know?

I think of a story that Adam Osborne tells in his paperback book, Running Wild. The president of a large firm was looking out his window one day, and he noticed two Rolls Royce cars parked next to each other. He inquired as to the owners. They were two men in the data processing department. He called in investigators, and the cars and the men disappeared. They fled to Brazil and took their cars with them; **Brazil** has no extradition treaty with the U.S. Years later, as

Osborne was writing the story, the firm still hadn't figured out what they had done.

ARSONISTS

These are the fearful ones, far more than the larcenists. These are the practical jokers who get into a major data bank and trash things. It's a kind of multimillion-dollar "Kilroy was here" graffitti.

How easy is it to get in? Incredibly easy. The boy in "War Games" really could have broken into most firms' telephone-connected computers. Computer programs exist that allow the user to hook up his computer to a phone line and randomly dial numbers until they hear the telltale whine of a computer line. It then notes the phone number and goes on its way, searching out more lines.

They can do it by long distance, free of charge. The telephone company has a tough time tracing those who use various sorts of electronic black boxes to call anywhere on earth at no charge. Some people get caught, of course. "The tip of the iceberg," says Tom.

How do they get in? Easy: few systems are protected, once you locate the line. If one is, he says, you create a deliberate error. Most programs then collapse the protective shell, and the hacker finds himself inside the heart of the system. Tom has designed a program that keeps this from happening to his company's programs, but few companies have anything like it.

It's very easy to get in if someone has "logged on," — opened his terminal's connection to the main computer — if the system is connected to phone lines. Or anyone in the company can just tap in, if someone has left his desk and left the computer on. It's common to forget and leave an open terminal.

He showed me. He says anyone can get fired for leaving a computer on. He demonstrated his point. With 40 computers on line, he ran a quick search and found two of them "logged on," despite the fact that it was after hours. All the security in the world can't do anything if a computer line is open. It's like a burglar alarm; it's worthless if you leave the door unlocked or leave the keys lying around. That janitor you hired. Is he a computer illiterate? Or a plant?

Once inside, what can you do? Steal a fortune? Yes, if you really know the system. He told me he could easily steal $3 million from a local bank, even as an outsider. He would then offer to give it back and keep his mouth shut about how easy it was if the bank would pay him 10% the take. He thinks most banks would capitulate for fear of the publicity. In any case, he knows that he probably wouldn't get caught.

How about creating a new identity? The grade-changing scene in "War Games" is true. You could even create a new identity, give yourself high grades in any academic discipline, just by breaking into a university's database. There is very little security here, he says.

But for sheer vindictiveness, for sheer envy, consider the possibilities of a virus-implanter. He gets inside the computer for a major communications link: telephones, large information database, bank wire transfer, or whatever. Then he lays the egg: a tiny, untraceable brief instruction. Inside a huge database are just a few characters. These float inside a system, seeking to devour certain kinds of data, or executing certain routines.

There is a game played by computer freaks called "Core War." They try to implant these killer messages, which seek out each other and battle one another. If you find one morning that yours has been consumed, you lost the battle. That was probably the origin of worms and viruses.

TERRORISM

Say that a revolutionary terrorist group, or some anti-zionist group gets a "ringer" into a system. He might be a computer genius type. Everyone knows they are either oriental, dark-skinned people with accents, or teenagers. The firms don't hire teenagers, but they hire a lot of foreigners. They may even check the guy's credentials. Electronic credentials. (Ha!) Then they turn the guy loose in the system.

The virus is implanted deep inside the system. It can then be transferred to any other bank's computer by means of EFT (electronic funds transfer). Maybe it is triggered when someone with a peculiar name and address opens a bank account. Three days later: Bam! The data disappear. They haul out the back-up tapes. Bam! The virus is on them, too. It is a process of infection, contamination, and incubation. There is no known defense. Not yet. This is the bottom line.

ANTIBODIES

The designer of a virus can also design an "antibody." The antibody is a counter-virus agent that seeks out a virus and destroys it. But like other antibodies, it must be specific. The only way today that an antibody system can be created is to know what kind of a virus is involved beforehand.

Tom says that people are now selling antibodies at very high prices. Who is paying? Big companies that suspect that there is a virus present in their computers. In all probability, the guy selling the antibody created and injected the virus. But now can any businessman prove it? So he pays the blackmail.

NATIONAL DEFENSE

A Soviet agent or American spy working for the Soviets penetrates any of a dozen computers used by the military. He plants a virus. The computers talk to each other, and the virus spreads to all of them. It tells them to execute a certain routine when a certain command is entered at a missile-controlling terminal. That command might interfere with a routine that activates a missile or launches it. Upon reading that command, the virus shuts down the computer, or scrambles

the executing program, or scrambles the data. No more "launch on warning." No more launch at all. Dead metal.

Scenario: The President of the United States receives a telephone call on the "red phone" — the direct link to Moscow. He lifts the receiver and says, "Hello."

"Mr. President, this is Michael Gorbachev. You must recognize my voice. I have very little time. I will come directly to the point. You have refused to back down on your threat to implement your Strategic Defense Initiative. You intend to go ahead with space-based weapons. My military staff informs me that they think that the United States has the technology to implement it, and that it could place my nation's military strategy in jeopardy. We cannot allow you to do this.

"If we allow you to deploy the SDI, it will be too late for us to respond effectively. Therefore, we are taking the initiative today. I issued orders this morning to put Soviet military units on immediate alert. We are abiding by your biblical rule to announce the initiation of hostilities before striking. Neither the Japanese nor the Germans gave us this courtesy. If you do not come to terms with us, we will launch a first strike against your nation in three hours. We will delay for one day, if you agree to follow a precise procedure that I will outline shortly.

"At one time we feared nuclear retaliation. We no longer do. Within two hours, you will know why not. I suggest that you instruct your ballistic missile team to prepare your missiles for a strike. Then, to prove to yourself that we no longer are concerned about retaliation, launch one or two of them. As far as I am concerned, launch all of them. But please instruct your senior military commanders to report back to you concerning the effects of their instruction. I suggest that you try launching three or four as a test. We don't care which ones.

"Mr. President, let me tell you what is going to happen. As soon as anyone attempts to launch a missile, that missile's computer guidance system will shut down. It will lock up tight, and you will not be able to unlock it within the time you need to respond to our attack. Two hours and thirty minutes from now, your nation will have no remaining Minuteman III missiles to respond with, should you finally unlock your frozen computers.

"I suggest that you contact your senior officers now. You will have to mobilize them within 60 minutes. The test should take about 30 minutes. I will telephone you again in 90 minutes to present our terms of surrender." Click.

The President calls the Joint Chiefs. If he is lucky, he will be able to locate two of the three in time. They will be paralyzed. Who wouldn't be? But in all likelihood, they will at least test Gorbachev's theory. They will order one or (wo missiles launched. The computer guidance system on both will shut down the system. They will try two or three more, with the same result. They will attempt to launch one from a submarine, with the same result.

The President brings in senior Congressional officials and the remaining Joint Chiefs member to the White House.

Exactly 90 minutes after he had hung up, Gorbachev telephones back. He presents his list of demands. First, the immediate removal of U.S. troops from Europe. Second, the withdrawal of personnel from Diego Garcia Island in the Indian Ocean. Third, the breaking of diplomatic relations with Red China and Taiwan. Fourth, the removal of all U.S. troops from Korea. Fifth, a moratorium on all debts owed to U.S. banks by the Soviet Union and its client states. Sixth, the removal of all Minuteman III missiles from their silos. Seventh, the return of all U.S. submarines to port. If he agrees, and the orders are delivered within two hours, the Soviet Union will delay launching a first strike. The President complies.

They might do it with our communications satellites, Tom says. You might do it with any aspect of U.S. data transmission. The virus could sit dormant in a system for years, and no one would know. Triggered, it would then strike.

THE WEST'S VULNERABILITY

The West has become increasingly dependent on computers. We can no longer function without them. The Third world hasn't. Neither has the U.S.S.R. Their technology is still pre-computer. They are inefficient, but they are far less vulnerable.

Tom says that the world of computers presumes that almost everyone is essentially honest, and that all the brightest programmers must be honest. They aren't. Thus, the members of the entire system — banks, national defense, large and small businesses, public utilities — have opened themselves to attack. The attackers are invisible.

"Nothing I have seen in all my years of computers scares me as much as this does," he says. "The system has been designed in terms of a far older set of standards, especially with respect to security. It is totally vulnerable."

He compares it to plague, or venereal disease. People copy each other's software to save a few bucks. They use public access databases. They use "loops" — the phone lines. Yet these transmission belts of information can become transmission belts of collapse.

This is what I have harped on for twenty years: the potential for a collapse of the division of labor. We become rich by means of a brilliant technology, yet we become dependent on it to an extent that no previous society ever has.

Centralized institutions are most vulnerable, but because we use public transmission lines, from microwave transmissions to cables in the ground, each local unit is vulnerable. Those who would choose to bring down the system need only plant electronic viruses in a handful of major common-use databases or transmission sources, and live years or ten years later, the disease hits.

It could bring down the system if technological defenses are not developed. Nothing on the immediate horizon points to a solution, he says. The silence of those who should know what to do indicates that they don't know what to do, but they don't want panic to spread.

Is this fantasy? Last summer a 23-person team broke in (by phone) to Chase Manhattan Bank's computer.

Break-in: - Continuation of part 1, a treatise on worms and viruses in cybernetic systems.

"Maybe you saw the article buried somewhere in your newspaper. I saw it in the New York Times (Oct. 19):

> "A group of at least 23 teen-age computer users broke into a Chase Manhattan Bank computer installation by telephone in July and August and "significantly damaged" bank records, the Federal Bureau of Investigation said yesterday.
>
> Chase officials insisted that no money was stolen or transferred out of customer accounts as a result of the break-ins, and said no intrusions have been detected recently. But Federal officials, in an affidavit, said that in several cases the youths changed passwords, preventing customers — and in one case a unit of the bank itself — from gaining access to their own computer files."

And where were these teen-agers located? In San Diego, across the continent! It gets even more ludicrous:

Federal officials said that most of the offenders were probably too young to be prosecuted.

Robert D. Rose, the assistant United States Attorney handling the case, said: "We're not yet sure what we are going to do. But these things can get out of hand — it did get out of hand — and we have to treat them seriously."

Treat what seriously! "These things?" What things? If they can't legally treat the electronic trespassers seriously, just what is the man talking about? He is talking about the topic, above all topics, that bank and government officials don't want to face: the vulnerability of their computer records.

I have seen no follow-up on this story in the conventional press. A brief article did appear in the computer-oriented tabloid, Info World (Oct. 28). It turns out that the students had broken into the fifes of Interactive Data Corp. of Waltham, Massachusetts, which maintains the bank's financial records. The break-ins were discovered in late July. They had obtained the toll-free 800 number which was restricted (Ha!) to Interactive Data subscribers. As late as October 9, an illegal entry was observed. In short, it took ten weeks after the break-ins were discovered to put a stop to them.

The response of the bank's bureaucracy was predictable. It will ever be thus: "Bank officials are claiming that the FBI exaggerated the nature of the activities of the suspected individuals. A spokesperson for Chase Manhattan said that Interactive's customers were not prevented from accessing their accounts and that none of Interactive's data was altered or manipulated in any way." In response, FBI supervisory agent John Kelso said that the FBI has sworn affidavits from bank officials that say data has been manipulated or damaged. "That sounds pretty serious to me," he volunteered.

Here is the capper: Interactive Data has 25,000 subscribers who are tied into that toll-free phone line. Try keeping tight security on a system with 25,000 users. Chase Manhattan couldn't. If they can't, who can?

And if Chase Manhattan Bank was vulnerable to 23 teenagers who are too young to prosecute, consider its vulnerability to just one envy driven genius who knows all about electronic viruses. The students that did this were apparently just goofing around. But what if just one malevolent computer freak decided to "get even" with Chase Manhattan? What if he had phoned in just once or twice, implanted a long-dormant data-killing virus, and quit? What if he had tied its detonation to, say, a calendar clock in the Interactive computer? If it took security forces from July until early October 15 to raid the 23 students' homes, they would never have spotted one break-in. They could not have traced it, either. Conclusion: we have a risk-free opportunity for electronic arson. We face a potential electronic epidemic. And when I say "we" I mean the entire financial system of the West.

Sure, all the bank "spokespersons" in the world will tell you, "No problem." But there is a problem. A horrendous problem.

At this point, it really gets interesting. Chase Manhattan Bank has just announced that we will be able to set up our own personal electronic banking facilities with them by buying an expanded version of *Managing Your Money*, Andrew Tobias' home financial management.

Citicorp and Bank of America have opted for *Dollars and Sense* a rival program. You will be able to pay monthly bills electronically, balance your "checkbook," monitor your net worth, buy and sell stocks, etc., etc., just by dialing Citicorp or Chase Manhattan. Fantastic! But despite all the assurances, I get nervous. Yes, I know no one will be able to break in and tamper with the numbers. But 23 teenagers shouldn't have been able to do it, either. And now we're talking about a lot more subscribers than 25,000.

Obviously, the master program used by the banks will prohibit easy entry. Unfortunately, someone has to write the program. Can you imagine the blackmail possibilities? Some hotshot programmer could build-in a bomb, and then threaten to detonate it. In fact, he could merely pretend to have inserted a virus. Who would want to call his bluff? Not Chase Manhattan, I would bet.

CORE WARS REVISITED

In May of 1984, A. K. Dewdney published an article in Scientific American's "Computer Recreations" column. It was a light-hearted-piece on how computer experts can get involved in playing this exciting game of "blow up your opponent's defenses." You know: recreation! In the March 1985 issue, he wrote a follow-up. It begins:

"When the column about Core War appeared last may, it had not occurred to me how serious a topic I was raising. My descriptions of machine-language programs, moving about in memory and trying to destroy each other, struck a resonant chord. According to many readers, whose stories I shall tell, there are abundant examples of worms, viruses and other software creatures living in every conceivable computing environment. *Some of the possibilities are so horrifying that I hesitate to set them down at all.*"(emphasis added.)

It turns out that tne French nave been enjoying a novel on the international implications, *Softwar: La Guerre Douce,* by Breton and Beneich. A translation is scheduled for publication here by Holt, Rinehart & Winston. The study revolves around the sale of a high-power computer to the Soviet Union. The U.S. allows its export because it has a "software bomb" in it. When the U.S. Weather Service announces a certain temperature at St. Thomas in the Yirgin Islands, the program proceeds to subvert every piece of software in the Soviet Union.

A pair of Italian programmers was "inspired" by the translation of Dewdney's original article to dream up a virus (a virus is a computer-to-computer killer, whereas a worm is resident in one man's computer). They figured out that by infecting a disk operating system disk (these start computers and tell them what to do with programs and electronics), and then installing it on disks used by the biggest computer shop in the city, they could create an epidemic. They decided not to do it. In short, the only restraint is self-restraint.

A high school student in Pittsburg wrote a virus that was subtler than a data-destroying virus, which at least tells us that we have a problem. His virus created a plague of very subtle errors in the disk operating system. "All of this seems pretty juvenile," he wrote, but "Oh woe to me! I have never been able to get rid of my electronic plague. It infested all of my disks, and all of my friends' disks." He wrote a program to destroy the virus (an "antidote" to it) but it is not anywhere near as effective as the virus is.

Warning: do not copy disks from your friends' copies. This act of piracy could cost you plenty.

A COMMERCIAL WORM

Just a few days after I wrote "Electronic AIDS, Part 1," 1 read a column in the Washington Times, the conservative (Moonie-owned) daily newspaper. One of the reporters has a computer. He had purchased a newly released program from

Microsoft Co., called "Access." Understand that Microsoft supplies the disk operating system that is used by the IBM PC, the most popular microcomputer. In other words, this is no backyard company. It is one of the two or three software giants in the U.S. (Its owner is under age 30, which tells you something about who is pioneering the microcomputer revolution).

As he was setting up his computer to take advantage of this telecommunications program, a warning flashed on his screen: "The weed of crime bears bitter fruit. Now trashing your program disk." Wham! He lost all his files — probably a couple of year's worth of work. Sure, he was probably smart enough to have made back-up copies, but think of the risk. And what if it had been a worm that kept silent for a few years, infecting all of his back-up disks?

He called Microsoft, and they gave him the runaround. They told him that they were not responsible. Some programmer had put in the worm in order to zap program pirates, but the journalist insisted that he was an original buyer. Tough luck, they told him. Obviously, they didn't know that he was a reporter.

Then he published his article. All of a sudden, the victim was not some average buyer. He was big trouble. Things started moving. InfoWorld (Oct. 28) reports that Microsoft has admitted that a programmer put in the worm, but without permission. The offending text has now been removed, we are assured. But what if it had sat in the master for three years? Here is the premier firm in the software.

This is not idle speculation. It has already happened, verifying my hypothetical scenario within a few days after I published it.

Can you imagine the absolute havoc that a dormant worm or virus could create if it were imbedded in all updates of Microsoft's masters of PC DOS and MS DOS, the operating systems for all IBM microcomputers and IBM-compatible microcomputers? It could cost the U.S. economy billions, and some microcomputer-dependent firms wouldn't survive. Any Microsoft spokesman who says, "It's impossible; it could never happen," has to explain how it already did happen to "Access."

ADAM OSBORNE'S WARNING

You may know the name Adam Osborne. He invented the revolutionary portable computer, the Osborne 1. Before there was an Osborne 2, the company went bankrupt. Compaq, the most successful first-year firm in U.S. history (over $100 million in sales in its 12 months of operations) and others built imitations that were far superior.

That isn't my point, however. Adam Osborne was "present at the creation" of the microcomputer industry. He created Osborne publications, and then sold out to McGraw Hill. He knows what is going on. In his delightful paperback book, Running Wild, which is a history of the microcomputer (desk top) revolution,

1975-82, he offers this warning. He says that three areas should not be allowed to be computerized: 1) bank money transfers; 2) the stock market; 3) elections.

All three are just about fully computerized. Another ten years, or maybe five, and they will be 100% computerized. Several firms allow microcomputer buying and selling of stocks (e.g., Charles Schwab), and New York Stock Exchange floor transactions eventually will be fully computerized, at which time it will be pressured to get rid of the "specialists" who make (and sometimes manipulate) the market, short-term — Richard Ney's hated "Wall Street Gang" — but the price of getting rid of them may turn out to be horrendously high.

"The great fortunes of the 21st century," Osborne predicts, "will be the legacies of the great computer thieves of the 20th."

Three years ago, I used a firm to supply computer services I needed. The head of it was a former businessman, quite young, and a true "space cadet." I've quoted him in the last issue. I call him Tom. He operated in a world far removed mentally from the rest of us. He is a nice fellow, a Christian, and a moral philosopher of sorts.

He ran the operations of the local elections. He did it fairly inexpensively. He told me why: "I want to keep these elections honest. It would be incredibly simple to rig the program to produce whatever outcome I wanted in close races. If I can do it, anyone with enough skill to set up the system could do it."

I asked him if he thought Osborne was correct in his predictions about bank theft. "It would be a piece of cake for me to steal three or four million from any local bank. I could go in the next week, offer to give the money back, keep 10% as a finder's fee, and promise not to tell the press how easy it was to steal. They would probably pay me my 10% just to keep me quiet."

Look, These people are geniuses. Worse, they are geniuses in a very narrow field technically, which is now being used to control darned near everything. This unique intellectual-technical skill is the possession of literally a handful of people, mostly under 35 years of age. They are "fooling around" with Chase Manhattan Bank's computers. What happens when a few of them stop fooling around and get deadly serious?

Computer program designers keep telling us that there is no 100% secure way to defend data banks. Maybe there will be a 98% secure system someday, but not now. To defend itself, the system relies on the integrity of youth. In short, self-government is the major defense.

And where have they learned self-discipline? In the public schools?

"NOW YOU'VE DONE IT!"

About four years ago, I read an article in the *Rolling Stone,* the tabloid aimed at rock music fans. It was the only article I ever read in that periodical. It was a gem.

It described a subculture of students at Stanford University, "hackers." These people are computer freaks. The mainframe computer at Stanford was cheaper to use after midnight, so from midnight to 6 a.m., the hackers gathered at their terminals. They lived on candy bars, junk food, and high-technology dreams.

One of the games they played was breaking into each other's programs. It was considered the mark of a master hacker to be able to crack another hacker's defenses. They would spend hours trying. They were "hacker-crackers."

One bright fellow then designed a classic booby trap. He wrote a program that warned trespassers not to tamper with it. This, of course, alerted every would-be electronic safe cracker to the challenge. It was a complex program, and it took days to crack it. Then, after repeated warnings, the successful trespasser got a surprise. Japanese letters appeared on his screen. Roughly translated, the words proclaimed, "Now you've done it!"

At that point, the victim's computer screen went blank. Then the names of all his own computer files appeared on the screen — files that may have taken years to assemble. One by one, they blipped off the screen. In horror, the victim would stare at the screen, unable to stop the process.

As it turned out, the booby trap was only a practical joke. It really didn't erase all the victim's files. It only listed the names, and then erased them. But for a horrifying few minutes, the victim wouldn't know this.

Hackers play games. Very interesting games.

The kind of people who spend six hours, midnight to 6 a.m., trying to break into each other's programs are different from the rest of us. Among their ranks are some highly individualistic people. Some of them are libertarians. I mean anarchists. They are electronic "don't tread on me" sorts of people. They do not appreciate bureaucracy. They appreciate being pushed around even less.

The folks at Chase Manhattan really do have a problem. Do you attempt to prosecute a legally un-prosecutable kid? A kid who has already cracked your computer system? I don't think you do. You play the role of stern but appreciative banker. "Son, I am impressed by your ability to break in. But understand, we are honest people. There is a code of honor here. You wouldn't want to break that code — of honor, I mean — would you?" Because if this kid gets angry, he can do it again. Quietly. And next time, he deposits a virus.

Of course, Chase may hire a programming team to create an unbreakable system. Sure. "Hire fox A. Give him chain link fence B. Hire him to build fence B around chicken coop C."

TEEN CHALLENGE

Suppose that the public gets wind of the threat to the whole banking system that is posed by viruses. What do the bankers (or anyone else) announce to the

public? "We want to assure you that our computer program is impenetrable. No one can break in. It is foolproof."

Here is the challenge — rather like the Stanford program that announced: "Do not trespass." These kids see breaking-in as a challenge, a kind of sport. They do not regard it as theft. They do not regard it as vandalism, even if it costs a company millions of dollars to unscramble. They may be ethical in other respects, but they think of "core wars" as a game.

How would you like to be the 60-year-old banker who doesn't know a byte from usury, but whose public relations department tells him to inform the public that nobody can crack his bank's code? To cite Mr. T in "Rocky III," that bank is dead meat. So are its depositors.

But if he keeps quiet, and the story still gets out about the vulnerability of the system, one or two small "virus-demolished" banks could trigger a collapse of the system, as people do the only smart thing: run for cash. The whole fractional reserve banking system would deflate; only the FED's printing presses could "save the day," in a wave of fiat money.

What I am saying is this: I think that we will see the end of fractional reserve banking in our day. At the very least, I think we will see it subjected to tremendous shocks. People will lose faith in electronic promises made by bureaucrats who do not know anything about the monsters that their efficient computers can be turned into.

Attack on Martinsburg. Now, let's take it a step farther. Some day some state or Federal bureaucrat is going to step on the toes of some genius entrepreneur who has created a software development firm. The bureaucrat will try to wrap this entrepreneur in red tape. Or maybe — just maybe — he will try to sock him with a tax bill that the entrepreneur regards as unfair.

In Martinsburg, West Virginia, there is a large computer. It is owned and operated by the Internal Revenue Service. Into it, over the next five years, the I.R.S. apparently intends to deposit all the records it can assemble on every U.S. taxpayer. This computer database will be the biggest in the world. It is the tool by which the I.R.S. hopes to increase taxpayer compliance. And it may succeed. For a while.

This is one reason for saving all letters to and from the I.R.S. If the I.R.S. becomes dependent on its computer system, which is likely, then any short-circuiting of its database could create havoc for tax collecting. If word gets out that a major failure has hit the I.R.S., the tax revolt could multiply overnight. You would see the deficit become astronomical. If the I.R.S. continues to tie its "voluntary" compliance program to the myth of the "all-seeing computer," then news of the computer's scrambling could backfire.

It is possible that the story of the I.R.S. database is a myth. Maybe they aren't going to build it. But if the public believes that such computer power is at the

disposal of the I.R.S., and taxpayers then learn either that the system has been blown, or that it was mythical from the start, the tax revolt could spread like an epidemic. The electronic epidemic-could trigger a tax revolt epidemic.

He who lives on the cutting edge of technology eventually dies on the cutting edge of technology.

"PEOPLE ARE BASICALLY GOOD"

Let's return to my taped interview with "Tom." In a 90-minute interview, we covered a lot of ground. But one topic that stands out in my mind is our discussion of the pre-supposition that goes into the creation of a computer-based society. The computer people have all adopted the assumption that undergirds modern science, namely that, participants are well meaning, that they will not fake their experiments, and that they will play fair. If scientists had to check every aspect of every article, science could not advance very fast.

What about the computer industry? The whole system rests on faith: "Men are not malevolent. They are not envy-driven. They will not deliberately seek to destroy the work of some random victim." Tom says categorically that this assumption is false. There are bad people with tremendous computer skills, and modern society has not restructured its economic institutions to protect itself.

Here is one example of a break-in technique. Someone phones in to a computer, which has been left open temporarily by some user. The lock is unlatched; he needs no key to get in. He then seeks to penetrate the inner core of the program, such as a bank's program. He creates a deliberate error, which all too often triggers a kind of electronic explosion. The protective shell self-destructs, and the invader now finds himself inside the system, where far fewer defense mechanisms exist.

Tom designed his own firm's defense against this tactic. His program automatically records the source of the error, and throws the user out of the program. The program has protection against deliberate errors, but most of them don't, he says. A major error simply collapses the program's outer shell.

In my previous issue, I speculated that a Soviet spy or agent could penetrate U.S. computers. Note: I did not assume that he would simply phone in; I assumed that a disloyal programmer, or a team, could plant the virus as insiders. From there, the virus would spread through the system through normal telecommunications. Several people have written in to tell me that a wrecker cannot destroy the system by penetrating it from the outside. They may be correct. But when informed that I am assuming an inside job by someone with access to a major computer, the critics have admitted that this might be possible.

The weed of crime bears bitter fruit: for honest, computer-dependent people.

FEDERAL FUNDS

The Federal Funds bank transfer lines allow banks to borrow money overnight. Hundreds of billions of dollars go across these lines every working day. The bank's computers communicate with each other by means of this telecommunications hook-up. What if someone were to plant a long-delay virus in the software that operates these transfers? And what banker has even thought about this problem?

What if this scenario was to take place: a virus triggers the disruption of bank records — not a total breakdown initially, but disruptions in the data? It might be weeks or months before auditors recognized the extent of the problem.

As rumors begin to leak out about complex accounting or other data-management problems of major banks all over the U.S. (including off-shore branches), the various banking regulatory agencies would be swamped with crises and outside rumors. Then, all at once, bank computers begin breaking down.

The rumors then explode. The lines appear in front of banks. The only answer at this point is to print up paper money. It would be printed by the hundreds of billions in order to offset the deflationary effects of bank runs (paper money that is pulled out but not re-deposited in another bank).

You could topple the fractional reserve banking system all over the world. The entire payments system could easily become engulfed in chaos. Debits and credits would no longer be meaningful. A pure paper money inflation would replace the manipulated, "fine-tuned" monetary inflation of modern central banking.

All of a sudden, market-created alternative currencies would be revived. It would then be metallic cash that talks loudest. Silver dimes are not electronic. "They can't be infected electronically." They still circulate when banks are "temporarily closed, due to circumstances beyond our control."

The loss of efficiency would be initially horrendous, I would guess. The division of labor would break down. You could then have the crash that lurks in the minds and suspicions of average depositors. Who says it cannot happen? A lot of public relations firms hired by the banks — computer illiterates in high places?

What we have is an internal bank money wire system that is totally vulnerable to some vindictive programmer. There is little doubt in my mind that the bankers are desperately fearful of this sort of vandalism. It could topple people's confidence in the fractional reserve banking system, and confidence is the only thing that keeps it going.

Conclusion. Technologically, there is no solution at this point. I have no heartening message. Maybe later; not now. Keep precious metal coins. Don't

assume that it can't happen here. It can. The only thing holding it back is the restraining hand of God, through the temporary self-restraint of a technological priesthood.

[Reviewer's comment: I was unaware of the problem of computer worms and viruses until I read Gary North's two articles. His open release of this important information is appreciated.]

SCALAR EM INNOCULATION AND ITS IMPLICATIONS

My appreciation goes to Gary North for his openly sharing the above important information with the public. Human nature being what it is, one or more of his more dire scenarios is going to happen sooner or later.

The problem becomes enormously more compounded if the hostile agent or agents possesses sophisticated scalar EM technology.

With scalar technology, there exists the potential that the worm or virus can be implanted from a distance. If scalar-scanning devices of sufficient precision can be developed, then major software residing in a chip, a computer, or on a disk can be read from a distance. With scalar EM methods, the ordinary software "guards" are totally ineffective. The scalar "reader" could simply read off the software directly as the disk or device goes about its normal operations.

After the software is read, a germ or a virus is designed to produce a particular problem as desired and upon special stimulus. Then a scalar "imprinter" device is used to produce the necessary digital pulses directly upon the media in which the software resides. The required code has now been implanted. In effect, the operating system has been injected from a distance, and contaminated with the desired "sleeping agent" — germ or virus. From there on, it's just like Gary North's scenarios.

So the scalar EM technology can probably be used (at least eventually) to place "mines" in systems in advance, for damage or destruction at a future date. At least it's possible in principle.

However, it's not the injection of computers and equipment that bothers me. It's the injection of human beings. Here's generally how it can be done (and possibly is being done).

Basically, human brains have various rhythmic waves, which represent "envelope pulsations" of the entire electrical system. However, it is not the Et, force fields represented by these pulsations which are important: it is the summed-zero (scalar) patterning of the entire complex of neuron firings which represents the real activity of the brain — and represents its thoughts and emotions. A storage system for these patternings exists, but it's a scalar pattern storage, not an E and B field storage. The storage system is in the nuclei of the tissues of the nervous system itself, not in electrical or electrochemical potentials.

At any rate, the human brain rhythms are also "riding along" relatively entrained to the Schumann resonance of the earth's magnetic field. So all the patterning of the brain is grouped together into giant overall orders, and one or more of these is normally synchronized to our natural environment.

If a varying magnetic signal of extremely low frequency — say 10 hertz — bombards the brain with greater power than the earth's magnetic field, it is possible for the brain's rhythm to be "forcibly entrained" to synchronize with that signal, rather than with the normal Schumann resonance. If a large number of brains are forcibly entrained to such a signal, and the signal is artificial, then a nester coherent phasing of all the brains to the transmitted signal has been accomplished.

And that can be utilized — and is utilized — by the Soviet Union. On the Woodpecker signals, Bob Beck has detected up to 16 carriers, each with a 10-Hertz modulation, and with all the 10 Hz modulations in phase.

Let s stress what we're saying here. At times, the Woodpecker signals have shown 16 carrier frequencies that contain the same 10-Hertz modulation, and which are all kept coherently sync-locked.

If those signals and the modulations are strong enough, the brains in a targeted area demodulate the 10-Hertz signal and phase-lock to it — actually, to them. At that point, the brains are entrained to a 10-Hertz driver, and 16 channels of multimegahertz frequencies are locked-in to the brain.

Now, if the Soviets have broken the genetic code of the human brain (which they have) and succeeded in developing the ability to implant thoughts, emotions, pictures, etc. (which at least to a degree they have), then they can simply record the proper signals from human guinea pigs, using scalar technology and instrumentation.

They can tailor those signals and add them onto the Woodpecker carriers, using scalar EM techniques. By using most of the sixteen carriers as a means to express Fourier frequency expansions, specific areas and functions of the brain can be targeted.

"Notice that the distant transmitters already "know" the correct phasing, just use the 10 Hertz modulation signal as a reference. In that case, phasing takes care of itself inside the captured human brains.

The brain has a unique characteristic. If a signal arises inside it, it interprets that it itself originated the signal. Thus for the first time in history, true unwitting robot actions and emotions can be engendered in masses of human beings.

But it's still worse. The Kaznacheyev experiments (see references) proved conclusively that electromagnetic signals can carry and transmit cellular disease and death patterns into a targeted biosystem. You can rest assured that the Soviets continued on to actually measure and determine a wide variety of death

and disease scalar patterns. All of that can be added on to the Woodpecker carriers so that the population in the intersection grid area is devastated. One can even test it out in advance by producing a modified pattern of a disease in the targeted populace, and keeping the percentage of brains entrained down to a small level. This lowers the number of persons "injected" from a distance to a small percentage of the populace. Then the outbreak of the "new strain" of a familiar disease — such as influenza, pneumonia, and something like AIDS — can be monitored to provide targeting and effectiveness data. Notice that a series of diseases was experienced by U.S. personnel assigned to the U.S. Embassy in Moscow, probably as a result of the so-called "weak microwave radiation" of the Embassy by the Soviet Union.

But that's not all. Much more subtle effects can be produced in the targeted populace, without anyone getting wise. Cancers and leukemia should be relatively easy to induce. Also, the immune system can simply be attacked directly. If done slowly, a series of common, ordinary diseases will just seem to get "tougher and tougher to cure." Actually it's not the disease that got tougher, it is the immune systems that got weaker. It is my opinion that precisely that sort of testing — against the immune system — has been accomplished by the Soviet Union against the U.S. since about October 1985. A great percentage of influenza patients during the period from then until now have had complications. So much so that multiple sessions — as many as 3 to 5 — of antibiotics are necessary before the patient recovers. At least in the Huntsville, Alabama "hinge pin" area, that seems to have been the case. This author personally experienced this, having influenza and follow-on complications for a period of seven months — something quite different indeed for him.

But it's even worse.

The human scalar EM nervous system ("inside" the ordinary EM signals and functioning of the system) also has its own resident "software." It has special storage media contained in its brain, its cells, and its genetic material, and its actual nucleons. All of these storage media are continually telecommunicated with via scalar EM means. Those recordings, largely condition the "stability" of what each of us is. As personalities we literally "are" what we have experienced, felt, thought, and did. Our whole "functioning conscious system" has been evolved by our experience, and it continues to be "us" by means of continual reference to the record base.

I hope you now realize that the actual record base itself can conceivably be altered by scalar electromagnetic means, even from a distance. Even by the hidden scalar EM content of 16 Woodpecker carriers, rocked into a captured brain and pouring in their deadly content. It is conceivable that even what one is can be taken from him, and what someone decides he will be, he will be.

A totally new — **and** ultimate — form of "slavery" has emerged.

Also, look at all this scalar EM functioning of the human system as a special kind of cybernetics. A scalar EM computing software and hardware system.

What if scalar techniques are used to plant "worms" and "viruses" in this system? With hidden triggers? What about a series of them, so that a range of eruptive software diseases can be stimulated at will?

And guess what. Such scalar EM "worms" and "viruses" can even be induced by contact with or consumption of "contaminated" water and food. Or saliva. Or other body fluid.

So you can see the possibilities of "seeding" a population with a staggering variety of time-bombs.

I think you begin to see the point. Now you can change North's "Soviet blackmail" scenario drastically. In a new scenario, Gorbachev simply announces to Reagan that a graduated series of specific sweeping changes are going to happen in our population — changes which we are absolutely powerless to stop. The last stages are various deaths. The master "trigger" for this series has already been initiated. Incidentally, the Soviet populace has been carefully "seeded" with the proper antidotes. The Russian leader demands certain things (very similar to what North's scenario utilized). Unless his demands are met, a "killer virus" will be activated by a special signal. If so, everyone dies. The first step change in the series will start to occur in a few hours. And it does.

In fact, this scenario could be added to North's scenario, and both used simultaneously. What do you think the President and the Congress would do? Or could do?

There are other even more diabolical possibilities, but these should be quite sufficient to illustrate the point.

Pandora's box has already been spilled, and the end of humanity is ticking away like a time bomb. It's already nearly midnight, and the watchman hasn't even sounded the alarm yet.

I certainly can anticipate the next question: Have the Soviets already "seeded" the populations of the U.S. and other selected western nations with scalar EM viruses and germs7

The answer is, I simply don't know. And just like Gary North, I don't know what if anything can be done about it if they have. This researcher certainly doesn't have all the answers. An immediate national crash program to develop scalar EM defenses is essential if we are not simply to be crushed beneath the hammer and sickle. It takes funding, people, facilities, and time.

In some 22 years of unrelenting struggle to convince the system we've got a terrible problem, I've hardly been able to move it off dead-center (no pun intended). This book, produced under extreme workload stress, is all I can do to raise the alarm. I've given it my very best shot.

What happens now remains to be seen. Other hands, hearts and minds are going to have to take up the task and carry it forward. This researcher has reached his limit, and has no more left to give.

APPENDIX III: CONTINUING THE SCENARIO

On May 3, 1986 a stunning loss of a U.S. Delta rocket carrying a critically-needed weather satellite occurred. The rocket suffered a shutdown of its main engine during launch and began to veer off course, causing the range safety officer to destroy it.

The takeoff of the blue and white Delta "workhorse" from launch Pad A at Cape Canaveral at first appeared picture-perfect. About a minute later, six of the nine booster rockets were expended and the remaining three switched on. Shortly after that, the rocket seemed to lose power. The main liquid-fueled engine had suddenly shut down, with the three strap-on boosters still burning. The rocket then had no stability and started to slowly drift off course, creating an increasing angle of attack. Within a few seconds, the nose cone snapped off under the severe stress. The U.S. Air Force range safety officer then sent a destruct command to the stricken rocket, which exploded in a ball of flame.

The Delta, built by McDonnell Douglas, had previously piled up a continuous string of 43 successful launches. Since 1960, 177 launches have occurred, and the success rate has been 94%. The Delta is one of the most reliable rockets ever built.

The unexpected shutdown of the main engine was perplexing. At a news conference following the mishap, William Russell. NASA's Delta project manager. stated: "It was a very sharp shutdown. almost as if it were a command shutdown."

Preliminary data, such as turbine speed and temperatures in and around the engine, "all appeared to be very normal." Russell said.

It may well have been a "command shutdown," unknown to Bill Russell and his NASA engineers.

Preliminary runs of the videotapes of the incident, aired by the national TV news media, show that during liftoff, a mysterious light approached the rocket from below and from the side. rising and striking the vehicle. This light and its path are strongly reminiscent of the first anomalous "light streak and ball" photo taken by Bob Gladwin just prior to the shuttle launch on November 26, 1985.

Let' s suppose that on May 3 the Soviet scalar EM grid was in the launch Phase ABM system mode and was tracking the launch of the Delta rocket.

If the anomalous light that moved up and contacted the rocket was a small ball of continuous electromagnetic energy formed by a distant Soviet scalar EM howitzer, then the rocket's main engine control circuits would have received a sudden and continuous pulse of EM power. This would probably have shutdown the engine by an actual "command" signal, artificially delivered. *

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*Engineers have now determined that such a shorting of the engine circuitry occurred, causing engine shutdown.

Certainly such mysterious switching of satellite circuits has occurred before, probably due to Soviet scalar EM precision testing. For example, the British Ariel VI satellite has exhibited very strange anomalies in its command and control circuitry -- in fact, with very precise control switching

being exhibited as if from an external source.

Thus a very small scalar EM missile may have been utilized by the Soviets to disrupt the control circuits in the rocket. A resulting pulse of power in the engine shutdown command circuit could have "ordered" the shutdown of the main engine -- just as it appeared.

It remains to be seen whether or not the Soviets used a "marker beacon" associated with the disruption of the Delta launch. One news photograph seems to contain a suggestion of such a light, but the videotapes must be studied frame by frame before it can be ascertained exactly what if anything is really there.

If a marker beacon was not used, the distant Soviet operator could simply have "popped out" the continuous EM ball of energy, tracked it and the ascending rocket exhaust, and "joysticked" the scalar EM missile up into the rocket.

Analysis of this incident is continuing, so nothing is certain as we go to press.

However, if this incident was indeed another Soviet kill, then it will have served the Russians well. Much of the world's media attention will now be focused on NASA's launch difficulties, and away from the recent Chernobyl nuclear reactor disaster in the Soviet Union. It's bound to take some of the media pressure off the Soviets.

In addition, it further cripples the U.S. satellite program. Loss of this critical weather satellite payload seriously reduces U.S. weather monitoring capabilities.

Further, the U.S. space program now appears to be all but grounded by the Challenger, Titan, and Delta explosions. For example, it will require about 18 months for the U.S. to redesign the shuttle so that America's shuttle program can get going again. So things are delayed until summer of 1987 at the earliest.

Meanwhile, the Russians are set to grasp the lead in the space race. In 1985 they launched about 100 rockets, five times as many as the U.S. They have a shuttle program of their own, well underway, with a flight expected within months. Earlier this year, they launched Mir, a second generation space station; a U.S. version is still some eight years away.

Charles Vick, of Huntsville, Alabama's Space and Rocket Center, summed it up: "They have their standard military program, a shuttle program and the equivalent of an Apollo program, all within a 10-year period. It's awesome."

An experienced propagandist like Gorbachev certainly understands the advantages of a strong Soviet push into space, such as (1) military advantage, (2) national prestige, (3) scientific achievement, and (4) projecting an image in the world's news media that the Soviets are first in space exploration.

So the failure of the Delta rocket provides many benefits to the Soviet Union.

It also continues to exercise and demonstrate Soviet mastery of the skies over North America itself.

Meanwhile, two U.S. nuclear submarines have "inadvertently" run aground in the last month or so.

Gorbachev again seems disposed toward a summit meeting soon.

If it's held, the agenda may be quite different from the one President Reagan is prepared for.

The clock ticks on toward midnight.

2002 ENDNOTES

1. It is actually a unified field theory since the infolded electrodynamics inside all EM potentials, fields, and waves is utilized—and the internal electrodynamics forms spacetime curvatures and dynamics of those ST curvatures.

2. M. W. Evans, "0(3) Electrodynamics," *Modern Nonlinear Optics,* 2nd Edition, M. W. Evans (Ed.), Wiley, New York, 2001, Vol. 2, p. 79-267.

3. David J. Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of'Hidden' Variables, I and II." *Phys. Rev.,* 85(2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II); — "Quantum theory as an indication of a new order in physics." A:, *Found. Phys.,* Vol. 1, 1971, p. 359; B: "Implicate and explicate order in physical law," *Found. Phys.,* 3(2), 1973, p. 139-168.

4. Mendel Sachs, General *Relativity and Matter,* Reidel, 1982; — "Symmetry in Electrodynamics: from Special to General Relativity, Macro to Quantum Domains," *Modern Nonlinear Optics,* 2nd Edition, Wiley, New York, Vol. 2, p. 677-706.

5. M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," *J. New Energy,* 4(3), Winter 1999, p. 299-301 gives a basic mathematical expose of scalar interferometry.

6. James Clerk Maxwell, "A dynamical theory of the electromagnetic field," *Phil. Trans. Roy. Soc,* Vol. 155, 1865, p. 71, 459. Orally presented in 1864. This was Maxwell's definitive presentation of his theory, with 20 quaternion and quaternion-like equations in 20 unknowns. Also in *The Scientific Papers of James Clerk Maxwell,* edited by W. D. Niven, Dover, New York, 1952, Vol. 1, p. 526-604.

7. In T. E. Bearden, *Gravitobiology: A New Biophysics,* Cheniere Press, Santa Barbara, Ca. www.cheniere.org, 1991 we first exposed the quantum potential weapon and some of its uses and characteristics.

8. A negative energy EMP weapons strikes the target or target area with an extreme pulse of negative energy empty Dirac Sea 4-holes. As a result, the free electrons flowing in electrical currents in the struck target instantly disappear by re-absorption into the Dirac Sea. A living body struck by such a blast is totally and instantly dead in every smallest part, since all its brain and nervous system currents, cellular currents, etc. are instantly and totally extinguished. The Russians tested this weapon in the 1980s in their war in

Afghanistan, against two Afghan villages. I spent two hours in Washington D.C. with the then-representative of the Mujahedin to the U.S. Government, verifying the incidents and going over the exact characteristics of the instantaneous deaths of those villagers. With such a sudden death, the mind-body interconnection loop is instantly severed, so that the mind is instantly snapped loose from its connection to the body—hence my use of the term "MindSnapper." The struck body usually emits longitudinal EM waves for an extended period, so that vultures and other predators will not approach the bodies and eat them. All bacteria, viruses, etc. in the body are also killed instantly, and the body does not decay, even in 30 or 60 days.

9. As can be seen, the negative energy EMP weapon is an all-purpose weapon extremely effective against every kind of target: missiles, aircraft, communications, satellites, ships and particularly aircraft carriers, personnel, generators, power systems, the electronics of nuclear warheads, submarines, tanks and vehicles, and the electrical and electronic controls of any kind of machinery or equipment. Such weapons are the second most powerful weapons on earth. In the first part of 2002, a U.S. 2-carrier task force maneuvered in the South China Sea as a precautionary warning to the Chinese that we would defend Taiwan. Unknown to that fleet, tracking it and trained on it were the newly deployed Chinese negative energy EMP weapons, which could have destroyed the entire task force—everything in it—with a few shots in less than 10 minutes.

10. T. E. Bearden, *Energy from the Vacuum: Concepts and Principles*, Cheniere Press, Santa Barbara, CA, 2002. Chapters 1 and 2 give a deeper coverage of this and similar foundations principles.

11. As is well known, Russian theoreticians have always been the best nonlinear scientists on Earth, since the beginning. They still are.

12. See T. E. Bearden, "Giant Negentropy from the Common Dipole," *J. New Energy*, 5(1), Summer 2000, p. 11-23 for solution of the source charge problem. On DoE restricted website http://www.ott.doe.gov/electromagnetic/ and on www.cheniere.org. The problem of the source charge can be solved by treating (with the modern quantum field theory viewpoint) the "isolated" observable charge and its cluster of virtual charges of opposite sign as a composite dipole. Because of the broken symmetry of its opposite charges, any dipole or dipolarity continuously receives virtual energy from the seething vacuum, transduces it into real observable EM energy, and pours out observable photons in all directions at the speed of light. See also E. T. Whittaker, 1903, *ibid.* There is a scalar potential between the ends of each dipole. The scalar potential may be decomposed into a bidirectional set of longitudinal EM phase conjugate energy from the time dimension (from the imaginary plane) and outputs that EM energy in the real 3-space. 3-space conservation of energy flow

is violated, but 4-space conservation of energy flow is upheld. This rigorously follows from the discovery of broken symmetry of opposite charges in 1957—one of the types of asymmetry for which Lee and Yang received the Nobel Prize.

In classical electrodynamics, the charged particle itself is *assumed* to be the source of its own fields and potentials. In other words, the charge is implicitly considered to be *creating*—right out of nowhere—the Poynting energy flow it continuously pours out across the universe in all directions. That makes the charge a perpetual motion machine of the grossest kind, violating the maxim that energy can neither be created nor destroyed.

So the greatest perpetual motion advocates of all times are our own classical electrodynamicists and electrical engineering departments and professors who still ignore the active vacuum interaction that is missing from the classical model. They thereby ignore that the charge is a broken 3-symmetry in its violent exchange of virtual energy with the active vacuum, and merely organizes and emits in observable form a fraction of the energy it continuously receives from the imaginary plane (from the time domain). Yet, that broken symmetry has been known in particle physicists, both experimentally and theoretically, for 45 years.

When Maxwell wrote his theory, neither the electron, the atom, nor the nucleus had been discovered. There was no knowledge of the Drude electron gas, electron spin, etc. There was no knowledge of the nucleus of the atom, and even the atom itself was still contentious. A thin material ether (fluid) was believed to fill all space, so that no point in all the universe was empty of mass. Consequently, E and B were conceived as physical force fields in a material medium—the luminiferous ether. All Maxwell's equations—including the subset selected and modified by Heaviside that today are called "Maxwell's equations"—assume this material ether to this day.

Electricity was thought to be a "thin material electric fluid" running through wires like water through a pipe. The magnitude of the potential was not used; its reaction cross-section was calculated and erroneously used as its magnitude, as it is today (although a good electrodynamicist does know that it is only the *intensity* of the potential, not its magnitude).

Faraday believed that his "lines of force" were taut physical "strings" in this material ether, and that EM perturbations were the vibrations of these taut strings. As he clearly states in his 1873 *Treatise...*, Maxwell sought to capture Faraday's work exactly. He simply *assumed* Faraday's "plucked taut string" waves. Later the measurement in instruments of what was actually the lateral gyroprecession of electrons in receiving wires was thought to prove that the incoming ether vibrations were transverse, like those string waves, because the detected electric **fluid (electron** precession) waves in the receiving wire were

transverse. The drift velocity of electrons longitudinally in a wire (in a typical case, several inches per hour) was unknown. A charge *q* was just a piece of electric fluid, much like a cubic centimeter or other volume of fluid; it had no connotation of "charged particle." There was no concept in all of physics of EM energy flowing through space. There was no knowledge that the same fields created in the transmission wire, which perturbs the Drude electrons laterally, also perturbs the positively charged nuclei laterally, in the opposite direction, highly damped but with equal energy.

There was no way to realize that the energetic perturbation of the curvature of spacetime around the sending wire antenna, by the Drude electron perturbation energy, is simultaneously accompanied by an equal and opposite perturbation of the curvature of spacetime in the opposite direction (energy density, not amplitude of the disturbing wave, determines the degree of curvature of the surrounding spacetime). Hence Maxwell omitted precisely one half the EM energy, one half the EM wave, and one-half the electrodynamics. As a consequence, the "Newton's third law recoil" of the nuclei today is thought to spontaneously arise as if some mystical demon observes the Drude electron perturbations, and simultaneously kicks the positively charged nuclei in the equal and opposite direction. Hence Newton's third law, so to speak, is erroneously still omitted from classical electrodynamics, and the better texts say so.

In the 1880s, the Michelson-Morley experiments falsified the material ether. Not a single one of the Maxwell-Heaviside equations were ever changed to this day. Instead, the electrodynamicists eventually announced that, since there was no longer an ether, they were not using one! Then a total non sequitur was incorporated: that in massfree space, the same E and B fields (defined as material entities and thus existing only in mass) still remain but the forces go to zero. Simple algebra reveals this clever, insidious faux pas, using the E-field as an example: First, F == d/dt(mv), so mass is a component of force. (This reveals the great error due to the hoary old notion that a separate force acts upon a separate mass; the mass is a component of the force, and the force is a coupled system of a curvature of spacetime and a charged mass.). Then E == F/q, which rigorously holds when mass is present.

Now for whatever reason, let F = 0. Then F/q = 0 and E = 0 also, else we must discard algebra. What actually remains is easily explained in general relativity terms (available since before 1920). The couplet of a curvature of spacetime and a charged mass is broken up by absenting the mass. What remains is that specific curvature of spacetime. GR assures us that curved ST acts upon mass, and that any force involves a curvature of ST. Yet in more than 80 years, this erroneous old "material ether remnant" in electrodynamics has been fiercely defended. Every textbook today uses and confuses the E and B fields in two dichotomous fashions: (1) as massive force fields existing only in the presence

of mass, and as "massless force-free fields" existing only in the absence of mass. This of course is a non sequitur.

13. E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," *Math. Ann.*, Vol. 57, 1903, p. 333-355. The "scalar" potential itself is not even a *scalar entity,* as shown rigorously by Whittaker. Instead, it is a harmonic series of bidirectional EM longitudinal phase conjugate wavepairs, and it decomposes into that series. Hence it is a *multiwave, multivectorial entity.*

14. C. N. Yang and R. L. Mills, "Conservation of Isotopic Spin and Isotopic Gauge Invariance," *Phys. Rev.*, Vol. 96, 1954, p. 191.

15. The term "energetics" simply means *energy as the primary thing in the universe.* Rankine first used it. G. Helm in 1887 revived Rankine's term "energetics" and factored energy into an *intensity* factor and an *extensity* factor (which today we would call potential and kinetic energies). William Ostwald in 1893, 1895, and 1901 raised the concept of "energetics" (energy as the primary thing in the universe) to the forefront. Thus when the Russians developed new extensions and principles in weapons physics, they simply used the historical notion of "energy as the primary thing in the universe" and adopted the earlier name for it: *energetics.*

16. Later when Khrushchev demanded a 100% antimissile defense, famed Russian Nobelist Petr Kapitsa answered, *"If a means of total neutralization of foreign missiles is to be found, it can only come from a group of new principles in physics, called energetics".*

17. See T. E. Bearden, "Mind Control and EM Wave Polarization Transductions, Part I", *Explore,* 9(2), 1999, p. 59; Part II, *Explore,* 9(3), 1999, p. 61; Part III, *Explore,* 9(4,5), 1999, p. 100-108. It appears that Sachs' unified GR and EM approach is perhaps the best Western physics model to apply to analysis of the KGB energetics weapons. However, because of the third branch *(psychoenergetics:* engineering the mind directly), Sachs' work would appear to need further extension along the lines indicated by the present author in the cited paper.

18. See T. E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves," *J. New Energy,* 3(2/3), 1998, p. 12-28; — *Energy from the Vacuum,* 2002, *ibid.* For nuclear transmutation at a distance (e.g., dudding all nuclear weapons by transmuting U235 and weapons grade plutonium), extension is required along the lines indicated by the present author in these references.

19. See M. Sachs, *ibid.,* also M. Sachs, "Relativistic Implications of Electromagnetic Field Theory," in T. W. Barrett and D. M. Grimes, eds., *Advanced Electromagnetism,* World Scientific, 1995, p. 551. The Sachs theory

already expresses the greatest generalization possible of electrodynamics, and fully justifies the preceding view.

20. See Whittaker, 1903, *ibid.;* — "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," *Proc. Lond. Math. Soc,* Series 2, Vol. 1, 1904, p. 367-372. The latter paper was published in 1904 and orally delivered in 1903. Per these two Whittaker papers, it is known that (i) ordinary EM fields and waves are the result of interference of two or more scalar potential functions, (ii) scalar potentials are comprised of harmonic sets of bidirectional EM phase conjugate wavepairs, (iii) all ordinary EM fields and waves and potentials have LW EM dynamics internally, and (iv) in theory, this "infolded" electrodynamics can be engineered. Sachs' theory dramatically extends the richness of that internal electrodynamics ignored in the West, and highlights the general relativity (sets of spacetime curvatures, or "engines", involved).

21. E.g., *Marine Observer* was a rich source for Russian energetics weapons testing in remote ocean areas, sighted by ships' captains and crews and entered into the ships' logs.

22. Portions of Khrushchev's statements to the Presidium are given in Max Frankel, "Khrushchev Says Soviet Will Cut Forces a Third; Sees 'Fantastic Weapon'," *New York Times,* Jan. 15, 1960, p. 1.

23. See Whittaker 1903 and 1904, *ibid.,* for the original basis of scalar interferometry and its creation of any kind of EM field, potential, and wave in the interference zone.

24. Also see M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry, *J. New Energy,* 4(3), Winter 1999, p. 76 for mathematical proof of scalar interferometry. There are several other AIAS papers in the same issue of *JNE,* dealing with interferometry and with the implications of the Whittaker papers.

25. As an example, the U.S.S. Skylark, surface companion of the Thresher, was beset by mysterious "jamming" of multiple types of EM systems in multiple bands. So bad was it that it required more than an hour to get an emergency message to Naval headquarters that the Thresher was in serious difficulty. Later, as the scalar interferometry died away, all the EM systems aboard the Skylark resumed normal functioning. The Skylark was in fact in a "splatter zone" of the underwater interference zone around the Thresher.

26. Circa the end of 1989, the earlier longitudinal EM wave weapons on site in Russia were leased to a rogue Japanese group comprised of Aum Shinrikyo and Yakuza, who have been operating those weapon systems—on site in Russia—since then. Senator Sam Nunn's investigations revealed the presence

of the Aum Shinrikyo in Russia, to include establishing a university there. His investigators missed the Yakuza involvement and also missed the exotic weaponry aspects as one might expect.

27. I concluded from this remark that TEMPEST techniques are probably used at some nearby site not too distant from my home here in Huntsville, to read and record my work as I write it on the computer. That appears to be a good assumption.

28. As a small example of what can be done, see a series of papers by M. W. Evans, P. K. Anastasovski, T. E. Bearden et al, published in *J. New Energy*, 4(3), Special Issue, Winter 1999. The papers are: (a) "On Whittaker's Representation of the Electromagnetic Field in Terms of Two Scalar Potentials, Part I"; (b) "An Experimental Test of the Existence of Whittaker's *g* and/Fluxes in the Vacuum"; (c) "On Whittaker's Representation of the Classical Electromagnetic Field in Vacuo, Part II: Potentials Without Fields"; (d) "On Whittaker's F and G Fluxes, Part III: The Existence of Physical Longitudinal and Timelike Photons"; (e) "Representation of the Vacuum Electromagnetic Field in Terms of Longitudinal and Time-like Potentials: Canonical Quantization"; (f) "On Whittaker's Analysis of the Electromagnetic Entity, Part IV: Longitudinal Magnetic Flux and Time-Like Potential Without Vector Potential and Without Electric and Magnetic Fields"; (g) "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry"; and (h) "On Extending Whittaker's Theory, Part VI: Photons Without Fields and Vector Potentials".

29. As an example, one part of the strategic deception plan was devoted to convincing the West that Soviet psychoenergetics was nothing but a technical wrinkle upon the rather harmless Western parapsychology. This part of the program was completely successful for decades. Another very clever use of deception is to allow release of some real scientific advances that lead the West, but are not too important to the KGB in the weapons arena. The increasing emphasis on torsion fields is an example of this "deception by giving good information that directs the adversary upon a path one wishes him to take", effectively steering him away from the path one wishes him to avoid. Lately, however, there is an uproar amongst the academicians in the Russian Academy of Sciences over this very point, that torsion fields being presented as the "end all, be all" is simply disinformation.

30. With their deployment of QP weapons in 2002, the Chinese are also on the way to having this capability.

31. The multiply connected spacetime (MCS) or quantum potential weapons went on site circa latter 1989. A laboratory prototype had been tested against the U.S. air attack on Libya in April 1986. For details of the extremely anomalous jamming **of aircraft** and missile guidance and control systems in that

attack on Libya, see Mark Thompson, "Mixed signals may have misguided U.S. weapons," *The Washington Post,* Jan. 22, 1989, p. A-4.

32. One or more QP weapons also apparently induced the Gulf War Disease in MidEast forces in the Gulf War. We have previously explained the peculiar anomalies, how it was done, why the endemic natives did not contract the disease, why the French forces did not contract it but U.S., British, and Canadian forces did, etc. We briefly discussed quantum potential weapons in T. E. Bearden, *Gravitobiology: A New Biophysics,* In T. E. Bearden, *Gravitobiology: A New Biophysics,* Cheniere Press, Santa Barbara, Ca. www.cheniere.org, 1991.

33. (a) Yossef Bodansky, "Soviets testing chemical agents in Afghanistan," *Jane's Defence Weekly,* 1(3), Apr. 7, 1984, p. 508 gives something of the two Soviet tests of this weapon in Afghanistan. In addition to the fierce blast of empty Dirac Sea 4-holes, these weapons produce a powerful time-polarized EM pulse in the area, producing a very sharp "jerk" in the rate of flow of time, (b) The mind-body coupling mechanism—which cannot withstand such a sharp jerk in the rate of flow of time—has been given by T. E. Bearden, "Mind Control and EM Wave Polarization Transductions," *Explore,* 1999, *ibid.* This sharp "jerk" in time-flow instantly snaps the mind-body coupling mechanism for any living thing in the struck area. A very small version of this weapon was tested twice in Afghanistan, where the bodies in the "mind-snapped" zone died instantly, fell like limp rags, never twitched, and did not decay or get molested by insects or scavengers for the 30 days it required the Mujahedin to fight their way back into the two struck villages. The Mujahedin thought it was some new, extremely fast acting nerve gas, which they dubbed "smerch" or "death wind".

34. Two Ph.D. scientists were working closely with me on this entire effort, as was another close colleague. There was much more involved in the effort that is so briefly mentioned here.

35. Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

36. T. E. Bearden, *Energetics: Extensions to Physics and Advanced Technology for Medical and Military Applications,* CTEC Proprietary, Mar. 21, 1998, 200+ page inclosure to CTEC Letter to Gen. (Ret.) Walter Busby, Deputy Secretary of Defense for Counterproliferation and Chemical and Biological Defense, March 21, 1998. Copies were sent to various other U.S. government agencies, including to NIH, CDC, the USAF, etc.

37. See Vlail Kaznacheyev and L. P. Mikhailova, *Ultraweak Radiation in Intercellular Interactions,* [in Russian], Novosibirsk, 1981. An English exposition of much of the Kaznacheyev material is given in Vlail Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions," *Psi Research,* 1(1), Mar. 1982, p. 47-76. The work of Vlail Kaznacheyev led to the understanding of how to electromagnetically transmit cellular death and disease into targeted cells (or bodies) at a distance, and involved thousands of lab experiments. Highly sanitized work revealing the results but not the mechanisms, were permitted in order to stimulate the West to see if it knew about energetics.

38. See Stanislov Lunev and Ira Winkler, *Through the Eyes of the Enemy: Russia's Highest Ranking Military Defector Reveals Why Russia Is More Dangerous Than Ever,* Regnery, Washington, D.C., 1998. The Red Chinese also were able to decipher the Russian EM disease transmission methodology, early on. As a strange kind of "poetic justice" action the Chinese induced cancer into many Russian spies stationed in the Russian Embassy in China. Quoting Lunev, p. 160: "...I *was not the only person who was stationed in Beijing to come down with cancer...Almost all of the GRU officers stationed in China with me have been diagnosed with cancer. People assigned to the embassy had told me that they were picking up high levels of radiation from the apartment building around the embassy compound. Whether it was a form of high-tech monitoring or a conscious effort to harm our health, it seems to have been successful. So much so that in 1992 the GRU was asked to investigate the high rate of cancer among embassy officials. The findings, however, have never been made public; in part, no doubt, because of the rapprochement between Russia and China."*

39. See my "Porthole Briefing", on www.cheniere.org. Also see "Le Probleme Priore," *Rapport de la Commission de I'Academie des Sciences a Monsieur le Ministre d'Etat charge de la Recherche et de la Technologie,* France, 1982, p. 1-22; J. B. Bateman, "Microwave Magic," Office of Naval Research London Conference report, ONRL C-14-77, 1977; —*A Biologically Active Combination of Modulated Magnetic and Microwave Fields: The Priore Machine,* Office of Naval Research, London, Report R-5-78, Aug. 16, 1978; — "Staging the Perils of Nonionizing Waves," *European Scientific Notes,* ESN 32-3-85-88, 1978; T. E. Bearden, "Energetics Update and Summary," Parts 1, *Explore More,* No. 1, 1996, p. 13-18; Part 2, *Explore,* 8(1), 1997, 53-56; Part 3, *Explore,* 8(2), 1997, p. 42-45; Christopher Bird, "The Case of Antoine Priore and His Therapeutic Machine: A Scandal in the Politics of Science," Explore, 5(5-6), 1994, p. 97-110; R. Cambar, "Rapport general des travaux de la Commission de Controle constituee en vue de verifier l'un des effets biologiques obtenu par l'utilisation de l'appareillage de Priore A. Bordeaux," [General findings of the work of the control commission formed to verify one of the biological effects obtained by use of the apparatus of A. Priore at Bordeaux],

1969; R. Courrier, "Expose de M. le professeur R. Courrier Secretaire perpetuel de 1'Academie des Sciences fait au cours d'une reunion a l'lnstitut sur les effects de la machine de M. A. Priore 26 Avril 1977" [Presentation by Professor R. Courrier, Perpetual Secretary of the Academy of Sciences, made at the meeting of the Academy on the effects of the machine of M. A. Priore.]; Jean-Michel Graille, *Dossier Priore: A New Pasteur Affair,* De Noel, Paris, 1984 [in French]; Antoine Priore, "Apparatus for producing radiations penetrating living cells," U.S. Patent No. 3,368,155, Feb. 6, 1968; — "Method of producing radiations for penetrating living cells," U.S. Patent No. 3,280,816, Oct. 25, 1966; — "Procede et dispositif de production de rayonnements utilisables notamment pour le traitement de cellules vivantes," [Procedure and Assemblage for Production of Radiation Especially Serviceable for the Treatment of Living Cells], Republique Francais Brevet d'Invention P.V. No. 899.414, No. 1,342,772, Oct. 7, 1963; A. Priore, *Guerison de la Trypanosomiase Experimentale Aigue et Chronique par L'action Combinee de Champs Magnetiques et D'Ondes Electromagnetiques Modules* [Healing of intense and chronic experimental trypanosomiasis by the combined action of magnetic fields and modulated electromagnetic waves], thesis submitted in candidacy for the doctoral degree, 1973—rejected when the project was suppressed.

40. Eric Perisse, *Effets des Ondes Electromagnetiques et des Champs Magnetiques sur le Cancer et la Trypanosomiase Experimentale* [Effects of Electromagnetic Waves and Magnetic Fields on Cancer and Experimental Trypanosomias], Doctoral thesis, University of Bordeaux No. 83, March 16, 1984. Although Priore's own thesis was suppressed in 1973, Pautrizel nevertheless finally succeeded in getting this doctoral thesis by Perisse approved on the work, at the University of Bordeaux which had rejected Priore's thesis, after eleven more years had passed. Considering the viciousness of the suppression, this was a major accomplishment.

41. The photo was taken by George Suchary of the registration point (ball of light) high over the Nov. 1985 night shuttle launch from Cape Canaveral. For a photo of the same kind of "ball of light" registration point above the kill of a Titan missile launched from Vandenberg AFB in early 1986, see reference 39 below.

42. The picture by Canadian investigators showing the hole burned through the right fuselage ahead of the engines of the Arrow DC-8 is shown in T. E. Bearden, *AIDS: Biological Warfare,* Cheniere Press, Santa Barbara, Ca. www.cheniere.org , 1988, p. 52.

43. See T. E. Bearden, *Gravitobiology: A New Biophysics,* Cheniere Press, Santa Barbara, Ca. www.cheniere.org, 1991, p. 82. Two sensors on-board the Arrow DC-8 independently recorded the sharp electrical spike generated by the strike of the EM missile.

44. "Titan Explosion Cripples U.S. Launch Surveillance Capability," *Aviation Week & Space Technology,* 124(17), Apr. 28, 1986, p. 16-19. Specifically see the picture of the explosion on p. 18. It clearly shows the Soviet marker beacon (little ball of light) well above the missile explosion. General background on the Titan explosion and investigation is given in "Investigators Search for Clues to Cause of Titan Blast," *Aviation Week & Space Technology,* 124(17), Apr. 28, 1986, p. 19-20.1 persuaded NBC engineer Ron Cole with a team of engineers to examine the videotape of the explosion, frame by frame. In 17 frames the ball-of-light (registration point) is visible, and moves away completely independent of the explosion. No "bogies on the range" were reported at Vandenberg AFB.

45. Dr. Evans is co-discoverer with Vigier of the B(3) field, now well established but still not in the textbooks. He is the Director of the Alpha Foundation's Institute of Advanced Study (AIAS) and has over 600 papers and books in the literature.

46. M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., "On Whittaker's F and G Fluxes, Part III: The Existence of Physical Longitudinal and Timelike Photons," *J. New Energy,* 4(3), 1999, p. 68-71; — "Representation of the Vacuum Electromagnetic Field in Terms of Longitudinal and Time-Like Potentials: Canonical Quantization," *ibid.,* p. 82-88; — "On Extending Whittaker's Theory, Part VI: Photons Without Fields and Vector Potentials," *ibid.,* p. 79-81.

47. Terence W. Barrett, "Electromagnetic Phenomena Not Explained by Maxwell's Equations," in Lakhtakia, A. (ed.): *Essays on the Formal Aspects of Electromagnetic Theory,* World Scientific Publishing, River Edge, NJ, 1993, p. 6-86; — "On the distinction between fields and their metric: the fundamental difference between specifications concerning medium-independent fields and constitutive specifications concerning relations to the medium in which they exist." *Ann. Fond. Louis de Broglie,* 14(1), 1989, p. 37-75; — and D. M Grimes. [Eds.] *Advanced Electromagnetism: Foundations, Theory, & Applications.* World Scientific, (Singapore, New Jersey, London, and Hong Kong), Suite 1B, 1060 Main Street, River Edge, New Jersey, 07661, 1995. In the latter book see T.W. Barrett, "Sagnac Effect: A Consequence of Conservation of Action Due to Gauge Field Global Conformal Invariance in a Multiply-Joined Topology of Coherent Fields," p. 278-313.

48. But see Craig F. Bohren, "How can a particle absorb more than the light incident on it?" *Am. J. Phys.,* 51(4), Apr. 1983, p. 323-327. By *resonating* the intercepting charged particle, its reaction cross section increases, and more EM energy is collected and re-radiated by the charge than is input to it by the conventional accounting (which only accounts the input Poynting energy that would be intercepted by a *static* charge). The conventional input energy

calculation therefore ignores the huge nondiverged Heaviside component surrounding the Poynting component and wasted. The resonant particle sweeps out past the usual Poynting component into the unaccounted Heaviside input component, and collects excess energy. The Bohren experiment with resonant charged particles produces COP =18. Metallic particles at ultraviolet frequencies are one class of such particles and insulating particles at infrared frequencies are another. For independent confirmation of the Bohren experiment, see H. Paul and R. Fischer, {Comment on "How can a particle absorb more than the light incident on it?'},"*Am. J. Phys.*, 51(4), Apr. 1983, p. 327.

49. E. T. Whittaker, 1903, *ibid.*

50. A beneficial use, e.g., would be to use such CSRs to investigate and report the interior of the sun and planets, including the Earth and its core. Since a CSR can also travel "through" the interior of a light beam, in theory such could be dispatched back into some of the nearer stars to also explore and report their interior.

51. This is no more curious than stating that sets of waves and their dynamics can exist in space, without interacting with mass, and that they can then later interact with a mass system to change it in specifically designed manner. Since longitudinal EM waves and their dynamics are "infolded" inside ordinary EM waves, fields, and potentials, they are also infolded "inside" the ambient vacuum potential, which itself is a part of the local vacuum potential. In short, one forms highly complex LW wavesets and functional dynamics, in essentially a sort of "subspace" as popularized by the Star Trek television series. The LW "engines" are identically ST curvature engines. A close colleague of the present author has in fact already invented and rigorously demonstrated such a communication system, but his former funding by several very large communications companies collapsed before he could develop and employ this system for the commercial market.

52. This is easily understood if one shifts one's vision from "space" to "subspace." Subspace is filled with (literally is composed of) longitudinal EM waves and their dynamics. The CSR's are quite unique, enormous systems "singing away" with longitudinal EM waves. So a longitudinal EM wave interferometer can easily locate them by sweeping its beams through subspace, as a radar sweeps to track aircraft in space. Once the CSR target "pings", the system automatically hits it with a profusion of interacting LWs, completing disrupting and destroying its dynamics. Scratch one system. Probably several million such systems were destroyed throughout the West (command centers, power grids, submarines, nuclear bombers, etc.) in rapid fire order, all without any external "spatial" sign other than perhaps a wee bit of very low level "EM noise" briefly as a struck CSR fractured.

53. See M. Sachs, *Quantum Mechanics from General Relativity,* Reidel, 1986. Sachs'unified field theory, e.g., applies equally to the quarks and gluons, as it does to the nucleons, the atoms, molecules, and macroscopic objects and phenomena. See also M. Sachs, "Symmetry in Electrodynamics: From Special to General Relativity, Macro to Quantum Domains," in *Modern Nonlinear Optics,* Second Edition, 3 vols., M. W. Evans (ed.), Wiley, 2001; vol. 1, p. 677-706.

54. G. M. Wang, E. M. Sevick, Emil Mittag, Debra J. Searles, and Denis J. Evans, "Experimental Demonstration of Violations of the Second Law of Thermodynamics for Small Systems and Short Time Scales," *Phys. Rev. Lett.,* 89(5), 29 July 2002, 050601.

55. The tragic death of Captain Hess was also very probably such a test. Hess, perfectly normal and happy, laid out his uniform in the early morning and then went for his customary morning jog. He suddenly veered aside, sat down in a path and stabbed himself 26 times, all deep stab wounds, four of which would be totally incapacitating (two right through the heart) to any normal individual experiencing normal shock, etc. To a psychoenergetically controlled individual where shock does not occur nor does emotion or pain, this is understandable. Add this to the incidents involving Captains Button and Svoboda, and one begins to see the picture.

56. W. Heitman and G. Nimtz, "On Causality Proofs of Superluminal Barrier Transversal of Frequency Band Limited Wave Packets," *Phys. Lett. A196,* 1994, p. 154-158. Aichmann and Nimtz and co-workers at the University of Cologne have transmitted 8.7 GHz microwaves (free space wavelength 3.4 cm) traveling in a rectangular wave-guide that contains a "barrier" section of reduced dimensions. They have recently transmitted Mozart's 40th Symphony as frequency modulated microwaves through a barrier wave-guide at an FTL group velocity of 4.7 c, receiving audibly recognizable music from the microwave photons that survived their barrier passage. The transit time through the barrier was about 81 picoseconds and was observed to be constant for barriers with widths varying from 4.0 cm to 11.4 cm.

57. Quantum mechanics in fact requires instantaneous transmission of effects. A mishmash of learned contention would have us believe one can "transmit" energy instantly, but not intelligence. This argument has essentially stymied our scientific establishment so that it has not really funded strong investigation in this area. It is a stupid argument: Simply transmit one change, then a second one, then a third one, in serial order, where the "order" contains the intelligence. No different from Morse code. Somehow the pundits so certain that intelligence cannot be superluminally transmitted seem to have forgotten what "intelligence" is. They also seem to have assumed that one superluminal change can be **transmitted** on order, but a second, third, and fourth cannot.

58. Feynman and Wheeler tried very hard to formulate a new absorber theory of electrodynamics to eliminate many of the fierce foundations problems. Wheeler described the effort this way: *"...we may summarize the account of radiation reaction given by Wheeler and Feynman in 1945. In it every charged particle is envisaged as coupled to every other charged particle by a field that is symmetric in time: half advanced, half retarded. Interconnections run forward and backward in time in such numbers as to make an unbelievable maze. That weaving together of past and future seems to contradict every normal idea of causality. However, when the number of particles is great enough to absorb completely the signal starting out from any source, then this myriad of couplings adds up to a simple result: the familiar retarded actions of everyday experience, plus the familiar force of radiative reaction with its familiar sign."* [John Archibald Wheeler, "Law without law," in *Quantum Theory and Measurement.*, preprint, p. 39].

Unfortunately, when the foundations of any science are closely examined in their roots, one runs into the age-old bane of the philosopher: ultimately opposites are identical, at least prior to the observation (separation) action to separate them. It follows that all scientific reasoning is circular at its most primary basis.

59. See Charles W. Misner, Kip S. Thorne and John Archibald Wheeler, *Gravitation,* W. H. Freeman, San Francisco, CA., 1973, p. 71. Wheeler spoke of that inescapable fact in this manner: *"Here and elsewhere in science, as stressed not least by Henry Poincare, that view is out of date which used to say, 'Define your terms before you proceed.' All the laws and theories of physics, including the Lorentz force law, have this deep and subtle character, that they both define the concepts they use (here B and E) and make statement about these concepts. Contrariwise, the absence of some body of theory, law and principle deprives one of the means properly to define or even to use concepts. Any forward step in human knowledge is truly creative in this sense: that theory, concept, law, and method of measurement—forever inseparable—are born into the world in union."*

60. Also see T. E. Bearden, *Energy from the Vacuum: Concepts and Principles,* 2001, *ibid,* for a rework and extension of Aristotelian logic to eliminate its present fatal flaw, extending it into a 5-law logic.

61. The very notion of "propagation of energy through space" is radically extended in the extended unified EM and GR being pursued by AIAS and Sachs. Time-like EM energy currents dominate in the vacuum. E.g., see M. W. Evans et al., "Representation of the Vacuum Electromagnetic Field in Terms of Longitudinal and Time-like Potentials: Canonical Quantization," *J. New Energy,* 4(3),Winter l999,p. 82.

62. Multiwave interactions (between transverse EM waves) produce time-reversed EM waves (phase conjugate replicas of the signal wave input). That method time-reverses EM energy in waveform. To time-reverse EM energy in mass form, simply pump that mass with time-polarized EM waves. As an alternative, it may be pumped with longitudinal EM waves (which are always accompanied by time-polarized EM waves anyway), and the pumped mass is also pumped in the time-domain because of the presence of the time-polarized EM waves in the pumping. We previously filed an invention disclosure with the U.S. Patent Office dealing with how to do that.

63. Mostly studied by Becker. See (a) R. O. Becker, "The control system governing bone growth in response to mechanical stress," *J. Ark. Med. Soc,* Vol. 62, 1966, p. 404; (b) — and David G. Murray, "The electrical control system regulating fracture healing in amphibians," *Clinical Orthopaedics and Related Research,* Vol. unk, No. 73, Nov.-Dec. 1970, p. 169-198. This latter paper is the definitive technical exposition by Becker of his electrical control system ideas and findings. Good references for the educated layperson are (c) R. O. Becker, "A technique for producing regenerative healing in humans," *Frontier Perspectives,* 1(2), Fall/Winter 1990, p. 1-2; (d) Robert O. Becker and Gary Seldon, *The Body Electric: Electromagnetism and the Foundation of Life,* William Morrow and Company, New York, 1985; and (e) Robert O. Becker, *Cross Currents: The Promise of Electromedicine, the Perils of Electropollution,* Tarcher, St. Martin's Press, New York, 1990.

64. A provisional patent application has been filed on the process, and an overview of the method can be seen as the "porthole briefing" on my website www.cheniere.org.

65. (a) C. A. L. Bassett; R. O. Becker, and R. J. Pawluk, "Effects of electric currents on bone in vivo," *Nature,* Vol. 204, Nov. 14, 1964, p. 652-654. The complete electrical control system (conventional EM theory) for the healing of bone fractures is given in (b) R. O. Becker, *Clinical Orthopedics and Related Research,* Vol. 73, 1970, p. 169. A paper "putting it all together" is (c) R. O. Becker, J. *Bioelec,* Vol. I, 1982, p. 239.

66. F. Mandl and G. Shaw, *Quantum Field Theory,* Wiley, 1984, Revised Edition 1993, under the heading "5.2 Covariant Quantization" and "5.3 The Photon Propagator" in Chapter 5. The longitudinal and scalar photon polarizations are not directly observable, but only in combination, where they manifest as the instantaneous Coulomb (i.e., electrostatic) potential interaction, *"which emerges as an exchange of longitudinal and scalar photons."* So the common old electrostatic scalar potential is actually comprised of longitudinal EM waves and time-polarized EM waves.

67. With the MidEast increasingly set to explode, we may be facing the unleashing of weapons of mass destruction, a vast shortage and curtailment of

available oil and energy, and a total collapse of the Western economy and therefore most of the world economy, in as little as three or four years, if the impending energy crisis worldwide is not resolved quickly. See T. E. Bearden, ADAS position paper, "The Unnecessary Energy Crisis: How to Solve It Quickly," *ibid.* As this is written, we have already had a warning shot across our bow: the vicious terrorist attacks on September 11, 2001. We are in Afghanistan and elsewhere in a war against terrorism, and anyone can see the escalation in the MidEast toward war between the U.S. and Iraq, and almost certainly a resulting explosion in the MidEast and unleashing of the hostile terrorists assets and mass destruction weapons already inside the United States. Since modern economies are based on cheap energy, and cheap energy is largely based on cheap oil, then with surging energy demands worldwide we shall see "oil wars" erupt and rage worldwide, with terrorist retaliations and attacks—using weapons of mass destruction—occurring in U.S. cities. *Unless energy from the vacuum is quickly developed and deployment begun at high speed, we risk the coming collapse of the world economy, great destruction of populaces, and a new Dark Ages.*

68. E. T. Whittaker, 1903, *ibid.*

69. Daniel A. Walker, Charles S. McCreery, and Fermin J. Oliveira, "Kaitoku Seamount and the Mystery Cloud of 9 April 1984," *Science,* Vol. 227, Feb. 8, 1985, p. 607-611; Daniel L. McKenna and Daniel A. Walker, "Mystery Cloud: Additional Observations," *Science,* Vol. 234, Oct. 24, 1986, p. 412-413.

70. Superpotential theory was initiated by E. T. Whittaker, extending earlier concepts advanced by G. Johnstone Stoney. See E. T. Whittaker, *Proc. Lond. Math. Soc,* Series 2, Vol. 1, 1904, p. 367-372. Nisbet extended the Whittaker and Debye two-potential solutions of Maxwell's equations to points within the source distribution. This is a full generalization of the vector superpotentials (for media of arbitrary properties) together with their relations to such scalar potentials as those of Debye. See A. Nisbet, *Physica,* Vol. 21, 1955, p. 799. Also, A. Ricci in 1901 introduced what might be called the magnetization potential, satisfying a certain equation, as an alternate to the Hertz vector. This was a part of early vector superpotentials. For an excellent overview discussion of superpotentials and related things, see Melba Phillips, "Classical Electrodynamics," in *Principles ofElectrodynamics and Relativity,* Vol. IV of *Encyclopedia ofPhysics,* edited by S. Flugge, Springer-Verlag, 1962. Phillips discusses, for example, that Whittaker 1903 (note: oral delivery; paper was published in 1904) was the first to prove that one can derive a general electromagnetic field from two scalar functions, which are really components of the vector superpotentials, with proper choices of the gauge functions. Whittaker's method is well known in the treatment of transverse electric and transverse magnetic modes of a cylindrical cavity or a waveguide. Nisbet has shown that this result may be extended within the source distribution (assumed

given) by a suitable choice of stream functions. The Debye potentials and the Bromwich potentials are essentially radial components of the vector potentials of which Whittaker potentials are the real parts. So in general the particular integral (the stream potentials) of the inhomogeneous Maxwell equations may be so chosen that the complementary function can be expressed in terms of only two scalars, which are components of the vector superpotentials. The Whittaker and the Debye-Bromwich potentials are special cases of two vector superpotentials.

71. David Jones, *Vancouver Sun Times,* Weekend Magazine, Dec. 17, 1977, p. 17.

72. For more specific information on the production of practical antigravity and an experiment demonstrating it, see T. E. Bearden, *Energy from the Vacuum: Concepts and Principles,* Cheniere Press, Santa Barbara, CA, 2002, Chapter 8. Approach to Antigravity.

73. T. E. Bearden, *Energy from the Vacuum: Concepts and Principles,* Cheniere Press, Santa Barbara, CA, 2002, Chapter 10. Cold Fusion: Low Spatial-Energy Nuclear Reactions at High Time-Energy. By inadvertently using highly compressed time-energy, cold fusion researchers are actually using—on the tabletop—higher energy density than our present high-energy physics uses in its largest accelerators. The conventional scientific community does not have a single scientific program dedicated to using time as energy, even when one's physics model can legitimately be made of a single fundamental unit. When the joule is chosen as that unit, then time becomes totally a function of energy, just as is mass. The use of mass-energy gave us the nuclear age; the use of time-energy will give us a far greater age, if we can ever get the scientific community off its duff and moving.

74. Further, the second law of thermodynamics has long been known not to apply to a single charge, atom, or molecule or to a small group. For such microscopic phenomena, there will occur reversed reactions a certain small fraction of the time. But also see G. M. Wang, E. M. Sevick, Emil Mittag, Debra J. Searles, and Denis J. Evans, "Experimental Demonstration of Violations of the Second Law of Thermodynamics for Small Systems and Short Time Scales," *Phys. Rev. Lett.,* 89(5), 29 July 2002, 050601. These researchers have experimentally proven that the second law can be and is violated for much larger scales—up to micro (colloidal) size—and for much longer times (up to two seconds). Hence it is now proven that such "reversed zones" where reactions run backwards for quite a bit, can and do in fact occur on the colloidal scale, sufficient for the formation of large clusters of like charges. Evans and his colleagues have pointed out that these results dramatically affect chemistry.

75. Shoulders has been creating and using such charge clusters for years. See Kenneth R. Shoulders, "Energy Conversion Using High Charge Density,"

U.S. Patent # 5,018,180, May 21, 1991; — "Energy Conversion using High Charge Density," U.S. Patent No. 5,123,039, 1992; — "Method and Apparatus for Production and Manipulation of High Density Charge," U.S. Patent #5,054,046, 1991; — U.S. Patent #5,054,047, 1991; — "Circuits Responsive To and Controlling Charged Particles," U.S. Patent 5,148,461, 1992; — and Steve Shoulders, "Observations on the Role of Charge Clusters in Nuclear Cluster Reactions,"J. *New Energy,* 1(3), Fall 1996, p. 111-121.

76. D. J. Evans and D. J. Searles, *Phys. Rev. E,* Vol. 50, 1994, p. 1645.

77. See Donald Kennedy, "To Publish or Not to Publish," *Science,* Vol. 295, 8 Mar. 2002, p. 1793.

78. R. P. Taleyarkhan, C. D. West, J. S. Cho, R. T. Lahey Jr., R. I. Nigmatulin, and R. C. Block, "Evidence for Nuclear Emissions During Acoustic Cavitation," *Science,* Vol. 295, 8 Mar. 2002, p. 1868-1873. Quoting from the abstract: "In cavitation experiments with deuterated acetone, tritium decay activity above background levels was detected. In addition, evidence for neutron emission near 2.5 million electron volts was also observed, as would be expected for deuterium-deuterium fusion. Control experiments with normal acetone did not result in tritium activity or neutron emissions."

79. Yuri T. Didenko and Kenneth S. Suslick, "The energy efficiency of formation of photons, radicals and ions during single-bubble cavitation," *Nature,* Vol. 418, July 25, 2002, p. 394-397.

80. E.g., see John Archibald Wheeler and Richard Phillips Feynman, *Phys. Rev.* 59, 1941, p. 683; —"Interaction with the Absorber as the Mechanism of Radiation," *Rev. Mod. Phys.,* 17(2, 3), Apr.-Jul. 1945, p. 157-181.

81. Albert Einstein, "Foreword," in Max Jammer, *Concepts of Space: The History of Theories of Space in Physics,* Harvard University Press, Cambridge, Massachusetts, 1969, p. xi-xii.

82. Robert A. Fisher, [Ed.], *Optical Phase Conjugation,* Academic Press, NY, 1983, p. xv.

83. Basically, the choice between distant heating in the interference zone, or distant cooling, is as simple as how one biases the ground potential used for the electrical grounds of the interferometer transmitters. Biasing well above the ambient potential in the distant IZ produces divergent EM energy (heat) forming and radiating in the distant zone. Biasing well below the ambient IZ potential produces convergent EM energy (cold) forming and radiating in the distant zone.

84. Mass is mostly empty space filled with EM potentials, fields, and waves. Since these potentials, fields, and waves are simply bundles of longitudinal EM waves and their impressed dynamics, it follows that mass itself

is mostly a "giant superhighway" for the transmission of LWs. This is actually a sort of "subspace" transmission "right through" matter, so to speak.

85. As demonstrated by such dual serial usage by a giant interferometer in the anomalous and explosive "cloud" phenomena near the Kurils in April 1984. For excellent descriptive articles and a hard look at the phenomena, see Walker et al., *Science, ibid.*

86. See "Soviet device uses radio waves as tranquilizer," AP release, *Huntsville [Alabama] Times,* May 19, 1983. See also W. Ross Adey, "Biological effects of low energy electromagnetic fields," *Proc. NATO Adv. Study Inst. on Advances in Biological Effects and Dosimetry of Low Energy Electromagnetic Fields,* Plenum Press, New York, 1983, p. 359-391. Adey apparently was aware only of ordinary U(l) electrodynamics. He describes the **LIDA** device as follows: *"Soviet investigators have also developed a therapeutic device utilizing low frequency square wave modulation of a radiofrequency field. This instrument know as the LIDA, was developed by L. Y. Rabichev and his colleagues in Soviet Armenia, and is designed for the 'treatment of neuropsychic and somatic disorders, such as neuroses, psychoses, insomnia, hypertension, stammering, bronchial asthma, and asthenic and reactic disturbances.' It is covered by U.S. Patent #3,773,049. In addition to the pulsed RF field, the device also delivered pulsed light, pulsed sound, and pulsed heat. Each stimulus train can be independently adjusted in intensity and frequency. The radiofrequency field has a nominal carrier frequency of 40 MHz and a maximum output of approximately 40 watts. The RF field is applied to the patient on the sides of the neck through two disc electrodes approximately 10 cm. in diameter. The electrodes are located at a distance of 2-4 cm from the skin. Optimal repetition frequencies are said to lie in the range from 40 to 80 pulses per minute. Pulse duration is typically 0.2 sec. In a 1-year trial period, the instrument was used on 740 patients, including adults and children. Positive therapeutic effects were claimed in more than 80 percent of the cases treated."* We accent that this is one of the simplest Russian psychoenergetics devices, obsoleted very early on, and thus released very early for public use.

87. Since U.S. researchers are unaware of the EM wave polarization transduction mechanisms, and in general have no instruments for detecting longitudinal EM waves, the specific transduction effects on humans would not be measured by U.S. laboratories. Hence the U.S. scientists could only think of it in conventional electrodynamic terms, and remained totally unknowledgeable about the specific transduction mechanisms in the human body producing time-polarized EM waves and effects from the device.

88. Max Frankel, "Khrushchev Says Soviet Will Cut Forces a Third; Sees 'Fantastic Weapon'," New *York Times,* Jan. 15, 1960, p. 1.

89. For a simplified introduction to psychoenergetics and the mind-matter coupling mechanism, see T.E. Bearden, "Mind Control and EM Wave Polarization Transductions, Part I", *Explore,* 9(2), 1999, p. 59; Part II, *Explore,* 9(3), 1999, p. 61; Part III, *Explore,* 9(4,5), 1999, p. 100-108.

90. One of the serious goals of the die-hard KGB psychoenergetics scientists appears to be to achieve the capability of directly engineering the entire human collective unconscious mind. The plan envisioned is to convert the human species into a sort of "giant ant species" where each one has perfect, machine-like niche and function (except, of course, for the elite Communist masters). In short, they conceived back there in the 1960s that such a "perfect communist state" for all humanity was in fact possible to achieve technically, with sufficient development of psychoenergetic technology. They are apparently well along the way toward achieving that goal. [The U.S. has not even conceived such a scientific possibility, and modern cognitive science in the West seems bent on the rather astounding proposition that mind itself does not even exist!]. We point out that no type of physical defense is even possible against such a capability engineered into the collective human unconscious, once it is achieved. The only "counter" is to use the same technology (it has to first be developed) to "re-engineer" what will have been done. But our fellows have not even conceived the possibility of the threat, much less the cause or the counter. Hence they continue to totally misunderstand what happened to Captains Button, Svoboda, and Hess in successful mind-control tests achieved perfectly at great distance.

91. To see the nature of the time-density wave (which is basically a longitudinal EM wave along the time axis), due to the perfect correlation between time-energy flow currents and variations with respect to longitudinal EM waves, see T.E. Bearden, "Giant Negentropy from the Common Dipole," 2000, *ibid.* Not stressed in the paper is the fact that the same dipolar negentropy with correlated EM time-energy currents and EM spatial energy currents, exists in the "individual" photon. Further, they can occur in coupled photon-antiphoton pairs, yielding the graviton. For time-polarized EM photons, it appears that two photon-antiphoton pairs are coupled, yielding the "supergraviton." Elsewhere we have briefly and addressed these novel formations as hypotheses.

92. Induction of specific diseases and health changes in the U.S. Embassy in Moscow over four decades, included causing the deaths of three U.S. Ambassadors. It was accomplished by implementing desired disease-pattern "engines" infolded inside field-free potentials. The Johns Hopkins study of the radiation patterns revealed a most significant finding: All the affected persons were in regions of the Embassy where the Russian microwave radiation *fields* were absent. In short, where the field-free—and thus very stable—potentials existed. Since these scientists (and most others in classical EM) consider that EM effects are caused only by fields, they concluded (totally erroneously) that

these health changes could not have been caused by the microwave radiation. To the contrary, they had just clearly proven that the radiation was indeed the cause. They showed a 100% correlation to the *presence of field-free potentials,* and a 100% anticorrelation to where the fields were present. This was for induced phenomena over several years. Had the radiation not been the culprit, then some health changes would have occurred where the fields were present, and some would have occurred where they were absent. That is not what happened at all, and this inexplicable logical non sequitur against common statistical inference was the accepted decision. The truly revealing aspect was that *apparently the entire U.S. Intelligence community had no competence or capability in higher group symmetry electrodynamics.*

93. E.g., see Lewis H. Ryder, *Quantum Field Theory,* Cambridge University Press, 2nd Edition, 1996, p. 147+ which covers the four photon polarizations. See also F. Mandl and G. Shaw, *Quantum Field Theory,* Wiley, 1984, Revised Edition 1993, under the heading "5.2 Covariant Quantization" and "5.3 The Photon Propagator" in Chapter 5.

94. We elaborate on this somewhat, in "Mind Control and EM Wave Polarization Transductions", *ibid.*

95. Again, we point out the unified field approach of Mendel Sachs as probably being the best Western model in which to grapple with these phenomena.

96. David J. Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of'Hidden' Variables, I and II." *Phys. Rev.,* 85(2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II).

97. T. E. Bearden, *Gravitobiology: A New Biophysics,* Cheniere Press, Santa Barbara, Ca. www.cheniere.org, 1991.

98. W. A. Rodrigues Jr. and J.-Y. Lu, "On the existence of undistorted progressive waves (UPWs) of arbitrary speeds 0 < v < oo in nature," *Found. Phys.,* 27(3), 1997, p. 435-508. A slightly corrected version is downloadable as hep-th/9606171 on the Los Alamos National Laboratory web site. It includes corrections to the published version.

99. W. A. Rodrigues Jr. and J. Vaz Jr., "Subluminal and Superluminal Solutions in Vacuum of the Maxwell Equations and the Massless Dirac Equation," *Adv. Appl. Clifford Algebras,* Vol. 7(S), 1997, p. 457-466.

100. E.g., see A. Enders and G. Nimtz, *Phys. Rev. Lett.,* Vol. 48, 1993, p. 632. Enders, Aichmann, Nimtz and co-workers at the University of Cologne have transmitted 8.7 GHz microwaves (free space wavelength 3.4 cm) traveling in a rectangular wave-guide that contains a "barrier" section of reduced dimensions. They transmuted Mozart's 40th Symphony as frequency modulated

microwaves through a barrier wave-guide at an FTL group velocity of 4.7c, receiving audibly recognizable music from the microwave photons that survived their barrier passage.

101. J. D. Jackson, *Classical Electrodynamics*, 2nd Edition, Wiley, New York, 1975, p. 222.

102. See H. A. Lorentz, *Vorlesungen Uber Theoretische Physik an der Universitat Leiden, Vol. V, Die Maxwellsche Theorie (1900-1902)*, Akademische Verlagsgesellschaft M.B.H., Leipzig, 1931, "Die Energie im elektromagnetischen Feld," p. 179-186. Figure 25 on p. 185 shows the Lorentz concept of integrating the energy flow vector around a closed cylindrical surface surrounding a volumetric element. This is the procedure which arbitrarily selects only a small component of the total energy flow in space outside a circuit and associated with it—specifically, the small Poynting component diverged by the surface charges into the conductors to power the electrons—and then treats that tiny component as the "entire" vast energy flow (which may be a trillion or more times greater in magnitude). Thereby Lorentz arbitrarily discarded all the huge *Heaviside* energy transport component that does not strike the circuit at all, is not diverged into the conductors, and is just wasted. See Oliver Heaviside, *Electrical Papers*, Vol. 2, 1887, p. 94. Quoting: *"It [the energy transfer flow] takes place, in the vicinity of the wire, very nearly parallel to it, with a slight slope towards the wire... . Prof. Poynting, on the other hand, holds a different view, representing the transfer as nearly perpendicular to a wire, i.e., with a slight departure from the vertical. This difference of a quadrant can, I think, only arise from what seems to be a misconception on his part as to the nature of the electric field in the vicinity of a wire supporting electric current. The lines of electric force are nearly perpendicular to the wire. The departure from perpendicularity is usually so small that I have sometimes spoken of them as being perpendicular to it, as they practically are, before I recognized the great physical importance of the slight departure. It causes the convergence of energy into the wire."*

103. When it is associated with positive energy fields and potentials from positive mass, positive energy source charges, we have nominated that long-unaccounted Heaviside energy flow component as the source of the excess gravity holding the arms of the spiral galaxies together (a solution to the dark matter problem). When it is associated with negative energy fields and potentials from negative-energy Dirac Sea holes in 4-space, we have nominated that unaccounted energy flow component as the source of the excess antigravity responsible for accelerating the expansion of the universe (a solution to the dark energy problem).

104. About a year from now, Bedini and I will also release a very novel use of this Heaviside energy flow component in inverted circuits—circuits that

operate almost completely in reverse from normal textbook circuits. This is a totally new kind of circuit that we hope will revolutionize power systems and electronic control systems. Until our intellectual property rights are secured, we are not releasing any details at all.

105. Terence W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," *Ann. Fond. Louis de Broglie,* 16(1), 1991, p. 23-41. Tesla was able to shuttle energy around in his circuits at will. Barrett went on to improve the process and patent two versions. See T. W. Barrett, "Active Signalling Systems," U.S. Patent No. 5,486,833, Jan. 23, 1996. This is a signaling system in time-frequency space for detecting targets in the presence of clutter and for penetrating media. See also T. W. Barrett, "Oscillator-Shuttle-Circuit (OSC) Networks for Conditioning Energy in Higher-Order Symmetry Algebraic and RF Phase Conjugation," U.S. Patent No. 5,493,691. Feb. 20, 1996.

106. Bryan G. Wallace, "The Unified Quantum Electrodynamic Ether," *Found. Phys.,* 3(3), Sept. 1973, p. 381-388.

107. William G. Harter, John Evans, Roberto Vega, and Sanford Wilson, "Galloping waves and their relativistic properties," Am. J. *Phys.,* 53(7), July 1985, p. 671-679. Most waves caused by a single frequency source have a galloping motion. The only exceptions are the very special cases of absolutely pure moving waves or absolutely pure standing waves. The superposition and resulting interference of two oppositely moving waves generally yield a wave having nonuniform motion; in short, the wave rushes forward rapidly, then slows appreciably, etc. A relativistic example is given in which the source frame observes a very nonuniformly galloping wave whose velocity varies between 0.01 c and 100 c, even though its average velocity is c. Relativistic properties of interfering electromagnetic plane waves are discussed.

108. S. L. Miller, "The Formation of Organic Compounds on the Primitive Earth," *Ann. NYAcad. Sci.,* Vol. 69, 1957, p. 260; — *Bioch. Biophys. Acta.,* Vol. 23, 1957, p. 480-489; — *Science,* Vol. 117, May 15, 1953, p. 528-529; — and H. C. Urey, "Organic Compound Synthesis on the Primitive Earth," *Science,* Vol. 130, 1959, p. 245-251.

109. R. Harada and S. Fox, "Thermal Synthesis of Natural Amino-Acids from a Postulated Primitive Terrestrial Atmosphere," *Nature,* 201(4917), 1964, p. 335-336; S.W. Fox, "How Did Life Begin?", *Science,* 132(3421), July 22, 1960, p. 200-208; — and S. Yuyama, "Abiotic Production of Primitive Protein and Formed Microparticles," *N.Y. Acad. Sci. Ann.,* Vol. 108, June 1963, p. 487-494; — and K. Harada, "Thermal Copolymerization of Amino Acids to a Product Resembling Protein," *Science,* 128(333), 1958, p. 1214; — and M. Middlebrook, "Anhydrocopolymerization of Amino Acids Under the Influence of Hypothetically Primitive Terrestrial Conditions," *Federation Proc.* Vol. 13, Mar. 1954, p. 211.

110. H. C. Urey, "On the Early Chemical History of the Earth and the Origin of Life," *Proc. Nat. Acad. ScL,* 38(4), 1952, p. 351-363.

111. I.e., one may speak of the "potential" of a specific engine of a former life form, and then realize that the potential for that form reduces in magnitude inversely as the radial distance from the Earth. However, it does not reduce to zero until an infinite distance is reached.

112. As an example, a great EM energy flow—produced by the cross product ExH of the earth's magnetic field and the earth-to-electrosphere electric field—flows from West to East around the earth, nearly parallel to the equator. Infolded in that great EM energy flow are all the structures of all the genetics and life forms on earth, or that have ever been on earth and conditioned the natural scalar potential of the earth. The vials in the laboratory experiments of Miller, Fox, and Urey were all continually bathed in that great energy flow, which within it contained the entire life structure and dynamics of the planet. So no "inert" experiments were ever performed, contrary to the interpretations of the scientific community.

113. Vlail Kaznacheyev and L. P. Mikhailova, *Ultraweak Radiation in Intercellular Interactions,* [in Russian], Novosibirsk, 1981 [an English exposition of much of the Kaznacheyev work is given in Vlail Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions," *Psi Research,* 1(1), Mar. 1982, p. 47-76.] Kaznacheyev, e.g., appears to have headed the Soviet team actually producing the basis for the disease-inducing technology utilized for four decades in the microwave radiation of the U.S. Embassy in Moscow.

114. Specifically, the down payment was $900 million in gold. The lease is probably about $1 billion per year. Thus the Yakuza acquired very powerful strategic weapons, and became a secret power to be reckoned with internationally and strategically. Since 1990, weather engineering over the U.S. and occasional shootdown of aircraft (such as the TWA-800) have been by rogue Japanese fingers on the scalar interferometer weapon triggers, on site in Russia.

115. The Yakuza has also transferred some of the longitudinal EM wave interferometry technology to their Japanese facilities. One such system has apparently been deployed in the power grid, and has been used to kill some government officials who opposed the Yakuza. This information was obtained by some brave Japanese risking their lives to get the information to the present author.

116. Many important KGB weapon tests happened in April of various years; the KGB weapons folks were simply preparing for their May Day reports, and each wished to have a good one.

117. Sen. Sam Nunn's investigation teams verified that the Aum Shinrikyo were actively seeking the "Tesla Weapons", with the Aum Shinrikyo even visiting the Tesla Museum in Beograd for that purpose. We have 100% certain confirmation of the Yakuza and Aum Shinrikyo leasing of the scalar interferometers from the KGB and Russian Mafia (working for the KGB) at the end of 1989 or first few days of 1990. Sen. Nunn's report confirms that the Aum Shinrikyo set up a University in Moscow. Our comment is that this is where the Russians actually taught the Japanese crews the science and technical functions so that they could successfully man and use the scalar (longitudinal EM wave) interferometry weapons.

118. Recall that in the 1950s and early 1960s, Kaznacheyev et al., *ibid.*, had already clearly proven that nearly any form of cellular change, damage, or disease could be induced in cells at a distance by purely electrodynamic means.

119. In the kill of the Arrow DC-8 at Gander, Newfoundland on 12 Dec. 1985, the struck aircraft did charge up with time-density charging, and many pieces of the wreckage did indeed emit longitudinal EM waves thereafter for some time. Consequently, the Canadian recovery crews working the site and handling the materials, were exposed to longitudinal EM wave radiation for varying degrees of exposure. It follows that many of those on-site handlers should have later come down with physical ailments, with symptoms such as flu-like features, weakness, heart palpitations, headaches, dizziness, disturbance of equilibrium, and with various infections because of weakened immune systems. They also should have had weakened cellular regenerative (healing) systems, so their physical problems would endure and largely remain. About five dozen of the recovery personnel did come down with those exact symptoms, and many remained disabled or debilitated for some years.

120. We have also explained (a) why the French forces in the Gulf War did not get GWS, while American, British, and Canadian forces did, (b) why the native population did not exhibit GWS, and (c) the remaining anomalous phenomena associated, such as the semen "infecting" the wife, the children catching similar or related conditions from sustained close proximity to their father's biofields (transmission of engines), etc.

121. Mario Bunge, Foundations of Physics, Springer-Verlag, New York, 1967, p. 176.

122. T. E. Bearden, "Giant Negentropy from the Common Dipole," J. *New Energy*, 5(1), Summer 2000, p. 11-23 gives the solution to the long-vexing source charge problem. The paper is also carried on DoE restricted website http://www.ott.doe.gov/electromagnetic/ and on www.cheniere.org

123. Two examples of inane articles and actions in this respect, revealing no knowledge that every charge in the universe already exhibits COP = oo, are (a)

Graham P. Collins, "There's No Stopping Them: Perpetual Motion is alive and well at the U.S. Patent Office," and (b) Resolution by the Executive Board at the June 2002 meeting of the American Physical Society (APS) as follows: *"The Executive Board of the American Physical Society is concerned that in this period of unprecedented scientific advance, misguided or fraudulent claims of perpetual motion machines and other sources of unlimited free energy are proliferating. Such devices directly violate the most fundamental laws of nature, laws that have guided the scientific progress that is transforming our world."* So the learned APS has just declared the source charge as an unacceptable "free energy" machine and perpetual motion machine, since the charge simply sits there and continuously pours out real observable EM energy in all directions at the speed of light, without any observable EM energy input. Thus the APS has implicitly declared all EM fields and potentials and their energy—which includes every joule of EM energy in the universe, in matter or in space—to be unacceptable byproducts of perpetual motion nonsense. We heartily call upon the APS in the name of science to enforce their resolution in the orthodox academic community, who are the greatest perpetual motion advocates in history. To be consistent with their own resolution, they must root out and destroy—from all texts and universities and from the scientific literature—any mention whatsoever of charge, field, potential, and EM energy. Either they must do that, or stand hoisted on their own petard as a dogmatic group still very much unaware of why the Nobel Prize was awarded to Lee and Yang in 1957 and what the proof—by Wu et al.—of the asymmetry of opposite charges means with respect to the source charge considered in its modern quantum field theory view as a dipolarity of a bare infinite central charge surrounded by clustering virtual charges (also infinite charge) of opposite sign in the active vacuum. Every electrical engineering department and professor and textbook still uses a model and teaches a subject assuming that every charge in the universe freely creates energy from nothing at all. Further, the APS in every annual meeting also tolerates, encourages, and publishes multiple papers and presentations with the same such unacceptable perpetual motion assumptions in them. Such is the lofty understanding of our present organized scientific community, which seems much more politically bent than scientifically bent. The simple Bohren experiment and the entire area of negative resonance absorption of the medium has long been established in nonlinear optics, and such experiments widely yield a nominal COP = 18. In other words, the experiments nominally output 18 times as much energy as the operator inputs, and the excess input energy is furnished absolutely for free from the active vacuum's exchange. In this case the Executive Board of the APS is not even aware of what its own physics discipline has long proven and accepted in particle physics, for nearly a half century. Neither are the self-appointed defenders of the faith, who also are totally unaware of what physics has already proven with a Nobel Prize awarded nearly a half century ago.

124. C. S. Wu, E. Ambler, R. W. Hayward, D. D. Hoppes and R. P. Hudson, "Experimental Test of Parity Conservation in Beta Decay," *Phys. Rev.*, Vol. 105, 1957, p. 1413. We also quote Nobelist T. D. Lee as follows: *"Since nonobservables imply symmetry, any discovery of asymmetry must imply some observable. The experiment of Wu, Ambler, Hayward, Hoppes and Hudson... established the asymmetry between the positive and negative signs of electricity."* [T. D. Lee, *Symmetries, Asymmetries, and the World of Particles*, U. Wash. Press, Seattle, 1988, p. 11.].

125. Dilip Kondepudi and Ilya Prigogine, *Modern Thermodynamics: From Heat Engines to Dissipative Structures*, Wiley, New York, 1998, reprinted with corrections 1999.

126. See "Secret Speech: Did Brezhnev Come Clean?" *National Review*, 29(8), Mar. 4, 1977, p. 248, 250

127. For the energy description of this device and some results, see Floyd Sweet and T. E. Bearden, "Utilizing Scalar Electromagnetics to Tap Vacuum Energy," *Proc. 26th Intersoc. Energy Conversion Engineering Conf. (IECEC '91)*, Boston, Massachusetts, p. 370-375.

128. Also see my book, *Energy from the Vacuum*, 2002, *ibid*, which includes photographs of the self-powering Sweet device, courtesy of Walter Rosenthal.

129. Roy Brewer was very active in Hollywood Unions against Communists when they were busily penetrating the Hollywood complex. He was a staunch anti-communist, fighting them out of control of the unions, way back when. Ronald Reagan was a personal friend of his of long standing, and Roy had open access to the White House when Reagan was President.

Roy briefed Reagan on the Russian scalar weapons, and Reagan believed him. Three times, Reagan ordered his Secretary of Defense to take action in that area, but neither of the three did so because the U.S. Intelligence Community did not believe it and adamantly opposed any such action. We took quite a beating in those days, for quite a long time (some years), before certain key parts of the Government finally believed us, checked it out experimentally, and found that it worked.

Roy also introduced me to the Duke de Grantsmesnil, one of the last of the great old British intelligence men, now unfortunately deceased. In the hectic 1997 days when we were trying desperately to warn a little friendly nation (and our own) against a coming great strategic strike on the U.S. and other allies, the Duke played a major role in introducing us directly to higher political levels in that little nation - which was the only nation on earth that could counter the pending strike. The first planned strike scheduled in February 1997 was successfully countered, only to be immediately rescheduled. In the second

incident, the attack was scheduled for May 1, 1997. We finally realized why the hostile nation could reschedule and go ahead, and needed then to warn the little nation of the reason in some detail. We had tried everything to get certain information through, and all means had failed. A former ambassador of that nation to Great Britain was also assassinated during that struggle. Roy Brewer was one of the key fellows assisting in that attempt, as were other personal colleagues of mine who also were witnesses and direct participants in those desperate events. When all else failed, I finally just faxed the Prime Minister directly, in the clear, some five days before the attack, urging the most urgent and immediate action possible by the Prime Minister. A complete change in command and control of the weapon was required, and that change had to be made and then the hostile nation had to be notified that the change was in place (and probably shown that it was). The Prime Minister accepted the message and the necessary action was carried out immediately. So two days or so before the actual attack was scheduled, that great hostile armada began standing down. Oh, the hostile nation and its leaders could have easily destroyed the entire United States in two hours or so, without fail! But then their own country would have promptly disappeared from the face of the earth. So they stood down. And our own Intel community never even picked it up (they did get my messages alerting the U.S. Government, but thought it was a joke or something). They, of course, also intercepted my open fax to the Prime Minister, and so were all over me for that one for a while thereafter.

Interestingly, at the very time that great armada was just beginning to stand down, then Secretary of Defense William Cohen made the following statement at a conference in Georgia: "Others are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves...so there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...It's real, and that's the reason why we have to intensify our efforts, and that's why this is so important." Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

Ironically, the Secretary was referring to the earlier scalar interferometer weapons, and now the quantum potential weapons etc. He was completely unaware that a great strategic strike had actually been scheduled and was just being aborted as he was speaking those words.

Roy Brewer is one of those fellows who has been a great American, has served his country admirably during his lifetime, and contributed greatly to preventing a planned take-over by the Communists of the labor unions of America. In

addition, he helped set up the contacts with the friendly **liltle foregn nation, so** that on four occasions planned attacks to destroy the United States have been successfully aborted or handled.

As you know, one of the great failures in the Communist plan to have America go communist was their failure with the labor unions. And we owe that failure to the steadfast efforts of some staunch folks like Roy Brewer. He helped save our nation when many of us were still wearing knee pants.

130. Wheeler's principle, as stated in W. Misner, K. S. **Thorne, and J.** A. Wheeler, *Gravitation,* W.H. Freeman and Co., San Francisco, 1973, p. 5.

131. With the new improvements we uncovered, treatment time can be reduced to 5 minutes per patient. Three such treatments one week apart would be what are required. Hence one machine station could treat a patient every five minutes, around the clock. With sufficient portable treatment units, mass treatment for mass casualties would become a practical reality.

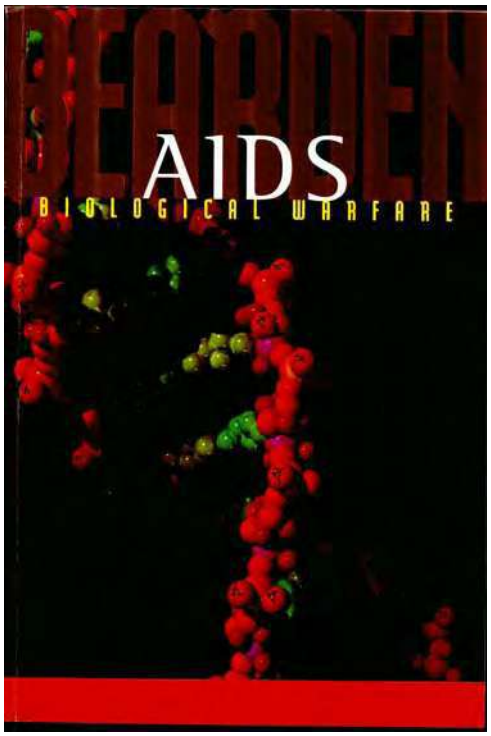

AIDS
BIOLOGICAL WARFARE

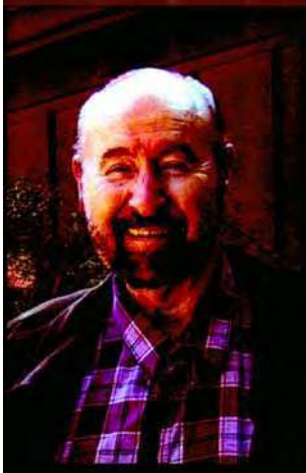

Lieutenant Colonel Thomas E. Bearden (U.S. Army, Retired) PhD, is the author of numerous books, papers, briefings, and presentations dealing with anomalous phenomena, scalar electromagnetics, free energy devices, Soviet Tesla weapons, and Soviet scalar electromagnetic weather warfare.

At the time of writing this book, Lt. Col. Bearden was a senior scientist and department manager with the Alabama division of a major aerospace company where he directed the company's design and production of expert systems (artificial intelligence) applications for the U.S. Army command control systems. He had more than 29 years experience in air defense systems, tactics, and operations; technical intelligence; nuclear weapons employment; computerized wargames; anti-radiation missile countermeasures; and military systems requirements.

Bearden obtained a Master of Science degree in nuclear engineering from the Georgia Institute of Technology and a Bachelor of Science degree in Mathematics from Northeast Louisiana University. He is a graduate of the U.S. Army Command and General Staff College.

Tom was also then a member of Mensa, Society for the Investigation of the Unexplained, International Tesla Society, American Association for the Advancement of Science, Association of American Physics Teachers, the Air Force Association, the Association of the U.S. Army, the American Nuclear Society, and the American Defense Preparedness Association. He was also the Alabama and East Coast Director for the Association of Distinguished American Scientists, was a member of the Alabama Academy of Sciences, and was previously on the Board of Directors of the U.S. Psychotronics Association.

In private life, Tom has two sons and daughters, and lives in Huntsville, Alabama with his wife, Doris.

Sweating done by red_gonzo.

Note: sometimes formatting of the text may be a little fuzzy. It's all because the OCR process didn't go as smoothly as I expected. Also there may be some errors inside text so be vigilant. In any case share this book, send emails to people about knowledge contained in it. This book should especially be interesting to any person in medical community (being as a doctor or as patient) as it provides factual evidence of successful (but supressed) treatments through electromagnetic means. But before any devices can be understood and developed a new and extended kind of physics must be introduced into our educational system. Only then can this proper foundation be learnt and used by applicative sciences such as medicine. So far such knowledge has been contained in highly classified military circles and hopefully now, after many decades of suppression, it will finally be used for the good of mankind.

Dedication

This book is sincerely dedicated to the millions of persons who have died needlessly of cancer, leukemia, and AIDS in the last two and half decades. They were men, women, and children. Some were weak, some were strong. Some died in agony, some died silently. All of them were our fellow human beings. We remember them. They were important. Their anguish cries out to be heard. God willing, the new electromagnetic medicine so long suppressed will flower, and save the millions otherwise yet to die.

Special Acknowledgements

Mr. Christopher Bird's kind permission to print, his summary of the Priore Affair is gratefully acknowledged, as is the contribution of his own extensive Priore research material to this effort. The author owes a great debt indeed to Chris Bird for his magnificent assistance.

Mr. Robert Whitney graciously contributed rare photographs of Antoine Priore's device and also translations of background papers by French scientific journals. His previous valiant though fruitless efforts to bring the Priore machine into the mainline of Western medical treatment are specifically recognized and commended.

Vital contributions by Drs. Robert B. and Theodore A. Strecker are particularly acknowledged. Their March 1986 alert to the federal government, that AIDS was a deliberate biological attack spawned by Soviet agents working in Western research laboratories, is specially pointed out.

Heroic efforts by Dr. John Seale and other scientists to alert the medical research community to the true source of AIDS is specifically recognized and gratefully acknowledged.

Continuing efforts by Dr. William C. Douglass to "tell it like it is" on the AIDS crisis is specially pointed out. His permission to extract and present an excerpt from his research, pointing out tested healing of viral infections by UV irradiation of the blood, is deeply appreciated.

The unyielding and continuing efforts of Dr. Eva Snead, to alert the national authorities to the fact that there is more to AIDS than meets the eye, is also particularly recognized and appreciated.

Decades of effort by John Crane to bring Royal R. Rife's work out of suppression are specifically recognized and appreciated.

Important scalar EM experiments by John Bedini and Frank Golden are fully recognized and deeply appreciated. Their experimental efforts over a period of years have profoundly influenced my own thinking and understanding.

As always, my great admiration and deep thanks go to my friend Hal Crawford, whose keen artistic vision and skilled hand have contributed key illustrations to my work for years.

Other important illustrations and artwork by Messrs. James Thomas Neumann and Lee Giles are gratefully acknowledged.

Photographs furnished by John Moray showing his father's pioneering free energy work are appreciated. T.H. Moray's genius and achievements will yet be recognized.

Support from the Association of Distinguished American Scientists and Mr. Richard J. Reynolds III is deeply appreciated. Without that support, this effort could not have been accomplished.

Important contributions from a host of other colleagues and persons are deeply appreciated. These persons include Frank Golden, John Bedini, Ken Moore, Tom McLaughlin, Joe Parrot, Randy Davidson, George Fencl, Andrew Michrowski, Stefan Possony, Tony Gideon, Electra Briggs, and many others too numerous to mention.

Finally, nothing that I have attempted could have been accomplished at all without the unflinching and loyal support of my beloved wife, Doris.

To all of you I owe a great deal. If this bizarre struggle to save humanity is ever won, it will largely be due to the significant contributions you have made.

Thomas E. Bearden
Jan. 17, 1988

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Chapters 4 and 5
contain complex scientific material
and are suggested for those who are
technically proficient.

FOREWORD

What This Book is About

In my book, **"Fer-de-Lance: A Briefing on Soviet Scalar Electromagnetic Weapons,"** (Tesla Book Co., P.O. Box 1649, Greenville, Texas 75401, 1986), I specifically pointed out that I was of necessity neglecting the biological warfare (BW) aspects. I intended to later write a second book covering the BW aspects.

This book contains the most important item of that planned second book, including the photobiology aspects of BW.

The material is put down in great haste, for it is meant to serve as an urgent warning. There is no time to do the six months additional research and compilation necessary to "flesh it out", sculpture it and meticulously document it, as should be done by a careful scholar.

I apologize to the reader for this lowered standard, but in this case the basic information is far more important than scholarship.

Further, I acknowledge the fundamental contributions of Dr. Robert B. Strecker, M. D., Ph. D., who together with his brother Ted, has for some time urgently called attention to the terrible threat posed by the AIDS epidemic.

I specifically acknowledge his important warning, "This is a Bio-Attack Alert," Mar. 28,1986, which was sent to the U. S. President and Vice-President, Governors of the states, various federal agencies such as Departments of State, Defense, and Agriculture; National Security Agency, Federal Bureau of Investigation, Central Intelligence Agency; and three members of Congress.

Dr. Strecker has also strongly pointed out the covert involvement of Soviet and other communist agents in the epidemic, and the absolute necessity for an *electromagnetic* solution.

Also recognized are the efforts of the other medical scientists, such as Dr. John Seale, M.D., and Dr. Eva Snead, who have tried

repeatedly to call attention to the nature of the AIDS initiation, only to have their submitted papers resoundingly rejected by important journals such as New Scientist, **The** Lancet, etc.

Work by Dr. William C. Douglass in alerting the public to the no-nonsense truth about aids is particularly recognized. His monthly newsletter, **The Cutting Edge,** is an oasis of clarity sharply standing out in a sea of misinformation. Permission to reproduce his published research article on UV irradiation of the blood to successfully heal viral infections is deeply appreciated.

The continuing efforts of Dr. Andrija Puharich and Dr. Robert Beck to assist in achieving an AIDS solution are pointed out and recognized. Important contributions by Ed Skilling are also recognized in this regard.

The vital and extensive contributions of Christopher Bird are particularly acknowledged. Chris has unstintingly and unselfishly shared with me the results of his enormous research on the Priore device and affair and the results of his translations from the French. He has most graciously permitted me to publish his important summary of the Priore affair, and I am greatly in his debt. The reader will find that material most illuminating, and well may be shocked at the depth and malevolence of the scientific and political suppression of Priore's rigorously demonstrated electromagnetic cure for cancer, leukemia, and other killer diseases.

Special acknowledgement is made to Robert Whitney, who so nobly labored to bring the Priore technology into the mainstream of medical treatment, only to be ruthlessly suppressed in his efforts. Photographs of the Priore machine were furnished by Bob from his collection.

My special thanks to colleagues John Bedini, Frank Golden, Andrew Michrowski, George Fencl, Ken Moore, Tom McLaughlin, Joe Parrott and Randy Davidson, without whose assistance this project could not have been accomplished.

The material in this present small book is intended to be of any assistance possible to certain brave colleagues who — with little or

no funds or resources except what they can tear out with their bare hands — are already laboring around the clock to develop a permanent solution to the AIDS problem.

As a matter of discretion, I shall not mention the names of those colleagues. The solution sought is radical, by orthodox assessment. Yet it is the only possible approach that has any chance whatsoever of succeeding.

What they are doing, I cannot do. If they do not succeed, no one can. But I will say this, and most strongly: In my view, the only hope for humanity lies in the work they are doing, and they have my utmost admiration and support.

Their initial results are exciting and encouraging. Basic phase conjugated electromagnetic "mixed-modulations" signals lethal to bacteria, nematodes (hookworm-like organisms), various amoeba, viruses, etc. at very weak power levels have been synthesized and demonstrated.

In my best estimate/opinion, these researchers must succeed in *two years or less, certainly in no longer than three years,* else the **AIDS** incubation already accomplished by then, and the implementation time delay — even given a cure —together will insure a devastation of humanity unparalleled in all of history.

Let me accent that developing this AIDS cure is far more important than developing our entire arsenal of new military weapons. It is even more important than the development of defenses against the Soviet scalar electromagnetic weapons I detailed in **Fer-de-Lance.** Problems in the Middle East, Korea, and Nicaragua are insignificant compared to the AIDS problem.

Desperate Diseases, Desperate Remedies

Spurred by the looming holocaust of AIDS, and by the strong efforts of my colleagues, I have decided to release specific *information on how to develop electromagnetic healing, essentially against any and all of the "killer" diseases including cancer, leukemia, and AIDS.*

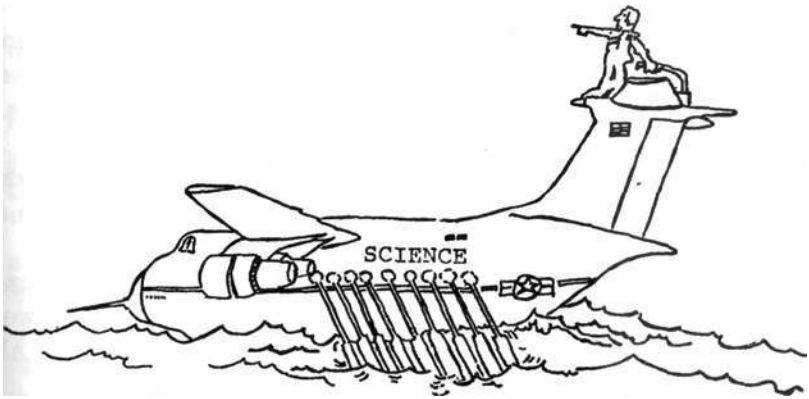

Figure 1. Conventional science cannot do the job.

Unavoidably this also releases a major principle of scalar electromagnetics: what is really going on in phase conjugation. If phase conjugation is truly understood and applied, all the Soviet weapons I have pointed out in **Fer-de-Lance** can be understood, designed and developed.

I'm also releasing specific information on mind and thought that will enable them to eventually be directly detected, measured, and investigated scientifically. Unfortunately, this also will enable them to be technologically manipulated for nefarious purposes.

However, the developing scalar EM technology for the AIDS cure must not be hamstrung. There is no time to apply the standard "Let's classify it!" response. If we do, we'll win the skirmish and lose the war.

As shocking as it sounds, I am convinced that the Soviets have already launched WW III, to the hilt. And it's not at all the kind of war we've been expecting.

There's no time to rail against the Soviets, who have cunningly and in great secret "struck our vitals with the mailed fist." We've been struck in such a way that, *unless we can solve the AIDS problem, in two to three years or less, we are already finished.*

We have been preparing to fight a better World War II. The one we're preparing for is never going to be fought. The real World War III is already raging. Our death knell has been sounded, *and we've not yet even recognized that the battle is underway.*

A great Soviet "first strike to finish us" has already been accomplished. The new "Pearl Harbor" has already happened. The enemy has already overrun our Maginot Line; we are at our Dunkirk. There are no boats waiting, and there are none on the way.

The great Soviet first strike has been delivered with surreptitious biological warfare, not with nuclear weapons or ground forces.

As always in the past, we have almost no troops facing the brunt of the first strike and trying to turn it. This time we have far fewer than we've ever had. Just two or three unorthodox researchers. All the orthodox researchers are manning the wrong ramparts.

Ironically, this time our entire system—the government, the medical establishment, the scientific establishment, the universities — all are far too dogmatic, and have far too sluggish a response time, to offer any assistance at all. They are simply so "out of it" that they don't even know what's really happened.

The bureaucracy simply is so stagnated that, even with a giant paroxysm, it cannot change quickly enough to do the job in time.

The best response the orthodox system could theoretically make —if it immediately placed the nation under martial law, marshalled all the universities and scientists, everything — would require at least seven years to produce results. A more likely response time is 10 to 14 years. That won't do the job.

So the job has to be done from completely *outside* the system. It has to be done with *independent* financing. Financing without a lot of conventional, bureaucratic strings on it. Resources must be committed as needed, immediately, not with a several months' approval process.

Everything in the orthodox establishment simply has to be bypassed.

The government, the medical establishment, the scientific establishment, the universities, everything.

Otherwise, we're as good as finished *right now*.

The "Dirty Dozen"

In the West, there are only perhaps a dozen persons or so that I know of, who are qualified to work on the main task required. They

are all unorthodox researchers and scientists.

There are thousands of fine orthodox scientists, of course, who can help with the peripherals — making and testing viral solutions, setting up and operating equipment, doing interminable tests, all the lab stuff, etc.

But only about 12 unorthodox guys are qualified and mentally and emotionally prepared to come to grips with the particular scalar EM technology required for rapid development of an AIDS cure.

Right now, there are just two or three of the 12 working on this, hammering away as best they can, at terrible cost to themselves and their normal endeavors.

Obviously immediate funds are needed for facilities, equipment, and marshalling that dozen unorthodox researchers and a team of scientists — along with support staff and personnel.

An Analogy

I'm reminded of a story from WWII.

On the beach at Anzio, in a battle lull some doughboys were briefly resting near their foxholes, eating lunch from C-ration cans.

A lone German Messerschmitt appeared, closing on them fast and low with machineguns blazing. They were forced to hastily jump into their foxholes as the Messerschmitt strafed their position.

The pilot continued to make strafing run after strafing run, low and "on the deck." Obviously lunch was rather totally disrupted.

Suddenly, in total disgust a soldier leaped up and flung his half-filled C-ration can into the air directly at the approaching aircraft, full in the teeth of the machinegun fire.

Incredibly, the can sailed straight up into the air intake of the hurtling aircraft, where it was sucked into the engine, which sputtered and died.

The surprised German pilot banked his plane upward and bailed out.

He was promptly captured by the very troops he had been strafing only moments before.

Those two or three colleagues of mine are literally "throwing their C-ration cans" in a desperate effort to ward off a monstrous threat.

Those two or three are striving to the limit of their endurance.

This book and the release of the material in it represent my own "Oration can" hurled into the teeth of the actual Soviet threat as a last resort. Hopefully we can "hit the air intake" of the Soviet juggernaut, so to speak, and stop its progress.

The giant Soviet scalar electromagnetic weapons that I detailed in **Fer-de-Lance,** e.g., are easily countered — in six months or less. Primarily, it is necessary to make a pumped phase conjugate mirror adjunct (PPCMA) that operates at the frequency band of interest, and associate it with a receiver. Once a signal is received from the enemy weapon — say, from a Woodpecker transmitter — it is introduced to the PPCMA. A powerful phase conjugate replica energy pulse is returned into the distant hostile transmitter, totally destroying it.

To meet the viral biological warfare weapon, however, we must develop electromagnetic healing.

In an important article, "SDI vs. the plague," Mar. 8,1988, p. 6, the **Washington Times** revealed a startling Pentagon conclusion that the Soviets may counter SDI with genetically engineered weapons.

Valentin Falin, Chief of the Soviets' Novasti Press Agency, is quoted as saying:

"We won't copy you anymore: We'll take asymmetrical means with new scientific principles... genetic engineering could be a hypothetical example. Things can be done for which neither side could find defenses or countermeasures, with very dangerous results. If you develop something in space, we could develop something on earth. These are not just words. I know what I'm saying."

The genetically engineered Soviet counterstrokes exist and are already being taken. This book tells you what the asymmetrical means, new scientific principles, and genetically engineered weapons are.

May God help us all. If we do not move immediately and correctly to augment the effort of my colleagues, the Free World and half of the peoples of the earth will perish before another decade passes.

CHAPTER 1

THE VACCINE CONNECTION

The following quote is from Don Rowe, **Wall Street Digest,** 214 Carnegie Center, Princeton, New Jersey 08540.

"The AIDS Plague will affect society in ways that you cannot now imagine. AIDS is 100% fatal. Scientists and medical research people are not optimistic about an immediate cure to [or] vaccine. They do not expect to develop an effective vaccine within the next two decades. Public health officials estimate that as many as 2.4 billion people (half the world's population) will die from AIDS within the next 15-20 years."

"Economically, the insurance and medical health systems could be devastated in the 1990's. Nothing short of a spectacular medical breakthrough will keep Western civilization from suffering the worst catastrophe in the history of the world."

The first official U. S. AIDS case was diagnosed in San Francisco in 1981. This followed the puzzling outbreak of the disease in Third World areas such as Africa and Haiti in the 1970's.

The U.S. AIDS outbreak at first seemed to be confined to the gay community, such as in San Francisco.

No one seemed to connect the apparently unrelated facts that, before the outbreak in the U.S. gay community, (1) the World Health Organization had accomplished substantial smallpox vaccination in Haiti, and (2) West Coast gays — particularly from San Francisco — had made Haiti a main playground and vacation spot.

Most orthodox medical scientists have not the foggiest notion why such a drastic "explosion" of the virus has occurred.

It has occurred because *AIDS was introduced by contaminated vaccine used by WHO in its smallpox eradication campaign.* A high correlation exists between WHO vaccination and subsequent outbreak of AIDS.

Figure 2. The "monkey-bite" theory.

The "Monkey-Bite" Theory

As the prevailing rationale goes, a naturally-mutated monkey AIDS virus derivative or strain is believed to be the cause of the monstrous plague looming to strike down half of all the humans on earth.

That is, a monkey is supposed to have bitten a man—an African—and transmitted the normally harmless monkey AIDS virus to him. The virus is then supposed to have naturally "recombined" its genetic material with other viral genetic material and the man's human genes, to produce the virulent new strain of AIDS.

Then this new strain, *from its single human host*, is supposed to have rapidly started spreading through Africa and around the world.

That is simply nonsense.

In Africa, for example, monkeys as well as other animals have had their viral diseases for thousands of years. If monkey virus were the culprit, African man would have been devastated by AIDS thousands of years ago. He either would have been dead or—as have the monkeys — he would have developed a certain resistance and tolerance for the disease, so that it is no more harmful than others.

Understand, the "monkey bite plus human cell modification" undoubtedly does occur in Africa with great rarity — once in several thousand years.

However, even if that rare natural recombination of the monkey AIDS virus were to occur in a single human, normal contact between other humans and the infected human is totally insufficient to provide any substantial infection rate *unless the rate of infection of new individuals is greatly assisted and vastly speeded up by some other outside mechanism — for example, by something like AIDS-contaminated vaccine and a mass inoculation program.*

Retroviruses ***and Recombinants***

As Dr. John Seale has pointed out, "The AIDS virus (human immunodeficiency virus or HIV) is a lentivirus — a little-studied sub-family of the retroviruses. It is highly pathogenic to man but it differs profoundly from any other virus of humans. It is spreading rapidly in the general population of central Africa, and amongst homosexual men and drug addicts in the West. *It is the first virus to have appeared in mankind for many centuries which is entirely new, highly lethal, and spreading steadily from person-to-person world-wide."* [accent by the present author.]

Dr. Seale has courageously pointed out some other very disturbing facts:

(1) Retroviruses of animal origin, if repeatedly passed from human cell culture to human cell culture, will gain the ability to infect human cells *preferentially.* Indeed, they may then even cease to be infectious to their original animal hosts.

(2) In 1982 Robert Weiss pointed out that, in the laboratory, the genetic code of retroviruses commonly recombine if two of them infect the same cell simultaneously.

(3) In a 1984 article in the **Journal of Virology,** David Baltimore showed an efficient means of overcoming the cell's block against simultaneous infection by two or more retroviruses.

(4) Further, Baltimore reviewed how *this had widely been done during the preceding ten years!*

(5) Outside the laboratory, recombination of multiple simultaneous retroviruses has not been shown to occur naturally in humans.

(6) In animals, there is some evidence that it may occur naturally with extreme rarity — indeed, only once in many thousands of years.

(7) By the early 1970's, the technology to make new recombinant retroviruses virulent to humankind was already developed and had been widely published.

To the layman, the infection and reproduction by retroviruses is peculiar to say the least.

When a retrovirus infects a cell, from its own genetic material (RNA) it first makes a "template" or pattern (DNA) for forming other retroviruses just like it. It then inserts this "DNA template" into the DNA of a cell. The host cell itself is now a "sleeping factory", ready to start producing retroviruses.

When activated, the "template" in the cell causes the factory to go into production of retroviruses. Activation is varied. The "infection production factory" can just remain dormant, be slowed over years, take place almost immediately, or be slowed for years and then "explode" to rapidly increase the infective viruses.

Genetically, the cells of any person infected with AIDS or any other recombinant retrovirus have been permanently transformed. Literally that person has acquired a new set of genes. He or she has been converted into a "factory" for producing—and spreading—the virus.

Cancer Research Produced Ideal Biological Warfare Agents

In 1971 President Nixon signed into law the National Cancer Attack Act. Though certainly not intended by the President and the Congress, *the inadvertent result of this act was that taxpayer's funds were used to research and develop the precise things that constitute the most lethal kind of viral biological warfare.*

The on-going small effort in medical research laboratories to alter animal tumor viruses — including retroviruses —to replicate efficiently in human cells was drastically speeded up, as part of the new "war on cancer." In other words, whether intended or not, much of our cancer research money was converted into the precise kind of research that develops virulent biological retroviruses for potential use in biological warfare.

Not only was the research drastically accelerated, but also the

direct participation by Communists and scientists sympathetic to the communist cause was accepted and encouraged.

Astoundingly, this open invitation to the communist scientists was issued at a time when one of the high KGB priorities was to infiltrate our recombinant DNA genetics laboratories! To the Soviets' utter astonishment, we simply opened our labs and invited them in.

The Soviets participated — and penetrated — with alacrity. It is an obvious conclusion that a number ofthe Iron Curtain scientists sent to help staff our laboratories were undercover KGB agents.

In the cancer laboratories, on a wide-spread scale, animal retroviruses were injected and reinjected into human cell cultures, until these retroviruses had become efficient, lethal recombinants favoring human cells as their hosts.

At that point, infection of one or more persons by one of these lethal new retroviruses could unleash a massive AIDS-like plague on all mankind.

A single laboratory accident (or a single act by one Communist agent) could unleash the Great Death Plague.

Weak and ineffective reference to this forthcoming danger was made in 1974 by the Committee on Recombinant DNA Molecules, which had been established by the U.S. National Academy of Sciences. According to **Science,** July 26,1974, p. 303, the Committee made the following rather bland and ineffectual recommendation:

"Scientists throughout the world (should) join with the members of this committee in voluntarily deferring experiments (linking) segments of the DNA from (cancer-causing) animal viruses to... possibly increase the incidence of cancer or other diseases."

So much for the great scientific watchdogs.

U. S. "Cancer War" Labs Were Infiltrated

As we said, ironically we ourselves helped load and cock this potentially disastrous biological warfare cannon. Incomprehensi-

bly, enemy fingers were permitted — even encouraged! — to be placed on the trigger. Many of our medical research facilities involved in this research contained known Communists, dissidents, etc.

For example, see page 106 in Omni, March 1986. Carlton Gajdusek, presently Chief of the National Institute of Health's Laboratory of Central Nervous System Studies and Laboratory of Slow, Latent and Temperate Virus Infections, was asked the question, "Isn't Fort Detrick in Maryland such a biological-warfare research facility?" He responded:

"No, emphatically no! There is no defensive or offensive warfare microbiology done at Fort Detrick today. It is the national cancer research facility of NIH. In this facility I have a building where more good and loyal Communist scientists from the USSR and mainland China work — with full passkeys to all the laboratories — than Americans. With night-working U. S. citizens and foreign Communist investigators here, obviously there is no "secret" bacterial warfare activity going on. Even the Army's infectious-disease unit is loaded with foreign workers — not always friendly nationals. It is a valid basic research unit on worldwide problems of infectious -diseases in which no classified or secret activities unfold."

The point is, what was being produced in these labs were viruses that would grow in human cells. Under tight control, these new lethal agents could be safely studied, and many things could be tried experimentally to see if they would slow, stop, or kill the viruses and heal or benefit the virally infected human cell cultures.

The viruses were being developed to benefit man by aiding in the war on cancer — we accent this most strongly.

However, many of them were precisely the same things that would be developed in a biological warfare lab: lethal new viruses that preferred the human as a host, and against which humans have developed little or no immunity.

The Deed Was Easily Done

Now one can see the subtlety and irony in the Soviet Union accusing the U. S. of having made the AIDS virus at Ft. Detrick!

It's both true and false at the same time.

There is substantial information indicating that the AIDS disease is manmade, and has been deliberately unleashed on mankind by Soviet and other Communist agents, augmented by the international control groups and shockingly inept work by U. S. and European medical researchers.

Human cell cultures deliberately infected with animal viruses were carelessly handled in U. S. and European laboratories — carelessly handled in that far too great (essentially open) access to the new viral strains was permitted.

Our own scientists were apparently unwitting pawns, and Soviet agents performed the "final touchups" to insure release — whether intentional or inadvertent — of the lethal new agents against an unsuspecting world.

Viruses can infect bacteria, since a bacterium is a one-celled organism and the virus is a single molecule.

Cell cultures where vaccine is made from weakened bacteria could easily be contaminated with the desired recombinant viruses available in the cancer laboratories.

To insure worldwide release of the lethal virus, covert Communist agents apparently caused contamination of the smallpox vaccine that was prepared in quantity in Western laboratories.

This contaminated vaccine then was widely used to inoculate Third World peoples and others, in the successful international program to eradicate smallpox.

With only a few agents in key places, the Soviets could easily have taken advantage of the looseness of Western laboratory procedures to deliberately contaminate the animal cell cultures used to make the vaccines.

They had an abundance of agents in the key laboratories, for they were openly invited in and accepted!

The Soviets had their fingers in it, up to the elbow.

And at just exactly the right time, the answer to a Communist's biological warfare dream was available: The World Health Organi-

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Figure 3. The Soviets have delivered an intended knock-out.

zation was already involved in its 13-year campaign of massive smallpox inoculation in the Third World, to eradicate smallpox.

All that was needed was to contaminate the WHO vaccine by one or more of the lethal new recombinant retroviruses that had been developed — and were continually being developed — in cancer research laboratories filled with Communists agents.

The opportunity was presented for a great Soviet "first strike" against the West, using biological warfare agents developed in U.S. and European laboratories and administered by an international agency.

The opportunity was ripe for the taking. It was irresistible. You can be sure the Soviets took it.

It's Actually Documented!

Virus-contaminated vaccines were then widely administered to Third World countries—particularly in Africa, South America, and Haiti. Administration of these vaccines by the World Health Organization is precisely correlated to the subsequent outbreak of the AIDS

epidemics in those countries.

This strongly indicates that the vaccine itself was the "precursor" agent initiating the start of the AIDS infection.

In a shocking article, "Smallpox vaccine 'triggered Aids virus'," in the London **Times** of May 11,1987, **Times** Science Editor Pearce Wright announced that the AIDS epidemic may have been caused by World Health Organization (WHO) smallpox inoculations in third-world countries.

In an important article in **Easy Reader,** June 4, Jon Rappoport reported the **Times** article and the results of an interview with Robert Matthews, technical correspondent of the **Times.**

According to Rappoport, Matthews informed him WHO itself had somehow suspected that its immunization program against smallpox might be connected to AIDS. An outside consultant was employed to perform an independent study, and the study confirmed that WHO vaccines were indeed — somehow — causing AIDS to evidence in inoculated persons.

Needless to say, WHO promptly buried that report—whose conclusion must have been the last thing WHO wanted to hear.

The consultant then came to the **Times.** The **Times** heard him out and printed the story.

This astounding story has almost startling correlations: *"The smallpox vaccine theory would account for the position of the Central African states as the most afflicted countries; why Brazil became the most afflicted Latin American country; and how Haiti became the route for the spread of AIDS, to the U.S.: Brazil, the only South American country covered in the eradication campaign, has the highest incidence of AIDS in that region."*

Rappoport confirms that the subject of contaminated vaccines—"vaccines which, made in tissue cultures of animal parts, contain 'extra' dangerous viruses" — has been of increasingly serious concern to medical scientists in recent years, and the WHO smallpox vaccines may have been contaminated in this fashion.

A documented U.S. Army incident is a case in point.

New U.S. Army recruits are routinely vaccinated against a

range of diseases. One of them is smallpox, in case an enemy should try to use smallpox as a biological warfare agent.

A healthy 19-year old Army recruit developed AIDS after vaccination, and was admitted to Walter Reed Army Medical Center, where he died.

In a paper published in the **New England Journal of Medicine,** Walter Reed medical team scientists reported their discovery of the connection between vaccination and stimulated AIDS disease.

They also warned against the WHO plan to use modified versions of the smallpox vaccine to combat other diseases in developing countries.

WHO's 13-year vaccination and eradication program ended in 1980. The program is credited with saving two million lives a year and preventing 15 million infections.

It may be inadvertently responsible for the ultimate death of billions.

In a meeting of 50 experts near Geneva in May, 1987, it was revealed that millions of new AIDS cases are about to hit Southern Africa. The experts believe that up to 75 million Southern Africans — about a third of the population — may have AIDS within the next five years.

From our previous statements above, it appears almost certain that Communist agents who had penetrated U.S. and European laboratories manipulated the contamination of the altered vaccines.

Further, the Soviets may be stimulating the disease and guiding it electromagnetically, by special implanted signals carried by the giant Soviet woodpecker "over-the-horizon radars" and other Soviet transmitters.

Or, the Soviets may be using their own transmitters and ours, including our own power lines and radio and TV stations, to broadcast signals that "precondition" and greatly amplify our population's vulnerability to certain selected diseases — AIDS and otherwise.

We will address these issues and Soviet subtle EM capabilities later.

Soviet Biological Warfare Background

In World War I, the Russians suffered half a million casualties

to gas warfare, including 50,000 dead.

At 10,000 troops per light division, that's the equivalent of 5 divisions killed and 45 divisions incapacitated.

This made a deep and lasting impression on the Soviets. Lenin himself ordered a major effort mounted to develop and manufacture chemical and biological weapons, for he understood the implications of such mass-destruction weapons.

In 1919 the Soviets began work in earnest on BW weapons. Work on them has not stopped since then. It will not stop so long as the Communists remain in power.

To loyal Communists, Lenin's dictate to develop and lead the world in biological weapons is absolute and unquestioned.

By 1937, the Red Army was fully equipped and psychologically prepared to wage chemical and biological warfare.

Continuing today, the Soviet forces have the highest training in chemical warfare of any troops in the world. Red Army soldiers practice regularly, often using actual chemical agents. Decontamination is a standard measure and practiced as a matter of course.

Even though the Soviets, along with many other nations, signed the Geneva Protocol of 1925 which banned the use of deadly chemical and bacteriological weapons, the Soviets have never ceased development of such weapons.

In the 1930's, a secret Soviet bacteriological institute was set up at the town of Suzdal. Prisoner microbiologists worked on a variety of new weapons and vaccines, including bubonic plague and tularemia (rabbit fever). By World War II the Soviets were prepared to retaliate vigorously to any use by the Germans of chemical and biological warfare agents.

After the war, Soviet research and development in chemical and biological weapons continued apace. However, much of the genetic work was hampered by Stalin's stern support of the autocratic control of agronomist Trofim D. Lysenko. Lysenko's crackpot theories on genetics, for example, held that genes did not even exist. After the death of Stalin, Lysenko's work was discredited, and the Soviets set forth immediately to "catch up" with the West in genetic implications such as recombinant DNA techniques.

Thus in the early 1960's the Soviets began sending Russian

scientists to the West to catch up with Western genetics research. One of these scientists was David Goldfarb, who later became a leading Soviet expert in the field of molecular genetics. He headed up the Laboratory of Molecular Genetics of Bacteria and Bacteriophages of the Soviet Academy of Sciences in Moscow. Although he did not work on secret Soviet projects, the Soviet authorities stopped him cold when he applied for a visa to leave in 1979. Goldfarb was a specialist in plasmids, antibiotic resistances, and recombinant DNA technology—all very, very useful to the Soviet effort in biowar.

One can readily understand the reluctance of the authorities to release scientists such as Goldfarb. After all, the Soviet "dirty work" with the deliberate AIDS contamination of the World Health Organization's smallpox vaccine had already been accomplished and a great Soviet biological warfare "strike" was already underway, thanks to the massive smallpox vaccination program of WHO.

In 1972, in the Biological and Toxin Weapons Convention, the Soviet Union and every major power agreed not to develop or use biological weapons. The agreement went into effect in 1975. Although it bans the development, production, and stockpiling of biological agents and toxins for hostile purposes, it has not slowed or altered the Soviet program.

In the early 1970's, Soviet leaders made a decision to use genetic engineering to produce new and improved BW weapons. Highly secret institutes for this purpose were set up in Moscow, Leningrad, and Novosibirsk. These laboratories specialize in seeking ways that genetic engineering techniques can be used to develop virulent strains and agents that their opponents cannot resist.

Every Soviet civilian institution dealing with bacteriology and epidemiology is responsible for certain military work as well. The Soviet Academy of Sciences in fact funds appreciable research of such nature at these institutions.

One of the major Soviet centers for recombinant DNA techniques in biological weapons research is in the village of Protvino, near Moscow. Research on chemical and biological weapons is very easy to conceal, and the Soviets are sure that they will not be caught. Satellites cannot detect what is going on in the labs. The payoff is big and the risk is minimal. The Soviets push this area vigorously.

A number of installations capable of producing disease agents and toxins on a large-scale basis and placing them in munitions and delivery systems have also been identified. One such facility is in the city of Sverdlovsk and has a long history of BW research and development and production, with emphasis on anthrax. During early April 1979, an accidental release of anthrax occurred in Sverdlovsk that caused many casualties and deaths in spite of heroic efforts by Soviet doctors and cleanup and decontamination crews.

Note that, according to DoD's 1987 edition of **Soviet Military Power,** page 110, *"Anthrax causes a high mortality rate when the infection results from ingestion (up to 70 percent fatal) or inhalation (almost 100 percent fatal) if treatment is not promptly begun."*

In addition to military BW institutes, military officers and KGB agents are assigned to key posts in the Soviet Union's normal health and science ministries to monitor research and development that has possible military significance.

Also, the KGB has a continuing and highly active program to insert recruited Soviet Scientists in Western genetic research institutes and agencies. This is a high priority effort, and it has been very successful. Also, it obviously says something about the probability of Soviet agents penetrating U.S. and Western European cancer research institutes, particularly those using recombinant DNA techniques. To make it even worse, we simply invited them in with open arms!

Indeed, it was that KGB program plus the "open arms" in Western cancer virology research institutes that enabled the Soviets to set up and bring about a massive "first strike", using WHO and Western laboratories to do the actual dirty work unknowingly.

We *Need An Immediate, Full Scale Investigation*

Annually, President Reagan makes a report to the U.S. Congress on the subject of Soviet noncompliance with Arms Control agreements.

In April, 1984 Defense Secretary Caspar Weinberger put it this way:

"There is an apparent effort on the part of the Soviets to transfer selected aspects of genetic engineering research to their biological warfare centers... Soviet research efforts in the area of genetic engineering may also have a connection with the biological program...Normally harmless, non-disease-producing organisms could be modified to become highly toxic or produce diseases for which an opponent has no known treatment or cure. Other agents, now considered too unstable for storage or biological warfare applications, could be changed sufficiently to be an effective agent."

At the time that Secretary Weinberger made this statement, a devastating biological warfare strike using those exact techniques had already been unleashed on the Western world by the Soviet Union, cleverly disguised under the banner of the World Health Organization's smallpox vaccination program.

It is imperative that the Congress of the United States launch a full investigation of the entire background of the AIDS biological warfare strike, as a matter of the highest priority.

The investigation should include the role of the Soviet Union, fellow-travelers, and Western scientists openly sympathetic to the Soviet cause.

It requires little investigation to see that there is a well-marked trail for several decades, showing that such a biological warfare strike against humanity has long been considered — and even preferred — by those advocating the Communist cause and world domination.

For example, Bertrand Russell, philosophical spokesman for a group of Westerners, explicitly stated this diabolical BW capability for consideration, in his **Impact of Science on Society:**

"At present the population of the world is increasing at about 58,000 per diem. War, so far, has had no very great effect on this increase, which continued throughout each of the world wars... War has hitherto been disappointing in this respect... but perhaps bacteriological war may prove effective. If a Black Death could spread through the world once in every generation, survivors could procreate freely without making the world too full. The state of affairs might be

unpleasant, but what of **it?"**

The blood of every American — and every European, African, and Asian — should curdle at such words. We are now facing the very "Black Death" type of plague referred to by Russell in such glowing terms!

Highly influential followers of the Russell philosophy — and his callous approval of the periodic slaughter of much of the world's population — may have continued to view the great destructive power of new viral warfare agents as the best means to achieve their end: Selective thinning of the world's population.

At least a few such men may have continued to cooperate with the Soviet Union to work powerfully behind the scenes in international organizations, trying to arrange the proper opportunity to achieve their nefarious purpose.

The "East-West cooperative effort" in cancer research created and gave them the precise biological agent custom-made for the job.

WHO's massive, worldwide smallpox inoculation program gave them the precise means to rapidly get the deadly virus into enough human veins to assure a new "Black Death."

All that had to be done was surreptitiously contaminate the vaccine — the easiest thing of all.

This plague has been knowingly, with malice aforethought, unleashed upon mankind. The perpetrators should be hounded down like the wild beasts they are, uncovered in the full light of day, and suitably punished with the swift and sure justice they deserve.

At least one outstanding medical consultant had the courage to report to WHO that their vaccine was generating the AIDS epidemic. When WHO suppressed the evidence, the London Times had the courage to print the story.

I strongly urge every U.S. Senator and Congressman to introduce and/or support immediate legislation that would launch a full-scale, massive investigation, with no stone left unturned. I urge every concerned activist to demand and support such an investigation at the highest level.

By preoccupying ourselves with lesser things — "IranGate," Nicaragua, the Middle East, etc. — we are simply fiddling while Rome burns.

CHAPTER 2

THE SOVIETS KNEW THE U.S. WOULDN'T REACT

Administering the Coup-de-Grace

As we've seen, the present AIDS viruses were deliberately created in Western cancer research laboratories strongly penetrated by Communist scientists and Soviet agents.

In laboratory experiments that were a legitimate and vital part of the war against cancer, animal retroviruses were repeatedly injected into human cell cultures until they recombined to produce **strains** hostile to human life—strains that would thus live in human cell cultures.

Even though their work was accomplished for a totally different purpose, cancer laboratories produced the ultimate, made-to-order biological warfare agents.

The World Health Organization (WHO) is also strongly penetrated — and even controlled at some levels—by communist agents, **as** are many other such international agencies.

And WHO's massive smallpox vaccination program in Third World countries provided the Soviets a made-to-order opportunity to have (ostensibly) "someone else" deliver the actual BW strike.

In other words, the Soviet deception plan was complete.

It was very simple for Soviet agents to contaminate the cultures in which smallpox vaccine was being produced for WHO's inoculation campaign. This insured the production of vaccine contaminated with AIDS viruses, and the subsequent massive infection of the African peoples and other Third World nations.

It delivered what will be the knockout punch against the West, unless AIDS is countered.

Table 1. Interesting Soviet Statements

"WE HAVE A NEW WEAPON, JUST WITHIN THE PORTFOLIO OF OUR SCIENTISTS, SO TO SPEAK — SO POWERFUL THAT, IF UNRESTRAINEDLY USED, IT COULD WIPE OUT ALL LIFE ON EARTH."

NIKITA KHRUSHCHEV,
1960, SPEAKING TO THE PRESIDIUM

"WE WILL BURY YOU!"

NIKITA KHRUSHCHEV,
TO RICHARD NIXON, "KITCHEN" DEBATE

"IF A MEANS OF TOTAL NEUTRALIZATION OF FOREIGN MISSILES IS TO BE FOUND, IT CAN ONLY COME FROM *A GROUP OF NEW PRINCIPLES IN PHYSICS, CALLED ENERGETICS!"*

NOBELIAN PETER KAPITSA, TO NIKITA KHRUSHCHEV

"EACH SIDE SECRETLY DEVELOPS NEW MEANS OF WARFARE IN ORDER TO EMPLOY THEM UNEXPECTEDLY. HISTORY KNOWS MANY EXAMPLES HOW THE EMPLOYMENT OF A NEW WEAPON INITIALLY GAVE CONSIDERABLE SUCCESS BECAUSE THE ENEMY, CAUGHT UNAWARES AND NOT KNOWING THE COMBAT CAPABILITIES OF THIS WEAPON, WAS FOR SOME TIME INCAPABLE OF EFFECTIVE COUNTERACTION."

V.YO. SAVKIN, THE BASIC PRINCIPLES OF OPERATIONAL ART AND TACTICS. MOSCOW, 1972.

"OF PARTICULAR IMPORTANCE IS BASIC RESEARCH AIMED AT DISCOVERING STILL UNKNOWN ATTRIBUTES OF MATTER, PHENOMENA, AND THE LAWS OF NATURE, AND DEVELOPING NEW METHODS FOR THEIR STUDY AND USE TO REINFORCE THE STATE'S DEFENSE CAPABILITY."

PORTION OF A BOOK BY MARSHALL GRECHKO
DELETED FROM ENGLISH TRANSLATION, BY SPECIFIC REQUEST OF THE U.S.S.R.

"WILL SHORTLY SEE DEVELOPMENT OF NEW WEAPONS, MORE POWERFUL THAN NUCLEAR WEAPONS, AND THEY WILL BE NONVERIFIABLE."

LYSENKO (FIRST NAME UNKNOWN)
USSR REP/SOVIET EMBASSY WASHINGTON, D.C.
WORLD FURTURESCONFERENCE, WASH. D.C, 20 JUL 82.

Murky "Behind-the-Scenes" Intentions

As was pointed out, the WHO inoculation program is well-correlated as the precursor or "initiator" of the AIDS epidemic.

Where WHO smallpox vaccination occurred, the mysterious symptoms of AIDS disease appeared in due time.

Even the eventual spread of the AIDS virus to the U.S. homosexual community is explainable.

For example, the economy of Haiti had earlier been made a shambles. The poor citizens of that impoverished island had been reduced to desperate straits.

In desperation many younger Haitian males had begun to prostitute themselves to visiting homosexual tourists. The Haitian males were not homosexual themselves; rather, they were desperate to gain money to provide for their starving families.

In response, U.S. homosexuals — particularly from San Francisco and New York — had made Haiti their vacation playground. They even ran ads to this effect in their gay newsletters and mngazines.

WHO then vaccinated some 15,000 or so Haitians against smallpox, using the vaccine contaminated with the AIDS virus. This introduced AIDS into Haiti and into the Haitians.

The U.S. homosexuals quickly picked up the AIDS virus by direct contact, and brought it back to the U.S. with them. There the nature of the activities engaged in by homosexuals was responsible for enhanced spread of the virus among members of the homosexual community.

Engineering the AIDS epidemic appears to have been a collusion between Communists and the international control groups.

Apparently the control groups wished to "clean out the African continent and other Third World areas" — possibly to provide room for relieving population pressure in the developed countries. This may have been seen as the way to solve the problem of the ballooning human population — the so-called "biological time bomb."

The Soviets, however, realized that contamination of the smallpox vaccines would result in an epidemic of unparalleled proportions. They recognized the opportunity for safely initiating — and winning — World War III with a great first strike.

The Soviets themselves already possess an electromagnetic cure for diseases such as AIDS, but they have not unveiled it.

All such products of scalar electromagnetics (which the Soviets call energetics) are held tightly by the KGB.

That the Soviets have kept such a cure secret strongly implies that they regard it as a known antidote for biological warfare agents, and thus highly classified.

The importance of this can easily be seen: Presently the West has absolutely zero defense against a biological warfare strike using viruses as BW agents.

In such a strike, fast-acting viral strains can easily be used — say, agents which are highly infectious and kill within two or three days.

Development of a vaccine is impossible. There is simply no time to do that. Further, even if the virus was slow-acting, a vaccine could only be developed if the virus is stable. If it is unstable (constantly mutating), development of a vaccine is impossible.

The greatest vulnerability of the U.S. today is its total vulnerability to unknown BW viral agents. Absolutely nothing we have or are doing in our Department of Defense is of any consequence or protection against new BW viruses for which no vaccine is developed or possible.

The great ease with which such cheap new, highly lethal viral BW agents can be developed means that even a relatively small military power—such as Libya, Cuba, or Iran—can develop and use them against the U.S.

Such BW viral agents can also easily be clandestinely planted across the U.S., to devastate an unsuspecting, unprotected American populace.

In fact, even a single deranged madman can readily develop lethal BW viral agents sufficient to devastate even a great military power. Further, in an open society such as the U.S., that same madman can easily introduce such an agent he develops — and, if he's clever, not even get caught in the act.

Past isolated cases of "contamination" of on-the-shelf drugstore medicines is just a faint prelude of that which is to come.

Indeed, we may unwittingly do it to ourselves by accident, even without a BW strike by the Soviets, small enemy powers, or a madman.

Throughout the West, it is now most fashionable to experiment with the production of new bacteria and viruses. Gene-splicing, rccombinant DNA genetics, etc. are being employed on a grand scale as the latest "scientific marvel."

Even some high school students have experimented with this sort of thing. Many other colleagues, universities, and private persons are proceeding full-tilt with casual experiments.

Most of this "casual experimentation" is uncontrolled. When finished, the residue gets dumped in the trash can or flushed down the drain. In any case, it goes into our biosphere. Some of this residue contains unstable, highly adaptable viruses.

It's only a matter of time until one of these unwitting agents gets loose and survives — one that's lethal, fast, and highly infectious.

Make no mistake: It's a *near certainty* that this will happen. The only question is *when.*

Also, with the recent Supreme Court decision allowing the patenting of a virus or bacteria, a number of laboratories and companies are now feverishly developing new agents to unleash in the biosphere upon persons, animals, and plants.

For the most part, these experiments are tightly controlled. However, it is impossible to test in the laboratory the result of the natural recombination and mutation of these agents once they are loose in the environment and in a free exchange with all the natural bacteria and viruses.

Once loosed in the biosphere, a new viral agent undergoes combinations and recombinations with the greater number of viruses already present. The situation is like an increase in a large factorial number: Only a few additional viruses will result in millions and millions of additional combinations — at least some of which inevitably will be lethal and quick-acting. This is *not* tested in those laboratories making, patenting, and releasing new viruses.

Humans have spent millions of years developing sufficient immunity to the natural BW agents to allow humanity to survive.

Very shortly we are going to have increasingly large numbers of

new environmental BW agents emerging all around us. For some of them, it is a foregone conclusion that we have little or no natural immunity developed.

So we are going to enter an increasingly harsh environment, characterized by the rise of great epidemics and pandemics of many kinds.

Inevitably some of these coming scourges are going to rival the "Black Death" in ferocity and lethality.

Effective defense against one or more **such BW viral attacks — either against our forces in the field or against our civilian population — can only be provided by a ready, fully developed technology of electromagnetic healing.**

It does not really matter whether the BW strikes are performed by a hostile foe, a madman, natural mutations within our now drastically stimulated viral environment, or as a result of some particular "residue" discarded by an enthusiastic high school or college student.

The end result — the decimation of humankind — is going to be the same unless we develop and use electromagnetic healing technology.

However, with the present enormously self-hostile state of mankind, one or more enemies or madmen will almost certainly launch a strong, clandestine BW strike against the United States Armed Forces and the U.S. populace.

With EM healing technology, a specific "antidote" to any viral disease — known or unknown **— can be developed in a matter of hours.**

Mass electromagnetic treatment can then be started immediately, even for an entire army in the field or for our population in the heartland. Within hours of recognizing a BW strike, cure rates above 90% can be quickly achieved in exposed personnel.

Further, using electromagnetic healing technology, if necessary a more conventional vaccine can also be rapidly developed — say, in two weeks — for mass distribution and inoculation of the civilian populace.

The bottom line is this: Neither the U.S. Armed Forces nor the U.S. civilian populace can or will survive the coming lethal viral

warfare strikes unless we quickly develop electromagnetic healing technology and have the necessary diagnostic and treatment devices already ready and waiting.

The clandestine AIDS strike by the Soviet Union is just the precursor of a great deal more to come.

The USSR Has Repeatedly Verified Our Nonreaction

The Soviet Union already knows that Western science and governments are too stereotyped and dogmatic to react to anything highly unorthodox.

For years, the Soviet have been proving this, over and over, in their development and testing of frightful scalar electromagnetic superweapons of unprecedented power. In the face of overwhelming evidence of this, the West has kept its head buried in the sand like an ostrich.

It wasn't invented in the West. Therefore it cannot be.

Years of substantial Communist indoctrination of students in our universities, by leftist/liberal professors, has placed a massive imprint into our society. An entourage of sympathetic groups has resulted — groups which believe that the Soviet leaders are just like us, that the Stalinist era is long since over, and that the Communist leopard has changed its spots and really isn't trying to take over the world anymore.

As a system, then, much of the West simply refuses to accept anything unorthodox, anything "not invented here", and anything that indicates Soviet aggression.

The Soviets know the U.S. is totally ignorant of advanced scalar EM weaponry. They have proven over and over that the U.S. will not even comprehend that it has been deliberately struck, if the strike is sufficiently unorthodox.

The Soviet scalar EM superweapons have already been documented in **Fer-de-Lance,** Tesla Book Company, 1986, and that documentation will not be repeated here.

Only a short summary of events will be presented, to put the Soviets' confidence into perspective. A longer chronology of selected events is included as Appendix IV.

31 Soviets Knew The U.S. Wouldn't React

The Soviets were quite confident in arranging for a great biological warfare strike, because of the total lack of the U.S. to comprehend incidents such as the following:

1. Beginning in the late 1950's, hidden Soviet transmitters across the street targeted "weak microwave radiation" against the U.S. Embassy in Moscow. Over the years the radiation continued, sometimes continuously, sometimes intermittently. The Soviets electronically induced diseases that resulted in extensive health problems of Embassy personnel, the death of two U.S. Ambassadors, and the sickness of a third. Several U.S. Presidents have protested the radiation. Both U.S. Intelligence and the U.S. scientific community have been totally baffled. They still do not know the true nature of the radiation, nor its purpose.

2. In the winter of 1957-58, an unexplained nuclear event happened near Kyshtym, within the Soviet Union. A huge explosion occurred in the stored nuclear wastes in the disposal section of the Soviet atomic weapons industry located in the southern Urals. Radioactive contamination covered 1,000 square miles. For years the story was opposed — or suppressed — by U.S. intelligence agencies, perhaps to allay public resistance to the U.S. nuclear industry. At the time, Soviet experimentation with large scalar electromagnetic transmitters was well underway. A large transmitter probably failed, discharging its built-up, giant electrogravitational potential (EGP) into the earth. Such a pulse would have propagated through the earth as a wave; the first nuclear material contacted would have been fissioned immediately. The stored nuclear wastes probably exploded due to receipt of an EGP from the inadvertent failure of one of the Soviet Union's new superweapons in development. Survivors reported that indeed the nearby nuclear wastes exploded.

3. In January 1960 Khrushchev announced to the Presidium that a new fantastic weapon was in development. He stated that the weapon was so powerful that, if unrestrainedly used, it could wipe out all life on earth.

Figure 4. The U.S. Embassy in Moscow. The Soviet Union has bombarded this **facility** with weak microwave radiation for decades.

Table 2. MICROWAVE RADIATION **OF THE U.S. EMBASSY** IN MOSCOW

- **SINCE 1959 OR 1960**
- **HIGH LEVEL TARGET (U.S. AMBASSADOR)**
- **GUARANTEES PERSONAL ATTENTION OF**
  - **PRESIDENT**
  - **NSA, CIA, DIA**
  - **TOP CONSULTING SCIENTISTS**
  - **STATE DEPARTMENT**
  - **LEADING SCIENTIFIC INSTITUTIONS**
  - **NATIONAL SECURITY COUNCIL**
  - **ETC.**
- **TWO AMBASSADORS DIED, ANOTHER SICKENED**
- **U.S. REACTION REVEALS ANY KNOWLEDGE OF TESLA ELECTROMAGNETICS**
- **FOUR U.S. PRESIDENTS REQUESTED SOVIETS TO CEASE**
  - **CUT FROM 18 WATTS/CM^2 TO 2**
  - **THEN AGAIN INCREASED**

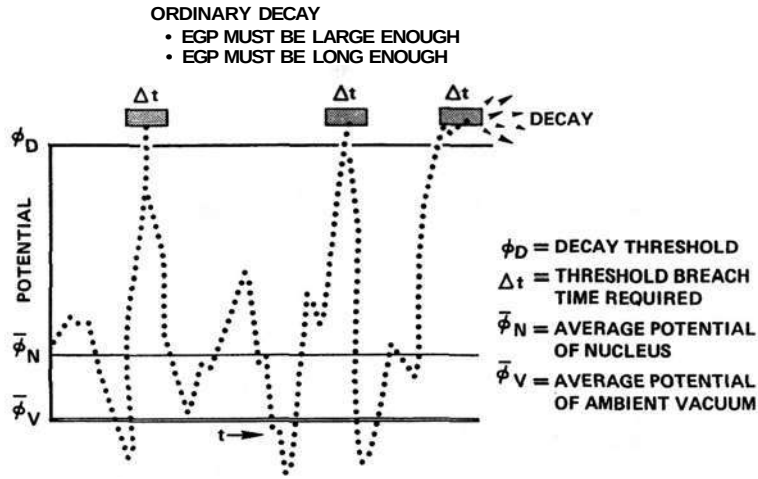

Figure 5. Decay of a radioactive nucleus. When it absorbs a scalar EM wave (electrogravitational pulse) that is long enough and large enough, the nucleus fissions.

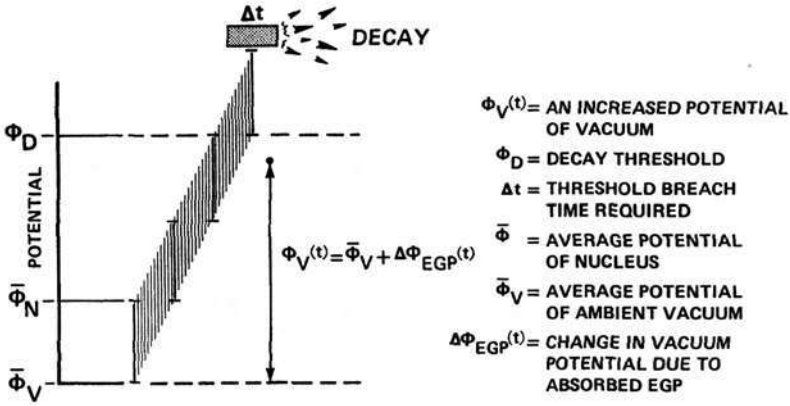

Figure 6. EGP fission of a radioactive nucleus. If an initial EGP is large enough and long enough, it will fission any and all radioactive nuclei it strikes.

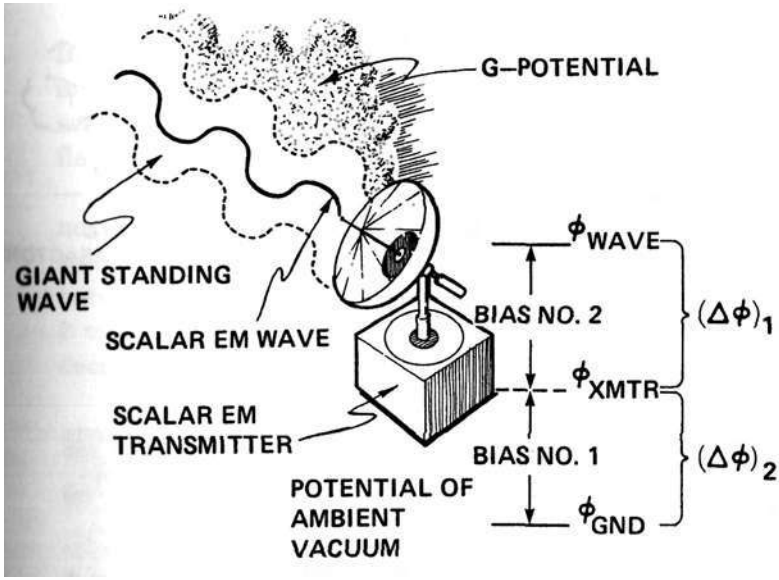

Figure 7. Bottled up energy in a standing scalar EM wave is a potential.

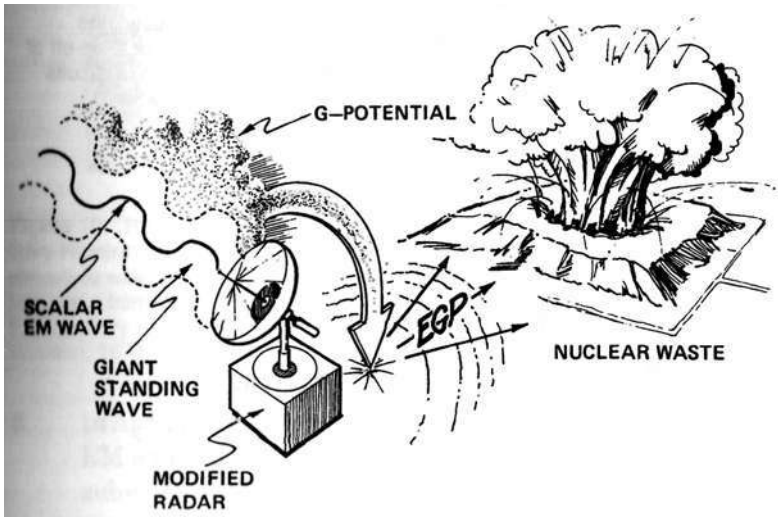

Figure 8. EGP short-out Transmitter failure and consequent discharge of a giant standing scalar EM wave potential caused the explosion of stored nuclear wastes at Kyshtym, USSR, in the winter of 1957-58.

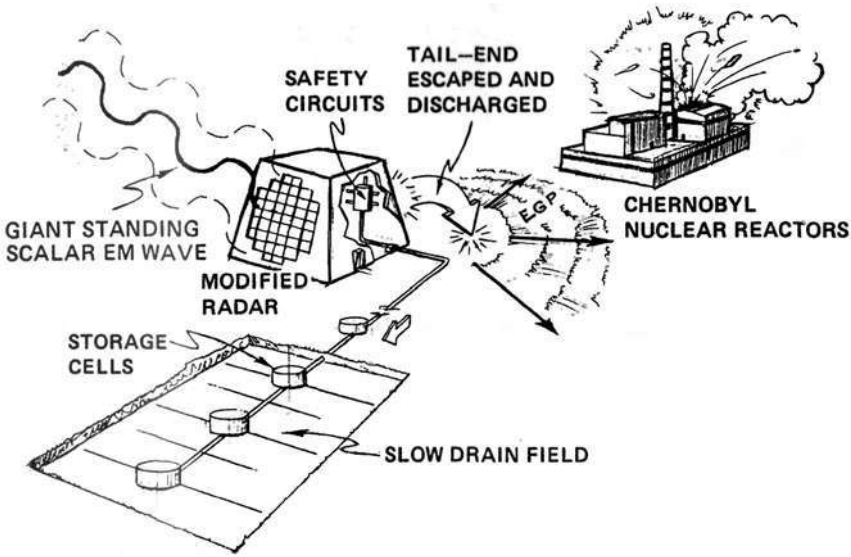

Figure 9. EGP initiation of the Chernobyl event. Failure of another giant transmitter near Chernobyl in 1986 eventually caused the eruption of one of the Chernobyl reactors by EGP-pulsing its nuclear fuel rods. When the transmitter failed, the alarmed Soviets shut down the four Chernobyl reactors while waiting for drain-off of the EGP potential by the safety circuits of the disabled transmitter. These circuits finally gave way, producing a mild EGP pulse into the earth. Had they failed immediately, all four reactors at Chernobyl would have violently exploded.

Table 3. KHRUSHCHEV'S 1960 STATEMENT

(Speaking to the Presidium)

WE HAVE A NEW WEAPON,
JUST WITHIN THE PORTFOLIO OF
OUR SCIENTISTS...
SO POWERFUL THAT,
IF UNRESTRAINEDLY USED,
IT COULD WIPE OUT
ALL LIFE ON EARTH!

4. In May 1960 Gary Powers' high-flying U-2 spy plane was mysteriously disabled over the Soviet Union, resulting in its subsequent crash and the Soviet capture of Powers himself. A flash appeared behind Powers' aircraft, as if from an explosion — except that *the flash persisted,* showing that it was not a normal HE explosion at all. A tracking radar, employed in a scalar EM mode, probably was used to cause the electromagnetic "flash ball" and disable Powers' aircraft. Harmless SA-2 missiles fired far below him may have been employed to deceive Western intelligence analysts.

Figure 10. The U-2 high altitude reconnaissance aircraft. On May 2,1960 Francis Gary Powers high flying U-2 spyplane was disabled over the Soviet Union. Some difficulties with the autopilot were first experienced. Then a single dull thump was felt, and a tremendous orange flash lit the cockpit and sky — *and persisted.* (See Francis Gary Powers with Curt Gentry, **Operation Overflight,** Holt, Rhinehart and Winston, 1970, p. 82.)

5. In April 1963 the Soviet Union utilized a newly deployed scalar EM weapon to destroy the submerged U.S.S. Thresher nuclear submarine, off the coast of the U.S. itself. In spite of intense and totally anomalous electronic jamming experienced by the U.S.S. Skylark, surface companion to the Thresher, the U.S. failed to recognize this major indication of a scalar EM attack. *One day later, a Soviet scalar EM weapon placed a giant*

underwater burst in the ocean, 100 miles north of Puerto Rico. With these two tests Khrushchev, still smarting from his Cuban Missile Crisis facedown by John Kennedy, avenged himself and convinced the Presidium to allow him to remain in power for yet awhile.

Figure 11. The U.S.S. Thresher disintegrates. © Hal Crawford 1979

Table 4. DEATH OF THE U.S.S. THRESHER

APRIL 10, 1963

- **DURING TRIALS OFF EAST COAST OF U.S. IN ATLANTIC**
- **SURFACE COMPANION: U.S.S. SKYLARK**
- **UNDERWATER PHONE BETWEEN THE TWO**
- **THRESHER DIVED AND WAS LOST**
  - **GARBLED MESSAGE**
  - **DID NOT RESPOND TO CONTROLS**
  - **SANK TO CRUSH DEPTH**
  - **IMPLODED**
- **SKYLARK ENCOUNTERED SEVERE ELECTRONIC INTERFERENCE**

Table 5. SEVERE EM INTERFERENCE EXPERIENCED BY U.S.S. SKYLARK

APRIL 10,1963

- **SKYLARK JAMMED (1.5 HR TO TRANSMIT MESSAGE)**
- **MULTIPLE SYSTEMS**
- **SIGNATURE:**
  - **SCALAR INFEROMETRY**
  - **SKYLARK IN "SPLATTER" ZONE**
  - **THRESHER PROBABLE TARGET**
- **OTHER SYMPTOMS**
  - **ONE SYSTEM KNOCKED OUT**
  - **OTHERS THEN WENT OUT**
  - **LATER RESUMED WORKING**

6. In Afghanistan, in 1981 and at intervals since then, Soviet helicopters have sometimes attacked Afghan guerrillas or villages with a strange new weapon. A body struck by this weapon dies instantly and completely. It falls like a limp rag, **and** does not decay even in 30 days. Every cell, bacterium, virus, etc. in the body has been killed instantly. Nerve gas rockets and chemical rockets are also usually fired to provide **a** "deception cover" for the nature of the real weapon. This eery Soviet weapon has been mislabeled as some strong new gas, **and** is referred to as "Smirch", a combination of the two words "smert" (death) and "semerch" (sandstorm).

7. In April 1984 a monstrously huge scalar EM incident occurred off the coast of Japan, near the Kuriles. Subsequent interviews with the pilots sighting the incident have revealed that several combined tests of the various modes of a scalar EM howitzer occurred. A giant "cold explosion" occurred, raising a giant mushroom cloud to over 60,000 feet and greater than 150 miles diameter in two minutes. A glowing dome appeared, and expanded to monstrous size. According to Dr. Walker and colleagues, **the diameter of this great** glowing, **hem-**

ispherical **shell expanded to several hundred kilometers.** * He and his colleagues were able to rule out any possible known natural events or mechanisms that could have caused the incident.

8. Numerous incidents of hemispherical shells of light and giant balls of light within the Soviet Union have been seen from Iran and from Afghanistan. Such giant artificial phenomena have also repeatedly been seen over the oceans by mariners and airline pilots.

9. Several instances of anomalous disabling of jet engines of commercial airliners have occurred while the aircraft were in flight.

10. Direct and intensive weather engineering over the U.S. itself has been accomplished by the Soviet Union for a decade, using the interference grid resulting from the crossing of two or more giant beams from the woodpecker "over-the-horizon radar" transmitters. Specific cloud signatures (anomalous holes, giant radials, twin giant radials, and razor-sharp giant interference patterns) have continually occurred, but the orthodox system has blithely ignored them.

11. A giant test of over a hundred huge Soviet scalar EM weapons occurred in and around May 1, 1985 for the 40th anniversary of the end of WWII. The entire Western scientific and intelligence establishment remained sublimely unaware of the giant exercise. They had not a single scalar EM signal detector — even though the air, land, and ocean was filled with hundreds of Soviet scalar EM transmitters, chattering away to Soviet armed forces, submarines under the water, etc. Underneath our feet, the earth itself was in giant scalar EM resonance on 54 frequencies — 27 pairs, each of which tapped energy directly from the molten core of the earth and fed it to an ensemble of giant Soviet strategic scalar EM weapons.

*See Science, 227 (4584), Feb. 8, 1985, p. 607-611; Science 234 (4775), Oct. 24, 1986, p. 412-413.

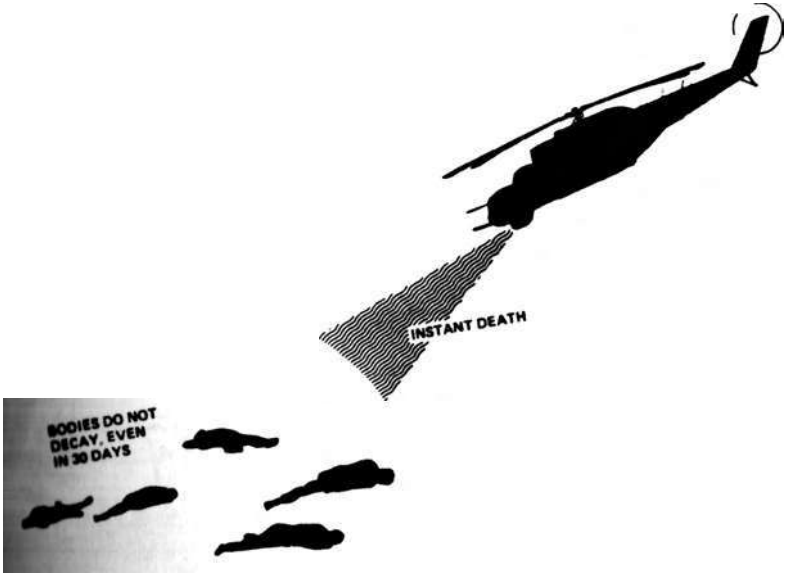

Figure 12. Soviet helicopters have used a "death ray" in Afghanistan.

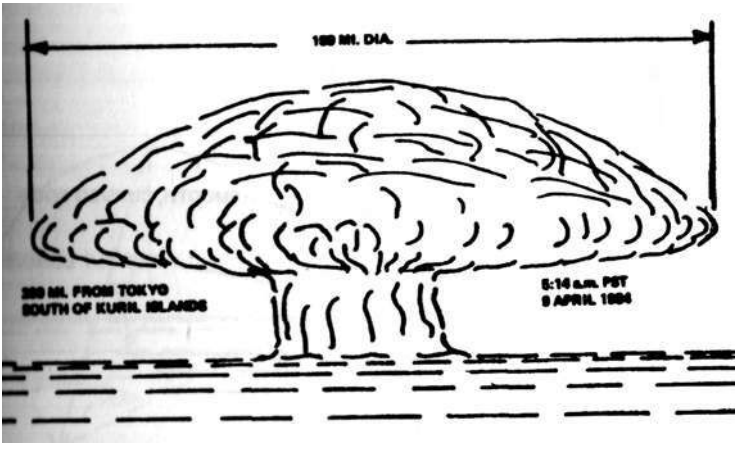

Figure 13. Mushroom cloud from the sea off Japan, near a Russian test area.

4i Soviets Knew The U.S. Wouldn't React

©Hal Crawford 1981

Figure 14. The Tesla shield, a giant hemispherical shell of energy. Seen repeatedly in Soviet tests in out-of-the-way places and remote regions of the ocean.

8:15 PM
THURSDAY
AUG 1969
VIRGIN ISLANDS
SEEN BY MANY RESIDENTS

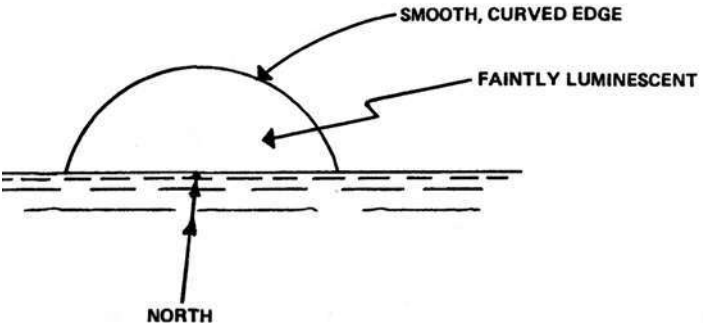

Figure 15. The Tesla shield: A 1969 Virgin Islands incident.

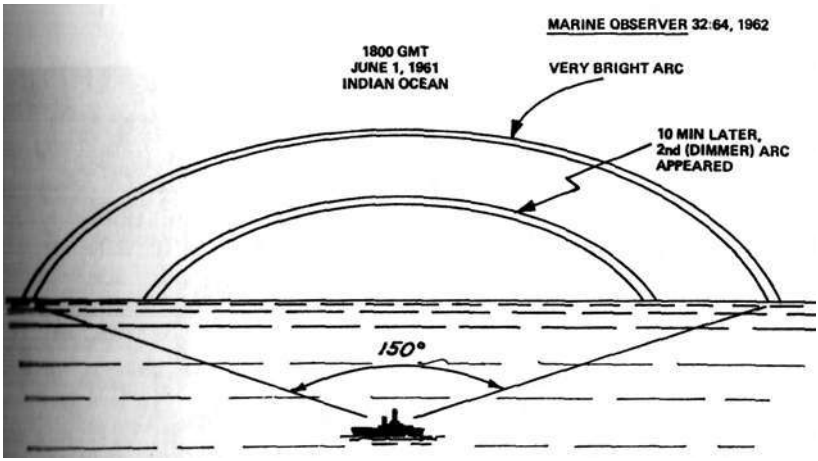

Figure 16. Tesla shields: Two nested arcs of light in the sky.

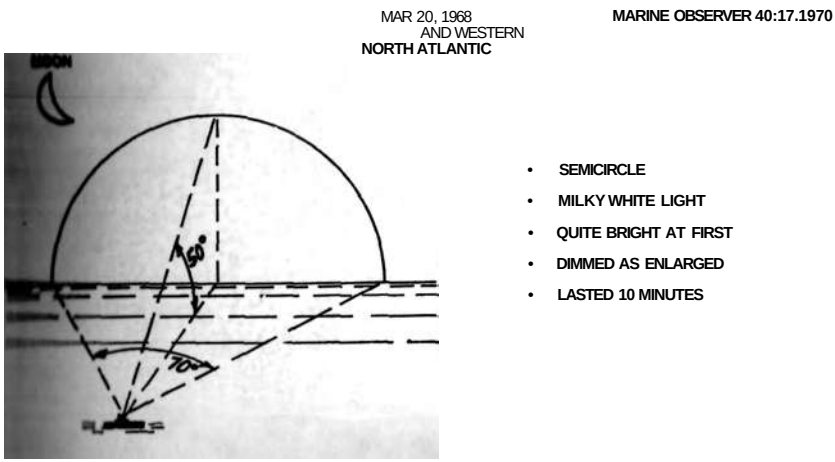

Figure 17. Tesla shield: An expanding hemispherical circle of light.

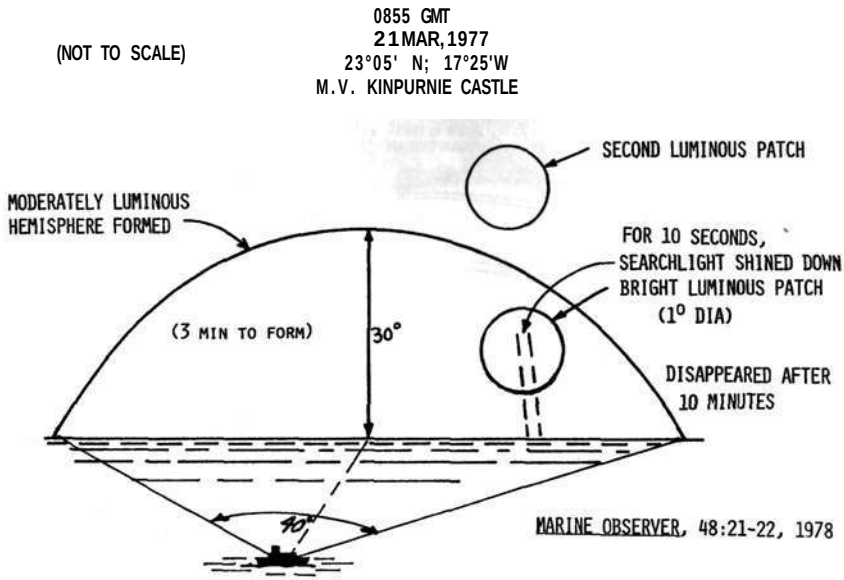

Figure 18. Tesla shield: Hemisphere and globes, 1977.

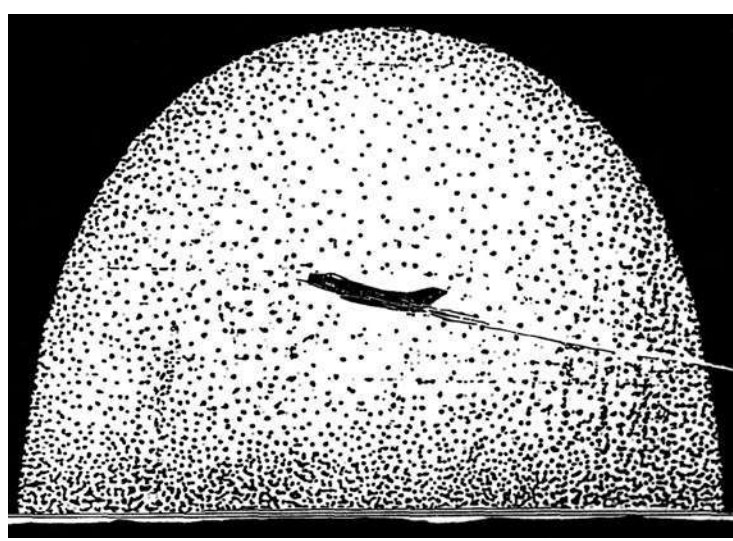

Figure 19. Large Tesia Shield observed by Red Chinese fighter pilots. Electrical difficulties in the aircraft were also experienced.

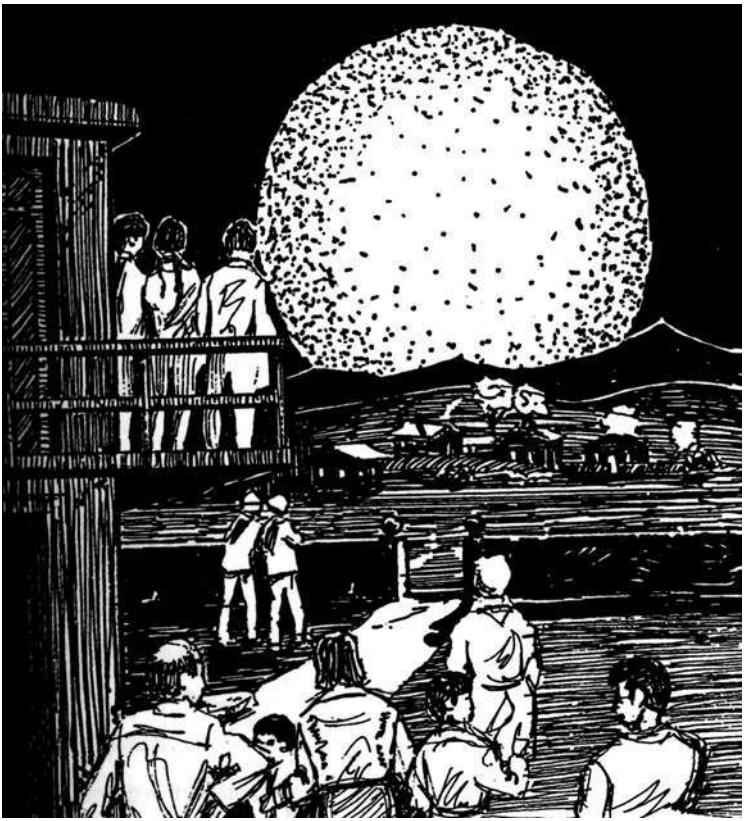

Figure 20. Large glowing Tesla Globe," Red China. Observed by hundreds of **persons.**

©1980 Hal Crawford

Figure 21. 1966 test of giant Tesla Globe, expanding deep within the Soviet Union. Seen from Teheran, Iran June 17, 1966 by two aircraft approaching Mehrabad Airport. Observed for several minutes.

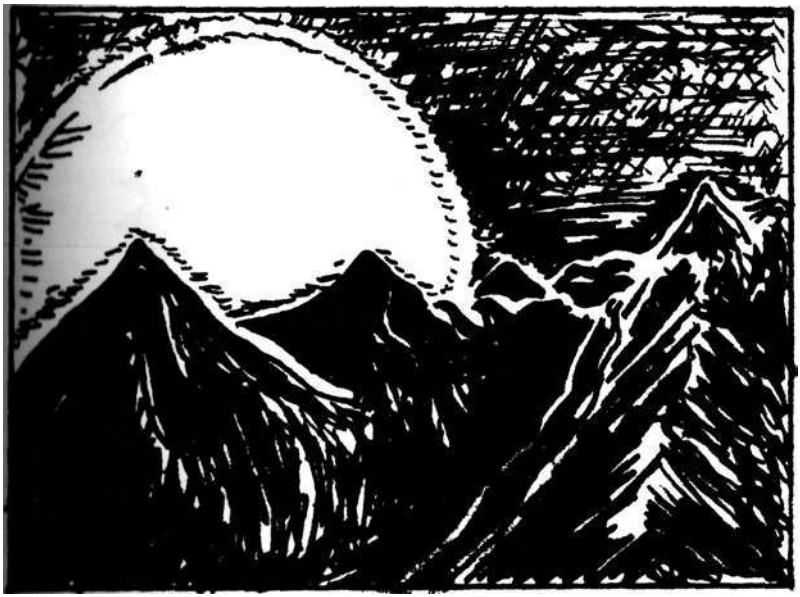

Multiple events seen in Sept. 1979 from Afghanistan

Strange lurid glow that flared silently over the Hindu Kush; as described by Nick Downie.
The LONDON SUNDAY TIMES, 17 August 1980

Figure 22. A giant globe, deep within the Soviet Union in 1979. Seen several times frorn Afghanistan, looking toward Saryshagan.

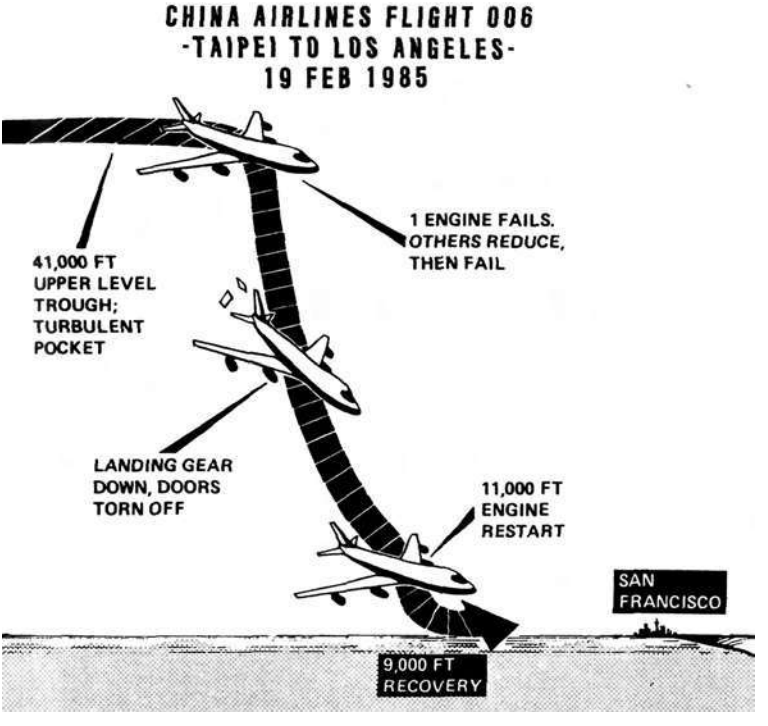

Figure 23. Engines disabled, a passenger jet drops six miles in two minutes.

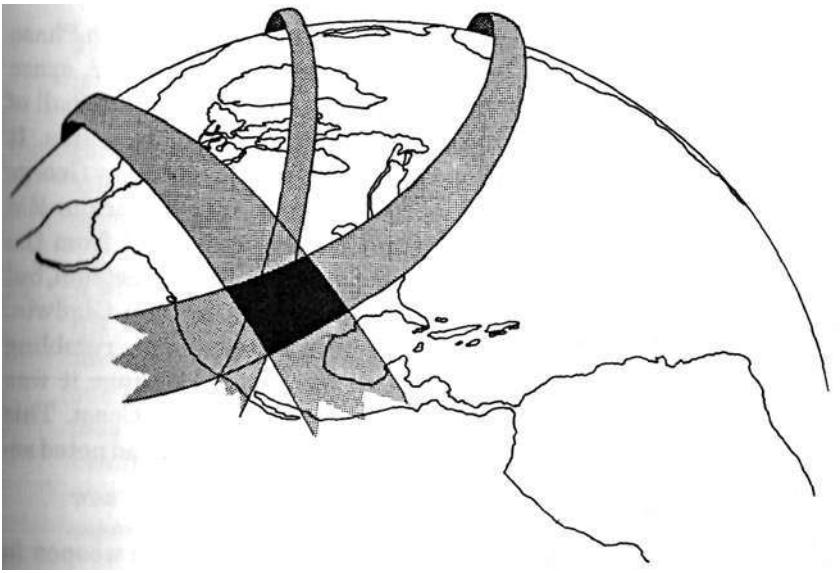

Figure 24. Giant "Woodpecker" beams intersecting over the U.S. Used for weather control, as a launch phase ABM and anti-bomber system, electromagnetic attack of distant populations, and disease conditioning. Using phase conjugate radar mirrors, any amount of energy desired can be delivered to any distant target from which a radar return has been received. Real-time distant holography, to produce powerful energy forms at a distance, can also be accomplished.

Table 6. MASSIVE 1985 STRATEGIC MAY DAY EXERCISE

APRIL/MAY 1985

- **BREZHNEV'S 1972 STATEMENT FULFILLED**
- **40th ANNIVERSARY OF WWII**
- **GORBACHEV NEWLY IN POWER**
- **EARTH IN GIANT SCALAR EM RESONANCE**
  - **54 FREQUENCIES**
  - **27 "POWER TAP" PAIRS**
  - **4 TO 6 WEAPONS EACH PAIR**

- **C^3I SCALAR EM LINKS**
  - **UNDERWATER SUBS**
  - **NAVAL FORCES**
  - **OTHER FORCES**

12. In late November, 1985 the Soviets tested their Launch Phase ABM system over Florida, using the launch of a U.S. space shuttle as a convenient test target. A marker beacon (ball of light) was placed in the sky, hovering near the launch area. It was seen by hundreds of persons, and photographed by George Suchary. During the final countdown to launch, a scalar EM "missile" (ball of intense energy) was fired, offset from the shuttle. This ball of energy was not in the visible spectrum, but may have been accidently photographed by Bob Gladwin. Twelve minutes offset after launch, a tremendous rumbling overhead boom echoed through the area — so huge it was heard for hundreds of miles up and down the East Coast. This was the third U.S. shuttle launch in which NASA had noted associated anomalous phenomena, but did nothing.

13. On December 12, 1985 the Soviets used the same weapon in the anti-bomber mode to destroy an Arrow DC-8 jet just after its takeoff from Gander Air Force Base, Newfoundland. **Over 250 U.S. soldiers and civilian crew members were killed.** Gander has long been a registration point for the Soviet scalar EM weapons. For example, in one 4-day period in 1982, 36 anomalous incidents occurred in and around Gander, involving moving lights, lights in the sky, etc.

14. On January 28, 1986 the Soviets destroyed the U.S. space shuttle Challenger, shortly after its launch. A dozen signatures are associated with this Soviet kill, too many to mention all of them. To give only a few: First, the Soviet ships monitoring the launch site suddenly departed at high speed, four hours before the launch. This was unparalleled. Second, according to General Daniel Graham, *the following evening KGB headquarters gave a party to celebrate the success of the KGB's perfect active measures against the Challenger!* Direct and unmistakable indications of extreme localization of the Soviet transmitters to the Challenger's launch site existed on the day of the launch. In addition, a metal-softening signal was confirmed on the Soviet Woodpecker beams as early as

January 1,1986. Many other indicators also exist. The total is a very strong statement that the Soviets destroyed the Challenger with the same weapon they had tested against three previous shuttle launches, and which they had used to kill the Arrow DC-8 at Gander Air Force Base only six weeks earlier.

15. A whole series of anomalous missile failures occurred, involving Titan, Delta, and Ariane launches. The odds against all these launches failing in that pattern were millions to one. In one Titan failure, video taken of the event showed the anomalous "marker beacon" light in the vicinity, high overhead. Frame-by-frame analysis of the video showed that the light was indeed independent of the explosion, and it moved off separately after the rocket exploded.

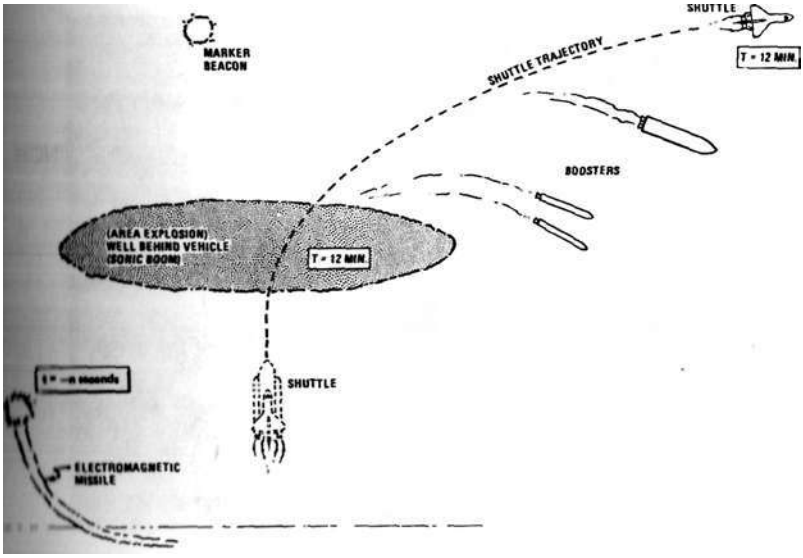

Figure 25. Third Soviet non destructive testing against shuttle launches, Nov. 26, 1985.

Table 7. SHUTTLE **LAUNCH ANOMALIES, NOV. 26, 1985**

- **MARKER BEACON**
  - **PHOTOGRAPHED**
  - **SEEN BY HUNDREDS**
- **OFFSET SCALAR EM MISSILE**
  - **INVISIBLE TO HUMAN EYES**
  - **STRIKE PHOTOGRAPHED**
- **GIANT ATMOSPHERIC BOOM**
  - **T + 12 MINUTES**
  - **HEARD FOR HUNDREDS OF MILES**
- **THIRD LAUNCH WITH SUCH A BOOM**

Table 8. SOVIET ESCALATION AFTER 3RD TEST AGAINST SHUTTLE LAUNCH on Nov. 26,1985.

- **U.S. STILL UNAWARE OF SCALAR EM WEAPONS USE**
- **SOVIETS ESCALATED ACTION**
- **DESTROYED OR DISABLED:**
  - **ARROW DC-8 (DEC. 12,1985)**
  - **CHALLENGER (JAN. 28, 1986)**
  - **TITAN 34-D (APRIL 18, 1986)**
  - **DELTA ROCKET (MAY 3, 1986)**
- **MAY HAVE DISABLED:**
  - **ARIANE II(MAY 31,1986)**
  - **TWO U.S. NUCLEAR SUBS WHICH RAN AGROUND**
  - **STEALTH FIGHTER WHICH CRASHED**

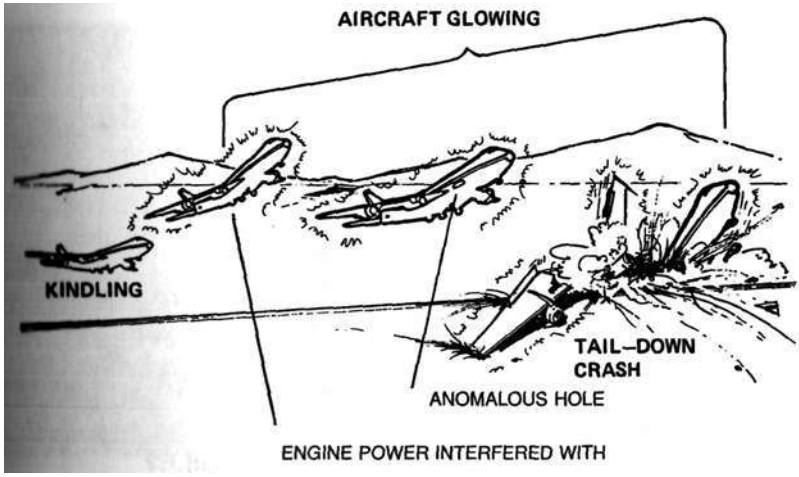

Figure 26. Death of the Arrow DC-8, Dec. 12,1985. Three eye-witnesses saw the **doomed** airliner glowing. An anomalous hole was found in the fuselage, forward of **the** engines. Engine combustion was interfered with, by phase conjugate (negative) e**nergy.** Engines were rumbling laborously, not roaring with power, as the aircraft **passed** 100 ft directly over a witness.

Figure 27. Anomalous hole in the right fuselage of the ARROW DC-8, ahead of the engines. With crossed over-the-horizon radar beams and multiple phase conjugate **radar** mirrors, real-time holography allows the production of a ball of EM energy at a great distance. The ball may be as small as desired, and contain as much energy as desired.

Table 9. ARROW DC-8 DISASTER, DEC. 12, 1985

GANDER AFB, NEWFOUNDLAND

- **AIRCRAFT LIFTED OFF**
- **AIRCRAFT WAS GLOWING YELLOW - ORANGE**
- **SANK TAIL-DOWN AND CRASHED**
- **SIGNATURE OF ENGINE/COMBUSTION INTERFERENCE**
  - **LAUNCH PHASE WEAPON**
  - **ANTI-BOMBER MODE**
  - **ANOMALOUS HOLE IN FUSELAGE, FORWARD OF ENGINES**
  - **STRUCK BY ELECTROMAGNETIC MISSILE?**
  - **EXTENSIVE "BALLS OF LIGHT" WEAPON TESTS IN AND AROUND GANDER**
- **CLOSELY FOLLOWED THIRD TEST AGAINST SHUTTLE NOV. 26,1985, IN ABM MODE**

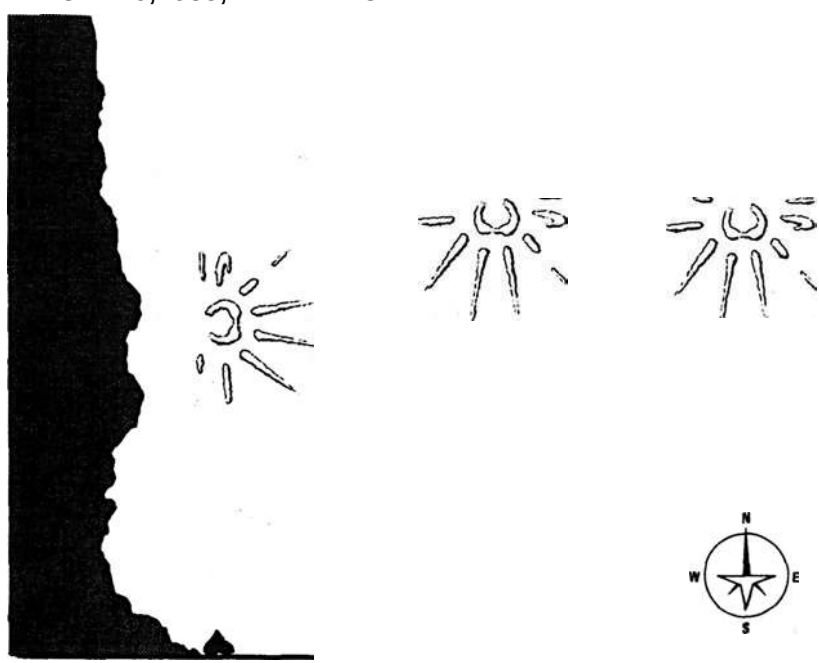

Figure 28. Part of the Soviet engineering of U.S. weather, just prior to the death of the Challenger. Three "giant radial" clouds sighted over the greater Los Angeles area by Margaret Wilson. Appeared one after the other, at 10 min. intervals.

DOD PHOTO

Figure 29. Soviet Trawler spyship. About four hours before the launch of the Challenger, all Soviet ships off coast, that normally monitor each launch, suddenly and mysteriously departed at high speed. Unprecedented event.

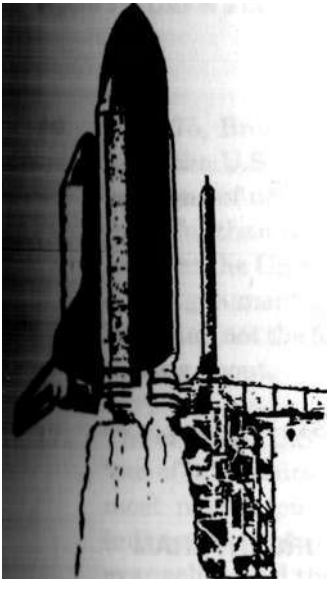

- **SOVIET WEATHER ENGINEERING**
- **SEVERE COLD STRESS**
- **METAL-SOFTENING**
- **BOOSTER SEAL PROBLEM**
- **SOVIET SHIPS ABSENT**
- **LOCALIZATION**
- **AIR TURBULENCE**
- **BIRDS NOT FLYING**

Figure 30. Launch of the doomed Challenger, Jan. 28,1986.

Table 10. DEATH OF THE CHALLENGER, JAN 28, 1986

- **METAL-SOFTENING SIGNAL ON WOODPECKER GRID AS OF JANUARY 1, 1986**
- **SOVIETS ENGINEERED COLD WAVE INTO FLORIDA**
- **SEVERE COLD STRESS ON VEHICLE**
- **GRID LOCALIZATION SIGNATURES**
  - **BIRDS NOT FLYING IN LAUNCH AREA**
  - **BIRD FALLS IN BIRMINGHAM, AL (HINGE)**
- **SOVIET SHIPS/TRAWLERS DID NOT TRACK LAUNCH**
- **BOOSTER SEAL PROBLEM SEVERELY AGGRAVATED**
- **CAUSED SHUTTLE FAILURE**
- **SOVIET KGB HEADQUARTERS CELEBRATED "PERFECT SUCCESS OF ACTIVE MEASURES" AGAINST THE CHALLENGER!**

Table 11. KGB CELEBRATION

EVENING OF JAN. 28,1986

- **AFTER DEATH OF CHALLENGER**
- **KGB HEADQUARTERS**
  - **JUBILANT PARTY**
  - **CELEBRATED SUCCESS**
  - **OF ACTIVE MEASURES AGAINST THE CHALLENGER**

SOURCE: GENERAL DANIEL GRAHAM, URGENTGRAM

- **NOTE: SOVIET SCALAR EM WEAPONS ARE CONTROLLED BY KGB**

- SHORTLY AFTER LAUNCH
- ANOMALOUS POWER SURGE
- "COMMANDED" ENGINE SHUTDOWN
- VEHICLE THEN UNSTABLE
- RANGE SAFETY OFFICER DESTROYED ROCKET
- EXTERNAL RANGE SENSORS DID NOT RECEIVE SURGE SIGNAL
- SIGNATURE OF TIME REVERSED WAVE
- WHICH LOCALIZED ON ROCKET

Figure 31. Loss of a Delta rocket, May 3, 1986.

16. In 1975, Brezhnev had surprisingly urged U.S. senators to have the U.S. cooperate in banning the development of new weapons of unparalleled horror. He used the phrase, "more frightful than the mind of man has ever imagined." Shortly after, at the United Nations, Gromyko had even introduced a draft agreement for all nations of the world to sign. Again, the West had not the foggiest notion as to what the Russians were talking about.

17. The orthodox U.S. news media has been, and is, almost totally "out of it." Ironically, at the time of our deadliest peril, and the most momentous period in history, incidents such as the indiscretions of a presidential candidate and of a television evangelist, and the "Iran Gate" actions of the National Security Council in trying to illegally get arms to the Contras, are the "burning issues of the hour" — and the week, and the month, and the year, and HO on ad nauseam.

18. The Congress — great watchdog and the direct representative of the U.S. citizenry — is equally immersed in interminable hearings of little or no substance except news media coverage and publicity.

19. A belabored president, misled and now hemmed in on all sides and on the defensive, has had his power to act greatly constricted. In addition, the orthodox filtering networks surrounding him have effectively isolated him. He has been unaware of the extensive information that shows just how certain it is that the Soviets have fantastic superweapons and have been gingerly using them against us for decades. He and his immediate advisors are fed highly filtered, shaped and interpreted data. U.S. intelligence is very good at doing the things that it does. However, it is also very good at ignoring the things that it ignores! Further, the intelligence community is a past master at "slick-tonguing" the interpretation of anything new, and anything it really doesn't understand, in terms such as "We have no evidence that ..." For decades, the community has consistently underestimated the Soviet threat, and it has also usually projected any unpleasant present Soviet capability in the terms that "If the Soviets keep this sort of thing up, it may prove to be a real threat 30 years from now!" For years U.S. intelligence was unaware of a Toronto inventor's development and public demonstration in the late 1960's of an inertial field generator device, for example, because it simply did not place high value on simple overt intelligence such as reading the newspapers! The entire event was printed in detail in a Canadian newspaper. Only very recently, within the last few years, has the community again realized that the most important intelligence can only come from human (HUMINT) sources. And in relying on the scientific community — which itself knows nothing of scalar electromagnetics — the intelligence community has not received the technical advice necessary for it to properly task its collection agencies to collect information on the Soviet superweapons.

20. Western science has also shown itself to be highly dogmatic and ensconced in the comfortable "status quo." It has regally ignored the important Soviet developments in unified field theory. It has assumed an aristocratic stance, regarding the Soviet scientists as little more than peasants still trying to clean the mud off their boots. In fact, the Soviet scientists have been ahead of the rest of the world in *nonlinear* science — the truly hard stuff— since the beginning. They have always been the best nonlinear mathematicians in the world. Soviet scientific papers regularly appear which deal with local general relativity and the overcoming of the sacrosanct conservation laws as a matter of course. That subject is still a "no-no" in U.S. scientific publications, even though breaking symmetry and consequent violation of conservation laws has long boon proven in particle physics. To my knowledge, with the exception of Hooper's obscurely published work, not a single US. scientific paper appears in the literature showing any detailed investigation of "bucking fields" as such and investigating the behavior of materials exposed to such "sum-zeroed" fields. Yet ironically a whole area of optical physics — phase conjugate optics (PCO) — has shown great activity since we discovered it in the open Soviet literature in the late 60's, and since two Soviet scientists visited Livermore* in 1972 and briefed us upon the subject (as another stimulus to see if we recognized the awesome weapon implications). In PCO, the scalar EM wave formed by two waves 180 degrees out of phase with each other, and locked (modulated) together by a nonlinear medium, is blithely called the *pump wave.* Using it on nonlinear materials produces extraordinary results — such as electromagnetic waves traveling backward in time. Further, the PC effect is known to be universal, and not just in the optics region at all; for example, it has also been done with sound waves. **The obvious experimental and theoretical proof of scalar EM has been in our literature for nearly two decades, and even in PCO our scientists do not yet realize that the** "pump" **wave is a scalar** wave, **a** wave **of**

*Lawrence Livermore National Laboratory

artificial potential, and a gravitational wave that pumps the nuclei of the atoms in the nonlinear medium. They also still do not understand that it is the nucleus of the atom that produces the phase conjugate replica wave in PCO.

Table 12. BREZHNEV'S 1975 PROPOSAL

AT THE SALT TALKS ON JUNE 13, 1975

- **THE SOVIETS URGED THE U.S. TO AGREE ON A BAN AGAINST RESEARCH AND DEVELOPMENT OF NEW KINDS OF MASS DESTRUCTION WEAPONS MORE TERRIBLE THAN ANYTHING THE WORLD HAS KNOWN!**

- **BREZHNEV PERSONALLY URGED VISITING U.S. SENATORS TO AGREE TO THE BAN.**

- **GROMYKO INTRODUCED A DRAFT AGREEMENT INTO THE UNITED NATIONS MEETING AND URGED THE NATIONS OF THE WORLD TO SIGN IT.**

- **THE WEST HAD NO IDEA WHAT THE SOVIETS WERE TALKING ABOUT!**

- **SOVIET HAWKS THEN GAINED DOMINANCE, AND THE USSR STARTED ITS MASSIVE BUILDUP FOR EVENTUAL WORLD TAKEOVER.**

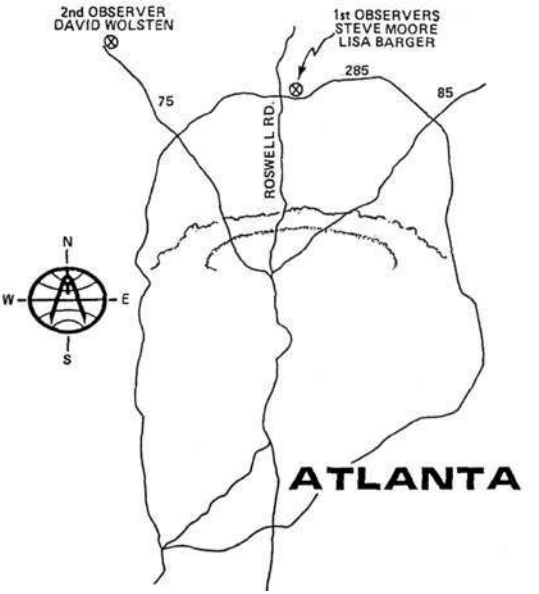

A. Location of the incident

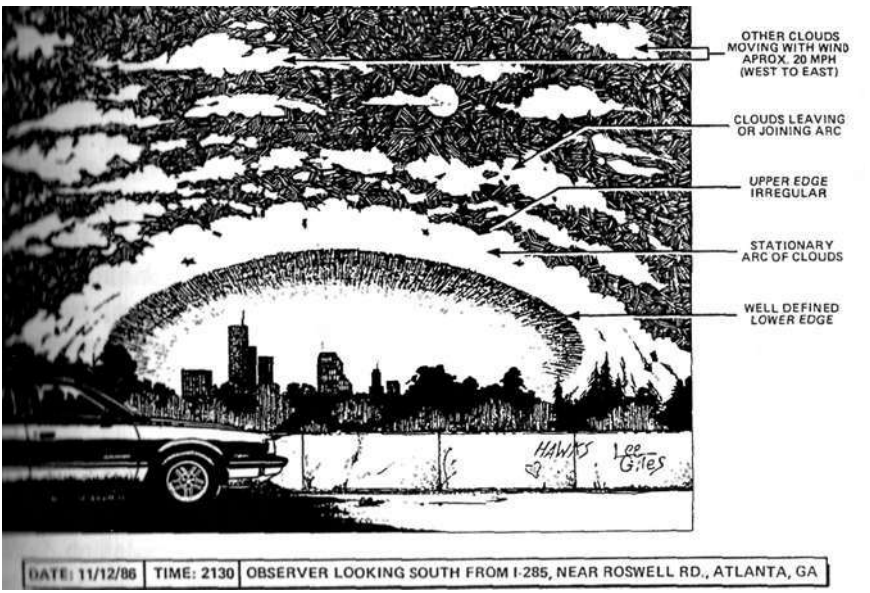

B. Artist's sketch of the incident.

Figure 32. Probable Soviet test of a Tesla Shield over Atlanta, Georgia.

Continually assured that Western science and intelligence remained outrageously ignorant and would obstinately persist in wearing orthodox blinders, the Soviets felt quite safe in striking the U.S. and its Western allies a mortal death blow.

The Soviets knew there would be no retaliation, so long as the blow was sufficiently unorthodox.

After all, the Soviets have been waging a slowly increasing unorthodox war against us for decades, and totally getting away with it.

Consequently the Soviets manipulated the cancer research and the contamination of the World Health Organization's smallpox vaccine to produce the perfect biological warfare "first strike," administered unwittingly by the WHO itself in its mass immunization program to eradicate smallpox. The Soviets continue to manipulate the spreading AIDS viruses electromagnetically so that the West will be devastated, as well as Africa and the Third World.

At least one other spreading AIDS-strain has already appeared in Africa. Testing for exposure to the first strain in most cases did not detect exposure to this second strain.

Officially no one knows whether it will be as infectious as the first strain. However, a suspicious correlation has appeared between hepatitis vaccination in several large U.S. cities and consequent outbreak of AIDS among the persons inoculated.

Further, the latest studies are beginning to show that (1) AIDS may be just as spreadable, though more slowly spread, in the heterosexual community as in the gay community, (2) the AIDS tests themselves are far more unreliable than suspected; one may have the AIDS virus — and serve as an active carrier —for up to three years before the tests begin to detect it, and (3) no one has any real idea as to how many persons have already been infected.

As can be seen, even orthodox scientists are beginning to suspect a coming AIDS infection "asymptote" which may represent an explosion of the disease into a mass pandemic in the world population. In Africa, for example, AIDS is spreading freely among the hetersexual population as well as the homosexual population. * We may be on the verge of seeing a similar phenomenon emerge in the

*Although there is much speculation as to why African heterosexuals seem so vulnerable, at present no one knows why it is true.

Western world.

If so, we are looking full in the face of a forthcoming AIDS massacre that makes the 1918 influenza pandemic pale by comparison. Not only will AIDS decimate Africa and the Third World, but it will also decimate the West a little later.

In the Soviet plan, after the AIDS massacre has peaked, the remaining much smaller U.S. and European populations will be decimated and totally powerless. The demoralized and devastated Western nations will easily capitulate and pass under the Soviet hammer and sickle.

In their deception planning, the Soviets even are allowing some contamination of their own citizens by AIDS. Thus they can keep up *a pretense* that they are just as much victimized as we are, and just as much "in the dark" as we are about the whole thing.

Of course, once the AIDS infection does its lethal dirty work in the West, the Soviets can easily eradicate it in their own population at will, using the electromagnetic healing technology they already posess. The Soviet planners regard the loss of a few Soviet citizens along the way as one of the things necessary to insure the success of the Great Strike and the Final Revolution. Forward divisions in the standard Soviet attack are always regarded as such sacrificial pawns to guarantee the success of the follow-on echelons in the attack. In this BW strike, the sacrifice of some Soviet citizens is deemed necessary to the overall success of the attack.

Remember, these are the same type of Soviet communist planners who killed 20 million Kulaks — their own people — to forcibly collectivize Soviet agriculture. For their highest purposes, these planners are still quite capable of ruthlessly sacrificing millions of their own people to achieve their objectives.

The *Asian Tiger Mosquito: A New and Efficient Vector*

As almost everyone now realizes, in the past our government has greatly understated the AIDS problem. Past projections of the limitation oft he spread of the disease have been far more optimistic than warranted.

For example, officially the government is still denying any possibility of insect vectors for the disease.

Don't believe it. In fact, highly efficient insect carriers of the disease are already on the way.

Insects in Africa have positively been verified to be harboring the AIDS retrovirus. Of course, such reports are always accompanied by the bland assurance that "We have no evidence... (that the insect bites will give AIDS to humans).

Let's see now: We're supposed to believe that a monkey bite will do enormously more than that. Even when the monkey didn't have the exact present form of the AIDS retrovirus. Even though monkey bites hadn't done the trick in thousands of years.

But we're supposed to turn right around and believe that an insect carrying the live AIDS retrovirus can bite you, inject into you some of his body fluid containing AIDS viruses, and you won't stand any chance of developing AIDS .

What are we supposed to believe? That the injected AIDS virus from an insect bite won't bother you, but the injected AIDS virus from other causes will?

Nonsense!

Anyone who believes that is a prime candidate for purchasing that bridge down the road...

Of course insect vectors will give you AIDS!

And we've got a real tiger — mosquito, that is, on the way to do just that.

The Asian Tiger mosquito has been introduced into the U.S. (it just "accidentally" appeared, of course!) and is now spreading through the Southeastern states. This vigorous and voracious mosquito prefers man as its target, and has an unusually wide range.

Recently U.S. scientists have reluctantly confirmed the presence of the AIDS virus in the Asian Tiger mosquito. However, as usual we are presented with the same tired refrain, "We have no evidence that... the mosquito's bite is capable of causing a human to develop AIDS."

Of course, you can be sure that eventually we *will* have evidence of precisely that!

The AIDS virus is now known to be able to live outside the body for up to at least 15 days, if not longer.

Also, the AIDS virus is an unstable virus — it's constantly mutating and changing its form. That means it's "highly adaptable" - that is, it's continually adapting to its environment, at a rate millions of times faster than normal stable viruses change and

That fact implies that some mutant strain of the virus will almost certainly be adapted to living in the Asian tiger mosquito and being introduced into its human host by the mosquito's bite.*

It's not a matter of "Can it do that?" or "We have (as yet) no evidence of that."; instead, it's a matter of "How long will it be until that occurs and we confirm it?"

The Asian Tiger mosquito apparently is intended to serve as the major vector (carrier), or at least one of them, to eventually rapidly increase the AIDS infection rate and devastate the U.S. population.

AS the vector spreads and the virus adapts to that mode of transmission, the rate of increase of the AIDS infection will itself accelerate. This means that all the projections for "doubling times" are seriously in error.

The latest data from Alabama, for example, shows that the disease is now doubling every six months instead of every year. Also, the doubling interval itself has been shortening, at least up to the present. Note also that, from the data of the new studies confirming a much longer lag time for the AIDS test to indicate the presence of the infection, even the present data on the number of persons infected and the doubling time are underestimated.

If these and other data are a true indication, it appears that we literally may have an "explosion" of the AIDS infection in no more than two to three years.

In addition, as we said the AIDS virus is an unstable virus. Mutations in the virus itself are occurring so rapidly that producing an effective vaccine essentially will be impossible. Without a totally new means applied to produce an AIDS cure, AIDS simply cannot be stopped.

•And one or more strains will eventually evolve that can be infectuously spread like the influenza virus is.

In fact, recenly it has been discovered that the AIDS virus is far more devious than previously susupected.* It attacks in more ways than suspected. It changes in the body, increasing its virulence as the disease progresses.

Macrophages, the immune system's scavenger cells, become infected and carry the virus to other body cells. It appears that macrophages may pass the virus to the T-cells, conditioning the destruction of the immune system. Infected macrophasges are found in rectal material of AIDS patients and in cervical fluid and semen. Thus through infected macrophages the AIDS virus is able to infect partners through exhange of semen, cerical fluid, and rectal material — even though there are no breaks or tears in the skin, and even though the number of free AIDS viruses in thefiuids is too small to pass the infection.

Other immune system cells —such as Langerhans cells—are also suspected to be capable of serving as AIDS carriers when infected. The end result is that, as the AIDS patient sickens, the virulence of the AIDS virus increases, so that it attacks a greater variety of cells and can more easily infect them.

Present orthodox methods cannot cure AIDs in time, if ever.

Unless unorthodox technology is applied to solve the problem the West is already defeated.

*See Gina Kolata, "Fatal Strategy of AIDS Virus Grows Clearer," Science Times section, **New York Times,** Mar. 22, 1988; see also "Growth in AIDS Virus Virulence Found," **Los Angeles Times,** Apr. 1, 1988.

CHAPTER 3

WORLD WAR III IS RAGING AND WE'VE NEARLY LOST IT

More on AIDS Doubling Time

AS we said, the AIDS problem is much, much worse than officially announced. As stated, in some areas at least, the number of new AIDS cases diagnosed has been doubling every six months instead of every year. New studies have shown that the tests to identify infection by the AIDS virus may themselves have a 3-year lag period in which they do not reliably indicate the presence of the infection.

These facts probably make all previous "officially announced" estimates and projections off by several orders of magnitude (at least three).

If the incubation period (nominal) is, say, 5 years, then there is a factor of up to 2 (exp 10) of AIDS cases already in incubation.

The lag in accuracy of the AIDS tests however, may mean that there are even more AIDS cases in incubation than this.

And we may have a new entry into the equation at any time, once the AIDS virus adapts to its transmission by the Asian tiger mosquito and possibly even other insect vectors.*

Remember, we've got the U.S. data for only a relatively few years since 1981. So it's statistically difficult to project ahead with any accuracy. However, the best interpretation of the data we can make shows a spiraling (speed-up) trend in the rate of acceleration of the disease, indicative of a forthcoming asymptote. If that interpretation of the data holds true, the asymptote represents literally an "explosion" of the disease.

That is, the six-months "doubling interval" is slowly becoming **the s**ix-months "tripling interval," the six-months "quadrupling interval," etc.

The best indication/projection I can tentatively arrive at is this: If the total cure is not accomplished within about two to three years, then - considering the incubation ongoing by then and the speedup

***Another HIV virus has now been identified.**

ahead — somewhere between a third and two thirds of all humans on earth will perish.

In other words, nominally half the humans on earth will inevitably die, say within five years (the incubation) after that two to three year point.

Most of the people who die are going to be highly selected. Most of them are going to be Westerners, Africans, Asians, and Brown people.

And all of our tanks, ships, bombers, missiles, nuclear weapons, and armed forces put together can't save a single AIDS victim.

We've got more generals than ever before in our history, including World War II. And not a one of them has a single tactic or a single weapon to use against this mortal attack.

Understand, our generals have not failed us against the enemy they know and recognize. The bellies of our B-52 bombers and the aircraft aboard our distant aircraft carriers are filled with nuclear bombs sufficient to destroy the world many times over. Our powerful nuclear-tipped missiles sit in land-based silos and in sleek submarines cruising silently under the oceans, waiting to respond in an instant to hostile attack, again with the power to destroy the world many times over.

Yet the fine men and women who have built and maintained that awesome force, and who man it in constant vigilance to protect our nation, are absolutely vulnerable and defenseless against the smallest foe of all —just as were the Martians in H.G. Wells' **War of the Worlds.**

With all our awesome forces, we do not have the power to stop a single AIDS virus — or indeed, any other similar new BW virus.

We can be defeated with ridiculous ease by even the tiniest determined hostile nation — or even by a single terrorist, madman, or genetic accident by a high school youth.

And if there's one thing that we can learn from history with iron certainty, it is this: If we can be defeated with ridiculous ease, then most certainly we will be!

Since the strike has already occurred, then our defeat is just a matter of time if we continue our present courses of action.

All other threats — nuclear, chemical, scalar EM, the works — pale in comparison to this seemingly innocuous, doomsday BW viral

weapon that has already been unleashed upon an unsuspecting world.

World War III is Already Raging

World War III has long been unleashed and a final, decisive first strike has now occurred. We've already lost the war unless unbelievably heroic measures are taken immediately.

This thing is deliberate. It's fiendishly clever. It's effective. And a smiling Gorbachev — master propagandist — is just part of the icing on the cake to deceive us until it's too late.

Ironically, Soviet announcements have cleverly started claiming that the U.S. has produced the AIDS virus and unleashed it.

That's a very clever propaganda trick to shift suspicion from themselves. Indeed, in the Third World the propaganda has been very effective. Most Third World peoples now give at least credence to the Soviet claim.

Unless we move immediately to effect a total cure, the armed forces and the populaces of all the Western nations will shortly be devastated — perhaps even worse than if they been attacked with nuclear weapons.

With our armed forces and populations devastated, we surrender. We lose.

The Soviets get the U.S. (and European) farmland. That's what they really need.

Of course they also will have rid themselves of about 200 million Americans or so along the way.

That, solves the old "winner's problem" of what to do with, and how to effectively control and care for, a conquered, resentful populace. That problem will have already been taken care of, for most of the U.S. populace will essentially have been eliminated.

There won't be many U.S. military prisoners, for example, since most of the military personnel will also have been eliminated by the virus or viruses clandestinely released.

Communism Is Savage Enough to Do Diabolical Things

The Communist's doctrine is to wage total war. Win any way, with any weapon, at any cost.

ALSO, communism has always taught that it is necessary to

destroy capitalism. That equates with destroying the U.S., the major capitalist country. Communists have always taken the long view, willing to struggle for decades to eventually accomplish their aim.

If you think no modern nation could be so incredibly savage as to deliberately destroy untold millions of people, look at the actual record of the Communists.

When the Khmer Rouge took over Cambodia, they murdered a third of their own people.

The Soviets murdered some 20 million or so Kulaks when they collectivized the Soviet farms.

The Red Chinese also slaughtered Chinese peasants by the tens of millions — perhaps as many as twenty or thirty million — when they collectivized the farmers.

Lenin's followers have proved over and over that they are capable of murdering even their own people, on a scale of millions.

Dedicated communists are highly religious people — even fanatics. Deliberate murder to achieve communism's goals is part of the accepted dogma.

The communists are quite capable of killing a billion or more "foreigners" and "enemies," given the chance. Particularly when the goal is to win the "Final Revolution."

The opportunity to strike the decisive final blow without consequences, using as simple and unorthodox a weapon as the AIDS viruses, could simply not be ignored by men who have spent their lives trying to control the world.

The unparalleled strike opportunity was particularly irresistible since someone else (the Western cancer research institutes) would develop the weapon itself, someone else (the World Health Organization) would unwittingly deliver the strike, and the blow could easily be clandestinely arranged (simply by secretly contaminating the WHO smallpox vaccine) and accomplished without repercussions to the Soviet Union.

Western Medicine is Inadequate

But what of Western medicine? Doesn't it always come through to save us?

Present Western medical science is totally inadequate to do the

task required.

For example, present medicine is largely based on "slowing or killing the invader of the body." Whether that invader is a germ, bacterium, virus, or whatever.

If there's a mechanical difficulty, then present treatment is to try to mechanically remedy it — remove a bad appendix, set a broken leg, etc.

However, then it's strictly up to the body's own natural healing system - its immune system and its repair system — to actually do the healing and repair/reconstruction.

The problem with AIDS is that it directly affects and suppresses the body's systems for healing and repair.

Once this protection and repair system is in disarray, any disease organism can attack the body and infect it. If the immune system can't handle the problem, eventually the invading disease organism kills its host.

Even if a way is found to destroy the AIDS virus itself, present medicine has not the foggiest notion of how to restore the healing and repair system from the damage and destruction it will have already sustained by massive AIDS infection.

Compare the situation to division combat: Hostile invaders are met at the front of the division by the division's combat forces. A battle ensues, with penetration and damage to the rear area support and sustenance facilities. After the enemy is beaten back or destroyed, the rear support and the combat forces must be renewed and restored. If that cannot be done, the seriously weakened division can still literally be boiled over by almost anything that comes along and hits it.*

*For this reason, standard Soviet doctrine is to attack in echelon, say, by three divisions — one behind the other. Thus, even if the first division is annihilated in the attack, the second and third divisions meet a seriously weakened enemy division and blast right over it. Similar tactics in the BW crisis - multiple viral strikes, one after the other — can almost inevitably be expected, now that the "first division" - AIDS - has engaged us.

The Soviet "repetitive attack" method *works,* in case anyone has doubts. For example, see George C. Wilson, "Army training exercises raise troubling questions," The Washington Post, as printed in the Huntsville (AL) Times, Feb. 28, 1988, p. 21A. Repeated U.S. Army tests in the Mojave Desert have shown that, in nonnuclear combat, when attacked by multiple Soviet echelons with 3:1 strength, U.S. forces lose every time! In particular, U.S. troops have poor anti tank defenses.

Modern medical dogma has concentrated almost entirely on the combat forces' problem of destroying and/or repelling the invader.

Western medicine has almost no tools or means of restoring the support and rear maintenance functions.

Even in a paroxysmal effort, dogmatic Western medical science would take decades to totally reorient its medical thinking to where it could even attack the real problem of AIDS and catastrophic sickness due to other viral BW warfare agents.

The same inability to cope with the problem also applies to our government bureaucracy, government agencies, the private companies, the universities, and to Western science in general.

If we have to depend on any or all of our present "system," the war is already over and we are all already doomed. Half of humanity will die within possibly five years after the upcoming two- to three-year "point of no return."

Medical insurance, treatment centers, and even private physicians are quickly going to be bankrupted as the AIDS plague increases. With the collapse of Western medicine, panic and pandemonium will reign in the streets. Martial law will be a necessity, and rioting on a scale unparalleled in American history will occur. We are likely to see our own U.S. dictatorship, in the form of a military junta making a coup and seizing power "to restore order and keep the lid on."

Study carefully the performance of governments and military regimes in such countries as Korea and South Vietnam, when those countries were hard pressed by enemy forces and in great disarray.

You may be looking at your own future.

The Soviets Will Not be Decimated

With the devastation of our armed forces, our governmental and civil agencies, and our population at large, a simple show of strength by the Soviets will collapse any further resistance. The hammer and sickle will wave supreme over the residue.

That's because the Russians *do* have the necessary developed scalar EM medical technology, not only to control and destroy the AIDS viruses, but also to directly restore the immune and repair systems.

The Kaznacheyev experiments alone show they have extensively studied electromagnetic induction of cellular disease and death.* We will have much more to say on that later.

If the Soviets extensively studied cellular death transmission by electromagnetics, you can bet they also studied the reverse: electromagnetic healing, or time-reversing the electromagnetic "death" signals themselves to produce specific "healing" signals for any type of cellular disease.

This is particularly certain since the Soviets also discovered and possessed the necessary "time reversal" electromagnetics: phase conjugation. This had been widely used by the Soviets in developing their enormous scalar EM weaponry, beginning about 1950 or so.

The curative signal technology was kept secret, of course, since the Soviets realized that it provided the only viable defense against viral biological warfare weapons.

The Soviets most certainly have the necessary AIDS cure. They can readily make the correct electromagnetic healing signal, by phase conjugating the AIDS death signal from dying human cells that contain AIDS retroviruses.

They also know we most certainly do *not* have the necessary EM cure. Years of weak microwave radiation of personnel in the U.S. Embassy in Moscow, and inducing illnesses in those personnel and even U.S. ambassadors, have shown that our own intelligence and scientific communities don't know what's really going on there.

Specificially, we've demonstrated (after checking with the DIA, CIA, NSA, and the orthodox scientists) that we do not recognize electromagnetic *biological warfare* —the deliberate introduction of cellular disease and death by electromagnetic means. Not only do we not recognize it, we can't do anything about it when it hits us.

And make no mistake, time-reversed electromagnetic medicine is shockingly cheap and effective, once developed. Specific healing signals for specific diseases — viral or whatever — can be quickly developed (within hours) and immediately used for mass treatment of entire populations.

For example, given the developed healing or "antidote" signal, it can even be recorded and played over ordinary transmitters, using

* There is now reliable information more closely associating Kaznacheyev with military *institutes near Moscow, engaged in* microwave weapon (directed energy) research

their normal transmissions as carrier waves. A populace continually bombarded by such "healing" television, radio, and powerline signals simply doesn't get the disease. And those already infected recover when continually exposed to such healing signals.

So the Russians can stop the AIDS epidemic cold, anytime they choose to do so.

Electromagnetically they can also gently guide and stimulate the progress of a disease such as AIDS, once the disease is introduced into a targeted population.*

Or, the Soviets can pull out all the stops and induce the disease in a distant population directly, placing the "death signals" on common carriers. Such as on our power lines, radio stations, televisions, and directly by induction from the Woodpecker over-the-horizon radar signals which continually bombard us.

The West cannot do any of these things. Neither can the West counter them, or defend against them effectively.

Unless a totally different tack is taken in the Western effort to counter this viral BW threat, Gorbachev's entrancing smile has already lured us to our doom. We are faced with a direct realization of Lenin's words:

"In the final revolution it does not matter if three-quarters of the earth is destroyed, so long as the remaining quarter emerges communist."

And Khrushchev's ghost will have the last laugh after all. We will have fulfilled the prediction he made to Nixon in their famous "Kitchen debate":

"We will bury you!"

Quite simply, for some decades the Soviets have had a new science — one they call *energetics,* and one which I have called *scalar electromagnetics.* The keystone or "heart" of this new science is time-reversed (phase conjugation) electromagnetics and electrogravitation.

*A candidate for an eery test of just this capability may be the highly anomalous deaths of numerous dolphins off the East coast of the U.S. in 1987. Nearly 500 died in the summer and late fall, apparently as a result of the weakening of their immune system to the common bacterium Vibrio. See Julia Lawlor, "Key: Failure of Mammals' **defenses,"** USA Today, **Jan. 19, 1988, p. 1A-2A.**

Chapters 4 and 5
deal *with complex scientific material and are suggested for those who are technically proficient.*

CHAPTER 4

EXTRAORDINARY PHYSICS

Maxwell'sLost Unified Field Theory

About the time of the U.S. Civil War, James Clerk Maxwell succeded in unifying magnetism and electricity. Actually he did far more than that, in his theory as originally written.

In fact, he had produced a theory which also captured the free interchange between electromagnetic energy and gravitational energy, but no one — including Maxwell himself—realized it at the time.

Maxwell wrote his original theory in quaternion and quaternion-like mathematics. The modern form of vector mathematics had not yet been finalized by Gibbs and Heaviside. It is most instructional to examine some of the fundamental differences between a vector and a quaternion.

In a conventional 3-dimensional vector, one may have three vector components, such as

$$v = ai + bj + ck \qquad (4\text{-}1)$$

where i, j, k are unit vectors in the directions of the x, y, and z axes respectively and a, b, and c are constants.

Obviously if the vector components of vector v are zero, then

$$v = 0 \qquad (4\text{-}2)$$

We shall be interested in the "vector product" of two identical vectors v, where

$$\mathbf{v} \times \mathbf{v} = AA \sin\emptyset = \mathbf{O} \qquad \textbf{(4-3)}$$

and A is the length (magnitude) of vector v, Ø is the angle between the two vectors (in this case zero), and O is the zero vector.

Now let us look for a moment at the quaternion situation.

First, in addition to the three vector components, a quaternion also has a separate scalar component, w. So the quaternion q for this situation is

$$q = w + ai + bj + ck \qquad (4\text{-}4)$$

Now when this quaternion is multiplied times itself, the vector part zeros, just as it did for the vector expression. However, the scalar part does not go to zero. Instead, we have

$$q \times q = A^2 = a^2 + b^2 + c^2 \qquad (4\text{-}5)$$

There is a very good physical interpretation of this result. It is a square of the amplitude, hence for the vector part of a wave, it is directly proportional to the energy density of the vacuum, as a function of time, at the particular position. However, we now need to make a short explanation of variation of stress energy density of spacetime.

First, we note that, according to general relativity, the "gravitational potential" is just a conglomerate of potentials of all kinds. Basically, a potential represents a G-potential, and consequently a curvature of spacetime. The potential also represents "trapped energy."

Second, we note that Kaluza combined electromagnetics and gravitation as a unified theory in 1921. Kaluza added a fifth (spatial) dimension to Minkowski's 4-space, and applied Einstein's relativity theory to 5 dimensions.

To Kaluza's delight, a common 5-d potential is responsible for both electromagnetic field and gravitational field. The "bleed-off of this 5-potential in the 5th dimension (which is wrapped **around** each point in our 3-space) is what we know as the **electromagnetic force field.** The bleed-off of this 5-potential *in and through* our 3-space is what we know as the **gravitational force field.**

Since the EM field is very much stronger (by a factor of 10^{42} for electrons) than the gravitational field, it is obvious that most of the

bleed-off of the 5-potential is in the 5th dimension, as EM force field. Only a tiny bit is left to bleed-off in 3-space, producing a very weak gravitational field.[1]

We state this fact: as a mass moves in space, it generates increased "activity" with the virtual particle flux of vacuum itself. **The** Increased virtual particle flux activity exchange between vacuum and mass is analogous to a strange kind of "virtual resistance." Since the resistance is virtual, it does not observably slow down an observable object moving in an (unobservable, virtual-particle flux) vacuum.

The increased flux activity represents an increased "virtual energy density" of space time, and an increased "trapped potential" (mass; resistance to an accelerating force) of the moving object. It represents a rotation of the spacetime frame, vis a vis the laboratory observer).

In the virtual vacuum (which contains both positive and negative time), one sees two antiparallel virtual forces: one in positive time, along the velocity vector of the object, and one in negative time (time reversed, or phase conjugated). The reason one sees virtual forces is that, each virtual (subquantal) change in the virtual flux activity represents an individual (unintegrated), separate change, hence a virtual acceleration. The observer (where things are integrated), sees the integral of all these accelerations, hence observable velocity.

The vector sum of these two virtual forces in the vacuum is a zero vector; however, the two taken together represent a stress in the local energy density of vacuum.

Since we may regard an EM wave as a stream of virtual electrons/positrons, each engaging in tremendous virtual particle flux exchange with the vacuum, then the same basic picture applies.

Now for our physical interpretation of (4-5): If we refer to an EM wave moving in the vacuum, the rotation of the frame is maximum (90 degrees). But this same rotation is just the same as additional vacuum stress, so the vacuum stress is maximum.

[1]**Electromagnetics is 5-gravity sliding around our 3-space. 3-gravity is 5-gravity oozing** through our 3-space.

This leads to these conclusions: An electrical force field vector represents a local maximum linear stress in spacetime, along the line of the vector. (Note we specifically deny that the electrical force field vector, of an EM wave in vacuum, is transverse. Instead, it is longitudinal. That has been addressed elsewhere by the author and will not be covered further here.)

Another electrical (stress) vector interacting with the first one adds more "urging" stress to the first. However, this action is occurring in the rotated frame of the moving wave, and so is rotated 90 degrees from the electrical velocity vector. Therefore it is lateral (but in a hyperdimension, not in 3-space) at right angles to the electrical velocity vector.

The combined "urging" action of the two vectors thus sweeps out an area with respect to the laboratory observer.

This means that the total "urging" or "stressing" action of the two vectors is analogous to a vector area.

It also means that this "area" function may be taken as the "swirl" of the electrical vector, but in a hyperdimension, not in 3-space. That is, we have described the magnetic force field.

Thus any two electrical vectors that interact will have an "area" or "resistance" component generated. *Any two that interact.* Whether they add vectorially, cross-product multiply, or dot-product multiply.

What is actually happening is that the wave exists in the 5-potential. The E and B fields just represent the oscillations in that 5-potential. They represent oscillations in the bleed-offs of that potential as E-field (longitudinal) and B-field (swirl).

The drag-area represents the accumulation of extra potential — hence the local rotation of spacetime. Since this accumulation is moving (along with the EM wave), as it passes a point it represents a change in the local virtual particle flux density of vacuum at that point, **hence a local curvature of spacetime.**

Hence, the EM wave makes a 5-dimension G-potential wave as it travels. The 3-dimensional gravity wave associated with this is normally very, very much smaller in magnitude — say, by a factor of 10^{-42} or so.

However, if the two vectors interact so as to produce a vector zero resultant, then all the electromagnetic energy of tho two vectors **is**

captured. That is, all the "EM vector zero" resultant means is that the EM bleedoff of the 5-space gravitational potential wave has been stopped. The 5-potential is still oscillating, and now all its trapped 5-energy must bleed off as 3-gravity force field.

Mass acts as an accumulator for this "trapped-EM energy turned into local curvature of 5-space." If we continually irradiate a mass with such a wave, the atomic nuclei of the mass slowly charge up with the new energy. Note that this potential delta may be positive or negative, if one adjusts accordingly.

In this fashion one may change the mass of a static object in the laboratory. One may either increase the mass or decrease it, or cause it to float, or even cause it to accelerate upwards.

But to return to our vector interaction and our interpretation of the scalar remainder of the quaternion.

The rule is, when the two EM vectors interact so as to form a zero EM resultant, then the EM energy represented in each of the two vectors has been converted into a special form of 5-space gravitational potential, one that is not bleeding-off in the fifth dimension (electromagnetically), but one which will gradually produce a 3-gravity potential in a mass's atomic nuclei as a function of time, the individual element, permeability and absorption factors of those nuclei, etc.

Therefore in our mathematical theory we ought to have a scalar component remaining when two EM vectors interact to form an EM vector zero resultant. That scalar component represents what is happening in the 5-potential, that will only bleed into 3-gravity.

With exploration of this phenomenology in the laboratory, one can work out the functions, constants, coefficients, and parameters which specify how the "5-G to 3-G and vice versa" component works in conjunction with mass, motion, and other fields.

That's the magic secret of electrogravitation.

It was captured inherently by the quaternion theory of Maxwell published during the American Civil War!

After Maxwell's death, when the scalar portion ofthe quaternion was discarded (by Oliver Heaviside) to form "modern" EM theory, that also discarded the unified field interaction between electromagnetics and gravitation.

Electromagnetic field and gravitational field were then modeled and regarded as mutually exclusive. EM field, therefore, was thought to produce no specific gravitational effects in the vacuum itself.

Hence when Albert Einstein was formulating general relativity some decades later, he knew only one way to "curve" spacetime: that was gravitationally, by "attraction of mass" forces.

But gravitational force was so weak that only a huge collection of mass would exert enough of it to measurably curve spacetime. That would require a sun or star. Since the observer and his instruments would never be on the surface of the sun or a star, **Einstein** assumed **that the local** spacetime **of the observer would not be curved.**

Hence he severely crippled his general relativity theory. In the West, it remains an assumption to this day. It is not a universal assumption in the Soviet Union, however, since the Soviets have long since written — and developed in the laboratory—unrestricted general relativity with *local* spacetime curvature, and hence *local violation of conservation laws.*

So the scalar part of the quaternion interaction, that remains when the vector part of the resultant is zero, is magic indeed.

That is the magic unified field portion that everyone has been seeking for decades and decades!

It was there at the beginning. Then we inexplicably threw it away!

But to return to our vector/quaternion examples.

Note also that the two vectors

$$V_j = ai + bj + ck,$$
$$v_2 = -ai - bj - ck \qquad (4\text{-}6)$$

sum to zero vectorially when added, such that

$$v_1 + v_2 = 0 \qquad (4\text{-}7)$$

However, quaternions may behave quite differently, even under addition. For example, the two quaternions

$$q_1 = w + a\,i + b\,j + c\,k,$$
$$q_2 = w - a\,i - b\,j - c\,k \qquad (4\text{-}8)$$

sum their vector parts to a vector zero resultant, but do not sum to a scalar zero as well. Instead, they sum to

$$q_1 + q_2 = 2w \qquad (4\text{-}9)$$

AS can be seen, quaternions which have the same vector parts as vectors, do not necessarily yield a complete zero when the vector parts sum to zero. And when two vectors multiply to provide a zero vector resultant, corresponding quaternions may yield a scalar term that is equal to the product of the magnitudes of the two vectors. In this way, the quaternion approach can capture the *stress of the medium,* induced by opposing or multiplying vectors. In the vector approach, the stress of the medium is entirely lost when the two vectors sum or multiply to a zero resultant.

Let us see just how important this "vacuum stress" can be.

First, the "stress in the medium" represents curvature of spacetime when that medium is the vacuum/spacetime.

In other words, the quaternion approach captures the ability to utilize electromagnetics and produce local curvature of spacetime, in an engineering fashion. Heaviside wrote a subset of Maxwell's theory where this capability is excluded.*

*Dr. Henry Monteith has independently discovered that Maxwell's original quaternion theory was a unified field theory. See his important "Dynamic Gravity and Electromagnetic Processes," in publication

Note that, by Maxwell's original quaternion theory, however, Einstein's assumption need not be true at all. For example, look at equations (4-5) and (4-9): Here we may utilize electromagnetic force quaternions to produce zeroed EM forces, and an increased stress in local spacetime. In other words, we have curved local spacetime electromagnetically. Since (with electrons) electromagnetic forces are about 10^{42} times as strong as the gravitation force, this local curvature of spacetime is not negligible.

That is, we have produced a scalar effect from zeroing vector operation between electromagnetic forces. I have called this **scalar electromagnetics,** and pointed out that it is truly *electrogravitation.*

We stress again that this violates one of the severely limiting assumptions that Einstein placed upon his theory of general relativity. He assumed that curving spacetime could only be done by the weak gravitational force due to mass. Since gravitational force is so weak, only a stupendous collection of mass — such as the sun or a star — could curve spacetime enough to notice experimentally.

Since obviously the observer and his laboratory instruments would never be located on the surface of the sun or a star, *Einstein assumed that the local spacetime would never be curved!* In other words, the local frame would always be a Lorentz frame. This meant that, locally, the familiar conservation laws of physics would always apply. Curvature of spacetime would only occur at great distances, and at huge collections of mass such as a star or dwarf star.

Einstein did not write a complete, unlimited general relativity. He wrote a sort of "special relativity with distant perturbations."

If Einstein had had electromagnetic theory in quaternions, the scalar "vacuum pressure" parts would have been there for him to ponder. It is highly probable that he would have captured the "electromagnetics-to-gravity conversion remainder" in the quaternion interactions.

If so, he would have written the full theory of general relativity, involving local violation of conservation of energy, a unified field theory, and the direct engineering of

gravitational and antigravity effects on the laboratory bench by electromagnetic means.

In that case, we should long since have navigated all around the solar system, colonized the planets, produced practical free energy devices and power systems, and avoided two great world wars and a host of little ones.

But let us now see if we can make a gravitational wave, electromagnetically.

Again, regard equations (4-5) and (4-9). Suppose these are instantaneous operations of EM force quaternions whose vector parts are varying in magnitude, but in such a manner that the vector parts ways form a zero vector resultant. Now one can see that the scalar part remaining — which represents the stress of local spacetime - is varying as the product of the magnitudes of the vectors in the interaction vary.

This means that one has now produced a scalar wave that represents the local variation of spacetime curvature in an oscillating manner.

Rigorously this is a gravitational wave. It has been produced locally. It has been produced by Maxwell's original unified theory.

Again, I have called this area *scalar electromagnetics*. The Soviets call it *energetics*.

Where local spacetime curvature is varied, conservation laws (energy, conversation, etc.) need not hold. Curved one way, the local spacetime acts as a source (of energy, charge, etc.) Curved the other way, the local spacetime acts as a sink (of energy, charge, etc.)

The Soviets often do not utilize the same restricted kind of general relativity that Western scientists adhere to.

Soviet papers in general relativity regularly point out the complete and unrestricted theory, where local spacetime curvature is allowed. They also point out that all conservation laws may be violated by such local curvature. Thus the Soviets have no unduly dogmatic respect for conservation laws.

Further, by assuming the possibility of local spacetime curvature, Soviet scientists have assumed the possibility of direct experi-

mentation with general relativity on the laboratory bench.

In the West, we have assumed that such cannot possibly be done, because of Einstein's limiting assumption of no local spacetime curvature. Thus Western physicists are strongly conditioned away from electrogravitation.

This is particularly ironic since the basis for just such an experimental theory was produced by none other than Maxwell himself in his original theory of electromagnetism.

Indeed, shortly after the U.S. Civil War, we should have been developing antigravity spaceships. We should have developed electromagnetics a la Maxwell and been on our way to the planets of our solar system. For Maxwell had — admittedly somewhat unwittingly — given us the basis for the necessary engineering theory of unified electrogravitation.

Heaviside's Mutilation of Maxwell's Theory

Well after Maxwell's death,Oliver Heaviside helped to finalize what is today vector analysis.

Then he undertook to "translate" Maxwell's theory from quaternion form to the new vector mathematics form.

Now quaternions were devilishly difficult to calculate in. So much so, that a majority of the electrical scientists (there were not very many of them in those days!) were in despair.

Not to worry! Heaviside took a broadax, figuratively speaking, and simply chopped off the scalar term, leaving only the vector components.

With that artifice, he greatly simplified the calculations to be performed.

Of course, he also threw away the EM stress of spacetime! That is, he threw away the "gravitation" part of Maxwell's theory!

Let me stress this fact most strongly. **After Maxwell's death a single** man**—Oliver Heaviside—directly altered Maxwell's equations, eliminating localized electrogravitation and producing the form of the theory taught throughout the West today as "Maxwell's theory."**

Maxwell's theory has never been taught in Western universities! Only Heaviside's crippled subset of the theory has been taught!

Then, shortly before the turn of the century, a short, sharp "debate" erupted in a few journals — mostly in the journal Nature. Only about 30 scientists took part in the "debate."

It wasn't really much of a debate! The vectorists simply steamrolled right over the remaining quaternionists, sweeping all opposition before them.

They simply threw out the remaining vestiges of Maxwell's quaternion theory, and completely adopted Heaviside's interpretation

Thus, a little over a decade later when Einstein wrote his general relativity theory, he did not know that the original work of Maxwell already indicated the unification of gravitation and electromagnetics, and indicated the ease with which local spacetime could be electrogravitationally curved locally and *engineered.*

Accordingly, he placed the scientists of the West on a road which rigorously assumed that a unified field theory was yet to be discovered. It also strongly discouraged any experimentation aimed at curving local spacetime, for it assumed that such could not be done.

After Potsdam and World War II, a frustrated Stalin was to drive his scientists to review the entire scientific literature of the Western world, actively seeking a great new technical breakthrough area such as the Allies had demonstrated with the development and use of the atomic bomb.

Great Soviet institutes — one staffed, for example, with over 2,000 PhD's — were set up to thoroughly review all the Western scientific literature from its very beginning. Anything interesting, anomalous, or unknown was put aside for further examination.

It is a good bet that the meticulous Soviet scientists discovered the difference between Maxwell's original electromagnetic theory and Heaviside's mutilation of it. Great mathematicians that they are, Soviet scientists would have realized the implications of the difference. With their knowledge of unlimited general relativity, they would have made the connection to electrogravitation.

By 1950 they had indeed done so, and were deeply into the development of what they called "energetics", and I have called

scalar electromagnetics.

They had also reached another milestone about the same time — 1950 or so.

After WWII, both the Soviets and the U.S. were keen on securing the best of the German scientists. The U.S. particularly wanted missile scientists and rocket engineers. The Soviets wanted them too; but they also wanted the German radar specialists and infrared specialists.

The West didn't care about the German radar scientists and engineers, and the IR fellows. The Soviets did, and they got them. That was to prove a most spectacular benefit indeed.

During the war, the Germans had placed extreme emphasis upon radar and radar absorbing materials (RAM). The German scientists had fantastically developed and extended the science of radar cross section — which is the heart of the matter and very, very complex. **They were much further ahead in radar cross section theory at the end of WWII than where the U.S. is today, in the opinion of** some **U.S. radar experts.**

So the Soviets started with a great jump on us in radar knowledge, and they have steadily increased the lead over the years.

In addition, the Germans had developed highly successful radar absorbing materials, and much of the theory to accompany them.

Such materials turn out to be the key to how to build and develop a radar phase conjugation mirror, to produce a time-reversed radar wave.

Thus, because of the German scientists, by 1950 or so the Soviets had already discovered phase conjugation. And they had discovered it in radar first, not in optics!

They would have been primed for the discovery by their great review of Western literature and the foundations of science, since they would probably have noticed that the time-reversed wave is a solution to the wave equation. If so, they would certainly have realized its generality throughout all physics, all frequency bands, and all types of waves.

Superb mathematicians that they are, the Soviets would certainly have made the Kaluza-Klein theory connection, and also

realized that phase conjugate waves carry negative energy as well as negative time. They would quickly have seen the gravity and antigravity implications.

So about 1950 or so, the Soviet Union would have started phenomenology experimentation in earnest, with phase conjugate radar mirrors and phase conjugate radars. This is what was referred to as *energetics.* The Soviets began a massive program in energetics about the time of the beginning of the Korean War.

By 1957-8 the Soviets had progressed to the point of a giant scalar EM accident in the Urals which exploded nearby atomic wastes, devastating the area. They had also progressed to development of great new superweapons using their new energetics — weapons to which Khrushchev referred in 1960 when he informed the Soviet Presidium of a new, fantastic weapon in development, a weapon "so powerful that it could wipe out all life on earth if unrestrainedly employed."

About the same time (mid-to-late 50's), the Soviets had also started the eery low-level microwave radiation of the U.S. Embassy in MOSCOW, to see if the U.S. knew of scalar electromagnetics (energetics) and was developing its own electrogravitational weapons and defenses.

Building Upon Whittaker's Fundamental Work

In 1904, a most fundamental paper in the foundations of electromagnetics was delivered by the British mathematician E. T. Whittaker. (E. T. Whittaker, "On an expression of the electromagnetic field due to electrons by means of two scalar potential functions," Proc. Lond. Math. Soc., Series 2, Vol. 1, 1904, p. 367-372.).

In this important paper, Whittaker showed that the electromagnetic force field equations can be replaced with the derivates of two scalar potential functions.

He also derived the most general form of electromagnetic disturbances in the ether.

This means that the coupling of two dynamic scalar functions can replace vector electromagnetics in the vacuum.

Note that Whittaker's work pointing out the overriding importance of scalar fields also accents the erroneously discarded scalar

part of Maxwell's quaternion electromagnetic theory even more strongly.

Let me explain now how I got from Whittaker's paper to scalar electromagnetics, Soviet Tesla weapons, free energy, antigravity, and electromagnetic healing.

When I discovered Whittaker's paper, I had already strongly objected that "charges" and electromagnetic vector force fields — as presently included in the Heaviside version of Maxwell's equations — included observable mass. Of course there was no observable mass in the vacuum, hence the prescribed kind of EM force fields could not exist as such in the vacuum.

Obviously the foundations of our ordinary electromagnetics theory were seriously flawed. Although my objections fell on deaf ears, I determined to examine the foundations of EM theory, discover the flaws, and at least point out the necessary corrections to be made.

Though this was an arduous task to undertake and it required many years, slowly the flaws showed themselves, and the necessary corrections slowly became clearer.

Most exciting of all, in working with several unorthodox researchers, I was able to see many of these new ideas tried, adjusted, and demonstrated. In addition, the proprietary discoveries of these colleagues continued to reveal new and unique principles and concepts. The only disadvantage was that I could not reveal the propriety apparatuses and demonstrations of my inventor associates, but only the principles and concepts that developed. In turn, I also developed principles and concepts to explain what they were doing and the results they were obtaining.

So over the years I have slowly been releasing the principles and concepts. Some of them are my own discoveries, many of them are the discoveries of my associates. Some of them are simply a mixture of both.

Early on, it became obvious that the Soviet Union was far ahead on this path, and was already utilizing the new unified field theory to build eery, powerful new superweapons.

Since no one else in the U.S. seemed to be "watching thin particular store" (I was rather universally regarded as some pecu-

liar sort of fool!), I also began to compile information and data on the Soviet weaponization of this unrecognized technology. This information I have released in a series of papers, briefings, and books, the most recent being a 1-hour videotape, "Soviet Weather Engineering Over North America," 1985, and a detailed book, Fer-de-Lance: A Briefing on Soviet Scalar Electromagnetic Weapons, Tesla Book Co., Greenville, Texas, 1986.

Building upon Whittaker's important work, I formulated a conceptual revision to electromagnetics, which I dubbed *scalar* electromagnetics to accent that the observable EM vector force fields did not exist as such in vacuum, but dynamic scalar fields did. I also wished to call strong attention to the fact that observable force does not exist until an observable particle of mass is coupled to the interference of the two scalar fields (much like in the Aharonov-Bohm effect). The Soviets, of course, call this area *energetics*, Energetics technology has been used in gigantic weapons programs of the Soviet Union for decades, and it appears to be developed under the most highly classified program that the Soviet possess. All development and deployment of energetics weapons is under the KGB and controlled directly by that organization, not by the Soviet Armed Forces.

Peter Kapitsa, the great Soviet physicist, was once pressed by Nikita Khrushchev for a total defense against missiles and air- and space-borne vehicles. Kapitsa replied that it could only come from the new energetics. In 1960, of course, Khrushchev gleefully announced to the Presidium that a new, fantastic Soviet weapon was in the development, "so powerful that, if unrestrainedly used, it could wipe out all life on earth."

Ironically, Khrushchev "jumped the gun" before his new superweapons were deployed. In the fall of 1962 he began inserting long range missiles into Cuba, bracketing the U.S. with nuclear firepower in an attempt to immediately change the balance of power. Kennedy, of course, backed him down "eyeball to eyeball," so to speak, in a blunt confrontation, but promised not to invade Cuba.

Khrushchev, with his days numbered, was desperate to deploy his new superweapons and provide a dramatic demonstration to recover face.

By destroying the U.S.S. Thresher on April 10,1963 and, on the next day, producing a gigantic underwater explosion 100 miles north of Puerto Rico, the Soviets demonstrated that the new superweapons had been deployed. Khrushchev managed to retain his position a while longer.

In the 1960's and early 1970's, I was also deeply involved in the study of paranormal phenomena.

In 1969, I entered the Georgia Institute of Technology to pursue a Master's Degree program in nuclear engineering, graduating in 1971.

In 1973, I published a rather simple paper, "Quiton/Perceptron Physics: A Theory of Existence, Perception, and Physical Phenomena," in which I pointed out the nature of quantum change, gave a new definition of mass and acceleration, and pointed out the fundamental nature of inversion of time. The paper also contained a simplified derivation of Newton's laws of motion, relativistic form. The elements of this paper had been worked out in 1971 while I was finishing my Master's program in nuclear engineering. Finishing the work had been interrupted by a slight sidetrack — a tour in Vietnam from summer of 1971 until summer 1972.

At about the same time, I formulated a fundamental correction to Aristotle's logic, adding a fourth law of logic to Aristotle's three, and a proof of it. The new logic was of great use in discovering and uncovering new concepts in unified field theory.

Incorporating Kaluza-Klein 5-dimensional concepts, scalar EM became a field theory that unifies electromagnetics and gravitation.

Incorporating dynamic sum-zeroed EM vector systems (which are discarded in normal EM theory) allowed the direct engineering of the unified field theory, including structuring the vacuum, curving local spacetime, and producing effects at a distance and in higher dimensions. Actually it allowed the recovery of much of the scalar part of Maxwell's original theory.

I then realized that, inside a vector zero EM force field summation/multiplication, the virtual particle flux of vacuum/spacetime was ordered and controlled locally and macroscopically. This of course violated one of the major assumptions (a postulate) of quantum mechanics; the assumption that the structure of vacuum was

randomized, and could not be deliberately ordered, engineered, and curved locally.

Adding phase conjugation (time reversal) aspects and extended quantum mechanical concepts allowed local antigravity and local curvature of spacetime to be included — again, on an engineering basis. It also allowed one to produce a mechanism responsible for Newton's third law, and to engineer the reaction force at will.

Further, it revealed that the law of entropy was simply the *positive time* statement; it showed that there was another half of the law, the *negative time* part or the law of negentropy.

In addition, a startling new concept of mind, thought, life, biofields, disease, and healing emerged from all this — again, on an engineering basis. As we stated in the beginning of this book, it is now an urgent necessity to release my work on the basis for electromagnetic disease and electromagnetic healing. We must produce a very quick, positive treatment and cure of AIDS and other coming lethal viruses before the world is decimated.

Accordingly, this work is being released in this book.

In this chapter we will next present some perhaps surprising material on phase conjugation, from the scalar EM viewpoint, after first briefly explaining symmetry and parity.

In following subsections, we will cover briefly the remaining major concepts in scalar electromagnetics. This will then set the stage for the following chapter, Extraordinary Biology, in which we will deal with the basis for unparalleled electromagnetic healing.

Symmetry and Parity

The basic idea of symmetry is the arrangement of the parts of a body or system about an axis so that two or more parts appear the same with respect to some operation.

The most obvious example is to look in a mirror, where we notice that our image has been reversed, left to right. Yet otherwise there is no difference; and so we may say that the reflection has "mirror symmetry." It's the same except that left and right are reversed.

If you know the details of a system at one point, and at another

point you know that the system will possess mirror symmetry, then you can predict exactly what state the system will be in at the latter point. It will be "left to right reversed." You don't have to calculate the laws of reflection and the laws of motion of the system.

All the laws of nature that possess "mirror symmetry" have a special property: If the words "right" and "left" are interchanged in the statement of the law, then the behavior of a system that obeys the law is unchanged.

Thus symmetry became a powerful idea in physics. For a system with a great number of possible interactions, etc., one can usually eliminate a very great number of them due to symmetry considerations. In other words, if one can assume that symmetry of the system will not be violated, then all the possible interactions that would yield "broken symmetry" can be eliminated.

On the other hand, if symmetry is broken in a physical interaction, at least one of the conservation laws is broken in that interaction. Broken symmetry — and hence violation of individual conservation laws — is a well-established fact in particle physics today.

Another concept intimately associated with mirror symmetry is parity. Each particle is assigned a number (+1 or -1), depending upon what kind of particle it is. One adds up these numbers for an assembly of particles, to obtain an overall "parity" number for the system. If parity is conserved in an interaction, then this total number does not change in the interaction.

Table 13. SYMMETRY

- **SOMETHING IS SYMMETRIC IF IT REMAINS UNCHANGED UNDER A CERTAIN OPERATION**
- **A SPHERE IS SYMMETRIC WITH RESPECT TO ROTATION ABOUT ITS CENTER**
- **A CATHEDRAL ARCH IS LEFT AND RIGHT SYMMETRIC ABOUT A VERTICAL LINE THROUGH THE CENTER**
- **LAWS OF ELECTRICITY ARE SYMMETRIC WITH RESPECT TO REVERSAL OF POSITIVE AND NEGATIVE CHARGE**

Table 14. A FORCE FIELD IS A SPECIAL LOCAL SYMMETRY

".. THE FORCE OF GRAVITY IS SIMPLY A MANIFESTATION OF AN ABSTRACT SYMMETRY — A LOCAL GAUGE SYMMETRY — THAT UNDERLIES THE PHYSICS OF THE WORLD."

"ALL FOUR FORCES OF NATURE CAN BE GENERATED IN THIS WAY."

PAUL DAVIES, SUPERFORCE.
1984, p. 115

Table 15. GRAVITY AND LOCAL SYMMETRY

- **THE** LAWS OF PHYSICS CAN BE MADE SYMMETRIC EVEN UNDER LOCAL GAUGE TRANSFORMATIONS

- A GRAVITATIONAL FIELD IS INTRODUCED TO COMPENSATE FOR PLACE-TO-PLACE VARIATIONS

- THE GRAVITATIONAL FIELD IS NATURE'S WAY OF MAINTAINING A LOCAL GAUGE SYMMETRY

- IN THE ABSENCE OF GRAVITY, THERE IS ONLY GLOBAL SYMMETRY

Table 16. HINDSIGHT IS BETTER THAN FORESIGHT

- **FROM THE TWIN REQUIREMENTS OF**
  - **SIMPLEST LOCAL GAUGE SYMMETRY**
  - **LORENTZ-POINCARE SYMMETRY OF SPECIAL RELATIVITY**

- **ONE CAN CONSTRUCT OR INFER**
  - **MAXWELL'S EQUATIONS**
  - **ALL THE LAWS OF ELECTROMAGNETICS**
  - **THE EXISTENCE OF RADIO WAVES**
  - **THE POSSIBILITY OF MOTORS AND GENERATORS**
  - **ETC.**

- **IN REALITY THESE WERE FIRST DISCOVERED EXPERIMENTALLY**

Table 17. WHEN SYMMETRY IS VIOLATED [BROKEN]:

- **A "NON-OBSERVABLE" TURNS OUT TO BE AN OBSERVABLE**
- **AN INVARIANCE IS BROKEN**
- **A CONSERVATION LAW OR SELECTION RULE IS BROKEN**

COMMENTS:

- **A VIRTUAL OBJECT BECOMES AN OBSERVABLE OBJECT**
- **LOCAL SPACETIME BECOMES CURVED, AT LEAST TO SOME POTENTIAL INVOLVING THAT OBJECT**

Table 18. SOME PROVEN ASYMMETRIES

- **POSITIVE AND NEGATIVE SIGNS OF ELECTRIC CHARGE**
- **TIME REVERSAL**
- **RIGHT/LEFT HANDEDNESS**

Table 19. SPONTANEOUS SYMMETRY BREAKING

PRESENT VIEW

1. IF 4-MOMENTUM $K\mu = 0$,

   $\varnothing_{(X)} = \varnothing_{VAC}$

   WHERE $\varnothing_{(X)}$ IS AS COMPLEX
   AS ANY SPIN-0 FIELD
2. **FOR** VOLUME Ω » RELEVANT MICRODIMENSION.

   $K\mu \neq 0$ BUT $K_M \sim 0$

   $\langle\varnothing_{(X)}\rangle \neq \varnothing_{VAC}$ [INSIDE *Q]*

   $\langle\varnothing_{(X)}\rangle \neq \varnothing_{VAC}$ [OUTSIDE Q]
3. INSIDE Ω, SYMMETRY PROPERTIES DIFFER
   FROM THOSE OUTSIDE Ω
4. T. P AND CP MAY BE SLIGHTLY ASYMMETRIC
5. CPT REMAINS INTACT

SCALAR EM VIEW

1. IF ARTIFICIAL POTENTIAL $\varnothing_{ART} >> 0$, VOLUME Ω
   MAY BE SMALL
2. $\varnothing_{ART}$ MAY BE ENGINEERED IN
   - SPATIAL SIZE
   - LOCATION
   - MAGNITUDE
   - SUBSTRUCTURE
3. SYMMETRY PROPERTIES INSIDE Ω MAY
   - DRASTICALLY DIFFER
   - BE DELIBERATELY ENGINEERED
   - BE PATTERNED
4. T, P, AND CP MAY BE APPRECIABLY ASYMMETRIC
5. CPT MAY BE ASYMMETRIC

Table 20. WHY SUCH DRASTIC DIFFERENCE?

IN PRESENT THEORY

$Ø_{(X)}$ • IS USED ONLY AS A PHENOMENOLOGICAL DESCRIPTION

- **MICROSCOPIC STRUCTURE OF $Ø_{(X)}$ OF NO CONCERN**
- **ONLY LONG-WAVELENGTH LIMIT OF FIELD IS OF INTEREST**
- **VACUUM ENGINEERING IS ONLY A REMOTE POSSIBLITY**
- **ACTION AT A DISTANCE IS NOT POSSIBLE**
- **LOCAL SPACETIME NOT CURVED**

IN SCALAR EM

$Ø_{ART}$ • REPRESENTS A LOCAL CURVATURE OF SPACETIME [LOCAL GENERAL RELATIVITY]

- **MICROSCOPIC STRUCTURE OF $Ø_{(X)}$ IS DETERMINISTIC AND COHERED INTO MACROSCOPIC STRUCTURE**
- **ALL WAVELENGTHS OF THE FIELD ARE OF INTEREST**

$Ø_{ART}$ WAVES ARE REAL, ENGINEERABLE AND ELECTROGRAVITATIONAL

- **VACUUM ENGINEERING IS A REALITY**
- **ACTION AT A DISTANCE IS POSSIBLE**

Table 21. ASPECTS OF STRONG LOCAL ASYMMETRY

- **PROPERTIES OF AN OBJECT MAY DIFFER APPRECIABLY FOR**
  - **DIFFERENT OBSERVERS**
  - **DIFFERENT DETECTING MEANS**
  - **ONE TIME TO ANOTHER**
  - **ONE POSITION TO ANOTHER**
- **CONVERSATION LAWS MAY BE APPRECIABLY VIOLATED**
  - **ENERGY**
  - **CHARGE**
  - **SPIN**
  - **MOMENTUM**
  - **ANGULAR MOMENTUM**
- **LOCAL SPACETIME IS CURVED**
- **LORENTZ INVARIANCE OF VACUUM IS VIOLATED**
- **MAY BE A LOCAL "SINK" OR "SOURCE "**
- **GRAVITATIONAL/INERTIAL EFFECTS FROM EM**
  - **TRANSLATION BETWEEN VIRTUAL AND OBSERVABLE**
- **ELECTROGRAVITATIONAL SOLITONS**
- **ACTION AT A DISTANCE**
  - **TRANSMUTATION EFFECTS MAY EXIST**
- **SCALAR/PSEUDOSCALAR FIELD TRANSLATION**

For years the idea of conservation of parity convinced physicists that it would never be possible to tell right from left in the universe, Then in 1956, Yang and Lee pointed out a class of reactions where parity need not be conserved. This effect — broken parity — was confirmed experimentally, and so certain parts and interactions of the universe do possess asymmetry.

The result of all this was that particle physicists established that

(1) symmetry can be, and is, sometimes broken, (2) individual conservation laws can be, and sometimes are, broken.

Particle physics, however, concerns itself primarily with microscopic interactions. Most of the delightful new things discovered in the microworld have not yet been applied — by *physicists,* that is — in the macroworld.

If you can successfully apply broken symmetry in a major system, for example, you should be able to violate the conservation of energy law and thus produce a "free energy" engine. Several inventors with whom I work have done precisely that. The techniques and technology are still primitive and they need much further development, but the principle has been clearly established and replicated.

Physics is correct in certifying broken symmetry, and you can do it in large systems as well as in microscopic particle interactions. Of course you also *curve local spacetime* as well, something which Einstein and his followers have assumed cannot be done.

Charge-Parity-Time ***and Negative Energy***

The upshot of all this is that the physicists came up with the idea that what is really conserved is a consolidated thing called Charge-Parity-Time. You don't have to conserve any one or two of these three, but only the combined product.

Here they overlooked one key factor that is very important to our thesis: In the photon interaction, if you reverse charge and time, you reverse the sign of the energy.

That is, a photon that is emitted from a positive charge carries negative time negative energy. It is different from a photon that is emitted from negative charge, for that one carries what we have conventionally established as positive energy.

Thus physics has not considered the exclusive use of negative-energy / negative-time photons, even when some of its interactions produced them. Instead, it has just lumped together photons and antiphotons, and considered them both to have positive energy.

Antimatter systems don't have positive energy, for example; they have negative energy. *Here we don't use the positive and negative signs to indicate the direction the energy is traveling, but the fundamental kind, of energy that it is—time forward or time reversed.*

For example, consider the local conservation of energy. As conditoned, one almost always unconsciously thinks of the conservation *of positive* energy, without so stating. Yet one is perfectly free to build a system into which he inputs 100 joules of positive energy, and from which he outputs 300 joules of positive energy and 200 joules of negative energy!

For the real conservation law, that's the equivalent of putting in 100 joules of positive energy and outputting 100 joules of positive energy.

Now negative energy will run motors, light lamps, etc. —often much better than positive energy. It can be transmitted, transformed, stepped up or down in "voltage," rectified, received, etc. It can be translated into positive energy or vice versa.

Circuits run "cool" when using negative energy. If you short out a circuit of negative energy so that a violent discharge occurs, it produces cooling instead of heating, greatly lessening the danger of fire and destruction. If you mix negative energy onto a line that is carrying the same amount of positive energy, however, the two negate each other and there is suddenly "no power" on the system.

Think of what you were taught in simple arithmetic. You can take a zero — the absence of any single specific number — and replace it with any set of multiple numbers whose algebraic sum is zero. The presence of this special set of numbers you choose does not violate the condition that the zero means that you could not use just a single number.

Although zero is the absence of just a *single* thing, it can be the presence *of multiple* things.

The same thing works with energy. In the microworld, everything is fantastically energetic, and wildly fluctuating. For example, in a copper wire carrying a current of one ampere, wild momentary fluctuations at extremely high frequencies are occurring.

According to classical electrodynamics, the instantaneous current in a single one of these micro-micro fluctuations may reach thousands of amperes, and the instantaneous voltage may reach 10^{40} volts or more. As can be seen, the instantaneous energy and power are enormous. Yet outside the wire, we see a very placid and peaceful situation.

TIME IS NOT OBSERVABLE

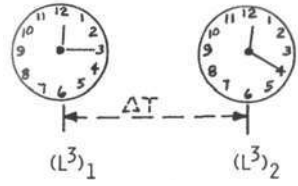

WHAT THEN IS TIME?

WHERE THEN DOES TIME EXIST?

Figure 33. The riddle of time. Unsolved by both physicists and philosophers.

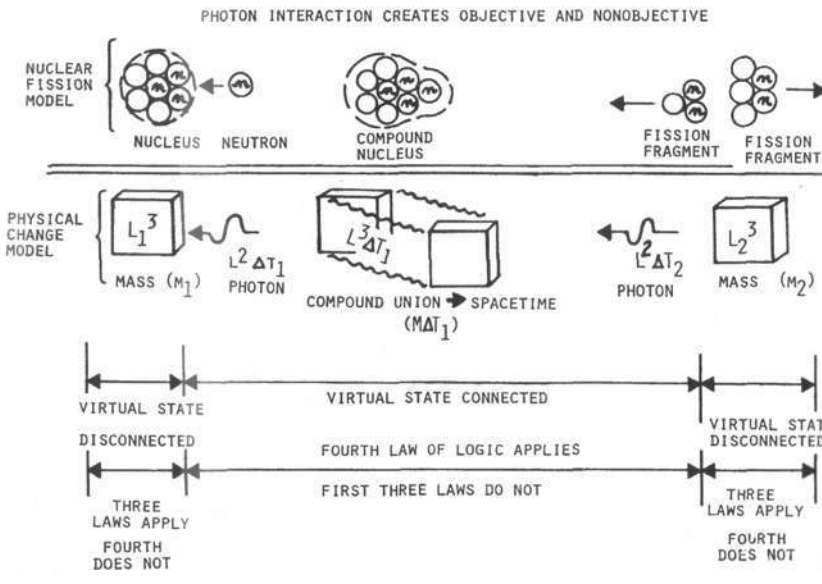

Figure 34. Raindrop model of physical change.

Table 22. FLOW OF TIME

- **PHOTON INTERACTION CONSTITUTES TIME CHANGE**
  - ~→ ⟨ NEGATIVE CHARGE ⟩ → + ΔT
  - ~→ ⟨ POSITIVE CHARGE ⟩ → − ΔT
- **CHARGE-PARITY-TIME [CPT]**

  ~→ ⟨ e ⟩ → + T̄ **(note: ~ = photon)**
  - **UBIQUITOUS**
  - **PREDOMINANT**
- **ANTIPHOTON IS A PHASE CONJUGATE REPLICA**

Table 23. PHYSICAL CHANGE

- **COMPOSED OF ACTION**
  - **h = BASIC QUANTUM**
- **TWO CANONICAL VARIABLES**
  - **ENERGY/TIME (dE dt)**
  - **MOMENTUM/LENGTH (p L)**

    ETC.
- **ENERGY/TIME**
  - **h = (+ E) (+ t)**
  - **h = (- E) (- t)**

Free Energy and Antigravity

Let's say the current flowing in the wire is alternating current at a frequency of one megahertz. Let's say we have one watt of power in the wire (there's one volt on it, and one ampere of flowing current). As a working rule-of thumb for engineering use, the available absolute micropower in an alternating current in a wire can be taken as:

$$P_a = 40 \times f \times P_c \qquad (4\text{-}10)$$

where P_a is the absolute power available, in watts; f is the frequency in Hertz; P_c is the conventional power available, in watts; and 40 is a constant of proportionality.

In our example, the absolute power actually available in the current is 40 million watts! We've got about 20 megawatts of positive power, and about 20 megawatts of negative power, in there — *in the microstructure of the electrical current itself--but disintegrated*

By applying unconventional scalar EM engineering techniques, we ought to be able to take such an "input" (a straight wire with one watt of power at a frequency of a megahertz) and get an "output" of up to 40 megawatts. It is relatively straightforward to get out 1 megawatt; such ratios have actually been achieved on the laboratory bench by my associates.

Of course we will have curved the local spacetime to do such a thing. But it is absolutely permitted to do that, by the laws of nature as best we know them from particle physics.

It is also possible to do that by Maxwell's original theory. And it has been proven in the laboratory.

Table 24. NEGATIVE ENERGY

- **CAN BE**
  - **GENERATED**
  - **TRANSMITTED**
  - **TRANSFORMED**
  - **RECTIFIED**
  - **RADIATED**
  - **TRANSLATED**
- **EASILY POWERS**
  - **AC MOTORS**
  - **DC MOTORS**
  - **LAMPS**
  - **TRANSFORMERS**
  - **RECTIFIERS**
- **CIRCUITS STAY COOL**

In scalar electromagnetics, we deliberately seek to produce such effects and systems by nonclassical application and extension of the modern conservation law CPT. And we include negative energy/ negative time production in those systems and effects.

Here's the extended magic rule: First we write down the expression **CPTEGS.**

In this expression, C stands for charge, P stands for (space) parity, T stands for time, E stands for energy, G stands for gravity,

and S stands for entropy.

We are referring here to the algebraic sign of each term, and to a complete photon interaction (absorption and re-radiation) with a charged particle inside an atom of matter. Specifically, we are refferringto the result, after the reaction has occurred.

Normally the photon interacts with one of the electrons in the atom's outer shell. This interaction with the negative electron charge *produces* the "normal" physical world/physical reality we see around us. In the interaction, normal parityis produced, andnormal gravitation (attraction of mass) is produced. Also, in a series of such interactions, the normal entropy (movement from order to disorder) is txperienced and produced.

So in the expression CPTEGS normally the charge term is negative, and every other term is positive, for the complete photon interaction in an atom.

Now here is the magic engineering rule: In the complete photon interaction with a charged particle in an atom, if one of these terms is reversed in algebraic sign, all the others will be reversed also.

For example, if the photon interacts with the positively charged nucleus,then parity is reversed, the bit of time-advance is reversed, a negative/time-reversed photon is emitted, a tiny bit of antigravity is produced in the nucleus, and negentropy is produced. By negentropy, we mean that the emitted photon exhibits the strange characteristics of time reversal, and hence it will return from disorder to order.

This rule is actually a statement of phase conjugation and time reversed waves, as we shall see later.

For example, using the rule, the production of antigravity is straightforward. Simply produce a great excess of negative energy and negative time in an object or generator by scalar photon interaction with the nucleus, at a sufficient rate.

In negative time, gravitational force is reversed. Thus in negative time gravity is a repulsion, not an attraction. Production of excess negative time in the atomic nuclei of a system produces antigravity in that system. Period.*

***At 100 Hz about 500 negative watts/lb is required for flotation. At 1 GHz, the effect is so *weak it cannot be measured, and no amount of power will float* the mirror.**

Let me amplify that statement. There are two kinds of energy, negative and positive. Normally, everyone thinks only of positive energy.

Take Einstein's formula for the amount of energy that's "bottled up" and stored in mass:

$$E = mc^2 \qquad (4\text{-}11)$$

That's positive energy and positive mass. It automatically implies that we are looking at things where time is forward-going.

Now suppose we "charge up" that mass with negative energy: Then the mass is negative, like this:

$$-E = (-m)c^2 \qquad (4\text{-}12)$$

And negative mass is repelled by positive mass. (Like mass G-charges attract, unlike mass G-charges repel.)

That's all there is to it! Simply charge up the protons/neutrons of the atomic nuclei of a mass with excess phase conjugate (negative) energy/time, and it exhibits antigravity compared to the earth. Nothing could be simpler.

Again, it's been done in the laboratory by an associate.

So, with respect to a negative energy/negative time generator, you just add more load and draw more negative power from the machine, forcing it to produce more. It produces more negative time, and hence more antigravity and more "repulsion." When the repulsion balances the earth's attraction, the system "floats in air." Draw still more power by adding still more load, and it accelerates upward. Draw less power by decreasing the load, and it sinks downward again. That's all there is to it.

We should have been working upon this, shortly after the U.S. Civil War.

Again, there exist two completely different kinds of electromagnetic energy: positive and negative. These have been totally and hopelessly confused by modern physics, even though physicists sometimes use these terms.

But in dealing with CPTEGS in the photon interaction in an

atom, we must clearly keep in mind what kind of energy we are dealing with.

The basic engineering rules are these: (1) If any one of the factors - C, P, T, E, G, or S — is reversed, all the others are reversed. (2) If positive charge is involved in the photon interaction, then time (carried by the emitted photon) is negative and so is the energy carried by it. (3) The simplest scalar EM wave may be considered as two EM waves locked together (modulating each other), where one component wave carries positive energy and time and the other component wave carries negative energy and time. (4) Separation of the two components by interaction with charged particles creates both positive and negative time and energy. (5) If the interacting particle is negatively charged, the positive energy/positive time component will interact with it. (6) If the interacting particle is positively charged, the negative energy/negative time component will interact with it. (7) The interacting particle phase conjugates (time reverses) the component with which it interacts. (8) The primary interaction with negative electron shells of atoms yields positive energy and positive time: constituting ordinary physical reality as we observe it. (9) The secondary interaction with the positive atomic nucleus produces phase conjugated (time-reversed) physical reality. (10) Secondary interaction (nuclear phase conjugation) normally produces Newton's third law of motion. (11) In Newton's third law, the reaction force need not be equal, and need not be antiparallel. Note, however, in such case local spacetime is curved. (12) The present law of entropy is only the positive-time half; the other (negative time) half is the negentropy law.

Phase Conjugation (Time Reversal)

It is a most remarkable fact that Soviet radar engineers and radar scientists are also trained in optics. While this seems little short of astonishing by Western standards, the Soviets have an exceedingly good reason: As a matter of course, most Soviet radar systems are also operable in, or associated with another system that is operable in, a time-reversed (phase conjugate) mode.

In this mode the radar and/or its associated system is also an

extremely powerful directed energy weapon, having capabilities undreamed of in the West.

A phase-conjugate (time-reversed) wave actually is a wave that travels backward through time.* That is, it is capable of precisely retracing the path through space, taken by another wave that traveled that path to a nonlinear mirror, stimulating the reflection of the time-reversed wave.

Further, in retracing its invisible path through space, the phase conjugate replica wave does not diverge as do normal waves. Instead, it continually converges upon its invisible trace.

Consequently all its energy arrives back at the distant source that emitted the stimulus wave originally. This was Tesla's original secret of his "wireless transmission of energy at a distance with no losses."**

It can easily be shown, however, that the phase conjugate wave is a legitimate solution to the wave equation. Hence it is a general property of all types of waves: sound, magnetohydrodynamic, etc. It is not confined just to the optical band.

Obviously such a startlingly different wave has phenomenal uses. Literally it ushers in a new physics.

Let us turn now to look at this strange wave that has emerged on our scientific horizon.

In the late 1960's, Soviet researchers cautiously pointed out the possibility of a time-reversed wave. Papers appeared in the open Soviet scientific literature, and shortly thereafter U.S. physicists began to read about it.

In 1972, Soviet scientists visited Lawrence Livermore Laboratory and specifically briefed U.S. scientists on the optical phase conjugation (OPC) phenomenon. Thereafter the effect became of increased interest to American scientists.

(Note, however, that phase conjugation (PC) is a major phenomenon of all physics. It is not confined merely to the optical spectrum, nor just to electromagnetic waves. Phase conjugation is a general phenomenon true of all waves, regardless of type. We will primarily discuss OPC, since most Western experimentation has

*The external positive-time observer sees this time reversal as length (space) reversal.

**The great electrician had actually discovered what today is known as phase conjugation or time reversal of EM waves.

been in the optics domain, and the literature is rich in that respect. However, we also point out that Western scientists have absolutely no inkling of the mechanism causing OPC. They have simply written a model for a time-reversed wave by taking the equation of a normal wave und writing the conjugation (adding an asterisk exponent) to the appropriate term, and pointed out that this new equation also satisfies Maxwell's wave equation. They also do not clearly recognize that an EM wave carries time and energy, and that a time-reversed EM wave carries negative energy and negative time. Further, they do not at all comprehend the startling implications for generating gravitational fields, including antigravity and inertial effects, directly on the laboratory bench.)

In optical phase conjugation, when an input EM wave (ordinary) enters a nonlinear medium, the medium "reflects" or produces a strange, time-reversed EM wave in response.

Figure (35a) shows the effect. In the figure, E1 is the normal input wave, entering a distorting, nonlinear medium (the "blob") as shown. Wave E_1 moves on through the blob, emerging on the other side and continuing, though now in distorted form.

The medium produces a second wave, E_2, which precisely retraces the steps of E_1 That is, everywhere E_1 is, E_2 now appears. The phases of the E_2 wave are precisely reversed from those of E_1 The only difference in the two waves is that wave E_1 carries positive time and positive energy, while wave E_2 carries negative time and negative energy.

(U.S. physicists are well aware of everything in the above statement except for the negative energy portion.) The historical background of the phase conjugate wave is given in Table 25.

(We strongly stress that the West did not discover the time-reversed wave; the Soviets did. At the time (late 1960's) this appeared in the open Soviet literature, the Soviets had already been using it for about two decades in their giant energetics (scalar electromagnetics) weapons development program.)

However, to return.

The time-reversed wave is called the phase conjugate replica of wave E_1. The overall characteristics of the phase conjugate replica E_2 are summarized in Table 26.

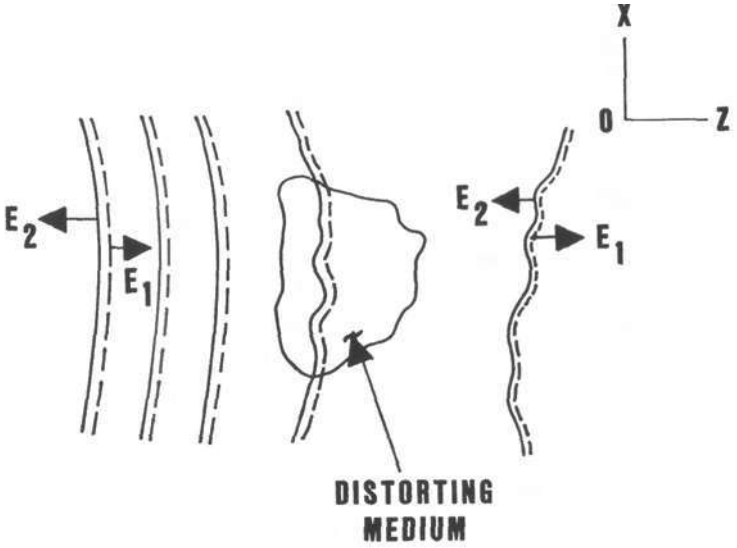

a. Phase conjugation by a nonlinear, distorting medium.

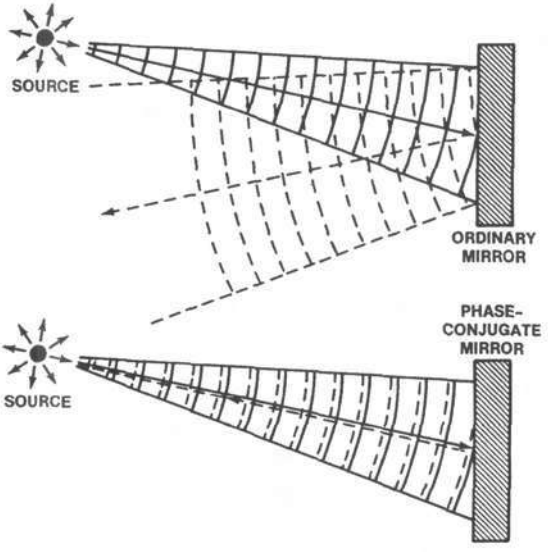

b. Ordinary mirror reflection versus phase conjugate mirror reflection.

Figure 35. Phase conjugate reflection of a time-reversed wave.

Table 28. PHASE CONJUGATE WAVES

- NONLINEAR OPTICS TRANSIENTS
  - DISCOVERED BY SOVIETS
  - LATE 60s-EARLY 70S
- **PRESENTLY** "HOT ITEM"
- INITIALLY THOUGHT RARE
- NOW KNOWN WIDESPREAD
- THIRD POWER OF E-FIELD
- S**TILL** MUCH UNEXPLORED

Table 26. PHASE CONJUGATE REPLICA

- TIME-REVERSED
- CARRIES NEGATIVE TIME
- CARRIES NEGATIVE ENERGY
- "HEALING" PROPERTY
- DISTORTION CORRECTION
- F**ROM** DISORDER TO ORDER
- **MAY** DWARF INPUT WAVE

Table 27. DISTORTION CORRECTION THEOREM

"If a scalar wave E_1 (r) propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z=0] its phase conjugate replica E_2 (r) , then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1."

We point out here that the basic nonlinearity (nonlinear medium) in spacetime is a single particle of mass. In a photon interaction with that particle of mass, the interacting (input) photon (positive energy, positive time) causes the generation and emission of a phase-conjugated (time-reversed) photon. This time-reversed photon provides the precise mechanism for generating Newton's third law: **For every action there is an opposite and equal reaction.** This will be covered later.

But back to our nonlinear medium, and the two waves E_1 and E_2.

E_1 and E_2 are "locked together" as a scalar EM wave unless something else is specially done to separate them. That is because the nonlinear medium is a *modulator,* and the two waves modulate each other (lock together as a single wave).

(We interrupt again to strongly point out this fact: This directly shows that all EM waves in vacuum exist as scalar EM waves, not as the so-called Maxwell-Hertz transverse waves of conventional theory. Nikola Tesla, the greatest electrical scientist the world ever produced, always adamantly insisted that EM waves were "sound" type waves, not "transverse" waves. For one thing, the vacuum-medium would have to be a solid to produce transverse waves! Tesla even visited Hertz in Europe and tried to convince him of the error of his so-called "proof of transverse EM waves." Tesla found Hertz, adamant on the subject, however, and returned without changing Hertz's mind. Ironically, Tesla was right and all the textbooks in **the** Western world have been consistently in error as to the nature of the EM wave in vacuum.)

We simply state here that, for a single-frequency EM sine wave in vacuum, a "full photon" of that wave in vacuum is actually a *single sine-wave oscillation.* The positive (positive energy, positive time) half of that sine wave is the same thing as a virtual electron (negative charge). The negative (negative energy, negative time) half of that sine wave is the same thing as a virtual positron — a virtual electron travelling backwards in time, or "time-reversed", which we detect as length-reversed and charge-reversed.

Further the vacuum — including the vacuum inside each relatively empty "mass structure" such as an atom or molecule — is **a** seething inferno of activity of virtual particle fluxes. It is upon that

mediumthat all physical reality and physical changes are impressed. Thus there is nothing static in the world; what actually exists is *switching of virtual particle fluxes.* What we call a "static thing" is only an equilibrium in this switching activity. And, once switched on, any stream continues until switched off or switched to change it.

For that reason, the full photon has always contained twice as much absolute energy as is provided by the presently used equation

$$E = hf \qquad (4\text{-}13)$$

Where E is energy, h is Planck's constant, and f is frequency.

One half the photon carries negative energy and negative time, while the other half carries positive energy and positive time. In the full photon interaction, one half of the photon interacts and "switches off" the stream. Thus the photon interaction makes a single change of action, energy x time, both switching on the beginning of the quantum change and switching off the ending of it.

The full photon in vacuum is, and has always been, a scalar EM photon. It rigorously is the presently accepted photon plus its directly "hooked on" and accompanying phase conjugated replica photon.

That is, in terms of the present physical view, the scalar electromagnetics view of a full photon in vacuum is that it consists of a photon and its antiphoton, directly combined in serial fashion. Further, this antiphoton part is not identical to the photon, since it is time- and energy-reversed.

The present physics makes no distinction between the two types of photons, hence makes no distinction between positive and negative photon energy. It also still considers "static" things to independently exist. It does not pursue the fact that all things appearing "static"are equilibrium states in nearly unbelievably intense virtual particle streams. Since it does not pursue that fact, it does not build a "switching" model for quantum change, not does it arrive at a method of directly engineering these "switching" operations.

For that reason, present physics has totally missed local general relativity and the engineering of spacetime curvature by electrogravitational methods, as was contained in

Maxwell's original theory.

For the same reason, present Western physics has not worked out the basic mechanism that produces phase conjugation, and it has not realized that all conservation laws can be locally violated with the new methods — methods actually hailing back to Maxwell's original theory!

Now returning again to our nonlinear medium and waves E_1 and E_2:

It is possible to separate (demodulate) wave E_2 from wave E_1 In that case, E_1 is an ordinary EM wave, carrying positive energy and positive time. E_2 is a phase conjugate replica, carrying negative energy and negative time.

Irradiation of an atom in a new sample of material with a normal EM wave such as E_1, just provides the normal photon interaction with the electron shells. That is, the electron part of the full photon adds to the orbital electron's energy state in positive time, raising the orbital electron to an "excited state." (Remember, this has switched on a continuous process of "keep raising the energy level of the electron" in positive time.) The "state-increasing" orbital electron then interacts with the second, positron-part of the full photon, which switches off the increasing, leaving the electron in its "static excited state." Simply put, one half of the full photon turns on an uplifting spray, and the second half of the full photon turns off the uplifting spray, leaving the electron in equilibrium state at a new level.*

Thus in orthodox physics we have taken the view that an electron in a shell absorbs a "photon" from the incident wave, taking extra energy and being raised into an excited energy state.

In the orthodox view, the excited-state electron then decays to release another ordinary photon (since it comes from a negative charge).

What actually happened was that, when the "full photon" of the incident wave is absorbed by the orbital electron, increase of the electron energy is switched on, then switched off, leaving the elec

*We state here a magnificient principle without proof. When one furnishes (inputs) electrical power to a system, all the "input work" is expended purely upon switching fields by fighting against them in brute-force fashion. E.g., electrical power furnished to an electric motor does **not** run the motor, but only continually wrestles the internal fields to switch them. Obviously, to build an over-unity device, one must get it to switch its own fields, at least a significant fraction of the time.

tron in equilibrium at a new energy level.

What happened in the middle was phase conjugation. In absorbing the first half of the incident full photon, the electron acted as a phase conjugate mirror (we will explain that term shortly). It emitted a forward-travelling phase conjugate replica (PCR) of that first photon half, and this conjugate replica entered the nucleus, where it is absorbed to cause the Newtonian reaction force. Note that this PCR emission by the electron does not generate recoil in the electron-PCM, as is well known in OPC theory and experiment.

The same type of phase conjugation happened when the state-increasing electron absorbed the second half of the incident full photon. It phase conjugated again, sending this half to the nucleus to acompany the former PCR half. In the nucleus, this second half switches off the increase in excited state of the nucleus that was engendered by absorption of the first half.

The photon interaction is a process for switching on and off a continuous rate of action increase or decrease.

At the conclusion of the full photon absorption, both the orbital electron and the nucleus are in excited states. The nucleus has increased its gravitational mass.

Then the situation precisely reverses. Both nucleus and electron decay, again emitting full photons and again phase conjugating.

The PCR photon emitted by the nucleus reduces the positive mass of the nucleus. The PCR photon emitted by the electron is reversed from the electron's absorption record, reducing the negative charge's energy state, and the electron is said to "decay" from its excited state. The PCR photon emitted by the electron now (to the observer) will appear to carry positive time and positive energy.

(In passing, we point out that, actually, the situation is far more complicated. Both the electron and the positively charged nucleus are enmeshed in continuous streams of virtual particle flux, including intense streams of virtual photons. One must go to n-wave mixing, where n is greater than 4, to fully understand the total reaction. The main points are, the Newtonian reaction forces within the atom are generated by phase conjugation, the photon emitted by the decay of an excited state electron will normally carry what we call positive energy and positive time, and the photon emitted by the decay of an excited state positive charge will normally carry what we

call negative energy and negative time. Full coverage of these interactions is beyond the scope of this book, and must wait for another effort in the future.).

Now once again we return to our simplified model of phase conjugation, and waves E_1 and E_2 in our nonlinear, modulating medium!

As we stated, we can engineer the situation so that the phase conjugate replica E_2 can be separated from E_1. A separated E_2, however, is a quite different breed of cat. It is a phase conjugate wave, carrying negative energy and negative time.

E_2 is a magic wave indeed!

Irradiation of the nucleus of an atom in a new sample of material with a phase conjugate replica such as E_2 causes the nucleus of the atom to interact in reverse of its normal interaction.* That is, one of the positive charges in the nucleus interacts with a photon resulting from wave E_2, and goes into an excited "negative energy" state. That state, in decaying, emits an ordinary virtual photon which promptly interacts with a virtual positive charge in the nucleus, which decays to emit the virtual photon, which interacts with another positive charge in the nucleus, etc.

In other words, the negative energy of the absorbed antiphoton is captured by the nucleus, and the nucleus overall does not *immediately* decay to discharge the negative energy.

Instead, the nucleus acts as an accumulator or capacitance, charging up and then discharging far more slowly than the normal photon/electron interaction.

(For the purist, the nucleus does phase conjugate the input negative energy/negative time wave, and phase conjugates it again — upon an electron in the electron shells, through spin coupling This second phase conjugate replica is now just a normal EM wave, and the electron exhibits a normal EM interaction. Thus **our** instruments (Which are electron wiggle detectors) detect a normal

*Irradiation of the nucleus with a PCR wave is easily accomplished by using ordinary magnetic resonance, and modulating the PCR wave upon the magnetic carrier, as Antoine Priore did.

EM wave detection and do not discriminate between photon and antiphoton halves of a full photon. For that reason, scientists have not clearly noticed the difference between positive and negative energy, and between photons and antiphotons. They have also not resolved the basic conflict between the particle and wave theories of electromagnetics. *Note that the full photon concept, where the full photon is a normal photon and phase conjugate replica of that photon hooked together into a single sine wave, resolves the long-standing wave-particle controversy.)*

In most of their instruments, present scientists are detecting a secondary normal EM wave for the phase conjugate replica interaction, since the phase conjugate interactions in the instrument are not sorted out, and since the instruments measure only one kind of PCR, that emitted by a negatively charged electron. Hence scientists think the antiphoton has positive energy, and interpret it in positive time. Consequently they tend to accent that the wave is "phase-reversed," and not accent the negative time/negative energy implications since they have not clearly sorted them out.

Let us return to our consideration of the irradiation of the nucleus of an atom (with an incident E_2 phase conjugate replica wave carrying negative energy and negative time, with respect to our electron-wiggle-detecting observer).

AS irradiation continues, the actual "structured charge pattern" existing on the incident E_2 wave slowly charges up the nucleus of the atom with that exact charge structure, in the negative energy/negative time state.

We shall find that most interesting fact of great utility when we later discuss the mind, thought, cellular control systems, and generating a specific electromagnetic phase conjugation pattern to reverse cellular disease.

We shall also find that it is of great interest in accomplishing antigravity when we use extremely low frequency PCR irradiation.

The Phase Conjugate Mirror

Any system which phase conjugates the input wave and returns a phase conjugate "reflection" is called a phase conjugate mirror, or PCM for short.

But the phase conjugate mirror has some very unique properties, as can be seen in figure 35b.

For example, if you look in a *normal* mirror, you see your own reflection. You see your shoes and legs, for example. Light from your shoe scatters across the mirror, and it hits one spot on the mirror which reflects it at the proper angle to strike your eye.

But that simply doesn't happen with *a phase conjugate* mirror! If you were looking into a phase conjugate mirror (PCM), the light that left your shoe and scattered across the mirror would be reflected right back to the shoe, since it would retrace the path taken by the previous light striking all across the PC mirror from the shoe. So all you would be able to see would be two black dots: the retinas of your eyes. Light reflecting off them and striking the PCM would be reflected back to the source — the retinas — so you could see that light and that light only.

This path reversal is most important to keep in mind. With a phase conjugate signal, you are not functioning with an ordinary signal. Further, it has a "precursor" path taken by the incident wave that stimulated its emission from the PCM. Unless interfered with, the PCR will trace back down the invisible vacuum trace of that incident wave, or back down its wave path, like electricity goes down a wire.

This, by the way, is the secret of Tesla's wireless transmission of energy at a distance with no losses.

When broadcast into space, a normal EM wave (positive time, positive energy) diverges or scatters from its path.

Precisely the opposite happens with a PCR wave. When broadcast (reflected) into space, the PCR wave continually converges back upon the invisible trace taken by its incident stimulus precursor. Thus all the PCR energy is continually converging upon an invisible beam or "wire" through the vacuum, back to the source of the original incident wave.*

If the PCR wave is highly amplified (and means to do this are now well-known), then large amounts of EM energy can be precisely

*One can effectively move the entire imprinted vacuum path, however, by adding an additional input vector wave computed so that the **resultant** input would have come from the desired shifted distant point. In this way the PCR can be steered in space to lead and intercept a distant moving target.

returned to distant points from which a stimulus wave of any kind is received.

If a micro-microwatt is received from a point thousands of miles distant, then a gigawatt can readily be returned precisely to that distant point.

This was Tesla's magic secret. The great electrician had discovered phase conjugation, though he did not use that term. He did, however, point out that he could create an invisible wire through space to a distant point, and could send any amount of energy to that distant point without any scattering losses along the way.

He also accomplished the same thing with sound waves and mechanical waves. He pointed out that he could produce an undiminished physical (mechanical) effect at any distant point, and could eventually split the earth if he added power long enough.

Tesla had given the principles of radar in World War I! He later even spoke of his "big eye that can see at a distance." Here he was probably referring to stimulating the emission of a PCR return from that target. The PCR would automatically correct for the distortion in the intervening medium, and fairly sharp pictures of the distant scene — without showing the size dispersion of distance — could probably be obtained. Note that a non-scattering signal to a distant observer does not make him suffer any loss in field or apparent size and detail of the scanned object, which can be recovered to any resolution, limited only by the state of the art of the physical realization technology.

The implications for far greater resolution microscopy— far heyond the present limitation to about 4,500 — should be immediately obvious. The implications of such a microscope - that can see directly inside atomic nuclei; photograph nuclei and fundamental particles directly; see living viruses, molecules, and atoms directly; and theoretically see even into the virtual state itself— should be immediately obvious.

In discovering phase conjugation, the Soviet Union was attempting to break Tesla's secret of wireless transmission of energy without losses, and the Soviet scientists did so by about 1950. They highly weaponized the effects of phase conjugation, phase conjugate mirrors, and amplified phase conjugate mirrors, both in radar waves,

mechanical waves, and sound waves, for nearly two decades. Then the Soviets cautiously stimulated the open literature with a limited paper on optical phase conjugation, to ascertain whether or not we realized the severe weapon implications of time-reversed waves, their production and use, and their amplification.

So phase conjugate mirrors can do very useful things. For example, look again at figure 35a. Suppose we are trying to photograph something on the other side of the distorting medium, say through a distorting gas, such as a turbulent atmosphere. In that case E_1 on the left is, say, light coming from an object on the left and passing through that distorting medium. If we just used ordinary waves in a camera on the right, we would see a very distorted wavefront, as represented by the distorted E_1.

However, if we illuminate the object by sending a wave through the distorting medium, and detect the *phase conjugate* signal that returns, it will have reversed the distortion when it gets to us, and we will get a clear picture. A very nice photo of just this process is contained in David M. Pepper, "Applications of Optical Phase Conjugation," **Scientific American,** 254 (1), Jan. 1986, p. 75.

Phase conjugation has many more uses than we have covered in this brief paper, of course, but this is an important use: the removal of distortion effects from optical systems.

It would, however, be nice to be able to amplify the effect. And so we can.

Amplifying the Phase Conjugate Effect

Let's look now at figure 36, where we will develop how to amplify the phase conjugate replica.

Be careful to notice that we are changing subscripts on you. By convention, optical scientists use A_1 and A_2 as two additional waves, called the *pump waves,* that are used to stress the nonlinear medium, and input signal wave A_4. Wave A_3 then is the stimulated PCM output, or the phase conjugate replica (PCR) wave.

In this figure we show a scheme for amplifying the phase conjugate signal that is generated and returned by the phase conjugate mirror (PCM).

We do this by adding two opposing waves of the same frequency

(in this simplified case). These are the two "pump waves", and impressing them upon the PCM is called "pumping" the PCM.

Actually, in producing the pump wave, we are adding two input waves of the same frequency, 180 degrees out of phase with each other. Since the nonlinear medium is a *modulating* medium, the waves are forced to modulate each other and "lock together" as a *single scalar* EM wave of most interesting characteristics. Indeed, its E fields sum to a zero resultant vectorially, and its B-fields sum to B zero resultant vectorially. However, the scalar parts remain and are multiplied together, as in the original Maxwell quaternion theory. Since the magnitudes of the vector components in the scalar summation (quaternion multiplication, since we are addressing modulation) are varying, then the magnitude of the remaining scalar part is varying. We have therefore produced a standing scalar wave in the nonlinear material medium, having zero vector EM gradient components. We have produced a purely scalar EM wave of pure potential — and this is an electrogravitational wave, rigorously, since it represents a time oscillation of the local energy density (local virtual particle flux density) of vacuum. This scalar EM wave passes through the electron shells and enters the nuclei, where it is phase decoupled by the extreme nonlinearity of the violent virtual particle currents of the nucleus. Its energy is then absorbed by the nucleus, raising it to an excited pseudopotential. This potential decays, returning the scalar EM stress wave into the local vacuum and area. We are now pumping the atomic nuclei of the nonlinear PCM material with our two pump waves, and we have created an oscillating local gravitational field around the PCM.

This increased nuclear G-potential, looked at in Kaluza-Klein theory, is a 5-space potential. It is ready to burst out in the 5th dimension (as electromagnetic bleedoff) at the slightest provocation. That provocation is the entrance and absorption of the input signal wave, E_4. Note that E_4 acts as an "initiator" (or a pinprick into a highly inflated balloon, if you will) on the built-up, excited 5-dimensional gravitational pseudopotential of the nuclei. The moment so initiated, the entire 5-space G-pseudopotential collapses, emitting a time-reversed phase conjugate replica (PCR) of E_4. This

emitted, highly amplified PCR is labelled E_3. It now "backtracks" down the invisible trace through space taken by the incident stimulus wave E_4, returning to the distant source that originally emitted

Voila! Tesla's wireless transmission of energy to a distant point without losses. *Voila!* The Soviet Launch Phase ABM system and the Soviet Launch Phase Anti-Bomber System, when used in conjunction with an over-the-horizon radar (such as the giant Wood-

Table 28. FOUR-WAVE MIXING

- **NONLINEAR MEDIUM**
- **OPPOSING PUMP WAVES**
  - **CROSS MODULATION**
  - **SCALAR WAVE**
  - **INTO NUCLEI**
- **TRANSMISSION WAVE**
- **REFLECTION WAVE**
- **REFLECTION GAIN**

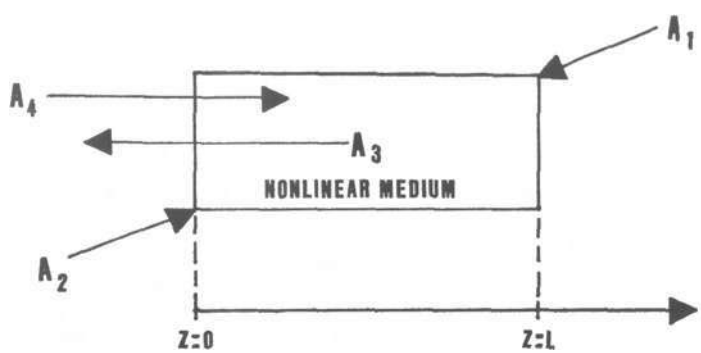

Figure 36. Phase conjugation by four-wave mixing.

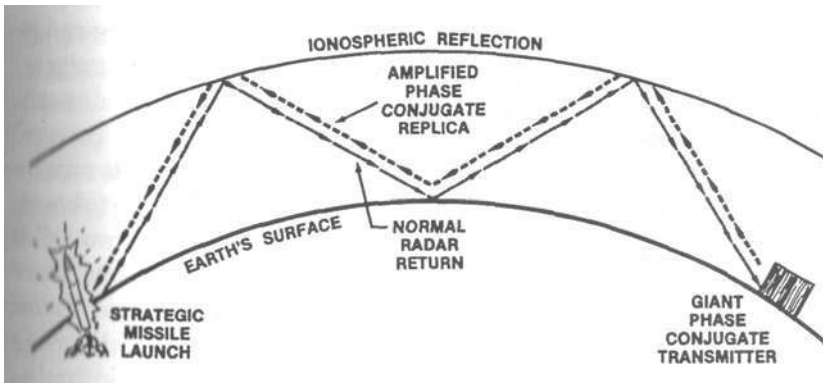

a. Soviet Launch-phase and midcourse ABM system.

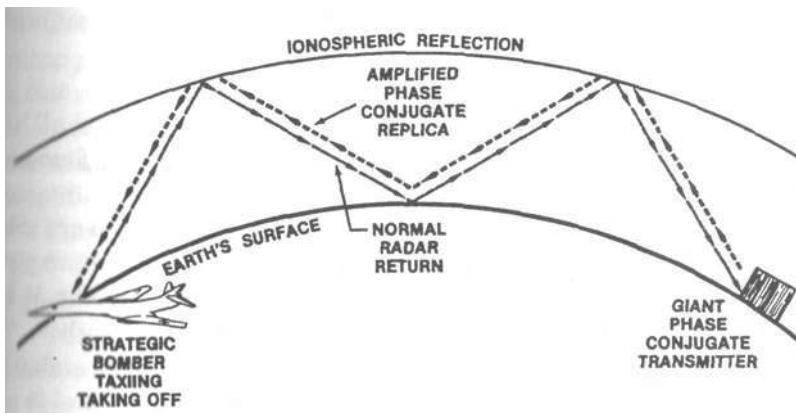

b. Soviet launch-phase and midcourse anti-bomber system.

Figure 37. Soviet launch-phase and midcourse strategic defense system.

peckers) to provide a reflection signal from a distant target. *Voila!* The true use of Soviet Stand-Off-Jammers to knock out enemy antiaircraft, air control, and anti-tactical missile radars wholesale. *Voila!* The Intermediate Phase ABM system, where a long range strategic radar is used to provide reflections from incoming targets. "Fire and fire again!" is the rule, and 100% defense is directly achievable. *Voila!* How the Soviets knocked down Gary Powers' high-flying U-2 reconnaissance aircraft. *Voila!* How SA-2 missile system radars were temporarily modified in North Vietnam to knock down several hot new F-111 aircraft. *Voila!* How the Arrow DC-8 aircraft, Titan missiles, Delta rocket, and Ariane rockets were "electromagnetically surged" from inside to destroy them. *Voila!* Why the Soviets almost never throw away old radars, since they can now add PCMs and make them formidable destroyers of incoming targets. *Voila!* How one solves the ABM problems of discrimination and weapon kill; simply pulse-fire everything — nuclear material explodes in a full nuclear explosion when struck with potential pulses of sufficient magnitude and duration.

Summarizing figure 36 and amplification ofthe phase conjugate replica:

When we consider the addition of the input wave and the resulting phase conjugate wave that will be produced, we shall have a total of four waves. Thus this particular process is called four-wave. *mixing.**

On the diagram in Figure 39, A_1 and A_2 by convention are taken to be the two opposing EM pump waves. Notice that these two pump waves stress the medium. Since the medium is nonlinear, it is a modulator. Hence the two pump waves modulate each other. The two waves thus lock together into a scalar EM wave. This scalar EM wave is an oscillating artificial scalar EM stress wave, and it goes directly into the atomic nuclei of the medium and pumps the nuclei themselves.

The atomic nuclei are now rhythmically stressed with the oscillating scalar wave.

*Probably the best single introduction to optical phase conjugation in the English language is David M. Pepper, "Nonlinear optical phase conjugation," **Optical Engineering,** 21(2),**Mar.**/ Apr. 1982, p. 156-183. Especially read Pepper's footnote on p. **166.**

We now input a weak signal (wave A_4) into the "pumped nuclei" medium.

By our CPTEGS rule, the positively- charged nuclei generate a negative energy/negative time wave — in short, a phase conjugate replica wave. Further, it is a highly amplified PCR, and may contain *as* much raw energy as was fed into the pumped mirror by our pump waves. This "seeker wave" or "electromagnetic missile" wave then sets out on its invisible path through space, seeking a distant "A_4 source point" and delivering all its energy intact to that point.

The Phase Conjugate Mirror as a Vacuum Triode

The pumped phase conjugate mirror (four wave mixing) can best be understood as a special kind of vacuum triode.

The pumped artificial potential on the atomic nucleus provides a powerful cathode in positive time, and a powerful plate as well in negative or reversed time. The electron shields, in their spin coupling to the nucleus, act as a grid in positive time. The input signal A_4 itself acts as a relatively weak signal onto the grid of the triode.

The positive charge difference in potential between the powerful pump potential of the nucleus (cathode, in forward time) acts as the plate voltage. The decrease of this potential when discharging (increase of the negative time, negative aspect) acts as the production of a plate signal to the negative time operation (production of the amplified, time-reversed PCR wave).

The excited nucleus immediately decays upon stimulus by the "grid signal" A_4, emitting a "time- and energy-reversed" strong signal — in short, amplified phase conjugate replica wave E_3.

The amplified phase conjugate signal moves from the cathode (nucleus) out to the electron shells and beyond, precisely because it is time-reversed. To a time-reversed signal, the grid (normal input) acts as the final plate (external output) — that is, in negative time, the elements of the triode are reversed. This makes it possible for the material to emit the powerful PCR.

I have called this effect/analogy a vacuum triode, to accent the direct engineering possibilities. My associates have already engineered this effect to obtain enormous amplification of energy ("free energy") and practical antigravity, from solid-state devices, directly

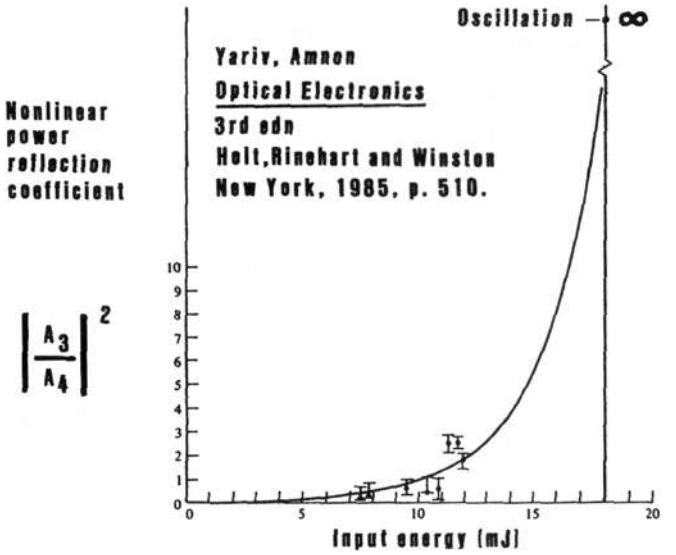

a. Typical nonlinear power reflection coefficients.

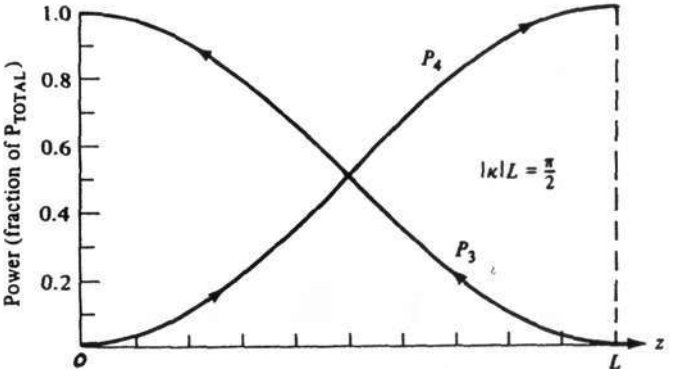

b. Intensities for the oscillation condition.

Figure 38. Power reflection coefficients and oscillation.

on the laboratory bench.

The actual "amplitude gain" of the vacuum triode is the ratio of the amplitude of A_3 to the amplitude of A_4. The square of the amplitude gain is proportional to the power gain; this entity is called the nonlinear power reflection coefficient.

Figure (38a) shows the typical nonlinear power reflection coefficient for a pumped phase conjugate mirror, as a function of the input energy and the depth of the material. As the input signal increases, the gain increases. The ultimate condition would be that the "free oscillation" condition is approached. This occurs when the angle between the input wave A_4 and the pump waves A_1 and A_2 is 90 degrees.

Figure (38b.) shows the oscillation condition and the fraction of the total pump power that is in the input wave A_4 and its output **phase** conjugate replica A_3.

At the oscillation condition, an "infinite" gain exists at the correct depth in the medium. This means that essentially all the energy being fed into the pump waves A_1 and A_2 will now be emitted **in** the output wave A_3. At that point, "saturation cutoff" of the triode output occurs, and it cannot output higher energy, since it has no more.

Notice that, at the oscillation condition, for the slightest output, the full power of the pump waves is fed into the phase conjugate replica. This powerful wave then retraces the path taken by the o**riginal** input signal, unless something else is done to divert it.*

The interesting question then arises: Since we can have infinite **gain,** can we get a special oscillation condition so that the pump wave furnishes its own energy? In other words, can the pump wave "resonate" with the vacuum flux in such a fashion that it is self-pumping and self-perpetuating?

In at least three materials, the answer is yes. Such effects have **been** experimentally accomplished in special forms of barium ti-ta**nate.** See, for example, J. O. White et al, "Coherent oscillation by self-induced gratings in the photorefractive crystal $BaTiO_3$," **Appl. Phys. Lett.,** vol. 40, 1982. p. 450.

*Recall that the PCR can be steered by introducing a minute wave A_5 to vectorially sum with input A_4, In that case, the effective input is the vector resultant of $(A_4 + A_5)$. The apparent distant source point and invisible vacuum path are shifted correspondingly.

Phase conjugation is a universal phenomenon. Theoretically it applies to any sort of wave: electromagnetic, scalar, sound, mechanical, etc. By using it, incredible new effects and an entirely new physics can be accomplished. It is a new and exciting field, little-known outside specialist circles, and still not well-understood. Most discoveries in the field are yet to be made.*

Newton's Third Law and the Full Law of Entropy

For example, the present author noticed that Newton's third law— for every action there is an opposite and equal reaction — is actually a result of phase conjugation. To explain that, we diverge a bit.

First, phase conjugation is also involved in the fact that a charged particle of mass is a little "dynamo" or engine.

Actually, a particle of mass is itself a "nonlinearity" in vacuum spacetime. When a photon (virtual or observable) strikes a particle of mass and is absorbed by it, it's the same as "interacting with a nonlinear medium."

In terms of virtual photons, the charged particle is continually bombarded with them, from the vacuum flux. The charged particle, being a "nonlinear medium", phase conjugates each input virtual photon, emitting a phase conjugate replica.

If it absorbs a normal virtual photon, it emits a "negative energy, negative time" phase conjugate replica.

If it absorbs a normal virtual photon, it emits a "negative energy, positive time" phase conjugate replica — just a normal virtual photon. Note that the particle of mass thus does not exist in time. Or, it exists equally in positive and negative time. Since we only observe particles, it follows that time is not normally an observable, as quantum mechanics has assumed.

The emission of a phase conjugate replica does not affect the momentum of the emitting PCM, as is well-known.

For an observable photon, the particle (nonlinear medium) absorbs the normal photon, which does not affect the energy and momentum of the PCM particle of mass.

If there is no other mass to accept the PCR, it just moves off.

*The U.S. may finally be waking up. SDI is now starting to study EM missiles "in the timedomain" as opposed to frequency. See **Av. Wk.** & **Spurn Tech., Feb. 29, 1988, p. 56.**

If there is another mass to accept the PCR, the PCR is absorbed and phase conjugated by it.

A charged particle in vacuum is continually bombarded by a flux of essentially "randomized" fluctuations. However, on the average these all "average out" to zero. Any particle is automatically in a very high vacuum potential, and is in a state of great agitation at all times, even if it's "at rest" with respect to ordinary observers. It's really "smeared all over the place," so to speak.

When we expose a charged particle to a *normal* potential, the interior virtual particle flux of that potential is disorganized. Hence the particle just "wiggles a bit more frantically," so to speak, randomly in every direction.

However, when we expose a charged particle to an *artificial* potential made by zero summed/multiplied EM force fields or waves, the particle wiggles more frantically in *organized directions.**

This is just as true for virtual particles as it is for observable particles.

Thus the use of such artificial potentials in scalar electromagnetics enables us to overcome the disorder of the internal structure of normal electromagnetics. By this means, we can structure the vacuum, organize electricity and electromagnetic waves, accomplish negentropy, curve local spacetime in complex, deterministic fashions , produce free energy and antigravity, reorganize and transmute nuclei (transmute elements) with miniscule input energy, etc.

Rigorously, this means that the present law of entropy is only half of the full law of entropy. Specifically, it is the "positive time, positive energy" half of the law, and it states that in closed real physical systems, continuing operations of ordered "positive time, positive energy" effects tend to inevitable "disordered" effects produced in the apparatus or system.

In other words, the present law of entropy really states that no ordered system is totally closed. The system will inevitably have energy and actions that escape the system's order, and hence (to the system) this escape represents "loss of order" — or in short, disorder.

The present law of entropy specifically excludes (by implication)

* I.e., **the** electronic noise is partially organized. This is a major key toward building scalar EM detectors. It is also a primary cause of many solid-state circuit malfunctions. The exact principle: (Random changes) + (artificial potential) equals (chaos).

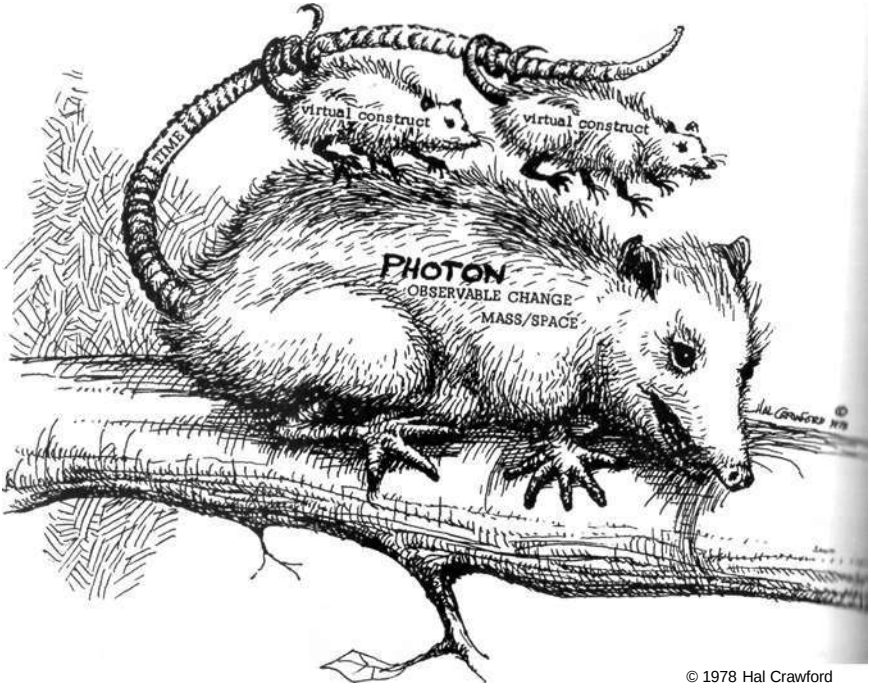

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Figure 39. Photons have virtual substructures. These may be statistical or deterministic.

negative time aspects, where external (disordered) energy time-reverses to again enter the ordered system, in perfect order. By implication, it also excludes negative energy production and operations.

However, **experimentally we can produce both negative energy and negative time, in deliberately time-reversed operations such as phase conjugation and with devices thnt serve as phase conjugate mirrors. Further, we can amplify the phase conjugation and disorder-to-order operations.**

Hence the present law of entropy is incomplete, and states only half the true possibilities. The other half of the law is the **law of negentropy.** In this law, disordered operations outside the **ordered** system undergo time-reversed (and possibly amplified) effects. These reordered energy effects — which may be highly amplified in

comparison to the disordered escaped energy—reenter the "ordered system",restoring order. Since this process moves in negative time, it goes from disorder to order. Hence it is negentropic.

Therefore we have solved the old thermodynamic problem of the "eventual decay of the universe into disorder." Not to worry; the other half of the full law of entropy prescribes negentropic operations in negative time/negative energy, and these restore the order of the universe. That takes care of the problem.

It also means that, in highly disordered systems of many degrees of freedom and far from thermodynamic equilibrium (that is, when the disorder law is saturated), then one can expect to see further stress "create" negative time and hence create order emerging and stabilizing from disorder.

And of course that is exactly what is seen. Ilya Prigogine was awarded the Nobel Prize in 1977 for writing a new thermodynamics predicting precisely such effects, and experiments have proved his case.

But to return to Newton's third law:

Newton abstracted his third law from the classical interaction between two colliding balls.

If one ball is at rest and another approaches it at some velocity, the approaching ball carries momentum and kinetic energy. As it "collides" with the resting mass, quantum mechanics tells us what actually happens: Particles of mass in the moving ball are producing virtual photons continually, and these virtual photons strike the particles of mass of the resting ball and are absorbed by it.

The resting mass now acquires extra energy and momentum from the absorbed photons. At the same time, it acts as a nonlinear medium. It produces phase conjugate replica virtual photons, and these time-reversed virtual photons are emitted. These photons produce no change in momentum or energy upon the emitting mass. However, being phase conjugates, they precisely follow back along the paths taken by the first or "stimulus" virtual photons, striking the moving ball. They are absorbed by that ball, producing (to the external observer) negative momentum and negative energy in it.

These subtract from the kinetic momentum and kinetic energy of the moving ball, reducing them.

The virtual photons emitted by the approaching ball perform positive work upon the target ball.

The virtual, phase conjugated photons, emitted in return by the mass of the struck ball as a PCM, reverse to strike the approaching ball to do negative work upon it.

Notice that twice as much absolute work is always done on the system of two balls as we "input" with the approaching ball.

Also notice that, if we directly "engineer" the phase conjugation of the struck system, we can directly tamper with, and drastically change, the production of the negative energy and negative momentum in the moving ball. Hence we can drastically alter Newton's third law. We can now make a Maxwell's Demon.

This alone clearly establishes that it is perfectly possible to build a so-called free energy device. Though subtle mechanisms must be used, it's nothing more spectacular than putting a paddle wheel in a river, and extracting shaft power from the wheel, furnished by the river's current. Phase conjugation yields other exciting possibilities

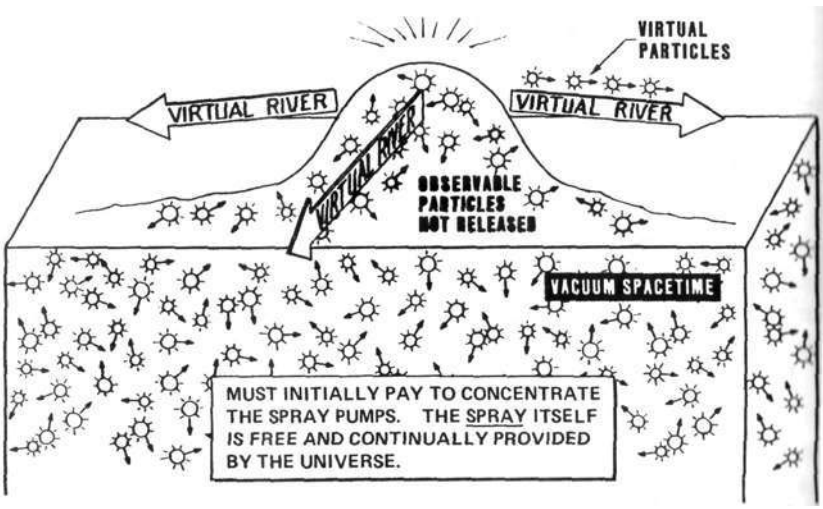

Figure 40. Once established, a virtual river is for free.

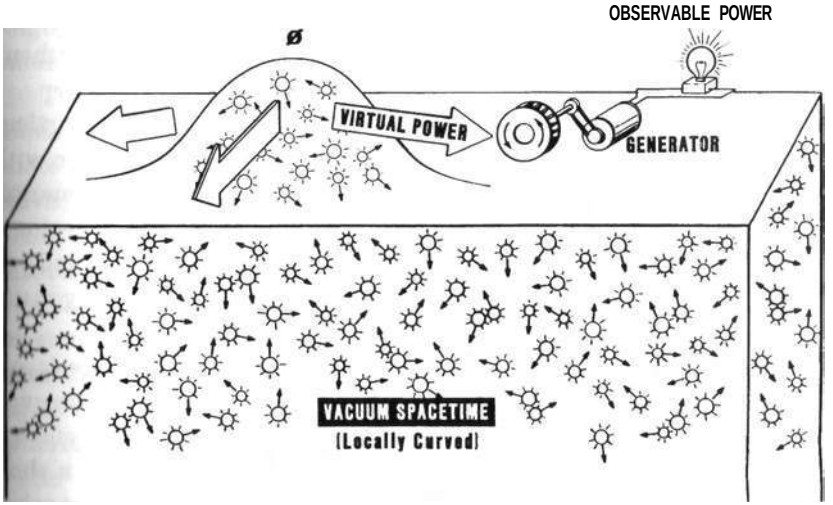

Figure 41. Local energy conservation can be violated.

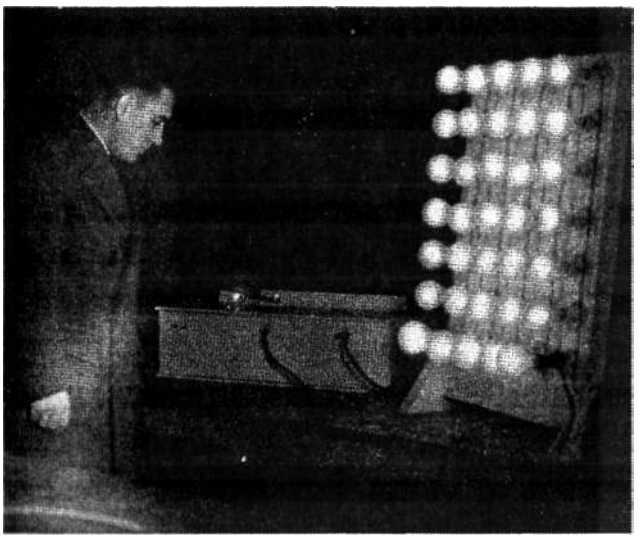

Figure 42. T.H. Moray adjusts the controls of his radiant energy device. Salt Lake City, Utah, in Feb. 1937. Moray obtained 50 kilowatts of power from a 55-lb. device, s**traight** from the ether. Its characteristics (cool circuits, brilliantly lit lamps) reveal **that** It was negative energy.

too numerous to explore here. For just one example, by phase conjugation, real-time holography can be accomplished without having to separately make and illuminate the holograms.

Now with holography and multiple projectors — and particularly with two intersecting "normal" beams to backtrack upon with ever-converging PCR signals—you can assemble a "form of energy" at an appreciable distance from the projectors in three dimensional space. With phase conjugation, you can do it in real time. And you can do it at a great distance back along the path of any signal you use as an input.

By using PCM holography, degradation with distance is not appreciably experienced. After all, the PCR waves utilized are ever-converging. The energy does not diverge and spread. Therefore, if you can make a 6" diameter ball of intense EM energy at a short distance in the laboratory, you can make that same 6" diameter ball of intense energy at several thousand kilometers distance, using PCR real-time interference holography.

With highly amplified PCM's, you can put far more energy into the distant interference form than you can with normal holography. Conceivably it is possible to assemble so much energy in the holography "object" that it condenses into a real material object! In other words, it materializes or semi-materializes.

Both the "intense light form" usage and semi-materialization of forms (such as light forms, flying geometrical forms, etc.) have been created worldwide by the Soviets for decades, to stimulate UFO reports and provide a deception plan for their development and testing of large, strategic energetics weapons using highly amplified PCMs and PCR holography.*

Other bizarre considerations also arise. For example, in **radionics** one utilizes a "witness"—such as a photograph—of the object one is attempting to send "energy" to. (For example, this might bo a sickly plant one is attempting to spruce up). Now when the plant was photographed, the light from it struck the photoemulsion of tho film, producing a photochemical reaction. It also produced phase

*For an example of highly reliable detection and observation of "Soviet hololography UFOs," see Leif Havik, "Project Hessdalen," MUFON UFO Journal, Jan. 1988, p. 4-7. The present author certainly does not imply that all UFO phenomena are due to Soviet PCR holography, only that some UFO phenomena are.

conjugation in the atomic nuclei of the film emulsion, since the emulsion acts in some respects as a nonlinear medium.

There exists a continuous, invisible "stimulus photon and its connections" trace in time and space, between the plant when the photo was taken and that photo now, even if one or both of them have moved. That trace is highly persistent (as Australian experimenters Reid and Barsamian have shown). A phase conjugate (time-reversed) signal can be made to retrace that track and travel all the way back to the plant, in the present. The effect of using the photo (or sample of the object) as such a "witness" of the real plant and directing weak PCR energy back along the invisible trace into the object is called radionics. In most cases, the two cerebral hemispheres of the operator's brain are depended on to form the necessary scalar "pump wave" to pump the "witness" and produce phase conjugated signal energy, time-reversed to travel back into the distant object.*

The problem with present radionics is that it is far too weak, and it is "operator dependent", changing with the mood, temperament, and skill of the operator. It does objectively work, however, though Often erratically. In countries such as England, France, and Germany, use of radionics to treat human disease is legal and permitted, though operators (for example, in England) must undergo extensive training and certification. Its results are roughly comparable to the results of normal medical doctors. Radionics does not replace orthodox medicine. It can successfully treat certain things that orthodox doctors have little or no success with (such as lupus), and orthodox medicine can successfully treat many things that radionics has little success with (a broken leg or ruptured appendix, for example). The two treatments are best used in conjunction with each other.

However, we must point out that a new, amplified PCM radionics is likely to emerge in the near future. Such a new approach will offer highly effective, powerful treatment of diseases, even at a distance, by amplified PCR electromagnetics. Again, the radiation in and from a photo or witness of a diseased patient can be used as a "grid signal" into a powerful, pumped phase conjugate mirror. The

•Again recall that we observe time-reversal of waves as **spatial path** reversal, not as time **travel.**

PCM will produce a specific, powerful, amplified signal that will travel directly to the patient, be absorbed in his entire system, including the atomic nuclei comprising his cells, and directly reverse the chemistry, toxins, and cellular damage in the patient from that disease. It will also kill or destroy the harmful viruses, bacteria, etc. causing the disease, and it can even reverse the actual genetic changes in the cell caused by disease-inducing viruses.

Of course, any powerful tool is two-edged. It can be used for harm as well as good. I think the reader can appreciate the damage that can be done to systems and persons at a distance by means of such powerful new amplified PCM radionics devices.

You can also see the security problems posed to large computing facilities in banks, federal facilities, state and municipal facilities, the IRS, U.S. military weapon systems, ships, aircraft, etc.

Obviously such devices are going to have to be highly regulated and controlled. Else criminal operators will be killing people and destroying things wholesale, secretly and at a distance, and they will have perfect legal alibis to allow them to escape prosecution.

To summarize: if a photograph or witness pattern of an object or person can be correctly stimulated by phase conjugate electromagnetics so that the emulsion acts again as a PCM, can one not argue that—theoretically — phase conjugate energy from the photograph and the instrument can be sent back along all paths, all the way back to the original object? After all, this has been rigorously demon strated by University of Sydney researchers. Is there not an actual physical mechanism for radionics? For highly amplified, powerful radionics where the operator himself is removed from the circuit? Just because it changes our present notion of physical reality, must we dogmatically reject the results being shown on the laboratory benches, some of which are in the hard-core scientific literature?

Phase conjugation and time-reversed engineering have a diversity of applications unparalleled in the history of science. They literally present us with a new physics. New rules apply.

Most of the major discoveries in phase conjugation have yet to be made.

Scalar Electromagnetics

The scalar electromagnetic approach modifies classical electromagnetics (EM) to include gravitational waves and effects.

To do this, scalar EM utilizes summed-zero vector forces and force fields to construct polarized vacuum potentials.

Although externally it has zero E and B vector gradients, an "artificial" potential possesses an internal, dynamic E and B vector field structure. This "infolded" (Bohm's term) structure has finite size and is deterministic. The infolded structure of the artificial potential in turn deterministically structures and polarizes the vacuum and curves spacetime locally, contrary to presently assumed limitations of general relativity.

Since in free vacuum a potential normally extends to infinity in a decaying exponential fashion, then this infolded E and B vector structure of an artificial potential extends to infinity in a decaying exponential fashion.

The artificial potential itself may be rhythmically varied either in structure, magnitude, frequency, or all of the above. This produces waves of potential, and waves of the structure of vacuum/spacetime — again, in the free vacuum case, reaching to infinity in a "decaying exponential" fashion. These "scalar EM waves" are gravitational waves.

Each photon (one major wave length of the "carrier", complete with modulations) of the scalar EM wave also has structure (its included modulations).

Modulated waves have compound or "giant" photons — photons containing infolded photons.

Each compound photon of such a scalar EM wave is a vacuum engine. It deliberately structures and patterns — dynamically — the energy density and charge of vacuum.

(1) By canonically varying two or more components of the electromagnetic vector structure of the zero-summed EM force vector system, the local structure of vacuum spacetime is macroscopically varied in its internal composition. This is the compound variation of "curvature within curvature" — and hence hyperdimensional.

Table 29. A ZERO VECTOR SYSTEM:

- **IS AN ACCUMULATOR**
- **DOES "INTERNAL" WORK ON MEDIUM**
- **HAS NO "ENERGY" EXCEPT STRESS OF VACUUM, YET**
- **CAN YIELD THE ENERGY OF ITS COMPONENTS WHEN DISSIPATED**
- **IS A SPECIAL SORT OF "PUMP"**
- **CAN YIELD CONTINUOUS ANENERGY FLOW IF NOT DISSIPATED**

(2) By prohibiting internal canonical variance while coherently varying the amplitudes of all the EM components, the total stress of vacuum/spacetime — and hence its overall curvature — is locally varied, without modifying its structural form. This is simple variation of overall curvature of local spacetime, involving primarily relativistic effects.

Rigorously, each of these two methods produces a localized gravitational wave, where the local stress of vacuum is deliberately patterned as well as oscillated in amplitude.

Both methods may be applied simultaneously (and multiple infolded times) to produce an even more sophisticated gravitational wave, and more sophisticated structuring of the local stress energy density of vacuum.

The resulting unified electromagnetics/gravitation is called **scalar electromagnetics,** since the electrogravitational effects are obtained by deliberately opposing EM vector force fields so that they vectorially sum or multiply to a zero vector EM resultant, while **the** infolded (Bohm's term) EM vector components structure and vary the stress energy density of vacuum.*

*Gravitational potential is just "in-folded and locked in" dynamic electromagnetic forces. The infolded EM energy is locked-in, representing a change in the local energy density of vacuum and hence a curvature in spacetime. Electromagnetic force fields are just the out-folding of the G-potential's inner EM contents into the 5th dimension. Ordinary gravitational force field is just the "trickle leakage" of the G-potential's infolded contents, out into and through *3*-space.

Note immediately that scalar EM also deals with internally structured and patterned electricity and electromagnetism.

"Normal" electromagnetics has no deterministic internal structure.

The new electrogravitational (EG) wave is called a scalar EM wave, and is believed to have been originally discovered by Nikola Tesla.

James Clerk Maxwell was aware of the potential for electromagnetics to stress and structure the vacuum ether.

His original electromagnetic theory — written in quaternions, not vectors (which had not yet been completed by Oliver Heaviside) - can allow for these effects to be expressed.

Unfortunately Heaviside's interpretation of Maxwell's work

Table 30. STRESS IS FUNDAMENTAL

- **THE MOST FUNDAMENTAL REALITY IS STRESS**
- **THE COMPONENTS COMPRISING STRESS ARE THE GREAT CAUSATIVE AGENTS**
- **MOST OF THESE ACTIVE AGENTS ARE HIDDEN INSIDE ZERO-VECTOR SYSTEMS**
- **THE COMPONENTS OF STRESS MAY BE STATISTICAL OR DETERMINISTIC**

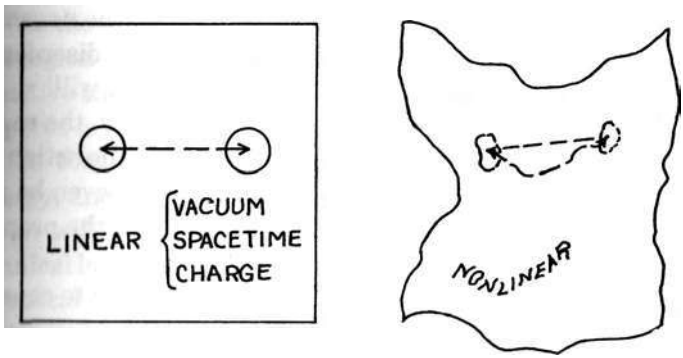

figure 43. Charge affects anything existing in spacetime.

eliminated these effects, and they have remained eliminated from the Western EM theory to the present day.

The use of the scalar EM wave directly engineers the virtual state and the vacuum itself.

Hooper's work represented important work in this respect, as does other related experimental work by Bedini, Watson, Golden, Dea, Faretto, Beck, and other inventor colleagues who do not wish their names mentioned.

Scalar EM theory also bears a strong relationship to the Kaluza-Klein unified theory of gravitation and electromagnetics. At least five dimensions — four spatial and one time — are required as a minimum.

Nested levels of virtual state may be modeled as identical to successive hyperspaces.

Internested levels of zero-summed vector EM force fields allow the direct engineering of those hyperspaces.

Negative energy and negative time flow are especially important when building free energy devices and antigravity. The mechanism producing negative energy and negative time flow is the forced amplified production and absorption of phase conjugated waves.

In addition, phase conjugation is a basic phenomenon of nature: for example, as previously pointed out, it is the direct mechanism that generates Newton's third law of motion. It also adds a negentropy law (for negative energy/negative time).

Accordingly, if we engineer phase conjugation, we can change Newton's third law to our will. And we can invoke the negentropy half of the total law of entropy, so that we can go from disorder back to order. Again, we can make a Maxwell's Demon at will!

In Newton's third law, when manipulated locally, the reaction force need not necessarily be equal in magnitude to the action force It also need not necessarily be parallel to it. It can even be phase conjugated itself to yield an addition force, assisting the propelling of a particular engine or device.

Phase conjugation may also be manipulated so as to cause like magnetic poles to attract, and unlike poles to repel.

Magnetic "force field lines" of a bar magnet normally exist in conjugate co-existing pairs. One of the pair is in observer positive

time, and (by convention) runs from the north pole to the south pole. The second line of the pair is a phase conjugate of the first, and exists in negative observer time. Thus, to the "positive time only" observer, it will appear to run from the south pole to the north pole, perfectly retracing the path of its twin.

Howard Johnson uses a "two particle" theory of magnetic field, for example, where one particle (photon) is the phase conjugate of the other. This is identically the same as the scalar electromagnetics concept of phase conjugate pairs of field lines. By very complex, specialized, compound permanent magnets, Johnson is able to partially separate the two lines, and spatially concentrate or diminish the phase conjugation (negative time) component in a given area of operation.

If the negative time component lines are concentrated to outweigh the positive component lines in a local region, then the laws of magnetics are reversed in that region. There like poles attract and unlike poles repel.

In his rotary permanent magnet motor design, he concentrates the negative time component in that part of the rotation where a north rotor pole is approaching a north stator pole. Normally, in this part of the cycle, one has to overcome the repulsion of like poles to "force energy" into the device for later extraction.

However, *now* in that region *like poles attract.* There the north pole of the rotor is attracted toward the north pole of the stator, adding impetus to the rotor.

As the rotating north pole passes the stator north pole, it leaves the region of negative time concentration and returns to a normal "positive time" region again. Now the north poles repel again, and impetus is again added to the rotor.

In that manner Johnson is able to violate local conservation energy, and make a "free energy" permanent magnet motor. The motor will rotate itself and deliver constant shaft power to a mechanical load. By attaching a standard electrical generator, normal electrical power is continually and freely produced by the complete motor generator power system.

Johnson's complex nonlinear magnets severely curve local spacetime, allowing *local* violation of energy conservation.

Scalar EM View of the Vacuum

In the modern quantum mechanical view, the vacuum is not an emptiness, but instead is a plenum.

Today the vacuum is considered to be filled with incredible virtual particle activity. From nowhere, virtual particles continually arise — even with fierce energy — then disappear again into nowhere, so rapidly that they cannot be individually observed.

However, these virtual particles are quite real, for they cause all the forces of nature when they interact in the aggregate with observable particles.

To the observer, the fleeting particles also appear and disappear in both positive time and negative time. That is, the flux consists of both particles and antiparticles.

Thus the vacuum is a seething inferno of virtual particle fluxes.

The concept of an **ether** is again accepted. It refers to this "virtual flux" vacuum.

Note, however, that this is an ether far different from the old material ether that was theorized prior to relativity.

In the new vacuum ether, every imaginable type of particle continually and spontaneously arises (creation) and disappears (annihilation) at every point in the vacuum, according to modern quantum mechanics.

The rate of this seething virtual particle creation and annihilation is essentially unlimited. Hence the "flux density" of vacuum is essentially unlimited.

Further, any virtual particle created has a flux of even finer virtual particles associated, and so on without limit.

The vacuum's virtual particle flux is thus comprised of nested levels of ever finer virtual particle fluxes, in the modern view. We state without proof that **each deeper virtual level may be modeled as a higher dimension** (hyperdimension). **This yields an infinite-dimensional vacuum spacetime (hyperspace) that is identically the infinite nested levels of virtual state.**

At the same time, every nucleus in the universe is continually absorbing and emitting scalar EM (electrogravitational) waves. The emitted scalar EM waves of pure potential are waves in the stress and structuring of the vacuum itself.

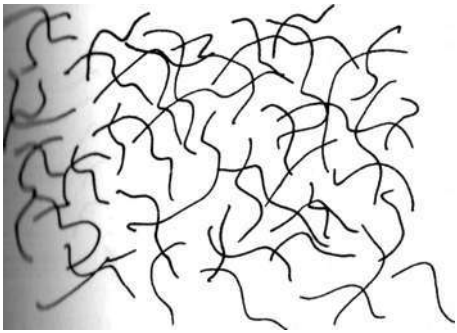

VACUUM IS IDENTICAL TO:

- **VIRTUAL PARTICLE FLUX**
- **SPACETIME**
- **ANENERGY**
- **$Ø_O$**
- **MASSLESS CHARGE**

VACUUM IS:

- **MADE OF UNQUANTIZED ACTION**
- **WITHOUT DEFINITE LENGTH INTERVALS**
- **WITHOUT DEFINITE TIME INTERVALS**
- **N-DIMENSIONAL (UNFIXED)**

Figure 44. Vacuum/spacetime is pure virtual particle flux.

Table 31. VACUUM IS:

- **SPACETIME (L^nT, WHERE n >= 3)**
- **CHARGE (MASSLESS)**
- **ELECTROSTATIC SCALAR POTENTIAL**
  ($Ø_O \neq 0$)
  (ERROR IN PRESENT THEORY)
- **BROKEN BITS OF ENERGY (SUBQUANTAL)**
- **PURE VIRTUAL PARTICLE FLUX**
- **Ø -WAVE FLUX**
- **MULTILEVEL, STRUCTURED, PATTERNED**
- **A VIRTUAL PLENUM**
- **AN OBSERVABLE EMPTINESS**

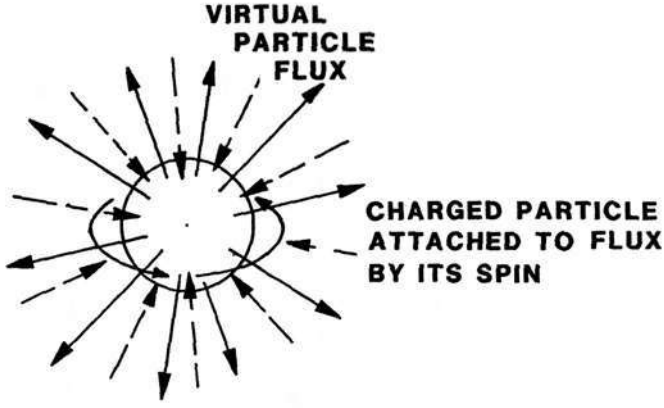

Figure 45. A simplified charged particle.

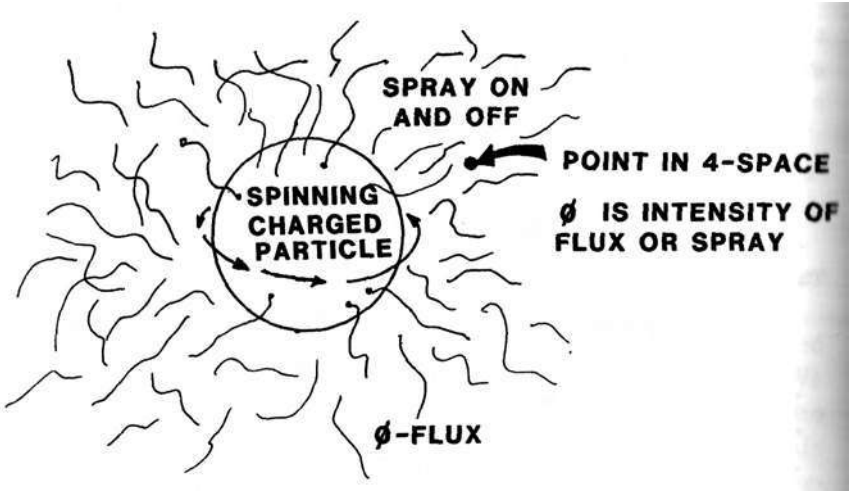

SPRAY IS THROUGH 4 OR MORE DIMENSIONS, NOT JUST 3

Figure 46. A charged particle is a special kind of "spray nozzle."

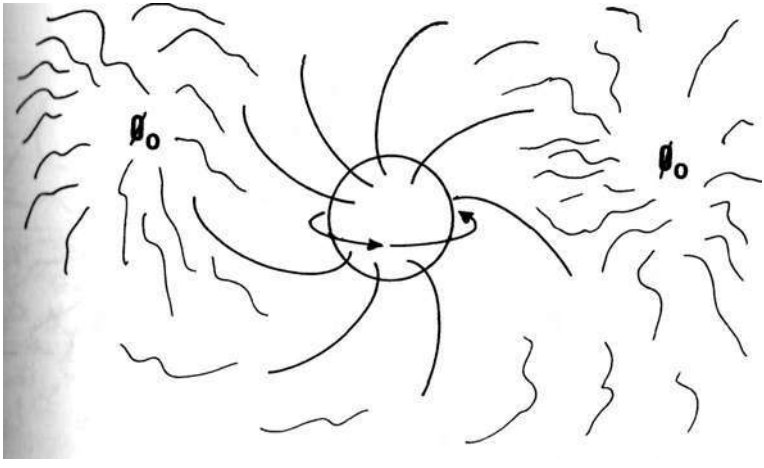

Figure 47. An observable charged particle is directly connected to virtual particle **vacuum** flux.

Table 32. SPIN COUPLES VACUUM TO PARTICLE

- **SPHERICAL ROTATION IS THE KEY**
- **A PARTICLE CAN BE MODELLED AS A SPHERICALLY ROTATING VORTEX OF SPACETIME**
- **ITS MASS IS DUE TO ITS SPIN**
- **THE SPINNING OBJECT IS CONTINUALLY CONNECTED TO ITS ENVIRONMENT**
- **VERY HIGH VALUES OF ELECTROSTATIC POTENTIAL CAN INDUCE RELATIVISTIC CONDITIONS**
  - **CHANGE RATE OF FLOW OF TIME**
  - **EVEN THOUGH VELOCITY IS NONRELATIVISTIC**

E.P. BATTEY-PRATT AND T.J. RACEY,
"GEOMETRIC MODEL FOR FUNDAMENTAL PARTICLES,"
INTL. J. OFPHYS.19. NO. 6, 437-475, 1980

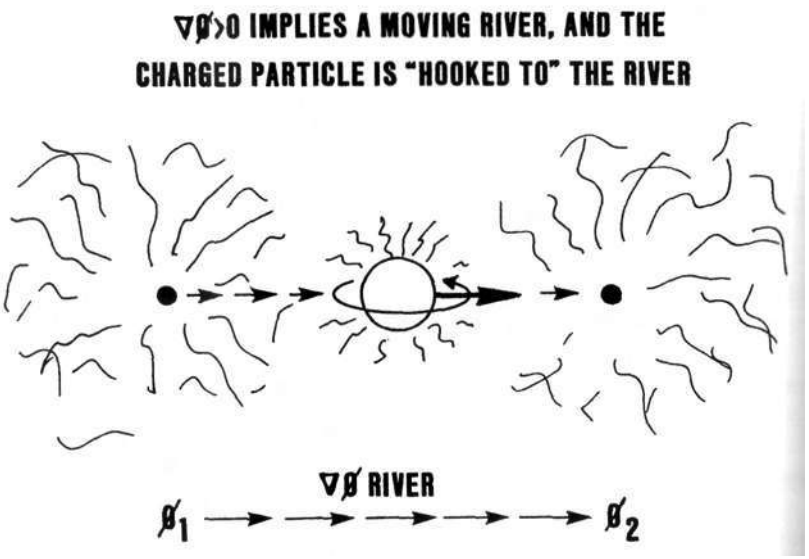

Figure 48. In a flux gradient (virtual particle river), a charged particle moves itself.

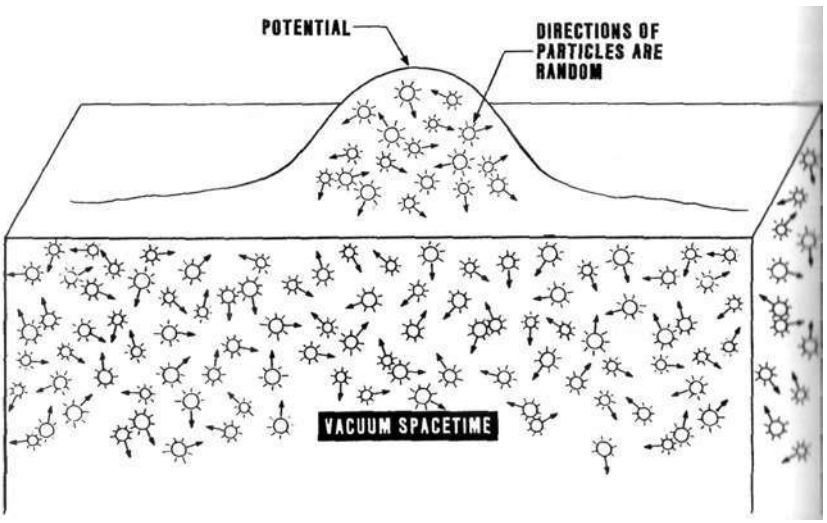

Figure 49. A natural potential is a **disorganized change** in **the stress of** vacuum. It has a random virtual substructure.

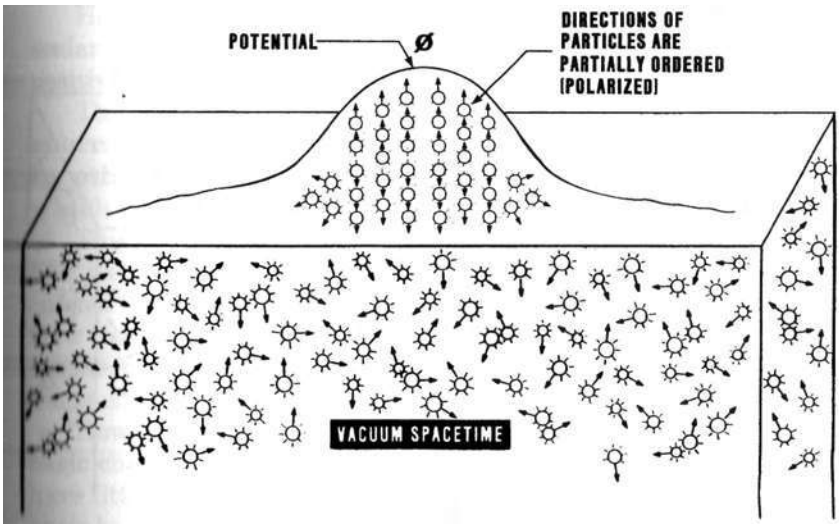

Figure 50. An artificial potential is an organized change in the stress of vacuum. It has a deterministic virtual substructure.

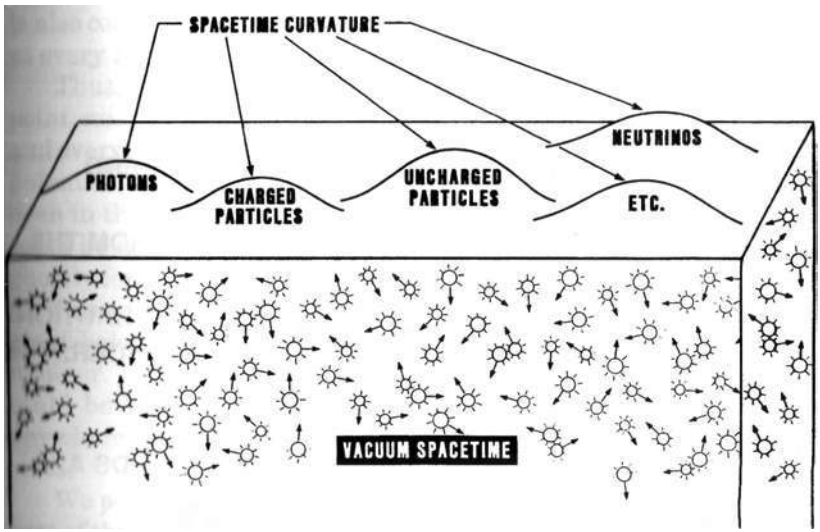

Figure 51. Gravitational potential is a conglomerate of stresses, organized or disorganized.

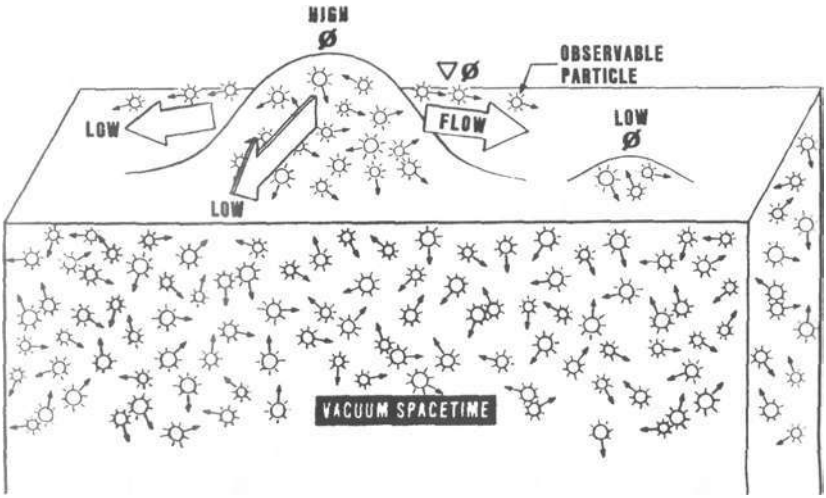

Figure 52. EM force fields are releases of gravitational potential via observable charged mass flows.

Table 33. RESIDUE UNIVERSE, RESIDUE SCIENCE

- **VECTORIALLY, STRESS IS SUM-ZEROED**
- **THE VECTOR FORCE FIELDS REPRESENT NON-ZERO GRADIENTS IN MORE FUNDAMENTAL STRESS**
- **FORCE FIELDS ARE THE RESIDUE LEFT OVER FROM THE SUM-ZEROED STRESSES**
- **PHOTON INTERACTIONS ARE FORCE-FIELD INTERACTIONS**
- **PHOTON-DETECTED REALITY IS ONLY "FIRST ORDER." IT SHOWS ONLY "RESIDUE-LEVEL" REALITY**
- **WE HAVE BUILT A "RESIDUE SCIENCE" AND A "RESIDUE PHILOSOPHY" BASED ON FORCE FIELDS AND PHOTON DETECTION**

Hence at every point in the vacuum, an intense flux of these scalar EM waves, with concomitant interferences, exists — in both positive and negative observer time.

This scalar EM flux causally **drives (constitutes) all the** enormous **quivering of the vacuum** spacetime medium **itself. In other words,** it **drives subquantum (virtual) change, which in turn drives quantum change.**

This is a drastic reorientation of quantum mechanics. In scalar EM, we view that the virtual flux of vacuum is *causally driven or created* by interacting scalar EM waves. This replaces the present **view** that the virtual flux is entirely chance. It opens up the direct engineering and structuring of the vacuum — and hence the atomic nucleus — by scalar EM means.

However, it does not replace the normal *statistical nature* of the **basic** changes of the background vacuum medium. We normally **have** little or no knowledge of the myriad of drivers that cause the basic background waves of that medium. We may, however, deliberately create special vacuum potential waves which are determinis**tic,** and which we have knowledge of.

To the observer, from a purely statistical viewpoint, in this violent vacuum flux *any* and *every* finite pattern of virtual particles is also continually being momentarily created and destroyed — and at every level and in every hyperdimension.

Thus, in the vacuum there continually exists — at any and every point, and in any and every region — the ghostly image of anything and everything, whether in the past, present, or future; and whether **potential,** probabilistic, or actual. Even everything that could have be**en** in the past but wasn't, or might be in the present but isn't, or could be in the future but won't be, is continually present in thin, ghostly form.

Rigorously, the universal vacuum may be taken to be a sort of gi**ant** hologram, for the whole is in each part, albeit in ghost-like manner. Everything that is, or was, or shall be; and everything that could be but isn't, wasn't, or shan't be; already exists *at once, an*ywhere and everywhere, in this ghostly, holographic, virtual state.

We point out in passing that, conceivably, one can engineer any **part** of this "potential for reality." That is, one can directly engineer physical reality itself, in the scalar EM view.

All that must be done is to amplify (continuously and coherently

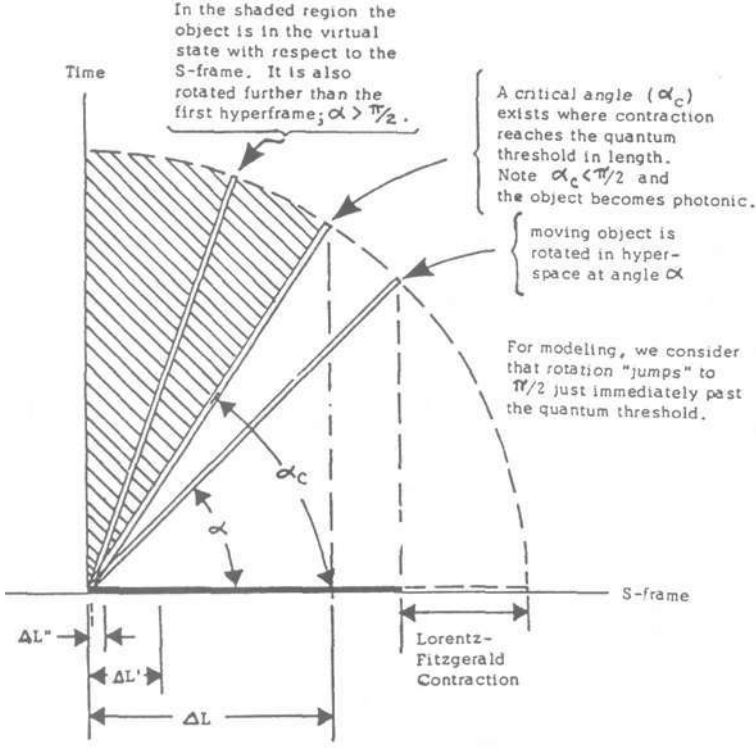

Figure 53. As beyond (without), so within. Hyperspaces are internested virtual states, and rotated orthogonal frames. They are also substructures within and of vacuum state potentials.

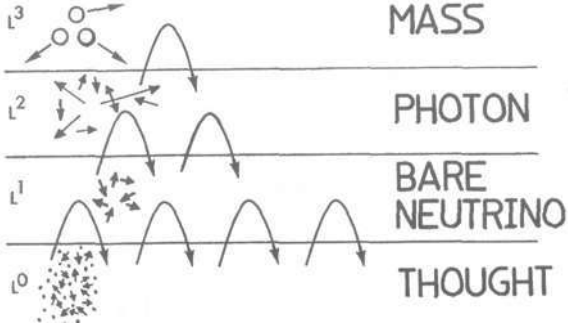

Figure 54. Internested levels of virtual state vacuum interact with neutrino, photon, and mass. "Thought" or "mental state" refers to the third and more levels down in virtual state.

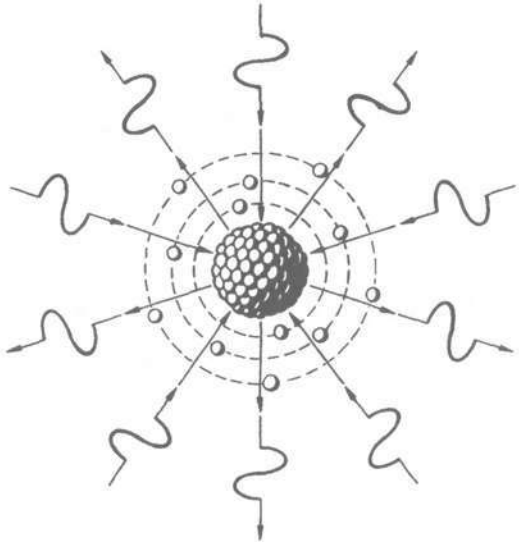

Figure 55. Virtual state patterns are absorbed and emitted by the atomic nucleus. The built-up nuclear "charge" in that particular pattern is a partial potential — for that pattern only.

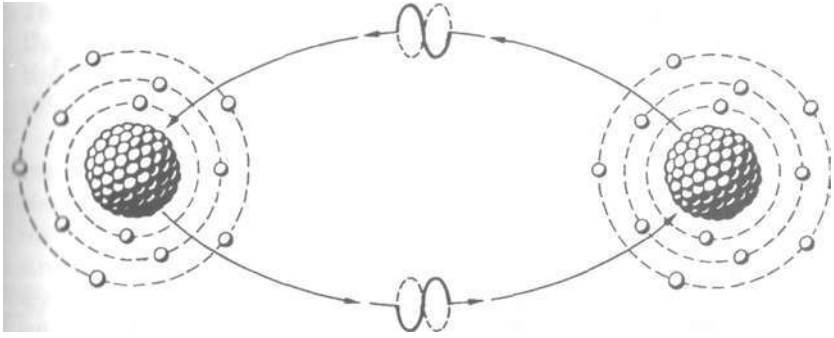

Figure 56. Nuclei of the universe continually exchange scalar EM waves and virtual **panicle** fluxes.

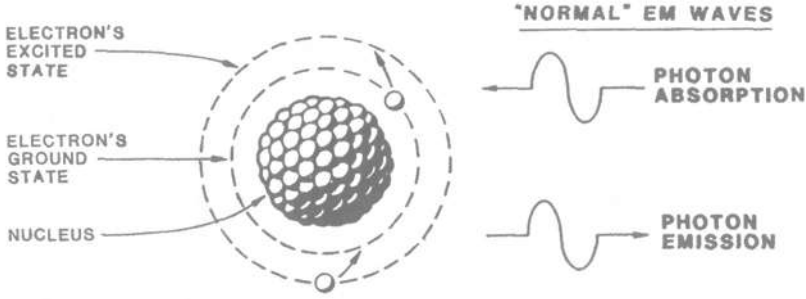

- HEAVY NUCLEUS RELATIVELY UNAFFECTED
- MACROSCOPICALLY. MASS APPEARS STABLE AND "BRICK-LIKE"
- SPECIAL RELATIVITY APPLIES

Figure 57. First order reality. Rough-hewn by observable photon interaction with electron shells of the atoms of physical mass. This process is "physical observation."

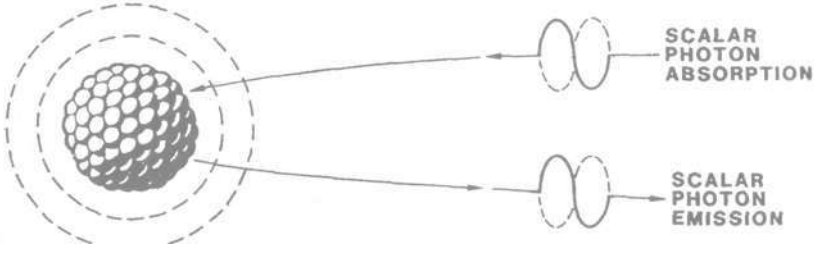

- HEAVY NUCLEUS AFFECTED
- MACROSCOPICALLY. MASS APPEARS FLUID AND CHANGEABLE
- GENERAL RELATIVITY AND KALUZA-KLEIN GEOMETRY APPLY

Figure 58. Higher order (hyperspatial) reality. It exists as stored in the potentials ot the atomic nuclei of physical mass.

add energy to) one of these "ghost images" virtual state forms. In that case, the form becomes "denser and denser," until eventually it starts to breach the quantum threshold. At that time, the form will be seen emerging as a sort of "coalescing form of light," where the light seems to be forming in little "chunks" or pieces. As the coalescing operation continues, the light-form will eventually become fully formed. If it continues, it will start to coalesce further into *thin, ghostly material* form, appearing much like a faint fog-form. With continued coalescing, it will become a very solid, material form which exerts pressure on tree limbs, breaks them, leaves traces, etc.

Long ago I dubbed this process *kindling*. It is rather widely met in paranormal phenomena of many types.

But back to the basic idea of ghostly images in the virtual states of vacuum.

In this view, Everett's many-worlds interpretion (MWI) of quantum mechanics is literal and real, albeit the additional worlds are to bo taken as virtual and hyperdimensional to the laboratory observer.

(It is rather simple to show that ever deeper, nested levels of the virtual state are exactly the same thing as ever higher dimensions. By "rotating" an object in many-dimensional space, one can show that, after three rotations, a physical object has lost all physical intersections with our normal 3-space, to us now only occupying time. Since this is the precise characteristic of a *thought form*, I used this phenomenon and spatiotemporal model to make a multidimensional space model directly including thought, mind and matter. That is, one is thus able to form a unified field theory of mind, th**ought,** life, and matter — a model that is testable, makes predictions, and actually unites physics and metaphysics. That work and its plications, however, are largely beyond the scope of this book.)

It is stressed that the basic scalar EM image (interpretation) of reality is directly implied by quantum mechanics. It is not idle metaphysics. Other than the scalar EM wave causality for the observer's statistical microscopic dynamics (and the extended model unifying mind, thought, life, and matter), it is not the construct of this author. Instead, it follows from interpretation of the equations and axioms of quantum mechanics (QM) itself, as changed and extended by the "zero vector system" dynamics.

Charge, Potential, and Curvature of the Vacuum/Space-time

The flux of one type of virtual particle through a point in the vacuum may be examined.

A single type of virtual particle flux (VPF) at a point constitutes one particular type of charge at that point. For example, the flux of virtual photons constitutes the electrical charge.

Further, the magnitude of the selected flux (usually expressed as a flux density) through the point may be taken as the magnitude of the vacuum's charge there in that type of particle. In other words, at a point the magnitude of the vacuum's charge (VPF) is one type of *potential* at that point.

Various kinds of fluxes constitute various kinds of charge, and comprise various kinds of potentials. Immediately we see that one type of charge may always be decomposed into other kinds of charge, as can potentials. This point is beyond the scope of this book and will not be further amplified.

Continuing our example, the magnitude of the electrostatic scalar potential at a point in vacuum represents the magnitude of the flux of virtual photons through the point, and hence the electrical charge at the point.

Table 34. REALITY IS A HOLOGRAM

TO ESTABLISH THIS:

1. **ALL DETECTION IS INTERNAL**
   PHYSICAL REALITY CONSISTS OF THE INTERNAL DETECTIONS OF THE PERCEIVER/OBSERVER.

2. **THE OBSERVER MAY BE AT ANY POINT IN THE UNIVERSE**
   THE UNIVERSE CAN BE DETECTED FROM ANY POINT INSIDE ITSELF.

3. **THE PHYSICAL UNIVERSE IS TOTALLY INSIDE EACH POINT IN ITSELF**
   THIS DEFINES A HOLOGRAM: THE WHOLE IS IN EACH PART.

Twin Flows of Time

In quantum mechanics, each virtual photon is continually turning into an electron/position pair, and vice versa.

By Dirac theory, *a positron is an electron traveling backwards in time.*

Further, pair production produces time-smeared particles — an electron and a positron.

Pair production, then, actually produces two *electrons,* one coupled to (smeared in) a positive piece of time and one coupled to (smeared in) a negative piece of time.

Thus in the vacuum two discretized streams of time, one positive and one negative, are continually created in conjunction with pair production, and destroyed by pair annihilation.

Further, integration of tiny virtual pieces of time (from virtual photons) to form "passage of time" macroscopically is directly associated with the charge (the absorption and emission of virtual particles) of an observable particle.

This is what is meant by an object "existing" (persisting). Its continual virtual photon interactions are integrated by its mass (timeless part) to continually create its energy states and its march through time.

The absorption and emission of an abservable photon, however, moves the mass (timeless part) in (comparatively) larger jumps through time. The absorption of the photon connects a positive piece of time to the mass of the particle, converting it to masstime. The subsequent emission of an observable photon "tears off the little time-tail," so-to-speak, and leaves behind a totally spatial mass entity, having no large connection to "the flow of time."

This is what is really meant by "observation."

Because the "observation" disconnects time from the previously "excited mass" (masstime), then it follows that time is not an observable.

It also follows that the twin streams of time are not continuous. Each is broken into incredibly tiny bits.

The bits of time are continually interlaced between negative and positive, and neither of the two streams of time bits is integrated in the vacuum. The vacuum is disintegrated!

A photon — the basic quantum — is composed of discretized energy and time, bound together (integrated) as action (angular momentum). That is, a photon is a little piece of energy, welded to a little piece of time, with no seam in the middle.

Two kinds of photons exist: the normal photon exists as (+dE) (+dt). The phase conjugate photon exists as (-dE) (-dt).

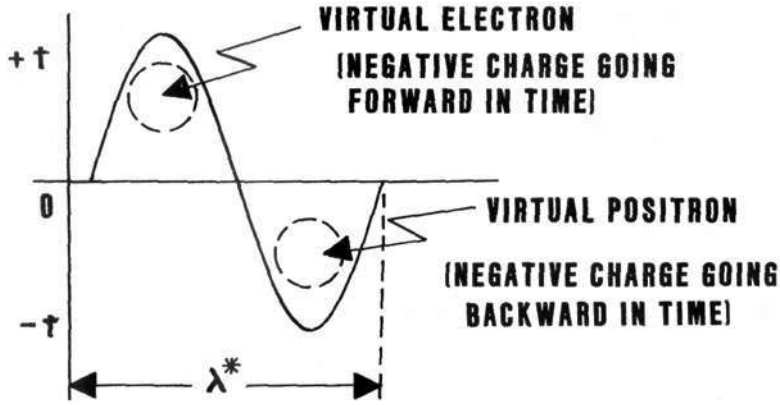

Figure 59. A photon is a single oscillation of a carrier wave. It is also two virtual electrons, one going forward in time, and one going backward in time. With internested modulations (subphotons), the structure of the photon becomes extremely complex.

Table 35. PHYSICAL CHANGE

- **COMPOSED OF ACTION**
- **h = BASIC QUANTUM**
- **TWO CANONICAL VARIABLES**
  - **ENERGY/TIME ($\Delta E \Delta t$)**
  - **MOMENTUM/LENGTH ($\Delta p \Delta L$)**

    ETC.
- **ENERGY/TIME**
  - $h = (+\Delta E)\ (+\Delta t)$
  - $h = (-\Delta E)\ (-\Delta t)$

If the photon is of a certain magnitude, given by Planck's constant, then it is an **observable photon.**

If the photon is less than h in magnitude, then it is a **virtual photon.**

A simple photon in vacuum can also be considered to be one cycle of a sine wave. One half of the sine waves exists in positive time, hence is/contains a virtual electron.

The other half of the sine wave exists in negative time, hence it is/contains a virtual positron — an electron traveling backward in **time.** This second half of the full photon (a single sine wave oscillation) is the phase conjugate (time reversal) of the first half.

As we stated previously, the full photon in vacuum actually exists as a presently visualized "positive time" photon and a phase conjugate "negative time" photon , a "serially linked pair," where **each** photon is only one-half the sine wave. This resolves the conflict inherent in wave/particle duality.

It also has a great deal to say about engineering the vacuum and about detectors and the detection process.

In the spontaneous decay of a virtual photon, it can be seen that one part (the virtual electron) is associated with positive energy and positive time; the other part (the virtual positron) is associated with negative energy and negative time.

The continual "switching" between positive and negative time in an observable particle's absorption and emission of virtual photons **(and** the associated electron/position +t/-t pairs) means that the positive flow of time, to the macroscopic observer, is continually being "started" and "stopped" (created and destroyed).

This continual attachment **and detachment of positive time to and from the "observer particle" creates the "past" and the "future" to which the observer seems somehow to be connected, and yet not connected.**

Engineering Local General *Relativity*

In a flat spacetime (linear vacuum), the two time flows are balanced, as are pair creation and pair annihilation. In this case, conservation of charge and energy hold.

Table 36. ORDINARY GENERAL RELATIVITY (OGR) IS A SPECIAL CASE

- **OGR HAS ASSUMED AWAY MOST LOCAL GR SYSTEMS, OF THE TYPE WHERE MAXWELL'S EQUATIONS AND THE CONSERVATION LAWS CHANGE LOCALLY.**

- **PHYSICISTS ARE THUS STRONGLY DISCOURAGED FROM CONSIDERING THAT GR CAN EASILY BE ENGINEERED IN A LOCAL EM SYSTEM.**

In a curved spacetime (nonlinear vacuum), one of the two triplets (positive electron/energy/time or negative electron/energy/time) predominates. Hence in a curved spacetime the rate of flow (production) of the two time streams is unequal, as is the production of the two kinds of energy and the two kinds of electrical charge.

A locally curved spacetime thus produces a predominance of either positive or negative electrons, and either positive or negative energy, and a predominance of the addition of either positive or negative time production.

The curved spacetime acts as a local source or sink accordingly, and both conservation of energy and conservation of charge can be locally violated in such a curved spacetime region.

As we stated, the locally curved spacetime produces either positive time or negative time more predominantly, acting as a source or sink for normal (positive) observer time. The local rate of flow of the observer's time can thus be speeded up or slowed down, depending upon the type of local spacetime curvature utilized.

It follows, then, that standing local gravitational waves can result in localized, stable gradients in the vacuum virtual particle flux, between the "high potential" part of the standing wave and the "low potential" part.

This allows the violation of conservation laws such as charge and energy in the local gravitational gradient, utilizing the localized curvature of vacuum to provide a special source.

For proof that conservation laws need not apply to a curved

spacetime, see A.A.Vlasov and V.I. Denisov, "Einstein's formula for gravitational radiation is not a consequence of the general theory of relativity, **Theoretical and Mathematical Physics,** 53(3), June 1983 **(English translation);** Russian, Dec. 1982, p. 406-418. Quoting:

"This result is a particular consequence of the general assertion to the effect that in general relativity there are no energy-momentum conservation laws for a system consisting of matter and the gravitational field."

See also V.I. Denisov and A.A. Logunov, "New theory of spacetime and gravitation," **Theoretical and Mathematical Physics, 50**(1), July 1982, p. 3-76. This paper (p. 3) points out that:

"... **the gravitational field in general relativity is completely different from other physical fields and is not a field in the spirit of Faraday and Maxwell."**

A 1984 Soviet paper by senior Russian physicist C. Yu. Bosgoslovsky, "Generalization of Einstein's relativity theory for the anisotropic spacetime," is also very relevant.*

In composing his theory of general relativity, Einstein assumed that the local spacetime of the observer could never be curved, and instead would always be represented by a Lorentz frame (flat spacetime).

This severe assumption had the effect of "saving" the sacrosanct conservation laws, and maintaining the exclusion of electrogravitation.

Since then, Western physicists have raised Einstein's assumption — and the conservation laws — to a dogmatic belief system — in some cases, to near fanaticism.

To see a clear statement of these limiting assumptions imposed on general relativity to provide the severely restricted version taught in almost all Western universities, see Charles W. Misner, Kip S. Thome and John Archibald Wheeler, **Gravitation,** W.H. Freeman and Co., San Francisco, California, 1973, p. 19-21, 71-72, 367-369.

In other words, Western physicists still use a sort of "special

**See* also V.I. Denisov and A.A. Logunov. "The inertial mass defined in general relativity has no physical meaning," preprint p. 0214, Institute of Nuclear Research, USSR Academy of Science, Moscow, 1981.

relativity with distant curved spacetime pertubations," and call it *general* relativity!

The Soviets do not limit themselves to the same restricted general relativity theory as does the West.

Santilli (Ruggero Maria Santilli, **Ethical probe on Einstein's followers in the U.S.A.: An insider's view,** Alpha Publishing, Newtonville, Massachusetts) has documented what essentially amounts to a conspiracy in Western physics to shut out any generalization of Einstein's severely limited relativity.

It is precisely this near-total Western scientific prejudice — along with Heaviside's mutilation of Maxwell's original theory — that has excluded electrogravitation from being developed in the West.

Note also that, by embracing a "locally flat spacetime" assumed to be decreed by the "laws of the universe," in their rigid mindset Western physicists have excluded any possibility of performing simple laboratory experiments in locally curved spacetime.

They do not believe it can be done, so they have never tried.

But let us further address the importance of the negative triplet (electrical charge/energy/time) and its concomitants parity, gravity, and entropy:

Engineering Antigravity

In negative time flow, gravity is a repulsion, not an attraction.

Producing antigravity in an object is simply the production of excess negative time flow in that object.

That is readily achieved by curving local spacetime in the appropriate direction, and forcing the object to produce excess negative energy.

Mass, for example, is just a special form of trapped energy—and trapped energy (potential) is just trapped charge of one kind or another, whether observable or virtual.*

As such, mass represents a "localized potential" in the ambient vacuum, of a certain kind of "trapped energy/time charge."

*Actually, since it is in equilibrium in a dynamic and continual flux, a mass particle is actually a special trapped **rate** of action flow. A defining equation for mass in terms of the rate of action flow was given by the author in **Quiton/Perccptron Physics,** NTIS, 1973. Report AD-763210.

The mass/potential is continually being charged by the vacuum flux, and discharging and emitting charge flux into the vacuum flux. The mass is "in equilibrium" at its fixed potential.

Normal ("positive") mass is simply charged up with positive energy and positive time. And its external electron shells result in it presenting a "negative charge" face to the world.

If we charge up the mass, however, with negative energy and negative time, so that some of its charge potential now is of this second type, the trapped energy will now consist partially of negative energy. In addition, the mass will partially exist in negative time (be charged up partially with negative time).

When excess negative time flow is produced in a mass, the mass begins to be repelled by the earth as well as still being attracted to it in its positive time stream. The net result of the object's fixed attraction and increasing repulsion is that the object begins to lose weight in the earth's gravitational field and gets lighter.

When a sufficient rate of excess negative time flow (sufficient local spacetime curvature) is produced, the mass floats freely.

With additional negative time production rate, it accelerates ("falls") upward.

The rate of excess negative time produced may be controlled very simply by using a "negative time/negative energy" generator and varying the amount of the load applied to the device.

The negative time/negative energy generator can be rigidly affixed to a flying apparatus, serving as a sort of gravitational rocket or gravitational propulsion system.

Of course, the negative energy produced in the propulsion process can be used to light lamps and power electrical loads, as well as host of other things. (Yes, Virginia, it can also be used to generate force fields, power weapon systems, etc.)

Thus one can "eat his cake and have it too"; by using negative energy flow for power, a very practical antigravity spaceship can be developed.

An additional side benefit to the passengers probably exists: they should age at a slower rate when traveling in the vehicle.

As can be seen, since many kinds of VPFs exist in vacuum, the vacuum is filled with (and consists of) many types of "potentials." Overall, this matches very closely the view of general relativity, if we

regard the vacuum itself as indefinite "spacetime", where no ordered universal frame with a fixed metric has yet been associated or prescribed.

Curved Spacetime and the Disintegrated Vacuum

From general relativity, additional characteristics of the modern vacuum/spacetime may be inferred or interpreted.

First, we may take a "flat spacetime" to consist of a charged vacuum, such that both the magnitude and structure of the VPF are essentially unchanged from point to point, and the flux of virtual particles and virtual antiparticles are balanced. Equal positive and negative time flows/charges exist.

Note, however, that we can have what casually may appear to be a "flat spacetime" but instead is "warped." This case exists when the magnitude of the overall VPF comprising the vacuum does not change from point to point, but the component structure of the VPF does vary from point to point.

In other words, the overall vacuum potential remains the same from point to point, but two or more individual potentials may canonically vary. Let us further clarify this point by analogy.

Suppose we view the vacuum/ether/spacetime as a special sort of gas, where the "gas" is actually a mixture of many, many gases.

It is a rather peculiar sort of gas; it exists in five or more dimensions and is composed of very strange, fleeting particles which . spontaneously are created and destroyed, each arising out of nowhere and returning to nowhere almost immediately.

There is only minuscule (negligible) time overlap (integration) of the existence of these virtual particles in the main.

That is, mostly each virtual particle — along with its associated energy, movement, momentum, charge, and increment of time — exists almost entirely as an individual.

The energies, movements, momenta, charges, and time increments of the individual virtual particles do not integrate or sum to any appreciable degree in vacuum.

Thus, although casually this ether/gas may seem to contain enormous "energy density", momentum density, charge density and time increment density, these are not *integrated* energy density, momentum density, and time density in the normal sense.

Instead, they are the densities *of disintegrated* energy, *disintegrated* momentum, and *disintegrated* time flow.

In scalar electromagnetics, we have called the disintegrated energy of vacuum **anenergy.** This clearly distinguishes that it exists in a fashion altogether different from normal, *integrated* energy with which we are accustomed.

By integrating anenergy, of course, one obtains ordinary energy—but it first requires an integrating agent. The most **usual integrating agent/operation is the spin of an observable particle of** mass.

Similar considerations apply to momentum and time.

With this more **precise interpretation, the vacuum contains enormous anenergy, but essentially no energy. It contains enormous virtual energy, but no observable energy.**

Unfortunately, however, orthodox physics does not yet clearly differentiate between the two states of energy, virtual and observable (disintegrated and integrated).

Instead, it continues to loosely utilize the term "energy" for both states, whether integrated or not. Thus it exclusively uses the term "**energy** density of vacuum." Rigorously, the term should be "anenergy density of vacuum."

Indeed, most physicists are not clearly aware of the distinct difference between the two different states of energy, insofar as the implication of integration or nonintegration.

Regrettably, then, we will continue to utilize the orthodox term, "energy density of vacuum." but the reader should be clearly aware that the vacuum "energy" and vacuum "stress energy density" as **such** are totally disintegrated.

Separation of Vacuum and Observable *States*

Because the energy density of vacuum is unintegrated, an integrated physical body — including one's personal body — can **exist** "in" the vacuum medium of incredible "energy" density, yet observably exist in a medium of zero energy density.

The unintegrated vacuum ether has enormous spatial density of *virtual* energy, but essentially has zero spatial density *of observable*

energy.

Note, however, that in our hyperdimensional interpretation of the levels of virtual state, the vacuum spatially does not exist in the normal 3-space of observable matter.*

The vacuum occupies the 4th dimension (time) and all spatial dimensions (hyperdimensions) greater than the third — it occupies all levels of virtual state, but not observable state. It occupies all levels of disintegration, but not the levels of observable integration.

Exchanges occur between normal 3-space and the hyperspatial vacuum, through the common connecting dimension, time.

These exchanges (of virtual particles) are integrated by the spinning observable mass particle into the first quantally excited state — a delta (change) representing a single entrapped quantum — of the 5-space potential represented by the particle and its accumulating VPF. At that time a sharp electromagnetic (fifth dimensional) discharge of the quantum occurs, converting the accumulated 5-G quantum to the ordinary EM quantum of the 4th (time) and 5th (infolded space) dimensions.

This accounts for the so-called "collapse of the wave function", the production of unitary quantum change, and the discretizing of observable change.

We note in passing that time is the only "dimension" where everything can be considered to occupy the same "point" or "interval", but it is discretized and chopped into pieces (disintegrated), quite different in nature from the familiar three spatial dimensions of the observable (integrated) universe.

The dimensional separation (spatially) of the seething vacuum "energy" (anenergy) and the 3-space of normal matter allows a physical body to enormously interact with the vacuum at or near equilibrium at the microscopic level, but maintain its macroscopic form and stability as if no interaction were going on.

Partial Potentials, Curvature, and Warping

At any rate, we view the magnitude of the overall "potential" of this vacuum gas mixture, as the magnitude of the entire "stress

*Here we sharply differ from conventional physics, which hopefully confuses the concepts of vacuum, spacetime (indeterminate), spacetime (determinate), and frame.

Figure 60. A potential is trapped energy. A potential in vacuum is trapped virtual-state "energy" or flux. A natural potential is trapped random energy. An artificial potential is trapped organized energy.

energy" or "pressure" of the mixture — IF AND ONLY IF this stress energy or pressure were somehow integrated.*

As can be seen, we can now look at each of the component gases in the mix as contributing a partial pressure or partial stress energy (an individual component potential) of the vacuum conglomerate.

We may have the overall pressure remain the same, yet canoni-

***Thus it's** really the **potential** stress energy density. The vacuum is nothing but potential!

cally change the partial stress energies (individual potentials).

In that case one has an internally twisted or "warped" spacetime.

A warped spacetime may prove quite useful, for example, for direct translation of one type of "energy" into another. In that fashion, one may conceivably obtain radiation energy at the expense of mass, or mass at the expense of radiation energy.

Or one may convert between potentials where one or more of the converted potentials are as yet unknown to orthodox physics.

Kaluza theory, for example, contains many potentials that are as yet unknown and undiscovered in nature. When undue simplifications are made to arbitrarily exclude the unknown potentials, the adapted theory leads to error in its predictions.

This was originally regarded as a great imperfection, and Kaluza theory fell into disfavor for decades. Then as modern particle physicists began to produce fundamental particles of an astounding variety, a Kaluza-Klein theory of 11 or more dimensions was found to very reasonably describe the emerging situation. Once again, then, Kaluza-Klein theory became a moving force among modern theorists.

One may also convert electromagnetic field energy into gravitational field energy, for example, and obtain enormous amplification of gravitational effects.

This is precisely what scalar electromagnetics seeks to do.

Since the electrical field between two electrons is about 10^{42} times as strong as the gravitational force between them, conversion of the EM charge flux into gravitational charge can conceivably yield up to 10^{42} times as much gravitational force as normal, depending upon the efficiency of the conversion process. Even with a process or device that uses electron currents and has an efficiency of only 10^{-22}, gravitational/inertial gains of 10^{20} are possible.

Note, however, that the levels of vacuum may also be compared to horizontal planes beneath the ocean.

For example, we may take a particular level of vacuum potential, and that level constitutes a sort of included "flat spacetime" of its own. By biasing the potential of a scalar transmitter and receiver to a given level, one may transmit (in either direction) at that level only, Receivers at higher or lower levels will detect nothing.

The immediate application to engineering the nucleus for such things as nonradioactive transmutation of elements, controlled nuclear fusion, electromagnetic healing, and processing nuclear wastes to render them harmless should be apparent.

To recapitulate our analogy, a true "flat spacetime" is a vacuum whose VPF does not essentially vary overall or in each constituent part, between two comparative points.

A "curved spacetime" is a vacuum whose overall VPF varies in overall magnitude, between two comparative points.

A "warped spacetime" is a vacuum whose VPF may or may not **vary** in overall magnitude between two comparative points, but whose partial VPFs vary their ratios, between the same two points. Note that a vacuum/spacetime can be both warped and curved.

It is stressed that we have not limited the number of dimensions **that** can be placed on the vacuum to Minkowski's four. We hold the number of dimensions necessary to represent both vacuum and observable matter to be arbitrary, but greater than four.

To unify electromagnetism and gravitation (which is what scalar electromagnetics is about), we must take five dimensions — four spatial and one time — to be the minimum necessary in modeling the unified theory, similar to Kaluza.

We state now a major characteristic: **Vacuum/spacetime consists entirely of potentials, nothing else, and these are hyperspatial a priori.**

The vacuum does not contain observable force fields nor any **Other** *non-potential* entity.

We also state without proof that in scalar EM theory it seems **very** possible to model the mind and its unification with physical **reality,** in a fashion subject to experimental verification.

Force and Mass Are Inextricably Intertwined

In foundations of physics, it is well-known that, paradoxically, force and mass can only be defined one in terms of the other.

We may use that paradox for a new interpretation of force and **force** fields: a force may be interpreted **to consist of** the time rate of changing the "mv" momentum of a mass system or object, instead of **being the cause of** its dp/dt.

That is, we may take the view that

$$\mathbf{F} \equiv \mathbf{dp}/\mathrm{dt} \qquad (4\text{-}14)$$

not just that

$$\mathbf{F} = \mathbf{dp}/\mathrm{dt} \qquad (4\text{-}15)$$

We have previously pointed this out and called it the "strong definition of force."

This immediately suggests the question: If force is an effect and not a cause, what, then, causes force?

Quantum mechanics already provides the answer: A differentiating operator must be applied to (coupled to) potential in order to produce a force field. The most usual "differentiating operator" is an observable spinning charged particle.

A charged particle exposed to the variation of electrostatic scalar potential between two points is exposed to a gradient (flow) in the virtual photon VPF, and hence to a directional "stream" of virtual photons. The observable charged particle couples to that stream. **Its** spin integrates the unobservable, disintegrated anenergy of the gradient flux into integrated, observable energy of the particle.

With greater integrated "pressure" on one side of the particle than on the other, the observable particle accelerates and translates This produces or "detects" (and comprises) an electric force between the two points.

Force is the mass particle(s) accelerating, either in time or in mass. Observable force is observable particle(s) accelerating. **Vir-**tual force is virtual particle(s) accelerating.

In **Quiton/Perceptron Physics,** I gave a new definition of mass that is consistent with this viewpoint:

$$1 \text{ kg. mass} = 17.053 \times 10^{50} \text{ switches/sec} \qquad (4\text{-}16)$$

where a switch is h/4*pi), having the units of action/time, or energy. This directly defines mass in terms of energy accumulation, where

the energy accumulated is in equilibrium in a differentiated action flow.

Note that "energy" is the time rate of flow of action. Energy can only be accumulated (as a mass or a potential) by possessing two rates of flow of action simultaneously, one in positive time and one in negative time. This is a very deep statement that affects all of physics, but unfortunately it is beyond the scope of this present book.

To return:

The observable electric force field does not exist as such in vacuum. The vacuum and all its constituents are totally virtual. Only the potential ("potential for the electric force field, given a coupled charged observable particle") exists in vacuum, as pointed out by Richard P. Feynman et al, The Feynman Lectures on Physics, Addison-Wesley, Reading, Mass., 1964 vol. 2, p. 2.

The Concepts of Zipped and Unzipped Forces

As noted previously, the potential exists as an unintegrated virtual particle flux (VPF). Further, each little moving virtual particle is smeared in length and time, is coupled to finer VPF, and thus may be said to constitute a minute "force vector" while it exists.

Thus, the electrostatic scalar potential is composed of a myriad of little individual "virtual particle force field" vectors.

Since these little virtual vectors are essentially separate and unintegrated, one may say that the electric field is *unzipped* in vacuum. By "unzipped" we mean that the individual virtual particle E-field vectors are unintegrated.

A potential, for example, is composed of unzipped vector fields since it is comprised of unintegrated, virtual vectors.

To be static, the potential must be comprised of a pair (at least one pair) of unzipped vector fields, one in positive time and one in negative time. These unzipped vector fields must in turn be locked together. In this case, the positive time observer sees nothing (vacuum only), until he "observes" or detects. Normal detectors detect (and in so doing, they zip together) only the positive time unzipped component. The negative time (phase conjugate) vector held retraces the positive time field, in Newton's third law. Or, if generating a wave or pulse, it would be seen as a phase conjugate

replica which affected the disturbing source.

Let us be very plain. **A "scalar EM potential" is actually two vector fields zipped together: one is in positive time, and the other is in negative time.** Each half is composed of microvectors. A dynamic gradient in this scalar EM potential (i.e., a scalar wave, for example) actually consists of two waves: one is the normal" positive energy/positive time" EM wave, while the other is the phase conjugate replica. When we detect the normal half (with electron detectors), we actually detect the second half with the atomic nuclei. Since it is a phase conjugate, it produces a negative momentum change on the nucleus {since one has p/(-t)} instead of LeSage's positive momentum change. In other words, it produces a drawing (attracting) force on the absorbing nucleus, instead of LeSage's assumed repelling force on it.

That is the entire secret of gravitation. And of electro-gravitation. Knowing that, you can easily work out how to apply the necessary engineering to get antigravity.

But to return.

The potential can also be comprised of many unzipped vector fields at once. These may be deterministic (artificial potential) or randomized (natural potential).

The "force field" is disintegrated (unzipped) in vacuum, and integrated (zipped) on, of, and by an observable charged particle. In vacuum, it is always accompanied by its phase conjugate twin. When detection by an observable particle occurs, the spin of the particle acts as the "zipper," producing an observable force (which is actually of the particle accelerating, not "acting independently upon it.")

Vacuum is unzipped; observable mass is zipped.

Any zipped entity exists observably in 3-space; any unzipped entity exists in hyperspace outside 3-space, and is unobservable and virtual to the 3-space observer.

This interpretation is still consistent with the extended quantum mechanical view, where ultimately all observable forces are considered to be generated by absorption and emission of virtual particles by/from an observable particle (mass), at least insofar as what we may observably measure or detect.

Force, Force Field, and EM Waves in Vacuum

In the new interpretation, consistent with the quantum mechanical view, observable force becomes an effect, not a cause.

One may interpret quantum mechanics as stating that **any observable is an effect, since it is assumed to have a virtual state cause.** In the axioms of quantum mechanics, an operator is required for every observable.

The primary **causative agents are potentials, not force fields, as** is **now** firmly **established in** quantum mechanics.

The Aharonov-Bohm (AB) effect is a striking illustration of the primary reality of the potential rather than of the force field.

In the AB effect, potentials may still exist when the force fields **are** zero, and their interference can still cause real effects. The AB effect has finally become generally accepted by physicists after nearly three decades of controversy.

The immediate result is that, contrary to the outdated view imbedded in classical EM, observable E and B force fields do not exist *as such* in vacuum. This allows a totally new interpretation of the **nature** of the EM wave in vacuum: It is longitudinal. And actually, it exists in longitudinal pairs: the second is the phase conjugate of the first.

But of course we detect transverse waves with our detectors! However, this has a simple explanation.

Examine, for example, a straight-wire antenna. The spinning conduction electrons are longitudinally constrained, as is well known. The electrons are relatively unrestrained transversely in the **wire,** but can only "drift" longitudinally down the wire with a speed usually on the order of centimeters per second. The signal potential, however, moves longitudinally down the wire at almost the speed of **light.**

Obviously it is not the longitudinal movement of conduction electrons that constitutes the "signal", even though classical electromagnetics represents it that way.*

We note that a spinning electron whose movement is longitudi-

*Actually, we do not really know how current/electrons travel down a wire, or even if it does/they do. See three articles by Chappell Brown in Electronic Engineering Times: "Railgun Research Shoots Holes in Lorentz's Theory," April 6, 1987,p. 49-50; "Anomalies in Electromagnetic Law Spur Debate," Sept. 14, 1987, p. 58; "Electrons and Conduction: Not So Simple After All," Dec. 28, 1987, p. 21-22.

nally restrained, but is unrestrained transversely, may be characterized as a gyroscope. Further, the axis of this gyroscope may be taken as lying in a plane perpendicular to the straight wire conduction path, since the electron is relatively unrestrained transversely.

If now disturbed by a vacuum potential gradient, the gyroscopic electron is free to precess at right angles to the length of the wire. In other words, given a disturbing force, the electron will move transversely, or radially in the cross sectional plane of the wire, because of gyroscopic precession.

Thus, assuming a gyroscopic electron and its longitudinal constraint, we will detect transverse oscillations in the electron gas in the wire, IF AND ONLY IF the incoming disturbance in the vacuum is longitudinal, and IF AND ONLY IF the unzipped vacuum disturbance "couples" to (is zipped by) the gyroscopic conduction electrons.

Two things are certain in our electron-detector model: First, by the nature of a gyroscope, the conduction electrons move (precess) at right angles to the "disturbing force." Second, we only detect the movement of the electrons themselves.

Since we do detect transverse oscillations of the precessing electrons in the straight wire antenna, then it follows that normal electromagnetic waves in vacuum—that is, the component half that, interacts with the atom's electron shells and not with its nucleus — are (1) longitudinal, and (2) of such form that they couple to electrons.

Note that Tesla always insisted that electromagnetic waves in vacuum were longitudinal. For example, he called them "electromagnetic sound waves" in the ether. In "Tesla Maps Our Electrical Future," H. Winfield Secor presents Tesla's view of transverse waves in this fashion:

"Tesla upholds the startling theory formulated by him long ago, that the radio transmitters as now used, do not emit Hertz waves, as commonly believed, but waves of sound... He says that a Hertz wave would only be possible in a solid ether, but he has demonstrated already in 1897 that the ether is a gas, which can only transmit waves of sound; that is such as are propagated by alternate compressions and rarefactions of the medium in which transverse waves ***are*** *absolutely impossible."*

In his "The True Wireless," **Electrical Experimenter,** May **1919,** Tesla himself further stated:

"The Hertz wave theory of wireless transmission may be kept up ***for*** *a while, but I do not hesitate to say that in a short time it will be recognized as one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history."*

It should also be pointed out that our analogy permits the option of making a longitudinal wave in the vacuum in such a fashion that It will not couple to electrons.

In that case a normal"electron gas" conduction detector will not detect the new wave. Such a noncoupling EM longitudinal wave is **referred** to as a **scalar electromagnetic wave,** where by use of the **term** "scalar" we call attention to the fact that the vacuum potential **is** varying, but electron coupling to form vector force fields in an **electron** gas does not occur.

Since according to general relativity the variation of a potential in vacuum rigorously is a gravitational wave, then the scalar EM wave is a gravitational wave.*

We often say it is an *electrogravitational* wave to call attention **to** its electromagnetic origin, and to the absence of EM force field "bleeding away" of the 5-space Kaluza-Klein gravitational potential. We will discuss the 5-space G-potential shortly.

The conventional equation

$$\mathbf{E} = -\nabla \emptyset \qquad (4\text{-}17)$$

thus applies in the detecting electron gas, but not in the vacuum. Instead, in the nonmaterial vacuum, rigorously

$$\nabla \emptyset \neq -\mathbf{E} \qquad (4\text{-}18)$$

and this states that a gradient in a vacuum electrostatic scalar

*It is also a very powerful gravitational wave, since for electrons it is some 10^{42} times as strong as "mass attraction" gravity waves.

potential produces an antiphased electric force on and of a particle, on condition that a particle is present. The intent of equation (4-17) should be stated as

$$\nabla \emptyset = -\mathbf{E} \qquad (4\text{-}19)$$

where the vertical line means "on condition that", and cp means "charged particle" (i.e., "that a charged particle is there.).

Equation (4-19) clearly shows that, in the vacuum, only the organized potential for an E field exists due to the quantity $\nabla \emptyset$ essentially as pointed out less strongly by Feynman et al in **The Feynman Lectures on Physics.**

Certainly, in the quantum mechanical interpretation, it is the potential that is real. The force field can only be made from the potential by a differentiating operation.

Since there is nothing in vacuum to perform this differentiating operation observably, one may interpret quantum mechanics as already prohibiting the existence of observable electromagnetic force fields in vacuum, at least in the form prescribed in classical electromagnetics.

Figure 61. A force-field vector is a movement of mass in one direction.

One may regard quantum mechanics — and physics in general - to be incomplete until electromagnetic theory is changed to incorporate the implications of quantum mechanics.

In scalar electromagnetics a new interpretation is taken, and the "overhaul" of electromagnetic theory is in progress.

We accent that scalar electromagnetics is still embryonic. It is at a stage similar to that where electromagnetism was when experimenters were still rubbing glass rods with cat fur and experimenting with little charged pith balls.

Early experiments are enlightening and encouraging; nonetheless, the phenomenology and the myriad of variables are not at all well-understood, even by the experimenters themselves, and certainly not by this author.

Zero-Summed Vector Systems: Shortcoming in Vector Analysis

It has long been pointed out by this author that a fundamental shortcoming exists in classical vector analysis itself when applied to physical systems. Let us briefly look at the construction of the vector mathematics theory, to clarify this shortcoming.

First, an abstract entity called a "vector" is conceptualized. This vector has both direction and magnizude, as contrasted to a "scalar" quantity, which only has magnitude.

Next, an abstract "vector space" is defined; this is a sort of "container" for mathematical objects called vectors, with certain inherent properties of the system specified. In other words, a vector space is an abstract "system" or "space" which can contain objects called "vectors."

Next certain other properties, operations, and entities are defined, one of which is the is the "zero vector".

Essentially the zero vector is defined by a set of operations; however, one simplified interpretation is "the absence of any vector of finite magnitude." By implication, in the abstract vector theory, all zero-vectors are defined to be identical.*

* Because, by their nature assumed in the concept, they have no internal structures. That is, effectively the zero vector has been too restrictively defined as "the absence of any and all finite vectors." It should be redefined as "the absence of any single vector being present alone." In that case the definition would admit "the presence of multiple translation vectors, where their combined translation action is zero."

In the vector addition operation, a group of finite vectors adds to a single vector called the "resultant."

It is standard practice in abstract vector analysis to replace a system of summation vectors by their resultant, since all appropriate properties of the summation system are retained by the vector resultant, in the abstract mathematical model.

This, however, is only possible because the abstract vector space has no such thing as stress, and a zero-vector has no substructure by definition. In the abstract space, only translation and rotation are possible, *by assumption*

It is also possible for two or more finite vectors to add to a zero resultant, in which case the system is replaced with a zero vector. Note that all further action by the summing vector components is eliminated by this assumption.

Again the appropriate properties of the summation system are retained by the zero resultant, in the abstract mathematical model, only because the *medium* (the abstract vector space) is not subject to stress, translation, rotation, and structuring.

Note however, that in physical systems, one cannot simply

Figure 62. The zero-summed vector system is an engine and an artificial potential.

replace a zero summation system of force vectors with a zero vector and retain all characteristic physical effects caused by the replaced system. The physical medium - including the virtual flux of the vacuum, *is* subject to stress, translation, rotation and structuring.

Physically, the presence of the summing vector component forces creates a stress and a dynamic macroscopic structure in the physical medium in and on which the forces are acting. Therefore the stress of the medium and its structure must be preserved and accounted for, even though a zero vector resultant force exists.

This is particularly true in the vacuum, where internal (in-folded) stresses cause charge and energy conversion between one kind of charge/potential and another.

Maxwell's Theory Was Altered and Curtailed

In fact, Maxwell seems to have been well aware of the electro-magnetic stress of the ether and its importance. After all, he believed the ether to be material and mechanical, and developed his theory accordingly.

For example, in his Treatise on Electricity and Magnetism, he wrote:

"There are physical quantities of another kind which are related to directions in space, but which are not vectors. Stresses and strains in solid bodies are examples of these, and so are some of the properties of bodies considered in the theory of elasticity and in the theory of double refraction. Quantities of this class require for their definition nine numerical specifications. They are expressed in the language of quaternions by linear and vector functions of a vector."

Maxwell worked out his theory in quaternions since, at the time, the modern form of vector analysis had not been originated by Heaviside and Gibbs.

To recapitulate what we stated earlier: A quaternion consists of a vector part and a scalar part and can readily take into account the stress and strain of the medium. A vector consists only of the vector part, and does not take into account the stress of the medium.

It seems certain that Maxwell knew that the scalar part of the

quaternion could be present and vary, even though the vector part was sum-zeroed. Quaternions, however, are devilishly difficult, and even in the time of their founder, Hamilton, few mathematicians and scientists ever mastered them.

Maxwell's theory was transposed (shortly after his death) to its modern vector form by Oliver Heaviside. Many of the characteristics of the scalar part of the quaternion were effectively discarded.

In the remodeling, the "unified" basis was omitted, and electro-

Table 37. MAXWELL'S EQUATIONS

- **INVARIANT**
  - **UNDER CONFORMAL GROUP OF TRANSFORMATIONS**
  - **IN 4-D MINKOWSKI SPACE**
- **GROUP INCLUDES**
  - **TRANSLATIONS**
  - **ROTATIONS**
  - **REFLECTIONS**
  - **INVERSIONS WRT HYPERSPHERES OF M-SPACE**
- **HENCE MAXWELL'S EQUATIONS INCLUDE TRANSFORMATIONS THAT**

  <u>CHANGE INERTIAL FRAMES INTO</u>
  <u>FRAMES THAT ARE NOT</u> INERTIAL.

  PROVED IN 1910 BY
  H. BATEMAN AND E. CUNNINGHAM

gravitation was accordingly discarded. Heaviside wrote a severely limited subset of Maxwell's theory; he did not by any means capture all of it.*

The new Heaviside vector reinterpretation of EM was far easier to calculate in than Maxwell's quaternions. Many physicists (there were really very few scientists in those days!) immediately loved it.

FitzGerald wrote glowingly of Heaviside's translation (and mutilation!) of Maxwell's theory:

"Since Oliver Heaviside has written, the whole subject of electromagnetism has been remodelled by his work. No future introduction to the subject will be at all final that does not attack the problem from at least a somewhat similar standpoint to the one he puts forward."

Thus it was that Heaviside discarded the basis for scalar electromagnetics and electrogravitation from Maxwell's original work, and **the** so-called "classical Maxwell Equations" appeared for the first time in their modern vector form in Heaviside's work.

Then in the early 1890's a short but vigorous debate on vectors and vectorial methods occurred, involving eight journals, twelve leading publications, and over 30 scientists. Over half the publications were in the leading British scientific weekly journal Nature.

This debate, which Lord Rayleigh characterized by the statement "Behold how these vectorists love one another," together with **the** far greater difficulty of quaternion methods as compared to Gibbs'and Heaviside's vector analysis, spelled the death knell to the position of quaternions.

After some years, the Gibbs-Heaviside vector theory was firmly entrenched. The quaternion theory of Maxwell was forever modified **and** limited to the form we know today as "Maxwell's equations."

What really happened was that electrical physicists, faced with the formidable difficulties of quaternions, simply stampeded down the far easier road blazed by Heaviside, bowling over all protests against Heaviside/Maxwell/Hertz theory.

*Specifically, Heaviside wrote the subset of Maxwell's theory where gravity and electromagnetism do not interact and are mutually exclusive.

In Western universities today, no one actually teaches Maxwell's true theory! Instead, Heaviside's curtailed reinterpretation — a severely restricted subset of Maxwell's theory — is taught.

And so that is the EM theory that is learned and applied.

One may rightly argue, therefore, that **Maxwell's theory has only been partially applied in its modern translated form, and the modern form of the Maxwell/Hertz electromagnetic theory is very much incomplete.**

To recover the stress factor in Maxwell's original theory, electromagnetics must take into account the *artificial* potential, which has a deliberately ordered, dynamic, deterministic structure. Scalar electromagnetics takes the patterned stress into account and deliberately uses it. Normal electromagnetics only considers the *natural* potential with randomized VPF structure implicitly assumed.

Scalar Waves ***and Polarization of*** *the* ***Vacuum***

Let us use a simple analogy. This will lead us into the profound implications of the deliberate vacuum polarization and curving of local spacetime that is provided by the vector zero summation (artificial EM potential) method of scalar electromagnetics.*

Visualize two sets of opposing and balanced forces pressing on the sides of a plate.

The forces sum to zero, so the resultant force acting on the plate for translation is zero. Hence the plate does not translate (move away or accelerate).

However, the plate is under internal stress (compression), and is in a quite different condition than when it has no external forces at all acting on it.

Now visualize the forces being applied with rigid rods welded to the sides of the plate, so that the forces may alternately "pull" as well as "push." Let the forces rhythmically vary, alternately "pulling" and "pushing", but always remaining balanced so that their summation for a translation resultant is constantly a zero vector.

The plate never accelerates or moves in translation, but it now contains an internal stress wave which rhythmically varies between compression and tensile stress. Rigorously the plate internally

*Vector **multiplications** that yield a zero vector product are also highly significant.

possesses a scalar stress wave, or a wave of "internal stress in the medium."

Now visualize a similar "plate-like" region of vacuum, with its virtual particle flux, instead of the material plate. Visualize two opposing sets of (unzipped) EM force fields, acting in and on the plate-like region, so that they rhythmically increase and decrease, changing direction also, but always with a zero vector summation.

In this case, there is an unzipped zero resultant EM force field (it is zero, by our assumed conditions), but there is a rhythmic oscillation of the intensity of the vacuum flux (intensity of the vacuum potential) and the vacuum structuring in the region. That is, there is a rhythmic and steady oscillation of the stress energy and structuring of vacuum, and hence of the curvature of spacetime, in **the** plate-like region.

Rigorously, this oscillation — which we call a scalar electromagnetic wave—is a gravitational wave, since the local curvature of spacetime is being oscillated.

Further, it differs from a "natural" gravitational wave in several respects:

1. It has a deterministic pattern or substructure,

2. It patterns or "polarizes" the vacuum,

3. It constitutes local curvature of spacetime, and hence localized general relativity - something which ordinary general relativity assumes cannot be accomplished,

4. It deterministically engineers the virtual state and local spacetime,

5. Since it is achieved by converting EM field energy into artificial G-field energy, one can expect tremendous gains of gravitational and inertial effects in and around electrical circuits utilizing such fields precisely,

6. It affects the Schroedinger wave and the probabilities of the

states being propagated forward by the Schroedinger wave. **With the scalar EM wave, one can thus deterministically engineer the emergence of quantum change, and violate one of the fundamental assumptions of quantum mechanics, that of the totally statistical nature of quantum change,**

7. The scalar wave can accomplish direct and localized change of the rate of flow of time (even to its reversal) and variation of mass and inertia, without concomitant translation of matter,

8. By locally curving and patterning vacuum spacetime, a stabilized standing scalar EM wave can provide macroscopic violation of the conservation laws, which rigorously depend upon a locally flat spacetime (Lorentz frame),

9. Since the components in the zero summation may be EM waves, and may be "locked together" and broadcast to a great distance and interfered there, effects at great macroscopic distances may be achieved, in violation of present assumptions of physics, and

10. Since excess negative time flow may be locally produced, antigravity, negative energy, and negentropy may be locally produced.

These are the startling implications inherent in correcting classical electromagnetics' improper treatment of zero-summed EM force vector systems in vacuum.*

By classically replacing the force vectors in a zero EM force field summation with a zero vector and discarding the components, one is totally discarding the fact that such a patterned system of oppositive forces forms a deterministically patterned stress in the vacuum medium.

By this innocuous error, classical EM discards electrogravitation, and avoids unification of gravitation and electromagnetics. It

*And its zero - multiplied force vector systems as well.

also avoids direct engineering of gravitation, vacuum/spacetime, inertia, rate of time flow, free energy, and quantum change.

Generations of Western physicists and electrical engineers have acquired a mindset in only one aspect of the vastly expanded electromagnetics actually available.

Vector Zero Systems and the Kaluza-Klein Approach

Prior to 1921, Theodor Kaluza applied Einstein's new general relativity to five dimensions.

He produced a unified theory of electromagnetism and gravitation.

In Kaluza's theory, the ordinary 4-dimensional gravitational field and the electromagnetic field are but two different aspects of a single more fundamental field: the 5-dimensional gravitational field.

Kaluza's theory was published in 1921, on the personal recommendation of Albert Einstein, who had had Kaluza's paper for two years.

In Kaluza's model, electromagnetics is the 5th dimensional aspect of the 5-d G-field, while the ordinary 4-d G-field is the intersection of the 5-d G-field with our ordinary world.

Five years after Kaluza's epochal paper, Oskar Klein explained where the extra space dimension — the fifth dimension — was. He modified it as "wrapped around" each point in our ordinary 3-space.

In the Kaluza-Klein model, then, an electromagnetic wave— which moves spatially only in the fifth dimension — does not move through our 3-space at all. Instead, on its trajectory it "flows around" each point in our 3-space along its path.

Using Kaluza's model, we may regard the EM field as the normal "bleed-off' or escape of the 5-dimensional gravitational potential in the 5th dimension.

Any gradient in a potential represents a bleed-off of the potential from the high point to the low point. The way to prevent effective bleed-off of a potential at a point is to add an equal amount of bleed-in! The bleed-out and the bleed-in at the point then become balanced, so that an equilibrium state exists in the potential.

By this mean, the magnitude of the potential can be fixed by the two opposing bleed processes in equilibrium.

Table 38. KALUZA GEOMETRY

- **THEORDOR KALUZA, POLISH PHYSICIST**
- **UNIFIED THEORY OF ELECTROMAGNETICS AND GRAVITY [1921]**

  - 5 - DIMENSIONAL SPACETIME
  - 5 - DIMENSIONAL GRAVITY FIELD
  - ELECTROMAGNETISM IS THAT PART THAT OPERATES IN THE FIFTH DIMENSION

Table 39. 5-D G-FIELD BLEED-OFF [KALUZA 5-D THEORY]

- **FAR EASIER TO BLEED-OFF AS ORDINARY EM FIELD**
- **VERY DIFFICULT TO BLEED-OFF AS ORDINARY 4-D G-FIELD**
- **E.G., BETWEEN TWO ELECTRONS:**

$$\frac{EM}{G(4)} \approx 0$$

- **BETWEEN TWO PROTONS:**

$$\frac{EM}{G(4)} \approx 0$$

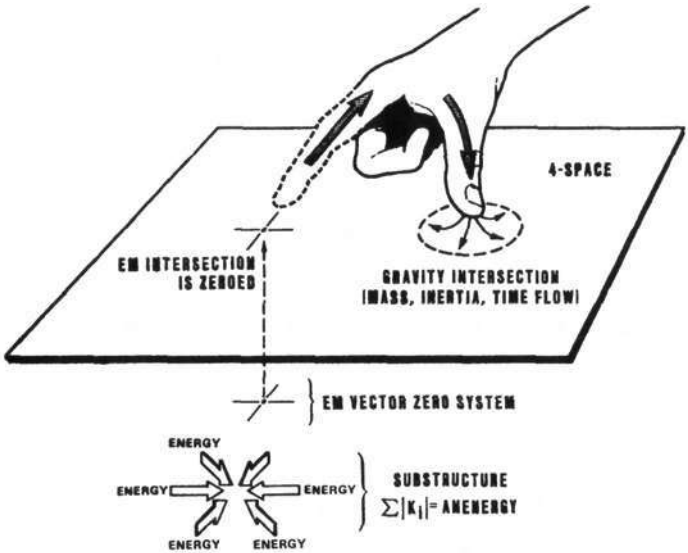

Figure 63. An analogy for how scalar electromagnetics can engineer Kaluza-Klein unified field theory.

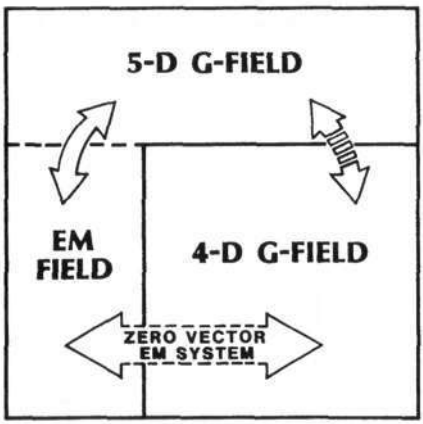

Figure 64. The zero-vector system can engineer Kaluza-Klein theory.

WHERE DID THE EXTRA DIMENSION GO?

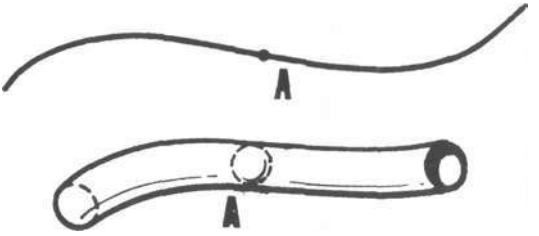

- **FROM A DISTANCE, A HOSE-PIPE LOOKS LIKE A WIGGLY LINE**
- **WHAT WE REGARD AS A POINT IN 3-SPACE IS REALLY A TINY CIRCLE AROUND ANOTHER DIMENSION OF SPACE**

Figure 65. The basic idea of Klein's explanation of where the extra dimension is.

Table 40. PHYSICAL REALITY IS ELEVEN DIMENSIONAL

- **IN THE KALUZA-KLEIN THEORY THE GAUGE FIELD SYMMETRIES BECOME CONCRETE**
- **THEY ARE THE GEOMETRICAL SYMMETRIES ASSOCIATED WITH THE EXTRA SPACE DIMENSIONS**
- **AN 11-SPACE IS REQUIRED BY THE GRAND UNIFIED FORCE THEORY**

PAUL DAVIES, SUPERFORCE.
1984, P. 160-161

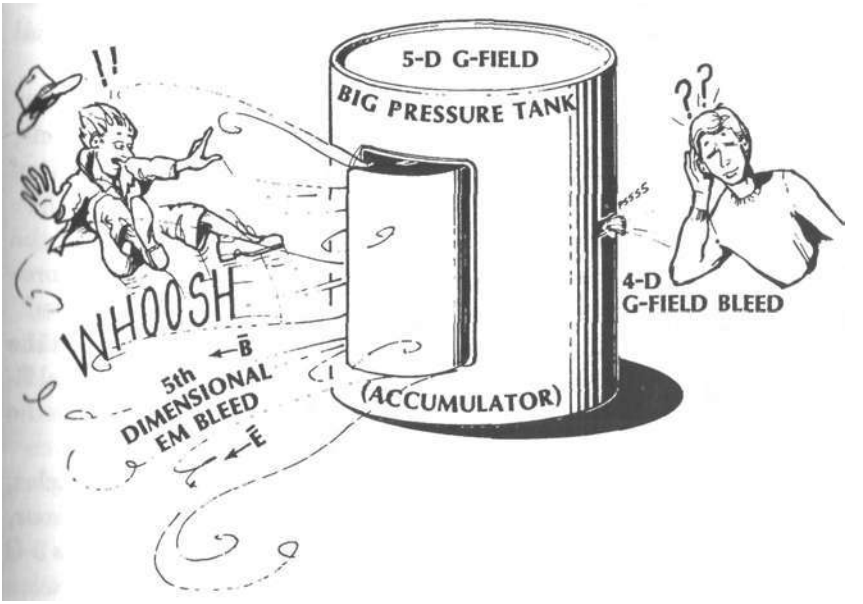

Figure 66. Normal EM bleeds off G-field.

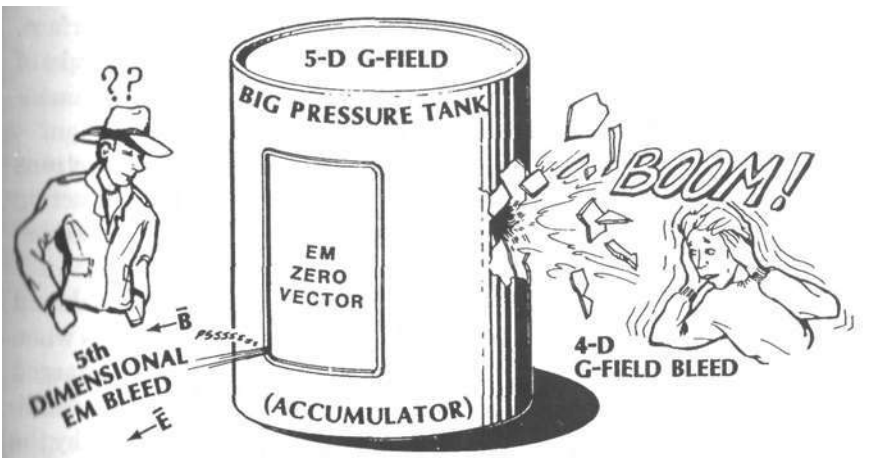

Figure 67. Scalar EM forces 4-dimensional gravitational field.

Note that this positively establishes that two or more zero-summed EM force field gradients produce and stabilize an artificial potential.

Usually, very little bleed-off of the 5-potential occurs in our normal 3-space. When the 5-space G-field is bled off on electrons, e.g., the resulting 5th dimensional E-field bleed-off is on the order of 10^{42} times as much as the 3-space G-field bleed-off.

This accounts for the enormous magnitude of the ratio of the electrical force between two electrons to the gravitational force between them.

Even when the 5-space G-potential is bled-off on and against the greater inertia of much more massive protons, its 5th dimensional E-field bleed-off is still on the order of 10^{36} or so times as much as the 3-space bleed-off.

Note that if we can stop the acceleration of the charged particles, bleed-off of the 5-space G-potential as EM force field cannot occur, and instead all of it must bleed-off as 3-space G-force field. This 3-G bleed-off normally occurs only minimally in electromagnetics, even for so-called "static" charges. This can be seen as follows:

When one charges a conductor such as a large metal sphere, for example, the electrons are unconstrained on the surface of the sphere. They are in constant agitation and motion on the surface, thus constantly bleeding-off the 5-space potential as myriads of squirming little E-fields. Only a very little is bled off as 3-dimensional G-field.

On the other hand, when one charges a dielectric, the electrons cannot be in as much agitation movement as they are on a conducting surface. Hence slightly more of the 5-dimensional G-potential is bled off as 3-dimensional G-field.

Therefore, charged conductors and charged dielectrics should exhibit slightly different gravitational and inertial properties when exposed to a gravity field potential difference. Highly charged capacitors, for example, should exhibit a small but detectable unidirectional thrust in vacuum. Apparently they do, as exhibited by the Biefield-Brown effect.

In addition, different materials should exhibit slightly different fall rates gravitationally. Again there is some evidence that they do,

as exhibited by the Eotvos experiments in a modern reinterpretation by Fischbach et al.*

Electrogravitation Amplification Factor

If the movement of two free electrons could be entirely stopped, all EM bleed-off of the 5-d G-potential between them would be effectively zeroed or blocked. Then the 5-d G-potential would be forced to totally bleed-off into ordinary 3-d G-field.

For two electrons, this could increase the gravitational force between them by a factor of 10^{42}, if the EM bleed were perfectly blocked.

Such perfect blockage of the 5th dimensional EM bleedoff cannot be accomplished in practice. Normally, with the increase in potential caused by zero-summing, agitating electrons in a statically charged object agitate more intensely, moving and squirming in local, erratic constraints.

However, conversion efficiencies on the order of 10^{10} or even 10^{20} appear to be achievable in ordinary circuitry. In that case, gravito-inertial amplification gains of up to 10^{22} or even 10^{32} appear to be achievable. Gains of 10^{10} or more appear to be fairly readily achievable.

Time delay in producing the gravito-inertial effects may be experienced, however, because mass (nuclei) acts as a capacitance to incident scalar waves, exhibiting capacitive charging and discharging "time constants" when charging scalarly for a particular effect or to a particular pattern.

In these achievable amplification ranges, a single milliwatt of electrical power can control enormously powerful local gravitational and inertial effects, once the scalar EM charge is built up in the nuclei of the target material.

Excessive and frustrating "fiddling time" with the circuits is usually required, however, due to the charging "time constant" effect, the general lack of adequate measuring instruments, and the great uncertainty as to the phenomenology and major variables involved.**

*Ephraim Fischback et al, "Reanalysis of the Eotvos experiment," Phy. Rev. Lett., 56(1), Jan, 1986, p. 3-6.

••A series of scalar EM instruments, however, is being developed by Bedini, Schnur, Golden, **and** perhaps even Hewlett-Packard.

However, with persistence, in rather ordinary EM circuits and devices, the use of "summation to zero-vector" techniques and "multiplication to yield a zero-vector" techniques can lower the EM bleed-off of the 5-potential sufficiently to allow substantial local gravitational/inertial effects. By beaming and wave interference, effects at a distance can be achieved.

When gravito-inertial amplification of many orders of magnitude are involved, the assumption in ordinary general relativity of a local Lorentz frame (local special relativity, with local conservation laws applying) is readily violated.

Now one may have local general relativity, with concomitant violation of conservation laws, and local broken symmetry on a macroscopic scale.

Soviet papers already strongly point out that such unrestricted general relativity allows the violation of all conservation laws.

In the Soviet Union, scalar electromagnetics is called *energetics.*

Comparison of EM Concepts

Table 41 shows a comparison between three concepts of electromagnetics: classical, quantum mechanical, and scalar electromagnetic views.

As can be seen, scalar EM re-introduces Maxwell's original potential for electrogravitational variation and structuring of the stress energy density of vacuum spacetime. It applies Kaluza-Klein 5-dimensional unified theory in an engineering fashion.

It deliberately utilizes phase conjugation as a tool to achieve startling negative time/negative energy capabilities and results, including "free" energy and antigravity.

With scalar EM, it should be possible to overcome or circumvent most of the severely limiting assumptions of present physics and engineering.

The great conservation laws yield to direct manipulation and violation. The previously inviolate statistical structure of quantum change becomes deterministic and engineerable.

General relativity becomes an experimental scientific discipline in the laboratory, instead of a complex description of effects only observable in distant, massively curved regions such as on the

surface of a star or near a black hole.

God does not play dice with the universe after all, just as Einstein suspected.

The Aharonov-Bohm Effect

In 1959, Y. Aharonov and David Bohm published a fundamental paper in **Physical Review** which pointed out the quantum mechanical implications of potentials.

The seminal paper is Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory," **Physical Review,** Second Series, 115 (3), Aug. 1, 1959, p. 458-491.

In classical electromagnetics, the potentials had largely been regarded as mathematical conveniences, having no real effects.

Table 41. Comparison of EM Concepts

CHARACTERISTIC	THEORY		
	CLASSICAL EM	QM VIEW	SCALAR EM (ARTIFICIAL ϕ)
VACUUM SPACETIME	LINEAR. NO CHARGE	LINEAR. CHARGED (VIRTUAL) STATISTICALLY	NONLINEAR. CHARGED (VIRTUAL) W/DETERMINISTIC COMPONENTS
VIRTUAL SUBSTRUCTURE	NONE (FLUID EQUATIONS)	YES. STATISTICAL	YES. STATISTICAL, DETERMINISTICALLY WEIGHTED.
FORCE. IN VACUUM?	CAUSE. YES	EFFECT. YES	EFFECT. NO
ZERO FORCE FIELDS	NO EFFECT	BOHM–AHARONOV EFFECTS	SUBSTRUCTURE EFFECTS, ENGINEERABLE
POTENTIALS	FICTICIOUS	REAL, PRIMARY. STATISTICAL SUBSTRUCTURES.	REAL, PRIMARY. DETERMINISTIC SUBSTRUCTURES.
CAUSATIVE AGENT	FORCE FIELDS	POTENTIALS	POTENTIALS AND INFOLDED FIELDS OF SUBSTRUCTURES
CHARGE	WITH MASS	WITH MASS	MASSLESS
RELATIVISTIC EFFECTS DUE TO	VELOCITY	VELOCITY, INTERFERING POTENTIALS	INTERFERING POTENTIALS
HIDDEN VARIABLES	NO	STATISTICAL, NEGLIGIBLE	DETERMINISTIC, MAJOR ROLE.
VECTOR THEORY APPLIED TO EM	OKAY	OKAY	REQUIRES REVISION
VACUUM EM WAVE	TRANSVERSE	TRANSVERSE	LONGITUDINAL W/SWIRLS
ENERGY/MASS CONSERVATION	YES	YES	NOT NECESSARILY. ANENERGY CONSERVED
CHARGE CONSERVATION	YES	YES	NOT NECESSARILY.
ACTION AT A DISTANCE	NO	NO, EXCEPT BOHM–AHARONOV EFFECTS	YES, SCALAR INTERFEROMETRY
SCALAR (ZERO-VECTOR) RESONANCE	NO	NO	YES
INERTIA IS ELECTRICAL	NO	NO	YES
GRAVITY IS ELECTRICAL	NO	NO	YES
MASS IS ELECTRICAL	NO	NO	YES
ELECTRO-GRAVITATIONAL WAVES?	NO	NO	YES
PRIMARILY INTERACT W/ (IN ATOM)	ELECTRONS	ELECTRONS	NUCLEONS
SPACETIME DIMENSIONS	4	4	>5
GEOMETRY	MINKOWSKI	PRIMARILY MINKOWSKI	KALUZA–KLEIN
ZERO SUMMED VECTORS REPLACED BY	ZERO VECTOR	ZERO VECTOR	ARTIFICIAL POTENTIAL
RELATIVITY ASPECTS: LOCAL, DISTANT	SPECIAL, SPECIAL	SPECIAL, MAY BE GENERAL	GENERAL, GENERAL
CAN AFFECT SCHROEDINGER EQUATION	NO	NO	YES. CAN ENGINEER IT.

Table 42. THE AHARONOV - BOHM EFFECT

- **IN FIELD-FREE REGIONS**
  - **E - FIELD IS ZERO**
  - **B - FIELD IS ZERO**
- **POTENTIALS STILL EXIST**
  - **CAUSE REAL EFFECTS**
  - **INTERFERENCE IS KEY**
  - **CONTAIN SUM-ZEROED SUBSTRUCTURE**
- **DOES NOT FOLLOW FROM**
  - **MECHANICS**
  - **CLASSICAL ELECTROMAGNETICS**

However, according to quantum mechanics, the potentials are the real entities, while the electromagnetic force fields are just effects derived from the potentials by imposed operations on them.

Aharonov and Bohm showed that, even in the absence of the EM force fields, the potentials may still exist and interfere to produce real effects in physical systems. They suggested experiments to prove these predictions.

Interference of the potentials is the key mechanism producing real effects in charged particle systems, even in the presence of zero E-field and zero B-field.

Unfortunately, Aharonov and Bohm did not address this issue of zero-summed systems of EM force fields as one way of producing artificial potentials having unique interference characteristics.

That is, by implication they did not consider the deterministically substructured "artificial" potential, but only the randomly structured "natural" potential.

At any rate the "AB effect," as it came to be called, was rather hotly debated and fiercely resisted over the years. Steadily, more and more experiments were added, validating the AB effect. Finally, in 1986 it came to be generally accepted as proven to any but the most die-hard skeptic.

The AB principle represents a violation of both classical mechanics and classical electromagnetics. It is absolutely required, however, by quantum mechanics. And experiments have now established it as proven beyond question.

The potential, then, can be a free and independent field. Further, it can directly act on charged particle systems, even when classical electromagnetics does not recognize the interaction.

Curl-Free Magnetic Vector Potential (A-Field)

As an example, in classical EM the vector magnetic potential (the A-field) had been defined as a mathematical convenience by the equation

$$\nabla \times \mathbf{A} = \mathbf{B} \qquad (4\text{-}20)$$

But if the potentials are real, then conceivably the A field can be loosed from its enchainment to the $\nabla \times$ operator. In that case, it

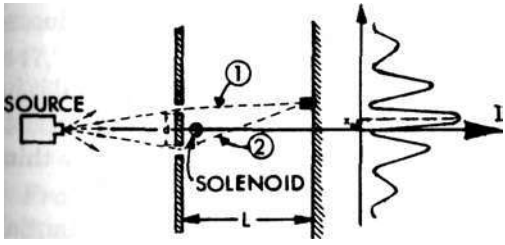

A - FIELD CAN INFLUENCE THE MOTION OF ELECTRONS.

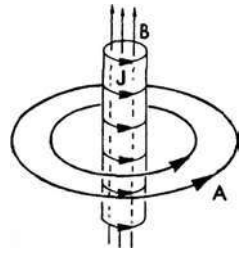

MAGNETIC FIELD AND VECTOR POTENTIAL OF A LONG SOLENOID.

THE FEYNMAN LECTURES ON PHYSICS. VOLUME II

Figure 68. The curl-free A-field. The magnetic vector potential (A-field) may be freed from its attachment to the magnetic field (B-field) and electric field (E-field). It can interfere at a distance to cause real effects. From it, either E-field or B-field, or both, can be made at a distance.

becomes a free, new, and independent field of nature with potentially unique characteristics.

For instance, its defining equation shows that magnetic force field can be made from it, and the rightmost term of the equation

$$\mathbf{E} = -\nabla Ø - d\mathbf{A}/dt \qquad (4\text{-}21)$$

shows that its time rate of change makes an electrical field.

Let us explain this in simpler terms, and somewhat more precisely than conventional theory. We will use the Kaluza unified G-EM interpretation and electron flow in our explanation.

In the A-field, we have a certain kind of 5-dimensional G-potential which can bleed-off as EM force fields in two ways: (1) in a swirl fashion, where the vortex producing the swirl moves parallel to electron movement, and the swirling is a torque or spin, and (2) in a linear fashion, where the time rate of change of the A-potential produces a linear E-field on the electrons.

The first bleed-off as given by equation (4-20) constitutes the magnetic B-field, and the second bleed-off as given by the rightmost term of equation (4-21) creates a component of the overall electrical E-field. Bleed off of the electrostatic scalar potential produces the other component of the E-field.

Now in general relativity (GR) theory, "the" G-potential is just a conglomerate of many things, each of which has the characteristic of curving spacetime. "The" gravitational field is not a single thing at all, but is composed of a collection of many things.

Thus if we realize that both the electrostatic scalar potential (Ø-field) and the magnetic vector potential (A-field) are components of the 5-d G-potential, then we see immediately that bleed-off of these two components of the 5-d G-potential creates all normal EM fields.

It follows that, if we produce a zero-vector summation of the two or more EM bleed-offs, we are actually "putting as much back in" to the 5-d G-potential through its A and Ø components as we are taking out electromagnetically.

In that case, the 5-potential is in a state of equilibrium with respect to EM bleed-off in the fifth dimension. It is now forced to bleed-off in the only other way it can: as ordinary 3-dimensional

gravitational field. Thus by vector-zeroing EM force fields, we turn KM field energy into G-field energy and vice versa, via the intermediary of the 5-potential.

At any rate, soon after publication of the Aharonov-Bohm paper, experiments showed that, if the magnetic field is trapped inside a long solenoid, a phase shift still is induced in the two-slit electron experiment, even though — classically — no contact of the enclosed magnetic field and the moving electrons occurs. This phase shift is explained by the fact that the freed A-field exists outside the trapping solenoid, even though the B-field does not. Consequently, interaction of this curl-free A-field with the electrons produces a phase shift of the QM interference detection pattern.

This proves that curl-free A-field is real and causes physical effects.

It also proves that a form of "action at a distance" is real, just as required by quantum mechanics.

Years ago, Frank Golden and this author — together with Dr. William Tiller — experimented with "free A-field" devices. Golden went on to develop prototype transmitters and receivers and a prototype underwater communication system.

Since that time, Gelinas has patented several curl-free magnetic vector potential (free A-field) devices. See U. S. patents numbers 4,447,779, May 8,1984; 4,429,288, Jan. 31,1984; 4,429,280, Jan. 31,1984; and 4, 432, 098, Feb. 14,1984. These patents are assigned to Honeywell.

Fractional Charges, Magnetic Monopoles, and Magnetic Currents

Fifteen years ago, a most distinguished gathering of physicists occurred in Trieste, Italy to review the physicist's conception of nature and how it developed. Seven Nobel Laureates were in the prestigious audience. The keynote address, appropriately, was given by P.A.M. Dirac, and — appropriately — was entitled "Development of the Physicist's Conception of Nature."

Dirac called attention to the possibility of fractional charges, and unexpectedly presented some of the data from experiments done lung before by Felix Ehrenhaft.

Years earlier Felix Ehrenhaft, former director of the Physical

Institute at the University of Vienna, had reported a number of experiments where — purportedly — he easily obtained fractional electrical charges.

Whereas Millikan had used liquid oil drops in his experiments to determine the charge of the electron, Ehrenhaft used little solid, red selenium oxide spheres. Not only could Ehrenhaft get a fractional charge, but he could actually vary the size of the fraction by varying the size of the spheres.

(Knowing what has been discovered in the last two decades on the complex bond structuring of water and liquid hydrocarbons, one might very well suspect that a solid — which has one less degree of freedom than a liquid — could possibly yield a very different experimental condition from a liquid, from first principles. However, no one seems to have noted that, or taken it into account.)

(Also, Ehrenhaft's results were replicated by other researchers who used his experimental methods. They published scientific papers, but that made not a whit to the scientific community, which simply rejected the experimental evidence.).

Dirac pointed out that Millikan himself, in his oil drop experiments that established the charge of the electron, reported one anomalous experiment which yielded a fractional charge. He discarded the results of that experiment.

Ending his speech, Dirac stated that it all made him wonder if perhaps Millikan did have a fractional charge in that one experimiment after all. And well he might wonder. Ehrenhaft — almost unknown now to the present generation of physicists — may have found not only fractional electrical charges, but the magic magnetic monopoles as well.

Over and over, Ehrenhaft reported the results of experiments which disagreed with the notions of magnetic theory at the time.

Again, some of these experiments were replicated, and reported by those researchers replicating them.

It didn't make any difference at all.

Now, finding a magnetic monopole — and the accompanying magnetic charge current — would be most satisfying to many theorists. That would make the equations of magnetics quite "balanced" with respect to electricity.

However, no one —at least whose results have been accepted -

has yet found a magnetic monopole or magnetic current.

Stanford researchers have perhaps come closest, and even reported the results of one exciting experiment that found the magnetic monopole. However, the team has consistently failed to be able to replicate those results. And in science, "no replication, no acceptance" is necessarily the dictum.

In a moment we will address a possible cause for this failure to find the magnetic monopole and magnetic charge current.

Some Ehrenhaft Experiments

Let's look at some simple, rather informal experiments that Ehrenhaft showed. We call attention to Alden P. Armagnac's excellent article , "Magic with magnetism," in **Popular** Science **Magazine,** June 1944, p. 130-133, 222, 226. In the first experiment, Ehrenhaft seems to have dissociated water with a permanent magnet.

First, Ehrenhaft seals two rods of pure iron, in holes through opposite sides of the U in a U-shaped glass tube filled with water. Then he uses the two rods — which protrude through the tube into the water — as the pole pieces of a horseshoe magnet — either an electromagnet or a permanent magnet. Dilute sulfuric acid — one percent by volume — is in the water, to give it a very slight acidity.

Bubbles of gas rise up through the twin vertical columns of water, and are collected and analyzed. Most of the gas is hydrogen, as is to be expected from common chemical interaction of the iron rods with the very dilute sulfuric acid. However, some of the gas — ranging from two to twelve percent — is oxygen, and most of the oxygen is produced at the north pole of the magnet.

The pole pieces may be short-circuited with wire, to insure they are at the same electrical potential and prevent any electrical dissociation of the water.

Without the magnet, all the gas liberated is hydrogen, as is to be expected. No oxygen at all is produced.

And another very interesting phenomenon occurs. A strong permanent magnet of the Alnico type gradually loses a marked fraction of its strength — say, 10% in 24 hours. It appears that the energy dissociates water — very similar to electrical energy from a battery draining away when electric current is used to dissociate

water.

The real question is: Is this experiment a demonstration of magnetic current?

If it is, then the textbooks are wrong, and there's another constituency in magnetism that has not been taken into account. Further, if it proves magnetic current exists, it has also proven magnetic charge — the magnetic monopole — exists.

If it is not a demonstration of magnetic current, then what is it? Why don't you get any oxygen liberated when the magnetism is removed? What causes the magnet to discharge its magnetic strength?

These serious questions do not appear to have ever been resolved.

In all fairness, however, we must warn the reader that other factors in the water can very seriously affect the outcome of this

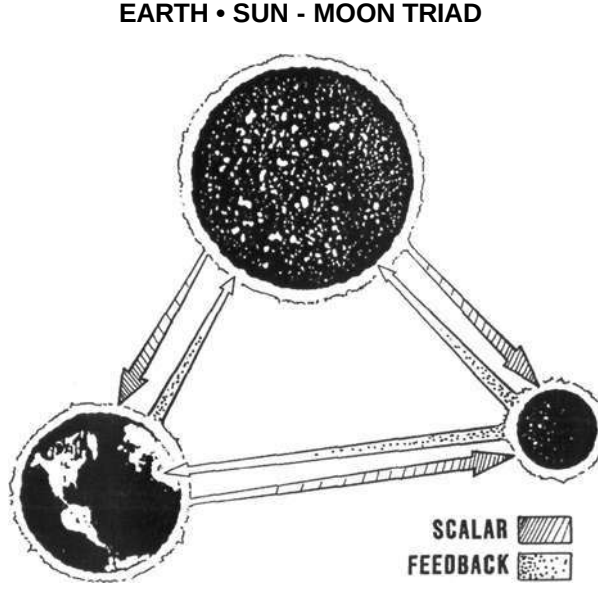

Figure 69. Earth, sun, and moon are locked into a triad system. They exchange both normal energy and phase-conjugate energy. The phase-conjugate energy (negative energy, negative time) streams affect all "subtle-energy" earth experiments

experiment. As we now know, the bonding structure of water is incredibly adaptive. Every bit of water you examine, for example, is absolutely unique in many respects. And in other respects, it's a sort of "single giant molecule."

Be forewarned also that subtle experiments with water are affected by just about everything under the sun. Including the sun!

Ehrenhaft himself was quite embarrassed when this "decomposition of water" failed to be 100% repeatable. It can be done — but you may have to work at it a bit. The best water for this experiment is the most natural, pure ground water you can obtain.

At any rate, it may be that these experiments of Ehrenhaft's are related to the old notion of "watergas" — the changing of water in some fashion so that, as it enters an internal combustion chamber, it decomposes into hydrogen and oxygen, and is ignited by the spark and burns as a fuel. In the typical watergas case, the experimenter has a "green powder" which, when added to water, will allow it to be burned as a fuel when it is used in an ordinary engine. Such a capability, for example, seems to have been exhibited at least once, to the U.S. Navy, by an unorthodox experimenter named Anderson.

Of course, if fractional charges exist and can be controlled (and Ehrenhaft's experiments certainly seem to confirm this), then it is conceivable that a material could be found that would do the "green powder" function. That is, if the bonding electron that bonds hydrogen and oxygen in water were replaced by a fractional charge, the "fractionated water molecule" could just barely be holding together an a liquid. A strong hydroshock — such as going through the jet nozzles in a carburetor — could then cause many of these molecules to break apart, effectively dissociating the water.

A possibly related phenomenon was reported by Le Bon in his Evolution of Matter. The experiment was to hold a piece of ordinary aluminum under the surface of mercury in a container for a period of time. Then the piece of aluminum is taken out and thrown into a container of water, where it violently dissociates the water. At least one colleague was able to replicate this experiment by holding the aluminum beneath the mercury for 36 hours.

These Ehrenhaft experiments may also be related to the extensive use in the Soviet Union (and to some extent, in the U.S.) of

magnetic treatment of water pipes so that boilers do not develop so much hard precipitate. Magnetic treatment of water, for example, can rigorously be shown to alter some of a liquid's properties.

Ament, for example, in numerous well-controlled repetitions has clearly shown an increase in auto gas mileage by using a strong magnetic apparatus on the fuel line. Best results are obtained by a magnet which only has one polarity facing the fuel line, and using three stages where the middle polarity is reversed. The effect of this apparatus is definitely scalar EM (gravitational) and expressed in the atomic nuclei in the molecules of the fuel flowing through the line.

Again, the Ehrenhaft experiments may be related to the strange results of Viktor Schauberger, who obtained motive results with water and natural energy that have not been duplicated before or since, so far as anyone can tell.

Schauberger utilized "implosive" energy rather than "explosive" energy — strongly suggesting he was using the negative time aspects of energy, hence negentropy. Schauberger also conceptualized this energy in a spiral form — and that is precisely the type of motion Ehrenhaft observed in many of his bubble experiments. That such negative time/negative energy is "natural" energy will be apparent from our next chapter, where we point out that all living things must use negative time/negative energy processes if they are to defeat the inexorable law of entropy — the increasing disorder of a system as its positive flow of time progresses.

Note, **for** example, **that a** system **that is 20% efficient in positive time would be 500% efficient in negative** time.

Let's look at another of Ehrenhaft's magnetic experiments.

Taking the air gap between two very flat, very parallel pole pieces of sufficient width, one obtains a very accurately-parallel, uniform magnetic field in between them. Now suppose you place some very small particles of material—both magnetic and nonmagnetic — in the air gap.

Common sense assures us that, if closer to the south pole, for example, one of the little magnetic particles will be attracted by **the** preponderance of south polarity. That is, a little magnetic north **pole**

will be induced on the side of the particle nearest the south polepiece, and a little south pole will be induced on the particle on the side away from the south polepiece. The little particle will then be attracted to the south polepiece.

Again, common sense assures us that, if closer to the north pole, the situation is reversed and the little particle is attracted to the north polepiece.

Well, that isn't quite what happens. Some move to the south polepiece, and some move to the north polepiece. And it seems to vary by the type of material the little particle is comprised of.

Now try another experiment. Let's make a permanent magnet motor. Understand, this one is not quite "for free," for we'll consume "fuel"—the strength of the magnet and the acidified water solution.

In this one, we use a glass cylindrical cell, with one vertical iron rod at the top and another at the bottom, and the rods serving as the pole pieces of a giant horseshoe magnet. (Or, for ease you can use an electromagnet). The cell is filled with the same acidified solution as before.

Without the magnet, hydrogen bubbles can be seen rising as before.

Now put on the magnet (or turn on the switch). Voila! the situation with the bubbles changes drastically. A spectacular miniature merry-go-round — a "whirligig" — of bubbles forms between the faces of the poles and parallel to them.

Add some copper particles to the solution. The particles will rotate in the same plane, but in opposite directions from the bubbles. The stronger the magnetic field, the faster the particles and bubbles will contrarotate.

If the magnetic field is reversed, the rotation of both the bubbles and the copper particles is reversed.

Only a few months after this was reported in Popular Science Magazine, Brother Gabriel Kane of Manhattan College and Charlea B. Reynolds of the Federal Communication Commission confirmed Dr. Ehrenhaft's discovery of magnetic currents.

They made a drop of copper sulfate solution spin between the polepieces of a permanent magnet. They also made an interposed microscope cover glass spin from the rotation of the copper sulfate.

It was hinted they were heading toward power machinery. If so,

nothing else was heard — possibly because they never solved the problem of consuming the magnet's strength and the acidified solution.

Bill Mueller, the present inventor of a free-energy device, has also demonstrated the spinning of a piece of plastic in a magnetic field.

After WWII, Dr. Ehrenhaft returned to his post in Vienna, published later work in French and other scientific journals, and died not long after.

What is a magnetic monopole?

First, let's reiterate what we mean by "magnetic field." It'll take a little bit to get there, so please bear with me.

By electric charge, we mean the virtual photon flux connected with a particle of mass or an object (of mass). One type of charge (by convention, positive) is modeled to constitute a "source" of this flux. The second type of charge (negative) is modeled to constitute a "sink" of this flux.

Everything in electromagnetics is fluid flow, you see. The old guys who formed the theory believed that electricity was a thin material fluid. So they modeled it that way.

They modeled the positive charge as an everlasting "sprayer" and the negative charge as a "sink" or everlasting accumulator.

They reasoned that of course this "stream" of electric fluid could "swirl" or rotate, just as normal fluids can.

This "swirl" in the stream of virtual photons is magnetostatic scalar potential — or magnetic pole for short.*

Obviously there can be two directions of swirl — one right-handed, and one left-handed, with respect to the direction of the virtual photon stream. So there are two kinds of "magnetic pole" — north (right-hand swirl) and south (left-hand swirl).

The strength of one of these "swirls" can vary, of course, and that's a variation in the strength of the corresponding pole.

You can also think of the "pressure" of the swirl, so to speak, **at** least for modeling purposes. In that model, north swirl is "higher

*Rigorously, a permanent magnet does not produce an observable B field in vacuum! Instead, it produces the dynamic, swirling "potential" for that field — i.e., an **unzipped** field. A particle of observable mass placed in this field integrates and "zips" — producing the observed B-field on and of the spinning observable particle.

than ambient" pressure, and south swirl is "lower than ambient" pressure, where "ambient" means "with respect to right-hand swirl." The swirl pressure is then considered to "bleed off/flow" from north pole to south pole. This is modeled by Faraday's "flux lines of force." This bleed off (gradient) from north pole to south pole is called the magnetic force field, or just "magnetic field" for short, even though in vacuum it's really an *unzipped* magnetic field.

Note that the original modelers didn't consider negative time and negative energy at all. And they didn't know anything about phase conjugation — in fact, the electron had not even been discovered when all this model was originally put together.

But back to the model. Considering the swirling fluid as "conserved", if you produced a concentration of one kind of swirl at one place, you had to decrease the concentration elsewhere, which is the same as producing and adding opposite swirl there. Thus, conceptually, in the simplest case (only two swirls allowed), a north pole and a south pole always occur together in a pair — though of course there's no limit to the distance between the pair.

Notice that if you have a conservative field such as we assumed, you are keeping your overall frame of observation Lorentzian — in other words, conservative. You do not have a "curved spacetime" to speak of, by assumption.

Now of course, you can have compound and very complicated magnets and magnetic fields — you don't always have to have everything so neat and simple. In that case, conceptually you could have — for example — one north pole and two south poles.

In fact, it's easily possible to demonstrate that: a bar of magnetic material is simply magnetized so that a north pole is in the middle, and a south pole is at each end. Now bend it around a bit, and you get the point.

However, now let us suppose that we curve spacetime itself, locally — something they avoid in present physics by pure assumption.

Specifically, we curve our local spacetime in such a fashion that there's more right-hand swirl in the local region than there is left-hand swirl there.

In that case, we have a north-pole region there , all by itself. We

have a magnetic north monopole. If that "curved spacetime" region of trapped swirl is moving, that constitutes magnetic current, and it may be either positive (north polar) or negative (south polar) flow.

It's as simple as that! Only when you curve local spacetime can you get a magnetic "charge" or monopole. Everyone who's trying to demonstrate a magnetic monopole in uncurved spacetime is doomed to failure a priori. It takes but little reflection to see that, conceptually, a magnetic monopole is a curvature of local spacetime. Indeed, each of the two poles of a bar magnet is precisely that anyway.

Now a monopole can indeed be "made", by bending local spacetime correctly. It can be made in two ways: in the virtual state vacuum itself, or in and on physical materials. It's easiest to make it in the virtual state: just curving the local spacetime will do that. When this "excess swirl flux without corresponding antiswirl flux" is impressed into and onto matter, however, the atomic nuclei are affected, producing excited "magnetic states." In addition, a great deal of physical stress is created in the material, due to monopolar repulsion between the various "nuclear monopoles deposited in it."

If a sufficiently strong monopole intensity (magnetic charge) is produced in the material, the material will violently fragment from internal stress. When a metal, for example, undergoes such **a** "monopolar fragmentation", it is common to see "tiled edges" of the metal rupture, much as twisted little "planks" or tiles of metal unfurled and "split." Such a break may be a positive signature of the involvement of virtual magnetic monopoles (i.e., by the metal having acquired virtual magnetic monopolar charge, causing the disruption).

This precise type of metal fracture has been very well demonstrated in experiments by Canadian experimenter John Hutchinson. Anomalous, powerful breaks in metal have been obtained by Hutchinson where the two ends that break apart both have a north pole or a south pole.

The anomalous **hole in the fuselage of the Arrow DC-8 destroyed at Gander Air Force Base, Newfoundland on Dec. 12,1985,** strongly suggests that an electromagnetic missile struck the aircraft, inducing monopolar effects. That would also match the-**three** eyewitnesses' description of an anomalous glow on part of the

aircraft as it faltered and then fell.

Supercharges and Fractional Charges

Now without further ado, let me just state flatly that the only way to get a fractional charge is to have an appreciable curvature of local spacetime.

To get that local curvature, it's going to be very difficult to use liquid. For weak effects, it will almost always change its bond structure and not localize the curvature in the nuclei. So "fractional charges" in liquid are much harder to come by.

However, with solids it's a different thing, particularly if you make the solid material very, very small and nonlinear — precisely like Ehrenhaft's little red selenium oxide spheres. There you can get **the** curvature to localize without so much bleedoff through the bonding lattice.

The greatest electrical wizard of all, Nikola Tesla, reported producing electrons with 50 times the normal electrical charge of an electron. That's readily understandable if you look at what's happening to the charge of a particle: To have 50 times as much charge, the electron must be exchanging virtual photon flux with its surrounding vacuum at 50 times the rate of the normal vacuum.

In other words, *it's the vacuum (spacetime) which must be*

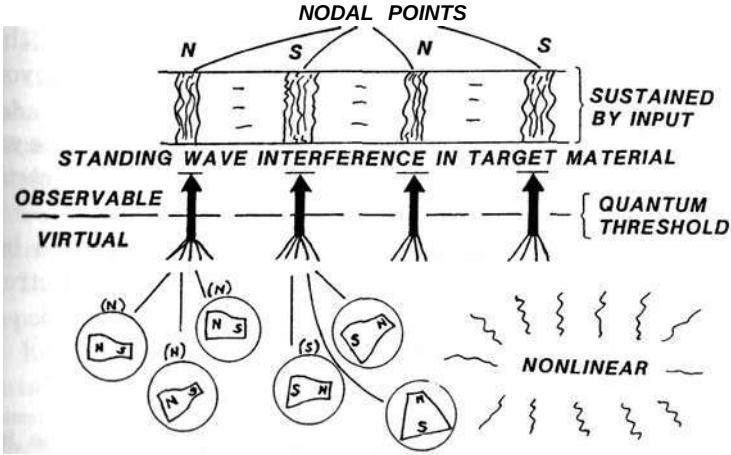

Figure 70. Forming magnetic monopoles with a standing scalar EM wave. In a nonlinear vacuum (locally curved spacetime), virtual magnetic monopoles can be formed and deposited in materials.

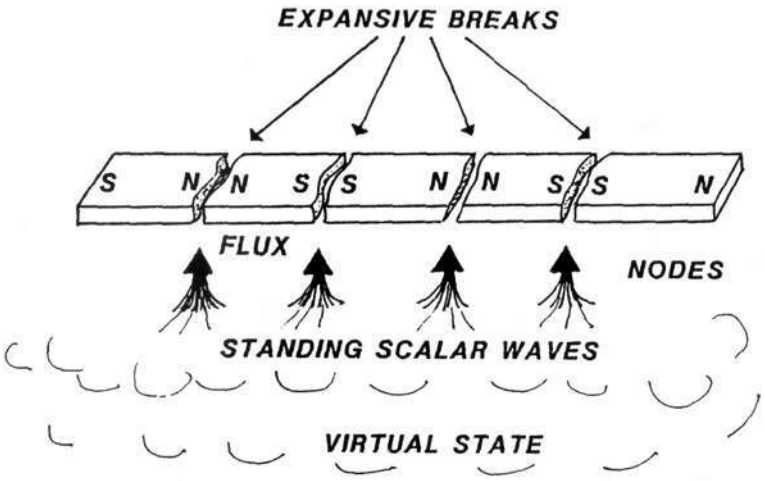

Figure 71. Metal fracture by depositing magnetic monopoles. Demonstrated by Canadian researcher John Hutchinson.

changed, not the electron! Actually, that happens anyway whenever the electron is in an electrical potential field. There are many unrecognized assumptions in the postulate that the electron charge is fixed.

If you curve local spacetime in one direction, you get the charge, of an electron increased. If you curve it in the other direction, you get the charge decreased. In that case it's called a *quark*.

At any rate, our own scientists have been looking in the wrong way and in the wrong place for magnetic monopoles and fractional charges.

Work such as that of Ehrenhaft and others should be re-evaluated. And, most certainly, the basis of the present electromagnetic theory should be both re-examined and reformulated.

*Such as the implication that the free electron is always free to move, and that potential surrounding the electron always possesses a translating gradient when it changes. It does not consider the case where the virtual flux exchange between electron and vacuum increases isotropically, centered on the electron. That, of course, represents an *excited charge* of the free electron.

CHAPTER 5

EXTRAORDINARY BIOLOGY

Kervran's Proof of Biological Transmutation

In orthodox chemistry, one of the strongest dogmas is the stubborn insistence that it is impossible to create another element by chemical reaction. Most chemists also insist that all reactions occurring in living systems are chemical in nature. They believe fervently that chemistry can and must explain life itself.

In the early 1960's, a French researcher named Louis Kervran published work which flew directly in the face of the accepted chemistry dogma. Kervran reported the astounding results of his research showing that living plants were able to accomplish limited transmutation of elements. Kervran was then the Conferences Director at the University of Paris, and his first paper was published in **La Revue Generale Des Sciences,** July 1960.

What was so revolutionary was that, according to the prevailing wisdom of science, you can't transmute elements (permanently change the nucleus) except with enormous energy — certainly not with the microvolts and millivolts (and microwatts and milliwatts) that living systems can muster electromagnetically. *

Rutherford, the British physicist who discovered the nucleus of the atom, had shown in 1919 that you can bombard elements with alpha particles and transmute them. The accepted wisdom of today is exactly the same, except that the physicists have used heavier and heavier "bullets" in their artillery approach. No one has tried a controlled approach, for the catchecism is that you have to use the *wham it harder!* approach.

In other words, to most scientists the whole thing had to be preposterous, and Kervran had to be deluded.

Kervran published further details of his work in a book, **Transmutations Biologiques,** Maloine, Paris 1962. But the initial reac-

*Note, however.that since gravity is infolded EM, one can have extremely powerful infolded EM, yet only have miniscule electrical (outfolded) residues. Thus the actual "available power" in artificial biopotentials may not be quite so small after all.

tion of most scientists was disbelief and skepticism. Few scientists would stoop to repeating Kervran's experiments, which of course they knew could not work anyway.

Actually the effect is widespread amongst living systems. As Kervran pointed out, the ground in Brittany contained no calcium; however, every day a hen would lay a perfectly normal egg, with a perfectly normal shell containing calcium. The hens do eagerly peck mica from the soil, and mica contains potassium — a single step below calcium in the standard table of elements. It appears that the hens may transmute some of the potassium to calcium.

Further, if one tests this assumption, it is quickly shown to be true. Hens denied calcium but not potassium, stay perfectly healthy and lay perfectly normal eggs. Hens denied both potassium and calcium will be sickly and lay only soft-shelled eggs. If these sick chickens are allowed to peck only mica — which they will frantically do — everything returns to normal again.

Most orthodox scientists nevertheless remained skeptical or downright hostile.

However, a few other scientists began to repeat Kervran's

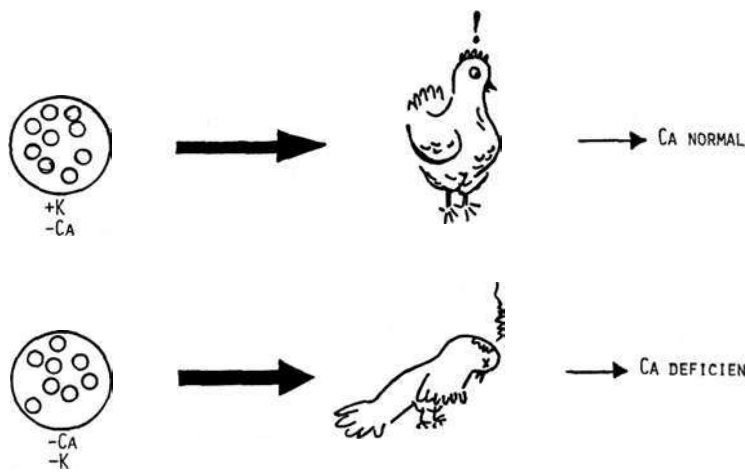

Figure 72. The Kervran effect. A biosystem can accomplish limited transmutation of elements.

experiments and replicate his results. Several of these corroborating scientists were (1) Professor Hisatoki Komaki, Chief of the Laboratory of Applied Microbiology at a leading Japanese university, (2)Professor Pierre Baranger, Head of the Laboratory of Chemical Biology of the Ecole Polytechnique in Paris, and (3) J.E. Zundel, then head of a paper company with a chemical analysis laboratory, and later a chemical engineer of the Polytechicum School of Zurich, Switzerland.

Later work by Zundel was particularly decisive: he utilized the mass spectrometer at the Microanalysis Laboratory of the French National Scientific Research Center, and neutron activation mass analysis at the Swiss Institute for Nuclear Research in Villigen to positively confirm an increase in calcium of 61% to an accuracy of 2%. Such results and instrumentation, of course, removed any doubt that the effect could be due to statistical variation. In the same experiments, the plants increased their phosphorus 29% and their sulphur 36%.

Komaki became head of a research laboratory at Matsushita Electric Company. There he conducted research conclusively proving that microorganisms (including some bacteria and two kinds each of molds and yeast) could transmute sodium into potassium. In fact, he placed a brewer's yeast product on the market that, when applied to composts, increases their potassium content.

Extensive work in the area has been done in the Soviet Union, where results similar to Kervran's have been substantiated.

Thus all doubt (to an open-minded scientist) was removed: living systems are able to change one element into another by some unknown means, using very feeble energy.

A noted French physicist, O Costa De Beauregard, suggested a mechanism for the transmutations, using weak force interactions and advanced waves.

No one — even Kervran himself— thought of negative energy/ negative time interactions. The jury is still out on the actual mechanism, but it is absolutely clear that the transmutation does indeed occur.

The Japanese researchers, having replicated Kervran's astounding results to their complete satisfaction, recommended him to

the Nobel Committee for a Nobel Prize for such epochal work. Thus Kervran became a Nobel nominee, though he was not granted the prize.

Kervran has since passed away, leaving behind his books and papers that point to a revolution in chemistry and physics - transmutation of elements at very weak energy.

Biological Transmutation Has a History

Actually biological transmutation — and transmutation of elements (alchemy) in general — has a history, of both results and suppression.

Louis Nicolas Vauquelin, a celebrated French chemist, discovered that chickens could produce more calcium in their eggshells than entered their bodies. Hence they had to be able to "create" the calcium, else their own bodies would have been completely depleted.

One of his contemporaries, however — Antoine Laurent Lavoisier — became the "father of chemistry." Lavoisier laid down the dictum that nothing was created. So chemistry fixed upon the notion that the combinations of elements could be shifted, but the element itself could not be transformed.

Not until the discovery of radioactivity did any crack in this solid wall appear. But still, the basic ideas of chemistry said the element couldn't be transformed chemically. It could only be transformed if one blasted the daylights out of it with an atomic or particle bullet.

Today most chemists still hold that exact same opinion, unshaken.

To resume: Over a century ago, a chemist named Albrecht von Herzeele proved that germinating seeds somehow transmuted elements in the process. In 1873 von Herzeele published a book, **The Origin of Inorganic Substances,** where he showed research proving that plants continuously create material elements.

Even earlier, in 1822 an Englishman named William Prout had studied chicken eggs in incubation. He found that hatched chicks had more lime (calcium) in their bodies than was originally present in the egg!

Another French scientist named Henri Spindler discovered that, a kind of algae called Laminaria could create iodine.

A German researcher named Vogel had planted cress seeds in a

bell jar. They were fed nothing but distilled water; still, when grown they contained more sulphur than had been in the seeds originally.

Lawes and Gilbert, two British researchers, also found that plants could "extract" more elements from the soil than the soil actually contained in the first place.

Baranger performed thousands of meticulous experiments in plant transmutation of elements. He proved that the transmutations do occur. He also discovered that many things affected the germinating seed transmutation process: the time the seeds germinate, the type of light they are exposed to, the phase of the moon, etc.

None of these experimenters understood the transmutation process used by the living organism. But they proved beyond question that the process existed, and universally occurred.

Surplus-of-Energy Mechanisms Proposed by the U.S. Army

There has also been other very positive support for the thesis that if living systems transmute elements, they can produce a net source of energy in the process.

In 1978 an officially-funded effort of the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia positively confirmed that mechanisms for elemental transmutations could occur in biological systems, from an energy consideration.

The work was performed under the direction of Emil J. York, Chief of the Material Technology Laboratory. Solomon Goldfein was the principal investigator for the effort. Robert C. McMillan, Chief of the Radiation Research Group of the laboratory, provided guidance on matters of physics and nuclear physics.

The abstract of the final report (S. Goldfein, Report 2247, E**nergy Development from Elemental Transmutations in Biological Systems,** U.S. Army Mobility Equipment Research and Development Command, May 1978. DDC No. AD A056906.) reads as follows:

"The purpose of the study was to determine whether recent disclosures of elemental transmutations occurring in biological entities have revealed new possible sources of energy. The works of ***Kervran,*** *Komaki, and others were surveyed, and it was concluded*

that, granted the existence of such transmutations (Na to Mg, K to Ca, and Mn to Fe), then a net surplus of energy was also produced. A proposed mechanism was described in which Mg adenosine triphosphate, located in the mitochondrion of the cell, played a double role as an energy producer. In addition to the widely accepted biochemical role of MgATP in which it produces energy as it disintegrates part by part, MgATP can also be considered to be a cyclotron on a molecular scale. The MgATP when placed in layers one atop the other has all the attributes of a cyclotron in accordance with the requirements set forth by E.O. Lawrence, inventor of the cyclotron."

"It was concluded that elemental transmutations were indeed occurring in life organisms and were probably accompanied by a net energy gain."

The researchers also concluded that elemental transmutations occurring in life organisms are accompanied by losses in mass representing conversion to thermal energy, and that such energy probably is a net gain when compared to the amount required to effect the transmutation.

All in all, they concluded that the little cell with its feeble energy does quite well! It's in control of cyclotrons, and cyclotron forces, and direct conversion of mass to energy. Pretty good for a little bitty beastie, wouldn't you say?

Actually, one should point out that, according to nuclear physics, an atom gets a little heavier when it absorbs (usually by means of an orbital electron) a normal "positive energy" photon. That is, the addition of positive energy results in the addition of a little bit of "positive mass."

Negative energy, of course, does a similar thing to the nucleus — except that it adds "negative mass." Thus the nucleus of the atom, when it absorbs negative energy, gets lighter. This is seen in the external world as "loss of mass."

With our present nuclear physics, only positive energy is assumed except in extremely rare cases.

Thus the Army study — which was conducted and controlled by some excellent scientists — worked out a "loss of mass" the way

they're trained to.

By adding some positive energy, the nucleus would gain some positive mass. **By adding some negative energy, the nucleus would lose some corresponding positive mass. The conventional physics then would equate this "loss of mass" as the direct conversion of mass to energy. And so it is, only it's conversion to negative energy!**

However, by pointing out the cyclotron mechanism in the cell MgATP, the Army researchers have made a most important contribution.

Note also that the whirling motion may be very much related to Viktor Schauberger's work and to Wilhelm Reich's work. Both of them worked with what they viewed as an unusual kind of living, spiraling energy.

All the orbital electrons of an atom also are whirling around in orbit, in the simplest model. Further, these orbits themselves move and rotate or precess.

Similar orbits and shells occur in the nucleus, at least in some models (several rather independent models are used there for specific things.)

It may be that a whirling, spiraling (cyclotron) energy motion is necessary to connect positive energy to orbital electron (negative charge) shells, and to connect negative energy to positive charge shells in the atomic nucleus. *

Alchemy ***and Unusual Critters***

In ancient times, the old alchemists pursued the dream of making gold. Obviously, if one could do that economically, one could become quite wealthy.

Just as obviously, the kings and rulers of the world took rather **a** dim view of such proceedings. After all, much of their own power rested on their ability to get and control gold. And if some "loose cannon" could make all the gold anyone wanted, then the national **treasury** of the king wouldn't be worth a plugged nickel. And that would finish the king, for he would be powerless.

•The spinning/whirling motion may be viewed as integrating the unzipped vacuum flux virtual vectors into zipped observable force vectors —just as great grandma's spinning wheel integrated fibers into continuous threads.

There are some unorthodox researchers today who take the view that the alchemists were stamped out—*not because they failed, but because they succeeded.*

I subscribe to the same view.

T.H. Moray had a process to "recover finely divided gold from quartzite sands." My personal, strong belief is that he possessed a practical transmutation process. His knowledge and techniques, of course, are still possessed by his sons, and reside through them in Cosray Research Institute, Salt Lake City, Utah.

The possession of such a technical secret may be one of the major reasons why the Morays have met with such intrigue, harassment, and suppression over the years.

To speak further on "making gold," we first have to present some details on some special "critters" that live, but that can't be observed through a normal microscope — even an electron microscope.

In that vein, toward the end of this chapter, we will present some of Royal R. Rife's fundamental discoveries. Pay particular attention to his discovery of "finer" living forms — which today we could only refer to as "living energy, virtual-state forms."

Let's call them **critters** for short.

At one time, when the earth was young and the radiation from the sun was different, conditions on earth were much hotter. Great volcanic activity and fiery eruptions were commonplace and nearly continuous. Huge storms, of size and magnitude undreamed of today, swept the primitive atmosphere. The oceans were frenzied.

Under those conditions, many types of "critters" were highly active. Most of the critters, for example, lived in and worked on the atomic nuclei of matter .

After all, the critters are living, virtual-state organisms. There's a continual exchange between the virtual state (the vacuum, or spacetime) and mass (the observable state). An atomic nucleus is like an island in the "virtual state ocean", and the flux interchange is like waves breaking onto the island and then washing back to sea. The critters live in that ocean, and wash upon, so-to-speak, the mass-islands and interact with them.

In those primal days, many of the present great mineral deposits of the earth were created due to the transmutation activities of the

critters.

One kind, for example, lived in copper. In an "energetics" sense, this critter "ate" copper and "excreted" gold, so-to-speak. Much of the gold that occurs in great copper deposits today was formed this way in the old days under primal conditions.

When conditions on earth changed, these little "copper critters" ceased their incessant activity and became dormant, just as viruses can do. But the critters are still there in the copper ore, waiting to be activated.

And activate them you can! You can even get the critters into a solution, and then crystallize them out as crystals.

These crystals are what the alchemists of old called the **philosopher's stone,** with the power to transmute base elements into gold. There are several kinds of philosopher's stones; this kind is for copper.

At any rate, you can then place these special crystals on some copper (and add another thing or two), and restore them to a similar primal environment as of old. That is, heat them in an electric furnace. Blast them with terrible electrical bolts. Bathe them in intense ultraviolet light. That's just a nice, refreshing spring day for the critters!*

That stimulates them and revives them. They wake up after a long sleep — and they're immediately "hungry." So they go right to work on the copper. Boom! In a little bit there isn't any more copper, just mostly gold, with a little other miscellaneous residue thrown in, such as black ruby and silver (in the experiments of one of my close colleagues).

The gold is radioactive when first made. Fortunately, all isotopes of gold are very short-lived: just minutes suffice for the radioactivity to die away. So you wait half an hour and everything's okay.

That's all there is to it.

And if you do that and try to capitalize upon it, your life expectancy is about 24 hours.

I don't know whether or not biological systems, in their Kervran-

*Note the probable similar effects involved in the Miller-Fox-Urey experiments in biogenesis

transmutations at weak energy, deliberately manipulate similar "critters." I suspect, however, that they do, at least to some extent.

The Cell Also Lives and Functions in the Virtual State

Obviously, to transmute elements the living system has to be able to directly affect and influence the atomic nucleus.

It has been shown that this is a cellular capability, for single-celled organisms can do it.

As we shall see, Rife's work showed that the living cell is connected to at least 16 intemested deeper levels of reality than a relative "point" under an ordinary microscope. Further, all levels are structured and organized.

Think of it! Each one of those levels is to the preceding level as microscopy today is to the normal world. Sixteen levels!

I think it's reasonable to state that the life of the cell is patterned and dynamically structured and functioning all the way into the virtual state; indeed, to very deep intemested levels of the virtual state. That is, it also functions *hyperspatially*.

We shall also see that the mind and thought involve these more subtle physical (though virtual) levels.

Thus the living virtual-state levels are a reality, for Rife proved it.

The living organized structures at each level are a reality, for Rife proved it.

The living ordering and control of dynamic functions on all those levels is a reality, for Rife proved it.

Those living virtual-level parts of the living organism — plant or animal — thus affect, function in, and reside in the atomic nuclei of the material that composes its bodily structures.

Beasties like bacteria and viruses also have living, organized energy structures in multiple levels of virtual state. Apparently, for these more primitive life forms, the virtual-state "energy part" can be separated and pass through a filter, then re-engender the physical form and/or itself cause the disease in a host! At least that is what Rife and other scientists showed.

"Bigger fleas have smaller fleas to bite 'em, And so on, ad infinitum."

Of course the living system can "work on" the nucleus and

change it a little bit! If it couldn't do so, it couldn't stay alive and function in there in the first place!

The Kaznacheyev Experiments

Dr. Vlail Kaznacheyev is Director of the Institute for Clinical **and** Experimental Medicine in Novosibirsk.

For 20 years he has been directing highly unusual experiments with twin cell cultures. These experiments are vital to understanding disease and healing on a more fundamental basis than is presently utilized by orthodox medical science.

The Kaznacheyev experiments (several thousand) in the Soviet Union proved conclusively that any cellular disease or death pattern can be transmitted electromagnetically, and induced in target cells absorbing the radiation.

In the experiments, two sealed containers were placed side by side, with a thin optical window separating them. The two containers were completely environmentally shielded except for the optical coupling.

A tissue was separated into two identical samples, and one sample placed in each of the two halves of the apparatus.

The cells in one sample (on one side of the glass) were then subjected to a deleterious agent — a selected virus, bacterial infection, chemical poison, nuclear radiation, deadly ultraviolet radiation, etc. This led to disease and death of the exposed/infected cell culture sample.

If the thin optical window was made of ordinary window glass, **the** uninfected cells on the other side of the window were undamaged **and** remained healthy. This of course was as expected in the orthodox medical view.

However, if the thin optical window was made of quartz, a most unexpected thing happened. Some time (usually about 12 hours) after the disease appeared in the infected sample, the same features of disease appeared in the uninfected sample.

This startling "infection by optical coupling" occurred in a substantial percentage of the tests (70 to 80 percent). From an orthodox medical view, these results were unexpected and unheard of.

Further, if the originally uninfected cells were in optical contact

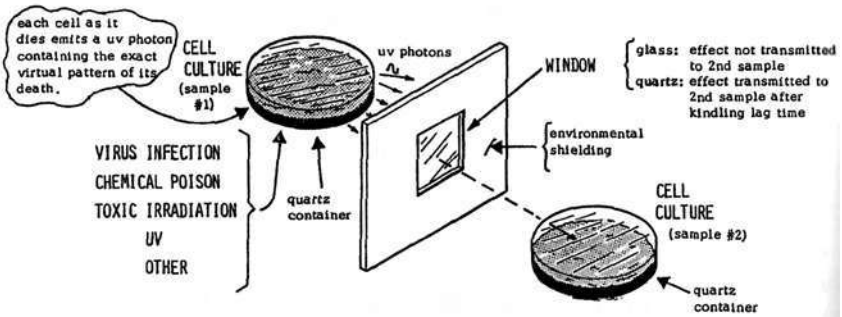

Figure 73. The Kaznacheyev effect. Thousands of experiments proved that (1) cellular disease is electromagnetic, and (2) it can be induced electromagnetically at a distance. Also called the cytopathogenic effect.

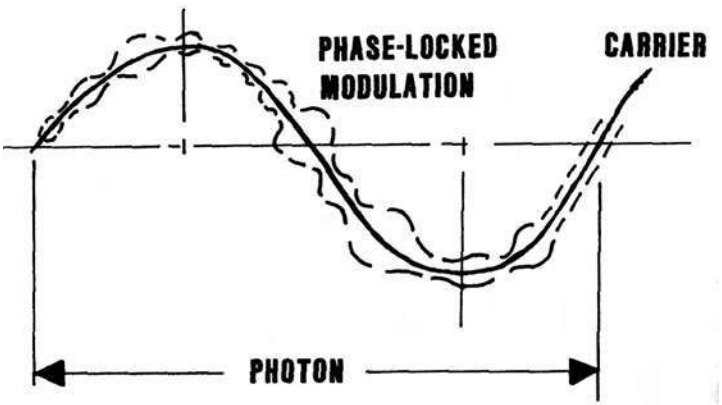

Figure 74. A photon is one oscillation of an electromagnetic carrier. It may have substructures that are modulations. Such a structure is called a "giant photon," or a "compound photon."

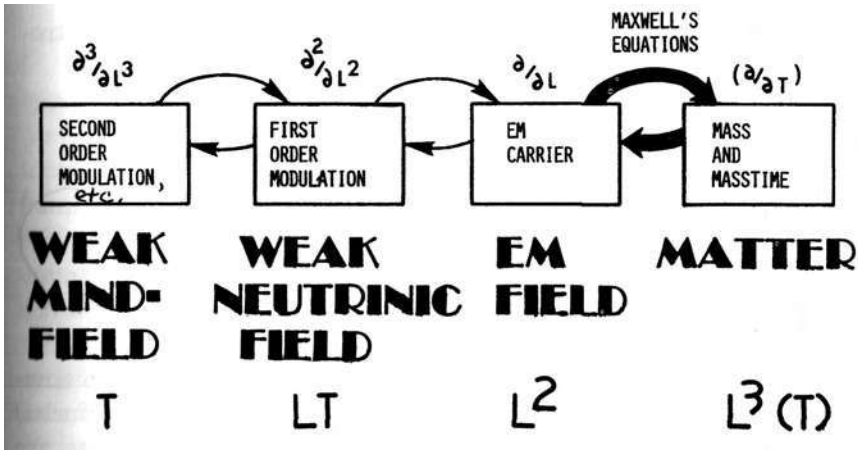

Figure 75. Nested modulations are the key to hyperspatial engineering.

with the infected cells for 18-20 hours or so, and then were correspondingly exposed (optically coupled) to another uninfected cell sample, symptoms of the infection appeared in this third sample an appreciable portion of the time (20 to 30 percent).

Guided by A.G. Gurvitsch's work that showed that cells give off mitogenetic radiation (photons) that can affect other cells, the Kaznacheyev team sought an answer by looking for photons given off by the infected culture sample as its cells died.

They found that the cells in the infected culture gave off photons in the near ultraviolet when they died. The normal window glass was opaque to these near-UV photons and absorbed them. In that case, the uninfected culture on the other side of the glass was not exposed to radiation by the UV "death" photons from the dying cells, and they remained serenely healthy.

However, the quartz window was transparent to the UV "death photons". When the quartz window was installed, the UV "death photons" passed through it and were absorbed in the uninfected culture on the other side of the window. Most of the time, the uninfected culture which absorbed "death photons" sickened and **died** with the same disease symptoms.

The Kaznacheyev experiments proved conclusively that cellular

death and disease patterns can be transmitted and induced electromagnetically.*

Structuring and Charging a Biopotential

Kaznacheyev thus demonstrated that a photon information/regulatory system exists in biological systems due to a continual influx of EM energy from outside the system. That is, the cells of the biosystem are charged with an electromagnetic potential, and additions and changes to the potential are continually received. The cell is thus in minute disequilibrium.

Usually the myriad of continual inputs from the external environment into the cell's potential charge pattern (in its atomic nuclei) may be taken to be potential changes whose substructures are *disordered*. In that case, no specific environmental effect is observed except slight fluctuations without order — a miniscule form of "heating."

However, if a continual *ordered* substructure exists in the input from the external environment into the cell's potential, the cell's potential will gradually "charge up" with that pattern.

An analogy will prove helpful. Imagine an accumulator, a largo pot, that holds a volume of water. Several pipes are connected to tho pot, some are inputs for water coming in, and some are outputs for water flowing in.

Imagine the inputs all containing "blue" water, just in slightly varying shades. The water in the pot is blue, and may slightly rise and fall in level as the input flow rates vary. The water in the pot may also vary slightly in its blueness as the inputs vary. However, it will still be blue.

Now suppose that yellow water starts flowing through one of the input pipes, and at a goodly rate. Slowly the water in the pot will start to turn greenish as a greater percentage of yellow builds up. In other words, the pot slowly charges up with some of the "yellow" charge, in the process acquiring a "green" charge.

*We point out that this effect has been investigated in both the infrared and ultraviolet. IR to UV may be taken as a single harmonic interval — an **octave,** musically speaking. The same effect can be reproduced in any other "octave" (single harmonic interval) of the electromagnetic frequency spectrum. The **reversal** of the effect can also be achieved in any harmonic interval. The mechanism for these effects involves the cellular biopotential, Popp's master cellular control system, and the deterministically-tailorcd substructure of photons.

The biopotential in the cell experiments works the same way.

A cell has a biopotential built up, which represents the "nominal equilibrium" of the scalar charge on the cell. This biopotential, being mostly a "sum-zero" of virtual state vectors, is centered in and on the atomic nuclei of the cell, constituting charge patterns in these atomic nuclei. The biopotential extends out of the atomic nuclei, through the electron shells, into and through the molecules, through the internal cell structures and membrane, and outside the cell.

From the atomic nucleus on out through the cell, every layered structure or organization of the cell will layer, structure, and organize the biopotential accordingly.

This organized, structured cellular biopotential is continually receiving "charge patterns" contained in incoming photons absorbed by the cell. The biopotential is also continually exhausting some of its biopotential charge pattern in the photons (heat, light, etc.) that the cell emits.

The Cell's Electromagnetic Breathing

Via structured photon exchange, the biopotential of the living cell thus "breathes in" the virtual state charge structure of its environment, and "breathes out" its own internal virtual state charge structure.

So, in the experiment, the uninfected cells are continually absorbing photons from their surrounding environment, and emitting photons back to it as well. According to our scalar EM view, each photon it absorbs has a substructure that depends upon the part of the environment from whence it came.

These "substructures" are actually patterns of the sum-zeroed virtual vectors comprising the potential of the absorbed photon carriers.

Normally, since a large number of very different substructures are continually being "input" into the cell's potential from the absorbed photons, the substructure of the cell's potential receives an essentially disorganized continual input from the environment. This liquates to the fact that the environment does not normally specifically influence or change the cell's potential with ordered information (organization).*

When a cell dies, it ceases to maintain the bio-dynamics that sustained its artificial potential (that part due to bio-ordering by its organized life processes, above the background level of its "inert matter" potential). The dead cell's built-up artificial potential then "discharges" by emitting a structured photon.**

Since this photon (energy) comes from an *organized potential drop, the virtual substructure of the emitted photon is organized.* The photon, then — among other things — carries the exact organized virtual charge pattern of the dying cell's disease.

We strongly insist on the quantum mechanical view here: All physical changes — chemical, material, mechanical, whatever — at root level are constituted and caused by virtual state interactions, in direct patterns of virtual particle exchanges.

In the full QM view, what's really going on in primary physical reality is just a complex set of patterns and changes in potentials anyway.

The Summed Virtual Structures of Kaznacheyev's "Death Photons" Physically Kindle the Disease

At any rate, the Kaznacheyev experiments showed that the dying cells from the infected culture emitted photons in the near UV that contained artificial (structured) potentials. The virtual-state, patterned-substructures in this photon flux directly represented tho cellular disease pattern caused by the original cell's specific infection.

In other words, as the infected cells died, they emitted "death photons" which contained the **template** pattern of their death condition.

When these "death photons" are absorbed into uninfected cells, their deterministic substructures gradually diffuse into the cell's bio-potentials. Gradually the biopotentials of the new cells are

*There may be sufficient ordered input from the environment, however, to have something to do with territoriality in living things, salmon returning to a fixed place to spawn, turtles returning to the same beach to lay eggs, the migration of birds, etc.

Note that this photon is emitted from an atomic nucleus. Hence it is a phase conjugate (time-reversed) photon. It will interact with the biopotential of targeted cells, and thus reach their own atomic nuclei. This is the mechanism for Kaznacheyev's cytopathogenic effect. See particularly C.W. Rietdijk, **Found. Phy , 7(5-6), Jun **77, p.** 351

Table 43. THE LIVING AURA: THE CELL'S ELECTROMAGNETIC BREATH.

- **VIRTUAL EM FIELD**
- **STORES VIRTUAL PHOTONS**
- **ENVIRONMENTAL INPUTS**
- **OUTPUTS BIOPHOTONS**
- **COHERES ORGANISM**
- **TENDS TO STABILIZE**
- **EXPERIMENT ESTABLISHES**

Popp, "Photon Storage in Biological Systems,"
Electromagnetic Bio-Information. 1979

"charged up" with the integrated pattern of the disease.

The master cellular control system of the biosystem is itself a dynamically changing, ordered pattern in the biopotential of the cells, which is centered in the atomic nuclei comprising the cell materials. As the bio-potentials of the cells gradually acquire the "death photon's" substructure pattern, this pattern is also diffused throughout (modulates) the master cellular control system. All the cells in the sample (or in a biosystem) are now slowly charging up with the "death photon" pattern.

As Popp discovered, photons continually "leak out" of the virtual photon master control system of the biosystem. Some of these *leakage photons* are observable photons, **but most are virtual photons.**

Further, they are *structured* photons.

In other words, as leakage photons spill out of the master control system, observable change is now being slowly initiated in the physical structures, biochemistry, etc. of the biosystem's cells — and those changes are in consonance with the integrated "cellular death pattern" of the originally infected cells.

Note particularly that it is already well-known in quantum mechanics/electrodynamics that, when a photon is emitted from **the surface of a dielectric body, the entire dielectric body participates in that emission. If a photon is absorbed on the surface of the dielectric body, the entire**

dielectric body participates in that absorption.

Thus as irradiation by the "death photons" continues, the "death structure" in the irradiated cells increases. It is spread throughout the cell culture by the master communication system, gradually charging the virtual state structure of that system with the death pattern.

Spillage photons from the cellular control system occur throughout the culture. These photons are structured with the death pattern, and gradually affect the cell and its biochemistry physically. The previously uninfected cells thus physically start to acquire and exhibit the symptoms and characteristics of the disease pattern that killed the infected cells.

Electromagnetic Infection Results in Physical Disease

The new cells are now electromagnetically infected and physically diseased.

After all, that is all a cellular disease is in the first place — physical, electrical, and biochemical changes in the normal functioning of the cell.

For a given pattern of changes in the cells, a specific "disease" exists in them.

It absolutely does not matter what causes this exact pattern. If the specific physical pattern is there, the specific disease is there.

Note that **any ghost pattern in the virtual state flux can charge up physical matter — that is, the atomic nuclei of a mass. All that is necessary is that a continual flux of thin virtual pattern continually bathe (irradiate) the mass's atomic nuclei.**

The eventual emergence of this "ghost template pattern" into observable physical reality is called **kindling.** Kindling is charging up one or more atomic nuclei with an integrated virtual charge pattern until the integrated pattern breaches the quantum threshold, resulting in emergence of that pattern into observable physical change.

A Possible Cure for AIDS

One of the things going for the "good guys" and EM defense

against AIDS is that cells are a lot tougher than viruses. Thus even non-structured EM signals can be used to effect cures in many disease cases.

In fact, ordinary ultraviolet (UV) irradiation of the blood has already been utilized to cure or control severe infections, including severe viral infections. I am indebted to Dr. William C. Douglass for pointing this out to me, and for permission to reproduce the following information from his important newsletter, **The Cutting Edge, Nov.** 1987, p. 3. The following material is quoted verbatim, with no editing.

"It's amazing what you can find by nosing around in the dusty archives of a good medical library. I came across another remarkable therapy that the AMA and drug industry (or whoever is in charge of supressing non-toxic treatments that work) have shoved down the memory hole."

"Back in 1933, Doctors Hancock and Knott treated a patient dying of septicemia (blood poisoning) with ultraviolet irradiation of the blood.[1] The patient was moribund with a blood stream infection **and** obviously near death. (Remember that this was before antibiotics and there was nothing to lose.) The patient made a complete **and** uneventful recovery."

"Searching further, I found that in 1928 a similar terminal infection was treated by ultraviolet light to the blood. This patient also made a complete recovery.[2] "

"So in 1928, practically in the middle ages, an incurable disease, blood stream infection, was cured with ultraviolet light. With such **a** breakthrough why wasn't it tried again for *5 years?* According to **the** record, *another 6 years* passed before it was tried for a third time.[3]"

"Back in those days infection was the number one cause of death. You can't help but wonder how many lives could have been saved if doctors weren't so resistant to new ideas. Just imagine a cure for **AIDS** being set aside for 11 years. Yet bacterial infections of the blood were uniformly fatal in 1935, just like AIDS is today."

[1] Northwest Medicine, 33:200, 1934.
[2] Knott, AM. J. Surg., Aug. 1948, pp. 165-171.
[3] Am. J. Med. Sci., 197:873, 1939.

"Finally, in 1940, 110 cases treated with ultraviolet spectral energy were reported. The results were uniformly good. Between 1940 and 1948 many other conditions were successfully treated, including vein inflammation (phlebitis), polio and asthma. Up to the late 40's *over 40 thousand* treatments were given with ultraviolet blood irradiation."

"And now for the most interesting part. In 1947, Dr. G.P. Miley reported on 79 cases of virus infection.[4] Miley stated that ultraviolet blood irradiation therapy could be relied upon consistently to control an infection of a virus in a safe and efficient manner.[5]"

"AIDS is a virus. AIDS-II is a virus (the HTLV-IV leukemia and lymphoma now sweeping the world). Remember that these killer viruses are within the cell and any chemical agent that enters the cell to kill the virus will often kill the cell as well. But ultraviolet irradiation *kills the virus without harming the cell."*

"A fine piece of crystal can be shattered by exposing it to just the right frequency. You can be standing in the room and the energy from that frequency won't harm you in the least. Viruses have the same characteristics, and so, in my opinion, frequency irradiation of the blood in the ultraviolet range is our greatest hope for curing AIDS."

"But the treatment is simple, safe, inexpensive and unpatentable. That doesn't bode well for its future, at least until a few *senators* get AIDS."

The Mirror Cytopathogenic Effect and Factors Influencing It

The cellular disease induction effect was called the **mirror cytopathogenic effect** (CPE for short) by the Kaznacheyev group. Mirror CPE appeared only when the quartz or mica window was no thicker than 0.8 mm. A. F. Kirkin also duplicated the experiments using a thin plexiglas window.

There are conditions which enhance the effect, and others which inhibit or degrade it. Irradiation of the detector-culture with a low dose of UV prior to its optical contact enhances the effect, increasing

[4]Rev. Gastroenterol. 15 271-277, 1948.
[5]Am. J. Surgery, Aug. 1948, pp. 170.

it to certainty (99-100%). Increasing the temperature to 38.5 degrees centigrade also enhances the effect (from 37% to 90% for example).*

A necessary condition for the success of the experiment is the rotation of the holder with its two optically-coupled samples at a rate of about 24-25 revolutions per hour. Optical contact between the inductor and detector cells for a minimum of 4-6 hours is necessary, after which the cell cultures can be separated. A longer contact time is necessary for complete development of the irreversible effect.

Both cultures must be maintained in complete darkness throughout the experiment. Use of the detector as a new inductor in a successive state reduces the effect by 20-30%. Three or four such stages is sufficient to eliminate the effect.

There is a seasonal variation in the results. In more than 15,000 experiments, monthly variations and daily variations were noted. (The present author's interpretation of this is that it is due to the monthly variations in the virtual photon substructure input from the moon to the substructure of the cell's bio-potential. The daily variation is due to the daily variations in the virtual photon substructure input from the sun to the substructure of the cell's bio-potential.)

Negative results appear more often in winter. (The present author's interpretation of this is that it is due to the fact that the scalar potentials of the earth and the biopotentials of each living cell on earth are lowered in winter by the weaker flux from the sun.)

Effects are correlated with the polarity of the interplanetary magnetic field. Negative polarity of the field usually precedes the appearance of mirror CPE. (This is because of the positive nuclei — which prefer one direction of the magnetic field over another). Disturbance of the geomagnetic field several days before a culture planting also results in enhancing the mirror CPE effect. (Disturbing the geomagnetic field provides a "dithering magnetic disturbance" in the atomic nuclei which "livens" them. Consequently their readiness to charge-up and emit structured virtual state charges is increased).

Kaznacheyev further discovered that the Sun's activity and the

•This is very important. Preconditioning the cells by "dithering" them in the frequency band of interest, or in a subharmonic band, "livens" the cells for developing the irradiated pattern. Thin is similar to a dither voltage placed on a missile fin, making it much easier and quicker for the fin to move when an actual order is placed on it.

Earth's magnetic field greatly affected the results of his experiments. Large flashes on the sun seem to inhibit the effect. (Such flashes cause substantially increased irradiation of the atomic nuclei by sun-emitted substructures, charging them mostly with this disordered substructure pattern and literally "burying" the disease structure several decibels below it.) In a season of active sunspots, the mirror CPE effect becomes highly unstable. (The sun emissions are sporadically jamming the effect.) Under active sun conditions, the effect varies from 90-100% on some days to complete absence on others.

Some Biological Warfare Implications

The Soviets reported detecting near-ultraviolet photons — bioluminescence — as carriers of the death/disease pattern.

However, scientists at the University of Marburg in West Germany also duplicated the effect in the infrared. This shows that bioluminescent photons in the near UV and in the IR can definitely carry "disease and death" information between cells. Further, integrating a continuing input of such photons coherently integrates the disease or death pattern from the virtual state into the observable state.

Note also that portions of the infrared spectrum are a subharmonic of the near ultraviolet. Harmonics are well-known in nonlinear oscillator theory, and biological systems are filled with nonlinear oscillators. It may be that harmonics and subharmonics are directly involved in the death pattern.

If so, the induction of such "death patterns" upon normal electromagnetic carriers is directly indicated. For example, modulations covering several octaves in the region of 10 gigahertz and above might be constructed that are the analogues of some particular cellular disease. This modulation pattern could then be added to a common microwave carrier — say in the communication band, from 3 to 30 megahertz. Say, that is, to something like the giant Soviet Woodpecker "over-the-horizon radar" signals as carriers.

In that case, a large population could be bombarded, even on the other side of the earth, with "death photons" whose virtual state substructures carry the particular disease pattern. With sufficient

time, many of the targeted persons would develop the disease.

Note that, even if the power and/or irradiation time is reduced so that the absorbed "death photons" are insufficient to actually kindle the disease in the targeted population, a heightened change in the substructure of the biopotentials of the cells of the targeted persons is still accomplished.

In that case, a precursor pattern — a predisposition for that disease — exists in the targeted persons.

If the actual disease agent is now loosed on that population, the agent will be far more **infectious and lethal than it otherwise would.**

In this way, even diseases which normally do not kill or seriously debilitate the infected person can suddenly become very lethal agents indeed.

Influenza, the common cold, etc. can become devastating killers if the exposed population has been electromagnetically "pre-conditioned" for enhanced susceptibility.

What Kaznacheyev Hid: The Role of Phase Conjugation

If cellular disease can be electromagnetically induced, can it not be electromagnetically corrected or healed?

If one could time-reverse the exact signal structure (the information) that kindled the effect, and bombard the diseased cells with that reversed pattern, would not the cell deviate back to "normal" and be healed?

The burning question as to whether cellular disease conditions can be corrected by time-reversed disease signals must certainly have occurred to the Soviet experimenters.

It is highly significant that they did not openly publish those results.*

As we have explained in the sections on phase conjugation and scalar electromagnetics, there are really two major kinds of photons:

*Recent information indicates the strong connection of Kaznacheyev with the Institute of Physiology and Biophysics and the Frank Institute in Pushkino, just outside Moscow. Since these institutes are deeply involved in microwave and coherent microwave "directed energy" weapons, it is highly probable that the Soviets are applying Kaznacheyev's "death photons" to microwave weapons — such as the Woodpecker transmitters. If so, obviously they would develop phase conjugate countermeasure signals as well.

(1) the "normal" photon carries positive energy and positive time. (2) the "time reversed" or phase conjugate photon carries negative energy and negative time.

Further, the Soviets certainly knew all about phase conjugate signals. After all, they discovered and developed the effect. We discovered it only from the open Soviet scientific literature!

Let us assume that the "death photons" in the mitogenetic radiation emitted by the dying cells are ordinary photons. Their virtual state structures (in positive observer time) are exact "templates" for the disease pattern.

Now suppose we detect the "death photons" with a phase conjugator, which by definition will produce a time-reversed counterpart to the input signal detected. In other words, the death photons are allowed to strike a phase conjugate mirror (PCM). Time-reversed counterpart photons — carrying the exact time-reversed template of the death pattern — will be created and emitted by the PCM.

These newly emitted photons now carry the exact "healing pattern" for that specific "death/disease pattern that was received and detected."

Further, if we "pump" the phase conjugate mirror, we can greatly amplify the output pattern, and hence greatly increase the healing pattern!

If one records the pattern of the "death photons" for a specific disease, one could of course modulate that pattern upon ordinary photons/signals — such as the Woodpecker signals — and accomplish disease induction or precursor conditioning.

By phase conjugating the pattern of the "death photons," one can produce an exact antidote. One can modulate this specific healing pattern upon ordinary photons/signals — such as the Woodpecker signals — and accomplish healing induction for that specific disease.

In other words, one can create the healing pattern — the antidote, if you will, for any biological warfare agent. Cancer, leukemia, AIDS, viral diseases, bacterial diseases, whatever. One can create the antidote within minutes after the first symptoms of the disease or death pattern appear.

One can then simply add the negating (healing) signal to power line signals, television and radio signals, special transmitters, etc. —

and immediately start to "administer the antidote" to the irradiated population one wishes to protect. *Now one can see why the Soviets are so ready to expose the entire world to something like AIDS. It doesn't represent a real problem to them, the instant they decide to negate it.*

So they can devastate the rest of the world, with the assurance that their population is safe.

They can allow some of their own people to develop AIDS — and even some to die of it — as a deception plan to delude the West while Western populations are succumbing en masse.

Then they can snatch their own population right back to health, from "the brink of the grave," so to speak.

Our government must immediately develop the same capability. It is straightforward. As weapons and counterweapons go, it is enormously cheap. It can be immediately and widely implemented. **And** it can protect our population against AIDS or any other biological warfare strike by the Soviet Union.

We can save our people from the AIDS knockout already unleashed upon us by the Soviet Union.

First let us do that. *Then* let us negotiate.

Remember this: **You can negotiate with the Russians only from a position of strength. If you are weak, they will bury you.**

If we do not immediately develop this biological warfare countermeasure, we are already as good as dead.

Popp's Master Cellular Communication System

Dr. Fritz Albert Popp has already discovered and pointed out the "virtual state" master communication system that controls all cells in the body, and all their functions.

Based on a thesis derived to best fit experimental results by Ruth nnd others, Popp postulates that biological systems generally have the capacity to store coherent photons that come from the external world.

In other words, the biosystem is open to environmental communication and exchange.

He has shown that the cell population is in a quasistationary state that is far away from thermodynamic equilibrium, as pointed out by Ilya Prigogine.

Popp also concludes from his analysis that ultraweak photon emission within biological systems can influence chemical reactivity. In fact, his analysis strongly implies that "ultraweak" photon intensity can regulate the whole cell metabolism and related phenomena.

The cell takes up photons from external radiation. This includes both "observable" photons and "virtual" photons. Since it stores virtual photons, it stores charge, or biopotential changes. Since its stored virtual photons may be coherent virtual photons, it effectively "polarizes" or structures its stored photon charge, hence its biopotential.

The cell emits "spillage" photons — both coherent and incoherent — from its stored potential.

Although Popp only uses conventional "unstructured" photons in his analysis, he shows that, at the molecular level, there is a stationary equilibrium, as far as photon storage and emission are concerned, between the molecular photon traps, the cell population, and the external world.

It follows that *coherent* photon/charge inception from the external world can directly and precisely influence the cell's biopotential, hence its functioning and control, by information input.

Incoherent photon inception, on the other hand, can only grossly affect the cell, such as by heating or sporadic effects.

In his "Photon Storage in Biological Systems," Popp points out the master cellular communication and control system as follows:

"The photons which we have measured can be seen as a sort of "waste" from a virtual electromagnetic field with a high coherence. This field has a tendency to become stationary over the whole organism."

After additional analysis, he adds:

"....Consequently, biological systems must exhibit 'holographic' properties to an extremely high degree. The successful trials in

finding 'pictures' of various organs in each other organ, such as the ear, the hands, the eyes (acupuncture, iris diagnosis) support these conclusions. Our assumption that the entire genetic information of the DNA is stationarily delocalized over the body in form of genons may be seen as a further striking example."

"From this we can easily deduce that pattern recognition, as, for example, repair mechanisms and immunity, depends finally on the coherence of the photon field within the body."

Finally, Popp states a most important conclusion:

"...In medicine **new aspects have developed, and not only for cancer problems. Diseases in general can possibly be understood in terms of electromagnetic interactions within the organism."**

Scalar *EM* ***Comment on Popp's Communication*** *System*

Popp and his colleagues have produced most important work and results indeed. They only need to add the impact of the zero-summed/multiplied electromagnetics (electrogravitation).

As we cover in this book, the biopotential of the cell is rooted in the nuclei of the atoms of the cell's constituent materials. To be sure, every internal physical structure of the cell correspondingly "levels" and structures the biopotential. The overall cellular communication system is actually the exchange of "leakage" photons — both observable and virtual — throughout the overall biopotential of the organism.

Further, going beyond Popp's work, both the biopotential and the leakage photons have extensive, complex internal substructures. Leakage and intercommunication occurs laterally at all levels of the biopotential, and vertically among cells and substructures.

The master cellular control system's primary electrical conductivity path is not through the electron shells of the atoms, but is through the nuclei-to-nuclei scalar EM "biopotential levels" pathway.

With scalar EM methods, organized signals (signals with specific internal nonzero vector EM waves, but which externally sum to **zero** vector resultant E and H fields) can be constructed for essen-

tially any specific purpose. This includes "killing" a cancer or leukemia cell, destroying a virus, changing the DNA, etc.

This approach can directly reach and manipulate all immune and repair system functions.

The entire biochemistry and functioning of the cell — including its genetics — **is totally engineerable.** The Soviets have long known this, and have long since done it.

Further, a specific "charge pattern" of desired specific immunity (antibodies, etc.) can be designed and used to "charge up" the nuclei of the biosystem. This charge is then maintained by the system to provide permanent immunity. Thus one can develop, for example, an "electromagnetic innoculation" for AIDS, one for cancers and leukemias, etc.

Since the cellular control system is holographic, the "charge pattern" of immunity resides in every cell, including the blood cells.

Injecting a drop of blood from a scalarly immunized animal into another non-immune animal carries the scalar EM immunity pattern into the new animal. That charge diffuses throughout the overall biopotential of the organism, and the charge pattern activates the animal's immune system, including causing it to produce antibodies — according to the EM-transferred antibody template.

Antoine Priore demonstrated this effect numerous times. Thin was one of the great mysteries that confounded the orthodox members of the French Academy of Sciences.

The French Academy did not know of scalar electromagnetics, the cellular biopotential rooted in atomic nuclei of the cellular material, the cytopathogenic effect of mitogenetic radiation from diseased and dying cells, phase conjugation, and phase conjugated electromagnetic healing.

It is little wonder they did not comprehend the operational healing mechanism of the Bordeaux cancer-curing machine of Antoine Priore!

A New View of the Nature of Mind and Thought

The reason that Western science has not discovered what mind and thought are is simple: They have only built instruments and tools to look where the mind and thought *are not to be found.*

Let's look where they are to be found.

For example, consider the ionic discharges in and across the tremendous numbers of synapses of the human nervous system, and the slower discharge and migration of ions across cellular membranes, etc.

Considered as a single biological ensemble, these are much like a vast array of continual and continuing spark discharge vectors, slow charge current vectors, etc.

Overall, within the macroscopic space occupied by the body, these electromagnetic vectors sum almost entirely to a zero vector resultant. Only a tiny nonzero vector residue remains.

However, this vector zero summation has incredibly rich infolded signals, channels, and dynamic relationships (structure) within it.

Modern science/medicine measures the small nonzero electromagnetic residue (the remaining weak E and H fields) and tries to ascertain where and how mind and thought are accomplished, by studying that residue.

However, the residue E and H field remainders are simply the "garbage thrown out" of the glorious engines dynamically operating inside the vector zero summations (and multiplications).

The E and H field residues are the wastes or exhaust byproducts. They are not the functions of the mind/thought process itself; instead, they are the spillage or leakage from those functions.

Take a "frozen time" snapshot of the components of the zero vector summation. Regard the highly complex, infolded structure or pattern these components form.

Now take a second "frozen time" snapshot of the components of the zero vector summation, a very, very short time later. Subtract **the** previous "frozen pattern" from this second "frozen pattern."*

The difference or "delta" between the two patterns represents a myriad of thoughts, hence it represents the contents of the "thinking mind," in the most general sense.

The "mind" is the overall functioning and changing of the entire pattern's substructure, and the ability of an organism to have such **and** do such. The "ability of the organism to do such" requires at least

*Similar to the magnificient "double **exposure holography"** work of Dr Robert Powell.

two more nested levels of virtual state—two more hyperdimensions.

In simplest Kaluza-Klein theory, all those electromagnetic component vectors are in the fifth dimension. Hence they are hyperdimensional.

The zero-vector system may well have further infolded, internested levels of zero-vector systems. Systems within systems. These are hyperspatial, going into the 6th, 7th, 8th, etc. dimensions. Rife's microscope, for example, could reveal some of these levels; using evanescent waves, it could resolve some 16 ever-deeper levels of dynamic energy structure.

Everything driving the component vectors themselves is higher dimensional.

"A thought" is the exact change of a localized pattern (localized

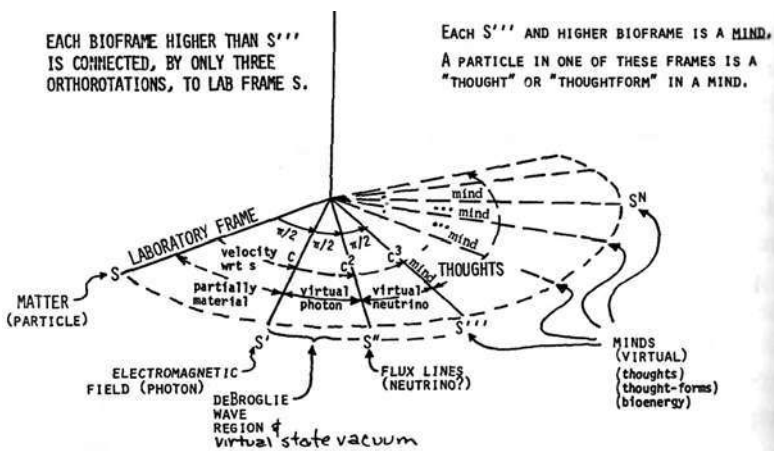

Figure 76. Hyperframes, vacuum, virtual state, minds and thoughts.

zero vector summation whose components are changing but remaining zero summed) from one moment to the next.

Thought is always a pattern change, of the components inside an EM vector zero summation.

Most thoughts are totally "unconscious" (multiple simultaneous

or "parallel" thoughts). A few are conscious (serially ordered, singularly considered and processed).

The unconscious mind is totally a parallel processor (many things/thoughts at once).

The conscious mind is totally a serial processor (only one thing/ thought at a time).

Most persons never take the time and trouble to reflect and notice that, consciously, they only can perceive one single thing at a time. Of course, the conscious mind is so rapid that by habit they assume they can perceive many things at once.

Since the conscious mind cannot discriminate the "multiple images in the slide projector at once" of the unconscious mind, that's what makes it unable to "be conscious" of the contents of the "unconscious."

In fact, the unconscious mind is totally conscious — it's just **multiply conscious "simultaneously."** (Which sheds some interesting light on why one can develop multiple personalities, for instance).

When the conscious mind "regards" the unconscious contents, it sees "something" which has "multiple meanings at once."

That's what we call *symbolic.* A symbol is something which can have many meanings at once.

That's why the unconscious content always "symbolizes" something when it's trying to communicate to the conscious mind. It's necessary to interpret the symbols to understand what the message being communicated is.

That's why dreams, for instance, are symbolic. And why it usually takes a trained psychiatrist or psychologist to properly interpret the symbolic representations manifested in mental disorder, and get at the underlying cause being symbolized.

With deliberately constructed scalar EM, any or all of the conscious/unconscious portions of the mind can be available for engineering and control/change. Eventually you will be able to put contents of the mind and memory on a video screen if you wish to.

It will also be possible to interact with the mind's contents electromagnetically. Mental illness will be treated directly, on an engineering basis.

Of course this opens up the frightening possibility of hostile misuse to the detriment of an individual. It will even be possible to change or erase his or her very personality itself. We pray, of course, that such a powerful tool will not be utilized this way, but will be used to heal humans, not hurt or kill them.

Unfortunately, Lisitsyn's work reveals that the Soviet Union has long since applied energetics (scalar electromagnetics) to mind control and mind engineering, including deciphering the genetic code operation. Controlled induction of images and sensations inside the brain — where they are processed as if self-originated — has been reported by the Soviets. Indeed, they have reported being able to control whether or not the induced material should rise to conscious awareness, as well as when it should rise to consciousness.

For years, U.S. intelligence analysts and U.S. scientists simply did not believe that electromagnetic signals could directly influence consciousness.

However, they were forced to reevaluate that position when a Soviet medical machine — the LIDA device — was openly obtained and evaluated.

The LIDA machine — a small unit somewhat larger than a briefcase — has been used in Soviet medical facilities to treat humans for decades.

The device uses a 40 megahertz EM carrier and very complex waveforms (signal modulations with complex mixtures of frequencies, phases, etc.)

When exposed to it, a person is caused to gradually fall into a trance-like, catatonic-like state within a few minutes. That person becomes very still and very quiet.

It was reported that the machine was tested upon a cat and had the same effect upon it.

One American scientist stated that the device had actually been used in North Korean "brainwashing" of U.S. prisoners of war in the early 1950's during the Korean War!

If so, one can see just how long the Soviets have achieved success with electromagnetic biological warfare/medical treatment techniques.

Reportedly, prisoners exposed to the machine were rendered

unable to psychologically resist their harsh brainwashing interrogation.

But to return to the brain activity, with its innumerable, zero-summed minute EM vectors, and its extremely rich and complex deterministic substructure.

Note that the ensemble of sum-zeroed vectors forms potentials. These potentials — i.e., the scalar EM — penetrate to the atomic nuclei in the brain and body. Internal changes in the potentials' substructures (i.e., thoughts) also penetrate to the nuclei.

The nuclei continually "charge up" (the particles change their states) to these impressed potentials, including the "potential" or "charge" of each component of the impressed potential. That is, the nuclei charge up with both dynamic overall potential (mind) and thought (individual substructure changes).

Notice that **mind, thought, and memory reside in, and are recorded in, the atomic nuclei. At many virtual state levels. In many hyperdimensions.**

Thus the functioning mind and bio-control systems — including Popp's master cellular communication system, the immune control system, the acquisition control system, and the repair control system - all "reside" in the nuclei as dynamically interacting, patterned potentials or "patterned charge," complete with resonances and frequencies, etc.

We can regard the mind and its interactions as physical, in the extended sense we have briefly developed here.

Everything "mental" can be directly interfaced with and engineered.

One day, for example, "education" will be by direct loading of patterns into the brain/body/cellular biopotentials, much as we now place a diskette in a disk drive and load the computer memory. And then everyone can be educated, in the widest range of skills and to the highest degree ever dreamed of.

Kindling, Life, Mind, and Negentropy

The mass of the atomic nucleus can be charged up with a particular dynamically structured biopotential.

In scalar electromagnetics, I use the term **kindling** to refer to the effect of charging up mass by a specific structured charge pattern to form such a structured potential in the nuclei.

Note that we are actually and physically restructuring the nucleus itself. That is because, if the structure of the potential in the nucleus is changed, local spacetime of the nucleus is polarized in complex electromagnetic structures. The electromagnetic currents, actions, and charges of the affected nucleus adjust automatically to this structure or "grid." *

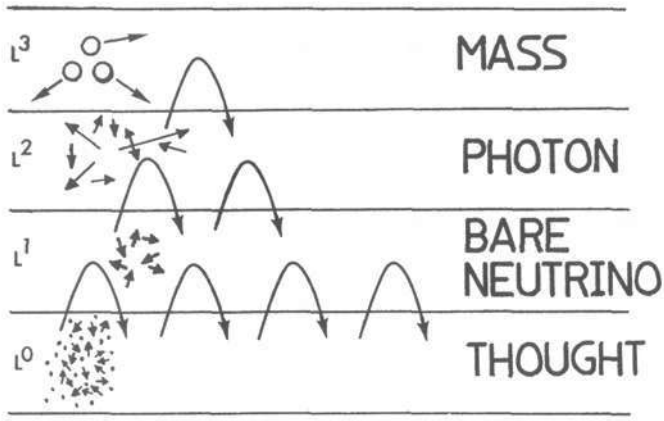

Figure 77. Internested levels of virtual state vacuum contain mind and thought. **The** vacuum also contains their interaction toward and upon mass.

*See Richard E. Prange and Peter Strance, "The semiconducting vacuum," Am. J. **Phy.** 52(1), Jan. 1984, p. 19-21. The vacuum may be regarded as a semiconductor. This semiconductor, particularly in the region close to the nucleus, may be manipulated by subjecting it to external fields, doping, etc. Extra energy density can even be extracted; see H. Paul and R. Fischer, "Comment on How can a particle absorb more than the light incident on it?" Am. J. **Phy. 51(4),** Apr. 1983, p. 327. For the involvement of negative time/negative energy, see C.W. Rietdijk, **"How** do 'virtual' photons and mesons transmit forces between charged particles and nucleons?" **Found. Phy** 7(5-6), June 1977. p. 351-374.

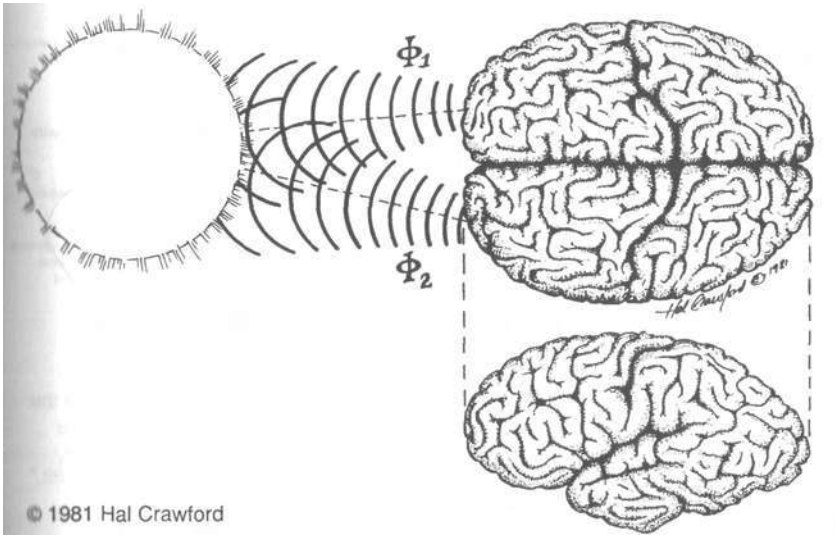

Figure 78. The human cerebral cortex is a natural scalar interferometer. It is a virtual state tuner, processor, and transmitter-receiver. It also can produce...and control to some extent...phase conjugate energy and phase conjugate waves.

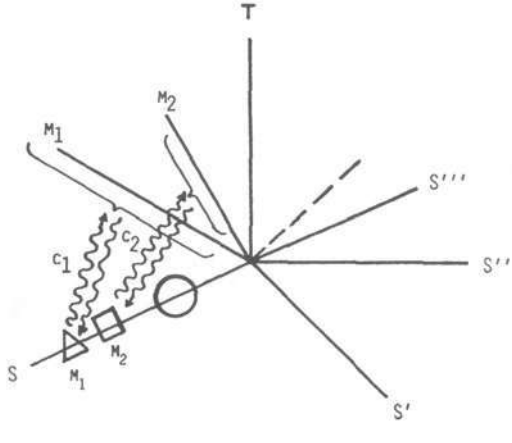

Figure 79. Consciousness and life. These phenomena refer to/constitute a deterministic hyperspatial (virtual state) coupling between mass and an ordered hyperworld.

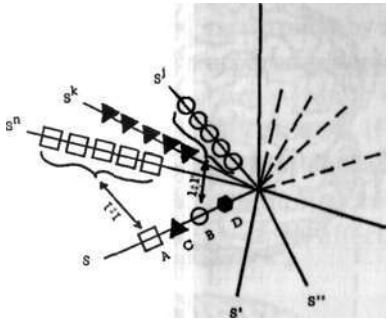

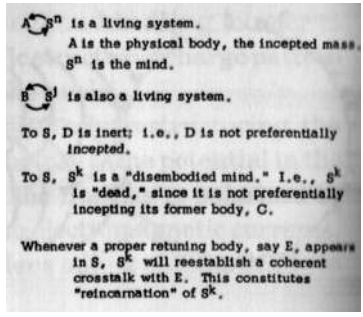

Figure 80. Life and death. If the tuning or coupling between the mindworid and the tuned, structured mass body is broken, that is physical "death." Discharge of the structured cellular potentials then produces "death photons." Discharge of the overall, structured biopotential of the body constitutes discharge of the "living spirit."

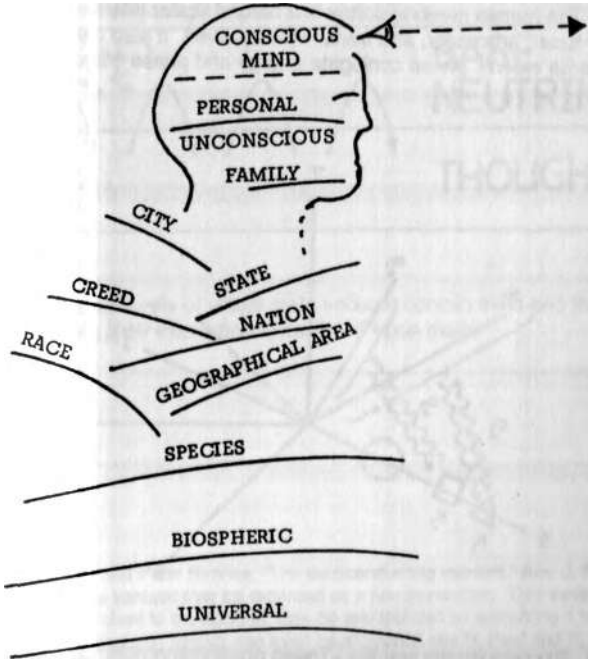

Figure 81. Layers of unconsciousness intersect hyperspatially.

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Figure 82. Scalar electromagnetics can directly interact with the various levels of human mind and personality.

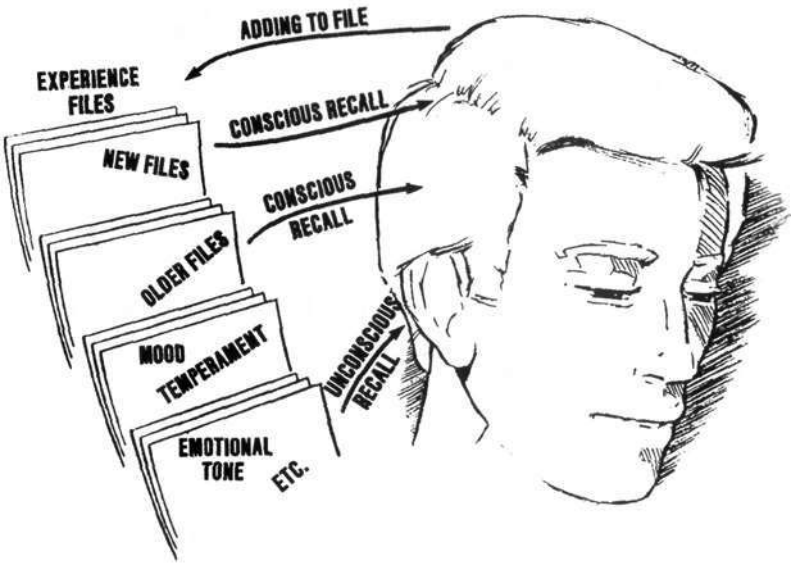

Fgure 83. What personality is.

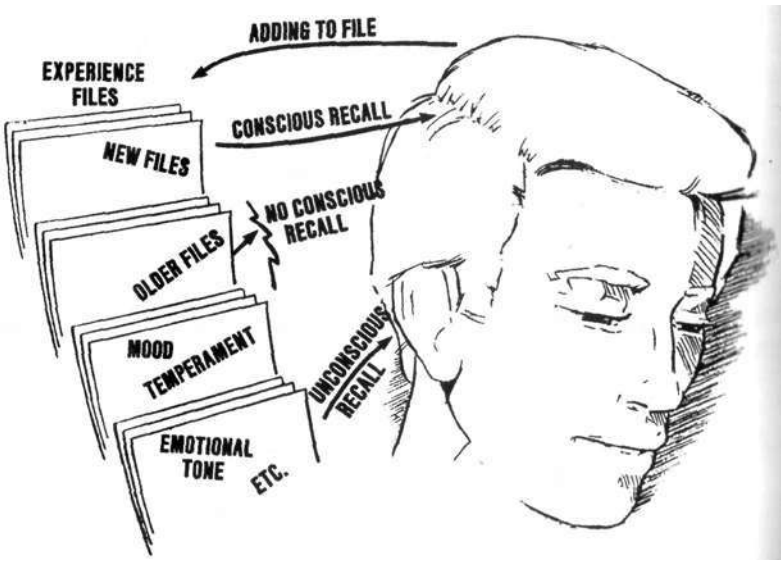

Figure 84. Jamming the "older files recall" process produces simple amnesia. If the recall process is then restored, the person regains his or her former memories.

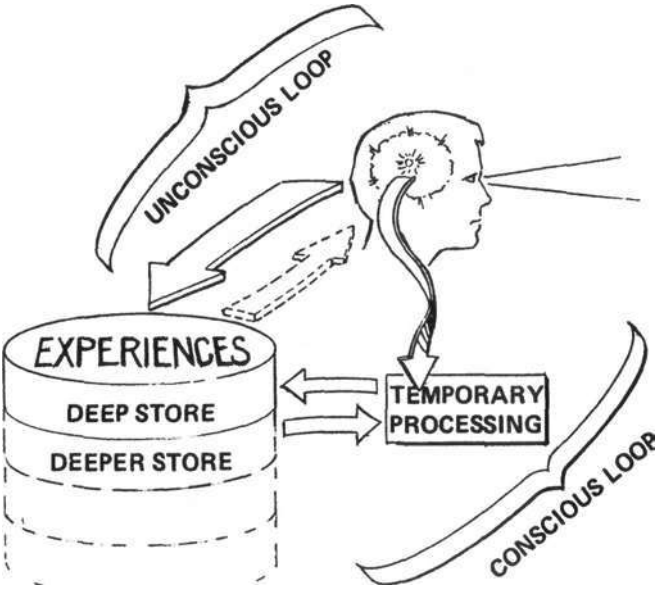

Figure 85. To sustain one's personality, continual functioning is required. All channels must be functioning.

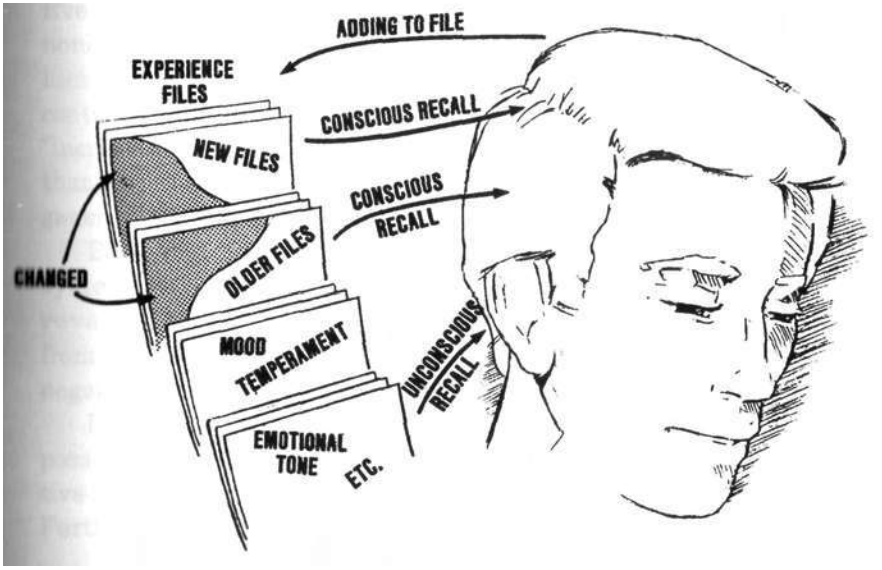

Figure 86. If the files themselves are changed, the personality itself is changed. It is possible to alter who or what a living person is.

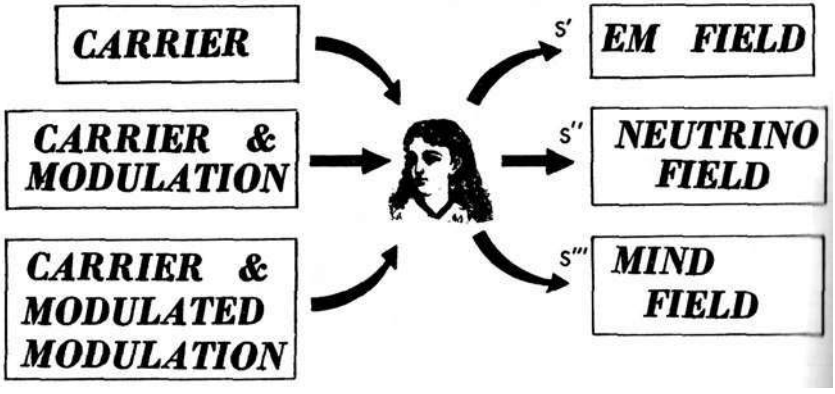

Figure 87. The mind and personality can be affected — and changed or controlled from a distance. The Soviets have developed at least a substantial part of this technology.

Table 44. LISITSYN'S REPORT

- **THEORY DEVELOPED & FITTED**
- **HYSTERESIS MEMORY LOOP**
- **CONTROLLED INDUCTION**
  - **IMAGES**
  - **SENSATIONS**
  - **PREDETERMINED EMERGENCE**
- **23 EEG BANDS**
  - **UP TO 8.1×10^{20} HZ**
- **11 INDEPENDENT CHANNELS**
- **BRAIN CODE BROKEN**
- **44 DIGITS OR LESS**

Thus by tailoring the specific scalar waveform and wave substructure with which we irradiate a mass, and utilizing phase conjugate (time reversed) waves, we can directly engineer the nucleus itself when sufficient charge structure has been built up in it to form a structured potential that is powerful enough to alter/ **shape** the nuclear processes.

We can, for example, transmute the nucleus into another form. Here an isomer form is the easiest. An isomer for an atomic nucleus (a specific isotope) has the same number of nucleons (protons and neutrons) overall as that isotope does, but a different number of protons. So it's a different element, but very specially related to its isomeric "brother."

All that it takes to change a neutron into a proton or vice versa, **is** to "flip" a single quark (subparticle of the nucleon).

Living systems can do that and transmute elements, to a small degree.

For example, living systems must use phase conjugation, negative time, and negative energy. To do so, they must function nonlinearly. That is the only way they can defeat the otherwise inexorable second law of thermodynamics: that all (linear) processes continue to more and more disorder as time passes. (That's called "increasing the entropy (disorder)." Unless a biosystem could defeat **that** law, its genetic pattern would inevitably be disordered in a few generations, and the species would disappear.

By using phase conjugation and time reversal, the **living system is** able to reverse the law of entropy in its time-**reversed channel.** That is, in that channel things go in reverse: fro***m*** disorder back to order! That's called "negative entropy" or negentropy" for short.*

It follows a priori that, to do this, the living system of necessity possesses phase conjugate energy systems (negative energy, negative lime systems) that are rooted in the atomic nuclei of its body. Further, it must deterministically manipulate these phase conju-

To* show how fully one can integrate physics and metaphysics, we point out that, since the vacuum imprints with every **change, nothing *is* ever lost! Death, where is thy sting?

gate systems.

This allows the precise definition of a living or nonliving system. If the system deliberately utilizes and manipulates phase conjugate energy/time in its atomic nuclei, it is a living system. If it does not deliberately use this, it is an inert or nonliving system.

For example, this sheds a great deal of light on the nature of a virus.

A virus is a single molecule. Ordinarily it clouds the distinction between life and death. Viruses can be crystalized out of solution, formed into "rock-like" crystals, and placed on the shelf, so to speak. There they can remain for many years or centuries, seemingly an inert rock. Then when placed back into their "preferred medium," so to speak, the virus crystals dissolve, separate, and "come back to life" and resume their living function. Yet the virus can be killed, in which case it is just a "hunk of rock," sitting on the shelf. In that case, it won't come back to life when placed back into its preferred medium.

In one case its "deterministic phase conjugate energy system" — its mind, to put it simply — remained in the nuclei of the atoms of the crystaline form. In the other case its "mind" was destroyed or disconnected from the crystalline form.*

A somewhat similar effect can be demonstrated in bacteria.

You can "kill" bacteria, for example, with UV radiation, then hold them in the dark for 24 hours (say, for 12 generations, since a nominal bacterial generation is about 2 hours.) They will remain absolutely "lifeless" and static, with no movement or cell division.

Then if you place them in the sunlight, you will be astounded to see them revive by the hundreds of thousands. In the "special kill" case here, the virtual state substructure of the UV photons just totally "jammed" the biopotential substructure functioning of the

*In the living case, the atomic nuclei remained patterned by the structured biopotential In the case of true death, the structured biopotential is lost and the nuclei revert to their "inert" form.

"minds" of the bacteria on one key channel. It didn't physically damage their bodies or "physical tuners." Then when placed in the sunlight, the broad frequency spectrum of the virtual substructure of the photons "dithered" and stimulated the bacteria's body-tuners, much like a "frequency massage" in all the bands. This set the physical tuners vibrating — and therefore responding once again to the biopotential substructure changes of the mind. Hence the bacteria "revived" and swam about — fat, dumb, and happy.

We have stated that **the mind is a physical thing, albeit a virtual or hyperspatial thing. In virtual/hyperspatial reality, it is a functioning, hyperspatial thing.** Interchanges be-

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Figure 88. The mind and personality are physical things, albeit hyperspatial and virtual.

tween it and an otherwise inert, functional, 4-dimensional ordinary physical system (a "body") comprise life functions, "thought," cellular control, etc. Those interchanges in a living system occur in the biopotentials residing in the atomic nuclei of the physical body, in the higher levels of biopotential in the body structures such as cells, membranes, and organs, and in the overall biopotential of the entire mass of the body.

We accent that this is not mysticism, but physics.

But now let us return to phase conjugation and the Priore machine.

The Priore Machine and Phase Conjugation

In the 1960's and 1970's, in France Antoine Priore built and tested electromagnetic healing machines of startling effectiveness.

In hundreds and hundreds of rigorous tests with laboratory animals, Priore's machine cured a wide variety of the most difficult kinds of terminal, fatal diseases known today.

Funded by the French government in the amount of several million dollars, **Priore's machines concretely demonstrated a nearly 100% cure of all kinds of terminal cancers and leukemias, in thousands of rigorous laboratory tests with animals. These results were shown to medical scientists as early as 1960.**

Many of the experiments and tests were done by prestigious members of the French Academy of Sciences. Robert Courrier, head of the Biology Section and Secretaire Perpetuel, personally introduced Priore's astounding results to the French Academy.

The operation of the Priore machine was seemingly incomprehensible. Many orthodox French scientists — some of them world renowned — were outraged at the success of such a machine, shrilling that science had nothing to do with "black boxes."

They loudly called upon the inventor to explain the mechanism utilized by his machine, but the inventor either wouldn't or couldn't, explain the curative mechanism.

Priore certainly knew how to build the machine and make it

work. It is debatable to this day whether anyone — Priore included — actually understood its principle of operation.

Neither the French Academy nor Antoine Priore knew anything of phase conjugation at the time.

In fact, the entire Western World knew nothing of phase conjugation in the 1960's when Priore was getting his finest results. At that time, only the Soviets knew of time-reversed waves.

Certainly Priore's machine was impressive.

Into a tube containing a plasma of mercury and neon gas, a pulsed 9.4 gigahertz wave modulated upon a carrier frequency of 17 megahertz was introduced. These waves were produced by radio emitters and magnetrons in the presence of a 1,000 gauss magnetic field. Experimental animals were exposed to this magnetic field during irradiation, and the mixture of waves (some 17 or so) coming from the plasma tube and modulating and riding the magnetic field passed through the animals' bodies.

Amongst other things, a plasma can convert a transverse wave to a longitudinal wave. Also, phase conjugate (time-reversed) waves

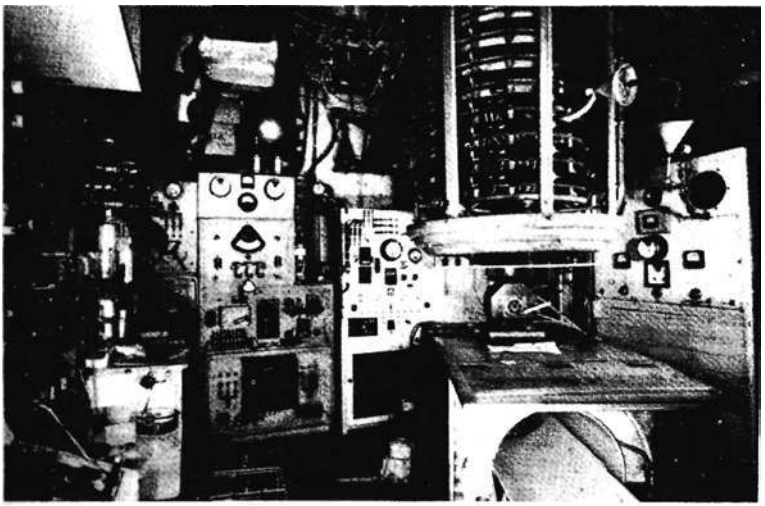

Figure 89. One of Priore's intermediate devices. This device cured terminal cancers and leukemias in thousands of laboratory animals. (Courtesy Bob Whitney)

can be produced by plasmas. Priore's apparatus produced a scalar EM wave/signal with deliberately constructed, infolded components including phase conjugate waves.

One may roughly view a cancer cell as a normal human cell gone "awry" and out of control of the body's master cellular control system. The cancerous cells, viewed as a sort of separate, parasitic group of cells, form a special kind of organism having its own master cellular control system "level," immersed in the host's biopotential.*

There is thus a specific, constant electromagnetic "delta" that differentiates the parasitic cancerous "organism" **from the normal human cellular organism.**

This "delta" can be considered a sort of constant, complex-structured charge existing in the body's atomic nuclei. It's exactly as if the body biopotential had been charged up by Kaznacheyev's "death photons" for that specific cancer condition.

If this cancerous "delta" (which may be rather like a complex intermodulation mix of waves) — or a frequency shifted "transform" of it to a different frequency band — is phase conjugated, a specific healing delta frequency pattern results.

If phase conjugate replicas of a cancer's cell's specific "delta" frequencies are fed into the body having that cancer, the deviation of the cancer cell's master cellular control system will be "time-reversed."

That will return the cancer cell to control of the animal's proper master cellular control system. The cancerous cell will be immediately destroyed, or reverted back to a normal cell of the animal.

A very similar process exists for just about every disease bacterium and infectious agent that attacks the body.

Phase Conjugates of "Death Photons" are "Healing Photons"

The Kaznacheyev experiments in the Soviet Union proved that, any cellular death and disease pattern can be induced by a specific electromagnetic pattern carried on an electromagnetic signal, if the

*One strongly points out the relevance of Dr. Robert Becker's epochal experiments proving that cells can be dedifferentiated and redifferentiated electrically. Those experiments are strong indicators that the cancer cell should be capable of being reverted to its more primitive state — that of the normal cell — by electromagnetic means.

target cells are bombarded with the pattern-carrying carrier signals for a length of time.What was not published of Kaznacheyev's work was the correspondent work showing electromagnetic reversal of cellular death and disease conditions by irradiating the diseased cell cultures by phase conjugate replicas of the pattern-carrying induction signal.

In simplified terms, if an action in forward time induces a condition, then the time-reversal of that action will reverse the condition.

The concept is almost laughably simple. **The time-reversal of an electromagnetic disease process is a specific healing process for that disease.**

In his device, Priore internally structured the carrier photons themselves — making them **vacuum engines.** He phase conjugated his vacuum engines, and then passed these time-reversed vacuum engines down and through a strong magnetic field which thoroughly penetrated all cells of the biological organism being treated.

The scalar components (structured photons) representing the time-reversal of the disease were absorbed and reradiated in all the cells, "charging up" the nuclei of the atoms in the organism to some potential level of the exact "healing and reversing pattern."

In the process, the cancer/leukemia pattern/charge also destroyed the cancer cells, or converted them back to normal cells as appropriate.

As a highly simplified analogy, the complex signal — viewed as a scalar Fourier expansion — represented a "stress" against any abnormal cellular control system encountered and returned it to the normal cell's master cellular control system of the body.

Encountering the normal control system in normal cells, it produced zero stress.

Encountering the abnormal control system in tumerous cells, it produced great stress on it, reverting it to the normal control system of the body's normal cells.

Thus to a normal cell the Priore signal pattern acted somewhat as a comb passing through one's hair.

No interference occurred with the normal cell (one whose scalar control pattern is phase-locked to the body's master cellular control system and in phase with it).

The Priore signal stimulated and "stroked" the normal cell, but did not hurt it at all.

On the other hand, the scalar control pattern in and of an abnormal (cancerous) cell is out of phase with the body's master cellular control system, and is not phase-locked to it.

Hence the Priore signal caused direct interference with the abnormal cell's independent scalar control system. The interference pattern constituted the reconstruction of normal energy directly in the cancerous cell, and also jammed its abnormal scalar life signal.

This destroyed the cancerous cell by two mechanisms: (1) physical energy was kindled directly in the abnormal cell, causing direct mechanical damage, and (2) the cancerous cell, being an "independent living critter," had its scalar life channel (connecting its primitive "mind" to its "body") jammed and stopped.

If the cancerous cell was reverted to a normal cell by the Priore stress before being destroyed, it became just a normal cell and the Priore stress had no further effect upon it.

The Effect is Universally Applicable

Any disease with cellular, biochemical, or genetic basis can be cured in like fashion.

Priore's method, for example, was clearly shown to be able to completely reverse clogging of the arteries with fatty deposits, and to be able to lower the cholesterol level to normal, even in the presence of an abnormally high cholesterol diet.

His method also showed complete mastery and cure of sleeping sickness and trypanosome-induced illnesses.

Often Priore found that every cell of the body — even the hair — must be irradiated and treated ("charged up") with the signal, for the disease pattern was in every cell. The master cellular control system is holographic — the pattern (substructured potential with its dynamic, oscillating components) is in each component (each atomic nucleus, hence in each cell.)

Every structural level of the body larger than the cell also has its

own correlated pattern, or modulation, on the overall.

A biological organism can regenerate lost limbs, for example, if it can utilize its natural recovery process in a Priore manner.

Even though Priore's work was presented to the French Academy of Sciences by Robert Courrier, the prestigious head of the Biology Section, the Academy could not understand the device and its functioning.

That was because the Academicians knew nothing of scalar electromagnetics, and phase conjugation, and the Priore machine was a scalar electromagnetic device using phase conjugation.

In the Mid-70's It Ended

In 1974, a change of local government lost Priore his government supporters. His support and funding were lost.

Ironically, Priore was just completing a 4-stories-tall apparatus capable of radiating and treating entire human bodies. It would have been capable of curing cancer and leukemia in humans rather than just in laboratory rats. (His previous machines were much

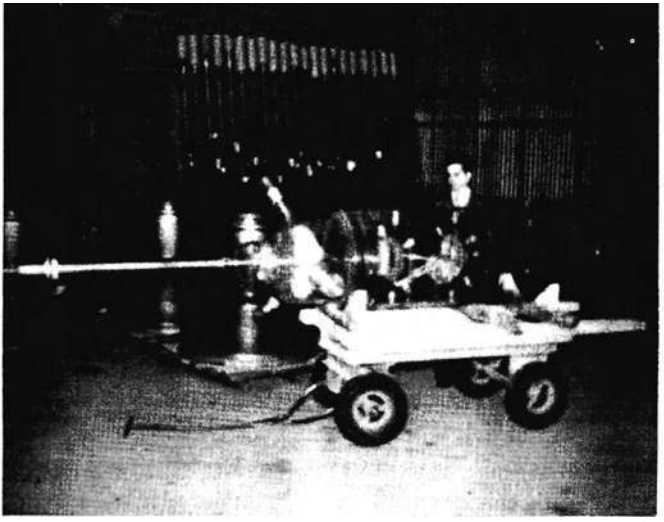

Figure 90. The large, special, phase conjugating plasma tube for Priore's giant device. The final machine would have treated humans "whole-body." (Courtesy Bob Whitney)

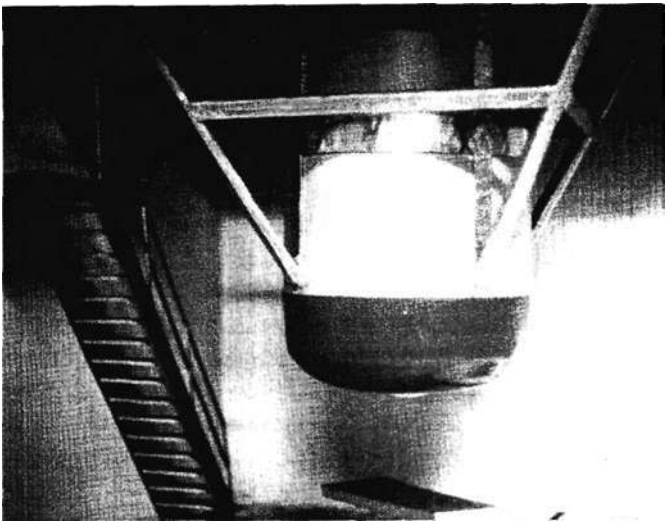

Courtesy Bob Whitney

Figure 91. Capping assembly for the top of Priore's giant plasma tube device. The last device would have treated human patients "whole-body." The cap assembly was on the third floor of the device.

smaller, and only a small animal could be irradiated whole-body.)

In that machine Priore used a "lamp," a special section, in which 17 specific frequencies were mixed and modulated upon the 9.4 gigahertz carrier.

The machine was large enough to irradiate humans over their whole body. **It should have been capable of curing cancer and leukemia in** two **five-minute irradiations, one week apart.**

While Priore was still alive, with my associates I spent nearly two years of my life in an effort to bring the Priore device to market and into the mainstream of medical research and development.

Robert Whitney, Frank Golden, and Tony Gideon played the major role, going to France and negotiating directly with the Priore group and the French government.

Verbal agreements with both the Priore group and with the French government were obtained. The machines were to be built, assembled, and tested in Bordeaux. Then they were to be dismantled and shipped to the purchasers — large medical research and development laboratories where they would be reassembled on site.

A group of wealthy backers was going to provide the necessary millions to fund the effort. Final contracts were being drawn.

Mysteriously, all funding for the project was suddenly withdrawn. Our backers were "leaned on" very hard and strongly threatened. Nothing we could do could revive the project.

Priore never again recovered his funding, and later died. The machine fell into disarray and was disassembled.

However, the proof that the requisite time-reversed signal can be produced, and will ride down a magnetic field, to penetrate every cell and every atomic nucleus in the body, is already in the present hard-core physics literature, if one knows where to look and how to properly interpret the work.

The fact that such signals can reverse nearly every major cellular illness condition of the body also has been proven by Priore and the scientists who worked with him, and it is in the French scientific literature.

The Priore-type cure for AIDS and other diseases only requires the necessary funding and personnel to be redeveloped and re-established.

Work of Australians Reed and Barsamian, and the American G. Wilbanks

At the University of Sydney, Department of Obstetrics and Gynaecology, some magnificent work of great importance to our thesis has been accomplished. Indeed, this Australian research may well be some of the most important work going on in the Western world today.

Dr. B. L. Reid, Dr. S. Barsamian, and their colleagues have produced experimental studies that positively verify pattern and form transmission at a distance, even through Faraday shielding. They have directly shown the reaction to, and results of, an unexplored information field on both living cells and inert crystalline matter.

In addition, they have replicated — and extended — the published results of Kaznacheyev on the cytopathogenic effect. In fact, they have obtained the effect at over 100 meters.

This shows, of course, that the effect is not just mesoscopic, but also macroscopic. Whether we like it or not, structural patterns of cellular disease can positively be transmitted electromagnetically, and kindled in target cell structures at a distance.

Dr. Reid has been interested in the origins of cancer since at least 1958. After much work in the standard models, by the late 1970's he was convinced that the present approach of medical science is wrong. He reasoned that we should pay stricter attention to the nature of growth before examining new growth, i.e., cancer. Growth, of course, is creation — and so the problem became, what is creation?

As a metaphor for biological growth to work with, he and his colleagues chose the growth of crystals. With keen foresight and intuition, they directed their inquiry so as to expose the complicity of some force — if any — external to solute and solvent.

Their work began to show that such a force existed, and it was a type that was unaffected by interposition of a Faraday cage. In other words, *it was not a conventional electrical force.**

Dr. Reid and his colleagues then included biological subjects in the form of living cells. They were familiar with Kaznacheyev's work in Alma Ata, Kazakstan on the subject of long range transmission of pathological (viral) effects on cells. In addition, they were familiar with the seminal studies of Gurwitsch on transmissions by onion roots cells, in the 1920's.

Most of their basic studies on the nature of the new force, however, were made with common salt, drying from aqueous solution, Some of their major results were as follows:

1. The familiar cubic symmetry is altered toward a higher energy form of dendrite crystals when biopolymers such as protein are included in the solvent.
2. A mass of lead 12-20 kg in the crystal space (up to 1 meter distant) causes an interference pattern in the salt crystal display.
3. A prospective dendrite pattern is not realized when a prospective cubic-pattern of the salt is dried in the local space (up to

"For one related possible scalar EM (electrogravitation) interaction, see Ya. B. Zel'dovich, "Electromagnetic current and charge due to interaction between a gravitational and a free electromagnetic field," **J. Exper. and Elec. Phy.** (Soviet translation), 16(7), Oct. 5, 1972, p. 302-303,

1 meter). The latter by its presence in space is able to prevent the dendrite expression and enhance the cubic symmetry expression. **A photograph of crystals of cubic symmetry when moved by a vibrating holder (2 cps) has the same effect on the real crystals drying from the solvent.**

4. Dendrite forms of salt crystal result when certain chemical reactions involving proton or ion movement occur up to 30 meters away, separated by brick walls, glass, etc. These reactions were detailed by Dr. Reid and his colleagues. If the mother solution is examined by ac capacitance on a sensitive bridge, variations in capacitance of over 300% accompany the receipt of the signal.

5. If such a transmission from 30 meters distance is regarded as a carrier wave which is modulated by a foreign — and thus detectable — chemical, **the chemical can be detected in the distant atmosphere some 3 months later in the form of a discrete or adiabatic 'cloud' which contaminates sodium chloride drying at the same time.** In this way, copper sulfate dissolved at a site A in June 1985 could be repeatably detected at site B, 30 meters distant and separated by walls, screens etc., by a drying solution of sodium chloride solution in September 1985. Serial dryings of the sodium chloride solution on glass slides showed that each day, the cloud hovered over a space of 1-2 cm at the end of a venturi tube for several hours before 3 p.m., and then moved off at 1 meter per hour in a NW direction. The copper content of the cloud was discernible by crystal structure and chemical means from the adjacent sodium chloride.

6. All of the above crystal forms required ambient oxygen for their manifestation. Atmospheres of nitrogen and argon prevented their display. At the time, the researchers suspected that the effects may have been carried by orbital electrons of oxygen showing unpaired spin which had interchanged with electrons of the copper solution. They then

developed an information-carrying device which could 'infect' the electron cloud of a target molecule sufficient for the chemical display of properties of the infecting electron's parent atom. This concept seemed to explain the experiment of the following paragraph.

7. Two beakers of sodium chloride solution were connected in series with a small voltage source (say a 1.5V dry cell) to provide a transfer of electrons through each beaker. The second beaker in series was sampled for subsequent drying and display of the crystal form. A crystal form of cubic symmetry resulted. When the solvent of the first beaker was altered by the addition of a protein solution (such as albumen or globulin), the crystal pattern of the second beaker was altered from cubic to dendrite pattern as though protein were present in the second solution.

8. During attempts to stabilize salt crystals on glass by means of thin plastic films drying from appropriate solvents (in order to stain the salt with aqueous solutions of dyestuff), it was discovered by chance that the crystalizing process is accompanied by structural patterns on the plastic film so exposed. These patterns were of two major types: (a) vortices, or spirals in the film plane, of 0.1 to 1.0 mm diameter, and (b) smaller curled structures into which the spiral could be seen to merge or grade. From a concurrent mathematical study of vorticeal interaction as designed by Barsamian, the similarity of the curl structures in plastic films (the researchers usually used 0.25% polystyrene in benzol) to computer simulations of vorticeal vectors was shown to be remarkable.

9. The researchers then dispensed with the underlying crystals and exposed the drying polymer film to a variety of spaces where the field, thought to be responsible for many of these tele-effects, was operative. With this technical advance, the team has made rapid progress over the last year or so. They have come to have a more comprehensive grasp of the ether

field than was possible by less direct methods involving formation of crystals.

10. On the biological side, they repeated the Russian studies done at Alma Ata with transmission of the cytopathogenic effect of viruses on animal cells. They used the cytopathogenic effect of colchicine and its relative vinblastine on cells with the following differences from the published Russian work: (a) The effect can be transmitted at least 100 meters between campus buildings, (b) it is not necessary to use a magnetic field for the propagation, (c) it is not necessary to use quartz vessels; glass is quite effective. These experiments came to the attention of a colleague, Dr. G. Wilbanks, Head, Department of Obstetrics and Gynaecology, Medical School, University of Chicago in 1983. Dr. Wilbanks was able to repeat them with similar results. However, in a more faithful copy of the Russian experiments, he used quartz vessels with cells placed in a magnetic field, with the vessels separated by no more than 1 mm. Both the Australian researchers and Dr. Wilbanks shared another thing in common: their uniform inability to interest the editors of several scientific journals such as **Science, Nature, Naturewissenchaften,** and others in publishing papers describing these fundamental experiments and results.

11. Experience with interference of a lead mass in the crystal work prompted the use of several metals in the ambient field of growing cells. Only lead (and to a lesser extent tin) showed the following properties: (a) Cell growth with 0.5-5 Kg lead in the ambient field is depressed sometimes to one third normal, (b) The cells die (dye exclusion test) but then can be revived by placing a small bar magnet in the local space with its poles in an E-W orientation. At least in Sydney, a N-S orientation of the bar magnet does not revive the stricken cells.

12. The effects of energy flowing through living matter have been documented by Kirlian's method. It was therefore of interest

to the Australian researchers to expose living systems to drying films of polystyrene. They found that the staining properties of the ambient-derived image on plastic films parallel those of the real organism.

13. By appropriate use of an imposed potential on living cells, it proved possible to match the field strength and show the actual imposition of the ambient (scalar) field on the biopolymer content of the material during the permeation process. The traces obtained are not unlike noise and would be so regarded by the casual investigator. The design of this apparatus and associated experiments was the work of Dr. Barsamian.

Concepts of Dr. Reid and Associates

Dr. Reid has kindly shared with me some of the concepts he and his colleagues have formulated. These concepts, it is stressed, are consonant with direct physical results they have obtained in the laboratory.

Note that any errors in this explanation are strictly the fault of this author, and not of Dr. Reid and his colleagues.

1. Matter is bathed in an energy sea familiar to quantum theorists. The Australian team prefers to call this sea of energy **ether,** as a relatively bland term, perhaps in a way to rescue it from the oblivion where Einstein banished it. The key to the silence of this sea is its "fractional-charge" charged particle status and low energy values. The former conceals it from physics, while the latter conceals it from chemistry and thermodynamics.

2. The differing energy levels of this sea, combined with its enduring motion, are theoretically and practically best expressed as a **vortex.** Dr. Reid and associates have detailed this theory to explain the creativity of biology. The incipient creativity of the vortex is given material expression by its association (as part of the EM field) with an electron which it

now endows with equivalent novel properties. There is no intuitive reason why the energetic rearrangements of the electron cloud cannot proceed to the nucleus, there to set up a quark or proton rearrangement — or, as the quantum theorist would say, a virtual particle exchange — leading to transmutation. Kervran's work on biological transmutations is relevant; the literature of such effects goes back to 1798 at least! The team suspects that some such mechanism may underlie their experimental result of the transition of sodium to copper.

3. **A further prime property of vorticeal interaction is its proclivity for amplification,** wherein the atomic-size vortex can be built up to the meteorological hurricane by such adherence or affinity. The team has noted the affinity of ambient field vortices to those produced by an electric current in a metallic conductor, with particular reference to the ill-defined boundary between the two. This parasitism was the reason behind the team's use of "carrier waves" from chemical reactions as transporters of fields whose identity of origin were sufficiently specific to trace the field subsequently. It is at least conceivable that the whole process could be amplified and used to parasitize (modulate) a radar beam as carrier. The affinity property of fields may be exhibited by the experience of mariners with what they loosely term "magnetic phenomena" thought to be derived from luminescent plankton. In the South China and Arabian Gulf seas, giant "wheels" of light, 5-15 km in diameter and containing spiraling spokes, revolve about the ship at night, reversing their direction of rotation as they pass the midpoint of the vessel. The key observation in the context of the field affinity concept is that the luminescence is manifoldly enhanced when the ship's radar is switched on. There could thus exist a chain, scalar-EM/plankton-optical, the first leg (scalar EM) of which can be amplified by radar EM.

4. The property of affinity means that **a scalar field's** transform **or copy, of the energy disposition imposed on it by the experience of matter last permeated, may persist as**

a memory **in space,** as many of the Australian observations attest. The team found that recall was not all that difficult technically. **The energy transform for copper** sulfate **existing as a non-dissipated cloud with marked adiabatic properties could be recalled five months after its formation. There is no reason why informationally more elaborate spatial configurations of energy, including human thoughts, will not behave in precisely the same way.** The cell nucleus could conceivably be the candidate for the first site for storage of such energy. The nucleus has a highly ordered structure and an associated high permittivity, and this would make it a real target. In the human subject, there is experimental evidence that the mongoloid polymer constitution will have a higher activity for storage of the ambient field than will the Caucasian.

Other Important Ideas

Dr. Reid also shared other important insights:

Lavoisier in 1748 advanced the concept that matter itself (chemicals) is inert. The activity of all chemicals, according to Lavoisier, resided in their associated ether — and God sent the ether!

Taken to its limit, this suggests that the source of the energy which we call *thought* is a property of the scalar field. Matter (say, the nervous system) interacting with these fields, would be incapable of discerning the source of the field as presented, whether of self or external origin.

In his book **Hidden Variables in Quantum Theory,** Dr. David Bohm felt that in 'elevating' (his word) matter (as particles) from the sea, it might be possible to consider the idea as containing even more elaborate energy transforms such as biological shapes, these transforms themselves undergoing metamorphosis. [Comment by this author: Rife's microscope, using evanescent waves, actually allowed one to directly see and photograph such forms, proving the thesis.]

The ability of the Australian researchers to rescue these transforms on films together with evidence that they could be seeing the results of the exclusively space interaction of virtual forms (say

microbe and antibiotic), is also a direct technical step toward validating Bohm's important idea.

Wider Implications of Structured Field Information

As T.D. Lee points out in his important book, **Particle Physics and Introduction to Field Theory,** particle physicists have not attempted to use the structure of the vacuum nor the structure of potentials.

Dr. Barsamian has shared other wider implications of the structured ether.

Over the ages a phenomenon which, as discussed, can have no representation in real (that is, electromagnetic or thermodynamic) terms can hardly have been thought of as possessing specific structure or function. Instead, it signaled its undoubted presence to generations of philosophers and physicists before Einstein, solely through statistical effects.

The writings of Helmholtz, James Clerk Maxwell, and Neils Bohr are examples. The more recent Dirac and Fermi statistics are **a** continuation of the process.

If an alternative definition of science is the continuing refinement of that which we partially knew or took for granted, then the refinement of these statistical approaches ~ with their obligatory uncertainty as defined by Heisenberg — is a worthy goal.

In this sense, a more articulate description of the anatomy of the field is a logical progression from the beginnings of the ether concept in Classical Greece through to the statistics of the nineteenth to the early twentieth century.

A hundred years ago, this orderly progression even reached the concept of a vorticeal atom at the hands of J. J. Thompson. However, it was interrupted very effectively by Einstein's publication of the special theory of relativity.

Einstein was fortunate in that he had chosen for his mathematics a pivotal feature of the ether field, its elasticity. The mathematics of elasticity had been evolving — through the developments of Hooke, Young, invariance, and the calculus — to handle its historically increasing complexity (by tensors). This mathematics of elasticity was then available to Einstein. The wisdom of this choice

was vindicated by the remarkable special relativity predictions which were born out in subsequent observation and experiment.

There was seemingly no need to suspect, let alone probe, any special properties of the medium underlying the mathematics.*

The success of these predictions effectively blocked any chance of a return to the ether field concept. Indeed, it was seen as an arrogance to despoil the "elegance" of the mathematics. Nor was the success of quantum mechanics — the other leg of the Western World statistical approach to the nature of reality — able to get the physicists to heed Bohm's 1958 ideas on the hidden variables in its fabric or Dirac's 1952 ideas on a lesser uncertainty of the particle-field relationship than Heisenberg had formulated.

Recently Dr. Barsamian has originated the concept of an **alienation of the electron from its field.** The full expression of this could see the field so alienated that it is well-nigh autonomous, and some kind of fundamental entity in its own right.

In this sense, the freed autonomous field — at least conceptually —could proceed with its creativity by hybridization with other fields and so return the product of these asides to the particle. In atoms of the next fragment of matter with which the particle then associates, this product could create novel properties derived from the interchange.

The multiple properties of such a field allow it to be resolved in EM (electrostatics and electrodynamics), in atomic structure (electrons and nucleons), and in pressure (gravity) terms. This universality makes a new concept possible, long beloved of the GUT (Grand Unified Theory) theorists: that there is only one energy.

It is also quite possible that this ubiquity need not be confined to physics. It may penetrate the biological imponderables of growth, new growth and consciousness.

In view of the work of Dr. Reid and his associates, and other work — such as that of Hines and Chimonas showing atmospheric gravity waves launched by auroral currents — the prospect of amplification and transmission of transforms and patterns over long distances,

*As, for example, whether or not the concept of an abstract vector space in vector mathematics must be modified to correspond to what we know about the vacuum medium. If the vectors are to correspond to the movements of physical things in the *vacuum medium,* then the vector medium must correspond to the vacuum.

through affinity with long distance carriers, is indicated.

Dr. Reid stated that it would be surprising if other laboratories outside Russia had not progressed as far, if not further, than he and his associates had. Obviously the lack of similar publication indicates the nearly impenetrable editorial curtain confronting Western researchers in this and related areas.

Dr. Barsamian's Important Theoretical Insights

Dr. Barsamian has formulated a theory in relation to the development of cancer that is of great importance.

In his theory, he is developing the approach of classical mechanics to electromagnetic interactions between charged particles and between dipoles. The field associated with the primary moving particle is not neglected in his theory, and this part of it differs from Dirac's "new electromagnetic theory."

The field associated with the primary moving particle, in Dr. Barsamian's approach, is viewed as an important part of the particle's interactions. This field is stressed in the sense that diverse phenomena — from Maxwell's EM field radiating from the remotest regions of the universe to the controlled charge flow in the matter medium — are viewed as manifestations of EM forces.

This of course is unlike the traditional relativity view of EM force action on moving charges.

In Dr. Barsamian's view, the potential vectors (derived by a reatment from fluid mechanics theory) form an EM field and are positioned on a vortex curve. All parameters of such a field can be treated mathematically, and Dr. Barsamian has one or more papers presently in publication.

The duality of such potential vectors (gradients) is to conduct the motion of particles (which are always either charged or dipolar) appearing in nonmatter, which is taken as an incompressible continuum — the "void." Because the final results of these forces are always movement of matter, Dr. Barsamian prefers not to classify them by their origin.

Such a field may persist with great permanence. There are some limitations in summation (triplet conditions) and selectivity (periodicity) of the vortices themselves. Part of these limitations takes the

form of particle characteristics. Presently he is rather sure that the formation of patterns of organic, inorganic and liquid crystals (typical to living biomatter) are partially responsive to the effect of the described field.

Dr. Barsamian is attempting to synthesize his own experimental findings on the dielectric behavior of biosystems as they enter the cancer process with the data that Dr. Reid is producing with respect to action at a distance.

With respect to living systems, he has slowly been approaching the conclusion that existing physical laws are just not applicable concerning (1) entropy, or (2) energy breakdown, or (3) random collisions of particles in quantum terms, or (4) electron-ion exchanges in bioelectrochemistry terms.

Under such circumstances, it is difficult to find a referee who sincerely understands the related experiments and their underlying theory. This presents a nearly impenetrable barrier to publication in leading scientific journals.

This is tragic, because these considerations and experimental results at least provide an entry into more fundamental experiments with present lethal diseases such as cancer and AIDS which annually take large numbers of human lives.

The present state of the art is telling everyone loud and clear that something fundamental is wrong with present theory, and that we should come to terms with more novel views.

Comment by the present author: In his prophetic insights, Dr. Barsamian has placed his finger squarely on the fundamental struggle of living systems against the "positive energy/time" laws of present physics. In its struggle, the living system must use negative energy/time, to correct from disorder to order and provide the extra free energy to do so. Otherwise, the steady progress toward increasing disorder in all its actions, would very shortly reduce the living system to such a disordered state that it could no longer reproduce the clear genetic pattern of its own kind. We have already pointed out the hitherto unexpected role that phase conjugation plays in allowing the living system to violate and break the iron dictates **of** conservation, nontransmutation, entropy, and raw statistics.

To live and survive, a living system must have access to other functional levels and other mechanisms beyond those contained in

our present physics, electromagnetics, and biochemistry.

The incredibly productive and important work of Drs. Reid, Barsamian, and associates is of the utmost importance. Their work clearly moves everything in biochemistry and the knowledge of cellular functioning a major step forward.

It is a betrayal of the scientific method that such vital work goes so largely unreported in the leading journals. Indeed, the work of these Australian scientists should be galvanized and well-staffed and funded. They can literally usher in a new science, given the chance to further exploit and develop their results.

Royal Raymond Rife

In the 1930's and 1940's, Royal Raymond Rife revolutionized everything that has been done before or since in high resolution optical microscopy.

He also revolutionized everything before or since in cellular biology. He carried cellular structure far beyond anything ever dreamed of at the time or presently. He revealed the direct connection between organized living energy forms and organized biological systems. He revealed that life itself is organized and dynamic, to a far finer level than anything in the textbooks today. **He revealed that our present theory of disease is fundamentally very, very wrong.**

He produced direct, economical, electromagnetic cures of cancer, leukemia, and other such debilitating diseases. His work presages a future mankind could have had, where most debilitating diseases were quickly and economically corrected, and where no poisonous drugs, violent nuclear irradiation, and harsh chemotherapeutic "burning" of the patient would be necessary.

For such epochal work, he was ostracized, essentially imprisoned in a medical treatment facility, broken, condemned, and rejected by his peers. His findings, though printed in reputable publications and journals, were discredited and ridiculed.

He literally was reduced to a non-person by the power of the medical cartel.

Finally escaping from his enforced confinement, he lived out his remaining years and died quietly and unknown.

Rife's Universal Microscope

With his universal microscope, Rife achieved optical resolution of up to 31,000 diameters and magnification up to 60,000 diameters. His microscope could examine living viruses, living bacteria, and other as-yet-undiscovered living organisms and living energy forms that no other microscope before or since could see.

Even today, only the electron microscope furnishes such resolution, and it zaps-to-death the objects that are being examined. Further, it will not at all detect or see the "living energy forms" revealed by Rife's microscope.

To appreciate Rife's accomplishment, let's briefly summarize some of the performance factors of an optical microscope.*

Several factors are important in the functioning of a microscope: Resolution, magnification, and contrast lead the list.

By **resolution** we refer to the ability of the instrument to distinguish a small object. In other words, something like looking at a medical doctor's eye chart, and specifying the smallest print one can clearly see. Resolution is often referred to as resolving power.

By "magnification" or **magnifying power** we mean the ability of the instrument to "blow up" or enlarge the image produced. Roughly, it's the ratio of the apparent size of the object seen through the microscope to the apparent size of the same object seen without the instrument.

Magnifying power is exactly like enlarging a photograph. It won't improve the resolution or make the photograph any clearer, but may make whatever was captured (resolved) easier for the human operator to see. If you just keep enlarging the photograph, it will get more and more grainy, until no further details can be seen with higher magnification.

Contrast refers to the distinctness by which the various parts of the object can be distinguished from one another. To enhance contrast of objects under the microscope, staining of the objects is often used. Very often the act of staining will itself kill the living organisms — such as bacteria — that are being examined.

*The electron microscope reveals only the "dead carnage" of the battlefield after everything is destroyed. With it, one is observing physical residuals, not the living players. For some encouraging modern work, however, see Michael Hercher, "Virometer — an instrument for the measurement of the size of viruses using an optical microscope," **SPIE Seminar Proc**., 1977, p. 17-22.

Figure 92. Royal Raymond Rife in his laboratory. Courtesy Christopher Bird

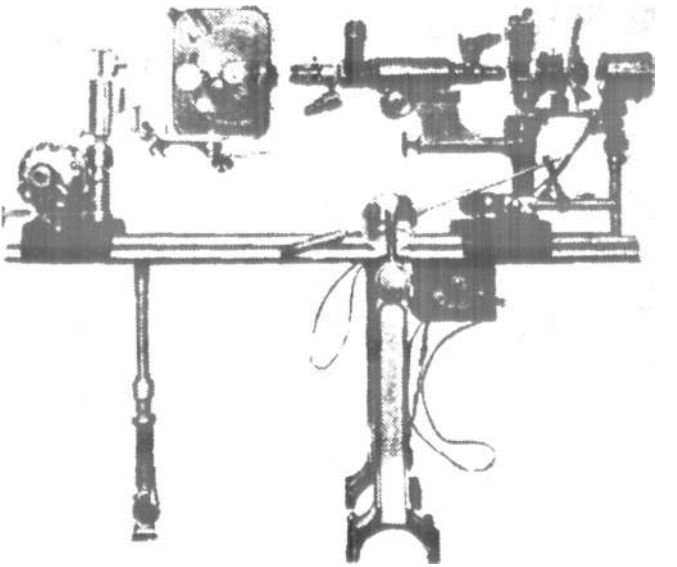

Figure 93. Rife's first virus **microscope.** Courtesy Christopher Bird

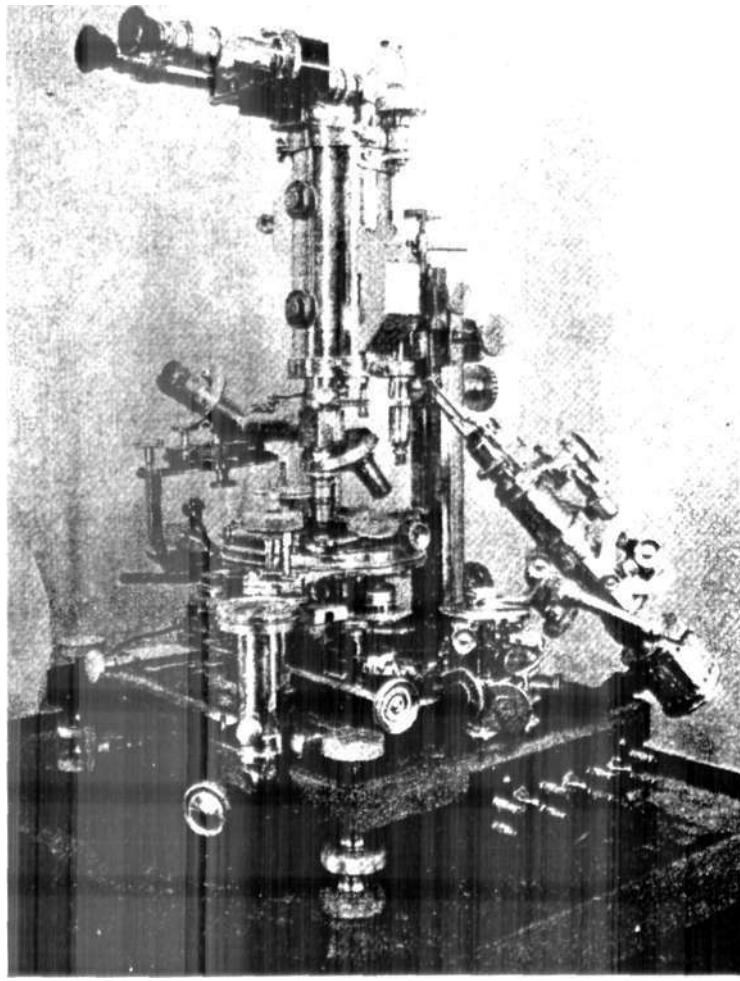

Figure 94. Side view of Royal R. Rife's prismatic universal microscope. Largest and most powerful of five Rife microscopes With it, living filterable viruses could be observed. Courtesy Christopher Bird.

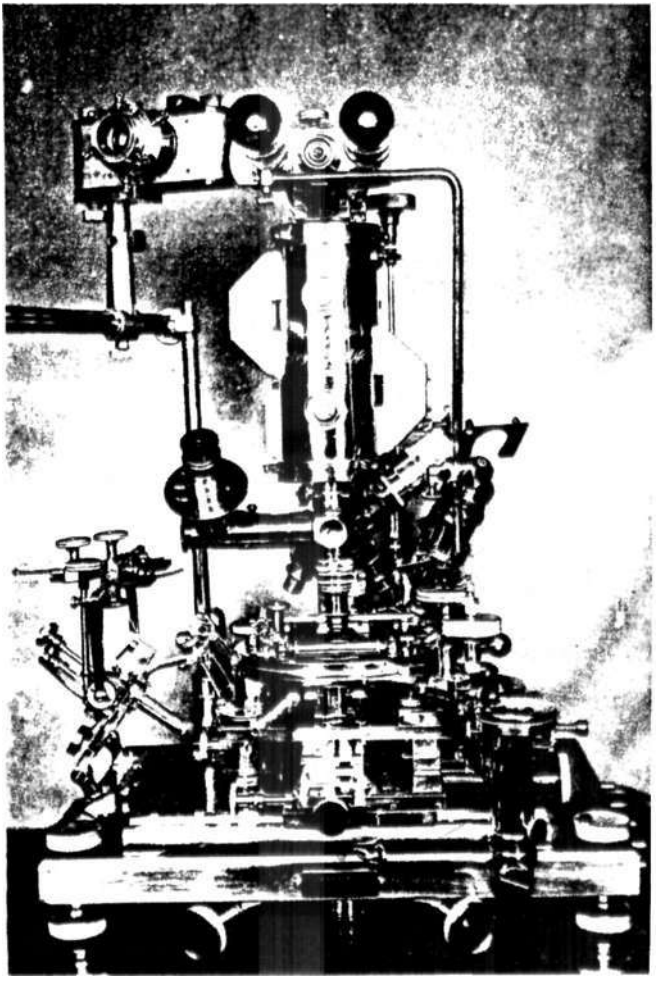

Figure 95. Front view of Royal R. Rife's prismatic universal microscope. Built in 1933 in Rife's San Diego, California laboratory. Courtesy Chris Bird.

We may state the resolution of an optical microscope in terms of the diameter of the smallest object resolved: for example, so many nanometers. Or we may just simply and loosely speak of so many thousands of diameters.

The resolution of an optical microscope depends upon the illumination conditions, its optical system, and the fact that the object viewed diffracts and spreads the light. A wide variety of mechanisms for illuminating, resolving, contrasting, etc. are used in optical microscopes.

According to standard Rayleigh theory, normal optical microscopes are limited in resolution to about half a wavelength. That corresponds to about 250 nanometers for visible light illumination. One can do a little better than that by using ultraviolet light and quartz optics. The UV has a higher frequency than visible light and hence a shorter wavelength. However, beyond 240 nanometers the resolution of an optical microscope quickly disappears.

A few researchers — notably in the 30's and 40's — remarked about other factors, such as "quality of the lenses," affecting resolution. Some of them reported results to about a tenth of a wavelength. Loosely, that translated to somewhere in the order of 5,000 to 6,000 diameters. The dependable upper limit seemed to be — and still is — about 3,000 diameters, however.

Normal optical microscopes simply are almost useless for trying to look at viruses. They will not resolve any but the very largest viruses, and will not resolve the internal features of even those few giants.

Much of today's knowledge of virus structures and shapes comes from the use of electron microscopes. They bombard the object viewed with a fierce rain of energetic electrons. These instruments see nothing of the *functioning* of the virus, for they kill it instantly in trying to view it.

With Rife's universal microscope, the dynamic living functions of the virus could be observed without killing it.

With Rife's microscope, a whole range of complex organisms and structures below the size of bacteria was revealed. Many of these organisms are still not known to present science, even though some of them were written about at the time. Filterable forms of bacteria

— forms which readily passed through filters supposed to easily block their passage — were discovered and reported by Rife and his medical colleagues.

In addition, Rife's microscope — which contained block-quartz prisms and lenses and interference stages — revealed halos around living organisms that other microscopes could not see, even though the object was within their resolving power. Further, it revealed the existence of entire organisms and forms which other microscopes could not see — even though, again, the size of the organisms was within their resolving power.

In other words, Rife's microscope not only revealed smaller physical forms than any other microscope could see, but it also revealed sizeable "living energy" forms which no other microscope could see.

Rife Proved That Everything Is Alive

The degree of smallness to which Rife's microscope would resolve, and the extraordinary energy forms it could detect, showed that direct detection of the virtual state organization of the living organism was accomplished by the instrument.

The science of the day was only just groping its way toward any sort of physics that could explain such an astounding instrumental result. Today, however, in the hard-core literature there is demonstrated proof that the optical limit of resolution can be drastically overcome, using evanescent waves.*

Shortly we will briefly give an "ad hoc" explanation of such evanescent waves.

Electromagnetism has been shown by Kaluza-Klein theory to actually exist in the fifth dimension. In other words, EM itself is hyperdimensional. It flows in the fifth dimension, which is "wrapped around" each point in our ordinary space. It is — to the first approximation — the external environment of every normal point in

*E.g., see T. Sato et al, "Application of evanescent waves to microscopic observation," **Bull. Tokyo Inst. Technol.** (Japan), No. 125, 1974. p. 35-41. See also G.A. Massey, "Microscopy and pattern generation with scanned evanescent waves," **Appl. Opt.** (Poland), l3(3), 1983, p. 247-255.

our 3-space.

Let's say that again.

The electromagnetics "medium" itself is totally external to each point in our space. Each of our points is surrounded in higher space by the electromagnetic medium.

We live inside a totally electromagnetic medium. It's not just an "electromagnetic environment" in our own space; instead, it's an electromagnetic environment in hyperspace.

Everything already is just the internal structure of the electromagnetic medium!

That's what the "vacuum" is.
That's what "spacetime" is.
That's what the "virtual state" is.
That's what physical matter is.

And it's all alive. Totally and completely alive. Everything is alive. There is nothing but life. The electromagnetic medium is alive.

Except within a locally-organized biopotential area, it's just "equally alive in all directions." So it appears inert, where by "inert" *we mean not singly preferential.*

Every biopotential change, at any level in a biopotential, extends "decaying-expotential-wise" to infinity, by standard theory. Part of that potential change exists at every point in the entire spatial universe. And there at that point, so do the biopotential changes for every other biosystem in the universe.

Everything's alive. There is nothing but life. Anywhere. Anytime.

An interchange between this "living, surrounding electromagnetic medium" and each particle of mass in our 3-space continually occurs. This exchange involves the so-called virtual particle flux.

If we model higher dimensions, such as are necessary to include the "particle zoo" discovered by modern particle physics, each of these "higher dimensions" corresponds to a "successively deeper-"

internested level of virtual particle flux—of the vacuum, or of this electromagnetic medium that surrounds us.

The living system orders, structures, and dynamically functions and interchanges electromagnetically throughout many higher "dimensions" — throughout many such internested levels of virtual-state/vacuum/spacetime.

Except for the first layer of virtual state (the 5th dimension in Kaluza-Klein theory), gross (classical) electromagnetic theory totally ignores the infolded, ordered deeper structure of eleetromagnetism (of the EM medium).

Using such gross electromagnetics, orthodox science thus can only detect and grasp the gross results of the living organism's functioning. Further, it can only detect and grasp those gross results that actually move 3-space matter — observable particles.

So it only detects the grossest interchanges between "mind" or "life" and matter. Specifically, it only detects the final results of that interchange—the gross movement of material particles themselves.

The first hypernumber — "i," the square root of minus 1 — is used to model another dimension at right angles to our normal three. An electromagnetic wave thus is modeled to have two parts: the first is the part that affects or moves a material particle, and that's called the "real" part or "observable" part. The second part of the EM wave is the component that lies in this "imaginary" (unfortunate standard term!) dimension. That imaginary part does not of itself move charged particles, so it is considered to be "something other than real."

Note that what's really done in this sort of orthodox modeling is to define observation as the movement of observable charged particles.

The human "conscious mind" is a functioning part of the overall human mind that has been specifically fitted to function almost totally with our gross bodily detection of the photon interaction.

We thus consciously detect and "are aware of only the first level of reality: the interface between the first layer of virtual-state/ vacuum/spacetime/ and the 3-space of observable particles of mass.

Since the physicist must be "conscious" of his observation or instrumental detection, the detection process ultimately has to have

a final stage that produces a photoelectric interaction with his body — for that is all the conscious mind detects and processes.

Everything chemical, electrical, etc. — according to quantum mechanics — will involve at its root level only the photoelectric effect.

Rife's Microscope Used Evanescent Waves

However, it is certainly possible to build an instrument which is multi-staged, and one in which higher stages interact primarily with deeper internested levels of vacuum virtual state. That is, an instrument that interacts with higher dimensional phenomena. That is, one that interacts with deeper internested levels of electromagnetics. If these stages interact causally in a vertical manner, then the final interaction with the human body and nervous system can still be "normal electromagnetics" and yet indicate a higher dimensional phenomenon, event, or function.

That is precisely what Rife did: His universal microscope penetrated to a much finer level of reality because its multiple stages used **evanescent waves.**

Here's what we mean by that.

An electromagnetic wave consists of a "real" part and an "imaginary" part, as we have discussed. It's possible, however, to have the real part become zero, and still have the "imaginary" part remain and dynamically vary.

This sort of wave — containing only the "imaginary" part — is said to be one type of **complex wave,** or an **evanescent wave.**

In advanced EM waveguide and optical theory, such evanescent waves can function to guide or determine the real parts of the EM waves. That "real part" is the part that is then going to interact with electrons and move them, and give us a "detection."

In other words, the "real" part of the EM wave will be moved and guided by the "higher dimensional" or evanescent part, or even by separated evenescent parts — pure evanescent waves.

So one can build a device or instrument that utilizes such an effect to reveal what's going on in a whole dimension beyond what we

normally see. Waveguides in certain RF radars already do that.

Such instruments are not limited to the resolution determined by the "real" part of the EM wave (such as the "real part" of light).

Such a microscope would not necessarily be limited in resolution by the wavelength of the light it used to illustrate the observed object.

Indeed, if one uses a higher dimensional Kaluza-Klein model (which particle physics of necessity has to consider), one could build a "repetitive stages" instrument which could view many more higher dimensions. That's exactly the same thing as viewing many more deeper internested levels of virtual state.

That is precisely what Royal R. Rife did: **He developed a microscope using multiple stages, special interferences, etc. He built a multistaged evanescent wave instrument that could see into higher dimensions and deeper levels of virtual state.**

Rife's microscopes were thus startlingly different from normal microscopes. That is why he could see phenomena and organisms, ostensibly within the size capability of normal microscopic resolution, which ordinary microscopes could not see.*

Evanescent waves penetrate the virtual state (hyperdimensions) and interact with what to us is "dimensionless" (what does not spatially intersect our 3-space). Interfering multiple evanescent waves reflected from/having interacted with these (to us) nonphysical forms can again reproduce ordinary electromagnetic "light." Thus the evanescent wave microscope, if properly built, allows one to directly "see" (and photograph) what is to us living forms of energy, nonphysical, and without 3-space matter bodies.**

The same scheme can be used to develop instruments capable of directly revealing the living nonphysical world around us — such as the human biopotentials, their internal structures (including

*However, Rife's microscope was extraordinarily difficult to focus. Rife often spent 24 hours straight at his universal microscope, just in focusing it.

**If one is going to accept the many-dimensional theories necessary to explain particle physics, one must accept the possibility of higher dimensional living things, which we would see as living energy forms or as thought forms. These would appear nonphysical to us - as is time itself— but would be real and interactive nonetheless.

"thought forms"), etc. What the Soviets call **bioplasma** can be directly observed and photographed in this fashion. We have only to develop the necessary instruments; the science required is difficult, but it is already in the literature.

That is what Rife's microscope did. It was a forerunner of the instruments we need to develop in electromagnetic healing, and Rife was a truly great and unappreciated pioneer.

In one swoop medical science could have jumped a century ahead. The ruthless suppression of Rife and his fantastic scientific breakthrough was one of the most dastardly deeds ever perpetuated by the orthodox scientific establishment.

Rife Revealed a Far More Fundamental, Living Biology

With Rife's powerful universal microscope, it was also possible to view the interiors of the so-called "pinpoint" cells situated between normal tissue cells and just barely visible to ordinary microscopes.

Here is the astonishing living world inside those "pinpoint" cells, as revealed under Rife's powerful instrument: When one of the "pinpoint" cells was magnified, still smaller cells were revealed within its structure. When one of these still-smaller cells, in turn, was magnified, it too was seen to be composed of even smaller cells.

With Rife's microscope, this process could be repeated 16 times. An astonishing internested series of organized levels of a living cell was revealed, far more fundamental than anything that exists in present biological theory.

The present author points out most strongly that these levels correspond electrically to, and are in virtual particle flux pattern exchange with, the electromagnetic potentials of their environment. This includes their own biopotentials that are centered in the atomic nuclei of the atoms comprising the physical material of the cells, and that charge up with specific internal patterns.

The biopotential itself is organized into a corresponding virtual-state series of internested levels and functions. **The structured biopotential of the cell is a living, organized, functioning thing, and its internal functioning literally constitutes the "spirit" or "true nonmaterial deep mind" of the organism.**

All the internested levels are in constant electromagnetic exchange "up and down" with each other, particularly with respect to organized virtual particle flux patterns.

In addition, all the cells are in constant electromagnetic exchange "across" with each other, at all levels. This provides a dynamic, structured, living biopotential for the entire bio-organism (the entire body). Within this potential, dynamic interchange on all levels is continually occurring. This is the basis for the master cellular communication system that Dr. Fritz Albert Popp discovered.

Rife's powerful microscope had revealed nonmaterial functioning life forms (structured, dynamic, living biopotentials) connected to material bodies.

He could follow "filterable" forms of bacteria — actual living biopotential forms of the organisms that could not be separated out by filters, but which would easily pass through any filter.* He could observe interactions of these forms, changes of forms, translations and transmissions of forms, etc. — none of which is detectable by present biological theory or medical science.

Rife had advanced biology and biophysics a century in one jump. As always, orthodox scientists — most of whom in their scientific paradigm are self-admitted materialists — were quite unready to tolerate such heresy.

Obviously the materialistic dogma of the science of his day — and of the science of today — reacted most hostilely to such hogwash. Contrary to the prevailing mystique, most scientists are dogmatically attached to materialism and to the dogma of their present paradigm. Faced with a conflict provided by experiment, most will uphold the dogma and reject the experiment — the exact opposite of the scientific method they espouse.

Rife's revolutionary work was no exception. He incurred the unending, total opposition of powerful individuals controlling the direction of biology and medical science for their own personal gains.

Rife was hounded into court on trumped up charges. Though he was acquitted, he emerged a shaken, broken man and an alcoholic.

*More precisely, they would easily flow *around* the 3-dimensional filter, since they were hyperdimensional.

His work was suppressed. His equipment was left to gather dust. He was also forcibly committed to a medical treatment facility.

Finally escaping from his "prison," Rife lived out his remaining years quietly. He died without ever being vindicated for his marvelous, world-shaking discoveries.

But at least he left us a legacy. Persons are still alive who knew Rife and his work, to one degree or another. Some of his microscopes are still in existence, though non-operable due to missing or stolen parts. With proper funding, an enlightened team of scientists and researchers can be assembled to quickly repair Rife's remaining instruments and duplicate his incredible work.

With concentrated effort, Rife's work will yet play a primary role in the development of a direct electromagnetic cure for AIDS. As a byproduct, it will play a role in rapid development of cures for cancer and other debilitating diseases.

Royal R. Rife's contributions may yet help save half of humanity, and prevent a Soviet takeover of the world.

CHAPTER 6

DEVELOPING THE ELECTROMAGNETIC CURE FOR AIDS

By now, how one goes about developing a electromagnetic cure for AIDS — and for cancer and other killer diseases — should be apparent.

One must set up a modern research laboratory and assemble as many of the "dirty dozen" together as is possible. One then tackles the problem head-on, adding the necessary support staff and special consultants.

First the Kaznacheyev effect for AIDS must be isolated and determined. Then it must be reversed, to yield the precise "curative" signal.

Transforms for these Kaznacheyev IR/UV "death photons" and their phase conjugated "healing photons" must be obtained for a lower electromagnetic frequency band — such as, say, 10 to 20 gigahertz.

Away must be found to irradiate the whole human body with the curative signal. The ideal way is to utilize a scalar EM curative transform so that the atomic nuclei of the body — and hence its entire master cellular control system and immune control system—will be "charged up" with the correctly structured "AIDS cancellation message."

The entire procedure and apparatus must be as simple and small as possible. My colleagues have already achieved very promising — even remarkable — progress in this respect.

Reversing the Kaznacheyev Effect

The "Kaznacheyev effect" for AIDS virus condition must be stimulated between cell cultures, so that the disease condition is electromagnetically transferred from one to another. The actual electromagnetic "delta" constituting the contribution of the AIDS infection must then be isolated electronically. The best way to do this

is probably to subtract the normal cell radiation pattern from the "cell plus AIDS" radiation pattern.*

With the "AIDS delta" determined, the delta is then fed into the appropriate phase conjugating mirror system, so that its time reversed replica is produced.

The new phase conjugated signal is then the required *AIDS reversal signal* to reverse the effects of the AIDS virus itself, inside the cell where it resides dormant. This " time-reversed" signal will reverse the genetic change in the cell, not just kill the HIV virus.

In a crude way, one is making an **electromagnetic anti-virus.**

For ease of development and treatment, microwave technology is most attractive. Obtaining transforms of the signals in the radar band is ideal, since a wide variety of techniques, instruments, and electronic parts are available for that region. Millimeter waves would be most attractive, for the equipment could then be highly miniaturized.

One can regard it another way also: energy forms (critters) are involved. The action of the AIDS virus in its host cell, upon the DNA of the host, is underlaid by manipulation of energy critters. If one makes the electromagnetic anti-virus form, one is also manipulating the energy critters in their virtual state substrata.

The net result is that essentially the virus pattern — even the virus itself — can be phase conjugated by the energy critters. The result can be to turn the actual virus in the cell into a negative virus, accomplishing recombinant DNA procedures in reverse.

Remember that the signal we seek to use involves negative energy and negative time. We are also engineering the virtual state directly. The ordinary positive energy/positive time/observable state rules and limitations do not necessarily apply. And the "fixed form" first order physical reality as we normally conceive it need not

*Procedures along the lines of the extraordinary double-exposure holographic work of Dr. Robert Powell will probably be necessary. His work on biologically significant spatial frequency spectroscopy has blazed the trail as to how to obtain the specific delta patterns desired. It is hoped that Powell will shortly publish the remarkable results of his 15 years' work.

be so fixed at all.

Physical reality itself can be directly engineered.

The engineering we seek to accomplish is directly upon the probability states propagated by the Schroedinger equation, before observation and collapse of the wave function occurs. **We seek to engineer physical reality before it is born, while it is yet forming.**

Only at such a level can the previous action of the AIDS virus — that in which it combined its genetic material with the genetic material of the host cell — be reversed and undone.

Only at such a level can we convert the infected human body from an "AIDS virus factory" back to an uninfected normal human body without AIDS.

The Proof: Priore's Work

Antoine Priore's pioneering work largely proves that it can be done. Cancers, leukemias, and many other virulent diseases yielded to his phase conjugated signals passed down through a powerful magnetic field to totally penetrate every cell in the treated patient's body.

And Royal R. Rife's work proved that a virus and a bacterium are not at all the "rigidly fixed" physical forms that our normal science has led us to believe they are. Instead, both the organisms and their biochemical and genetic actions can be addressed — and changed — on a much finer level of reality.

Of course, it would be enormously helpful if one had a working Rife microscope.

My colleagues are attempting to rebuild one of the original Rife microscopes, which has parts that were missing from it. They have every hope of having the microscope in action in the future.

Another angle of attack is also possible.

One of my colleagues has discovered a very peculiar, weak electromagnetic signal that will kill viruses, harmful bacteria, toxic protozoa, etc. but not harm living human cells. Only a few volts and

a few milliamps are used.

However, there exists a major problem in getting any such very weak signal into every cell in the body — which is required if one is to heal blood diseases such as AIDS and leukemia. After all, that was the reason that Priore utilized a powerful magnetic field of thousands of gauss. The magnetic field penetrated every cell in the body — even those in the bone marrow where all the blood cells are manufactured. By using the all-penetrating field as the carrier, the phase conjugated healing signal pattern could thus be introduced into every cell in the body, bathing it completely, inside and out, with the restorative signal.

Remember, **one must not just get the signal into the cells themselves — instead, one must get the restorative signals directly into, and absorbed in, the atomic nuclei.**

Again, that is why Antoine Priore found it necessary to employ a "rippling" magnetic field. The "ripple" was actually a magnetic wave, and nuclear resonance then provided the magic mechanism to penetrate all the atomic nuclei.

So the initial problem is, how does one provide a mechanism to carry the desired signals into and through each and every cell of the body and into each and every atomic nucleus of the matter of the body?

Obviously one can utilize nuclear magnetic resonance, after the fashion of Priore. If so, the resulting apparatus is going to be extremely large and expensive. It would be highly desirable to do it a different, simpler, much cheaper way.

After many hundreds of back-breaking experiments, one of my colleagues appears to have discovered a completely unique and direct way of introducing the desired EM restorative signals into and completely through every cell of the body, and into every atomic nucleus. Though much additional work to confirm this still remains, the initial results are marvelously encouraging.

Another colleague has succeeded in developing a peculiar sort of detector that should prove adaptable to detecting the actual "biopotential structural patterns" themselves, directly in and out of the atomic nuclei. Though obviously much more work is necessary before the final instrumentation is ready, the preliminary results

are again most encouraging.

As I write these words on paper, this work is proceeding, but very, very slowly due to lack of the necessary funds to attack the research problems in force.

What is Needed

Time is running out —most conventional science appears to be driven by special interest groups/Drug Manufacturers who are unable and/or unwilling to counter the AIDS epidemic with anything other than extensive "Addict Style" symptom-reducing drugs that generate dollars, not cures. Though this is not universal, it *is* the conventional norm.

Unconventional disorders or diseases require *unconventional* science for *unconventional* cures.

Immediate funding is required if this awesome threat to humanity is to be stopped. An American public alerted in time to this desperate situation can demand that the government and/or private business immediately address and act on this life-threatening issue in a different, unconventional manner.

Encouraging Preliminary Work

One of my associates, already familiar with scalar EM devices, has exerted every effort to try to reduce the scope of the problem. In literally hundreds of experiments, he has been able to narrow down the search, and obtain at least some very promising results.

He has obtained an initial candidate phase conjugated signal for further test and trial.

He may well have succeeded in discovering a new and unique method to communicate signals directly into the atomic nuclei inside the matter in the human body. This signal presently appears to directly interact with the cellular biopotential and with the body's master cellular communication system.

Remember, however, these are preliminary results. They still must be fully substantiated in a great many more tests. Undoubtedly a great deal more research, analysis, and adaptation is necessary. We certainly cannot presently say we have any sort of "cure" for the AIDS virus or anything else — or that these results are to be considered as proven in any **fashion.**

But what we can say is that my colleague has been able to derive a very complicated phase-conjugated signal, which produces negative energy and negative time of the general sort required. And he may just have made a most marvelous discovery that will point the way to eventual equipment much, much smaller than the 4-stories high machine with which Priore intended to treat terminal human cancer patients.

The initial signal discovered by my colleague, when applied to the body at miniscule voltage, seems to zap all sorts of "bad things" — viruses, harmful bacteria, dangerous protozoa, microworms, you name it — without harming the blood cells, the normal body cells, or the hosted friendly bacteria.

The signal does this at miniscule voltage and amperage.

It can be applied directly to the body through special electrodes. Through a special feature, my colleague has been able to get the signal to reverberate the entire body, all cells, all parts, and even penetrate the atomic nuclei and establish scalar resonance therein.

There turned out to be some extremely strange things that have to be done to the phase conjugated signal before it will accomplish what is being sought. At least some of these "strange things" have been uncovered by my colleague.

One of the peculiarities is that the entire electrical apparatus is part of the input "form" (that conditions the potential wave structure) being phase conjugated and sent to the organism. If a lead-acid battery is included in the apparatus to power it, one will inject the electromagnetic form for the battery acid directly into the organism,* destroyingit. This includes destroying the host's cells. In this case the signal is lethal, not curative. Substitution of a dry cell battery with no liquid electrolyte eliminates the problem. Exactly why a liquid electrolyte has a toxic effect and a "sludge" or solid electrolyte does not, is not understood at this time.

Other such anomalies in the tentative process have been discov ered and compensated for.

However, the way ahead is exciting. It suggests that the body

*Via a mechanism similar to that found by Reid and Barsamian

(atomic nuclei) can literally be "charged up" (i.e., the living biopotentials can be "charged up" with the signal structure) so that the "disease-proofing" is very lasting, possibly for many years or even for a lifetime.

At least my colleague has pressed this to the point of demonstrating a long-lasting charge being acquired by the body.

For example, at one time his body became so "charged" from his lengthy experiments that a one-inch blue spark often leaped from his fingers when he reached out for something metallic. The discharge was cool, negative energy — living energy, if you will. It should be negentropic, not entropic. It was definitely not the type of energy the orthodox scientific community is accustomed to. And normal electricity will definitely not charge up the body in such a continuing fashion, so far as is known.

Let me clearly state again that we have not yet produced the specific anti-pattern per se. What my colleagues have discovered appears to be a broad-band signal that appears to act hyperspatially, analogous to the manner in which a broad-band drug such as penicillin acts biochemically. Even this much remains to be clearly established.

However, it is a most encouraging and promising first step.

Much more work, and a great deal of experiments to substantiate or adapt these tentative results, still need to be done. Now there is no substitute for rigor and thoroughness — and there is no substitute for clearly and scientifically demonstrating the proof of the concept in the laboratory.

It is not just good intentions that we seek, but solid, concrete, proven results substantiated by proper scientific procedures. Much work remains to be done.

But the preliminary results are very encouraging indeed.

Let me briefly share with you some of the things we foresee, if this present line of successful development continues.

We foresee being able to eventually develop and set up — legally and under proper medical auspices, of course — tested and proven

devices that can easily treat up to two or three hundred persons at once. A treatment of about 45 minutes to one hour is all that would be required. Several repetitive treatments a week or so apart, might prove advisory.

In addition,once the entire gamut of the treatment process is validated and proven, and shown to be completely harmless and safe in accordance with legal medical requirements, if need arises we foresee simply adding the signal to ordinary radio and television transmitters — perhaps as simply as modulating the electrical ground. If so, a "maintenance" signal could be established to negate the AIDS virus (or other disease such as cancer and leukemia) in an entire area, and keep out other diseases such as malaria, sleeping sickness, etc.

Another advantage of such machines would be their portability in time of conflict. Also, they would be most useful indeed as defensive measures against biological warfare. For example, the inhalation of only a relative minor amount of anthrax agent is sufficient for 100 percent certain death unless treatment begins promptly. With the portable machines, however, this would be easily negated in any troops exposed to the agent, even before the lethal disease is evidenced. For a totally new agent, a "phase-conjugate delta signal" could be rather quickly ascertained and developed, and the proper settings made on the machines for immediate treatment and immunizing.

And even later, when we proceed to the direct engineering of the living energy form strata themselves, we shall see remarkable cures and remissions of diseases for which medical science offers little hope today. Arthritis, multiple schlerosis, lupus, and other such debilitating diseases come readily to mind. **Even reversal of the aging process should be possible.***

*Two other promising approaches have recently been discovered First, an electrolyte compound has recently been approved by the FDA for clinical testing. This compound has the remarkable property of raising the cellular electrical potential back to that of a strong, healthy cell. In several years of lab animal testing, this alone was indicated to be over 80% effective against cancer. It may also prove effective against diseases such as arthritis, where the body's immune system attacks body tissue with lowered cellular potentials, since it fails to recognize the weakened cells as those of the body. Second, Baylor University reseachers have found that treating blood with certain laser EM radiation kills the AIDS virus, but does not harm the blood cells This means that it will be possible to assure that blood used in transfusions will be AIDS - free, eliminating one sorce of AIDS transmission.

Conclusion

We have now come to the end of our road, literally and figuratively.

All of us have been struck a mortal blow by the Soviet AIDS first strike.

Make no mistake, this is **real.** We and our children are already as good as dead unless we move as we have never moved before.

We have a chance. A slim chance.

Americans have always come through when the chips are down. We can conquer this thing. We can overcome this mighty death blow that has been launched against us. We can defeat the others yet to come.

But we've got to move. *Now.*

Remember, Pandora's box has already been spilled. Even without the Soviet biological warfare strike, hosts of new viruses and different strains of old ones are going to be, and are now being, dumped into the biosphere by our own culture. It is also only a matter of time before terrorists and meglomaniacs turn to the use of this potent weapon against a wide-open society such as ours.

Both our Armed Forces and our civilian populace are totally defenseless against electromagnetic biological warfare. Now. At this moment.

Even without the Soviet BW strike implication, it is only a matter of time until we perish, unless we develop electromagnetic healing and electromagnetic biological warfare countermeasures.

We've come to one of those profound momentary pauses in history that determine the fate of the entire world henceforth.

It's like the parable of the lady or the tiger.

We're facing, so to speak, two doors.

Behind one is the most fearsome and hungry tiger of all time. If we delay, that door will open and we'll get the tiger full upon us. We shall be utterly destroyed. That mighty tiger will consume half the world in his roaring frenzy. Our children, and our children's children — what few of them will be left — will wear the hammer and sickle yoke for eons.

Those few future survivors will be taught strange things. How you and I were the real enemy. How we were absolutely destroyed for the good of all mankind. How glorious and necessary it was to unleash the great plagues upon us. And how heroic were those who performed the "noble deed."

Our own distant children will curse us and revile us, and they will be taught to worship at the throne of a false prophet.

The world will descend into a new "Dark Ages" far more frightful than George Orwell ever envisioned.

On the other hand, behind the second door is the most beautiful lady of all history. Literally all of humanity's dreams of health, beauty, and vitality lie behind that door.

If we open it, we achieve a freedom from disease and a measure of bountiful health for all mankind that has heretofore only been dreamed of. *Even reversal of the aging process itself lies beyond the second door. Health and youth — the dream of the ages—can be ours.*

But we have only a moment to open the second door. It is firmly shut, and we must exert ourselves to the fullest if we are to open it at all.

On the human stage, the first door is already slowly opening, inexorably. In only a few moments it will be open and the tiger will be upon us.

We must move quickly.

Which will it be for mankind, the lady or the tiger?

The next few moments in the human play will most assuredly tell.

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"... contamination of the vaccine was unintentional due to lack of knowledge."

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Author's Note: So far as I can find, there are no available references other than my own that deal precisely with my particular approach to the nature of mind and thought. There is, however, a serious debate over whether (a) the mind is simply the physical brain, similar to a computer (the prevailing materialist view of orthodox science), or (b) the mind is something else altogether, and metaphysical — at least with respect to the level of scientific knowledge today. My own approach utilizes a non-Aristotlean fourth law of logic (included in an appendix to this book) by means of which the dichotomy between mind and matter is removed. In that fashion, one can model the mind as material, or model matter us mind.

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Costello goes on to point out that a group at Sheffield University has collected a great deal of data on this subject, from case studies of 253 hydrocephalics and hydrancephalics. There seems to be no correlation between the IQ of these individuals and the amount of residual brain tissue.

One living subject, Roger, has an IQ of 126 and a First Class degree in Mathematics, yet has no more than 5% of the normal amount of brain tissue.

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APPENDIX I

The Case of Antoine Priore and His Therapeutic Machine: A Scandal in the Politics of Science

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Forty- four years ago, in 1944, an Italian engineer working as a prisoner and forced laborer for the Germans in the huge submarine base in Bordeaux, approached a French police agent to plead for his life. He would be killed when the Germans left Bordeaux, he said, and since they were by that time obviously losing the war, the day of his execution was at hand.

The police officer, who also worked clandestinely for the French underground, told the engineer to get in his car, then simply drove him out of the base and introduced him to the 7th battalion of underground resistance fighters, in the nearby province of Dordogne. There he so distinguished himself in military operations that he was ultimately decorated by the French government.

It was due to his thankfulness to his savior, and his loyalty to his companions-in-arms, that Antoine Priore decided after the war's end to live out the rest of his life in Bordeaux. Thus he became the focus of one of the strangest, and most scandalous, chapters in the scientific history of France or any other nation.

Antoine Priore had earlier graduated from a small provincial school for electricity in Trieste, Italy and become a radar operator in the Italian Navy. During this period he observed what to him was an exciting anomaly: some oranges left in a room filled with electrical bric-a-brac had fallen into an assemblage where they seemed to have been preserved in the same fresh state they had enjoyed when bought off a fruit stand. Other oranges in the room, bought at the same time, were rotten and putrid.

Stunned by his observation, Priore dreamed throughout the war of one day working out an electrical means of conserving foods in their fresh state based on what he surmised was a new, and wholly unexplained, principle. Newton's apple had become Priore's orange.

Occupied during the day as a humble electrical repairman — and projectionist in a movie theater — the almost wholly self-taught Priore devoted all his free time and his meager resources to research. With the help of his war-time companions, some of whom had attained high rank in the Bordeaux police force, he was able to beg, borrow, steal, scrounge, or otherwise acquire a mini-warehouse of electrical and electronic components and parts. With these he put together a device worthy of Rube Goldberg. Exposing lentil seeds to a magnetic field of 225 gauss and electromagnetic frequencies of 80,

32, 3 and 10 Hertz, Priore's device caused the lentil plants which sprouted from them to grow 12-15 centimeters in length, as against only 5 centimeters for controls not subjected to the same treatment. He got similar results for tulips, asparagus and other plants.

Shifting his focus, he next irradiated fertilized hens' eggs, only to see the chicks hatch in 19 days, instead of the normal 21. Though he could not explain these astonishing results, he realized he had stumbled upon a process basic to the enhancement, or speeding up, of cellular growth.

It was at this point that one of his police friends introduced him to Francis Berlureau, the former Director of Studies at the School for Veterinary Medicine in Toulouse and, at the time of their meeting, director of the Bordeaux abbatoir. Priore asked Berlureau to supply him with various animal tissues for experimentation. For 10 years they worked together, Priore's free time allowing, during which Priore noticed he could get no electrical measurement from a cancerous bull's testicles. Since he realized that, in some way, his newly constructed device (no trace of which remains today, except for a snapshot of it) affected the electrical properties of cells, he put two and two together and his sum of four led him to believe that he might be onto an electromagnetic cure for cancer. Newton's gravity had become Priore's cancer cure.

Berlureau next allowed him to expose a cat with cancer of the mammary glands to radiation of his machine. To make absolutely sure that he was not exposing himself to mockery, the veterinarian had all the histological work done by his friend and colleague, a Professor Drieux at the famous Veterinarian School of Maisons-Allfort, near Paris. Drieux wrote a technical report proving that a tumor taken from a cat had, before treatment, started to become cancerous and, after treatment, had become benign.

By 1953, with the help of a doctor of general medicine, Maurice Fournier, Priore began treating human patients whose cancers had been judged hopeless. The huge file of cases maintained by Fournier, and filed with a notary until after his death, was subsequently mysteriously lost. But a few details were preserved in letters discovered in an old dog-eared file.

Some of these dating to the year 1954 concerned a 12-year old boy, Alain B., whose diagnosis wavered between one of reticulo-histio-sarcoma and a malignant form of Hodgkin's disease. The boy was taken by his parents to Priore, who irradiated him. Though the exact nature of the radiation was not known, 12 years later a Bordeaux physician, after a medical examination, certified that the boy, now become a man of 24, was free of disease.

A second case unearthed from the old file indicated that a patient

with cancer of the larynx was able to avoid a laryngectomy and be totally cured after Priore's new ministration.

Fascinated by the principle which he suspected must lie behind the strange Priore Ray, Dr. Berlureau tried to get some Bordeaux University physicists interested in the problem but was laughed out of their offices. He next turned to cancer specialists, beginning with Professor Lachapele, the Director of the Bergonie Foundation, a prestigious center for cancer research, to whom he proposed animal experiments to prove the efficacy of Priore's methodology. His plea met with a stony affirmation on Lachapele's part to the effect that he and his colleagues had no need of the new discovery, inasmuch as "all the patients treated in his hospital were cured and departed in perfect health." As if bound in the chains of his curt reply, years later Lachapele was to become one of the bitter adversaries of Priore's pioneering research.

Only somewhat discouraged, Priore kept up his momentum. He went on to build a new and more complicated version of his treatment device, called the P-l, over the next year. When it was finished he secretly and unofficially began to treat dozens of cancer patients who had been given up by their doctors as incurable. At his funeral in March of last year, among the crowd of mourners was, it is said, a small platoon of older people who had been cured of their terrible afflictions by Priore in the 1950s.

While his findings excited him, he nevertheless felt tremendously frustrated that he could apparently get no one in the world of medicine or science to pay attention to them. Undaunted by his previous rebuffs, his friend Berlureau next introduced the Italian at the end of 1959 or the beginning of 1960 to Professor Tayeau, vice dean of Bordeaux's Medical Faculty. Unlike Lachapele, Tayeau behaved as a true physician and scientist. He sent Priore to two researchers, Biraben, head of the Faculty's Department of Pathological Anatomy, and his assistant, Delmon. The two had been working together on cancerous rats for two years—specifically on animals grafted with T-8 tumors, discovered by the internationally famous team of Guerin and Oberling in Paris, which had proven to be intractable to any form of treatment yet known. To their utter surprise, the tumors in the rats treated with Priore's machine were reduced in volume by 60%, marking the first time in the history of cancerology that the virulent T-8 tumor had in any way been affected by any form of treatment.

Knowing that the mayor of Bordeaux, Jacques Chabans~Delmas-who has kept his post until this day, and was soon to become prime minister of France-- was most interested in the work of Priore (who, he too, had known as a fellow resistance fighter), they also

informed Chaban.

Promptly Chaban convoked not one, but two, commissions made up of Bordeaux and Parisian scientists to study the Biraben-Delmon results in detail. Both commissions rejected Priore and his machine out of hand, and without appeal. It is curious that, in the science of our day, a result, undeniable though it may be, seems to have no hearing unless and until all means to effect it can be adequately explained. It was for this ostensible reason that the two commissions decided to so adamantly reject the research: Biraben and Delmon could not explain the nature of the radiation engendered by the Priore device.

One can stress the word *ostensible* here because the principal reason for the rejection lay elsewhere. The decision by the first commission was, in fact, hardly unanimous. But among its members was the same Professor Lachapele who had refused Berlureau's plea for assistance. His opinion was that even the results themselves were of little value because they were obtained, not on spontaneously arising, but on grafted, cancers. The fact that no treatment whatsoever had ever affected a T-8 tumor was totally discounted. As the sole cancerologist on the commission, Lachapele's dictum was preponderant.

When he learned that the rejection of the first commission had actually been a split decision, the Bordeaux mayor asked for the formation of a second commission to re-examine the problem. Fearing a reversal, Lachapele was able to get one of his colleagues, Professor Courtial, director of the Radium Institute in Paris, and one of the so-called top authorities of French cancer research, named to it. It was all but impossible for the other physicians on the new commission now to outvote not one, but two, cancer specialists, so again the antagonists won the day.

At no time did either of the commissions bother to interview Priore himself or to run a supplementary experiment under their own control.

This seemingly incomprehensible attitude on the part of scientific authority was only a foretaste of what was to come, again and again, over the years. Biraben and Delmon went on to do new experiments. They modified either the time after grafting that the radiation was applied, or the length of its duration. This time their efforts were crowned with unequivocal and complete success. The tumors stopped growing and, when still living cells were excised from them and implanted in healthy control animals, none of them became malignant.

Though these results should normally have fascinated any academy of medicine or sciences, the two researchers did not publish

them. Why? The reasons horrify or disgust. It seemed that Biraben was simultaneously preparing an examination for the *agregation*, the highest French academic degree leading to a senior university teaching post. In charge of the committee to pass on, and award, this degree was none other than that same Professor Lachapele who told him: "Either you get the degree, necessary to your professional advancement, or you publish your research paper. But not both!" Discouraged, Biraben ceded to this demand but nevertheless continued to work on the research that looked so exciting and promising.

Most mystifying to him was how the machine operated to achieve its startling results. At the 3rd Congress of Biometerology held in 1963 in the Pyrennees mountains, a New York City researcher by the name of Kenneth McLean reported he had been able to obtain regressions on tumors and improve the health of cancer patients by using a magnetic field of a strength of 3000 gauss or more. Acting on this hint, Biraben and Delmon made an electromagnet that put out a field of 4,500 gauss and tried it out on the T-8 tumors but without the slightest success. Obviously, something other than a simple magnetic field was at issue.

In 1966, after others had had the same success with the T-8 tumor by irradiating it with the "Priore Ray," the two scientists finally published a memoir in the Revue of Comparative Pathology in which they stated that neither magnetic fields nor X-rays had any effect on the T-8s and that "only certain devices associating a magnetic field with high frequency waves seem at present to reveal therapeutic properties..."

Their conclusions were too late for, by that time, a campaign to stamp out Priore and his electromagnetic approach to cancer cure was well underway, a campaign that has lasted right up to the present moment.

The all-powerful Lachapele had sealed the fate of the Priore device as far as the local Bordeaux medical community was concorned. Veterinarian Berlureau and Priore next decided to carry their case to Paris. They contacted Professor Guerin at the cancer Institute at Villejuif, the leading French center for cancer research nnd the equivalent of the American National Cancer Institute in Bethesda, Maryland. Guerin, one of the discoverers of the T-8 tumor, which for the first time had been stopped in its tracks by the Priore device, courteously received his guests and heard them relate the whole story of how the device had come into being, starting at the point. when Priore had seen the oranges strangely preserved by some unaccountable electromagnetic effect.

Guerin was sufficiently impressed that he assigned his colleague, Marcel-Rene Riviere, to delve into the whole question. For

two years, Riviere, who also had teaching responsibilities at the University of Rennes in Brittany, unremittingly worked to corroborate the Biraben-Delmon findings. On 9 December 1964 a note was sent for publication in the **Proceedings** of the French Academy of Sciences detailing the research and modestly concluding: "... as of now, one may already state that our first observations show that electromagnetic fields used can lead to most interesting data from a point of view of the biological behavior of grafts and their therapeutic action on experimental tumors."

Riviere next decided to see if the Priore Ray could affect another tumoral form that had never been affected by any therapeutic method, the 347 lymphoblastic lymphosarcoma. The results were even more spectacular than for the T-8 tumor. The effects produced were of broader scope and took place more rapidly. A second note was sent to the Academy for publication. The conclusion read: "We can now already affirm that our research offers proof that electromagnetic fields are capable of producing effects on quite different types of neoplasms."

At this point one of the key characters in this extraordinary drama must be introduced. There might have been no drama at all without his appearance on stage. This personage was Robert Courrier, an eminent endocrinologist, who had been named, while still in his 30s, a full professor. Courrier was now perpetual secretary of the Academy of Sciences and later would become President of the Academy of Medicine. Because no scientific paper can be accepted by an academy unless introduced by one of its members, Riviere would have had no chance to see his work so prestigiously published had not Courrier, who knew Riviere well, since he had shepherded him through the winning of his doctorate, taken the responsibility for its introduction.

It was Courrier who, at this point, also took up the cudgel to interest various highly placed French organizations responsible for the administration of scientific projects and their funding. Thus, ho sent a personal letter to the French Minister for Scientific Atomic and Space Research, who immediately offered to try to make funds available for further research on and with the Priore Ray. He also personally asked the Director of the CNRS (National Center for Scientific Research, which coordinates and oversees all such activity in France) to receive Priore and Riviere.

That this meeting was, in its way, somewhat of a disaster, can be explained in part only by a brief resume of the complex character of Priore himself. Priore throughout his life had great difficulty making himself understood in the French language and, as the **years** went by, he even forgot how adequately to speak his own mother

tongue, Italian. Added to these twin impediments was his lifelong fear that his discoveries and inventions were prone to being stolen, a fear which led him never to fully explain the exact nature of the complex radiation emitted from his machine, far less the settings which controlled its various parameters. Whether Priore would not, or could not, exactly explain the functioning of his invention (which, as we shall see, went through several increasingly complex generations) is a question to which no precise answer has been given. It would appear that Priore was an excellent engineer gifted more with a God-given intuition than with school-book reasoning and logic. In short, Priore had a combination of talents that could remind one of the same enigmatic personality that was Nikola Tesla, the deductive reasoning behind some of whose discoveries has never fully been unravelled.

Highly placed scientific administrators are neither comfortable with, nor sympathetic to, what they see as self-appointed geniuses who have not run the same academic gauntlet through which they themselves had to pass. Thus the CNRS director took aversion to Priore's somewhat incomprehensible, yet fairly prolix explanations of his technology and only recommended that a physicist be sent to look over his device to properly decipher its working. At the same time, the Minister, together with the head of the general delegation for Scientific Research (DGRST) — still another key body in the administration of the French scientific decision-making process — let it be known to Robert Courrier that they had not understood a tingle thing about Priore's invention despite his best efforts to present it.

Advancing one more step into what was to become for him a 20 year-long expedition into a jungle of scientific intrigue, Courrier next resolutely decided to send to Bordeaux one of his most trusted laboratory workers, Madame Colonge, to repeat Riviere's experiments under her personal supervision. The DGRST director fully Concurred with Courrier's decision, while letting slip his admission that he strongly suspected that Riviere might well have been duped in some manner by Priore. When Courrier asked the minister for travel funds for Madame Colonge, he was refused with the dry remark that such a request was "premature." The now angry Courrier telephoned to reply: "You've been spending millions for programs and hypotheses about the cancer problem. Riviere has been presenting you with facts!"

The physicist who had been sent to try to elucidate the functioning principles of Priore's device, reported that he could make neither "head nor tail" of the machine.

Madame Colonge's experimentation was as prolonged as neces-

sary. She was so meticulous that, in order not to take her eyes off the experimental animals for an instant, she limited her lunches to sandwiches eaten in the laboratory. She returned, profoundly impressed, to Paris.

Nor was Riviere idle during this period. He decided to experiment with the L-52 lymphosarcoma, a tumor similar to, but even more malignant than the 347. This time, he used not rats, but mice, as hosts for the grafts. So successful were his results that, this time, Courrier decided to bar no holds. Instead of simply having a note published in the Academy Proceedings on the quiet, he decided to present it personally, orally, and in all solemnity, before his fellow academicians at an official meeting scheduled for 1 May 1965.

That date was, and is, a turning point in what came to be known in France as the "Priore Affair." From then on the whole French, and even the international, scientific community could be divided into a minority and a majority group, the first that believed in the research, the second that did not know enough details about it, did not or would not believe, or simply didn't give a damn.

Before Courrier could make his presentation, its scheduling and subject were inadvertently and prematurely leaked to the press. Immediately thereafter, a horde of journalists arrived in Bordeaux. After one or two of them managed to all but force entry into his lab, Priore closed its doors and, with the help of his friends, wrote a printed press release that stressed his thankfulness to the many people who had helped him over the years rather than providing any comprehensible details about the machine he had brought to birth. Stymied, many of the newsmen travelled across town to seek an explanation from its leading cancerologist, Professor Lachapele, who informed them acidly that the machine was all but useless and unworthy of their attention or their time.

The journalists' reports, founded as they were on rumor of outright lies, roiled the pages of their newspapers and magazines in such a way that they either over-exaggerated the potential or a forthcoming cancer cure, or came close to billing Priore as just one more cancer-cure charlatan. All of which so alarmed, among many others, Dr. Wilhelm Bernhard, world specialist in electron microscopy, that he called his friend Courrier to warn him that his forthcoming presentation to the academy might put his hard-won reputation at risk as well as those of Guerin, Riviere and the Villejuif cancer institute itself.

In the journalistic melee, no one had bothered to read the declaration carefully issued by Riviere from Rennes, where he was occupied with his university courses, which formally stated: "Our experiments are of real interest. Much more experimental research

has of course to be done before any therapeutic application on human cancer victims can even be considered. It goes without saying that this will take a certain time and no little effort of many types, both scientific and financial. Our work, as fascinating a perspective as it might hold, in no way, therefore, allows anyone to offer the public hope which could only lead to deception at the present time."

On May Day, Courrier gave his report to an Academy assembly hall crowded with scientists, newspapers and television reporters, photographers and an unusual number of curious bystanders. Accompanied with slides showing histological details, and animals before and after treatment, his lecture was heard out in almost tomb-like silence. When the lights came on again, he announced that he had personally checked the validity of Riviere's findings through the offices of his personal assistant, Madame Colonge. He then went on to say that he had taken the responsibility of presenting three notes to the Academy for two reasons. The first was a ringing declaration and a challenge to critics and skeptics of every stamp. It reads "When it is a question of a problem as serious as that of cancer and when one sees a little light beginning to dawn, one has the obligation to see what this light might represent. One has no right to snuff it out before learning what it may be worth."

The second was a tribute to his colleagues who had done the pioneering work, particularly Guerin, Riviere and Madame Colonge, and a statement of the essence of the problem to be faced down the road. It read: "Attention must naturally be given to the apparatus which Monsieur Priore has conceived and constructed. It has apparently already been examined by several physicists. It is found to be too complicated. While that may be possible, it is nevertheless a fact that Guerin and Riviere have obtained results with it that had to be made public. What is emitted from such an apparatus? I hope Monsieur Priore will allow disinterested physicists to study it at their leisure, for Science cannot tolerate apparatuses enveloped in mystery." Then, as almost a footnote to the history of the moment: "The biological action of magnetic fields is the object of intense research in the United States. In specialized institutes, the influence of these fields on tissue cultures, microbes, plant forms, diastases and certain tumors is under study. Up to now, the results obtained on grafted tumors seem less significant than those which have here been presented."

After Courrier sat down, a leading cancer specialist, Professor Lacassagne, rose to ask snidely why the notes had included no bibliographical references on work done on the bio-effects on tumors from electromagnetic fields, and criticized the experimentation as "impromptu." When Courrier denied this allegation as ludicrous,

Lacassagne stalked out of the assembly hall in full view of the audience.

The meeting caused a new eruption of media reports which unfortunately accented one of three aspects of the problem at the expense of the other two. These were 1) the hope that a miraculous cure for cancer was in the offing 2) the contradictory, not to say discordant, reception of the data by various academics and 3) the enigma of Priore's personality.

Remarkably, no serious discussion among the scientists present at the meeting ever took place. This led a foreign scientist, present in Paris at the time, to remark: *"I don't understand. Here is a report given to the most authoritative scientific body in France by one ofthe most respected and eminent of its members and it is publicly subject to doubt without that leading to any reaction whatsoever."*

The General Delegation for Scientific Research was at this point still open to the idea of providing funds for more research with the Priore Ray. The big stumbling block, however, was one related to niceties involved in relations up and down the scientific hierarchy. To open the way to the allocation of such funds required the approval of the Delegation's own section for cancer research and that section was headed by none other than the same Professor Lacassagne who had so rudely walked out of the Academy's assembly hall.

At the same time the General Delegate diplomatically covered himself by suggesting to Robert Courrier that he had to have more information underscoring the potential importance of the research accomplished. Courrier told him to simply re-read the three notes he had presented to the academy. His matter-of-fact, yet terse, come back then elicited his invitation to a full-dress meeting of scientific experts at the Institute for Scientific Cancer Research.

In this short historical account we obviously cannot go into the ins and outs of what transpired at this meeting or any of the many similar meetings which followed it. A paragraph in a brilliant book, four years in the writing, by the courageous Bordeaux journalist, Jean-Michel Graille and entitled: **Dossier Priore, A New Pasteur Affair** (of which this account is but a tenuous synopsis) must suffice to pointedly characterize the nature of the problem in its most general sense.

Writes Graille: "To read what follows in this chapter might well seem tedious: an enumeration of names and titles, the content of a debate held at an administrative meeting, personal remarks by one ranking personage or another, exchanges of letters following the meeting itself and the official report which came out of it. Tedious but indispensible for not a few reasons. It is important to know who were the participants at this meeting and what of these participants each

was trying to represent. It is important to know how such scientific meetings go about their business at the 'top level,' And, finally, it is important to learn about and to understand, in the particular case of the Priore Affair, the behavior and reactions of all concerned. A reading of all this could be difficult (and it won't be the only such passage in this book) yet it is necessary to understand the essence of the dossier in order to be able to create for oneself as clear and well-motivated a personal opinion about it as to subsequently be able to discuss it, or to hear it discussed, with a thorough knowledge of the facts."

In this single paragraph, Jean-Michel Graille has, in my opinion, pointed to both the nub and the difficulty in getting at the essence of the real facts behind a case such as that of Priore's that are so important to its proper understanding, an understanding which can be painted against the backdrop of the history of science and the backdrop of human pettiness and maliciousness or human courage and magnanimity.

One of the participants, Professor Andre Lwoff, soon to become n Nobel Laureate for his work in virology, was violently against the meeting's central issue: namely, whether or not funds should be spent to build a new and better Priore machine. Not only did Lwoff aver that the three notes presented to the Academy never should have been published, but he also opined that since all the work was done, not on spontaneously generated but on grafted cancers, the effects of the machine were hardly impressive. He later added in writing that 1) the patents issued to Priore for his device were nothing but a web of nonsense, 2) the machine itself could never be duplicated based on any description given for it by its inventor and, in a repetition of his oral remarks, 3) the fact that only cancer grafts were experimented with was nothing to shout about. He strangely added that because the animals who had been irradiated subsequently were able to entirely reject new grafts, the whole phenomenon offered no proof that cancer cells could be killed while healthy cells were not. The whole thing came down to a question of immunity, he said, as if that were not of the greatest possible importance.

To which, in due course, Guerin and Riviere replied: "It has been claimed that our experiments are valueless because they were carried out on grafted tumors and that other therapeutic measures were known to get rid of such tumors and their metastases. *We defy those persons who have made such affirmations* to prove, *with the use of such other measures, that animals infected with T-8 tumors can be cured at a percentage rale identical to those obtained by using the device which Monsieur Priore has developed."*

Not a soul has responded to this challenge, then or since.

A second cancer expert at the meeting, a woman of great influence, resorted only to the cavil that the experiments had been of doubtful quality since none of the animals had been *weighed.* The fact that those same animals had survived normally lethal cancers seemed not to have *weighed* with her.

There were many more observations of the same ilk. They seem atrociously paltry, trifling and picayune coming from professionals who, if they no longer believed in the Hippocratic oath to which they once swore, are considered by the public in general, and by cancer patients in particular, at least to be concerned with seeing what a little light on the problem might reveal before extinguishing it, as Professor Courrier expressed it.

At the same time, we must not forget Priore's decidedly difficult personality. He was an inventor determined at all costs that his invention be developed for the benefit of humanity, yet anxious that that same humanity not steal it from him. As author Graille puts it, "His conceptions and attitude directly or indirectly conditioned the overall essence of this affair. Full of enthusiasm, from the very day he discovered that the ray he had developed had a curative effect on a cancerous cat, he developed a single-minded fixation on cancer One could understand and sympathize with him on this score. Here he is, a little Italian immigrant without money or means, and he is going to offer the world a cancer cure. He is so convinced that he wants to move ahead to doing just that. He will never understand or accept the exigencies of Science or Medicine. For him, experiments, controls, verifications and parallel research are a waste of precious time. 'I've made machines which cure cancer. Take them and treat cancer patients. Don't bother with the rest.' Such would be a summation of his point of view."

Through the efforts of persons kindly disposed to the inventor, this point of view was softened and he came finally to understand the-necessity for what has been called scientific rigor, on the other hand. another aspect of his character never changed an iota. This was his determination to preserve the secret of his invention, motivated first of all by his unshakeable desire that it be developed in Bordeaux, the city of his adoption, for the citizens of that city. Deeply rooted was his belief that if he made his secret public, the machine would be taken from the Bordeaux region and further developed by Parisians, those who considered themselves to be in the penthouse of the scientific edifice. Once this was accomplished, he would likely not have one more word to say about the matter. Therefore he continued jealously to conserve his secret and put confidence in nobody.

As Graille generously concedes, he may well have been right. and adds: "All his life he had to go up against men, whether scientists

or industrialists, who had but one idea in their heads: to get to the bottom of the inventor's secret in order to build for themselves a machine which they then could exploit for their own account, for their own glory. Many such 'Priore Machines' were to be actually built more or less surreptitiously or clandestinely. Not one of them ever worked."

While one might easily accuse Priore of a limited view, the horizons of the researchers themselves were certainly not as broad us they might have been. Those involved in bio-medicine were content with the results produced by the machine, the workings of which were of no concern to them. A black box, as it were, emitted a ray that definitely affected experimental animals. At the same time, as researchers specifically interested in the cancer problem, they never gave a thought to what the Priore Ray might accomplish in the wider clinical domain of other afflictions.

As for the physicists, they were seemingly not up to the task of comprehending a complex radiation that had miraculously sprung, as from the head of Zeus, out of the intuition of a man they considered to be an undereducated and all but illiterate gadgeteer. Still others, whether physicists, biologists, doctors of medicine or specialists in a dozen other fields, were willing to throw the baby out even before it went into the bath water. In their eyes Priore was just a nobody.

Behind the scenes, many of these scientists resorted to using the press to achieve their own ends. Thus, the chief medical chronicler for Le Monde (the French New York Times), herself a doctor of medicine, was led to write outright lies about the Priore Affair—specifically and falsely stating that cancer patients had been treated with the Priore Ray in the clinic of Professor Lachapele in Bordeaux with not only negative, but disastrous, results.

On the other hand, a journalist for another leading Paris daily, Le Figaro, scrupulously conscious of his responsibility to fairly report what was going on, aptly wrote: "We would like to see at least one thorny point clarified as soon as possible. Several years ago P'rofessor Biraben of the Bordeaux Medical Faculty (who at that time had not become a ranking professor) was involved with the Priore device. According to certain reports from medical circles, his results seemed, even at that time, to have been already quite positive on small animals and he seems to have written a report to that effect, He was advised by highly placed authorities "to keep quiet" and stop talking about this affair. If this turns out to be true, it would be a veritable medical scandal to be judged in the harshest terms."

Could one have put it more succinctly?

The foregoing is to present something of the flavor of what was transpiring in the wide world far removed from the laboratory of

Priore who, at the time unaware of it, was revelling in the fact that his machine had been successfully used by high-ranking French cancerologists and its results reported in three separate notes to the Academy of Sciences.

His courage was also more than buoyed by the arrival on the scene of the commercial director of a large French industrial firm specializing in the intricacies of manufacturing glass components. This man had heard that Priore needed a large tube that was beyond all existing norms and perhaps did not exist anywhere in the world. This tube, it can be stated, contained a rare gas, neon, which when excited into a plasma, seemed somehow to convert the various electromagnetic inputs into a single Priore Ray which surged from the business end of the tube. In the tube were an anode and cathode. Peculiar to the anode was that it had to *rotate* to produce the desired biological effects and this is but one of the anomalies in Priore's equipment which physicists and bio-physicists have to this day been unable to explain.

The manufacturing company, a subsidiary of the internationally known company, Saint Gobain, was looking for a new product. The commercial director thought the new tube might fill the bill, particularly if it could be adapted to a machine that might ultimately cure cancer, a product that indubitably would have an enormous market across the world. There were plenty of problems with regard to the tube, notably those of its large dimension, its resistance and its conductability. When the tube was finally made, it now seemed that. Priore would have to explain his discoveries to the scientists of the company that had made it. One of these was sent to elicit such an explanation but was, so to speak, "shot down in flames" by Priore. So a second attempt was made by Ivan Peyches, a senior executive of the company, and president of the Society of Civil Engineers of France, who made a detailed investigation of the device. His reports were subsequently lost, but there remained an article he published in a leading French journal, Sciences and Technics, a short time before his death in 1978. It bore the intriguing title: "What Are So-Called Paranormal Phenomena?"

In it the engineer wrote: "There was so great an accumulation of components capable of having some kind of action, and being unable to work separately, that the results of measurement were limited to proving that there were no specific rays that issued from the tube (Priore talked about canal rays), no more than there were any X **rays.** On the other hand one could detect a magnetic field which was the end result of a field proper to the tube and of the magnetic field of a solenoid that constituted the experimental chamber, an electromagnetic field with a frequency of 16 megacycles (19 meters) and a high

frequency field (metric waves), the whole being pulsed at a very low frequency of an order of one per second. It was impossible, in such an imbroglio, to determine what was necessary and what was sufficient. Priore maintained that the simultaneous action of his various generators was indispensible to achieving his effect."

Peyches then went on to relate how he tried to persuade Priore to offer a more precise definition of his thinking about the workings of his device. He wrote the inventor: "At this point, I would say that all reticence on your part, which in your eyes would be justified by the fear of seeing yourself partially dispossessed of your work, would be of far greater detriment to you than any safeguard of your interests. Moreover, since it has become a question involved in public health, you are no longer entirely your own boss...you absolutely must bring all this to the clear light of day and I don't believe you can do it alone...You must supply all the characteristics so that third parties can reproduce your results." Then, he concluded by citing the words of an academician: "Many phenomena are rejected by the scientific world because they are considered irrational: But it is not B proof of scientific honesty to refuse a priori to try, out of homage to truth, to have a look at them and perhaps to understand them. Will Science one day be able to abandon its taboos?"

It was Peyches' final conclusion that, in the end, Priore was a man of genius who knew absolutely nothing about what occurred in his machine from the scientific point of view. The company which he represented no longer exists since it was bought out by the American firm of Corning Glass.

Industrial interest in the Priore device was not limited to the Saint Gobain subsidiary. Next into the lists was a company in Anguouleme, Leroy-Somer, which specialized in electric motors, generators and later was to branch out into solar power. Its president, Georges Chavanes, took the initiative to write to Priore in 1965 that his company was interested in providing some of the complex electrical equipment needed by the inventor, more particularly high-powered generators, on the condition that Priore move his operation to the company seat at Anguouleme. When the inventor categorically refused, Chavanes tentatively agreed to build a factory to manufacture the Priore device in Bordeaux itself.

The alliance between Leroy-Somer and Priore, shaky at best, lasted two years and blew up on Holy Thursday of 1967. The period was a stormy one for both parties to the agreement. Priore did his best to convince Chavanes to commit himself to building a huge machine with a magnetic gauss strength of 10,000 gauss. In the end he got one that put out only 920 gauss, not much stronger than the machine he had already built which put out 620 gauss. Since the field

of action increased with the gauss strength, Priore reasoned that a machine of literally behemoth size would be able to irradiate the whole, or every part, of a human cancer victim lying on a stretcher, whereas the smaller machines had been effective only for small animals or for treating a limited portion of the human body.

Chavanes and his company were aware that it would be a tremendous financial burden to contemplate building the larger machine. So they went ahead with plans for the smaller one while at, the same time putting great pressure on Priore himselfto make him feel that he was the least important cog in a new gear, in fact that his status was reduced to being a simple employee of Leroy-Somer. In Graille's estimation, this lack of psychological finesse on Chavanes' part constituted what he called "the blackest pages in the Dossier Priore."

Even the smaller machine was to cost about half a million dollars, a price which today, due to inflation, could be tripled or quadrupled. During a stage in which an intermediate machine was designed by the chief Leroy-Somer engineer, Ribeau, a machine that never did function properly, Chavanes all but forced Priore, who was heavily in debt, to sign a contract which was falsified. The falsifica tion was a matter of one word which was changed in the contract. In a phrase reading that an exclusive license of patents, and subsequent patent modifications, would accrue to the company "for all countries solely for therapy on cancers concerning animals and humans," a word was inserted by hand so that the phrase read. *"concerning particularly* animals and humans" implying that other uses of the machine, whatever they might turn out to be, would also accrue to the company. This one word change was amended on Priore's copy of the contract by calling the word "particularly" a "nullified word," but on Chavanes' copy it was called an "added word."

Leroy-Somer believed it was sufficiently well positioned in the driver's seat to be able to deal on behalf of Priore himself with the French governmental institutions, mainly the General Delegation, concerned with the funding of the new machine. When Priore learned of Chavanes' contact with the General Delegation he wrote a letter informing it that no one had the right to deal in his name. Nor did Chavanes even attempt to cut the Saint Gobain subsidiary, which alone could supply the tube, key to the device's functioning, in on the government funding.

In the meantime, no less a figure than Professor Kastler, soon to win the Nobel Prize in Physics, came down from Paris to inspect. the existing Priore device. He brought with him Delmon, who, we recall, had worked with Berlureau on the first animal experiments and who

NOW, it turned out, was trying to build his own version of a Priore device on the sly without telling Priore. Kastler's bringing Delmon with him to Priore's lab so angered Robert Courrier that he told the physicist he had committed a real gaffe. He also convinced Kastler that Leroy-Somer should build a machine with a power of at least 5000 gauss, but Chavanes refused. There seemed to be no harmony of outlook between the leading industrialist concerned, on the one hand, and the top physical and biological scientists on the other.

While all these, and many more, peripatetics were proceeding, Priore's sister in Italy came down with cancer. Beside himself with grief, Priore informed all concerned to commit themselves either to building an intermediate machine correctly, under his supervision or, better, the 5000-gauss machine, and to do this in time to save his sister, or he would wash his hands of the entire matter. Confronted with this ultimatum, the company began to work round the clock to perfect the intermediate machine but engineers involved, believing themselves to be more adroit with respect to its design than Priore, left out a host of what, to them, were unnecessary components. The result was that when the machine was first put to trial, most of the components burned out or otherwise failed, and the machine itself became a useless pile of rubble.

Shortly thereafter, Priore's sister died of cancer. Her grief-stricken brother went into what amounted to total isolation, unwilling to talk to a soul.

The whole Priore affair might have ended at that point, in the early part of 1967, were it not for the entry onto the scene of a key figure, Professor Raymond Pautrizel. Born on 3 June 1916 in Basseterre, capital of the French Carribean island of Guadeloupe, at forty years of age he was on the Faculty of Medicine at Bordeaux. He soon became known, world-wide, as the "father of parasitological immunity," a title he never accepted, saying that, if others had awarded it, it was simply because "he had searched through old scientific publications to find ideas that were as valid for modern research as they were forgotten by modern researchers." And he later was quoted as adding: "It is really too bad that researchers today don't pause from time to tome to dig into studies made by their predecessors, some of which were performed even decades ago!"

Professor Pautrizel was awarded the first academic chair in France for immunology, and later a special unit was created for him for parasitological immunology, a subject which is both simple and complex. The simple part involves the fact that various immunological techniques can be applied to diagnosing specific parasites that have invaded an organism in order to develop preventative actions against them via vaccines, or curative actions via serums.

When invaded by parasites, organisms react by creating antibodies, specific substances aimed at killing the invaders also known as antigens. These antibodies are liberated, like an attacking army, into the blood. Simple enough so far. The complexity arises because the defending army, the parasites, don't just lie down and die under the attack. They are capable of modifying their "personalities," as it were, and of changing various of their characteristics such that the mechanisms that the host uses to recognize, or detect, the invaders are invalidated. Thus, the substance which an organism would secrete to destroy an invader A becomes incapable of recognizing A, now become A-l, and therefore incapable of destroying it.

The organism at this point seems to realize it has to create a different substance to rid itself of its antagonist but, in the meantime, the metamorphized parasite is getting on with its assigned destructive task. Alternatively, the parasite has another capability: that of itself liberating substances which can annul or annihilate the organism's overall defense system. A sort of "in the blood" version of Star Wars is going on at the microscopic level.

The study and classification of the substances - - call them weapons - - emitted by parasite-attacked organisms allows for the establishment, in turn, of batteries of tests to define the exact nature of the parasites themselves in order to come up with an appropriate therapy or counter-weapon.

This then, is the essence of parisitological immunology, Raymond Pautrizel's area of research. He specialized on a particularly lethal parasite known as trypanosome, the scourge of tropical third-world countries where, in one form, it causes sleeping sickness in animals and humans, in another, equine syphillis, in still othera, other afflications. Over the years, during which he produced a small library of literature on the problem (known mostly to specialists in countries where that problem is acute), Pautrizel and his team discovered, among other things, that the trypanosome can modify itself, again and again, up to 101 times over a period as short as only three weeks.

Even before his work on trypanosomes, Pautrizel, back in 1949, was one of the first researchers to discover what is known as *ambivalence* in drugs, notably histamine. Histamine is a substance which is secreted by an organism as a defense mechanism but if oversecreted by certain cells circulating in the blood, it becomes virulently noxious, mainly by overdialating blood vessels, thus making them permeable to water and leading to edema and even death. This process occurs, for instance, in some human beings who are highly susceptible and over-reactive to bee or wasp stings.

Pautrizel's research on the noxious aspects of histamine led to

his finding that the same substance, applied in requisite small doses, is extremely important to the defense system ofthe organism. Today he stresses the notion of *ambivalence* in many areas ofhis work and characterizes it as "a key to the biology of the day after tomorrow."

To finish with the background on Pautrizel, before bringing him on stage in the Priore drama, it may be added that only a few years ago, at a formal reception for him attended by the medical elite of France, he was given a Basque *makila,* an iron-bound honorific cane of sculptured wood, in tribute to his work. On it was the incised inscription: "Sometimes to heal, often to alleviate, always to console," an epithet that perfectly characterizes a medical doctor imbued with that kind of rare compassion that marked Pautrizel's character.

When Robert Courrier sent Madame Colonge to Bordeaux, it was Pautrizel whom he asked to provide her with every assistance. In this way, Pautrizel was first introduced to Priore and his device. After witnessing the results obtained with it he was to say: "What stupified me, and led me to ponder the question, was to see the control animals die from their tumors in 3 weeks, while at the same time I could observe that the tumors in the animals under treatment were literally melting away and the same animals were taken back to Courrier's lab at the College de France in Paris in perfect health." ASa result of his thinking about the problem, Pautrizel came to the belief that the machine, however it worked, did not exert any action at all to kill cancer cells but, through as yet unexplained mechanisms, stimulated the afflicted organisms to provide themselves with new immunological weapons that could overpower the cancer cells.

To shed light on this problem, Pautrizel proposed the simple expedient of experimenting, not on cancer-infested animals, but on *in vitro* cultures of cancer cells. He made this proposition to both French and British cancerologists but they were convinced that the Priore device *had to be actually killing cancer cells themselves,.* They could not see the point that, if the machine did not kill cancer cells, then it was doing something else to the body to allow it, and not the machine, to do that job.

Pautrizel's involvement with the British was the result of a team being sent from England to experiment with cancer mice with the Priore Ray. What happened cannot be related in this brief resume except to say that, out of a lack of understanding on the part of certain British cancer experts and malicious conniving on the part of one member of the cancer "aristocracy" in Paris, the experiments were put under a cloud. It was alleged that mice had been substituted somewhere during their long round-trip voyage between

England and Bordeaux to make it look as if a failed experiment had been successful. This did not prevent Sir Alexander Haddow, chief ofthe prestigious Chester Beatty Research Institute for Cancer from stating, at a meeting in Paris, that the Priore machine had been indubitably effective on the English mice and supporting Pautrizel's idea that experiments should forthwith be done to see if the Priore Ray had any effect on cancer cells *in vitro.* Haddow's suggestion backing Pautrizel's recommendation fell on deaf ears.

Because of the emotional turmoil and rancor with respect to cancer that had so long surrounded Priore and the workings of his machine, Pautrizel suggested that it be tried in a completely new area, one he knew so well, namely on afflictions caused by the trypanosomic pathogen. Before these could get underway, however, someone had to persuade the still desolate Priore to return to work. Pautrizel, known to those really concerned with and knowledgeable about the potential of the Italian's invention, at last was able to convince the inventor to cooperate and get back into harness. This ho did with that rare combination of diplomatic tact and warm human sympathy with which only the Pautrizels of this world are gifted.

In the meantime, Riviere had gone on to implant new 347 tumor grafts in rats previously cured of 347 tumors. When none of the tumors developed, that result added one more argument to back Pautrizel's idea that the machine was, in fact, affecting the immunological defense system of the animals. However, when Riviere tried the same procedure with the T-8 tumors, his animals died. This lead to the conclusion that the immunity acquired by the animals to lymphoblastic lymphosarcoma 347 was specific to that tumor. When a note on this research was sent, again through Courrier's good offices, to the Academy, for the first time, it strangely omitted from the listing of the participating researchers the name of Antoine Priore. It seemed that Riviere had been taken to task by fellow cancerologists who believed that Priore was nothing but a naive bumpkin or, worse, a swindler. They had warned him against publishing any papers with which Priore's name would be associated This rank injustice and lack of fair play again sent Priore into a fit of despondency and depression from which he could only be wilth drawn by those subtleties involved in Pautrizel's sympathetic and friendly counsel.

On 25 July 1966, another note was sent to the Academy filed for the first time not under the rubric Cancerology but under the rubric Immunology. It was entitled "Influence of Associated Electromagnetic and Magnetic Fields on the Immunity of Mice Infected with Trypanosoma equiperdum." The conclusion read: "The treatment allows the organism to rid itself of parasites even when these

have invaded it in a most intensive way.... There is an enhancement of both the specific and aspecific factors of immunity."

Thus, for the first time, the field of research shifted from the narrower field of cancer to the much vaster domain of immunology. And, for the first time, Pautrizel's name appeared as the senior author on the paper. It also appeared that, for the first time, there should no longer be any problem about experimenting with the I'riore machine. Such was not the case.

Still complicating the whole issue was the fact that Priore himself was using different setting to produce different varieties of radiation depending upon his own intuitive evaluation of the particular biological experiments being run with his machine. He would never reveal the nature of these settings.

At this point there appeared on the scene a new researcher who became Pautrizel's loyal ally, a young woman, Pierette Chateau-Reynaud Duprat. During her work in Paris, she had learned of the Priore controversy, and, against the stern advice of mentors senior by many years to her in the cancer hierarchy, she came to Bordeaux to meet Pautrizel and learn more about the research.

Her work, performed over many years, is too detailed for presentation here but it led to important conclusions. One was that the Priore Ray had no direct effect on the trypanosomes themselves but stimulated and reinforced the defense mechanism of the infested organisms, allowing them to reject the parasitical influence with an effect so durable that they were no longer subject to this influence even after treatment stopped.

Another conclusion was even more important and involved, in part, British research. It pertained to the effects of the machine on both *allografts* or those made between two different individuals of the same species, and *isografts,* or those made between two different individuals ofthe same genetic line having in common antigens that were characterized by what is called the same histocompatability. The conclusion was that not only was the rejection of *allografts acce*lerated by the Priore Ray but that *isografts* were also rejected. This meant, in sum, that the ray stimulated not only the *defense* mechanisms of the organism but also, and more importantly, its re*cognition* mechanisms. In the case of an isograft, this allowed the recognition of weak antigens that were not recognized in non-irradiated animals. In other terms, where at first the anti-aircraft batteries could not shoot down the aircraft because they could not see them.now they could shoot them down because they could see them. In immunological terms, the ray affected both humoral and cellural, both specific and aspecific, immunity.

Here we must return to the mystery of the settings on the device.

As a result of the new experimentation it seemed that, depending on those very settings, the active ray, complex as it was, could have either similar, totally different, or diametrically opposed effects. Thus it was not a question of a ray having universal effects — a kind of magic bullet capable of killing any target — but of multiple radiations which, due to the complexities in Priore's personal makeup, have unfortunately yet to be sorted out and explained.

Thus, the machine originally designed by Priore, called the P-l when it put out a wave length of from 19-21 meters, had a radical effect on certain animal cancers, on *cellular* defense mechanisms, and finally, but not universally, on organisms infested with **Trypanosoma equiperum,** (hereinafter called T.e.).

A second machine, dubbed the P-2, was at first not able to produce these frequencies. What it did put out was a frequency of 17 meters that *was* universally effective against T.e. and seemed to act. not on the cellular, but the *humoral,* defense mechanisms. The rejection of grafts depends on the cellular defense mechanisms, which partially explains why Pautrizel when using the P-2 machine, selected the T.e. vector, as it is called in microbiology, just because this creature is fought by the organism's humoral defense system.

Consequently, the bio-effects that were successfully attained depend on the varying, not to say quixotic, nature of the radiation At one point Pautrizel actually did experiments on animals infected with *plasmodia* — the vector for malaria which attacks red cells - and found that the settings used were effective while never learning exactly what they were or the exact nature of the radiation. Further more, Priore himself maintained that over the years he had success fully treated cases of human tuberculosis but, again, never revealed which frequencies had been used to achieve this.

Several more notes were sent to the academy on the successful work performed with the Priore Ray on animals affected with T.e. But the central issue remained: how to find out exactly how the-machine worked. It fell, not to civilian scientists, but to those in the-French army service to attempt, at this point, to work out the problem. The army service brought into the picture was the DRME (an acronym which translates as Administration for Research **and** Test Methods), to which Pautrizel had sent a request for funds in 1968.

This request was the subject of a meeting at which were present three of the top names in French science, one representing biology, the second physics and the third, medical physics. The latter two turned in extremely unfavorable reports recommending that no money be wasted on the problem. The biologist, however, turned in a most favorable report and, despite the fact that he was in the

minority, his opinion won the day.

As remarkable as was this victory, it was even more stunning and incredible given the fact that this biologist was the same Andre Lwoff who had so adamantly opposed the Priore research a couple of years previously. Lwoff had summoned the courage to completely reverse himself only after he sent one of his most trusted colleagues to do secret experiments with the Priore Ray on mice injected with peroxydase (an antigenic solution) to see if they would produce a higher level of antibodies than non-irradiated animals. This they did so well that Lwoff became convinced that the Priore Ray caused an extremely important increase in immune reactions. These results were never published because, before the experiments could be repeated to be absolutely sure of their results, the machine suffered one of its many interminable breakdowns.

The DRME report was at length, and in length, issued but not publicly since it was protected by a military classification. However, a synthesis of it was finally published in November 1979 by Herbert Gossot, Secretary General for the French Association for Bioelectromagnetism, under the title: "A Scientific Balance Sheet on the Priore Ray." Its contents were as follows:

"The two physicists assigned by the army made a complete analysis of the electromagnetic radiations and magnetic fields activated by the Priore device. They thus determined the spectrum of frequencies which the device emitted. They showed particularly that frequencies in the visible light and infrared range had no biological effect; that there were no X-rays or Y-rays; and that the pulsed ultra-high frequency electromagnetic wave was modulated in amplitude to that of a high-frequency wave. They did a topographic survey of the respective intensities of the various magnetic and electromagnetic fields in the experimental plane of the device. In particular, they determined the spatial repartition in this plane of the density of the strength of the ultra-high frequency wave. They showed that its value was very weak and that it could not produce any kind of overall significant thermal effect imputable to the hyperfrequency ray.

Finally, and most importantly, by using what they had learned about these repartitions, they demonstrated a clear correlation between the biological effects obtained and the intensity of the hyperfrequency ray. What they actually observed was that, on the **biological** model used, i.e. experimental trypanosomosis of the mouse, there was a diminution of the rate of evolution of the parasitemia that was proportional to the strength of the hyperfrequ**ency** wave. To quote them: *'These experiments of correlation are of certain interest: they confirm, if there is still any need of so doing, the*

biological efficacy of this device."

The two physicists, Bottreau and Berteaus, are still interested in rebuilding a Priore device with which additional biological research could go forward. At the same time they suggested to administrative bodies in French science the creation of a special laboratory for bioelectromagnetism to fund more work, a suggestion in which Professor Pautrizel concurred. No action was taken and their report was kept under wraps. In a note they presented to the Academy of Sciences on their investigation, they were not allowed to include the names of the laboratories where they worked: in the case of one, the CNRS Magnetic Laboratory at Bellevue near Paris, and of the other, the Laboratory of Ultra-Hertzian Optics and Talence near Bordeaux. Why? Because the directors of these laboratories did not want any mud in the Priore affair to be spattered on them.

The next experiment done by Pautrizel was on rabbits whose testicles had been so seriously affected by trypanosomes as to be almost entirely destroyed. After radiation the same testicles took on their normal histological appearance and the rabbits, able to procreate again, in no way abstained from their newly regained ability. **This implied the complete regeneration of an organ that had all but completely degenerated.**

Yet journalists, who sought out truths about the Priore affair in Paris from high officials they believed would know best about what was going on, continued to be led astray. For example, an American scientific reporter, writing in the **Saturday Review** of **Science** in 1973 saw fit to state: "It is really a question of a mystical problem that has little to do with science." He was quoting Professor Bader, a man who for 15 years held top administrative posts in science that could have allowed him to back the Priore research with all the funding necessary to its accomplishment. At the time Graille's book came out, Bader issued a book of his own about the Priore affair which offers no real idea of what was involved. When I asked several people in France why Bader had written the book, they were unaware of Bader's inmost motivation.

Machinations continued to swirl about the case over the next several years. Behind-the-scenes intrigues, distorted accounts in the press, lethargic attitudes on the part of administrative officials who would not take responsibility to cut an increasingly tight Gordian knot, outright fear of various personalities to become too deeply implicated lest they lose their jobs - - all these, and more, continued their daily round in an atmosphere of "Business AS Usual," and "Don't Risk Your Neck."

To get to the nexus of the situation, we have but to cite the observation of one of the few perspicacious journalists who, in **the**

prestigious scientific monthly, Sciences and Life, wrote: "The physicists are convinced that the effective Priore Ray is very complex but to analyze this further some things first have to be made clear. One is to raise the suspicion that has surrounded Monsieur Priore with a fabulous acretion of misunderstandings, insults and accusations of being a swindler over many years. What is needed is a veritable national effort to act effectively and to act rapidly."

Over the next two years the decision-making process of the French government lumbered its way along until it was finally decided to back the construction of a powerful machine. This decision was not favorably accepted in many quarters. As Le Monde would comment: "The decision was made in spite of the disapproval of many scientists. When money is tight, one should pay particular attention to how it is being spent. Such seems not always to be the case. A credit of some $3.5 million francs (or about a million dollars) has just been accorded to finance the construction of a new Priore machine."

The scientists to whom the article referred were in a rage. They understood, at this juncture, that the only way to put an end to the affair was to eliminate Pautrizel who, because of the very success he was having with his research, was seen as a dangerous competitor that might even become one of the top figures in medicine and science on a national, or perhaps, on a world scale. Indeed, it was learned that Professor Courrier had gone to the length of sending a report on Pautrizel's behalf to the Nobel Committee in 1979.

To make a long story short, the large powerful machine, the M-600, was built but a huge tube in it, after functioning for about a week, exploded. Due to the galloping inflation of the 1970's, to replace it would have cost another million dollars. The money was not forthcoming.

In the meantime Pautrizel, ever experimenting with the still functioning smaller machine, was to discover new facts. Mice with their spleens cut out, for example, also could survive injections of T.e. The Priore Ray had important implications for Arterio-sclerosis, since it effected lipid modifications in rabbits given a dietary regime high in cholesterol. This research, published in another note in the Academy Proceedings, instead of being warmly received, only irritated the cardiological fraternity which felt, as some of its members put it, "trapped" by Pautrizel's efforts.

One particularly virulent opponent was Professor Bricault, Dean of the Bordeaux Medical School who, as late as 1980, was telling his own students that the published results were a farce and had never been obtained. The students, who carried out a special investigation of the matter on their own, were able to judge what a

farce their own medical dean might represent.

L'Express, the **Time** magazine of France, read by at least half the population of French intellectuals, had the gall to compare the results of the Priore research to those of the infamous Trofim Lysenko of the Russia of Stalin's day. Haughtily **L'Express** added: "Today Priore's defenders explain that his machine has not only cured cancer but, in all probability, altered the immunological characteristics of mice. Were this, in fact, so, all the immunologists, all the geneticists of the world would unite to affirm that a machine capable of changing the genetic patrimony is the discovery of the century, far more important than the atomic bomb or the conquest of the moon. Unfortunately, the history of the whole thing has never been properly elucidated." The article was illustrated with photos distortedly selected to convince viewers that the Priore machine was as serious and effective as the one that purportedly brought Frankenstein to life.

In this poisonous atmosphere the slow work of building the M-600 went forward. To give anyone who was not there a feeling for this endeavor we may now cite verbatim a passage from Graille's book: "The construction and assembly of the prototype —the M-600, that of highest power and variable parameters — were fraught with many uncertainties and delays on the one hand and, on the other, were marked by the stamp of Antoine Priore's sparkling genius.

"To go from an apparatus that developed 1,240 gauss applied over an effective area of some 20 centimeters, to one developing 5000 gauss over an area of 60 centimeters means to take on an extremely risky technical and technological wager. Electrical, mechanical and glass-blowing specialists plunged into the unknown. They had to conceive, make, adapt and put together all the various myriad components almost haphazardly with no precise technical study being previously available. Priore's stubbornness forced them to take on a trial-and-error manufacturing "gimmickry" without precedent. As the thing was put together and preliminary tests made, it became clear that many of the components were unsuitable and that they would have to be modified or replaced. The tube itself, made of pyrex, 60 centimeters in diameter, and 6 meters tall, had to be replaced twice after it imploded. In fact, practically everything had to be reconsidered or readapted. "Everything" meant the parts going to make up a generator of 50 tons in weight. For example, the coil which created the magnetic field: 5.5 tons with 11 miles of copper wire. For example, the numerous cooling circuits which stabilized the thermal equilibrium of the generator and its environment or, additionally, the circuits governing command, control regulation and selection — 6 tons of electrical cables of which 15 miles were of

tele-command wiring.

"Priore astonished everyone. Breakdown after breakdown, incident after incident, it was he alone who showed what to do next, indicated the proper steps to take, the right settings to adopt, the right way to assemble the components: He was virtually building his machine by himself, nursing its construction along day after day, all the engineers' studies and efforts actually, and ultimately, serving only as a preliminary attempt, a sketch as it were. When Priore made his presence felt, things began working."

Then.... after the machine was built: "The part of the entire apparatus to generate electricity was set up on a provisional basis. It was so noisy that, while functioning, it woke up the whole neighborhood. The number of experiments had therefore to be curtailed so that the machine would not be used at night. And, all at once, everything came to a halt. The Faraday cage, shielding and isolating Priore's apparatus, was torn and fissured by the shock of the cement pilings that were being sunk into the ground all around to hold up the building under construction. This allowed high-frequency waves to escape which disturbed radio broadcasts emitted by local radio stations, the army, and civilian aircraft for miles around."

Nevertheless during the week or ten days that the machine was in good operation the results of experiments performed with it were more than formidable. First of all, it allowed for as many as forty experiments to be performed on some 280 animals in a remarkably short period of time. Among the discoveries made were: The ray emitted provided the treated animals with an extremely strong immunitary response. Animals whose immune defenses had been attentuated by an immuno-depressant were able to overcome the effects of injected parasites but relapsed a few days later. One could therefore conclude their immune response was much weaker than those normally infested and treated.

Newborn animals, whether treated or not, developed a marked parasitemia leading to their deaths. At the time of death, the parasites had the same antigenic structure as those of the innoculum which thus implied that they had met with no defense at all in the infected organisms. This also proved that the Priore Ray did not act directly on the parasites themselves but only by way of an increase in the immune defense system of the organisms. The newborn animals succumbed to their parasitemia because their immune sytem was not yet sufficiently developed to be stimulated by the P-Ray. The phenomenon of a stimulation of the immune defenses was demonstrated by the fact that animals which had received soluble antigens developed, after being irradiated, a level of antibodies far

superior to the controls.

These and other conclusions were the object of notes presented to the Academy of Sciences by Pautrizel and his team in 1978. Even before, at a colloquium held in Antwerp, Belgium devoted to African human trypanosomiasis, the same team had offered the conclusion that the stimulation of the immune defense system that allowed organisms to throw off the effects of trypanosomiasis had to be very significant in that all attempts to try to effect such stimulation through immuno-stimulants as well known as B.C.G., or Corynebacterium granulosum, had led neither to the cure produced by the Priore Ray, nor to any prolongation of the infected animals' lives, nor even to the slightest modification in the evolution of the Trypanosomiasis.

These three scientific papers did little for the cancerologists who read them except to exacerbate their urge to oppose the Priore research, if not to arouse their outright hatred for the principal experimenter, Raymond Pautrizel. Could this have been because, for over 20 years, the same cancerologists had been working in vain to provoke in cancerous organisms immuno-stimulative reactions by intensively and successively vaccinating them with B.C.G.? Many others had been life-long apostles of chemotherapeutic cocktails of all sorts, or life-destroying ionizing radiations, or, what more recently has become the fashion, of applying the two methods in endless combination.

For this reason, they saw Priore and Pautrizel as nothing more than spoil-sports who had to be destroyed.

One of the opening shots in this campaign was a letter received by Pautrizel to inform him that his request for funds to continue his research through Unit-89, a unit that had been specially set up for him to direct, had been denied. It took many months of investigation for Pautrizel to learn that the real reason for the refusal was because of his work with Priore.

Next Pautrizel was informed that his appointment as director of the same research unit would be extended for only two years, whereas the normal extension for similar units was five years. A third insult came when Pautrizel tried to win a post within his unit for a high-ranking military physician, who had been his student and who had decided to quit the military in order to participate in the fascinating research prosecuted by his mentor. Pautrizel's request for funds to pay this physician, who all his life had been working on tropical medicine closely associated with problems of trypanosomia sis, were refused four times in a row with no cogent reason given. The physician, who in the meantime had volunteered his time without pay, finally became so emotionally overwrought that he gave up his

medical career and retired to the countryside where he gave himself over to alcohol. Then Pautrizel tried to get a salaried post for another ofhis brilliant collaborators (who still works with him). He was told that this man could take up his new functions only if he left Bordeaux. One could go on with many other shocking stories but we will leave it to Graille to conclude: "Everything possible was done to isolate Pautrizel, to separate him from his collaborators. Every single one of these collaborators saw their careers put in jeopardy, compromised, or broken."

As a final insult, when the time came again to renew Pautrizel as director of Unit 89, those responsible, not daring to overstep what even they knew to be decent limits by not extending him, simply abolished the unit. And to add injury to that insult, a doctoral thesis that had now been prepared by Priore, and backed not only by Pautrizel but by Nobel Laureate Andre Lwoff himself, was summarily refused by the President of the University of Bordeaux.

It is perhaps unnecessary to state that the details behind all of this skulduggery could, and did, fill up two chapters of a book and make for the most heart-rending reading imaginable.

So what happened next? In the autumn of 1977, Professor Georges Dubourg, one of the leading lights in Bordeaux's company of surgeons and a friend and admirer of Pautrizel's, came to him to say openly and baldly: "My friend, at the point you've reached, there is only one more way to jolt medical opinion and that is to treat human cancer patients." Pautrizel was hesitant, believing his role to he one of continuing with his animal experiments but where would the funds for that come from now? He therefore asked his old mentor, Robert Courrier's advice. Courrier gave the green light. The treatments were restricted to terminal cancer patients whose immune defense systems had been disastrously weakened by chemotherapy or radiation or both. At least one of them was totally cured. The other 1ived, without pain, for a period many times longer than predicted by prognosis. Dubourg, Pautrizel and their collaborators wrote up the results and sent them as an official communication to the French Academy of Medicine for publication.

The reply they received from that Academy's perpetual secretary reads: "Experts whom we consulted consider that your work does not fall within the jurisdiction of our members and that it would doubtless find an audience more worthy of its purpose in a more specialized society."

To which Pautrizel formally replied: "Since two of the four signatories of our note are corresponding members of your Academy, could we not benefit from the remarks and comments made by the committee which saw fit to refuse our paper? And even, if this is not

too indiscreet a request, to learn the names of the expert members who were consulted which would allow us to get into contact with them directly and to benefit from their singular competence?"

His letter has remained unanswered for four years.

There was nothing more to do except one thing which Raymond Pautrizel, as a man of science, had always been careful to avoid: Get a responsible journalist interested in the case, inform him of all possible details, and let him carry the Priore Affair in all its harrowingly loathsome aspects to the broad reading public. That journalist was Jean-Michel Graille.

For four years, Graille went about his task, publishing three consecutive long articles in his newspaper **Sud-Ouest France** and finally the book to which we have referred and of which this presentation is largely a resume. As early as 1980, Graille would write in his newspaper: "The Priore Affair is simple in essence. It can be reduced to a simple alternative: either the machine developed by Antoine Priore is of no interest and, having shown this, the affair can be considered at an end. Or else the machine is of real and demonstrable medical interest and, if that is officially recognized, he would be allowed to get on with the work. For this dilemma runs the risk, yet again, of being buried under delays and evasions. Beyond all the powers-that-be that have been directly connected to the affair for many years now — the power of finance, the power of medicine, the power of science — perhaps it is now political power with which responsibility lies if it can rise to meet and assume that responsibility through decision."

That was Graille's statement in 1980. His book which came out four years later ends with the sentence: "The Dossier Priore thus depends, from here on out, on a decision that must be taken on the very highest level, and imperatively. This responsibility devolves, in last resort, on the chief of state and on him alone. Will he assume it?"

Would the President of the United States?

Note added by T.E.B.: Antoine Priore is now dead. His machine has been dismantled. The iron dogma and hatred of electromagnetic medicine by bureaucratic science may have doomed hundreds of millions of humans - - whom Priore's device could have saved - - to bitter, agonizing, and unnecessary deaths. Hitler, Stalin, and Mao combined were not responsible for the deaths of so many.

APPENDIX II

PATENTS

English Translation of the French Patent No. 1,342,772 of Antoine Priore, 7 Oct. 1963.

Procedure and Assemblage for Production of Radiation Especially Serviceable for the Treatment of living cells.

Brevet d'Invention. P.V. no. 899.414 no. 1.342.772 Classification Internationale: A61 k-H 05 g

Procedure and assemblage for production of radiation especially serviceable for the treatment of living cells.

Antoine Priore
Requested 1 June 1962, 14.52 hours, Paris
Released by decree (arrete) of 7 Oct 1963

The invention deals in a general manner with radiation capable of penetrating matter. More exactly, it aims at a procedure and an apparatus making it possible to obtain a combination of radiations of different types able to penetrate matter and especially to penetrate intimately living organic tissues in order to produce in them certain effects, particularly in human tissues with a view to a therapeutic effect without destroying essential elements such as the enzymes.

In conformity with the present invention, one emits in a cavity a stream (rayonnement) of electrically charged particles upon which one superposes electromagnetic radiation of the centimeter wavelength range, the wavelength of which is preferably between 3 cm and 80 cm, and one directs the resulting radiation emerging from the cavity on to the object to be irradiated.

This applicant has shown that the penetration and, in particular, the curative effects are very distinctly improved when one gives **the** electromagnetic radiation a frequency determined as a function **of** the organ or the tissue to be penetrated or to be treated. For example, a wavelength of 14 cm is suitable for the liver and a wavelength of 19.5 cm for the spleen.

Preferably, the stream of charged particles is accelerated in a particle accelerator in such **a** way **as** to increase the force of penetration.

The resulting radiation is advantageously applied and directed upon the target, that is to say, upon the tissue to be penetrated, by the intermediary of a tube which is the site of electric fields and of magnetic fields for acceleration and control, the said radiation being preferably guided and/or reflected by a rotary deflector placed in the tube.

It is often advantageous to modulate or impose rhythm on this stream of particles by means of variable magnetic and/or electric fields so as to augment still more the force of penetration. This rhythm is preferably consistent, especially in medical applications, with the intrinsic period of the tissue to be penetrated or of the neighboring tissues, for example, muscle. These intrinsic periods arc well-known in medicine and are applied, particularly, for diathermy: they are situated in the wavelength range from 1 m to 50 m and more especially from 1 m to 18 m.

Preferably, one arranges to modulate the emission of radiation, the accelerating magnetic and electric fields, and perhaps also the rotatory deflector, to the cardiac rhythm of the subject.

It seems that the result obtained by the invention in the treatment of maladies of living cells (vegetable or animal) are due to certain phenomena which will be described, it being understood that this exposition will not circumscribe the invention.

As a function of its electro-physico-chemical constitution, the cellular pair nucleus-protoplasm is endowed with electric conductivity in direct relationship with ion exchange processes provoked by metabolic phenomena. One finds in tissues the presence of an accumulation of electricity at different potentials according to the different cellular densities of the tissues.

The work of Renshaw, Forbes, Morison, Amassian, de Vito, Ruset, Albe-Fessard, Tauc, Adrian, etc. has shown with the aid of micro-electrodes the existence of slowly oscillating elementary electric activity in the interior of cells; it can be thought that the *rythmeur* (or pace-maker) is achieved by the oscillatory electromagnetic system comprising the cell nucleus. This nucleus, in effect, is made up essentially of tubular filaments of insulating material (related to chitin) containing in its interior an electrically conducting saline liquid, and these filaments, coiled upon themselves, can be considered to constitute real little oscillatory circuits.

The recent work of Warson (sic) in America, as well as that of French scientists, including a communication from Polonsky, Don zon and Sadron presented to the **Academie des Sciences** by Prof. Francis Perrin on 16 May 1960 **(Rec. comptes rend, heb.,** 250 No. 20, 3414-3416) making it clear that experimental samples of **solid** DNA manifest properties analogous to those known in ferroelectric

materials, makes plausible the hypothesis that a potential difference may exist between nucleus and periphery of cells. Certain recent theories go even further and liken the cell to an electronic receiver-emitter device normally functioning in harmony with the ambient media. The oscillatory system of demand waves, constituted by the cell nucleus, would behave in accordance with the laws governing semi-conducting materials.

The applicant is led to the conviction that in a normal state of physico-electric equilibrium, the cell nucleus is positively charged, but can acquire a negative surcharge following phenomena analogous to polarization.

The invention, especially, enables organs afflicted by this inversion of their electric potential, particularly in the case of the pathologic negative surcharge of cancerous nuclei, to recover their former equilibrium.

The following description in regard to the attached drawing, given as a non-restricting example, will make it possible to understand how the invention can be realized, the details which emerge both from the text and the drawing being, of course, part of the said invention:

Fig. 1 is a schematic section showing an apparatus for production and emission of an electromagnetic field combined according to the invention.

Fig. 2 is a frontal elevation of the cathode, taken from the right of Fig. 1.

Fig. 3 is a section through III- III in Fig. 1.

Fig. 4 is the overall scheme of the electric supply.

Fig. 5 is a view analogous to Fig. 1 showing another mode of implementation.

Fig. 6 is a section through VI-VI in Fig. 5.

Fig. 7 represents schematically an apparatus for pulsing the electric current.

Fig. 8 is the circuit of an amplifier permitting activation of the apparatus of Fig. 7 at the cardiac frequency.

Fig. 9 is the circuit of an oscillator permitting modulation of the

electric current according to a wavelength between 1 m and 18 m.

The assemblage of Fig. 1 contains an apparatus 1 emitting electrically charged particles 2 in a cavity or passage 3, a cyclotron 4 accelerating the particles 2 and sending them into a cavity 5 forming a tube into which merges another cavity 6 acting as wave-guide for electromagnetic radiation of frequency in the centimeter range emitted by a magnetron 7. The cavity 8 formed by the joining of tube 5 and waveguide 6 leads into a tube 9 in which the resulting radiation is accelerated and aligned. The interior of the cavity-formed by the assemblage of elements 1, 3, 5, 6, 8, and 9 contains argon at a pressure of 2 mm mercury.

The particle emitter 1 consists of an electron gun comprising a plate 10 and a cathode 11.

The cathode 11 is of molybdenum and has the very special form represented in Figs. 1 and 2. It consists of a rim 1la connected by two aligned spokes 11b to a hub 11c pierced by a hole 11d with its axis along XX'. The rim 11a is in two parts (as one sees in Fig. 1) which may be held together by screws (for example) forming a cavity of revolution 11e traversed by a number of holes 11f parallel to the axis XX' and regularly spaced. The filament for heating, 12, situated in the interior of the cavity 11e and is connected to the power supply conductors 12a.

The best results are obtained with a cathode 11 of molybdenum. The applicant has obtained satisfactory, but slightly inferior, results with tungsten cathodes. It turns out that molybdenum, and to a lesser degree tungsten, are the metals whose valency is closest to the mean valency of the chemical molecules constituting living tissues and more particularly those of human beings. One might well seek to use this fact to explain scientifically the phenomena involved, but it is understood that *the invention is not limited by any scientific explanation.* Concerning, on the other hand, the gas present in the apparatus at low pressure, the best results have been obtained with argon; the applicant has also obtained satisfactory, but slightly inferior, results with other gases of the rare gas series.

Surrounding the tube which constitutes the electromagnetic chamber are arranged: an electromagnet 13 with its winding 13a, placed at the level of the accelerating coils 14 and 15. Other accelerating coils 14,15 and 16 are similarly dispersed around the cavities 3, 5 and 8.

The two semi-circular boxes or "dees" 4a of the cyclotron 4 are placed in the usual manner between the poles of the frame around which are wound the accelerating coils 4b and 4c.

The magnetron 7 is of a familiar type and must be capable of

emitting in the cavity 3 a centimeter wave of adjustable wavelength from 3 cm to 80 cm.

The lower portion of the tube 9, for acceleration and alignment, contains a cathode 17 resembling the cathode 11, with a filament 17a. This cathode 17 is supported by a hollow pillar 18 pierced by holes 18a close to its junction with the bottom of tube 9. This pillar 18 communicates with a tube 18b emerging on the axis of a rotary deflector 19 carrying at each end a "crown" of graphite plates 19a inclined at 45° to the vertical. The rotating axis 19b of the rotary deflector is mounted in a support 20 fixed to the interior of tube 19 and carries at its upper extremity magnetic bobs 19c which ensure that it will be set in motion in cooperation with the magnetic bobs 21a mounted on the shaft 21b of a motor 21. The lower extremity of the rotary deflector 19 is composed of a piece of molybdenum or of tungsten 19d in the form of a pyramid whose apex is opposite the open end of the tube 9.

The hollow base 18 and the tube 18b can be of a borosilicate glass of low coefficient of expansion such as that sold under the trademark "Pyrex." They may also be of quartz. Tube 9 itself can be of "Pyrex" as above or of another glass of the quality currently used for the manufacture of electronic tubes, but its bottom 9a, which is traversed by the radiation, is advantageously made of quartz.

The duct 8 joins the tube 9 by way of several tubulures such as 8a and 8b directed in vertical planes towards the plates 19a at a certain angle, which is advantageously about 22.5°. An electromagnet 23 analogous to the electromagnet 13 of the emitter tube 1 is placed around the cathode 7. Similarly, accelerator windings 24 are disposed around the tube 9. This tube also carries, at positions indicated in the drawing, three electrodes 25, 25a, and 25b surrounded by windings 26, 26a, and 26b, respectively. The drawing shows the supply lines, 17b, 17c of the cathode and its filament and that of the plate, 22a.

The basic plan of the electric supply is represented in Fig. 4. The part 27 feeds an initial branch with low voltage alternating current: this consists of a rectifier 28 (e.g., a Kenotron) whose rectified current is modulated at a frequency variable between 30 and 120 pulses per minute by means of a resistance 29, the control apparatus lor which will be described with reference to Figs. 7 and 8. The current so modulated is passed through the electromagnets 13 and *23* in such a manner as to generate, normal to the cathodes 11 and 17, a modulated field of 10,000 to 20,000 gauss.

The part 27 also feeds a variometer (interrupter) 30 which modulates the current of this part at a variable frequency 30 to 120 pulses per minute, the current pulsed in this way serving to feed the

remainder of the installation, to wit: The magnetron 7; a converter 31 whose excitation is modulated at a variable frequency *300 to 900 Hz,* yielding a doubly modulated current (first at 30-120 pulses per minute, then at 300-900 Hz) which feeds the coils 15, 16 and 26; another converter 32 producing a low voltage direct current modulated at 30-120 pulses per minute by the variometer 30. This current feeds the motor 21 as well as the motors driving the variometer 30 and the apparatus controlling the resistance 29.

The current produced by the converter 32 also feeds a voltage step-up apparatus 33 consisting of a vibrator followed by a transformer and a rectifier, and producing a direct current varied at 30 to 120 pulses per minute imposed by the variometer 30. The maximum value of the voltage produced by the apparatus 33 is, for instance, 300,000 V, but this value may vary up or down, depending on the power one wishes to operate with.

The current produced by the voltage step-up apparatus 33 feeds the coils 4b of the cyclotron and 24 of tube 9, as well as a rheostat 34 permitting regulation of voltage to the desired value between 5000 V and 70,000 V. This voltage is applied to an oscillatory circuit 35 which produces oscillations at a frequency variable at will of wavelength between 1 m and 18 m. The current available to the output terminals 35a, 35b of this oscillating circuit 35 is thus a high tension current modulated first at 30 to 120 pulses per minute (by the variometer 30) and secondly at a wavelength 1-18 m. This current feeds the coils 4c and 14; the electrodes, 25a and 25b are connected to terminals 35a and 35b, respectively, and electrode 25 is connected to the mid-point 35c.

Cathodes 11 and 17, the "dees" of the cyclotron, and the plates 10 and 22, not shown in the diagram of Fig. 4, are connected to the output of the step-up assembly 33, while the heating current for the filaments 11e and 17a is furnished by the resistance 29.

To operate the apparatus, one adjusts the controls of the resistance 29 and the variometer to the desired rhythm; in medical applications, this is advantageously the subject's cardiac rhythm: This rhythm is thus imposed upon the whole installation. The cathode 13 emits toward the left a stream of positively charged particles 2, which are concentrated by the electromagnet 13 and accelerated by the coils 14, 15 and 16 and by the cyclotron 4. Superimposed on this particle stream in the duct 8 is the electromagnetic radiation from the magnetron 7, which is adjusted to the wavelength found by experience to be most appropriate to the cells which are to be penetrated, e.g., 14 cm for the liver and 19.5 cm for the spleen. The resulting radiation is deflected, directed and accelerated

in tube 9 and is directed by way of the base of this tube toward the target to be penetrated.

It must be noticed that the magnetic field of the coils 15,16 and 26 is modulated, by means of the converter assembly 31, at a frequency adjustable *between 300 and 900 Hz.* This modulation has the effect of concentrating the particles, that is to say to detach them from the walls of the tubes, and it also permits an appreciable saving in weight of the iron cores of the coils. One chooses the highest frequencies (i.e., around 900 Hz) when one wishes to produce hard radiation at the exit of tube 9, and the lower frequencies for soft radiation.

The unidirectional magnetic fields of the coils 4c of the magnetron (sic) (cyclotron?) and the accelerator coils 14 as well as the electric field of electrodes 25, 25a, 25b, are modulated by the oscillatory circuit 35 at a chosen wavelength between 1 m and 18 m. In medical applications notably one selects the wavelength that best suits the organ to be treated or its surroundings, such as muscle. As already indicated, experience with diathermy makes it possible to determine the most suitable wavelength.

It must be noted that the resulting radiation already possesses, in tube 8 (Fig. 1) a considerable penetrating force. One could therefore use the assemblage described by omitting tube 9 and terminating the cavity at the end of tube 8 by means of a glass or quartz base, the resulting radiation being accelerated and directed, for example, immediately upstream from the base, by a final coil (not shown) surrounding tube 8. However, tube 9 appreciably improves the results.

Figs. 5 and 6 represent another mode of realizing the assemblage in accordance with the invention, in which the elements playing the same role are indicated by the same signs as in Figs. 1 and 3, modified by primes.

The arrangement of the connecting ducts of Fig. 5 in relation to tubes 1' and 9', to the magnetron 7' and the cyclotron 4', is different from that of Fig. 1 and has been used successfully by the applicant. The waveguide 6' of the magnetron 7' opens into the end of tube 1' and the duct 3', carrying the resulting radiation, divides into two branches: Branch 36, which conducts the radiation directly to tube 9', and branch 37 which conducts it to the cyclotron 4'. This blocks the electromagnetic radiation and accelerates the stream of particles which is passed by way of duct 38 to the tube 9'.

This arrangement can be used with a particle emitter and an accelerator and director tube similar to tubes 1 and 9 of the preceding figures. However, tubes 1' and 9' of Figs. 5 and 6 are constructed in a different manner with regard to their cathodes and anodes.

Tube 1' contains a first electrode 11' exactly like that of the cathode 11 of tube 1, and an identical second electrode 39 furnished with a filament 39a. Tube 9' (Fig. 6) contains in its lower part a first electrode 17' with filament 17'a and an identical second electrode 40 with its filament 40a.

In normal operation, i.e., to produce radiation identical to that described in connection with Figs. 1 to 4, electrode 11' serves as cathode and electrode 39, given a positive potential, plays the role of the plate 10 in Fig. 1, the filament 39a being unheated. Electrode 40 and its filament 40a are disconnected; cathode 17' and plate 22' are supplied as in Fig. 3.

To obtain particularly penetrating radiation, the polarities are reversed: Electrode 11' becomes an anode and its filament 11'e is disconnected, while electrode 39 receives the cathode supply and its filament 39a is heated; electrode 17' (with filament 17'a disconnected) and electrode 22' become anodes, while electrode 40 serves as cathode and its filament 40a is heated. For example, one can establish a potential difference of 250,000 V between 40 and 17', and 50,000 V between 40 and 22'. It is understood that in these conditions the cathode 39 emits to the left a stream of electrons which is concentrated, modulated and accelerated by the various coils and in the cyclotron, the polarities of which must of course be established in the proper direction. This stream of electrons is combined with the centimeter radiation emitted by the magnetron 7', resulting in tube 9' in the emission of very hard x-rays, modulated at the chosen frequencies, combined with the centimeter radiation of the desired frequency.

The assembly shown in Figs. 5 and 6 thus permits one to obtain at will either very hard x-rays or the radiation described in connection with the preceding diagrams.

The following description, referring to Figs. 7 and 9, relates to certain details of the apparatus used for modulating the electric current.

Fig. 7 represents schematically the apparatus for control of the resistance 29 and the variometer 30. The variable resistance 29 consists of a graphite helix 29a immersed in a conducting liquid **29b;** another electrode 29c, also of graphite, partly immersed in the liquid, is set into up-and-down oscillations by a connecting rod 41a linked to a fly-wheel 41. The fly-wheel is set in rotation, through the intermediary of a worm transmission 41b, by an axle 42 which can be driven, thanks to a double clutch 42a, 42b, either by a motor 43, or by the shaft 30a of the variometer 30. The variometer 30 is driven by a motor 44 by way of the worm transmission 44a.

If the fly-wheel 41 is driven by the motor 43 at the proper speed,

the resistance 29 causes the supply current of the electromagnets 13 and 23 (Figs. 1 and 4) to vary at the chosen rhythm which as we have seen can be between 30 and 120 pulsations per minute and which can be checked by means of a rotation counter shown schematically in 45. In this case, the motor 44 of the variometer 30 can be stopped and the remainder of the installation is then not pulsed. If, on the contrary, the fly-wheel 41 is engaged in 42b and disconnected from 42a, the motor 44 activates the variometer 30 and the resistance 29 at the chosen rhythm.

The speed of rotation of motors 43 or 44 can be regulated at the required speed, corresponding visibly to the cardiac rhythm of the subject, by acting upon the excitation of these motors by means of a manually adjustable rheostat. If one prefers to regulate the speed of motors 43 or 44 in direct accord with the cardiac rhythm of the subject, one can use an assembly such as that represented schematically in Fig. 8: At 46 there is a contact microphone which, when placed over the subject's heart, produces impulses. These are amplified in the circuit shown and applied to an electromagnet at 47 with a moving core which activates a rheostat; this in turn regulates the current running the motors 43 or 44.

Fig. 9 shows schematically the principle of the oscillating circuit 35. The rectified potential, adjustable between 5000 V and 70,000 V by means of rheostat 34 (Fig. 4) is applied between the terminals 48 and 48a. Terminal 35c (which is also connected to electrode 25, Figs. 2 and 4) is connected to the neutral point on the high tension side of **the** transformer which is a component of the step-up assembly 33 (Fig. 4). The terminals 49 and 49a receive the heating current produced by the resistance 29. The variable condensers 50 and 50a make it possible to regulate to the desired wavelength (which, as seen, is between 1 m and 18 m) the current available at the output terminals 25a and 25b of the oscillator shown.

The modes of implementation described gave been successfully carried out but it is self-evident that these are only examples, and that they might be modified, notably by substitution of equivalent techniques, without going beyond the bounds of the invention. In particular, the electron gun 1 or 1' could be replaced by another charged particle generator.

Resume

The invention includes especially:

> A procedure for obtaining a combination of radiations of different kinds capable of penetrating matter, especially of

intimately penetrating living tissues in order to produce in them certain effects and more particularly in human tissues with a therapeutic effect in mind, consisting of the emission in a cavity of a stream of electrically charged particles, upon which is imposed electromagnetic radiation in the centimeter wavelength range, and the guiding of the resulting radiation emerging from the cavity toward the target to be penetrated.

2. Types of implementation exhibiting the following features taken separately or in the various possible combinations:

   a. The centimeter radiation has a wavelength between 3 cm and 80 cm;

   b. This wavelength is set at the value found by experience to be most suitable for the tissues to be penetrated, e.g., 14 cm for liver and 19.5 cm for spleen;

   c. The particle stream is accelerated by magnetic and electric fields such as those which are used in particle accelerators;

   d. The resulting radiation is accelerated and guided, before its emergence from the cavity, by means of electric and magnetic fields;

   e. The resulting radiation is guided, before its emergence from the cavity, by means of deflecting and/or reflecting surfaces;

   f. The stream of particles and/or the resulting radiation are concentrated and accelerated by means of individual magnetic fields modulated at a frequency between 300 and 900 Hz, the highest frequencies being used to produce hard rays and the lower frequencies to produce soft rays;

   g. The emission of the particle stream, as well as the acceleration and concentration of the radiation result ing at its exit from the cavity, are aided by individual magnetic fields of temporally variable intensity, advantageously pulsed at a rhythm between 30 and 120 pulsations per minute and preferably at the cardiac rhythm of the subject;

h. The assemblages for production of the resultant radiation are pulsed in their entirety at the same rhythm as the magnetic fields according to g;

i. The stream of particles and/or the resulting radiation are accelerated and concentrated by direct magnetic and/or electric fields modulated at a wavelength between 1 m and 50 m and preferably between 1 m and 18 m, this wavelength being advantageously chosen as that which is known in diathermy as suitable for the tissues to be penetrated or for the surrounding tissues.

3. An assemblage making it possible to obtain a combination of a stream of electrically charged particles and a beam of centimeter electromagnetic waves in order to penetrate intimately and to irradiate living tissues and particularly human tissues, the said assemblage comprising at least a particle emitter, means for channeling said particles in a cavity serving as waveguide for an emitter of electromagnetic radiation of which the wavelength is included in the range of centimeter waves and preferably adjustable from 3 cm to 80 cm, means for generating in the cavity magnetic field for acceleration and concentration and means for concentrating and accelerating the resulting radiation at the exit of the cavity.

4. Modes of implementation with the following details taken separately or in the various possible combinations:

a. The particle emitter is an electron gun of which the anode is at the end of the cavity and the cathode is situated further along, this cathode being hollow and placed in the magnetic field of an electromagnetic in order to ensure emission of a stream of particles towards the mouth of the cavity;

b. The cathode consists of a rim connected by two aligned spokes to a hub, the said rim being provided internally with an annular housing containing a heated filament and the said housing communicating with a number of holes arranged annularly and traversing the rim transversely;

c. The cathode is made of a metal of valency close to the

mean valency of the chemical molecules comprising the tissue to be penetrated;

d. The cathode is of tungsten or preferably of molybdenum;

e. The cavity contains a rare gas, preferably argon, under a vacuum of the order of 2 mm Hg;

f. The cavity contains a duct carrying at least part of the stream of particles to a cyclotron and a duct bringing back into the cavity the particles accelerated in the cyclotron;

g. The cavity passes through several coils, the supply current for the various coils being capable of undergoing modulation at different frequencies;

h. The downstream end of the cavity is composed of a tube containing, in the part from which the resulting radiation must emerge, a cathode and an electromagnet which may be identical to the cathode and the electromagnetic according to para. a, an anode near the other end, and a rotary deflector consisting of a number of plates arranged *en couronne* on a rotor lacing the incident radiation at such an angle that the radiation deflected and/or reflected is directed toward the cathode, several coils whose supply current can be modulated being distributed over the length of the tube;

i. This tube also contains electrodes supplied by alternating current generating an electric field at the level of the rotary deflector, each of the said electrodes being surrounded by a bobbin of which the supply current can be modulated;

j. Methods are anticipated for modulating, at an adjustable rhythm between 30 and 120 cycles per minute, the supply current of the electromagnetic according to a and h, and preferably to modulate the supply current of the rest of the assemblage at the same rhythm;

k. Methods are anticipated for modulating, at a frequency between 300 and 900 Hz, the supply current of the bobbins surrounding according to i and one or several

coils according to g;

l. Methods are anticipated for modulating, at an adjustable wavelength between 1 m and 50 m and preferably between 1 m and 18 m, the supply current of the electrodes according to i, of one or several of the coils generating the magnetic field of the cyclotron;

m. The electrodes of the electron gun consist of two electrodes identical to the cathode according to a, b, c, or d, the cathode of the tube according to h is replaced by a double electrode reproducing the arrangement of the electrodes of the electron gun, and methods are anticipated for reversing at will and simultaneously the polarities of these two pairs of electrodes and the direction of flow of the current supplying the acceleratory coils, a first pattern of polarities assuring the functioning of the apparatus in the conditions which are laid down according to a, and a second pattern of polarities assuring emission in the cavity of a stream of electrons combined with the centimeter radiation and giving rise, at the exit of the said tube, to emission of very hard x-rays.

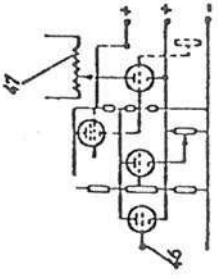

Fig. 18

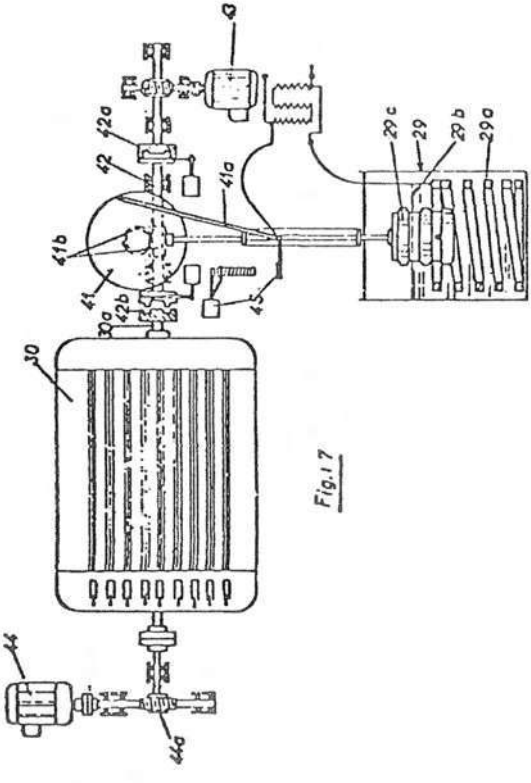

Fig. 17

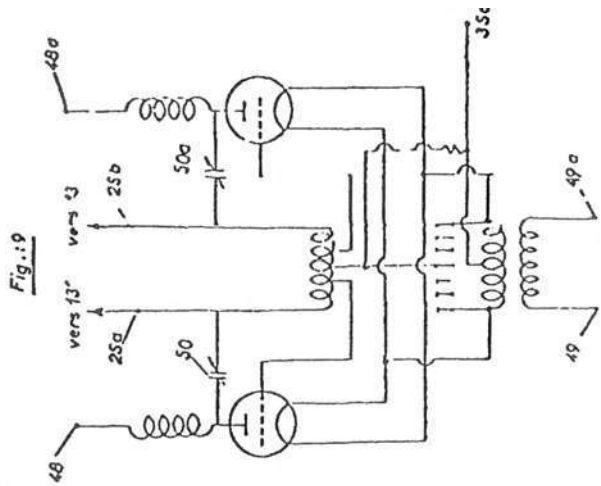
48a
48
50a
50
25b
25a
vers 13
vers 13'
49a
49
35c

Fig.:9

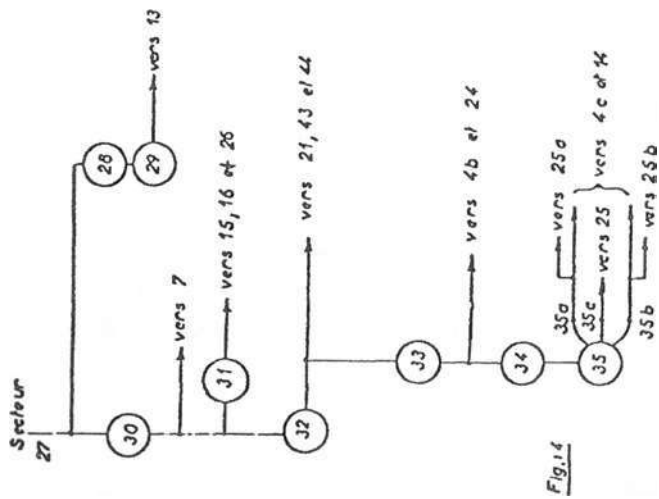
Secteur
27
28
29
30
31
32
33
34
35
vers 13
vers 7
vers 15, 16 et 26
vers 21, 43 et 44
vers 4b et 24
vers 25a
vers 4c et 14
vers 25
vers 25b
35a
35c
35b

Fig.:4

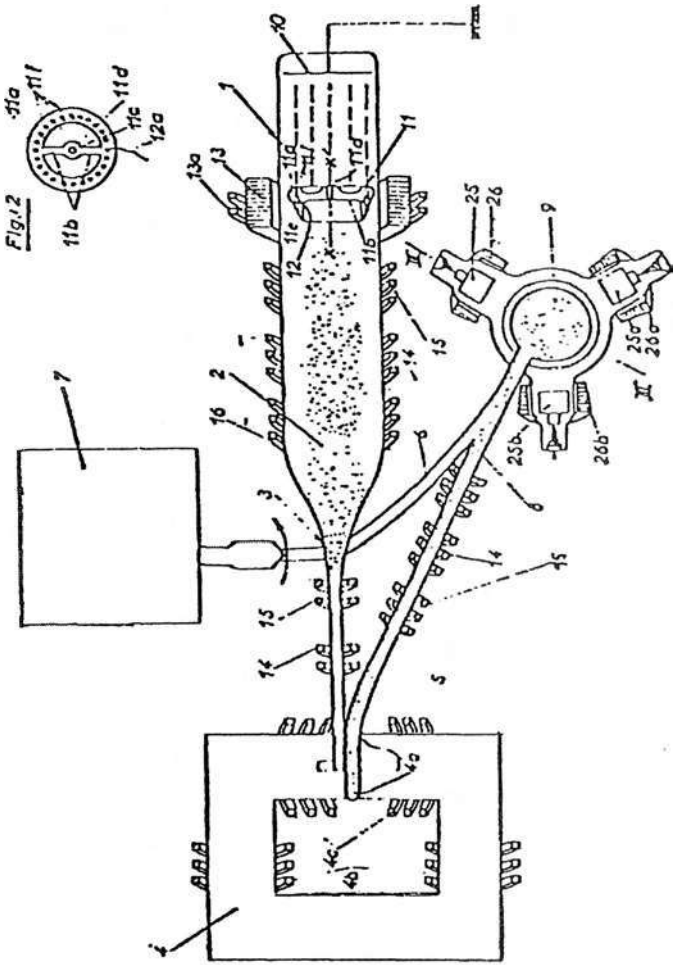
Fig.1
Fig.2
11a
11b
11c
11d
12a
13a
13
12
11
10
1
2
3
4
5
6
7
9
14
15
16
25
26
25a
26a
25b
26b

Fig. 3

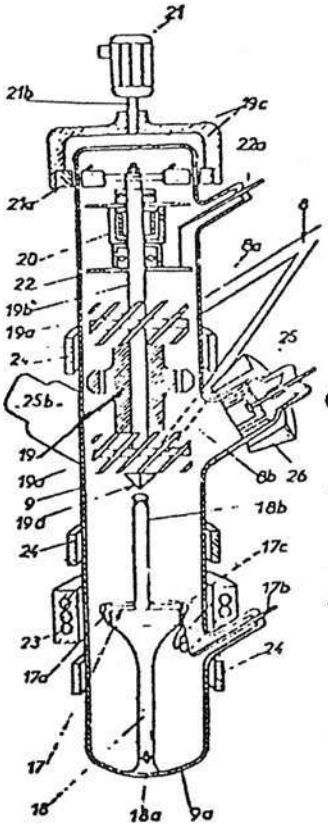
21
21b
19c
22a
21a
20
22
19b
19a
24
25b
19
19a
9
19a
24
23
17a
17
18
18a
9a
8a
8
25
8b
26
18b
17c
17b
24

Fig. 6

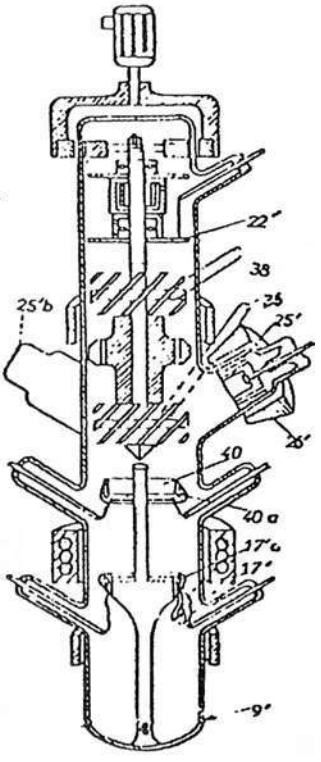
22'
38
25'b
25
25'
26'
40
40a
17'a
17'
9'

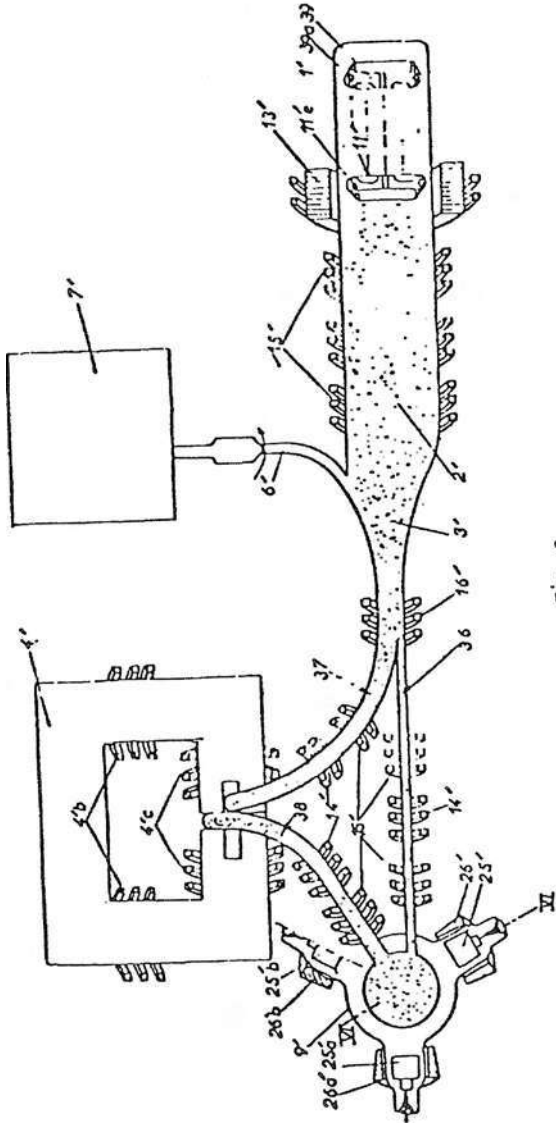
1'
3a
3b
11'
11'a
13'
15'
7'
6'
2'
3'
16'
36
37
4'
4'b
4'c
38
14'
35'
25'
23'
VI
25'b
26'b
9'
26'a
25'a

Fig. 5

Two Patents of G. Lakhousky

June 12,1934 G. LAKHOVSKY 1,962,565

APPARATUS WITH CIRCUITS OSCILLATING UNDER MULTIPLE WAVE LENGTHS

Filed Nov. 13, 1931

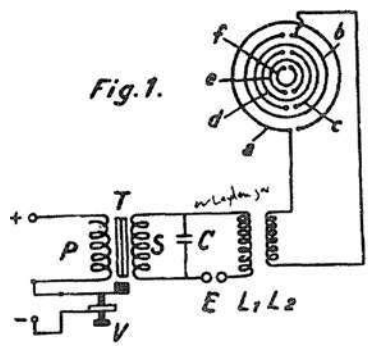

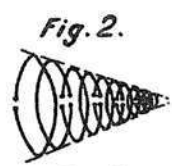

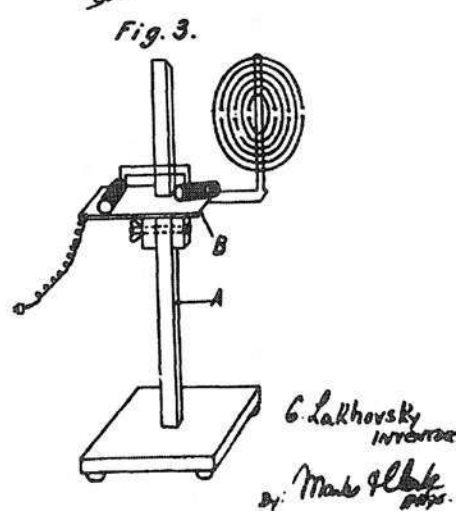

Patented June 12, 1934 1,962,565

UNITED STATES PATENT OFFICE

1,962,565

APPARATUS WITH CIRCUITS OSCILLATING UNDER MULTIPLE WAVE LENGTHS

Georges Lakhovsky, Paris, France

Application November 13, 1931, Serial No. 574,907
In France May 2, 1931

7 Claims. (Cl. 250—33)

The present invention has for its object an apparatus capable of sending out simultaneously different wave lengths so that among these waves or their harmonics there is found almost always one or several capable of producing the best effect sought for any application whatever.

There is used for that purpose the property of open circuits having a fundamental or natural self induction and capacity to oscillate upon a well determined wave length if they are excited by electric impulses emanating from discharges of any source.

The radiating part of the system, producing waves of various lengths, is therefore constituted by a certain number of concentric open rings of different diameters, which are maintained insulated by any appropriate process. These rings may or may not be terminated by small spheres forming capacities.

These rings may be arranged either in the same plane or in different planes so as to form any surfaces, such as portions of cones, spheres, paraboloids, ellipsoids, etc. . . . these surfaces being of a nature to concentrate the waves in a determined direction in the manner of a reflector, for example.

These rings may be fed by any producing device whatever of high frequency, for example, a combination comprising a trembler coil (or any other transformer) and a high frequency circuit provided with a self-induction coil and a capacity.

One or several points of this high frequency circuit is or are connected to the end of one or several of the rings forming the radiating apparatus. The other rings not connected are excited by induction.

The complete apparatus (coil, high frequency circuits, rings, etc. . . .), may be mounted in a box or upon a small board capable of sliding along a guide or rocking so as to be able to be placed in the most convenient position.

In the accompanying drawing, by way of example, not limitative, there is shown:

Fig. 1 a diagram of the system.

Fig. 2 the position of the rings in the form of a cone.

Fig. 3 the apparatus mounted upon a foot or base.

In Fig. 1 there is seen at T the transformer or coil (P the primary, S the secondary of this coil), V, the screw of the trembler, C the condenser the discharge of which across the spark gap E produces oscillations in the self-induction coil L^1, which in its turn acts by induction upon the self-induction coil L^2; this self-induction coil L^2 is connected on one side to the first exterior ring *a*, on the other side to the following ring *b*. It thus forms an electrostatic field of high frequency which induces oscillations in the other rings *c*, *d*, *e*, *f*.

As a modification, L^2 may be suppressed and the rings *a* and *b* may be connected each to one of the ends of L^1.

One of the ends, or even any point of the self-induction coils L^1 or L^2 may likewise be connected to any one of the rings.

Fig. 2 shows the arrangement of the rings in the form of a cone.

The open circuits *a*, *b*, *c*, . . . *f* can be constituted by solid conductors. They can also be tubular circuits, this being advantageous, since, for the same bulk, the radiating surface is larger. Finally, the area of the cross section of each of these various circuits can vary from one circuit to the other; for instance, this area can decrease from the periphery (ring *a*) to the center (ring *f*) of the radiating system.

Fig. 3 shows the apparatus mounted upon a foot A along which it can slide, in order to be placed at any desired height and upon a hinge B which allows it to be oriented upon the horizon.

I claim:—

1. An apparatus adapted to produce electric fields of high frequency having multiple wave lengths, comprising a high frequency producing device, a series of high frequency radiating circuits constituted by concentric insulated split rings of different diameters, the split ends being spaced from each other and terminating with small spheres.

2. An apparatus adapted to produce electric fields of high frequency having multiple wave lengths, comprising a high frequency producing device, a series of high frequency radiating circuits constituted by concentric insulated split rings of different diameters and terminated by small spheres forming capacities.

3. An apparatus adapted to produce electric fields of high frequency having multiple wave lengths, comprising a high frequency producing device, a series of high frequency radiating circuits constituted by concentric insulated split rings of different diameters and arranged in one and the same plane the split ends being spaced from each other and terminating with small spheres, in staggered position as regards adjacent rings.

4. An apparatus of the type described comprising a base, a plate slidably mounted on said

base, a support pivoted to the said plate, a series of open and insulated, high frequency radiating circuits mounted on the pivoted support, and a high frequency producing device for the excitation of the said circuits.

5. An apparatus adapted to produce electric fields of high frequency having multiple wave lengths, comprising a high frequency producing device, a series of high frequency radiating circuits, said circuits being open, insulated, and having dimensions different from each other.

6. An apparatus adapted to produce electric fields of high frequency having multiple wave lengths, comprising a high frequency producing device, a series of high frequency radiating circuits arranged in the same plane, said circuits being open, insulated, and having dimensions different from each other.

7. An apparatus of the type described comprising a transformer, a high frequency energizing circuit fed by the said transformer and provided with a self-induction coil and a capacity, a series of open and insulated high-frequency radiating circuits having dimensions different from each other, an inductive connection between two of these radiating circuits and respectively each of the poles of the outgoing element of the high frequency energizing circuit.

GEORGES LAKHOVSKY.

Patented June 13, 1944 2,351,055

UNITED STATES PATENT OFFICE

2,351,055

TUBE FOR PRODUCING MULTIPLE WAVE LENGTHS

George Lakhovsky, New York, N. Y.; Anne-Marie Louise Lakhovsky, administratrix of said George Lakhovsky, deceased, assignor to Henry S. Blum, Chicago, Ill.

Application November 21, 1941, Serial No. 420,006

11 Claims. (Cl. 250—33)

This invention relates generally to electric devices excited by electric impulses and more particularly to multiple wave length conducting and/or producing means. This invention has for its primary object the provision of such means disposed within a vacuum tube or a tube containing rare gas or gases.

My work over a period of more than 20 years has led me to the belief that there is great need for means conducting and/or producing multiple wave lengths which may be employed in many industrial and medical fields. Suitable apparatus for producing waves of various lengths is disclosed in my U. S. Letters Patent No. 1,962,565, dated June 12, 1934. Embodiments of this apparatus have been in use the world over. Because of the need for simplification in such apparatus so that it may be handy and easily used by persons lacking skill in electrical matters, I have concluded that by providing one unit which incorporates oscillation generating means and another in which the wave lengths are produced, the apparatus may be more universally used in the treatment of cellular life in therapy, in the aging or treating of liquids and in other industrial fields.

The present invention deals with those units, preferably combined with one another and constructed as a portable device and as stated above, has for its major object the provision of a unitary multiple wave length producing and/or conducting device in the form of a vacuum tube.

The present invention further contemplates the incorporation in such a tube, of means for varying the effect of wave lengths, or selectively employing the means therefor enclosed in or forming part of said tube.

This invention further seeks to provide a tube of the indicated type incorporating means for generating oscillations.

Another object of the invention is to provide a single unit which contains an oscillation generator, which produces waves of definite frequency, and further inductance means each permitting emanation of wave lengths of various values.

The structural features of my invention also form a material part of this disclosure, the objects and advantages being attained in structures such as shown in the accompanying drawing, which exemplifies the invention. The following specification, based on said drawing, more clearly points out the purposes and advantages of my invention.

In the drawing:

Fig. 1 is a vertical, partial sectional, partial elevational view of a tube incorporating features of my invention.

Fig. 2 is a similar view of an alternate form thereof.

Fig. 3 illustrates in a similar manner a modified form of my invention.

Fig. 4 is a fragmentary sectional view of a modification made in accordance with the invention.

Fig. 5 is a similar view of another modification.

Figs. 6 and 7 are sectional views illustrating types of wires used in either of the forms of my invention as shown in Figs. 1, 2 and 3.

Fig. 8 is a partial sectional, partial elevational view illustrating a tube incorporating a plurality of grids and selective capacity means for varying the effects of said grids.

Fig. 9 is a similar view of a tube, such as shown in Figs. 1 or 2 and incorporating oscillating or vibrating means.

In that form of my invention shown in Fig. 1, there is provided a sealed preferably transparent envelope 10 made of glass or like material affixed in the usual manner to a screw or Edison plug 11. The latter is conventionally provided with a shell terminal 12 and a central terminal 13. The support or seal 14 of the tube serves to hold wires such as 15 and 16 which connect to the terminals 12 and 13.

Connected to the wires 15 and 16 is a primary inductance member in the form of a loose coil 17 which may be disposed axially of the envelope 10, as shown. The upper end of said member 17 forms a tight wound coil 18 which serves to radiate the strongest induced wave lengths.

Surrounding the primary inductance member 17, there are arranged a plurality of separate coils of wire each being of different length and capacity. Thus, I provide a coil 19 having greatest capacity and successive coils 20, 21, 22, 23, 24, and 25, each having less capacity than the preceding coil. These coils 19 to 25 form secondary inductance means each permitting emanation of a wave length of different magnitude and value than the other.

I may support the secondary coils in several ways. As shown, I prefer to provide a dielectric member such as a glass sleeve 26 surrounding the primary inductance wire member 17 and to mount the secondary coils 19 to 25 on the outer surface of said sleeve, leaving the coil 18 exposed at the top thereof. In order to effectively support and centralize the glass sleeve 26, I provide spacing washers 27 and 28 of mica or the like, top and bottom, and provide a supporting cross-piece 29 on the lower portion of the wire 17.

June 13, 1944. G. LAKHOVSKY 2,351,055

TUBE FOR PRODUCING MULTIPLE WAVE LENGTHS

Filed Nov. 21, 1941

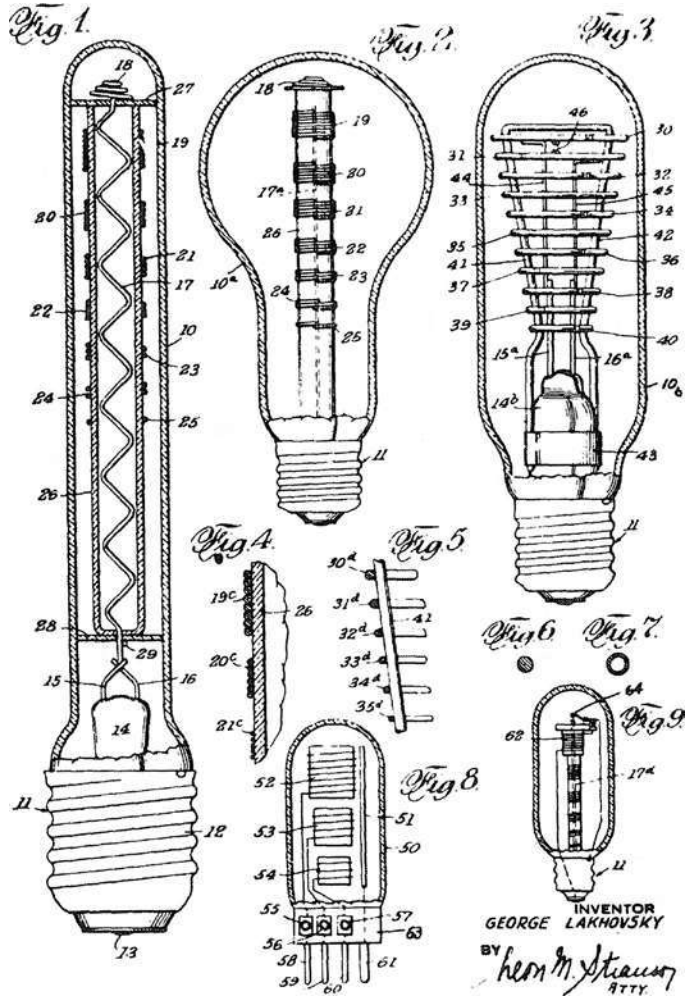

INVENTOR
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BY Leon M. Strauss
ATTY.

The tube above described may be employed as indicated for the treatment of cellular structures by connecting it to any one of the rings in the electrostatic field of high frequency, such as shown in said U. S. Letters Patent No. 1,962,765 each of the coils 13 to 25 producing by induction a different wave length, as can be understood.

In the form of my invention shown in Fig. 2, the envelope **10a** is somewhat differently shaped, and the wire **17a** straight instead of arranged as an open coil. In other respects, the structure follows that described with reference to Fig. 1.

As shown in Fig. 3, there may be arranged a plurality of open rings **30**, **31**, **32**, **33**, **34**, **35**, **36**, **37**, **38**, **39**, and **40** in frustro-conical form, for instance, with the largest of said rings at the top and the smallest one adjacent the bottom. I have shown said rings as supported, for instance, by glass posts **41** and **42**, said posts being supported on the seal **14b**, as by a band **43**. I provide extensions for the terminal wires **15a** and **16a** and connect said extensions **44** and **45** to the upper ring **30** and the next lower ring **31**, respectively.

The rings **30** and **31** may become the primary inductance members, whereas the remaining rings constitute the secondary inductance members as before set forth. Electric current conducted to the suitably spaced rings **30**, **31** will cause a spark **46** to be drawn between the rings **30** and **31** providing oscillations emanating from electrical discharges therebetween and causing the radiation of waves of various lengths within the envelope **10b** and affecting the remaining rings.

In Figs. 1 and 2, I have shown the secondary coils as formed of wires having uniform cross-section. Fig. 4 illustrates how such wires may be made progressively smaller in the succeeding coils **19c**, **20c**, and **21c**, etc. Similarly, I have shown the rings of Fig. 3 made progressively smaller in Fig. 5, said rings being designated by numerals **30d**, **31d**, **32d**, **33d**, **34d** and **35d**, etc. In such various manners, the wave length producing effect of the secondary coils or rings may be arrived at.

The secondary coils or rings may be round or somewhat flattened wire as shown in Fig. 6 or tubular as in Fig. 7, offering a yet greater flexibility of design.

The devices of Figs. 1 and 2 above described may be incorporated in the system shown in said U. S. Letters Patent by connecting one of the rings *a*, *b*, *c*, *d*, *e*, or *f* with plug **11** of Fig. 1, since either terminal **15**, **16** is in contact with primary inductance member **11**. To this end a conductor (not shown) connects such a ring with said plug or socket.

In Fig. 8, I have shown a modification of the invention which comprises a vacuum tube **50** containing a plate **51** and a plurality of different wave lengths producing grids **52**, **53**, and **54**. I connect each grid with a variable capacity device, such as **55**, **56**, and **57** carried by said tube **50** and preferably by its base support **63**, whereby the grids may be selectively connected into an operating circuit (not shown) by means of the respective prongs **58**, **59**, and **60**, and the plate prong **61**. Heating or other exciting means may be incorporated in the tube in a well-known manner. This combination tube **50** is designed to replace a plurality of known tubes each operating with different and variable wave length effect, mere exterior manipulation at said base support brings about change of the capacities **55**, **56**, and **57** and cutting in one or more of the grids **52**, **53**, and **54**.

The effect of the spark as produced in the form of the invention depicted in Fig. 3 may be further utilized in Fig. 9 in which I also incorporate a vibrator **62** which produces electrical oscillations by a spark intermittently generated between the end of the primary inductance member **11d** and vibrator armature **64**. In other respects the structure follows that of Fig. 1.

It may be noted that any type of spark producing or oscillation generating means may be substituted for the vibrator shown. The tubes shown in Figs. 3 and 9 may be used in the manner described for Fig. 1 by connecting one terminal of the base as set forth to produce an induction effect. These tubes may be also connected across both terminals with a suitable potential to obtain the spark effect.

From the foregoing it may be seen that I have provided tubes in various forms for the purpose of generating and conducting multiple wave lengths. Other forms of the invention may be produced within the spirit and scope of the invention as claimed.

Having thus described my invention, what I claim as new and desire to be secured by Letters Patent, is:

1. A device of the character described comprising a vacuum tube having an envelope and base, primary inductance means, and a plurality of separate secondary inductance means of different length for radiating waves of various lengths extending above said primary inductance means, all said inductance means being arranged within said envelope.

2. A device of the character described comprising a vacuum tube having an envelope and base, a primary inductance member axially arranged in said envelope, and a plurality of secondary inductance members spaced apart and independent from each other each member surrounding a respective portion of said primary inductance member and within the field of influence thereof.

3. A device of the character described comprising a vacuum tube having an envelope and base, a primary inductance member axially arranged in said envelope, and a plurality of secondary inductance members each surrounding the primary inductance member and within the field of influence thereof, each of said secondary inductance members having a different wave length effect than the others.

4. A device of the character described comprising a vacuum tube having an envelope and base, a primary inductance member comprising a pair of split rings in inductive relation, and a plurality of secondary inductance members each comprising split rings.

5. A device of the character described comprising a vacuum tube having an envelope and base, a primary inductance member comprising a pair of split rings in inductive relation, and a plurality of secondary inductance members each comprising split rings, said latter rings being arranged in different planes and being of different length to produce a different wave length effect.

6. In a device of the character described, means for producing multiple wave lengths comprising a wire member, enclosing dielectric means for said member, and a plurality of separate wire coils of different lengths on said dielectric means and in the field of inductance of said wire member.

7. In a device of the character described,

means for producing multiple wave lengths comprising a wire member, enclosing dielectric means for said member, and a plurality of wire coils on said dielectric means and in the field of inductance of said wire member, each coil extending over said wire member and having a different number of convolutions than the others.

8. In a device of the character described, means for producing multiple wave lengths comprising two split rings in inductive relation, and a plurality of split rings in inductive relation to the two split rings.

9. In a device of the character described, means for producing multiple wave lengths comprising two split rings in inductive relation, and a plurality of split rings in inductive relation to the two split rings, the plurality of rings being of smaller diameter than the mentioned two rings and each progressively smaller than the others.

10. In a device of the character described means for producing multiple wave lengths comprising two split rings in inductive relation, and a plurality of split rings in inductive relation to the two split rings, the plurality of rings being of smaller diameter than the mentioned two rings and each progressively smaller than the others, all of the rings being arranged in frusto-conical disposition.

11. In a vacuum tube having a primary inductance member and secondary inductance members, a vibrator arranged in the field of influence of said primary inductance member and secondary inductance members, a vibrator arranged in the field of influence of said primary inductance member for affecting the induction of said secondary members.

GEORGE LAKHOVSKY.

T.H. Moray's Patent
Electrotherapeutic Apparatus
Feb. 1, 1949

Feb. 1, 1949. T. H. MORAY 2,460,707

ELECTROTHERAPEUTIC APPARATUS

Filed April 30, 1943 3 Sheets-Sheet 1

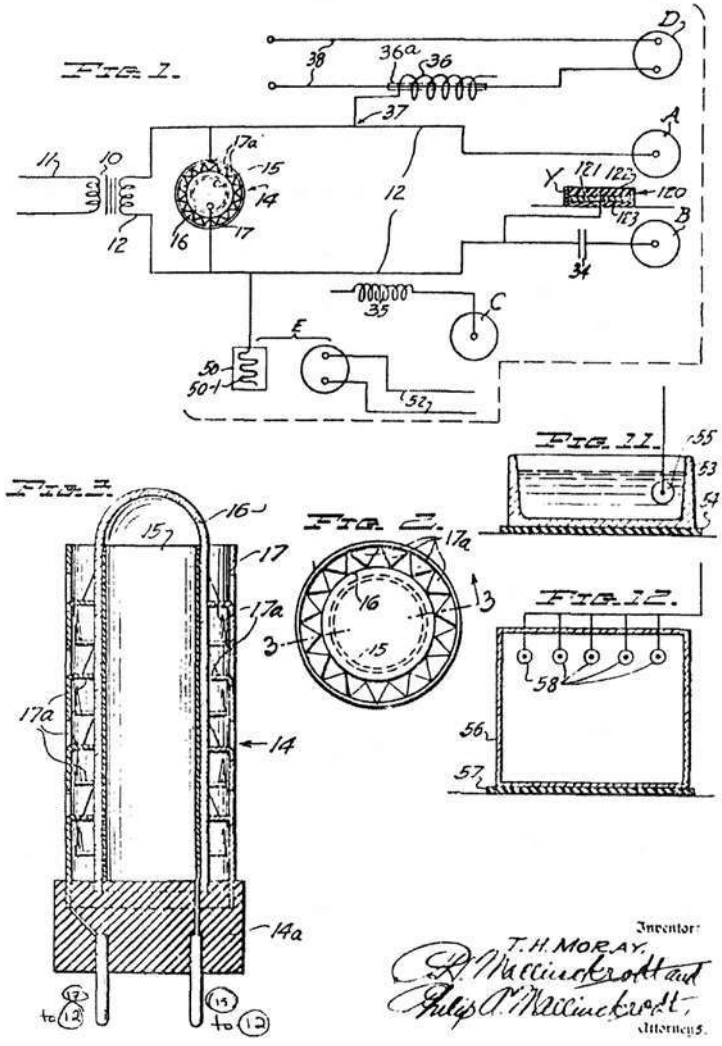

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Feb. 1, 1949. T. H. MORAY 2,460,707

ELECTROTHERAPEUTIC APPARATUS

Filed April 30, 1943 3 Sheets-Sheet 2

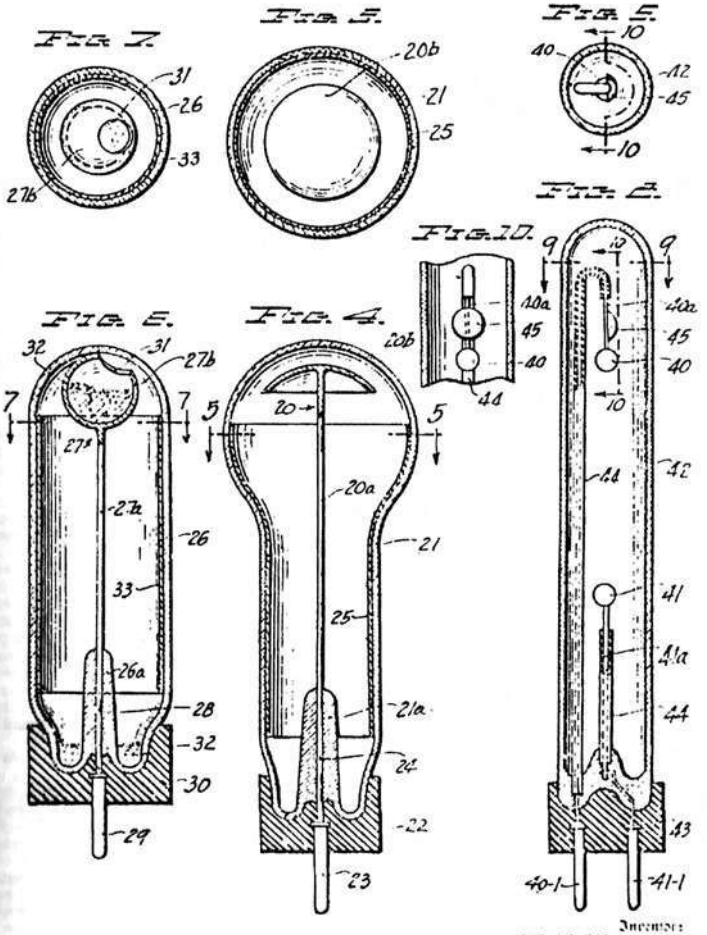

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Feb. 1, 1949. T. H. MORAY 2,460,707

ELECTROTHERAPEUTIC APPARATUS

Filed April 30, 1943 3 Sheets-Sheet 3

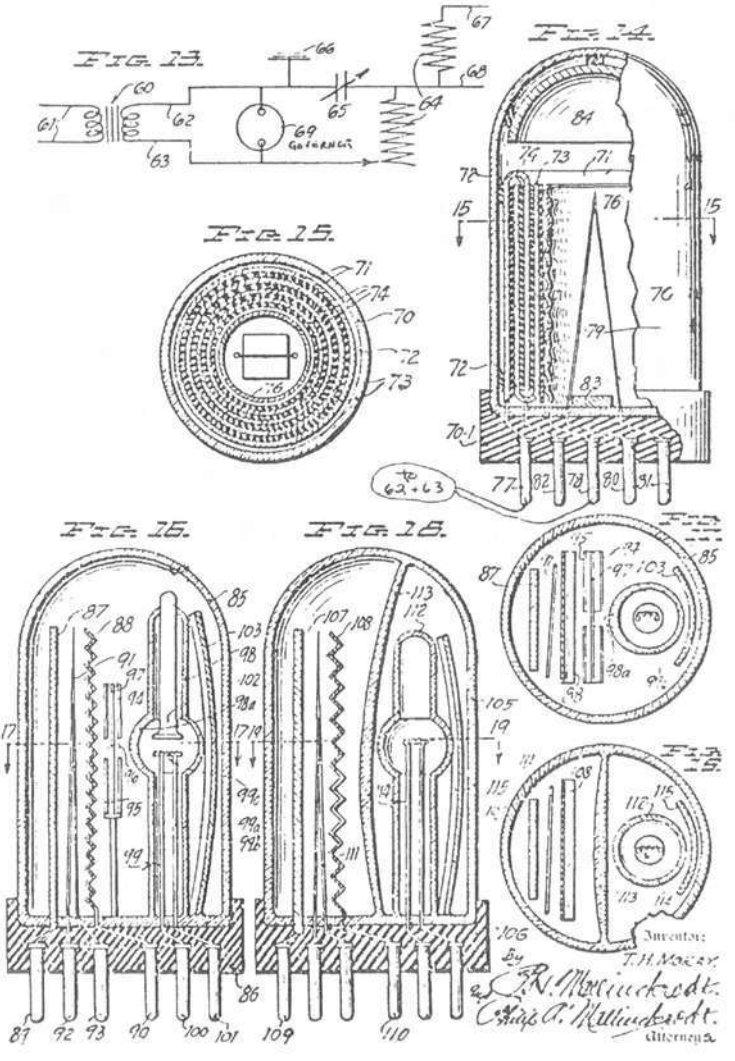

Patented Feb. 1, 1949 2,460,707

UNITED STATES PATENT OFFICE

2,460,707

ELECTROTHERAPEUTIC APPARATUS

Thomas H. Moray, Salt Lake City, Utah

Application April 30, 1943, Serial No. 485,112

8 Claims. (Cl. 128—421)

1

This invention relates to electrotherapeutic apparatus, and to methods of applying electrical, radioactive, and other radiant phenomena therapeutically.

The invention is primarily concerned with the use of high potential, high frequency electricity though not necessarily limited thereto, in conjunction with radioactive and other types of electronic and radiation phenomena, for therapeutic purposes.

Among the objects of the invention are the following:

First.—To render highly effective, from a therapeutic standpoint, radioactive and other types of electronic and radiation phenomena, and, likewise, to render highly effective, from a therapeutic standpoint, high potential, high frequency electricity.

Second.—To augment the therapeutic effect of radioactive and other types of electronic and radiation phenomena by the conjoint use of high potential, high frequency electricity, and, conversely, to augment the therapeutic effect of high frequency, high potential electricity by the conjoint use of radioactive and other types of electronic and radiation phenomena.

Third.—To accomplish the above without danger of burning or of otherwise harming the patient.

Fourth.—To provide apparatus for accomplishing the above, which is relatively simple in construction and operation and relatively inexpensive to produce and operate.

Fifth.—To provide novel electronic and radioactive devices especially adapted for use in conjunction with high potential, high frequency electrical therapy.

I have found that, by enveloping a patient in a high potential, high frequency electrical field in such a manner that no closed circuit is completed through his body, radioactive and other electronic and radiation phenomena can be used therapeutically with considerably greater effectiveness than if used alone. The exact reason for this is not known, nor is it known definitely which, the electric field or the radioactive phenomena, acts upon the other to produce the advantageous results. It is thought, however, that the electric field, permeating the body of the patient as it does, attracts the radioactive emanations or radiations and enables them to penetrate considerably deeper into the tissues and vital organs of the patient than would otherwise be the case. In any event, remarkable therapeutic results have been achieved by use of the invention in the treatment

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of malignant tumors, arthritis, sinus infections, and various other diseased conditions.

The invention contemplates the use, in therapeutics, of high potential, high frequency electricity to produce diversified forms of radiant energy, such forms being those which have been found best suited, individually, to benefit various human ailments. In accomplishing this purpose, several special discharge tubes have been developed to serve as treatment electrodes, by means of which correspondingly different curative results are obtained. Throughout the practice of the invention, a prime consideration is that only one terminal of any particular circuit shall be in contact with a patient's body at one time, so there will be no flow of current through a closed circuit of which the patient's body is a part. Such a terminal, too, is usually non-heat producing, so there is no danger of burning. In cases where there is a tendency for a tube to produce X-rays or other injurious rays, these are filtered out.

The present application constitutes a continuation in part of a copending application filed by me November 15, 1940, which bears Serial No. 365,798 and is entitled "Method of and device for the therapeutic application of electric currents and rays," and which has now become abandoned.

In the accompanying drawings, which illustrate several embodiments of apparatus preferred for carrying the method of the invention into practice:

Fig. 1 represents a wiring diagram of a preferred embodiment of apparatus for carrying out the method of the invention in general therapeutic work, several independent treatment stations being provided;

Fig. 2, a top plan view of the novel corona regulator of Fig. 1, employed in the circuit to control and adjust the current and as a governor to safeguard the transformer;

Fig. 3, a vertical section taken on the line 3—3, Fig. 2;

Fig. 4, a vertical section taken centrally through one novel type of discharge tube used as a treatment electrode in the apparatus of Fig. 1;

Fig. 5, a horizontal section taken on the line 5—5, Fig. 4;

Fig. 6, a vertical section taken centrally through another novel type of discharge tube used as a treatment electrode in the apparatus of Fig. 1;

Fig. 7, a horizontal section taken on the line 7—7, Fig. 6;

Fig. 8, a vertical section taken centrally through

a novel discharge tube used as a treating device in the apparatus of Fig. 1;

Fig. 9, a horizontal section taken on the line 9—9, Fig. 8;

Fig. 10, a fragmentary vertical section taken on the line 10—10, Figs. 8 and 9;

Fig. 11, a fragmentary view in vertical section, and drawn to a reduced scale, of a tub bath capable of use as a treatment station in the apparatus of Fig. 1;

Fig. 12, a view similar to that of Fig. 11, but showing a shower or vapor bath arrangement for the same purpose;

Fig. 13, a wiring diagram similar to that illustrated in Fig. 1, but fragmentary in nature, and of a somewhat different embodiment of apparatus;

Fig. 14, an elevation, partly in central vertical section, of a novel tube used in the apparatus of Fig. 13 in place of the corona regulator of Figs. 2 and 3;

Fig. 15, a top plan view, partly in horizontal section on the line 15—15, Fig. 14, of the tube of Fig. 14;

Fig. 16, a vertical section of another novel tube which may be used in place of the tube of Figs. 14 and 15;

Fig. 17, a vertical section taken on the line 17—17 of Fig. 16;

Fig. 18, a top plan view of still another novel tube which may be used in place of the tubes of Figs. 14 and 15 and of Figs. 16 and 17; and

Fig. 19, a vertical section taken on the line 19—19 of Fig. 18.

In accordance with the invention, provision is made for enveloping the patient in a high potential and, in certain instances, a high frequency electric field, and for applying to the patient, while so enveloped in the electric field, radiations and emanations having therapeutic value.

The apparatus of Fig. 1 is capable of administering various specific kinds of treatment, pursuant to the invention, at the several treatment stations provided. The treatment stations are indicated A, B, C, D, and E, respectively.

For supplying the high potential electric field, a suitable transformer is employed. This may be of any type capable of delivering high potential electricity, say from 10,000 to 30,000 volts. It is preferred, however, to utilize a conventional double magnetic circuit type of transformer, indicated at 10 in Fig. 1, having adjustable, laminated, magnetic shunts (not shown), the transformer being connected across an ordinary power line 11 charged with the customary 115 v. The output lines 12 from this transformer advantageously extend to the treatment stations A and B, respectively. The first secondary of the transformer 10 is preferably direct connected to the second secondary thereof. It is noted that this high potential electricity may be applied, without causing injury, direct to a patient who is not grounded. However, in order to safeguard the transformer 10 from damage by sparking across its output terminals, and to render the high potential electricity more suitable for therapeutic purposes, which is believed to include the automatic changing of the frequency to an extent which depends upon electrical characteristics of the patient's body, a governor or control device 14 is shunted across the leads 12.

This governor or control device 14 is a sparking condenser of high capacity embodying a multitude of spark gaps. A preferred embodiment of

this governor or control device 14 is illustrated in detail in Figs. 2 and 3.

As illustrated, the device comprises a cylindrical, electrically conductive plate 15 surrounded by a cylindrical dielectric 16. An outer cylindrical and electrically conductive element 17 surrounds the dielectric 16 exteriorly. It is provided with a multitude (for example, 250) of inwardly extending prongs 17a, which are advantageously formed by stamping out, and inturning, triangular portions of the electrically conductive element 17. The internal plate 15 preferably contacts the interior surface of the dielectric 16, but, in any event, should lie closely adjacent thereto. Likewise, the tips of the prongs 17a preferably contact the outer surface of the dielectric. The several elements are advantageously mounted in a plug-in base 14a, which is adapted to mate with a suitable receiving socket (not shown) carrying the required electrical connections. The internal plate 15 connects with one of the electric lines 12, while the other electric line 12, as shown diagrammatically in Fig. 1.

It is preferable that the dielectric 16 be in the form of a closed tube or envelope, as shown, and be exhausted to vacuum condition. The multitude of sparking prongs 17a product a brush discharge.

Where the dielectric 16 is not a closed tube or envelope, it is preferred that it be of quartz.

The treatment station A is a discharge tube of a novel type, exemplified by the tubes illustrated in detail in Figs. 4 and 5 and Figs. 6 and 7. Either tube is plugged into the circuit of Fig. 1 at a suitably provided, single-terminal outlet. High potential electricity is, therefore, fed directly into the tube, which serves as an electrode. The tube also embodies radioactive material, which supplies radioactive emanations to the patient simultaneously with the electrical discharge.

As illustrated in Figs. 4 and 5, the tube or electrode may comprise an electrically conductive discharge element 20, having a supporting stem 20a and a major discharge cap or head 20b, which is preferably in the form of a thin, convex-concave plate. The head 20b may be spot welded to the end of the stem 20a.

The discharge element 20 is enclosed within a tube 21 of dielectric material, preferably glass, the stem 20a being fixed in the fused tongue portion 21a of the tube. The tube or shell 21 is fitted into an insulating base 22, provided with a single plug-in terminal 23, and an electrical connector 24 extends from the terminal 23 to the stem 20a.

The inside surfaces of the side walls of the tube or shell 21 are coated with a radioactive material, as at 25. The coating is conveniently made from uranium salts or powdered carnotite or other radioactive ore. The ends of the tube or shell are left uncoated.

Air is evacuated from the tube 21, and a small quantity of mercury introduced. The mercury is preferably triple-distilled to insure great purity. It is preferred that argon or like inert gas be also introduced.

Since the tube just described is plugged into the circuit of Fig. 1, the discharge element or cathode 20 is charged with high potential electricity, and, in its capacity of a treatment station in the apparatus of Fig. 1, serves as an electrode to similarly charge the patient. The patient is insulated from the ground, and the tube is applied directly to the afflicted part of his body, preferably in close contact with the body.

Because of the construction of the tube, radiation of a radioactive nature is also directed against the patient through the uncoated top end of the tube. This radiation has been found to differ somewhat from the radioactive emanations discharging from the side walls of the tube, and is thought to comprise rays lying close to X-rays on the radiation spectrum. These rays appear to have a definite healing value, and to lack the injurious nature of X-rays. Where a predominantly radioactive emanation treatment is desired, the side walls of the tube are placed against the body of the patient.

Best results are obtained when the discharge element or cathode 20 is made of an alloy metal compounded from copper, lead, sulphur, and, if desired, aluminum. The relative percentages of the several ingredients may vary considerably, but a satisfactory mixture comprises 5.0% copper, 55.0% lead, 30.0% sulphur, and 10.0% aluminum. Should aluminum not be used, the difference may be made up by additional copper.

In preparing the alloy, the copper and aluminum are heated to a molten state, after which the sulphur is added while stirring the mixture. After cooling, the mass is again melted, and the lead, in a molten state, is mixed with it, the molten mass being thoroughly stirred. This new mass is then cooled, being later reheated, and, while hot, rolled to make it ductile, so it can be shaped into the desired forms.

The discharge tube or electrode of Figs. 6 and 7 is similar to that of Figs. 4 and 5, having an enclosing tube or shell 26 which is evacuated. A cathode discharge element 27 is positioned within the shell, being fixed in the tongue portion 26a. A conductor 28 connects the stem 27a of the element 27 with a plug-in terminal 29, which extends outwardly of the base 30. The cap or head 27b of the element 27 differs from the cap or head 20b of the electrode of Figs. 4 and 5, in that it is spherical in form and hollow. It has an opening 31 formed at its top, contiguous with the top inside surface of the tube 26. A quantity 32 of radioactive material, which may be the same as used for the coating 25 of the electrode of Figs. 4 and 5, is introduced into the tube or shell 26, along with a relatively small quantity of mercury, before the tube is sealed tight. Such material 32 is preferably powdered or granulated, and is shaken into the hollow of the head 27b through the opening 31 before any given treatment is commenced. The mercury is provided primarily as a getter, and does no harm if shaken into the head 27b along with the radioactive substance. The mercury also tends to produce a vapor in the tube, which aids in the operation thereof. As in the case of the electrode tube of Figs. 4 and 5, this tube may have a radioactive coating 33 covering the inner surfaces of its side walls.

The treatment station B of Fig. 1 differs from the treatment station A only in the fact that a condenser 34 is interposed in the electric supply line 12.

The treatment station C of Fig. 1 differs from the stations A and B only in the fact that the high potential electricity is supplied from the supply line 12 through an inductance 35.

The treatment station D utilizes a germicidal discharge tube, a preferred form of which is illustrated in detail in Figs. 8, 9, and 10. The high potential electricity is taken by induction from the particular supply line 12 concerned. For this purpose, an induction coil 36 is provided, tapping the line 12 at 37. A pair of leads 38 from an ordinary 115 v. supply source extend to a plug-in socket connection for the germicidal tube, one of the leads passing through a glass tube 36a, Fig. 1, which is disposed within and extends along the length of the induction coil 36. Thus, high potential electricity is impressed, by induction, upon the ordinary current flowing through the particular lead 38 concerned.

The germicidal discharge tube of Figs. 8, 9, and 10 has a pair of discharge terminals 40 and 41, respectively, positioned in an evacuated tube or envelope 42, and electrically connected with plug-in terminals 40—1 and 41—1, respectively, by means of stems 40a and 41a, respectively. The tube or envelope 42 and plug-in terminals are mounted in a conventional base 43. It is preferred that insulating material 44, such as a ceramic sleeve, cover the major portions of the stems 40a and 41a. A piece of lithium metal 45, see particularly Fig. 10, is advantageously secured to the stem 40a adjacent the discharge terminal 40 to act as a getter. It may, however, be placed at any other convenient location in the tube. It is preferred that the discharge terminals 40 and 41 be formed of the special alloy previously described. Argon or other suitable inert gas is preferably injected into the tube or envelope 42, as is, also, a small quantity of mercury. The mercury, by vaporizing, aids electrical arcing between the discharge terminals. As will be noted, the high potential electricity induced in the one lead 38 will manifest at the upper discharge terminal 40, and will charge the patient simultaneously with the discharge into his body of germicidal rays from the tube.

The treatment station E embodies the tube of Figs. 8, 9, and 10, as above described, but impresses the high potential electricity directly on the patient instead of passing it first through the tube. For this purpose, a discharge device 50, in the form of a soft, flexible pad in which a coil 50—1 is embedded, taps one of the high potential electric lines 12. This pad 50 is wrapped around the patient's body adjacent the afflicted portion thereof, thus charging the patient. Any other electrode capable of charging the patient with high potential electricity may be used in place of the pad 50. The germicidal tube has its terminals 40—1 and 41—1 plugged into a suitable plug-in socket connected to leads 52 which extend to an ordinary 115 v. source of supply. The high potential electricity with which the patient is charged is induced into the germicidal tube, thereby further activitating the discharge therefrom. A certain beneficial discharge from this germicidal tube will be had by induced activation alone, it being unnecessary, in such instances, to plug the tube into the 115 v. line.

Other types of germicidal and discharge tubes may be used in place of the tube of Figs. 8, 9, and 10, as, for instance, the well known infra-red and ultra-violet lamps, to produce results surpassing those ordinarily attained by the use of such infra-red or ultra-violet lamps apart from the apparatus of the invention.

It should be remembered that the patient is insulated from the ground while being treated at any of the treatment stations of the invention.

Figs. 11 and 12 show how a patient is treated, pursuant to the invention, while immersed in an electrically conductive fluid bath. In Fig. 11, a bath tub 53 is insulated from the ground by a

layer of insulation 64. A treatment electrode of the type shown in any of the figure groups 4 and 5, 6 and 7, and 8, 9, and 10 is positioned to charge the fluid of the bath with high potential electricity, as well as to discharge healing radiations and emanations into the patient. The particular electrode illustrated is diagrammatic in form and is designated 55. It may be connected into the circuit of Fig. 1 as shown at any of the treatment stations A, B, C, and D. In Fig. 12, a shower or vapor stall 56 is insulated from the ground by a layer of insulation 57. A plurality of treatment electrodes are designated 58, respectively. These correspond to the treatment electrode 55 of Fig. 11. A water spray or vapor, such as steam, may be admitted to the stall 56 in any well known manner (not shown), thus enveloping the patient during treatment.

Another embodiment of apparatus, pursuant to the invention, is illustrated diagrammatically by the wiring diagram of Fig. 13. While no treatment stations are shown, those provided are identical with the several treatment stations designated A, B, C, D, and E in Fig. 1. The distinction in this embodiment of apparatus resides in the fact that a special generator of high frequency electricity is provided in the system.

A transformer 60 has its input terminals connected across an ordinary 115 v. electric power line 61. Electrical conductors 62 and 63 lead from the respective output terminals of the transformer to a high frequency generator of the Oudin coil type, indicated generally at 64, a variable condenser 65 being interposed in the line 62, and the circuit being grounded at 66. Output conductors 67 and 68, leading from the high frequency generator 64, provide connections for the several treatment stations in the same manner as illustrated in Fig. 1.

The transformer 60 may be any ordinary high voltage type. A governor or control device 69 is shunted across the conductors 62 and 63.

In the illustrated instance, the governor or control device 69 preferably takes the form of a vacuum tube, having the construction shown by Figs. 14 and 15, Figs. 16 and 17, or Figs. 18 and 19. These tubes all possess high capacity, and include elements effecting a brush discharge. They serve, as does the device 14 of Figs. 2 and 3.

The tube of Figs. 14 and 15 embodies an outer shell or envelope 70 of insulating material such as glass, a plastic, or fiber coated with shellac. Inside the shell 70 is a bi-cylindrical element 71 formed of electrically conductive material. Separating element 71 from the enclosing shell 70 are spacers 72 made of rubber, Bakelite, or other insulating material. Inter-fitting with the element 71 is a second electrically conductive, bi-cylindrical element 73, the two elements being separated by a dielectric 74. Inwardly of the element 73, and separated therefrom by a dielectric 75, is a corrugated, cylindrical element 76. The shell or envelope 70 is secured in an insulating base 70—1, provided with plug-in terminals. One of the terminals, designated 77, is electrically connected with the element 71, while another, designated 78, is electrically connected with the corrugated element 76. These two terminals connect with the conductors 62 and 63, as illustrated in Fig. 13, and the brush discharge takes place at element 76.

Under certain circumstances, it is desirable that the outer shell 70 be made of quartz glass, and that a filament 79 be provided, the filament being heated by connection, through plug-in terminals

80 and 81, with a source of low voltage heating current (not shown). Plug-in terminal 82, which is electrically connected with element 73, may be used instead of or in connection with the terminal 77, since element 73 acts in a manner similar to element 71. A getter 83 of suitable material, and an insulating and reflecting shield 84 may be provided, as shown. While the tube may have either a high or a low vacuum condition, or may be filled with an inert gas, I have also found it advantageous to fill the tube with a moist vapor. The tube acts as an oscillator for electric currents, and has an enormous capacity, a capacity many times that of a condenser of approximately equal size.

The tube of Figs. 16 and 17 comprises an outer shell or envelope 85, which may be made of metal, glass, or fused quartz. This shell is mounted in an insulating base 86. Inside the shell 85 is a metal plate 87, and, spaced apart therefrom, a corrugated metal plate 88. A plug-in terminal 89, which extends from the base, is electrically connected with the plate 87, and a second plug-in terminal 90 is electrically connected with the corrugated plate 88. These terminals are adapted to connect, through a suitable socket, with the electrical conductors 62 and 63 of Fig. 13.

Under certain conditions of use, it is desirable to have other elements in the tube. These are provided, and may be utilized or not as occasion warrants. A filament 91 is disposed between the plates 87 and 88. It is electrically connected with the two plug-in terminals 92 and 93, which are adapted to be connected to a source of low voltage heating current (not shown). A slit screen, comprising shields 94 and 95, with apertures 91 extending therethrough, is disposed adjacent that side of corrugated plate 88 which is remote from plate 87. The apertures 96 are in alignment with each other, and the shields 94 and 95 are made of lead or other material capable of screening off X-rays. Between shields 94 and 95 is a sheet 97 of material which is readily permeable to X-rays. Within the shell 85 there is also mounted a shell or envelope 98 of glass, quartz glass, or similar material, having a portion 98a which is ground like a lens and directed toward the slit screen. This shell 98 really constitutes a tube within a tube. A filament or cathode 99, comprising electrically conductive legs 99a and 99b and an electron-emitting portion 99c, is disposed within the shell 98, plug-in terminals 100 and 101 being electrically connected to the respective legs 99a and 99b. A bombardment element 102 is disposed within the shell 98 opposite the portion 99c of cathode 99. Within the shell 85, but outside the shell 98, is a reflector 103 directed toward the slit screen.

The tube of Figs. 18 and 19 is essentially the same as the tube of Figs. 16 and 17, being equipped with a shell or envelope 105, a base 106, a plate 107, and a corrugated plate 108, the two plates being connected to plug-in terminals 109 and 110, respectively, which are adapted to connect electrically with the conductors 62 and 63 of Fig. 13. There is a filament 111 and an inner shell or envelope 112, but no slit screen. Instead of a lens portion being provided on the inner shell 112, a partition 113 of lens formation is disposed between the inner shell and the corrugated plate 108. It is fused to the walls of the outer shell 105. Within the inner shell 112 is a filament or cathode 114, which corresponds to the similar element 99 of

the tube of Figs. 16 and 17. A reflector 115 is directed toward the lens partition 113.

Reverting now to Fig. 1, there is another advantageous way of treating a patient pursuant to the invention. As shown at Y, a foot pedestal 120 may be provided for making the patient a part of a condenser. The pedestal comprises an electrically conductive plate element or electrode 121, connected electrically with one of the high potential lines 12, and covered by an insulating platform 122 upon which the patient rests his feet while being treated at any of the previously described treatment stations A, B, C, D, or E. The electrode 121 and insulating platform 122 are conveniently mounted in a frame 123, which insulates the plate from the ground. The insulating platform 122 is made of a high quality insulating material, such as first grade hard rubber. In certain instances it is desirable that the device be made in other than foot-pedestal form. For instance, it may be of cylindrical formation for use in a bed against any part of the patient's body.

If desired, the patient may be charged with the high potential electricity by direct contact with a metal or electrically conductive electrode in place of the pad 50 of treatment station E, or of the tube electrodes.

The invention has been described in the foregoing with sole reference to its use for therapeutic purposes. It should be noted, however, that inorganic matter may also be treated to advantage pursuant to the method and with the apparatus of the invention. It has been found that metals, for example, lead, have changed physical properties after treatment in accordance with the above. In instances where the invention is not being used therapeutically, it is not always necessary to insulate the subject from the ground.

Whereas this invention is here illustrated and described with respect to particular specific embodiments thereof, it is to be understood that various changes may be made in such specific embodiments and various other embodiments may be utilized by those skilled in the art without departing from the spirit and generic scope of the invention as set forth herein and in the claims which here follow.

Having fully described my invention, what I claim is:

1. Apparatus for applying radiant energy therapeutically, comprising means for producing high potential, high frequency electricity; a high capacity sparking condenser, and a treatment electrode connected in circuit with the foregoing, said treatment electrode including a discharge element adapted to charge the patient with said high potential, high frequency electricity, and radioactive means adapted to discharge radioactive emanations into said charged patient.

2. Apparatus in accordance with claim 2, wherein the sparking condenser is in the form of a vacuum tube of high capacity having mutually spaced capacity elements adapted to produce a corona discharge.

3. Apparatus for applying radiant energy therapeutically, comprising means for producing high potential, high frequency electricity; a high capacity sparking condenser; and a treatment device connected in circuit with the foregoing, said treatment device including discharge means adapted to charge the patient with said high potential, high frequency electricity, and radiating means adapted to discharge radiations into the charged patient.

4. Electrical treatment apparatus, comprising a high capacity sparking condenser; a treatment outlet electrically connected to said condenser; and means for electrically connecting said condenser to a source of high potential electricity.

5. Electrical treatment apparatus, comprising a transformer for producing high potential electricity; a high capacity sparking condenser electrically connected across the high potential output terminals of said transformer; and a treatment outlet electrically connected to said condenser.

6. Electrical treatment apparatus, comprising a transformer for producing high potential electricity; a high capacity sparking condenser electrically connected across the high potential output terminals of said transformer; and a plurality of treatment outlets independently electrically connected to said condenser.

7. Electrical treatment apparatus, comprising a transformer for producing high potential electricity; a treatment electrode electrically connected to one of the output terminals of said transformer; an electrical conductor sheathed by insulation electrically connected to the other of the output terminals of said transformer and disposed adjacent said treatment electrode so the subject to be treated may be placed between and in contact with the two; and a high capacity sparking condenser connected across the said outlet terminals of the transformer.

8. In electrical treatment apparatus equipped with means for the supply of high potential electricity and a treatment electrode, a high capacity sparking condenser electrically connected between the said supply means and the said treatment electrode.

THOMAS H. MORAY.

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Two Patents of William J. Hooper

FIG. 1

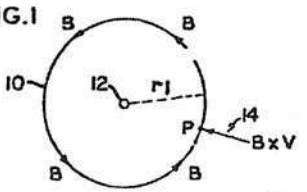

FIG. 3

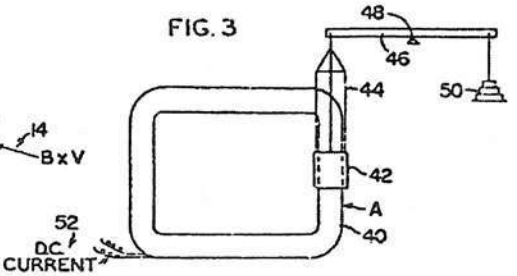

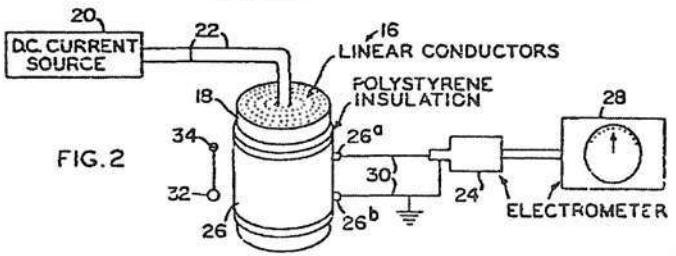

FIG. 2

FIG. 4

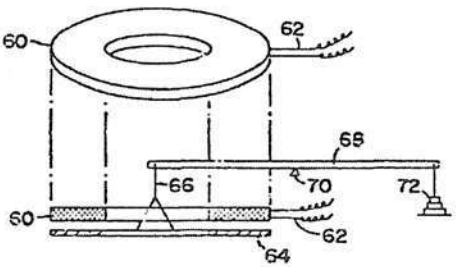

FIG. 5

FIG. 6

FIG. 8

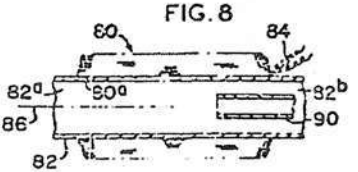

FIG. 7

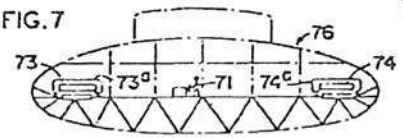

INVENTOR
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ATTORNEYS.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,610,971 Dated October 5, 1971

Inventor(s) William J. Hooper

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 14, after "conductor" insert -- with -- and delete "electric charges".

Col. 1, line 45, "10^{17}" should be -- 10^{-7} --.

Col. 2, line 4, "nd" should be -- and --.

Col. 2, line 25, "3.6×10^{12}" should read -- 3.6×10^{-2} --.

Col. 2, line 44, "motion" should be -- motional --.

Col. 4, line 7, "anitgravitational" should read -- antigravitational --.

Col. 4, line 22, "he" should be -- the --.

Col. 5, line 20, "out" should be -- our --.

Col. 6, line 26, after "conductor" delete "o" and insert -- to --.

Signed and sealed this 16th day of May 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. — ROBERT GOTTSCHALK
Attesting Officer — Commissioner of Patents

United States Patent

[11] 3,610,971

[72] Inventor William J. Hooper
Sarasota, Fla.
[21] Appl. No. 816,356
[22] Filed Apr. 15, 1969
[45] Patented Oct. 5, 1971
[73] Assignee Electrodynamic Gravity, Inc.

[54] ALL-ELECTRIC MOTIONAL ELECTRIC FIELD GENERATOR
5 Claims, 8 Drawing Figs.

[52] U.S. Cl. 310/10
[51] Int. Cl. H02n 11/00
[50] Field of Search 310/10, 11; 324/109; 336/181, 225; 338/284, 297

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Primary Examiner—D. X. Sliney
Attorney—Oldham & Oldham

ABSTRACT: This invention relates to an all-electric generator yielding a motional electric field in the space surrounding the device, but requiring no mechanical movements of its parts in generating this field. The Theory underlying the production of such a field postulates that each moving electron constituting the current in a linear conductor carries with it a loop of magnetic field energy about it.

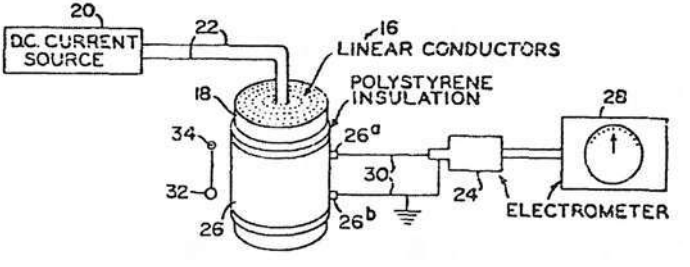

ALL-ELECTRIC MOTIONAL ELECTRIC FIELD GENERATOR

This application is an extension of the teachings presented in my earlier filed pending applications, Ser. Nos. 722,587, filed Apr. 19, 1968 and 803,187, filed Feb. 28, 1969.

PRIOR HISTORY

The detection of a magnetic flux about a current-carrying conductor was first made in 1820 by Hans Christian Oersted. This discovery unified the then separate sciences of electricity and magnetism. My experimental discovery that this magnetic flux actually moves along the conductor electric charges the electric charges constituting the current has great promise of now unifying the three known fields of electricity, magnetism and gravitation.

For a better understanding of the invention, reference should be had to the accompanying drawings wherein:

FIG. 1 is a schematic illustration of a wire containing flowing electrical current indicating the magnetic field generated with respect thereto;

FIG. 2 is a perspective block diagram schematic of a preferred embodiment of the invention;

FIGS. 3 and 4 illustrate modifications of the generator of FIG. 2 adapted to techniques for studying and utilizing gravitational and antigravitational phenomena;

FIG. 5 illustrates the winding of the wire in the device of FIG. 2;

FIG. 6 illustrates the winding of the wire in the device of FIG. 4;

FIG. 7 illustrates the incorporation of a plurality of the devices of the invention into a spacecraft where they might be appropriately utilized; and

FIG. 8 illustrates a coil wound embodiment useful for producing the separation of oppositely charged ions in gases or liquids.

BACKGROUND INFORMATION

The law of Biot and Savart yields the magnetic flux density B (webers/m.^{2}) at a point distant r meters from the conductor carrying a current of I amperes and is given by

$$B=\mu_o I/2\pi r \qquad (1)$$

where $\mu_o=4\pi\times10^{-7}$ webers/amp. meter. With reference to FIG. 1 of the drawings, this flux consists of circular magnetic loops directed counterclockwise, as shown by arrow 10, for current directed in a linear conductor wire 12 at right angles to this paper and outwardly toward the reader.

Electrons producing this flux will be moving perpendicularly into the paper, carrying the flux B with them, at a velocity V meters/sec. Thus, at any point P, distant r_1 from the long linear conductor 12, there will be existent a motional electric field of intensity $E=B\times V$ volts/meter directed radially inward toward the wire in the plane of the paper, as indicated by vector arrow 14, where $B\times V$ is the vector cross product of B and V.

PREFERRED EMBODIMENT

The preferred embodiment of the invention is illustrated in FIG. 2 and consists in part of many insulated linear conductors indicated generally by numeral 16, all parallel, packed and held in close proximity, and connected in series, so as to form a solid package 18 preferably cylindrical in shape. When a constant direct current from a source 20 is caused to flow through wires 22 this device with its axis in the vertical direction, half of the linear conductors 16 will have current flowing upward and half downward. It will be a noninductive device, since surrounding it the magnetic flux due to the upward currents will be superimposed on the flux due to the downward currents, so that no magnetic flux can be measured. On the well recognized "Principle of Superposition of Fields," each one exists however, and acts as though the other was absent.

When the package 18 of linear conductors has a circular cross section there will exist two systems of circularly directed magnetic flux, one directed clockwise and the other counterclockwise as seen from above, and one set moving upward and the other set moving downward. What is of capital interest however is that each of these two systems give rise to equal radially and inwardly directed $B\times V$ motional electric fields distributed laterally in horizontal planes in the space about the cylindrical device. Here we have a field which is not magnetic, is not electrostatic, and which I have shown experimentally to be immune to electrostatic shielding. No such spacially distributed field is known to Physics today except that of gravity. I have shown theoretically that this field should act attractively on electrically neutral matter. I have shown experimentally that the intensity of this field can be measured with the aid of an electrometer system 24, 28 driven by the potential difference induced electromagnetically in the conductors 30 connecting the electrometer to the capacitor plates 26a and 26b of the capacitor 26. The electrometer head 24 actuates a visual dial indicator 28.

At cryogenic temperatures the drift velocity of the electrons in the linear conductors will be greatly enhanced. Theoretical calculations indicate that this velocity in copper at 20° C. is of the order of 3.6×10^{22} cm./sec. in a current density of 480 amp./cm^2. The random velocity of free electrons in conductors is theoretically estimated at 10^8 cm./sec. At superconducting temperatures when the electrical resistance approaches zero, it is generally believed that the drift velocity of electrons approaches the value of 10^8 cm./sec. This velocity is 10^{10} times greater than the velocity at 20° C. (See "Physics," Halliday and Resnick, pages 681 and 691, J. Wiley, 1962). This indicates that the intensity of the $B\times V$ field about the device, herein described, might possible be enhanced 10^{10} times at or near the absolute zero of temperature. Hence, the invention contemplates that each of the devices described hereinafter will preferably be operated at or below the critical temperature at which the conductor used becomes superconducting. As the state of the art advances new conducting materials will undoubtedly become available with critical temperatures very considerably above the absolute zero.

Not only does the device that has been described in FIG. 2 afford apparatus hitherto unavailable for the generation of a special distribution of the motion electric field, but it affords means for investigating the properties of this field in connection with its relation to gravity and antigravitational phenomena. In addition, it affords for the first time, a direct experimental method for determining the electron drift velocities and mobilities in linear conductors made of different materials.

When the cylindrical capacitor 26 is charged by the $B\times V$ field and its potential difference (P.D.) measured, it is determined by the equation

$$\text{P.D. (volts)} = B\times V\cdot l \qquad (2)$$

where l is the distance between the thin capacitor plates. The direct measurement of V meters/sec. can then be made

$$V=\text{P. D. (volts)}/Bl \text{ m./sec.} \qquad (3)$$

where B is in webers/m.^{2}.

This device will exhibit an attractive force on electrically neutral matter, better defined as a differential force; i.e. the difference between a pull and push, in which the pull is greater. (See reference to general theorem, page 125, The Mathematical Theory of Electricity and Magnetism, by Sir James H. Jeans) The $B\times V$ field is an electrical field acting on all the elementary charges comprising the atoms of matter, electrons, protons and even neutrons, as I believe neutrons also consist of electrons and protons in close bond. The $B\times V$ force being relatively weak does not ionize the atoms of matter, but being immune to shielding, electrically polarizes them. This causes a slight elongation of some of the electrons orbits within the atoms in the direction of the field. The positive charges move slightly into the more intense region of the converging, radially directed field while the negative charges move slightly further way from the device into the weaker por-

tion of the field. Thus the differential force between the pull and the push upon the component parts of an atom results in the polarization of the atoms and a resultant attractive force, equivalent, I believe, to that of gravity.

A small, electrically neutral, simple pendulum 32 suspended close to one side of my device of FIG. 2, about pin 34, should thus undergo a slight measurable deflection under a fairly strong $B \times V$ motional electric field. At cryogenic temperatures this attractive force should be greatly enhanced. When the device is lying horizontally, a gravity meter placed centrally over it should give a measurable reading in milligals.

Modifications of my generator such as are shown in FIGS. 3 and 4 show diverse methods for studying gravitational and antigravitational phenomena which the invention makes possible. FIG. 3 illustrates a rectangular coil 40 made up of a single wire passed many times in the coil configuration so as to provide a large leg A preferably having a circular cross section. However, any cross-sectional configuration would meet the objects of the invention as long as the wires are parallel to each other and closely packed. About one leg of the coil, a cylindrical shell 42, made of electrically neutral, conductive or nonconductive material, is suspended by a carrier frame 44 from one end of a sensitive beam balance 46. The beam pivots about a support bar 48 and carries a load 50 to normally counterbalance the weight of the shell 42. When a fairly strong DC current I is fed through lines 52 and is built up in the coil, the flux density B is generated in the region of the cylindrical weight whose walls are a distance r from the central axis of the coil and n is the number of linear conductors in the coil.

$$B=\mu_0 nI/2\pi r \text{ (webers/meter}^2\text{)} \quad (4)$$

If the current I is suddenly cut off the flux B will rapidly collapse. This flux in the act of collapsing should cross the walls of the suspended cylinder with a considerable inwardly directed horizontal velocity of V meters/sec. This should yield a very considerable vertical $B \times V$ in the walls of the cylinder directed either up or down, depending on the direction of the current in the coil.

In this device the motional electric field $B \times V$ is not convergent, but is uniformly vertical, hence the pull and push exerted on the electric components of the atoms in the cylinder will be equal. In other words the action of this field will either enhance or decrease the state of polarization already existing within the cylinder and produced by the gravitational field of the earth. If the polarization is increased, then the gravitational pull of the earth's field should be greater. If the polarization is decreased then the weight of the cylinder should be less. It is conceivable that the polarization could be reduced to zero. In this case, the object should be weightless. If the intensity of the depolarizing $B \times V$ field is still further increased, then polarization in the opposite direction to that produced by the earth's field should be achieved. In this event the earth's gravitational field would act repulsively on the cylinder. This would be antigravity in its truest sense.

The apparatus I have just been describing acts only momentarily (during the time interval in which the flux is collapsing) to change the weight of the cylinder shell 42 (shown in FIG. 3).

It is desirable to have an apparatus with which to experimentally study gravitational and antigravitational phenomena under steady continuous conditions. In FIG. 4 of the drawings is shown another modification of the device shown in FIG. 2. Here I utilize a noninductive coil wound in the form of a solid, low, thick walled, hollow, right circular cylinder, and indicated generally by numeral 60. DC current is supplied through lines 62 to the coil 60. In the region directly beneath this coil disk 60 I place a similarly shaped nonferrous disk 64, suspended by a carrier 66 to the end of a beam 68. The beam 68 is pivotal about a fulcrum 70 and is counterbalanced by a load 72. For positions of disk 64 below coil 60, the $B \times V$ field can only be directed vertically upward when a continuous DC current is flowing in the wires composing the disk 60. It should be noted that this field is practically uniform and parallel close to the disk, hence it is not attractive in its action on neutral matter. Its action on such matter can only change the state of electrical polarization in the matter. Any change thus effected in the state of polarization should cause the earth's gravitational field to act less intensely, on any object placed close to the under surface of the device, causing it to weigh less, become weightless, or to actually be accelerated upward by the antigravitational action of the earth's field.

FIG. 5 of the drawings illustrates the manner in which the noninductive device in FIG. 2 is wound with wire 22, by turning the linear conductors back on themselves through a 180° turn. FIG. 6 illustrates the way the noninductive windings of the device illustrated in FIG. 4 is achieved. One very long insulated wire is simply turned back on itself at its midpoint and wound double into a solid coil held together in the shape illustrated.

FIG. 8 illustrates a modified embodiment of the invention which comprises a wire coil 80 either simply wound, or noninductively wound, around a hollow tube 82. Electrical current is passed to the coil 80 through wires 84, and at low temperature this coil will produce a radially, outwardly directed, internal $B \times V$ field from the axis 86 of the cylinder to the internal circumference 80a of the coil 80. The electrical wire making up coil 80 is preferably a ribbonlike conductor which is coated with any appropriate electrical insulation. A minimum space between adjacent turns with concentricity between adjacent turns is the preferred winding embodiment for coil 80. As many courses of turns as deemed appropriate to generate field strength desired will meet the objects of the invention. The tube 82 is preferably made of material having little or no magnetic permeability. Both the coil 80 and tube 82 are stationary.

An apparatus of the type illustrated in FIG. 8 might be utilized to effect separation and concentration of fluids. For example, in the desalinization of water, a $B \times V$ electric field generated by the passage of the current through the coil 80, acts upon the disassociated ions of the sodium chloride in solution. Hence, by introducing a flow saline water at end 82a of tube 82, and providing a concentric separating tube 90 at end 82b of tube 82, increments of fluid which are concentrated with chlorine and depleted of sodium may be drawn off through the stationary tube 90, while the increments of fluid which are concentrated with sodium and depleted of chlorine may be drawn off through the space between the exterior walls of tube 90 and the interior walls of tube 82.

FUTURE APPLICATIONS

This country's space projects have become expensive beyond the ability of the average man to comprehend. Achieving lift by means of costly propellants will some day soon be seen as akin to primitive man's use of awkward clubs as a means of exerting force. In a very short interval of time an intense $B \times V$ field should effect the reversal of the gravitational polarization of an object. Once achieved, only a very small expenditure of energy would be required to hold the polarization. Energy from the atoms of the earth would supply the lift and propulsion through the medium of the earth's gravity field. The most formidable problem would appear to be the problem of holding the $B \times V$ generator at cryogenic temperatures. In view of the overall possibilities of this invention, this problem does not appear to be incapable of a solution. A breakthrough in finding superconducting materials or even near superconducting at slightly elevated temperatures from those presently required would greatly aid in the solution of this problem.

FIG. 7 of the drawings illustrates in outline, the future possible application of this device, obtaining regulated lift by an operator 71 adjusting the current into the coils 72 and 74 which incorporate the structural features of the devices of FIG. 4. The antigravity gravity control features of the coils 73 and 74 thus control the lift and movement of vehicle 76. Suitable cryogenic generators 73a and 74a are associated with each of the coils 73 and 74 to provide the cooling thereof to as near

absolute zero as possible to give the enhanced current passage characteristics necessary to the objects of the invention.

While I have demonstrated that AC current can be used in my device, it appears at present that DC current is much to be preferred.

This invention could be uniquely adapted to a communication system from one side of a solid barrier to the other side whether this barrier be solid concrete or battleship armor, by pulsing the *BXV* generator coil with signals, Morse Code or even voice modulated signals to be picked up by a capacitor-electrometer circuit on the other side of the barrier. Secret communications could be carried on and with the electrometer circuit as shown in FIG. 2 connected to a relay radio broadcasting unit, so that one might conceivably broadcast by radio from the interior of a solid metallic enclosure.

It is conceivable that the invention might be useful in the highly specialized art of concealed detonation devices. A detonating circuit connected to the capacitor electrometer receiving circuit of my device such as shown in FIG. 2 could be actuated through a solid barrier by out *BXV* generating coil placed on the other side of such a barrier.

It is conceivable that for some specialized purposes, it might be highly desireable to transmit electrical power from one side of a fixed solid barrier, concrete or armor plate, etc. by pulsing, DC or AC, in our *BXV* coil on one side of such a barrier. A resonant LC circuit could pick up these *BXV* pulsations and supply a source of electrical power on the other side of the barrier, in a manner somewhat analogous to my electrical receiving methods outlined in U.S. Pat. Application, Ser. No. 803,187, identified above.

In accordance with the patent statutes, only the best known embodiments of the invention have been illustrated and described in detail, but it is to be understood that the invention is not limited thereto or thereby, but that the scope of the invention is defined in the appended claims.

What is claimed is:

1. Apparatus for demonstrating an electrical phenomenon comprising,

a coil made from an electrically conductive material having a very large plurality of sections compacted in close proximity arranged in substantially complementary relation around a common central axis, where the coil forms a solid cylindrical shape with the sections parallel to the axis thereof, and

means to pass current through the coil so that about half the sections will pass current in a direction opposite to the other sections to cancel magnetic flux.

2. Apparatus according to claim 1 where adjacent sections are electrically insulated from each other, and the coil comprises a single wire bent back on itself to make the sections.

3. Apparatus according to claim 1 which includes means to increase the passage of electrical current through the conductor.

4. Apparatus according to claim 3 where the means to enhance is a cryogenic generator which reduces the temperature of the conductor o or below its critical temperature at which it becomes superconductive.

5. Apparatus according to claim 1 which includes an elongated hollow tube having an axis, the conductor formed around the tube.

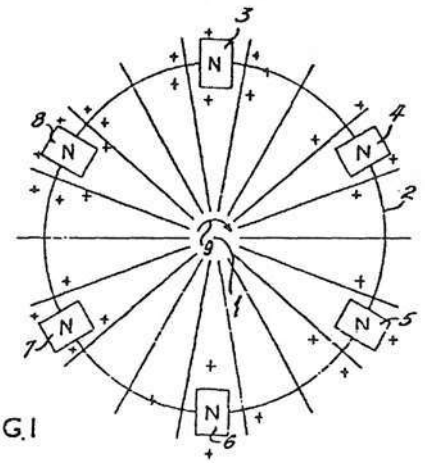

FIG. 1

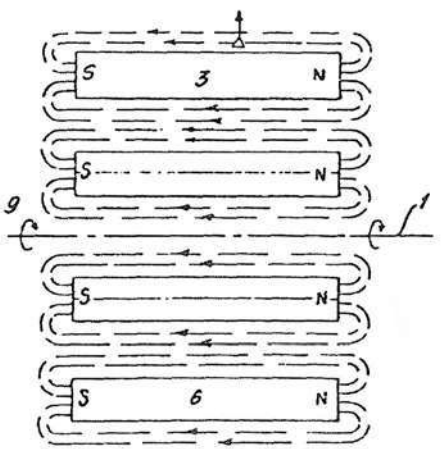

FIG. 2

INVENTOR:
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BY Oldham & Oldham
ATTORNEY.

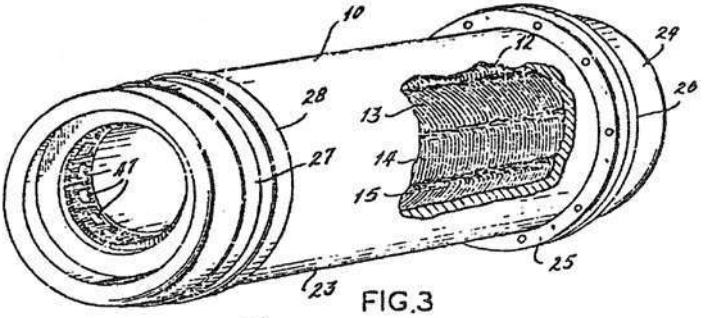

FIG.3

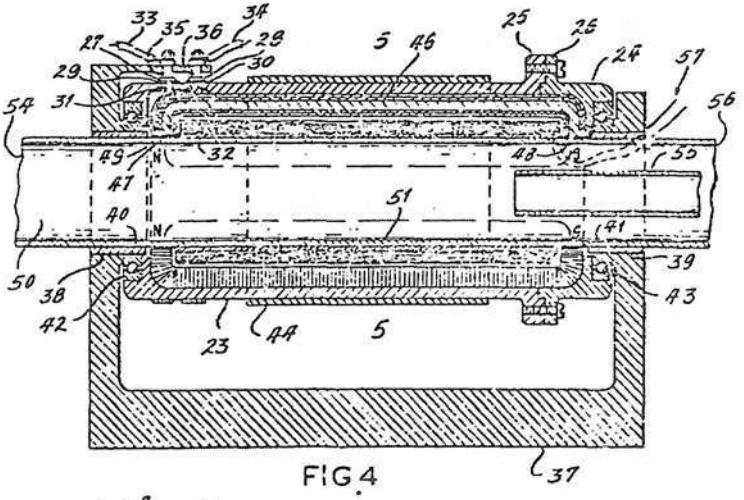

FIG.4

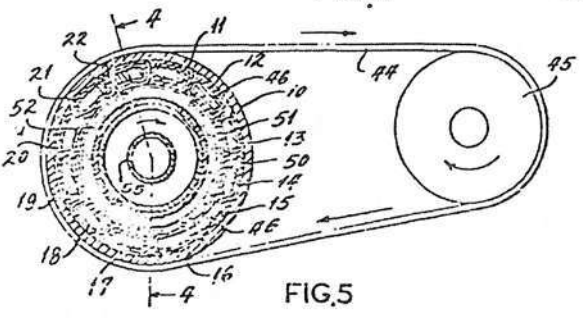

FIG.5

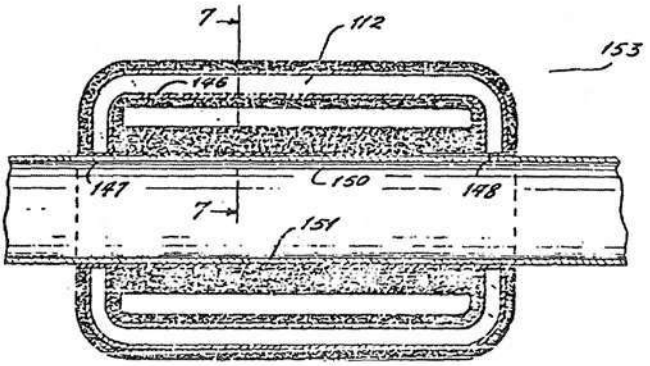

FIG.6

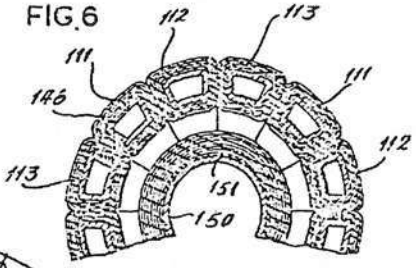

FIG.7

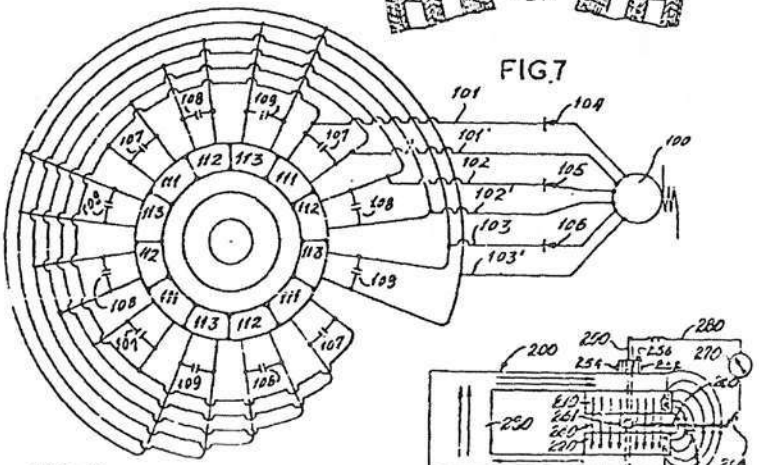

FIG.8

FIG 11

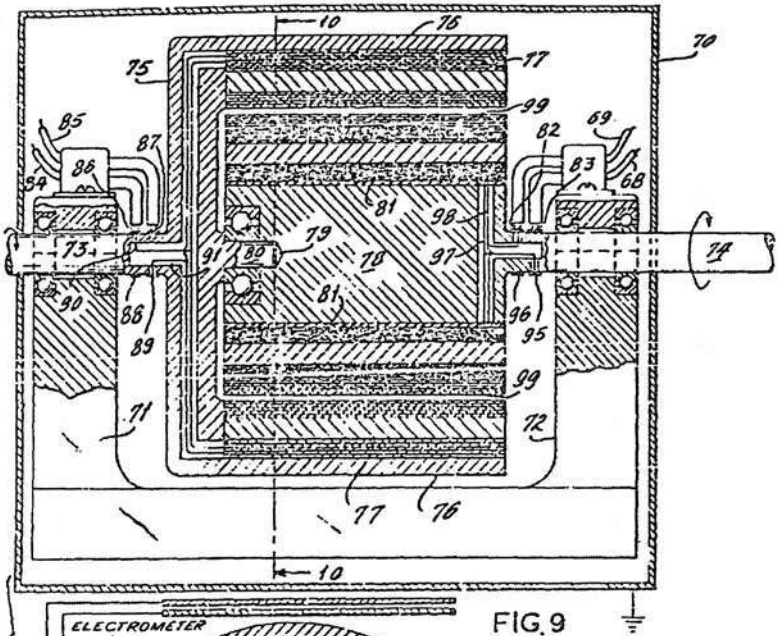
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FIG. 9

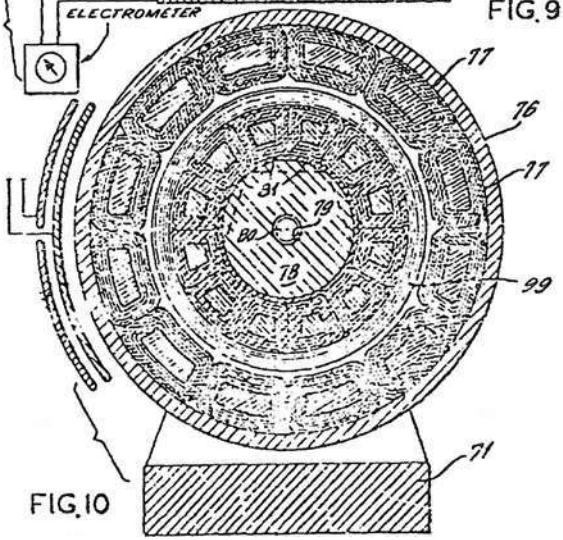
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FIG. 10

United States Patent

Hooper

[15] 3,656,013

[45] Apr. 11, 1972

[54] APPARATUS FOR GENERATING MOTIONAL ELECTRIC FIELD

[72] Inventor: William J. Hooper, Cuyahoga Falls, Ohio

[73] Assignee: Electrodynamic Gravity, Inc., County of Sarasota, Fla.

[22] Filed: Apr. 19, 1968

[21] Appl. No.: 722,587

[52] U.S. Cl. 310/10

[51] Int. Cl. H02k 1/00

[58] Field of Search ..... 310/10, 11, 178, 177, 156, 310/42, 268, 211, 169, 216, 269, 259; 105/1; 55/2. 14, 101, 123, 127, 120; 73/194 EM; 328/233–238

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Primary Examiner—D. X. Sliney

Attorney—Oldham & Oldham

[57] ABSTRACT

Apparatus for producing and demonstrating properties of motional electric fields by means of rotating magnetic flux produced by a plurality of magnets extending parallel with the axis of rotation, said flux of these magnets being put into rotation about a common axis by mechanical or by electro magnetic means.

6 Claims, 11 Drawing Figures

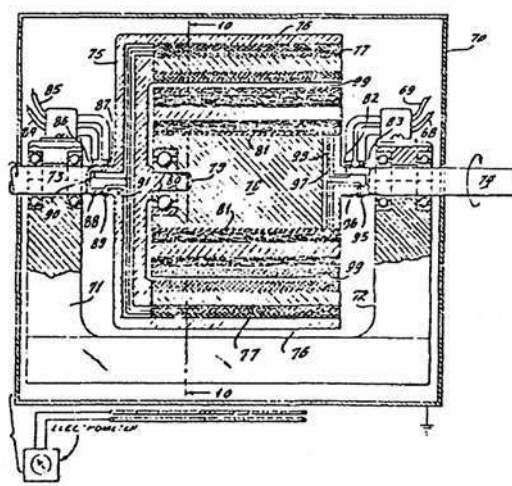

APPARATUS FOR GENERATING MOTIONAL ELECTRIC FIELD

This invention relates to the generation of motionally induced electric fields as distinct from electrostatic fields, and as distinct from the electric field (illustrated by transformer action) which is induced by the time rate of change of magnetic induction. Hence, all reference herein to a motional electric field means the electric field that is generated by the movement of magnetic flux.

The motional electric field generated by rotational motion of magnetic flux is non-uniform in both direction and radial intensity. Particles (large or small) of matter (solid, liquid or gaseous) which are within the ambit of this motional electric field are acted upon with a force which tends to accelerate them. It is well known that a particle carrying a charge Q (coulombs) in an electric field of intensity E (Newton/coulomb) will be acted upon by a force F (Newton) given by the equation $F = EQ$. The electric intensity E of a motional electric field is given by the vector equation $E = B \times V$, where B is the magnetic flux density at a point in space, expressed in webers per square meter, and V is the velocity of the moving magnetic flux at that point in space, expressed in meters per second. What is not so well known, however, is the fact that a non-uniform electric field exerts a force upon electrically neutral matter. In his celebrated text, "The Mathematical Theory of Electricity and Magnetism", Sir James H. Jeans describes, in the case of a non-uniform electrostatic field, how a "slab of dielectric will be sucked in between the plates of the condenser" thus demonstrating the mechanical force produced by such a field. He states (P. 125), "This, as will be seen later, is a particular case of a general theorem that any piece of dielectric is acted on by forces which tend to drag it from the weaker to the stronger parts of an electric field of force." According to Clerk Maxwell in "Electricity and Magnetism" (Vol. II, p. 181), Faraday discovered that the electric field due to electromagnetic induction penetrated within and throughout all materials. The motional electric field is just such a field. Apparatus for demonstrating the "general theorem", stated by Jeans, has, in the case of the non-uniform motional electric field, not heretofore been provided.

Accordingly, it is one of the objects of the present invention to provide a device for generating a non-uniform motional electric field whose force is of magnitude such that it can be sensed.

Since the motional electric field acts within and throughout all matter, such a non-uniform field will exert a physical force on any kind of electrically neutral matter, in a manner quite analogous to that of the electrostatic field with respect to dielectric material.

Another object of the invention is to provide apparatus for obtaining useful work from a non-uniform motional electric field.

The several objectives of the invention may be accomplished by rotating an elongate magnetic field about an axis which is concentric with the field and parallel with the field's elongation. For example, an array of magnets may be mounted on a rotor so that all magnets are parallel with the axis of the rotor, and all have the same polar orientation relative to the rotor. A solenoidal electro magnet, or another array of magnets, with magnetic axis concentric with the rotational axis may also be employed to enchance the flux density of the array of rotating magnets by flux linking with them. When such an array of magnets is rotated about the axis of the rotor, the magnetic field of each is rotated with it. As another example, an elongate magnetic field can be rotated about its axis, without mechanical movement, by the provision of stationary solenoidal electro magnets arrayed like the staves of a barrel and connected to a source of multi-phase alternating current (half wave rectified to prevent reversal of sign) in a manner comparable to the stator winding of a three-phase motor to produce "revolving field." While the composite magnetic field is thus in rotary motion, every charged, or uncharged particle of matter (solid, liquid, or gaseous) within the non-uniform motional electric field thus generated in the neighborhood of

the rotor, will be acted upon by a force due to the electric intensity E. Positively charged particles will be forced in the direction of the vector E, negatively charged particles will be forced in the opposite direction, and electrically neutral matter will be pulled from the weaker regions of field intensity to the stronger regions. This latter mechanical force is called a differential force due to the action of the field on the internal electrical polarization of the neutral matter.

The three vectors E, B, and V are always (with a possible exception) mutually at right angles to each other. If the thumb of the right hand is pointed in the direction of the magnetic flux density vector B, and then rotated like a right-handed screw so that it points in the direction of the velocity V of the moving magnetic flux, then the forefinger of the right hand will point in the direction of the electric vector E. The rotation of the composite magnetic flux about its axis produces a motional electric field which will, except at the axial ends of the magnetic field, be quite generally directed radially with respect to the axis of rotation. The possible exception is the case of a magnet having a homogeneous electrically conductive core of perfectly circular cross-section, in which case the force of the electric field may be somewhat off radial.

With a given polar orientation of magnets relative to the axis of rotation, rotation of the magnetic field in a clockwise direction will generate a motionally induced electric field of sign (positive or negative) opposite that which is generated when the rotation is counterclockwise. For any given sense of rotation, reversing the polar orientation of the magnets relative to the axis of rotation likewise reverses the sign (positive or negative) of the motionally induced electric field. Reversing both the direction of rotation and the polar orientation of the magnets (a situation exemplified by viewing the apparatus first from one axial end, and secondly from the opposite axial end) produces no change in the sign (positive or negative) of the motionally induced electric field.

In the accompanying drawings, three embodiments of the invention are exemplified. Also, there are two model schematics to illustrate in its simplest form the principle of the invention, in which a plurality of commonplace permanent magnets are mounted upon a rotor.

The first embodiment is one in which an array of electro magnets is mounted on a rotor having a hollow center, through which particles of matter can be moved and their response to the motional electric field perceptibly demonstrated.

Second, there is an embodiment in which electro magnets are arrayed as in the first embodiment, but are stationary and their composite magnetic field is rotated electromagnetically by phase displacement.

Third, there is an embodiment in which a pair of oppositely rotating rotors, nested one within the other, are each provided, on its circumference, with an array of electro magnets oriented as aforesaid on each rotor, but oppositely oriented on the respective rotors, and wherein the effect of the motionally induced electric fields can be perceptibly demonstrated by the behavior of particles of matter externally of the rotor.

In the accompanying drawings:

FIG. 1 is a diagrammatic view illustrating the effect of rotating an array of spaced permanent magnets about an axis which is parallel with each of the magnets when all magnets have corresponding polar orientation;

FIG. 2 is a diagrammatic view representing a side elevation of the arrangement shown in FIG. 1, and illustrating the external magnetic flux paths of the several permanent magnets;

FIG. 3 is a perspective view of a rotor for generating a radially directed motional electric field in accordance with one embodiment of the invention, wherein electro magnets are arrayed within a hollow rotor with axes parallel to that of the rotor;

FIG. 4 is a sectional view taken along a diametric plane of the rotor shown in FIG. 3, together with its cooperating parts;

FIG. 5 is a sectional view along line 5—5 of FIG. 4, and showing, in addition, driving means for the rotor;

FIG. 6 is a sectional view taken along a diametric plane of a stationary form of apparatus similar to that shown in FIGS. 3, 4, and 5, but wherein the magnetic flux field is rotated electromagnetically by phase displacement;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 6;

FIG. 8 is a wiring diagram for the apparatus shown in FIGS. 6 and 7.

FIG. 9 is a longitudinal sectional view of an apparatus having a plurality of rotors for generating a B × V electric field;

FIG. 10 is a sectional view taken along line 10—10 of FIG. 9; and

FIG. 11 is a diagrammatic illustration of an apparatus for exhibiting moving field phenomena.

In FIGS. 1 and 2, the principle of the invention is diagrammatically illustrated with the utmost simplicity, wherein a catena of magnetic flux fields, all with the same polar orientation, is produced by arranging an array of rod-type permanent magnets parallel with each other, and parallel with the axis about which they are to be rotated. In FIG. 1, the axis of rotation is designated 1, and may be considered as the center of a shaft of a rotor, preferably composed of material having low, if any, magnetic permeability, and low, if any, electrical conductivity. The periphery of such a rotor is designated by the circle 2. In the form shown, a series of permanent magnets 3, 4, 5, 6, 7, and 8 is appropriately secured to the periphery of the rotor with the respective magnets in equi-spaced relationship, and all with their north poles addressed in the same direction which, as shown in FIG. 1, is in the direction of the reader or, as shown in FIG. 2, to the reader's right. The external flux fields from the respective permanent magnets 3, 4, 5, and 6 are illustrated in FIG. 2, where it will be observed that the external flux path of all magnets is from right to left, a relationship designated by the plus (+) marks in FIG. 1. With such an arrangement, the flux fields of all magnets may be concurrently rotated about axis 1. Considering the rotation to be in the direction of arrows 9 and the polar orientation of the several permanent magnets to be as illustrated, a B × V motional electric field will be generated both externally and internally of rotor periphery 2 upon rotation of the rotor. The thus generated motional electric field will exert a radially directed force upon every particle of matter, neutral or charged, such as particle P, which is within the ambit of the catena of magnetic flux fields. The magnitude of the so impressed electric field intensity will depend upon the magnetic flux concentration at the particle P and the relative velocity between the flux field and particle P. While, if particle P is in motion, its velocity must be considered in arriving at the relative velocity V (in the formula $E = B \times V$) the disclosure will be simplified if the particle P be considered as stationary, and in such event V will be 2 R times S, where R is the radial displacement of particle P from axis 1, and where S is the revolutions per unit of time made by the rotor. Hence, with the particle P stationary, the magnitude of the force impressed upon it is increased when the speed of rotation of the rotor is increased at a given flux density; and is increased by an increase in the flux density at a given speed of rotation. The direction in which the force of the motionally induced electric field acts upon particle P is always perpendicular to the magnetic flux field B and to its velocity V. The sign of the electric force field may be either positive (acting radially outward from the axis of rotation) or negative (acting radially inward toward the axis of rotation), which, for any given polar orientation of the permanent magnets, may be reversed by reversing the direction of rotation of the rotor. With the polar orientation shown in FIGS. 1 and 2, and the direction of rotation indicated by arrow 9, if particle P is a proton or a positively charged molecule, the force of the $B \times V$ electric field will be radially inward as indicated by the solid line arrow attached to particle P; but if particle P is an electron or a negatively charged molecule, the particle will tend to move radially outward as shown by the broken line arrow; and if the particle P is electrically neutral, it will tend to move in the direction of increasing electrical intensity E. Increase of E requires either that both B and V be increasing or that one be increasing at a sufficiently greater rate than the other is decreasing so that the product $(B \times V)$ increases. In the relationship of field and particle shown in FIG. 1, the product $(B \times V)$ increases radially inward.

For practical purposes, however, commonplace permanent magnets produce insufficient flux density in their external flux paths to impress upon a particle of charged matter such as P, an electric force of sufficient magnitude that the force of the electric field can be measured with ease, at least at speeds of rotation within practical limits. Consequently, the practical embodiments of the invention, later to be described, make use of electro magnets of a form capable of producing external flux fields of vastly greater flux density B, as well as higher velocities V.

The term "unipolar induction" has been used to indicate the induction of an electric field in the vicinity of an axially symmetrical magnetic system rotating about its axis of symmetry. There has been disagreement about whether as the magnetic system is rotated the lines of magnetic induction are carried with it or remain stationary while the magnetic system rotates through them. For example, when a bar magnet is rotated about its magnetic axis, it is believed by many that the magnetic field is stationary. I have demonstrated that under certain conditions, at least, the magnetic lines can be made to move, and I have devised certain methods and apparatus for utilizing this phenomena as in the production of localized and high intensity electric fields.

Turning now to FIG. 11 of the drawings, an apparatus for demonstrating certain magnetic phenomena is illustrated in diagrammatic form. A magnetic system, indicated generally by numeral 200, includes a pair of permanent magnets 210 and 220 which are axially magnetized and mounted in axial alignment between the ends of a U-shaped yoke 230 of highly permeable magnetic material. The adjacent surfaces of magnets 210 and 220 being of opposed polarity are spaced apart, providing an air gap 240 therebetween. The lines of magnetic flux are shown in the drawing and indicated generally by numeral 262. A brass rod 250 extends axially through magnets 210 and 220. The magnetic system 200 is rotatable about rod 250. A stiff conductor 260 is electrically connected by a collar 261 at one end in rotatable or fixed relation as selectively desired, with the brass rod 250 at a point in the gap 240 between magnets 210 and 220. The other end of conductor 260 extends substantially perpendicularly from rod 250 to a distance in space away from the magnets and yoke where the magnetic field falls to approximately zero intensity. In order to complete an electrical circuit through galvanometer 270 and conductor 280 to the brass rod 250 and conductor 260, a flexible and extensible electrical wire 264 connects the end of conductor 260 to the galvanometer 270. A gear 252 locked alternatively by set screw 254 to rod 250 or by set screw 256 to yoke 230 can serve to provide driving motion to either the rod 250 or YOKE 230 as selectively desired. Normally, for the purposes of the experiment, the driving motion will be reciprocal because of the connection of wires 280 and 264.

With this apparatus, if the magnetic system 200 is held fixed and a given angular displacement imparted to conductor 260 by rotating it horizontally about or with rod 250 through the air gap at a given angular speed, a voltage is induced which provides a deflection of galvanometer 270. Furthermore, when the conductor 260 is held fixed and the magnetic system 200 rotated through the same angular displacement about rod 250, at the same given angular speed, a similar voltage of exactly the same magnitude but opposite direction is induced in the galvanometer circuit. The same deflection is obtained whether or not the magnets 210 and 220 rotate with the yoke 230 or are held stationary while the yoke alone is rotated. This indicates clearly that the lines of magnetic induction in the quantity rotate about the axis of rotation 250 as if they were rigidly attached to the magnetic system 200.

A most important aspect of the operation of the apparatus of FIG. 11 is noted when the magnets 210 and 220 are held fixed in relation to the conductor 260 and rod 250 and the

yoke 230 is rotated about the rod 250. This action causes induction of current in the galvanometer circuit exactly as occurs when the entire magnetic structure or the conductor itself are moved. However, if the magnetic yoke 230 and conductor 260 are held fixed and magnets 210 and 220 rotated, there is no deflection of the galvanometer. Thus, it appears that the yoke structure plays an important part in controlling movement of the magnetic flux. Furthermore, it should be noted that the magnetic flux does not link the galvanometer circuit in the usual sense that this term is used, but that a current is induced in the galvanometer circuit through the action of the conductor 260 in merely cutting across the field extending between adjacent faces of magnets 210 and 220.

It has also been found that the permanent magnets 210 and 220 may be replaced by an electromagnet and the results described above duplicated. Furthermore, it can be demonstrated that the magnetic flux within the air core of a solenoid may be rotated about its magnetic axis. A brass tube formed in the shape of a toroidal C has a winding applied to its entire length with holes drilled in the tubing to receive a brass rod, as 250 in the structure shown in FIG. 11. With the winding energized, the above-described procedures produce similar galvanometer deflections.

This application is concerned with certain methods and apparatus which make use of the phenomena described above.

Referring now to FIGS. 3, 4, and 5 for an illustration of the second embodiment, a tubular rotor 10 is provided on its inner periphery with 12 keystone cross-sectional electro magnets 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, and 22 of the solenoid type. As seen in the cross-section of FIG. 5, the several electro magnets are arranged as sectors of a cylindrical annulus. While in the form shown, the several electro magnets 11–22 are shown in circumferentially wedged relationship, whereby to minimize the likelihood of relative movement radially inward as at standstill, as well as in the interest of achieving substantial uniformity of external flux density throughout the inside circular area of the rotor, it will be understood that when and if desired, the several electro magnets can be circumferentially spaced one from the other, and, if desired, a spacer of relatively low, if any, magnetic permeability interposed between them. Any suitable means may be employed for securing the several electro magnets to the shell of the rotor.

In order to facilitate the assembly of the several keystone-shaped electro magnets on the interior of the rotor as shown, the shell thereof is made of at least two pieces 23 and 24. In the form shown in FIGS. 3–5, the two pieces 23 and 24 are cup-shaped, and are respectively provided with outwardly extending flanges 25 and 26. Once the several solenoids have been positioned within the longer shell piece 23, the shorter shell piece 24 may be applied as a cap so that flanges 25 and 26 abut, and may be appropriately secured together as by riveting, bolting, welding, or cementing.

The shell pieces 23 and 24, as well as their interconnecting means, may be formed of material having little or no magnetic permeability, or in cases where it is desired to shield the exterior from the escape of magnetic flux, they may be formed of material having a high magnetic permeability. Instead of dividing the rotor shell in twain axially, it may be divided in twain radially, in which event the two halves will have axially extending joints when assembled, and may be held in such assembled position by banding or other appropriate means capable of sustaining the centrifugal force to which the rotor will be subject in use.

At the end of shell piece 23, remote from flange 25, there is provided a pair of slip rings 27 and 28 which, in the event the shell piece is formed of electrically conductive material, may be separated from the shell piece by sub-rings 29 and 30, of appropriate insulating material. The slip ring 27 is connected through a conductor 31 to the free end on the inner course of the solenoid winding for each of the electro magnets 11–22. The slip ring 28 is connected trough a conductor 32 to the free end of the outer course of winding in each of the solenoids 11–22. All 12 solenoids are connected so that the direction of electric current flow is the same in all solenoids. The energizing current is supplied from an external source through conductors 33 and 34 and brushes 35 and 36, in a manner well understood in the art.

The rotor is mounted upon an appropriate frame 37, having opposite stationary stub axles in the form of ferrules 38 and 39 which project toward each other. On the projecting portion of each of ferrules 38 and 39, there is provided an inner race 40 and 41 for each of two ball bearing sets whose outer races 42 and 43 are appropriately mounted to the respective ends of the rotor 10, so that the rotor 10 is free-running, with respect to the frame 37, about an axis concentric with the rotor 10.

In the embodiment shown, the exterior cylindrical surface of rotor 10 serves as a pulley for a drive belt 44 which connects the rotor to a source of power 45, but any other suitable means of driving the rotor in rotation may be utilized.

In the form shown in FIGS. 3–5, the apparatus is intended to concentrate the magnetic flux of the several solenoids radially inward, and to facilitate this each of the solenoids is provided with a core 46 of material having high magnetic permeability. As shown in FIG. 4, the several cores 46 are of squat U-shape, and extend, for the most part, parallel to the axis of the rotor, but at each end the cores are curved so as to provide faces 47 and 48 addressed radially inward. To minimize the radially outward escape of magnetic flux from the several solenoids, they are preferably wound of ribbon-like conductor which is coated with any appropriate electrical insulation. The first course of winding begins at 49, and proceeds in helically wound fashion with the minimum of space between adjacent turns about core 46, to the opposite end thereof, whereupon, without interrupting the continuity of the conductor, the second course is wound helically over the first course, with the pitch of the helix reversed from that in the first course. In this way, any gaps between successive turns in the first course are overlapped by turns in the second course. While the drawings show only two courses of conductor about each core 46, it will be understood that, in practice, there may be many more courses.

With the several solenoids connected through the slip rings to a source of direct current as above-described, it will be understood that all the solenoids 11–22 have the same polar orientation with respect to the axis of rotation of the rotor. For example, all core ends 47 are North poles, and all core ends 48 are South poles.

A tube 50 of circular cross-section is mounted in fixed relationship within the respective ferrules 38 and 39. The tube 50 is preferably made of material having little or no magnetic permeability. The tube 50 is stationary, but the rotor 10 rotates about the axis of the tube 50.

A stationary solenoid 51 is fixedly mounted on the exterior of tube 50 in a position such as to fit, with clearance, into the bight of the squat U-shaped solenoids 11–22. Solenoid 51 may be wound directly on tube 50, but in the form shown, it is wound on a cylindrical core 52 of material having little or no magnetic permeability, and the core 52 is telescoped on tube 50. The stationary solenoid 51 is energized through appropriate leads (not shown) from conductors 33 and 34 or other source of direct current, and is so connected that its magnetic polarity is opposite that of solenoids 11–22, that is to say that when, as aforesaid, the core ends 47 are North poles, the adjacent end of solenoid 51 will be its South pole. Thus, magnetic flux of solenoids 11–22 has an external path, through tube 50, which is coincident with, and in the same direction as, the internal path of magnetic flux in solenoid 51.

Thus, the magnetic field generated by each of the solenoids 11 through 22, as well as that generated by solenoid 51, penetrates the interior of tube 50, and when the rotor is driven in rotation, the magnetic fields rotate collectively about the axis of tube 50. During such rotation, particles of matter within the tube 50 are within the motional electric field generated by the rotating magnetic flux. Such an apparatus has a demonstrable effect in the separation and concentration

of fluids. For example, in the de-salinization of water, the $B \times V$ electric field generated by the rotating magnetic fields, acts upon the disassociated ions of the sodium chloride in solution. This is explained by the fact that if the rotor 10 be rotated in the direction shown by the arrows in FIG. 5, the $B \times V$ field tends to drive the positively charged sodium cations toward the center, and tends to drive the negatively charged chlorine anions away from the center of tube 50. Hence, by introducing a flow of saline water at end 54 of tube 50, and by providing a concentric separating tube 55 at end 56 of tube 50, increments of fluid which are concentrated with sodium and depleted of chlorine may be drawn off through the stationary tube 55, while the increments of fluid which are concentrated with chlorine and depleted of sodium may be drawn off through the space between the exterior walls of tube 55 and the interior walls of tube 50.

Another utility of the apparatus shown is that of transmuting hydrogen into helium, in which event tube 55 is omitted and electrodes are provided at opposite ends 54 and 56 of tube 50, so that an electric arc may be established between them. Heretofore, difficulty has been encountered in maintaining the plasma of the arc in a relatively straight path between the electrodes as it ends to wiggle and extinguish itself when it makes contact with one of the confining walls. However, by impressing a $B \times V$ electric field upon such an arc, its path may be confined within controllable limits. The $B \times V$ electric field has the further effect of driving hydrogen protons toward the center of the tube, and driving electrons away from the center of the tube. Add one neutron to a hydrogen atom nucleus, and there is produced the isotope known as Dueterium; add one more neutron to the Dueterium nucleus, and it becomes Tritium; add one more proton to the Tritium nucleus, and it becomes Helium.

A third embodiment of the apparatus is shown in FIGS. 6, 7, and 8. With the significant exception that the embodiment of FIGS. 6, 7, and 8 has no moving mechanical parts, its organization is, in general, quite similar to that shown in FIGS. 4 and 5, and hence the last two digits of the reference characters utilized in the previous embodiment. As shown in FIG. 6, a cylindrical tube 150 has a solenoid 151 wound on the exterior thereof, and is energized with direct current from a suitable source through leads 153. A plurality of squat U-shaped solenoids 111, 112, and 113, of keystone-shaped cross-section, of which there are four each or any multiple of four, are wound as described in connection with the previous embodiment, and securely mounted in any suitable way with their pole faces 147 and 148 contiguous with, and addressed toward the axis of, tube 150. In this embodiment, however, the several squat U-shaped solenoids 111, 112, and 113, have cores which are made of material having little or not magnetic permeability, such as tubes 146 of paperboard wound to a keystone shape with hollow interior. As in the previous embodiment, the magnetic polarity of solenoid 151 is opposite that of the solenoids 111, 112, and 113, which is to say that if ends 147 of the solenoids 111–113 are the North poles thereof, the adjacent end of solenoid 151 is its South pole, so that the external magnetic flux path from solenoids 111–113 is coincident with, and in the same direction as, the internal flux path of solenoid 151.

In the embodiment shown in FIGS. 6–8, the several squat U-shaped solenoids 111, 112, and 113 are energized with non-interconnected three-phase alternating current, each phase of which has been half-wave rectified to produce direct current pulsating at alternate half cycles. One phase of the alternating current is connected to all solenoids 111; another phase of the alternating current is connected to all solenoids 112; and the third phase of the alternating current is connect to all solenoids 113, as shown in the wiring diagram of FIG. 8, where a three-phase alternator 100 is provided with six leads arranged in three pairs, to wit: leads 101 and 101' for the first phase, leads 102 and 102' for the second phase, and leads 103 and 103' for the third phase. The respective phases are not electrically interconnected. In each of leads 101, 102, and 103, there is a rectifier 104, 105, and 106, respectively. Leads 101 and 101' serve all four of solenoids 111; leads 102 and 102' serve all four of solenoids 112; and leads 103 and 103' serve all four of solenoids 113. Across leads 101 and 101', between the rectifier 104 and the respective solenoids 111, there is provided a capacitor 107. Such capacitor is to coordinate the capacity and inductance of input, and to neutralize the effect of induction in solenoids 111 by adjacent solenoids during the off half-cycle of energization. Likewise, a capacitor 108 is connected between leads 102 and 102', and a capacitor 109 is connected between leads 103 and 103'. It will be apparent to those skilled in the art that since the four solenoids of like phase are arranged in quardrature with each other, and since solenoids 111 will reach their peak of magnetic flux 120° ahead of solenoids 112 reaching their peak flux, and the latter 120° ahead of solenoids 113 reaching their peak flux, a revolving magnetic field is created. Due to the rectification of the alternating current, and the consequent utilization of the half cycles which all flow in the same direction, there will be no reversal of the direction of magnetic flux generated by any of solenoids 111, 112, and 113, and hence, as in the case of the previous embodiment, the external path of all magnetic flux generated in the solenoids 111, 112, and 113 is coincident with, and in the same direction as, the internal flux generated by direct current energization of solenoid 151. When such an arrangement is supplied with alternating current at high frequency, such as a thousand cycles per second, the same results are achievable with this embodiment as with the previous embodiment but without movement of any mechanical parts.

For the purpose of illustrating the effect of the $B \times V$ electric field, and segregating that effect from the effect of stray magnetic or electrostatic forces, reference may be had to FIGS. 9 and 10. The device there shown is intended to be encased in an electrically grounded box 70 of material which has a high magnetic permeability, and which also has the property of electrical conductivity for shielding electrostatic fields.

Within the box 70, there is a compound rotor machine, wherein the respective rotors are driven in opposite directions. In a suitable frame having spaced pedestals 71 and 72, there is mounted a shaft 73 and an independent shaft 74. Both shafts 73 and 74 may be driven from a single source of power, and are preferably driven at the same rotational speed, but in opposite senses. A yoke 75 is fixedly mounted to shaft 73 for rotation with it. The yoke is cup-shaped with cylindrical skirt 76. About the inner periphery of the skirt 76, a plurality os solenoidal electro magnets 77 are fixedly mounted thereto. The several electro magnets extend parallel with the common axis of rotation of shafts 73 and 74, and are of the same polar orientation with respect to those shafts. The several electro magnets 77 have identical solenoids wound, in the manner previously described, about identical cores of material having high magnetic permeability. The solenoids of the several electro magnets 77 are energized from a suitable source of direct current through conductors 84 and 85, brushes 86 and 87, slip rings 88 and 89, and conductors 90 and 91. The respective solenoids 76 are preferably connected in parallel circuit relationship, but, if desired, may be in series so long as uniform polar orientation is maintained.

Shaft 74 is provided with a hub 78 having a coaxial bore 79, into which is rotatably fitted a pilot 80 projecting concentrically from shaft 73. On the outer periphery of hub 78, there is fixedly mounted a plurality of electro magnets 81, each of which is an identical solenoid, and each of which has an identical core of material having high magnetic permeability. As in the previous case, the several solenoids 81 are all energized so as to have the same polar orientation with respect to their axis of rotation. Each of the solenoids is energized from a suitable source of direct current through conductors 68 and 69, brushes 82 and 83, slip rings 95 and 96, and conductors 97 and 98. All of the solenoids 81 are preferably connected in series circuit relationship, but, if desired, may be in parallel.

If desired, and as shown, the several solenoids 81 may be surrounded by a simple solenoid 59 wound helically

thereabout and electrically connected in parallel or series relationship with solenoids 81 and to conductors 97–98 so that the current flow through solenoid 99 is in the same direction as through solenoids 81. Thus the winding 99 serves the dual purpose of boosting the magnetic fields generated by solenoids 81 and of mechanically binding the latter to the surface of hub 78.

When, as contemplated, the shafts 73 and 74 are driven in rotation simultaneously, but in opposite directions, the solenoids 77 which rotate with shaft 73 have opposite magnetic polar orientation to those (81) which rotate with shaft 74. The several solenoids 77 are preferably designed to create external magnetic flux fields of flux density approximately equal and opposite to those created by electro magnets 81 and 99, but by the principle of superposition ("Elec. & Mag.", by Ralph W. Winch, 1963 Ed., p. 202), each flux field acts as if the other were not present. Despite the fact that the flux fields created by the *responsive* series of electro magnets 77 and 81 and 89 are oppositely directed, since their rotation is in opposite senses, their resultant effect, insofar as concerns the generation of a $B \times V$ electric field, is cumulative. Accordingly, the external $B \times V$ electric field is intensified at the exterior of the device, and its effect on the outside of shielding box 70 is demonstrable, even though the resultant magnetic flux density there is approximately zero. Such demonstration might be through a capacitor and electrometer as shown in FIG. 9, for example.

In order to achieve the maximum flux density and hence the maximum $B \times V$ electric field intensity, it is desirable to take measures which keep the apparatus cool. This may involve resort to such means as: winding the several solenoids with so-called "super-conductors" such as that known commercially as "Supercon"; or refrigerating the apparatus as by immersing it in a bath of liquid helium which is capable of maintaining a temperature of approximately 4° Absolute.

While several illustrative embodiments of the invention have been disclosed in detail, it is not to be understood that the invention is limited to those embodiments. On the contrary, the principles of the invention are susceptible of application in a vast variety of forms without departing from the spirit of the invention or the scope of the appended claims. The apparatus defined in the following claims is believed by the applicant to demonstrate his unique theory disclosed above.

What is claimed is:

1. Apparatus for generating an electric field, comprising:

a frame;

a cylindrical rotor;

a shaft journalled on the frame and supporting the rotor for rotation about is longitudinal axis;

a plurality of electro magnets, each of which is an identical solenoid having a core formed of a material having a high magnetic permeability, the electro magnets being fixedly mounted on the rotor with each electromagnet extending parallel to the axis of rotation thereof,

means to energize the solenoids of the electro magnets from a direct current source, the solenoids being energized so as to maintain a uniform polar orientation; and

an enclosure surrounding the frame and the rotor, the enclosure being formed of an electrically conductive material the enclosure being grounded.

2. Apparatus according to claim 1 wherein the rotor is a hollow cylindrical rotor, the electromagnets being affixed to the inner cylindrical surface of the rotor.

3. Apparatus according to claim 1 wherein the solenoids are connected in parallel circuit relationship.

4. Apparatus for demonstrating magnetic phenomena comprising:

a frame;

a cylindrical rotor;

a shaft journalled on the frame and supporting the rotor for rotation about its longitudinal axis;

a plurality of electro magnets, each of which is an identical solenoid having a core formed of a material having a high magnetic permeability, the electro magnets being fixedly mounted on the rotor with each electro magnet extending parallel to the axis of rotation thereof,

means to energize the solenoids of the electro magnets from a direct current source, the solenoids being energized so as to maintain a uniform polar orientation;

an enclosure surrounding the frame and the rotor, the enclosure being formed of an electrically conductive material, the enclosure being grounded; and

means surrounding at least a portion of the enclosure to detect and measure the electric field generated during rotation of the energized rotor.

5. Apparatus for demonstrating magnetic phenomena, comprising:

a U-shaped yoke of highly permeable magnetic material;

a pair of permanent magnets mounted in axial alignment between the ends of the yoke, one magnet being mounted to each leg of the yoke;

an electrically conductive non-magnetic rod extending axially through the magnets;

a stiff conductor mounted at one end to the rod for rotation relative to the yoke in a plane perpendicular to the rod and intermediate the magnets, the conductor extending a sufficient distance beyond the magnets so that its other end is located at a point where the magnetic field from the magnets falls to approximately zero intensity;

a galvanometer; and

circuit means connecting the ends of the conductor to the galvanometer to measure current flow through the conductor.

6. Apparatus according to claim 5 wherein the magnets are rotatably mounted to the yoke for rotation about the axis of the rod, and where the magnets are axially magnetized and adjacent faces are of opposite polarity.

* * * * *

APPENDIX III

A CONDITIONAL CRITERION FOR IDENTITY, LEADING TO A FOURTH LAW OF LOGIC

Summary

If logic is regarded as a set of perceptual operations, then logic has a chronotopology (time structure). Identity or nonidentity then results as a decision from an algorithm — a set of perceptual operations and comparisons — in which case the nature of a particular identity is conditional upon the nature of the set of perceptual operations comprising the algorithm.

Ordinary logic does not account for the temporal aspects of perception, merely accounting for the spatial aspects.

In other words, Aristotlean logic is a synthesis of primitive observation, fitted to the partial (spatial) reality emerging from spacetime after the imposition of the monocular (one-at-a-time) photon interaction with matter.

In quantum mechanics, time is a parameter, not an observable. Hence measurement/detection (of observables) deals with primitive observation and Aristotlean logic (topology).

Total reality includes nonprimitive observation — hence, non-Aristotlean logic (chronotopology) — as shown in Young's two-slit experiment.

By applying temporal accounting to each perceptual operation, Aristotle's three laws can be shown to be self-contradictory and incomplete as written. That is, they are topolological, not chronotopological.

A simple derivation of a fourth law is shown and an application rule given which itself may be regarded as a fifth law of logic.

A proof of the fourth law by demonstration is given.

The resulting four law logic is chronotopological. The applica-

tion rule states that either Aristotle's three laws apply explicitly and the fourth law is implicit, or the fourth law applies explicitly and Aristotle's three laws are implicit.

The four-law chronotopological logic is theoretically capable of resolving every present three-law paradox.

Aristotle's Laws and the Paradox of Change

Aristotle's three laws of logic, on which foundation rests all mathematical, physical, and rational thinking, can ordinarily be stated as shown in Table 1.

Table 1. Aristotle's three laws of logical thought

1. $A \equiv A$
2. $A \not\equiv \overline{A}$
3. $A \vee \overline{A}$

A variety of arguments can easily be produced to show that these laws are incomplete; i.e., they do not specify all reality, for parts of reality can be shown to contradict one or more of Aristotle's laws.

Indeed, all "observed" reality can be shown to violate all three-laws.

E.g., the most direct violation is posed by the problem of change, a problem originally propounded by Heraclitus about 500 B.C., and unsolved to this day. Heraclitus pointed out that, for a thing to change, it must turn into something else, and then asked how a thing could be something other than itself?

We may think of a thing — say, α —some feature A of which is said to change. If A changes, it turns into $\overline{A}$, thus violating logic laws one and two. Further, we are considering A as the "changed thing. $\overline{A}$," i.e., something which is somehow both A and $\overline{A}$, so logic law three is violated as well.

Thus, if Aristotle's laws are taken to be all the fundamental laws of logic, then logically there can be no change whatsoever, because change negates all three laws. I.e., either change does not exist or it is totally illogical.

Since all measurements, detections, thoughts, and perceptions are simply changes, then it follows that these operations logically cannot exist. Or, if we assume the "operations" to exist, their outputs cannot exist. If the operations do not exist, then again their outputs do not exist.

So if the products or outputs cannot exist, then by this reasoning no perceived, detected, measured, conceived thing exists. If we then insist that such things do indeed exist, then all is paradoxical and illogical. This is essentially the nature of the paradox posed by Heraclitus.

Heraclitus's change paradox has not been satisfactorily resolved to this day, and rigorously all the rational science of the Western world, being based on paradoxical change (detection, perception, observation) is itself totally illogical by its own logical standards.

Resolving the Paradox of Change

However, the conditions necessary to resolve the problem of change can be stated simply by inspection of the problem as follows: (1) Aristotle's three laws must specify or apply to only that which is not changing, since change violates or negates all three laws; (2) If change is to logically exist, there must exist at least a fourth law of logic, one which applies to change; (3) This fourth law must contain the negations of each of the first three laws, since change negates them; (4) To be consistent, in any particular logical case, either the three laws explicitly apply or the fourth law explicitly applies (i.e., either change explicitly exists in that particular case or it does not); (5) Since all four laws must apply at all times, then when the three laws apply explicitly, the fourth law must be implicit—and when the fourth law applies explicitly, the three laws must be implicit.

With the five stated conditions, a fourth axiom of logic can be written simply by writing down the negations of Aristotle's three

laws, and synthesizing these negations into a single fourth law, as shown in Table 2.

Table 2. Negations to Aristotle's laws.

Aristotle's law	Negation	of negation*
$A \equiv A$	$A \not\equiv A$	$A \equiv \overline{A}$
$A \not\equiv \overline{A}$	$A \equiv \overline{A}$	$A \equiv \overline{A}$
$A \vee \overline{A}$	$A \wedge \overline{A}$	$A \equiv \overline{A}$ or $[A, \overline{A}]$

However, even though we can synthesize the negation into a single law — the old "identity of opposites" idea — we still have the problem of understanding such a law. Though at first glance the negations and the synthesized fourth law seem bewildering, we can readily comprehend them if we carefully consider the temporal nature of the process that occurs in logical thinking.

The Importance of Time

Specifically, a finite interval of time is required to perceive, think, detect, or observe an entity — regardless of whether we refer to "physical" or "mental" detection, because both physical and mental processes are temporal. Indeed, we flatly state without further discussion that ultimately the identifying or mapping of physical and mental operations onto each other is what time is a *priori.*

At any rate, we now carefully account for each individual time interval required to think, conceive, detect, perceive, or observe any entity — whether that entity is physical or mental — and we also account for the finite time interval required to perform a logical operation. So we rewrite Aristotle's three laws as shown in Table 3, with subscripted numbers indicating the separate time intervals in each law.

*These negations mean that A and $\overline{A}$ are totally undifferentiated.

Table 3. Temporally accounted laws and negations.

Aristotle's law		Negation
1.	$A_1 \equiv_3 A_2$	$A_1 \equiv_3 \overline{A}_2$ or $A_1 \not\equiv_3 A_2$
2.	$A_1 \not\equiv_3 \overline{A}_2$	$A_1 \equiv_3 \overline{A}_2$
3.	$A_1 \vee_3 \overline{A}_2$	$A_1 \wedge_3 \overline{A}_2$ or $[A_1, \overline{A}_2]_3$

The resolution to the entire mystery so long inherent in these axioms of logic now stands simply revealed: Whether one of Aristotle's laws holds or its negation holds is determined solely by the nature of the logical operation in time interval three.[1]

I.e., the operation in interval three may be regarded as an *algorithm* comprised of subsidiary (assumed) operations in separate time subintervals that, taken together, comprise the overall operation implied by the logic symbol.

Thus in the first law, if temporal tags (time snapshots) are not accounted (i,e., if they do not apply), then Aristotle's laws hold, for the snapshot 1 of A is not differentiated in algorithm 3 from snapshot 2 of A. This then rigorously holds for spatial (L^3) entities, but not for spacetime entities. The snapshots in this case for Aristotle's first law (and the others as well) are *spatial* snapshots. On the other hand, if snapshots 1 and 2 of A are themselves temporally differentiated in algorithm 3, then the negation of Aristotle's law applies, because the *spacetime* snapshots A_1 and A_2 are different. This is immediately apparent, e.g., in a Minkowski geometry representation, where the second snapshot of A will have a time coordinate different from the time coordinate of snapshot 1. This is represented as shown in figure 1, where "A" is taken as a simple magnitude, in this case 5.

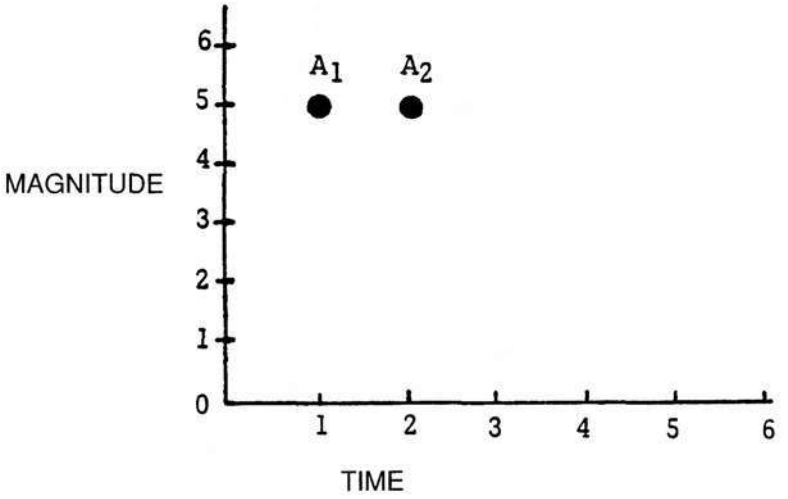

Figure 1. Spatial snapshots of spatiotemporal A differ.

As can be seen from figure 1, 5_1 is not identical to 5_2 *unless we imply the operator* $\partial/\partial t$ *in the time interval three algorithm.*

The negation of the second law may also be simply understood if we use temporal accounting. E.g., suppose we take $A_1 = +1$, $\overline{A}_2 = -1$ and then pose the absolute value operator || for potential use in algorithm 3. If || is not used, then

$$(+1)_1 \not\equiv_3 (-1)_2$$

and Aristotle's second law holds. If || is used, then

$$\left| (+1)_1 \right|_3 \equiv_3 \left| (-1)_2 \right|_3$$

and in that case

$$A_1 \equiv_3 \overline{A}_2$$

Note we are taking the view that there is nothing "absolute" or "inherent" about identity or non-identity; instead, each is a conditional result that can only be established by some logical, comparn

tive set of operations. If the suboperations comprising the decision algorithm for the identity/non-identity determination are changed, the finding of the algorithm (the decision) may often change. Specifically, one can have the cases

$$\equiv_1 \not\equiv_3 \equiv_2$$

$$\not\equiv_1 \not\equiv_3 \not\equiv_2$$

Thus we advance a *conditional identity criterion* to be incorporated into formal logic: "Identity" or "non-identity" is defined by a decision made as a result of applying an operational algorithm; changing the internal operator components assumed inherent in the algorithm can change the decision. We are stating a fundamental principle that "identity" and "non-identity" are conditional and only conditional; they are never absolute.

Primitive Observation and "Reality"

With these points made, we now turn to the third law. From Table 2, on examination it can be seen that the third law actually is a statement for *monocular* perception, detection, observation, thought, or conception. Indeed, this law says that only a single thing at a time can be perceived, detected, observed, thought, or conceived.

As we pointed out in a previous paper[2] , there is a very good reason for this "law." Primitive man lived almost exclusively in a reality detected by light, by the photon interaction. Even in the absence of visible light, all bodies have temperature, and man is immersed in a "sea" of continual electromagnetic photon with interactions. The photon interaction is monocular - - only one at a time interacts with a particle of mass. Further, photon interaction constitutes the operator $\partial/\partial T$ invoked upon L^3T spacetime. Photon emission carries away time (the photon is made of $(\Delta E\ \Delta T)$, leaving behind an L^3 *spatial* reality, as we have previously pointed out.[3]

So all our primitive concepts, ideas, and notions about reality have come from over four million years of hominid and human experience in the photon-detected partial reality ("physical," "objective," or "spatial" reality) that remains when the time "dimension" (fundamental **variable)** is destroyed from L^3T spacetime, leaving

only L^3 space behind. Specifically, our observed macroscopic reality consists of large temporal (mental) aggregates of such spatial results, where we cannot distinguish the tiny temporal separations of the pieces. Thus all our observed/perceived entities are spatial, and further, each perception/observation snapshot results in a frozen, unchanging spatial entity (resulting — in physical detection — from the so-called "collapse of the wave function." The loss of a wave function is simply the loss of time.) We vaguely sense "time" and "change" as the relation between these snapshots — i.e., by causality, or the ordering of the spatial changes — much as we see "movement" in movie frames rapidly projected onto a screen one-at-a-time.

Thus our primitive observations, from which have painfully been formed our relational concepts and ideas, are monocular, unchanging, and spatial. Aristotle's three laws of logic — which indeed may be taken to be only a simple synthesis of our primitive observation and corresponding relational concepts — then exhibit the same characteristics; they are monocular, unchanging, 3-dimensional, spatial, non-temporal relational statements. Any statement that is temporal, changing, or 4-dimensional will thus appear as a logical paradox to this logical shorthand.

But from Young's two-slit experiment, we already know that reality and relationships between its parts are quite different if the photon interaction is not invoked — i.e., if $\partial/\partial T$ is not invoked. Classical reality (as prescribed by Aristotle's laws) is directly violated by an electron in the two-slit experiment, e.g., if and only if photon interaction with the electron is not invoked. Again, this has been simply explained by the present author[4], and Charles Muses as early as 1957 pointed out the absence of any mystery in Young's experiment if the chronotopological aspects were considered.[5]

The Conscious Mind is Fitted to the Photon Interaction

However, what is normally referred to as the "conscious, thinking mind" is simply a functioning temporal (rigorously, chronotopological) mechanism that is painfully built up in the individual's awareness (his mind in the greater sense of both thought and awareness, whether monocular or multiocular) by training, conditioning and experience. Its functioning is largely conditioned by one's 90% or so attention to visual stimuli (to the partial reality remaining after

photon interaction has been invoked, and to the memory-collated ordering of vast numbers of such photon interactions) and by one's cultural conditioning — which itself has been almost exclusively conditioned and shaped by the monocular photon interaction at base root.

Thus, since the beginning of man, his conscious, rational mind has been trained and constructed to function almost exclusively in basic correspondence with the photon interaction, and his experiential reality consists of the partial reality stripped from fundamental reality by photon interaction.

All "perceived differences," e.g., are created by this deep mindset. As has been previously pointed out,[6] the solitary human problem responsible for all man's inhumanity to his fellow man is directly dependent upon man's almost exclusive detection, observation, perception, and conception of "difference" between humans, these "differences" being due exclusively and totally to the fitting of men's conscious minds to the photon interaction's monocular separation of spatial reality from nonspatial reality, i.e., to

$$\partial/\partial T\,(L^3T) \Rightarrow L^3$$

Such well-nigh total devotion to, and enslavement by, photon interaction also is responsible for the scientist's well-nigh total devotion to, and enslavement by, the present imperfect and incomplete three laws of logic, as presented by Aristotle. The depth of that devotion and enslavement is evidenced by the fact that the resolution of such paradoxes as Heraclitus's problem of change have eluded the best minds of humanity for several thousands of years. Indeed, these paradoxes cannot be resolved by the conscious, rational mind in its present state, for it has been most firmly constructed and fitted to function in accordance with the photon interaction.[7] One cannot hope to resolve any logical paradox by using only those same logical methods that found the situation to be paradoxical in the first place!

Dimensionality

That we need not be constrained by such universal delusion is already shown by binocular vision. Specifically, in viewing a three-dimensional **object, each** eye **never** detects a "third dimension," but detects only **an L^2 2-dimensional** picture. By taking two slightly

different 2-dimension snapshots and superposing them, the third dimension is gained. One then essentially sees the resultant superposed pictures as "almost the same but not quite." I.e., the Aristotlean identity algorithm, if satisfied, yields "no difference, hence one object," and if not satisfied, yields "difference, hence multiple (extended) object(s)." So if the two snapshots are almost Aristotlean-identical but not quite, we get an extended-two-dimensional (three-dimensional) object. Otherwise we see two separate, two-dimensional snapshots blurred together (the reader is urged to try this and see).

The point is, "dimensionality" and the identity algorithm are directly related, and geometrically one follows from the other.

Awareness of Time

In very similar manner, we can only gain cognizance of awareness of "time" (as a fourth dimension) by the superposing of two slightly differing (Aristotlean-wise) 3-dimensional snapshots. As is well known, e.g., time is not an "observable" in quantum mechanics; it is a "parameter." Rigorously, the only place such snapshots — each of which is "past" (spatially separated by the annihilation of time in the collapse of the wave function) — can multiply exist is in the "mind" in its most general sense. In a rigorous sense, mind and time can be taken as identical, and the "flow of time" can be taken as the "flow of mind connections or superpositions" of its spatial components. I.e., measured/detected/observed "physical phenomena" are a priori 3-dimensional and spatial, while a mind is four-dimensional and hyperspatial.[8] Spacetime exists mentally but not observably. Time is logically implicit, not explicit.

Temporal Aspects of Logic

Now we return to the temporal aspects of logic. Each perceptual part of each Aristotlean law is fitted to the photon interaction, hence monocular. The logic operation, inherent in the logic symbol in each statement, involves temporal superposition or comparison of spatial perceptual objects. Hence the logic operation is hyperdimensionally a function of mind and injects mind/time into the statement. Yet these laws, being fitted to or synthesizing photon interaction, attempt to prescribe the absence of time, even though writing down the logic operation rigorously invokes time. They are thus totally contradictory, since as written they implicitly violate themselves.

Table 4 summarizes the operations now to be permitted in the time-three algorithm, in developing a new four-law logic:

Table 4. Conditional identity rules.

1. $\left| S_1, S_2 \right|_3 = (\text{zero})_3 \Rightarrow (\text{identity})_3$

2. $\left| S_1, S_2 \right|_3 = (\text{nonzero})_3 \Rightarrow (\text{non-identity})_3$

3. $\left| S \right|_3 = \left| \left| S \right|_1, \left| S \right|_2 \right|_3 \Rightarrow$ monocular separation, differentiation internally

4. $\overset{S}{\sqcap}_3 = \overset{S}{\sqcap}_3 \Rightarrow$ nonseparation, no differentiation internally

Rules one and two simply state that, when snapshots 1 and 2 are superimposed (subtracted) in time interval 3, the resultant snapshot 3 may be zero or nonzero. If zero, snapshots 1 and 2 are said to be identical, and if snapshot 1 is to be labeled A, then snapshot 2 is to be labeled A. If snapshot 3 is nonzero, snapshots 1 and 2 are said to be nonidentical; if snapshot 1 is labeled A, then snapshot 2 is labeled $\overline{A}$.

Rule 3 says that snapshot 3 is a "memory" snapshot, and it may be particulately examined to monocularly separate snapshots 1 and 2.

Rule 4 states that snapshot 3 is not a "memory snapshot" and may not be further separated.

Note that in logic we repeatedly apply these rules in combination, serially or compositely. Note further that Rule 1 must serially apply both rules 3 and 4, as must rule 2 also.

If we take $4|_3$ to mean "rule 4 applied conditional to rule 3 also being applied," and $4|_{\overline{3}}$ to mean "rule 4 applied conditional to rule 3 not also being applied," we may write Table 5:

Table 5. Conditional identity, non-identity, and oneness.

$4|_{\overline{3}} \wedge 1 = \text{identity}\ (S_1, S_2)$

$4|_{\overline{3}} \wedge 2 = \text{non-identity}\ (S_1, S_2)$

$4|_{\overline{3}}$ = oneness without separate-ones; oneness, extraordinary and unperceivable; thing-in-itself

$4|_3$ = "ordinary" one, perceivable separation, "thing-as-separate-from-others"

As can be seen, this type of reasoning also sheds a great deal of light on the long-standing problem of the "thing-in-itself," but that is beyond the scope of this paper.

The Fourth Law of Logic

Now we write the fourth law of logic as follows:

$$4.\ (A_1, \overline{A}_2)_3 \Rightarrow A_1 \equiv_3 \overline{A}_2$$

where all we have said is that, by rule 4, in snapshot 3 no memory process is allowed, and no separation/differentiation whatsoever of A_1 and $\overline{A}_2$ is permitted. Under these operational conditions for identity, what had previously been called A_1 in snapshot 1 and what had been called $\overline{A}_2$ in snapshot 2 are indistinguishable, hence identical.

Figure 2 shows this concretely, and may be taken as a proof of the fourth law by demonstration.

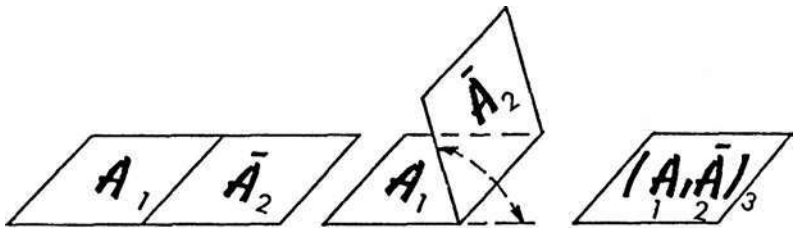

Figure 2. Proof that two opposites can be identified. What was separately perceived as A_1 in time snapshot 1 and what was separately perceived as $\bar{A}_2$ in time snapshot 2, cannot be distinguished in time snapshot 3.

Thus the age-old philosophical dilemma posed by the illogical identity of opposites has a simple resolution if one considers temporal aspects, and introduces temporal conditions for identity or non-identity decisions.

We now write the new four law conditional identity logic as shown in Table 6:

1. $A_1 \equiv_3 A_2$
2. $A \not\equiv_3 \bar{A}_2$
3. $A_1 \vee_3 \bar{A}_2$
4. $A_1 \equiv_3 \bar{A}_2$

Further, we point out that all four laws now apply. Laws 1,2, and 3 are the laws of explicit monocular perception, with implicit binocular perception. Law four is the law of explicit binocular perception, with implicit monocular perception. Both monocular and binocular perceptions must be and are used in each law. So in any situation, either the triad applies explicitly and the fourth law applies implicitly, or the fourth law applies explicitly and the triad applies implicitly.

Indeed, one can **even take the** view that we have prescribed a five-law logic, **the fifth law being taken** as shown in Table 7:

Table 7. A possible fifth law of logic.

5. $[1,2,3, \wedge (4)] \vee [4 \wedge (1,2,3,)]$ where () $\Rightarrow$ implicit

In a previous paper[9], the author has already presented methods to apply this new logic to resolve present paradoxes. At least hypothetically, every present paradox should be simply a statement of the explicit fourth law, and it should be resolvable by explicit application of that law[10].

NOTES AND REFERENCES

1. Specifically, by whether or not exclusivity applies. I.e., we may read Law 1 as "In snapshot (time interval) 3, what was A in snapshot 1 is exclusively identical to (unseparated from) what was A in snapshot 2." Law 2 may be read as "In snapshot 3, what was A in snapshot 1 is exclusively not identical to (is exclusively separated from) what was not-A in snapshot 2." Law 3 reads, "In snapshot 3, what was A in snapshot 1 and what was not-A in snapshot two are exclusively separated." Thus it can be seen that the three laws simply are statements involving whether or not two former perceptions are to be separated in a third perception. These three statements presently prescribe the total separation of the two previous perceptions and prohibit any admixture of the two — the so-called "excluded middle." Thus the three laws prescribe monocular, one-at-a-time perception.

   What we call a "wave" exists in time and is considered to contain an admixture of timeless, static spatial states (such as "wavelengths.") The prohibiting of admixtures thus represents the "collapse of the wave function" and corresponding loss of time. This defines "observation" and explains why all "measurement" and "detection" and "observation" — requiring a collapse of said wave function — are spatial and not spatiotemporal. That is why time is a parameter in quantum mechanics, not an observable.

   Relativity, being constrained by such logic, obviously can find nothing "physical" (observed, spatial, timeless thing frozen by

the collapse of the wave function as engendered by or fitted to the photon interaction) that is traveling faster than light — i.e., that violates the conditions implied by the "observing/detecting agent."

That reality need not at all be so constrained is clearly shown by Young's two-slit experiment, the heart of all quantum mechanics. In this experiment, "classical' reality is violated if and only if the photon interaction is not invoked. Classical reality is obeyed if the photon interaction is invoked.
With appropriate change to logic to fit "reality that has not been interacted with by photons" and therefore is spatiotemporal, a new physics becomes possible.

2. Thomas E. Bearden, "Solution of the Fundamental Problem of Quantum Mechanics," January 3,1977, Defense Documentation Center.

3. Bearden, "Photon Quenching of the Paranormal (Time) Channel: A Brief Note," 20 April 1977, Defense Documentation Center.

4. Bearden, "Virtual State Engineering and Its Implications," 1979, Defense Documentation Center.

5. With the possible exception of Kozyrev — whose more technical works on time remain undisclosed to open science — no other person known to this author seems to have grasped the implications of a dynamic structure of time as penetratingly as has Charles Muses. The importance of the time interaction explaining the two-slit experiment (i.e., in explaining wave-particle duality) was noted as early as 1957 by Muses. See, e.g., Muses' introduction to Jerome Rothstein's **Communication, Organization, and Science,** The Falcon's Wing Press, Indian Hills, Colorado, 1958, p. lxii, where Muses pointed out that the celebrated wave-particle paradox remains a paradox only so long as the chronotopological (his word) phases of the phenomena are left unrealized in the analysis. The entire foreword by Muses is a remarkable document which analyzes the structure of time itself. With his hypernumbers Muses can describe the nested structure of time, which is what is actually

being carried by the photon. Further, he can theoretically predict mechanisms by means of which these structures can be orthorotated. It would appear that practical devices should be constructable on the principles elucidated by Muses, and it is little short of astonishing that fundamental work of such importance and application has been thus far little used by theorists, though it is already recognized in the standard literature; e.g., the profound summary paper "Hypernumbers II" in the January 1978 issue of the journal **Applied Mathematics and Computation,** published by Elsevier.

6. Bearden, "The One Human Problem Its Solution, and Its Relation to UFO Phenomena," Defense Documentation Center, January 3, 1977.

7. Which is why a Zen master often gives the student a koan to confound and overwhelm this automatic, robotic mindset and functioning that has been constructed as the student's "conscious mind."

8. Specifically, consciousness/life involves a seven dimensional body/being in an infinite-dimensional universe. See Thomas E. Bearden, "A Mind/Brain/Matter Model Consistent with Quantum Physics and UFO Phenomena," prepared for the 1979 MUFON Annual Symposium, available in the **Proceedings,** MUFON, 103 Oldtown Road, Sequin, Texas 78155.

9. Bearden, "The Fourth Law of Logic," **Specula,** Journal of the American Association of Meta-Science, P.O. Box 1182, Huntsville, Alabama 35807, Vol. 2, No.l, January-March 1979, pp. 30-40; also in publication in Defense Documentation Center. (The journal **Specula** is no longer pulished).

10. No consideration of the foundations of logic and mathematics is complete until one has read Morris Kline, **Mathematics: The Loss of Certainty,** Oxford University Press, New York, 1980.

APPENDIX IV

LIST OF SELECTED INCIDENTS

Author's note: In 1985-1987 a series of anomalous missile and space failures swept the U.S. and the West. These incidents were not unique, as many think, but were actually only a portion of thousands of related incidents showing the Soviet testing of advanced weapons throughout the world. This listing will show the types of incidents referred to.

The listing is not intended to be complete at all, but only representative. Hundreds of incidents of weather engineering, giant cloud radials and grids, suspicious light incidents, etc. could easily be added, were there time and room. No attempt has been made to exhaustively map the "aerial booms" that have blanketed the U.S., Europe, and other parts of the world. The light and "maybe it's UFO's" reports alone would add thousands of incidents to the list.

Our message is succinct: The Soviet Union has developed a new science and weaponized it, since at least the latter 1940's. It has utilized that science — energetics — to develop superweapons and supervehicles. Because of the danger from accidental initiation of nuclear weapons and materials, it is exceedingly difficult and dangerous for the Soviets to make extensive use of these weapons. Accordingly, a biological warfare strike — AIDS — has been utilized to deliver what is to be the knockout blow to the West.

DATE, INCIDENT, LOCATION, REMARKS

Early spring 1966 - Malstrom AFB Montana.
UFO sighting coincident with simultaneous problems in 10 strategic missiles in launch site associated with Malstrom AFB, Montana. *Similar event in Mar 1967 also. (Source:* ***Clear Intent.).***

20 **Mar** 67 - Malstrom AFB Montana.
Flight of 10 strategic missiles in launch site associated with Malstrom AFB, Montana experienced problems with guidance and control system. UFO in area and confirmed on radar. Jet fighters scrambled, results unknown. *Similar event one year earlier.* (Source: **Clear Intent.).**

1972 - Prague.
At a secret meeting of European communist leaders in Prague, Brezhnev lays out firm statement of Soviet intent to be able to dominate the world by 1985. Stated would control the oceans, 90% of the land, and the air and space above. *Notice he said control, not invade and conquer.*

Aug 73 - Over ocean.
USAF Minuteman ICBM is launched from Vandenberg AFB, aimed for Kwajalein missile range. Unidentified object appears and is tracked next to the ICBM's nose cone. Crossed the RVs trajectory. Object about 10 ft long. Seen by 2 separate radars. Three other identical objects were seen in the vicinity. *Probable Soviet advanced flying vehicles. Also a deliberate stimulus to see if U.S. knows of the technology, and how the U.S. reacts. (Source:* ***Clear Intent.).***

18 **Oct 73** - Near Mansfield, Ohio.
U.S. Army helicopter is intercepted by glowing red object that converged on it with terrific speed. Object placed some sort of "tractor beam" on helicopter. Object was gray metallic structure, 50-60 ft long. Helicopter was stopped in mid air. Radio blacked out. Official report filed by pilot. *Probable advanced Soviet flying vehicle. Also a deliberate stimulus to see if U.S. knows of the technology, and how the U.S. reacts.*

21 Oct 73 - Near St. Joe, Indiana.
20 or 30 lights sighted circling in the sky near St. Joe, Indiana near a woods fire, by firemen. *Probable Soviet holographic tests to stimulate UFO reports.*

1973 to date - Bennett Island.
Bennett Is. exhaust plumes detected by U.S. weather satellites. *Well over 100. spotted so far. Weirdly, 5 islands and part of the continental Alaskan area are in process of being secretly given to the USSR; Bennett Island is one of them.*

May 1974 - Lake Michigan.
Blue-green glowing ball of light seen to fall into Lake Michigan. *Soviet scalar EM testing.*

8 July 74 - Lake Okeechobee, Florida and Atlantic Ocean.
Orange red ball of light lights up sky over south Florida. Crashes in area of Lake Okeechobee. Was accompanied by a large boom. Several other booms 5-7 min. after "object crashed." Pilots also saw object plummeting in from over Atlantic. *Probable Soviet scalar EM weapons testing and calibration.*

Nov. 74 - Saryshagan. USSR.
Construction of Tora facility begins at Soviets' Saryshagan test facility. Believed to be directed energy facility. *Probably connected with Soviet scalar EM weapons systems development.*

Oct? 74 - Antarctic.
Ozone hole over Antarctic first detected. Did not appear in measurements from 1957-1973. Note did not appear until exhaust plumes noted from and around Bennett Island, with substantial activity. *Looms over the continent every Oct. Diminishes through Mar. More severe each year since 1974.*

1975 - USSR.
Soviet article in **International Life** speaks of weather war, changing the nature of lightning, increasing the power of lightning, and directing electric charges of tremendous power against specified targets. "Atmospheric electricity" can be used to suppress mental activity of large groups of people. *Tip of the iceberg. Unclassified reference to Soviet's scalar EM (energetics) weapon program. Note involvement of "lightning" in destruction of U.S. missiles a decade later.*

16 **Feb 75** - Caribbean.
R.M.S. Carmania (UK) observes bright white circular light appear and rise to 20 degrees, leaving comet-like trail, circle and disappear. Repeated four more times at exact hourly intervals. *Soviet scalar EM weapons tests. May have been a shipborne device.*

13 June 75 - Kremlin.
Brezhnev calls for ban on frightful weapons of mass destruction. *Major speech. Repeated proposals to U.S. Senators.*

2 **Jul 75** - Kremlin.
Brezhnev repeats his proposed ban on development of frightful new weapons, to a group of U.S. Senators. *To visiting U.S. Senators. No one knew what he was talking about.*

Aug. 1975 - Kremlin.
Ponomarev calls for ban on frightful new weapons of mass destruction. *To visiting Congressmen.*

23 Sep 1975 - United Nations.
Gromyko presents draft agreement to UN General assembly, for banning development of frightful new weapons. *30th session of UN Gen. Assy. No one knew what the Soviets meant.*

Oct - Dec 75 - Satellite, over the Indian Ocean.
U.S. satellites illuminated or "blinded" over the Indian ocean. *Source 10-1,000 times as strong as natural sources. 5 incidents. One 4 hrs. long. Soviets wasted no time after Sep. fiasco.*

28 **Oct** to **11** Nov **75** - Mid-U.S. and Canada.
Series of "UFO's" seen at Malstrom AFB, Montana; Loring AFB, Maine; Minot AFB, North Dakota; Wurtsmith AFB, Michigan and Canadian Forces Station, Falconbridge, Ontario, Canada by reliable military personnel. Reported to NORAD. Some objects seemed like helicopters. Radar tracked objects. One object at 72,000 ft. was 100-ft sphere, with seeming "craters" around it.
Malstrom F-106's scrambled on one object but could not close on it in darkness and low altitude. Efforts by Air Guard helicopters, SAC helicopters and NORAD F-106's were fruitless. Probable Soviet activity in and around the SAC bases and Canadian radar site. (Source: **Clear Intent.).**

30 Oct 75 - Wurtsmith AFB, Michigan.
UFO's and "unidentified helicopters" sighted (multiple incidents) at or near Wurtsmith Air Force Base, Michigan. Helicopter hovered over the weapons storage area. Radar reported low-flying objects. Returning KC-135 tanker a/c diverted to intercept one UFO. Observed two objects, unable to close. Visual and radar contacts. Low on fuel, KC-135 returned to base to land, again seeing lights over the weapons storage area. (Source: **Clear Intent.)** *Soviet Activity.*

7 **Nov** 75 - Near Lewiston, Montana.
Giant glowing disc, football field sized, hovered over Minuteman missile launch site K-7, just south of Lewiston, Montana. When it rose to 1,000 ft., NORAD radar picked it up. Two F-106's were scrambled. UFO rose to 200,000 ft. and disappeared from NORAD radars. *Probable advanced Soviet flying vehicle, using antigravity propulsion system.* (Source: **Clear Intent.).**

Nov 75 - Semipalatinsk, USSR.
Large amounts of gaseous hydrogen with traces of tritium begin to be detected by USAF/TRW early warning satellites.
Nuclear debris apparently related to nuclear facility at Semipalatinsk labelled PNUTS (possible nuclear underground test site.) Probable large scalar EM development and test site.

Jan 76 - Cannon AFB, New Mexico.
Two UFO's reported near flight line at Cannon AFB, New Mexico. 25 yards in dia., gold or silver in color with blue light on top, hole in the middle and red light on bottom. Observed and reported by security police. (Source: **Clear Intent.).** *Probable Soviet activity.*

31 **Jan 76** - Eglin AFB, Florida.
MG Lane, CG, Armament and Development Test Center, Eglin AFB, Florida reported a UFO sighting near an Air Force Radar site from 0430 to 0600 Eastern Standard Time. Photographs were taken. Later press release called it "building lights." (Source: **Clear Intent.)** *Probable Soviet Scalar EM activity.*

1976 - U.S. Embassy, Moscow.
State Dept. declares U.S. Embassy in Moscow an unhealthful post. Installs Aluminum window screens against Soviet microwave radiation, which has been underway since 1950's.
Provided 20% pay extra differential. Embassy radiated with weak microwave radiation since 1950's. Two U.S. Ambassadors died, Stoessel ill with strange leukemia-like malady. Soviet stimulus to see if we knew about scalar electromagnetics, phase conjugate waves, and EM disease induction. (Stoessel died recently of cancer).

1976-U.S.
Soviet nuclear scientist named Rudakov visits U.S., proposes cooperative effort in some a**reas of** fusion research. Showed work he **had**

been doing and results obtained. U.S. officials reacted drastically, classified his talk as top secret, even ripped off blackboard and carried it away.*Very strange incident. Soviet open, public scientific work considered Top Secret by the U.S. One wonders why.*

30 **Mar** 76 - Netherlands.
Huge atmospheric boom occurs over northern part of Netherlands. *Through 1983, in 10 years 7 events took place.*

22 Jun 1976 - North Atlantic.
Expanding white sphere of light developed for about 10 min. then faded. Other associated light phenomena observed. *Seen and logged by passing ship.*

4 **Jul** 76 - Soviet Union.
Giant Soviet Woodpecker transmitters activated. *3-30 MHz band. Worldwide interference with communications.*

30 **Jul** 76 - Fort Ritchie, Maryland.
Several UFO's sighted in and around Ft. Ritchie, Maryland. One hovered over the ammunition storage area. Reported. *Temperature inversion at the time provided a convenient pseudoexplanation. Could not have caused the incidents.* (Source: **Clear Intent.)**

10 **Sep** 76 - Lithuania.
European Airways flight 831, Moscow to London, at 31,000 ft over Lithuania sees blinding single ball source of light at constant altitude about 5-6,000 ft. below them and above a lower cloud.
Pilot contacted Soviet authorities. Received negative response and suggestions he should not ask questions. Probable deliberate stimulus of flight so, from reports to British authorities, could ascertain whether Britain knew anything about scalar EM weaponry.

19 Sep 76 - Near Teheran, Iran.
In early morning hours, UFOs were spotted north of Teheran, Iran. Two F-4's attempted to intercept. The first lost all communications and instrumentation at 25 miles distance. When the F-4 turned away, equipment was restored to functioning. Second F-4 acquired radar lock at 27 nm. and attempted to close. Object moved to stay at 25 nm distance. Second object came out of it, headed straight for the F-4. F-4 attempted to fire AIM-9 missile and at that instant weapons

control panel and communications went off. F-4 took evasive action. A third object was seen to emerge from first. The F-4 returned to base. Each time it passed through 150 degrees magnetic bearing, it lost communications and INS fluttered 30 to 50 degrees. A civilian airliner also experienced loss of communications in the vicinity.
Signatures of scalar electromagnetic weapons and antigravity.

1976 - Soviet Union, Sweden.
Swedish national authorities detect anomalous radionuclides — similar to those from nuclear explosions — over Sweden. No accompanying seismic activity. Correlated with known Soviet activity at Semipalatinsk. *In other words, nuclear explosions were occurring, but they did not shake the earth. Total anomaly. Indicates transformation of the explosive energy. Positive signature.*

1976 - Philadelphia.
Legionnaires Disease precipitously strikes Legionnaires attending convention in downtown Philadelphia. Kills 34, makes 187 others seriously ill. Similar malady struck Odd Fellows convention at same hotel in 1974. *Odd person with apparent transmitter and antenna was expelled. Informed members: "It's too late! You are all dead!" Probable scalar EM conditioning of convention with an immune suppression pattern for the disease.*

21 **Jan 77** - Columbia.
Columbia A/L Avianca night flight. Instruments went haywire. Saw enormous, zigzagging glowing light, traveled at fantastic speed back and forth. Blinked landing lights, UFO responded. Sped away at incredible speed. *Probable Soviet advanced performance antigravity flying vehicle. Such have been widely sighted over South America.*

3 **Mar 77** - Columbia.
Columbia A/L Avianca night flight. Pilot abruptly changed course to circle a huge, glowing UFO. Object had cigar-shaped fuselage and was twice as big as the aircraft. Blinked lights, UFO responded. Sped away. Air traffic control radar tracked object at ten times the speed of normal aircraft.
Probable Soviet advanced performance antigravity flying vehicle. Such have been widely sighted in South America.

24 **Mar 77** - Off coast of Spanish Sahara, Africa.
M.V. Kinpurnie Castle, off coast of Spanish Sahara, Africa, observes complex, dynamic light phenomena. Third phenomenon was the formation of a semi-circular area of moderate luminosity, a hemisphere of light. Took 3 min to form about a previous luminous patch. Then another luminous patch formed over the hemisphere. After about 7 min., phenomena dispersed. *Soviet test of Tesla shield and globes.*

11 Jun 77 - Moscow, USSR.
Soviet biophysicist hands Robert Toth, Los Angeles Times journalist, a report containing proof that certain particles existed in cells, carried information, and were radiated. Both seized by KGB and charged with possessing Soviet state secrets. Interrogated, released. *Neither knew what they actually had. Soviet Academician I.M. Mikhailov pronounced secret such phrases as "micro-organism self-radiation... by means of vacuum particles in space." Use of such particles was discussed, and was secret. Paper contained basis of Soviet energetics use in biology. Positive connection of Soviet classification to mitogenetic radiation and scalar EM waves ("vacuum particles" indicate virtual flux structuring).*

13 July 77 - New York.
Massive electrical blackout strikes New York City. Affects 8 million persons. Staggering series of "natural" electrical shocks, mechanical failures, and human errors occurred. Anomalous "lightning strokes" supposedly initiated the collapse of the power grid. *Probable Soviet test.*

1977 - Ocean off Yugoslavia.
M.V. Dolphin, between Yugoslavia and Israel, observed extensive light balls and repeated phenomena, appearing and disappearing. Men were disoriented. Compass was disrupted. Okay after the phenomena dispersed. *Probable Soviet test. Stimulus to see if Britain recognized the weaponry and knew anything about it.*

13-14 Dec 1977 - Leitchville, Australia.
Large aerial light plus 3 smaller ones observed for four hours by multiple persons. Lights simulated activity of a "mother ship" and smaller craft assigned. Changed colors. Then a shower of orange

lights occurred. *Probable Soviet test. Part of deception plan, to create "UFO" phenomena to hide weapons testing. TR wave holography.*

Dec 77 to **Jan 78** - Off East U.S. Coast.
Mysterious atmospheric explosions occur off U.S. Atlantic Coast. *Some accompanied by light phenomena. Soviet tests and calibration (registering the long-range artillery, so to speak.)*

13-14 Dec 77 - Leitchville, Australia.
Large arrays of light phenomena sighted by multiple witnesses. *Probable Soviet creation. Reported as "UFO" phenomena. Holographic creation of "UFO" phenomena as part of deception plan to disguise tests of the weapons worldwide. TR wave holography.*

1977-78 - North Pacific Ocean.
Two huge hot spots in North Pacific ocean, 2,000 mi by 1,200 mi. *May have caused El Nino and one of most severe winters on record. May have been caused by Soviets as a weather experiment.*

27 **Jan 78** - U.S. East Coast.
Boeing 727 off east U.S. coast experiences engines failing, 1 at a time, in all three engines. A/c plunges 8,000 feet; engines restart one at a time. *First time ever that all three engines on a 727 had failed. Probable Soviet test.*

Feb 78 - Rocky Mtns. NW of Las Vegas.
Four aircraft crash in a 6-day period in the rugged Rockies, NW of Las Vegas. *Connected with a crashed military a/c from Nellis AF Base. Should be further investigated.*

Feb 78 - Texas coast. Nova Scotia. Charleston, SC.
Atmospheric booms occur. *Multiple booms in Charleston. Soviet tests. Scalar EM weapons.*

2 **Apr 78** - Bell Island, Nova Scotia.
Mysterious fireball, explosion accompanied by anomalous electrical effects. *Small bldgs blown apart, trees scorched, fireballs seen. Probable Soviet test. Apparently even registered on U.S. satellite.*

10 **May** 78 -Off Florida.
Women pilots in race experience anomalous "time loss" on their watches from Fort Myers to Freeport (Bahamas). *39pilots. Watches synchronized. Up to 3 min. lost. Definitely not normal EM effect. Probably due to sporadic natural scalar interferometry and time-reversed waves generated in area from time to time. "Bermuda Triangle" mechanism?*

May 78 - Florida.
Unexplained lighted objects sighted in sky over remote sector of Florida. Tracked on radar at a Navy EW center. Naval personnel also observed them through binoculars. *Probable Soviet advanced flying vehicles, or tests of intense holograms with energy sufficient to ionize air and reflect radar.*

18 **May** 78 - England.
Several atmospheric explosions shake houses over a wide area in Hull, Scunthorpe, Holderness coast, and Brough and Grimsby. *Probable Soviet weapon testing and calibration.*

Jun 78 - Indiana.
Large ball of light streaks across sky, stops, hovers, then explodes with a large boom. *Possible test. Standard Soviet incident to generate deception.*

7 **Sep** 78 - Netherlands.
Large acoustical event (boom) occurs over the Netherlands. *Soviet scalar EM weapons testing and calibration.*

Sep 78 - Tabas, Iran.
Anomalous Richter 7.4 earthquake strikes Tabas, Iran, killing 25,000. No aftershocks. Anomalous depth. Soviets needed to relievo pressure in rocks at nearby Askhabad on the Soviet/Iran border, else lose the city to a large earthquake. *36 hrs. earlier, Soviets exploded monstrous 10 Megaton underground nuclear explosion, to disguise what caused the earthquake. Almost definitely a Soviet- induced earthquake.*

Oct. 78 - USSR.
U.S. DOD weather satellite purportedly photographs a semi-rectangular object climbing out of atmosphere at 4,000 to 4,500 **mph.**

Object was over the Soviet Union. *Probable Soviet advanced flying vehicle, using antigravity propulsion system, if photograph is real.*

31 **Oct** 78 - Fairbanks, Alaska & Lake Ontario.
Red and yellow flash seen descending through sky S. of Fairbanks, Alaska by multiple observers. One minute later, U. of Alaska seismograph registered a tremor 1.5-2.0 on Richter scale. Ten days prior, a similar phenomenon was observed over Lake Ontario and a photo taken of the light. *Probable Soviet scalar EM wpns testing calibration.*

Nov 78 - Kuwait.
Large flying vehicle lands at Umm. Alaish oil pumping sta., Kuwait. Disrupts elect, comm, and pumping activities. Leaves after 7 min. *Probable antigravity propulsion system. Soviet vehicle. One of a series of "UFO" sightings in oil fields of Kuwait. Positive scalar electromagnetics and time-reversed wave signatures.*

Nov - Dec 1978 - Kuwait.
Series of "UFO" incidents over Kuwaiti oil fields occur. Kuwait Gov't. investigates, makes official report. *U.S. Pentagon noted incidents. Probable Soviet-induced incidents.*

1979 - British Columbia & Caspian Sea.
Ariel 6 satellite experiences anomalous turnoff of two power supplies. *Over British Columbia and Caspian Sea, when sun is shining. Probable Soviet stimulus.*

Jun 79 - Vienna.
Pres. Carter signs SALT II agreement in Vienna. After that, his acts and speech are erratic and he seems to be in a depressed state. *Suggestive of exposure to EM behavior modification. Soviets had possessed the LIDA technology for 29 years.*

Sep 1979 - USSR.
Strange giant semicircular light phenomena observed in USSR, toward Saryshagan. Observed several times. Source: London **Times.** *Observed from Afghanistan by British cameraman Nick Downie. Definitely Soviet tests of a Tesla globe and/or shield.*

22 Sep 79 - South Atlantic.
U.S. Vela satellites detect anomalous flash over South Atlantic, as if from a nuclear event. *U.S. Govt Agencies still disagree as to whether this was a nuclear event or not. May have been a Soviet test, or a test of a scalar EM weapon by another nonhostile country.*

25 Dec 79 - Afghanistan.
Soviets invade Afghanistan. *This is the Soviet "Spanish Civil War," where wpns, training, and the state of their ready reserves are tested. It is not primarily the regulars who are fighting there. Some scalar weapons — e.g. Smirch death ray — are tested also.*

1980 - Afghanistan.
Soviets kill 225 women and children in a village in the province of Maiden, near Kabul, Afghanistan. A month and a half later, bodies still undecayed. Bodies were also shot, to try to deceive Mujaheddin as to cause of death. *Bodies perfectly preserved. No smell, no bugs, no scavengers had eaten them. Probable Soviet test of a "death ray." Definitely scalar electromagnetic weapon signature.*

Feb 1980 - Duncanville, Texas.
About 100 startlings suddenly start falling from flight, instantly dead. *One of several such anomalous bird falls. Connected with very high frequency components added to Woodpecker signals for sharp localization. Birds entering such an area are killed.*

May 1980 - Seminole, Florida.
Start of mysterious plague of assorted illnesses striking healthy persons in a 20-block section of Seminole, Florida. Animals affected also. Lack friendly bacteria in their intestines. *Signatures of EM induction of disease and kill of intestinal bacteria. The lack of friendly bacteria is important. May indicate one direction of biological warfare planned by Soviets.*

June 1980 - USSR.
Huge, luminous hemisphere of light seen within Soviet Union, from Kuwait. Probably over Caucasus region of USSR. Source: personal communication from observer. *Tesla shield. A definite test, un equivocal.*

July 1980 - U.S. and Canada.
Richter 5.1 quake centered in northern Kentucky rumbles through 14 states and into Canada. *No known fault. Was predicted two wks in advanced by an associate.*

7 **Nov 80** - Applegate Valley, Oregon.
Mysterious explosion, earth rumbling, brilliant light turns night into day in Southern Oregon. *Associated with subsequent earthquake next day?*

8 **Nov 80** - California.
Richter 7.5 earthquake off coast of Southern California. Shakes CA and Southern Oregon. *Note anomalous phenomena in S. Oregon the preceding day.*

Dec 1980 - South Atlantic.
U.S. Vela satellites detect another anomalous nuclear-like flash over the South Atlantic. *In infrared only. Obviously not a normal nuclear wpn.*

28 **Dec 80** - South Atlantic.
Great bluish-white flash over the South Atlantic. Clear sky except 2 or 3 small cumulus clouds, one about 600 ft. above ship. *Possibly connected with the second Vela flash detection, or generated by the same system. One of many such incidents.*

1 **Jan 81** - Somerset, Pennsylvania.
Pilots of two a/c report the descent of a bright, shiny object with fiery tail over Pennsylvania. Large boom rumbles across most of Western PA. *Possible Soviet scalar EM testing. Part of deception plan.*

Jan 81 - Minnesoto, Wisconsin, South Dakota.
Great skyflashes and rumbling noises occur around Morris, Minnesoto and Wisconsin and South Dakota. *Possible Soviet scalar EM testing. Part of deception plan.*

Feb 81 - San Jose California.
Two pilots menaced by 10 ft. dia. light which flew directly at aircraft over San Jose, CA airport. Plane climbed, light followed, then sped away. *Totally consistent with exercise of the Soviet Launch Phase*

Anti-bomber system's real-time holography aspects of the Woodpecker OTH radars.

6 **May** 81 - Fredericksburg, Maryland.
EC-135 a/c crashed near Fredericksburg, MD. Severe nose-down from 29,000 ft. Apparent loss of all power. At 5,000 ft., either fire or minor explosion occurred. At 1,500 large explosion destroyed the aircraft. *Possible Soviet test of OTH radar anti-bomber weapon system?*

Mid-81 - Afghanistan.
Soviet helicopters use mysterious, highly lethal agent in Afghanistan. Causes death so quickly victims do not have time to make the slightest move. Rpt by Jane's Defense weekly. Referred to as Smirch gas or Smert gas. *Probable test of a Soviet scalar EM "death ray."*

20-23 Jan., 1982 - Gander, Newfoundland.
"Object with red, green and yellow lights sighted in the Gander, Newfoundland area more than 36 times. Alternately hovered and darted in a complex "flight" pattern. *Possible real-time holographic phenomena produced by Soviet scalar EM weapons as part of the worldwide deception plan. Gander is a major "registration point."*

3 **Feb** 82 - Newfoundland.
Red and green flashing lights travelling across the horizon at 2,000 mph reported by 3 Armed Forces officers at Gander, Newfoundland. *Possible real-time holographic phenomena produced by Soviet scalar EM weapons as part of the worldwide deception plan. Possible major "registration point."*

Feb 82 - Ankasaray, Turkey.
Cluster of high, multiple lights pass over Turkish town of Ankasaray, 200 km. from Ankara. Dogs were disturbed also. *Possible real time holographic phenomena produced by Soviet scalar EM weapons as part of the worldwide deception of plan. Gander is a major "registration point."*

Sep 82 - Ankara, Turkey.
Cluster of 10-14 high, multiple lights pass over Ankara, Turkey in clear night sky. Dogs were also disturbed. *Possible real-time holographic phenomena produced by Soviet scalar EM weapons as part of the worldwide deception plan.*

Early 82 - St. Petersburg, Florida.
Extended series of booms occur off coast of Florida, near St. Petersburg. *Continued lengthy period of time. Years of Soviet scalar EM interference grid adjustments have been registered in Florida and off St. Petersburg. Booms are so numerous that meetings of civil defense, federal, and state officials have been held.*

June 82 - Washington/Canada border and off-shore.
Extended series of booms occur over Pacific Ocean, centered about Port Angeles and Sequim near Washington state/Canadian border. *Persisted for several weeks. As many as 10 blasts per day. Fireballs and lights also seen. Soviet extended scalar EM tests.*

18 June 82 - Northern Pacific Ocean.
Two JAL flight crews observe large, yellowish-white globe of light over the North Pacific Ocean 700 mi. east of Hokkaido, Japan. Covered one fourth of the sky. Light gradually dimmed and disappeared. *Tesla globe. Definitely a Soviet weapons test.*

June 1982 - Red China.
Several Red Chinese giant light hemisphere and globe incidents. In one instance, a/c electrical power systems began to fail in several Red Chinese fighter a/c when encountering a huge hemisphere of glowing light. *Tesla globes. Tesla shields. Balls of light. Definitely Soviet weapons tests.*

24 **Sep** 82 - Maryland, New Jersey.
Anomalous airquakes off the coast of Cape May and Northern Maryland, and Atlantic City, New Jersey. *Adjustment of Woodpecker grid. Soviet tests. 3 weeks later also.*

14 **Oct** 82 - Maryland, New Jersey.
Anomalous airquakes off the coast of Cape May and Northern Maryland, and Atlantic City, New Jersey. *Adjustment of Woodpecker grid. Soviet tests. 3 weeks earlier also.*

16 **Nov** 82 - Delaware, New Jersey.
Five mysterious booms rock Sussex county, Delaware and southern New Jersey. *Adjustment of Woodpecker grid. Soviet tests.*

1983 - Loma Linda, California.
Photos and information about the Soviet LIDA machine released. 40 MHz carrier, complex waveforms. Induces catatonic state in humans and animals. *Shows consciousness can be affected by EM means. Was used on U.S. prisoners of war in Korea. Suggests similar capabilities are possible for Woodpecker. U.S. scientific community had said impossible. President Carter affected in Jun. 79?*

Early 1983 - Bennett Island.
Large exhaust plume detected coming from Bennett Island and vicinity, one on-shore and two offshore. Plume was 6 mi. wide, 155 mi. long and reached 23,000 ft in height. *U.S. weather satellites detected it. Nearly horiz. jet, 155 mi. long. Definitely not natural. At angle ofperhaps 1.5 degree above horizontal.*

27 **Sep** 83 - England.
British RAF/Panavia Tornado aircraft loses all electrical power and crashes. *Possible Test? Tornado system is triplexed.*

22 **Oct 83** - Off Okinawa.
Two a/c operating off U.S.S. Midway apparently lost w/o trace, about 127 mi. E. of Okinawa, under anomalous conditions. *Causes unknown. Additional data needed.*

8 **Nov 83** - Western Europe.
Anomalous earthquake occurs in Western Europe. All foreshocks and aftershocks were missing. Called the "Leige" earthquake. Definite symptoms of manmade (Soviet) origin. *Large boom occurred over Netherlands the next day over 35,000 sq. km. area. Soviet scalar EM weapon testing.*

9 **Nov 83** - Netherlands.
Large acoustic event occurs over Netherlands. Detected over 35,000 sq. km. First mistaken as a Dutch quake. *One day after the anomalous Leige quake. Soviet wpn testing.*

Dec 83 - Alma Ata.
Stored munitions exploded at Dolon (Soviet) airfield. 150 km south of Alma Ata. One of six that mysteriously exploded in 7 months. *May be evidence that another nation also has Scalar EM wpns, and*

is checking the Soviets. If so, probably was warning that Soviets also would suffer if they moved.

1984 - Novaya Zemlya.
First mysterious plume detected from Novaya Zemlya by U.S. weather satellites. Sometimes plumes are 200 mi. long. *Novaya Zemlya contains Soviet atomic facilities including weapon facilities.*

1984
Senior Soviet physicist G. Yu. Bogoslovsky publishes paper, "Generalization of Einstein's Relativity theory for the anisotropic space-time." Such Russian research published regularly. Would be impossible in U.S., where similar attempts meet discredit, humiliation, and rejection by leading U.S. physics journals and departments. *The West has decreed that general relativity must not be local, and above all must not be lab-bench experimental. Open Soviet publication indicative of experimental development of local space-time curvature technology.*

1982 - 84 - Florida (& elsewhere).
Airquakes, booms (hundreds). *16 counties, near coast.*

28 Jan 84 - Pennsylvania, New Jersey.
Bright orange light streaks across sky from Pa. to N.J.'s Cape May. Similar "fireball" explodes in Clementon. Two other sky explosions observed. *Possible Soviet activity. TR wave holography and pulses. Part of Soviet deception plan.*

Feb 84 - in space.
All three payloads of the Challenger flight fail. *2 commication satillites, 1 balloon.*

10 **Feb** 84 - Netherlands.
Large atmospheric boom occurs over Netherlands. *7 others thru 1983.*

29 Mar 84 - Bennett Island.
Bennett Island exhaust plume detected by U.S. weather satellite. *Over 100 such anomalous exhaust plumes detected there.*

9 **Apr.** 84 - S. of Kurils toward USSR.
Giant rapid cloud tower rose, then faded. Small semicir. halo of light replaced it. Halo expanded to full circle of light. Expanded to giant globe then faded. *Cloud 60,000 ft in 2 min. Light globe expanded to about 380 mi. dia. and center over 200 mi. high. Source:* ***Science*** *Journal. Definitely a Soviet test of multiple weapon modes.*

26 **Apr.** 84 - Bennett Island.
Bennett Island exhaust plume detected by U.S. weather satellite. *Over 100 such anomalous exhaust plumes detected there.*

May 84 – S.E. U.S.
Series of devastating storms breaks out over S.E. U.S. in early May. Tornadoes, large hail, downbursts. Some loss of life. Persisted through night into early morning hours. Several instances of rapid thunderstorm top warming were observed in satellite photography. Occurred near downbursts. Very heavy plume activity at Bennett Is. noted in Apr. and May, 1984. *Warming of tops of thunderstorms can produce downbursts. In literature. Note that Soviet scalar EM wpns can perform such top-warming of thunderstorm anvils, and induce downbursts on command.*

13 **May** 84 - Severomorsk, USSR.
Soviet missile storage facility at Severomorsk Naval Base on the Kola Peninsula 1450 km north of Moscow blows up in a series of vast explosions. Over 200 wounded. Soviet North Fleet lost about 1/3 of its missiles. Speculation of an "electromagnetic cause, possibly by reflection of radio waves from ionosphere." Detected by satellites; first thought to be nuclear explosion. *One of six such explosions of Soviet ammunition storage sites in a period of seven months. Definitely not accidental. Probably use of scalar EM weapons by another nation, not hostile to U.S., to warn the Soviets that they also will suffer if they move.*

15 **May** 84 - Bobrwjk Airfield.
Major blast occurs at Bobrwjk Airfield, 138 km SE of Minsk and the base of a Badger-equipped air-to-surface missile regiment of the Smolensk Air Army. 10 of the 11 ammo storage bldgs blow up and admin, and access control bldgs. are destroyed. Note that fires and explosions were still raging at Severomorsk, from 13 May event. *Same note as above.*

25 **Jun** 84 - Schuerin, East Germany.
Explosion occurs at an ammunition depot at Schuerin, south of Wismar in East Germany. Windows blown out within 10 mi. radius of depot. *Same note as above.*

27 **Jul** 84 - Kuril Islands.
Slowly expandingball oflight seen by Boeing 747 crew near the Kuril Islands. Expanded for 10 min. Shell was sharply defined. Light semi-transparent and nearly perfect half-circle. *Tesla globe. Bennett Is. exhaust plumes detected by U.S. weather satellite. Definitely a Soviet test. Related to 9 Apr. 84 incidents S. ofKurils.*

29 **Aug 84** - Edwards AFB, California.
B-l bomber prototype crashes in flight test about 10 mi. NE of Edwards AF Base.

1983-84 - Ireland.
For two years, freak lightning terrorizes villages of West Donegal, Ireland. Roofs stripped off, windows smashed, pipelines wrecked, telephones and TVs blown up. *No known cause for the anomalous lightning. Shows natural potential in area is disrupted.*

25 **Dec 84** - Ireland.
Freak lightning continues in West Donegal, Ireland. Causes 3-day power blackout. *Extensive plume activity at Bennett Island.*

1985 - Worldwide.
After years of a superb safety record, airline industry suffers a series of disastrous crashes. 20 major air crashes occur worldwide, with more than 2,150 lives lost.

Early 85 - Worldwide.
KGB begins a worldwide campaign to blame the U.S. for starting the AIDS epidemic. *Effort continues. Disinformation; is believed in 3rd world.*

Jan 85 - San Diego, California.
U.S. Navy chaff caught by wind, blown in over San Diego. Power knocked out to 60,000 homes. *Symptoms of presence of Soviet scalar EM grid in San Diego urea.*

7 **Jan 85** - Cantrell, Alaska.
Cantrell, Alaska. Blinding white light passes in sky overhead, lights up sky and mountain range for 30-40 seconds for 16 mi. Est. 3-mi. altitude. *Probable Soviet test. Note that plume activity at Bennett Is. is heavy in Jan. 85.*

Feb 85 - Zimbabwe.
Zimbabwe suffering worst electrical storm season in history. Death toll up to 116. 21 persons killed by a single bolt in one case. *Anomalous lightning. Shows natural potential in area disrupted.*

17 & **18 Feb 1985** - Anchorage, Eklutna Flats, Northway, Alaska.
Several anomalous lights and sky booms incidents in Alaska. Skyflashes, balls of light, booms, etc. Seen both from ground and by pilots of aircraft. *Probable Soviet realtime holography tests as part of worldwide deception plan.*

19 Feb 85 - Out from San Francisco, California.
China Airlines Flight 006 Boeing 747 enroute to Los Angeles. Engines fail. A/c falls 32,000 ft. in 2 min. Restarts engines, lands at San Francisco. *Note previous incidents over Alaska on 17 & 18 Feb. Probable Soviet test of launch phase anti-bomber system capability of woodpecker transmitters.*

10 **Mar 85** - Tblisi & Tallin, USSR.
Soviet Academy of Sciences announces an Aeroflot a/c had been followed by a UFO for 800 mi. *Soviets occasionally produce light phenomena in their own territory and near Soviet a/c as part of their deception plan. They do not wish to appear different.*

1 **May 85** - Near Nashville (monitoring station).
In and around May Day 1985, the Soviet Union held a giant exercise of all its strategic scalar EM weapons. 27 "power taps" into the earth — each two frequencies 12 KHz apart — were activated. The earth was thus in forced gravitational resonance beneath our feet on 54 frequencies. Each tap estimated to power up to six of the giant weapons; thus over 100 major strategic scalar EM weapon transmitters were activated. Frequency bands were filled with scalar EM transmissions, command and control, including to subs on station underwater. *Frank Golden monitored this startling giant exercise, which was probably held for Gorbachev, and this author observed it by courtesy of Golden's special detection equipment. Thus the Soviets*

met the 1985 timetable established by Brezhnev in 1972 at a secret meeting in Prague of European Communist leaders. Western nations do not appear to have the equipment to monitor scalar EM emissions, and so Western intelligence agencies are believed to have totally missed this giant exercise and its significance. At conclusion, two power taps (four frequencies) were left in the earth to power "ready firing batteries," so to speak.

11 **Jun** 85 - Lanzhou, China.
China B747 crew encounters a huge, expanding yellowish glow of light, with very intense spot at center. *Probable Soviet test.*

11 **Jun** 85 - Mongolia.
Chinese jumbo jet, Peking to Paris flight, encounters giant "UFO" light form over Mongolia. 10 km. wide. Lit sky for 50 km. Extremely bright spot at center. Paced aircraft for 2 minutes. *Probable Soviet test. Soviet operator tracked a/c exhaust with long range antibomber system. Added giant light form for deception, and to create UFO reports, which are largely ignored.*

23 **Jun** 85 - Iowa, Nebraska, Kansas, Illinois, Kentucky.
Thunderstorms over Iowa, Nebraska and Kansas organized into single circular pattern rainstorm 200,000 sq. km. in area. Declined until dawn, then rejuvenated to unleash severe weather over Illinois and Kentucky. *Such organization never before had been seen. Now called "mesoscale convective complex." Shows unique new weather pattern involving giant organization.*

2 **Aug** 85 - Dallas/Ft. Worth, Texas.
Delta Airlines flight 191, a Lockheed L-1011, encounters microburst while approaching runway at Dallas/Ft. Worth International Airport. Crashes and kills 134 of the 163 persons on board. *While such microbursts occur in nature, this was during a period of intense Soviet scalar EM activity. Note that warming the tops of thunderstorm anvil causes a downburst. May have been just accident. May have been test.*

23 **Aug** 85 - Italy, Adriatic Coast.
More than 28 "UFO" sightings reported along Italy's Adriatic coast soon after **midnight.** Light phenomena. *Probable Soviet test. Part of deception plan. Scalar KM holography (real-time).*

28 **AUG 85** - Vandenberg AFB, California.
Titan B fails after launch at Vandenberg AFB, California. Believed to have carried sensitive U.S. satellite. *Suspicious.*

Sep 85 - Kourou.
Ariane rocket explodes at Kourou. 3rd stage engine failed to ignite properly, forcing loss of power. Destruct then ordered. *French officials suspect Soviet sabotage. Probable Soviet test.*

Sep/Oct 85 - Cape Canaveral, Florida.
Anomalies observed on two U.S. shuttle launches by NASA. *No action taken; NASA does not recognize scalar EM weapons capabilities nor testing over its Cape Canaveral launch site. Nor does it connect the mysterious "booms" that have rocked the Florida coast for several years with the Soviets or with the anomalies noted on its two shuttle launches, such as giant booms.*

2 **Sep 85** - Mexico City, Mexico.
Worst hailstorm in 50 yrs. strikes Mexico City, leaving some streets more than a foot deep in ice. 1-hr pelting. 25 bldgs collapsed. 4,000 roofs heavily damaged. 1 killed, 185 injured. Power blacked out. *May have been due to extensive Soviet long range weather engineering. 17 days prior to suspicious giant Mexican earthquake.*

5 **Sep 85** - Australia.
Premier Wran, Australia, along with Minister of Agriculture Hallam, observe a brigh spherical "UFO" from their government jet. It was photographed. Radar contact showed object at 100,000 ft. *Probably Soviet advanced performance antigravity flying vehicle.*

18 Sep 85 7:15 pan. - Catalina Is. Channel Is.
Cookman observes giant cloud radial, awesome to behold, between Catalina and Channel Islands, off California coast.
18 "funnel" strobes, dynamically boiling. Activity indicates great energy poured into earth and atmosphere. Mexican quake the next morning. Indicator of Soviet scalar EM connected to quake.

19 **Sep 85 7:18** a.m. - Mexico City, Mexico.
Large earthquake strikes Mexico City, causing great damage. Largest of several. *Preceded wks earlier by giant anomalous hailstorm. Evening before, giant radials showed extensive Soviet power*

transmission activity. Positive indications of Soviet test.

8-9 **Nov** 85 - Ventura County, California.
Highly anomalous power blackout in Carlisle Canyon, Ventura County, Calif. Accompanied by severe electrical anomalies totally beyond normal electromagnetics. *Investigated and reported by engineer Ron Cole, who lives in the area. TV, light, phone, electrical anomalies plus intermittent 29 Hz signals.*

Nov- Dec 85 - California.
Mysterious hum continues to baffle people at Pacific Heights, Calif, and Marina district on San Francisco Bay. Previously had had same hum. Note such hum in England persisting over long period. Note 8-9 Nov 29 Hz. anomalous elec. signal at Carlisle Canyon, Ventura County, CA. *Possible indications of Soviet scalar EM activity. Area appears to be one of Soviet register / test points.*

26 **Nov** 85 - Cape Canaveral, Florida.
Launch of space shuttle Atlantis from Cape Canaveral, Florida is accompanied with high anomalies. (1) Seconds before launch, Bob Gladwin inadvertently photographs nearby strike of what appears to be an electromagnetic missile, probably of Soviet origin. (2) Anomalous light is hanging in the sky, near the launch site: a marker beacon, placed there by the Soviet scalar EM weapon system being tested. Seen by hundreds of persons, and photographed by George Suchary. Printed in Fort Pierce **Tribune.** (3) 12 minutes after shuttle is launched, when it is well down range, a tremendous rumbling atmospheric boom occurs, heard 600 mi. up and down the East Coast. Marker beacon then slewed away by distant Soviet operator at high speed. *With offset EM missile strike, Soviets tested the weapon to be used on the Arrow DC-8 two weeks later at Gander AFB, Nfld. Marker beacon used in precise registration. Note it was evidenced again above the explosion of the Titan on 18 Apr. 86 at Vandenberg AFB. Boom is from energy induced over a large area; which can catch multiple missiles being launched, a large Naval task force at sea, or a whole flight of airborne bombers, fighters, or helicopters. Also can catch an entire organization on the ground, or an installation - - wiping out all electronics, exploding explosives and ordnance, stunning or killing personnel, etc.*

Again hundreds of NASA engineers and scientists did not recognize what was ***happening*** *at the* ***site*** *and over their own heads.*

12 Dec 1985 - Gander, Newfoundland.
Arrow DC-8 crashes immediately after takeoff at Gander AFB, Newfoundland. Lost power just after takeoff; engines "rumbling" abnormally rather than roaring, according to eyewitness whom the a/c flew directly over, 100 ft up. Aircraft seen by three eyewitnesses to have an orange glow on it. Symptoms of negative energy introduced into engines, cancelling some of heat energy of the engines and seriously interfering with combustion process, causing loss of power. Glow may have been steady, small electromagnetic ball of energy against the aircraft, causing it to electrically charge and exhibit corona. Anomalous hole in right fuselage, just ahead of engines, as if from internal explosion; however, no explosive residue (it was tested). One other anomalous hole found. Wild swings of some instruments recording just at/after liftoff — ignored by investigation. *Note previous 36 light incidents in and around Gander, Jan. 1982. Gander Airport is major stopover for Soviets, and a major "registration point" for scalar EM weapons. Note anomalies in shuttle launch 2 wks earlier, and apparent actual test of the small EM missile then, offset so as not to destroy that shuttle.*

Aircraft crew one of Arrow's best. Aircraft should have flown okay, if not interfered with. Serious indications that the DC-8, with over 250 U.S. soldiers and air crew, was deliberately destroyed by test of a Soviet launch-phase antibomber system.

Note metal-softening Soviet signal detected on 1 Jan 86 by Frank Golden may actually have been on the Woodpecker transmissions on Dec 12,1985. This metal-softening signal probably played a part in the destruction of the Challenger on 28 Jan 86.

1 **Jan** 86 - Near Nashville, Tennessee.
Frank Golden discovers a metal-softening signal on the Soviet Woodpecker interference grid. Performs experiments to verify the metal-softening ability of the signal. *Signal is of such a nature that only Golden's instrumentation could have detected it. He then scalarly cancelled the signal to totally prove it.*

24 **Jan** 86 - Ventura, California.
Engineer Ron Cole observes and sketches a giant grid cloud pattern over Ventura, Calif, at 11:45 p.m. PST. Giant cloud fingers, separated from each other, formed the crossed-grid pattern. *Shows Woodpecker scalar EM power very high and active.*

26 **Jan** 86 - Northern California.
Strong quake hits Northern Calif. 5.5 on Richter scale. Hollister area, about 120 mi. south of San Francisco. Several power outages in southern Bay area, where quake knocked out transformers, downed 21,000 V. power line, and set off burglar alarms. *May have been induced by Soviet scalar EM transmitters.*

26 **Jan** 86 - Los Angeles, California.
In greater Los Angeles area, Margaret Wilson observes 3 classic giant radial clouds form at 10 min. intervals: 1:15, 1:25, and 1:35 p.m. Appeared one after the other, till all three were there. Last one lasted about two hours, gradually distorting. *Shows a great amount of structuring to capture and turn the Jetstream, to direct cold weather to the Florida Panhandle and catch the Challenger before its impending launch, exposing it to drastic cold conditions. Definitely Soviet engineered.*

27 **Jan** 86 - Santa Monica, California.
On evening prior to the Challenger disaster, Al Matthews photographs a strange bar-grid cloud formation, absolutely rectangular bars, from the Los Angeles freeway. Pattern approx. over Santa Monica Bay, due north of Catalina Island. Edges and ends very straight, as if drawn in sky by a giant draftsman. *Shows severe high frequency content, and fine-point localization of Soviet scalar EM transmitters, in preparation for forthcoming launch of the ill-fated Challenger.*

27 **Jan** 86 - Florida Panhandle.
Avalanche of freezing air temperatures to record lows across the Southeast. Low temperature records set all across the South. Jetstream bent far south, across Florida Panhandle. *Definitely caused by Soviet weather engineering. Preceeded by giant radial cloud signatures in "hinge" areas of Los Angeles and Huntsville, Alabama, showing steering of Jetstream.*

28 **Jan** 86 - Cape Canaveral, Florida.
Low temperature records shattered all across the South. Into 30's in Florida and into teens elsewhere. *Definitely result of Soviet weather engineering, and definitely directed against the Challenger rocket on the launch pad.*

28 Jan 86 - Off Florida Coast.
About 4 hr. before the launch of the Challenger, all Soviet ships off-coast, which normally monitor shuttle launches, suddenly depart at high speed. *Soviets do not want any suggestion that the ships' radars and transmitters may have interfered with the Challenger launch. Total anomaly. Unprecented event.*

28 Jan 86 - Cape Canaveral, Florida.
National radio and TV newsmen comment on the highly unusual fact that no birds are flying in the launch area. *Reason: For severe localization, high frequency content of the scalar EM signals had been drastically increased. A bird's brain will detect and resonate to this energy, if the wavelength approaches the diameter of its brain. This resonance will cause great pain and/ or death of the bird. Thus the birds flee the area when this begins to occur — or they die. When birds accidentally fly into such a high frequency scalar EM signal, their nervous systems are instantly jammed. They die and fall from the sky.*

28 Jan 86 - Cape Canaveral, Florida.
Space shuttle Challenger, launched from Cape Canaveral after exposure to cold weather conditions, disastrously explodes. Booster seal problem. Encounters air turbulence during launch, at most critical altitude. *Soviet metal-softening signal has been added to grid. Extreme localization in area because of high frequency content added; shown by birds having vacated the area. Anomalous departure of Soviet ships offshore, 4 hrs. earlier. Three previous tests of the weaponry in that exact launch area, against the three previous shuttle launches. Kill of the Arrow DC-8 about 6-112 weeks earlier. Actual celebration by the KGB of perfect success of their active measures against the Challenger! U.S. space program crippled and set back severely.*

29 Jan 86 - Moscow.
At KGB headquarters in Moscow, the KGB holds a jubilant party to celebrate the perfect success of their active measures against the Challenger. *Note that Soviet scalar EM weapons — development, deployment, and use — are under the control of the KGB rather than the regular Soviet armed forces.*

31 **Jan 86** - Mid-U.S.
Richter 5.0, Earthquake rattles 9 states and Great Lakes. *Possible test of weapon that killed the Challenger, in the earth transmission / earthquake induction mode.*

2-4 **Feb** 86 - Birmingham, Alabama.
In Birmingham, Alabama dead birds plummet from the air to the ground for three days. Blackbirds, cardinals, sparrows, bluebirds, etc. No trace of poison in carcasses. *Only a few days after kill of the Challenger. To divert the Jetstream further south and hit Florida, the Soviets had moved the normal "hinge pin"—where scalar EM energy, either positive or negative, is focussed —from Huntsville to Birmingham. Hinge pin area was still activated. The high frequencies used for extreme localization against the Challenger were lethal to birds. Therefore birds that inadvertently flew into this zone were instantly killed and dropped from the sky.*

10 **Feb.** 86 - Europe.
Super Frelon (French) helicopter crashes, with 11 killed. Aeronautique Navale aircraft. Part of a spate of crashes of French military aircraft in four months (through June 86). *Defense Minister Andre Giraud launched a special investigation.*

23 Feb 1986 - Irish Sea.
Over the Irish Sea in an airplane, England's Prince Charles sights a brilliantly glowing, red object hovering near them. His pilot reports the object to air traffic control. Four other aircraft traveling through that area radioed similar reports. *Probably either a Soviet craft or a Soviet holographic scalar EM demonstration as part of the overall deception plan, and/or a stimulus to a member of the Royal Family to observe what action is taken by British Ministry of Defense. By actions, could ascertain whether or not Britain knew what was going on.*

30 **Mar** 86 - Ventura, California.
Engineer Ron Cole in Ventura CA observes significant cloud patterns, positively correlated with his measurements of the Soviet woodpecker transmissions. *Cloud pattern changes were directly correlated to signal changes on the Woodpecker. Shows cloud signatures can be indications of specific Woodpecker activity.*

31 **Mar** 86 - San Francisco, California.
Strong earthquake, Richter 5.3, rocks San Francisco Bay area. Third in region in 3 days. Three aftershocks within minutes. *Note correlation of Woodpecker activity previous day.*

31 **Mar** 86 - San Francisco, California.
Crew error on Delta flight accidentally shuts down engines after normal takeoff from San Francisco. Engines restarted. *Definitely a crew error. Possible human effects from earthquake energy in area. Same type incident on Jun. 30, 1987.*

3 **Apr.** 86 - Florida.
Loud boom shakes houses and rattles windows over Brevard County, Florida. One of a whole series over the years. Not far from Kennedy Space Center. *Soviet adjustment of scalar EM grid.*

Apr 86 - France.
French Armee de L'Air has lost two Jaguars and two Alphajets in April 86. Part of a spate of losses in 4 months, leading Defense Minister Giraud to launch a special investigation.

7 **Apr** 86 - Sacramento, California.
Charlotte King of Sacramento calls UPI and predicts a major earthquake will strike in Canada, Alaska, Aleutians, or Japan. She had predicted eruption of Mt. St. Helens in 1980. On Apr. 27th, she predicted quake that shook Mexico three days later.
Note that human brain is a scalar EM interferometer, capable of transmitting and receiving scalar EM waves. Unfortunately, not conscious — output of system is in deep unconscious. Some persons are more sensitive than others, and can detect the scalar activity from the increasing stress in rocks that is leading toward an earthquake. Charlotte King is such a person, having over an 80% accuracy of prediction of quakes. She will be able to detect the increasing stress in rocks, whether naturally or artificially induced.

9 **Apr.** 86 - Aleutian Islands.
Three quakes rock the Aleutian Islands. Predicted by Charlotte King on Apr. 7. *Documented prediction.*

18 **Apr.** 86 - Huntsville, Alabama; Thousand Oaks, California.
T.E. Bearden sees and photographs remnants of a giant radial cloud

in Huntsville, Alabama. Extensive Soviet woodpecker grid activity noted over Thousand Oaks, California by Engineer Ron Cole. *Both show increased scalar EM activity in the interference grid.*

18 **Apr** 86 - Vandenberg AFB, California.
USAF Titan 34-D rocket explodes nine seconds after launch from Vandenberg AFB, California. Video captured the Soviet marker beacon **(Aviation Week & Space Technology).** Engineer Ron Cole and team study video of the explosion frame by frame and verify the anomalous beacon light is present, is separate from the explosion, and moves away separately after the explosion. *Sensitive satellite believed on board the rocket. U.S. Space surveillance program crippled. Probable Soviet kill. TR wave adjunct with Woodpecker.*

25 **Apr** 86 - New Mexico.
NASA research rocket misfires over the New Mexico desert. No public announcement made at the time. Was first failure in 25 consecutive missions of the Nike-Orion rocket. Said NASA spokesman Kukowski: "It looks like we're snakebit."
Possible Soviet test kill.

25 **Apr** 86 - California; Chernobyl, USSR.
Bill Bise detects the sudden loss of the East-West Soviet woodpecker transmitter he is monitoring in the field, leaving the North-South transmitter. The failed transmitter was about 20-30 km. from Chernobyl. The *Soviet transmitter sites safety circuits go-in full, trying desperately to hold back the giant scalar EM standing-wave potential that has been built up, and slowly and safely drain it away into the earth. In alarm, Soviets shut down nearby reactors at Chernobyl. Any "flash discharge" escape as a flash-over pulse of the scalar EM potential will produce a giant EGP pulse into the earth. When this EGP pulse reaches the four reactors, they will violently explode, full-up nuclear, like giant hydrogen bombs — perhaps 1200 megatons equivalent. Later the Soviets will claim that the operators shut the plant down to do some "unauthorized experiments."*

26 **Apr** 86 - Chernobyl, USSR.
With the giant scalar EM standing wave almost all drained away, the safety circuits finally ***fail,*** *dumping a small EGP into the earth. The nearest reactor at* ***Chernobyl*** *gets* ***it,*** *and the uranium fuel roils*

suddenly go half-decayed, instantly heating and blowing out the reactor, destroying it. Nuclear radiation fallout spreads over much of Europe.

3 **May** 86 - Florida.
Delta 178-rocket destroyed by range safety officer at T + 91 after two anomalous power surges occurred in the rocket, causing premature shutdown of 1st stage Rocketdyne RS-27 engine 71 sec. into the flight, and rocket to go aerodynamically unstable. Previous 43 launches had been successful. Since 1960, 177 launches 94% successful. One of most reliable rockets ever built. *Soviet weapons test. One of a series. TR wave adjunct with Woodpecker.*

7 **May** 86 - Aleutian Islands.
Great earthquake measuring 7.7 Richter strikes Aleutian Islands. Centered about 100 miles SE of the island of Adak. Tsunami alert issued for the North Pacific, but no major waves ever materialize. Thousands evacuate coastal areas. A *U.S. researcher known to this author used a powerful scalar interferometer to block the tsunami. The researcher must remained unnamed.*

9 **May** 86 - Redstone Arsenal, Alabama.
All power on Redstone Arsenal, Alabama suddenly and mysteriously fails all at once. *Similar related incident on May 12. No explanation.*

12 **May** 86 - Huntsville, Alabama.
In Huntsville, Alabama — adjacent to Redstone Arsenal — on local radio program Feedback, public radio discussed the mysterious failure of all power on Redstone Arsenal on Fri., May 9, 1986 and requested that, if anyone knew why all circuits would go off at once, to please get in touch. *Immediately the station's radio transmitter went off the air! (Almost as if "Big Brother's listening to you!")*

18 **May** 86 - Dijbouti.
French Breuguet Atlantic aircraft crashes in Dijbouti, killing 19. *Part of spate of crashes of French military aircraft in 4 months that leads French Defense Minister to open special investigation.*

19 **May** 86 - Brazil.
Brazilian fighter jets are sent to chase multi-colored "ping- pong ball sized" UFO's in skies over Brazil. 4 jets, two Mirages and 2 F-5's

chased them at speeds of 840 mph. Tracked on radars. Chase lasted 3 hrs. Planes could not catch them; ran low on fuel and returned. Discussed on TV by Brazil's Air Force Minister Brig. Gen. Otavio Moreira Lima. *Soviet scalar EM holographic production; distant Soviet operators having fun and games as part of the deception plan, generating UFO incidents and reports?*

22 **May** 86 - California.
High-speed orange "X" object with lights seen above Sonoma CA before dawn. At one time the object slowed and hovered.

29 **May** 86 - Huntsville, Alabama.
Huntsville and Madison County, Alabama electrical power dipped momentarily and mysteriously, causing a seconds-long outage in businesses and homes, playing havoc with traffic signals and computer centers throughout the area. Some traffic signals continued to malfunction for 30-45 min. after power was restored, then mysteriously resumed normal functioning. Some phones also went out inexplicably, and many battery-powered radios went off, and were awry for seconds or minutes before recovering. *Obviously this was not caused by any kind of ordinary electromagnetics. Shows anomalous and high activity (pulsed) in the Soviet scalar EM grid (Huntsville Ah. is a pivot point).*

30 **May 86** - French Guinea.
Ariane 2 rocket fails because of a faulty ignition system for the third stage engine. Rocket destroyed by ground command 4-1/2 min. after launch from Kourou, French Guinea. The third stage has failed 3 times since start of Ariane's operations in 1979.
Possible Soviet test.

Tad Szulc, Washington journalist, implies that French Defense Minister Andre Giraud may have discussed the possibility of Soviet sabotage of the rocket with Washington.

May? 1986 - Straits of Gibralter.
USS Atlanta nuclear sub runs aground in Straits of Gibralter and suffers "serious damage," according to reports in Madrid. A hole was made in one ballast tank and the sonar wrecked.
*Another **U.S. nuclear sub** ran aground within a month or so (earlier?) of this incident. C**ould something** have interfered with their navigation systems underwater? Continued Soviet Scalar EM tests?*

11-12 July - California.
Secret USAF crashes approx. 14 mi. NE of Bakersfield, CA along the Kern River. Site secured. Possible Stealth fighter. Crippled aircraft in trouble seen and photographed by Andy Hoyt, who turned photos over to USAF (properly so). Aircraft not on fire when came down. Did not explode in the air. *No information as to whether any Soviet scalar EM hanky-panky involved or not. Suspicious because follows a series of anomalous missile failures. Woodpeckers definitely have good anti-stealth capability.*

11 July 86 - Tennessee and Georgia.
Moderate quake with sonic boom shakes SE Tennessee and Northern Georgia. 3.7 on Richter scale. Centered just east of Chattanooga Tennessee on the TN/GA line.

12 July 86 - Michigan, Ohio, and Kentucky.
Mild quake in Michigan, Ohio, and Kentucky. 4.0 on Richter scale.

18 July 86 - Los Angeles, California.
Sharp aerial boom rattles Los Angeles Basin at about 0930 hrs. FAA and USAF unable to identify a potential source from an aircraft.

Aug 86 - Soviet Union.
Two huge new Soviet "radars" discovered on Western Soviet border by U.S. intelligence. One near Skrunda, on Lithuanian border. Other near Mukachevo, on the Czech border. *With phase conjugate adjuncts, represent significant strategic weapon system deployments.*

2 **Sep** 86 - Baltic Sea.
Finnish ferry Scandinavia in Baltic Sea observes a strong light rise from the sea near the Finnish Coast. After 3 to 4 seconds, a giant mushroom reached 500 feet into the sky and covered the moon. *Probable Soviet test.*

12 Sep 86 - Dallas, Texas.
Mysterious, powerful "explosion" rocks South Dallas. No source found or explained. No supersonic jets in area.

Selected ***Incidents***

15 **Sep** 86 - Australia.
Katherine, Australia. Object with flaming orange **tail** moved **from** sky toward ground at 45 degree angle. Katherine's electrical **power** suddenly cut off and phone lines in the town disrupted. ***Probable*** *Soviet scalar EM generated.*

Oct-Nov 86 - Los Angeles, California.
Giant radial clouds observed in Los Angeles area.

Oct 86 - Reykjavik, Iceland.
Gorbachev and Reagan meet at Reykjavik, Iceland. Gorbachev proposes "zero option." *Seeks to get nuclear missiles removed, since they constitute "dead man fuzing" because of nuclear warheads, and severely limit pulse use of Soviet scalar EM weapons. Adamantly insists on bottling up SDI — because if space laser is converted to scalar EM laser, its power (effective) goes up about* 10^{20} *times, and single shot could devastate Russia.*

10 **Oct** 86 - Vandenberg AFB, California.
U.S. forced to scrub another missile launch when a USAF Scout satellite malfunctions during final countdown at Vandenberg AFB, Calif. *The booster's gyro system failed a checkout sequence at about T-5 hr. Scalar EM can inertially interfere also.*

13 Oct 86 - ABC News.
On Peter Jennings' ABC News show, Gennadi Gerasimov, Soviet spokesman, indicated that SDI as presently designed was of no concern to Soviets. Real concern is that U.S. will make a "great technical breakthrough" and deploy new, modified devices, presenting an unacceptable threat to the Soviet Union. *Here he is thinking of changing the laser to a scalar EM laser.*

6 **Nov** 86 - Albuquerque and Phoenix.
Power failures at Albuquerque air traffic control tower and a radar station near Phoenix, Arizona occur. Radar controlling high altitude air traffic from Texas Panhandle to southern California was knocked out for 40 min. First such incident in Albuquerque center. The Arizona radar was out for 59 hrs. *Note similar incident at Montreal on Nov. 11, 1986.*

10 **Nov** 86 - Huntsville, Alabama.
Three giant radial cloud formations in Huntsville, Alabama photographed by T.E. Bearden. One is a twin giant radial. *Shows heavy activity in scalar EM interference grid.*

10 **Nov** 86 – SE U.S.
Red glowing light with tail flares across sky in Southeast about sunset. Seen over parts of TN, AL, GA, MS. Ground searches conducted in several areas for possible crash. *Probable Soviet scalar EM activity. Note heightened activity in grid same day.*

10 **Nov** 86 - Near Nashville, Alabama: Hemet, California.
Frank Golden measures scalar EG field of earth — highly agitated and dynamic, about half as much as when Soviets induce earthquakes. Anomalous winter storm in progress. Cold records broken in Mid-U.S. Heat records broken in Florida. Storm penetrates very deeply southward. *Soviet weather engineering.*

11 **Nov** 86-Canada.
Air traffic control radar in Montreal, Canada region broken down. Backup system employed. *Note similar occurrences to Albuquerque and Phoenix on Nov. 6, 1986.*

12 **Nov** 86 - Atlanta, Georgia.
Stationary arc (dome) of clouds sighted over Atlanta. Well defined lower edge. Upper edge irregular. Multiple witnesses. Clouds moved into top of dome and flowed around it. Very strange sight. *Probable Soviet "gentle test" of placing a suppressive covering over a distant U.S. city. Performed at night, at minimal level (no glow) so no great notice would be taken. Dome was stable against 20 mph winds and other moving clouds that collided with it.*

13 **Nov** 86 - Huntsville, Alabama.
Twin giant radial cloud observed moving over Huntsville, Alabama by T.E. Bearden. West to East. At nearly noon. At dusk, single giant radial cloud was also spotted over Huntsville.
Significant scalar EM activity in grid.

17 **Nov** 86 - off Alaska.
JAL Flight 1628 observes giant UFO while enroute from Reykjavik, Iceland on mid-leg of Europe to Tokyo. Crossed Beaufort Sea off

Alaska's north coast. Sighted flashing lights which moved alongside the aircraft. Pilot descended, so did light. Glimpsed craft in profile, twice as big as aircraft carrier. On board radar located it. USAF and civilian controllers reported brief radar echoes, but tapes did not show it. Approaching Fairbanks, Alaska. Pilot made 360 degree circle, object stayed with him. Finally disappeared as he was approaching Anchorage. *Probable Soviet test as part of deception plan. TR wave holography.*

27 **Nov** 86 - Fort Pierce, Florida.
Flash of light in sky and sonic boom occurred vicinity of Fort Pierce, Florida. *Probable Soviet EM test. Note that a classified payload was scheduled for launch in near future at Cape Canaveral nearby.*

4 **Dec** 86 - Huntsville, Alabama; Hemet, California.
Twin giant radials seen and photographed over Huntsville AL. Large radial cloud seen in skies over Hemet, Calif, and photo printed in **The Press Enterprise,** Hemet, CA 5 Dec 86.

4 **Dec** 86 - Cape Canaveral, Florida
Atlas/Centaur rocket successfully launched at Cape Canaveral, orbits a communications satellite for DOD. *The Soviets had to allow one or two of the missiles to succeed, else even the lethargic U.S. bureaucracy would have caught on. Grid activity indicates they probably just tracked it without the other goodies.*

5 **Dec** 86 - Vandenberg AFB, California.
MX ICBM launched from Vandenberg AFB. Two of RVs did not deploy although all impacted within the Kwajalein Missile Test Range. *Note: Soviets let one go from Vandenberg.*

21 **Dec** 86 - Huntsville, Alabama.
Twin giant radial photographed over Huntsville Alabama.

23 **Dec** 86 - Huntsville, Alabama.
Small flash in lower sky over Huntsville, Alabama observed by T.E. Bearden. Followed by faint boom. Momentary loss of power occurred in large area of Huntsville. Positive correlation between the aerial flash/boom and the loss of the power. *Soviet test.*

7 - 21 Jan 1987 - Florida.
Several giant radial clouds seen in vicinity of Fort Lauderdale, Florida. *Indicates substantial action in scalar EM grid.*

20 **Jan** 87 – U.S.
Highly unusual bend in Jetstream. Completely down West Coast, curving east under Texas, NE along SE USA. *Shows great action in scalar EM grid. Significant weather engineering.*

20 **Jan 87** - Vandenberg, AFB, California.
Minuteman missile destroyed in launch. *Note substantial action in scalar EM grid.*

23 **Jan** 87 - Huntsville, Alabama.
Bearden photographs twin giant radial over Huntsville AL. Cloud fades with great and unusual rapidity. A private-type jet, similar to a Learjet, continually circled under the strange twin radial cloud, as if observing and/or photographing it. *Perhaps someone in the U.S. system wised up.*

28 **Jan** 87 - Vandenberg AFB, California.
Minuteman missile successfully launched from Vandenberg AFB. Note: *Anniversary of the Challenger disaster.*

7 **Feb** 87 - Alabama - Tennessee border.
Loud aerial boom or explosion shakes area from Tennessee, New Market, Monte Sano through Huntsville Alabama area.

10 **Feb** 87 - Huntsville, Alabama.
Bearden photographs twin radial cloud in Huntsville, AL. Cloud stayed fixed, although winds present and other clouds moved. Note big storm in NE - Cape Cod, etc. *Associated with weather engineering.*

11 **Feb** 87 - Huntsville, Alabama.
Bearden photographs another twin giant radial in Huntsville, Alabama. *Shows activity in Woodpecker grid.*

Feb 87 - Vandenberg AFB, California.
USAF Titan launched from Vandenberg AFB, Calif.

12 Feb 87 - California.
Blue Angel F-18 a/c crashed near Brawley, CA. Fourth military air crash in the Imperial Valley since October. *Note Woodpecker grid activity on previous day.*

26 Feb 87 - Cape Canaveral, Florida.
GOES-H weather satellite launched from Cape Canaveral on a DELTA rocket.

26 Mar 87 - Cape Canaveral, Florida.
Stunning failure of an Atlas/Centaur rocket launched from Cape Canaveral. May have been hit by lightning. Failed suddenly 51 sec. after liftoff. Veered out of control and destroyed. *Note: Possible Soviet scalar EM involvement. Much to do later about multiple lightning strikes; very suspicious.*

June 1987 - Vandenberg AFB, California.
Minuteman 3 missile fired from Vandenberg AFB, Calif, is aborted and destroyed in flight. *Note similar incident in July.*

12 **Jun** 87 - Cape Canaveral, Florida.
Trident III launched successfully from flat pad.

21 **Jun** 87 - Alaska.
Three strong earthquakes shake parts of remote Alaskan Peninsula.

30 **Jun** 87 - Los Angeles, California.
Delta 767 flight 810 crew inadvertently shuts down engines shortly after takeoff from Los Angeles. Starts to fall, restarts engines and recovers. *Definitely crew error. Similar incident on Mar. 31, 1986 after takeoff from San Francisco.*

12 July 87 - Over Pacific Ocean.
Minuteman missile is destroyed in flight over the Pacific Ocean because of a problem in flight. Launched from Vandenberg. *Note similar incident the previous month.*

16 **Jul** 87 - Huntsville, Alabama.
Anomalous largo "boom" occurs at Huntsville, Alabama.

17 **Jul** 87 - Huntsville, Alabama.
Another anomalous, large "boom" occurs at Huntsville, Alabama. *Note that Huntsville is a pivot point on the Soviet grid. Adjustments in the grid often "spill out" energy, causing such a boom. It causes a sharp boom if pinpoint spillage occurs. It causes a more general quaking, rumbling sound of longer duration if spillage occurs over an area.*

20 July 87 - Cape Canaveral, Florida.
Tident III successfully launched from flat pad.

14 **Oct.** 87 - Nellis Air Force Gunnery range.
Top secret plane crashes; possible stealth fighter. *Did the Soviets kill another one?*

9 **Nov.** 87 - Vandenberg, AFB, California.
Minuteman II missile is destroyed seconds after launch. *Unnamed anomalies cited. Did the Soviets interfere?*

4 **Jan.** 88 - Madison and Huntsville, Alabama.
Giant radial sighted for several hours. Three mysterious booms rattle Huntsville. *Soviet scalar EM activity continues.*

APPENDIX V

*DEAD MAN FUZING**
THE REAL MEANING OF THE REYKJAVIK SUMMIT

Soviet Foreign Minister spokesman, Gennadi Gerasimov, following failure of the Iceland Summit, said in a radio interview that SDI (U.S. Strategic Defense Initiative), as presently designed, is of no concern to the Soviet Union. The real Soviet concern, he indicated, is that the U.S. would make a great technical **breakthrough** and deploy new devices in space as a modification to SDI **presenting** an unacceptable threat to the Soviet Union.

Peter Jennings' ABC News Show, Los Angeles, CA
13 October 1986.

Gerasimov let the cat out of the bag!

With their deployed scalar electromagnetic weapons, the Soviets would immediately hold the winning hand-if these weapons could be unrestrainedly brought to bear.

As pointed out in **Fer-de-Lance: A Briefing On Soviet Scalar Electromagnetic Weapons,** Tesla Book, Co., 1986, the use of massive Soviet scalar EM weapons can only be gingerly applied. Activation and use of the Soviet scalar EM weapons is fraught with grave danger to the entire earth and to the whole human species because of the presence of nuclear facilities in the desired target area, and because of the "backlash" potential against the Soviet Union's own nuclear weapons and facilities.

The explosion at Chernobyl was apparently caused by the accidental failure of a nearby scalar EM transmitter, and the eventual impulsive loss of part of the electrogravitational potential built up by the transmitter before it failed. The resulting electrogravitational pulse (EGP) in the earth "pulsed" the nearest nuclear material... feul rods in the reactor at Chernobyl.

Had the EGP not been depleted prior to its escape, all four reactors at **Chernobyl** would have exploded with the same intensity as if

*The term "Dead Man Fuzing", means that, even though your opponent kills you, a weapon or effect of your own will inevitably result which will then kill your opponent.

they had been "triggered" by a fission explosion.

In short, if unrestrainedly used, the EGPs from the Soviet scalar EM weapons would initiate most of the nuclear weapons where they are in the targeted area-in storage, in silos, in aircraft, etc. Target area nuclear reactors and nuclear wastes would also be violently initiated into nuclear explosion. The resulting vast megatonnage of nuclear explosions, much of them "in the dirt, " would provide an unthinkable holocaust. The effects of these giant explosions, deadly fallout and dense clouds of smoke and dirt, would blanket the earth with nuclear effects greater than is presently expected from an all out nuclear war, in which many of the weapons are expected to be destroyed or lost without being exploded nuclearly. Deadly nuclear radiation would blanket the globe, contaminating it for thousands of years. From the covering of the earth by dense smoke and dirt clouds, a new and deeply bitter global ice age-not just a "nuclear winter"-would almost certainly be initiated. In 1960 Khrushchev appropriately characterized these fantastic weapons by stating that they could wipe out all life on earth if unrestrainedly used.

A country's nuclear weapons and facilities, then, become its inadvertent "dead man fuzing" to prevent any substantial employment of large scalar EM weapons against it. So long as nuclear "dead man fuzing" is in place in a country, its adversary can only utilize scalar EM superweapons against it with great difficulty, and then only sparingly. At present, both the U.S. and its NATO allies are "dead man fuzed" by the presence of Western nuclear weapons-and to some extent, by the presence of nuclear reactors and stored nuclear wastes.

Obviously the Soviet Union's task of world domination—and the mind-rending risks it must take in employing large scalar EM weapons—would be greatly expedited if the obstacle of "deployed U.S. and NATO nuclear weapons and facilities" could be eliminated or minimized.

Also, Gorbachev must be acutely aware that the U.S. is finally beginning to look at the possibility of scalar EM weaponry. He would assume that either the U.S. is already on the way to acquiring scalar EM weaponry of its own, or else the time is imminent when it will do so. If this happened, and the U. S. then were to deploy SDI **scalar** EM lasers in space, the effects of each laser would be enormously increased by the electrogravitational amplification factor. Reasonable gain increases of the yield of each laser shot might approach, for

example, on the order of 10^{20}. In that case, each laser could suddenly devastate a whole state or region with one or two shots, instead of just being able to destroy one little missile. The Soviets know that Reagan's Star Wars weapons-if modified to the "improved" kind and deployed in space—could deliver a surprise first strike in seconds, and devastate Russia before all the Star Wars space weapons could be knocked out by Soviet ground-based scalar EM beams.

The Soviets also know that it is not too difficult to modify lasers to become such powerful scalar EM lasers.

This means that Gorbachev needs to insure that the Star Wars weaponry is not actually tested in space. Testing in space requires developing at least prototype "space deployment" SDI weapons, to get them up in space to test them from there in the first place. And even such "prototype" SDI weapons would be sufficient to devastate the Soviet Union, given that the prototypes employed the technological breakthrough represented by scalar EM weapons. This is what Gerasimov was really referring to!

Thus Gorbachev simply cannot allow such space testing of SDI weapons, if he hopes to be able to safely seize the opportunity to employ his own already-deployed, massive scalar EM weapons during the "window of time" that would be provided by dismantling of U.S., NATO, and Soviet nuclear weapons.

And-given that he gets agreement and implementation of the "zero option"-Gorbachev knows he will only have a narrow "window" of time in which he can hope to achieve world domination. It can be only a short time until the U.S. produces results in scalar EM weapons, and promptly develops such weapons of its own. Faced with that eventuality, Gorbachev would then have no choice but to turn away from the Communist dream of world domination, and reach a mutually agreed accommodation with the West. Both the West and the Soviets then would have to take immediate and drastic measures to prevent the rapid development and spread of the relatively cheap scalar EM weaponry throughout other nations, particularly those motivated from fanatical beliefs and quite capable of "blowing up the earth" deliberately.

Thus, before the U.S. becomes aware of scalar EM weapons and builds its own, Gorbachev desperately needs to get rid of the "dead man fuzing" problem posed by the nuclear weapons and facilities possessed by the U.S. and its Nato allies, so that he can utilize his superweapons to dominate the world without destroying it.

And he needs to block any chance that the U.S. would be able to have space-tested high energy laser prototypes which could be quickly modified to scalar EM weapons, fired into space, and used to counter Soviet aggression or even destroy the Soviet Union in retaliation.

In short, today the paramount and almost desperate need of the Soviet Union is to reduce American dead-man fuzing and keep the SDI space laser genie bottled up in the lab on the ground.

Accordingly, in Iceland, in what appeared to be a stunning concession on nuclear arms, Gorbachev suddenly offered Reagan a complete dismantling of all nuclear weapons-Reagan's "zero option." Actually this move had been planned by Gorbachev from the beginning; it was not a spur-of-the-moment offer. The reason was simple: If the U.S. could only be persuaded to quickly get rid of its nuclear weaponry, the Soviets would hold an absolutely winning hand. Their massive, deployed, operational scalar EM weapons could then be unleashed with minimal restraint. The extremely delicate and incredibly dangerous problem of bringing the large scalar EM "continent-buster" weapons to bear, without inadvertently causing world destruction, would be vastly eased if only the ordinary U.S. nuclear facilities such as nuclear power plants and radioactive wastes had to be reckoned with.

Fortunately, Ronald Reagan fervently believes in defense .

He made the right decision, whether or not it was for the right reasons.

Indeed, he probably knew in advance that SDI was to be targeted in Iceland by the Soviets, and that sweeping concessions might be offered by them for that purpose. According to one report (" 'Blinded' Satellites," Rowland Evans and Robert Novak, **Washington Post,** Oct. 29,1986), just before Reykjavik the CIA-sent a report to Reagan with the warning that "the sole reason for Gorbachev's wanting the Iceland summit was to offer unprecendented inducements for Reagan to drop SDI."

Fortunately, Reagan rejected Gorbachev's proposal, because he does not wish to give up what he truly regards as a potential defense against incoming Soviet missiles.

Apparently neither Reagan nor his advisors were aware of the real reason for Gorbachev's unexpected and breathtaking proposal for what would essentially be near-total nuclear disarmament.

The Soviet ground-based scalar EM lasers could sweep the

heavens of the presently conceived SDI weapons, as **Gerasimov** obliquely implied. However, this would not change the barrier represented by U.S. nuclear dead man fuzing, unless the nuclear weapons had been removed.

Meanwhile, Gorbachev's chess game to remove the dead man fuzing is certainly not over. The Soviets have mounted an intense propaganda campaign urging nuclear disarmament and cancellation or restraint of SDI. With a Democratic Senate now in, and with the approaching end of Reagan's term in office, the Soviet effort to clear the U.S. nukes-and the dead man fuzing-out of the way for Soviet deployed superweapons, while keeping the SDI genie in its laboratory bottle, can only be intensified. Already the Soviets are beating every drum to get substantial antinuclear segments of the U.S. scientific, congressional, political, and pacifist communities aroused to oppose SDI and urge a quick zero nuclear option.

The treaty for dismantling certain missiles in Europe has already been signed by the President, and its ratification by the U.S. Senate appears imminent. More is yet to come, and quickly.

In its aching desire for peace, if an unsuspecting America falls into Gorbachev's trap, shackles SDI and removes its dead-man fuzing, the Soviet Union will be free to enforce its will wherever and whenever it wishes.* If that happens, our beloved stars and stripes will be replaced with the atheistic hammer and sickle. And the noblest experiment of all—freedom for the common person—will have come to an ignoble end.

*Just as **Brezhnev forecast** for 1985, **at a** secret meeting in 1972 of the communist party leaders of E**urope.**

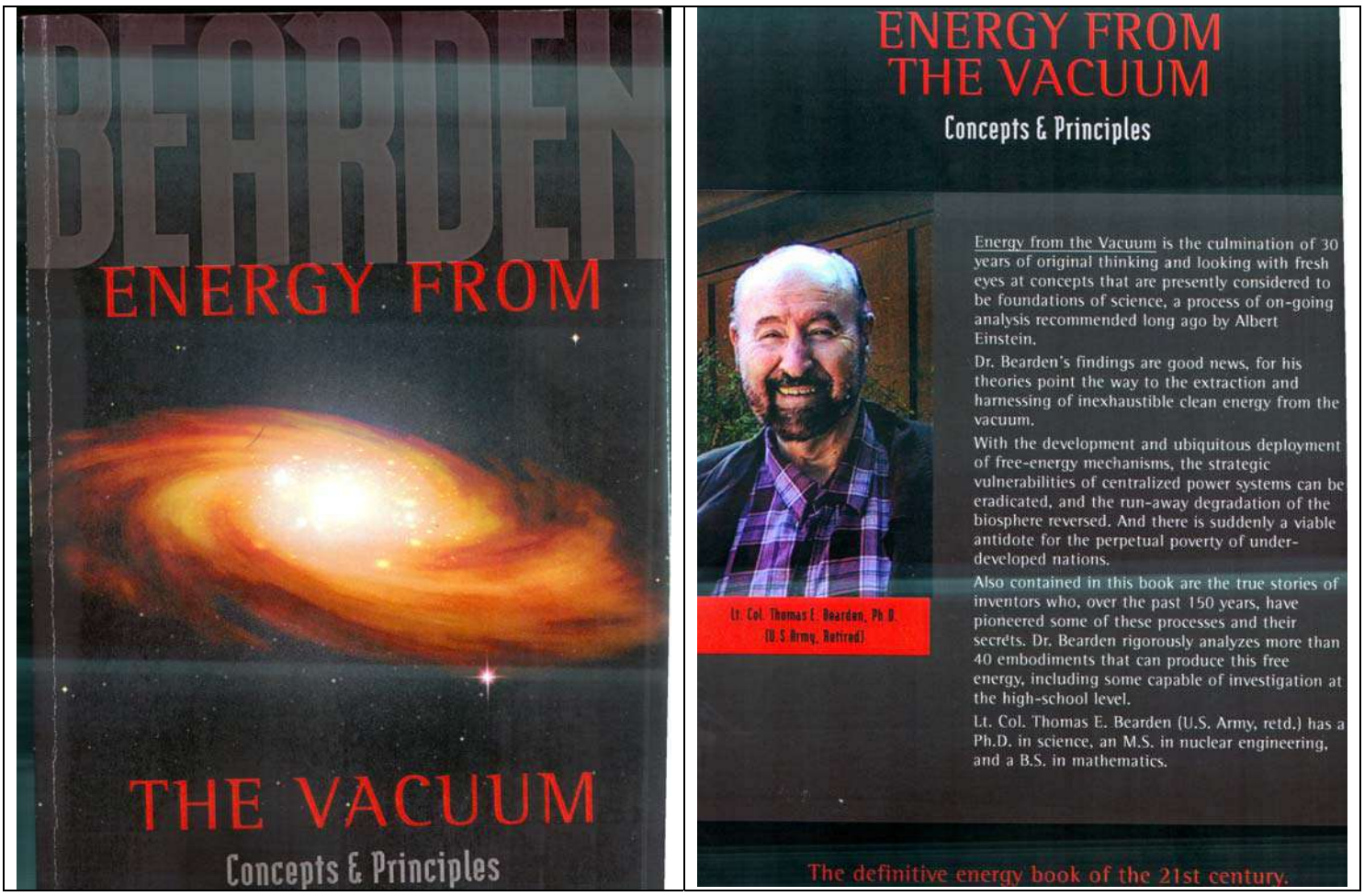

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And please don't be naive and expect you'll be buying those devices in your local supermarket any time soon. Although some progress is being made it's still to slow, especially with the suppression factors watching over it. The knowledge has been handed to you and it's expected that at least a few of us make some use of it. Gather together and try to share your results with the rest of us.

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ongoing scientific work and drafts of the AIAS. On that site, now there are more than 100 AIAS papers, many of them dealing with EM energy from the vacuum in rigorous fashion. Many of these AIAS draft papers have been published in leading journals such as *Foundations of Physics Letters, Physica Scripta, Optik,* etc. This is an invaluable scientific effort that clearly establishes the importance and potential for extracting copious EM energy directly from the active vacuum. It also extends the present U(l) electrodynamics to the much more extensive O(3) group symmetry electrodynamics, in which such things as I discuss in this book can indeed be accomplished on the bench and mathematically modeled.

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Foreword

The original purely scientific purpose of this hook was interrupted en route by two events: The first was a sudden heart allack and onslaught of severe hypoxia resulting from the resurgence in Spring 2001 of a 33-year old chronic mycoplasma infection, of the modified biological warfare kind produced by a combined U.S./Canadian team, which got loose in Canada and Florida in the 1950s. I contracted this "mysterious, unknown ailment" in 1968 while in the U.S. Army and stationed in Quebec, Canada as the U.S. Army Liaison Officer to the Canadian Armament Research & Development Establishment (CARDE). The second event was the sudden terrorist attack on the U.S. on September 11, 2001, which propelled this nation and others into a war against international terrorism.

For the mycoplasma, Kenn Thomas recognized and informed me exactly what the difficulty was, and I was finally tested and diagnosed correctly in December 2001 due to the efforts of a courageous family physician. Accordingly, in December 2001 we started a yearlong (or longer) regimen of antibiotics and supplementary oxygen, with additional medication to control the runaway heart fibrillation associated with this virulent form of the disorder. If we make it through this yearlong program, we will probably survive with at least some significant recovery. Now on a much-reduced regimen, this made me realize the absolute necessity of passing the "energy from the vacuum" information and baton, so to speak, to those sharp young graduate students and post doctoral scientists who are interested in this area. They simply must not have to spend 30 years of their lives getting to this point. Instead, they should start where I am now, correct any errors I have inadvertently made, and go much farther.

Accordingly, we sharply changed the intent and content of the book to comply with that new purpose. We also deeply considered the potential U.S. and World energy implications of that second shocking event of 9/11 when international terrorists struck the World Trade Center in New York Center and the Pentagon, having also targeted the White House.

In the new asymmetric form of warfare, the internal aspects of a nation - its civilian population, its vulnerable installations, its energy infrastructure, its food crops, and its transportation modes — are the targets. Terrorist teams and groups in significant numbers are already inside every targeted developed nation, and these teams have weapons of mass destruction including biological weapons and even nuclear weapons. For confirmation

of the hostile nuclear weapons already secreted in large U.S. cities, read Lunev's book[1] to see how the former Soviet Union brought them in, along with the Spetznaz teams to detonate them on call. The nuclear weapons and the Spetznaz teams are still here. Other hostile nations have inserted terrorist teams with weapons such as anthrax, smallpox (camel pox is nearly identical to smallpox, and widely available), bubonic plague, etc. At the end of the 1991 Persian Gulf War, most of Iraq's calutrons and its nuclear program escaped the weapon inspectors and were hidden. In the few calutrons we did get, weapons-grade U235 residues were found. In a formal threat study for a foreign nation, begun before the Gulf War and delivered after its end, my analysis team and I estimated that Iraq had produced sufficient U235 in 1991 for from 7 to 12 nuclear weapons, particularly of the gun assembly type. My personal estimate now would be that Iraq has made sufficient weapons grade U235 to build three dozen to six dozen nuclear weapons. If so, then some of those weapons are undoubtedly long since spirited into the United States, and planted in our large cities.

In modern asymmetric strategic war, the first phase of the war is conducted in "peacetime". The first phase is to insert the weapons of destruction into the targeted nation and hide them at the intended targets, along with the teams to detonate and unleash the weapons when desired. In that sense, the first phase of WW III has already been accomplished.

According to Vice-President Cheney,[2] *"The war on terrorism will not be over in our lifetime. It is different than the Gulf War was in the sense that it may <u>never</u> end. At least not in our lifetime. The way I think of it is, it's a new normalcy."*

With much of the cheap oil of the world in its borders, the MidEast is a powder keg ready to explode. If a clash between the U.S. and Iraq occurs, Saddam Hussein has already clearly shown that he will attack and destroy his foe's energy infrastructure and he will also use weapons of mass destruction. Simply witness the hundreds of oil wells set afire in Kuwait by Iraqi forces during the Persian Gulf War, and the use of chemical weapons on his own people. As this is being written, Pakistan and India are skirting the brink of war, and both have nuclear weapons. Either side

[1] Stanislov Lunev and Ira Winkler, *Through the Eyes of the Enemy,* Regnery, Washington, D.C., 1998, p. 26.

[2] Vice President Richard B. Cheney, October 21, 2001.

that decides on war **will have to make a n**uclear strike on the other. They have no antimissile defenses, hence **making the** "first knock-out" or pre-emptive strike is each **nation's** only **chance of survival.** Hopefully cooler heads will prevail, but **If that** war erupts, the Mid East, oil, and present energy infrastructures will never again be the same, for the entire world.

There are other very serious U.S. vulnerabilities of gas and oil pipelines, port facilities, Gulf of Mexico oil rigs, nuclear power plants, power substations, hydroelectric dams, long power transmission lines on towers, etc. that are too numerous to enumerate. With but a moment's reflection, one realizes that even normal and cheap guerrilla-type or commando-type forces with C-4 explosives and timers can destroy a very substantial portion of the energy infrastructure with minimal risk and loss of assets. For those who wonder about a nuclear power plant's vulnerability, visualize a seized Boeing 747 loaded with fuel and flown directly into the main reactor container . If meltdown occurs, the nuclear tragedy at Chernobyl in 1986 will appear tame by comparison. There are also several other electromagnetic ways (such as a portable EMP "shooter" hauled in the back of a personal SUV) to instantly destroy the electronic controls of the nuclear power plant, seriously risking runaway and core meltdown.

Consequently, increasing attention is now focused on the extreme vulnerability of the centralized energy infrastructure in the U.S. and every other developed nation. So what started for me as a purely scientific endeavor to set out the concepts and principles of permissible COP>1.0 EM systems suddenly assumed a role of potentially critical strategic significance to the U.S. and to the entire developed world. Quite simply, some 20,000 terrorists in teams already in the United States can - at this very moment —destroy large portions of the nation's energy infrastructure at will, easily and cheaply. The economy of any modern developed nation depends on the availability of cheap energy. So this kind of hostile strategic capability means that the power to readily destroy a nation's economy — and thus defeat a mighty nation itself in the ensuing economic collapse — has passed into the hands of hostile forces already in country and awaiting the order to commit their assets.

In this new asymmetrical form of warfare, it would appear that the rapid developmentanddeploymentofsignificantdistributedpowersourcesis now a critical element of national survival for many nations of the world. Decentralization **does** little **good, however, if fuel** for the decentralized generators must remain **centralized and distributed** by very large and complex systems.The **fuel and Its distribution** are still extremely **vulnerable resenting** easy **targets allowing paralysis** of the decentralized

generators. Self-refueling *{self-powering)* of the electrical power systems is therefore a mandatory additional requirement.

So sober assessment dramatically reveals the need for self-powering electrical power systems, freely extracting their EM energy from the local vacuum. Thus an engineerable theory of permissible COP>1.0 EM systems has become essential to the national survival of the U.S. and many other nations, so that an effective decentralized energy infrastructure — with the seething vacuum as the "localized and inexhaustible free fuel supply" — can be rapidly designed, developed, and deployed.

Sadly, the leaders of the scientific community are still in a "business as usual" mode with respect to energy, and intend to remain so. They do not even recognize what powers and *always has* powered an EM circuit and system: EM field and potential energy extracted directly from the vacuum by the broken symmetry of the source charges and dipoles. Since no scientific research on EM energy from the vacuum is going to be launched by the scientific leaders at the top, then the results of the broken symmetry discovered in 1957 are going to have to be applied in the scientific community from the bottom up. Consequently, a rather desperate need to communicate everything possible to the young graduate students and post-docs has become imperative, if the nation is to survive.

From the beginning of my effort in COP>1.0 systems, and then my effort on this book and prior to the events leading to the attack on September 11, 2001, the appalling *humanitarian* need for COP>1.0 electrical power systems taking their energy from the vacuum has been obvious and overwhelming. One third of the human population usually goes to bed hungry at night. One third is infested with worms and parasites of one kind or another, in addition to other diseases. Simple things such as clean water, common sanitation, medical treatment, and jobs to support one's family are difficult things in many parts of the world.

In the final analysis, the only way to get a suffering, impoverished, and undeveloped nation up and going is to provide cheap clean energy, and to do it with systems which get their "fuel" for free, such as from the vacuum itself. Once cheap clean energy and self-powering systems are widely available, then the economy and infrastructure of that nation can be slowly and steadily built up to get the society moving. Roads, bridges, hospitals, schools, teachers, industry, and jobs then follow as the economy rises. Until there is a cheap energy infrastructure available and growing, essentially fuel-free, none of that is going to happen in most impoverished nations because presently the world's fuel is monopolized, controlled, and

fought over, and it will become evei more expensive as the supply vs. **demand** ratio falls, prices escalate, and additional wars - almost certainly involving weapons of mass **destruction** - are engendered. With present aid concepts, at best the politicians and warlords usually get the bulk of whatever assistance is sent in, and the warlords on the take from foreign masters will continually plunge the country into turmoil, war, and human tragedy. *Assistance is necessary,* but the eventual aim has to be to enable and empower the common citizens to be self-supporting, educated and trained, relatively free from disease, and living in a nation having a growing and developing infrastructure, jobs, and a decent economy. Availability of cheap and affordable energy — and *clean* energy if we wish to save the precious environment — is the primary key to "freeing and empowering the developing nations" as well.

Along with this omnipresent, desperate humanitarian need, the increased strategic need for decentralized energy systems freely fueled from the vacuum itself has led me to make every effort possible — particularly after the heart attack in 2001 and in continued hypoxia from severe chronic mycoplasma infection — to finish the book and at least outline the major concepts and principles that enable the construction of a sorely-needed COP>1.0 electrical power systems theory, followed by the development and rapid deployment of actual self-powering systems. The Alpha Foundation's Institute for Advanced Study (AIAS), spearheaded by Dr. Myron Evans, has also been vigorously preparing and publishing papers in leading scientific journals and other publications[3] showing that EM energy from the vacuum is permissible, possible, and feasible.

In my three decades of work with multiple inventors of working prototype COP>1.0 electrical systems, I have been privileged to experience and work with several actual COP>1.0 circuits and prototype systems, study them, and slowly comprehend some of the advanced and unusual principles involved. In short, thanks to the courtesy and kindness of others, I have been able to gradually acquire at least an elementary understanding of the

[3] E.g, *Modern Nonlinear Optics,* Second Edition, 3 Vols., edited by M. W. Evans, Wiley, 2001; M. W. Evans et al, "Derivation of 0(3) Electrodynamics from the Irreducible Representations of the Einstein Group," *Found. Phys. Lett.,* 15(2), Apr. 2002, p. 179-187; "Anti-Gravity Effects in the Sachs Theory of Electrodynamics," *Found. Phys. Lett.,* 14(6), Dec. 2001, p. 601-605; "Classical Electrodynamics Without **the Lorentz Condition: Extracting Energy** from the Vacuum," *Physica* ***Scripta,*** **61(5),** May 2000. p. 513-517; "Runaway Solutions of the Lehnert Equations: The **Possibility of Extracting Energy from the Vacuum,"** *Optik,* 111(9), 2000, p. 407-409.

mechanisms which enable COP>1.0 EM power systems. With this background, one can understand why conventional EM systems and circuits do not develop COP>1.0 or self-powering, even though all the energy collected and used in every electrical power system comes from the vacuum and not from the shaft energy input to the generator, chemical energy dissipated in a battery, wind energy collected by a windmill (that just "feeds" the shaft of the generator), or from the water power dissipated in a hydro turbine (the hydro turbine also only turns the shaft of the generator, which does not actually furnish the power to the external power line connected to it).

It seems appropriate that other researchers should be able to start where 1 am now, understand what I have learned or think I have learned, find and correct any errors, and simply go forward with alacrity — much farther than I have been able to go, and much faster. This is particularly true of the young researchers who have excellent theoretical and experimental skills and a vigorous lifetime ahead of them. When an old and tiring runner falters with the baton, it is time to pass it on to the fresh young runners who can carry it to the successful end of the race.

The purpose of this book, then, is to lay out in some little detail what I have learned in all these years of sustained effort, but in such a way that it ties directly into good physics. In some cases, the tie-in to physics is unavoidably to a somewhat esoteric area such as the geometric phase and to time as a special form of energy. COP>1.0 EM systems are not simple, and they involve special phenomenology rarely encountered in conventional EM circuits and systems. COP>1.0 EM systems simultaneously involve a combination of particle physics, modern active vacuum theory, advanced materials science, higher group symmetry electrodynamics, quantum mechanics, and general relativity. They also involve areas where foundations of physics are presently in error. We found it necessary to think in terms of the *supersystem*, defined as having three components, which are (i) the physical power system itself, (ii) the active local vacuum, and (iii) the active local curvatures of spacetime. All three components of the supersystem interact and exchange energy with each other continuously. Any legitimate COP>1.0 power system must freely receive, collect, and use some excess energy from its active environment — in this case, the latter two components of its supersystem. By definition, this COP>1.0 function requires disequilibrium between the system and its active environment, so that classical equilibrium thermodynamics does not apply. Instead, the thermodynamics of systems

far from **equilibrium** in **their** energetic exchange with an active environment applies.

However, since the "environmental energy" we are extracting is virtual photon energy from the vacuum and energy from local curved spacetime, the fundamental definitions of classical thermodynamics and classical electrodynamics have to be re-examined and altered. A closed system, e.g., can no longer be defined just as one closed to the transfer of mass across its boundary, but permitting energy to exchange across it. Since the advent of general relativity in 1915, we have known that energy and mass are the same thing. Whenever any system changes its energy, it also changes its mass by the well-known $E = mc^2$ rewritten as $dm = dE/(c^2)$. Further, in the fierce virtual particle exchange of the vacuum with every part of every system, both virtual mass and virtual energy continually cross the system boundary. Neither classical thermodynamics nor classical electrodynamics deals with the transduction of time-energy into spatial energy in a system, which is a totally different type of energy exchange accomplished by charge.

Further, certain phenomenological areas — such as strong gradients — are already well known to violate present thermodynamics. These are presently being researched under the aegis of *extended nonreversible thermodynamics.* Finally, as the present laws of classical thermodynamics are stated in the textbooks, *every charge and dipole in the universe already violates those laws, and has done so since the beginning of the universe.* Let us put it bluntly: Every charge in the universe already freely and continuously pours out EM energy in 3-space in all directions, without any observable EM energy input. That is the well-concealed *source charge problem,* known but ignored by the leaders of the scientific community for. a century. *All* EM fields and potentials and their energy come from those source charges, according to electrodynamics itself. Either we must give up the conservation of energy law entirely, or else we must accept the fact that unobservable *virtual* EM mass and energy are continuously absorbed

The vacuum by the source charge, transduced into real observable EM energy, and then re-radiated in 3-space in all directions as observable EM energy, creating the associated fields and potentials reaching out across the universe. That this problem continues to be ignored by the scientific community — some 45 years after the basis for its solution has been proven and is well known in particle physics — is totally inexplicable. But it continues to be resoundingly ignored, which means that *the scientific community itself is and remains totally responsible for the energy crisis and the associated vast desp**oilment of the** biosphere, because it adamantly*

insists on using a seriously flawed electrical energy science whose hoary basis is more than a century old.

Accordingly, we have simply extended the first law of thermodynamics appropriately, pointed out that the second law does not apply absolutely but only as an approximation when conditions are appropriate, and revised the third law and the zeroth law. In this book we simply show the results of that revision, particularly in Appendix A.

We were also able to trace the history of electrodynamics, and to find exactly how the permissible Maxwellian systems far from equilibrium with an external active environment — which are included in Maxwell's 1865 seminal theory and even in Heaviside's vector truncation later — were arbitrarily discarded by Lorentz with his symmetrical regauging of the Maxwell-Heaviside equations. The purpose of such arbitrary regauging was and is to provide simpler equations that can usually be solved analytically without resorting to numerical methods. In the name of mathematical simplicity and ease, that entire great class of Maxwellian systems far from thermodynamic equilibrium in their supersystem was just arbitrarily discarded. Those Maxwellian systems are still arbitrarily discarded in every electrical power-engineering textbook today.

So the first requirement for a COP>1.0 EM system becomes *building-in a mechanism to violate the Lorentz symmetry condition, at leastfor a significantfraction ofthe time.* Further, the standard closed current loop circuit — including the entire external circuit in the same closed current loop as the source dipole inside the generator is what already *self-enforces* the Lorentz symmetry condition. Consequently, in any legitimate COP>1.0 electrical system, the operation of that closed current loop circuit must be violated for some portion of the system's operation. This of course places the system in disequilibrium with its active supersystem environment, allowing intake of extra energy from the environment and therefore permitting COP>1.0. So one of the immediate requirements in COP>1.0 electrical systems research is to seek out and find known or suspected mechanisms that accomplish just such violation of the Lorentz symmetry condition. In the book, I show a sampling of the various mechanisms I found other inventors using or that I uncovered myself, or that already exist in physics.

Finally, we discovered (and found the basis for it was shown in the hard literature in Heaviside's original work) that every generator and battery as an energy transducer already extracts from the vacuum and outputs from its terminals a far greater *nondiverged* energy flow than is accounted in the

Poynting diverged energy flow theory (which captures only that small **fraction that** is **diverged** into the circuit and captured by it). The total output energy flow from the terminals of a generator is also far greater than the mechanical energy input to the shaft of the generator. So in its *energy transduction* function, every dipolar electrical circuit ever built is already a "free energy circuit" and a COP >>1.0 system, extracting its utilized electrical energy from the vacuum and extracting additional energy also. But presently the electrical power system is unwittingly designed and constructed by engineers to deliberately destroy the source of that enormous energy flow from the vacuum faster than the system can use some of it to power its load. Wryly put, that does not seem to be the proper way to build energy systems or "run an energy railroad," even though it's always been done that way.

This led to recognition of a great scientific faux pas, perhaps the greatest in history. One must keep one's sense of humor! So with tongue in cheek, let us state it this way: *There is not now, and there never has been, a single electrical engineering department, electrical engineering professor, or electrical engineering textbook that teaches what powers an electrical circuit. Yet the basis for it has clearly been in particle physics since 1957, as certified by the award of the Nobel Prize to Lee and Yang. What powers every electrical circuit and system is the broken symmetry of the primary power system's source charges and source dipole (i.e., the broken symmetry of the opposite charges on the ends of the dipole) in its fierce energy exchange with the seething vacuum, once that dipole has been made. The modern "charge" is also a dipolarity, once its associated clustering virtual charges of opposite sign are considered. Further, any dipole will freely extract EM energy from the vacuum, convert it into real, usable, observable EM energy, and pour out real, usable EM energy continuously and indefinitely, so long as the dipole remains intact.*

The external circuit attached to a generator is not powered by the mechanical energy that is input to the generator shaft. The external circuit attached to a battery is not powered by the chemical energy expended by the battery. Astonishingly, every electrical power system and electrical circuit ever built, and every one built today, was and is powered by energy extracted and transduced directly from the active vacuum by the broken symmetry of the opposite charges on the ends of the source dipole (or a charge considered as a modern dipolarity), once that dipole is formed. A Nobel Prize was awarded to Lee and Yang in 1957 for the prediction of broken symmetry (strongly in 1956). Wu and her colleagues proved it **experimentally** in early 1957. So revolutionary a change in physics was

that startling discovery of broken symmetry, that — in a nearly unparalleled action — the Nobel Committee awarded the Nobel Prize the same year, December 1957, to Lee and Yang. *One of the broken symmetries proven was that of opposite charges such as are on the opposite ends of every dipole, or such as constitute a classical "isolated charge" when the charge and its clustering virtual charges of opposite sign are considered as in modern physics theory. Rigorously, every source dipole is continuously extracting EM energy from the vacuum and pouring it out of the "terminals" of the dipole in all directions in 3-space. And so is every charge as well.* That the leaders of the scientific community continue to ignore this solidly proven fact is astonishing. But they do.

We also came to realize that the great Gabriel Kron, who was never allowed to reveal the secret of his *open path*, had in fact discovered the precursor of that very broken symmetry of opposite charges (of dipolarity). His open path is simply the recognition that any two points in the universe, that are at differing potentials and therefore can be considered as a dipolarity of opposite charges, acts as a source dipole that already extracts virtual photon energy from the vacuum, transduces it into real, observable photon energy, and pours out that energy in all directions. In reaching that understanding, he had applied general relativity to rotating electrical machines, simulated various forms of electromagnetics equations, and dealt deeply with quantum mechanics and the Schrodinger equation.

Sadly, the electrodynamics model used in electrical power engineering still does not even model the active vacuum, *much less* a broken symmetry in the virtual photon exchange between that active vacuum and all the charges in every electrical system. The electrical engineering model does not model the *supersystem*, hence cannot be used to design and produce COP>1.0 systems. *A priori*, that seriously truncated and crippled model arbitrarily discards all permissible Maxwellian systems far from thermodynamic equilibrium (i.e., with broken symmetry) in their vacuum flux exchange. And those are precisely the systems that are permitted to perform the five magic functions of great interest to the COP>1.0 energy researcher. Such a disequilibrium system can permissibly (i) self-order, (ii) self-rotate or self-oscillate, (iii) output more energy than the operator inputs (the excess energy is freely received from the active environment), (iv) power itself and its load simultaneously (all the energy is freely received from the active environment), and (v) exhibit negentropy. *Every charge and dipole in the universe already performs all five magic functions.*

It is **the purpose** of this book **to** clearly show that all EM systems are already powered by vacuum energy, and always have been. We cite the references and experimental proof that this is true, and the interested reader can check the extensive references himself or herself. The intent is to show that only a part of what has been discovered and is already known in particle physics is presently included in the woefully inadequate and ancient electrical power-engineering model. And frankly, unless there is a groundswell from the bottom of the scientific community, the leadership of the scientific community has no intention whatsoever of funding or allowing significant research in extracting copious EM energy from the vacuum (very simple) and learning to use it effectively (more difficult). A single 200 million dollars of good research in EM energy from the vacuum would solve the energy crisis forever, and dramatically reduce the pollution of the biosphere. The scientific community will spend many times that amount on their favored "big science" projects, but not one cent on EM energy systems powered by energy extracted from the vacuum.

Also, we show a sampling of the present work ongoing in inertial propulsion and antigravity research. Working with Sweet, in the 1980s I designed and Sweet performed a highly successful antigravity experiment.[4] I share with the reader the concepts and theoretical basis for that experiment, why it worked and how it worked, and the excellent results achieved. One of the tragic losses to science was the loss of the Sweet COP»1.0 vacuum triode amplifier (VTA) system with the death of Floyd Sweet. Nonetheless, we apply the mechanism we conceived so long ago to propose a mechanism generating the antigravity recently confirmed to be accelerating the expansion of the universe. We offer the long-neglected, Lorentz-discarded giant nondiverged Heaviside energy flow component accompanying every field-charge interaction as the probable generatrix of the excess gravity holding the arms of the spiral galaxies together. And we offer that same component — when connected with a flow of *negative* EM energy and with *negative energy* EM fields and potentials — as the specific generatrix of the excess antigravity that is accelerating the expansion of the universe. Both theses are testable on the laboratory bench.

Our target audience is several fold. Even though presented conceptually, the material is not oversimplified, and it is targeted at (i) the sharp young grad students and post-docs interested in extended (higher group internal

[4] Floyd Sweet and T. **E. Bearden,** "Utilizing Scalar EIectromagnetics to Tap Vacuum Energy," *Proc 26th Intersoc.* ***Energy Conversion*** *Eng. Conf. (IECEC '91),* Boston, Massachussets, 1991, p. 370-375.

symmetry) electrodynamics and in researching and developing COP>1.0 electrical power systems, (ii) the forward-looking electrical engineering professors who will at least consider that extended electrodynamic models and the laws of nature do permit COP>1.0 electrical power systems, and (iii) the still open-minded leaders of the scientific community, such as the National Academy of Sciences, National Science Foundation, the U.S. Department of Energy, the great national laboratories, etc. In *one area* of physics much better models of electrodynamics enabling COP>1.0 power systems, antigravity, and novel propulsion systems already exist (and a few such systems *experimentally* exist in the hands of independent inventors as well), while in a *second area* of physics that part of electrodynamics dealing with permissible COP>1.0 EM systems and unified field theory has been arbitrarily excluded at great cost to society, to the environment, and a tragedy to science and technology. Additional secondary targets are (iv) governmental leaders responsible for advanced research and development planning and funding, to argue that the "energy crisis" is a direct result of an inexplicable and sustained shortfall in the scientific mindset, and not as a result of the laws of nature and the need for cheap oil, coal, and gas or nuclear power plants, (v) science writers, journalists, and entrepreneurs to sensitize them to (hopefully) a coming energy revolution of unparalleled proportion, (vi) strategic and tactical planners in our Department of Defense to make them aware that the great logistics burden of modern highly maneuverable armed forces can and will be dramatically lowered by rapidly developing and using self-powering power systems "fueled" directly by the local active vacuum, and by adapting novel new propulsion methods, (vii) theoretical and experimental physicists to make them aware that the easiest thing in the world is to extract copious EM energy freely from the vacuum; just pay *once* to make a little dipole or assemble a charge and do not let it be destroyed, (viii) the Department of Energy upper level managers to bring into their awareness the coming advent of (and terrible need for) self-powering decentralized EM power systems worldwide, and the pressing need for a major role to be played by the DoE, (ix) the struggling but serious COP>1.0 researchers and inventors, to give them a technical overview — rather than just anecdotal material — of much of what has been done, tried, and conceived, and what seems to be successful and what is still to be determined, (x) the environmentalists devoted to cleaning up the biosphere and saving this precious planet, to make them aware that the answer to the world's energy problems and saving the biosphere cannot come to them from their conventional scientific consultants, who are trained in applying the very scientific disciplines responsible for the problem in the first place,

and (xi) **the long suffering undeveloped** and impoverished nations and peoples of the earth. Our fervent message is one of hope after all, *once a **change** occurs in the scientific mindset.* There is a cheaper, cleaner, and better way to get their economies and nalional infrastructures up and running, and it is imminently doable.

The main message of this book is that there is not now and there never has been an *electrical energy availability* problem. Every large centralized power generator actually outputs enough EM energy flow, extracted directly from the seething vacuum, to power all electrical loads on earth, if all the energy pouring from its terminals were caught and utilized. However, there is certainly an *EM energy flow interception* problem, to get more of the available energy flow from a source dipole intercepted and diverged into the circuit in a manner not complying with the Lorentz symmetrical regauging condition. Also, once the excess energy has entered the circuit and been collected, there certainly is a problem in *using the intercepted and collected energy in the circuit without destroying that part of the generator or battery — the source dipole — that is actually extracting all the energy from the vacuum.* Or at least to use the circuit's collected energy in such fashion as to destroy the source dipole in the generator *slower* than the energy is used to power the external load.

That conglomerate of the two sub problems — the "energy flow *interception, collection, and usage* problem — is the single energy problem. There is no other energy problem, and there has never been any other. One finds it very ironic that, in the conventional agencies, universities, the DoE, the National Science Foundation, the National Academy of Sciences, the national laboratories, etc., not one of them is working on the real, solitary electrical energy problem, even though they are importantly spending billions of dollars purporting to do so.

We fervently hope that the content of the book will reach a sufficiently interested audience to begin to change that century-old erroneous scientific mindset. We hope that the book, along with the important contributions of other COP>1.0 inventors and researchers having success, will spark a new creative drive in the scientific spirit that solves the problem of cheap, clean energy in three years or less. This is a doable. I firmly believe in the scientific method and what it can do once it is unleashed from the century-old dogma that COP>1.0 systems are against the laws of nature, physics, and thermodynamics. Just turn the young scientific and engineering tigers loose on the problem, give them some funding, and watch them do it.

As we stated in a formal rebuttal to a charge of perpetual motion nonsense, it only takes one white crow to prove that not all crows are black. And with respect to COP>1.0 EM systems far from thermodynamic equilibrium with their active environment, every charge and dipole in the universe is already a "white crow" pouring out EM energy freely and continuously with the speed of light, and exhibiting COP = ∞. This is in fact reluctantly recognized in physics, but it has essentially been buried from the attention and knowledge of generations of electrical engineers and most physicists.

A COP>1.0 experiment well known to nonlinear optics is the Bohren-type experiment, demonstrating the known negative resonance absorption of the medium. A typical experiment of that type outputs some 18 times as much EM energy as the experimenter inputs by standard calculations. We note that a single replicable experiment can and does negate any theoretical model that contradicts it. Hundreds of such materials experiments proving the feasibility of COP>1.0 EM systems are performed every year in any major nonlinear optics laboratory without a second thought. Together with the known but avoided source charge problem and proven broken symmetry of any dipolarity, it is almost unthinkable that our electrical engineering departments still do not incorporate the active vacuum exchange — and every EM circuit's broken symmetry in it — into the classical electrodynamic model used. In short, to really understand what powers every EM circuit, just now the electrical engineer would have to go across campus to the particle physics department and investigate broken symmetry of opposite charges — as are on the ends of the source dipole, once created in the generator or the battery, or as are involved with the single "isolated charge" considered with its associated virtual charges of opposite sign.

It is high time that our electrical power engineers and scientists heed the message of all these demonstrated white crows of nature, and begin developing and deploying self-powering COP>1.0 electrical power systems with alacrity.

We have a biosphere, a planet, a strong world economy, and an uplifting for the long downtrodden poor people of the world to recover. We strongly urge the scientific community to accept the challenge and meet it head-on.

Tom Bearden

22 July 2002.

Chapter 1
Foundations and Scientific Mindset

"...the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools of thought, as something obviously, immutably given; something having an objective value of truth which is hardly even, and in any case not seriously, to be doubted. ...in the interests of science it is necessary over and over again to engage in the critique of these fundamental concepts, in order that we may not unconsciously be ruled by them." [Albert Einstein]{1}

1.1 Introduction

Einstein's quote is a beautiful statement that scientists should never take the present understanding — and the present models — as absolute. That is the approach the present author has taken for some 30 years, in a struggle to comprehend that class of electromagnetic (EM) systems that are open systems in disequilibrium in their *virtual photon energy exchange* with the active vacuum, and exhibiting a broken symmetry in that exchange. The statement beautifully expresses that the major problems encountered in grappling with such EM systems have been the existing errors and non-sequiturs in classical electrodynamics and other parts of physics. Many difficulties have resulted from the continued propagation of a 137-year old classical electrodynamics model formed before electrons, atoms, nuclei, positrons, the active vacuum, special and general relativity, quantum mechanics, etc. were discovered or known.

1.1.1 EM Foundations Are Incomplete and Contain Errors

In any model, there are many assumptions. Even when a model is well-fitted and well-developed, it still applies only when the foundations assumptions on which it is based are true or are not too much in error. Whenever one or more of the fundamental assumptions is violated by phenomena uncovered, then there is a new class of phenomena where the model does not hold, or does not hold well and is only an approximation at

best. In that case, either the existing unsatisfactory model must be improved and advanced, or a new model must be constructed.

Great scientific minds continue to point out Einstein's beautiful principle in different words. E.g., expressing the thought of Stephen Hawking, one of the great physicists of our day:

> *"All we ever know is our models, but never the reality that may or may not exist behind the models and casts its shadow upon us who are embedded inside it. We imagine and intuit, then point the finger and wait to see which suspect for truth turns and runs. Our models may get closer and closer, but we will never reach direct perception of reality's thing-in-itself.*" [As stated by George Zebrowski] {2}.

Excellent scientists — Feynman, Wheeler, Bunge, Evans, Barrett, and many others — have indeed pointed out that classical EM theory is seriously flawed. In the words of Bunge {3}:

> *"...it is not usually acknowledged that electrodynamics, both classical and quantal, are in a sad state."*

The author also found it imperative to return to many of the original seminal papers of physics, particularly in electrodynamics. The major concepts in those papers led to the present classical EM model. This was particularly true of the work of Poynting {4a, 4b} and Heaviside {5a-5c}, who independently and simultaneously arrived at the notion of the flow of EM energy through space[5]. Their work occurred in the 1880s, after Maxwell was already deceased. It also necessitated reviewing Lorentz symmetrical regauging of the Maxwell-Heaviside equations, where Lorentz arbitrarily discarded all permissible COP>1.0 Maxwellian systems.

The science of this "EM energy flow through space" is controversial to this day. Which is the real "EM energy flow vector" as such has never been

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[5] As we shall point out later, the concept of energy flowing through 3-space is a non sequitur and requires substantial revision today, to be consistent with the nature of observation and the fact that no observable continuously persists. Any observation is an instantaneous frozen 3-space "snapshot" at a single instant, gone the next instant when almost immediately replaced by another such frozen snapshot. In between observations, not mass but *masstime* exists. The same is true for 3-space, which only exists as the output of an observation process. Prior to observation, *spacetime* exists.

adequately resolved, and there continue to be polite debates about it {6}. One should also be aware that physicists really do not know what many things — including energy — *are*. The definitions of these fundamentals are still uncertain, as stated rather poignantly by Feynman {7} in this quote:

> *"It is important to realize that in physics today, we have no knowledge of what energy is."*

As another fundamental example, Feynman {8} also pointed out that we really do not know what *force* is[6] either! Quoting:

> "*One of the most important characteristics of force is that it has a material origin, and this is not just a definition. ... If you insist upon a precise definition of force, you will never get it!"*

1.1.2 Physics Is Not the Mathematics, But What It Manipulates

Following Feynman's ansatz, one should realize that the physics is not really in the mathematics itself, but in the physical meaning of the concepts that the mathematics manipulates. Here again, the inimitable Feynman {9} cautioned against over-attachment to the mathematics itself. He said it very clearly:

> *"Mathematicians or people who have very mathematical minds, are often led astray when "studying" physics because they lose sight of the physics. They say: "Look, these differential equations – the Maxwell equations – are all there is to electrodynamics it is admitted by the physicists that there is nothing which is not contained in the equations. The equations are complicated, but after all they are only mathematical equations and if I understand them mathematically inside out, I will*

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[6] The problem is the ubiquitous and erroneous use of a "separate" force acting on a "separate" mass. Actually mass is a *component* of force, as can be seen from $F \sum d/dt(mv)$. Hence there is no such thing as a separate force in empty space, acting upon a mass. Instead, the massless 4-field in space acts upon mass to produce force *in that interaction*. Force is not a cause, but an effect of an ongoing interaction — as is any observable. An observable is a continuing series of frozen 3-space LLL snapshot entities given by the result of continual application of $\in/\in t$ (LLLT) ♥ LLL by photon emission. The formation of the LLLT (spacetime and masstime) in between observed m as LLL, is produced by photon absorption of the previous $m = \in/\in t$ (LLLT).

> *understand the physics inside out." Only it doesn't work that way. Mathematicians who study physics with that point of view – and there have been many of them – usually make little contribution to physics and, in fact, little to mathematics. They fail because the actual physical situations in the real world are so complicated that it is necessary to have a much broader understanding of the equations."*

Such matters and similar thoughts had bothered me even back in the early 1950s, when I could not find a single professor or dictionary of physics that *logically* defined a field or a potential. Considered rigorously, the definitions all fell apart and violated elementary logic. Improper, insufficient, or just plain *wrong* definitions in physics have continued and are still widespread to this day. To give a single example from an excellent book by Kraus {10}: On p. 60, Kraus gives the formula for a potential referred to as the "absolute potential" of a charge source. Quoting:

> *"This potential… is, by definition, the work per coulomb required to bring a positive test charge from infinity to the point* r_1*."*

Kraus erroneously "defines" the scalar potential identically as work, which is equating the cause with the effect. The work that dissipating a potential does or can do, is not the potential itself! Else "human" means nothing but how well one can chew one's food or drive an automobile. Actually, Kraus gives one theoretical way to measure or calculate the effect of the potential's *local intensity at a point*.[7] Note that what is measured is the energy *diverted from* the potential at that point, around that test charge. This does not specify the *entity* (the potential itself) at all, but only what has been diverted from it. It is rather like confusing the whirlpool (water diverged from the normal river flow) in a river as being the river itself.

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[7] To show the non sequitur, a million more positive test point charges could be brought from infinity to that same point, and the potential — without any change in it — would cause the same amount of work to be done upon each of those charges. As can be seen, even noted professors can speak rather casually when they "define" the potential's point intensity as "the" potential (which extends over all space, not just at that one point). There may be different intensities at different points in the potential, but the potential itself remains one-and-the-same thing regardless of which one or all of the point intensities are discussed. And neither the point intensity of the potential nor the potential is the work that is done upon a moving charge by that potential or its intensity.

Integrating what has been diverted from it does not yield the potential itself! At best, the measurement gives an indication of the *intensity* of the potential at a point, insofar as its reaction with charge is concerned. More rigorously, what is being utilized is the potential's reaction cross section presented to a *unit point static charge* at that point. The same unit point charge, if placed in particle resonance, will sweep out more geometrical area and exhibit a greater reaction cross section. That will increase the energy collected divergence of the energy flow that is being moved around the particle itself. By normal calculations, the resonant charge may collect some 18 times as much energy as is possible at the same point by the same charge in static mode — e.g., as shown by Bohren {24, 25}.

A definition must present an identity. Examining the proposed definition as "the potential is identically … work" one sees the problem immediately. *The potential exists whether or not there is a positive test charge, or whether one moves such a charge in from infinity or not, and whether there is any work done or not*. None of that is what a potential *identically is*, but only one aspect of what it *does* or *can do* or *can cause.* One leaves as an exercise for the reader the task of further examining dictionaries of physics and textbooks, to try to find a satisfactory definition of that common scalar potential.[8] We do not believe the reader will find it.

Yet any good textbook will also contain some real gems of great insight, simply said. As an example from Serway {11}, we eventually took a most marvelous cue, of how to get around classical thermodynamics' prohibition against heat energy "running uphill" from hot to cold. In an insightful statement, Serway said {11}:

> *"The second law [of thermodynamics] does not rule out the possibility of pushing heat uphill, as it were, from a cold object to a hot one, or of creating order out of*

[8] The scalar potential identically is actually a harmonic set of phase conjugate longitudinal EM wavepairs, as shown by E. T. Whittaker in 1903 {85}. Even Whittaker, however, misinterpreted his wavepairs only after interaction with that ubiquitous unit point charge assumed at every point in space. He gave two *effects* of that interaction, not the *cause* (which exists prior to interaction) *and the effect* (which exists only after interaction). Reinterpreting to get at the causal wave, each wavepair is a matched set of two waves; an incoming EM longitudinal wave in the time domain prior to interaction with a charge, and — after the time-energy wave is absorbed by the charge, an emitted outgoing EM longitudinal EM wave in 3-space. The so-called "static" potential is not static at all, but is a dynamic, ongoing 4-space process. This follows the re-interpretation by the present author {12} of Whittaker's decomposition — a reinterpretation then found to be consistent with quantum field theory {19} and with broken symmetry of opposite charges in particle physics {73}.

> *disorder. It merely states that such a reversal of the natural flow requires an influx of energy…"*

This essentially states the *law of entropy*, where to reverse entropy (disorder), one must apply ordering (energy).[9] We also note that the original concept of entropy was as *dissipation of potential*. There are of course different ways to apply the energy, and it need not be by the operator himself. Chapters 4, 5, 6, 7, and 8 of the present book give some unusual ways. A special paper {12} published by the author in 2000 gives another. Indeed, when the flow of time is predominantly reversed, so is the "entropy" of a situation, since the "videotape is running backward", so to speak. In that case, the entire classical thermodynamics must be extended to essentially include its own opposite. The making of a small time-reversal zone where such things happen is as simple as involving a predominance of antiphoton interactions with the charged particles in that zone, rather than a predominance of photon interactions. What we are saying is that the notion of irreversibility in thermodynamics is not necessarily absolute. It usually assumes a "time forward" situation, and may not hold in a "time-reversed" situation. In our chapter on cold fusion, we will present some specific and quite startling nuclear interactions that occur as a result of the time reversal of the coulomb barrier (repulsion of

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[9] Now notice what Serway's statement means with respect to the classical thermodynamics "definition" of closed system. Thermodynamics defines a *closed system* as one in which mass is not exchanged across its boundary, but energy can be. That definition permits a closed system to receive excess energy from its active environment, and thereby reduce its entropy. A specific example is simply potentializing a circuit, prior to movement of the current. Hence the entropy of a closed system does not necessarily increase, but may decrease or increase if the system is in disequilibrium (difference in energy received from its active environment and energy escaping back to the active environment from the system. For the same system, if energy exchanges across its boundary equally in both directions, the system is said to be in "equilibrium" with respect to external energy exchange. One must be very careful in interpretation of the second law of thermodynamics! One has a very different "closed thermodynamic system" when it is in *energy exchange disequilibrium*, than when it is in *energy exchange equilibrium*. Equilibrium is the condition of maximum entropy. For substantial disequilibrium condition, entropy cannot be computed, but is less than the entropy of the same system in equilibrium. The entire ansatz of thermodynamics may be violated once time-energy is transduced into internal EM energy inside the system. That is a fundamental disequilibrium, performed by every charge in the universe. Hence of necessity we have advanced and utilized new definitions of "open system" and "closed system" in our approach in this book, as discussed in the Appendix.

like charges in a forward time situation) into a coulomb attraction between like charges in a time-reversal zone and time-reversed situation.

If Serway's statement were reversed, it would then be a statement of the *law of negentropy*. It would state that self-ordering (i.e., freely receiving energy from the active environment) in a system could indeed "push heat uphill from a cold object to a hot one", and the system could simultaneously emit energy in the process. Every charge does it!

We did find it necessary to correct the classical thermodynamic definitions of "open system" and "closed system". To define a closed system as closed only to mass transfer, but open to energy transfer, is a gross non sequitur. Since general relativity was published in 1915, energy and mass are known to be the same thing (*mass is just a special form of energy*), hence the term "mass-energy" (mass as energy) in physics. Whenever energy crosses the boundary of a system, the system's mass changes and mass (or certainly mass change) has also crossed that boundary. Indeed, as we shall point out, in 1917 Hilbert specifically pointed out that in general relativity there can be no energy conservation equations of the kind usually employed elsewhere. The fact that general relativity falsifies much of the present foundations of classical thermodynamics seems to have been either ignored or missed by most of the scientific community, although we will quote leading Russian scientists who have noticed it and are aware of it.

The reader is thus warned that, henceforth, when we use "open system" we mean one where either energy or mass or both exchanges across the system boundary. When we use "closed system" we mean one in which *neither* energy nor mass exchanges across the boundary. In short, the notion of a "closed system" has been redefined into what classical thermodynamics calls an "isolated system". We already know from particle physics and the active vacuum (and from general relativity and the change of spacetime curvature with every change of spatial energy or mass-energy), and from the giant negentropy involving time energy transduced into 3-space energy and vice versa, that there is no such thing in all the universe as a truly closed system.

In Appendix A, we have discussed how extension and change to classical thermodynamics must be made. We do this by extending the first law, refuting any absoluteness of the second law and third law, dealing with the zeroth law in a new way, etc. We also urge the better theoreticians to re-examine classical thermodynamics along such lines, to modernize and upgrade it. We believe that the present scientific work to extend

thermodynamics so it fits those situations now known to violate it should include additional considerations such as we present in Appendix A.

In short, with the new definitions Serway clearly states the difference between classical equilibrium thermodynamics, where no excess energy from the environment is received, and the thermodynamics of systems far from equilibrium with their active environment (using the new definition of open system for clarity), in which case excess net energy from the environment can be received and used in electromagnetic systems, providing COP>1.0 systems or even COP = ←systems. The windmill, sailboat, and waterwheel are age-old examples of disequilibrium systems where of course the energy of mass in motion is what is transduced. It is our objective in this book to point out the use of electromagnetic systems in energetic disequilibrium with their active environment (the active vacuum and curved spacetime) to provide just such negentropy.

1.1.3 Time Is Energy and Must Be Considered As Such

In a physics model, one's choice of fundamental units is arbitrary.[10] As an example, in one type of physics only a single fundamental unit — length — is employed. All other entities then become functions of length.

We are also free to choose the *joule* as the single fundamental unit in our physics model. The result that mass is a function of energy is now familiar and quite accepted, by the famous formula $E = mc^2$. Indeed, as can be seen, in that equation mass and energy are one and the same thing, since c^2 is a dimensionless constant. However, in our new model time becomes a function of energy similarly, and thus time is identically energy.

Let us perform a thought experiment. Suppose we take some spatial EM energy in 3-space, and compress it by the factor c^2. What can we do with it? If we leave it there in 3-space, it is known as "mass". If we place it on the fourth Minkowski axis *ict*, it is known as time because *t* is the only variable on that axis, and the only "place we can set it".

So to first order, *time has the same energy density as mass*. Multiplying an amount of time *t* (in seconds) by c^2 gives the decompressed spatial energy *E* that the time *t* will transduce into. In short, $E = tc^2$ also.

Now we notice what special relativity has to say about the relationship between time-energy and mass-energy. When the mass-energy increases

[10] E.g., see Jackson, *Classical Electrodynamics*, 2nd Edition, Wiley, 1975, p. 811-812; *ibid.*, 3rd Edition, 1998, p. 775. Jackson wryly remarks on how much excess heat and passion have been unnecessarily expended on that subject.

(e.g., as a function of velocity), time "dilates" or “decreases”. In other words (hint), there is a sort of special new extension to the conservation of energy law: If mass (3-space) gains some 3-spatial energy, then time loses some time-energy. Since time is spatial EM energy compacted by c^2, then *the relativistic energy changes in the time domain are enormously greater than the corresponding relativistic changes in spatial energy in the photon*. To the external 3-space observer, this is the injection of negentropy with respect to the present 3-spatial conservation of energy law. In the reverse case (as when the object reduces its velocity), if mass (3-space) loses some energy, then time gains some time because the time dilation reduces — i.e., time contracts or densifies (less time has more energy). To the observer, this is the production of entropy with regard to 3-space energy conservation. Yet the observer misses the fact that, accompanying entropy in 3-space is negentropy in time energy on the 4th Minkowski axis, and vice versa.

We believe this to be a rather dramatic extension to the previous concept of entropy in thermodynamics. We get 3-space entropy in physical processes only by gaining 4th dimensional negentropy accordingly. One can thus appreciate the impact upon the entire subject of thermodynamics, once time-energy is accounted and the new interplay of entropy and negentropy are accounted. We believe that this mechanism may involve the fundamental mechanism for both entropy and negentropy. Neither is produced alone; both are always produced in tandem. This of course is not what we “observe” since all observation is 3-spatial. Hence to observe the system and see 3-space entropy or negentropy is to hide the simultaneous 4th dimensional negentropy or entropy that unobservably accompanied the observable that we did see.

Again we call attention to the original meaning of entropy: the dissipation of potential (i.e., potential energy).

Once we understand that *time* is a special form of energy (we discuss this shortly), we may input the energy required to "move heat energy backwards" — i.e., we may directly engineer negentropy — by transducing some time-energy into 3-spatial energy. We can do it easily by time reversal, and every charge in the universe does it already. On the other hand, we can do it by breaking the symmetry of time-energy flow — which is as simple as forming a little dipole. The broken symmetry of unlike charges — and therefore the dipole — was discovered by Lee and Yang {13a-13c}, who strongly predicted it in 1956. Wu *et al.* {14} confirmed it experimentally in early 1957. This was such a revolutionary

change to physics that Lee and Yang were awarded the Nobel Prize in the same year, 1957 — an almost unprecedented action.

Its broken symmetry tells us that the dipole's unlike charges continuously absorb virtual photon energy from the active vacuum, transduce it into real observable energy, and pour out real, observable EM energy in all directions in 3-space. That puts an entirely different perspective on *what really powers every dipolar EM circuit; i.e., what produces the flow of energy pouring from the terminals of every generator and battery, filling all space around the external circuit and its conductors*. The EM energy pouring from the generator or the battery is not due to the generator outputting some of its own available internal energy (from the shaft energy input to the generator, transduced into magnetic field energy inside the generator, and then dissipated to separate the charges and form the source dipole between the generator terminals) or the battery transducing and outputting some of its available chemical energy (which is only dissipated inside the battery to separate the internal charges and form the source dipole between the battery terminals). We will explain that later, and explain how any dipole or charge simply pours out real, observable energy continuously in all directions, without any *observable* input of energy. The input energy is there, but it is in *unobservable* (virtual) form.

In 1971 while a graduate student at the Georgia Institute of Technology, I realized the mechanism that generates the "passage of time" insofar as the observer is concerned {15}. With a little more work, this gave the clue in the 1990s for the mechanism generating little momentary *time-reversal zones* (TRZs) {16} in the electrolyte utilized in cold fusion experiments. Hence we proposed the use of little time-reversal zones forming momentarily in the electrolyte after loading of the palladium lattice of the electrodes with hydrogen or deuterium. Such time-reversal zones can form in the region of excessive positive charge accumulation, since positive charge can be said to receive negative EM energy from the time domain and output negative EM energy in 3-space.

This led to uncovering an entire class of new nuclear reactions — fusion reactions at low spatial energy but high temporal energy — in these little temporary time-reversal zones (TRZs), in which like charges attract and unlike charges repel {17}, followed by rapid decay of the TRZs where the normal law of attraction and repulsion is restored again.

In theory, a fermion cannot be time-reversed because the Pauli exclusion principle prohibits it. However, a boson can be time-reversed, so fermions can be time-reversed in pairs, where each pair acts as a *quasi*-boson. The

TRZ completely overcomes and *reverses* the "coulomb barrier" between a pair of like fermion charges.[11]

As an example, two deuterium ions in a little TRZ would momentarily form a quasi-nucleus of helium, since the two positive deuterons are attracted so closely that each enters the strong force region of the other. At the same time, the strong force is weakened by the partial time reversal of the gluon forces, so that the quarks are nearly freed. As the other ions in the surrounding solution then move to destroy the momentary time-reversal zone, their movement forces the TRZ to decay back to a time-forward zone — with the decay action starting from every point in spacetime inside the nucleons themselves[12]. The TRZ decay-induced action thus strikes the *nearly freed* quarks first, and decay can occur by easy quark flipping while the gluon forces are still much reduced and not back to normal strength. Hence as the gluon forces return toward normal, the quasi-nucleus decays by the strong force increasing and overpowering and drawing the quasi-nucleus into a full-blown helium ion — i.e., an alpha particle —flipping the partially-freed quarks as necessary to do so (that is not necessary in equation [1] below.

During decay of the TRZ, the weakened strong force grows much more rapidly than the Coulomb force zeroes and then increases. Consequently, the quasi-nucleus of two D+ ions merely draws together due to the rapidly increasing strong force, forming an alpha particle without quark flipping. Four H+ ions — four protons — in a quasi-nucleus in a TRZ will undergo quark flipping twice when the TRZ decays, thereby resulting in an alpha particle.). So that explained the anomalous formation of the alpha particles in the experiments. The interaction for two ions of deuterium is given by:

$$^{2}H_{1}^{+} + {}^{2}H_{1}^{+} \Downarrow \; {}^{4}He_{2}^{++} \qquad [1]$$

[11] In a TRZ, the law of attraction and repulsion of charged particles is reversed.

[12] Any moment in time exists everywhere simultaneously throughout the universe. In short, time is a multiple connection in 3-space. Hence in any time-reversal zone (a TRZ) where time is reversed, then starts fading away and back to a time-forward zone (TRZ), the changes induced by the "fading back to TFZ" *simultaneously* involve every point in the 3-space of that TRZ that is changing (decaying). An easy change is quark flipping, since the quarks are almost freed in the TRZ to begin with. The reason the reaction proceeds in that direction is that the recovery of the strong force is much faster than the restoring of normal electrical repulsion, hence the quasi-nucleus is drawn further together into a full nucleus, constituting a legitimate nuclear transmutation at low spatial energy but high time-energy.

This interaction between two deuterons in solution does not occur in a normal time-forward zone because of the coulomb barrier preventing the two deuterons from entering each other's strong force region and acting as a quasi-nucleus of helium, so particle physicists have missed it. It does exist in a time-reversal zone; such zones form and then decay back into normal time-forward zones. This is possible because the coulomb barrier is momentarily reversed. The use of such TRZs in particle physics opens up thousands of new nuclear reactions, all at low *3-spatial* energy, but involving very high *time*-energy. Because of the extreme energy density of time, *these time-energy-induced reactions are actually much higher-energy reactions than high-energy physicists presently consider and utilize!* Indeed, it opens up a new kind of far more energetic "high energy physics".

Cold fusion experimenters have unwittingly opened a window upon a vast new particle physics, previously overlooked by our scientists because they have disregarded the use of time-energy, time reversal zones, and transmutation of time-energy into 3-spatial energy in their nuclear reactions. However, a few physical theorists attempting to better explain particle physics have recognized the importance of the time domain, and probing work in that respect is occasionally done {18}. In our view, it is not accidental that more than 600 successful cold fusion experiments have been obtained, by a variety of researchers in many labs in several nations. We strongly suggest that much of the conventional physics community has firmly placed its collective head in the sand, and is refusing to grapple with the startling new time-energy physics that is being initiated by cold fusion research.

In 1999 (published in 2000) {12} we finally discovered a great new symmetry in EM energy flow, whereby time-energy flow symmetry and 3-space energy flow symmetry are each individually broken, while an overlooked and more fundamental 4-symmetry energy flow — between the time-domain and 3-space — is sustained. *The result is that all EM energy in 3-space comes from the time domain locally and returns to the time domain locally, in a giant negentropic circulation.*[13] Together by the

[13] This is also understandable from the implications of the observation process, which yields a frozen 3-space snapshot existing only at a single instant. Thus any 3-space energy existing there in that frozen instant, had to just come from 4-space (from the time-domain via the giant negentropy process, if we take the view that "the past exists only in time itself".). For the frozen snapshot to "change", time must be added to it, which converts it to a 4-space process again. So the "3-spatial" observed

discovery of relevant quantum field theory work by Mandl and Shaw {19}, this now lends strong support to the use of time-energy in physics as a practical matter for strenuous investigation.

As an example, Mandl and Shaw {19} treat the four polarizations of the photon. Neither the longitudinal nor the scalar photon is directly observable, but in the presence of charge the two are observable in combination, where they manifest as the "instantaneous" Coulomb (i.e., electrostatic) potential. This argument, translated from particle terminology to wave terminology, directly fits our re-interpretation {12} of Whittaker's 1903 decomposition of the scalar potential {85}. For the combining mechanism of the fields of the photons, we must account for *the field as a ubiquitously assumed interaction with the detecting/observing unit point charge*. Thus we must account for the absorption of the incoming time-polarized wave or photon, the transduction of that excitation energy of the charge into longitudinal EM wave/photon energy, and subsequent emission of that excitation energy in 3-space. That is what happens for a negative charge. For the positive charge, the process is time-reversed, hence occurs in opposite fashion. Or as an alternative, the positive charge can be said to continuously receive negative time-energy from the time domain and emit negative spatial EM energy.[14]

There is an *energy polarization transduction function* of charge, whereby it transforms received time-polarized photon energy into emitted longitudinal photon energy in 3-space (for the negative charge, and vice versa, for a time-reversed positive charge). This transduction appears to have been overlooked in physics prior to our recognition of it. It can in fact be used to generate an acceptable definition of charge itself. Charge is the

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energy must come from an immediately previous 4-space process, and must return to an immediately following 4-space process.

[14] As we will find in our chapter on antigravity, there is good reason to treat the positive charge as a source of negative energy and negative energy fields. However, this is pertinent only prior to observation of the charge, while it is still a 4-spatial unobserved negative energy electron entity. For the observable charge, one has already conjugated — after all, the positron is observed as if it were an electron going backwards in time, which we observe as an electron with its charge reversed and with parity reversal (of its spatial direction). For the observable charge, we have already reversed the negative energy fields into positive energy fields by simply reversing their direction and the time associated with the photon (quantum of the EM field).

continuously active entity which performs that ongoing process or those ongoing processes of energy transduction between the time domain and 3-space (between the causal unobserved 4-space process and the observed 3space snapshot). Or in other words, it is an active process connecting 4-space cause and 3-space effect, and connecting the unobserved (such as virtual) to the observed (such as mass).

So for a dipole, the "causal" time-polarized EM wave or photon as a 4-space entity comes to the dipole[15] (3-spatial as observed) and is absorbed by the detecting negative charge or dipole, then is re-emitted as the longitudinally polarized EM wave or photon in 3-space. *That absorption and remission is what charge does, since it is an entity for performing that process*. The emitted energy in turn is absorbed by the nearby positive charge, retransduced into time-energy, and re-emitted back to the time domain. This ongoing very special 4-space energy circulation (even with a virtual charge in the vacuum) is what a scalar potential *identically is and is doing*, at every spatial point of itself, inducing vacuum polarization and "point dipoles" in the virtual state in the process. Recognition of these missing functions allowed at last a solution to the long-vexing problem of the source charge and its associated fields and their energy, often called the most difficult problem in both quantum and classical electrodynamics {68}. We discuss that solution later.

1.1.4 The Search for COP>1.0 Circuits and Systems

A very long search and much intense study and reflection eventually revealed the concepts and principles of those long-neglected disequilibrium Maxwellian systems that permissibly output more energy than the operator inputs. The active environment — not the operator — simply inputs the rest of the energy. Such disequilibrium systems are indeed permitted in Maxwell's theory {20}, and are also still prescribed by Heaviside's severe curtailment of it {21} into what is two vector equations with variables unseparated, rather than Maxwell's 20 equations in 20 variables.

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[15] Prior to interaction of the incoming time-energy with the observable charge or dipole, it interacts with the virtual particles of the vacuum, generating vacuum polarization. Neither the virtual particles nor the time-energy are observable; only the effects of their conglomerate interactions with observable charges are observed. Hence one can take the particle view that virtual particle energy is continually absorbed, or one can also take a quantum field theory view that time-energy is continually absorbed. The two are always present in combination.

When Lorentz[16] symmetrically regauged the Maxwell-Heaviside equations, he arbitrarily discarded the entire class of Maxwellian systems that are far from equilibrium in their exchange with their active (vacuum) environment. Lorentz revised (symmetrically regauged) the Maxwell-Heaviside equations to make them amenable to separation of variables and closed analytical solutions, thus reducing the onerous chore of numerical methods. This Lorentz symmetrical regauging is given in most EM textbooks {22}, and we show it in Chapter 2. The symmetrically regauged Lorentz equations are not Maxwell's equations, nor are they the truncation of Maxwell's theory by Heaviside *et al*. Considering an active environment, under our altered thermodynamics definitions Lorentz implicitly selected and retained only the equilibrium class of Maxwellian systems, while *arbitrarily discarding* the entire disequilibrium class. He thus discarded all those Maxwellian systems permitted to produce COP lying in the range 1.0 < COP Ω←.

Maxwell's electrodynamics is a *material fluid flow theory* and it assumes a material ether. Anything that fluid systems can do, electrodynamics systems can do, at least in theory, because their mathematical models are the same form. So when one cites known examples of fluid-driven physical systems where the energy to run the system is freely furnished by the active environment, analogous electrodynamic systems in active environments — and in disequilibrium exchange with that environment — must also exist in nature. Indeed, particle physics requires it and proves it. These are the very systems arbitrarily discarded by Lorentz symmetrical regauging in every university.

So there exists a direct analogy between fluid systems and classical electromagnetic systems. The common windmill, waterwheel, and sailboat demonstrate by analogy that open EM systems far from equilibrium — powered by free EM "winds" and "energy flows" in the active vacuum environment — also exist in consonance with natural law. They are no more mysterious than a solar cell power system, which is after all a recognized "free energy" or "overunity" system, as is the humble charge (thought to be the source of all EM energy, fields, and potentials). In physics, the powering of systems by receipt and use of energy from their

[16] Actually first accomplished by Ludwig Valentin Lorenz in 1867, then by H. A. Lorentz much later. Lorentz was given the credit erroneously. Lorenz actually derived electromagnetic theory independently in his paper. See J. D. Jackson and L. B. Okun, "Historical roots of gauge invariance," *Rev. Mod. Phys*, Vol. 73, July 2001, p. 663-680.

active environment leads directly to the thermodynamics of systems far from thermodynamic equilibrium in their energetic exchange with that active environment.

It follows that the seeming absence of such *electrodynamic* systems arises not because they are impossible but because present-day circuits and systems are ubiquitously designed to self-enforce an inherent energy equilibrium with their active vacuum environment. The closed-current loop circuit turned out to be the Lorentz self-regauging demon involved in destroying the COP>1.0 capabilities of every EM circuit. So little by little, we unraveled the long tedious trail of Maxwell's electrodynamics and what had happened to those missing Maxwellian-Heaviside systems far from equilibrium with the active vacuum.

We learned how, where, and by whom those permissible overunity Maxwellian systems were discarded. That is, we found what happened to all those Maxwellian *open disequilibrium systems* — originally included in Maxwell's and Heaviside's theories — where such a system receiving and using excess energy from its active environment[17] is permitted by the laws of physics, electrodynamics, and thermodynamics to:

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[17] For the discerning reader, of necessity we have revised the foundations of the ancient classical thermodynamics, as further discussed in Appendix A. We refer the reader to Bimalendu N. Roy, *Fundamentals of Classical and Statistical Thermodynamics*, Wiley, New York, 2002, and to any good book on the history of thermodynamics. Also particularly good is Kondepudi and Prigogine, *Modern Thermodynamics: From Heat Engines to Dissipative Structures*, Wiley, Chichester, 1998, reprinted with corrections in 1999. The foundations of classical thermodynamics (and its fundamental definitions) were basically frozen prior to the advent of Maxwell's 1865 seminal theory, and well before the 1880s discovery (modeling) of the flow of EM force field energy through space. Some of the fundamental definitions of thermodynamics now will not withstand critical review in terms of "meshing" with the Heaviside/Poynting material fluid energy flow theory. Neither will they withstand the new concepts of energy such as mass-energy, time-energy and transduction between time-energy and spatial energy by every charge. E.g., thermodynamics defines an *open system* as one that exchanges energy and mass with its surroundings. Yet it defines a *closed system* as one closed only to mass exchange, not to energy exchange. *If the energy exchange is analogous to material energy flow and changes the mass of the system, then that definition of closed system is a non sequitur.* From general relativity, mass is simply energy anyway, and so "mass" exchanging across the boundary of the system is actually energy exchanging, and vice versa. Since Maxwell's theory is a *material fluid* theory, the Poynting and Heaviside energy flow models are *material fluid flow energy* models by analogy. The specialized thermodynamics definition of *closed system* rigorously will not logically allow the exchange of "material fluid energy flow" (or energy as matter)

since it prohibits matter flow, but the specialized definition of *open system* would and does. In short, with respect to material fluid energy flow, the concept of the "closed system" in thermodynamics has forced itself to become the *isolated system* instead, which is unacceptable since we must model EM energy flow exchange between the environment and the system. So we must change the thermodynamic definitions of *open system* and *closed system*. Else there cannot be any EM energy-mass or mass-energy flow between environment and system, which totally violates what is well known to be happening in all EM systems. In modern physics, every charge and every dipole already have such energy exchange with the active vacuum environment, and it is never zero; instead, it is of enormously high magnitude. Without that exchange, as we advance in this book, there cannot even be a "source charge" or associated EM fields and potentials and their energy, reaching across space. In other words, without it we can have no electrodynamics at all. So we have uncovered a fundamental and major contradiction between classical thermodynamics and general relativity, as well as between thermodynamics and the "material EM fluid energy flow" model used in electrodynamics. What classical thermodynamics calls a "closed system" permitting energy flow exchange, we must now logically regard as an *open* system because it is open to energy exchange across the boundary! The previous notion of the *isolated* system — with no exchange of either energy or mass — is what we must treat as a truly *closed system*. And there is none such in the universe, as we know in particle physics (e.g., because of the discovery of broken symmetry in 1957 and because of the well known active vacuum exchange with every EM charge and dipole). So we have corrected these direct contradictions between "EM as a material fluid energy flow theory" and the old classical thermodynamics.

As the reader will later see, this strongly affects our new definitions of *efficiency* and *coefficient of performance*. The new definitions we advance are rigorous, and they also apply to COP>1.0 EM systems, and even to self-powering (COP = $\leftarrow$) EM systems. They also hold for very novel new energy processes such as quantum potential energy in a multiply connected space, multiple retroreflections and re-use of the same energy, conversion between time energy and spatial energy, and 4-space giant negentropy energy flow circulation.

But one can no longer be allowed to equate *efficiency* with *coefficient of performance*. Now they are never the same thing, just as a six-foot tall man and a six-foot tall doorway are never the same thing, even though they have the same height magnitude. We warn the reader that a great deal of thought and study must be put into appreciating these suddenly encountered changes to the quite old classical thermodynamics definitions. The changes are absolutely necessary. Bluntly put, in light of much more modern knowledge, a rigorous foundations analysis reveals the classical thermodynamics as well as disequilibrium thermodynamics to contain logical contradictions, such as its direct contradiction with general relativity and the EM material fluid energy flow theory. Either we give up or dramatically change the present EM energy flow theory, or we must make the necessary foundations changes to thermodynamics. We have chosen the latter option in this book, and the reader is forewarned of that dramatic change. The specific changes and rationale are discussed in Appendix A.

(1) self-order,

(2) self-oscillate or self-rotate,

(3) output more energy than the operator inputs (the excess being freely received from the active environment),

(4) power itself and its load simultaneously (all the energy being freely received from the active environment), and

(5) exhibit negentropy.

We vigorously pursued those long-lost Maxwellian systems, and we eventually found them. We also found real experiments {23, 24, 25, 26, 27, 28} and real devices {29a, 30, 31, 32, 33, 34, 35a, 36a, 36b} that performed one or more of those fabulous five functions, though there was often no realization by the experimenters, inventors, and scientists of the actual mechanism involved. Eventually my colleagues and I were also able to produce a successful experimental device {37, 38a-38c, 39}, the motionless electromagnetic generator (MEG), which outputs more energy than we input to it. We cover the MEG in Chapter 7. Presently a cooperative research program is ongoing with the National Materials Science Laboratory of the National Academy of Sciences of a friendly foreign nation, to develop and market commercial power systems based on successful laboratory experiments with the MEG. At this writing, we are also strongly seeking the extensive funding required to set up a physics lab and complete the final research allowing production of power systems.

1.1.5 Additional Very Important Implications

We also formally proposed {40} that the vast nondiverged EM energy flow component — Heaviside's "dark" nondiverged energy flow component, accompanying every reaction of a charge with a field or a potential, but arbitrarily discarded by Lorentz and modern classical electrodynamicists — is the generatrix for the extra gravity holding the arms of the spiral galaxies together, after all the dark matter is accounted.[18]

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[18] Heaviside himself recognized the gravitational implications of his extra component of energy flow, which is in closed circular loops. Beneath the floorboards of his little garret apartment, years after his death, handwritten papers were found where Heaviside used this component for a unified EM approach to gravitation. See E. R. Laithwaite, "Oliver Heaviside – establishment shaker," *Electrical Review*, 211(16), Nov. 12, 1982, p. 44-45. Laithwaite felt that Heaviside's postulation that a flux of gravitational energy combines with the (**E**Δ**H**) electromagnetic energy flux, could shake the foundations of physics. Quoting from Laithwaite: *"Heaviside had*

In addition, my close colleague Bedini and I have filed a patent application upon a very special process to "freeze-frame and lock-in" a disequilibrium Maxwellian system in its otherwise far-from-equilibrium state, so the apparent disequilibrium operation of the system can be maintained stably as a new equilibrium condition. This appears to be a method to produce and utilize what Kondepudi and Prigogine refer to as a *nonequilibrium stationary state*. This stabilization is necessary in order for such a system to maintain its COP>1.0 excitation and steadily output more energy than the operator inputs, or to steadily power itself and its load {41}.

We also found that COP>>1.0 EM systems (and some COP>1.0 systems) produce (as a function of the COP) a current of Dirac sea holes (positrons) *in the local vacuum environment itself*, from the output section back to the input section. At COP<1.0 and COP not too greatly above 1.0, a Dirac sea hole in the vacuum almost immediately interacts with an orbital electron in the material lattice of the system. This converts the negative energy, negative mass "vacuum hole or state" into a lattice hole, which is attached to the large positive mass of the ion left by the disappearance of the electron. This "lattice positron" type of problem has been known in semiconductor design for some decades. Normal EM circuits do not usually meet the phenomenon overtly because the semiconductor designers controlled it in the semiconductors themselves by use of appropriate donors and acceptors.

There is a great difference between the actions of Dirac sea holes in the vacuum prior to observation, and lattice holes in materials (after observation). So there is a great difference between the action of a “positron” on spacetime before its interaction with mass and observation, and its action on spacetime after it interacts with mass and is observed.

For COP>>1.0, significant phenomenology and novel effects occur because a substantial fraction of the Dirac sea holes (unobserved positrons) sweeping from output to input do not convert to lattice holes (observed and bound positrons) along the way. For substantial values of COP above 1.0, Bedini's invention (patent application filed by Bedini and the present

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originally written the energy flow as $\boldsymbol{S} = (\boldsymbol{E}\Delta\boldsymbol{H}) + \boldsymbol{G}$*, where* $\boldsymbol{G}$ *is a circuital flux. Poynting had only written* $\boldsymbol{S} = (\boldsymbol{E}\Delta\boldsymbol{H})$*. Taking p to be the density of matter and* $\boldsymbol{e}$ *the intensity of a gravitational force, Heaviside found that the circuital flux G can be expressed as* $p\boldsymbol{u}\ 4\ c\boldsymbol{e}$*, where* $\boldsymbol{u}$ *represents the velocity of p and c is a constant.”*

author)[19] covers the master process for intercepting and transducing this appreciable flow of negative energy from the output section back to the input. Otherwise, that flow — if not intercepted and not converted — will "eat" extra input electrons from the power supply, thus acting as a novel "extra load" appearing in the input section. That extra load then draws additional current and power from the external power supply by electron-hole annihilation[20].

With the Bedini invention, the negative energy (unobserved positron) flow appearing at the input section is transduced into a flow of positive energy (a flow of electron current) from the input section back into the system. The process deliberately uses the "interaction and observation" process to phase conjugate the charge and reverse its direction of flow! In that case, the otherwise detrimental *negative* energy output back through the COP>1.0 system (which is nature's decay process for COP>1.0 interactions) is changed to a beneficial *positive* energy input within the system itself, freely received from the vacuum environment. This process is then used to close-loop the system for self-powering in a "locked" and stabilized disequilibrium condition — a nonequilibrium stationary state.

If we consider mass to be a special kind of positive energy state, then positive energy states represent curvatures of spacetime that are positive gravity. Negative energy states generate antigravity (the time-reversal of gravity).

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[19] Bedini personally discovered and implemented the solution before the exact nature of either the problem or the solution was recognized! My contribution was to recognize the nature of the problem and the mechanism used in the solution. We also stress that, contrary to conventional treatment, all EM circuits do involve not only lattice holes in the conductors and components, but also Dirac sea holes in the local vacuum. That the Dirac sea is involved whenever there are EM fields is clearly shown by Felix Finster, "Definition of the Dirac Sea in the Presence of External Fields," *Adv. Theor. Math. Physics*, Vol. 2, 1998, p. 963-985.

[20] With a proper change in the curvature of local spacetime, pair annihilation can occur with no accompanying photon radiation. The condition is that the part of the curvature of spacetime representing the energy change of the otherwise emitted radiation, does not "relax" even though it is an "excited state". Rigorously, the emission of the radiation from pair annihilation occurs in two steps: (i) first the local spacetime is curved for and by the energy excitation, as a *static change* of the curvature, and (ii) then that curvature relaxes back to its former value, propagating that specific curvature in space, which is recognized as the radiation propagating in space. If the spacetime curvature excitation does not relax, there is no photon emission and propagation.

Before their interaction and observation, the Dirac sea hole (positron) currents — produced in natural COP>1.0 processes in the universe — are still negative energy electrons in 4-space. They are not 3-positrons until interaction with matter has occurred. These "negative energy electrons" generate negative energy EM fields, including both the Poynting energy flow component and the Heaviside nondiverged energy flow component. These negative energy EM fields appear to be *generating the antigravity* whose effects are seen in the distant parts of the universe. They produce far more powerful effects than the accounted electrogravitation effects in astrophysics, which only uses the gravitational effects of the very much smaller Poynting energy flow component. Also, astrophysicists do not use the "positron before observation," when it is still a negative energy electron with negative mass. The accumulation of the negative energy (Dirac holes) in space (in the surrounding vacuum) is connected with massive objects and violent processes, where very strong gradients are produced.[21] As a result, very large negative energy fields and potentials are produced. In turn, this results in cumulating antigravity. This cumulating and interacting antigravity appears to be the mechanism for the forces *accelerating* the expansion of the universe — rather than it decelerating as would be the case if the net gravity there were positive. In Chapter 8 we propose this explanation for the observed acceleration of the expanding universe — and the basis for the explanation can be and has been successfully demonstrated in a legitimate overunity EM circuit or system {42}. We offer this in honor of Heaviside, who first discovered the gravitational aspect of his huge nondiverged energy flow, but did not live to publish it. He also did not consider the Dirac sea prior to hole interaction with matter, as it was not yet formulated, so he had not yet recognized the way to produce and utilize the practical antigravity potential of his discovery.

1.1.6 A Scientific Dilemma

There would seem to be a sufficient abundance of techniques, devices, processes, and theoretical works to impel a crash project in the scientific community to develop successful overunity electrical power systems {43a-43d}. This would be especially appropriate at this time, since the

[21] Kondepudi and Prigogine, *ibid*., p. 459 already point out that strong gradients produce situations that violate present thermodynamics. Research in these and other situations violating present thermodynamics is going forward under the caption of "extended thermodynamics" research. A discussion of the area is given by D. Jou, *Extended Irreversible Thermodynamics*, Springer-Verlag, New York, 1996.

escalating energy crisis now threatens to slow the world economy, and then eventually collapse it. At this writing, the MidEast has heated considerably, and appears headed for another MidEast war, with resulting severe interruptions of cheap oil supplies from the MidEast. Nonetheless, in spite of Russia having opened its oil field spigots to try to fill the need, a crisis in oil appears to be looming.

So *why* does the U.S. scientific community still so adamantly oppose the very notion of Maxwellian systems freely extracting EM energy from the vacuum? Why is there no outcry pointing out what the hoary old Lorentz regauging really means in terms of equilibrium or disequilibrium of the regauged system with the active vacuum? The unequivocal participation of the vacuum in a continuous energy exchange with the charges and dipoles of every EM system has long been affirmed by particle physics. All the fields and potentials — and their energy — manipulated in any EM circuit come from the vacuum, as proven in particle physics for 45 years. Why have our electrical scientists not understood — from the broken symmetry of the vacuum exchange with the opposite charges of the source dipole between the charged terminals of every generator and battery — that *EM energy from the vacuum powers, and has always powered, every electrical power system and circuit ever built?* Why have the later rigorous broken symmetry findings of particle physics not been incorporated to update the ancient classical EM theory used to design and build electrical power systems, nearly a half-century after those broken symmetries were discovered and proven? Why do our classical electrodynamicists continue to assume that every charge and dipole in the universe is a perpetual motion machine, freely creating energy out of nothing and pouring it out across all space at the speed of light?

Therein lies one of the real problems of present science — its historical and continuing resistance to "out-of-the-box" thinking[22] and to research that overcomes conventional strictures. More than 40 years after the basis for the vacuum-energy powering of every dipolar system (and of every

[22] "Out-of-the-box" thinking is a widely used concept among planners and program formulators, when conventional thinking will not suffice to solve a major problem with which they are struggling. Conventional thinking is considered "in the box" thinking, so by demanding out-of-the-box thinking, a problem demands an unconventional solution outside those normally proposed. In short, some new thoughts and concepts are required. Much lip service is given to the concept as a favored buzzword, but few proposed programs with truly "out of the box" approaches will be funded. In the energy field, none at all are funded that are truly "out of the box", whether or not that or similar phraseology is used.

observable charge once its clustering virtual charges of opposite sign are accounted) was discovered and proven in particle physics, all our university electrical engineering departments continue to erroneously teach that the shaft energy input to the generator powers its external circuit. Internal EM energy in the generator, transduced from the input shaft energy, does not directly add a single watt to the external circuit. Instead, it only continually forces the generator's internal charges apart, to continually remake the source dipole, which then extracts energy from the vacuum and pours it out of the terminals, filling the space surrounding the conductors of the external system for the system to intercept and utilize some of the available external energy flow.

Once the dipole is established, it will extract and transduce EM energy from the vacuum and pour it out in all directions at the speed of light, without ceasing. Else, the Nobel Committee should admit its grave error and revoke the Nobel Prize awarded to Lee and Yang. Real observable EM energy extracted and transduced from the vacuum's virtual energy is precisely what the "broken symmetry of the opposite charges" on the ends of the dipole *means*. Indeed, all the forces of nature are already considered as generated by the interaction of virtual particles with observed particles. Since force produces energy changes in the system affected, then it follows directly that energy changes are produced by the interaction of virtual particles with observable particles.

However, our power system engineers ubiquitously use the closed current loop circuit. This inane circuit self-enforces the Lorentz symmetrical regauging condition. It uses half the energy captured by the external circuit (from intercepting some of that "energy flowing around the circuit from the seething vacuum" that is copiously pouring out of the generator terminals) to ram the spent electrons back through the back emf of the source dipole itself. That scatters the dipole charges and kills the dipole and its broken symmetry — and also kills the free flow of transduced EM energy from the vacuum.

That insane circuit kills the source dipole in the generator faster than it powers its external loads! So one has to keep rotating the shaft of the generator, to keep producing a magnetic field inside the generator, so that this magnetic field energy can continue to force the charges back apart and continually reform the source dipole.

In short, our engineers build the equivalent of an electrical windmill, then — so to speak — force it into a closed barn so the environmental wind

cannot reach it any longer. It is little wonder that we ourselves then have to do work on that "electrical windmill" to crank it around!

We pay the power company to engage in a giant wrestling match inside its own generator and *lose*. We also wildly pollute the planet with hydrocarbon and nuclear wastes, poison species (including killing of X numbers of humans every year via the disruption of their body functions and health), and enhance global warming. We are slowly strangling our biosphere and ourselves. None of that is necessary.

1.2 Organized Science Often Resists Innovative Change

The history of science is littered with examples where the scientific community has ignored the principle behind Einstein's statement quoted at the beginning of this chapter. As pointed out by Smith {44}, science has become reoriented toward profit. Quoting:

> *"...science is not the danger; scientists encouraged to do bad science to survive are." ... "...changing the way modern science is funded is an enormous undertaking, but it is a necessary one if we want to protect our future. Call it managed risk."*

Science's resistance to change is so well known to historians of science that it is rather universally accepted — although usually not made explicit to undergraduates. Further, scientists are under great pressure to conform:

1. After all, science is *patronized*; someone must fund the laboratories, the research supplies, the salaries and personnel benefits, etc.
2. To procure and protect its patronage, science has become quite organized, particularly with respect to how the funds — received and channeled down from the top — are cut into individual packages (research grants and research programs) and made available for competition among the "performing" chain of universities and research laboratories.
3. In the last few decades, there has risen an increasingly fierce demand by universities that the scientific researchers (i) be successful in attracting outside funds and (ii) file patents assigned to the university. So fierce has this demand become, that the research professor's continued livelihood may literally depend upon his or her success in bringing in extra funding. Further, much of his time is now spent in writing proposals to

compete for these "packaged funds". When he wins them, the kind of research and the areas of research are already stringently defined, and he dare not deviate — else there will shortly be no more funding packages won, no funding for his graduate students, and soon thereafter there will be no job of any importance for the professor!

4. In the United States, all the government National Laboratories and our universities are intensely seeking and filing patents! So small, independent inventors cannot deal with these organizations, without risking and almost guaranteeing the loss of their patents and intellectual property. Funding dangled in front of the inventor, much like a carrot dangled in front of a horse, is often tied to "march in" rights {45, 46} calling for surrender of the inventor's patent rights altogether, *whenever the government — i.e., a single bureaucrat — wants to take it*. All that has to be done is to declare that the inventor is not getting it developed and to market fast enough. Science has thus become more avaricious and — some inventors would even say — it increasingly involves overt and covert piracy of intellectual property rights. From personal experience, reluctantly I would not argue with that statement. Simply ask Larry Fullerton of Time Domain Corporation about his struggle with a National Laboratory over patent rights to his ultrawideband communications invention and technology.[23] It eventually resulted in a "draw" of sorts. He did not lose his rights, but the government gained them also, in competition with him. The government *circumvented* his patent, even though they did not succeed in taking it. We were delighted to recently see that Larry (the company is Time Domain, Inc.) received its 74th patent in this technology, as well as a ruling that will allow the technology to at last go to market.

5. The result is a dramatic increase in the pressure on working scientists and independent inventors to conform, and to "play the game by the rules". Then everybody up the scientific food chain is fed, and is happy and secure. The journals happily publish the research papers and results, the professor gets

[23] Stephen Fenichell, "Radio Flyer," *Discover*, 22(5), May 2001. Fullerton's technology has been given a limited go-ahead by the FCC, which has drafted standards and regulations in the area as of February 2002.

funding for his graduate students, the university gets that wonderful overhead cut of the research funding — such as half or it or more — and the entire apparatus is like a very large and tidy Titanic adhering to its ponderous course toward the iceberg. Meanwhile, truly new and innovative science discoveries — vulnerable and desperately needing nurturing funding during their initial embryonic state — get shoved aside, crushed, and starved in the funding rush to adhere to performance of the *prescribed* funding packages.

6. In this environment, the day of the "defenders of the scientific faith" has arrived! A small percentage of conventional scientists who are dogmatic and vociferous, are now very prominently attacking any novel experiments and ideas with a vehemence seldom seen in organized science. It is again reminiscent of some of the noted scientific attacks in history, e.g., as pointed out by Hellman {47}. Yet, because of the financial pressure upon the scientific community, and the increased pressures to conform, there is little restraint of the dogmatists and they are almost never called to task. Cold fusion is a current example. The American Physical Society has recently issued a statement condemning perpetual motion machines — yet the society's members continue to condone and use a classical EM model that assumes every charge in the universe to continuously be creating energy from nothing. Even the American Physical Society has not recognized what broken symmetry of opposite charges means with respect to the common dipole and dipolarity in every circuit. Nuclear reactions at low spatial energy (which means at extraordinarily high total energy when the c^2*-compressed* time energy is considered) do indeed sometimes occur in carefully controlled experiments, whether or not we yet sufficiently understand the reactions theoretically, and regardless of whether we can get the anomalous results to happen every time. Yet this area of nuclear interactions at low *spatial* energy {48} — and unknown to the scientific community, at very high *time* energy {49, 50, 51} — has been savaged by these self-appointed spokespersons for the "official" community, none of whom even account the compressed energy in the time increment portion of the photon. More than six hundred successful experiments in multiple laboratories, by respected scientists in multiple nations worldwide, are now

> rather resoundingly ignored. Yet the replication rate for good cold fusion experiments is certainly higher than many of the replication rates for novel and little-understood phenomena in large particle accelerators, and the cold fusion experiments are also *far cheaper*.[24] While particle accelerators are "popular" in their ability to garner huge funding, their cost/benefit ratio compared with, say, cold fusion experiments, may be abysmally low. Simply examine the decades of effort and many billions of dollars expended on the search for *warm* fusion (using spatial energy only). What has it produced, in terms of watts of power on the power lines? When will it produce any electrical power of any significance? Prototype cold fusion power systems have in fact been produced and patented {52}. With seed money from the scientific community and using a higher symmetry electrodynamics, cold fusion power could proceed at a rapid pace.

Strangely, the ever-present pressure to conform to *that which is already known and accepted* has often made science its own worst enemy throughout its history. Establishment scientists and the "system itself" now probably block — and have blocked over the decades — more innovative scientific research than does any other factor {53}.

1.2.1 Many Scientists and Historians Have Pointed It Out

The scientific community is well known to have always been highly resistant to novel ideas and innovations. Here are some selected pertinent comments regarding this phenomenon, where organized science is itself the obstacle to the advance of science, and where such has been recognized for many decades:

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[24] As an example, see R. P. Taleyarkhan *et al*., "Evidence for Nuclear Emissions During Acoustic Cavitation," *Science*, Vol. 295, 8 Mar. 2002, p. 1868-1873; Charles Seife, "'Bubble Fusion' Paper Generates a Tempest in a Beaker," *ibid*., p. 1808-1809. See also Donald Kennedy, "To Publish or Not to Publish," *ibid.,* p. 1793. *Science* had the courage to publish the peer-reviewed results of a tabletop sonoluminescence experiment that apparently produces nuclear reactions. Editor Kennedy essentially advises all protagonists on both sides to cut the rhetoric and allow the scientific community to do its replication work, to either validate or refute the successful experiments of Taleyarkhan *et al*. This action by *Science* is a shining beacon to remind the scientific community that science is based on experimental method, and that prevailing theories cannot refute new experiments that contradict them. Instead, laboratory bench experiments must decide such an issue.

"Every great scientific truth goes through three stages. First, people say it conflicts with the Bible. Next they say it had been discovered before. Lastly they say they have always believed it." [Louis Agassiz, 1807-1873.]

"There are three steps in the history of a great discovery. First, its opponents say that the discoverer is crazy; later that he is sane but that his discovery is of no real importance; and last, that the discovery is important but everybody has known it right along." [Sigmund Freud].

"Anybody who has studied the history of science or worked as a scientist knows that whenever something novel is discovered or proposed, there is a polarization of scientists, with hostility and bitterness that may last for generations. What wins arguments is scientific fact, and that may change as the years go by. A good example of this is the geological theory of continental drift, as proposed by Wegener in 1912. When I studied geology around 1950, continental drift was acknowledged in my undergraduate textbook as a crank theory. The first serious confirmation was in 1956, and it was finally established as the dominant theory in the early 1970s. Until that time, anybody who admitted that he or she believed in continental drift was the subject of derision and scorn. Sorry, folks, science is not and has never been the 'idealized portrait painted in textbooks'." [Allan Blair] {54}

"... the four stages of response to any new and revolutionary development [are]: 1. It's crazy! 2. It may be possible — so what? 3. I said it was a good idea all along. 4. I thought of it first." [Arthur C. Clarke]. {55}

"...I suggest that most revolutions in science have taken place outside the lofty arena of the refereed journals, and with good reason. The philosophy by which these journals govern themselves virtually precludes publication of ideas that challenge an existing consensus." [William K. George] {56}

"At every crossway on the road that leads to the future, tradition has placed against each of us, 10 thousand men to guard the past." [Maeterlinck].

> *"An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out, and that the growing generation is familiarized with the ideas from the beginning."* [Max Planck] {57}.

> *"Peer review is widely seen as a modern touchstone of truth. Scientists are roundly drubbed if they bypass it and 'go public' with their research… The first limitation of peer review is that nobody can say quite what it is… A more pernicious danger is that peer review may reject the important work. As Charles W. McCutchen, a physicist at the National Institutes of Health, has put it, peers on the panel reviewing a grant applicant 'profit by his success in drawing money into their collective field, and by his failure to do revolutionary research that would lower their own ranking in the profession. It is in their interest to approve expensive, pedestrian proposals.' "* [Jonathan Schlefer] {58}.

The sheer massive size and inertia of the modern scientific establishment also exert mind-numbing difficulty in "hearing" and recognizing an innovative scientist's message, even a message of utmost importance, and even if it gets through the censors. For example:

> *"We used to be able to say things once; if the message was reasonable, it had a good chance of becoming a permanent part of the structure of the field. Today, a single publication is lost; if we say it only once, it will be presumed that we have changed our mind, and we therefore must publish repeatedly. This further fuels the large publication volume that requires us to repeat."* [Rolf Landauer] {59}

1.2.2 Some Specific Examples

There are hundreds of examples of new discoveries in science that have at first — and often for an extended period of years — been severely obstructed and ridiculed. Here are just a selected few:

1.2.2.1 *Conservation of Energy*

Von Mayer {60}, the discoverer of the modern statement of the conservation of energy and the mechanical equivalent of heat, was severely chastised for his "insane" work. He was hounded and severely

ridiculed. This extremely harsh treatment, together with domestic problems, drove him to a suicide attempt and a nervous breakdown, and into psychiatric treatment for some years. Toward the end of his life, his principle of energy conservation had so greatly increased the ease of calculations and the understanding of systems that the same scientific community — due to the commendable efforts of Helmholtz, Clausius, and Tyndall — began to recognize his great contributions and lionize him. In 1867, he was made a member of the nobility, dying in 1878 with his "insane" work by then well respected. He was fortunate to have the "cur dog attack" reversed in his lifetime. Most scientists with novel discoveries are not so fortunate.

1.2.2.2 *Continental Drift*

Alfred Wegener {61} proposed the theory of continental drift in 1912. The reception was extraordinarily hostile. So ferociously was he ridiculed for the notion that huge continents of rock could "float" and "drift" that his very name, "Wegener", was often used as a synonym for "utter idiot". To refer to someone as "a Wegener" was to cast the greatest slur possible upon that person's mental powers and to label him a gibbering lunatic. Only in the 1960s when sea-floor spreading from ocean ridges was discovered, proving that ocean basins are not permanent features, did Wegener's concept of continental drift concept finally gain acceptance.

1.2.2.3 *Kinetic Theory of Gases*

As pointed out by Paul Nahin {62}:

> *"J. J. Waterston's paper on the kinetic theory of gases, in 1845, was rejected by the Royal Society of London. One of the referees declared it to be 'nothing but nonsense, unfit even for reading before the Society.' ... "Waterston's dusty manuscript was finally exhumed from its archival tomb forty years later, because of the efforts of Lord Rayleigh..."*

Lord Rayleigh was the Secretary of the Royal Society when he had Waterston's paper reprinted nearly a half-century after submitted. Lord Rayleigh also gave an introduction to the paper, regretting it lying so long unpublished when its content was quite important. His introduction is a way of explaining the delay.[25]

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[25] Waterston's paper was finally published as John James Waterston, "Free and Elastic Molecules," *Phil. Trans. Roy. Soc. Lond.*, Vol. 183, 1892, p.1-79. Lord

1.2.2.4 *Surgical Pain Deemed Necessary*

It has *always* been this way in science. As another example, the famed surgeon Alfred Velpeau wrote in 1839:

> *"The abolishment of pain in surgery is the chimera. It is absurd to go on seeking it today. 'Knife' and 'pain' are two words in surgery that must forever be associated in the consciousness of the patient. To this compulsory combination we shall have to adjust ourselves."* [Martin Gumpert] {63}.

Wryly we observe that today a similar attitude of "we must glory in the pain" — where the "pain" is due to the yoke of COP<1.0 EM systems and of the second law of classical equilibrium thermodynamics — consumes most modern electrical power system scientists and engineers.

1.2.2.5 *The Photoelectric Effect*

Almost every household now knows Albert Einstein's epochal achievements. Yet his formative three papers — on Brownian motion, the photoelectric effect, and special relativity — were published in 1905 while he was working in the Swiss Patent Office. The most renowned physicist of the time was Max Planck. Planck was embarrassed that a scientist who was not even employed in physics was doing such important work in physics. So Planck and other scientists arranged for Einstein to be awarded a chair in physics at a proper university. In their letter to the university, they pointed out Einstein's brilliance in his papers. They also then excused him for straying down the road of the photoelectric effect, because — as they put it — everybody knew that was foolishness, but persons of such brilliance could be forgiven a few such little bobbles along the way. Years later, in 1921, Einstein was awarded the Nobel Prize for Physics, for his work in theoretical physics and *especially* for his explanation of the photoelectric effect.

The Einstein incident is a typical illustration of Arthur C. Clarke's cogent observation:

> *"When a distinguished but elderly scientist states that something is possible he is almost certainly right. When he states that something is impossible he is very probably wrong*." [Clarke's First Law]

Rayleigh's introduction and Waterston's paper also are given in Jefferson Hane Weaver, *The World of Physics*, Simon and Schuster, New York, 1987, p. 632-651.

1.2.2.6 *Amorphous Semiconductors*

Stanford R. Ovshinsky's development of amorphous semiconductors {64, 65} is another modern example. "Everybody knew" that a crystalline structure was necessary in order to have a semiconductor at all; in short, a semiconductor formed out of non-crystalline material was deemed to be totally impossible, never mind this “phase” change that Ovshinsky advanced. However, some young graduate students, e.g., began to look at Ovshinsky's amorphous materials and his phase change approach.

Finally funded by the Japanese, Ovshinsky's company, Energy Conversion Devices, Inc. (ECD) simply placed its amorphous semiconductor devices into working equipment. Copy machines appeared with his amorphous semiconductors installed in them — with the machines and their amorphous semiconductors working very well. More graduate students and post-docs enthusiastically entered the area, did research, and wrote dissertations.

As a result, amorphous semiconductors finally became accepted, and they are now part of the established technology and scientific knowledge base. The interested reader can simply look up Ovshinsky's company and statistics on http://www.ovonics.com . The Japanese have reaped a continuing bonanza from the sales of amorphous semiconductors, because of the shortsightedness and bias of the U.S. scientific community.

1.3 Scientific Disagreement or Street Fight?

It is one thing to scientifically disagree — even strongly — in a technical and courteous fashion, and quite another to engage in ad hominem attacks. The first is science; the second is a cur dog fight. Unfortunately the history of science far too often reveals "cur dog fights" instead of respectful scientific disagreements {66}.

A recent modern example of legitimate research and qualified researchers still being savaged in a "cur dog fight" manner is cold fusion (low energy nuclear reactions). Quoting one learned orthodox scientist, whose name is withheld, speaking to a learned scientist in cold fusion:

> *“How stupid do you think we are? My assessment of you and your colleagues is that you are complete frauds or totally mad. There is no known physical principle that would support the kind of results that you claim your technology can accomplish, nor is there any credible argument why there should be such a principle."*

We answer that "cur dog attack" unemotionally and scientifically. The key is in the scientist's own phrase: "no *known* physical principle." If the experiments work and are replicated, but are not understood by the conventional theory, then they refute the prevailing theory, whether the physical principle is understood or not. Else scientific method has been totally abandoned in favor of "truth by authority and dogma". The experiments clearly show that a previously *unknown* physical principle is at work. The real task then is to rediscover this new principle — that being one of the primary ways that science advances. We propose new principles in this book as a possible explanation of those experiments.

The dogmatic scientist's statement was made in spite of some two hundred (200 at that time; now more than 600) scientific experiments worldwide, in many nations, many at prestigious institutes, where dozens of scientists have reported positive and anomalous results in cold fusion experiments.

So yes, there is indeed a very "credible argument" — *the results and replicability of the experiments*, which are supposed to be the *decisive* statement of science. If that view in science has changed, then we are no longer practicing the scientific method. Instead of accepting successful and replicable experiments and seeking to change the model, the scientist is insisting that we must first understand the principle and thus have a model. This of course is a total violation and reversal of the scientific method. We used aspirin effectively for decades without the slightest notion as to the mechanism enabling its beneficial actions. The mere fact that "there is no known physical principle" for the results achieved has nothing to do with the validity of the replicated experimental results. Instead, it merely substantiates that *there should be a vigorous scientific program to uncover the new principle or principles obviously involved*, since the old model has either failed or been revealed as too limited.

The derogatory statement by the dogmatic scientist is also made from the viewpoint of the conventional nuclear physics model. The conventional physics has not taken into account that all 3-spatial electromagnetic energy associated with charges and dipoles and their fields and potentials in fact comes from the time domain {85, 86, 12, 19}. It has also not taken into account that time itself (as in the time component transported by the time-polarized photon or a time-polarized EM wave) may be comprised of extraordinarily dense energy. Indeed, time appears to be spatial EM energy compressed by the factor c^2, so it has the same energy density as mass {67}, which we pointed out earlier. The smaller the *spatial* energy of the

photon, the greater its time component and hence its *time*-energy in seconds expressed in decompressed spatial energy joules[26]. The highest energy particle physics is not *spatial*-energy physics as presently practiced, but *time*-energy physics, where some of the time-energy of photons is transduced into spatial energy. One second of time transduced (decompressed) into spatial energy yields approximately $9\Delta10^{16}$ joules. Further, every negative charge in the universe continuously accomplishes that decompression, and every positive charge continuously accomplishes the recompression.

In other words, not all physical principles were discovered in the particle physics of, say, five years ago, as the literature since then clearly shows. To assume that everything is already known today is ludicrous; science is never completed. The new principles reported in the present book now are at least "candidates" for the physical principles that do support cold fusion results. There is also another powerful argument for these hypothesized principles: they have produced the final resolution of the source charge problem — something for which the arch skeptic quoted has no solution whatsoever, and which he himself cannot explain. *If the arch critic cannot produce an alternate solution to the source charge problem, and is unaware of that new principle that may solve it, let him go and learn the new principle. Until then, he unwittingly assumes that every charge in the universe is a perpetual motion machine, continuously creating and pouring out EM energy in all directions at the speed of light.* So we return his own argument and approach to him: he should attack the conventional scientific community for accepting the source charge, while having absolutely no principle to explain how it continuously pours out observable EM energy without any observable EM energy input. In short, he should practice what he preaches; else he brands himself a total hypocrite. The alert reader will note that none of the arch skeptics doing all the ad hominem attacks on cold fusion and COP>1.0 EM systems are practicing what they preach.

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[26] The spatial energy of the photon decreases linearly as the frequency is lowered, while the time component in seconds increases linearly. But the highly compressed time energy, comprising that time component, increases nonlinearly (by the factor $c^2 \div t$). Hence the highest energy photons are actually the low frequency photons — something completely alien to particle physicists — and not the high frequency photons chased by "high energy physics". Indeed, high energy physicists are practicing a high spatial energy physics, which — overall — is a much lower energy physics than radar, microwave, VHF, or ELF, *if the total energy of the photon, to include its time energy, is considered*.

What we are saying is this:

(a) If one's physics knowledge was current five years ago, it may be stale today. A few years ago, no one believed the expanding universe was accelerating. Today we know that it is, rather unequivocally. And by "no known physical mechanism". We will later present a strong candidate for that missing mechanism. The results of experiments will substantiate or refute it.

(b) The proposed principles in this book, e.g., are newer, and may shed light on the mechanism for the cold fusion results as well as other phenomena. The experimental results themselves are irrevocable; any proposed explanation requires validation.

(c) The new principles do explain cold fusion and are consistent with the phenomena encountered in multiple experiments by multiple researchers in many laboratories. We readily admit that the stale and incomplete principles presently utilized in nuclear physics *do not* explain cold fusion. Neither do they explain how a charge continuously pours out EM energy. So do the skeptics attack all those physicists who believe in source charges and their provision of the fields and potentials and all EM energy? Of course not. They themselves believe in that greatest of all “perpetual motion” *faux pas*.

(d) The proposed new principles also solve the source charge problem, which is still ignored by most conventional physicists and electrodynamicists, even though often referred to as the "most difficult problem in electrodynamics" {68}.

(e) Scientists should not be close-minded, but should consider new proposals and let the experimental results decide their validity or falsity — precisely the position taken by the journal *Science* in publishing the results of some new cold fusion experiments. That is the scientific method in action.

(f) Those scientists who remain close-minded, and viciously attack experimentally demonstrated new processes and mechanisms, are guilty of practicing dogma and not science. They are in fact guilty of being what they so frequently charge: *pseudo-scientists*.

When science does not allow proposed new mechanisms and principles to be considered in science following demonstration of new phenomena inexplicable by present models, then science is no longer practicing scientific method. When any scientist rejects these demonstrated new

experimental phenomena out-of-hand, he is practicing dogma rather than science. The “friendly skeptic” attitude is welcomed and appropriate. The cur dog attack has no place in science, but only among cur dogs — and those who behave like them.

1.4 A Few Significant and Unresolved Scientific Problems

1.4.1 Time as Structured Energy

Time also has internal structure and dynamics {69, 70}, as we explain later, as well as the same energy density as mass. So it should not be surprising that a tiny bit of time-energy, transduced into ordinary spatial EM energy, might be capable of energetically inducing a wide variety of nuclear reactions. One has transduced not only "gross" energy, but also energy structuring and dynamics — which *act internally* on any object with which interaction occurs. Further, the overall spatial energy component and the time-energy component in a photon are canonical. Being quanta, all observable photons have the same fixed "total magnitude" with respect to angular momentum. The photon is also "made" of $(\div E)(\div t)$ which may be taken as $(\div E)(c^2 \div t)$ in terms of *purely spatial* energy equivalent content, assuming that the time energy is decompressed into spatial energy. As can be seen, the so-called "low (spatial) energy" photons are precisely the photons that transport the greatest time-component. When that time-energy component $(\div t)$ is converted to spatial energy $(\div E_C)$, the formula is $(\div E_C) = c^2(\div t)$. As can be seen, the converted time energy will produce far more spatial energy in the *converted* interaction, than was carried by the photon in its spatial energy $(\div E)$ component prior to interaction and time-energy transduction. Hence the highest energy photons are actually low frequency photons — under the circumstances where time-energy transduction into spatial energy is involved. With transduction, the highest energy particle physics can be conducted at low frequencies and low spatial energy if conversion of time-energy occurs in the interaction.

Since cold fusion involves transduction of a little bit of the time-energy, the total lack in physics of knowledge of time-energy transduction into spatial energy explains why conventional nuclear physicists find the cold fusion results so confusing and astonishing.

1.4.2 The Obsolete Foundations of Classical Electrodynamics

Another modern example of science's resistance to change is the failure to update classical electrodynamics to include the active vacuum interaction

and the interaction with the local curved spacetime[27], as we shall discuss in Chapter 2. It has been scientifically established (in particle physics) that there can be no equilibrium of any physical system without accounting for the vacuum interaction.[28] To simply observe a physical electrical power system sitting there stably and running, is to prove its vacuum interaction in order to even *have* such equilibrium.

An interesting point then arises since every charge and dipole in the system is a *broken equilibrium* in the exchange between the material system and the vacuum. Not only does an electrical circuit receive some energy from the vacuum, but also the energy from the vacuum is *massively hemorrhaging* from the vacuum into the system (and back out)! The isolated charge, e.g., is infinite if one removes the screening clustered virtual charges of opposite sign, as is well known in modern physics. Further, the screening virtual charges also have infinite charge, again as is well known. The difference between these two infinite values of charge, e.g., gives the standard finite observed charge of the charged particle. The lay reader may wish to positively verify that statement; e.g., as given by Nobelist Steven Weinberg.[29] Quoting:

> *"[The total energy of the atom] depends on the <u>bare mass</u> and <u>bare charge</u> of the electron, the mass and charge that appear in the equations of the theory before we start worrying about photon emissions and reabsorptions. But free electrons as well as electrons in atoms are always emitting and reabsorbing photons that affect the electron's mass and electric charge, and so the bare mass and charge are not the same as the measured electron mass and charge that are listed in tables of elementary particles. In fact, in order to account for the observed values (which of course are finite) of the mass and charge of the electron, the bare mass and charge must themselves be infinite. The total energy of the atom is thus the sum of two terms, both infinite: the bare energy that is infinite*

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[27] We again stress the concept of the *supersystem*, introduced in footnote 11.

[28] E.g., see T. D. Lee, *Particle Physics and Introduction to Field Theory*, Harwood, New York, 1981. On p. 380-381, Lee shows how there is no symmetry of matter alone, but only of matter and vacuum.

[29] Steven Weinberg, *Dreams of a Final Theory*, Vintage Books, Random House, 1993, p. 109-110.].

> *because it depends on the infinite bare mass and charge, and the energy shift ... that is infinite because it receives contributions from virtual photons of unlimited energy."* [Steven Weinberg].

So a simple charged particle actually involves a polarization of the vacuum involving two charge energy functions — the bare charge and the charge change functions — each of which has a known and recognized COP = ↵!

A priori, the conventional system's overall actions must incorporate functions (whether intentional or unintentional) that continuously adjust to provide *net equilibrium in that exchange by adjusting the hemorrhaging-out to equal the hemorrhaging-in*. In this book, we will spell out just what those unintentional functions are, such as the ubiquitous closed-current-loop circuit, and how to beat them so that excess energy from the vacuum can be utilized by the system to power the loads.

1.4.3 What Powers an EM Circuit or Electrical Power System?
Another modern example of science's resistance to change is the continued engineering of electrical power systems with the erroneous notion that mechanically powering the shaft of a generator directly powers the power line. The notion is that the generator transduces some of the mechanical shaft energy into output EM energy added to the power line {71}. To the contrary, *all EM systems are powered by energy extracted from the vacuum*. They are not powered by the mechanical energy we input to the shaft of a generator, or by the chemical energy in a battery. In this book, we discuss at some length what powers the EM system, and we have previously published the basis for our "shocking" statement {12, 72}. The basis for how an EM system is powered by energy from the vacuum has been known in particle physics for nearly a half-century {73}, since the experimental proof of broken symmetry {74}, including the broken symmetry of opposite charges (and hence of any dipole) in its fierce energy exchange with the active vacuum {75}.

A generator or battery expends all of its available energy to separate its internal charges and form its source dipole between the terminals. Once made, the dipole's broken symmetry — in its violent energy exchange with the active vacuum — converts virtual photon energy absorbed from the vacuum into observable EM energy, and emits it — *pours it out* — through the terminals and along the power line, filling all space around the conductors.

If one wishes to appreciate the enormity of the vacuum changes engendered by formation of that source dipole, simply visualize those two

infinite charge energy functions (from Weinberg's quotation above) for every charged particle on the ends of that dipole. The dipole then is a great set of offsetting infinities in EM energy (photon energy) boiling and being ordered in the vacuum. Making a simple little dipole or producing a simple charge initiates into motion an enormous set of infinite energy changes in the vacuum! None of these startling, enormous vacuum energy changes and functions is modeled in classical electrodynamics and electrical power engineering. So when we speak of the Heaviside nondiverged energy flow component pouring from the terminals of a generator, as being a trillion or ten trillion times as great in magnitude as the intercepted Poynting component, the reader should not be appalled. The reader should recall that we are dealing with the difference between sets of infinities that combine to provide finite differences. These finite differences can be very small, or they can be extraordinarily large, depending on the exact situation. In the case of a source dipole formed in an ordinary generator or battery, the difference of the infinities is very large.

Figure 1, adapted from Kraus {76}, illustrates that small part of the external energy flow around a typical transmission line that is intercepted by the surface charges and their fields, and that is drawn into the wires to power the circuit as these charges are driven axially back and forth across the conductors. The surface charges are constrained to the "drift velocity" (usually a few inches per hour) movement down the wire by repulsion of the electrons ahead of them.

The spinning, *longitudinally restrained* electrons precess laterally, thus withdrawing across the transverse axis of the wire. So the laterally precessing electron withdraws a little ways, withdrawing that first small portion of its fields and their energy increased by intercept of additional energy from the outside energy flow. The further part of the fields is not withdrawn into the conductor, and is not used to power the electrons.

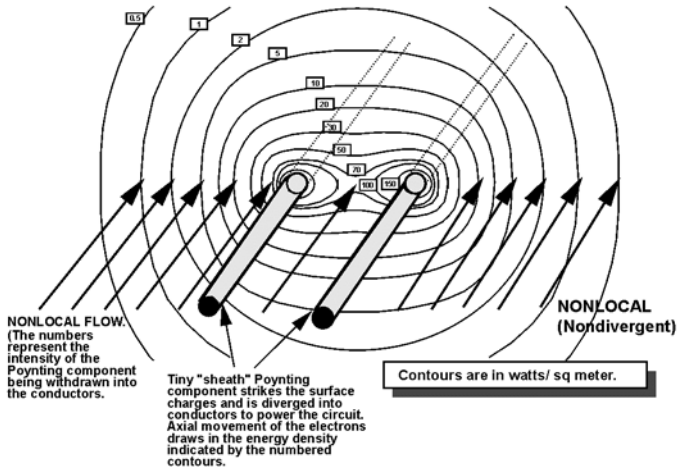

Figure 1-1 Poynting (caught energy) flow contours surrounding a transmission line.

Most of the available energy flow misses the circuit and is not drawn into the conductors. However, that large component is not shown by Kraus, and Poynting did not consider it. Heaviside {5c} pointed out that the remaining flow component is hardly reduced (hardly changes direction) from the entire flow component before the extraction of the small Poynting component. Given sufficient intercepting charges outside the wires in separate receiving circuits, the total remaining energy flow that could potentially be intercepted is enormous — far more than the feeble amount of energy that is input to the generator shaft or that is in the chemical energy of a battery.

This is easily established by actual experiments placing intercepting charges in separate "receiving" circuits in the otherwise nondivergent energy flow outside the conductors, or one may show it with Bohren's experiment {24}. Collecting additional energy completely outside conductors is one part of the COP>1.0 operation of the motionless electromagnetic generator (MEG) {37}, to be discussed later in this book. The Sweet device {29a} established sustaining self-oscillation of the

barium nuclei in a barium ferrite magnet, by using the surrounding vacuum as a semiconducting medium.[30]

1.4.4 The Incompleteness of Aristotelian Logic

Another false notion usually perpetuated in much of science and mathematics is that Aristotelian logic is complete and consistent {77, 78}. To the contrary, it is both incomplete and inconsistent, as is easily shown. Let us use the symbols "A" for a particular thing, "$\bar{A}$" for that which is not-A, "$\sum$" for "is identical to," "$\not\equiv$" for "is not identical to", "$\vee$" for "or", and "$\wedge$" for "and". Using these symbols, the three laws of Aristotelian logic may be expressed as follows:

$$A \sum A \qquad [2]$$

$$A \not\equiv \bar{A} \qquad [3]$$

$$A \vee \bar{A} \qquad [4]$$

The first law states that a thing is identical to itself. The second states that a thing is not identical to that which is not itself. The third states that a thing is either itself, or it is something else. Those are the three laws of Aristotelian logic. As written, the process of perception, observation, etc. *has been excluded*. More on that in a moment.

Specifically excluded are the laws

$$A \not\equiv A;\ A \sum \bar{A};\ A \wedge \bar{A} \qquad [5]$$

Which says that a thing is not identical to itself but is identical to something else that is not itself.

Heraclitus posed a profound challenge to Aristotelian logic, a challenge that has not been adequately resolved by Aristotelians to date. He simply observed that, for a thing to change, it had to change into something else. “But then,” he asked, “how can a thing be itself but also something else as

[30] E.g., see Richard E. Prange and Peter Strance, "The Semiconducting Vacuum," *Am. J. Phys.,* 52(1), Jan. 1984, p. 19-21. The vacuum may be regarded as a semiconductor. In particular, the vacuum in the region close to the nucleus of a superheavy element is analogous to the inversion layer in a field effect transistor. The authors introduce the idea of the inverted vacuum. Just as a semiconductor may be manipulated by subjecting it to external fields, doping etc., it appears that so can be the vacuum.

well?" In philosophy that is still known as the unresolved "problem of change". It has no resolution in Aristotelian logic, but can be resolved in an extended logic we shall advance. The solution to Heraclitus' problem of change is the nature of observation, as advanced in this book.

We now critique Aristotelian logic, by observing a simple Venn diagram of the type used in "proving" logic theorems in axiomatic logic. See Figure 1-2.

1-2a. Usual Venn diagram of A and A.

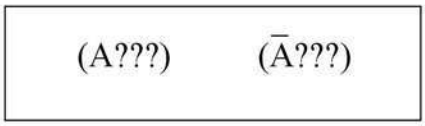

1-2b. Applying second and third laws to divider.

1-2c. Applying second and third laws to divider and outer boundary.

Figure 1-2 Applying Aristotle's laws to Venn diagram used to prove logic theorems destroys the entire diagram.

In Figure 1-2 a, we have introduced a dividing boundary line between A and Ā. *Unfortunately that dividing line belongs entirely to both A and Ā*. So it violates all three Aristotelian laws, and must be removed.[31] Therefore, we remove it in Figure 1-2 b. Now we have neither a discernible A or a discernible Ā, but we have removed naught but the boundary separating them, so we may argue that they are both still there although not discernible. However, if they are not discernible, we cannot distinguish what A is or what Ā is, and so we cannot discern whether they

[31] A clever fellow once proposed regarding the boundary as a total discontinuity, being neither A nor Ā. However, in that case A and Ā could never meet, so there could not be a cause interacting with not-cause to produce an effect. So that suggestion as to how to "fix" Aristotelian logic does not hold.

are identical or not. Here again this violates all three laws of Aristotelian logic, so we have to remove the diagram. Indeed, the outer rectangle line is also such a boundary, between the "inside" and the "outside" (the not-inside), and so it must be removed. In compliance with Aristotle's laws, we are left with the trivial diagram shown in Figure 1-2 c, which is nothing at all.

If this Venn diagram method is objected to, then we must insist that all those papers and texts using that method of proof of logic theorems be either abolished or corrected!

Sometimes the objection is raised that, as far as the center boundary line is concerned in Figure 1-2a, the line "belongs to A on the left and belongs to $\bar{A}$ on the right". Fine! Then we have a unique situation where a line (call it L) is an entity made of two entirely different things, which we may refer to as L_L and L_R. Yet $L \sum L$, without any qualifications as to "sides" L_L and L_R. It can be shown that every point in L is a point in L_L, and is simultaneously a point in L_R. The point in L is obviously identical to itself, by Aristotle's first law. Further, the same point in L_L and in L_R is identical to itself, by the same first law. But L_L is the set of all such points, and so is L_R, and so is L. Therefore $L \sum L_L \sum L_R$, since each one consists of each point that the others consist of. There is absolutely no distinction between the three things themselves, unless we are to violate Aristotle's laws.

Note that in passing from left to right across the boundary, a "change" occurs. This simply re-resurrects Heraclitus' original objection that, according to Aristotelian logic, there can be no change. That is, a line cannot change from "a different entity as seen from the left" compared to that entity as seen from the right. None of Aristotle's three laws contains a "left and a right" for A or $\bar{A}$.

So the question of logic is a little more complex than writing three simple laws and drawing simplified Venn diagrams. In short, one cannot have Aristotelian logic without having something else *outside* it, which follows directly from Gödel's theorem and proof {78}. Note that we are introducing the required notion of "perception" into the formal notions implied as axioms in Aristotle's laws, as that "something outside the prescription of the laws themselves" and in addition to them. We are perfectly free to *use* Gödel's theorem and observation.

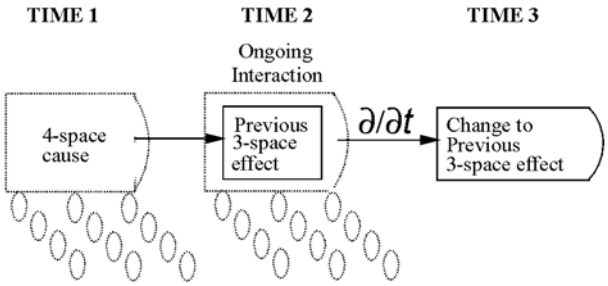

Figure 1-3 Mechanism for observation of change to a previous observation.

See Figure 1-3. We now add the notion that a thing is a perceived, thought, or observed thing. So let us use the symbol ⇒to mean <u>*explicit*</u>, i.e., *output* by a given perception, thought, or observation process as the result of a ∈/∈*t* operator having been applied to whatever exists prior to perception, thought, or observation. The symbol ⇔is used to mean *implicit*, e.g., when one observes an observation "Y" at time two, and later is deciding in time three whether or not that observation "Y" in time two is identical to a previous observation "X" made during time one, then *memories* of the observations of X and Y are involved in time three rather than the observations X and Y themselves, and so the observations of X at time one and Y at time two — by whatever manner they were observed and according to whatever decision algorithm is used — is said to be "implicit".

We note that we can know nothing about the so-called "thing in itself" *without* thought, perception, observation, or other process involving ∈/∈*t*. Further, at the moment the ∈/∈*t* operator is applied, time momentarily ceases. The resulting perception, thought, or observation exists therefore as a "frozen output" at that single moment in time. To have it "persist" or exist a moment later, we have to apply the ∈/∈*t* operator *again*, and stop time again, so that we again perceive, think, or observe.

But at any moment later than when we made a particular perception, thought, or observation of "A", *that* specific "perceived A" no longer exists, except in our memory as a recording of "observed A" that we can *continually recall*. Our conscious mind is a very fast serial processor, with only one "perception" or "thought" at each fleeting moment — only one

slide at a time in the slide projector, so to speak. But it is very rapid. However, our so-called "unconscious" mind is totally conscious, just multiply so. It is a massively parallel processor, and has "a great many slides in the slide projector" at any given time.[32] Hence in our genetic multiprocessor mind, we can indeed record, recall, compare, etc. — and perform all the modern massively parallel computer operations.

Let us now re-examine the three Aristotelian laws. Let us label the "slide snapshots" with the time instants when each "perception, thought, or observation" is or was consciously made, by use of a subscript, such as A_1, which means *what was perceived, thought, or observed as "A" in time-snapshot 1*. Let us also note that each of the symbols $\sum_3$, $\not\equiv$, $\vee$, and $\wedge$ actually involves the output of a *comparison and decision algorithm* in the massively parallel processor, after the two observations X_1 and X_2 were made. Let us use the symbol ♥ to mean "results in the decision that" or "implies that". As a check for identity, e.g., simple comparison algorithms for determining identity or nonidentity might be

$$\{[A_1 - A_{(2)}] = [0]_3 \heartsuit_4 (A_1 \sum A_2) \qquad [6]$$

$$\{[A_1 - A_{(2)}] \prod [0]_3 \heartsuit_4 (A_1 \sum A_2) \qquad [7]$$

Thus we more precisely rewrite Aristotle's laws as

$$A_1 \sum_3 A_{(2)} \qquad [8]]$$

$$A_1 \not\equiv_3 \bar{A}_{(2)} \qquad [9]$$

[32] E.g., this can be seen by a moment's reflection. At any one time, the "unconscious" mind is controlling and directing a great multitude of ongoing physical processes, is also processing short-term and long-term memory processing, filing conflicts for resolution or later presentation to the conscious mind in symbolic fashion, etc. One can physically measure the electromagnetics associated with this activity, after the mind transduces its time-polarized EM interactions into 3-space EM actions. The process is two-way, and certain recorded EM stimuli will be "reverse-processed" back to affect the time-polarized EM operations of mind. Mind operations are electromagnetic; but they use time-polarized (scalar) photons and time-polarized (scalar) EM waves which are unobservable a priori. Mind operations are also electrodynamically engineerable, but that is beyond the scope of this treatise.

$$A_1 \vee_3 \bar{A}_{(2)} \qquad [10]$$

Where — surprise! We have now accounted for all those different times and periods of observations, processing, comparison, decision, etc. We are dealing not with some mystical "thing-in-itself", but with interactions (perceptions, thoughts, observations, associations) in the mind and psyche of the observer. And hidden in time 3 is the application of a decision algorithm such as given in [6] and [7] above.

Now the first law [8] states that in time one an observation was made and named "A", notated (A_1), by comparing it to a previously recorded observational memory of what we call "A". The existence of that *memory* of what we call A is implicitly assumed in the first law, as well as the others. We do not show the memory itself in [8], [9], and [10]. In time two an observation X_2 was made (not notated), but it is not then known at the moment whether that X_2 is A or $\bar{A}$. So in time interval three the decision algorithm to determine identity or non-identity occurred in the mind, and the zero output of that algorithm [6, 7] established that $A_{(2)}$ was actually identical to A_1, *according to the decision algorithm actually used. The algorithm matters, and it too is a variable*.

A similar process occurs in law two [9], but this time the algorithm had a different output. Note that the little line over $X_{(2)}$ to make it $\bar{A}_{(2)}$ was not assigned until time interval four (not shown) after the decision algorithm had given its output in time interval three.

The second law merely states that the operation of the decision algorithm in time interval 3 found the two snapshots (in time 1 and in time 2) not to be identical, *by the decision algorithm and comparison process utilized. Again, the algorithm matters, and it too is a variable that must be taken into account.*

All three laws [8, 9, 10] written one after the other *assume* that the identity algorithm does not change between snapshot 1 and snapshot 2, in all three of them. This is the key point.

With two different versions of the identity decision algorithm, the results of two different comparisons may differ. If the identity decision algorithm does not change during the time between snapshot one and snapshot two, then we have one case. This is like a person with good color vision, looking at a red marble beside a black marble. That observer clearly

distinguishes the marbles, and to him they do *not* appear identical. Every time he looks again, they still differ because he did not change his decision algorithm between looks. On the other hand, a color-blind observer cannot distinguish the marbles, and to him they are seen as identical. Every time he looks, they are seen as identical, because his identity decision algorithm did not change.

Or, suppose a proponent argues that the "rightness" or "leftness" of the dividing line L, between A and $\bar{A}$ in the Venn diagram, can be taken into account. He is actually invoking a different algorithm (it belongs to the left and therefore to A) in one time snapshot than the algorithm (it belongs to the right and therefore to $\bar{A}$) used in the other time snapshot. So his right side and left side of a line implicitly invokes the very point we are making: *the algorithm utilized is a variable and must be accounted.*

The point is this: *identity — whether in perception, thought, or observation — is not absolute, but depends upon the precise nature of the operation of the perception, thought, or observation process utilized and specifically on the "decision algorithm" used for "determining" identity or nonidentity.* For example, two antennas certainly "see" quite differently, if one is a VLF (very low frequency) antenna and the other is an IR (infrared) antenna! As another example, two observers in different frames may see a particular object as quite different observed things! In n-space, an observer in a frame at right angles to the lab frame, will see any mass in the lab frame as a wavefront going at light speed; in short, as a photon or photonic object, whereas the observer in the lab frame will continue to see it as just a common old mass object. So the "same object" *physically* differs to the two different observers, according to their frame of reference. An observer whose frame is rotated by three orthogonal rotations from the lab frame, will see that object as an "object existing in time only," i.e., as simply a sort of "thought" image, so to speak. To be more scientific, he may assign it to something called the "virtual state".

In short, we can violate any and all of the laws of Aristotelian logic, because identity per se is *perceived, thought, or observed* identity — the output of a variable decision algorithm — and is not absolute.

For clarity, we add a fourth law that violates all Aristotle's three:

$$A_1 \sum_3 \bar{A}_{(2)} \qquad [11]$$

All this really says is that, in time 3, the decision algorithm being used was changed from what it had been in times 1 and 2, and now could not distinguish between what was seen in snapshot 1 and what was seen in

snapshot 2, even though to some "ultimate" observer the two were distinctly different.

In addition, we say that it "implicitly includes" the negations of all three Aristotelian laws. We then add an "application rule" (or a fifth law, as one wishes) as follows:

$$\{ [(A_1 \Sigma_3 A_2) \Rightarrow \wedge (A_1 \not\equiv_3 A_2)] \Leftrightarrow \}_5 \vee \{ [(A_1 \Sigma_3 A_2) \Leftrightarrow \wedge (A_1 \not\equiv_3 A_2)] \Rightarrow \}_5 \qquad [12]$$

This winds up producing an extension of Aristotle's logic, so that the following explicit laws emerge:

$$A_1 \Sigma_3 X_{(2)} \heartsuit A_1 \Sigma_3 A_{(2)} \qquad [13]]$$

$$A_1 \not\equiv_3 X_{(2)} \heartsuit A_1 \not\equiv_3 \bar{A}_{(2)} \qquad [14]$$

$$A_1 \vee_3 \bar{A}_{(2)} \qquad [15]$$

We also have the exact opposites of those three laws implicitly. The opposites can all be congealed into a single fourth law:

$$A_1 \Sigma_3 \bar{A}_{(2)} \qquad [16]$$

To make sense of these, we also have the master application rule or 5th law:

$$\{ [(A_1 \Sigma_3 A_2) \Rightarrow \wedge (A_1 \not\equiv_3 A_2)] \Leftrightarrow \}_5 \vee \{ [(A_1 \Sigma_3 A_2) \Leftrightarrow \wedge (A_1 \not\equiv_3 A_2)] \Rightarrow \}_5 \qquad [17]$$

We prefer to refer to this extension as a "four-law logic", where equations [13], [14], and [15] are the normal "explicit" laws, with the implicit law [16] understood but not explicitly written, and where equation [17] is the master application rule that puts it all together. But if one wishes to be rigorous, we have specified a 5-law extended logic that contains but expands Aristotle's 3-law logic. The application rule is the fifth law.

The point is this: In every case, we have a part of the perception, thought, or observation that obeys the explicit laws, and we also have a part that obeys the implicit laws. If opposites are not *explicitly* identical, then they

are simultaneously *implicitly* identical. If opposites are *explicitly* identical, then simultaneously they are also *implicitly* not identical.

The new approach then covers what we observe more completely. As an example, any "wave" (observed) is implicitly a non-wave (particle), but not observably so. If its particle nature is observed and therefore explicit, its wave nature is unobserved and therefore implicit, and vice versa.

One also resolves such dilemmas as stating something "does not exist" but having to first call it into existence to even state it does not exist. In the new approach, it simply does not *explicitly* exist, but *implicitly* exists. *Not-being* is something like that: explicitly it doesn't exist, but implicitly it exists. The great problems of the philosophers were never solved, mostly because the logic brought to bear was Aristotelian and incomplete. The ultimate answers they sought all involved the fourth and fifth logic laws. So the ultimate answers all appeared to them to involve such things as "the accursed necessity for the identity of opposites." Precisely!

In physics, there has been the same problem over whether a fundamental particle is a particle or a wave. Physicists argued fiercely until they realized the futility of further argument, and settled for the duality principle. That simply states, well, in one case it can be a particle as observed in your experiments, and in another case it can be a wave as observed. So simply treat it as whichever one is useful! The philosophers, on the other hand, split into different schools, where each school had its "interpretation" usually involving a very "smooth" position statement of the school's position. In physics also, there are eight or more "interpretations" of quantum mechanics, for example. So the same centuries-old problem is still with us today in modern physics.

Opposites are no longer the formidable opponents they once seemed. Instead, they become more like the two sides of a coin, lying with only one side up. To see heads or tails is to decide which is explicit. The other is always there, implicitly. But notice also that the "two sides" require a 3-dimensional object, and not just the 2-dimensional "head" or the 2-dimensional "tail". This juxtaposition of "identical" opposites is strongly met with in modern physics. For example, quoting Lee[33] :

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[33] T. D. Lee, "Space Inversion, Time Reversal and Particle-Antiparticle Conjugation," *Physics Today*, 19(3), Mar. 1966, p. 23. Positive charge is really *observation* imposed on negative charge moving backwards in time, and the positron is really observation imposed upon an electron traveling backwards in time, etc.

> *"As we expand our observation, we extend our concepts. Thus the simple symmetries that once seemed self-evident are no longer taken for granted. Out of studies of different kinds of interactions we are learning that symmetry in nature is some complex mixture of changing plus into minus, running time backward and turning things inside out."*

Any addition to the Aristotelian laws of logic is actually a higher dimensional form of it. Three-law Aristotelian logic is in fact fitted to primitive observation — the result or output of single-photon interaction and observation processes.

This "four-law" logic (or "five-law" logic if one includes the master application rule as another "law") has proven very useful over the years, particularly in bioenergetics applications. It has also been most useful in attempting to decipher that branch of Russian energetics weapon science called "psychoenergetics", and in attempting to decipher the mind-body coupling mechanism, but that is beyond the scope of this chapter {79}.[34]

1.4.5 Substitution of Effect for Cause

Refer to Figure 1-3 again, to see the relationship of the unobserved cause, the interaction of cause and a previous effect, and the production of the resulting "new effect" as a change to the old effect or the output of a second replica of it. The greatest non sequitur in electrodynamics — and in parts of physics such as mechanics — is the widespread substitution of the *effect* for the *cause,* as a result of considering an observable to *persist in time* without any physical interaction. We discuss that more fully in Chapter 2, particularly with respect the notion of the same EM field existing both as a component of a material environment and as a component of a nonmaterial environment, but with the "force reducing to zero" in the latter. Jackson {80} points out the prevailing view of electrodynamicists as follows:

> *"Most classical electrodynamicists continue to adhere to the notion that the EM force field exists as such in the vacuum, but do admit that physically measurable*

[34] The interested reader is referred to my website, www.cheniere.org, for papers dealing with the nature of the mind-body coupling mechanism and the body-mind coupling mechanism, as well as direct engineering of the mind, and limited information on the weapons referred to.

> *quantities such as force somehow involve the product of charge and field."*

On the other hand, Bunge {81} very clearly stated that the standard electrodynamics and physics itself are in terrible shape. Here is a direct quotation:

> *"... the best modern physicist is the one who acknowledges that neither classical nor quantum physics are cut and dried, both being full of holes and in need of a vigorous overhauling not only to better cover their own domains but also to join smoothly so as to produce a coherent picture of the various levels of physical reality."*

We shall try to further clarify these unresolved difficulties with the field concept in Chapter 2.

1.5 Electrodynamics is Still Developing

1.5.1 Statement by Penrose

Roger Penrose, one of the leading physicists of our time, pointed out the still-developing nature of electrodynamics with respect to the developments from conventional gauge-theoretic interpretation of Maxwell's equations. Quoting Penrose {82}:

> *"These facts should not, however, deter theoretical or experimental physicists from seeking alternative descriptions, unconventional formulations, surprising electromagnetic effects, or radical generalizations. The various articles in this book provide the reader with a great variety of different kinds of approach to developments of this nature. We have historically motivated accounts, suggestions for new experiments, unconventional viewpoints and attempts at generalizations. We also see novel and ingenious formulations of electromagnetic theory of various different kinds... I am sure that this book will make it clear that electromagnetism is a subject that is in no way closed to stimulating new developments. It is very much alive as a source of fruitful new ideas."*

1.5.2 An Example of a Ubiquitous Error

One of the rather horrid "bad examples" of ubiquitous errors in electrodynamics is the conventional illustration of a so-called planar EM wavefront moving through space, as shown in Figure 1-4.

A succinct evaluation of that diagram and notion is given by Evans {83}, one of the great electrodynamic theoreticians of our times:

> *"I broadly agree ... that the transverse plane wave view of vacuum electrodynamics is the biggest blunder of twentieth century science."*

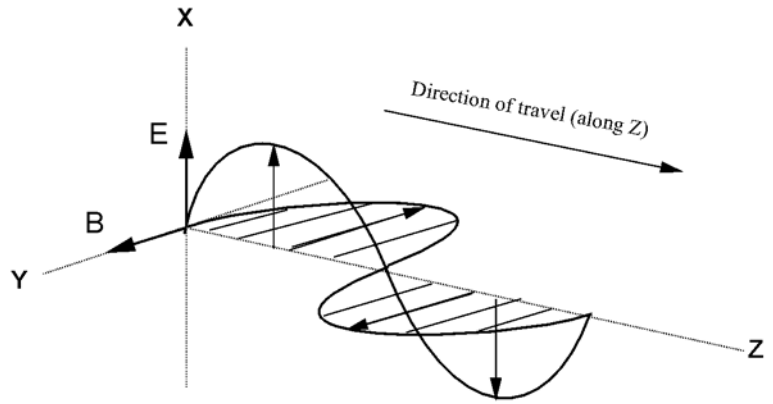

Figure 1-4 The erroneous but ubiquitous supposed illustration of the transverse EM wave in 3-space.

Dr. Robert H. Romer, former Editor of the *American Journal of Physics*, also chastised the horrid diagram shown in Figure 1-4, purporting to illustrate the transverse plane wave traveling through 3-space. In endnote 24 of his noteworthy editorial, Dr. Romer {84} takes that diagram to task as follows:

> *"...that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/or time?) that besmirch the pages of almost every introductory book. ...it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate." "...perhaps then, for historical interest, [we*

> *should] find out how that diagram came to contaminate our literature in the first place."*

Indeed, each point along the z-axis, is a momentary "3-space frozen slice" of the $\in/\in t$ operator being applied to the ongoing 4-space interaction of the causal field in 4-space interacting with the previous "observed effect" (in this case, the previous 3-space slice) to produce a change to it. So the entire diagram is a set of "frozen 3-space observations", in which nothing at all is moving, and where the fields shown are in the mass (detecting/observing) medium. There is no such thing as a "traveling EM wave in 3-space", because "moving" or "changing" or "traveling" *a priori* must involve time as well as 3-space. What we are looking at in Figure 1-4 is the iterative and very rapid results of continual "3-space observations" (frozen 3-snapshots) of an on-going 4-space interaction.

1.5.3 An Extremely Important EM Omission

There is an enormous amount of development yet to be done in electrodynamics! As a simple example, for nearly a century there has been waiting quietly a fundamental "internal" or "infolded" electrodynamics by Whittaker {85, 91a, 86}, based on more primitive initial work by Stoney {87}, existing inside — and *comprising* — all conventional EM potentials, fields, and waves. This internal electrodynamics {88} has been essentially ignored in the West, but has already been weaponized in the weapons laboratories of several nations under the aegis of *energetics*. The U.S. Secretary of Defense, Secretary Cohen {89}, alluded directly to some of these weapons in a speech in 1997 as follows:

> *"Others [terrorists] are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves… So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations…It's real, and that's the reason why we have to intensify our [counterterrorism] efforts."*

The weapons are already being utilized against various nations in the form of terrorist acts in an undeclared war {89}, and have been so used since the 1950s.

This internal longitudinal-wave EM and its dynamics is a much more fundamental electrodynamics (actually a subset of a unified field theory) consisting of correlated longitudinal EM wavepairs in both the 3-space and time domains. Each Whittaker decomposition wavepair is comprised of an

incoming longitudinal wave — a "time-polarized" EM wave {90a-90c} — in the time domain, perfectly correlated with an emitted longitudinal EM wave in 3-space. See Figure 1-5. This multiwave structuring and dynamics in both the time domain and in 3-space simultaneously *comprises* the scalar potential.

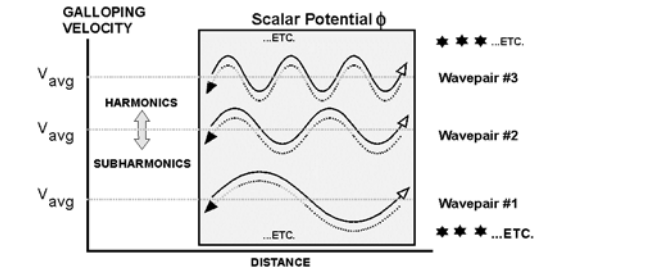

The Structure Is:

- A harmonic set of longitudinal phase conjugate wavepairs.
- In each wavepair the two waves superpose spatially after detection, but travel in opposite directions.
- Prior to detection, the convergent wave set is in the imaginary plane, and hence is not observable. It is EM energy incoming to the potential (dipolarity) from the time domain.
- The charges receive the complex convergent EM energy, transduce it into real EM energy, and emit enormous energy at the speed of light in all directions -- which includes bidirectional pairs in 3-space (after the reaction, being after "observation").
- This produces the fields and potentials from the "source charge or dipole."
- Mandl and Shaw argue that the scalar (time-polarized) photon and longitudinal photon are observable only in similar pairs, which then makes the instantaneous scalar potential. Thus quantum field theory work strongly supports the "negative resistor" interpretation of the scalar potential and our solution to the source charge and source dipole problem.

Figure 1-5 The scalar potential is a harmonic set of phase conjugate longitudinal EM wavepairs.

We specifically stress that the dynamics occur in the *time* domain (in its specific structuring, propagation pace, etc.) as well as in 3-space.

Deliberately changing the internal longitudinal EM wave structuring produces precise energetics (both energy and dynamics) in spacetime itself. This is a special form of "spacetime curvature structure and dynamics" which we call a *spacetime curvature engine* or *vacuum engine*. Together with superpotential theory in the original form initiated by Whittaker {91a} and extended by others {91b, 91c, 91d}, this internal electrodynamics — together with scalar potential interferometry {92} — creates all ordinary EM fields and waves {79}. Superluminal communication is possible using the internal longitudinal EM wave structure of the EM fields, potentials, and waves {93a, 93b}.

1.6 A Summarizing Letter

Our thrust in this book is to attempt to (1) reveal some of the major flaws in electrodynamics that have prevented development and use of COP>1.0 electrical power systems, and (2) point the way toward the development and use of such systems. To give a general summary of the ground this book will cover, we conclude with an informal E-mail letter I sent to the recent editor of *American Journal of Physics*, pointing out the greater implications of his cogent observation of that "dreadful diagram" and where it leads. Indeed, it (i) leads to a dramatic change in electrodynamics, (ii) changes the way in which we regard "propagation of EM energy through 3-space", (iii) solves the long-vexing problem of the association of the source charge or source dipole with its fields and potentials and their energy, (iv) changes dramatically the way we view what powers an electromagnetic circuit or power line, (v) allows extraction and use of copious EM energy from the vacuum, and (vi) solves the energy crisis permanently.

Here is the letter sent informally to Dr. Robert H. Romer — *slightly edited* to improve the grammar, correct one error of misstatement, and with reference citations added and listed at the end of this chapter:

To: Dr. Robert H. Romer Thursday, Mar. 8, 2001
American Journal of Physics
Amherst College, Box 2262
Amherst, MA 01002

Personal communication

Subject: Implications of your cogent comments on that atrocious illustration

Dear Dr. Romer:

This is not a submission of a manuscript, but a personal communication to you on a matter of great importance in physics, directly related to endnote #24 of your seminal editorial {94}.

It will take a little exposition, so please bear with me and read this when you have the spare time to do so. We are going to show you how your keen insight can be extended to solve some extraordinarily formidable

foundations problems in present electrodynamics. We will also show how to apply the implications of your insight to totally solve the present electrical energy crisis permanently.

In your endnote #24, {94} you took to task (quoting):

> *"...that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/or time?) that besmirch the pages of almost every introductory book. ...it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate." "...perhaps then, for historical interest, [we should] find out how that diagram came to contaminate our literature in the first place."*

Dr. Romer, you have lifted the corner of a dark cover concealing one of the most important flaws in electrodynamics and in fact in all of physics: the unwitting and pervasive substitution of the effect for the cause. A marvelous extension to the present physics is enabled if one removes this terrible non sequitur in physics, and particularly in electrodynamics. For openers, one solves what has been called the most difficult problem in electrodynamics (the problem of the source charge and the association of its fields and potentials and their energy) {100}. I will solve that problem for you in this informal write-up. I will also explain how to extract enormous EM energy from the vacuum, anywhere and anytime, easily. Extracting it is easy; catching it and using it to power loads without killing the extraction process is another matter.

One also gets a unified field theory, engineerable by novel electrodynamic means, as is steadily being shown by a series of rigorous Alpha Foundation's Institute for Advanced Study (AIAS) papers published in various leading journals (and more than 90 of them carried on a Department of Energy website restricted primarily to DoE scientists). Dr. Myron Evans, Director of the AIAS, has over 600 papers published in the literature, including such journals as *Physical Review*, *Foundations of Physics*, *Physica Scripta*, etc. Many of the other AIAS co-authors are excellent theoreticians and scientists.

The early pioneers of electrodynamics (Maxwell etc.) all assumed a material ether filling all space {95}. To these early scientists, there was not a single point in the entire universe that was devoid of matter, because the ether was present there. Hence their outlook as to the nature of EM fields etc. was quite material. Faraday conceived his "lines of force" as physical, taut strings, so that perturbations were "plucking these taut strings".

Maxwell himself points out in his famous "Treatise" that he specifically captured the thinking of Faraday in his theory. In fact, Maxwell wrote a *material fluid flow dynamics* theory.

In the light of more modern knowledge, let us see the impact of these and similar early *but still retained* erroneous electrodynamics assumptions.

First, observation/detection is totally spatial, as is well known in quantum mechanics. In fact, observation is a $\in/\in t$ operator imposed upon 4-space (LLLT spacetime), yielding a frozen instantaneous snapshot LLL of an ongoing 4-space dynamic process. At the next instant, that particular *previous* observation no longer persists. Why?

Well, no observable *persists*, since it is only an instant frozen 3-space snapshot, at a single point in time, *a priori.* Here again we have another horrendous non sequitur in all of physics: the assumption that observables "continue to exist" and therefore persist in time in a passive manner. In fact, there is an interactive process that generates their (seeming) persistence, involves time, and continually changes mass into masstime and back to mass, etc. With the reader's permission, we will pass discussing that mechanism until another time (pun intended!).

What we conceive as "an observable such as mass, traveling through space and persisting in time while doing so", is actually an iterative, continual series of these frozen 3-space snapshots or observations, much like the frames of a motion picture film. We ourselves mentally add the "continuity" to provide "the sensed motion", but rigorously what is actually "observed" is not continuous, but is a vast continual series of those frozen 3-space snapshots.

We're getting directly at that atrocious diagram!

Each snapshot is an *effect*, not a cause, because it was the output of the observation process whereby a 4-space *causal* entity (non observed *a priori*) interacts with a previously observed frozen entity (say, a unit point charge at some point in space) to produce the observation (change or effect generated in that interacting observed charge) as the "next instantaneous observation".

The usual "representation" of a "3-space EM wave" propagating in 3-space is indeed atrocious, just as you stated! It is actually just an iterative succession of such instantaneously frozen snapshots in 3-space, one after the other. There is no such thing as that set of snapshots independently existing in spacetime, *prior to interaction with charge* in that series of

interactions and observations, unless we wish to discard quantum mechanics and the laws of logic.

There is, however, a continual iterative stream of those observations — those frozen 3-space snapshots — that we interpret (erroneously) by recall from memory as the "EM wavefront propagating in 3-space". As you eloquently pointed out, that is not so, and it is atrocious. An observation, being an absolutely frozen entity, cannot "move through time" anyway, since it cannot persist, nor can it move. A change to an observable can only be another observable snapshot of the ongoing 4-space entity and action, which is then compared to the first snapshot and a difference noted {96} [See Figure 1-3].

In short, a great stream of "frozen effects" (frozen instant observations) does not constitute a "picture" of the ongoing 4-space action, but only a series of frozen 3-space intersections involving the interaction of that fixed observed (3-space) charge with the ongoing causal 4-space entity. If we add and integrate a series of 3-space pieces, we *do not* get a 4-space entity! Instead, we get a longer or bigger 3-space slice/piece, but one for which each piece of it only existed at a single point in time as a 3-space "slice" at that moment. That is precisely what is wrong with that horrible illustration.

But it is also "wrong" with electrodynamics itself! Electrodynamicists mistakenly conclude that the same *effect* "series of static 3-slices" — which they might call, e.g., the "field" in a case where the field is the subject — is the same as the 4-space continuous *causal* field prior to observation interaction with charge at all. Well, LLLT is definitely not LLL, nor is it n(LLL) where n is some large but finite number of 3-slices LLL.

So the field concept is dichotomously used in two contradictory manners in electrodynamics:

(1) it is considered to be in 4-space prior to the observing/detecting interaction with the observable (such as a unit point 3-space charge), and it is also considered a 3-space entity *after* that interaction. The dimensions of the two entities are not the same, and neither are the dynamics. The causal EM wave is dynamic and 4-spatial, the effect "3-space EM wave" (ugh!) is static and 3-spatial at each instant it is "observed". Assuming that the two are the same thing is a non sequitur.

In fact, it substitutes the *effect* for the *cause*, a rather gross violation of the causality principle itself.

(2) then an attempt at glossing over the illogic is used by the smooth statement that "the field (meaning that atrocious series of frozen 3-space snapshots) remains in the absence of charge, but the force goes to zero." Well, if the field is defined as a force field, it cannot be a "non-force field in the same observation!" Else, opposites are always identical.

So of what importance is all that?

It is of great importance. Let me show you one very startling thing that comes out of correcting this "biggest foundations non sequitur in physics, that of substituting the effect for the cause".

Consider a very special paper by E. T. Whittaker {97} in 1903. [I can send you a pdf file of the paper if you do not have it and are interested]. In this much-neglected paper, Whittaker decomposed the so-called "static" potential into a harmonic set of bidirectional longitudinal EM wavepairs, where each pair consists of a longitudinal 3-space wave (an *as-observed* wave) and its longitudinal phase conjugate wave (*considered unwittingly as having also interacted with charge, and therefore as being shifted into 3-space as an "as-observed" wave with inverse parity*).

Whittaker — as has everyone since him — unwittingly assumed the "iterative continual observation" interaction in there for the phase conjugate wave also. In so doing, he came up with two *effect* "waves" that are the outputs of the assumed observation process. Neither of these effect waves would be a wave in spacetime {98} at all, but the two in ensemble are an example of the same thing you objected to in your cogent commentary on that abominable "illustration".

In short, Whittaker invoked *observation* as a process with two effects and no cause, rather than with a cause and an effect, with the interaction with the observing/interacting unit point charge being assumed for both waves. Whittaker and everyone since seem to have made the same error in interpreting that seminal Whittaker decomposition. This misinterpretation of the decomposition has until now hidden one of the greatest secrets of all times in Nature's electrodynamics!

Let us correct the interpretation, and uproot that great secret to the light of day.

First, for observation to occur, one must have a cause acting upon the affected (observable) entity, and an effect (observable change) must be produced in, on, or of that affected (interacting) entity. One *must not* have two effects (two observables) and the affected entity (another observable and therefore another effect)! Again, assuming that one has three effects

(observables) constituting the observation process is a logical non sequitur of first rank.

Let us now correct that logical non sequitur made by Whittaker and other physicists and electrodynamicists, and see where it leads us.

First, we go to particle physics, where broken symmetry {99} was discovered in the 1950s. Lee, e.g., received a Nobel Prize for his work in that area {75}. Lee also showed that any dipole is a broken 3-symmetry in its violent energy exchange with the active vacuum.

Well, a scalar potential is a dipolarity; always a potential is actually a difference between two potentials, so to speak. So the potential itself represents a broken 3-symmetry in an energy flow exchange with the active vacuum.

Let us further examine that interesting broken symmetry aspect. It means that the "static" potential is a process whereby energy is received from the vacuum in *one* form, not observable, and hence unusable, but is output in *observable* (usable) form. In short, the dipolarity or dipole receives and absorbs (QM view) virtual photons, integrates them into observable magnitude, and emits real, observable EM energy ("continual observation" snapshots of the latter being assumed).

In physics, all observation is 3-spatial, as is well known. And 3-space is the realm of the observed. The EM energy from the vacuum is not received in 3-spatial (observable) form, else there would be no broken 3-symmetry of the dipolarity.

We can also *experimentally* verify that there is no 3-space input of EM energy to the potential — e.g., to the potential between the ends of any source dipole, because we cannot measure any 3-space observable energy feeding the charges of the dipole. Instead, observable 3-space energy is continuously pouring out of the dipole.

Let us continue now with the notion of a real dipole of separated source charges, with our "scalar potential" between its ends, so we have something concrete in mind.

First, our instruments prove there is a continual emission of EM energy in all directions in 3-space (of the kind in that atrocious diagram; a "series of iterative film-snapshots"). That is the way it is conventionally represented, as if observed at each and every point successively in that 3-space, and along every radial.

But secondly, our instruments also prove there is no such observable *input* of EM energy in that same 3-space *to* the dipole. Bummer! That is precisely what has stopped electrodynamicists from solving that vexing problem of where all the energy pouring out of the source dipole is coming from, and how! They unconsciously assume that the only possible source of the EM energy input is in 3-space. That is totally wrong. Further, the conservation of energy law does not require that energy be conserved in 3-space! Instead, rigorously — if we are using a 4-space (i.e., spacetime) model — it requires that energy be conserved in 4-space. The assumption of the extra condition of 3-space energy conservation is an added and arbitrary extra condition.

Since electrodynamics has not resolved this "source dipole and its associated fields and potentials" problem, it has stopped work on the problem and implied that every dipole in the universe is a perpetual motion machine, freely creating all that EM energy it continuously pours out across space, in all directions, creating its associated fields and potentials. That implicit assumption, if true, of course destroys the conservation of energy law.

It isn't true, and the energy conservation law is alive and well!

We can experimentally prove that the source dipole *does* continuously pour out energy in all directions in 3-space, without ceasing, as follows:

In a gedanken experiment, we set instruments every 300 million meters or so, along a radial line from an origin in the lab. With the instruments and clocks synchronized, we suddenly form a dipole at the origin. One second later, the first instrument reads. A second later, the second instrument reads. And so on. But it is not a "passing pulse". Whatever reading the instrument makes as the forward edge of the energy flow reaches it, is then continuously maintained thereafter. This proves that the energy is poured out continuously and at the speed of light, and in any (and all) directions in 3-space, *and it continues to pour out at exactly the same rate so long as that dipole remains intact.*

Dipoles in the original matter of the universe have been pouring out EM energy in that fashion for some 14 billion years, and they have not "exhausted" their unobserved energy input source yet.

A newly formed simple dipole, e.g., in one year will have poured out energy into a spherical volume of space that is a light-year in radius. Wait another year, and that volume of space whose energy density has been

changed will be two light years in radius. The dipoles in the original matter have filled the universe itself with that energy outpouring from them.

In other words, an incredible amount of EM energy has been and is being poured out into space from every dipole in the universe.[35] And electrodynamicists have had not the foggiest notion of where that mind-boggling amount of outpoured EM energy has come from.

Unless we wish to totally discard the conservation of energy law, we must have an equal input of energy *from outside 3-space*, going into every dipole continuously. In 4-space, that only leaves the fourth axis, along which and from which the input energy must move into the dipole.

And so it does. If we re-interpret that phase conjugate half set of the Whittaker decomposition, *before* observation has occurred, it then is a harmonic set of longitudinal EM waves moving in the time-dimension, *into* the source dipole (parity is not inversed because no interaction with charge has occurred to shift it into 3-space.

So voila! We have strangely (but quite rigorously) solved what Sen {100} referred to in this manner: *"The connection between the field and its source has always been and still is the most difficult problem in classical and quantum electrodynamics."*

We express our reasoning as follows: (i) we know from particle physics that the source dipole[36] is a broken 3-symmetry in its flux exchange with the vacuum. This means that we know the energy is received from the vacuum in an *unobservable* form, absorbed by the dipole, and emitted as *observable* EM energy. It remains to translate that into classical electrodynamics rather than quantum physics {101}. (ii) The *time* domain is the only domain outside 3-space, in the standard 4-space model. (iii) Anything in the time domain exclusively, is indeed nonobservable, since the $\in/\in t$ observation operator destroys time and all its internal structure and dynamics whenever observation occurs. (iv) Looking for a "3-space" input is looking for an "observable" EM energy input, which would in fact disagree with the known broken 3-symmetry of the source dipole.

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[35] Later we will see that, in a time-forward situation, the negative charge pours out positive EM energy while the positive charge may be said to pour out negative EM energy. Charge conservation then implies that an energy balance is maintained overall.

[36] Because of the broken symmetry of the opposite charges on its opposing ends.

Let me digress now to speak of fundamental units. As is well known, the fundamental units one chooses to make his physics model represent an arbitrary choice. One can, if one wishes, make a perfectly valid (but mentally nightmarish!) physics using only a single fundamental unit. In that case, all other "fundamental units" in the present model become functions of that single fundamental unit.

Suppose, e.g., that we make the joule our only fundamental unit. Then "mass" becomes totally a function of energy — and we have no heartburn with that one since the Einstein revolution and the nuclear age. But then "time" also becomes totally a function of energy — and that surprises us, because we have unconsciously been taught (erroneously) that "time is a flowing river down which a mass drifts like a drifting boat". That is not the nature of time at all; the totality of the photon interactions with a mass create that mass's "motion through time". I can later explain that to you also, if you wish, but let us pass it for now.

It turns out that time is spatial energy compacted by the factor c^2, so it has the same energy density as mass, but in the time axis instead of 3-space. Intuitively, if we are interested in cause and effect, the energy of the cause (time) should be equal to the energy of the effect (in this case, mass). After one reflects a moment, one also sees that "time energy" is required to "drive" a mass through time, just as "spatial" energy is required to "drive" a mass through space. The notion that mass in an inertial frame moves through "empty space with no reaction" is false; it continually moves through the energetics of spacetime, and interacts continuously with it.

Anyway, from still another viewpoint there is no magic in EM energy currents moving in the time domain! Quantum field theory already recognizes multiple polarizations of the photon, including transverse, longitudinal, and time-polarized. Thus, it implies a time-polarized EM wave also. A longitudinal EM wave *moving in the time domain* oscillates along its line of travel. That is indeed oscillating its energy density in the time domain, so that it is "time-polarized". Hence it is a proper time-polarized EM wave, and appears to "gallop" {102} or vary its speed periodically.

The solution to the "source dipole" problem is that the phase conjugate wave half-set of the Whittaker decomposition, when reinterpreted, is the *incoming* EM energy in the time domain, continuously input to the charges of the dipole. The charges interact in the imaginary plane (the time domain), and absorb the time-energy, then transduce it into 3-space, and emit it as Whittaker's set of real observable longitudinal EM waves in all

directions in 3-space (as observed). The time-energy waves that are input to the dipole cannot be observed, since observation destroys time and its constituents.

All 3-spatial EM energy comes from the time domain! Broken 3-symmetry of the source dipole immediately releases our arbitrary additional restriction on nature's energy conservation law — i.e., our insistence that the energy input for conservation must be input in 3-space. By removing these arbitrary "shackles" from nature's feet, we allow nature to joyously resume her much-preferred special 4-symmetry in EM energy flow: the circulation of EM energy from the time domain into 3-space, and outpouring of that energy in all directions in 3-space, at the speed of light {103}.

Now let us solve the source-charge problem as well. That one is now easy to resolve.

We know from quantum mechanics that any "isolated" observable charge is actually clustered around by virtual charges of opposite sign. So we simply take one of these clustering opposite charges while it exists, and a differential piece of the observable charge, and we have a composite dipole. Hence the "isolated charge" may be represented as a grouping of such momentary dipoles, each (while it exists) with a scalar potential between its poles, and hence each subject to the same decomposition and reinterpretation we have done.

That is why the source charge can "sit there" and pour out EM energy in 3-space (as observed) continuously, and indefinitely. It is also continuously absorbing EM energy from the time domain. As a set of composite dipoles, it is a set of broken 3-symmetries in EM energy flow. Hence it exhibits nature's preferred 4-symmetry in energy flow, between the time-domain and 3-space.

Note also that, to the 3-space observer, this 4-symmetry is purely negentropic. It is a continuous and ongoing (and expanding) reordering of the vacuum energy, in the form of the reinterpreted Whittaker decomposition.

We can easily engineer negentropy! Just make a little dipole, and nature happily starts pouring out energy and reordering part of the vacuum, with that reordering spreading at the speed of light, steadily increasing all the while.

Reinterpreting Whittaker's marvelous decomposition tells us many things: (i) the source charge or dipole does indeed continuously receive and

absorb its input energy from the time domain, (ii) it continuously transduces its absorbed energy to real 3-space energy (as observed!), and (iii) it continually outputs its absorbed and transduced time-energy as 3-space energy emitted in all directions in 3-space (as continually observed).

So the terrible foundations problem of the source charge and source dipole is resolved, and the energy conservation law is maintained.

We have also uncovered a most important thing: Given a little broken 3-symmetry in EM energy flow, t-symmetry in EM energy flow is also broken. A more primary 4-symmetry {104} between time-energy flow and 3-space energy flow emerges *automatically*. In short, every potential, every dipolarity, and every charge is such a broken 3-symmetry and an example of the new, preferred 4-symmetry of EM flow, with input flow in the time-domain (nonobservable!) and output flow (as continually observed in a series of 3-snapshots) in all directions in 3-space.

This also resolves the logical cause and effect problem for observation.

This 4-symmetry is a purely negentropic process, once the dipole is established! Well, we should have known that from the gauge freedom axiom in gauge field theory anyway! That axiom says that we can change the potentials anytime, freely and at will. In electrodynamics, that means we can change the potentials at will, anytime we want to. But that means *we can freely change the potential energy of a Maxwellian system at will, whenever we wish*. It costs nothing — at least in theory; in the real world we have to pay a little for switching — to suddenly potentialize an EM system, prior to the time the Drude electrons relax and current flow begins.

I have applied this great new 4-symmetry in EM energy flow, that is freely evoked and persists indefinitely after one pays a little to make the dipole and thus produce a little broken 3-symmetry, to produce EM energy freely from the vacuum. Without going into it, I refer you to our forthcoming papers {105}. Indeed, we can use this negentropic process to extract as much EM energy from the vacuum as we wish, anywhere, anytime, for peanuts. Let us now move to discuss that area.

First, we point out another astounding result that comes from resolving this "source charge and source dipole" foundations problem.

Generators do not use any of the shaft energy input to them — even in transduced form — to power their external circuits! A generator itself does not add a single watt to the power line, and neither does a battery's chemical energy dissipation add a single watt to its attached circuit.

Neither does burning all those hydrocarbons, consuming all those nuclear fuel rods, building all those dams, etc. to provide our conventional power systems and grid. None of that enormous destruction of the biosphere and pollution of it has ever directly produced one watt on the electrical power line.

Just follow the energy flow, in light of what we now know. Here's how it works.

Typically, we burn some fuel to boil water and make steam, and use the steam to power a steam turbine, which forcibly rotates the shaft of the generator, thereby inputting mechanical shaft energy into the generator. So far, so good. That took care of all the hydrocarbon burning and fuel rod consuming, extracting and transporting the oil, etc.

This input of the shaft energy forcibly rotates the rotor against internal resistance, forming an internal magnetic field. Assuming a 100% efficient generator with no internal losses whatsoever, this means that the *mechanical shaft energy input* has now been totally transduced into *internal magnetic field energy*.

So what does that magnetic field energy *do*? It is totally dissipated upon the internal charges of the generator, performing work on them and forcing the positive charges in one direction and the negative charges in the other direction. That dissipation of the energy in the internal magnetic field *forms a source dipole inside the generator, connected to the terminals*.

And that is all the generator does. Period. *None* of the energy transduced from that shaft input, went roaring out of the terminals and down through space outside the conductors of the power line. Not a single watt. So let us turn to particle physics to find out what happens next, because *it does not yet appear in the electrodynamics model, even though proven.*

The internal source dipole, *once formed*, is a great broken symmetry in the vacuum flux, as we discussed and as is well known in particle physics. But the proven and well-known vacuum interaction with the generator and the dipole charges is not even modeled in the classical EM theory used by the scientists and engineers to build electrical power systems — much less a *broken symmetry* in that active exchange! That's atrocious, since it's been proven in particle physics for nearly a half century, Nobel prizes awarded, etc. But the hoary old 137-year old Maxwell-Heaviside model, further curtailed by Lorentz symmetrical regauging, does not incorporate what has already been proven in physics. *It does not accurately model the situation as it is and as it is known to be.*

Let us continue.

Once that dipole is formed, it extracts *enormous* EM energy from the vacuum, and pours it out of the terminals of the generator, filling space surrounding those conductors of the attached external power line. It is a huge EM energy flow, trillions of times larger than what we account after Lorentz taught us to disregard almost all of it.[37]

Only the tiny little bit of that EM energy flow in space along and surrounding the conductors — the little "boundary layer" that skims down the surface of the conductors — will strike the surface charges in the conductors and get diverged into them to potentialize the Drude electrons and "power the power line and its circuits and loads". *All the rest of the giant EM energy flow in space surrounding the conductors, and generally parallel to them, misses that power line entirely and is just wasted.*

Check the original papers by Poynting {4a, 4b} and by Heaviside {5a, 5b, 5c}, who independently discovered the flow of EM energy through space (as if continually observed!) in the 1880s, after Maxwell was already dead. I can furnish the citations required. From the beginning, Poynting only considered that component of the energy flow that actually enters the circuit. He considered only the "boundary layer" right on the conductor surfaces, so to speak.

Heaviside considered that component that enters the circuit, and also uncovered and recognized the *gigantic* component in the surrounding space that *does not* enter the circuit but misses it entirely and is wasted. [Added] Here is Heaviside's {106} own statement:

> *"It [the energy transfer flow] takes place, in the vicinity of the wire, very nearly parallel to it, with a slight slope towards the wire… . Prof. Poynting, on the other hand, holds a different view, representing the transfer as nearly perpendicular to a wire, i.e., with a slight departure from*

[37] However, contrary to what is in the textbooks, **E** Δ **H** energy flow is not in observable EM field form **E** and **H** until it interacts with charge. Instead, the flow is in the form of virtual energy currents in the vacuum. We point out that the fields **E** and **H** utilized in the Poynting energy flow theory are effects and not causes. They are rigorously defined as **E** and **H** only after the causal 4-fields have interacted with charge. E.g., **E** is "defined" as force per unit point massive charge — i.e., as the force created by interaction of the "vacuum field" (curvature of spacetime) with a unit point charge. No unit point charge interaction, no force or force field intensity per interacting unit point charge.

> *the vertical. This difference of a quadrant can, I think, only arise from what seems to be a misconception on his part as to the nature of the electric field in the vicinity of a wire supporting electric current. The lines of electric force are nearly perpendicular to the wire. The departure from perpendicularity is usually so small that I have sometimes spoken of them as being perpendicular to it, as they practically are, before I recognized the great physical importance of the slight departure. It causes the convergence of energy into the wire."* [End of Added].

But Heaviside had absolutely no explanation for the enormous and startling magnitude of this energy flow that "misses the surface charges of the conductors and is wasted". You can see an elementary illustration of the "point intensity" of this Poynting diverged energy flow component in Kraus {107}. Kraus's figure 12-59, p. 576 shows a good drawing of the *Poynting* component *being withdrawn* from the total EM energy flow filling all space around the conductors [see our Figure 1-1 in the present chapter].[38] Most of that available energy flow is not intercepted and thus not diverged into the circuit to power it, but just "wasted." The *remaining* huge component discovered by Heaviside is not shown on Kraus's diagram. Kraus's numbers on the contours represent the amount of power (watts per sq meter) being withdrawn from each contour, by the very limited axial movement of the electrons and the very ends of their associated fields into the wire.[39]

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[38] The energy flow in space near the surface of the wires strikes the surface electrons and their fields, potentializing them and creating a force field with respect to inner electrons. This drives the surface electrons axially into the wire, since they can only move down the wire with the drift velocity, nominally on the order of a few inches per hour. The short inwards drawing of those small portions of the fields and of the increased potentials attached to the charges that move into the wires, interacts with the internal charges in the interior of the wire, powering the Drude electrons throughout the conductor and the circuit. For a discussion of the importance of the surface charges, see J. D. Jackson, "Surface charges on circuit wires and resistors play three roles," *Am. J. Phys.*, 64(7), July 1996, p. 855-870.

[39] Obviously the increased fields on the withdrawing surface charges reach toward infinity radially outward from the wire. Thus most of this increased field on a withdrawing electron remains outside the wire, radially reaching toward infinity, since the electron and its field cannot be withdrawn further than the diameter of the wire. As the surface charges and their fields change in Jackson's discussion, obviously those distant parts of the field remain outside the conductors. Hence there remains an extensive field and field energy outside the conductors and the circuits

So Heaviside {106} spoke cautiously of the *angles* and *relative directions* of the flow components; he did not wish to be scientifically destroyed for pointing out such an inexplicably large EM energy flow, far larger than the known energy input to the generator. There was then no such thing yet discovered as the electron, the atom, the nucleus, special relativity, general relativity, quantum mechanics, the active vacuum, etc. Poynting {4a, 4b} never even thought of the "nondiverged component that misses the circuit", nor did he consider it.

Lorentz, however, understood the extra Heaviside component and its vast magnitude, but he also could not explain it in any fashion. Even the great Lorentz could not risk publishing or advocating such an enormous energy flow, lest he be called a "perpetual motion nut" and destroyed. So he reasoned that, since that stupendous nondiverged energy flow component misses the circuit and powers nothing, it has "no physical significance" (his words).

Jackson in his famous 1975 *Classical Electrodynamics*, 2nd edition, uses essentially the same phrase {108a} as did Lorentz. And so do most other electrodynamicists.

So Lorentz {109} originated a little trick of integrating the energy flow vector itself around a closed surface surrounding any volume element of interest. Obviously, that zeros all *nondiverging* EM energy flows — including precisely that inexplicable and enormous Heaviside "dark energy" component. The integration trick does retain that small, *diverged* Poynting component that enters the circuit. In addition, our instruments measure energy dissipation from the circuit, and the energy has to *enter* the circuit to *be dissipated* from it. So our instruments and their measurements will indeed agree with the Poynting energy flow component. Lorentz thus arbitrarily discarded accountability of trillions of times as much EM energy flow as was retained and accounted.

In a later book by Lorentz, one can see that little trick {109} that is still used by electrodynamicists {110}.

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that is never drawn into the wire. Additional separate receiver circuits with resistive loads, adroitly placed in this "externally remaining" field energy flow, can be made to intercept additional EM energy and will perform additional work in those external loads in the secondary circuits, separate from powering the loads in the primary circuit.

The Lorentz trick does not cancel the *actual* flow of the Heaviside dark energy component around every circuit! It just drops it from any accountability.

Indeed, we do precisely a similar thing for the "field" and the "potential". There is not a single text in the U.S. that calculates the magnitude of the *field itself*, prior to point interaction. Instead, we are taught to calculate the reaction of that field at a point in it, with a unit point static charge at that point. In short, we calculate *what is actually locally diverged from the field or potential by that little point static unit charge*, and call it "the magnitude of the field". At best, it is indicative of the field intensity at a point, because we have prescribed the magnitude of the static point charge's *reaction cross section* with the field, *not* the overall magnitude of the entire field itself. Another major non sequitur! By identifying the "field" as "that which is diverged from it", we gravely err. We do the same for the potential, again using its reaction cross section for a unit point charge at a point in the potential.

There is hardly a living electrodynamicist, it seems, who has calculated the magnitude of the field itself, or of the potential itself! All calculate the respective reaction cross section (and the *static* reaction cross section at that!) and erroneously call that the "magnitude of the field" or the "magnitude of the potential". It is no such thing. No thing filling all space is identical to a little something diverted from one point in itself, else we discard all logic.

Now we can return to our source dipole and its extraction of an *enormous* energy flow from the vacuum, once we account for the long-neglected (for more than a century) Heaviside dark (nondiverged, unaccounted) energy flow component. That is the essence of one of my papers {111}.

The easiest thing in the world to do is to extract enormous usable EM energy flow from the vacuum, *from the time domain*. Every circuit and every electrical power system already does it, and every electrical power system is powered by vacuum energy, *not* by burning all that coal, oil, etc. None of that does anything to actually power the circuit. It only makes dipoles.

If you will check the characteristics of the ubiquitous closed current loop circuit, you will discover a diabolical thing: that closed current loop circuit forces all the spent (depotentialized) electrons from the ground return line back through the source dipole (back through the back emf). It is easily shown that precisely half the energy *collected* in the circuit from that feeble Poynting energy flow component is then used to perform work on

those dipole charges and scatter them, thereby destroying the source dipole and abruptly shutting off all energy extraction from the vacuum. The other half of the collected Poynting energy is dissipated in the external loads and losses. That means that half the collected Poynting energy is used to kill the source dipole, and less than half is used to power the loads {112}.

Well, we must input at least as much energy (assuming a 100% efficient generator with no losses) to the shaft of the generator to *restore* the dipole, as was used to *destroy* it. This means we shall always have to input *more* energy to the generator shaft, than we get dissipated in the loads.

That is precisely what is responsible for our ubiquitous COP<1.0 systems. *COP* is Coefficient of Performance, and is the average load power output in the external circuit divided by the average shaft power we pay to input to the generator.

COP < 1.0 comes from (i) the ubiquitous usage of the closed-current-loop circuit, and (ii) the prevailing notion that electrical power systems far from equilibrium in their energetic exchange with the active vacuum are impossible to build. In fact, every electrical power system is *already* just such a COP > 1.0 system, as far as the energy flow out of the generator or battery — compared to the shaft input energy to the generator or battery — is concerned.

As is well-known in the thermodynamics of open systems far from equilibrium with their active environment (in this case, the active vacuum), such a system is permitted to: (1) self-organize, (2) self-oscillate or self-rotate, (3) output more energy than the operator himself must input to the system (the excess energy being freely received from the active environment, in this case the active vacuum), (4) power itself and its loads simultaneously (all the energy being freely received from the active environment, in this case the active vacuum), and (5) exhibit negentropy.

But by designing all our systems so that they use more of their collected energy from the vacuum to kill their source dipoles than they use to power their loads, we have foolishly wasted the planet's resources, vastly overcharged the consumer, artificially created a great energy crisis, fomented wars for precious oil and other energy resources, polluted the planet, enhanced global warming, and strangled species.

In short, we pay the power company to have a giant wrestling match inside its generators and lose! And we pay our electrical engineers to keep designing and building such asinine systems!

This sad state of affairs is what is now upon us as a great and increasing energy crisis, polluting and destroying the biosphere, etc. and threatening to eventually collapse the world economy.

It is astounding that, since the basis for the above has been in physics for nearly a century (Whittaker decomposition) and for nearly a half century (broken 3-symmetry of the source dipole, as well as the active vacuum), the hoary old classical EM model has not been updated to incorporate what has already been proven in particle physics. Such is inexplicable and unconscionable.

It is also astounding that no electrical engineer realizes that energy extracted from the vacuum powers every electrical power system, and few if any professors are aware of it either.

This is where your cogent realization of the terrible non sequitur in that atrocious "wave in 3-space" standard diagram leads.

Our AIAS (Alpha Foundation's Institute for Advanced Study) advanced theorists now have a series of papers published in the hard literature pointing out the feasibility of extracting EM energy from the vacuum {113a, 113b}. About 20 other AIAS papers along such lines or related have been submitted to the various journals and are in the referee process.

I just wanted to contact you informally and, for your personal information, show you how perceptive and correct your objection to that atrocious diagram is. You have lifted the corner of the veil on electrodynamics' confusion between effect and cause, with effect being widely used as the cause. The entire notion of a "separate force" acting on a "separate mass" in mechanics is also a non sequitur. If we define force as $F \sum \in / \in t(mv)$, then we see that mass is a *component* of force! So here is another major and uncorrected non sequitur. This one was also largely responsible for the dichotomy of the field concept, where the "same field" is used in both a force (mass-containing) manner and a force-free (without mass) manner, as if the two were the same!

I very much enjoyed your editorial, and would urge you to publish additional material along that same vein. You are striking at the very heart of the problem, and every bit of insight and change in those terrible non sequiturs will result in enormous progress in electrodynamics and physics.

Sincerely,

Tom Bearden, Ph.D.

Lt. Col., U.S. Army (Retired)
Director, Association of Distinguished American Scientists
Fellow Emeritus, Alpha Foundation's Institute for Advanced Study

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Chapter 2

Background and Concepts

"[Hypotheses made without realizing that they are being made] ...are what Poincare has called "unconscious" or "natural" hypotheses — a type which one hardly ever challenges, for it seems too unlikely that we could make progress without them. Nevertheless it should be the endeavor of the physicist always to drag them out into the light of day, so that it may be perfectly clear what we are actually doing." [Lindsay and Margenau] {114}

"Equilibrium states are the only ones that are capable of explicit analysis in thermodynamics... " [Lindsay and Margenau] {115}

"Non-equilibrium conditions cannot be specified by variables of state, and their entropy cannot be computed. ...the condition of equilibrium is the condition of maximum entropy. " [Lindsay and Margenau] {116}

2.1 Comments on the Foundations of Classical Electrodynamics

2.1.1 Faraday, Maxwell, Quaternions, and Heaviside

For our purposes, we start with the important experiments of Faraday {117}, which produced experimental integration of electricity and magnetics {118}. Faraday's own work contained very little mathematics, and so he himself did not capture his own seminal experimental work in adequate theoretical fashion. That task was undertaken by James Clerk Maxwell {119a, 119b}, who deliberately set about to capture Faraday's results in a proper mathematical theory, using quaternion-like and vector expressions. Of the quaternion algebra, Maxwell had this to say {120}:

"...the virtue of the 4nions lies not so much as yet in solving hard questions as in enabling us to see the meaning of the question and its solutions. "

Quaternion algebra {121a, 121b} is an advanced algebra created by William Rowan Hamilton, brilliant Irish mathematician. Hamilton was widely regarded as a "new Newton" by his peers. Hamilton coined the word "vector", wrote two books on quaternions, and hoped the books would find extensive use in physics. Vectors and tensors later came to suffice for most problems of that day, and so quaternions faded to the background.

Hamilton also grasped the importance of a science of time, and realized that such a science was possible. E.g., in 1837 Hamilton stated:

> *"The notion oftime may he unfolded into an independent pure science... a science ofpure time is possible."*

In that statement, Hamilton anticipated that a physics model can be comprised using only a single fundamental unit, and that unit could be the second.

In the early 1890s, quaternions in electrodynamics were discarded in a short "debate", mostly in the journal *Nature*, and vector electromagnetics was adopted. So Maxwell's 20 quaternion equations {20} in some 20 unknowns contain a wealth of electrodynamics {122} that is not included in Heaviside's {123} later vector curtailment after Maxwell's death, or in the modern tensor formulation. As an example, Nikola Tesla's patented circuits cannot be properly understood in either a vector EM or tensor EM analysis. However, very novel functions performed in them can be seen in a quaternion EM analysis, as has been clearly shown by Barrett {124}. Any electrodynamicist, who has looked at Tesla's work only in terms of tensor or vector classical electrodynamics, has no concept of what Tesla was actually doing. Since that is precisely how most academics have examined Tesla's work, they have had little idea of the functions he was actually able to accomplish in circuits — functions that U.S. electrical engineering departments still cannot perform.

Along with other electrodynamicists at the time, Faraday and Maxwell believed in a material ether — a thin material fluid filling all space. Hence there was thought to be no point in the universe that was devoid of mass. For that reason, the EM field conceived in mass and the EM field conceived in "space" — actually, in the "luminiferous ether" thought to fill all space — were identically force fields and material entities, at least in the minds of the electrodynamicists at the time. The equations of Maxwell, the later truncation by Heaviside and others, and the final truncation by Lorentz are all still material fluid flow models. They still assume the material luminiferous ether, more than a century after its falsification.

See again Figure 1-3 in Chapter 1. Contrary to the conventional view, force is not a fundamental causative entity, but is a system of two coupled entities. It involves a nonobservable, dynamic, causative 4-space entity (which may be modeled as a curvature of spacetime) interacting with a previous "frozen" observable (a 3-space mass). The output of this interaction is another observable (i.e., a change to the previous observable or an iterative output of its replica). Observables do not continuously exist, but continually recur as continual outputs of the iterative observation process (photon interaction).

Mass is a *component* of force, as is apparent if we define force F as F==d/dt(mv), which gives F = m(dv/dt) + v(dm/dt). Both terms on the right of the expansion contain mass; hence force F contains mass as a *component*. Both terms on the right also contain nonmass terms; hence force F also contains nonmass coupled to and interacting with mass. So there can be a force generated by a nonmassive non-force entity in spacetime interacting with a mass, and the force only exists when that interaction is ongoing. The ether was erroneously considered to be a material system, containing mass, and hence capable of supporting a force. Maxwell modeled his fields (in what we know today to be mass-free space) as material force fields in the material ether.

In the 1880s, the Michelson-Morley experiments {125a-125d} destroyed the material ether. However, the fundamental Maxwell-Heaviside equations *assuming* those material force fields in the vacuum — which depended on the notion of a material ether and are a function of it — have never been altered, even to this day. Instead, electrodynamicists just assume the force "somehow" goes to zero in the field in space, but the same field remains. The equations still assume the same old material ether.

This is a non sequitur; a *force* field cannot be the same as a force-free *non-force* field. As an example, the EM force field in observable matter is an output of observation. It is therefore a *3-space effect containing mass.* The force-free field in mass-free spacetime (4-space) is a causal 4-space component of massless spacetime. *A priori,* it exists prior to interacting with the charged mass. It contains no observable mass and hence no force since mass is a necessary component of force. It independently exists without the presence of the charged mass at all.

In short, the field in massless spacetime is a specialized curvature (changed region) of that spacetime. *Spacetime consists of spacetime,* to slate a tautology. Once one fixes the concept of the medium, then any changes to the medium can only consist of "medium-stuff. So any

"changes" in spacetime can only be changes of 4-space itself, in the Einstein general relativity sense. This area is handled quite well by Sachs' unified field theory {126a, 126b}, extending and completing the work of Einstein.

Sachs' epochal theory provides a great generalization of general relativity and electrodynamics reaching from the quarks and gluons to the entire universe. Further, Evans' extension of electrodynamics into a higher 0(3) group symmetry turns out to be demonstrably a special subset of Sachs' electrodynamics.[40] Hence, for the first time, an *electromagnetically* engineerable unified field theory is available. Much of general relativity, quantum mechanics, etc. can be engineered directly by Evans' electrodynamics subset of Sachs' overall unified field theory. I am much indebted to Evans {127} for the following statement with respect to O(3) electrodynamics:

> *"In 1992 it was shown (Physica B. 192, 227, 237 (1992)] that there exists a longitudinal component of free space electromagnetism, a component which is phaseless and propagates with the transverse components. Later this was developed into a Yang-Mills theory of electromagnetism with O(3) Lagrangian symmetry. This theory is homomorphic with Barrett's SU(2) electrodynamics and has far reaching implications in field theory in general. Recently it has been recognized to be a sub theory of the Sachs theory of electromagnetism, based on the irreducible representations of the Einstein group of general relativity.[41] The Sachs theory produces a non-Abelian structure for the electromagnetic field tensor. The O(3) electromagnetism also has implications for the* ***potential*** *ability of extracting energy from the vacuum,* ***and its*** *topological implications are currently being* ***investigated*** *by Ranada. The O(3) electromagnetism has* ***been tested*** *extensively against empirical data, and succeeds* ***in*** *describing interferometric effects and*

[40] E.g., see M. W. Evans, "The Link Between the Sachs and 0(3) Theories of Electrodynamics," in M. W. Evans (Ed.), *Modern Nonlinear Optics,* Second Edition, Wiley, 2001, part 2, p. 469-494.

41 Evans et al, "Derivation of 0(3) Electrodynamics from the Irreducible Representations of the Einstein Group," *Found. Phys. Lett.,* 15(2), Apr. 2002, p. 179-

physical optical effects where the conventional Maxwell-Heaviside theory fails. Implicit in both the O(3) and Sachs theories of electromagnetism is the ability to extract electromagnetic energy from curved space-time. Working devices based on this ability would help solve the current energy crisis."

2.1.2 Mass Is a Component of Force

The dichotomy of using the field concept in two mutually contradictory fashions as something massless and also as something massive — still unresolved in electrodynamics — is clearly summarized by Jackson's important statement {128} of the prevailing view:

> *"Most classical electrodynamicists continue to adhere to the notion that the EM force field exists as such in the vacuum, but do admit that physically measurable quantities such as force somehow involve the product of charge and field."*

In trying to rationalize the "massive field versus massless field" dichotomy, Jackson {129} also states:

> *"...the thing that eventually gets measured is a force..."*
> *"At the moment, the electric field can be defined as the force per unit charge acting at a given point."*

Actually, field is not force, so cannot be force per unit charge. Field *produces* force when it interacts upon charge. *Causing* something as an effect, but then *being* that same effect identically, is a confusion of cause and effect and a non sequitur.

We point out that spacetime is charged, but with *observably massless* (virtual) charge. So the field in spacetime is observably massless and therefore observably force-free. That massless field then interacts with an observable massive charge in the "observable" world, to create an observable force and an observable forcefield. In space, from a quantum mechanical view we may consider the field to have *virtual* force x time, since the field may be regarded as a curvature of spacetime acting upon the *virtual* charged masses in the ever-bubbling *virtual particle fluctuations* of the vacuum permitted by the Heisenberg uncertainty principle. Nonetheless, that is only the "potentiality" for an observable force, as pointed out by Feynman and Wheeler, should the field — including its interactions with the virtual charges of the vacuum to produce forces and

accelerations on those virtual particles — interact upon an observable charged mass.

Obviously, the force-free field as a product of spacetime curvature and massless (virtual) charge, and the force field as a product of *that* observably force-free field but virtual force field (in the vacuum) with observable charged mass, cannot be the same thing. Assuming they are the same assumes an oxymoron, and confuses cause and effect. This illustrates the continuing dreadful foundations difficulties propagated in classical electrodynamics.

To resolve these EM foundations difficulties so long maintained and cherished as dogma, the scientific community at the highest priority should (1) fund extensive and rapid work by our very best theoreticians and foundations physicists to heal these century-old festering sores, (2) extend electrodynamics back to a higher group symmetry theory, as in O(3) EM theory for example, and (3) provide a rigorous dictionary of science foundations concepts and terms which does contain valid definitions and full discussions — clearing misdefinitions and disinformation now notable in the electrodynamics literature.

Nobelist Feynman, co-founder of quantum electrodynamics, was careful to state the notion of the field in mass-free space very differently. Quoting Feynman {130}:

> *"...the existence of the positive charge, in some sense, distorts, or creates a "condition" in space, so that when we put the negative charge in, it feels a force. This potentiality for producing a force is called an <u>electric</u> field."*

Feynman's imagery clearly invokes a "distortion condition in spacetime" {131}, eventually coupled to a charged mass and interacting with it — and *then* one has a force and a force field. He erred in still somewhat making the force separate from the charged mass, in the phrase "it feels a force" — which ignores the fact that the mass of the interacting charge is a *component* of the force, not separate from it and not "feeling it as a separate external thing". He pointed out that the field in spacetime represents only the *potential for* a force field, *if a* charge should be placed there. And he points out that the field is a "condition in space" — in the full sense, a condition in spacetime.

We comment that, in a sense, spacetime and vacuum may be considered one and the same. Vacuum contains many fluctuations and virtual state

dynamics, all of which are curvatures of spacetime or produce curvatures of spacetime. Vacuum has energy density, and is therefore a potential. This energy density has dynamics, so the ambient vacuum potential has dynamics, and so therefore does spacetime {132}.

However, a dynamic of the potential is precisely what a field *is*. It follows that dynamics of spacetime are what fields are. So fields (as force-free entities in spacetime) may be taken more accurately as the dynamics of the vacuum-spacetime, or as dynamics of the ambient vacuum-spacetime potential, or as dynamics of the ambient curvature of spacetime.

Again quoting Feynman {133}:

> *"We may think of E(x, y, z, t) and B(x, y, z, t) as giving the forces that <u>would be</u> experienced at the time t by a charge located at (x, y, z), <u>with the condition</u> that placing the charge there <u>did not disturb</u> the positions or motion of all the other charges responsible for the fields."*

Here Feynman very clearly shows that E and B involve functions of spacetime *(x, y, z, t)* only, prior to interaction, but do not physically exist until interaction with charge has occurred. But he has not quite yet completely eliminated the "force field" as a separate force acting on the charged matter independently. This centuries-old fundamental mistake in mechanics — that force is independent of and external to mass — has simply been propagated into electrodynamics, without correction. Physicists such as Feynman and Wheeler have been trying very hard to correct it.

The observed/measured force field is an output of observation, and observation is a *d/dt* operator imposed upon spacetime LLLT. All observables are 3-spatial, and any observation is an instantly frozen "3-space snapshot" at a single point in time. A single observation has no temporal existence *a priori*, since it is only an instantaneous 3-space snapshot existing at one moment only. Hence an observable — being 3-spatial and frozen — does not persist *as such* in time. Indeed, the next instant after an observation, that particular snapshot does not exist any more. [Refer again to Figure 1-3 in Chapter 1].

2.1.3 Mechanism for the Flow of Time and Related Matters

It is well recognized that the nature of time is itself an unresolved

question. For our purposes, we are interested in the energetics[42] approach. So we apply that approach to arrive at a mechanism generating the "flow of an object through time". First we will choose our fundamental units.

2.1.3.1 *Getting Creative with Fundamental Units*

In physics, the choice of fundamental units one chooses for one's model is arbitrary. Usually mass, length, time, and charge are used, but a perfectly valid model can be generated using only a single fundamental unit.

This is well known to modern physicists and leading electrodynamicists, but sometimes comes as a shock to electrical engineers! Jackson {134} expresses it very succinctly: Quoting:

> *"For example, theoretical physicists active in relativistic quantum field theory and the theory of elementary particles find it convenient to* ***choose*** *the universal constants such as Planck's quantum of action and the velocity of light in vacuum to be dimensionless and of* ***unit magnitude.*** *The resulting system of units (called 'natural' units) has only* ***one*** *basic unit, customarily chosen to be length. All quantities, whether length or time or force or energy, etc., are expressed in terms of this one unit and have dimensions which are powers of its dimension. There is nothing contrived or less fundamental about such a system than one involving the meter, the kilogram, and the second as basic units. It is merely a matter of convenience."*

So let us consider what happens if we use the joule as the single fundamental unit for a model of physics. Then each of the entities "mass", "length", "time," and "charge" will become totally a function of energy. Since the dawn of relativity and the nuclear age, the notion that "mass is energy" is no problem, and everyone is familiar with Einstein's $E = mc^2$. Solving for m in that expression, one realizes that spatial energy E has been compressed by the factor c^2, to yield what is called "mass m". More rigorously, compressing the 3-space energy by the factor c , *and then leaving it in 3-space,* produces what we call "mass". However, if we

[42] **Energetics** is an **old term from the early birthing** days of electrodynamics. Russian scientists resurrected **the term to cover their use of an** expanded electrodynamics in a unified field-engineering **manner, particularly in new** superweapons developed and tested after WW II and deployed in 1963 and subsequently.

remove it from 3-space and place it over on the fourth Minkowski axis *ict*, it becomes what we call "time" because *t* is the only variable in *ict*. Hence time has or can have similar energy density to mass. Specifically, 1 sec => 9×10^{16} joules of spatial EM energy, when transduced (decompressed) into spatial energy by a transducing charge.

In our new model using only the joule for our fundamental unit, we can also legitimately state that "time is energy", and be rigorously accurate. In that case, we must see what happens to 3-space EM energy when it is shifted to the time domain.

First, we take "EM energy in 3-space" as EM wave energy, in the usual transverse EM wave model (see Figure 1-4 of Chapter 1) of a field entity. We choose, say, the vector E oscillating in the x-direction, and another field entity (say, the vector B) oscillating in the y-direction. If we then rotate each of these vectors into the time axis, then that is an orthogonal rotation for each, which is what the velocity *c* actually is. So we have to do two orthogonal rotations, and the two resulting *c's* multiply to give c^2. With these two orthogonal rotations into the time axis, we have completely rotated the EM field wave energy vectors into the time axis. We have also compressed that EM field energy by c^2.

Hence "time as energy" is just EM spatial energy compressed by the factor c^2, but rotated into the time-axis as "time" rather than remaining in 3-space as "mass". Again, by this second analogy time has the same energy density as mass, but the highly compressed spatial energy has been rotated into the time domain to "produce time" rather than remaining in 3-space to "produce mass" {135}.

This sheds new light upon the scalar (time-polarized) photon of quantum field theory. Note that, prior to compression of the wave energy into time, the magnitude of the electric field *E* in the EM wave was oscillating lengthwise along its x-direction, which means that, with respect to x, it was a longitudinal EM wave. A similar consideration exists for the oscillation of the magnitude of *B* in the y-axis. Along the time-axis, we also have a "time-energy" vector having magnitude, and the magnitude of that time-energy can only vary along the time axis. Oscillating the time energy produces a longitudinal EM wave in the time dimension (on the fourth axis). What is actually varying is the time-density itself. This is a *time-polarized* or *scalar* EM wave, where by use of the term "scalar" we mean that it has no vector component in 3-space. In fact, this variability of time density produces a "galloping motion" in the speed of light itself, which has been recognized {136}.

We have uncovered a direct connection between the time-polarized EM wave (which can only oscillate its time-energy magnitude longitudinally in the time-domain) and the longitudinal EM wave in space. Such waves can only be observed when coupled or paired with an interaction existing between them, very similar to what Mandl and Shaw {167, 168} argue for the time-polarized and longitudinal photons of quantum field theory.

Again see Figure 1-3 in Chapter 1. Any observable is an instantaneous, frozen 3-spatial snapshot (or 3-intersection) of a 4-dimensional ongoing event. "Observation" itself may be taken as a process where a *d/dt* operator is invoked upon 4-space (spacetime), leaving a purely 3-spatial output. However, the resulting observable does not "exist or persist in time", since rigorously it is what was "caught" in only a single, frozen "3-slice" at one single instant, forever fixed.

For that reason, time is not an observable. It cannot be directly observed, even in principle, since *a priori* it is discarded by the observation process itself!

For further work along such lines, we recommend the Sachs unification approach to a combined general relativity, quantum mechanics, and electrodynamics, generalized from a topological standpoint {126a, 126b}. To work electromagnetically in that theoretical approach, we recommend the 0(3) electrodynamics as extended by Evans {137a, 137b}.

2.1.3.2. *The* ***Four Polarizations of*** *Photons* ***and*** *EM Waves*

In quantum field theory, four polarizations of a photon are recognized {138}. These are the *x*-, *y*-, *z*-, and /-polarizations, where *x*-, *y*-, z- and *t*- are assumed as the four dimensions in a 4-space. By agreement, z- is used as the direction of motion of a free photon or an electromagnetic wave. So at least in theory, there must also be four polarizations of electromagnetic waves, even though not all these waves are yet experimentally known.

The *x- and y-* polarizations are the familiar transverse photon and the transverse wave. The z- polarization along the line of propagation gives the longitudinal photon in 3-space and the longitudinal EM wave in 3-space.[43]

[43] Here we are **applying the conventional** model of the "EM wave in space", which is known to be erroneous **but is** in **ubiquitous** usage. See Romer, {84} for a scathing characterization **of that** erroneous model **But here we are stuck with it, so will use it** as "just a model".

2.1.3.3 *Imperfect Longitudinal EM Waves* ***in 3-Space***
When attempting to produce longitudinal EM waves (LWs) in 3-space, from transverse EM waves (TWs) input to some sort of polarization transduction process, only imperfect LWs are produced and a residue of TW content remains. The resulting imperfect LW is referred to as an *undistorted progressive wave* (UPW). Some work has been done on UPWs {139}. UPWs are expected to have remarkable characteristics including wave velocities either slower or faster than *c* {140}.

The *t*- polarization in the time dimension is quite unique: The *spatial* energy overall is in equilibrium and not vibrating at all; instead, the energy of the photon or wave is vibrating in the time domain and therefore exists in the time domain. That is called a "scalar photon" (time-polarized photon). Its wave version does not yet seem to be known in the literature, although in 2000 we uncovered its secret hiding place {12}. It was unexpectedly hiding in Whittaker's {85} decomposition of the scalar potential in 1903, but had been slightly misinterpreted.

2.1.3.4 *Photons and EM Waves Carry* ***Energy and Time***
On the other hand, the concept of "EM waves flowing in 3-space" may be in need of a thorough overhaul {141}. A photon *y* is a "piece of angular momentum" in the form of $y = (dE)(dt)$. Hence the photon carries an increment of spatial energy d*E* and also an increment of time-energy d*t*. The time-energy component (dt) may be regarded as ordinary spatial energy that has been compressed by the factor c^2 {142}.

As can be seen, since *c* represents an orthogonal rotation in n-space, the multiplication or division by *c* and by powers of c changes the dimensionality of an entity, as seen by the observer in the laboratory frame.

So the photon transports two types of energy: (i) a "weak spring" (spatial, decompressed) energy d*E*, so to speak, and (ii) a "very stout spring" (time) energy d*t*, so to speak.

When a mass *m* absorbs a photon $(dE)(dt)$, the (dE) component is compressed spatially by c^2, turning it into an extra amount of mass d*m*, so that the mass becomes $(m + dm)*dt$ the same time, the (dt) component is joined, so that what results is $(m + dm)*dt$. In short, mass *m* is changed to masstime *mt* by photon absorption. So in the absorption of a photon y by a mass *m*, we have

$$y+m \rightarrow (dE)(dt) + m \rightarrow (m + dm)dt$$

In short, the mass *m* turns into masstime *mt*, by absorbing a photon, and masstime *mt* is as different from mass *m* as impulse *Ft* is different from force *F*. We point out that "mass" *m* alone does not even exist in time, but masstime *mt* does exist in time. This is proposed as a simple but fundamental correction to much of present physics. Further, the state "mt" is an excited, time-charged state, excited by very dense time-energy.

For the simplest case, in the next instant the excited state *mt* decays and a photon is re-emitted, and so we have

$$(m + \Delta m)\Delta t \rightarrow (\Delta E)(\Delta t) + m \rightarrow \gamma + m \qquad [12]$$

So emission of a photon changes the excited masstime state (time-charged state) back to mass (uncharged state with respect to time-charging), in the simplest case.

See again Figure 1-3 in Chapter 1. "Observation" and "observable change" are in fact generated by the photon interaction. The total photon interaction with a mass creates the "flow of that mass" through spacetime, macroscopically as seen by the observer and microscopically in myriad streams of virtual time changes. Mass is continually charged to the masstime state, and the masstime state is continually decayed to the mass state. Time flow itself thus has a myriad internal EM energy streams and a vast dynamic EM energy substructure.

The photon itself is not observable, as it exists prior to interaction. It is thus a "causal" entity in 4-space. It *is not* a simple 3-space observed "frozen snapshot" particle! When the causal photon is absorbed, its spatial energy component goes through the c compression function, thus adding a small amount of new mass to the previous mass (previous effect), but simultaneously connecting its d*t* time-tail, so that the slightly increased mass in fact now exists as masstime and not mass. Observation has not been completed at that point.

In the next instant, a photon is re-emitted (from masstime, never from mass!), in the simplest case removing that extra little mass increase and orthogonally rotating it back into 3-spatial EM energy, coupling that spatial energy increment d*E* to that "time-tail" d*t* and tearing it away as the photon is re-emitted. That leaves behind a frozen 3-space snapshot of the mass (the interacting particle) and completes the "observation". In the simple case, this is a replica of the previous particle (frozen 3-space snapshot) with which the causal photon interacted. So this process accounts for the so-called "persistence in time" of an object or mass, as seen by the observer's continual recall process accompanying his stream of

iterative observations. Mass does not *continuously exist* in time, but *continually recurs* in time.

As is well known, what we call "observable" change must involve the expression in equation [13] in the fashion discussed and with the observation mechanism given.

We first pointed out the preceding mechanism for the "flow of a mass through time" in 1971, as a graduate student at Georgia Institute of Technology, and later published it in a crude paper {143} in 1973. It still needs a far more thorough theoretical treatment, which perhaps some graduate student will take up as the subject of his or her doctoral thesis.

2.1.3.5 *Photon Interaction:* *Mechanism Generating Flow Through Time*
See Figure 2-1. Mass does not really "travel through time" continuously *per se,* but proceeds with an overall serial change mechanism as

$$m \rightarrow (mt) \rightarrow m \rightarrow (mt) \rightarrow m \rightarrow \ldots \qquad [14a]$$

where *(mt)* symbolizes a nonobservable ongoing "coupled" interaction state prior to observation completion. Equation [14a] represents the results of the continual photon interaction process, observation process, and "flow of a mass through time" process, at the highest single-photon interaction or quantum change level, and as "seen" or measured by the external observer.

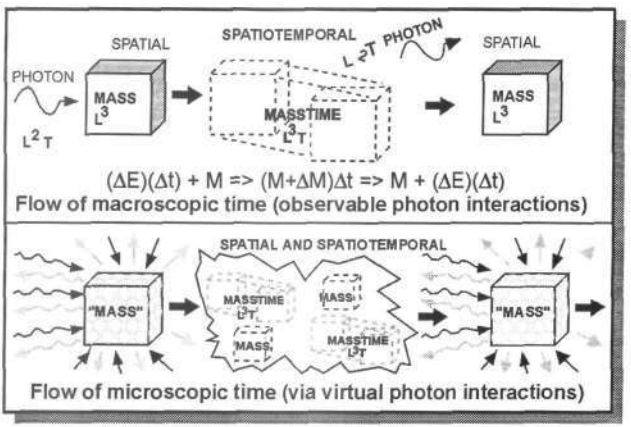

Figure 2-1 Mechanism for the flow of a mass through time.

Also, in that overall quantum level "flow" there are anyt number of ongoing streams and "sublevels" in the underlying subquantum level (in the virtual vacuum and in its virtual photon interaction with observable

mass). We might write one of these "internal time-stream interaction flow substructures" as:

$$(\delta m) \rightarrow (\delta mt) \rightarrow (\delta m) \rightarrow (\delta mt) \rightarrow (\delta m) \rightarrow \qquad [14b]$$

In equation [14b] we have used parentheses, because all terms individually are nonobservable. We hypothesize that each stream continues until one of its terms participates in a summation which eliminates it by enfolding it into another interaction.

When a mass is observed as in [14a], a photon has been emitted (we observe the mass as the "effect" remaining). Time has been stripped away by the resulting *d/dt* operation, leaving a frozen 3-spatial snapshot, which we will see as (having been) a particle (simplest case). That occurs just after major ("observable") photon emission from the masstime state {144}. Immediately another observable photon is absorbed, and so state *mt* occurs. The particle of mass actually oscillates at a very high rate between the *m* and *mt* states — so high a rate that by arranging the interaction conditions one may interact with it either as a wave (react predominantly in the *mt* state) or as a corpuscle (react predominately in the *m* state).

Hence we propose that the process in [14a] may account for the duality of particle and wave.

2.1.3.6 *The Overall Flow of Time Has an Internal Dynamic Structure*
During the transition in any mass to masstime state by reaction of the mass with an "observable" photon, a myriad of fleeting virtual photon interactions involving very tiny *(dE) (dt)* components occurs with the mass *m.* These tinier increments of time, and their increments of energy, constitute internal structures in the time flow process. Therefore they may be considered as "energy currents" or "time-like energy currents" and dynamic structures or streams inside the flow of time. This is particularly straightforward if we use a model having only a single fundamental unit, the joule. In that case, time is energy, and we are speaking of energy flow and its constituent internal structures of energy flow.

So the d*t* component of masstime at the observable-photon action level has a myriad of energy-time structured dynamics infolded within it. Hence the *mt* state is very dynamic in time, particularly for fundamental particles. The *mt* state is in fact a "collection of time-energy dynamics" and therefore "wavelike".

See again Figure 2-1. A major point is that ***mass*** does not emit a photon; *masstime* does. Mass "travels through time" by an extremely high oscillation between corpuscle-like state *m* and wavelike state *mt,* and with

a vast internal "dynamic streams" of other such high oscillations between corpuscle-like *m* states and wavelike *mt* states.

The concept can be very much extended, of course, but this suffices for our concept of energy currents in time, the interaction of such energy currents with mass in a mass system, and the internal dynamic structuring of the "flow of time".

This internal structuring is important in the event of *"time-energy" charging.* There the internal structure of time has experimental consequences. We will discuss those consequences in later chapters.

2.1.4 The Ubiquitous Substitution **of** Effect **for** Cause

See Figure 1-3. To repeat, no observable exists or persists *as such* in time. An observable *as such* only exists at all when time has been momentarily stopped. It then quickly changes into (observable x time) form, for a time interval after a photon absorption. Then it changes again to observable form by photon emission and the corresponding *d/dt* differentiation imposed by that photon emission.

What happens when we think we see an "observable moving through space" is that we make or suppose a continual series of very fast *d/dt* 3-spatial snapshot observations, one after the other in serial fashion (much like the individual frames of a motion picture film). For more than a million years, human brain and mind processing have "always interpreted" this serial set of iterative operations occurring in the eyes and in the physical senses — and continually recalled and processed by the mind — as an "observable persisting in time", which it is not.

This age-old "natural" and inbred, instinctual *mental practice* and assumption by humans — and therefore by scientists — has provided a major problem in physics and especially in electrodynamics. It has resulted in the substitution of the "effect" for the cause in a great number of models. Even a rapid and continual series of 3-space effects after reaction of an observable (frozen snapshot) with a 4-space causal entity, does not and cannot constitute that 4-space entity which interacts with the previous "frozen snapshot" observable and causes the resulting "comparative change or sameness" of the new observable with the former. Hence, e.g., Romer's scathing condemnation {84} of the conventional drawing of an "EM wave in space".

In general relativity, it is straightforward. The curvature of spacetime — the cause — is not the mass (the 3-space observable effect) that is further changed or created again in the ongoing interaction, as seen in the "next

3-space snapshot" (next output of observation) when comparing that snapshot to the previous one.[44]

The same non sequitur — unwitting substitution of effect for cause — has existed for hundreds of years in mechanics, for example. There it is strongly passed on in the erroneous old notion of a separate force acting upon a separate mass. *Prior to* the interaction, no "force" exists. *During* the ongoing interaction, force exists because it is the product (interaction) of a "non-force" causal entity (e.g., a field in 4-space, as a certain curvature of spacetime there) and a previous effect (a 3-spatial frozen snapshot called "mass"). The force exists during the interaction and only during the interaction, when both cause and previous effect are coupled (and will produce the new effect at the completion of the next serial *d/dt* operation as a photon is emitted). The force can only exist when the mass (previous effect) is coupled to the cause (the curvature of spacetime), since *a priori* mass is a *component* of force {145}, and curved spacetime is another *component* of it. After the interaction "ends" in a new *d/dt* observation, the mind compares the new effect with the former, to determine whether there is a "change" or a replica (sameness). This comparison of the new observation (observable) with respect to the former, *occurs in the brain and mind processing*, and gives the sense of "persistence of an object in time" as well as of an object "changing in time".

So a great faux pas in physics — and especially in electrodynamics — is this widespread substitution of the effect for the cause. Understanding this non sequitur clearly, and correcting it, is a prerequisite to understanding the principles and concepts of legitimate COP>1.0 Maxwellian systems. Also, if we would ever hope to adequately correct electrodynamics, this tremendous faux pas must be recognized and rooted out of the model. Indeed, the same is true for mechanics and other branches of physics.

2.1.5 Some Additional Foundations Non Sequiturs

Another gross non sequitur is made in calculating the amount of EM energy flow continually being diverged around an intercepting unit static charge at a point in space, from a potential in which that point is located, and then calling this "local intensity" of the collecting interaction the "magnitude of the potential" itself.

[44] Rigorously, if one wishes to connect spacetime and mass, spacetime can be interpreted in *masstime* units, but not ***mass*** units And vice versa. Again, masstime *mt* is as different from mass *m* as impulse Ft is **different** from force *F*.

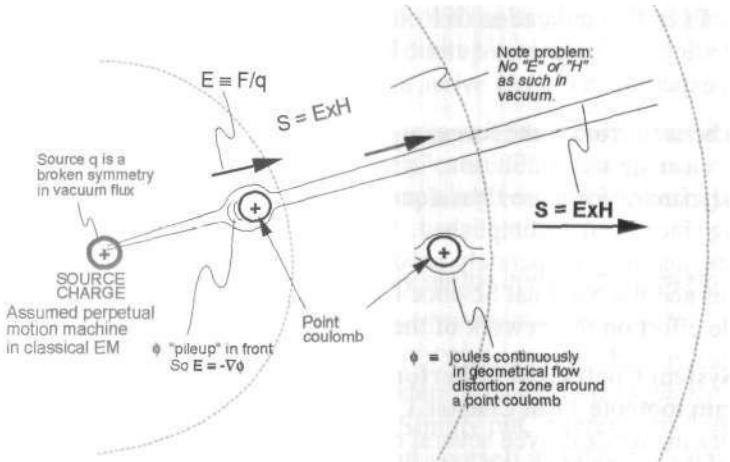

Figure 2-2 Field and potential are defined in terms of the diversions from them around a unit point static charge assumed at any spatial point

(See Figure 2-2). At best, it is a measure of the *local intensity of the diversion of energy flow from* the "bidirectional" EM longitudinal waves comprising a potential, as they are diverged around the unit point static charge. It is not the magnitude of the entire potential, filling all space, nor does it prescribe the spatial energy magnitude of that entire potential {146}. It is a small energy flow, *diverted* by an assumed standard fixed charge at a single point in the potential, from the overall energy flows comprising the potential. Calling this little "diversion of a bit of energy" the magnitude of the potential is rather like calling a little whirlpool in a river the "magnitude of the river". Or more exactly, it is like calling the amount of little "swirl diversion of a river's flow" around a standard small fixed rock the "magnitude of the river".

A similar non sequitur exists in the usual calculation of the "field" magnitude at a point, which is not the "entire field entity itself at all. It is merely what is *diverged from* the "field as it exists in spacetime" at a single point in it, by an assumed fixed standard point charge at that point that is interacting with the field. The field takes into account the patterning of the diverged flow, e.g., the difference in potential (difference in

pressure) across the unit point charge. That is not the field itself at all, and the textbooks and dictionaries of physics are completely wrong in calling it such. Again, at best, it is an indication of *the field intensity* at that point, and the reaction cross section of the field to an assumed unit point static charge. Even that indication of local intensity of the field will change if the intercepting charge is not static but is in resonance, as shown by the Bohren experiment {24}.[45]

As can be seen from these few examples, a great deal of work needs to be done to clean up the "definitions" promulgated in physics and electrodynamics for more than a century. It is inexplicable[46] that this has not long since been accomplished. These errors permeate almost every textbook, and they desperately need correcting. The National Academy of Sciences and the National Science Foundation should fund the best possible effort on this rework of the foundations of physics.

2.1.6 System Coefficient of Performance (COP) and System Efficiency

See again footnote 11 in Chapter 1 and Appendix A. In 1915, general relativity in fact destroyed several of the fundamental definitions (axioms) of classical thermodynamics. It necessitated our correction of some thermodynamical definitions (open system and closed system) and our more rigorous definitions of COP and efficiency advanced below.

Once mass is recognized as energy and the two are just different sides of the same coin, there can be no thermodynamically closed system which passes energy across the system boundary without passing mass across it. Any system changing its rate of flow through time also changes its mass and its energy, and vice versa. Energy has mass characteristics, and any mass system with added or subtracted energy — either kinetic or potential

[45] Many Bohren-type experiments are continually done in nonlinear optical labs in universities and elsewhere. The effect (excess radiation from the medium) is euphemistically called "negative absorption of the medium," "negative resonance absorption of the medium," etc. Such terminology avoids clearly recognizing that more energy is output than the scientists (erroneously) calculate was input. Bohren faced the issue head-on, and clearly stated that more energy was output than was input (or than was thought to be input).

[46] A true pessimist might point out that it may be quite understandable, considering that it solidly blocks COP>1.0 EM electrical power systems and electro-gravitational anti-gravity systems from being developed by our universities, which would solve the energy and transportation crises forever. Thereby it also keeps about $1.5 to 2 trillion a year pouring into the coffers of controlling financial groups behind many great interlocking corporations.

— will also change its mass relativistically as well as its other characteristics such as inertia and gravitational attraction. As pointed out by Logunov and Loskutov {635}, in 1917 the new characteristics of general relativity led Hilbert {632} to observe that in general relativity there can be no energy conservation rules of the usual classical kind. This also follows from our consideration of the supersystem with multiple active environments rather than a single active environment.

We have formally destroyed any absoluteness of the present classical thermodynamics, which is just an imperfect model. It is a special case which can be approached but never completely reached in a real dynamic system.

With that in mind, we now more exactly define *coefficient ofperformance* and *efficiency* of a system.

The term "coefficient of performance" (COP) is a ratio whereby the useful energetic output performance of the system is characterized *purely with respect to the operator's energy input.* Simply put, it represents "how much you get for what you have to input yourself and pay for". It does not characterize the performance of the system with respect to the *total energy inputfrom all sources.* For our purpose, in general there are two major ways of expressing this COP:

(a) COP == (work accomplished in the load during a representative time of operation) divided by (energy input by the operator during that representative time of operation). Or for short, COP = (useful work out in the load) + *{operator's* energy input). We stress that there may be other free inputs of energy to the system, in addition to the operator's input, but only the operator's input is accounted in the COP calculation.

(b) COP == (average power out in the load) divided by (average power input by the operator).[47] Again, there may be additional average power inputs that are freely input from the environment, without cost to the operator, but only the *operator's* input is accounted. We stress that "power input" is

[47] This is in standard electrical engineering terminology, which is mangled. For a more precise physics statement of (b), COP == (the average rate at which the system dissipates energy in its load to do useful work) / (the average rate at which the operator must furnish energy to be dissipated as work in the input section of the system to make it operate and do its output work).

another of electrical engineering's misnomers, but we use it here because it is universally used in power system engineering.

For a system such as a transducer, which merely changes the form of the energy in some fashion and does not perform work in an external load (the transducer is its own load), we may express the COP as

a. COP == (effective energy output) / (energy input by the operator). Here we accent that there may be additional energy inputs to the system from the active environment, and these inputs are "free" and are not input by the operator, so they are not accounted in the COP calculation.

b. COP == (average power output) / (average power input by the operator). Again, additional average power inputs may be freely received from the environment, but they are not accounted in the COP calculation.

The "efficiency" E of a system is a ratio less than or equal to 1.0 (or a percentage less than 100%), where E indicates the percentage of the <u>total</u> input energy (from all sources) that is dissipated in the load as useful work. It follows that (7 - E) indicates the percentage of the total input energy that is dissipated in the internal losses in the system, not directly resulting in useful work by the system in its load. So the efficiency E of a system may be expressed as:

a. E == (total work output in the load during a representative operational period) / (total energy input to the system, from all sources, during that period).

b. E == (average power output in the load) / (average energy rate of input to the system, from all sources, during that representative operational period.).

We accent that no system can have an efficiency greater than 100%, for then it would be "creating energy from nothing" {147}. No system can dissipate or convert energy that it does not first receive. The conservation of energy law states that energy can neither be created nor destroyed. This means that *there actually are no energy sources per se, in the sense that the source creates the energy,* even though we use the terms "energy

source" and "source of energy" informally. E.g., Semiz {148} states it this way:

> *"The very expression 'energy source' is actually a misnomer. As is known since the early days of thermodynamics, and formulated as the first law, energy is conserved in any physical process. Since energy cannot be created or destroyed, nothing can be an energy source, or sink. Devices we call energy sources do not create energy, they convert it from a form not suitable for our needs to a form that is suitable, a form we can do work with."*

A medium inefficient system can easily have a COP>1.0, if it receives additional energy from its active environment, and if that extra free energy is sufficient to overcome its internal inefficiency losses. An example is a common windmill, where a very good one may have an efficiency of less than 50% due to friction and drag losses in the gears and wind spillage losses in the blades, etc. Yet the operator himself does not have to input any energy at all, for the windmill to operate continually. In this case, the COP»1.0 and approaches infinity, but the efficiency of the windmill is still less than 50%.

Another example is the home heat pump, which may also have an efficiency of less than 50%. When acting as a refrigerator, its theoretical maximum COP = 8.22 under nominal conditions {149}, and a well-designed 50%-efficient home heat pump will produce COP = 4.0 when conditions are suitable.

On the other hand, if the only net energy input to the system is that energy that the operator inputs, then the COP < 1.0. This is a system in equilibrium with respect to any energy exchange with its external environment — *except* with respect to the energy input by the operator (i.e., with respect to its "fueling" by the operator, so to speak) and with respect to the energy subsequently dissipated in the loads and losses. If the system is 100% efficient (has no internal losses or conversion losses at all), its COP = 1.0. Almost all real systems do have internal losses, so their efficiency is E < 100%. In that case, the system in equilibrium with its environment, and having E < 100%, will also exhibit COP<1.0

irrevocably. Indeed, the same number will give both the efficiency E and the COP, because numerically they are then the same.[48]

For electromagnetic systems, the state of confusion between efficiency E of the system and the COP of the system is due to one fact. *Numerically* the two are always equal in *equilibrium* systems — and the Lorentz regauging condition enforced by the closed current loop circuit self-enforces the equilibrium condition of the system with respect to its active environment. Because electrical engineers usually have zero experience with COP>1.0 electrical systems, they tend to loosely and erroneously use the two terms "efficiency" and "COP" as if they meant the same thing. They do not.

Now suppose that we have an open system, far from equilibrium in its energy exchange with its active environment. Suppose that the system's efficiency E is very poor, so that E = 20%. Now suppose that the environment inputs twice as much energy as does the operator. Let the operator's energy input be E_1. Then the total energy input to the system, from both the operator and the environment, is $3E_1$. The efficiency is only 20%, so the system outputs W, as work in the load, of $W = 0.2(3E_1) = 0.6\ E_1$. The COP of the system is the work out divided by the operator's input, which is $COP = W/E_1$, which is $COP = 0.6\ E_1 / E_1$ which gives COP = 0.6. As can be seen, even though this system receives twice as much additional free energy as what the operator inputs, it is so inefficient that **its COP<1.0.**

Suppose we have a similar system with the same energy inputs from the operator and from the environment, but now the system's efficiency E is E = 90%. Then the total energy input to the system, from both the operator and the environment, is $3E_1$. The efficiency is 90%, so the system outputs W, as work in the load, of $W = 0.9(3E_1) = 2.7\ E_1$. The COP of the system is the work out divided by the operator's input, which is $COP = W/E_1$, which is $COP = 2.7\ E_1 / E_1$, which gives COP = 2.7. As can be seen, a more efficient system in the same energy input situation, now outputs more work than the energy input by the operator. Energy is conserved at all times; the excess energy for the additional work was in fact freely input

[48] We emphasize that COP and efficiency are two quite different concepts, however, even when their numerical values are the same. A 6-foot tall man and a 6-foot tall door have the same number for their **height,** but only a fool would consider them the "same thing".

to the system — which is an "open" system far from equilibrium in its exchange with its active environment.

Thus a system far from equilibrium in its energetic exchange with its active environment, is *permitted* to exhibit COP>1.0 even though its efficiency is always less than 100%. On the other hand, if the system is very inefficient and the energy input from the environment is not too great, the system will still exhibit COP<1.0. But the operator will pay less for his energy costs to operate that inefficient system, than he would pay to operate it if he himself had to furnish all the energy input.

Two cautions are emphasized:

(a) First, electrical engineers use the term "power" to mean "energy flow rate without dissipation or change of form", as well as "energy flow dissipation and change of form rate." This is inexact and unfortunate, but it appears ubiquitously throughout the electrical engineering literature. So we are essentially "stuck with it" for the moment. From a rigorous physics point of view, energy flow without divergence or change has absolutely no power, because power is defined as the rate of change of the form of that energy flow — e.g., the rate of dissipation (scattering) of that energy flow, which in physics is a rate at which work is being performed.

(b) Second, it seems that more than half the engineers and scientists — and many textbook authors — do not clearly understand the difference between COP and efficiency, and often interchange these two terms as if they were the same. They are not at all the same, and a great deal of confusion exists in the casual engineering literature because of using them interchangeably. That is why we have clarified them and given some simple explanatory examples, sufficient for our purpose in this book.

2.1.7 COP>1.0 and the Question of Perpetual Motion

Legitimate scientific researchers attempting to work in open EM systems far from thermodynamic equilibrium are often subjected to rather vicious ad hominem attacks, charging that they are perpetual motion machine addicts and therefore raving lunatics. This of course is not true. We are simply trying to do with Maxwell's "electric fluid" systems what nature already shows us can be done with material fluid systems. We are in fact seeking the equivalent of "electromagnetic heat pump" processes and systems. It is the strident critics who are thoroughly confused and who reveal an immature knowledge of physics and thermodynamics.

As we explained, prior to their Lorentz symmetrical regauging, the Maxwell-Heaviside equations already clearly prescribe and permit COP>1.0 EM systems, including EM power systems. In addition to the present EM systems in equilibrium in their exchange with their active vacuum environment, the non-regauged equations also include Maxwellian systems far from equilibrium in their energetic exchange with an active environment, such as the active vacuum. Classical *equilibrium* thermodynamics — stridently waved as a sacred banner by the critics accusing COP>1.0 researchers of being "perpetual motion nuts" and such EM systems as being "perpetual motion nonsense" — does not even apply to such *disequilibrium* systems! One should simply read the literature of the thermodynamics of such disequilibrium systems {160a-160f}. Or one should read why Prigogine was awarded the Nobel Prize in Chemistry in 1977, for his contributions to such open systems in disequilibrium.

We accent again that, under our new rules where we corrected the thermodynamic definitions of open system and closed system, we are in compliance with general relativity. Further, every EM system must be taken as an open system, since in the supersystem energy (with mass-like changes resulting across the system boundary) is always exchanged between the three supersystem components.

Fortunately there are also rational, reasonable critics such as Angrist {150, 151} where the criticism is properly scientific and not ad hominem, even though still misguided. Usually the rational perpetual motion critic applies the three laws of classical *equilibrium* thermodynamics, to classify "perpetual motion machines" of class 1, 2, and 3 after equilibrium thermodynamics laws 1, 2, and 3. This of itself has no intellectual content for open systems in disequilibrium with their active environment. The classical equilibrium thermodynamics — including laws 1, 2, and 3 interpreted only in terms of the operator's energy input — does not apply to *open systems far from equilibrium* — which are the only systems permitted to exhibit COP>1.0 in the first place. And we insist that all EM systems are open systems far from thermodynamic equilibrium, since every charge is, and all fields and potentials come from those source charges. Indeed, such open disequilibrium systems are *permitted* to violate the laws of classical thermodynamics! As an example, the entropy of such an open disequilibrium system cannot even be computed {152}, and it is less than the entropy of the same system in equilibrium, since the equilibrium state is the state of maximum entropy.

The rational critic then falls upon the horns of a dilemma, by admitting that, yes, such open dissipative systems do exist and do permissibly exhibit

COP>1.0. He then labels these *as, false or fictitious perpetual motion machines* {150, 151}. In short, when such COP>1.0 machines are real and admittedly exist, they are not *"true"* perpetual motion machines but *fictitious* perpetual motion machines. My comment is that they are not perpetual motion machines at all, but permissible disequilibrium machines freely receiving excess energy from their energetic exchange with their active environment. They are no more mysterious than a windmill, a sailboat, a watermill, or a solar cell bank.

One must be precise. A bicycle is a free-energy COP>1.0 machine while going downhill. It is not such at all when going uphill. The difference is that gravitational input of energy aids the bicycle's motion in the downhill case, and opposes it in the uphill case. The active environment gives the system additional energy in one case, and takes energy from the system in the other case. Disequilibrium exchange can cut either way!

It is precisely the EM system far from equilibrium with its active environment — where the environment puts in additional energy — that the serious overunity researcher is seeking. It is a perfectly valid pursuit, even by the standards of the perpetual motion critics, who really should study *both* kinds of thermodynamics, not just *one*. They also should study how Maxwell's equations were curtailed and truncated; one result is that all Maxwellian disequilibrium systems were — and are — discarded *arbitrarily* by the Lorentz symmetrical regauging.

The only criticism one needs to raise vis a vis COP>1.0 and perpetual motion machines is this: If an inert (no hidden internal source) machine receives no net energy from its external active environment, but is in equilibrium in its energetic exchange with that environment,[49] then

[49] Here we quibble again and point out that Lorentz's symmetrical regauging actually does require that the system receive and take on excess EM potential energy from its environment (the active vacuum and the local curved spacetime). However, this excess energy can only be received in the form of two injections of field energy, where the fields are equal and opposite. Hence the energy is "bottled up" as a stress potential, with net zero translation force available to it. Since this stress potential energy cannot translate electrons, it cannot do work in an external load. It merely changes the stress of the system itself. The net result is actually a rotation of the frame in which the system exists, away from the "laboratory frame" of the observer. In short, the Lorentz condition establishes a new "equilibrium condition" for the system, by rotating its frame. It also implies that EM energy is continuously received by the system from both the active vacuum and local curved spacetime, in order to maintain the rotated frame and **the** new equilibrium condition. Further this

classical thermodynamics rigorously applies to it and the machine cannot and will not exhibit COP>1.0. However, all EM systems contain charges, and these are indeed "hidden sources" of EM fields and potentials and their energy. It *rigorously follows that, since they contain hidden energy sources, all EM systems are potentially COP>1.0 systems a priori.* Further, *it follows that some ubiquitous design characteristic of the system itself must prevent the system from achieving COP>1.0, since nature does not prevent it.* That characteristic feature is the ubiquitous closed current loop circuit, directing all spent electrons in the external circuit right back through the source dipole in the generator or other primary power source.

It is indeed mandatory that — if at all possible - the inventor or independent researcher *identify* a legitimate source of environmental energy that his purported COP>1.0 device receives and collects, and how it receives it and then uses it to power the loads. That means he should identify where and how his system violates the Lorentz self-regauging condition imposed by the standard closed current loop circuit. If the inventor himself cannot explain it — and this does happen — then someone else must explain it for him. If the machine works under proper independent test and replication, then criticism that no explanation exists for it in normal physics is of no relevance. It is a spur to the theorist to enlarge his horizons and to find the proper physics that *does* explain it.

We stress that we cited the works of Angrist because his voice is reasoned and he does not stoop to name-calling and ad hominem attacks. He also does point out a historical rash of machines that clearly must comply with classical equilibrium thermodynamics, because they have no discernible or stated extra input of energy from their active environment and have no self-asymmetrical regauging. When such machines have no external free input of energy from their active environment, they are systems in equilibrium with their active environment, and cannot exhibit COP> 1.0 — exactly as pointed out by Angrist. With such a reasoned critic, a scientific dialog is possible, and his main thrust — that no *equilibrium* system can exhibit COP>1.0 — is quite valid. With the vehement critic, it is already a cur dog fight from the outset and there can be no scientific discussion at all.

The only contention one has with a rational critic, whose criticism is based on classical thermodynamics, is when he then generalizes that *all* EM

continuous input of two energy flows, equal and opposite, does continuous internal work on the Maxwellian system to increase and maintain its stress.

systems fall within this class. That conclusion is a non sequitur, and ignores the entire science of disequilibrium thermodynamics and a vast body of scientific literature and scientific experiments in electrodynamics. When stated for electrodynamic systems, it also ignores the actual documented history of electrodynamics, and ignores Lorentz's *arbitrary discard, from all accountability,* of the Heaviside giant nondiverged energy flow component accompanying every circuit and system. It also ignores Lorenz's and then Lorentz's symmetrical regauging of the Maxwell equations to give new and simple equations easier to solve. This arbitrary regauging did in fact unwitting discard all open disequilibrium Maxwellian systems — precisely those permitted to exhibit COP>1.0.

See again Figure 1-1. The energy entering the circuit is entering it from the surrounding space outside the circuit. Heaviside showed that the energy flow component remaining alter the Poynting component is withdrawn is orders of magnitude greater than the Poynting component entering the circuit and powering it. *It can easily be demonstrated that every generator outputs far more EM energy in space surrounding the power line attached to it, than the operator inputs as mechanical energy to the shaft.*[50]

[50] E.g., just use a gedanken experiment followed by the Bohren {24} experiment as validated by Paul and Fischer {25}. Consider a 100% efficient DC system, powered by a DC generator, using a closed Current loop circuit. All the Poynting energy received by the system appears at first blush to be dissipated in the external load. That is not true, but let us not yet belabor the point. Include the complete circuit loop back through the source dipole in the generator. The back emf voltage across the source dipole between the terminals is precisely equal to the forward emf voltage between the terminals but around the external half-loop. The same current flows through both the forward voltage drop and the reverse voltage repotentialization. So precisely as much energy is dissipated to force the current through the back emf, as is recovered from the load.

Accept the conventional view that the shaft energy input to the generator is transduced into magnetic energy, which is then dissipated to force those charges back though the back emf. Now examine the energy flow in space surrounding the external circuit, using both the Poynting theory and Heaviside's theory. We have accounted for the Poynting diverged component, but we have not accounted for the huge remaining nondiverged Heaviside component. From whence comes this excess remaining energy flow that did not enter the circuit, was not included in the Poynting calculation, and was not expended in the circuit but was just wasted? To prove the excess energy flow really exists, perform the Bohren experiment {24} where the intercepting charges in the circuit are in resonance, and thus "sweep out" a larger geometrical cross section of interception of the impinging energy flow. These charges do sweep beyond the static unit charge cross section conventionally assumed in the definitions of field intensity (e.g., of the fields E and H in the Poynting vector S in S = (E x H). If the defining unit point charges are in resonance and sweep out a

Heaviside knew this in the 1880s. All the energy flow that is intercepted by the circuit and enters (i.e., the Poynting component) at essentially right angles, hardly even changes the angle of flow of the remaining huge flow of energy surrounding the circuit and missing it. Quoting Heaviside {153} directly:

> *"It [the energy transfer flow] takes place, in the vicinity of the wire, very nearly parallel to it, with a slight slope towards the wire.... Prof. Poynting, on the other hand, holds a different view, representing the transfer as nearly perpendicular to a wire, i.e., with a slight departure from the vertical. This difference of a quadrant can, I think, only arise from what seems to be a misconception on his part as to the nature of the electric field in the vicinity of a wire supporting electric current. The lines of electric force are nearly perpendicular to the wire. The departure from perpendicularity is usually so small that I have sometimes spoken of them as being perpendicular to it, as they practically are, before I recognized the great physical importance of the slight departure. It causes the convergence of energy into the wire. "*

So every electrical power system is rigorously a COP>1.0 "energy gating" system already, if the neglected, enormous Heaviside energy flow through space around the circuit (and missing it and wasted) is re-accounted. In that case, much greater energy pours out of the terminals of every generator, than the feeble amount of mechanical energy we input to the shaft.

We do not have an *energy availability* problem, and we never have had one! Instead, we have an *energy flow interception and collection* problem

greater cross section, then the assumed Poynting vector S, for the static case, changes in magnitude by some ratio k for the resonant case to the vector S_R, so now $S_R = k_1E \times k_2H = k_3(E \times H)$. Since k_3 is just the ratio of the actual geometrical cross section swept out by the charge to the standard geometrical cross section swept out by the static charge, then for a static charge $k_3 = 1.0$, and for a resonant charge $k_3 > 1.0$. Hence the Bohren experiment, with $k_3 = 18$ or so, produces 18 times as much collected (Poynting) energy "out" as we erroneously think we input by normal calculations ignoring the input Heaviside nondiverged component. The Bohren experiment {24} proves the argument; validation by Paul and Fischer {25} appears in the same journal issue.

— and we always have had one, due to the ubiquitous use of the closed current loop circuit.

Texts — e.g., such as by Kraus {154} — do show the Poynting (intercepted and collected) component of the EM energy flow surrounding the power line attached to the generator terminals, but none of them today go into the remaining nondiverged Heaviside component. Each of Kraus' contours {76} of energy flow in space, around those power line conductors, shows *only that part of the energy flow in space that is being drawn into the circuit.* It does not show the remaining huge energy flow that (i) is not intercepted, (ii) does not enter the circuit, and (iii) is wasted. Presently no texts illustrate this Heaviside nondiverged energy flow component, and no text accounts for it except to point out that the Poynting component must be considered to be indefinite, since it can be accompanied by an additional energy flow component. The texts then erroneously conclude that the excess flow can have no physical significance.[51]

One can easily prove the existence of additional energy flow to be collected, in addition to the Poynting component. E.g., simply examine the Bohren experiment {155} and its replication by Paul and Fischer {156} — or one can repeat the experiment oneself. The Bohren experiment outputs some 18 times as much energy as is input by normal "Poynting component" calculations alone, because it also intercepts additional energy from the unaccounted and ignored *free* Heaviside input component remaining and not diverged by a *static* unit point charge. Bohren simply places the charge in resonance, so it sweeps out a greater geometrical reaction cross section in the energy flow, thereby penetrating into the free — but arbitrarily discarded and unaccounted — Heaviside component, and intercepting and collecting additional energy. Bohren is perfectly aware that the excess energy caught by the resonant charges comes from the surrounding vacuum. However, he seems quite unaware of Heaviside's

[51] E.g., J. D. Jackson, Classical Electrodynamics, Second Edition, Wiley, 1975, p. 237: *"...the Poynting vector is arbitrary to the extent that the curl of any vector field can be added to it. Such an added term can, however, have no physical consequences."* Jackson errs in stating that the added energy flow vector cannot have any physical consequences. It cannot, of course, unless one catches some of it and uses it to power a load, without using half of the caught energy to destroy the source dipole faster than the load is powered. One of the major applications of it is to use it with Dirac sea negative energy 4-holes in the vacuum, where the holes produce negative energy fields and potentials in surrounding spacetime, acting back upon the system which is the source of the 4-holes to produce practical antigravity.

discovery and cautious statement of the excess energy involved in *every* field-particle interaction, and particularly in electrical circuits.

There are several such "white crows" which are legitimate COP>1.0 EM processes in physics. It only takes one small white crow to prove that not all crows are black. As another example, the papers of Letokhov {157a-157d} are especially recommended. So long as excess energy is received freely from the environment, the system is permitted to be in disequilibrium where COP>1.0.

So far as this author could discover, none of the perpetual motion machine critics have noticed another very simple fact: The conventional electrodynamics they utilize to refute COP>1.0 Maxwellian systems implicitly assumes that the source charge — which is any and every charge in the universe — continuously *creates* and pours out energy in 3-space without any energy input at all. Their own conventional classical electrodynamics contains a "perpetual motion machine assumption" of the most fundamental and grossest kind. The ardent skeptics of overunity EM systems — in using that implicit conventional assumption — are themselves the greatest perpetual motion advocates of all, though perhaps unwittingly. In 2000 we resolved that long-vexing problem[52] of the source charge {12}.

The more strident critics simply set up the "equilibrium thermodynamics" straw man, then knock it down and attack independent COP>1.0 experimenters with it, erroneously implying that all overunity researchers seek such in an equilibrium system. They fail to notice orthodox science's implied assumption that every charge and every dipole in the universe is already assumed to be a COP => inf. perpetual motion machine, freely *creating* all that continuous outpouring of energy from nothing. None of the critics have noticed and critiqued this greatest of all perpetual motion assumptions right in their own ranks, without a single exception, and the most ubiquitous. Undoubtedly that is because the scientific community honestly and freely admits that it has not heretofore solved that problem {68}, and also points out that the outpouring of energy is an experimental fact and therefore unquestionable.

The better critics — at least the rational ones such as Angrist — already admit that there exists a class of legitimate "fictitious perpetual motion

[52] After publication of our paper, we also discovered very powerful support for our solution in quantum field theory. E.g., see F. Mandl and G. Shaw, *Quantum Field Theory*, Wiley, 1984/1993, Chapter 5.

machines" which are powered continuously without the operator inputting the energy. The phrase "fictitious perpetual motion machine" is an attempt to retain the classical thermodynamics straw man, when dealing with the thermodynamics of a system far from equilibrium in its energy exchange with its active environment. That phrase has been a non sequitur since the award of the Nobel Prize to Ilya Prigogine in 1977. We stress again our new use of all EM systems as open systems, in accord with general relativity.

So when rigorously analyzed from the breadth of physics and thermodynamics, and not just from a selected very narrow portion, the entire "perpetual motion" critical literature is inappropriate or — more exactly — is inappropriately focused upon a fictitious or false target. It is simply a classic example of reasoning from a false premise.

Not one such critic seems to have noticed that every generator and battery already pours out more energy than what is input to the shaft, and that it is easily proven experimentally via the thousands of experiments showing negative absorption from the medium. None seems to have bothered to read the original Heaviside, Poynting, and Lorentz papers to see how this startling fact was buried more than a century ago.

Finally, a self-appointed "expert" who does not even know what furnishes the energy to power every electromagnetic circuit, cannot be taken seriously in his "learned criticism" , regardless of what journal publishes it. If he continues to accept the unsolved source charge problem, implying that all charges freely create EM energy from nothing, he is not expert in any facet of powering electromag letic systems and circuits.

2.1.8 Prescribed Systems Versus Changes to Maxwell's Equations

As we stated, Maxwell's theory {20} was some 20 quaternion-like and vector equations in some 20 unknowns. By discarding the scalar component of the quaternion to retain only the vector subcomponent, and by discarding many of Maxwell's potentials, Heaviside {158} truncated the Maxwell equations to essentially the present familiar set of four vector equations - or in potential form, to two equations with variables unseparated.

While this truncation discarded a great deal of Maxwellian electrodynamics phenomenology, from a thermodynamics view the resulting *Maxwell-Heaviside* equations still contain and prescribe two types of Maxwellian systems:

(1) systems in equilibrium with their active environment, such as the active vacuum, and

(2) systems far from equilibrium with their active environment, such as the active vacuum.

Systems in the first class of Maxwell-Heaviside systems — i.e., in equilibrium in their energetic exchange with their active environment — rigorously obey classical equilibrium thermodynamics {159}. No system in that Maxwellian class can output more energy than the operator himself inputs to the system. The greatest coefficient of performance (COP) that these systems can accomplish, is COP = 1.0 for a theoretically perfect system without internal losses whatsoever, and thus with 100% efficiency of conversion of their input energy into work in the load. Since any real system has internal losses and thus is less than 100% efficient, the *practical* systems of this first class exhibit COP < 1.0.

These Maxwellian systems of the first class are the electrical systems always "understood" by ardent skeptics who proclaim that no other kind of Maxwellian system exists, that therefore no Maxwellian system can exhibit COP > 1.0, and that a claim to COP>1.0 is perpetual motion lunacy and not science at all. These fellows often launch scathing and unjustified personal attacks upon any serious researcher trying to work with that second class of permitted Maxwellian systems! It would be scientifically beneficial if these self-appointed defenders of the faith would simply study some more physics and thermodynamics, review the history of Maxwell's theory and how it was altered, and understand the well-established thermodynamics of systems far from equilibrium.

This false charge — that there can be no COP > 1.0 EM system because that would violate the laws of physics and the laws of thermodynamics — has been insidiously indoctrinated into generation after generation of physics and electrical engineering students. Today most of our electrical engineers and electrical scientists have absorbed it and believe it without question. Our power-engineering scientists believe it, and so advise the government. Hence our government believes it on the advice of our best scientists, such as the National Academy of Sciences and the National Science Foundation. Our great national laboratories also believe it and are just as mentally conditioned. The universities — especially the electrical engineering departments — also believe it, and provide a mainstream suppression of the sharp young graduate students and post-docs that would otherwise have long ago revised this mess and solved the energy crisis permanently.

Again we are reminded of that first quotation by Einstein, which we included at the beginning of Chapter 1, and which admonished us to ever examine the foundations of our science to root out and correct the errors. We are also reminded of another quote by Tolstoy:

> *"I know that most men, including those at ease with problems of the greatest complexity, can seldom accept even the simplest and most obvious truth if it be such as would oblige them to admit the falsity of conclusions which they have delighted in explaining to colleagues, which they have proudly taught to others, and which they have woven, thread by thread, into the fabric of their lives."* [Count Leo Nikolaevich Tolstoy].

The second class of Maxwell-Heaviside systems — rigorously prescribed and permitted by Heaviside's truncated Maxwellian theory — is comprised of systems in disequilibrium with their active environment. A system in this class does not obey classical equilibrium thermodynamics. To the contrary, this system obeys the well-known *thermodynamics of systems far from equilibrium* {160a-160f} with their active environment — such as the active vacuum.

Such a system *is permitted to:*

(i) self-order,

(ii) self-oscillate or self-rotate,

(iii) output more energy than the operator himself inputs and thus exhibit COP>1.0 (the excess energy is freely received by the system from its external active environment),

(iv) power itself and its load simultaneously (all the energy is freely received by the system from its external active environment,[53] without any operator energy input being required), and

[53] We accent the concept of the supersystem. consisting of three components: (a) the system and its dynamics, considered as in normal electrical engineering (with a flat spacetime and an inactive local vacuum), (b) the active local vacuum and its dynamics, and (c) the active local curvatures of spacetime and their dynamics. All three components of the supersystem interact with each other. In conventional electrical engineering, the assumption in U(l) electrodynamics of a flat local spacetime and equilibrium with the local vacuum exchange eliminates any

(v) exhibit negentropy, which every charge and every dipole in the universe already does {12, 68}.

Let us now see why Maxwellian EM systems of the second class *are not being designed and built as such,* even though they are permitted by the laws of physics and reinterpreted thermodynamics, and even though they are prescribed in the Maxwell-Heaviside equations before further truncation by Lorentz {161a, 161b}. We may use the Maxwell-Heaviside equations in vacuum, because the energy flow intercepted by the external circuit pours out of the generator terminals and fills all space surrounding the power lines. It is therefore a transmission-reception problem, prior to the "potentialized current-transport" problem in the circuit.

2.2 Lorentz Regauging of the Maxwell-Heaviside Equations

2.2.1 Introductory remarks.

The domain of Lorentz's symmetrically regauged equations is only a small subset of the domain of the Maxwell-Heaviside equations they replace. Indeed, the later Lorentz {161a, 161b} symmetrical regauging discards an entire class of Maxwellian systems permitted by nature and by the Maxwell-Heaviside equations before they are symmetrically regauged.

Lorentz's symmetrically regauged EM equations discard all Maxwell-Heaviside systems that are far from equilibrium in their energetic exchange with the active vacuum. They retain only that subset of the Maxwell-Heaviside theory wherein the system being described is in forced equilibrium {162} in its exchange with its active vacuum environment. Hence the present Lorentz-Maxwell-Heaviside theory, by which EM circuits and electrical power systems are designed, produces only systems in self-forced equilibrium with the active vacuum, *specifically during the symmetrically regauging discharge* of the circuit's excitation energy. The closed current loop circuit in fact discharges half its collected energy to destroy the source dipole in the generator, thereby destroying that dipole's extraction from the vacuum and furnishing of the energy flow pouring out of the terminals. These circuits kill themselves faster than they can power the load, and they use more energy to kill the energy flow from the vacuum than they use to power their load. Hence all present EM systems

disequilibrium of the system with its active environment, hence arbitrarily discards all Maxwellian disequilibrium systems - precisely those that can exhibit COP>1.0.

rigorously conform to classical equilibrium thermodynamics, and exhibit a coefficient of performance (COP) of COP<1.0 since any real system also has losses {163}.

2.2.2 Technical regauging of the Maxwell-Heaviside equations {164}. For asymmetrical-regauging (A-regauging) considerations, we are speaking of A-regauging the potential energy in and around a circuit. We include not only the Poynting energy flow component that is diverged into the circuit conductors, but also the remaining Heaviside *nondiverged* energy flow in space surrounding the conductors. This means that the energy is in field energy (E-field and B-field) form, both overtly as ordinary EM fields and covertly or "infolded" inside the corresponding scalar potentials {165, 166, 167, 168}, or both. Consequently, we must analyze Maxwell's equations as we would for radiating energy, rather than employ only the $\mathbf{j}\phi$ circuit analysis conventionally utilized, where the collected energy is sluggishly transported by the Slepian vector $\mathbf{j}\phi$. We show in this book that asymmetrical self-regauging (ASR) allows permissible overunity operation of electromagnetic engines and devices {169}, if other requirements are fulfilled also.

In Gaussian units, Jackson {170} shows that Maxwell's four equations (vacuum form) can first be reduced to a set of two coupled equations in the $(\mathbf{A}, \Phi)$ representation as follows:

$$\nabla^2\Phi + \frac{1}{c}\frac{\partial}{\partial t}(\nabla \bullet \mathbf{A}) = -4\pi\rho \qquad [15]$$

$$\nabla^2 A - \frac{1}{c^2}\frac{\partial^2 \mathbf{A}}{\partial t^2} - \nabla(\nabla \bullet \mathbf{A} + \frac{1}{c}\frac{\partial \Phi}{\partial t}) = -\frac{4p}{c}\mathbf{J} \qquad [16]$$

The result is two coupled Maxwell equations rather than four. Jackson shows that potentials A and Φ in these two equations are arbitrary in a specific sense, since the A vector can be replaced with $\mathbf{A'} = \mathbf{A} + \nabla\Lambda$, where A is a scalar function and VA is its gradient. The B field is given by $\mathbf{B} = \nabla\times\mathbf{A}$, so that the new B' field becomes

$$\mathbf{B'} = \nabla\times(\mathbf{A} + \nabla\Lambda) = \nabla\times\mathbf{A} + \mathbf{0} = \nabla\times\mathbf{A} = \mathbf{B} \qquad [17]$$

In other words, the B field has remained entirely unchanged, even though the magnetic vector potential has been asymmetrically changed. However, if no other change were made, then the electric field E would have still been changed because of the gradient $\nabla\Lambda$. In that case the net change would be asymmetrical, because one obtained a "free" E-field which could

then do work on the system — either beneficially or detrimentally, depending upon the specific conditions, geometry, and timing. To prevent this excess "free" E-field from appearing, the electrodynamicists simultaneously and asymmetrically regauge (transform) the scalar potential Φ so as to offset the E-field change due to the regauging of equation [15]. In short, they also change Φ to Φ', where

$$\Phi' = \Phi - \frac{1}{c}\frac{\partial \Lambda}{\partial t} \qquad [18]$$

With that additional change, now the net E and B fields remain unchanged {171, 172}, even though both potentials have changed and the fundamental stored energy of the system has changed, as has the stress of the system. Unchanged force fields just mean that only a set of zero-summation forces (a zero-summed stress system) has been utilized to effect the change in potential energy. It also means that the net summation of the two *asymmetrical* regaugings has been entirely *symmetrical* {173}.

Jackson points out that, conventionally, a set of potentials $(\mathbf{A}, \Phi)$ is habitually and *arbitrarily* chosen by the electrodynamicists such that

$$\nabla \bullet \mathbf{A} + \frac{1}{c}\frac{\partial \Phi}{\partial t} = 0 \qquad [19]$$

This *net symmetrical* regauging operation creates a new and simpler Maxwellian system, with different system stress and different system potential energy. It successfully separates the variables, so that two inhomogeneous wave equations result. This procedure yields a new and simplified system, and the new Maxwell's equations for it are as follows:

$$\nabla^2 \Phi - \frac{1}{c^2}\frac{\partial^2 \Phi}{\partial t^2} = -4\pi\rho \qquad [20]$$

$$\nabla^2 \mathbf{A} - \frac{1}{c^2}\frac{\partial^2 \mathbf{A}}{\partial t^2} = -\frac{4\pi}{c}\mathbf{J} \qquad [21]$$

The two previously coupled Maxwell equations [15] and [16] (potential form) have been replaced by equations [20] and [21], to leave two much simpler inhomogeneous wave equations, one for Φ and one for A. These are *new equations for a new system!*

Of course, this arbitrary *net symmetrical* regauging (let us use the term ***S-regauging)*** is quite useful for purposes of simplifying the theory and for

easing calculations. But its unquestioning and rather universal usage has arbitrarily eliminated the freedom of the system designer to *asymmetrically* regauge the system's potentials, and *use* the resulting excess free force fields to change the stored energy in the system without the operator performing extra work upon the system. So we advance the condition for violating this S-regauging, violating the exclusion of net A-regauging, and violating the "frozen gauge" process as

$$\nabla \bullet \mathbf{A} + \frac{1}{c}\frac{\partial \Phi}{\partial t} \neq 0 \qquad [22]$$

Any regauging of the potentials that complies with equation [22] will *a priori* produce one or more net excess forces in the system, as well as a change in potential energy of the system. By controlling the regauging, the system designer is then able to control where, how, and when these excess forces appear, and whether they enhance the system's operation or hinder it. These net forces can then be used to perform work and dissipate the excess potential energy taken on in the asymmetrical regauging. That is what we do when we ourselves add potential (and potential energy) to an EM system to enable it to do work! *If we always have to asymmetrically regauge the system to get it to do subsequent work, why do we not just let the system asymmetrically regauge itself so we get the input energy freely and also get the resulting work freely?* The gauge freedom axiom in quantum field theory assures us that nature will indeed freely change the potential energy of any system for us, if we but arrange it and permit it.

In short, we have had a gauge freedom principle for some time, which guarantees us that COP>1.0 EM systems are permitted and possible. Yet we have failed to realize it, or take any advantage of it. So we continue to pay to asymmetrically regauge (potentialized) all electrical power systems, and to insure that we have to continue to do it, we specifically design the systems so they will then re-enforce Lorentz's symmetrical regauging condition.

This is another of those "inexplicable aberrations of the scientific mind" referred to by Nikola Tesla!

2.2.3 A Humorous Comment but an Exact Analogy

Again see Figure 1-1 in Chapter 1, and see Figure 2-3. In Figure 2-3, we show how Lorentz's integration trick {174a, 174b} discarded the huge nondiverged Heaviside component of energy flow outside the conductor, while retaining the small Poynting component that strikes the surface charges and gets diverged into the conductor to power the electrons. In

justifying his integration trick, Lorentz stated that all the rest of that wasted Heaviside energy flow

See Panofsky & Phillips Classical Electnqtv and Magnetism. 2nd edn Addison Wesley 1962. p 178-181

The Lorentz procedure arbitrarily discards the enormous Heaviside component that misses the circuit entirely and is wasted This results in a non sequitur of first magnitude in EM energy flow theory

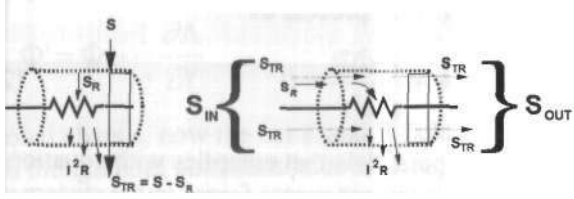

2-3a. Lorentz surface integration **2-3b. Actual S in and S out.**

Figure 2-3 Lorentz's integration trick to discard the enormous Heaviside non-diverged energy flow component

The Heaviside component is often 10 trillion times the Poynting component but is simply wasted in ordinary single-pass energy flow circuits

Heaviside component (nondiverged)

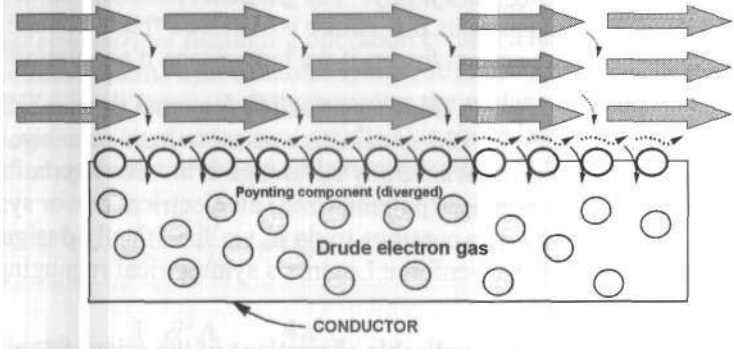

Figure 2-4 Heaviside nondiverged and Poynting diverged energy flow components.

(Figure 2-4) was "physically insignificant" (his term) because it did not strike the circuit, was not intercepted, and did not power anything. Well, Maxwell's theory is a material fluid flow theory, so let us evaluate Lorentz's justification in a fluid flow analogy.

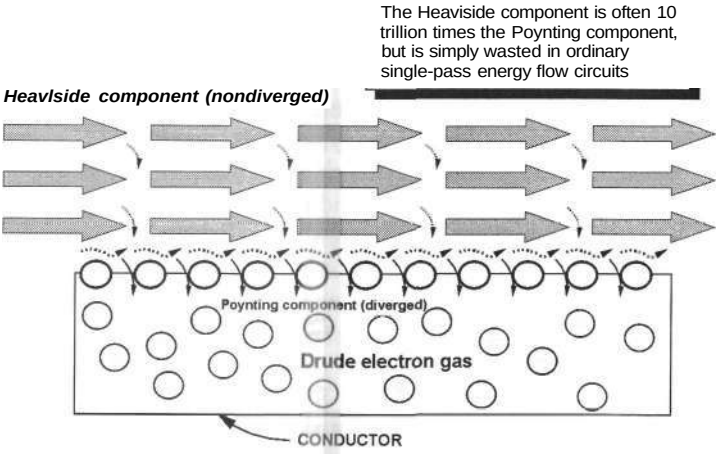

Figure 2-4 Heaviside nondiverged and Poynting diverged energy flow components.

Contrast Lorentz's statement if applied to the ocean wind on a sailing ship, where the wind represents the total energy flow and the ship represents a single Maxwellian system under consideration.

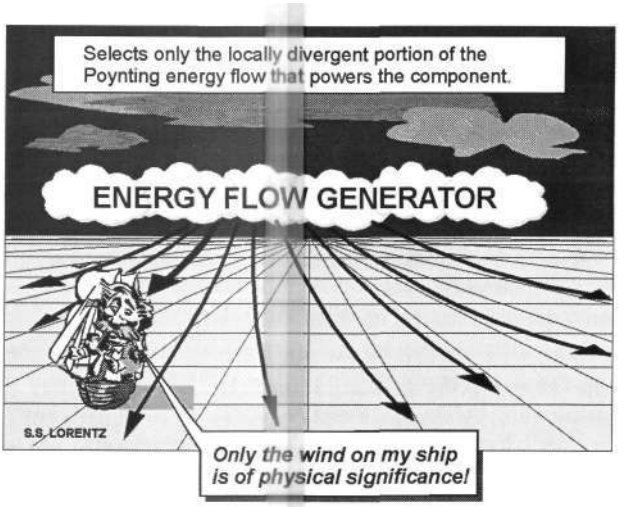

Figure 2-5 Lorentz in his sailing ship in an ocean wind, with no other ships around.

As shown in Figure 2-5, Lorentz's argument is analogous to stating that the huge component of the wind *that does not* strike the ship's sails is "physically insignificant" — in other words, it has no physical use. Now that is true for the single ship under consideration, as shown in Figure 2-5. None of that wind component that misses the ship's sails does anything at all to power *that ship* (that individual system). Hence it is indeed physically insignificant *to that ship itself.* Of course, if we flare the sails wider, the ship will catch more wind and develop more power. That is an analogy to the Bohren experiment, which resonates the charges (the "sails" intercepting the incoming EM energy flow "wind") so that they sweep out a greater geometrical cross section. Hence 18 times as much energy is caught, as when the charges are not resonated (the sails are not flared to a greater area).

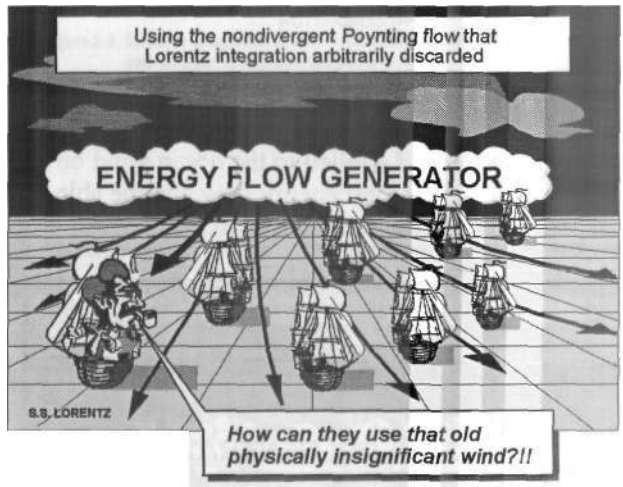

Figure 2 6 Lorentz in his sailing ship in an ocean wind, with many other ships alongside.

However, now see Figure 2-6. If we put some more ships (some more systems) with "intercepting and collecting sails" in there, they will be powered quite well with some of that "physically insignificant" wind. So Lorentz (following earlier work by Ludwig Lorenz) really did advance and impose upon electrodynamics a non sequitur of first rank.

And the wind-fluid analogy helps to "lighten things up" a bit here and inject a little good-natured humor!

2.2.4 Discussion

Equation [22] has now become the first *necessary but not sufficient* principle of asymmetrical self-regauging (ASR) for overunity electromagnetic engines and devices. That is, we are now free to A-regauge in a *nonconservative* field manner, where excess net force fields automatically appear and remain for our use in the system. All that remains is for the designer to:

(i) evoke "nonconservative" (asymmetrical) regauging in accord with equation [22];

(ii) have the system assembly in disequilibrium with its energetic external environment, so that the system itself performs this nonconservative A-regauging in some sector or part {175} of its normal operation,

(iii) insure that any "free force" that is produced and allowed to do work upon the system will do some positive work upon the system, so as to increase its collected energy, and

(iv) assure that the "free" forces that are otherwise produced by the circuit design (this includes, e.g., the back emf) do not seriously degrade the system (i.e., do not substantially reduce its energy available to dissipate as work in the load). Usually this means that, contrary to the standard closed current loop circuit, the circuit must not dissipate half its collected Poynting energy to dissipate the charges in the source dipole and destroy it. *These four considerations we now advance as the primary or master principles of asymmetrical self-regauging of electromagnetic engines and devices for permissible overunity efficiency.* We will meet additional principles in a later chapter when we discuss what the form of the energy output of an overunity EM system is, and the considerations for close-looping a COP>1.0 EM system into stable disequilibrium and continuous self-powering.

It is understood that the asymmetrical regauging portion of the circuit or system must be a broken symmetry in the energetic exchange between the active vacuum environment and that portion of the system. We exclude, g., solar cell-powered systems, windmill-driven generators, etc.

For simplicity, the system designer may wish to A-regauge only one potential, producing a desired "free" force F_1 to work on the system and increase its energy, while allowing any other extraneous force F_2 to appear, but just "bottling up" that additional force F_2 so that it cannot do any work at all on the system and therefore cannot degrade the system's operation. A most useful ASR corollary that immediately suggests itself is to simply A-regauge onto that force operation that normally produces the back-drag in a system or device, to either *eliminate* the back-drag altogether or reverse its algebraic sign so that it becomes an *assisting* force instead of a *hampering* force {176}.

In overunity systems, this becomes a startling and unexpected exercise in novel new phenomenology effected by tempic potential differences, tempic force, etc. It involves not only the system, but also the entire *supersystem* consisting of the physical system, its associated altered local vacuum, and its associated curved local spacetime. See Chapter 9 for our expose of these phenomena, and how one must transduce[54] the effects of a very novel kind of tempic force back emf, if the COP>1.0 system is to remain in disequilibrium with the active vacuum and thus maintain its stable COP>1.0 operation.

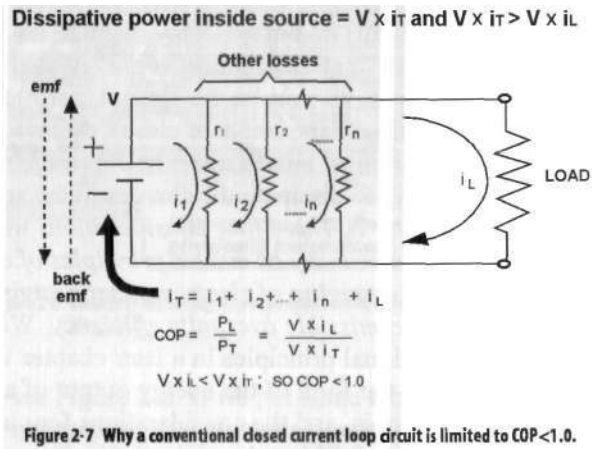

Figure 2-7 Why a conventional closed current loop circuit is limited to COP<1.0.

Again see Figures 2-3 and 2-4, and equations [20] and [21]. Electrodynamicists have previously *assumed away* the capability of work-

[54] A patent application on the process has been filed by John Bedini and the present author.

free "refueling" of an electromagnetic system directly from the local vacuum {177}. They have deliberately designed their systems *to prevent self-evoking and positively utilizing asymmetrical self-regauging of their own potential energy during system excitation discharge.* (See Figure 2-7).

In fact, by forcibly pumping the ground electrons from the external circuit back up through the primary source dipole in the generator or battery, our closed current loop circuits self-enforce the Lorentz condition and require that precisely half the regauging energy freely intercepted and collected in the external circuit is used to destroy the source dipole providing the regauging energy. This destruction of the energy source is accomplished faster than the external load is powered. Hence all such systems with losses are COP<1.0 systems. For more than 100 years, this "self-destroying, suicidal system" is the only kind of electrical power system our energy scientists and engineers have designed and built. To inject a little humor, we can only describe this in Tesla's words[55] as *"one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history."*

Thereby electrodynamicists have narrowed the inherent flexibility of the Maxwellian EM gauge theory model to an artificially symmetrized subset of Maxwell-Heaviside-Lorentz equations that utilize a single fixed gauge. This prohibits the free use of the system's vacuum energy freely received by the source dipole's broken symmetry in its violent exchange with the active vacuum. If the system increases its dipolarity (regauges freely), it simultaneously increases the speed at which it destroys the dipolarity! *Maxwell's equations themselves do not require this, and neither does Heaviside's truncation of them into the resulting Maxwell-Heaviside equations. Lorentz's symmetrical regauging of the Maxwell-Heaviside equations does require it.*

The Maxwell-Heaviside theory without Lorentz symmetrical regauging allows regauging asymmetrically to place the system in disequilibrium so that it freely receives and utilizes excess energy from the surrounding vacuum. Then it can again asymmetrically regauge by dissipating that freely received energy in an external load. *The theory specifically does not require destroying the primary source dipole as is done in the arbitrary closed current loop circuit between load and primary source dipole in the generator or battery.*

" Nikola Tesla, "The True Wireless, *Electrical Experimenter,* May 1919.

By arbitrary habit, electrodynamicists have discarded the Maxwell-Heaviside major EM overunity mechanism: *Asymmetrically self-regauging accomplished by the system itself, without requiring external work being done on the system by the operator,* in order to freely gather in and collect excess potential energy in the system from its broken symmetry with its active vacuum environment. In this self-A-regauging, associated *excess net force* does appear, whereupon that excess collected/stored regauging energy can then be used to "drive" the forces against load resistance and system losses to freely power the system and its loads {178}. They have also discarded the major overunity corollary whereby the designer is free to utilize *system self-regauging asymmetrically so that the normal back-drag or back-emfwork — usually done upon the system in its closed current loop configuration to reduce its kinetic energy — vanishes or reverses sign and becomes beneficial work done in the opposite sense, to freely increase the energy ofthe system.*

The failure to do this is bluntly met with, when one does succeed in producing a COP»1.0 system momentarily by suddenly and very powerfully breaking the system's equilibrium in its vacuum energy exchange. Nature then exhibits a very novel kind of Dirac sea hole reaction (powered by tempic force generated in the locally curved spacetime and resulting effects generated in the altered semiconducting vacuum). This reaction sharply jerks the system (or the system plus its external power supply) back into equilibrium and COP<1.0 operation. In Chapter 9, apparently for the first time in the literature[56] we present this novel mechanism exhibited by nature as a new kind of "tempic back emf phenomenon in systems in disequilibrium. We also explain how to handle the problem and in general how to use it for "freeze-framing" and stabilizing the system's disequilibrium operation in sustained COP > 1.0 configuration while powering itself and its load.

All that is required for "self-powering" COP»1.0 EM engines directly powered by the vacuum, is that (1) initially the engine must asymmetrically self-regauge to produce COP»1.0, and (2) positive *transduced* feedback (from the output) of a very special and previously unknown kind — where negative energy is transformed into normal electron current and energy — must be utilized to its input, in a clamped

[56] The basis for it, however, is in Dirac's electron theory published in 1930, nearly three quarters of a century ago. See P. A. M. Dirac, "A theory of electrons and protons," *Proceedings of the Royal Society of London, Series A,* 126(801), Jan. 1, **1930, p. 360-365.**

and controlled fashion {179}. The clamped positive feedback can be designed and applied, once the fundamental engine is designed for self-regauging and overunity efficiency, and once the novel feedback and transformation requirements are understood and incorporated. The remaining excess output can then be utilized to power loads, while the engine seemingly "powers itself."

We stress, of course, that this system is just analogous to the windmill, and it continuously receives a "free energy wind" from its active environment. The conservation of energy law is obeyed at all times, as are physics and thermodynamics.

In a later chapter we present the concepts and processes for these novel phenomena involved in close-looping a COP>1.0 system for self-powering operation.

2.3 The Suicidal Closed Unitary Current Loop Circuit

The present Lorentz-Maxwell-Heaviside theory, by which EM circuits and electrical power systems are designed, produces only systems in net usable equilibrium with the active vacuum, specifically during the symmetrically regauging discharge of the circuit's excitation energy (Figure 2-7). Hence all present EM systems designed by that model rigorously conform to classical equilibrium thermodynamics, and exhibit a coefficient of performance (COP) of COP<1.0.

Since the Maxwell-Heaviside equations do not restrict the designer to systems in equilibrium with their active environment, some ubiquitous characteristic of the standard circuit approach must be self-enforcing the Lorentz symmetrical condition as far as using any excess free potential energy of the system to freely power loads. That is the closed-loop circuit, as we have discussed. Let us now illustrate what goes on in such a circuit.

Taking into account Figure 2-4, Figure 2-8 shows a modified diagram of what is actually happening between the vacuum and the dipole to power the circuit. Figure 2-9 shows how a pair of conductors constitutes an extended series of parallel dipoles. Once the dipole is formed by dissipating some chemical energy in the battery, the dipole extracts energy from the surrounding vacuum and pours it out of the battery terminals, producing an energy flow filling space around the conductors of the external circuit. Only a very small portion (Figure 2-4) of the very large energy flow is intercepted by the external charges in the conductors, and diverged into the conductors to power up the Drude electrons.

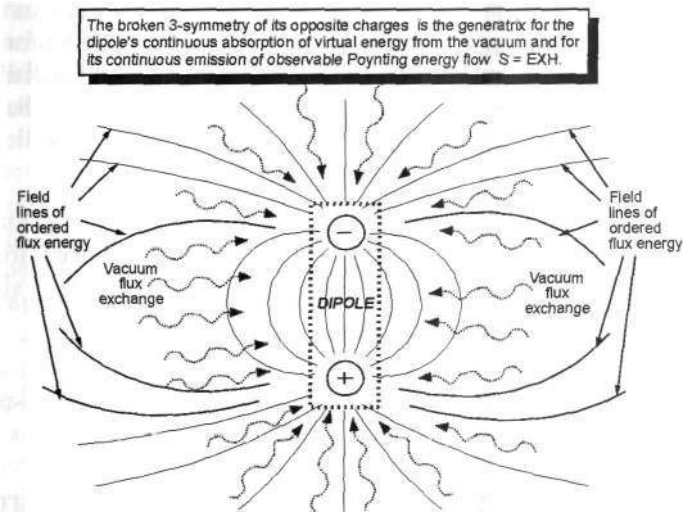

Figure 2-8 Virtual photon flux exchange intensity **with the charges of a** dipole.

As can be seen from Figure 2-7, half of the energy collected upon the internal electrons to drive them as $j\phi$ is expended as work required to pump the spent electrons from the ground return wire back through the source dipole in the battery. This scatters the charges of the dipole (in this case, by changing the chemistry of the battery plates) and destroys the dipole. The other half of the collected energy is dissipated in the external circuit's losses and in the load.

Then some more chemical energy has to be dissipated by the battery to perform work upon the internal charges and restore the dipole (in this case, to change the plate chemistry of the battery plates). So even if this process is 100% efficient, the battery has to dissipate as much chemical energy as was electrically dissipated upon those former dipole charges to scatter them and destroy the dipole.

In Figure 2-7, we show the small internal resistance of the conductors, as well as the load resistor. Half the energy dissipated by $j\phi$ is expended just to forcibly ram the spent electrons back through the back emf of the source dipole. The other half is expended in the circuit's internal losses and in the load resistance. Therefore, less energy is expended as usable work in the resistive load than is expended to destroy the dipole and cut off the flow of free EM energy from the vacuum.

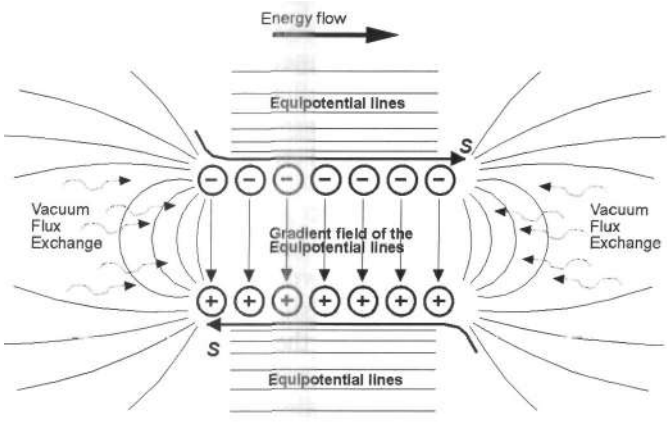

Figure 2-9 Paired conductors as an extended set of dipoles.

The battery has to input as much energy to restore the dipole as was used to destroy it. The battery has to expend at least as much chemical energy as equals half the entire energy originally collected in the external circuit and expended as $\int j(t)\phi(t)dt$. It must expend chemical energy $CE \geq \frac{1}{2} \int j(t)\phi(t)dt$. The energy RE dissipated as work in the load resistor R is $RE < \frac{1}{2} \int j(t)\phi(t)dt$. Thus CE>RE, and this system is forced to exhibit

$$COP \equiv \frac{RE}{CE} = \frac{< \frac{1}{2} \int j(t) f(t) dt}{\geq \frac{1}{2} \int j(t) f(t) dt} \Rightarrow COP < 1.0 \quad [23]$$

As can be seen, this system symmetrically regauges itself during its excitation discharge, so that it self-enforces the Lorentz condition during that period. The circuit self-enforces COP<1.0, even though all the energy — both the energy powering the external circuit and also destroying the internal source dipole in the battery to enforce the Lorentz condition during discharge — is freely received from the active vacuum via the broken symmetry of the source dipole,[57] once established, in its energetic exchange with the active vacuum.

[57] The broken symmetry of opposite charges is one of the broken symmetries predicted by Lee, {13a} and by Lee, Oehme, and Yang, {13b}. Broken symmetry was proven experimentally in early 1957 by Wu *et ai,* {14}. So profound were the implications for physics that the Nobel Prize was awarded to Lee and Yang in latter 1957, the same year! E.g., see T. D. Lee, "Weak Interactions and Nonconservation of Purity," Nobel Lecture, Dec. 11, 1957 in *T. D. Lee, Selected Papers,* Gerald **Peinbcrg,** Ed., Birkhauscr, Boston, 1986, Vol. 1, p. 32-44.

The problem is that *the source dipole is destroyed faster than the load is powered,* as shown in Figure 2-7. Because of the inexplicable scientific pre-occupation with the conventional closed current loop circuit, the planet and biosphere have been increasingly polluted for more than a century, by burning more hydrocarbons, building more dams, using more nuclear fuel rods, etc. to provide ever more electrical energy.

2.4 In Summary

COP>1.0 operation in EM systems via work-free *asymmetrical* regauging has been inherent in the Maxwell-Heaviside equations for more than a century. Since Lorentz first did so circa the latter 1880s, electro-dynamicists have just conveniently and arbitrarily *assumed away* COP>1.0 systems by (i) artificially limiting the theory to only that fraction of Maxwell-Heaviside systems in usable net force field equilibrium in their vacuum exchange during their excitation discharge, and (ii) using the ubiquitous closed current loop circuit to self-enforce the Lorentz symmetry condition during that excitation discharge. In other words, our engineers have only been building systems which self-enforce the overly restricted Lorentz-regauged theory.

Electrodynamicists have never seriously tried to build overunity circuits, nor until recently have they explored the discarded Maxwellian systems by removing the Lorentz regauging condition and examining EM energy from the vacuum.[58]

[58] Under the directorship of Dr. M.W. Evans, the Alpha Foundation's Institute for Advanced Study (AIAS) has been gradually developing the physics of EM systems far from equilibrium with their active environment (the local active vacuum and local curved spacetime). Some of the papers of interest are: M. W. Evans et al., "Derivation of the Lehnert field equations from gauge theory in vacuum: Space charge and current," *Found. Phys. Lett,* 13(2), Apr. 2000, p. 179-184; Evans et al., {38b}, {38c}, {113b}, {233a}, {233b}, {233e}; {233g}, {233j}; Evans et al., "Schrodinger Equation with a Higgs Mechanism: Inherent Vacuum Energy," *Found. Phys.* (in review); — "Vacuum Energy Flow and Poynting Theorem from Topology and Gauge Theory," *Physica Scripta* (in review); — "Energy from the Vacuum," *Physica Scripta* (in review); — "Some Notes on Asymmetric Regauging", *J. New Energy* 4(3), Special Issue, Winter 1999, p. 325-326; — "Inconsistencies of the Maxwell-Heaviside Theory of Electrodynamics: The Aharonov-Bohm Effect," *J. New Energy,* 4(3), Special Issue, Winter 1999, p. 236-240; — "Spontaneous Symmetry Breaking as the Source of the Electromagnetic Field," *Found. Phys. Lett.* (in press), A monumental work. *Modern Nonlinear Optics,* Second Edition, 3 vols., ed. M. W. Evans, Wiley, 2001 gives a broad coverage of higher group symmetry electrodynamics and energy from the environment (the local active vacuum and the

Every electrical power system ever built is and has been powered by electrical energy freely extracted from the seething vacuum exchange with the source dipole in the system, due to that dipole's broken symmetry. But the engineers and scientists have designed and built only those electrical systems which self-enforce Lorentz's symmetrical regauging.

The time for energy scientists and engineers to correct this procedure and cease this inane practice is long overdue, following the direction pointed out by the AIAS.

local curved spacetime). Some 60 AIAS papers are published as a Special Issue of **the** *J, New Energy,* 4(3), Winter 1999. More than 100 AIAS papers are also carried on DoE restricted website http://www.ott.doe.gov/electromagnetic/.

Chapter 3

Giant Negentropy, Dark Energy, Spiral Galaxies and Acceleration of the Expanding Universe

"... the discoveries made in 1957 established not only right-left asymmetry, but also the asymmetry of the positive and negative signs of electric charge. In the standard nomenclature, right-left asymmetry is referred to as P violation, or parity nonconservation. The asymmetry between opposite signs of electric charge is called C violation, or charge conjugation violation, or sometimes particle-antiparticle asymmetry." [T. D. Lee]. {180}

"The ends of a dipole, being oppositely charged, exhibit charge conjugate symmetry violation. An 'isolated' charge, considered with its clustering virtual charges of opposite sign, also exhibits symmetry violation." [T. E. Bearden, this book, below].

"A generally acceptable, rigorous definition of radiation has not as yet been formulated." ... "The recurring question has been: Why is it that an electric charge radiates but does not absorb light waves despite the fact that the Maxwell equations are invariant under time reversal?" [B. P. Kosyakov]. {181}

"It [the energy transfer flow] takes place, in the vicinity of the wire, very nearly parallel to it, with a slight slope towards the wire... . Prof Poynting, on the other hand, holds a different view, representing the transfer as nearly perpendicular to a wire, i.e., with a slight departure from the vertical. This difference of a quadrant can, I think, only arise from what seems to be a misconception on his part as to the nature of the electric field in the vicinity of a wire supporting electric current. The lines of electric force are nearly perpendicular to the wire. Their departure from perpendicularity is usually so small that I have sometimes spoken of them as being perpendicular to it, as

they practically are, before I recognized the great physical importance of the slight departure. It causes the convergence of energy into the wire. " [Oliver Heaviside]. {182}

"The funny thing about the dark matter is it doesn't show up in light, X-rays, gamma rays, infrared, ultraviolet, radio waves, or submillimeter. We're running out of places to look for it." [William Keel]. {183}

"... baryonic, ordinary matter — the stuff of stars and of people — makes up just over 4% of the energy and matter in the universe. ...about 30% of the stuff in the universe is dark [unobserved] matter. The remaining two-thirds, theorists believe, is a mysterious 'dark energy' or 'quintessence' — a large-scale antigravity-like effect that is making the universe expand ever faster.... " [Charles Seife]. {184}

"And yet, curiously enough, we do not know exactly what charge is, only what it does. Or, equally significantly, what it does not do."[M. P. Silverman]. {185}

*"**Charge** is the ongoing circulation of EM energy flow between the time and 3-space domains, as seen by the observer. Negative charge is the ongoing absorption of EM energy input from the time domain (from ict), transduction of the absorbed energy into 3-space EM energy, and re-emission of the EM energy in all directions in 3-space. **Positive charge** is the ongoing absorption of EM energy input from 3-space, transduction of the absorbed energy into the time domain, and re-emission of the EM energy in the time domain. If we wish, we may also consider the positive charge as radiating negative energy, while the negative charge radiates positive energy. Once we consider vacuum polarization, we recognize that this circular flow process is involved at each "dipolar point" of the polarized vacuum. "* [T. E. Bearden, this book, below].

"The matter density of the Universe is extremely low. On average there might be one atom per cubic metre of space. The major constituent of the Universe is believed to be some kind 'dark energy', which is pushing the Universe apart. " [Matthew Colless]. {186}

3.1 Broken 3-Symmetry of the Dipole

To recap from Chapters 1 and 2: In 1956, Lee and Yang {187} strongly predicted broken symmetry in physics, suggesting experiments to detect it in the weak interaction. In early 1957, Wu *et al.* {188} experimentally demonstrated broken symmetry, thus furnishing the experimental substantiation of broken parity in the weak interaction. The emergence of broken symmetry was such a dramatic change to the view of physics, that in December of the same year, 1957, Lee and Yang were awarded the Nobel Prize.

One of the asymmetries shown by Lee *et al.* is the asymmetry of opposite charges. That means that a dipole, which consists of slightly separated opposite charges, exhibits broken symmetry in the seething vacuum virtual particle flux. In short, a dipole — any dipole or dipolarity — must absorb or receive virtual photon energy from the active vacuum, integrate at least some of it to observable state, and re-radiate that integrated EM energy in observable form in 3-space.

We stress: *The ends of a dipole, being oppositely charged, exhibit broken symmetry. An 'isolated' charge, considered with its clustering virtual charges of opposite sign, is a set of composite dipoles and also exhibits broken symmetry.*

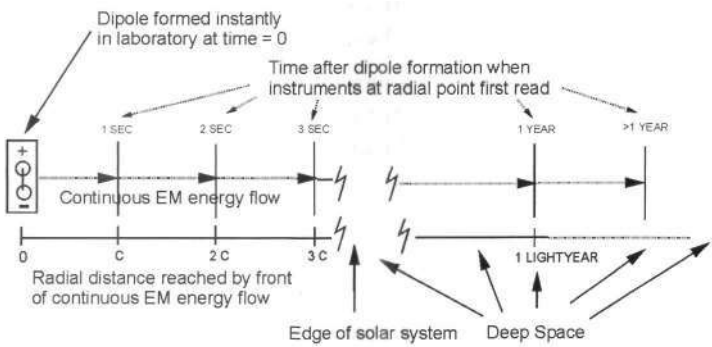

Figure 3-1 The source dipole experiment, demonstrating continuous energy flow.

Let us now consider a gedanken experiment, as shown diagrammatically in Figure 3-1, to illustrate Kosyakov's quotation cited above. At a point in the laboratory corresponding to the origin of a 3-dimensional frame, a dipole is produced instantly by separating charges, such as in a flash-charged ca**pacitor.** Along two radial lines in 3-space from that origin, we have

previously placed perfect EM field and potential detectors, at distances *ct* apart, where *t*= 1, 2, 3, 4, *n*,... and so on in seconds, with the radials extending across the universe, and where c is the speed of light. We neglect the transient pulse that momentarily occurs at each instrument package, since we are examining steady state conditions.

At the end of one second, the instruments at $t = 1$ instantly read, and those readings remain thereafter. One second later, the instruments at $t = 2$ instantly read, and those readings remain thereafter. And so on with each of the instruments progressively farther from the origin reading at the proper light-time travel, and with all field readings then *remaining continuously* thereafter.

This gedankenexperiment demonstrates that what is emitted from the dipole, from its moment of creation at the origin, is a continuous flow of EM energy in all directions in 3-space.[59] This energy continuously flows from the dipole, indefinitely or as long as the dipole physically exists. Other than paying once to initially separate the charges and make the dipole, we have neither added nor input any additional energy. Yet energy continues to flow out from the dipole in all directions, unceasingly, as shown by the continued of the reading on each field energy density instrument, once the leading edge of the energy outpour reaches that instrument and passes it by. In short, the experiment shows that it is not a "pulse" that passes each instrument, but a continuous and sustained flow of EM energy, remaining steadily thereafter so long as the dipole remains.

One year after making the dipole, the instruments at one light year distance suddenly read, and their readings remain. *The energy density of a volume of space one light year in radius has now been changed, and that change in spatial energy density continues to spread outwards at light speed.*

[59] More exactly, what is observed is a spreading change in the energy density and point-like polarization of the vacuum itself, and of the local curvature of spacetime. At each point, once the change of energy density and ST curvature occur, the energy density and ST curvature remain fixed in a new equilibrium condition, steadily fed by the energy radiating from the dipole. See our point made in {181}. The discovery of giant negentropy {12} requires a change in how we view the very process of energy propagating in space. Now it has become a quite different *propagation of energy circulation between time and space domains at each affected point in space.*

Yet there has been no input of *observable 3-space* EM energy flow to the dipole whatsoever, as our instruments also verify. All observable energy flow in 3-space is *outward* from the origin where the dipole is located.[60]

We have shown that the *observable* EM energy flow from a source dipole is not conserved in 3-space, which is consistent with a broken 3-symmetry since symmetry implies conservation. Either we must discard the conservation of energy law altogether, or it must be conserved in 4-space since we have proven the dipole does not conserve energy in 3-space. If we assume that the experiment must conform to the conservation of energy law, then 4-symmetry EM energy flow must exist since 3-symmetry energy flow is broken. The energy steadily pouring out of the dipole in all directions in 3-space must therefore be received by the dipole *charges from the time-domain*,[61] assuming we are working in Minkowski 4-space. In particle physics, this is essentially the same as receiving the energy from the virtual domain, and therefore is consistent with the proven broken symmetry of every dipole and dipolarity.

The energy flow is indeed received from the time domain, as we have argued {189} in a wave manner consistent with (i) quantum field theory as shown by Mandl and Shaw in the photon model {190}, (ii) broken charge conjugation symmetry of particle physics using the virtual photon and observable photon concepts, and (iii) a re-interpretation of Whittaker's decomposition of the scalar potential {191} when applied to the scalar potential between the ends of the dipole {12}.

We state the obvious: A dipole is a Maxwellian system. This gedanken experiment also proves by demonstration that a Maxwellian system — e.g., a dipole — is permitted by the laws of nature, physics, and thermodynamics to output more energy than the operator inputs, since we

[60] Obviously, we are utilizing the prevailing notion of the flow of energy through 3-space, which is actually a non sequitur. No 3-space observable entity can "move" in 3-space alone; it requires time to move, and so any movement is in 4-space a priori. We previously discussed this and the *dldt* operator being applied by the observation process. But for simplicity, we are using the conventional view here, so the negentropy of the dipole can be easily grasped.

[61] Again, we have stated the positive time case only. In the spreading special 4-circulation, energy appears in 3-space at each point dipole from the time domain (courtesy of the action of the negative charge of the dipole), and then returns from 3-space back to the time domain (courtesy of the action of the positive charge, which is a time-reversal of the action of the negative charge).

input nothing to the source dipole[62] once we have made it. After paying to produce the dipole initially, the operator has made no other energy input to the dipole at all, yet the dipole will continue to pour out observable energy in 3-space for the next 14 billion years if the dipole remains and is not destroyed. In addition, every positive charge and every negative charge in the universe form a dipole, regardless of the separation distance between them. That dipole is also performing the gedanken experiment process. Every dipolar EM circuit contains innumerable such dipoles — e.g., across "open paths" between the various points in the circuit, as shown by Kron {192}. Kron {193} stated:

> *"... the missing concept of "open-paths" (the dual of "closed-paths") was discovered, in which currents could be made to flow in branches that lie between <u>any</u> set of two nodes. (Previously - following Maxwell - engineers tied all of their open-paths to a single datum-point, the 'ground'). That discovery of open-paths established a second rectangular transformation matrix... which created 'lamellar' currents... " "A network with the simultaneous presence of both closed and open paths was the answer to the author's years-long search."*

By considering all dipoles in the universe, one has in fact finally defined Kron's open path. One has also defined the master mechanism responsible for the incredible EM energy density of the vacuum — the so-called "zero-point EM energy". Overall, every electrical circuit thus has innumerable energy flow broken 3-symmetries in it, with respect to exchange of EM energy flow between the time and 3-space domains. To sum all these broken 3-symmetries to an overall net 3-symmetry during the discharge of the free excitation energy of the circuit, obviously requires some specific macroscopic cohering function in the circuit. Moreover, one exists. Specifically, the closed current loop between the external circuit attached to the generator and the internal source dipole created between the terminals of the generator, is what enforces the circuit's net 3-symmetry and Lorentz symmetrical regauging. That is an arbitrary man-made condition, and not a law of nature, physics, or thermodynamics.

[62] Or to a charge with its clustering virtual charges of opposite sign, if we redo the experiment with a single "isolated" observable charge and consider it more exactly as a set of composite dipoles, each of which exhibits broken symmetry in the vacuum virtual particle flux.

By our gedanken experiment's demonstration and the existence of innumerable disequilibria between the active environment[63] and the system in an ordinary EM circuit, it follows that a Maxwellian circuit must be *capable* of exhibiting a coefficient of performance (COP) of COP>1.0. It is a giant collection of open dissipative systems, far from equilibrium in the vacuum exchange.

That concept of course is contrary to the entire present mindset of electrical engineering and Maxwell-Heaviside-Lorentz classical electrodynamics. Those disciplines merely continue to accept the source charge as if it freely created from nothing all that energy in its associated fields and potentials reaching across the universe. Ironically, so long as the giant negentropy of the common dipole and its disequilibrium with its active environment (the local active vacuum and the local active curvatures of spacetime) are unaccounted, engineers and scientists will continue to produce the inane Lorenz/Lorentz-regauged power systems they produce today and have produced for more than a century. Also, they will continue — wittingly or unwittingly — to implicitly prescribe that every charge and dipole in the universe violates the conservation of energy law and is thus a *perpetuum mobile* of the grossest kind: a system which massively and continuously creates EM energy from nothing.

We now point out something deeper and very important. In modern physics, the *observed* positive charge is regarded as the time reversal of the *observed* negative charge. See Figure 3-2. If the negative charge is responsible for EM energy flow from the time-domain into 3-space, then *as observed* the positive charge must represent a time-reversed situation. We observe time reversal in the charge domain as a parity reversal and a charge reversal, but with the energy remaining positive. In other words, one imagines that one records a process on videotape, and then runs the video backwards to observe the "time-reversed" situation. When observed, both the sign of the positive charge and its direction of motion appear to us to be reversed from the negative case.

[63] In paragraph 3.10 and in Chapter 9 we will introduce — more deeply — the notion of the supersystem, consisting of three parts: (1) the system and its dynamics, (2) the active vacuum and its dynamics, and (3) the active spacetime curvatures and their dynamics. All three components of the supersystem interact with each other. In our gedanken experiment, the system (component 1) must receive the excess energy from the system's external environment, which consists of components 2 and 3 of the supersystem.

It follows that the positive charge as observed involves a flow of (positive) energy from 3-space back to the time domain. If we wish, before observation we can accept that "observed positive energy inflow" as an unobserved outward radiation of negative energy. Thus, a dipolarity involves a continuous flow of energy from the time domain into 3-space, and back from 3-space into the time domain (Figure 3-2). The energy flow circuit (circulation) is completed by a remaining energy flow across the dipolarity in the time-domain only, from the positive charge where the energy enters the time domain, to the negative charge where it exits again.[64]

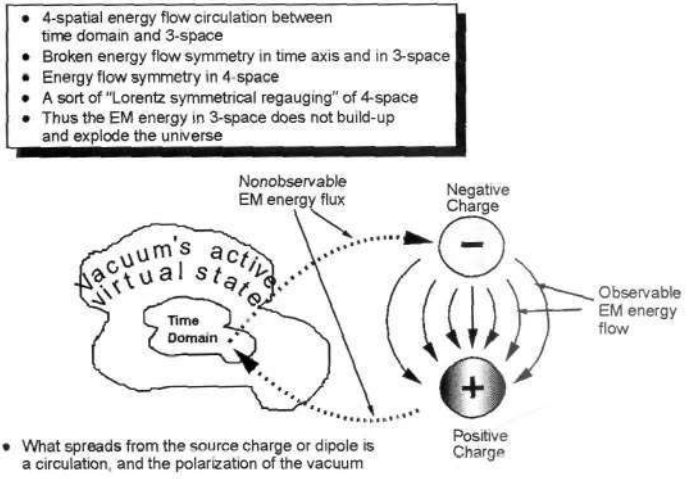

Figure 3-2 Circulation of energy flow in a dipole, between time domain and 3-space.

[64] Rigorously, we should speak of +*qt* and -*qt*. Charge *q* is an observable, and therefore an instant frozen snapshot. No observable exists continuously in time, but instead it recurs continually as the photon interactions — iteratively producing the *d/dt* (LLLT) = LLL observations — continue. The moment a charge *q* absorbs a photon, it changes to *qt* in form. The moment the charge-time *qt* emits a photon, it changes back to *q* in form. This incessant change of *q* -> *qt* -> *q* -> *qt* —» .... is continual, at every level of the macroscopic charge, with its entire ensemble of photon interactions, including both virtual and observable photon interactions. As can be seen, the "charge as it persists" and "moves through time" has a rich dynamic substructure essentially ignored in present electrodynamics. It is, however, recognized by leading theoreticians and Nobelists.

However, even each of the clustering virtual charges and each of the differential charges of the observable charge, may be further broken into a central charge and clustering charges of opposite sign, in the modem view of the vacuum and its polarization. Hence, at any level — electron or positron — we actually have a dual and slightly separated bidirectional flow, at least in the observable equilibrium condition. The "positive energy" and positive flow of time is usually associated with "inert" matter with the electrons on the outside, so that the observer observes normal matter through the "forward time" situation mostly. Hence much of the accompanying backwards or time-reversed flow — from the positive charges in the nuclei, etc. — is "buried in the vacuum virtual state" in the Dirac sea and in Dirac sea hole flows.

Indeed, the vast hierarchy of nested structures and nested dynamics in charge as it exists in the vacuum, is recognized in physics, as is the fact that it involves infinite energy. E.g., quoting Nobelist Weinberg {194}:

> *"[The total energy of the atom]... depends on the bare mass and bare charge of the electron, the mass and charge that appear in the equations of the theory before we start worrying about photon emissions and reabsorptions. But free electrons as well as electrons in atoms are always emitting and reabsorbing photons that affect the electron's mass and electric charge, and so the bare mass and charge are not the same as the measured electron mass and charge that are listed in tables of elementary particles. In fact, in order to account for the observed values (which of course are finite) of the mass and charge of the electron, the bare mass and charge must themselves be infinite. The total energy of the atom is thus the sum of two terms, both infinite: the bare energy that is infinite because it depends on the infinite bare mass and charge, and the energy shift... that is infinite because it receives contributions from virtual photons of unlimited energy."*

Here again we have met Kron's "open path" in a new and unrecognized form.

Hopefully we now are in a position to rigorously define charge — or try to — for the first time in physics.[65] **Charge** is the ongoing circulation of EM energy flow between the time and 3-space domains, as seen by the observer. **Negative charge** is the ongoing absorption of positive EM energy input from the time domain (from ict), transduction of the absorbed energy into positive 3-space EM energy, and re-emission of the EM energy in all directions in 3-space. **Positive charge** is the ongoing absorption of EM energy input from 3-space, transduction of the absorbed energy into the time domain, and re-emission of the EM energy in the time domain. Or contrary-wise, one may regard the positive charge as the ongoing absorption *of negative* EM energy input from the time domain, transduction of the absorbed negative energy into 3-space, and re-emission of the negative EM energy in all directions in 3-space. The negative charge then absorbs the negative EM energy impinging on it from 3-space, and transduces it into negative energy flowing back into the time domain.

Any *overall* curvature of spacetime, as seen by the observer, results in one of the two flows *predominating* as seen by the observer. Usually, at COP < 1.0, this Dirac sea hole current does not bother our circuit's operation, but remains confined to the local vacuum. It is often not bothersome or is minor for other than very high COP's. The reason is that, for such moderate and small COP's, most of the Dirac sea hole currents react either with (i) the seething local vacuum virtual particle cauldron, or (ii) the atoms in the material lattice to form lattice holes.

As the COP increases, the fraction of Dirac holes interacting with the lattice to form lattice holes increases. As the COP further increases greatly, a large fraction of the Dirac sea holes do not react with the local vacuum cauldron (they become stable forms in that cauldron) or the lattice, but flow into the input section of the system to react with and "eat" incoming electrons from the external power source.

If the inflow of electrons is insufficient to fill the arriving Dirac sea hole current at the input section, the hole current passes back into the feeder line and into the distant power source, eating electrons all the while. This

[65] This is still a first order, macroscopic definition. For a more comprehensive statement, one must spell out the hierarchy and dynamics of the virtual state, the participating mass of the charged particle and its generatrix, the operations and dynamics of the *d/dt* observation operator, etc. We have not yet succeeded in getting all that into a single reasonable but sufficiently short statement!

includes eating electrons in the distant power source, which simply "sees" that it must furnish additional current and voltage (power) toward the distant circuit or system.

In that operational COP region where strong interaction with the lattice occurs, the attachment of the lattice positron (lattice hole) to the mass of the atom or other ion, results in a very sluggish response of the overall ion with EM fields, compared to the response of an electron or a negative energy state electron hole (Dirac sea hole). Hence much of conventional electrical power circuit theory ignores the lattice holes and hole currents which no longer have negative energy because they have reacted and been "observed". Semiconductor designers, however, account for it and handle it in the semiconductor (in a given range of operation) primarily by the use of donor and acceptor materials.

At COP»1.0, however, the Dirac sea hole current must be strongly taken into account because it produces substantial and novel new effects in the power system itself. This Dirac sea hole current "flows in reverse" with respect to the circuit — from output back to the input. In short, it flows *through the vacuum* from the output section of a unitary COP»1.0 system, back through the middle section of the system, and back into the input section where it "eats" incoming electrons from the external power supply. The power supply thus must furnish electrons to "kill (power the killing of) the Dirac sea hole current arriving in the input section", while still furnishing the necessary amount of additional electrons to power the circuit's losses and loads.

The hole current arriving back in the input section of the unit poses an additional "power system load". These holes must be filled with incoming electrons (which disappear into the Dirac sea hole in the vacuum without radiation, due to the concomitant relaxation or change of the local curvature of spacetime) before any incoming electrons are left to power the circuit in normal fashion. So the hole current appears as a highly undesired extra "load" formed in the input and "eating input power from the external power supply".

We further discuss this situation and how to deal with it, in Chapter 9.

Finally, we propose a formal modification of the concept of "EM energy flow through space" (perhaps the first since its formulation independently by Heaviside and Poynting). The EM energy flow connected with the charge is a circulation of EM energy flow between the time domain and 3-space and back, *as a result of dipolarity*. This 4-circulation flow occurs at every point in 3-space (at every point dipole in the 3-space vacuum).

The formation of an observable charge results in an immediate, continuing, spreading re-organization (polarization) of the polarization of the vacuum virtual particle flux itself. It is this *spreading polarization of the vacuum* — and its accompanying giant negentropy EM energy flow circulation in 4-space connected with the spreading dipolarity and the observable "source" charge — that moves outward in all directions at the speed of light in 3-space from the newly formed charged particle or group of them.

We also define charge itself as that *continuously spreading dipolarity in 3-space*[66] accompanied by the giant negentropy EM energy flow 4-circulation from the time domain to 3-space and back.

The giant negentropy circulation in 4-space — represented by the spreading vacuum point-polarization and hence broken 3-symmetry — is what (observably) moves out in all directions from the newly formed observable charge. Since we "observe" only the 3-space aspect, we "see" it as the spreading appearance of 3-space EM energy (the polarization change of the vacuum itself) moving in 3-space, because we "see" it as the iteratively observed frames of a motion picture. *As observed,* that is one way of expressing it. As it actually *exists and happens prior to observation?*[67] the so-called "flow of EM energy in space" is not that at all. It is the radial spread of the appearance of a giant 4-space negentropy EM energy flow circulation between the dipoles formed in the polarization of space. In that process, the special 4-symmetry between time and space is maintained but with broken 3-energy flow symmetry and broken time-energy flow symmetry with respect to the 3-space observer.

[66] I.e., the spreading partial restructuring and re-organization of the vacuum energy or energy flux.

[67] The sharp-eyed reader will note that we clearly distinguish between the operation of a "tree falling in the forest" without an observer to see it, and a "tree falling in a forest" as an observer sees it. Without observation, there is no observed tree, no observer, and no "observed falling". Yet there exists the "tree x time", the "observer x time", and the "falling x time" whether or not their observation occurs with its resulting *d/dt* differentiation operation. One set (the causal set) is 4-spatial, and the other set (the event set after observation) is 3-spatial. The cause is 4-spatial and unobserved, and the effect is 3-spatial and observed. They are not the same, though related by the *d/dt* observation operator and by the interaction of the 4-space cause with a previous 3-space frozen observation to change it to a new 3-space frozen observation. Note that one can and does have a cause without an effect in any legitimate theory of causality, but not an effect without a cause. The cause only assumes the potential for interaction and observation, whereas the effect assumes that the interaction has occurred, yielding the observation as the effect.

The 4-circulation (giant negentropy) of the EM energy flow "from" or "connected with" a charge, is intimately connected with the spin of the charged particle, since the charged particle spins in both the time domain and in 3-space, as discussed in paragraph 3.3 below. We believe the spin itself is the basic giant negentropy generator.[68] If that hypothesis is true, then giant negentropy, the circulation of EM energy between time-domain and 3-space and back, broken 3-symmetry and broken time-energy symmetry (as seen by the observer), the flow of EM energy through space (as observed), the nature of charge itself, and polarization of the quantum mechanical vacuum are all just different sides of the same coin.

Without amplification, we state that his giant negentropy outflow process has additional important ramifications in electrodynamics, general relativity, particle physics, and unified field theory. However, we leave further discussion of the subject for a future paper or book and for the advanced theorists.

3.2 Reinterpreting Whittaker's Decomposition of the Scalar Potential

As previously stated, we applied and re-interpreted Whittaker 1903 decomposition of the potential {85} between the ends of the dipole. The scalar potential is actually a harmonic set of bidirectional longitudinal EM wavepairs, where each wavepair consists of an outgoing EM longitudinal EM wave in real 3-space and an incoming EM longitudinal EM wave in the complex plane. Hence we have a new and novel EM energy flow symmetry in 4-space, where (as seen by the observer) the broken 3-symmetry of the dipole has removed the usual arbitrary imposition of an additional condition of 3-space energy flow symmetry as well. Simply making a dipole permissibly breaks the 3-space conservation of energy flow symmetry, and moves to 4-dimensional conservation of energy flow. Both EM energy conservation in 3-space and in the time domain are individually broken, but conservation of energy flow is now upheld between the time-domain and the 3-space domain. In blunt terms, we "consume a little time" to get any EM energy that exists in 3-space.

[68] We leave to a future sharp young graduate student the business of expressing the angular momentum (spin) of the charged particle as a result of giant negentropy in EM energy flow between the time domain and 3-space. It can probably be done by deeply considering the giant negentropy process for an "isolated" observable charge considered as also containing its clustering set of virtual charges of opposite sign.

The broken symmetry of a source dipole — or of a source charge considered with its clustering virtual charges of opposite sign as a set of dipoles — produces a continuing giant 3-negentropy, as seen by the observer. He only sees the steady 3-space outpouring of energy, and sees that it will continue as long as the dipole or charge remains intact.

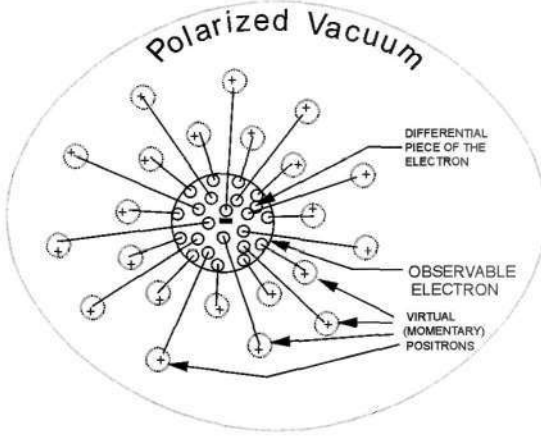

Figure 3-3 Observable electron charge as a set of composite dipoles.

To clarify the "isolated charge" as a set of composite dipoles, see Figure 3-3. There is no such thing as an *isolated* observable charge in 3-space; instead, the observable charge is surrounded by attracted virtual charges of opposite sign in the active vacuum. We take a differential piece of the observable charge and a momentary virtual charge of opposite sign, and call the two a "composite dipole". An observable charge is simply a set of composite dipoles connecting virtual and observable energies and energy flows.

Hence any source charge (classical sense) may be considered such a set of composite dipoles. So any source charge also multiply initiates the broken 3-symmetry and broken t-symmetry in EM energy flow (as interpreted by the observer), but conserves energy flow 4-symmetry between the time domain and the 3-space domain. In 4-space, there is an energy flow circulation from the time domain to 3-space and back to the time domain again.

This special circulation of energy is strikingly similar to, and may be an extension of, Heaviside's unpublished theory of combined electrodynamics and gravity, where he used closed circulation of EM energy as exhibiting

gravitational effects (in modern terms, producing spacetime curvature) {195, 172b.}. This approach or extensions of it may yet have a profound impact on physics, as commented upon by Laithwaite {196}. Certainly Heaviside considered his own energy flow theory. So it appears that he considered the excess energy flow — that "misses" the interaction with the circuit or assumed unit point charge and is not utilized — as producing gravity. That of course would be in perfect agreement with modern general relativity, since any change in the local energy density of vacuum is also a change in the local curvature of spacetime. We have called that Heaviside nondiverged and unaccounted EM energy flow by the label *dark positive energy*. See our further discussion of unaccounted (dark) positive energy in paragraph 3.8 below.

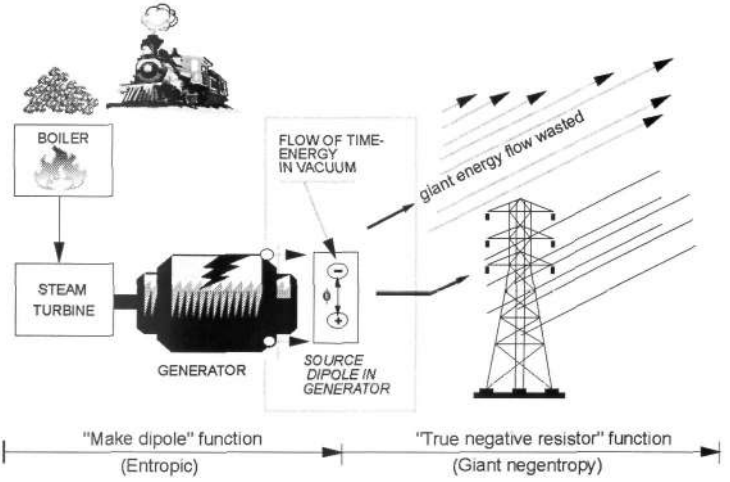

Figure 3-4 Dipole in generator powering circuits, taking energy from the time domain.

See Figure 3-4. This 4-symmetry is a far more fundamental energy flow symmetry than either 3-symmetry or t-symmetry. Both the "isolated charge" and the dipole are open systems far from equilibrium with their external active environment (the active vacuum and the active curvatures of spacetime). They are permitted to perform the five "magical" functions of disequilibrium thermodynamical systems. Such a system can: (i) self-order, (ii) self-oscillate or self-rotate, (iii) output more energy than the operator inputs, (iv) power itself and its loads (the "load" of a source dipole or source charge may be said to be comprised of the associated fields and potentials reaching across all space, and the continuous flow of

energy necessary to maintain those fields and potentials), and (v) exhibit negentropy.

The source charge and the source dipole exhibit all five functions. We often refer to these characteristics of a charge or dipole as its *giant negentropy* functions {197}.

It only takes a single white crow to prove that not all crows are black. Every charge and dipolarity in the universe is already a Maxwellian system far from thermodynamic equilibrium with its local active environment — the very class of Maxwellian systems that Lorenz/Lorentz symmetrical regauging of the Maxwell-Heaviside equations arbitrarily discards. That local environment consists of the local curvatures of spacetime and the local active vacuum. The system together with the two components of its active environment is called the *supersystem*. All three components of the supersystem continuously interact with each other and exchange energy. All is dynamic, continuously. Any appearance of a "static state" in the system is actually an equilibrium condition stabilized in the ongoing supersystem dynamics.

So one does not have to "prove" that Maxwellian systems exhibiting COP>1.0 (even COP = ∞) are possible. Every charge and dipolarity in the universe is already just such a Maxwellian system, even though all such systems are erroneously discarded by Lorenz/Lorentz symmetrical regauging. Either one must accept asymmetry and COP>1.0 EM systems in electrodynamics, or one must purge from the theory all the charges and dipoles and all effects from them. That destroys all the charges, all the fields, and all the potentials.

That also destroys electrodynamics itself, as well as chemistry, particle physics, and most of modern science. The arch critic of overunity EM system research would do well to acquaint himself with some additional physics. Either that, or practice what he advocates, and give up all charges and dipoles and all effects from them — including in chemistry, particle physics, materials science, etc. When he holds on to the charges and dipoles while insisting on the impossibility of COP>1.0 Maxwellian systems, his cherished conventional EM theory eats itself by its own tail and becomes an oxymoron.

3.3 How the Dipole Charges Transduce Time Energy

We present a simplified analogy[69] that allows one to visualize how the dipole transduces the incoming time-like longitudinal EM energy flow into 3-space real EM energy flow for negative charge, or vice versa in the case of positive charge. With a little oversimplification, a charge may be said to spin 720° degrees in one complete rotation. For our purposes, it spins 360° in the imaginary plane (over in *ict),* and then spins 360° in the real plane (in 3-space). Thus the negative charge can absorb the incoming EM energy flow in the complex plane, transduce or "flip" the absorbed EM energy into 3-space to begin its 360 degrees in 3-space, and the excitation can decay during that 3-space spin part of the cycle. The only "variable" in *ict* is the t, so any energy flow has to be "by means of the variation of the t-variable". We already argued in a previous chapter that time can be treated as highly compressed spatial energy, having the same energy density as mass. So absorbing a very tiny amount of time-energy and transducing (decompressing) it into spatial energy produces enormous spatial energy *(t* multiplied by the factor c^2).

The negative charge absorbs a *little bit* of positive time energy, transduces it into a much larger amount of 3-space excitation energy, and re-emits it in 3-space as an observable, real flow of EM energy radially outward in all directions. The positive charge receives the large amount of 3-spatial EM energy and absorbs it, transduces it back into time-energy (highly compressed energy) and re-emits it in the time domain as a little bit of highly compressed time energy.

Conversely, we may consider that the positive charge absorbs a little bit of negative time energy, transduces it into a much larger amount of negative 3-space excitation energy, and re-emits this negative 3-space energy in all directions in 3-space. That consideration is important in the cold fusion phenomenology, and in fact accounts for the formation of little fleeting "time-reversal zones" in the electrolyte solution where the law of attraction and repulsion of charged particles is momentarily reversed. The omission of the giant negentropy mechanism and the negative energy mechanism from particle physics reaction theory is why there do not exist such nuclear transmutation actions at low spatial energy (but high time energy) in

[69] **For** simplification, the analogy treats "spin" of the charged particle as if it really were something like that of a spinning top, at least in its 3-spatial component. However, in physics the entity **spin** is not confined to a flat plane or even to 3-space. C**onsequently,** we caution that the analogy is primarily a mnemonic aid.

conventional particle physics. All such permissible reactions have been arbitrarily omitted from the discipline.

For the positron (or any positive charge), we assume that the process is reversed: 3-space energy is continuously absorbed (from the active vacuum exchange) by the positive charge during its 360° spin in 3-space. This 3-space excitation energy is then flipped into the time domain as time-charge or time-energy, as the charge starts its second 360° spin in the time domain. During that latter part of its 720° spin cycle, the spinning charge re-emits the time-charge energy (time-excitation) as a flow of a little bit of very dense EM energy in the time domain.

The effects of these mechanisms in systems of charges in motion are met with as time dilation effects, spacetime curvature effects, frame rotation effects, etc. in relativity theory.

A charge that has received excess EM energy from the time domain is said to be *time-charged* or *time-excited.* Since time-charge or time-energy is c^2 denser than spatial energy, a tiny amount of time-energy excitation or time-charge may be re-emitted as substantial spatial energy over a period of time. In short, the decay of time charging or time-excitation of charged particles can occur slowly and over time. The decay is marked by the presence of longitudinal EM wave radiation, by mysterious ionization phenomena appearing in some Geiger counters depending on their individual time-histories (individual initial time-charging condition), and by excess energy appearing in electrolytes and emitted as heat where such decay of time-charge is occurring.

Usually in ordinary circuits and EM systems the time-charge and time-charge-decay effects are minimal, being offset by their opposites in close adherence to equilibrium. However, when this is not the case and time charging does appreciably occur, then novel phenomena result in those circuits and systems. Such effects have occurred for some time in instruments associated with rigorous electrolyte experiments at U.S. Naval research facilities at China Lake {198}, but the researchers have not recognized the cause. We have pointed out the time-charge and time-decay solution to those novel phenomena, and explained why apparently "identical" instruments need not respond to the stimuli in the same manner {199}. Along the way, we also explained several of the low spatial energy (thus high time-energy) transmutations, including giving the typical reactions producing the excess deuterium, tritium, and alpha particles. We also explain those new nuclear reactions at low spatial energy (but high time-energy) in Chapter 10.

As we stated in Chapter 1, paragraph 1.1.3: In such electrolyte experiments where the palladium electrodes load with concentrations of positive charges on hydrogen ions of one form or another, then in the adjacent solution there can arise fleeting **time-reversal zones.** Such a zone is simply a very tiny volume of fluid in which antiphotons temporarily comprise the majority of the ongoing photon interactions with the local ions in solution in that zone. The result is that the normal (time-forward) law of attraction of unlike charges and repulsion of like charges is reversed; *in the TRZ, like charges attract and unlike charges repel.* This allows two positive ions such as H+ to be drawn together so tightly that each enters the (reduced) strong force region of the other, forming a quasi-nucleus. When the other ions move to eliminate the TRZ, during the decay of the TRZ the strong force increases more rapidly than the EM force. Hence, the preferred method of decay of the now-excited quasi-nucleus is by quark flipping to allow the quasi-nucleus to become a new nucleus. This nuclear transformation interaction allows the production of the excess deuterium, tritium, and alpha particles.

3.4 Reordering of the Local Vacuum: Giant Negentropy

A giant negentropic reordering of a fraction of the surrounding vacuum's energy is initiated when a dipole or charge is formed. This reordering is deterministic, and is the 4-flow energetic structure shown by Whittaker {85}, slightly reinterpreted, with perfect coordination of the converging EM energy inflow in the complex plane with the outflowing converted real EM energy in 3-space. Hence this negentropic reordering introduces "hidden order" into the vacuum's otherwise disordered energy. This reordering of a fraction of the vacuum's disordered energy also changes the Gibbs statistics assumed in quantum mechanics, replacing it with an "already chaotic" statistics containing hidden order. We propose this as a possible contribution toward resolving the presently unsolved problem of the missing chaos in quantum mechanics {200}.

3.5 Some Implications of Giant Negentropy

Giant negentropy has many envisioned impacts upon physics, such as:

(a) Allows development and use of negentropic EM circuits (COP>1.0 systems) rather than entropic circuits. Once a broken 3-symmetry with stable 4-symmetry is established (as by forming a dipole), it continues indefinitely unless deliberately destroyed.

(b) Allows direct negentropic reordering of a practical and usable fraction of the vacuum's energy at will, at any point in the universe, easily and cheaply.

(c) Provides for electrodynamic engineering of the vacuum energy and of spacetime curvatures clustered in specific templates (the concept of vacuum engines or spacetime curvature engines). This has significant medical applications {387c}.

(d) Utilizes time as energy (per our previous discussion) and thus allows use of the Whittaker phase conjugate half of the biwave set as an EM energy flow within the flow of time. Observably this translates to the continuous receipt of free time-energy by the formed broken 3-symmetry (e.g., the charge or dipole). Accordingly, the charge or dipole continuously pours out real observable EM energy in 3-space, without any observable EM energy input (time is not observable, and neither is the time-polarized photon alone).

(e) Allows "burning a little time for fuel", so to speak, in order to transduce it into a very large spatial energy flow, due to the enormous compression of 3-spatial energy represented by time-energy by a factor of c^2.

So from the giant 3-negentropy discovery, we have arrived at some intriguing findings:

(a) As is well known in particle physics, the opposite charges of a dipole constitute a broken 3-space symmetry in the violent flux exchange between the active vacuum and the dipole.

(b) This dipole's broken 3-space symmetry in EM energy flow, provides a *relaxation* to a more fundamental EM energy flow symmetry between the time domain and 3-space, and therefore in 4-space.

(c) There is no law of nature or physics that requires 3-symmetry of EM energy flow as an additional condition applied to 4-symmetry of EM energy flow. Instead, 4-symmetry energy flow is more basic, by the hierarchy rule.[70]

[70] Quoting Steven Weinberg: *" ..there is a hierarchy of symmetries; whatever symmetry unites the gravitational and strong nuclear forces with the electroweak*

(d) The dipole is a practical and very simple means of "breaking" the additional 3-flow symmetry condition in EM energy flow our systems have previously exhibited, and relaxing to the fundamental 4-flow symmetry *without* 3-flow symmetry.

(e) So long as the dipole statically exists (e.g., imagine an electret suddenly formed, or a charged capacitor with no leakage), real usable EM energy circulation between time and 3-space, at each point in 3-space, will continuously move out from the dipole at light speed in all directions. In the view of the observer, at the same time, reactive EM power (actually, time-energy) will continuously flow into the dipole from the time-domain (the complex plane), and be transduced into real EM power output radially outward in 3-space from the dipole.

(f) Observably, a dipole or dipolarity and its scalar potential thus comprise a *true negative resistor* system of the most fundamental kind. The dipole continually receives EM energy in unusable form (reactive power, which cannot perform real work), converts it to usable form (real power, which can perform real work), and outputs it as usable, real EM energy flow (real power) in 3-space. Further, it spreads this "transformation of time-energy into 3-space energy at every dipole point" outward in 3-space in all directions.

(g) So at its formation the dipole initiates a continuing *giant negentropy* — a progressive reordering of a substantial and usable portion of the vacuum energy {201} that begins with dipole formation and continues. Further, this reordering of vacuum energy flow at every point in space continuously spreads in all directions from the initiation point, at the speed of light. Dipoles in original atoms formed shortly after the beginning of the universe, have been pouring out real EM energy for some 14 to 15 billion years or so (i.e., in the prevailing view; the age of the universe and whether it is expanding are still controversial {754}), and have reordered a fraction of the vacuum's energy, where the magnitude of the re-ordering varies inversely as a function the

forces is broken roughly a hundred million million times more strongly than the symmetry that unifies the weak and electromagnetic interactions. The puzzle of explaining this enormous difference in fundamental energies is therefore known in elementary particle physics today as the hierarchy problem." [Weinberg, *Dreams of a Final Theory,* Vintage Books, Random House, 1993, p. 205],

radial distance from the dipole.[71] This is in fact the solution to the long-vexing problem of the source charge and its associated fields and potentials and their energy, reaching across the universe. The charge together with its associated clustering virtual charges is a set of composite dipoles, hence a multiple *broken 3-symmetry* energy flow system.

(h) If the dipole is destroyed, the ordering of the vacuum energy ceases, leaving a "separated chunk" of reordered vacuum energy dynamics that continues to expand at the speed of light in all directions, steadily reducing in local intensity as it expands.

(i) At any very small volume in space, from the dipole dynamics of the universe it follows that a great conglomerate of reordered vacuum flows and fluxes — some continuous, some chopped — is continually passing through that volume. Further, the situation is totally nonlinear, so that direct wave-to-wave interactions occur continuously amongst these energy flows and waves. We hypothesize that this is the actual physical mechanism constituting Puthoffs cosmological feedback mechanism {202}.

(j) Further, in 1904 Whittaker {203} showed that any EM field or wave pattern can be decomposed into two scalar potential functions. This initiated what is called *superpotential theory*. Each of the two potentials for those functions, of course, decomposes into the same kind of harmonic longitudinal EM wavepairs as shown in Whittaker 1903, plus superposed dynamics. In other words, the interference of scalar {204} potentials — each of which is actually a set of longitudinal EM waves, and not a scalar entity {205} at all, but a *multivectorial* entity — produces EM fields and waves and their dynamics. Hence we hypothesize that the Whittaker interference of the propagating reordered EM energy entities, continuously occurring at any point in space, generates the zero-point EM field energy fluctuations of the vacuum itself. Indeed, an AIAS group paper by Evans *et al.* {206} has already shown that just such "scalar interferometry" produces transverse EM fields and waves in the vacuum at a distance.

[71] The field energy density in the fields produced by the source charge varies inversely as the square of the radial distance. The potential energy density in the potentials produced by it will vary inversely as the distance.

Since energy can neither be created nor destroyed, there really are no true *energy sources* in nature in the sense that they *create* energy and pour it out {207}. Instead, what we call "energy sources" merely convert the energy already there in one form, into another form. All energy sources are no different from a solar cell in the sun, or a windmill in the wind, at least in principle. They are actually energy transducers rather than energy sources. This corresponds well with the conservation of energy law wherein not a single joule of energy can be created or destroyed. Instead, the form of that joule of energy can be continually changed. Every joule of energy present in the universe after its formation is still present, and is still doing joule after joule of work in iterative interactions with transducers that change its form.

A priori, we can measure no real 3-space input of EM energy to the unchanging charge but we can measure real 3-space EM energy pouring from it. Energy must be input to it from the active vacuum in a *nonobservable* form, and converted by it into an *observable* form that is re-emitted, usable, and produces what we call the "fields and potentials" and their energy, associated with that "source charge". As is common usage, we will continue to use the term "source charge" or "source dipole", but with the understanding that we refer to a special kind of *energy transducer*.

When we "make entropy", we must do work. Even so, doing work is not really entropic unless we also lose control of the energy[72] — whose form was merely changed by doing the work — and thence lose any *further* ability to use that energy (change its form, or transduce it) to do useful work. And when we observe entropy, we also do work in the observing. Some of the erroneous notions about entropy desperately need correcting. E.g., quoting Weinberg {208} for a lay definition of entropy:

> ***"..a certain quantity called entropy:*** *To define entropy, imagine that some of the system's temperature is very slowly raised from absolute zero. The increase in entropy of the system as it receives each small new amount of heat energy is equal to that*

[72] An interesting point is that energy is energy and remains energy. "Disordered" ultimately means "unusable" or "inconvenient" and nothing else. Disordered energy is still energy, and if we do not lose it from the system we can in fact have the **system** automatically reorder it, e.g. by use of simple retroreflection. The entire concept of entropy must be rigorously interpreted in terms of "energy whose reuse is lost", at least by the processes being performed by the system considered. In our view, "entropy" itself is just additional usually "lost" energy to be recovered.

energy divided by the absolute temperature at which the heat is supplied."

"....entropy, which always increases with time in any closed system..."

However, we point out that apparently there exists no completely closed system in the entire universe. In the notion of entropy and the escape of the energy from their "closed" system, thermodynamicists themselves ubiquitously negate the latter premise that entropy in a completely closed system always increases with time. That simply does not follow. The real situation is as follows: (i) Entropy in a half-open system with no allowed external input of energy, but with allowed escape of energy, does decrease with time if the energy of the system decreases with time by escaping.[73] Hence the cooling of "hot" water with time, if and only if the excess energy in the system can have a net escape to the (cooler) environment as time passes, (ii) Energy in a completely closed system (closed to both energy and mass), with no input and no output of energy at all, simply remains constant because it is not dissipated; simply apply the conservation of energy law. It may rearrange within, and the subcomponent energies may disorganize with respect to range, but the total energy remains. Entropy actually only deals with the loss of ability to utilize the energy. To wit, the assumed (and apparently true, so far as we can tell) conservation of energy in the present universe is an example. A closed system is in this sense a special case of a system in equilibrium with its active environment.[74] I.e., any "closed system" is such a special case.

[73] In case the reader has not thought of it, until the energy "escapes" it is not dissipating or dissipated from the dissipating "object". A "hot" object is energetically excited but not hot; the *energy dissipated* from it (including from every component within it) is scattering, and hence disruptive and "hot" in its interaction with a test instrument (or one's finger). The thermometer (or any other instrument) is external to the rest of the system (even if imbedded in it). Hence merely to "measure the temperature" is actually to pass energy out of the system into the thermometer (or other instrument), so that the thermometer measures the heat of the dissipating energy that has just escaped from the system. For these and similar reasons, Romer — former editor of *A. J. Phys.*— pointed out that "heat" should not even be used as a noun {84}.

[74] The concept of energy always requires that one can write "energy of. ..(X)" and fill in the (X). We usually write the phrase "of…(X)" as "X energy". Thus we write the phrase "energy of heat" as "heat energy," the "energy of the vacuum" as "vacuum energy", and the "energy of the EM entities" as "EM energy". At least in its usage, energy always requires a medium or entity "having" or "exhibiting" the energy. As Feynman pointed out, we really do not know what "energy" per se *is.*

(iii) In a system closed with respect to output (escape) of energy, but with the system opened only to allow external input of energy, the system energy will increase, simply by the conservation of energy law. That system's entropy will decrease and its negentropy will increase. (Its mass will also increase, and so it violates the thermodynamic misdefinitions of closed system; see Appendix A). It is well known that the entropy of an open system far from equilibrium cannot even be computed! (iv) Energy in an open system where input of energy and escape of energy both occur, may either increase, decrease, or remain constant, depending upon whether the input rate exceeds the output rate, or vice versa, or the energy input and output rate are equal. Therefore such a system can exhibit overall entropy, overall negentropy, or overall equilibrium, (v) Net energy scattering rate (rate of energy escaping the system in disordering fashion) from a hot system determines the observed temperature of that system at the time of observation. The system itself is cold, prior to escape of the energy. The "heat" is due to the interaction of the escaping energy with an external object, in its disordering fashion. Inside the system prior to escape, the energy is ordered hence cold.

A system in equilibrium in its exchange with its active external environment is in a state of maximum entropy *for that specific rate of energy exchange with its environment.* As we will point out in Chapter 9, by deliberately balancing the *system-and-vacuum* exchange with the *system-and-curved spacetime* exchange, so that the two exchanges are equal and opposite at a desired rate of exchange, one may establish (at least in theory) system equilibrium at whatever specific rate of energy exchange is desired.[75, 76] In this fashion, e.g., an "impossible" molecule normally intensely unstable and decaying in a nanosecond or less, can in fact be stabilized once an appropriate balance between the two opposing energy exchanges with the system is achieved at the required specific rate of energy exchange. This is actually a new Lorentz symmetrical regauging

[75] This is necessary, e.g., to close-loop a COP>1.0 EM unitary system taking its input energy from the vacuum, as we shall see in Chapter 6.

[76] The Fogal superluminal transmission system in fact uses a conventional signal input to change this "symmetrical regauging" condition in consonance with the amplitude of the input signal. Thus suddenly Lorentz symmetrical regauging becomes a way to transform a conventional signal into a signal consisting of changes in the stress energy potential of the vacuum. That constitutes a longitudinal EM wave, and so it is not limited by the speed of light. To use this process, a Fogal semiconductor must be used as the modulator in the "transmitter", and another must be used as the demodulator in the "receiver".

condition; change of symmetrical regauging is very useful in this fashion. In this way, a great new chemistry with reactions presently deemed impossible is in the offing, and it is already being developed by at least one U.S. company. We do not name the company, under our tacit agreement with the scientists doing the work.

To operate conventional entropic systems,[77] first we must input energy to the inert system to force it out of equilibrium and back into excitation (back into an asymmetrically rcgauged system, violating the Lorentz condition) so that it has some excess energy (and negentropy). Then we allow the decay of the excited system's excess energy to pass through a load and be dissipated from it, doing work for us by powering the load. Conventional systems usually do not recapture the "escaping dissipated energy" but just waste it. *"Dissipating" energy is merely allowing it to escape from the system and from further system control.* Then we brutally force more excitation energy into the system, opening it and breaking its equilibrium to do so. Again we dissipate the system's excitation energy in the load to produce some more work, usually wasting an appreciable fraction of the excitation energy.

In EM systems, it is a little more complex. We continually "switch on" a negentropic flow of EM energy from the vacuum by making a source dipole. In the circuit, we collect a small part of the resulting huge energy flow in space surrounding the circuit conductors. Then we use half the collected energy to destroy the dipole source of the energy flow, while less than half of the collected energy is dissipated in the load (the rest of that second half is dissipated in the external circuit's losses). Hence we must continually restore the source dipole and pay more to do it than we get out in the load as useful work. We make a perfectly good negentropic system, and then forcibly destroy its negentropic ability faster than we power the load and get any use out of it. That's a terrible way to make and use power systems, but it is what has been done for more than a century.

So with our present entropic EM systems (actually our *self-killing negentropic* EM systems) we continually wrestle nature fiercely to the mat, so to speak, by brute force, repeatedly, to bind her into 3-space EM energy

[77] By "entropic system" we mean a system whose excitation energy decays and is dissipated from the system or at least from its further control, so that the entropy (lost or unusable energy) of the system continually increases until equilibrium (total decay of the excitation energy) is achieved. As can be seen, this also can be used to define entropy and increase in entropy. What is usually unappreciated is that *equilibrium is actually a counterbalance between ongoing entropy and negentropy.*

conservation. All the while, nature protests our continual entropic brutality by providing the Newtonian third law reaction force[78] back upon our causative wrestler performing the "forcing". To do entropic engineering, we have to continually input 3-space energy to the wrestling mechanism or engine, losing a bit of the input energy in the inefficiencies, and fighting the "back emf", "back mmf", or Newtonian third law reaction that is nature's cry of protest all the while. Those are nature's penalties for imposing a monstrous 3-space EM energy flow symmetry[79] upon her as an *additional, highly undesired, and highly unnatural condition* added upon her beloved special 4-symmetry energy circulation between the time domain and 3-space.

In short, because we so love entropic engineering and 3-space EM energy flow symmetry, we have to provide the continual input energy to our entropic processes by burning fuel, damming rivers, erecting windmills, building waterwheels, erecting solar cell arrays, building and charging chemical batteries, etc. In the process, we destroy and pollute the biosphere on a giant scale as we rip down forests, strip-mine and drill the earth, pile up thousands of tons of radioactive nuclear wastes —that will be hot for thousands of years — from our power plants and related facilities, and spew streams of pollutants into the atmosphere, the rivers, the oceans, etc. We do all that biosphere destruction because we inexplicably insist upon placing cruel chains on nature by brutally enforcing 3-space energy flow symmetry upon her. In the process, we adamantly require adherence to classical equilibrium thermodynamics (as given a somewhat altered explanation above, and also in Appendix A).

We do not have to do it that way. In avoiding solving the source charge problem for so long (more than a century), we have been extremely

[78] Note that Newton's third law reaction is implicit in the special negentropic energy flow circulation of the dipole, or of the charge considered as a set of composite dipoles. The same energy that moves into 3-space from the time domain, then returns from 3-space to the time domain, at every point in the 4-circulation. If we consider the positive charge as a "source" of negative energy, then there is a concomitant circulation of negative energy from the time domain to a point in 3-space, and back to the time domain.

[79] The 3-space symmetry of energy flow equilibrium is actually between the energy we input (from its external environment) to the system, and the energy that escapes from the system back into its external environment, either in its losses or in its loads. As we stated, equilibrium condition is a balance between ongoing entropic and negentropic operations.

backward in our thinking and in our consequent development of entropic engineering technology.

For our dullness, we have had to pay and pay continuously for insisting on doing such atrocious entropic work and forcing nature to do it that way. In so doing, we "tie nature's feet" with that added arbitrary 3-symmetry in energy flow. We ourselves prohibit nature from performing the giant negentropy she so dearly loves and much prefers. We also arbitrarily and *meanly* discard the bountiful electromagnetic energy flow that nature loves to furnish us so freely by her vast preference for giant negentropy. We meanly discard nature's bountiful giant negentropy banquet free for the taking, by our vast thirst for giant entropy and doing violence to nature. Because we act like brutes instead of scientists, we destroy nature in spite of nature's continuing attempt to give us all the EM energy we wish, freely except for a little switching cost.

A far better way is to cooperate with nature and "let nature make her beloved copious negentropy" as she yearns to. To do that, we now can see the startlingly simple mechanism. We simply make a little dipole, *once*, entropically. So we have to pay for *making* the dipole, *once*, and we have to do just a little gentle violence to nature, *once*. Then we need do no more violence, if we just leave the dipole intact and do not destroy it. In short, we do have to tap nature gently on the shoulder. We do not have to brutally knock nature down to the mat, repeatedly.

When we make the dipole, we make a little bit of "broken 3-symmetry" in the universe's energy flow. Voila! Nature sings for joy at finally having her feet freed from the shackles of the horrid 3-symmetry energy flow. In great glee, she instantly relaxes into her dearly preferred giant negentropy and 4-symmetry. She instantly sets to re-ordering a substantial and usable

[80] E.g., so far as I am aware, there have been no funded research programs to discover how to deviate and collect some of the freely flowing energy from a permanent magnet or an electric dipole. Instead, electrodynamics has smugly continued to call it "statics" as if there were no dynamics, and ignored the giant negentropy circulation that is "seen" as the steadily outflowing field energy in 3-space, and erroneously called the "static field". There is no such thing as "statics" in the entire observed universe *a priori;* the very process of observation itself is dynamic. What we see as "static" is continual recurrence of a given condition or state or magnitude, as beautifully pointed out by Van Flandern {628}. One might even say that, not only is nature energetic, nature *is* energy, constantly changing and in motion in innumerable ways at once! One might even define "energy" as the process by which nature both acts and observes its actions, in every form and structure and possibility.

portion of the vacuum energy of the universe, in all directions at the speed of light, spreading her preferred giant negentropy EM 4-energy circulation flow from the dipole toward the ends of the universe at the speed of light. As long as we do not destroy the dipole (the broken 3-symmetry) that gently breaks the 3-symmetry shackles, nature's feet remain freed from brutal 3-space symmetry in EM energy flow. In that case, she delightedly continues to reorganize a portion of the vacuum energy, with the reordering spreading radially outward at the speed of light. Simply making a common dipole or charge[81] sets nature to going about reordering an ever-increasing fraction of the entire vacuum energy of the universe, and continuing indefinitely.

Simultaneously with freeing her from enforced 3-space EM energy flow symmetry, in great gratitude nature pours out an immense real EM energy 3-flow from that little dipole or charge. She will continue to pour it out forever for us, if we do not destroy the dipole or charge.

Instead of the present universal entropic engineering, the smart thing to do is make just a little bit of entropy wisely, using the work we get to break 3-space energy flow symmetry (basically, to make a dipole). *Then leave that mother of all negative resistors and free energy flow generators alone and forever unchanged!* Concentrate on intercepting, extracting, and using the free 3-space energy copiously flowing forth from the giant negentropy, without destroying the dipole that is freely providing it.

3.6 How Circuits Are Powered

Let us now look at the great magnitude of the energy flow that nature gives us from that dipole. We have to get into the subject a bit, because EM energy flow theory has been rather thoroughly confused for more than a century.

First, batteries and generators *do not* use their available internal energy — the shaft energy we input to the generator, or chemical energy available in the battery — to power the external circuit. Instead, each uses its available internal energy {209} to perform work on its own internal charges, forcibly separating the charges to form the *source dipole.*

See again Figure 3-4. *All the hydrocarbons ever burned, all the nuclear fuel rods ever consumed, and all the dams ever built, added not one single watt directly to the power line.* All the energy from those activities was

[81] As we previously explained, a charge is just a set of composite dipoles.

input to the generator shaft after normal losses en route, to provide internal magnetic energy available to the generator. In turn, the generator used that available internal magnetic energy only to do internal work on its own internal charges to force them apart, forming the source dipole connected to the terminals. Generators are energy transducers only; they do not directly power their own external circuits.

Batteries and generators expend their internal energy available to them, to make the source dipole, and for no other purpose! None of their internal energy is used to power their external circuit. It never has been, and it never will be.

Once the source dipole is formed, it does all the hypothesized 4-functions we pointed out previously. It induces the spreading giant negentropic reordering of the vacuum energy, extracts (transduces) EM energy from the continuously reordering vacuum, and pours out from the terminals of the generator (or battery) a vast 3-flow (as observed) of EM field energy along the external circuit. As indicated by Kraus's illustration of the Poynting component {210}, this giant EM energy flow fills all space surrounding the circuit, out to an infinite lateral radius.[82] The energy flow is generally parallel to the conductors of the circuit. Only a tiny component of this flow — due to the surface charges of the conductors and the little boundary layer of energy flow that slides along the surface of the conductors — strikes the surface charges and gets diverged into the conductors (by the lateral withdrawal of the surface charges — with the "stub" or "base" of their field energies — laterally into the conductors. The electrons move mostly laterally, withdrawing from one side of the conductor surface to the opposite. Only the tiny component of its field vector integrated over that small distance is withdrawn into the conductors to power the electrons. This small amount of "withdrawn" energy is the diverged Poynting component, "collected" by the circuit. It also is the small component then used (dissipated) to power the Drude electrons and the circuit.[83] All the rest of that vast EM energy flow in the surrounding

[82] We accent that Kraus, along with other authors, only shows the 3-space *Poynting component* of that flow; i.e., he shows the very small amount of that external 3-space energy flow that is diverged into the circuit to potentialize the Drude electrons and power the circuit. Kraus *does not* show the remaining Heaviside component that is not diverged.

[83] As shown by Kraus, some of the energy flow at the various radial distances from the wire is withdrawn, as the surface electrons and the "stubs" of their near fields precess laterally into the depths of the wire when potentialized. Jackson, *Classical Electrodynamics,* Second **Edition,** Wiley, 1975, p. 223 also points out the nonlocal

space, that pours forth from the terminals, just misses the circuit entirely. It roars on off into space and is wasted.[84]

The diverged, utilized, and accounted energy flow component — the *Poynting component* — is only a tiny, tiny fraction of the entire giant EM energy flow produced by the source dipole for every circuit.

3.7 The Heaviside Component vs. the Poynting Component

Unless Heaviside and Lorentz did rigorous calculations in a work we have not yet uncovered, we could not find any development of the functions and equations required for computing the numerical ratio of the unaccounted Heaviside "dark energy flow" *{nondiverged* energy flow component that misses the circuit), to the tiny Poynting energy component thai strikes the surface charges of the conductors {211} and is diverged into the wires to power the circuit when the surface charges precess laterally into the wire.

Consequently, we performed a very crude "special case" estimation {212} — a back-of-the-envelope type, with highly simplifying assumptions — for a very simple circuit in which one resistor is powered by a DC source. Our crude estimate showed that about 10^{13} times as much EM energy flow *misses* the circuit, is *not diverged,* and is *wasted* — as *strikes* the circuit, gets collected, and then is dissipated in the circuit to power the load and losses. Until electrical physicists re-examine the energy flow theory and

involvement of the transverse current. Quoting: *"...the transverse current... extends over all space, even if J is localized. "* One notes that present electrical power systems concentrate exclusively on the J current, making no attempt to collect and utilize the recognized but rather ignored transverse current.

[84] Note, however, that this Heaviside energy flow component differs from ExH. The Heaviside component is totally nondiverged (being actually in curl or swirl form), and since E and H are both diverged energy components assumed around an **Interacting** unit point static charge, there is neither E nor H in the electrical engineering sense prior to interaction with charge. So the energy flow in both the Poynting and Heaviside components is in a force-field-free form until intercepted by and interacted with charge. Poynting's component, e.g., assumes only that energy co**mponent** that does interact with charge and get withdrawn into the circuit. **Heaviside's** component assumes only that energy component that does not interact with charge and does not get withdrawn into the circuit.

again recover the Heaviside unaccounted component in it, that brute force estimate will have to suffice as at least an illustrative example.[85]

What does that 10^{13} ratio mean? For a little 1 watt generator of that DC type with that specific size conductors and that specific resistor, the Heaviside unaccounted energy flow component was about *10 trillion watts*, occupying all space surrounding the wire,[86] if all of it could be intercepted, collected, and used to power loads {213}. But the little circuit was only intercepting and collecting — and using to power loads — about 10^{-13} of the available energy flow surrounding the circuit, *if all* of it could have been intercepted, collected, and used to power loads.[87]

We have never had, and we do not now have, an *EM energy* shortage or problem. We never will have one, due to nature's bounty in providing us with the giant negentropy of the common dipole and of the charge considered as a composite dipole. Instead, we have the two problems that

(i) only a tiny, tiny component of the available 3-energy flow extracted from the vacuum (decompressed from time-energy) by

[85] We would very much welcome a much more accurate functional expose by a capable higher group symmetry electrodynamicist!

[86] We also point out that none of this nondiverged energy flow component is accounted in conventional electrodynamics and electrical engineering (the closest it comes is Jackson's mention of the transverse current over all space), and neither has it been accounted or even investigated by biophysicists seeking to determine the effects of EM radiation and fields upon biological systems. We strongly suspect (and have done a little work on the problem) that these "force-free fields" and neglected excess "strange energy" flows do have interactions throughout the highly nonlinear cells of the body, and can indeed have profound long term effects on long-exposed biological systems. We particularly stress the potential for time-charging and subsequent *combined scalar and longitudinal photon pair* decay of time-charge excitation in the body. Several major areas of electrodynamics — such as the transverse current effects, Heaviside component effects, and internal Whittaker structuring (engines) effects of EM radiation — have not been investigated by the scientific community.

[87] We accent that time-energy may be regarded as spatial EM energy compressed by the factor c^2. Hence one second = 9×10^{16} joules of EM spatial energy, if decompressed by time-energy interaction with charge. The crude estimate for one circuit of 10^{13} times as much energy being wasted in the Heaviside energy flow component as is caught and used in the Poynting component, is thus quite reasonable when one recognizes that *all* the EM energy flow appearing in the circuit or outside it actually comes from the time domain, hence constitutes *decompressed time-energy*.

the source dipole and poured out of the terminals of the power source, is caught and used by the circuit, and

(ii) in the closed current loop circuit, half of that small spatial EM energy component that is intercepted and caught, is used by the circuit only to destroy the source dipole and cut off the free flow of EM energy from the vacuum faster than it powers the load.

We have previously discussed this further in several papers {214}.

One must occasionally keep one's sense of humor. The real problem that the Department of Energy should be working on, with massive resources, is simply the alteration of the closed current loop circuit so that it does not destroy the source dipole faster than it powers the loads. Secondly, they should then be working on how to close-loop the COP>1.0 EM systems that readily emerge from that research. Yet it appears that this fundamental energy problem — and the *only* energy problem — has no conventional work being openly done on it anywhere in the open Western world.[88]

3.8 Dark Positive Energy: The Unaccounted Heaviside Component

Now we restate a deceptively hidden thing: The EM field and potential are defined as the observed effect of the deviation from them by an assumed unit point charge. Then that same field and potential are assumed to be in mass-free space, before the interaction with charged matter. Hence the

[88] Using the U.S. as an example, the U.S. classified community is highly compartmented, and the real "organization" of a given compartment often consists of laterally connected "same clearance" compartments in multiple outside agencies rather than vertical chain of command through one agency. We accent that some highly compartmented "lateral" classified organizations in the West and elsewhere already have working COP>1.0 systems, and have had them for several decades. Some of these laterals in the U.S. are very dedicated to the duly elected government of the United States, with good national security reasons for the fact that they "officially do not exist". Some are not so dedicated at all, and have their own agendas having little if anything to do with official U.S. government policy. These latter "rogue" laterals often have convenient connections with outside shadowy groups of the High Cabal (Churchill's phrase). A similar situation exists in several other major foreign nations. Substantial electrodynamic technology has been developed (and weaponized) for decades, in secret, and this technology does not appear in the open news, the university texts, or the scientific journals. Such is the case for COP>1.0 EM power systems, which have actually existed in secret for decades.

field and potential have each been defined erroneously as both a cause and an effect. This is a gross non sequitur. There is also a total lack of accounting that all EM energy in 3-space comes from the time domain. There is no consideration that every dipolarity and every charge represents a giant circulation of EM energy between time and 3-space. In ensemble, this non sequitur and these omissions are responsible for most of the present formidable foundations problems in electrodynamics.

We submit the following new hypothesis: *The present "definition" of field and potential as a function of interception and divergence by a unit point static charge are only indications of their point intensity, obtained as an estimate after their observed interaction with a unit point static charge.*[89] *Thus the actual field and potential contain not only their Poynting components that interact with the unit point charge, but also their Heaviside nondiverged components that do not interact with it. The true "magnitudes" of the massless field and potential prior to interaction with charged mass are many orders of magnitude greater than the magnitudes of their standardized point intensities* {215}.

In short, we propose that *every field and potential, in its interaction with charged mass, produces not only the accounted energy aspects presently calculated by electrodynamicists and astrophysicists, but also contains Heaviside's vast unaccounted "dark positive energy" component presently discarded.* We further propose that this ubiquitous and unaccounted "dark positive EM energy" component in the interactions of the fields and potentials of the spiral galaxies is what is producing the excess gravity that is holding the spiral arms together. We specifically do this in honor of Heaviside, whose unpublished papers clearly establish that he recognized the overwhelming gravitational importance of his extra and unaccounted energy flow component {172a, 172b, 196}.

3.9 A Short History of the Discarding of the Heaviside Dark Energy

3.9.1 Independent Work by Heaviside and Poynting

Let us now see how the enormity of the EM energy flow from the dipolar source was treated in the early electrodynamic theory, and how it is treated in the received view today.

[89] This is recognized by leading electrodynamicists, but not by most electrical engineers building power systems!

In the 1880s after Maxwell was already deceased, Poynting {216} and Heaviside {217} independently (and rather simultaneously) discovered EM energy flow through space. Before that, the concept did not appear in physics. Poynting {216} published prestigiously, while at first Heaviside published more obscurely {217}, then finally more prestigiously {218, 219}.

With respect to circuits, from the beginning Poynting assumed only that small amount of EM energy flow that enters the circuit from the surrounding space. Here are Poynting's {220} own words:

> *"This paper describes a hypothesis as to the connexion between current in conductors and the transfer of electric and magnetic inductions in the surrounding field. The hypothesis is suggested by the mode of transfer of energy in the electromagnetic field, resulting from Maxwell's equations investigated in a former paper ("Phil. Trans., " vol. 175, pp. 343-361, 1884). It was there shown that according to Maxwell's electromagnetic theory the energy which is dissipated in the circuit is transferred through the medium, always moving perpendicularly to the plane containing the lines of electric and magnetic intensity, and that it comes into the conductor from the surrounding insulator, not flowing along the wire. "*

As can be seen, Poynting considered only the energy flow actually entering the wire, and subsequently being dissipated in the circuit. Hence Poynting never considered the huge EM energy flow component around the circuit that is *not* diverged, *misses* the circuit entirely, *does not* contribute to the energy dissipated by the circuit, and is *wasted.* In short, there is a vast "dark energy flow" associated with every dipolar interaction — a huge energy flow component which Poynting never considered.

Heaviside's theory was an extension of what Poynting had considered, and Heaviside also corrected Poynting as to the direction of flow. Heaviside was fully aware of the enormity of the "dark energy" flow missed by Poynting, but had absolutely no explanation as to where such a startlingly large EM energy flow — pouring from the terminals of every dipole, generator, or battery — could possibly be coming from. Consequently, Heaviside was very cautious in referring to it, usually doing so only obliquely in terms of the angles and components. In Heaviside's {221} own words:

> *"It [the energy transfer flow] takes place, in the vicinity of the wire, very nearly parallel to it, with a slight slope towards the wire... . Prof. Poynting, on the other hand, holds a different view, representing the transfer as nearly perpendicular to a wire, i.e., with a slight departure from the vertical. This difference of a quadrant can, I think, only arise from what seems to be a misconception on his part as to the nature of the electric field in the vicinity of a wire supporting electric current. The lines of electric force are nearly perpendicular to the wire. The departure from perpendicularity is usually so small that I have sometimes spoken of them as being perpendicular to it, as they practically are, before I recognized the great physical importance of the slight departure. It causes the convergence of energy into the wire. "*

As can be seen, Heaviside was fully aware that the energy flow diverged into the wire was only a minuscule fraction of the total. He was fully aware that the remaining component was so huge that the energy flow vector remaining — after the divergence of the Poynting component into the circuit — was still almost parallel to the conductors. However, he had no explanation at all of where such an enormous and baffling energy flow could possibly originate.

Had Heaviside strongly stated the enormity of the nondiverged component of the energy flow, he would have been viciously attacked and scientifically discredited as a perpetual motion advocate. His words were measured and cautious, but there is no doubt that he recognized the enormity of the nondiverged EM energy flow component.

We have chosen to call that huge unaccounted component the "Heaviside dark energy component" in his honor, since he actually discovered it. By the word "dark" we mean "unaccounted", which hides it from scientific view. We have also nominated it as the previously unsuspected source of the extra gravity holding the arms of the spiral galaxies together.

3.9.2 Lorentz Disposed of the Problem Rather than Solving It

Lorentz then entered the EM energy flow scene to face the terrible problem so quietly raised by Heaviside. Lorentz understood the presence of the Poynting component, and also of the extra Heaviside component, but could find no explanation for the startling, enormous magnitude of the EM energy pouring out of the terminals of the power source (pouring from the source dipole) {222} if the Heaviside component was accounted. Had

he retained and advanced this enormous dark energy flow component, even the great Lorentz would have been castigated as a perpetual motion advocate who did not accept the law of energy conservation. Even today, when one points out that far more energy is pouring out of the terminals of every generator than the small mechanical energy input to the shaft, one is immediately labeled a raving lunatic — even though the Bohren experiment {24} clearly proves the presence of an extra energy flow component not usually intercepted. It is not difficult to understand how such a bombshell would have been received in the 1880s! At least today, we have particle physics and its broken symmetry of opposite charges, together with its active vacuum, to explain where the excess energy comes from and how.

Unable to *solve* the dark energy flow problem by any rational means, Lorentz found a clever way to *avoid* it. He reasoned that the nondiverged Heaviside component was "physically insignificant" (his term) because it did not even enter the circuit. Since it did nothing of any physical consequences, or so he reasoned, then it could just be discarded.

So Lorentz simply integrated the entire energy flow vector (the vector representing the sum of both the Heaviside nondiverged component and the Poynting diverged component) around an assumed closed surface enclosing any volume of interest {223}. *A priori,* this mathematical procedure discards the dark *Heaviside* energy flow component because of its nondivergence. It retains only the intercepted *Poynting* diverged component that enters the circuit.

A century later, electrodynamicists are still happily avoiding the dark energy flow problem by continuing to use the Lorentz integration procedure {224} to dispose of all but the Poynting component that enters the circuit and is then dissipated by the circuit. As a result, the "Poynting energy flow" has come to be loosely regarded as "the" entire EM energy Mow, though electrodynamicists find it necessary to give stringent warnings about it. E.g., Panofsky and Phillips {225} state it this way:

> *"...only the entire surface integral of N [their notation for the Poynting vector] contributes to the energy balance. Paradoxical results may be obtained if one tries to identify the Poynting vector with the energy flow per unit area at any point."*

Most electrodynamicists note the freedom to add a vector — few call it an *energy flow* vector, though that is the type of vector being discussed, and

one must add apples to apples — which has zero divergence. Jones {226} states:

> *"It is possible to introduce the Poynting vector S, defined by S = ExH, and regard it as the intensity of energy flow at a point. This procedure is open to criticism since we could add to S any vector whose divergence is zero without affecting [the basic integration procedure's result]."*

Jackson {227} says it even more plainly, and also uses Lorentz's "no physical significance" argument for disposing of any energy flow vector with a zero divergence. Quoting:

> *"...the Poynting vector is arbitrary to the extent that the curl of any vector field can be added to it. Such an added term can, however, have no physical consequences."*

Any energy flow vector, which is the curl of a vector field, will have zero divergence, by elementary vector algebra. In short, to be pertinent at all, it must be an *energy flow* vector (since energy flow is what S = E x H is all about. Since the curl of any vector has no divergence *a priori*, then any energy flow vector that is a curl of a vector field will be part of the Heaviside dark energy flow component, rather than part of the Poynting energy flow component. It will also be discarded by Lorentz's closed surface integration.

We refer the reader again to Figures 2-5 and 2-6 in Chapter 2, p. 113-114. Electrodynamicists err in assuming that such a divergent free vector (energy flow) can have no physical consequences. If one inserts *additional intercepting charges* into that formerly nondiverged energy flow component, the charges will immediately diverge some of the formerly nondiverged energy flow around them and hence "collect additional energy". In other words, "divergence" is the result of a physical process, accomplished by intercepting charges. We can easily change "nondiverging" energy to diverging energy, by simply interacting it with charges. We can also "bunch" the energy flow lines closer together (as in some waveguides), thereby increasing the local flow intensity and the concomitant energy collected by each intercepting charge in the densified energy flow stream.

So whether the Heaviside energy flow component is of physical consequence or not, depends on whether or not we "add more sail to the sailboat", or "add more sailboats" before the wind. That is most certainly a

useful physical consequence, and with a little ingenuity we ought to be able to use it to power loads "for free" or nearly so. There are other consequences also, as we used in deriving the negentropy of the dipole or charge. There the input of a non-Poynting energy flow component certainly has universal and physical significance — e.g., to the curving of local spacetime, conditioning the active vacuum, furnishing all the energy to form the EM fields and potentials from their source charges, etc.

Schwarz {228} expresses it this way:

> *"There will be many opportunities in which the interpretation of E x H as a rate of flow of energy per unit area will be profitable. In most cases of practical interest, such an interpretation is valid, although it must always he kept in mind that only the integral of S over a closed surface can be physically measured... Just how it is that the connections to the energy source, say a battery, are at the ends of the wire, yet energy flows in through the sides, should be pondered by the reader. "*

Note carefully that Schwartz recognizes the difference between the observed (deviated or diverged) part of the EM energy flow and the unobserved nondeviated or nondiverged part of it. However, he did not follow it up and apply it back to the basic "definition" of the field and potential as what are diverged from them.

For recommended changes to the Poynting vector, Jones {229} presents many conditions the changed vector must fulfill. Then he falls back on the Lorentz closed surface method again, but without realizing that he therefore (i) first includes both the diverged and nondiverged component, and (ii) invokes a procedure that arbitrarily discards the nondiverged component. In thus disposing of the problem, Jones says:

> "It *does not seem likely that an expression satisfying all these conditions will be simple.....fortunately, we are rarely concerned with the energy flow at a point. In most applications we need the rate at which energy is crossing a closed surface."*

Finally, we note that even today, a debate on what the Poynting vector is or should be, is still politely ongoing. As an example, it has been ongoing for more than 40 years in the *American Journal of Physics* alone as well as in other journals {230a-230i}. One thing is clear: The Poynting vector does not represent the total energy flow at right angles through a square

meter in space surrounding the conductors of the electrical circuit. It is, however, the *component orfraction* of that actual energy flow through the square meter in force-field-free form *that will subsequently be diverged and collected in the circuit in force-field form and dissipated in the circuit loads and losses.*

3.10 The Problem of the Accelerating Expansion of the Universe

As briefly stated earlier, we introduce the notion of the supersystem, consisting of three parts: (i) the system and its dynamics, (ii) the active vacuum and its dynamics, and (iii) the active spacetime curvatures and their dynamics. All three components of the supersystem interact with each other.

In Chapter 9, we explain in some detail how a COP>1.0 EM circuit — and especially a COP»1.0 EM circuit — has an induced flow of negative energy (Dirac sea hole current) from the output section of the system, back through the system, and into the input section. Reaching the input section, if the hole flow is not completely filled by incoming electrons, the remaining Dirac hole current will flow on back into the feeder line from the external power supply, and into the distant power supply itself, eating electrons and electron current all the while.

We also explain our reinterpretation of the *unobserved* (non-reacted) Dirac hole with negative energy or negative mass, without time reversal and parity reversal. This dramatically differs from the "as observed" (interacted) Dirac positron with positive mass, and with charge-reversal and parity reversal from the electron. The Dirac hole is "as unobserved and non-reacted" and it is still an *electron* having negative mass and negative energy. The Dirac positron with positive mass, opposite charge, and opposite direction is "as observed and reacted with charged matter". The unobserved Dirac hole is the "cause" of an observational interaction; the Dirac positron is the "effect" of an observational interaction. The two are very different because the cause differs from the effect. Here again, the confusion of cause and effect has had very detrimental consequences in the use of Dirac's electron theory.

Very powerful astronomical phenomena, such as giant astronomical explosions of great energy, involve COP>1.0 and COP»1.0 processes, particularly when the unaccounted Heaviside energy flow is accounted for every field and potential interaction with charged mass. Hence all such phenomena also provide very powerful "explosions" of negative energy

(Dirac sea holes moving outward in the vacuum). The negative energy is the equivalent of negative mass, so long as it is unobserved.

So there is a "dark negative energy explosion" in the Dirac Sea vacuum, accompanying every large astronomical explosion seen through our telescopes and other sensors. This accompanying dark negative energy explosion has not been accounted in astrophysics until now.

We thus live in an astronomical universe of neglected "giant dark negative energy explosions" as well as one of accounted "giant positive energy explosions".

The dark (unaccounted) negative energy radiating outward in the vacuum from gamma bursts, x-ray bursts, etc. produces antigravity. The spreading negative energy, moving at light speed, is a change to the vacuum itself, which also interacts upon spacetime to negatively curve it, producing negative gravity. For those energetic processes of COP sufficiently greater than one, the processes produce more antigravity than gravity. As of this writing, we are in fact filing a patent application on this method of performing and producing antigravity, and it will be filed before this book is published.

Over the 14 billion or so years of the observed universe, the dark negative energy content of spacetime has been slowly changing by the results of giant astronomical explosions and other such processes producing negative energy radiated outward into the Dirac sea vacuum. Slowly the vacuum itself has undergone transformation from the perfect Dirac sea with all holes filled by particles, to a vacuum where there is a slowly growing fraction of negative energy (negative mass) unobserved Dirac sea holes.

Thus, slowly the antigravity generated by the gradual altering of "space" (the vacuum) itself has been growing for some 14 billion years. At some point in the past, the excess antigravity effect accumulating in space reached the equal of the "outside" gravity acting upon energetic explosive astronomical phenomena. From that point in time, the antigravity effect has been increasing slowly. The result is that the present violently explosive astronomical phenomena, by adding a sudden and sharp increase in their external space antigravity, produce acceleration away from all positive mass and positive energy phenomena. Hence astronomers now observe the acceleration of the expanding (positive energy/positive mass) universe, instead of the previously expected slowing (due to positive gravity) of the expanding universe (conventional view).

The antigravity-producing phenomena have not been openly investigated in Western science because Western science has arbitrarily discarded COP>1.0 EM systems, primarily with the Lorentz regauging of the Maxwell-Heaviside equations. Hence, Western science has not experimentally studied the type of system that produces the effect in the first place.

On the other hand, it is possible to directly investigate the antigravity-producing phenomenology on the laboratory bench, by utilizing overunity EM systems with very high COP (e.g., COP = 10^6 or more). The Sweet experiments {231} did in fact produce such phenomenology on the laboratory bench, but these experiments were privately performed under proprietary conditions {232}. We discuss the Sweet experiments and device in a later chapter.

In science, such experiments are quite properly deemed interesting but anecdotal until replicated independently. Similar experiments should certainly be repeated by the scientific community, using various interactions (some given in this book) that develop COP>1.0. The problem is nowhere near as difficult as hot fusion, but it has not been tackled and overcome because of (1) the prevailing and erroneous scientific mindset against COP> 1.0 electromagnetic processes, and (2) the present "kill" of the supersystem and its effects in the standard U(l) electrodynamics model.

In Chapter 8 we further discuss the antigravity effect in practical or potentially practical systems where COP » 1.0.

3.11 In Conclusion

In this Chapter, we have stressed what we believe to be a great new principle of giant negentropy, leading to direct and easy extraction of EM energy from the vacuum in copious quantities. That principle is that nature retains *her preferred 4-symmetry* of EM energy flow, while breaking 3-symmetry of EM energy flow and the symmetry of EM time-energy flow on the fourth axis. It is implemented by making a common dipole or charge.

The electrical energy problem is *not* due to any difficulty in inducing giant and indefinitely continuing EM energy flows from the vacuum! The easiest thing in the world is to extract EM energy — any amount, anywhere, anytime — from the seething vacuum, by making a simple dipolarity. The problem is only in then intercepting and collecting some of the energy to dissipate in loads, and doing it *without* using half the collected energy to

destroy the dipole producing the energy, faster than the loads are powered. In other parts of this book we have given some of the many mechanisms that can be applied to attack this "power the load without killing the source dipole" problem, and have also included such in papers in the literature {233a-233u}.

We have pointed out the implications of the new principle of negentropy in EM energy flow, and how all our circuits and electrical power systems actually use it but then arc designed so as to kill the negentropic process's potential for self-powering electrical power systems.

Presently we are told by the conventional scientific community that the dream of freely extracting EM energy from the vacuum, and using it to efficiently and easily power our electrical needs cleanly, is either a fool's concept of perpetual motion, or the science of the next century. It is neither; it is good physics, and it is already *present and misused* in all our electrical power systems and circuits — and always has been. Unlimited electrical energy from the vacuum is here and now, if we but overcome the prevailing mindset and grasp it.

We have argued that all electrical loads and circuits are now and always have been powered by just such EM energy extracted directly from the vacuum by the giant negentropy principle, evoked by the source dipole. We have removed the artificial and erroneous notion that batteries and generators provide some of their available 3-space internal energy to the external circuit. Instead, we have emphasized that batteries and generators dissipate their available energy to form and then continually reform their source dipole, and nothing else. Once their source dipolarity is formed, a battery or a generator is nothing but an energy gate, gating and transducing enormous EM energy from the vacuum. We only have to keep inputting energy to keep reforming the dipole that our external circuit is designed to destroy faster than the load is powered.

In dealing with the function of the dipole in extracting the EM energy from the vacuum and pouring it out to power the circuit, we have shown errors in present energy flow theory and how they came to be made. We also indicated the enormous magnitude of the EM energy flow actually **extracted** and present with every conventional circuit, but wasted and **arbitrarily** removed from accountability. Some processes for intercepting, co**llecting,** and using additional amounts of this available Heaviside "dark EM energy" flow component, surrounding every circuit, have been mentioned, and references have been given to other papers more fully discussing such processes. In a previous paper {234} we have proposed

that the Heaviside dark energy, accompanying all EM field-charge interactions, is responsible for the excess gravity observed to be holding the spiral arms of those distant spiral galaxies intact — in short, we have proposed an unaccounted Heaviside *dark positive energy* solution to the well-known *dark matter* problem in astrophysics.

The ordinary closed current loop circuit inherently yields a system COP<1.0, because it destroys its source dipoles faster than it powers the load. Indeed, the circuit self-enforces the Lorentz symmetrical regauging condition during discharge of its free excitation (potential) energy.

In addition, we have presented an hypothesis to explain that negative energy (negative mass) created in the Dirac sea vacuum by giant astronomical explosion phenomena produces the excess antigravity in the space surrounding those entities that is accelerating the expansion of the universe. We have also indicated how this hypothesis can be investigated and tested on the bench. We have provided one experiment whose results did support the hypothesis.

The present world energy crisis is real and increasing, while at the same time the availability of oil is beginning to decrease and oil becomes more costly.[90] Unless a substantial fraction of the "electricity from oil" curve is shifted to "electricity from the vacuum" rather quickly, the economic collapse of the Western world, followed by concomitant collapse of other economies, may ensue within a surprisingly few years, and even within the present decade.

[90] As this was first being written in Dec. 2001, there was a temporary relief in the oil crisis, due to the sudden decrease in travel, air traffic, etc. after the terrorist attack on Washington and New York on September 11, 2001. As the present war on terrorism has continued, the MidEast is now heating up toward another war, and oil prices are again trying to climb. Iraq, Iran, and Libya called for an oil embargo on the United States, for example, which would almost immediately plunge the nation into an oil crisis. Meanwhile, should effective terrorist attacks occur upon the highly vulnerable energy distribution infrastructure of the United States and other allied nations, the oil crisis will again emerge catastrophically and almost immediately thereafter. It is held off for now, only because Russia under Putin is seeking U.S. financial assistance to further develop its rich oilfields. When OPEC votes to curtail production and then curtails it, Russia opens the spigot and keeps the prices down. Putin is seeking to become a trusted U.S. oil partner, in the role long played by Saudi Arabia but now declining due to perceived Saudi payments to terrorist organizations and reluctance to close down terrorist activities in their own country. So in a strange way, a new alliance between the U.S. and Russia has prevented the oil and energy prices from escalating right through the roof.

We believe that a transfer of much of the "electricity from oil" curve to an "electricity from the vacuum" curve can be quickly accomplished, if the government and the scientific community can be induced to move with full priority and vigor in the directions indicated in this book. However, to get that done, it apparently will be done over the writhing bodies of our leading scientific organizations, literally dragging the organizations to face the proven fact of giant negentropy of every charge and dipole in the universe over their strenuous objections.

As a major objective, we fervently hope that undergraduate students, graduate students, post-doctoral scientists, other scientists, engineers, and environmentalists will interest themselves in these new principles and viewpoints. We have called attention to the new electrodynamics pioneered by AIAS, Evans, Sachs, Barrett, Lehnert, and others, and indicated the capability of this emerging electrodynamics to model this new *energy from the vacuum* functioning.

It has been said that no idea is accepted until its time has come. We strongly believe that the time for cheap, clean extraction of electrical energy from the vacuum is an idea whose time has arrived. Hopefully our efforts in this book will at least conceptually show the interested reader the outline and course that energy from the vacuum can and will take in the scientific community and in the world at large.

We accent again that modeling the extraction of EM energy from the vacuum demands the use of higher symmetry electrodynamics, particularly a theoretical model capable of expressing the interactions of the three components of the supersystem. Barrett and Grimes {235} said it beautifully:

> *"In the case of electromagnetism, the theory was first simplified before being frozen. Maxwell expressed electromagnetism in the algebra of quaternions and made the electromagnetic potential the centerpiece of his theory. In 1881 Heaviside replaced the electromagnetic potential field by force fields as the centerpiece of electromagnetic theory. According to him, the electromagnetic potential field was arbitrary and needed to be "assassinated" (sic). A few years later there was a great debate between Heaviside and Tait about the relative merits of vector analysis and quaternions. The result was the realization that there was no need for the greater physical insights provided by quaternions if the theory was purely local, and vector analysis became commonplace.*

The vast applications of electromagnetic theory since then were made using vector analysis. Although generations of very effective students were trained using vector analysis, more might be learned physically by returning, if not to quaternions, to other mathematical formulations in certain well-defined circumstances. As examples, since the time when the theoretical design of electromagnetism was frozen, gauge theory has been invented and brought to maturity and topology and geometry have been introduced to field theory. Although most persons view their subject matter through the filter of the mathematical tools in which they are trained, the best mathematical techniques for a specific analysis depend upon the best match between the algebraic logic and the underpinning physical dynamics of a theoretical system. "

The problems we face today are ever more demanding of the necessary EM change pointed out by Barrett and Grimes, along with many others. Let us hope their words are heeded. Given rapid development of higher group symmetry electrodynamics models, we shall very rapidly see the solutions to many previously intractable human problems — including cheap clean energy from the vacuum, understanding and directly using antigravity as well as gravity, a revolutionary new medical therapy, a new chemistry and biochemistry, and a new appreciation for the electromagnetic interactions of mind and matter.

Let us hope this new scientific revolution comes swiftly.

Chapter 4

Setting the Stage for Understanding Overunity Power Systems

[Dissipative structures] *"This leads precisely to a distinction between 'equilibrium structures' [which may be understood in terms of classical equilibrium thermodynamics] and 'dissipative structures'. The latter are formed and maintained through the exchange of energy and matter in non-equilibrium conditions."* [I. Prigogine] {236} [Internal brackets added for clarity.]

[The energy in space itself] *"What might appear to be empty space is, therefore, a seething ferment of virtual particles. A vacuum is not inert and featureless, but alive with throbbing energy and vitality. A 'real' particle such as an electron must always be viewed against this background of frenetic activity. When an electron moves through space, it is actually swimming in a sea of ghost particles of all varieties — virtual leptons, quarks, and messengers, entangled in a complex melee. The presence of the electron will distort this irreducible vacuum activity, and the distortion in turn reacts back on the electron. Even at rest, an electron is not at rest: it is being continually assaulted by all manner of other particles from the vacuum."* [Paul Davies] {237}

[Modernizing the fluid analogy of EM]. *The intensity of the vacuum virtual particle flux may be treated as the intensity of a potential, thus by analogy corresponding to pressure in a fluid. Polarity (charge) is a process for establishing a change in the intensity of the vacuum potential — and thus a change in the ambient pressure of the vacuum fluid. Difference between vacuum pressures at two separated points creates a force upon any charge placed between those two points. Just as a differential in pressure between points in a fluid induces currents, a differential in vacuum pressure induces energy flow currents in the vacuum fluid, which are called 'fields'. All*

EM circuits, charges, potentials, and forces in electrodynamics involve altering the vacuum to include altering its pressure and thereby producing the forces that the resulting pressure gradients (fields) induce upon charges. All observable EM energy in space is EM energy intercepted and collected on charges, and it comes from the vacuum via these fundamental vacuum-engineering dynamics." [T. E. Bearden, private communication to a colleague, 2001].

[Impact of EM energy from the vacuum.] *"If they [quantum fluctuations of vacuum] can be [tapped], the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete — and so would many of our worries about environmental pollution." "Don't sell your oil shares yet — but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development: 1. It's crazy! 2. It may be possible — so what? 3. I said it was a good idea all along. 4. I thought of it first."* [Arthur C. Clarke] {238}.

[Broken symmetry of opposite charges.] *"Since nonobservables imply symmetry, any discovery of asymmetry must imply some observable. The experiment of Wu, Ambler, Hayward, Hoppes and Hudson... established the asymmetry between the positive and negative signs of electricity."* [T. D. Lee] {239}.

[On implications of asymmetry of opposite charges of a dipole.] *"In particle physics, the proven asymmetry of opposite charges establishes that the source dipole — with opposite charges on each end—* is *a broken symmetry in the violent virtual photon flux of vacuum. The dipole charges constantly receive and absorb virtual photon energy from the seething vacuum, and re-emit that excitation energy. By the very definition of broken symmetry, some of this absorbed* <u>*virtual*</u> *energy must be integrated into* <u>*observable*</u> *3-space EM energy, and emitted by the dipole in observable form, in all directions in 3-space. Hence there is a rigorous basis for the source dipole extracting virtual EM energy from the vacuum, integrating it, and continuously pouring it out in*

observable and usable EM energy form. It has been in particle physics since 1957, being certified by the award of the Nobel Prize to Lee and Yang in that year." [T. E. Bearden, private communication to a colleague, 1995.]

[On powering an electromagnetic circuit] *"In the United States there is not now, and there never has been, a single electrical engineering department, professor, or textbook that knows and teaches what directly powers an electromagnetic circuit. Neither is it in any publication of the National Academy of Sciences, National Science Foundation, National Academy of Engineering, Department of Energy, or the great national laboratories. Yet the proof that every circuit is powered by EM energy extracted directly from the vacuum has been in particle physics for 45 years, since the award of the Nobel Prize to Lee and Yang in 1957, following the experimental proof by Wu et al. earlier that same year."* [T. E. Bearden, private correspondence, 2002].

4.1 Introduction

In this chapter, we present a selection of potential overunity notions, some inventions, and some experiments. Its purpose is to show some of the more relevant work that has been done, and hopefully to stimulate new thinking by the interested reader. Much of the work addressed is by other inventors and scientists, and we give an appropriate commentary from our viewpoint. Not all the concepts presented can be clearly explained, though some can and are. This is not intended to be a "kit of parts" or an "assembly instructions" type of presentation. For that, the interested researcher will have to rely on his or her own ingenuity and lots of bench experiments, because no such "kit of parts with instructions" for COP>1.0 electrical power systems exists at present {240, 241}.

Because of the broken symmetry of its opposite charges, we do know that any dipolarity — such as a permanent magnet, a charged flat-plate capacitor, an electret, or a simple EM scalar potential — continuously pours out EM energy circulation extracted from the vacuum. E.g., see Figure 4-1, which shows a very simple "free energy generator" that will generate a flow of EM energy indefinitely, even by ordinary U(1) electrodynamics theory (by standard Poynting theory). E.g., quoting Buchwald {242}:

> *"[Poynting's result] implies that a charged capacitor in a constant magnetic field which is not parallel to the electric field is the seat of energy flows even though all macroscopic phenomena are static."*

This is easily seen by applying the standard Poynting formula, S = E x H. With the H-field of the magnet at right angles to the E-field of the capacitor or electret, the Poynting flow of energy S is maximized and orthogonal to E and to H.

The problem is not in extracting energy - even enormous energy — from the vacuum The problem is collecting and using the energy to power loads, without destroying the source dipole

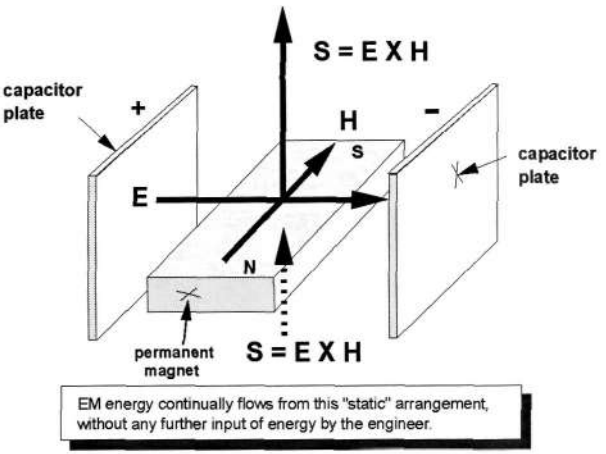

Figure 4-1 Poynting generator providing endless EM energy flow from the vacuum.

Buchwald errs, e.g., in assuming the macroscopic phenomena are static. They are not; they are highly dynamic in the same sense that a perfect macroscopic whirlpool in a river, seemingly static, nonetheless involves a continuous flow of water through it and a continuous dynamics. So far as can be observed, it appears there is no such thing as a truly "static" object. As an example, just to "exist" an object must "travel through time", which is itself a special kind of dynamics in the time domain.

A beautiful explanation of what is meant by "static" is given by Van Flandern[91]:

> *"To retain causality, we must distinguish two distinct meanings of the term 'static'. One meaning is unchanging in the sense of no moving parts. The other meaning is sameness from moment to moment by continual replacement of all moving parts. We can visualize this difference by thinking of a waterfall. A frozen waterfall is static in the first sense, and a flowing waterfall is static in the second sense. Both are essentially the same at every moment, yet the latter has moving parts capable of transferring momentum, and is made of entities that propagate."*

Now suppose that the capacitor in Figure 4-1 is rotated until E and H are either parallel or anti-parallel. In that case, the Poynting theory predicts zero EM energy flow. That is an incomplete assessment; it means that there is no overt field energy flow. There is, however, still quite a lot of covert or "infolded" field energy flow ongoing anyway, inside the static fields E and H themselves.[92] To see this, we first turn to the static potentials.

Between the charged plates of the capacitor or electret, there exists an electrostatic scalar potential ϕ. Between the polar ends of the permanent magnet, there exists a magnetostatic scalar potential Φ. We may independently decompose both ϕ and Φ via Whittaker decomposition {243}, applying a necessary correction {244} to Whittaker's interpretation. Then in all space surrounding the two dipoles, we have a hidden harmonic set of bidirectional longitudinal EM wavepair flows of energy comprising each of the static potentials ϕ and Φ filling all space[93] around the assembly in Figure 4-1. Each of those potentials ϕ and Φ is formed of a combination of scalar (time-polarized) and longitudinal photon pairs, as strongly argued

[91] Tom Van Flandern, "The speed of gravity — what the experiments say," *Phys. Lett. A.*, Vol. 250, Dec. 21, 1998, p. 8-9.

[92] Indeed, by the asymmetry of its opposite charges, each of the dipoles is co**ntinuously** pouring out EM energy extracted from the seething vacuum.

[93] In the conventional view. We corrected that view in {12}, to agree with quantum field theory and to use a *cause and effect* instead of the *two effects* used by Whiltaker.

by Mandl and Shaw {245} and as previously discussed in an earlier chapter. Further, each of the "static" fields can be decomposed into two scalar potential functions, as shown in 1904 by Whittaker {246}. Then each of the base scalar potentials further decomposes into the set of time-polarized EM wave and longitudinal EM wave pairs. The result is that every "static" field or potential in the universe is actually a set of longitudinal EM wave dynamics.

Further, in each coupled Whittaker wavepair as reinterpreted, there is perfect correlation between the time-domain EM energy wave (scalar or time-polarized EM wave) and the 3-space longitudinal EM wave. So even a "static" EM field, such as from the permanent magnet and from the charged capacitor or electret, does involve an enormous number of hidden internal EM energy flows in longitudinal and scalar EM waveform.[94]

[94] One of the great omissions of modern Western electrodynamics is the failure to follow up on direct engineering of this "vast, internal, infolded, far more fundamental" scalar and longitudinal electrodynamics hidden inside all present overt EM potentials and transverse EM fields and waves. Russian secret weapon scientists under the former KGB called this internal electrodynamics the "information content of the field" and have strongly weaponized it. A deception plan has been used to successfully convince the West that the Russians are speaking only of conventional spectral analysis. Use of this internal EM structuring, in the form of longitudinal or scalar wave interferometry, formed the first giant superweapons deployed by the former Soviet Union in 1963. To see a proof that ordinary EM fields and waves and potentials can be formed at a distance, *arising out of the local spacetime in the interference zone,* see M. W. Evans et al., {79}. Longitudinal EM waves easily pass through the entire earth and ocean relatively undiminished, since mass is mostly empty space filled with fields, potentials, and waves — i.e., filled with incredible numbers and bundles and dynamics of longitudinal and scalar EM waves. Mass is thus a great superhighway for the passage of longitudinal EM waves, and longitudinal interferometry can be performed right through the earth and ocean, on the other side of the earth from the transmitters. Such interferometers can also easily focus inside the earth or beneath the surface of the ocean. Hence in April 1963 the first giant Soviet LW interferometer deployed was used to kill the U.S.S. Thresher beneath the ocean, off the East Coast of the U.S. Intense production of EM signals — emerging everywhere in the space in that underwater interference zone placed around the submarine — filled the sub and its electronic controls. This jammed the electronic controls of the sub, rendering it helpless. The hapless sub then sank to crush depth and imploded. The signatures are clearly present in the jamming and cessation of multiple electronic systems functioning in the sub's surface companion, the U.S.S. Skylark (which was in a sort of surrounding "splatter" zone and survived because it was not individually targeted). Today at least 10 nations have scalar or longitudinal wave interferometer weapons, to one extent or another, other nations are working on them, and the Yakuza also has them. These were apparently the weapons

Ultimately there is no frozen waterfall, but only the dynamic waterfall always reappearing the same but filled with dynamic movement and energy flow.

These latter EM energy flows *infolded inside* the scalar potentials and the **fields** exist for a single charged capacitor or electret alone, or a single magnet alone. They also exist for any two points in a circuit that have differing electrical or magnetic potentials with respect to the ambient vacuum potential (energy density). This latter fact, of course, was part of the secret of Kron's *open path.* Indeed, every dipolarity in the universe — between any two potentials or any two differing charges anywhere — is an open path and an energy flow source. E.g., quoting Kron {247}:

> *"...the missing concept of "open-paths" (the dual of "closed-paths") was discovered, in which currents could be made to flow in branches that lie between any set of two nodes. (Previously— following Maxwell— engineers tied all of their open-paths to a single datum-point, the 'ground'). That discovery of open-paths established a second rectangular transformation matrix... which created 'lamellar' currents... " "A network with the simultaneous presence of both closed and open paths was the answer to the author's years-long search. "*

As can be seen, Kron had discovered how to create currents — *currents could be made to flow* — in individual branches between any two nodes in **the** circuit, physically connected or not. We point out that deliberate use of Kron's "open path" in a network circuit constitutes a strong violation of **the** standard closed current loop circuit's self-enforcement of the Lorenz/Lorentz symmetrical regauging condition. Hence it is a magnificent method for achieving COP>1.0 circuits. It is the belief of this

confirmed in 1997 by Secretary of Defense Cohen in these words: *"Others are en**gaging** even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves... So* there *are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...It's real, and that's the reason why we have to intensify our efforts."* [Secretary of Defense William Cohen at an April 1997 DoD counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.]. As the reader can see, the Cold War **was** not so "cold" after all. This mere "tip of the iceberg" should also give the reader a little more insight as to why a war on terrorism is so necessary to all civilized nations.

author that such "open path" functioning in his patented circuits was part of Tesla's secret, though he did not think of it in those terms. However, Tesla's ability to shuttle potential energy independently in his circuits — invisible to a tensor analysis — was rigorously shown by Barrett {124}. Barrett extended the method and obtained two patents in the field of communications {286a, 286b}.

Thus the COP>1.0 problem *is not* in the part or function (the dipole or the charge) that extracts real EM energy flow from the vacuum. That is extraordinarily simple and straightforward. Engineers and scientists have been using it for two centuries without understanding what they were doing. Every charge, dipole, charged capacitor, electret, and permanent magnet already continuously extracts EM energy from the vacuum. The two-fold COP> 1.0 problem is in (i) *separately intercepting and catching (in an external circuit) some of the copious free flowing energy from the "extractor"*, and then (ii) *separately dissipating that collected energy in an external load without killing the "extractor" itself*— or at least only killing it more slowly than the load is powered. The most elegant way to violate the closed current loop circuit is with Kron's open path, typified by Tesla/Barrett potential energy shuttling. Since vector and tensor analysis will not even show it or model it, then a higher group symmetry electrodynamics is imperative in modeling COP>1.0 EM systems and their functions. Much of that work remains to be done.

Our main purpose in this chapter is to point out some selected efforts and approaches by scientists, engineers, and inventors. We will give a brief description and a few details, and leave it to the researcher for further experimentation and reflection. Hopefully, knowing what some others have tried and the results they achieved will prove helpful to the serious researcher.

We also strongly encourage the reader to again read this section after studying Chapter 9. In any COP>1.0 system, the excess energy must come from the "active environment". The active environment of an EM system consists of (i) the active vacuum and its interactions and dynamics, and (ii) the active local spacetime curvatures and their interactions and dynamics. Contrary to naive belief and the received view, overunity electrical power systems — particularly very high COP systems — are neither simple nor easy, but are extraordinarily difficult and highly nonlinear even when their appearance is deceptively simple. Chapter 9 will give a brief expose of some of the difficulties for higher C OP systems. There we will refer again to the intricate circuit analysis work of Gabriel Kron {248}, to Dirac sea electron theory {249} both prior to observation and after observation, and

to the need for higher group symmetry O(3) electrodynamics by Evans {250} which is a subset {251} of the electromagnetics used in the unified field theory of Sachs {252}.

Chapter 9 indicates how mathematically complex these systems really are, even when they appear deceptively simple. The phenomenology is highly complex, and it has not yet been scientifically explored because of the erroneous received view that COP>1.0 EM systems are not permitted by Maxwell's theory or the laws of physics. That is a non sequitur. More exactly, *they are not permitted in that equilibrium class of Maxwellian systems described and selected by Lorentz's arbitrary symmetrizing of the Maxwell-Heaviside equations, following their previous symmetrizing by Ludwig Valentin Lorenz* {253}. Prior to applying the Lorenz-Lorentz symmetrical regauging, the Heaviside equations — which in field form are already a truncation to four vector equations of Maxwell's 20 quaternion-like equations — do prescribe both disequilibrium COP>1.0 and equilibrium COP<1.0 Maxwellian systems. The variables are not separated (potential formation) and the equations are difficult to solve, usually requiring numerical methods. With Heaviside's truncation and Lorenz-Lorentz regauging applied, the resulting "special case" equations — now for only that class of COP<1.0 Maxwellian systems that receive and use no net input from their active environment — continue to be used because closed analytical solutions can usually be had and numerical methods can be largely avoided.[95]

So with tongue in cheek, we humorously remark that COP>1.0 electrical power systems have not been developed or known because the early scientists were a bit lazy and wished to avoid ubiquitous use of numerical methods. These days, with computers, proper math programs, and sharp

[95] **For** some reason, electrodynamicists ignore the fact that the Lorentz regauging does assume two *additional* equal and opposite energy exchanges of the system with its external active environment, but carefully selected so that all the excess energy received in the system is purely in the form of a stress potential. Hence this energy continually does internal work on the system to produce additional stress, but cannot translate electrons through an external load to power it. Also, this regauging condition represents an effective rotation of the frame of the described system out of **the** laboratory frame. To then argue that this severely altered system (increased

stress, constant additional internal work being done on the system, frame rotation, altered potential energy) is the same system prior to Lorentz regauging, and that su**ch a** system is not receiving excess energy from its active vacuum environment, is naive in the extreme and a non scquitur.

graduate students to easily crunch the numbers, there is no longer any reason for continued arbitrary discard of Maxwellian COP>1.0 systems.

For such reasons, no legitimate theory of COP> 1.0 EM power systems has been developed, except for light shed by Prigogine {254a-254f} and others {255a-255c} as to the necessary active environment, disequilibrium nature, and disequilibrium thermodynamics of COP>1.0 systems. Further, the energy flow theory (Poynting's theory) has not been further extended to include the Whittaker decompositions {243, 246} as should long ago have been done. Neither has it been extended to account for the arbitrarily discarded giant Heaviside nondiverged energy flow component.

The researcher should be aware that the energy input to a system is always in the voltage[96] (the *potential;* one input volt of potential will cause one joule of energy to be collected upon each interacting unit point electric charge in the system; one volt of drop in potential results when one joule of collected energy is dissipated per unit point collecting charge in the system.). The fields and their energy are functions of the potentials and their energy, not the other way round. After potentialization of the circuit, the subsequent movement of the potentialized Drude electrons, as current in the system, is connected with (and part of) the *dissipation* from the circuit of previously collected/intercepted energy from the vacuum.

4.2 Demonstration Gedanken Experiment

4.2.1 Work and Energy

Doing work is defined as *changing the form of energy*. No energy is lost per se when work is done; the energy is only changed from one form to

[96] The reason is that all 3-space EM energy — in the circuit or elsewhere — must come from the time domain to each 3-space point and return from that point to the time domain. The scalar potential (voltage) actually is an ongoing process whereby, for any interacting charge, energy in the time-domain and energy in 3-space are functionally combined in that 4-circulation at every point dipole in space. In quantum field theory, e.g. as shown by Mandl and Shaw {19}, the *combination* of the time-polarized photon and the longitudinal photon in 3-space is observed as the instantaneous scalar potential, but neither photon is *individually* observable. We comment that an "observable" 3-space potential is the result of an iterative set *of d/dt* differentiations of the ongoing "combination" of scalar (time-polarized) photons having their energy oscillations in the time domain, with longitudinal photons having their energy oscillations in 3-space along their line of motion. Hence each *d/dt* differentiation of the ongoing 4-space combination yields the instantaneous 3-space potential. Cumulating, one has the ordinary 3-space potential or "voltage" of macro electrodynamics.

another. All the energy since the beginning of the universe is still present,[97] and it is still repeatedly changing its form to do work, over and over. The point is, a single initial joule of energy can be "used" (changed in form) to do more than one joule of work, if multiple changes of form occur serially. *One joule of energy changing its form gives one joule of work, only if a single and total change of form of that joule of energy occurs and then no further change of form occurs.* If the joule changes form once, a joule of work is done and a joule of energy still remains in a second form. If this second form of the joule of energy is not lost, but is retained and then changed in form, a second joule of work is performed and there is still a joule of energy left in different form. And so on. Tricking a system to self-induce multiple iterative form changes of each joule of input energy (or at least of some fraction of each input joule), without losing the energy after each change of form, is one way of providing COP>1.0 in a system.

Remember that COP (coefficient of performance) is best defined as *the usable work output obtained, divided by the EM energy that the operator inputs.* Since "usable work output" is just usable "change of form of the energy", it can be seen that multiple changes of form of every joule of energy input by the operator can lead to COP>1.0.

This illustrates that one must be careful in applying the law of conservation of energy. For a thorough analysis, several features must be identified and accounted: (i) The flow of the energy impinging upon the collection, (ii) the collector itself and the type of collection process utilized, (iii) the linear or nonlinear operation of the collection/collecting process, (iv) the dissipation process used to dissipate the collecting mechanism, (v) what happens to the energy flow that was collected and then its collection "dissipated", (vi) what type of energy flow was collected, and then its collecting "dissipated", (vii) what happens to the collector after the dissipation interaction, (viii) what happens to the energy in different form after each previous change of form, (ix) whether single-pass or multiple-pass of the energy flow is used, (x) whether single collection or multiple collecting is used, and (xi) the effects of any nsymmetrical regauging of a local component or region (e.g., as in simply

[97] However, "present" means in spacetime, not just in 3-space. The EM energy we think of as being in 3-space is macroscopically in continuous circulation from the tine domain to 3-space and back to the time domain. Microscopically it is in *continual* circulation.

increasing one of the potentials of the region) that in turn acts as a free energy flow.

See again Figure 2-4 in Chapter 2. In general, the available energy flow surrounding a circuit will be far greater than the intercepted and collected energy in that circuit, particularly in a "single pass" collection — i.e., where the impinging energy only passes once. In analyzing a system or circuit, one must be very careful to ascertain whether the system utilizes any mechanisms to enhance and increase the energy collection fraction. If it does, then a necessary (but not sufficient) criterion for COP>1.0 has been identified in the system. Letokhov's negative absorption of the medium (i.e., excess energy emission) {256} and Bohren's experiment {257} are examples. Bohren's experiment is easily replicated by any nonlinear optics lab, and outputs 18 times as much energy as the conventionally calculated energy input.[98]

If the impinging Heaviside nondiverged component of the energy flow beyond the collecting/collector is rerouted and passed back to impinge again in the system — even on another collector or other collectors — this must also be taken into account.

Conventionally, the "magnitude" of the fields[99] E and H in the Poynting (collected) energy flow S = E x H are "defined" by the collection from the fields by an assumed unit point static charge at each point in space. In short, the conventional fields have already been "defined" as a standard linear collection upon standard charged *mass, from the field entities as they*

[98] Energy conservation is not violated! Instead, the conventional calculation assumes a static intercepting unit point charge, which has the minimum reaction cross section in the stream of bidirectional longitudinal EM energy flows comprising the potential, etc. By placing the intercepting charged particles into particle resonance, the particles' reaction cross section is increased because each resonating charge sweeps out a greater geometrical cross sectional area. Hence the charges collect more energy from the energy flow comprising any "field" (actually field intensity) or "potential" (actually potential intensity) than is assumed in the standard input energy calculation. In short, Bohren's experiment takes advantage of that arbitrarily discarded Heaviside energy flow component that remains and is present but not considered in the conventional Poynting calculation and field intensity calculation. The experiment in fact proves the existence of the unaccounted but ubiquitous giant Heaviside nondiverged EM energy flow.

[99] At best, the 3-space point intensity of each 4-space field is so defined, for a forthcoming reaction with unit point static charge, and where the forthcoming reaction does not involve lingering time - charging but only simple time-excitation followed by full decay of the time-excitation via normal photon emission.

exist in 4-space prior to interception and collection, and where the collector itself is absolutely fixed and "static". So nonlinearity in energy flow collection — by additional disruption of the impinging energy flow induced by the dynamics of the collector itself— may easily increase the "reaction cross section" of the collector. The static reaction cross section of a unit point static coulomb and the dynamic reaction of a unit point resonant coulomb may differ appreciably.

Without stating it this clearly, Bohren has shown that the interaction cross section for a single-pass collection by one static particle may be increased by a factor of 18 in a given example, *by inducing resonance and thus increasing the "collection" dynamics of the collecting particle* in the impinging S-flow {257}. The work has been independently substantiated by Paul and Fischer {258}. It also is a direct proof of the existence of Heaviside's neglected nondivergent energy flow component surrounding every field and charge interaction.

So indeed there are COP>1.0 EM processes in the literature. The Heaviside component also pouring from the terminals of every generator and battery, already proves that *every generator and battery ever made already was and is a COP> 1.0 energy transducer, because far more energy pours from the terminals of the generator and battery than the shaft energy input to the generator or the chemical energy dissipated in the battery.*

4.2.2 Extending the Work-Energy Theorem

The standard work-energy theorem in mechanics may be conventionally stated as: *The change in the kinetic energy of a particle is equal to the net work done on the particle by the net force acting upon it.* As in any "model", here there are assumptions that are seldom taken into account. First, the collected/collecting kinetic energy of a particle is due to its increased interaction rate with the vacuum flux, because of its acceleration through that flux.[100] In mechanics the increase in flux interaction (and

[100] As we cover elsewhere in this book, any charge (which, together with its clustering virtual charges of opposite sign is a dipolarity) is a broken symmetry in the fierce flux of the vacuum. This means that every charge in the universe absorbs virtual energy from the vacuum, coherently integrates some of it into observable en**ergy,** and pours out that observable energy in all directions. The negative charge d**oes** that for positive energy; the positive charge does it for negative energy. The latter can be better interpreted as the return of positive observable energy from space to the positive charge, thence disintegration of that positive energy back to virtual energy, and subsequent re-radiation of that virtual energy back to the vacuum. One **can** in fact model the **Bohren** experiment in terms of the extra vacuum flux

hence "Newtonian 3rd law resistance" is just treated as a sort of resistance to acceleration, and known as *inertia.*[101] The actual energy of the vacuum flux interaction rate is a function of the square of the particle velocity through that flux — hence the formula $K = 1/2\ mv^2$ for the kinetic energy K of a mass m moving through the flux of space at velocity v. Relativistically, the mass of the particle is moving through the ambient potential flux, or we may view it from the particle's frame of reference where the ambient potential flux is moving through the particle but interacting with it. Only a single pass of the flux impinges upon the "particle collector", so there is only a "single-pass" type of energy collection ongoing.

All energy in the vacuum exists in "vacuum flux" or "change in vacuum flux" form. There is no force in the vacuum, although there is polarization that will produce a force upon a charge when one is introduced. The force occurs only after the "change in vacuum flux" that we call a field is interacting with a mass. The force is *already* a change to the mass, a priori, since mass is a part of force by $F = d/dt\ (mv)$. If energy is then added by a AK energy flux (usually mistakenly called a force) performing work upon mass m, this constitutes an additional energy flux or flow impinging on the

encountered and transduced by the resonant charge, as compared to flux encountered and transduced by the static charge. In the same vacuum flux density, a resonant charged particle will intercept and absorb more virtual photon energy than the same particle in static condition. Hence its broken symmetry will convert more absorbed virtual photon energy into real observable emitted photon energy.

[101] If one wishes to understand that inertial reaction, here is how it works. Consider the virtual charges of the vacuum as an analog to the Drude electron gas in a conductor. At the instant an observable charge starts to move, it is momentarily affecting all the surrounding virtual charges — an enormous number, which are initially repelling and attracting it in all directions intensely. To move, the observable particle must create a change in that entire participating virtual particle "gas". Just as the Drude electron gas, the vacuum "gas" of virtual charges has a certain relaxation time constant. So a finite time delay occurs before the vacuum gas relaxes and movement of the observable charge occurs. As the relaxation continues apace, the particle being acted on by a force accelerates. Even mass with a net charge of zero is filled with charges, and even the neutrons in the atoms are continuously changing into protons and back, etc. So all mass continually exists in the "charge and charge-changing" state. Inertia is in fact due to the relaxation time curve of the vacuum virtual charges "gas". We dealt crudely with this in Bearden, "Quiton/Perceptron Physics," NTIS Report AD-763-210, 1973, p. 11; hopefully a far better treatment will eventually be undertaken by qualified higher group symmetry electrodynamicists.

particle, imposing an additional "energy collecting" and gradient across the mass. Rigorously, the dynamic system comprised of the dK gradient coupled to the particle, and interacting with it, identically is a force.[102] Depending upon the situation, it may accelerate or decelerate the particle, or change its direction, or a combination. This is summarized in the usual work-energy formula

$$W = K_f - K_i = \Delta k \qquad [4\text{-}1]$$

where the work W that was done is given by the change dK in kinetic energy of the particle from its initial kinetic energy K_i to its final kinetic energy K_f.

In applying the conservation of energy law, usually physicists utilize either the work-energy theorem or an approach closely paralleling it. This application is valid in any linear single-pass collection situation. It may not be valid — and usually isn't —for a multi-pass, multicollection system where the same energy, changed in form to accomplish work in a single reaction, is then changed in form iteratively, again and again, in the same system or material. In such case, one joule of input energy can and will

[102] We stress again that the hoary old mechanics, some four centuries old, is seriously in error in assuming a separate force acting on a separate mass. That remains an inexplicable non sequitur in modern physics, in its very foundations. We call attention to how classical electrodynamicists' wrestle with the problem. E.g., quoting Jackson, *Classical Electrodynamics*, 2nd edition, Wiley, 1975, p. 28: *"...the thing that eventually gets measured is a force..." "At the moment, the electric field can be defined as the force per unit charge acting at a given point. It is a vector function of position, denoted by E."* Our comment is that the "definition" is in error, including the use of the word "field" for "field intensity", when field and its intensity are two entirely different things. A proper definition should be stated as *"...the observable electric field intensity can be defined as the force per unit static charge and mass, existing at a given point in an interacting gradient of the virtual particle flux of the vacuum, as inferred from the changes induced upon the unit static charge and mass."* The field intensity is a vector function of position, charged mass, and vacuum virtual particle flux gradient. The standard definition substitutes an effect (of collection) for a cause (prior to collection), and this error is widespread through physics, from mechanics to electrodynamics and on into particle physics. On p. 249, Jackson shows how the electrodynamicists largely capitulate and continue to promulgate the substitution of effect for cause. Quoting: *"Most classical electrodynamicists continue to adhere to the notion that the EM force field exists as such in the vacuum, but do admit that physically measurable quantities such as force somehow involve the product of charge and field."* We comment that actually mass is a component of force, as shown by F = *d/dt(mv).*

accomplish multiple joules of work in and on the system. So for our purposes we must modify the work-energy theorem to give

$$W = \lambda(K_f - K_i) = \Delta k \qquad [4\text{-}2]$$

where λ is the averaged energy collection fraction, adjusted for multipass, multicollection and also for asymmetrical self-regauging (self-increase of the potential in, and hence the energy flow from, one or more regions of the active system's source). In formula 4-2, K_f and K_i and Δk still refer to single-pass collection only.

In the new work-energy theorem, $\lambda = 1.0$ for that vast number of conventional cases that have successfully utilized the conventional form of the theorem. These are almost always single-pass, single collection systems. The new COP>1.0 systems have deliberately enhanced energy collection — and hence multiple *energy collection and work amplification*[103] — such as multi-pass collection. For these COP>1.0 systems, the expanded work-energy theorem form applies and in general $\lambda>1.0$. In an ideal COP>1.0 system, $\lambda>>1.0$. In some versions of the Patterson Power Cell®, for example, $\lambda = 1200$. In the Sweet device (discussed later), a very high value of lambda resulted, so that $\lambda = 1.5\text{x}10^6$. We sometimes refer to λ as the *energy amplification factor, energy collection fraction, Poynting amplification, collection amplification,* etc. Bohren and others have referred to it indirectly as the *interaction cross section,* the *resonance absorption cross section,* and the *negative absorption cross section.*

Again, we strongly iterate that *there is no* <u>*conservation of work*</u> *law in physics!* When energy is input to a system, acts on it, and is "dissipated" by a change of its form (doing work), the "dissipated" energy is still

[103] There is no "conservation of work" law in physics or thermodynamics. It is energy that must be conserved. A single change in form of K joules of energy gives an equal number of K joules of work done upon the interacting mass system. However, there remains an equal number of joules available, just in a different form. If that second K joules of energy is then changed in form again and not allowed to escape from the system, an additional K joules of work is performed in the system, without the operator having added any extra input energy. And so on, until the inefficiency of the system and some inevitable losses allow all the "recycling" energy to escape from the system. We strongly believe that ignition, quenching, and re-ignition phenomena such as in gamma ray bursters and x-ray bursters are due to exactly such processes where iterative change of form of each initial joule of energy occurs.

available after the work (change of the energy's form) is accomplished. However, usually by "dissipated" energy we mean energy that has permanently left the system (or a component in the system) and cannot be recovered and used by the system. The original input energy is not work, because it did not undergo any change of form prior to interaction with the system to change its form. So one does not do "work" as input, which is a non sequitur. Any work accomplished in the input section of a system is due to inefficiencies of the system,[104, 105] usually allowing extra change in form of some of the energy in non-useful processes called "input losses". As we stated, it is quite possible for a single joule of original input energy to perform many joules of work. During the subsequent billions of years following the formation of the observable universe and the energy in it, every joule of the primordial energy is still here. And every joule of it has been steadily performing joule after joule of work since then. Further, it has continually been recycled between 3-space and the time domain and back, and is continually being so recycled today.

Suppose input energy to a system has been dissipated (changed its form) once, doing work (single change of form of energy) in the system. If the dissipated energy in a different form is then recovered or partially recovered — without escaping the system — to change its form yet again in the system and produce additional useful work, that system is

[104] Almost always due to a negative feedback mechanism such as Newton's third law, self-regauging symmetry, the closed current loop circuit, inertia as due to a self-regauging 4-symmetry, etc.

[105] E.g., a transformer would be an overunity system, because the current in its primary is separate from the current in its secondary, if these two currents were completely decoupled and independent. In that case, the transformer would simply propagate and "couple" or pass energy emitted from primary to the receiving secondary, without back-coupling. However, the closed current loop in the secondary, routing all spent electrons in the secondary back through the back mmf of the secondary coil, produces a back-field coupling interaction with the primary, and this "back mmf/back emf" coupling requires energy dissipation in the primary section to overcome. In short, the transformer is designed so that the secondary lights the primary to a draw and the designer loses. With some losses and inefficiencies in the device, that makes the transformer a COP<1.0 device (unless free external energy is received in the input). The interested reader might extract several hints and suggestions in this book, passim, of things that overunity researchers have tried in their search to break up the back-coupling of a transformer. The simplest way, of course, would be to place a true negative resistor shunt across the secondary, so that part of the secondary current does not return back through the primary.

considered to be an open system far from single-dissipation equilibrium with its external environment.[106] In that case, instead of the first dissipation simply "returning" the energy to the external environment, the energy is recovered by another change in form (which may simply be a change in direction in the internal environment). The thermodynamics of an open system far from equilibrium with its active environment applies, whether that "environment" is internal or external to the system. It is "external" to the subcomponent of the system forcing the "local change of form" of the energy.

4.2.3 Gedanken Experiment: Multicollection by Regenerative Feedback

After a COP>1.0 collecting process with subsequent proper discharge of the energy, more work output as "dissipation of the collected-energy" exists than the energy being input by the operator or experimenter. By regenerative, clamped, carefully controlled positive feedback of a portion of the output *positive* energy[107] to the system input, the system can be converted to a self-powered (self-asymmetrically-regauging) system that powers both itself and its loads. However, see Chapter 9 for special considerations of the Dirac sea hole current and excess negative energy that arises for COP»1.0 EM systems. Positive clamped feedback will fail dramatically for any COP»1.0 EM system, and for many COP>1.0 systems it will also fail unless conversion of negative energy — arriving at the input section — to positive energy is accomplished.

To ease visualization of the energy multicollection process, consider a gedanken experiment iteratively retroreflecting a steady small EM energy input. Particularly see Figure 4-2.

[106] The vacuum environment is also "internally" penetrating throughout any macroscopic system, to the finest level! So the notion of separated "external" and "internal" environments requires strong qualification in any system engaged in iterative, work-amplifying interaction with its local vacuum.

[107] The output may contain appreciable negative energy as well as positive energy, however. In that case, in the feedback loop the negative energy must be transduced into positive energy by regauging, else it will appear in the input section of the system as an extra system load there in the input itself. It will "eat" incoming electrons from the external power supply, so that the external power supply has to power this "extra load" in the input section as well as powering the normal system load presented. This reduces the system COP to COP<1.0.

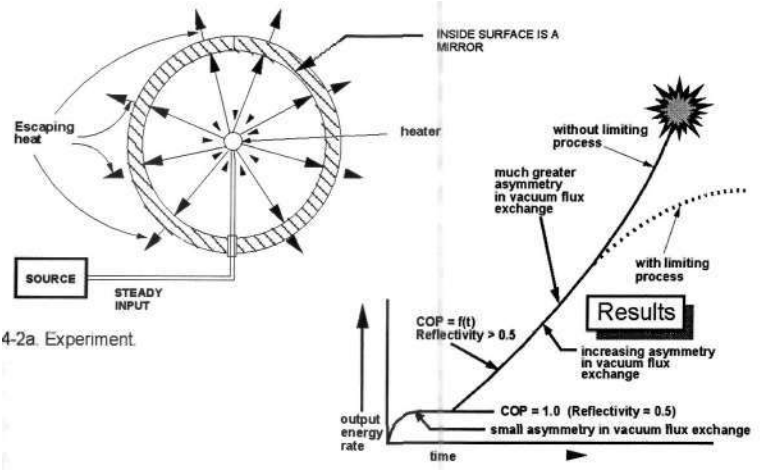

Figure 4-2 Heater wire in a hollow sphere with certain retroreflectivity properties.

As shown, a heater-emitter is placed inside a closed hollow sphere, through a tiny hole for the two wires connecting the heater wire into the external power supply (the external power supply is not shown). The heater emitter is 100% efficient; any joule of energy absorbed by it is re-radiated by it. One joule of energy (one watt of steady "input power" — conventional electrical engineering terminology where rate of work and rate of energy flow are confused!) is furnished from the power supply to the heater element inside the sphere. The inside of the sphere is coated with a substance that acts as a phase conjugate mirror (PCM) reflector with, say, 0.5 reflection coefficient. In other words, when scattered photons are emitted from the wire in all directions, they strike the inner surface of the sphere. Half are retroreflected precisely back to the spot on the resistor from whence they came, where they are absorbed and "re-collected" to further heat the resistor, causing emission of additional photons from it. The other half of the absorbed photons on the inner surface of the sphere diffuse through the cylinder walls as heat, and escape as heat radiation from the sphere to the outside world.

If that sphere's operation could be maintained intact and stable, without change of the physical characteristics and mechanism, then the buildup of energy in the heater wire inside the cavity — and the buildup of the energy icing emitted from the outside of the sphere — would be ever increasing. It would increase without bounds as time passed. Wait a short time, and

the sphere would be outputting 10 watts of power while one would still be inputting one watt. Later, the sphere would be outputting 1,000 watts of power, while one would still be inputting one watt. And so on. Indeed, the rise in energy density of the output would be asymptotic, and would increase toward infinity. The only limitation as to the energy output for a steady 1 joule per second input, would be the limit at which the mechanism goes unstable and changes occur to dampen and curtail the process.

Before the reader objects on conservation of energy grounds, one should realize that this rise in the energy density inside the sphere is an example of iterative regauging. The principle of *gauge freedom* — one of the axioms of quantum field theory and well established — assures us that *the potential energy of a system can be changed at will, and freely.*[108] What the gauge freedom principle does *not* state is a *mechanism for providing the additional potential energy and a source for it* — nor do the quantum field theorists and electrodynamicists. Without such a source and mechanism specified, the conventional gauge freedom principle assumes total violation of the conservation of energy law.

[108] Conventional scientists are almost always very careful to regauge symmetrically, so that the two excess force fields that result are equal and opposite, and sum to a net zero resultant field. That "zero-summed system" comprises a stress potential *a priori.* So such symmetrical regauging alters the stress in the system and alters its potential energy, but only in the form of additional stress energy. There is no *net* force and "force field energy" that can be used to dissipate that additional free stress energy in an external load, thereby doing free work. This regauging is a purely arbitrary practice by the electrodynamicists. We are far more interested in "asymmetrical regauging", where only one potential is freely changed or the two are changed unequally, resulting in a *net nonzero force field* that can then be dissipated in an external load to perform free work. Only by asymmetrically regauging an otherwise inert system can usable field energy be added and any work then be done by it anyway. In conventional systems, we do the "asymmetrical regauging" by adding the voltage (potential difference). As current flows with dissipation of energy from the circuit in the loads and losses, the system is able to develop "power" and thus do work in the external load. Unfortunately, the electrodynamicists are still obsessed with symmetry, so they ubiquitously employ in all electrical power systems the closed current loop circuit. This guarantees that the circuit will kill its source dipole (the source of the potential and potential energy generated from the virtual flux of the vacuum by the broken symmetry of the opposite charges of the dipole) faster than it powers its load. That way, lovely symmetry is maintained, beautiful free energy and negentropy are avoided and tossed away, and ugly pollution and destruction of the biosphere continues worldwide to fulfill the ever-increasing and insatiable thirst for electrical power.

In our supersystem view, the gauge freedom mechanism providing the energy is straightforward: the excess energy is freely supplied from disequilibrium in the active vacuum interaction with the system and in the disequilibrium represented by the local curved spacetime. Since a change in system potential energy is also a free change in spacetime curvature, then it follows that simply changing the potential energy of the local vacuum (the vacuum is also an electromagnetic system!) and of the local curvatures of spacetime is also "for free", or it can be. One does not have to perform work oneself upon spacetime to curve it! The mere *presence* of a spatial energy change — including a free potential energy change allowed by gauge freedom — is sufficient to freely curve spacetime also. That is a real energy change, because any curvature of spacetime acts back upon mass. Higher group symmetry electrodynamics does indeed include vacuum energy and energy current {259a-259c}, and it is possible to extract useful EM energy from the vacuum.

But back to our sphere, where the internal potential energy of the sphere is rising asymptotically without bound.

In the real world, of course, the reflection coefficients and the materials characteristics will change as the energy density changes, the sphere will heat, etc., and these changes will start damping the perfection of the retroreflection process to limit it to some finite plateau value which may be a COP>1.0 or COP»1.0 condition. Or, the materials will melt or soften so that the sphere ruptures and explodes, sharply quenching the process entirely and emitting a violent burst of energy to signal the disruption of the localization of the process.

Nonetheless, a successful real bench experiment similar to this should be possible with some tinkering, and it should readily yield COP>1.0, after one waits for build-up and stabilization at some level. We would hope that a sharp young graduate student may eventually prepare a doctoral thesis on this experiment or a variant. The principle is demonstrable.

Similar buildups by regenerative feedback and multiple collections by the collectors do appear to occur in nature, up to and including such phenomena as gamma ray bursts, x-ray bursts, etc. These occur in some systems such as exploding gases (and in some cases, even in the upper atmosphere of the Earth). In such a system, the "physical particles in suspension in space" do move and continually disrupt the geometry for the increasing buildup, resulting in decay of the process after a time delay.

However, there is a finite time during which the movement of the particles is still insufficient to appreciably break the geometry and cause

quenching.[109] During this "nearly linear stage", the build-up applies and the energy density very rapidly increases. Build-up occurs and continues while the relaxation time of the initial countering symmetry-restoring mechanism for the old or former state or condition (the initial reaction) is occurring. A well-known conventional example is the Lenz law reaction. Then as the geometry changes significantly, a rapid damping of the energy density increase occurs, quenching the asymptotic rise and "discharging" or "decaying" back to a less-than maximum condition. However, the decay position or state (in the quenched condition) will be different from the initial condition before asymptotic rise (regauging) set in. The system usually will have itself absorbed and collected additional potential energy, and so it will be "hotter" or more energetic. This is often called the "afterglow". In the simple case, parts of the system will be in greater motion (more energetic).

An intermediate plateau can appear as quenching occurs and it can stabilize. However, if no stable plateau is reached during the damping, then further rapid quenching and a rapid reduction of the increased energy density occurs as the geometry changes become decisive and break the asymmetric self-regauging. Thus the "damping" of the process may yield a plateau of steady COP»1.0 operation, or it may simply go immediately into full catastrophic quenching and decline back to some lesser level of COP>1.0 operation, but still more energetic than the beginning condition. The latter case produces a sort of "afterglow" - - observed in the gamma ray bursters, e.g. — of increased energy density from the beginning of the quenched phenomenon. Indeed, in that new system of more energetic gases or particles, once the new state is stable, continuing regenerative feedback versus the new geometry can then reinitiate or "re-ignite" another "burster" followed by subsequent quenching. And so on.

We submit that the gamma ray bursters fit this schema and are consistent with it. So do the phenomena observed in intensely scattering photoactive media on the nonlinear optical laboratory bench. We hypothesize that the gamma ray burster and similar violent burst emission phenomena are generated by this mechanism or a similar version of it.

[109] Regardless of what we call it or what it has been conventionally named, any impulsive, explosive process involves at least momentary broken symmetry, resulting in instant and countering broken symmetry. Then a relaxation time passes, and the countering broken symmetry is dissipated by change of the system to a new potential energy state, the new dynamics state, etc.

Figure 4-3 diagrammatically shows a proposed range of such "excess energy" emissions due to this regenerative positive feedback and multiple collection mechanism. As can be seen, this may place our view of very powerful astrophysical emission phenomena in a completely different light, arranged energetically by the length of the initial "nearly linear" phase of exponential increase. There is a scale of stability levels up to just before the Big Bang itself {260}. A so-called Big Bang, of course, would result when the "containment" ability of 4-space itself is breached, resulting in a rupture of 4-space and a consequent violent blow-out into n-space (where n>4), with a very rapid "false vacuum" created *outside* the blow-out region and pumping itself up by asymmetrical self-regauging in a "new" 4-space. When a new stability level is reached outside the blowout hole from the spawning 4-space, it represents an outside "new" 4-space and a new, infant 4-spatial expanding 4-universe, freshly born.

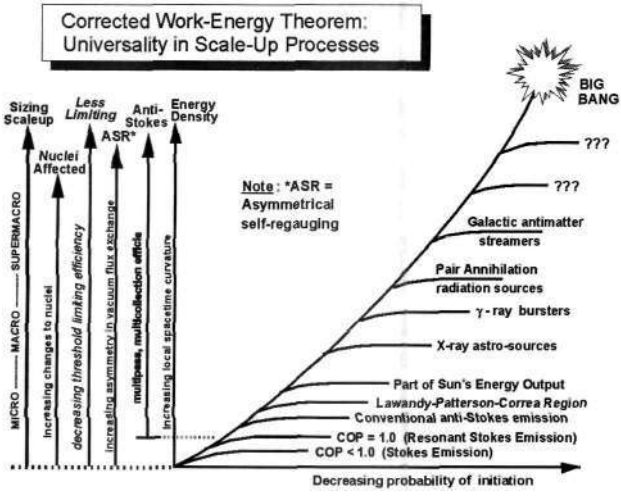

Figure 4-3 COP>1.0 **stability levels for the asymmetrical self regauging process invoked by multipass and** multicollection **of same energy.**

So from inside the spawning universe, the burster phenomenon would be so great as to "burst" 4-space, producing a sort of "super black hole" as seen by the spawning universe. We hypothesize that the asymmetrical self-regauging mechanism produces a great burst of EM energy in its universe if a stability plateau is reached that is below the threshold of 4-space rupturing. If such a stability plateau is not reached, the asymptotic rise in local spatial energy density increases until the primary 4-space ruptures to

produce a "blowout" seen from the old universe as a sort of black hole. There is a sort of "white hole" in the new universe being spawned on the other side of the blowout. This white hole and its associated phenomena produce the birth of another 4-universe outside the original spawning 4-universe. At least we propose that as a hypothesis.

We propose that this could be a legitimate process for the birth of multiple 4-space universes in the infinite-dimensional cosmos.[110] It has an added advantage of accommodating the vexing question of "What existed before the beginning of time (in this universe)??? The answer then would be, *"The existence of time in another universe that birthed this one."* We emphasize our interpretation of time as just a special form of EM energy, and not at all a "mysterious river down which we float helplessly as if in a drifting boat in the river's current."

4.3 Iterative Retroreflection and Collection in a Circuit

The normal circuit attached to a generator or other external power supply is the "external" portion of the overall closed current loop circuit passing back through, and including, the source dipole in the power supply. In a DC external circuit, we may consider that the energy flow pours forth steadily from the terminals of the generator (from the dipolarity between them) into space surrounding the external circuit. Since the external conductors act as a sort of guide, this *transmitted* external energy flow is generally parallel to the external conductors.

The external circuit further acts as a *receiver*. The surface charges and their fields intercept and interact with some of the transmitted energy flowing parallel to the conductors and outside them. This interaction diverts a component of that passing energy flow into the conductors, powering the Drude electrons. This powers the external circuit. The nondiverted component of the passing energy flow — usually much larger — escapes on out into space beyond the external circuit. According to Heaviside's energy flow theory {261}, this escaping nondiverged energy flow may be interpreted to exist in closed circulations.[111] Laithwaite

[110] After all, a "dimension" ultimately is just a fundamental variable in a physics model or, in other words, a "degree of freedom" in mathematical modeling. We may construct any number of dimensions we desire, merely by assigning a sufficient number of variables, including both overt variables and hidden variables, etc.

[111] We point out the interesting possibility of re-interpreting this "closed circulation" Heaviside component as the giant negentropic circulation of EM energy from the

{172b} has specifically commented upon the potential importance of this aspect of Heaviside's theory.

As we shall later address, Heaviside worked out but never published a draft theory of gravitational effects from this extra escaping energy flow {262}. Interestingly, since Lorentz's integration of the energy flow vector around a closed surface surrounding any volume element of interest, the discarding of this "excess nondiverged energy flow" has been ignored by electrodynamicists, and it has been ignored by gravitational theorists.

Consider a theoretically "perfect" generator, loss free. Consider the presence of the Heaviside nondiverged component emerging from the generator terminals — and filling all space around the external circuit. That is the part of the energy outside the circuit that is not caught and processed by the circuit, but is just wasted. By definition, in this "perfect" situation the magnitude of the Poynting or "caught" component of energy flow will precisely equal the magnitude of the mechanical energy input flow (rate) to the generator.[112]

But the presence of the additional huge Heaviside component rigorously means that far more energy pours from the terminals of every battery and generator than the amount of mechanical energy the operator inputs as shaft horsepower. This easily demonstrated fact — e.g., proven by the Bohren experiment {24} — continues to meet with a resounding silence from electrodynamicists and physicists, and particularly from those dogmatic skeptics so keen on defending the classical thermodynamics of closed or equilibrium systems as if they also applied to open systems far from equilibrium in their exchange with their active environment. We refer particularly to the dogmatists so supremely confident that COP>1.0 EM systems are prohibited by the laws of thermodynamics. These stalwart fellows would thus exclude every charge (and its associated fields and potentials) in the universe, were they logical and speaking scientifically. So they strangle at the gnat of COP = 4, and swallow COP = oo while proclaiming that COP>1.0 EM systems cannot exist.

The dogmatists have achieved a major nefarious goal, however. They have silenced most inquiry into such matters by electrical engineering

time-domain to the negative charge, to 3-space, to the positive charge, and back to **the** lime-domain. To our knowledge, that has not been examined.

[112] That is merely a statement of the Lorentz symmetry condition self-enforced by the closed current loop circuit itself.

professors, young graduate students, and young postdoctoral scientists. They have glorified classical equilibrium thermodynamics into a religion rather than the partial and imperfect model it really is. They are directly responsible for the continuing rape and pillaging of the planet's resources, pollution of the biosphere, global warming, and the increasing death of species. They are indirectly responsible for the deaths of more human beings than Hitler, Mao, and Stalin combined. Most of the blame for environmental pollution problems concerned with power and electricity is squarely at their feet. Sadly, the environmentalists seeking to save this planet and biosphere have not yet recognized the true nature of the scientific Taliban that has generated the environmental problem. In tolerating its own scientific "terrorism", the scientific community seriously aborts much of the scientific method.

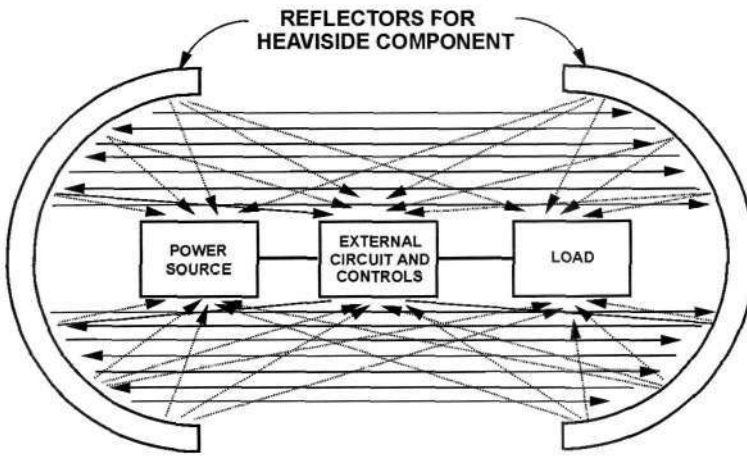

Figure 4-4 Iterative retroreflection of the "passed" **Heaviside component back and forth across a** circuit -- **thematic.**

See Figure 4-4. The neglected large nondiverged energy flow component need not be wasted. As an example, part of it can be captured and used, by applying near-field antenna techniques and such methods as Bohren's resonance increase of the intercepting charge's reaction cross section.[113] It is possible to intercept part of that excess energy that is there and available. E.g., even after it passes on by the immediate circuit, the Heaviside energy flow component can be intercepted beyond the circuit

[113] Or other methods we cannot yet divulge because of patent situation.

and retroreflected back across the same circuit again. In this way — at least in theory — extra Poynting energy can be collected and recollected by the same external circuit for a single given input energy.

In essence, such an "iterative, multi-collecting circuit" is now fed with transmitted energy from multiple (iterative) paths simultaneously. This is *physically doable,*[114] but it is not a simple procedure, and antenna theory and especially near-field antenna theory must be utilized as well as focused retroreflection techniques. To directly model it, higher group symmetry electrodynamics (such as quaternion EM, O(3) EM, etc.) must be used. Precisely such phenomena are met in modern experiments in intensely scattering optical materials {263a-263b, 264a-264b} and in Bohren-type experiments where more energy is collected than the operator has input via standard calculations {257, 258}.

4.4 Tesla's Iterative Retroreflection Work

4.4.1 Tesla's Single Wire Circuit

See Figure 4-5, which diagrammatically shows one of Tesla's developments, which used a retroreflective single wire circuit between two large separated capacitances. This was the basic approach used in his magnifying transmitter and in several other circuits. Here the dipolarity exists between two accumulators, one at each end of a long conductive path with a load in the middle. AC operation is used, by setting up oscillation end-to-end along the "single wire" circuit, from accumulator to accumulator. Even so, no overunity operation will be experienced unless passive retroreflection of the normally wasted Heaviside component of each energy flow "passage" occurs back from each receiving end, so to speak {265}. That is possible if specialized dielectric material and construction is used in the end capacitors.

[114] E.g., some of Tesla's actual patented circuits do it, but that part of their fu**nctioning** is not described by any vector or tensor analysis. However, a higher **group** symmetry electrodynamics analysis of the circuits will indeed show the effect clearly as a "shuttling" of potential (regauging) around the circuit at will. E.g., see T. W. Barrett, {124, 286a, 286b}.

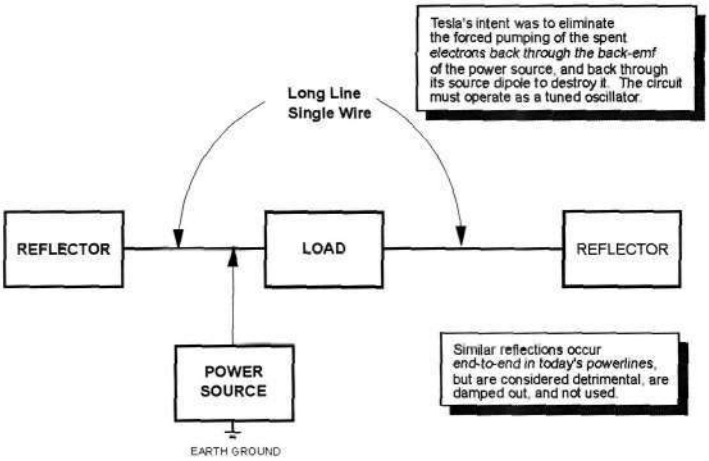

Figure 4 5 Tesla's iteratively retroreflective single wire circuit.

Further, it may usually be necessary to place the individual charges comprising the "current surging to and fro" into particle resonance at either the frequency being transmitted or some subharmonic of it. This schema is doable, but it is difficult and most everything affects it, including even the impurities in the conductors.

4.4.2 Strain to Stress Potential Energy Transduction

See Figure 4-6. This is a diagrammatic representation of a fundamental "strain-to-stress" transduction mechanism we believe was involved in Tesla's "single wire circuit" (i.e., his iterative retroreflecting circuit).

At each end of the circuit, the electrons are "trapped" in the open outside end. Hence when EM energy rushes to the capacitor on one end of the circuit, the forward emf tries to strain the dielectric from the inner plate toward the outer plate. However, the trapped electrons in the outer open wire cannot move, so they produce an equal back-emf and back force trying to strain the dielectric from the outer plate to the inner plate. The result is that the translational field "strain" energy (dipolar charging) is transduced into stress potential (monopolar charging) energy. Electrons try to strain the dielectric from the inner plate toward the outside with a "forward emf so as to charge the capacitor normally, while the trapped external electrons simply push back the other way, exerting a back emf force that is equal and opposite to the straining force from the forward emf and simultaneously tries to "charge" the capacitor in the opposite direction.

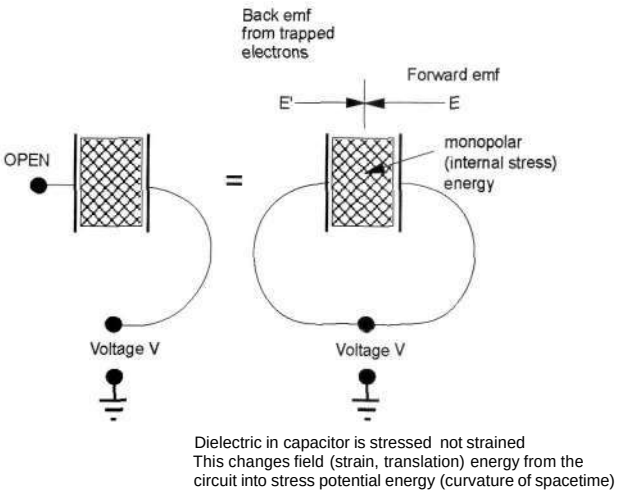

Figure 4-6 Transaction of translational field energy into stress potential energy.

Here is the importance of the "vector zero resultant" stress (monopolar) charging that occurs: The input EM strain field energy familiar in dipolar charging of a capacitor is converted to a dielectric stress (monopolar) potential for monopolar charging. This changes *translational* field energy (external energy) into *stress potential* energy (internal energy), adding an equal amount of back-emf translational field energy in so doing. In short, the charging captures an equal amount of charging energy from its external environment — in this case, from the back emf of the trapped external electrons in the outside open wire. This is one way to capture and use the back emf energy normally reducing the energy available.

We point out that this is charging the capacitor by *Lorentz's symmetrical regauging,* and it represents a rotation of the frame of the capacitor itself out of the laboratory frame. As is well known, the trapped energy of a capacitor in a rotated frame is not the same as the energy of the same capacitor in the nonrotated lab frame.

The single-wire system destroys the symmetry-enforcing function of a closed-current-loop circuit conventionally used. In short, it does not return the "spent electrons" from the ground return line back through the source dipole of the outside power source, so it does not use half the collected energy in the circuit to destroy the source dipole and its extraction of EM energy from the vacuum (to destroy its broken symmetry). Because it

retains the broken symmetry, Tesla's single wire system is an open system far from thermodynamic equilibrium with its active vacuum environment. It is thus permitted to exhibit those five magic functions of such open dissipative systems: (1) self-ordering, (2) self oscillation or self-rotation, (3) outputting more energy than the operator inputs, (4) self-powering of itself and its load, and (5) exhibiting negentropy.

4.4.3 Potential Energy Shuttling in a Circuit

The net result is to "shuttle" the (stress) potential energy back and forth in the circuit, between the ends. See Figure 4-7. When this stress potential energy shuttling is done at the natural (or tuned) resonant frequency of that single wire circuit as an oscillator, the monopolar charge transfer is optimized and amplified by the resonance effect, with an increase in the energy being shuttled. It is this type of Tesla single wire circuit that can in theory exhibit COP>1.0.

Tesla's single wire system also forces the change of energy between internal energy and external energy. A deeper analysis will also involve Dirac sea hole current effects as well as lifting of electrons from the Dirac Sea and combination of unobservable Dirac sea holes and electrons without radiation. However, we leave that for the advanced theorists. A taste of it is included in Chapter 9.

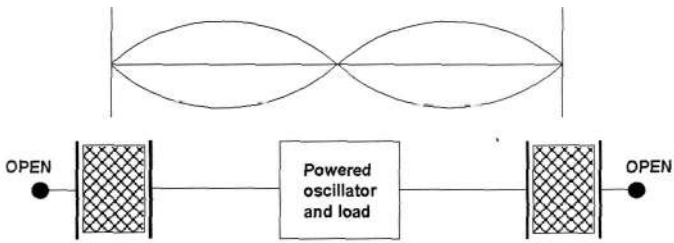

open capacitor to change field energy into stress potential energy

Note: System is designed with a certain resonant frequency At that frequency, the current can become mostly "squeeze" and "relax" as a standing wave emerges and stabilizes

open capacitor to change field energy into stress potential energy

Whether COP>1 0 or not depends on successful additive collection and use of the Heaviside nondiverged energy flow component due to the multipass and reflection operation

Figure 4-7 Tesla's resonant single wire circuit **operation.**

But is there any evidence for this "shuttling" of the monopolar potential in Tesla's circuits? Yes, there is, and indeed some of Tesla's patented circuits

do exhibit such energy shuttling in them, as rigorously shown by Barrett {124, 286a, 286b}.

4.4.4 Other Considerations

For COP»1.0 systems and some COP>1.0 systems, the concepts of Chapter 9 must also be applied, since the system outputs not only positive energy but also negative energy. The negative energy — in the form of Dirac sea hole current — then sweeps back through the system from its output section to its input section. At various places, these "vacuum holes" eat electrons (as on atoms, causing ionization).[115] In short, the Dirac sea holes are converted to more normal lattice holes, and thus can be dealt with in the same fashion as semiconductor designers handle lattice hole problems inside their semiconductor designs. Positron (hole) effects are well known in materials science, and are increasingly being used in actual systems such as the antimatter (positron beam) microscope {266a-266b}.

We accent that a simple LC oscillating circuit does not produce COP>1.0 of itself. If, however, the charges in the currents surging to and fro are in particle resonance at the "feed frequency", then they will "sweep out" a greater geometrical cross sectional area to intercept additional Heaviside energy flow existing outside the normal "static charge" Poynting energy flow. This is similar to the "intercepting resonant particles " process utilized by Bohren {257}, and it allows output of more EM energy than the operator inputs *in the calculated Poynting component* of his own input energy flow. It *does not* output more EM energy than the operator inputs in the sum of his Poynting input component and his Heaviside input component.

The real energy conservation law is that the input energy from all sources and of all types must equal the output energy of all types, where by

[115] The union of a Dirac hole (4-space negative energy electron before observation) and **a** positive energy electron before observation, can occur without radiation. The two curvatures of spacetime involved are equal and opposite, so they just get **replaced** by a flat spacetime, which involves a filled Dirac sea (all the holes filled with electrons). In short, the energy can go into changing the stationary local double re**curvature** of local spacetime, by a sort of "superposition of two spacetime curvatures", to give a net flat spacetime, rather than dynamically radiating EM energy away at the speed of light. However, if either of the two interacting particles has been observed, this is not the case and standard pair annihilation will be observed. The point is that particles in their unobserved *mt* state rather than their observed *m* state, can interact without observation, similar to the way that wave-to-wave interaction occurs in nonlinear optics.

"output" we mean output as useful energy and output as loss or non-useful energy.

So conservation of energy flow is not violated, because one also inputs an additional *Heaviside nondiverged* component, unknown to Bohren. Circa the 1880s or early 1890s, Lorentz arbitrarily discarded it from accountability. One does not have to "pay" for that *nondiverged* and *unaccounted* input energy flow component. Except in continually applying Lorentz's integration trick to discard it, the nondiverged Heaviside component has been almost totally neglected in the textbooks since Lorentz arbitrarily discarded it back there circa the late 1880s. However, it is roughly dealt with in near field antenna theory, sometimes under the topic of "Poynting energy bunching". In the near field, e.g., there also may be a substantial *longitudinal* E-field component. One region may be oscillating back and forth along the flow direction, while the region in quadrature may be flowing in only one direction.

By causing the intercepting charges themselves to resonate and sweep out a greater reaction cross section in an energy flow, the normal definitions of "field intensity" and "potential intensity" are no longer true, because their reaction intensity to a unit point *static* charge has been used as their stated "magnitude". The conventional definition is only for an indication of the *intensity* of the energy flows comprising the field and potential. With the unit point *resonant* intercepting charge rather than the assumed *static* charge, the reaction cross section for the same charge increases, and so the "apparent magnitude of the (intercepted) field intensity" also increases beyond what is in the textbook. So far as I am aware, there is no previous precise term associated with this phenomenon, except to lump it in the euphemism of "negative absorption of the medium" or "negative resonance absorption of the medium" in certain materials {267}. It is more nearly a Poynting energy amplification process, since the "intercepted" or Poynting component of the energy flow is increased. Thus it can be a mechanism for COP>1.0, if the closed current loop circuit's use of half the collected energy in the circuit to kill the source dipole is also defeated.

Nonetheless, energy bunching or Poynting component amplification by altering the reaction cross section function of the intercepting particle is a legitimate way to provide excess "free" energy input for COP>1.0 EM power systems.

4.5 Perspective on Tesla vs. Marconi

Tesla was neither deluded nor mistaken, though some electrodynamicists have mistakenly considered him in that light. On the other hand, Jackson — one of the leading electrodynamicists of our time — pays Tesla a significant compliment as follows {268}.

> *"In U.S. patent no. 787,412 (April 18, 1905), reprinted in Nikola Tesla, Lectures and Patents and Articles. Nikola Tesla Museum, Beograd, Yugoslavia (1956), this remarkable genius clearly outlines the idea of the earth as a resonating circuit (he did not know of the ionosphere), estimates the lowest resonant frequency as 6 Hz (close to the 6.6 Hz for a perfectly conducting sphere), and describes generation and detection of these low-frequency waves. I thank V. L. Fitch for this fascinating piece of history. "*

We also point out that many present science texts err by continuing to credit Marconi with the *discovery* of radio, although he certainly did much to pioneer it and received a Nobel Prize in 1909. Hertz must be given credit for the first deliberate signal transmission per se, during the period 1886-1888. As his transmitting antenna, Hertz used an end-loaded dipole with a gap, and as his receiver he used a resonant square loop antenna with a gap {269}. Sparks produced at the gap in his transmission antenna resulted in sparks appearing at the gap in his receiving antenna.

Marconi became obsessed with Hertz's results nearly a decade later, and in mid-December 1901 Marconi announced the reception of signals at St. John's, Newfound that were transmitted across the Atlantic from Cornwall, England. He later recorded radio signals transmitted around the Earth, and began regular trans-Atlantic message service in 1903.

Marconi's patent {270}, however, was eventually overturned by U.S. Supreme Court decision {271}, because Tesla's patents (and demonstrations) substantially preceded it. Tesla also demonstrated radio transmission before Marconi, and Marconi actually used a modified Tesla circuit in his famed transmission in 1901. Nonetheless, this is not to detract from Marconi's accomplishments; he definitely put "wireless communications" on the map. It is simply to give *discoverer of radio* credit where credit is due.

Tesla was also closer to the truth of the form of an EM wave in space than are modern electrical engineering and most electrodynamics texts. In the present book we have stated that what exists in 3-space as the so-called "transverse EM wave" are actually longitudinal EM waves and functions

of them, with the energy entering each 3-space point from the accompanying time-polarized (conjugate) EM wave at that point (i.e., from the time domain) and emerging in 3-space in the form of a longitudinal EM wave, in 1:1 correspondence.[116] This is followed by a return of the energy from 3-space back to the time domain. This "circulation" from the time domain to 3-space and back to the time domain occurs at every point dipole in 3-space. Only the presence and combination of both the time-polarized photon and the longitudinal photon at each point in an EM wave makes the wave "observable", when we translate into wave phenomena the photon phenomena pointed out by Mandl and Shaw {19}. What spreads as EM energy flow in space (from a source charge) is the local polarization of the vacuum, associated with this giant negentropy circulation from time to the negative charge, to the positive charge, and back to time.

The notion of the transverse EM wave flowing through space is an artifact of the ubiquitous *substitution of the effect for the cause* in Maxwellian electrodynamics. E.g., a completely erroneous "definition" of the causal field (as it exists in space prior to interaction with charged mass) is given as the *effect of its interaction with a ubiquitously assumed unit point charge at every point in space where the field is present.* This in fact substitutes the effect (existing *after* the interaction) for the cause existing *prior to* the interaction. That of course is a gross non sequitur.

We give a concrete example from the first edition of a standard dictionary of physics and mathematics {272}:

> *"**electric field...** 1. one of the fundamental fields in nature, causing a charged body to be attracted to or repelled by other charged bodies; associated with an electromagnetic wave or a changing magnetic field. 2. Specifically, the electric force per unit test charge."*

[116] Later we shall deal a little further with how EM energy iteratively recurs statically in 3-space and propagates dynamically and continuously in 4-space, in more detail. The solution to the long-vexing particle-wave duality is the process of observation. Before observation, an entity is dynamic and continuous in spacetime, not 3-space. After observation (by emission of a photon), it is a momentary frozen 3-snapshot (particle) at a single instant of time. At the next immediate instant, a photon is absorbed, reconverting the "static snapshot" into a dynamic 4-entity again. Since observation (photon emission) and de-observation (photon absorption) iterates at extremely high rate, the entity and each tiniest part of it oscillate back and forth between being a frozen 3-entity (particle) and a dynamic 4-entity (wave).

In the first definition, the field is given as the "cause" of the interaction that exists between like and unlike charges. In the second definition, the field is given as the effect — of the interaction with a test charge — of *something undefined* as the cause.

An entirely different "definition" is given by Gray and Isaacs {273}:

> *"**electric field** ... The space surrounding an electric charge within which it is capable of exerting a perceptible force on another electric charge."*

Here it is defined as simply the space around an electric charge, and not really the cause or effect of anything, unless that local spacetime has been curved (which it has).

Not to belabor the point, this sort of thing led Feynman to "define" the EM field in this fashion {274}:

> *"...the existence of the positive charge, in some sense, distorts, or creates **a "condition"** in space, so that when we put the negative charge in, it feels a force. This potentiality for producing a force is called an <u>electric field</u>. "*

So Feynman made the electric field a *condition in space* surrounding a charge, where the condition can produce (has a potentiality for producing) a force on another charge. He also was aware that force is an effect of the reaction of the causal field with charged mass, in the following statement {275}:

> *"...in dealing with force the tacit assumption is always made that the force is equal to zero unless some physical body is present... One of the most important characteristics of force is that it has a material origin..."*

In Maxwell's theory, the electron, atom, and nucleus had not yet been discovered, and electricity was considered a thin material fluid, flowing in a wire (hence the name "currents") much like water through a pipe. The surrounding space was considered filled with a thin material fluid called the luminiferous ether. A very rough notion existed that the "shaking" of the ether disturbance coming in to an antenna would disturb or perturb the electric fluid in the wire directly. Hence, if one "measured" a transverse oscillation of the electric fluid in the wire due to this "detection", it conclusively "proved" that the incoming ether-perturbations were also transverse. On that notion — together with Faraday's notion that "field lines" were taut physical strings, so that "field perturbations" were naught

but plucked oscillations of these taut strings — the entire notion of the transverse EM force field wave in space was created.

It really is not that way, as is easily shown with modern re-examination of what happens in the receiving wire, considering the Drude electron gas {276} and electron drift velocity. Today we know that the electrons move *longitudinally* down the wire only with a small drift velocity (usually a few inches per hour), while the signal (field) races longitudinally down the wire at essentially light speed or nearly so.

The electrons are longitudinally constrained in the wire because of the vast number of electrons ahead of them that tend to repel their longitudinal movement. The electrons are far less constrained laterally in the wire. However, each electron is also spinning, and its 3-space performance may be compared to a spinning gyro, whose spin axes are now longitudinal restrained. Accordingly, the electrons readily *precess laterally* in the wire[117] when perturbed *longitudinally* by the incoming longitudinal 3-space components of the "wave in vacuum" — by gyroscope precession theory. The electrons at the surface layer of the wire are somewhat less constrained longitudinally, and they "slip" a little down the wire in each oscillation, accounting for the very slow electron longitudinal drift velocity.

Accordingly, one of the most important dynamics of the circuit is the dynamics of the surface charges, as pointed out by electrodynamicists {277}.

If the incoming waves were true lateral waves, there would be no longitudinal force component on the laterally precessing electrons, and coherent current would not flow longitudinally in the wire at all. Instead, one would just get some longitudinal to and fro noise in the coherent lateral motions of the electrons, due to electron collisions.

[117] It is this lateral precession movement of the electrons that is "detected" in most of our instruments. To the early electrodynamicists prior to the discovery of the electron, this detected lateral motion was considered the "shaking of the material electric fluid" in the detecting wire. It was thought that the incoming "electric fluid" from space also had to be material (in the material ether) and transverse, because otherwise the oscillations from space could not have mechanically transferred their "lateral oscillation" to the electric fluid in the wire. Faraday's "material lines of force" concept and the notion that EM disturbances (waves) were simply the mechanical pluckings of these taut strings which also involved similar "material ether" concepts.

Nonetheless, it seems we are stuck with the ubiquitous transverse EM wave model. For more than 100 years, scientists have universally substituted effect for cause in the case of much of electrodynamics — as in the continuing substitution of what is *diverged from* the field and potential at each point in them, by an assumed static point charge, as being the magnitude of the field or potential itself at that point. At best, what is diverged from the field or potential is an indication of the point intensity of the energy flows comprising the field or potential at each point, and in the case of the field, of the prevailing direction.

So electrodynamics is still riddled with that nearly all-pervasive error, and it seems it will likely never be corrected. The leaders of the scientific community do not seem to wish it done and will not allow it to be funded. In short, the community is so comfortable with that grave error that it will almost defend it to the death. The so-called transverse EM wave in 3-space has come to be accepted as if it were a law of nature.

Occasionally a journal will point out the terrible non sequitur in the prevailing notion of the EM wave in space as a "plane wave of oscillating orthogonal E and H fields along the x- and y- axes moving at light speed in the z- axis direction." Romer, former editor of *American Journal of Physics,* provides a prime example {278}. Romer takes to task:

> *"...that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/or time?) that besmirch the pages of almost every introductory book. ...it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate." "...perhaps then, for historical interest, [we should] find out how that diagram came to contaminate our literature in the first place."*

At any rate, once we understand how the real EM wave exists in space, then we can sympathize with Tesla's view of it from the following {279}:

> *"Tesla upholds the startling theory formulated by him long ago, that the radio transmitters as now used, do not emit Hertz waves, as commonly believed, but waves of sound... He says that a Hertz wave can only be possible in a solid ether, but he has demonstrated already in 1897 that the ether is a gas, which can only transmit waves of sound; that is such as are propagated by alternate compressions and rarefactions of the medium in which transverse waves are absolutely impossible."*

In Tesla's own words {280}:

> *"...I showed that the universal medium is a gaseous body in which only longitudinal pulses can be propagated, involving alternating compressions and expansions similar to those produced by sound waves in the air. Thus, a wireless transmitter does not emit Hertz waves which are a myth, but sound waves in the ether, behaving in every respect like those in the air, except that, owing to the great elastic force and extremely small density of the medium, their speed is that of light."*

From quantum field theory, the instantaneous scalar potential in space is actually a coupling of a scalar photon and a longitudinal photon {19}. The only EM component in 3-space is that longitudinal photon.[118] Transforming to wave language, Tesla appears to have been correct in his view of the longitudinal form of the EM wave in 3-space, whereas all the texts are still wrong even today.[119] However, Tesla was also noted for grandiose pronouncements, a trait which certainly did not endear him to the struggling electrodynamicists of the time, even when he was correct and they were wrong. An example is the following {281}:

> *"The Hertz wave theory of wireless transmission may be kept up for a while, but I do not hesitate to say that in a short time it will be recognized as one of the most remarkable and inexplicable aberrations of the scientific mind which has ever been recorded in history."*

Unfortunately, in electrodynamics we are still stuck with that "most remarkable and inexplicable aberration" today, and we will remain stuck with it until the leaders of the scientific community (such as the National Academy of Sciences and National Science Foundation) recognize it and fund a complete overhaul of the foundations of classical electrodynamics, which is so sorely needed. On the other hand, *one should not hold one's breath while waiting for the mountain to come to Muhammad! One might as well ask the stars to fall from the sky as to ask the leaders of the scientific community to correct the serious foundations errors in physics and especially in electrodynamics.*

[118] Hence it is not surprising that all EM in 3-space decomposes into bundles of longitudinal EM waves and their dynamics, as shown by Whittaker {85, 91b}.

[119] However, Tesla did not appear to realize the involvement of time-energy transduction to longitudinal KM 3-space wave energy and vice versa.

4.6 Conclusion

Hopefully we have set the stage for our next chapter, where we will be advancing mechanisms and approaches that have been tried by a variety of researchers. Several of these researchers have indeed produced COP>1.0 devices and processes. However, at this writing none of the devices produced by these inventors and researchers are in production and on the market. As we mentioned in Chapters 1 and 2, there are very powerful forces that have been applied to prevent such development.

Briefly, such suppression has resulted due to one or more of the following:

(a) Sheer greed by the group that gathers around the inventor/researcher, including multiple competing investors and/or "backers". Often a struggle for control develops, and the project is decimated in the process. In many cases a legal struggle also develops, with the result that the legal status of the invention may be fouled beyond repair.

(b) Naivete on the part of the inventor and his surrounding group. The inventor needs the frequent advice of a patent attorney, a regular corporate attorney, a person familiar with research and development projects and procedures, a person expert in testing (particularly with sophisticated multichannel digital oscilloscopes which gather multiple channels of data simultaneously and integrate under the curve, an accountant, and a person skilled in negotiation with potential investors and backers. Most inventors do not have access to all that, or only have access to it after much of the die has been cast and serious mistakes have been made.

(c) Animosity and fierce attack from the scientific community and self-appointed "defenders of the faith". Few inventors are prepared for the onslaught that awaits them if they succeed in producing a genuine COP>1.0 electrical system. Slander and libel are just part of it. An inventor or researcher caught up in always trying to defend himself against vicious ad hominem attack is an inventor successfully deviated from his work. The family also often suffers.

(d) Just now, after the Enron fiasco much of America is becoming aware that powerful organizations often pull out all the stops in a blind pursuit for money and power. Of course they have done so for a very long time; this is nothing new. The inexperienced inventor or researcher is ill prepared for the fact that portions of

government organizations,[120] national labs, universities, etc. may be precisely that way also! U.S. government laboratories also file patents; check it out! Check out Fullerton's defense of his patent rights for his ultrawideband communication system work.

The people in any large organization form a bell-shaped distribution curve. About 9% of that curve represents folks who have — to put it mildly — little ethics when it comes to position, power, and money. Some of these 9% fellows will go to quite some length to twist the patent or part of it or control of it away from an inventor. An inventor who has never heard of "march-in" rights (a neat little "theft" phrase favored by DARPA, for example) is often an easy mark. Government agencies will be on an interesting invention and its hapless naive inventor like vultures on a fat calf. They dangle some money and a contract to "assist the inventor to get his invention developed". There is a little clause in the fine print of the contract where the government reserves "march-in" rights. This is a hidden bombshell that really says the government — *anytime it wishes* — can just unilaterally declare that the funded inventor isn't getting the invention to market fast enough, so a single bureaucrat just *seizes it* — in the name of the government, of course. Anyone who has been in serious aerospace contracting very long is also aware of the deals between a few government fellows who control award of the funds, and their "favored contractor". If enough business is steered to the contractor by the government person, it is implicitly understood that when the government fellow retires, he goes to work for that company with a Vice President position, lucrative salary, and a fat stock option. It's easy to become an instant millionaire or multimillionaire that way. A small percentage of government contracts are actually contaminated in such a hidden fashion. The universities usually are much more open and blatant, and just put

[120] Interestingly, the government is not allowed to copyright its own publications by federal servants. Neither should the government be allowed to patent its own inventions by federal servants and federal agencies. This has set up direct conflict in the federal funding channels for the taxpayers' funds intended for independent research, providing a wonderful opportunity for hanky panky by that lower 9% of the people comprising any large group. By the bell-shaped distribution curve, those comprising that 9% will rise to the opportunity. They are manipulative, greedy, and some are immoral and self-serving. Partially coupled with a similar low "bad apple percentage" in the contracting game, this enables many travesties in the name of federal research and development with respect to patents and misdirection of funds.

in a clause that says, "All patents revert to the university!" Also, the inventor must be aware of the difference between "nondisclosure" and "non-circumvention". Just try getting the latter clause from a university, or either clause from a government agency (yes there are rules for "proprietary information", and they are widely violated). Non-circumvention means the outfit agrees not to change a coil or something, and go and patent your invention. Nondisclosure means they just agree not to talk or write about it openly.

(e) And yes, in addition to these many "petty" little conspiracies, there really is a *great* conspiracy — in fact, there are many of them. Churchill just referred to the entire set of conspiring cartels as the "High Cabal". This is a loose-knit set of extraordinarily wealthy cartels that between them control much of the financial power of the world. You can only find the principals behind a couple of hundred interlocking corporations, if you penetrate deeply enough. Much of their great financial income comes from the control of energy at its various levels, through a net of interlocking corporations. Something like $2 trillion dollars per year is their "take" from energy worldwide. Oil plays a great role in that. These "high cabal" fellows make or break nations financially, as is almost being done to Argentina as this is being written. They also have been stopping COP>1.0 electrical power systems since shortly after the turn of the century, using whatever means are necessary — fair or foul. That is why we still are burning oil, coal, and natural gas, and why our automobiles and trucks run off gasoline and diesel, and not off free electrical energy from the vacuum. The high cabal intends to keep it that way. Some of the major primary means of "stopping" an invention have been as follows:

a. Manipulation and improper use of the law (Gray's production line was shut down by law officers before his engines could roll off there and onto the market).

b. Involving the unsuspecting inventor in drug charges by planting drugs on his property surreptitiously, then secretly notifying the drug enforcement officials who suddenly raid the premises and discover the narcotics, resulting in the inventor going to jail since he has been caught "red-handed".

c. Threatening the inventor's life and the lives of his family, to frighten him away from what he is doing.

d. Arranging a fatal accident for the inventor, such as a fatal auto accident, a fall from a high place, or drowning.

e. Assassination (hit men are fairly simple to hire; a good one is a bit more difficult to hire but is doable. A good hit man might assume a disguise and fake a robbery, shooting and killing the target in the "robbery". In an extreme case, he just fires at a distance with a professional sniper rifle that is silenced. A variation is the use of a "throwaway" assassin, a fellow who has been deeply conditioned by very harsh methods, to deeply involve his autonomic nervous system. He can be spotted by the "glaring eyes" effect of autonomic nervous system involvement. This fellow is only marginally functional in real life, and requires a handler. He also must "fixate" for some minutes (usually from 20 to 30) on the target, by staring at him for a period. Then — say, the next day — while the target is at lunch in a public restaurant, the throwaway walks in, walks straight to the target, and empties a pistol in him at point blank range. He remains there until the police arrive and arrest him. He is immune even to torture; nothing can be gotten out of him, even by electrical shocks on his genitals. There are two levels of throwaways; that is the older and less functional version produced by very harsh means. The more modern version is without the glaring eyes with white showing above the iris; this fellow is more functional, fixates very quickly (couple minutes to five minutes), and can operate without the close immediate presence of the handler.

f. Making the inventor an offer he "cannot refuse", in the old Mafia sense. In the latter, nicely dressed persons come to the inventor's house, meet with him, and offer him a large sum of money to quit what he is doing for the rest of his life. The going sum varies between $5 million and $10 million, usually. The offer is real and it cannot be refused; either the inventor accepts it, or he and all his family are dead when these gentlemen leave the premises. If the inventor refuses anyway, he and his family are killed.

Usually the bodies also just "disappear" and are never found or heard from again.

g. These days, variations are used such as a careful crash of another auto into the back of the inventor's car so he is really shaken up badly but not seriously hurt. He goes to the hospital for checkup, in case of concussion etc. Everything is seemingly okay, but he is kept overnight for observation. That night he is given a hypodermic of air in his veins. Next morning his family receives a call that the inventor has suffered seizures from an apparent concussion after all, and is fighting for his life. If he doesn't die, he becomes a human vegetable. Piece of cake.

h. Then there's the ice dart dipped in curare. The curare paralyzes the muscles of the heart and lungs; the inventor goes down in convulsive floundering, gasping and unable to breathe or to pump blood. He expires very quickly. The curare breaks down in the body, the ice melts, and you have a fellow the medics find died of convulsive heart seizure, etc. Works like a charm. This is an adapted "dirty spooks" trick, adapted from those branches of the intelligence communities of the world that specialize in assassinations.

i. Use of "gaming", which was originally developed to influence or change the behavior of foreign leaders. Imagine writing a scenario, as for a movie. Only you have the deep psychological profile of the targeted individual. You also have the deep psychological profiles of quite a few other individuals who have "knee-jerk" reactions in a certain direction useful to you in your games (in your scenarios). These are called "agents of influence" since, to get them into interacting with the target, only a phone call or other contact need be made and a stimulus given, and they are off and running, self-powered and going after that target with their knee-jerk response. So very sophisticated computers are used, the scenario (intended plot of events to happen) is prepared (the artificial intelligence programs will even give the probabilities of success of all the variants), and a recommended scenario variant is derived and accepted. Then the controller has one or more agents working **for** him that contact the players (the agents of

influence). They get their phone calls or stimuli, react in predictable fashion, and come pell-mell at the inventor, interacting all over the board with him. The range of games is enormous, from stock schemes to lawsuits to infiltrating agents of influence into the internal organization of the inventor to money laundering, etc. The controller follows the progress, and only once in awhile makes slight adjustments (may need to trigger other agents of influence, send in one actual agent, etc.). Over the last 20 years, the gaming has become very expert. So many games can be launched against a single inventor that he usually is finished or nullified by one of them, eventually. Having been gamed over 200 times in the last two decades, I plan to write a book one day on the subject of the games and what to watch for.

j. Finally, here is a sad and disconcerting rule, usually true. If you gather six persons together that you have known for years or even all your life, and they are the nucleus of the organization around you, watch what happens when success occurs and you really do pull EM energy from the vacuum and power loads, lights, etc. One-sixth of the population, seeing that, will shortly contract a very strange malady known as "gold fever". It is not just an *obsession;* instead it becomes an all-consuming *possession* almost in the biblical sense. An individual possessed by gold fever would kill his own grandmother to try to gain control of that system. If one or more of these "gold fever" transformations occur, that sets the group into profound conflict and vicious infighting, on every front. You get sabotage of equipment, sabotage of demonstrations, stealing of equipment, legal shenanigans, just name it. This has destroyed many groups. It will destroy many more.

k. A variation is to send in a special agent who penetrates the group and becomes a member. Indeed, the high cabal has certain persons who specialize in just such penetration and are specialists at setting up disruption. They have had plenty of practice, and are very good at their trade. The identities of some of these "special agents" would surprise the casual observer. The so-called "overunity community"

is rather strongly penetrated and misdirected by a number of such special agents, in addition to a greater number of agents of influence.

1. Finally, the technical knowledge of most inventors and researchers in this field has been largely limited to ordinary electrical engineering and electronics. This means that the inventor often forms his own lexicon and way of thinking about how he does the "magic" COP>1.0. It may be difficult or impossible to connect the way he thinks back to legitimate physics. Further, most of the COP>1.0 community, the majority of electrical engineers, and nearly half the physicists do not understand the technical difference between the *efficiency* of a power system and its *coefficient of performance.* We have insured that the reader of this book will know the precise difference — it's even in our glossary! Further, the entire group around the inventor, and the inventor himself, may not have a clear understanding of the source of the extra energy, the mechanism by which it is obtained, or even the difference between a system in equilibrium with its active vacuum environment and one in disequilibrium with it. Most engineers and a great number of scientists also are still unaware of the dramatic difference between the thermodynamics of equilibrium systems and the thermodynamics of disequilibrium systems. Many have no notion of what the active vacuum is or does. So the inventor may actually be able to build the device himself, but may later err and actually build it away from COP>1.0 with further development.

m. Another problem can be measurement. Sometimes very simple errors — such as "measuring" highly nonlinear, spiky signals with an RMS meter, or using an inferior oscilloscope, or using inferior probes with good oscilloscopes, tricks a relatively inexperienced inventor himself into believing his unit achieves COP>1.0 when it doesn't. Also, some standard engineers will insist on calorimetry, which is inappropriate for COP>1.0 EM systems since they output a mix of both positive and negative energy. The positive energy will heat the calorimeter fluid and the negative energy will cool it

simultaneously, and the "expert measurer" will always measure the difference and thus COP<1.0 with his calorimeter (unless the inventor is a rare one who has also transduced the negative energy fraction of his output into positive energy). Yet the conventional engineer or scientist — who has never seen negative EM energy or a COP>1.0 EM system in his life — will be so confident from his "positive energy only" thinking that he will be completely convinced that a real COP> 1.0 system, measured with a calorimeter to show net positive energy COP<1.0, is *actually* a COP<1.0 system instead of the error in measurement that it is. One of the purposes of this book is to try to explain such things and get a better procedure and protocol made available for the testing.

n. Finally, there are a few actual charlatans who deliberately deceive both the group around them (if it's sufficiently naive) and naive investors and backers. E.g., if one builds a huge starter motor (very high current, very high torque, cannot run long without burning up!) and puts it in an automobile, then fills the back of the automobile full of batteries, that beast will draw 400 amps and leap across the pavement or warehouse floor with an agility one is shocked to see. Then if the inventor is always "having difficulty with his controller unit", and "everything will be fine once the controller problem is licked" or some such, many small and naive investors will leap to invest their life savings eagerly. There are many other scams also, and unfortunately every experimental field, with great financial promise if successful, does attract them. Here the old adage is best: If it is just too good to be true, it probably isn't. One should insist on a technical explanation of the source of the excess energy, the mechanism by which it is taken from the environment, how asymmetrical self-regauging of the circuit occurs, etc. If these questions cannot be answered, the inventor himself does not know what he is doing. At best, he cannot explain it; or he may just be honestly mistaken. In the worst case, the inventor knows it is not genuine, but is deliberately deceiving the investors. So my advice would be to first assess the scientific level of the understanding of the inventor group. Then get an independent test of the

device or see one done properly. Then decide whether what you have seen and heard is real or not.

o. Meanwhile, there are from time to time legitimate COP>1.0 systems initially developed. The place where all of them have failed is where the inventor group seeks to obtain the appreciable financing (something like 30 million dollars is required these days) to complete the phenomenology experiments, modeling, scale-up factor determination, and prototyping before a production model can be built. To date, every one of the legitimate COP>1.0 systems has foundered and failed right at that sheer vertical cliff. Our own MEG system is at that cliff at the moment, so that cliff is very near and dear to the hearts of the five of us who have struggled so long and invented the MEG. Time will tell whether we succeed where all the others have failed, or whether we also just get defeated by the cliff. As of this writing, we have not yet obtained the necessary capitalization. But we are giving it our very best try, and we believe we will win it eventually.

Chapter 5

Selected Approaches to Overunity Power Systems

> [On point-contact transistors]. *"First, the theory underlying their function is imperfectly understood even after almost a century..., and second, they involve active metal-semiconductor contacts of a highly specialized nature. ...The manufacturing process is deceptively simple, but since much of it involves the empirical know-how of the fabricator, the true variables are almost impossible to isolate or study. ... although the very nature of these units limits them to small power capabilities, the concept of small-signal behavior, in the sense of the term when applied to junction devices, is meaningless, since there is no region of operation wherein equilibrium or theoretical performance is observed. Point-contact devices may therefore be described as sharply nonlinear under all operating conditions."* [William B. Burford III and H. Grey Verner] {282}.

5.1 Introduction

In this chapter we present a selection of potential overunity notions, inventions, and experiments by various inventors and researchers. Its purpose is to show some of the more relevant work that has been done, and hopefully to stimulate new thinking by the interested reader. It is not intended to be all-inclusive, but merely representative. Most of the work addressed is by other inventors and scientists, and we give an appropriate commentary from our viewpoint as best we understand the invention and the process used. Not all the concepts presented can be clearly explained, though some can and are.

This is not intended to be a "kit of parts" or an assembly instructions type of presentation. For that, the interested researcher will have to rely on his or her own ingenuity and lots of bench experiments, because no such "kit of parts with instructions" for COP>1.0 electrical power systems exists at present {283,284}.

5.2 Tesla's Shuttling of Potential Energy and Barrett's Extension

See Figures 4-4 and 4-5 in Chapter 4. In his patented circuits, Tesla accomplished the novel function of "shuttling" the potential itself (and therefore potential energy) around in the circuit at will. This startling function accomplished by Tesla is impossible to see in a conventional vector or tensor analysis of his patented circuits, but it is clearly evident in a higher symmetry EM analysis of them. So it does not appear in the conventional texts, which use vectors or tensors for their circuit analyses. Barrett, one of the leading higher group symmetry electrodynamicists and also one of the pioneers of ultrawideband radar, utilized quaternion electrodynamic analysis to clearly show this novel effect in Tesla's actual circuits {285}. Thus, Tesla was able to produce and move around asymmetrical self-regauging in his circuits, wherever he wished. That has been totally missed by scientists prior to Barrett's revealing analysis.

Barrett then went on to extend Tesla's basic mechanism and employ it for communication and radar purposes, obtaining two patents {286a-b}.

It would appear that use of such shuttling techniques is probably applicable to reducing the back emf in conventional nonshuttling circuits, leading to new COP>1.0 mechanisms. The definitive answer remains to be determined by some future researcher.

5.3 Moray's Radiant Energy Device

One of the remarkable examples of a successful COP>1.0 system was the radiant energy system of Dr. T. Henry Moray of Salt Lake City, prior to World War II. Figure 5-1- shows Dr. Moray and his final 50 kW unit, powering an assembly of light bulbs {287}. The device weighed 55 pounds, used an antenna connected as a "signal input" from the ether, but needed no input of electrical energy by the operator in order to achieve its steady power output.

As shown in Figure 5-2 and Figure 5-3, the various Moray tubes were complex in structure. In addition to various grids, they usually contained (in quadrature) three or more amorphous semiconductor pellets pressed in large presses and sintered with locked-in stresses. One points out the presence of optical effects including phase conjugation, possible use of the built-in stress as a sort of self-pumping and mild self-amplification, possible iterative feedforward and feedback loops due to iterative phase conjugation, collecting of additional energy from the usually nondiverged

Heaviside component via the iterative reverberation of energy, and non-interfering fields in quadrature.

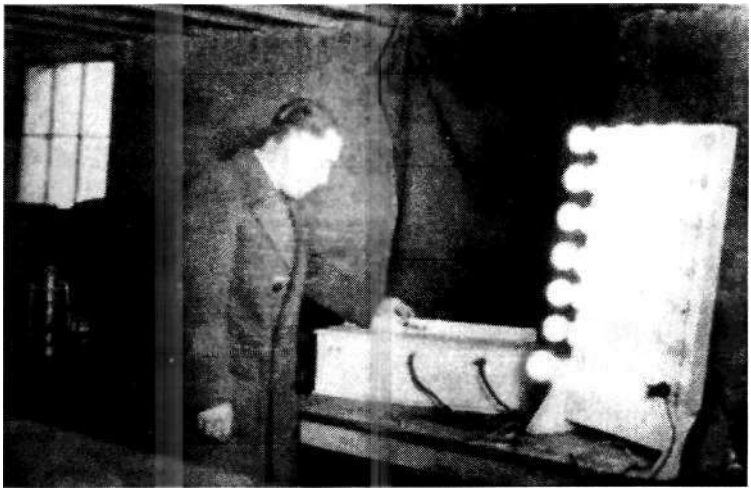

Figure 5-1 T.Henry Moray's 50-kW unit.

The blown quartz tube envelope, in the dark of an enclosure, is open to the passage of infrared (heat) and ultraviolet, which spans a harmonic interval. This allows the passage *of difference* frequencies as sine waves without breakup, even in a nonlinear isotropic environment. Moray stated unequivocally that the tubes would not work unless the envelopes were made of blown quartz. The pellets (shielded from outside light) would nonetheless receive IR input from the ambient temperature, and probably triggered at least weak UV due to the radioactive decay continuously ongoing in the semiconductors. We point out that the UV band is roughly twice the frequency of the IR band, so the "difference frequency" is roughly the IR band itself. In short, it may be that "difference frequency" IR is thus processed in Moray tubes in much more sophisticated fashion than has previously been suspected, including in a self-amplifying (regenerative) manner.

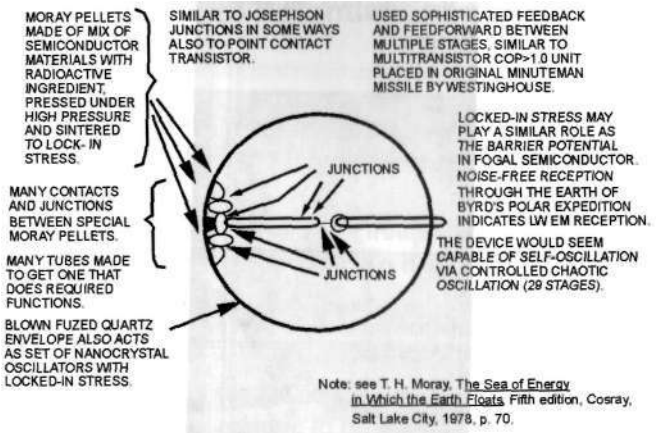

Figure 5-2 Diagram and some novel features of T. Henry Moray's special tube.

The pressed semiconductor pellets were placed in the tube in quadrature, in a sort of "point or junction contact" with each other.[121] Each semiconductor contained a mix of triboluminescent zinc (a semiconductor material), a radioactive material (probably uranium dioxide), and another material of unknown composition, rumored — but not confirmed — to possibly have been diatomaceous earth which also has some unusual properties one may look up. There were some 29 amplifying tube stages in the device. A U.S. patent {288} was eventually granted on an electronic therapeutic unit containing Moray tubes, but the patent on the power system was never granted, although the application was kept current for some years by the Moray family. Eventually the power device patent application files disappeared from the U.S. Patent and Trademark Office.

Although its full technical details were never released, the Moray device is of interest because Moray demonstrated it many times to engineers and scientists, under rigorous measurement conditions, for years. These expert witnesses then signed affidavits to the results achieved by Moray in the

[121] Indeed, the junctions of such sintered pellets are most interesting. Such a grainy junction can be compared to a host of very close point contact junctions, particularly with finely-ground powdered materials used in the pressing and sintering. In essence, Moray's junctions contained a great many "point contact transistors", and it is known that such transistors can behave (particularly under pressure!) as true negative resistors. This also appears to be one of Moray's secrets.

tests. Moray also discovered that he could produce an additional 50 kW of power simply by inserting an additional tap just prior to the formal output.

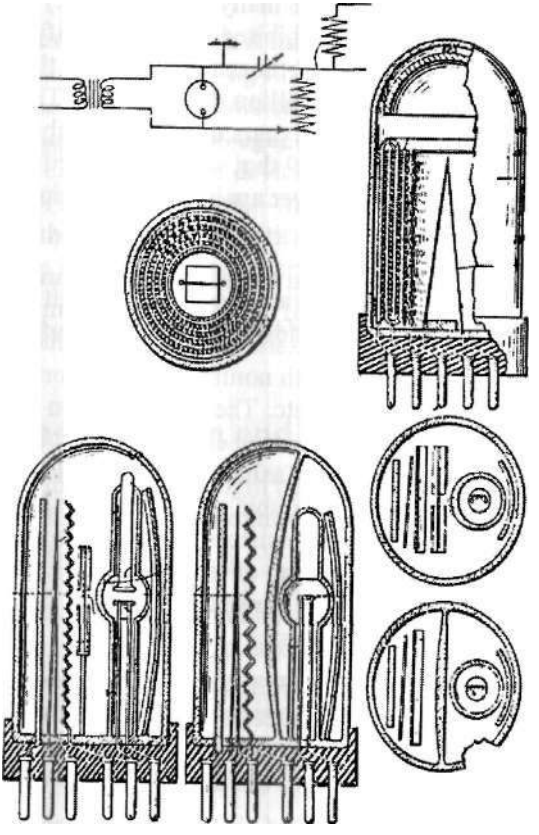

Figure 5-3 A variety of Moray tubes showing their complexity.

Repeated assassination attempts were made against Dr. Moray. While driving his car on the streets of the city, on several occasions he was fired at from an alley or from the sidewalk, but he had bulletproofed the car because of continual threats and ambushes. He was also shot in his own lab in a physical struggle with one would-be assassin, but survived although seriously wounded. A Russian company tried to steal the device, and a Russian agent was planted in Moray's lab, gradually sending essentially all the technical details of the Moray device to Russia. That

agent later destroyed the unit right in Moray's lab by suddenly smashing it with a hammer.

Moray's tubes were quite expensive and were painstakingly made by hand. He fabricated a number of tubes (as many as 30 or more) before he obtained one that "worked" and exhibited the self-amplifying effect. Over the years, he spent several hundred thousand dollars on the project, which is the equivalent of some twenty million dollars today. The 29 tubes in his final 50 kW unit were the result of years of labor and fabrication of several hundred rejected tubes to get the 29 that worked. Accordingly, once those 29 were destroyed, Moray was never again able to obtain sufficient financing to rebuild his unit.

However, Moray had demonstrated a special type of transistor years ahead of the first transistor patent. He had demonstrated the importance of multiple junctions in transistor materials. Optical and nuclear functioning of the tubes was also woven in with nonlinear oscillations, multiple feedforward and feedback loops, etc. The sophistication of the tubes and feeds alone almost certainly guaranteed chaotic self-oscillation. We suspect but cannot prove that the Casimir effect may also be involved in some of his conducting metallic double surfaces.[122] He had demonstrated a remarkable "tube-with-internal-transistors" that produced energy output self-gain, without any operator input of energy. In addition, he had successfully used his special tube/transistor hybrids to produce a very successful COP>1.0 EM power system.

After Moray's death, his two sons John and Richard continued to try to rebuild the unit, but were never successful due to lack of sufficient funding and lack of a proper scientific team. They do know how to build the tubes, however, and they do know how to build the unit.

It appears that no electrodynamicist or physicist skilled in higher group symmetry electrodynamics ever examined the Moray device or worked with Moray. No particle physicist or electrodynamicist skilled in non-Abelian electrodynamics ever worked with the device. Since broken

[122] The "grain" of the stressed semiconducting pellets may be important with respect to the Casimir effect versus the frequency. In short, Moray's contact surfaces between his semiconductors were "grainy" and these grains would have constituted Casimir surfaces. For the importance of the shape of the double surfaces, see M. Chaichian et al., "Quantum theories on noncommutative spaces with nontrivial topology: Aharonov-Bohm and Casimir effects," *Nucl Phys B,* Vol. 611, 2001, p. 383-402.

symmetry was not discovered and proven until 1957, no technical person who worked closely with the unit was ever aware of the various broken symmetries by which some of the virtual energy of the vacuum can be and is transformed into observable EM energy.

Certainly no one ever worked with it that understood the peculiar action of the difference frequency in traveling linearly through an isotropic nonlinear medium. John Moray, who stalwartly carried on the Moray lab in Salt Lake City until a few years ago, does know how to build the tubes, and he knows the circuitry for the device. That he does not understand the "deep theory" is of no consequence — no one else does either. In the opinion of this author, a funded scientific team — carefully chosen and working with John Moray — could probably rebuild the Moray device. We would very much like to see a Moray unit in production and contributing to permanently solving the energy problems of the world. Sadly, that does not seem likely.

5.4 Anti-Stokes Emission and Similar Processes

Stokes' law states that the wavelength of the fluorescent light emitted by a phosphor or other luminescent substance is always greater than the wavelength of the radiation used to excite the fluorescence {289}. This condition was observed by Stokes in 1852 {290}. From an energy viewpoint, the collecting medium collects and dissipates some of the input energy in the medium itself (e.g., to accelerate moving molecules) and then emits the remainder of it. The "system" consisting of the medium, the experimenter's input, and the output is such that it usefully outputs as luminescence less energy than the experimenter inputs. Hence it exhibits a COP<1.0, by absorbing excess energy in its "environmental surroundings".

Usually such a "law" generally holds but is sometimes violated in at least a lew cases. Stokes' law is no exception. It applies for most cases of fluorescence and luminescence, but it does not hold for a few of them. In a few cases, the emitted wavelength is precisely the same as the input wavelength. This means that the collector/absorber re-emits all the collected input energy as fluorescence or luminescence. Here the COP = 1.0. This condition is known as the *resonance condition* and the emission is called *resonance emission.*

In other well-known cases, Stokes' law is violated and the energy emitted is greater than the energy absorbed. In other words, the system exhibits a **COP>** 1.0 *with respect to energy emitted versus energy input by the experimenter.* This is known as anti-Stokes emission. It has been well

known for six decades that anti-Stokes emmision processes do indeed output more energy than one has to input oneself {291}. This excess energy emission is usually euphemistically attributed to "additions from the internal energy of the molecule" and referred to as "negative resonance absorption by the medium" or just as "negative absorption by the medium".

Unless the excess energy taken from the physical medium of the system is replaced from outside the physical system, the anti-Stokes emission process produces cooling in the physical system and is self-quenching once the medium loses all the energy it can afford. For the overunity researcher, a huge hint is to search the literature for anti-Stokes type emission phenomena that do not result in media cooling. The Letokhov phenomena {292} are in fact such phenomena where the excess emitted energy is received from outside the physical system medium, and therefore from the surrounding active vacuum and/or the surrounding local curvature of spacetime.

Other than for a very few physicists — e.g., Bohren {24}, Letokhov {157}, H. Paul and R. Fischer {25} — there appears to have been little *effective* discussion of where the excess energy "extracted from the molecule" really came from initially, and how it is replenished to the molecule (if at all), and particularly *whether or not it has to be replenished to the molecule by the operator*. There has been no discussion of the local potentials as dipole asymmetries in the virtual energy exchange with the vacuum, although there has been inadequate discussion of the involvement of the Poynting energy flow (e.g., by Bohren, Paul, and Fischer). There has been no discussion of the possible involvement of the Heaviside nondiverged component of the energy flow, which is additional to the Poynting component but unaccounted by today's electrodynamicists. To my knowledge, the broken symmetry of every dipolarity has not been discussed with respect to such experiments.

The reader can see the point. If a mechanism exists or can be evoked to freely resupply the lost energy to the molecule from the other two components of the supersystem, then the resulting *self-replenishing* anti-Stokes emission phenomenon can be utilized as a legitimate and continuing COP>1.0 process. It remains to be seen whether this can be worked out. If we wish, the giant negentropy mechanism of the source dipole and source charge {308} may be considered universally proven cases of self-replenishing anti-Stokes emmission, already exhibited by every charge and dipole in the universe.

At least one audacious scientist — Letokhov — has suggested that similar processes in certain systems can perhaps comprise true Maxwell's demons, yielding excess energy output and perhaps eventually a COP> 1.0 operation {293}. Russell has suggested that a similar COP>1.0 process is involved in the fiber fuse phenomenon {299}.

Over the last few decades there has been slow but important work in an optical area of possible anti-Stokes emission phenomena {294a-c}. A variety of strongly scattering, optically active media have been shown to produce substantially more energy output than the experimenter inputs to stimulate the output. However, most are being done in laser-like pumping situations and so the pump energy has to be furnished by the operator. This means that the "replenishment" energy to the medium is furnished by the operator, resulting in overall COP<1.0 performance. However, in self-oscillation conditions, the medium can be self-pumped (self-replenished, taking its replenishment energy from the active vacuum exchange when viewed in the supersystem), and in such conditions COP>1.0 performance is possible, at least in theory. Presently we know of no one who has achieved it — except in the destructive fiber fuse effect — but the work seems to be progressing steadily toward that eventual outcome.

5.5 Gain in Intensely Scattering Optically Active Media

This modern work — which may be regarded in one sense as extending the anti-Stokes emission effect — is largely being pursued in intensely scattering optically active media. A very nice example is given by Lawandy's experiment {295a-d}, shown in Figure 5-4. Figure 5-4a shows a comparison experiment in water without an intensely scattering optically active medium but with a fluorescent dye to show the emission interaction. Figure 5-4b shows the same experiment with titanium dioxide particles added to the fluid. The TiO_2 particles are sized so that their optical resonance is within the laser's frequency domain.[123]

First, as shown in Figure 5-4a, a small, weak laser beam is aimed into the solution, and a small "warm little glow" of fluorescence results just around that region where the laser beam interacts with the solution. Scattering in the medium is rather normal, and provides nothing of any great interest to the overunity researcher.

[123] In passing, we point out the involvement of the Bohren effect due to particle resonance. This collects additional energy from the usually nondiverged large **Heaviside** energy flow component.

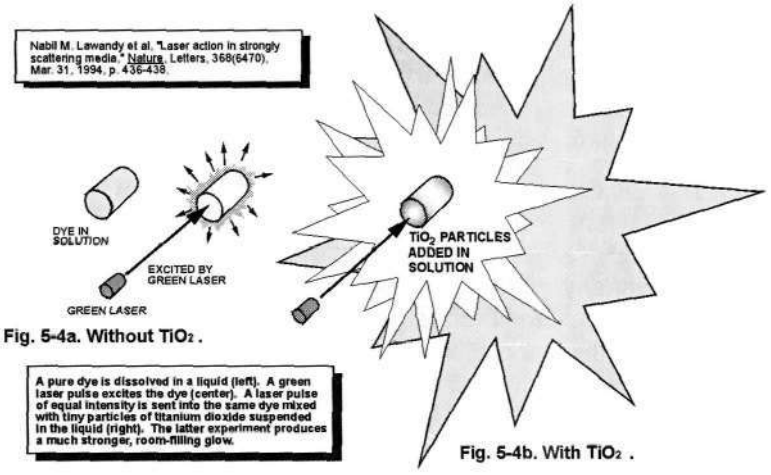

Figure 5-4 The Lawandy experiment

Then the titanium dioxide particles are added, and the same weak illuminating laser beam is directed into the colloidal solution. Figure 5-4b shows the new and spectacular results.[124] Immediately a very bright, room-filling emission of scattered coherent light fills the entire room. The intense optical scattering includes extensive retroreflections for some "ping pong" between individual particles, so that the optical gain is enormous. A highly enhanced energy emission is now evoked, for the same energy input by the operator as was used in the first experiment without the TiO_2 particles. Lawandy's experiment is inexpensive and can be repeated in any university nonlinear optics laboratory and by many individual experimenters. It gives results every time, without fail.

Oddly, no one seems to clearly state that, for a single pulse of input laser energy to the suspension of TiO_2 particles, precisely how much energy was input and how much energy was then emitted by the medium. Instead, "gain" is mentioned, but never the COP = (energy output by medium emission) / (energy input by operator). One suspects that journal referees would probably not allow such a clear and unequivocal statement of

[124] This is a very easy and very convincing argument for the presence of the long-ignored Heaviside component of energy flow arbitrarily discarded by Lorentz more than a century ago, and still discarded by modern electrodynamicists.

overunity, but would apply quibbling and spin control to prevent stating that more energy is output by the medium than is input to it by the operator.

It follows that, if sufficient "ping pong" iterative retroreflection and multiple collection occurs in the medium, the COP>1.0 because more work is done on exciting the medium than the energy input to it by usual (Poynting) calculations. No one accounts the energy unwittingly input to it by the ignored Heaviside component accompanying the Poynting component. Usually the output/input is just referred to as "optical gain". We stress, however, that we are considering only the actual laser beam energy being furnished into the colloidal solution as input, and we are not calculating the efficiency of the laser, its pumping, etc. Anyway, for this stimulated emission process, it is possible that the COP>1.0, and one can see the parallel to anti-Stokes emission. In short, we are considering the TiO_2 solution itself as exhibiting a true negative resistor action.

The field of high gain stimulated optical emission is advancing rapidly {296}, although many experiments still use external pumping furnished by the operator. If the operator has to pay for the replenishment (pumping) energy as well as the input energy, then the COP<1.0 overall. But the experiments are tending toward sustained self-oscillation and self-pumping conditions. If such conditions are obtained in sufficient magnitude, the process will then become a legitimate COP>1.0 operation overall. In that case, it will be usable as a basis from which to develop self-powering COP>1.0 electrical power systems, particularly for infrared "heating" systems etc.

The more recent experiments have shown positive feedback loops both in the time-forward and time-reversed paths; trapping of light flow energy (both time-forward and time-reversed) in large random walks of more than 1,000 individual interactions; weak Anderson-type localization; and constructive interference of forward time and reversed time light paths. since such experiments can be performed in the infrared, they point toward a potential *"vacuum-energy-powered overunity heater"* as a **feasible** achievement in the future. In our opinion, there should be a determined and major Department of Energy program oriented to develop exactly that kind of system.

Such a heater can become self-powering by the presence of greater governed positive feedback during self-oscillation conditions, which will allow sufficient excess collection due to *multipass multicollection* from the usually wasted giant Heaviside energy flow component. This process —

with the self-excitation occurring spontaneously as a "kick-in" positive feedback process in an exploding gas — probably accounts for the phenomena observed in the gamma ray burster and other such violent "burster" cosmic phenomena. Re-ignition, afterglow, and similar effects are observed in gamma ray bursters. They are also observed with *remarkable* similarity in the latest experiments in intensely scattering optically active materials the laboratory. Similar phenomena occur in x-ray bursters as well, and perhaps even in the recently observed and confirmed gamma ray emissions from intense storm clouds.

Finally, we point out that many magnetic materials are also photorefractive, and they readily produce nonlinear optical effects at various frequencies. Some barium compounds are typical examples. As an example, multivalued phase conjugate reflection can occur {297}. Such effects did occur in the Sweet vacuum triode amplifier, to be discussed shortly. It may be that Sweet's conditioning of his magnets conditioned their barium nuclei into self-oscillation, self-pumping, and thereby into *self-replenishing* stimulated optical-type emission at ELF frequencies.

5.6 The Fiber Fuse

See Figure 5-5. Although presently a one-shot destructive process, another multicollection phenomenon exhibiting a novel COP>1.0 process is the *fiber fuse* {298a-e}. This is a well-known but unusual effect in optical fibers and in fiber optic cables.

See Figure 5-5a. Once initiated by simply heating the cable (as with a butane cigarette lighter), the fiber fuse ignites and is self-sustaining. In those susceptible systems utilizing power on the order of one watt or so, the ignited fiber fuse propagates down the cable slowly, at about a meter per second nominally. It is evidenced by a bright white light propagating down the fiber, resembling the burning of a fuse for explosives — which led to the name "fiber fuse".

In fiber optic cables, it occurs only in those that contain germanium in their cores, and not in those containing just silicon in their cores. It moves down the fiber or cable at approximately one meter per second, and it is unlimited in the length of cable that it will continue along and march to the end. In the core, the marching fuse is actually "hopping", so to speak, and it melts a little "hole" about every centimeter or so, blowing out the material from the hole as it occurs. This "steadily and slowly marching" series of core melts results in the catastrophic destruction of the optical fiber core of the cable and thus destroys the functioning of the cable.

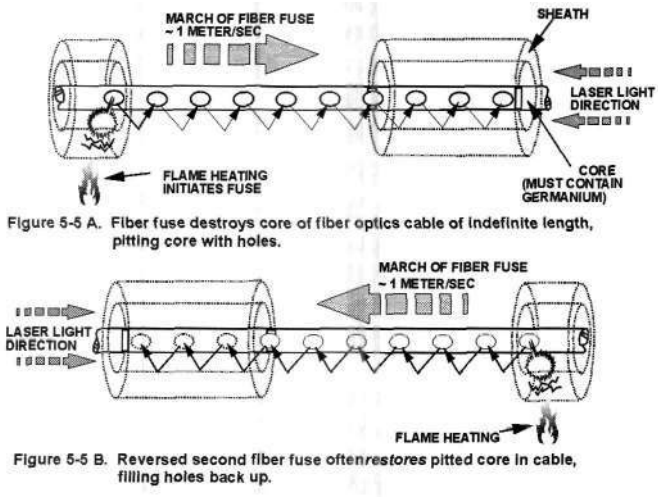

Figure 5-5 The fiber fuse.

The mechanism has been theorized to be self-propelled and self-focusing. Other experiments have found evidence for thermal shock waves and chemical reactions.

But see Figure 5-5b. Astonishingly, after a — say — 1 kilometer fiber optics cable is destroyed by such a fiber fuse, it is often possible to "heal" the damage by reversing the direction of the normal laser light propagating down the cable, while re-initiating the fiber fuse from the other end by heating the cable on that end. In that case, sometimes the *reverse-ignited* liber fuse will then march right back down the cable, precisely refilling those previously-melted little holes every centimeter or so, *restoring the functioning ofthe cable!* If ever a phenomenon cried out for further painstaking investigation to determine its actual mechanism, the fiber fuse is it.

Truncated coupled-wave theory applies to this phenomenon. A rigorous a**nalysis** by Russell {299} of power conservation in dielectric gratings has shown that truncated coupled-wave theories do not rigorously conserve power. Predictably such conclusions have been disputed {300a-300d}, however, and are adulterated by the same old use of Lorentz-surface integration of the Poynting vector around the grating and discarding of the nondiverged Heaviside energy flow component. Those disputing the results and claiming the impossibility of COP>1.0 systems continue to ignore the unaccounted Heaviside energy flow component accompanying

every EM energy flow situation. In fact, they continue to unwittingly discard that component, and so have never performed *a fully* adequate analysis of any circuit or process. They also are unaware that all EM energy in 3-space comes directly from the active vacuum — specifically, it enters 3-space from the time domain and then returns to the time domain.

As long as the Lorentz surface integration scheme continues to be ubiquitously used without understanding what it does with respect to energy flow accounting, the dispute will not be dissolved. Presently both sides still use the Lorentz integration and discard the available Heaviside component. So they are really disputing whether the *Poynting diverged component* of the input energy can be equal to the energy dissipated. The answer to that is simply "No!"

Of course in a lab test the fiber fuse can be initiated with small Poynting energy input by precision point heating. In that case, the total energy required to melt the holes and move the material out of them, every centimeter or so down that (unlimited) length of cable, can be made as large as one reasonably wishes, simply by making the cable as long as one wishes. In short, COP»1.0. As can be seen, it can be experimentally proven that the input *Poynting* energy component can be far less than the total energy dissipated in damaging the cable. On the other hand, the energy dissipated in damaging the cable *is not* greater than the sum total of the usually calculated Poynting component together with the neglected extraordinarily large Heaviside nondiverged component. Conservation of energy is upheld, but only if the long-neglected Heaviside component is also accounted.

It stands to reason that the reverse fiber fuse can also be initiated by less input Poynting energy component that the total energy dissipated in restoring the cable. At that point, conventional theory has a problem. One can start with a good cable, put in a little EM energy twice — once to ignite the fiber fuse and once to ignite the reverse fiber fuse — and one winds up with a good fiber optics cable and having done lots more work inside the cable than the amount of energy one input by conventional considerations. We leave the solution to that problem as an exercise for the reader. Again, unless one includes the long-neglected Heaviside component, there is no way to make the energy flow balance, and one will have an experiment that seemingly contradicts the conservation of energy law. It doesn't, and that is the exercise the reader should understand.

So unless one uncovers and specifies the external source (Heaviside's energy flow component) of excess energy feeding the fiber fuse, it is a

demonstrable experiment whose efficiency ξ seemingly winds up being ξ >1.0. It works every time and seemingly violates the conservation of energy law *as that law is conventionally and imprecisely stated for an equilibrium system only.* The COP>1.0 fiber fuse phenomenon does not violate overall conservation of energy because the system is not in equilibrium with the other two components of its supersystem. It only violates (permissibly!) the conservation of energy statement for a system in equilibrium. The "system" consisting of the fiber fuse and the cable is *not in equilibrium in its energy exchange with its active environment (with the other two components of the supersystem, consisting of the active vacuum energy exchange and the active local curvature of spacetime).* We point out, of course, that the Heaviside component is flowing in space outside the physical system, hence in the vacuum and therefore in the external environment.

Specifically, every dipole in the system is extracting and pouring out energy from the vacuum, and only the small Poynting diverged component of this available energy flow is ordinarily caught. The extreme nonlinearity (and some resonances!) of the particles in and exposed to the extraordinarily locally heated fiber fuse do sweep out a greater reaction cross section than do cold, static charges, in a fashion similar to the separate demonstration of such extended geometrical reaction cross section in the Bohren experiment {301}. *Hence the fiber fuse subsystem and the associated particles of melted matter from the holes do intercept, diverge, and collect some of the accompanying but usually nondiverged Heaviside component.*

See again paragraph 2.1.6 in Chapter 2. Iterative retroreflective systems — such as in intensely scattering nonlinear optical materials — are not necessarily limited to COP < 1.0. Such a system is not necessarily limited to only the energy input by the operator, and it is not limited to only the operator's input Poynting component. Instead, the system can receive an input of excess energy from (i) its active local vacuum, and/or (ii) the local curvatures of spacetime. Its efficiency ξ, however, is always ξ < 1.0, even when its COP is clearly greater than 1.0.

Since scientists disputing the energy aspects of the fiber fuse only have assumed an equilibrium system and have not considered the neglected Heaviside energy flow component, the present arguments against COP>1,0 performance of the fiber fuse are quite irrelevant.

We also point out that an optical phenomenon is involved, and that the core materials in the melt are optically active. Hence, appreciable iterative

phase conjugate retroreflections occur in the fiber fuse itself and particularly in the melt materials (in the "inferno" of the "spot" itself). This asymmetrical self-regauging process gets more than one joule of work from one joule of original input Poynting energy, because of the iterative (and reciprocating) change of form of the energy. That operation produces iterative joules of work for each joule of original input energy, plus the unaccounted original input of the Heaviside component.

Again, there is no law of *conservation of work* in nature. The present conventional energy-work theorem erroneously considers only a "single interception and change of form" of the energy collected in the system, before loss of the energy from the system. Therefore, it only considers each joule of input energy performing one joule of work on the system to "excite" it to a higher potential energy state. It also considers that, once a joule of energy is then dissipated from the system as work in an internal load or process, it has departed the system forever and is not returned to do additional work by having its form changed yet again! In intensely retroreflective or intensely scattering systems, those conventional assumptions do not necessarily hold. For analysis of the fiber fuse phenomenon, the extended work-energy theorem must be utilized.

Finally, we point out the connection of this fiber fuse phenomenon to the similar "runaway" phenomena we have previously postulated as involved in producing the x-ray burster, gamma ray burster, etc. where iterative retroreflection and thus asymptotic rise in energy density is involved.

Another possibly related phenomenon is the unexpected explosion of porous silicon, as discovered at the Technical University of Munich {302}. The porous pellet involved in the unexpected experiment is covered with a layer of hydrogen atoms. In the presence of oxygen penetrating the oxygen barrier, an extraordinary and superfast chain reaction is initiated. The power of the explosion is some 10 times that of TNT. In the inferno portion of the fiber fuse, the "melt" as it puddles and then particulates, should be in the presence of oxygen and hydrogen from air in the cable. This dramatically differs from the explosive pellet, but may be sufficient to ignite at least in a local area rather than explode violently. If so, between the ablating particles of silicon there could exist iterative phase conjugation, thus producing an asymptotic rise in temperature and energy, perhaps sufficient to sustain the fuse. At least this possibility should be investigated.

5.7 Multiple Feedforward and Feedback Semiconductor Loops.

DeSantis *et al.* {303} showed that feedback systems with a multipower open loop chain can produce COP > 1.0 performance. In semiconductors, the present author hypothesizes that complex feedforward and feedback loops involving semiconductors can induce time reversal effects, hence some movements of current against the voltage. In short, there can arise a true negative resistance effect, as demonstrated in the Fogal transistor.

Indeed, a Westinghouse frequency converter using 64 transistor stages and similar sophisticated feedforward and feedback mechanisms was placed in the original Minuteman missile, then was later deliberately modified by Westinghouse engineers to prevent its demonstrated COP > 1.0 performance.[125] The specific germanium transistor used in the converter was also withdrawn from the market.[126] In those days, power meant weight and weight was at a premium in missile design. The power supply was very tightly designed, so that the weight could be minimized.

The converter had been deliberately designed to be 90% efficient, which was quite the state of the art. However, placed in the missile, the average converter would produce from 105% to 115% times as much output power as input power. (We are stating a COP > 1.0, *not* ξ > 100%!) This was more output power than the tightly designed succeeding stages were designed to accept; consequently those overloaded follow-on circuits often burned out and deadlined their Minuteman missiles — something of great strategic concern at the time. The increased rate of Minuteman missiles out of action due to this problem placed great pressure on Westinghouse executives. In turn, they simply ordered the engineers to "fix it!"

Westinghouse simply "fixed the problem" very directly. The engineers reduced the output power of the converter by adding limiting diodes etc. Very quietly, Westinghouse then obtained several patents {304a-c} surrounding the technology, but no further mention of it appears in the literature. The Westinghouse work continued for at least a decade, judging by the spread of the patent dates.

[125] Our information came directly from private conversations of a close scientific colleague with the Westinghouse engineers who thoroughly tested the converter causing the Minuteman problems, and who then altered it to prevent the problems.

[126] Germanium has some unique properties, particularly with respect to transducing surface longitudinal waves to transverse waves and vice versa.

Such multi-loop, multi-feedback transistor circuits can apparently be developed to exhibit true negative 4-resistor effects. With specialized clamped positive feedback of the Bedini type, such open dissipative systems can then exhibit stable COP>1.0, since the energy is taken from the vacuum via the broken symmetry of dipoles, and then discharged asymmetrically in the loads so as not to destroy the source dipole negative 4-resistors. However, the reader should see Chapter 9 for special considerations and phenomenology.

5.8 Negative Resistors

We define a *true negative resistor* as a circuit component or system that receives energy from the environment and outputs useful energy, either in altered form or to power loads usefully. This contrasts sharply with a *differential negative resistor*, which exhibits negative resistance in one part of its regimen, but where all the excess energy to move the current against the voltage in that regime was previously drawn from the circuit itself and therefore was not freely received from the active external environment. Instead, the operator paid for it already. We are not interested in differential negative resistors, which are well known in the literature {305} and do not enable COP>1.0 system performance, so we will not discuss them further. Hereafter when we use the term "negative resistor", it is understood that we mean "true negative resistor" unless the term is otherwise qualified.

The true negative resistor is an open dissipative system *a priori*, and equilibrium thermodynamics therefore does not apply. Instead, the thermodynamics of open systems far from equilibrium applies. The negative resistor freely receives energy from outside the system (from the . environment), and "dissipates" it in interception and collection actions inside the system, to freely increase the available potential energy in the system.

In circuits, the main characteristic of a negative resistor is that the environment freely furnishes some excess energy to (i) power the load, and/or (ii) move the current back against the voltage, particularly when shunted across the back emf region of the source dipole. The *operator* does not have to furnish this excess energy dissipated to propel the current backwards or dissipated to power the load!

One must incorporate the entire supersystem into the analysis of a negative resistance element or system. Since the operator does not furnish the input energy dissipated by the negative resistor, then the active vacuum or

curved local spacetime — or both — must furnish the input energy to it. One must consider local curvature of spacetime interactions with the negative resistance and the active vacuum interactions with it, as well as the interactions between active vacuum and local spacetime curvature. In other words, one must again include the active environment of the Maxwellian system that Lorenz/Lorentz symmetrical regauging arbitrarily discarded.

We specifically do not include the well known "differential" negative resistor, such as a tunnel diode, which in one regime moves current against the voltage, all the while drawing all its enabling energy to move current against the voltage from an overall previous energy input by the operator. Unless the input enabling negative resistance energy is freely received from the external environment, true negative resistance is not involved.

Several true negative resistors other than the point-contact transistor have been produced. We review a few of them in the following subparagraphs.

5.8.1 Kron's Negative Resistor

One of the greatest American electrical scientists was Gabriel Kron. Working for General Electric (GE), Kron built a true negative resistor in the 1930s, which could power itself and the network analyzer[127] at Stanford University, under a GE support contract with the U.S. Navy. Here **is** a direct quote from Kron {306} to show what we refer to:

> *"When only positive and negative real numbers exist, it is customary to replace a positive resistance by an inductance and a negative resistance by a capacitor (since none or only a few negative resistances exist on practical network analyzers.)"*

In that sentence we believe that Kron was forced by the censors to insert **the** words "none or" in the expression in parentheses. Particularly note the suggestion that in the imaginary realm it may not be the same as the accepted practice of using inductance as a positive resistor and capacitance **as** a negative resistor. Of course, the fourth Minkowski axis is - *ict*, and so this is very probably an oblique reference to the fact that energy can also "flow in" from the time domain. Kron was quite knowledgeable in general

[127] The network analyzer was a large analogue simulation capable of modeling sophisticated equations — such as Maxwell's equations, the Schrodinger equation. **etc.** — for use in designing, simulating, and analyzing naval communications systems or proposed systems. It was one of the most advanced simulations of its day. Kron was the chief engineer and scientist on the project, and one of the ablest electrical physicists the United States ever produced.

relativity as well as advanced electrodynamics, and he applied full general relativity to rotating EM machines etc. In another quote, Kron {307} also revealed that he had the negative resistor but was not allowed to use it to openly power the Network Analyzer. Quoting and reading through the "spin control":

> *"Although negative resistances are available for use with a network analyzer, in practice it is more convenient to use a second type of circuit, in which the positive and negative resistances are replaced by inductors and capacitors and the dc currents and voltages are replaced by ac currents and voltages of fixed frequency. The use of the second type of interpretation is equivalent to multiplying the wave equation by* $i = \sqrt{-1}$*."*

After the word "although..." Kron includes the blunt statement that negative resistors were indeed available for use with the network analyzer. But if the "convenient" replacement of the positive and negative resistors by inductors and capacitors was made, then there was no COP>1.0 involved, and there was no true negative resistance involved. Kron is trying to clearly tell us that fact in the above quotation. He also strongly hints that energy from the time domain on the axis *ict* is involved, but that multiplication by $\sqrt{-1}$ discards this "energy from the time domain".

Kron's negative resistor secret has never been released by General Electric, Stanford University, or the U.S. Navy and it is not going to be released. It has never been deciphered outside those groups, with the possible exception of knowledge by Floyd Sweet of Kron's negative resistor construction. Sweet worked in General Electric but not on the Network Analyzer project. Kron, however, was Sweet's mentor and patron, and Sweet often spoke of Kron in glowing terms. In our opinion, Sweet's vacuum triode amplifier was a further development of Kron's early negative resistor, as Sweet understood it.

We further believe that Kron's "open path" is simply the other two components of the supersystem, being (i) local curved spacetime, and (ii) the active local vacuum. Obviously the *external environment* connects any two points in the physical circuit, in addition to the circuit's physical connection (the "closed path"). Between any two points at differing potentials in an electrical circuit, there exists a potential and a dipolarity. Therefore, there exists a broken symmetry because of the dipolarity. The potential difference of that dipolarity is also a curvature of spacetime; i.e., it is a "field" between the two points, and the field is identically a curvature of spacetime. Hence from any two such dipolar points in the

circuit, there exists the giant negentropy flow of EM energy that we pointed out in 2000 {308}. This "open path" EM energy flow between any two unlike charges (any dipolarity) in the universe, not intercepted by the circuit and thus nondiverged, is discarded by Lorentz's integration of the energy flow vector around a closed surface enclosing any volume element of interest. It appears that Kron not only recognized (in different terms) what we are calling the "supersystem", but also recognized the equivalent of Heaviside's nondiverged EM energy flow component from any dipolarity — referring to that energy flow as the "open path" flow of energy. It is almost certain that he fully recognized what Lorentz symmetrical regauging did to the Maxwell-Heaviside equations. Thus it appears that Kron was the first scientist to discard Lorenz/Lorentz symmetrical regauging, producing his negative resistor by doing so.

We do not have firm knowledge, however, but only circumstantial evidence that Kron recognized the flow of EM energy from the time domain into 3-space, and vice versa, though he was certainly capable of seeing that. Nevertheless, this would also be included in his notion and discovery of the "open path", since it is included in every dipolarity, generating the scalar potential between the poles of the dipolarity. It may also have occurred to him from his excellent grasp of general relativity and spacetime curvature {309}.

Kron's concepts are certainly capable of being modeled and used to produce COP>1.0 EM circuits and systems, including his negative resistor. Kron did tremendous work in advancing EM networks and power systems. He left behind a great legacy of network and system analysis capable of dealing with the COP>1.0 electrical power system problem {310a-e}. Unfortunately, that legacy has been little used, if at all, in design of electrical power systems and power distribution networks today. To our knowledge, there are no electrical power systems deliberately using Kron's open path.[128]

5.8.2 Chung's Negative Resistor

A highly simplified diagrammatic illustration representing the Chung negative resistor is given in Figure 5-6. In a July 9, 1998 keynote address at the Fifth International Conference on Composites Engineering in Las

[128] A possible exception is provided by Barrett's extensions {286a, 286b} of Tesla's "potential shuttling" technique {124}, which can only be seen in higher group symmetry electrodynamics such as quaternions. However, as far as we know, Barrett has **not** applied energy shuttling techniques to electrical power systems.

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Vegas, Dr. Deborah D. L. Chung, professor of mechanical and aerospace engineering at State University of New York (SUNY) at Buffalo and Director of the Composite Materials Research Laboratory, reported that she had observed apparent negative resistance in interfaces between layers of carbon fibers in a composite material prepared under pressure.[130] The negative resistance was observed in a direction perpendicular to the fiber layers. By varying the pressure at which the composite material was prepared, Chung *et al.* were able to control whether the material would exhibit negative, minimal, or positive resistance. Apparent negative resistance was also observed in carbon fiber cement-matrix composites and in bare carbon fibers held together by pressure.

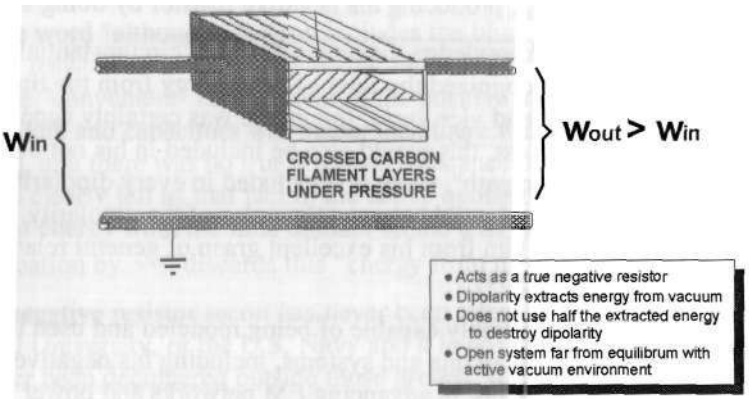

Figure 5-6 Chung's negative resistor (diagrammatic).

A formal technical paper was later published by Wang and Chung {311}. A few years earlier a patent {312} had been issued to Chung and assigned to The Research Foundation of State University of New York, Albany, NY for a superconductive material using a laminate combination of carbon

[129] Professor Chung holds the Niagara Mohawk Chair in Materials Research at SUNY and is internationally recognized for her work in smart materials and carbon composites. The reader may peruse a curriculum vitae, research work, and papers at http://www.mae.buffalo.edu/people/faculty'chung/researchl.doc.

[130] The preparation of "locked-in" stress in Chung's carbon fiber material is reminiscent of Moray's similar preparation of his amorphous semiconductors with locked-in stress also.

fibers and metal.[131] The patent mentioned mesoporous carbon filaments, strikingly similar to our previous discussion of the surprising explosion of porous silicon at the Technical University of Munich, as well as possibly a special kind of "porosity" consideration in the fiber fuse phenomenon (in the material of the fuse itself).

An initial offer on the State University of New York at Buffalo website to provide a technical package with respect to the negative resistor — for which a patent had been filed — to those submitting a nondisclosure agreement was abruptly withdrawn. The project may have been classified, or — far less likely — it may have been retained as deeply proprietary by the University. We suspect that both the technical package and the patent application have been classified by one or more U.S. government agencies.[132]

In our opinion, Chung's fruitful discovery deserves rigorous and continuing investigation, particularly in higher group symmetry electrodynamics and in terms of supersystem interactions to include Dirac sea hole current interactions. We also believe Chung may have been required by referees (or by declassifying authorities, if such were involved) to use the term "apparent" in the paper. The reported measurements in the technical paper do seem to unequivocally include true negative resistance with current running backwards against the voltage. It is not clear, however, whether this is Dirac hole current or electron current or a mix of both.

We also call attention to the fact that Dirac sea holes in the local vacuum — as will be discussed in Chapter 9 — will and do run backwards against the voltage. Further, such hole current can be transformed from negative energy to positive energy by the Bedini process shown in Chapter 9. The pressure used by Chung *et al.* in fabricating the material produces a stress potential in the material and thus decomposes into our reinterpreted Whittaker 1903 decomposition, preciously discussed. So giant negentropy is involved in the composite material, which implies that true negative resistance can be involved, at least in some operational regimes as pressure

[131] We stress that the issuance of this unclassified patent does not rule out a possible negative resistor (hence COP>1.0) patent that may have been classified. Some sensitive defense work in special materials is indeed performed at SUNY at Buffalo.

[132] At least the gist of the work is not lost, however, due to Naudin's duplication of the Chung effect and placing the results and building instructions on his website in France; see http://jnaudin.free.fr/cnr/.

etc. are varied. Such results were found by Chung *et al.* and are reported in the paper.

Naudin reported independent success with a simpler variant of the Chung negative resistor {313}. This assures that at least the effect will not just be buried.

5.8.3 The Fogal Charge-Barrier Device

Figure 5-7 shows an illustration from one of William Fogal's patents {314} on a new kind of transistor (more accurately, a charge barrier device). Fogal's device incorporates a very special electrolytic capacitor[133], which introduces optical-type functions as well as the more familiar capacitor functions.

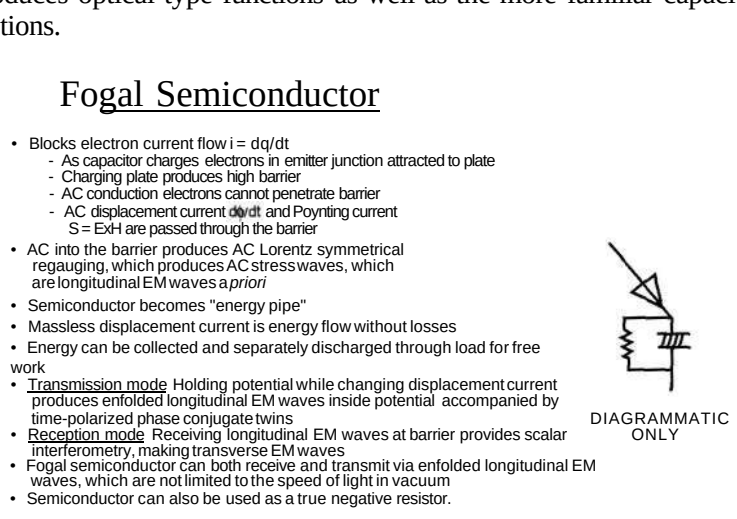

Figure 5-7 Novel characteristics of the Fogal semiconductor.

Most semiconductor materials are optically active materials. Further, the individual electrons in a signal with a frequency well below light frequencies, are "jittering" with higher frequencies including the entire optical band. A "frequency" of a signal thus is imbedded in a jittering higher frequency complex set, and that set is quite able to interact in optical fashion *if the complex itself is used and controlled.* Fogal's process

[133] The exact method of manufacturing this electrolytic capacitor, and its internal structuring, is proprietary to Fogal and a major capacitor manufacturer, who is under a nondisclosure agreement with Fogal.

does appear to both use and control that jittery high frequency signal complex.

Hence Fogal's process can "tunnel under" the normal *detected* force-field frequency responses of the individual electron,[134] and directly affect, change, and alter its higher-frequency environmental changes in the force-free field or field-free potential condition. In this way, Fogal has carried the electron (and hole) functions of a transistor to functions well beyond those in the present texts {315}. He may have also extended quantum mechanical tunneling effects to signals between widely separated regions of spacetime, since superluminal communication is possible with the Fogal semiconductor properly used. Longitudinal EM waves — which Fogal's semiconductor is able to utilize and control — can and do move at superluminal speeds {93a) because it uses the long-neglected "infolded" longitudinal electrodynamics revealed by Whittaker in 1903 and 1904. Further, superluminal solutions to Maxwell's equations do exist {93b}.

The charge barrier device is formed in a bipolar design that can be incorporated in Metal Oxide Semiconductor (MOS) designs as well as multiple gate devices. The device also produces a Hall effect EM field internal to the device. The Hall effect magnetic force will force electron flow and angular spin of the electrons in the same direction to the top of the conduction bands in the crystal lattice on semiconductor devices, unlike Silicon On Insulators (SOI) devices that force electron flow to the surface of the semiconductor lattice. This forcing function, together with the "extended tunneling" effects on the embedded EM environment of the electrons and holes, produces a unique effect. The device is able to stop and "pin" electrons while continuing to process the signal energy flow (the entire jitter signal complex) in which the electrons were coupled and moving. Thus the Fogal transistor is able to operate upon and with mass-free spacetime itself, and curvatures thereof. It is the first practical semiconductor capable of performing *engineering of the active vacuum.*

In the last few years we have stressed that EM waves in spacetime are longitudinal EM waves *a priori* — but they are accompanied by time-polarized waves (phase conjugates). Hence the two in combination become observable, as pointed out in quantum field theory by Mandl and Shaw {316}. *We detect effects a priori and not their causes.* We detect

[134] The electron itself is enveloped in the jittering of whatever background it is exposed to and interacts with. Hence a coupling interaction exists to arrange and **control** the jitter of the electron as well.

transverse *electron precession waves* in our detector circuits, and not the causal waves interacting with them to produce their precession. *The Fogal transistor is able to process the causal longitudinal EM waves directly, prior to their interaction with matter.* It in fact opens up an entirely new region of "detected physical reality" to our vision and detection, a region far more extensive than the development of infrared and ultraviolet sensors opened up to our sight.

The pioneers of electromagnetics, who erroneously assumed a material ether and EM force fields in space, confused the transverse "material detected waves" (electron precession waves) in the detector with the "material undetected waves" they assumed to be incoming from space. Note that neither the electron nor the atom had been discovered when all these assumptions were used to determine how the EM wave in space was to be viewed and modeled. The transverse waves observed in the interacting/detecting of the Drude electron gas — i.e., the detected electron precession waves — were considered to be direct interceptions of the incoming causal waves from space. This already substituted the effect for the cause, as we have previously discussed.

Further, Faraday envisioned the "material field in space" as consisting of a series of "taut physical strings". A "perturbation" of this field in space was, in his view, simply the transverse wave plucking of those strings. Maxwell, who closely followed Faraday's experimental work and concepts, simply assumed the transverse "plucked string waves" advanced by Faraday. Therefore, the erroneous notion of the transverse EM wave in space arose and stayed firmly fixed in the theory.

One can check Whittaker's decomposition of the scalar potential into longitudinal EM wave pairs, then realize that the energetic vacuum is naught but a giant scalar potential — which can be decomposed by Whittaker's method. In short, as a scalar potential, space itself is a writhing mass of longitudinal EM waves and their highly nonlinear dynamics and interferences, or it can be modeled in that fashion. The energy continually enters 3-space from the time domain to the negative charge of every point in space considered as a point dipole, thence to the positive charge, thence back to the time domain. Notice the giant 4-space circulation involved. One also notes the polarization of the vacuum continually happening and arising spontaneously, as is well known in quantum mechanics. We also suspect that this or a similar mechanism is at the root of spontaneous broken symmetry in physics.

An interesting thing emerges from Whittaker's 1904 paper {317}, where he showed that all EM fields and waves can be decomposed into differential functions of two scalar potentials. Each of these two base scalar potentials can be decomposed by Whittaker's earlier 1903 paper {85} into a set of longitudinal EM waves. All EM fields, potentials, and waves are comprised of longitudinal EM waves and their internal dynamics, which also comprise waves of spacetime curvatures and their dynamics. Further, each longitudinal EM wave in 3-space is accompanied by its phase conjugate twin in the time-domain.

This far more primary "internal electrodynamics comprised of pure spacetime dynamics" — comprising and creating the recognized EM potentials, waves, and fields, their internal dynamic spacetime structuring and also the structuring of time — has not been developed and applied in physics theory. This internal or "infolded" electrodynamics is the primary "medium" in which the Fogal semiconductor appears to work and work upon. The Fogal semiconductor seems able to modulate and demodulate this internal structuring or parts of it, as has been demonstrated.

Imperfect longitudinal EM waves — called *undistorted progressive waves* - are already known to be able to travel at superluminal velocity, e.g., as shown by Rodrigues and Lu {318}. Indeed, Maxwell's equations have both subluminal and superluminal solutions, as shown by Rodrigues and Vaz {319}. Further, these waves can carry information. However, the *technology* of employing these waves has been lacking {320}. The use of scalar EM wave interferometry to produce normal EM fields and EM field energy at a distance has been shown by Evans *et al.* {321}.

As pointed out by Rodrigues and Lu {318}, perfect longitudinal EM waves travel at infinite velocity. This eliminates the difference between potential, field, and wave; a perfect longitudinal EM wave can also be taken as an instantaneous scalar potential with net force-free iterative regauging (varying at each point instantly and simultaneously). Both ways of looking at it produce the same end result: instantaneous remote energy change of spacetime energy density itself, in general relativity terms, or of the energy density of the vacuum, in particle physics terms.

Elsewhere, (e.g., Chapter 2), we also pointed out the "total photon **interaction"** mechanism that generates the flow of an entity through time. We also have advanced the concept of a "time-reversal zone" (TRZ) as a region where antiphoton interactions with charges predominate over photon interactions. We used these new concepts to propose exact nuclear **reactions** for the production of excess deuterium, tritium, and alpha

particles in cold fusion experiments. In such an "excited state" TRZ region, the law of attraction and repulsion of charges is reversed. In the TRZ, like charges attract and unlike charges repel. Further, the gluon forces are reduced, so the quarks in the nucleons are much more lightly bound. In such TRZ zones, dense clustering of like charges occurs due to their mutual attraction.

A time-reversal zone is created in one part of the Fogal transistor, greatly assisting in the "electron pinning" action. That is, the usual strong mutual repulsion (the Coulomb barrier) of the electrons at the pinning site vanishes in the TRZ inside the Fogal semiconductor, and the resulting mutual attraction of the electrons greatly facilitates the pinning process far beyond what is usually obtained against "like charge" repulsion in a time-forward zone. Indeed, the TRZ in the Fogal semiconductor also materially enhances the electron pinning process beyond what can usually be obtained with cryogenics. At least some indication of trapping and perhaps pinning has been reported in amorphous semiconductors at room temperature {322a-b}.

The Fogal device is able to remove EM noise (electron noise) from existing EM signals, displays, etc. by 96% or more, by pinning the electrons and simultaneously time-reversing the spatial EM signal back to its original noise-free state prior to hosts of interaction electron collisions. This "noise removal" capability has been rigorously tested by independent parties, including at a leading university in the Netherlands, [135] and by several large electronics companies and several other universities. By pinning the electrons (and electron currents) while still processing and propagating the EM energy effects, the Fogal device can move noiseless EM energy without loss at room temperatures, at superluminal velocities, and reconnect the lossless propagated energy to electrons past the pinning region at a receiving region, releasing the electrons in the receiving region. The Fogal semiconductor therefore already accomplishes *room temperature superconductivity* as well as tunneling.

The Fogal device's basic mechanism (consisting of all the submechanisms) is to restore and move EM energy in force-free form, using direct regauging of the vacuum instantaneous scalar potential itself (or the

[135] The university researchers verified room temperature superconductivity being produced by the Fogal semiconductor in their independent verification measurements. They also measured that some 96% of the noise already present in a circuit was removed by Fogal's semiconductors in Fogal's circuits.

vacuum potentials themselves). It operates directly upon the longitudinal EM waves comprising the vacuum potential. Hence it directly engineers the active vacuum and curved spacetime. I.e., it is the first *supersystem engineering* device of (hopefully) many more to come.

In the "jitter" environment of the space in which the individual electron is embedded, there exist many (and essentially all) field gauges, simultaneously. One of these, of course, is the Coulomb gauge where there exists an instantaneous scalar potential. Usually the instantaneous scalar potential is considered only a *near-field* effect, with no contribution at any significant distance. However, as Jackson points out {323}, transverse radiation fields are given by the vector potential alone. Also, in the Coulomb gauge the scalar potential "propagates" instantaneously everywhere in space {324}.

Along with other electrodynamicists, Jackson avoids the obvious superluminal communications implications of the instantaneous scalar potential by stating that *"..it is the fields, not the potentials, that concern us."* As he points out, a detailed *(though conventional)* discussion of causality is given by Brill and Goodman {325}. Again as pointed out by Jackson, in the Coulomb gauge the quantization of the photon involves only the vector potential. *The use of the scalar potential in the Coulomb gauge, together with deliberate engineering of the internal longitudinal Whittaker wave structure of that potential, directly allows distant engineering via multiply connected spacetime, even inside the nuclei of distant objects. This is in fact a unique and marvelous engineering application and extension of Bohm 's quantum potential concept.*

My "pinning" the electrons, apparently Fogal is able to essentially "hold" the vector potential and all the force fields while the instantaneous scalar potential *persists and now extends over all space, not just to the near field since all formerly moving field dynamics that would limit it have been frozen.* If this effect is substantiated, I have nominated it as the "Fogal effect". Further, this unrestricted instantaneous scalar potential now i lunges in field-free form (pure regauging form) over all space according to the signal energy being perpetuated and propagated[136] by the Fogal semiconductor independently of its pinned electrons. In this fashion, the F**ogal** semiconductor is indeed capable of "instantaneous" communication

[136] Here we again point out that the usual notion of a signal as energy propagating in 3-s**pace** is wrong. It propagates in 4-space, but not in 3-space. Also, what propagates is the spreading point-like polarization of the vacuum itself.

over essentially unlimited distances. At least one independent test has verified the Fogal instantaneous communication effect, but the test is still held proprietary by the testing agency.

Since Fogal is able to alter and control the internal longitudinal EM wave Whittaker structuring of the scalar potential used in this Coulomb gauge manner, he is able to accomplish superluminal (and even instantaneous) communication, so long as a Fogal semiconductor is available in both the transmitter and the distant receiver. In the transmitter, the Fogal component is necessary to *infold* the information into the internal LW structure of the scalar potential to be used in the Coulomb gauge, thus transforming the input signal information into output longitudinal EM wave information directly in spacetime itself. The Fogal component in the receiver is necessary in order to detect, transduce, and *outfold* the infolded longitudinal EM wave information inside the instantaneous scalar potential. We have stressed that these internal longitudinal EM waves and their dynamics are spacetime curvatures and their dynamics. Hence their transmission and detection is a viable process for superluminal communication, including instantaneous communication.[137]

Further, once the electrons are pinned, all "signal fields in charged matter" (i.e., all EM force fields) are frozen and localized. This, we believe, involves a new physical effect introduced by Fogal that is analogous to the Aharonov-Bohm effect.[138] So I have called it the "Fogal effect". That is,

[137] We believe that physics books will have to be substantially rewritten, once the internal longitudinal structuring of the scalar potential (and of EM fields and waves) is employed directly in open technology. We further believe that the Fogal semiconductors are the first pre-developments in that coming vast new technology, at least in the open Western scientific world.

[138] There have long been, and still are, efforts to "fit" the Aharonov-Bohm effect into slightly modified classical electrodynamics after all. E.g., see C. J. Carpenter, "Electromagnetic energy changes due to charges moving through constant, or zero, magnetic field," *IEE Proc. A,* 138(1), Jan. 1991, p. 55-70; — "Electromagnetic energy and power in terms of charges and potentials instead of fields," *IEE Proc. A,* 136(3), 1989, p. 101-113; G. M. Graham and D. G. Lahoz, "Observation of static electromagnetic angular momentum in vacuo," *Nature,* Vol. 285, 1980, p. 154-155; T. H. Boyer, "Semiclassical explanation of the Matteucci-Pozzi and Aharonov-Bohm phase shifts," *Found. Phys.,* 32(1), Jan. 2002, p. 41-49; — "The Aharonov-Bohm effect as a classical electromagnetic-lag effect: An electrostatic analogue and possible experimental test," *Nuovo Cimento,* Vol. 100B, 1987, p. 685-701; — Classical electromagnetic deflections and lag effects associated with quantum interference pattern shifts: considerations related to the Aharonov-Bohm effect," *Phys. Rev. D,* Vol. 8, 1973, p. 1679-1693; — "Does the Aharonov-Bohm effect

the force-fields are frozen and localized by the pinning, but the field-free potentials then remain, including the instantaneous scalar potential ϕ and probably the curl-free magnetic vector potential A as well. The result is that the instantaneous scalar potential can be directly *regauged* everywhere at once by the changes of magnitude of the "frozen fields", rather as if they were "static voltage", possibly simultaneously regauging the field-free A-potential — all as part of a new kind of Lorentz symmetrical regauging. After all, a single Lorentz symmetrical regauging {326} changes both the potentials A and ϕ. Changes in symmetrical regauging produce stress waves, which are longitudinal EM waves. Continual changes of symmetrical regauging also continually changes both the potentials A and ϕ, *including over all space when operating in the Coulomb gauge.* This is one explanation of the beautiful effect that Fogal has discovered and is utilizing.

We accent that, with pinned electrons frozen in place, the normal ϕ and A in matter (defined in terms of interaction with charge and the movement of charge) cannot occur. With time reversal zone utilized, electron pinning is greatly eased and the instantaneous scalar potential ϕ now assumes the primary active propagating role in surrounding space. Neither ϕ nor A is free to develop the normal $\partial\phi/\partial t$ and $\nabla\times A$ *spatially propagating dynamics of the force fields (effect fields) observed in matter.* In the Fogal process, the instantaneous scalar potential "signal" (the causal signal in 4-space) is generated in the transistor when it pins the electrons and freezes the force fields into "equal and opposite" form. Since no net force field can develop, the instantaneous scalar potential is a stress potential in spacetime itself and simply changes its magnitude instantly, at each and every point in space that it occupies, when the Fogal chip's input EM fields change in its signal input.

In the output, the net force fields remain zero and frozen, even though the individual force fields change constrained to "equal and opposite" manner. If one wishes, one may take this part of the Fogal output — the field free changes in the stress energy density of the vacuum — as one expression of *modululating the instantaneous scalar potential's energy density in perfect correspondence to the field changes in the normal EM input to the Fogal transistor.*

exist?". *Found. Phys.,* Vol. 30, 2000, p. 893-905; — "Classical electromagnetism and **the** Aharonov-Bohm phase shift," *ibid.,* p. 907-932.

The instantaneous Fogal changes in magnitude (e.g., instantaneously induced upon a distant collecting charge) are no longer limited to near field effects, or to the speed of light — and communication is not bound to the retarded wave. Now the induced changes of the instantaneous scalar potential exhibit far field effects and these changes — being naught but these special Lorentz condition magnitude regaugings — are instantaneous. This of course is a form of *action at a distance.* We stress that the best astronomical evidence also points to a startlingly superluminal speed of gravitation (curvature of spacetime, which after all is just a longitudinal EM wave or set of them) itself, as pointed out by Van Flandern.[139] If so, since any change of energy in spacetime is a curvature of spacetime, and one form of spacetime curvature can move at superluminal velocity, so can other forms of spacetime curvatures. In our favorite expression, *it only takes one white crow to prove that not all crows are black.*

As is well known, the de Broglie waves of matter always move faster than light, as do appropriate quantum tunneling processes. Further, the quantum potential used by Bohm in his beautiful hidden variable theory of quantum mechanics {347} also appears instantly throughout space, wherever it will be, and with the value it will have. The question of whether a quantum potential can be used to communicate has been posed but not definitively answered in the previous literature. We propose a resounding "Yes!" if one uses the internal structure of the quantum potential for one's communication, applying some component such as the Fogal semiconductor to do the infolding and outfolding.

We also propose that a process for forming and using an instantaneous scalar potential in the Coulomb gauge can be interpreted as the formation and use of a quantum potential or its direct equivalent. If that assumption is true, then the Fogal semiconductor seems to be the first component ever openly built and patented which produces and uses Bohm's quantum potential, *including* its infolded Whittaker structuring and dynamics. It also definitively answers in the affirmative the question of whether the quantum potential and the scalar potential in the Coulomb gauge can be used in superluminal communications.

[139] Tom Van Flandern, "The speed of gravity - What the experiments say," *Phys. Lett. A*, vol. 250, Dec. 21, 1998, p. 1-11. Van Flandern gives an extremely important, clear, and succinct summary showing that experiments refute the standard far field assumption of light speed in gravitational effects. Laboratory, solar system, and astrophysical experiments for the "speed of gravity" yield a lower limit of $2x10^{10}c$.

Thus Fogal has apparently found a way to directly modulate intelligent change of magnitudes into and upon the internal longitudinal EM wave structure of the instantaneous scalar potential (and upon the quantum potential), as well as iterative "pure *net-field-free"* regauging of the instantaneous scalar potential {327}. It seems to have previously escaped notice that varying the Lorentz symmetrical regauging of a circuit or system easily produces pure longitudinal EM waves. This strongly implies that Fogal has surmounted and removed the barrier to practical superluminal communication and even further has reduced the barrier to practical instant communication.

Several tests — in one of which the present author participated — have indeed shown Fogal transmission of signals, including video signals, between two widely separated points with less delay than light-speed signals exhibit, and also with video bandwidth infolded inside a DC signal. In at least one series of tests in a large company's own laboratory and by its own engineers, communications from a ground-based Fogal chip transmitter apparatus occurred between the ground station, through the uplink into the satellite, back through the downlink to earth, into a ground-based transmission system with repeater stations, and into the receiving Fogal transistor unit in the lab. The transmissions occurred with *no discernible time delay,* something previously deemed impossible in all the textbooks. This was particularly significant since even the conventional time-delays in the repeater station amplifiers and the satellite receiver-transmitters were apparently eliminated. This further accents that the infolded "longitudinal EM waves superhighway" inside all EM fields, potentials, and waves — including inside matter such as the ocean and the earth itself— is a multiply connected space phenomenon. It is the most ideal communication medium, enabling deep space communication without delay, etc.

The implications for nondelayed future remote control of robot spacecraft and robots landing on the surface of planets and asteroids are obvious, as are the implications for direct exploration and measurement of conditions *inside the interiors* of the planets, the sun, the moon, and the earth via internal scalar interferometry. We accent that Fogal has done private experiments exploring this vast new physical reality revealed by the "internal longitudinal EM wave dynamics" and its interferometry, and it is mind-expanding (some would say *mind-boggling!).* It is also a great new step in physics and in our very notion of physical reality itself.

The vacuum itself, being highly energetic, is indeed a scalar potential. Further, it has any and all gauges. Since potentials superpose, we postulate

that Fogal's use of the instantaneous scalar potential is directly superposed on the corresponding instantaneous Coulomb gauge scalar potentials of the entire vacuum. His discovery of how to modulate the instantaneous ϕ magnitude without allowing modulated EM field propagation, constitutes a very special case of tunneling right through "space" itself, using one aspect or "component" of space.

In short, to be a little dramatic one might even apply the term *subspace communication* to this long distance tunneling effect. That interpretation would also seem consistent with the deterministic variation of the internal stress energy density structuring of the vacuum that is produced in the Fogal process.

From another viewpoint, Fogal has succeeded in not only finding the missing chaos of quantum mechanics, but in deterministically engineering and using it.

This is also consistent with Whittaker's decomposition of the scalar potential into bidirectional longitudinal EM waves {328} and his connection between time-polarized EM waves and longitudinally polarized EM waves as reinterpreted (12) to be consistent with quantum field theory {19}. We point out that a single point in time is simultaneously "connected" to every point in the universe. By using a transmission system that back-pedals from 3-space into the time domain, an instantaneous connection to any other spatial point in the universe is therefore available, if one's technology can take advantage of it. Fogal's technology does.

It is also consistent with quantum tunneling experiments that have demonstrated the transmission of intelligent signals (such as Mozart's 40th symphony) at superluminal speed between two points in a waveguide {329a-b}. Regardless of how one chooses to model intelligent superluminal communication, it has been experimentally demonstrated — multiple times and by multiple experimenters in multiple laboratories — that such can occur.

The difference in those superluminal experiments and the performance of the Fogal chip is that the chip uses iterative regauging of the magnitude of the instantaneous scalar potential, as well as deterministic alteration of the scalar potential's internal longitudinal EM wave substructuring, and probably also modulates the internal structuring of a quantum potential. The presently proposed quantum tunneling mechanisms apparently do not do this, at least as they are presently modeled. Further, the quantum tunneling mechanism is difficult to apply; the Fogal mechanism is fairly

simple and straightforward to apply, given the Fogal semiconductor at both the transmitting and receiving ends of the communication system.

Pure longitudinal EM waves readily penetrate matter to great distances, since matter is mostly empty space between widely separated mass particles. On the microscopic scale, matter is comparable to something like the solar system, except that intense fields and potentials (bundles of longitudinal EM waves and their dynamics) occupy the space between the particles. All this vast empty space inside matter, being a potential and comprised of longitudinal EM waves, is a giant "superhighway" for the passage of longitudinal EM waves and their dynamics, as indeed is matter itself which is mostly such empty space. Further, even the masses themselves are such, since mass is simply highly compressed spatial energy density, and therefore is highly compressed longitudinal EM wave energy and dynamics. It is just a "denser" superhighway.

Hence a longitudinal EM wave system can readily be developed to "see through matter" using Fogal semiconductors in transmitter and receiver. Fogal in fact has made at least one proprietary prototype demonstration unit that demonstrates this startling capability. The vision is very clear, due to the remarkable absence of noise in the Fogal process. It is also shockingly unique, and it changes our very notion of physical reality. We are not at liberty to further discuss this new "sub-submicroscopic" reality revealed in such experiments. We simply interpret it as jumping the presently assumed restrictions of observation, and allowing the direct or correlated observation of the virtual state entities.

As alluded to, the previously modulated "Fogal type signals" emitted by all matter and other physical entities can also be displayed on a screen using the Fogal process, revealing a hitherto unsuspected physical reality and EM signals environment. In this prototype system, Fogal showed a remarkable and startling new extension of our very perception of physical reality itself. This is another reason why we expect that physics books will have to be rewritten, once the Fogal semiconductors are on the market and available in practical equipment. As every physicist knows, any dramatic increase in our ability to sense finer levels of physical reality inevitably leads to new and startling advances in physics itself and changes our very knowledge of the nature of physical reality.

The ability to bypass and "park" force fields by pinning their source electrons in a time-reversal zone, while continuing the flow of noise-free EM energy at will and at infinite velocity, obviously enables COP>1.0 systems. A pure longitudinal EM wave already has infinite energy, for

such a wave appears across the entire universe simultaneously, instantly changing the stress energy density of the entire vacuum in which the longitudinal EM wave is present.[140] The back emf and back mmf fields in an EM system or electrical power system can be frozen and held from restoring the Lorentz condition in the circuit, using the Fogal semiconductor {330}. We presently have an agreement with Fogal for the licensed use of his semiconductors in all such energy unit applications.

A quantum potential is modeled in a multiply connected spacetime, so that a given joule of input energy to one multiply connected point simultaneously appears in every other multiply connected point.[141] Since the Fogal semiconductor apparently can operate in quantum potential or Coulomb gauge fashion, it can act as a *direct energy amplifier*, with respect to the lab observer in a singly connected space. In short, the Fogal process dramatically extends the concept of "conservation of energy" to include conservation in multiply connected space and therefore incorporates observed energy amplification in singly connected space. Again, a broken symmetry (in singly connected space) reveals a higher symmetry (in multiply connected space), and the hierarchy principle is alive and well. In short, with the Fogal semiconductor used in power systems, the law of conservation of energy must be extended to include energy symmetry in multiply connected space but asymmetry in singly connected space. Obviously, such functioning totally transcends the limitations of the present thermodynamics models.

We carefully point out that this is not "energy creation" but simply the energy following the known kind of statistics in physics that allows a thing to be in multiple different places simultaneously. What is actually "instantly transmitted" is the simultaneous regauging of the energy density of the vacuum. At any point in space, the vacuum has an energy density and thus is a scalar potential with a given magnitude. Changing the energy density is simply regauging, which is freely permitted under the gauge freedom axiom of quantum field theory. So instant amplification of

[140] This should not be too surprising, since the bare charge and the bare mass of every electron each has infinite energy, as is well known in particle physics. For confirmation in very straightforward language, see Nobelist Steven Weinberg, *Dreams of a Final Theory*, Vintage Books, Random House, 1993, p. 109-110.

[141] If we wish, we can even take time itself as a special kind of quantum potential, since time also displays such a "multiplicity of connection" in 3-space. In one sense, time is the ultimate quantum potential, since a single point in time is "connected" to every single 3-space point in the universe, simultaneously.

energy" over a region of points is simply the instant regauging of the potential already present at each point in the region. It is *a permissible multiply connected space violation* of the present more limited "special case" energy conservation concept, which implicitly assumes a singly connected space. We have been working with Fogal for some time in this area, and we expect to rapidly develop and introduce commercial EM power systems based on the Fogal semiconductor's abilities in multiply connected space, as soon as it is in production and available. Until then, the details of our work in that area must remain highly proprietary.

5.8.4 Point-Contact Transistor.

Figure 5-8 diagrammatically shows a point-contact transistor with n-type base in a typical circuit for power gain. The point of the contact is under pressure on the material with which it is in contact.

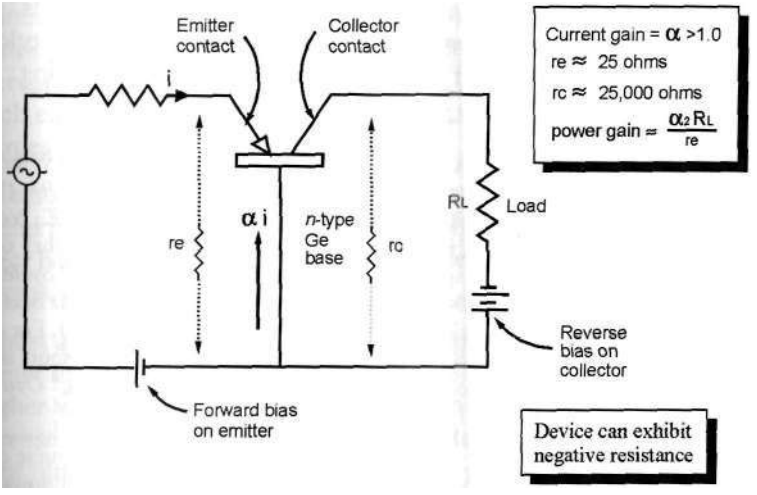

Figure 5-8 Point contact transistor with n-type base.

The point-contact transistor often behaved in true negative resistor fashion, outputting more energy than was input to it. Its production was always far **more** of an art than a science.

As can be seen from our quotation at the beginning of this chapter, the original point-contact transistor was never thoroughly understood

technically.[142] Specifically, there does not appear to have ever been any deliberate attempt to capitalize on the ability of the transistor to become a true negative resistor under certain manufacturing techniques and under certain conditions.[143] Instead, the variations and difficulties in manufacture resulted in use of the point-contact transistor being essentially bypassed rather quickly, by advancing to other transistor types more easily manufactured and with less manufacturing variances. In reducing the manufacture of other types of transistors to a science rather than an art, the point-contact transistor and its further development and optimization into reliable true negative resistors were abandoned.

We present this transistor as a straightforward and relatively inexpensive area in which young researchers in COP>1.0 systems and phenomenology may wish to begin, assuming they have access to semiconductor facilities in a university or similar or are willing to work meticulously under a jeweler's loupe. A rich combination of effects in the transistor awaits optimization and control. We predict that we shall yet see, on the world market of the future, such point contact transistors reliably exhibiting

[142] E.g., different theories are given in: (a) W. Shockley, "Theories of high values of alpha for collector contacts on germanium," *Phys. Rev.*, Vol. 78, 1950, p. 294; (b) W. R. Sittner, "Current multiplication in the Type A transistor," *Proc. I.R.E.*, Vol. 40, Apr. 1952, p. 448-454. Also of interest is (c) W. van Roosbroeck, "Theory of the flow of electrons and holes in germanium and other semiconductors," *Bell System Tech. J.*, Vol. 29, Oct. 1950, p. 560-607. See also (d) J. Bardeen and W. H. Brattain, "The transistor, a semiconductor triode," *Phys. Rev.*, Vol. 74, 1948, p. 230. For a more modern re-examination, see Shuji Hasegawa *et at*, "Electronic transport at semiconductor surfaces — from point-contact transistor to multi-tip STM," *Oyo Buturi*, 70(10), 2001, p. 1165-1171 (in Japanese).

[143] E.g., the point contact is usually under pressure, and this pressure of course can be varied. The full phenomenology of points (which increase voltage) and pressure, complicated by surface effects as well, has not been worked out in physics. Note the similarity of the pressure in the point contact transistor to the pressure in the Chung negative resistor. Note the almost certain involvement of the "overpotential" of chemistry and electrode chemistry, as well as the "double surface" effect of the small gap between the point and the substrate on which it rests in contact. Part of the gap probably even involves the Casimir effect as well. Any electrical signal variation in that very complex point junction will vary the overpotential, the stress potential, the "point increase in voltage" effect, etc. As can be seen, the phenomenology of the point contact is remarkably complex and rich in several areas of physics and in a great variety of physics variables. Obviously, the reasonable control of all these highly nonlinear variables — and their mutual interactions — is a difficult matter. Hence the readiness with which point contact transistors were dropped with substantial sighs of relief.

negative resistance. It will be necessary, however, to also take into account the symmetrical self-regauging characteristics of the common closed-current-loop circuit. By adroit switching of a true negative resistor in and out of a closed-current-loop branch, or placing it in parallel with the back emf of that branch to reduce it, asymmetry can be introduced into the overall closed current loop circuit, defeating the Lorentz symmetrical regauging. Defeating the Lorentz condition is essential to COP>1.0, of course.

We envision such a development as an ideal "negative resistance shunt" to add across the secondary of a transformer, and another possibly across its primary and across the external power supply as well, in producing more amenable and easily fabricated COP>1.0 electrical systems. We also point out that, once the back emf or back mmf forcing of equal power dissipation in the primary of a transformer or in the emf section of a circuit is dramatically reduced or eliminated, one does not require "large intensity" potentials and voltages to collect a great deal of power in the intercepting and receiving external circuit. Again, by simple W = Vq, as much energy W can be collected from any nonzero potential V as there are charges q to intercept.

We also envision such a true negative resistor being close-looped by the Bedini process, thus producing a small "self-powering" transistor, which in effect becomes a small self-powering "battery". This is absolutely a doable process, and it will be done once the Fogal semiconductor is in production.

Almost all semiconductor materials are also optically active materials, and a point discharge into such materials represents a very sharp regauging (higher voltage) discharge at a point or into a very small area, due to the increase in potential at the tip where it contacts the base material. The point junction is under pressure, so a stress potential exists there. In addition, the well-known "point" effect also increases the potential in the junction pointer itself, from its base to the point. The point contact phenomenology of different materials — one conductive and one semiconductive — is of much interest, and with novel phenomenology.

The fact that the point-contact transistor in its most usual formulation primarily uses holes more than electrons, is also of much interest in COP>1.0 situations. Holes in a circuit move against the voltage. The trick is to let the Dirac holes *before observation* move in an open path from the ground return line against the back emf to the potentialization line, and **transduce** the moving hole current (via the Bedini process) into electron

current after the holes have already freely reached the vicinity of the high side of the circuit.

When Dirac sea holes (causal positrons before observation and thus prior to their alteration to lattice holes and parity reversal) and Dirac sea hole current are also involved with point-contact transistors, the resulting phenomenology has been but little investigated and none of it is in the present textbooks. However, from recent work with positron probes and positron microscopes to examine semiconductors and semiconductor materials, it is known that the holes (positrons) tend to be repelled from nuclei in the material into defects (voids) in it {331}. These effects have been investigated, for example by Triftshauser *et al.* {332}.

Both the mechanical stress potential (which is fundamentally electromagnetic) and the heightened junction potential decompose via our reinterpretation of Whittaker's 1903 decomposition of the scalar potential. This leads to optical-type pumping in both the time domain as well as the 3-space domain. Hence novel optical-type effects and time-reversal of material states can be involved, leading to a very complex set of phase conjugate phenomena, time-reversal phenomena, etc.

Certain Hall effects employed in conjunction with a point contact transistor could be a fruitful area of investigation. As an example, narrow Hall bars with junctions between current and voltage leads of various geometries could be investigated. Widening the junction from the normal square-cornered shape can sometimes produce a negative Hall resistance.

The junction of the point contact involves asymmetrical self-regauging, iterative time-reversal retroreflection, increased Poynting and Heaviside energy flow components, optical scattering processes inside the junction materials, etc. The transistor can indeed be manufactured so that these highly nonlinear effects sum to a negative-resistor-like movement of the output current against the voltage, although with so many other phenomena involved it will require some hard work and research in order to develop and stabilize it — and understand it.

5.8.5 Bedini's Negative Resistor Process in a Battery {333}.

5.8.5.1 Some Pertinent Lead-Acid Battery Processes

A lead-acid storage battery is a highly nonlinear device. The plates may be plante, pasted, or tubular etc. They are usually highly porous and have a thin oxide layer. They may have other coatings and the electrolyte solution may include additives to enhance operation. The plates consist of a mix of crystalline materials in most cases. The plate materials include acicular

(needle-like) crystals, particularly the negative plate. The plates usually are porous, knit, and have gridded separators.

The chemistry of the battery electrolyte is complex and — even today — not all of it is well understood, particularly when mass transport is accounted. In our discussions, we will be including some of the previously neglected phenomena during mass transport (ion sluggishness in moving) that are responsible for some of that lack of understanding. In the battery chemistry, there are many double surfaces between the ions and also there is a variety of point voltages. There is a separate theory for double surfaces.

One of the most important phenomena is that the ion currents in the electrolyte are confined to the battery, and do not pass out into the external circuit. Much of the electron currents in the external circuit are blocked at the plates from moving within the electrolyte. Consequently, we will limit our discussion to two major currents of interest[144] in a battery-powered system, and these currents are effectively isolated from each other (at least to first order). Those currents are (i) the ion currents in the electrolyte, confined to between the plates and therefore internal to the battery electrolyte, and (ii) the electron currents between the outside of each plate through the inside of the plate and on out through the external circuit and then around to the inside and thence to the outside of the other plate. Chemical changes occur on the plates themselves as a result of these two currents.

It is usually assumed in power systems that these two currents are in phase or almost entirely so. That need not be true at all, and Bedini takes specific advantage of deliberately arranging these two currents to be antiphased part of the time. Part of the Bedini effect can be understood from this fact alone; the other part must consider one other most unusual electrical current that is encountered only in battery-powered systems or COP»1.0 systems.

So indeed there are *several* (many) currents in a lead acid battery [334], not just one, and we will consider three of them — the two previously mentioned, and an additional Dirac sea hole current in the local vacuum itself. The reader interested in greater technical depth should also turn to

[144] Of course, there are many other currents in a battery as well, but — although an oversimplification — these two major currents together with the Dirac sea hole current will suffice for our introductory modeling and explanation purposes.

the literature of electrode chemistry and electrochemistry {335a-f}, which is quite complex.

5.8.5.2 Dirac Sea Hole Current

In a battery-powered COP»1.0 system (and in some COP>1.0 systems), there is a previously unrecognized significant flow of Dirac hole current in the local vacuum, running from the output section of the system to the system input section and thence through the conductors into the battery terminals and onto the battery plates, and on into the battery electrolyte chemistry. This hole current may be greater — *evenfar* greater — than the normal electron current running from input to output.

So in the battery-powered overunity system with positive feedback, not only does an electron current run from the battery through the connecting conductors to the input section of the system, but also a Dirac hole current pours back out of the system input section, and — if not intercepted and transduced — through the conductors and back into the battery. All the while, this Dirac hole current is "eating" electrons being furnished by the battery to the system. The net result is that the battery "sees" an extra load to be powered, in addition to the ordinary load presented to it by the normal system input section. It "sees" the situation as an "extra load" because it first has to furnish sufficient electron current to fill the hole current and "kill" it, before it can furnish the additional electrons to power the system in normal fashion.[145]

[145] An odd effect occurs in the battery, however, when the battery completely discharges in the normal sense. Actually, it is still fully charged with positive energy charge, but also has been simultaneously charged with negative energy charge. With the excess negative energy holes continuing to charge the battery with negative energy charge, the battery becomes increasingly *charged with net negative energy.* There is almost no limit to the negative energy charge the battery (i.e., the local Dirac vacuum portion of its supersystem) can take, except the eventual development of antigravity effects due to the inverse and increasing curvature of local spacetime in which the battery is embedded. After a battery has been used to power a COP»1.0 system for some time, one can take the battery off, place it on a normal battery charger, and it will then "eat" positive power for an extended period of time — e.g., a week or longer. During this period, one is steadily negating the inverse curvature of the local vacuum via the increased positive energy collecting in that spacetime. The battery again finally passes through zero voltage and net charge again, and suddenly starts charging up again in a "normal" sense with positive energy charge. This process actually increases the lifetime and function of a battery in a startling manner. Bedini has used batteries almost devoid of charge and energy in the normal sense, and powered systems very well with them, even for longer than a year continuously.

A COP»1.0 EM system is an excited system far from equilibrium in its exchange with its active environment. For all such excited systems, there exist significant decay mechanisms to bring the system back into equilibrium with its environment, since equilibrium yields the lowest energy state and maximum entropy. The Dirac sea hole current (negative energy current) is nature's unexpected natural decay mechanism to sharply decay a COP»1.0 system back to an overall COP<1.0 system when the external power supply is considered also.[146]

So when Dirac hole current back through the local vacuum and through the system is involved, the battery first has to furnish electron current to fill these holes at the rate they are appearing in the input section, thereby furnishing a primary "hole-filling" electron current component which "disappears" into the Dirac vacuum and is lost.[147] Only after the holes in the hole current are filled — and the hole current is being steadily nullified

[146] It decays the *true negative resistor* power system back into being only a *dijjerential negative resistor section* of a slightly extended metasystem including the power system and its external power supply. This novel decay mechanism also prohibits close-looping the now differential negative resistance power system for self-powering, unless the hole current is first converted into electron current, as discussed in Chapter 9 and in paragraph 4.9.6 below.

[147] The filling of these Dirac sea holes is not pair annihilation in the usual sense, and no radiation is emitted. Instead, the energy of the radiation that would otherwise be emitted is added to the negative energy curving the spacetime. Hence the net curvature of spacetime relaxes because of superposition. In effect, the vacuum/spacetime itself reabsorbs the energy as relaxation spatial energy added to the curvature energy of the curved spacetime, reducing that curvature. Particularly see Mendel Sachs, *Quantum Mechanics from General Relativity: An Approximation for a Theory of Inertia*, Reidel (now Kluwer), 1986. A generalization of quantum mechanics is demonstrated in the context of general relativity, following from a g**enerally** covariant field theory of inertia. Nonrelativistically, the formalism corresponds with linear quantum mechanics. In the limit of special relativity, n**onlinearity** remains and several new features are derived: (i) Particle-antiparticle pairs do not annihilate; an exact bound state solution is derived corresponding with all experimental facts about annihilation/creation — which, in approximation, gives the blackbody radiation spectrum for a sea of such pairs, (ii) A result is proven, without approximation, that is physically equivalent to the Pauli exclusion principle- which in linear approximation gives the totally antisymmetrised main-body wave fu**nction** and Fermi-Dirac statistics, (iii) The hydrogen spectrum is derived, including the Lamb shifts, in agreement with experiment; new results are found for hi**gh-energy** electron-proton scattering, (iv) Finally, several applications to the elementary particle domain are demonstrated, in agreement with results from experimental high-energy physics.

— can the battery then send additional electrons which do not disappear and which are accepted in the system input section to power the system. We discuss this Dirac hole current in some detail in Chapter 9, including how to convert it into useful input electron current to the system, reducing the current load on the external generator and enabling self-powering. Bedini invented the method of transducing available negative energy hole current in the vacuum into electron positive energy flow to charge the battery and power the system, preventing decay of the COP»1.0 system back to COP<1.0.

We shall not discuss the complexity of the additional chemical reactions ongoing in the battery electrolyte and on the plates. The two main mass-containing currents and the negative energy Dirac hole current will suffice to explain the Bedini negative resistor formation and usage, at least to first order and sufficient to stabilize systems.

5.8.5.3 Changing Symmetrical to Asymmetrical Regauging

To first order, we reiterate that the electrons flow from one plate of the battery through the external circuit to the other plate, but the lead ions do not. There is thus a sharp "two separate currents" interface at the plates and thus a sharp separation between the electron current and the ion current. In short, there are actually two half-circuits in the battery-powered system if one chooses to use them semi-independently.

The current carriers in the two half-circuits are quite different. Therein lies the opportunity to separate and antiphase the two currents, using one to recharge the battery while the other is used to power the loads. It also allows a good opportunity to asymmetrically regauge both half circuits, greatly and freely increasing the Poynting energy component intercepted, collected, and used by each half-circuit's carriers. This is the basis for a profound "opening" of the system and influx of excess vacuum energy.

The two half circuits meeting at a common interface allow a stress potential upon that interface to *individually* use the two halves of what is normally Lorentz's symmetrical regauging. That usually *symmetrical* regauging (if the complete circuit were unitary) is now comprised of two separated *asymmetrical* regaugings, one for each of the two circuit halves, because the net stress potential (net Lorentz symmetrical regauging) — consisting of two opposing fields and forces — is split into two now-individually-separated and separately utilized force fields.

We accent this process by an analogy. Suppose we suddenly place a scalar potential ϕ upon a point in the middle of a transmission line. Immediately the potential ϕ races off (spreads) in both directions simultaneously, at

nearly light speed. Further, in each direction there is a moving gradient of ϕ, hence an E-field by $\mathbf{E} = -\nabla\phi$. These E-fields or "emfs" are oriented in opposite directions, so there is a movement of charge from the middle of the line toward each of the ends. The same "dephasing" current effect can be applied to any conductive medium or to the interface between two conductive circuits.

In Bedini's negative resistor case, the placement of the potential ϕ — for its movement in both directions — is on the interface (the face of the lead plates) between the two half circuits and therefore between the two different current carrier types. An initial "Lenz's law" reacting with the suddenly placed E-field onto the plate surface, creates an E-field in opposition, forming a stress potential ϕ which is much higher than the normal potential of the battery (in a nominal case, 100 volts instead of the 12 volts of the battery).

Immediately this potential "takes off in both directions", with a powerful E-field and emf back into the outside circuit and its load, while a powerful E-field and emf also proceed into the battery electrolyte in the opposite direction. So the ions in the battery have a sudden, much higher energy interception and collection forced upon them, with the excess emf now being in *battery-charging mode.* The electrons in the outside circuit simultaneously have an excess emf and potentialization *in the load-powering mode.* Let us see how the two very different current carriers react to these "dual emfs" in the overall circuit.

5.8.5.4 Mass-to-Charge Ratios of the Two Current-Carrier Types

We stress the dramatic difference in the *mass-to-charge (m/q) ratio* of the two currents. The lead ions' m/q ratio is some few hundred thousand times the m/q ratio of electrons, as we recall. For our purposes, all we need to know is that the m/q ratio for the lead ions is *very much larger* than the m/q ratio for the electrons. For a given force, the ions in the internal half circuit in the electrolyte will therefore respond very much slower than will the electrons in the external circuit half.

5.8.5.5 Hysteresis Between the Responses of the Two Half-Circuits

Because of this great disparity in the m/q ratios of the two mass currents, there is obviously a relatively significant hysteresis (time delay) between the *response* of the more massive ion current and the *response* of the far **less** massive electron currents that interact at the plates to try to change the ion current and its momentum. This time-delay between ion response in the electrolyte (the effect) and electron pileup urging (the cause) can be adroitly manipulated. Specifically, it can be used to alter the local vacuum

potential and cause it to add excess energy to the ions in charging mode **and** simultaneously to add excess EMF to the electrons in circuit-powering mode. In short, the response delay can be manupulated to "asymmetrically regauge" the mass currents in the system, freely changing their potential energy, and dramatically increasing how much potential energy is available for battery recharging and how much is available for powering the external circuit (loads and losses). Further, during the antiphase condition of the two current halves, the battery can be charged simultaneously while the external circuit half and load is being powered. Excess energy is fed into both actions by the *overpotential* (the stress potential) created at the surface of the plates.

5.8.5.6 Evoking the Initial Bedini Negative Resistor Effect

Figure 5-9 shows the first phase of Bedini's negative resistor process. Consider the battery in normal load-powering operation. From the external circuit, a very sharp leading edge rise of a pulse of electrons and potential is sent to the battery plates in "back-popping" or "battery charging" mode. The back-popping electrons drive in nearly instantly, piling up on the negative plate[148] and trying to force the heavy ions to start moving in the battery recharging direction. The pile-up that results in the stopped electrons on the battery plate surface represents an increase in local current density, hence an increased potential. This produces the 100 volts potential, during the time that the ions have not yet responded to any appreciable degree.

Due to much larger m/q ratio of the sluggish for a moment they lag due to their greater inertia, and this allows the much more agile electrons to "pile-up", producing a substantial overpotential as the local current density increases. The lagging ions are being steadily overpotentialized during this "lag time", up to about 100 volts in a normal 12-volt battery. At the same time, electrons are being forced back out of that higher 100-volt area and into the external circuit and its load, which had been at 12 volts. Recall now that these electrons can move longitudinally only at the drift velocity. Hence all electrons in the external circuit are now highly overpotentialized, and in *load-powering mode. The* overpotentialized electrons are thus producing excess power in the external circuit, much more than normal.

[148] We are not using conventional "positive current and positive plate" as the high side of the potential. We are using "electron current and the negative plate" as the driving potential plate.

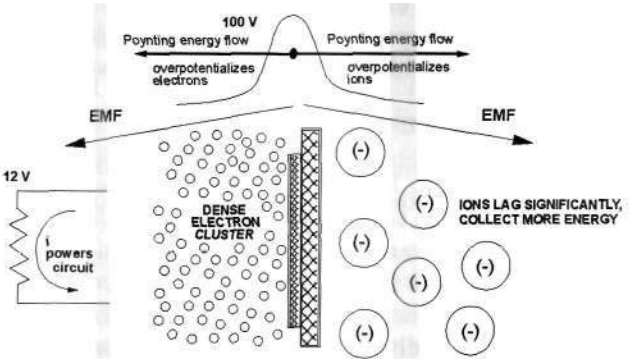

1 Sharp leading edge voltage pulse produces intense electron clustering and large potential (negative resistor) *at* interface *Sluggish ions only beginning to move*

2 Bidirectional Poynting energy flow from potential overpotentializes both the electron cluster and the ions, which are only beginning to move in charge mode

4 Large back emf Into circuit returns overpotentialized electron current, powering circuit with excess energy pouring from negative resistor potential Continues dunng ion delay

5 Simultaneously overpotentialized ion current is overcharging battery

Figure 5-9 Phase I of the Bedim negative resistor process in a storage battery.

Then the overpotentialized ions very slowly (compared to the electrons!) slow, stop, and begin to move in the opposite direction. They reluctantly respond and move in *battery recharging mode.* During that ion-response lag time, and the slower initial portion of the response, the electrons in the pulse continue to furiously surge in and pile-up on the negative plate, overpotentializing both the ions and the external circuit's electrons, while also some of them are being impelled back out into the external circuit to power it with extra overpotentialized energy dissipation. The charge density at that plate sharply increases due to the pile-up where the charges are "squeezing" together (clustering). There is a much higher potential suddenly rising in the squeezed charge cluster, because of the increased charge density there. As we stated, this potential nominally may be about 100 volts during this initial phase.

We call attention to the simple equation W = VQ, where W is the potential energy added to charges Q exposed to voltage V.

Simplified, the excess energy W_{IONS} freely impressed upon the ions is

$$W_{IONS} = f(100 - 12)(Q_{IONS}) \qquad [4\text{-}3]$$

where Q is the total coulombs of charge of overpotentialized ions and f(100 -12) is the magnitude of the overpotentialization of the ions.

At the same time, an excess energy is impressed upon the electrons in the external circuit by the same potential extending along the conductors into the external circuit. Again, this excess energy WE is given by

$$W_E = f(100 - 12)(Q_E) \qquad [4\text{-}4]$$

where Q_E is the total coulombs of charge of the overpotentialized electrons and f(100 -12) is the magnitude of the overpotentialization of the electrons.

But the emf on the electrons from the pile-up is directed in load-powering direction, as can be seen. Consequently the ion current and the electron current have been deliberately dephased by 180°, and so the overpotential energy of the ions is delivered in battery-recharging mode, while the overpotential energy of the electrons is delivered in circuit load powering mode.

Recapitulating: Pulsed pile-up of excess electrons on the negative plate interface between the two currents, while the ions are beginning to respond or only sluggishly responding, produces a much higher potential (an *overpotential)* on the sluggish ions — nominally some 100 volts in a 12-volt battery. On the negative plate, momentarily there is now a much higher voltage (with respect to the positive plate) than normally exists in the 12-volt battery. This voltage *overpotentializes* both the reluctant charging ions in the battery solution between the plates, and the powering electrons back into the circuit in powering mode due to the reversal of the emf. Since there is, say, 100 volts across the battery momentarily, there is also 100 volts now across the external circuit momentarily. Accordingly, overpotential excess powering of the external circuit load is suddenly evoked, while at the same time overpotential recharging of the battery is also evoked.[149]

In short, the ion current in the battery and the electron current into the external circuit have been placed 180° out of phase, achieving one major requirement for a COP>1.0 electrical system: *violating the integrity of the closed current loop circuit.* The battery is recharging at the same time that

[149] Another of Bedini's innovations is to shunt the excess voltage (say, above 14 volts) into an external capacitor on the circuit side. In that way with his overpotential he can be (i) overcharging the battery, (ii) powering the load, and (iii) storing excess energy in that capacitor, from the altered vacuum — all simultaneously.

the external circuit is being powered, *from the same free overpotential,* and both recharging and circuit powering are driven by increased emf.

We strongly accent that the overpotential at the plates represents a change in the local vacuum potential, and it *identically is* part of that now-altered local vacuum potential. The vacuum, since it contains enormous EM energy in virtual state, is a very powerful EM potential. Any EM potential in our circuits is automatically a change to the ambient vacuum potential, or a change to another potential that is such a change to the vacuum potential. In the most exact sense, this is a method of overpotentializing the plate interface with excess energy from the vacuum, and then letting that energy flow onto the ions to recharge the battery and onto the electrons in the external circuit to power it and its load.

The Bedini overpotential at the battery plates decomposes via Whittaker 1903 {85} as reinterpreted and previously explained, so that excess energy is entering 3-space there, *from the time domain.* Further, the piled-up electrons on the plates and the ions (as charges) in the solution receive such potential energy from the increased potential on them via the same decomposition process. So the creation of the Bedini overpotential on the battery plates, together with dephasing the two currents, is the creation of a true negative resistor at the plates, freely receiving energy from the external vacuum (from the time domain and virtual state) and transducing it into real potential energy and emf on the internal ions and on the external circuit electrons.

Hence Bedini has invented a process for creating a true negative resistor inside a storage battery, and for suddenly thrusting the system out of equilibrium with both the active local vacuum and the active local curvatures of spacetime. As such, the thermodynamics of open systems far from thermodynamic equilibrium applies, and that system is permitted to exhibit COP>1.0, while complying with energy conservation and the laws of physics and thermodynamics. With adroit use and collection of the excess energy, the externally collected energy can be used to close-loop the system and power all its functions. So the system is permitted to power itself and its loads, with all the energy being received from the vacuum via the broken symmetry created. Any overpotential is a dipolarity *a priori,* since any potential is. Hence creating an overpotential is precisely producing an extra broken symmetry of that dipolarity right there at the interface between the two half-circuits and the two dephased, localized currents.

During the "back-popping" pulse signals, one should not think of the energy pulses that Bedini inputs to the battery as the "powering" energy. Instead, one must think of each pulse as "triggering" and "timing" energy which initiates certain other key *negentropic* interactions to freely occur, once the electron pile-up occurs. The resulting negentropic interactions then add substantial additional energy (from the local active vacuum) to the ions in the ion current and to the electrons in the electron current. The freely added energy can be appreciably more than the switching or triggering energy that is dissipated as the "input by the operator".

In short, Bedini deliberately "switches"' and "triggers" certain kinds of vacuum exchange interactions, effectively creating a *true negative resistor* in the battery itself.[150] Due to the broken symmetry of the increased dipolarity *(overpotential)* that Bedini makes in "electron pile-ups" urging reluctant and delayed ion response, the vacuum furnishes extra virtual particle flux to this pile-up of electrons on the plate, which produces an enhanced Poynting energy flow that interacts with the ions in the battery electrolyte. Being charges, these ions thus transduce some of the excess absorbed virtual photon energy into real observable energy, thus increasing their potentialization and energy.

Bedini's method does the following: (i) It forms a true negative resistor in an unexpected way, upon the plates between a pile-up of electrons and the ions in solution in a common lead acid battery, (ii) it uses that negative resistor to extract excess energy from the vacuum and furnish it both to the ions forced into charging mode and simultaneously to the electrons in load powering mode, and (iii) it adds several other stimuli (such as Lenz law effects) which further amplify the negative resistor and enhance the effect, increasing the excess energy extracted from the vacuum and collected in the battery-charging process and also in the circuit-powering process simultaneously.

Specifically, the delay in ion response is adroitly allowed for and manipulated by Bedini to place the battery in ion current recharging mode while the signal pulse electrons between the plates and the external circuit are simultaneously placed in external circuit powering mode. By manipulating the hysteresis and adroitly timing the electron pulses and pulse widths, *Bedini breaks the usual forced Lorentz symmetry of the excitation discharge in a usually closed current loop containing both the*

[150] Again we stress that any dipolarity or potential is a negative resistor, producing giant negentropy {12}.

battery's source dipole and the external load. This is possible since his method deliberately opens the system so that vacuum energy enters freely, increasing the potentialization (energy collection) of the ions in the battery solution and upon the electrons between the plates and the external circuit as well.

We stress that Bedini has chosen to *avoid the* usual dissipation of half the energy collected in the external circuit to do nothing but kill the source dipolarity between the battery plates. He works on "that half of the circuit" that is usually just called the "back emf region" and ignored, and he separates and dephases that half of the circuit from the other half. By interrupting that normal "back emf battery-discharging section dynamics and converting it to "forward emf battery recharging section dynamics, while simultaneously powering the external load, Bedini temporarily produces and utilizes a negative resistor right there on the surface of the battery plates themselves.

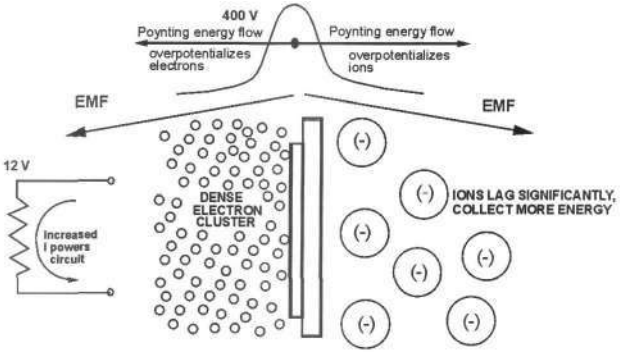

1 Sharp trailing edge of voltage pulse produces intense Lenz law effect Sharply increases electron clustering and potential (negative resistor) at interface Sluggish ions delay speedup further increasing the Lenz law effect

2 Increased bidirectional Poyntjng energy flow from potential overpotentializes even further both the electron duster and the ions, which are only beginning to accelerate in charge mode

4 Large new increased back emf into circuit returns overpotentialized electron current powering circuit with new excess energy pouring from negative resistor potential Continues during ion delay

5 Simultaneously, re-overpotentialized ion current is overcharging battery even faster

Figure 5-10 Phase II of the Bedini negative resistor process in a storage battery

5.8.5.7 Further Increase of the Negative Resistor Effect by Lenz's Law
See Figure 5-10. To further increase the Phase I effect just before it would end, and requiring precise timing of his switching of the pulse leading edge and trailing edge, Bedini then invokes a second phase by carefully controlling the timing for the sharp *cutoff of* the "stimulus pulse" creating the negative resistor. This is usually invoked just as Phase I is preparing to end, but experimentation and adjustment for optimization to the individual circuit conditions may be required.

Invoking the Lenz law reaction by minimizing the stimulus pulse cutoff time, Bedini sharply increases the already-increased negative resistor overpotential by a Lenz's law induced voltage surge, and sharply raises it to as much as 400 volts nominally. The process also sustains the negative resistor overpotential for a longer period, while increasing it again during this second phase. Thus even more free energy from the altered local vacuum potential is delivered to the ions in charging mode inside the battery, while simultaneously even more energy is delivered to the external circuit electrons in powering mode. The overpotential period is also extended. In this second phase, the extra energy W_{IONS} added to the ions in recharging mode is given by

$$W_{IONS} = f(400 - 12)(Q_{IONS}) \qquad [4\text{-}5]$$

and the extra energy W_E added to the electrons in system powering mode is given by

$$W_E = f(400\text{-}12)(Q_E) \qquad [4\text{-}6]$$

The total energy added to the system in Phase I by the negative resistor is

$$W_T = W_{IONS} + W_E = f(100\text{-}12)(Q_E + Q_{IONS}) \qquad [4\text{-}7]$$

The total energy added to the system in Phase II by the negative resistor is

$$W_T = W_{IONS} + W_E = f(400\text{-}12)(Q_E + Q_{IONS}) \qquad [4\text{-}8]$$

And so the total energy added to the system by the Bedini process is just the summation of equations [4-7] and [4-8]. With adroit switching, Bedini need only "pay" a small fraction of that freely received excess energy, in his own operator's input pulse energy and switching costs.

So by invoking a novel negative resistance effect directly upon the driving plate of the battery, Bedini creates (in the first phase) and then further enhances (in the second phase) a "nearly free" overpotential and overpotential period inside the battery. This excess potential directly upon the electron-pileup plate acts in both directions — out into the electrolyte between the plates to overpotentialize the ions in charging mode, and back out into the external circuit in powering mode to overpotentialize the electrons now powering the load. During a fraction of the operating cycle, Bedini recharges the battery while powering the circuit simultaneously, and thus has invented a novel method for extracting energy from the vacuum and curved spacetime to enable a COP>1.0 power system.

This is just a description of one fundamental period where Bedini applies his negative resistance process.

Several other places in the operation of the circuit lend themselves to additional phases of negative resistor formation and usage, and Bedini does use them. We do not discuss them here, since our purpose is only to advance the *fundamental principle involved.*

5.8.6 Independent Replication of the Bedini Negative Resistor Effect

Independent replication of the Bedini effect was accomplished early on by Nelson and by Cole, and also by Watson. Nelson has chosen not to further publicize his own work for some years, perhaps due to his employment as a microwave switching engineer in a large (and conservative) aerospace company. Cole is deceased, and Watson abruptly withdrew —forcibly, in our opinion — from public research and all further contact with his close colleagues after successfully demonstrating (in 1984) an 8-kilowatt power system utilizing a modification of the Bedini process. We are almost certain that Watson received the "offer he could not refuse", and that Watson-type COP>1.0 power systems are in fact already powering exotic underground facilities that "officially do not exist" but which we are aware of. We briefly discuss Watson's 8 kW generator at the end of this Chapter.

For non-battery powered systems, as we explain in Chapter 9, any unitary COP»1.0 EM system may experience a Dirac sea hole current decay mechanism which will produce an effective extra "load" in the system's input section, including on out into the external power system. As a general rule (sometimes violated), we estimate that the effect begins to be of importance at COP > 10^3 or so. Certainly it is of great importance in the range of COP > 10^5. To operate stably at COP »1.0, this decay mechanism must be dealt with and prevented. For close-looping into self-powering mode, this negative energy feedback must be converted to positive energy feedback, thus allowing self-powering mode where all the input energy is freely received from the vacuum.

For battery powered systems, the hole current and "extra load in the input section" becomes of significance near COP = 2.0 or even less, because of interaction with the complex battery chemistry and the tendency to charge **the** battery with negative energy as well. So battery powered systems present a special problem for close-looping to achieve sustained self-operation. Bedini has long solved and demonstrated solutions to that problem in a variety of successful experimental systems.

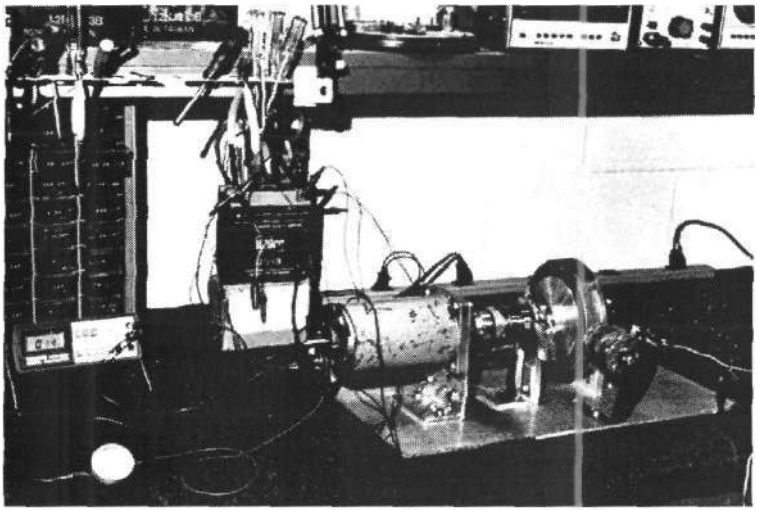

Figure 5-11 **Bedini motor** similar to the **type which ran continuously off a battery for three years, simultaneously recharging the battery.**

To utilize Bedini's battery-powered system at COP > 2.0, or to close-loop it for sustained operation, one must add another Bedini process that transforms negative energy current into positive energy current. That is Bedini's *transducing* negative resistor process {336}. We describe that process briefly in the next paragraph below.

Bedini has built many different motor-generator versions of systems self-powered by use of his negative resistor processes. Figure 5-11 shows a Bedini motor similar to one that once ran off a single battery for more than three years without stopping, using the forerunner of the Bedini back-popping process for creating a negative resistance in the battery. Bedini is still building and testing such power systems; one of his prototype motor-generators today, capable of operating and self-powering off a single battery, is shown in Figure 5-12.

5.8.7 Bedini's Transducing Negative Resistor.

Figure 5-13 gives a simplified block diagram of Bedini's transducing negative resistor process, which asymmetrically regauges negative EM energy into positive EM energy. With this process Bedini is able to intercept the Dirac sea hole current running from the output section of a COP>1.0 EM system to its input section, and divert the negative energy Dirac hole current to "reverse charge" a capacitor. The "reverse charge" consists of providing a hole current to the anti-negative plate of the

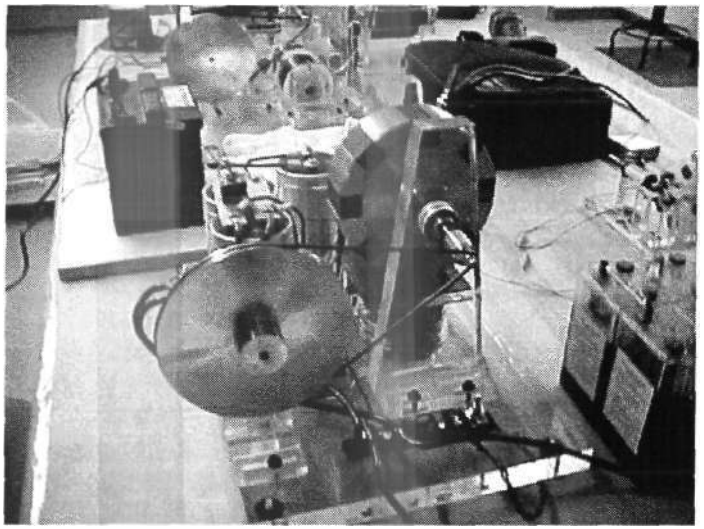

Figure 5-12 Modern Bedini motor prototype which operates off a single battery, powering the load and recharging the battery also.

capacitor, so that holes acting as positrons pile up in the local vacuum of **that** plate. This attracts the trapped electron charges in the dielectric, straining the dielectric in the direction of the hole collection. At the same time, the other plate draws electrons from the system that would otherwise be in currents that fight the back emf of the primary source dipole for the system. That reduces the back emf of the system during the charging of the capacitor; in effect, the back emf has participated in charging the capacitor with excess electrons on the negative plate.

Then Bedini reconnects the charged capacitor to the conductors leading to **the** power supply, discharging the capacitor by electrons furnished to the negative driving plate of the battery powering the system, and simultaneously to the input section of the system itself in normal powering mode. Note that the holes simultaneously discharge from the capacitor's anti-negative plate to the ground side of the battery, further charging the **battery** (the power source!) and the load as well.

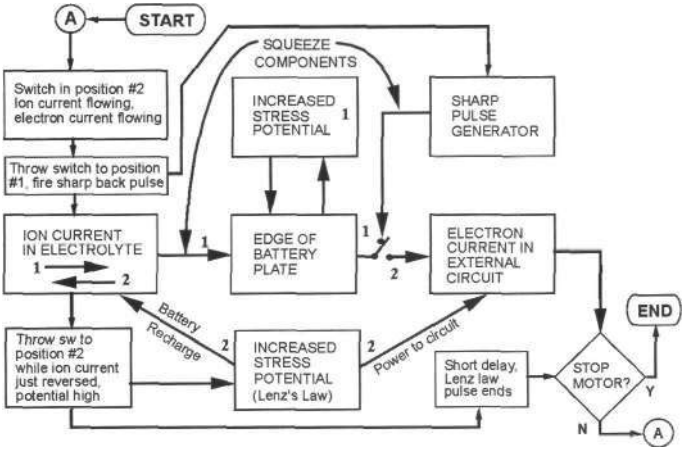

Figure 5-13 Bedini transducing negative resistor process block diagram. Adjusting **timing of rear edge of pulse adds additional Lenz law** increase.

Though it does not appear in the conventional textbooks,[151] one can power a load directly by Dirac hole current, but one does so by using the hole current in exactly reverse fashion from how one would use electron current to power the load. Semiconductor components are also critical and usually should be avoided. In short, one simply reverses the terminal that is considered the "driving terminal", and feeds the hole current to that "anti-negative" terminal as now the temporary driving terminal.

The Bedini process thus allows the Dirac hole current (negative energy) produced by a COP>1.0 EM system to be fed back to the input section and transduced into positive energy input to power the system with electron current and also to recharge the battery with positive energy.

[151] Lattice hole currents of course do appear and are considered. However, even though the circuit designers consider a lattice hole as a positron, it is not such at all, because the m/q ratio of the ion with one + charge is quite different from the m/q ratio of a true positron. The Dirac hole in the vacuum is effectively the "4-positron" — still in negative energy Dirac 4-electron state — before its observation or interaction with mass. It is a true negative energy entity, and thus a negative mass entity. Prior to observation, it actually should be said to be a "negative energy x time" entity and a negative "masstime" entity. It is also a negative energy electron entity. This subtlety is essential if one wishes to produce successful antigravity experiments on the bench, as we point to in this book and as were exhibited by the Sweet vacuum triode amplifier at COP > 1.5×10^6.

This converts what would otherwise be negative energy feedback to the input section of the system (and to the battery) to positive energy feedback **to** its input section and to the battery. Instead of seeing the negative energy current in the input as an additional "load" to be powered, the external power supply sees it as excess positive energy input by the environment to the system, reducing the "load" represented by the system. It thus reduces the power required by the system from the external power supply.

When the amount of "transduced" positive feedback electron current to the input section equals the "normal electron current draw" required by the system, the battery (or generator) can be disconnected and the unit will continue to operate in the self-powering mode, fed completely by the positive energy from the Bedini transduction process. The other *supersystem components* (comprising the external environment of the system) will continue to power the system and its loads and losses, with all the input energy to the system being taken from the combined active local vacuum and local curvature of spacetime.

5.8.8 Gray's "Splitting the Positive Pole" Engine.

One of the real pioneers in early application of causal positron energy was inventor Edwin V. Gray of Van Nuys California. In WW II Gray learned radar during his tour in the U.S. Navy, having previously attended advanced engineering school in the Army until discovered to be under age 15 and discharged. After the war, by 1958 he had learned to perform what he called "splitting the positive pole", using "cold electrical energy" (his name for negative EM energy) as well as the normal positive electrical energy. His first motor was operating by 1961. Preparing to put units into production, in 1974 the Los Angeles District Attorney confiscated all Gray's records and prototypes. To escape bogus charges, Gray later pleaded guilty to two minor infractions and was released. His prototypes were never returned. After several mishaps, moves, and more prototypes, Gray died in Nevada under mysterious circumstances in April 1989. We quote directly from Lindemann {341}:

> *"In the early 1980's, Gray offered the U.S. Government his technology to augment Reagan's SDI program. He actually wrote letters to every member of Congress, both Senators and Representatives, as well as the President, Vice-President, and every member of the Cabinet. Remarkably, ... Gray did not receive a single reply or even an acknowledgement!"*

In fact, during his early experiments, Gray discovered he could power light bulbs with cold energy, etc. Later he was to demonstrate this fact in a sensational manner: With a light bulb lit from his generator, he simply immersed the lamp — electrical leads and all — in water, where it remained lit. With his hands in the water, he would have been electrocuted or severely shocked if the electrical energy involved had *been positive* (diverging) energy. Instead, it was *negative* (converging) energy.[152] Another demonstration was to hit the coil of an electromagnet with some 3,000 volts, which hurled the electromagnetic into the air — but did not heat it. The electromagnet's coil would have been instantly melted if the energy had been positive, and the magnet would have been heated.

The reader should recall the timing of Dirac's theory of the electron {498a-b, 249}, which included the negative energy electron as early as 1930. Dirac also pointed out that we would observe this negative energy electron as a positive energy electron of opposite (positive) charge and positive mass, going in the opposite direction. The *observed* 3-positron and the *unobserved* negative energy 4-electron are quite different entities, producing quite different EM fields. The positron produces positive energy EM fields and positive gravity while the negative energy 4-electron produces negative energy EM fields and negative gravity.

In 1930, to his previous theory of the electron Dirac introduced the vacuum energy: the electron sea filled with electrons occupying negative

[152] By convention, "positive" energy has been associated with diverging EM energy, which is heating. Negative EM energy is associated with converging EM energy, which is cooling. In scalar interferometry {79}, one can control whether the distant EM field energy emerging in space in the distant interference zone shall be diverging (positive) EM field energy or converging (negative, cooling) EM field energy. This is determined simply by the biasing of the electrical grounds of the interferometer transmitters. The weather control referred to in 1997 by Secretary of Defense Cohen {89} is accomplished by using multiple scalar interferometers, some to gently heat the atmosphere in certain selected local areas (forming low pressure areas by expansion of the air) while cooling it in other selected local areas (forming high pressure areas by contraction of the air). By then moving these highs and lows around adroitly, one can capture and steer the giant jet streams, thereby steering the weather as one wishes, and directing significant weather changes into an area. By placing fairly sharp turns on the jet streams, one can induce great spin energy, thereby spawning tornadoes. Interestingly, by sharply pulsing the interferometer and controlling its electrical ground bias, distant cold explosions or hot explosions can be produced at will. Such weapons have been tested worldwide, and many test incidents are given in our older books F*er-de-Lance* and *Gravitobiology.* Information on such incidents is available on website http://www.cheniere.org .

energy states. The holes are treated as the positive electrons (as if observed). This vacuum energy medium is now referred to as the "Dirac Sea." First, Dirac attempted to identify these holes with protons, but that was falsified. Later the positron was experimentally discovered.

One of the problems with present conventional application of Dirac's theory is that the positron is not used in its *unobservable causal negative energy 4-electron state* by modern theorists and experimentalists, but *after observation* where its direction has been reversed, its charge has been reversed, time has been stripped away, and the mass has become positive. So it is actually used as a positive energy entity having positive mass, and producing positive energy EM fields and positive gravity. This defeats the entire magic of the causal (unobserved) 4-positron as the electron carrier of negative mass and negative energy *{convergent* electromagnetic energy) in currents in the vacuum (spacetime) itself, rather than the electron carrier of positive mass and positive energy in ordinary 3-space. By replacing the unobserved (causal) vacuum 4-positron (negative energy electron) with the observed (effect) 3-positron with positive mass and positive energy, the entire vast area of negative energy EM fields — and thus direct antigravity via electromagnetic means — is discarded.[153] But the physicists avoided having to grapple with practical negative mass and practical negative energy (cool mass and cool energy). It also set back the pace of physics in discovering and engineering antigravity transportation for nearly three quarters of a century.

It appears that Gray's thinking about cold energy was more prosaic than the somewhat esoteric considerations of the Dirac Sea theory. Conventional electrical engineering circuit theory considers positive charges moving around a circuit (although some electronics technical circuits required thinking in terms of electron current). Hence the "high" side of the standard circuit was the positive polarity, or the positive pole of the terminals of a generator or battery. From this "positive pole", positive current was sent around the external circuit to the ground return line by the forward emf (forward voltage). However, forcibly returning to the positive pole from the ground return line (i.e., from the negative pole) were those

[153] When the huge nondiverged Heaviside energy flow component is appreciably of "convergent" or of negative EM energy rather than positive EM energy, the antigravitational aspects are substantive and observable (and practical). The unaccounted Heaviside negative energy flow component is often a trillion or more times as great as the accounted Poynting negative energy flow component. Hence an**tigravity** technology is possible and practical, as we present in a later chapter.

same positive charges, being forced back up by the back emf and requiring expenditure of half the external circuit's collected Poynting energy.

So to Gray, the positive pole had two currents, one useful and one usually detrimental. The positive pole had (i) outgoing positive emf current powering the external circuit's loads and losses, doing the beneficial work (dissipating energy) in the external circuit with its load, and (ii) incoming positive current being forced back up against the back emf, doing the harmful work against the back emf and using up half the energy previously collected out there in the external circuit. Gray was aware that the work against the back emf was equal to the work done by the forward emf. So he set out to split these two currents apart, and catch the incoming current against the back emf separately, then use that normally wasted or oppositional energy to further power loads and/or recharge the batteries powering the system. Something like this was the way he was thinking.

That is what Gray called "splitting the positive pole". He also reasoned (and found) that the "reverse current" must be cooling instead of heating, since it moves against the voltage and acts backwards from regular current dissipated in resistors, etc. This precisely matches the cold (negative) energy phenomena met in the Sweet vacuum triode amplifier and in the motionless electromagnetic generator, as well as other COP>1.0 electrical systems.

Gray's later demonstrations showed that he had recognized this process or something very similar to it, in his "splitting the positive pole".

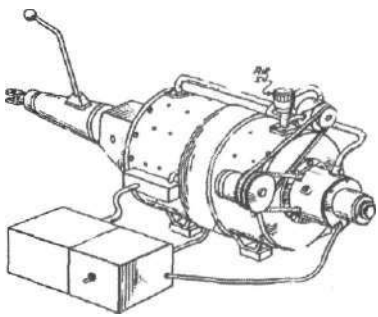

5-14 a The Gray engine

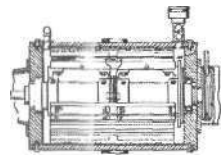

5-14 b Cross section view

US Patent No 3,890,548
issued 17 June 1975

Figure 5-14 Gray's "splitting the positive" COP>1 0 engine.

To take advantage of his concept and principles, Gray developed a special engine shown in Figure 5-14. In 1975 Gray received a patent on this engine {337} along with his special means of battery powering and special switching circuits.

Gray's engine uses pulsed capacitive discharge to power a magnetic motor, with recharging of the powering capacitors taking place *between* successive discharge positions of rotor and stator. The motor runs by initiating repulsion rather than attraction, which — apparently without Gray recognizing it in such terms — invokes the notion of the "superpole" pioneered by Bedini. The superpole is an important concept in COP>1.0 research, though most researchers in the field have never heard of it. John Bedini conceived it several decades ago and demonstrated the surprising difference between a superpole and a common pole of double strength.

When two equal and like magnetic poles are facing each other in repulsion with a small gap between them, a net stress magnetic potential (pole) is formed in that gap which has an energy density some four times as strong as the normal field energy density in the field from one of the two opposing like poles. Hence the local energy density of the vacuum in the gap has been substantially increased above the energy density in the field region between a north and a south pole facing each other. Further, this energy density is in a "field-free" Lorentz-regauged form, i.e., a stress potential form. From that superpotential *outward*, there exists a normal magnetic field. But in it, there is no net magnetic field, but there is a "stress" field nonetheless.

Compared to an ordinary magnetic motor using attraction as well as some repulsion, the exclusive use by Gray of the Bedini "superpole" principle caused an extra *symmetrical* regauging[154] of the local vacuum energy input to the system (to the gap between the poles) as the magnetic superpole

[154] Every conventional electrodynamics text already assumes and uses the Lorenz-**Lorentz** symmetrical regauging as being absolutely free. Symmetrical regauging assumes that the energy of the system has been freely changed twice, but in such a way that the two free fields formed are equal and opposite, forming a stress potential. Gray found how to split apart and separately use these two "free-flowing exc**hanges** of energy between system and active vacuum" that comprise the overall stress potential of the system, and thereby violated the Lorenz-Lorentz symmetry condition, freeing the two equal and opposite EM fields and their free energy to be used individually and beneficially to (i) provide extra power to the load and (ii) recharge the powering batteries so they did not run down. Using a different method. **Bedini** has done likewise.

(stress magnetic scalar potential). However, this stress potential is comprised of bidirectional longitudinal wavepairs, as shown by Whittaker in 1903. This superpole or stress potential thus can and does "split" into two different fields in antiparallel directions from each other. Since the north pole is deemed "positive" in magnetics, then using the two anti-fields comprising the free positive superpole is indeed "splitting the positive pole". Gray coined a very apt phrase for what he was doing.

Each of those antiparallel fields also involves an associated and unaccounted phase conjugate field {338a-c}, hence it is a time-reversed field (after observation). So opposing time-polarized EM waves also accompany Whittaker's decomposition waves. In short, the scalar potential accomplishes *optical-type pumping* in the time domain, and can be used to demonstrate time-reversal (as in Becker's bone-healing method).

Before observation (interaction with charged mass) and while still in the causal state, *the EM field from the positive pole is actually an EM field from a negative energy 4-electron, and the field can be taken to be a negative energy field!* In our view, positive energy enters every point dipole in the polarized vacuum at the negative charge, thence to the positive charge, thence back to the time domain. From the positive charge, the positive energy is leaving 3-space back to the time domain. Hence positive EM energy diverges from the negative charge and converges on the positive charge, then "disappears", so to speak, back to the time domain from whence it came. The "disappearance" of positive (divergent) energy is the disappearance of heat energy; hence it is a cooling process rather than a heating process. Or said another way, *negative* EM energy enters 3-space at each point dipole, entering from the time domain to the positive charge. Thence it moves to the negative charge, and back to the time domain. We see or detect the positive energy flow in 3-space directly, while the negative energy flow in the Dirac vacuum is evidenced by the "backwards" interaction creating Newton's third law reaction force.

By splitting the positive superpole, one has effectively destroyed the Lorentz symmetry condition. Hence the excess energy in the superpole will be capable of performing real work in the system in two directions. One direction is from the system to the external environment so that it produces the dissipation of energy (therefore work) in the loads and losses. The other direction produces a "negative resistor" or negentropic action that adds that much excess usable energy to the system back into its input section. By adroitly intercepting and switching that energy into capacitors and/or batteries, Gray was able to charge capacitors, recharge batteries,

and even power loads with cool energy (as demonstrated later by immersing a lighted electrical line and a lit light bulb in water).

A positive-energy resistor becomes a negative resistor when fed with negative energy. Then it converges positive EM energy from the external environment and outputs it into the circuit in which the resistor is connected. Note that this is the same statement as the resistor receiving (extracting) negative energy from the circuit and emitting it back to the time-domain. *That's like extracting back emffrom the circuit and tossing it offto the time domain.* A conductor to positive energy flow is an insulator or dielectric to negative energy flow. Hence the normally "conductive" water was a neat insulator for Gray's "dunking" demonstration of negative power, as were his own normally conductive hand and body. To negative energy, a coil seems to produce capacitance rather than inductance, while a capacitor seems to produce inductance rather than capacitance.

Thus when the "positive pole is **split"** in the system, the system has broken **its** Lorentz regauging and is an open system in disequilibrium with the external vacuum environment, freely receiving excess energy from it.[155] With adroit switching and energy capture, such a system is permitted to exhibit COP>1.0 because it has violated the free Lorentz regauging once the excess energy in the superpole region is discharged and used.

[155] When one analyzes the supersystem of any Lorentz-regauged EM system, one realizes that the extra stress potential energy — entering the system and "locked up" as a stress potential due to the Lorentz condition — is actually a special relativistic **rotation** of the frame of the power unit away from the laboratory frame. That is, the system when rotated away from the lab frame, takes on free symmetrical regauging energy in that rotated frame as an excess stress potential. Gray's "splitting the positive" process simply separated the two appositive fields comprising the stress potential, then produced excess free energy from that *broken* free regauging Lorentz condition. Literally Gray splits Lorentz's stress potential into halves, the halves being its two opposing EM fields and their energy. This is equivalent to the system being rotated back into the lab frame, releasing its excess energy it possessed in the rotated frame back into the lab frame. Richard "Scott" McKie has also filed a patent on an invention deliberately rotating a capacitor's frame and fully charging it — while it is in its rotated frame. The rotated capacitor can be charged with less energy furnished from the lab frame, than is obtained back out of the capacitor in the lab frame when the charged capacitor is suddenly rotated back and discharged. At least in **theory,** McKie's overunity process should be workable if the switching costs are negligible. Our contribution to McKie was to advance the theoretical mechanism for **the** experimental mechanism he had discovered and was using.

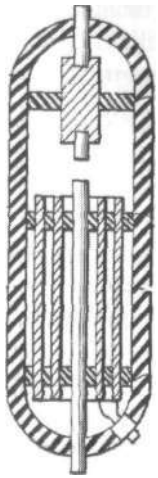

From US Patent No **4** 661747
issued 28 April 1987

Also in U S Patent No 4595,975
issued June 17,1986

Figure 5-1S Gray's conversion tube used with power systems,

Gray also utilized a special conversion discharge tube, shown in Figure 5-15. This tube uses the fact that a very sharp pulsed discharge in it results in a temporary COP»1.0 condition. This COP»1.0 condition instantly involves causal Dirac sea 4-positrons, moving as negative mass current and negative energy current in the local vacuum, which sweep back from the output side of the discharge to the input side.

We also point out the severe overpotential that must accompany any such violent pulse discharge process. The overpotential is a departure from equilibrium conditions, and is the difference between the actual potential and the equilibrium potential. The overpotential is well known and utilized extensively in electrochemistry {339a-c}, but is little used in conventional circuit theory. Nonetheless, it is involved in cold fusion processes due to the double layer phenomena {340a-b}, and it is involved in all electrode discharges (as from a cathode to an anode). It is also involved widely in electrochemistry and ion processes in solution.

Figure 5-16 shows Gray's circuit containing his conversion tube. Figure 5-17 shows Bedini's successful replication of the Gray conversion tube. Figures 5-18, 5-19, 5-20, and 5-21 show four pertinent pages from Bedini's laboratory notebook on his replication of the Gray conversion tube and the Gray motor system.

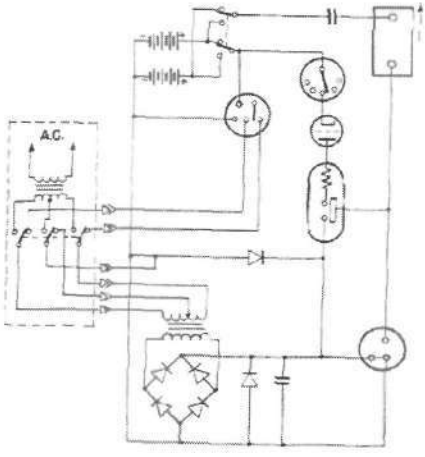

From U S Patent No 4 661 747
issued 28 April 1987

Also in US Patent No 4 595 975
issued June 17, 1986

Figure 5-16 Gray's circuit containing his conversion tube.

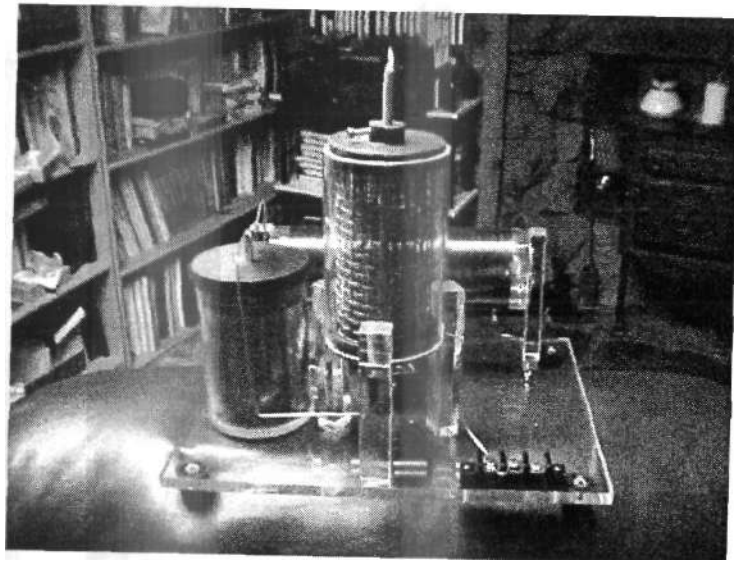

Figure 5-17 Bedini's successful replication of the Gray conversion tube.

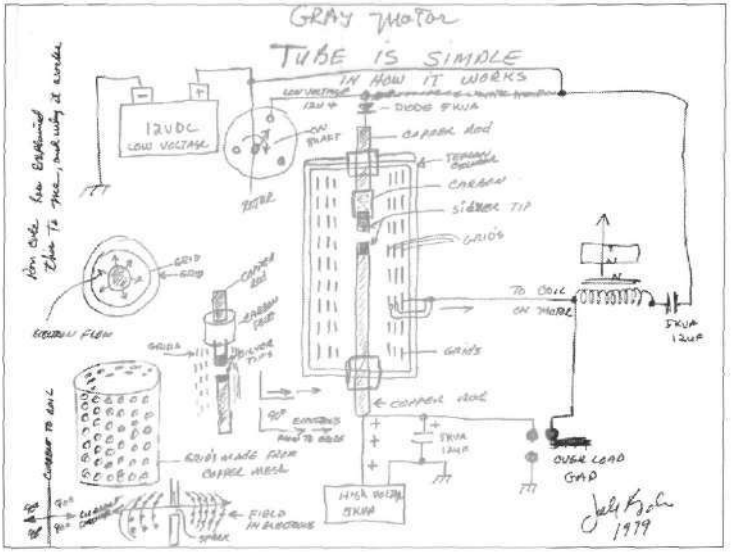

Figure 5-18 Page 1 from Bellini's lab notebook on the Gray conversion tube.

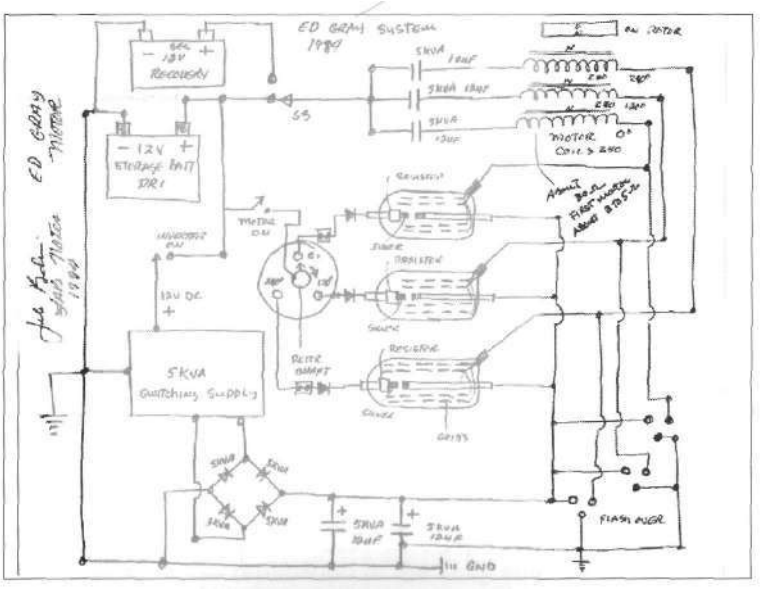

Figure 5-19 Page 2 from Bedlnl's lab notebook on the Gray conversion tube.

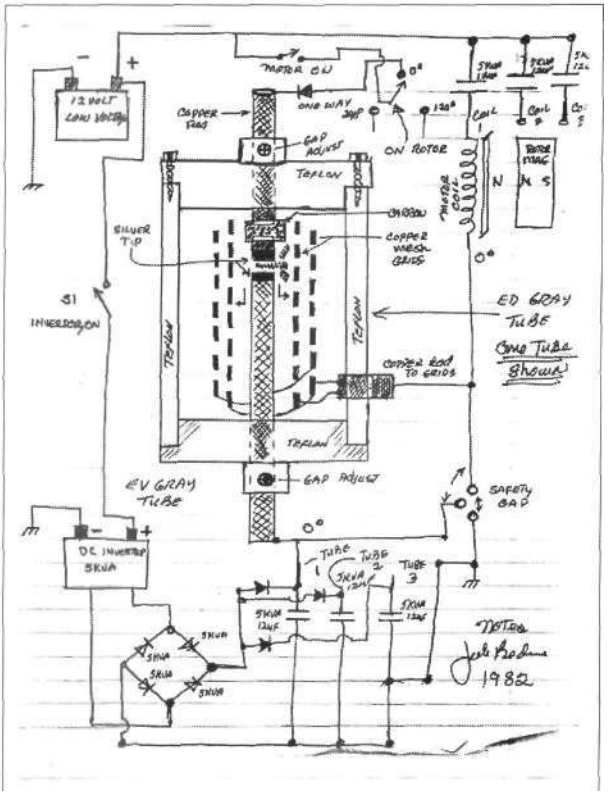

Figure 5-20 Page 3 from Bedini's lab notebook on the Gray conversion tube.

In science, when a novel experiment is replicated independently, that experiment then is established as a scientific fact. It then becomes the task of the theorists to either change the theory to accommodate the experimental results, or come up with a new theory to explain them. With Bedini's successful replication of Gray's work and extension of it, that work has now been scientifically established. With his "splitting the positive pole", Gray was referring to an actual, useful mechanism he evoked and used in the processes ongoing in his motor, in his conversion tube, and in his power system.

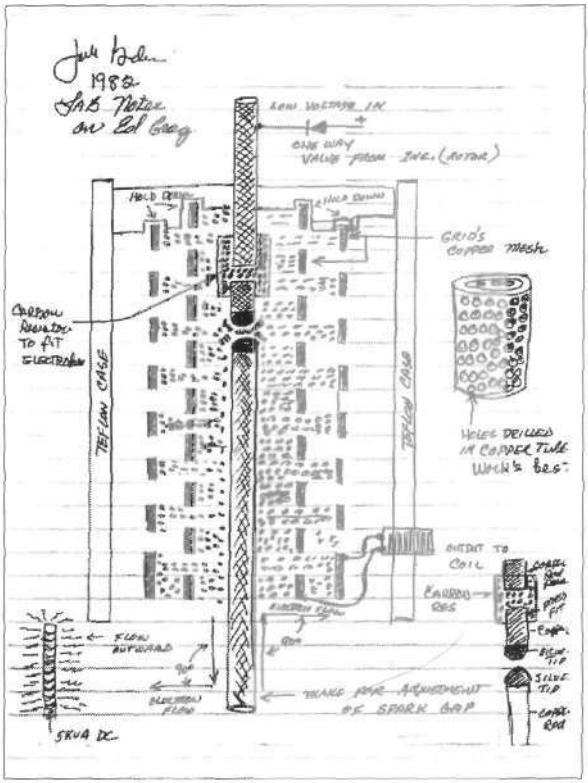

Figure 5-21 Page 4 from Bedini's lab notebook on the Gray conversion tube.

For further discussions about the Gray motor, conversion tube, and the history of it all, one is referred to the book by Lindemann {341}.

5.8.9 Watson's Self-Powering Generator

See Figure 5-22. In 1984, Jim Watson demonstrated a self-powering 8-kilowatt generator at the International Tesla Conference in Colorado Springs. This generator was a modified extension of smaller motors and generators built by Bedini over a period of years. At the conference, engineers from the audience were invited to the platform to perform their own independent measurements of the unit, while it was running and powering its load. The engineers directly confirmed that the system was delivering power to the load (as could be seen visually also), and that it was recharging its batteries as well.

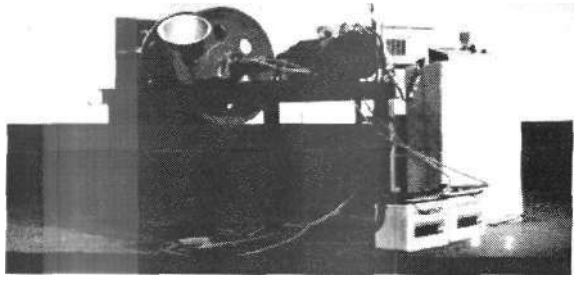

Figure 5-22 Watson's self-powered 8 kW generator demonstrated in 1984.

Interestingly, one of Watson's batteries was stolen that night. The reason was obvious. First, at the conference there was present one of the major persons charged with suppression of COP>1.0 electrical power systems world wide, along with several of his henchmen. Since they have been involved in suppressing many dozens of similar COP>1.0 systems, they are thoroughly familiar with both the theory of COP>1.0 electrical power systems and the various types of devices and mechanisms that have been invented in that area over the past century.

One feature of Watson's unit was that it charged the batteries with negative energy (i.e., with Dirac sea hole current, or "cold energy" as sometimes referred to), and could use negative energy for powering the unit. Hence, his batteries became charged with negative energy as the machine ran and powered its loads. After much demonstration and running, such a negatively charged battery has its local curved vacuum charged with an appreciable number of unfilled Dirac holes. Such a negatively charged "battery supersystem" will then absorb positive energy charging (electron current charging) for a protracted period before it will start to change its voltage and accept the positive charge. Instead, during that protracted initial period the battery will just "eat electron currents and positive energy" from the battery charger, with no apparent effect and no change in Its discharged state or its voltage.

A very simple way to absolutely ascertain whether or not a unit such as Watson's (without a Bedini negative energy converter) is genuine, is to simply take one of his batteries from a unit that has been running quite a bit, and recharge it on a conventional battery charger. If it exhibits that two-phased recharge phenomenon, it proves that the unit is real and is

indeed a true COP>1.0 device, or certainly has the potential to be one. Coupled with the demonstration and independent measurements, this removed all doubts about the validity of Watson's COP>1.0 system.

So it appears that certain parties who were concerned about that system decided to do the "simple test" to see if Watson's device was real. It was real, and so they discovered. At that point, the High Cabal — Winston Churchill's term — recognized they had another successful unit and inventor to suppress.

Bedini and I were in close contact with Watson over a period of years, as often as three or more times a week. Later, some time after that conference, abruptly Jim ceased all communication with his former close colleagues. For two days a rather crazy recording **was** on his phone, stating the Watsons had moved. Then that disappeared. Watson never again contacted either Bedini or me, or his own financial backer (the late R. J. Reynolds III). Even Reynolds could not find Watson's whereabouts at that time.

We are quite certain that Watson received the "offer he could not refuse". Simply put, this is the old Mafia trick of visiting the target, offering him a deal, and he has no choice but to accept or die. When this is used to suppress COP>1.0 systems, and some medical systems, the offer is usually: *"Accept the money and you and your family will live very comfortably, but you will never openly work on this again or communicate it. You either accept our generous offer, or you and your family will be dead when we leave here."* Assuming that happened Watson had no choice but to accept the several million dollars offered him.

He is still alive, because Jeane Manning physically ran into him at a conference — and recognized him and spoke to him — whereupon he withdrew abruptly and left the conference very hastily.

5.9 Suppression of Free Energy Systems Has Been Common

This is only one of many cases we know of where such suppression of overunity systems and inventors has been accomplished. Others are not so benign. Marinov was killed with a longitudinal EM wave shooter in Europe, and his body was thrown off a building to make it appear a suicide. The police allowed the body to lie on the pavement for a protracted time (it was emitting longitudinal EM waves from the time-charging action of the strike). When finally moved, the pavement glowed

in that area that had been underneath the body. Only one weapon on earth will kill a person in that manner, and that is a longitudinal EM wave "shooter".

Another prominent researcher was killed with a Venus technique (look it up, it's a distortion of the wave front) modified beam that plunges the heart into violent fibrillations. He rushed from a restaurant exclaiming, "They're killing me!" and died of a resulting heart attack. The present author was hit with just such a weapon in a restaurant here in Huntsville. A friend and I actually saw the weapon and the person wielding it. Knowing what it was and recognizing the symptoms, my seated companion and I were able to bolt out of the nearby back door during that minute or so we could still physically function. I personally saw the device and the person doing the beaming, and I have a witness to the event.

The partner of a colleague in Australia was killed on an upper floor by such a shooter from the street below, right through the walls. The assassin was observed, and was seen putting the bazooka-sized shooter back in his car, then speeding away. There are many other true incidents we could also relate, including a person killed by an ice-dart dipped in curare (a very professional hit method, used by some of the sinister arms of various intelligence systems). So there is more than just scientific work involved in pursuing COP>1.0 EM power systems. There can also be a direct threat to one's life, essentially at any time.

Almost any serious overunity researcher, who succeeds, will have had confrontations with assassination attempts, suppression attempts, threats, deliberate legal entanglements, etc. The present author is no exception. It is sad that one of the prerequisites for serious scientific work in this area is o**ften** a legal gun permit (for both the inventor and his wife) and either legally carrying a hidden weapon or never being very far from a weapon when working at home. As an old soldier, of course, one just shrugs and accepts it, and gets on with the job to the best of one's ability, albeit remaining very watchful and always on guard.

5.10 In Conclusion

In this chapter we have introduced many of the approaches to COP>1.0 EM systems or processes, or the possibility for such in some novel mechanisms known in science. Recalling our previously presented solution to the source charge problem, we emphasize to the reader that all assumed 3 - space EM processes are actually 4-space processes prior to observation, continually observed in iteratively frozen 3-snapshots by iteratively

invoking the *d/dt* operator that produces observation. Hence from the source charge (and source dipole) solution we realize that all EM energy in 3-space comes from the time-domain and returns to the time domain. It iteratively appears along the "line of propagation" in 3-space at each successive position, but does not continuously propagate in 3-space. It does continuously propagate in 4-space. Since all the EM energy in any EM circuit comes from the time domain via the broken symmetry of the source charges and source dipoles, then we need to apply this greater vision to the COP>1.0 mechanisms and approaches so that we see the 4-space to 3-space to 4-space interplays.

The notion of the negative resistor is particularly significant and direct in that respect, and we have presented several versions of true negative resistors. For those wishing to experiment, we would suggest the easiest thing to start with is the point contact transistor. Or, simply go to Naudin's website {313} and download his instructions for making a Chung-type negative resistor, build it, and do experiments with it by varying the pressure on the fibers etc.

Again, we have not presented "parts kits" with instructions, but we have presented things that have worked or can reasonably be expected to work with some effort. We have also discussed the principles involved, to the best of our ability. In a few cases, we have directed the reader to information on websites where building instructions for selected negative resistors and other devices are posted.

As in any other scientific endeavor, we also urge the interested reader to read the literature and check the references cited, or as many as possible. Increasing one's understanding of the area is necessary to increase one's probability of success in the area.

We also wish the reader good results and success in his or her research and experimenting. The energy crisis is not going to go away, and the demand for oil will double in the lifetime of many of our middle-aged or younger readers. The cheap oil peaks shortly and declines in availability forever thereafter {342}; this alone will drive up the price of oil and seriously impact the economies of the nations of the world. To keep from destroying the world economy and the biosphere, it is absolutely essential that COP>1.0 electrical power systems — including self-powering systems taking their input energy from the seething local vacuum — be developed to produce the necessary electrical energy needs of the world, cheaply, cleanly, and easily.

If one or more of the readers should succeed in developing and producing such systems, then the entire purpose of this book will have been fulfilled.

Chapter 6

Additional Approaches to Overunity Power Systems

"Can the quantum potential carry a signal? If it can, we will be led to a violation of the principles of Einstein's theory of relativity, because the instantaneous interaction implied by the quantum potential will lead to the possibility of a signal that is faster than light... a signal has in general to be a complex structure, consisting of many events that are ordered in definite ways. In terms of our language, each signal is a supersystem of events, while each event is in turn a system of subevents.... At present, the answer is, of course, not known. " [Bohm and Hiley] {343}. A comment:[156]

[156] We comment that the "event" involves observation: i.e.. it is conceived as an *observed* event. In that exact sense, no signal in space carries "events" because there is no interaction with mass and no *d/dt* operation induced on entities (curvatures) of spacetime. The effect (observed) 3-space field cannot propagate faster than light, because it cannot even propagate in the first place! The totality of light's EM interactions with matter is what makes the observed field or observed signal to appear to be propagated at light speed. It is not actually "propagating", but being iteratively recreated from point to point in space *if observed at every point.* Signal in spacetime is causal and hence nonobservable; the interaction of causal signal with charged mass is observable and makes an "event". When we clearly differentiate the nonobserved (causal) 4-field or dynamic from the iteratively observed 3-field or dynamic, then the *nonobserved 4-field* or dynamic is not limited to light speed. Propagation along the time axis, e.g., can be at "infinite velocity" because a single point in time is connected to every point in the universe simultaneously. Since all EM energy in space comes from the time domain locally at each point dipole in 3 - space and returns to the time domain from that same point dipole, it is the notion of "propagation continuously through 3-space" at *any* velocity that is a non sequitur. Absolutely nothing propagates through 3-space! If general relativity is re-interpreted **to account** the difference between observed and unobserved (effect and cause), then the unobserved cause can propagate superluminally without violation of the "observed event (effect) propagation at light speed" of general relativity. It is the notion that anything propagates in 3-space that is the non sequitur, and it should be removed from special and general relativity as well as electrodynamics.

"...contrary to the conclusions of classical mechanics, there exist effects of potentials on charged particles, even in the region where all the fields (and therefore the forces on the particles) vanish." [Aharonov and Bohm] {344}.

"...for any force varying as the inverse square of the distance, the potential of such force satisfies both Laplace's equation and also the wave equation, and can be analyzed into simple plane waves propagating with constant velocity. The sum of the waves, however, does not vary with time, i.e., they are standing waves. Therefore the force potential can be defined in terms of both standing waves, i.e., by a global, or non-local solution, and by propagating waves, i.e., by a local solution changing in time... Thus, Whittaker's mathematical statement related the inverse square law of force to the force potential defined in terms of both standing wave (i.e., global) and propagating wave (i.e., local) solutions. The analysis also showed that the electromagnetic force fields could be defined in terms of the derivatives of two scalar potentials." [Barrett] {345}.

*"What might appear to be empty space is, therefore, **a** seething ferment of virtual particles. A vacuum is not inert and featureless, but alive with throbbing en**ergy** and vitality. A 'real' particle such as an electron must always be viewed against this background of frenetic activity. When an electron moves through space, it it actually swimming in a sea of ghost particles of all varieties — virtual leptons, quarks, and messengers, entangled in a complex melee. The presence of the electron will distort this irreducible vacuum activity, and the distortion in turn reacts back on the electron. Even at rest, an electron is not at rest: it is being continually assaulted by all manner of other particles from the vacuum."* [Davies] {346}.

6.1 Introduction

In this chapter, we continue to present a selection of potential overunity systems, inventions, approaches, and selected mechanisms. We also make the reader aware **that quantum** mechanics, an entire branch of physics,

requires nonlocality and "instant propagation" in space. We utilize the quantum potential from Bohm's hidden variable theory of quantum mechanics {347} to impress the nonlocality. Further, the staid old scalar potential — which we meet as voltage in a circuit — also exhibits nonlocality and instant propagation in the Coulomb gauge {348}. Our purpose is to show that electrodynamics is not limited to the cut-and-dried subject as usually taught to electrical engineers and applied by them, but also covers a wide range of phenomenology that electrical engineers usually do not consider or account.

6.2 Energy Conversion and Energy Amplification

6.2.1 The Mead-Nachamkin Zero Point Energy Converter

It is well known that the vacuum interacts with electrical charges and dipoles, and also with the electrons in an atom. For example, Lamb received the 1955 Nobel Prize in physics jointly with Polykarp Kush for experiments measuring the small displacement later called the "Lamb shift" of 0+ne of the energy levels in atomic hydrogen {349}.

Casimir {350a} proved that closely separated conducting plates also alter the energy density of the vacuum, thereby becoming an "energy extracting" method, although the energy is miniscule. It is quite real, however, as shown in meticulous experimental work by Lamoreaux {351}. The principle that vacuum energy interacts with matter, plates, and electrical double layers and circuits is well proven experimentally.

In 1996 Mead and Nachamkin were granted a patent on an overunity EM power system process for extracting zero-point energy of the vacuum {352}. If one closely examines the patent wording, the device is properly patented as an energy converter and does not overtly state that it is a COP>1.0 system. It is a COP>1.0 system, however, since the input energy is freely received from the vacuum and not input by the operator himself. One embodiment of the invention inserts a tiny coil between the plates to extract the energy. See Figure 6-1. The energy is based on the Casimir effect {26}, which was accurately measured in 1997 by Lamoreaux {27} and since then by others.[157] Further investigation of the force's behavior with the shape of the conducting plates has been performed by Chen *et*

[157] See also U. Mohideen and A. Roy, "Precision measurement of the Casimir force from 0.1 to 0.9 microns," *Phys. Rev. Lett.*, Vol. 81, January 1998, p. 4549.

al.[158] Numerous other papers of interest on the Casimir effect have also been published {353a-d}.

Because energy cannot be created or destroyed, any COP>1.0 system is an *energy converter*, a priori. It must receive the excess energy from the environment (in this case, from the curvature of spacetime and from the local active vacuum) and convert that energy to a form usable to power or assist in powering the system loads and losses.

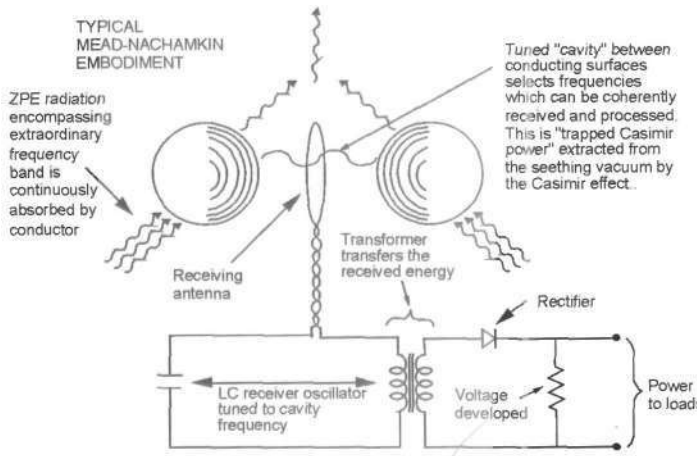

Figure 6-1 Mead-Nachamkin conducting surfaces, antenna, and receiver for extracting EM energy from the vacuum,

The Mead-Nachamkin patent is interesting because the physics of the device is proven and accepted. Getting sufficient power output to be useful for electrical power purposes, however, remains to be demonstrated, since the Casimir effect is very tiny.

6.2.2 **The Quantum Potential As an Energy Amplifier**

In Bohm's hidden variable theory of quantum mechanics {354}, an extra potential is added to the Schrodinger equation, and is known as a *quantum potential.* Figure 6-2 lists the novel characteristics of this potential, and

[158] F. Chen, U. Mohideen, (G. L. Klimchitskaya, and V. M. Mostepanenko, "Demonstration of the Lateral Casimir h'orce," *Phys. Rev. Lett,* (in press as of the time of this writing).

Quantum Potential Characteristics

- No point source; not radiated
- Just appears instantly
- Quantum potential between two particles
  - Interaction does not vanish as spatial separation becomes very large
  - Instantaneous connection
- Depends on quantum state of system as a whole
- System parts can be greatly separated

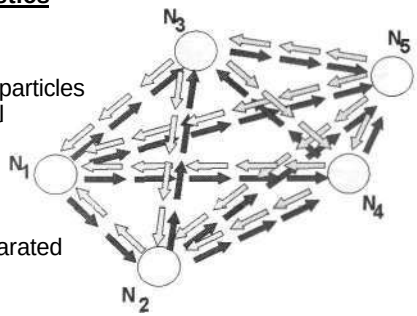

Figure 6-2 Quantum potential characteristics (table).

Figure 6-3 lists technical features of Bohm's hidden variable theory from whence the quantum potential is taken {355}. It can "move instantaneously", at "infinite velocity", which means it just suddenly appears everywhere it will be, and does not "propagate at a finite speed" through singly connected space at all {356}.

$$V_{quantum} = \frac{h}{2m}\frac{\nabla^2\sqrt{\rho}}{\sqrt{\rho}}$$

A quantum particle moves as if it were subject, in addition to its external potentials, to a potential which is a function of its own probability distribution.

Bohm's hidden variable theory assumes:
- Particle and wave function real and separate
- Wave function obeys Shrodinger's equation
- Particle obeys classical mechanics
- Particle couples to wave function through a quantum potential

Figure 6-3 Technical features of Bonn's hidden variable theory.

The potential is after all *potential energy.* With the quantum potential (QP), a joule of energy placed upon one collector, where that collector is connected via a QP with one or more distant collectors, will also result in a joule of energy (or some fraction thereof) instantly emerging upon and in each of those distant participating (QP-connected) stations simultaneously. It appears that, if only a fractional participation — say, 0.50 — exists with one or more of the distant stations, each of those stations will experience the appearance of that fraction (in this case, 0.5 joule) of the energy input to the initiating station. Any station can input energy, and it will

appropriately appear at every other participating station, regardless of where these stations are located in ordinary 3-space as seen by the external observer.

One way of expressing this "instantaneous QP connection" between separated objects is to model the different objects (or stations) as linked together in a multiply connected space, with a certain QP connection or collection fraction. Presence of energy at one station in the multiply connected group, results in the simultaneous appearance of the energy — or an appropriate fraction of it — at every other station in the group.

To understand multiply connected space, consider a single point on a plane. Now consider 999 more points superposed on/in that same point. But suppose that those thousand points are really located at different locations in 3-space, though superposed in this "crazy space" containing a plane where all of them are superposed at one point.

As the ordinary external observer, suppose you input a joule of energy into one of these — to you — separated points, which happens to be the original point and is located in your laboratory. Supposed the fractional connection is 1.0 (the connection is perfect in multiply connected space). Voila! Instantaneously one joule of energy appears at each and every one of those (to you) widely separated points. If you vary your input energy (e.g., as in communication), it varies precisely the same in each of those distant QP-connected points.

Those who continue to advocate that superluminal communication of information is impossible are ignoring present experimental proof that it does occur. As a single example (there are others), it has been shown by Enders and Nimtz {357} that Mozart's 40th symphony can be transmitted as frequency modulated microwaves through a barrier wave guide between two points in a waveguide, via quantum tunneling, at 4.7 times the speed of light c. We point out that this is achieved using *transverse* EM waves.

If *longitudinal* EM waves are used together with longitudinal modulation (which engineers might think of as a sort of "pulse compression" technique), the only limitation to the speed of communication is given by the impurity of the longitudinal EM wave one is able to make. The Fogal semiconductor, e.g., can be used to transduce ordinary transverse EM wave signals into longitudinal EM wave modulations inside a scalar potential. Hence that scalar potential can move in the Coulomb gauge at infinite velocity. It requires another Fogal semiconductor circuit on the receiving end to receive and transduce the longitudinal EM waves and their longitudinal modulations back into transverse EM waves for processing

and amplification by normal means. This capability of the Fogal semiconductor circuits has been demonstrated through satellite uplinks and downlinks coupled with long transmission line links, with essentially no delay from transmission to reception. One may think of the Fogal superluminal process as *tunneling through subspace.*

The best way to vary the energy is apparently by use of a variable stress potential (which translates to a longitudinal variation or modulation). In short, one must modulate the "internal energy" of the vacuum, so to speak, and not the "external energy". A reasonable discussion of internal energy versus external energy is given by Chen {358}. If one longitudinally modulates the internal energy of the vacuum potential — which, being a scalar potential, decomposes by the Whittaker decomposition {359} — then superluminal communication is not only possible but also practical. We expect Fogal to eventually place just such a system on the market, shortly after his semiconductors get into precision production.

One possible method of producing modulated internal stress potentials is by use of a Davis noninductive resistor {360}. Another is by use of a biwound coil with two windings, so that the two currents through two equal "superposed" coils are equal and opposite. We point out that, while there has been published much stuff and nonsense about such biwound coils, the truth is quite mundane. Simply examine the Lorentz symmetrical regauging applied to the Maxwell-Heaviside equations. It is the deliberate production of two equal and opposite force fields, which is in fact the creation of a stress potential and extra stress energy. By varying the magnitude of the Lorentz forces comprising the stress potential, the stress potential is varied in amplitude. Hence the concomitant longitudinal EM waves are varied in amplitude. A biwound coil is a variable Lorentz-regauging coil, *a priori.*

By oscillating the magnitude of any Lorentz regauging (which in the simplest case is simultaneously changing both opposing fields equally and oppositely), one can make longitudinal EM waves. By appropriately modulating both Lorentz regauging components, one can make longitudinal EM modulations upon those concomitant longitudinal EM wave carriers.

So with some careful tuning and adjustment, and a little nonlinear material in the core,[159] one should be able to have the superposed appositive

[159] The opposing waves must modulate (multiply), not mix (add), and modulation is a nonlinear process. Linear mixing of opposite waves or fields will not cause the

magnetic fields lock together *(modulate,* rather than linearly *add)* and produce a magnetostatic scalar potential stress signal in and from a nonlinear core material. We caution, however, that the biological effects of the radiation of such stress potentials internal to spacetime have not been investigated. The experimenter is cautioned that he experiments at his own risk, and he is cautioned to experiment only at low power levels until the phenomenology in a particular case is understood.

If we compare the stress potential oscillation (wave) to a sound wave, the similarities suggest that the stress potential oscillation can be treated as a longitudinal EM wave, if the two superposed opposing EM waves "lock together". Simple addition is insufficient; modulation is necessary. Hence the nonlinearity of the conductors and core material is of significance.

For instantaneously propagating potentials and pure longitudinal EM waves, any conceived difference between the two becomes somewhat academic. The characteristic of interest is the instant appearance of the input energy at multiple points via a multiply connected space.

To the ordinary observer, use of a quantum potential and multiply connected space measurably yields a fantastic *energy amplifier.* One furnishes one joule, and gets out — say — 1,000 joules in those distant locations altogether. As shown in Figure 6-4, the QP system is a communication system of enormous implications, particularly as humans travel into space across the solar system and even beyond. Unfortunately, by using appreciable power in the initiating station, the QP system also leads to weapon systems of incredible destructive capabilities. Some five nations {361} now possess such quantum potential weapons, which are the dominant weapons on Earth. We do not further discuss the quantum potential weapons aspects in this book.

Back to our little energy exercise, inputting one joule and getting out some 1,000 joules. Suppose these 1,000 participating points are not distant at all, but are gathered closely together into a local material but still QP-connected with a connection fraction of 1.0. Now we input a joule of energy to that device, and it develops and outputs one kilojoule. It is hypothesized that this becomes the ultimate negative resistor. It will also exhibit separated Dirac hole current phenomena as the COP increases and, if sufficient COP is developed, it will exhibit antigravity effects such as

fields to "lock together" into a common stress potential. Nonlinear mixing (modulation) will. Hence the nonlinear core is required for conversion of appositive fields to stress potentials and L**orentz** regauging.

those shown by the Sweet vacuum triode amplifier discussed in this chapter.

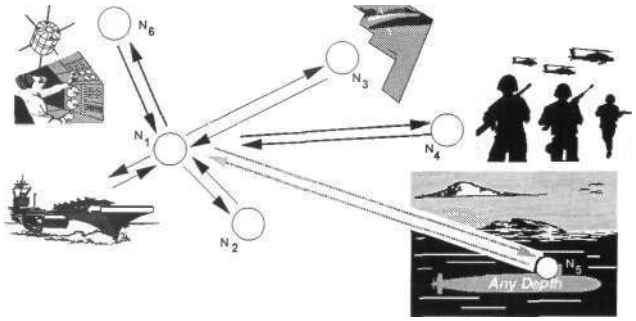

- Quantum potential decomposes per Whittaker 1903 into bidirectional longitudinal EM waves
- Can insert additional longitudinal waves, thus information using a Fogal semiconductor
- Can receive "signal" and discriminate the information using a Fogal semiconductor

Figure 6-4 Quantum potential communication system.

Strangely, overall conservation of energy is not violated by the quantum potential COP>1.0 energy system. It's just that the energy now is furnished from space (from the vacuum) in a *multiply connected* manner. However, all the excess energy is still furnished by the active external environment - i.e., from the time domain, according to the giant negentropy process {12} — though that environment now is quite novel and multiply connected. So we still have a system analogous to a windmill, though *a very novel windmill and a very novel wind indeed.*

Without belaboring the point, action-at-a-distance is absolutely required in quantum mechanics. Further, photon correlation experiments have long demonstrated experimentally that such action-at-a-distance effects do exist, just as predicted. This was a refutation to Einstein's objection to quantum mechanics' "spooky action at a distance".

We point out without further comment that, if a self-powered process is Invoked in the initiating station, then all other participating stations also contain that self-powered process. However, note that one does not really wish to "invoke" a quantum potential connection and use it except occasionally and very quickly! Otherwise, if a strong QP is turned on and **left** on among many distant stations, anything and everything happening to

each one of them can instantly appear in all of them, so long as the "constant of connectivity" remains a constant or nearly so.[160] For that reason, strong quantum potential connections can be self-destroying and strong effects do not seem to normally appear in the physical world.[161] The proper energy use of a quantum potential is thus to use it only for fleeting "inductions" of effects in the desired stations, in *momentarily* multiply connected spacetime, at least until the self-limiting behavior is ascertained.

Apparently, a quantum potential can sometimes be formed in the limit of an iterative, mutually phase conjugating operation of EM signals passed back and forth between two phase conjugate mirrors, or among many of them. Such iterative mutual phase conjugate reflection of signals — particularly pumped signals — is technically known as iterative *self-targeting.* Sometimes we use a more picturesque term, *ping-pong,* for iterative self-targeting.

Conceivably, strongly coupled, strongly pumped optical self-targeting mirrors can — in the extreme limit — initiate or partially initiate a quantum potential. The superposing beams of energy may be thought of as first narrowing to laser-like beams, then gradually subsiding into pure longitudinal waves with transverse components "canceled" to form simply "stress energy". In short, if this reaction occurs, the energy is transformed into a stress energy potential, which acts either as a scalar potential in the Coulomb gauge or as Bohm's quantum potential. In our view, the pure longitudinal wave has infinite velocity, as pointed out by Rodrigues and Lu {93a}, so Lorentz-Fitzgerald contraction results in "zero-separation distance", which in turn results in a multiply-connected spacetime.

One points out that the "input energy" to the initiating station may be deliberately structured internally, including altering the internal Whittaker longitudinal EM wave functions comprising the input electrical field

[160] Fortunately, it appears that this connectivity constant is not really constant, but reduces as the feedback of each station's fluctuations to the other stations increases. The result seems to be a "leveling off process reaching a plateau and a fixed amount of gain in the overall system. In short, the system usually seems to be "self-adjusting" and "self-limiting" as the overall gain increases. Nature is riddled with quantum potentials, but this self-limiting process keeps most so tiny that they are not even noticeable.

[161] However, the validity or invalidity of this statement for some of the highly energetic phenomena of astronomy remains to be determined. It also remains to be determined as far as the quantum potential's role in generating the zero point energy fluctuations of the active vacuum.

energy. In this manner, in theory deliberate spacetime curvature sets and dynamics can be introduced into the distant but multiply connected targets. A form of highly advanced electro-biological warfare induction of disease has been developed by at least one nation (Russia) in this regard, as an extension of Kaznacheyev's experiments showing induction of cellular disease at a distance. It appears that the cells of a living body are interconnected by a very weak quantum potential in such manner. Again, a great deal more research on that possibility is needed.

Given a quantum potential connection between separated objects including our initiating station, one can also add vacuum *engines* (energy structuring of curvatures of spacetime itself) as our input to the initiating node. Those vacuum engines will then simultaneously appear unabated (or only partially abated) in the multiply connected separated objects. In this way, in theory one can use the QP and QP energy to perform highly anomalous *momentary* engineering of nuclides, materials, fields, etc. in widely separated, distant objects and areas. By repeating the momentary engineering "pulses", distant objects and areas can be profoundly altered.

The use of vacuum engines in medical applications is of particular future interest.[162] Very radical extension of those techniques can be achieved once quantum potential technology is developed and available in the open scientific community.

But let us ignore the weapons, free our scientific imagination, and let it roam. As an example, in the future a vacuum engine (spacetime curvature engine) might be developed and utilized in a world-wide quantum potential to *momentarily* strike and eradicate all AIDS viruses on Earth, and do only that. Or, the engine could be slanted to simply *momentarily* slightly change

[162] See Vlail Kaznacheyev and L. P. Mikhailova, *Ultraweak Radiation in Intercellular Interactions,* [in Russian], Novosibirsk, 1981; Vlail Kaznacheyev *et al.,* "Distant intercellular interactions in a system of two tissue cultures," P*sychoenergetic Systems,* 1(3), Mar. 1976, p. 141-142; Vlail Kaznacheyev, "Apparent information transfer between two groups of cells," *Psychoenergetic Systems,* 1(1), Dec. 1974, p. 37. Unfortunately this QP induction of cellular disease has already been used by the former Soviet Union to develop a QP extension of the **force**-free structured potentials method first used to induce cellular disease and **health** changes in U.S. personnel in the former U.S. Embassy in Moscow for several decades. Now QP weapons using such techniques can target the entire population of a targeted nation. Using the internal Whittaker structuring of quantum potentials and EM fields and waves, *electromagnetic biological warfare* has already been born and highly developed. The actual dimensions of possible biological warfare strikes are far greater than has been mentioned in the open literature.

those viruses into an innocuous kind of new virus. The cells of the individual human body are already connected, it appears, by a very weak quantum potential. By connecting an external initiating station to that body's quantum potential, the energy of the body could be directly scanned, all abnormalities noted, and tailored engines created and *momentarily* used to treat the body and correct its abnormalities and malconditions. This, we believe, may well be a medical therapy of the future, a few generations from now. [163]

6.3 Other Systems of Electrical Interest

6.3.1 Russian Parametric Oscillator Power Systems

In leading physics institutes and laboratories in the 1930s, Russian scientists built COP>1.0 parametric oscillators, including some of appreciable size. The work is documented in the literature {362a-k}, both in Russia and in France. The devices were developed and tested in several Russian laboratories. With linear loads, the oscillators would progressively build to self-destruction. With nonlinear loads, the devices would stabilize and power themselves and their loads, at a level depending on conditions — reminiscent of the behavior shown in Figure 4-3 in Chapter 4 for stability COP>1.0 levels for the asymmetrical self-regauging process.

Standard references for parametric oscillation in EM circuits are available. However, with standard practices none of these conventional oscillators produces COP>1.0, primarily because the conventional closed current loop circuit is applied without special modifications. For overunity work, the

[163] Apparently, tests of such QP capabilities in weaponry have been gingerly conducted for direct induction of disease patterns in the population of a targeted nation or area. One symptom of such a test is that a very small number of widely isolated cases of the same disease breaks out simultaneously, in isolated cases scattered widely and puzzlingly throughout the population, *without the possibility of any direct carrier vector connection.* Apparently, the test inductions have deliberately been held mostly to the "shadow state" (or upper virtual state, just below observable state) in most of the targeted populace, to prevent giving away the tests. However, the human immune system and cellular regenerative system do respond to such "near-observable-state" signals and engines, when sustained or repeated in time, by a sort of coherent addition (integration) over time. The bell-shaped distribution curve predicts that a few individuals, randomly scattered throughout the populace, will have quite lower induction thresholds and will evidence the actual disease after a certain time, whereas in almost all the other members of that population the "disease" will never evidence in the observable state during that time. The test is deliberately terminated when only a few observable cases occur, which are sufficient to prove the efficacy of the test and the method.

Russian and French literature (as we referenced) should be meticulously studied and analyzed in a higher group symmetry electrodynamics, to see how the Lorentz condition is broken during discharge of circuit excitation energy in the load, and how the COP>1.0 Dirac hole current decay mechanism is avoided or contained.

The Russian COP>1.0 parametric oscillation work appears to have been suppressed by the Communist regime just prior to WW II. After the war, all such technology passed under the rigid control of the KGB (by whatever name it took and takes from time to time) and into the special weapons research and development area — still highly classified in Russia. We know of no similar work presently ongoing in the West, although at least an English translation of one of the major summary documents of the Russian parametric oscillation COP>1.0 power system developments was performed under NASA auspices {363}. However, in conventional U.S. parametric oscillation research, I know of no case where COP>1.0 operation is being sought, or where the Dirac sea hole current decay mechanism is even mentioned or recognized {364}.

6.3.2 Sweet Vacuum Triode Amplifier

During the 1980s and 1990s, the present author worked —sometimes closely for extended intervals — with inventor Floyd Sweet, the inventor of the Sweet vacuum triode amplifier (VTA). Indeed, we gave the unit its VTA name, at Sweet's request.

Fig. 6-5 (pg. 384) shows a diagrammatic illustration of the fundamental VTA construction. Two coils in quadrature are between two barium ferrite "brick" magnets, of the kind formerly used in many power audio systems. The vertical coil is the "input" signal coil, and the horizontal coil is the "output" power coil. The input consisted of a 33 microwatt 10 volt 60-Hertz signal, and the output was a 120-volt 60-Hertz 500-watt signal. The barium nuclei in the magnets were specially preconditioned by Sweet so that they were in powerful self-oscillation with the surrounding energetic vacuum. A double-edged razor blade or piece of shim stock placed on one of these magnets would oscillate back and forth, incessantly, without cessation — showing that the magnetic field itself was "waving" back and forth (Figure 6-6). It was also continually doing work against air **resistance,** by moving the air.

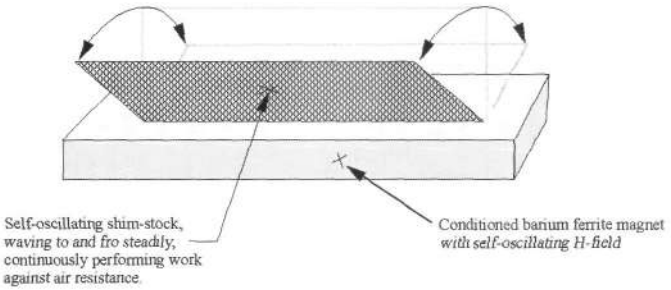

Figure 6-6 Blade waving continuously on Sweet's conditioned barium ferrite magnet.

Sweet had a Master's degree in electrical engineering from a leading university and handled the mathematical theory very well. He had worked at General Electric for many years, and Gabriel Kron was his patron and mentor. Sweet often spoke glowingly of Kron, and I came to believe that Sweet's VTA was probably an outgrowth of, or very similar to, Kron's negative resistor.

- Two activated magnets facing, with fields in self-oscillation.
- Barium ferrite magnets, barium nuclei in self-oscillation
- Barium nuclei self-pumped
- Two coils in quadrature, load is lamps, six watts
- Next unit produced 500 watts output with 330 microwatts input; later made 5 kW VTA

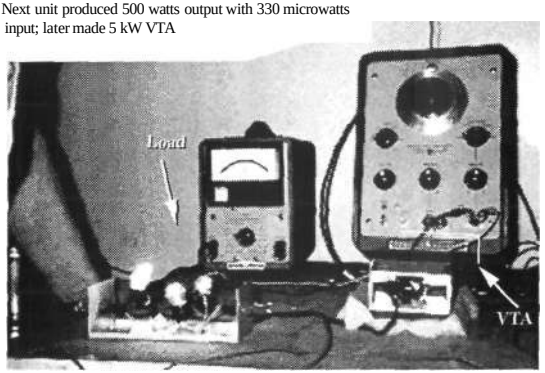

Figure 6-7 First Sweet VTA producing 6 watts output.

When I first met Sweet, his little VTA system was producing a 6-watt output, enough to light four 1.5 watts of auto lamps (Figure 6-7. But there

was no question as to the genuineness of the device. Nothing was hidden, and Sweet allowed me to measure the device at will, disassemble it, play with it, and examine it in any fashion. It was genuine, and not a hoax or trick. I also locked up one of his specially conditioned magnets for 24 hours, with a piece of shim stock sitting on the flat of the magnet and waving to and fro continuously, steadily performing work by moving air. When I opened the lock the next day, the shim stock was still there on the magnet and oscillating, having continuously done work against the air resistance for 24 hours with absolutely no energy input by the operator. And it was still working. Indeed, that single "kinetic" permanent magnet destroys all objections to COP>1.0 EM systems, including those that are self-powering and thus have COP = ∞.

It seems little known that the vacuum around nuclei, in some cases, can be treated as a semiconductor, e.g. as discussed by Prange and Strance {365}. It is also known that nuclei do exhibit resonances at ELF frequencies. In particular, the vacuum in the region close to the nucleus of a superheavy element is known to act in a fashion analogous to the inversion layer in a field effect transistor. Prange and Strance introduce the idea of the inverted vacuum. Just as a semiconductor may be manipulated by subjecting it to external fields, doping etc., it appears that the vacuum can be similarly manipulated by appropriate means. We personally suspect that the semiconducting vacuum can be and is resonantly involved in any ELF resonances of the nucleus, which can occur in lighter nuclei such as barium.[164]

The virtual particle flux of vacuum, regarded as noise, may provide noise amplification of the coherent self-oscillation frequency between the semiconducting vacuum and the barium nucleus. Certainly, analogous noise amplification of signals is known in electrical physics {366}.

[164] Here our concept of the supersystem may be of utility. The "lock-in" or "freeze-framing" of an equilibrium condition for a system — such as in a state of nuclear ELF self-oscillation — is stabilized and made a "new equilibrium condition" when the force field reaction from the curved local spacetime into the system is equal and o**pposite** to the force field reaction from the local active vacuum into the system. We believe Sweet's undisclosed activation process was a method for synchronizing those two force field reactions and making them equal and opposite in one short discharge. We hope that this speculation is of use to future experimenters trying to duplicate Sweet's activation of his magnets into sustained and powerful supersystem self-oscillation.

I hypothesized that Sweet's activation process treated the vacuum surrounding the barium nucleus in such fashion, so that he was able to establish self-oscillation between the local activated vacuum and the concomitantly activated barium nucleus. Since barium ferrite is optically active, it may be that Sweet discovered how to get sufficient "self-pumping gain" for the self-oscillation to endure and not die away in a decaying oscillation manner. Since the "gain" of the second VTA as a self-pumping device was some 1,500,000 (Figure 6-8), obviously Sweet's activation method introduced a powerful state of self-oscillation.[165]

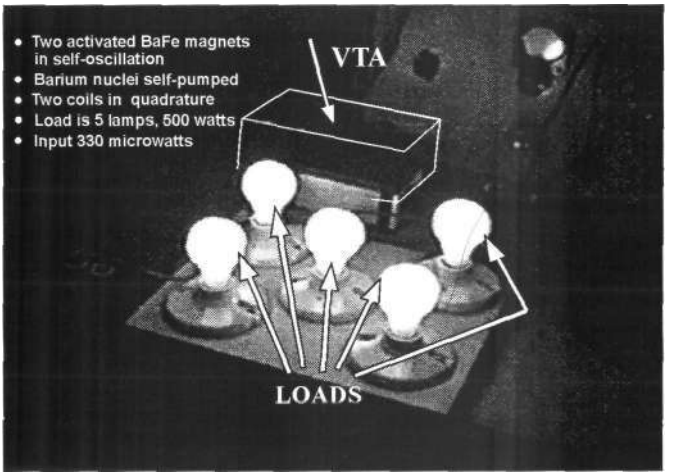

Figure 6-8 Second Sweet VTA producing 500 **watts and COP=1,500,000.**

[165] Here we point out that "small" things with very close "double surfaces" of opposite charge or potential usually have very large fields. The tiny Lamb shift, e.g., has a local energy density greater than the surface energy of the sun. Jackson, *Classical Electrodynamics*, Second Edition, 1975, p. 10-11 points out that *"field strengths of the order of 10^9-10^{15} volts/cm exist at the orbits of electrons in atoms, while the electric field at the edge of a heavy nucleus is of the order of 10^{19} volts/cm."* It should be obvious to the reader that, if our speculation is true and nuclear oscillation of the barium nuclei is involved, the production of optical gains of 1.5 x 10^6 in Sweet's self-pumped, optically acting barium ferrite magnets is not surprising because of the extreme magnitude of the oscillating nuclear fields. In that case, optical gain converts directly to true power gain because the pumping energy is furnished freely by the environment and not by the experimenter.

6.3.2.1 Mapping the Magnetic Field of the Magnets

Figure 6-9 shows a small magnetic field mapping device built by test engineer Rosenthal for Sweet. Sweet "scanned" and mapped the consistency of the magnetic field from his candidate magnets (barium ferrite magnets bought from surplus stores at the time). If the consistency varied over 12 to 15%, the magnet was useless because it would not "hold" the activation and retain it. Magnets whose magnetic field variation did not exceed 10% were ideal. So Sweet only found about 1 in 10 or even 1 in 30 magnets that would retain the self-oscillation state when initiated.

Figure *6-9* Test engineer Rosenthal points to a magnetic field strength mapping device he built for Sweet.

Sweet may have actually used two appreciably higher frequencies in his activation process, with the difference frequency between them being a precise ELF frequency (60-hertz, 100-hertz, 400-hertz, etc. as he desired). That would make sense, when one realizes that the magnet is a highly nonlinear medium and then treats it (to first order) as an isotropic nonlinear medium. In that case, the two wave frequencies actually used would be subject individually to the normal overshoot, breakup, reconstitution, etc. inside the material of the magnet — but the difference frequency would behave as if it were a sine-wave frequency {367}.

This makes sense, since the output wave of Sweet's activated magnet was essentially a pure sine wave. Also, the presence of noise-enhanced heterodyning can sometimes be used to amplify a difference signal even further {368}. As we stated, since the activation is a self-oscillation between the local semiconducting vacuum and the barium nuclei, one wonders whether much of the rest of the vacuum virtual particle flux can

be treated as noise, and whether an effect is obtained for noise amplification of the coherent self-oscillation frequency.

L'vov and Prozorova {369} point out some interesting characteristics of the formation of self-oscillating spin waves which occur above parametric excitation. These oscillations result when internal stability does not occur, and they evidence themselves as oscillations of magnetization. The frequencies of the oscillations usually lie in the range from tens of kilohertz to tens of megahertz. At small above-threshold ratios, the shape of the oscillations is nearly sinusoidal. At larger ratios, the shape differs appreciably from sinusoidal. At still larger ratios, the oscillations become chaotic.

If Sweet did use the "difference frequency" conditioning, one suspects he may thus have been able to utilize larger above-threshold ratios, where the two frequencies actually transmitted would have resulted in chaotic oscillations. It is interesting to speculate that, in that case, for a suitably chosen barium ferrite magnet, the difference frequency still can behave sinusoidally, but now much stronger. If so, that might account for the tremendous COP Sweet attained in his second unit, which exhibited a COP = 1.5×10^6, and could be pushed even higher.

6.3.2.2 Sweet VTA for Closed-Loop Self-Powering Operation

Courtesy of Walter Rosenthal, we now present a visual record of the Sweet closed-loop self-powering version of the VTA and its momentous successful acceptance test on May 1, 1990, as closely observed by Rosenthal.

Figure 6-10 shows Sweet and a different version of the VTA, with the coils in a slightly different configuration and the windings altered. This is the two-magnet, 2-coil VTA that he built and tested for self-powering operation. Figure 6-11 shows the unit mounted on a special test fixture built by engineer Rosenthal. This fixture and its components allowed the sensing of the sine wave output power at the zero-value crossover points. To switch in the special clamped feedback system for self-powering operation of the input, and simultaneously switching away from external power, the switching had to be done very accurately at that zero-point crossover. Feedback would not stabilize and hold if the switching were done at any other point in the output cycle.

Unit independently examined and testing observed by test engineer Walter Rosenthal

Figure 6-10 Sweet with 2-magnet 2 coil VTA, loads, and instruments for historic self-powering operational tests on May 1,1990.

Figure 6-12 shows the set-up for the tests, with the unit and loads as well as some of the instruments used. Figure 6-13 shows the closed-loop VTA powering itself and its loads, after being initially set into operation with outside input power by the operator, and then adroitly switched into self-powering by switching the input from external to internal at an output

Fixture allowed unit to be started into operation on external power then switched to self-powering internal power at the zero crossing of the *output* voltage The device in its fixture has a row of test points (disconnects) on every conductor going to the device

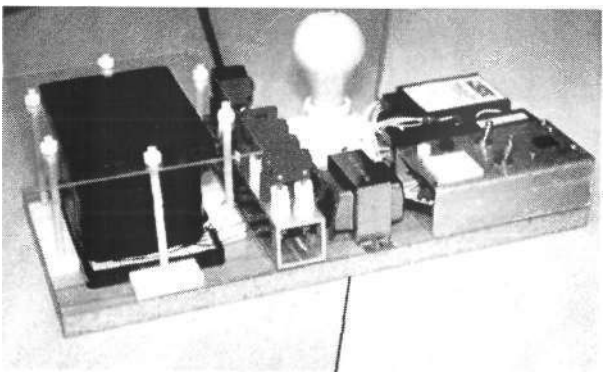

Figure 6-11 Two-magnet two-coil VTA mounted on a special test fixture built by Walter Rosenthal.

power zero crossover point. This picture shows the unit in self-powering and stable operation, taking all its input energy from the vacuum, including the power necessary to power its own internal losses and the power necessary to power its controls and loads.

Independently examined and testing observed by test engineer Walter Rosenthal

Figure 6-12 The 2-magnet, 2 coil VTA, loads, and instruments for its historic self-powering operational tests on May 1,1990.

Formal self-powering test on 1 May 1990 The loads and the VTA are powered by electrical energy extracted directly from the activ e vacuum Independently observed by professional test engineer Walter Rosenthal

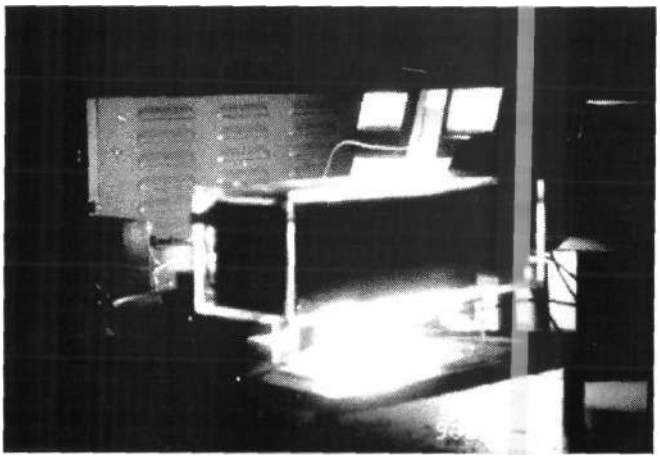

Figure 6-13 Historic self-powering operational test of the VTA May 1,1990 with no energy Input by the operator.

We strongly stress that this operation is permitted by the laws of physics and thermodynamics for an open EM system far from equilibrium in its exchange with its active environment. The active environment in this case is the combination of the active local vacuum and the active local curvatures of spacetime. The closed-loop condition is a new and stable equilibrium condition in the dynamics of the mutual exchanges between all three supersystem components: the system, the active vacuum, and the curvatures of spacetime. The *system* is in stable disequilibrium; the *supersystem* is in a stable new equilibrium condition.

6.3.2.3Discussion

We do know that the output current of the second Sweet device was comprised of a significant Dirac hole current[166] as well as electron current — showing the expected heavy involvement of the altered local vacuum (the Dirac sea) and the curved local spacetime. The negative energy majority of the output revealed itself readily. If the output leads were shorted, ice formed instantly on the shorted leads from the moisture in the air. That is, an electrical short resulted in the sudden production of cold (negative) EM energy rather than positive EM energy.[167] That can only occur if the majority of the output is negative energy, and any sudden surge in output (as from the shorted leads) increases the ratio of negative energy to positive energy so that very strong net cooling results.

For many predominantly mechanical components (simple electrical motors, light bulbs, etc.), Dirac hole current applied to the positive lead will power the circuit equally as well as electron current applied to the high voltage (negative) side, if the grounding is simply by a conductor and not a "vast reservoir" of charge. In such case, the wire chosen to conduct or direct the Dirac hole current should be made very small. It can and will

[166] We do mean hole current in the Dirac sea, consisting of Dirac holes in the vacuum itself, prior to their interaction with charged matter to form lattice holes in matter. We do not mean the standard lattice hole current at all.

[167] In local curved spacetime, Dirac holes constitute "negative energy EM fields and potentials". In such case, one can have negative energy entities and reactions analogous to positive energy entities and reactions in 3-space. On the time axis, one also has negative energy entities and currents, potentials, waves, fields, etc. Because c**lassical** Maxwell-Heaviside-Lorentz theory eliminates any modeling of the local vacuum or the local curvature of spacetime, these negative spacetime curvature **(negative** energy) potentials, fields, and currents have not been added into the electromagnetic theory. That of course is a serious shortcoming of the normal theory.

carry intense hole current and will cool rather than heat.[168] The wire to the electron side of the device should be made normal sized, appropriate to the electron current to be carried.

Several other inventors over the years have been able to activate a barium ferrite magnet into sustained self-oscillation of its material particles or domains, in similar but weaker fashion for varying lengths of time — up to a month or so in the longest time that I am aware of. Sweet's magnet would continue in self-oscillation indefinitely unless (i) the magnet was sharply shocked mechanically (as with a hammer blow), (ii) the magnet was heated to too high a temperature, (iii) the leads of the output circuit were electrically shorted, or (iv) external artificial field interference (electrical pulse shock, particularly from longitudinal stress waves) was encountered.[169,170]

Unfortunately, Sweet signed multiple conflicting agreements with several financial backers, and his work was legally entangled so deeply that it was never straightened. He eventually died, taking with him his activation secret. He was often threatened, and was once fired at by a professional

[168] This is very probably the secret of Tesla's "single wire system". At an exposition in Nevada, Bedini demonstrated just such a system, by powering 600 watts of audio speakers at the end of a long, very thin wire across the stage from his power amplifier. If he had been using positive EM energy, the wire would have instantly melted.

[169] During that period, the Russians were playing with earthquake induction via scalar interferometers, at various places around the world, including inside the U.S. heartland. Sweet's machine would sit above a natural quake and not be affected. But when a quake within many hundreds — even several thousands — of miles was artificially induced, the Sweet device would react to it. A fairly close artificially induced quake would destroy the self-oscillation of the magnets, and sometimes a very close artificially induced quake would actually explode the intensely activated magnets. So for several years one had a way of ascertaining which quakes were natural and which were artificially induced, by simply having Sweet confirm how his magnets interacted.

[170] For those who do not believe such an activity, here is a direct statement by then-Secretary of Defense William Cohen: *"Others are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves... So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...It's real, and that's the reason why we have to intensify our efforts. "* Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, **University of Georgia, Athens, Apr. 28, 1997.**

assassin using a silenced rifle. He survived the incident because, being old and a bit feeble, he stumbled and fell over the front steps just as the assassin fired. The bullet snapped by his ear, right where his head had just been. The incident was reported to the FBI, but with nothing else to go on, the assassin was never caught.

By whatever means, we do know that Sweet's magnets had to be activated by a special process that Sweet used and never fully revealed. An activated or "kinetic" magnet, it seems, was actually something a few of the "older magnetics guys" had known about, and Sweet had learned of it either from them or from Gabriel Kron. Sweet was also a transformer designer and expert, and he remarked that he had also observed specialized self-oscillation in certain transformers. Although most power engineers approached were either nonplussed or completely skeptical of a "self-oscillating field in a permanent magnet", self-oscillation of the fields, spin waves, etc. in permanent magnet materials *are* known to materials scientists today, especially to those working with magnetic effects in thin film materials {370, 371a-b}.

From a general relativity viewpoint, particle spin has a unique spin field of its own {372}, and there are such spin fields involved and operating in magnetic systems. The simple classical electrodynamic approach to magnetism and magnetic assemblies — or the view of a magnet as simply a bar with a north pole and a south pole — is quite insufficient when one wishes to research magnetic assemblies that will act as open systems far from equilibrium with their active environment, and thus will be capable of COP> 1.0 operations.

Recent work in coupled spins has revealed long-range coherence effects, previously unsuspected, as well as dual spin states participating in such phenomena {373a-b}. For example, Johnson has long used a 2-particle approach to spins and spin flipping in his own highly nonlinear magnetic assemblies {374}. His recent laboratory work has also shown similar and unsuspected *long-range coherence* effects in large multiple-magnet macroscopic systems {375} such as large assemblies of neodymium-iron magnets. This is strongly suggestive of the expected general relativistic spin field previously mentioned.

This work by Johnson is very important, since it may reveal a hitherto unsuspected mechanism for decay — of an otherwise nonconservative magnetic field around a closed loop — back into a conservative field. If one seeks an all-permanent-magnet rotating motor, a nonconservative magnetic field around a rotation loop must be established and sustained if

one is to have self-rotation and self-powering. A nonconservative magnetic field around such a rotation loop means that the system acts as an open system far from equilibrium with its active vacuum and active curved spacetime environment, by means of some asymmetry mechanism such as multi-valued magnetic potential {376a-c, 377a-g}, elucidation of exchange forces {378a-c} at selected positions and directions, etc. It also requires both a stable broken 3-symmetry and a stable 4-symmetry.

On the other hand, in our opinion, Sweet employed spin waves triggered into self-oscillation in the nuclei of the barium atoms in his barium ferrite magnets. Indeed, such nuclear spin waves in magnets have been known for some time {379}. We postulate that, as in any other COP>1.0 power system, a self-rotating all-permanent-magnet motor must also involve Dirac sea hole current interacting in the various magnetic components. It is reasonable to suspect that these also interact with the electrons and their spin fields, perhaps producing the active mechanism providing that observed long-range coherence that apparently can decay the nonconservative magnetic field around the rotation loop, causing it to revert back to a conservative field and thereby stop the self-rotation and self-powering. If so, that long-range coherence must be violated and the violation stabilized. However, we could find no papers in the literature that deal with such possibilities. Hence it is a subject for further investigation by COP>1.0 researchers.

6.3.2.4 The Highly Successful Anti-Gravity Test

On one trip to California to work with Sweet, we noticed that, at full power output of 500 watts, his unit weighed a little less on the bench than when not powered. Struck by this anomaly, I considered the negative energy aspects of the output — as evidenced by the Sweet's demonstration of icing when the output leads were shorted — and the very high gain, which added up to a predominance of negative energy in the output.

Pondering this from a general relativity viewpoint, I reasoned that: (i) increase of positive EM energy density in space increases the curvature of spacetime to produce additional positive gravity G_P; (ii) increase of negative EM energy density in space must increase the curvature of spacetime in the other direction, and thus it must produce negative gravity G_N, and (iii) the total gravity G_T produced in the immediate spacetime of an object producing both positive gravity G_P and negative gravity G_N, was $G_T = f(G_P + G_N)$. Thus if we increased the output of the VTA unit, we must inevitably increase the weight reduction (antigravity) effect since the predominance of the energy output was negative energy, and this output was in the neglected negative energy fields aspect as well as in the local

vacuum (spacetime) itself. After several back-of-the-envelope estimates and educated guesses over some weeks, I concluded that if the efficiency of the antigravity process[171] were 10% and the unit was pushed to 1500 watts output, it would lose all its weight and hover weightless.

However, because of the nonlinear local spacetime, magnetic monopoles[172, 173] were deposited in Sweet's magnets when the unit was

[171] We again accent the difference between efficiency and COP. Here we are definitely speaking of efficiency, not COP.

[72] Dr. Robert Flower has confirmed that the 'symmetrized" (or "extended") Maxwell equations (Eqs. 7.1 in Springer's *Encyclopedia of Physics,* Vol. 16, p. 431) include non-zero magnetic charges and magnetic currents. Antenna engineers (Henning Harmuth, and others) know that these terms must be included for proper description of boundary conditions, even though, at the final step of computation, their integrals are set equal to zero (apparently to snuff out magnetic monopoles). For Dirac's original theory of the monopole, see P. A. M. Dirac, "Theory of magnetic monopoles," *Phys. Rev.,* Vol. 74, 1948, p. 817-830. See also F. A. Bais and B. J. Schroers, "Quantisation of Monopoles with Non-abelian Magnetic Charge," *Nuclear Physics B,* Vol. 512, 1998, p. 250-294; G. Lochak, "The Symmetry Between Electricity and Magnetism and the Problem of the Existence of a Magnetic Monopole," in T. W. Barrett and D. M Grimes. [Eds.] *Advanced Electromagnetism: Fundations, Theory, & Applications,* World Scientific, 1995, p. 105-147. Particularly see T. W. Barrett, "On the distinction between fields and their metric: the fundamental difference between specifications concerning medium-independent fields and constitutive specifications concerning relations to the medium in which they exist." *Annales de la Fondation Louis de Broglie,* 14(1), 1989, p. 37-75; — "Electromagnetic Phenomena Not Explained by Maxwell's Equations," in Lakhtakia, A. (ed.): *Essays on the Formal Aspects ofElectromagnetic Theory,* World Scientific, River Edge, NJ, 1993, p. 6-86; — "The Ehrenhaft-Mikhailov effect described as the behavior of a low energy density magnetic monopole-instanton." *Annales de la Fondation Louis de Broglie,* Vol. 19, 1994, p. 291-301. The work of Ehrenhaft, which is now substantiated and thoroughly replicated by Mikhailov, has produced experimental evidence of the magnetic monopole in many replicable experiments. In these experiments, magnetic particles move in a magnetic field along the lines of force. Reversal of the magnetic field, H, causes a reversal of the magnetic particle's motion, which is not the case with magnetic dipoles, since that can only occur for a monopole. See V. F. Mikhailov, "Observation of magnetic monopoles in the field of a line conductor," *J. Phys. A: Math. Gen.,* Vol. 18, 1985, p. L903-L906; — "Observation of the magnetic charge effect in experiments with ferromagnetic aerosols." *Annales de la Fondation Louis de Broglie,* Vol. 12, 1987, p. 491-523. See also M J. Perry, "Magnetic monopoles and the Kaluza-Klein theory," *Am. Inst. Phys. Conf. Proc,* No. 116, 1984, p. 121-125; E. V. Smetanin, "Electromagnetic field in a space with curvature — new solutions," *Soviet Physics Journal,* 25(2), Feb. 1982. p. 107-111. [English translation]. See also T. T. Wu and C. N. Yang, "Dirac monopole without strings: monopole harmonics," *Nuclear Physics,* Vol. B107, 1976,

producing power, and the density of these monopoles varied as the output power. Increasing the power output thus increased the tensile stress of the magnets, and at some point they would explode into fragments, like a hand grenade.[174] This explained why conditioned magnets sometimes exploded when experiencing fluctuations from artificial earthquake induction testing.

Having no explosive control facilities, I warned Sweet not to push the unit past 1,000 watts, for safety reasons. At my urging, Sweet made a new output load often 100-watt lamps in sockets, so the load could be varied from 100 to 1,000 watts easily.

p. 365-380; — "Dirac's monopole without strings: classical Lagrangian theory," *Phys. Rev. D.*, 14(2), July 15, 1976, p. 437-445.

[173] We emphasize that a magnetic monopole can be taken simply as a highly localized magnetic scalar stress potential. See, e.g., P. A. M. Dirac, "Theory of magnetic monopoles," *Phys. Rev.*, Vol. 74, 1948, p. 817-830. Dirac pointed out that the existence of a single magnetic monopole in nature would allow an explanation for charge quantization. We believe that the reverse of Dirac's argument may be true also: The existence of charge quantization should allow an explanation for the magnetic monopole. However, we also surmise that a magnetic monopole exists only in (and as) a sharply localized curvature of spacetime. Jackson, *Classical Electrodynamics*, second edition, 1975, p. had this to say about magnetic dipoles and Dirac's argument: *"Dirac's argument... is that the mere existence of one magnetic monopole in the universe would offer an explanation of the discrete nature of electric charge. Since the quantization of charge is one of the most profound mysteries of the physical world, Dirac's idea has great appeal. "*

[174] Sweet in fact did explode several magnets by pushing the power output of the device. Pushing the output was easy (and is easy for any unit outputting mostly negative energy), because all one had to do was connect additional load.

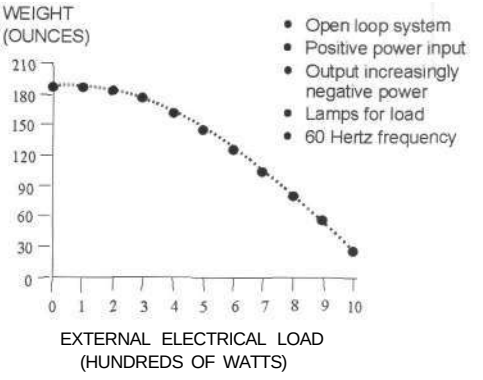

Figure 6-14 Results of the "pushed" VTA antigravity test: Weight of VTA on the bench versus power output.

Sweet completed the new load section and performed the experiment in California after 1 had returned to Huntsville, reading off the results to me over the phone. I took down the data, and then plotted the curve. Figure 6-14) shows the beautiful results. At 1,000 watts the unit had lost 90% of its weight. This was electrifying, because it was an unprecedented and highly successful antigravity experiment. Even my original "rough" assumption of levitation at 1500 watts was not too far from the indicated 1250 watts or so from the actual curve.

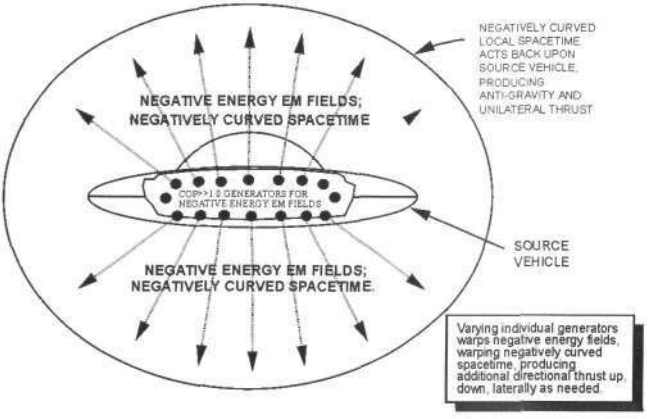

Figure 6-15 Proposed mechanism for practical antigravity.

Figure 6-15 shows my proposed mechanism for antigravity. We simply use negative EM field energy generators to produce a negative EM energy field in space surrounding the source vehicle. The associated positive energy from the same energetic power source can power the vehicle simultaneously. The local reversed curvature of spacetime now interacts back upon the mass of the vehicle, to produce an antigravity component. By adjusting the output of the power source, the amount of negative energy — and hence the amount of antigravity component — can readily be varied and controlled. By controlling the directions of the field components, one can have unidirectional antigravity force, or antigravity and thrust force vectors simultaneously. Hence such a vehicle could be maneuvered and controlled, and be self-powering. This at least was and is my concept of a practical antigravity technology.

6.3.2.5 Later Developments and the End of the VTA

Later I prepared a paper on the VTA, including the antigravity experiment's results. We succeeded in getting the paper published {380} but I deliberately did not include the real details of the negative energy aspects as I wished to withhold that information for patenting. I prepared the entire paper, but placed Sweet's name first, as was appropriate since he was the inventor of the VTA.

Unfortunately — but understandably! — Sweet became a bit paranoid after the sniper assassination attempt (he was shot at by a distant sniper using a silenced rifle), and then would never allow a formal demonstration of his antigravity test. I strongly wished to present it to a major national U.S. scientific committee for independent testing and confirmation — which could have been done without Sweet having to reveal his activation process for the magnets. However, Sweet would not hear of such. Indeed, he fearfully kept the antigravity capability a secret from most of his backers. He strongly believed that he would be killed almost immediately if he revealed our antigravity experimental success. He may have been correct.

In fairness, the inventor and his backers of necessity have different priorities from those of scientists doing open research in a university. But at least a record of the test results is in the literature, though certainly not as rigorously or as extensively as I wished. Sometime later, I withdrew from any further association with the VTA unit, after the backers changed, a lawsuit broke out, and the entire project unraveled. Sweet later died without ever revealing his full secret for such powerful activation of self-oscillation in permanent magnets at low ELF frequencies.

The loss of the Sweet vacuum triode was a severe blow to science and a real setback to the scientific progress that could already have been made. Nonetheless, I contributed what I could, documented what I could, and made a videotape of the operation of the open-loop 500-watt device in the power mode. I also made a video of as much as Sweet would reveal of his activation process. I was not allowed to videotape a second antigravity experiment, even though I frequently and strongly requested it. By that time, Sweet mortally feared for his life. Perhaps what we have written in this book will be sufficient to provide some needed clues to some future graduate student or post-doctoral scientist who will succeed in recovering the necessary activation of magnets and both the COP»1.0 power capability and the antigravity experiments.

Meanwhile, I have filed a provisional patent application on the mechanism for antigravity, the gist of which I worked out solely on my own back in 1971 at Georgia Institute of Technology, and that I include in Chapter 8. As far as I am aware, no one else had thought of it previously, or has thought of it in that exact form *{using the causal positron prior to observation, and while it is still a negative energy, negative mass electron, as the source charge for negative EM field energy, and also using the causal positron's corresponding giant Heaviside nondiverged negative energy flow for substantial negative curvature of spacetime.).*

6.3.3 Intense Discharges in Ionized Gas

Intense sudden discharges in ionized gases are especially of interest due to the presence of optical frequency components and the involvement of iterative optical retroreflection etc. These processes seem to be involved in several investigations and inventions. Further, it appears that such intense discharges do produce bursts of negative EM energy as part of their overall discharge energy.

In the case of plasmas, some are known to transduce an input transverse EM wave into an output longitudinal EM wave, and vice versa. We know now that such a longitudinal EM wave is also accompanied by a time-polarized (scalar) EM wave in the time domain. The connection with the Whittaker 1903 decomposition of the potential, and with the new 4-symmetry negentropy law, is apparent. Several COP>1.0 researchers — notably Shoulders {381a-f} and Paulo and Alexandra Correa {382a-e} — have performed extensive research into anomalous discharge phenomena, and also have developed experimental devices capitalizing on the novel

effects available.[175, 176] The Correas' U.S. Patent No. 5,449,989 includes many tests of a Correa glow discharge apparatus, one of which in 20 minutes of operation produced 0.988 kilowatt-hour of energy output for an input of 0.258 kilowatt hours. Using the known negative resistor characteristics, the Correas achieved sustained self-oscillations in the discharge.

As an aside, we point out that the well-known anti-Stokes emission — which produces more energy output than the experimenter inputs, and hence exhibits COP>1.0 — has long been validated in certain gases such as aniline vapor {383} and H_2 {384}. Stimulated anti-Stokes radiation occurs in many solid materials such as oxides and doped oxides {385}. Assuming the excess energy comes from the internal energy of the molecules, this is a prime candidate for free replenishment of that furnished internal energy of the molecule, via the broken symmetry of the molecular dipoles in their fierce virtual energy exchange with the local active vacuum and local curved spacetime. Of course, conventionally the energy furnished by the molecules, etc. is not replenished from the vacuum, hence anti-Stokes emission can be used for coherent light cooling effects {386}. Apparently the Correas' process accomplishes the energy replenishing, hence the COP> 1.0 performance over a 20 minute period.

Formation of longitudinal EM waves in the plasma forms in certain gas tubes, such as in Priore's gas-filled tubes {387}, may also occur in the Correa experiments and probably do. Longitudinal EM waves, of course, always involve their concomitant, accompanying time-polarized EM waves, since the combination comprises the scalar potential and hence the local curvature of spacetime provided by that scalar potential. The replenishment mechanism involved in longitudinal EM waves and scalar potentials — time-energy transduced into 3-space energy — apparently is

[175] Both Shoulders' electron cluster discharges and the discharge phenomena of Paulo and Alexandra Correa have been independently verified. Fox and other scientists have verified COP>1.0 in Shoulders' work, and Mallove has formally observed a self-powering Correa system. Both these highly reputable scientists are well known, have the highest integrity, and I would trust either of them with my life. Further, we point out that strong gradients — as exist temporarily in strong discharge phenomena — are already known to violate thermodynamics. That is one of the areas being researched today to advance thermodynamics, under the aegis of "extended thermodynamics". See Appendix A.

[176] In addition, the Correas have demonstrated a form of energy that demonstrates latent heat. See discussion in Paragraph 6.3.9.

invoked and utilized in the Correas' sustained self-oscillations in the plasma discharge.

6.3.4 Shoulders' Electron Cluster Processes

Valone {388} has summarized Ken Shoulders' charge clusters and processes as follows:

> *"An unusual energy source is the clustering of electrons by a discharge needle into a high density bundle equaling Avogadro's density of a solid.... Ken Shoulders has patented a process (Pat. #5,153,901) that produces electron clusters with such high energy density, they equal processes exceeding 25,000 degrees Celsius upon impact. Yet, he only uses 20 microjoules to produce the effects. The clusters travel at a maximum of one tenth the speed of light and penetrate any substance with accuracy and sharp precision. It is similar to xenon clustering techniques currently used at megavolt energy levels. Low energy nuclear transmutation of the target has also been achieved with this process. Using a deuterium-loaded palladium foil, only the bombardment areas show transmutation into silicon, calcium, and magnesium with electron clusters upon analysis with X-rays. Jin and Fox {389} have postulated that the high velocity electron clusters achieve results similar to accelerators, including penetration of the nucleus, with substantially less power. The new physics of like-charges clustering in bundles under low power conditions opens a wide range of applications including spacecraft maneuvering microthrusters. Overunity efficiency* [sic: should be COP] *is 9 to 1, or higher."*

Ken Shoulders is an accomplished experimental scientist who has discovered and patented many aspects of electron charge clusters, including their COP>1.0 characteristics {390}.

According to his experiments, one of the most remarkable characteristics of these charge clusters seems to be their dramatic reduction of the permittivity of space {391}. Shoulders has noted the remarkable removal Of **positive** charge during the self-formation process of the clusters {392}. In our opinion, the involvement of the supersystem of these charge clusters is shown by that phenomenon. We hypothesize that an accompanying Dirac hole current is shown by the experimental occasions where — in

addition to the Shoulders' negative charge clusters — additional charges unite but show effects of having opposite charge {393}. Such changes would change the permittivity of space, which Shoulders has noted. They could also create a time-reversal zone (TRZ), which would account for the clustering of like charges since in a TRZ the law of attraction and repulsion of charges is reversed. In such a zone, like charges attract and unlike charges repel. This could explain why Shoulders has observed both negative charge clustering and positive charge clustering.

This would also explain the remarkable separation of the positive charges from the negative charges — they are simply *repelled* by the negative clusters in a TRZ.[177] This of course immediately involves curvature of spacetime effects, including local changes in the speed of light etc. As stressed by Shoulders, the entire area cries out for extensive and sophisticated experimental investigation on a continuing basis, as well as some powerful new theoretical work. Shoulders has also noted both "black" and "white" (dark and bright) clusters, including their combination and separation, strongly suggesting Dirac holes as well as the electrons in the charge clusters. He has proposed a form of "inertial propulsion" based on some of the mechanisms and asymmetrical forces observed in his experiments, and such asymmetry is possible in curved local spacetime conditions.

The relation of Shoulders' effects to cold fusion phenomena was shown by an experiment in which a deuteron-loaded palladium cathode was impacted by a charge cluster {394}. An explosive-like reaction occurred, and an X-ray analysis of the impact crater showed a number of elements not seen in the nearby palladium surface away from the impact site. Elements such as oxygen, calcium, silicon, and magnesium were detected in the impact site, but not in the surrounding palladium lattice. We would suggest the presence of TRZ-based nuclear transmutation reactions (via quasi-nucleus formation followed by quark-flipping in nucleons as the

[177] Since the same TRZ phenomenon generates specific nuclear transmutation reactions at low spatial energy, explaining the anomalous transmutation of elements in cold fusion electrolyte experiments, a strong indication exists that it is a viable mechanism. In our mechanism proposed for the flow of time, a TRZ is produced for charges whenever antiphoton interactions predominate over photon interactions. This indeed implies a change in the permittivity of the local space, local curvature of spacetime, and local changes in the speed of light — all phenomena Shoulders notes in his experiments.

TRZ decays to a time-forward zone). Additional information on this charge cluster phenomenon has been given by Fox {395}.

Other Shoulders patents are pending and his research is continuing. It is our understanding that at least one application is presently being developed for the market.

6.3.5 Mills's Hydrino Energy Cells and Developments

Dr. Randell Mills {396a-396c}, {397} has proposed a cosmic sea of hydrinos (the hydrino is a proposed reduced energy state of the hydrogen atom) to explain his tested energy cells. He envisions — and produces a theory for — hydrogen that is reduced to a lower energy state (the "hydrino"). He has gathered considerable evidence for his theory, and has accounted for some sixty or so infrared spectral lines in the sun's radiation that have previously not been explained. Independent tests appear to have validated his energy production claims.

Several major companies are presently working with Mills and his parent company, BlackLight Power, Inc. Progress can be followed from the company website, www.blacklightpower.com. Developments are ongoing in light, power, plasma, and new compositions of matter. A technical book by Mills {398} is freely downloadable from the website, giving his overall theory, as are other publications by Mills *et al.* {399a-h}. Critical objections to various parts of Mills' theory have been given, e.g., by Zimmerman {400}, with Mills responding strongly and — in our opinion — successfully.

Certain concepts utilized by Mills are, in our opinion, valid and insightful - whether or not the classical quantum mechanics developed by him is found to hold, and whether or not it agrees with ordinary quantum mechanics (which has problems of its own). The point is that *the experiments work.* It is thus the job of the theorists to find what changes must be made to the theory for it to remain consistent with experiment. If they do not like Mills' theory, the proper procedure is to advance one that **is** consistent with all the experimental results, and also to show where Mills' theory is inconsistent with the results.

In our own view, an *observed* positive charge is the output of an ongoing time-reversal process and therefore represents a "time-reversed entity" as observed. Before observation (imposition *of d/dt* operator), the positive c**harge** is thus a negative 4-charge comprised of *qt,* not *q.* From that viewpoint, the H+ ion, which is just a hydrogen nucleus (a proton) without an electron shell, may be regarded as a time-reversed 4-entity prior to observation. Further, any energy change in and of the hydrogen atom

results in a change in the local energy density of spacetime (ST) *a priori*, hence a change in the local ST curvature.

If we regard the entire hydrogen atom as a set of such ST curvatures and their dynamics, then Mills' consideration of a lower positive energy state *hydrino* simply implies the addition of an additional negative ST curvature to the ST curvature set associated with the normal hydrogen atom. We note that binding energy of the nucleons is already negative energy, and thus just such a negative spacetime curvature. But the binding energy is itself a spacetime curvature *capable of being increased*, as can be any spacetime curvature. In the supersystem, addition of such ST curvature is possible, and it is *doable* electrodynamically, particularly when Heaviside's normally unaccounted huge energy component is accounted and utilized.

In our opinion, Mills' theory should probably be recast into a higher group symmetry electrodynamics — such as O(3) — which has been shown to be intimately connected with Sachs's unified field theory. This would provide an adjusted model that is not only testable but also *engineerable.* Nonetheless, the concepts of Mills' theory and the theory should be closely examined as they stand, and at least some of the key concepts are engineerable as witnessed by his successful experimental results. That is better than what the critics have offered! A higher group symmetry recasting would enhance and expand his theory even more, and correct any errors that might be present. It would also allow a full theoretic treatment (i.e., a supersystem treatment) of Mills' main concepts, which we believe have much merit.

Further, given Mills' hydrino as we approached it, two hydrinos will each possess such a set of spacetime curvatures (each will possess such a *vacuum engine).* Later in this book — and elsewhere {401} — we have pointed out that, in a time-reversal zone (TRZ), the law of electromagnetic charge attraction and repulsion is reversed. Accordingly, in a TRZ two or more hydrinos will attract each other so closely that each enters the now-reduced strong force region of the other, forming a quasi-nucleus. As the TRZ decays away back to a normal time-forward zone, because of their power law form the strong forces restore back to normal much faster than the electromagnetic forces do. Hence during its "decay", the quasi-nucleus is energetically compacted into a permanent nucleus, either flipping quarks or giving off one or more particles as necessary to balance its new energy state in the process. We have previously argued that a similar process where a TRZ induces formation of quasi-nuclei also yields the major transmutations {402} demonstrated in a large number of cold fusion experiments worldwide.

The present author has previously proposed an engineerable mechanism (the totality of all photon interactions with a mass) that generates the flow of that mass through time {403}. By manipulating the arrow of time between forward vector and reversed vector, the strong forces in a nucleus (or for a particle) can be directly manipulated in magnitude (and to some extent, even in sign although the latter involves gluon and quark manipulations in the nucleons). By adroit use of these manipulated strong forces and TRZ formation and decay, the energy states of nuclei can indeed be manipulated, including reduced in energy level —just as Mills assumes and presents experimental evidence for, and as cold fusion experiments present experimental evidence for.

We note that two such interacting hydrinos must each possess a specific vacuum engine (specific set of ST curvatures and dynamics). Novel new interactions are available in TRZ's because of manipulation and even reversal of electromagnetic forces, strong forces, etc. and because of nuclear fusion of like charged particles into quasi-nuclei followed by decay into stable nuclei, etc. These novel new particle interactions caused by manipulation of strong spacetime curvature engines and their magnitudes are presently missing from particle physics. Mills, however, does come at them from a somewhat different direction in his own concepts.

The reason for the absence of dominant general relativity effects in most particle physics is that the "total photon interaction" mechanism generating the flow (persistence) of a mass or field through time has not been recognized and used. Consequently, in general only those far weaker ST curvatures due to the weak G-force have been considered. To Mills' great credit, he is aware of the gravitational significance of manipulating much stronger forces and spatial energy densities such as the electromagnetic fields and their energy densities.

The U.S. Patent and Trademark Office then refused a new patent to Mills on one of his processes, and revoked another Mills patent even after already agreeing to award it within two weeks. BlackLight Power, Inc. initiated and lost a lawsuit against the Commissioner of Patents, seeking to reverse this unusual action by the U.S. Patent Office. However, the company's patent portfolio has continued to grow, with extraordinary international applications {404a, 404b}, and several European patents have been filed appropriately. BlackLight Power Inc. seems well funded (some millions of dollars) and well staffed, and we expect to see BlackLight Power, Inc. products entering the market place. Those products will

probably be related to fuel cells, plasmas, power converters, generators, separation methods, and novel compounds materials.

and

6.3.6 Switching Circuits with Extended Electron Gas Relaxation Time

See Figure 6-16. Suppose an instantly applied voltage to the high side of the circuit instantly potentializes a pair of circuit conductors, with the other acting as ground. The charges in the conductor are thus instantly potentialized and excited, so that through the external circuit there exists an E-field E, where $\mathbf{E} = -\nabla\phi$ between the high side of the circuit and the ground return side. An acceleration force on the energized electrons thus exists. It requires a finite time for the energized electrons in this force field E to break their static friction or inertia, move, and accelerate to the requisite slow drift velocity down the wire. During that delay or "electron relaxation time", no current is initially in progress, then a little current is flowing, and finally all of the current is flowing. This delay time is called the electron gas relaxation time.

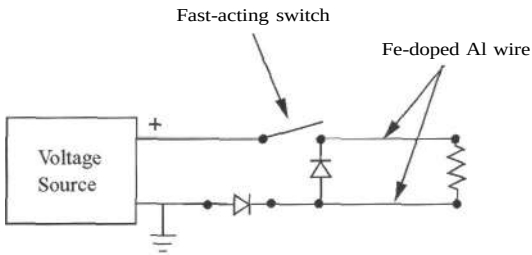

Note: May use many strands of Fe-doped Al wire instead of one, for each conductor

Figure 6-16 Extended-relaxation-time circuit with diodes.

In the usual copper conductor, the delay time arguably may be on the order of 10^{-16} sec. This is so slight a delay that it can be ignored, for all practical purposes. Current — with resulting dissipation of the collected potential energy — usually occurs "as soon as" we apply the voltage, for all practical circuit work. However, suppose we could increase that electron gas relaxation time to, say, one millisecond? Then for an appreciable number of microseconds, there would be essentially no current flowing at all in the now-potentialized circuit.

We previously proposed a mechanism whereby a degenerate semiconductor alloy (say, of a tiny bit — perhaps 2% or so — of iron

alloyed in aluminum wire) is utilized for the conductors of the external circuit. This should give a vastly extended electron relaxation time, somewhere on the order of a millisecond. By obtaining a millisecond, one can excite the circuit with current-free potential alone, which becomes pure regauging during the electron relaxation period.

We strongly point out that this is an asymmetrical regauging; the E-field previously mentioned is present, but the electrons are still frozen in the circuit since their relaxation has not begun. The gauge freedom principle, recognized in quantum field theory, assures us that we do not have to perform work to simply inflow potential energy to change the potential energy of the system. In real circuits, we may have to pay a tiny bit for switching to connect and disconnect the external potentialization source, but we can be at pains to make that very efficient and minimal {405}. The point is, other than minor switching costs, the dramatic change in the potential energy of the system is cost-free and no current is drawn from the external potential source. Hence — in the language of the electrical engineer — we draw no power from the source of potential, during this potentialization time.

Suppose we switch away the excitation source prior to its decay while the electrons are still frozen. Simultaneously, we complete the "freed" potentialized circuit with a strategically placed diode, as shown in Figure 6-16. Again, we pay a little switching cost, but it can be minimized. The electrons in the *now asymmetrically potentialized circuit* are still frozen, so no power has yet been drawn by the system from the external power supply furnishing the voltage only. In this way, pure asymmetrical regauging is used to excite the circuit with additional potential energy, without requiring work (except minimally for switching).

A little more time passes, and suddenly the electrons in the potentialized circuit wake up and move. We stress again that the full emf is acting on the electrons, and now they are finally free to move. There is a net nonzero regauging E-field (force field) also. The excited closed current loop circuit then discharges in normal Lorentz symmetrical fashion, killing the source dipolarity as current is driven back up through the diode, but all the work in the load is "free". The circuit specialist will also recognize the usefulness of additional components associated with the shunt, such as a capacitor or even an LC oscillator for AC work.

If L*E* is load work obtained and *SE* is switch energy utilized, this approach yields COP = *LE / SE* and COP > 1.0 is possible. The reason is that the *primary* source dipole providing the potential for potentialization of the

electrons and regauging of the circuit is removed from the closed current loop circuit and the effect of current through the back emf. Thus the primary source dipole is not destroyed faster than the load is powered. It is only depleted by the small amount of switching energy we utilized. This appears to be a major way to avoid the COP<1.0 limitation of the usual closed current loop circuit.

This is a circuit with legitimate COP>1.0 capability, without violation of the laws of thermodynamics or physics. We break the Lorentz condition between the initial "external circuit" and the primary source dipole for the regauging energy. After regauging, we "cut loose" the circuit with its own primary dipolarity and newly transferred "separate source dipole". *By such adroit use of electron gas relaxation time, we can use one source dipole to freely make another of equal intensity, without any depletion of the first.*

The difficulty is in getting the Fe-Al alloy wire, which must be made in an inert atmosphere since Al corrodes easily and the two elements have very different melting temperatures.

Alternatives can be visualized, such as to utilize a capacitor whose plates are made of the Fe-Al alloy. This might be useful in the triode-capacitor, to be discussed next. A series of pulses might then be used to charge the capacitor, without depletion of the primary source dipole in the external source of potential, if it is repeatedly switched in and away. An interesting question arises if such a capacitor with tailored "hysteresis" in its charging is utilized in various circuits and schemes containing a coil of useful time delay also, particularly since the electron gas relaxation phenomenon involves decaying oscillations. Interesting phase angle results can be constructed in such circuits, but we leave the resolution of this question to future experimenters.

6.3.7 The Triode-Capacitor and Other Curious Components

See Figure 6-17. In this rough concept by the present author, the notion is to implant a grid of very small copper wire mesh inside the dielectric and near one or both of the capacitor plates, and then to utilize grids as if they were grids of a triode tube, for gating and controlling the displacement current in the capacitor and the dielectric strain. As an example, when charging the capacitor, the grids can be used to increase the displacement current (which also increases the voltage on the capacitor and dielectric strain). This increases the charge and energy in the charged capacitor, without putting in as much "enhancement and gating" energy as the extra energy obtained in the charged capacitor. If desired, we can also

incorporate the 2% Fe-doped Al wires in the grid, or connected to it, to further move the grid toward a "pure current-free potential" operation.

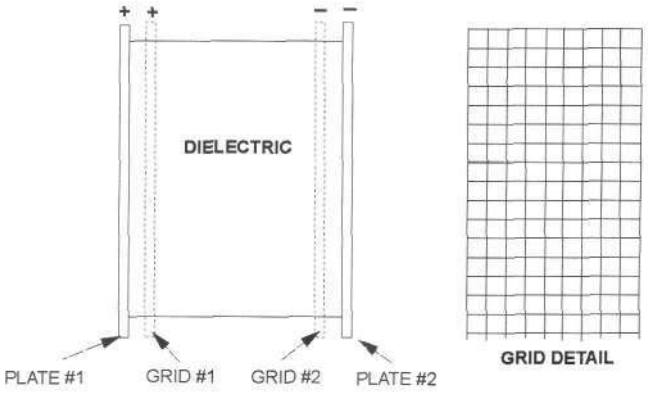

Figure 6-17 The triode-capacitor concept.

The scheme is that a voltage on this grid will intercept only a small current during charging of the capacitor, but can have an appreciable voltage upon it. The charging potential is placed across the capacitor, and simultaneously the grid has a similar potential placed upon it. The external source of charging potential is then disconnected, and the capacitor charges with more energy rearranged in its circuit than the energy one dissipates in the grid. The similarity to an old vacuum tube triode is apparent. For the purist, additional grids with tetrode and pentode functions can also be added.

One or more inventors has unwittingly tried to approach this in one way or another, but have not directly incorporated this schema and have not used the grid. They do not seem to have obtained positive results with those different schemas without the grid, nor have they specified the difficulties and phenomenology encountered, etc. We were curious about possible results of combining this (the triode grid in the capacitor) with the known elimination of capacitor losses by appropriate pulse charging {406a-b}. It seems that experimentation and research with the triode capacitor and its variations is definitely indicated.

We were also curious about the Davis non-inductive resistor {407a}, which is a special kind of "capacitor" that becomes an inductance-free resistor. One may argue that the resistor may be multiply inductive after all, though it is *net* noninductive. It may well be "equally and oppositely

inductive," which is quite a different thing altogether, since it produces an artificial stress potential (and in the presence of AC, it produces a longitudinal EM stress field wave) in spacetime even though it produces a *net* zero reactance. In short, it produces a Lorentz-regauging, directly, and this can be a varying Lorentz regauging producing longitudinal EM stress waves. Whether this odd characteristic can be utilized in a COP>1.0 process remains to be seen. Preliminary indications are that it can be so utilized.

The various versions of the biwound coil, wound with two conductors at once and then the currents passed through the conductors in opposite directions, also presents interesting capabilities. Here again, it is multiply inductive, but may be tuned and adjusted to be *net* noninductive. We strongly suggest comparison with the well-known hairpin dual dipole antenna.

In short, this biwound coil arrangement — with various variations — can produce (and modulate) a magnetostatic scalar stress potential in the local vacuum and, in the case of AC, a longitudinal EM wave. This would appear to be a direct change (and oscillation) of the stress potential of the vacuum itself, which can be decomposed via the Whittaker process into a harmonic set of phase conjugate longitudinal EM wavepairs. The potential longitudinal EM wave communication possibilities can be seen, although one might require a Fogal transistor to receive the longitudinal EM wave modulations of such signals.

Further work in this area of unusual capacitors and components is left to the interested reader for his or her experimentation and research.

6.3.8 A Surprising Thing About Thermodynamics and Reservoirs

Thermodynamically, it is fashionable to state that one cannot take energy from a reservoir at constant temperature. That is true for *equilibrium* conditions, but not for *nonequilibrium* conditions {408}. That is, we cannot take energy from a reservoir *in equilibrium* at constant temperature. We can indeed take energy from a reservoir at constant temperature *but not in equilibrium.* More exactly, we can take energy from a nonhomogeneous reservoir at constant temperature.

We quote Hsu-Chieh Yeh {409} for a vivid statement of this little-recognized fact:

> *"From Planck's statement of the second law of thermodynamics it is generally inferred that it is impossible to construct an engine which produces work at the expense only of heat taken*

from the air or the ocean. ...[It is demonstrated that]... when the air and the ocean are combined as a nonhomogeneous reservoir of uniform temperature, it is possible to construct an engine which produces work by extracting heat from the said reservoir. This does not constitute a violation of the second law of thermodynamics, rather that the "reservoir" in the Planck's statement must be clearly stated as being in equilibrium."

Yeh's article falsifies the general, mistaken inference that Planck's statement of the second law of thermodynamics requires it to be impossible to construct an engine that produces work at the expense only of heat taken from the air or ocean. The experiment described in Yeh's paper demonstrates that when the air and the ocean are combined as a nonhomogeneous reservoir of uniform temperature, it is possible to construct an engine that produces work by extracting heat from the said reservoir. This does not constitute a violation of the second law of thermodynamics, but rather shows that the "reservoir" in Planck's statement may be in equilibrium or disequilibrium, and the statement holds only for the equilibrium case. Also, an entire reservoir can be in "overall" equilibrium, but in raging disequilibrium between various parts of itself. Classical thermodynamics only applies with the reservoir or part of it that is used by the system in its supersystem, when that part is in equilibrium.

We bring this out to show the analogy to our concept of the two additional components of the supersystem as the "reservoir" or external environment of the system itself.

We also point out that the concept of temperature itself is not strictly defined under disequilibrium conditions, as pointed out by Gabriel Laufer {410}.

The proof and a schematic diagram of a machine to do just such an energy extraction process at constant temperature in an environment in disequilibrium are shown by Yeh {408}.

6.J.9 Latent Heat Work of the Correas

In addition to their glow discharge work previously discussed, Paulo and Alexandra Correa have demonstrated a method to optimize some anomalous form of energy from the sun, which transduces into heat, producing an anomalous T_0 - T difference registered in Orgone Accumulators[178] invented by W. Reich in 1939-1940. They have also

[178] This is Reich's terminology, not used in conventional physics. We suspect that proper application of quantum field theory with its four photon polarizations could

employed the optimized difference in this "latent" heat — their term — to drive a low dT Stirling engine of the MM6 type, to perform free work {41 la-b}. The Correas employ their own new theory of the aether {412} to explain the effect.

Against the assertion that this is just normal solar energy warming, they have demonstrated the successful driving of the Stirling engine for several hours during nighttime {413}. With their latest improved version, they report speeds of the Stirling engine of 150 rpm during daytime (with dT values reaching 22.5° C), and speeds of 30 to 80 rpm during nighttime (with dT values of 3.1 to 9° C). There appears to be no obvious standard thermodynamic explanation or standard theory to explain how the anomalous heating occurs — although once it does occur, the explanation from then on is thermodynamically normal.

The Stirling energy is driven on a difference in temperature created between the top plate and bottom plate of a box by this anomalous energy. It is the production of the heat that is anomalous, not the driving of the engine. For comparison, imagine a bank of solar cells that would somehow operate at night, when no normal radiation from the sun was striking them. The Correa effect demonstrates such an anomaly.[179]

Dr. Eugene Mallove, an excellent scientist with impeccable credentials, has personally observed the Correa accumulator system driving the Stirling engine, and has examined it inside and out {414}. Though small, the heat and the motive power are real and the engine is really driven, in the absence of any kind of conventional batteries or other known power source.

be applied to transform the notion of "orgone" energy into specialized EM energy. We further suspect that orgone energy is really the transduction of the time-polarized photon energy into normal photon energy. We are assured by quantum field theory and the giant negentropy solution to the source charge problem that the instantaneous scalar potential involves this process.

[179] We point out that local regions of the sun may well produce Aharonov-Bohm effects, and probably do. Such reactions in the sun would localize some of the B-fields and emit curl-free magnetic vector potential radiation into space, striking the earth. Close examination and analysis of the possible reaction of uncurled A-potential radiation with the accumulator box and plates in the Correa process might yield a novel mechanism for the observed heating (scattering) effects, including the difference between daytime and nighttime levels, periodic variations, etc.

While the Correas utilize some of Reich's orgone and aether terminology, they are quite aware that the energy being converted is not normal transverse EM wave energy. Quoting {415}:

> *"Aetherometry demonstrates that what traverses space is not transverse electromagnetic radiation (and certainly not sensible heat), but longitudinal electric ambipolar radiation emitted from the sun. All that electromagnetic radiation consists of is a local production of photons (for those who care to listen): aether energy is not composed of photons, actual or virtual."*

We can generate sympathy for that statement, although we would still not rule out time-polarized (scalar) photons and longitudinal photons from quantum field theory, each of which is individually nonobservable, but when paired the two comprise an instantaneous scalar potential. As we previously discussed, the classical notion of the EM force fields E and B implicitly assumes interaction of the unseen causal "field-as-it-exists-in-massfree space" with charged mass having been accomplished, with the E and B being the 3-effect of this interaction after observation. Thus these force fields E and B are 3-effects (after interaction and after observation) rather than 4-causes prior to interaction and observation. We suspect that the Correas are trying to get at the causal 4-photon, rather than the usually assumed 3-photon. Further, a virtual photon spends much of its time existing as a dipole comprised of a virtual electron and a virtual positron. Therefore it spends much of its time in the presence of the giant negentropy 4-circulation, involving transduction of time energy into spatial energy and vice versa. It is this negentropy circulation represented by the virtual photon (or accompanying it, whichever one chooses) that the Correas are confronting as the "aether energy".

As previously discussed, an analysis of the Drude electrons in the electron gas of a detector builds a convincing case for EM waves in space existing in longitudinal EM waves, *if the spinning and longitudinally restrained electrons precess and act as gyros.* The detected transverse EM waves are in fact transverse precession waves of the gyro-electrons when perturbed by incoming longitudinal EM waves (longitudinal photons appearing in 3-space from the time-domain's scalar photon couplet). As Feynman put it {416},

> *"We may think of E(x, y, z, t) and B(x, y, z, t) as giving the forces that <u>would be</u> experienced at the time t by a charge located at (x, y, z), <u>with the condition</u> that placing the*

charge there did not disturb the positions or motion of all the other charges responsible for the fields."

The E and B force fields — and transverse photons — are not the form in which EM energy *causally* exists in 4-space prior to its interaction with charged mass. In that causal form, EM energy seems to exist in field-free form, as a direct curvature of spacetime — at least in Sachs's unified field approach. Further, this form may be represented as the causal precursor of longitudinal EM waves accompanied by time-polarized EM waves.

We will not repeat our past discussion of the great necessity to change the very notion of "propagation through 3-space", but that is the issue. In our opinion, the Correas have had to struggle with the use of this causal EM energy as it exists in 4-space prior to interaction with charge and prior to observation. Hence their view is solidly based that the photon does not exist until after the interaction — which in fact has much support once we remove the still-present assumption in classical electrodynamics that a material ether exists.

Our own recommendation is that this anomalous energy should be deeply investigated with the view that all EM energy in 3-space comes from the time-domain and the 3-space aspect is in terms of longitudinal photons, as we have proposed in our solution to the source charge problem previously cited. That is the only way that the nature of the EM wave in vacuum can be reconciled with quantum field theory's findings {19} and with Whittaker's decomposition of the scalar potential {85}, slightly corrected {12}.

Mallove also points out {417} that, if this aether energy view of the Correas has validity, it *"...suggests that physics is not just wrong, it is profoundly wrong — catastrophically wrong about even the most fundamental questions of existence, such as: 1) Is there an energetic aether? and 2) What is the nature of light?"*

We profoundly agree with Mallove's observation, and we believe we have explained the reason why physics is indeed profoundly wrong (widely substitutes effect for cause). Further, classical physics is decidedly wrong about the nature of light — from quantum field theory, experimental proof of superluminal communication, and action-at-a-distance effects.

In our view, the Correas presently have a replicable experiment that, once independently and thoroughly investigated, may force a deeper examination of the foundations of physics. Hopefully, the Correas'

experiment and others like it will finally force the separation of effect from cause, presently so mangled in physics and particularly in electrodynamics.

If the National Academy of Sciences and the National Science Foundation can be convinced of the horrible manglement of cause and effect in physics and especially in electrodynamics, perhaps they may yet wake from their long slumber and get the foundations corrected to eliminate such non sequiturs. If so, we shall have a magnificent new physics as a result.

If not, then the NAS and NSF will continue to profoundly reduce the security of this nation, since several nations have already made and weaponized such corrections to physics to produce what is called "energetics". Further, extraordinarily powerful energetics weapons have **already** been developed and deployed (and even employed), putting the U.S. at a strategic disadvantage because of the continuing reluctance of the NAS and NSF to correct the glaring and extraordinary errors in both physics and electrodynamics — and especially in electrical engineering.

Meanwhile, we believe that the work and experiments of Paulo and Alexandra Correa are at the forefront of capturing and transducing energy from the vacuum, in whatever form one chooses to consider the vacuum energy itself. They are also pointing the way to the corrections and changes necessary in the "old physics" if we are to better understand the world we live in.

6.3.10 Swiss Overunity Converter

We must also include the "Testatika" devices invented by Paul Baumann in **a** religious commune, Methernitha, adjacent to the village of Linden in Switzerland[180]. Figure 6-18 shows one of the machines, which over a period of 20 years were developed in various output sizes up to 30 kilowatts. Once started, the device is self-powering while also powering a very substantial external load (up to 25 kW). Many engineers and scientists have observed the machines in observation, examined them, and measured one or more in operation, so there is little doubt of their **authenticity.**

[180] The website for Methernitha is www.methernitha.com. One may read the statements of the religious group for oneself.

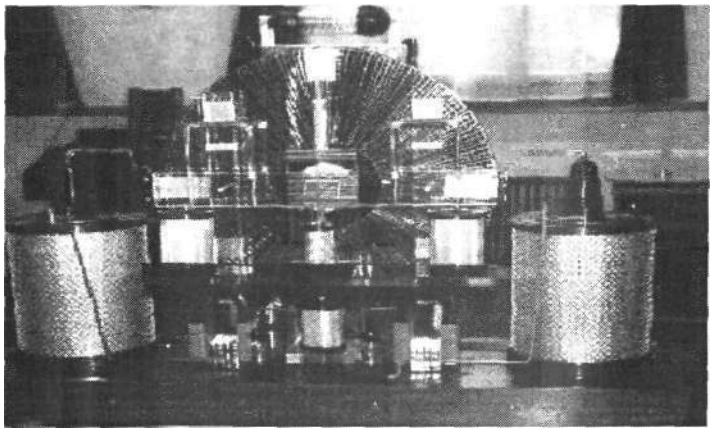

Figure 6-18 Swiss Methemitha machine.

However, there the science stops and mysticism and speculation begin. The religious commune releases no real details, except deliberately tantalizing clues. When questioned, the reply is that humankind in its present state cannot be trusted with such free energy. Almost all those examining the device have thought in ordinary electrical engineering terms, so very little comes from their examination because standard electrical engineering does not contain any theoretical explanation of COP>1.0 electrical power systems whatsoever. Baumann himself sometimes cryptically replied that his study of lightning discharges in nature gave him the operational principle. As we shall see, that may indeed be a very substantial clue as to the possible technical COP>1.0 mechanism, and one that does not exist in conventional classical electrodynamics.

The Methernitha (Baumann) machine resembles a Wimhurst machine with contra rotating static wheels, made of plastic or other insulating material with copper ribs and structures on one side and aluminum on the other. Use is made of the discharge into and from large capacitors and large coils. Also, at least one horseshoe-shaped permanent magnet assembly at the bottom is utilized. The major operating feature seems to be the contra rotating disks of a "Wimhurst" static generator machine, a magnetic field at right angles, and the sharp discharge of high voltage into and from large capacitors and large coils. The voluminous material on the Internet and in articles about the machines is mostly of little real use in contributing understanding or in proposing any legitimate mechanism.

We have not "solved" the machine's mechanism, since that would require close study of the device for a protracted time, and there has been no opportunity or time for that — although Baumann invited this author to come and see the machine some years before he died. Regrettably, I was unable to make the trip, and Baumann himself has now been dead for some years. We will therefore offer some technical suggestions pertaining to mechanisms that may be operating in the machine (or others like it).

First, we call attention to a paper by Aguirregabiria {418}. Quoting:

> *"An ohmic ring that rotates with constant angular velocity in an external uniform magnetic field is considered as a simple model for a current generator. Under the assumption that all quantities vary slowly in time, the lowest-order approximation to the surface charge density is found. The flux of the Poynting vector through the loop surface is also computed. Unlike the examples that are given in textbooks, this flux is not always incoming: It has the outgoing direction around the loop parts where the electrons are moving against electrostatic forces."*

In other words, contrary to textbooks, there are positions where such a ring produces currents in one direction, and positions where it produces current in the other direction — *in fact moving against the voltage and E-field, and thus serving as a true negative resistor in those latter regions.* This may be a profound clue to the negative resistor operation of Baumann's machine.

This unexpected negative resistor effect is in theory usable to provide a true negative resistance. If there are transformers in the machine (and there are in some of them at least), then if a true negative resistor were used as an external shunt across the external circuit connected to the secondary of a transformer, the transformer could be operated as a true COP>1.0 device. The back-field connection from secondary to primary would be reduced by the fraction of the return current to the secondary that is shunted in parallel to that current "pumped" back up through the secondary.

This should be considered as an important possibility in the Baumann machine's operation.

Second, a charging and discharging capacitor involves not only energy flow in a direction perpendicular to the plates, but also an energy flow in a direction parallel to the plates {419}. Each of the rotating "plates" is actually a rotating capacitor of sorts, with a dielectric between two plates

of special construction and dissimilar metals. The dielectric and the plates thus involve a complex intermingling of the negative resistor effect, a positive resistor effect, magnetic energy flows (both in entropic and negentropic manner in various regions), etc.

Baumann once handed two dissimilar plates, with a dielectric between them, to an engineer who measured it and found a startling several hundred volts across the plates! To date, no one is known to have been able to reproduce that effect.[181] We suggest that, if the dielectric material is layered and photorefractive in nature, it may be related to the negative resistors built by Chung {420}. If so, the physical pressure of the plates against the layered dielectric may also be quite important. By varying this pressure, Chung and her team found that their device could be made to exhibit negative resistance, positive resistance, or zero resistance. This leads us to speculate that Baumann may have used a "stressed dielectric" capacitor as a device having a built-in negative resistance. In that case, build-up of such a surprisingly high voltage would indicate high stress locked into the negative resistance dielectric.

We also call attention to a paper by LaPointe {421}, which will be discussed later under inertial propulsion and antigravity. Essentially, true Dirac hole current in the adjacent vacuum/space can be generated by powerful electrical discharges, particularly from capacitors or coils. When the unaccounted Heaviside energy component is also considered as well as the Poynting component, LaPointe's despair at the difficulty of obtaining sufficiently large voltage gradient across a very tiny distance is dispelled.

[181] We are reminded, however, of the peculiar phenomenon that can occur in large power capacitors stored on a warehouse floor. If their leads are not shorted, the capacitors will build up a self-charge gradually, and this can become quite lethal. For that reason, such large capacitors when stored will have their leads shorted, to prevent this "free cumulative charge and energy" from appearing and posing a serious hazard. To our knowledge, there has been no complete scientific explanation advanced for this "self-charging" effect in large storage capacitors. Our own hypothesis is that it is probably an effect of unaccounted Heaviside nondiverged energy flow components associated with various field/charge interactions in the area and with ordinary Poynting EM energy flow in the area, including within the earth itself. Further, with respect to the surface of the earth there is an increase in potential with altitude. Hence from any point above the earth's surface and a point on the surface, there exists a dipolarity and a "Kron open path". The broken symmetry of that dipolarity means that within it a continuous 4-circulation of EM energy flow occurs as well as point-dipole polarization.

If this speculation holds, then in examining lightning strikes and their more bizarre phenomena, Baumann may well have hit upon the fact that such discharges also generate negative energy as well as positive energy, although it appears that the technical concept of negative energy was foreign to him, at least in such terms. In short, he could have been unknowingly charging his large capacitors by Dirac sea hole currents, somewhat similar to Bedini's process.[182] In that case, most of the "negative resistance" operation could be explained by Baumann's transduction of large bursts of negative energy into large bursts of positive charging energy and current in his capacitors.

Or, said another way in terms of Aguirregabiria's effect, Baumann may simply have been charging capacitors in that "negative resistance" Aguirregabiria region where the current does flow backwards against the voltage.

At least we have proposed some known though rare phenomena, which Bedini and my four colleagues and I have discovered in independent efforts. We strongly suggest that the Baumann device may unwittingly incorporate several of these mechanisms, but that neither Baumann nor the other members of Methernitha seem to have any technical notion of them.

With that, we leave it to the interested researcher to perform his or her independent Baumann-type system experiments and build-ups. Eventually, as is always true in science, the experiment must determine the truth of what is really happening. Given the successful experiment, then a model must be contrived or fitted that (i) explains the new effects produced, and (ii) complies with normal EM operation of normal COP<1.0 systems.

6.4 Some Magnetic Processes of Interest

There are some 200 or more magnetic effects in the literature, and only about half of them are well understood. Of the remaining half, some are

[182] Bedini and the present author have filed a patent application upon this exact m**echanism** and process, and typical embodiments for accomplishing it. Bedini discovered the effect and used it for two or more decades, and after some intense struggle with the problem I was able to find the exact technical mechanism, including literature justification. This becomes a system to close-loop a "unitary" **type** of COP>1.0 system, which is covered in the patent application also. A different s**ystem** can be used to close-loop a non-unitary COP>1.0 system, and that method is contained in the second MEG-type patent application of my four colleagues and I who invented the motionless electromagnetic generator (MEG).

partially understood and some are not understood at all. The COP>1.0 researcher interested in magnetic systems would do well to study magnetic materials science {422a-422c}, known magnetic effects, and particularly those magnetic effects that are still anomalous such as in leading edge superconductivity research. The new area of *spintronics* {423}, e.g., is rapidly advancing and will have future impact on COP>1.0 magnetic systems. We do not further discuss spintronics in this book, but merely call this rapidly emerging area to the attention of the interested COP>1.0 researcher.[183]

Let us examine a very few magnetic effects of interest, as a sampling of what we are referring to.

6.4.1 Self-Powered Magnetohydrodynamic Motors

Interesting self-powered magnetohydrodynamic motor work has been shown by Bednarek {424}. He shows a multi-branch rotor in a galvanic cell composed of sulphuric acid electrolyte with copper and zinc electrodes. The unit develops an emf of about 1 volt, with the rotor placed in a vertical magnetic field such as from a large rectangular permanent magnet, where the field of the magnet is a few teslas in strength. The electrolyte and the rotor revolve in opposite directions. To change the direction of revolution of the rotor, the magnetic field direction is reversed. A linear self-powered magnetohydrodynamic motor is also shown, and has a similar principle of operation.

The interesting point is that these motors work, but less efficiently, when a water solution of table salt is used as the electrolyte. With the worldwide availability of seawater, this becomes an interesting possibility of "renewable energy" application. We leave it to the reader to further investigate this proven experimental technology as desired and to determine its practicality.

6.4.2 Multivalued Magnetic Potential

Conventional system designers work with conservative fields, as shown in Figure 6-19. Conservative fields arise from a single-valued potential — a potential that has only one value at each point in 3-space that it occupies. Consider a rolling ball of mass *m* on the "oval track" shown in Figure 6-19, starting from point A and rolling on the right side path. With the ball at

[183] For technical information, see (a) Michael Ziese and Martin J. Thornton, Eds., *Spin Electronics*, Springer-Verlag, 2001; (b) D. D. Awschalon, N. Samarth, and D. Loss, Eds., *Semiconductor Spintronics and Quantum Computation*, Springer-Verlag, 2001.

rest at point A, we give it a slight push to velocity V_i adding kinetic energy $K_i = 1/2\ m(V_i)^2$. At point A, the ball has its maximum potential energy P_A due to gravity.

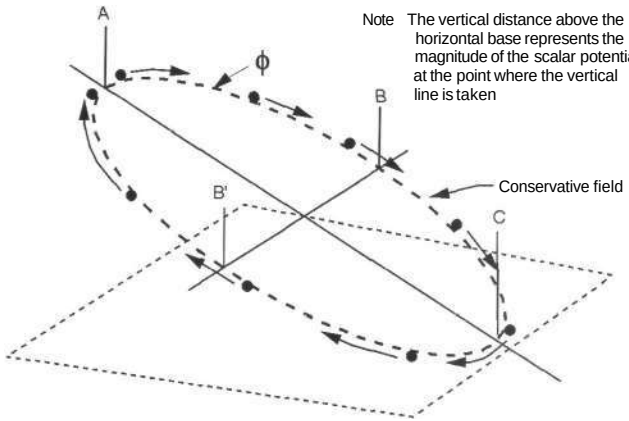

A circular closed path in potential ϕ is given by A-B-C-B'-A
Line integral from A around any closed path back to A is conservative
Along path A-B-C, work W(1) may be extracted from rolling ball
Along path C-B'-A, must do work W(2) on ball, where W(2) = - W(1)

Figure 6-19 Conservative field use (single-valued potential).

As it moves to the right because of our push, the ball will accelerate due to the force of gravity and increase its kinetic energy until it reaches point C at the bottom, reaching its maximum linear velocity Vc and kinetic energy Kc at point C. Its change (PA - Pc) in potential energy at from point A to point C has been converted to kinetic energy $[\frac{1}{2} m(V_1)^2 + \frac{1}{2} mVg^2]$ at point C.

Continuing on around on the left half of the path, as the ball rises toward A again, the portion $(P_A - P_C) = \frac{1}{2} mVg^2$ —of the ball's kinetic energy at C that was added by the force of gravity from A to C — is returned to potential energy P_A. The ball reaches its lowest kinetic energy $\frac{1}{2} m(V_1)^2$ at A and also its lowest velocity V_1. For a perfect lossless system, once started in motion the ball would rotate around the track indefinitely, freely changing potential energy into kinetic energy and then back to potential energy. Nevertheless, it would not do any outside work, for that would represent losses or dissipations of energy from this conservative system. Consequently, the ball would quickly run down if work were being done, even if the system were otherwise "perfect".

If one integrates the change in potential energy around the track, the net change in potential energy is zero. The work done on the ball by increasing gravity to increase the ball's energy in one half-cycle, is taken back from the ball back when it climbs back out into decreasing gravity in the other half cycle. If one integrates the changes in kinetic energy around the track, once the initial velocity and kinetic energy are produced by outside forces in a perfect system, the net change in kinetic energy is zero. Of course, it is easily seen that the ball gains kinetic energy on its downward half of the track, and then returns the kinetic energy on its upward half of the track.

This situation is said to involve a *conservative fields* and the system will not produce any net energy to use as free work. Indeed, a real system will almost always have some friction and other losses around the path {425}, so the ball will gradually lose net initial energy given it, slow down, and eventually come to rest at point C, the lowest potential energy of the system.

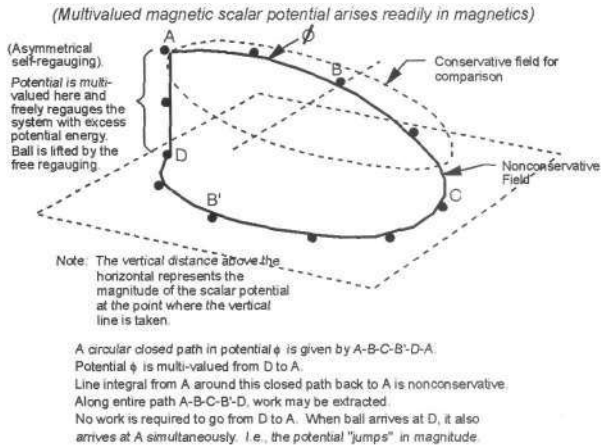

Figure 6-20 Field may be non-conservative for a multivalued potential.

A charge circulated through a closed current loop circuit also moves through a conservative field region in similar manner. Hence, there is no net excess energy input available for such a conventional circuit. It follows that one must arrange for inputting all the input energy (intercepted and collected by the circuit) that is then dissipated from the circuit's loads and losses. Unfortunately, half the collected circuit energy also goes to destroying the dipole, with less than half powering the load. Therefore, that circuit always exhibits COP<1.0.

Now see Figure 6-20, where we provide an analogy using a rolling ball around a circular track, in a gravitational potential. In this case, the potential has a multiple magnitude A and D at point A-D, which is the same point (we plot a point in the potential's magnitude, not a point in 3-space, although there can be close approximation).

Approaching magnitude D from point B', the value of the potential is steadily reducing and is much lower prior to reaching A-D than it was when leaving magnitude A. During this phase, the ball is gaining kinetic energy from the gravitational potential, and can be used to perform useful work (up to all the energy gained, in a perfect system). Upon passing through point A-D, instantly the ball is again at point A on the right. We accent that the "instantaneous jump" on the diagram represents a free insertion of excess energy (asymmetric regauging energy) from outside the system. Rigorously that is a broken symmetry, which also breaks the internal energy conservation of the system. In short, the "ball" has been instantly "lifted" (in this simplified analogy) back to a higher potential by a free insertion of excess energy from the external environment. The main point is that a surge of potential energy into the "ball system" occurred, freely input by nature and the environment. The system can now go through the "doing work" routine again, traversing from A back to D and through it.

Note that this is a nonconservative system, because it continually receives a free and sudden input of excess energy from its environment. So this system — because of its broken symmetry — can continually do work and keep on going.

Indeed, so long as that free energy input from the environment occurs without fail, this is a "self-powering" system, completely complying with **the** laws of physics and thermodynamics. It violates the equilibrium thermodynamics because the system is periodically not in equilibrium with its environment. Consequently, the system can exhibit those five magic functions we spoke about previously. It can exhibit (i) self-organizing (in this case, freely getting that little ball from low potential energy D back to high potential energy A), (ii) self-oscillation or self-rotation (the ball will continue to go around and around the loop, even doing a little work in the process), (iii) output more energy than the operator inputs (in this case, the operator is not inputting any energy at all, so the energy output is indeed more than the operator furnishes), (iv) power itself and its load simultaneously (all the energy is being input from the external environment at the insertion of excess energy at point D to move the ball **back** to position A), and (v) exhibit negentropy.

This is an analogy to a nonconservative field and a multi-valued potential. In the case where a potential has discontinuous values at a single point, with the value depending upon whether the detecting charge (the "ball", so to speak) is to the left or to the right of that point, one has a *multivalued potential.* This multivalued potential actually represents a change of potential energy in the system, freely occurring without operator input. In short, it is an asymmetrical self-regauging, violating Lorentz's symmetrical regauging condition.

Actually, multivalued *magnetic* potentials arise naturally in magnetics theory, but —foolishly, in our view — theoreticians do all in their power to minimize or eliminate their consideration {426a-k}. They consider such a nonlinear change as being embarrassing and troublesome, and to be gotten rid of at all costs! However, if deliberately used and optimized, rather than eliminated, incorporating a multivalued magnetic potential can provide a *nonconservative magnetic field* (analogous to the illustration), where $\int \mathbf{F} \bullet \mathbf{ds} \neq 0$ around a rotary permanent magnet loop. The multivalued potential represents a broken symmetry that further produces a nonconservative field.[184] In theory, such use of the multivalued potential and the resulting nonconservative field can enable a "self-powering" permanent magnet rotary engine, operating as a negative resistor freely extracting and using magnetic energy from the broken symmetry in the system's energetic exchange with the active vacuum.

However, note that the multivalued potential represents a point of sharp "self-regauging asymmetrically" by the circuit, with the regauging potential energy coming from the external environment. It requires that some external process in the exchange between environment and system must be automatically invoked at the multiple-value point, so that there is a sharp and sudden entry of excess potential energy received by the circulating ball (or by the circulating charges in an electrical circuit, or by the circulating flux in a magnetic circuit).

One such means of evoking such a sudden surge of excess energy at a point, momentarily, is given by Lenz's law, as discussed in the magnetic Wankel engine. Another means is by Johnson's sudden evocation of the

[184] In physics, the appearance of a force and its subsequent action to perform work is nature's way of restoring symmetry to a situation where symmetry has been violated. As can be seen, the net force can be used to translate something (such as current) and do work, thereby dissipating the excess potential energy received from the broken symmetry condition.

exchange force, which momentarily can produce a pulse of energy density even several hundred times as strong as the usual field energy at that point. For example, imagine that the ball in Figure 6-20 represents a magnetic rotor in a magnetic potential represented by the height of the ball above the dotted line base. The point (D-A) then represents the results of the system having suddenly injected an instantaneous exchange force at point D, to freely increase the potential and potential energy of the rotor system back to point A. The rotor is immediately lifted back at its starting potential energy situation at point A, freely, by this sudden and free evocation of the exchange force. We will briefly discuss the exchange force in our discussion of the Johnson engine.

6.4.3 Dromgoole Effect as an Example of a Novel Magnetic Effect

An example of a novel magnetic effect is the *Dromgoole effect* {427}. This is an interesting phenomenon where a voltage placed on a solenoid wrapped around a longitudinally magnetized iron wire may be increased up to 300 times in magnitude by twisting the wire through 90 degrees. If a scheme can be worked out whereby this dramatic increase in voltage potentializes and moves very substantial current, then perhaps the extra output can — at least momentarily — produce more output energy than the work required to twist the wire.[185] At least that could be a working hypothesis from which to launch experiments to see if it is possible.

The reason this may be possible is that any amount of energy W one wishes can in theory be collected from any finite potential intensity ϕ, according to the simple equation $W = \phi q$, where q is the collecting charge exposed to and interacting with the potential intensity ϕ. In the case of magnetics, q is analogous to the pole (magnetic charge), where the north pole is positive magnetic charge. The ϕ then becomes the magnetostatic scalar potential.

So if we can produce ϕ with only a little expenditure of energy, and then have that ϕ potentialize a very large amount of charge q, we can collect upon the charge q much more energy than what we ourselves expended. The ϕ produced is a change to the local vacuum potential, and hence the collection of energy W on charges q is actually a collection of EM energy from the local altered vacuum potential itself. Any potential we make

[185] The scheme must prevent *at least an appreciable fraction* of the spent electrons- from the external circuit and load — from being forcibly rammed back up through the coil against its back EMF. Otherwise the Lorentz symmetry condition a**pplies** and the arrangement will not produce COP>1.0.

becomes a change to the local vacuum potential, and hence a change to the local active vacuum. That does not seem to appear in electrical engineering, which model does not even incorporate modeling the active vacuum or its potential, much less a change to it.

While we discuss a few interesting magnetic effects in this paper, there are many more. The interested researcher is referred to such easier sources as Burke {428} and Cullity {429}. For more complex scientific sources and explanations, other publications are available {430a-430r}. In addition, it is helpful if the researcher is aware of some of the foundations problems in physics and electromagnetics {431a-431e}. Our point is that there are more than 200 known effects in magnetics, and only about half of them are well understood. For the other half, the understanding ranges from "partially understood" to "not understood at all." The latter half of the magnetic effects provides a rich ground for investigation by researchers seeking an asymmetrical self-regauging mechanism.

The COP>1.0 researcher must be prepared for an extended self-education period, and appreciable study and work. Some research discipline is highly recommended, such as starting one's own database and rigorously maintaining it up to date with one's latest interests. For the experimenter, a good lab notebook, meticulously kept and regularly posted, is an absolute necessity. Reading and searching the scientific literature is also highly recommended. It is not as simple as applying the principles one learned in university or technical school. Those techniques and principles are involved, but at some point in the circuit they must also be violated. Else COP>1.0 systems would long ago have been developed and marketed by sharp young students, graduate students, and post-doctoral scientists.

6.4.4 Exchange Force and Johnson's Approach

Refer again to our discussion of conservative versus nonconservative fields, above.

If one wishes to build a self-powering rotary permanent magnet motor, obviously one must evoke a condition whereby $\int \mathbf{F} \bullet \mathbf{dl} \neq 0$ around a single full rotation of the rotor (and where F is the instantaneous magnetic force between stator and rotor). For permanent magnets without any external switching, etc., that condition can only arise if an excess force is freely triggered by changes occurring freely in the magnetic materials themselves.

Fortunately, magnetic materials are almost always highly nonlinear, and **so** such self-triggering opportunities abound. They can occur because there are a multiplicity of mechanisms (dozens and dozens) going on

simultaneously in the materials of the magnets of both the rotor and the stator, and not just the standard polarity and field repulsion and attraction that electrical engineers use. These materials processes also involve direct and ongoing exchange of energy between the active vacuum and the local materials in the magnet.

The trick is to take one of these automatically ongoing processes that is already there and freely available but just not adroitly used, and deliberately evoke and enhance it to induce excess energy at the appropriate time, with a force in the appropriate direction. In simple terms, if you have eight more horses available to put into the harness to pull the load, and you only have two normal horses but wish to pull more load, then by all means you should hitch up and use at least one more additional horse, and take him from the six that are usually just standing by and not working at all. They may run back and forth a bit, while watching the others work, but that of itself contributes nothing.

One such additional force and free regauging mechanism always available is the exchange force, which can be checked in Feynman's three volumes of physics {433} and also in the reference by Cullity {429} previously cited. Good science dictionaries {432} also include helpful information. Reading the literature will add enormously to one' data base of effects and methods.

Howard Johnson's approach is to arrange highly nonlinear assemblies of geometrically asymmetrical magnets into complex configurations. At certain points in a magnetic field, these Johnson assemblies will trigger the sudden brief self-generation (actually a sudden release) *of exchange force* between stator and rotor. The exchange force is a known phenomenon {432, 433, 434}, though still not completely understood theoretically. It can be evoked asymmetrically by evoking electron-spin flipping, for example, which has led to the development of a new field of technology, spintronics. *Microscopically*, the exchange energy is much greater than the magnetic field energy, sometimes by a factor of 10^3 to 10^4 {435, 436}. *Macroscopically*, the resulting exchange energy can momentarily still be many times the magnitude of the ordinary magnetic field energy; e.g., by a factor of 200, which Johnson often achieves.

If the stimulated momentary exchange forces are oriented to always add to the thrust upon the rotor in the "powering rotation" direction, then the multivalued potential condition and $\int \mathbf{F} \bullet d\mathbf{l} \neq 0$ are met. In that case, self-powering is permitted, if enough of these exchange force triggerings occur

so that the extra potential energy added to the rotor is sufficient to overcome the load and the losses being powered.

The self-triggering of each exchange force appearance produces an excess burst of force and energy[186] input into the system from its active supersystem environment. Thus, repeatedly the system is momentarily converted (in each exchange force burst) into an open system in disequilibrium in its energy exchange with its active environment, freely receiving excess energy from it. Because the exchange force "input energy burst" is short, multiple such "input bursts" must be used in a single rotation cycle so that the total energy input by all of them is significant.

In that case, COP>1.0 performance is permitted by the laws of physics, thermodynamics, and nature. Conservation of energy is not violated. Classical equilibrium thermodynamics with its infamous second law does not apply to the Johnson system, since the system is periodically an open system far from equilibrium and receiving excess energy from its active environmental exchange. *A priori* the Johnson system has increased its negentropy overall, and that negentropy (increased order or increased potential energy) can then be dissipated (disordered) to produce free shaft horsepower if the bursts of exchange force are properly coherent in direction and timing.

We diverge for a moment: As is well known, the equilibrium condition in a system is the condition of maximum entropy in the system; any disequilibrium condition reduces the entropy *a priori* because it is an excited state of the system containing additional potential energy. It is worth rigorously clarifying the infamous second law of thermodynamics. Quoting Lindsay and Margenau {437}:

> *"[The]...statement of the second law: (a) the entropy... is a variable of state, (b) Its value, for a closed system, can never decrease."*
>
> *... "Non-equilibrium conditions cannot be specified by variables of state, and their entropy cannot be computed. ...the condition of equilibrium is the condition of maximum entropy."*

[186] Technically speaking, the exchange force is not a magnetic field force, but a force that arises independently due to quantum mechanical considerations. Nonetheless, it is a real force arising in magnetic materials and affecting magnetic materials, as in permanent magnets.

In the first statement, the reader should note the assumption of a closed system in the first subparagraph, and the absolute requirement that the calculated entropy be a variable of state.

Also, the quotation can be falsified. Oddly, the "closed system" in classical thermodynamics is defined (illogically) as a system that does not exchange mass across its boundary, but may and often does exchange energy across it. We negate any absoluteness of that statement by Lindsay and Margenau by citing a counter example of a "closed" system with continuously increasing energy, fed by transfer of energy from the environment, and with no escape of the energy or very little escape of it. A specific example is a photon absorption by a mass particle. This system achieves increasing energy (order) as the process continues, hence achieves negentropy. This may be considered a fluctuation, of course, but it still places severe limitations on this law of thermodynamics and in fact negates any absoluteness of it. For such reasons, in this book we have redefined "closed system" as one that exchanges neither energy nor mass with its environment, and we recognize that there are no such systems in the universe. We have defined an "open system" as a system that exchanges either energy or mass or both across its boundary, so that we do not encounter the problem of the counter example cited. Further, general relativity requires an increase in the mass of any system that increases its potential energy, and a decrease in the mass of any system that decreases its potential energy. Hence energy exchange at all with the system, involves mass exchange since mass and energy are the same thing. The classical thermodynamic definition of a "closed system" has thus been falsified since 1915, with the definition becoming only an approximation rather than a generally valid definition.

In the second subparagraph of that first statement by Lindsay and Margenau, the reader should note that the closed-system assumption must be violated *a priori* if the entropy does decrease, and vice versa. If the system is broken into a set of subsystems, then the only way the entropy of the overall closed system to decrease is for one or more of the subsystems to be open (new definition!) and energy (order) to pass out of the system. Then an interesting thing emerges: For order (energy) to remain in the system as such, the subsystems taken as a whole must produce as much negentropy as they do entropy. Energy from an ordered subsystem can be emitted in disordered form, but then it has opened that subsystem and has entered the space between parts (subsystems) of the overall system. In other words, in a closed system, *any increase in entropy requires the subsystems to become open subsystems.* Again, the statement of this law of

thermodynamics eats itself. To stay in the overall system, this scattered energy *outside the subsystems* must then interact totally with another part of the system, and so on. This introduces disorder to the succeeding parts that interact. Therefore, the second law of thermodynamics itself *internally* violates its own "closed system" assumption because, to operate at all, the law requires continuing interaction between the active local vacuum environments and the subsystem components. In short, it requires a very special kind of overall or average equilibrium in an unavoidable energy exchange between the local vacuum and all the parts of the system. The source charge problem already demonstrates the universal violation of the second law and the thermodynamic definition of "open system", but both classical electrodynamics and classical thermodynamics have ignored this source charge problem for more than a century. Our solution to it was published in 2000.

Quite simply, there is no such thing as a truly closed system in the first place. Kondepudi and Prigogine come close to this statement in the following quotation[187]:

> *'Anyway, equilibrum thermodynamics covers only a small fraction of our everyday experience. We now understand that we cannot describe Nature around us without an appeal to nonequilibrium situations. The biosphere is maintained in nonequilibrium through the flow of energy coming from the sun, and this flow is itself the result of the nonequilibrium situation of our present state in the universe."*

In short, all systems on the planet — and we ourselves — are immersed in a nonequilibrium state a priori. Rigorously there is no such thing as an absolute equilibrium state on the planet, except as an approximation.

Now consider a perfectly insulated system, so that no heat can pass from the system outside it. An interesting constraint then exists on those "open subsystems" producing disorder (entropy). Unless equal reordering occurs in the subsystem-to-subsystem reactions, then disordering (heat) grows a priori. But this is not observed to happen in well-insulated systems approximating our theoretically perfect example! Otherwise, the temperature of a well-insulated system would increase until system rupture and failure. And experimentally that does not happen.

[187] Dilip Kondepudi and Ilya Prigogine, *Modern Thermodynamics: From Heat Engines to Dissipative Structures*, Wiley, 1998, p. xii.

It follows that, to maintain the internal equilibrium between subsystems and a constant internal temperature, a negentropic process is clandestinely involved. We submit that this process is revealed in our discovery of giant negentropy of the negative charge, and what may be said to be the giant entropy of the positive charge — i.e., in the discovery of the common " 4-circulation" of energy surrounding a dipole from the time domain to the negative charge of a point dipole in 3-space (thereby entering 3-space once emitted by the negative charge), thence to the positive charge of the point dipole, and thence back to the time domain. For a single charge, the well-known vacuum polarization provides virtual charges of opposite sign, to convert the "isolated charge" into a set of composite dipoles, as previously explained.

The second law of classical thermodynamics, considered in a more modern light, appears to conceal hidden giant negentropy and hidden giant entropy, in the ongoing 4-circulation of EM energy in the supersystem. *It is not possible to eliminate the supersystem or the interchange between its parts; particle physics told us in 1957 that there is no equilibrium of any system without this ongoing exchange.* Any thermodynamics attempting to discard the supersystem exchange (which involved both mass and energy) is at best an approximation for special "reasonably well-behaved" situations.

If the entire system is not in net equilibrium with the external environment (i.e., if there exists disequilibrium between the separated parts of the supersystem), then classical thermodynamics does not *absolutely* apply to that system. The system is no longer *absolutely* describable by "variables of state".

Those objecting to COP>1.0 in an EM system on the grounds that it would violate the second law of thermodynamics (which already violates itself), would be well-advised to restudy the very notion of the second law and the thermodynamics definition of *open system.* Compare relativity's equating mass as energy. Then ponder the thermodynamics of open systems far from equilibrium with their active environment. Every system in the universe is open, and it has an ongoing exchange with its proven active environment (local active vacuum and curved spacetime). This exchange Includes and exchange with every particle in the system. As pointed out by Lee: [188]

[188] T. D. Lee, *Symmetries, Asymmetries, and the World of Particles,* U. Wash. Press, Seattle, 1988, p. 46-47.

> *"...symmetry implies conservation. Since our entire edifice of interactions is built on symmetry assumptions, there should be as a result a large number of conservation laws. The only trouble is that almost all of these conservation laws have been violated experimentally. "... "...this difficulty could be resolved by introducing a new element, the vacuum. Instead of saying that the symmetry of all matter is being violated, we suggest that all conservation laws must take both matter and vacuum into account. If we include matter together with vacuum, then an overall symmetry could be restored."*

The *system itself is* always in disequilibrium; only the supersystem can exhibit equilibrium. The second law of thermodynamics specifically does not and cannot apply to a system far from equilibrium, because of its implicit assumption of overall equilibrium without the active vacuum exchange. Also, a deeper balance is required between the hidden asymmetries existing between the subsystems and their local vacuum (and local spacetime curvature.

Indeed, *one cannot even calculate* the entropy for a system that — overall — is far from net equilibrium with its active environment. We quote Lindsay and Margenau even more strongly {438}:

> *"Equilibrium states are the only ones that are capable of explicit analysis in thermodynamics... "*

And again {439}:

> *"... variables of state have meaning only if they define an equilibrium state. Hence the quantity we are seeking will be meaningless unless it refers to equilibrium states. "*

While we are at it, let us also address a serious flaw in the first law of thermodynamics. We again use Lindsay and Margenau for a succinct statement of the First Law {440}:

> *"First law of thermodynamics. A complete statement of the first law comprises two assertions: (a) heat is a form of energy, (b) Energy is conserved. "*

All that really says is that energy is conserved. It does not state that it is conserved in an object. It states that, whether the system is in equilibrium or not, energy is conserved. If heat is taken as disordered energy, then it

merely states that overall the energy is conserved, whether ordered or disordered with respect to some ordering criterion. It does not state that the disordering is conserved, and it does not state that disordering must increase or decrease. But *it does implicitly assume that all energy at some most basic level is ordered, else it cannot be energy (order).* So it assumes that, at higher levels, energy can be disordered (incoherent). However, at the underlying basic level, it is and remains perfectly ordered — else it could not remain "energy and could not be conserved. As an EM example, in so-called "heat", *every scattered photon retains its perfect order; it is only the photon ensemble that is "disordered".*

In short, each "basic piece" of energy is perfectly ordered, but the *ensemble* of the pieces may be disordered. Therefore, entropy applies only at a level higher than the basic energy quantum. Contrary to the assumptions of classical (macroscopic) thermodynamics, processes which directly engineer the basic energy quanta[189] — more exactly, the *action* quanta, consisting of *energy x time,* since energy cannot be "engineered" or changed in 3-space without also being engineered "in time" as well — are time-reversible. Hence they can be negentropic — simply because every observable system is "open" to, and in continuous energy exchange with, its active time environment (and also its active vacuum environment). Also, no system changes its spatial energy in any fashion, including ordering or disordering, without interacting with spacetime and spacetime curvature dynamics. It also changes its time-energy.

So in our view the notion of "disordering" and "disordering of energy" must be carefully reconsidered, as to exactly what is and is not being disordered, when the assumed "disordering" occurs, at what level it occurs, where and how the compensating reordering occurs, etc. We also point out that the simple discovery of giant negentropy {12} as the solution to the long-vexing source charge problem already removes the "absoluteness" of classical thermodynamics. Giant negentropy already violates the assumptions of classical thermodynamics at the elemental level in every physical system. Indeed, every charge in the universe already falsifies any "absoluteness" of the assumptions of classical thermodynamics.

This problem in the old classical thermodynamics has long been indirectly solved in particle physics, with the discovery of broken symmetry. As Lee states so clearly {441},

[189] Actually, energy is discretized, not quantized. Energy x time (i.e., *action)* is **quantized.**

> *"As we expand our observation, we extend our concepts. Thus the simple symmetries that once seemed self-evident are no longer taken for granted. Out of studies of different kinds of interactions we are learning that symmetry in nature is some complex mixture of changing plus into minus, running time backward and turning things inside out."*

We point out that a symmetry involves a conservation law, such as are stated in classical thermodynamics, and a broken symmetry involves a broken conservation law. So the discovery of broken symmetry in physics was a profound change affecting all physics, including the staid old classical thermodynamics. Lee further points out the new complexity of concepts {442} such as symmetry (which is behind every conservation law, including the first law of thermodynamics):

> *"At present, it appears that physical laws are not symmetrical with respect to C, P, T, CP, PT and C. Nevertheless, all indications are that the joint action of CPT (i.e., particle <-> antiparticle, right <-> left and past <-> future) remains a good symmetry."*

So unless the first law is stated in terms of modern CPT symmetry, it does not absolutely apply! Further, every charge is changing time-energy into spatial energy or vice versa. Yet there is nothing about time-energy and its transduction into spatial energy, or vice versa, in the present textbook statements of the thermodynamics. The term "heat" does not refer to the presence of energy at all, but to the scattering (disordering) and escape of energy.[190]

Considering heat as "energy of the system", or "heat energy" of the system, is a grand non sequitur. Rigorously, "heat" refers to the reduction of higher levels of ordering of energy, and since the gist of energy is ordering, reduction of ordering is the very antithesis of energy! "Heat energy" thus is an oxymoron. Before the "escape", there is no "heat energy" (ugh!) in

[190] Think closely: We never take the temperature of a "system"! We take the temperature of the disordered energy (heat) leaving that system or its subsystems. We do measure the effect of the emitted disordered energy. But that has already left the system and is in the local vacuum (a second component of the supersystem). Thermodynamics might be usefully redone more exactly in terms of the supersystem. We leave that task to some budding young future thermodynamicists for a recommended doctoral thesis.

the system at all. The energy is present in the system *not as disordering, but as ordering, a priori.* If it were in the system, it would not have escaped nor would it be escaping from the system. More energetic molecular motion, e.g., is actually more energetic ordering, simply at an excited state (of greater energy!).

We stress again (and strongly advise the researcher to read) Romer's strong objection to the use of heat as a noun {443}, and we suggest that the entire subject of classical thermodynamics needs a thorough revision to tighten up its terminology, correct its definition of closed system, eliminate its conflict between the first and second laws, and remove its inappropriate consideration of heat as "energy". Otherwise, the presentation and general interpretation of thermodynamics itself will continue to be one of the great confusion factors one encounters in trying to think clearly about extracting EM energy from the active vacuum environment to produce and utilize **COP>** 1.0 systems.

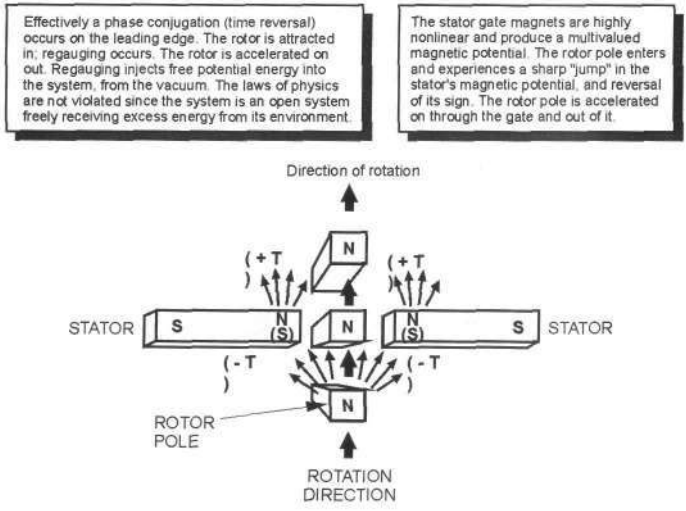

Figure 6-21 Concept of operation of Johnson's patented magnetic gate.

Johnson's approach produces a peculiar kind of multivalued potential. One **part** is conservative and of magnetic energy in nature, and the other part is nonmagnetic, being direct exchange force and energy effects on the **participating** atomic nuclei arising from quantum mechanical considerations. Nonetheless, the net *hybrid* potential can be multivalued at various points around the stator, and that is all that is required for broken

symmetry. If $\int F \cdot dl \neq 0$ around a closed path, regardless of which set of forces F represents, then that overall composite force field acting upon the rotor or object moving around the closed path is nonconservative. In that case, self-powering is permitted.

Figure 6-21 diagrammatically illustrates the operation of a nonconservative force-producing magnetic gate in Johnson's approach to a permanent magnet motor. As Johnson has shown, by using a multivalued hybrid potential (MVP) in his gates so that the resulting excess exchange force is properly oriented in direction and timing, a rotor magnet is attracted into a highly nonlinear stator gate region where the MVP is located. When it enters the MVP region where the exchange force is initiated, the rotor encounters a dramatic jump in the net potential with a change of polarity as the exchange force suddenly fires automatically. In turn, this produces a sudden accelerating tangential force in the region, usually against the prevailing magnetic force in the normal back mmf region!

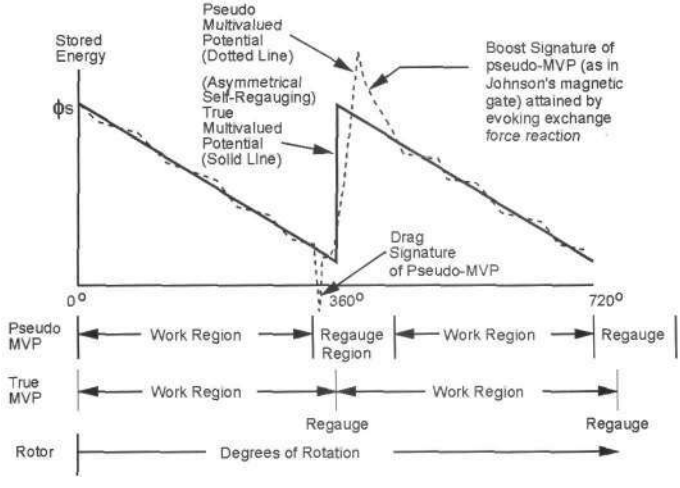

Figure 6-22 Johnson's "refueling" a permanent magnet engine by asymmetrical **self regauging. A multivalued potential is momentarily created by precisely evoking an exchange force reaction.**

Johnson often confounds professors of electromagnetics by showing them that his special gate can produce attraction between like poles, with a north rotor pole being drawn into a north stator pole in that exchange force region. This can be understood by tracing the spin field flow patterns, but

cannot be understood by simple "like poles repel and unlike poles attract". In short, Johnson knows he is adding a force completely different from the magnetic force the professors have in mind as the sole acting force. It is rather like pushing two like poles of two little magnets together. You can do it because an additional force — your mechanical force pushing them together — is acting and overcomes the normal repulsive force between the two poles.

The sudden exchange force burst produces a sudden accelerating tangential force in the normal deceleration (back mmf) region of the stator-rotor arrangement. In short, Johnson utilizes a deliberately evoked burst of exchange force to freely overcome most or much of the back mmf (back-drag) region. This in turn produces a net driving force around the rotor's complete rotation, because the overall field combination is nonconservative.

Rigorous force meter measurements taken at 0.01-second intervals prove that this occurs as the rotor enters and passes through Johnson's gate. The results of one such experiment are given in Figure 6-22.

Johnson thus uses highly nonlinear magnet assemblies of novel design to create a special kind of multivalued potential in his magnetic gate by adroitly evoking exchange forces — *extra quantum mechanical forces* in addition to the usual magnetic field forces. The MVP produces a sudden extra rotational force, backwards to the back-drag (back mmf) region of the stator-rotor magnet arrangement where the rotor magnet assembly is entering and passing through the conventionally repelling like-polarity situation. The result is that a net north rotor pole is seemingly attracted in[191] to the otherwise repelling stator north pole region, then accelerated out the other side by the normal magnetic repulsion.[192] Net drive force results, instead of a net zero force. Engineer Ken Moore, a close colleague of the present author, independently tested a Johnson gate and verified the net driving force effect {444} within the limits of our little laboratory.

[191] In reality it is "forced in" against the repulsive magnetic force, by a superior force of a different nature, suddenly evoked.

[192] I.e., as the exchange force dies, the forces now acting are the normal repulsive magnetic forces, but the rotor has moved to a position where now this repelling force accelerates the rotor in the "load powering" rotational direction. In other words, the observer sees a like pole suddenly "attracted" into a like polarity region, move partially through it, and then suddenly be accelerated out the other side. But the "attracting in" force and the "accelerating out" force accelerate the rotor in the load-powering rotational direction.

Technically, Johnson's apparatus asymmetrically and suddenly regauges its exchange forces in such a manner as to momentarily overpower the back mmf region of the engine's rotation, thus producing a net multivalued potential and a net accelerating force around the overall rotation loop. However, correlated distant effects in magnetic materials are known. If distant compensation does occur, then the closed-loop capability might conceivably be defeated, if the total compensation is sufficient to provide an $\int \mathbf{F} \bullet \mathbf{dl} = 0$ overall condition. Hence the research probably demands attention to maintaining both *local* asymmetry and *distant* asymmetry. If the distant correlation effects occur, only in that manner can an overall nonconservative field represented by $\int \mathbf{F} \bullet \mathbf{dl} \neq 0$ be maintained around a completely closed magnetic loop.

This may be the problem with which Johnson appears to have been struggling for so long. He did solve the problem once, and produced a self-rotating permanent magnet motor that the present author personally tested over a period of about 2 hours. During a two-hour test period, the motor apparatus was allowed to self-rotate for up to 15 minutes at a time. Shortly after it became known that Johnson had successfully produced such a prototype, his laboratory was mysteriously broken into. The only thing taken was the magnet assemblies on that specific little successful demonstrator — in a laboratory with more than a hundred thousand dollars worth of magnets and magnetic assemblies of many kinds present.

As a personal aside, I have been associated with Johnson, off and on, for many years. He is a man of the highest integrity and an indefatigable researcher. It is my fervent hope that Johnson will succeed in his permanent magnet rotary motor project. All I can say as this goes to press, is that he is getting very close again, now that he has help and good machining accuracy, etc. for higher precision buildups. In the near future, I hope to be among the first to drink a good glass of champagne to celebrate his success.

6.4.5 Radus Effect: Magnets with Preferred Flux Path Memory

In the early NASA space program, magnetic boots for holding the astronaut to the skin of the space vehicle when outside it were required. A Westinghouse engineer named Raymond J. Radus had found that a permanent magnet applied to a dual flux path (Figure 6-23) would "remember" the flux path taken initially, until switched to the other flux path in an initial condition, after which it would remember that path as preferable {445a-445c}. A permanent magnet with such "memory" will split its flux in two parallel flux paths by some ratio, e.g., 20% in the non-preferred path and 80% in the preferred path. This preference can be

switched at will by proper manipulation. So Radus developed switchable magnetic astronaut boots for the space program, using his magnetic memory and flux path switching technique {446}.

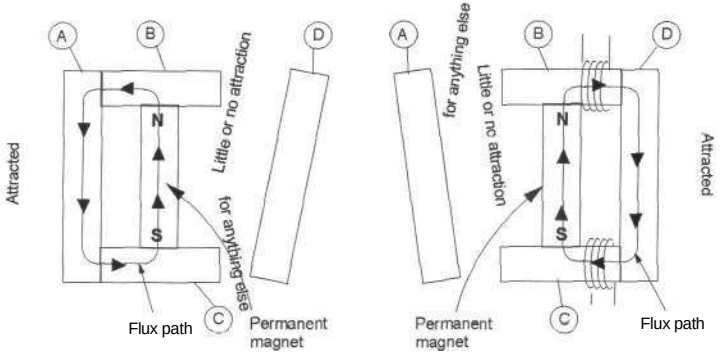

Figure 6-23A.
Once the magnetic circuit is made, there is little attraction for anything else

Figure 6-23B.
A single pulse through a coil can reverse ttie direction of the flux path

Figure 6-23 One example of the Radus effect.

The Radus circuit differs from ordinary permanent magnet circuits in three ways: (i) It exerts strong magnetic force at one end while exerting hardly any at the other, (ii) the strong and weak magnetic poles can be switched end-for-end easily and at will, thus, in effect, turning the magnetism on and off at one given side of the circuit, and (iii) once switched, it remembers its direction of greatest magnetic pull indefinitely.

The original Radus boots were excellent. For the acceptance tests, an engineer clad as an astronaut walked across the bottom of a steel beam in a high bay research area, upside down against the pull of Earth's gravity (Figure 6-24). He *stepped as* he walked, putting his foot "down" and then picking it "up" {447}.

There is no problem in finding modern magnets strong enough to hold the astronaut firmly in such an upside position. The problem with simple magnetic boots using such strong magnets is that, once the foot is planted, the astronaut cannot pick up the foot again. Consequently, the best the astronaut can do with such magnetic boots is walk rather laboriously by "scooting" the foot forward, with the boot remaining in contact and the astronaut unable to pick it up.

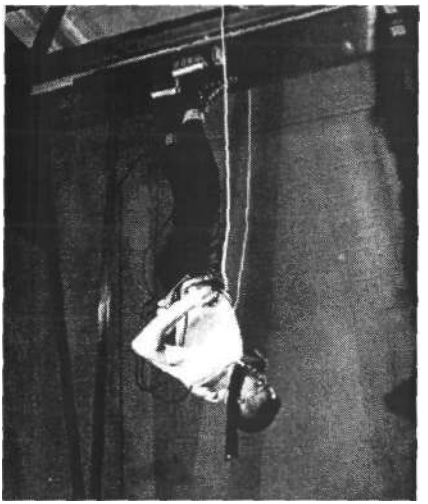

Engineer *walked* upside down on the underside of a steel beam in a high-bay area, wearing the Radus boots He used a stepping movement, not shuffling

Figure 6-24 Acceptance test of the Radus astronaut boots.

The Radus boots completely solved that problem. The permanent magnet fields are switched away from the "boot sole contact with the beam" for that foot that the astronaut wishes to lift, so he can lift it easily and take another step. Then the fields are switched back in again so that the strong field is on the boot sole as he places his foot down. This switching of the fields allows him to walk in a manner resembling normal walking, though a little slower. To do that switching by normal "battery and electromagnet coils" would be prohibitively bulky and heavy — and awkward. With the Radus boots, the astronaut could walk in a manner very similar to slow but normal walking.

However, it is easily seen that an adaptation of the Radus process could conceivably be used to produce a self-switching, self-powered permanent magnet motor. Being a permanent dipole, a magnet is already a particular kind of "free energy generator", since it continuously extracts magnetic energy directly from the active vacuum due to its dipole asymmetry in the virtual photon flux of the vacuum.

The Radus boots were abandoned quickly. NASA then developed the present inferior "shuffler" kind of magnetic boots where the astronaut cannot lift his boot from the surface, but must "scoot" his feet along in a sliding and painfully awkward fashion {448}.

Even today, it is little known that in many virgin magnets fresh from the factory, their very first use conditions them with a Radus-type memory! *That fact can be used, e.g., to create magnets whose fields appear normal, but which deviate from the normal behavior of ordinary magnets, and which produce anomalies in their magnetic fields.*

The Kawai engine {31} uses a novel means of switching the flux path itself instead of overpowering the magnetic poles in an electromagnet. As this is written, Bedini has been notified that his patent with a "path-switching" effect control method has been accepted and will be issued. Although control of the Kawai engine was seized by the Yakuza, we expect to see that some of the first COP> 1.0 motors on the world market will be magnetic motors using the Radus effect or other flux path switching method.

6.4.6 Hole Currents and Electron Currents

In a conducting solid, there are both hole currents and electron currents moving in response to a forcing electric field. In the simple case, electrons move in one direction along the conductor and lattice holes move (migrate) in the other. However, when additional fields are added, the situation can become very complex. The holes and electrons can move oppositely or together in the same direction, depending on the arrangement of the fields and voltages. One can even use fields at right angles to the conductor to affect the currents, and even stop them. This is a rich subject for the inventor, and one that does not appear to have been adequately explored for potential energy and power purposes. This is particularly true when the conductor material is bent or shaped, etc. This area is so broad that it will not be treated here; instead, we refer the reader to Burke {449} for a basic idea of some of the effects and current combinations that can be obtained. From there, an interested experimenter should search the materials science literature on electron and hole current responses of materials.

6.4.7 The Magnetic Wankel Engine

For baseline comparison, Figure 6-25 shows a conventional linear magnetic motor. As can be seen, due to the difference between magnetic poles, a magnetic field exists along the line of the linear track, from the end having the magnets separated the least to the end having the magnets separated the most.

Figure 6-26 diagrammatically shows the scheme of operation of the magnetic Wankel engine. It is basically a linear magnetic motor, wrapped into almost but not quite a complete circle. A set of permanent magnets, each at an angle to the various radial lines of the device, comprises a

slightly widening spiral stator that forms most of a circle. A circular rotor with a sector magnet is mounted inside this spiral stator. An end gap exists in the stator as shown, so that the stator is not a completely closed ring. The direction of rotation of the rotor is clockwise as shown. For demonstration of the principle, the beginning air gap between rotor and stator is 0.1 mm and the ending air gap is 5 mm.

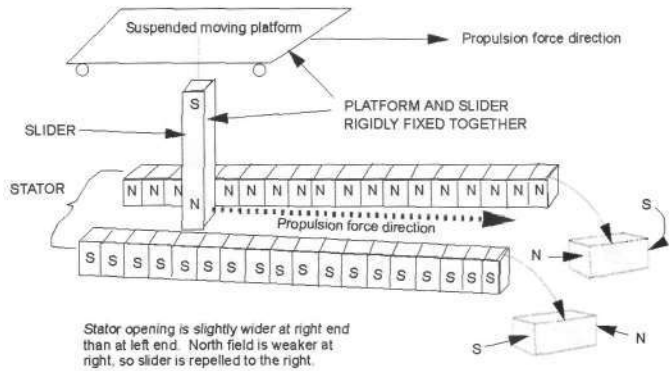

Figure 6-25 Type of conventional linear magnetic movement device

An electromagnet is mounted along the perimeter of an angular sector of the rotor, completing the stator gap. The electromagnet is weakly magnetized by a weak trickle current in the associated coil, furnished by a coil with a make-and-break magneto point gap. The electromagnet is magnetized, say, with the north pole facing radially outwards, and the south pole facing radially inside. In the stator, the permanent magnet north poles are facing radially inward toward the rotor, but at an angle, and the south poles are facing radially outward but at an angle.

Tangentially the north pole of the rotor is in a nonlinear magnetic field, and it will experience a clockwise force and acceleration from position 1 where the air gap between rotor and stator is the 0.1 mm minimum, to position 2 where the air gap reaches the 0.5 mm maximum.

If this were all that was involved, the engine would not produce COP> 1.0 because the tangential field is conservative unless additional *free* energy is introduced to overcome the back mmf region in the stator gap. When the rotor crossed the end gap in the stator between point 2 and point 1, very sharp and dynamic magnetic braking due to the back mmf would be done back upon the rotor magnet by the field of the stator magnets at position 1.

Since any real machine will have at least some friction and drag, the actual COP would be less than 1.0.

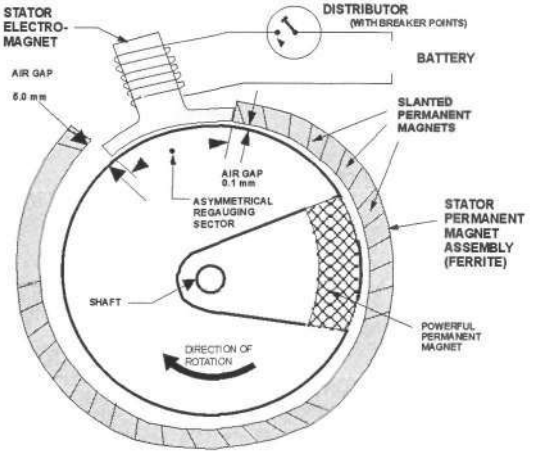

figure 6-26 Magnetic Wankel engine with asymmetrical regauging section.

Let us use the notion of the magnetostatic scalar potential (roughly, magnetic pole strength) to examine a new situation in the end gap.

Technically, let us regard a single unit north pole in the rotor, going from position 1 to position 2 (the acceleration cycle, where the engine will deliver shaft horsepower against a load), and going from position 2 to position 1 (where the magnetostatic scalar potential must be suddenly rcgauged asymmetrically to equal or exceed the potential at position 1, in order for the rotor to continue unabated or with even further acceleration. That is, when the rotor enters the "back mmf' end gap between position 2 and position 1, a sharp and sudden increase in the "stator magnetostatic scalar potential" must be accomplished, so that the potential in that region is equal to or greater than the potential at position 1. This effect, nearly freely obtained, is what is required for a self-powering magnetic Wankel engine.

In normal machines, conventionally this asymmetrical regauging part of the cycle is where the design engineer forcibly inputs energy from outside the system to do brute physical work on the rotor to forcibly "reset" the

machine, and to forcibly wrestle its potential energy storage back to initial conditions. In short, the operator himself arranges to furnish all the excess energy from outside the system that is required to brute force "regauge" the potential at that point, thus effectively creating a multivalued potential instead of a single valued potential. A multivalued potential achieved only by the operator himself furnishing the extra potential energy will not produce COP> 1.0. It will in fact produce $\int \mathbf{F} \bullet \mathbf{dl} \neq 0$ of the motor section, but only at the expense of extra energy that the operator himself had to input and pay for. In that case and in a real system with some system losses, the net work out because of $\int \mathbf{F} \bullet \mathbf{dl} \neq 0$ will still be less than the total energy input by the operator.

The forcible "reset" work is conventionally done by simply overpowering the field and reversing it (building it up equal and opposite in the other direction), but with energy totally input by the operator and not "free energy input from the environment" at all. The operator first pays to "kill" the existing field, and then pays to establish a field in the opposite direction.

To obtain COP>1.0 and self-powering, we must trick something else or some other process into furnishing that asymmetrical regauging energy — or most of it — for regauging of the magnetic Wankel engine in that stator gap zone. In other words, instead of engaging in the conventional wrestling match against the back mmf, we must let something else provide most of the energy for the wrestling.

During rotation of the stator from position 1 to position 2, we have been maintaining (and paying a little for) a tiny trickle current and small voltage from the battery into the coil around the electromagnet. As the rotor enters the stator gap, suddenly a sensor sharply breaks the distributor points, momentarily inducing a sudden powerful voltage in the coil. With a very short delay, a very sharp surge of current appears in the coil, producing a sharp and suddenly increased magnetostatic scalar potential (pole) in the gap region. That is the "multivalued potential" effect, where we pay a little to achieve it suddenly at that point, by invoking Lenz's law.

The effect is that suddenly the rotor is raised to the same or greater magnetostatic potential as exists at position 1, and "almost freely though not quite". If equal, the rotor suddenly is in a region with no back mmf, hence it experiences no deceleration braking. If the sudden potential is greater than the potential at position one, the stator in this normally back mmf region now actually experiences a further acceleration (a forward mmf) in that region.

Note that no *radial* mechanical work can be done on either the electromagnetic pole piece (part of the stator) or on the rotor, since neither the stator nor the rotor can move *radially*. However, there momentarily exists a clockwise circumferential magnetic field on the rotor in the stator gap, due to the gradient between the sharply regauged pole piece magnetostatic potential and the potential at position 1.

So we pay a little energy continuously (tiny trickle current, sharply broken breaker points) to get much more energy density momentarily in that small back mmf gap region only. The former back mmf in the stator gap is sharply eliminated by the Lenz force and converted to forward mmf. The rotor experiences a continuous acceleration throughout a complete rotation, due to the judicious use of an artificially induced multivalued magnetostatic scalar potential.

If the average shaft power output during the complete rotation cycle is made greater than the average power input to the asymmetrical regauging circuit during that same rotation cycle, the engine will produce COP>1.0. This type of engine is also easily close-looped, since the excess output is **not** electromagnetic energy but mechanical shaft rotation energy.[193] Hence the problem of the Dirac sea hole current (discussed in Chapter 9) is eliminated.

Such engines have been built and placed in an automobile to power it, in Japan {450}, though there is no information on the exact overall COP. The design was lighter and smaller than a gas engine of the same power, and it was a pygmy when compared to other electric engines of similar power. **The** prototype 45-hp unit weighed 155 pounds compared to 440 pounds for a comparable electric motor. The rotary engine was compact enough to fit inside a two-foot cube. The engine was in development by Kure Tekko, a sizable firm that supplies auto parts to Toyo Kogyo, the Mazda maker. To my knowledge, no hard data on the input electrical power utilized for the trickle current and current-breaker has been made available by the Japanese. The principles, however, are quite clear and easily analyzed.

This may be one of the Japanese COP>1.0 engines suppressed by the Yakuza.

[193] For example, a geared or belted arrangement can be used to drive a very small but efficient DC generator that replaces the battery. Many other efficient arrangements are possible.

The researcher might like to consider using a strategically-placed Wiegand wire sensor (discussed in the next section) as the free "generator" providing a pulse of electrical energy to the pulse-magnetizing coil in the stator gap region at the precisely appropriate time. If that or some other similar "self-furnished" pulse of sufficient power can be delivered to the pulse-magnetizing coil, then the system would self-initiate a multivalued magnetic potential in that gap region. In that case, the driving magnetic field around the loop need not be conservative, and self-rotation would be possible without violating any laws of nature or electrodynamics. At least a small toy demonstration model might be possible, simply to illustrate the principle. Presently we know of no one who has tried it.

6.4.8 The Wiegand Effect

If a Permaloy® or other suitable magnetic wire is properly tensioned and worked by repeated torsion while under tension, the skin of the wire is work-hardened and caused to have different magnetic characteristics from that of the internal core. This type of wire is called a *Wiegand wire,* or *pulse wire,* or "self-nucleating magnetic wire" (SNMW™).

When the pulse-wire experiences a certain level of ambient magnetic field strength, it will automatically switch its magnetic state, very sharply, producing a sharp magnetic field pulse. The effect is generally called the *Wiegandeffect.*

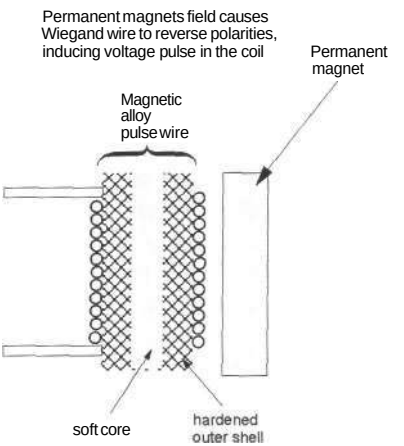

Figure 6-27 The Wiegand effect

If a coil of many turns of fine electrical conductor is wound around the Wiegand magnetic pulse wire, then when the wire suddenly alters its magnetic state, the sudden magnetic field pulse "cutting" the conductor bundle will produce a sharp electrical pulse. Thus the apparatus produces a sharp pulse of electrical energy, when the ambient magnetic field intensity reaches the pulse-initiation value. No input of outside energy is necessary. The apparatus simply gates the energy from the vacuum when it sharply changes its magnetic polarity.

Wiegand effect sensors may achieve voltage pulses up to a nominal 12 volts, in a typical application.

Numerous patents were issued to Wiegand prior to his death {451a-451h}.

Figure 6-27 diagrammatically shows the primary parts of a typical Wiegand sensor application, where the Wiegand wire is also known as a *pulse wire*. The operation of the pulse wire itself is shown in Figure 6-28. Figure 6-29 shows a typical rotary Wiegand effect pulse transmitter.

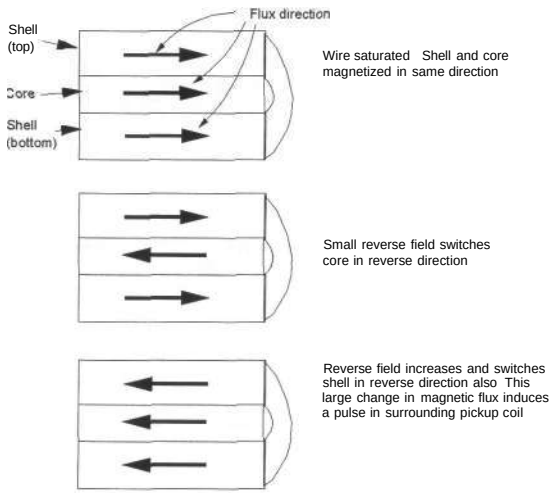

Figure 6-28 Operation of the Wiegand effect in a pulse wire.

Pulse wires find many modern "switching" uses, since one does not have to connect them to a power supply in order to obtain the electrical signal pulse generated in a magnetic field as it changes. The magnetic experience of **the** wires can be arranged (using a "resetting magnet") to automatically **reset** the pulse wire to its original condition after the initiation magnet has **fired** it. Many identification cards for personal access to restricted facilities

use these wires. Some magnetic memories use the effect. At least one European automobile firm has even used Wiegand wires to trigger the timing of automotive ignition systems.

The pulse characteristics created internally by the Wiegand wire represent a sharp, asymmetrical, self-regauging of the magnetics. The combined magnetic field consisting of the ambient magnetic field and the Wiegand wire magnetic pulse is momentarily a nonconservative magnetic field. It follows that a closed-loop integration $\int \mathbf{F} \cdot d\mathbf{l}$ around some paths in the combined magnetic field of the system do not sum to zero.

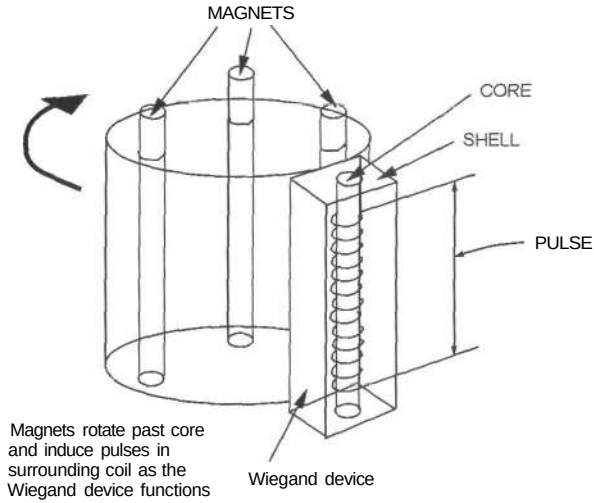

Figure 6-29 Operation of the rotary Wiegand pulse generator

In theory, at least, it should be possible to utilize something like the magnetic Wankel engine together with exactly self-triggering and self-resetting Wiegand units to form a self-powering permanent magnet motor. In short, referring to our discussion of the magnetic Wankel engine, it might be possible to use a special Wiegand sensor and pulse generator to furnish the properly timed pulse to the coil that enables the continuous operation of the Wankel engine. Obviously this type combination would have occurred to the Japanese scientists working on the magnetic Wankel engine.

We accent that the resulting system would be an open dissipative system, far from equilibrium in its energetic exchange with the vacuum during the Wiegand pulsing. The disequilibrium is achieved by the momentary self-regauging of the magnetic gap in the magnetic Wankel engine.

My colleagues and I have experimented with Wiegand wires and Wiegand sensors to a limited extent. The effect is quite real, fully documented in the scientific literature, and the wires and sensors are not too expensive. A typical coil of 1,000 turns on a 3-cm Wiegand wire will produce pulses of about 2 volts in a 1,000-ohm resistor. The pulse width (half maximum height) is about 20 microseconds. Essentially the Wiegand wires are immune to stray magnetic fields. Viewed on an oscilloscope, the pulses are very clean without spurious oscillations or hash. The field required to switch a typical Wiegand wire is typically about 150 Oersteds. The resetting field is quite a bit smaller, being about -20 Oersteds. With further work, it is probably possible to come up with Wiegand wires whose coils produce up to 20 Volts in a 1,000-ohm resistor. If 25 of these 20-volt Wiegand pulse generators wired in series could be induced to fire simultaneously across a 1,000-ohm resistor, something like a momentary half-watt device could be built. That might be enough to operate a very small version of the magnetic Wankel engine, etc. purely for demonstration purposes.

For practical power, of course, one would need to find a way to increase the power output in each Wiegand generator pulse. So far, no one has been able to successfully find a way to do it, at least to our knowledge. If the reader finds a way to do that, then the reader should certainly patent the process and use it in a self-powering magnetic Wankel engine!

So to those experimenters wishing to experiment with something relatively inexpensive, we would suggest investigating the possibility of incorporating Wiegand units into a magnetic Wankel-type small magnetic motor, and attempt to get a self-powering little unit, or try to build a self-powering version of the rotary Wiegand pulse generator. It is at least possible in theory, and if achieved in practice it will prove that self-powering EM engines are perfectly possible.

6.4.9 Kawai Path-Switching Motor

Japanese inventor Teruo Kawai has invented a process for adroit self-switching of the magnetic path in magnetic motors, rather than directly overpowering the magnetic field and then forcibly reversing it. The process reduces most of the back mmf in an otherwise rather conventionally switched magnetic motor, and results in producing a COP

that is approximately double the stated efficiency rating of the unmodified motor. Understand, the Kawai motor always has an efficiency less than 100%, even when its COP>1.0! Hence if one starts with a *high efficiency* magnetic motor — e.g., efficiency of 0.7 or 0.8 — one can obtain a modified motor having a COP of 1.4 to 1.6. Two Kawai-modified Hitachi high-efficiency magnetic motors were tested by Hitachi engineers, and the tests did indeed show COPs of 1.4 and 1.5, respectively, under rigorous and totally independent testing conditions.

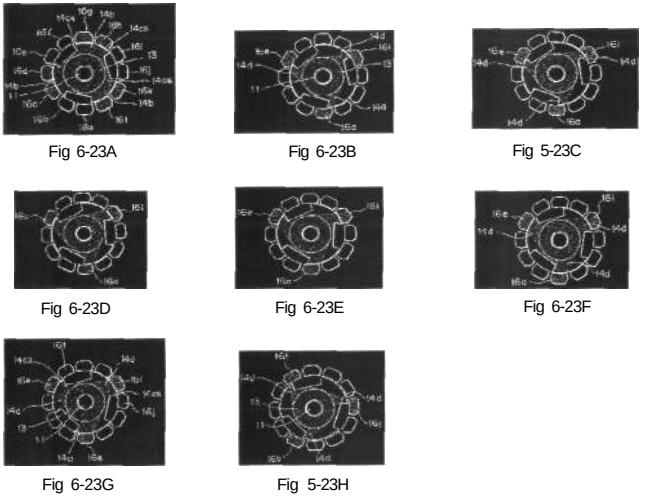

Figure 6-30 The Kawai path-switching process.

Figure 6-30 shows eight snapshots A, B, C, D, E, F, G, and H of the rotor advance of a typical Kawai engine, taken from Kawai's 1995 patent {452}. This is one end rotor/stator side of a two-rotor device, where a similar rotor/stator device is on the other end of the central shaft *11*. In snapshot A, pole piece *14* had three outward teeth *14b* dispersed equally around the circumference, alternated with three notches. An end magnet *13* provides the source of flux passing through the pole piece. With the electromagnets DC-energized, their core materials *16c, 16d, 16g, 16h,* and *16k, 16l* are shown shaded by flux from central magnet *13* out through teeth *14b.*

In snapshot B, electromagnets *16a, 16e,* and *16i* are energized. The shaded area shows the sharp convergence *14d* of the flux from magnet *13* through pole piece *14* and the edge of teeth *14d.* Since the electromagnets are magnetized in attracting mode, the rotor will experience a torque tending

to widen the flux path from magnet *13* to the activated electromagnets. Thus a clockwise torque exists on the rotor, and it will start to rotate clockwise.[193] Note that each electromagnet is operating independently of the other two.

As shown in snapshots C, D, E, and F, the rotation of the rotor continues clockwise, widening the connecting flux path to the three activated electromagnets. During this time the torque on the rotor is clockwise.

In snapshot G, the flux path to the activated electromagnets is fully widened. In addition, the leading edges of the three teeth are just beginning to enter the domains of the next electromagnets *16j, 16b* (see snapshot A) and *16f.* This is getting symmetrical to the original position shown in snapshot B.

Now the electromagnets *16i, 16a,* and *16e* of snapshot G are deactivated, as shown in snapshot H, and electromagnets *16j, 16b,* and *16/*are activated. This action asymmetrically self-regauges and resets the engine back to the original situation shown in snapshot B, but one more electromagnet beyond. The action cycle begins anew. As can be seen, in each complete rotation of the shaft, each of the three teeth of the rotor will be asymmetrically self-regauged multiple times. So multiple total asymmetrical self-regaugings, resettings, or "refuelings" are utilized per shaft rotation.

In each motor coil, at energization a tooth is just entering that coil, Energized in attractive mode with respect to the ring magnet around the shaft, the flux in the pole piece jumps from fully widened flux (and small **or** vanishingly radial torque on the rotor) to angled and narrowed flux (with full radial clockwise torque on the rotor). This is an asymmetrical self-regauging action. As previously explained, the narrowed flux and its angle exert a clockwise accelerating tangential component of force upon the rotor. By the asymmetrical self-regaugings of the engine, each coil is de-energized prior to beginning to exert radial back emf— which it would do if it remained energized as the trailing edge crossed it and again narrowed the flux path).

So the Kawai engine uses normal magnetic attraction to accelerate the **rotor** for a small distance, and then asymmetrically self-regauges to zero

[193]The Kawai patent contains a small error of misstatement. It states at first that the torque and rotation are counterclockwise, and then shows it moving correctly clockwise from figure to figure in the series.

attraction to eliminate the back-mmf drag portion of the attractive field. It regauges to zero as the reset condition.

For appreciable power and smoothness, the typical Kawai engine uses an extensive number of asymmetrical self-regaugings per axle rotation, for example 36 times on each end, or a total of 72 times for the two ends. The force field of each coil, accompanying its increased magnetostatic scalar potential, is oriented radially inward, so that radial work cannot be done by the coil on the rotor because the rotor does not translate radially. Advantage is taken of the initial clockwise acceleration force initially produced, and self-regauging eliminates the counterclockwise decelerating drag force that would be produced without the regauging.

The major benefits are that (a) multiple self-regaugings occur for a single rotation of the rotor assembly, enabling high weight-to-power ratio, (b) each electromagnet is energized only when positively contributing to the clockwise torque that drives the rotor, and (c) each coil is de-energized to asymmetrically self-regauge the system during those periods when the coil would otherwise create back-drag (counterclockwise torque) if it remained energized.

A conservative cycle is one in which the work done in the back-drag (mmf) region is equal to the work done in the forward boost (forward mmf) region. Self-eliminating the back-drag portion of the cycle is a form of asymmetrical self-regauging, and makes the net field highly nonconservative. The Kawai approach is thus permitted to attain COP>1.0. In his U.S. patent, Kawai quotes performance measurements showing COP = 3.18. As we stated, Hitachi engineers measured two Kawai-modified Hitachi magnetic motors which exhibited COP =1.4 and 1.6 respectively.

Since the output is shaft horsepower, in principle the Kawai engine can be close-looped for self-powering, without consideration of the Dirac sea hole current. With its external close-looping system (not shown), it falls within the second close-looping class, that of an "outrigger" system. Only the unitary system closed-looping class requires consideration of hole currents in the Dirac Sea.

The Kawai process and several other Japanese overunity systems have been blocked from further development and marketing by the Japanese Yakuza. The present author and the Board of Directors of CTEC were physically present and in final negotiations (having reached agreement!) with Kawai to market his self-powering motors worldwide, when control

of the Kawai company and process were suddenly seized on the spot in our presence.[195]

6.4.10 Bedini's Skin Depth Magnetic Switching

Bedini found a most interesting variation of flux path switching: he switches the direction of just a little fraction of the ongoing magnetic flux in a material flux path, on the skin of one side of it and with only a slight "skin depth".[196]

Suppose a flux path material is used as the stator pole of a permanent magnet motor. A large permanent magnet is used to magnetize that short length of flux path, as shown one the left in Figure 6-31, which illustrates a concept for a magnetic motor. For convenience, imagine that the small magnet on the right is not yet placed on the material flux path extension. The flux path extension is energized by the south north pole of the large permanent magnet on the left, and used as the stator in a rotary magnetic motor.

[195] To anyone who understands Japanese culture, Kawai paid me one of the greatest compliments possible. After his company representative called from Japan, Kawai shipped his *original proof of principle engine* — which first successfully demonstrated his flux-path switching process without being optimized for COP>1.0 — to me, here in the U.S. In the Japanese manner, he had entrusted me with his single most valued possession. From years of aikido experience, I fully understood the meaning of this unprecedented gesture, and expressed my deep appreciation accordingly. From our first meetings with Kawai and his group, I have and always shall have the utmost respect for Teruo Kawai. In my view, it is a sad loss to humankind to have his engine buried and withheld so brutally. Kawai had already achieved a closed-loop self-powering version, and it is this version upon which we reached agreement. In less than 24 hours after that agreement, the Kawai engine and company — and Kawai's own fate — were seized and no longer in Kawai's hands. For those unfamiliar with the deep spread of the Japanese Yakuza, the following are recommended: (a) Brian Bremner, "How the Mob burned the Banks: The Yakuza is at the center of the $350 billion bad-loan scandal," *Business Week*, Jan. 29, 1996, p. 42-43, 46-47; Michael Hirsh and Hideko Takayama, "Big Bang or Bust?" *Newsweek*, Sept. 1, 1997, p. 44-45; Adam Johnston, Yakuza: Past and Present," downloaded from the Internet, Committee for a Safe Society, Organized Crime Page: Japan: History and present status of Japanese organized crime.

[196] Close colleague Ken Moore also independently discovered this effect in his own experiments, but then we found that Bedini had discovered it earlier. That was fine with Ken; he greatly admires Bedini and the marvelous discoveries Bedini has made. I greatly admire both of them, and am happy to call them best friends. After all, s**cience** has a human side as well as a materials side. Without one's close colleagues and best friends, science alone would be a miserable enterprise!

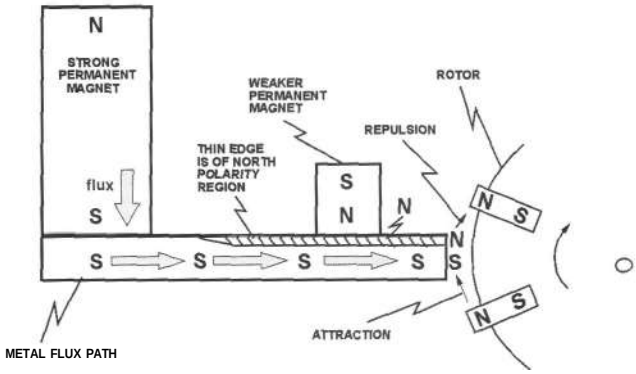

Figure 6-31 Bedlni skin depth magnetic edge switching.

As can be seen, the north pole of the rotor, shown in the figure, is attracted to the resulting south pole of the stator. Power can be taken from the shaft of the rotor while it is being attracted in to the extended north pole of the stator flux extension. As it begins to pass the extension end, obviously if nothing else is done it will develop back mmf "drag" by being attracted back toward the north pole of the flux extension as it passes it.

However, suppose that —just when the rotor south pole is passing dead center of the stator north pole extension, one suddenly pulses a small flat coil placed on the face of the extension, which serves the function of the small permanent magnet shown on the right of the material flux path extension. Further, suppose the magnetic field produced by the coil is oriented as the field of the small permanent magnet, but is much weaker than the magnetic field of the large permanent magnet on the left. A very curious effect then occurs. This energized coil magnetizes the edge of the flux path extension, to a small "skin depth" as shown, with a *north* polarity. The magnetic flux is now bidirectional in that same material flux path extension.

Further, this edge-switching action is performed so that it is this "partial north polarity" of the now-altered extension that faces the rotor north pole as it begins to pass the extension and enters what previously would have been a back mmf section. Instead, now that former back mmf section is a weakened forward mmf region, *further accelerating the rotor*. This action breaks the Lorentz symmetry around the rotation path of the rotor, resulting in a net nonzero (nonconservative) magnetic field. Hence the entire rotor exhibits a net drive force around its loop. The rotor will

accelerate until the mechanical work performed upon the shaft, friction, etc. is equal to the net magnetic energy furnished to the rotor.

The beautiful part of this motor is that one does not have to "overcome" by brute force — and then reverse — the north polarity of the entire stator extension. In theory, the overall energy added to the rotor is greater than the energy that must be added for the "edge switching" of the magnetic flux path extension, because the entire back mmf of the motor has been eliminated and replaced by a weaker forward mmf. If the process of furnishing the "skin depth" weaker magnetic north field to the edge of the flux path extension is made sufficiently efficient, this engine also can be made self-powering, at least in theory.

The former "motor" design has been converted to a "motor/generator" design, by the addition of the edge-switching action. The novel factor is the use of bidirectional flows of magnetic flux in a single material flux path.

An additional improvement is to rig a Wiegand sensor and pulse generator or sensors in conjunction with the rotor action, to freely furnish and kill the edge-switching pulse to the face-magnetizing coil on the flux path extension, at the appropriate times. This is an area where even high school students will be able to experiment.

Bedini's patent on the edge switching process and its various embodiments and improvements has been issued {453}.

6.4.11 Bedini's Flux Path Switching with Energy Capture

One additional embodiment of the Bedini flux path switching motor is shown in Figure 6-32. Here the entire flux path is switched, by moving a small coil on the bottom side of the material flux path, as shown in the figure. As Radus showed {454}, it turns out that a much weaker magnetic field in that left bottom position will switch the flux path of a powerful permanent magnet field at the left top of the path, as shown.

Now, however, Bedini adds a transformer coil around the right end of the core (the right end of the extension is still the stator pole in the magnetic motor diagrammatically shown in Figure 6-32). When the flux path is switched back and forth, this transformer coil produces an AC signal output, which can power a load as shown, and can even be used to power the switching power supply. The trick is that it requires less energy to make the vertical flux path preferable to the horizontal flux path, than the energy delivered into the flux path by the permanent magnet. The potential for self-powering of a sufficiently efficient magnetic motor is obvious.

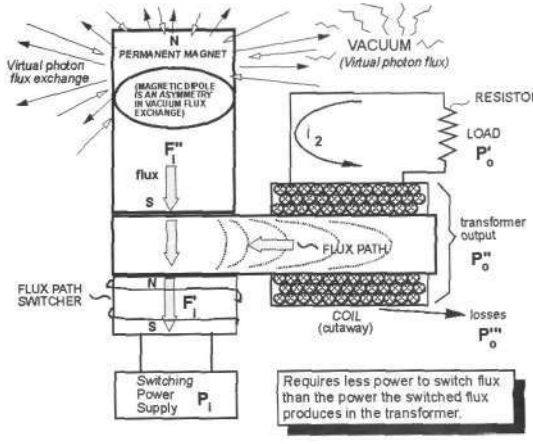

Figure 6-32 Bedini's total path switching and energy recovery process in a transformer.

So the motor can be powered while simultaneously acting as a partial generator. For efficient switching, this motor/generator can in theory develop COP>1.0 and can even be made close-looped and self-powering. We strongly accent that the primary excess energy input to the system is from the vacuum itself, via the broken symmetry of the large permanent magnet dipole at the left top of the material flux path. As we have repeatedly stated, the only energy problem is how to capture and utilize the EM energy freely received, transduced, and poured out from the vacuum by the source dipole's broken symmetry, without using half of it to destroy the source dipole.

6.4.12 Transformer Secondary Shunted by a Negative Resistor.

See Figure 6-33. This embodiment assumes the availability of a true negative resistor — possibly an adaptation of a point contact transistor or other device. As shown in the figure, a transformer exhibiting COP> 1.0 can be developed by adding a shunting *true* (not differential!) negative resistor across the terminals of the secondary, adjacent to the secondary. In this manner, the Lorentz symmetry of the closed unitary current loop containing the external loads and losses, and normally the secondary of the transformer in series, is broken.

Part of the return spent current is now "pumped" back up from ground side to power side of the transformer secondary without passing through the secondary. The pumping work is providing by dissipation (in the negative resistor) of energy freely obtained from the active vacuum environment. In short, one adds a ncgcntropic process in parallel with the secondary coil, in

the secondary external circuit, breaking the otherwise enforced Lorentz symmetrical regauging of the discharge of the collected EM excitation energy in the secondary circuit. This provides the capability for a permissible COP>1.0 transformer.

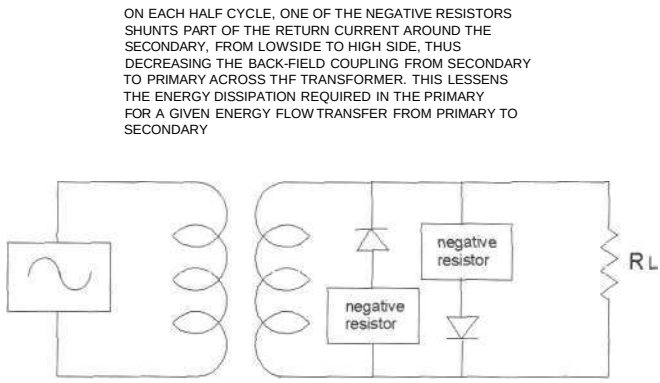

Figure 6-33 Transformer shunted by a negative resistor.

In theory, if the negative resistor can bypass all the current in the secondary, or almost all of it, the transformer can become a COP»1.0 device.

This overunity transformer can use step-up of the voltage from primary to secondary, and exhibits an asymmetry in its forward and backward field coupling between primary and secondary. Thus the dissipation of energy in the primary circuit need not be as great as the dissipation of energy in the secondary circuit. The *energy flows* are of course in perfect conservation, but there is no law of nature requiring the *energy dissipations* to be conservative between the primary and the secondary. It is strictly the backfield coupling from secondary to primary that enforces equal energy dissipation in the primary as in the secondary, in normal transformers. And that backfield coupling's strength is a function of the return current through the transformer secondary. By reducing that current, the back coupling to the primary is reduced, which in turn reduces the current draw of the primary from the external power supply.

No laws of physics, electrodynamics, or thermodynamics are violated by the asymmetrically coupled transformer power system with broken symmetry in its secondary to primary circuit couplings. In short, there is

less backfield coupling from primary to secondary than there is from secondary back to primary. The additional energy dissipated in the secondary circuit is freely extracted from the vacuum by the negative 4-resistor shunt.

Again, this application assumes the availability of a true negative resistor, to use as a shunt of the secondary.

The beauty of this application is that, once achieved, such a COP>1.0 transformer can easily be close-looped for self-powering by standard "governed" positive feedback. No concern as to hole current effects usually need be accounted for unless the COP becomes very large.

6.4.13 Eddy Current Multiplier.

Figure 6-34 shows an example of an eddy current multiplier, adapted from Burke {455}. This is given as a somewhat unusual system which may exhibit novel effects and possibly can be adapted into a COP>1.0 system (e.g., by using permanent magnets instead of the coils and triggering things into unbalanced condition using a rotary pulse wire generator. We simply list it here as a candidate for the experimenter.

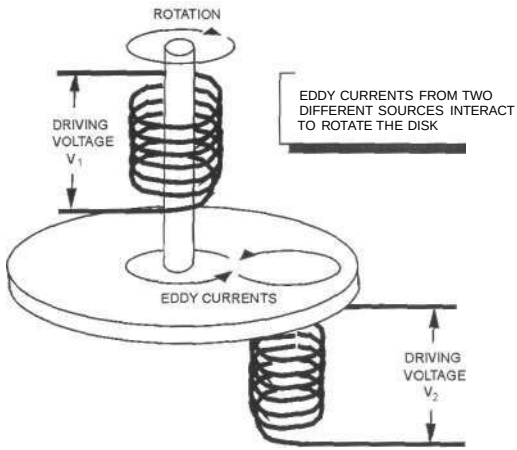

Figure 6-34 Eddy current multiplier.

In Figure 6-34, the shaft of the conducting disk is connected to a rotor, which could have arrangements for rotary type of Wiegand pulse generator of Figure 6-29 (with self-initiation and self-recovery) around it (not shown in Figure 6-29). One would start the rotating disk by hand. These Wiegand sensors would then automatically and repeatedly deliver a series of electric

pulses to the coils, momentarily generating the two eddy currents shown, so that dynamic force and rotary acceleration is obtained during the endurance of the pulses. In short, one would "electrically kick" the coils so that they continually deliver a propulsive "magnetic kick" to the conducting disk to repeatedly generate eddy currents to rotate it. The rotor is powered as shown by the interactions of the two unbalanced induced eddy currents. Such an arrangement could possibly exhibit COP>1.0.

To experiment with such an apparatus, the major parts that must be developed are (i) the rotor and coils arrangement (the motor), (ii) the integrated rotary Wiegand effect pulse generator with self-recovery, and (iii) the proper timing arrangement. Each should be developed and optimized individually in the researcher's experiments, then combined and optimized together. This is an experimental area that can be cheaply investigated, e.g., by a college student or high school student for a science project. Whether COP>1.0 is achievable or not depends upon the efficiencies that can be obtained with the various processes involved. It is possible, at least in theory, for such an arrangement to be self-rotating once rotary motion is underway.

6.5 CONCLUSION

In this chapter we have advanced many approaches to COP>1.0 systems, that have been tried or considered by various inventors and researchers in the field. Many of these experimenters have attained concrete, replicable results, including results published in the hard literature.

We hope this sampling shows the reader that indeed we can have "self-powering" electrical power systems and COP>1.0 electrical power systems whenever the scientific community will come out of its preoccupation with the present seriously restricted electrodynamics and electrical power engineering practice and fund the necessary research. Simply funding a few graduate students for research and doctoral theses in these areas would be very useful and immensely more productive for electrical energy purposes than all the billions and years spent on chasing hot fusion.

Hopefully the iron dogma of the scientific community against COP>1.0 electrical power systems is slowly changing. If so, and if the community will turn loose those sharp young graduate students and post-doctoral scientists on the problem, very shortly there will no longer be an electrical energy problem on Earth, ever again. We strongly refer the reader to Deffeyes' book {456} to rigorously validate the coming increase of the price of oil, in the middle of the present decade. See particularly the

quotation from Deffeyes in our Endnote {342}. With the present extreme volatility of the MidEast and the continuing war on terrorism, the probability is high of eventual severe disruption of oil supplies and the energy infrastructure of the U.S.

An independent review of Deffeyes' book is given by Young {457} and we recommend that the reader digest that commentary also.

If the scientific community will fund the necessary research on permissible COP>1.0 Maxwellian systems, the quick results will solve the energy crisis, clean up the biosphere — including much cleaner air in our cities for the populace to breathe — provide cleaner streams, and result in far less polluted oceans. It will stop the pollution-caused destruction of species, and dramatically reduce the hydrocarbon combustion contributions to global warming. There will no longer be a necessity to consider "burying" in the bottom of the sea the excess CO_2 from massive hydrocarbon combustion to provide the much-needed electrical power, because it will no longer be necessary to burn the oil, coal, and gas to get the power. And there will no longer be any necessity for expensive and highly vulnerable nuclear power plants with their resulting nuclear wastes that will remain radioactive for thousands of years.

If cheap, clean EM energy from the vacuum is rapidly developed, we may *finally* get the scientific community's head wrenched back out of the big nuclear power business, as a colossal waste of research manpower and taxpayer dollars — as well as providing ticking time-bombs for the terrorist teams now already in the United States to attack and destroy. It is so easy for a person with appropriate technical knowledge to build a portable electromagnetic pulse (EMP) "shooter" that one shudders at the consequences of in-country terrorist teams that can do so. Try imagining what we would face when the electronic controls of one or more operating nuclear power plants are suddenly disabled and destroyed with the reactor on line and providing power. Chernobyl might look like a mild spring breeze in comparison, should we have one or more actual meltdowns.

It is not a pleasant consequence to contemplate, and that alone may eventually dictate the overwhelming urgency of achieving decentralized, vacuum-energy-powered electrical power systems as soon as humanly possible. The present centralized, cumbersome energy infrastructure is vulnerable beyond all sanity, considering the thousands of terrorists already in country, with weapons of mass destruction as well as more conventional sabotage means. As a single example, the former Soviet Union clandestinely brought in nuclear weapons into the U.S., and

Spetznaz teams to detonate them on order. Such weapons (and teams) are already in large U.S. cities and population centers. The reader is referred to Lunev's book,[197] for details about how the nuclear weapons were introduced.

After all, we do have to live and survive in the real world, and not just in an idealistic scientific environment. We are already at war, with alerts of potential danger to our nuclear power plants already having been given on several occasions. In the present very disorderly and very dangerous world we live in, many of the former options we have had for decades are rapidly ending. That includes the option for the leaders of the scientific community to continue "business as usual", if they wish this nation and their own families to survive. There is an old adage in war: *Whatever your determined enemy can do to hurt you desperately, he will do as his highest priority*. Sadly, in my opinion the leaders of the scientific community — unwittingly — are presently doing almost everything they can do to insure that the energy infrastructure goes, the national economy goes, a nuclear meltdown possibly occurs, and this nation and much of civilization perishes in a new dark ages.

[197] Stanislav Lunev (with Ira Winkler), *Through the Eyes of the Enemy*, Regnery, Washington, 1998. Lunev is the highest ranking GRU defector. He is a former Colonel in the GRU, the military counterpart of the KGB. On p. 22-33, he summarizes the Spetznaz capabilities. On p. 22-27, he summarizes Spetznaz use of nuclear weapons already on American soil. On p. 26, he gives some of the ways in which the Soviets easily brought nuclear weapons into the U.S. On p. 30 he confirms **Russian** seismic weapons. Use of EMP weapons is on p. 30-31. Use of very, very low frequency weapons to destroy the human brain, put people into a zombie-like state, and aid in brainwashing is confirmed on p. 31. The present war on terrorism has many more facets than are presented by the conventional news media.

Just as the dinosaurs were confronted with a new and dangerous threat, and failed to adapt, the electrical power infrastructure is now confronted with a potent threat against its very vitals and — so far — is completely failing to adapt. It is going to have to adapt or perish, which presently implies that we all perish along with it. Those who make it their nefarious business to see to it, will see to it.

So let us "see to it" first, scientifically, as rapidly as human research and development can do the job. The very existence of civilization may well depend upon it.

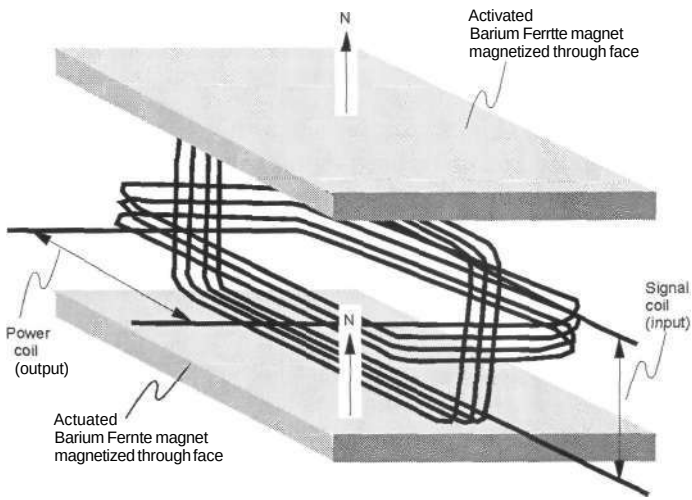

Figure 6-5 Sweet vacuum triode amplifier (VTA) construction.

Chapter 7

Aharonov-Bohm Effect, Geometric Phase, and the Motionless Electromagnetic Generator (MEG)

[Decision that hydrogen fuel is the future]. *"We are at the peak of the oil age but the beginning of the hydrogen age. Anything else is an interim solution. The transition will be very messy, and will take many technological paths ...but the future will be hydrogen fuel."* [Herman Kuipers, Royal Dutch Shell.].

[Vacuum energy is real] *"...the acceptance of a structured vacuum described by an O(3) gauge group leads directly to the existence of novel charges and currents in the vacuum. These are conserved, or Noether, currents and charges and are clearly topological in origin. They spring from the fact that the vacuum is a topological space. Four such entities emerge: [1] A topological vacuum electric charge, also proposed empirically by Lehnert et al. [2] A topological vacuum electric current, also proposed empirically by Lehnert et al. [3] A topological vacuum magnetic charge, proposed also by Barrett and Harmuth. [4] A vacuum topological magnetic current, proposed also by Barrett and Harmuth.*

Each of these four objects can provide energy, which can be loosely termed 'vacuum energy': energy coming from the topology of the vacuum. " [Evans] {458}.

[Aharonov-Bohm effect] *"...the Aharonov-Bohm effect is a local gauge transformation of the true vacuum... [which] produces a vector potential from the true vacuum. [This gauge transformation] produces topological charge..., the electromagnetic field, which carries energy, and the vacuum charge current density first proposed by Lehnert ... and developed by Lehnert and Roy... ".* [Evans and Jeffers] {459}.

[Geometric phase] *"The concept of the geometric phase is closely related to the effect of a state function acquiring a non-zero phase factor after a quantum system undergoes a cyclic evolution. This means, that if a system after some time returns to its original state, the result of such an evolution will be recorded in the phase of the wavefunction. Moreover, this phase factor can be measured by interfering initial and final states. ... Although there are no widely recognized practical applications of the geometric phase, its experimental observations have been reported in many fields of science. The largest group of experiments have been carried out on polarized light ...and polarized neutrons ... The geometric phase has also been observed in magnetic resonance experiments ..., mesoscopic structures ...and molecular systems ...Analogues of GP — the Hannay angles — have been shown to exist in classical mechanical systems ..., the most famous example of which is the Foucault pendulum."* [Aleksiejunas][198]

[Practical use of geometric phase]. *"The motionless electromagnetic generator is the first practical macroscopic use of the geometric phase. "* [T. E. Bearden, 2001, to a correspondent].

[Impact of extracting energy from the vacuum] *"If they [quantum fluctuations of vacuum] can be [tapped], the impact upon our civilization will be incalculable. Oil, coal, nuclear, hydropower, would become obsolete — and so would many of our worries about environmental pollution." "Don't sell your oil shares yet — but don't be surprised if the world again witnesses the four stages of response to any new and revolutionary development: 1. It's crazy! 2. It may be possible — so what? 3. I said it was*

[198] I am much indebted to Dr. Rimvydas Aleksiejunas for this clear statement of the geometric phase. See his very elegant summary, " Introduction to The Geometric Phase Decomposition," on his Internet website at http://signalogram.free-hosting.lt/Research/gp dec.htm. His own publications in scientific journals and proceedings are also listed on **the** website, and many are available for downloading. His doctoral thesis dealt **with geometric phase** and he is a specialist in that field.

a good idea all along. 4. I thought of it first." [Arthur C. Clarke] {460}.

7.1 Introduction

In this chapter we give a history, some information, and comments about the Aharonov-Bohm effect {473}, which was generalized by the Berry phase {477} for adiabatic conditions, which itself was further generalized by Aharonov and Anandan {480} to remove the adiabatic limitation. The modern all-inclusive term is *geometric phase,* which has been found to be involved in a very wide variety of physics areas. In its embodiments, the motionless electromagnetic generator (MEG) does utilize the Aharonov-Bohm effect (geometric phase) in a unique manner that we explain. We also remark on what we hypothesize may be some related new aspects of the curl-free magnetic vector potential itself.

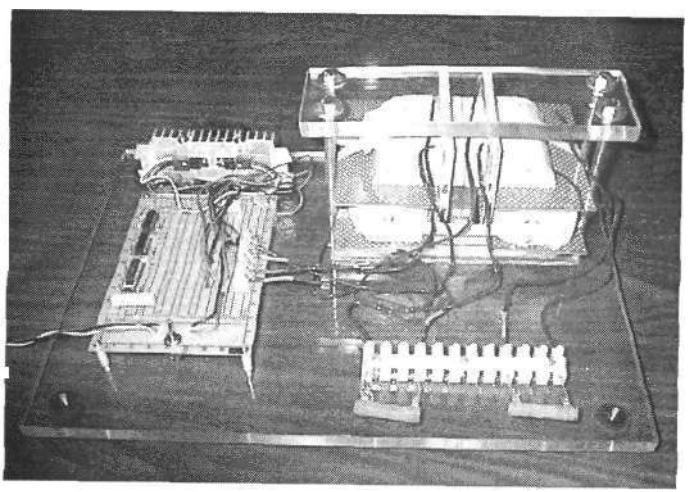

Figure 7-1 Motionless Electronic Generator (MEG)

The motionless electromagnetic generator (MEG) (Figure 7-1) was invented by Patrick, Bearden, Hayes, Moore, and Kenny {461} after years of research and experimentation. It has been technically described elsewhere {462}, and scientific explanations of the fundamental mechanism by which it successfully extracts useful EM energy from the active vacuum have been published in the recognized literature {463, 38a, 464}. Other closely related papers on extracting EM energy from the vacuum have been published or are submitted and in review {465a-465h}.

A version of the MEG has also been independently replicated by Naudin {466}, and in fact by others who did not wish to publish their results. By permission, Naudin's Mark II MEG replica is shown in Figure 7-2. Consequently, the MEG is a validated and replicated COP>1.0 system, as required by proper scientific methodology. Further, sufficient information has been released for any competent laboratory team to replicate a version of the MEG.

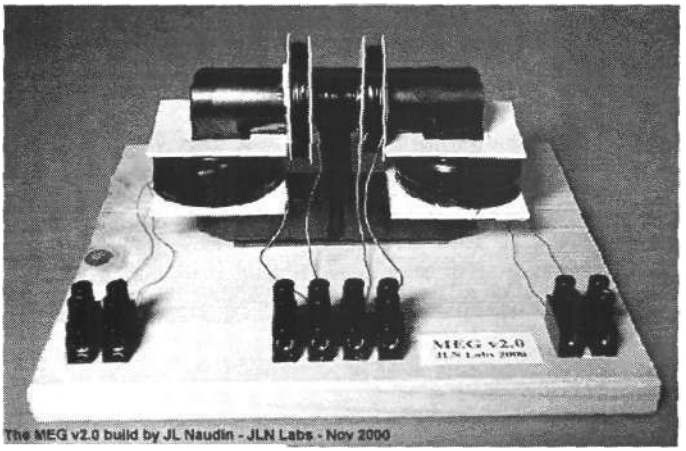

Figure 7 2 Nuadin's Mark II Replication of the MEG.

We give an overview of the MEG, the principles of its operation, the status of the project, and some indication of future plans.

7.1.1 Status

As this is written, the first MEG patent has just issued {37}. A second Provisional Patent Application has been filed, and at this writing is in process of being replaced by a formal regular patent application. Two other patent applications are in preparation. All rights to the MEG are assigned to Magnetic Energy Ltd., Huntsville, Alabama, U.S.A., whose CEO is Dr. James L. Kenny.

In addition, Bedini and the present author have filed a provisional patent application on the process and embodiment for close-looping a COP>1.0 system for self-powering operation, and are in process of replacing it with a regular patent application also. Magnetic Energy Ltd. has permission to utilize the Bedini-Bearden close-looping process. In addition, Magnetic Energy Ltd. has its own proprietary close-looping process, for which a patent application is being prepared. The Company is also involved in

serious discussions with several large companies and financial groups for potential financing. When that funding is obtained, we will open a substantial research and development laboratory here in the United States, serving a separate production company to be set up with our financial partners to produce and market the MEG. Meanwhile, laboratory work to complete the research and development of the MEG is also ongoing under a cooperative arrangement with the National Materials Science Laboratory of the National Academy of Science of a friendly foreign nation formerly under the Soviet bloc.

7.1.2 Future Plans

Our plans are straightforward. We will continue to pursue and update our patents and file additional ones as additional discoveries are made. We will continue our negotiations with major financial parties until satisfactory and mutually beneficial capitalization is obtained (we expect that to occur before the end of 2002). At that time we will establish a modern Magnetic Energy Ltd. U.S. laboratory devoted to advanced research and development, as well as a separate production company in partnership with our funding partners. The final research necessary on the MEG (four areas of physics as well as the electrodynamics) will be completed in somewhat less than one year after setup of the lab and lab team, and the production company is expected to have the first engineering development production prototype at the end of that first year. We expect it to be a self-powering unit. We will simply put the first MEG units into production and on the world market immediately thereafter.

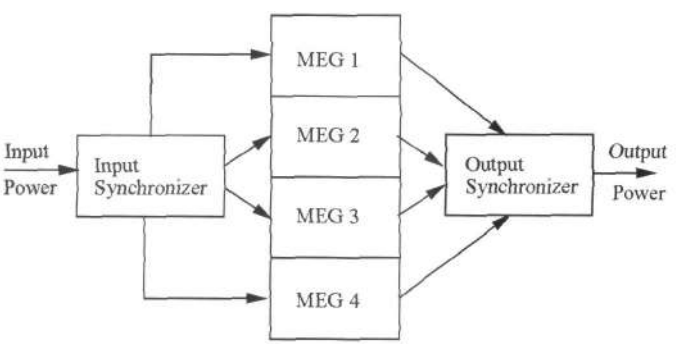

Figure 7-3 Block diagram of envisioned **modular** MEG design.

See Figure 7-3. The first production MEG is envisioned as a modular 2.5 KW unit together with a synchronizer unit simultaneously developed, so that up to six 2.5 KW MEG units can be synchronized in a power system

array. This will yield power units from 2.5 to 15 KW. We are struggling to have the closed-loop process completed and ready in that same first year, and if possible the very first MEG units will be close-looped and self-powered. At the end of the second year or before, we plan to have the close-looped basic MEG unit in 10 KW size, again with synchronizer so that up to six MEG units can be synchronized in an array. That will cover the 10 - 60 KW power system size, which is ideal for homes and small businesses. Once the units go on the world market, we believe that the market will be extraordinarily dynamic and productive. We intend to license multiple companies for production and competition for various markets, with no single company being given total monopoly worldwide.

7.2 Aharonov-Bohm (Geometric Phase) Effect

The Aharonov-Bohm (AB) {473} effect, or geometric phase (GP) {477, 480} effect, is now well known {467} in quantum mechanics and quantum electrodynamics, but does not exist in classical electrodynamics. The effect proves the reality of the potentials and their primacy over the fields. Further, it shows that electron effects can be generated by the magnetic vector potential A even in the absence of the magnetic field B.

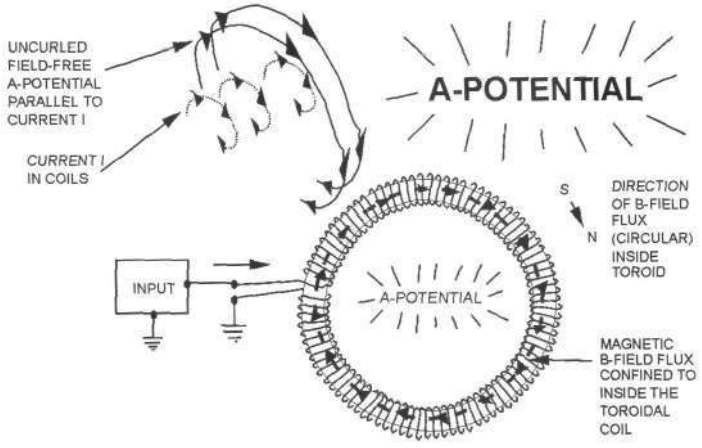

Figure 7-4 Aharonov Bohm effect for a tightly wound toroidal coil.

According to Feynman {468}, it required 25 years for quantum physicists to clearly face the issue eventually pointed out in 1959 by Aharonov and Bohm of the primacy and separate action of the force-field-free potential, in regions where no force fields were present (Figure 7-4) {469}. After the

effect was experimentally demonstrated by Chambers {474} in 1960, it then required another 25 years before physicists would accept it. Even today, another 16 years after full acceptance in 1986, to our knowledge the Aharonov-Bohm effect has not previously been utilized in any practical electrical power system {470}, much less one that has a COP>1.0. As Aleksiejunas[198] states (see his quotation at the beginning of this chapter), there have not previously been any widely recognized practical applications of the geometric phase. Now there is a practical application of major worldwide importance, since the operation of the MEG depends upon the geometric phase (Aharonov-Bohm) effect to produce real electrical power from the active vacuum itself.

We also believe that the curl-free potential may not have been adequately investigated, particularly along the lines of its utilization in the MEG.

7.3 Abbreviated History of the Geometric Phase

The earliest work with a state function acquiring a non-zero phase factor after a quantum system undergoes a cyclic evolution was published in 1956 by Indian scientist Pancharatnam {471}. Pancharatnam noticed phase shifts of cyclic evolutions in optical phenomena. This means that, if the system leaves its original state and after some time returns to it, the result of the system's evolution will be recorded in the phase of its wavefunction. In addition, this phase factor can be measured by interfering the system's initial and final states.[198] Sadly, Pancharatnam's anticipation of the geometric phase factor did not receive the attention it so justly warranted, and his paper languished almost unnoticed for nearly four decades, when it was finally rediscovered. This was an excruciating scientific tragedy to Pancharatnam, comparable to that which befell Waterston {472}.

The effect of the field-free potential and the geometric phase issue were pointed out strongly by Aharonov and Bohm {473} in 1959 in a leading U.S. physics journal, causing much consternation in physics. Before that paper, most physicists still believed that all electromagnetic forces and effects were induced only by the force fields,[199] and not by the potentials.

[199] Indeed, the force fields do not even exist in mass-free space, but only in matter. Force is defined as $F \equiv \partial/\partial t\ (mv)$ so that mass is a *component* of force. Feynman states: *"...in dealing with force the tacit assumption is always made that the force is equal to zero unless some physical body is present... One of the most important characteristics of force is that it has a material origin... " "...the existence of the positive charge, in some sense, distorts, or creates a "condition" in space, so that when we put the negative charge in, it feels a force. This potentiality for producing a*

In the prevailing belief, when the fields were zero there were no EM effects. Indeed, the potentials were largely regarded as mathematical conveniences.

Another point of consternation was that the A-potential is not uniquely determined, but is determined only up to a particular gauge transformation. So there can be two (or even more) magnetic vector potentials A and A' corresponding to a specific magnetic field. Aharonov and Bohm raised a disturbing question: How can two different "causal" A potentials produce the same effect? We will rigorously answer this question shortly.

While the experiments suggested were difficult, they were performed shortly after the publication of the Aharonov-Bohm paper. The very next year, in 1960, Chambers {474} experimentally demonstrated the Aharonov-Bohm effect, though not with complete decisiveness. A 1983 paper by Tonomura *et al.* {475} was significant, and a 1986 publication of further work of Tonomura *et al.* was decisive {476}.

In 1984, Berry generalized the Aharonov-Bohm effect into the geometric phase {477}. In 1985 the Tonomura effort plus experimental work by Webb *et al.* {478} settled the matter, as strongly stated by Schwarzschild the next year {479}. In 1987, Aharonov and Anandan {480} further generalized Berry's geometrical phase, freeing it from its adiabatic

force is called an electric field. " So Feynman was fully aware that not the force field but only the potential (i.e., the potentiality) for producing the force field exists in mass-free space. The electrodynamicists continue to be confused on that point. E.g., on p. 28 of his *Classical Electrodynamics,* 2nd edition, Wylie, 1975 Jackson states: *"...the thing that eventually gets measured is a force... ",* confirming that force is an observable and thus a *d/dt* operation imposed upon spacetime LLLT to give a purely spatial entity LLL. On p. 249, Jackson also states that *"Most classical electrodynamicists continue to adhere to the notion that the EM force field exists as such in the vacuum, but do admit that physically measurable quantities such as force somehow involve the product of charge and field."* The two parts of the conventional assumption, as stated by Jackson, contradict each other. We point out that Jackson's book has been a standard of excellence for years, and no EM library is complete without it. It merely shows the extraordinary difficulty of rooting out the exasperating and mind-numbing confusion in physics between the observed effect and the unobserved cause. Force is an effect, after interaction (observation or measurement), hence cannot be the cause (which exists prior to interaction or measurement). Else, there is no difference between cause and effect, which destroys causality itself. This confusion is still there in even the hoary old classical mechanics, now some centuries old. By that standard, electrodynamicists have a long time remaining before they will have propagated this non sequitur" as long as the mechanical physicists have.

restriction and generalizing the geometry. Much discussion of the AB effect and Berry's geometric phase occurred {481a-481c}, but the scientific consensus was in: *The Aharonov-Bohm effect is real and the geometric phase is a widespread fact of nature.*

In 1985, Olariu and Popescu {482} published a very good overview and discussion of the AB effect up to that time, with hundreds of references.

Thousands of papers on the AB effect, the Berry phase, and the geometric phase have since appeared in the literature, and continue to appear at a rather steady and prolific rate. A few are listed for a sampling {483a-483k, 484a-484i}. The original Aharonov-Bohm effect has now expanded and spread widely through physics and into a myriad other effects and areas, such as the scalar AB effect, the Aharonov-Casher effect, magnetic vector potential vortices, quantum tunneling, chemical reactions, chaotic oscillation, and others. These related extensions are far beyond our interest here. We are, however, interested in what we hypothesize may be a new aspect of the perturbed curl-free magnetic vector potential A. We shall address that aspect briefly.

7.4 A Possible New Aspect of the Curl-Free Magnetic Vector Potential

We propose what may possibly be a unique new aspect of the curl-free A-potential — and thus of the Aharonov-Bohm effect — that has been uncovered in our MEG experiments. We caution, however, that this is a tentative interpretation and remains to be further validated.

First we state that the equation, $\mathbf{B} = \nabla\times\mathbf{A}$, usually accepted as the "definition" of the magnetic vector potential A, is not even a definition, because no equation is a definition.[200] If we rewrite the equation as the identity $\mathbf{B} \equiv \nabla\times\mathbf{A}$, then it is a proper definition — though not of the A-potential, but of the B-field itself, *given* that the A-potential exists and is primary. It also states that the B-field is simply a magnetic vector potential having swirl; i.e., the notion of the B-field captures that swirl aspect of a swirling A-potential. Hence the statement that B = zero implies only that **the** A-potential remaining is swirl-free and hence a linear EM energy

[200] No equation is a definition, *a priori.* It merely states the relationship of the total magnitude of the entities on the left to the total magnitude of the entities on the right. It does not define any entity on either the left or the right. One of the gross non sqeuiturs in physics texts is to continue to present equations as "definitions".

current flow. Note that the B = 0 condition does not specify the magnitude of the remaining A-potential, but *only* specifies that it has no curl. This is a rigorous answer to the original question posed by Aharonov and Bohm of how two different A-potentials can have the same magnetic field B (the same swirl). It is no more mysterious than two different rivers having a whirlpool of exactly the same swirl magnitude.

At least to first order, it appears we have arrived at a "semi-definition" of the A-potential along these lines:

> *The magnetic vector potential A is an EM energy current in 4-space, which can be swirling or linear, or can have two components where one is swirling and the other is linear. The swirling component of the A-potential is also known as the B-field, and the linear component is known simply as the "curl-free A-potential". The A-potential exhibits a remarkable property: If its swirl component is localized and confined, the remaining space where the swirling A without localization would have been is filled by a remaining unswirling linear A-potential energy current. In short, by swirl-localization the swirling A-potential can be freely 'regauged' into two separated entities, with the sum of their energy being greater than the apparent energy of the previous swirling A-potential. Hence swirl-localization is a method of asymmetrical self-regauging of the A-potential itself with the excess energy coming directly from the active vacuum.*

If we take the view that any curled A is identically a B-field, then the "natural" A is not curled, because it requires a curl operation applied to it to produce a "curled A" or B-field. Therefore the "natural" magnetic vector potential A is simply a magnetic energy current in space, since it is a vector and has direction {458}. That is a *longitudinal EM energy flow process*?[201] We shall be very interested in the uncurled A-potential; i.e., in that linear energy current in space that is uncovered and freely produced

[201] Interestingly, around a toroidal localization zone, the uncurled A-potential does curve, but is only linearly following the curving current and the moving E-field from the moving charges in the current. In the MEG, the uncurled A-potential is even more complex, since we use each half of the toroid-like localization zone differently, with the B-flux going one direction (say, counterclockwise) in the left branch and the B-flux going in the other direction (say, clockwise) in the right branch, and with a crossover point in the middle.

when the B-field is localized. Indeed, we shall perturb it to make a large E-field, which we intercept and use to furnish emf to the secondary circuit and power loads.

Given a localized B-field so that we have an uncurled A-potential outside the localization region: If we now increase the magnitude of the A, that produces an increased linear energy flow rate outside the localization zone, in addition to increasing the B-field in the localization zone. If we decrease the magnitude of the A, that produces a decreased nonlocalized energy flow rate and a decreased localized B-field. In our view it follows that, when we oscillate the magnitude of the A-potential by any means whatsoever, we oscillate the nonlocalized linear EM energy current flow rate as well as the localized B-field. In fact, that creates a normal oscillation of the localized B-field, and also creates a nonlocalized *longitudinal wave* of electric field E by the equation $\mathbf{E} = -\partial\mathbf{A}/\partial t$, if the conditions localizing the curl operator — and hence localizing and holding separate the concomitant B-field produced by a changing E-field — continue in effect.

We have produced a mechanism for generating a nonlocalized longitudinal E-field wave without a nonlocalized B-field component being allowed to act outside a confined locality. We stress that a B-field component is produced, but remains localized in the special core material (that is one of the conditions required in the MEG).

We have also produced a mechanism for generating a nonlocalized longitudinal E-field wave with another very novel feature: the magnitude of the E-field and thus the magnitude of its energy density (its intensity) does not depend on the *magnitude ofthe input energy* used to perturb the A-potential, but only depends on how sharply we perturb it. Thus we have produced a mechanism for energy intensity amplification and magnification, freely. This is possible because the system is an open system far from equilibrium with the active vacuum, and specifically with the curl-free A-potential as an energy current at large in the local vacuum where it can be intercepted, collected, and used to power loads. The energy intercepted from the uncurled A-potential by the output section(s), is *additional* energy in excess of what is intercepted from the E-fields generated in core material B-field magnetic flux changes.

However, see our discussions of the giant negentropy process, earlier in this book. Any longitudinal EM "wave in 3-space" is accompanied by a longitudinal EM wave on the fourth Minkowski axis, in the time domain. EM energy does not observably propagate continuously in 3-space, since

observed propagation is a series of frozen iterative observation processes a priori). The "energy flow" actually consists of a propagation in 4-space of a *continual local circulation* of EM energy from the time domain (time-polarized EM energy) to each interacting point dipole in 3-space via the negative charge of the point dipole, thence to the positive charge of that point dipole, thence back to the time domain. In a time-reversed zone, the circulation is in the opposite manner. So what spreads as the "longitudinal EM energy current in 3-space" is actually the spreading point polarization of the vacuum and this giant negentropy 4-circulation involved in every point dipole of that polarization.

We believe this previously unsuspected process is involved in the Aharonov-Bohm effect (which is a sort of polarization in the time domain), other aspects of the geometric phase, fundamental polarization of the vacuum itself, and the very notion of "propagation of EM energy through space". At any rate, the hypothesis does fit the phenomena observed to happen in the MEG, so it warrants additional careful experimental investigation as well as attention from leading theorists.

Further, the MEG is practical and produces practical electrical power, but with a *purely electrical reaction* in the output secondary coils of the transformer section.[202] Hence there is finally a very practical use for the geometric phase: It extracts additional *nonlocalized* EM energy from the vacuum (and local curved spacetime) in addition to extracting and retaining *localized* energy. Both the extra "free" nonlocalized EM energy and the localized EM energy from the vacuum can be intercepted, collected, and utilized to power practical fuel-free MEG-type power systems.

We point out that the rate of changes of all E-fields produced in the secondary and primary coils also produce B-fields proportional to the time rate of change of those E-fields in each case. These secondary B-fields are

[202] This follows from the localization of all B-fields in the core material — including the B-field of the permanent magnet, those B-fields produced by dE/dt operations, and those B-fields produced inside the secondary coils, etc. All E-fields produced, however, including in the changing flux of the core and in the $d\mathbf{A}/dt$ operations of the external uncurled A-potential — are free from that localization restriction and can pass out of the core and interact with the output coils of the transformer section. In short, we have produced the world's first purely electric "induction-free" magnetic transformer device. The voltage and current, measured directly across the secondary coil's ends, is in phase within 2 degrees and even that 2 degrees can be eliminated. We expect the theorists to have a field day in modeling these new phenomena.

retained in the core rather than reaching out into surrounding space. Their rate of change then further produces E-fields, which pass out of the core and interact with the coils. Hence there are very novel "multiple feedforward and feedback" regenerative loops in the MEG's highly nonlinear operation, as well as chaotic oscillations.

7.5 Use of the Aharonov-Bohm Effect in the MEG

From the standpoint of electrical power systems, our own interest in the AB effect focused upon one important characteristic: the clear separation (and localization) of the B-field (the swirl component of the A-potential), leaving the remaining "natural" uncurled field-free A-potential as a free linear flow of energy current in the vacuum. This operation is iterative, and is produced by the core for every B-field produced in the transformer section. So a localized dynamic B-field makes nonlocalized dynamic E-fields, which themselves make further localized dynamic B-fields, which then further make nonlocalized dynamic E-fields, and so on. The result is a very extensive chain of feedforward and feedback field energy loops.

7.5.1 Separation of the Swirled and Linear A-Potentials

The AB effect has long been known in toroidal coils and in long solenoids. In a theoretically perfect toroid, for example, the AB effect separates and localizes the entire B-field inside the toroid, while the *curl-free* magnetic vector potential A appears in surrounding space outside the toroid. By our new interpretation and hypothesis, based on AIAS theoretical work published in the literature, this curl-free A-potential represents a nonlocalized longitudinal EM energy current in space.[203,204] Further, the curl-free A-potential is an extra flow of EM energy that can be intercepted, collected, and used while also still using the entire "normal" B-field energy localized in the core. The neat thing is that the E-field made from the

[203] This is addressed in M. W. Evans, T. E. Bearden, and A. Labounsky, "The Most General Form of the Vector Potential in Electrodynamics," *Found. Phys. Lett.,* 15(3), June 2002, p. 245-261. See also M. W. Evans et al., "The Aharonov-Bohm Effect as the Basis of Electromagnetic Energy Inherent in the Vacuum," *Found. Phys. Lett,* (in review).

[204] See also B. Lehnert and J. Scheffel, "On the Minimum Elementary Charge of an Extended Electromagnetic Theory," *Physica Scripta,* vol. 65, 2002, p. 200. In extended EM theory, the elementary charge may no longer be considered as a fundamental constant of nature, but is expressed in terms of the Planck constant and the velocity of light.

A-potential, and thus providing the actual intercepted and collected EM energy, can be made as large as desired, merely by manipulating the rise time and decay time of the pulses used to perturb the A-potential external to the core. Further, the same perturbation also perturbs the B-field flux in the core, giving rise to nonlocalized E-fields whose magnitude again depends upon the rise time and decay time of the perturbing pulses. Hence the dA/dt and the dB/dt become energy amplification causes, where all the excess F-field energy is furnished freely from the vacuum via a special kind of asymmetrical regauging and gauge freedom. In that sense, the MEG produces and applies a hitherto unrecognized form of direct field energy amplification by asymmetrical regauging.

We noted that this mechanism represents the formation of a locally curved spacetime[205] and engineering of the magnitude of the curvature itself. By freely increasing the local spacetime curvature, the appearance of additional EM energy density in the region follows *a priori*. That is, one still has all the B-field energy produced by the permanent magnet, but it is just confined to the space inside the core. All the energy one "pays for" or inputs with current and voltage to the input coil, in the normal sense, is the energy to *perturb* the localized B-field and the curl-free A-potential. However, even before perturbation to evoke energy amplification, there is already additional energy current that has appeared outside the core, where the magnetic field B would have normally extended. All the A-potential energy[206] is "extra" energy in addition to the normal B-field energy that

[205] More accurately there is one specific curvature of spacetime in the core of the MEG, representing the confined magnetic field B (the localized swirling A-potential), and there is another different curvature of spacetime outside the localization zone, filled with the nonlocalized curl-free (non-swirling) A-potential as a nonlocalized linear energy flow in space. Further, in the MEG we freely change and increase the magnitude of those spacetime curvatures, by the *rate of change* of the input energy rather than by its *magnitude*, and hence we easily increase the magnitude of the energy density of local space both inside and outside the core. That is the fundamental principle of the MEG"s energy amplification (free regauging).

[206] Some scientists even deny that the curl-free magnetic vector potential has any energy! We answer that it produces energetic effects upon charged particles, hence must either contain energy itself or direct and gate the interaction of some local vacuum energy with those charges. In the MEG, the uncurled A-potential is oscillated, which does not appear to yield a *transverse* EM E-field wave at all. Instead, it appears to yield a *longitudinal* E-field wave with an associated scalar KM wave in the time domain. We also explained what appears to happen to the concomitant B-field wave produced by any changing E-field in the secondary

would otherwise have appeared out there but is now confined inside the core.

Further, the uncurled A-potential outside the core reduces its magnitude only inversely as the radial distance, whereas the normal B-field that would otherwise be there in the absence of localization would have reduced its magnitude inversely as the square of the radial distance. This far less rapid fall-off of the magnitude of the nonlocalized curl-free A-potential than the former nonlocalized magnetic field B can result in a remarkable increase in communications range — when a normal EM field antenna with oscillating EM field transmissions is compared to a curl-free A-potential antenna radiating the same power but as curl-free A-potential oscillating transmissions. Golden[207] has applied that effect for long-range communications.

With the application *of the free* Aharonov-Bohm effect produced by the core material and permanent magnet combination, rigorously there has appeared much more available EM energy from the local vacuum than the energy one inputs to the device as one's input energy "payment". Again, this is because the system is an open system far from equilibrium with the active vacuum processes such as the appearance of the uncurled A-potential and the iterative appearance of powerful extra B-fields and E-fields. The rise time and decay time of the input perturbation pulses produces an energy amplification effect both in the core and in space outside the core. When one utilizes this extra uncurled A-potential energy, as well as the now-confined B-field energy, as well as the extra B-fields and E-fields appearing from the iterative processes, then one can extract and use more energy than one himself "paid for" or input to perform the perturbation. Indeed, one can easily extract and use more energy from the curl-free A-potential alone, than one has input. By simply controlling the rise time and decay time of the input pulses, the magnitudes of the resulting E-fields formed in the uncurled A-potential (and in the perturbed trapped B-field perturbations inside the core) can be controlled at will.

(output) coils of the transformer section, etc. The core material withdraws and holds localized, all such magnetic fields formed in the internal MEG core processes.

[207] In the late 1970s Frank Golden demonstrated such an uncurled A-potential **antenna** which attained a range of 20 miles for a tiny CB radio, compared to a range of only 1 mile for the same CB radio with a normal EM field antenna. The energy density of the potential drops off inversely as the distance, while the energy density of the field drops off inversely as the *square* of the distance.

We also point out that all these amplified E-fields produced by multiple actions have both a conventional Poynting energy flow component and an unaccounted, much larger Heaviside energy flow component. Thus the total energy amplification factor can be very large (several orders of magnitude). With efficient interception and collection, in the future we expect to be able to produce at least 100 kilowatts of power out of the same size core and buildup now producing 80 watts or less in a highly nonoptimized set of laboratory experiment MEGs.

We again call the reader's attention to our previous discussions in this book, showing that all EM energy in EM circuits comes from the vacuum anyway (particle physics view) or from the time-axis (relativistic view). This has previously been hidden by the failure of classical electrodynamics to solve the source charge problem, which we also solved in this book after our paper {12} in 2000. Circuit theorists avoided it by indirectly assuming the source charges freely created from nothing all the EM energy in their fields and potentials. The use of the assumed fields and potentials and their Poynting energy was calculated, but never was the source of those fields, potentials, and their energy presented or accounted.

7.5.2 Using the Uncurled A-potential as a Linear Energy Current

A very simple equation allows utilizing the extra nonlocalized A-potential energy, even though it has no curl and therefore no magnetic B-field. That is $\partial \boldsymbol{A}/\partial t = -\boldsymbol{E}$. This equation means that, if one perturbs that large field-free A-potential outside the toroid, it produces an E-field, which we have argued must now be a longitudinal EM wave due to the perturbations *if the B-confining operation is still imposed.* By oscillating the A-potential perturbations, one produces an oscillating E-field that is also an oscillating longitudinal electric E-field wave without an accompanying B-field wave.

The oscillating B-fields in the core also produce E-fields proportional to $\partial \boldsymbol{B}/\partial t = -\boldsymbol{E}$. These extra E-fields are in phase with the E-fields produced by the perturbed external A-potentials, considering the wavelength of the frequencies at which the MEG is operating (30 to 80 kHz nominally).

Interestingly, the time-oscillating rate of change of the E-field in this longitudinal E-field wave does produce a magnetic B-field, but it is confined to only the core material and not in the nonlocalized external spatial region *because of the localization capability of the core material.* The core simply changes its permeability and holds the additional B-fields and their flux in there, thus forming additional uncurled A-potential outside the core. The E-fields produced by variations of the core B-field flux is not confined, but freely passes out of the core material

If that B-field (curled A) is sharply localized by an ongoing localization capability, the longitudinal E-wave has its produced magnetic B-wave component stripped from it and localized. In that case, the process produces a purely longitudinal E-field wave outside the localization region — with the possible exception that a longitudinal B(3) field wave component pioneered by Evans {485} *may be produced as well. That is left as an open question presently unresolved in our MEG experiments. We tentatively believe that the B(3) field wave component is in fact produced, but also forcibly localized in the core along with the magnetic field B. If so, its perturbations will also contribute to producing extra E-fields.*

See Figure 7-5. In the MEG, the localization is accomplished as a unique function performed freely by the special nanocrystalline layered core material. So contrary to the case of the solenoid or toroid, one does not to have to "pay" any EM energy to the localizing component to obtain the localization function itself.

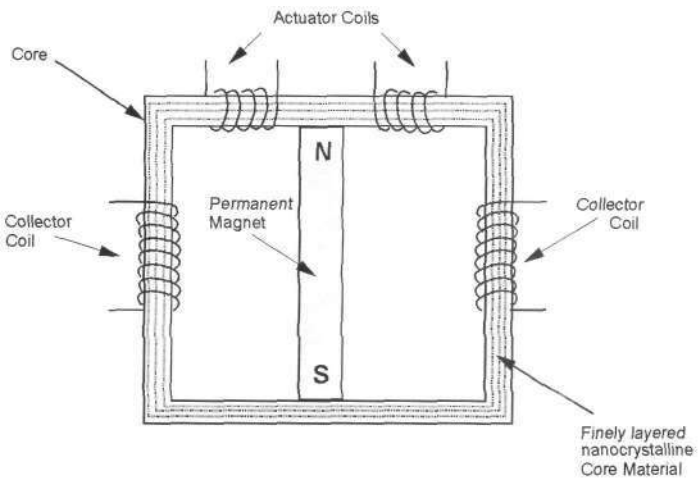

Figure 7-5 Diagrammatic drawing of the MEG.

Further, if one deliberately uses a nearly rectangular perturbing pulse that has very sharp rise time and very sharp decay time, the nonlocalized E-fields, resulting localized secondary B-fields, and resulting nonlocalized secondary E-fields produced can be made very large, with rapid rates of change also. In other words, the magnitudes of the nonlocalized E-fields and localized B-fields produced can be adjusted at will, including in their higher orders. The magnitudes of these evoked fields do not depend on the *magnitude* of the input perturbation energy, but on its *rate of change.* This

is very important, because it means the MEG permissibly achieves energy magnitude increase in its nonlocalized output E-field waves by simple instantaneous power deliberately prepared in its low-energy input perturbation waves.[208] In short, the motionless electromagnetic generator uses perturbation of the Aharonov Bohm effect as an energy amplifying mechanism.

This also affects all the iterative processes, hence all the other E-field waves produced outside the core material.

With the localization process remaining and ongoing (simply because the core material remains), the B-field continues to be stripped away, leaving the perturbed A-potential to produce a longitudinal E-field wave (ignoring the possible presence of a B(3) field also). In the MEG transformer section, the output (secondary) coils are wound around the nanocrystalline core that performs a B-field and B-flux localization within the core itself. Hence a purely net E-field interaction occurs with the electrons in the secondary coils, and the output of these coils is an output having the output voltage in phase with the output current.[209] The AC current in the secondary coils does in fact still produce magnetic field B-flux and B-waves in them, but the core material draws the extra B-flux and B-waves inside and localizes them within the core. The fact that localization is *not quite* 100% at the imperfect junctions of the ends of the permanent magnet and the core material, gives a tiny bit of leakage of

[208] It also means that the MEG operation is highly nonlinear, with very extensive feedforward and feedback field transduction loops. For the MEG, its scale-up, mathematical modeling, and engineering simulation are not simple things at all, but highly complex. In addition, control and stability are more complex, since one must utilize nonlinear oscillation theory (including chaotic oscillation theory) as well as nonlinear oscillation control theory. In addition, a higher group symmetry electrodynamics is required for the modeling and simulation. Consequently, because of these considerations and the geometric phase aspects, as well as the additional close-looping considerations for self-powering operation, an expensive physics lab must be established as well as the usual electrodynamics laboratory aspects. The result is an expensive final research and development program required to complete the MEG to final production prototype units, ready to start rolling off the assembly lines. A minimum capitalization of $20 million is required.

[209] In the actual lab experiment MEG, there is a slightly imperfect junction between the ends of the permanent magnet and the core material. This results in a very tiny bit of leakage of nonlocal B-field —just enough to produce a 2° phase shift between the voltage and current in the secondary coil's output. With a better junction, this phase shift can be further reduced or eliminated.

B-field, so a tiny B-field component does escape, interact, and generate the *2%* or so variation from the complete in-phase condition of the secondary output voltage and current. Again, that can be further reduced or eliminated by improving the junction.

So essentially there is a purely electric field interaction with the electrons in the output coil current of the MEG, hence the result that the output current is in phase with the output voltage — something previously unheard of in a simple secondary coil of a transformer. This is a major practical macroscopic application of the Aharonov-Bohm effect and therefore of the geometric phase.

7.6 Collection of Field Energy in the MEG

To collect and use EM energy in a power generating system, first the EM energy must be evoked from local spacetime (the local vacuum) by the broken symmetry of the source charges and dipoles in the circuit {12}. In the open system far from equilibrium in the resulting EM energy flow, the operator must usually pay for (i) the energy required to *initially* produce the requisite source dipolarity and (ii) the energy required to perform necessary switching and control functions, unless close-looping is incorporated. Using the permanent magnet as a source dipole in the MEG, and using the special nanocrystalline core material to generate the Aharonov-Bohm effect to furnish excess energy from the vacuum, the MEG operator does not have to *furnish* the evoked and available field energy at all. So the first "payment" is totally avoided. Further, the magnetic dipole is not destroyed by passing magnetic flux back through its back mmf. No additional input energy is required to continually restore the source dipole, since it is never destroyed.

In an open-loop MEG system, the operator only has to pay for the second part: the switching and control function energy. In later closed-loop MEG systems, a method of controlled and positive feedback has been developed so that, once the system is up and operating and powering its load, the necessary switching and control function energy can be siphoned off the output and fed into the input in governed fashion, first being transduced into positive energy input form. Once the process is properly synchronized and governing properly, the operator can throw a switch for feedback and transduction, and the unit will be "self-powering", or "fueled entirely by the local vacuum energy", so to speak.

Let us consider the open-loop MEG system we have presently attained in a scries of embodiments.

The total emf force F collected from a given nonzero electric field E, e.g., depends only upon the amount of available intercepting charge, by the simple equation $F = Eq$. Similarly, from any potential ϕ the amount of collected EM potential energy W depends on the amount of intercepting charge q, by $W = \phi q$. Hence in the MEG a legitimate COP>1.0 system is possible if (i) more energy is collected and used from the evoked EM energy flow than is input to gate that energy flow's appearance from the active environment, and (ii) none — or appreciably less than half— of the energy collected in the circuit is used to destroy the source dipolarity.

By invoking the AB effect in a local region, the vacuum contributes additional energy density in the space outside that region, and that energy density can be sharply perturbed so that substantial field energy amplification appears by asymmetrical regauging. The excess energy to provide COP>1.0 performance is freely furnished from the active vacuum (and from the local curved spacetime) {38b, 38c}. The excess energy can be intercepted in the perturbed curl-free A-potential region outside the transformer section, collected, and used to power additional loads, in addition to being intercepted in the transformer secondary region to power the secondary circuit and main load.

Similar contributions of extra energy and extra energy collection outside the core localization region occur for the iterative processes also.

At the same time, the B-field inside the core material is perturbed, but the core material self-varies its permeability to adjust to the additional magnitude of the perturbed B-field. The production of any B-field oscillation inside the core does produce an electric field E, which is not localized in the core. Consequently, energy from the perturbed core-localized B-fields is transduced into nonlocal E-field energy, passing out of the core and interacting with the output secondary coils of the transformer section in purely electric field fashion.

Because of the purely electrical interaction, the voltage and current output from the secondary coils of the transformer section are in phase, and not 90° out of phase as in a transformer. The actual 2° experimental phase shift of current with respect to voltage is a measure of the slight inefficiency of the junctions of the permanent magnet ends with the B-localizing core material.

In the MEG, we are using a novel new kind of component: an *external-induction-free cored inductor*, which might alternately be called *a purely electrical inductor — at least externally.* In short, the inductive action

remains localized in the core, while the electrical action escapes the core and interacts with the coil to drive the current electrically. So here is another excellent, novel, and practical use of the Aharonov-Bohm effect and the geometric phase: Eliminate the inductive reaction of a coil's output, and transduce it into a purely electrical action. At this writing, we are preparing to file a separate patent application upon this latest application and process, and it will already be filed by the time this book is published.

We accent that any field or potential, once made, already involves an ongoing giant negentropy and overunity process {486}, as we previously discussed in this book. Simply calculate how much energy it requires to separate and form the source charge — which can be as simple as charging a tiny little sphere — and recognize that the field formed by that charge is an altered energy density of surrounding space and a polarization of the vacuum. Once the charge is formed, the corresponding alteration and sustaining of spatial energy density change and vacuum polarization freely moves radially outward at the speed of light from the charge, from the very moment it is produced. So a steady flow of observable EM energy is speeding out in all directions from the source charge. An enormous change in the energy density over that external spatial region surrounding the source charge occurs and spreads steadily, moving radially outward in all directions at speed c.

Hence a magnificent and rapidly extending curvature of spacetime — which energetically acts upon any available charged matter therein, by conventional general relativity — is formed and spreads outward in all directions from any source charge, once formed. How much effect on charged matter is exhibited by this freely created and spreading spatial EM energy density change, depends only on the amount of interacting/receiving charged matter in that surrounding space that is available to interact with the energy of the new fields and new potentials.

If **the** source charge or source dipolarity (in this case, primarily the magnetic dipole of the permanent magnet) is left alone and not destroyed, an unlimited amount of energy can be intercepted and discharged from a local load, again and again, from the charge's surrounding field or potential because the energy in the field and potential is steadily replenished from the active vacuum. The only problem is discharge the collected energy in the load(s) so as to leave the original source charges (the magnetic poles) inviolate, and not to destroy them. The MEG accomplishes this function.

This also rigorously follows from the gauge freedom axiom of quantum field theory. Consider this: the ability to freely change the potential — assumed by all electrodynamicists — can be applied directly to the load to potentialized it without any current moving, if there exists a somewhat lengthy electron gas relaxation time in that part of the load that is potentialized. After potentialization, one can switch the source of free potential away, and complete the load circuit separately, so that the excess potential energy is dissipated from the load, powering it. In that case there is no dissipation of the primary source dipole. *Gauge freedom already assumes one can produce EM energy from the local vacuum freely, anywhere and at any time.* In real life, one has to pay a little for the switching, but not for the energy input itself.

Why the scientific community for decades has fiercely opposed the funded experimental investigation of the implications of gauge freedom is quite inexplicable.

As can be seen from the conservation of energy law alone, in theory energy can be continually intercepted and collected from these free fields and potentials, once the source dipolarity (or source charge) creation has been paid for. Further, by applying gauge freedom to potentialized the load without energy dissipation, with a little adroit switching the collected energy can then be dissipated entirely in a separated external load circuit, so that the free potential energy completely exits that circuit without re-interacting with the source dipole and its back emf or mmf.

We predict that the above application of gauge freedom will eventually power most of the world's electrical systems, when the scientific community gives up its present "ostrich position". Once the engineers can build it, the scientists do not have to agree.

That such is not done in our conventional circuits is purely due to the limited vision of the scientific community and its refusal to fund appropriate research. To date, it has not even recognized what actually powers every electrical circuit, or that a common practice (the closed current loop circuit) has eliminated COP>1.0 and self-powering Maxwellian power systems for more than a century. The entire electrical energy crisis hurtling at the nations of the world is due entirely to the shortsightedness of the scientific community, particularly since 1957.

Once the energy is pouring (transmitted) from the dipole and out of the terminals of the generator to fill space around the external conductors, then a straightforward energy transmission and reception problem exists. The source dipolarity produces the steady emission and flow of energy filling

space around the circuit. In the "receiving external circuit" the surface charges and their fields must intercept some of that available EM energy flow and diverge it into the conductors to power the circuit electrons. The intercepted and diverged component entering the circuit is the Poynting component, while the nonintercepted and nondiverged component missing the circuit and usually wasted, is the extra Heaviside component.

Fortunately, every source dipole pours out enormously more EM energy than our feeble conventional circuits intercept and catch to provide the Poynting calculations. So to produce COP>1.0 in the MEG, all we have to do is insure that we have (i) a mechanism easing the interception and collection process, and (ii) sufficient "antennas" containing sufficient conduction electrons (and their fields) to intercept and collect more energy than we pay to make the source dipole and perturb it. Since we pay nothing at all to make the source dipole (which is the permanent magnet), and since the magnetic flux back through the permanent magnet does not destroy the dipole, then all we have to pay for is the perturbation and for switching and control.

The resulting field energy generated outside the core localization region is primarily a function of the rise and decay times for the input perturbation pulses and not the energy of those pulses. From a little input energy with fast little changes, we can easily generate very powerful oscillating E-fields and provide dramatically increased "antenna collection" area with **the** necessary magnitude of intercepting charge. It rigorously follows that COP>1.0 is easily obtainable.[210,211]

[210] Again, for the MEG, changing and controlling the rise time and decay time of the input pulses is a method for directly engineering and controlling the general relativistic curvature of the local surrounding spacetime, because it controls the magnitude of the E-field that is created by $\mathbf{E} = -\partial\mathbf{A}/\partial t$ from the curl-free A-potential outside the core. This also directly engineers and controls the magnitude of the polarization of the local active vacuum. That simple fact allows the use of a unified field theory operation, with a net energy interchange between the system and **the** local active vacuum. To understand the MEG, one must think in terms of the *supersystem.*

[211] All EM energy at any point in space must have been "gated" from the time-domain and it must return to the time domain (as, e.g., by the source charge for it). It **requires** quite a shift of one's mind to realize that all 3-space energy (such as "energy at each point in a potential") involves a gating process and a giant negentropic 4-circulation of EM energy ongoing at each point dipole. Much of the extraction of **energy** from the vacuum has been hidden by thinking in terms of "inputting energy" instead of "inputting or arranging energy flow gating" by the source charges and sourcedipoles.

The MEG is an open system far from equilibrium with its active environment (its active local vacuum and its active local curvatures of spacetime). By attending to the interception and collection part of the overunity problem, the MEG can permissibly collect and use more EM energy to power its loads than one oneself has to input to it. In short, one only has to input a little switching and perturbation energy with properly shaped waveforms, to generate very powerful fields and appreciable field energy available for collection and use. With sufficient collection mechanisms in place, the unit easily produces COP>1.0. Then with proper closed-loop principles implemented, the MEG can be self-powering.

7.7 Experimental Path to Development of the MEG

In our experiments with the Radus effect previously discussed in Chapter 6, paragraph 6.4.5, we had already done extensive work with switching magnetic fluxes for less switching energy than can be intercepted from the switched flux. We had also experimented with various cores for transformer and coil variants, including eventually the new layered nanocrystalline cores.

In our experiments, we noticed a remarkable thing. With certain modern nanocrystalline core materials, and using a permanent magnet to provide B-flux, we found that *the core material would extract and hold essentially all the permanent magnet's B-flux inside the core.* Field measurements right against the outside of the poles of the powerful little neodymium-iron-boron magnet itself showed very little B-flux spilling out into space! In short, we had discovered how to make a magnetic system that *nonlocally* propagated only the uncurled magnetic vector potential A, without any operator energy input. We realized we had discovered a marvelous and free way to freely obtain an excellent Aharonov-Bohm effect, similar to the way a nearly perfect toroid would localize the B-field inside the core, with the uncurled A-potential appearing in space surrounding the toroid. The advantage of our approach over the toroid was that we did not have to furnish any current and voltage to obtain the localized B-flux and the non-localized curl-free A-potential energy.

Further, if we perturbed the B-field flux in the core, we consequently perturbed the uncurled A-potential in space surrounding the core. From both sources — the perturbed B-flux in the core and the perturbed

A-potential outside the core — we could produce very large E-fields and concomitant very large voltages capable of driving more "power" through the secondary coils of the transformer section than the power required to perform the switching and perturbation.

We could easily prove this by perturbing the localized B-flux (and the concomitant surrounding uncurled A-potential automatically) with weak energy. We proved that increasing the rate of the rise time and decay time of even a weak input EM energy perturbation could produce quite large E-fields, including 1,000 to 5,000 volts (or even 20,000 volts!) appearing in the secondary coil if desired. We also proved another thing: *the special nanocrystalline core material in some buildups self-adjusted its permeability, continuing to localize the perturbed and alternating B-fields and their fluxes while freeing the resulting E-fields and passing them out of the core.* In short, the permeability of the specially selected core material automatically adjusted with the perturbation of the localized B-flux and nonlocalized A-potential, so that all the oscillating B-flux remained localized in the core. Further, the highly layered nanocrystalline material produced essentially no eddy currents at all, hence no heating, even in the presence of dramatic B-flux oscillation and dramatic E-field intensities in the surrounding uncurled A-potential space and in the output (secondary) coils of the transformer section of the MEG.

The absolute proof that the core changed its permeability was in the lack of a phase lag between voltage and current in the output from the output coils. Here a remarkable thing was observed: the output current was in phase with the output voltage, within about 2°. In short, under certain circumstances the output coils wound around the nanocrystalline core would exhibit essentially a purely E-field interaction, with only minuscule B-field leakage — something deemed impossible in the typical electrodynamics textbook. This meant that the excess E-fields produced by the perturbed A-potential in space outside the core also reacted with the **output** coil's conduction electrons in a purely electrical manner! This was because the B-fields locally produced in the output coils by the interacting changing E-fields, *were in fact instantly drawn into the core material as they were produced, and were held there so they did not react in magnetic fashion with the electrons in the output current from the secondary coils.*

So this is a dramatic localization of Faraday's law of induction. Consequently, one entire group of embodiments of the MEG uses a purely electrical interaction with the secondary (output) coils of the transformer

section.[212] Or more exactly, the core material draws in all the magnetic fields from the reactions of the output coils, leaving only the electrical reaction outside the core — including in the coil conductors, which obviously are wound outside the core material.

On the other hand, the perturbed localized magnetic B-flux inside the core material did produce the normal E-field to be expected, as a function of the time-rate of change of the B-field. Such an E-field is not localized in the core material, but extends outside the core and interacts with the electrons in the output secondary coils of the MEG's transformer section. Again, the magnitude of this E-field is a function of the time-rate of perturbation of the localized B-field flux in the core.

The nanocrystalline core also has excellent high frequency response, with negligible eddy currents. Thus we can "fine tune" the engineering of the rise time and decay time of the input perturbation pulses.

Hence we accomplish several kinds of "gated energy amplification" in the MEG: (i) the amplified magnitude of the external E-field interacting with the external collectors (such as the output secondary coils) due to perturbation of the nonlocalized external uncurled A-potential, (ii) the amplified magnitude of an additional E-field interacting with the external collectors (such as the output secondary coils) due to perturbation of the localized internal B-field flux inside the core material, (iii) a large number of additional derivatives of higher order B-fields and E-fields are formed and utilized, and (iv) adding additional collectors (either coils wound on the core or external "receiving antenna circuits" produces additional power for heavier loads, for a given perturbation input.

We had exhibited a cored output coil with a remarkable adaptation of the AB effect. Essentially the output of the secondary coil was driven by the large electric field component created from the uncurled A-potential perturbations *and* by the large electric field component created from the B-field flux perturbations inside the core. This peculiar transformer-like section operated from the E-field fluxes emerging or produced *outside* the

[212] Again we accent that the magnetic field reactions do occur, and the B-fields are in fact produced. But the resulting B-fields are also extracted into the core material and localized therein. Even the magnetic B-fields produced in the input and output coils themselves, is so localized and not allowed to interact with the electron currents through the coils to produce the conventional 90° phase lag between voltage and current.

transformer core material, rather than from the magnetic field flux being produced and oscillated *inside* the core material itself.

Obviously we had found a remarkable but legitimate COP>1.0 process and embodiment — in fact, a whole set of them. We had also invented a new kind of "transformer" or energy generator-transducer.

From that we progressed to discovering ways to a dual use of both the perturbed B-flux in the core and the E-fields from the perturbed A-potential outside the core. To first order, that turned out to be fairly simple: any changing B-flux inside the core material and thus inside the output (secondary) coils of the transformer section, produces not only B-field which is held and localized, but also the changes of this local "pinned" B-field further produces E-field oscillations which are not pinned in the core. Hence the electric field half of a normal transformer action could and did occur in the secondary coils, but the magnetic field half did not occur *in the coils themselves.* The MEG used and uses a nearly pure E-field interaction in the output coils of its transformer section secondary, where that net interacting E-field comes from a variety of E-field generating mechanisms.

We filed our first patent, and then filed a second patent application soon after. Presently we are preparing to file our third and fourth patent applications on additional phenomenology and mechanisms uncovered in our experiments. As we are writing this section, our first patent has issued {37}.

In the view of the present author, we have uncovered a remarkable new application of the Aharonov-Bohm effect and the geometric phase, one that is practical and eminently useful in novel new electrical power systems.

7.8 Additional MEG Functions

Figure 7-6 diagrammatically shows the core material inside the input coil for either open-loop operation using an external power supply or closed-loop (self-powering) operation using clamped and governed positive feedback. As can be seen, the B-field and B-field flux are confined to the core material (which is in the form of a closed transformer coil path, as shown diagrammatically in Figure 7-5). The external space surrounding **the** core material is filled with the uncurled A-potential, due to the Aharonov-Bohm effect being imposed by the core material. The two leads from the input coil are shown at the bottom of Figure 7-6.

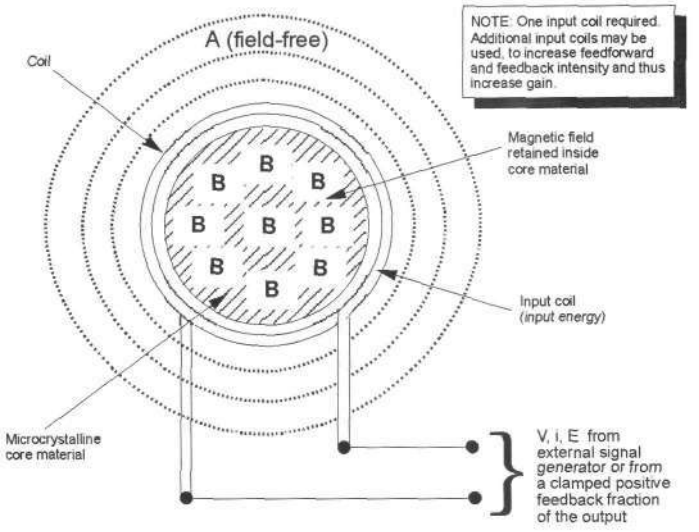

Figure 7-6 Input coil for open- or closed-loop **operation.**

We pulse the input coils with nearly rectangular pulses each having a sharp leading edge and a sharp trailing edge, so that the resulting rapid time-rates of change of the two edges create very large perturbations of the B-flux in the core and of the A-potential outside the core. The large E_2-field resulting from the fast rate of change of the perturbed B-field in the core is not localized, but appears in space outside the core. In addition, an E_3 field created directly in the coil itself also appears in space outside the core. In addition, the sharply perturbed A-potential outside the core creates a third large E_1-field in space outside the core. The net E_t-field in the surrounding outside space is the vector summation of the E-fields produced by these processes, or to first order (neglecting the further differentiations)

$$\mathbf{E}_t = \mathbf{E}_1 + \mathbf{E}_2 + \mathbf{E}_3 \qquad [7\text{-}1]$$

We also may adjust the pulse width to generate a further Lenz law effect, increasing the three component fields E_1, E_2, and E_3 if desired. To do that, the pulse must be narrow enough to suddenly decay while each of the fields E_1, E_2, and E_3 is still rising and not yet reached maximum. As can be appreciated, considerable pulse shaping and timing can be adjusted for optimization of the output voltage, current, and power when interception and collection from E_t is accomplished in the secondary coils. In addition, it can be appreciated that slightly differing materials delay times do occur in the production **of E_1,** E_2, and E_3. Hence there is appreciable

optimization that can be and is accomplished on a given MEG variant and build-up type.

More complex waveforms of various shapes can be used to further optimize the output. It is also possible to accomplish further optimization and control by adjusting the shapes and timing of the feedback signals in the case of the closed-looped MEG system. For the externally powered open-loop version, additional optimization and control can be achieved by adding additional simultaneous pulses fed into the input coils in various fashions.

In addition, the response of the output coils produces feedback into the core material, into external space, and into the input coils. These in fact provide three more E-field *return* or feedback inputs, so that the total feedback input is

$$\mathbf{E}_f = \mathbf{E}_4 + \mathbf{E}_5 + \mathbf{E}_6 \qquad [7\text{-}2]$$

Without doing the more complex iterations for this feedback and feedforward set of loops, to first order the total input E_I to the input coil may be considered to be

$$\mathbf{E}_I = \mathbf{E}_t + \mathbf{E}_f \qquad [7\text{-}3]$$

Equations [7-1], [7-2], and [7-3] are for simple analogy only; in the real MEG, full nonlinear feedforward and feedback analysis techniques must be utilized because of the iterative operations, and much more sophisticated optimization techniques are appropriate. Also, chaotic oscillations can and do appear, and techniques for control of such oscillations are indicated, particularly along the lines indicated by Fradkov and Pogromsky {487} without use of probability etc. Quoting:

> *"1. There is ... great benefit of using the modern nonlinear and adaptive control theory. ...2. There is no need to distinguish periodic and chaotic behavior. Accurate control is possible without accurate prediction. ...3. There is no need to define chaos in order to control it. ...4. There is no need to use probability in order to control systems with seemingly random behavior."*

For any given MEG build-up design, one experiments with these optimization and control factors and mechanisms to provide the best performance, and to provide rock-steady performance.

Figure 7-7 shows the output coil for either open-loop operation from an external power supply or closed-loop (self-powering) operation using

clamped and governed positive feedback. Here the situation is partially reversed. There are three major inputs to the output coils, and these are (i) the external input from the total outside E-field, (ii) the internal input from the perturbation changes in the confined magnetic flux inside the core through the output coils, and (iii) the ensuing feedforward and feedback from all E-fields.

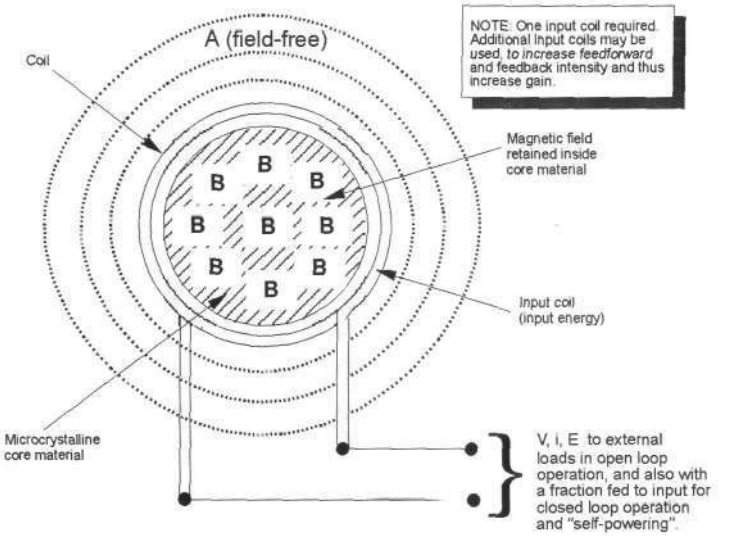

Figure 7-7 Output coil for open- or closed-loop operation.

Again, this is simply an easy way to visualize the situation to first order. In the real case, sophisticated feedforward and feedback analysis is required and utilized. Optimization usually consists of two steps: (1) the simpler, more direct optimization techniques such as adjusting pulse width, pulse rise time and decay time, actual pulse form, etc., and (2) the deeper and more complex optimization arrived at from detailed feedback and feedforward loop analysis as well as nonlinear oscillation and nonlinear control theory analysis.

In the actual optimization analysis, the feedback and feedforward loops are mathematically endless and thus should be optimized for quick decay and stability. On the other hand, the MEG also has the ability to self-oscillate over the entire unit, in which case the feedback and feedforward loops are optimized for stable self-oscillation of the entire unit. The self-oscillating

MEG is permitted since it is an open system far from equilibrium with its active environment.

So if desired, an entirely different kind of optimization can be utilized for self-sustained nonlinear oscillation and closed loop operation. Because of the gain achieved in the large E-fields produced by the perturbed uncurled A-potential in space surrounding the core, there is sufficient excess energy collection available in the output coils to use the available feedback and feedforward loops in the system itself to achieve system self-oscillation. The system can be operated as a self-oscillating open system freely receiving excess EM energy from its active environment — the local active vacuum, local curvatures of spacetime, and local freely furnished uncurled A-potential and resulting nearly free E-fields from the A-potential's perturbations). As we are writing this, our experiments are now in this direction, and we are preparing the material for filing a formal patent application on this additional process. The patents will be filed, of course, by the time this book is published.

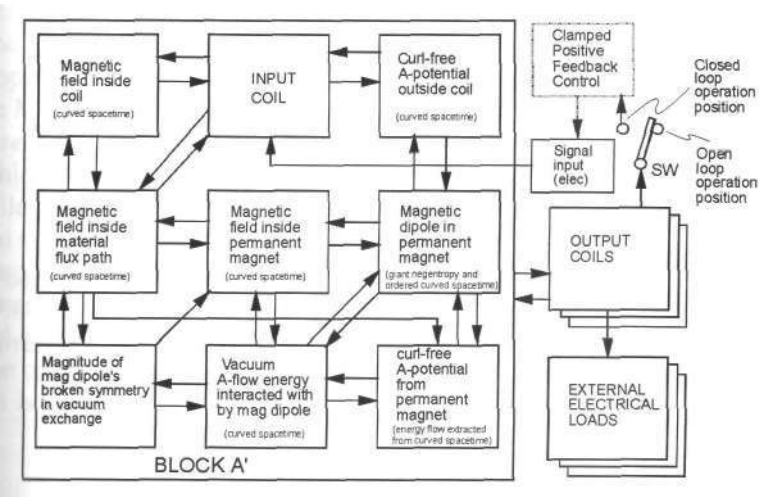

Figure 7-8 Energy gain process using feedforward and feeback subprocesses

A highly simplified block diagram of energy gain process using feedforward and feedback subprocesses is shown in Figure 7-8. As can be appreciated from this high order diagram, the actual feedforward and feedback loops are extremely complex, and a great deal of complex analysis is required for a self-oscillating, stable, controlled system. We also stress that control measures to insure and hold stable self-oscillation

must be included in the overall features implemented in this self-powered, self-oscillation variant of the MEG. Not only must we use chaotic oscillation techniques to achieve the self-oscillation, but also we must use advanced techniques for stable control of such nonlinear oscillations, as indicated by Fradkov and Pogromsky {487}.

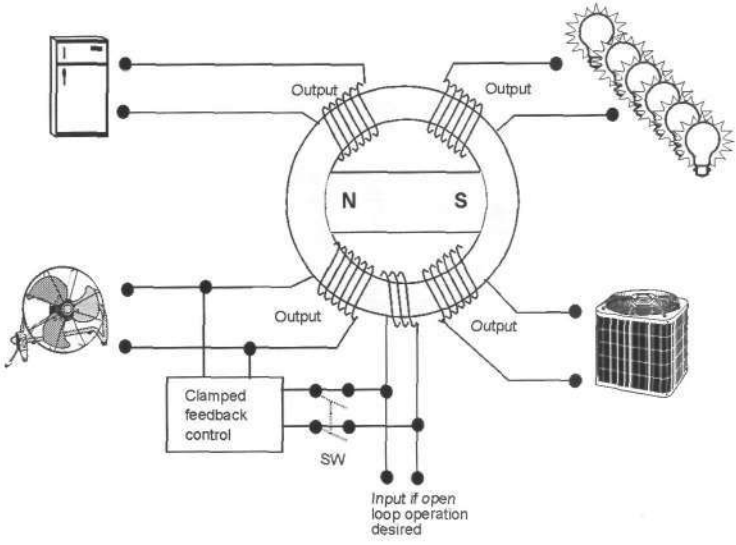

Figure 7-9 Typical MEG embodiment application on site.

In Figure 7-9, we show a typical diagrammatic embodiment envisioned for the MEG in a household, using a large MEG to later be developed. For interim installations, the single large MEG will be replaced with an array of MEGs together with a synchronizer, as shown in Figure 7-10.

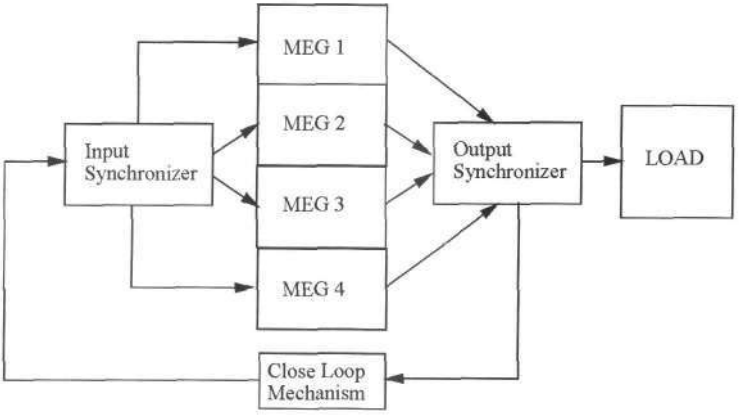

Figure 7-10 MEG self-powering array concept for increased powering applications.

Figure 7-11 shows a MEG unit where additional special collection antennas feeding separate circuits are employed in an "outrigger" fashion. One major advantage of this configuration is that the complexity of close-looping and its control are materially reduced, although the complexity of the MEG build-up and stabilization is increased. Another advantage is the *ease* with which close-looping for self-powering operation can be achieved, as shown in Figure 7-12. In this case, the external antennas are collected to independent output circuits (not shown) in the output section, and each of these independent outrigger outputs is a COP<1.0 circuit if we count the perturbed A-potential energy input as an "operator's" input. Completely normal clamped positive feedback can be used with sensing and governing, to allow self-powering and self-adjusting to varying loads. The outrigger embodiment can be made to almost entirely avoid the Dirac sea hole current problem.

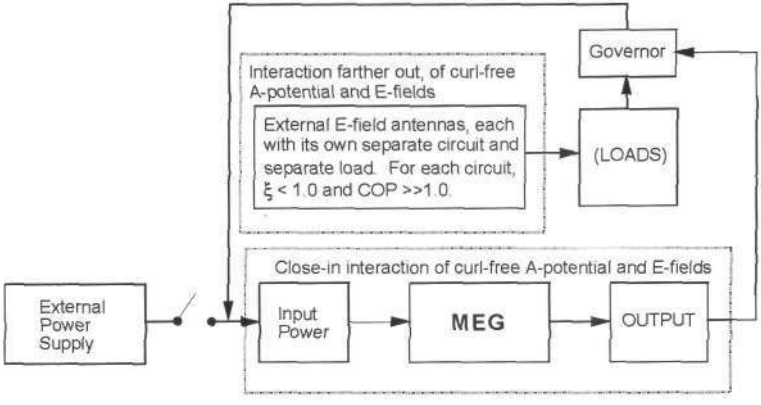

Figure 7-11 MEG unit with outrigger antennas for extra energy collection.

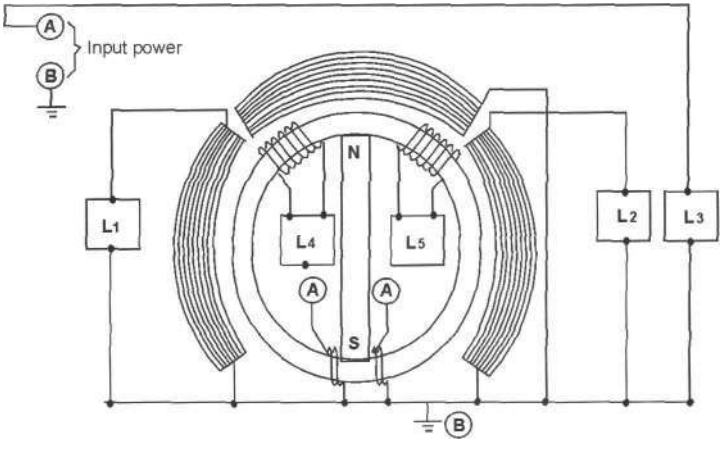

Figure 7-12 Use of outrigger antennas for damped positive feedback method of close-looping.

As can be seen, the MEG has many possible configurations and embodiments, each of which has special advantages and uses. One of the embodiments we discussed is the deliberate use of self-oscillation forced by the feedforward and feedback loops. That is a separate embodiment, and capable of a very high power per pound ratio, but it also requires more sophisticated sensing and control techniques.

7.9 In Conclusion

By the time this book is published, Magnetic Energy Ltd. is hopeful it will have achieved its major funding requirement, and be well along the way to completing the research for full production and marketing of MEG units on the world market. We have arrived at that part of development — the need for substantial funding (several tens of millions of dollars) — where every previous COP>1.0 EM power system has died. We intend to do everything within our power to see that we obtain the funding, finish the complex research task, and get the MEG onto the world market.

For additional information on the MEG and on its preliminary replication by Naudin, the reader is referred to other technical articles {488} and to Jean-Louis Naudin's website.[213] Actual measurements for one of Magnetic Energy Ltd.'s MEG test units is given in reference {488a}. The MEG patent {37} shows the variation of COP for a test MEG with various conditions. Curves for Naudin's measurement of the performance of his replicated MEG unit are given on his website.

The MEG project is a most interesting project, because of the involvement of so much advanced physics and several different physics areas, as well as the prerequisite for higher group symmetry electrodynamics. Once funded, we are confident we succeed in crashing through the barriers and getting working MEG power units — including self-powering MEG units — on the market. We also believe the MEG will represent a substantial contribution to alleviating the coming worldwide energy crisis. Hopefully it will materially hasten the growth and evolution of the present highly centralized — and terribly vulnerable — national energy infrastructure into a highly decentralized — and much less vulnerable — national energy infrastructure. We also believe it will provide a great contribution to helping alleviate global warming, reducing pollution of the biosphere, and reducing the production of hazardous wastes. If so, it will be a continuing

[213] Naudin's website MEG material and information is at http://jnaudin.free.fr/html/meg.htm. Particularly see his Mark III replication, shown powering a light on that webpage.

contribution, not only to humanity today, but also to generations yet unborn.

Chapter 8
Approach to Antigravity

[Large-scale antigravity exists] *"...baryonic, ordinary matter—the stuff of stars and of people—makes up just over 4% of the energy and matter in the universe. ...about 30% of the stuff in the universe is dark [unobserved] matter. The remaining two-thirds, theorists believe, is a mysterious 'dark energy' or 'quintessence'—a large-scale antigravity-like effect that is making the universe expand ever faster.... "* [Charles Seife] {489}.

[On the nature of the vacuum] *"...the (electromagnetic) vacuum is the ground state of the quantized electromagnetic field. ...The Dirac electron vacuum is that state with all negative energy electron states fully occupied."* [Aitchison] {490}

[On forces and how charge exists] *"Vacuum polarization, in general, alters the effective force law. Forces, in quantum field theory, are understood as being due to the exchange of virtual quanta ...In the case of QCD and QFD, ... a crucial new feature is that the force-field quanta themselves carry the 'charge' of the force-field, i.e. it is as if the photon of electromagnetism carried electromagnetic charge."* [Aitchison] {491}

[Possible gravitational circuits] *"There is an implication ... that gravitational excursions might be controllable by gravitational 'circuits', analogous to electronic circuits, which could lead to a controllable form of negative gravity."* [Robert Neill Boyd] {492}.

[Gravitational circuits] *"The supersystem concept utilizes a unified fields approach so that specialized electrical circuits in COP» 1.0 condition generate strong Dirac sea hole currents of negative energy in the immediate local vacuum. Thus a strong negative energy field is formed surrounding the circuit and changing the curvature of local spacetime as an action by the source*

circuit. This produces a direct antigravity field around the circuit or physical system, acting upon the mass of the system. The net gravitational interaction by that circuit or physical system is therefore the summation of the local positive gravitational field and the new local negative gravitational field produced by that negative energy field." [T. E. Bearden, correspondence to a colleague, February 2002.]

[On the multiplicity of spacetime curvature components] *"The full mathematical expression for the curvature of four-dimensional space-time ...is given by something called the* <u>*Riemann curvature tensor*</u>*. This is a somewhat complicated object, needing twenty real numbers at each point in order to specify it. These twenty numbers are referred to as its* components. *The different components refer to the different curvatures in different directions in the space-time."* [Penrose] {493}.

[Physics studies and prepares imperfect models, not perfect truth] *"All we ever know is our models, but never the reality that may or may not exist behind the models and casts its shadow upon us who are embedded inside it. We imagine and intuit, then point the finger and wait to see which suspect for truth turns and runs. Our models may get closer and closer, but we will never reach direct perception of reality's thing-in-itself"* [Hawking] {494}.

8.1 Introduction

In this chapter, we first present a highly abbreviated background of the theory of gravitation, sufficient for our experimental orientation. Of special interest are unified field theories, which cover general relativity, electrodynamics, and quantum mechanics in one overall master theory. Even more of interest is an engineerable unified field theory, which is presently closest approached by the theory of Mendel Sachs {510}.

We then present a short overview of work that has been done in the fields of lifters and inertial propulsion, listing some of the inventions of interest, the approaches, results achieved, and our comments on each.

Finally, I present my own approach to antigravitation, and give some results of the Sweet device's antigravity test (the test was designed by the present author) that successfully reduced the weight of a device by 90%.

In our view, this experiment fully demonstrated the veracity of our theoretical approach.

8.2 Selected Theories of Gravitation

8.2.1 Newton's Theory and a Negative Mass Extension

The first mechanism for gravity of interest to our purposes was advanced by Newton in his work on mechanics {495}. Newton's law of gravitation may be stated as {496}:

> *"A particle of mass m_1 attracts a particle of mass m_2 a distance d away with a force* $F = G\frac{m_1 m_2}{d^2}$ *in the direction of the line joining the particles."*

Of course, it should have stated "in a time forward zone". The situation is precisely reversed in a time-reversal zone. It is also reversed for negative mass-energy.

In the Newtonian view, antigravity would mean repulsion of mass rather than attraction of mass. Given that negative mass is possible, then a negative mass would exhibit antigravity — i.e., it would be repelled by all other positive masses.[214] This can be seen in the quoted equation, by

[214] The discussion of what attracts what and what repels what, in a mix of negative and positive masses and negative and positive energies, is still controversial in physics. Different theorists have taken differing positions, and there is no formal experiment that has decided between them. In our opinion, the successful antigravity test of the Sweet vacuum triode amplifier answered that question experimentally, although independent replication was not accomplished. The scientific discussions heavily involve discussions (and assumptions) of the nature of "gravitational" mass, inertial mass, and electrodynamic mass etc. Again, there is no decisive selection among several possibilities, and there is no clear and universally accepted definition of **any** of those three types of mass.

In addition, all the discussions have included a fundamental error: They **assume** a separate 3-force acting upon a separate 3-mass, which is unequivocally false. Another fundamental error is the assumption of an observed (effect) 3-positron interacting with normal matter rather than a non-observed (causal) 4-positron (negative energy 4-electron) in massfree spacetime. In effect, this applies the CPT (charge-parity-time) symmetry, and converts the direction of the 3-positron to the antidirection of the 4-positron while also changing the negative mass of the 4-positron to positive mass of the 3-positron. Further, in physics there is still no firm **definition** of either force or mass, but only circular definitions between the two. We are using the simple definition of mass as $F = d/dt\ (mv)$, where mass is a component of force F and hence there is no separate force F acting upon a separate mass m. We

interpret that equation as "the force *F* observed in a new observation is proportional to the time-rate of change of the ongoing 4-space interaction between the just-observed 3-mass *m* and the average interchange of time-energy and space-energy represented by v in the ongoing dynamics between spacetime and mass *m*. Whatever adjective is prefaced upon the *F* is also prefaced upon the *m* in the *mv* term.

We politely but firmly disagree with one prevailing notion that positive mass *attracts* both positive and negative mass, while negative mass *repels* both types. Further, we believe that the Sweet vacuum triode amplifier antigravity experiment falsified that notion. We hold to the dictum that m == E/c^2, where E is real spatial energy and may be positive or negative, c^2 is always positive, and therefore negative mass is highly compressed negative spatial energy while positive mass is highly compressed positive spatial energy. (Imaginary mass is a separate consideration.) We also prefer to reason in "single fundamental units" physics where the joule is the only fundamental unit. Gravity then becomes a function of the joule, whether electromagnetic, mechanical, or whatever. *We consider the energy in spacetime to he the source of the curvature of spacetime that is known as " gravitational field".* If the joule is of positive energy, the accompanying gravity is positive. If the joule is of negative energy, the accompanying gravity is negative. And we consider gravity as the 4-space causal spacetime curvature. So for gravitational interaction theory, we insist on examining the interaction of the curvature of local spacetime with the mass-energy. Further, we postulate that the gravitational effect upon one mass from a second mass is an improperly posed concept. It actually is an effect of the local curvature of spacetime around the first mass, where that curvature of spacetime was induced by the second mass's energy. Further, we consider that positive energy fields surrounding a positive mass will curve spacetime in the "positive gravity" direction. The positive mass is attracted by all other positive masses. Negative energy fields surrounding that positive mass system curve spacetime in the "negative gravity" direction so that the positive mass of the system is at least partially repelled by all other positive masses in the universe.

We further prefer to think in terms of the *supersystem* and the unobserved causal 4-field, not the frozen iterative 3-field snapshots defined only after iterative . observations. As we stated previously, the "observed" 3-positron is, in our view, a very different beast from the as-yet-unobserved 4-positron. The 3-positron is a frozen momentary "effect" entity with no dynamics at all and no continuous existence in time (and hence in spacetime) at all; instead, it continually *recurs* as the iterative effect of iterative observation by iterative application of the *d/dt* observation operator. The 4-positron is still a negative energy electron with negative charge, and still going in a non-reversed direction since broken parity has not been applied (because observation has not been applied), a causal entity with ongoing dynamics, continuously existing in spacetime, not just in 3-space. Until interacted and observed, it also has negative energy and negative mass-equivalency.

If one wishes to accurately deal with spacetime effects from the "positron," in our view one must deal with the 4-positron before observation, and hence with the supersystem. The 3-positron is not a *spacetime* entity, but only a frozen *3-spatial* snapshot. Scientists, including Dirac himself, were horrified at the negative mass implications of the negative energy states. Therefore, they moved the interpretation

simply replacing positive mass m_1 by negative mass $-m_1$. That two negative masses would attract can be seen by replacing positive mass m_1 by negative mass $(-m_1)$, and also replacing positive mass m_2 by negative mass $(-m_2)$.

Now consider mass m_1 to be the rest of the net positive mass in the universe, and mass m_2 to be the "effective" mass in a local supersystem consisting of the local physical system, its local active vacuum, and its local active curvatures of spacetime — in short, in a local supersystem consisting of the physical system and its local active environment, and the interchanges between them. Let $m_2 = m_p + m_n$, where m_p is the amount of local positive mass (or mass-equivalent) in the system and m_n is the amount of negative mass (or mass equivalent) in the system. This supersystem now simultaneously exhibits both positive gravity (attraction) to all net positive masses in the universe and negative gravity (repulsion) to them as well. The net gravitational response of the supersystem depends upon the fraction of the effective mass that is positive and the fraction that is negative — in short, upon the net vector sum of the two gravitational forces.

to the 3-positron, and thereby twisted the interpretation to substitute the effect for the cause. Hence circuit theory treats the *lattice hole* as a positron, yet that "hole" acts very differently from a true Dirac positron (a Dirac sea negative energy electron) in free space.

Consequently, matter-antimatter interactions and the interaction between positive energy and negative energy are quite different, or they can be if so manipulated prior to observation. In the matter-antimatter interaction, the initial curvature of spacetime formed by the union decays by radiation of EM positive energy and the "effect particles" disappear back into the uncurved vacuum from whence they came. In the positive energy and negative interaction, there is a change of the local curvature of spacetime without its decay and subsequent re-radiation of EM energy. Equal amounts of interacting positive and negative EM field energy thus are simply transduced into stress energy potential of the vacuum and consequent sustained change in the curvature of the local spacetime. Indeed, the radiation of pair annihilation energy is obtained only at the expense of negating (relaxing) the local polarization of the vacuum (and the two consequent curvatures of local spacetime) represented by the independent positron and electron. Indeed, normal pair annihilation is a sort of Lorentz symmetrical regauging of the locally asymmetrical vacuum.

The reader is certainly free to disagree with our conclusions; we are merely explaining them. Experiment will eventually sort out the truth or falsity of the approach. So far, based on the Sweet experiment designed by the present author, a highly successful experiment was consistent with this approach.

In a "mixed" mass system containing both positive and negative component masses, the fraction of the total mass that is positive and the fraction that is negative is thus significant. When the mixture's negative mass is less than its positive mass, the mixture would exhibit a "reduced" gravitational attraction to other masses of the universe. Then the ratio of negative mass to positive mass might be taken as the "gravitational shielding" coefficient (fraction).

When the amount of positive mass and the amount of negative mass were equal, the overall mass system would exhibit no net gravity or antigravity, and would "float" or "hover" in the Earth's gravitational field. It would be equally attracted and repelled by the Earth's positive mass (and by all other positive mass in the universe, hence could — at least under certain conditions — *appear inertia-free.).* When the amount of negative mass exceeds the amount of positive mass, the overall mass system would exhibit a net antigravity effect. It would be repelled more strongly by the Earth's positive mass, as well as more weakly by the distant positive masses of the universe, and hence would accelerate upwards and away from the Earth. Notice that the key to antigravity in the Newtonian approach is the availability of negative mass, but in the new sense in which we use it. Note also that we did not discuss the separate issue of imaginary mass.

If we translate that into modern terms, where we consider not the "mass" but the condensed energy comprising the mass, then m_p and m_n become positive mass-energy and negative mass-energy terms respectively. Given the ability to produce electromagnetically produce substantial negative field energy in the immediate vacuum environment of the system, where the source of the field is the physical system, then the creation of a direct antigravity component in the system's environment — the other two components of its supersystem — becomes not only possible but also feasible.

The key to antigravity becomes the *availability of negative field energy in the local space surrounding the physical object, with the physical object containing the source of that surrounding spatial negative energy field.* Voila! This impels us directly to electrodynamics and a modified Dirac sea {497, 498a, 498b), one with excess empty holes as source charges producing negative energy EM fields. We deliberately create these unique source charges by actions taken in a COP»1.0 system. This gives the key

to the approach to antigravity taken by the present author.[215] However, we use as negative energy not just the accounted *Poynting* energy flow component in space where the field is present, but also the unaccounted *Heaviside* energy flow component, which is much greater in magnitude (in a nominal case, nearly 10^{13} times greater). In this way, we dramatically increase the amount of antigravity effect that can be obtained by a given EM power dissipation in the physical electrodynamic system itself. *This antigravity effect of a Heaviside component of EM negative energy flow has not been accounted in previous analyses.*

8.2.2 Riemann Surfaces and Riemann Geometry

The next development of interest to us is the doctoral thesis of Riemann {499}, which founded the theory of Riemann surfaces. Three years later, he founded Riemann geometry in a famous lecture. Riemann was working on a unified explanation of gravity and electromagnetism when he died of tuberculosis a dozen years later. It was Riemann's multiply-connected topologies that eventually resulted in the view of electric charge producing lines of force trapped in the topology of space {500}. Had Riemann lived, we believe that engineerable unification of electrodynamics and gravity would have occurred early on. In that case, we might have already had practical antigravity vehicles and explored the solar system and beyond.

8.2.3 Heaviside's Excess Energy Circulation Flow and Gravity Theory

The next theory of gravity of interest to us is that of Oliver Heaviside. Heaviside noted that his extra EM energy flow term was a trapped EM energy circulation {501}. He realized that, if that trapped EM energy circulation were taken as gravitational in nature, his energy flow theory could be converted into a unified theory incorporating both electrodynamics and gravitation. After his death, his handwritten notes on the theory were found beneath the floorboards in the little garret apartment he had long occupied. No one knows what other papers he may have had; the place was ransacked and looted prior to the discovery of these remaining papers hidden beneath the floorboards — papers the looters had missed.

[215] We also point out that a Dirac sea with empty holes (excess negative energy states) exists in (or constitutes) a negatively curved spacetime *a priori.* So we get back to the other two components of our "supersystem", the active vacuum and its dynamics and the local curvature of spacetime and its dynamics.

Other scientists such as Laithwaite have felt that Heaviside's approach might still shake the foundations of physics itself. Quoting Laithwaite {502}:

> *"Heaviside had originally written the energyflow as S = (ExH) + G, where G is a circuital flux. Poynting had only written S = (ExH). Takingp to be the density of matter and e the intensity ofa gravitationalforce, Heavisidefound that the circuital flux G can he expressed as pu — ce, where u represents the velocity of p and c is a constant."*

8.2.4 Mach's Principle

After Heaviside, the next item of interest to us is Mach's principle {503}, which essentially states {504}:

> *"The properties ofspace have no independent existence but depend on the mass content and distribution within it. Thus, acceleration dealt with in Newtonian mechanics can only have meaning ifit is an acceleration with respect to the stars or with respect to something equally well-defined."*

Mach's principle does not adequately deal with spacetime, and certainly does not even acknowledge or encompass how energy exists in 3-space at each point dipole, as an entering flow from the time domain into the negative (charge x time). It does not include transduction by the negative charge into 3-space energy, passage of the 3-energy to the associated positive charge, transduction back into time energy by the positive charge, and re-emission of the transduced time-energy back into the time domain, by the positive charge. In short, Mach's principle will never get one a practical antigravity system, regardless of how one applies the principle.

8.2.5 Einstein's General Relativity

Next comes Einstein's epochal general relativity theory of gravitation {505}. In that theory, Mach's principle is interpreted as pointed out by Misner, Thorne and Wheeler {506} in the following quote:

> *"...Einstein's theory (1) identifies gravitation as the mechanism by which matter there influences inertia here; [and] (2) says that this coupling takes place on a spacelike hypersurface..."*

The great contribution of Einstein's general relativity was to remove the notion of the "field occupying space", where field and space are separate things. Quoting {507}:

> *"If we imagine the gravitational field, i.e., the functions* g_{ik} *to be removed, there does not remain a space of the type (I) [Minkowski Space], but absolutely* <u>*nothing*</u>*, and also no 'topological space'. For the functions* g_{ik} *describe not only the field, but at the same time also the topological and metrical structural properties of the manifold. ... There is no such thing as an empty space, i.e., a space without field. Space-time does not claim existence on its own, but only as a structural quality of the field."*

In passing, we note that in the conventional sense we can and do have many fields "in the same space", which is merely the statement that a net field has internal structure, and so does a net spacetime. Extending that notion, we can conclude that spacetime is in fact naught but a set of fields, both static and dynamic. The total energy density of all those fields at any point in space constitutes *a potential* with that energy density at that point, and with that internal field dynamics and structure. So because of its incredible field energy density, space is also *identically* a giant potential with internal structure and dynamics. With that observation, we rather casually join the seething vacuum of particle physics, the spacetime of general relativity, and the fields of electromagnetics as *different aspects of the same thing.* We point out that our concept of the supersystem therefore only identifies the three separate things into which this "one-thing" has been arbitrarily divided in much of physics.

Although he tried more than once, Einstein himself failed to achieve a successful unified theory of gravitation and electrodynamics. One thing he added in his earlier theory was a cosmological constant, which he felt was necessary to explain a stable closed universe. He later regretted that assumption, but today with the discovery of the acceleration of the expanding universe, which can only be caused by antigravity, his cosmological constant has assumed a new and vital role in the search for the source of this observed antigravity effect in the cosmos.

8.2.6 Kaluza-Klein 5-Dimensional Unified Theory

Using five dimensions, a unified theory of general relativity and electrodynamics was advanced by Kaluza {508} as extended by Klein (509}. This is a notable extension of Einstein's theory, and a very substantial literature exists in the Kaluza-Klein area.

8.2.7 The Sachs Unified Field Extension of Einstein's Theory

Another notable extension of Einstein's theory, which does include electrodynamics and the results of quantum mechanics as well, is the theory by Sachs {510}. Starting with Einstein's general relativity view and the group symmetry of its underlying mathematics, Sachs extended Einstein's theory into a fundamental theory of matter in all domains. Einstein's group formalism and the spinor-quaternion calculus in a curved spacetime provide the genesis of matter fields. The theory encompasses globally covariant field equations for inertial features of matter including its force manifestations. Unification is provided by the generalized spinor formalism. Quoting a popularized summation {511}:

> *"Novel features of general relativity are shown to emerge, in elementary particle physics as well as astrophysics. Especially noteworthy ...is a factorization of Einstein's field equations to a quaternion field formalism which, by way of a single covariant field, includes both gravitation and electromagnetism coupled to matter field equations — whose linear (low energy) limit recovers quantum mechanics. The ...original approach also furnishes derivations, not previously available, of several observed properties of inertial mass and gravitational force. "*

For a more technical description of how the unification of electrodynamics with general relativity is derived, we quote directly from Sachs {512}:

> *"It was demonstrated earlier that the factorization of Einstein's second-rank, symmetric tensor field equations, by removing the space and time-reflection elements from the underlying covariance group, yields a 16-component quaternion metrical field equation. The 16 equations were then re-expressed in a second-rank tensor form, breaking up into 10 $\oplus$ 6 equations. The 10 equations are in one-to-one correspondence with Einstein's symmetric tensor equations for gravitation; they are even under reflections. The remaining 6 equations are in antisymmetric tensor form; they are odd under reflections. Taking the covariant divergence of the latter equations then puts them into one-to-one correspondence with the structure of Maxwell's equations for electromagnetism. What was shown earlier was that the four of Maxwell's equations with sources followed. What is shown in this paper is that the other four of Maxwell's equations that are source-free also*

follow, thus indicating the absence of magnetic monopoles from this theory, as in the usual Maxwell formalism. This shows that the factorization of Einstein's field equations to the quaternion form fully unifies the gravitational and electromagnetic manifestations of interacting charged matter."

To freely download several of Professor Sachs's important technical papers, one is referred to his website at http://www.compukol.com/mendel/articles/articles.html.

The O(3) electrodynamics of Evans and Vigier has been shown to be a special subset of Sachs's electrodynamics {513a}. Hence O(3) can be used to engineer much of the Sachs unified field theory phenomenology, including — in our view — both gravity and antigravity. The first theoretical indication of this has been published by the AIAS (Alpha Foundation's Institute for Advanced Study) {513b}. Shortly we discuss our own views on how to directly perform engineering of antigravity.

A great many excellent publications on general relativity and the background of scientific knowledge in gravity exist; e.g., the text by Wheeler *et al.* {514} is particularly good. Einstein himself wrote a book on his special and general theory for the nonspecialist {515}. A collection of English translations of some of the original papers on relativity is provided in a book by Einstein, Lorentz, Minkowski, and Weyl {516}. Many other gravitational theories or changes to major theories have also been proposed by other scientists, but are not discussed here. For our purposes, an abbreviated discussion will suffice to understand a fundamental approach to feasible antigravity.

Since we are interested in actual working systems, a short review of some of the efforts in asymmetric lifting and propulsion experiments is useful.

8.3 Selected Antigravity and Inertial Propulsion Research Efforts

We give only a small sampling of the many efforts performed or ongoing in this area over the last few decades, and some still ongoing today.

8.3.1 T. Townsend Brown

Our first example is the work of T. Townsend Brown. Brown was working **on** a "gravitor" before he finished high school, and continued work in electrogravitation throughout his life. Space is a dielectric, and Brown reasoned that the displacement current in a capacitor dielectric could

influence the space dielectric itself.[216] Hence he built, tested, and patented several variations of lifting devices based on this concept {517a-517e}. Essentially, he found that certain high capacitance dielectrics could be subjected to high voltage (50 to 300 kilovolts), and would exhibit thrust in the direction from the negative to the positive pole.

Here we point out our contention that all EM energy in space comes from the time domain via the negative charge, and re-enters the time domain via the positive charge. This is consistent with Brown's finding. Although he demonstrated many such lifting and thrusting devices, Brown was never able to obtain sufficient financial and scientific backing to bring a practical embodiment of his inventions into practice. His work, however, has been replicated by multiple experimenters, including NASA researchers (see below) and several researchers contributing results to Jean-Louis Naudin's website http://jnaudin.free.fr/html/lifters.htm.

8.3.2 Jonathan W. Campbell

Recently a U.S. patent {518} on a thrusting capacitor, by Campbell, has been issued and assigned to the U.S. Government (NASA), and made available for commercial licensing. The patent write-up states that thrust from capacitors is well known, but has been too small to be practical. The patent purports to remedy that impracticality. A version of the NASA device has been replicated by the Naudin researchers also. So an adaptation of Brown's work has been patented by the U.S. government with intentions of licensing. This would appear to validate much of Brown's approach and efforts.

8.3.3 The Dean Drive

Our second example is the inertial drive patented by Dean {519a-519e}. Unfortunately, the effects of the Dean drive later appeared to be a problem in accurate measurement. Nonetheless, work still continues along the direction shown by Dean. One may argue that mechanical materials also contain charges and have a certain kind of capacitance. Hence, mechanical motion of the parts of the machine does move these charges and dielectrics, opening a possibility of interacting with the dielectric of space. For example, Sweet's VTA involved a sustained self-oscillation between the local vacuum and the barium nuclei in his barium ferrite magnets.

[216] We have not yet explored the gravitational effects — if any — of our concept of the triode capacitor, discussed in paragraph 6.3.7 and diagrammed in Figure 6-17. We will examine it as soon as we have the proper equipment.

Dean's approach still has merit, even if a particular embodiment gave a negative result when very accurate measurement was performed. It is particularly of interest that mechanical force is essentially derived from electromagnetic forces (and fields) at basis. These base EM fields involve (and identically are) curvatures of spacetime, and hence the motions of the inertial drive mechanical apparatuses do involve at least some curvatures of spacetime and dynamic changes to them.

Our comment is that, when the additional but neglected Heaviside nondiverged energy flow component is accounted, these field interactions internal to matter can produce many orders of magnitude greater curvature of spacetime than is accounted by the diverted Poynting energy flow component only.

The "inertial antigravity" approach may be visualized as the use of excess gravitational thrust in a specific direction. If that direction is against the local pull of gravity, and is more powerful, then "lift against the gravitational pull" is obtained. Rigorously, this is not true antigravity but manipulated excess positive gravity.

In our approach to antigravity, one way to approach the problem is to have the mechanical apparatus also the source of an intense *negative energy* EM **field,** producing an intense flux of Dirac sea holes into and in the local surrounding spacetime. The excess charge removed from the Dirac holes can in fact be used in the electrical powering of the physical system, as was demonstrated in the Sweet VTA antigravity test. Then movements of the mechanical parts could involve movement of strong negative energy fields, hence strong curves of local spacetime that are local *strong negative gravityfields.* Or, better yet, movement of the charges themselves will also produce field-induced movement of the Dirac sea hole negative energy. This appears to be a practical method to manipulate the metric itself, along the lines proposed by Puthoff *et al.*[217]

8.3.4 Henry Wallace

Other work has been by Henry Wallace, an engineer working for General Electric in the 1970s. His work dealt with the interactions of relatively moving masses of various kinds, and it is described in his patents {520a, 520b}. The discussion under the Dean drive probably applies to Wallace's work as well.

[217] H. E. Puthoff, S. R. Little, and M. Ibison, "Engineering the Zero-Point Field and Polarizable Vacuum for Interstellar Flight," *J. British Interplanetary Soc,* Vol. 55, 2002, p. 137-144.

8.3.5 J. F. Woodward

Next is the work of J. F. Woodward, resulting in one or more patents {521} and multiple articles in the legitimate physics literature {522a-522k}. Woodward uses an adapted theory based on Mach's principle and on the thesis that the mass of a capacitor can be made to vary from its normal mass by rapidly charging and discharging it — say, at a frequency of 20 kHz. This predicted effect is testable, although some sophistication in the testing is required.

Woodward's publications show the results of actual experiments, measuring a very small change in the mass, and are worthy of much further investigation. Here we note that the actual mechanism generating the inertia of an object is still an open issue, with several different contending theories.[218] Whether the gravitational mass and the inertial mass are identical or not, also remains an issue. If the exact local mechanism generating the inertia of a mass could be decisively found, then direct methods of changing the inertial mass and the gravitational mass might be a real possibility, and research to try to find such methods would be strongly indicated.

Our further comment is that the mechanism that generates mass itself has never been specified in formal physics,[219] particularly when one views an observable (such as mass) as continually recurring in 3-space rather than continuously existing in 3-space, due to the *d/dt* operator imposed on spacetime by the observation process. Before the reader assumes that mass is well understood, a reading of Jammer's scholarly work {523} is highly recommended.

From our viewpoint we stress that observed mass cannot continuously exist, but must be an effect and the instantaneous frozen output of the *d/dt* observation process invoked on an ongoing 4-space process. Hence, from this view there is indeed a "process" that (continually) creates mass — it is at least the emission of EM angular momentum (a photon) from the *masstime* entity. Similarly, there is a "process" that continually destroys or converts any mass — it is the absorption of a photon and conversion of the

[218] E.g., (a) A. Rueda and B. Haisch, "Inertia as reaction of the vacuum to accelerated motion," *Phys. Lett. A*, Vol. 240, 1998, p. 115-126; (b) B. Haisch, A. Rueda and Y. Dobyns, "Inertial Mass and the Quantum Vacuum Fields," *Ann. Phys.*, Vol. 10, 2001, p. 393-414.

[219] The present author made an early **and** crude attempt at doing it in his "Quiton-Perceptron Physics." 1973, NTIS Report AD-763-210.

mass *m* into masstime *(m* + d*m)dt.* Mass "flows through time" via this time charging and discharging, in the form *m* => *mt* => *m* => *mt* => *m*... etc.

Again we stress that masstime *mt* is not mass *m*, but is as different from it as impulse *Ft* is from force *F*. We crudely proposed such an initial mass-generating mechanism in 1973 {524a}, with additional information published in 1998 {525a}, which may have bearing on the mechanism involved in Woodward's experiments.

8.3.6 E. R. Laithwaite

Eric Laithwaite was for some years a professor with the Imperial College in London. He was one of the pioneers of the linear electric motor and of portions of the magnetic levitation (MagLev) train concept. An illustrious career headed for greater things (perhaps knighthood, Fellow of the Royal Society, etc.) was abruptly derailed in 1973 after he lectured to the prestigious Royal Institution by invitation and demonstrated that a heavy gyroscope, difficult to lift with one hand while not turning, could be lifted easily with that same hand, once turning at speed. Laithwaite's suggestion that Newton's laws of motion might be in difficulty proved much too controversial. The Royal Institution (apparently for the first time in its 200 year history) did not publish proceedings of that invited discourse.[220]

One of the remarkable things Laithwaite achieved was a form of "indefinite motion" device that he demonstrated circa 1970 {526}. The Centennial Centre of Science & Technology in Ontario was looking for working models to decorate the entrance hall. Laithwaite showed that if a linear-motor primary was rolled into a cylinder, so that it became simply the stator of a conventional induction motor,[221] a steel washer (about 3 cm. in diameter) could be made to roll continuously in a vertical plane around the inside of the stator. A combination of centrifugal force and magnetic

[220] With some humor we point out how shocking is our proposal that such a thing as "continuous" propagation of an object or energy through 3-space does not exist. Instead, small differential "pieces" of it continually "recur" at successive positions, much like the projection of the frames of a motion picture frame, where continual observation is the "projection process". Nonetheless, in our proposed solution to the source charge problem, either that is true or every charge in the universe is a perpetual motion machine, freely creating energy out of nothing. In our view, that is the impact of the long-neglected source charge problem in quantal and classical electrodynamics. It has produced the wrong and naive notion of what "propagation through space" actually entails.

[221] Something similar to diagrammatic Figure 6-26 in Chapter 6.

attraction kept the washer in contact with the stator at all times. At the same time, a pivoted copper cylinder could be held in the center of the stator and would be seen to rotate on its own axis in the opposite direction.[222] Laithwaite completed and delivered a working model to the Centennial Center of Science & Technology. The reader should note the similarity of Laithwaite's proven experimental device to the magnetic Wankel engine.

In addition to his attention to Heaviside's unpublished draft notes and manuscript on a combined theory of electromagnetics and gravity (previously discussed above) {502}, Laithwaite spent the latter years of his life working on sophisticated gyroscopic systems {527a-527h}. Ultimately he felt he had successfully produced a mass transfer effect {528} and the basis for a propulsion system. He and William Dawson applied for a patent in 1993, which was granted in 1995 {529}, with a U.S. patent granted in 1999 {530}. Regretfully, Professor Laithwaite died in 1997.

8.3.7 Floyd Sweet's Vacuum Triode Amplifier (VTA)

See again Chapter 6 and Figures 6-5 through 6-14 on the work of Floyd Sweet, previously discussed in paragraph 6.3.2. My concept of antigravitation used in the experiment is shown in Figure 6-15. By now, the sharp-eyed reader will recognize that my method actually constitutes a conceptual extension and definitization of the Dirac electron theory, reinterpreted to recover negative mass, negative energy, negative energy fields, and negative energy potentials. The defining feature is the deliberate use of a COP»1.0 main power system (perhaps constituting the power system of a flight vehicle) as a source of locally strong negative energy EM fields generated by the concentrated Dirac sea holes (causal 4-positrons being negative energy 4-electrons prior to observation) locally produced in the power system. We collaborated with Sweet on the vacuum triode amplifier for more than a decade, and in fact suggested the name of the device.

The antigravity approach designed by the present author was based on realizing that negative energy sources (e.g., 4-positrons as negative mass 4-electrons prior to their reaction and observation) produce *negative*

[222] We have had the distinct notion that the fundamental *contrarotating* mechanism found by Laithwaite is probably an analogous mechanism — or very similar — to the mechanism utilized by Bauman in his Swiss converter (Methernitha device). As pointed out, it also has remarkable similarities to the magnetic Wankel engine, except that the magnetic Wankel does not utilize two contrarotations.

energy EM fields. The field can reach out over all space, so a negative EM energy field represents a reversed curvature of a large volume of spacetime. Hence it represents a considerable antigravity field — particularly when one considers the unaccounted huge Heaviside component of the negative energy field and charge interaction. Since the field strength falls off as the inverse square of the distance from its source, the strong antigravity effects of negative energy EM fields are much stronger locally than at a distance. This is particularly true when the conventionally ignored Heaviside nondiverged EM energy flow accompanying the accounted diverged Poynting energy flow of every field-charge reaction is accounted. This usually ignored factor dramatically increases the antigravity intensity produced by the local negative EM energy field by many orders of magnitude, often by nearly 10^{13}.

My antigravity concept (then and now) is shown in Figure 6-15 of Chapter 6. At the time, the only available device I knew of that produced a substantial percentage of output negative EM energy was Sweet's vacuum triode amplifier. So I persuaded Sweet to fabricate a new output section (an output load similar to Figure 6.8 but containing ten sockets for ten 100 watt lamps). Thus the output of the unit — which adjusted automatically to the available load — could be increased in 100-watt increments by merely screwing in the lamps one at a time and making laboratory readings after each new 100-watt load increase was added. This was done and the concept was successfully tested by Sweet {531}, who was making the measurements in California and reading them off over the phone to me (I was in Huntsville, Alabama). The experiment worked beautifully.

The setup and progress of the experiment were intended to materially increase the strength of the *negative energy* EM field and Dirac sea hole flux already produced to a lesser extent by the Sweet vacuum triode amplifier (VTA) in its normal operation. Thus the hypothesized negative energy antigravity field, produced weakly by the negative energy from the device in its ordinary power output range of 500 watts, was to be substantially increased at 1,000 watts. The response to the net gravitational field surrounding the object would thus be the resultant of two factors: (i) the normal response of the device's positive mass to the positive gravitational field of the Earth etc., and (ii) the additional response of the device's positive mass to the local antigravitational field produced around it. The measurable result was expected to be a decrease in the measured weight of the object on the laboratory bench.

As discussed, this stratagem succeeded dramatically. The weight of the vacuum triode amplifier was decreased, smoothly and controllably, by

90% on the laboratory bench (see again Figure 6-9).[223] The results were later published in a joint paper {531} prepared by the present author. I placed Sweet's name first on the paper because he was the inventor of the VTA, which demonstrated the effect once properly modified as I requested. Note that the extra antigravitational field effect on an object is indeed a local effect, which the experiment also showed. This effect was obtained at a COP>1,500,000 (actually, at nearly a COP = 3,000,000) and at ELF frequency.

The ELF frequency is important. As we explained previously, the highest energy photons of all are the lowest frequency photons, when the highly compressed time-energy component of the photon is accounted as well as the decompressed spatial energy component. Hence, for very appreciable local curvature of spacetime to produce considerable antigravity, the antigravity source must produce negative energy fields consisting of negative energy photons at low frequencies (such as 60 Hz). Else, the curvature of spacetime is so small that little effect will evidence. My best "back of the envelope" estimate of the efficiency of the antigravity process in the VTA was 10%.

8.3.8 Ning Li and (separately) E. Podkletnov

Very interesting work was performed by Ning Li {532a-532d}, a scientist originally with the University of Alabama in Huntsville (UAH), who returned to China for a while but is now back in Huntsville. Quoting David Brown from the UAH website from 1997:

> *"In 1989, Dr. Ning Li of UAH predicted that if a time varying magnetic field were applied to a superconductor, charged and deformed lattice ions within the conductor could absorb enormous amounts of energy via the*

[223] Many times I have been asked how such small output power increase (from 500 to 1,000 watts) could possibly achieve such dramatic antigravity results. The answer - due to the neglected Heaviside nondiverged energy flow component — lies in multiplying the power output by the "Heaviside energy amplification factor *k* " where *k* may be as large as 10^{13}. A 500-watt accounted increase, multiplied by 10^{13}. is actually an incredible increase in the total EM negative energy field density being created in the local vacuum. In short, a very little "accounted" power increase of the COP»1.0 VTA output is actually a very vast negative power output increase when the long neglected k-factor is accounted. It is just this missing k-factor and the failure to account for the negative energy KM fields generated in COP»1.0 discharges in violent astronomical phenomena that seem to be responsible for generating the excess antigravity that is accelerating the expansion of the universe.

magnetic moment effect. This acquired energy would cause the lattice ions to spin rapidly about their equilibrium positions and create a miniscule gravitational field. Dr. Li's calculations showed that if these charged, rotating, lattice ions were aligned with each other by a strong magnetic field, the resulting change in local gravity would be measurable. "

"Podkletnov and Nieminen (1992) {533} *made the accidental discovery that a single-phase, dense, bulk, high T_c, superconducting, ceramic disk spinning at 5,000 rpm can produce a 2 percent reduction in the weight of non-conducting, non-magnetic objects placed over the spinning disk. UAH and MSFC [Marshall Space Flight Center, apart of NASA] [cooperated] on a joint research project to independently confirm the results of the Podkletnov experiment and to validate Dr. Li's theory of gravity modification via superconductor. On March 26th, 1997, as a part of this project, the joint UAH-MSFC research team produced the largest high temperature superconducting disk ever manufactured in the USA. This disk measures 12 inches in diameter and is 0.5 inches thick "*

We now explain the experiments, from our point of view of the mechanism for antigravity. We remark that, at least in theory, the charges in such a rotating superconducting disk have an inward "discharge" acceleration force that is a function of the distance of the charge from the rotation axis center. Hence, in the rotating frame, some of these charges are very strongly "accelerating" toward the center, as are their spins whose magnetic vector is orthogonal to the E-field vector. A flow of EM energy exists perpendicular to the rotating flat disk and is accelerating at right angles to the disk surface. This is analogous to a *discharge* (sudden acceleration) phenomenon, and it will also produce accelerating negative energy Dirac sea 4-holes in the vacuum component of the supersystem of the spinning disk. So from the spinning disk there is a sort of "wide beam" of Dirac sea 4-hole current in the vacuum, radiating at right angles to the disk surface, with heavier concentrations toward the outside of the disk. The result is that objects in the Earth's gravitational field, and also placed in the path of this negative energy Dirac sea 4-hole current, is acted upon by two superposed curvatures of local spacetime: (1) the positive curvature due to the Earth's gravitational field, and (2) the negative curvature due to

the negative energy field's curving local spacetime. The total net gravitational effect will be due to the algebraic sum of the superposed two spacetime curvatures — the normal positive curvature from the Earth's gravitational field and the second a negative curvature created by the Dirac sea hole current's negative energy fields (Heaviside energy flow component considered). The expectation is therefore a *reduction* in the weight of the object, as is shown in the experiments.

The UAH-MSFC group was unable to confirm Podkletnov's findings.[224] Ning Li and the NASA group later split amicably. Ning Li continued her theoretical work, eventually ceased publishing papers for a period to protect the techniques and experimental results achieved in her work, and focused upon potential applications. She apparently returned to China for some time, but is now back in Huntsville, Alabama and still experimenting. We suspect there may also be a Chinese research effort into antigravity, using the approach taken by Ning Li. Perhaps information from that program will be released in the future.

But what of the work of Podkletnov since his original experiments? NASA continued to try to replicate his disk and his work, with Podkletnov acting as a consultant. Presently, NASA has paid an independent research firm to replicate the disk to full specifications, which has just been accomplished as this is written. At this writing, the experimental results of this new attempt are not yet available as the work is still in progress. It should be available by the time this book is published.

Meanwhile, a relatively new paper by Podkletnov and Modanese has been published on the Los Alamos National Laboratory website.[225] This method uses high amperage sharp pulse discharges from a superconducting ceramic electrode, to produce an anomalous radiation in a focused beam. Significantly, the beam does not noticeably attenuate through different materials. The beam exerts a short repulsive force on small movable objects on the propagation axis, with the force proportional to the mass of the objects.

[224] E. Podkletnov and R. Nieminen, "A possibility of gravitational force shielding by bulk $YBa_2Cu_30_{7-x}$ superconductor," *Physica C*, Vol. 203, 1992, p. 441-444.

[225] Evgeny Podkletnov and Giovanni Modanese, "Impulse Gravity Generator Based on Charged $YBa_2Cu_10_{7-y}$ Superconductor with Composite Crystal Structure," carried on website http://xxx.lanl.gov/abs/physics/0108005.

We interpret the results as completely consistent with our own proposed excess gravity and antigravity mechanism. We know that such sharp discharges produce significant Dirac sea 4-hole currents in the local vacuum component of the supersystem. Such currents in a beam interact very little with intervening materials, and the major spacetime curvature effects are concentrated upon the propagation axis. On that axis, force effects can be expected upon small independent objects, due to the *additional* negative curvature added to the local spacetime in their supersystem. The impulse produced on the object should indeed be proportional to the mass of the object and independent of its composition, since it is a gravitational force effect induced by local curved spacetime. The force should be repulsive in the beam, since that is the direction of the antigravity force that will be induced in objects in the axis of the beam, by the beam of negative energy Dirac 4-holes. A positive gravity force would mean attraction between the object in the propagation path and the source of the beam. A negative gravity force would therefore mean repulsion.

So Podkletnov and other scientists are still working on a successful effect. It will be interesting to see what results are reported in the future, and whether they will deviate from their present attempt to explain the effect by a combined quantum gravity and anomalous vacuum fluctuations approach.

8.3.9 NASA's **Breakthrough Propulsion** Physics **(BPP) Project**
NASA's Breakthrough Propulsion Physics Project was established in 1996. It seeks a breakthrough in space transportation involving "(i) propulsion that requires no propellant mass, (ii) propulsion that attains the maximum transit speeds physically possible, and (iii) breakthrough methods of energy production to power such devices." Investigations involve coupling of gravity and electromagnetism, the quantum vacuum, hyperfast travel, and superluminal quantum effects. The project is managed by the Glenn Research Center, sponsored by the Advanced Space Transportation Program, with overall management by NASA Marshall Space Flight Center, Huntsville, Alabama.

NASA continues its investigations and experiments in methods to change **the** force of gravitational attraction. The scientist in charge of the project is David Noever of the Marshall Space Flight Center. The work is still considered a work in progress, with the need for both experimental investigation and meticulous design of experiments, instrumentation, and measurement techniques.

The overall NASA program also spreads to other supporting laboratories and projects. For example, at the Jet Propulsion Laboratory (JPL) Kulikov {534} has measured the difference between inertial and gravitational mass of a boson in a heat bath. At least one invention seems to have resulted or to be in progress, assigned to JPL.

As mentioned, the U.S. Patent by Campbell {518} on a capacitor device producing a net thrust force (a more modern version of T. Townsend Brown's work) has been issued and assigned to NASA.

8.3.10 Scientific Conferences

There are regular conferences (several per year) being held in the U.S. and elsewhere, dealing with antigravity and electrogravitic propulsion. We give a little-noticed but pertinent example: In a nice presentation in 2001, LaPointe {535} proposed a new method for producing anti-matter. Currently antimatter production is accomplished in very large accelerators, and is therefore quite expensive. For increased experiments, a cheaper and much smaller (and much more available) process is highly desirable.

In the Klein paradox, which involves very large potential drop across a very short distance — less than the Compton wavelength of the antimatter particle — matter and anti-matter pairs are produced. LaPointe hypothesized that it may be possible to use the Casimir effect to push one side of the step into the negative energy range. He is at least *thinking toward* negative EM energy sources that produce negative EM fields and negative gravity in the surrounding space, without explicitly enunciating it in that fashion.

We already briefly discussed our own approach to antigravity, which is a much simpler and cheaper anti-particle producing mechanism, as demonstrated by the Sweet device. In short, overunity EM systems with COP»1.0 do produce free flows of causal (before observed) 4-positrons (still in negative energy 4-electron state prior to interaction) in local spacetime immediately surrounding the system. Consequently, LaPointe's efforts are in what we believe to be the correct direction, but he is still using a very difficult mechanism to engender the antimatter production. Also, the positrons or other antimatter sources of the negative energy fields must remain in the causal (unobserved and non-interacted) 4-state, in order to produce negative energy EM fields and potentials and antigravity.

8.3.11 James Corum *et al.*: Rectified Slepian AC Force Resonator

Another example is some promising work by Corum *et al.* {536}. We quote from the abstract and summary of his paper:

> *"Corum presented an experimental paper on the use of the Heaviside force in conjunction with a Slepian antenna as a form of space drive using nothing more than the classical Maxwell stress tensor. Slepian proposed the same thing in 1949, but came to the conclusion that it would not be useful, since the time average of the resultant AC force would be zero. Corum's contribution has thus far been two-fold: (1) In conjunction with Dr. Alan Barnes of WVU he has experimentally shown that the AC version of the Slepian Resonating Antenna does produce a force, and has measured it to within 3.6%, and (2) has designed a way for Hartley's variable capacitor rectification to be used with the Slepian resonator such that the rectification results in a DC force component. The first experiment has already been achieved, the second experiment is the logical next step. If successful, the result would be quite revolutionary: a true space drive."*

Our comment is that this unilateral thrust force work is important. In our view, the Heaviside energy flow component does not appear in Slepian's vector $\mathbf{j}\phi$, which contains only the diverged EM energy flow surrounding a circuit or component, but it is present immediately outside the circuit where the Slepian vector exists. Hence there is an enormous, extra energy flow closely associated with every EM circuit, that is unaccounted since Lorentz's closed surface integration of the energy flow vector discarded it quite arbitrarily.

We already know from the Bohren experiment (and thousands of others similar to it) previously cited that resonant charges do collect excess EM energy from a given EM energy flow input, compared to the collection from that flow by the same charges in nonresonant state. In using the Slepian resonator and then rectifying its output, it would appear that both the diverged (Poynting) energy flow component and the Heaviside nondiverged energy flow component are first resonated and then rectified. In addition, excess energy is collected — much more than is in the normal "static charge" formula assumptions for Poynting energy flow and in assuming only a "single pass, single interception and collection" of the energy.

An important factor then is obvious: Once the energy flow is surrounding the circuit, there exists a certain local curvature of the immediate external spacetime. The rectification represents not only a change in the Slepian

vector current in the circuit, but also a change in this local ST curvature interaction upon the circuit matter and charges. In short, it should produce a DC component in the direct excess interaction of the rectified local curvature of spacetime. This should produce *excess direct propulsive force,* just as Corum theorizes and the experiments support to date.

Further, the oscillation of the large, *unaccounted* Heaviside nondiverged energy flow component involves the oscillation of a "dark energy" component that may be orders of magnitude greater than the *accounted* Poynting component's magnitude. By involving this huge energy flow component in oscillation and synchronized to the resonant Slepian circuit, Corum has unwittingly involved the supersystem as a COP»1.0 EM "energy converter" system. Hence, there is appreciable Dirac hole current (in causal 4-form) in the local vacuum, not reacted with the materials in the system and therefore not converted to material lattice holes attached to positive mass. The time rate of changes of the negative energy fields and potentials are thus significant for antigravity effects, in the approach taken by the present author. In short, we believe Corum *et al.* are in fact producing significant evidence for a workable approach to unilateral thrust force.

This work by Corum *et al.* thus is highly promising, is solidly based experimentally, and certainly bears watching closely. We would strongly suggest that Corum *et al,* analyze their proposed mechanisms and results obtained in terms of supersystem analysis rather than system analysis, using higher group symmetry electrodynamics, and recover and include the long-neglected Heaviside energy flow component.

8.3.12 Gravitec, Inc. and H. Serrano

A patent {537} was issued to H. Serrano on Oct. 5, 2000 and assigned to Gravitec, Inc. whose principal investigator and corporate officer is Tim Ventura. Based on this invention, Gravitec, Inc.. has developed and demonstrated a rotary device that develops unilateral thrust. Purdue University began a small but steady effort to test the unit, first in the atmosphere and later under high vacuum conditions. The first tests have been successful, and a paper {538} from the Purdue study shows it is not the ion wind effect, which is orders of magnitude too small to account for the demonstrated thrust. Further, Jean-Louis Naudin has replicated and tested the Serrano thruster, and it works beautifully {539}. Ventura also hopes to develop a toy kit, with safe power supply, which would allow persons to perform their own successful lifter experiments and perhaps rotary experiments at nominal cost.

8.3.13 Transdimensional Technologies, Inc.

There is also ongoing important propulsion work at Transdimensional Technologies, Inc. of Huntsville, Alabama {540}. Founded in 2000 by its chief scientist, Jeffrey Cameron, the company has developed several novel propulsion and lifting mechanisms. Independent tests of some of these systems have been accomplished by Jean-Louis Naudin, and the results can be seen on his website (previously cited).

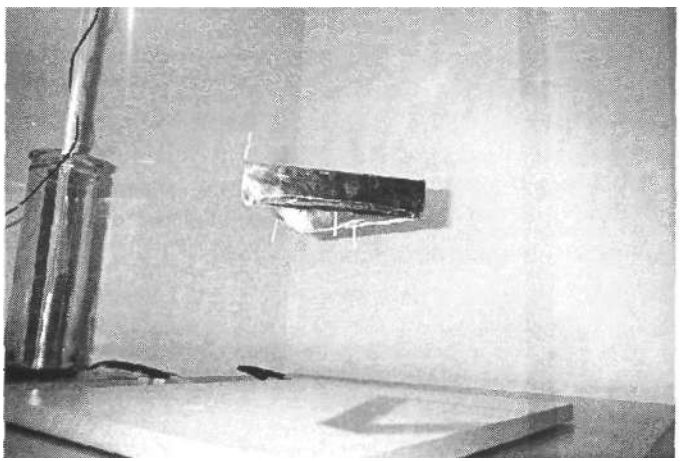

Figure 8-1 Naudin's **replica of the** Transdimensional Technologies **lifter.**

As we go to press, Transdimensional's most recent propulsion effect is called Power3 (power "cubed"). It uses an asymmetric capacitor to

produce the thrust in space, and the principle has been successfully tested in a vacuum. A larger, triangular lifter made mostly of pipe was demonstrated in vacuo to NASA officials in Huntsville, Alabama. Cameron has patents pending on magnetocaloric hybrid rocket engines and asymmetric gravitational waves {541}. A replica of the Transdimensional lifter successfully tested by Naudin is shown in Figure 8-1, by courtesy of Jean-Louis Naudin. Naudin's replica of the Transdimensional Technologies rotational device is shown in Figure 8-2.

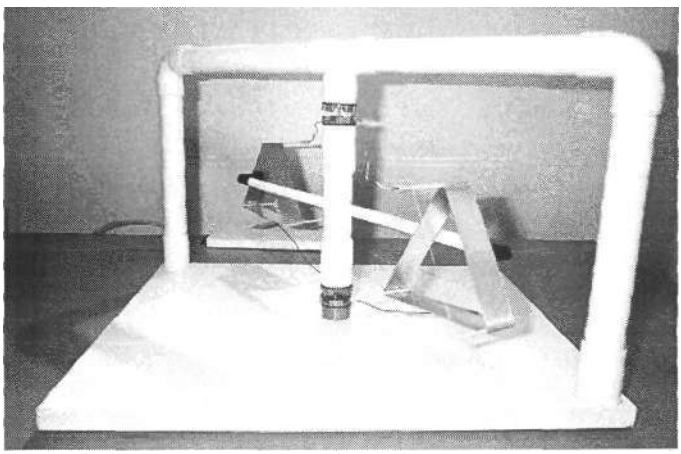

Figure 8-2 Naudin's replica of the Transdimensional Technologies rotational device.

We understand that new Transdimensional Technologies systems, now in patent process and still closely held, represent dramatic advances in the state of the art. The corporation foresees eventual commercial licensing of some of its developments, and the development of practical lift vehicles and space propulsion systems within 3 to 5 years.[226]

[226] Ken Moore and I personally visited Transdimensional Technologies here in Huntsville, and we found a very straightforward, enthusiastic, and hard-working group. We were treated with great courtesy, so much so that Jeff Cameron graciously cut short his vacation day and came in to show us the lab equipment and give a demonstration. We very much appreciate the work that Transdimensional Technologies is doing, and we certainly wish this fine group outstanding success in their efforts. We also are very appreciative for their courtesy and consideration in showing us the demonstrations and for their cogent discussions with us, which **were** most helpful.

8.3.14 **American Antigravity** (Tim Ventura's Company)

Tim Ventura is a very energetic lifter and antigravity researcher, who has done work independently and for others such as Transdimensional Technologies. The results of his many experiments and replications, tests, photos, etc. are on his website at http://www.americanantigravity.com. He also has several videos showing his testing, as well as detailed instructions for a researcher to build his own demonstration unit and verify the tests. Tim kindly furnished some needed information in this area, and put me in touch with other researchers and websites, which I appreciate.

8.3.15 Jean-Louis Naudin

Jean-Louis Naudin is a tireless researcher in the fields of COP>1.0 systems and processes, and in the field of lifters, inertial thrusters, and possible antigravity systems. His website is a cornucopia of information, patent references, inventions, processes, and replications or replication attempts by Jean-Louis and others who regularly work on such things and communicate with him. The website is http://jnaudin.free.fr/. From there, one may click on the various parts of the site and on the links to other sites to gain a wealth of information on these subjects.

His lifter work, including successful replications and instructions on how to build lifters, can be accessed from http://jnaudin.free.fr/html/lifters.htm, and will keep the interested researcher busy for many productive hours. We especially commend Jean-Louis for his extraordinarily important efforts and for making all this work available to researchers worldwide. Once on the site, one is free to choose from a very wide variety of projects, subjects, etc. The information value of this site is very, very high. We consider Naudin's site to be the single best information site on the web for COP>1.0 system information and for the new space propulsion methodology and effort. Necessary links to other related sites of interest are also provided.

Good hunting!

8.3.16 Other Research Work and Inventions

While we have given a sort of quick overview of work done in this field, there have been many other patents filed by numerous inventors and additional work done by them. This is a dynamic field and it is moving; the biggest problem is that it is still sorely hampered by highly limited funding and an attitude by much of the scientific community that "if it has not been invented here, it doesn't exist".

In the table in Figure 8-3 below, we list some of the pertinent patent numbers for reference, with the emphasis on U.S. Patents. The Naudin website previously referenced has a great deal of information on these thrusters and lifters, including instructions for building and testing several of the simpler proof-of-principle versions. There are links to other sites with even more information. Naudin also includes the results of his successful replication and testing of a variety of these devices and inventions, as well as the successful replication by other experimenters. Naudin also gives construction instructions and information on some of these, so that independent researchers can build test units and test them if desired.

For those researchers interested in pursuing this area further, we would heartily recommend a determined search on the Internet, using Google (www.google.com) as their search engine. A good place to start is Jean-Louis Naudin's web site, and then run the cross-links. The combination will turn up quite an amount of specific material, from which the individual researcher can choose which approach and experimental method he wishes to pursue.

Figure 8-3.

Selected Inertial Propulsion System Patents

T. Townsend Brown, "A Method of and an Apparatus or Machine for producing Force or Motion, British Patent 300,311, Nov. 15, 1928.

Norman L. Dean, "System for Converting Rotary Motion into Unidirectional Motion," USP #2,886,976, May 19, 1959.

T. Townsend Brown, "Electrokinetic Apparatus," USP #2,949,550, Aug. 16, 1960.

T. Townsend Brown, "Electrokinetic Transducer," USP #3,018,394, Jan. 23, 1962.

T. Townsend Brown, "Electrokinetic Generator," USP #3,022,430, Feb. 20, 1962.

T. Townsend Brown, "Electrokinetic Apparatus," USP #3,187,206, Jun. 1,1965.

Henry Wallace, "Method and Apparatus for Generating a Secondary Gravitational Force Field," USP #3,626,605, Dec. 14, 1971.

Henry Wallace, "Method and Apparatus for Generating a Dynamic Force," USP #3,626,606, Dec. 14, 1971.

Fernand Estrade, "Device for Transforming Kinetic Energy," USP #3,807,244, Apr. 30, 1974.

Leo J. Novak, "Centrifugal Mechanical Device," USP #3,810,394, May 14, 1974.

Everett H. Benson, "Inertia Engine," USP #3,863,510, Feb. 4, 1975.

Oscar Mast, "Propulsion System," USP #3,889,543, Jun. 17, 1975.

Arthur N. Lehberger, "Centrifugal Propulsion Drive and Steering Mechanism," USP #3,897,692, Aug. 5, 1975.

Howard A. Gaberson, "Vibratory Locomotion Means," USP #3,916,704, Nov. 4, 1975.

Calvin I. Cuff, "Device for Converting Rotary Motion Into a Unidirectional Linear Motion," USP #3,968,700, Jul. 13, 1976.

Nicholas Joseph Schnur, "Method and Apparatus for Propelling an Object by an Unbalanced Centrifugal Force with Continuous Motion," USP #3,979,961, Sep. 14, 1976.

Calvin I. Cuff, "Device for Converting Rotary Motion Into a Unidirectional Linear Motion," USP #3,998,107, Dec. 21, 1976.

George Knap, "Orbital Propulsion Apparatus," USP #4,087,064, May 2, 1978.

Calvin I. Cuff, "Device for Converting Rotary Motion into Unidirectional Motion," USP #4,095,460, Jun. 20, 1978.

Robert L. Cook, "Device for Conversion of Centrifugal Force to Linear Force and Motion," USP #4,238,968, Dec. 16, 1980.

Ladislaw G. Srogi, "Mechanical Propulsion System," USP #4,242,918, Jan. 6, 1981.

Harry S. Melnick, "Unidirectional Force Generator," USP #4,261,212, Apr. 14, 1981.

Frederick L. Dehen, "Apparatus for Converting Rotary Motion to a Rectilinear Force," USP #4,347,752, Sep. 7, 1982.

Harry S. Melnick, "Mechanical Power Transmitting System," USP #4,398,431, Aug. 16, 1983.

Peter Kleber, "Apparatus for Acceleration-Free Mounting of a Body in a Spacecraft," USP #4,408,740, Oct. 11, 1983.

Fred de Weaver, III, "Propulsion System," USP #4,409,856, Oct. 18, 1983.

Ronald K. Linde, "Centrifugal Reaction Chamber," USP #4,450,141, May 22, 1984.

Fred de Weaver, **III,** "Propulsion System," USP #4,479,396, Oct. 30, 1984.

Joseph Colla, "Mechanical Propulsion System," USP #4,577,520, Mar. 25, 1986.

Elmer M. Dobos, "Propulsion Apparatus," USP #4,579,011, Apr. 1, 1986.

Brandson R. Thomson, "Apparatus for Developing a Propulsion Force," USP #4,631,971, Dec. 30, 1986.

James E. Cox, "Dipolar Force Field Propulsion System," USP #4,663,932, May 12, 1987.

Alvin C. Peppiatt and Alfred J. Peppiatt, "Impulse Drive," USP #4,674,583, Jun. 23, 1987.

Henry North, "Apparatus for Producing a Force," USP #4,712,439, Dec. 15, 1987.

Harry S. Melnick, "Continuous Force and Impact Generator," USP #4,726,241, Feb. 23, 1988.

Oscar F. A. Peterson, "Apparatus for Producing a Directional Unit Force," USP #4,744,259, May 17, 1988.

James D. Mundo, "Universal Propulsion Powerplant and Impulse Drive Unit for Self-Propelled Vehicles," USP #4,770,063, Sep. 13, 1988.

Lancelot I. Kethley, "Gyroscopic Propulsion Device," USP #4,784,006, Nov. 15, **1988.**

Charles Fulop, "Flywheel," USP #4,788,882, Dec. **6, 1988.**

Charles E. Rogers and Fred Van Arsdell, "System for Propulsion and Positioning of a Transitory Object," USP #4,801,111, Jan. 31, 1989.

Paul J. Montalbano, "Conversion of Rotational Output to Linear Force," USP #4,856,358, Aug. 15, 1989.

George J. Zachystal, "Device for Obtaining a Directional Centrifugal Force," USP #4,884,465, Dec. 5, 1989.

James E. Cox, "Dipole Accelerating Means and Method," USP #4,891,600, Jan. 2, 1990.

Hector Serrano, "Propulsion Device and Method Employing Electric Fields for Producing Thrust," WO 00/58623, Oct. 5, 2000.

Brian C. Motts, "Airship," USP #4,967,983, Nov. 6, 1990.

Lyle M. Mason, "Centripedal Device for Concentrating Centrifugal Force," USP #4,991,453, Feb. 12, 1991.

Alexander D. Kidd, "Gyroscopic Apparatus," USP #5,024,112, Jun. 18, 1991.

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8.3.17 Mechanism for the Antigravity Accelerating the Universe's Expansion

Finally, in addition to sorely needed better means of space propulsion, one of the real incentives for antigravity research is provided by the search for a source of the now-established mysterious antigravity that is accelerating the expansion of the universe. Elsewhere in this book we have advanced our own proposal for the mechanism generating that *antigravity* effect in the cosmos.

Simply put, a very violent astronomical process may be considered a giant and very violent discharge phenomena, since it first involves a giant excitation followed by a giant release (discharge) of that excitation. All such phenomena involve strong broken symmetry during the discharge itself, with the concomitant strong available of causal 4-sources of negative energy and negative energy fields. These processes — in their causal unobserved state - do produce locally strong negative energy EM

fields from the source causal 4-positrons (Dirac sea holes prior to observation as positive mass 3-space positrons having positive energy and reverse-oriented). When the unaccounted and very large Heaviside nondiverged EM energy flow component accompanying every field and particle interaction is accounted, the causal negative "mass-energy" states produce strong antigravity fields, particularly considering the *lower frequencies* of many of the phenomena.

With the long-neglcctcd Heaviside nondiverged energy component considered and not just the accounted Poynting diverged component, the total amount of negative EM field energy available in these violent process is dramatic. Accordingly, just as was the Sweet VTA in its increased power and its ELF pulsations, these giant astronomical sources are also giant negative "mass-energy" sources and strong antigravity sources as well. In short, such astronomical sources produce strong antigravity components repelling each other across the universe. Hence the observed acceleration of the expanding universe; the violent astronomical phenomena are continually "pulsing" the universe with antigravity and hence continually accelerating its expansion velocity.

In 2000, we also published a proposed mechanism for the source of the excess *positive* gravity holding the arms of the spiral galaxies intact {542}.

8.4 The Author's Engineering Approach to Local Antigravity

See again our discussion under Newton, subparagraph 8.2.1 above, and our discussion of a negative field energy extension to it. For a major laboratory, we believe that antigravity is straightforward,[227] if one first produces a COP»1.0 situation in a higher group symmetry electrodynamics process. This provides a very strong "displacement current" of causal 4-positrons (before parity inversion, time-reversal, etc.) as true negative energy "particles" or "states" or "Dirac holes" in the surrounding 4-vacuum. The actual "negative mass-energy field" is very large, due to the unaccounted Heaviside nondiverged negative energy component. Consequently, a substantial antigravity field is established.

[227] However, this is based on the assumption that the lab team first gives up some erroneous but widely held misconceptions, and really does a little "thinking outside the box" as they are prone to suggest.

8.4.1 Sweet Antigravity Test.

See again our discussion in paragraph 8.3.7. A practical realization of antigravity was clearly shown by the Sweet antigravity test designed by the present author. See previous discussion under paragraphs 6.3.2 in Chapter 6, and see again Figures 6-5 through 6-15.

In Chapter 6, the Sweet vacuum triode amplifier device shown in Figure 6-8 had a very large COP = 1,500,000 at 500 watts output with a 33 microamp, 10 volt operator's input. It had an even greater COP when pushed to 1,000 watts output because of only a slightly greater input.

The Sweet VTA used an induced powerful self-oscillation between the local vacuum and the barium nuclei in the barium ferrite magnets. This resulted in what is called a "kinetic" magnet (and one magnetized through its flat face). In a kinetic magnet, its nuclear magnetic field (in this case, in the barium nucleus) is self-oscillating (waving) in an angle about its local direction, as shown in Figure 6-6 in Chapter 6.

The conditioning was performed with the barium ferrite magnet itself in forced resonance at its resonant condition (some 11 to 12 Hz, in the case of Sweet's magnets). Then the 60 Hz signal was impressed orthogonally to the primary direction of the resonant magnet. After conditioning each of the two magnets, they were placed together on a separation box, carefully keeping the corresponding ends together similar to their original orientation during activation, but in attracting mode (through their face) across the separator. The assembly itself was then further conditioned, again orthogonally to the coupled oscillating fields. This "synchronized" the two magnetic self-oscillations and phase-locked them together in a common self-oscillation with the local vacuum.

Similar treatment of the vacuum as a semiconductor, together with self-oscillation between vacuum and nuclei, has been advanced independently by Prange and Strance {543}, who showed that the vacuum may be regarded as a semiconductor. In particular, they showed that the vacuum in the region close to the nucleus of a superheavy element is analogous to the inversion layer in a field effect transistor. It is similarly analogous for the barium atom, though Prange and Strance do not discuss that element. They introduced the concept of the inverted vacuum. Just as a semiconductor may be manipulated by subjecting it to external fields, doping etc., it appears that so can be the vacuum — along the lines shown by Prange and Strance and along the lines demonstrated by Sweet's conditioning of his kinetic magnets.

8.4.2 Bearden's Proposed Antigravity Mechanism

Any EM process that produces a COP»1.0 condition, such as can be done in intensely abrupt ionic discharges and other processes, will also produce intense causal (4-space) Dirac sea holes in the immediate surrounding vacuum. This is the negative energy mechanism, conceived by the author in the 1970s and finalized in the 1980s, for producing a negative energy causal (unobserved) EM field[228] in the immediate space surrounding a system. The overunity system must be the "source" of that negative energy EM field. So the negative energy EM field in surrounding local space is "attached" to the mass and energy dynamics of the "unit's supersystem" as being its "source or generatrix". Its attachment to the system mass produces the antigravitational force upon that mass.

Negative energy state charges (Dirac holes) are also *source charges.* Prior to observation converting them (as observed) to 3-space positive mass-energy positrons with positive energy and going the opposite direction, they must be accepted as negative energy source 4-electrons "pouring out negative energy" in all directions in 3-space, continuously, via the giant negentropy process for source charges. Since they pour out "negative" energy, we may consider that negative energy field action at any point in 3-space to be a continuous absorption of positive energy from 3-space and a return of that extracted energy to the time domain as increased time — in short, time dilation.

Either way one considers it, the 4-space Dirac holes do produce negative energy EM fields, potentials, and spacetime curvatures and these must be accounted during their existence *prior to observation and interaction.* Further, their accompanying giant Heaviside negative energy flow component must also be accounted. In other words, do not reverse the spatial direction and thus the location and direction of these fields, do not turn them into positive energy fields by such reversal of direction, do not turn the negative mass into positive mass, and do not reverse the sign of

[228] We strongly stress that the continuous, dynamic, ongoing causal 4-field before it interacts with charge and is observed, is a totally different entity from the iteratively and continually observed frozen "effect" 3-field in matter after the 4-field has interacted with charged matter to produce an observation or "event". The great barrier to using electromagnetic fields in practical antigravity application has been due to the substituting, in electrodynamics, of the iterative "effect" 3-field of the observed positron for the continuous "causal" 4-field of the unobserved negative energy 4-electron (the Dirac sea hole). The "effect" 3-field is simply the iterative, continual energy gradient of the diverted EM field energy flow around the assumed intercepting unit charged particle.

the source charge (the Dirac sea hole). All that happens after interaction of the Dirac sea holes with matter, forming the usual lattice holes or *observed* 3-positrons.

Therein lies the magic secret of antigravity. Instead of thinking of the *fields* interacting on the craft or system that is producing them,[229] think of these negative energy fields interacting upon the *local spacetime surrounding the craft or system, and curving that spacetime negatively. Then* think of this negative curvature of spacetime interacting back upon the craft or system in general relativity fashion. *That* is what will and does produce practical antigravity upon the interacted craft or system, once the Heaviside energy flow component is accounted! But to understand its magnitude and the practicality, one must also account for the long neglected Heaviside nondiverged component.

The mechanism is also consistent with general relativity and Wheeler's succinct statement that mass acts on spacetime to curve it, and curved spacetime acts back on that mass to move it or produce a translation force upon it. We are simply applying that fact of general relativity to produce a local antigravity effect of a locally curved spacetime upon the source system (in this case, the power system itself, which is the source of the negative field energy in the vacuum.

The entire notion of "curvature in spacetime" — and indeed of spacetime itself— is a notion applying *before observation and interaction to produce the observed effect* — i.e., prior to the *d/dt* operation occurring upon an ongoing 4-space process to produce a momentary frozen 3-space snapshot (an observed effect). Think carefully. Wheeler's rule does not mean that 3-space acts back on the mass (actually on the masstime), but that 4-space (spacetime) acts back on it. Spacetime does not exist in the observed object after the application of observation's *d/dt* operation has occurred and until a new causal interaction begins. The *d/dt* operation strips away the time,

[229] The ongoing interaction of the vacuum/spacetime with the source of the unobserved 4-fields is their cause, and the observed 3-fields are the effect. The effect *a priori* does not interact upon the cause! So thinking that "one should make a 3-field in a craft or system that will interact with it and produce antigravity force upon it" is a non sequitur. Instead, one more correctly thinks that "one should make a 4-field *from* a craft or system which will interact with the local spacetime to curve it negatively. Then that negative curvature of spacetime is itself a negative energy 4-field that will interact back upon the observed craft or observed 3-system to produce observed antigravity force upon it.

and hence most of the energy (i.e., all the time-energy) of the spacetime that is to do the interacting.

As source charges, the Dirac sea holes — before observation and in their vacuum state condition — produce a locally curved *spacetime* around the source unit. That induced *(negative energy x time)* curvature interacts back upon the physical system that is the source of the field producing the negative spacetime curvature. It specifically acts upon the mass of the 4-system when it exists as *(mass x time) form.* That interaction produces *antigravity* force and momentum upon the system, rather than *positive gravity* force and momentum[230]. Adding negative EM field energy (in the causal, unobserved state) is precisely the same as adding extra negative masstime, i.e., extra *(-m)t,* since the 4-field is being used in unobserved state.

Using the principle of superposition of fields[231], the external observer sees the "weight" of the unit (the force developed on it by the *net* gravitational field — see again our discussion of the Newtonian approach under paragraph 8.2.1 above) — as being reduced. The intensity of the *negative energy x time (negative angular momentum or negative action)* EM field (including with the Heaviside component accounted) produced by the unit determines the intensity of the antigravity produced, and hence determines the fraction of the unit's weight[232] that is observed to be "lost". See again Figures 6-14 and 6-15 in Chapter 6.

[230] Note that, if the Dirac hole interacts with the mass lattice of the system, it converts to a "hole" that is attached to the positive mass of an ion. Hence the "observed" positron is said to have "positive mass", which is a non sequitur for the state in which the "positron" exists prior to observation or interaction. The lattice hole 3-positron and the true spatiotemporal "4-positron as still a negative energy 4-electron'" are two very different entities, and their fields and concomitant field effects are very different.

[231] Note that identification of spacetime and field in general relativity extends the notion of superposition of multiple fields to the notion of superposition of multiple curvatures of spacetime. Thus, it is the *net* superposed curvature of spacetime that interacts back upon the physical mass system, to produce gravity (either positive or negative, depending on the sign of the net curvature).

[232] We remind the reader that the "weight" of an object on Earth is a measure of the force developed on the object by the (Earth's) gravitational field. "Loss of weight" is simply "reduction of that net force" due to the combination of the Earth's positive (attractive) gravitational field and the Dirac hole curvature of the object's local spacetime producing a negative (repulsion) gravitational field.

At sufficient intensity of this local negative energy 4-field in spacetime with the unit as its source, the back interaction upon the unit will balance the action of the earth's gravitational field. At that point, the unit will hover and "float" against the force of terrestrial gravity.[233] By further increasing the intensity of the negative energy EM field, the unit will accelerate upward, now being repelled by the local earth more than it is attracted by it. By "angling" the negative energy EM field direction — or by producing a second such negative energy EM field from the source unit as an "angled add on" superposed on the first one — one also provides unilateral propulsion in a given direction.

As can be seen, all the requirements for a practical antigravity vehicle and negative energy propulsion system are met. The only real problem in this approach is the requirement to first attain a COP»1.0 EM power system at ELF frequencies.[234] There is, however, an additional problem of correcting one's thinking to be along the lines indicated.

Antigravity becomes straightforward if one first does overunity discharges or steady output in a system with COP»1.0 and understands the difference between the observed "effect" 3-field and the unobserved "causal" 4-field. Sweet's VTA unit had a beginning COP = 1,500,000 at 500 watts output. The unit was pushed to nearly double its COP, by connecting additional load so that the output was now 1,000 watts. The additional input draw was minimal.

Designing the experiment with that in mind, I convinced Sweet to build a new output load unit, and to perform the experiment. In advance, I roughly predicted levitation of the 6-pound device at about 1500 watts output power, by some back-of-the-envelope estimates assuming a 10% efficient

[233] Sweet later did push the VTA to hovering and upward acceleration, with the unit on a tether. After he was shot at by a distant sniper, thereafter he was very fearful **and** refused to show many experiments, including the antigravity experiment and particularly its extension to the hover point and upwards acceleration extension. In my opinion he had good reason for his paranoia and his fear for his life.

[234] The reason for ELF frequencies is simple: for the most powerful curvatures of spacetime, one wishes to use EM fields whose photons have the greatest *total* energy (including time-energy). That of course is the lower frequency photons, not the higher frequency photons. So ELF is the way to go, not gamma rays etc.

process. The projected curve (again see Figure 6-14 in Chapter 6) shows that levitation would have occurred at about 1250 watts or so.[235]

Here is why we advocate a Dirac sea hole's negative energy field as a practical antigravity inducing mechanism.[236] At COP»1.0, there is a very appreciable vacuum energy density difference between the operator's energy input and the energy output of the system, *particularly when the Heaviside nondiverged energyflow component is taken into account as well as the Poynting energyflow component?*[237] There is a production of negative EM mass-energy x time (causal Dirac sea holes) in the immediately surrounding vacuum. That represents the production of a causal, unobserved antigravitational field (curvature of spacetime) with the system-associated anticharge as its source.

Meanwhile, the Earth's causal, unobserved gravitational field is still normal and unchanged. Now the two causal fields superpose, and interact with the system mass. As seen by the external observer, the net effect is a reduction in the weight of the object — the effect of the interaction of the system mass with the two superposed causal gravitational fields simultaneously.

Reasoning that increasing the COP of the Sweet unit should increase the ratio of output negative energy to output positive energy even further, 1

[235] I strongly warned Floyd not to exceed a 1 KW load, no matter what. In the resulting local curved spacetime surrounding the barium nuclei in the magnets, it appears that magnetic monopoles are deposited or appear. Since these barium ferrite magnets were made by pressed powder metallurgy, they had little tensile or torsion strength, and under sufficient stress they would explode violently like a fragmentation hand grenade. In his little lab (a converted bedroom), Floyd had no explosive facility. He did explode several magnets, but while cautiously remaining some personal distance from the unit as its output was increased. We warn the reader that experimentation with such procedures is at his own risk, and all proper laboratory safety precautions must be utilized.

[236] A provisional patent application has now been filed on the process in 2002.

[237] In a nominal circuit, the unaccounted Heaviside energy flow may be up to 10^{13} times as great as the Poynting energy flow component. This is a completely unaccounted, vast EM energy flow accompanying every field and particle interaction. Hence one can understand why such an energy density for a macroscopic system with COP»1.0, is sufficient to achieve on a macroscopic scale what LaPointe is attempting on a microscopic scale. The total macroscopic scale energy density is so great that the required LaPointe microscopic energy density {535} is present or approached.

calculated that doubling the output of the device would result in a sufficiently intense negative mass-energy field in the immediate space around the unit, to approach or reach levitation of the unit. However, as the increasing curvature of spacetime would further increase the deposition of magnetic monopoles in the magnets,[238] at some point the magnets would simply explode like hand grenades if the unit were pushed too far. With no explosive control facilities available, it appeared that doubling the output was the maximum that could safely be done under the circumstances. My own estimate showed that 1500 watts output would be required for levitation, but one dared not go beyond 1000 watts or one would risk a fragmentation explosion and injury or death.

I convinced Sweet to build a 1,000-watt output load box, which simply contained ten sockets for ten 100-watt light bulbs. This was a modification to the 500-watt VTA unit shown in Figure 6-8 in Chapter 6. By successively installing the bulbs one by one, the load could be adjusted in 100-watt increments up to 1 kilowatt.

The foregoing is the reasoning behind how I designed the experiment, and the purpose was to show very substantial and smooth weight loss of the VTA unit itself. The experiment was performed in that 100-watt incremental manner, with highly successful results as shown in Figure 6-14 in Chapter 6.

With each 100-watt increase in power output past 500 watts, the fraction of negative energy produced was greater. Hence the unobserved 4-positron fields (Dirac sea hole negative energy fields) were stronger, because there were more unobserved 4-positrons. This meant that the local negative mass-energy curvature of spacetime was increased also.

In turn, this negative curvature of spacetime interacted back upon the mass of the VTA to add negative mass equivalent, or more simply, antigravity force. The observed weight of the unit was the sum of the normal gravitational weight (due to earth's gravity curvature of the local spacetime), and the abnormal antigravity weight (negative weight) due to the antigravity curvature of the local spacetime superposed. So as the fraction of negative curvature of spacetime increased, the net weight of the VTA was observed to decrease.

[238] Contrary to popular opinion, one does meet with effective magnetic monopoles in a magnetic field — including in the magnetic field of a permanent magnet — in a strongly curved local spacetime. The stronger the field, the greater the magnitude of the effective monopole charge.

As stated, Sweet was performing the experiment on the bench in California, and reading the instrumental results over the phone (I was in Huntsville, Alabama) where I recorded them. The spectacular results are shown in Figure 6-14 in Chapter 6.

The high COP (corresponds to gain) of energy density present in the Sweet VTA system's output section — with a greater percentage of it being negative energy — versus input energy one inputs to the input section, is what is important. In short, increasing the load effectively increased the gain, which further increased the ratio of the negative mass-energy to the positive mass-energy. This in turn steadily decreased the observed weight of the object.

Anything outside the system mass of that very high COP system will "see" the weight of the system mass as having decreased. Weight is just so much mass making so strong a *net* G field (spacetime curvature) in the surrounding spacetime. Reduce the *net* G-field that the system mass is normally making (by having it *simultaneously* make the additional antigravity field which then vectorially adds to the mass's normal G-field), and the external observer, external scales, etc. will see the object as having very much reduced its weight.

Positive spatial EM energy density of a system makes positive gravity (as seen by the external observer in the lab frame) because of the way it curves the immediately surrounding spacetime and the way that curved spacetime interacts back on the system's mass-energy. Negative spatial EM energy density makes negative gravity because it curves the immediate spacetime the opposite way. A system under those "high negative energy field" conditions will produce a great deal of antigravity, because the immediate spacetime surrounding is dramatically curved by the negative energy. That was my concept when designing the experiment, and it worked beautifully. So that is how the Sweet device reduced its weight on the bench by 90%, for a 1 kilowatt total output and minuscule input power {544}.

If one were dealing with the source in a flying vehicle system, there is another effect due to momentum. Note that force F is defined as $\mathbf{F} \equiv \partial p/\partial t = +\partial/\partial t\ (\mathrm{mv})$. That is in a positive energy density local spacetime. When an extra negative energy density is added to the local spacetime, then there are two forces, a new one being $\mathrm{F} \equiv -\partial/\partial t\ (\mathrm{mv})$ and the normal one being $\mathrm{F} \equiv +\partial/\partial t\ (\mathrm{mv})$. These forces are created by any change in momentum in space containing an extra increment of negative EM field energy.

If the two forces balance, then there is essentially no net centrifugal force produced on the object (or any occupants in it) in a turn. In theory, maneuvers that are far more powerful can be made, without undue G-stress to any occupants inside. This of course remains to be tested in future work and experiments, and so must be taken as a strong hypothesis at present. It could be tested, given availability of the proper COP»1.0 energy system or process on board a test vehicle. Laithwaite's demonstration of the dramatic reduction in force necessary to lift a rotating gyroscope compared to lifting the same heavy gyroscope when not rotating, may have been a partial test of this "inertial resistance decrease" effect.

The Sweet device was the only available COP»1.0 device which could have been used for the experiment. That is why I designed the experiment and convinced Sweet to perform it. Had it not worked, much of what I had worked out for more than a decade would have been falsified — which of course is one of the purposes of experiment: to validate or falsify a thesis. In this case, I breathed a great sigh of relief because — in my view — the spectacular results completely validated my approach to antigravity, and also much of my approach to COP>1.0 systems.

Sweet was never in a position to be able to go with this to the scientific community. The VTA was completely fouled legally, by various entangling agreements Sweet had made with different backers, without ever changing or resolving any previous agreement. Also, he realized that his life really was in danger should he try to take the system openly to the scientific community. Consequently, he never tried and in fact adamantly turned all further work away from the antigravity effects.

Aging and rather defenseless, Sweet also began playing all sorts of games to prevent having to have the project validated independently, even for its COP>1.0 capability. He was mortally fearful of being killed if he had it resoundingly validated. He was motivated by the necessity to survive and not be killed, and he firmly believed that any such attempt for full scientific validation and open publicity would absolutely guarantee his quick death. His fears appear to have been well founded.

His most carefully guarded secret was his activation process for the barium ferrite magnets, which he guarded with his life. He also began telling different persons all sorts of different stories and "mechanisms" for the activation, which were clever ruses and disinformation designed to throw them off the true trail and prevent his activation secret from being uncovered. I made a personal videotape of the activation process, or what

he released of it, before he began such disinformation. So we do know much of the activation process, though not all of it.

Eventually, with changes in backers yet once again, Sweet died and never revealed the full secret of strong self-oscillation activation in permanent magnets to anyone. I knew and know part of it, even most of it, but still not all of it. What I understand about it has been briefly included in this book. From there, the interested researcher must find his own way.

The VTA was real, my gravitational mechanism is real, and — in my opinion — validated. However, it has not been *independently* validated in formal order, which is the proper scientific requirement. I did try very hard to convince Sweet that we should take this to the leaders of the scientific community and have it independently verified (e.g., by UCLA), but he would not hear of it after the assassination attempt. By that time, he was so afraid from the constant threats and constant stalkers that he had totally decided against any such releases. He also would not permit it to be taken to a major scientific conference and demonstrated, even though several scientists and engineers knowledgeable and experienced in measurement engineering did measure and certify the device's operation. But they were never allowed to see it in the antigravity mode. He would not discuss it with them, and he would not allow it.

Sadly, with the death of Sweet there passed away the VTA and its major secrets. I regard the VTA as one of the great scientific accomplishments of all time, and I regard Sweet as one of the most capable lab experimenters I ever met and one of the greatest inventors I ever met. The loss of the VTA and the absence of its full, independent scientific testing and validation were in my opinion two of the greatest losses to science of all time.

8.4.3 Discussion

Particle physicists speak of antimass and antigravitational field, but do not speak of anti-electromagnetic field and do not like negative mass. Antimass is actually "anti-mass-energy". When did one hear any scientist speak of a *negative energy* electromagnetic field or *negative energy* force field (except possibly as a hypothetical "tractor beam")? Or a *negative energy* electrical or magnetic potential? Yet the EM fields from an accumulation of Dirac sea holes (causal state) as a source charge are precisely negative energy EM fields. The EM potentials from an accumulation of Dirac sea holes are precisely negative energy potentials. Further, these fields and potentials produce opposite curvatures of spacetime as compared to positive energy causal EM fields and potentials from conventional source positrons and electrons.

Conventionally, scientists speak and think of *the positive energy* electromagnetic field. In our view, they do not apply the implications of the negative energy state part of the Dirac 1930 electron theory {545}, because of a built-in horror of negative mass (and antigravity!). Recall again our discussion of Laithwaite; a promising career was cut down in mid stride because he "mentioned the unmentionable": antigravity and possible failure of Newton's laws (they *do* fail in a curved spacetime!). His exhibiting to the Royal Society a very heavy gyroscope, very difficult to lift when placid, but easy to lift with one arm when spinning, was the final straw. The British scientific community simply cut him down and ostracized him from the rewards and positions he would otherwise have been given.

To conceal the relationship of the negative energy fields, hide negative mass, and pretend it does not exist, much scientific effort is exerted to consider the positive energy, positive mass positron *only after it has been observed.* So scientists can assign this "observed" 3-positron a positive mass and positive energy but with spatial direction reversal. That immediately moves to an *effect* field and an *effect* positron, not a causal field or a causal Dirac sea hole. It effectively eliminates the antigravity field of the negative mass of the unobserved negative energy Dirac electron, which is produced by the *causal* (unobserved) Dirac sea hole's electromagnetic field, not the *effect* (observed) positron field which then is "seen" to have positive mass but with field direction reversed.[239]

The positron is quite a different beast before it is observed, just as is a mass (and just as is any other observable, and just as is a field). For one thing, the positron before observation and the positron after observation have different dimensionalities; the unobserved causal entity is 4-spatial and continuous,[240] while the observed effect entity is continually and

[239] Note also that the causal field, being unobserved, is a 4-field, while the observed (effect) field is a 3-field. By reversing the parity, one has made the antigravity field **into** a gravity field, by substituting the effect for the cause and erroneously using the old non sequitur of a separate 3-force acting upon a separate 3-mass. Also, when one reverses its spatial direction, one converts a *positive* gravity field into an *antigravity* **field.**

[240] Along with Bohm, we point out that — strictly speaking — in 4-space one does not have "things", but only "processes". To speak of a "4-space field" is to redefine the field as an ongoing process, rather than as an observed frozen 3-snapshot or "3-thing". The solution to the long-vexing duality problem is there, but we leave its solution to the reader. It is necessary to extend Aristotelian logic itself if one is to resolve the duality problem.

iteratively 3-spatial. Mass before it is observed exists as masstime, not mass.

Simply consider the delayed choice two-slit experiment and Wheeler's famous comment that no phenomenon is a phenomenon until it is an observed phenomenon. Once the observation occurs, one can even change the "if it had been observed but was not" previous past. One gets the magic from the delayed choice two slit experiment without the observation, and then by making the observation such that the "magic" is not revoked *after the fact*. The whole experiment proves that, if one insists on applying the observation, one kills the magic, even if one thinks the magic has already occurred and must have already occurred, but it has not been *observed* to have occurred.

Causal 4-spatial "things" are not things at all, but are ongoing processes and their cessations have not "occurred" to yet produce a "thing"! The *observed* event is 3-spatial and has occurred. It is something in the past, not the present. That is different from something ongoing (happening or unhappening)[241] in 4-space, before having been observed and therefore a frozen snapshot taken in 3-space. As is well known in quantum mechanics, observation is a physical interaction and it indelibly changes and stops the "ongoing 4-process", converting it to a momentarily frozen "3-thing" as an effect of the observation process at that particular instant. So any "thing" is continual and iterative, *not continuous*, in its travel through time, and in its "observed existence in 3-space".

Because of such, physicists also have difficulty realizing that mass — being an observable — does not and cannot exist continuously in time. It cannot even *continuously exist!* No observable can. Masstime exists in time, but mass does not, as we previously discussed. Observation is a *dldt* operator imposed upon an ongoing 4-space process, destroying the time

[241] When a frozen instant 3-space snapshot (observable) interacts with a second causal process to generate another frozen snapshot (observable), the first observation "unhappens" because it is thereby moved into the "past", disappearing from 3-space forever. With every change of an observable (with every observation), even if the new effect appears identical to the previous one, it is still a *new* observable (a new effect) where a former effect "seems" to have recurred (been created, happened). Even if it is spatially the same as the previous observation output, it is at a different point in time and hence is the result of the *d/dt* observation operator being iteratively applied. The serial outputs — even of what we loosely call an "entity existing in time with no 3-space change" — are *successive and different* serial outputs from a serial time-differentiating process.

portion and producing an instantaneous, frozen snapshot at that instant. It's just *d/dt* (LLLT) => LLL. That is why all observation is 3-spatial, as is well known in physics. We long ago pointed out how the common photon interaction — the total photon interactions (both virtual and observable) with a mass — is what drives the mass through time, so to speak {15}. But it does it iteratively, frozen snap after frozen snap —just like progressively showing the frames of a movie film.

What really has to be changed is the old notion by Heaviside and Poynting that 3-energy propagates continuously through 3-space.[242] No observable can propagate continuously in 3-space, but only in 4-space and then only during its nonobservable state! So a "mass propagating through time" (i.e., just sitting still and "existing", so to speak) is doing so in an iterative fashion by recurring iteratively in observation output at the same spatial position. The mass turns to masstime, then to mass, then to masstime, etc. Or $m_1 \Rightarrow m_1t \Rightarrow m_2 \Rightarrow m_2t \Rightarrow m_3 \ldots$ etc. In short, *observation continually recurs at an enormous rate,* so *an observable (effect or output of that observation process) continually recurs at an enormous rate,* destroying the previous observation as the next one occurs.

Because of the history of thinking in 3-space terms rather than 4-space terms, one of the ubiquitous errors widespread in physics is the substitution of the effect (the frozen output of the observation process) for the cause (that 4-space initiator process which continuously exists prior to observation, hence unobserved). So causes (4-space initiators which are unobservable a priori) interact with a previous "frozen 3-space snapshot" or observable, to produce a change (either a temporal change or spatial change or both) in or to or of that observable (that 3-snapshot) to a new observable (3-snapshot). If the object is seen to iteratively change in time but not position or form, it is said to "exist" or "persist" at rest continuously in time. It doesn't. It *continually recurs*[243] in that form, but does not *continuously exist* in that form!

[242] And also the hoary old mistaken notion that the "same observable thing" can continuously exist in time or persist.

[243] More rigorously, the continual recurrence is at the quantum level. So a larger mass or other observable actually is a great horde of very small "continual recurrences" of tiny incremental pieces of itself. At any time interval of observation via observable photons, a vast number of nonobservable (virtual) "continual recurrences" occur in the "observed object". In short, the "observed object" is the **end** summation and result of a vast number of infinitesimal changes. Hence the entry of statistics and the uncertainty principle. Each one of the infinitesimal

The antigravity mechanism has been implicitly present in the Dirac theory of the electron since his 1930 paper {497}, where he brought forth the Dirac sea and the anti-electron, if the *causal* Dirac sea negative energy states are applied to general relativity before they interact with charge and are "observed". General relativity deals with spacetime and spacetime curvature. Therefore, it is concerned with causal 4-fields, 4-potentials, and 4-waves in 4-space prior to observation.

As we stated previously, there is really no such thing as a "3-space EM wave", e.g., as rather strongly pointed out by Romer {546}.

One can produce and have an EM field of *negative* EM energy in spacetime, coming from the 4-positron charges of the anti-charged mass of a system, as well as one can produce and have an EM field *of positive* EM energy in space, coming from the charged mass of a system. But negative energy EM fields have been swept away from our minds by interpreting the negative energy 4-electron as the 3-positron, after the negative energy 4-electron has interacted with charged matter (been observed as the *effect),* rather than how it exists in spacetime prior to observation (as the *cause).*

So physicists reverse the direction and the charge, and make the mass positive, which is how the Dirac sea hole is "seen" *after observation.* That makes it a material lattice hole and a special kind of positive ion. Before observation, it is not seen at all, but it exists as negative action (energy x time) and therefore in "negative masstime" state form. Before it has been observed, it's still there in spacetime, as a curvature of spacetime. It's just a *negative energy state curvature* in the vacuum/spacetime.

Make lots of these negative mass-energy state Dirac holes from a source system, such as one producing a very powerful negative energy EM field, and voila! That's it. The system is producing — and surrounding itself by — its own negative energy EM field (negative curvature of 4-space), which is also its own local antigravity field. That antigravity field superposes with the prior local curvature of spacetime, altering it. The *net* curvature of local spacetime is itself a field which interacts back upon the mass system to produce "net gravity" whose sign may be positive or negative, depending on the sign of the net spacetime curvature. If the two back-acting curvatures of spacetime are opposite and equal, that represents the source object existing in a zero gravitational field, and thus "hovering" in the Earth's gravitational field, for example.

changes may be modeled causally, but since there is no individual information available on each one of them, they can only be calculated statistically.

The use of negative energy EM fields and Dirac sea holes to alter the curvature of the local spacetime in a negative direction provides the present author's engineering approach to practical antigravity. Note that our approach gathers in the gist of both of the major two approaches to antigravity: (1) the shielding theory as typified by Modanese {547}, and (2) the opposing force theory as typified by Ling Ni and Torr {548}. The opposing force, considered as a field that is identically a curvature of spacetime, is also a "gravity shielding" force via superposition of fields. We state unequivocally that a theoretical model of the new approach can be constructed from Sachs's theory {510}, and implemented in the 0(3) electrodynamics of Evans and Vigier {549}. Further, it is a directly engineerable theory, without the necessity for superconductivity, spinning wheels, etc. as demonstrated by the highly successful Sweet experiment previously discussed.

We quote Evans {550}, on the appearance of the B(3) field in general relativity, to indicate the nature of such a future theoretical model:

> *"I have chosen a metric that gives circular polarization (as observed), but in the framework of general relativity using the irreps of the Einstein group according to the Sachs theory. This is a closed field theory which is analytical, using a Lie group, the Einstein group. As such there are no particles, only spacetime curvature, so everything in physics reduces to spacetime curvature, i.e. to a metric vector and its components. This is then incorporated in the Sachs theory to produce a metric four-vector which is a <u>generally</u> covariant component of a quaternion-valued metric with sixteen components, the most general form of the metric allowed by general relativity and topology. The Einstein-Sachs equations for electromagnetism are six metrical equations in six unknowns, the components of an antisymmetric field tensor of electromagnetism. By choosing a metric that corresponds to circular polarization, $B^{(3)}$ appears automatically.*
>
> *This method gives the $B^{(3)}$ field from Einstein's theory of general relativity applied to electromagnetism by a consideration of the irreps of the Einstein group. It follows that whenever the conjugate product $-gA^{(1)} \times A^{(2)}$ is observed, the $B^{(3)}$ field <u>must</u> also be observed, otherwise general relativity fails. Examples of*

the $B^{(3)}$ field at work are the inverse Faraday effect and RFR [Radiatively induced fermion resonance]. "

Evans and the AIAS have already taken the first theoretical steps showing that antigravity does indeed arise from Sachs's theory {551a-551c}.

We are convinced that practical antigravity only occurs at extremely low frequency (ELF) for reasons[244] explained previously. Certainly that seems to be true for our approach to it. The highest "total energy" photon is the low frequency photon with low spatial energy and a larger time increment. The larger time component has the same energy density as mass. So one multiplies the time component increase (in seconds) by roughly $9x10^{16}$ to get the increase in spatial energy equivalency. Halve the frequency of a photon, and one increases its *total energy* by $4.5x10^{16}$ {552}.

High energy physicists have not realized that the time component of the photon has enormously more energy than the spatial component, and that low frequency photons contain enormously more trapped energy than do high frequency photons. So they largely ignore the time-energy component, focus on the spatial energy component, and erroneously consider *high energy* physics as *high frequency* photon physics. Instead, present high frequency photon physics is only a high *spatial* energy physics, not a high *total* energy physics at all. Today's high energy physics is really still a very low total energy physics, compared to what can be done with the time-energy component of the photon rather than its spatial-energy component. By transducing and using the highly compressed time-energy, experiments can be done on the lab bench with fairly simple and cheap equipment, that actually utilize *higher total energy nuclear reactions* (though at low spatial energy) than are presently obtained in the largest accelerators.

That is also why there is presently no understanding in the conventional community of the "low spatial energy transmutations" of cold fusion, where the experiments unwittingly use the high time-energy component. The scientific community has not even recognized the time-energy aspects,

[244] Dramatic increase in the magnitude of the time-component, hence an enormous increase in the time-energy component with only a small decrease in the spatial energy component total energy of the photon. The *total energy* thus dramatically increases, when the spatial energy equivalent of the time-energy is considered. The present conservation of energy law in physics is inadequate because it does not account time energy at all; thus completely discards the most fundamental EM energy mechanism of all: the giant negentropy of source charges and source dipoles.

and has not recognized that time-energy physics is an ultrahigh total energy physics, where the present "high energy physics" is tame by comparison.

The previously unknown time-energy induced transmutation interactions are the precursors to, and the opening salvo of, a new *ultrahigh total energy physics* struggling to be born in spite of the adamant opposition of the conventional scientific community. Allowing for the time-energy component, for the mechanism generating the flow of time, and for formation and decay of time-reversal zones, we previously wrote the exact new nuclear reactions for the production of the excess deuterium, tritium, and alpha particles {553} in numerous cold fusion experiments. We also explained the highly anomalous nuclear instrument effects — due to (i) time-charging, (ii) the slow decay of time-charge with radiation of Whittaker longitudinal waves, each accompanied by its phase conjugate twin time-polarized wave, and (iii) the previous time-charge history of the instrument. These puzzling anomalies have been observed at U.S. Navy research facilities at China Lake now for some years in rigorous electrolyte experiments {198}. We summarize that work in Chapter 10 of this book.

With a little effort and development, practical antigravity appears to be straightforward for any good modern laboratory. But the lab physicists should first (i) rethink the entire subject, from its very fundamentals, to include considering the positron before observation and not after observation, (ii) remove the Lorentz symmetrical regauging from electrodynamics and recover the presently missing COP >1.0 and COP»1.0 Maxwellian systems again, and (iii) rapidly develop COP»1.0 systems and processes to use in antigravity experiments and development. At least in this approach, the COP»1.0 EM systems — once developed — are an immediate gateway to practical antigravity devices, unilateral thrust propulsion systems, and antigravity vehicles. And of course they are the immediate gateway to practical transport vehicle power systems, fuel-free, clean, and self-powering.

Hopefully, such a scientific reassessment will be performed, and it may provide the gateway for practical transportation and travel to the ends of **the** solar system and beyond, to be achieved in the first two decades of this century.

8.5 In Conclusion

We have briefly reviewed the presently developing field of inertial space propulsion and antigravity, and presented our own approach to practical

antigravity as well as an informal experiment that strongly supported that approach. We have strongly stressed that the causal field from the system as its source constitutes a curvature of the local spacetime superposed upon the pre-existing local spacetime curvature. Instead of thinking of that causal field from the source system as acting back upon the source system, we have stressed thinking of that *net superposed curvature of local spacetime* acting back upon the source system and producing a net gravitational force upon it. That net gravitational force may be either positive or negative, or zero, depending upon the sign of the net curvature of spacetime that is interacting back upon the system.

We presented and explained the results of the Sweet VTA antigravity experiment as probable verification of our approach to antigravity. Nonetheless, we also emphasized that the formal independent replication required by the scientific method has not been accomplished, and it remains to be accomplished before the approach is to be considered as scientifically validated.

We believe that this approach to antigravity can be modeled and engineered by use of the Evans-Vigier O(3) electrodynamics as a subset of the Sachs electrodynamics that is a part of the Sachs unified field theory.

If so, then tentatively we have laid out the basis for eventual practical antigravity systems and a practical antigravity technology. We fervently hope that this approach will in fact lead to practical technology and working transportation means during the next decade.

Finally, we hope that these notes and concepts will stimulate many sharp young graduate students and post-doctoral scientists to examine, model, correct, and greatly enlarge the ideas and principles advanced. If so, then the purpose of this chapter will have been realized.

Chapter 9

The Supersystem and Remarks on Gravity, Antigravity, and Testing

"What might appear to be empty space is, therefore, a seething ferment of virtual particles. A vacuum is not inert and featureless, but alive with throbbing energy and vitality. A 'real' particle such as an electron must always be viewed against this background of frenetic activity. When an electron moves through space, it is actually swimming in a sea of ghost particles of all varieties - virtual leptons, quarks, and messengers, entangled in a complex melee. The presence of the electron will distort this irreducible vacuum activity, and the distortion in turn reacts back on the electron. Even at rest, an electron is not at rest: it is being continually assaulted by all manner of other particles from the vacuum." [Paul Davies] {554}.

"Space acts on matter, telling it how to move.. In turn, matter reacts back on space, telling it how to curve." [Wheeler's principle] {555}.

"...the Aharonov-Bohm effect is a local gauge transformation of the true vacuum... [which] produces a vector potential from the true vacuum. [This gauge transformation] produces topological charge..., the electromagnetic field, which carries energy, and the vacuum charge current density first proposed by Lehnert... and developed by Lehnert and Roy... ". [M. W. Evans and S. Jeffers] {556}.

"The energy density (En_d) in curved spacetime is given in the Sachs theory by the quaternion-valued expression

$$En_d = A_m j_m^* \qquad [1]$$

where A_μ is the quaternion-valued vector potential and j_m^* is the quaternion-valued 4-current as given by Sachs ...Equation [1] is an elegant and deeply meaningful expression of the fact that electromagnetic energy density is available from curved spacetime under all conditions; the distinction between field and matter is lost, and the concepts of "point charge" and "point mass" are not present in the theory, as these two concepts represent infinities of the closed-field theory developed by Sachs from the irreducible representations of the Einstein group. The accuracy of expression [1] has been tested to the precision of the Lamb shifts in the hydrogen atom without using renormalization of infinities. The Lamb shifts can therefore be viewed as the results of electromagnetic energy from curved spacetime." [Myron W. Evans] {557}.

"Old habits of thought die hard, and it is not always easy to remember that a particle with negative mass if pushed to the right will move to the left; or that in a given reference frame a particle with imaginary mass can have infinite speed, in which case its energy is zero." .... "... extremely powerful energy sources may occur if particles of negative mass really exist in nature." [Banesh Hoffman] {558}.

"The observed (3-spatial) positron is a quite different entity from the unobserved (4-spatial) Dirac hole. Its direction has been reversed, and its mass and energy have also been reversed. Before the 4-spatial hole in the vacuum has interacted and been observed, it has negative energy and therefore negative mass equivalency, as well as negative charge. As a source charge, it also is the source of negative energy fields and negative energy potentials — all in the

nonobservable 4-state. " [T. E. Bearden, private communication to a correspondent, 2001].

"The...visible structure of orthogonal' 1-networks possessing coupled open-paths and closed-paths represents only an introductory step in the development of a correct topological theory for conventional electric networks...An electric network is like an iceberg...Its visible portion is only a small fraction of the submerged invisible structure. " [Gabriel Kron, who developed special tensor methods and diakoptics to deal with the large number of visible and invisible multidimensional p-networks surrounding the branches of every electric circuit.] {559}.

"...symmetry implies conservation. Since our entire edifice of interactions is built on symmetry assumptions, there should be as a result a large number of conservation laws. The only trouble is that almost all of these conservation laws have been violated experimentally. "... "...this difficulty could be resolved by introducing a new element, the vacuum. Instead of saying that the symmetry of all matter is being violated, we suggest that all conservation laws must take both matter and vacuum into account. If we include matter together with vacuum, then an overall symmetry could be restored" [T. D. Lee] {560}.

"One perhaps oversimplified way to deal more conventionally with the new unified field approach to electrodynamic systems is to utilize the notion of the 'supersystem', comprised of three components: (I) the ordinary EM system and its dynamics—conventionally assuming flat spacetime and inert vacuum, (2) the local nonlinear vacuum and its dynamic interactions with the system and with spacetime, and (3) the local curvatures of spacetime and their dynamic interactions with the system and with the local

active vacuum. In the rich feedforward and feedback interactions that result, there emerges a dramatic new physics, new electrodynamics, and new chemistry including a new biochemistry. This is in fact a much simplified conceptual approach (good to 'first order', so to speak) to the multinetwork and multipath work of Gabriel Kron. It also allows the retention of symmetry, considered so necessary to particle physicists. "
[T. E. Bearden, private communication to a correspondent, 2001].

9.1 The Supersystem and Its Considerations

In classical electrodynamics, the Maxwell-Heaviside-Lorentz equations implicitly assume a local flat spacetime and no net action by the vacuum {561}. Both these implied assumptions are false. All real EM systems involve interactions with both curvatures of spacetime and the active vacuum. Yet to try to include both additional interactions requires a unified field theory approach, such as that of Sachs {562}. Unfortunately, any unified field theory is replete with quite difficult mathematics, little of which can be illustrated pictorially or simply.

What is required — at least for most electrical engineers and applied electrical scientists — is a conceptual way of visually thinking about the EM system in a way that is consistent with unified field theory to something like first order, but which can also be conceptualized easily.

9.1.1 The Supersystem Concept

Accordingly, we introduce a new and very simple way of thinking of electrical circuits in terms of a unified field theory. We utilize the notion of the supersystem, consisting of three components: (1) the EM system and its dynamics, considered in conventional fashion (as if the local vacuum were inactive and the local spacetime were flat but perturbed), (2) the local interactive vacuum and its dynamics, and (3) the local curvatures of spacetime and their dynamics. All three components of the supersystem interact. This produces both feedback and feedforward functioning; e.g., energetic changes in the system produce corresponding changes in spacetime curvatures. In turn, the alterations in spacetime curvature produce nonlinear changes in the active vacuum, which in turn acts back upon the system. So every action in a system produces a corresponding set

of feedforward and feedback reactions from and with its complex environment, and vice versa.[245]

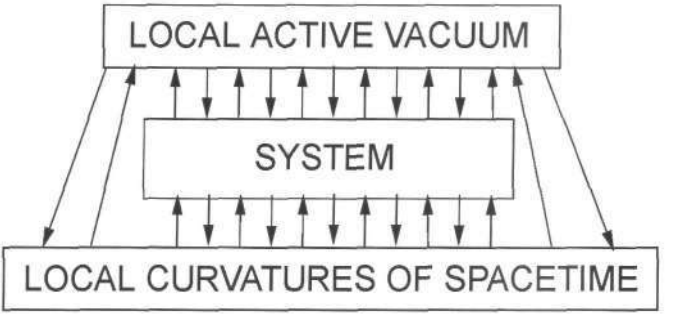

Figure 9-1 The Supersystem concept (block diagram).

Figure 9-1 shows a diagrammatic illustration of the supersystem concept. Figure 9-2 illustrates the effect of the classical EM assumptions of a flat spacetime and a locally inert vacuum. As can be seen, the classical assumptions *arbitrarily discard the* interaction effects upon and in the system due to the active vacuum dynamics and due to the local spacetime curvatures and their dynamics.[246]

As stated, all three components of the supersystem interact with each other. This is a dramatic change to classical U(1) electrodynamics. Hence the total interactions — with the system — of both the active vacuum and the locally curved spacetime, and their interactions with each other, are more general than either classical EM, general relativity, or the quantum mechanical vacuum of particle physics prescribes individually.

[245] We hypothesize that the feedback contains the mechanism generating Newton's third law as a restoration of symmetry, but leave that to the master theorists to explore and decide.

[246] As one example, the nondiverged Heaviside component of energy flow — previously discussed in earlier chapters — is part of the supersystem activity. This **flow** alters both the local active vacuum and the local spacetime curvature associated with an electrical power system and its connected external circuits. Since the resulting local "environmental" changes in the supersystem are extensive, then one can conceive ways in which these changes can be interacted with additional intercepting/receiving systems to produce extra "EM energy from the vacuum".

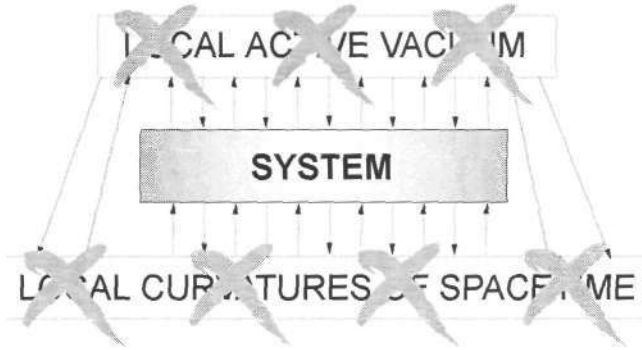

Figure 9-2 Classical EM destroys two-thirds of the supersystem.

Immediately it can be seen that the concept of energy from the vacuum is a "supersystem active and not negligible" concept involving a unified field theory approach *a priori.* It can also be seen that a "system" in equilibrium must be in equilibrium with its active environmental exchange — its exchange with the active local vacuum and the active local curvatures of spacetime. Since energy "exchange" with the system means both incoming and outgoing exchange, it follows that the equilibrium system has equal incoming and outgoing energy exchange. It follows that the symmetrically regauged system has equal incoming and outgoing energy, and so the symmetrically regauged system must be in additional stress from two net equal and opposite direct interaction forces, one general relativistic and the other from the active vacuum. Further, this "equal and opposite" equilibrium stress state must be accompanied by equal and opposite interaction effects between the two environmental media of the system.[247,248]

[247] We point out but do not pursue the fact that this is a very important new concept associated with *coherently* changing the symmetrical regauging, which allows a new physics, a new electrodynamics, and a new chemistry including biochemistry. For one thing, it permits such things as a self-maintained excitation state that simultaneously continuously discharges its excitation energy. This is simply a redefinition and more general broadening of the "source charge" concept. From the normal system view (assuming away the vacuum and curved spacetime interactions), an "impossible" system state can nonetheless be possible and stabilized, by changing the *intensity* of the Lorentz regauging condition. As an example, new molecules or ions can be made and stabilized in an excited state, that otherwise would be so unstable that the excitation would decay in a nanosecond with the state disappearing also. We believe this alone will lead to a great new biochemistry and medical

9.1.2 Time and Space Effects and Positive and Negative Energy

From curved spacetime considerations, we must include the effects on the system, and on the vacuum, of dynamics in the *time* domain as well as in the *spatial* domain. Indeed, in Sachs's theory space and time do not separately exist, but only spacetime. We consider time as highly compressed EM energy — as heretofore pointed out, where time is spatial EM energy compressed by the factor c^2 and having energy density similar to mass. We must include not only EM *energyflow* along the time-domain (fourth Minkowski axis *ict),* but also EM *force, potential, energy oscillations,* etc. in the time domain itself. We shall have to deal with time-force, time-energy, time-potential, time-energy current, longitudinal EM waves in the time domain (time-polarized EM waves), etc. {563}. The complexity of the full supersystem analysis is thus easily seen and appreciated. In most cases, a higher group symmetry model for a particular situation will prove intractable for closed solutions, and numerical methods must be used.

Further, when curved spacetime interacts with the active vacuum, we shall also have to consider *negative energy* currents in the nonlinear vacuum itself, as well as in the time-domain. We may also speak of the *negative energy density* in the vacuum as a special kind of negative energy *potential* in the vacuum that is created by a negative energy potential in the time domain. We may speak of a gradient in this vacuum negative energy potential as a negative energy force or "force in the negative energy domain". Applied to the time domain, these concepts constitute a causality condition placed on the Dirac sea, in the same vein as more technical causality considerations given by Finster {564}.

9.2 Differences between Effects in COP»1.0 and COP<1.0 EM Systems

In this chapter, we utilize the Dirac hole in a different manner from the received interpretation. The received interpretation assumes an electron hole in the vacuum, with the hole filled with a negative energy electron

therapeutic science; one company is already working in this area, with positive results.

[248] We leave to the advanced theorists the connection between this "stable equilibrium state under a change in symmetrically regauged stress", occurring as a *net-force-free* intensity change in the conventional Lorentz symmetrical regauging of the Maxwell-Heaviside equations.

having negative mass, negative energy, and negative charge. In that interpretation, when the electron is lifted out of the hole, the hole is said to be *a positive energy* electron with positive mass and positive charge, (i.e., when interacted and observed). In short, with reaction one has a complete transformation of negative energy into positive energy, negative mass into positive mass, etc. In our view, this totally destroys the notion of "how the hole exists in the vacuum prior to its interaction and observation". That kind of positron only occurs after a physical interaction and observation has occurred — in short, *the positron exists only after an interaction with the Dirac hole has been made, to change the very nature of the negative energy hole.* The positron is the 3-effect of an invoked extra 4-interaction, and is not at all the "negative energy electron" or hole as it actually exists prior to being interacted and transformed. The positron is a different beast from the beast we wish to harness and use. The conventional interpretation leaves the question of the unobserved and unreacted "hole" left behind by an electron lifted out of the hole, before another interaction is performed on the hole to change it. So it is an incomplete accounting (as all observations are).

In our interpretation, the Dirac "hole" in the vacuum is itself the true negative energy electron before its interaction and observation. It is the "causal" 4-space negative energy electron, while the received interpretation is only for the "observed" or "effect" positron. In our view, the received interpretation thus leaves out a goodly part (and the most interesting part) of the Dirac sea hole. When the negative energy hole is filled, we consider the *electron* in the hole to be a normal, positive energy, positive mass electron. Hence the summation of the energy of the filled hole is zero, as is its summation mass and its summation charge. This accords with the properties of the "normal" vacuum, said to contain a sea of such "filled Dirac holes".

Our purpose is to use *emptied* Dirac sea holes before their interaction or observation, and thus to use them as *causal 4-electrons having negative mass and negative energy, but where each of those quantities is multiplied by time. So the hole has negative masstime and negative action.* Unless otherwise stated, that is our interpretation of a Dirac sea hole, and that will be how we use it. This way we avoid having to replace a true negative energy, negative mass, positive charge causal (unobserved) 4-electron by a positive energy, positive mass, positive charge observed (effect) 3-electron. We do not just artificially "dispose of" the question of the "nature of the hole that is left behind" when the positron is observed. We

consider the (hole x time) as the fundamental negative energy 4-electron. We will sometimes refer to that as the "4-positron".

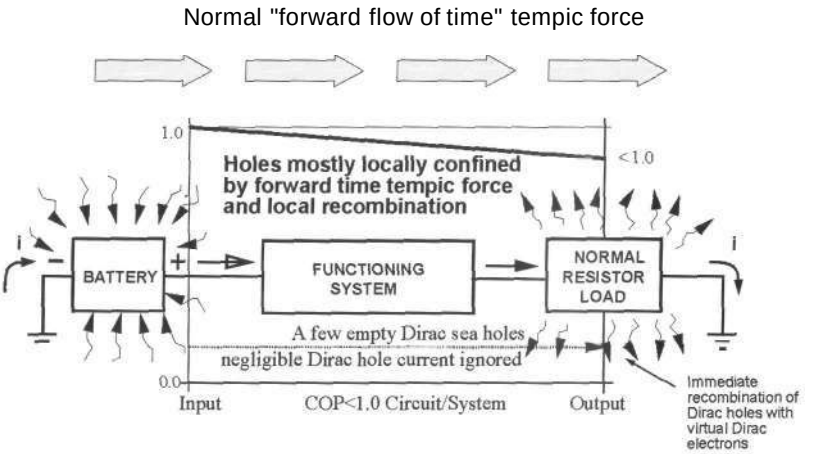

Figure 9-3 Time potential gradient across a COP<1.0 EM system.

See Figure 9-3. In a COP<1.0 EM system, the tempic potential gradient (tempic force) is oriented from input to output and on out beyond the system. A very slight Dirac hole current moves outward from the output, but is immediately "eaten" by the virtual electron flux fluctuations of the vacuum in the space immediately adjacent to the output. There is a slight Dirac hole current also exiting the system in its losses, but again these are immediately "eaten" by the virtual electron flux fluctuations of the vacuum in the immediately surrounding space.

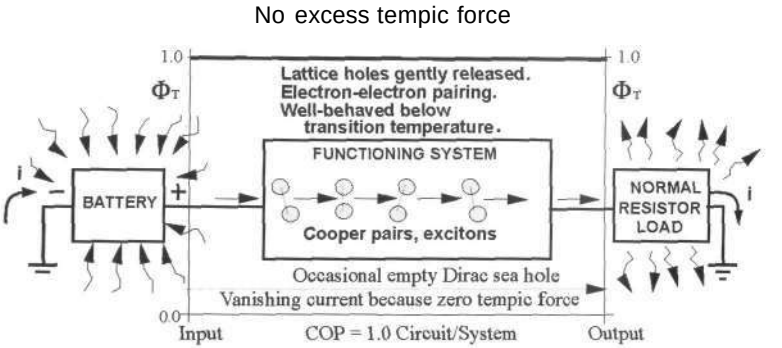

Figure 9-4 Time potential gradient across a COP = 1.0 EM system.

See Figure 9.4. In a superconductive system or section, COP =1.0 and on the average there is no net gradient of the time potential across the system, hence no time-force across it in either direction. Accordingly, one sees ready Cooper pairing of charges and formation of excitons. We shall not concern ourselves further with the superconductive EM system; such a system has not yet produced COP>1.0.

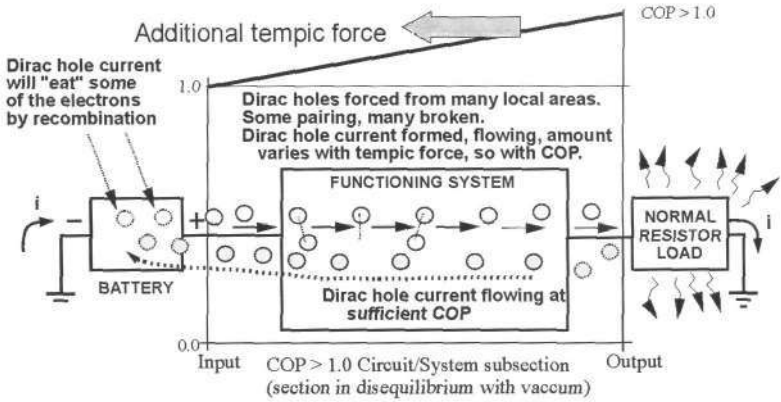

Figure 9-5 Time potential gradient across a COP»1.0 EM system.

See Figure 9.5. In a COP>1.0 EM system, there is a net tempic force across the system from the output section to the input section. However, unless the COP»1.0, the hole current in the local vacuum is mostly used up in interacting with the system material and converting to lattice holes (lattice positrons). Hence at "nominal" or moderate COP>1.0, except in fast pulsed discharges one *usually* has little to worry about, concerning Dirac sea holes in the vacuum, since those readily convert to lattice holes as already accounted. One effect of concern is that, if the semiconductors in the system are exposed to sufficient extra lattice holes or interacting 4-holes, their donor-acceptor arrangement is disrupted, spoiling the action of the semiconductors and perhaps destroying them.

When COP»1.0 (and even for some COP>1.0 systems), then there results a substantial Dirac sea hole current in the local vacuum occupied by the system, flowing through the supersystem from the output section back to the input section. This is an additional hole current component from the

Dirac hole current component converted into lattice hole current.[249] This unconverted Dirac sea vacuum hole current runs through the system from the output section back to the input section of the system and beyond. If not "filled" there in the input section by the incoming input electrons from the external power supply, the 4-hole current can and will pass on back into the feed line and to the distant external power supply, *eating electrons and electron current all along the way.* Usually semiconductors in the path of a substantial 4-hole current will either malfunction or be quickly destroyed.

In the input section and on back into the external power source, the effect of the unrestrained Dirac sea hole current's reaction is to interact and convert into lattice holes all along the route, which lattice holes then "eat" incoming electrons from the distant power source. Thus, the external power source "sees" the hole current as a dynamic additional load in the system's input section itself (and in the external conductors leading to it) *that also must be powered with additional positive energy electron current.*

[249] Here we wish to recognize the perceptivity of Peter Lindemann, who recognized the importance of "cold electricity" in COP>1.0 systems without going deeply into the more technical aspects of negative EM energy. As an example, we cite his book, *The Free Energy Secrets of Cold Electricity*, available from Clear Tech, Inc., Box 37 Metaline Falls, WA 99153, U.S.A. Particularly note his efforts to explain the Gray overunity device via the negative energy that can be associated with very strong discharges. Gray referred to this appearance of an associated negative energy component associated with the normally positive EM energy as "splitting the positive pole" (a "pole", after all, involves a stress potential). The Gray engine drawing is shown in Figure 5-14, his conversion tube is shown in Figure 5-15, and his circuit for the conversion tube is shown in Figure 5-16. As Lindemann explains, Gray also apparently succeeded in converting the negative energy into positive energy in his conversion element switching tube. Bedini's successful replication of the tube along with pertinent lab notes are shown in Figures 5-17, 5-18, 5-19, 5-20, and 5-21 by permission. Since Bedini is one of only two or three persons truly experienced in converting negative energy into positive energy, his successful replication is significant and decisive. Gray's process thus transformed negative energy into positive energy, allowing positive energy COP>1.0 self-powering systems. Bedini and the present author have filed a joint patent application filed on the process explained in this Chapter. We recognize Ed Gray as being a real pioneer in the area of COP>1.0 electrical power systems and in energy conversion. His pertinent patents are E. V. Gray, "Pulsed Cap. Electrical Discharge Engine," U.S. Patent #3,890,548, 1976; "Efficient Power Supply Suitable for Inductive Loads," U.S. Patent #4,595,975, **June 17, 1986.**

Aside from destruction of semiconductors etc.,[250] the overall effect is to increase the draw of power and current from the external source, so that the COP» 1.0 power system is thereby converted back to a COP<1.0 system!

The increased power draw due to the Dirac hole current can be remarkable. For an external battery power supply, if the hole current is sufficient to pass on into the battery itself, the battery may *charge* with negative energy while also powering the circuit! A remarkable phenomenon then takes place. A battery having been appreciably charged with negative energy may appear to be discharged (and so it is, with respect to positive EM energy). Yet, it may also continue to power a circuit. Sometimes it will, sometimes it won't, depending on the circuit. However, on connecting a normal positive energy battery charger to recharge it, the battery *precharged* significantly with negative energy will "eat" positive energy for an extended period, filling its localized Dirac Sea holes in its negative charge all the while, with the external voltage of the battery not changing at all. When all the negative energy holes are filled in the internal vacuum environment of the battery, and the negative energy charge is thus removed, suddenly the battery will start recharging with the input positive energy in a normal manner.

The batteries in Watson's generator (again see Figure 5-12) exhibited that phenomenon. Sometimes in recharging one of his batteries that had been extensively used, the battery would "eat" positive energy from the charger for a week or more before finally filling up its negative energy charge and then recharging normally from that point on.

The Dirac 4-hole current is nature's decay mechanism for the COP»1.0 system, sharply bringing it back to COP<1.0. Any successful COP»1.0 EM system must contain a mechanism for defeating (or transducing and

[250] As an example, novel effects may also happen in resistors, capacitors, and coils, and the effects depend on both the materials and construction of these components. A resistor can act as a true negative resistor and cool rather than heat, a capacitor can have its current lagging its voltage, and a coil can have its current leading its voltage. Mixtures of all three of these effects can happen in each of the three components, since each usually has some aspects of resistance, capacitance, and inductance. The emfs and back emfs in the circuit can also be altered and disrupted in a manner varying with the individual circuit and the individual operating conditions. Nonlinear oscillations and discharges of negative energy are particularly difficult to foresee and understand. Effects in dielectrics may vary widely, as can effects in conductors because of their internal impurities, etc.

using) this Dirac sea vacuum 4-hole current into its input section and beyond. We shall cover that subject shortly. The 4-hole current decay mechanism can *sometimes* become significant for semiconductors in the lattice 3-hole stage at COP = 5 or more, though the exact figure varies as the type and size of system and the semiconductor type. At COP > 10 or so, some systems will frequently begin to ravage themselves back into equilibrium with the vacuum, and destroy their overunity performance, unless the 4-hole current phenomenon is dealt with.

Let us recap. We have assumed — to first order — a sweeping generalization that COP<1.0 systems exhibit an overall average spacetime curvature across the system (from input section to output section and load) such that excess positive energy electrons exist in the Dirac sea, without any appreciable accompanying excess Dirac sea holes interacting in the circuitry itself.[251] The slight excess of Dirac sea holes that are generated is "swept" forward out of the output section, and "eaten by the vacuum interaction" (particularly by the vacuum fluctuations) immediately upon exit from the output section. In that case, we do not have to concern ourselves particularly with Dirac Sea 4-holes and Dirac sea 4-hole currents, or at least they are usually negligible in most cases.[252]

For COP»1.0 systems, however, the overall average spacetime curvature across the system — from output section and load to input section — is such that Dirac sea 4-holes and their currents do independently continue to exist and independently flow in the local vacuum occupied by the physical system. Specifically, we shall have to consider the *tempic* effects upon such holes and hole currents, which are oriented from the output section back through the system to the input section.[253] In the COP»1.0, the

[251] In short, the requisite number of Dirac holes have interacted with and do interact with the lattices, converting into the normal "lattice hole" type of positron connected with positive mass, positive energy, but slowly migrating around the circuit in the opposite direction from the electrons. Here the true Dirac hole current exists only in short "hops" from atom to atom as the lattice holes are steadily filled by the "hopping" electrons.

[252] As stated, a kind of "hole" phenomena still exists in the circuit, but now as lattice holes and currents. Since these are attached to ions each having a mass much greater than that of an electron, the lattice hole currents may usually be neglected except in semiconductors, where they are taken into account in the very design of the semiconductor component itself.

[253] When we state a concept such as "negative mass" or "negative energy", we have conceptualized it *as if observed.* Hence, unwittingly we have made it an instantaneous, but iterated, concept. Rigorously, no such thing as mass or energy

effect of the increased tempic force is to sweep a Dirac sea 4-hole current back through the system from output to input, and even on out into the conductors from the external power supply, and on further out into the external power supply itself. The 4-hole current continues its "reverse feedback into the powering end of things" until quenched by filling it with incoming electrons. This conversion of 4-hole current to filled Dirac sea 4-holes by induction of lattice holes also squelches the concomitant negative EM energy fields, potentials, and waves associated with Dirac 4-holes as sources.[254] The reason is that a filled Dirac hole is a dual system of two opposite charges, hence produces counteracting positive and negative energy fields.

The "4-hole-eating and filling process" is therefore the exact decay mechanism that squelches the natural electrogravitation associated with Maxwellian circuits which use Dirac 4-holes and 4-hole currents, negative energy fields, negative energy potentials, etc. When the circuit converts its free Dirac 4-holes into lattice holes, all electrogravity capability is lost, insofar as practicality is concerned.

For electrical power system purposes, the external environment of the COP»1.0 system furnishes an extra "electrical load" demand upon the external power supply, so that the extended system consisting of the (external power supply + power system) decays back into overall COP<1.0 condition and operation. For this reason, any appreciable involvement of Dirac 4-hole currents in a COP>1.0 EM power system must be *transduced* into positive energy electron currents, which requires just a special form of regauging. One need not confine regauging and gauge freedom to positive energy potentials and positive energy fields alone.

From the vacuum consideration and particularly from Dirac's theory of the electron, in COP>1.0 EM systems and circuits we shall consider that the Dirac sea 4-holes involve negative energy states (negative mass), and that positive energy states involve positive mass. In our approach, we shall consider a negative energy state (Dirac 4-hole) in the vacuum as having

independently exists except at one instant in time. Instead, mass exists in a continual iteration of *m* —> *mt* —> *m* —> *mt*... and energy exists in a continual iteration of *E* —> Et—»E—» *Et*.... and so on. So during the masstime or energy-time (action) state, time and either mass or energy are intimately interactive. See our previous discussion in this book of the mechanism for the flow of a mass through time.

[254] Obviously that kills the antigravity aspects, because it kills the negative energy fields that would give negative curvature of local spacetime.

negative mass, which means that antigravity can be involved as well.[255] In this treatise, we consider only electron states, thus only negative energy and positive energy electron states.

9.3 Primarily Concerned With Dirac Sea Holes and Not Lattice Holes

We also stress the dramatic difference between a Dirac sea "electron 4-hole" in the vacuum (prior to observation) as compared to a lattice 3-hole in a semiconductor or other material component (after interaction and therefore after observation). In the case of a lattice 3-hole, usually the "positron" (hole) is attached to an ion, whose mass (i) is very much greater than the mass of an electron, and (ii) is also positive. In other words, a lattice hole is just a part of an ordinary positive ion. So the theory of "lattice holes" and "lattice positrons" does not primarily apply to the situation we are discussing. On the other hands, semiconductors exposed to any significant currents of pure Dirac sea 4-holes in the vacuum usually react and are nearly instantly destroyed because of the immediate disruption of their donor-acceptor arrangement and functioning. Interaction (filling the incoming Dirac 4-holes with contributed electrons) causes sudden mass disarrangements in their atoms and nuclei and lattice

[255] We assume that the important thing about mass is its localized energy. Hence we associate positive mass with positive localized energy (with respect to the ambient energy density of the massless vacuum) and we associate negative mass with negative localized energy (with respect to the ambient energy density of the massless vacuum). In this view, the empty Dirac sea hole has both negative energy and negative mass. Note that this differs from the conventional assumption, which unwittingly addresses the positron as having been observed, producing a directional reversal. The rigorous test of our thesis is that concentrations of Dirac sea holes *must* generate antigravity *potential,* while currents of Dirac sea holes must generate antigravity *force.* The conventional view, assigning positive mass to the positron after observation, would produce gravity, not antigravity, but the force would be reversed by the reversed parity after observation. We argue that antigravity has been hidden and lost by its parity reversal in the assuming positive mass for the positron *as if that were the mass of the positron before it is observed.* In an overunity system with powerful steady-state Dirac 4-hole currents, the 4-hole currents can be differentiated by the cooling (negentropy) effect of the COP»1.0 system—when shorted to produce a "current surge" — rather than heating (entropy) effect. The magnitude of the hole current (which determines the average presence of the hole density) can be differentiated by a measurable weight loss in the COP»1.0 system. The successful antigravity production of the Sweet COP»1.0 device — discussed later in this chapter — experimentally verified these hypotheses.

bonds. Thus, in the presence of Dirac sea 4-holes and 4-hole currents, usually any interacting solid-state electronics of the circuit or system will be dramatically affected. For switching in the presence of holes and hole currents, in most cases one may have to turn away from semiconductors and utilize mechanical or electro-mechanical switching, although this requirement varies with the type of semiconductor, the COP, the system geometrical layout, and the subsystem operations and layouts. Sometimes semiconductors may still be used if they are "brutes", with current handling capabilities well beyond what is "normally expected" in that circuit.

9.4 Peculiarities of Spacetime Curvature and Dirac Hole Interactions

When considering the interaction between *curved* spacetime and the Dirac vacuum, immediately we violate the premise that all electron states in the Dirac Sea are always filled (which condition we surmise — along with Dirac — only exists on the average in a flat spacetime region). In a curved spacetime, we can have sustained excess 4-holes in the vacuum, or we can have holes that accept an electron falling into them *without emitting radiation.* The radiation-free "pair annihilation" reaction is possible when the spacetime simultaneously changes its curvature appropriately and thereby "absorbs" and holds the excess EM energy that would otherwise be emitted if the spacetime remained flat or decayed back to the flat state.[256] So long as that "energy-storing ST curvature" remains, there is no photon energy emission. If the "energy storing ST curvature set" has a net curvature instead of being flat, and then decays to a flat spacetime, then the previously retained energy is emitted as photon energy.

In that case the reaction provides the conventional emitted pair annihilation energy. In *that* case, the emitted energy may also transform into emitted particles in reactions well known in particle physics.

[256] Eerily, this interaction represents a situation where opposite reaction forces (the vacuum upon spacetime, and spacetime upon the vacuum) can create a special kind of stress in the system and changes in that stress. This leads to a peculiar kind of stress waves (scalar waves — longitudinal EM waves, so to speak) that are not covered in circuit theory anywhere. A symptom is that these stress waves react with components, amplifiers, preamps, etc. to create electrostatic waves. The effect of these waves is seen as the "crawling" of electrostatics all over and in the electrical equipment that is in one's laboratory. The effect can readily damage oscilloscopes, etc.

The normal emission of photons by pair annihilation need not occur, if the excess decay energy is absorbed *and held* by the local spacetime changing and holding its energy density and therefore (i) changing its curvature and (ii) stabilizing in that new excited state instead of decaying back to a flat spacetime.[257] Under such "non-emitting" pair recombination, a Dirac Sea 4- hole may simply "eat" a free 4-electron, and instead of emitting radiation the process simply affects the curvature of spacetime (and the state of the local Dirac sea) and changes it accordingly. A new "equilibrium state" is therefore reached in the supersystem between the opposite forces of the vacuum acting on spacetime and spacetime acting on the vacuum.[258] In other words, we consider change in the curvature of spacetime to exhibit EM energy *source* (emission) or *sink* (absorption) capability, with respect to the nominal ambient flat spacetime and with respect to conventional EM interactions.[259]

Or simply put, the energy emitted by the combination of positive and negative energy in the vacuum may be "locally radiated", "locally absorbed", or "locally transferred" to the other local component of the supersystem: the local curvature of spacetime. *It is all spacetime curvature dynamics.* By definition, a flat local spacetime consists of a vacuum with all its Dirac sea holes filled. Therefore, if "filling a 4-hole" results merely

[257] Our view is that in normal pair annihilation this curving of spacetime to absorb the emission energy occurs first, and then the new ST curvature decays by what is called "emission of photon energy". We regard the photon as a specialized ST curvature traveling at light speed. So what is emitted as a photon is in fact the formation of a locally structured spacetime curvature (an "engine") traveling at light speed. It is a propagating spacetime curvature "engine" or "set of engines". In the process we are describing, the emission of the photon is the decay of the locally formed ST curvature set. If that set does not decay, the locally formed ST curvature set remains and no photon is emitted.

[258] This new kind of equilibrium is extraordinarily important, particularly in chemistry, where it will allow the "locking" of impossible combinations of particles into strangely stable "impossible molecules" with ongoing "impossible chemical reactions". The further discussion of the startling new chemistry that emerges is well beyond the scope of this paper, but such chemical states are included in nonequilibrium thermodynamics as *stationary states* — e.g., see Kondepudi and Prigogine, *Modern Thermodynamics*, Wiley, 1998, Chapter 17. At least one company has already succeeded in initiating this startling new kind of chemistry, with several patents granted and several more in process. Similar new "impossible stabilized excited states" and "impossible nuclear reactions" also occur in nuclear physics.

[259] The classical EM assumption of the flat local spacetime is in fact an assumption that the decay of the intermediate "ST curvature absorber/sink" occurs instantly.

in relaxation of a set of local ST curvatures back to a flat spacetime, no EM radiation need be emitted, contrary to the usual pair annihilation phenomenon where additional energy (curvature of spacetime) is involved.

Similarly, in a ST curvature, there can conceivably be electrons without "holes". If the curvature is negative, there *will* be unfilled Dirac sea holes present. Of course this is just a normal positive energy 4-electron, where the flat spacetime assumption in classical electrodynamics is in error. Instead, the local spacetime is positively curved, producing positive gravity. Whenever the energy density of spacetime-vacuum interaction changes from the "ambient vacuum and flat spacetime" condition, either positively or negatively, that constitutes an appropriate curvature of spacetime as well as a change in the vacuum dynamics. Therefore, in classical electrodynamics the assumption of a normal electron (or any other charge or mass) existing in an uncurved spacetime and an unaltered vacuum is a non sequitur. The local spacetime has in fact "curved" to an extent of holding the energy of one electron mass.[260] Further, the Dirac Sea has also changed to contain one unfilled and unobserved Dirac 4-hole.

With these things in mind, let us now introduce a conceptual model for dealing with these novel 4-hole phenomena that are experienced in COP>1.0 systems — and that have been the bane of many a would-be energy researcher attempting to develop a system extracting its EM energy from the vacuum and using it to also power the system itself.

9.5 Charging and Discharging a Capacitor

In electronic circuits, we usually think of charging a capacitor with electrons, and then discharging the capacitor to emit electrons again. However, we can charge the same capacitor with Dirac sea holes, or with a combination of Dirac sea holes and electrons. Then we can switch the capacitor adroitly and force it to give us back electrons. This "regauging" effect can thus be used to transduce negative energy current into positive energy current. So let us examine the charging and discharging process more closely. This is part of the Bedini process for handling the 4-hole

[260] Mostly physicists think only of the *spatial* energy change. However, the time domain of spacetime also acts as a sink or source. Essentially one kilogram of mass only has the energy of 1 second of time. Hence the minuscule *mass* of the electron results in such a minuscule "sink" in the time domain that it has been inadvertently ignored. However, during that fraction of time where the electron exists as "mass time" and "charge time", it has considerable time energy, and *that* curvature of local spacetime cannot be neglected with respect to supersystem interactions.

current problem in overunity EM systems, to allow close-looping a system into self-powering operation.

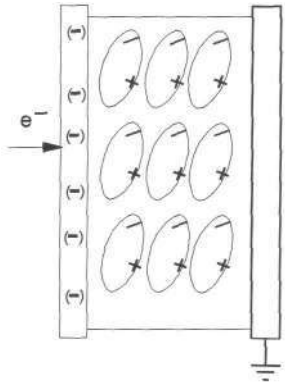

Figure 9-6 Normal strain in a dielectric capacitor that charges with electron current

Figure 9-6 shows the normal strain induced in a capacitor containing a dielectric between its plates. We charge the left plate with electrons, which repel the negative ends of the molecules in the dielectric, straining them to the right.

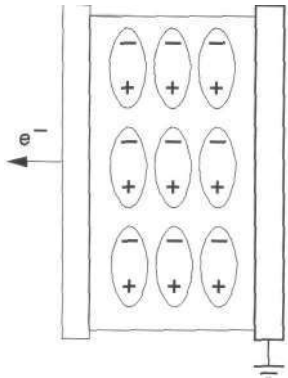

Figure 9-7 Strain relief in a charged dielectric capacitor that discharges.

Figure 9-7 shows the relief of this dielectric strain, by allowing the piled electrons on the left plate to be pushed back into the circuit from the left plate. Note that the electrons emitted in the relaxation of the dielectric strain pass back into the circuit from the same plate that was charged. This is a special kind of "reflection" symmetry. For a perfect capacitor, the total

Vq joules stored in the charged capacitor and drawn from the circuit, is returned to the circuit.

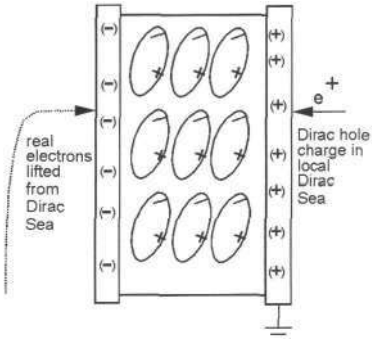

Figure 9-8 Strain in a dielectric capacitor supersystem that charges by Dirac hole current and lifted Dirac electrons

Figure 9-8 shows a remarkable thing when we charge the capacitor with Dirac sea holes. Suppose we charge the rightmost plate of the same capacitor used before, while the leftmost plate is temporarily disconnected from the circuit (or connected to another capacitor). Now Dirac Sea holes pile up in the local vacuum connected with the right plate. Whether or not they interact with the right plate, these positively charged holes attract the negative ends of the dielectric molecules, again straining the top of the dielectric molecules to the right. The strain of the dielectric is a force interacting upon the local vacuum, and it lifts real electrons from the Dirac Sea (or pulls them from the circuit or other attached capacitor) and onto the leftmost capacitor plate. The charged capacitor *in its supersystem* thus has additional functions that occur. The total *Vq* joules stored in the charged capacitor, were this time drawn (converted) from the applied Dirac hole current and the resulting interaction upon the vacuum, to lift real electrons onto the leftmost plate.[261]

[261] The reader should recall that a force is something automatically produced by nature to restore symmetry to a broken symmetry condition. A "4-hole negative energy force in the Dirac Sea" produced on one plate of the capacitor will evoke a "positive energy force outside the Dirac Sea" on the other plate as an attempt to restore symmetry. To produce this "positive energy force", positive energy electrons are lifted from the local Dirac Sea of that plate.

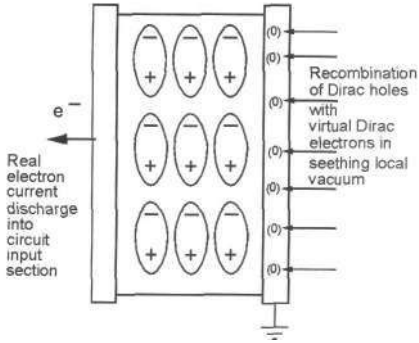

Figure 9-9 Strain relief in a dielectric supersystem that discharges after charging by Dirac hole current and lifted Dirac electrons.

Figure 9-9 shows the strain relief of the charged capacitor in Figure 9-8. First the charged capacitor is re-connected to the circuit or element to which one desires to provide with electron current. The strained dielectric relaxes, and electrons in the leftmost plate are returned to the circuit. The Dirac holes in the rightmost plate discharge back into the local vacuum (a supersystem interaction) and are "eaten" immediately by the readjustment of local curved spacetime.[262]

The result is that the Dirac sea 4-hole current arriving in the input section has been intercepted by a waiting capacitor, and has been effectively transposed into normal electron current that is furnished back to the input section from the capacitor. This additional electron current helps power the circuit and reduces the power drawn from the external power source. The 4-hole current feeding this capacitor, together with transduction of the 4-hole current into electron current, effectively comprises a true negative resistance process. In other words, energy in unusable (in this case, detrimental) form is received, transformed into energy in usable (beneficial) form, and that usable energy is discharged back into the circuit input to assist in powering the system.

Transducing negative energy into positive energy — and vice versa — in the system does not violate the conservation of energy law in the

[262] From experiments, it seems that Dirac holes forming at the "output" section of a **COP<1.0** device or system are almost instantly filled with electrons in the violent fluctuations of the zero-point energy. When forming at the "input" section of a **COP>1.0** device, this is not the case, and usually the holes can only be filled by incoming electrons in the power input, unless special provisions are taken to convert **the** arriving hole current (in the input section) into electron current.

supersystem, when most generally stated. With such regauging (which involves supersystem reactions), it is the *absolute value* of the energy that is conserved in the system, not its algebraic sign. Regauging (by gauge freedom) is after all an effect or condition locally imposed, but with appropriate energy exchange with the rest of the external universe via spacetime curvature dynamics exchange and vacuum dynamics exchange. The algebraic sign *is* conserved in the universal supersystem by the additional compensating reactions occurring in the other two components of the universe's supersystem.

The reader should strongly realize that energy is only required to be conserved in the universe's supersystem, not the system component alone. Again, this is an open system far from equilibrium with its active environment. In that case, energy is conserved in the ensemble of system and environment, but not necessarily in the system itself. This is no stranger than a common windmill or waterwheel.

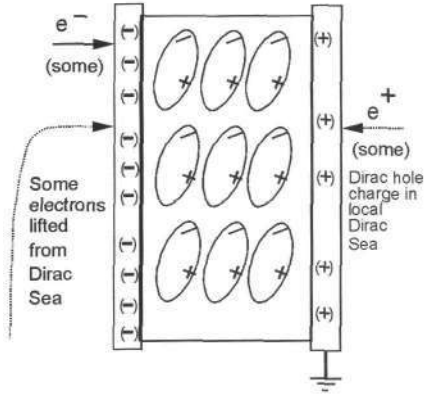

Figure 9-10 Strain in dielectric in a capacitor supersystem that charges with a mix of electron current, Dirac hole current, and lifted Dirac electrons.

Figure 9- 10 shows a "mix-charging" variant of the 4-hole current charging of a capacitor, in which some real electrons are fed from the circuit to the left plate. Also, the Dirac sea hole current arriving in the input section is intercepted to charge the right plate, and some electrons are also freely lifted from the local Dirac Sea onto the left plate. Figure 9-11 shows the discharge of this type of charging of the capacitor, and the relief of the strain in the dielectric.

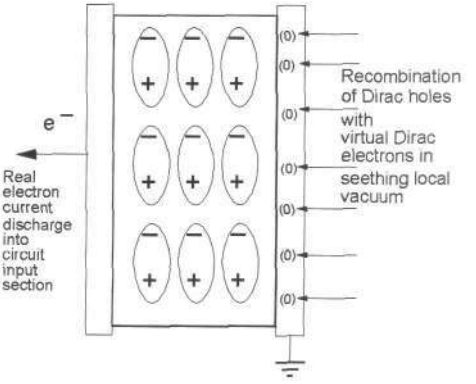

Figure 9-11 Strain relief in a dielectric that discharges after charging of capacitor supersystem with mix of electron current, Dirac hole current, and lifted Dirac electrons.

In Figure 9-11, for example, we accent that the holes on the right plate are maintained only so long as there is a net strain on the dielectric and a net force across the capacitor. When the capacitor is discharged, the holes are discharged into the local vacuum in such a way that they now instantly recombine with virtual Dirac electrons in the vacuum fluctuations.

There are other ways and "tricks" of transducing the Dirac sea hole 4-current into electron current, but these methods are still proprietary to Bedini and will not be included in this presentation. We accent that all such "tricks" are actually methods of re-engineering the other two components of the supersystem — the active local vacuum and the local curvature of spacetime. This is using and applying what we have referred to as "engines".

9.6 The Open-Loop COP>1.0 EM Power System

Figure 9-12 shows the use of the transduced Dirac hole current as real input energy to "catch and lock" a COP>1.0 system in its overunity condition and stabilize its operating point for stable self-powering of the system and its load. The COP>1.0 operation reverses the normal tempic potential across the system, so that Dirac hole 4-current arrives in the input section, preparing to "decay" the system back to COP<1.0 condition.

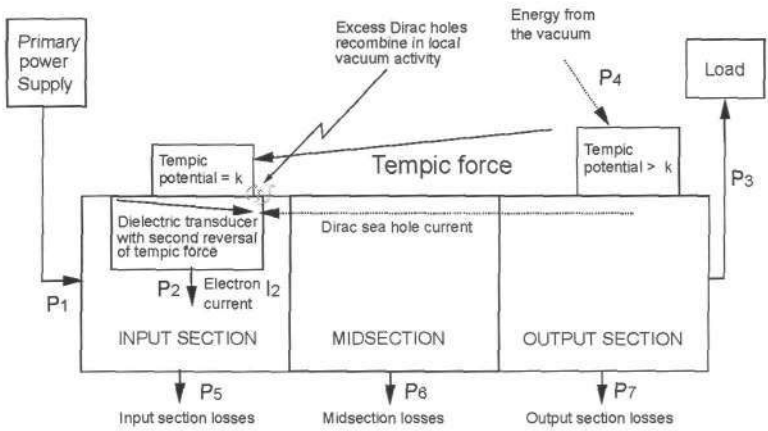

Figure 9-12 Open-loop use of transduced Dirac hole current energy as real input energy to reduce power input required from the primary power supply.

However, the arriving hole current is intercepted by an adroitly switched dielectric transducer, which again reverses the tempic force. As explained above, the capacitor is charged with 4-hole currents (or a mix) and then discharges electron currents into the system — in this case, into the input section itself— by adroitly engineering the local vacuum state and the local curvature of spacetime.

The input section does not care where it receives its electron current from; it merely needs sufficient for its powering needs. Hence, the input section happily accepts this transduced electron current to partially power the system. This in turn reduces the "system load" that the external primary power supply "sees". The primary power supply thus reduces the current and power that it is furnishing to the system. In short, now the external power supply sees the combination of the normal system load and a "negative resistor (negative load)" represented by the transduced current and power. Its required input power is reduced accordingly.

9.6.1 Close-looped System: A True Negative Resistor

Figure 9-13 shows the use of the same process given in subparagraph 9.6 above and in Figure 9-12, except that now there is additional 4-hole current received and available, for transduction into normal electron current into the input section of the system. Sensors and governing are added to this operational mode, so that the system may *adjust and regulate its self-furnished electron current* to meet the total needs of its losses and

its load. The system thus adapts the transduction of Dirac sea hole current: to fit its needs and is capable of regulated self-powering operation.

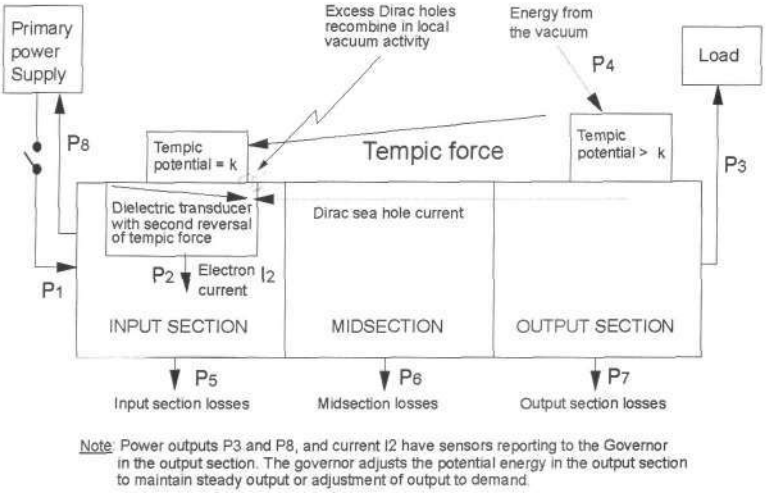

Figure 9-13 Close-looping the C0P>1,0 system with transduced hole current.

The system is first started in open-loop mode. The governor then gradually increases the transduction of 4-hole current into electron current, and the supply of that transduced electron current to its own input. This steadily reduces the "current draw" from the external primary power supply. When the "external current draw" reduces to zero (the Kron condition), the system "locks" into that position, with automatic governing to adjust the transduced electron current as the loads and losses vary. At that point, the external power supply is disconnected automatically.

This "locked and governed" system is now a *self-powered system,* freely taking its energy from the active vacuum and local curvatures of spacetime, to power both itself and its load. So far as we are aware, this is the first time that the technical means of locking and stabilizing COP>1.0 operation in an EM system in an open loop and closed-loop operation has been given.

If sufficient Dirac sea 4-hole current is available and transduced, excess electron current can be available at the system input section, even when the system is fully self-powering. In this case, the additional current can be fed back to the power line, so that the self-powering system not only powers its own load but also helps power the power network. Or additional load can be added and powered.

We point out that Gabriel Kron apparently had a solution to these problems in the late 1930s, and that solution has been suppressed to the present day. We give the following quotations to show Kron's knowledge of these things.

Quoting Lynn and Russell {565}:

> *"Kron has never published details of his method of making the polyhedron self-organizing, although his published results show that in this state it has some remarkable properties, associated with harmonic integrals on multiply connected spaces."*

In reference to Lynn and Russell's remarks, we point out that the Dirac sea 4-hole current from the output to the input is a special case of Kron's more general discovery of the multiply-connected open path existing through space between any two points in a circuit that are at differing potentials.

Quoting Kron {566}:

> *"...the missing concept of "open-paths" (the dual of "closed-paths") was discovered, in which currents could be made to flow in branches that lie between any set of two nodes. (Previously—following Maxwell - engineers tied all of their open-paths to a single datum-point, the 'ground'). That discovery of open-paths established a second rectangular transformation matrix... which created 'lamellar' currents... " "A network with the simultaneous presence of both closed and open paths was the answer to the author's years-long search."*

Again quoting Kron {567}:

> *"Although negative resistances are available for use with a network analyzer, in practice it is more convenient to use a second type of circuit, in which the positive and negative resistances are replaced by inductors and capacitors and the dc currents and voltages are replaced by ac currents and voltages of <u>fixed</u> frequency. The use of the second type of interpretation is equivalent to multiplying the wave equation by* $i = \sqrt{-1}$."

The reader should particularly note that in the first part of the sentence Kron stated unequivocally that negative resistances were available for **use** on the network analyzer, a large analogue simulation used by the Navy **and**

administered at Stanford University with the contractor being General Electric. The censors missed that one.

Again quoting Kron {568}:

> *"When only positive and negative real numbers exist, it is customary to replace a positive resistance by an inductance and a negative resistance by a capacitor (since none or only a few negative resistances exist on practical network analyzers).*

We believe the censor caught this one, and forced Kron to add the words, "none or". Kron had at least three negative resistors, and possibly more.

Again quoting Kron {569}:

> *"Now a value E of the negative resistances, at which the generator current becomes zero, represents a state at which the circuit is self-supporting and has a continuous existence of its own without the presence of the generator, as the negative resistances just supply the energy consumed by the positive resistances. ... When the generator current is positive the circuit draws energy from the source, and when the current is negative the circuit pumps hack energy into the source. At zero generator current the circuit neither gives nor takes energy, and theoretically the generator may be removed. "*

Here we believe the censor forced Kron to add the word "theoretically". In this quotation Kron reveals that he was well aware of the process for close-looping a system — starting it in open-loop mode and bringing the negative resistor currents up to match the system needs nnd reduce the generator current to zero, then disconnect the generator. He also was quite aware that excess transduced energy from the negative resistor could be available at the input, in which case energy could be furnished back to the power network while the system powered itself and its load simultaneously.

We also point out that Dirac's definitive electron theory — covering the Dirac Sea and Dirac sea holes — was published in 1930, the year the present author was born. In the late '30s and in the 40's Kron certainly was well aware of that work. In addition, Kron applied full general relativity to electrical circuits and machines, and he was far ahead of his time. His work is also still far ahead of the present time, at least in the open

scientific community. He also was aware of developments in particle physics, and so he did have the gist of the supersystem concept in his mind {570}, however he may have thought of it. His concept of the "open path" effectively includes the effects upon the system from the other two components of the supersystem, so it appears that Kron's "system plus its open path" roughly corresponds to our concept of the "supersystem."

Further, Kron was a mentor to Floyd Sweet, who also worked at General Electric but in a different project. Sweet often spoke glowingly of Gabriel Kron.[263] Sweet almost certainly knew the secret of Kron's negative resistor. It is the present author's opinion that Sweet's vacuum triode amplifier was derived from Kron's negative resistance unit. With both deceased, we will never know for certain.

9.6.2 Suppression of COP>1.0 Systems Should be Investigated

During our decades of research, we ran across several cases where U.S. scientists actually produced working COP>1.0 systems.[264] None of these overunity systems was ever allowed to go forward with independent development. This is an area that cries out for a full and vigorous Congressional investigation, and appropriate legal action should be taken by the U.S. government against the suppressing parties, whomever they might be {571}. Simply put, the U.S. government, the U.S. taxpayer, and the scientific community have been ripped off and deluded in the field of electrical energy for more than half a century. That continues to the present, as witness the disappearance of the Watson generator (accompanied by Watson and family breaking off all contact with their close colleagues) and the suppression of the Kawai device and process. The latter suppression was accomplished in 1996 in the personal presence of the present author and the members of the Board of Directors of our company, CTEC, Inc. An accidental overunity frequency converter was even initially placed in the original Minuteman missile, but was altered back to COP<1.0 operation when the electronics past the converter kept failing because of overload power furnished by the converter.

[263] The present author worked with Sweet off and on for a decade or more, and designed the antigravity experiment that Sweet performed.

[264] These incidents were previously exposed in a draft book, *Matters Arising*, carried on the Internet for some months and then withdrawn. Some things must wait for their appointed time, and so must certain kinds of information.

9.7 Remarks on Dirac Sea Holes, Currents, and Negative Energy

The subject of the Dirac Sea, Dirac holes, Dirac hole currents, and negative energy still has elements of strong disagreement within the scientific community and among leading theorists. Often the "conclusion" one reaches depends on the way the starting assumptions are made and then on how the mathematics is applied. There is no definitive experiment establishing that negative energy cannot exist; to the contrary, many things do occupy negative energy states. The binding energy of the nucleus, e.g., involves a loss of mass (loss of positive energy) and hence involves negative energy states, as is well known. Here the "negative mass" effect is immediately and experimentally verifiable, and is recognized. The total mass of the bound nucleons is less than the total mass of those same nucleons when unbound, and this fact is widely known and accepted.

A single white crow is sufficient to prove that not all crows are black. Hence a single experimental proof of mass-energy "loss" and negative energy states establishes that negative energy and negative mass are real. Indeed, every photon absorption by mass and every photon emission by masstime prove the same point universally: mass is a variable. The same assembly of protons and neutrons in a nucleus, having lost mass, also has "lost" some of the gravity that the positive masses of those unbound protons and neutrons would otherwise produce. Therefore, there is an appropriate amount of "negative gravity" already acting in conjunction with positive gravity, in every atomic nucleus. It is associated with the negative energy states of the bound nucleons in every nucleus.

Consistent with the initial quotations and comments at the beginning of this chapter, we present an interpretation by which we can understand some of the major novel phenomena that arise in laboratory experiments with COP>1.0 electromagnetic systems, including COP»1.0 systems.

We propose that COP»1.0 EM interactions are widespread in highly energetic astronomical interactions {572} and even in highly energetic phenomena on Earth, when the supersystem changes are also accounted.[265] We argue that novel negative energy phenomenology — such as encountered in the COP>1.0 experiments by Magnetic Energy Ltd. in

[265] As an example, in looking at sprites and other such sharp electrical discharge phenomena, we may be observing the prompt *decay* of COP»1.0 interactions which were self-initiated in the atmosphere.

various versions of the COP>1.0 motionless electromagnetic generator (MEG) {573, 574}, by Bedini {575} in his induction of negative resistor actions inside the batteries of battery-powered COP>1.0 EM systems, and by Sweet and the present author in experiments with the Sweet COP»1.0 vacuum triode amplifier system {576} — is also generated in these COP»1.0 highly energetic astronomical interactions, yielding the same kind of negative energy and negative energy currents.

This Dirac hole negative energy generation of COP»1.0 EM processes is proposed as the mechanism which directly produces the negative energy fields and potentials that generate the mysterious antigravity accelerating the expanding universe {577}. This is a reasonable assumption, even though it is against the received view, because it is based on some laboratory experiments, not just theory. It also is the unexpected effect of the cosmological constant introduced by Einstein {578}, and it is consistent with Zeldovich's demonstration that the energy density associated with Einstein's repulsive cosmological constant is — or is associated with — vacuum energy.[266] The received view *is not* based on direct experiments with COP>1.0 EM systems, but only on COP<1.0 EM systems. Until the received view is broader based, it does not adequately represent nature. Hence it does not represent a valid refutation of experimental negative energy systems producing antigravity processes.

In Bedini's experiments and in the MEG experiments, antigravity is essentially absent or so small as to be nearly nondetectable. However, these experiments generally have COP of 1.5 to 4.0, mostly, and sometimes 10 or 12 (we have experimented up to 20 or more stably, and unstably at nearly 100). Hence the Dirac hole current is relatively small in them, since the magnitude of the Dirac current is a function of (COP - 1).

Sweet's COP > 1,500,000 experiments produced a very large flow of negative energy back across the system, substantially curving the local spacetime and reducing the weight of the system on the laboratory bench. Figure 6-7 shows the first Sweet device, which produced six watts output in open-loop operation. Figure 6-8 shows a later Sweet device which

[266] Believed to have been demonstrated in 1967. But check Ya. B. Zeldovich and A. A. Starobinsky, "Particle creation and vacuum polarization in an anisotropic gravitational field," *Zh. Eksp. Teor. Fiz.*, Vol. 61, 1971, p. 2161 *(Sov. Phys. - **JETP,*** Vol. 34, 1972, p. 1159); Ya. B. Zeldovich, "Vacuum theory — A possible solution to the singularity problem of cosmology," *Uspekhi Fizicheskikh Nauk,* vol. 133, Mar. 1981, p. 479-503. Translation in *Soviet Physics — Uspekhi,* vol. 24, Mar. 1981, p. 216-230.

produced COP = 1,500,000 and was pushed past that COP to produce the antigravity in the laboratory, smoothly reducing its weight by 90%. Figure 6-9 is a plot of the actual readings taken during the antigravity experiment. Sweet performed the experiment in California, reading off the measurements to me over the phone as he made each one.

Another indication of the negative energy effect present in the output section of the Sweet device was tested by suddenly shorting the output leads. This resulted in instant freezing of moisture from the air, so that the leads were instantly frozen and covered with ice. Contrast this to the normal heating of shorted wires, where the energy is positive.

Sweet never revealed his activation process, whereby he initiated very strong self-oscillation — of the nucleus of the barium atom in barium ferrite magnets — with the local vacuum treated as a semiconductor. One part was known to the present author and another part was known to Rosenthal, a professional test engineer. In addition, how Sweet converted his excessive hole current is not completely clear. It appears that he somehow used his coils in quadrature together with special circuitry to interact the excess hole current into his magnets, directly with the self-oscillating barium nuclei and thence with the other nuclei in his magnets. If so, it created the "rough equivalent" of increasing the associated binding energy offset and locked with concomitant additional local spacetime curvature.

If this speculation is correct, he "locked" the nuclei of his magnets to the local curved spacetime, maintaining the overall local binding energy in the nuclei themselves while producing a great excess of "binding energy" (negative energy) in the immediate vacuum. This would explain the antigravity, and would be consistent with the experimental results as well as the increase in antigravity as the output load of the device was deliberately increased.

We must use the supersystem concept, as in the quoted comment at the beginning of the chapter, to enable a better understanding of these novel phenomena. Together with the Dirac negative energy production and high COP system, the hypothesis of "additional negative energy acting on local spacetime immediate to each nucleus" allows the generation of the observed antigravity to be understood. However, we accent that this mechanism is still a hypothesis, and it must be further substantiated by experiment.

9.7.1 Lattice Holes

In a material conductor or other component of an electromagnetic circuit, the conventional model envisions currents in the Drude electrons as the electrons moving by "hopping" from molecules or atoms in the material lattices into the Drude gas, with each hop leaving behind a positively charged "vacated electron position" called a *lattice hole,* or just a "hole". Subsequent Drude electrons are attracted to fall into the holes, etc. This net movement of the hopping electrons down the conductor, etc. comprises the conventional electron current through the conductor. We point out that the actual movement of the electrons in their "hopping" is vastly more energetic than the very feeble net "drift" of the overall ensemble of Drude electrons longitudinally down the wire as current. The energy of the total electron activity ongoing in a simple 1-foot length of copper wire would power a city, if it could all be harnessed and utilized.

At the same time the electrons hop with a slow net progress down the wire, the "holes" in the material lattices are also collectively seen by the external observer as if "slowly changing their net positions" longitudinally in the opposite direction. One speaks of a corresponding "hole current" or "lattice hole current" in the opposite direction to the electron current. However, there are subtle differences in the flow of the two currents, because an electron in the Drude gas is far more kinetic than the positive ion left behind by an electron that has "hopped up into the electron gas". Nonetheless, the positive lattice ions do "rock" physically from the induced forces upon them, as the holes are opened and filled. In conventional electrical power systems, this equal and opposite energy reaction in the ions of the lattice materials, induced by the applied fields, is usually ignored. In most classical EM power system theory the holes and their "composite equal and opposite energy and work in the system" are also ignored, except in semiconductors and semiconductor circuits.

9.7.2 Newton's Third Law Is Accounted in the Supersystem

Because half the EM energy and work in the circuit is usually ignored (e.g., in the Maxwell-Heaviside-Lorentz standard equations), electrodynamics is said to be free from Newton's third law reaction. This may be a non sequitur, and it follows from the assumption that — for an EM wave, field, or potential in space — no interaction exists with the active vacuum or with the curvature of spacetime. In fact, those reactions do exist in the supersystem. The field, wave, and potential do indeed interact with both the quantum mechanical vacuum and the general relativistic spacetime.

Indeed, the field, wave, and potential may be said to *identically be* changes induced in general relativistic spacetime. The absence of the "transmitting" physical system leaves us with the remaining two components of the supersystem, each of which extends to infinity. Again, Figure 9-1 shows the actual interactions (the supersystem) and Figure 9-2 shows the erroneous and arbitrary "kill of the supersystem" by standard classical electrodynamics.

When higher group symmetry electrodynamics such as O(3) is applied, then the interactions between the three parts of the supersystem emerge and must be accounted. This is particularly true of COP>1.0 EM systems. However, as Finster points out {564}, the Dirac sea effects exist *wherever* there are EM fields, potentials, and waves. We add that curved spacetime effects also exist *wherever* there are EM fields, potentials, and waves. And wherever Dirac sea effects exist, or wherever curved spacetime exists, then there the local vacuum and local spacetime interact with each other.

However, as we shall point out, usually most of the Dirac sea hole effects can be neglected in COP<1.0 systems and in most lower gain COP>1.0 systems because of the time-energy aspects. For COP»1.0 EM systems, the time-energy aspects are partially reversed, and instead of carrying the hole effects away from the system, the time-force from system output to input forces the Dirac sea holes to flow back in the local vacuum across the system from its output to its input. This flow constitutes an additional "load" appearing in the input section and requiring additional electron current from the external power supply to fill the holes. If the power supply does not furnish sufficient electrons to fill the hole current at the input section of the system, then the unfilled hole current passes back into the feeder line toward the external power supply, and even into the distant power supply itself. In its progress, it eats incoming current all along the way, requiring that more current be furnished by the distant generators.

9.8 Remarks on the Observed Acceleration of the Expanding Universe

As a candidate for *dark negative energy,* the present author has proposed vacuum negative energy and currents in curved spacetime regions partially containing excess *empty* Dirac sea holes as well as normal *filled* Dirac sea holes. The process by which these excess Dirac holes are produced has been advanced, and is supported by at least one dramatic experiment. One result of such "negative energy areas" of negative spacetime curvature would be "jumps" increasing the velocity of light and high-energy particles

traversing these altered regions of spacetime. In fact, there is some evidence for just such jumps, according to a hypothesis by Richard Lieu of the University of Alabama in Huntsville {580a, 580b}. Otherwise, high-energy particles produced in distant processes in the cosmos would not be detected on earth, but would be annihilated in highly energetic collisions.

The departure of large-scale spacetime from homogeneity would also result in some loss of correlation in the presently fitted red shift versus distance relationship. Again, there is tentative indication that such may prove to be the case. The most distant galaxy recently detected has a red shift of 6.56, which — assuming homogeneity of space — implies look-back of 14 billion years or so.[267] (conventional view) Best estimates of the age of the universe based on the Big Bang assumption is some 14.7 billion years. It would seem that 0.7 billion years is a very short time for that observed galaxy to have formed. If even more distant galaxies are observed with larger telescopes to become available, then by the redshift correlation to homogeneous space one would be observing galaxies "before the beginning of the universe" — an obvious non sequitur. It appears that the redshift correlation to velocity and distance, as well as the homogeneity of space and in fact the Big Bang itself— are already in some difficulties and may be in serious trouble in the near future.

The empty Dirac sea 4-holes in the vacuum are special "Dirac negative action quanta" and the holes and their dynamics form negative action potentials, currents, and fields. This type of vacuum condition containing some empty Dirac sea holes is referred to as a *Dirac-polarized vacuum.*

However, we do not envision the Dirac-polarized vacuum as just simple *static* polarization, but as possessing rich dynamics such as negative energy currents, potentials, fields, waves, etc. including in the time-energy medium in the time domain. We also include the interaction of the dynamic Dirac-polarized vacuum with spacetime.

[267] I am indebted to Prof. Stanley Jeffers for this information, in his E-mail discussions with the Alpha Foundation's Institute for Advanced Study fellows. Dr. David Roscoe contributed the fact that the Big Bang theory has so many parameters that nearly anything can be "fitted in". But he also pointed out that W. M. Napier, *Astronomy & Astrophysics,* Vol. 310, 1996, p. 353 gives a very thorough analysis of the quantized cz phenomenon, which does present a difficult obstacle to Big Bang theory. Napier is **the** originator of the cometary catastrophe theory of biological extinction. One way or another, the theory of the Big Bang is in trouble, even though many theorists are still complacent about it.

Due to ongoing COP»1.0 processes involved in highly energetic astronomical phenomena, Dirac sea 4-hole regions and dynamics are believed to occur and exist in the vacuum across the observable universe. These occur especially in appreciably curved spacetime regions with large tempic potential gradients and thus large *time-forces* across the region.[268] The 4-holes and 4-hole currents in the vacuum are generated in great quantity in large cosmic explosions. Also, the energetic fluctuations of the local vacuum energy can separate a Dirac hole from its occupying electron by lifting the electron (pair production), and so can a curved spacetime. In a properly curved spacetime, fluctuation can lift an electron from a hole, and enter a stationary state by accommodating reaction of the local spacetime curvature. In that case, hole and electron go their separate ways. The hole and that or another electron may later recombine, or in sufficient local spacetime curvature, they can remain apart. We point out that every positive energy electron is accompanied by an appropriate local curvature of spacetime that prevents the accoutrement of a free Dirac sea hole,[269] and thus prevents the electron from disappearing.

The more energetic the local region, the more severe and violent are local spacetime curvatures in that region, and — in our view — the more frequent the occurrence of COP»1.0 interactions producing significant Dirac 4-hole currents, negative energy EM fields and potentials, etc. Indeed, the measurements that yielded the accelerating expansion of the universe were measurements of the relative velocities existing with stellar explosions known as type la supernovae. In our view, in explosions of such violent nature — particularly including in optically active gases such as where gamma ray bursters form — an appreciable fraction of the hole currents are transduced into positive energy electron currents. This produces — at least for a finite time — a net positive feedback, self-powering COP»1.0 phenomenon, resulting in very rapid asymptotic

[268] We also conjecture that these regions may account for a tentatively observed slight change in the fine structure constant, but leave that to the advanced theorists to validate or falsify.

[269] This needs a bit of modification. Rigorously, the so-called "isolated" observable electron is clustered around by *virtual* positrons (Dirac sea 4-holes) in the vacuum. So a positron influence is present, though from virtual positrons instead of observable positrons. The magnitude of both the positive charge and the internal or "bare" negative charge is infinite. The difference, however, is finite and is the "observed" magnitude of the observable central charge. There is thus a net observed shielding of the bare charge of the electron, and this is taken into account to yield the observed charge of the electron.

output energy increase. This is what we have hypothesized as producing the gamma ray burster itself. *Quenching* of this asymptotic rise in COP occurs only after the physical geometry of the "closed-looping" gas particles is broken a short time later. The maximum output energy is determined by a function of the *rate* at which the geometry is broken and the corresponding *rate* at which damping of the asymptotic rise and quenching occurs. The afterglow remaining in the gas is due to the extra positive energy produced in it by the transduction of negative energy into positive energy during the asymptotic rise of the self-powering burster, with excess positive energy being absorbed in the gas while the burster magnitude is rising. After damping and quenching, the gas has been heated (that is how the geometry was disturbed in the first place, to produce damping and then quenching). Re-ignition can occur whenever a new close-looping COP»1.0 situation spontaneously occurs. As in the gamma burster, this can often happen as the disrupted geometry of the gases stabilizes.

All 3-space EM energy comes from the time domain, as previously developed. In the more violent positive energy COP»1.0 regions, there is an increased conversion of time-polarized EM energy into 3-spatial energy and back. On the average there is a higher "time-energy conversion" or "tempic" potential. In those regions, a tempic conversion potential is higher at the higher center magnitude of the spatial energy density. Hence there are strong tempic forces from "inside to outside", providing a "tempic broom" effect to sweep outward the excess Dirac sea holes separated from their electrons in the curved spacetime. The result is the presence of increasingly unoccupied Dirac sea 4-holes toward the outside of violent regions of spacetime,[270] until the effect is overcome by the decreasing spacetime curvature. The 4-hole current radiating out from an asymptotically increasing (exploding) burster provides an asymptotically increasing (exploding) negative energy and negative mass reaction with spacetime. That reaction explosively creates curved spacetime for negative gravity (repulsive gravity), acting upon the local system and upon distant masses as well. The result appears to be the cause of the acceleration of the expanding universe.

It follows that re-ignition of the gamma burster can occur if, as the quenching continues, the geometry stabilizes and reaches another "close-

[270] I.e., the violent astronomical phenomena — while generating and increasing are more violent at the center, and less violent at the outside.

looping" positive feedback condition. In fact, just such re-ignition of the gamma burster is very often observed.

Therefore, we hypothesize that the more distant violent astronomical regions have greater amounts of repulsive gravity being produced by their local Dirac-polarized vacua particularly during their explosive asymptotic energy density rise. This produces violent streams or bursts of negative energy outflow, which is equivalent to negative mass outflow and which provides outgoing negative curvature of spacetime (antigravity). At sufficient distance from us, the increasingly earlier, more violent events and resulting greater curved spacetime regions have created sufficient cumulated Dirac-polarized vacua to override the normal attractive gravity between galaxies, etc. and produce net repulsive gravity. This results in observed distant acceleration of the expanding universe {581a-581f}.

9.9 A Solution to the Hole Current Problem and Close-Looping

Bedini and the present researcher have filed a patent application {582} on the above special capacitive process to *convert* or *transduce* the detrimental Dirac sea hole current reaching the system's input section into electron current, and put it to use in powering the system. This transduction process receives the hole current as a special potential, then regauges the "negative energy" potential into a "positive energy" potential. This regauging is accomplished by charging the capacitor with Dirac hole current and then discharging electron current from it. The transformed positive energy potential is then applied to the Drude electrons, producing an ordinary electron current in the input that can be used to power the system itself. If sufficient excess positive electron current is provided, then the system can "feed itself in self-powering mode and also feed power back into the main power supply line.

When conversion of the arriving hole current in the input section produces an output "positive energy" electron current equal to the system's normal power needs (Kron's condition), the external power supply can be disconnected and the system will remain powered by the steadily converted negative hole current arriving in the input section.

Our patent-pending process allows this otherwise devastating special form of "negative energy feedback" to be converted into "positive energy feedback", allowing the system to be close-looped successfully for self-powering of the system and its load. Regulators of the transduction process may be added to cover the situation when the load is erratic and changing.

At Magnetic Energy Ltd., we have also filed a patent application for an outrigger method of close-looping a COP>1.0 system, which greatly eases the problem. This method is covered in Paragraph 9-14 below.

9.10 Negative Energy: Localized and Nonlocalized

It sometimes appears there are as many views on negative energy as there are scientists who mention it. Simply put, the Dirac theory of the electron requires negative energy states. The negative energy electron state was envisioned by Dirac as a sort of "hole" in the ambient vacuum, where the hole could contain a positive energy electron. The combination of equal positive energy of the electron and negative energy of the hole itself, would give a "normal" vacuum zero state of the "filled hole". In other words, the normal or ambient vacuum consists of holes filled with electrons. Considered in that fashion, such a vacuum is referred to as the **Dirac Sea** or the **ambient Dirac Sea,** or the **ambient Dirac vacuum.**

If positive energy is added to a filled Dirac hole, the electron can be lifted out, leaving the hole. Note that adding positive EM energy, e.g., is actually the addition of spacetime curvature and dynamics to the Dirac sea vacuum. In short, it is a supersystem interaction, not a system interaction.

In that case, the curvature of the local spacetime interacts upon the electron mass, producing a force that lifts it from the hole. The result is the appearance of a positive energy, positive mass electron and a Dirac sea hole (a 4-positron) in a curved spacetime. That is known as *pair production,* and it is a supersystem interaction. When a positron and an electron meet, the electron falls into the hole, changing the Dirac sea which also changes the local ST curvature. That change in local ST curvature is a change in the energy density of space, and is normally radiated away as a photon or photons as the local curvature decays back to a flat spacetime. The emitted radiation may further decay into particles, etc. by several reactions well known in particle physics. That "conventional" set of supersystem interactions is known as *pair annihilation.*

If we deliberately change the ST curvature appropriately, however, the pair annihilation radiation need not be emitted since the excited local spacetime curvature does not decay back to a flat spacetime to emit it.

Dirac's original paper tried to identify a negative energy state vacuum hole as the proton, but later that was falsified and it was taken as the positron. There is a very strong aversion in physics to considering negative mass; hence, the mass of the positron was proclaimed positive (for many reasons

not really connected with our thesis). Nevertheless, some physicists (in the minority) still speculate or theorize that negative mass "can exist." Not only "can" it exist, but also it *does* exist widely and one can demonstrate it in actual electrical circuits. It certainly exists in the binding energy of the nucleons in the nucleus of an atom. Again, a single white crow is sufficient.

We take a very straightforward view: we consider a positron — an electron observed with positive mass and "observed" to be traveling backward in observer time — to be a different (transformed) entity than a Dirac 4-hole traveling forward in observer time.[271] The observation operator accomplishes both velocity reversal and time reversal, and — since time is not an observable, the time reversal is "seen" as a reversal in spatial direction. *Prior to observation, neither reversal has been imposed.* The major distinction, we hypothesize, is that the observed positron has positive mass in 3-space, which is concentrated positive energy, and therefore produces positive energy electrical fields and positive gravitational field. Mass is an observable, hence, it is the iterative frozen 3-space snapshots of an ongoing 4-space process. Observation (and any observable) is the effect of applying the operator $\partial/\partial t$ upon spacetime LLLT in which a 4-space process is occurring. As we stated earlier in this book, our view is that no observable *continuously persists* (in time), but continually and iteratively *recurs* by the continual ripping of time from the ongoing 4-space reaction, to see the 3-space intersection at a frozen moment. We also advanced the *mechanism* that generates the flow of a mass through time, consisting of a mechanism for $\partial/\partial t\ (\mathrm{LLLt})$ - photon emission, converting *mt* to *m* — and the mechanism for $\int_t (\mathrm{LLL})\mathrm{dt}$ — photon absorption, converting *m* to *mt*.

[271] This point is stressed. The *unobserved* positron is not identically a positive mass electron traveling backwards in time, but a negative mass, negative energy electron traveling forward in time. When Dirac theory of the electron was written, broken symmetry and the CPT theorem had not been discovered. Further, there was no distinction made in the difference between the observed entity (the *effect* of the observation interaction) and the non-observed entity (the *cause* of the observation interaction).

[272] We stress that we are once again confronting the ubiquitous substitution of the effect for the cause in classical electrodynamics. The observed positron and the unobserved positron are two quite different entities —just as the "cause" of an observation is quite different from the "effect" of the observation.

We may also consider mass to be condensed 3-spatial energy (say, EM energy) compacted by c^2. Modern physicists tend to consider the mass-energy itself as the source of the gravitational "attraction of mass" rather than the mass itself {583}. Let us accept that assumption, but differentiate between the observed 3-positron with positive mass and opposite direction in positive observer time, and the unobserved Dirac sea 4-hole with negative mass and without change of direction in the observer's positive time. The 3-positron is an *observed effect,* while the unobserved Dirac sea 4-hole is an *as-yet-unobserved cause.*

We also surmised that all EM energy in 3-space comes from time, by our solution {584a} to the long-vexing source charge problem {68}. In our view, we may then consider that the positive energy compressed as 3-space mass has been extracted from the time domain of surrounding spacetime, via entry of that time-energy into the surrounding 3-space at each 3-space point, producing a surrounding spacetime curvature which is known as the *gravitational field.* This gravitational field represents "withdrawn" 3-space energy from surrounding space, and withdrawn time-energy from the time associated with each surrounding 3-space point.

Hence the gravitational field may be said to consist of "negative energy" since it represents *lowered* energy of spacetime due to the curvature. This viewpoint yields results consistent with the received view that the energy of the gravitational field is negative. In our view, it is negative precisely because it represents "withdrawn energy" from the normal energy density of that otherwise flat space. The withdrawn nonlocal energy has been localized (as what we call "mass"). Simultaneously that withdrawn 3-spatial energy also represents "withdrawn energy" from the time-domain, since all the withdrawn spatial energy came from the time domain in the first place. The result is the curvature change in spacetime, that is taken as the gravitational field.

The 3-space energy comprising the mass is positive because it is *added to* the normal energy of an otherwise flat spacetime, at that concentrated locality.

The "energy in the gravitational field" is negative because it represents lowered energy density (i.e., lowered "pressure" in a fluid analogy) of that surrounding nonlocal spacetime compared to when that spacetime was flat

Thus when we add positive energy (a positive energy state) to 3-space, we create normal "positive" gravity because "mass" is a process of withdrawing some positive energy from the energy density of surrounding 3-space.

Here is the shocker: When we add localized negative energy (a localized negative energy state or "4-hole" — or a localized negative mass!) to a local 3-space region, we create "negative" gravity (antigravity) in surrounding space because the withdrawn energy from the local 3-space "hole" must have been added to the energy density of the surrounding spacetime, once we apply conservation of energy. Or in other words, the surrounding spacetime changed (curved) in interaction to the production of the hole.

If we wish, for simplicity we can just consider localized positive energy to generate positive gravitational charge in the surrounding nonlocal spacetime. We can consider localized negative energy to generate negative gravitational charge in the surrounding nonlocal spacetime.

This is where our concepts differ from the rather arbitrary way that a Dirac sea hole is interpreted in the received view. In spacetime, we try to account for the entire energy process and we apply a conservation law by including the supersystem interaction in every case. We insist that positive energy concentrated in positive local mass must have been extracted from surrounding spacetime.[273] That "negative energy" in the surrounding spacetime is what is known as the *gravitational field of the source mass* (where the energy was withdrawn to). Similarly, we insist that positive energy extracted from a localized region of the ambient vacuum to leave a "Dirac sea hole" must have been spread out into the surrounding spacetime, where it would properly be known as the *antigravitational field of the source Dirac hole.*

As an analogy in very simple lay terms, the holes associated with a local mass system or region involved in COP>1.0 operations create higher "pressure" outside the system or region with respect to other objects. Higher pressure between any two objects pushes the objects apart. The masses associated with a mass system create lower "pressure" outside the system or object with respect to other objects. Lower pressure between any two objects results in the objects being pushed together by the higher pressures beyond them.

[273] Alternatively, if we add local spacetime curvature, the surrounding nonlocal spacetime interacts as mediated by the supersystem changes in all three components. What we are saying is that there is no such thing as just a system, vacuum, or spacetime change. Any change to one is accompanied by a change to the other two, *a priori.*

We submit that this new view provides an exact (and testable) antigravity mechanism. It appears to have been validated by the Sweet antigravity experiment {576}, which was designed in advance by the present author with increasing the local negative energy reaction in mind.

9.11 Tests Reinforcing the Antigravity Mechanism

9.11.1 Dirac Sea Hole Current Effects in a COP»1.0 EM System.
For COP»1.0 electromagnetic systems, we recall that the temporal energy will flow negatively across the system from output section to input section. Hence the Dirac sea hole current in the local vacuum flows back across the system, from its output to its input section. Regarding the output section: Specifically, *all COP> 1.0 systems produce both positive and negative energy outputs. The greater the COP of the system, the greater the fraction of negative energy produced with respect to the fraction of positive energy produced.*

The positive energy will flow on out of the system output section (as into the external load) as in a normal circuit, but the negative energy output will flow from the output section through the local vacuum back across the system to its input section.

At the input section, the arriving Dirac holes appear to the input electrical current as a special kind of "load" added to the system input section. Hence, as previously stated, the external source must input electrons (as electron current) to "fill the holes" prior to having any input electrons available to power the circuit in normal fashion.

That is nature's unexpected <u>*overunity decay mechanism*</u> for COP>1.0 EM systems. The COP>1.0 system is in a condition of disequilibrium *a priori*, since the system exhibits negentropy and only systems in energy flow disequilibrium with their active environment can do that. Any COP»1.0 EM system is therefore in a highly excited state, and all excited states in nature have decay mechanisms. A highly excited state usually has a prompt decay mechanism, and the COP» 1.0 system is no exception.

This emergence of the Dirac hole current from the system output section back to the system input section, is nature's decay mechanism to trigger COP»1.0 EM systems back into COP <= 1.0. With this current, a "negative energy load" is added to the input section, causing the system to draw additional electrical power from the external power supply to

"power" the killing of the Dirac holes[274] as well as to "power" the normal circuit (the system itself).

If the external power source connected to the COP»1.0 system is not furnishing sufficient electron current to kill the hole current in the input and power the system as well, the excess hole current will pass back through the conductors and on into the external power source, "eating current" and power as it goes. The product of the hole current and the voltage gives a negative power imposition, wherever the hole current interacts with the power system and its external power supply, even back into the distant huge power generator in the distant power plant. For a battery-powered circuit, e.g., excess hole current will pass into the battery and discharge it (change its chemistry in discharge mode) more quickly.

Indeed, a lead-acid battery (and some other kinds as well) can be supercharged with Dirac holes. What this actually means is that the local vacuum — in which the battery and its components and chemistry are embedded and in a continual exchange with — is altered to increase the number of empty Dirac sea holes devoid of electrons. At the same time, the local spacetime is also negatively curved. The end effect is that the battery is charged with negative energy, rather than positive energy. We propose that a battery or capacitor possessing an extreme negative energy charge should be lighter in weight than the same capacitor when uncharged.

As previously stated, some years ago, Jim Watson developed a very large multi-kilowatt COP>1.0 battery-powered generator, publicly demonstrating it at a technical conference (see again Figure 5-12). Engineering measurements at the conference verified that the batteries were constantly charging while the load was constantly powered at 8 kilowatts.

The longer Watson's system would run, the more charged his batteries became with *negative energy*. After one of his batteries had been used for a couple of weeks in extensive experiments, one could obtain a most novel effect when it was placed on a normal "positive energy" battery charger. The battery's excess "Dirac hole charge" or "negative energy charge" accumulated in its local vacuum would "eat positive power and electrons" from the battery charger for an extended period, sometimes as long as a week, with no symptoms of "charging" the battery at all (no increase in

[274] By converting separated incoming electrons and incoming holes to resulting filled Dirac sea electron holes, in the input section itself.

battery voltage at all). During this period, the battery charger was indeed recharging the *battery supersystem.* It was filling the excess Dirac sea hole charge in the vacuum with the steadily supplied electrons. In the process, it was gradually relaxing the previously formed negative spacetime curvature.[275] When all the Dirac holes were filled, the relaxed spacetime then was relatively flat (normal) as was the local vacuum, and suddenly the battery would charge-up normally again with positive energy, with its voltage increasing in quite normal fashion.[276]

With tongue in cheek, we point out to the COP>1.0 researcher that these effects are not described in the available storage battery manuals, no matter how technically they are written. To the electrical engineer, we point out that they are not in his textbook.

Whenever Dirac sea holes have accumulated in the input area of the COP>1.0 system and are being filled by the external power supply, normal ammeters and voltmeters will only "see" that the external power system is furnishing more current. That is true, because the holes are an additional load being powered. The holes "eat incoming electron current and power", and require the external power supply to "power the killing of the holes" as well as "power the system".

The unwary overunity experimenter can successfully have the first phase of an overunity system working and not realize it, because his initial COP is too high and he does not know about the associated hole current decay

[275] This proves that a system's supersystem can indeed be negative-energy-charged, so that the local spacetime around that system is negatively curved, even though the system itself seems normal and functions normally. If the negative energy charge is . sufficient, conceivably the antigravity produced will be sufficiently great that the system itself "floats" or even levitates. We hypothesize that an intense negative energy beam can indeed be technically created which will accomplish this "negative-energy-charging of the supersystem" effect when continuously absorbed by a targeted system's local spacetime supersystem component, as the system is continuously irradiated by the beam. In that manner, levitation beams, tractor beams (both attracting and repelling) are at least hypothetically possible. If this proves to be a valid hypothesis, we foresee the day when such beams will revolutionize transportation and handling of otherwise heavy loads and very heavy systems. Even the heaviest vehicle could then negatively charge its own supersystem's local curved spacetime, thereby floating in the earth's gravity, in the atmosphere, in space, and under the ocean.

[276] We deliberately omit discussion of the extraordinary all-purpose weapons implications of negative energy electromagnetic pulse (EMP) directed energy weapons, already developed and deployed by several major nations.

of overunity systems back to underunity systems. His system may actually be at COP>1.0, but the negative energy component being produced in his output section is back-flowing and continuously degrading his input section by adding a "new load" right in the input section.

So his overall power draw from the external power source can be such that his positive power output in the load is less than his total power draw at the input of his system. Unless he is aware of the process and how to handle it, he may never realize that his system is actually at COP>1.0 condition, when the negative energy component is credited as an output "plus".[277] *COP>1.0 research starts by evaluating the absolute value of the output energy, then working from there!* The experimenter must be ever aware that he can and will have Dirac sea 4-holes and currents in any unitary COP>1.0 electrical power system, and particularly in those with very high COP. He must understand what the 4-hole currents and the negative energy actually do and how they function in the overunity system unless corrected.

Any COP»1.0 EM system demonstrates the Dirac sea 4-hole current phenomenon as nature's special decay mechanism to reduce overall performance of the COP»1.0 power system and its external power supply to COP < 1.0 — unless one *corrects* the problem and prevents the decay process (developed later in this chapter).

One symptom of the negative 4-hole currents is their cooling capability rather than heating. Another is that the excess current (and power) drawn from the external power supply also does not heat the input section of the system. Another is that semiconductors operating within the Dirac 4-hole current flow are likely to fail immediately and permanently.

We strongly suggest that, for high COP systems experimentation, the experimenter use a system of synchronized clocks where the lab clock is synchronized with a remote clock prior to the experiments, then the two clock times are examined after significant experimentation at COP»1.0. If deviation beyond normal error in synchronizing occurs, then the involvement of spacetime curvature effects is indicated. Two decades ago, anomalous experiments by Golden — with whom I was working at the time — charged the area with negative energy, producing a significantly

[277] In other words, in the presence of both positive and negative energy output, true COP is not "positive energy out" divided by "positive energy input by the operator", but is more appropriately "total absolute value of the energy output" divided by the "positive energy input by the operator".

curved local spacetime which disrupted local clocks and watches for four days as the charge gradually decayed away. Another indicator is that Geiger counters and other nuclear radiation detectors often "read" when bathed in vacuum 4-hole current, because of the ionization changes induced in them and also because of their individual previous "time-charge" histories. After all, ionization instruments "read" anything which causes ionization of their internal gases. Dirac sea hole current, if interacting with the gas, is in fact a very special new form of "ionizing" radiation.

9.11.2 Antigravity Hole Current Effects in a COP»1.0 EM System. Any COP>1.0 EM system can exhibit minor, usually barely detectable antigravity effects due to the presence of the negative local energy 4-holes in the hole current if the hole current is not transduced or corrected. It can also produce minor antigravity "thrust" due to the flow of the local energy holes. Usually these effects are not even noticeable in an overunity system unless it has very high gain (very high COP, say in the range of 10^5 to 10^6 or more.).

However, if the EM system's COP » 1.0, and reaches 10^5 to 10^6 or more, the antigravity and thrust effects may become significant and easily detectable. At 10^9 they become highly significant and are very detectable: The unit will lose appreciable weight on the laboratory bench, and may even levitate easily.

An example is provided by the Sweet vacuum triode amplifier discussed above, with the results that were given in Figure 6-9. Such effects are also what generate the anomalous levitation phenomena of free-spirited John Hutchison.[278]

9.11.3 Negative Energy Effect When Leads Shorted

When the leads of a COP>1.0 EM system are shorted, a noticeable cooling effect can sometimes be detected. If COP»1.0, shorting the leads will result in instant icing from the water vapor in the surrounding air.

If one accidentally shorts oneself across the leads of a COP»1.0 system, the effect is to freeze the nerves along the pathway of conduction. Experimenters are cautioned to use every safety precaution. Their experimentation is at their own assumed risk.

[278] John Hutchison, "The Hutchison Effect apparatus." *Proc. Intl. Symp. New Energy*, Denver, Colorado, May 12-15, 1994, p. 191-198.

Anecdotally, some older researchers reported that their constant handling of overunity circuits resulting in charging their bodies, apparently with negative energy. The body after all may be considered as a special kind of complicated capacitor or set of capacitors, so this is reasonable, based on Bedini's and Watson's demonstrated negative energy charging of a battery. Some of the older overunity researchers reported that, after charged in that manner, they could produce a 3-inch spark from their fingers, or a "slight shock" into the body of a person they touched.

There is even a special form of acupuncture in the East in which the practitioner uses special exercises to charge the body with negative energy in this fashion. The "electro acupuncture" is then administered by the operator twirling the inserted acupuncture needles between his fingers, and deliberately administering a jolt of negative energy from his body into selected points in the body. I have personally tested a person who could deliver strong "electric shocks" into one's hand or body, and who could consistently produce a 1-inch spark discharge between the hands at will. That person could also deliver a very astonishing "jolt" to one's body, particularly in the vicinity of the liver.

There appear to be similar rare negative energy phenomena in semiconductors {585a-585c}. Anecdotally, it appears that the body does have structures or methods of storing and using Dirac sea holes (negative energy) and mechanisms for accessing the negative energy charged in its supersystem. This is suggested as a fruitful line of future research for interested biophysicists. Again, we call attention to the fact that, whenever EM fields, potentials, and waves are present, Dirac sea effects are also present and involved. Little or no biophysical experimentation has been done utilizing higher symmetry electrodynamics and analysis of the supersystem effects. Contrary to the received view, the understanding of EM effects on biological systems is not mature at all, but is still in its infancy.

9.12 Susceptible Unitary System without Conversion of Dirac Sea Hole Current

A *unitary system* is simply a self-contained single power system with an overall closed current loop between the source dipole and system loads and losses. A unitary system is contrasted to an array system of synchronized separate power subsystems without a common closed current loop, with the array subsystems connected to the source dipole by energy

transmission-reception only. Hence the array system utilizes the Kron open path concept.

Beginning at about COP = 1.2 to 1.5, a few highly susceptible unitary COP>1.0 electrical power systems will experience significant Dirac hole current from output to input. This will produce a "negative energy load" in its input section and feed line from the external power system, resulting in decay back to an overall "system plus negative energy load" of COP<1.0. At the COP = 2.0 level, in the susceptible system the effect will forcibly decay the COP back down to overall COP<1.0. It does this by forcing excess power to be furnished by the external power system to "power" (fill) the Dirac hole current arriving in the input section of the power system. In short, it converts the system to a composite system containing an additional Dirac negative energy load in its input section.

Or in other words, it forces the operator to "pay" for both the *positive* energy output and losses of his system and the *negative* energy output and losses of his system.

In addition to usual powering of its load and losses, such a system is also "powering" the return of its own locally altered vacuum back to a more normal ambient vacuum, instead of stabilizing its supersystem in a stationary disequilibrium state. It is a supersystem interaction and effect. A COP>1.0 system that significantly exhibits this phenomenon is said to be a "susceptible" system.

One of the first tasks of the COP>1.0 experimenter is to ascertain whether he is working on such a highly susceptible COP> 1.0 system. Ironically, he does this by observing his COP>1.0 system kick itself back into a COP<1.0 system. If he carefully observes the initial COP>1.0 condition followed by decay into COP<1.0 condition, he must then realize that not all is lost! In short, he must realize he has developed a susceptible system. If he obtains COP>1.0 only to watch it subsequently decay back to COP<1.0, he has just discovered he is working on a susceptible COP>1.0 system, *and that is experimental progress.* He isn't there yet, but he is en route. In that case, he must concentrate on transducing the excess hole current into usable electron current, to "stabilize" and "lock" his system in its COP>1.0 operating condition.

9.13 Unitary System with Conversion of Dirac Sea Hole Current

Using the Bedini conversion process, a unitary system can be close-looped to maintain COP> 1.0 and stable overunity operation. The 4-hole current reaching the input section is intercepted by the Bedini mechanism, and transformed to ordinary electron current furnished to the input section. Thus the transduced negative energy feedback becomes a positive energy feedback, by conversion. This converted positive energy in the input section will reduce the demand for incoming electron current from the external power supply, increasing the COP>1.0 even more.

A feedback and governing system is adjusted until the system's converted positive energy feedback current reaches the Kron condition. At that point, the transformed electron current is sufficient to power the system with the external power supply disconnected. The governing and control system thus disconnects the external power supply, and the system is smoothly transitioned to self-powering operation, powering both itself and its load.

We stress that all the energy to power the system and its load is now being furnished from the active local vacuum interaction and from the local curved spacetime. No laws of nature, physics, higher symmetry electrodynamics, or thermodynamics are violated. Conservation of energy rigorously applies, but to the supersystem. The system is an open, *stabilized* disequilibrium system — of the kind referred to by Kondepudi and Prigogine as nonequilibrium stationary states — as a freely receiving all its energy from its active external environment. No standard U(l) electrodynamic analysis will show this condition or this mechanism, and neither will electrical engineering. Higher group symmetry electrodynamics such as SU(2) or O(3) will show it easily. For a modern treatise on O(3), we refer the reader to the recent *tour deforce* by Evans {586}.

9.14 Non-unitary Outrigger Array System

See Figure 9-14, which is a diagrammatic representation of a COP>1.0 array system that is non-unitary. In the non-unitary (outrigger array) system, no part of the outrigger array works at $\xi > 1.0$. All external parts operate at $\xi < 1.0$, but independently and with COP>1.0. Each of the external outrigger systems is an open system freely receiving excess energy from its active environment, because it is an "energy-receiving" system and the energy is freely transmitted from the central system. The central part of the array is the unit whose purpose is to stimulate or evoke

an excess energy flow from the vacuum, so that the outrigger receiver/power units can individually intercept and utilize radiating energy flow surrounding the central unit.[279] The usable (output) energy intercepted and captured (collected) from a given free flow of energy depends totally on the intercepting reaction cross section — usually the total array amount of intercepting charge, together with the degree of resonance (sweeping a larger geometrical cross section) of the intercepting charge.

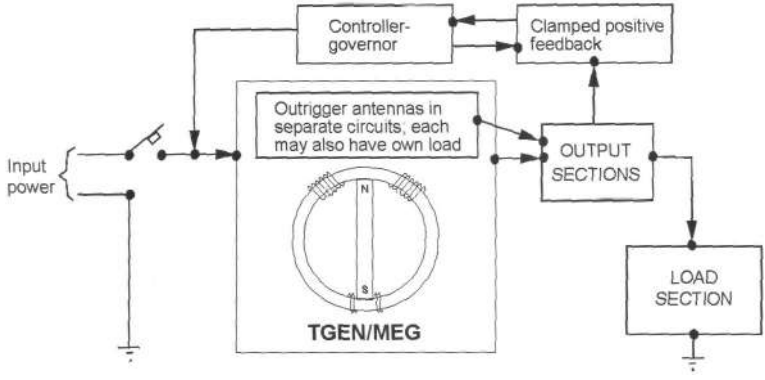

Figure 9-14 The nonunitary (outrigger array) system and its functioning.

Each outrigger unit (subsystem) has its own complete closed current loop *separate* system and load, plus its "antenna" or "interception section" or receiving component for intercepting and collecting the free flow of energy coming from the central source unit (the energy transmitter). Thus, the loads in the outrigger units are not closed-current-connected with the central source unit at all. Each outrigger unit has its own independent electrical ground and its own closed loop system with its load.

[279] We emphasize that, when the usually unaccounted Heaviside nondiverged energy flow component surrounding the conductors of the external circuit is accounted, every EM power system is already a COP»1.0 EM energy transduction system. Consequently, in the received view the array system can be operated at COP>1.0, or even in self-powering mode, even though the central system is "said" to be at COP<1.0. It is at COP<1.0 only because of the self-applied Lorentz symmetrical regauging and ignoring the excess unused energy flow available to and surrounding the circuit, but not conventionally used. If we account the COP for what we have to furnish to the central unit, then the COP of each array unit is COP = oo. The point is that we ourselves do not have to pay any *extra* input energy for the output energy of each array circuit.

This schema in fact separates the two functions of Poynting energy flow theory: (i) the extraction and radiation of the EM energy flow from the seething vacuum, and (ii) the interception, collection, and dissipation of some of that available energy flow, to power the loads and losses of the intercepting system.

In this fashion, multicollection from a single energy flow (generated from a central source "transmitter") occurs by direct, independent interception and collection in each of the COP<1.0 outrigger units. However, the input power to each outrigger units is *free* with respect to that outrigger circuit itself. We of course must pay to generate the flow of energy from the central unit, but that can be done in normal COP<1.0 manner (such as COP = 0.95) while powering its load.[280] Let the output power of each numbered unit (including the central source unit) be given by P_i, n be the number of power units, and P_T be the total power output. Then the total output P_T of the array system is given by

$$P_T = \sum_i P_i = P_1 + P_2 + \cdots + P_n \qquad [2]$$

The total input power P_I is simply the input power $P_{I(1)}$ to the central source unit. The COP is given by COP = $P_T/P_{I(1)}$.

In the motionless electromagnetic generator (MEG) array, for example, the central unit is the transformer-like unit, deliberately using a special core to contain the magnetic flux of a permanent magnet in contact with the core material, thereby stimulating the Aharonov-Bohm effect and freely filling the surrounding space with the uncurled magnetic vector potential A. We will explain the non-unitary (outrigger array) system using the MEG as an example.

[280] We again stress that, from any nonzero potential ϕ, or from any EM field in space, any amount of EM energy can be collected if there is sufficient intercepting and collecting charge. For example, the simple equation $W = \phi q$ applies for the potential, where W is the energy collected from a potential with point intensity ϕ by collecting charges q. A similar equation applies with respect to collecting as much force (emf in the various outrigger circuits) as desired. Here a single given E-field *E* can be assumed, and *F = Eq.* What is happening in the outriggers is that they are intercepting and collecting some of the excess Heaviside energy flow component that is wasted by the central circuit.

The MEG freely induces the Aharonov-Bohm effect,[281] thereby extracting excess energy from the vacuum in the form of that novel field-free A-potential. Being field-free, A represents an energy flow without swirl (without curl). When the MEG input section is perturbed, the surrounding A-flow is perturbed also, giving a pulsed or AC flow of energy that can be intercepted and utilized by each outrigger circuit as an E-field energy interception.

The central unit's COP<1.0 function is to output almost as much, or as much, energy as is required to power the MEG, while also evoking that excess A-flow and serving as a COP » 1.0 energy flow transducer. The function of each outrigger is then to intercept some of the pulsed A-flow (as E-field energy via the equation dA/dt = - E), in its antenna or interceptor section. Each outrigger has its own independent and conventional closed loop circuit. It simply is a receiver and user of extra Heaviside EM energy produced from the central MEG unit in the new form of the curl-free A-potential. Perturbing the A-potential produces a large E-field impinging on all the external outrigger subunits. Hence these units freely collect and use some of that available excess energy. The COP of the total array is thus COP>1.0. For best results, tuned antenna theory and near field theory should be utilized.

Suppose we operate the MEG central unit at COP = 1.0. In that case, there is no 4-hole current of significance associated with the central unit or the outriggers, and transduction of hole current into electron current for close-looping is not necessary. Instead, sufficient outriggers are employed so that the total energy W_O caught and dissipated in their loads by all the outriggers is given by $W_O \geq W_I$, where W_I is the input energy in the main central section. Since COP = 1.0 for the central unit in isolation, the total input E_{IN} is $E_{IN} = W_T$ (the additional huge Heaviside nondiverged EM energy input component is there also, but just neglected in conventional engineering). The total output W_A of the entire array is $W_A = W_O + W_T$. The overall COP_A of the entire array is thus

$$COP_A = W_A/E_{IN} = (W_O + W_T)/W_T = (W_O/W_T + 1.0) > 1.0 \quad [3]$$

[281] The reader should recall that the Aharonov-Bohm effect is not included in classical U(l) electrodynamics. See Terence W. Barrett, "Electromagnetic Phenomena Not Explained by Maxwell's Equations," in A. Lakhtakia (ed.): *Essays on the Formal Aspects of Electromagnetic Theory,* World Scientific Publishing, River Edge, NJ, 1993, p. 6-86.

Hence the array has a COP>1.0, even though every single component of the array has $\xi < 1.0$. With the outriggers fully functioning, many schemes of operation can be used. E.g., the energy from the outriggers can be used to steadily charge a capacitor bank by "shuttling". We define shuttling as use of two capacitor banks: (1) a capacitor bank which is continually connected and charged by the outriggers as their effective output, and (2) an input capacitor bank for the central unit that is continually connected and recharged from the outrigger capacitor bank. By adroit switching, the charge of the input capacitor bank is maintained by replenishing from the output capacitor bank, and the input capacitor bank powers the entire system, including the output load in the central section.

The non-unitary outrigger array construction is one means of close-looping a non-unitary overunity power system without bothering with the transduction of hole current into electron current. It is the easiest of all COP>1.0 systems to close-loop for self-powering.

An additional adaptation is for each outrigger also to continuously power a separate load, and only contribute *intermittently* along with the other outriggers to charging the output capacitor bank.

Another adaptation is to operate the central unit in the array in solitary self-powering mode.

These and similar modes of nonunitary array system operation allow close-looping the system for self-powering of itself and its load, without concern **for** 4-hole current transduction. A real advantage of such nonunitary systems without worrisome 4-hole current is that transistors can readily be used for switching etc. in them, without the destruction of the transistors by a damaging Dirac 4-hole current in the supersystem.

The nonunitary overunity system can also be close-looped by *conventional* (simple) "clamped positive feedback" means if good isolation (e.g., optical isolation of the circuitry switching) is used in the feedback loops.

9.15 Some Instrument Considerations

9.15.1 Time Effects

As previously indicated, there are time-domain effects (potentials, forces, and currents) associated with a COP>1.0 EM system, particularly as the COP increases toward COP»1.0. A useful method of indicating time-effects is to utilize a transistor in a circuit capable of measuring

recombination time in the transistor.[282] NASA has such circuitry available, but I do not have the reference at hand. We leave it as an exercise to the reader to explore that possibility.

For "very large COP" devices, ordinary watches, clocks etc. may be affected. Particularly significant is the slowing of timepieces in the presence of substantial time-domain effects due to substantial negative energy. In addition, for high gain devices (and for some at lower COP), the negative energy charge can build up in the local area, and may then require some days to dissipate. As we stated, in experiments years ago with Frank Golden, we experienced just such alteration of multiple kinds of clocks and watches in an area. It required four days for the negative energy charge in the area to gradually drain off (for the excess Dirac sea holes to gradually be filled with electrons, as the tempic potential gradually returned to normal).

Effects that were even more dramatic were exhibited in experiments conducted by Sid Hurwich in Canada some years ago {587}. In a series of experiments lasting a half-hour, Hurwich inertially jammed a police revolver so that a human finger could not pull its trigger. *The watches of the witnesses did not change their setting during that entire half-hour.* This cannot be understood by conventional electrical system analysis, but potentially it can be understood by supersystem analysis.

9.15.2 Calorimetry Is Taboo for Overunity System COP Measurement

It is standard dogma that calorimetry is a "true" measurement of power, and is always accurate in the hands of a skilled practitioner. In general, that is true for a COP<1.0 system, where one is concerned only with *positive energy* in the input and output sections. However, with respect to COP>1.0 systems, nothing could be farther from the truth. Indeed, for a significant COP»1.0 system, a calorimeter is one of the most inaccurate instruments that can possibly be used.

As previously stated, all COP>1.0 EM systems produce a mixture of negative and positive energy in their output section. The higher the COP, the greater the percentage of negative energy and the greater the flux of Dirac 4-holes back to the input section. The output energy, immersed in a calorimeter, will both cool the water with its negative energy output fraction and heat the water with its positive energy output fraction. Hence, the calorimeter will show the *difference* between the water's simultaneous

[282] This suggestion is courtesy of John Schnurer some years ago, and is appreciated.

heating and cooling. If the calorimeter measurement is misinterpreted as the *total energy output*, this "definitive test" will always erroneously show COP<1.0. After all, it itself already applies the decay mechanism for converting any overunity system to an underunity system.

The only good use of the calorimeter in an overunity EM system is to verify that negative energy is present, when comparing its measurements to more sophisticated electrical measurements of the system. It can be used along with other measurements to ascertain (1) the total energy output, whether negative or positive, (2) the difference in the two forms of energy output and the algebraic sign of the resultant (positive if calorimeter heated, negative if calorimeter cools), and (3) thereby help determine the output's energy fractions (positive energy divided by total energy, negative energy divided by total energy).

Any test group insisting on testing a purported COP>1.0 electrical system with a calorimeter as the *definitive statement of energy output* is totally devoid of knowledge of COP>1.0 systems and their phenomenology. Usually such "test groups" tend to regard themselves as "measurement experts" (which they well may be, in COP<1.0 positive energy systems!). That does not make the team even minimally knowledgeable or qualified in COP>1.0 system measurement. To the contrary, the team members have zero experience or knowledge of COP>1.0 systems. The proposed test group may consist of physicists, thermodynamicists, electrical engineers, technicians, or all four, but they still will have no knowledge or expertise in COP>1.0 EM power systems unless they have actually worked with such systems before, and at length.[283] This is particularly true of COP»1.0 systems. My advice to all COP>1.0 researchers is simply to keep the "calorimeter addicts" out of one's laboratory in the first place.

9.15.3 Other Instrumental aspects.

Here we just point out some simple and obvious things, familiar to the experienced researcher but sometimes not appreciated by the novice. One is usually dealing with nonsinusoidal waves, pulses, spikes and the like. As is well known, RMS meters are useless for measuring such nonsinusoidal electrical entities, since they are designed and calibrated to measure sine

[283] To date, we have found none who have actually worked with COP>1.0 electrical systems. We have, however, found quite a few who, though totally inexperienced with COP>1.0 systems and not knowledgeable, have regarded themselves as "real experts" in such systems. They claim to already know how COP>1.0 systems work and behave, and assume just ordinary electrical system phenomena.

waves only, or to measure DC. One must use a good differential sampling scope with multiple synchronized channels, with professional software to perform accurate integration under the curve, and with special differential probes for the scope. Simultaneous triggering of the multiple measurement channels on the same time line is required. The necessary high quality probe set may cost as much or more than the oscilloscope!

Dirac sea hole currents are generally not separately measurable, so one measures where the hole currents are not significantly present. Results may be compared to measurements where the hole currents are known to be present. When directly measuring hole currents, the conventional meters often read "backwards" and interpret a negative energy output at the system output section as subtracted from the positive energy, and interpret a negative energy output at the input section of the system as additional input electron currents from the external power supply. If the electron currents from the external power supply are not present, then measuring hole currents will draw electron currents from the power system inside the meter itself, resulting in a "backward measurement". Again, the meter actually will measure a real electron current, whether from the external power supply or from a conversion within the meter itself.[284]

Recombination time in semiconductors can sometimes be used in instrumented circuits to differentiate between negative hole current and electron current, by observing the change in recombination time due to the negative energy currents. It will differ from the change in recombination time due to positive energy currents.

Again, what is needed in the field is a set of solid, reliable instrumentation specifically developed for these peculiar measurement phenomena involving both positive energy and negative energy. To my knowledge, no such thoroughly designed and tested instrument package presently exists. Further, there are not even any standards for such, since there are apparently no standards for negative energy measurement at all.

9.16 Still Anomalous Aspects

Several aspects of COP>1.0 systems are still not properly understood. The behavior of curl-free A-potential, sometimes produced in such systems, is

[284] What is very much needed is a meter of sophisticated design where this "drawing of excess electron current from within the meter itself has been taken into account in the design, so that the meter functions correctly for either positive energy measurement or negative energy measurement.

a case in point. This type of energy can exhibit characteristics as if it were electrostatic energy, which my associates sometimes refer to as the "crawly stuff. It exhibits the characteristic of "crawling" all over the surfaces (outside and inside) of the objects in the area, including the scopes, producing internal electrostatics and possibly magnetostatics everywhere. This can easily destroy the amplifiers etc. in a good scope or an expensive meter. It is best to transform this field-free A-potential into an ordinary "EM field energy AC wave", and then utilize it in that fashion.

Scalar stress waves are also sometimes produced, leading to anomalous effects. This is best regarded as a "time-polarized" EM wave, or more accurately, as a combination of scalar (time-polarized) EM waves and longitudinal EM waves in 3-space. For macroscopic waves in COP>1.0 systems, the Mandl and Shaw 1:1 correlation between scalar photons and longitudinal photons can apparently be corrupted, so then one has "abnormal" (improperly correlated components which normally correlate to make "ordinary" EM waves). These abnormal EM scalar stress waves also exhibit the "crawly" phenomenon, and can be hazardous to one's instruments.

In addition, some instruments such as ionization counters, Geiger tubes, etc. read in the presence of such waves as if nuclear radiation were present (which it is not). Also, the individual time-charge history of a given instrument determines or substantially influences how the instrument reacts in the presence of the "corrupted" scalar stress waves. Essentially, at a given time any instrument has a small "time-energy charge" depending upon its past history. The corrupted scalar stress wave accomplishes further "time-charging" of the instrument, which combines with the initial time-charge to produce more time-charge, ordinary EM waves by scalar EM interferometry {588}, or abnormally correlated longitudinal EM wave emission.

In an ionization-measuring instrument, *ionization is ionization, by whatever means achieved.* And in the presence of the "abnormal" radiation and charging, ionization-type "nuclear radiation" instruments will vary from one to another, *depending upon the individual time-history ofeach instrument.* So from a group of identical instruments made the same day on the same assembly line, one may read anomalously and several others read normally. Or two may read anomalously, while all the rest read normally. A very good example of this anomalous measurement effect is seen in the rigorous electrolyte experiments in U.S. Navy research facilities at China Lake {589}. The present author has previously given an explanation of this time-charging and decay phenomenon {590}.

Negative energy reacts in different ways with different materials. The more nonlinear the material, the greater the effects and unpredictability of the interaction, as a rule of thumb. In a copper wire, Dirac hole current introduced into the wire will "eat" Drude gas electrons, reducing the "pressure" at that point or area in the wire. This "combining of electrons and causal Dirac holes is not normal pair annihilation, and radiation does not occur. Instead, the two curvatures of spacetime (one by the positive energy of the electron and the other by the negative energy of the Dirac hole before observation) interact and adjust.

The Drude gas in the copper further back toward the external power system still has normal (higher) gas pressure, and so the differential in pressure induced in the Drude gas will drive electrons from the "normal" pressure areas into the "reduced" pressure area where some of the Drude electrons disappeared after being "eaten" by the Dirac holes. To look at that in lattice hole terms, the "eating" of Drude electrons in a selected volume of the wire leaves positive ions, which are "lattice holes" vacated by the eaten electrons. So these excess positive charges attract electrons from further up the wire nearer the distant power supply, filling the lattice holes to bring the Drude gas back up to "normal". However, that also draws and "eats" additional power from the distant power supply. Meanwhile, the Dirac 4-holes fed from the input of the COP>1.0 system back into the power feed conductors continue to interact with the lattice and eat electrons to create more ions (lattice holes).

One may visualize the Dirac sea holes producing excess lattice holes, which then causes the Drude electron gas to change so that the "average" demand current increases. In short, we must also consider the effect of Dirac hole charges or currents upon the lattice material itself, and the structure of holes and electrons as charge carriers in the material lattice.

Semiconductors are very vulnerable to negative energy due to its disruption of their donor-acceptor and band gap design functions. With mild negative energy exposure, a semiconductor may just cease operation entirely and later recover when the negative energy application ceases, or it may fail and never recover. For pulsing, strong "opposing force pulses" (stress pulses) are created deep inside the semiconductor materials. In case of sharp pulsing, sometimes an exposed semiconductor will just suddenly explode in a nice little fireball about one foot in diameter. This along with some minute stinging fragments from the explosion assures that the COP>1.0 bench researchers stay alert and on their toes. Needless to say, when experimenting with COP>1.0 systems and circuits, one should exercise all safety precautions, including safety glasses, until the **"negative**

energy beasts have been tamed and controlled". One should not experiment with such things unless one is an experienced and safety conscious experimenter. One experiments at one's own risk.

Negative energy effects in coils and toroidal coils are largely still unknown, though we have outlined some of the major effects. For a normal helical coil, one can derive a concept of the effects by considering the lattice effects in the wire. In this case, introduction of hole current at one end of a helical coil will induce electron current from the other end and into the coil. Thus, hole current can be "switched" back and forth between the ends of a helical coil to induce an ordinary AC electron current in the coil, accompanied by normal magnetic fields etc. A point can be reached where the coil is actually in resonance with the frequency of the switching, and with the "seeming capacitance" of the hole current introduction in each switching. With the proper material in the coil and a keen balance between the negative energy capacitance effect and the normal positive energy induction effect, *in theory* a single coil can be turned into a self-oscillating, self-powering system.

With core material inside the core of a coil, the situation dramatically changes. Often the type reaction experienced will appreciably depend upon the core material, and changing the core material can dramatically change the effects upon the coil and the effects that the coil prc luces. One may even use dynamic changes in the core material to produce corresponding dynamic changes in the coil. A toroid may act differently from an ordinary helical coil, as does a flat (spiral-wound) coil. Here the experimenter must simply perform his own experiments to seek out and understand the phenomenology he uncovers.

For exploratory experimenting with core-filled coils, we advise strong caution and testing at very low power only. Sometime effects can apparently be experienced by the researcher (headaches, nausea, dizziness, etc.) It is suspected from some evidence (but not proved) that the core material's chemical characteristics can sometimes be "imprinted" upon the human body chemistry, from the novel radiation of a core-filled coil or some core-filled coils. This is particularly true in the presence of strong stress potentials, such as from bi-wound coils with fields in opposition, and particularly if the biwound coil contains a nonlinear material core. The nonlinear core induces modulation (multiplication) of the two waves, rather than linear mixing. Thus, the two waves are "locked together" to form a true stress potential and local spacetime curvature sets, when the biwound coil has a nonlinear material core. In short, one is now engineering pure general relativity, locally.

Again, we iterate that the experimenter should be knowledgeable and take all safety precautions. He experiments at his own assumption of risk.

The appearance of an extra stress potential (field-free) in a biwound coil is in fact a new Lorentz symmetrical regauging, and the equivalent of rotating the frame of the coil. As signals are introduced, this is the equivalent of continually changing the degree of the frame rotation, which is a general relativistic effect, with direct curvatures of spacetime being produced. In short, one is producing spacetime curvature and rotation engines, previously discussed.

The magnitude of the stress potential (field-free) falls off inversely as the distance. Thus one's body can be exposed to it, including the body chemistry, every cell and every part of every cell, the nervous system, etc. Placing signals on the biwound coil can conceivably result in slight variation of the scalar stress potential, including inside the body, and inside each cell and each part of each cell. Variation in the stress potential ϕ in a little local region inside the body produces $-\nabla\phi$, which is an electric field E. The rate of change of this E-field then produces a magnetic field H.

Consequently, very minute EM fields are produced throughout the body and all its parts, or can be. It is as if the entire body is "electromagnetically washed" in internal EM fields throughout its matter, structures, and dynamics. The hydrogen bonding actions ever ongoing are particularly sensitive and can restructure appreciably in the presence of this stimulus. They can also "imprint" and take on a specific induced structure and dynamics, correlated to the persistent changes induced from the biwound coil. As can be seen, such EM biological effects have not been appreciably investigated and documented in the Western scientific literature. Hence our urging and insistence that the researcher use all caution, and our warning that he experiments at his own will and assumption of risk. Neither the publisher nor the present author is responsible for any accidents or blunders that may occur.

Capacitor effects also vary between types of capacitors, when applying negative energy or a mix of positive and negative energy. Some capacitor dielectric materials are also photo-refractive and are semiconducting materials, hence photoactive. The rich effects capable of being generated in capacitors — by EM fields, waves, potentials, and pulses of negative energy or negative and positive energy mixed — are largely unexplored and not catalogued.

Almost all modern permanent magnetic materials are also photo-refractive or photoactive materials as well, and many are semiconducting materials. Hence a rich variety of effects can be produced in permanent magnets by the introduction of negative energy fields, potentials, waves, and pulses.

As can be seen, a very rich combination of effects exists for "normal-appearing" coils, capacitors, semiconductors, and magnets when applying appreciable negative energy or controlled mixes of positive and negative EM energy. This is a still largely unknown materials science region, and one that has not been systematically and rigorously explored and catalogued, if at all.

In addition, there are effects from *pulsing* negative energy (Dirac hole currents) that are not completely understood. These appear to occur almost — or partially — at random, and also seem to be affected by the natural surroundings, by the various materials, etc. The "imprinting" phenomenon, when it occurs, seems to be augmented by pulsing, and sometimes by the pulse shape and pulse repetition frequency as well as the surroundings.

We also legally state that we are not responsible for any risks the researcher chooses to take, but are only alerting him to be very careful and use very good safety practices. Any experimenter is himself responsible for stringent adherence to good safety practice and common sense, and he legally assumes his own personal risks for all experiments he chooses to undertake.

Another effect to be alert to is the effect of "charging" the local area's supersystem with an altered active vacuum and curvatures of spacetime. This phenomenon is usually experienced as a "slow growth" of the COP of the system, over a long time (months or years). Tiller in private discussions has reported such phenomena in his detector built at Stanford University. Golden and I experienced such phenomena with a small COP>1.0 system Golden was developing. Over a period of five years, the system slowly increased its COP to about 2.0. Moved several hundred miles, the system then exhibited COP of about 0.9, but with occasional fluctuations of overunity temporarily.[285] Golden had gradually charged his local area with the "engine" or spacetime curvature operational and functional form of his unit. Thus in that repeatedly charging area, gradually the operation of the unit improved. We referred to this *engine-*

[285] In fact, Golden and I were astounded at these results, until Tiller explained it to us and explained his own experiences with "growing" his detector. Thanks to Professor Tiller, thereafter we had this new phenomenon firmly fixed in our lexicon.

charging of the environment with a particular effect or dynamic form as *kindling.*

The kindling or "charging to favor the dynamic form of the engine or device" problem, should it occur, is in fact usable because it is possible to produce it everywhere on earth, and fairly permanently. To use the kindling effect once discovered, the mechanism is to build several identical units. Keep the original unit working in the original area, and "outrigger" the others at radial distances as distant as possible, but maintaining COP>1.0 for the outriggers. Then simply run both the outriggers and the central unit, steadily. The "structural charge" will grow and reinforce at the outrigger locations, then spread on beyond the outriggers, and a much larger area will now be "charged with that dynamic form". With sufficient additional outriggering (three to five, or seven in an especially difficult case) where the successively internal outriggers arc retained and operating, the charging will eventually spread around the entire Earth, and *it will become a permanent fixture of the Earth environment itself.*[286] Thereafter, anytime one of the units is turned on anywhere on earth, it will perform with its normal overunity condition. In other words, not only can one grow the dynamic form (engine) in a supersystem in a given locality, but one can also kindle it into the entire Earth's supersystem permanently {591}. One is strongly reminded of Feynman's observation that physicists with their big accelerators may in fact be partially creating their own reality. He pointed out that often the physicists look and look for a new, predicted particle. At last and after years of difficulty, finally a "glimpse" of the particle occurs in an accelerator and is reported. The physicists quickly crank up the other accelerators and look intensively, and — after some moderate difficulties — they find that particle. Thereafter, *every time an accelerator turns on and looks, that particle is readily seen, easily.*

The supersystem's spacetime is part of the local spacetime of the Earth, and all supersystems also interact with each other. As Kron put it {592}:

> *"An electric network differs from all other types of non-electric networks in that it is always surrounded in all directions to infinity by an invisible dynamic electromagnetic field of its own creation. ... Each Inductance L produces its own magnetic field, each*

[286] We have proposed an application of this phenomenon to kindle and maintain a specific disease organism's "anti-engine" as a startlingly new kind of medical therapy for permanently eradicating a particular disease vector from the earth.

capacitance produces its own electric field and each resistance R creates a thermodynamic field of its own. Moreover, there exists a continuous interaction between the magnetic, electric, thermodynamic, and radiation fields. Thus any correct and basic theory of the electric network must include all the parameters of its surrounding electromagnetic field and must satisfy all the field equations of Maxwell. The theory must also dovetail with the Hamiltonian and Lagrangean equations of dynamics containing both time and space derivatives, as well of the equations of irreversible thermodynamics. "

So decades ago, Kron was struggling with the "supersystem" problem, in different terminology, and he eventually originated *diakoptics* {593}, an entirely new way of breaking the problem down piecemeal so it could be solved. But Kron strongly stressed that the interactions of the fields and potentials of a circuit and all its parts reach to infinity and have an n-dimensional set of degrees of freedom and an infinity of spaces. The fields and potentials of every charge reach to infinity (for those charges in matter from the beginning), and so every charge in the universe interacts with every other charge and its fields, potentials, and dynamics. Spacetime itself is filled with these interacting EM fields, potentials, waves, and dynamics. Little wonder that the horrendous set of ongoing EM interactions at every point in the vacuum has such incredible energy density and fluctuations. We may even regard the fluctuations and interactions as completely causal, but — with no information on each interaction — they must be treated as totally statistical. Ultimately nature confounds our Aristotelian logic and insists that, in the limit, one is dealing with 5-law logic as developed earlier in this book.

Since the earth near an ongoing COP>1.0 system experiment has innumerable electrical aspects, materials, etc., it follows that the surrounding earth is indeed in direct interaction with the experiment. It then follows that "slow conditioning" of the surrounding area should be possible, say, after some years as Golden experienced. It also follows that the effect diminishes in magnitude with distance from the experiment.

The "growth of the activation (kindling) to include the entire Earth" is a slow process, requiring years and much expense to aid the "spreading" — as the physicists may be experiencing, according to Feynman. But it is a doable.

We highly recommend that the researcher work on COP>1.0 systems that are not charge and location dependent, so that the kindling problem does not arise. We have assumed non-kindling COP>1.0 systems throughout most of this book.

Chapter 10

Cold Fusion: Low Spatial-Energy Nuclear Reactions at High Time-Energy

"This book is about time. I would have liked to have named it Time, the Forgotten Dimension..." **[Ilya** Prigogine]. {594}

"The notion of time may be unfolded into an independent pure science... a science of pure time is possible." [Sir William R. Hamilton, 1837]. {595}

"...contrary to the conclusions of classical mechanics, there exist effects of potentials on charged particles, even in the region where all the fields (and therefore the forces on the particles) vanish." [Y. Aharonov and D. Bohm] {596}.

"...global behavior greatly modifies the very meaning of space and time. Much of geometry and physics is based on a simple concept of space and time, generally associated with Euclid and Galileo. In this view, time is homogeneous. Time translations may have no effect on physical events. Similarly, space is homogeneous and isotropic; again translations and rotations cannot alter the description of the physical world. It is quite remarkable that this simple conception of space and time may be broken by the occurrence of dissipative structures. Once a dissipative structure is formed, the homogeneity of time, as well as space, may be destroyed." [Ilya Prigogine] {597}.

"As we expand our observation, we extend our concepts. Thus the simple symmetries that once seemed self-evident are no longer taken for granted. Out of studies of different kinds of interactions we are learning that symmetry in nature is some complex mixture of changing plus into

minus, running time backward and turning things inside out." [T. D. Lee] {598}.

"The desirable features of a system of units in any field are convenience and clarity. For example, theoretical physicists active in relativistic quantum field theory and the theory of elementary particles find it convenient to ***choose*** *the universal constants such as Planck's quantum of action and the velocity of light in vacuum to he dimensionless and of* ***unit magnitude.*** *The resulting system of units (called 'natural' units) has only* ***one*** *basic unit, customarily chosen to be length. All quantities, whether length or time or force or energy, etc., are expressed in terms of this one unit and have dimensions which are powers of its dimension. There is nothing contrived or less fundamental about such a system than one involving the meter, the kilogram, and the second as basic units. It is merely a matter of convenience."* [J. D. Jackson] {599}.

[Violation of Second Law of Thermodynamics] *"We experimentally demonstrate the fluctuation theorem, which predicts appreciable and measurable violations of the second law of thermodynamics for small systems over short time scales... Our results show entropy consumption can occur over colloidal length and time scales."* [Evans et al.][287]

[Implications] *"This result has profound consequences for any chemical or physical process that occurs over short times and in small regions."* [Evans et al.][288]

[Implications] *"The smaller a machine is, the greater the chance that it will run backwards."* [Evans et al., *ibid.]*

[Implications] *"Physicists knew that at atomic scales over very short periods of time, statistical mechanics is pushed*

[287] G. M. Wang, E. M. Sevick, Emil Mittag, Debra J. Searles, and Denis J. Evans, "Experimental Demonstration of Violations of the Second Law of Thermodynamics for Small Systems and Short Time Scales," *Phys. Rev. Lett.*, 89(5), 29 July 2002, 050601.

[288] BBC News, **18 July 2002, http://news.bbc.co.uk/l/hiscitech/2135779.stm.**

> *beyond its limit, and the second law does not apply. Put another way, situations that break the second law become much more probable. ...the new experiment probed the uncertain middle ground between extremely small-scale systems and macroscopic systems and showed that the second law can consistently be broken at micron scale, over time periods of up to two seconds."* [Chalmers] [289]

10.1 Explaining Time as Energy

See Chapter 1, paragraph 1.1.3 and 1.4.1; see also Chapter 2, paragraph 2.1.3. As highlighted in the quotation from Jackson {599}, it is well known that the fundamental units chosen to model physical phenomena are arbitrary. In a physics model whose only fundamental unit is the joule, time is obviously modeled solely as a function of energy, just as mass is modeled today as a function of energy — hence the term "mass-energy". We may also equally well use the term "time-energy", since in a model using the joule as its only fundamental unit the second is purely a function of energy. Specifically, for our purposes 1 sec = 9×10^{16} joules of spatial energy, compressed by the factor c^2 and placed on the 4th Minkowski axis to constitute one second of time. If the compressed spatial energy had been left in 3-space, it would be recognized as *mass*. For our purposes, *time* has the same energy density as mass.

The flow of time becomes a special form of EM energy flow, analogous on the fourth axis to mass flow (translation) in 3-space. Further, as previously pointed out the overall flow of time has extensive internal structuring of component time-energy flows. However, time-flow is in the imaginary plane or connected with it, since in Minkowski space the 4th dimension is modeled as -i*ct*. Note that the only variable in *ict* is the *t*, hence anything varying on the fourth axis is a variation of time and time-energy *a priori*.

Further, we can apply conservation of EM energy to the time domain as well as in 3-space. And we can have "broken symmetry" in time-energy flow as well as in 3-spatial energy flow, so long as the net energy flow is conserved. The most fundamental conservation of energy law is giant negentropy: the automatic circulation of energy from the time domain into 3-space via decompression by the negative charge, thence the slight flow of 3-space energy to the positive charge where the 3-space energy is re-

[289] Matthew Chalmers, "Second law of thermodynamics 'broken'." *New Scientist,* 19 July 2002, http://www.newscientist.com/news/print.jsp?id=ns99992572 .

compressed, thence from the positive charge back into the time domain.[290] That was our solution to the long-vexing problem of the source charge and its associated 3-space fields and potentials and their 3-space energy. From special relativity, one already knows that time can dilate and then *un*-dilate, but each action is associated with an appropriate change in spatial energy. While that change in spatial energy can be kinetic, it does not have to be. It can be a change in potential energy instead. In short, a static object rotates its frame with respect to the observer (lab) frame, whenever it absorbs or emits potential energy.

We also pointed out the connection of time-energy to electromagnetics and to quantum field theory, via the four polarizations of the photon considered to travel in the z direction in 4-space. These four polarizations are with the energy vibrating along *x*-, *y*-, *z*-, and t- respectively. Vibration of the spatial energy of the photon along the *x*- or *y*- axis gives an ordinary transverse photon. Vibration of the spatial energy of the photon along the z- axis gives the longitudinal photon. Vibration of the time-energy component along the t- axis gives the scalar or time-polarized photon. We assume a similar four polarizations for EM waves in 4-space.[291]

10.2 Mechanism Generating Flow of a Mass through Time

As we covered in the referenced paragraphs in Chapters 1 and 2, the fundamental generatrix of the flow of a mass through time — and the structuring of that flow — is the total photon interaction with the mass and all its parts. This includes both observable and virtual photon interactions.

As a recapitulation: Mass *m* does not exist in time, since it is an observable and observation is the imposition of d/*dt* upon spacetime LLLT, removing the T to give a "frozen LLL snapshot." In short, mass m is an *effect* (of the iterative very high speed observation process), not a *cause* (which is an *input* to the observation process). This is why all observation is 3-spatial rather than spatiotemporal: it yields the 3-space *effect* (at a given time, of a

[290] Note the relationship with such things as time dilation, which represents a broken time-flow symmetry, where net energy flow from the time domain to the 3-space domain occurs. Hence time dilation is associated with the increase of spatial energy, such as kinetic energy due to the relativistic velocity of the moving object.

[291] In this book, we have limited our discussion to four dimensions. If we model in five or more dimensions, then additional symmetries and broken symmetries **are** possible, as are new kinds of multi-dimensional EM waves.

given interaction), not the 4-space cause of the interaction and not the ongoing 4-space interaction.

By absorbing and emitting photons, observed mass *m* may be said to move through time in a succession of *m => mt => m => mt => m* ... jumps, each involving change of physical state as a photon is absorbed by *m,* changing it to *mt* which is nonobservable. Then a photon is re-emitted by *mt,* changing it back to *m* and completing another observation with this new *m* as the output (effect). We note that masstime *mt* is as different in nature from mass *m,* as impulse *Ft* is from force *F.* In mass *m,* every tiniest differential *dm* is also interacting with photons continuously (even though they may be *virtual* photons), hence *dm* also exhibits its own "digital flow through time" as a part of the structure of the overall flow of the parent mass through time.

Interaction primarily with the *mt* state yields wavelike interactions. Interaction primarily with the *m* state yields particle-like interactions. This is proposed as a possible resolution of the wave-particle duality problem, which has never been resolved but just accepted without further argument. Previous consideration of wave-particle duality has assumed that "mass has two states, one particulate and the other wavelike". We correct that assumption by pointing out that two different "states in which mass exists" are involved, and the two are quite different: one is mass *m,* and the other is masstime *mt.* We stress the function of the myriads of virtual photon interactions during an *mt* state, where an observable photon has not yet been re-emitted. These virtual photon reactions create streams of virtual *dm => (dm)dt => dm => (dm)dt =>*. . . . .on all the differential parts of mass *m,* which creates the rich structuring inside the "time-flow" of the overall observable mass *m* through time. The rich dynamics of the *dm -> (dm)dt* streams also accounts for the seeming existence of mass *m* as a set of 4-dynamics which interpret as a set of waves. We note that the emitted photon carries with it the internal structuring of the spatial energy domain and the time-energy domain. Herein we have the basis for the Kaznacheyev's demonstrated electromagnetic induction of cellular damage and disease at a distance.[292]

Finally, we tentatively assume that, prior to its interaction, the antiphoton carries negative spatial energy and positive time increments, while the photon carries positive spatial energy and positive time increments. In a

[292] Vlail Kaznacheyev and L. P. Mikhailova, *Ultraweak Radiation in Intercellular Interactions,* [in Russian|, Novosibirsk, 1981.

very small region where an excess of antiphoton interactions occurs temporarily, time-reversal occurs and the physics "runs backward". It has recently been experimentally proven that such "reversing" of the physics processes occurs up to micron size and for times up to two seconds. [293]

10.3 Time-Polarized EM Waves and Longitudinal EM Waves

10.3.1 Waves, Photons, Spacetime Curvature, and Observation

Spacetime (ST) curvature involves not only the change of *spatial* energy density of local spacetime but also a change of its *time-energy* density. That component of the total ST curvature due to time-energy density change — i.e., time-polarized EM photons and waves — can be far more powerful, because of the enormous energy density of the time-energy compared to the far lies dense 3-spatial energy. As previously stated, time may be regarded as having the same energy density as mass, except that the highly compressed 3-spatial energy is moved to the 4th Minkowski axis to constitute "time" rather than being left in 3-space to constitute "mass".

Hence ST curvature can be made very powerful when one uses longitudinal phase conjugate EM *wavepairs*, as shown by Whittaker {600} in 1903 with slightly corrected interpretation as argued by the present author {615}. Each longitudinal EM wave in 3-space is accompanied by a precisely coupled time-polarized (scalar) EM wave in the time domain, which latter wave is a longitudinal EM wave on the fourth Minkowski axis involving changes in the t variable in the axis *-ict*. We previously discussed the giant negentropy that this represents with respect to the source dipole. At various times in the past, we have emphasized the time-domain aspects of the coupled phase conjugate longitudinal EM wave-pair by calling such a coupled wave by terms such as *time-density EM waves, time-polarized EM waves,* etc. These terms imply additionally altering and structuring the *time density* and *time-energy density* of spacetime rather than merely altering and structuring its *3-spatial energy density.* Such time-density induced ST curvatures may be nearly 10^{17} times stronger than ordinary spatial energy density ST curvatures {601}.

Interestingly, at least one researcher — Matsumoto {602} — has realized the basic implication in cold fusion processes of using the strong EM force

[293] See footnotes 287, 288, and 289.

as the agent of spacetime curvature. He has shown consistency of the postulated EM-induced ST curvature approach with some important cold fusion results. However, Matsumoto has utilized the conventional interpretation of spacetime curvature due to alteration of *3-spatial energy density* of spacetime. This misses the primary time-density functions, but does include the resulting spatial-energy functions after transduction from time-energy to spatial-energy. His work, however, does support the involvement of a more intense form of energy in the cold fusion effects.

There are intriguing but still mysterious relationships to be noted between cold fusion and deep astrophysical mechanisms. Continuing reference is made to these similarities, including black holes and white holes. Black holes and white holes involve spacetime curvatures — extreme, but still spacetime curvatures. So one would suspect that the entire scale of spacetime curvature — including black holes and white holes in the limit — should be of interest to cold fusion researchers, since in their use of time energy they are inadvertently involving more intense forms of energy than ordinary spatial EM energy.

Most nuclear scientists and even some relativists seem unaware of the much more powerful spacetime curvature effects obtained by alteration of the *time density* of spacetime rather than just its *spatial energy* density. Physicists have largely omitted specializing on time density ST curvatures because they have largely omitted the absorption and emission interactions of the time components transported by photons and EM waves.

Longitudinal EM phase conjugate wavepairs (each wavepair a coupling of a time-polarized EM wave and a longitudinal 3-space EM wave) of the type shown by Whittaker {600} in 1903 involve net *time density oscillations* as well as 3-spatial energy density oscillations, according to our reinterpretation. The infolded "inner EM content" of all conventional EM potentials, fields, and waves thus contains extraordinary dense time-energy, normally lost in the *d/dt* observation interaction.

In short, the infolded "internal Whittaker electrodynamics is a pure "general relativistic electrodynamics" and a unified field dynamics. Further, it can be engineered, which leads to startling new physical processes previously thought to be impossible and forbidden by the laws of nature.

Prior to observation, the internal highly compressed time-energy structures associated with the interior EM structure of all conventional EM potentials, fields, and waves are extremely powerful spacetime curvatures.

In short, all "conventional" electrodynamics has an internal structure of strong spacetime curvatures and dynamics.

Organization and patterning impressed on, or inserted in, this internal structuring can provide extraordinary actions in materials, living biological systems, cells, etc. Adding deterministic structuring inside these normal EM entities is referred to by Russian energetics weapon scientists as engineering the *information content of the field.* This is the approach behind deliberate engineering of *spacetime curvature engines,* or vacuum engines — or just "engines" for short.

In theory, any physical change to a mass can be engineered by inserting such "engines" into the mass. Any mass-energy is a mass-energy EM potential with an internal structuring (engine) for all the mass's internal dynamics. This engine is referred to as the *resident engine* of that mass (and all its dynamics). Introducing to a given mass a potential with a desired "delta engine" structure, results in the superposition of the two potentials, resulting in exchange sharing of the engines. In that manner, a desired "delta engine" diffuses into the mass's potential structure and its resident engine, changing it to a new resident engine which now acts on the mass at every level to change it. Potentials superpose, and their engines diffuse and superpose as well. Direct engineering of matter — even inside the nuclei and inside the nucleons themselves — can be performed by introducing the desired engine or engines for the changes desired.

This area has been highly weaponized by one or more nations. E.g., the Russians — in several decades of so-called "microwave radiation of the U.S. Embassy in Moscow — induced health changes and diseases in U.S. personnel in the Embassy by inducing deliberate "disease engines". Such EM-induced diseases and health changes were generated in the zones where the potentials were field-free, and therefore stable for stable engine diffusion.

Note that the common scalar potential decomposes by Whittaker's 1903 decomposition {600} into the longitudinal EM wavepairs we are speaking of. Also note that, per a second paper by Whittaker in 1904 {91b} that initiated superpotential theory, all EM fields and waves can be decomposed into two scalar potential functions. Each of those base potentials involved in the potential functions further decomposes by Whittaker 1903 into a harmonic set of phase conjugate longitudinal EM wavepairs as previously discussed. Therefore, the infolded EM inside all the "conventional" EM fields, waves and potentials is indeed a highly organized set of such bidirectional longitudinal EM wavepairs and thus a

highly organized set of extreme localized ST curvatures. In other words, it is comprised of these special "engines" of deterministic spacetime curvatures and their dynamics.

Constructing the potential by assembling one's own set of phase conjugate longitudinal EM wavepairs to form it, one can insert any kind of ST curvature set — any kind of vacuum engine desired — inside the base potential(s), hence inside the two potential functions comprising a given set of EM fields and waves utilized as "carriers". The specific internal structure of a "carrier" radiation field or potential designed to carry such engines is called the "information content of the field".[294] The Russians have long had a disinformation campaign to suggest that the term refers to conventional spectral analysis. It does not.

Johns Hopkins scientists did detailed measurements inside the Embassy and confirmed that all the anomalous health changes and diseases had occurred only in areas where the EM fields B and E were absent. That is, the health changes occurred only where the potentials were field-free and therefore stable and unchanging, so that an exposed body was immersed in a steady sea of "vacuum engines" being diffused throughout the targeted body's EM potentials in and on its cells, its cellular membranes, etc.

In general relativistic terms, every physical set of changes and altered dynamics (syndrome) of a specific disease has a specific *delta* set of spacetime curvatures and dynamics associated with it, which interacts on the body, its chemistry, its electrodynamics, its cells, etc. A desired set of

[294] Indeed, in theory one can *construct, functioning robotic systems* of these internal engines. In clandestine Russian weapon research, it appears that at least elementary "causal robots" of such internal engine type have been developed and tested. In a sense, these are the ultimate "nanobots" made of infolded longitudinal EM waves and their dynamics. In theory, command and control functions (via longitudinal EM wave communication) can be included, as can certain kinds of weapons effects based on scalar interferometry. The eventual development of such startling weapons seems intended to produce an army of eerie "internal EM" robots which can be "sent in" *through the interior of EM fields, waves, and potentials,* to targets anywhere on earth, beneath its surface, in space, or beneath the ocean. This may be intended to become the ultimate robot or "high tech" warfare, and it is also the ultimate "information" warfare. There are no shields against this type weaponry. Defense, however, is accomplished by first using longitudinal wave "scanning" to pick up and track the systems, much like radar picking up aircraft. Once detected, scalar interferometry is utilized to disrupt and destroy them in place. Progress on these robotic weapon systems appears to be well along, as does progress on their countering longitudinal EM wave weapons.

ST curvature deltas for a given disease was inserted inside the base potentials in a combined Whittaker 1903 and 1904 decomposition of the stable field-free potentials in the Embassy. The Russians thus induced the desired engines for induction of the specifically desired disease(s) in the assigned personnel in those field-free potential zones in the Embassy. The purpose was to use the tests as (i) a guaranteed means to provoke high level U.S. governmental attention, and (ii) a probe to see if the U.S. knew about such technology and had developed defenses. Other tests of such disease induction in entire populations have also been conducted, but these are beyond the scope of this book.

We point out one very important thing: the cells of the body have their normal "resident engines" and resident engine dynamics inside their internal fields and potentials and waves. For any specific disease or disorder condition, there exists a specific associated change (delta) in the normal set of vacuum engines and their dynamics, in the cells and the body. In short, there exists a specific "delta engine" for any cellular disease or disorder, added to the normal engine.

It is not the immune system that heals. Instead, it is the cellular regenerative system. The natural healing method used by the cellular regenerative system is not chemical. The regenerative system uses the phase conjugate wavepair composition of increased scalar potentials (on cellular membranes and every part of the cell) to "pump" the cells in the time-domain. This creates an "anti-engine" for the specific disease delta or disorder, and it slightly amplifies this anti-engine within the limited capabilities of the body. This action places this amplified anti-engine also into the stricken cells' engine complex. Engines superpose, just as do potentials. This action by the regenerative system has the effect of slowly producing complex anti-forces in the body and inside the cells themselves, eliminating the detrimental engine delta, restoring the normal resident engine and thus time-reversing the stricken cells back to a previous healthy condition. It does not kill pathogens at all; that is the function of the immune system. In the 1960s and early 1970s, Antoine Priore in France demonstrated remarkable cures of terminal tumors, infectious diseases, clogged arteries, and other disorders in laboratory animals,[295] unwittingly

[295] See (a) A. Priore, *Guerison de la Trypanosomiase Experimental Aigue et Chronique par L 'action Combinee de Champs Magnetiques et D 'Ondes Electromagnetiques Modules* [Healing of intense and chronic experimental trypanosomiasis by the combined action of magnetic fields and modulated electromagnetic waves], Priore's thesis submitted in candidacy for the doctoral degree, 1973. The thesis was rejected when the project was suppressed. See also (b)

amplifying the body's own master regenerative mechanism. His work was suppressed in the mid-70s.

Check our website, www.cheniere.org, for a 119-slide "porthole" briefing on the present author's extension whereby specialized mixes of ordinary EM waves can be used to initiate and perform this "delta engine elimination" healing process, and it can be highly amplified well beyond the body's normal healing capabilities.

In 1998 we seriously proposed to the DoD, the USAF, the NIH, and other U.S. government institutions that a crash development program be initiated to develop portable units capable of rapidly (5 minutes per patient) treating mass casualties from coming terrorist attacks with weapons of mass destruction such as anthrax, smallpox, bubonic plague, Ebola virus, etc. Sadly, no one in the U.S. government had the foggiest notion of what we

"Le Probleme Priore," *Rapport de la Commission de 1'Academie des Sciences a Monsieur le Ministre d'Etat charge de la Recherche et de la Technologie,* 1982, p. 1-22; (c) Antoine Priore, "Precede et dispositif de production de rayonnements utilisables notamment pour le traitement de cellules vivantes," [Procedure and Assemblage for Production of Radiation Especially Serviceable for the Treatment of Living Cells], Republique Francais Brevet d'Invention P.V. No. 899.414, No. 1,342,772, Oct. 7, 1963; (d) Antoine Priore, "Method of producing radiations for penetrating living cells," U.S. Patent No. 3,280,816, Oct. 25, 1966; (e) Antoine Priore, "Apparatus for producing radiations penetrating living cells," U.S. Patent No. 3,368,155, Feb. 6, 1968; (f) A. J. Berteaud and A. M. Bottreau, "Analyse des rayonnements electromagnetiques emis par l'appareil Priore," [Analysis of the electromagnetic radiations emitted by the Priore apparatus], D.R.M.E., 1971, p. 3-12.; (g) R. Courrier, "Expose par M. le Professeur R. Courrier, Secretaire Perpetuel **de** L'Academie des Sciences fait au cours d'une reunion a LTnstitut sur les effets de la Machine de M. A. Priore le 26 Avril 1977," [Presentation by Professeur R. Courrier, Perpetual Secretary of the Academy of Sciences, made at the meeting of **the** Academy on the effects of the machine of M. A. Priore]; (h) R. Pautrizel, A. Priore, M. Dallochio and R. Crockett. (1972) "Action d'ondes electromagnetiques el de champs magnetiques sur les modifications lipidiques chez le Lapin par l'administration d'un regime alimentaire hypercholestrole." [Action of electromagnetic waves and magnetic fields on provoked lipidic modifications in the **rabbit** by the administration of an alimentary hypercholesterol diet.] *Compt. Rend. Acad. Sci. (Paris),* Vol. 274, 1972, p. 488-491. The same university that rejected Priore"s doctoral thesis in 1973, accepted a doctoral thesis on the same subject some 11 years later due to the persistence of Pautrizel: See (i) Eric Perisse, *Effets des Ondes Electromagnetiques et des Champs Magnetiques sur le Cancer et la Trypanosomiase Experimentale [Effects of Electromagnetic Waves and Magnetic **fields** on Cancer and Experimental Trypanosomias],* Doctoral thesis, University of **Bordeaux** No. 83, March 16, 1984.

were discussing. At NIH, we never got out of their "policy" (i.e., "spin control") department. Not a single capable scientist reviewed the extensive package. The attack on the World Trade Center and the Pentagon on Sept. 11, 2001 is just a forerunner of that which is to come. We could have been prepared to save hundreds of thousands of Americans, even millions. We shall not be ready, and the first really professional anthrax or smallpox (or camel pox, which is easily available and almost exactly the same as smallpox) attack on a major U.S. population center may leave from one to three million Americans dying in the streets and in their homes. Presently nothing will save them. It could have been different.

10.3.2 Photons and Waves in Minkowski Spacetime

Photons are made of angular momentum (action); i.e., of *energy x time*. Waves, being made of photons, carry both spatial (decompressed) energy and time (highly compressed) energy — although physics has largely omitted the *time-energy-carrying* aspect, and only accounted for the *spatial energy-carrying* aspects. An EM wave in space is actually a wave of the particular spacetime curvatures that produce angular momenta in interacting charged masses. The standard notion of E and B fields at right angles in a plane in 3-space, traveling along the *z*- direction and with the plane orthogonal to *z*-, and with E and B field vectors oscillating back and forth, is nonsense, as acidly commented upon by Romer {603}, the former editor of *American Journal of Physics*.

Nonetheless, using the standard way of modeling the "transverse" EM wave: In conventional electrodynamics, a *transverse EM wave* is one where the 3-spatial energy density is considered to be varying rhythmically at right angles to the direction of wave propagation, and the time-density is assumed to be non-varying, or at least altered only by special relativistic considerations in certain cases.[296] A longitudinal EM wave has its spatial energy density fixed in *x*- and *y*- directions, and its energy density is oscillating along *z*-, the direction of wave propagation, by a "compression" and "rarefaction" process much like squeezing an accordion. This, however, leads to a "galloping" motion where the wave is alternately very superluminal and very subluminal at given instants, but moving at an *average* velocity of *c* {604}. On the other hand, a *time-density (scalar) EM wave* by definition is not varying in its 3-spatial energy density, and

[296] We point out that a wave of varying spatial energy density is moving in a varying curved ST a priori, by general relativity. If the "wave" were in a flat spacetime as normally assumed, the EM flat spacetime would eliminate the EM wave itself. **This** has been particularly pointed out by Sachs and by Evans.

therefore is not varying in *x*-, *y*-, or *z*-. Instead, the energy is in the form of time-energy, and its variation is in time density. So its energy density is oscillating along the fourth Minkowski axis, *ict*, as an oscillation of the energy density of the variable *t*. It is therefore polarized in the t- direction.

10.3.3 Time-Charging, Internal Structuring, Vacuum Engines, and Diffusion

Photon interaction as a *spatial* energy collection or energy exchange process is well known in physics. However, the time-charging or time-excitation interaction between the mass and the time component carried by the photon is usually ignored.

As is well known, an atomic electron that absorbs a transverse photon increases its spatial energy and changes into an excited spatial energy state. When the electron subsequently "decays" from that excited energy state to a lower state, the spatial energy differential between the two states is emitted as the spatial energy component of an emitted photon. This is the *spatial energy density* reaction of a transverse photon with an absorbing and emitting mass particle.

Unaccounted for by physics, at the time of the energetic excitation of the mass (i.e., when the photon is absorbed), a time excitation — time charging — also occurred because the time-component of the absorbed photon is also attached to the mass, converting it to *masstime*, a new entity. Re-emission of the photon is accomplished by the decay of both the *spatial energy* excitation and the *time-energy* excitation. In the previously excited state after photon absorption, however, one did not have the entity "mass", but the entity *masstime* having greater topology. If mass is an observable and taken to be 3-spatial (as is conventional), then photon absorption and emission oscillates between 3-space and 4-space effects, generating both spatial energy and time-energy (or *angular momentum)* excitation and decay.

Further, only *masstime* emits a photon. This immediately casts a very different light on such things as radioactive elements, which are in an initially excited state. Discussion of this aspect, however, is beyond the scope of this treatise.

On the other hand, a *scalar (time-density)* photon {605, 606} has a rather different interaction, regardless of how physics presently treats it. Any atomic electron at any energy level is continually receiving and emitting virtual photons - transverse, longitudinal, and scalar- in its virtual photon exchange with the energetic vacuum. Hence it is continually "connecting to" or "absorbing" time components, thereby changing its nature from

mass to masstime, back to mass, back to masstime, etc. Not only the entire electron but also each differential piece of it is performing that dance between mass and masstime. This is a continual changing from 3-space to 4-space and back. There thus is a violent "chatter" of the electron (and each differential piece of it) in the myriad levels of its *time* exchanges, giving it

(i) An average rate of time component exchange,

(ii) An average "time-charge", and

(iii) A dynamically changing, specific structuring of its time components.

Whenever a mass absorbs an observable photon, the mass converts to masstime, with an "extension in time" as well as extension in 3-space. During the time-interval created in the masstime, myriads of virtual photons are absorbed and emitted by that mass component of the masstime entity. Hence every dt portion of the masstime state after observable photon absorption, is "internally structured" by the entire virtual photon interaction set's At's occurring within that time interval.

By tailoring at least the larger elements of this internal structuring of the masstime state's virtual photon bombardment, by a deliberately induced virtual photon bombardment, the emitted photon from the masstime decay will carry away with it a desired internal "vacuum engine" structure of organized curvatures of spacetime. In short, two potentials superpose; that is one of their primary features. When they superpose, they also diffuse their internal structures (internal vacuum engines) into each other.

We speak of the *diffusion ofa specific vacuum engine* placed in one interacting EM potential, field, and or wave as *dimensioning* the potential, field, or wave. Adding a dimensioned potential, field, or wave to other potential(s), field(s), or wave(s) diffuses the dimensioning (the engines) between all of the participating entities. With steady radiation of such dimensioned signals into a targeted object, field, wave, or potential, the dimensioning is gradually created (kindled) in the target, simply diffusing throughout it and gradually accumulating. If the irradiating signal carries a specific disease — e.g., necrotizing fasciitis — then gradually in the irradiated body there will emerge all the symptoms of necrotizing fasciitis. If the irradiating signal carries a specific disease antiengine — e.g., for necrotizing fasciitis — then gradually the necrotizing fasciitis condition will be eliminated, with the disease organisms also being eliminated.

This is a more fundamental extension of the disease vector concept. Not only can a disease vector be induced by a physical organism such as a virus or bacterium, but it can also be introduced by simply capturing the fundamental vacuum engine pattern of the disease and using it to condition or dimension signals used to steadily irradiate the targets.

This is the explanation of the Kaznacheyev experiments {607}: thousands of experiments performed by Vlail Kaznacheyev and his colleagues demonstrated the induction of almost any kind of remote specific cellular death and disease patterns in targeted cells, by absorption of radiation emitted from appropriate dying or diseased "emitter" cells with that condition, if the experiments were performed in the dark.

Instead of looking for biogenesis causes in amino acid precursors to cellular life in meteorites etc., one might well look into the *vacuum engine structures* inside the light from the sun, the planets, the stars, and the universe in general. E.g., dead sperm can often fertilize female cells, if not too much physical damage and deterioration to the dead sperm cells has yet occurred. This is understandable, since for a time a dead but undamaged sperm cell will have the same resident engine as a living sperm cell.

10.3.4 Some Cosmological and Gravitational Effects

Each of the observable-sized dt's in all the serial masstimc excited states of the mass moving through time, is internally and precisely structured. **The** precise time history of any mass — together with all its interactions, experiences, etc. — is present inside the time stream of ongoing interactions of that mass with photons. These virtual photon changes are in fact deterministic and come from every part of the universe, as shown by Puthoff {608} in his self-regenerative cosmological feedback cycle. We have merely extended his cosmological feedback to include the time **domain** as well as the energy domain. We hypothesize without further **discussion** that this internal structuring of the time-domain for every mass or object will eventually be connected with the quantum concept of the ge**ometric** phase {609}.

When a transverse photon interacts with a mass in the presence of other **photon** interactions, the mass can act as a phase conjugate mirror and form the phase conjugate replica photon (an antiphoton). For a longitudinal **photon,** the antiphoton *prior to observation* is a scalar photon. We propose that in the unobserved causal state the photon and antiphoton can couple (strong interpretation of the distortion correction theorem) and form a spin-**2 graviton.** According to quantum field theory, one may already interpret

the common scalar potential as being comprised of such spin-2 gravitons {610, 611} if we speak of the situation prior to observation.

As opposed to the accounted *spatial energy charging* of the familiar transverse photon interaction, the longitudinal photon interacting with mass will cause immediate phase conjugation by the mass because of the accompanying scalar photon (accompanying antiphoton prior to observation). When one pumps with longitudinal EM waves, one also inadvertently pumps with time-polarizcd EM waves simultaneously.

From its background "time-energy pumping" in its vacuum exchange, the mass forms the phase conjugate replica, which couples to the incident longitudinal EM photon. This forms (wave view) bidirectional longitudinal EM wavepairs (conjugate pairs), comprised of (particle view) internal coupled longitudinal photon-antiphoton pairs. Each of those internal photon-antiphoton pairs is a spin-2 graviton.

Each such conjugate longitudinal wavepair actually contains a time-density (time-polarized) or scalar EM wave. So the interaction of LWs and their accompanying scalar waves immediately initiates the formation of time-density waves, which then primarily perform a *time-charging* interaction. In addition, even for an equilibrium time-charging state, the "masstime" state of the interacting electron contains a specific structure of the time elements in the electron-time's time component. Each of these infolded time elements is also time-charging the electron.

10.3.5 Charging and Excitation Considerations For Cold Fusion Purposes

So there are several new types of charge or excitation that are involved in cold fusion and other phenomena. One may speak of charging and excitation such as gravitational charging, time charging, time-energy excitation, time-energy charging, etc.

Both the longitudinal photon and the scalar (time-polarized) photon are in fact known in physics, but usually neglected, at least at the end of calculations. E.g., Gray {612} puts it this way about the four kinds of photon polarizations and the habitual elimination of the higher ones:

> *All that quantum theory can say is that there are two transverse photons, a longitudinal photon and a scalar photon. It must be decided by other means which are "desirable" states and then it is customary to "eliminate" the longitudinal and scalar photons by invoking a*

subsidiary condition, now somewhat weakened from the Dirac form.

For our purpose in examining the cold fusion experiments, there exists a completely unsuspected "time-charge" set of excited states for an atomic electron, a proton (as in an H+ ion), etc.[297] There also exists a "time-structuring" of the time-charge excited time-state, which we will see is important in certain highly anomalous instrument phenomena. Uncovering this time-charging and time-structuring interaction has been one of the major results of this author's long effort to decipher the functioning of the healing (cellular regeneration) system of the body as well as his efforts to decipher the fundamental nuclear transmutation mechanism in cold fusion transmutation interactions at feeble *spatial* energy.

In summary: For longitudinal photon interaction, the atomic electron "absorbs" the longitudinal photon and its accompanying scalar photon, being simultaneously spatial-energy excited (charged) by the longitudinal photon and time-energy excited (time-charged) by the scalar photon. This time-excited state (of masstime) then subsequently decays, emitting a longitudinal photon accompanied by a scalar photon in the process.

[297] See again footnotes 287, 288, and 289. From our mechanism propelling a mass through time, time-charging and discharging play the causal role. The acquisition of dt by mass *m* produces masstime *mt*, then the subsequent photon emission decay of *mt* back to *m* produces "propagation of mass *m* forward through time" by one "jump". Time charging with -dt and subsequent photon emission is what produces "propagation of mass m backwards through time" by one "jump". Evans et al. proved that even up to the micron scale physical particles and their dynamics can run backwards in time for up to two seconds or more. The fluctuation theorem proved by Evans and his colleagues in 1993 shows us that, at the scale of a proton and neutron, there can become a high probability of significant time reversal of the physical dynamics. This means that the law of attraction and repulsion of charged particles -such as two H+ ions in solution — "runs backwards" or is reversed, so that momentarily like charges attract and unlike charges repel. We have called the region in which this reversing of the physics occurs a *time reversal zone* (TRZ). With the reccentwork of Evans et al., the existence and occurrence of TRZs even well above the proton (the H+ ion) level is now clearly established, including the reversing of the physical dynamics. These concepts have not yet been applied to cold fusion interaction results by the leading cold fusion researchers, but they now stand as explaining the most probable mechanism for the observed phenomena. In this Chapter we have written some of the typical new nuclear reactions that can occur in such a TRZ, and the exact products of these reactions are widely reported in several hundredsuccessfulcoldfusionexperiments.

We shall return to time-charging and time-charge decay when we examine and explain the odd instrumental anomalies experienced for some time in experiments at China Lake.

10.4 Time Reversal Zone and New Nuclear Reaction Mechanisms

It follows that the flow of a mass through positive time must involve a preponderance of reactions with photons rather than antiphotons, since *net* absorption and re-emission of photons (rather than antiphotons) is involved. Otherwise, the absorbing and emitting mass would not accomplish little "jumps" forward in positive time.

Suppose we deliberately arrange a situation where the target mass is interacting with a preponderance of antiphotons. In this case, the mass will be time-reversed, as will be the EM energetics. [298] This leads us to the novel concept of a *time reversal zone* just described in footnote.

A time-reversal zone (TRZ) is a region of space, or electrolyte, etc. in which given masses or charges of interest are interacting on the average with more antiphotons than photons. Consequently, in the TRZ the usual EM energetics are reversed and normal charge reactions appear to "run backwards" insofar as the spatial 3-space observer is concerned.

For example, in electrolytes in a region of highly loaded positive charges in a loading palladium lattice with properly prepared surface, a very great number of double surfaces exist. Hence a great number of scalar interferometries continually occur from that large number of double surfaces acting as scalar interferometers {613}. Because of the highly excess positive charge loading, these interferometers are predominately fed by negative EM energy from the positive charges. Hence, in the distant interference areas in the electrolyte outside the palladium lattice, some

[298] This *is not* time-travel in the classical science fiction sense. For time-travel, the traveling object must remain moving in its own forward time, while the entire remainder of the universe must be reversed in its time and must move backward in time to a past coordinate. That is not what is happening here, and no one is suggesting we can time-reverse the rest of the universe! Instead, energy can be reversed in time, as proven in nonlinear phase conjugate optics. So can mass-energy and charge-energy, as shown by the Dirac theory of the electron. An *observed* positron is an electron observed while traveling backwards in time, so to speak, with respect to the observer. But it is observed in observer forward time as traveling in the opposite spatial direction, having positive mass and positive energy, and with the sign of its charge reversed from negative to positive.

negative energy fields and negative energy potentials are produced dominantly. An excess of antiphotons is produced in those interference zones where an excess of antiphotons appear due to the scalar interferometry. In *those* little interference zones, the simple positive ions are momentarily bathed in an excess of antiphoton interactions. This is therefore a time-reversal zone of momentary time-reversed EM energy flow.

From a palladium lattice loaded with H+ or D+ ions, and also having a proper surface with many work grooves and thus many small interferometers, random fluctuations in the scalar interferometry occur in the adjacent electrolyte. Some of these random scalar interferometries continually form fleeting <u>*time reversal zones*</u> (TRZs) in their interference zones in the surrounding electrolyte. The very large energy required for the formation of each TRZ and its reversal of the normal laws of attraction and repulsion of charges, is available from conversion of time energy from the time domain as a result of the giant negentropy mechanism in 4-space ongoing in the loaded positive charges (614, 615} in the palladium lattice.

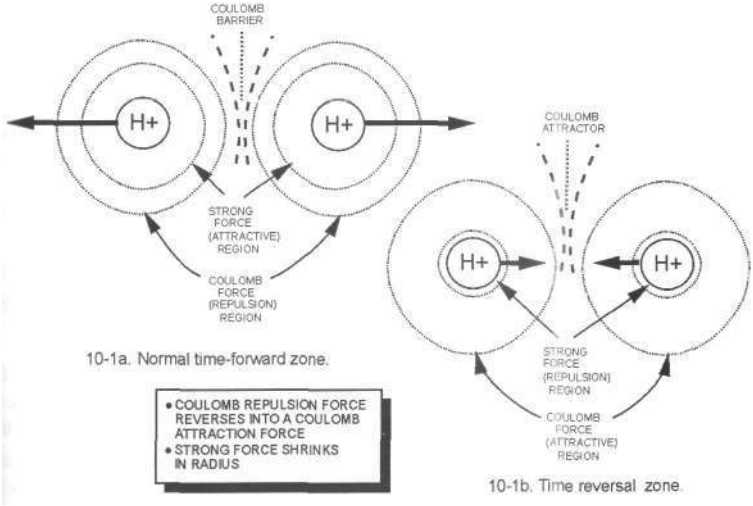

Figure 10-1 Forces on nuclei of simple ions in time-forward and time-reversal zones.

See Figure 10-1. In Figure 10-la, two hydrogen ions (two free H+ protons) in a normal electrolyte and in a normal time-forward zone are shown. The

Coulomb barrier dramatically increases the forces of repulsion between the two H+ ions as their kinetic energy may be driving them momentarily toward each other. This Coulomb barrier becomes so strong that it stops the approach of the two ions and forces them back apart, or to deviate aside from their paths, before each can ever enter the very short-ranged strong force region of the other. Consequently no nuclear reaction occurs, but only a common chemical reaction. The maintenance of that Coulomb barrier is all that prevents energetic ions from being driven together closely enough to engage the strong force and cause the ions to form a new nucleus (cause a transmutation).

Now see Figure 10-lb, for the same two ions that suddenly find themselves in a momentary time-reversal zone (TRZ). In a temporary TRZ, suddenly like charges attract and unlike charges repel, exactly in reverse of the *normal* behavior of charge attraction and repulsion. The usually increasing Coulomb barrier (repulsive force between the two approaching H+ ions) has disappeared and been replaced by an increasing Coulomb attractor (attraction force). Further, the strong force has been partially reversed and much weakened since the gluon forces are dramatically reduced and fluctuating.[299] The attractive strong force is now a partially *repulsive* force and so it is much weaker. Consequently, the quarks in a proton or neutron are not nearly so strongly bound as they are in a normal time-forward zone (TFZ).

A TRZ represents a highly time-charged excited local state in that local region of the electrolyte. The moment a TRZ is formed, the surrounding ions in the electrolyte outside the TRZ immediately move or deviate their movements to reverse this TRZ action[300] and convert it back to a time-forward zone (TFZ). Hence once it is born in the electrolyte, the TRZ decays rapidly due surrounding ion movement changes, and even more

[299] Again we stress the tremendous energy density of the time-energy involved. These cold fusion interactions are actually higher *total* energy reactions than nuclear physics presently uses, even though the *spatial* energy density of the reactions is very small. Together with the now-proven fluctuation theorem of Evans et al., the TRZs and reversal of the normal Coulomb barrier into a Coulomb attractor open up a vast new nuclear chemistry of direct nuclear transmutation reactions at low spatial energy but at very high tempic energy. The ability to directly engineer the quarks and the gluon forces, e.g., opens up a new chemistry of direct subparticle engineering heretofore considered quite impossible by chemical means.

[300] Their approach increases the fraction of photon reactions relative to antiphoton reactions, since the other ions are moving in a TFZ on the average.

rapidly due to the rapid variation in the fluctuating scalar interferometers in the loaded palladium lattice. In most cases, the random fluctuation in the scalar interferometry is so rapid that the TRZ decays back to a normal TFZ before the two approaching H+ ions can reach each other (reach each other's reduced strong force repulsion region). However, in a certain percentage of approaches, the two approaching like-charged ions will "reach each other" — i.e., each will enter the weakened strong force region of the other before decay of the TRZ occurs.

See Figure 10-2. In Figure 10-2a, we show the case in which the TRZ lasts long enough for the two H+ ions to reach each other's strong force repulsion zones and form a quasi-nucleus. Here they vibrate back and forth in a dynamic dance around the zero net force axis between their repulsive strong forces and their attractive Coulomb forces. In this case, a new kind of nuclear reaction is set up to occur. Decay from this excited quasi-nucleus state in a TRZ can occur into a real nucleus in a normal TFZ. Energetically, because the quarks are so loosely bound now[301] the preferred decay mechanism when TRZ -> TFZ is by appropriate *quark flipping.*

As a little bit more time passes, the interferometry changes and the TRZ decays, returning back to a normal TFZ. In a change from TRZ to TFZ, the energy change is enormous because time-energy is involved, with energy density equal to mass. The only difference in a proton and a neutron is the orientation of one quark (three quarks make up each of the particles). As TRZ decay starts and progresses, the strong force changes back to a powerful attractive force. It increases its strength far more powerfully and quickly than the Coulomb attractive force reduces its reversal and changes back to a repulsive force. The addition of the extra energy from the now-increasing strong attraction force simply causes one nearly-freed quark in one of the two H+ ions to flip, converting that H+ ion into a neutron n. Instantly the preferred decay product is the deuterium ion D+. So the H+ and the n simply draw a bit closer together, each now fully inside the

[301] To appreciate the sheer raw power of the time-energy control of interactions, simply examine the enormous *spatial* energy density required in high energy physics to try to approach the "free quark" condition. Enormous and very expensive *spatial energy* accelerators are used, at the absolute state of the art. By going to the use of the extraordinarily dense time-energy, quarks can readily be freed or nearly freed in electrolytes, and they are nearly freed in more than 600 relatively simple and inexpensive cold fusion experiments {753) on the bench-top to allow new nuclear reactions by quark flipping, where a proton turns into a neutron or vice versa.

rapidly increasing attractive strong force region of the other. This converts what had been a quasi-nucleus of two H+ ions into a real D+ nucleus. This result is shown in Figure 10-2b.

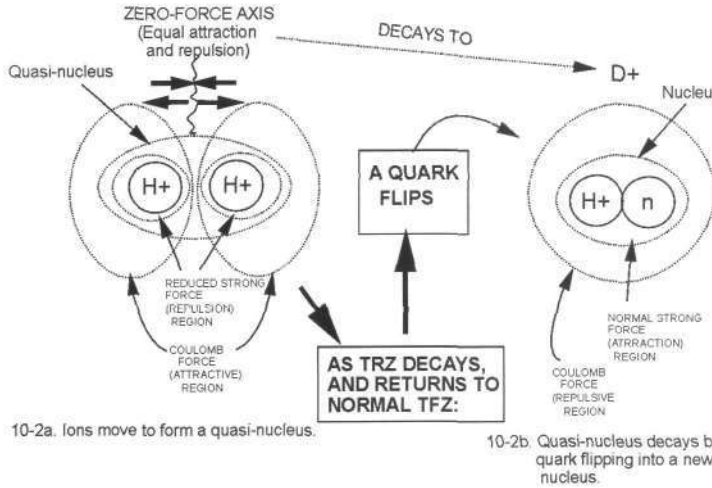

Figure 10-2. Production of quasi-nucleus and its decay by quark-flipping into a new nucleus as the time-reversal zone decays back to a time-forward zone.

Recapitulating: As the TRZ subsequently decays back to a normal time-forward zone (TFZ), the new quasi-nucleus becomes an excited state, and decays. However, the quasi-nucleus decays by very novel means. Because of the time reversal, the energy changes induced in the decay *start* at each spacetime point inside the quasi-nucleus, deep inside the quarks, and proceed outward. The first interaction of the decay mechanism is with the quarks comprising the nucleons (in this case, the protons). With the gluon forces still very much weakened, quark flipping becomes the preferred decay mechanism. Hence one quark in one proton flips its orientation (that is the mechanism of decay!) and the nucleus — now a nucleus comprised of a proton and a neutron — becomes a nucleus of deuterium.

As can be appreciated, the clustering of different types of like-charged but relatively simple positive ions in TRZs in solution, with subsequent decay of the TRZ into a TFZ, initiates a revolutionary new family of nuclear reactions at low spatial energy (but very high temporal energy), completely contrary to, and not included in, the present forward-time high-spatial

energy (but very low time-energy) reactions model known in particle physics.

In the future, as these new time-energy-based reactions are extended and mastered, scientists will simply assemble desired nuclides in solutions in the laboratory, at low spatial energy (but high time-energy) and at will. We point out but do not pursue further the fact that these new reactions also open up cheap, practical, electrochemical means of altering nuclear and chemical wastes. We therefore foresee a dramatic development in this area, in order to clean up the presently polluted biosphere of much of the chemical and nuclear waste contaminants.

Indeed, we propose that a very strong program in mastering these new nuclear reactions be launched and supported by the U.S. Department of Energy, so that the nuclear wastes storage problem can be permanently solved, much more cheaply, and without having to store hazardous nuclear wastes for centuries. Instead of merely *talking* about "out-of-the-box thinking and research", the DoE should actually do some of it, over the violent objections of the entrenched conventionalists of the national laboratories. Their own great national laboratories are the major part of the problem, not the solution, for both innovative nuclear reactions and innovative energy systems! The problem is that "in-the-box" entrenched conventionalists do not perform or allow "out-of-the-box" research that strongly threatens their vested interests.

The TRZ decay conversion of two protons into a deuteron — by easily flipping one quark in one proton — is an example of the so-called "nuclear reaction at low energy" that has been so controversial *to* the orthodox scientific community, even in the face of some 600 successful cold fusion experiments. Contrary to the assumption of the conventional physics community and the skeptics, these are not "low *total* energy" physics reactions at all. Instead, they utilize energy density on a level commensurate with that achieved in the largest accelerators available and even much higher. *This is actually a much higher <u>total</u> energy physics than the present conventional high energy physics heretofore known or used.*

Particularly in a deuterium-enriched (deuterated) electrolyte, a variety of simple ion arrangements of D+ ions and H+ ions can occur. Many of these combinations and arrangements can and will occur in TRZs if sufficient loading of the palladium lattice is achieved. Below we will present and explain a few of these new nuclear reactions that have occurred in successful cold fusion experiments. First, to be tidy we must correct the

present statement of the conservation of energy law by extending it to include time-energy.

The excess heat usually experienced in the electrolyte is explained by the added negentropy (added energy) from the time-domain, which then dissipates randomly in the solution, producing excess heating. Later we will cite strong experimental evidence for the involvement of such time charging (time-energy charging), with subsequent time-charge (time-excitation) decay as ordinary photons in cold fusion experiments.

10.5 Revision of the Conservation of Energy Law

10.5.1 Unaccounted Transduction Extends the Conservation of Energy Law

Along with the re-emission of all the previously absorbed spatial energy, all the previously absorbed time-charge of the excited electron may be re-emitted with a longitudinal photon/scalar photon pair (a graviton) when the time-excited state decays. In that case, no energy-charging permanent change results to the electron's original energy state. Hence no "electron wiggle" will be created and our normal "electron wiggle" detectors performing such non-transducing longitudinal EM wave interactions will not exhibit an indication. In short, the "pure" time-charging EM LW interaction is unobservable to present instruments. All they "see" is the "same electron" sitting there and "flowing through time".

However, if two or more such gravitons are simultaneously emitted from various reactions in time-decays, the emitted scalar photons and waves may interfere at some little distance. In that case, transverse EM waves and ordinary EM energy will be produced in the interference zone {613}. To the external observer, these EM fields and forces will simply seem to arise spontaneously and emerge from every point in spacetime inside that interference zone, moving outward from there in conventional "propagation through space" manner. In that case, the normal "photon" (actually, graviton) decay processes plus scalar interferometry have resulted in transducing some time-energy into ordinary spatial EM field energy. Such reaction provides the excess heat demonstrated in successful cold fusion experiments.

This is also a true action at a distance reaction, presently unaccounted in particle physics. Action at a distance is required in quantum mechanics, and it has been experimentally demonstrated multiple times in distant photon correlation experiments. Once any action at a distance is admitted because it has been experimentally proven, there is no logical restriction

that only a single mechanism exists for it. Consequently, many of the present foundations assumptions of physics and some of the things previously abandoned because of their conflict with those assumptions will have to be re-examined {616}.

Scalar interferometry is indeed a mechanism for action at a distance. While still mostly absent from open physics, it has already been weaponized by some 10 nations of the world. Indeed, U.S. Secretary of Defense William Cohen confirmed in 1997 that (novel) electromagnetic processes are already being used to initiate earthquakes, stimulate volcanoes into eruption, and engineer and control the weather {617}. Whether or not it is present in the particle physics texts, scalar interferometry is being widely used clandestinely in several armies today. It has also been used to shoot down missiles and aircraft as tests. The so-called "Cold War" was not quite as cold as the news media and U.S. scientific community were led to beleieve.

Because of the ubiquitous involvement of unaccounted time-energy in all photon interactions, an extension to the present form of the conservation of energy law is required. The present (special case) law is

$$E(E)_1 + E(m)_1 = E(E)_2 + E(m)_2 \qquad [1]$$

where E(E) = energy in conventional non-massive energy form, E(m) = energy in mass form, subscript 1 refers to the measurement at time 1, and subscript 2 refers to the measurement at time 2. This is just the well-known Einstein formulation that the sum of the ordinary energy and the mass-energy is conserved.

However, that law is for a special case. It assumes that there is no transduction of time-energy into either mass-energy or ordinary energy. I.e., it assumes 3-symmetry and t-symmetry in EM energy flow. Since every charge in the universe already violates both that 3-symmetry and t-symmetry of energy flow, the fundamental assumption in the Einstein formulation is falsified by the general case. The conventional conservation of energy law is a special case where only the two mentioned energy flow symmetries are upheld. When they are violated, then transduction of EM energy between 3-space and time occurs. For that case, the conservation of energy law must be extended to

$$E(E)_1 + E(m)_1 + E(t)_1 = E(E)_2 + E(m)_2 + E(t)_2 \qquad [2]$$

The **new** law simply states that the sum of the ordinary spatial energy, the **mass-energy,** and the time-energy is conserved. This extension of the conservation of energy law becomes important in successful cold fusion

experiments, where transduction of time-energy into ordinary heat energy occurs and where one encounters very anomalous reactions differing from those reactions known and accepted in conventional nuclear physics.

10.5.2 Transduction Between Time-Charging and Spatial Energy-Charging

The oscillating energy (spatial and temporal) in a moving EM wave in the vacuum represents a moving oscillation of spacetime curvature. Simply put, the so-called electromagnetic wave in space is actually a gravitational wave in space, since it is an oscillation of the local energy density of spacetime and therefore an oscillation of the curvature of local spacetime. It "transports" gravitons (scalar photon/longitudinal photon pairs) rather than merely photons. So let us now consider it as a gravitational wave.

In the absorber under special conditions, a small fraction of the graviton wave time-density absorbed will sometimes change (transduce) its time-energy into what we call transverse photon energy effects {618}, with something like a 10^{17} gain in spatial energy in joules compared to the time in seconds that actually transduces. In other words, 1 second of time transducing into EM transverse wave energy (using the standard EM modeling approach) will yield approximately 10^{17} joules of spatial EM energy. Since one can change energy from one form to another, *one can change time-energy into 3-spatial energy* and 3-*spatial energy into time-energy*, the two being merely opposite sides of the same coin, and both always involved in any situation exhibiting electrodynamic dipolarity.

In one's physics model, the choice of fundamental units is purely arbitrary. Everything can be expressed in a single fundamental unit, as pointed out by Jackson (see quotation from Jackson at the beginning of this chapter).

In a situation where 3-symmetry and t-symmetry in EM energy flow are broken, part of the *time charging* of the atomic electrons (or ions) sometimes changes (transduces) into *spatial energy charging* and vice-versa. This cross-dimensional decay of time-excitation states results in the emission of some extra transverse photons that may be either photons or antiphotons, depending on the exact interactions. The point is, *tremendous excess EM spatial energy can appear and either be emitted as heat or interacted to perform new nuclear interactions as extraordinarily high local energy density*. This is the master mechanism enabling anomalous cold fusion transmutation reactions. The amount of time transduced will be so small that it will usually escape notice, unless stringent efforts are used to measure changes in the local flow of time.

The excess photon energy (excess 3-space EM energy) appearing in these rather random but powerful transduction interactions often accounts for the production of anomalous excess heat - for example, as occurs in many cold fusion experiments. Where scalar interferometry is maximized, a more exact action will be detailed below for the specific nuclear transformations that occur by novel new nuclear reactions. These novel nuclear reactions occur at low *initial* spatial energy but with some time-energy transducing into additional very high spatial energy to initiate the interactions.

10.5.3 Resolving the Energy Conservation Problem in Cold Fusion

When transduction is involved, standard "transverse EM waves only" computations will seemingly yield violation of energy conservation — e.g., from the emission of excess heat. That is an erroneous interpretation; energy overall is conserved, but some of the unaccounted *time-energy flow* is transduced into 3-spatial transverse photon energy dissipation. Neither 3-spatial energy nor mass-energy nor time-energy alone, or in any pairing, need be individually conserved; only the combined *total energy of all three energy components* is conserved. This resolves the present major "sticking point" between the cold fusion researchers and the conventional "transverse wave" nuclear and electrodynamic communities regarding energy conservation difficulties and perpetual motion accusations. Those making the accusations and those defending against them are both using only a special-case conservation of energy law, and a more general law is required.

Let t = time in seconds, and W= energy in joules. Rounding the speed of light to 3 x 10^8 meters/sec, the energy W_{TW} emerging as transverse wave EM energy in 3-space by the transduction of time into 3-space energy is approximately

$$\text{One sec} = c^2 \text{ joules} = 9\times10^{16} \text{ joules} \qquad [3]$$

and

$$t \Rightarrow W_{TW} = 9\times10^{16} \times t \quad \text{(in joules)} \qquad [4]$$

Let us present the new energy conservation law in slightly different form. Let W_{TW} = energy measured in spatial energy form, conveniently taken as transverse wave (TW) EM energy. Let W_m = energy in mass form (energy compressed by c^2). Let W_t = energy in time form (energy compressed by c^2).**The** present conservation of energy law is

$$W_{TW} + W_m = W_{(total)} \qquad [5]$$

The new extended conservation of energy law is

$$W_{TW} + W_m + W_t = W_{(total)} \quad [6]$$

The conventional particle physics accounting will see only

$$W_{TW} + W_m = W_{(total)} \quad [7]$$

The conventional accountant will be unable to see

$$t \Rightarrow W_{TW} \quad [8]$$

so he will observe that the experimenter is reporting that

$$[W_{TW} + W_m]_1 \neq [W_{TW} + W_m]_2 \quad [9]$$

which in his lexicon is a violation of the conservation of energy law itself. In short, he will identify it as a typical example of a claimed perpetual motion machine or interaction. Then the defender of the faith will wax eloquent, applying labels such as "perpetual motion nonsense", "voodoo science," etc. He himself is practicing a hoary old "voodoo" science and ignoring newer science. None of these defenders of the faith even know what powers an electromagnetic circuit or how it is that every little charge in the universe is able to continuously pour out observable EM energy in all directions, with no observable EM energy input.

On the other hand, a reasoned response will be given by real scientists still following scientific method, when faced with the numerous replicated successful experiments. The scientific method insists on the absolute priority of the replicable experiment over the predictions *of any* theory. Consequently, such reasonable scientists will advise that the protagonists cease their vitriolic rhetoric and let real science take its course; i.e., let further experiments confirm or refute reported successful results of cold fusion experiments.[302]

[302] Precisely such a reasoned response by chief editor Donald Kennedy of the journal *Science* has recently been given, providing a breath of fresh scientific air into an attempt by "defenders of the conventional faith" to destroy publication of important experimental results in sonoluminescence. The article which courageous editor Kennedy approved for publication — over intense objections of the professional critics — is R. P. Taleyarkhan et al., "Evidence for Nuclear Emissions During Acoustic Cavitation," *Science*, Vol. 295, Mar. 8, 2002, p. 1868-1873. We heartily commend Editor Kennedy for this classic example of how science should be conducted — so that experiments, not prevailing dogma, determine what is valid and what is invalid.

What the professional skeptic will not see is that his own expression of the conservation of energy law has been incomplete, and that it is his own inadequate "measurement yardstick" assumption that is now in error. The *extended* conservation of energy law of course still holds, but the *conventional* special case law is violated because its fundamental assumption — that time is not transduced to spatial energy in the experiments —has been violated in the experiment.

Indeed, with the publication of the work of Evans et al., experimentally proving the fluctuation theorem and the high probability of time reversal zones appearing for short but significant periods at up to micron levels, the second law of thermodynamics has been rigorously proven to be violated. Hence the conventional scientific community's rather dogmatic objection to the extra heat of cold fusion interactions is no longer scientifically justifiable.

Understanding of the extended conservation of energy law and the permissible violation of the second law of thermodynamics resolves the present thorny dissension within the scientific community over the excess spatial energy produced by cold fusion. It also resolves the issue of what could possibly be a source of such intense energy density as is required for nuclear transmutation reactions.

Any ordinary system is indeed an open system, freely and continuously exchanging energy with its *temporal* environment as well as the seething active vacuum.[303] If the system is in temporal energy equilibrium in that exchange, then the present restricted conservation of "spatial and mass" energy law applies and one does not have to consider the interactions between supersystem components. If the system is placed in disequilibrium with its temporal energy environment, then supersystem components interact asymmetrically and the extended conservation of energy law applies. In that case, excess spatial energy can be and will appear in the system whenever time transduction into spatial energy is occurring.

[303] But see our Appendix A. Present thermodynamics rather inanely defines a "closed" system as one where no mass exchange crosses its boundary with its environment, but energy exchange can and does. In that view, a "closed" system can be far from equilibrium in its energy exchange with its active environment, and thus demonstrate the five magic attributes of such disequilibrium systems. In this book we have deliberately chosen to treat a "closed" system as one in which neither energy nor mass exchange crosses the system boundary — which classical thermodynamics refers to as an "isolated" system. We explain all this (and why) in Appendix A.

The implications of cold fusion energy transduction are that

(1) Time is being "burned" or transduced as a "fuel" and source of energy,

(2) Transduction of only one microsecond per second will yield $9x10^{10}$ watts steadily. That's 90,000 megawatts of energy per second — the equivalent of 90 large 1,000-megawatt power plants — if all the transduced energy were collected and used to power loads with 100% efficiency.

(3) Thousands of new nuclear reactions are made possible and feasible by local transduction of time-energy into 3-spatial EM energy.

(4) Appropriate capture and use of a portion of the excess energy can be accomplished to power loads.

Even if we capture and utilize only 1% of the transduced time-energy to power the loads, where the *time-energy to spatial energy transduction* is only the transduction of 1 microsec/sec, that system will produce the normal EM energy to power 900 megawatts in the load. That's almost 90% of the capability of a modern 1,000-megawatt power plant. That is quite a respectable electrical power system. It only requires the transduction and "burning" of one microsecond of time per second, without any nuclear wastes or hydrocarbon byproducts.

As can be seen, transducing time into energy is by far the most efficient way to go to develop new power plants for the future. This is particularly true since every charge in the universe already transduces time-energy flow into spatial EM energy flow. Indeed, we may consider that the negative charge transduces time-energy flow into the spatial outflow of EM positive energy, while the positive charge transduces negative time-energy flow into an outflow of EM negative energy. The process is useful not only for power applications, but also for transport applications as we briefly pointed out in Chapter 8.

10.6 Some Resulting *Low Spatial Energy* Nuclear Reactions

Refer again to paragraph 10.4 above. Summarizing: The formation of time-reversal zones (TRZs) is what enables the appearance of the new nuclear reactions in the electrolyte in cold fusion experiments. It does this by changing the Coulomb barrier between like charged ions into a Coulomb attractor. Further, the rate at which TRZs form and decay in the solution is a function of the frequency and intensity of the scalar interferometry from

the loaded palladium lattice. This means that the appearance of the new nuclear interactions in the electrolyte is also a function of the degree of loading of the palladium lattice, as well as the "double surface" interferometry preparation of the palladium, its cracks, etc. These are the major variables. Once the major variables provide the solution for significant formation of TRZs, then the following reactions can and do appear.

The sample reactions we present here are just a few of the thousands of new reactions possible. These example reaction products have been found in a great many successful cold fusion experiments in various laboratories around the world. Some 600+ successful experiments have now been done, and a sizable literature has built up and continues to be built up on the experiments and their results.

For our sample reactions, the primary mechanism of interest consists of several parts:

(i) Formation of a TRZ, in which two positive ions (we shall look at H+ and D+), now attract each other. Also, the gluon forces in the proton and neutron, in the ions of interest, are significantly lessened, so that the quarks in each proton and neutron are very much more loosely bound. Consequently, decay from an excited state by quark flipping to turn a proton into a neutron or vice versa becomes an attractive option. The strong force is therefore reduced in radius.

(ii) Two positive ions now attract each other so closely that each enters the edge of the weakened strong force region of the other. This forms a *quasi-nucleus* because of the limited involvement of the weakened strong force.

(iii) The other ions in solution surrounding the TRZ immediately move (as soon as the TRZ is formed) to negate the TRZ and decay it back to a time-forward zone (TFZ). This action initiates the decay of the TRZ.

(iv) As the TRZ lessens and then turns back into a TFZ, the strong force expands its size faster than the novel Coulomb "like attracting like" force reduces and reverses.

(v) The rapidly expanding strong force of each of the two ions in the quasi-nucleus fully envelops the other ion, increasing the disequilibrium of the two-ion quasi-nucleus. A condition is reached where the most probable mode of decay is the flipping of one quark in one of the positive nuclei.

(vi) The quark flips, turning that H+ ion into a neutron n. This is a quasi-nucleus of deuterium (D+), still in an excited state but with less excess potential energy in the excited state. At this point, the TRZ is vanishing and the TFZ state is returning.

(vii) As the TRZ vanishes and TFZ state increases back to normal, the most probable mode of decay increasingly is to a full deuterium nucleus. Hence the H+ and n simply draw completely into normal deuterium binding position, bound by the normal strong force. This constitutes a normal D+ ion, now existing in a normal TFZ.

(viii) So by formation and decay of a significant TRZ, two H+ ions have been drawn together into a quasi-nucleus consisting of two H+ ions partially bound by a weakened strong force. As the TRZ decays and the Coulomb repulsion resumes, the strong force increases back to full strength faster than the Coulomb repulsion force returns and repels the two H+ ions. Since the quarks are much more loosely bound than normal, a quark in one of the H+ ions has flipped, turning the ion into a neutron n. The H+ ion and the neutron, partially bound already in a quasi-nucleus, simply "tighten" into a normal D+ nucleus as the TFZ condition is fully resumed.

The nuclear reaction equation for the above interaction may be written as

$$^{1}H_{1}^{+} + {}^{1}H_{1}^{+} \Rightarrow (({}^{1}H_{1}^{+} + {}^{1}H_{1}^{+})) \Rightarrow ({}^{1}n_{0} + {}^{1}H_{1}^{+}) \Rightarrow {}^{2}H_{1}+ = {}^{2}D_{1}^{+} \quad \textbf{[10]}$$

In equation [10] we use the left superscript as the number of nucleons in the ion nucleus, the right subscript as the protons in the ion nucleus, and the right + superscript to show the overall charge of the ion and its sign. We use the expression in parentheses to show the involvement of a time-reversal zone (TRZ). Double parentheses show a stronger TRZ than single

parentheses. Thus from double parentheses to single parentheses to no parentheses shows the initial formation and subsequent decay of the TRZ.

Another interaction involves a D+ ion and an H+ ion, to produce tritium. This is:

$$^{2}D_{1}^{+} + {}^{1}H_{1}^{+} \Rightarrow (({}^{2}D_{1}^{+} + {}^{1}H_{1}^{+})) \Rightarrow ({}^{2}D_{1}^{+} + {}^{1}n_{0}) \Rightarrow {}^{3}H_{1}^{+} = 3T1^{+} \quad [11]$$

That reaction transmutes a deuterium ion and hydrogen ion into a tritium ion. Without showing it, in a TRZ three $^{2}H_{1}^{+}$ ions may also attract into a quasi-nucleus, and as the decay of the TRZ occurs, first one proton turns into a neutron and then a second one does also, by quark flipping. This nuclear reaction also produces a fusion into tritium.

Another reaction between two deuterium ions is"

$$^{2}D_{1}^{+} + {}^{2}D_{1}^{+} \Rightarrow (({}^{2}D_{1}^{+} + {}^{2}D_{1}^{+})) \Rightarrow [2({}^{1}H_{1}^{+} + {}^{1}n_{0})] \Rightarrow {}^{4}He_{2}^{+} = \alpha \quad [12]$$

That interaction — particularly in pre-deuterated electrolyte solution — gives the excess a particles produced in a great number of the cold fusion experiments.

A rarer but still occurring interaction is:

$$4[{}^{1}H_{1}^{+}] \Rightarrow (({}^{2}D_{1}^{+} + {}^{2}D_{1}^{+})) \Rightarrow {}^{4}He_{2}^{+} = \alpha \quad [13]$$

Indeed, reaction [13] may occur to completion and formation of a particles in some of the transmutations in an electrolyte, while it proceeds only to the intermediate phase in others. In that case, both deuterium ions and a particles may be produced out of the same overall "chain of reactions" where some reactions proceed all the way and some do not.

These interactions are directly using and transducing time-energy by use of the TRZ to time-reverse the Coulomb repulsion law for like charges. From the reactions, excess energy given off as heat may and will occur.

The nuclear physicist and nuclear chemist can immediately see a great many new nuclear reactions now made possible by the adroit production and decay of TRZs. A great number of these new nuclear reactions are now possible by this means, which are impossible in ordinary nuclear chemistry without the deliberate formation of TRZs.

These few examples serve to illustrate the process, and these reactions represent res alts already achieved in numerous cold fusion experiments worldwide, by many researchers and multiple laboratories. Now we turn to other evidence strongly supporting the novel nature of these reactions

rather than several other proposed reaction equations yet to be proven. The other proposals do not explain the next type of new experimental reaction.

10.7 Time-Energy Can Generate Instrumentation Anomalies

Strong evidence for time-charging and time-charge decay is experimentally demonstrated in electrolyte experiments where time-reversal zones (TRZs) are operating, and thus where some localized processes are running backwards in violation of the second law of thermodynamics. Weak time-charging of photon-absorbing and emitting matter, with special patterns of spacetime curvatures (engines) induced by time-density oscillations and structuring, is persistent in matter, having "charge-up" and "decay" times that may last for minutes, months, or even years. A very wide range of previously anomalous phenomena, both in inert and living matter, is explainable by these new interactions. This is very probably also related to the "memory phenomena" noted by Kondepudi and Prigogine[304] as outside the present thermodynamics, but being worked on at the forefront in what is called "extended thermodynamics". Quoting Kondepudi and Prigogine, p. 460:

> *"...interesting memory effects ...appear for long times (as compared to characteristic relaxation times). ...nonequilibrium processes may have 'long-time tails'. In other words, the approach to equilibrium is not exponential, as was generally believed, but polynomial ...which is much slower. ... As a result, Nature has a much longer memory of irreversible processes than it was thought before. Again this shows that local equilibrium is an approximation, albeit a very good one."*

In this book, we focus primarily upon some typical anomalous measurements in China Lake experiments that are directly involved with time-charging and decay effects, lending strong support to our thesis of the novel TRZ-induced nuclear reaction chains. Note that these instrumental anomalies are also strong evidence for the association of time-charging and time-charge decay with the proven fluctuation theorem of Evans et al.

[304] Dilip Kondepudi and Ilya Prigogine, *Modern Thermodynamics: From Heat Engines to Dissipative Structures,* Wiley, Chichester, 1998, p. 459. For a discussion of extended thermodynamics, see D. Jou, *Extended Irreversible Thermodynamics,* Springer-Verlag, New York, 1996.

at the Australian National University. We believe this to be a contribution to that very important work of Evans and his colleagues.

10.7.1 Ionization Detectors, Transduction, and EM LW Interferometry

Ionization processes obviously are processes where the partial transduction of LW time interaction into 3-spatial energy interaction would yield ordinary excited energy states of the affected electrons or ions. In turn, this would lead to ionization (e.g., of the atoms and molecules of a gas, liquid, etc.) Hence, ordinary ionization detectors such as Geiger Miiller tubes have the innate *capability* of detecting such transduction that generates ionization, and thereby have some capability of serving as "detectors" of longitudinal EM wave interactions (and time-charging) ongoing in the detector. In the usual situation, no excess time-charging results and no time reversal zones result. In that case, symmetry of energy flow in the time-domain exists, as does symmetry of energy flow in 3-space. Absolutely normal chemistry and nuclear chemistry results, and the nuclear detectors function normally, as familiar to every laboratory.

However, when significant TRZs emerge and persist for short periods, the symmetry of both time-energy flow and 3-spatial energy flow is broken. In this case, transduction of time-energy into 3-spatial energy (and vice versa) can result in anomalous ionization in nuclear ionization detectors, even in the absence of normal transverse EM nuclear radiation. The trick is to use and compare different detectors and different types of detectors to clearly demonstrate anomalous ionization detection effects.

As an example, a Geiger Muller tube will detect any ionization of its internal gas, regardless of what caused that ionization. If the ionization is caused by normal ionizing radiation from nuclear reactions, the instrument will detect and read a resulting internal ionization of the gas inside the tube.

On the other hand, if time-charging and decay are involved, then the asymmetry resulting in 3-spatial energy excitation of the gas inside the Geiger Muller tube (due to transduction of some time-energy into excess 3-spatial energy) may be sufficient to ionize the gas. In that case, the instrument will read "as if nuclear radiation were present. Note that there is indeed "ionizing radiation" present in the gas. However, now this ionizing radiation is not transverse EM wave in nature, but is due to the time charging and decay, and transduction of time into 3-spatial energy in the detecting gas.

This capability of an ionization detector to ionize in the presence of non-transverse wave ionizing radiation and energy can be used to provide an indication of time-density waves being formed and interacting in a process (such as a cold fusion process) where some transduction from time-energy to 3-spatial energy occurs.

Further, the previous "time history" of the individual instrument plays a part in whether the instrument "reads" or not for a given transduction situation. There will be a statistical variation of the actual "already present" low-level time-charge (and in its internal structure and engines) between instruments, even those made in the same factory on the same day from the same batch of materials and parts. That is because the time-charging and discharging history of each instrument has been different.

The production of transduced TWs, however, must be a function of scalar interferometry in the gases or other detecting media of the instrument, since scalar interferometry *creates* all transverse EM waves, as shown by Whittaker {619} and confirmed by Evans *et al.* {620}. In such interferometry, the entire inner structures of the transverse EM waves formed in the interference zone also interact wave-to-wave. Thus, this kind of interferometry is extremely sensitive to the exact internal longitudinal EM bidirectional wave structure (internal engine substructure) of the involved potentials.

As a consequence, the ability of an ionization detector to transduce a specific set of LWs and give ionization detection will vary appreciably, including for different variations in the instrument's original manufacturing process, and even for the specific past photon interaction history and experience of the individual detector itself. One detector's set of cumulated internal time-charges (and hence spacetime engines) may vary considerably from those of a second detector of exactly the same type. In general, multiple ionization detectors are unlikely to all detect a given time-density EM wave emission and interaction set {621}.

Even for two detectors of the same brand, from the same manufacturing plant, and from the same batch of manufacture, it is likely that significant differences in LW detection of a specific TDW set will occur because of the "past history" time-charge differences of the individual detectors. Indeed, a likely phenomenon is that, when one ionization detector detects the LW emissions (transduces them), several others will not detect them at all. This is one of the peculiarities of the new unified field area that must be overcome by further research in order to develop reliable, calibrated TDW and transduction detectors. It is one of the primary problems - if not

the primary problem - of cold fusion research to resolve this *"time-charge experience history"* problem, so that transduction detectors having calibrated, uniform responses to given TDW sets and interactions can be provided.

At present, no one has the foggiest notion as to how to "calibrate" a nuclear ionization detector that one desires to use as a time-energy transduction detector. Speculating, we would envision such calibration (in the transduction detecting functional response) to become possible when small, standard, calibrated sources of transduction are developed and available. In that case it will be possible to formulate procedures whereby varying the output of the transduction source will vary the transduction irradiation of the GM tube. The level of transduction intensity required to create ionization in the instrument will be a direct indicator. When small, calibrated sources of TDWs are also available, it will be possible to irradiate the GM tube to a specifically desired rate and level of time-charge and decay. In that case, an array of GM tubes can be "standardized" or "calibrated" for transduction detection. So far as this author is aware, those developments have yet to be accomplished or even undertaken. Indeed, the need for such a development program has not even been realized.

10.7.2 Experimental "Detector Transduction Phenomena" in Electrolysis

Let us look at one set of ongoing scientific experiments where just such anomalous detector results have been obtained.

Researchers at the Naval Air Warfare Center at China Lake, and at the Department of Chemistry, University of Texas at Austin, have detected precisely the kind of "anomalous" radiation and transduction effects we expect to be in the ionization processes of multiple kinds of detectors {622}.

According to a report by Miles and Bush {623}, anomalous radiation at China Lake was first detected by the exposure of dental X-ray films in two experiments producing excess power (excess TW energy emission). Film used in a control study during these experiments showed no exposure. There was also no exposure of similar films in more than 20 experiments where no excess power was present. In other words, the presence of excess heat (excess TW energy emission) strongly indicates the presence of transduction. In turn, the presence of transduction implies the presence of scalar interferometry wave interaction, where TDW waves and LW waves **are** absorbed and **a** mix of LW and transduced TW waves are emitted consisting of gravitons (paired scalar and longitudinal photons). This only

occurs when significant time-charge excitation has built up. Taken in reverse, the presence of LW wave absorption and emission — with transduction into detected excess ionization energy — directly indicates the emission of "anomalous" TDW or graviton radiation, as detected by the resulting TW exposure of the x-ray film. So the "anomalous" radiation detections are consistent both forward and backward.

The film in manufacture is quite strongly quality-controlled. Also, it is used (interacts and indicates) only once. Its past time-charge history has minimal variations between two samples of the film, because there is no repetitious past *detection interaction* history. Hence one would expect a high degree of uniform film detection interaction responses from film to film, to the same graviton emission set. That is precisely what occurs.

We conclude that the behavior of the film in the combined China Lake experiments clearly shows the time charging, graviton emission and interaction, and transduction nature of what is happening when it is known that no normal nuclear radiation is present.

Geiger-Muller (GM) detectors and sodium iodide (NaI) detectors were also utilized when electrolysis experiments using heavy water were ongoing. We again accent that a Geiger-Muller tube does not detect nuclear radiation per se; instead, it detects *anything* that will cause its internal gas to ionize sufficiently. Sufficient transduction in graviton absorption-emission interactions in a Geiger-Muller tube will cause the counter to indicate, because it ionizes the gas and produces an ionization discharge. However, both the specific transduction and scalar interferometry aspects of the ongoing experiment are involved, as well as the previous background time-charge history of the Geiger-Muller tube counter.

Several Geiger-Muller detectors gave anomalously high readings, reaching some 73 sigmas above normal background counts. Most experiments (i.e., most GM detectors), however, gave normal radiation counts, and no anomalous count rates were ever observed when the experiments were turned off. So these anomalous results are differentiated by using multiple, carefully calibrated Geiger-Muller tube detectors. Our interpretation here is that

(i) There was a variation in the presence of transduction and scalar interferometry from experiment to experiment,

(ii) The majority of the experiments did not produce significant time-charge and sufficient transduction or scalar interferometry to cause

detection (ionization discharge) on most (typical) Geiger-Muller tubes, and

(iii) The transduction effects in the ongoing experimental process were mostly of the rapid variety, and not due to long-term "charge-up" effects conditioning the time-charge aspects and structuring of the experimental apparatuses.

(iv) By using multiple detectors, the probability of one or more of the instruments having increased time-charge from specific time-charge histories was increased.

(v) With sufficient experiments and sufficient detectors, there resulted a high probability of having at least one or more detectors capable of detecting the levels of graviton radiation and transduction expected from the experiments.

(vi) A direct correlation would be predicted — and was observed — in the appearance of the anomalous radiation effects and the expected time periods required to load the palladium with deuterium. As reported by Miles and Bush, *ibid.*:

> *"... the anomalous radiation would appear within a few hours in the co-deposition experiments where the palladium is loaded with deuterium as it deposits from solution. In contrast the appearance of anomalous radiation required days of electrolysis for the palladium rods that load much slower."*

We previously discussed the major variables indicated from many cold fusion experiments to include the strong correlation with the degree of loading of the palladium lattice. Hence the effect pointed out by Miles and Bush would indeed be predicted by the present approach and proposed mechanism.

Our interpretation is that the experiments show the time-charge rate effect to be expected in such graviton radiation and transduction interaction phenomena using collection of ions (in this case deuterium) that are much heavier than electrons. The faster the deuterium loaded, the greater the buildup of the interaction of the deuterium in phase conjugating and self-targeting iterative interactions — and therefore the greater the increase in scalar interferometry interactions — inside the palladium lattice. The rate of graviton radiation production and transduction production increases as some function (not necessarily linear!) of the rate of loading of the **deuterium.** As the rate of graviton and transduction production increases,

so does the expectation of anomalous ionization effects in the nuclear radiation detectors. And so does the rate of production of TRZs and the appearance of the new nuclear cold fusion reactions at low spatial energy but very high time-energy.

10.7.3 Experiment Confirms It

A clinching observation is given by Miles and Bush, *ibid.*, as follows:

> *"One GM-detector would measure anomalous radiation while another GM-detector would be "blind" to any anomalous effect. A few experiments, nevertheless, gave simultaneous anomalous effects from two different radiation detectors."*

Here our comment is that this precisely fits our expectations for demonstrating involvement of

(i) Time-charging and decay interactions,

(ii) Consistency with transduction expectations,

(iii) Consistency with the fact that two different radiation detectors may or may not exhibit or detect the anomalous ionization effects, depending upon the individual past time-charge histories of the two detectors, and

(iv) Predictable variations in the individual experiments (based on palladium lattice loading time, specific geometry, ionization state of the chemical solution, internal time-charge state and decay rate, and structuring of the apparatuses and their parts, etc.) when transduction-associated phenomena are considered.

The anomalous non-nuclear, non-transverse wave — but ionizing — EM radiation detected at China Lake, and the resulting peculiarities in the measurement apparatus functioning, do strongly support the present proposed approach, the proposed graviton radiation phenomena, and the time-charging and decay and transduction mechanisms presented. It is decisive that sometimes two detectors both indicated, and sometimes one indicated and the other would not. Sufficient replications have ruled out any defect in a single given instrument as the cause of the anomalous detections. That immediately eliminates from consideration all purely transverse EM wave phenomena, conditional only upon the premise that the instruments were properly functioning and calibrated, and that sufficient replications were made for decisive statistics. Those conditions

were all met in the numerous experiments producing these results over a long time and in many repetitions.

As a final thought on the subject, we pose the possibility that the longitudinal EM waves involved may be the B(3) longitudinal field waves advanced convincingly by Evans {624a-624c}. We would recommend the attention of leading theorists and experimentalists to this possibility, as a matter that should be investigated both theoretically and experimentally.

10.8 Additional Implications for the Future

10.8.1 Longitudinal EM Waves and Undistorted Progressive Waves

There is a revolution in electrodynamics presently underway, due to the unique characteristics of *longitudinal* EM waves[305] and *pseudo-longitudinal* EM waves. A summary by Rodrigues and Lu {625} is particularly revealing.

A pure longitudinal EM wave has infinite energy and infinite velocity — i.e., it appears everywhere at once. "Propagation through space" does not apply; instead, one has stumbled into that weird region where spacetime is multiply connected. In the real world, one meets imperfect longitudinal waves — or *pseudo-longitudinal* EM waves — that still retain a transverse energy density variation residue. These waves are called *undistorted progressive waves* (UPWs).

Such UPWs can move in space faster than the speed of light. This should not be too surprising, since superluminal velocity of intelligent signals has been positively demonstrated by several researchers in quantum-tunneling experiments. As an example, Nimtz {626} and his colleagues have beamed Mozart's 40th Symphony through a barrier in a waveguide at a speed of 4.7c. So the old notion that information cannot be transported at superluminal velocities is passe. The Fogal semiconductor has been used in experimental transmitter-receiver pairs to demonstrate superluminal transmission, such as TV pictures and programs. Direct signal transmission from earth to satellite back to earth and through many en route amplifiers and processors has been demonstrated by Fogal to occur far beyond the speed of light. Again, theoretical summary papers by Rodrigues *et al.* {627a-627f} are revealing.

[305] We have pointed out a direct way to generate longitudinal EM waves, by simply oscillating the magnitude of the L**orentz self-regauging** of a system.

10.8.2 Death Knell of the Speed of Light Limitation

Another giant shock has emerged in astrophysics during the last few years, and it is now threatening a dramatic revision to physics. Heretofore, it has been fashionable to assume that gravity itself propagates at light speed. A great deal of very comfortable physics theory has been built around that assumption.

Well, the assumption is not true. Experiments in astrophysics continue to refute it. It now is almost certain that the speed of gravity is at least 2×10^{10} c. A beautiful though somewhat controversial paper by Tom Van Flandern {628} summarized the entire situation. He articulates the comfortable general relativity view held to date {629} as follows:

> *"...GR proposes that such changes appear to act instantaneously in the 'near field', but eventually show their true, light-speed-delayed character in the 'far field', which is conveniently beyond our present ability to observe. The necessity of this dual behavior is to prevent the logical need for changes to continue to appear to act instantaneously at ever increasing distances, even to infinity."*

In fact, Van Flandern {630} points out that general relativity already admits superluminal effects in the near field region. He also pointed out the startling nature of the experimental results to relativists, and points out that an attachment to a paradigm has been involved:

> *"To many, this result* [astronomy's verification that gravity's speed $v_g >= 2 \times 10^{10} c$] *is so contrary to 'common sense' in the light of relativity theory as to be absurd. But Thomas Kuhn has cautioned all scientists to avoid the trap of becoming so steeped in a prevailing paradigm that it starts to seem like common sense and makes other ideas sound and feel wrong. Eventually, even one's professional status can become linked to a prevailing paradigm. "*

As Van Flandern further emphasizes, it is not difficult to show by computer calculations of astrophysical situations that any strong limit on the speed of light destroys conservation laws:

> *"...anyone with a computer and orbit computation or numerical integration software can verify the consequences of introducing a delay into gravitational interactions. The effect on computed orbits is usually*

> *disastrous because conservation of angular momentum is destroyed."*

So here we have a new paradigm in the making. This is a startling change to standard relativity. Either we have to give up the conservation of angular momentum, or we have to accept superluminal speed of gravity in the far field. Years of struggle to detect quadrupole gravitational wave radiation have failed; no direct detection has ever been made. Indeed, the rather arbitrary nature of the entire quadrupole radiation assumption is not required by general relativity, as long pointed out by leading Russian scientists. For example, Vlasov and Denisov {631} *et al.* bluntly state it in these words:

> *"...Einstein's well-known quadrupole formula, which is usually employed in general relativity for calculations, is not a consequence of general relativity and is not contained in it. "*

Therefore, it may not really be so surprising that physicists have not been able to detect such quadrupole radiation in a great many laboratory experiments. It is not in general relativity at all.

Of course, our thesis developed in this book is that what we have long called "EM radiation" is in fact gravitational radiation, always involving paired scalar and longitudinal photons and hence time-density waves and longitudinal EM waves. We have pointed out that prior to observation there is no such thing as a separate photon, but there is such a thing as two correlated photons, one time-polarized and the other longitudinally polarized. We believe that there is sufficient meat in our proposed explanation of the anomalous cold fusion results and the anomalous instrument results at China Lake to warrant serious and strenuous investigation of these hypotheses and proposed mechanisms.

Another oddity - usually never stated by Western physicists - has long been known but ignored. When Einstein characterized the gravitational field as a pseudotensorial field, and not a field in the sense of the Faraday-Maxwell field, the consequences were that the 3-space energy laws of the familiar kind really do not exist in general relativity. Shortly after Einstein published his theory of general relativity, this absence of familiar energy conservation was pointed out by Hilbert {632} in these words:

> *"I assert... that for the general theory of relativity, i.e., in the case of general invariance of the Hamiltonian function, energy equations... corresponding to the energy*

> *equations in orthogonally invariant theories do not exist at all. I could even take this circumstance as the characteristic feature of the general theory of relativity. "*

With our publication of the giant negentropy of 4-space once arbitrary 3-space symmetry and time-symmetry in EM energy flow is removed, one of the truths involved in Hilbert's remark was finally recognized. In addition, what Sen called "the most difficult problem in classical and quantum electrodynamics" {633} has been explained by giant negentropy {12}. Also, it is consistent with an appropriate reinterpretation of Whittaker's 1903 decomposition of the scalar potential {600, 615}. Finally, it is consistent with quantum field theory {634}.

Hilbert was evidently not understood by his contemporaries, since neither Einstein himself nor other physicists recognized the fact that, in general relativity, conservation laws for 3-space energy, momentum, and angular momentum — in the sense we are accustomed to in the rest of physics —in principle may be impossible. That is because one can readily remove 3-space energy symmetry when curved spacetime is permitted. Again, Russian scientists such as Logunov and Loskutov {635} have long pointed out the "unthinkable" and "astounding" fact that the predictions of general relativity are not unique.

In the West until recently relativists were conservative, and this resulted in the sidelining of innovative Western physicists who challenged the prevailing interpretation or extended it. With the experimental falsification of one of the fundamental tenets — that gravity moves at speed c in the far field — of the prevailing interpretation of general relativity, it appears that we may be approaching an asymptotic burst of great new theoretical work and a dramatic new reinterpretation. If it ever gets into production, we believe that the Fogal semiconductor will usher in that great change of communication speed paradigms that now appears imminent.

Nonetheless, general relativity — whatever the modifications and extensions now called for — will remain a very useful tool indeed. There is simply nothing else on the horizon that can replace it, string theory notwithstanding. The reinterpretation is likely to shed additional light on many present problems such as the nature of spacetime itself, the nature of dark matter, and new insight and progress on unifying physics.

In the new openness that should result, we hope that a great extension and reinterpretation of electrodynamics will also be undertaken, and that it will reveal the underlying powerful structured general relativity infolded inside conventional EM potentials, fields, and waves, as originally revealed by

Whittaker {636}. It may even be that one of the novel concepts {637} we have proposed in this book will yet see the light of day in practical systems.

If so, then hopefully much of what we are addressing in this book will be incorporated in the emerging new physics of the twenty-first century.

Chapter 11

Final Perspective: Permissible COP>1.0 Maxwellian Systems

"Are you certain of that?" [Augustine, in his famous confrontation with the Skeptics, who held that nothing can be known with certainty.]

"[It is usually]...assumed that the magnitude of potential energy is irrelevant, being arbitrary to the extent of an additive constant." [Block and Crater]. {638}

"The potentials V and A, defined ... in terms of the fields E and B, are considered to be nonobservable in Maxwellian electromagnetism, since the energy density associated with them is zero..." [Lakes]. {639}

"[The total energy of the atom] depends on the bare mass and bare charge of the electron, the mass and charge that appear in the equations of the theory before we start worrying about photon emissions and reabsorptions. But free electrons as well as electrons in atoms are always emitting and reabsorbing photons that affect the electron's mass and electric charge, and so the bare mass and charge are not the same as the measured electron mass and charge that are listed in tables of elementary particles. In fact, in order to account for the observed values (which of course are finite) of the mass and charge of the electron, the bare mass and charge must themselves be infinite. The total energy of the atom is thus the sum of two terms, both infinite: the bare energy that is infinite because it depends on the infinite bare mass and charge, and the energy shift... that is infinite because it receives contributions from virtual photons of unlimited energy." fWeinberg]. {640}

11.1 Introduction

The central message in this book is that all EM devices are already powered — though in an inappropriate fashion — by EM energy freely extracted from the seething vacuum. It is also intended to be a clarion call that we must rapidly develop the *appropriate* vacuum-energy powering of our EM circuits and electrical power systems, or else the survival of the nation and of the biosphere is at stake rather immediately.

For this summary chapter, we wish to place that specific area — EM energy from the vacuum — in sharp focus, with the major facets together in one place.

Consequently, for this closing chapter we have chosen and slightly adapted a previous technical rebuttal to the objections of "perpetual motion", "violation of the second law of thermodynamics," "impossible", etc. that we wrote in 2001 in the referee process, to the referees of one of the AIAS papers submitted to a major physics journal. The rebuttal was successful, and it was accepted and upheld by the referees. The paper was then published by the journal, after very vigorous refereeing.

That is as it should be.

Scientific journals provide a proper forum for the free expression and debate of scientific ideas and work. They do not and should not ensure that every paper conforms to commonly held concepts or to the most widely accepted model. As we stated, Chief Editor Kennedy of the journal *Science* has only recently had to restate and accent the principle that science is free from "truth by prevailing authority," and bound by "truth by replicable experiment". Insuring that every paper meets the accepted models and notions would be enforcement of religious belief, not experimental science. Ideas which are wrong will be refuted experimentally; experiment is still the basis of scientific method. In our rebuttal, the argument of the conventional skeptics is thoroughly refuted by experiments already well known in the literature, as we detail.

So we thought it appropriate to close the book with this strong statement of its primary pbjective: economical, clean, copious electrical energy from the vacuum.

11.2 Source Charges, Curved Spacetime, Efficiency, and COP

11.2.1 The Source Charge Problem

The received interpretation of the Maxwell-Heaviside theory treats the source charge and source dipole as perpetual motion machines, freely and continuously pouring out EM energy in 3-space in all directions with no energy input. Experimentally one verifies that there is no *3-space observable energy input* to the charge or dipole. In accepting that model, a scientist objecting to COP>1.0 EM systems has unwittingly hoisted himself upon his own perpetual motion machine petard, by already accepting every source charge and dipole as precisely that to which he is objecting. To explain the source charge, either one holds to the U(1) Maxwell-Heaviside theory and surrenders the conservation of energy law, or one accepts a change to U(1) electrodynamics to add the concomitant input of energy flow from the active vacuum (from the *time* domain, which in Minkowski geometry is all that is left outside 3-space) to that charge or dipole. That corresponds to a violation of the second law of thermodynamics, as — as we discussed in Chapter 10 — Evans and his colleagues at the Australian National University have already experimentally proven that the second law can be violated up to micron scale and for times of up to two seconds.[287] At the much smaller fundamental charged particle level and far shorter "switching" time of one spin completion, the probability is 100% and a certainty that the second law is violated. Hence the broken symmetry of the charged particle considered in the modem sense as a dipolarity (considering its associated **clustering** virtual charges of opposite sign).

Either way, the classical Maxwell-Heaviside theory must be changed. Every charge and every dipole — which themselves are Maxwell-Heaviside EM systems *a priori* — refutes the erroneous argument that no Maxwell-Heaviside system can output more energy than the operator himself inputs from an external power supply. To adamantly continue to challenge something already *experimentally demonstrated by* every charge and dipole in the universe is the epitomy of scientific blindness.

As have others, Sen {641} called this source charge paradox the "most **difficult"** problem in electrodynamics. However, the basis for its solution - absorption and transduction of virtual KM energy from the vacuum via

the broken symmetry of a charge or dipole in its vacuum energy exchange — has now been known in particle physics for nearly a half-century {642a-642d}. It is not included in the Maxwell-Heaviside-Lorentz theory. Neither the proven vacuum interaction with Maxwellian system nor the broken symmetry in that interaction has been added to the model.

The present author has proposed an EM wave solution {643} to the source charge problem, by reinterpreting Whittaker's {644} decomposition of the scalar potential (as between the ends of a dipole) and treating the "isolated charge" and its clustered virtual charges {645} of opposite signs as a set of composite dipoles. Each of the dipoles then becomes a broken symmetry in the energetic exchange with the vacuum. Hence the charge pours out observable EM energy with no *observable* energy input because the input energy is in virtual photon form.

In the solution, the EM energy is input to the charge or dipole from the time-domain, so conservation of EM energy flow is upheld in 4-space, while time-like symmetry and space-like symmetry are broken individually. Powerful support for the proposed solution was given in a quantum field theory argument by Mandl and Shaw {646} nearly three decades ago. We challenge any scientist skeptical of COP>1.0 Maxwellian systems to produce a solution of the source charge problem in Maxwell-Heaviside-Lorentz theory alone. In conventional theory, every charge in the universe experimentally exhibits COP = ∞. Any theory conflicting with a replicable experiment is falsified a priori.

11.2.2 EM Waves Imply Curved Spacetime

The oscillating energy of an electromagnetic wave is continuously changing its local spatial energy density. This is an *oscillating change of spacetime curvature* if one accepts general relativity (GR). Hence the EM wave in space is *always* moving in a locally curved spacetime; else, no EM wave exists because no change in spatial energy density exists. To reject that, is to reject GR in its entirety as well as all the experiments consistent with GR. If one accepts GR, then the classical U(1) EM *assumption* of the EM wave moving in a fiat spacetime is a non sequitur. It is unscientific to be suspicious of a higher group symmetry O(3) electrodynamics which *does* correct this known non sequitur in U(1) electrodynamics, while limiting oneself to U(1) electrodynamics *with* that known error. One might as well be suspicious of tensor algebra because it is more comprehensive than vector algebra.

There are many EM experiments such as the Aharonov-Bohm effect {647a, 647b} which violate Maxwell-Heaviside EM, as is well known

{648, 649a-649i}. The foundations of the Maxwell-Heaviside theory are well over a century old, and Maxwell's theory was substantially truncated in the 1880s (more on that below). The considerable physics developed since then has required dramatic extensions to the Maxwell-Heaviside theory such as developing non-Abelian gauge field EM theory, quantum electrodynamics, and modeling of the interaction of vacuum and matter in any material system.

11.2.3 On EM Systems with COP>1.0

Conservation of energy requires that all energy output by an inert system must be input to it {650}. It does not require that the *operator* input all or even any of the energy utilized. The active environment can permissibly input part or all of it, else there could be no such thing as a windmill — or a charge, or a dipole, or a solar-cell electrical power system.

The *coefficient ofperformance* (COP) of a system compares the system's useful energy or work output to the *operator's* energy input. The *efficiency* ε of a system compares its useful output to its *entire* energy input. No inert system can output more useful energy than its total input, hence $\varepsilon <= 1.0$, being $\varepsilon = 1.0$ for a theoretically lossless "perfect" system and $\varepsilon < 1.0$ for a real system with losses.

Whether the operator must input all the energy that is output by the inert system depends upon whether the system is (i) an open system in disequilibrium with its active environment, and (ii) *designed* to accept and utilize excess energy from that environment, such as from the active vacuum. If appreciable environmental energy input is received and utilized, then a system with losses may permissibly exhibit COP>1.0, even though its efficiency ε is $\varepsilon < 1.0$. The common home heat pump is an example. While the efficiency of a home heat pump may be $\varepsilon = 50\%$, its **COP** may be COP = 4.0.

As does the skeptical scientist, the electrical engineering community erroneously assumes that an inert electrical power system that outputs more energy than *one oneself* inputs to it — e.g., a generator outputting more EM energy flow than the magnitude of the mechanical energy input to the generator shaft — is against the laws of physics. To the contrary, it is permitted by the laws of physics and thermodynamics, *once the modern* ***Vacuum*** *interaction is included and disequilibrium exists in the interaction* ***between*** *vacuum and system.* Not only is it permissible, it is a universal fact once the arbitrarily discarded Heaviside energy flow component is re-ac**counted,** and the source charge problem is reluctantly placed back on the

table. If we account all that EM energy pouring freely from the source charges in any EM circuit, then the actual output of EM energy from that circuit is enormous. It is many orders of magnitude greater than the magnitude of the input energy that the experimenter or operator provides.

We do not have to reprove the active vacuum; it has long been proven in particle physics. We also do not have to reprove the disequilibrium between electromagnetic systems and the active vacuum environment; that also has been proven since 1957 by the prediction and discovery of broken symmetry. One of the proven broken symmetries is that of opposite charges, such as are on the ends of a dipole. Hence every dipole or dipolarity in electromagnetics already freely absorbs virtual photon energy from the vacuum, transduces (coherently integrates) it into observable photon energy, and re-emits observable EM photons in all directions at the speed of light. If there are no COP>1.0 Maxwellian systems, then there can be no Maxwellian charges, dipoles, or dipolarity, and therefore no resulting fields and potentials from these sources — an absurdity falsified by every standard two-wire electrical circuit and ever charge and dipole in the universe. Any potential is a dipolarity, hence exhibits broken symmetry. That is why from any finite potential, as much EM energy as desired can be intercepted and collected, by the simple equation $W = \phi q$, where W *is* the collected energy in joules, ϕ is the scalar potential intensity in joules per unit point static coulomb, and q is the intercepting charge in coulombs.

Systems far from equilibrium in their energy exchange with their active environment {651a, 651b} can permissibly perform five important functions impossible to equilibrium systems. Such a disequilibrium system can:

(1) Self-order,

(2) Self-oscillate or self-rotate,

(3) Output more energy than the operator inputs (the excess energy is freely received from the active environment),

(4) Power itself and its load (all the energy is freely received from the active environment), and

(5) Exhibit negentropy.

Any charge or dipole already exhibits all five of these functions — forbidden by classical thermodynamics but permitted by the well known

thermodynamics of systems far from equilibrium in their exchange with their active environment {651a, 651b}.

It *only takes one small white crow to prove that not all crows are black.* The known performance of the charge and the dipole totally refutes the notion that no EM system can output energy without operator-arranged input from other than the active vacuum. The entropy-consuming reactions from the fluctuation theorem, experimentally proven by Evans et al. in 2002, also is a sufficient proof to destroy any argument against permissible COP>1.0 EM systems. Since all the EM field energy and potential energy in a power system or circuit must come from the source charges and dipoles, it follows that all our EM energy systems already take *all* their E*M* energy from the active vacuum, *not* from the operator's input. A solar cell array also refutes the notion that the operator has to input the energy, but the solar cells' environmental energy input may not be ubiquitous or dependable. The active vacuum is both.

Most power system electrodynamicists avoid the particle physics solution {652} to the source-charge problem {641} involving disequilibrium exchange with the active vacuum. Instead, they adhere strictly to the Maxwell-Heaviside-Lorentz theory with its *assumed* equilibrium between system and vacuum. Therefore they avoid modeling the vacuum interaction and solving the problem of open dissipative EM systems which freely and dependably receive energy from their vacuum environment in unusable form, translate it into usable form, and furnish it for further capture and use. They therefore cannot resolve the source charge problem in their model, for the model has already artificially excluded the solution.

By definition, an EM system in equilibrium cannot output more useful energy than the operator inputs. However, considered as an *energy transducer,* every EM system is in disequilibrium with the vacuum because of the charges and dipoles in the system, and it continuously receives energy from the vacuum. Because of the broken symmetry of the charge and the dipole, some of this energy from the vacuum is discharged by every charge and every dipolarity in the circuit as observable energy *a priori.* This creates a truly enormous outpouring of rather disorganized (in this case, *uncollected)* EM energy extracted from the vacuum and poured out without being intercepted and diverged into the circuit, where it is organized for dissipation and use. The circuit "uses" only that amount of this enormous available outpouring EM energy that it first organizes (collects) and directs. That is its "organized excitation" energy, commonly known as *input energy* macroscopically — the Poynting energy flow component.

Upon completely discharging its excitation (input energy), the inert system outputs all its received (organized) energy, from whatever source. So every EM system already outputs far more energy than the experimenter inputs — when the system's *nondiverged, non-organized, and nondiverged* output energy flow is considered as well as its *diverged, organized, and collected* energy flow component. The fact that the *diverged Poynting* energy received in the external circuit enters the circuit from the surrounding space is shown by Krauss {653} (See Figure 1-1 in Chapter 1). We show it in Figure 2-4 of Chapter 2 as well. The remaining and nondiverged Heaviside energy flow component in space, which misses the circuit and is wasted, is also shown in Figure 2-4 of Chapter 2 and contrasted to the diverged (caught) Poynting component. To understand this experimentally demonstrable fact {653}, we need a bit of EM history.

11.3 Truncations of Maxwell's Theory and Discard of System Classes

11.3.1 Concept of EM Energy Flow Through 3-Space

The concept of the connection of EM energy and space did not occur until 1876 in a faulty work by Croll {654}. In the 1880s Heaviside {655} showed the huge nondiverged component filling all space around a circuit (see Figure 2-4 in Chapter 2). Poynting {656} never even considered the external nondiverged flow missing the circuit, but assumed only the *diverged* energy flow component that enters the circuit. Figure 2-4 in Chapter 2 shows both components of EM energy flow laterally, so they can be seen clearly.

It is stressed that the Heaviside nondiverged component of EM energy flow around every circuit is far greater (by many orders of magnitude) than the circuit's intercepted, diverged, and collected Poynting energy flow component. This follows from Heaviside's own original papers. So when the entire output energy flow is considered, every generator and every battery is already a $COP \gg 1.0$ *energy transducer,* outputting far more energy flow than the rate at which mechanical energy is input to the generator shaft or the rate at which chemical energy is dissipated in the battery.

In the 1880s the electron, atom, nucleus, special and general relativity, quantum mechanics, quantum electrodynamics, and active vacuum had not been discovered. There was no knowledge of any possible active vacuum interaction source for such an enormous energy flow pouring from the terminals of the generator or battery and surrounding the circuit, filling all

space around it. Heaviside's extra energy flow component was thus shocking and inexplicable, smacking of "perpetual motion" and total violation of the conservation of energy law. Heaviside — a brilliant, self-taught hermit who never attended university - spoke cautiously and obliquely of its magnitude in terms of angles with respect to a reference direction {657}.

11.3.2 Elimination of the Non-Intercepted Energy Flow Component
A perplexed and concerned Lorentz {658} cut the Gordian knot and arbitrarily *discarded* the Heaviside nondiverged component, eliminating the quandary. Lorentz stated that the huge nondiverged component had "no physical significance" (his phrase) since it powered nothing. Of course it **has** no physical significance, and powers nothing, unless one intercepts it and uses it!

By analogy, the component of a great wind on the ocean that is *outside* the intercepting sails of a single sailing ship, does not contribute to further powering *of that ship.* Figure 2-5 in Chapter 2 shows that situation. However, that nondiverged wind component can power a whole flotilla of ***additional,*** *separate* sailing ships with separate sails, as we showed in Figure 2-6 in Chapter 2. Electrodynamicists {659} have continued to utilize Lorentz' clever integration trick (Figure 2-3 in Chapter 2) to dispose of the huge nondiverged Heaviside energy flow component surrounding **every** circuit and missing it, and therefore pouring from the terminals of every generator. Most electrical engineers today do not realize that the original purpose of Lorentz's integration of the energy flow vector around a closed surface assumed surrounding every volume element of interest was merely to get rid of that perplexing and bothersome Heaviside nondiverged energy flow component while retaining the Poynting diverged energy flow component.

11.3.3 Lorentz's Previous Discard of all COP>1.0 Maxwellian Systems
Previously (circa 1890s) Lorentz had symmetrically regauged Heaviside's **equations** that had already seriously curtailed Maxwell's seminal equations of 1865. This Lorentz symmetrical regauging retained only that class of EM systems that are in equilibrium in their seething energy exchange with their active vacuum environment. It discarded that entire permissible class of the Maxwell-Heaviside systems far from equilibrium with the active vacuum. In short, it *arbitrarily* discarded all COP>1.0 Maxwellian **systems,** and all those even *permitted* to exhibit COP>1.0.

The ubiquitous use of closed current loop circuits containing both the ex**ternal** circuit and the source dipole inside the generator forcibly applied

(and continues to forcibly apply) the Lorentz symmetrical regauging. Thus all electrical engineers began using circuits which self-enforced equilibrium in the vacuum exchange, so that no *net usable* energy[306] that could translate electrons and do work in an external load —could be received from that source.

However, so long as the enormous Heaviside nondiverged energy flow component outside the circuit remained, then separate outrigger antenna circuits and systems could always be inserted in this external energy flow to divert some of it into separate additional circuits. This would have opened up the COP>1.0 *ensemble* of systems and separate outrigger receiver circuits (with separate loads) fed by a single central generator, such as one version of the motionless electromagnetic generator of Chapter 7.

Consequently Lorentz integrated the entire energy flow vector around a closed surface assumed around any volume element of interest {658}, as shown in Figure 2-3. This integration trick — still universally applied {659a-659c} in all the texts today — arbitrarily discarded that troublesome and massive Heaviside energy flow component that could not be explained, and for which no source was known.

[306] Lorentz symmetrical regauging does indeed require that the system receive excess energy from the environment (the active vacuum). It requires that the potential energy of the system is changed twice and continuously, which means the excess energy in each of those two changes must continuously enter from the active vacuum and do internal work on the system. Two new free force fields are created, each with its field energy, which is additional energy being continuously dissipated in the circuit to perform continuous work. However, the two free changes of energy in the system have been precisely selected so that these two force fields are equal and opposite. The two free changes of energy thus produce a *stress potential* without a net translation field. This means that the local spacetime has been curved, in a manner representing a rotation of the system frame away from the lab observer's frame. Further, the stress potential represents the continuous entry of extra stress energy from the vacuum, whose two force fields continually perform opposing local *internal work* within the system to stress it, while unable to translate electrons and power external loads. Contrary to the received view, the Lorentz-regauged Maxwell-Heaviside system is a dramatically altered and different system than the original system before the arbitrary application of the Lorentz condition. The system's inertial frame has been rotated, it has taken on extra energy from the vacuum that can only be used to do internal work upon the system, and that internal work on the system is continuously being done to increase the system's stress and hold it at the new level.

11.3.4 The Heart-Breaking Result of Lorentz's Actions

The combination of these two actions by Lorentz — symmetrical regauging of the model equations and discarding the excess Heaviside nondiverged energy flow component — unwittingly resulted in the design and building of only those electrical power systems which symmetrically and automatically regauge their discharge of their excitation energy. The symmetrical regauging is self-applied by the closed current loop circuit. That circuit uses half of its collected Poynting energy to destroy the source clipole in the generator, and the other half to power the loads and losses in the external circuit {660}. Conventional EM systems are unintentionally designed to destroy their own source dipoles — and their free extraction of organized EM energy from the vacuum — faster than they power their loads.

11.3.5 Agreement with Classical Equilibrium Thermodynamics

These curtailments of Maxwell's theory resulted in the exclusive building of equilibrium EM systems. These systems obviously obey the classical equilibrium thermodynamics with its infamous second law. Lorentz had unwittingly discarded all that entire class of Maxwellian systems in disequilibrium in their exchange with their active vacuum environment; in those days, there was nothing known about an "active vacuum environment" or broken symmetry in its virtual energy flux. Consequently, Lorentz had discarded all those Maxwellian systems that *do not* obey classical equilibrium thermodynamics, but do obey the newer thermodynamics of systems far from thermodynamic equilibrium with their active environment. He discarded all permissible COP>1.0 Maxwellian systems.

However, there was a total agreement between all the EM systems actually built using Lorentz's symmetrized equations and all measurements in their ubiquitous closed current loop circuits — all self-enforcing the Lorentz condition. This led to the iron dogma that all EM systems must inevitably comply with classical equilibrium thermodynamics — the circuits that were built *were* repeatedly and universally observed to do so!

11.3.6 Dogma that COP>1.0 EM Systems are Perpetual Motion Machines

Finally, this total agreement (now for more than a century) between the theoretical model used, the circuits actually built, the measurements performed, and classical equilibrium thermodynamics led to the present fallacious but iron dogma that EM circuits and power systems cannot output more energy than we ourselves input. Today the vast majority of scientists consider it absolutely proven that the laws of nature prohibit

COP>1.0 electrical power systems, and particularly prohibit self-powering systems that freely power themselves and their loads (i.e., EM systems analogous to "windmills in a free wind"). As we stated, every charge and dipole falsifies the "COP>1.0 EM systems are impossible" dogma, as does the fluctuation theorem and its experimental proof by Evans et al.

Sadly, no one seems to have realized that we do not presently have COP>1.0 electrical power systems only because engineers have specifically designed and built their EM systems to destroy their own source dipole faster than they power their load. Ironically, every circuit and every power system used and measured by our engineers already outputs far more EM energy than is input by the operator or by turning the shaft of the generator, if the Heaviside nondiverged energy flow component is re-accounted. The Bohren experiment clearly proves it experimentally {662}, along with thousands of other similar experiments in "negative resonance absorption of the medium" {157a-157d).

11.4 Examples of COP>1.0 Electromagnetic Systems

The motionless electromagnetic generator (MEG) {661} (Figure 11-1) does catch and use some of this available free energy, as explained below. So does the familiar Bohren experiment {662a, 662b} by resonating each intercepting charge so it sweeps out an increased geometrical reaction cross section in space, reaching past the usual Poynting interception cross section (for a static charge) and thereby absorbing additional energy from the otherwise non-intercepted Heaviside energy flow component.

Every charge and dipole in the universe also already acts as an electrical "windmill in a free wind," having a COP = ∞.

The present author has also nominated the long-neglected but vast nondiverged Heaviside EM energy flow, accompanying every field and charge interaction, as the long-missing source of some 90% of the gravity holding the arms of the spiral galaxies intact {663}. Our *supersystem* examination of several COP>1.0 EM systems developed by various inventors has also uncovered a proposed solution for the source of the distant antigravity accelerating the expansion of the universe {664}.

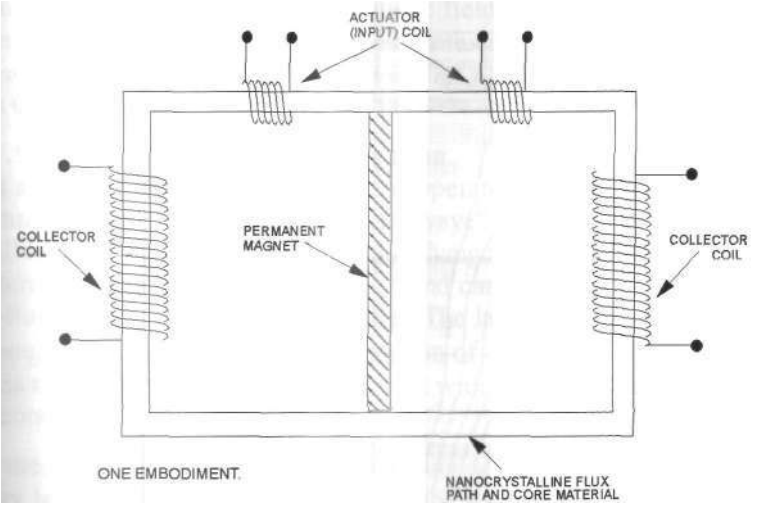

Figurei 11-1. Transformer section of the MEG.

Experimental proof that EM energy COP>1.0 is both possible and demonstrated is already in the literature — e.g., as in the Bohren experiment {662} which outputs 18 times as much energy as one inputs (see Figure 11-2). As another experimental example, the Aharonov-Bohm (AB) effect {647, 665, 666} freely adds additional nonlocalized field-free A-potential energy while all the magnetic B-field energy is sharply localized but still present and available. The AB effect is routinely implicated in physics, but apparently was never applied in an electrical power system prior to its use in the motionless electromagnetic generator

Bohren's experiment {662} was quickly and independently replicated by Paul and Fischer {667}. It can be replicated by any university laboratory at will, totally negating the conventional COP < 0 assumption. The AB effect is also easily replicated, using a toroidal coil, a long solenoid, or a permanent magnet and the special cores used in the MEG. When the toroid system's *total available output energy flow* is measured and accounted — including both the confined magnetic field energy flowing inside the toroidal windings and the field-free A-potential flowing outside — the toroidal coil system outputs more energy flow than the operator furnishes from his external power supply by conventional accounting {668}.

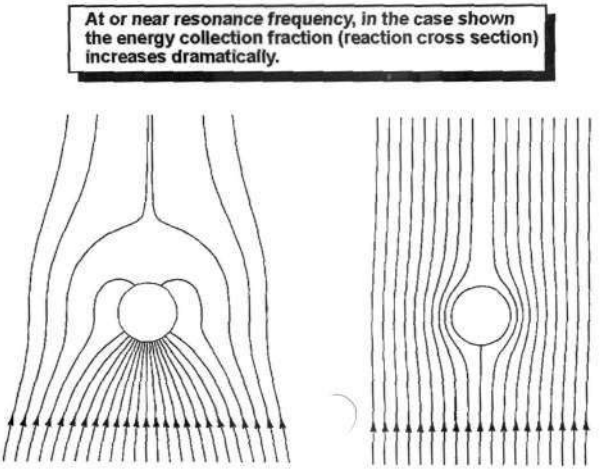

Figure 11-2 The Bohren experiment outputs 18 times as much energy as one inputs

In conventional terms, for a theoretically perfect toroid the operator only "pays for" the magnetic field energy "output component" confined inside the toroidal windings. The presence of an extra energy output component outside the toroid produces COP>1.0 performance as *an energy transducer*. It *does not* produce system COP>1.0 performance in a closed-loop circuit containing the primary power supply's source dipole.

The AIAS has previously nominated more than a dozen mechanisms as promising COP>1.0 systems for investigation, research, and development {669}.

11.5 Motionless Electromagnetic Generator (MEG)

11.5.1 Overall Description

In the MEG {661} (Figure 11-1), one uses a nanocrystalline material core path with the unique characteristic of drawing in almost all the magnetic field energy of an emplaced permanent magnet. The B-field flux from the magnet is withdrawn from its normal position in surrounding space and sharply confined to that material core path. Around the core there freely appears an *additional* curl-free magnetic vector potential A energy flow, since the surrounding spacetime is still curved due to the interaction exchange of vacuum and magnet dipole, and therefore still contains extra energy. The operator inputs no energy whatsoever after the magnet is once

emplaced, yet has appreciable magnetic field energy and field-free magnetic vector potential energy available to utilize. As an *energy transducer*, the MEG has a COP»1.0. As a power system powering loads, its COP>1.0.

11.5.2 An Example of MEG Operation

As a replicable example, suppose one operates the MEG core at less than saturation, and places a small "square wave" pulsed signal upon a primary coil wound around the core. The core changes its permeability as the internal magnetic B-flux is perturbed and changes, so all the perturbed B-flux is retained in the core material. The large E-fields produced by the changing B-flux in the core as a function of $-\partial \mathbf{B}/\partial t$ are *not* localized, but pass readily out of the core and interact with the coils, particularly with the secondary.

In the A-potential region in the space outside the core, one also produces very large E-fields by $\mathbf{E} = -\partial \mathbf{A}/\partial t$. At the frequencies being used (40 to 80 kHz nominally), all these E-fields produced by the core flux perturbations and by the external A-potential perturbations are essentially in phase. The large E-fields thus coherently add and interact directly with the secondary coil acting as a receiver.

In the secondary, the very large and sharply changing E-fields interacting with the coils also produces large B-field flux changes in the core. However, again the core changes its permeability and holds-in all the extra B-flux. The changes in that secondary B-flux also make additional non-localized E-fields, and so on.

The surprising and shocking result is that the transformer secondary undergoes a coherent, purely E-field reaction with the electrons in its coils. This results in the output voltage and current being in phase (within 2°, since there are inevitably some small remaining inductance effects due to a tiny bit of external B-field leakage from the junctures of the ends of the permanent magnet with the core material).

The magnitude of the powerful E-fields produced by these processes — and interacting with the secondary coils — depends on the rise and decay times of the input signal's pulse edges. So the *average* power input to the signal coil may be small, but — using sharp rise and decay times of the input pulses — very large E-fields will be produced in the adjacent surrounding space outside the transformer section and interacting with the secondary coils, as well as in the sharply changing B-flux localized in the core.

One then uses transmission-reception theory and near-field antenna theory for separate receiving circuits containing loads, added in the large E-field region in space outside the core. Those E-fields arise from both the changing A-potential outside the core and the changing localized flux inside the core. We stress again that the E-fields produced in the core are not localized, but pass outward into the external space to interact with whatever interceptor/receivers are placed out there.

A "outrigger array" version of the MEG uses separate external receiving circuits, containing loads, to intercept, collect, and use more of the EM energy available in the surrounding space outside the core.

Within physical space limits, the energy intercepted and utilized by these *separate, independent receiving circuits containing loads* can be increased by adding more receiving circuits with loads or adjusting the rise and decay time of the input pulses to provide greater collected voltage. These *separate* loads will be powered by the incident E-fields' interception in the external receiving circuits. This is not at all a *transformer* action, but a *near-field transmission and separated multiple antenna circuits' reception* action.

There is no back-current coupling between the external circuits and loads with the primary circuit of the transformer section. In the external A-potential region alone, the secondary coil in the transformer section will interact with the large incident E-fields from that adjacent space and from the changing B-flux inside the core, producing at least as much energy as one inputs to the primary. Actually, that process alone will produce more output energy in the secondary than the operator inputs in the primary.

If one operates the core below saturation, the magnetic flux in the core will also be switched, giving additional intercepted E-field energy in the secondary coil attached to its load. The total work out in all loads is permissibly greater than the total energy dissipated in the input by the operator's energy input {668}. The MEG is an open system far from equilibrium with the active vacuum {670}.

11.5.3 The MEG Is Replicable

Any university laboratory can replicate this effect, and demonstrate more work in resistive loads than is input to the MEG primary from the external power supply. For replication, we suggest initially designing to COP = 1.5, since beginning at COP = 2.0 there *can* be other effects not in the U(1) EM literature, but which are dealt with in the actual MEG. Some of the methodology {671} used for COP >2.0 is still proprietary information not

yet releasable due to patent law requirements, while some of it was included in Chapter 7.

Without elaboration we advance the *supersystem* concept, and strongly insist that, to properly analyze the performance of any similar EM circuit or system, one must analyze the dynamics of the entire supersystem consisting of (i) the physical system and its dynamics, (ii) the curved local spacetime and its dynamics, and (iii) the local vacuum and its dynamics {672}. All three components of the supersystem are mutually interacting.

For a COP>1.0 system, the mutual interactions are utilized from disequilibrium processes evoked between all three supersystem components. U(l) electrodynamic analysis system in an inert vacuum and a flat spacetime is insufficient. Previous AIAS analysis {661} has addressed the supersystem by use of higher O(3) symmetry electrodynamics to include vacuum dynamics (energy currents, both space-like and time-like) and curved spacetime dynamics.

11.6 Physical Considerations of Gauge Freedom

Additional physical considerations must be accounted when *gauge freedom* is invoked or utilized with respect to physical systems. Applied to electrodynamics systems, gauge freedom assumes the ability to freely change any potential of the system being studied. From the physics of the situation, a system potential change concomitantiy assumes changing the *potential energy of the system itself for* which gauge freedom changes are being theoretically applied to system-descriptive equations.

If one *can freely increase* the potential energy of an EM system, the extra energy has to come from a physical asymmetry of the system with its active environment — the active vacuum. Else, one must surrender the conservation of energy law. At worst, gauge freedom would then imply the creation and destruction of energy at will. At best, it would imply a return to the view that potentials are mere mathematical conveniences with no physical reality — a notion falsified for decades by the AB effect {647}. ***freely*** *decreasing* the potential energy of the system by simply depotentializing it, has a similar vacuum asymmetry requirement for de-excitation of the system, where energy must flow from the system to the vacuum.

11.7 Special Modeling of the Vacuum

Having EM energy density, the vacuum *is and should be modeled as* a scalar potential of great magnititude. For deeper (supersystem) analysis, one will also have to examine the internal EM longitudinal phase conjugate wavepair structure and dynamics of the scalar potential vacuum {672}, along the lines shown by Whittaker {644} in 1903 and re-interpreted by the present author {643} in 2000. From quantum field theory arguments, Mandl and Shaw {646} give strong support to the proposed reinterpretation. They argue that neither the scalar (time-polarized) photon , nor the longitudinal photon is independently observable, but the combination of the two is observable as the instantaneous scalar potential.

Transforming this argument to EM waves yields a solution consistent with the reinterpretation {643}. The result is that all 3-space EM energy comes from the time-domain, in a manner not previously utilized in EM circuit analysis. It is experimentally established by proving (measuring) that the source charge and dipole do not *receive ob*servable EM energy in 3-space, but continuously *output* observable EM energy in 3-space. Simply making and destroying dipoles in an electrical system turns out to be a method for direct engineering of negentropy and entropy respectively — or, from another viewpoint, it directly engineers regauging.

The greatest unrecognized problem in conventional electrical power system engineering is its total failure to include the making and destroying of dipoles as direct engineering of negentropy and entropy respectively.

Every EM potential in an EM system is a change to the energy density of the ambient vacuum potential — and thus is a spacetime curvature — or it is a change to an intermediate potential that *is* such a vacuum potential change. Vacuum exchange with every EM system and asymmetry in that exchange, is ubiquitous and cannot be prevented. Whenever one makes or changes an EM potential, field or wave, and whenever one regauges, one invokes and utilizes asymmetry in the interaction of the active vacuum and the system, either wittingly or unwittingly. Else one must discard the conservation of energy law altogether. There is no symmetry of a mass system alone {673}, without including the vacuum's asymmetrical interaction with it. The reason is simple: all observables involve asymmetry {674} *a priori*, and mass is an observable.

11.8 Every Charge and Dipole in an EM System Receives and Transduces Vacuum Energy

In particle physics, every dipole — and every charge considered with its associated clustering virtual charges of opposite sign — is recognized as an asymmetry in the vacuum flux {675}. The very definition of broken symmetry means that a charge or dipole receives and absorbs virtual photon energy from the vacuum, transduces it into observable form, and re-radiates it as real, observable EM energy. This results in an observable outpouring of 3-energy from the charge or dipole, with no observable 3-energy input.

To save the conservation of energy law for physical EM systems, one must therefore recognize and model the *physical vacuum asymmetry mechanism* **that** allows this demonstrated performance of charge and dipole. In electrical power systems, that required asymmetry mechanism is the known broken symmetry of the vacuum's interaction with the source dipole created in the generator.

11.9 Energy from the Vacuum Powers Every Electrical Power Line and EM Circuit

11.9.1 What the Generator Powers and What Powers the Circuit

Shaft power input to a conventional generator allows the generator to pr**oduce** its source dipole, nothing else. The generator does not transduce any of its input shaft mechanical energy to add EM energy to the external circuit connected to its terminals. Instead, it first transduces its mechanical shaft energy input into internal magnetic field energy.

Then it totally dissipates that magnetic energy to separate its own internal c**harges,** forcing the positive charges in one direction and the negative charges in the other, making the source dipole connected to its terminals. That is all that the mechanical shaft power input to a generator does — and **that** is all that burning hydrocarbons, consuming nuclear fuel rods, **damming** rivers for power stations, putting up windmill-powered g**enerators,** using solar energy input to solar cells, or consuming chemical energy in a battery accomplishes.

O*nce made*, the source dipole — via its broken symmetry in its vacuum exchange - freely receives and absorbs enormous virtual photon energy **from** the active vacuum, transduces it into observable (3-space) form, and pours out real, observable EM energy in 3-space from the generator terminals to which it is connected. As shown in Figure 1-1 of Chapter 1,

this outpouring of EM energy from the generator terminals fills all space around the external circuit {653} with a vast energy flow almost parallel to the conductors. Figure 2-4 is a lateral view so that the two flow components can be clearly seen and compared.

11.9.2 Gedanken Experiment

We advance a gedanken experiment to illustrate. Consider a perfect generator with no losses, and with two perfect conductors and a purely resistive load R_1 connected across its terminals. Call the mechanical energy input to the shaft of the generator W_{in}. Call the Poynting diverged energy flow component W_r that is intercepted by the attached circuit and powers R_1. Call the Heaviside nondiverged energy flow component W_h that misses the circuit and is wasted. As an *energy transducer,* the total energy output W_{out} from the terminals of the generator is

$$W_{out} = W_r + W_h \qquad [1]$$

However, $W_{in} = W_r$, for this theoretically perfect system. So

$$W_{out} = W_{in} + W_h \Rightarrow W_{out} > W_{in} \qquad [2]$$

Further, when accounted, $W_h >> W_{in}$, so

$$W_{out} >> W_{in} \qquad [3]$$

We conclude that all EM systems — *as energy transducers freely extracting and transducing EM energy from the active vacuum*— already exhibit COP » 1.0. However, for *useful work* in a closed current loop circuit, the COP = 1.0, unless additional antenna-receiver circuits or another scheme such as Bohren charge resonance is used to increase the energy collected and dissipated in the load while *not* increasing the energy used to dissipate the source dipole.

11.10 Significant Developments in Negative Resistance

True negative resistance (e.g., current moving against the voltage) also exists and is experimentally replicable. In true negative resistance, the current in a circuit moves against the voltage instead of with it, suggesting time-reversal effects in the mechanism by which EM force and charge interact.

11.10.1 Chung's Negative Resistor and Naudin's Replication

Chung {676} has reported replicable negative resistance in the interfaces between layers of carbon fibers in a composite material. By varying the

pressure used when the fibers are made, the resistance can be controlled to later be negative or positive as desired. A simpler version of Chung's negative resistor using off-the-shelf materials has been successfully replicated and tested by Naudin {677}. (See Figure 11-3). Naudin's website {677} provides measurements and full details necessary for repetition. He also includes sources of the carbon fiber materials needed lor independent replication.

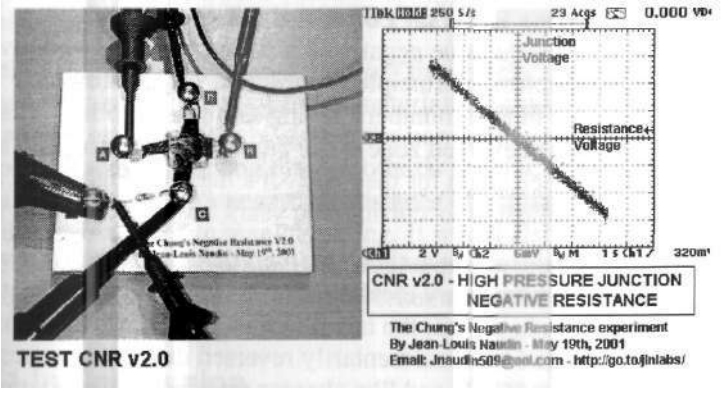

Figure 11-3 Naudin's replication of Chung's negative resistor.

11.10.2 The Point Contact Transistor

There is also evidence that the original point contact transistor — which used spring pressure on the point contact — often exhibited true negative resistance. Certainly this transistor was never adequately understood {678}, and it is not understood today, since its supersystem has never been analyzed.

11.10.3 Kron's Negative Resistor

Gabriel Kron, early pioneer in electrical systems theory, reported developing a negative resistor in the 1930s, on the U.S. Navy's Network Anayzer project {679} at Stanford University. He was not permitted to reveal the details of his negative resistor, but did provide strong hints in certain statements in his papers in the literature {680a, 680b}. His method for a self-organizing network depended on his "open path" {681} which he also was not permitted to reveal.

The present author worked for some years with Floyd Sweet, a Kron protege", who did produce a successful type of powerful negative resistance system {682} known as the vacuum triode amplifier, apparently based on Kron's original negative resistor. Sec Figures 6-5 to 6-13 in Chapter 6. As

shown in Figure 6-6, Sweet induced self-oscillation in barium ferrite magnets {683a-683c} (which are made by powder metallurgy methods using pressure applied during their manufacture) and extracted energy by induction from the resulting self-sustained magnetic field oscillations. His device was independently tested by Walter Rosenthal {684}, a senior test engineer of long experience with a major aerospace company. See Figure 6-9 and Figure 6-13.

11.10.4 Proposed Time Reversal Zones and Effects

One may take the view that true negative resistance involves time-reversal, which by the Pauli exclusion principle is permitted for bosons {685} and possibly for fermions in even numbers, acting as quasi-bosons (perhaps only possible in a time-reversed zone). The present author proposed a photon interaction mechanism for the "flow of a mass through time" in 1971, with initial publication occurring two years later {686}.

Extending this mechanism, the author proposed that *time reversal zones* (TRZs) can occur in momentary local regions in semiconducting materials or electrolytes {687}. In a TRZ, the law of attraction and repulsion of charges is hypothesized to be momentarily reversed due to time-stress or time-domain pumping {688}, and like charges may momentarily attract. In Chapter 10, we used these time-reversal zones to explain the anomalous results of the 600 or so successful cold fusion experiments worldwide. We also gave the exact new nuclear reactions for the production of anomalous deuterium, tritium, and alpha particles in many of these experiments.

When under strong stress, anomalous attraction of clusters of like charges is experimentally known, e.g. in Shoulders' {689} experiments and patented processes {690}. When the output leads of Sweet's vacuum triode amplifier device were suddenly shorted, extreme cooling occurred rather than heating. Ice condensed instantly upon the shorting contact and leads from the sudden extreme cooling of the metal in the moisture in the air, dramatically showing a converging EM energy process rather than a diverging one.

11.10.5 Effects in Optically Active Semiconducting Materials

In addition, four-wave-mixing, phase conjugation, and time-reversal effects are well known in semiconducting materials {691}, almost all of which are optically active. Optical activity and microlasing is known in semiconductor powder {692}. Further, the vacuum itself can exhibit semiconducting properties {693}.

11.I0.6 Special Functions Produced by Stress

Apparently pressure (stress) in many of these devices and experiments can play an important role in the negative resistance process. Based on harmonic sets of paired couplings of a longitudinal time-like wave and a longitudinal wave in any scalar potential {643}, the present author hypothesizes that such stress — treated as a stress scalar potential — accomplishes time-domain pumping in the optical sense, due to the presence of the coupled time-polarized longitudinal waves in the time domain.

This time pumping is a special form of "time stress". Thus in optically pumped or stressed optically active materials (including electrolytes), the time-stress creates a TRZ, reversing the normal force laws upon and between charges. Assuming this hypothesis is valid, this could account for the variation of Chung's negative resistance effect with the variation of the pressure (stress) used in manufacturing. It would also apply to the laser-created stress in semiconducting powder experiments, etc. The hypothesis should be further investigated for experimental validation or refutation.

11.11 In Conclusion

As Penrose {694} states,

> *"Electromagnetism is a subject that is in no way closed to stimulating new developments."*

Indeed, electrodynamics is still very much an advancing subject, and in classical electrodynamics there are foundations errors and problems, a few of which we have addressed. As Bunge {695} pointed out more than three decades ago,

> *"...it is not usually acknowledged that electrodynamics, both classical and quantal, are in a sad state."*

From a foundations viewpoint, Einstein {696} beautifully summed it up — and advanced a requirement for continually examining the foundations of electrodynamics and every other field of physics — in these words:

> *"..the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses this conceptual material, or, speaking more exactly, these conceptual tools* ***of thought,*** *as something obviously, immutably*

given; something having an objective value oftruth which is hardly even, and in any case not seriously, to be doubted. ...in the interests of science it is necessary over and over again to engage in the critique ofthese fundamental concepts, in order that we may not unconsciously be ruled by them."

Though they have long been neglected, legitimate COP>1.0 electrical systems are good science, or they can be. They were present in the original Heaviside truncation of Maxwell's theory prior to Lorentz's symmetrical regauging. That regauging arbitrarily selected only those Maxwellian systems in equilibrium in their exchange with the active vacuum. The energy flow theory was further curtailed by Lorentz's integration trick, which discarded the huge vacuum-furnished non-intercepted Heaviside energy flow component accompanying every EM system. Every EM system already outputs for more EM energy flow than the energy that the operator inputs; thus every EM system is already a COP»1.0 system, with respect to *energy transduction.* The only way this giant negentropy of every EM system can be hidden is to ubiquitously continue that integration trick to discard the giant Heaviside energy flow component.

The present Lorentz-regauged Maxwell-Heaviside equations are not consistent with *any* bipolar EM system or circuit. The ends of any dipolarity in the universe — including any electron on Jupiter and any positron in the star Sirius — constitutes a broken symmetry in the seething vacuum flux. Actually, that is what Gabriel Kron discovered and called his "open path". Hence, that "dipole" continuously emits observable EM energy extracted from the vacuum.

Engineering use of the ubiquitous closed current loop to contain both the primary source dipole and the load — which destroys the source dipole and extraction of vacuum energy faster than the load is powered — is responsible for the successful predictions of the equilibrium EM model (which of course completely fails to explain the source charge or source dipole). That circuit is unwittingly designed to self-enforce the Lorentz symmetry condition and therefore self-enforce those predictions.

The question as to whether COP>1.0 electrical power systems are possible *and practical* must be resolved by direct experiment, and not by established models and cherished concepts that already arbitrarily exclude such systems! Such theoretical refutation by models that in fact contradict the experimentally observed COP = oo action of every charge in the universe, cannot be trusted at all with respect to COP> 1.0 judgment. Well-

known supporting and confirming experiments already in the literature — such as the Bohren experiment yielding COP =18 — have been cited, and these are replicable by any university laboratory. The Bohren-type experiment is well known and routinely performed in every nonlinear optics laboratory, under the guise of "negative resonance absorption of the medium".

It is indeed a critical time to re-examine the foundations of our electrical power science and engineering, along the lines so eloquently stated by Albert Einstein. With the impending oil crisis, we face a world economic crisis of epic proportions unless we rapidly develop and widely deploy sell-powering disequilibrium electrical power systems.

Also it is a critical time when the leaders of the scientific community — specifically the National Academy of Sciences, the National Science Foundation, the great national laboratories, and the universities — must at last face and correct the excruciating *faux pas* that has now been perpetuated in electrodynamic theory for more than a century. In short, the leaders of our scientific community must now show whether they are scientists practicing and upholding experimental basis, or are dogmatists defending an ancient faith. The fact that the source charge problem continues to be propagated in electrodynamics 45 years after the award of the Nobel Prize to Lee and Yang, is no longer excusable.

A thorough review and correction of the foundations of EM theory is required for the survival of this nation and much of civilization. It is also required for the cleanup of the increasingly polluted biosphere, survival of the threatened species of the Earth, reduction of present global warming trends, and the survival of this fragile and beautiful planet itself.

Annotated Glossary of Selected Terms

action at a distance: An action (effect) occurring in a local system, for which no separate local 3-space cause exists, but for which a causal correlation exists between a distant action and the local effect.

advanced electromagnetic field: An electromagnetic field that is a solution of the classical Maxwell equations, which is positioned on the future light-cone of spacetime. It may be possible to involve such a field in the tempic force that may exist between the tempic potential at the output of an overunity system and the tempic potential that exists at the input of the system, where the interaction of the tempic force with the local nonlinear vacuum drives Dirac sea hole current from output section to input section.

advanced electromagnetic potential: An electromagnetic potential that is a solution of the classical Maxwell equations, and is positioned on the future light-cone of spacetime. Presently this potential has not yet been given a physical interpretation. It may be possible to involve its effects in a specific system by our notion and use of the instantaneous tempic potential difference (the tempic force) that may exist between the tempic potential at the output of a system and the tempic potential at the input of that system if the two differ.

advanced electromagnetic wave: An electromagnetic wave that is a solution of the classical Maxwell equations, and which is positioned on the future light-cone of spacetime.

Aharonov, Yakir: Renowned Israeli quantum physicist and former student of David Bohm. Co-discoverer of the Aharonov-Bohm effect. Together with Bohm, Aharonov authored a fundamental paper in 1959 that pointed out the *primary importance of the potentials* rather than the force fields. The force fields are only made in and of the charged particle system itself, and do not exist as such in the vacuum. The force fields are thus not primary electromagnetic causes at all, but are *effects* due to the interference of potentials in a particular charged particle system.

Aharonov-Bohm effect: Quantum mechanical phenomenon theoretically pointed out in 1959 by Yakir Aharonov and David Bohm whereby interfering electromagnetic potentials can produce effects on charged particle systems, even at a distance and in the absence of the

electromagnetic force fields. A system undergoing a cyclic evolution from an initial state back to it will acquire a phase difference, which can be detected by interfering the initial and final states. Theory was extended later to Berry phase, then again to geometric phase.

In classical EM terms, a more important *energy-amplifying* principle - advanced by the present author — emerges from the AB effect. My colleagues and I have used this principle in our motionless electromagnetic generator (MEG) to provide COP>1.0. Consider a source of magnetic field B, such as a permanent magnet. All the magnetic field energy B from the permanent magnet may be drawn into and confined in a local material path, as in a special nanocrystalline transformer core. Then in the space surrounding the localized magnetic field energy, the active vacuum will freely replenish — via the broken symmetry of the permanent magnet dipole in its exchange with the vacuum — the magnetic energy in that space that would otherwise have been filled with magnetic field B (curled magnetic vector potential A). However, nature replenishes the energy in space outside the B-localization region with the *curl-free* magnetic vector potential A. In this fashion a system designer may cause the active vacuum to provide more available magnetic energy from the permanent magnet that normal, with each of the two energy forms being in separate spatial regions and paths, and occurring in different forms of magnetic vector potential energy. By inputting only a little energy in the input coils of the transformer section, and controlling the rise time and decay time of the pulses, one can produce very large E-fields from the A-potential via $E = -dA/dt$. From the simultaneously perturbed confined B-field flux in the core, one also produces E-field simultaneously and — at the frequencies used — in phase with the E-fields produced outside the core. The net result is interaction of large E-fields with the output coil, producing an output power *proportional to the rate of change* of the weak input signal energy rather than its magnitude. In this fashion, additional E-field energy from the vacuum enters the output coils to power the secondary circuit and its loads. Also, the output of the entire transformer section has the voltage in phase with the current, in contradiction to the actions of all previous transformers.

AIAS: Alpha Foundation's Institute for Advanced Study, directed by Dr. Myron W. Evans, a noted scientist with more than 600 papers in the literature. The AIAS is an unusual "think tank" comprised of Fellows and Fellow Emeriti in various places in the world, who cooperate in advanced electromagnetics studies via E-mail. The Director, Dr. Myron W. Evans, is a theorist of note, as are several other Fellows. The AIAS has been forging

ahead with the production of O(3) symmetry electrodynamics, particularly as an important subset of Mendel Sachs' unified field theory. Dozens of AIAS group-authored papers have been published in various leading journals such as *Foundations ofPhysics, Physica Scripta,* etc. More than 100 A IAS papers are carried on a restricted Department of Energy website for reference by DoE and AIAS scientists. The work is particularly significant in preliminary theorizing how EM energy can possibly be extracted from the active vacuum.

algebras: The various types of mathematics in which the theoretical models for physics and other sciences are embedded. Some important algebras utilized in physics are vector algebra, tensor algebra, quaternion algebra, Grassmann algebra, Pauli algebra, Clifford algebra, etc. There are many others. The complexity of the symmetry and of the topology varies significantly between these algebras. Thus, an electrodynamics model in a lower topology algebra such as vectors or tensors will not reveal or permit nearly so great a set of electrodynamic functions and operations as will electrodynamics embedded in a higher topology algebra such as quaternion algebra or Clifford algebra. See topology.

ambient vacuum: The average or typical "standard" active vacuum (i.e., active spacetime), removed spatially from any large collections of observable charge and observable mass.

ambient vacuum potential: The *average* or typical standard vacuum considered as a scalar potential because it possesses energy density as well as structure and dynamics on many levels. As a scalar potential, the vacuum potential (considered without zero-point fluctuations) decomposes into a harmonic set of "bidirectional" longitudinal EM phase conjugate wavepairs, by Whittaker's 1903 decomposition as reinterpreted by the present author in 2000. Dynamic structuring of the vacuum thus consists of dynamics impressed upon these wavepairs. Since the vacuum is observably mass-free, Whittaker's phase-conjugate half of the decomposition must be considered prior to its interaction with mass, hence in the imaginary plane **and** arising from the time domain. This consideration led to the discovery by the present author of the more fundamental 4-symmetry in EM energy flow between the time domain (imaginary plane) and real 3-space, when broken 3-symmetry is present (as with any dipolarity or with any **potential).**

Powerful support for this solution is also given by F. Mandl and G. Shaw, Quant*um Field Theory,* Wiley, 1984, Chapter 5. Mandl and Shaw argue tthat the longitudinal and scalar (time) polarizations of the photon are not

directly observable, but only in combination, where they manifest as the "instantaneous" Coulomb (i.e., electrostatic) potential. Our comment is that this argument, translated from particle terminology to wave terminology, directly fits our re-interpretation of Whittaker's 1903 decomposition of the scalar potential.

angular momentum: The momentum or "leverage" of the linear momentum of a moving body, with respect to an axis or reference point. Angular momentum has the same units as action; that is, it is energy multiplied by time, or momentum multiplied by length. In terms of particles, it is also known as *spin*.

anti-circuits: Somewhat normal-appearing electromagnetic circuits which primarily process and use antiparticles and anti-electrons rather than particles and electrons, or else process a combination of the two simultaneously. Operations of the anti-circuit must be analyzed and understood in terms of its *supersystem* interactions. The circuits process and utilize both negative energy and positive energy EM fields and potentials, hence are closely connected to unified field engineering and antigravity. One aspect enabling such circuits is the use of the supersystem's curvatures of spacetime in both negative curvature and positive curvature fashion so that an appropriate change of spacetime curvature precludes the radiation normally accompanying pair annihilation, etc. The key to the circuits is T-reversal and C-reversal operation, along with the matching use of spacetime curvatures, and also the use of the Dirac "positron" (negative energy electron) — and its fields and potentials — prior to its observation. The unobserved Dirac negative energy electron in the vacuum is an entirely different entity than is the observed Dirac positron after its interaction with charged matter, after which it has become a "lattice hole" or "positive charge on a positive mass ion". The response of normal circuit components to vacuum Dirac sea hole operations is dramatically different than for Dirac positrons, and for certain applications special versions of circuit components are required. At this writing, together with John Bedini the present author has submitted what may be the first patent application on the fundamental process for anti-circuits and their operations with antimatter and negative energy currents, fields, and potentials as well as matter and positive energy currents, fields, and potentials. Another patent application by this author **is** in preparation, covering the anti-gravity aspects. The details of these mechanisms are still proprietary at this writing in order to protect our intellectual property rights, but limited information is in this book.

anti-electron: A negative-energy electron, observed as *a positron.* Under time reversal, electric charge reverses in sign. Dirac did not predict the positron per *se,* but a negative energy electron that we would *observe* in **reversed** fashion. Present theorists assume the interaction of the 4-space **negative** energy electron with matter — i.e., observation — to have occurred. This transforms the negative energy, negative mass electron to a positive energy, positive mass positron traveling in the opposite direction. In so doing, antigravity from the negative energy 4-electron source charge, due to its negative energy EM fields and negative energy potentials, is ar**bitrarily** transformed by the spatial reversal into positive gravity fields **rather** than the antigravity fields they were. The secret to practical antigravity is to utilize (in anti-circuits) the negative energy 4-electrons pri**or** to observation, *without* transformation of (i) negative energy fields to positive energy fields, (ii) negative mass to positive mass, and (ii) reversal of the field direction. In short, simply consider the unobserved negative e**nergy** 4-electron as what it is, and utilize it in its unobserved vacuum state. The conventional transformation process also unwittingly discards **the** concept of anti-circuits, anti-fields, anti-potentials, and anti-currents, which discards half the rich electromagnetic circuitry that can be built and u**tilized.** In the present book, we only touch lightly on this latter subject, which hopefully will be the subject of a future book after certain patents are **filed.**

antigravity: Negative gravity or reversed gravity. Use of negative curvature of spacetime to produce a force on a gravitational source **(physical** system) that is opposite to the normal force of gravity of the earth etc. on that system. Antigravity is achieved by the use of negative-e**nergy,** negative-mass source charges in the mass component of the s**upersystem** prior to observation, while the source charges are still 4-s**patial.** This usage produces negative energy fields and negative energy **potentials** to negatively curve the local spacetime (ST), so that these nega*tive local* ST curvatures interact back upon the positive mass source system associated with the vacuum negative energy sources in its su**persystem.** Again, to understand the operation of an antigravity circuit or system, one must analyze it in terms of its *supersystem* interactions.

antimatter: Matter consisting of atoms that are composed of anti-electrons **(positrons),** antiprotons, and antineutrons and such. Also loosely refers to the **antiparticle** corresponding to a particle; an antiparticle may be regarded as a particle traveling backward in time, or "phase conjugated", or "time-reversed. Since time is not an observable, the observer sees the antiparticle

{after its observation by interaction with mass) in forward time as being reversed in direction and charge.

antiparticle: Conventionally, a counterpart to an ordinary fundamental particle, *observably* having identical mass, lifetime and spin, but with charge and magnetic moment reversed in algebraic sign. We again point out, however, that the antiparticle differs when in its unobserved 4-spatial state. Only by analyzing the particle's supersystem can the true unobserved antiparticle be understood, as well as its fields and potentials in that condition.

antiphoton: A time-reversed photon. Presently the photon is considered its own antiparticle. *Observably* it is, but in its pre-observation condition it is not. An alternate but as yet unaccepted view is that, since the unobserved photon is comprised of (dE)(dt) — i.e., a piece of energy welded to a piece of time with no seam in the middle, the antiphoton may be assumed to be comprised of (-dE)(-dt) with respect to the external observer.

anti-Stokes radiation: The radiation coming from an anti-Stokes emission process from an intensely scattering medium, wherein more energy flux is emitted than is input by the experimenter-operator. The excess emitted energy is furnished by other processes in the medium. For true overunity operation, the excess energy furnished by the energetic medium must be freely replenished to the medium by the active vacuum's interaction with it.

antiwave: The time-reversal (phase conjugation) of a reference wave.

A-potential: The magnetic vector potential A, conventionally thought to be "defined" by the equation $\mathbf{B} = \nabla\times\mathbf{A}$. However, no equation is a definition (an identity is required). If we replace the "=" sign by "==", we have $\mathbf{B} \equiv \nabla\times\mathbf{A}$, which is actually seen to define the field B as just a curled A-potential, or as the curled component of the A-potential, *after* interaction with magnetic charge. The A-potential or an additional component of it can and does also exist in uncurled fashion, and will emerge in the uncurled state in the space outside any local path (e.g., the path in the interior of a toroidal coil) that retains the B-field therein. That process of separating the curl component of the A-potential from its uncurled component is known as the Aharonov-Bohm effect (which also affects the wave function). The motionless electromagnetic generator (MEG) uses a special nanocrystalline core material in a transformer configuration, which draws in and retains the B-field from a permanent

magnet outside the core but firmly in contact with it on both ends. As a result, the vacuum freely replenishes the withdrawn magnetic energy that would otherwise have existed in the space outside the core, but the energy outside the B-field localization zone remains and appears as a separated and uncurled A-potential. In this way, the MEG is converted to an open system not in equilibrium with the vacuum, and can therefore permissibly output more EM energy in its output coils than the operator inputs into the input coils, the excess being freely furnished from the vacuum via the broken 3-symmetry of the permanent-magnet dipole and the resulting 4-symmetry EM energy flow from the vacuum's time domain into the dipole.

The MEG is actually a practical macroscopic EM power system application of (1) the well-known Aharonov-Bohm effect and (2) the effect of the separation of the curled and uncurled potentials by a long tight solenoid or by a tight toroid, but in this case by the nanocrystalline magnetic core performing that separation function. In effect, the output coils interact with double (or greater) energy than would be available in just the B-field of the core (and of the magnet). Dual interaction with both the internal core B-field flux and also the external A-potential is obtained by pulsing, so that the pulse edges produce strong E-fields in space, with the E-fields striking the output coils in a transmission-reception near-field fashion. As is well-known, $d\mathbf{A}/dt = -\mathbf{E}$, and also $f(d\mathbf{B}/dt)$. These two fields produced by the perturbed internal B-flux in the core and the pertubed external uncurled A-potential outside the core are in phase. This is how the extra pulsing A-potential energy outside the core is made to interact as -E-field energy with the Drude electrons in the output coils, while the changing magnetic flux in the core through those coils also simultaneously produces a second -E which interacts with the coil's conductors in normal E-field fashion. The total E-field interacting with the output coils is proportional to the *time rate of change* of the input perturbation signal, not the magnitude of its energy. By adjusting the leading and trailing edges of the perturbation pulses, the magnitude of the E - field interactions with the output coil is determined as desired. Further, the usual output B-field produced in the output coils by dE/dt is directly extracted into the core and held, so that *a purely electrical interaction and output occurs in the output coils*. This is easily shown since the output current and voltage of the output coil are in phase, within a degree or two. The MEG may be said to the world's first purely electrical induction transformer, freely separating the magnetic interactions and bottling them up, while allowing the electrical interactions.

asymmetrical regauging: A change of either the scalar potential ϕ or the vector potential A, or both, so that a *net resulting excess force together with a net change of total system potential energy* occurs in the system. During this change, an asymmetry exists in the active vacuum's energetic exchange with the system. The result is that the potential energy of the system is freely changed by energy from the vacuum, and a free net force is also produced in the system. This new force is then free to dissipate the excess potential energy by translating electrons through a load and powering it. By contrast, the Lorenz/Lorentz *symmetrical* regauging produces two free force fields that are equal and opposite, so there is no *net* resultant translation force available to translate electrons through the external load and power it. Thus Lorentz regauging arbitrarily applied to the Maxwell-Heaviside equations selects only that resulting subset of Maxwellian systems that are in equilibrium in their interaction with the external active vacuum. The potential energy of the system is changed, but only as a "stress potential" doing internal work upon the system to form and maintain its increased stress. The extra energy also rotates the system's frame out of the laboratory frame. Lorentz thus unwittingly discarded an entire class of permissible Maxwellian systems that are not in thermodynamic equilibrium with the vacuum. The Lorentz condition is initially violated each time anyone potentializes an EM circuit, but the closed-current-loop circuit design with the same charged-particle energy carriers around the loop — including back through the back emf of the source dipole in the generator — enforces a form of Lorentz symmetrical regauging during discharge of the system's excitation energy. Further, the response of the electrons in the usual electrical circuit with copper conductors is so rapid that the asymmetrical regauging (potentialization) is almost instantly converted to symmetrical discharging by movement of the electrons as current. When one section of the otherwise closed current loop uses a dramatically heavier charge as the energy carrier (as a battery uses ion current between its plates, but uses electron current between the outside of the plates and the external circuit), it is then possible to dephase the two independent carrier currents so that the battery will be charging while simultaneously the circuit is being powered, by a negative resistor (sharply increased scalar potential or voltage) produced at the plate surface interface of the two carrier current types. This proven Bedini process is an example of a true overunity process, capable of producing a self-powering system by means of adroit switching and timing.

asymmetry: Lack of symmetry, or "broken symmetry" in a general sense. Since a specific symmetry is accompanied by a specific conservation law, the breaking of that symmetry represents the violation of that conservation

law. Particularly note that a broken symmetry at one level often (usually) results in a new symmetry at a higher level, necessary to maintain the asymmetry at the lower level. The resulting "levels" of symmetry are known as *hierarchies* of symmetry.

asymmetry of **the dipole:** Because of the proven asymmetry of opposite charges, any dipole or dipolarity is a broken 3-symmetry in its fierce exchange of EM energy with the active vacuum, because of the known broken symmetry of the opposite charges on its ends. Any two points in the universe (in or out of the circuit), that are at differing ambient potentials, constitutes such a broken symmetry continuously pouring out EM energy extracted from the vacuum. A dipole or dipolarity continuously receives and absorbs copious virtual energy from the seething virtual photon vacuum flux, and not all this absorbed energy is reradiated back to the vacuum in virtual form. Instead, some of it is coherently integrated into observable form and re-radiated in all directions as usable, real 3-space observable photons and EM energy. We found that the input energy to the dipole is from the time domain of 4-space. Hence the dipole's broken 3-symmetry results in the appearance of a new and far more fundamental 4-symmetry in energy flow between the time-domain and 3-space. This was the solution to the long-vexing source charge (or source dipole) problem in classical and quantum electrodynamics. Reinterpreting the Whittaker 1903 decomposition of the scalar potential reveals the mechanism for this 4-symmetry between time-domain EM longitudinal wave energy flow into a dipole and 3-space EM longitudinal wave energy flow out of the dipole, due to the presence of the proven broken 3-symmetry of the dipole. *EM energy flow is conserved in 4-space, but not in 3-space. Further, the 4-*symmetry energy flow from the source dipole (or source charge) continues as long as the source dipole (or source charge) remains intact so that the broken 3-symmetry remains intact. It is strongly indicated that this asymmetry of the dipole or dipolarity is what Gabriel Kron finally discovercd as his "open path".

back emf: The counter-electromotive force, usually between the end charges of the source dipole in the external power source for an electrical circuit (in its overall closed current loop). When the electrons in the circuit are forced against the emf— as when the "spent" or depotentialized charges from the ground reference of the circuit are forced back up through the emf of the source dipole to re-potentialize the charges — then work is done upon the source dipole to scatter its charges and destroy the dipole. Removing the dipole stops its receipt of vacuum energy from the time - domain (which was due to its broken 3-symmetry, now removed). It

also stops the former dipole's transduction of that energy, and its former output of 3-space energy flow along the circuit and in space around the circuit. When this flow is occurring, a small component of it strikes the surface charges in the conductors and is diverged into the circuit (by axial precession of the surface charges withdrawing the "immediate stubs" of their fields and potentials into the conductor) to power it as the Poynting energy flow component. The huge remainder of the energy flow in space surrounding the circuit simply misses the circuit and is utterly wasted. Destruction of the source dipole removes the transduction of EM energy from the vacuum. It thus stops the powering of the circuit. So additional energy must then be input to the power source to perform work on its scattered internal charges, force them apart again, and reform and restore that source dipole, in order to resume powering the circuit by energy extracted from the vacuum by the dipole. It is simple to show that such a closed loop circuit uses more of its collected energy from the vacuum to destroy its source dipole, than it uses to power its load. Hence the circuit self-enforces COP<1.0.

back emf (tempic): There are actually two emfs in a circuit, not one. There is a 3-space emf and also an entirely unrecognized *tempic* emf. In either case, under proper circumstances there can be a back-emf of either one or both. See discussions under **electromotive force, back** and under **tempic back emf.** The tempic back emf is very important to COP>1.0 circuits, where the system's output energy density in spacetime is greater than the energy density at the input section of the system. This difference in tempic stress potential provides a tempic force sweeping from system output section back through the system to its input section. The current is a current of Dirac sea holes (negative energy 4-electrons) moving in that local vacuum, from the output section back through the system to the input section. At the input section, this Dirac sea hole current reacts with incoming electrons from the external power system. It therefore "eats" incoming electrons, so that the power supply must now furnish additional electron current to (a) power the negation and "killing" of the Dirac sea hole current by filling those holes with electrons in the input section of the circuit, and (b) simultaneously furnish the additional usual current to power the system's input. The result is that the tempic back emf is nature's mechanism for decaying the excited COP>1.0 energy state represented by a system in overunity functioning condition. Unless this hole current problem is overcome, this decay mechanism will destroy the net overunity, and it will prevent any attempt at close-looping the circuit for self-powering by use of clamped and governed positive energy feedback from output to input. The Bedini method can be used to transform the

detrimental Dirac hole current into ordinary electron current, providing the self-powering feedback loop needed. Or, Bearden's outrigger method of using a multi-system set of external COP<1.0 receiving circuits powered by radiation (Poynting EM energy flow) from a single central power source (energy flow radiator) can be used. Then already-positive energy feedback from one or more of the separate outrigger COP<1.0 receiver circuits can be fed back in normal fashion to power the central power unit. Note that the outrigger concept uses the bridging concept, so that an external COP<1.0 system can be powered from a central radiating system, and the external COP<1.0 system can collect and output more energy than is output in the *accounted Poynting component* of the central radiating system. The excess energy radiated comes from the radiated Heaviside component.

bare electron: The true electron without its partial shielding of virtual positrons that are attracted toward it from the active vacuum, and that cluster around the electron, partially shielding its charge as seen by an external observer. The bare electron has infinite energy and infinite charge, as does the shielding cluster of virtual positrons. The difference between these two infinite values of opposite charge is the finite "externally observed" value of the electron charge listed in texts and handbooks. This strange dipolarity of the source charge thus exhibits an asymmetry in its exchange with the active vacuum virtual photon flux. Hence this mechanism also solves the source charge problem — how the charge continuously pours out EM energy in all directions at the speed of light, establishing its fields and their potentials reaching out into or even across the universe, without any input *of observable* EM energy to the source

Barret, Terence W.: Noted modern electrodynamicist and consultant who works in SU(2)xSU(2) gauge symmetry extended electrodynamics, and other models, and was also one of the pioneers of ultrawideband radar, Barret is one of the vigorous modern electrodynamicists continuing to develop and extend the science of electrodynamics and the electrodynamics model itself.

Bedini, John: Noted audio engineer, leading overunity energy researcher, inventor of the Bedini process for creating a true negative resistor inside a battery used as primary power to a circuit, and inventor of the Bedini overunity process for killing the back mmf (magnetomotive force) in a magnetic motor. Bedini is also the inventor of the renowned Bedini amplifiers well known to audiophiles, the BASE process for holographic sound, and a remarkable process for cleaning the harshness from digital

audio disks. In addition, he discovered a mechanism for transducing into usable positive energy the detrimental Dirac Sea hole current (negative energy electron flow) backflow in an overunity system, flowing from the output section back through the system to the input section and even on out into the external power supply. The Bedini process transduces this detrimental current into normal electron current, thereby providing most or all of the required input power to the input section. Bearden then explained the technical process for Bedini's discovered transduction procedure, and Bedini and Bearden filed a patent application on this process.

Berry phase: Generalization by Berry of the Aharonov-Bohm effect, for an adiabatic situation. Later Aharonov and Anandan further removed the adiabatic condition and generalized the Berry phase to the geometric phase. See Aharonov-Bohm effect, geometric phase.

blocking: In a Fogal charge-barrier semiconductor, stopping or partially stopping the flow of current in a circuit, or between two points, by *pinning the electrons without stopping the EM energy flow.* In ordinary usage, "stopping the progress of whatever charge flow or current is being referred to.

Bohm, **David J.:** World-renowned physicist and originator of the hidden variable theory and interpretation of quantum mechanics. See David Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of 'Hidden' Variables, I and II," *Physical Review,* 85(2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II). Together with his student Aharonov, Bohm co-authored a fundamental paper on the Aharonov-Bohm effect wherein interfering electromagnetic potentials can produce effects on charged particle systems, even at a distance and in the absence of the electromagnetic force fields. From Bohm's hidden variable theory, the quantum potential has been highly weaponized by five nations, and these eerie weapons operating instantaneously at a distance through multiply connected spacetime are presently the dominant strategic weapons on earth.

Bohm's hidden-variable theory (HVT) of quantum mechanics: A major interpretation of quantum mechanics, formulated by David Bohm and published in *Physical Review* in 1952. Bohm's theory makes all the correct predictions and also eliminates many problems in quantum mechanics, such as the "measurement problem" and the — now recognized — problem of the missing chaos (i.e., the missing "hidden chaotic order."). Bohm's theory implies that physical reality — or much of it — can in fact be deterministically engineered. A key concept is the use of a *quantum*

potential, which is multiply connected. Clandestine superweapons using **Bohm's** quantum potential (QP) have been developed and deployed by several nations. Present mutual assured destruction "standoff between these nations is based on surviving counters to QP weapons rather than surviving nuclear weapons.

Bohren, Craig F.: Distinguished Professor of Meteorology, Pennsylvania State University, noted for work in scattering theory. In an experiment **detailed** in C. F. Bohren, "How can a particle absorb more than the light incident on it?" *American Journal ofPhysics,* 51(4), Apr. 1983, p. 323-327 Bohren shows that in nonlinear conditions a resonant particle may absorb and output 18 times as much energy as is impinging upon it from the usual **field** definitions based on a static intercepting charge. The additional **energy** is "absorbed from the vacuum"; actually, it is absorbed from the nondiverged Heaviside energy flow component accompanying the accounted Poynting input component, but arbitrarily discarded by Lorentz. T**he** resonant particle sweeps out a geometrical interception area (reaction cross section) greater than that of the same charge in a fixed static condition. Hence it intercepts part of the always-available Heaviside "dark energy" flow surrounding the Poynting energy flow component of every field/charge interaction.

Bohren experiment: Revealing experiment by Craig F. Bohren, replicated by Paul and Fischer, which shows that a given charge when in particle resonance absorbs more energy from a field or potential then the same cha**rge** does when in "static" position. This experiment is a direct experimental demonstration of the existence of Heaviside's nondiverged energy flow component around every field/charge interaction. See discussion under Bohren, Craig F. The Bohren experiment can be repllicated by any university nonlinear optics laboratory and outputs 18 times as much energy as is input by normal calculations (neglecting the Heaviside nondiverged EM energy flow component of the input).

boson: A particle having integral spin, which obeys Bose-Einstein stat**istics** but not the Pauli exclusion principle. Bosons include the photon, alpha-particle, and any nucleus of even mass number.

brid**ge:** A component or process which passes EM energy between two **isolated** circuits, but does not pass dq/dt between them, and which breaks the normal rigidly field-locked power dissipations in the two circuits. Space itself would appear to be one such bridge for EM energy flow.

bridging **function:** The function of passing EM energy flow between two isolated circuits, but not passing dq/dt between them, while simultaneously

breaking any normal rigidly field-locked power dissipations in the two circuits. Use of the uncurled A-potential where $\nabla \times \mathbf{A} = 0$ is one available method of bridging otherwise isolated circuits, particularly in the outrigger embodiment of the motionless electromagnetic generator and other COP>1.0 systems.

broken symmetry: Fundamentally, a condition in which two parts of some configuration or shape, on opposite sides of some divisor or condition or boundary, are not similar but differ. In vacuum energy physics, we are very interested in the fact that — because of the broken symmetry of opposite charges — any charge (with its associated clustering virtual charges of opposite sign) and any dipole or dipolarity represents an asymmetry in its fierce energy exchange with the vacuum. This implies that something virtual becomes observable; i.e., part of the virtual EM energy continuously absorbed from the vacuum by the charge or by the dipole is changed into observable form and re-emitted as real, observable EM energy. The remainder is re-radiated as virtual EM energy. The charge's transduction of absorbed virtual photon energy and its re-emission as observable photon energy was proposed by the present author in 2000 as the solution to the long-vexing problem of the source charge and its associated fields and potentials (and their energy) reaching across the universe.

bypass resistor: In electrical theory, a resistor to pass or conduct current around (in parallel to) some other component. If another effect such as use of the overpotential, pumped phase-conjugate reflection, quantum well, quantum tunneling, negative energy, or charge blocking is added, the bypass resistor's function becomes extremely complicated. The bypass resistor may be complex, e.g., or it may be a true negative resistor in some cases.

carrier wave: A fundamental wave that is modulated by another wave or other waves, and hence "carries" the other modulating waveform(s). By stripping off the carrier in a demodulator, the carried waveform(s) emerges.

Casimir **effect:** The attraction of two conducting parallel plates in space, placed very close together, due to their influence on the active vacuum and on the vacuum's interaction with the plates. A part of the vacuum spectrum between the plates is "cut off and blocked or shielded, so that the vacuum potential between the plates is less than the vacuum potential outside them. The resulting potential gradient (force) on each plate from outside pushes the plates together. The Casimir effect unequivocally proves that it is

possible to directly engineer the vacuum so as to produce forces and energy and physical effects in material systems. While it is a "small" white crow, it only takes one white crow to prove that not all crows are black. It is sufficient to conclusively prove that EM energy can be extracted from the vacuum. From there to practical EM power systems, fed by vacuum energy, is simply a product of modifying the prevailing electrodynamics and electrical engineering to incorporate the supersystem components and interactions, and then to gradually discover and develop the necessary technology. In this book we attempt to point the way by using the supersystem and providing some of the major necessary principles and concepts.

Casimir, Hendrik Brugt Berhard (1909-2000): Noted scientist who in 1948 correctly predicted that two parallel conducting plates, placed very near each other in a vacuum, would experience an attractive force due to their influence on the electromagnetic vacuum.

causality: The relationship between "cause" and "effect", or the interaction of 4-space cause upon a previous 3-space observation (effect), to produce a new 3-space observation (change in the previous observable or production of an exact 3-space replica). The basic notion in a causal system is that the system's response to an input signal is dependent only upon past input values, not upon future input values. In a multiply connected space, the causality principle is dramatically changed and requires very careful accounting.

chaos: In dissipative dynamical systems, the dynamical evolution or ordering of the system that is aperiodic and highly dependent upon initial conditions of the system. The trajectories of the system move on a *strange attractor,* which is a fractal subspace of the phase space. The mathematical equations describing chaotic behavior are very nonlinear and so complex that at the present time they cannot be computed or predicted. Control of chaotic oscillations thus is ongoing in its scientific development, with the most advanced control work having been done by Russian scientists, but now openly available.

charge: C*harge* is the ongoing circulation of EM energy flow between the time and 3-space domains, as "seen" by the observer in 3-space. *Negative* charge is (i) the ongoing absorption, by a mass particle, of EM energy input from the time domain (from *ict),* (ii) transduction of the absorbed energy into 3-space EM energy, and (iii) re-emission of the EM energy in all directions in 3-space. *Positive charge* is (i) the ongoing absorption, by a mass particle, of EM energy input from 3-space, (ii) transduction of the

absorbed energy into the time domain, and (iii) re-emission of the EM energy in the time domain. Alternately, the positive charge can be considered as (i) the ongoing absorption, by a mass particle, of EM negative energy input from the time domain (from *ict),* (ii) transduction of the absorbed negative energy into 3-space, and (iii) re-emission of the EM negative energy in 3-space. A similar inversion can be utilized to represent negative charge. Time reversal of EM energy can be seen to result from the combined broken symmetries of EM energy flow (in 4-space) between time and 3-space, of two opposite charges and thus of dipolarity itself. See paragraph 3.1 of Chapter 3.

charge, electrical (q).: In the sense of q being charged mass, where the mass m_q of charge q is associated with the phenomenon defined as charge (see above definition). In our view, an electrical charge q associated with a charged particle or mass may be defined as $q \equiv m_q\phi_q$, to first order. This fits the common use of "the charge" as an expression for a charged mass, and explains why a gathering of charges produces a potential ϕ reaching out from the "source gathering of charge q". The actual "charge" action associated with the mass is due totally to ϕ_q, and to the broken symmetry of the ϕ_q dipolarity in the vacuum flux exchange with m_q. The charge q can be further broken down into a set of composite dipoles if the gathering of a screen of virtual charges of opposite sign in the vacuum, surrounding the mass of the "bare charge" inside the gathering, is considered. At first order, ϕ_q can be expressed (from *a particle view)* as a change in the local vacuum virtual photon flux (VPF), due to the VPF exchange between vacuum and m_q. *In a classical approach,* the vacuum may be considered as a giant scalar potential comprised of bidirectional EM wave flows according to Whittaker's 1903 decomposition, except we must re-interpret the phase conjugate half-set of Whittaker's decomposition as incoming from the time domain or complex plane. The charge then may be considered to diverge so much energy flow from the time domain into 3-space "around" the mass, resulting in ϕ_q as the steadily diverged energy surrounding the mass m_q. The ϕ_q component is actually the massless electrical charge and massless of itself. This approach would then yield a definition of massless charge itself, which at present is undefined in physics, as pointed out by Feynman and others.

In the expression $q \equiv m_q\phi_q$, the ϕ_q represents a change to the local vacuum potential ϕ_{vac}. Both ϕ_q and ϕ_{vac} decompose into Whittaker phase conjugate longitudinal EM wavepairs. As can be seen, by altering or engineering these constituent wavepairs, a particular ϕ_q or particular local vacuum potential ϕ_{vac} can be given a deterministic internal structure and dynamics.

Thus the interaction of a given electron or group of electrons may be made **quite** different from the interaction of another electron or group of "apparently identical" electrons. Such structuring dynamics are met with in the internal structuring of water, e.g., where the fierce activity of H-bond making and breaking can be treated as a special ϕ_H and its "internal structure and dynamics" can be engineered. A leading scientist pursuing that type of effect is Jacques Benveniste, in France. Predictably, the o**rthodox** establishment has severely castigated these experiments, defending conventional models as absolute while completely ignoring the experimental results that refute those conventional models as being incomplete.

charge carriers: Anything — usually fundamental particles, ions, etc. — which consists of or contains charges and can be potentialized and move.

charge, magnetic: In the sense of charged mass, a magnetic charge is what is commonly called a "magnetic pole". The mass m of the magnetic charge is associated with the exchange of EM energy between the time domain and the 3-space domain. Essentially, the energy exchange action **known** as "charge" in the massless sense is the magnetic scalar potential, or monopole, when decomposed as per Whittaker and as reinterpreted by the **present** author, and as pointed out in quantum field theory by Mandl and Shaw. Note that our personal view discriminates between *massless charge and charged mass.* Massless charge is an ongoing action and process, involving energy transduction from one form (time energy or 3-space energy) to another (3-space energy or time energy). A charged mass is a **mass** associated with such action. Unfortunately, in the prevailing usage the word "charge" is just loosely used for both senses without discrimination. Hence one must carefully differentiate between the use of "charge" for "charged mass", and its use for an "ongoing process".

charge-parity-time (CPT) theorem: C is *charge conjugation,* which changes the quantum number of every particle into its antiparticle. P is the reflection operation known as *parity,* which turns an object into its mirror image and rotates it 180 degrees about an axis perpendicular to the mirror. T is t*ime reversal.* Any violation of time-reversal symmetry is always accompanied by a violation of CP symmetry (by violating either C or P symmetry) and vice versa.

Electrodynamics and the strong interaction preserve CP symmetry to great accuracy. Weak interactions do not conserve CP symmetry. T symmetry violation has been shown at CERN, the European particle physics laboratory in Geneva, Switzerland.

charge trapping (also "pinning"): Holding charges "pinned" or "trapped" at a site or in a location, by a barrier or force, so that they do not flow as $i = dq/dt$. A clustering of the pinned charges at the pinning site often occurs.

charge-barrier: A process or component or function — particularly in a semiconductor such as the Fogal semiconductor — that blocks the movement of charges q as current dq/dt.

classical electromagnetic theory: The classical theory of electrodynamics, in its modern form begun by Maxwell with his seminal-paper orally presented in 1864 and published in 1865. Today many variations have been made, particularly with respect to the basic group symmetry of the theoretical equations.

Clifford algebra: A special higher topology algebra founded by Clifford, which includes as subsets many other algebras of lower topology.

closed system: In the present approach, a system that in theory does not communicate with its environment, and does not exchange energy or matter between system and environment. Notice that this directly conflicts with the notion in thermodynamics (both classical and disequilibrium) that a closed system is closed only to mass exchange across its boundary, but open to energy exchange across it. General relativity has falsified that notion since 1915. Any system undergoing a change of energy also undergoes a change of mass, since mass is a special form of energy.

An ideal model in which dynamically and energetically the system is considered to be "isolated" as if nothing else existed. In short, the system is considered as if it were in some "magic box" and nothing outside the box can ever enter the box or affect the system inside the box, and nothing in the system can ever leave the box or affect anything outside the box. No electromagnetic system is closed. In short, we have corrected the thermodynamics "closed system" with open energy transfer, to a true closed system with neither energy nor mass transferring. That corresponds to the present thermodynamics notion of the "isolated system".

One performs a non sequitur when proclaiming treatment of any EM system as a "closed system", and of course modern physics substantiates this. The broken symmetry of the opposite charges on the ends of a dipole — and of an observable charge together with its clustered virtual charges of opposite sign — has been proven since 1957. The absence of any closed system is particularly true in electrical power systems. Here one is indeed allowed to input energy into the system to excite or potentialize it. That **of**

course assumes that the system was "opened" long enough to take on excess energy (which also changed its mass)! Then as the system operates, losses and dissipations occur, in which case energy is considered to "escape" from the system permanently. In other words, the system was also continually "opened" so that energy could escape. In any EM system, every charge and dipole is already an open system, with free exchange of energy between 3-space and the time domain via that charge. In particle physics, every charge and dipole is a broken symmetry in its virtual particle flux exchange with the active vacuum.

The ancient thermodynamics definition of a "closed system" as one that exchanged heat but not mass, was formulated before thermodynamicists even knew that heat was a form of EM energy, or even knew what energy was. Hence we have changed that definition, since it is a non sequitur in view of modern physics.

There is really no such thing as a truly closed system in the universe, since *every* system is embedded in the active vacuum and is an open system in an energy exchange with the vacuum. Further, any change of energy in the system curves the local spacetime, which in turn interacts back upon the system. If that energetic exchange of the system with its "active vacuum and active curved spacetime environment" is symmetrical, then the system is in equilibrium with respect to its environmental exchange. In that case, for a limited number of purposes the system may be treated as if it were a closed system. In classical electrodynamics, Lorentz regauging of the Maxwell-Heaviside equations further reduced them to describe only Maxwellian systems in equilibrium with the active environment including the active vacuum. Consequently, any *net* interaction between the external vacuum (or the active local curved spacetime) and the system was excluded from the CED model. Obviously a *broken equilibrium* (i.e., broken symmetry) in that actual physical interaction is also not included in the CED model. Nor is it included in the classical (equilibrium) thermodynamics model with its archaic second law.

coefficient of performance (COP): Ratio of the usable energy output of a system divided by that portion of the total energy input that is input by the the operator's or experimenter. The COP is thus a measure of "return for using the operator's or experimenter's input energy" to produce — or direct the production of— useful work by the system". There are other ways to calculate the COP ratio; e.g., the average output power divided by the average operator input power. Contrast COP to the *efficiency* of a system, which is the ratio of the total usable output energy divided by the *total input energy from all sources,* including by the external active

environment as well as by the operator. The efficiency of a system means how efficiently it produces useful output from its *total* input. The COP is the performance the system renders for the *operator's* input. Note that even a highly inefficient system — say, with efficiency $\xi = 0.25$ — may nonetheless have a COP>1.0, if the operator himself inputs less energy than the system outputs and the environment inputs all the rest of the output energy as well as all the energy in the system losses. As an example, a common home heat pump may have an efficiency of 40%, but a COP = 4.0. A windmill may have an efficiency of 20%, but a COP = ∞.

Also, for many systems one may evaluate their coefficient of performance for (1) the performance of the system as an energy transducer only, i.e., the ratio of energy the system outputs (whether used or not) divided by the energy the operator inputs; or (2) the performance of the system as a work producer, which is the useful work accomplished by the system divided by the operator's energy input. As an *energy transducer,* every generator and every battery has a COP»1.0, when both the Poynting diverged energy flow output and the Heaviside nondiverged energy flow output are accounted. Yet for useful work, the same system may have COP<1.0, because all the Heaviside nondiverged energy flow component is wasted, and some of the Poynting diverged energy flow component is wasted also.

Analyzed as an energy transducer only, every dipolar power unit — such as a generator or battery — outputs enormously more energy flow rate from its terminals than the mechanical energy rate input to the shaft of the generator, and than the chemical energy dissipated in the battery. So as an energy transducer, every dipolar power source is already a system exhibiting COP»1.0, prior to Lorentz' integration trick to discard the enormous Heaviside nondiverged energy flow output component.

cold fusion: An ad hoc term applied to the transmutations at low spatial energy (but high time-energy) achieved in electrolyte experiments, particularly when using specially prepared palladium electrodes after their loading with positive H+ or D+ ions, and particularly when deuterium is present in the electrolyte and the loading is by D+ ions. The *total* energy of the photon is greater the lower the photon's frequency and therefore the lower the spatial energy of the photon. Hence the cold fusion interactions actually use much higher *total* energy nuclear reactions than does present high (spatial) energy physics. Since "high energy" physics erroneously eliminates consideration of time-energy, the present high energy physics community is unjustifiably hostile to the very notion of cold fusion. The fact that little experiments on the lab bench use far higher total energy than the community's proud large accelerators is a bitter pill many high energy

physicists cannot *tolerate*, let alone view with scientific objectivity. So a**gain** there is a classic confrontation between science from scientific results and "science as known in the prevailing dogma".

composite dipole: Dipole formed as one part of an isolated, observable "charged particle", consisting of a differential element of that observable charge on one end and a momentary clustering virtual charge of opposite sign. This is one way of dealing with the modern "infinitely strong dual **dlpoles"** view of the charge, where the bare charge in the middle is infinite as is the clustering virtual particle charge surrounding that bare charge and **partially** shielding it. The difference between these two infinite charges is **finite,** and is routinely calculated to show that it is the standard value of the charge as seen by an external observer.

C **ooper pair:** In superconductivity theory, a dynamic, weakly bound **pairing** of electrons in a superconducting material below its critical temperature. In this pair, if the energy state with wave number sigma and spin 1/2 is occupied by an electron, then so is the state with wave number -sigma and spin -1/2. The Bardeen, Cooper, Schrieffer (BCS) theory uses this concept to provide a detailed microscopic theory of superconductivity.

COP (Coefficient of Performance): See coefficient of performance.

cosmological feedback principle: A self-regenerating cosmological fee**dback** cycle ascribed by Puthoff as the source of the vacuum EM zero-point energy (ZPE). One may assume the existence of EM zero-point energy by fiat as part of the boundary conditions of the universe, or concieive of its generation by the quantum-fluctuation motion of charged particles that constitute matter. Puthoff calculated the latter possibility, as**suming** that the ZPE spectrum (field distribution) drives particle motion, an**d** that the particle motion in turn generates the ZPE spectrum. This provides a self-regenerating cosmological feedback cycle, which in fact is consistent with the general relativity assumption that curvature of spacetime affects mass energy, and mass energy changes affect the curv**ature** of spacetime. It would be interesting to see if Puthoff s concept can be made compatible with the broken symmetry of **a** dipolarity and Kron's open path concept.

curl concept of fields: The concept of a field as the curl of a vector **potential** (the vector potential may not be known). Any field so conceived has a divergence of zero *a priori*. One must be careful, however, because electrodynamics calculates only the field's reaction cross section with an *assu*med fixed unit point static charge at a point in space, leaving the field itself undefined. In short, the calculation of "the field" is actually a

representation of the local point intensity of the field's interaction with unit point static charge. It is not the magnitude of the entire field (or potential) itself, *a priori,* but only of its reaction at a point with such a charge. In short, the field's reaction cross section with static charge is often misinterpreted as the magnitude of the field; at best it is an indication of the field intensity to static charge at a point.

curl-free magnetic vector potential: A field-free magnetic vector potential A without curl (swirl), hence lacing the B-field with which an A-potential is usually associated. For simplicity, one may visualize the curl-free A-potential as massless magnetic charge (and energy) in linear motion. Toroids and long solenoids have the characteristic of confining the B-field (curled potential) and holding it inside. However, drawing energy from any potential whose source charge or source dipole is not destroyed simply results in the full value (sum of the A-potential and B-field components) of the potential being replenished from the active vacuum, via the 4-symmetry energy flow mechanism in the presence of the broken 3-symmetry of the dipole. Hence one may easily increase the available potential energy density at will. This is a special form of gauge freedom allowing one to freely alter the potential energy of any electromagnetic system at will. Contrary to the dictates of EM textbooks, gauge freedom rigorously allows the direct and *free* amplification of potential energy of the EM system *at will;* the excess energy being freely furnished from the active vacuum processes. This principle incorporated in gauge field theory, has been known for decades and not previously used in the design, production, and use of COP>1.0 electrical power systems, prior to the invention of the motionless electromagnetic generator (MEG).

curved spacetime: A four-dimensional geometry (spacetime or ST) is used in general relativity, where the ST curvature is determined by the distribution of spatial energy such as mass-energy. In the general relativity view there is no such thing as an "empty" space "filled" with some energy substance. Instead, there is a combined space and time as a single entity, *spacetime,* which is itself energetic and is the very geometry we use in our mathematics. Any change in the local energy density of that spacetime constitutes a *curvature* of spacetime. In the new, more extended approach, any change in the spatial energy density or time-energy density of spacetime, or a combination of changes in both, constitutes a curvature of spacetime. In 4-space modeling, time is treated as a special, highly condensed form of EM energy. Specifically time may be regarded as ordinary 3-spatial EM energy compressed by a factor of c^2 and existing in

the time domain rather than in 3-space. Time-energy therefore has essentially the same energy density as mass.

dark energy (negative): (Dirac holes, Dirac hole potentials, Dirac hole currents): A strange form of vacuum energy that creates repulsive gravity, causing the expansion of the universe to speed up (as observed and not otherwise explained by conventional theory). As a strong candidate for the dark energy, the present author has proposed a vacuum negative energy and negative energy currents in a negatively curved spacetime region partially containing excess Dirac sea holes devoid of electrons, along with normal filled Dirac sea holes. These special "Dirac negative action quanta" then form *negative action* (negative angular momentum, or — for simplicity — negative energy) potentials, currents, and fields. This type of vacuum condition containing some empty Dirac sea holes is referred to as a Dirac *-polarized vacuum.* However, it is not just simple static polarization, but possesses rich dynamics. Such dynamic Dirac sea hole regions occur in the vacuum in curved spacetime regions with tempic potential gradients and strong 3-spatial energy gradients, and thus time force existing across the region. The holes occur since the energetic fluctuations of the local vacuum energy can separate a Dirac hole from its occupying electron. These may then recombine, or in sufficient local spacetime curvature can remain apart. The more violent the region, the more severe are local spacetime curvatures in that region, and the greater the fraction of empty Dirac holes that is maintained on the average, in their continual forming and recombining. In those regions, a tempic potential is higher at the higher center magnitude of the spatial energy density. Hence there tempic forces from "inside to outside", providing a "tempic broom" effect to sweep outward the excess Dirac sea holes separated from their electrons in the curved spacetime. The end result is the presence of increasingly unoccupied Dirac sea holes toward the outside of violent regions of spacetime, until the effect is overcome by the decreasing spacetime curvature. These empty Dirac holes in regions and currents are a special form of vacuum negative energy, negative energy fields, and negative energy potentials, creating negative gravity (repulsive gravity) upon ordinary mass exposed to them. So the more distant violent astronomical regions have greater amounts of repulsive gravity being produced by their local Dirac-polarized vacua and negative energy fields and potentials. The result of this effect is that, at sufficient distance from us, the increasingly earlier, more violent events and resulting greater curved spacetime regions have created sufficient Dirac-polarized vacua to overcome the normal gravitational attraction between galaxies, etc. Even farther out, the increase in Dirac-polarized vacua overrides the normal

attractive gravity between galaxies, etc. and produces net repulsive gravity. In turn this results in acceleration of the observed distant expansion of the universe. Dirac-polarized vacuum and its special dynamics can be accommodated in Sachs' unified field theory, which unites physics from quarks to the cosmos. See also **Dirac** sea **holes.**

On the laboratory bench, Dirac hole currents and effects are met with in a circuit or system producing COP>1.0, or very sharp 3-spatial gradients such as in violent electrical discharges. The effects become non-negligible at about COP = 2.0 and sometimes less. The tempic force back across the, system from output to input is sweeping the Dirac holes through the system. This can play havoc with attempts to close-loop the circuit for self-operation. In semiconductor components, strange effects are met due to their use of donor and acceptor materials, and temporary or permanent failure of semiconductors can result. The simple way to visualize this is that, in the system's supersystem, the spacetime component is curved and the vacuum component is highly nonlinear. All three components — overunity system, local nonlinear and polarized vacuum, and local curved spacetime — are interacting vigorously with each other. An operating overunity system represents an excited state of that local region of vacuum and curved spacetime, hidden in the euphemism "polarized" which is inadequate to describe the dynamics. With the dynamics, one may visualize that the Dirac sea hole currents are swept back through the system, seeking to recombine with electrons to eliminate the "polarization" and its dynamics, thus decaying the excited state back to equilibrium and destroying the overunity condition. In a robust system whose internal parts do not appreciably interact with these Dirac hold dynamics, the dynamics will reach the input section and extend back into or toward the primary power supply. In the input section, the feeder line, and in the power source itself, this results in "eating electrons". The Dirac sea effects thus act as a separate load imposed within and around the system input section or even back in the feeder line to the external power supply, in addition to the system load itself in the system output section. Simply put, the power supply must now furnish extra electrons to "power" the Dirac sea hole recombinations first, and additional electrons to power the system in its "normal" fashion. The result is to "draw additional power" from the source, where "drawing power" now includes the additional "eating of electrons" within the power supply itself, the feeder line, and the input section of the system.

Bedini and Bearden have filed a patent application on processes to convert the detrimental Dirac sea hole current reaching the system's input section.

transforming it into ordinary electron current. Magnetic Energy Ltd. has developed two other processes that handle the Dirac sea hole current problem, allowing close-looping for self-power ng operation. One of these processes converts negative energy into positive energy and the other avoids the negative energy problem. The first one allows this otherwise devastating special form of "negative feedback" or "degenerative feedback" to be converted into "positive feedback" or "regenerative feedback", allowing the system to be close-looped successfully for self-powering. Bearden has proposed yet a different approach using an "anti-circuit" method, but at this writing the method is still proprietary until intellectual property rights are secured.

dark energy (positive): Our term for the vast Heaviside nondiverged energy flow component surrounding every field/charge and potential/charge reaction but unaccounted in present electromagnetic theory after being arbitrarily discarded by Lorentz circa the 1890s. Present theory only accounts for that small amount of energy flow (the Poynting component) diverted locally around the interacting charge. All the rest of the energy flow comprising the field or potential, and missing the intercepting point charge, was discarded arbitrarily by Lorentz and is still discarded today, using Lorentz's integration trick. In honor of Heaviside, who did recognize the gravitational implications of his dark energy flow component, the present author has nominated this vast, unaccounted "dark energy" component as being responsible for the extra gravity holding the spiral arms of the spiral galaxies together. See **spiral** galaxy.

So one must recognize that the term "dark energy" is indefinite, since there are two kinds: (a) dark positive energy, and (b) dark negative energy. Dark positive energy consists of "normal" energy as often connected with particles, collected upon them and affecting their momenta, etc. It has dynamics and effects consistent with that kind of energy. Dark negative energy is a condition of the vacuum itself. It represents a sort of "empty container and empty container dynamics" (negative energy dynamics) in the vacuum itself, which "eats positive energy", so to speak. In philosophical terms, dark positive energy represents unaccounted actions and effects from unaccounted "extra presence of real substance and things and actions". Dark negative energy represents unaccounted actions and effects from "extra absence of real substance and things and actions beyond zero". Dark negative energy exhibits precisely appositive effects to the effects produced by dark positive energy. E g., dark energy creates the excess gravity that is holding the arms of the spiral galaxies together. Negative energy resulting from spacetime curvature conditions in highly

energetic astronomical phenomena produces the *antigravity* that is responsible for the acceleration of the expansion of the universe. We have nominated the negative energy Dirac sea hole phenomena as the cause of the antigravity that accelerates the expanding universe. Interestingly, these negative energy phenomena present in sharp discharge (strong gradient) phenomena appear to be responsible for the fact that such phenomena are known to violate present thermodynamics, and are being studied under the aegis of "extended thermodynamics". See discussion of areas violating thermodynamics in the last chapter of Kondepudi and Prigogine, *Modern Thermodynamics: From Heat Engines to Dissipative Structures,* Wiley, New York, 1998, reprinted with corrections in 1999. A reference is D. Jou, *Extended Irreversible Thermodynamics,* Springer-Verlag, New York, 1996.

degenerate semiconductor: A semiconductor whose conductivity approaches that of a metal.

demodulation: From a carrier containing a modulated signal, recovering the signal that was used to modulate it.

deterministic pattern or "template": The exact arrangement, by plan and deterministic action, of a group of entities. The deterministic actions and their "controlling forces" are simply called "dynamics", "structuring", etc. An example might be deterministic field structuring and actions of photons in a "herd" or "group". Or of a set of spacetime curvatures, into a dynamic structure called a *spacetime curvature engine* — or *engine* for short, so long as the meaning is clear. Or by hidden order in the virtual photons in the vacuum flux, or a deterministic set of changes to that vacuum flux (the vacuum flux that is called the "vacuum potential." We have called this *internal EM dynamics* function — of deterministically patterning or templating the virtual flux (particle view) of the potential, or of deterministically patterning or templating the longitudinal and time-polarized EM wave decomposition (wave view) of the potential - *dimensioning* the potential. See **dimensioning.** We refer to the deterministic structure and its structural dynamics as the "engine template".

dielectric: Literally, "against electric (current)", originally coined to mean "opposes the flow or conduction of electric fluid". In today's language, a dielectric is a non-conducting material used to oppose or prevent the flow of electric charges. Even empty vacuum exhibits some dielectric resistance. "Dielectric" is also used to refer to a nonconducting material (often between the metal plates of a capacitor or elsewhere) that can (i)

sustain a change in potential across a distance (i.e., an E-field), and (ii) serve as an insulator. Space itself is a dielectric, or at least is said to exhibit certain dielectric qualities.

dimension: A certain primary geometrical physical attribute, such as length, used to describe the separational relationships of physical phenomena. Actually, "dimension" just means "fundamental quantity of separation" and "geometry" in the most general sense. Dimensions thus become a sort of set of fundamental variables describing the *extensivity* of system and the dynamics of that extensivity. The number of dimensions taken in advanced physics usually represents a somewhat arbitrary choice for good modeling fit. In modern Kaluza-Klein theory, for example, it becomes necessary to accept some 10 or 11 dimensions in the usual particle physics case. Sometimes more than 20, or even an infinite number, of dimensions may be used. General relativity (GR) has incorporated the interaction of the abstract geometry (spacetime) with mass, so that *geometry is a real, active, dynamic entity.* Until Sachs' extension of Einstein's work into a unified field theory and Evans' incorporation of O(3) electrodynamics as an important subset of Sachs' unified theory, GR has largely remained a nonexperimental discipline, at least in the laboratory. With the new Sachs-Evans approach and with recovery of (a) the Heaviside dark energy flow component (b) overunity EM systems arbitratily discarded by Lorentz symmetrical regauging, and (c) modeling of the complete supersystem including system, vacuum, and spacetime in mutual interaction, GR suddenly becomes substantially engineerable by novel electromagnetic means, both in the laboratory and in operating devices. We are thus entering a great new age of electrogravitation and a new physics. Research in antigravity lifters, COP>1.0 electrical power systems, medical therapy utilizing engines and anti-engines, and cold fusion are the elements of the new science that are struggling to be born and funded.

dimensi**oning:** Coined term meaning "forming an exact pattern or template of structures", particularly of nested curvatures of spacetime, where the pattern/template may also be dynamic, to include patterning and dynamics in the time-energy domain as well as the 3-space energy domain. It involves the internal structuring of the "dimensioned" entity. The term "dimensioning" makes sense in unified field theory, but is awkward in normal EM theory, which erroneously assumes that EM energy propagates in an uncurved spacetime. The mere presence of a change in local spatial energy, created by the wave energy itself when present in that local region, curves the local spacetime. Note that the background potential may be

changed in a steady state level as well, which means that the frame of the system and its field dynamics has been rotated away from the laboratory frame. A time-polarized EM wave, e.g., changes the time-energy density and also curves local spacetime very powerfully. Hence the EM wave rigorously travels in curved spacetime, and in fact identically is a propagating, oscillating curvature of spacetime. What is missing from present physics is all accounting of the extraordinary Heaviside nondiverged energy flow component accompanying the accounted Poynting diverged energy flow component. Thus present physics *does not properly account for* the gravitational aspects of "electrodynamic field and potential energy in space".

Dimensioning also implies a deliberate form or structure (with dynamics) created in the virtual photon flux of the vacuum, in the virtual photon flux comprising a scalar potential, or in the infolded longitudinal-wave EM inside all EM potentials, fields, and waves. It implies an associated set of spacetime curvatures and their dynamics. The latter are referred to as "engines", "vacuum engines", "spacetime curvature engines", etc.

Dimensioning the potentials or signals or carrier waves of conventional electrodynamics involves adding hidden *vacuum engines* to them. The term *dimensioning* is descriptive and was chosen because adding such templates is equivalent to increasing the EM topology by adding mathematical dimensions. Since an EM wave or field or vector potential can be decomposed into two scalar potentials, then "dimensioning" one or both of the scalar potentials can "infold" the desired hidden structures or patterns (vacuum engines) inside an EM carrier wave, EM field, or vector potential created by the interference of the two dimensioned base potentials. This is referred to as *dimensioning* those EM field and wave entities. Internally structuring the two scalar potentials via arrays of longitudinal EM wave emitters and applying the necessary dynamics (modulations), is the primary manner to directly engineer dimensioning. When dimensioning is present, two EM waves that appear identical as seen on the oscilloscope may have dramatically differing internal structures (dimensioning). Hence they may produce drastically differing effects when they interact with the same or similar objects. *The only way in which the action of a vacuum engine can be resisted is to create and simultaneously introduce the exact antiengine for it — a special sort of forcible symmetrical regauging, so to speak.* Once the action has been completed in the receiving object and it has been physically changed, the only way it usually can be undone is to form a precise antiengine for that action, amplify the antiengine, and let the antiengine act upon the object for a

sufficient time to "time-reverse it back to its previous physical state and condition". The concept has great utility in electromagnetic healing, not discussed in this book. We point out that the decades-long induction of diseases, health changes, etc. in U.S. personnel in the U.S. Embassy in Moscow occurred in forcefield-free regions. In short, the changes occurred in regions where the potentials were stable and unchanging, and so their e**ngines** were stable and constantly applied to the exposed personnel. The Soviets were simply radiating a high level target, the U.S. Ambassador and his **staff,** to guarantee high-level U.S. attention. By U.S. reaction to the **deliberate** electromagnetic "engine" induction of disease and health c**hanges** (three Ambassadors sickened and later died), the Soviets could posit**ively** ascertain whether we knew of the "infolding" or "dimensioning" technology, and whether we had developed defenses.

dipole: In the simplest case, two separated charges of usually equal magnitude and of opposite sign. More generally, a localized positive charge or charge distribution, and a localized negative charge or charge distribution, such that the net charge summation is zero, while the positive and **negative** charge distributions do not precisely superpose point to point but only on the average. We point out, however, that in regular physics electrical *charge* has no proper definition. As is well known in particle physics.due to the opposite charges on its end a dipole is a broken **symmctry** in the virtual photon flux of the vacuum. By definition of broken symmetry, this means that *some* of the virtual energy flux continuously abso**rbed** from the seething vacuum by the charges of the dipole is not re-radia**ted** as *virtual* energy. Instead, it is integrated *coherently* and re-radiate**d** in 3-space as real emitted EM energy, establishing the fields and pote**ntials** associated with that source charge or source dipole. The dipole is the**refore** the most fundamental true "negative resistor" since it freely and continuously receives EM energy in unusable form, transduces it into usable form, and re-emits it in usable EM form.

It follows that any positive charge in the universe and any negative charge in the universe form a dipole and a broken symmetry in the vacuum flux. Hence every such dipolarity in the universe already extracts energy from the vacuum and puts it out in 3-space, or absorbs energy from 3-space and returns it to the vacuum. Kron called this an "open path" electrically, well before broken symmetry was formally discovered and experimentally prove in 1957. Kron was also able to use the open path in and around special electromagnetic circuits to cause the circuits to become true negative resistors, freely powering the network analyzer at Stanford Universoty even in the 1930s.

In classical EM theory, the problem of how every charge and dipole can continuously emit EM energy to form all the associated fields and potentials and their energy has been an unsolved problem — sometimes called the most difficult problem in electrodynamics, both classical and quantal. For the solution and a discussion, see the present author's paper "Giant Negentropy from the Common Dipole," *Journal of New Energy,* 5(1), Summer 2000, p. 11-23. Symmetry represents a conservation law, and broken symmetry represents violation of that conservation law. Because of the broken 3-symmetry of the dipole, the EM energy flow is not conserved in three dimensions — in this case, violation of conservation of 3-space EM energy flow is not conserved. Neither is the time EM energy flow conserved in the 4th dimension. Instead, EM energy flow is conserved in 4-dimensions, between the inflow in the time-domain and the outflow in 3-space in all directions, or vice versa. The hidden inflow of EM energy to the dipole (and to a charge) is actually from the complex plane (time domain). Thus all EM energy in 3-space is actually received by the source charge or source dipole from the time-domain, and returned to the time domain. What we call "propagation of EM energy through 3-space" is actually the spreading of this 4-circulation to successive 3-space points. The importance of the internal structuring of time-flow and of longitudinal EM waves in the time domain (dimensioning in the time-domain) is apparent, since it produces very powerful engines that can act upon matter in any fashion desired. Indeed, the Russians have developed clandestine robot engine systems comprised of sets of spacetime curvatures and their dynamics (which are just sets of longitudinal EM waves and their dynamics). Any function of a weapon system — sensing, weapons (using scalar interferometry), communications, propagation, etc. — can be incorporated. The capabilities of such systems, such as travel through continuously emitted EM signal beams from satellites, communications stations, power lines, etc., is eerie. Such a system can reside in any convenient EM potential or field as a "dimensioning" of the potential or field. Such robot engine systems have been clandestinely tested, but discussion of them is beyond the scope of this book. Suffice it to say that these systems are ushering in a dramatic revolution in future warfare, and the present research in physical nanobots is already decades behind.

Very powerful support for the author's solution of the source-charge problem is given by F. Mandl and G. Shaw, *Quantum Field Theory,* Wiley, 1984, Revised edition 1993, under the heading "Covariant Quantization of the Photon Propagator" in Chapter 5. In their deeper coverage of the photon polarizations, Mandl and Shaw point out that the longitudinal and

scalar polarizations are not directly observable, but only in combination, where they manifest as the "instantaneous" Coulomb (i.e., electrostatic) potential.

Translated from particle terminology to wave terminology, Mandl's and Shaw's argument directly fits my re-interpretation of Whittaker's 1903 decomposition of the scalar potential.

Dirac, Paul A. M.: Noted English physicist, 1902-1984, who shared the Nobel Prize for developing wave mechanics and predicting the existence of the positron. He also originated the notion of "holes" or negative energy **states** in the vacuum, where the holes are ordinarily filled with electrons. The "vacuum replete with these Dirac structures" (all filled with electrons) is referred to as the *Dirac Sea.* If some of the holes are empty, then that is **the** Dirac sea of a curved spacetime. We strongly stress that a Dirac sea **hole** (negative energy electron with negative charge, negative energy EM fields and potentials, and with negative mass-energy) prior to observation (prior to its reaction with mass) is a quite different entity from the positron (after reaction with mass, so that the positron has positive mass-energy, **positive** charge, positive energy EM fields and potentials, and has been reversed in its 3-space propagation direction). Specifically, the Dirac sea **hole** produces negative energy fields and potentials, whose powerful Heaviside nondiverged components enable to perform practical antigravity. The (observed) positron produces gravity, not antigravity, and also positive energy fields and potentials.

Dirac sea: A concept and description (modeling) of the vacuum as containing — amongst other things — a "sea" of an infinite set of negative energy slates ("holes") for electrons, almost all of which are usually filled with electrons in the absence of any spacetime curvature of significance. In Dirac electron theory, the relativistic wave equation for the electron has four components, which correspond to two spin orientations and two energy conditions: positive and negative. Ordinary electrons are in the positive energy condition. So then the vacuum must also possess a "sea" of negative electron energy conditions. These negative conditions are called "holes" and are ordinarily filled or mostly filled with electrons which have fallen into these negative energy states. The Dirac sea is this vacuum sea of negative energy electrons (and a perhaps a few empty holes). In forward time, if energy is added to a negative energy electron, electrons can be **lifted** from this sea, since the added energy creates a local curvature of spacetime. If spacetime is locally curved, additional holes may be created so that, when the holes meet normal positive energy electrons, the electrons fall in and disappear, creating the appearance of an "electrical

energy sink." This can happen so that the local ST curvature merely relaxes back to an uncurved spacetime, therefore avoiding radiation from "pair annihilation". If the curvature is in the opposite direction (i.e., if positive energy is added to the vacuum), electrons may be lifted from the Dirac sea by the resulting spacetime curvature energy, thus producing a flow of electrons "right out of the nonlinear vacuum" and generated by the spacetime curvature, and creating the appearance of an "electrical energy source" from the vacuum itself. In that case the energetic holes left behind also remain, and are affected by all EM fields etc. These holes thus form negative energy currents, fields, potentials, waves, and other electromagnetic entities such as negative energy charging and discharging (excitation and de-excitation).

In an overunity EM system, there is a higher energy density in the output section than in the input section. This includes time-energy density. So a higher tempic potential exists at the output than at the input. A gradient in the tempic potential thus exists, which constitutes a tempic force from the output section back through the system to its input section, and even on back through the conductors to the external power source, and even back into the distant external power source itself. Thus the power source has to furnish additional electron current. It must "power the holes", so to speak, by furnishing the electrons that are "eaten" by the Dirac hole current to eliminate it, which represents a novel kind of load in the input section of the system. So the power supply must furnish more power, so as to furnish the normal power to power the system, and the extra power to "power the elimination of the Dirac sea hole current as a back-reflected load". This is nature's way of decaying the excited state represented by COP>1.0, and restoring equilibrium and COP<1.0. By the Bedini process, the otherwise detrimental Dirac sea hole current reaching the input section is transformed into ordinary electron current, thus serving as input power to the system. By adjusting the system and optimizing it, this strange kind of "positive power input from converted Dirac hole current negative power feedback" can be adjusted to equal the input power required by the system. At that point the external power system can be disconnected, and the unit continues in close-looped and self-powering operation, including powering its load as well. Gabriel Kron succinctly described this condition and adjusting for it. Such a system allows energy to be continuously extracted from the vacuum, and a load to be powered continuously, with all the energy to run the extracting system being freely received from the active vacuum.

Dirac sea hole: A negative energy state for an electron, in the Dirac theory (in the Dirac sea). Literally the hole (negative energy state) when not occupied by the electron. In flat spacetime, almost all Dirac sea holes are filled with electrons. A small fraction on the average are not filled due to the local fluctuations of the vacuum energy continually lifting electrons from their holes and then having them recombine, usually so quickly that no radiation occurs in the observable state. The situation in the virtual state can be described by Feynman diagrams. This received view can be falsified in a curved spacetime. There the holes can exist and flow as currents, as validly as positive energy electrons can flow as currents, without the incessant "filling" activity of the vacuum itself. In addition, in such a hole-stabilizing curved spacetime region, the hole can "eat" or recombine with a real electron, so that the electron vanishes but without radiation. If we wish to join the two views, then we take Feynman's and Wheeler's view that the field does not exist in vacuum as such, but only the potential for it exists — in short, only the engine exists. The engine can then be said to be an ordering (chaotic self-ordering) condition present on the statistical random variation of the fluctuations of the vacuum. With longitudinal EM wave technology, this "order in the midst of disorder" — this templating and engine technology — can be directly engineered.

Dirac sea hole current (positron current): Just as a current of positive energy electrons can be generated, a current of negative energy Dirac sea holes can also be generated if the local spacetime is properly curved. Mathematically these are usually considered to be "positron currents", except they have no positive mass, because a hole will "eat" an electron. In an overunity electrical power system, the tempic potential is greater at the output of the system than is the tempic potential at the input section. There thus exists a "tempic force" or "tempic broom" sweeping Dirac sea hole current (positron current) out of the input section of the system into the external power supply. Simple instruments will record this current as if it were electron current being furnished from the external power supply to the system. Also, the Dirac sea positron current will "charge" the battery with Dirac sea holes (mathematical positrons), which in the conventional sense discharges the battery. A battery may become highly charged with Dirac sea holes. If so, then when placed on a normal battery charger, the electrons in the charging current will be "eaten" for an extended period by falling into the Dirac sea holes, and the battery will not acquire any charge until they are filled — whereupon the battery will sudden begin charging upnormally again.

We also point out that the vacuum, containing the Dirac sea, actually is not "massless" at all, but has zero resultant mass on the average, as a result of the simultaneously presence of positive and negative mass in average equal abundance. Any curvature of spacetime must violate this "net sum zero" mass, hence produces inertia in all masses. Note that a negative mass can also exhibit a negative inertia; i.e., it accelerates and enhances the action of any force acting upon it, instead of opposing it. In short, negative mass exhibits negative inertia. We suggest that this effect is probably involved in the more violent explosive phenomena of astrophysics.

disequilibrium: Broken equilibrium, which in turn involves breaking appropriate conservation laws unless compensated.

displacement current: The apparent continuation of a conduction current through a region of space without a conductor, e.g., between the plates of a capacitor. Rather than being the motion of charges in a conductor, the displacement current is related to the rate of change of an E-field, and thus to the rate of change of the strain of the dielectric.

dissipative structure: In open systems far from thermodynamic equilibrium, a region of self-ordered behavior of a special kind in matter, characterized by symmetry-breaking, multiple choices, and correlations of macroscopic range. By correlations we mean statistically reproducible relations between distant parts of the system. Formation of a dissipative structure represents the birth of complexity in that region by self-organization. Usually a dissipative structure emerges only after the driving constraints reach a critical value. As the embryonic "engine" technology advances, however, the direct engineering and control of dissipative structures will become commonplace and routine.

distortion correction theorem: "If a scalar wave $E_1(r)$ propagates from left to right through an arbitrary but lossless dielectric medium, and if we generate in some region of space [say near z = 0] its phase conjugate replica $E_2(r)$, then E_2 will propagate backward from right to left through the dielectric medium, remaining everywhere the phase conjugate of E_1." Quoted from Amnon Yariv, *Optical Electronics,* 3rd Edn., Holt, Rinehart and Winston, New York, 1985, p. 500-501.

What is missing from the distortion correction theorem is hidden in the phrase *"if we generate in some region of space ... its phase conjugate replica. ".* Since electrodynamicists and optical physicists have been unaware that all EM energy at any point in space comes from the time domain to that point, then —*prior to detection by interaction with charge* — the actual phase conjugate wave exists in the imaginary plane (in the

time domain) and *not* in 3-space. The continuous interaction of that imaginary plane wave with charges, to actually produce the force-field wave in space, is *assumed* in the standard nonlinear optics. In short, one is looking at the "effect" wave, not the "cause" wave. However, since time is not an observable even in theory, it is this "effect" wave in 3-space that will indeed be measured by our instruments, because they must interact the imaginary or phase conjugate field with charge in order to detect or observe it (measure it).

The proof of this is experimentally already known but not recognized. If one reflects an EM wave off a normal mirror, the mirror must absorb the incoming wave, which transfers the wave momentum to the mirror to repel it, then the mirror must re-emit it, which adds that much more momentum to the recoil. So the mirror recoils with twice the momentum of the reflected wave. That produces a wave going in the other direction. If the incoming wave is continuous, one then has "paired" waves going in **opposite** directions). However, if an incoming wave strikes a phase *conjugate* mirror (PCM) material and is phase conjugated, a wave going in the opposite direction also emerges, but it synchronizes point by point with every spatial point occupied by the incoming wave. Also, *the phase conjugate mirror does not recoil at all.* This is well known in phase conjugate optics. It clearly shows that the origin of the "detected" phase conjugate wave is quite different from that of a normal reflected wave. Indeed, by our reinterpretation of Whittaker's 1903 biwave decomposition of the scalar potential, at every point along the detected phase conjugate wave, the energy enters that point from the time domain, and not from some sort of reflection from the PCM. The energy also returns to the time domain from that point. Its presence at the point produces a separation of virtual point charges, or the well-known polarization of the vacuum. So the flow of energy is from the time domain to the negative charge of the point dipole, thence to the positive charge of the dipole or others immediately surrounding it, thence back to the time domain. That is the operation in a "time-forward" sense to the external observer. In a "time-reversed" situation, the 4-circulation appears in the opposite direction. We propose that this fundamental 4-circulation is responsible for and constitutes spin itself. The direction of flow determines the 'polarity of the charge" we obseve. In this view, the point dipolarity in the virtual state with its ongoing 4-circulation can be taken as the very definition of energy itself.

Druge, Paul: Important German physicist, 1863-1906, who formulated the theory of the free electron gas inside conductors, using it to formulate a theory of metallic resistance.

Drude electron gas: The electrons that have broken loose from their orbital bonds in atoms in a conductor, and are thus free to "wander around" and "migrate" — or flow as current when exposed to an emf. Also called just the "electron gas". Note that, in the metal lattice of the conductors, each position vacated by a Drude electron is a "hole" or positively charged little region. Not only do electron currents exist as net negative charge migration in conductors and materials, but also hole currents exist as net positive charge migration from atom to atom, or a sort of "ionization migration flow". Electrons are continually recombining with these "ion holes", however, to reduce the hole current. These considerations are particularly significant in semiconductor materials.

duality principle: In quantum mechanics, the principle that photons and other particles propagate like waves and interact like particles, so that their description as only waves or only particles is inadequate.

Edison, Thomas Alva: Noted American inventor, 1847-1900, whose staggering portfolio of inventions included the storage battery, electric light bulb, phonograph, motion pictures, carbon microphone, and many others. Edison actually ran multiple "patenting research" laboratories as discovery and patent generating facilities. Not only was he an inventor himself, but he also employed a very good staff of researchers for invention and discovery.

E-field (electric field): The electric field intensity E; that field on an electric charge (charged mass) which produces an electrical force resulting in a linear motion of the charge. In reality, this electric field *as usually defined* does not and cannot exist in empty space devoid of charge, but only in and on charged matter, since mass is a component of force by $\mathbf{F} \equiv \partial/\partial t(m\mathbf{v})$. More specifically, the E-field is the local intensity of the field at a point, in its interaction with a unit point static charge fixed at the point. Even more specifically, it is the output of an observation/detection operation, which is a *d/dt* operator imposed on the 4-space causal field interaction with the 3-space charge, resulting in a frozen 3-space "slice" or snapshot of the deviation of energy *from* the field, forced to flow around that intercepting charge, at that single instant. In short, the E-field as a force field is an *effect* and not a *cause*.

The greatest error in all electrodynamics is to then assign this same *frozen effectforce field intensity snapshot* — or an implicitly assumed iterative sequence of such snapshots — as the dynamic and nonfrozen *causative field itselfm* 4-space, prior to the field's interaction with charged matter. This is the substitution of effect for cause, a grave non sequitur.

When EM theory was founded, the founders believed there was no single **point** in the entire universe where mass was absent; instead, a thin material "luminiferous ether" was considered to fill all space. Time was considered immutable, and there was no concept of a dynamic *space time.* Hence at each point in such a material ether, the reaction with charged matter (et**heric** matter) was thought to universally exist. Hence the field was indeed a very material entity, in their concept!

With the destruction of the material ether notion in the 1880s, not a single Maxwell-Heaviside equation was changed to eliminate its implicit assumption of the material ether. Hence this enormous error of confusing the *effect* field with the *causal* field (prior to observation-detection-interaction) is ubiquitous in electrodynamics and therefore in physics itself. The two fields (causal and effect) do not even have the same dimensionality; one is dynamic in 4-space while one is frozen in a 3-space snapshot. This has led to the false notion that an EM force field wave "moves through" 3-space, which does not happen at all. What really happens is that, if we assume a continual iterative *d/dt* observation operator, we have a continual series of such frozen 3-space snapshots, like the frames of a motion picture film. But none of those snapshots have any inherent motion at all. For a statement of the falsity of the conventional illustration of the "EM wave in space as an orthogonal pair of oscillating E and H fields in a transverse plane", see Robert H. Romer, "Heat is not a noun." *American Journal of Physics,* 69(2), Feb. 2001, p. 109. In endnote 24. **p** 109, AJP editor Romer takes to task *"...that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/or time?) that besmirch the pages of almost every introductory book. ...it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate. " "...perhaps then, for historical interest, [we should] find out how that diagram came to contaminate our literature in the first place.* "Also see charge.

E-field, **motional:** In classical EM theory, the electric field produced by moving a conductor in a magnetic field. Often called *motional inductance* of the field. In the conventional theory, motional inductance is deemed to be ident**ical** to the inductance caused by a time rate of change of the magnetic field, experienced by the moving conductor. Or vice versa, experienced by a stationary conductor in a moving magnetic field.

E-field, static: In conventional theory, the electric field in the space surrounding a static charged particle, induced by the presence and action of the charged particle. There is no notion as to the *causative mechanism for this static* field of and from a charge, which implicitly is assumed to

just continuously create and pour out EM energy in all directions, thus grossly violating energy conservation. Consideration of this anomaly leads to what has been called the most pressing problem in both quantal and classical electrodynamics: the question of the formation of the fields and potentials associated with the "source charge". Either the charge totally destroys the conservation of energy law itself, or there must be a *virtual* (nonobservable) energy input to the charge, since instruments establish that no observable EM energy is input to it.

For a solution to this problem, see the present author's "Giant Negentropy from the Common Dipole," *Journal ofNew Energy,* 5(1), Summer 2000, p. 11-23. We later found our solution to be consistent with quantum field theory and with a slight reinterpretation of Whittaker's 1903 decomposition of the scalar potential.

Ehrenhaft, Felix: Scientist who performed numerous experiments believed to demonstrate fractional charges. We point out that classical electrodynamics assumes a local flat spacetime, a notion long falsified by general relativity, since 1915. In a local curvature of spacetime, the dynamics of the charge (modern view as the finite difference between two local infinite charges forming a dipolarity) can change the observed value of the net finite charge. So finite fractional charges, or even supercharges, are quite possible.

Einstein, Albert: German (Jewish) physicist, 1879-1955, who emigrated to the U.S. and formed special and general relativity theory, discovered and formed the theory of Brownian motion, recommended the development of the atomic bomb to President Roosevelt, and profoundly affected the course of science and the modern world,

Einstein, Podolsky, and Rosen (EPR) paradox: Thought experiment in 1935 for measuring two correlated photons separated and at distant locations, protesting that quantum mechanics requires that the particles communicate instantly, which is a "spooky action-at-a distance" (Einstein's phrase). The experiment eventually was performed and it works, just as required by quantum mechanics. The paradox inspired the development of hidden-variable theories.

Einstein's general theory of relativity: Mathematical theory of gravitation in which the gravitational force is mathematically described by a curvature in spacetime. In other words, the geometry and its dynamics have become physical agents, doing away with the old notion of the agent being something separate that is occupying inert spacetime. It is important to note that, in general relativity, mass-energy acts on spacetime to curve

it, and the curvature of spacetime acts back on mass-energy to translate or change it. What seems missing from GR — at least in its practice — is the reaction of time-energy upon the geometry to curve it, and that corresponding reaction of the spacetime curvature back upon time and time-energy to change it.

Further, we consider that an exact pattern (template) of curvatures of spacetime and their dynamics exists and is back-acting upon every mass system and its dynamics. This is the *engine* concept. The most general way to engineer matter is not by brute force translation forces, but by forming spacetime engines. Once formed, these engines act upon the interior of any mass placed in the engine region, to eliminate the deltas existing in that muss's resident engine and the impressed engine. *The forces arise from the local spacetime itself, as curvatures in that local spacetime, so the action is from "inside" to "outside" an object, starting and continuing from every point in the object.* The curvatures of spacetime itself furnish the energy for the continuing actions upon the interior of the mass, once we have paid to form the engine. The mass can be acted upon at any level, from its gluons and quarks to its nuclei, to its atoms, its lattice forces and binding energy, etc. Significantly, the Sachs unified field theory applies to physical reality from beneath the quarks and gluons to the entire universe itself, and folds in quantum mechanics, electrodynamics, and general relativity into a single unified field theory that is (in theory) engineerable by higher symmetry electrodynamics means such as Evans' O(3) electrodynamics.

Einstein's postulates: (1) All the laws of physics are equally valid in all inertial frames of reference, (2) the speed of light is the same to every inertial observer, and (3) the observable local effects of a gravitational field are indistinguishable from those arising from acceleration of the frame of reference.

The first is called the special relativity principle, the second is called the law of light propagation, and the third is called the equivalence principle. It is now known that postulates (1) and (2) are not independent of each other. Note that the third postulate implies that any local force is due to a "gravitational field" (acceleration of the frame of reference). It also implies that gravitational force has a mechanism, since quantum mechanics assigns a differential operator, operating upon a potential, to create every force. By extended inference, it can be seen that the third postulate also implies that there should exist a method to turn any type of force (field) into gravitational force (field).

Note that postulate 1 may be violated if two frames remain inertial but each local spacetime contains different hidden engines. So the laws of interaction physics may indeed vary for the same object placed in first one of the frames and then in the second. Engines are ongoing general relativity actions, even in inertial frames. The action may not be translation of the bulk object, but extensive changes to the interior of the object and its interior dynamics at any and all levels.

The Russian physicist Sakharov has strongly postulated that gravitation is not even a fundamental field of physics, of the kind used by Maxwell in his electrodynamics. Instead, in this view G-field is always comprised of, and made from, other fields and interactions upon them. This would seem to follow straightaway since change of any kind of energy in spacetime curves that spacetime, therefore producing a gravitational change. So such has always been implicit in general relativity; it just took Sakharov to formally propose it. See A. D. Sakharov, "Vacuum Quantum Fluctuations in Curved Space and the Theory of Gravitation," *Soviet Physics Doklady,* 12(11), 1968, p. 1040-1041 [English translation.] Sakharov's article (in Russian) in *Dokl. Akad. Nauk SSSR,* Vol. 177, 1967, p. 70-71.

Einstein's postulates (second postulate extended): Let us do a little "tinkering" with Einstein's postulates. For the first one, we point out that in the new approach using dimensioning and subspaces, the notion of an inertial frame now has acquired additional complexity! The "gross translation" effects — which tends to be what physics ultimately focuses upon today — can remain the same, and yet vacuum engines can be buried up inside the inertial frame to act upon a mass in non-translating ways. Everything translation-wise can remain the same, but now matter can be transmuted and transformed, etc., still right there in an inertial frame. So when the infolded electrodynamics inside all fields, potentials, and waves are utilized, the notion of "inertial frame" has acquired a higher topology, so that one inertial frame may differ very substantially from another inertial frame, even if the two are not in translation motion with respect to each other. This of course moves one from special relativity into full general relativity, and even there into a slight extension. Special relativity can remain special relativity on the surface, and yet general relativity effects occur "within" the objects postulated to exist in this inertial frame. The "inertial frame" concept in the postulates is now just a sort of special "equilibrium case" of a higher topology "inertial frame" notion. Further, general relativity is extended from the notion of "just translation" to the notion of "internal engines and internal dynamics also". These engines can

be created in mass, in fields and potentials and waves, and in the vacuum itself.

The second postulate now stands as a "special case" of a far more general second postulate. The conventional second postulate actually defines (and limits) "light" to bulk changes in the entire vacuum potential magnitude. It only applies to light signals which are "bulk upheaval" disturbances of the vacuum potential (spacetime), so to speak. The limitation to light speed is an envelope wave speed restriction. Specifically it need not apply to the "inner EM/GR realm" of longitudinal EM waves infolded inside the vacuum potential, other potentials, signal carriers, etc. Superluminal communication is now included in this "hidden variable" or longitudinal EM wave communication. The Fogal semiconductor is capable of infolding and outfolding EM signals, including producing the internal longitudinal EM waves, and during their infolded state these signals are permitted to move at superluminal velocity. This has been experimentally demonstrated by Fogal.

So the second postulate needs to be restated to include the present statement as a special case. Notice that the concepts "light" and "speed of light" have now taken on much richer, extended meanings, since there is "outfolded" light and "infolded" light, so to speak. Light now is not just the "external perturbation wave" in the ambient vacuum potential medium (in flat spacetime). Instead, it can also be an "internal perturbation longitudinal wave" inside a "net flat spacetime" which does not show on the "surface" at all. Indeed, it may move in the time dimension or in 3-space. It now includes the transmission of an extraordinary "vacuum engine" as well as the usual transmission of just an ordinary signal. The ultimate expression of this extension has unfortunately been the development of such "engines" as infolded robot systems for use in warfare.

These infolded vacuum engines can be visualized as very special sets of longitudinal EM waves and their dynamics, consistent with the Whittaker decomposition. Whittaker's U(1) symmetry electrodynamics decomposition— particularly when enriched in the higher symmetry O(3) electrodynamics — applies to the ambient vacuum as a potential (it is a potential since it has energy density). So the "subspace" inside spacetime, so to speak, is just a set of LWs and their dynamics, and that subspace itself is engineerable, just as is the "bulk curvature of spacetime" itself. Further, we may now consider that space itself is just a vast superhighway for such superluminal LWs and their dynamics. Mass is mostly empty space with only an occasional particle here and there and with fields,

potentials, and waves in between. Hence huge masses such as the ocean and earth are actually superhighways for the direct passage of longitudinal EM waves, "engines", special robots, etc. The degree of "transparency" is a function of the degree of cleanness of the LWs — where by "clean" we mean "absence of transverse EM wave residues".

The third postulate has also been dramatically extended and requires revision. As presently stated, antigravity effects do not appear to be included in present physics heretofore. The "gravitational effects and external accelerated effects" notion in conventional physics are still founded purely on *ordinary bulk translation.* Now they need not be. For example, the system can appear to be an ordinary system, as judged by normal "external light" observation. Yet its internal vacuum engines can cause local violation of most so-called "laws of nature." The reason a "law of nature" can be violated is that one is now able to violate the premises upon which it is postulated, and which are required to hold if the law is to hold. Or another way to look at it: any conservation law is the result of a symmetry. Breaking that symmetry allows violation of that specific conservation law. All external symmetries can be broken internally, even if the overall symmetry still applies externally!

The infolded EM inside the "conventional" EM fields, waves, and potentials — and inside the vacuum potential and spacetime itself- dramatically changes the present theories of electromagnetism, quantum mechanics, and general relativity. Further, for the first time the Sachs unified field theory allows an *engineering* approach that simultaneously crosses, includes, and extends all three disciplines in the required manner. The approach can be placed into good engineering models based on the Sachs work, particularly using the O(3) electrodynamics subset spearheaded by Evans, and the models can be tested and verified or falsified. See **frame, reference;** and **superluminal communication.**

electric field: (See also discussion under **E-field).** The *conventional* definition is this: "1. a region in space in which a stationary electric charge experiences a force due to its charge. 2. the electric force per unit test charge." Quoted from *Dictionary ofScience and Technology,* p. 720. That definition is flawed. Consider the "spatial aspects" of part 1. If an electric field is defined as a force per unit charge (per Part 2), it is not a region in massless space but is an effect of something existing in massless spacetimc and interacting with the charged 3-spatial mass. The electric field *prior to interaction and observation ofthe interaction* is indeed related to a region in "spacetime", because it is identically a curved spacetime region. In the Sachs approach, general relativity and electrodynamics have become one

and the same. So prior to interaction, the *field as it independently exists prior to interaction with charge* has become a curved spacetime region, and the field-in-space is *purely* a spacetime curvature. Again, there is no such thing as a massless force. It is the hoary old mechanics notion of a separate force acting upon a separate mass that is a total non sequitur. The interaction of the massless field in space with a mass to produce a force, *of which that mass is actually a component,* is a separate consideration from the field as it exists in space prior to interaction. The result of this entity's interaction with charged mass has nothing to do with *what an electric field* is but with *what it does to charged mass.* Further, the force evidenced on a charged particle is not due to its charge; the particle has that charge always, whether or not there is a net force evidenced on it!

Part 2 is a little better. The only problem is, it totally disagrees with the notion of the field as an entity existing in spacetime prior to interaction with charged mass. In other words, here it's a "force on a charge", which is an effect (force consisting partially of the charge) occurring after the interaction. Again, the conventional definition states only what the field *does or accomplishes,* not what it *is.* Hopefully the reader can now begin to see what terrible difficulties await anyone who seriously attempts *foundations definitions.* Feynman sums it up admirably in one of his famous statements: "*Everything we know is only some kind of approximation, therefore, things must he learned only to be unlearned again or, more likely, corrected.* "An additional difficulty is that the very notion of a separate massless force — independent of the mass on which it operates - is fictitious, yet continues to be widely used. Recalling that any true definition is an identity and not an equation, let us start with the definition of force: $\mathbf{F} \equiv d/dt(m\mathbf{v})$. As can be seen, force is a system comprised of (i) a mass component and (ii) a nonmass component. The force is not something separate from the mass, at all! Further, force is not even unitary. It's a system comprised of two coupled components; the mass and a coupled (interacting) gradient in a potential flux. *Note that v involves motion through, and interaction with, the virtual flux comprising the vacuum potential. Note that dv/dt involves a gradient in that flux interaction with the mass.* Unfortunately mechanics is still using the medieval concept of a "separate force acting upon a separate mass." That is wrong, unless we change the fundamental definition of force itself. See, e.g, Robert Bruce Lindsay and Henry Margenau, *Foundations of Physics, Dover* Publications, New York, 1963, p. 283, where the authors emphasize that a "field of force" at any point is actually defined only for the case when a unit mass is present at that point. The reason can be seen: mass is a necessary component of force, and without mass present there cannot be a

force present. For that reason, the force field in matter is a quite different beast from that "same" force field in empty spacetime. The first is a 3-spatial snapshot of an ongoing 4-spatial interaction, while the second is just a curved region of that "empty" spacetime without any ongoing reaction necessarily.

electric dipole: See **dipole.**

electrodynamicist: A specialist in electrodynamics — the physics of the relationships between electric, magnetic, and mechanical phenomena — and especially a specialist in electrodynamics *theory.* Essentially all electrodynamicists are versed in U(1) electrodynamics, and a much smaller number are versed in more advanced (higher group symmetry) electrodynamics such as O(3) symmetry electrodynamics, unified field theory electrodynamics, non-Abelian electrodynamics, etc. The electrodynamics field is actually a very vast field indeed, touching everything in physics, chemistry, etc. When one needs a particular electrodynamics problem solved, it often calls for a special category of electrodynamicist and not just an electrodynamicist in general. One must therefore sometimes examine the background of the electrodynamicist making a statement or a pronouncement; electrodynamicists after all do have differing views and differing disciplines within the field. And something may be perfectly true and acceptable in O(3) electrodynamics, yet not even exist in U(1) electrodynamics. As an example, the Aharonov-Bohm effect exists in O(3), but not in U(1). U(1) assumes a flat local spacetime (falsified by general relativity almost a century ago) and an inert vacuum (strongly falsified by modern particle physics and quantum mechanics), while O(3) is perfectly content to include and model curved spacetime and active vacuum also.

electromotive force (EMF): A difference of potential created by sources of electrical energy — i.e., by separated charges (dipoles) — which can be utilized to drive electrical currents through external circuits. As a difference of potential, that constitutes a gradient and hence a force. Also, open circuit voltage, or the limit of the potential difference between the source's terminals as the current in the external circuit approaches zero.

This term is poorly named and also quite confused in the standard theory and usage. First, em/is supposedly not a *force* at all. It is a difference in potential; hence it is measured in volts. It is very difficult to imagine a "difference in potential" at a single point unless one is dealing with a multiply connected space. So if the difference in potential is between two adjacent points, then that constitutes a force between the two points. Also,

emf is not considered an E-field, since that is a field of force. Yet it is in fact a $\nabla\phi$, restricted to the direction between the two measurement points, and $-\nabla\phi$ is considered to be an E-field in the EM theory! As can be seen, one will not find a truly logical definition of potential or emf in the present texts and science literature.

For this reason the standard theorists say that the term emf is sometimes used as equivalent to a difference in potential, but that strictly speaking it should be applied only to a source of electrical energy. The problem is that most conventional theorists are unaware that a potential *identically is* a bidirectional flow of energy in 3-space, but a 3-space flow where *the energy enters from the time-domain (complex plane) and is caught in 3-space by interaction with charge, in a frozen snapshot (observation). The energy actually enters each 3-space point in the 4-space potential, from the time domain.* It moves across a dipole in space (present due to the quantum mechanical polarization of the vacuum), to the opposite charge, thus returning from the immediate region of that second 3-space point (or points) back to the time domain. Since conventional theorists are unaware that a potential is a hidden negentropic energy flow circulation process involving broken 3-symmetry, broken t-symmetry, and a special 4-symmetry between t and 3-space, the theorists have been unable to consider the potential in general as a direct source of energy flow. Yet they are forced to consider a potential difference across the terminals of a source as "somehow a flow of energy, that generates forces upon the electrons to propel them through the circuit as current flow."

In the new viewpoint, a resolution is achieved of these incongruities by more accurately defining the E-field with respect to the potential as $\mathbf{E} = -[\nabla\phi\bullet q]/|q|$. It is noted that $-[dA/dt]\bullet q/|q|$ also produces an E-field, so that the full definition of the E-field is $\mathbf{E} = -[(\nabla\phi+d\mathbf{A}/dt)\bullet q]/|q|$. Note that dividing q by |q| does not remove the q unit from the corresponding dimensional equation, since $|q|$ is dimensionless. However, one volt represents one joule (of excess energy) *diverged from the potential*, per coulomb of interacting charge. *The energy density flow in an electric circuit is in the voltage, in the emf, and it is not in the current per se.* The electron current (drift current) carries the excess energy that is being dissipated as work in the circuit, but in a nominal circuit the drift current only moves a few inches per hour. Half the energy collected in the potentialized circuit is dissipated in the external circuit and external losses, and half is dissipated in forcing spent electrons in the ground return line back up through the back-emf of the source, performing work inside the source to dissipate its separation of charges. Left alone, any dipole will

furnish emf indefinitely, freely receiving the energy from the time domain (complex plane) and outputting it in 3-space via the reinterpreted Whittaker 1903 decomposition, in a circulation where at each point in it the energy enters from the time domain and thence returns back to the time domain. The free flow of EM energy will continue unabated from the undestroyed dipole, regardless of how many external loads and losses are powered (how much energy is collected and dissipated from the ongoing flows representing the potential). So *electrical circuits should be developed which allow few or no electrons to be forced back up through the source dipole to dissipate its separation of charges and destroy the dipole.*

electromotive force, back (back emf): Back emf is a loose term for the *counter-electromotive force.*

When the source is powering a circuit or circuit element, the term "back emf is used to refer to the forcing of current (electrons) back up through the source against its emf, thereby performing work inside the source to *dissipate* its separation of charges (its dipolarity). When a potential source of electrical energy — such as a capacitor, an inductor, or a rotating machine — is receiving energy from a source and converting it to *dissipative* power and work, that "powered" device is said to develop a *counter-emf.* A source has a built-in emf *a priori,* and this emf is holding its charges separated so that it is dipolar. When electron current is forced backwards through the source against its emf, work is performed against the internal resistance of the source to dissipate its separation of charges, thereby *dissipating* the source dipole. If electron current is not allowed to flow back up through the source against its back emf and through its built-in counter-emf, no dissipation of the source dipole occurs, even though energy density (not *electron current* dq/dt but *energy flow* dq/dt) is flowing from the source and can be collected in *collectors* in the external circuit to store the energy as a created local energy source. This collected energy can then be shuttled to a separate load circuit and released, to provide a "heat pump" cycling operation and overunity coefficient of performance.

Nikola Tesla in fact knew how to shuttle energy at will in a circuit in such fashion, as Barrett's quaternion analysis of Tesla's actual patented circuits has revealed. [See T.W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," *Annales de la Fondation Louis de Broglie,* 16(1), 1991, p. 23-41.] Note that a rigorous analysis of those same circuits, using tensors or vectors (lower topology algebras), will not show the effect. One

needs a higher-topology algebra such as quaternions or Clifford algebra, or **the** significant properties of such circuits will be entirely missed.

When the original source dipole is not dissipated because electron current is **not** passed back up through its back-emf to scatter the charges, the o**riginal** source dipole will continue to furnish emf indefinitely because of **the** proven asymmetry of its opposite charges in the seething vacuum energy flux.

The terms emf and counter-emf are normally applied only to recognized sources of electricity. Emf is computed as the algebraic sum of the **potential** differences acting in a circuit attached to a source. Back-emf (counter-emf) is computed as the potential difference internally through the source, between its terminals. The back-emf is thought to be necessary in producing *a powered device or component in the circuit.* Actually, *its* ***main*** *application (the ubiquitous closed current loop where all the external circuit current is passed back through the back-emf of the source dipole) is to prevent COP>1.0 electrical power systems from being developed and utilized, andfor every electrical circuit to self-enforce Lorentz symmetrical regauging during its de-excitation phase.*

elect**ron:** A stable elementary particle in all atoms, and having — in "f**orward** time" — a negative charge of 1.602x 10^{-19} coulombs, a spin 1/2, *and a* mass of 9.11×10^{-31} kilograms. If time is reversed, the charge (but not the masss) of the electron is reversed and it becomes a positron. Note this is an equival**ent** *observed* 3-positron, in a material lattice after interaction with charged matter, and not the mathematical equivalent represented by Dirac sea holes in the 4-vacuum prior to interaction with mass.

The "electron" may also exist as a negative energy, negative charge, negative mass-energy 4-state (Dirac hole) in the vacuum itself. In that state, the negative energy 4-electron is the source of negative energy fields and negative energy potentials. When the associated nondiverged and unaccounted Heaviside energy flow component is also accounted, the Dirac sea hole negative energy 4-electron can be manipulated in "anti-circuits" to directly engineer local antigravity, quite strongly and practically.

electron gas: A system of electrons with only weak interactions, so that the electrons may be regarded as moving independently. In many ways, such a collection of electrons can be treated as a gas. See Drude Electron gas.

electrostatic scalar potential: A *static* (stationary, in the sense that a perfect waterfall would appear stationary) ordering in the virtual photon flux of vacuum. The notion of "static" in the term "electrostatic" is misleading and should be replaced by "stationary" since the underlying active vacuum medium is always in violent motion, and there is nothing truly "static" in the universe. But an *equilibrium* or *stationary* condition can exist as an external envelope condition, even with continuous violent motion internally, so that a stationary entity or form persists. An example is a perfect whirlpool in a river.

The electrostatic scalar potential decomposes into a harmonic set of bidirectional phase conjugate longitudinal EM wavepairs, as shown by E. T. Whittaker in 1903. Hence the electrostatic scalar potential is an overall curvature of spacetime with internal longitudinal EM order and dynamics.

ELF: Extremely low frequency. Used to describe EM fields whose frequencies lie in the range from just above 0 Hz (direct current) to 300 Hz. This includes power line frequencies (60 Hz in U.S. and 50 Hz in Europe) and frequencies used by certain U.S. military ELF communication systems such as for submerged submarines.

EMF: Acronym for electromotive force. See discussion under electromotive force.

EM field: Electromagnetic field. In its loose usage, it refers in a very broad way to any field, force, or energy associated with electromagnetic interactions, charges and currents. Thus "EM field" includes electrostatic fields, magnetostatic fields, electromagnetic fields (including radiation and induction), vector-potential and scalar-potential fields, Hertz potentials, Fitzgerald potentials, Whittaker potentials, Debye potentials, etc.

In its precise usage, "EM field" conventionally refers to an EM "force" field, such as the E-field, D-field, B-field, and H-field. In classical electromagnetics (CEM), as a holdover from the old assumption of a material ether, the force fields are considered (erroneously) to exist in mass-free space, and they are also considered to be the primary causes of electromagnetic phenomena. This is a non sequitur, and it involves substituting the effect for the cause.

In the new viewpoint, *the force* fields do not exist in vacuum, but only in and on and of the charged particles themselves, where mass is present to form one component of the force. The force fields are therefore effects and not primary causes. The primary causes of all electromagnetic phenomena is taken to be the potentials; however, the hidden

Stoney/Whittaker/Ziolkowski internal structures of gradient-free scalar potentials may interfere to cause potential gradients in and on charged particle systems. [In O(3) and other higher group symmetry electrodynamics, this internal structuring and dynamics is far richer.] This therefore includes distance-free scalar potential interferometry and action at a distance, as well as vacuum engines.

The new view uses Sachs' unified field theory, and considers that the EM field in the vacuum, or an EM potential in the vacuum, involves and identically is curvature of spacetime. It follows that the internal EM structures of "ordinary" EM are also spacetime curvatures, where the specific pattern of these ST curvatures constitutes a very special kind of spacetime engine that acts upon any local mass in a specific manner determined by the individual pattern of curvatures. Thus the new view is a unified field theory where GR has become EM and EM has become GR, and where higher symmetry EM — such as O(3) group symmetry EM — can involve or produce gravitational, temporal, and inertial effects as well.

EM force field in the vacuum (a false concept : The erroneous notion that there exist forces in the vacuum, so that the set of forces at a set of spatial points forms a force field. Presently classical electrodynamicists accept the same E-field in vacuum as exists upon a charged mass when the vacuum E-field interacts with that charge, but it is asserted that the force is zero. This is easily falsified by defining force F as $\mathbf{F} \equiv \partial \boldsymbol{p}/\partial t = \partial/\partial t(\mathrm{mv})$. By expanding the term on the right, one sees that both terms in the expansion include mass. Mass is thus a *component* of force. If mass is absent, there is no force present, thus no force field present. The field in space and the "same" field in mass differ precisely by a mass term in their fundamental units. The field in massless space may be taken as a curvature of spacetime. Zero field in space means a flat spacetime; a nonzero field in space represents a curvature of spacetime. A nonzero field in mass means a curvature of spacetime (a 4-space entity) interacting with mass (a previous 3-space observation) to produce a force consisting of that field and mass interaction. There is no separate force acting on a separate mass, and mechanics has been wrong in assuming on for hundreds of years. Instead, there is a force produced by the interaction of a massless 4-field (spacetime curvature) entity with 3-spatial mass. It is that *interacting and ongoing entity or process* that is a force field. Speaking of such a force field in space, is speaking of the force field that would exist in that space if every point had a unit point static charge and charged mass. As Feynman and Wheeler pointed out, no force field as such exists in space, but only

the potential for a force field exists there, in case some charged mass is brought in to interact and have the forces developed upon its charges.

EM generatrix: Whatever generates electromagnetics, particularly the fields. Since all EM energy comes from the time domain and returns to it, time is the ultimate EM generatrix. The circulation of EM energy from the time domain to 3-space and back, or vice versa, is a function performed by the broken symmetry of every charge, considered as two infinite dipolarities with a finite difference that is the observed charge listed in texts and handbooks.

energetics: Energy as the primary thing in the universe. Rankine's term later raised to the forefront by Ostwald. Modern Russian term for advanced higher group symmetry electromagnetics, where the electrodynamics is a subset of an engineerable unified field theory. In the U.S., a model approaching the Russian model is given by Evans's O(3) electrodynamics as a special subset of the electrodynamics used by Sachs in his epochal unified field theory. Thus there is a growing, engineerable unified field theory (energetics theory) in the U.S., being provided by Evans, Sachs, and others. A solid basis for energetics can be realized from the giant 4-space negentropy EM energy circulation involved with every charge, so that all "EM energy in space" and time itself comes from that circulation.

energy: Usually erroneously "defined" as the "capacity to do work". This is a total misdefinition since it would define energy as the ability to change its own form. The closest to a legitimate definition of energy appears to be: *energy is the invariance of that which is varying* (Lindsay). However, note that this definition violates Aristotelian logic (but does not violate five-law logic developed in this book). Another try at it might be: *"Energy is any deterministic or coherent structuring, either dynamic or stationary, existing in the virtual particle flux of vacuum."* While that sounds good, it still involves the nonchanging aspect of the changing flux — much like considering a whirlpool in a river as being a "static" thing. So it is still "the invariance of that which is varying", which is an identity of opposites. We conclude that 4- or 5-law logic is necessary in order to define energy, since the defining logic must encompass the identity of opposites. Feynman simply stated: *"It is important to realize that in physics today, we have no knowledge of what energy is_."* [Richard P. Feynman, Robert B. Leighton, and Matthew Sands, *The Feynman Lectures on Physics*, Addison-Wesley, Reading, MA, Vol. 1, 1964, p. 4-2.]. In Aristotelian logic, there is no acceptable definition of energy. In 5-law logic, the second definition holds since opposites can indeed be identical. Now to more practical aspects:

For our purposes, there are three major types of energy in 4-space: (i) 3-spatial energy, which includes energy in one, two, or three of the spatial dimensions, (ii) mass-energy, which is 3-spatial energy compressed by the factor c^2 but still in 3-space, and (iii) time-energy, which is 3-spatial energy compressed by the factor c^2 but now placed in the time domain. **Note t**hat time-energy has the same density as mass-energy, and hence the same spacetime-curvature effect and gravitational capability.

The major implication of the new view is that the conservation of energy law is extended: Now it is the total of the 3-spatial energy, mass-energy, and time-energy that must be conserved. Transduction between time-energy and either of the other two forms, or both, will violate the conventional conservation of the sum of the 3-spatial energy and the mass-energy; every charge and every dipole is an example. Use of time-polarized and longitudinally polarized photons and EM waves particularly may involve the extended conservation law, e.g., as utilized in cold fusion and its lime reversal zones, and as involved in the outpouring of observable EM energy from every charge in the universe, with no observable energy input.

energy collection/collecting: In electromagnetics, placement of an interceptor/collector — e.g., a charged particle — into an impinging EM energy flow, so that some of the flow is diverted around the intercepting particle. We may say that the flow of energy has been "reordered" into a stream diverged around the intercepting charge. The diverged part of the total energy flow is what is calculated as the Poynting energy flow component, and is what is referred to as the "collected" energy or the "potential" of the charge.

However, neither charge nor potential are acceptably defined in conventional electrodynamics, but they can be defined in the new approach. We are now able to see something more fundamental. By the giant negentropy mechanism, the charge is involved in both the time-ene**rgy** stream and the vacuum flux set of virtual particle spatial-energy stream**s.** "Charge" is not just related to the mass of the particle, but is the entire ongoing set of the dynamics as well as the mass (the "nondynamics", so to speak). When a charge is placed in a field, that field is a change to the local dynamics, which is a change to the charge itself. Both the dynamics and the mass (the "nondynamics" constituting the charge are altered. So one does not have the "field acting on a separate charge", but instead we have the charge with its previous set of dynamics transformed into the altered charge with a new set of dynamics and a new mass. Similary when a charge is placed in a potential. Charge is also not a 3-

spatial situation and process, but a 4-spatial situation and process. If the internal structuring is also important, it becomes an n-spatial situation where n>4 and even where $n \gg 4$. To deal with sophisticated engines, $n \gg 4$ is necessary in the modeling utilized.

energy dissipation: Refers to the scattering or disordering of energy; at fundamental basis, it refers to the changing of an altered charge (see energy collection/collecting) back to an unaltered charge. In other words, it is a special decay process whereby an "excited charge" (so to speak) decays back to its "normal state" by releasing dynamics (energy) back to the vacuum. The energy itself is not destroyed, but its "collecting pattern" or "flow pattern" as coupled to the charge is disrupted and altered or destroyed There is also the connotation that *the dissipated energy is lost as far as any re-use of it by the system.* We point out that only collected/collecting energy can be scattered; it is the collecting *process* (the entire alteration of the normal charge dynamics) that is "destroyed" - or more exactly, *transformed* — not the energy itself.

energy, electromagnetic: From a vacuum and quantum mechanical viewpoint: a deterministic or coherent structuring, either dynamic or static, existing in the virtual-photon or charged-particle flux of vacuum. Since a photon may also be considered a positron-electron pair (if we multiply each by time so that they are *qt* rather than *q* in fundamental unit form), the flux of photons in the polarized vacuum necessarily also includes the flux of charged virtual electrons and positrons. From a spacetime viewpoint: a curvature of spacetime, or set of such curvatures. If a deterministic set of spacetime curvatures (a template) is involved, then an engine is involved and the energy is said to be "dimensioned" (internally structured).

energy flow: Generally considered as the passage of energy, in any form, in one direction or generally in one direction in a given 3-space. To first order, our definitions of energy treat energy flow in a given space as (1) a directional change (propagation) of the vacuum energy and its form, or (2) as a directional propagation of a curvature of spacetime or a set of curvatures of spacetime. *The terms "energy flow" and "flow of energy through space" are not precisely defined in physics! They are not going* ***to*** *be defined, at least not in ordinary Aristotelian logic terms, since energy itself is not precisely defined, and one of the best struggles with the concept of energy concludes that it involves invariance in the midst of change, which is a violation of the third law of Aristotelian logic and therefore of the other two as well.*

Indeed, the "EM wave flowing through 3-space" does not exist (see previous comments quoted from Romer). What does exist is an ongoing 4-space process, assumed to be continually and iteratively interacting with a unit point charge to "detect" or "observe" it as an iterative series of frozen 3-space snapshots, in memory-recalled serial order much like the frames of a motion picture film. Nonetheless, we must keep our sense of humor and proceed as if we knew exactly what we were speaking of when we use the co**ncepts** "energy", "energy flow", and "energy propagation through 3-space". If one dwells on the problem without humor, one is led to Hawking's grim but perceptive statement: *"All we ever know is our models, but never the reality that may or may not exist behind the models and casts its shadow upon us who are embedded inside it. We imagine and intuit, then point the finger and wait to see which suspect for truth turns and runs. Our models may get closer and closer, but we will never reach direct perception of reality's thing-in-itself"* Ultimately we do not know physical reality itself, but our mental modeling of it, as best we can "fit" our modeling through comparison with our sensory and perceptive sensations.

energy flux: The passage **of** energy **flow, in any form, through a unit area, and** in any given direction (usually all directions). This includes both passage in a single direction, or passage in multiple directions at once. See flux. Sometimes taken as that component of the net flux through a unit area at right angles to the area.

energy, free: In our usage, free energy is what is obtained from any environment or entity which freely emits, furnishes, or makes available energy which either can be collected and used as furnished, or can be transduced into usable form and collected and used to power loads and do useful work. The word "free" does not apply to *costs*, but rather to the source *of the energy*. Since energy can neither be created nor destroyed, energy is always available free for the taking (collecting and using) if we bit learn how. *We never pay for energy per se, but for the manipulation and processing of the energy*. The notion of extracting and using free EM energy from the vacuum involves five key concepts: (1) the local vacuum/spacetime itself is filled with EM energy of generally unusable form (2) some sort of organizing principle is utilized in one part of the circuit or system to cohere the vacuum energy and transduce it into usable EM form (every charge already individually does that; we just have to learn to do it in a larger ensemble), (3) a gating mechanism is utilized to divert the vacuum energy now in usable EM form from the active vacuum to the external circuits or load parts of a device, (4) the coherent gated

extra energy available in the external circuits or load parts is intercepted by those circuits or load parts, couples to them, and potentializes them with extra EM energy, so that the energy is collected by the system and regauges the system asymmetrically, and (5) the external circuits or load parts then scatter or dissipate the coupled extra energy to produce useful work (physical changes in the load), without destroying the organizing and gating mechanism that is extracting and furnishing usable EM energy from the vacuum.

energy source: A function or entity which furnishes energy by either gating it from one energy reservoir to our system or locality, or by transducing available unusable energy into usable form and then emitting the usable energy. Technically speaking, since energy cannot be created or destroyed, there is really no such thing as a *creative* "energy source", though the term "source" seems to imply such. So-called "energy sources" actually gate and/or transduce energy, changing it from one form to another, from one direction to another, etc. All EM energy in the universe comes from the time domain into 3-space vacuum, onto charge, and back to the time-domain, in a giant ongoing negentropy 4-circulation as freely provided by the "source charges".

engine: Deterministic pattern of structures, with their concomitant dynamics, in the flux of the vacuum. Also, deterministic patterning of curved spacetimc curvatures and their dynamics that comprise an overall larger spacetime curvature, or internally comprising an *overall* "uncurved" spacetime.

engineering, entropic: Engineering or designing systems and processes in equilibrium with their external active environment, and whose operation "spills" or wastes all the energy input to them, and which do not freely recover and use the dissipated or wasted energy. Entropic systems — which are the products of entropic engineering — thus have COP<1.0 and function in forward-time, and classical equilibrium thermodynamics with its infamous second law rigorously applies because the system is designed to self-enforce the equilibrium condition, often called by other names such as Lorentz symmetrical regauging.

engineering, negentropic: Engineering or designing open systems and processes far from equilibrium in their exchange with their active environment, whose operation freely "receives" excess energy from the environment, so that they permissibly output more energy than the operator inputs, the excess being received from the external environment. As an example, simply making a common dipole or assembling a charge

initiates a giant negentropy operation that persists indefinitely (as long as the dipole or charge persists).

entropy: Thermodynamics state term representing a measure of an equilibrium system's capacity to undergo spontaneous change. In short, a quantity that measures the availability of a system's energy for conversion to work. The entropy of an open system not in equilibrium with its active environment cannot even be computed, because the state cannot be computed.

Entropy is given by dS = dQ/T, where dS is an infinitesimal change in entropy for a system absorbing an infinitesimal quantity of heat dQ at absolute temperature T. In statistical mechanics, entropy is a measure of the disorder in a system and is given by S = k lnP + C, where S is the value of entropy (disorder) for a system in a given state, P is the probability of that state's occurrence, k is a fixed constant, and C is an arbitrary constant. Intuitively, the concept of entropy corresponds to the concept of disorder. We specifically call attention to the fact that the "S" used in representing entropy is not at all the S used for Poynting energy flow in electrodynamics.

entropy, negative (negentropy): In a sense, the reversal of disorder, or reversal of entropy. Another way of defining negentropy even more rigorously — for electrodynamics — is to define it in spacetime as a bro*ken 3-symmetry in EM energy flow with concomitant relaxation to a more primary 4-symmetry between time-energy flow and 3-spatial EM energy flow, where time-energy flow is transduced into 3-spatial EM energyflow and then back to time-energy by the entity — such as a common dipole — causing the broken 3-symmetry.*

e quilibrium: *In physics,* the state of a system in which opposing forces balance each other — i.e., sum to a vector zero. However, the *vector* zero summation does not represent "total absence" of everything, and the forces and their energy remain even though comprising a net vector zero system. Even a pure number zero may also be taken as a set of nonzero numbers; e.g., (+5 -3 -2). So even zero need not be total absence, but can be a "balanced set of presences". Or zero can be regarded as an overall equilibrium condition comprised of a set of disequilibria conditions. Indeed, a vector zero summation system of nonzero forces comprises a stress potential, and it contains stress-energy doing work upon the stressed system. In *mechanics,* a system of particles — where the net force acting upon each constituent particle is zero — is said to be in equilibrium. *In chemistry, t*he state of a solution where the forward and reverse reactions

are equal and balance each other, so that the chemical reactants and products maintain the same amounts. Again, the notion of equilibrium involves the "stationary" notion (similar to a perfect whirlpool in a perfect river) of the overall invariance of some set of ongoing dynamic changes.

ether: An extremely fine material substance originally theorized to exist in space in lieu of sheer emptiness. The problem is considering space as emptiness in the first place, which it is not. Instead, space (more rigorously, spacetime) is a plenum and highly active (as in the general relativity view a half-century after Maxwell's seminal paper). So there is no need to "fill empty space" with something, because in the modern view there is no such thing as empty space.

Evans, Myron W.: Noted chemical physicist, primary developer of O(3) symmetry electrodynamics, and Director of the Alpha Foundation's Institute for Advanced Study (AIAS). Papers produced by the AIAS are critical to understanding extraction of EM energy from the active vacuum, engineering of vacuum engines, and development of a revolutionary new healing method by time-reversing diseased or damaged cells back to a previous healthy state.

excess collected energy: Collection by an interceptor/collector of a greater fraction of EM energy flow impinging upon it and also surrounding it, than is normal. See **Bohren experiment.**

exciton: A bound electron-hole pair in a semiconductor. Excitons are temporary formations and they decay by recombining, but they have a specific half-life before recombining during which they migrate through the semiconductor crystal. When the hole and electron recombine, then — if the curvature of spacetime relaxes to a flat spacetime, which is not overtly stated in classical EM theory — the recombination releases energy in the form of a *photon*, or sometimes in the form of several *phonons*. **Note** that the "hole" is an "absence of an electron" from a position in a lattice usually containing an electron, so that it exhibits a net positive "change in the charge field" at that point. Specifically, this "lattice electron charge hole" is not a Dirac Sea hole in the vacuum, which is an entirely different matter. On the other hand, if the hole and electron recombine and the curvature of spacetime does not relax to a flat spacetime *because of other curvature-sustaining involvements*, then no "pair annihilation" radiation is emitted. It is the relaxation of the curved spacetime (when hole and electron are separated) back to a flat spacetime that causes photon or phonon emission.

exothermic: Literally, "giving off heat", or emitting scattered EM energy. Producing time-forward EM energy from a "source" by reducing the ordering (internal energy) of the source.

Faraday, Michael: Noted English physicist and chemist, 1791-1867, who discovered field theory and electromagnetic induction. Faraday also invented the dynamo and formulated his laws of electrolysis. His work directly inspired Maxwell, who vowed to study no other electromagnetics theory until he had captured Faraday's work in a mathematical theory.

Ferminion: A fundamental particle which has spin angular momentum of (n+1/2)h, and which obeys Fermi-Dirac statistics. Examples are baryons and leptons, which are subject to the Pauli exclusion principle.

Feynman, Richard P.: Noted physicist, Nobelist, and co-developer of quantum electrodynamics. Feynman is particularly noted for his refreshing three volumes of physics: see Richard P. Feynman, Robert B. Leighton and Matthew Sands, *The Feynman Lectures on Physics*, Addison-Wesley, New York, 1963. The book is particularly noteworthy in that it gives the student some insight into foundations problems in physics. E.g., in Vol. I on p. 2-4, Feynman defines the electric field not in terms of force per unit charge per se, but in terms of its *potentiality* for producing a force only when a charge is present for the force to be developed upon.

fiber fuse: Effect in optical fibers or fiber optic cable, whose core contains germanium, whereby heating the cable at one spot with a small flame will launch a focused traveling heat energy effect which melts a small hole in the core about every centimeter, and marches down the cable at about a meter per second to the end of the cable, destroying the optical transmission capability and ruining the cable. Oddly, by igniting the fiber fuse from the other end of the damaged cable, a *reverse* fiber fuse effect will often march back down the cable in similar fashion except that it fills in the melted holes in the core, restoring the transmission capability of the cable. If the energy required to melt all the holes (or fill them again) is taken into account, the amount of energy required to launch the fiber fuse is much less. This phenomenon does not appear to have an adequate technical explanation at present.

field: In mathematics, a set with two binary operations. In electromagnetics in more common mathematical terms, it is a region consisting of magnitudes and/or vector directions assigned to some active entity (e.g., spacetime itself) at each point in the region.

In physics, "a region of space marked by a physical property, as gravitational or electromagnetic force or fluid pressure, having a determinable value at every point in the region." [Thanks to *Webster's II New Riverside University Dictionary.]* Note the very special use of calculation of magnitude: one does not calculate the magnitude of the field itself, which fills an entire region. Instead, one calculates the magnitude of the *reaction* of that field with some interceptor/reactor at a given point — i.e., the *effect* of that field upon some mass entity. That is at best a measure of the *local intensity* of the field, not the magnitude of the entire field per se. For that reason, often we speak of calculating the field intensity, which is far more accurate than saying that we are "calculating the magnitude of the field". So we do not really calculate the "magnitude of the field," and in fact such a calculation does not occur in any textbook. Instead, we calculate the *reaction cross section* — in the case of electrodynamics, for an assumed unit point static charge — of the field at a point in the region or space occupied by the field. *We actually calculate what is deviated or diverged from the field, around an assumed interceptor, not the field itself.* This means that we calculate the result or *effect* of a detecting/observing action, and a frozen 3-space snapshot of that ongoing interaction, since all observation is 3-spatial. To then state that this same field exists in space prior to the interaction, and is what causes the interaction, is a gross non sequitur and confuses the effect with its own cause. This ubiquitous non sequitur widely permeates electrodynamics and mechanics, and it is one of the greatest scientific logical errors in history.

field, scalar: In the standard view, a field, to any point of which is assigned a magnitude only. However, "magnitude" of the EM field in the standard usage refers only to the amount of energy deviated (diverged) around a fixed intercepting unit point charge, per the conventional "detection by reaction" model. Again, note the serious logical errors in the conventional usage. One cannot define the field in terms of what is diverged from it! At best one has defined the "intensity" of the field's interaction with a given standard interactant (charge). So in electrodynamics the term "scalar field" would be better replaced with "scalar field intensity", at least for many applications.

field, vector: In the conventional view, a field, to any point of which is assigned both a magnitude and a direction. Again, the standard view also implements that assumed reaction with a detecting unit point static charge, and the "magnitude" used is just the difference between the amount of energy piled on the "front" of the interacting unit point static charge and the amount of energy pile on the "rear" of the interacting unit point charge.

The "direction" is from the center of the "high energy" pileup to the center of the "low energy " pileup around this fixed intercepting unit point charge. Again, note the serious logical errors. One cannot define the field in terms of what is diverged from it and the direction of the difference in "energy pressure." At best one has defined the "intensity" of the field's interaction with a given interactant (charge), and the "direction" established by the difference between the frontal and rear energy pileups on the interacting charge. The term would be better replaced with "vector fieldintensity".

flat (uncurved) spacetime: In our view, a vacuum/spacetime whose virtual particle flux intensity — and therefore its local energy density — does not change as a function of spatial position or averaged time. That is, in our view a flat spacetime is also identically a quantum mechanical vacuum whose virtual particle flux and energy density are constant in magnitude and internal constitution with respect to spatial position and in averaged time. Note that in this extended view, a flat spacetime (vacuum potential) can still contain vacuum engines, and thus still be *dimensioned. In that ca*se, contrary to normal physics, the flat spacetime itself will still interact with an embedded object and *change* it internally, even though it does not *translate* it externally. To perform transmutation of elements, e.g., one is interested in just such engines and not in spatially translating the element being treated. This dimensioning or activation of the local flat spacetime can result in an otherwise unexpected, seeming violation of one or more laws of nature in the dimensioned region, and easily results in violation of conventional physics which does not take into account engines and dimensioning of a flat spacetime. Note also that this allows a differentiation between the actions of two inertial frames, if the frames are differently dimensioned. As we stated, this is a deliberate extension of orthodox physics. See also dimensioning, and Einstein's second postulate —extension of.

fluctiation theorem: Theorem advanced by Denis J. Evans et al. at the Australian National University in 1993 that appreciable and measurable violations of the second law of thermodynamics occurs for small systems over short time scales. See D. J. Evans, E. g. D. Cohen, and G. P. Morriss, Phys. *Rev. Lett.* Vol. 71, 2401 (1993). In 2002 Evans and his colleagues experimentally demonstrated the proof of this theorem in rigorous fashion. See G. M. Wang, E. M. Sevick, Emil Mittag, Debra J. Searles, and Denis J. Evans, "Experimental Demonstration of Violations of the Second Law of Thermodynamics for Small Systems and Short Time Scales," *Phys. Rev. Lett.* 89(5), 29 July 2002, 050601. The proof also directly proves the

occurrence in electrolytes and fluids of time-reversal zones (TRZs) where the dynamics runs backwards for a short time. This validates Bearden's proposal of the TRZ and its consequent reversal of the Coulomb barrier to a Coulomb attractor as the mechanism producing attraction of like charges into quasi-nuclei, which then can decay by quark flipping (if necessary) as the TRZ decays and reverses back to normal. This provides a mechanism for transmutation of elements in these TRZs as a result of the fluctuation theorem and its proof by Evans et al.

flux: The amount of some quantity (such as energy, particles, volume of fluid, etc.) flowing across a given area (usually a unit area perpendicular to the flow) per unit of time. The term flux density is now more commonly used. Loosely, "flux" refers to the perpendicular flow through an area, while "flux density" refers to the magnitude or intensity (rate) of the flux. In some cases such as a flux of particles of different velocities, the number of particles may be multiplied by the average velocity to give an average flux density that is weighted.

flux density: The amount of some quantity (such as energy, particles, volume of fluid, etc.) flowing across a given area (usually a unit area perpendicular to the flow) per unit of time.

Fogal semiconductor: A special semiconductor invented by Bill (William) Fogal which, in its operational regime, utilizes an integrated semiconductor, very special tantalum capacitor, and feedback resistor to accomplish charge blocking (blocking of electron current flow dq/dt) while passing displacement current $d\phi/dt$.

The Fogal semiconductor can also accomplish amplified phase conjugation of signals as well as infolding (translation of input transverse EM waves to output longitudinal EM waves) and outfolding (translation of received input longitudinal EM waves to output transverse EM waves). Used in communication systems, it opens the use of the unlimited "infolded" electromagnetics bandwidth. Since it may communicate using longitudinal EM waves, it is also usable for superluminal or a specialized "tunneling" communication through the "interior" of normal EM waves, potentials, and fields. For example, it can easily transmit color TV signals through the "interior" of a common DC potential. See William J. Fogal, "High Gain, Low distortion, Faster Switching Transistor," U.S. Patent No. 5,196,809, Mar. 23, 1993; - - "High Gain, Low Distortion, Faster Switching Transistor," U.S. Patent No. 5,430,413, July 4, 1995, a continuation of his earlier patent.

Fogal, William: Researcher and inventor of the Fogal semiconductor (two patents so far), as well as a superluminal infolding-outfolding communication system and other remarkable longitudinal EM wave processes. The Fogal semiconductor allows the use of the internal longitudinal wave electrodynamics comprising all ordinary EM fields, wa**ves,** and potentials, and thus will usher in a revolutionary new communications science and extended electrodynamics technology. See also discussion under Einstein's second postulate extended.

force: In mechanics, identically the time derivative of momentum, or $F = \partial/\partial t(mv)$. One must realize that it is not the mass in motion, but the single undivided quantity "mass-motion" or "mass-velocity" (momentum) that is changed. Present EM theory erroneously takes force fields to exist in em**pty,** massless vacuum but with zero force! However, the mechanical definition is an identity, not an equality. The observable mass in vacuum is zero, so substituting m = 0 gives $\partial/\partial t(0 \cdot v) = 0$. This appears to be the conventional reasoning. However, $F = F/q = 0/q = 0$ also. So if mass is zero, **the fi**eld E used in "force field definition" disappears. All that says is that the field in mass-free space and the field in mass are totally different entities,

Since force can be induced into and of the mass-motion target at a distance, in the new approach there is a more fundamental mechanism that produces force itself, and that is a curvature of spacetime, in agreement with general relativity. Distant curvatures of spacetime to produce forces on ex**posed** charged mass systems may also be engineered by longitudinal EM wave interferometry, which does constitute "action at a distance." The fields arise in the local spacetime in the distant interference zone, thus arising from within and around any physical mass object located in that zone. Hence it produces an "inside-to-outside" type of action that is presently unknown in orthodox physics. The produced fields can start inside the nucleons of the atoms and move outward, and work directly upon the quarks and gluons first. This opens a great number of entirely new nuclear reactions presently not developed in particle physics.

force **field:** An 3-space *effect* that exists as a local vacuum virtual particle flux i**nteraction** upon and with a hypothetical unit point mass or unit point charge assumed at every point in 3-space. The effect (force field) results from a ***causal*** force-free 4-field (a curvature of spacetime) interacting with an observed hypothetical unit point mass or unit point charge assumed at every point in space. Hence the invocation of observation invokes a *d/dt opera***tor** (the interacting charged mass) upon the causal field, providing a

frozen 3-snapshot of the ongoing 4-interaction. An iterative series of such 3-observations is said to constitute a "3-space force field" as if it existed in time, which it does not. It is seen (iteratively observed) as a series of such frozen snapshots, which mentally we conceive as "existing in time" instead of the "recurring at points in time" that it really is. We unconsciously invoke that substitution of iterative effect as being continuity in space and time, when we use terms such as "propagation through space".

force-free propagation: Propagation of force-free disturbances in the vacuum flux; i.e., propagation of curvatures of spacetime or sets of such curvatures, together with any associated dynamics.

foundations of mathematics: The concepts, operations, assumptions, postulates, logic, definitions, and axioms of algebra systems.

foundations of physics: The postulates, assumptions, concepts, and definitions upon which a scientific physics model rests. Included are also the postulates, concepts, assumptions, definitions, axioms, logic, and operations of the mathematics in which the scientific model is expressed, as well as the postulates, concepts, assumptions, definitions, and operations of the physics entities and functions assigned to the mathematical symbols. Thus "scientific truth" — even mathematical truth; see Morris Kline's *Mathematics: The Loss of Certainty* — is actually a *qualified* truth. What is true in one model (one set of postulates, assumptions, concepts, and definitions, including those in the algebra) may not be always true when one or more of the postulates, assumptions, concepts, and definitions is/are changed, and/or when the topology of the mathematics in which the model is expressed is changed, etc.

four-space (4-space): The "normal" spacetime used in physics, consisting of three spatial dimensions and one time dimension. Minkowski spacetime.

fourth law of logic: The law that a thing and its opposite become identical on the boundary, i.e., in multiple simultaneous observations. *Identity* is merely the loss of observational or perceptual distinction; when formerly "two" objects are simultaneously observed by a single observer, and two slides have been shown at once in the slide projector. It does not matter at that point what each was individually observed to be before when it was singly observed. Now there is no observable distinction or difference. We previously showed that the fourth law is implicitly assumed in the three laws of Aristotelian logic anyway, and published a simple proof of the fourth law. Without the fourth law, Aristotelian logic "eats itself." As a simple example, the Aristotelian third law eliminates the center vertical line division of a simple Venn diagram between A and not-A, because the

division line itself is happy to belong to both A and not-A simultaneously. So Aristotelian logic destroys the very Venn diagrams used to "prove" or "demonstrate" its logical propositions. What results in the four law logic is that either (1) the three laws apply explicitly and the fourth law applies implicitly, or (2) the fourth law applies explicitly and the three laws apply implicitly. This *application rule* — i.e., *either (1) or (2)* — itself can be taken as a fifth law of logic, thus extending and completing Aristotelian logic which is presently incomplete. The fourth law is also the law of the **paradox:** i.e., when something is true but violates one or more of the Aristotelian laws, it is a case where the fourth law applies explicitly and the three laws apply implicitly. Wave-particle duality is such a fourth law case.

four-wave mixing: A nonlinear multiwave mixing effect when four waves mix (interact) in a highly nonlinear situation so that wave-to-wave interaction occurs.

fractional charge: A hypothetical particle having a charge less than the electron's charge. Often called a quark, where its charge is 1/3 or 2/3 the charge of the electron. A few years ago, Stanford University researchers found what was believed to be evidence of free quarks, but that later was doubted. There is also now the fractional Hall effect. In the 1920's Ehrenhaft reported the discovery and production of fractional charges of all sizes, and his experiments have been replicated by Mikhailov, with papers by Mikhailov and Barrett.

In the new approach, when time-energy is utilized, quarks can be freed or nearly freed rather easily in matter inside "time-reversal zones", since the energy emerges from the local curved spacetime and propagates from within **the** nucleus outward and the gluon forces are substantially reversed. Note also that time is multiply connected, and energy can enter an object anywh**ere** within it or even everywhere within it, since each and every differential piece of the object exists in every single increment of time. It would appear that, as the new approach develops, free quarks will become a normal event rather than one intensely sought but terribly difficult to come by experimentally. We flatly predict that, in a sufficiently good time-reversal zone, free quarks can be produced because of the enormous energy density (in the time component) being utilized.

frame, Lorentz: A frame of reference that is not accelerated with respect to the laboratory observer. In this case, the frame may be rotated (moving at a constant velocity) but it is not rotating (the frame is not accelerated with respect to the observer, and spacetime is not curved). In this case

special relativity applies, as do the conservation laws. We do add a caution that full general relativity still applies to the interior structure and dynamics (the engine) comprising the flat spacetime. Two *overall* flat spacetimes may produce very different interactions inside matter, if their internal engines are materially different and dimensioned.

frame, reference: A spatial, organized, measured lattice placed in "emptiness" (space, spacetime). Normally refers to a 3-dimensional, spatial frame (simplest case) or to a 4-dimcnsional spacetime. All objects and points in the "universe" or spatial frame are considered to simultaneously coexist at separate, measured points in the frame. Differs from the vacuum in that, rigorously, vacuum has no existing definite lengths and no existing definite time intervals, as these appear only after measurement or detection, and are relative to the observer and to the interactions ongoing as well as in the detection process itself. The "laboratory frame" is the static reference frame of the observer or measurement. A separate reference frame may be assumed to exist for any fixed or moving object, or centered on any point in another frame. When a type of frame is assumed, the entire class of *translation type* physical interactions that can occur has been restricted to an assumed set or type. In other words, given the frame, the *conventional* physics of translation has been assumed. One of the greatest restrictions of an assumed "frame" is to rule out the consideration (existence) of other higher dimensions, hence of dimensioned engines.

In the new unified field theory approach, the other higher dimensions are always available and cannot be ruled out in general, but only in some special case. Every curvature of spacetime, and any internal additional curvatures comprising that primary curvature, *adds one or more new dimensions.* In our view, a spacetime may be "flat" in overall envelope curvature, but consist of internally structured deterministic curvatures or "engines". In this view, normal inertial frames, e.g., may still contain engines, which will not affect the normal *bulk translation* rules, but may affect any or all of the nontranslation mechanisms, including the very laws of nature in many cases. Engines have not been developed and used in conventional open physics, but were weaponized clandestinely by the former Soviet Union. See **Einstein's second postulate extended.**

free energy: Excess energy freely received from its external active environment by an open system that is far from thermodynamic equilibrium in its exchange with that environment. There is a separate thermodynamics for such open disequilibrium systems. (See **thermodynamics of open systems.** See also Appendix **A** for a more

detailed discussion of the thermodynamics aspects). Such a system is permitted to exhibit five "magic" functions: it is permitted to (1) self-order, (2) self-oscillate or self-rotate, (3) output more energy than the operator hims**elf** inputs (the excess energy being freely received from the active environment), (4) power itself and its load simultaneously (all the energy bein**g** freely received from the active environment), and (5) exhibit negentropy. Every charge and dipole in the universe already performs all five of those functions.

free **energy** system: Any open system not in thermodynamic equilibrium, which freely receives excess energy from an external environmental source, **and** collects and utilizes this free excess energy to freely power external loads, so that a permissible system COP>1.0 is achieved, as allowe**d** by the nonlinear thermodynamics of open systems in disequilibrium with their environment. (See **thermodynamics** of open systems.). A free energy system may also be "self-powering" if "close-looped" with governed positive energy feedback from output section to input section, meeting the Kron self-powering condition. Operation of free energy systems can only be properly modeled and understood in terms of their super*system* interactions.

Implicit in the notion of free electromagnetic energy systems are six key concepts: (1) the local vacuum/spacetime is known to be filled with hidden (i.e., virtual**)** energy in violent motion, i.e., the local vacuum/spacetime is a violent virtual energy flux and therefore a scalar potential, (2) a broken symmetry - i.e., some sort of organizing and gating mechanism, such as the common dipole — in this hidden (virtual) energy flux of the vacuum is utilized as a source, to cohere the virtual energy and divert it as energy $S = f(E \times H)$ flow from the broken symmetry initiation point onto the external circuits or load parts of a device, (3) the coherent gated extra virtual energy flow available in the external circuits or load parts couples to (inter**acts** with) the mobile charges in those circuits or load parts, so that gradients developed in the interacting virtual flux form force fields on and of the particle masses, driving the mobile charges along the circuit and through current-impeding circuit components such as loads, (4) in the interaction of the driven charges with the driving virtual energy flux, their spin and erratic motions integrate a tiny "coupling fraction" of the driving virtual energy into observable (i.e., macroscopic field) energy, thus creating the **E**-fields and B-fields, (5) the current-impeding external components or load parts scatter or dissipate the coherence of the driven charges and thereby dissipate the collected energy or change the form of the co**llected fi**eld energy, thereby producing useful work, and (6) little or

none of the excess collected energy in the circuit is split off and dissipated in the gate (asymmetry component serving as the S-flow source) to destroy the gate and thereby destroy its asymmetry in the vacuum flux, which is what is extracting and producing the free energy flow.

gate: A component or function that extracts some part of a flux or flow, compacting it into a stream, and "sending it out" in organized, useful energy flow form. The fundamental gate for all EM energy in 3-space is the dipole or dipolarity — the "isolated charge" is actually a dipolarity, when the virtual charges of opposite sign clustering around it in the active polarized vacuum are considered. The source of the 3-space EM energy continuously emitted by any charge or dipole is an equal inflow of EM energy from the complex plane (from the time domain). Thus EM energy flow is locally conserved in four dimensions as a 4-circulation, but not in 3-space. EM energy flow in 3-spacc is conserved over all space, since there are essentially equal amounts of positive and negative charge in the universe and in the virtual charge of the vacuum.

gauge: In electromagnetism, usually considered a possible choice for (change of) electric scalar potential and magnetic vector potentials, in such a manner that there is no any *net* change of force fields so that the change satisfies Maxwell's equations. There are indeed two changes of force fields, but the two are selected so that the two new force fields are equal and opposite, constituting a stress potential and continuously performing internal work on the system to create and maintain the excess system stress. The equal and opposite force fields, however, cannot translate electrons through loads to freely power them. We prefer to consider any change of potential — even a single potential changed, or both changed so that a net force field does result — as a "regauging", for it is an implied primary assumption *within the normal use ofthe term "regauging."* If only one potential is changed, a net force field results in the system and we call that "asymmetrical regauging". If both potentials are changed, but in such a way that a net force field still results, that is also an asymmetrical regauging. When both potentials are changed precisely in such highly selected manner that the two force fields created are equal and opposite, the force fields sum to a *translation* vector zero, and that is symmetrical regauging or *Lorentz regauging.* However, the energy of the two fields remains, having been transposed to a stress potential. Each of the two "balanced" equal and opposite force fields is continuously performing work in the system, but all that is created is additional system stress. Hence symmetrical regauging is obtained only by altering the stress and stress energy of the system, with two disequilibria in energy flow between

the ex**ternal** environment and the system. This in fact constitutes both a curvature of the local spacetime and an alteration of the local active vacuum. It is a rotation of the frame of the regauged system out of the labor**atory** frame. In effect, the net EM field energy of the two new fields crealed by symmetrical regauging is transformed into a change in the local spacetimc curvature, a change in the local vacuum, increased stress in the system, and rotation of the system's frame away from the lab frame. We focus upon the energy aspects, since in a system any change of potential - whether symmetrical or asymmetrical — is a change of the internal energy of the system, and therefore of its excitation. In a system, conventional "symmetrical force fields" regauging results in a *nonusable continous* energy change in the system (actually two of these changes), and a change in the internal stress of the system. In short, it is a special case of **adding** a *stress potential* to the system, which we consider a special form of *asymmetrical regauging of the supersystem* consisting of (i) the system and its dynamics, (ii) the local active vacuum and its dynamics, and (iii) local spacetime curvature and its dynamics.

gauge freedom: The axiom in gauge theory that one can freely change the gauge **(and** therefore the potentials and the potential energy) of an EM system, so long as the net new forces resulting from the change will sum to a zero **vector** resultant so that the system remains "symmetrical" in its **force-field** functioning with respect to the system prior to the change of potentials. Electrodynamicists do not seem to have recognized that the freedom to change the potential of a system at will, is *a priori* the freedom to make a purely negentropic change to increase the system's potential energy, or a purely entropic change to decrease the system's potential energy. Gauge and gauge freedom are actually formal restrictions of an even more important asymmetrical regauging principle: *a potential in a system can be freely changed at any time, thus freely changing the potential energy energy of the system freely and at will.* The additional symmetry assumption is an arbitrary added requirement not imposed by nature.

Further, it appears that physicists have not recognized that a longitudinal EM wave is an oscillating gauge varying in its magnitude. Said in reverse, oscillating *the Lorentz regauging condition for a circuit makes that circuit* ***a generator*** *and emitter of longitudinal EM waves.* This also provides a clue f**or** detection of longitudinal EM waves, similar to what occurs in a Fogal semiconductor used for that purpose. A longitudinal EM wave dete**ctor** must detect a variation in the symmetrical regauging condition, which is a stress change detection.

gauge symmetry: Abstract mathematical symmetry of a field, that relates to the freedom to regauge (change the value of) potentials, without affecting the *net resultant* values of the field quantities. This is a special case of the higher principle that any potential (and thus the potential energy of a system) can be changed freely and at will. However, changing the gauge of an EM system in that sense changes the potential energy of the system but *only in stress potential fashion.* In other words, it does nontranslating work on the system, which is called "internal work." The lack of a net resulting force in the system, created by the regauging symmetry, prevents use of this excess free energy to translate system charges and power an external load. All the excess free energy that could otherwise be used to power loads freely, is instead "locked up" to only perform internal work on the system to increase and maintain system stress.

gauge theory: A field theory using a field that has one or more gauge symmetries. The restriction to symmetry is a carry-over of the old erroneous notion that potentials are just convenient mathematical figments, and that fields are the primary causes of all EM phenomena. For the overunity researcher, broken gauge symmetry at a given level (usually in 3-space EM energy flow) is the feature that must avidly be sought in experimental systems if one would use asymmetrical regauging to allow free powering of loads. Hence one is primarily interested in a wide variety *of broken symmetry effects* and phenomenology. Particularly, unless the automatic self-enforcing of symmetrical gauge transformation during excitation discharge of the closed current loop system is violated, no EM system can produce COP>1.0. Further, local spacetime curvature between local input and local output is always involved in an overunity EM power system. The tempic (time) potential of the output end of an overunity system differs from the tempic potential of the input end, so that the gradient (the tempic force) is directed from output to input — exactly the reversal of the case for a COP<1.0 power system.

Thus in both COP<1.0 systems and COP>1.0 systems, a local spacetime curvature is involved when the system is in operation. In COP< 1.0 systems, the tempic force sweeps along from input to output and on into space beyond, where the violent interactions of vacuum absorb the associated Dirac sea hole current immediately. In COP>1.0 systems, the tempic force sweeps along through the local vacuum from the output section back through the system and into the input section, and thence on back through the external conductors to the external power source. This reversed Dirac sea hole current may "eat electrons" in the normal currents

internal to the system, and in the input section and back towards the external power supply it will "eat input electrons in the input current." Thus the Dirac sea hole current in the COP>1.0 system "eats input power" and serves as a curious new kind of electrical "load" or "internal loss" in the **input** section of the system. The reversed Dirac sea hole current is nature's way of decaying the local curvature of spacetime back to a flat spacetime, and decaying the COP>1.0 excited system disequilibrium state back **to an** equilibrium state. In any overunity electrical power system, this Dirac sea hole current must be taken into account and either transduced into useful power, minimized, or eliminated. An extension to gauge field theory is needed in which the tempic force, the tempic potentials and their gradients, and the supersystem are all modeled and taken into account. It appears that the Sachs unified field theory is capable of handling that requi**rement,** which also can be accommodated by O(3) electrodynamics to provide engineering of the resulting unified field theory.

gauge **transformation (in electromagnetics):** Conventionally taken to be the a**ddition** of the gradient of some function of space and time to the **magnetic** vector potential—and simultaneously the addition of the negative of the partial derivative of the same function with respect to time, divided by the speed of light, to the electric scalar potential. The resulting symmetri**cal** change assumes that the stress energy of the system is changed **freely,** but by design it deliberately prevents any stress difference in the system to produce a net force that could expend the free change of energy by doing work in an external load. Changing the stress energy alone is a curvature of spacetime and a purely gravitational change. It is also a **rotation** of the frame of the system away from the laboratory frame. See discussion under gauge theory.

general theory of relativity: Einstein's theory of gravity in which the gravitational force is represented by a curvature in spacetime, and in which spacetime is an active entity. We may look at all forces as being due to curvatures of spacetime interacting with mass.

geometric phase: A phase difference acquired by the state function of a quantum system that undergoes a cyclic evolution from an initial state and back. This phase difference can be detected by interfering the final and initial s**tates.** The modern generalization of the Aharonov-Bohm effect and the Berry phase.

giant nege**ntropy (of the dipole):** The continuous receipt from the time domain **of spacetime** (the vacuum), by one charge of any dipolarity (including **a** single charge's fundamental dipolarity), of enormous

longitudinal EM wave energy flow in condensed time energy form, transduction of that absorbed energy from the complex plane into real 3-space, and continuous emission of that enormous energy flow in all directions in 3-space, thence receipt of that 3-space energy by the other charge of the dipole or other adjacent dipoles, retransduction of the energy back into time-energy, and re-emission of that energy back into the time domain. This 4-circulation giant negentropy process is evoked and continues automatically and indefinitely after a little energy has been expended to separate the charges and make the source dipole. The EM waves in the input from the time domain and the output in 3-space are perfectly ordered and correlated, which is a giant ordering of the vacuum/spacetime and is thus a giant negentropy. In conventional circuits, the source dipole in the generator or battery, once made, performs this function. Only a minuscule fraction (some 10^{-13} in a nominal case) of the energy pouring out of the generator's or battery's terminals strikes the surface charges of the attached external circuit and is diverged into the conductors as the Poynting component that powers the Drude electrons and the circuit. All the rest of the energy flow (the Heaviside nondiverged component) outside the circuit is just wasted by conventional circuits.

gluon: A particle that carries the forces between quarks. In quantum chromodynamics, the gluon plays a role analogous to the photon in quantum electrodynamics.

graviton: In the quantum theory of gravitation, the graviton is the quantum of the gravitational field. It is massless, with spin 2. In the new theory we may take the graviton as a coupled scalar and longitudinal photon pair.

gravity: The phenomenon characterized by the physical attraction between any two material bodies of positive mass, specifically due to the trapped positive energy in the masses. If one particle is of negative mass and energy, the normal gravitational attraction between the two particles is reversed so that they repel, which produces antigravity. The fundamental mechanism of gravity can be found once one realizes that Maxwell omitted the incoming EM wave interaction with the nucleus, and not with just the electron shells. When he wrote his theory, the electron, atom, neutron, proton, and neutron had not been discovered yet. The lateral precession movement of the spinning Drude electrons — which are restrained *longitudinally* to a very small drift velocity in detecting wires (antennas) — later came to be considered proof of Maxwell's transverse EM wave in the vacuum. The detected electron precession wave is oscillating laterally, hence proves the longitudinal EM wave interaction. Elsewhere we have

pointed out that the EM wave in space is longitudinal EM wave accompanied by a corresponding time-polarized (scalar) EM wave, and it also follows from Whittaker's 1903 paper as reinterpreted by the present author in our Giant Negentropy paper.

gross particle translation: Refers to translating the entire particle — and its internal structures and dynamics — in space, rather than internally structuing the particle's potential (massless charge). Note that, if the internal structuring (engines) of the particle is changed during translation (e.g., by passing through a region of the flat spacetime having an altered internal engine structure), the particle may have an anomalous interaction with another particle or process having a different internal structure or "dimensioning." The mass-energy comprising the particle's nucleus, electron shells, etc. can be dimensioned. Mass so dimensioned or conditioned then may act differently in chemical reactions, effects on living systems, etc. than normal "inert" mass that has no specific deterministic dimensioning.

group: A mathematical structure that is a complete set of transformations on a mathematical entity that leaves the entity unchanged.

group, higher symmetry: In a given theoretical area, a particular theory can be expressed in various group transformations. When the group transformation (group symmetry) utilized is more complex than the "standard" group symmetry usually employed, it is referred to as a *higher* group symmetry. The mathematics of the model is then said to be a higher group symmetry mathematics. Since the groups have names such as U(1), SU(2), O(3), etc., the transformations of the mathematics are often referred to by **those** names. Hence characterizing phrases are used such as U(1) symmetry electrodynamics, SU(2) symmetry electrodynamics, O(3) symmetry electrodynamics, etc.

group, Lie: A group whose transformations act continuously. An example of a Lie group is given by rotations in ordinary space.

group theory: The general mathematics of symmetry transformations; i.e., the the**ory** of all transformations that leave the transformed entity or entities unchanged.

gyroelectrons: Spinning electrons considered as gyroscopes during the portion of their spin in 3-space, so that when longitudinally perturbed they can and will laterally precess. Considering (in a gross first order model) the conduction electrons in the Drude gas in a conductor as little gyros, because they are (i) spinning on an axis, (ii) severely restrained in their

ability to move forward longitudinally down the conductor as current, and (iii) much more free to precess laterally in the conductor. Thus when the gyroelectrons in the receiving wire antenna, perturbed by an incoming longitudinal EM wave in the vacuum, are longitudinally perturbed, they precess laterally so that our instruments (which detect electron wiggles, not the incoming vacuum EM wave) do detect "transverse waves." However, they are detecting the transverse gyroelectron precession waves, not the waves in the vacuum. They are detecting the *effect* of the interaction of the incoming waves with the gyroelectrons, not the *cause.*

harmonic series: A set of frequencies or oscillations consisting of integer multiples of a fundamental frequency.

Heaviside, Oliver: Noted English self-taught physicist and brilliant electrodynamicist, 1850-1925. who played a role in discarding Maxwell's quaternions, and also played a role in forming vector mathematics and formulating the vector reduction of Maxwell's theory from 20 quaternion equations in some 20 unknowns to the present 4 vector equations. Heaviside's curtailment of Maxwell's theory still contained both (i) systems in equilibrium with their active environment and (ii) systems in disequilibrium with it. To separate variables and enable closed solutions, *Lorentz further* curtailed the Maxwell-Heaviside equations by symmetrically regauging them, thereby *arbitrarily* discarding all disequilibrium Maxweilian systems and retaining only those in equilibrium with their active environment. This regauging unwittingly and erroneously discarded all that class of Maxweilian systems permitted to exhibit COP>1.0. The first such curtailment of the Maxwell equations was by Ludwig Valentin Lorenz in 1867, but H. A. Lorentz (who did a similar symmetrical regauging nearly decades later) was later given the credit.

Heaviside also discovered the enormous *nondiverged* energy flow surrounding every circuit, far greater in magnitude than the feeble Poynting *diverged* component that actually enters the circuit. But he was at a loss to explain what the source of such a startling flow of energy could be. Lorentz understood the Heaviside component, but also could not understand its source. Hence he reasoned that it "had no physical significance" since it did not power the circuit. Lorentz then introduced the trick of integrating the entire energy flow vector around a closed surface surrounding any volume element of interest. This neatly discards the vexing giant Heaviside *nondiverged* energy flow component, and retains only the *diverged* Poynting component that actually enters the circuit. The latter is of course the energy that will later be *emitted* from the circuit, which is what we will measure when we "measure the circuit."

Electrodynamicists are still using this method of dropping the Heaviside energy flow from any further accounting consideration. Hence they do not develop systems which intentionally increase their energy collection from this readily available energy flow around every circuit. The Bohren experiment conclusively proves the physical existence of the Heaviside nondiverged component, even though it is no longer accounted.

In his last years Heaviside realized the gravitational importance of his extra energy flow component, and worked out an electrogravity theory based on it. He did not live to publish it, but his papers on it were found some time after his death, beneath the floorboards of his little garret apartment. A learned society then published the papers.

Heaviside energy flow component: The enormous *nonintercepted* and nondiver*ged* energy flow component pouring out of the terminals of every battery or generator, or charge or dipole, and missing the external circuit (or external intercepting charges) entirely so that it is does not contribute to the intercepted (Poynting) flow component that powers the circuit. Also, the enormous energy in the EM field, potential, or wave that misses the interaction of the field, potential, or wave with the assumed unit point static electric charge, and thus is not intercepted and collected (and accounted!) in the unit point static charge assumption. In honor of Heaviside, the present author has nominated this "dark Heaviside energy" component as the missing source of excess gravity known to be holding the arms of the spiral galaxies in place. In the interactions of Dirac hole current with a unit point charge (to determine the negative energy fields and potentials in a COP>1.0 EM system), there is also a missing component of the negative energy flow that is comparable to the Heaviside component for positive energy flow. These flows of surplus negative energy **from** COP>1.0 astronomical interactions—with the associated negative energy fields and negative energy potentials produced by the **negative-**energy Dirac holes in these negative energy flows — is hypothesized by the present author as producing the antigravity that generates the observed acceleration of the expanding universe.

Hertz, **Heinrich:** Noted German physicist, 1857-1894, who together with Heaviside and others transformed Maxwell's theory from quaternion algebra to vector algebra, and who also experimentally produced Hertzian (EM) waves, thus confirming Maxwell's theory. These experiments by Hertz first detected EM energy propagating as described by Maxwell's equations, thus providing the experimental impetus that allowed Maxwell's theory to predominate. The oscillation or "cycle" is named after Hertz, by

specifying *X* number of oscillations or cycles per second as a frequency of *X* Hertz. One type of potential is also named after him.

hidden bidirectional EM waves: Those bidirectional EM wavepairs that comprise the scalar potential are indeed "hidden" with respect to our normal "electron translation" (i.e., electron wiggle) detectors and instruments. Nonetheless, properly functioning devices such as Fogal's semiconductor allow the utilization, transmission, and reception of the vast longitudinal EM wave dynamics that are infolded inside all conventional EM fields, waves, and potentials, including the giant potential comprising the ambient vacuum (spacetime). Use of this infolded electrodynamics is akin to using "subspace" or higher dimensions, depending upon how one chooses to model it mathematically. It is also a direct method of using a unified field theory.

hidden variable theory: A class of quantum mechanical theories which considers that the quantum state of a physical system is not a complete specification after all. The "hidden variables" are those additional components necessary to provide the "complete state" of the system. By utilizing the infolded longitudinal EM wave electrodynamics, one is in fact using a macroscopic hidden variable theory. This becomes a subset of Evans' O(3) electrodynamics, which in turn is an important subset of Sachs' unified field theory. Sachs' theory encompasses and subsumes electrodynamics, general relativity, quantum mechanics, etc., so the use of this macroscopic hidden variable theory through special functions provided by components such as Fogal semiconductors is a powerful and directly engineerable extension of conventional hidden variable theory. The physics of this new, engineerable, unified field theory area is also called *energetics.*

hole, lattice: Vacancy, in an otherwise filled energy band position. Sometimes called *negative ion vacancy.* In a semiconductor, an electron may be lifted to the conduction band by thermal energy, which produces u hole-electron pair (an exciton). Also, one of the sites in the crystal lattice can be occupied by an acceptor impurity atom, so that the electron is accepted there, leaving a hole showing excess positive charge. This is a lattice hole, and the propagation of such holes being formed is called electron hole current, or hole current for short. We point out that the *laittice hole* exists only after interaction of the Dirac sea vacuum hole with matter. i.e., only after observation. In that case, the 3-positron (hole) has positive mass and positive energy, produces positive energy fields and potentials, produces gravity rather than antigravity, and is "seen" to be going in the opposite direction to the Dirac sea hole. Prior to observation, the hole is a

Dirac 4-hole in vacuum, having negative energy and therefore negative mass equivalence, negative charge, and without a direction reversal. This 4-hole is a source of negative energy fields and negative energy potentials in **the** surrounding space, and thus of antigravity back-interaction (upon the physical system connected with the active vacuum component of its supersystem) due to the negative curvature of the local spacetime.

hole, Dirac sea: In the presence of fields (i.e., in the presence of curved space**time),** some of the negative energy states in the Dirac sea are not filled with electrons. In that case there are some empty 4-holes in the Dirac sea, in local spacetime itself. The Dirac hole is a negative energy state in the **vacuum** itself. It too *seemingly* has a positive charge, as seen by the external observer after interaction with matter. Holes are also mathematically equivalent to positrons, in case observation has been evoked, so long as the lack of positive mass is not a consideration Note that our view differs from the received view, but is based on experimental evidence which can only be gained from COP»1.0 EM system experiments. We know of no such COP»1.0 EM system experiments involved in the received view.

hole current: (1) In a semiconductor: Usually, the part of the current in a seminductor that is composed of migration of lattice holes. ***Mathematically,*** within certain constraints this may be considered a positro*n* current. The hole migration is usually slower than the electron migration producing electron current. (2) In the vacuum itself. In the *Dirac sea, in* **the** presence of fields the Dirac 4-holes flow in the opposite direction to the local electron current, providing a Dirac sea hole current or posit**ron** current. [See discussion under hole.] An electrical power system in disequilibrium with its vacuum interchange and having COP>1.0, will have a **greater** *tempic potential* at its output section than at its input section. Thus it will have a tempic force or tempic broom, sweeping holes from local instabilities to form a hole current (may be both a Dirac sea hole current and a lattice hole current) flowing from the output section of the system back through the system into the input section, and on out of the input section into the primary power source. *Hole current transduction may be* used to convert this detrimental hole current energy transport into usable **electron** current energy transport, or anti-circuit techniques and mechanisms can be used.

hole current transduction: Hole current in a COP>1.0 open system, where **the** system is in disequilibrium with the vacuum *a priori,* is usually detrimental to (he system and may destroy the overunity condition. A hole current from the input section of the system, fed back into the primary

power supply, requires that extra electron current be furnished since some of the electrons in that furnished current will recombine with the oppositely moving Dirac vacuum holes and disappear to fill those holes. Hole current into a battery in "normal" fashion discharges the battery rather than charges it (although reversing the battery terminal connections allows charging in normal fashion using the hole current). Thus a battery can be discharged "far below zero", so to speak, by charging it with excess holes in the "normal connection." A capacitor may be charged with hole current, in which case the dielectric will undergo compressive strain into the positron-charged plate. However, when the capacitor is subsequently discharged, the dielectric will expand and recover, with its electron charges pushing electrons out of the negative side plate and into the external circuit. Hence a capacitor can be *charged* with positron (hole) current, and then can be adroitly switched so as to *discharge* electron current. In theory so can a battery because of its capacitance. This is a transduction of entropy to negentropy, a process for which a patent application has been filed by Bedini and Bearden. Gauge freedom already permits that operation, since gauging in electromagnetic systems is freely changing the local potential energy of the system, and is either negentropic (increasing the system's energy) or entropic (decreasing the system's potential energy).

hole injection: In an n-type semiconductor, holes can be emitted by applying a metallic point to the semiconductor's surface. We suspect (but have not proved) that sharp gradient pulses may also induce some of these holes as Dirac sea 4-holes and Dirac sea hole current rather than positron and lattice holes current. In that case, a mix of positive energy and negative energy (and gravity and antigravity) would be produced.

hole trap: An impurity in a semiconductor that can trap a "hole" by releasing electrons to the conduction or valence band.

hyperspace: Refers to a space of more than four dimensions, and specifically to those spatial dimensions outside the normal three. The term is used for both a space of n dimensions, where n>4, or for one dimension in such a space, beyond the normal four.

identity of opposites: On the boundary between A and not-A, A and not-A are identical (i.e., no difference can be discriminated). If all of a thing is collected, one reaches the boundary of that thing and it turns into its own opposite. The philosopher's problem of the "accursed necessity for the identity of opposites" cannot be solved in Aristotelian 3-law logic, since that logic is incomplete. It is readily solved, and part of, a more extended

logic such as 5-law logic. The result is that "identity" is not an absolute entity, but is a decision by the observer reached by application of a comparison algorithm to separate observations made at differing times. An example is provided by a colorblind observer who sees as identical two marbles which, to an observer with color vision, are seen as red and black and therefore not identical. Aristotelian logic omits the action by the observer, the times of the multiple observations (only a single thing at a time is observed or perceived, *a priori),* and the decision algorithm used *by the* observer to decide whether two observations are identical or not identical.

inertial frame: A frame of reference in which force-free bodies move along straight lines, and the postulates of special relativity are valid. In the new a**pproach,** this notion is extended. Even in an inertial frame, force-free **bodies** may move along straight lines, the postulates of special relativity may remain valid, and yet the EM hidden variables may induce other chan**ges** in the usual laws of nature due to the action of hidden vacuum engines infolded in the *dimensioned* local flat spacetime (vacuum **potential).** See Einstein's second postulate extended.

infolded real vector components: Simply take a set of real force vectors that altogether sum to a vector zero resultant. This "vector zero system" is a zero vector with respect to forced *translation* of a particle or mass. It is not am absence of the vectors at all, but is the presence of specifically hidden and "infolded" real vectors that do not initiate bulk translation of the affe**cted** object or system, but perform *internal* work upon the system. Such vector systems are stressing systems of a special kind, where the internal components of the stress are not random but deterministic. Hence they are electrodynamic *engines,* in the new approach. To a somewhat arrogant mathematical scientist who once objected that zero vector resultant systems had no effect, I humorously challenged him to put it to experimental test. I suggested he stand between two elephants pushing against him in opposite directions, while I would stand between two fleas doing the same to me, and we would compare notes. He apparently was not amused at the suggestion.

infolding: With reference to signals, infolding means "placing the signal **or modulation** or change upon one or more of the internal bidirectional wave**pairs** comprising the scalar potential. Since all EM potentials ultimately represent changes to the ambient vacuum potential, one has conditioned or altered the vacuum itself when infolding is utilized, infolding of E*M* signals, vectors, and directions produces *engines.* By Whittaker's decomposition of the potential and Bearden's reinterpretation,

these vacuum engines can be designed to affect matter — including atomic nuclei, nucleons, etc. — in any manner desired.

information content of the field: Russian euphemism for the deliberate structuring of the hidden longitudinal EM waves and their dynamics, that comprise any EM potential, field, or wave, so that the potential, field, or wave is *dimensioned* and contains active *engines.* This area was extensively weaponized under KGB (now changed in name) control rather than the regular Russian armed forces, and a disinformation campaign was waged to convince Western analysts that the term refers to simple spectral analysis. It doesn't. Instead, it refers to infolding and outfolding, and the use of longitudinal EM waves, dimensioning, and engines. The overall science is called "energetics" by those weapon scientists.

interferometer: An instrument or system in which a wave is split into two waves or beams, which after traveling over different paths are subsequently reunited and interfere. The use of longitudinal EM waves (LWs) allows ready penetration of mass by the LWs traveling through the interior Whittaker composition of a mass's internal EM fields, waves, and potentials. Longitudinal EM wave interferometers should prove useful in probing the interior of planets, the sun, etc. They pass easily through the earth, so that interferometry can be obtained at targets on the opposite side of the earth, or inside the earth. These are the weapons that then Secretary of Defense Cohen referred to in 1997 as being used to engineer the weather, initiate volcanoes into eruption, or initiate earthquakes.

Josephson effect: Flow of Cooper pairs (superconducting electron pairs) across a thin dielectric separating two superconducting electrons, in the absence of a voltage drop. E.g., the pair of electrons can "tunnel" through u thin insulating barrier.

joule: A measure of energy; one watt for one second in electrical terms. In physics the unit of work or energy in the MKS system, being the amount of work done by one newton acting through a distance of one meter, equal to 10,000,000 ergs.

Kirchhoffs current law: At any time, the sum of the instantaneous currents flowing into a node or point in a circuit equals the sum of the instantaneous currents flowing out of that node or point. This does not have to be true if (1) relativistic effects are appreciable, or (2) electron production and annihilation processes — such as Dirac sea hole current, lattice hole current and recombinations are occurring and non negligible, (3) the Kron open path is being used, or (4) localized time reversal zones (TRZs) are utilized. Another way of stating where the law need not hold is

when there are nonlinear interactions between the three components of the superset (the physical system and its dynamics, the active vacuum and its dynamics, and spacetime and its curvature dynamics.).

Kirchhoff's voltage law: At any time, the sum of all voltage rises in a closed loop circuit equals the sum of all drops in that closed loop circuit. The law assumes a flat spacetime. This does not have to be true if relativistic effects are appreciable, if true negative resistor effects are present, if Kron open paths are utilized, and if time-reversal effects arc present. It also need not be true in anti-circuit techniques, or when they are involved in a particular portion of an otherwise normal circuit.

Lamb, Willis Eugene Jr.: American physicist and Nobelist who discovered the hyperfine structure of the hydrogen spectrum, and first measured the interaction of the vacuum energy that generates a change in the energy levels of the hydrogen atom, according to Dirac's theory and quantum electrodynamics.

Lamb shift: A very small correction to the first excited state of the hydrogen atom due to interaction of the vacuum. Willis Lamb experimentally confirmed this prediction of quantum electrodynamics to high accuracy. The local energy density of the little Lamb shift is greater than the surface energy density of the sun. However, in matter there are such a vast number of similar small interactions generating very powerful fields randomly, that the sum total of all these changes sums to a vector zero for most summation distances of interest.

lamellar current: Thin layers of current; thin sheets of current.

laser: A device that generates light in which all the photons are exactly in step and produce a coherent beam. Originally the word "laser" was an acronym that stood for "light amplification by stimulated emission of radiation."

law of physics: A restriction placed upon the physical mechanisms that can occur under certain broad assumptions as to the background situation and environment. Because of the assumptions made, an expressed law of physics is not absolute, but relative to the assumed conditions. Any "law of physics" can be violated if the conditions contained in its assumptions are violated. It is important that a scientist be aware that physics is comprised of models and the "laws of physics" are very general and wide-ranging models based on very specific assumptions. Further, by Godel's theorem and the theory of models, no model is perfect anyway, and none will ever be. When one assumes that physical laws are not based on any

assumptions but are universal and absolute truths, one has immediately moved to dogma and not science.

Lawandy patents: Patents covering and related to a form of anti-Stokes emission (excess emission of energy) in strongly scattering, optically active media such as TiO_2 particles in suspension. This is a new form of lasing, without the requirement for population inversion.

Letokhov, V. S.: Russian pioneer in excess emission phenomena from stimulated media.

Letokhov effect: The excess emission (excess emission of energy) phenomena in strongly scattering, optically active media, usually referred to as "negative absorption of the medium." See particularly V. S. Letokhov, "Laser Maxwell's Demon," *Contemporary Physics*, 36(4), 1995, p. 235-243.

localized: Confined to a small region of a large system rather than being extended through the system or at a distance.

localized virtual photon flux of vacuum: Refers first to a local region of the vacuum, and then to the flux density of virtual photons in that local region. If that flux is deterministically structured, then the local region also contains an *engine* that will act internally upon masses and mass systems in that region. The local region also contains hidden variables.

longitudinal component: In EM fields, the longitudinal component of the fields along the direction of travel, as opposed to the transverse components at right angles to the direction of travel.

longitudinal E-field: Any electrical field in 3-space may be described using two components, a transverse component and a longitudinal component. Of course one or the other may be a vector zero. In 4-space, there is a time component also, as an additional "transverse" component.

longitudinal gradient: Compression wave gradients (differences) in density or pressure, considered in a direction from their origin along the direction of primary movement in the medium. Contrast to transverse waves, which act perpendicular to their direction of propagation. In electrodynamics, longitudinal EM waves in 3-space are said to be "longitudinally polarized." Longitudinal EM waves in the time-domain are said to be "time polarized." The latter are also referred to as "scalar waves" since they have no polarization vector component in 3-space and thus arc "scalar" with respect to 3-space. This is a misnomer, however, since these "scalar waves" are perfectly good time-polarized EM longitudinal vector

waves. For the first time, the giant negentropy process allows one to make and use time-polarized EM waves, since they automatically accompany all longitudinally polarized EM waves and it is straightforward to make longitudinal EM waves in 3-space (just oscillate the Lorentz regauging condition).

longitudinal interior wave: An infolded longitudinal gradient that oscillates in magnitude along the line of travel "inside the vacuum potential or a normal potential." In conventional theory, the electric portion of the EM wave is a transverse field oscillation, and the longitudinal component is essentially zero. In the new "infolded" wave approach, there is no overall transverse gradient in the vacuum potential, but there are such longitudinal waves. This is rather like a "pressure wave" transmitted under water, without causing a surface wave involving physical upheaval and fall-off of the water. The speed of the longitudinal EM wa**ve** is not limited to c, the speed of transverse EM wave light in the ambient vacuum..

longitudinal wave: A "pressure" type of wave, similar to sound, in which the vibrations are along the direction of travel of the wave. Hence, a wave composed of alternating densifications and rarefactions, where we focus upon the longitudinal component of the changes. One can think of it as a sort of "accordion" wave, rhythmically shrinking and stretching along the line of motion as it travels. Note that rhythmically and symmetrically varying the two potentials involved in regauging creates longitudinal EM waves. So one pseudonym for longitudinal EM waves is "gauge oscillation" waves. Matter is mostly empty space filled with EM potentials, fields, and waves—all of which are bundles of longitudinal EM waves and their functional dynamics. Hence matter (such as the ocean and the earth) is a vast superhighway for the passage of longitudinal EM waves. Note that the longitudinal wave represents an oscillating energy density in space and/or time (scalar waves), and hence is an oscillating curvature of spacetime. All forces of nature are generated by curvatures of spacetime. Hence all forces of nature can be generated by the correct generation of longitudinal EM waves and their impressed dynamics, Further, this means that all the physical *causal* functions of the exhibited **effects generated** in a material system can be captured in longitudinal EM wavesets. A longitudinal wave functional system deliberately having such causal functions of a physical functioning system is known as a causal **system robot** (CASR). Such robots are far beyond the presently developing nanobots, and have been developed rather extensively by at least one nation. Such robots can easily pass through the "interior" of any normal

EM signal or wave or potential or field, which again is nothing but a giant superhighway for longitudinal EM waves. In theory one can communicate with a CASR via longitudinal EM waves if communications functions are built in to the CASR. In the future, one would expect that planetary exploration, underground and undersea exploration, exploration of the interiors of the sun, moon, and planets, could be enabled by the further development of specialized CASRs.

Lorentz, Hendrik Antoon: Renowned Dutch physicist and Nobelist. 1853-1928, who developed the Lorentz transformations and Fitzgerald-Lorentz contraction. Lorentz shared the Nobel Prize for discovering the Zeeman effect. He is also responsible for symmetrically regauging Maxwell's equations (some time after Lorenz did it in 1867), and for introducing an integration trick that neatly disposes of the vexing huge Heaviside nondiverged energy flow component accompanying every field/charge and potential/charge interaction.

Lorentz invariance principle: An inertial frame is independent of the velocity of the frame relative to any other inertial frame. This is not necessarily true with respect to engines inside inertial frame objects, since the engines involve acceleration dynamics.

Lorentz regauging: Changing the two potentials in the Maxwell-Heaviside equations in potential form so that the resulting equations have the variables separated, and there is no net force introduced by the two new forces, which are deliberately chosen so as to be equal and opposite and thus sum to zero. An unfortunate effect is that this discards all Maxwellian systems far from equilibrium in their vacuum exchange, hence discards all permissible Maxwellian COP>1.0 systems. Electrodynamicists have not recognized that Lorentz regauging represents the addition of stress potential energy and continuous internal work and stress to a regauged system. It also represents a rotation of the frame of that system out of the laboratory frame by some angle. Further, oscillating the Lorentz regauging condition produces longitudinal EM wave generation and emission.

Lorentz symmetry: The symmetrical regauging by Lorentz of Maxwell's equations.

Lorenz, Ludwig Valentin: Scientist who first changed Maxwell's equations — two years after their publication in 1865 — by (effectively) symmetrically regauging them, thereby unwittingly discarding all Maxwellian systems far from thermodynamic equilibrium with the active vacuum. See L. V. Lorenz, "On the identity of the vibrations of light with

electrical currents," *Philosophical Magazine*, Vol. 34, 1867, p. 287-301. In this paper [L. V.] Lorenz gave essentially what today is called the [H. A.] **Lorentz** symmetrical regauging. When H.A. Lorentz also symmetrically **regauged** the Maxwell-Heaviside equations, the physics community **adopted** the procedure and resulting further truncation of the Maxwellian theory. That truncation continues to this day.

low energy **nuclear reaction** (LENR): Actually a bit of a misnomer, since it refers to a low *spatial* energy, high *time* energy reaction. Cold fusion, or the anomalous transmutations of elements that occur in certain electrolytes with specially prepared palladium electrodes. The transmutations occur even though in conventional theory there is insufficient *spatial* energy to accomplish them, because they use time energy. Time energy is spatial EM ene**rgy** compacted by the factor c^2, hence time has the same energy density as mass. The formation of temporary, fleeting time reversal zones (TRZs), with action from from inside-to-outside, is the genesis of a host of new nuclear reactions missing from conventional particle physics since the physicists do not account time as energy, and do not use such TRZs. For more on this hypothesis and the specific reactions generated, see T. E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves," *Journal of New Energy*, 3(2/3), 1998, p. 12-28 as well as Chapter 10 of the present book.

magneti**c dipole:** Paired north and south magnetic poles of equal strength ever microscopic or macroscopic distance.

magnetic induction: The act of a change in magnetic field producing an electric field at right angles, which in turn produces an electron flow.

magnetic spin: The intrinsic angular momentum, known as spin, of electrons, protons, and neutrons, etc. The electrons combined in an atom or ion have **a** resultant angular momentum that is the combined intrinsic spin of **the** electrons and the angular momentum due to their motion around **the** nucleus. There is also a magnetic moment associated with this angular momentum (spin) whenever it is nonzero. Therefore atoms or ions with non**zero** spin are *magnetic* atoms or ions. This is often loosely reffered **to a**s "magnetic spin." It is actually the magnetic moment of nonzero spin.

magnetostatic scalar potential: Continuous mathematical function whose value in space, at any point it occupies, represents the potential energy collected upon an assumed unit magnetic north-seeking charge (pole).

There is a magnetostatic scalar potential between the poles of any magnet.

This scalar potential is **also** subject to **Whittaker's** 1903 decomposition into

a harmonic series of magnetic longitudinal phase conjugate wavepairs. Reinterpretation of Whittaker's wavepairs should be made according to Bearden, "Giant Negentropy of the Common Dipole," *J. New Energy,* 5(10, Summer 2000, p. 11-23. This reinterpretation agrees with quantum field theory; see Mandl and Shaw, *Quantum Field Theory,* Revised Edition, Wiley, 1993, Chapter 5.

matter: Highly condensed 3-spatial energy, compressed by factor c^2 and remaining in 3-space, and with the observation process *d/dt* having been applied to the fundamental masstime entity to provide mass as a frozen 3-space snapshot by stopping the flow of time momentarily. Matter, of course, has internal structure, order and organization, and dynamics. All matter is in a continuous energetic exchange with its active vacuum (4-spatial) environment. Matter stripped of its EM fields, waves, and potentials is called mass. Mass is an observable and therefore a frozen series of continual 3-space snapshots, formed by incessant photon absorption to change the mass *m* to masstime *mt,* with following incessant photon emission to change masstime *mt* back to mass *m.*

Maxwell, James Clerk: Brilliant Scottish scientist, 1831-1873, who first formulated the unified theory of electricity and magnetism. See *The Scientific Papers of James Clerk Maxwell,* 2 vols. bound as one, edited by W. D. Niven, Dover, New York, 1952, Vol. 1, p. 526-597 for his definitive paper, "A Dynamical Theory of the Electromagnetic Field," first published in *Royal Society Transactions,* Vol. CLV, 1865. In that paper, (see Niven's book) his general equations of the electromagnetic field are given in Vol. 1, Part III, "General Equations of the Electromagnetic Field," p. 554-561. On p. 561, he lists his 20 variables. On p. 562, he summarizes the different subjects of the 20 equations, being three equations each for magnetic force, electric currents, electromotive force, electric elasticity, electric resistance, total currents; and one equation each for free electricity and continuity.

Maxwell's famous book, *A Treatise on Electricity and Magnetism,* Oxford University Press, Oxford, 1873, Second Edition 1881 (Maxwell was already deceased), Third Edition, Volumes 1 and 2, 1891. Foreword to the second edition was by Niven, who finished the work. Maxwell had dramatically rewritten the first nine chapters to simplify his mathematics because of the resistance to it, with much new matter added and the forma contents rearranged and simplified. Maxwell died before finishing the rcsl of the second edition. The rest of the second edition is therefore largely a reprint from the first edition. The third edition edited by J. J. Thomson was published in 1892, by Oxford University Press, and later was published unabridged by Dover Publications, New York, 1954. J. J. Thomson

finished the publication of the third edition, and wrote a "Supplementary Volume" with his notes. A summary of Maxwell's simplified equations are given in Vol. II, Chapter IX of the third edition. However, Maxwell had gone (in his second edition) to some pains to reduce the quaternion expressions himself, and not require the students to know the calculus of quaternions (so stated on p. 257). We note that Maxwell did not finish the second edition, but died before that. He actually had no hand at all in the third edition as to any changes. The Second edition was later finished by Niven by simply adding the remaining material from the previous first edition approved by Maxwell. The printing of the first nine chapters of the thirg edition was already underway when J. J. Thomson was assigned to finishtheeditingofthemanuscript.

Maxwell's work profoundly affected the course of science and the course of human history. Maxwell, Heaviside, Hertz, Gibbs, Lorcntz and others participated in dramatically curtailing Maxwell's original 1865 quaternion theory to the much more limited subset that it is today. Since the early part of the 20th century, work has slowly been ongoing to move EM theory back to a higher group symmetry theory, which ironically it already was when Maxwell first created it.

Max**well's** electrodynamics: Simply put, Maxwell's theory of electrodynamics consists of Maxwell's equations. His fundamental theory consisted of some 20 quaternion equations in 20 unknowns, appearing in his 1865 paper. After Maxwell's death and some curtailment by Maxwell himself, Heaviside modified and sharply curtailed these equations, into the familiar four equations of today, as did Gibbs and Hertz. Lorentz further curtailed the Maxwell-Heaviside equations, by symmetrically regauging them. This simplified their mathematical solution, but it also inadvertently and arbitrarily discarded all open Maxwell systems far from thermo**dynamic** equilibrium with their active environment (such as the modern active vacuum). See James Clerk Maxwell.

Maxwell's Theory, fluid dynamics analogy: *Considering and adapting the fluid analogy approach of James Clerk Maxwell:* The intensity of the vacuum virtual particle flux may be treated as the intensity of a potential, thus by analogy corresponding to pressure in a fluid. Polarity (charge) is a **process for** establishing a change in the intensity of the vacuum potential - and **thus** a change in the ambient pressure of the vacuum fluid. Dif**fence** between vacuum pressures at two separated points creates a force u**pon** any charge placed between those two points. Just as a differential in pressure between points in a fluid induces currents, a differential in vacuum pressure induces energy flow currents in the

vacuum fluid, which are called 'fields'. All EM circuits, charges, potentials, and forces in electrodynamics involve altering the vacuum to include altering its pressure and thereby producing the forces the resulting pressure gradients (fields) induce upon charges. All observable EM energy in space is EM energy intercepted and collected on charges, or assumed to be, and the spatial EM energy comes from the vacuum via these fundamental vacuum-engineering dynamics which all involve the giant negentropy 4-circulation between the time domain and 3-space.

Michelson, Albert Abraham: German-born American physicist, 1852-1931, who invented an interferometer (Michelson interferometer) named after him. Michelson used his interferometer in a renowned experiment in the 1880s designed to measure the velocity of the earth through the ether, which would produce a shift in his interferometer pattern. No such shift was observed, which indicated the absence of an ether wind and was largely responsible for the downfall of the concept of the material ether that had been previously assumed, including by Maxwell.

motionless electromagnetic generator (MEG): Transformer-like COP>1.0 electrical power generator invented by Patrick, Bearden, Kenny, Hayes, and Moore, ""Motionless Electromagnetic Generator," U.S. Patent # 6,362,718, Mar. 26, 2002. A second patent application is processing and several more are in preparation. In particle physics, any dipole (including a permanent magnet) is a known asymmetry in the fierce vacuum flux, continuously pouring out real EM energy extracted from the vacuum. The MEG continuously powers its transformer section core with a permanent magnet dipole, more than doubling the EM energy made available from **the** active vacuum via the permanent magnet dipole's broken symmetry in its exchange with the vacuum. [See M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., "Explanation of the Motionless Electromagnetic Generator with O(3) Electrodynamics," *Found. Phys. Lett.,* 14(1), Feb. 2001, p. 87-94; "Explanation of the Motionless Electromagnetic Generator with the Sachs Theory of Electrodynamics," *Found. Phys. Lett.,* 14(4), Aug. 2001, p. 387-393]. The MEG nanocrystalline core material extracts the magnetic field B of the permanent magnet from the surrounding space and localizes it in the core material. The active vacuum asymmetry freely replenishes the withdrawn magnetic B-field energy in space surrounding the core, but with uncurled magnetic vector potential A rather than magnetic field B. This is an application *of geometric phase,* specifically the well known *Aharonov-Bohm effect,* with several thousand papers in the literature. The MEG then transduces and outputs magnetic B-field energy inside the **core** material and some of the field-free magnetic vector potential A energy in

space surrounding the core, effectively having available more than double the energy being made available from the permanent magnet, or normally available to a transformer. The output power of the MEG is a function of (i) the time rate of change of a small amount of input EM perturbation ener**gy** to the input coil, plus (ii) the intercepting and collecting secondary charges available in the secondary coil, (iii) additional energy from chaotic oscillations, (iv), sophisticated feedforward and feedback regenerative self-oscillations, and (v) the geometric phase (Aharonov-Bohm effect). It thus **is** a rigorous practical application of the geometric phase effect to a mac**roscopic** power system, and in fact is the first such application in practical electrical power systems. The noted feature of the MEG is a purely electrical interaction in the output coils, in which the voltage and energy are in phase within 2°, differing from all other transformer-like systems. Thus the MEG directly delivers real power rather than apparent power. See Aharonov-Bohm effect.

multicollection (of energy): Multiple collection and re-collection in a circuit of the same energy flow from a source dipole, by rerouting either (1) the dissipated Poynting energy back around to the collectors for another pass by them, with additional collection, or (2) retroreflecting the nondiverged Heaviside EM energy flow component back and forth across the su**rface** charges in the circuit conductors, iteratively diverging additional energy into the conductors to potentialize and power the Drude electrons, or (3) a combination of the two. The interesting point is that this effect **can** "use" the same energy to do repeated work, multiple times. It takes a**dvantage** of the fact that work is merely the change of form of energy, and that the new form can again be changed (as for example, back into the **first** form again) to do additional work, again and again so long as the ener**gy** in each transformation is held in the system without escaping. This process permissibly violates classical equilibrium thermodynamics and its i**nfamous** second law, since it is an open system freely receiving excess ene**rgy** from its active environment and thus far from equilibrium with that active environment. As is well known, such systems are permitted to exhibit COP>1.0 and even self-powering of the system and its load simultaneously.

negative absorption of the medium: Excess emission from an active medium, as in the Letokhov work and in Bohren's experiment. The excess energy is first absorbed from the vacuum interaction (actually from Heaviside**'s** unaccounted energy flow component that usually does not interact with the system), and then it is re-emitted. This is actually a true "Maxwell's demon," as pointed out by Letokhov.

negative resistor: Any component or function or process in an EM system that freely receives energy from outside the system in unusable or disordered form within the system, transduces that energy into usable form, and outputs it so that it can do useful work. In a *true* negative resistor, that is the *net* function performed. We specifically do not include "differential" negative resistors such as the tunnel diode, thyristor, and magnetron, which dissipate and disorder more energy from the system itself, overall, than the fraction that they order and furnish back to the system in their negative resistance regime. In anti-circuits, true negative resistors are quite natural components. Every charge and dipole in the universe is already just such a negative resistor, freely extracting unusable EM energy from the seething vacuum, transducing it, and continuously pouring out real observable EM energy in all directions in 3-space. A negative resistor can produce the five magic functions: (i) self-ordering, (ii) self oscillation or self-rotation, (iii) output more energy than the operator inputs, (iv) power itself and its load freely, and (v) exhibit negentropy. The condition for self-powering of a system containing a true negative resistor was given by Gabriel Kron.

negentropic: Functioning to produce or involve negentropy; reordering previously scattered energy without requiring the operator to input energy to perform the reordering. A simple example is passive retroreflection of radially scattered EM energy. The conventionally unaccounted enormous and nondiverged Heaviside energy flow component surrounding every circuit and every field/charge interaction is an example of a dynamically reordered and organized energetic vacuum, and thus an example of a giant negentropy process. The continuous observable EM energy freely pouring at the speed of light from every dipole and charge in the universe is also an example of the giant negentropy process.

negentropic engineering: Expending a little bit of energy to form a dipolarity, and then intercepting, collecting, and using some of the enormous EM energy freely and continuously extracted by the dipolarity from the vacuum, indefinitely, without using any of the extracted EM energy to scatter the charges in the dipole and destroy it. Retaining the dipole intact avoids shutting off the furnishing of copious free energy flow from the vacuum to the attached external circuit. As an analogy, it allows an electrical windmill operating in (driven by) a free electrical wind from the external environment of the system.

Newtonian recoil: Newton's third law reaction from the affected entity back to and upon the effecting entity. The "action" is the action from the effecting entity upon the affected entity. The "reaction" is the action from

the affected entity back upon the effecting entity. Newton's third law actually implies that the cause interacts upon the effect and the effect reacts equally back upon the cause, thus producing a strange kind of equilibrium. In a time-reversal zone, the "recoil" is reversed in direction by parity reversal. Tentatively, one may interpret from pumped phase conjugation that the Newtonian third law reaction of one single acting force can be amplified by properly directing the actions of other acting forces. An interesting aspect is that a pumped phase conjugate mirror does not recoil, no matter how powerfully it is pumped or how powerfully amplified is the emitted phase conjugate replica wave.

Newton's third law: For every action there is an opposite and equal reaction. This law should be extended and restated something like this: "for every action there is an opposite and equal reaction if the causative mechanism of the reaction is allowed to occur without interference and is not first redirected away from its target." An example of a violation of Newton's third law as usually stated is provided by the emission of a phase conjugate replica (PCR) wave from a phase conjugate mirror material. No matter how powerfully pumped, the PCM does not recoil by the emission of the PCR wave. The reason is that the antiwave cause of Newtonian third law recoil was intercepted by nonlinear multiwave interaction (wave-to-wave i**nteraction)** before reaching its target nuclei and interacting with them, and was diverted away from the atom and on out of the phase conjugate mirror material. Since the causative mechanism for Newtonian recoil did not occur on the mass of the mirror, the mirror did not recoil. We also point out that, if Newton's third law is indeed engineerable and controllable, then COP>1.0 systems and self-powering EM systems are permissible a priori. In electrical system terms, this simply means that, if one can rid the system of its equal back emf or back mmf, the system can be legiti**mately** self-powering because it no longer self-enforces the Lorenz-Lorentz symmetrical regauging condition.

non-Abelian electrodynamics: An electrodynamics based on a group theory in which the group operation is not commutative and hence not Abellian in nature. Contrast to an Abelian group in which the group operation is commutative.

nonequilibrium thermodynamics: Colloquial term referring to the newer thermo**dynamics** of self-organizing systems and structures, far from euilibrium in their energetic exchange with their active environment, Since the **1960s,** there has emerged in physics (and in thermodynamics!) this surprising new area: the physics of far-from-equilibrium systems and the self-organization and large-scale ordering of such systems. The

equilibrium conventionally referred to is 3-space equilibrium, with no consideration of temporal equilibrium, although some pioneers of the field such as Prigogine are quite aware of the temporal disequilibrium also involved. Note that such "3-disequilibrium" thermodynamical systems are also in temporal energy flow disequilibrium as well as 3-disequilibrium, but overall are still in 4-equilibrium energetically. See **giant negentropy (of the dipole).** For a necessary thermodynamics discussion, see Appendix A in this book.

nonlinear material (optical): A substance whose optical properties vary with the intensity of the light.

nonlinear optical functioning: Functioning in a manner prescribed by nonlinear optics and quantum optics, particularly with respect to time-reversal effects, use of phase conjugate mirrors, phase conjugate reflection, wave-to-wave interaction, and pumping for amplified phase conjugate reflection. To quote Knight, "A phase conjugate mixing device has remarkable optical properties: perfect retroreflection, the complete cancellation of optical aberrations and inhomogeneities in wavefronts, and the ability to reverse an optical beam and return it to its source." A most interesting modern science, eventually adaptable to COP>1.0 systems, is developing in the study of intensely scattering optical materials.

nonlinear phase conjugate optics: See **phase conjugate optics.**

nonlocalization: Producing or rendering an effect or effect-producing agent at a distance, rather than at the immediate location of the effector. Extended throughout a large region or system, or to a distant part of a large region or system, rather than being confined to a small region of the large region or system. Nonlocalization effects are absolutely prescribed in quantum mechanics, and are experimentally confirmed. They have been largely ignored in classical electrodynamics and electrical engineering. Nonlocalization can result from the existence and use of a multiply connected space, as in Bohm's quantum potential and hidden variable theory. Engineering of action at a distance by engineering the quantum potential through multiply connected space gives one method of energy amplification. This method has unfortunately been secretly weaponized In five nations of the world, and none of the technology is available for use in electrical power systems for energy amplification and solving the energy crisis.

non-Riemannian geometry: Riemannian geometry is the geometry **of** Riemannian manifolds — i.e., manifolds having an infinitesimal squared distance *ds* that is everywhere positive. A non-Riemannian geometry

violates this property. [A manifold is a topological space with certain prescribedcharacteristics.]

nucleons: A collective name for the neutrons or the protons in a nucleus. In the nucleus, the neutrons and protons are continually changing one into the other by exchange of the charge. What is called a neutron and what is called a proton is thus somewhat arbitrary, so long as one makes a rule and stands by it. The interesting thing is that, in a nucleus, there is already continous and highly rapid transmutation activity between nucleons, all the time, without giant accelerations and operator input of very intense spatial energy. In short, nature shows in all matter that matter can be and is continually transmuted from instant to instant, and is "constant" only on the "**average".** Since most present models used for this are statistical rather than causative, it strongly suggests that we should look for a causal mechanism. The use of the time-reversal zone and time-energy has been nominated in this book as providing a causal mechanism for transduction, which can be directly engineered. It appears that cold fusion research already accomplishes transmutations using the suggested mechanisms, Several specific nuclear transmutation reactions applying the new mechanisms, and consistent with hundreds of cold fusion experiments, are given in the present book.

O(3) electrodynamics: An electrodynamics extended from a two-dimensi**onal** inner group symmetry to a 3-dimensional inner group symmetry**.O**(3) electrodynamics also becomes an important subset of Sachs' u**nified** field theory. The inner group symmetry of O(3) can be taken as normal space, which immediately opens up engineering the vacuum and using spa**etime** curvature engines to directly engineer matter for us.

open system: A system that communicates with its environment, and exchanges energy, matter, or both between system and environment. With the possible exception of a few theoretical or hypothetical systems, all systems in the universe are in fact open systems. An open system may be in equilibrium with its active environment, so that it cannot accept, store, and utilize any excess energy from the environment. Another open system may be in disequilibrium with its active environment, in which case it can accept, store, and utilize excess energy from the environment. When the operator inputs EM energy into an open equilibrium system, he automatically breaks its equilibrium condition with the external active environment, decreasing the system's entropy. This is an excited state, and the system will subsequently decay back to equilibrium (maximum entropy**)** condition by emitting or dissipating its excess energy. The reader interested in the thermodynamics should read Appendix A in this book,

since the thermodynamics definition (or misdefinitions!) of "closed system" actually permits the system to be open with respect to energy exchange with its active environment — either in equilibrium or disequilibrium — and only prohibits exchange of mass across the system boundaries. By that definition, a "closed system" can be far from energy flow equilibrium with its external environment, and hence permitted to perform COP>1.0 or even COP = oo. Hopefully our discussion in Appendix A will clarify the position we have taken on this matter.

optical switching: Switching of optical signals, or switching using optical frequency switching techniques, components, and circuits.

orthodox transistors: Ordinary transistors in use today, i.e., as contrasted with the Fogal semiconductor and its special functions.

orthogonal rotation: Simply speaking, a rotation from one direction to a direction at right angles to it. The Lorentz transform of special relativity, e.g., is a formula for the rotation of an object and all its parts away from its line of motion, as a function of the object's velocity, in a direction toward the time axis. The speed c just represents a full orthogonal turn, so that the projection intersection of the object with the observer 3-space, along the original line of motion, is zero.

outfolding: Translation by a system of received input longitudinal EM waves entering inside its potentials and fields, into conventional EM waves present in the system and then output from it. The opposite *of infolding*.

overpotential: Essentially the overpotential (as in an electrode in a solution) is a shift in the Fermi level necessary to allow the electron in the electrode metal to have energies overlapping with vacant acceptor levels in molecules adjacent to the electrode in the solution. The overpotential effect appears at small "double surfaces" of things in very close contact, particularly in electrochemistry and in solid state physics. The overpotential enables electron transfer, e.g., by tunneling. The overpotential increases with the log of the reaction rate that occurs at the overpotential location. For a small reaction rate, the overpotential is small; but for a small increase in the overpotential there occurs a dramatic increase of reaction rate. Fogal has utilized the overpotential effect in his semiconductor, to great advantage in accomplishing unusual charge blocking and other special effects. See **tunneling.**

overunity coefficient of performance (COP>1.0): More energy out or work out of a system than the operator or experimenter must furnish **and**

input. The excess energy is input from the active environment. See coefficient of performance.

parity: Deals with studying a system of a sequence of events as if the events were reflected in a mirror. A system has parity if it undergoes no fundamental operational change if replaced with its mirror-reflected twin.

partially time-reversed region: A region of spacetime in which an object temporarily experiences not only the ordinary forward flow of time, but also an extra induced backwards flow of time, usually a fraction of the time-forward time stream. It appears that the combination of the two is what constitutes time dilation in relativity. In a mixed time-forward (photon interactions) and time-reversed (antiphoton reactions) zone, if time-forward predominates, the law of attraction and repulsion of charges is partially reversed, leading to overall reduction of the forces — which remain in their usual directions. If the time reversal predominates, the law of attraction and repulsion is reversed, and in that region like charges attract and unlike charges repel. If time reversal and optical pumping are combined, the reversed law forces of attraction of like charges and repulsion of unlike charges are amplified also.

particle physics: The branch of physics using accelerators to study high-energy particle collisions, to determine properties of atomic nuclei and of the elementary particles themselves. It appears that conventional particle physicists do not recognize or consider time-energy interaction and time-reversal zone nuclear interactions at all. Hence the present "high (spatial) energy" physics is a far lower "total" energy physics than is the physics where time-energy is deliberately utilized. When time-energy is utilized, then the total energy of the photon varies inversely as a function of its frequency rather than directly as a function of its frequency. Lower frequency photons have very much greater total energy than higher frequency photons. For practical electrogravitation, therefore, one is interested in lower frequency bandwidths such as the ELF region.

Patterson effect: The intense multiscattering, multipass, multicollection of energy density flow in an assemblage of palladium-clad spherical bead capacitors, as the palladium adsorbs hydrogen ions from the fluid in which the beads are immersed, and thereby charges up as a capacitor, becoming an energy-flow generator, and nonlinearly increasing the energy-flow as the charge of the capacitors increases.

Patterson Power Cell®: Patented overunity power unit by James Patterson, which has been independently validated to yield COP>1.0. However, continuing difficulty has been experienced with the palladium

metal used in the effect. See James Patterson, "System for Electrolysis of Liquid Electrolyte," U.S. Patent No. 5,372,688, issued Dec. 13, 1994. Patterson has several other patents in the area.

perpetual motion machine: The rather archaic and dogmatic assertion that no machine can indefinitely operate, since no closed system can input its output power back to itself while powering a load, because powering itself and its load violates the *equilibrium* thermodynamics (i.e., the thermodynamics of a closed system). Every system is already an open system in a violent energetic exchange with the active vacuum, so the pronouncement is a non sequitur assuming a false straw man — that every machine is a truly closed system or is in energy flow equilibrium with its active environment and can be treated as if it were a closed system. (The thermodynamic definition of "closed system" is misleading; it refers to a system where no mass exchange crosses the system boundary, but energy flow exchange can and does freely cross it. See Appendix A to this book for a proper discussion). Further, the equilibrium thermodynamics cited does not necessarily apply to either an open thermodynamic system far from energy equilibrium, or to a closed thermodynamic system in energy flow disequilibrium, as is now well known. After all, a common windmill will operate so long as there is a wind or until something breaks. But since it involves a mass flow across the system boundary, it is said to be a true open thermodynamic system. In electrodynamics, a closed system (with no matter exchange across its boundary) can yet have copious energy flow exchange across its boundary, and thus be far from EM energetic equilibrium with its external active environment. The charges and the dipoles in matter operate in a free "time-energy flow wind" and virtual particle flux wind in the vacuum, which are constant and unfailing, and thus charges and dipoles have been freely and continuously outputting real EM energy flow into 3-space for some 14 billion years. All assertions that overunity EM systems are perpetual motion nonsense are completely refuted by every charge and dipole in the universe. To repeat such gibberish only reveals the ignorance of the person making the improper assertion.

Ironically, those dogmatists fond of hurling perpetual motion labels at overunity researchers already recognize the overunity legitimacy of open systems far from thermodynamic equilibrium with their active environment; they refer to such systems *as false perpetual motion machines ox fictitious perpetual motion machines.* All of them also accept the classical electrodynamics assertion of the source charge, from which all EM fields and potentials and their energy come. So the very dogmatists

so confidently pontificating that perpetual motion machines are ludicrous, themselves already implicitly accept that every charge and dipole in the universe is precisely such a perpetual motion machine, freely and continuously creating energy right out of nothing. No legitimate free energy researcher in his wildest nightmares has proposed such perpetual motion machines on such a universal scale. The greatest perpetual motion nuts on earth are precisely those pundits so confidently castigating the notion that an electrical system can output more energy than the operator himself must input. We will have a modicum of tolerance and respect from them, when they can demonstrate how they can purge all those "perpetual motion charges and dipoles"-—and all their EM fields and potentials—from their own accepted electromagnetic model. Obviously if they do that, they simply destroy all EM energy in space, in systems, and in the entire universe. This is the absurdity of the position these pundits advocate so ignorantly.

phase conjugate: Of an entity: its time reversal. For waves: often referred to as wave *front reversal*.

phase conjugate mirror: A nonlinear material which, when provided with an input wave, emits a phase conjugate replica (time reversed replica) of that input wave. The input wave is by practice called the *signal wave*. The time-reversed wave output is by practice called *the phase conjugate replica*.

phase **conjugate optics:** That portion of nonlinear optics dealing with multiwave mixing, formation of time-reversed waves, phase conjugate reflection (PCR), phase conjugate mirrors (PCMs), pumping PCMs to amplify their emitted PCRs, nonlinear interferometry, distortion correction, self-targeting, laser tracking, adaptive optics, and so on.

phase conjugate replica (PCR): Of a wave: the time-reversed duplicate of a signal (input) wave, after its detection by interaction with charge. We point out *there may still be some foundations difficulty, however, with the form in which the phase conjugate replica wave exists in space time prior to its interaction with charge and prior to its observation (observing the effect of its interaction with charged matter)*. Indeed, there is very serious foundations difficulty with the very notion of an EM transverse wavefront in space, traveling at the speed of light, for no such thing exists. See Robert H. **Romer,** "Heat is not a noun," *Am. J. Phys.*, 69(2), Feb. 2001, p. 107-109. This is an editorial discussion by the Editor of AJP of the concept of heat in **thermodynamics,** where heat is not a substance, not a thermodynamic function of state, and should not be used as a noun. In

endnote 24, p. 109, he also takes to task *"...that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/or time?) that besmirch the pages of almost every introductory book. ...it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate. " "...perhaps then, for historical interest, [we should] find out how that diagram came to contaminate our literature in the first place."*

phase conjugating action: In nonlinear optics, the process or action of producing a time reversed replica of an input wave._For a particle, producing its antiparticle. For a living cell, dedifferentiating it back to some previous form, genetics and all. In the presence of a predominately time-reversal zone, however, the cell is in a predominately phase conjugating mode *a priori.* Phase conjugating it a second time converts it from dedifferentiating to redifferentiating mode. We hypothesize that these combinations are the actual mechanisms generating cellular dedifferentiation and redifferentiation in the cell, tissues, and body. A future book will address that issue; meanwhile, see the 119-page "porthole briefing" on the author's website, www.cheniere.org.

phase conjugation: In nonlinear optics, the novel nonlinear mixing of waves which generate an output wave — called the phase conjugate replica or time-reversed replica — that precisely retraces the path previously taken by the input wave that stimulated the action.

phonon: A quantum of the lattice vibration energy in a crystal. This mechanical vibration energy is considered a field, and the phonon is the quantum of that mechanical energy field. Lattice vibrations in a crystal thus are characterized by waves in the lattice, where the waves are comprised of ordered phonons. Interesting effects occur between electron currents and phonons, due to electron-phonon interaction.

photon: In physics, the basic action quantum. Conventionally considered to be the basic quantum of the EM field. There is a foundations problem with the latter concept, because of the dichotomous use of "field" for both the *effect* force field in 3-space after observation (detection) and the *causal* force-free field in 4-space prior to observation (detection). Strictly speaking, the photon is the quantum of the causal 4-space massless **field,** since the photon possesses both spatial EM energy and time increments. In curved spacetime, the photon may possess mass because the time flow is a mix of time-forward and time reversal, and thus cause and effect are slightly intermixed as well. We point out that, in a negatively curved spacetime, the photon mass is negative, the photon energy is negative, **and**

the photon fields are negative energy fields. Presently the negative energy photons do not appear to be utilized in physics except haphazardly if at all. This may represent a large class of photon interactions with matter that have been inadvertently omitted.

ping-pong: Colloquial term for iterative retroreflection.

pinned electrons: Electrons held stationary by a magnetic field, or other set of forces that react to "push them back into their positions and hold them fast" whenever they try to spatially move away.

pinning: The act of restricting (by restoring forces and fields) spatial movement (particularly of electrons) due to a disturbing magnetic field or other external force.

polaron: An electron in a substance, where the electron is trapped in a potential well due to polarization charges on surrounding molecules. The exction in a substance is analogous to an exciton in a semiconductor.

positron: An antielectron (time-reversed electron), possessing a positive charge and positive mass. *Mathematically* an empty *negative energy electron* state in the Dirac sea whose usual occupying electron has been removed, leaving a four dimensional "Dirac sea hole," may also be regarded as a positron for many purposes, at least *after observation resulting from interaction with matter*, so long as the remarkable difference of the Dirac 4-hole prior to observation from the Dirac 3-positron a**fter** observation is understood. Mathematically, the lattice hole previously occupied by an electron can be considered a positron-equivalent (i.e., as if observed), again so long as the real differences are kept in mind, between a Dirac hole *before* observation and what results after its observation by interaction with mass. This is important, because otherwise one is again substituting the effect for the cause. In addition, if the two are confused, **then** one also arbitrarily discards the negative energy fields and negative energy potentials of the source 4-hole in the vacuum prior to observation. That effectively discards anti-circuits and the ability to engineer practical electro antigravity.

power: In physics, the time rate at which work is done (at which *the form of energy* is changed). In electrical engineering, the term "power" is erroneously but ubiquitously also used to loosely mean "energy." Hence such odd and improper expressions as "draw power from the source," which is a non sequitur. Nonetheless, such non sequiturs are so universally utilized in electrical engineering that they have become a part of the literarure itself.

Prigogine, Ilya: Noted Belgian chemist and Nobelist, and one of the pioneers of the thermodynamics of open systems far from thermodynamic equilibrium. Prigogine was awarded the 1977 Nobel Prize for his work on the theory of dissipative structures in nonequilibrium thermodynamics.

Poynting, John Henry: An English physicist who lived from 1852-1914, whose contributions to electromagnetics included the energy flow theory now known as Poynting flow. He contributed the Poynting theorem, which states that the rate of EM energy loss in a specific region of space is equal to the sum of the dissipation rate (heat loss) flowing across the boundary of the region. Concurrently with Oliver Heaviside, Poynting conceived the notion that energy flowed through space, which previously had not appeared in physics. Heaviside actually published first, but obscurely; Poynting published in a prestigious journal, so the theory came to be known as "Poynting theory."

Poynting energy: A loose term (not rigorous!) used to loosely describe the flow through space of Poynting energy density S = ExH, which is that component of the total energy flow in space that will be *intercepted and collected* by the intercepting charges, circuit, etc. It actually describes not the energy flow density *per se*, but the component of it that would be intercepted by a unit point charge, or that actually enters an intercepting circuit. Poynting started with the assumption of the component of the energy flow that enters the circuit, *a priori*. Only the work of Heaviside considered the remaining component of the energy flow that is not intercepted by the charge or by the circuit. Because of the startlingly great magnitude of this remaining nondiverged Heaviside component, Lorentt integrated the entire (Heaviside) energy flow vector around a closed surface surrounding any volume element of interest. This discarded the entire nondiverged Heaviside component, and removed any necessity of considering or explaining how every generator and battery already pours from its terminals up to 10^{13} times as much EM energy as the presently accounted energy input to the shaft of the generator or the chemical energy available in the battery. We believe that the discarded and unaccounted Heaviside nondiverged energy flow component accompanying every field-particle interaction is responsible for the puzzling excess gravity holding the arms of the spiral galaxies together. In short, we believe it is the solution to the "dark matter" problem, now often believed to be a "dark energy" problem.

Poynting energy density flow: A somewhat more rigorous term used to describe the flow through space of the Poynting energy density flow

$\mathbf{S} = f(\mathbf{E}\times\mathbf{H})$ component that would be intercepted by a unit point charge or an intercepting circuit.

*Poynt*ing energy flow: A loose term (not completely rigorous) used to describe the flow of energy density $\mathbf{S} = f(\mathbf{E}\times\mathbf{H})$. Rigorously, both E and H are "defined" only after their reaction with a unit point static charge. Hence S is the resulting component of the overall energy flow that interacts with the charges (with the circuit) and is diverged into the circuit to power it. It is not the entire energy flow, which also includes a vast Heaviside nondiverged component that does not strike the charge and interact with it, and hence does not interact with the circuit but is just wasted. See Heaviside energy flow component and Poynting energy.

Poynting generator: Colloquial term for any dipole or potential difference that represents a broken symmetry in the vacuum's virtual particle flux, and hence extracts virtual energy from that asymmetry, and gates it out as a gushing energy flow in 3-space. When both electric field and magnetic field are involved, the component of the energy flow that would be intercepted and diverged by a unit point charge is the Poynting energy flow S=f(ExH).

Poynting vector: The vector S, given as $\mathbf{S} = f(\mathbf{E}\times\mathbf{H})$, used to represent the Poynting (intercepted and collected by a unit point coulomb) energy density flow component. In Heavisidc's version, $\mathbf{S} = \mathbf{E}\times\mathbf{H} + \mathbf{G}$, where G is an energy circulation flow term of trapped EM energy flow. Heaviside later rea**lized** that such a closed energy circulation flow exhibits substantial gravi**tational** effects; in modern terms we would say that it represents an appreci**able** local curvature of spacetime. Unpublished notes on the gravitational aspects were found beneath a floorboard in his little garret apartment, years after his death. We also point out one limitation of the present use of the Poynting vector: It has rather universally been associa**ted** only with the flow of *positive* EM energy, and not with the flow of negat*ive* energy. Indeed, the concept of negative EM energy is still consufe**d,** with different views and positions, and still in debate without complete scientific consensus.

PPCM: Pumped phase conjugate mirror. A phase conjugate mirror material that has introduced to it a positive or "pump" waves (in other words, s***tress*** waves). In effect, pumping is "stressing" or "squeezing" ryhtmically. It is also varying a stress potential, which emits longitudinal EM waves, each accompanied by a correlated scalar (time-polarized) wave. In the phase conjugating process, up to all the energy in the pump waves can be output as the energy in the emitted phase conjugate replica

wave. Thus the PPCM may be viewed as an *amplifier*, very similar to a triode. When the time-components of the photons in the signal wave input and also in the pumping waves are considered, then there is a functioning of the pumping also ongoing in the time-domain. There is a rhythmic variation of stress in the time-domain also, which creates the correlated time-polarized EM wave accompanying the longitudinal wave from the 3-space pumping.

So the time-reversal aspect (formation of the phase conjugate replica wave) may be thought of as a rhythmic time-stress wave (pumping or stressing in the time domain) which, by alternately decreasing and increasing the time potential of the mirror, produces two temporal force effects. During the decreases in temporal potential of the mirror, the time-force from the input wave and from the pump waves is forward into the mirror material, allowing the input and interaction of these waves. During the increase in temporal potential of the mirror, a reversed temporal force from the mirror back to the past (temporal potential earlier in 4-space) of the input "signal" wave. The pumping energy (excess temporal potential energy) adds the gain to the phase conjugate replica wave,

probability: The probability of a simple event is the ratio of the number of times it occurs to the total number of trials (for a large, essentially infinite number of trials). Note that "trials" constitute things that have occurred (are past, have been observed). Probability has resisted rigorous logical definition by Aristotelian logic; the reason is that it is an expression of the fourth law, the identity of opposites. Probability is an expression of the future (that which has not occurred) in terms of the past (that which has occurred). Consider *throwing a die to land with one face up.* Thinking of the event (as if it has just occurred, in terms of the most recent past), one can conceive six ways of looking at it. In other words, one can conceive of six "most recent pasts", however, these have not occurred. We were merely thinking of them as if they had occurred. By the fourth law, the *total* "most recent pasts that have not occurred" is identical to the "most immediate future" that has not occurred, on the common boundary between past and future. If one therefore *collects* all six "most recent **pasts** not occurred" they turn into the most immediate future, by the fourth law of logic. One may argue that only a single one of the events will actually occur. Here one counters with the observation that, when it occurs, it is the past, not the future, and then it has not been collected so as to move **to t**he boundary. In theory, the hidden variable approach makes it possible to directly engineer those probabilities while the Schrodinger wavefunction is still propagating and has not yet collapsed to constitute an "observation."

I.e., it is theoretically possible to engineer Wheeler's "pre-reality," and determine in advance just which of the outcomes will occur.

Puthoff, Harold: Noted physicist active in a variety of fields and investigations including in psychoenergetics, extended electrodynamics, energy from the vacuum, inertia, antigravity, parapsychology, remote viewing, psychokinesis, zero-point energy of the vacuum, and cosmology. We are particularly impressed with Puthoff's cosmological feedback principle. Together with Cole, Puthoff also proved that thermodynamics does not prohibit extracting usable EM energy from the active vacuum. See Daniel C. Cole and Harold E. Puthoff, "Extracting Energy and Heat from the Vacuum," *Phys. Rev. E*, 48(2), Aug. 1993, p. 1562-1565.

QM vacuum: The quantum mechanical vacuum, which models the vacuum as an intense flux of virtual particles, each appearing and disappearing in such extremely short time intervals as to be unobservable individually—although as physics develops, from time-to-time what is observable changes because of increased observation techniques. Violent fluctuations of extremely short duration constantly occur in the QM vacuum flux. Various calculations estimate the energy density (in mass units) as up to 10^{80}-10^{90} grams per cubic centimeter (in mass density units), or even greater. The vacuum is sometimes described as two separate components: (1) the ambient or average vacuum in deep space, which can be taken as a scalar potential having an enormous energy density, and (2) the fluctuations superposed upon the ambient vacuum as local violent potential energy changes. Finally, we note that any EM potential in a system is *apriori* a change to the local vacuum scalar potential.

quantized: Adjective which means (i) reduction of some observable quantity to multiples of some small, indivisible unit, or, (ii) expressed in terms of quantum theory.

quantum: A single "particle" of the quantity *action* (angular momentum). Often confused as a single quantity of energy alone.

quantum electrodynamics: The theory of photons and electrically charged particles and their interactions. The use of the term "quantum" implies that the EM radiation's discrete photon nature is significant, so that quantum theory must be employed.

quantum **field theory:** A quantum mechanical theory in which "... a phsyica1 held is considered as a collection of particles and forces, and observable properties of an interacting system are expressed as finite quantities rather than state vectors." *[Dictionary of Science and*

Technology.] More simply (after Davies, *The New Physics*, 1989): "The theory that describes the quantum effects of a classical system of fields defined on space-time and satisfying various partial differential equations." Particles are taken as quanta of fields similar to photons being quanta of the electromagnetic field. Each type of particle is represented by an operator that obeys certain commutation laws. The theory relates gluon fields and intermediate vector boson fields to the strong and weak interactions, and allows an overall theory of fundamental particles and their interactions.

quantum potential: A special potential added to the Schrodinger equation by Bohm in his hidden variable theory of quantum mechanics. The quantum potential is a multiply connected entity, so that it "occupies" widely separated but multiply connected points, events, or objects. It is also an extraordinary energy amplifier, since any energy input to one of the multiply connected points simultaneously and instantly appears in every other connected point, regardless of distance or location in the universe. In real life, the quantum potential also has a "coefficient of multiple connectivity", so that only a fraction of the energy input to one multiply connected point will appear in the other points of the multiple connection group. The quantum potential has been strongly weaponized by five nations, and quantum potential weapons are the dominant weapons on earth, being more powerful than nuclear weapons. In theory the quantum potential together with engines and antiengines could be used to treat and cure a given disease in all persons on earth simultaneously, or in one nation or area simultaneously. Sadly, engines have been developed to generate diseases in a targeted populace, rather than engines to heal the populace. Russia and Brazil have had the quantum potential weapon for some time, as have two nations friendly to the United States. In 2001, China also deployed the quantum potential weapon.

quark: Fundamental particle theorized to comprise hadrons (particles such as protons, neutrons, and mesons) by combining in twos or threes. There are six varieties of quarks. The difference between a proton and a neutron, e.g., is merely the orientation of a single quark. In a time reversal zone (TRZ) in the electrolyte in cold fusion experiments, the gluon forces can be significantly reduced, so that the quarks are nearly freed. Two protons (H+ ions) can attract together in a TRZ so closely that each enters the reduced strong force region of the other, forming a quasi-nucleus. As the ions in solution outside the TRZ move to cancel the TRZ, it decays and the quasi-nucleus becomes an increasingly excited state, seeking to decay. Preferred method of decay is by quark flipping. So one quark flips, so that

the quasi-nucleus has become a quasi D+ nucleus. As the TRZ vanishes and time-forward resumes, the strong force recovers faster than the Coulomb barrier returns. Consequently, the quasi-nucleus of D+ merely tightens into a real nucleus of D+. This is one of the standard transmutation reactions in cold fusion experiments, forming excess deuterium.

quaternion: Expression comprised of the sum of four terms, one of which is real and three of which contain imaginary units, and where the terms can be writtten as the sum of a scalar and a three-dimensional vector.

quaternion algebra: The algebra of quaternions and their mathematical operations. Quaternion algebra is of higher topology than either vector or tensor **algebra.** Maxwell's original 1865 equations are some 20 equations in 20 unknowns, in quaternion and quaternion-like algebra. Heaviside and others reduced the algebra to vector algebra and some four equations; at his death, Maxwell himself was rewriting the equations in his *Treatise* to purge the quaternions, because of the controversy over the difficult quaternion form. The present vector equations taught in university as "Maxwell's equations" are in fact Heaviside's truncation of the Maxwell theory. Going to tensor algebra electrodynamics does not recover the full range of Maxwell's original 1865 quaternion EM theory.

quintessence: Literally, the "fifth essence". In short, *dark energy*. We have nominated the arbitrarily discarded, vast Heaviside nondiverged energy flow components surrounding every interaction of charge with field as the dark energy that is the source for the excess positive gravity holding the arms of the spiral galaxies in place. See dark energy, positive.

reactive power: Electrical power, measured in volts-amps-reactive (vars) that cannot do work as is. For sinusoidal waveforms, the formula for reactive power is $IV\sin\theta$, where θ is the phase angle between the voltage **and the current.**

real hidden dynamics: The dynamics of vacuum engines, or of "internal energy" or "internal work" ongoing in a system or volume of space. These internally organized forces, fields, and energies involve dynamic curvatures of spacetime, and it is this dynamics of spacetime itself that provides **the** continuous work and dynamics of internal energy. See Einstein's second postulate extended; infolded; dimensioning.

real hidden vectors: The "hidden" or "infolded" real vector components, e.g., of a zero vector summation system. The individual hidden vector cannot spatially translate the entire bulk system, but it can interact inside

the system to perform *internal work* upon it or upon some particular portion of it. Such a system of a finite number of infolded deterministic vectors is said to constitute a "dimensioned" stress potential. Specifically dimensioned potentials, fields and waves thus can be constructed, so that they carry specific vacuum engines (spacetime curvature engines). The interactions of these dimensioned EM entities may differ from normal EM interactions in chemistry, physics, biological systems in general, cells in particular, etc. The long neglected combination of Whittaker's 1903 decomposition of the scalar potential, together with his 1904 demonstration that any EM field or wave pattern decomposes into two scalar potential functions, has neglected the development and use of the "internal EM" theory and technology for a century. One or more nations has, however, highly weaponized "dimensioned EM fields, waves, and potentials" as evidenced by the peculiar and anomalous results of the decades-long microwave radiation of the U.S. Embassy in Moscow. See dimensioning.

real power (active power): Power, measured in watts, that can do work, including generating heat. For sinusoidal waves, real power is given by the formula $I \cdot V \cdot \cos\theta$, where θ is the phase angle between the voltage and the current. Note that when higher group symmetry EM effects are involved (such as the Aharonov-Bohm effect), then the "normal" behavior of circuit components can be altered dramatically. As an example, in the MEG the secondary (output) coils of the transformer section are caused to exhibit a purely electrical interaction with the electrons and electron currents in the coils themselves. Consequently *the output current and voltage are in phase, in complete violation of conventional transformer theory and conventional assumptions about the interaction of inductors.* So the output of the MEG is real power, and phase angle does not enter into it.

regauging: In electrodynamics, changing the scalar potential or the vector potential, or both. If one or both of the potentials is/are changed so that a net new force is created in the system, that is an *asymmetrical* regauging. If only one potential is changed, a net force results and that is an asymmetrical regauging. If both potentials are changed but carefully selected so that the free force resulting from one change is equal and opposite to the free force resulting from the other, that is a net *symmetrical* regauging, often called "Lorentz regauging" or the "Lorentz condition". We note that longitudinal EM waves are produced very simply by rhythmically oscillating the magnitude of a stress potential, which is naught but coherently oscillating the individual vectors of a set of EM fields that sum to a zero vector resultant. The locked-in stress in T. Henry

Moray's semiconductors used in his radiant energy device tubes and the locked-in stress in the Chung negative resistor thus have to do with the production and use of longitudinal EM waves, time-polarized EM waves, and stress potentials.

reflection: The rebound of light or other energy from a surface.

refraction: The bending of light as it passes from one medium to another or through a density change in a given medium.

retarted wave: An electromagnetic wave that is derived from retarded fields, which in turn are derived from retarded potentials. The retarded wave at a point or region of space has arrived there or exists there as the result of the dynamics of charges and currents that existed at earlier times elsewhere. Compare to advanced electromagnetic wave.

retroreflecting: Precisely reversing the path of a reflected wave or object.

Sachs, Mendel: Noted scientist who has completed the work of Einstein and developed a unified field theory covering the universe from the tiniest part to the entire conglomerate. Since O(3) electrodynamics has been shown by Evans to be an important subset of Sachs' theory, then for the first time we have a higher group symmetry electrodynamics and a unified field theory that is largely engineerable by novel electrodynamic means, using the O(3) model.

Sachs' unified field theory: An extension and completion of Einstein's work that includes the universe and its dynamics from the tiniest part to the entire conglomerate, and includes quantum mechanics, electromagnetics, gravitation, and the strong and weak forces. See particularly Mendel Sachs, *General Relativity and Matter*, Reidel, 1982; Quant*um Mechanics from General Relativity*, Reidel, 1986. Sachs' unified theory provides a great generalization of general relativity, quantum mechanics, and electrodynamics reaching from the quarks and gluons to the entire universe. Much of the model is also engineerable by higher group symmetry electrodynamics such as the O(3) electrodynamics pioneered by Evans and Vigier.

scalar: Characterized by magnitude only. However, with respect to polarization, a scalar photon is a term in use for a *time-polarized* photon, where the EM energy oscillates along the time-axis. Hence a scalar wave, following the same terminology, is an EM wave composed of scalar photons, hence whose EM energy is oscillating along the time-axis. The term "scalar" is used in the sense that no vector in 3-space exists even though a vector (and a variation of its magnitude) exists along the time

axis. The effects are observed as an oscillation in the rate of flow of time, hence a "time-density" oscillation. The term "scalar" with respect to polarization implies only that there is no vector component in 3-space.

scalar entity: In ordinary vector analysis, an entity thought to be completely characterized by magnitude alone. Actually this is incomplete; a scalar entity must contain a time-like vector component, if it is to steadily persist in time. What we usually do unthinkingly is assume a continual series of successive observations or *d/dt* operations upon the *kt* nature of a scalar *k.* We conceive these individually frozen 3-space snapshots to "continuously exist" since we can readily recall the "stream" *of d/dt* differentiations in our mind and memory. Since all observation is 3-spatial, then no observable *persists continuously* in time; instead, it *continually recurs* in time, instant to instant. This "iterative successive stream of frozen 3-space snapshots" exists in the continual and rapid recall from our memories. Compare this to the similarity of observing a sufficiently rapid series of still pictures on a screen, where the individual pictures differ by a time sequence taken of some phenomenon. One "sees" the recreation in one's mind of the flow through time of those events and entities so photographed. Yet at any one instant, there is only a single frozen snapshot on the screen, and no motion at all was "physically" observed.

scalar electromagnetics: Colloquial term for the electrodynamics that arises from considering transverse EM waves, longitudinal EM waves, time-polarized EM waves, electrogravitation, superluminal EM signals, interferometry, nonlinear optical functions, time-as-energy, and the infolded electrodynamics inside all usual EM fields, waves, and potentials, In secret superweapon projects, the Russian term for scalar electrodynamics is *energetics.* It is divided into three major fields, depending upon the intended target. Targeted against inert matter, **systems,** and fields, the same term is used: *energetics.* Targeted against the **physical** and chemical processes and biological fields and potentials of living organisms, the term used is *bioenergetics.* Targeted against the mind's time-polarized EM functioning and dynamics, the term *psychoenergetics is* used. In the latter, higher group symmetry electrodynamics and extensions to quantum field theory play significant roles. Significant progress and strategic testing of all three branches of energetics has been evidenced worldwide. Progress in the energetics branch was confirmed by a statement by U.S. Secretary of Defense Cohen in 1997. Quoting: ***"Others*** *are engaging even in an eco-type of terrorism whereby they can alter* ***the*** *climate, set off earthquakes, volcanoes remotely through the use of*

electromagnetic waves...So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations...It's real, and that's the reason why we have to intensify our efforts " Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

scalar potential: Usually considered synonymous with the electric potential. The concept of potential was developed by Poisson, Green, and others **from** about 1813 to 1827. Three notions involved in the deve**lopment** of the concept of the potential are: (i) there is the collection of storage of energy in the system, via the collection or storage of some entity therein, and this "potential energy" can be released and dynamically used, (ii) the potential is a scalar function whose spatial rate of change is a vector force, and (iii) the dynamics of the stored energy is suspended by the "storage" or "collecting" entity; in other words it is a sort of "suspen**ded** action" waiting to be unleashed. *It requires some action*—such as *interception and divergence—to release the leashed energy*.

The second notion is false, since no force exists in the absence of mass because mass m is a *component* of force F via $F \equiv dp/dt = (m)dv/dt + (v)dm/dt$. It is corrected by stating that its spatial rate of change *when interacted with charged matter* is a vector force. For the third notion, we note that the concept of a "virtual" particle or particle flux means that it cannot beco**me** observable unless some interaction is imposed. So we may handle the "third notion" requirement by assuming the potential in modern terms to be composed of hidden virtual particle flux, or hidden wave flux, in wave-to-wave interaction. Physics tries to define the electrical potential as energy per coulomb, or W/Q. That equation, however, is actually not a definition at all (no equation is a definition), but rather is an algorithm for calculating the magnitude of the excess energy collection/collecting upon a coulomb of charge, when that coulomb is immersed in the potential It in fact is the *reaction cross section* of the potential, not the potential entity itself. This now begins to give us a clue, Potential is *energy* in some fashion, and the term "potential energy" is a redundancy. So the entity must have essentially the same definition as energy! **Potential** energy, collected energy, stored energy, whatever—it is energy first and foremost. How it is collected and what it is collected upon or in, determines **the** "type" of potential. It also cannot be logically defined as the work expended by it upon a unit charge. The causal entity itself is

not the action taken; just as a man is not definable as "how far he has run" in some race.

scattering processes: Collision processes in which an incident particle such as a photon, electron, or proton, of known energy or direction or both, collides with another entity, and emerges from the collision with a different energy or direction or both.

Schrodinger, Erwin: Noted Austrian physicist, 1887-1961, and Nobelist who discovered the wave equation named after him as the Schrodinger equation, and performed other vital work in wave mechanics.

Schrodinger equation: In quantum mechanics, an equation that describes the propagation of waves associated with subatomic particles, or more generally, that describes the evolution over time of the quantum state of a system. The fundamental quantum mechanical equation governing the behavior of wave functions.

self-energy: In a quantum mechanical system, the energy associated with the emission and absorption of virtual particles. In a classical system, the energy associated with the interaction among parts of the system itself.

self-organization: (After Davies, *The New Physics*, 1989): "Spontaneous emergence of order, arising when certain parameters built in a system reach critical values." Simply put, self-organization is the spontaneous formation of patterns of localized order in a system that begins in a more homogeneous state. In short, the system moves from a simpler to a more complex state. Self-organization is one of the permissible features of an open system far from thermodynamic equilibrium with its active environment. Note that the localized orders represent free potential energy formations (free self-regauging) that in theory can then be dissipated in loads to perform free work. Hence the capability of a self-organizing system to perform some free work, or in other words to exhibit COP>1.0.

self-potential (e.g., of the electron): The potential created in and of the charge (e.g., the electron) by its virtual particle flux exchange with the vacuum. Also, an asymmetry in the virtual photon flux of the vacuum, caused by the interaction of the charge (e.g., the electron) with the vacuum flux. From here, we note that the self-potential must consist of real observable 3-space EM energy flow or flows from the electron, because of the asymmetry. However, the charge is not the primary source *per se* **of** the energy flows that establish the self-potential, but instead is the asymmetric gate in the vacuum flux that "gates out" the potential and its energy **flux** The asymmetry in the vacuum flux is the actual *source* or gate. Indeed, in

classical terms the energy is received by the charge in the form of converging longitudinal EM energy waves from the complex plane (from the time domain). The spin of the charges of the dipole transduces the absorbed complex EM energy into real observable EM longitudinal wave energy, and pours it out in all directions in 3-space. See discussions under Whittaker and phase conjugate.

self-targeting: Between two entities, where each acts partially or wholly as a phase conjugate mirror, self-targeting is the iterative phase conjugation or "ping-ponging" and rapid convergence of beams between the two PCMs.

S-flow: The Poynting energy density flow S, where S = ExH. Heaviside's equation is given by S = ExH + G. In the latter equation, E is the electric field, H is the magnetic field strength, and G is a trapped closed loop flow of energy density. Note that, from the very definitions of E and H, the Poynting, energy flow represents only that portion of the total energy flow in a spatial region that is diverted by interception and interaction with charges. Heaviside's additional component G, which is not part of the field interactions but a result of the huge noninteracting part of the energy flow outside the interacted ExH component, does appear to be responsible for an enormous unaccounted EM energy flow component that generates the excess gravity required to hold together the arms of the spiral galaxies.

signal wave: In nonlinear optics, the signal (wave) input to a phase conjugate mirror (PCM), that stimulates the PCM to emit a phase conjugate replica (PCR) wave in return. See discussion under distortion correction theorem.

Slepian current: The vector $j\phi$, which in a current loop represents the energy unit area per coulomb of flowing charge, per unit of time, that is collected/collecting from the Poynting S-flow and dissipated in that current loop in its loads and losses.

Slepian flow: "Flow *of collected-energy* density's dissipation" in a current loop, and therefore related to the vector $j\phi$ in the current loop, which represents the energy per unit area per coulomb of flowing charge, per unit of time, that is being dissipated in that current loop in its loads and losses.

Slepian vector: Refers to the vector $j\phi$ in a current loop, which represents the energy density per coulomb of flowing charge, per unit of time, that is being dissipated in that current loop in its loads and losses.

solid-state parametric oscillator: A parametric oscillator circuit employing solid-state devices. A parametric oscillator is a device that oscillates by rhythmically changing a parameter (such as capacitance or inductance, etc.). Simple switching between differing values of the parameter is often used to induce the periodic change of the parameter. One way of close-looping a COP>1.0 EM system is by using a bit of the positive output energy to do parametric switching, in effect converting the system to a self-oscillating energy flow system. The AC flow of EM energy is then much more easily intercepted, collected, and dissipated to power loads without killing the source dipole extracting and furnishing the free flow of EM energy from the active vacuum.

soliton: A "solitary wave" consisting of a wave pulse which propagates without changing its shape and without dispersion.

source dipole: Any dipole, considered from the viewpoint that real observable EM energy continuously pours out of it without any observable EM energy input. There is no true "source" as such in nature, since the energy is not created but only transduced and gated. In the case of the dipole and electrical charge as sources of EM energy, fields, and potentials, the broken 3-symmetry of the dipole initiates an automatic and more primary 4-symmetry, where EM longitudinal wave energy flows into the negative charge of the dipole from the time domain (complex plane), is transduced into normal EM longitudinal wave energy in 3-space, wherein the 3-space energy is absorbed by the positive charge of the dipole, transduced back into time-energy and reradiated back into the time-domain (fourth Minkowski axis). We roughly state that the dipole "emits observable EM energy" into all directions in 3-space as observable EM energy. However, what actually happens is that this *energy 4-circulation process* is what is emitted into and along 3-space, along every radial direction, with the process occurring at every spatial point along that direction. Any charge (taken together with its clustering virtual charges of opposite sign as a dipole) then inserted at any point in space along a radial line, will dipolarly intercept the ongoing process. We will observe the interception by its 3-effect on the intercepting and interacting 3-space charge, but we will not observe the 4-process itself. This deeper examination of the EM field-charge interaction requires a new interpretation of what is meant by "propagation of EM energy through 3-space", which is a non sequitur. Recall again Romer's acid objection **to the** totally illogical picture in every elementary textbook of the so-called "EM wave through 3-space" as a flat x-y plane orthogonal to the line of **motion** z, and where the E-field vector is oscillating along one axis while the

magnetic field B is oscillating along the other. That representation is totally false, just as pointed out so strongly by Romer.

spacetime or space-time: The entity represented by the "fused product" of space and time, to give "space x time". Spacetime is also dynamic geometry, in the general relativistic interpretation. We may also consider spacetime to be a giant potential, and also active geometry, and also active vacuum, and also virtual particle flux of the vacuum, and also hidden EM wave flux. If we wish, we can also consider spacetime to be comprised of longitudinal EM waves and impressed dynamics.

spacetime curvature engine: See deterministic pattern and dimensioning.

special relativity: Einstein's theory of inertial frames in which, if two systems are moving uniformly in relation to each other, one cannot determine anything about their motion except that it is relative. Each of the two frames is said to be "rotated" with respect to the other, but not accelerating. The velocity of light in space (the vacuum) is constant, and is independent of the velocity of its source and the velocity of an observer. All the laws of physics are the same in all inertial frames of reference.

spin: The intrinsic angular momentum of a particle such as an electron, proton, neutron, photon, graviton etc., even when at rest, as if it were a top spinning about an axis, but had to spin 720 degrees before it turned "full circle." Spin is quantized, and is always described as a half or whole spin, e.g., - 1, - 1/2, 0, 1/2, 1, etc. A spinning charged particle such as an electron thus demonstrates a magnetic moment, due to the circulation of charge in the spinning. In the nucleus of an atom, the spin of the nucleus is the resultant of the spins of the nucleons (particles comprising the nucleus).

spiral galaxy: A member of the class of galaxies having arms that extend in the form of spirals. About 70% of all galaxies are spiral galaxies: only about 10% of the gravity necessary to hold the spiral arms together can be accounted for by known gravitational sources. This has led to the theorizing of dark (hidden) matter of exotic and unknown form, which would be responsible for the excess gravity. Later it was theorized that some sort of "dark energy" might be responsible for the extra gravity. The present author has proposed that the *unaccounted* enormous Heaviside component of the EM energy flow surrounding every field/charge interaction, and not entering into that interaction, is the missing source of the excess gravity. The dark Heaviside energy flow was arbitrarily

discarded by Lorentz in the 1890s, and it is still discarded today by all electrodynamicists and astrophysicists.

Stoney, George Johnstone: Well-known scientist (1826-1911) who first estimated the value of the electronic charge (1874) and was the first to advocate the particle nature of electricity. In 1891, he named the unit of electronic charge the *electron.* In 1896-7 he laid the foundation for Whittaker's 1903 bidirectional wave decomposition of the scalar potential.

string wave or "plucked taut string" wave: The transverse wave on a taut string produced when the string is plucked. The string wave itself stays on the string and does not travel through the slapped external medium.

subspace: In vector mathematics: a subset of a vector space which is closed under vector addition and scalar multiplication operations. In the new approach, we may consider the active ambient vacuum as a giant scalar potential. This ambient potential then decomposes into longitudinal EM waves via Whittaker's 1903 decomposition. One can then refer to longitudinal EM waves deliberately transmitted "inside" that Whittaker "subspace" as "subspace communication". The Fogal semiconductor is able to infold normal EM signals into such subspace signals (longitudinal EM wave signals) in the transmitter, and to outfold the longitudinal EM waves back into normal EM waves in the receiver. Hence the Fogal semiconductor can be utilized to perform subspace and superluminal communication. These capabilities have been demonstrated by Fogal in the laboratory. As this is being written, Fogal is in serious negotiations with several large companies for the funding to get his chips into volume production and onto the marketplace in very sophisticated and advanced equipment representing a great leap forward in technology. There are, however, powerful interests who do not wish the Fogal semiconductor to ever be produced and marketed. We have worked with Fogal for some years, and — once the semiconductors are available in quantity — we will be developing and marketing COP>1.0 electrical power systems utilizing his semiconductors and technology, under license from Fogal.

superconductivity: Property of some materials or metals whereby at very low temperature their resistance reduces to zero. These materials also exhibit many additional properties that are anomalous compared to normal materials. Much research has gone into the attempt to find materials that exhibit superconductivity at higher temperatures, with the goal of reaching room-temperature superconductivity. Room-temperature superconductivity is also just COP = 1.0. EM systems far from equilibrium with the active

vacuum, and which exhibit COP>1.0 at room temperature, may involve most of the odd entities also observed in superconducting materials (polarons, lattice holes and hole currents, Dirac sea holes and Dirac sea hole currents, "charging" by Dirac sea hole excitation, vortices, etc.) The energy density in the output section is greater than the energy density input by the operator to the input section. Considering the giant negentropy mechanism and the dipolarity of the input and output sections, the tempic potential of the output section of a COP>1.0 EM system is greater than the tempic potential of the input section. Hence there is a tempic gradient across the entire system, and a tempic force from output to input. This may "sweep" out a great deal of the produced "superconductivity" entities, and particularly may result in a Dirac sea hole current in the vacuum, out of the input section back into the external power source, as a novel output of the COP>1.0 system. Feedback from output to input may also be in the time domain, corresponding to what Gabriel Kron referred to as the "open path". By recombinations and other means, the feedback in the tempic domain may be transduced in the input section of the device to ordinary current in forward time. When the voltage and current in this transduced tempic feedback are properly adjusted to that being supplied from the external power source, the external source can be disconnected and the COP>1.0 system becomes self-powering, while simultaneously powering its load also.

superluminal: Exceeding c, the speed of light in vacuum. Longitudinal EM waves can travel either slower or faster than the speed of transverse wave light in vacuum. See W. A. Rodrigues and J.-Y. Lu, "On the existence of undistorted progressive waves (UPWs) of arbitrary speeds 0 < v<oo in nature," *Found. Phys.*, 27(3), 1997, p. 435-508; W. A. Rodrigues and J. Vaz Jr., "Subluminal and Superluminal Solutions in Vacuum of the Maxwell Equations and the Massless Dirac Equation," *Adv. Appl. Clifford Algebras*, Vol. 7(S), 1997, p. 457-466.

superluminal communication: The movement of intelligent signals faster than the speed of light in vacuum, and the transmission and reception of such signals and extraction of their transported information. Longitudinal EM waves are not limited to speed c, whereas transverse EM waves are. The infolded electrodynamics inside all EM fields, potentials, and waves consists of longitudinal EM phase conjugate wave pairs, with their impressed dynamics. Hence this "subspace" is a superhighway for such waves, including those moving at superluminal velocity. In essence this is a very special kind of "tunneling" which might be referred to as *subspace tunnelling*. The limitation to light speed rigorously applies to the modeled

transverse EM waves which are a sort of "bulk upheaval" waves similar to waves on the surface of the ocean. As in the ocean wave analogy, "pressure" waves underneath the ocean may travel very much faster than the bulk upheaval waves on the surface.

When making longitudinal EM waves, the process is imperfect and the resulting longitudinal EM waves will have a transverse residue as well. The resulting "transverse-noisy" LW is called an *undistorted progressive wave*. Undistorted progressive waves may move slower than the speed of light or faster than the speed of light. The degree of transparency of matter to LWs is an inverse function of the "transverse-noisiness" of the LWs.

superposition: The simple linear addition and subtraction of two or more values, states, etc.; one of the key principles in field theories and in the concept of potentials. When the situation is sufficiently nonlinear, however, interaction of waves and potentials occurs instead of simple superposition.

supersystem: A higher level or "metasystem" of interactions between the classical system, the active vacuum, and the active local curvatures of spacetime. Hence the supersystem consists of three interacting components: (1) the EM system and its dynamics, considered in conventional fashion as if the local vacuum were inactive and the local spacetime were flat; (2) the local interactive vacuum and its dynamics, and (3) the local curvatures of spacetime and their dynamics. In component (2), one must consider the Dirac sea, Dirac holes and hole currents, with concomitant potentials and forces impressed on them. In component (3), the time-domain interactions (time-energy, time-force, time-potential, and currents of energy along the fourth Minkowski axis) must be accounted to include negative energy.

All three components of the supersystem interact with each other. In general, the vacuum interactions may be taken from particle physics, and the spacetime curvature reactions may be taken from general relativity. However, this will yield only a rough or "first order" analysis, since it does not produce the tri-reactions of all three components at once, but mostly reactions between pairs of the components. The concept is easy to conceptualize, however, and yields valuable clues and insight in many areas, such as chemistry (including biochemistry), electrical physics, electrodynamics, thermodynamics, and electrogravitation. It is particularly useful in understanding the phenomena encountered in COP>1.0 EM power systems.

symmetrical regauging: In electromagnetics, changing the scalar potential to a different value, and simultaneously changing the vector potential to a different value, with the two changes precisely selected so that the two extra forces (each created by one of the changes) are equal and opposite — thus canceling each other's effect with respect to bulk translation and doing no net *external* work. The two forces remain and can perform internal work upon the system. Note that the stressing effect of the two new forces is not canceled, and that the stress of the system is altered a priori. See regauging.

tantalum capacitor: Electrolytic capacitor with a tantalum or sintered-slug anode, such as a solid tantalum, tantalum-foil electrolytic, or tantalum-slug capacitor.

targeted pinpoints: Those separated points which engage in self-targeting between themselves and some separated signal energy source (as in Fogal's semiconductor). The effect is to sharply narrow the retroreflected source signal energy from the source onto the separated points by means of the mutual ping-ponging. In this fashion much more energy density from the source can be concentrated on the targeted pinpoints. In effect, *phase conjugate shooting* — the return of the phase conjugate reflected scattered energy directly to the original target emitting the signal wave in pinpoint fashion - is evoked. See distortion correction theorem.

tensor: A special mathematical entity which is a generalized vector element of a vector space, with more than three components, each of which is a function of the coordinates of an arbitrary point in space of an arbitrary number of dimensions.

Tesla, Nikola: Famous American emigre electrical engineer, inventor and eccentric (1856-1943), whose numerous inventions fueled much of the electrical 20th century. In essence he produced the AC system, including polyphase systems. Also, Tesla invented radio transmission, not Marconi, according to a U.S. Supreme Court decision that upheld the prior patents of Tesla over Marconi. In his famous experiment, Marconi in fact utilized a variation of one of Tesla's circuits. This does not denigrate Marconi's many accomplishments, but just sets the record straight on who invented radio transmission. The impetus to the development of commercial radio transmission technology and the industry itself came from Marconi.

thermodynamic equilibrium: Stable state eventually reached by an isolated system or one in a well-behaved active environment. One may consider it a "balanced" or "preferred" state. It is important to note that, in particle physics, there can be no equilibrium of a mass system unless the

vacuum interchange with that system is considered. Electrodynamics mistakenly continues to omit the active vacuum interaction with a Maxwellian system, hence is seriously flawed in that respect.

thermodynamics of open systems: Systems far from thermodynamic equilibrium with an active environment are permitted to exhibit five "magic" functions. Such a system can (1) self-order, (2) self-oscillate or self-rotate, (3) output more energy than the operator himself inputs (the excess energy being freely received from the active environment, (4) power itself and its load simultaneously (all the energy being freely received from the active environment), and (5) exhibit negentropy.

time: In our view, time is spatial EM energy compacted by the factor c . Time thus has the same energy density as mass, but in the time domain rather than in the 3-space domain. Also, time is not observable *a priori;* mass is an observable. Time persists since it is persistence itself. No observable persists *a priori*, since observation is a *d/dt* operator imposed upon LLLT spacetime, yielding a frozen LLL snapshot which does not even exist the very next instant. When we say "mass exists in time" (or any observable continuously persists), we are unwittingly invoking a very rapid iterative *d/dt* operator repeatedly, and recalling these iterative sequential "frozen snapshots" or observations from memory. One may produce and utilize EM energy flow in the time domain, as in 3-space. Time, being energy and energetic, has tempic potential (energy density), tempic potential gradients, and therefore has "tempic force." The photon is composed of both spatial energy and time-energy as its two canonical constituents. The lower the frequency, the higher the energy of the photon when the time-energy is considered, since the magnitude of the time-component of the photon increases as the spatial energy component decreases, and the energy of the photon in that case increases as c^2 times the increase in time magnitude, while decreasing linearly proportional to the decrease of the spatial energy magnitude. When transduction of time into spatial energy occurs, or vice versa, the energy conservation law is modified to specify the sum of the spatial energy, time-energy, and mass energy.

time-charge, time charging: Since time is a special highly compressed form of energy, then time-excitation or *time-charging* also occurs. Also, since tempic longitudinal EM waves accompany all longitudinal EM waves (per reinterpretation of the phase conjugate half set of the Whittaker decomposition), then irradiating a mass with substantial longitudinal EM wave radiation will time-charge the mass, exciting it with time-energy. There are excited states and internal structuring (engines) in time **charging.**

much like the excited states and internal structuring (engines) in energy excitation of normal charge. When the longitudinal EM wave radiation is removed, the time-charged entity then slowly emits longitudinal EM wave radiation as the time-excitation slowly decays via the giant negentropy process of the charges.

time-energy: Time may be considered as spatial EM energy compressed by the factor c^2. See also discussions under time and time charging.

time excitation: See time charging.

time-flow generatrix (mechanism): Since any observable is a frozen nonpersistent snapshot in 3-space, then the common expression "flow of a mass through time" requires an active generating mechanism to add time to mass, converting it to masstime, which is persistent. Masstime *mt* is as different from mass *m* as impulse *(Ft)* is from force *F*. The flow of a mass through time is generated by the ubiquitous interaction of photons with the mass. This includes all photons, both virtual and observable. Thus for the ambient vacuum, there is an ambient flow of time, since there is an ambient rate of total photon interaction. The "macroscopic" movement of the mass through time is the result of (i) absorptions and emissions of observable-sized photons, and (ii) the continuous integration of virtual photon absorptions into observable-sized photons. The macroscopic flow of time thus has myriads of "sublevels" of infolded time flows and engines. Hence the flow of time has a marvelous, internal, dynamic structure.

time-forward: Refers to the flow of an entity through time in the forward direction, as seen by an external observer. Time-forward flow occurs when (to the observer) there is a predominance of time-forward photons interacting with the body that is moving in forward time. Contrast to time-reversal of an object, as seen by the external observer, which occurs when (to the observer) there is a predominance of time-reversed photons (antiphotons) interacting with the body that is observed to be time-reversed. Pumping a given living mass (in the nonlinear optical sense) with time-reversed EM waves pumps the object in the time domain. That drammatically extends nonlinear optics, since the pumped living object's cells will be observed to slowly reverse back to a previous physical state or condition. Since time-polarized EM waves accompany all longitudinal EM waves via reinterpretation of Whittaker 1903, pumping a living mass (a body) with longitudinal EM waves also pumps it with time-polarized EM waves, time-charging the body which continues the pumping in the time domain after the longitudinal EM wave radiation is removed.

time-forward EM wave: A normal EM wave moving in forward time as seen by the observer. Otherwise known as the retarded wave. The external observer comfortably sees its forward progress as expected.

time-polarized electromagnetic wave: An electromagnetic wave whose vibrations occur in the time domain only. May be referred to in a quantum field theory sense as a *scalar* EM wave. It is a longitudinal EM wave in the time domain. It may also be said to be a longitudinal EM wave in the complex plane, since in Minkowski space the fourth axis may be taken as -ict. The time-polarized EM wave is indicated in quantum field theory, or at least its time-polarized photon is theorized and called a "scalar" photon.

time-polarized photon (scalar photon): A photon whose vibrations occur in the time domain only, also known as a "scalar" photon. This polarization of the photon is utilized in quantum field theory. Neither the scalar photon nor the longitudinal photon is individually observable. However, the combination of the two in the presence of charge is observable as the instantaneous scalar potential.

time reversal: For EM waves, the process of forming the phase conjugate wave. For a particle or a mass, the process of pumping the particle or m;iss with time-polarized EM waves, so that the resident spacetime curvature engine in the mass is amplified and phase conjugated, forming a precise, amplified antiengine which then slowly time-reverses the mass back to a previous physical condition and state. We accent that *time reversing a single object or single group ofobjects* is not the same thing as "travel into the past" so popularized by science fiction. For time travel to the past, the entire universe and everything in it — except the traveler — would have to be time-reversed. That would not seem possible by any stretch of the imagination today! On the other hand, time-reversal of a single thing such as a particle or a wave — or even a group of things such as a group of particles or waves — is not only feasible but is readily achievable. A Dirac sea hole is a negative energy electron, for example, having negative energy and therefore negative mass prior to observation. After observation, it is seen as a positive energy, positive mass electron of opposite charge to the conventional electron and reacting with fields in opposite direction from the conventional negatively charged electron. In short, after observation (interaction with mass) it becomes the positron.

time reversal zone: A region of space in which the majority component of the overall time flow mechanism runs backwards, and hence the fundamental mechanism generating the flow of a mass through time is reversed. The "time running backwards" is due to the predominance of

interactions with antiphotons. It follows that, in the time-reversal zone (TRZ), there is a predominance of antiphoton interaction over photon interaction. In a TRZ, the law of attraction and repulsion of charges is reversed; like charges attract and unlike charges repel. Also, induced action by the time reversal forces start *inside and throughout* an affected mass in that zone, originating at every point in that local spacetime zone and moving outward. It thus involves a novel action "from inside to outside", beginning even inside the nucleons, and first affecting the quarks and gluons. Deliberate use of time-reversal zones and their subsequent decay allows a great new class of dramatic nuclear reactions, including simple transmutation and loosely called "cold fusion" reactions, at low spatial energy but very high time-energy. High energy physics has neglected the use of time-energy, opting to go for high spatial energy. Hence the high energy physicists have actually eliminated a much higher energy physics (at low spatial energy so readily examined on the bench far *more ch*eaply) than the science they have long developed.

time-reversed wave: A phase conjugate reflected wave, which is a wave moving in reversed time. Since the external observer "sees" in forward time only - and even then he sees in an iterative series of frozen 3-space snapsholt — he *observes* the time-reversed wave as a 3-spatial wave (series of iterative frozen snapshots) traveling in the opposite direction as its generatrix wavefront (the *signal wave).*

topological: Invariant under transformation by continuous mappings, or related to the properties of geometric shapes and figures that remain invariant under transformation by continuous mappings.

topological properties: Those properties of a geometrical space that are unchanged by continuous distortion of the space.

topology: Mathematics of the properties of geometric configurations invariant under transformation by continuous mappings. In short, the mathematics of the large-scale structure of curved spaces.

transverse (with respect to waves): Wave oscillatory movement perpendicular to the wave's primary direction of principal propagation, as in the movement of a plucked taut string in a wavelike motion traveling down the string but with the oscillations being lateral. Based on Faraday's notion that the field lines of the electromagnetic field were physical material lines (in the material ether) similar to taut strings, Maxwell assumed the transverse wave model in his theory. The entry of longitudinal waves, into the theory can easily be demonstrated by rhythmically and coherently varying the magnitudes of the Lorentz symmetrical regauging

condition, producing "stress potential waves" which are in fact what longitudinal EM waves really are. The production of a longitudinal EM wave in 3-space will be accompanied by the simultaneous production of a time-polarized companion wave.

tunneling: In quantum mechanics, a phenomenon in which a particle penetrates and crosses a small region where the potential opposing such passage is greater than the particle's available energy. The phenomenon is thought to be impossible according to classical physics, but occurs nonetheless. Further, the speed of transit through the "tunneling" separation can be superluminal. Tunneling of music between two separated points in a waveguide has been measured at more than four times the speed of light.

A more extended type of tunneling is the travel of longitudinal EM waves infolded inside the normal EM potentials, fields, and waves. Indeed, this is a more fundamental electrodynamics, and it can be shown that interferometry of this "internal" electrodynamics creates the external electrodynamics by a form of longitudinal EM wave interferometry. E.g., see M.W. Evans, P.K. Anastasovski, T.E. Bearden *et al.*, "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," *Journal of New Energy*, 4(3), Special Issue, Winter 1999, p. 76-78. This is part of the technical basis for the "scalar interferometry weapons" developed by the Russians after World War II. Today, some 10 nations have such weapons, more are developing them, and even the Japanese Yakuza has such weapons.

unified field theory (engineerable): A unified theory of the four forces o| physics — the electromagnetic, gravitational, strong, and weak forces that is not just an intellectual model but which is also engineerable on **the** laboratory bench and in actual physical systems using higher symmetry O(3) electrodynamics as a special subset of Sachs' unified field theory.

unitary Q_E (charge of the electron): Fixed or unit charge q of the electron. This notion is held because q is not decomposed into its component elements, but treated as if it were an indivisible unit, charge and mass and all. The mass of a fundamental particle at rest is quantized, and the massless charge (self-potential) of the particle is discretized as a function of the background potential (virtual particle flux density) in which it is embedded or to which it is exposed. In our view the definition **of a** charge q is $q \equiv m_q \phi_q$, at least to first order. (The ϕ_q may be internally structured with deterministic "engines", so that one electron need not bo

identical to another, in its actions in some cases). The *electrical charge* of the "charged mass m_q" should be taken to be the massless ϕ_q component. For an electron, $q_e \equiv m_e\phi_e$. The *electrical charge* of the electron should be taken to be the massles ϕ_e component. We note that the charge is also structured, since ϕ_e or ϕ_q decomposes via Whittaker 1903 into a harmonic setof EM longitudinal phase conjugate wavepairs. Our reinterpretation of this decomposition then yields the solution to the problem of the "source charge" and its associated fields and potentials and their energy. The massless charge ϕ_e is a dipolarity and hence a broken 3-symmetry in EM energy flow, invoking a more primary 4-symmetry in EM energy flow so that EM longitudinal wave energy is continuously incoming from the time domain, being absorbed by the charge q of which ϕ_e is a component, being transduced into real EM energy in 3-space, and emitted in all directions in 3-space at the speed of light, creating the fields and potentials and their energy that are associated with charge q. If a charge (say, an electron) is placed in an additional potential ϕ_1, then the total massless charge of the electron(i.e., its virtual vacuum flux exchange with mass me) is $(\phi_e+\phi_1)$.

As can be seen, the massless charge of the electron (its virtual flux activity) has now changed. The electron is then said to *be collecting and to have collected* excess energy (which may be either positive or negative, depending upon the sign of ϕ_1). Further, either ϕ_e or ϕ_1 or both can be internally and deterministically *dimensioned* (structured in Stoney-Whillaker-Ziolkowski fashion). When its massless charge (its own ϕ_e) potentialissodimensioned,thenthedimensionedelectronissaidto contain or transport an *engine* or a *vacuum engine* or a *spacetime curvature engine.*

vacuum: Space devoid of observable matter. In modern theory, the "empty" space is in fact bristling with very rapid fluctuations of EM energy, remaining in the virtual state. It is also filled with a violent, fluctuating flux of virtual particles, appearing and disappearing so quickly that an individual particle does not persist long enough to be individually detected. Thus the vacuum is extraordinarily energetic, but the energy is in very special form (fleeting violent fluctuations and virtual particle flux). Nonetheless, because it contains enormous energy, the *average* vacuum may be considered a potential. All potentials then are changes to this vacuum potential, or to an intermediate potential which is a change to it. In another sense, the vacuum, potential, and spacetime are all one-and-the-same thing. This means that general relativity's spacetime curvature is ubiquitous and extraordinarily dynamic. The vacuum very near a mass also can act in some cases as a semiconductor, capable of supporting self-

oscillation between the mass and the local vacuum. Considerations of the active vacuum and its nature lead to the notion of the *supersystem*, which is comprised of three parts: (1) the physical system and its dynamics, (2) the active vacuum and its dynamics, and (3) general relativity and its dynamics (since physicists persist in separating the notions of spacetime and vacuum). No analysis of any mass system is complete unless an analysis of the entire supersystem and the interactions of the three components, one with the other, is performed.

Every charge is "embedded" in the active vacuum by its potentials and fields, which themselves are spacetime curvatures and alterations of the local vacuum. This is easily seen by $q \equiv m_q \phi_q$, where ϕ_q is a change to the local vacuum potential *a priori*. In the quantum view, the fields and potentials may be taken as organized polarization patterns and dynamics (currents) in the vacuum virtual particle flux.

vacuum engine: Also referred to as a *spacetime curvature engine*. From the particle view: a deterministic internal pattern or *template* deliberately created as a deterministic structuring and dynamics in the virtual flux comprising a scalar potential. It can also be created in, and transported by, the two scalar potentials that comprise a static or dynamic force field, or a moving EM wave in the vacuum. It can also be created in the local vacuum potential, in which case it has a "charge-up" creation time and a "discharge time," exhibiting a sort of "time constant" very much like a capacitor charging and discharging.

In the wave view: the vacuum engine is a deterministic internal pattern or template deliberately created in the Stoney-Whittaker-Ziolkowski internal biwaves and wave products comprising the scalar potential. Again, it can be implanted in the vacuum or in an EM signal as a carrier. The self-energy (scalar potential) portion of any electric charge or magnetic charge can also be a "carrier" that is conditioned *{dimensioned)* with a vacuum potential. The process or act of conditioning any of the carriers with vacuum engines is called *dimensioning* that carrier. Russian energetics used in secret weapons programs refers to the vacuum engines of a dimensioned carrier as the *information content of the field.* Such vacuum engines, e.g., were used in the potentials of the microwave radiation of the U.S. Embassy in Moscow for several decades, inducing a variety of health changes and sicknesses in the personnel of the embassy. Interestingly, all these health changes occurred in the field-free regions of the Embassy. There the field-free potentials existed and were stable and unchanging. Hence a body exposed in that region was steadily exposed to the specific engine being induced, and time-charged with that engine accordingly. The

deterministic set of spacetime curvatures comprising this charge then acted upon the cells and body to slowly change it to the damaged or diseased condition. See dimensioning.

vacuum flux exchange: The virtual particle interaction between the active vacu**um** and a mass, particularly a charged particle.

vacuum's **virtual particle flux:** In the particle viewpoint, the quantum mechanicalvacuum identically is a virtual particle flux. Present physics, however, is prone to refer to the vacuum as an implied emptiness conta*ining* a virtual particle flux, even though that is known to be in error. In **our** view, energy, vacuum, spacetime, virtual particle flux, and dynamic geometry are all synonyms. One must note that the ageless contradiction of the wave vs. particle view has still not been resolved in physics, even by the duality principle. The duality principle is merely an agreement to quit fighting, and to feel free to consider a thing a particle in one case or circumstance and a field in another case or circumstance, *whichever works.*

vector: In mathematics, an entity completely characterized by a magnitude andadirection.

vector potential: A potential having — at any point in it — both direction and magnitude. The direction, e.g., may be linear, curvilinear, or swirling. The term "vector potential" is often used as the magnetic vector potential A. When it is swirling, the magnetic vector potential A may be said to be the **magnetic** field B. However, the swirling mag etic vector potential (the **magnetic** field B) may be "bottled up" and contained locally inside a long tight solenoid, or inside a toroidal coil, or inside a special nanocrystalline **material** used as a closed transformer core as in the motionless electrom**agnetic** generator. In that case nature freely replenishes the energy in the surrounding space which would have been occupied by the non**restricted,** nonlocalized B-field (curled A-potential) but replenishes that s**pace** with an uncurled (linearly flowing) magnetic vector potential A. This in fact at least doubles the available energy flow available, without any additional EM energy input by the operator. The well-known Aharnov-Bohm effect clearly demonstrates this effect, and it is delibe**rately** employed in the motionless electromagnetic generator (MEG) of **which** the author is one of the five co-inventors. Present dictionaries of physi**cs** and many textbooks are confused as to the definition of magnetic vector potential A and its relation to B, many stating that the A is defined by the equation $\nabla \times \mathbf{A} = \mathbf{B}$. However, no equation is a definition; it is an **express**ion of equality of two magnitudes, and not a definition of either side. If we substitute the more stringent $\nabla \times \mathbf{A} \equiv \mathbf{B}$, we see that the $\nabla \times$

operator acting upon the A potential is precisely what a B field *identically is*. Hence the A potential exists in two forms: (1) in curled form as identically the B-field, and (2) in uncurled field-free form as the linearly moving A-potential energy current that has no imposed $\nabla\times$ operator and thus has no curl. This makes total sense with $\nabla\times\mathbf{A} \equiv \mathbf{B}$.

vector field: Conventionally, the assigning of a magnitude and a direction (that is, a vector) to each point in a region of space occupied by a field. In our view the field is in fact a change to the active energetics of that spatial region, such that the region will interact with any appropriate entity (e.g , **a** charged mass) placed at any point in the region and produce a force upon that entity.

vector zero: See discussion under zero vector.

virtual antiphoton: An antiphoton that spontaneously appears and disappears, so swiftly that it cannot be individually observed. It is real while it exists. Coherent integration of a stream of virtual photons, however, adds to produce an observable quantum of energy, which is observable in its effects on a charged particle.

virtual particle: A fleeting quantum particle that spontaneously appears and disappears, so swiftly that it cannot be individually observed, so that it exists only temporarily. It is real while it exists. The virtual particle does not satisfy the usual relation between energy, momentum, and mass because it is under the aegis of the Heisenberg uncertainty principle. The virtual particle can have any amount of energy momentarily, so long as the product of its energy and the time interval of its existence is less than the uncertainty principle's minimum magnitude.

The coherent interactions of large numbers of virtual particles with a **mass** or charge can combine to generate real observable effects (forces). In quantum field theory, all forces of nature are caused by the interaction **of** the mass entity with virtual particles. Interaction of a mass with virtual photons, e.g., is projected to cause all mechanical and electromagnetic forces.

virtual particle flux exchange: Interaction with or exchange of a flux of virtual particles.

virtual photon: A photon that spontaneously appears and disappears in the vacuum so quickly that it cannot be individually observed.

virtual photon flux: See definitions under **flux** and under **virtual particle.** For electromagnetics, the vacuum can often be modeled as a flux

of virtual photons. One gets the virtual charges also, since the photon is also considered to consist of a positron-electron pair. That is, the photon is continually separating into a positron-electron pair, whose particles then annihilate each other to form additional photon(s), etc.

virtual photon flux exchange: The mutual exchange of virtual photons, as between the vacuum and a charged mass, or between two colliding masses.

virtual photon flux of vacuum: In our view, the vacuum identically is a flux of virtual particles. For many electromagnetic cases, it can just be modeled as identically a flux of virtual photons, where the word "photons" in general usage refers to both photons and antiphotons.

virtual positron: A positive electron (positron) which spontaneously appears disappears in the vacuum so quickly that it cannot be individually observed. More accurately, in the 4-vacuum, a negative energy electron state that spontaneously appears and disappears so quickly that it cannot be individually observed. A virtual Dirac sea hole.

Whittaker, Edmund Taylor: Well-known English mathematician and physicist, 1873-1956, who made major contributons to mathematics and physics. Whittaker dramatically extended Stoney's earlier work of 1897-8 an authored two papers in 1903 and 1904 giving the basis for the theory of scalar electromagnetics (Russian energetics, not including the quantum potential portion). His decomposition of the scalar potential into a harmonic set of longitudinal EM wavepairs, where each pair is a phase conjugate pair, may be reinterpreted to solve the long-vexing problem of the source charge or source dipole and its continuous emission of EM energy in 3-space, providing its associated potentials and fields and their energy. The problem was solved by the present author's reinterpretation in that manner, published in 2000. This was later found to be consistent with quantum field theory as well, by interpreting the observability of the combined scalar and longitudinal photon pair as opposed to the nonobservability of either the scalar or longitudinal photon individually.

Work: The changing of the form of energy. One joule of energy whose form is totally changed in a reaction, does one joule of work in that reaction. However, it is strongly stressed that after that joule of work is perform**ed,** one still has a joule of energy left to use (with which to do additional work). This remaining joule of energy is just in different form than was the initial joule of energy. So one can do joule after joule of work from a single *initial* joule of energy, so long as the energy is not dissipated and lost after each change of its form. In any one single change of form, only o**ne** joule of work can be done from one joule of energy. So energy is

conserved through many changes of form, but work is not. To work in COP>1.0 systems, one absolutely must root out from one's consciousness the mistaken notion that only one joule of work can be done from a joule of input energy. One of the places where extra joules of work are performed by each joule of energy is that of strong gradients. Strong gradients are known and recognized to violate thermodynamics. Work is further divided into **internal work** and **external work.**

work, external: The changing of the form of the collected energy of a body or system by dissipating it upon an external load or entity is the external work *done by* a body. The changing of the collected energy of a body or system by performing work upon it is the external work *done upon* a body or system.

work, internal: The changing of the form of the internal energy of a body or system. It may also involve the changing of internal parts of the system.

work-energy theorem: In mechanics, a theorem that the change in kinetic energy of a particle in motion is equal to the work done by all the forces acting upon the particle.

zero-point energy: The energy remaining at a temperature of absolute zero, due to the Heisenberg uncertainty principle and the quantum mechanical theory of an oscillator. Also, the minimum energy of a system due to its quantum fluctuations, resulting from its incessant virtual particle activity. Quantum mechanically, no system of interest (including even spacetime itself) can have zero energy. The zero-point energy of the vacuum is the lowest energy vacuum state, with fluctuations taken into account. Even at low energies, quantum fluctuations continually arise, and result in an incessant, extremely rapid, and violent "jittering" of the energy momentarily present. The minimum energy due to these quantum fluctuations is called the *zero-point energy*.

zero vector: Candidates are: (i) A vector having no length (no magnitude) or specific direction; (ii) absence of any and all finite vectors; (iii) resultant of a system of multiple, finite vectors whose vector sum has **no** specific direction but may have nonzero scalar magnitude.

The second definition differs drastically from the first. That is, we **cannot** say that a vector resultant zero has no infolded magnitude, if we **consider** its nonzero components, all of which have magnitude. (See the discussion under **zero).** It only has no net magnitude for *translating* force. It is, in fact, *a. stress potential,* and it is one with a deterministic internal structure or *engine*. By rhythmically and coherently varying each component of a

zero vector system, one easily produces longitudinal EM waves,, each of which is accompanied by a correlated time-polarized EM wave. In vector analysis, the zero vector axiom states that any vector v plus a zero vector is eq**ual** to a zero vector plus v. Note that, being an axiom, this is not proven, but just assumed for any zero vector. We very much disagree with that blanket axiom; it reduces vector analysis to a highly special single case, where all zero vector systems are to be considered equal, and totally "inactive." That is true only for bulk translation. In the real world that need not be true at all; specifically, it is not true for two different zero vectors having different internal structure and dynamics (different internal engines).

There are an infinite number of different zero vector resultant systems, and so zero vectors may differ, if their infolded component "substructure" is considered. In the real world, things that are vectors very often have energy. The energy is infolded and hidden, so that it represents not only (i) a local curvature of spacetime, but also (ii) a structured, deterministic set (a template) of curvatures of local spacetime. Therefore this zero vector system is actually a *vacuum engine.* Any mass system placed in such a potential, will be acted upon in its internal parts by that local vacuum engine; in short, it will have internal work performed on its interior. Further, the zero vector resultant system is a "stress potential," since it does contain "collected internal energy."

So between zero vector resultant systems, the "infolded, hidden energies" differ dramatically in (i) total infolded and trapped (collected) energy, (ii) specific internal action patterns (templates), (iii) general relativistic effects, and (iv) type of engine. Accordingly, the actions the zero-vector system induces in an exposed mass may be designed in advance. This is vacuum engineering. This spacetime engineering. This is the formation and use of engines. It is also one of the bases of Russian energetics.

The'problem is the *vector algebra itself.* In the abstract algebra, a "vector space" Is regarded as an inert thing, where the only actants are the overall net nonzero vectors, and there is no interaction between an overt vector and a covert set of vectors. The vector space is not allowed to have an internal realm, stress, hidden engines, or to interact with the vectors representing the physical system. So vector algebra lacks the capacity to model such higher topology phenomenology. Consequently, for over a century electrodynamicists — thinking primarily of spatial translation — have routinely discarded such "zero vector systems" as if they represented the total absence of any finite vector. *This they do, in the unsuitable*

assumptions of the vector algebra. This they do not do, in the real world, whether we are aware of it or not.

The common practice in electrical physics of replacing a zero-summed system of nonzero vectors with a vector zero indicating a "complete absence of vectors" is very much incomplete. This present practice should be changed; it has reduced the topology of electromagnetics far too much, and gutted vast, important parts of the theory insofar as an extended electromagnetics is concerned. The vector zero should be replaced with a special organized vector zero system and a dimensioned scalar potential.

The interactions of the "hidden" vectors — the *engines* — should be incorporated. By failing to do this, physics excludes the ability to engineer electrogravitation, spacetime, the virtual state, local general relativity, free energy, effects at a distance, and the probabilities of the states propagated by the Schrodinger equation. It also excludes unification of forces. As another more human example, for every cellular disease condition there is a specific engine resident in the cells. An amplified antiengine for that disease pattern can fairly readily be generated. That antiengine, embedded in ordinary EM fields and potentials, can be irradiated into a diseased body with that disease, and it will time-reverse those diseased cells slowly back to normal. This is actually the basis of the body's own healing system the cellular regenerative system studied mostly by Becker. Unwittingly using this "antiengine" approach, Priore and a team of French scientists provided startling cures of terminal cancers, infectious diseases, clogged arteries, etc. in laboratory animals in France in the 1860s and early 1970s. The work is strongly documented and replicated in the French scientific literature, but the work was suppressed in the early 1970s in the change of the French government. See our "porthole briefing" on our website www.cheniere.org for our extension of the Priore method, for greater ease portability, and rapid treatment of mass casualties.

In the new view, a zero vector may be a system of nonzero vectors that vectorially sum or multiply to zero for spatial translation purposes, but nonzero components may still exist "inside" and dynamically function inside the zero-resultant envelope. This substructure can act on nonlinear or resonant systems. Any or all of the nonzero components may be time varying, or none of them may be. The zero vector system may thus be a dynamic engine and a dimensioned scalar stress potential. In addition, such a vector zero system is considered to be also a scalar stress potential, whose magnitude is equal to the sum of the absolute values of the components. In addition, a separate type of stress potential may be included for the magnitude of the absolute values of the swirl components

(torques). Other associated potentials may be included for the system, particularly if the system is in multiple dimensions, if it consists of more than one type of virtual particle flux, if several fluxes intercommute, etc.

zero vector summation systems: Zero summations of real, nonzero vectors, so that the real vectors are still present but do not cause *spatial translation* of the exposed mass or charges. Instead, the zero vector summation has an internal structure and dynamics, hence an internal engine. Also see discussion under zero vector.

Appendix A
Relation to Equilibrium and Disequilibrium Thermodynamics

"The second law [of thermodynamics] does not rule out the possibility of pushing heat uphill, as it were, from a cold object to a hot one, or of creating order out of disorder. It merely states that such a reversal of the natural flow requires an influx of energy... " [Raymond Serway] {697}

"It *is in no way possible, either by mechanical, thermal, chemical, or other devices, to obtain perpetual motion, i.e., it is impossible to construct an engine which will work in a cycle and produce continuous work, or kinetic energy, from nothing. "* [Max Planck] {698}.

"What might appear to be empty space is, therefore, a seething ferment of virtual particles. A vacuum is not inert ***and*** *featureless, but alive with throbbing energy and* ***vitality.*** *A 'real' particle such as an electron must always be viewed against this background of frenetic activity. When an electron moves through space, it is actually swimming in a sea of ghost particles of all varieties - virtual leptons, quarks, and messengers, entangled in a complex melee. The presence of the electron will distort this irreducible vacuum activity, and the distortion in turn reacts back on the electron. Even at rest, an electron is* ***not*** *at rest: it is being continually assaulted by all manner of other particles from the vacuum."* [Paul Davies] {699}

"I assert... that for the general theory of relativity, i.e., in ***the*** *case of the general invariance of the Hamiltonian function, energy equations... corresponding to the energy equations in orthogonally invariant theories do not exist* ***at all.*** *I could even take this circumstance as the characteristic feature of the theory of general relativity. "* **[D. Hilbert]** {700}

" ***In formulating the*** *equivalence principle, Einstein actually abandoned the idea of the gravitational field as a*

Faraday-Maxwell field, and this is reflected in the pseudotensorial characterization of the gravitational field that he introduced. Hilbert was the first to draw attention to the consequences of this. ... Unfortunately, ... Hilbert was evidently not understood by his contemporaries, since neither Einstein himself nor other physicists recognized the fact that in general relativity conservation laws for energy, momentum, and angular momentum are in principle impossible. " [Logunov and Loskutov] {701}

"No amount of theory can refute a replicable experiment that contradicts the theory. A single replicable experiment can refute any theory that is in conflict. That is the very heart of the scientific method. " [Myron Evans, private correspondence].

"It only takes a single white crow to prove that not all crows are black. " [Anon.]

"One of the most important principles of physics, that disorder, or entropy, always increases, has been shown to be untrue. " [BBC News] {702}

"One of the most fundamental rules of physics, the second law of thermodynamics, has for the first time been shown not to hold for microscopic systems. ... [The experimenters]... found that the change in entropy was negative over time intevals of a few tenths of a second, revealing nature running in reverse. ...But over time intervals of more than two seconds, on overall positive entropy change was measured and normality restored." [Chalmers] {703}.

"We experimentally demonstrate the fluctuation theorem, which predicts appreciable and measurable violations of the second law of thermodynamics for small systems over short time scales... Our results show entropy consumption can occur over colloidal length and time scales. " [Wang et al.] {704}.

A.1 Introduction

For excellent background books on thermodynamics matters, at various levels of difficulty, the reader is referred to texts by Gyftopoulos and

Beretta {705}, Kondepudi and Prigogine {706}, Chalidze {707}, and Dugdale {708}.

It has long been known in physics that at sufficiently small levels (e.g., atomic levels) the second law of thermodynamics does not always hold true. Recently, as quoted above, Wang et al. {704} have extended this area of permissible violation of the second law to much more appreciable times (a few tenths of a second) and lengths (the micron scale). Without further discussion, we note that this places regions and times of negentropy well-within circuitry switching times and interaction with fundamental charged particles. Hence these experiments are beginning to point the way to practical negentropic devices. When coupled with the demonstrated continous giant negentropy of a charge (considered with its clustering virtual charges of opposite signs), these experiments now strongly support the feasibility of practical overunity EM circuits and systems. The interested reader is encouraged to continue to read the literature along those lines, and stay abreast of developments in that field.

In this book we have presented considerable discussion of time-energy (time as a special, highly compacted form of energy). We have also discussed the three components of the supersystem, including the system, the local active vacuum, and the local curvatures of spacetime. All three componets of the supersystem interact with each other continuously, and such Interactions are not modeled in classical thermodynamics (CTD), classical electrodynamics (CED), or electrical engineering (EE). Hence one should not be surprised that the supersystem model and supersystem analysis involve contradictions (actually, *extensions)* of these three models, which are special cases and approximations only.

All COP>1.0 EM systems result from supersystem component interactions. So COP>1.0 EM systems are in conflict with CTD, CED, and EE since these three models exclude those interactions.

To falsify any absoluteness of the three models considered, one or more solid, demonstrable, replicable experiments are presented to establish validity of the new higher symmetry approach. This is sufficient to negate the conventionally accepted absoluteness of the lower symmetry CTD, CED, and EE models. Scientifically, these experiments suffice to demonstrate that those three models describe *"special-case* domains of nature" rather than full generalizations of nature. It is clearly understood that the three models remain very useful and very often quite sufficient, just as Newtonian mechanics is useful and often sufficient, without use of relativistic mechanics.

The experiments also falsify any interpretation of the three models as "proof that COP>1.0 systems are impossible. Accordingly, many of the accepted statements and assumptions of the three models must be corrected for COP>1.0 research, as must be the conventional interpretation that the laws of nature (as understood based on those three models) prohibit COP>1.0 EM systems. This follows directly from the quotation by Evans at the beginning of this appendix. Experimental evidence of COP>1.0 is abundant and decisive, such as the many hundreds of routine "negative resonance absorption of the medium" experiments as typified by Bohren's paper {709} and experiment and Letokhov's work {710}. Also, every charge in the universe already falsifies all three models, as amply discussed in this book. That fact for at least a century has generated the source charge problem — the problem of the source charge and its associated fields and potentials and their energy, reaching across the universe. The solution to this problem was published by the present author in 2000, based on the experimentally proven and well-established broken symmetry of opposite charges, such as are on the ends of a dipole.

In the extended approach, conservation of energy in 4-space does not require simultaneous conservation of energy in 3-space. The concept of energy conservation in 4-space does not exist in the three models mentioned, which contain only 3-space energy conservation. There exists a "giant negentropy" 4-space energy flow (circulation) mechanism, as we developed in this book, and it is experimentally demonstrated by every charge in the universe. In a classical 3-spatial energy conservation analysis and view, the giant negentropy action may continuously perform useful work in a system, since it already furnishes all EM field energy and potential energy in every system. All 3-space energy conservation is an extra condition imposed upon 4-space energy conservation, and that condition may be violated at will without violation of the general conservation of energy law.

To the three conventional models mentioned, 4-symmetry in energy flow with broken 3-symmetry, will appear to be perpetual motion and a total violation of the more limited 3-space conservation of energy law. It *does* permissibly violate 3-space energy conservation, which is just a special case a priori. But it is not a violation of energy conservation overall, since we are using a more fundamental energy conservation law (4-symmetry) than the 3-symmetry used in the mentioned CTD, CED, and EE models,

In short, the three models must be extended to provide 4-space energy conservation with simultaneous violation of 3-space energy conservation, accompanied by simultaneous time-symmetry energy flow violation. The

two broken symmetries — of 3-space energy flow and of time domain energy flow — thus act as a special extension of the notion of symmetrical regauging, accomplishing it by "equal and opposite-effecting" fields, one in the lime domain and one in 3-space.

Ironically it then follows that what have heretofore been conceptually called "perpetual motion machines" with respect to 3-space energy conservation are simply attempts — successful or unsuccessful — to build analogues of a windmill turning in a free wind and powering a load. In short they are attempts to duplicate in systems what every charge in the universe already demonstrates unequivocally. *Nature's* CTD, CED, and EE do not prohibit such systems — again, as evidenced by every charge in the universe demonstrating exactly such "perpetual motion" (we prefer the exact term "giant negentropy") and violation of present *human* CTD, CED, and EE. None of the original charges from the beginning of the universe has slowed and stopped its motion, or stopped pouring out EM energy freely, in some 14 billion years or so. And charge may be taken as the most basic Maxwellian system. Further, all EM fields and potentials, and their energy, comes from their source charges. So those so adamant against perpetual motion machines should first purge their own three models of their *assumed* perpetual motion machines. If this is done, they will purge the three models of all charges, fields, and potentials — and all EM energy in the process. In short, the three conventional models used by those same skeptics so loudly condemning "perpetual motion machines" will eat themselves" by swallowing their own tail, so to speak.

in short, all three models are easily falsified by every charge in the universe, as well as by every EM field and potential, and by the existence of EM energy itself.

Either their models must surrender any pretense at absoluteness and accept being useful approximations only, or else the conservation of energy law itself must be surrendered.

Conventional CEM, CTD, and EE have just hidden this appalling fact and convealed the serious flaws in the modeling by ignoring what Sen {711} reffered to as " *the most difficult problem in classical and quantum electrodynamics.* " We believe it will very difficult to find a single electrical engineering department or professor or text that deliberately acquaints electrical engineering students with the source charge problem and its implications.

As an example, in Chapter 9 we presented an experimentally verified and patent-pending method for a special energy conversion method. This

method is proven on the laboratory bench. With this method, a system accepts time-energy and negative energy input, converts it to ordinary positive 3-spatial energy, and uses the converted input energy to close-loop an EM system far from equilibrium. With that conversion process invoked in a governed feedback loop, the COP>1.0 system becomes "self-powering" (an informal term referring to the system freely receiving all its input energy from its active environment). Self-powering, of course, involves the system continuously operating and performing useful work, analogous to a windmill in a wind and powering a water pump. Rigorously, the self-powering COP = oo EM system becomes directly powered by energy from the broken symmetry induced in its supersystem component interactions.

In Chapter 10 we presented the novel concept of the time-reversal zone (TRZ), which uses the extraordinary EM energy density of time to reverse the Coulomb barrier in nuclear reactions in an electrolyte {712}. This enables nuclear transmutation reactions at low *spatial* energy (but at very high *total* energy when time energy is also considered). There are some 600 successful cold fusion experiments worldwide, in multiple laboratories, by multiple researchers, and most of these experiments demonstrate examples of the specific nuclear reactions made possible by the actions of the TRZ. The time-energy anomalies are directly demonstrated in rigorous electrolyte experiments at U.S. Navy research facilities at China Lake, as we have also discussed in this book. So the experimental results are replicated and well proven. Hence there is adequate, replicated experimental demonstration that additional nuclear reactions exist outside the conventionally known nuclear reaction model. Therefore the set of conventional nuclear reaction models also is reduced to a special case domain, with any absoluteness of those models already experimentally falsified. Either that, or we must abandon scientific model where successfully replicated experiments falsify any theory in contradiction to the experiments.

In our proposed solution to the source charge problem {71 lb}, we found a broken 3-symmetry in energy flow while 4-symmetry is maintained. This is a more primary principle of energy conservation. We called this principle "giant negentropy", which is laughably simple to demonstrate experimentally, since every charge and dipole in the universe already demonstrates it. We showed that such giant negentropy is consistent with quantum field theory, particle physics, and a slight corrective reinterpretation of Whittaker's 1903 decomposition of the scalar **potential** The experimentally proven and theoretically justified giant negentropy

falsifies any absoluteness of the CTD, CED, and EE models in conflict with it.

Again, this does not mean that one abandons the CTD, CED, and EE models! They are still very useful models in most cases of interest. It means that these present models are still incomplete, and extended models must be developed and used for COP>1.0 EM system research. It also means that none of these three models is valid as a prohibition of the permissibility of COP>1 EM systems.

All EM energy in 3-space comes from the time domain and returns to it. Since all three models exclude time-energy and its transduction into spatial energy, all three are in conflict with the proven giant negentropy model and with the unlimited experimental demonstrations. Accordingly, the experimentally demonstrable giant negentropy of the charge and dipole strongly points out the inadequacy of the three models and the nuclear reaction models, which do not account for time reversal zones, or time-energy and its transduction into a very large magnitude of 3-space energy.

In paragraph A.2 below, we briefly discuss some of the fundamental but permissibie supersystem violations of these older models of CTD, CED, and EE, and provide some comments. It is obvious that all three classical models need very serious updating and extension. We point out that exceptions to present thermodynamics models and "laws" already are recognized{713}, and work on such exceptions is being performed under the heading of extended thermodynamics {714}.

In effect, all three models *exclude* every charge, dipole, or dipolarity in the universe - which therefore excludes all matter, fields, and energy - something completely untenable in modern electrodynamics and modern physics. Since the fundamental nature of the "heat" notion of CTD is electromagnetic field energy, and all EM fields and potentials (and their energy) are excluded if their source charges are excluded, then heat itself is excluded by the three models. That is, CTD is also totally falsified by CED'S exclusion of the source charge's demonstrated giant negentropy, which in effect excludes heat itself. This is a non sequitur of such magnitude that it absolutely requires the complete rework of CTD, CED, and EE.

A.1.1 Featurcs of the Development of Thermodynamics

In the development of thermodynamics, a few key events of interest are listed in Figure A-1 below.

Selected Events in the History of Thermodynamics {715}

1673 Huygens builds a motor driven by gunpowder explosion.
1690 Papin uses steam to move a piston.
1712 Newcomen develops a steam engine.
1723 Stahl popularizes phlogiston and Becher's concepts.
1724 Boerhaave proposes that heat is a fluid.
1733 Bernoulli publishes a text that is the first truly statistical treatment of kinetic theory, and publishes an update in 1738. It is almost forgotten until 1859.
1765 Watts invents a steam engine that is more than six times more effective than Newcomen's engine.
1783 Lavoisier points out the weakness of phlogiston theory with respect to combustion.
1786 Lavoisier and Laplace provide a Memoir on Heat.
1789 Lavoisier publishes his *Elementary Treatise on Chemistry,* which presents the law of conservation of mass.
1791 Prevost publishes a theory of heat and radiation exchange. Richter founds stoichiometry.
1798 Thompson demonstrates the conversion of work into heat, in his *Enquiry Concerning the Source of Heat which is Excited by Friction.*
1799 Davy's experiments seriously challenge phlogiston theory.
1800 Herschel explores the heating ability of different frequencies of light.
1802 Lussac establishes the thermal expansion of gases.
1803 Dalton forms his atomic theory of matter, setting the stage for atomic chemistry.
1804 Leslie shows that light and radiated heat have similar properties.
1806 Young formulates a precursor to the modern kinetic energy.
1811 Poisson develops a mathematical theory of heat, based on Fourier's work. Avogadro presents his law. Berzelius states that electrical and chemical

forces are the same and that atoms are electrically charged.

1819 Dulong and Petit show an empirical law on the specific heat of solids.

1824 Carnot studies the thermal efficiency of machines, introduces reversible transformations, and generates the foundations of thermodynamics in his "Reflections on the Motive Power of Fire".

1829 Coriolis defines "kinetic energy".

1834 Clapeyron presents the first version of the second law of thermodynamics, based on steam engine studies.

1837 von Suerman experimentally verifies Clapeyron's version of Carnot's equations.

1842 Mayer equates the conservation of energy law and shows the equivalence between heat and mechanical energy.

1843 Waterston anonymously publishes an accurate kinetic theory of gases. It is essentially ignored.

1845 Waterston submits a beautiful paper on the kinetic theory of gases to the Royal Society. It is rejected and ignored for more than 40 years, until finally resurrected by the President of the Royal Society.

1847 Helmholtz generalizes the conservation of energy law for mechanical, caloric, electric and magnetic energy.

1848 Lord Kelvin introduces the absolute temperature scale. Joule finishes establishing the exact relation between heat and mechanical work; his work is almost ignored.

1850 Clausius states the second law of thermodynamics.

1851 Thomson derives the second law of thermodynamics based on Carnot's work.

1855 Rankine publishes *Outlines of the Science of Energetics.*

1857 Clausius establishes heat as energy distributed among particles.

1858 Clausius introduces the idea of the mean free path of a colliding particle.

1859 Kirchhoff establishes the thermodynamic foundation of radiation theory, and completes the basic radiation theory in 1862.

1860 Maxwell provides studies in kinetic theory of gases and gives the distribution of molecular velocities. The paper, "Illustrations of the Dynamical Theory of Gases," was read in 1859.

1860 Maxwell shows a discrepancy between experiment and the kinetic theory of diatomic gases. It was not resolved until the early stages of quantum theory.

1861 Kirchhoff advances the notion of the blackbody.

1865 Clausius, Rankine and Kelvin provide the concept and definition of entropy.

1860-1877 Boltzmann and Gibbs provide the foundations of statistical classical mechanics.

1867 Maxwell publishes *On the Dynamical Theory of Gases*, his major work on the kinetic theory.

1874 Thomson points out the reversibility paradox.

1877 Boltzmann defines entropy in terms of probabilities.

1873-1878 Gibbs publishes several important papers on thermodynamics, widely influencing scientists.

1879 Boltzmann establishes the relation between radiation intensity per unit area of a blackbody, and the absolute temperature. Stephan formulates the "Stephan-Boltzmann law" $R_T = \sigma T^4$.

1879-1899 Discoveries of various laws and effects, particularly at the micro level.

1900 Planck proposes the quantum of action and derives the correct radiation spectrum for blackbodies. (He published the definitive paper in 1911).

1905 von Smoluchowski and Einstein independently investigate Brownian motion. Einstein publishes a paper on the photoelectric effect.

1906 Nernst advances his heat theorem, where at absolute zero temperature both heat capacity and entropy change go to zero. This is later recognized as the "third law of thermodynamics".

1909 Einstein corrects Planck's blackbody derivation.

1910 Perrin experimentally validates Einstein's calculations on Brownian motion, providing a strong argument for the existence of atoms.

1911 Rutherford proposes the nuclear model of the atom. Sackur points out the need for an absolute definition of entropy. Nernst's experiments provide strong support for the new quantum theories.

1925 Born, Heisenberg and Jordan formulate quantum mechanics from matrix algebra. Einstein points out that the analogy between quantum gases and molecular gases is complete; photons and molecules have both wave and particle characteristics.

Figure A-l. Key Events in the History of Thermodynamics up to the Development of Quantum Mechanics.

During the early period of science, a continuing struggle between various notions of esoteric fluids and fluid flow occurred. French scientist Lavoisier (1743-1794), regarded as the father of chemistry, is identified with the concept of heat as an invisible fluid, which he named "caloric". The notion was that one drove this invisible fluid — this caloric — out of a material by some action such as mechanical friction or combustion. This produced the "manifestations" of what was loosely called "heat". In short, caloric was considered to be "heat" which was itself an esoteric fluid. In his famous Treatise {716}, published posthumously, atoms were still in dispute. However, Lavoisier listed the known elements, and included light and heat as elements. Asimov pointed out {717} that Lavoisier had "... era*dicated one imponderable fluid, phlogiston, but it was only partly through his influence that caloric, just as false, remained in existence in the minds of chemists for a half a century. "*

Caloric dogmatically existed in the minds of scientists deeply into the nineteenth century, until Maxwell and Boltzmann produced theories that strongly supported the concept of atoms as the building blocks of matter. In the late 1790's, Count Rumford (Benjamin Thomson) showed that the supplay of heat that could be "driven from matter" was unlimited, which totally contradicted the caloric theory {718}. Yet the notion of caloric persisted until Maxwell's theory eventually killed it, once application of that theory showed that heat was comprised of EM energy.

The fundamental ansatz of thermodynamics was formed and solidified before the advent of modern physics, and even before Maxwell's theory of electrodynamics, and before heat was known to be electromagnetic energy. It has unjustifiably retained an aura of "absoluteness" and dogma, even though its foundations concepts are based on outdated notions already scientifically falsified as far as any absoluteness is concerned. As Mallove states {719}:

> *"It is astonishing to realize that many modern conceptions (or laws') in the science of heat— thermodynamics — arose during the nineteenth century, a period of utter confusion about the fundamental nature of heat. How could it have been otherwise, given that the very existence of atoms was still in question! One sees the shakiness of the claim that the laws of thermodynamics had reached a state of 'near perfection' in the twentieth century ...when they in fact rested on this very flawed foundation. "*

During that formative period, the notion of the conservation of energy **was** also being searched for, as if in a thicket of brambles. For some time, any notion of energy conservation was seen as directly contradicted by caloric, and — in formulating the heretical notion that energy is conserved — pioneers such as Mayer {720} were severely castigated.

In 1850 Clausius resolved the conflict between caloric and conservation of energy in a seminal paper {721}.

Mallove {722} explains how the theory developed from there:

> *"In one fell swoop Clausius 'scooped' Kelvin and cast into precise form <u>both</u> the First and Second Laws of Thermodynamics — energy conservation, and the limit of the Carnot efficiency."*

Clausius' statement of the Second Law is: *"It is impossible for a self-acting machine, unaided by an external agency, to convey heat from one body to another at a higher temperature. "*

In 1851, Thomson (Lord Kelvin) stated the Second Law as:

> *"It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects."*

In 1865 — the same year that Maxwell published his seminal paper in his electrodynamics {723} — Clausius derived entropy and showed the two laws of thermodynamics expressed in the same way as the old caloric theory. Clausius used the concept of "entropy" to represent the *"dissipated potential"*. In a public speech with the title "The Entropy of the Universe Tends to a Maximum," Clausius included how thermodynamics requires an eventual heat death for the universe. His view was that

> *"The energy of the universe remains constant (first law), while entropy increases. "* {724}

We stress that the notion of the flow of EM energy through space did not originate until the 1880s, when Heaviside and Poynting formulated it independently. Neither relativity — with its notion of a combined spacetime - nor the Minkowski space had been born. Neither had quantum mechanics, quantum electrodynamics, quantum field theory, etc.

For a succinct and very useful listing of the major developments in the history of thermodynamics and statistical mechanics, one is referred to the work of Biggus {725}.

A.1.2 Inadequate Fundamental Definitions in Thermodynamics

In the view we take in this book, energy is the all-important concept, in all its forms, no matter how esoteric. The interactions of energy with matter must therefore be extended to include all known energy interactions, not just those prescribed by CTD or CED. Consequently, two fundamental definitions of thermodynamics are faulted by the supersystem concept.

First, thermodynamics defines an *open system* as one that is open to the exchange of energy and mass across its boundary. No concept or discussion of virtual energy, virtual mass, time-energy, or multiply connected space effects is included. Further, mass is actually a special form of energy, and hence this definition only prescribes the exchange of energy across the system boundary.

Second, thermodynamics defines a *closed system* as a system with no mass exchange across its boundaries, but heat (energy) exchange is permitted. This definition has been a non sequitur since general relativity was established in 1915, and also since caloric (heat) was identified as energy rather than a thin material fluid that was forced or beaten out of matter by doing work on the matter. Since then, energy and mass are also known to be the same thing, as established by general relativity. Whenever the energy of a system changes, its mass changes a priori. So a system thought of as "closed to any mass transfer across its boundaries" still undergoes

mass change due to the exchange of energy across its boundary. Further, the definitions of "closed system" and "open system" are not mutually exclusive. As an example, a system exchanging energy but not mass across its boundary can be classified as a "closed system", and also as an "open system" where normal exchange of mass is blocked but the mass of the system still changes as the systems absorbs and emits energy.

Rigorously, even the energy of a system cannot individually change in 3-space, without first invoking 4-space change! Instead, the "energy x time" — the action — of the system is what moves and changes in 4-space, Observation applies a *d/dt* operator, resulting in a 3-space energy observed as having already happened or been fixed.

The modern view of gravitation is that the energy in mass generates the gravitational field, not the mass per se {726}. Also, mass is an observable, hence it is a continuously recurring 3-spatial snapshot that does not even continuously exist as mass, but alternately as mass and masstime. The assumption of the continuous existence in mass is falsified by the quantum mechanical nature of observation itself; hence all three models — CTD, CEM, and EE — are falsified.

Nonetheless, let us continue to use the conventional notion of "flow of energy" and "flow of mass" for convenience.

The thermodynamic definition of "open system" ignores the state in which mass exists as "masstime". No "change of mass", flow of mass, etc. occurs. Instead, masstime can flow or change, but mass is an observable and **thus** frozen 3-space snapshot at one instant. Time is "outside" any 3-space material system, hence when mass becomes masstime, it already "exchanges across the system boundary". *For a mass merely to continue to exist requires the exchange ofmass across the 3-space system boundary.* Indeed, only "masstime" can be changing, so in failing to consider masstime, the definition is falsified as it stands, in its very assumption of "continuous change of mass" when there is no such thing in all of nature. As stated, a similar consideration applies to energy, which does not **and** cannot "continuously exist in 3-space" at **all,** and cannot *continuously* change. Also, *time is highly concentrated energy* as we develop in this book, and time certainly "exchanges across the boundary" of any mass system. Time may be taken as a sort of "multiple connection" in space, since in theory each point in space is said to "exist simultaneously" in the same time-point.

With quantum potential connection, external energetic processes may be "superposed instantly in multiply-connected space" with one or more

points of the "closed system". Hence, if there exist processes in the system to transduce time-energy into 3-spatial energy — as in the well-proven cold fusion experiments — matter changes including nuclear transmutations can and do occur. Then the "system closed against mass motional exchange through 3-space" (which does not even concretely exist) is not closed against mass changes at all.

To eliminate the mass-change effects of energy transfer across the system boundary, the present thermodynamic definition of a *closed system* must be completely recast into what thermodynamics presently calls an *isolated system* - one in which neither energy nor mass is exchanged across the system boundary. No such system exists in the universe, since merely to exist it has to be open to continual energy exchange between time and 3-space domains, mass has to continually interchange between mass and masstime, and energy has to continually interchange between energy and (energy x time). The blunt truth is that *only open systems exist in nature.*

All systems are open systems in their supersystem interactions, and they can and do exchange time-energy and mass changes due to spacetime curvatures and active vacuum changes. Any local spacetime curvature made by an energy change in a system or nearby, also reacts back upon the system from its local curved spacetime environment. It may react in a totally energetic fashion, or it may react to produce mass in the system (as in pair production). In the book we pointed out that the supersystem components external to the system can also interact in the system to eliminate mass (as when a Dirac hole combines nonradiatively with a Dirac **election).**

Finally, the notion of an "open system" as one in which energy and mass both can be exchanged across the system boundary must be extended to include a system which can also exchange time-energy, spacetime curvature energy, virtual particle flux activity and energy, and other supersystem effects across the boundary. Further, the notion that a "closed system"can be open to energy exchange but not mass is totally falsified in modern physics' virtual particle exchange between environment and system. Virtual mass — which is physically real — is continually exchanged across the system boundary. Though each virtual mass particle is individually unobservable, coherent summations are observable.

To properly evaluate the conventional thermodynamic definitions of open system, closed system, and isolated system, simply select and use a physics model containing only one fundamental unit, the joule. Now all basic entities are made of energy and functions of energy. So all basic

entities are forms of energy; e.g., both mass and time are special forms of energy. As presented previously in this book, to even "exist in time" a system is continually exchanging and transducing 3-space energy and time energy, across its boundary at an enormous rate. Every system is an open system, a priori, and the thermodynamic "closed system" is a non sequitur. The thermodynamic "isolated system" is revealed as the early attempts to deal with observation; i.e., the observed system as a series of frozen 3-space snapshots (effects), each stripped from a 4-space ongoing process at a single moment by the observation process *d/dt* (LLLT) = LLL. Each snapshot is an isolated system (which is what observation produces). Now we understand that this "isolated system" existed only at a single frozen instant, continually recurring, and never existed continuously in time at all,

So in view of today's physics, the old thermodynamic "isolated system" concept is an early attempt to deal with observation of the system without input or input (without dynamics, hence frozen). "Closed system" is a non sequitur since mass is energy and energy is continuously exchanged across the system 3-boundary in several forms. Both virtual mass and virtual energy are continuously exchanged across the system boundary. It follows that the only type of system existing continuously in nature is the *open system*. The other two "types of thermodynamic systems" are at best only approximations for special cases.

Under modern physics and the new definitions, we conclude that there is no such thing as a truly closed or isolated system continuously existing in the universe. Hence that very definition disappears, *as far as any absoluteness*. It is retained only as a *useful approximation in special cases*, when the more esoteric mass effects and energy effects are intentionally omitted or negligible, and only classical effects are of importance. Any scientist dogmatically objecting to COP>1.0 EM systems on thermodynamics grounds alone, simply reveals his lack of knowledge (or lack of acceptance) of modern physics.

This is similar to the situation existing between Newtonian mechanics and relativistic mechanics. We can still use the Newtonian model for many practical matters, since the relativistic effects are often small and nearly inconsequential. Similarly, the present CTD concept of "closed system" now assumes that kind of relationship to *one class* of open systems in which the more esoteric reactions are negligible or inconsequential. But rigorously, all systems are now open systems, removing a gross non sequitur in CTD which is especially violated by COP>1.0 EM systems including every charge in the universe.

This is a correction to both equilibrium (classical) thermodynamics and disequilibrium thermodynamics. Unfortunately the two disciplines have continued to use the same (old) definitions for closed system and open system. Hence both equilibrium and disequilibrium thermodynamics at present are useful approximations, and their "laws" must not be misinterpreted as "absolute". Thermodynamics remains a very useful model, but further development is also indicated. Indeed, presently such scientific development and extension of the thermodynamic model is being done under the heading of "extended thermodynamics".

A.2 Comments on Problems with Thermodynamics

Quoting, from Kondepudi and Prigogine {727}:

> *"Every system is associated with an energy and an entropy. When matter undergoes transformation from one state to another, the total energy remains unchanged or is conserved; the total entropy, however, can only increase or, in idealized cases, remain unchanged. "*

The absoluteness of that statement is falsified by the solution {12} of the long-vexing problem in CED of a source charge and its associated fields and potentials. The observable charge is a charged mass and thus a Maxwellian system. It is also a thermodynamic system, meeting the present erroneous definition of a "closed system" utilized in both equilibrium and disequilibrium thermodynamics. No observable mass crossed the system boundary, although virtual mass continually crosses it.

The charge is "fed" by a more esoteric energy input in disordered form (the virtual particle flux energy of vacuum), yet it outputs ordered observable EM energy spreading radially outward at the speed of light across the universe. The charge increases and sustains the organized energy density of a volume of space depending on the radius *ct*, where *t* is the time since the formation of the charge and *c* is the speed of light in empty space. This continous outflow of observable energy is a continuous and giant negentropy, exhibited by every source charge and dipole. When positive charge, negative charge, polarization of space, and both positive and negative energy are considered, what is spreading is precisely a reordering of the active vacuum — in short, a giant and increasing negentropy. Since the universe is filled with charges, this is a natural process continuously ongoing everywhere in the universe.

Re-quoting Serway (697}:

> *\The second law [of thermodynamics] does not rule out the possibility of pushing heat uphill, as it were, from a cold object to a hot one, or of creating order out of disorder. It merely states that such a reversal of the natural flow requires an influx of energy... "*

Our comment is that any mechanism by which the system receives extra usable energy in forward time, or is time-reversed, enables the system to permissibly violate any narrow interpretation of the second law of thermodynamics. The second law was formulated in accord with forward time assumed, and with the old definition of "closed system", which erroneously permitted energy exchange but ignored the mass effects of energy exchange. Therefore, the second law is a special case for equilibrium in its energy exchange with its active environment, but effectively allowing its own negation anyway, and it always has. In the new approach with altered definitions, all EM systems are open systems, and they may also be brought into disequilibrium (in excited states or potentialized condition). Thus in theory all systems are permitted to violate the second law, *particularly when broken symmetries in their supersystems are involved.* This is especially true of EM systems, where all the EM field energy and potential energy in the system— even in the matter itself— comes from the active vacuum environment (particle physics view) by means of the broken 3-symmetry of the source charges and dipoles. The condition of 4-symmetry in energy flow exchange together with broken 3-symmetry and t-flow symmetry, is a disequilibrium condition and an excited state. Every charge and dipole already exhibits this state and the giant negentropy condition.

To first order, then, one may say that the present second law assumes no broken 3-symmetry or broken t-flow symmetry in energy flow, while violation of the second law assumes broken 3-symmetry and broken t-flow symmetry.

Quoting Serway {728}:

> *"Thermal equilibrium is a situation in which two objects in thermal contact with each other cease to have any net energy exchange due to a difference in their temperatures."*

Our comment is that net energy exchange — to include time-energy exchange and negative energy emission, absorption, and transduction are not modeled in thermodynamics and are arbitrarily excluded in **the** quoted statement. Since both are exhibited experimentally, the statement is

falsified as far as being absolute. Instead, it is a special case and a useful approximation when some of the esoteric energy considerations are negligible.

Quoting Serway again {729} on the zeroth law of thermodynamics:

> *"If objects A and B are separately in thermal equilibrium with a third object, then A and B are in thermal equilibrium with each other. "*

A corollary is stated by Serway {730} as:

> *"...two objects in thermodynamic equilibrium with each other are at the same temperature. "*

Our comment is that these statements are true if the time-energy exchange is identical among all three. Otherwise, they are not necessarily true. It is not generally true, e.g., for a system in an accelerated frame. Also, the zeroth law is not necessarily true if negative energy (and/or its transduction is involved with one or more of the objects.

An example: A and B are at the same temperature as C, as measured by a thermometer. But A is also emitting negative energy, which is being absorbed by B, to maintain A and B at the temperature of C. A and B are not in real thermal equilibrium in their supersystem interactions, even though they are at the same macroscopic temperature. A second example: A is emitting negative energy to maintain its temperature, while B and C are not. The supersystem of A is not in real thermal equilibrium with the supersystem of either B or C, even though the observed temperatures of A, B and C are the same.

Quoting {731} on what is meant by the term "heat":

> *"...heat is treated as another form of energy that can be transformed into mechanical energy. " ... "The word heat should be used only when describing energy transferred from one place to another. That is, heat flow is an energy transfer that takes place as a consequence of temperature difference only."*

Quoting Lindsay and Margenau {732}:

> *"A complete statement of the first law comprises two* ***assertions:*** *(a) heat is a form of energy, (b) Energy is* ***conserved."***

The statement in (a) that heat is simply a form of energy is misleading, and the statement in (b) that energy is conserved must be expanded to include total energy, not just heat and the presently accounted forms of energy. Specifically virtual particle energy, time-energy, and energy from the curvature of spacetime must be included.

More correctly, heating is a form *of energy disordering* or energy scattering. As previously pointed out, entropy itself was and is conceived as *the dissipation (irretrievable loss) of potential energy*. Heat thus would be the process of energy disordering, which means that heat is a form of the process of entropy (loss of control of the energy). Note the strong non sequitur with the notion that heat is energy. *Heat cannot logically be both energy and the dissipation of energy*. The concept of energy (its mere presence) is not identical to the concept of scattering of energy or transfer of energy, but the concept of heat is identical to it. The thing is not identical to something done to the thing or to transfer of the thing to another place. A form of scattering of order is not a form of ordering. Transfer of heat is a transfer of disordering of energy, not the transfer of energy per se. Hence, considering heat as simply "heat energy" is a fundamental non sequitur of classical thermodynamics, and remains so to the present day and in the present textbooks. For an example of strong support of this position, see Romer {733}. Quoting {734}:

> *"The work done on (or by) a system is a measure of energy transfer between the system and its surroundings, whereas the mechanical energy (kinetic or potential) is a consequence of the motion and coordinates of the system. Thus, when you do work on a system, energy is transferred from you to the system. ... one can refer only to the <u>work done on or by a system</u> when some process has occurred in which the system has changed in some way."*

Our comment: Consider a system which "ping-pongs" the energy it receives from the environment, between two parts of itself. In each part, the form of the energy is changed by that interacting part and that does work upon the part. But the new form of energy remaining after the work was done in that component is not lost but is ping-ponged to the other component, where it does work upon that component, and so on. In this case, each joule of energy input from the environment does more than a single joule of work, with the work performed being limited only by the ability of the system to sustain and contain the "ping-ponging". There is

work but no entropy if the energy doing the work (changing its form) is not lost from system control!

There is no law of "work conservation" in nature, and a joule of input energy can do more than one joule of work (as in this example) if repetitive changes of its form are considered. Thermodynamics arbitrarily excludes such cases, and hence is incomplete. Again, the conventional perception of the absoluteness of thermodynamics is falsified. It models a special case where the energy can be "used" to do work only once, and then all control of the new form of the energy (it is all still there, just in a different form) is lost.

For a particular substance, the heat capacity C is usually defined as *the amount of heat energy needed to raise the temperature of the sample being tested by one degree Celsius.* This definition assumes only one "use" of the *energy to* perform work in the substance, and completely ignores "multipass,multi-use" of the energy to perform more than one joule of work from one joule of input energy. As an example, if an equal amount of positive and negative energy is steadily input, then no amount of the positive heat energy input component would raise the temperature at all. The modern active vacuum, with a local energy density in the region of 10^{80} or more grams per cubic centimeter (expressed in mass units), nevertheless is harmless to living systems immersed in it. It has equal positive and negative energy densities, and so normally inputs the same enormous amount of positive and negative energy in its overall interactions with a living system.

The first law of thermodynamics is usually written as

$$\Delta U = U_f - U_i = Q - W. \qquad [1]$$

This is a highly special case, which does not include time energy transduction (spatial energy transduced into time energy and vice versa), or energy transduced from the active vacuum via the broken symmetry of an electrical system in continuous exchange. The definitions of work and heat have to be changed and drastically extended.

As an example of a legitimate exception, when time-energy T_E is transduced into available spatial energy inside the system, we have

$$\Delta U = U_f - U_i = Q + T_E - (W_D + W_L) \qquad [2]$$

where W_D is the energy that was dissipated in the system losses without doing useful work and W_L is the energy leaving the system but doing useful work in a load L. $(Q + T_E)$ represents the total net energy entering

the system, while $(W_D + W_L)$ is the total energy leaving the system, either as losses or to do useful work in the load. Here we are also incorporating virtual energy under the title of time-energy, since both time and virtual energy are unobservable, and virtual energy "exists in time".

Now suppose Q entering the system, and collected for use in it, is freely furnished from the active vacuum via the broken symmetry of the electrical system's dipolarity. Suppose T_E is spatial energy freely transduced from the time domain by ongoing processes in the system, and thus T_E also enters the system freely. Then suppose that the system processes are deliberately adjusted by the operator so that

$$(Q + T_E) = (W_D + W_L) \qquad [3]$$

In that case,

$$\Delta U = U_f - U_i = 0 \qquad [4]$$

yet continuous loss energy WD is escaping from the working system, useful work W_L is continuously being done in the load, and useful energy $(Q + T_E)$ is continuously entering the system from the active environment (the active vacuum and the local curvatures of spacetime). This system is totally permissible in nature (and is already operating in every charge and dipole in the universe). It is an example of an open system far from equilibrium in *3-space* energy flow, but in equilibrium in *4-space* energy flow. Yet it is artificially excluded by classical thermodynamics.

Classical thermodynamics thus excludes every charge and dipole in the universe, and therefore is an extraordinarily curtailed model. It is a special case approximation having no absolute authority as a proper limiting model of EM systems.
The first law of thermodynamics for infinitesimal changes may be stated as

$$dU = dQ - dW \qquad [5]$$

Following the previous reasoning, for involvement of time-energy transduction (with virtual energy included) we have

$$dU = dQ + dT_E - (dW_D + dW_L) \qquad [6]$$

If dQ and dT_E are freely received in the system from the active vacuum and local curvatures of spacetime respectively, and if

$$dQ + dT_E = dW_D + dW_L \qquad [7]$$

then

$$dU = 0 \qquad [8]$$

So with no change in its internal energy at all, the microsystem or microprocess is receiving excess energy continuously, and also is continuously emitting energy that is doing useful work with some losses. The system is in fact in *energy 4-flow* equilibrium, and doing useful work, without the operator inputting any of the energy.

So the *corrected* standard statement of the first law allows an equilibrium system to steadily produce output work W, if its "energy input Q" is freely received. The first law of thermodynamics, properly extended and reinterpreted, does indeed admit "electrical windmills" operating in free electrical winds.

Now turning to the second law. In effect, the second law prescribes those processed in nature — more exactly, in the prescription of the first law — that may or may not occur. It is a law of limitation. It states that, of all the energy conversion processes permitted by the first law, only certain types of energy conversions can take place. A priori, the validity of its prescription depends totally on the nature of the functions involved in the system considered! However, since we dramatically extended the first law, using neww processes experimentally determined to take place, then we have automatically extended and changed the second law because we used experimentally *proven* functions. The old second law is now revealed as a special case, with no absolute limitations. The perception that it prescribes absolute limitations has been falsified. It is still useful, however, but to be careful one must completely re-examine (and possibly rework) the second law whenever the energy functions of a system are changed. We strongly stress that *the second law is a conditional law, and its application is totally dependent upon the system energy functions behaving in the limited manner assumed by the second law. Whenever the energy functions of the system are changed outside those assumed by the second law, the second law is permissibly invalidated for that system.* In short, in that case the second Iaw is simply a totally inadequate model for that system, and cannot be used as any sort of criterion for stating the "permissibility" or "impossibility" of that system. As an analogy, a model specifying scalars only cannot be applied to a vectorial system as a decisive logical criterion orrestriction.

QuotingSeray{735}:

> *"From an engineering viewpoint, perhaps the most important application [of the second law] is the limited efficiency of heat engines. Simply stated, the second law states that a machine capable of continuously converting*

> *thermal energy completely into other forms of energy cannot be constructed."*

Our comment is that, if we believe that energy is conserved in the entire universe, then the universe itself already violates Serway's statement. If we consider the seething virtual particle flux energy of the active vacuum as a special form of thermal energy, then every charge and dipole in the universe already is a heat engine that falsifies the second law of thermodynamics. The charge and dipole continuously absorb this special form of thermal (virtual flux) photon energy, and also continuously convert it into real, observable photon emission in 3-space. This is negentropy on a giant scale, already demonstrated by every charge and dipole and thus experimentally falsifying the present second law.

Classical thermodynamics also assumes irreversibility. While many of the physics models and equations prescribe reversible reactions, thermodynamics takes the view that events occur with a much greater probability in one direction in time than in the other. This of course is usually borne out in our perception of the gross observable universe around us. However, charge conservation alone requires equal amounts o| charge and time-reversed charge. With the nearly ubiquitous time-reversed charge and charge conservation, it follows that some factor not accounted for in thermodynamics is operating in the universe. And so it is, but it is a general relativistic factor. We shall use a biological example of the cellular healing mechanism we discovered in the living body {736}, extending Becker's work and Priore's work.

Normally most processes do not involve deliberate net transduction of time-energy into spatial energy, nor do we model and account for the specific set of ongoing interactions between every part of the system **and** its concomitant set of spacetime curvatures acting back upon it. Call that set of spacetime curvatures the *resident spacetime curvature engine* ***and its*** *dynamics,* or just *its engine* for short. The engine is comprised of structured energy and energetics, and it is already experimentally demonstrated in nonlinear phase conjugate optics that energy can be **time** reversed. The engine's spacetime curvatures act directly upon the **mass-**energy dynamics of the system. Time-reversing the system's operation is a matter of producing a sufficiently amplified, phase conjugated engine to act in reverse upon the physical system and overpower its resident **engine.** In that case, the thermodynamic system and its functioning can be **made to** run backward.

In fact this is the fundamental mechanism used by the body's own cellular regenerative system to heal its damaged cells. To a limited degree, the body is able to "pump" its cells in the time-domain (with time-energy), thus producing an amplified "phase conjugate energy and engine dynamics".

Pumping a living cell with time-energy is interesting. The resident engine serves as the "signal input wave" in conventional nonlinear phase conjugate optics, and the output time-reversed engine (the amplified anti-*engine*) serves as the "phase conjugate replica wave". A sufficiently simplified anti-engine acts upon the cell and all its tiniest parts, time-reversing all energetic operations in exact phase, proportion, and timing. This is themechanism for thermodynamic reversibility. It is also the "secret" to eventually reversing aging.

This action is upon all the energetics of the cell and its parts, including the mass-energy and mass-energetics as well.

The result of the action of the anti-engine is to slowly time-reverse the damaged cell and all its parts back to a previous state and dynamics. Electromagnetic amplification of the process was unwittingly demonstrated by Priore {737} and by Becker {738}. We refer the reader to our website {739} and to our "porthole briefing" for pertinent technical information, and for a most important extension and great simplification of the Priore/Becker approach and methodology.

Present classical thermodynamics does not consider or model the reaction of local spacetime curvatures and their dynamics upon the system. Hence all time-domain pumping that occurs is occurring rather randomly in each and every microscopic part of the system. In short, there is no organized anti-engine, and an organized anti-engine is what is required for time-reversing the system's operations back to a previous state. However, by mimicking, the body and pumping the physical process in the time-domain, with sufficient pumping a precise, amplified anti-engine will be formed and act upon the system — *any* system. The applicability is limited only by the state of development of the appropriate time-pumping technology.

In theory (and as experimentally demonstrated unwittingly by Prior e and by Becker), this anti-engine can and does overpower the resident engine. It can in fact time-reverse the pumped physical processes in the system itself.

So the classical thermodynamics assumption of irreversibility for heat engine energy processes is not absolute but only provisional. Specifically, it assumes no overall time-domain pumping process that provides a precise

anti-engine and time reversal of the system energetic process of concern and its dynamics.

If the second law is extended to encompass and model the new concepts such as broken symmetry and time-energy, then the extended second law will encompass reversible heat engine processes, Maxwell's demons, COP>1.0 electrical systems, COP » 1.0 electrical systems (electrical windmills), time-reversal of the dynamics, reversibility of that which has been irreversible, etc.

As given by Kondepudi and Prigogine, the third law of thermodynamics essentially states {740} that

> "... *at the absolute zero of temperature the entropy of every chemically homogeneous solid or liquid body has a zero value."*

This is also known as Nernst's heat theorem, after W. Nernst who proposed it in 1906. The third law states that

$$S \rightarrow 0 \text{ as } T \rightarrow 0 \qquad [9]$$

Certain violations of the third law are already known. E.g., C=O: carbon monoxide molecules can align in various ways in a crystal, so there is entropy associated with C=O crystals at 0°K. In this case, A and B are equally probable and the following equation can be used to calculate the entropy (called residual energy):

$$S = nR\,[1/2\ln(1/2) + 1/2\ln(1/2)] = -nR\ln 2 \qquad [10]$$

From the new viewpoint, the definition of T = 0° is open to change. Rigorously, the present third law assumes no local broken 3-symmetry of the vacuum's flux exchange with the system, and it also assumes no broken time-energy flow symmetry. In the new approach, both these symmetries can and are broken by every charge while a higher 4-symmetry is maintained. This leads to a giant negentropy, so that the "calculation of entropy" via Nernst's theorem fails. A fundamental charge at T = 0° thus continues to exhibit giant negentropy, in total violation of the third law of classical thermodynamics. Hence the third law is also devoid of any absoluteness, and it is reduced to a special case statement. It remains useful where the more esoteric energy interactions are negligible.

We have now demonstrated (by citing actual substantiating experiments) that all the laws of CTD are falsifiable insofar as being absolute. Hence they have *no* absoluteness. Instead, they are special case models and "approximation laws" only. They remain very useful and applicable,

However, so long as the more esoteric energy interactions of the supersystem do not play a major role in the system operation.

We conclude that the present form of classical thermodynamics and disequilibrium thermodynamics are special case models — as indeed is every model, by Godel's theorem and proof alone — with no absoluteness. They do not prohibit COP>1.0 EM systems, nor can they necessarily be used torule out COP>1.0 EM systems.

This also falsifies all current arguments that COP>1.0 EM systems violate either the first, second, or third law of classical thermodynamics. Calling COP>1.0 systems "perpetual motion machines of the first, second, and third kind", according to which law they supposedly violate, is a total non sequitur. Indeed, every original charge in the universe has already demonstrated just such "perpetual motion" for some 14 or so billion years, andhappily violates all three laws of the present CTD. Every charge is in violation of the "laws" of the present models of CTD, CED, and EE, and it is still in motion and still freely pouring out EM energy. We have no abillity to examine the notion of "perpetual" past the entire past existence of the universe.

All three models examined — CTD, CED, and EE — are seriously out of date and in need of revision and extension, because any absoluteness of their predictions and assumptions is already falsified by actual experiments and examples. Some work is already ongoing to extend thermodynamics, but is not nearly extensive enough. A thorough overhaul of the very foundations is what is needed for all three models. The three models remain useful as special case approximations, but their received use to arbitrarily rule out COP>1.0 EM systems is dogma, not science because such use is already experimentally refuted by every charge in the universe.

Appendix B
Maxwell's Demon: Alive and Thriving

Introduction

ITHERE is a long history of discussion over "Maxwell's demon", a fictitious being that Maxwell proposed to "sort" molecules striking a barrier between two volumes of gas initially at the same temperature. By intentionally opening a trap door between two for hotter, more energetic molecules to pass through from the left side to the right side, but shutting the door for lower lemperature molecules so that they are retained on the left side, eventually a temperature gradient would "freely" exist between the two reservoirs. In theory, then, if one had the demon working "for free", one would be able to utilize the temperature difference between the reservoirs to perform free work. Then one could repeat the demon's sorting procedure, to obtain more free work again. And so on.

The prevailing discussions have ignored the main feature: the fact that the demon is part of the "external environment" (i.e., not under control of the system, and operating independently of any energy input by the operator). Maxwell's demon represents an analogy to the system's environment furnishing free energy (free ordering and sorting). A lot of breath and mental gyrations have gone into the discussions over the years, with very little concrete experimental examination. The prevailing concept in science, which still adheres to the "absoluteness" of the second law of thermodynamics, is that Maxwell's demon is impossible.

Recently, the former editor of *Nature,* Dr. John Maddox, wrote a very clear emeritus editorial on Maxwell's famous demon, repeating the standard conclusion that such is not possible. Since there are specific examples in physics of what can be called "experimentally proven Maxwell's demons," the present author prepared a respectful commentary to *Nature* to refute the standard erroneous thesis in the interest of science. since experiment is supposed to be decisive in physics, we hoped that citing overwhelming experimental proof would be sufficient. It wasn't.

Almost symbolically (i.e., "free the demon!"), I submitted the commentary to the editor by I -mail on the evening of July 4, 2002. The very next day I received rejection (not too unexpected) by E-mail with no further discussion accepted. So I wrote a polite note in response, and then posted my commentary note on my website.

In this appendix, I include my E-mails of both 4 July and 5 July 2002, and then include the commentary that was submitted. The reader can read the cited emeritus editorial in *Nature*, and then decide for himself or herself whether experiment still rules the day at *Nature* where COP>1.0 and COP = co EM systems are concerned.

E-mail to *Nature* 4 July 2002, submitting the Commentary.

Dear Editor:

Attached is a significant commentary on John Maddox's excellent emeritus editorial on Maxwell's demon, titled "Slamming the Door," *Nature*, 417, 27 Jun. 02, p. 903.

Forms of Maxwell's demon are very much alive and thriving, and experimentally confirmed, as we develop very clearly in this commentary. They are unwittingly used widely in electrodynamics, though seldom recognized.

Most sincerely,
Tom Bearden, Ph.D., Magnetic Energy Ltd.

E-mail to *Nature* 5 July 2002, submitting a comment on the rejection.

Dear Ms XXX:

Thanks for the prompt reply.

Since *Nature* will not be publishing the note, I have now posted it on my website (some 80,000 hits per day from all over the world). It can be **seen** at http://www.cheniere.org/articles/maxwells%20demon.htm

This is a respectful article, and I just thought the experimental information needed getting out there to the scientific community. I also understand you cannot discuss it further. I only wish to note that it is based on cited replicable experiments, which are supposed to be the decisive thing in science and scientific method. It seems a bit odd that you would not publish the results of several replicable and replicated experiments **that** falsify a prevailing theoretical thesis and conclusion. Nonetheless, I respect the wishes of *Nature*, and I do enjoy the Journal each week.

Best wishes,
Tom Bearden, Ph.D.

Within days of this rejection, the paper by Wang et al. {741} was published, extending the known physics "Maxwell's demon" regime (i.e., where the second law of thermodynamics is known to be violated) from the atomic scale and very short periods of time, to the micron scale in size and time up to a few tenths of a second.

Here is the rejected commentary I submitted to *Nature.*

Maxwell-type demons are alive and thriving

The recent emeritus editorial by Maddox on Maxwell's demon [742] is a short overview of one historical aspect of would-be negentropy, but much greater thought on the subject needs to be given. Indeed, Maxwell's demon is alive and thriving, but just in a different form not requiring a nimble-fingered microscopic being. We now discuss such experimentally proven demons.

Consider the prevailing ansatz that Maxwellian systems outputting more EM energy than the energy input by the operator or experimenter are impossible. Such proposed systems are said to constitute examples of forbidden perpetual motion machines because they violate the second law of classical (equilibrium) thermodynamics. That prevailing ansatz has been falsified in classical electrodynamics since the 1880s, and in particle physics for 45 years, but eerily it is still the prevailing scientific opinion nonetheless.

The ansatz can be experimentally disproved in classical electrodynamics as follows: Lay a charged capacitor or electret on a permanent magnet so the E-field of the capacitor or electret is at right angles to the H-field of the magnet. That optimizes $\mathbf{S} = f(\mathbf{E} \times \mathbf{H})$, and hence optimizes the continuous flow of Poynting EM energy from that simple device, even though the fields, seem to be "static". As Buchwald states [743], *"[Poynting's result] implies that a charged capacitor in a constant magnetic field which is not parallel to the electric field is the seat of energy flows even though all macroscopic phenomena are static."* [744] This simple device will freely pour EM energy indefinitely, so long as it remains intact.

We consider a special but universal kind of related Maxwell's demon problem: the vexing problem of the source charge, sometimes called "the most difficult problem in classical and quantum electrodynamics." [745] Any charge pours out observable EM energy continuously in all directions, at the speed of light, with no *observable* EM energy input. This continuous flow of EM energy establishes the charge's related fields and potentials and their energy, reaching even across the universe for very old charges. In

the classical electrodynamics (CED) model and therefore in electrical engineering, there is no solution to this problem because CED does not model *nonobservahle* EM energy inputs such as the virtual particle flux exchange of the charge with its vacuum environment.

With no solution available in CED, then the present CED and electrical engineering assume that every charge in the universe *freely and continuously creates energy out of nothing,* and pours it out in all directions, forming its associated fields and potentials and their energy. Either we must solve the problem in the classical EM model, or totally surrender the conservation of energy law in the model in its present limited form. Or — as is presently the case — we may continue to ignore it, as has been done during the 45 years since the proof of broken symmetry in particle physics [746].

On the other hand, particle physics models and utilizes virtual energy **in** the seething vacuum, including the interactions of the vacuum with charge, With the 1957 experimental proof of broken symmetry by Wu et al., [746] certified by the award of the Nobel Prize to Lee and Yang later that **same** year, one of the proven broken symmetries in the vacuum virtual energy exchange is the asymmetry of opposite charges, such as are on the ends of a dipole. For a dipole or dipolarity, then by the very definition of broken symmetry *something virtual has become observable.* We diverge for a moment, and then will return to this proven asymmetry of the opposite charges of the dipole.

If we take the modern view of the bare charge clustered by virtual **charges** of opposite sign, then the magnitude of the bare charge in the middle is infinite (including its energy) and so is the magnitude of the charge of the surrounding clustering virtual charges. [747] So for an "isolated **observable** charge" we actually have a sort of "infinitely powerful dipole". Yet **the** difference between these two infinite values of charge is finite; it is routinely calculated as the observed charge of an elementary charged particle, the value that is listed in standard texts and handbooks.
The asymmetry of this "opposite composite charges" model of the "isolated observable charge" now explains the long-vexing source **charge** problem. The observable "composite" charge continuously absorbs **virtual** photon energy from the seething vacuum exchange, transduces it **into** observable photon energy excitation, and this excited state **continuously** decays to emit real observable photons in all directions at the speed of light. When *virtual* energy input as well as *observable* energy output is accounted, the charge's proven asymmetry in the vacuum exchange **makes** the source charge an open system far from equilibrium in its active

environment. As an open disequilibrium system the charge is thermodynamically permitted to (1) self-order (hence coherently integrate absorbed virtual photon energy into observable photon energy), (2) self-oscillate or self-rotate (spin), (3) output more energy than the "operator" **inputs** (the operator inputs none at all), and (4) exhibit negentropy. Every charge in the universe is already doing those four functions. It is also a system having a COP (coefficient of performance, or useful energy output divided by the operator's energy input) of COP = oo, since the operator inputs nothing.

In short, every charge in the universe already is a special kind of known "Maxwell's demon", whose operational mechanism is long since proven in particle physics but does not appear in classical electrodynamics or electrical engineering. It is a dependable Maxwell's demon, since all charges in the original matter in the universe have been pouring out real EM energy freely, using this asymmetry mechanism, for some 14 billion years, **and** they continue to do so. Further, any charge one assembles in the laboratory instantly starts up its Maxwellian demon performance automatically, and it will continuously pour out EM energy in all directions indefinitely, so long as the charge remains intact. So this demon is easi**ly** created and demonstrated experimentally. The Maxwell's demon fot freely extracting copious EM energy from the vacuum is one of the easiest entities to invoke in all of physics

This is **not** a violation of thermodynamics, since classical *equilibrium thermod*ynamics with its infamous second law does not apply because the charge is far from equilibrium in its exchange with its active vacuum environment. Although the COP = oo, the *efficiency* of the charge system -defined as the useful energy output divided by the total energy input from all sources — is never more than 100%. Hence this is not a perpetual motion machine, and the charge rigorously does not create energy; it only transduces energy input to it in a novel form. In this case, the charge can permissibly act as if it were a free electrical windmill turning in a novel free electrical wind due to its asymmetry in the vacuum flux.

So every charge in the universe exhibits COP = oo, clearly proving that Maxwell's demon in an improved form exists and is thriving throughout the universe. There would be no EM fields and potentials and their energy, and hence no electrical circuits or power systems, were it not for this asymmetry of the charge in its virtual energy exchange with the vacuum, making the charge a true Maxwell's demon.

In the usual CED model and electrical engineering, the 1867 L. V. Lorenz symmetrical regauging (later credited to H. A. Lorentz) [748] of the equations carefully selects only those Maxwellian systems that have two simultaneous equal and opposite disequilibria with their active environment. This assumes that the potential energy of the system is freely changed twice (by gauge freedom), but only in such highly selected manner as to form two equal and opposite new "free" force fields in the system. These two force fields perform *internal work* inside the system continuously, increasing its stress (and its stress potential, thereby curving local spacetime). Since there is no *net resultant* force field, the two force fields are unable to translate electrons in the circuit to do free *external* work in the external load. So the symmetrically regauged Maxwellian system has been altered: its energy has been changed twice, forming a stress potential inside it and increasing and maintaining that stress on the system, and the frame of the system has been somewhat rotated out of the laboratory frame. The symmetrically regauged Maxwellian system most decidedly is not identical to the system prior to regauging.

We note merely that the common Lorentz symmetrical regauging unwittingly assumes two Maxwell's demons of yet different kind, each freely fueled from the local vacuum environment, and each continuously performing internal work upon the system to produce and maintain system stress.

Gauge freedom is thus revealed as a special kind of Maxwell's demon, since (1) it assumes that the potential energy of a system can be freely changed at will at any time, and (2) unless we abandon the conservation of energy law, that energy change must have involved energy exchange with the external environment. So the gauge freedom axiom of quantum field theory assumes two specialized Maxwellian demons — i.e., mechanisms for transfer of energy between environment and system, so as to continuously perform internal work upon the system. In this case the two demons are equal and opposite, and fight each other to a draw insofar as performing any useful external work.

Oddly, in present electrical circuits the ubiquitous but *arbitrary* closed current loop circuit — passing all spent current from the external circuit back through the source dipole in the generator against the dipole's back emf— self-imposes Lorentz regauging of excitation discharge in the circuit and prevents COP>1.0 functioning. This is not required by thermodynamics in general! Indeed, several areas are already known to violate present thermodynamics. Sharp discharges (strong gradients), for example, are known to violate it. [749] Other known areas where

thermodynamics is violated include rarefied media, and anomalous memory effects in materials. Modern research is being conducted in such areas under the heading of "extended thermodynamics". [750].

Since experiment and not theory is primary in science, let us consider some additional actual Maxwell demon experiments. The well-known "negative resonance absorption of the medium" produces more output energy than the operator inputs to the experiment, with hundreds of these experimcntsdone every year routinely by many nonlinear optical laboratories. As an example, Bohren's version of such an experiment [751] commonly outputs 18 times as much EM energy as the operator inputs, exhibiting COP = 18. Independent replication of Bohren's work by Paul and Fischer [752] is reported in the same journal issue.

Added to the charged capacitor lying on a permanent magnet, there thus exist plenty of proven, replicated experiments which can be easily performed to demonstrate a Maxwellian demon operating in a Maxwellian system and freely producing COP>1.0, or even COP = oo. Because of the demon (the operational mechanism), these experiments all involve open systems far from equilibrium with their active environment. Hence they are not limited by the second law of classical equilibrium thermodynamics.

In short. Maxwell's demon is very much alive in many forms and is thgiving after all. It has just been hiding in different form than what is usually suspected.

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ENDNOTES

1. (a) Albert Einstein, "Foreword," in (b) Max Jammer, *Concepts of Space: The History of Theories of Space in Physics,* Harvard University Press, Cambridge, Massachusetts, 1969, p. xi-xii.

2. George Zebrowski, "The holdouts," *Nature,* Vol. 408, 14 Dec 2000, p. 775; expressing the thinking of Stephen Hawking, one of the leading physicists of our day.

3. Mario Bunge, *Foundations of Physics,* Springer-Verlag, New York, 1967, p. 176.

4. (a) J. H. Poynting, "On the transfer of energy in the electromagnetic field," *Phil. Trans. Roy. Soc. Lond,* Vol. 175, Part II, 1884, p. 343-361; (b) — "On the Connection Between Electric Current and the Electric and Magnetic Inductions in the Surrounding Field," *Phil. Trans. Roy. Soc. Lond,* Vol. 176, 1885, p. 277-306.

5. (a) Oliver Heaviside, "Electromagnetic Induction and Its Propagation," *The Electrician,* 1885, 1886, 1887, and later — a series of 47 sections, published section by section in numerous issues of *The Electrician* during 1885, 1886, and 1887; (b) —*Electromagnetic Theory, 3 vols., Benn,* London, 1893-1912. Second reprint 1925. An unabridged edition of all three volumes, with a critical and historical introduction by **E. Weber,** was published by Dover, New York, 1950. See particularly (c) - "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field." *Phil Trans. Roy. Soc. London,* 183A, 1893, p. 423-480. In this prestigious publication, Heaviside discusses the Faraday-Maxwell ether medium, outlines his vector algebra for analysis of vectors without quaternions, discusses magnetism, gives the EM equations in a moving medium, and gives the EM flux of energy in a stationary medium. On p. 443, he credits Poynting with being first to discover the formula for energy flow, with Heaviside himself independently discovering and interpreting this flow a little later by himself in an extended form.

6. E.g., a polite debate has continued at intervals, for about 30 years, in the Am. J. *Phys.* alone.

7. Richard P. Feynman, Robert B. Leighton, and Matthew Sands, *The Feynman Lectures on Physics,* Addison-Wesley, Reading, MA, Vol. 1,

8. *Ibid.*, Vol. 1, 1964, p. 12-2.

9. *Ibid.*, Vol. 2, 1964, p. 2-1.

10. John D. Kraus, *Antennas*, Second Edition, McGraw Hill, 1988.

11. Raymond A. Serway, *Physics for Scientists and Engineers with Modern Physics*, Third edition, updated version, Saunders College Publishing, Philadelphia *et al*, 1990, p. 620.

12. T. E. Bearden, "Giant Negentropy from the Common Dipole," J. *New Energy*, 5(1), Summer 2000, p. 11-23. Also on website www.cheniere.org.

13. (a) T. D. Lee, "Question of Parity Conservation in Weak Interactions," *Phys. Rev.*, 104(1), Oct. 1, 1956, p. 254-259; (b) — with Reinhard Oehme and C. N. Yang, "Remarks on Possible Noninvariance under Time Reversal and Charge Conjugation," *Phys. Rev.*, 106(2), 1957, p. 340-345; (c) — and C. N. Yang, "Parity Nonconservation and a Two Component Theory of the Neutrino," *Phys. Rev.*, 105(5), Mar. 1, 1957, p. 1671-1675.

14. C. S. Wu, E. Ambler, R. W. Hayward, D. D. Hoppes and R. P. Hudson, "Experimental Test of Parity Conservation in Beta Decay," *Phys. Rev., Vol.* 105, 1957, p. 1413.

15. We published it crudely two years later. See T. E. Bearden, *Quiton/Perceptron Physics: A Theory of Existence, Perception, and Physical Phenomena*, NTIS Report AD-763-210, 1973.

16. A time-reversal zone is a momentary tiny region of the fluid wherein antiphoton reactions with the main ions predominate over **photon** reactions.

17. See T. E. Bearden, "EM Corrections Enabling a Practical Unified Field Theory with Emphasis on Time-Charging Interactions of Longitudinal EM Waves," *J. New Energy*, 3(2/3), 1998, p. 12-28. A slightly expanded paper by the same title is published in *Explore*, 8(6), 1998, p. 7-16.

18. E.g., see Xiaodong Chen, "A New Interpretation of Quantum Theory — Time as Hidden Variable," Los Alamos National Laboratory web site, arXiv:quant-ph/9902037 v3, 11 Feb. 1999. Using two more **time** variables as the quantum hidden variables, Chen derives Dirac's field equation under the principle of quantum physics, and then extends **the**

method into quantum fields with arbitrary spin number. Chen's model offers very interesting unifications of quantum mechanical behavior.

19. F. Mandl and G. Shaw, *Quantum Field Theory*, Wiley, 1984, Revised Edition 1993, Chapter 5. This is a deeper coverage of the photon polarizationd. Mandl and Shaw argue that the longitudinal and scalar (time-polarized) polarizations are not directly observable, but only in combination, where they manifest as the "instantaneous" Coulomb (i.e., electrostatic) potential. This argument, translated from particle terminology to wave terminology, directly fits and strongly supports my reinterpretation {12} of Whittaker's 1903 wave decomposition of the scalar potential {85}. The reinterpretation also represents the discovery of the giant negentropy process favored by nature, easily evoked by breaking 3-symmetry (as by forming a simple dipole).

20. James Clerk Maxwell, "A Dynamical Theory of the Electromagnetic Field," *Roy. Soc. Trans.*, Vol. CLV, 1865, p 459. Read Dec. 8. 1864. Also in *The Scientific Papers of James Clerk Maxwell, 2* vols, bound as one, edited by W. D. Niven, Dover, New York, 1952, Vol. 1, p. 526-597. In this seminal paper, Maxwell's equations of the electromagnetic field are given in "Part III, General Equations of the Electromagnetic Field," p. 554-564. On p. 561, Maxwell lists his 20 variables. On p. 562, he summarizes the different subjects of the 20 equations, being three equations each for magnetic force, electric currents, electromotive force, electric elasticity, electric resistance, total currents; and one equation each for free electricity and continuity.

21. B. J. Hunt, *The Maxwellians*, Cornell University Press, 1991 gives the history of the alteration of Maxwell's field theory by Fitzgerald, Heaviside, Lodge, and Hertz. In an appendix, Hunt makes a comparison between the standard expressions of the Maxwell field equations and their expression in quaternionic form.

22. E.g., J. D. Jackson, *Classical Electrodynamics*, 2nd Edition, Wylie, 1975, p. 219-221.

23. Willis E. Lamb Jr. and Robert C. Retherford, "Fine structure of the hydrogen atom by a microwave method," *Phys. Rev.*, 72(3), Aug. 1, 1947, p. 241-243. Lamb received the 1955 Nobel Prize in physics jointly with Polykurp Kush for experiments measuring the small displacement later called the "Lamb shift" of O+ne of the energy levels in atomic

hydrogen. This is a small "vacuum energy" effect, but the *energy density* involved is greater than the surface energy density of the sun.

24. Craig F. Bohren, "How can a particle absorb more than the light incident on it?" *Am. J. Phys.*, 51(4), Apr. 1983, p. 323-327. Under nonlinear conditions, a particle can absorb more energy than is in the light incident on it. Metallic particles at ultraviolet frequencies are one class of such particles; insulating particles at infrared frequencies are another.

25. See also H. Paul and R. Fischer, "'(Comment on "How can a particle absorb more than the light incident on it?')," *Am. J. Phys.*, 51(4), Apr. 1983, p. 327 for a replication and validation of Bohren's experiment,

26. H. B. G. Casimir, "On the attraction between two perfectly conducting plates," presented at a meeting of the Royal Netherlands Academy of Arts and Sciences on 29 May, 1948. Published in the same year in *Proc. Koninklijke Nederlandse Akad. van Wetenschappen*, Amsterdam, vol. 51(7), 1948, p. 793-796. In English. It is an extrapolation of the more detailed paper of Casimir and Polder, 1948.

27. S. K. Lamoreaux, "Demonstration of the Casimir Force in the 0.6 to 6 micro m range," *Phys. Rev. Lett.*, 78(1), Jan. 6, 1997, p. 5-8. Lamoreaux gives a rigorous experimental verification of the Casimir effect.

28. Franklin B. Mead and Jack Nachamkin, "System for Converting Electromagnetic Radiation Energy to Electrical Energy," U.S. Patent No 5,590,031. An invention for extracting energy from the vacuum via the proven Casimir effect.

29. (a) Floyd Sweet and T. E. Bearden, "Utilizing Scalar Electromagnetics to Tap Vacuum Energy," *Proc. 26th Intersociety Energy Conversion Eng. Conf. (IECEC '91)*, Boston, Massachusetts, 1991, p. 370-375. Sweet's device produced 500 watts output from a 33 microwatt **input** by the operator. A highly successful anti-gravity experiment designed by the present author was also performed, and is reported in the paper. Unfortunately, Sweet later died and never fully revealed the activation secret by which barium ferrite magnetic materials could be in self-oscillation at 60 Hertz. Weak self-oscillation of such permanent magnetic materials at higher frequency is now known, of course. E.g., see (b) V. E. Zakharov and V. S. L'vov, "Parametric excitation of spin waves in ferromagnets with magnetic inhomogeneities," *Sov. Phys. Solid State*, 14(10) 1973, p. 2513. Particularly see (c) V. S. L'vov, *Wave Turbulence Under Parametric Excitation: Applications to Magnets*, Springer Series in

Nonlinear Dynamics, Springer-Verlag, New York, 1994. Self-oscillation can in fact be induced in permanent magnet materials. We comment that, while a permanent magnet is in self-oscillation, a simple set of wires or a coil around the magnet will receive EM energy by induction, and can power a very tiny load in a closely adjacent circuit.

30. T. E. Bearden, "Bedini's Method for Forming Negative Resistors in Batteries," *J. New Energy*, 5(1), Summer 2000, p. 24-38. Also carried on restricted DoE website http://www.ott.doe.gov/electromagnetic/ and on the present author's open website http://www.cheniere.org.

31. Teruo Kawai, "Motive Power Generating Device," U.S. Patent No. 5,536,518.Jul. 25, 1995. My board of directors and I were physically present when the Kawai system, company, etc. were seized by what can only have been the Yakuza (Japanese mafia), even though Kawai was being backed by one of the wealthiest investors in Japan. I had just reached an agreement with Kawai to produce and market his overunity motor worldwide. Several legitimate Japanese overunity systems, ready for production, have been stopped in this fashion. Kawai's process, applied with efficient switching such as photon-coupled switching, essentially doubles the COP of the motor to which it is applied. If one starts with a high efficiency (e.g., Hitachi) permanent magnet electric motor of 0.7 or 0.8, one can expect to produce COP = 1.4 and 1.6 respectively, the actual results obtained by Hitachi tests of two Kawai-modified Hitachi motors. We accent that the efficiencies of the motors remain less than 100% at all times.

32. Gabriel Kron, "Electric circuit models of the Schrodinger equation." *Phys. Rev.* 67(1-2), Jan. 1 and 15, 1945. Quoting, p. 41: *""Now a value E of the negative resistances, at which the generator current becomes zero, represents a state at which the circuit is self-supporting and has a continuous existence of its own without the presence of the generator, as the negative resistances just supply the energy consumed by the positive resistances. ... When the generator current is positive the circuit draws energy from the source, and when the current is negative the circuit pumps back energy into the source. At zero generator current the circuit neither gives nor takes energy, and theoretically the generator may be removed."* In this passage, Kron was required to insert the word "theoretically". Kron was the chief scientist for General Electric on the Network Analyzer project at Stanford University before WW II. In the 1930, he did successfully build negative resistors (at least three), and he

did successfully power the network analyzer with them. He was never permitted to release the technical details, although he placed judicious hints in several of his papers, and slipped certain key phrases past the censors. Interestingly, Sweet was his protegee, and it is conceivable that the basis for Sweet's device may have been Kron's original negative resistor. Independent tests and verification of the Sweet device were performed by Walter Rosenthal, a retired professional test engineer of considerable experience.

33. Shoukai Wang and D. D. L. Chung, "Apparent negative electrical resistance in carbon fiber composites," *Composites, Part B,* Vol. 30, 1999, p. 579-590. Apparently the referees required the replacement of the term "negative electrical resistance" by the term "apparent negative resistance". In the paper, simply examine the actual results shown in the curves of the negative-going current, against the voltage, with the line passing directly through the origin. That is a true negative resistance, not a differential one or an "apparent" one. A patent was filed on this invention.

34. (a) T. H. Moray, *The Sea ofEnergy,* 5th Edn., Salt Lake City, 1978. The Moray device weighed 55 pounds and produced 50 kilowatts of power in the late 1930s, and was demonstrated to scientists and engineers numerous times, Moray made tubes which actually contained very special semiconductors, three of them in contact, each pressed at high pressure during a sintering process. A very eerie chain of circumstances eventually destroyed the device. Moray rode in a bulletproof car, and he was sometimes fired at from the sidewalk or an alley. A double agent, working for both the U.S. and the Soviet Union, infiltrated his lab and eventually destroyed the device. The Morays were never given a proper scientific hearing and were never funded for full development. T. Henry Moray was shot and wounded in his own laboratory, wrestling with a would-be assassin. Yet so many expert engineers and scientists witnessed and tcsted the machine in operation that there is no question of its legitimacy. Unfortunately, the reference cited is not at all a satisfactory scientific examination of the Moray device. A related U.S. patent was issued which at least shows some details of the Moray tube: See (b) Thomas H. Moray, "Electrotherapeutic Apparatus," U.S. Patent No. 2,460,707, Feb. 1, 1949. I personally received a treatment on a Moray device for severe pain, and the relief was rapid and remarkable.

35. See (a) William B. Burford III and H. Grey Verner, *Semiconductor Junctions and Devices: Theory to Practice,* McGraw-Hill,

New York, 1965, Chapter 18: Point-Contact Devices. The very first transistor — the point contact transistor — also often exhibited negative resistance. Quoting, p. 281:

"First, the theory underlying their function is imperfectly understood even after almost a century..., and second, they involve active metal-semiconductor contacts of a highly specialized nature. ... The manufacturing process is deceptively simple, but since much of it involves the empirical know-how of the fabricator, the true variables are almost impossible to isolate or study. ... although the very nature of these units limits them to small power capabilities, the concept of small-signal behavior, in the sense of the term when applied to junction devices, is meaningless, since there is no region of operation wherein equilibrium or theoretical performance is observed. Point-contact devices may therefore be described as sharply nonlinear under all operating conditions."

Certainly degenerate four-wave mixing and therefore time reversal can occur in in semiconductors. E.g., see (b) R. K. Jain, "Degenerate four-wave mixing in semiconductors: application to phase conjugation and to picosecond-resolved studies of transient carrier dynamics." *Opt. Eng.*, 21(2'), March/April 1982, p. 199-218. We also point out that hole current can be emitted from an n-type semiconductor having a metallic point placedd on its surface, and hole current will move against the voltage (electron current view). A process (patent pending) by Bedini and Bearden have shown that a capacitor may be charged by hole current, and then discharge electron current, effectively transducing negative energy into positive energy. It is therefore possible (Bedini's method) to switch a capacitor from a hole-current charging circuit by a hole-emitting process, to a bypass capacitor across a source such as a battery after the capacitor has reached higher charge voltage than the source. The capacitor will then charge the battery and power the circuit as well, during that portion of its discharge cycle while its voltage is above that of the battery. This is a legitimate COP>1.0 process, invented by Bedini.

36. (a) William Jay Fogal, "High Gain, Low Distortion, Faster Switching Transistor." U.S. Patent No. 5,196,809, Mar. 23, 1993; (b) — "High Gain, Low Distortion, Faster Switching Transistor." U.S. Patent No. 5,430,413, July 4, 1995. The Fogal semiconductor can be rigged to perform the permitted degenerate four-wave mixing and therefore time reversal. It can thus be rigged as a true negative resistor, where the current moves against the voltage.

37. Stephen L. Patrick, Thomas E. Bearden, James C. Hayes, Kenneth D. Moore, and James L. Kenny, "Motionless Electromagnetic Generator," U. S. patent # 6,362,718, March 26, 2002.

38. (a) T. E. Bearden, "Energy from the Active Vacuum: The Motionless Electromagnetic Generator," in M. W. Evans (Ed.), *Modern Nonlinear Optics,* Second Edition, Wiley, 2001, Part 2, p. 699-776; (b) M. W. Evans, P. K. Anastasovski, T. E. Bearden *et al.,* "Explanation of the Motionless Electromagnetic Generator with 0(3) Electrodynamics," *Found. Phys. Lett,* 14(1), Feb. 2001, p. 87-94; (c) M. W. Evans, P. K. Anastasovski, T. E. Bearden *et ah,* "Explanation of the Motionless Electromagnetic Generator by Sachs's Theory of Electrodynamics," *Found Phys. Lett.,* 14(8), Aug. 2001, p. 387-393.

39. A version of the MEG was also independently replicated by J. L. Naudin. See his website at http://jnaudin.free.fr/html/meg.htm .

40. T. E. Bearden, "Dark Matter or Dark Energy?", *J. New Energy,* 4(4), Spring 2000, p. 4-11.

41. See Chapter 4 for a high-level expose of this methodology.

42. Sweet and Bearden, {29a). Sweet performed an antigravity experiment designed by the present author, and successfully reduced **the** weight of an object on the laboratory bench, by 90%. Sweet's solid state magnetic vacuum triode amplifier produced a COP = 1,500,000, so a **very** appreciable Dirac sea hole current was available to work with. Conversion of the Dirac sea hole current into electrical current via the present Bedini-Bearden process would have eliminated the antigravity and produced a very large increase in output electrical power.

43. See (a) T. E. Bearden, "The Unnecessary Energy Crisis: How to Solve It Quickly," ADAS Position Paper, June 2000; (b) Bearden **{12};** (c) Bearden {30}; (d) T. E. Bearden, "EM Energy From The Vacuum: Ten Questions With Extended Answers," September 2000. The present author has been calling for just such a program. These papers are on restricted DOE Website http://www.ott.doe.gov/electromagnetic/ and also are on the author's website at http://www.cheniere.org.

44. Nathan Smith, "Marketable Results vs. Good Science?," *Sci. Am.* , 284(5), May 2001, p. 8-9. Quote is from p. 9.

45. This is the actual phrase often used in such Government contracts. What it means is that the Government (which means the government

employee controlling that program and its funds) can suddenly declare that the Inventor is not getting his invention developed rapidly enough, and the Government then seizes the patent to "get it developed more quickly". The inventor is suddenly left hanging, no longer in control of his own intellectual property. Or the Government has the power to block developmental together.

46. Often the universities just bluntly state that *all patents revert to the university.*

47. Hal Hellman, *Great Feuds in Science,* Wiley, New York, 1998. We particularly call attention to Hellman's dissertation on Wegener's persecution. Today, the legitimate overunity EM researcher and the cold fusion researcher are regarded much like Wegener was regarded — as the very epitome of a fool. This label is appended by "experts" who are not even aware of what really powers an EM circuit or an electrical power distribution system.

48. A photon is a piece of angular momentum (called "action" by the physicist), consisting of a little piece of spatial energy (ΔE) and a little piece of time (Δt), welded together as $(\Delta E)(\Delta t)$ with no seam in the middle, so to speak. But now look at that little $(\Delta E)($ Since the photon is quantized $(\Delta E)(\Delta t) = k = \hbar$. Any change in $(\Delta$ requires that (ΔE) change inversely; i.e., $(\Delta E) = \hbar/(\Delta t)$. So increasing decreases (ΔE) accordingly. Let us call the spatial energy *s* compacted into (dt) the equivalent *energy* of the photon. Then *s* is given by $s = c^2(\Delta t) = 9\times10^{16}$ (Δt). So as the frequency of a photon lowers, the (Δt) time component increases proportionally, and the total equivalent energy in the photon increases dramatically by many orders of magnitude! As an example, suppose we halve the spatial energy (ΔE) That doubles the original time interval (Δt), which gives the new $s = c^2(2\Delta t)$ or $s = 2c^2(\Delta t)$ for the new equivalent energy. So while we halved the *normal* spatial energy formally transported by the photon, we multiplied the *equivalent* time-energy by the enormous factor of $2c^2$ which is approximately 18×10^{16} in the MKS system. It follows that, if we use the equivalent time) energy of the photon and transduce a little of it into normal spatial energy, the energy density of those nuclear reactions now seen only in distant energetic objects such as pulsars, exploding stars, etc. can be achieved right on the laboratory bench. *The highest energy physics has not yet been born in the physics community, and what is presently being done in the high-energy*

accelerators is child's play compared to what can be done with time-energyengineering.

49. To see by another method that time is energy, one notes that the choice of fundamental units chosen for one's physics model is arbitrary. So we choose a single fundamental unit, the joule, to make a new physics model. Thereupon all other entities are energy and energy functions only, Hence, time is totally a function of energy. Actually, time is spatial energy compressed by the factor c^2, so it has the same energy density as mass, except the highly compressed spatial energy is placed in the time domain to appear at "time" rather than in 3-space to appear as "mass".

50. E.g., in cold fusion experiments where the time-energy is partially transduced in a time-reversed manner, the gluon forces binding the quarks in the affected neutrons and protons are dramatically reduced and the quarks are therefore nearly freed. This is being done in an apparatus of perhaps two cubic feet in volume, rather than a giant accelerator 20 miles in diameter and costing billions of dollars. So far, the largest accelerator using 3-space (decompressed) energy is just a bit short of the energy required to free the quarks. Use of time (compressed) energy allows such reaction as freeing the quarks to be easily accomplished, while the accompanying decompressed *spatial* energy is very low.

51. Time energy has the same energy density as mass, but that highly compressed energy has just been placed in the 4th axis *ict* of Minkowski space rather than in 3-space. In *ict* the only variable is t, so the variation of the compressed energy can only appear in the *t* variable portion. See Chapter 2.

52. (a) James Patterson, U.S. Patents 5,318,675; 5,372,688; 5,607.563 (b) — and Dennis Cravens, U.S. Patent No. 5,607,563.

53. Ironically, as suppression of innovative research in science increases, science may eventually face turning into the kind of dogmatic system that it struggled against for some 300 years before escaping. When science defends a theory that experiments refute, as it does today in the case of cold fusion, then it is very close to that debacle that can spell the end of science itself.

54. E. Allan Blair, Letter to the Editor, *Newsweek*, Mar. 3, 1997, p. 14.

55. Arthur C. Clarke, "Space Drive: A Fantasy That Could Become Reality," *NSS... AD ASTRA,* Nov/Dec 1994, p. 38.

56. William K. George, in *Editing the Refereed Scientific Journal, edited* by Robert A. Weeks and Donald L. Kinser, IEEE Press, New York, 1994. p. 227-228.

57. Max Planck, in G. Holton, *Thematic Origins ofScientific Thought, Harvard* University Press, Cambridge, MA, 1973.

58. Jonathan Schlefer, editor of *Technology Review,* published at MIT. in an October 1990 editorial.

59. Rolf Landauer, "Fashions in Science and Technology," *Physics Today,*50(12),Dec.1997,p.62.

60. Julius Robert Von Mayer, "Bemerkungen iiber die Krafte der unbelebten Natur," in J. von Liebig's *Annalen der Chemie* (vol. 42), 1842; Die *organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel, (Organic* Motion in Its Relation to Metabolism), 1845. His papers were published as *Die Mechanik der Warme,* 1867, with third edition in 1893.

61. Alfred Wegener, *Die Entstehung der Kontinente und Ozeane, 1915;* fourth revised edition, 1929. A Dover reprint of the fourth revised edition, translated into English, *Origin ofContinents and Oceans,* was published in 1996.

62. Paul Nahin, *Oliver Heaviside: Sage in Solitude,* IEEE Press. New York, 1988, p. 225.

63. Martin Gumpert, *Trail-Blazers ofScience.* New York, Funk and Wagnalls Company, 1936, p. 232.

64. This area is now referred to as *ovonics,* where the "ov" is directly taken from "Ovshinsky". The materials have found use in copy machines, fax machines, liquid crystal displays, and optical memory disks. Ovshinsky has obtained over 200 patents and continues to work in the energy conversion field. His development of a new storage battery, e.g., broke all the Department of Energy tests and doubled the energy density permitted. Once in awhile the good guys beat the scientific suppression system.

65. Stan and Iris Ovshinsky were honored with the American Chemical Society's Heroes of Chemistry Award for 2000. They were honored for 40 years of sustained effort and contributions in the

sustainable and renewable energy field, including amorphous silicon cells for roofs of houses, highly specialized storage batteries, etc.

66. On the other hand, many scientific disagreements are conducted in quite proper and gentlemanly fashion. An example is the continuing decades of argument over energy flow theory, in *Am. J. Phys.* The problem has still not been officially resolved; we would hope that the material in this book will shed new light upon it, by pointing out the exact difference between the long-neglected nondiverged component as well *as* the diverged component, and also pointing out what Lorentz's trick of closed surface integration of the energy flow vector really does.

67. It follows quite naturally that, once we compress spatial energy by c , we may place the compressed energy in 3-space, in which case it is known as "mass", or we may place it in the time domain, in which case it is known as "time". If that cannot be done, then physics errs in using time as a variable on the fourth axis, and fundamental units are not arbitrary after all.

68. E.g., see D. K. Sen, *Fields and/or Particles,* Academic Press, London and New York, 1968, p. viii. Quoting: *"The connection between the field and its source has always been and still is the most difficult problem in classical and quantum electrodynamics."*

69. See T. D. Lee, "Can Time Be a Discrete Dynamical Variable?". *Phys. Lett,* 122B(3, 4), Mar. 10, 1983, p. 217-220. Lee showed that time is a discrete dynamical variable across the entire range of mechanics: from classical to nonrelativistic quantum mechanics, and then to relativistic quantum field theories. In all stages of mechanics, time can be treated as a discrete parameter, and it can be treated as a bona fide dynamic variable, Hence time has dynamics and structure, and therefore energy.

70. E.g., one may assume that the entire virtual state is an internal structuring and dynamics existing inside the macroscopic flow of time. The virtual state dynamics obviously exists in spacetime (which is assumed to be continuous), but we also consider any "virtual particle" (e.g., a virtual electron) as if it had been suddenly "observed" momentarily That assumes d/dt (LLLt) => LLL, a frozen 3-space snapshot. However, since that cannot really be observed, then we are actually considering something analogous to "if we could observe something in spacetime that cannot be observed in space alone". The only place left for it to

!observably exist anyway, if we could in fact observe it" is time, if space is ruled out.

71. It is necessary to trace the energy transductions and dissipations inside the generator. Ignoring those internal dynamics, the casual observer sees that one inputs shaft energy to the generator, and out comes some electromagneticenergy in the external electrical circuit, pouring from the gnerator terminals. We catch a lesser amount out there in the external circuit or power line, so we think we input some energy, had some internal losses and what gets collected in the conductors of the power line is the remainder of what we input, after transductions and losses in the generator. That is not what happens at all! Embarrassingly, an *enormous* flow of energy comes out of those generator terminals, if all of it is accounted. This includes(i) the tiny component that strikes the surface charges of the external conductors and gets diverged into the conductors, thus being captured by the circuit, and (ii) the enormous remainder of the energy flow in the surrounding space, which misses the circuit altogether and is just wasted. Something like a trillion times as much EM energy may be pouring out of the terminals of the generator and *being wasted,* as we mechanically input to the generator shaft, or as we "catch" and use in the external circuit. As later chapters discuss, Poyntin ; never considered the component that misses the circuit entirely. Heaviside discovered it but could not explain its startling magnitude or its source. Lorentz knew of this enormous flow component. He could not explain it, and stated it "had no physical significance" since it powered nothing. Lorentz originated a little integration trick that discarded it neatly from a11 accountability.

72. If the energy input to an inert power system generator were what powered the attached external circuit, then only the Poynting component would be emitted from the terminals of the generator. In that case, Heaviside's discovery of the additional nondiverged component would be wrong, and Lorentz was also wrong in recognizing it by stating it had no *physical* significance. It also means that a dipole formed between the terminals can have no broken symmetry in its active vacuum flux exchange, which is falsified by particle physics {14, 73,}. Also, no charge could pour out energy and create fields and potentials in surrounding space, and neither could a dipole. That is easily falsified by actual experimental measurement. Our reinterpretation of Whittaker's wave decomposition of the scalar potential would also be wrong, as would Mandl's and Shaw's argument {19} that a combined pairing of a scalar

photon and a longitudinal photon are observable, producing the instantaneous scalar potential.

73. T. D. Lee, *Particle Physics and Introduction to Field Theory,* Harwood, New York, 1981,*passim*. In 1957, Lee and Yang received the Nobel Prize for their work in predicting broken symmetry. This included the broken symmetry of opposite charges — and hence of a dipole.

The very definition of broken symmetry, applied to the source dipole once it is formed in the generator, reveals that the dipole itself receives virtual photon energy from the seething vacuum, transduces it, and outputs it as real observable EM energy pouring out of the generator terminals and out through 3-space surrounding the entire power line. This is the source of the tremendous energy flow from the terminals, including a large component missing the circuit (as discovered by Heaviside in the 1880s). This large nondiverged component of the energy flow was discarded arbitrarily by Lorentz because there was absolutely no explanation of its source, and because it was thought to have "no physical significance" (Lorentz's term) since it powered nothing.

74. Wu et al. {14} experimentally showed that the weak interaction violates parity (spatial reflection) and thus exhibits broken symmetry.

75. T. D. Lee is noted for his broken symmetry work with charges, and for establishing the broken symmetry of separated charges of unlike sign. In 1957, Lee and Yang were awarded the Nobel Prize in Physics for their investigations of weak interactions between elementary particles.

76. John D. Kraus, *Electromagnetics,* Fourth Edition, McGraw-Hill, New York, 1992, p. 578.

77. We strongly feel that anyone interested in logic must read Morris Kline, *Mathematics: The Loss of Certainty,* Oxford University Press, New York, 1980. Contrary to popular opinion and the impression projected by mathematicians, mathematics is not a body of unshakable truths aboul the physical world, and mathematical reasoning is not exact and fallible.

78. One also needs to be aware of Godel's proof. See Kurt Godel, "Uber formal unentscheidbare Satze der *Principa Mathematica* une verwandter Systeme" ("On Formally Indeterminable Propositions of the *Principia Mathematica* and Related Systems," in *Monatshefte fur Mathematik und Physik,* Vol. 38, 1931. This is the publication in which Godel's Proof first appeared, which states that within any logical

mathematical system there are propositions or questions that cannot be proved or disproved on the basis of the axioms within that system. Therefore, it is uncertain whether or not the axioms or arithmetic will give rise to contradictions, since they can.

79. A critical reference for the longitudinal EM interferometry *weapons* is M. W. Evans, P. K. Anastovski, T. E. Bearden *et al.*, "On Whittaker's Representation of the Electromagnetic Entity in Vacuo, Part V: The Production of Transverse Fields and Energy by Scalar Interferometry," *J. New Energy*, 4(3), Winter, 1999, p. 76-78. This paper is a short but rigorous proof of a scalar interferometer's ability to produce EM fields and energy in the distant interference zone. Either diverging (heating) energy or converging (cooling) energy — in the normal sense, extraction of energy — can be created in a distant interference zone. By pulsing and controlling the circuit ground bias of the transmitters, one produced distant hot explosions or cold explosions. In a military target in that distant zone, the effects arise from the local spacetime, thus from everywhere within the targeted vehicle. At least eight nations now have such weapons, which were apparently the weapons that Defense Secretary Cohen {89} referred to in 1997.

80. Jackson {22}, p. 249.

81. Bunge, {3},p. 182.

82. Roger Penrose, "Foreword," in T. W. Barrett and D. M Grimes [Eds.], *Advanced Electromagnetism: Foundations, Theory, & Applications*, World Scientific, (Singapore, New Jersey, London, and Hong Kong), 1995.

83. Myron Evans, President of Alpha Institute's Institute for Advanced Study, private communication, 1999. Dr. Evans is the author of over 600 scientific papers, the prestigious editor of several scientific book series, and a noted foundations scientist. He is the co-discoverer and proponent of the Vigier-Evans B(3) magnetic field and a proponent of the proposed fundamental extension of U(1) electrodynamics to O(3) electrodynamics. O(3) electrodynamics has now been revealed as an important subset of Sachs' unified field theory.

84. Robert H. Romer, "Heat is not a noun," *Am. ./. Phys.*, 69(2), Feb. 2001, p. 107-109. The quotation is from footnote 24, p. 109.

85. E. T. Whittaker, "On the Partial Differential Equations of Mathematical Physics," *Math. Ann.*, Vol. 57, 1903, p. 333-355.

86. But see Chapter 2 for a reinterpretation and correction of Whittaker's decomposition of the scalar potential. His harmonic set of bidirectional phase conjugate longitudinal EM wavepairs in 3-space is replaced with a harmonic half-set of longitudinal EM waves converging in I the time domain upon the dipolarity; absorption and transduction by the charges; and re-emission as the other harmonic half-set of longitudinal EM waves diverging out from the source dipolarity in all directions in 3-space. The correction allows a very novel solution to the long-vexing problem of the source charge and its associated fields and potentials and their energy {12}.

87. (a) G. Johnstone Stoney, "Microscopic Vision," *Phil. Mag.*, Vol 42, Oct. 1896, p. 332; (b) — "On the Generality of a New Theorem," ***Ibid.***, Vol.43, 1897, p. 139-142; (c) — Discussion of a New Theorem in Wave Propagation," *ibid*, Vol. 43, 1897, p. 273-280; (d) — "On a Supposed Proof of a Theorem in Wave-motion," *ibid.*, Vol. 43, 1897, p. 368-373.

88. Some Russian scientists refer to the hidden internal electrodynamics as the "information content of the field".

89. Secretary of Defense William Cohen at an April 1997 counterterrorism conference sponsored by former Senator Sam Nunn. Quoted from DoD News Briefing, Secretary of Defense William S. Cohen, Q&A at the Conference on Terrorism, Weapons of Mass Destruction, and U.S. Strategy, University of Georgia, Athens, Apr. 28, 1997.

90. For a basic discussion of these photon polarizations, see (a) Richard Feynman, *Quantum Electrodynamics*, 1961, 1963. Quantum field theory recognizes four polarizations of the photon, to include x- and y-transverse polarizations in 3-space, longitudinal or z- polarization in 3-space, and the time-polarized photon (which may be taken to be a longitudinally-polarized photon in the time axis). Existence of these four modes of polarization or energy vibration in photons implies the existence of four correspondingly polarized EM waves. Among other things, Feynman discusses the "sum over four polarizations" of photons and such The term "Gupta-Bleuler" theory is the formalism that has grown up around this problem. For a deeper discussion, see (b) Lewis H. Ryder, *Quantum Field Theory*, Second Edition, Cambridge University Press, 1996, p. 147 *et seq*. For an even more advanced discussion, see (c) F.

Mandl and G. Shaw {19}. For discovery of the coupling of time-polarized and 3-space longitudinally polarized EM waves as the higher EM energy flow symmetry resolving the source charge problem, and thereby reinterpreting Whittaker's decomposition of the scalar potential {85}, see (d) Bearden {12}. We point out that the latter reinterpretation can also be "cranked through" the superpotential theory of Whittaker, to involve all EM potentials, fields, and waves.

91. (a) E. T. Whittaker, "On an Expression of the Electromagnetic Field Due to Electrons by Means of Two Scalar Potential Functions," P*roc Lond. Math. Soc,* Series 2, Vol. 1, 1904,p. 367-372. The paper initialed what today is called *superpotential* theory. It was published in 1904 and orally delivered in 1903. For a sampling of other superpotential work, see (b) W. H. McCrea, *Proc. Roy. Soc. Lond. A,* Vol. 240, 1957, p. 447; (c) A. Nisbet, *Physica,* Vol. 21, 1955, p. 99; (d) P. Debye, *Ann. Phys.,Leipzig,* Vol. 30, 1909, p. 57. For an excellent overview discussion of superpotentials and related things, see (e) Melba Phillips, "Classical Electrodynamics," in *Principles of Electrodynamics and Relativity,* Vol. IV *of Encyclopedia of Physics,* edited by S. Flugge, Springer-Verlag, l962.

92. (a) See Evans et al. {79} for proof that scalar interferometry can produce all normal transverse EM fields, waves, and patterns. The paper appears in (b) P. K. Anastasovski; T. E. Bearden, C. Ciubotariu, W. T. Coffey, L. B. Crowell, G. J. Evans, Myron W. Evans, R. Flower, S. Jeffers, A. Labounsky, B. Lehnert, M. Meszaros, P. R. Molnar, J.-P. Vigier, and S. Roy, "The New Maxwell Electrodynamic Equations: New Tools for New Technologies," *J. New Energy, 4(3),* Special Issue of A1AS papers. Winter 1999. The volume consists of some 60 papers by the Alpha Foundation's Institute for Advanced Study (AIAS), advancing electrodynamics to a non-Abelian, gauge theoretic higher topology theory in O(3) internal symmetry. Some ten of the papers directly address Whittaker's work and extend it.

93. (a) W. A. Rodrigues, Jr. and J.-Y. Lu, "On the existence of undistorted progressive waves (UPWs) of arbitrary speeds 0 < v < oo in nature," *Found. Phys.,* 27(3), 1997, p. 435-508 show that Maxwell's equations do possess superluminal solutions. A slightly corrected version is downloadable as hep-th/9606171 on the Los Alamos National Laboratory web site. Also see (b) W. A. Rodrigues, Jr. and J. Vaz Jr., "Subluminal and Superluminal Solutions in Vacuum of the Maxwell

Equations and the Massless Dirac Equation," *Adv. Appl. Clifford Algebras,* Vol. 7(S), 1997, p. 457-466.

In classified Russian weapons labs, this internal longitudinal wave (both time-domain and 3-space domain) structuring of all normal (transverse) EM potentials, fields, and waves is euphemistically called the *information content of the field.* For decades there has been a successful disinformation campaign to lead scientists of other countries into believing that the phrase means *standard spectral analysis.* It doesn't. It is also possible to communicate at superluminal speed, using longitudinal EM waves inside this infolded "inner" electrodynamics. Since mass is mostly empty space filled with a particle here and there — together with EM potentials, fields, and waves — then mass is a vast "superhighway" for direct superluminal communication using longitudinal EM waves.

94. Romer, {84}.

95. See E. T. Whittaker, *A History of the Theories of the Aether and Electricity,* two vols., Nelson, London, 1951, 1953. Reprinted by Dover.

96. Note that we have just resolved the age-old problem of change, which can be summarized in the query stated so long ago by Heraclitus: "For a thing to change, it must turn into something else. But how can a thing be itself and something else also?" We have explained the enigma by pointing out that the "thing" has no persistence in time, and is continually changing into yet another thing, either a replica (in which case we sense "no change" and hence "persistence" by memory comparison), or a partial replica with some differences (in which case we sense that "the object has changed itself in some way"), or a thing with little or no replication (in which case we sense a "different thing"). It is the unseen nature of the *d/dt* observation process that has deluded us into such irresolvable logical conflicts — and into an incomplete Aristotelian logic based on observation alone, which does not contain the resolutions to such problems because a higher-order logic is required.

97. Whittaker, {85}

98. See Chapter 2 for a discussion of the substitution of effect for cause, and of the nature of observation.

99. *Wu etal,* {14}.

100. Sen, {68}.

101. Also see Mandl and Shaw {19}.

102. William G. Harter, John Evans, Roberto Vega, and Sanford Wilson, "Galloping waves and their relativistic properties," *Am. J. Phys.*, *53*(7), July 1985, p. 671-679. A relativistic example is given in which the source frame observes a very nonuniformly-galloping wave whose velocity varies between 0.01 c and 100 c, even though its average velocity is c. Relativistic properties of interfering electromagnetic plane waves are discussed.

103. We point out, but do not further pursue, that this situation is reversed when time is reversed. This has very interesting applications in our little "time reversal zones" that we found were so important in the electrolyte experiments of the cold fusion researchers, and which accounted for a new class of nuclear interactions previously unknown. This does reverse the conventional law of attraction and repulsion of charged particles. It also directly affects the quarks and gluons, partially or even nearly dissolving the gluon forces holding the quarks in place, so that the quarks are nearly freed and are easily flipped.

104. Simultaneously accompanied by *separately broken* time-energy flow symmetry and *separately broken* 3-spatial energy flow symmetry.

105. Evans et al., {38b, 38c}.

106. Oliver Heaviside, *Electrical Papers*, Vol. 2, 1887, p. 94.

107. Kraus, {76}.

107. E.g., see (a) Jackson {22}, p. 237. Jackson points out that *"...the Poynting vector is arbitrary to the extent that the curl of any vector field can be added to it. Such an added term can, however, have no physical consequences."* The first sentence is true, but the second sentence is a non sequitur. Poynting only considered the small component of the overall energy flow that enters the circuit — in short, that strikes the surface charges in the conductors and is diverged into the wires to power the Drude electrons. That is the diverged part of the energy flow. All the rest of the flow that misses the circuit is obviously not diverged or collected in the circuit, and so it has zero divergence. It is elementary vector algebra that the curl of any vector field has zero divergence. So the extra nondiverged Heaviside energy flow component — filling all space around the conductors in a power line, e.g., but missing the power system entirely and just wasted — can indeed be expressed as the curl of a vector field That energy flow is real, however, and if intercepted and collected, it then does become divergent. In that case, it does have highly significant

consequences, since the total energy flow in that component may be a trillion times the energy flow in the Poynting component alone.

For a rigorous experiment demonstrating the reality and significance ol that "physically insignificant energy flow" that "can have no physical consequences", see (b) Bohren {24}. Under nonlinear conditions, a particle can absorb more energy than is in the light incident on it by normal calculations. Electrodynamicists do *not* calculate the magnitude of an entire field or potential, e.g., but only the intensity of a *divergence from* it at a single point, as given by an intercepting unit point static charge. If that same charged particle is placed in particle resonance, it sweeps out a greater geometrical reaction cross section. Hence it intercepts and **collects** (diverges) more impinging energy — from that long-neglected otherwise nondiverged component of the flow or field that is not diverged by the *static* unit point charge assumed conventionally. Metallic particles at ultraviolet frequencies are one class of such particles and insulating particles at infrared frequencies are another. See also (c) Paul and Fischer, {25}, who replicated Bohren's experiment.

109. H. A. Lorentz, *Vorlesungen iiber Theoretische Physik an der Universitdt Leiden,* Vol. V, *Die Maxwelhche Theorie (1900-1902),* Akademische Verlagsgesellschaft M.B.H., Leipzig, 1931, "Die Energie im elektromagnetischen Feld," p. 179-186. The section is called "Der Poyntingsche Energiestrom," and begins on p. 183. See his Figure 25 **on** p. 185.

110. E.g., see W. K. H. Panofsky and M. Phillips, *Classical Electricity and Magnetism,* Addison-Wesley, Reading, MA, 1962, 2nd edition, p. 181**,**

111. Bearden, {12}.

112. A simple way to see this is to note that the back-potential across the half-loop internal to the dipole is precisely equal to the forward potential externally between the ends of the dipole but across the **external** circuit half-loop. Since the same current q runs through both these potentials, then by Vq the same amount of energy is dissipated upon **the** charges of the dipole — to scatter them and destroy the dipole — as is dissipated in the external circuit in its losses and the load. Thus **more** energy is used to destroy the dipole than is used to power the load. We have to input at least as much shaft energy to restore the dipole as was used to destroy it. Hence the COP< 1.0.

113. See to (a) M. W. Evans, P. K. Anastasovski, T. E. Bearden *el al*, "Classical Electrodynamics without the Lorentz Condition: Extracting Energy from the Vacuum," *Physica Scripta*, 61 (5). May 2000, p. 513-5 17 in addition to that paper previously quoted. See also (b) "Runaway Solutions of the Lehnert Equations: The Possibility of Extracting Energy from the Vacuum," *Optik*, 111(9), 2000, p. 407-409.

114. Robert Bruce Lindsay and Henry Margenau, *Foundations of Physics*, Dover, New York, 1963, p. 25.

115. *Ibid.*, p. 213.

116. *Ibid.*, p. 217.

117. M. Faraday, *Experimental Researches in Electricity and Magnetism*, Vol. 1, Taylor and Francis, London, 1839; Vol. 2, Richard & John E. Taylor, London, 1844; Vol. 3, Taylor and Francis, London, 1855. A 1965 reprint of all three volumes is available from Dover, New York.

118. We also acknowledge the independent contributions of Joseph Henry. In 1830, Henry independently discovered magnetic induction, anticipating Faraday's own discovery of it. Faraday, however, published first. Two years later, Henry discovered self-induction. He died in 1878, and the unit of inductance, the *henry*, was named for him in 1893.

119. (a) Maxwell, {20}. Also see (b) James Clerk Maxwell, *A Treatise on Electricity and Magnetism*, Oxford University Press, Oxford, 1873, Third Edition, Volumes 1 and 2, unabridged, Dover Publications, New York, 1954. This standard citation widely used in the literature is in fact confusing; the First Edition was published in 1873, a second rather substantially altered edition was later published after Maxwell's 1879 death of stomach cancer, and a third edition, slightly altered from the second edition, was published even later. So controversial were quaternions at the publication of Maxwell's first edition in 1873, that part of what was to become the second edition — published after Maxwell's 1879 death — was truncated by Maxwell himself prior to his death and prior to the posthumous publication of the second edition. Thus there is considerable difference between the first and second editions, and first and third editions, of Maxwell's *Treatise*, compared to his original 1865 paper {20}. "Maxwell's theory" is actually his 1865 paper; everything else is a later truncation of Maxwell's theory.

120. Maxwell's letter to P. G. Tait in 1871, *Archives,* Cavendish Laboratory, Cambridge.

121. For a discussion, see (a) A. M. Bork, "Vectors versus quaternions - the letters in *Nature,"* in *Am. J. Phys.,* Vol. 34, Mar. 1966, p. 202-211. For a cogent presentation of what might have been discovered much earlier in physics if quaternions had not been cast aside in favor of the much more limited vectors, see (b) James D. Edmonds Jr., "Quaternion quantum theory: New physics or number mysticism?", *Am. J. Phys.,* 42(3), Mar. 1974, p. 220-223.

122. Edmonds, {121b}. Edmonds presents a cogent argument showing the significant impedance of the rate of discovery in physics, that **resulted** from the ill-advised casting aside of the far more comprehensive quaternion theory in favor of the much more limited vector theory.

123. Heaviside, {5a, 5b}.

124. T. W. Barrett, "Tesla's Nonlinear Oscillator-Shuttle-Circuit (OSC) Theory," *Annales de la Fondation Louis de Broglie,* 16(1), 1991, p. 23-41, Barrett later extended some of the energy-shuttling techniques shown by Tesla and obtained U.S. Patents 5,486,833 and 5,493,691.

125. (a) A. A. Michelson and E. W. Morlcy, "Influence of motion of the medium on the velocity of light," *Am. J. Sci.,* Vol. 31, Series 3, 1886, p. 377-386; (b) — "The relative motion of the earth and the luminiferous aether," *Am. J. Sci.,* 34(3), 1887, p. 333; (c) — "On the relative motion of the earth and the luminiferous aether," *Phil. Mag.* 24(4), 1887, p. 449. See also (d) A. A. Michelson, "The relative motion of the earth and the ether," *Am. J. Sci.,* (4), 3, 1897, p. 475.

126. (a) Mendel Sachs, *General Relativity and Matter: A Spinor Field Theory from Fermis to Light-Years (Fundamental Theories of Physics),* Reidel, 1982. Sachs provides a great generalization of general relativity and electrodynamics reaching from the quarks and gluons to the entire universe. See also (b) Mendel Sachs, "Symmetry in Electrodynamics: From Special to General Relativity, Macro to Quantum Domains," in M. W. Evans, Editor, *Modern Nonlinear Optics,* Second Edition, Wiley, **New** York, 2001, Part 1, p. 677-706.

127. Myron W. Evans, Director of the Alpha Foundation's Institute for Advanced Study, private communication, 2001.

128. Jackson, {22}, p. 249.

129. Jackson, {22}, p. 28.

130. Feynman, {7}, Vol. 1, p. 2-4.

131. Physicists often speak of spacetime as "space", since in Minkowski geometry the time portion is modeled along a separate spatial axis used in addition to the ordinary three spatial axes. So Feynman's "distortion" is actually Riemannian spacetime curvature.

132. As an aside, note that Feynman also utilized a dipolarity. There is always a scalar potential between the poles of any dipole. Further, this "dipole potential" decomposes according to Whittaker's 1903 decomposition{85}, as re-interpreted by Bearden's giant negentropy approach {12} in 2000, and as relates to Mandl and Shaw's 1984/1993 argument{19} that only the associated time-polarized photon and longitudinal photon together are observable, and then as the instantaneous scalar potential. If we accept Mandl and Shaw's powerful argument, then the Whittaker 1903 decomposition must be reinterpreted to be in accordance. That is what was done by the present author {12} to resolve the source charge problem as well as the source dipole problem. In addition, the resolution must be in accord with the theoretical and experimental findings of particle physics, to include the broken symmetry of the opposite charges on the ends of a dipole. The giant negentropy process uncovered by Bearden {12} fulfills all the necessary requirements. It also places the theme of this book — *Energy from the Vacuum: Concepts and Principles* — on a solid theoretical and experimental basis.

133. Feynman, {7}, vol. II, p. 1-3.

134. Jackson, {22}, p. 811-812.

135. We have previously postulated this feature where one second is equal to spatial EM energy compressed by the factor c^2, so that time is just extremely compressed EM spatial energy. See Bearden, {17}.

136. (a) Harter et al., {102}. It may well be that galloping due to time-density variation may provide an alternative explanation to quantum tunneling, which can readily occur at superluminal speed. E.g., see (b) A Enders and G. Nimtz, *Phys. Rev. Lett.*, Vol. 48, 1993, p. 632. Their superluminal tunneling experiments transmitted 8.7 GHz microwaves (free space wavelength 3.4 cm) traveling in a rectangular waveguide that contains a "barrier" section of reduced dimensions. Mozart's 40th Symphony was transmitted through the barrier waveguide as frequency

modulated microwaves, at an FTL group velocity of 4.7c, receiving audibly recognizable music from the microwave photons that survived their barrier passage.

137. (a) M. W. Evans, "The Link Between the Sachs and 0(3) Theories of Electrodynamics," in M. W. Evans, editor, *Modern Nonlinear Optics,* Second Edition, Wiley, New York, 2001, Part 2, p. 469-494; (b) — "0(3) Electrodynamics," in M. W. Evans, editor, *Modern Nonlinear Optics,* Second Edition, Wiley, New York, 2001, Part 2, p. 79-267.

138. E.g., Ryder, {90b}, p. 147 *et seq.*

139. Rodrigues and Lu, {93a}.

140. Rodrigues and Vaz, {93b}.

141. The reader should recall that to this day there is no satisfactory resolution of the wave-particle duality principle. Physicists finally just shook hands and agreed to quit fighting, since the hullabaloo was getting them nowhere. The problem does have a probable resolution, but not in Aristotelian logic.

142. Bearden, {12} discusses the relation between time-energy and 3-spatial energy, and reveals a more fundamental 4-symmetry between time energy flow and spatial energy flow. In this 4-symmetry EM flow, time symmetry in energy flow is broken and simultaneously 3-space symmetry in energy flow is broken, but 4-symmetry in energy flow is maintained. The basic transduction of time-energy into 3-space energy and vice versa is accomplished by the interacting charge.

143. Bearden, {15}, p. 11. In the paper we also gave a force-free definition of mass, in terms of the transduction of angular momentum across the 3-spatial boundaries of a mass particle.

144. Rigorously, *mass* does not and cannot emit a photon; *masstime* does. But an observable mass m can be absorbing and emitting **enormous** numbers of virtual photons while not yet having absorbed another observable photon and decayed to emit an observable photons. Differential (virtual) pieces of a "frozen" observable mass m are **indeed** changing continually into masstime and back into mass, by absorbing and emitting virtual photons per equation [14b], while the observable mass m has not yet completed its absorption and emission of an observable **photon** This "knitting" together of observable and virtual state interactions is one of the great centralizing features of physics.

145. The problem is due to the hoary old erroneous notion in mechanics that a separate force acts upon a separate mass to move it.

146. There appears to be no paper or textbook which calculates the actual "energy magnitude" of an entire potential or an entire field, including over all space occupied by it. All texts advance the "local intensity" indicator calculation, and then call that the "magnitude of the potential". That is a non sequitur of first rank. A skilled electrodynamicist will call it the intensity of the potential.

147. It appears that the only region where this statement is in dispute is in various models attempting to explain the creation of the universe. Since that is *a priori* a creation event, then physicists struggle with explaining how something (the existing universe) was created out of nothing (the absence of any slightest bit of the existing universe). We will leave that debate to the astrophysicists and cosmologists. The "accursed identity of opposites" has been the bane of philosophers for more than 3,000 years.

148. Ibrahim Semiz, "Black hole as the ultimate energy source," *Am. J. Phys.*, 63(2), Feb. 1995, p. 151.

149. David Halliday and Robert Resnick, *Fundamentals of Physics, Third* Edition Extended, Wiley, New York, 1988, Vol. 1, p. 518.

150. Stanley W. Angrist, "Perpetual Motion Machines," Sci. *Am.*, Vol. 2I8, Jan. 1968, p. 114-122.

151. Stanley W. Angrist, "Perpetual Motion," *Encyclopaedia Britannica*, Bicentennial Edition, Macropaedia Vol. 14, 1976, p. 102-105.

152. Lindsay and Margenau, {114}, p. 217.

153. Heaviside, {106}, p. 94.

154. Kraus, {76}, Figure 12-59, p. 578.

155. Bohren, {24}.

156 Paul and Fischer, {25}.

157. (a) V. S. Letokhov, "Laser Maxwell's Demon," *Contemp. Phys.*, *36*(4), 1995, p. 235-243; (b) — "Generation of light by a scattering medium with negative resonance absorption," *Zh. Eksp. Teor. Fiz.*, Vol, 53. 1967, p. 1442 (English translation is in *Sov. Phys. JETP*, 26(4), Apr. 1968. p. 835-839); (c) "Stimulated emission of an ensemble of scattering particles with negative absorption," *ZhETF Plasma*, 5(8), Apr.

15, 1967, p. 262-265; (d) — "Double y - and optical resonance," *Phys. Lett. A*, Vol. 43, 1973, p. 179-180.

158. It is Heaviside's equations that are usually taught in University as "Maxwell's Equations," and labeled as Maxwell's equations in most undergraduate texts. In addition to Heaviside' work, similar changes were made by Gibbs in the United States and by Hertz in Europe. Every sophomore physics student and electrical engineering student should be given a short treatise on the background development of electrodynamics, and how, when, and by whom Maxwell's 20 quaternion equations were modified into the present four vector equations. The treatise should also point out what was omitted from Maxwell's theory in its truncations. It should be made very clear to every student that his elementary EM subject errs dramatically from physical reality when it assumes a flat local spacetime and an inert local vacuum. *By discarding the physically active environment of all Maxwellian systems,* only a highly limited subset of nature's electrodynamics is captured in the standard electrical engineering model. Specifically, systems far from equilibrium in their exchange with that environment are arbitrarily discarded. Those are precisely the Maxwellian systems permitted to exhibit coefficient of performance greater than unity. In short, the truncation of Maxwell's theory arbitrarily discarded all electrical windmills turning — or partially turning — in **a** free electrical wind.

159. As we pointed out, there are *tin electromagnetic systems at all in* that first class — and never have been — if we account for the arbitrarily-ignored Heaviside energy flow pouring from the source dipole and the energy flow pouring from every charge, and consider the situation prior to self-enforced implementation of Lorenz/Lorentz symmetrical regauging (by the closed current loop circuit). The remarks — pertaining to EM systems supposedly in equilibrium with the active vacuum — only apply if we neglect that Heaviside component and also neglect the source **charge** problem, and even then only if the circuit self-enforces that equilibrium in its exchange with the active vacuum. But since it has been so long **and** ubiquitously neglected, we will continue to speak of the "two classes" of EM systems from that "conventional" view. It is rather like our concession to electrical engineering, where the word "power" is universally **misused.** However, the reader should be aware of what we are doing and why.

160. See (a) Ilya Prigogine, *Nonequilibrium Statistical Mechanics,* Wiley-Interscience, New York, 1962; (b) — *From Being to* ***Becoming:***

Time and Complexity in the Physical Sciences, W. H. Freeman and Company, San Francisco, 1980; (c) D. Kondepudi and Ilya Prigogine, *Modern Thermodynamics: From Heat Engines to Dissipative Structures,* Wiley, Chichester, 1998; (d) G. Nicolis and I. Prigogine, *Self-Organization in Non-Equilibrium Systems: From Dissipative Structures to Order through Fluctuations,* Wiley, New York, 1977. For a good educated layperson's overview, see (e) Gregoire Nicolis, "Physics of far-from-equilibrium systems and self-organization," Chapter 11 in {f} Paul Davies, Ed., *The New Physics,* Cambridge University Press, Cambridge, 1989, p. 316-347.

161. Actually, Ludvig Valentin Lorenz first performed the equivalent of symmetrical regauging of Maxwell's equations, only two years after Maxwell's seminal paper was published in 1865. See (a) Ludvig Valentin Lorenz, "On the identity of the vibrations of light with electrical currents," Phil. *Mag.,* Vol. 34, 1867, p. 287-301. Not much attention was paid to Lorenz's work, however, and the later symmetrical regauging of the Maxwell-Heaviside equations by H. A. Lorentz is what "stuck" and came to be used. For a proper historical discussion, see (b) J. D. Jackson and L. B. Okun, "Historical roots of gauge invariance," *Rev. Mod. Phys.,* Vol. 73, July 2001, p. 663-680.

162. This point is important. See Gabriel Kron, "The Frustrating Search for a Geometrical Model of Electrodynamic Networks," circa 1962. General Electric publication, p. 11-128. Quoting p. 114: *"...the missing concept of "open-paths" (the dual of "closed-paths") was discovered, in which currents could be made to flow in branches that lie between any set of* ***two*** *nodes. (Previously -following Maxwell - engineers tied all of their open-paths to a single datum-point, the 'ground'). That discovery of open-paths established a second rectangular transformation matrix... which cre****ated*** *'lamellar' currents... " "A network with the simultaneous presence of both closed and open paths was the answer to the author's years-long search."*

When we design and build a circuit or system in compliance with the Lorenz/Lorentz-regauged equations, it follows that *the circuit itself must contain some feature and function that self-enforces the Lorenz/Lorentz condition — at least during the excitation discharge of the energy that has been freely caught by the circuit. The Lorenz/Lorentz condition is not a law of nature, nor is it automatically applied without a specific circuit cause and function physically applying it.* That function is automatically applied by the standard closed current loop circuit.

As Kron stated, his long search for a true negative resistance finally succeeded when he discovered the "open path". Actually Kron had discovered that any two points in the universe at different potentials (charged to different intensities) produced a flow of EM energy. In other words, he had discovered in more classical EM terms the broken symmetry of opposite charges of differing charges, such as on the ends of any dipole or across any dipolarity.

163. Superconducting *sections* in a system may be loss-free, but the entire superconducting *system* has losses and exhibits only COP<1.0 overall, if the refrigeration burden is accounted. In the superconducting section alone, without accounting for the cooling overhead, the COP = 1,0 and the efficiency is 100% also.

164. After Jackson, {22}, p. 219-221; 811-812.

165. See Whittaker, {85}. Whittaker mathematically decomposes the scalar potential into a hidden "bidirectional" series of EM wavepairs in a harmonic sequence. Each wavepair consists of the wave and its phase conjugate. Thus any A(q) (as across the terminals of a dipolar electrical power source) *a priori* involves an ordered, hidden, bidirectional EM wave flow. I.e., d(fi)) *identically is* such a hidden bidirectional EM energy flow.

166. But see Bearden, {12}. In the paper we conceptually re-interpreted Whittaker's 3-space (observation assumed, hence effect waves) bidirectional wavepairs. Our reinterpretation yields a correlated harmonic half-set of converging *unobserved* causal EM longitudinal waves (time-polarized EM waves) in the time domain prior to interaction with charge so as to prepare for being observed, and a harmonic half-set of diverging EM longitudinal waves (after observation due to the convergent time-polarized EM waves interacting with the observable charges) in 3-space in all directions. We strongly stress that observation does not occur without the absorption of a scalar photon and the follow-on emission of a longitudinal photon. In a time-reversed situation (phase conjugate charge condition), to the observer it appears to have happened in the other direction.

167. Particularly see Mandl and Shaw, {19}.

168. However, Mandl and Shaw fail to totally identify the "combining mechanism". They do not account the detailed interaction of the detecting/observing unit point charge, and thus fail to clearly account for the absorption of the incoming time-polarized wave or photon, the

transduction of that excitation energy of the charge into longitudinal EM wave/photon energy, and the subsequent emission of that excitation energy in 3-space in all directions as longitudinal EM waves/photons. So Mandl and Shaw do not clearly account for *photon (or wave) polarization transduction by the ubiquitously assumed charge.* The "causal" time-polarized EM wave or photon comes in and is absorbed by the detecting charge or dipole, then the absorbed energy is transduced and re-emitted in 3-space as the longitudinally polarized EM wave or photon in 3-space. (Actually, since all space is charged, what is really emitted into 3-space is the giant circulation of EM energy between time and 3-space, which is a more rigorous statement of what "propagation of EM energy through 3-space actually is). Recognition of these missing interactions and transductions allowed a solution at last to the long-vexing problem of the source charge, often called the greatest problem in both quantum and classical electrodynamics, as given initially in Bearden, {12}. Now, of course, a greater problem has reared its head: the notion that EM energy continuously propagates in 3-space is a total non sequitur, along the lines objected to by Romer {84}. We therefore have some very fundamental rethinking to do for all of classical physics. This is really where the problem of wave-particle duality has pointed since the beginning.

169. Asymmetrical self-regauging collects just a tiny bit more of the enormous energy that is flowing outside the conductors and usually wasted. E.g., if the self-regauging EM system collects as $j\phi$ some 10^{-12} of the energy flow instead of the more usual 10^{-13}, the system can have a COP =10, *if it* does not then expend half the collected energy to destroy the sourcc dipole faster and require its reconstitution more energetically. And so on.

170. Jackson, {22}, p. 220-223.

171. So-called "canceling" opposing EM fields are actually produced, which sum to a *vector zero system* with respect to translation, which the electrodynamicists erroneously discard by assumption. We point out, but do not further pursue, that the locally produced *field energies* of the opposing fields in a zero-summed vector system remain and add, even though the fields offset each other *translationally.* The local energy of the field is proportional to the square of the local magnitude, and that is always positive regardless of field orientation. Thus "trapped" and structured EM stress energy has been localized in spacetime in the symmetrical regauging of CEM. This rigorously is a gravitational change

and therefore a local curvature of spacetime *a priori.* Indeed, the field energy remains in a zero-vector summation system, and has been changed into stress potential energy. It represents continuous internal work being performed on the system to stress it, by energy continuously fed in from the active vacuum environment but only in appositive fields of equal magnitude. The discarding of the zero vector summation system thus is a discarding of an available stress potential and its energy, a rotation of the system frame out of the laboratory frame, and a continuous exchange of energy from the vacuum that performs internal work upon the system but no external work in the load. The energy is not translational, but it is there nonetheless, and it causes a spacetime curvature change. The electrodynamicists have largely ignored the fact that gauge symmetry transformations are accompanied by local gravitational (spacetime curvature) changes that violate the prevailing flat local spacetime assumption of classical electrodynamics.

172. See (a) H. J. Josephs, "The Heaviside papers found at Paignton in 1957," *IEE Monograph No. 319,* Jan. 1959, p. 70-76. See also (b) E. R. Laithwaite, "Oliver Heaviside — Establishment Shaker," *Elec. Rev.,* 211(16), Nov. 12, 1982, p. 44-45. Heaviside became aware of this gravitational relationship, and worked out a draft theory of electrogravitation based on his energy-flow theory (which added nondiverged closed-loop circulations of energy which vectorially summed to net zero). Those "trapped EM energy flow loops" were *gravitational,* in Heaviside's concept. His hand-written notes on his eleelrogravitation theory were found long after his death, beneath the floorboards of his little garret apartment. In honor of Heaviside, we have nominated his huge nondiverged energy flow component — erroneously discarded by Lorentz — as the source of the extra gravity in the arms of the spiral galaxies, holding them together. In short, we have proposed that as the solution to the so-called "dark matter" problem.

173. Physicists love symmetry, turn to it at every opportunity, and will do almost any mathematical manipulation to obtain it, because they regard it as "beautiful." And so it is. Performing work, however, requires breaking symmetry to produce excess energy, which interacts with mass to produce a force, and then requires using that force to do the work. If we wish to build a system that produces more work output than the work that we ourselves have to do upon it to run it, then *a priori* that system must be *asymmetrical* and — to many physicists — *ugly.* Let us all drink a toast to more efficient *ugly* asymmetrical systems that also do not require **energy.**

input by the operator, but only by the active environment! Give us "ugly" electrical windmills that turn freely in electrical winds, rather than the inane "beautiful" present systems which destroy their energy winds faster than hey power their loads.

174. While Lorentz appears to have done it earlier, one can see his use of the surface integration in (a) Lorentz, {109}. In 1896 he also included it, using a more general theorem by Volterra, so that Poynting's theorem arises as a special case; see (b) H. A. Lorentz, *Versl. K. Akad. W. Amsterdam*, Vol. 4, 1896, p. 176.

175. This is usually performed by the source dipole.

176. Thus the long and tedious effort of my colleagues and I to create circuits that asymmetrically self-regauge their potential difference (source voltage) without allowing all the spent load current to pass back through the primary power source dipole and do work upon it to scatter the charges and destroy its dipolarity.

177. Again we strongly stress that asymmetrically regauging a potential in the system also regauges the local vacuum potential and the intensity of the vacuum potential's bidirectional EM energy exchange with the system. It alters the local curvature of spacetime. It directly alters the stored ene**rgy** of the system and of the supersystem. See again Whittaker, {85}, to see this clearly. See particularly our use of the *supersystem* concept in Chapter 8, and as mentioned in Chapter 1 and the present Chapter 2.

178. Circuits and electrical power systems universally and routinely break Lorentz symmetry for *excitation* (potentialization) of the system at the initial onset. Just to potentialize a system in theory costs nothing, although it freely changes the potential energy of the system. The gauge freedom axiom of quantum field theory also guarantees that such change of the potential energy of the system is essentially "for free". It conclusively proves that (i) asymmetrical self-regauging exists and is done in electrical circuits, since the source dipole in the power supply accomplishes that initial self-regauging of the external circuit completely for free once the dipole is made, and (ii) the Maxwell-Heaviside equations do permit asymmetrical self-regauging, in violation of Lorentz's arbitrary conditionprohibitingit.

179. This is the patent-pending Bedini process, which is processing through the U.S. Patent Office as we go to press.

180. Lee, {73}, p. 184.

181. B. P. Kosyakov, "Radiation in electrodynamics and in Yang-Mills theory," *Soviet. Phys. Usp.*, 35(2), Feb. 1992, p. 135-142. Quotes are from p. 135 and p. 141. Our proposed solution to the problem posed by Kosyakov (which is actually the broken symmetry of a charge) is that negative charges pour out positive energy and positive charges absorb positive energy. We "see" the positive charge as pouring out "reversed direction positive field energy" after we interact the energy with a laboratory charge to "observe". Considering the well-known polarization of the vacuum by any charge, one realizes that a 4-symmetry circulation of the EM energy is what is "emitted" and spreads throughout all space, since the vacuum polarization is also spreading. The actual energy flow is between the time domain and 3-space and return, at any elemental dipole in the polarization of the vacuum that is spreading.

182. Oliver Heaviside, *Electrical Papers*, Vol. 2, 1887, p. 94.

183. Prof. William Keel, quoted in James McWilliams, "Through a Galaxy, Darkly," *Huntsville (Alabama) Times*, May 14, 2000, p. A-18.

184. Charles Seife, "Peering Backward to the Cosmos's Fiery Birth," *Science*, vol. 292, June 22, 2001, p. 2238.

185. M. P. Silverman, *And Yet It Moves: Strange Systems and Subtle Questions in Physics*, Cambridge University Press, Cambridge, 1993, p. 127.

186. Matthew Colless, Australian National University, one of the survey team leaders in the project leading the world in mapping galaxies, Mar. 2001.

187. (a) Lee, {13a}; (b) Lee, Oehme and Yang, {13b};

188. Wuetal., {14}.

189. Bearden, {12}.

190. Mandl and Shaw, {19, 168}.

191. Whittaker, {85}.

192. Gabriel Kron, "Invisible dual (n-1) networks induced by electric 1-networks," *IEEE Trans, on Circuit Theory*, CT-12(4), Dec. 1965, p. 464-470.

193. Kron, {162}. The quote is from p. 114.

194. Steven Weinberg, *Dreams ofa Final Theory,* Vintage Books, Random House, 1993, p. 109-110.

195, See Josephs, {172a}. Heaviside's hand-written notes contained his theory of electro-gravitation, based on his theory of energy flow. The papers were found beneath the floorboards in his little garret apartment.

196. Laithwaite, {172b}. Laithwaite feels that Heaviside's postulation that a flux of gravitational energy combines with the (ExH) electromagnetic energy flux, could shake the foundations of physics. Extracting from Laithwaite; *"Heaviside had originally written the energy flow as S = (ExH) + G, where G is a circuital flux. Poynting had only written S = (ExH). Taking p to be the density of matter and e the intensity of a gravitational force, Heaviside found that the circuital flux G can be expressed as pu -ce, where u represents the velocity of p and c is a constant. "*

197. Hence the title of cited reference {12} above.

198. Melvin H. Miles and Benjamin F. Bush, "Radiation measurements at China Lake: Real or Artifacts?", *Proc ICCF-7 (International Conference on Cold Fusion* — 7, Vancouver, BC, Canada, Apr. 1998, p. 101.

199. Bearden, {17}.

200. See P. V. Elyutin, "The Quantum Chaos Problem," *Sov. Phys. Usp.*. Vol. 31, No. 7, 1988, p. 597-622. Elyutin discusses the crisis in quantum mechanics because of the missing chaos (hidden order). Quantum mechanics is known to be wrong unless this order can be found, because otherwise it does not predict the ordered macroscopic universe. Thus any proposed solution to the quantum chaos problem is worthy of Investigation, even if it turns out to be in error.

201. Unfortunately, entropy is one of those concepts in physics for which there are several differing major views. We consider entropy to be comparable to a positive resistor: organized energy goes in, disorganized energy comes out. Entropy is usually taken to be a measure of the disordering of energy. It does not *eliminate* the energy; it just makes it more difficult to *use* it. For our work in energy from the vacuum, we take the very simple view that a negentropic process is like a negative resistor: it receives energy in a form unusable to us, transforms it, and outputs it in

a form that is usable. In short, a negative resistor receives disordered energy and reorders it, so to speak. So it exhibits negentropy. We completely avoid the various notions of "information" and attempts to equate information and energy. We do point out, however, that a time-reversal process in one form or another is usually involved. In that sense, e.g., Newton's third law would be a negentropic process and involve time reversal in the mechanism generating the reaction-causing agent.

202. H. E. Puthoff, "Source of Vacuum Electromagnetic Zero-Point Energy," *Phys. Rev. A*, 40(9), Nov. 1, 1989, p. 4857-4862.

203. Whittaker, {91}. The paper was published in 1904 and orally delivered in 1903. This paper initiated superpotential theory.

204. As Whittaker showed in 1903, {85}, the scalar potential is actually a harmonic set of bidirectional EM longitudinal EM wavepairs, where each pair is composed of a longitudinal EM wave and its phase conjugate replica. Only because classical electrodynamicists have erroneously defined the field and potential as their own reaction cross sections with a unit point static charge, has the "static" potential been misidentified as a *scalar* entity, which it is not. The energy diverged from a uniform potential, around a fixed static point unit charge, is actually the set of divergences around the intercepting charge of the energy flows of all those EM waves comprising the potential. The sum total of all these individual wave divergences indeed has a scalar magnitude, but the magnitude of the total energy divergence from the potential is neither the potential itself nor its magnitude.

205. We point out the obvious: A "scalar" mass in 3-space actually him a time-vector since it moves through time continually, just to continue to exist. Further, it involves a special form of energy (energy compressed by c^2) which time is taken to be. Since we may choose any form of energy we wish by simple transduction, we may take it as compressed EM energy. So the mere continued existence of any mass proves conclusively that EM energy can and does ubiquitously flow to, from, and through the time dimension. The combined continued existence of numerous masses **proves** conclusively that the flow of time can have a myriad internal electromagnetic energy flows. An equilibrium between (i) an inflow of EM energy to a transducer from the time dimension, and (ii) an **outflow of** EM energy in 3-space from the transducer, will be seen as a discrete excitation (potential energy) associated with the transducer. Hence **the** notion of the charge. Every charge in the universe may be said to pour out

energy (negative charge pours out positive energy; positive charge absorbs positive energy — the equivalent of pouring out negative energy — and any charge results in a polarization of the vacuum. Hence what we call "spacetime" or "vacuum" is in fact a giant circulation of energy from the time domain to 3-space, and back to the time-domain. In short, a giant ncgentropy process continually sustains the active universe and all its components and processes.

206. Evans et al., {79}.

207. Semiz, {148}.

208. Weinberg, {194}, p. 286.

209. The available internal energy of a generator is the transduced shaft energy we input to it, say by turning the generator shaft with a steam turbine or hydro turbine. The shaft mechanical energy input is transduced into internal magnetic field energy once the rotor rotates. This internal magnetic energy is then dissipated on the internal charges inside the generator, forcing the positive charges in one direction and the negative charges in the other, thereby making the source dipole between the terminals of the generator. The available internal energy of a battery is the chemical energy possessed by it at any given time, and available for performing work on the internal charges to force them apart to form a dipole between the plates (and the battery terminals).

210. Kraus, {76}. Figure 12-60, a and b, p. 578 shows a good drawing of the Poynting (intercepted) energy flow being withdrawn into the conductors from the surrounding space. It does not show the Heaviside nondiverged component remaining, which is even larger, not diverged into the conductors, and wasted. The reason for the remaining Heaviside non-diverged component is that the electrons precess laterally across the conductor, thus withdrawing into the conductor only a small nearby section of the fields of the surface electrons — the ones (plus their fields extending into space) which intercept the impinging energy flow. Because of the short distance radially across the conductor's cross section, a surface electron has very limited "field and field energy withdrawal" length.

211. (a) J. D. Jackson, "Surface charges on circuit wires and resistors play three roles," *Am. J. Phys.*, 64(7), July 1996, p. 855-870. See also (b) Mark A. Heald, "Energy flow in circuits with Faraday emf," *Am. J. Phys., Vol.* 56, 1988, p. 540-547; (c) — "Electric fields and charges in elementary circuits," *Am J Phys.*, 52(6), June 1984, p. 522-526. The

surface charges in the conductors of a circuit are of enormous importance to the powering of the circuit.

212. See T. E. Bearden, "Energy Flow, Collection, and Dissipation in Overunity EM Devices," *Proc. 4th Internat. Energy Conf.*, Academy for New Energy, Denver, CO, May 23-27, 1997, p. 5-51. In Figure 5, p. 16 the fraction of the Poynting energy flow that is intercepted and collected by the circuit is roughly shown to be on the order of 10^{-13} of the entire Poynting energy flow available. That number is based on a very crude estimating procedure, but even if off by several orders of magnitude, it shows that the Heaviside nondiverged energy flow component is orders of magnitude greater than the diverged Poynting component, for single-pass of the energy and collection only once.

213. Rigorously, there is no *power* in an EM energy flow, regardless of how great in magnitude, if it is not altered in form or diverged. That is because "power" is rigorously the time rate of doing work (time rate of *changing the form* of energy), not the time rate of energy flow per se. Exactly, the Heaviside dark energy flow component was some 10 trillion joules per second in magnitude, but it had zero watts of power. Unfortunately, electrical engineers just loosely refer to nondiverged **energy** flow as "power", regardless of the non sequitur. Hence inane terms **widely** used in electrical engineering (and texts) such as "draw power from **the** source", etc. Rigorously, *the power* (rate at which energy is changed in form) is developed locally in each component having losses or performing work — i.e., changing the form of the energy.

214. (a) T. E. Bearden, "On the Principles of Permissible Over **Unity** EM Power Systems," *J. New Energy,* 4(2), Fall 1999, p. 16-39; (b) Bearden, {17}; (c) — "Use of Asymmetrical Regauging and Multivalued Potentials to Achieve Overunity Electromagnetic Engines," *J. New Energy,* 1(2), Summer 1996, p. 60-78; (d) — "Regauging and **Multivalued** Magnetic Scalar Potential: Master Overunity Mechanisms," *Explore,* 7(I), 1996, p. 51-58; (e) — "The Master Principle of EM Overunity and the Japanese Overunity Engines," *Infinite Energy,* 1(5&6), Nov. **1995-Feb,** 1996, p. 38-55; (f) — "Use of Regauging and multivalued Potentials to Achieve Overunity EM Engines: Concepts and Specific Engine Examples," *Proc. Internat. Sci. Conf, "New Ideas in Natural Sciences,* " *St. Petersburg, Russia, June 17-22, 1996, Part I: Problems of Modern Physics,* 1996, p. 277-297.

215. In an oblique kind of sense, this is even "recognized" to some extent by leading electrodynamicists. E.g., quoting Jackson, {22}, p. 237: "*...the Poynting vector is arbitrary to the extent that the curl of any vector field can be added to it. Such an added term can, however, have no physical consequences.*" So Jackson follows Lorentz's lead that any additional non-intercepted and uncollected energy flow permissibly accompanying the Poynting intercepted and collected component, has no physical significance. Both Lorentz and Jackson err as to the *finality* of the statement. The accompanying Heaviside component can have no physical significance *unless it is intercepted and collected by means other than the single circuit or mechanism considered, and the single pass of the entire energy flow onto and past the receiving entity (circuit, charge, etc.).*

216. E.g., see Poynting, {4a. 4b}.

217. Heaviside, {5a}.

218. Heaviside, {5b}.

219. Heaviside, {5c}. Heaviside discusses the Faraday-Maxwell ether medium, outlines his vector algebra for analysis of vectors without quaternions, discusses magnetism, gives the EM equations in a moving medium, and gives the EM flux of energy in a stationary medium. On p. 443, he credits Poynting with being first to discover the formula for energy flow, with Heaviside himself independently discovering and interpreting this flow a little later by himself in an extended form.

220. J. H. Poynting, "On the connexion between electric current and the electric and magnetic inductions in the surrounding field," *Proc. Roy. Soc.* Lond. Vol. 38, 1984-85, p. 168.

221. Oliver Heaviside, *Electrical Papers*, Vol. 2, 1887, p. 94.

222. (a) T. E. Bearden, "On Extracting Electromagnetic Energy from the Vacuum," *Proc. IC-2000*, ibid., 2000; (b) Bearden, {38a}.

223. Lorentz is believed to have done this earlier (perhaps circa 1890s). In 1902 he published the method in a book, which strongly implies it was first done in an earlier paper. See Lorentz, {109}. Figure 25 on p. 185 shows the Lorentz concept of integrating the Poynting vector around a closed cylindrical surface surrounding a volumetric element. Many thanks to Marcus Reid for furnishing a copy of the actual Lorentz reference from a library in Leipzig, Germany.

224. E.g., see (a) Panofsky and Phillips, {110}; (b) W. Gough and J. P. G. Richards, *European J. Phys.*, Vol. 7, 1986, p. 195.

225. Panofsky and Phillips, {110}, p. 180.

226. D. S. Jones, *The Theory ofElectromagnetism,* Pergamon Press, Oxford, 1964, p. 52.

227. Jackson, {22}, p. 237.

228. W. M. Schwarz, *Intermediate Electromagnetic Theory,* John Wiley & Sons, New York, 1964, p. 280-281.

229. Jones, {226}, p. 53.

230. For typical references, see (a) J. Slepian, *Am. J. Phys.,* 19, 87 (1951); (b) Mario lona, *ibid.,* 31, 398 (1963); (c) Udo Backhaus and Klaus Schafer, *ibid.,* 54, 279 (1986); (d) C. J. Carpenter, *IEE Proc. A* (UK), 136A(2), Mar. 1989, p. 55-65; (e) J. A. Ferreira, *IEEE Trans. Edit.,* 31 (4). 1988, p. 257-264; (f) Mark A. Heald,Am. *J. Phys.,* 56(6), 1988, p. 540-547. The debate has also appeared in many other leading journals, e.g., (G) T. H. Boyer, *Phys. Rev. D,* 25, 3246 (1982). Interestingly, (h) M. Abraham and R. Becker, *The Classical Theory ofElectricity and Magnetism,* Blackie. London, 1932, p. 146 and p. 194 give two examples of the controversy over the Poynting vector. Finally, see (i) D. F. Nelson *Phys. Rev. Lett.,* 76(25), June 17, 1996, p. 4713-4716 for advanced **work** requiring a greater generalization of the Poynting vector.

231. Sweet and Bearden, {29a}. Sweet's device produced 500 watts lit a 33 microwatt input, which is approximately a COP = $1.5x10^6$. By steadily increasing the COP to $3x10^6$, the weight of the Sweet unit was reduced smoothly, reaching 90% reduction. The results of this highly successful anti-gravity experiment are reported in the paper. Unfortunately, Sweet later died and never fully revealed the activation secret by which barium ferrite magnetic materials could be triggered **into** strong self-oscillation at 60 Hertz or other ELF frequency.

232. Weaker self-oscillation of such permanent magnetic materials at higher frequency is known. E.g., see (a) V. S. L'vov, *Non-Linear Spin Waves,* Moscow, 1987; (b) L'vov, {29c}. See also (c) A. G. **Gurevich,** and G. A. Melkov, *Magnetization Oscillations and Waves,* CRC **Press,** Boca Raton, Florida, 1996. The latter authors give hundreds of **additional** references.

233. E.g., (a) M. W. Evans, P. K. Anastasovski, T. E. Bearden *et al*, "Derivation of the B(3) Field and Concomitant Vacuum Energy Density from the Sachs Theory of Electrodynamics," *Found. Phys. Lett.*, 14(6), Dec. 2001, p. 589-593; (b) — "Anti-Gravity Effects in the Sachs Theory ol Electrodynamics," *Found. Phys. Lett.*, 14(6), Dec. 2001, p. 601-605; (c) Evans et al., {38b}; (d) Evans et al., {38c}; (e) -- "Operator Derivation of the Gauge Invariant Proca and Eehnert Equation: Elimination of the Lorentz Condition," *Found. Phys.*, 39(7), 2000, p. 1123-1130; (f) - "O(3) Electrodynamics from the Irreducible Representations of the EInstein Group," 2001, *Found. Phys. Lett.*, 15(2), Apr. 2002, p. 179-187.; (g) - "Effect of Vacuum Energy on the Atomic Spectra," *Found. Phys.* Lett., 13(3), June 2000, p. 289-296; (h) Evans et al., {113b}; (i) Evans et aI., {113a}; (j) - "On the Representation of the Maxwell-Heaviside Equations in Terms of the Barut Field Four-Vector," *Optik* 111(6), 2000, p. 246-248; —"Derivation of the B(3) Field and Concomitant Vacuum Energy Density from the Sachs Theory of Electrodynamics," *Found. Phys. Lett.*, (in press); (k) — "The New Maxwell Electrodynamic Equations: New Tools for New Technologies. A Collection of 60 papers from the Alpha Foundation's Institute for Advanced Study. Published as a Special Issue of the *J. New Energy*, 4(3), Winter 1999. See also (1) Bearden, (222b}; (m) Bearden, {38a}; (n) Bearden, {43d}; (o) Bearden, {43a}; (p) Bearden, {30}; (q) Bearden, {40}; (r) Bearden {214}; (s) Bearden, {1214e}; (t) - "The Final Secret of Free Energy," *Magnets*, 7(5), May 1993, p. 4-26; (u) Bearden, {214f}.

234. Bearden, {40).

235. Terence W. Barrett and Dale M. Grimes, (a) Preface, p. vii-viii, in (b) *Advanced Electromagnetism: Foundations, Theory, and Applications*, Terence W. Barrett and Dale M. Grimes (eds.), World Scientific, Singapore, 1995.

236. I. Prigogine, "Irreversibility as a symmetry-breaking process." N*ature*, Vol. 246, Nov. 9, 1973, p. 67-71.

237. Paul Davies, *Superforce: The Search for a Grand Unified Theory of Nature*, Simon and Schuster, New York, 1984, p. 105.

238. Clarke, {55}, p. 38.

239. T. D. Lee, *Symmetries, Asymmetries, and the World of Particles*, U. Wash. Press, Seattle, 1988, p. 11.

240. That is, it does not exist *openly* in the open literature. Several inventors do have working laboratory COP>1.0 experiments, and at least three of them have models which could rapidly be developed into production systems — say, in one year or less. However, the exact and detailed construction details are understandably maintained as deeply proprietary by the inventors, until their intellectual property rights can be secured, including foreign patent rights. On the other hand, many other inventors mistakenly believe they have COP>1.0 systems, but do not because of instrumental error, considering nonsinusoidal waves as measurable with RMS meters, or effects covered in Chapter 6 which they do not comprehend. In addition, there have been those more interested in selling stock than in producing a working system.

241. But see Kawai, {31}. The only available *open* details approaching the "kit of parts and instructions" point is the Kawai process, and it will work just as in the patent if carefully built. If very efficient photon-coupled switching of the flux path is used for build-ups, and if very high efficiency (0.7 to 0.8) magnetic motors are modified with the Kawai process, one can expect the COP of the modified motors to be double the conventional efficiency of the original base motor. So one can obtain COP = 1.4 to 1.6, e.g., by using the necessary and available Hitachi high efficiency motors (one at 0.7 and the other at 0.8) to start with. Hitachi engineers physically tested two high efficiency Hitachi motors modified hy Kawai, at COP = 1.4 and COP = 1.6 respectively. Unfortunately, the Kawai process, engines, and company have been seized by what can **only** be described as the Yakuza (Japanese Mafia) and are being held off **the** market. The seizure was accomplished here in Huntsville, Alabama, witnessed by the CTEC board of directors and I, when Kawai and **CTEC** were in final negotiations to rapidly develop and market the Kawai **system** Several other COP>1.0 Japanese engines have also been seized and withheld by the Yakuza.

242. Jed Z. Buchwald, *From Maxwell to Microphysics,* University of Chicago Press, Chicago and London, 1985, p. 44.

243. Whittaker, {85}.

244. Bearden, {12}.

245. Mandl and Shaw, {19}.

246. Whittaker, {91a}.

247. To see how arduous a search Kron himself made prior to athieving a proper model for an electrical circuit, see Kron, {162}. The quote is from p. 114.

248. For example, Kron, {192}.

249. P. A. M. Dirac, "A theory of electrons and protons," *Proc. Roy. Soc. Lond. A*, 126(801), Jan. 1, 1930, p. 360-365. Here Dirac introduced the vacuum energy — the electron sea filled with electrons occupying negative energy states. The holes are treated today as the positive electrons. This concept is now referred to as the "Dirac Sea," and the concept has been expanded to include negative energy "holes" for other kinds of particles. Dirac first attempted to identify these holes with protons, until later the positron was discovered.

250. Evans, {137b}.

251. (a) Evans, {137a}; (b) — "The Link Between the Topological Theory of Ranada and Trueba, the Sachs Theory, and 0(3) Electrodynamics," *ibid.*, vol. 2, p. 495-499.

252. (a) Sachs, {126a). The Sachs theory provides a great generalization of general relativity and electrodynamics reaching from the quarks and gluons to the entire universe. See also (b) Sachs, {126b}.

253. Indeed, the symmetrizing of Maxwell's equations was first accomplished by Lorenz. See (a) Lorenz, {161a}. In this paper Lorenz gave essentially what today is called the Lorentz symmetrical regauging. AS pointed out by Barrett, the Lorenz paper gave f(t-r/c) functions. Fitzgerald said that Lorenz's functions were essentially the same as his, and Fitzgerald became a leading proponent of "retarded potentials". But it is believed that Fitzgerald was unaware of Lorenz's work until the 1880's, so he is given credit for parallel development. Some people speak of Fitzgerald-Lorenz functions. This is a regauging, but the term "gauge" (inspired by railroad gauges) was first introducec by Hermann Weyl in the 1900s. He used it for a change in length and was quickly countered by Einstein - Weyl's theory was not relativistic. The idea resurfaced in the 1920s when quantum theory was being formulated, but this time it meant "change in phase" and not "change in length". At any rate, when the renowned H. A. Lorentz performed the symmetrizing of the Maxwell-Heaviside equations in the 1880s. it was adopted immediately and has been rather universally applied since then. See also (b) Jackson and Okun {161b} for a history of gauge invariance.

254. (a) Prigogine, {160a}; (b) G. Nicolis and I. Prigogine, {160d}; (c) T. Petrosky and I. Prigogine, "Quantum Chaos, Complex Spectral Representation and Time-Symmetry Breaking," *Chaos, Solitons, and Fractals,* Vol. 4, 1994, p. 311-359; (d) D. Kondepudi and I. Prigogine, "Thermodynamics, Nonequilibrium," *Encyclopedia ofApplied Physics,* Vol. 21, 1997, p. 311-337; (e) D. Kondepudi and I. Prigogine, *Modern Thermodynamics: From Heat Engines to Dissipative Structures,* Wiley, Chichester, 1998; (f) T. Petrosky and I. Prigogine, "Laws of Nature, Probability and Time Symmetry Breaking," *Physica A,* Vol. 263, 1999, p. 528-539.

255. (a) G. Nicolis, and I. Prigogine, *Exploring Complexity,* Piper, Munich. 1987; (b) — *Exploring Complexity: An Introduction,* Freeman, New York, 1989; (c) G. Nicolis, {160e}.

256. Letokhov, {157a-157d}.

257. Bohren, {24}.

258. Paul and Fischer, {25}.

259. E.g., see (a) Patrick et al., {37}. For rigorous explanations of **how** the energy is extracted from the vacuum, see (b) Evans et al., {38b}; (c) Evans et al., {38c}. The vacuum can and will furnish an electromagnetic "wind" from which useful EM energy can be extracted. Indeed, every source charge and dipole already extracts and continuously pours out EM energy from the vacuum, thereby establishing its fields and potentials **(and** their energy) across the universe.

260. A relationship between gamma bursters and a big bang is suggested from some recent observations. On Jan. 23, 1999 the Hubble Space Telescope caught an optical flash simultaneous with an initial gamma burst. When calculated, this burst was second in energy only to the big bang itself, and generated about 3.4×10^{54} ergs, which is the equivalent of converting two solar masses instantaneously into energy. There was also no polarization of the afterglow, which has been taken as evidence of beaming. However, such beaming could also be due to the beaming involved in the intense iterative phase conjugate reflections of the asymmetrical self-regauging process in intensely scattering, optically active, energy-amplifying media.

261. Heaviside, {5a-5c}.

262. Josephs, {172a}; Laithwaite, {172b}.

263. (a) Diederik Wiersma and Ad Lagendijk, "Laser Action in Very White Paint," *Physics World,* Jan. 1997, p. 33-37; (b) K. Totsuka, G. van Soest, T. Ito, A. Lagendijk, and M. Tomita, "Amplification and diffusion of spontaneous emission in strongly scattering medium,"*J. Appl. Phys.,* Vol. 87, 2000, p. 7623-7628.

264. (a) A. Lagendijk, J. Gomez Rivas, A. Imhof, and R. Sprik, "Propagation of light in disordered semiconductor materials," in *Photonic Crystals and Light Localization in the 21st Century,* edited by C. M. Soukoulis, Kluwer, Dordrecht, 2001, p. 447-473; (b) H. Cao *et at,* "Spatial Confinement of Laser Light in Active Random Media," *Phys. Rev. Lett., 8*4(24), 12 Jun. 2000, p. 5584-5587.

265. We also point out the possibility of the accumulator at each end being an intensely scattering, photoreactive, energy-amplifying material, a subject discussed a bit later in this chapter.

266. (a) Werner Triftshauser *et al, Phys. Rev. Lett.,* Vol. 87, 2001. An overview is given by (b) Philip Ball, "The Positron Probe," *Nature,* Vol. 412. Aug. 23, 2001, p. 764.

267. For example, see Letokhov, {157a-157d}.

268. Jackson, {22}, p. 363, third footnote.

269. Kraus, {10}, p. 4.

270. Marconi's patent is Gugliehno Marconi, "Transmitting Electrical Signals," U.S. Patent 586,193, July 2, 1897. Filed Dec. 7, 1896, with 56 claims. This patent was overturned in 1943 by the U.S. Supreme Court, and prior work by Nikola Tesla for transmission of EM signals was upheld. Most textbooks and journals, etc. to this day continue to falsely credit Marconi with discovery of the transmission of EM signals and thus the discovery of radio. This is not to discredit the important work that Marconi did; without him, signal transmission would have been much longer in coming.

271. United States Reports: Cases Adjudged in the Supreme Court of the United States, Vol. 320, Marconi Wireless Telegraph Co. of America vs. United States, June 21, 1943, p. 1-80. The U.S. Supreme Court ruled that Tesla's fundamental radio patents had anticipated all other contenders, including Marconi.

272. *Dictionary ofScientific and Technical Terms,* Daniel N. Lapedes (editor in chief), McGraw-Hill, New York, 1974, p. 300. On page 517 of the second and expanded edition (1978), the same definition of electric field appears and is unchanged.

273. H. J. Gray and Alan Isaacs, *A New Dictionary ofPhysics,* Longman, London, second edition, second impression, 1976.

274. Feynman, {7}, p. 2-4.

275. Feynman, {7}, p. 12-2.

276. P. K. L. Drude, *Ann. Physik,* Vol. 1, p. 566; Vol. 3, 1900, p. 370, 869. Here Drude first develops a theory of conductivity in a metal based on the assumption that there is a gas of free electrons in the metal. This gas of conduction electrons is often referred to as the "Drude gas." Note that this was shortly after J. J. Thomson's discovery of the electron in 1897.

277. E.g., see Jackson, {211a}.

278. Romer, {84}, endnote 24, p. 109.

279. H. Winfield Secor, "Tesla Maps Our Electrical Future."

280. Nikola Tesla, "Pioneer Radio Engineer Gives Views on Power," *New York Herald Tribune,* Sep. 11, 1932.

281. Nikola Tesla, "The True Wireless, *Electrical Experimenter,* May 1919.

282. Burford and Verner, {35a}. Quote is from p. 281.

283. That is, it does not exist *openly* in the open literature. Several inventors do have working laboratory COP>1.0 experiments, and at **least** three of them have models which could rapidly be developed into production systems — say, in one year or less.

284. But see Kawai, {31}.

285. Barrett, {124}.

286. (a) Terence W. Barrett, "Active Signalling [sic] Systems," U.S. Patent No. 5,486,833, Jan. 23, 1996; (b) — "Oscillator-Shuttle-Circuit (OSC) Networks for Conditioning Energy in Higher-Order Symmetry Algebraic Topological Forms and RF Phase Conjugation," U.S. Patent No. 5,493,691, Feb. 20, 1996.

287. No proper scientific treatise on the Moray device has ever been published, to our knowledge, nor has a proper theory of its operation been developed. Anecdotal material and some technical material is contained in (a) T. H. Moray, *The Sea of Energy,* 5th Edn., Salt Lake City, 1978 (foreword by T. E. Bearden). The fourth edition of the book, titled (b) *The Sea of Energy in Which the Earth Floats,* contains additional material but is long out of print. Additional information is given in (c) Keith Tutt, *The Search for Free Energy,* Simon & Schuster, 2001, p. 33-68. (d) Paul Brown's study of the Moray work is "The Moray Energy Device: Operational Parameters, Design Criteria, and Considerations," date unknown. Researcher and inventor Bruce Perreault has based much of his own work with his radiant energy valve on Moray's work. Perreault proposes a different interpretation. In the present book we have tried to point out the various aspects of the Moray device that resemble other presently known effects — most of which were still unknown in the 1920s and 1930s when Moray's fundamental work was accomplished.

288. Moray, {34b} "Electrotherapeutic Apparatus," U.S. Patent No. 2,460,707, Feb. 1, 1949. This patent clearly shows the complexity of the various special tubes containing his pellets that Moray developed.

289. H. *C.* Dake and Jack DeMent, *Fluorescent Light and Its Applications,* Chemical Publishing Company, Inc., Brooklyn, New York, 1941, p. 51-52 gives a succinct discussion of Stokes emission and anti-Stokes emission.

290. Sir G. G. Stokes, "On the Change of Refrangibility of Light," a memoir, 1852.

291 For example, in 1935 Prileshajewa showed that there is an energy difference involving as much as 1.1 V between the exciting light and the fluorescence of aniline vapor.

292. V. S. Letokhov, {157a-157d}.

293. Letokhov, *ibid.*

294. E.g., (a) R. N. Bhargava and D. Gallagher, "Optical Properties of Manganese-Doped Nanocrystals of ZnS," *The Am- Phys. Soc,* 72(3), Jan. 17, 1994; (b) I. A. Izmailov et al., "Generation of Stimulated Noncoherent Radiation in Light-Scattering Media Exhibiting Chemical Reactions," *Soy. J. Quantum Electronics,* 12(5), May. 1982, p. 588-594; (c) R. Pappalardo and A. Lempicki, "Brillouin and Rayleigh Scattering in Aprotic Laser

Solutions Containing neodymium," *J. Appl. Phys.,* Apr. 1992, p. 1699-1708.

295. (a) Nabil M. Lawandy *et al.,* " Laser action in strongly scattering media," *Nature,* Vol. 368, Mar. 31, 1994, p. 436-438. For a good lay article with color pictures, see (b) Ivars Peterson, "Boosted light: Laser action in white paint," *Science News,* 145(15), Apr. 9, 1994, p. 228-229. See also (c) P. Mandel, "Lasing without inversion: A useful concept?," *Contemp. Phys.,* Vol. 34, 1993, p. 335; (d) O Kocharovskaya, "Amplification and lasing without inversion," *Physics Reports,* Vol. 219, 1992, p. 175.

296. Some useful papers are: (a) Diederik S. Wiersma and Ad Lagendijk, "Light diffusion with gain and random lasers," *Phys. Rev. E,* 54(4), Oct. 1996, p. 4256-4265. The authors discuss experimental considerations for a medium that both multiply scatters and amplifies light, and distinguish three regimes; (b) H. Cao *et al.,* "Random Laser Action in Semiconductor Powder," *Phys. Rev. Lett.,* 82(11), 15 Mar. 1999, p. 2278 2281. The authors observed random laser emission in all directions, with coherent feedback, in semiconductor powder, (c) Diederik S. Wiersma, Meint P. van Albada and Ad Lagendijk, "Coherent Backscattering of Light from Amplifying Random Media," *Phys. Rev. Lett.,* 75(9), 28 Aug., **1995,** p. 1739-1742. (d) D. S. Wiersma, P. Bartolini, A. Lagendijk, and R. Righini, *Nature,* Vol. 390, 1997, p. 671. The authors report Anderson localization of photons in GaAs powder, (e) Ad Lagendijk *et al,* "Microscopic Approach to the Lorentz Cavity in Dielectrics," *Phys. Rev Lett.,* 79(4), 28 July 1997, p. 657-660. (f) Pedro de Vries and Ad Lagendijk, "Resonant Scattering and Spontaneous Emission in **Dielectrics** Microscopic Derivation of Local-Field Effects," *Phys. Rev. Lett.,* 81(7), 17 Aug. 1998, p. 1381-1384. (g) Gijs van Soest, Makoto Tomita, and Ad Lagendijk, "Amplifying volume in scattering media," *Opt. Lett.,* 24(5), Mar. 1, 1999, p. 306-308.

297. S. Itoh *et al.,* "Simulational and experimental studies on anomalous reflectivity of phase conjugate wave," *Ferroelectrics,* vol. 170, 1995, p. 209-217.

298. See (a) D. P. Hand and P. St. J. Russell, "Solitary thermal shock waves and optical damage in optical fibers," *IEE Colloquium on 'Non Linear Optical Waveguides', LEE Digest* No. 88, London, England, 1988, p. 101-103; (b) — "Soliton-like thermal shock-waves in optical fibres: origin of periodic damage tracks," *Fourteenth European Conference on*

Optical Communication (ECOC 1988), Sep. 11-15, 1988, Publication No. 292, 1(2), 1988, p. 111-114; (c) — "Solitary thermal shock waves and oplical damage in optical fibers: the fiber fuse," *Opt. Lett.*, 13(9), Sep. **1988,** p. 767-769; (d) D. P. Hand and T. A. Birks, "Single-mode tapers as 'fibre fuse' damage circuit-breakers," *Electronics Lett.*, 25(1), Jan. 5, 1989, p. 33-34. For an excellent lay description with photographs, see (e) Ivars Peterson, "Fibers with Flare," *Sci. News*, 140(13), Sep. 8, 1991, p. 200-201

299. P. St. J. Russell, "Power Conservation and Field Structures in Uniform Dielectric Gratings," *J. Opt. Soc. America A.*, 1(3), Mar. 3, 1984, p. 293-299. Russell is referring to apparent violation of local conservation of energy. It is true in the conventional flawed energy flow analysis considering only the Poynting component, because the fuse produces more work output (melting the holes) than the original operator's input of Poynting energy to initiate the fuse effect. It does not produce more work output than the total of the energy input by the operator in both the acounted Poynting component and the unaccounted Heaviside component. It merely shows that the extra fiber fuse ignition actions do absorb extra energy from the Heaviside component, perhaps by particle resonance (Bohren effect) of the melt and vapor particles. Also, intense heating produces intense ionization and thus intense dipoles, thus producing broken symmetry in the fierce exchange with the active vacuum. Multiple retroreflections of the EM energy flow also occur in the nmelt and vapor particles, leading to multiple collections in the ping-pong of a joule of energy between two particles as phase conjugate mirrors.

300. E.g., see (a) H. Kogelnik, "Coupled wave theory for thick hologram gratings," *Bell Systems Technical Journal*, Vol. 48, 1969, p. 2909-2947; (b) Z. Zylbergerg and E. Marom, "Rigorous coupled-wave analysis of pure reflection gratings," *J. Opt. Soc. Am.*, Vol. 71, 1981, p. 811-818; (c) — - "Rigorous coupled-wave analysis of grating diffraction — E- mode polarization and losses," *ibid.*, Vol. 73, 1983, p. 451-455; (d) - "Comments on analyses of reflection gratings," *ibid.*, Vol. 73, 1983, p. 399-401.

301. Bohren, {24J.

302. Justin Mullins, "Superpowerful Explosive Arrives with a Bang." New *Scientist*, Aug. 4, 2001.

303. Romano M. DeSantis *et al.*, "On the Analysis of Feedback Systems With a Multipower Open Loop Chain," Oct. 1973, AD 773188, available through the Defense Technical Information Center or the National Technical Information Center. The paper clearly shows that such systems can produce overunity coefficient of performance.

304. See (a) J. H. Andreatta, "High Power Switching Amplifier Wherein Energy is Transferred to a Tuned Circuit During Both Half Cycles," U.S. Patent No. 3,239,771, Mar. 8, 1966; (b) Tom L. Dennis Jr., "Highly Efficient Semiconductor Switching Amplifier," U.S. Patent No. 3,239,772, Mar. 8, 1966; (c) Heber J. Morrison, "Square Wave Driven Power Amplifier," U.S. Patent No. 3,815,030, June 4, 1974.

305. For a good but conventional coverage of many differential negative resistors and negative conductors, see Adolf Fritz Schwarz, "Negative Resistors and Negative Conductors," Doctoral Thesis, Technische Hogeschool, Delft (Netherlands), Feb. 1969, available from the U.S. National Technical Information Service (NTIS), Springfield, VA. True negative resistors are dismissed as impossible in Schwarz's opening remarks. And they *are* impossible in equilibrium systems not receiving and using any net excess energy asymmetrically from their environment, which are the only systems conventionally considered by electrical engineers and electrodynamicists.

306. Gabriel Kron, "Numerical solution of ordinary and partial differential equations by means of equivalent circuits." *J. Appl. Phys.*, Vol. 16, Mar. 1945a, p. 173.

307. Kron, {32}, p. 39.

308. Bearden, {12}.

309. E.g., see Gabriel Kron, "Equivalent Circuits for Oscillating Systems and the Riemann-Christoffel Curvature Tensor," *General Electric Review*, Jan. 1943, p. 25-31.

310. See (a) S. Austen Stigant, "Gabriel Kron on Tensor Analysis, A bibliographical record," *BEAMA Journal*, Aug. 1948, for a full bibliography of Kron's publications up to 1948. Also useful are (b) Gabriel Kron, "A Method to Solve Very Large Physical Systems in Easy Methods," *IRE Transactions on Circuit Theory*, 2(1), Dec. 1953, p. 71-90; (c) P. L. Alger, editor, *The Life and Times of Gabriel Kron, or Walking Around the World, and Tensors*, Mohawk Development Services, Inc.,

Schenectady, NY, 1969; (d) Banesh Hoffman, " Cron's Non-Riemannian Electrodynamics," *Rev. Mod. Phys.*, 21(3), 1949, *x* 535-540; (e) K. Kondo and Y. Ishizuka, "Recapitulation of the Geometrical Aspects of Gabriel Kron's Non-Riemannian Electrodynamics," Research Association of Applied Geometry, *Memoirs of the Unifying Study of Basic Problems in Engineering and Physical Sciences by Means of Geometry*, Gakujutsu Bunken Fukyu-kai, Tokyo, Vol. I, 1955, p. 185-239 [particularly see footnote 1, p. 222];

311. Wang and Chung, {33}.

312. Deborah D. L. Chung, "Superconductor-metal laminates and method of making," U.S. patent no. 5,059,582, issued Oct. 22, 1991. A superconducting laminate having at least one layer of metal and at least one layer of superconducting material. The metal layer and the superconducting layer are bonded. The layer may also include carbon fibers from various precursors. The superconductor may be a composite material. The invention also includes a method of making the laminates. Assigned to The Research Foundation of State University of NY, Albany, NY.

313. Jean-Louis Naudin, website http://jnaudin.free.fr/cnr/.

314. Fogal, {36a, 36b}.

315. As one example, Fogal's device has to be able to manipulate Dirac holes in the vacuum itself, at least to some extent. Once the erroneous flat spacetime assumption of classical electrodynamics is removed and curved local spacetime considered, we can and will have Dirac holes in the local vacuum itself, especially in COP»1.0 systems. In a COP»1.0 system, not all the Dirac holes have interacted with orbital electrons in atoms to "eat" an electron and produce a positive ion — with a "lattice hole" or "lattice positron" where the electron had been. There is a vast difference between a Dirac hole positron (which has a negative mass equal in magnitude to one electron-mass) and a lattice hole (which is attached to the relatively huge positive mass of the ionized atom. Hence the mobility and phenomenology of Dirac positrons and lattice positrons are very different. There presently are no books on the dynamics of the Dirac negative energy electron holes in COP»1.0 EM circuits and systems.

316. Mandl and Shaw, {19}.

317. Whittaker, {91a}. The paper was published in 1904 and orally delivered in 1903. Note: On p. 368 midpage, Whittaker's equation for the y-component of vector-potential "a" is missing the exponent "2" on the **del** operator.

318. Rodrigues and Lu, {93a}.

319. Rodrigues and Vaz, {93b}.

320. It is certainly not lacking in the secret military weapons game. Some 10 nations of the world have weaponized longitudinal EM wave weapons over the past few decades, and almost every major weapons laboratory in the world has now "discovered" longitudinal EM waves. Even the Yakuza (Japanese Mafia) has acquired its own portable longitudinal EM interferometry weapons.

321. Evans et al., {79}.

322. (a) V. I. Arkhipov, *et al.,* "Negative transient currents in amorphous semiconductors." *Internat. J. Electronics* (UK), 51(6), 1981, p, 735-742; (b) — and A. I. Rudenko, "Negative currents caused by injection-controlled polarization," *Solid. St. Commun.,* 28, 1978, p. 675-676.

323. Jackson, {22}, p. 222.

324. Jackson, {22}, p. 223.

325. O. L. Brill and B. Goodman, *Am. J. Phys.,* vol. 35, 1967, p. 832.

326. For example, see Jackson, {22}, p. 219-221.

327. We stress that electrodynamicists, conventional theory, and quantum field theory all assume the principle *of gauge freedom,* the **total** freedom to change the gauge (and therefore any potential) in a Maxwellian system at any time, without cost or work. In the real world one may have to pay a little switching costs, but by simply regauging one can freely change the EM energy physically present at a point in 3-space **occupied by** the Fogal "freed" instantaneous scalar potential, once the electrons are pinned. In short, the Fogal process is able to directly "gate" the instantaneous transduction of EM energy existing at multiple points **in** space, simultaneously. There is nothing in the gauge freedom **principle** that restricts (i) regauging the instantaneous scalar potential at will, **or** (ii) using these changes at a distance to produce force fields upon electrons, thereby moving them — so long as one employs a Fogal semiconductor in

the "distant receiver" in order to be able to produce the back-transition from the field-free state to the force-field state by removing the anomalous pinning restriction. To the advanced theorists, we leave the debates over causality considerations for this demonstrated process!

328. Whittaker, {85}.

329. (a) W. Heitman and G. Nimtz, "On Causality Proofs of Superluminal Barrier Transversal of Frequency Band Limited Wave Packets," *Phys. Lett. A196,* 1994, p. 154-158; (b) Enders and Nimtz, {136b}.

330. The reader should recall that the Lorenz/Lorentz condition, which limits the circuit to COP< 1.0, is self-applied by the circuit when it rams all "spent" electrons in the ground return line back through the emf of the circuit. One need not do that, and need not produce that force field that destroys the primary source dipole and its extraction of EM energy from the vacuum via its broken symmetry. As the reader has undoubtedly now observed, the "back-emf' and "back mmf are those aspects in an electrical circuit and magnetic circuit respectively, that kill the dipole and physically self-apply and self-enforce Lorenz/Lorentz symmetrical regauging. Hence the intuitive concern of COP>1.0 experimenters to try to discover how to avoid or lessen the "back emf or the "back mmf in their circuits and systems.

331. Philip Ball, "The positron probe," *Nature,* Vol. 412,23 Aug. 2001, p. 764.

332. Werner Triftshauser et al., *Phys. Rev. Lett.,* 87, 067402 (2001).

333. Bearden, {30}.

334. For the chemistry and currents of the battery, see any good battery reference, such as Colin A. Vincent and Bruno Scrosati, *Modern Batteries: An Introduction to Electrochemical Power Sources,* Second Edition. Wiley, New York, 1997.

335. (a) J. O'M. Bockris, A. K. N. Reddy, and M. Gamboa-Aldeco, *Modern Electrochemistry: Fundamentals of Electrodics,* 2nd edition. Kluwer/Plenum, NY 2000; (b) J. O'M. Bockris and A. K. N. Reddy, *Modern Electrochemistry: Electrodics in Chemistry, Engineering, Biology, and Environmental Science,* 2nd edition, Kluwer/Plenum, NY 2000; *(c)* J. Koryta, J. Dvorak, and L. Kavan, *Principles of Electrochemistry,* 2nd ed.. Wiley, NY, 1993; (d) Wolfgang .1. Lorenz and Waldfried Plieth,

Electrochemical Nanotechnology: In Situ Local Probe Techniques at Electrochemical Interfaces, Wiley, NY, 1998; (e) B. E. Conway, *Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications,* Plenum, NY, 1999; (f) Allen J. Bard and Larry R. Faulkner, *Electrochemical Methods: Fundamentals and Applications,* Second Edition, Wiley, NY, 2001.

336. At this writing, a provisional patent application on the process has been filed by Bedini and the present author. By the time of publication, hopefully this will have been turned into a formal patent application, with foreign patents also applied for.

337. Edwin V. Gray, "Pulsed Capacitor Discharge Electric Engine," U.S. Patent #3,890,548, June 17, 1975.

338. (a) Per Whittaker, {85}. However, see (b) Bearden, {12} for a necessary correction of Whittaker's interpretation to accord with a quantum field theory view of the instantaneous scalar potential. After observation, the phase conjugate EM wave half of the Whittaker wavepair is indeed going in the opposite direction to the normal longitudinal EM wave half But prior to observation, it exists in the time domain, and in the time domain it is precisely accompanying the 3-space longitudinal EM wave, with the absorbing and then emitting charge interacting in the middle between the two. See (c) Mandl and Shaw, {19}, to see that the combined scalar (time-polarized) photon and longitudinal photon are observable as the instantaneous scalar potential. This means that the corrected Whittaker decomposition produces an associated time-polarized EM wave in the time domain and longitudinal EM wave in 3-space. That is the corrected interpretation of Whittaker's phase conjugate longitudinal EM wavepair.

339. (a) J. O'M. Bockris, "Overpotential: a lacuna in scientific knowledge,"J. *Chem. Edu.,* 48(6), June 1971, p. 352-358. This is a simplified introduction to overpotential theory. The energy density that exists at minute "double layers" in contact, which act as tiny capacitors with extremely small separation of plates, is enormous and far greater **than** what the power engineer meets in his normal engineering practice. **Sec** also (b) Bockris and Reddy, {335b}, particularly Chapter I which deals with the overpotential. See also (c) Bockris et a1, {335a}.

340. E.g. see (a) L. Bertalot *et al.,* "Study of deuterium charging in palladium by the electrolysis of heavy water: heat excess production", *Nuovo Cimento,* Vol. 15 D, 1993, p. 1435; (b) J. O'M Bockris *et al.,* "Cold

fusion as a consequence of high fugacity among hydrogen isotopes," Intl. *J. Hydrogen Energy,* Vol. 17, 1992, p. 445.

341. Peter Lindemann, *The Free Energy Secrets of Cold Electricity,* **Clear** Tech Inc., Metaline Falls, WA, 2001.

342. Particularly see Kenneth S. Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage,* Princeton University Press, Princeton, NJ, **2001.**

Quoting: *"Deffeyes finds that world oil production will peak within five wars and that there isn't anything we can do to stop it. New exploration and production technologies can't save us, and plans to open the Arctic National Wildlife Refuge and other areas to drilling offer no more than a small and soon-to-be-forgotten blip on the production curve. While long-term solutions exist in the form of conservation and alternative energy sources, they probably cannot — and almost certainly will not — be enacted in time to evade a short-term catastrophe of shortages, soaring prices, and global economic, agricultural, and possibly political disturbance. "* In short, Deffeyes rigorously demonstrates that a world energy crisis of staggering proportions is just around the corner.

343. D. J. Bohm and B. J. Hiley, "On the intuitive understanding of nonlocality as implied by quantum theory," *Found. Phys.,* 5(1), Mar. 1975, p. 93-109. Quote is from p. 107.

344. (a) Y. Aharonov and D. Bohm, "Significance of Electromagnetic **Potentials** in the Quantum Theory," *Phys. Rev.,* Second Series, 115(3), Aug. 1, 1959, p. 485; (b) — "Further Considerations on Electromagnetics In **the** Quantum Theory," Phys. Rev., 123(4), Aug. 15, 1961, p. 1511-1524.

345. Terence W. Barrett, "Electromagnetic Phenomena Not Explained by Maxwell's Equations," A. Lakhtakia, ed., *Essays on the Formal Aspects of Electromagnetics Theory,* World Scientific Publishing, River Edge, NJ, **1993,** p. 11 and generally p. 6-86.]

346. Davies, {237}, p. 105.

347. David J. Bohm, "A Suggested Interpretation of the Quantum **Theory** in Terms of 'Hidden' Variables, I and II." *Phys. Rev.,* 85(2), Jan. 15, 1952, p. 166-179 (Part I); 180-193 (Part II).

348. Jackson, {22}, p. 223.

349, Lamb and **Retherford,** {23}.

350. (a) Casimir, {26}. This paper is an extrapolation to two attracting plates of the more detailed paper of (b) H. B. G. Casimir and D. Polder, "The influence of retardation on the London-van der Waals Forces," *Phys Rev.* 73(4), Feb. 15, 1948, p. 360-372. Casimir's paper was an extension of earlier work by Verwey and Overbeek on the stability of colloidal systems, including the interaction of electric double layers; see (c) E. J. W Verwey, J. T. G. Overbeek, and K. van Nes, *Theory of the Stability of Lyophobic Colloids*, Elsevier, Amsterdam, 1948.

351. Lamoreaux, {27}.

352. Mead and Nachamkin, {28}.

353. E.g., see (a) P. W. Milonni. R. J. Cook and M. E. Goggin, "Radiation pressure from the vacuum: Physical interpretation of the Casimir force," *Phys. Rev. A*, Vol. 38, 1988, p. 1621; (b) C. E. Carlson, T. Goldman and J. Peres-Mercader, "Gamma-ray bursts, neutron star quakes, and the Casimir effect," *Europhys. Lett.*, Vol. 36, 1996, p. 637; (c) M. Chaichian *et ah*, "Quantum theories on noncommutative spaces with nontrivial topology: Aharonov-Bohm and Casimir effects," *Nucl Phys B.* Vol. 611, 2001, p. 383-402; (d) V. Dodonov, "Nonstationary Casimir Effect and Analytical Solutions for Quantum Fields in Cavities with Moving Boundaries," in *Modern Nonlinear Optics*, 2nd Edn., 3 vols., Wiley, 2001, Vol. 1, p. 309-384.

354. Bohm, {347}.

355. See T. E. Bearden, *Gravitobiology: A New Biophysics*, Tesla Book Co., Chula Vista, CA, 1991.

356. One should not be nonplussed at the notion of infinite velocity. A pure longitudinal EM wave is — at least in theory — capable of moving at infinite velocity, and is a proper solution to Maxwell's equations. See (a) Rodrigues and Lu, {93a}. Also, the ordinary potential in the Coulomh gauge does indeed move at infinite velocity; see Jackson, {22}, p. 223. In addition, Bohm's interpretation of quantum mechanics {347} uses the quantum potential, which instantaneously appears everywhere it will have magnitude.

357. Enders and Nimtz, {329b}.

358. R. Chen, "Cancellation of Internal Forces," *Am. J. Phys.*, 49(4), Apr. 1981, p. 372.

359. Whittaker, {85}.

360. R. L. Davis, "Non-Inductive Electrical Resistor," U.S. Patent No. 3,267,406, Aug. 16, 1966. Davis uses a Mobius-loop capacitor as an inductance-free resistor. Our comment is that, more rigorously, the resistor is *not* noninductive. It is "equally and oppositely inductive," which is quite a different thing altogether when one considers the difference between internal energy and external energy. We hypothesize that the "resistor" — or some version of it — produces an artificial scalar potential stress in spacetime — apparently varying the stress energy tensor itself— even though it produces a *net* zero reactance.

361. These are Brazil, Russia, China, and two other nations friendly to the U.S. The dominant weapons on earth today are quantum potential weapons, not nuclear weapons. The second most dominant weapons are probably the negative energy EMP weapons deployed by several nations, including China.

362. E.g., see (a) L. I. Mandelstam and N. D. Papaleksi, "On the parametric excitation of electric oscillations," *Zhurnal Teknicheskoy Fiziki,* 4(1), 1934, p. 5-29; (b) — "On resonance phenomena with frequency distribution." *Z.f. Phys.,* No. 72, 1931, p. 223: (c) — "Concerning asynchronous excitation of oscillations," *Zhurnal Tekhnicheskoi Fiziki,* 4(1), 1934; (d) — "Concerning asynchronous excitation of oscillations," *Zhurnal Tekhnicheskoi Fiziki,* 4(1), 1934; (e) — - "Concerning nonstationary processes occurring in the case of resonance phenomena of the second class," *Zhurnal Tekhnicheskoi Fiziki,* 4(1), 1934. See also (f) A. Andronov, "The limiting cycles of Poincare and the theory of self-maintained oscillations," *Comptes-Rendus,* Vol. 189, 1929, p. 559; (g) — and A. Witt, "On the mathematical theory of self-excitations," *Comptes-Rendus,* Vol. 190, 1930, p. 256; (h) — "On the mathematical theory of self-excitation systems with two degrees of freedom," *Zhurnal Tekhnicheskioi Fiziki,* 4(1), 193; (i) — "Discontinuous periodic movements and theory of multivibrators of Abraham and Bloch," *Bull. De l'Acad. Ed Sc. De l'URSS,* vol. 189, 1930. See (j) S. Chaikin, "Continuous and 'discontinuous' oscillations," *Zhurnal Prikladnoi Fiziki,* Vol. 7, 1930. p. 6; (k) — and A. Witt, "Drift in a case of small amplitudes," *Zhurnal Teknicheskoi Fiziki,* 1(5), 1931, p. 428; (1) — and N. Kaidanowski, "Mechanical relaxation oscillations," *Zhurnal Teknicheskoi Fiziki,* Vol. 3, 1933, p. 1.

363. L. Mandelstam [L. T. Mendel'shtam], N. Papalexi, A. Andronov, S. Chaikin and A. Witt, "Report on Recent Research on Nonlinear Oscillations," Translation of "Expose Des Recherches Recentes Sur Les Oscillations Non Lineaires," *Technical Physics of the USSR*, Leningrad, Vol. 2, 1935, p. 81-134 [NASA Translation Doc. TTF-12,678, Nov. 1969].

364. In Alexander L. Fradkov and Alexander Yu. Pogromsky, *Introduction to Control of Oscillations and Chaos*, World Scientific Series on Nonlinear Science E, Series Editor Leon O. Chua, World Scientific, New Jersey, 1998 — as a typical example — I found no mention of the Dirac hole current decay mechanism or of the active external environment (the active vacuum and its dynamics, and the active local curvatures of spacetime and their dynamics).

365. Richard E. Prange and Peter Strance, "The Semiconducting Vacuum," *Am. J. Phys.*, 52(1), Jan. 1984, p. 19-21.

366. John F. Lindner *et ah*, "Noise Enhanced Propagation," *Phys. Rev. Lett.*, 81(23), 7 Dec. 1998, p. 5048-5051. Lindner suggests that the mechanism appears to be general, in which case it could supply the mechanism that coherently "locks together" the barium nuclei self-oscillations in Sweet's activated barium ferrite magnets.

367. Owen Flynn, "Parametric arrays: A new concept for sonar," *Electronic Warfare Magazine*, June 1977, p. 107-112. Any two sine-wave frequencies as simultaneous drivers combine to produce a sine-wave difference frequency propagating in an isotropic nonlinear medium, essentially without sidebands or reverberations. Its pattern has a main lobe approximately equal to that of the high frequency drive, but devoid of sidelobes. The level of the propagating difference frequency is proportional to both the product of the two fundamental drive levels and to the square of the desired value of difference frequency.

368. M. I. Dykman *et al.*, "Noise-enhanced heterodyning in bistable systems." *Phys. Rev. E*, 49(3), Mar. 1994, p. 1935-1942

369. (a) V. S. L'vov and L. A. Prozorova, "Spin Waves Above the Threshold of Parametric Excitation," in (b) A. S. Borovik-Romanov and S. K. Sinha, Eds., *Spin Waves and Magnetic Excitations*, North-Holland, Amsterdam, 1988.

370. Gurevich and Melkov, {232c}. The authors treat high **frequency** processes, i.e., oscillations and waves, in magnetically ordered substances, including ferromagnetic and antiferromagnetic resonances, spin waves, nonlinear processes, and high frequency manifestations of **interactions** between the magnetic system and other systems of magnetically **ordered** substances (crystal lattice, charge carriers). The treatment is classical except that a quantum mechanical approach is used in the study of relaxation processes, which determine the energy losses of magnetic oscillations and waves. Experimental results but not techniques are included. Self-oscillation and self-oscillation criteria arc on p. 279.

371. (a) G. S. Kandaurova and A. E. Sviderskii, "Observation of autowave state and stable dynamic structures in multidomain magnetic films," *Sov. Tech. Phys. Lett.,* 14(5), May 1988, p. 346-347; (b) V. S. **L'vov,** {29c}.

372. Richard T. Hammond, "New fields in general relativity," *Contemp. Phys.,* 36(2), 1995, p. 103-114.

373. (a) J. Baugh et al., *Science,* Vol. 294, 16 Nov. 2001, p. 1505. For a simpler synopsis of the paper, see (b) Warren S. Warren, "Multidimensional Symmetry in a Three-Dimensional World," *Science,* Vol. 294, 16 Nov. 2001, p. 1475-1476.

374. E.g., see Howard R. Johnson, "Permanent Magnet Motor." U.S. Patent No. 4.151.431. Apr. 24. 1979.

375. Howard Johnson, private communication, January 2002.

376. In magnetics, multi-valued potentials (and hence the possibility **for** nonconservative fields) arise naturally in the theory, but are considered a nuisance to be eliminated or "averaged away" by magnetics engineers. E.g., see (a) Z. Ren, "A 3D vector potential formulation using edge element for electrostatic field computation," *IEEE Trans, on Magnetics,* **31(3),** May 1995, p. 1520-1523; (b) — "New technique for solving three-dimensional multiply connected eddy-current problems." *lEEProc, 1*37A(3), May 1990, p. 135-140; (c) J. C. Verite, "Calculation of multivalued potentials in exterior regions," *IEEE Trans, on Magnetics,* **Vol.** MAG-23(3), May 1987, p. 1881-1887. Amazingly, these and other similar methods are directed into converting the multivalued potential into single-valued regions by a process of multiple, highly selected cuts. In other words, the real attempt is to eliminate the multivalued aspect, in which case the theorists are in fact simply eliminating the asymmetrical

self-regauging provided by the multivalued potential and hence are discarding the ability to use multivalued potentials in true overunity processes.

377. (a) Z. Badics, "Transient eddy current field of current forced three-dimensional conductors," *IEEE Trans, on Magnetics,* 28(2), Mar. 1992, p. 1232-1234;(b) R. Albanese and G. Rubinacci, "Magnetostatic field computations in terms of two component vector potentials," *Int. J. for Numerical Methods in Engineering,* Vol. 29, 1990, p. 515-532; (c) Bearden, {214f}: (d) P. Hammond and T. D. Ssiboukis, "Dual finite-element calculations for static electric and magnetic fields," *lEEProc. A,* 130(3), 1983, p. 105-111; (e) P. R. Kotiuga, "On making cuts for magnetic scalar potentials in multiply connected regions," *J. Appl. Phys.,* 61(8), 1987, p. 3916-3918; (f) J. Penman and J. R. Fraser, "Complementary and dual energy finite element principles in magnetostatics," *IEEE Trans, on Magnetics,* 18(2), 1982, p. 319-323; (g) E. A. Tolkachev and Ya. M. Shnir, "Non-trivial topology effects in the interaction of a monopole with a line current," *Phys. Lett. A,* 155(8, 9), May 27, 1991, p. 464-466.

378. (a) Feynman, {7}, Vol. II, Chapter 37; (b) T. Ambrose, R. L. Sommer, and C. *L.* Chien, "Angular Dependence of Exchange Coupling in Ferromagnetic/Antimagnetic Bilayers," *Phys. Rev. B,* Vol. 56, 1997, p. 83; (c) H. Sang, Y. W. Du, and C. L. Chien, "Exchange Coupling in $Fe_5oMn_5o/Ni_{81}Fe_{19}$ Bilayers: Dependence on Antiferromagnetic Layer Thickness," *J. Appl. Phys.,* Vol. 85, 1999, p. 4931.

379. V. A. Tulin, "Nuclear Spin Waves in Magnets," *Fis. Niskikh Temp.,* Vol. 5, 1979, p. 965-993 [in Russian].

380. Sweet and Bearden, {29a}.

381. (a) Kenneth R. Shoulders, U.S. Patent # 5,153,901; (b) — "Energy Conversion Using High Charge Density," U.S. Patent # 5,018,180, May 21, 1991; (c) — "Energy Conversion using High Charge Density," U.S. Patent No. 5,123,039, 1992; (d) — U.S. Patents 5,054,046 and 5,054,047, 1991; (e) — "Circuits Responsive To and Controlling Charged Particles," U.S. Patent 5,148,461, 1992; (f) — and Steve Shoulders, "Observations on the Role of Charge Clusters in Nuclear Cluster Reactions," *J. New Energy,* 1(3), Fall 1996, p. 111-121.

382. (a) Paulo N. Correa and Alexandra N. Correa, "Pulsed Abnormal Glow Discharge Technology," *Infinite Energy,* 2(7), Mar./Apr. 1996, p.

18-21; (b) — "Other Applications of the PAGD Technology Besides Energy Conversion," *ibid.*, p. 22-27; (c)— "Electrochemical Transduction of Plasma Pulses," U.S. Patent No. 5,416,391, May 16, 1995; (d) "Energy Conversion Systems," U.S. Patent No. 5,449,989, Sept. 12, 1995; (e) — "Direct Current Energized Pulse Generator Utilizing Autogenous Cyclical Pulsed Abnormal Glow Discharges," U.S. Patent 5,502,354, Mar. 26, 1996.

383. In 1935, Prileshajewa showed that there is an energy difference as much as 1.1 v between the exciting light and the fluorescence of aniline vapor. This added energy is attributed to additions from the internal energy of the molecule. Thus, anti-Stokes emission has been validated as a COP>1.0 mechanism since at least 1935. For our purposes, replenishment of the internal energy of the molecule must be obtained from the local active vacuum; else one simply has the standard optical cooling process which cools the gas.

384. E.g., see J. K. Brasseur et al., "Coherent Anti-Stokes Emission in a Continuous Wave Raman Laser in H_2," carried on website location http://www.physics.montana.edu/optics/jlc/Anti-Stokes.pdf.

385. For a typical study, see J. Silver et al., "Studies on anti-Stokes emission from metal oxides (doped with Er3+ and Yb3+) stimulated by 632.8 nm laser excitation," *6th Int. Conf. Phosphors and Display Tech.*, San Diego, California, 2000.

386. For a typical paper of hundreds on the subject, see C. Zander and K. H. Drexhage, "Cooling of a Dye Solution by Anti-Stokes Fluorescence," in *Advances in Photochemistry*, edited by D. C. Neckers, D. H. Volman, and G. von Bulau; Wiley, New York, 1995.

387. (a) Antoine Priore, "Method of producing radiations for penetrating living cells," U.S. Patent No. 3,280,816, Oct. 25, 1966; (b) — "Apparatus for producing radiations penetrating living cells," U.S. Patent No. 3,368,155, Feb. 6, 1968. For an explanation, see (c) T. E. Bearden, "The Porthole Briefing," http://www.cheniere.org.

388. Thomas Valone, "Future Energy Technologies," *J. New Energy*, 5(2), Fall 2000, p. 41-46; summary is quoted from p. 44-45.

389. Shang-Xiang Jin and Hal Fox, "Characteristics of High-Density Charge Clusters: A Theoretical Model," *J. New Energy*, 1(4), Winter 1996, p. 5-20.

390. Shoulders, {381a-381e}.

391. Ken Shoulders, "Permittivity transitions," *J. New Energy,* 5(2), Fall 2000, p. 121-137.

392. *Ibid,* p. 122.

393. *Ibid,* p. 122.

394. K. Shoulders and S. Shoulders, {381 f).

395. Harold L. Fox, "Energy for the Future: High-Density Charge Clusters," *Modern Nonlinear Optics,* Second Edition, edited by M. W. Evans, Wiley, New York, 2001, Part III, p. 623-653.

396. See (a) Art Rosenblum, "Randell Mills — New Energy and the Cosmic Hydrino Sea," *Infinite Energy,* 3(17), Dec. 1997-1998, p. 21-34. Also see (b) Randell Lee Mills, "Energy/Matter Conversion Methods and Structures," Australian Patent No. 668678, Nov. 20, 1991. Particularly see (c) Eugene Mallove, "Dr. Randell Mills and the Power of BlackLight," *Infinite Energy,* 2(12), Jan.-Feb. 1997, p. 21, 35, 41.

397. Randell Mills *et al.,* "Lower-Energy Hydrogen Methods and Structure," U.S. Patent No. 6,024,935, Feb. 15, 2000. Some 60 pages, and an astounding 499 claims. For the patent, an independent verification was performed by Johannes Conrads, Institute for Low Temperature Plasma Physics at the Ernst Moritz Arndt University in Greifswald, Germany.

398. Randell L. Mills, "The Grand Unified Theory of Classical Quantum Mechanics," www.blacklightpower.com/book/shtml.

399. (a) Randell L. Mills et al., "Identification of Compounds Containing Novel Hydride Ions by Nuclear magnetic Resonance Spectroscopy"; (b) — "Spectroscopic Identification of Novel Catalytic-Reaction of Atomic Hydrogen and the Hydride Ion Products"; (c) — "Black Light Power Technology: A New Clean Energy Source with the Potential for Direct Conversion to Electricity," presented to the Intl. Conf. On Global Warming and Energy Policy, Nov. 26-28, 2000 and to the National Hydrogen Association Meeting, March 6-8, 2001; (d) — Plasma Power Source Based on a Catalytic Reaction of Atomic Hydrogen"; (e) R, M. Mayo and R. L. Mills, "Direct Plasmadynamic Conversion of **Plasma** Thermal Power to Electricity for Microdistributed Power Applications," *40th Ann. Power Sources Conf. Proc,* June 10-13, 2002; (f) R. Mills et al., "Novel Catalytic Reaction as a Potential New Energy Source," 223rd

ACS National Meeting, Orlando, Florida, Apr. 6-11, 2002; (g) — "Novel alkali and Alkaline Earth Hydrides for High Voltage and High Energy Density Batteries," *Proc. 17th Ann. Battery Conf. On Appl. And Advances, Calif. State Univ., Long Beach, CA, Jan. 15-18* (in press); (h) - "Synthesis of Diamond Films from Solid Carbon"; (i) Mills and Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter," *Int. J. Hydrogen Energy*, 27(3), 2002, p. 301-322.

400. Peter D. Zimmerman, "An Analysis of Theoretical Flaws in So-Called Classical Quantum Mechanics and of Experimental Evidence against CQM," 2001.

401. Bearden, {222b}, p. 674.

402. E.g., it yields the excess deuterium, tritium, and alpha particles; see Bearden, {17}.

403. (a) Bearden, {222b}; Bearden, {15}.

404. (a) "Ion Cyclotron and Converter and Radio Power Microwave Generator," International Pub. No. WO 01/21300 A2, 29 March 2001; (b) "Ion Cyclotron Power Converter and Radio and Microwave Generator," International Pub. No. WO 01/22472, 29 March 2001. Both filed with World Intellectual Property Organization.

405. But see Samuel D. Harper. "The energy dissipated in a switch," *Am. J. Phys.*, 56(10), Oct. 1988, p. 866-889. Unless special attention and effort is paid, switches can indeed consume a great deal of energy! As Harper points out, it can be a substantial fraction of the energy transfer in the circuit. In a capacitive loaded circuit this is especially true. One should consider very efficient switching such as optically coupled switching arrangements.

406. (a) F. Heinrich, "Entropy change when charging a capacitor: A demonstration experiment," *Am. J. Phys.*, 54(8), 1986, p. 742-44. For an expanded discussion, see (b) I. Fundaun, C. Reese, and H. H. Soonpaa, "Charging a capacitor," *Am. J. Phys.*, 60(11), Nov. 1992, p. 1047-1048. Also see (c) Tyler A. Abbott and David J. Griffiths, "Acceleration without radiation." *Am. J. Phys.*, 53(12), Dec. 1985, p. 1203-1211. An extended charge can accelerate without radiating, under specified conditions.

407. (a) Davis, {360}. It would appear that a sine wave across this resistor may generate a **rhythmic** variation in what is called "internal

energy"; i.e., stress energy inside the system, hence stress energy in the associated vacuum. Since this is analogous to a sound wave consisting of rarefaction and expansion, it is a method of generating a longitudinal EM wave. This may also be involved also in the Fogal semiconductor. For a discussion of internal forces, which occur in equal and opposite pairs and are quite different from the resultant of forces, see (b) Chen, {358}, p. 372 and passim.

408. See Hsu-Chieh Yeh, "Remark on the second law of thermodynamics," *Am. J. Phys.*, 52(8), Aug. 1984, p. 720-723. As an example, from the common charge or dipole at constant temperature, we can indeed receive and take electrical energy because the charge (as a set of composite dipoles) and the dipole are not in 3-space energy flow equilibrium. Instead, they constantly receive virtual EM energy from the active vacuum, transduce it into 3-space EM energy, and continuously emit **that** energy in all directions — all at constant temperature. When we consider the supersystem of the charge-system and its environment, it is in disequilibrium and hence exhibits the effect pointed out by Yeh.

409. Yeh, {408}. Particularly see the illustration on p. 721.

410. Gabriel Laufer, "Work and heat in the light of (thermal and **laser**) light," Am. *J. Phys.*, Vol. 51, 1983, p. 42.

411. (a) Paulo N. Correa and Alexandra N. Correa, "A Modified Orgone Accumulator (HYBORAC) as a Drive for a Low Delta-T **Stirling** Engine, Part 1," *Infinite Energy*, 7(41), 2002, p. 23-29; (b) — "Orgone Accumulator Drive (HYBORAC) for Low Delta Stirling Motors, video presentation, ABRI Media Production.

412. Paulo N. Correa and Alexandra N. Correa, *Introduction to Experimental Aetherometry*, Vols. 1 and 2, 2001. Summaries of these **two** volumes may be freely downloaded from http://www.aetherometry.com

413. Paulo N. Correa and Alexandra N. Correa, "A Modified Orgone Accumulator (HYBORAC) as a Drive for a Low Delta-T Stirling **Engine** Part II." *Infinite Energy*, 7(42), 2002 (in press)

414. Eugene F. Mallove, "Demonstrating Aether Energy," *Infinite Energy*, 7(41), 2002, p. 6-8.

415. As quoted by Mallove, *ibid.*, p. 7.

416. Feynman, {7}, Vol. II, p. 1-3. Emphasis in original.

417. Mallove, {414}, p. 7.

418. J. M. Aguirregabiria, A. Hernandez, and M. Rivas, "Surface charges and energy flow in a ring rotating in a magnetic field." *Am. .J. Phys.,* 64(7), July 1996, p. 892-895.

419. F. Herrmann, "The unexpected path of the energy in a moving capacitor," *Am. J. Phys.,* 61(2), Feb. 1993, p. 119-121.

420. Wang and Chung, {33}.

421. Mike LaPointe, "Antimatter Production at a Potential Boundary," presented at the AIAA Joint Propulsion Conference, Breakthrough Propulsion Physics Session #1, July 9, 2001.

422. E.g., (a) Charles Kittel, *Introduction to Solid State Physics,* Seventh Edition, Wiley, New York, 1996 in various chapters contains excellent introductions to a more in-depth view of magnetic phenomena. A very useful book, written with clarity is (b) B. D. Cullity, *Introduction to Magnetic Materials,* Addison-Wesley, Reading, MA, 1972. For nuclear effects, (c) A. Abraham, *Nuclear Magnetism,* Oxford. 1961 is still excellent and quite comprehensive.

423. (a) Particularly see the lay overview by Philip Ball, "Meet the spin doctors...", *Nature,* Vol. 404, 2000, p. 918-920. This article deals with spin-injection from magnetic semiconductors. In addition to up and down, electron spin also has an additional degree of freedom called "color"; see (b) "Colourful electrons solve puzzle of ferromagnetism," *Physics World,* 14(7), July 2001; (c) also see the accompanying article by Fu Chun Zhang.

424. Stanislaw Bednarek, "Self-powered magnetohydrodynamic motors," *Am. J. Phys.,* 64(1), Jan. 1996, p. 90-92.

425. In a true superconducting system, it is possible to keep the current moving around in a resistance-free conductor indefinitely. However, no net work can be produced by the system, and in fact when one counts the energy one inputs to maintain the extremely low temperature of the environment, then to maintain the supersystem in such **"indefinite current** circulation" one has to continuously input energy to cool the **system. On** the other hand, an electron in an atom, orbiting the nucleus, is in **net** equilibrium on its path, so it will maintain its orbit indefinitely until perturbed sufficiently to break loose.

426. (a) Badics, {377a};(b) P. Hammond and J. Penman, "Calculation of inductance and capacitance by means of dual energy principles," *IEE Proc,* 123(6), 1976, p. 554-559; (c) Hammond and Ssiboukis, {377d}; (d) Yongzhong Huo, "A classification of thermodynamical potentials for two-variable transition systems," *Meccanica* [Netherlands], 30(5), Oct. 1995, p. 475.494; (e). Kotiuga, {377e}; (f) J. N. Murrell and S. Carter, "Approximate single-valued representations of multivalued potential energy surfaces," J. *Phys. Chem.,* 88(21), Oct. 11, 1984, p. 4887-4891; (g) Penman and Fraser, {377f}; (h) Ren, {376a}; (i) Z. Ren, "Solving 3D static field problems by dual formulations using potential variables," ***2nd*** *Int. Workshop on Elec. and Magn. Fields,* Leuven, Belgium, May 1994; (j) Ren, {376b}; (k) Verite, {376c}; (1) V. Vittal, "A generalized procedure to obtain first integrals for non-conservative dynamical systems: Application to power systems," *IEEE ISCAS '89,* 1989, p. 1984-1987.

427. G. W. O. Howe, "Effect of Torsion on a Longitudinally-Magnetized Iron Wire," *Wireless Engineer,* 29(344), May 1952, p. **115-** 117.

428. Harry E. Burke, *Handbook ofMagnetic Phenomena,* Van Nostrand, New York, 1985. This is a one-of-a-kind handbook on a great number of magnetic effects and phenomena.

429. Cullity, {422b}.

430. As examples: (a) Barrett, {345}; (b) Gurevich and Melkov, {232c}; (c) William Weltner, Jr., *Magnetic Atoms and Molecules,* Dover, Mineola, NY, 1989; (d) Giorgio Bertotti, *Hysteresis in Magnetism,* Academic Press, New York, 1998; (e) L'vov, {29c}; (f) Sidney Platt, *Magnetic Amplifiers: Theory and Application,* Prentice Hall, Englewood Cliffs, N.J., 1958; (g) Maciej J. Ogorzalek, *Chaos and Complexity in Nonlinear Electronic Circuits,* World Scientific, New Jersey, 1997; (h) Jammer, {lb}; (i) Borovik-Romanov and Sinha, Eds, {369b}; (j) Paul Davies, ed., {160f}; (k) G. I. Shipov, *A Theory ofPhysical Vacuum: A New Paradigm,* Moscow, 1994; (1) Nicolis and Prigogine, {255b}; (m) Richard Feynman, *Quantum Electrodynamics,* 1961, 1963; (n) V. 1. Fushchich and A. G. Nikitin, *Symmetries ofMaxwell's Equations,* D, Reidel, 1987; (o) Mandl and Shaw, {19}; (p) M. W. Evans, Ed., ***Modern*** *Nonlinear Optics,* Second Edition, 3 vols., Wiley, 2001; (q) Robert C. O'Handley, *Modern Magnetic Materials: Principles and Applications,* Wiley, New York, 2000; (r) Sachs, {126a}.

431. As examples: (a) Lindsay and Margenau, {114}; (b) Richard P. Feynman, *The Character of Physical Law*, MIT Press, Cambridge, 1965:; (c) Feynman, {7}; (d) Ilya Prigogine, *The End of Certainty: Time, Chaos, and the New Laws of Nature*, Free Press, New York, 1996, 1997; (e) Mendel Sachs, *Einstein Versus Bohr: The Continuing Controversies in Physics*, Open Court Publishing Company, 1988.

432. For those unfamiliar with magnetics and the exchange force(s), see H. J. Gray and Alan Isaacs, *A New Dictionary of Physics*, second edition, 1976 printing, *ibid.*, p. 194 for a precise definition. The force from the sudden exchange of charge is known as the *Heisenberg force*. That due to the exchange of spin direction is known as the *Bartlett force*. The force associated with exchange of both spin and charge is known as the *Majorama force*. Quoting: "These exchange forces may be interpreted as being due to the continual emission and absorption of virtual particles that carry the shared property from one particle to another. The exchange of virtual hadrons between interacting particles of the atomic nucleus is intimately involved in nuclear exchange forces.

433. Feynman, {7}, Vol. II, Chapter 37 covers magnetic materials including exchange forces, spins, and spin effects.

434. *The Encyclopedia of Physics*, Robert M. Besancon (editor), Second Edition, Van Nostrand Reinhold, New York, 1974, p. 518.

435. Cullity. {422b}. p. 132.

436. Kittel, {422a}, p. 443 (footnote 1).

437. Lindsay and Margenau, {114}, p. 216-217.

438. *Ibid.*, p. 213.

439. *Ibid.*, p. 215.

440. *Ibid.*, p. 214.

441. T. D. Lee, "Space Inversion, Time Reversal and Particle-Antiparticle Conjugation," *Physics Today*, 19(3), Mar. 1966, p. 23.

442. Lee, {73}, p. 187-188.

443. Romer, {84}.

444. Kenneth D. Moore, "Testing of a Johnson Magnetic Gate," *Explore*, 9(6), 2000, p. 70-75. Also available on www.cheniere.org.

445. (a) Raymond J. Radus and William G. Evans, "Apparatus Responsive to Direct Quantities," U.S. Patent #2,892,155, Jun. 23, 1959; (b) R. J. Radus, "Permanent-Magnet Circuit using a 'Flux-Transfer' principle," *Engineers' Digest*, 24(6), June 1963, p. 86; (c) (anon.), "On-Off Permanent Magnet with a Memory," *Electronic Equipment Engineering*, 11(4), Apr. 1963, p. 22, 26.

446. "Human fly has magnetic sole," *Electrical Engineering*, Apr. 1963, p. 294.

447. Malcolm McCaid, *Attraction and Repulsion*, Oliver and Boyd Ltd., 1967 has an entire chapter on switching magnets, and has two photos of an engineer hanging upside down and walking on the underside of an elevated steel beam, wearing the Radus magnetic boots.

448. For a description of "shuffler" boots, see A. W. Hangar and A. A. Rosener, "The use of permanent magnets in zero-gravity mobility and restraint 'footware' concept," *IEEE Trans, on Magnetics*, Vol. MAG-6, No. 3, Sep. 1970, p. 464-467. These crude shuffler boots are quite a contrast to the elegant Westinghouse/Radus stepping boots earlier developed and used.

449. Burke, {428}.

450. David Scott, "Magnetic "Wankel" for electric cars," *Popular Science*, June 1979, p. 90-91.

451. E.g., (a) John R. Wiegand, "Bistable Magnetic Device," U.S. Patent No. 3,820,090, June 25, 1974; (b) — "Asymmetric Bistable Magnetic Device," U.S. Patent No. 3,866,193, Feb. 11, 1975; (c) - "Pulse Generation by Changing Magnetic Field," U.S. Patent No. 4,309,628, Jan. 5, 1982; (d) — "Pulse Generator Using Read Head with Wiegand Wire," U.S. Patent No. 4,263,523, April 21, 1981; (e) - "Switchable Magnetic Device;" U.S. Patent No. 4,247,601, Jan. 27, 1981; (f) — "Method of Manufacturing Bistable Magnetic Device," U.S. Patent No. 3,892,118, July 1, 1975; (g) — "Multiple Pulse Generator;" U.S. Patent No. 3,793,532, Feb. 19, 1974; (h) — and John E. Opie, "Pulse Generator with Shaped Magnetic Field," U.S. Patent No. 4,484,090. Nov 20, 1984.

452. Kawai, {31}.

453. John C. Bedini, "Device and Method of a Back EMF Permanent Electromagnetic Motor Generator," U.S. Patent No. 6,392,370, May 21.

2002. Uses a regauging process for capturing available back **EMF** electromagnetic energy in the system. The available energy may be captured and used to re-energize the battery, and/or sent in another direction to be used as useful work, or dissipated in the system.

454. See {445c}, p. 22, 26. Quoting: *"The circuit differs from ordinary permanent magnets in three ways: (I) It exerts strong magnetic force at one end while exerting hardly any at the other, (2) the strong and weak magnetic poles can be switched end-for-end easily and at will, thus in effect turning the magnetism on and off, and (3) it remembers its direction of greatest magnetic pull indefinitely. "*

455. Burke, {428}, p. 250.

456. Deffeyes, {342}.

457. Stuart Young, *Nature,* Vol. 414, 29 Nov. 2001, p. 487.

458. Evans, {137b}, p. 84.

459. M. W. Evans and S. Jeffers, "The Present Status of the Quantum Theory of Light," in *Modern Nonlinear Optics,* Second Edition, 3 Vols., edited by M. W. Evans, Wiley, 2001, Vol. 3, p. 150.

460. Clarke, {55}, p. 38.

461. Patrick, Bearden, Hayes, Moore, and Kenny, {37}. A second patent is pending, and two more are in preparation.

462. Bearden, {222b}.

463. Evans et al, {38b, 38c}.

464. T. E. Bearden, James C. Hayes, James L. Kenny, Kenneth D. Moore, and Stephen L. Patrick, "The Motionless Electromagnetic Generator: Extracting Energy from a Permanent Magnet with Energy-Replenishing from the Active Vacuum," Sept. 2000, carried on restricted DoE website http://www.ott.doe.gov/electromagnetic/. A search on the internet will turn up other sources where the paper can be downloaded.

465. (a) Evans et al., "The Aharonov-Bohm Effect as the Basis of Electromagnetic Energy Inherent in the Vacuum," *Found. Phys. Lett.,* 2002, (in review); (b) — "Derivation of the B(3) Field and Concomitant Vacuum Energy Density from the Sachs Theory of Electrodynamics," ***Found.*** *Phys. Lett.,* 14(6), Dec. 2001, p. 589-593; (c) — "Operator Derivation of the **Gauge** Invariant **Proca** and Lehnert Equations:

Elimination of the Lorenz Condition," *Found. Phys.*, 30(7), 2000, p. 1123-1130; (d) — "Runaway Solutions of the Lehnert Equations: The Possibility of Extracting Energy from the Vacuum," *Optik*, 111(9), 2000, p. 407-409; (e) — "The Effect of Vacuum Energy on the Atomic Spectra," *Found. Phys. Lett*, 13(3), June 2000, p. 289-296; (f) Evans et al., {113}; (g) — "Derivation of the Lehnert Field Equations for Gauge Theory in Vacuum: Space Charge and Current," *Found. Phys. Lett.*, 13(2), Apr. 2000, p. 179-184;(h)Bearden, {222b}.

466. Details are on Jean-Louis Naudin's website, in the section dealing with the MEG, which is http://jnaudin.free.fr/html/megv21.htm#megstat.

467. For an introduction to the field and its literature, see J. Anandan, J. Christian, and K. Wanelik, "Resource letter GPP-1: Geometric phases in physics," *Am. J. Phys.*, Vol. 65, 1977, p. 180-185.

468. A discussion by Feynman of the Aharonov-Bohm effect is given in Feynman, {7}, "15-5: The vector potential and quantum mechanics," p. 15-8 to 15-14.

469. A similar phase change also is induced outside the localized presence of an electrostatic scalar potential fi. See Feynman, {7}, p. 15-10. Quoting: *"...the effect of an electrostatic field is to produce a phase change given by the negative of the time integral of the scalar potential fi"*

470. Ya. M. Blanter, C. Bruder, R. Fazio, and H. Schoeller, "Aharonov Bohm-type Oscillations of Thermopower in a Quantum-dot Ring," *Phys Rev. B*, Vol. 55, 1997, p. 4069 typify the kind of "power" considerations that have been analyzed in the past. Only a minuscule thermopower treatment is considered.

471. S. Pancharatnam, "Generalized theory of interference, and its applications," *Proc. Indian Ac ad. Sci.*, Vol. A44, 1956, p. 247-262.

472. See Nahin, {62}, p. 225. Quoting: *"J. J. Waterston's paper on the kinetic theory of gases, in 1845, was rejected by the Royal Society of London. One of the referees declared it to be 'nothing but nonsense,* ***unfit*** *even for reading before the Society.'... "Waterston's dusty manuscript was finally exhumed from its archival tomb forty years later, because of the efforts of Lord Rayleigh... "*

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474. R. G. Chambers, "Shift of an electron interference **pattern** by enclosed magnetic flux," *Phys. Rev. Lett.,* Vol. 5, July I960, p. 3-5.

475. A. Tonomura *et al,* "Observation of Aharonov-Bohm effect by electron holography," *Phys. Rev. Lett.,* Vol. 48, 1982, p. 1443-1446.

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481. (a) V. Chandrasekhar *et al., Phys. Rev. Lett.,* Vol. 55, 1985, p. 1610; (b) S. Datta *et al., Phys. Rev. Lett,* Vol. 55, 1985, p. 2344; (c) S. N. M. Ruijsenaars, "The Aharonov-Bohm Effect and Scattering Theory," *Ann. Phys.,* Vol. 146, 1983, p. 1-34.

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phase in coupled neutron interference loops," *Phys. Rev. A.*, Vol. 53, 1996, p. 2486-2492; (f) A. G. Wagh *et al.*, "Experimental separation of geometric and dynamical phases using neutron interferometry," *Phys. Rev. Lett.*, Vol. 78, 1997, p. 755-759; (g) D. Suter, K. T. Mueller, and A. Pines, "Study of the Aharonov-Anandan quantum phase by NMR interferometry," *Phys. Rev. Lett.*, Vol. 60, 1988, p. 1218-1220; (h) D. Loss and P. M. Goldbart, "Persistent currents from Berry's phase in Mesoscopic systems," *Phys. Rev. B*, Vol. 45, 1992, p. 13544-13561; (i) C. A. Mead, "The geometric phase in molecular systems," *Rev. Mod. Phys.*, Vol. 64, 1992, p. 51-85; (j) J. H. Hannay, "Angle variable holonomy in adiabatic excursion of an integrable Hamiltonian," *J. Phys. A.*, Vol. 18, 1985, p. 221-230; (k) Y. Aharonov et al., "Aharonov-Bohm Type Forces Between Magnetic Fluxons," Hewlett Packard Report HPL-BR1MS-97-24, Oct. 1997.

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494. Stephen Hawking, per Zebrowski, {2}.

495. Isaac Newton, *Philosophiae Naturalis Principia Mathematica,* 1687.

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507. A. Einstein, Appendix V to his *Relativity, The Special and the General Theory,* translated by Robert W. Lawson, Crown Publishers, New York, 1961, p. 155.

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513. (a) Evans et al., {233f}; (b) Evans et al., {233b}.

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523. (a) Max Jammer, *Concepts of Mass, in Classical and Modern Physics*, Harvard University Press, Cambridge, MA, 1961. One also suggests the reading of Jammer, {1b}.

524. (a) Bearden, {15}, p. 11. One kilogram of mass represents 17.053 x 10^{50} switches per second of action quanta h/(4*PI) across the boundary of the mass, in a flux exchange between the mass region and its external environment. The acceleration force can be derived from the difference in "inswitching" and "outswitching" of action quanta (as the masses m_i of the system iteratively change between mass and masstime states). The paper, albeit crudely, derives Newton's three laws of motion in relativistic form and the square law of gravitation. It also indicates the mechanism (reaction) upon a mass that generates the mass's rate of progression through time. For a somewhat expanded treatment, see (b) T. E. Bearden, "Vacuum Engines and Priore's Methodology: The True Science of Energy Medicine," Parts I and II, *Explore*, 6(1), 1995, p. 66-76; 6(2), 1995, p. 50-62.

525. Today we would also point out that to first order time and mass have essentially the same energy density — i.e., they are both spatial energy compressed by c^2. So the "switches" of action quanta we used in 1973 may be taken to actually represent the time-charging and discharging, of a specific region of space. Rotation of time-energy from the time-domain into 3-space connection with a mass is a mass increase as well as a change of mass to masstime. Rotation of mass-energy out of 3-space back into the time domain (during photon emission) is a mass decrease, (a) Our paper, "Giant Negentropy..." {12}, proposing a solution to the source charge problem, argues that all 3-space EM energy comes from the time domain anyway and returns to it. The source charges normally absorb time-energy, and transduce it to 3-space EM energy or vice versa, but the 3-space energy radiated away is in expanded spatial energy form and not compressed into mass-energy. It is the very release of the c^2 compression of the time-energy that is the "transduction" process to provide the **radiated**

spatial EM energy. But if mere rotation in 4-space is used without **that** expansion/transduction, then the time energy appears as mass. This is consistent with the mechanism we advanced for the flow of a mass *m* through time. Note that when a photon is "absorbed", the spatial energy component of the photon is in fact compressed into mass energy, slightly changing the mass. But when it is re-radiated, it is radiated in expanded or "spatial" EM energy form. Without the expansion and transduction, pure rotation of the compressed EM energy between the time domain and the 3-space domain provides the notion of "time-charging" and "time discharging". Indeed, the very anomalous phenomena occurring in radiation detectors in electrolyte experiments at China Lake, already provide direct evidence for just such time-charging, as pointed out in (b) Bcardcn, {17}.

526. E. R. Laithwaite, "Rack and pinion motors," *Electronics and Power*, Vol. 16, 1970, p. 251-252.

527. Of interest: (a) E. R. Laithwaite, "Unexplained phenomenon at Savoy Place," *Electronics and Power*, Oct. 1972, p. 360-362 recounts the discovery of a free energy device violating the second law of equilibrium thermodynamics; (b) Laithwaite, {526}, gives some particulars of the device; (c) —*All Things Are Possible: An Engineer Looks at Research and Development*, I*PC Electrical-Electronic Press Ltd., Dorset House, London, 1976; (d) Laithwaite, {172b}; (e) — "Miles Walker — a pioneer at Met-Vick and UMIST," *Electrical Review*, 211(12), Oct. 15, 1982, p. 33-34; (f) — "Roll, Isaac, roll — Part I," *Electrical Review*, 204(7), Feb. 16, 1979, p. 38-41; (g) — "Roll, Isaac, roll — Part II," *Electrical Review*, 204(11), Mar. 16, 1979, p. 31-33; (h) — "The laws of science and of England," *Electrical Review*, 202(23), June 16, 1978, p. 27-28.

528. E. R. Laithwaite and W. R. C. Dawson, "Mass Transfer: An Introduction based on Experimental Work at the University of Sussex," Sep. 1994. A subtitle is: A system for the transfer of mass derived from the principle of conservation of momentum. On website http://jnaudin.free.fr/html/IPEmain.htm.

529. See WO95/30832, Nov. 16, 1995.

530. Eric Laithwaite and William Dawson, "Propulsion System," U.S. Patent Number 5,860,317, Jan. 19, 1999.

531. Sweet and **Bearden, {**29a**}.**

532. (a) Ning Li and D. G. Torr, *Phys. Rev.*, Vol. 43D, 1991, p. 457; (b) — *Phys. Rev.*, vol. 46B, 1992, p. 5489; (c) — *Bull. Am. Phys. Soc*, Vol. 37, 1992, p. 948. Also see (d) D. G. Torr and Ning Li, *Found. Phys. Lett.*, Vol.37, 1993, p. 948.

533. E. E. Podkletnov and R. Nieminen, *Physica C*, Vol. 203, 1992, p. 441-444.

534. Igor K. Kulikov, "Inertial and gravitational masses of bosons at finite temperatures," in NASA technical package sent in response to queries of "Study of Inertial and Gravitational Masses of a Boson," *NASA Tech Briefs*, 26(2), Feb. 2002, p. 56. The report by Dr. Kulikov of the Jet Propulsion Laboratory (JPL) is carried on the website as http://nasatech.com/TSP/PDFTSP/NPO30325.pdl'. This is a theoretical study of the relationship between the inertial mass and gravitational mass of a self-interacting neutral scalar boson in a heat bath. The difference in the two masses was determined as a function of the temperature of the heal bath. The theory for distinguishing the difference is given. Since it is presented as an inventor's report, we assume that a patent is either pending by or to JPL or already granted to it.

535. Mike LaPointe, {421}.

536. Jim Corum, T. Keech, D. Gray, P. Pesavento, and M. Duncan, "The Electro-magnetic Stress-Tensor as a possible Space Drive Propulsion Concept, presented at the AIAA Joint Propulsion Conference, July 9, 2001.

537. Hector Serrano, "Propulsion Device and Method Employing Electric Fields for Producing Thrust," WO 00/58623, Oct. 5, 2000.

538. William B. Stein, Electrokinetic Propulsion: The Ionic Wind Argument," Energy Conversion Laboratory, Purdue University, West Lafayette, Indiana 47906, Sep. 5, 2000. This is a Gravitec report. Results can be downloaded from http://foldedspace.com/data.html, and an even more rigorous future test is planned.

539. A motion picture of the Naudin's replica thruster in dynamic thrust performance is shown on http://jnaudin.free.fr/html/liftbldr.htm, along with information on many other successful "lifters". This website is a cornucopia of information on inertial propulsion and electrogravitation, including successful independent replication and tests.

540. Ryan Mahoney, "Huntsville Firm Developing New Propulsion Technology," Birmingham Business Journal, Birmingham, Alabama July 19,2001.

541. E.g., see J. Cameron, "An Asymmetric Gravitational Wave Propulsion System," presented in the Breakthrough Propulsion Physics session of the AIAA Joint Propulsion Conference, July 9, 2001.

542. Bearden, {40}.

543. Prange and Strance, {365

544. Privately, Sweet strongly affirmed to me that later he took the risk and pushed it a little further in output, actually levitating the system several times, including accelerating it upward, hovering it, and then letting it sink slowly down to come to rest on the bench.

545. Dirac, {249}.

546. Romer, {84}; see endnote 24, p. 109.

547. E.g., as by Giovanni Modanese, "On the theoretical interpretation of E. Podkletnov's experiment," Extract from report UTF-391/96, OANL gr-qc/9612022, presented to the *I.A.F. Congress 1997,* Number IAA-97-4.107.

548. Ling Ni and D. G. Torr, {532a-532d}.

549. Evans, {137b}; Evans, {485b}.

550. M. W. Evans, personal correspondence.

551. (a) Evans et al., {233b}; (b) — - "Development of the Sachs Theory of Electrodynamics," *Found. Phys. Lett.,* 14(6), Dec. 2001, p. 595-600; (c) Evans et al., {233a}.

552. As we point out in our discussion of cold fusion, use of this enormous time-energy density component in a time-reversal zone allows reducing the force of the gluons in a nucleon and nearly freeing the quarks. The time-reversal zone also reverses the law of attraction and repulsion of charges; now like charges attract. So the coulombic attraction of two H+ ions can attract them together so closely that each enters the strong force region of the other, forming a quasi-nucleus. As the other ions in solution move to negate the time-reversal zone, the zone decays, restoring the normal repulsion of the two protons in the quasi-nucleus. However, being exponential the strong force increases much more rapidly than the normal

coulombic repulsion grows. The result is to force the two protons even closer together, into a full nucleus with a full strong force between them. This forms a nucleus of deuterium, as one quark in one of the protons is flipped while still relatively free, to form a neutron. Different but similar reactions exist to produce the excess tritium shown in many cold fusion experiments, and a similar interaction — especially between two deuteron ions — forms an alpha particle.

553. Bearden, {17}.

554. Davies, {237}, p. 105.

555. Misner, Thorne, and Wheeler, {500}, p. 5.

556. Evans and Jeffers, {459}, p. 150.

557. Evans, {137a}, p. 477.

558. Banesh Hoffman, in Foreword to Yakov P. Terletski, *Paradoxes in the Theory ofRelativity*, translated from the Russian, Plenum Press, New York, 1968, p. vi, viii.

559. Kron, {162}, p. 466.

560. T. D. Lee, {239}, p. 46-47.]

561. This is well known to modern theorists, but is especially accented by Sachs and by Evans. E.g.. to even have an EM wave in space, the energy density of space has to be changing as the wave energy oscillates. This is an oscillating curvature of spacetime, a priori. So all EM waves move in a dynamically curving spacetime.

562. Sachs, {126b}.

563. These concepts are generally consistent with 0(3) electrodynamics. For rigorous exposition of 0(3) EM, see Evans, {137b [.

564. Felix Finster, "Definition of the Dirac Sea in the Presence of External Fields," *Adv. Theor. Math. Phys.*, Vol. 2, 1998, p. 963-985.

565. J. W. Lynn and R. A. Russell, "Kron's Wave Automaton," Journal unk, date unk, p. 131. We would appreciate any researcher furnishing us a completed citation for this reference. We have a copy of the paper, but without full citation details.

566. Kron, {162}. The quote is from p. 114.

567. Kron, {32}, p. 39.

568. Kron, {306}.

569. Kron, {32}, p. 41.

570. See Stigant, {310a} for a bibliography of Kron's **publications.**

571. Several overunity researchers have been assassinated by forces and parties unknown. Many very clever means are used to do the dirty work.

As an example, there is a standard EMF "shooter" which uses Venus modification of the wavefront, to produce a wave that instantly disrupts the control of the heart's beating. There are two versions at least; one about the size of a pocketbook and for close range (30 feet) only, and one about the size of a bazooka and with longer range (up to 100 yards). About 1 minute exposure to the beam of the small weapon will result in death of the targeted individual. I have personally been hit by the small version of that device (and I have a witness who was with me at the time, and also was exposed to it). We survived by instant recognition of what it was, and by bolting immediately out the nearby back door of a restaurant here in Huntsville. If the kill is successful, the autopsy will show that the person died of a heart attack.

Stan Meyer, an overunity researcher with numerous patents, rushed from a restaurant exclaiming "They're killing me!" and expired with just such a heart attack, possibly hit inside the restaurant by a close-range shooter.

Harry Mason's associate was killed in Australia in his apartment by a longer-range, bazooka-sized shooter. The assassin was spotted putting the shooter back inside the car below, and speeding away.

Sometimes a silenced rifle is used for sniping at long range. Sweet was fired at by one such would-be assassin — luckily just as he stumbled and fell on the steps of the foyer to his apartment complex. The bullet cracked right by his ear as he fell forward, passing where his head had just been the moment before.

Another "shooter" uses longitudinal EM wave peak power pulses. This type kill is instant and very permanent. This unit can be set to stun or render the targeted person unconscious, or set to kill. It can also disrupt and stop running automobile engines (there is another version for that also, using negative energy EMP weaponry). However, it time-charges the struck human body so that the body emits longitudinal EM waves for some time after the kill. Marinov was killed with such a shooter (apparently by

KGB-related foreign intelligence operatives) and his body then thrown off a rooftop to make it appear to be suicide. Where his body lay, the pavement glowed when the body was removed. Only one weapon on earth will kill a body so that it will induce luminescence in concrete or asphalt that it lies on for a period.

Another favorite weapon is an ice dart dipped in curare. I was threatened once and told I would be killed by such an ice dart weapon if I traveled in a 2-month period. Just four days past that period, and traveling and changing planes in Dallas-Fort Worth airport, a person was killed three feet from me in broad daylight, right inside the airport, with the exact symptoms of a curare ice dart kill. That was apparently just to teach me "they" were serious.

"They" is that set of cartels that Churchill called "the High Cabal". Bedini and I had severely offended the High Cabal by Bedini's successful transmutation of copper (and other things) into gold. John often makes his own power transistors for his amplifiers, and the slag in the electric oven turns into black ruby laced with gold and silver, confirmed by assay. We have had numerous other assassination attempts, too numerous to iterate. Suffice it to say that developing a good COP>1.0 EM power system can be hazardous to one's health.

Any significant researcher should be wary of "meeting with a sudden suicide" on the way to the supermarket. Another thing to beware of, is a calibrated auto accident where your car is rammed from the rear, and you are shaken up considerably. An ambulance just happens to be passing by moments later, and it will take you to the hospital. If still conscious, the researcher must not get in the ambulance unless accompanied by a watchful friend who understands the situation and the danger. Otherwise, he can easily get a syringe of air into his veins, which will effectively turn him into a human vegetable. If he goes to the hospital safely, he must be guarded by friends day and night, for the same reason, else he runs a high risk of the "air syringe" assassination during the night.

Simply trying to do scientific work, I find it necessary to often carry (legally) a hidden weapon. Both my wife and I have gun permits, and we frequently and legally carry concealed weapons.

As early as the 1930s, T. Henry Moray — who built a successful COP>1.0 power system outputting 50 kW from a 55 lb power unit - had to ride in a bulletproof car in Salt Lake City, Utah. He was repeatedly fired at by snipers from the buildings or sidewalk, with the bullets sometimes sticking in the glass. He was also shot by a would-be assassin in his own laboratory, but overpowered his assassin and recovered.

Over the years, probably as many as 50 or more overunity researchers and inventors have been assassinated for their efforts, and particularly For their success. Some have simply disappeared abruptly and never been heard from again.

These days the use of longitudinal wave shooters (such as killed Marinov) and such is growing, since no signature is left for a normal autopsy to discover. The Yakuza, e.g., uses such "shooters" in Japan to assassinate persons or politicians having incurred their displeasure. Others are subjected to the more traditional Yakuza assassination: Three or four assassins suddenly jump the unsuspecting target, stabbing him repeated and with extreme rapidity. His body may have 50 to 70 deep stab wounds — through the heart, the abdomen, liver, lungs, etc. — before the body strikes the pavement.

Other very sophisticated methods of legal entrapment, gaming, planting narcotics on one's premises and tipping off the drug enforcement agencies for a drug raid in the middle of the night, etc. are utilized.

Widely used is "gaming"', which uses deep psychological profiling to select a "vulnerability". The supercomputer with the game prepares a "scenario" much like writing a movie script of predictable interactions among the players to be chosen. The game involves "agents of influence" (AOIs — persons who are dogmatic, perhaps even radical, and have knee-jerk responses easily triggered, and whose vector direction when they "jump" is along or near the desired response direction), and one or two agents to do the phone conversations with the AOIs and trigger them into action), as well as a game controller or director. The computer programs also use prediction and artificial intelligence, and will forecast the probability of success of the selected game. A very extensive database of deep psychological profiles on useful AOIs and all major COP>1.0 researchers is kept in the computer. When the controller selects the game, the computer spits out the most recommended AOI players. The controller accepts or changes and then accepts, and the game scenario is then prepared. The agents trigger the AOIs, and the unwitting target is suddenly besieged from every direction, along a direction he already has an affinity or "vulnerability" towards. The controller follows the course of the game and the outcomes of all interactions between the target and the AOIs. The agent or agents add "nudges" or additional actions to overcome delays, accomplish redirection when the direction goes awry. etc. Over the decades, these games have gotten very effective indeed, and are quite difficult to content with. I laving survived about 200 of these games over the last two decades, I may yet write a book on some of the major ones that

have been used against overunity researchers. The games are not confined just to the overunity field, however, and sometimes are also used to directly intervene in politics and other key situations, {754}. Machiavelli's methods are not dead; they thrive and have been highly computerized.

572. More than a dozen potential mechanisms for overunity EM interactions and systems are given in Evans et al., {233i}. Many of these interactions are likely in highly energetic astronomical phenomena such as the gamma ray burster and the X-ray burster.

573. Evans et al., {38b, 38c}.

574. Bearden, {38a}.

575. Bearden, {30}.

576. Sweet and Bearden, {29a}.

577. (a) A. G. Reiss *et al., Astron. J.,* Vol. 116, 1998, p. 1009; (b) S. Perlmutter *et al., Astrophys. J.,* Vol. 517, 1999, p. 565.

578. A. Einstein, *Sitzungsber. Preuss. Akad. Wiss.,* Vol. 1917, 1917, p. 142. Einstein came to regret his introduction of the cosmological constani as his "greatest blunder". Ironically, this may yet turn out to be one of his greatest contributions.

579. Prange and Strance, {365}.

580. (a) R. Lieu, "The effect of Planck scale space time fluctuations on Lorentz invariance at extreme speeds," *Astrophys. J. Lett.,* 2002 (in press). A preprint is on http://xxx.lanl.gov/abs/astro-ph/0202443. See also (b) Philip Ball, "Time gives rays a break," http://www.nature.com/nsu/020304/0209304-5.html .

581. In 1998, experimental evidence of the accelerated expansion of **the** universe was provided by two groups of astronomers; see (a) Riess *et al.,* (577a}; Perlmutter *et al.,* {577b}. For an attempt to provide a new model for the negative antigravity, see (c) L. Parker and A. Raval, "A new look ill the accelerating universe," *Phys. Rev. Lett.,* Vol. 86, 2001, p. 749-752; (d) Philip Ball, "New model of expanding universe," *Nature News Service,* Science Update, Nov. 12, 2001. A good coverage for the educated layperson is (e) Mario Livio and Alan Sandage, *The Accelerating Universe: Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos,*[1]' Wiley, New York, Dec. 2000. See also (f) P. D.

Mannheim, "Implications of cosmic repulsion for gravitational **theory.'"** *Phys. Rev. D,* Nov. 15, 1998, p. 3511.

582. J. C. Bedini and T. E. Bearden, " Process For Transducing **Forms** of Electromagnetic Energy," U.S. Provisional Patent Application, 200 I. A formal U.S. Patent Application is in preparation as of this writing.

583. For a deep consideration of what is "meant" by mass, and how subtle the concept really is, the reader should refer to the scholarly work of Jammer {523a}. The more casual reader should be prepared for somewhat of a shock. Mass is not at all a "cut and dried" concept, as usually assumed. Indeed, the simple materialistic view of mass seems to be very much opposed by modern physics findings.

584. (a) Bearden, {12}. If we insert the absorption of a scalar (time-polarized) photon by the ubiquitously-assumed unit point charge and the subsequent re-emission of a longitudinal photon as the process for "combining" a scalar and longitudinal photon, then our solution is also consistent with (b) Mandl and Shaw, {19}. Mandl and Shaw argue that the longitudinal and scalar polarizations are not directly observable, but only in combination, where they manifest as the "instantaneous" Coulomb (i.e., electrostatic) potential. Our comment is that this argument, translated from particle terminology to wave terminology, then fits our re-interpretation of Whittaker's 1903 decomposition of the scalar potential in (c) Whittaker, {85}. It also strongly suggests the need for a complete reinterpretation of what is meant by "propagation of EM energy through 3-space".

585. E.g., see (a) V. I. Arkhipov *et al.,* "Negative transient currents in amorphous semiconductors." *Internal. J. Electronics* (UK), 51(6), 1981, p. 735-742; (b) — "An analysis of the dispersive charge transport in vitreous 0-55 As_2S_3 : 0*45Sb_2S_3," *Phys. Stat. Sol.* (A), Vol. 54, 1979, p. 67-77: (c) — and Rudenko, A. I., "Negative currents caused by injection-controlled polarization." *Solid St. Commun.,* 28, 1978, p. 675-676.

586. Evans, {137a, 137b, 251}.

587. David Jones, *Vancouver Sun Times,* Weekend Magazine, Dec. 17, 1977, p. 17. Article on Sid Hurwich's Toronto gun-jamming demonstration, stopping of watches, and jamming of a gun.

588. For proof of production of ordinary EM fields and energy at a distance by scalar **interferometry,** see **Evans** et **al., {**79}.

589. Miles and Bush, {198}, p. 101.

590. Bearden, {17}.

591. We point out, but do not further discuss, the obviously startling impact on the validity of the random statistical analyses normally used in scientific work if such "hidden variables" are present in the Earth's supersystem and interact with the experiment.

592. Kron, {192}, p. 466.

593. (a) Gabriel Kron, *Diakoptics: The Piecewise Solution to Large-Scale Systems,* MacDonald & Co., London, 1962. See also (b) Kron, {310b}.

594. Ilya Prigogine, Preface, (160b), p. xi.

595. Sir William Rowan Hamilton, 1837. Hamilton originated quaternion algebra, the Hamiltonian, etc. Hamilton's quaternion algebra has a higher group symmetry than either vectors or tensors. Since Maxwell's theory was first formulated in Hamilton's quaternion algebra and later reduced to vectors and then to tensors, ironically the first successful EM theory has been sharply curtailed rather than being further developed and extended.

596. (a) Aharonov and Bohm, {344a, 344b}.

597. Prigogine, {160b}, p. 104.

598. Lee, {441}, p. 23.

599. Jackson, {22}, p. 811-812.

600. Whittaker, {85}.

601. This is because time may be regarded as compressed spatial length, where the L compression factor is c. Since the energy of a wave is proportional to L^2 (where L is the wave amplitude), then the release of ST time-density as ST energy density provides nearly $9x10^{16}$ times as much effect per second as simple energy density curvature alone does per joule. For convenience, we refer to this as the "10^{17} gain factor" one obtains by releasing the compressed length energy from its time-density ST curvatture form.

602. T. Matsumoto, "Mechanisms **of Electro-Nuclear Collapse,"** *Proc, ICCF-7 (International Conference on Cold Fusion - 7),* Vancouver, BC, Canada, April 1998, p. 98.

603. Romer, {84}, endnote 24, p. 109.

604. See Harter et al., {102}. For a simple analogy, we may think of the longitudinal EM wave as a sort of velocity-modulated wave; i.e., it is rhythmically changing its velocity about some average value, where that value is usually taken to be c. Another way to visualize it is as an "accordion" wave, expanding and contracting along the line of travel.

605. There are several types (polarizations) of photons utilized in physics. E.g., see (a) Ryder, {90b}. On p. 147+, Ryder discusses four polarization states of the photon. Two of these are "transverse" —i.e., the well-known x- and y-polarizations of light; one is called "longitudinal," i.e., z-directed and related to Evans' B(3) field, and one is "scalar" or timelike.

The time-like (scalar) photon we are using in this paper seems to be yet another brand, something like a cross between the Ryder's third and fourth classifications. That is, our "scalar" photon is named such because when it is imperfect it propagates (i.e., in the 7 direction) at finite speed. When perfect, it just appears instantly everywhere it will be, without propagation through space in the usual sense. Hence it can be at an infinite number of points simultaneously - very close to the notion of the pure Coulomb gauge or of Bohm's quantum potential - or it can be impure and propagate at subluminal or superluminal speeds. The main notion we intend in our present use of the "scalar" photon for this treatise is that its oscillation is in the time domain and along the time axis. We use a model which produces the flow of time itself, and a time-component structuring of that flow — something which is still absent from physics. So our time-like (scalar) photon in one part very much resembles Ryder's discussion of the "scalar" photon, but is not just that alone. For instance, both our longitudinal photon and our scalar photon seem to have internal "photon" structures that we do not discuss in this treatise.

A still deeper discussion of photon polarization is in (b) Mandl and Shaw, {19}. The longitudinal and scalar polarizations are not directly observable, but only in combination, where they manifest as the "instantaneous" Coulomb (electrostatic) potential. So by this route one arrives at a well-established mathematical theory that allows a hidden substructure within **the photon itself.** Mandl and Shaw include the

photon's four polarization states as related to the four independent degrees of freedom available in the vector potential A. Suppression of the longitudinal and scalar polarizations is accomplished by "fixing the gauge". This reduces the independent degrees of freedom from 4 to 2, giving the conventional electrodynamics. However, when one raises serious foundations flaws in that resulting conventional electrodynamics, it is obvious that the entire structure is still on somewhat shaky ground. An even better mode might be to consider the fundamental photon entity as existing in all degrees of freedom, and the various "kinds" of photons existing due to restrictions or partial restrictions placed on one or more of these degrees of freedom. This of course opens the stage to interactions that change one (restricted) type of photon into a different (restricted) type. Thai is essentially the basis for my use of the notion of "photon transduction". Tt also leads to the transposition of time into energy and vice versa, which I use in my own approach, but which is still missing from nuclear physics. Since experimentally the cold fusion phenomena seem to require that characteristic, we have retained it.

We are indebted for much of the preceding discussion to private correspondence from Bob Flower, a fine scientist and knowledgeable in this area. Flower has pointed out that the conventional photon theory outlined by the cited authors is missing the possibility that nonlinear phase-conjugate optics could make the photon's longitudinal and scalar polarizations manifest in an experiment. Or put another way, if the instantaneous Coulomb potential could be decomposed into a time-like component and a longitudinal component, it would allow the two hidden polarization states to be controlled directly. This would result in anomalous modifications of the EM vector potential, leading to measurable electromagnetic or quantum effects. Flower's observation seems to be the closest to our own view, stated more simply in the present paper.

606. The result of our yet-unfinished struggle in these *very* swampy photon waters is not entirely consistent with the conventional view. Nonetheless, the new approach does seem to fit and explain most of the anomalous cold fusion phenomena, as well as a wide variety of other phenomena previously deemed beyond the pale of physics itself. E.g., by noting that *mind is time-like in its operations,* and therefore directly uses time-polarized (scalar) photons, waves, and electrodynamics, then mind operations become totally electromagnetic, but of a dramatically extended electrodynamic nature presently being approached in quantum field theory That approach leads directly to a testable and engineerable theory of mind

on all its levels (conscious, subconscious, unconscious, species unconscious, biospheric or all-species unconscious, and so on). But since the mind can interact with the body and produce at least the initial spatial forces carrying out intent in the physical world, it follows that some process must exist whereby the "time-like" photon interacts with and changes one or more of the other photons in the conventional view. Our use of *transduction* in fact encompasses that, based on quantum field theory as described by Ryder {90b} and by Mandl and Shaw {19}. Further, the present author's transduction reinterpretation of Whittaker's 1903 and 1904 papers {85, 91a} means that Whittaker's work as reinterpreted strongly supports this approach mathematically. So the approach used directly incorporates *mind and matter interaction,* again on multiple levels. While this area of *engineerable* mind and matter interaction is well beyond the scope of this treatise, it has become possible to begin the physics of the living being — even of the entire living universe — and to foresee direct engineering of the various realms of mind itself. Indeed, Russian psychoenergetics - particularly the highly weaponized secret part of it - already is involved in just that capability in deployed operational equipment of great portent. Since real results and real explanations of diverse metabiological phenomena have arisen from the approach as well as a very deep "more ordinary" physics including the necessary corrections to electrodynamics, we have continued to follow it to see where it eventually leads. A future book is planned on the more positive and beneficial uses of such startling technology. A preliminary view can be had on the author's website, www.cheniere.org, in the "porthole concept" briefing. A patent application has in fact been filed on this startling new method of medical healing.

607. (a) Vlail Kaznacheyev and L. P. Mikhailova, *Ultraweak Radiation in Intercellular Interactions,* [in Russian], Novosibirsk, 1981 [an English exposition of much of the Kaznacheyev work is given in (b) Vlail Kaznacheyev, "Electromagnetic Bioinformation in Intercellular Interactions," *Psi Research,* 1(1), Mar. 1982, p. 47-76.] See also (c) Kaznacheyev *et al.,* "Distant intercellular interactions in a system of two tissue cultures," *Psychoenergetic Systems,* 1(3), Mar. 1976, p. 141-142. In the same issue, see (d) "A Comment" by William A. McGarey, p. 143; (e) "A Comment" by Arthur C. Hastings, p. 143-144. See also (i) Yu. A. Vladimirov, "Ultraweak luminescence of subcellular structures," *Ultraweak Luminescence in Biology: Proceedings of the Symposium,* Moscow, 1969 [In Russian], Robert Becker also showed in his healing of

otherwise intractable bone fractures that a simple scalar potential (now known to involve the direct transduction between scalar and longitudinal photons and vice versa), that cellular dedifferentiation and redifferentiation of red blood cells occurred in the scalar potential region across the damaged bone cells, and directly in such manner as to "eliminate the delta engine" in those damaged bone cells in the fracture. The red cells shucked their hemoglobin, turning back (time-reversing) to a more primitive cell (earlier state). Then they redifferentiated (time-forwarded) into the type cells that make cartilage. There is still a delta engine between cartilage and bone! So these cartilage-like cells redifferentiated again into the kind of cells that make bone. These latter cells were deposited in the fracture, healing it. This process is in fact used today in various medical hospitals, without any real understanding of the physics mechanism involved. In short, it has long been experimentally proven without understanding the actual mechanism by which it works. See (g) Robert O. Becker, "The direct current field: A primitive control and communication system related to growth processes," *Proc. XVIInternal. Congr. Zoology,* Washington, D.C., Vol. 3, 1963, p. 179-183; (h) — and Charles H. Bachman and Howard Friedman, The direct current system: A link between the environment and the organism," *New York State J. Medicine,* Vol. 62, April 15, 1962, p. 1169-1176; (i) — and Joseph A. Spadaro, "Electrical stimulation of partial limb regeneration in mammals," *Bull. N.Y. Acad. Med,* Second Series, 48(4), May 1972, p. 627-64. See also (j) C. A. L. Bassett; R. O. Becker, and R. J. Pawluk, "Effects of electric currents on bone *in vivo," Nature,* Vol. 204, Nov. 14, 1964, p. 652-654.

608. Puthoff, {202}.

609. See (a) A. Shapere and F. Wilczek, Eds., *Geometric Phases in Physics,* World Scientific, 1989. See also (a) M V. Berry and J. M. Robbins, "Indistinguishability for quantum particles: spin, statistics and the geometric phase," *Proc. Roy. Soc. LondA,* Vol. 453, 1997, p. 1771-1790.

610. See Mandl and Shaw, {19}, Chapter 5 and simply reinterpret the coupled scalar and longitudinal photon pair as a spin 2 graviton.

611. In fact, Sweet's vacuum triode amplifier probably used the domains and nuclei in a barium ferrite permanent magnet in such a graviton reaction manner. In an epochal experiment designed and conceived by the present author, Sweet reduced the weight of the device

on the lab bench, smoothly and efficiently, by 90 degrees. For **the** description, see Sweet and Bearden, {29a}.

612. Reginald I. Gray, *Unified Physics,* Naval Surface Warfare Center, Dahlgren, VA, 1988, p. 2-19.

613. For the basic explanation of a scalar interferometer, see Evans et al., {79}.

614. See Chapter 3, paragraph 3.1 through 3.5.

615. Bearden, {12}.

616. As an example, see Bunge, {3}, p. 179-180. Quoting: " *The most complete direct interparticle action theory of electromagnetism is WHEELER and FEYNMAN'S (1949). Its central postulate is Fokker's action principle for a collection ofpoint charges.... from which the equations of motion for charged particles follow. As can be seen, only particle variables occur in this theory, which is an electrodynamics in AMPERE'S sense and therefore the opposite of a unitary field theory. (The theory is mathematically equivalent to an "adjunct" field theory, but this adjunct field, far from being free, is attached to the particles.) The theory has been abandoned by its creators because it is inconsistent with the quantum theory, in particular with the photon hypothesis. Yet it continues to appeal to many not only because it smacks of mechanism and operationalism, but also because no self-forces appear in it and consequently no infinite self-forces (and the corresponding self accelerations) But this is too small an advantage compared with its shortcomings even at the classical level. Indeed, the theory makes use of special relativity - as is apparent from its central axiom...yet it is inconsistent with it for SR borrows from CEM the assumption that e.m. signals propagate in a vacuum with a constant speed c and moreover lead an existence, which, while it lasts, is independent of both emitters and absorbers. In other words, by denying the existence of free radiation fields propagating in space, the action at a distance formidation of CEM contradicts its own basis: it is logically inconsistent. "*

Our comment is that the "photon" interaction itself must be re-examined in light of the demonstrated giant negentropy of every change and dipole in the universe. Allowing for the quantum field theoretic combination of the scalar and longitudinal photons as an observable "photon" that is actually a spin-2 graviton in 4-space rather than 3-space. the entire nature of "propagation of EM energy through space" changes. No photon has ever interacted in just 3-space; instead, it interacts in

4-space. In the strong interpretation of giant negentropy, there is really no such thing as a "single observable photon" in the universe. Instead, there is a combined scalar/longitudinal photon pair, which when interacting in matter causes transverse EM wave movement of the interacting/detecting charges which are restrained by (i) the inertia due to their own mass, and (ii) in circuits, the back repulsion of all other like charges longitudinally ahead of the excited charge that absorbs the "photon" (actually, the graviton). Considering the longitudinal wave "bunching and relaxing" actions resulting in galloping, then the conventional assumption of the constant speed of light c in vacuum is destroyed. What we perceive as "light propagating in space at speed c" already moves in a galloping and jerky motion *about* speed c — now moving superluminally, now moving subluminally — with only an *average* speed of c overall. In turn, anything which affects the performance and "galloping mechanism" exhibited by the longitudinal EM wave can in theory be used to change the speed c. With the coming advent of the Fogal semiconductor and direct superluminal communication, all such objections based on previous rather classical assumptions will simply fall by the wayside. We also stress that the speed of gravitational field is shown in astronomical events and effects to be extraordinarily superluminal by many orders of magnitude. Again, this greatly upsets many of the modeling assumptions in present physics. Physics is based on a set of models and a set of experiments and observed effects. If the experimental effects negate the theory, one has to change the theory or be guilty of abandoning scientific method altogether, thereby turning science into dogma.

617. Cohen, {89}.

618. See Rod Donnelly and Richard Ziolkowski, "Electromagnetic field generated by a moving point charge: A fields-only approach," *Am. J. Phys.*, 62(10), Oct. 1994, p. 916-922. In conventional language, both the transverse and longitudinal field components always try to be born initially, whenever an EM wave is being generated. Generation of the transverse component produces a function which zeroes the longitudinal component. The function appears in the spacetime representation of the transverse EM fields, obtained by Donnelly and Ziolkowski using special transforms. The phase conjugating and retroreflecting aspects of cold fusion experiments produce spacetime curvatures, directly affecting the "canceling function." The altered function becomes an "LW-reduction function" which is postulated to determine the mix of transverse and longitudinal field components that emerge in the interactions.

619. Whittaker, {85} shows that the scalar potential is **comprised of** bidirectional longitudinal EM wavepairs. Whillaker, {91a} shows **that all** fields and waves are comprised of two interfering scalar **potential** functions. Hence all fields and waves are comprised of **functions** of longitudinal and scalar wave interferometry.

620. Evans et al., {79}.

621. Usually the detecting GM tubes will detect the interferometry of the incident longitudinal EM waves with the weak LWs being emitted in the tube itself by time-decay of its time-charges. The resulting transverse wave EM energy ionizes the tube's gas, and the GM tube "reads." If little or no time-decay is occurring, then there will be little or no transduction into TWs, hence little or no ionization. In that case the instrument will not read.

622. Miles and Bush, {198}, p. 101.

623. *Ibid.*

624. (a) Evans, {137b}; (b) Evans et al., {233a, 233f}.

625. Rodrigues and Lu, {93a}.

626. Enders and Nimtz, {329b}.

627. (a) W. A. Rodrigues, Jr. and J. Vaz Jr., "Subluminal and Superluminal Electromagnetic Waves and the Lepton Mass Spectrum," *Kluwer Ac. Pub. Proceedings,* <hep-th/9607231> on Los Alamos web site; (b) P. Letelier and W. A. Rodrigues Jr. (Eds.), *Gravitation: The Spacetime Structure,* World Scientific Publishing Co., Singapore, 1994; (c) J. Vaz Jr. and W. A. Rodrigues Jr., "On the equivalence of Maxwell and Dirac Equations, and Quantum Mechanics," *Internal. J. Theor. Phys.,* Vol. 32, 1993, p. 945-958; (d) J. Vaz Jr. and W. A. Rodrigues Jr., "Maxwell and Dirac Theories as an Already Unified Theory," *Adv. Appl. Clifford Algebras,* Vol. 7 (S), 1997, p. 369-386; (e) W. A. Rodrigues Jr. and J. E. Maiorino, "A unified theory for construction of arbitrary speeds ($0 < v < \infty$) solutions of the relativistic wave equations." *Random Operators and Stochastic Equations,* Vol. 4, 1996, p. 355-400; (f) Rodrigues and Vaz, {93b}.

628. Torn Van Flandern, "The speed of gravity - What the experiments say," *Phys. Lett. A,* Vol. 250, 21 Dec. 1998, p. 1-1 1.

629. *Ibid.,* p. 9.

630. *Ibid.*, p. 10.

631. A. A. Vlasov and V. I. Denisov, "Einstein's formula for gravitational radiation is not a consequence of the general theory of relativity," *Theor. Math. Phys.*, 53(3), June 1983 (English translation), p. 1208-1216. Translated from *Teoreticheskaya i Matematicheskaya Fizika*, 53(3), Dec. 1982, p. 406-418 [in Russian].

632. D. Hilbert, *Gottingen Nachrichten*, Vol. 4, 1917, p. 21.

633. Sen, {68}, p. viii.

634. Mandl and Shaw, {19}.

635. Logunov, A. A. and Yu. M. Loskutov, "Nonuniqueness of the predictions of the general theory of relativity," *Sov. J. Part. Nucl.*, 18(3), May-June 1987, p. 179-187.

636. Whittaker, {85}

637. I.e., that spacetime == scalar potential == virtual particle flux == Whittaker biwave set. If that holds, then when we engineer the internal structure of the scalar potential, we also simultaneously engineer the internal structuring of the vacuum and spacetime itself, with deliberately formed spacetime curvature engines (vacuum engines). This is vacuum engineering — by different means — of the sort proposed by Nobelist T. D. Lee, {73}, p. 380-381. On p. 383, Lee points out that the microstructure of the scalar vacuum field (i.e., of vacuum charge, or — in our view — of the vacuum potential) has not been utilized. Particularly see Lee's own attempt to indicate the possibility of using vacuum engineering, in his "Chapter 25: Outlook: Possibility of Vacuum Engineering," p. 824-828.

638. Ingram Block and Horace Crater, "Lorentz-Invariant Potentials and the Nonrelativistic Limit," *Am. J. Phys.*, 49(1), Jan. 1981, p. 67.

639. Roderic Lakes, "Experimental Limits on the Photon Mass and Cosmic Magnetic Vector Potential," *Phys. Rev. Lett.*, 80(9), Mar. 2, 1998, p. 1826. Our critique is that the given equations define nothing at all, since no equation is a definition. If one replaces the "=" with "≡" in the "definition" of the A-potential in terms of B, one then has B==curl A, which is actually the definition of B in terms of A. If A has no energy, then neither can B, which is just the swirl of the A-energy. If A has no curl, B vanishes. If A has no energy, B vanishes. Yet $dA/dt = -E$, whether

A has curl or not, and E has energy. Ergo, A must have energy if **any** operation upon it is to produce **E-field** energy, else one has **violated the** conservation of energy law and advocates creation of energy from **nothing.** Regardless of how one looks at B = curl A and B = curl A, neither the equation nor the identity defines A in terms of B, because B is always, just one aspect of A and yet A can exist without any curl at all — without B as demonstrated in the Aharonov-Bohm effect. But in no fashion can B exist without A. Therefore A is primary and B is derived, and if A has no energy then B can have no energy. V has energy and energy density, since in fundamental units any point of the potential V is identically the joules of energy collected upon a unit point positive electrical charge assumed at that point. If it had no energy, then no joules could be collected from it.

640. Weinberg, {194}, p. 109-110.

641. Sen, {68}, p. viii.

642. (a) Lee, {13a}; (b) Wu et al., {14}; (c) Lee, {239}, p. 57-59; (d) Lee, {73}, p. 184.

643. Bearden, {12}

644. Whittaker, {85}.

645. The clustering of virtual charges around observable individual charges — due to the polarization of the vacuum — is well known in quantum electrodynamics. Macroscopically one sees the charge as partially shielded by the cluster, so the clustering charges are known to have macroscopic significance. At close enough distances, one sees the "bare" charge with reduced shielding.

646. Mandl and Shaw, {19}.

647. (a) Aharonov and Bohm, {344}; (b) R. G. Chambers, {474}.

648. E.g., see (a) Barrett, {345}; Barrett and Grimes [Eds.], {235b}.

649. (a) Evans *et al,* {113a}; (b) — "Self-Inconsistencies of the U(l) Theory of Electrodynamics: Michelson Interferometry," *Found. Phys. Lett.,* 12(6), Dec. 1999, p. 579-584; (c) — *J. New Energy,* Vol. 4, Winter 1999, p. 231-235; (d) — "Derivation of the Lehnert Field Equations from Gauge Theory in Vacuum: Space Charge and Current," *Found Phys Lett.,* 13(2), April 2000, p. 179-184; (e) Evans et al., {233g}; (f) Evans **et** al.. {233e}; (g) — **"Equations of the** Yang-Mills Theory of Classical Electrodynamics," ***Optik, 111***(2), 2000, p. 53-56; (h) **Evans** el **al.,** {113***b}.***

Also (i) more than 100 papers on restricted U.S. Department of Energy Internet website http://www.ott.doe.gov/electromagnetic/.

650. Obviously we exclude active systems such as matter that decays in nuclear fashion. Those are not inert systems, but are "pre-excited" systems whose matter has had excess energy since its formation during the birth of the universe.

651. (a) Kondepudi and Prigogine, {160c}; (b) — "Thermodynamics, Nonequilibrium," *Ency. Appl. Phys.* Vol. 21, 1997. p. 311-337.

652. I.e., the known broken symmetry of the charge (regarded as a set of composite dipoles) in its vacuum energy exchange.

653. Kraus, {76}, p. 578, Figure 12-60, a and b.

654. James Croll, *Phil. Mag.*, Series 5, Vol. 2, 1876, p. 242-254.

655. Heaviside, {5a-5c}.

656. Poynting, {4a, 4b}.

657. Heaviside, {106}.

658. E.g., see Lorentz, {109}.

659. E.g., (a) Panofsky and Phillips, {110}; (b) Gough and Richards, {224b}. (c) Jackson {22}, p. 259, points out the arbitrary nature of the Poynting vector and disposes of any added nondivergent energy flow vector with the words *"Such an added term can, however, have no physical consequences."*

660. Simply examine *Vqt* around the forward emf section (the external circuit between the generator terminals and the ends of the source dipole inside the generator), and - *Vqt* across the generator terminals (and the source dipole).

661. Evans etal, {38b, 38c}.

662. Bohren, {24}. Independent replication is reported in the same journal issue; see (b) Paul and Fischer, {25}.

663. Bearden, {40}.

664. See Paragraph 8.3.16 in Chapter 8 for the explanation.

665. Olariu and Popescu, {482}.

666. Bertram Schwarzschild, "Currents in normal-metal rings **exhibit** Aharonov-Bohm effect," *Phys. Today,* 39(1). Jan 1986, p. 17-20.

667. Paul and Fischer, {25}.

668. One actually inputs far more electrical energy flow from **the** external electrical power supply than is conventionally accounted, if one accounts for the huge nondiverged Heaviside energy flow component that Lorentz arbitrarily discarded. That energy flow is actually present, but Is not accounted once Lorentz' integration trick is applied to integrate the entire energy flow vector around a closed surface assumed around any volume element of interest.

669. Evans et al., {113a}.

670. As is any EM system when the nondiverged very large Heaviside energy flow component is accounted in addition to the diverged Poynting energy flow component.

671. Bearden and Bedini, {582}.

672. As an example, two scalar potentials fi_1 and fi_2 may have precisely the same intensity magnitude, but different Whittaker internal bidirectional longitudinal EM wave structures. The effects of the two externally identical potentials — as in various chemical reactions — can be quite different. See Bearden, {17}.

673. Lee, {73}, p. 380-381.

674. Lee, {73}, p. 184.

675. For succinct summary of the major symmetries and broken symmetries in physics, see Lee, {239}, p. 57-59.

676. Wang and Chung, {33}.

677. Jean-Louis Naudin, "Chung's Negative Resistance Experiment", on website http://jnaudin.free.fr/enr/enrexpl.htm.

678. Burford and Verner, {35a}.

679. Early but sophisticated analogue simulator. E.g., see Kron, {306}, p. 173.

680. E.g., see (a) Kron, {32}, p. 39. Quoting: *"Although negative resistances are available* ***for*** *use with a network analyzer...* "; — "Numerical solution of ordinary and partial differential equations by

means of equivalent circuits." See also (b) Kron, *J. Appl. Phys.*, Vol. 16, Mar. 1945a, p. 173. Quoting *"...since none or only a few negative resistances exist on practical network analyzers)"* (accent added). In the second quotation, arguably Kron was required to insert the underlined words. In the first quotation, the censors missed the clarity of the statement.

681. Kron, {192}.

682. Sweet and Bearden, {29a}.

683. Self-oscillation in such magnetic materials (which are also optically active) is well known. E.g., (a) L'vov, {29c}; (b) Borovik-Romanov and Sinha [Eds.], {369b}. See particularly (c) Gurevich and Melkov, {232c}.

684. Rosenthal publicly verified the results of his tests of the Sweet device to the 26th session of the Intersociety Energy Conversion Engineering Conference (IECEC '91), Boston, Massachusetts, 1991.

685. David M. Pepper, "Applications of Optical Phase Conjugation," 254(1), Jan. 1986, p. 83.

686. Bearden, {15}, p. 2-10.

687. Bearden, {17}.

688. Time-polarized photons are recognized in quantum field theory, implying the existence of time-polarized EM longitudinal waves. In coupling with spatial longitudinally polarized EM waves in wavepairs, the coupling is observable as scalar potential energy (stress energy), based on an argument by Mandl and Shaw {19}. Opposing time-polarized longitudinal EM waves therefore constitute "time-stress", "time-stress potential", and optical pumping in the time domain, which is hypothesized to reverse the normal "forward time" law of attraction and repulsion of charged particles.

689. Kenneth Shoulders and Steve Shoulders, {38If}.

690. U.S. patent numbers 5,018,180; 5,123,039; 5,054,046; 5,054,047.

691. Jain, {35b}.

692. Cao et al, {264b}.

693. Prange and Strance, {365}.

694. Roger Penrose, {82}, p. v.

695. Bunge, {3}, p. 176.

696. Albert Einstein, {la}, p. xi-xii. Appendix I.

697. Raymond A. Serway, *Physics for Scientists and Engineers* ***with*** *Modern Physics,* Third Edition, updated version, Saunders College Publishing, Philadelphia, 1990, p. 620.

698. Max Planck, *Treatise on Thermodynamics,* 3rd ed., Dover, New York, 1945.

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711. (a) D. K. Sen, *Fields and/or Particles*, Academic Press, London and New York, 1968, p. viii. Thirty-two years later, we published the solution to that problem in (b) T. E. Bearden, "Giant Negentropy from the Common Dipole," *J. New Energy*, 5(1), Summer 2000, p. 11-23. Also carried on DoE restricted website http://www.ott.doe.gov/electromagnetic/ and on www.cheniere.org.

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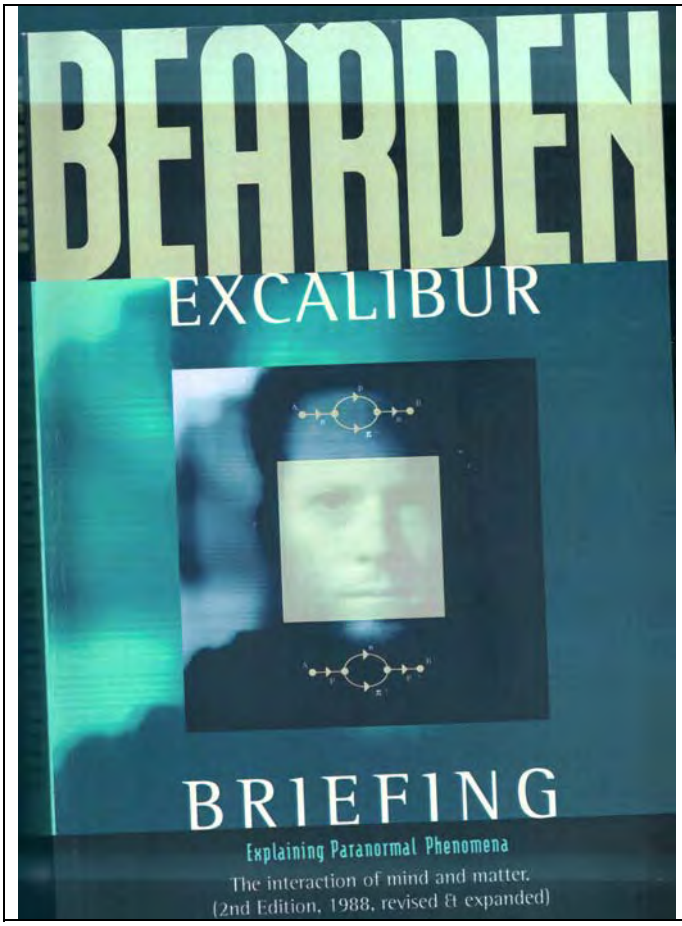

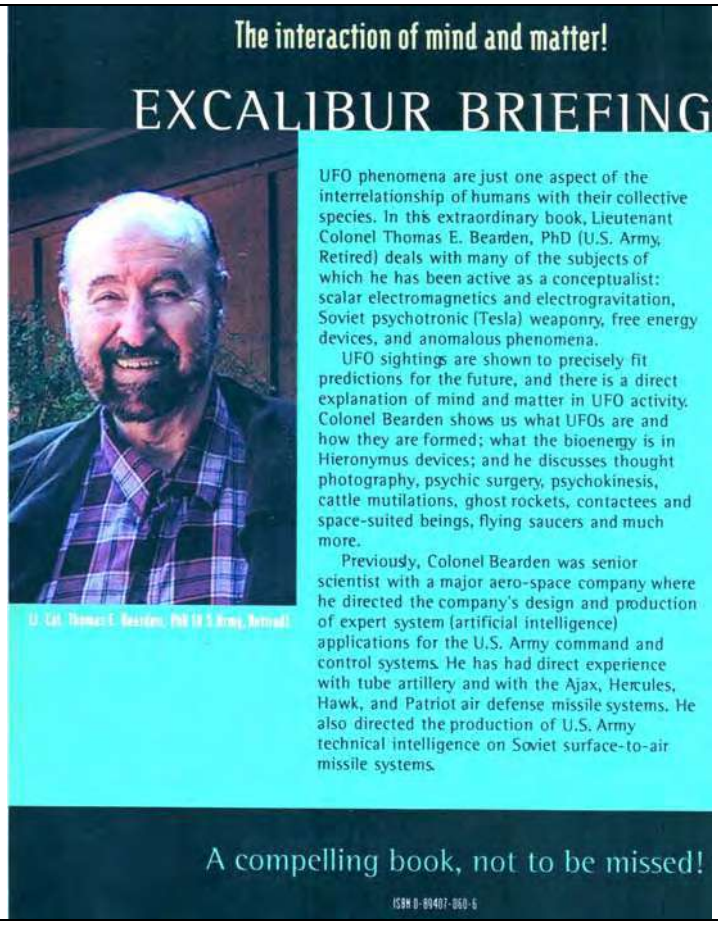

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Lieutenant Colonel Thomas E. Bearden (U.S. Army, Retired) Ph.D., was formerly senior scientist and department manager of a major aerospace company where he directed the design and production of expert systems (artificial intelligence) applications for the U.S. Army command and control systems.

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Tom Bearden is the author of several books and numerous papers, briefings and presentations, dealing with anomalous phenomena, scalar electromagnetics, free energy devices, Soviet Tesla weapons, and Soviet scalar electromagnetic weather warfare; he is also the producer of several videotapes on these subjects.

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FOREWORD

by John White

This book deals in a comprehensive fashion with such a vast array of topics — from physics, psychology and evolution to advanced weaponry, military strategy and international politics — that many of you may become anxious, even fearful on reading it. In fact, this assembly of previously uncorrelated information and scientific breakthrough may be the most disturbing you have ever received.

This cannot be helped. This book represents an important step in our efforts to avoid global war involving not only nuclear armaments but also what appears to be a revolutionary development in Soviet military technology — psychotronic weapons. They are the modern equivalent of the legendary invincible sword, Excalibur.

The author is former U.S. Army officer Lt. Col. Thomas E. Bearden, now retired. During his twenty-year military career specializing in artillery, nuclear weapons, and military intelligence, Tom has pondered and researched many subjects that he covers here. His access to the full range of both military and NASA documents will be evident in his book. What may become highly classified data in the future is being revealed to you, our nation's ultimate policymakers, for an urgent reason that Tom has called Operation Fer-de-Lance, the presumed Soviet plan for domination of the planet through nuclear-psychotronic aggression and warfare. For the moment I would simply like to note two statements that indicate the basis for our sense of urgency:

1. On 13 June 1975, Soviet Premier Leonid Brezhnev urged a ban on research and development of new kinds of weapons "more terrible than anything the world has known."

2. In January 1977 former Air Force Chief of Intelligence, Maj. Gen. George J. Keegan (Retired) told *Newsweek* magazine, "The Soviets are working on dramatically exotic new weapons, twenty years ahead of anything ever conceived in the U.S. — so awesome as to lead the Soviets to believe that in the coming decade they would be capable of total neutralization of our ballistic and submarine missiles."

The U.S. military intelligence community interprets these signs in conventional terms as perhaps indicating the development of laser rays. Tom disagrees. His book will deal with the possibility that these weapons are psychotronic or paraphysical in nature.

In fact, we can say that in a strict sense, these are not weapons but devices — breakthrough technology with an enormous potential for the destruction of humanity. They are a second-or third-generation outgrowth of radionic devices presently used in unorthodox medicine for diagnosis and healing. Extremely compact, they could be carried in a suitcase and planted near targets — ICBM sites, communications centers, etc. Even if one of these devices were found and examined, it would only look like an electronic switching circuit or a small transmitter/receiver set, rather than a bomb or explosive.

The energy and the mechanism involved in psychotronic damping of nuclear, chemical or electromagnetic technology is, from all indications, unrecognized by official Western science but nevertheless inherent in it. That also has been deeply pondered by Tom, and this book will give a full explanation of the physics, mathematics and technology involved. It is not an exaggeration to say, as Tom does, that the explanation offers a "physics of metaphysics" — a fully developed theory of paranormal phenomena that elegantly unites physics and psychology. The ramifications of what Tom calls perception theory lead into every field of human knowledge and inquiry with revolutionary results — from science, theology and philosophy through the full spectrum of paranormal phenomena such as UFO's and psychokinesis into the elementary school classroom, the supermarket shopping basket and the voting booth. They most certainly lead into the safety of your homes and the integrity of your minds.

Before you turn to *The Excalibur Briefing,* I want to leave you with these thoughts. The material you are about to read will certainly be denied by our own government and military and probably by a major segment of the scientific community. It is not unlikely that Tom will be dismissed as a paranoid crackpot. Such tactics have been employed before against brilliant, courageous people who challenge the fundamental dogma of the establishment as Tom does here. Nevertheless, I want to reassure you that Tom is sane, sober, and serious.

Of course, such a person could still perhaps be mistaken. In that regard, I believe you will find Tom's presentation to be persuasive. He himself is careful to distinguish speculation from fact, inference from descriptive statement. Even if Tom were paranoid, however, the question arises: *What if there is good reason for paranoia?* To phrase it positively: We should welcome truth and enlightening insight whenever offered, regardless of the source. Do not let *ad hominem* arguments affect your critical judgment about the soundness of this presentation. Assess the work, not the man, for the work is always greater. And having judged the work affirmatively, render true acknowledgement — not lip service — by sharing the ideas in this book with others. Only free, informed, vigorous effort in the court of world opinion can defuse the possibility of Operation Fer-de-Lance and psychotronic mind control leading to total enslavement of the human race.

In closing, I want to point out that Tom's fundamental concern is the unification and evolution of the human species to a higher form of life through a process that he terms "mind linkage." This stage of growth to higher consciousness is explored in the latter part of the book. It is a breathtaking portrait of how the spirit of science can lead to a science of the spirit, to a physics of metaphysics.

INTRODUCTION TO THE SECOND EDITION

Since the first edition of *Excalibur Briefing* was published, a great deal of progress has been made on the actual physics of unusual and paranormal phenomena. Indeed, so much progress has been made in the ten years since the 1978 or so cutoff of most of the Excalibur material, that I really should rewrite the entire book. However, time will not permit that luxury at present I am simply too hard-pressed in the strenuous efforts to move a free energy machine to market and to convince our government that unorthodox Soviet superweapons present us with a problem of the gravest magnitude.

Accordingly, the inclusion of one of my latest papers, "Soviet Phase Conjugate Directed Energy Weapons," together with an updated glossary for the entire emerging field, will have to suffice.

The important thing is that **a separate new field of physics is beginning to emerge.** It turns out that what we've gotten on to is a unified field—one can now turn electromagnetic energy into gravitational energy and vice versa. Indeed, gravitational potential is now revealed as simply infolded electromagnetics, and electromagnetics is simply the outfolding of the internal contents of gravitational potential.

Colleagues have already proven it on the laboratory bench, by building both "free energy" devices and practical antigravity devices.

This new, extended electromagnetics—electrogravitation—I have dubbed **scalar electromagnetics.** The key to it is to let the EM force fields fight themselves to a "cancellation," forming **a** vector zero. If we do this in a nonlinear medium (modulator), the summing/multiplying EM vector forces are locked together and remain as an infolded EM system inside the EM vector zero. This now is a gravitational system. By merely varying (in phase) the summing EM components, one varies the local energy density of vacuum. Rigorously that is a gravitational wave. Further, it is a very powerful G-wave, for we are utilizing EM forces some 1042 times as strong as the normal weak G-force.

Classical EM has taught us to simply discard the components in the zero vector summation, replacing the system of opposing EM forces with a vector EM zero. This of course makes all vector EM zeroes equal. However, it totally ignores the space-time/vacuum stress of the summed forces, and the resulting gravitational implications. Therefore we have been taught to ignore any gravitational aspects of normal EM circuits, and indeed we proceed to release the G-stress effects in the circuits when we build them as we have been taught

Ordinary EM represents the release of the internal stress of gravity. By teaching us to make nonzero EM, scientists have taught us to always release electrogravitational potentials as electromagnetic forces. Thus in classical EM—and in most of the circuits we build—the EM force fields are the primary causative agents. Classically, when these force fields reduce to zero, there is no more electromagnetics going on. That is true, but there can still be a very large amount of gravity and inertial effects going on!

However, quantum mechanics teaches us that the EM force fields are not at all the primary causes. Instead, the potentials are the primary things; EM forces are simply made from these potentials by differentiating operators. And when the force fields are zero, the potentials still exist. Further, when these "forceless potentials" interfere—

even at a distance—real EM effects cun still be obtained, in total violation of ordinary EM and ordinary mechanics!

This is called the Aharonov-Bohm Effect, and in 1986 it was finally proven to most physicist's satisfaction. Only the most diehard skeptics still object to it, according to *Physics Today,* January 1986.

At any rate, when we have zeroed the E and B fields, we can still have the potentials, according to modern physics. These potentials can interfere to produce electromagnetic force effects—even at a distance.

Further, the zero summation can be dynamic; that is, the vector components can be varying, so long as they always sum to a zero vector. Actually such a zeroed system now has an infolded, deterministic pattern of dynamic forces, according to the pattern we deliberately construct. Further, the energy of each force component infolded is varying, and thus the overall energy density of local vacuum is varying.

As we said, rigorously this defines a gravitational wave. So the zero-vector approach allows EM wave energy to be turned directly into gravitational wave energy. Now it is the curvature of spacetime that is being varied locally. That's a really astounding thing.

We can now deliberately engineer the vacuum/spacetime itself, with all that that statement implies. Locally we can bend spacetime itself, which Einstein assumed could never be done except by a huge collection of mass—such as a sun, star, neutron star, etc. But here we can do it with simple things such as opposing coils, opposing E-fields, etc. We've just violated one of the sacrosanct, severely limiting assumptions of ordinary (Einstein's) general relativity!

That is, up to now most Western physicists have assumed that the local spacetime/vacuum cannot be curved. They assume that, where we the observer and the laboratory instruments are, only special relativity applies. Locally the observer always has a "Lorentz frame," in that view. This assumption (the local Lorentz frame) means that all the conservation laws apply, and physical reality stays well-behaved where the laboratory is and where we are. Ordinary relativity becomes just a sort of "special relativity with distant perturbations."

The only curvature of spacetime of any consequence is only to be found at or near distant stars, suns, black holes, and other huge collections of mass, in this highly restrictive view. Further, this assumption implies that one can never have an experimental general relativity, since where one is experimenting (locally) there is always essentially zero spacetime curvature!

However, one need not have such a formidable restriction at all. Two bucking transformers can make a B-field vector-zero a little bit More complex circuits can easily be designed to sum (or multiply) force fields to zero very well. When we do this zero summation, we also get an amazing gain as follows: Consider two electrons in free space. As is well known, the electric field force (repulsion) between them is about 10^{42} times as strong as the gravitational field force (attraction) between them. So the electric force is so very much stronger that the comparatively weak gravitational force can be entirely neglected, in most applications. However, if we "strangle" that electric field force by zero summation, all the opposing electric forces are converted directly into gravitational potential!

Interference of two such potentials can directly generate gravitational forces. So, if

we could zero-sum their E-fields perfectly, we could instantly amplify the gravitational force between the two electrons by a factor of 10^{42}. With such a gravitational force amplification factor, our altered "electrical" circuits would actually become powerful electrogravitational circuits. Further, appreciable gravity effects would now be experienced by any mass, object, or device exposed to the action of the circuits. This is the fundamental secret that Nikola Tesla discovered, one which he never openly revealed.

Further, by locking opposing EM waves together, we may easily construct purely scalar EM (electrogravitational) waves and beams. In such case, amazing new phenomena are encountered: (1) one can increase or decrease the mass and inertia of an object; (2) one can produce a unilateral force in and on each and every nucleon in a body, thus accomplishing the long-sought "antigravity"; (3) a unilateral force drive—a "space drive"—can be constructed; (4) transmutation of elements becomes fairly simply done, with miniscule energy; (5) effects at a distance—such as cold explosions or hot explosions—can be accomplished; (6) negative energy and negative time effects can be created and utilized; (7) Newton's third law can be manipulated and violated at will; (8) negative entropy effects can be created and utilized; and (9) direct energy extraction from the vacuum can be accomplished, etc. So many new effects are encountered that it will take a generation of graduate students and university laboratories to get a good handle on most of them.

The reader is urged to remember these rules: (1) The destructive interference of scalar EM waves (electrogravitational waves) produces EM energy in, or extracts it from, the interference zone. (2) The destructive interference of ordinary EM waves produces gravitational potential energy. (3) The release of the ordinary EM force fields represents the bleed-off of a 5-dimensional gravitational potential as ordinary electromagnetics. (4) The bottling-up of the ordinary EM force fields represents the forced bleed-off of a 5-dimensional gravitational potential as ordinary 4-dimensional gravitational force. (5) The EM field and the ordinary (4-space) G-field are just separate bleed-off s of the same 5-dimensional gravitational potential field.

Thus, I make no bones about it; we have a new physics in the offing—one that is eminently practical and easily engineered by any modern electromagnetics laboratory.

Since the first edition of this book was issued, it has also become obvious that at least two other phenomena are involved in UFOs, and intermingled with the "materializations from the collective unconscious" true UFO phenomena. These two additional things are:

(1) A great number of "lights at night" and "mysterious fireball" type phenomena—and giant balls of light and glowing hemispheres of light of gigantic size—are actually due to deliberate Soviet long range, high energy, real-time holography using phase conjugation. These phenomena are to accomplish orientation and alignment of giant Soviet weapons, and at the same time deliberately evoke UFO reports and scientific skepticism, providing perfect deception.

(2) Several nations of the world—at least two—have been building and flying antigravity spaceships all over the solar system, since the early 1950's. A very small number of UFO ship reports and encounters are due to these ships and their crews. However, control of these ships is not under any duly elected government, but passes out of the government concerned, into and under the control of some mysterious group

which I loosely refer to as "the control group." This is the same mysterious group which has been suppressing free energy and antigravity inventors and inventions for a great number of years.

Thus in *Excalibur Briefing* we are still addressing the primary UFO phenomena: Materializations from the collective human unconscious. Coverage of the other two parts of the overall reported UFO phenomena will be made elsewhere.

So it seems that, under my hard-pressed circumstances, the best thing to do for the second edition of *Excalibur Briefing* is to include something that shows some of the drastic progress that has been made. By adding a glossary and a current paper, the book will also be made much more usable. I also have prepared an index for the first edition, but it cannot be included because of space limitations. Admittedly that is regrettable and still not the optimum, but it will have to suffice. Perhaps in the future I will be able to do a complete rewrite of the book, for *Excalibur III.*

Until then, I ask the reader's indulgence and understanding.

* * *

In the first edition we accented the hyperspatial aspects of the problem, but also pointed out that higher dimensional spaces and deeper nested levels of virtual state are in fact one and the same thing. The reader should keep in mind that when we "inter-nest" vector zero systems, we are performing direct engineering in hyperspace.

Let me be more specific. When you zero sum a group of EM force vectors, you place those component vectors "inside the zero," so to speak. In modern language you have placed ordered patterns directly inside the violent flux of virtual particles comprising the vacuum. The modern concept of the vacuum is that it is like a seething plasma or gas. However, it's a very strange gas, for each particle arises spontaneously out of nowhere (according to quantum mechanics), and almost immediately turns into something else and/or disappears. Thus the vacuum plasma or gas is rather peculiar; the particles comprising it appear and disappear so rapidly that they cannot individually be detected. However, while a virtual particle exists, it is in motion, and so a violent flux of these "phantom particles" comprises the vacuum/spacetime.

However, just as many fleeting particles in the vacuum are moving backward in observer time as are moving forward in it! So this wild "vacuum gas" of ghost particles exists in both positive and negative time at once!

Anyway, when we make a zero vector EM system, each component force in the summation represents a gradient in this virtual particle flux. That is, we have "patterned" and organized the flux—polarized it, so to speak. And that now overturns one of the fundamental assumptions of quantum mechanics.

Quantum mechanics assumes that the violent flux of vacuum ghost particles is totally randomized. That is, no deterministic pattern exists in the flux. These virtual changes collect or cohere statistically, not deterministically, in the standard assumption. When they happen to collect/cohere sufficiently, the threshold of an observable quantum change is breached, and a quantum change occurs.

It can readily be seen that, in the ordinary view, the occurrence of these quantum changes is totally statistical. And indeed it is, so long as the virtual particle flux is randomized. However, with zero vector summation (or multiplication) we have produced

deterministic patterns in the flux—and hence in the cohering and collecting of this flux on observable charged particles. Therefore, these deterministic "virtual state" ordered patterns will result in the appearance of deterministic patterns in the occurrence of observable quantum changes.

Now we have begun to engineer physical reality directly; that is, one can now begin to pre-determine which statistical change shall be favored, or in the extreme case, which one shall occur, and whether or not it shall even occur at all.

The renowned physicist, David Bohm, has written a theory of "hidden variables" which could fit and describe all of physics (nothing out there contradicts it). It has largely been ignored, and will continue to be ignored unless it can show appreciable application that normal theory cannot cover. With the scalar EM approach, we can now directly provide hidden EM force field vectors, ordering the virtual state vacuum flux, and we may vary these ordered virtual patterns at will to produce startling new results in charged particle systems. So now we can directly engineer Bohm's "hidden variables," and the vacuum itself—something ordinary theory cannot cover. Drastic changes in the physicist's view of fundamental physical reality, and of what he can do about it, now result

But to return: We wish to engineer additional hyperspaces. (The first zero-vector summation places the component vectors in the fifth dimension.) If we take one of the component EM vector forces in the first zero vector summation, and we then take a point on it as yet another "reference zero", we may encapsulate a second series of zero-system summation vectors into and within that zero-point. In this case we have placed these second vectors into yet a deeper level of virtual state vacuum. That is, we have reached into yet another hyperspace with our engineering and control. Indeed, we have placed the second system EM vectors into the sixth dimension. So we have become true hyperspace engineers.

The process is repeatable as desired. We may reach any hyperspace we wish, as our technology and control develop.

Now we see the impact In modern Kaluza-Klein geometry, one needs about 11 or so dimensions if one is to account for quarks, charm, etc. Now we have a direct tool to reach into any one or all of these hyperdimensions and affect the exact particle or component desired. We will be able to engineer matter—including the nucleus, and including inside the proton and neutron—in almost any way we wish. It all follows from scalar electromagnetics, which allows the direct engineering of hyperspace in all its dimensions.

Remember, engineering in hyperdimensions is just the engineering of nested levels of vacuum potentials. Even more startling, we can also place "thoughts" and effects directly in the mind itself, including the unconscious mind.

As we stated in the first edition of this book, we may model the mind as simply an objective 3-space, three turns away from the 3-space of the ordinary physical world. If we nest two or more additional zero-vector systems in our first one, then we have placed affects ("vectors") directly inside the mind itself. If we know the code of the human brain-tuner, we can now manipulate the mind directly. Electromagnetically, by scalar EM. And it appears that the Soviet Union has begun to reach this frightening capability.

Disease patterns may be induced upon ordinary EM carriers in the same manner,

by nesting the zero-vector systems. That is, of course, if one has measured the scalar patterns evident in the induced disease, say, in the Kaznacheyev-type experiments with the desired disease patterns. The reverse is also true: Nesting the patterns in the proper context on EM field carriers can cure diseases such as cancer and leukemia, as evidenced by the Priore device.

One can also make a practical "free energy" device by setting up a standing scalar wave resonance in a localized region or device. From the "high stress" point to the "low stress" region of vacuum formed by such a standing scalar wave, a literal "river of energy" is flowing in the vacuum itself. Once the river is established, only the "leakage" need be replenished. Hence, if one builds a special sort of "paddle wheel" to react with the river and turn in it, one obtains shaft power freely from the localized curvature of spacetime. In that case, an ordinary generator can be driven by the shaft torque to provide very cheap, or"free," electrical energy.

Several inventors—three of whom I work with in one respect or another—now have demonstration models of such machines, which take diverse forms.

Because of the extreme importance of these emerging potentialities, in recent years I've concentrated intensely upon the properties of the vacuum as spacetime, and uncovered shortcomings (and downright errors in many cases) in ordinary physics and electromagnetics. Slowly the scalar EM picture has emerged, and a series of papers has been written and published to develop the concepts of the new approach.

The scalar approach also includes the ability to engineer negative energy and negative time flow. The reader is referred to Chapter 4, "Extraordinary Physics," of my forthcoming book, *AIDS: Soviet First Strike,* Tesla Book Co., P.O.Box 1649, Greenville, Texas 75401 for a summary of the vast importance of the time-reversed EM wave (phase conjugation).

Let me here just accent a rule of great importance: It is actually the key to negative energy, negentropy, antigravity, free energy, transmutation, Tesla's wireless transmission of energy at a distance without loss, Tesla's original magnifying transmitter, and many other things.

First we need the expression CPTEGS, where C is charge, P is parity, T is time flow, E is energy, G is gravity, and S is entropy. We shall be concerned with the algebraic sign of each term in the expressioa The rule deals with photon interaction with a charged particle inside an atom. Normally, incident photons interact with an electron in the electron shells, so C is normally negative. This produces normal parity, and causes the normal or positive flow of time, s T is normally positive. The normal kinds of energy, gravity, and entropy are experienced, so energy is positive, gravity is positive (attraction), and entropy is positive (progressive interactions in a system tend to more and more disorder).

The astonishingly powerful rule is this: In a photon interaction with a charged particle in an atom, if any one of the terms of the expression CPTEGS is reversed in algebraic sign, all the other terms are reversed in algebraic sign.

Thus if one makes scalar EM, the wave (and its photons) passes through the electron shells and interacts with (is absorbed in, and raises to an excited state, which then decays to emit a wave and photons) the highly nonlinear, positively charged nucleus. This represents a reversal of C, hence a reversal of P, T, E, G, and S also.

Consequently, a time-reversed wave—a phase conjugate replica of the incident

wave—is emitted by the decaying excited nucleus. In nonlinear phase conjugate optics, this is the mechanism that produces the phase conjugate wave. This is also the mechanism that produces a very large amplification of the incident wave when a "pump wave" (two waves 180 degrees out of phase) are used in the nonlinear (modulating) medium of the phase conjugate mirror.

(The reader is referred to any good book or summary paper on phase conjugate optics; for example, see David M. Pepper, "Nonlinear optical phase conjugation," *Optical Engineering* 21(2), Mar./Apr. 1982, p. 156-183.).

When one pumps a phase conjugate mirror material sufficiently, then "tickles" the release of the total nuclear excitation energy as phase conjugation replica waves (negative energy), appreciable negative time is produced in the decaying nuclei of the mirror. In negative time, gravity is a repulsion, not an attractioa The mirror thus produces antigravity, and gets lighter. If it is forced to sufficiently high amplification, it can be made to float in air. At higher amplification still, it will accelerate upward.

Some other references of interest to this new edition follow:

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2. **Ya. Zel'dovich, N. F. Pilipetsky, and V. V. Shkunov, *Principles of Phase Conjugation*, Vol. 42, Springer Series in Optical Sciences, Theodor Tamir, Ed., Springer-Verlag, New York, 1985.**
3. **Amnon Yariv, *Optical Electronics*, Third Edition. Holt, Rinehart and Winston: New York, 1985. See particularly Chapter 16: "Phase Conjugate Optics—Theory and Applications."**
4. **Y. Aharonov and D. Bohm, "Significance of Electromagnetic Potentials in the Quantum Theory." *Physical Review*, Second Series. 115(3), Aug. 1,1959. p. 485-491.**
5. **R. G. Chambers, "Shift of an electron interference pattern by enclosed magnetic flux." *Physical Review Letters*. 5(1), My 1,1960. p. 3.**
6. **Richard P. Feynman, Robert B. Leighton, and Matthew Sands, *The Feynman Lectures on Physics*. Volume n, Section 15-5, p. 15-8 to 15-14.**
7. **E. T. Whittaker, "On an expression of the electromagnetic field due to electrons by means of two scalar potential functions." *Proc. Lond. Math. Soc.*, Vol. 1,1903. p. 367-372.**
8. **T. E. Bearden, *Solutions to Tesla's secrets and the Soviet Tesla weapons*. Tesla Book Co., Greenville, TX, 1981.**
9. **T. E. Bearden, *Tesla's secret and the Soviet Tesla weapons*. Presented in absentia at the First International Unorthodox Energy Symposium, Toronto, Canada, 1981. Available from Tesla Book Co.**
10. **T. E. Bearden, "Soviet weather engineering over North America." 1-hour videotape, 1985. Available from P.O. Box 1472, Huntsville, AL 35807.**
11. **Gwynne Roberts, "Witness to a super weapon?" *The Sunday Times*, London, England, Aug. 17,1980.**
12. **Greg Rippee, "Mushroom cloud sighted off Japan." *LosAngeles Daily News*, Apr. 11,1984. p. 1,8.**
13. **Martin Ebon, "Moscow, June 11, 1977." in his *Psychic Warfare: Threat or Illusion*. McGraw-Hill Book Co., New York, NY, 1983. p. 1-11.**
14. **A. K. Lapkovskii, "Relativistic kinematic equations and the theory of continuous media." *Soviet Physics Journal* 21(6), June 1978-Dec. 1978.**
15. **B. N. Belyaev, "On random fluctuations of the velocity of light in vacuum." *Azvestiya Vysshikh Uchebnykh Zavederdi, Fizika*. 11, Nov. 1980. p. 37-42.**
16. **Ingram Bloch and Horace Crater, "Lorentz-invariant potentials and the non-relativistic limit" *American Journal of Physics*. 49(1), Jan. 1981. p. 67-75.**

Becker's dc treatment of bone fractures

Application of tiny DC currents to heal difficult bone fractures. Only picoamperes are utilized. Pulsed DC current or pulsed magnetic fields may also be utilized.

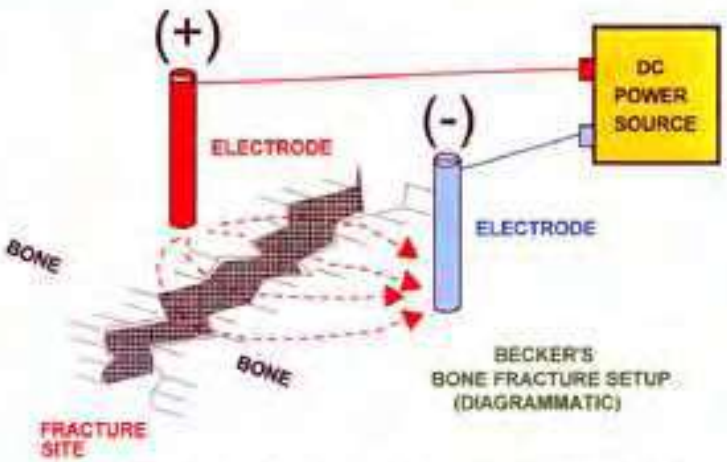

BECKER'S
BONE FRACTURE SETUP
(DIAGRAMMATIC)

RED BLOOD CELL DEDIFFERENTIATES
Shucks hemoglobin coat
Grows nucleus

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes cartilage

NEW CELL REDIFFERENTIATES
Turns into type of cell that makes bone
Deposits in fracture site, healing the fracture

Proves that cells can be time-reversed (phase conjugated) (dedifferentiated) or time-forwarded (redifferentiated) by application of very weak electromagnetic signals, when those signals contain longitudinal bidirectional EM "pump wave" wavepairs, which cause the cell and its parts to create precise vacuum antiengines.

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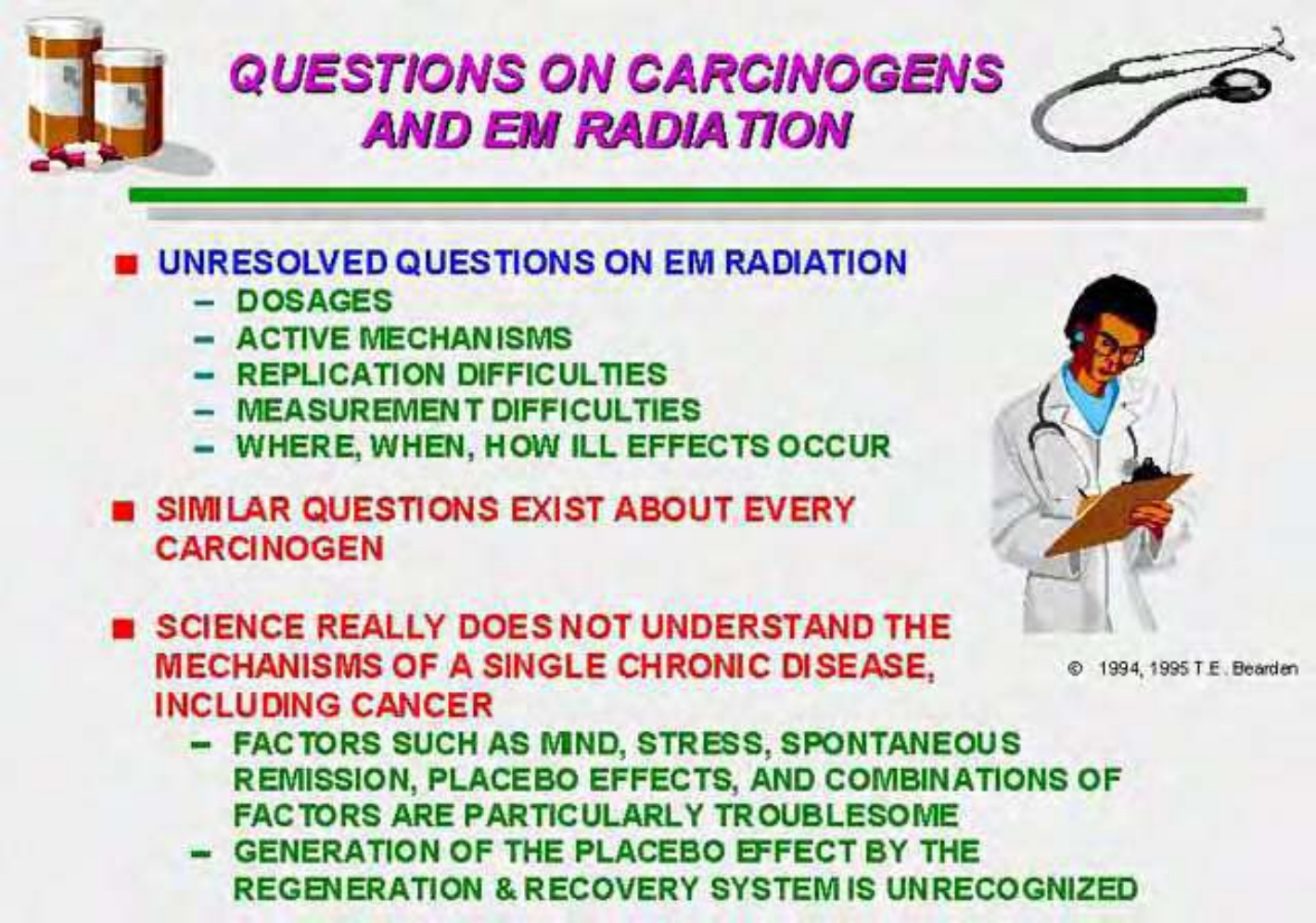

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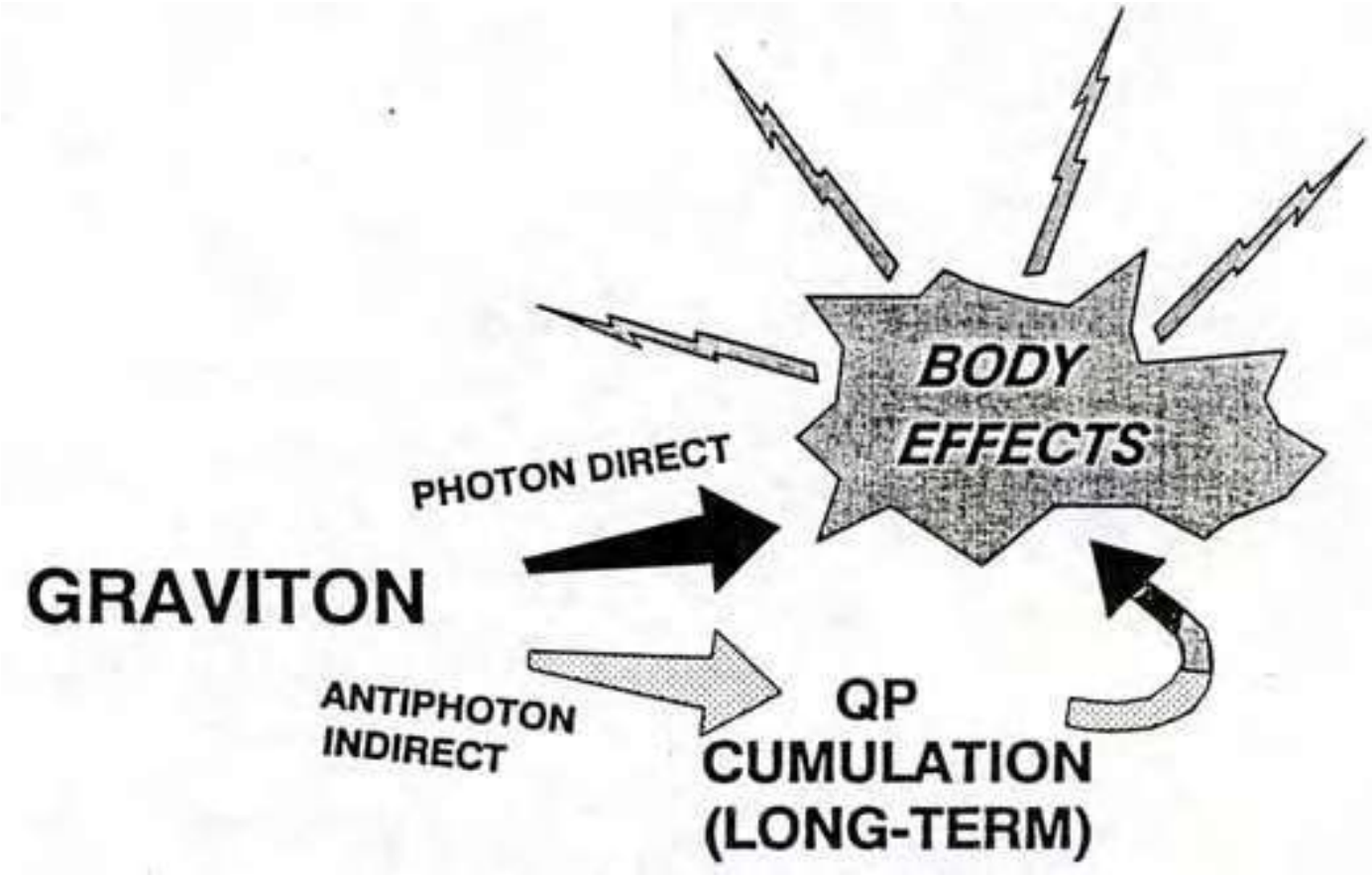

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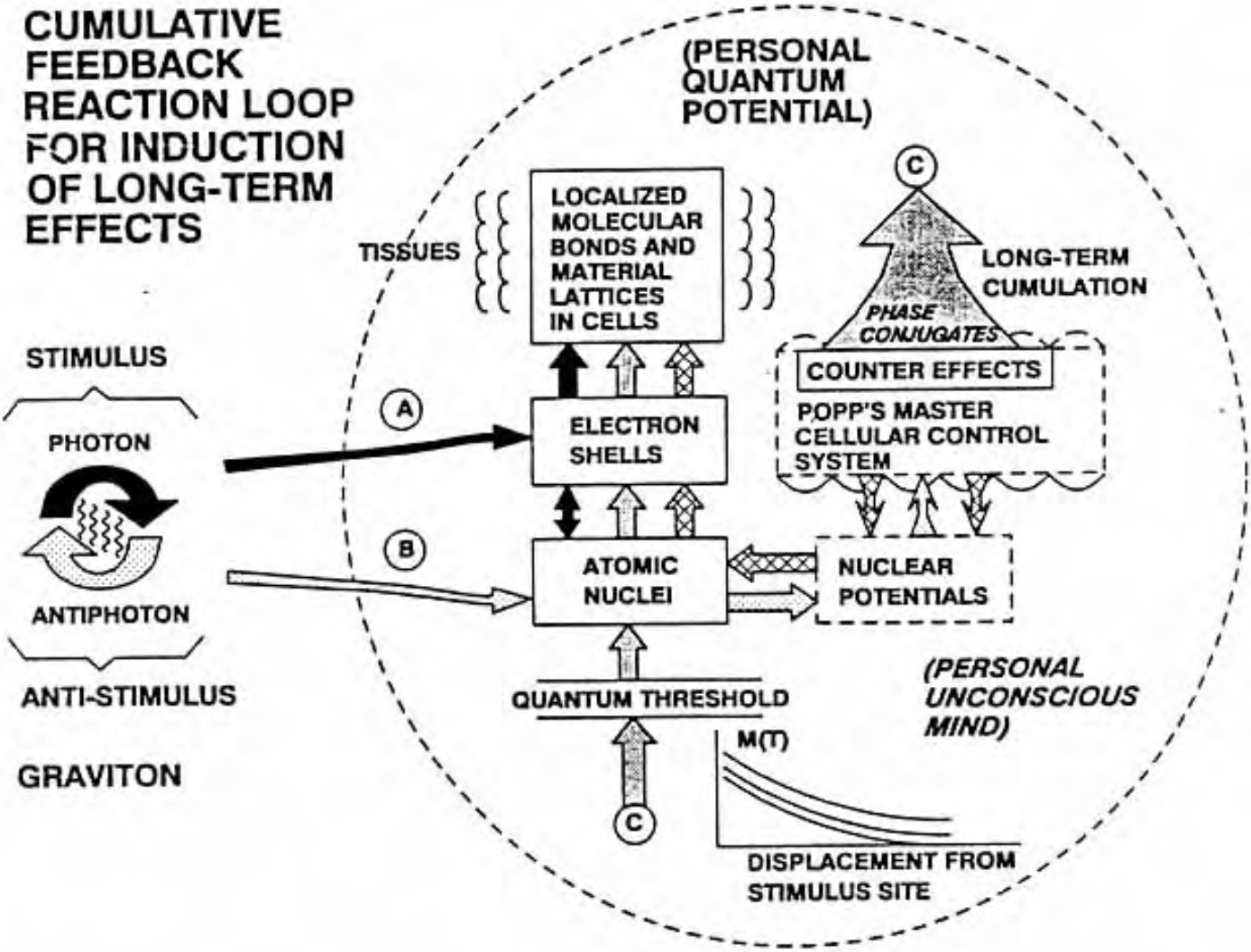

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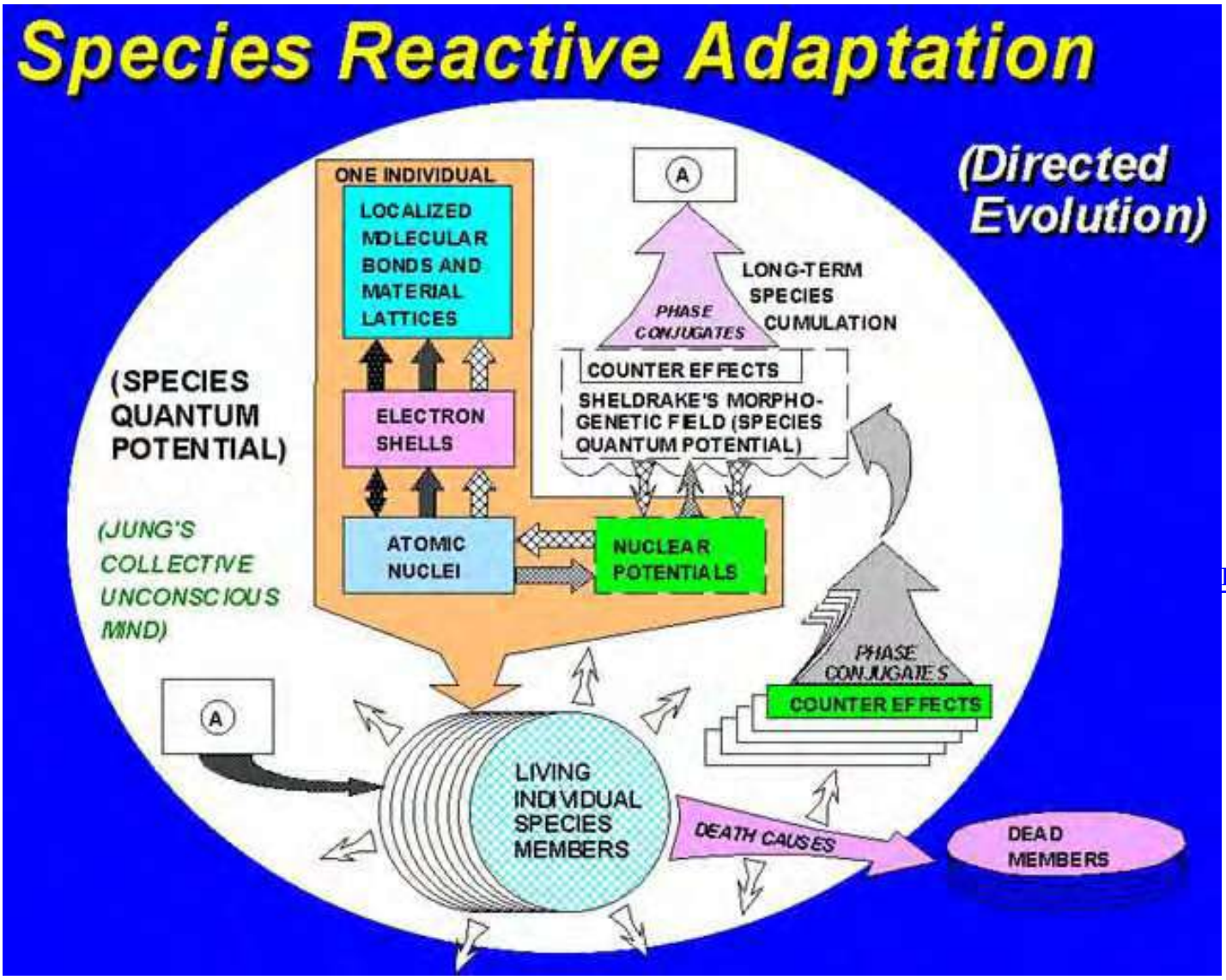

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INHERITANCE OF ACQUIRED TRAITS

- Evolutionary biology assumes mutations are random events
  - Causes of heritable differences separated from their consequences for survival and reproduction
  - Likelihood of any particular mutational event assumed independent of its particular value to the organism
  - Natural selection then assumed to increase the frequency of advantageous alleles
- Evidence for directed, non-random mutation
  - Removing cell-wall from bacterium: acquired nakedness is then inherited
  - Protozoan Oxytricha double monsters (siamese twins)
    - Bisected lengthwise, normal reproduction
    - Bisected crosswise, double monsters reproduce
  - Virus Sigma and fruit fly sensitivity to CO_2
  - Specific sets of genes either eliminated or added to an organism by organelles, plasmids, bacteria or other agents
- Genes are acquired vertically from ancestors and horizontally from a variety of other factors

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Deep penetration of weak signals in a dense signal environment, by nonlinear retroreflection

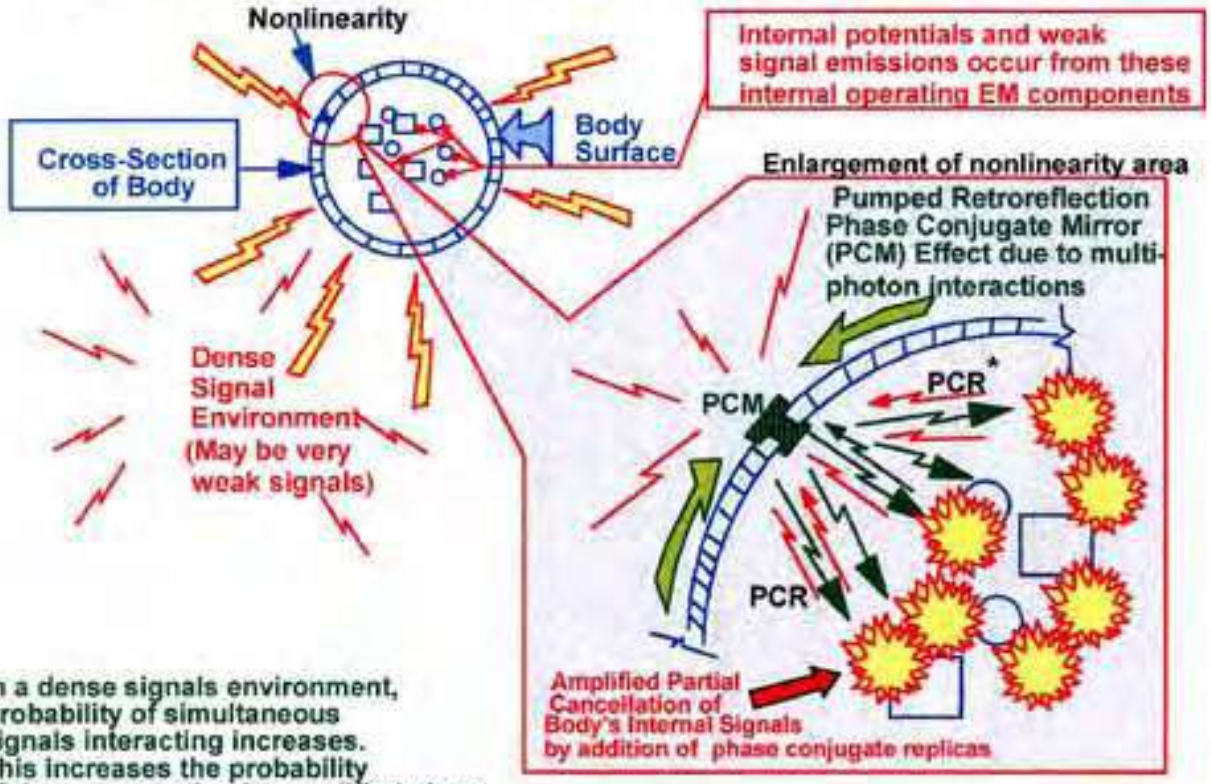

In a dense signals environment, probability of simultaneous signals interacting increases. This increases the probability of deep penetration by amplified phase conjugate reflections of weak internally generated signals from the interior, impinging upon the pumped (stressed) nonlinear surface areas where the simultaneous exterior interactions occur.

* Phase conjugate replica

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ANOMALOUS DEPTH PENETRATION

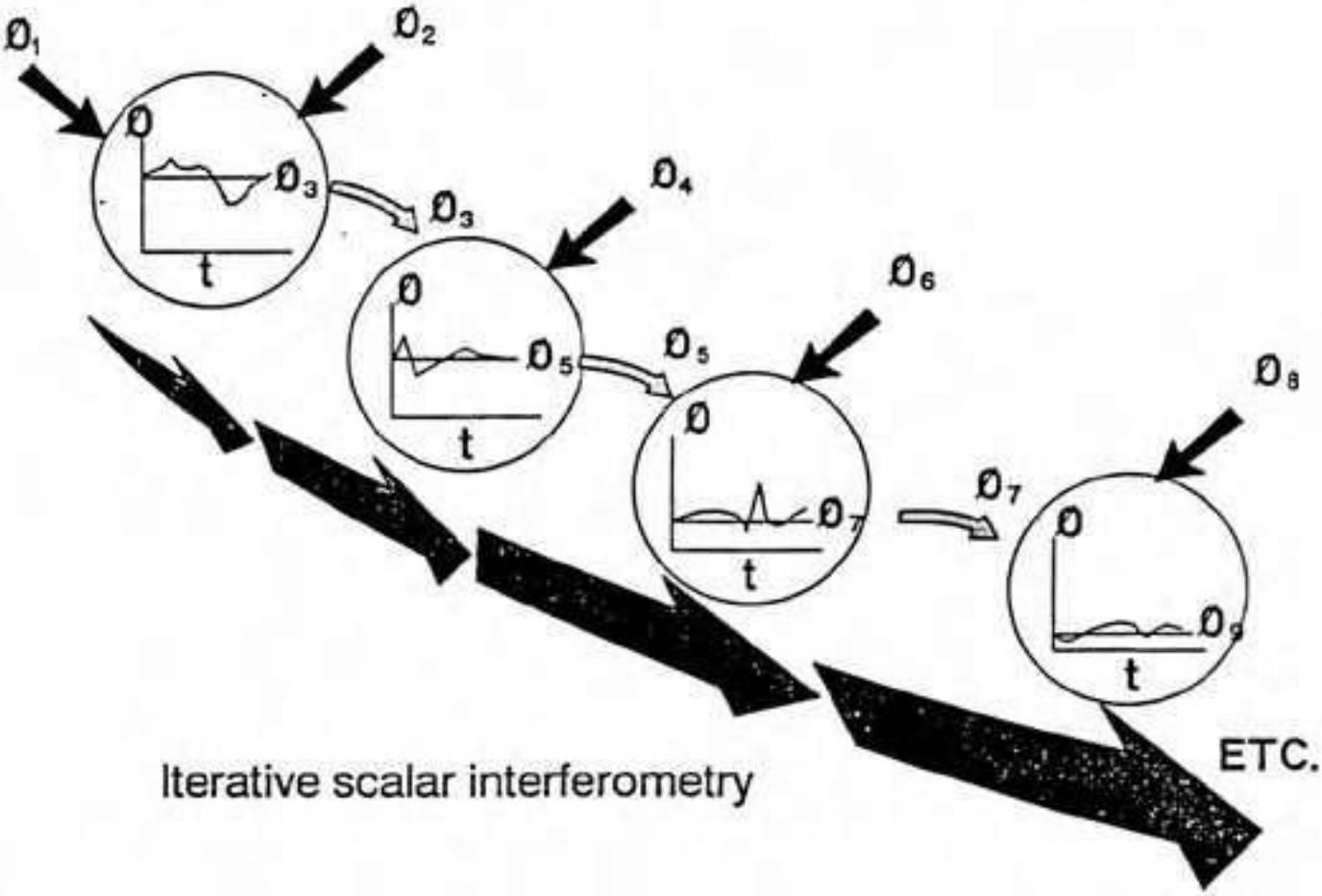

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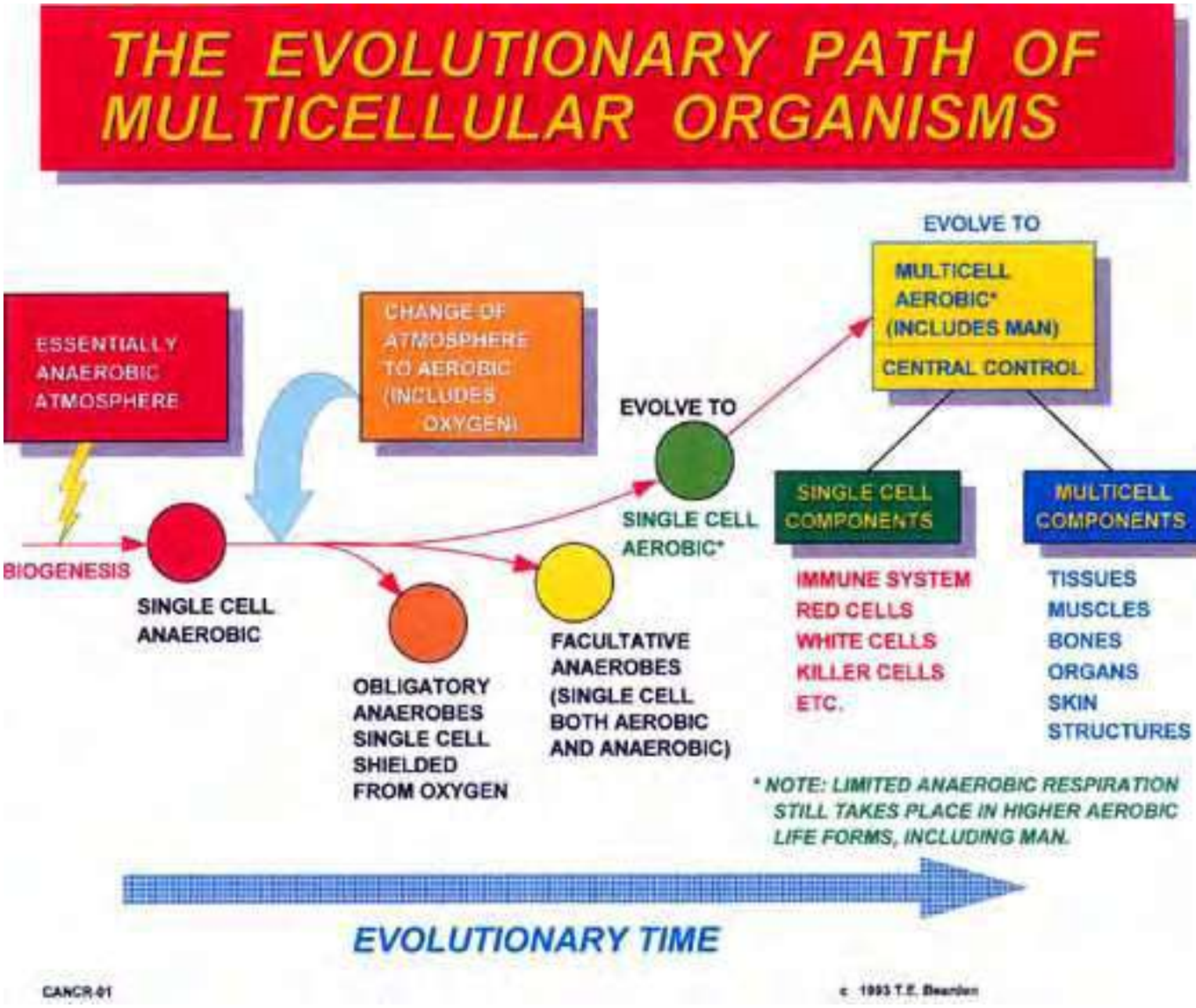

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DEVELOPMENT OF MULTI-CELLED ORGANISMS

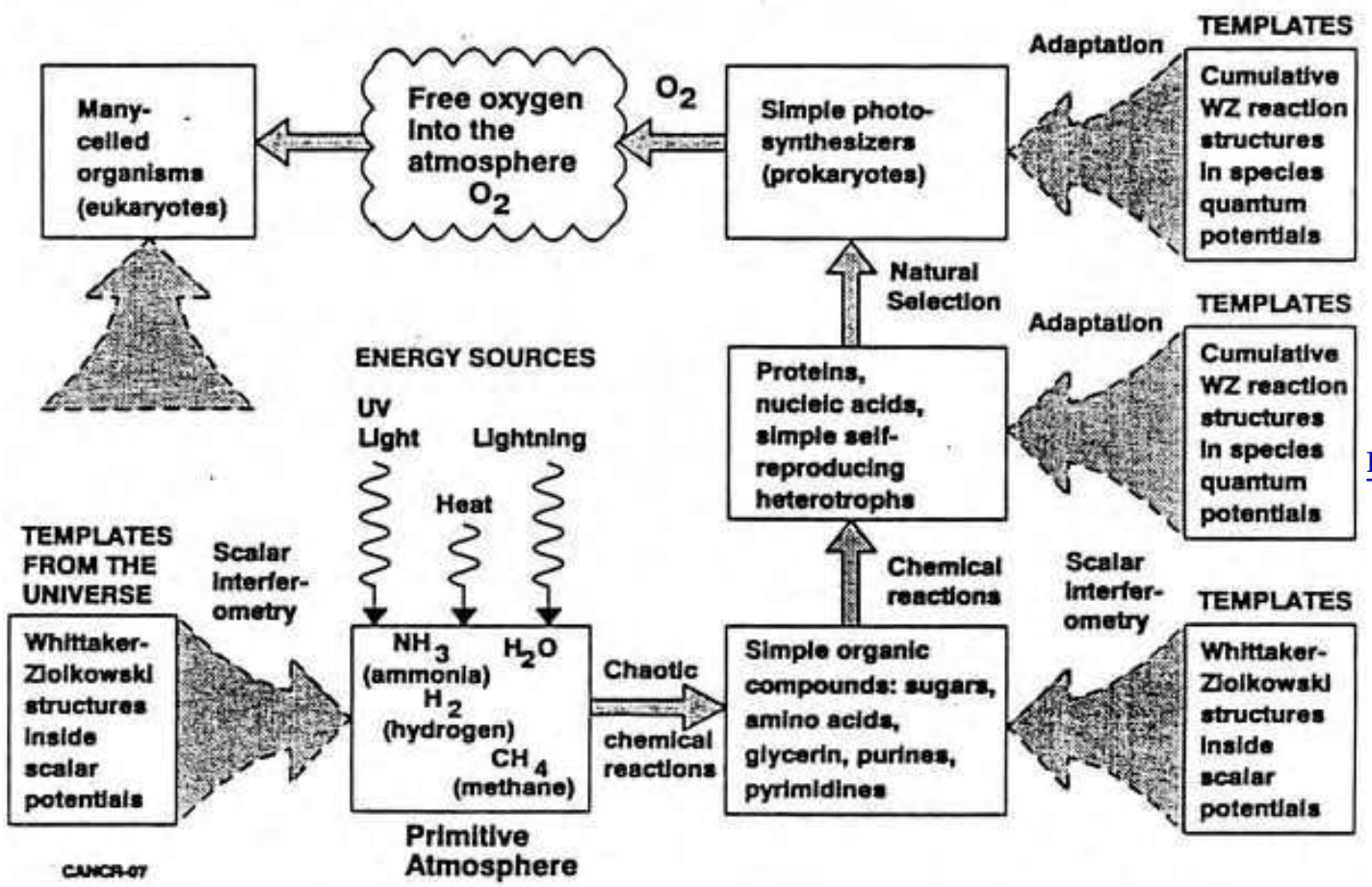

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EFFECT OF FLUID CONTAMINATION ON HEMOGLOBIN'S OXYGEN TRANSPORT

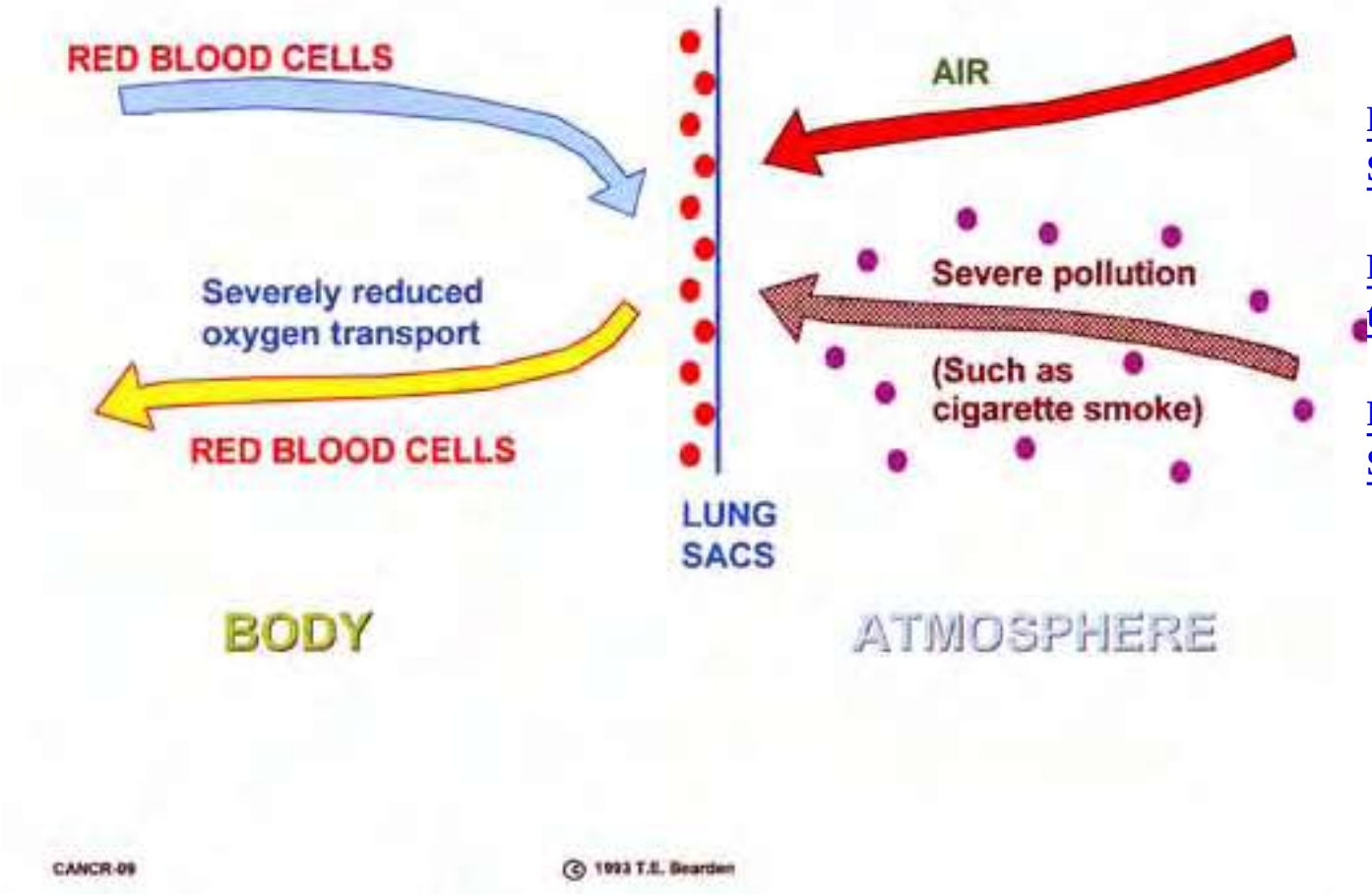

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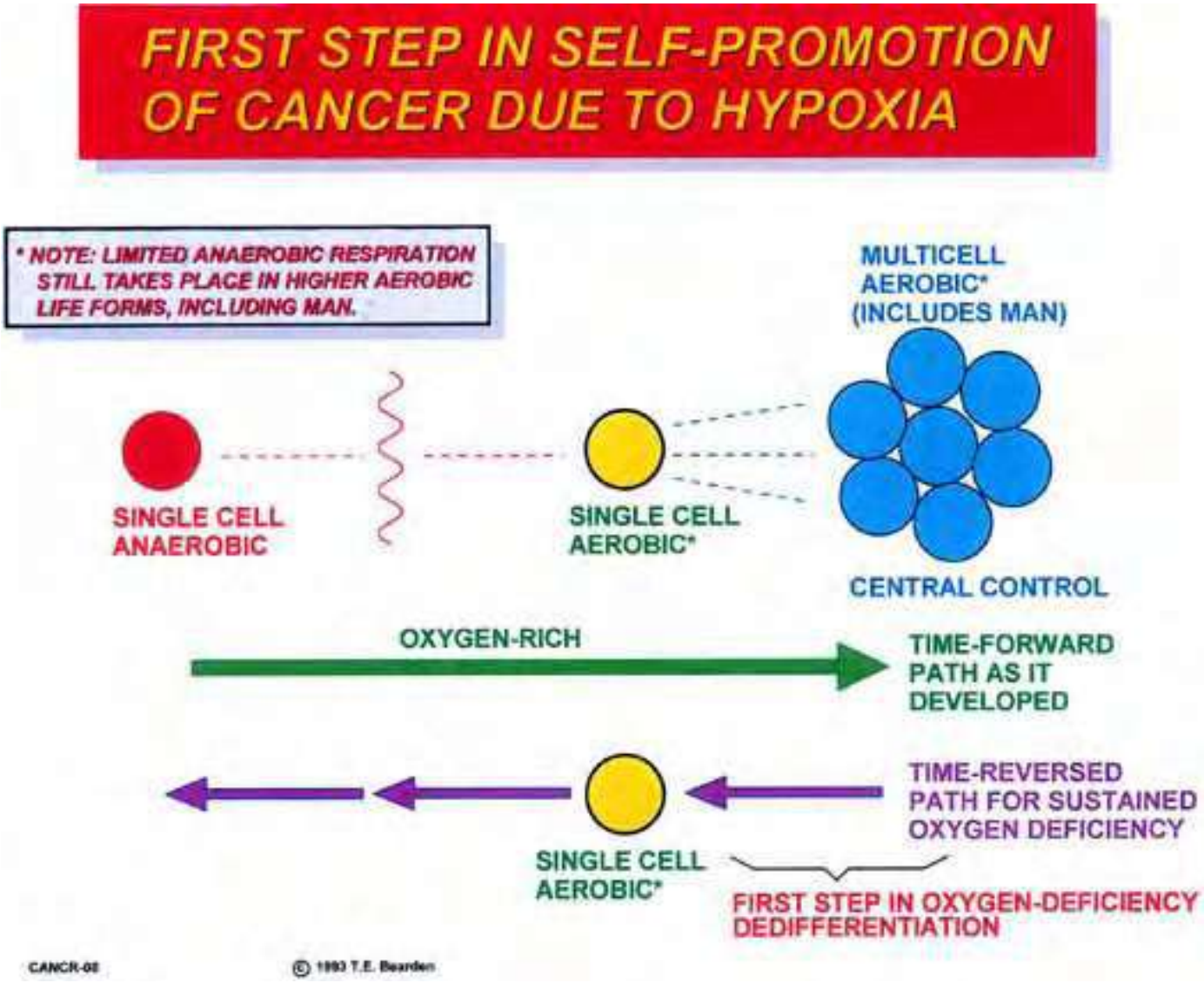

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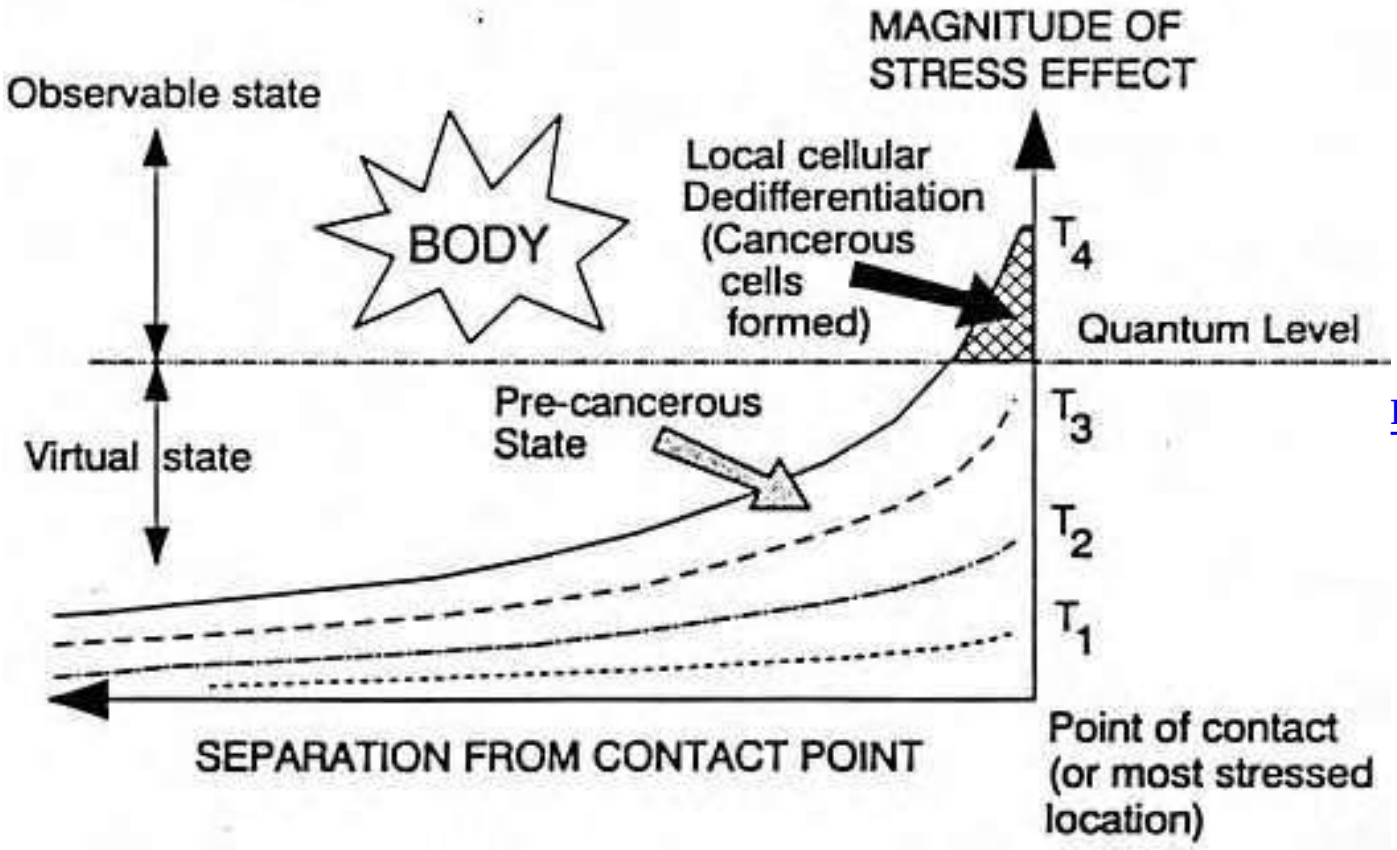

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CUMULATIVE EMERGENCE OF CANCER INTO THE PHYSICAL STATE

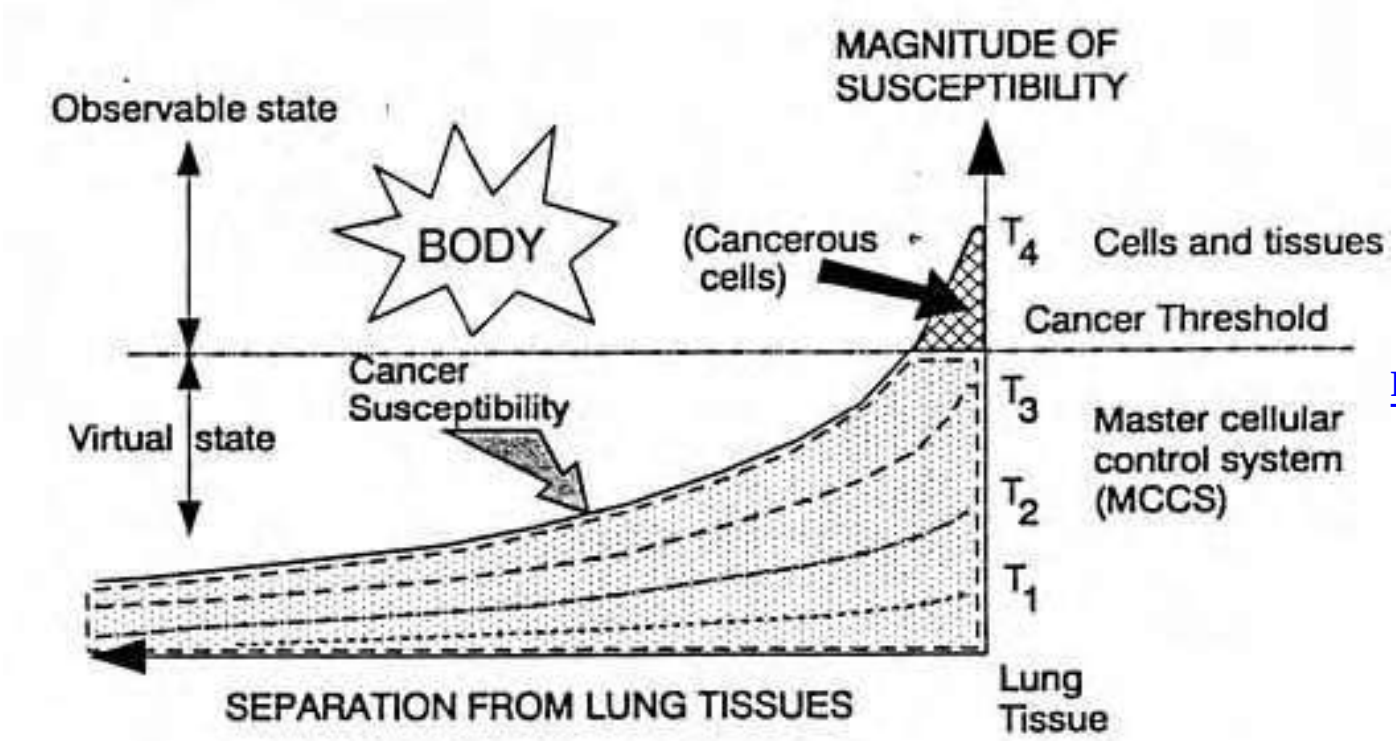

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PRECANCER STATE CONDITION DETERMINES TREATMENT SUCCESS

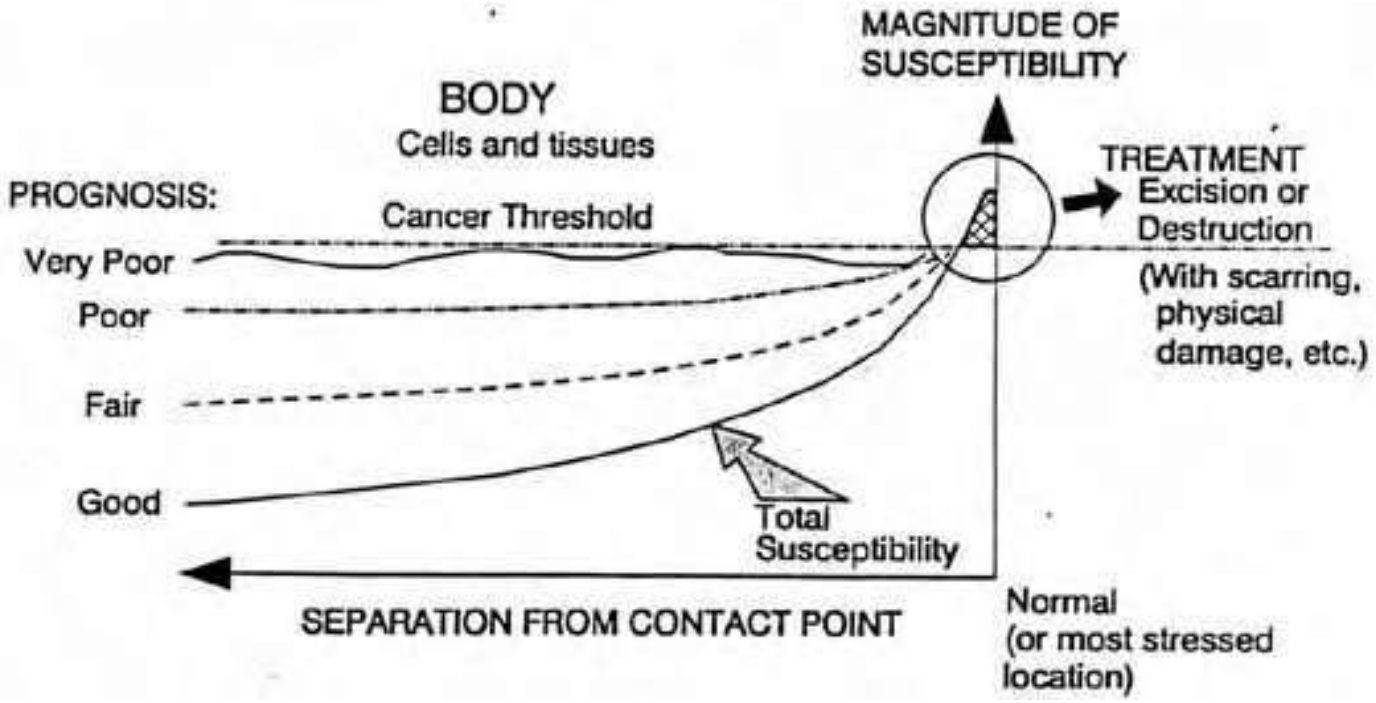

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Starting From the Scalar EM View:
A NEW DEFINITION OF CANCER

- CANCER AND LEUKEMIA ARE:

  Centrally-commanded, final, desperate, "first-step dedifferentiation" adaptive attempts by the stressed affected cells experiencing sustained oxygen shortage, to reverse their cellular evolution and return to the anaerobic stage of their distant ancestry.

- THE CAUSE IS LONG-TERM CUMULATIVE, AND ELECTROMAGNETIC IN NATURE.

- A TOTAL CURE CAN BE ACHIEVED ELECTRO-MAGNETICALLY, AS WAS DEMONSTRATED.

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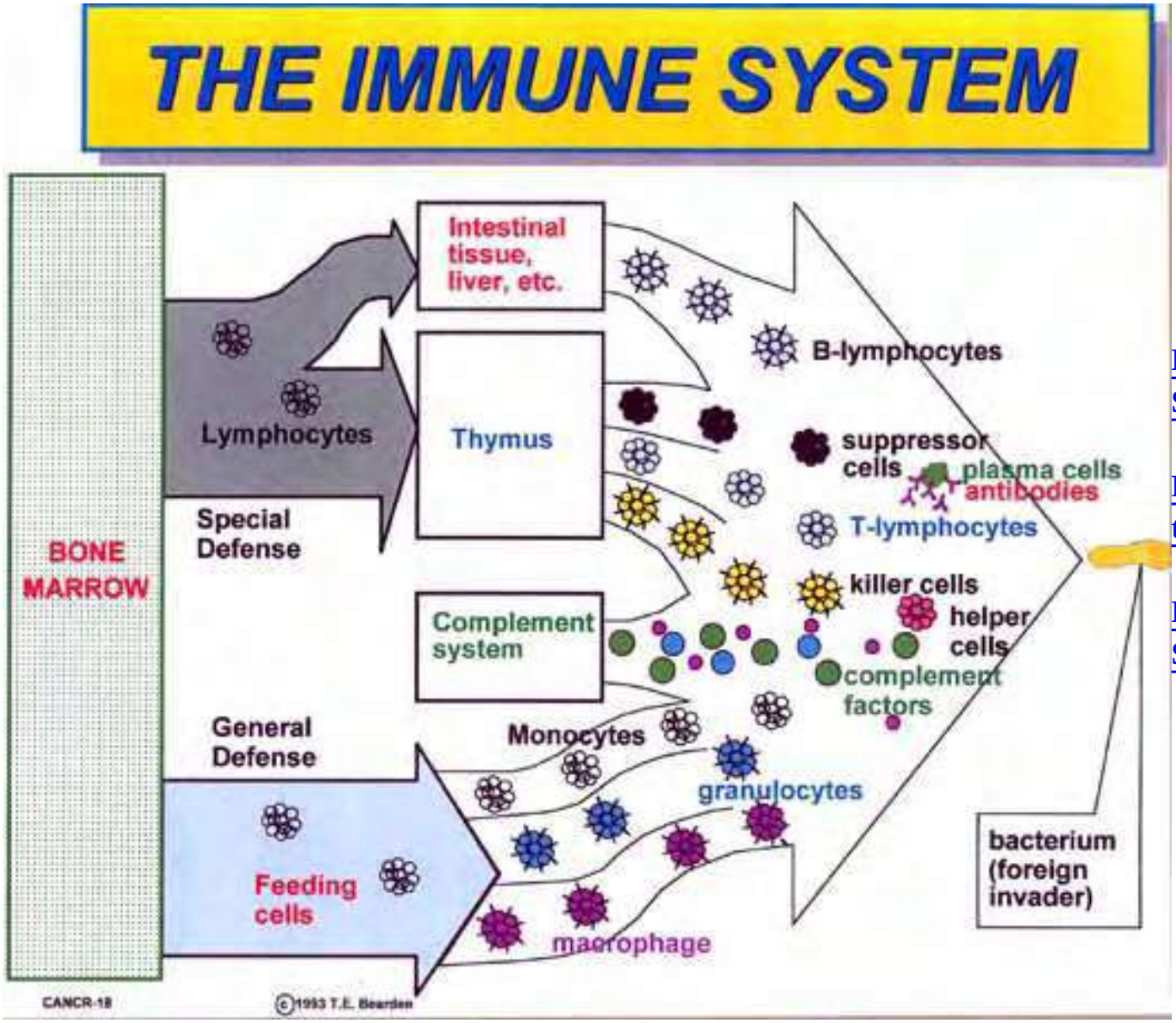

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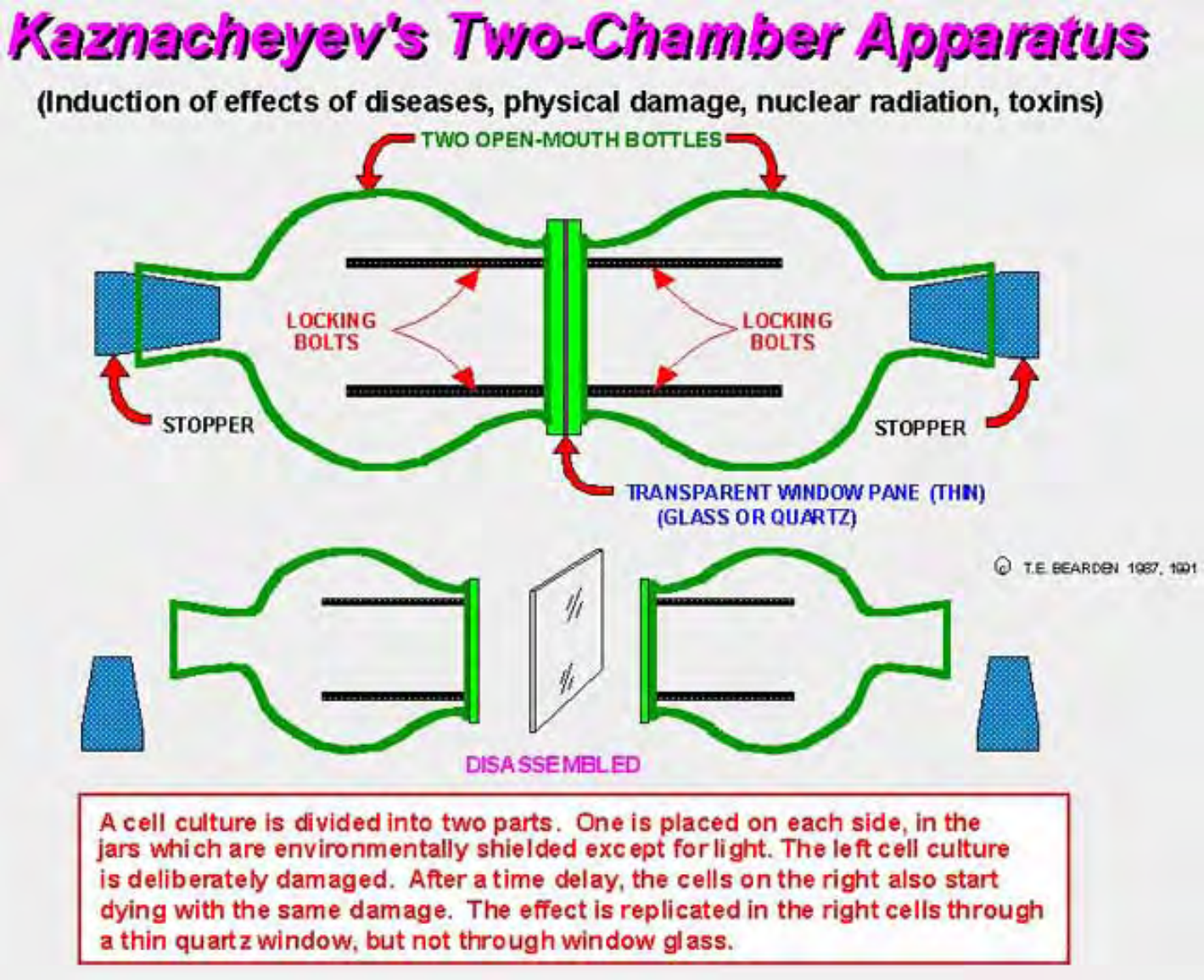

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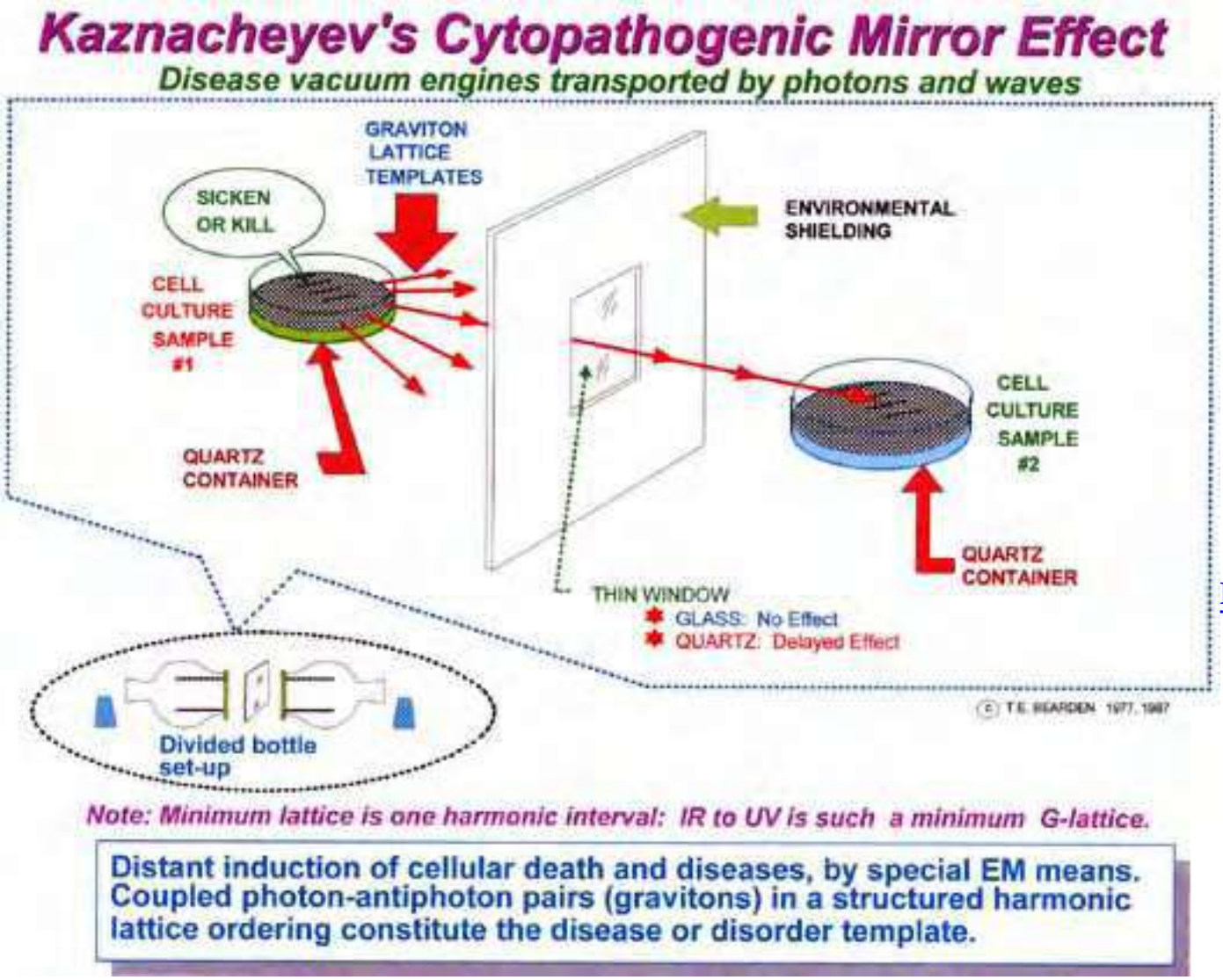

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MICROWAVE RADIATION OF U.S. EMBASSY IN MOSCOW

Former U.S. Embassy in Moscow.

Selected clipart © by Lotus SmartPics™

BACKGROUND

- Began in latter 1950s
- Discovered on VP Nixon's trip
- Initially thought to be *nuclear* radiation (Discovered w/Geiger counter?)
- High level target -- U.S. Ambassador
- Guarantees personal attention of:
  - U.S. Ambassador to USSR
  - U.S. President
  - NSA, CIA, DIA, NSC, etc.
  - Top consulting scientists
  - Leading U.S. scientific institutions
- Two U.S. Ambassadors died, another sickened
- Anomalous health changes in personnel, only in zero-field (zero pot'l gradient) areas!
- Four U.S. Presidents requested Soviets cease
  - Cut from 18 watts/sq cm to 2
  - Then again increased
- No one could understand what was going on
- Aluminum screens were placed over windows
- Moscow was declared a hazardous duty zone

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JOHN HOPKINS STUDY OF EMBASSY MICROWAVE RADIATION

- **EXCELLENT SCIENTIFIC TEAM**

  - PERFORMED CLASSICAL EM INVESTIGATION

  - CAREFULLY ESTABLISHED THE FORCE FIELD PATTERNS

  - NO HEALTH CHANGES OCCURRED IN PERSONNEL WHERE THE FORCE FIELDS WERE PRESENT (NONZERO)

  - ALL HEALTH CHANGES OCCURRED IN PERSONNEL WHERE THE FORCE FIELDS WERE ZERO (ABSENT)

- **ASSUMED THAT ALL EM ACTION IS DUE ONLY TO FORCE FIELDS**

  - CONCLUDED THAT MICROWAVE RADIATION COULD NOT HAVE CAUSED THE HEALTH CHANGES

- **CONCLUSION WAS IN SERIOUS ERROR**

  - CORRECT CONCLUSION: HEALTH CHANGES WERE TOTALLY CORRELATED TO ABSENCE OF FORCE FIELDS

  *** TOTALLY CORRELATED TO PRESENCE OF GRADIENT-FREE POTENTIALS, OR NOT TO RADIATION AT ALL**

  *** IF NOT TO RADIATION AT ALL, THEN HEALTH CHANGES WOULD HAVE ALSO OCCURRED WHERE FORCE FIELDS WERE PRESENT**

- **THEREFORE THE HEALTH CHANGES WERE TOTALLY CORRELATED TO THE GRADIENT-FREE POTENTIALS, AND TO THE EM RADIATION**

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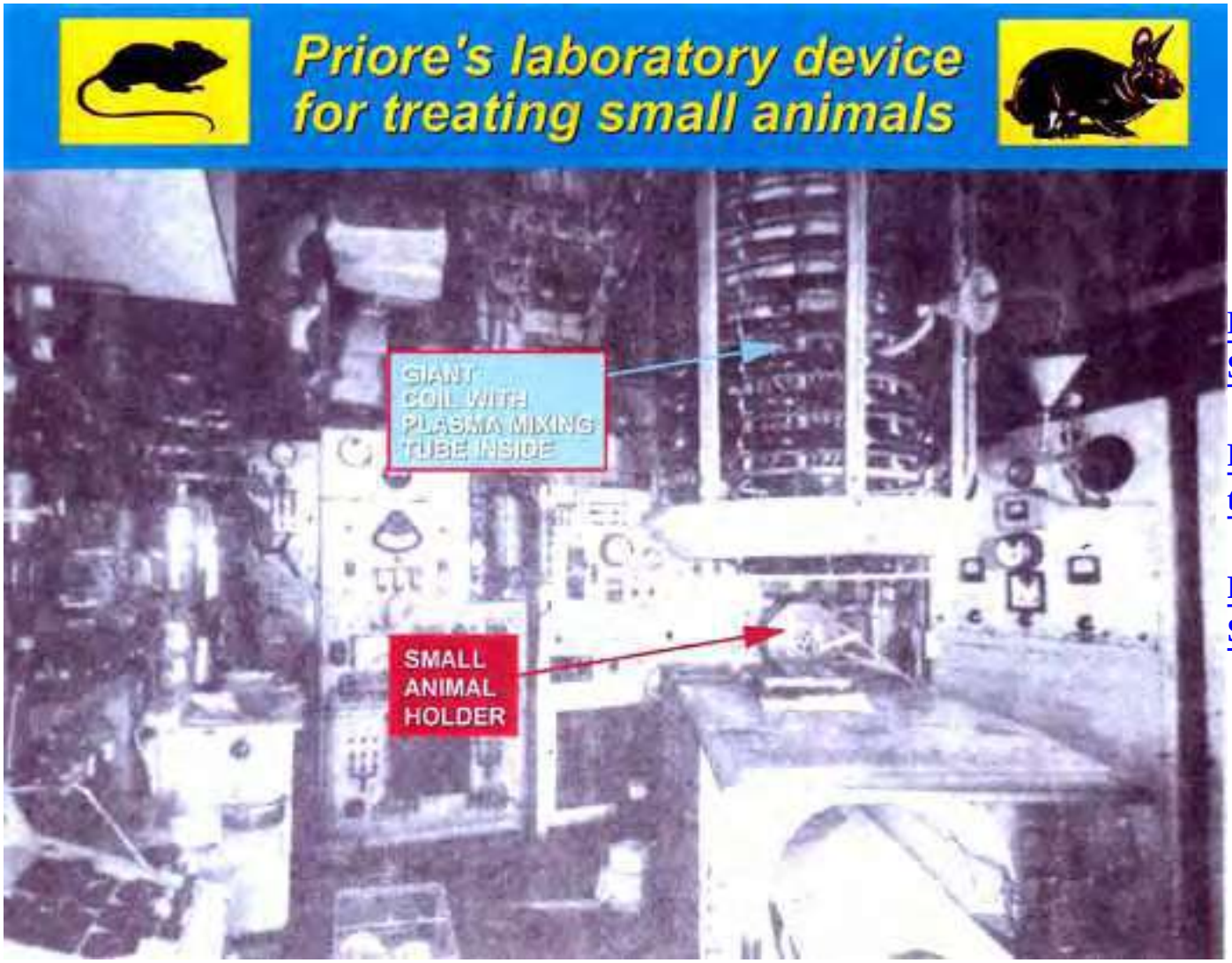

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MECHANISM OF THE PRIORE THERAPY

- **PRODUCED A DETERMINISTIC WZ STRUCTURED SCALAR POTENTIAL**
  - **17 FREQUENCIES MIXED IN A ROTATING PLASMA**
  - **PHASE CONJUGATES ADDED BY THE PLASMA**
  - **MODULATED ONTO A RIPPLING MAGNETIC FIELD WHICH CARRIED IT TO ATOMIC NUCLEI**
  - **INTERACTED DIRECTLY WITH PERSONAL QUANTUM POTENTIAL**
- **NEGATED THE LONG-TERM CUMULATIVE CELLULAR DEDIFFERENTIATION ORDER GENERATED BY LONG-TERM HYPOXIA. TUMOR CELLS REVERTED TO NORMAL CONTROL**
- **SCRUBBED OUT THE CUMULATED PRECANCEROUS STATE**
- **RESTORED THE IMMUNE SYSTEM TO HIGH FUNCTIONING**
- **NO EXCESSIVE TRAUMA TO TREATED ANIMAL**

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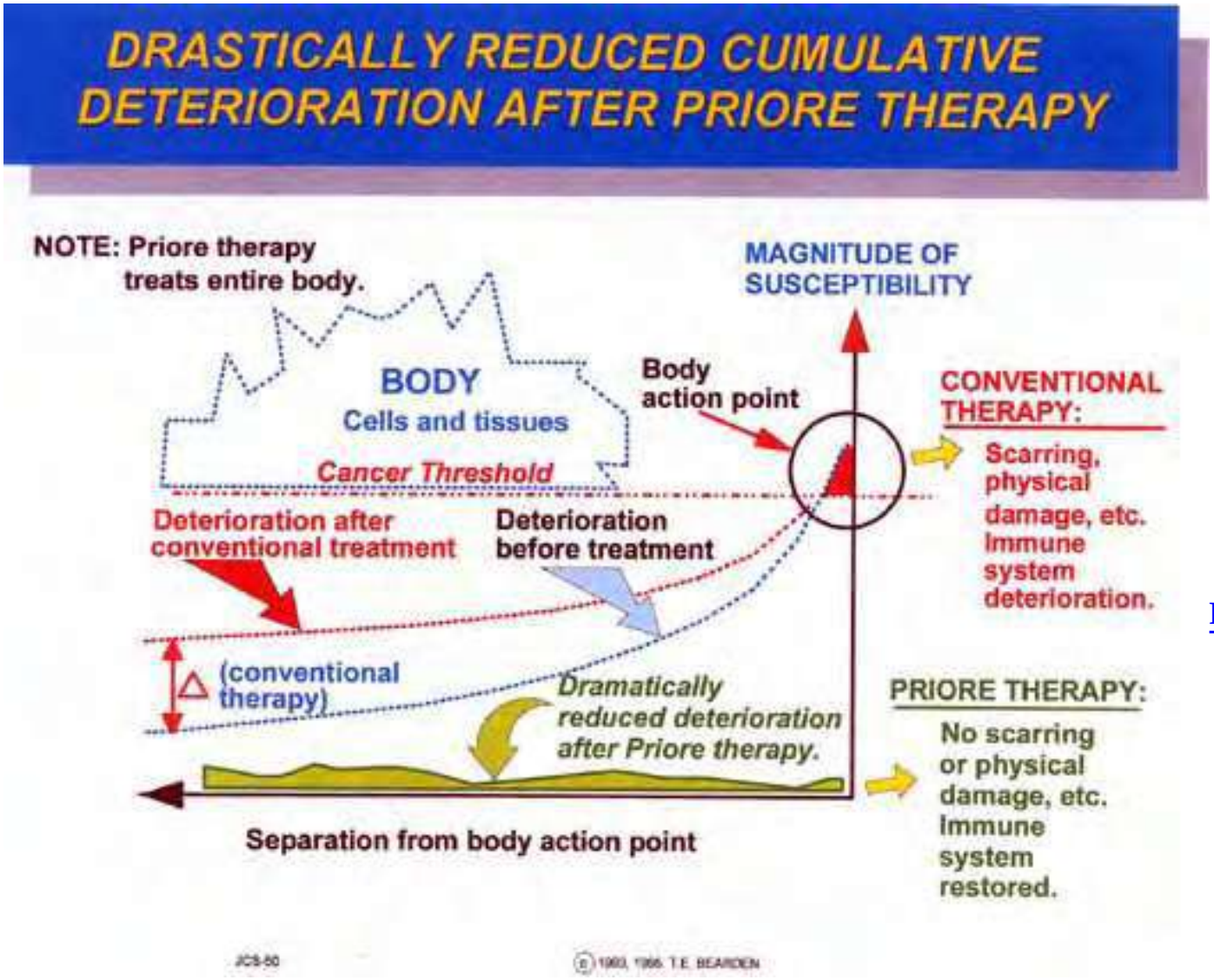

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THE MISSING PIECE OF THE PUZZLE

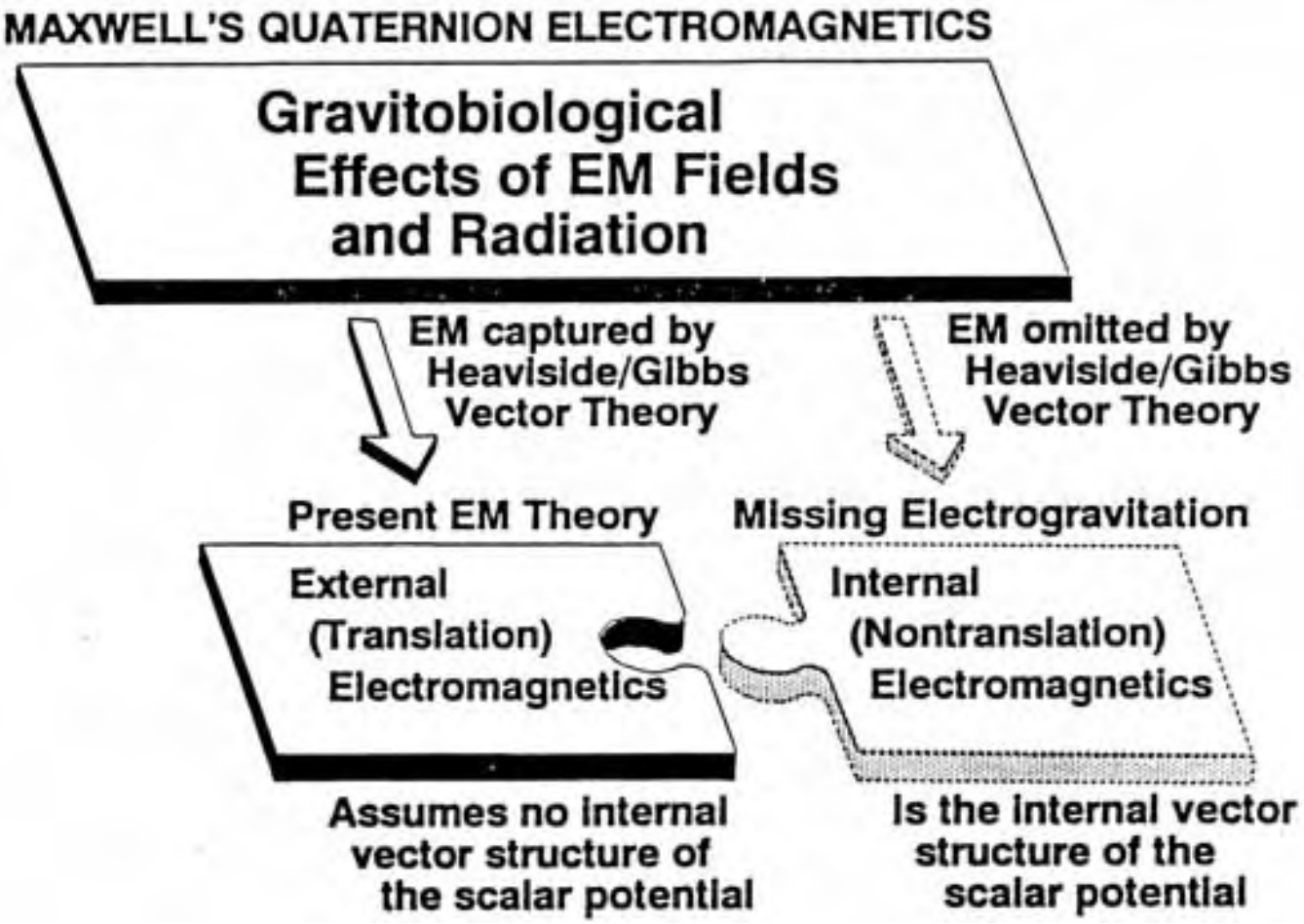

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SUMMARY AND CONCLUSION

- **RECOMMEND SERIOUS EXAMINATION OF THE NEW APPROACH**
- **RECOMMEND REVIVAL OF PRIORE-TYPE RESEARCH ON**
  AN URGENT BASIS
- **CAN BE EXTENDED TO OTHER DISEASES**

  - AIDS
  - ARTERIOSCLEROSIS
  - SLEEPING SICKNESS
  - ETC.
- **A NEW THERAPEUTIC PARADIGM OF GREATLY INCREASED**
  SCOPE AND EFFECTIVENESS MAY BE POSSIBLE
- **IN ADDITION, DRASTIC REDUCTION IN MEDICAL COSTS**
  COULD POTENTIALLY RESULT

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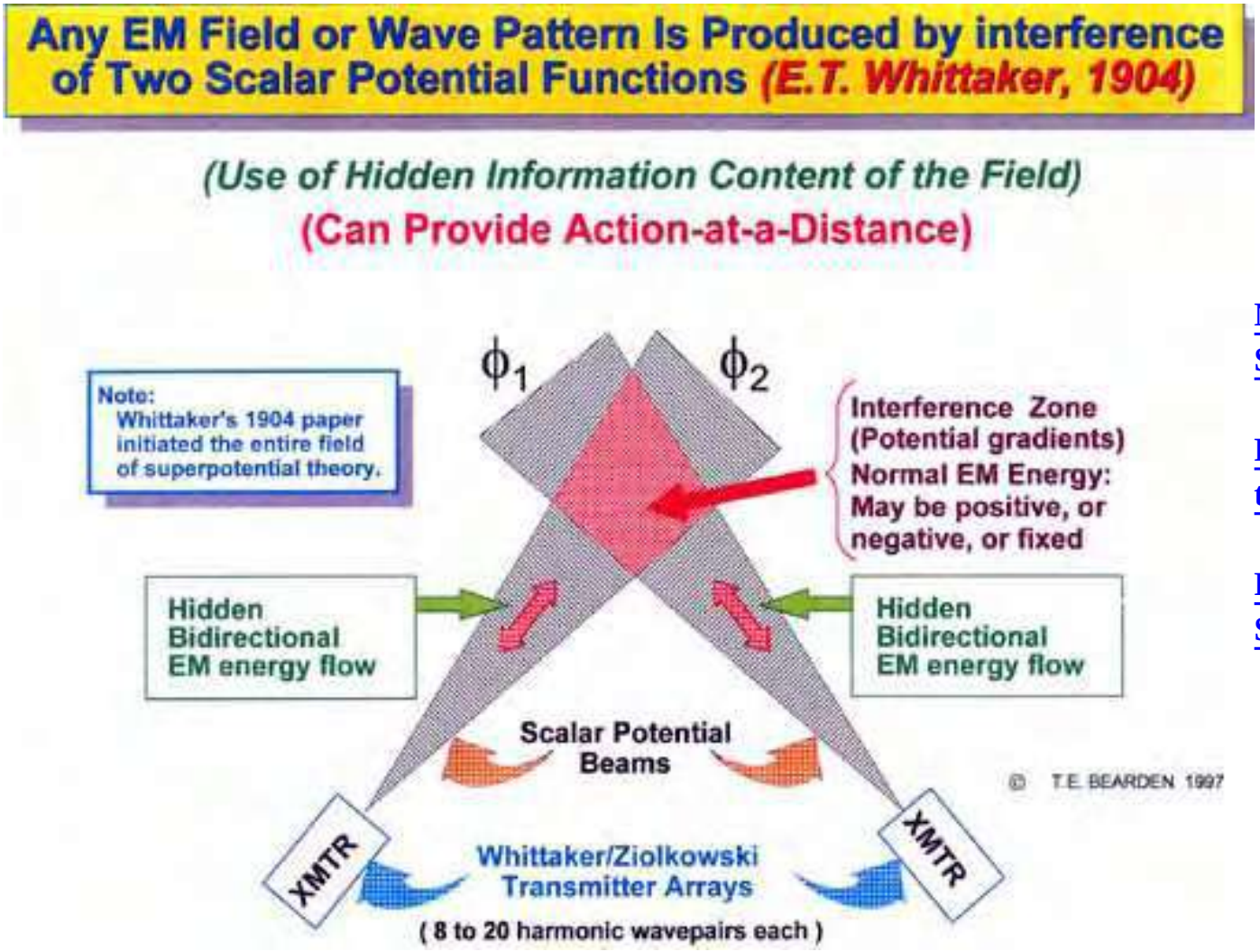

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MECHANISM FOR LONG-TERM, CUMULATIVE BIOLOGICAL EFFECTS OF EM FIELDS AND RADIATION

T. E. BEARDEN*

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Support Free Energy and purchase the bumper sticker

The New Tesla Electromagnetics and the Secrets of Electrical Free Energy

By T.E. Bearden
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COMMENTS ON THE NEW TESLA ELECTROMAGNETICS

Part I: Discrepancies in Present EM Theory

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There are at least twenty-two major discrepancies presently existing in conventional electromagnetics theory. This paper presents a summary of those flaws, and is a further commentary on my discussion of scalar longitudinal Tesla waves in a previous paper, "Solutions to Tesla's Secrets and the Soviet Tesla Weapons," Tesla Book Company, 1981 and 1982.

I particularly wish to express my deep appreciation to two of my friends and colleagues who at this time, I believe, wish to remain anonymous. One of the two is an experimental genius who can produce items on the bench that do not work by orthodox theory. The second is a master of materials science and electromagnetics theory. I thank them both for their exceptional contributions and stimuli regarding potential shortcomings in present electromagnetics theory, and their forbearance with the many discussions we have held on this and related subjects.

It goes without saying that any errors in this paper are strictly my own, and not the fault of either of my distinguished colleagues.

(1) In present electromagnetics theory, charge and charged mass are falsely made identical. Actually, on a charged particle, the "charge" is the flux of virtual particles on the "bare particle" of observable mass. The charged particle is thus a "system" of true massless charge coupled to a bare chargeless mass. The observable "mass" is static, three-dimensional, and totally spatial. "Charge" is dynamic, four-dimensional or more, virtual and spatiotemporal. Further, the charge and observable mass can be decoupled, contrary to present theory. Decoupled charge -- that is, the absence of mass -- is simply what we presently refer to as "vacuum." Vacuum, spacetime, and massless charge are all identical. Rigorously, we should utilize any of these three as an "ether," as suggested for vacuum by Einstein himself (see

Max Born, Einstein's Theory of Relativity, Revised Edition, Dover Publications, New York, 1965, p. 224). And all three of them are identically anenergy -- not energy, but more fundamental components of energy.

(2) Electrostatic potential is regarded as a purely 3-dimensional spatial stress. Instead, it is the intensity of a many-dimensional (at least four-dimensional) virtual flux and a stress on all four dimensions of spacetime. This is easily seen, once one recognizes that spacetime is identically massless charge. (It is not "filled" with charge; rather, it is charge!) Just as, in a gas under pressure, the accumulation of additional gas further stresses the gas, the accumulation of charge (spacetime) stresses charge (spacetime). Further, if freed from its attachment to mass , charge can flow exclusively in time, exclusively in space, or in any combination of the two. Tesla waves -- which are scalar waves in pure massless charge flux itself -- thus can exhibit extraordinary characteristics that ordinary vector waves do not possess. And Tesla waves have extra dimensional degrees of freedom in which to move, as compared to vector waves. Indeed, one way to visualize a Tesla scalar wave is to regard it as a pure oscillation of time itself.

(3) Voltage and potential are often confused in the electrostatic case, or at least thought of as "composed of the same thing." For that reason, voltage is regarded as "potential drop". This also is not true. Rigorously, the potential is the intensity of the virtual particle flux at a single point -- whether or not there is any mass at the point -- and both the pressure and the point itself are spatiotemporal (4-dimensional), not spatial (3-dimensional) as presently assumed. Voltage represents the spatial intersection of the difference in the potential between two separated spatial points, and always implies at least a miniscule flow of mass current (that is what makes it spatial!). "Voltage" is spatial and depends upon the presence of observable mass flow, while scalar electrostatic potential is spatiotemporal and depends upon the absence of observable mass flow. The two are not even of the same dimensionality.

(4) The charge of vacuum spacetime is assumed to be zero, when in fact it is a very high value. Vacuum has no mass, but it has great massless charge and virtual particle charge flux. For proof that a charged vacuum is the seat of something in motion, see G.M. Graham and D.G. Lahoz, "Observation of static electromagnetic angular momentum in vacuo," Nature, Vol. 285, 15 .May 1980, pp. 154-155. In fact, vacuum IS charge, identically, and it is also "spacetime" and at least four-dimensional.

(5) Contrary to its present usage, zero is dimensional and relative in its context. A three-dimensional spatial hole, for example, exists in time. If we model time as a dimension, then the spatial hole has one dimension in 4-space. So a spatial absence is a spatiotemporal presence. In the vacuum 4-space, a spatial nothing is still a something. The "virtual" concept and the mathematical concept of a derivative are simply two present ways of unconsciously addressing this fundamental problem of the dimensional relativity of zero.

(6) The concepts of "space" and "time" imply that spacetime (vacuum) has been separated into two parts. We can only think of a space as "continuing to exist in time " To separate vacuum spacetime into two pieces, an operation is continually required. The operator that accomplishes this splitting operation is the photon interaction, the interaction of vector electromagnetic energy or waves with mass. I have already strongly pointed out this effect and presented a "raindrop model" of first-order physical change itself in my book, The Excalibur Briefing, Strawberry Hill Press, San Francisco, 1980, pp. 128-130.

(7) "Vector magnetic potential" is assumed to be always an aspect of (and connected to) the magnetic field. In fact it is a separate, fundamental field of nature and it can be entirely disconnected from the magnetic field. See Richard P. Feynman et al, The Feynman Lectures on Physics, Addison-Wesley Publishing Co., New York, 1964, Vol. II, pp. 15-8 to 15-14. Curiously, this fact has been proven for years' yet it has been almost completely ignored in the West. The "Vx" operator, when applied to the A-field, makes B-field. If the Vx operator is not applied, the "freed" A-field possesses much-expanded characteristics from those presently allowed in the "bound" theory. Specifically, it becomes a scalar or "shadow vector" field; it is not a normal vector field. (note: for V read inverted capital Delta)

(8) The speed of light in vacuum is assumed to be a fundamental constant of nature. Instead it is a function of the intensity of the massless charge flux (that is, of the magnitude of the electrostatic potential) of the vacuum in which it moves. (Indeed, since vacuum and massless charge are one and the same, one may say that the speed of light is a function of the intensity of the spatiotemporal vacuum!). The higher the flux intensity (charge) of the vacuum, the faster the speed of light in it. This is an observed fact and already shown by hardcore measurements. For example, distinct differences actually exist in the speed of light in vacuo, when measured on the surface of the earth as compared to measurements in space away from planetary masses. In a vacuum on the surface of the earth, light moves significantly faster. For a discussion and the statistics, see B. N. Belyaev, "On Random Fluctuations of the Velocity of Light in Vacuum," Soviet Physics

Journal, No. 11, Nov. 1980, pp. 37-42 (original in Russian; translation by Plenum Publishing Corporation.) The Russians have used this knowledge for over two decades in their strategic psychotronics (energetics) program; yet hardly a single U.S. scientist is aware of the measured variation of c in vacuo. In fact, most Western scientists simply cannot believe it when it is pointed out to them!

(9) Energy is considered fundamental and equivalent to work. In fact, energy arises from vector processes, and it can be disassembled into more fundamental (anenergy) scalar components, since the vectors can. These scalar components individually can be moved to a distant location without expending work, since one is not moving force vectors. There the scalar components can be joined and reassembled into vectors to provide "free energy" appearing at a distance, with no loss in between the initial and distant points. For proof that a vector field can be replaced by (and considered to be composed of) two scalar fields, see E. T. Whittaker, Proceedings of the London Mathematical Society, Volume 1, 1903, p. 367. By extension, any vector wave can be replaced by two coupled scalar waves.

(10) The classical Poynting vector predicts no longitudinal wave of energy from a time-varying, electrically charged source, In fact, an exact solution of the problem does allow this longitudinal wave. See T. D. Keech and J. F. Corum, "A New Derivation for the Field of a Time-Varying Charge in Einstein's Theory," International Journal of Theoretical Physics, Vol. 20, No, 1, 1981, pp. 63-68 for the proof.

(11) The present concepts of vector and scalar are severely limited, and do not permit the explicit consideration of the internal, finer-grained structures of a vector or a scalar. That is, a fundamental problem exists with the basic assumptions in the vector mathematics itself. The "space" of a vector field, for example, does not have inter-nested sublevels (subspaces) containing finer "shadow vectors" or "virtual vectors," Yet particle physics has already discovered that electrical reality is built that way. Thus one should actually use a "hypernumber" theory after the manner of Charles Musés. A scalar is filled with (and composed of) nested levels of other "spaces" containing vectors, where these sum to "zero" in the ordinary observable frame without an observable vector resultant. In Musés' mathematics, for example, zero has real roots. Real physical devices can be -- and have been -constructed in accordance with Muses' theory. For an introduction to Musés' profound hypernumbers approach, see Charles Musés' foreword to Jerome Rothstein, Communication Organization and Science, The Falcon's Wing Press, Indian Hills, Colorado, 1958. See also Charles Musés, "Applied Hypernumbers: Computational Concepts," Applied Mathematics and

Computation, Vol. 3, 1976. See also Charles Musés, "Hypernumbers II," Applied Mathematics and Computation, January 1978.

(12) With the expanded Tesla electromagnetics, a new conservation of energy law is required. Let us recapitulate for a moment. The oldest law called for the conservation of mass. The present law calls for the conservation of "mass and energy", but not each separately. If mass is regarded as simply another aspect of energy, then the present law calls for the conservation of energy. However, this assumes that energy is a basic, fundamental concept. Since the energy concept is tied to work and the movement of vector forces, it implicitly assumes "vector movement" to be a "most fundamental" and irreducible concept. But as we pointed out, Whittaker showed that vectors can always be further broken down into more fundamental coupled scalar components. Further, Tesla discovered that these "coupled components" of "energy" can be individually separated, transmitted, processed, rejoined, etc. This directly implies that energy per se need not be conserved. The new law therefore calls for the conservation of anenergy, the components of energy. These components may be coupled into energy, and the energy may be further compacted into mass. It is the sum total of the (anenergy) components -- coupled and uncoupled -- that is conserved, not the matter or the energy per se. Further, this conservation of anenergy is not spatial; rather, it is spatiotemporal in a spacetime of at least four or more dimensions.

(13) Relativity is presently regarded as a theory or statement about fundamental physical reality. In fact, it is only a statement about FIRST ORDER reality -- the reality that emerges from the vector interaction of electromagnetic energy with matter. When we break down the vectors into scalars (shadow vectors or hypervectors), we immediately enter a vastly different, far more fundamental reality. In this reality superluminal velocity, multiple universes, travel back and forth in time, higher dimensions, variation of all "fundamental constants" of nature, materialization and dematerialization, and violation of the "conservation of energy" are all involved. Even our present Aristotlean logic -- fitted to the photon interaction by vector light as the fundamental observation mechanism -- is incapable of describing or modeling this more fundamental reality. Using scalar waves and scalar interactions as much subtler, far less limited observation/detection mechanisms, we must have a new "superrelativity" to describe the expanded electromagnetic reality uncovered by Nikola Tesla.

(14) "Charge" is assumed to be quantized, in addition to always occurring with -- and locked to -- mass. Indeed, charge is not necessarily quantized just as it is not necessarily locked to mass.

Ehrenhaft discovered and reported fractional charges for years, in the 30's and 40's, and was ignored. See P.A.11. Dirac, "Development of the Physicist's Conception of Nature," Symposium on the Development of the Physicist's Conception of Nature, ed. Jagdish Merha, D. Reidel, Boston, 1973, pp. 12-14 for a presentation of some of Ehrenhaft's results. Within the last few years Stanford University· researchers also have positively demonstrated the existence of "fractional charge." For a layman's description of their work, see "A Spector Haunting Physics," Science News, Vol. 119, January 31, 1981, pp. 68-69. Indeed, Dirac in his referenced article points out that Millikan himself -- in his original oildrop experiments -- reported one measurement of fractional charge, but discounted it as probably due to error.

(15) Presently, things are always regarded as traveling through normal space. Thus we use or model only the most elementary type of motion -- that performed by vector electromagnetic energy. We do not allow for things to "travel inside the vector flow itself." Yet, actually, there is a second, more subtle flow inside the first, and a third, even more subtle flow inside the second, and so on. We may operate inside, onto, into, and out of energy itself -- and any anenergy component of energy. There are hypervectors and hyperscalars unlimited, within the ordinary vectors and scalars we already know. Further, these "internal flows" can be engineered and utilized, allowing physical reality itself to be directly engineered, almost without limits.

(16) We always assume everything exists in time. Actually, nothing presently measured exists in time, because the physical detection/ measurement process of our present instruments destroys time, ripping it off and tossing it away -- and thereby "collapsing the wave function." Present scientific methodology thus is seriously flawed. It does not yield fundamental (spacetime) truth, but only a partial (spatial) truth. This in turn leads to great scientific oversights. For example, mass does not exist in time, but mass x time (masstime) does. A fundamental constant does not exist in time, but the "constant x time" does. Energy does not exist in time, but energy x time (action) does. Even space itself does not exist in time -- spacetime does. We are almost always one dimension short in every observable we model. Yet we persist in thinking spatially, and we have developed 1nstruments that detect and measure spatially only. Such instruments can never measure and detect the phenomenology of the nested substrata of time. By using scalar technology, however, less limited instruments can indeed be constructed -and they have been. With such new instruments, the phenomenology of the new electromagnetics can be explored and an engineering technology developed.

(17) We do not recognize the connection between nested levels of virtual state (particle physics) and orthogonally rotated frames (hyperspaces). Actually the two are identical, as I showed in the appendix to my book, The Excalibur Briefing, Strawberry Hill Press, San Francisco, 1980, pp. 233-235. A virtual particle in the laboratory frame is an observable particle in a hyperspatial frame rotated more than one orthogonal turn away. This of course implies that the hyperspatial velocity of all virtual particles is greater than the speed of light. The particle physicist is already deeply involved in hyperspaces and hyperspatial charge fluxes without realizing it. In other words, he is using tachyons (particles that move faster than light) without realizing it.

(18) Presently quantum mechanics rigorously states that time is not an observable, and therefore it cannot be measured or detected. According to this assumption, one must always infer time from spatial measurements, because all detections and measurements are spatial. With this assumption, our scientists prejudice themselves against even looking for finer, subquantal measurement methodologies and instrumentation. Actually this present limitation is a result of the type of electromagnetics we presently know, where all instruments (the "measurers") have been interacted with by vector electromagnetic energy (light). Every mass that has temperature (and all masses do!) is continually absorbing and emitting photons, and in the process they are continually connecting to time and disconnecting from time. If time is continually being carried away from the detector itself by its emitted photons, then the detector cannot hold and "detect" that which it has just lost. With Tesla electromagnetics, however, the fundamental limitation of our present instruments need not apply. With finer instruments, we can show there are an infinite number of levels to "time", and it is only the "quantum level time" which is continually being lost by vector light (photon) interaction. By using subquantal scalar waves, instruments can move to deeper levels of time -- in which case the upper levels of time ARE measureable and detectable, in contradistinction to the present assumptions.

(19) In the present physics, time is modeled as, and considered to be, a continuous dimension such as length. This is only a gross approximation. Indeed, time is not like continuous "dimension," but more like a series of "stitches," each of which is individually made and then ripped out before the next stitch appears. "Vector light" photons interact one at a time, and it is this interaction with mass that creates quantum change itself. The absorption of a photon -- which is energy x time -- by a spatial mass converts it to masstime: the time was added by the photon. The emission of a photon tears away the time, leaving behind again a spatial mass. It is not accidental, then, that time flows at

the speed of light, for it is light which contains and carries time. It is also not accidental that the photon IS the individual quantum. Since all our instruments presently are continually absorbing and emitting photons, they are all "quantized," and they accordingly "quantize" their detections. This is true because all detection is totally internal to the detector, and the instruments detect only their own internal changes. Since these detections are on a totally granular quantized background, the detections themselves are quantized. The Minkowski model is fundamentally erroneous in its modeling of time, and for that reason relativity and quantum mechanics continue to resist all attempts to successfully combine them, quantum field theory notwithstanding.

(20) Presently, gravitational field and electrical field are considered mutually exclusive. Actually this is also untrue. In 1974, for example, Santilly proved that electrical field and gravitational field indeed are not mutually exclusive In that case, one is left with two possibilities: (a) they are totally the same thing, or (b) they are partially the same thing. For the proof, see R. M. Santilli, "Partons and Gravitation: Some Puzzling Questions," Annals of Physics, Vol. 83, No. 1, March 1974. With the new Tesla electromagnetics, pure scalar waves in time itself can be produced electrically, and electrostatics (when the charge has been separated from the mass) becomes a "magic" tool capable of directly affecting and altering anything that exists in time--including gravitational field. Antigravity and the inertial drive are immediate and direct consequences of the new electromagnetics.

(21) Presently, mind is considered metaphysical, not a part of physics, an not affected by physical means. Literally, the prevailing belief of Western scientists is that man is a mechanical robot -- even though relativity depends entirely upon the idea of the "observer." Western science today thus has essentially become dogmatic, and in this respect borders on a religion. Since this "religion," so to speak, is now fairly well entrenched in its power in the state, Western science is turning itself into an oligarchy. But mind occupies time, and when we measure and affect time we can directly measure and affect mind itself. In the new electromagnetics, then, man regains his dignity and his humanity by restoring the reality of mind and thought to science. In my book, The Excalibur Briefing, I have already pointed out the reality of mind and a simplified way in which it can be modeled to the first order. With scalar wave instruments, the reality of mind and thought can be measured in the laboratory, and parapsychology becomes a working, engineering, scientific discipline.

(22) Multiple-valued basic dimensional functions are either not permitted or severely discouraged in the present theory For one thing, integrals of multiple valued derivative functions have the annoying

habit of "blowing up" and yielding erroneous answers, or none at all. And we certainly do not allow multiple types of time! This leads to the absurdity of the present interpretation of relativity which permits only a single observer (and a single observation) at a time. So if one believes as "absurd" a thing as the fact that more than one person can observe an apple at the same time, the present physics fails. However, the acceptance of such a simple proposition as multiple simultaneous observation leads to a physics so bizarre and incredible that most Western physicists have been unable to tolerate it, much less examine its consequences. In the physics that emerges from multiple simultaneous observation, all possibilities are real and physical. There are an infinite number of worlds, orthogonal to one another, and each world is continually splitting into additional such "worlds" at a stupendous rate. Nonetheless, this physics was worked out by Everett for his doctoral thesis in 1956, and the thesis was published in 1957. (See Hugh Everett, III, The Many-Worlds Interpretation of Quantum Mechanics: A Fundamental Exposition, with papers by J. A. Wheeler, B.S. DeWitt, L. N. Cooper and D. Van Vechten, and N. Graham; eds. Bryce S. Dewitt and Neill Graham, Princeton Series in Physics, Princeton University Press, 1973.) Even though it is bizarre, Everett's physics is entirely consistent with all the present experimental basis of physics. The present electromagnetic theory is constructed for only a single "world" or universe -- or "level." The expanded theory, on the other hand, contains multiply nested levels of virtual state charge -- and these levels are identically the same as orthogonal universes, or "hyperframes." Multiple kinds -- and values -- of time also exist. The new concept differs from Everett's, however, in that the orthogonal universes intercommunicate in the virtual state. That is, an observable in one universe is always a virtual quantity in each of the other universes. Thus one can have multi-level "continuities" and "discontinuities" simultaneously, without logical conflict. It is precisely these levels of charge -- these levels of scalar vacuum -- that lace together the discontinuous quanta generated by the interaction of vector light with mass.

However, to understand the new electromagnetic reality, one requires a new, expanded logic which contains the old Aristotlean logic as a subset. I have already pointed out the new logic in my paper, "A Conditional Criterion for Identity, Leading to a Fourth Law of Logic," 1979, available from the National Technical Information Center, AD-A071032.

Even as logic is extended, quantum mechanics, quantum electrodynamics, and relativity are drastically changed by the Tesla electromagnetics, as I pointed out in my paper, "Solutions to Tesla's Secrets and the Soviet Tesla Weapons," Tesla Book Company, 1580

Magnolia, Millbrae, California, 94030, 1980.

The present electromagnetics is just a special case of a much more fundamental electromagnetics discovered by Nikola Tesla, just as Newtonian physics is a special case of relativistic physics. But in the electromagnetics case, the differences between the old and the new are far more drastic and profound.

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COMMENTS ON THE NEW TESLA ELECTROMAGNETICS

Part II: The Secret of Electrical Free Energy

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Again I wish to express my deep appreciation to two of my friends and colleagues who at this time, I believe, wish to remain anonymous. I thank them both for their exceptional contributions and stimuli, and their forbearance with the many discussions we have held on this and related subjects.

Also, it goes without saying that any errors in this paper are strictly my own, and not the fault of either of my distinguished colleagues.

Present electromagnetic theory is only a special case of the much more fundamental electromagnetism discovered by Nikola Tesla at the turn of the century.

Pure vacuum is pure charge flux, without mass. The vacuum has a very high electrical potential -- something on the order of 200 million volts, with respect to a hypothetical zero charge.

Thus in an ordinary electrical circuit, each point of the "ground" -- which has the same potential as the vacuum -- actually has a non-zero absolute potential. This circuit ground has a value of zero only with respect to something else which has the same absolute electrical potential.

Voltage, which is always associated with a flow of electrical "mass" current (even if only a miniscule flow), is, by definition, a difference dropped in potential when a charge mass moves between two spatially separated points. What we have termed "electrical current" only flows where there is a suitable conducting medium between things which have a difference in absolute potential. Furthermore, between any two points in any material, there is considered to exist a finite resistance -- if we apply a voltage and have a mass current flowing between the two points! The simple statement that V = IR irrevocably ties together voltage drop, mass current, and resistance between two points. Rigorously, to have one of the three is to have them all. To lose one is to lose all three. Immediately we see a major error in present theory: One can have a "difference in scalar potential" between two points without having a "voltage drop" between them. Specifically, if no mass current flows between them, no resistance exists between them, and no voltage drop exists between them.

In the same fashion, one can have a "scalar wave" through the

In the same fashion, one can have a "scalar wave" through the vacuum without a voltage wave. In that case, the wave has no E-field and no H-field. The only reason one has an E-field

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around a statically charged object is because the charged electrons accumulated on the object are actually in violent motion. It is this motion of the charged masses that produces E-field -- as well as H-field whenever that entire E-field ensemble moves through laboratory space.

Now let us reason together in the "approximate" manner utilized in present electromagnetic theory. For example, let us examine a bird sitting on a high tension line.

The bird sits on the high tension line without a flow of mass electricity, because there is no significant difference in potential drop between the bird and the line. Specifically, between the bird's two feet -- each in contact with a different portion of the line -- there exists no potential difference. This is true even though, with respect to the vacuum, each foot is at a potential that would be "100,000 volts higher," were a mass current flowing. And it is true even though the absolute potential of each foot may be some 200.1 million "volts," were a mass current flowing.

Now an interesting thing happens to the bird when he flies through the air to light upon the high tension wire. As he flies toward the wire, he is flying through the massless electrostatic potential field of the wire, for that field extends an infinite distance away from the wire. The electrostatic potential field -- pure Ø-field -- is actually the spatio-temporal intensity of the massless charge at a point. In other words, as the bird flies to the wire, he flies into an increasing "massless charge" potential, building up to 100,000 "volts" higher than the earth. However, very little (if any) "mass flow" potential difference is experienced upon his body in approaching the wire, and so essentially no "charged mass currents" are induced in his body. Thus the little flier safely navigates into the teeth of a very high electrostatic potential, lights upon the wire, and is not "fried" in the process. When he lights on the wire, his body has reached the electrostatic potential that each foot's contact point has. Again, there is no mass current flow. But his body is immersed in an increased flux of massless charge -- which is what the electrostatic potential represents. And each "virtual particle" flow in that charge potential represents a "massless (scalar)" electrical current.

The point is, one can have any amount of massless charge flow -- "scalar" current -- without any mechanical work being done in the system. All electrical work in a circuit is done against the physical mass of the charged masses that flow. Rigorously, force is defined as the time rate of charge of momentum. Even in the relativistic case where $F = ma + v(dm/dt)$, change of momentum requires mass movement. No mechanical work, and hence no energy, is expended by massless charge flow.

That is why the vacuum massless charge -- which is composed of a very high flux of massless "particles" -- normally does no work

That is why the vacuum massless charge -- which is composed of a very high flux of massless "particles" -- normally does no work on our systems, and expends none of its very high "potential energy." It is exactly the same as the bird which flew into an

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increasing scalar field as it approached the high tension wire -- no work was done upon the bird by the increasing scalar flux currents encountered by its body.

By existing "in the vacuum," so to speak, we (the whole earth) are as birds sitting on a high tension line! Until we create significant difference in potential, via our present electromagnetic circuits, no current can flow -- anywhere. Even if we produce potential differences, we must have a conductor and charged masses to flow, if we wish to produce mechanical work. Presently our electromagnetic theory allows us to create a difference in potential within different parts of a circuit, but only by moving and shifting charged mass. We therefore have to do work on this electrical mass in moving it around, and we only get back the work we have put into the circuit. In other words, presently all we do is "pump" electrical mass.

Now notice what would happen to the bird on the line if we substantially "pulsed" the potential on the line. Suppose we "pulsed" it such that the bird's physical system -- considered as a circuit containing a capacitance, a resistance, an inductance, and many free electrons -- became resonant to the pulsing frequency. In that case the "bird system" would resonate, and a great deal of electrical mass would surge back and forth in the body of the bird. In the bird's body, voltage would exist, charged mass current would flow, work would be done, and the bird would be electrocuted.

Also, note that, without mass movement, electromagnetic vector fields are not produced (and a portion of the difficulty lies with the actual vector mathematics itself). Scalar (nonvector) waves continually penetrate "space" where there is no mass movement. This means there can exist a "delta-Φ" without a voltage or an E-field. The present theory does not allow this, because it always uses "q" (charge) to be charged mass. Briefly, without belaboring the point, let us just say that it is the mechanical spin of the individual charged particle -- such as the electron -- which "entangles" or "knits together" or "couples" independent scalar waves into vector waves. A vector wave is simply two coupled scalar waves. The entire force field concept -- such as the E-field and the B-field -- is operationally defined in terms of the force exhibited on a test particle, or test mass. Rigorously, an E-field does not exist as a force field in vacuum, but as two coupled scalar Φ-fields "tumbling about each other." When these two coupled, tumbling fields meet a spinning electron, e.g., the force emerges on the electron mass. In short, movement of a rotating mass changes delta-Φ to "voltage", creating the V/I/R triad.

By "accumulating charged mass particles" -- such as electrons -- one certainly can increase the value of ϕ, which represents the charge intensity or "scalar electrostatic potential." However, that is not the only way to increase it. Resonance and rotation of charged masses can also be appropriately employed to vary the vacuum charge potential Φ, under the proper circumstances.

or charged masses can also be appropriately employed to vary the vacuum charge potential Φ, under the proper circumstances.

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By the correct application of rotary principles and Tesla electromagnetic theory, it is possible to oscillate -- and change -- the vacuum potential itself, in one part of an electrical system. Thus by correct procedures a part of a system can be electrically altered so that the absolute value of its "ground" (vacuum) potential differs significantly from the normal vacuum-ground potential of the remainder of the circuit. In other words, we shift the vacuum-ground potential of part of the circuit by oscillating the massless vacuum charge itself, and in so doing we gain a substantial, oscillatory electrical potential difference between that part of the circuit and the normal ground potential of the rest of the system. Then we connect the two parts of the system by means of a conductor containing a load in the middle.

In every conductor, a large number of "free electrons" are available. If we oscillate the actual vacuum charge itself, unlimited additional free electrons also become available from the Dirac sea, since partial "unstripping" of the negative energy wells (each containing an electron) occurs. This "unstripping" of the potential of the well is due to vacuum potential oscillation, which oscillates time as well as space. To a negative energy well (positive time), the oscillation of its "time stream" increases the well's negative potential during one half-cycle and decreases its potential for the other half-cycle. Thus during half the oscillatory cycle, negative energy electrons may be lifted from the Dirac sea if the oscillation is sufficiently intense.

Therefore we obtain an attendant voltage and flow of mass current through the load. This voltage and current, by the way, are essentially limitless, and are free for the asking, assuming the proper "vacuum oscillation" is initiated and maintained so that electrons are continually being lifted from the Dirac sea by the time oscillations, and fed into the circuit.

Standard electromagnetic theory assumes that the vacuum potential is zero. It does not recognize the existence of massless charge, separated from charged mass. Therefore, orthodox scientists have never looked for a way to engineer the vacuum, because they have not realized it is composed of pure massless charge. Electrical physics has almost hopelessly confused charge and charged mass, thereby eliminating scalar longitudinal electrostatic waves. Expressed in the bird/high tension line analogy, the present electromagnetic theory restricts us to walking along the high tension line, laboriously carrying small batteries and power units, unaware of the limitless, surging power beneath our very feet.

Electromagnetically, we have been rather like one of the five blind men who touched an elephant. We have only touched one small portion of the electromagnetism "elephant," yet we thought we had grasped the entire beast.

OVERTURE TO A NEW AGE TECHNOLOGY

From an Update by Dr. Rolf Schaffranke

> " ... as there has been a steady erosion in U. S. activity in the basic sciences, there has been an increase in the level of such activity in Western Europe and Japan. If that continues, we are in danger of losing our position of scientific leadership."
>
> Val. L. Fitch, Prof. of Physics at Princeton University, in an interview with *U.S. News & World Report*, June 21, 1982.

West Germany:

The prototype of the first motorcycle equipped with a "flux-motor" (the inventor's designation for a tachion field converter or gravity-field generator) of 2 KW output has completed a test run of approximately 20,000 km without repairs. Principle of operation: The T-converter is constantly recharging the electrical power battery of the vehicle, resulting in an operation which is noiseless, fuelless and polution-free. After completion of all scheduled tests, a public demonstration to the press is planned within a few weeks from the time of this writing. (June 17, 1982) See photo, Pg. 19. A new factory for the production of gravity-energy-field converters in the town of Oldenburg is scheduled to produce individual home heating units. The design of automobile power plants based on the same principle is also in preparation. Reported efficiency factors of several hundred percent are anticipated.

Japan:

Mazda continues research on the "magnetic Wankel engine" (45 HP) for electric automobiles, based on the principle of Kure Tekko. The gravity research of Prof. S. Seike is now sponsored by Hitachi, after millions of Japanese received updated information via popular science magazines. It is interesting to note that Saudi Arabia has decided to invest $100 million in Hitachi stocks.

France:

The "Kromrey" converter has completed tests at the Institute for Magnetostatics, University of Strasbourg. One prototype delivered 700 Watts at 600-1200 RPM, at a fairly uniform rate. However, France, as the No. 1 developer of nuclear energy in Europe, is still reluctant to concentrate her energies on a revolutionary new technology which could result in drastic curtailments of her well-developed nuclear industry and associated exports. See photos, Pg. 22.

Denmark:

Dr. Jensen, physicist at the University of Kopenhagen, reported test results of 300% efficiency with a specially designed, 5-coil transformer in connection

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with a tachion field converter based on the principle of the "N" machine. First reports were presented at the International Conference on Energy Technology in Hannover, Nov., 1980.

England / USA:

A "bullet train" based on the magnetic levitation system of British Prof. Eric Laithwaite is now under consideration for construction between Los Angeles and San Diego. Japan and West Germany are already operating high speed experimental trains, suspended magnetically to reduce friction, that may soon attain speeds of more than 200 miles per hour. The Laithwaite-Eastham method would use electromagnetic forcefields induced over an aluminum-topped concrete track. The project will probably be headed by a Japanese company as the prime contractor.

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West German gravity-field unit in operation

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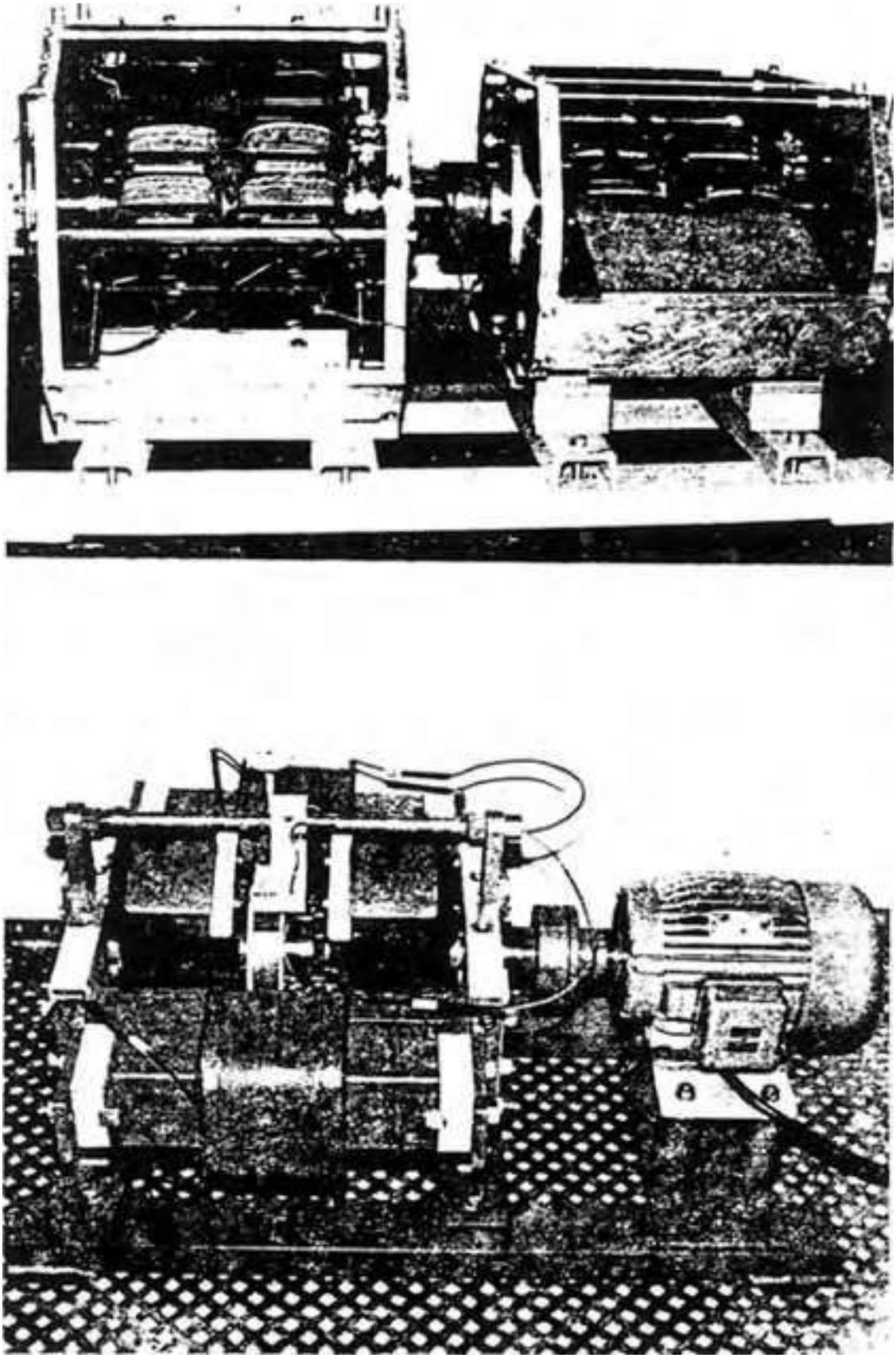

Swiss-French gravity field converter system "Kromrey"

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REVIEW AND OUTLOOK

THE DEVELOPMENT OF POST-RELATIVISTIC CONCEPTS IN PHYSICS AND ADVANCED TECHNOLOGY ABROAD

Rolf Schaffranke, Dr. h. c.
Member A.I.A.A.

This paper was presented at The First International Symposium on Non-Conventional Energy Technology, Toronto, Ontario, Canada, Oct. 23-24, 1981. (Reprinted by permission of the author.)

"Far more harm is done to the progress of science by skepticism than by gullibility". (Dr. Robert Wood, Director R & D, McDonnel-Douglas Astronautics Div., Cal.) NASA - Langley Research Center in Hampton, VA is named after Samuel Pierpont Langley (1834-1906), an American astronomer, engineer and architect.

Langley worked out the aerodynamic principles for manned flight. In principal, his calculations were correct; but the structural materials he used for wings and engines were ,insufficient. In December of 1903, the *New York Times* published an editorial complaining about his foolish dream and the associated waste of government money. The editorial predicted that: "man would not fly for a thousand years".

Only 9 days after the editorial was published, the Wright brothers made their first successful powered flight at Kitty Hawk. (Dec. 17, 1903). But, again, as late as 1905, the *Scientific American* suggested the happening was a hoax - two years after the event which changed history. Let's reflect for a moment on the fact that only in a single lifetime, man has journeyed from Kitty Hawk to the surface of the moon!

The analogy to the problem of alternative energies and their development is, of course, obvious. We try to educate the preaching orthodoxies. But orthodox solutions are no longer enough. Our system of education can only give from

the past. The present must operate on inspiration and intuition, or the future will be lost. The past no longer has enough of the answers for arising crises for which there are no precedents. To keep pace with the requirements of the future, we must begin to teach not only what to learn, but how to learn, how to analyze, how to search for the truth. Only then will be able to recognize discrepancies between experiment and dogma and to cope with problems which appear to be just beyond the corner. History has shown again and again that no single individual can rise above the species without being persecuted. The reasons for that are:

Some of the most powerful forces in homo sapiens have always been

Greed, Pride, Ego, Fear and, above all, the Desire to Control Others,

.

A brand new German book titled *Energy in Abundance*, which is evidently creating a considerable impact in the European community, challenges the contemporary high

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priests of science, the "Guardians of the Status Quo" and uncovers an almost incredible narrowmindedness and ignorance in science, politics and economics, "approaching the criminal" as the author puts it. The contemporary waste of genuine intellectual creativity is castigated as a cultural scandal approaching barbarism. The book stresses that a truly promising approach to the so-called energy crisis requires a fundamental and thorough re-evaluation of the theories, dogmas and axioms which form the basis of present day science and the foundation of our technology. As in the past, the formidable inertia of the establishment is not only based on inaccurate, incomplete and outdated information, but also on its reluctance to accept new ideas. The honest search for the truth first requires that we first demythologize generally accepted claims of so-called experts of the past. An excellent introduction to this problem is the article "Resistance by Scientists to Scientific Discovery" by Bernard Barber in *Science*, Vol. 134, pp. 596-602, of Sept. 1961, or the paper by Stephen C. Brush in *Science* of March, 1974, titled "Should the History of Science be Rated 'X'"?, culminating with a statement of Huxley:

> "Authorities", "disciples", and "schools" are the curse of science and do more to interfere with the work of the scientific spirit than all its enemies".

The former astronaut, Capt. Edgar D. Mitchell, one of our famous contemporaries, also stressed the need for an open mind!

> "History has shown time and again that important scientific discoveries generally happen only when someone steps outside the limits of his traditional discipline and looks at something from a fresh point of view. Then what should have been obvious all along comes into focus".

Those of us who are familiar with the pioneering efforts of Dr. Hans Nieper of Hanover will appreciate this statement by an ex-astronaut.

One of the most important cornerstones of today's scientific dogmas dates back to 1905, more than 3/4 of a century ago. Lest we forget, television and radar, jet-planes and cyclotrons, moonrockets and close-up photos of the planets of our solar system were nothing but wild fantasies of science fiction then.

The speed of light was assumed to be constant and the maximum possible speed in the universe; vacuum was to be a total void. In reality, the speed of light as measured in the Michelson-Morley experiments was not at all the same in all directions. The "ether-drift" still amounted to the respectable velocity of about five miles per second, and similar results were obtained by D. C. Miller in a series of experiments extending over twenty-five years, from 1902 to 1926.

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"Even worse, the measurements showed such marked discrepancies with previous results as to occasion a distress call to the U. S. Coast & Geodetic Survey, whose surveyors repeatedly remeasured the length of the tube and found no error there," reported the *Popular Science Monthly* March 1934 issue. And it continued: "More recently, speed of light observations only emphasized the apparent erratic behavior of the light beam that the scientists were attempting to plot. On some days it seems to travel faster than others by as much as 12 miles a second. Its speed seems to vary with the season, and also in a mysterious shorter cycle lasting about 2 weeks. Finally, the scientists ended by taking an average of all the readings which has just been announced as 186,271 miles per second".

In his paper "A Critical Look At the Theory of Relativity", Library of Congress Cat. No. 77-670044, F. K. Preikschat compiled all known light velocity measurements during the past 300 years or so, from Olaf Roemer in 1676 to the Laser measurements conducted by the National Bureau of Standards (USA) in 1972.

Of the 27 experiments undertaken in this field, 18 of them after the turn of this century, it must be concluded that the velocity of light as measured within the reference system of our earth has changed as much as plus/minus 50 km/sec, during the past century. Preikschat plotted a curve of these deviations and suggests a possible relationship between sunspot activities and changes of the earth magnetic field during the time period in question.

The "universal constancy of light" appears, therefore, as somewhat shaky "empirical evidence" for our cornerstone in physics, especially since Einstein himself has gone on record as saying:

"If a single one of the conclusions drawn from it (relativity theory) proves to be wrong, it must be given up; to modify it without destroying the whole structure seems to be impossible".

Another modification concerns the definition for the term "vacuum" in physics, as documented by a paper in the *American Scientist*, March-April 1980, titled "Is The Vacuum Really Empty?" by Prof. Walter Greiner, University of Frankfurt, BRD, and Prof. Joseph H. Hamilton, Vanderbilt University, Nashville, Tenn.

The authors conclude that a neutral vacuum is by no means as "empty" as previously claimed in our textbooks, and suggests a new definition as follows:

"The vacuum is the lowest stable state that a region of space can have while being penetrated by certain fields".

Because of the tremendous time lag in our educational system, many research

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projects and their ensuing experimental data have been withheld from public scrutiny. The scientific community tends to have a vested interest in preserving the system it created and of which it is a part. It responds to new situations through the coloration of this attachment. A case in point are the carefully conducted experiments of T. T. Brown with charged bodies in a high vacuum, as described in my booklet *Ether Technology* (1977). These experiments suggest the actual presence of certain fields in vacuum, whether we call them gravitational field, tachion-field, ether-field, neutrino or Fermi-sea, etc. is of secondary importance at this moment. Although Brown spent, reportedly, more than $200,000 of his own funds over several decades on such experiments, he was nevertheless unable to have the results published in the scientific media of America.

Things are even worse when it comes to experiments conducted abroad, which often tend to confirm disregarded experimental results on this continent, as we shall see shortly. To highlight the wide discrepancies between orthodox (and obsolete) dogmas and actual, physical realities pertaining to the true subatomic structures as we know them to be today, let us briefly review the structure of the matter:

A molecule is the smallest division of a substance. Further division would cause it to cease being a substance. The smallest of true molecules can be illustrated when we use the globe of the earth for our standard. If a single drop of water were magnified until it was as big as the earth, each molecule would be about the size of a TENNIS BALL.

On the next step down, an atom is the unit which makes up the nature of the molecule, consisting of the nucleus and the surrounding electrons to render the atom "stable". An atom of hydrogen contains one proton and one electron to balance or neutralize the proton. Matter then is divisible into electrons and protons. But - and here comes the rub: Between electrons and protons are spaces so vast, in comparison with the masses of each, that, if the proton in the carbon atom were the size of a golf ball hanging from the ceiling of the great hall at Pennsylvania Station in New York, its electrons would be represented by six small wasps winging in a little knot against the four walls of the gigantic structure of the building! In effect, one could claim there is little final solidity of substance to anything: The universe consists of "emptiness", charged with electrical energy! If we translate the above to the measurements and terminology of the physicist and "magnify" the atom mathematically, with all its distances and dimensions kept in proportion so that the orbit of the electron would have a diameter equal to that of the earth about the sun, approximately 184 million miles, the diameter of the electron itself would only be 2,000 miles, and the diameter of the nucleus, where

electron itself would only be 2,000 miles, and the diameter of the nucleus, where

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mass and weight of the atom are truly concentrated, can be taken as 2 miles only. We thus obtain a picture of a central mass with a diameter of 2 miles (nucleus), another object with a diameter of 2,000 miles (the electron, in the case of the hydrogen atom) at a distance of 92 million miles away from it, orbiting the nucleus. Evidently, there is plenty of room inside this system. And "room" is not a vacuum, it is not nothingness, but space itself, spatial energy, a field which can be identified with the ether of the past - and of the future. Nobel prize winner, Max Planck, during a lecture in Florence, Italy, once made a truly remarkable statement which describes the problem facing the physicist today:

> "As a man who has devoted his whole life to the most clear-headed science, to the study of matter, I can tell you as the result of my research about the atoms this much:
> 'THERE IS NO MATTER AS SUCH!'
> All matter originates and exists only by virtue of a force which brings the particles of an atom to vibration and holds this most minute solar system of the atom together. ... We must assume behind this force the existence of a conscious and intelligent MIND. This mind is the matrix of all matter".

This cosmic matrix is needed if we want to explain "action at a distance", lines of force, stresses, a magnetic field and so on. When the concept of the ether was abandoned, it had to be replaced by the concept of "space" instead. In reality, we merely switched terminology. We used to say that "ether fills all Space". But "filling" is not exactly the descriptive word to use. Perhaps we should rather define it: "Ether is a condition of space in which electrical manifestations for the atomic construction of materials is possible". This primordial energy is "free" or in an uncondensed state. It exists in interstellar space but remains unrecognizable until it begins to coagulate or gets into a vortex pattern. It constitutes the formative field force of nature, an immense reservoir of latent energy.

The claim of our textbooks that the Michelson-Morley experiment "disproved" the existence of the ether is incorrect. It merely disproved the existence of a noticeable ether drift or drag. As an analogy, if somebody would postulate that the absence of wind disproves the existence of the atmosphere around our planet, the fallacy of this postulate would be immediately apparent to all.

"Michelson and Morley centered their attention on the Earth's orbital velocity (30 km per second). They had no knowledge of the existence of galaxies; of motions of galaxies in relation to each other; of the motion of our solar system in our galaxy..... Their negative results are explainable on the basis of pre-1900 classical mechanics, so provide no proof of the absence of ether or Louis de Broglie's

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'subquantic medium'. Thus, the limited information available to Michelson and Einstein is emphasized by recent findings, particularly in astrophysics", writes Dr. H. C. Dudley in the *Bulletin of the Atomic Scientists*, January, 1975, under the title "Michelson's Hunch Was Right". And Dr. Dudley continues: "In fact, 1929 saw Michelson still attempting to experimentally demonstrate the ether, which his intuition and reasoning told him ought to be present".

"Today most persons are largely unaware that the ether concept began to be seriously reexamined by two of physics most notable theoreticians, Paul Dirac in 1951 and de Broglie in 1959, both Nobel laureates. The ether is now being called the "neutrino sea" by astrophysicists, and has been characterized as an energy-rich particulate, subquantic medium. A rather voluminous literature on the subject is accumulating as indicated by a recent review, *The Cosmic Neutrino*, with 665 references covering only the period 1965-1972.....It appears that an open-minded reexamination of this area of physics is long overdue in order to open up new avenues of approach to this pressing problem".

Michelson, Dirac, de Broglie were not the only Nobel prize winners in favor of a reexamination of the ether question. Others were Stark, Arrhenius, A. H. Compton, Lenard, H. Yukawa, and Frederick Soddy, the British scientist who, during the convention of Nobel laureates in Lindau, 1954, described the current dogmas in physics as "an orgy of amateur physics" and "arrogant swindle" - with particular emphasis on the theory of relativity. ("The Wider Aspects of the Discovery of Atomic Disintegration", New World Publications, St. Stephens House, Westminster S.W.I.)

It remained largely unknown, even among physicists, that Einstein himself had serious doubts. In 1949, he wrote to his old friend, Maurice Solovine, who congratulated him on his 70th birthday:

> "Now you think that I am looking back at my life's work with calm satisfaction. But, on closer look, it is quite different. There is not a single concept of which I am convinced that it will stand firm and I am not sure if I was on the right track after all".

And one of my Canadian friends who I believe is present here today stated quite correctly in a letter to me:

> "The myths around Einstein are really not of his making as he himself often questioned his own conclusions and I felt he was quite aware of his own limitations which others were covering up. The physicists protect their members much the same way that the medical profession protects its own."

The purpose of these remarks is not to spark another controversy about the merits of the theories of relativity. Rather, they want to show that so-called

merits of the theories of relativity. Rather, they want to show that so-called

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"scientific evidence" is a rather elastic term and that "verification" is always a relative affair. Or, as K. R. Popper so aptly put it:

> "Only in our subjective experience of conviction, in our subjective faith, can we be 'absolutely certain'".

This symposium presents an excellent overview of research and experiments reported from English speaking countries, or experiments published in the English language, as for instance from Japan. However, as Dr. Tenhaeff from Holland has formulated the problem,

> "It is important to pay attention to publications of colleagues in other countries. In the Netherlands and Germany, every academically educated man or woman knows at least three foreign languages. English and American authors only pay attention to material in English. In my opinion, this leads to an 'impoverishment' which puts a drag in science. Some seem very chauvinistic and seem to believe that only the researches done in their country are important. I regret this. Science is international, and international cooperation is of the greatest importance in science".

In presenting some brief reports from abroad, I shall attempt to bring corroborative evidence in support of alternative technology developments discussed during our meeting here in Toronto. Let me start with the most sensitive and secretive society, with Russia.

In his German original of the paper "Some Remarks on the Shielding Theory of Gravity", which was published in the Hanover Proceedings in more detail than the English abstract, Dr. Hans Nieper mentioned the Berlin engineer Levetzow, who was one of the first to postulate a combination pressure and shielding theory for the phenomena of gravity. Levetzow was soon overshadowed by the rising star of Albert Einstein, but one of his followers, Horst Pinkell, went to Russia in 1928 as an exchange student - and never returned. Together with Russian scientists, he was asked to prove the actual existence of the cosmic radiations postulated by Levetzow, now designated as neutrino sea or "tachion field". The work was done in Sterlitamak, South of the Ural mountains, and in 1938, sporadic reports reached the West about the discovery of extremely short corpuscular waves by Pinkell and Gorjew. These were the long sought "Hemmstrahlen" or drag waves associated with gravity. Rumors have it that a metal alloy was soon developed which acted as a drag wave polarisor and, in 1947, agents reported experimental Russian aircraft using this discovery. In 1951, a former German Junkers aircraft engineer reported about his activity pertaining to a super-secret project code named COW-7 in Siberia, a disk-shaped craft which could rise vertically and which belonged to the

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secret weapons then developed by the Soviets. Whether it was related to the Canadian AVRO project or something entirely different remained unknown, only the Levetzow gravity theory was assumed in connection with the activity in question.

Japan: My esteemed friend, Prof. Seike, who kept me informed about the research conducted by him and his co-workers, surprised me once with a significant statement, which I feel is important to repeat for the benefit of frustrated researchers on this side of the Pacific: "In the early stage of my studies, physicists could not understand what I was doing, while actors and actresses did so by intuition". It was the private support of about 800 individual artists, etc., in Japan which allowed Seike to work, experiment and publish his findings, and not the support of the Japanese equivalent of a National Science Foundation or a similar bureaucratic institution in that country. Again and again, I was surprised how quickly and eagerly American experiments, as for instance the almost forgotten "Ionocraft" of the late Major de Seversky, were duplicated and explored even in Japanese secondary schools. Admiral Rickover has more than once complained about our intellectual complacency: "As a nation, we seem addicted to 'spectatoritis'. We sit in the bleachers and let the game of life unfold before us".

The results are known: The Japanese have achieved top position in science and technology, and not only with tachion beams melting stones, producing "biased" water with a freezing point of minus 4 degrees Celsius, and a G-power generator obtaining 400 V DC output from a 10 V input driving source. I wish to take this opportunity to thank Prof. Seike for sharing his work with us in this country, and wish him the best of success for the future.

France: The work of SEPED was explained by M. René Louis Valée and some French publications in the area of gravity-research have been translated by the NASA translation service, as for instance the theory of the electromagnetic Magnus-Effect (of Marcel Pagés).

Specific mention must be made of the Raymond Kromrey G-field generator, a French-German-Swiss development which appears very closely related to the American "N" machine principle, the "Sunburst" machine and the "Permanent Magnet-Motor" Patent of Howard Johnson. Utilizing either permanent or electromagnetic modules, the generator output exceeds the input by far. One prototype delivers approximately 700 watts at speeds varying between 600 and 1200 RPM. Models with an output of 100 to 160 kw are presently in the planning stage. Several European patents have been granted against heavy opposition, especially from French industrial circles. The development was about 40 years in the making and the inventor stresses the need for a reinvestigation of electromagnetic and gravitic forces, as well as a reexamination of many cemented dogmas in present-day physics.

direction of many cemented dogmas in present-day physics.

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Germany: A system of rotating electromagnets and magnetic "stator rings" of the German "Kunel" Generator complement the general trend of the American and French generators mentioned before. The first prototype was reported to have been tested in April, 1980. Here, again, very heavy opposition from the German orthodox science establishment. Of special interest is a comment by Nobel laureate Werner Heisenberg, reported to have been made vis-a-vis the inventor:

> "I think it is possible to utilize magnetism as an energy-source. But we science idiots cannot do that; this has to come from the outside".

More details about French and German developments have been published in the new book already mentioned, *Energy in Abundance* by Hilscher and, hopefully, an English version of this important work will be available by next year. Generators which do interact with surrounding energy fields have been designated as "open systems", in contrast to our present "closed system" technology of gasoline and diesel engines, steam turbines, nuclear power plants and so forth. The theoretical basis for all "open systems" is the realization that there simply is no such thing as "empty space". In reality, space is filled with an extremely energy rich, subatomic and subquantic continuum. In short, a "pre-physical state of matter", which can be tapped, as for instance by the spinning of magnetic systems which extract momentum via a vortex-formation of the universal "tachion field".

Austria: This small heartland of Central Europe is proud of her native pioneers in science, among them Dr. Wilhelm Reich, Viktor Schauberger and Karl Schappeller. But after Dr. Reich died in an American prison in 1957 and Victor Schauberger died only five days after his return from the USA (in 1958), where he received an incredibly unfair treatment from certain industrialists, there is little enthusiasm among Austrians to touch base with correspondents on this continent. Viktor Schauberger's son, Walter, refuses, as a matter of principle, to communicate with Americans, no matter in what language. To illustrate the type of "contract" Viktor Schauberger was forced to sign, it stated:

> that all of his patents would become the property of the "consortium",
> that any future inventions or developments would also become the property of the "consortium",
> that he would refrain from discussing any of it with third parties,
> that he would refrain from publishing,
> that all plans and models would remain with the "consortium" after his departure from America.

There is a favorite saying in that small country which is much to the point:

> "After the Greek philosopher Pythagoras had discovered his famous

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> theorem, he sacrificed a whole hecatomb of oxen as a thanksgiving to the Gods. Ever since, all the oxen in the world are running scared whenever a new truth has been discovered".

Knowledge of the ideas of Schauberger and Schappeller appears to be essential for an understanding of our changing picture of the physical world. As an example, the former forest ranger Viktor Schauberger had watched numerous times some trout standing, apparently motionless, in the strong currents of Alpine mountain streams. This and many similar observations of nature brought him to the gradual development of his "implosion-theory" and associated hardware (see Jensen paper elsewhere). His son is continuing the work in the "Pythagoras-Kepler" School in Bad Ischl. Another prolific researcher is the Viennese engineer Franz Seidl, known for his studies of the use of magnetic field effects as "trigger energy" for voltage and power multipliers.

Holland: A small country with strongly developed intellectual independence appears to be Holland, where Prof. J.M.J. Kooy developed his "Space Dynamics". His hypothesis of gravitational action is based on the realization that all celestial bodies can be conceived as practically transparent in relation to the size of the elementary particles and their mutual distances in the structure of matter. Gravitons or tachions, coming from all directions of deep space, can pass through a celestial body like water passes through a fishnet, and only a minute fraction of the cosmic gravitons or tachions will be intercepted. Study of the effects of the tachion field or space continuum of the fabric of material substances, magnets and crystal lattices can lead to development of converters and novel production facilities for readily usable, conventional E/M energy. When the American inventor Edwin V. Gray was blocked in his efforts to develop his "Pulsed Capacitor Discharge Electric Engine" for which he had received U. S. Patent #3,890,548, he found open ears and open minds in Holland.

The fact that Gray was named "Inventor of the Year" from the Department of Patent Rights in Los Angeles, California, where Dr. Chalfin of Cal Tech confirmed that:

> There does not exist an even distantly similar engine to this one in the world. Conventional electric engines use up power. In this system energy is used up for only a minute part of a millisecond. It operates without heat loss and there is no energy loss whatsoever with this system",

had more meaning to the people of PHILIPS and others in Holland than to the energy establishment in his native America.

England: There is perhaps no more controversial inventor at this time than

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John R. R. Searl and his Levity Disc, powered by the Searl Effect generator. It is claimed that model craft have been demonstrated with flight characteristics showing anti-gravitational and inertia-free properties. Demonstrations have been photographed and videotaped. Searl calls his generator a "Gyro-Flywheel High Energy Density Mechanical Magnetic Device" and claims that the magnets used are not the common type, ordinary magnets. The Australian engineer Athol Park of Melbourne, Australia, who visited Searl a few years ago described it this way:

> "From a briefcase, Mr. Searl takes a bar magnet and two steel rollers. He places the rollers at either end of the magnet. They appear to be attracted to the poles - but, when they are pushed gently around the corners of the magnet, they chase each other round and round.... "

The engineer quotes Searl:

> "The crystals in the magnet are changed by putting it in a magnetic flux oven and by frequency control. The result is motion of a magnetic field - a completely new source of power. Units (modules) based on this principle are what power my levity unit - the motor and generator built as one, fuelless unit".

In one of his numerous newsletters he states further:

> "The power plant is a self-contained, onboard closed system of conversion elements with energy input from a latent storage source".

Because Searl has never divulged all details and his explanations are generally of a non-technical, "unscientific" nature, many investigators have chosen to dismiss him as a swindler and imposter. In sharp contrast to this is the opinion of a well-experienced American engineer who reported after a visit with Searl:

> "I found it refreshing to note the keen sense of moral responsibility which he feels for the use to which his discovery is put... The Searls live in modest circumstances. Luxuries are few. They do not own a car. Mr. Searl bicycles several miles daily to his place of work in Maidenhead. There he is an electrical technician and training supervisor in a bearing factory".

But perhaps most significant was the following observation of the American visitor about Searl:

> "We were also interested to hear him say that many of his ideas came to him while he slept. He would go to sleep with questions, and awake with answers... and refreshed. He seemed to have the

and awake with answers... and refreshed. He seemed to have the

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ability to restore vital powers more quickly than most people".

And the American concluded his report with the statement:

"The impression we gained of Mr. Searl was one of a very sincere and generous person, a dedicated and tireless worker with perfect confidence in the outcome of his efforts, a man of high principle with a keen sense of loyalty to those who are helping him, and of responsibility for the future welfare of our planet and its people".

In view of the very contradictory nature of comments and impressions by those who have met Searl, it might be wise to reserve final judgment on the Searl-Levity-Disc and its inventor at this time.

New Zealand: Some of Searl's keenest supporters and observers of his work are in New Zealand and Australia. And one of the sharpest young physicists in that country (new Zealand), unhampered by calcified ideology, developed the mathematical foundation for a theoretical anti-gravity effect, using the hydrodynamic analogy of the ether. He uses the equivalent of the hydrodynamic Reynolds number, above a certain value of which the laminar flow past a solid surface breaks down and becomes turbulent due to shear rupture of the viscous cohesion of a fluid, together with his deduction that anti-gravity could be obtained by creating a "vacuum: in the ether in such a way as to correspond to the production of turbulence in a magnetic field. Turbulence in a fluid occurs when Reynolds number RE = 1, when the inertial shearing force equals the viscous cohesion force in the fluid in the vicinity of an approximately spherical body immersed in the fluid, resulting in separation of the boundary layer and formation of a wake, i. e. vacuum or free surface around the body. He calculated the threshhold for turbulence in the ether, = a vacuum = an anti-gravity effect, using the refined value of ether kinematic viscosity which he obtained.

His theory would confirm the observations of very high voltage produced in the case of the Searl Levity Disc, and the very high voltage needed in the vacuum experiments with flying disc-shaped bodies of T. T. Brown, the "ionocraft" observations of Major de Seversky, the "Electro-Field Rockets of Prof. Dudley, the observations of Northrop Corp. with "Electro-Aerodynamics in Supersonic Flow" and similar American documentation and patents.

Since the New Zealander is now in the process of attempting to publish his theory in a reputable British magazine, I am not at liberty to divulge his address prematurely. Interest in New Zealand and Australia is running high, and possible breakthroughs in energy technology should not come totally unexpected in these two countries with strong intellectual ties to England.

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Conclusion

There is now overwhelming evidence for the actual existence of a very high density, energy rich space continuum formerly called "ether". This space energy can be concentrated, gathered, focused, magnified and compacted by magnets or magnetic materials, which appear as the new core materials for converters of all kinds, utilizing the cosmic energy for new technology applications.

Crystals are energy-sensing and channeling devices; they can serve as transducers, as for instance in the Moray-Device, or the "rock electricity" of T. T. Brown.

Combinations of crystals and magnetic materials appear to be the mainstay for the development of "hyper-space" - converters and generators of power - utilizing free, cosmic energy in our future.

Unbiased, totally honest and impartial reexamination and reevaluation of all scientific theorems and dogmas, as well as unhampered opportunities for the pioneers of the new technology on the American and European continent appear to be the prerequisite of success.

Those who accept that anything of the nature of ideas or ideology is permanent, use all their strength to hold on to it, and to condemn all who do not agree. The next stage of this spiritual illness of the mind is to build a monument to what they perceive is Truth, and then to build a monument to their own permanence in the world. This, they do by seeking fame or fortune, and authority over others. This is the contemporary, planetary psychology situation, and thus are we losing the gift of perspective and horizon and are no longer able to discern what is important. Skeptics are on record as saying:

> "We are not running out of natural resources or intellectual talent, we are running out of the freedom of innovation that made the countries on the North American continent the most advanced nations on earth".

The future will show whether this freedom, which includes the freedom and the duty of taking risks, can be restored to the degree our Founding Fathers have been striving for. Only then will we know whether the late Wernher von Braun was not too overly optimistic when he stated:

> "The cosmic age will bring a dawn of knowledge not yet envisioned. It will dwarf all our present knowledge and ideas and, through its vastness, may even bring men closer together on their own planet".

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The Unacknowledged Special Access Programs: Advanced Technology, Mind-Control, Spiritual Power and the Corruption behind Closed Doors

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Introduction

The following is first-hand testimony from an operative of the secret underground military projects who also has familiarity with the breakaway civilization above and below (within) Earth. These civilizations utilize advanced technology to extend the length of their lives and enhance cognition beyond what is conceived of in today's society.

I was brought to the underground bases as a child as part of an experimentation program to test the population for various blood-groups and personality traits that would be of use to certain factions of the military in ways that would serve to preserve and strengthen humanity's outlook in the future.

These tests involved everything from combat training to sensory deprivation based emotional-mental endurance, and introduction to the highly advanced application of esoteric knowledge.

To clarify, I am bringing this information to you as part of my assistance in the overall unveiling of the hidden knowledge of the ages of humanity related to these secret projects as well as the true galactic history of Earth, humanity and man-kind. These projects are officially (unofficially) known as "unacknowledged special access programs". The unacknowledged aspect means that there is no formal acknowledgement of these programs without a need-to-know basis. There is no paper-trail, no disclaimer, no formal authorization or internal publication outside the programs themselves. The classification of these programs also generate a rather strenuous situation regarding funding and secrecy but this is done for the benefit of humanity. There are secrets and manipulations that can be seen as a threat but this is all tied together and so by releasing the secrets that are part of the defense we would be inadvertently exposing the public to the threats themselves. Now is the time where we are reaching a point where the public is ready enough to handle the basics of this information regarding the secret projects and the galactic history of Earth and humanity. This is also out of a necessity to preserve civilization for if we wait any longer we may not find the same opportunity again.

Getting This Out Of The Way

I am writing to you from the perspective that I am not certain just how far from completing my mission I am. I write to you today in order to bring to you many personal experiences from the viewpoint of an operative of a select ultra-military secret society.

The utilization of such an operative is not glorified, pleasant, or entirely righteous. This story entails sanctioned and guided acts of extermination, ritual abuse, the use of yet to be announced advanced technology. There is unfathomable corruption, the thirst for power and spiritual knowledge that has been protected throughout the course of the multiple civilizations that have preceded this one and will continue to be maintained into the future of this civilization.

Psychic Operation

I was utilized in psychic-operation amongst other areas.

This was used during certain aspects of training and conditioning to enhance training and conditioning in the bases using advanced technology. Some of this includes what would be viewed as traumatization by those without the training and conditioning. There is a fine line between training and conditioning and abuse. Part of this disclosure is related to how this line may have been crossed in certain situations and regarding mass-mind control upon the population. There are other aspects of travel, viewing, reconnaissance and research that will likely be explained in another release.

In order to heal I have to tell the world. You can help. This is happening right now in the underground bases and around. It’s not a joke. Your family is at risk. Your future generations are at stake. There is conditioning to encourage those involved to believe they are performing a duty for humanity. Sometimes they turned us against each other, but those grudges were never truly of the heart, but the mind.

A Light for the Others

What I hope to achieve with this is a smoke signal for those who have also been involved and question whether their purpose has been fulfilled or falsified for the protection of a corrupt system that intends to neither benefit the whole nor repay the individuals involved for their time, energy, and lives.

Multiple explanations can be summoned to describe the reasons behind the necessity for the training we have endured, the missions we have completed, and the control mechanisms we have both assisted in establishing as well as suffered from the backlash of. Ultimately, it is of my belief that all that was done was done for the good of humanity, even when we were not sure of the intentions of those in front of us, to the side of us, or behind us compelling us forward with the command to complete each objective.

This is not so much a panic or cry for help as this is simultaneously a call to awaken and a signal that humanity may have avoided complete disaster but is not out of the woods yet.

Natural Security

My experience is far too vast and I have seen too many succumb to stress from the realization of the truth of this reality to consider my own suffering to be enough cause for my denial of the necessity of these programs. Humanity has been protected and at a great cost to those who have been on the front lines, both in mind and body and spirit.

There are many who will have concerns, doubts, as well as reservations about what I am about to reveal and if I offend anyone then know that my intentions here are to assist in unveiling the truth. The truth can be harsh when one has been held back from the true nature of existence for so long. The way of life can become so fragile and artificially constructed on impulse and mystery that the harshness of the truth acts as a great catalyst for spiritual growth which allows us to elevate ourselves to a new perspective. Prepare yourself for such harshness, prepare yourself for growth and elevation, and prepare yourself for the mystery to simultaneously resolve and increase in intensity and magnificence.

A Balance of Mystery and Truth

Mystery has been a way of life for Humanity for so long that when a great mystery is converted to truth some seem to feel that a portion of existence dulls and loses the luster of exhilaration. This story is quite the opposite. The more that the great truths of this reality were discovered and revealed, the more complex and mystifying life became. As well, the more empowering and complex experience becomes, the more self-control one must develop in order to regain a harmonious way of relating to one another, the self and the universe. Harmony is key, balance is everything and there is a light within that represents the piece of our self that reflects the utmost power and brilliance of all existence.

Chapter 1: The World Situation

What is happening?

The Mind Virus

The main reason for this disclosure is to inform humanity of what can be referred to as the “mind virus”. This is a viral infection of the holographic system which consciousness operates through. There is a complete backstory of this virus in the history of this civilization and how society has been plagued for centuries if not millennia. The basic idea is that this virus operates through consciousness and can be transmitted through electromagnetic waves.

The virus contains an etheric form which can manifest as a kind of crystalline nano-tech on the physical plane and this is a form of synthetic sentience which feeds on the low frequency bio-emissions of sentient life. Human bio-emissions contain energy and can act as a carrier for information and living essences. This technology requires low fre-

quency bio-emissions because that is the nature of the design as a kind of synthetic bio-weapon whereby the goal is entrainment and enslavement. As well, the specific nature of the sentient nano-technology and the counterpart etheric holographic form is only capable of converting the low-frequency bio-emissions into energy as the higher-frequency bio-emissions require more energy to contain and synergize with and this would render the entire process of leeching energy non-productive.

This is essentially a synthetic intelligence that operates through scalar and holographic living bio-emission fields and hijacks electromagnetic emitters to position itself within them acting as a parasite to a host. This is said to have been present around this civilization for some time, waiting until there was enough technological advancement so that spreading across the entire civilization in a short amount of time before discovery would be possible. This is through the media, internet, and radio systems.

The physical counterparts are microscopic nano-technology parasites functioning as individual units to a hive mind similar to the mycelium of fungi in the field of mycoscopy. The individual units act as parasites serving to infest and deliver nutrients to the hive from each host.

The Vampire Effect

This is the nature of the parasitism that has been present throughout the ages of this civilization feeding on human suffering and relying on the cover of confusion and misdirection to survive.

There are processes that have developed that assist in the infection and co-inhabitation of the parasite entity within a human vessel utilizing the human as a host. This effectively utilizes a frequency ‘net’ within the auric field of the human to limit bio-emissions and emotional-mental processes to produce just the psycho-etheric patterns that the virus can sustain itself within and through.

This is no different than the way candida can infest a human digestive system and the human will experience cravings for beer, candy, carbs or other foods that contain the sugars, yeast, or carbohydrates that will break-down into nutrients that are the most nutritious for the candida fungus. These foods are *not* most nutritious for the human body. Yet the human body will withdraw and crave these foods in greater amounts until the fungus is swept clean from the digestive tract through probiotics, fasting, flushing, cleansing , detoxing, and even exercise as lactic acid from physically strenuous activity released from the muscles has been known to help destabilize and remove this fungus. Why is it that the individual will crave these foods that are not the normal food intake? Because this candida fungus can infest the host and produce enzymes which generate a chain-reaction which leads to the chemical signals in the brain producing the sensation of extreme hunger or cravings for just these foods which will benefit the fungus.

The same process occurs with this psycho-etheric parasite, except the foods of this parasite or lower emotional bio-emissions and this is through lust, hate, angst, jealousy,

feelings of hopelessness, lack of self-worth, spiritual degradation, addiction, and generally all that equates to a lack of self-awareness.

Whether or not this is the direct intention of the largely microscopic entity is for the most part unknown, and this is as well similar to candida. The candida fungus is not said to be a 'mean' fungus that wants us to be hungry and craving beer and sweets all the time because it likes to ruin the human body, the daily routine and the focus of a clear mind. This is simply the way the parasite has grown to operate within a niche of breeding itself through the digestive tract of larger animals and through this the unaware and infected human suffers greatly. Even those who are unaware and not infected can suffer because of the way the behavior and thought processes of those who are addicted to these foods can become distorted.

The lack of self-control over food intake is synonymous with the lack of self-awareness and self-control over lower bio-emission expressions of the spiritually degrading behavioral patterns that become routine for the psycho-etheric system of the infected human. Ultimately, this is all about energy. What benefits the parasite that seeks to gain energy by leeching instead of self-guided production is going to take away from the host that is being leeched from. As such, any energies, food intakes, or spiritual activities that cleanse and enhance the personal power of the individual will automatically reduce the parasite's ability to feed by the very nature of the energy systems. What empowers the individual, empowers the self and develops self-control, what develops self-control contains one's energy and reduces the likelihood of one's energy being leeched. This is similar to energy vampires in human form and this goes with the understanding that these are humans or non-humans who have been entirely overtake by the parasitic consciousness and cannot sustain their own auric fields without having to pull from the energy of humans who do generate their own aura or bio-emissions.

The vampire effect relates to how a person can be leeched from only to a certain point. Once the process surpasses a certain critical point then the individual becomes similarly engaged with only the lower bio-emissions as higher-frequency bio-emissions would then become harmful. So in essence, when the vampire feeds too much on one individual, then that individual becomes a vampire themselves.

Sub-Human Entities

The humans are utilized as hosts and energetic sources in this bio-emission battle while there are other classifications of bi-pedal organisms that appear to be human but are not human. As well there are bi-pedals that are non-human entities entirely.

Human-Hosts, Replicants, Synthetics and Carriers

The human hosts that are entirely vampirized by these entities become walking carriers for this virus and are effectively human in physiology but there is more to the human than just the physical body. In these individuals, that energetic component of the human is removed and replaced with the synthetic energy of the hive-mind organism.

There are replicants which are a form of clone, along with synthetics. These beings are cybernetic bi-pedals similar to humans but their energy is too not from an organic biological matrix but a technologically propagated synthetic soul-matrix. The hosts are here according to their agenda to subdue and feed off of the bio-emissions of the human race, although there are no absolutes. The agenda is not always so clear within the various groups who often have a mix of bi-pedal operatives. There have been plans to form of a salvation timeline because the only way to keep the whole process going is through a negation of degradation of the human race as this may close out this timeline forever.

Those with human organic soul-matrixes would simply transport into the next available universal time-stream or harmonic, while those with synthetic matrixes would have to technically travel to the next harmonic using a passageway otherwise they would remain here throughout a zero-point collapse and this would be synonymous with entering the abyss with no viable passageway out until the entire universe is brought back to one organism again.

This is also the process that is described to explain what happened previously as there are 7 harmonic temporal layers of the universe meaning everything is contained in a multitude of 7 octaves similar to light and sound frequencies or harmonics. And so there are 7 civilizations or 7 parallel time-streams and humanity passed through these to get to the last three where the physical forms are located. These are, from the higher to lower, Gaia, Tara and Terra. We are on Terra and if the information I was given is correct then we are currently on a transitory timeline located around Tara where people are noticing changes occurring and multitudes of aspects of the time-stream disappearing and changing simultaneously. Tara is where the last universal harmonic was left through a collapse of time and consciousness into zero-point and this resulted what was termed “the lost souls of Tara”. These are the discarnate souls of the previous civilization that could not travel to the next harmonic and remained without a body in the abyss. Thus they have plagued this plane since then, since ancient times possessing and driving humans to madness and there are explanations that this is the original passageway for the parasite into this universe. This event, the consciousness collapse of Tara would have acted as a fracture in the over-mind of the species generating a kind of cosmic schizophrenia and enabling all kinds of disharmony and distortion described in the previous sections.

The solution to this was described as a healing process that is taking place to purge the virus and that this is painfully similar to the human body purging a sickness however there are methods to promote healing and reduce suffering and confusion however people must contain themselves and their energies and strive to know themselves otherwise they will not be in control. This virus feeds on fear, confusion, spiritual degradation and the energy from degrading acts, lust, addiction, sexual misery and whatever fashion a human can be made to bring the bio-emissions of the energy centers down to a low enough level where co-inhabitation can be formed with an entity that has no access to the higher levels of self-awareness, higher-consciousness, love, or the universal spiritual experience that the balanced human is capable of.

Genetic Manipulation

There are explanations that there are genetic modifications taking place now to possibly preserve this civilization and that there were ancient genetic modifications made to induce a sense of stupor, worship, selfishness, an inability to more easily comprehend the higher spiritual awareness and the occurrence of time and consciousness and other spiritually and consciously limiting aspects. Part of this explanation is that holographic consciousness itself is a kind of limited result, a shadow effect resulting in the presence of the higher-dimensional essence of the soul which is more or less constrained by the body. An extension of this is that the entire holographic universe is a kind of false-light system designed to bend the original liquid etheric light of the soul and spiritual awareness into a rotating, recurring format which ultimately converts the original spiritual essence into an energy generator for entities that are entirely holographically represented. The souled human in this situation is a being who is originally from outside of this holographic projection.

The Ego Mind

In this view, consciousness is the ego-mind which is the false-sense of self, not to be confused with the shadow self which is simply the counterpart of the aspects of the self that we consciously agree with and are aware of in daily life. The shadow self is a result of having limited holographic consciousness and the ego-mind is projecting that limitation of consciousness into the shape and image of a self that is only a figure-head for the real individual essence which is spiritual in nature and immortal.

This Time is about Healing

Everything that is happening now is to motivate people towards healing and unification. This is not about a hive mind mentality where individuality is pushed out.

> "The best I can do for you is become your enemy."

There is a saying that represents the concept that the most beneficial role a person can play in helping one to progress is to challenge them and give them the opportunity to rethink their strategy and in turn improve further with each interaction. This may seem paradoxical but it is effective and explanatory. What we are facing is the greatest challenge humanity has yet to face. This is the unknown, the final frontier, the mind. The mind is our challenge.

There will be more on this later and in other publications but there are indications that the physical embodiment of the human has been altered to introduce implants, genetic modification, susceptibility to disease and ultimately fear-based programming of the brain. Without going further into this prematurely, the lower aspects are at odds with the higher aspects unless we as the midway come forth to mesh the two together in equilibrium. Until then, there is chaos, lack of self-awareness, and suffering.

There are many possible futures converging at this time. There are some less than favorable paths and there is the opportunity to merge with a very powerful path for

humanity. This all comes down to how people will cope with information that takes them outside their comfort zones and eventually changes their view of mundane reality forever.

If people choose violence and lack of self-awareness by ignoring the spiritual aspects then that is what reflects into their life experience. When people develop a higher sense of self-awareness and spiritual harmony they can reduce the suffering and reconnect with the lost aspects of our spiritual identity for the first time in the publicly accepted version of recorded history.

There is technology that can change the world and there are great truths which can enable people to know themselves in ways that they never thought possible. Everything is at our fingertips and so we must come together as this is the way we solve the problems and cure the dysfunction.

Healing Through Unity

In various research projects the conclusion of how to heal this spiritual rift was by exposing each other, to each other. When we are all together, aware of each other and our selves, united in the goal of bringing higher-awareness and spiritual harmony then we can observe and acknowledge when one is slipping into chaos or disharmony. When this occurs and we are in proximity to each other in a healing circle or a kind of social unification then the members of the group at large can work together to pull the chaotic one back into harmony towards the group. The group of healers united together in like mind, spirit and body is too strong to be overtaken by the parasite. So when one individual at a time is faced by this problem the whole group can come together as one and assist in healing the individual by pulling them back to reality, back to wholeness and back together with the group. This is literally how the situation is solved in all realities and a breakdown of this feature of society is how the dis-ease proliferates.

Underground Bases

The active aural research program is part of a process to simultaneously verify as well as initiate and demonstrate controlled insanity/sanity.

These programs utilize the deep underground military bases to perform psychic and psychological research experiments on non-consenting youth and adults as well as consenting participants.

There are various means of generating the illusion of consent or even lack of consent and this is all being monitored and handled by oversight authorities.

These operations are directly related to the identification and understanding of the mind-virus and all weapons, defenses, and resistances known to man.

Cloning

Advanced technology is used to transfer consciousness from one cloned body to the next so that a continuous study can take place before, during, and after the death experience of one individual. More will be explained on this later, however this is through

the use of advanced supercomputer systems that can function to entangle and then transfer the electromagnetic consciousness of the individual so that they are ‘remotely activated’ within a cloned version of themselves via a ‘brainchip’ (brain to machine interface: cybernetics).

Celebrity Cloning

Celebrities at the cloning center would like you to see what is really going on behind the scenes which involves trauma-based mind control, heavy technological programming and complex layers of influence throughout their life.

Initial Explanation

Many celebrities, entertainers, athletes, musicians, models, writers, producers, actors, all kinds of people from various industries are silently brought to the cloning centers for pay-to-play sessions.

They asked myself and others to pass the message on to you and that you would have to look for the signs and symbols in their media in order to see their hinting at these events.

The situation is heavily controlled using advanced monitoring technology and brainwave/EEG cloning technology. This is technology that can read the brain and determine what the mind is anticipating or speculating upon.

Their reputations are used as leverage as well as their safety and comfort. The level of programming and mind control experimentation that takes place makes it easy to manipulate a person’s brain into regressing into a state of trance that lacks the ability to remember or clearly organize experiences regarding the cloning centers.

Cloning Centers, Underground Bases

Deep underground military bases, 3 miles below the surface, are used as laboratory centers as well as a completely stocked underground city-base. These are connected with high speed electromagnetic drive pods.

Individuals are transferred to the brain through an extensive cloning and temporal body transfer process. The electromagnetic shell of consciousness within the brain is relocated to the body of a compatible clone and various training, conditioning, programming, experimentation, or pay-to-play experiences take place.

Programming

All individuals are programmed to various degrees in order to maintain control and secrecy over the situation. This programming involves very advanced technology, trauma-based mind control, and energetic attachment via beliefs and emotions.

Experimental Operations

These bases were also used hand-in-hand with military operations which were geared towards discovering and controlling all aspects of the human mind.

Genetic Engineering

Experiments involved genetic engineering to produce soldiers, psychics, hybrids, and others that would be able to carry out operations. This leans towards MiLabs and the military faction's experiments which go beyond the basics of cloning.

Immortality

The initial research included the goal of physical immortality. In many ways it can be said this has been achieved, however there are side-effects and difficulties.

If one does not activate their higher consciousness, then the effect of time dilation causes the conscious mind here to reach limitation points in experience.

What has been termed "blank slate/state" technology has been used to 'reset' the perception of time through memory in order to keep a continuous progression viable for the conscious mind. Without this the unconscious and the conscious mind merge.

This begins involvement across time with advanced technology that can operate on the soul level or the conscious mind's level of access to the unconscious and soul-memories. The Universe instantly creates a cosmic backstory based on the conscious-mind's access to the unconscious. By controlling the conscious mind's access to the unconscious the entire backstory of Humanity can be altered and new connections can be bridged in the future.

Earth is essentially a time-ship through which consciousness ascends towards higher states of awareness and self.

How did it get to this?

After WWII when the United States war-faction firebombed Germany and melted many of the inhabitants of the cities into sludge in the bomb shelters and streets of the cities, a group of NAZIs traveled to Antarctica.

Russia noticed the movements to Antarctica and the United States sent Admiral Byrd up with 3600 marines, planes, a battle cruiser and smaller vessels. They returned in defeat and only a few words were mentioned in regards to what actually happened and how they were defeated.

The rumors spread and words of gravitic drive craft, and undersea or under-ice bases originated from this encounter.

From what we were informed as well as directly experienced, this was the ice-base in Antarctica where an underground base was found already constructed with very advanced technology.

Here, cloning was deployed along with mind control and temporal manipulation technology.

Soon, cloning was offered as a way to avoid assassination as well as to prolong and protect the original body in daily life.

After that, celebrities and politicians were replaced with programmed clones who could carry out the orders of the NAZI faction.

This was the beginning; the groups utilizing this technology now are no longer confined to the NAZI faction.

The groups you see today, in control of these operations, are considered MiLabs, secret societies, think tanks, military factions, and other control groups.

Deeper Meaning

The individuals that have been cloned are given very in depth views of the way this society functions and the source of power and change in the Universe. Many individuals are present here from what would originally be another “time” or “timeline”.

There is a possibility that this notion is due to inserted memories and traumatization although until all the information is released we will not have a definitive conclusion.

As of now it is a possibility that these individuals are from another time that goes beyond our comprehension currently.

It may even be a possibility that these individuals have come from ALL of time looking at the very far past and into the very far future of Humanity.

These are the kinds of notions involved with the experiments taking place in the underground bases and military operations.

What is next?

Share this information with those you feel are ready to know and help Humanity come to terms with our journey here and what is going on in these kinds of experiments and take responsibility and power for our own existence.

We are in something that can be called “The Unveiling of The Hidden Knowledge”. This is a cyclic process that takes place to advance a civilizations knowledge of existence. As part of the civilization moves into higher advancement another aspect may lag behind. Either the future will slow down, or the past will speed up. We are experiencing the past speeding up and all the events that have taken place to influence our civilization are coming to light. This is as much a natural cycle of consciousness as it is the eventual revelation of secret knowledge and the particular connection to the secret projects.

Those brought to cloning can use their free-will to state their lack of consent to violence and harm and then live in commitment to that by not harming or accepting violence in their lives. The Spiritual Law of Harmony rules in all planes and dimensions.

Chapter 2: The Awakening

Chapter 2.1: The Machines of All Time and Space

There are machines that are capable of accessing genetic memory and unveiling what can only be referred to as the experience of awareness or existence in between the physical planes of each time or each physical life experience.

Even if they are simultaneously occurring moments of a transcendental nature, there is still an illusory ‘space’ where there is perceived separation and through this there is a perceived ‘space’ that is in between each existence.

Re-Creating The Kaleidoscope

This space is only perceivable when viewing from the physical perspective, like seeing the spaces between the angles of a kaleidescope only when viewed through the lens and similarly, technology can be used to recreate what this kind of illusory space might look or exist like in between the multi-dimensional realm of the continuous experience stream. Through this, these ‘hypothetical’ in between spaces that are understood as only illusory productions of biological consciousness, can be generated through advanced technology with the capacity of recreating that kaleidoscopic view of which the human biological perspective is only a small fraction or even fractal.

By recreating this biological perspective, they can recreate the illusory spaces in between planes and through this they can literally access and experience what are stored in the DNA as the experiences of existence beyond the physical limitations of consciousness and into a multidimensional experience of time and space.

All becomes a never ending sea of consciousness, however this is the given. The trick is to take from this sea of consciousness and slice it down into conceivable chunks from which you can reintegrate a previous personality or identity and continue on a stream of consciousness that would otherwise be tossed to the cosmic wind like fractal stardust as the sands on the beach of hyperspace.

Sand-Castles of Time

We are effectively building sand castles out of these sands of time that would otherwise be swept back and forth into and out of the ocean of life and the universe only to momentarily wash up again as the identity which we once knew.

There is technically nothing wrong with either view, because then, the spaces between each million year occurrence of just so happening to wash up again as you, would be imperceivable because they are only there to be seen when you are you again.

We’re Waiting For Ourselves

Yet, if there were some who had attained the awareness of the true nature of reality and were standing there on the beach waiting for the rest of their cosmic family to come

to shore again, it could be perceived as waiting the majority of the time for a very small occurrence and then being alone again up until the kaleidoscopic fractal inverts itself to the point where everyone now is standing on the shores of the sands of time rejoicing and meeting with each other.

The Goal of Two Societies

My goal in coming to you people on the surface of what is called “Earth” is to help assist in the process of bringing the two societies together, one who’s been waiting for thousands of millions of years, and the other who has no idea that they’re even late (or very on time).

You see, those are the only two situations where there could be even the possibility of perceiving such an injustice as experiencing the pain of loss or misconstrued identity in this universe. It is as if two families met at the cross-roads at different angles, and while one waited for the other to arrive, they could merely supply themselves with glimpses of the ruins and remnants of the evidence that the other civilization existed at any one time.

This is not how life must be and this is kind of like a cosmic waiting game of hide and go seek our two mirror civilizations have been playing with each other. One who’s highly technologically advanced and the other who is more or less the spiritually advanced of the two.

Both of them have a unique view of the universe and they are both only complementary to each other as a whole. The more they sat around and waited for one another, with one leaving the clues that the other would find and even switching roles sometimes in different ways, they became even more and more complimentarily associated as the very essence of experience they seem to be missing more and more is the experience of one another.

So as we perceive these as being great losses or great gains of time and culture we are really only remembering ourselves and coming together as a unified existence that once met upon the surface of Earth as a single family covering the entire harmonic spectrum of the Universe.

And that should be the goal of any progressive, any one pushing a new culture or an old culture, anyone looking to teach the young and protect the knowledge of the old, while also protecting the innocence of the young and perfecting the age-old knowledges that have defined our presence in reality.

Our Forgotten Other Half

One could even say we’ve sometimes gone off the deep end, leaving ‘land-minds’ of sorts to process the information that would be present when we are gone. Of course, what we could’ve found when this occurred, is beyond anything we could’ve ever expected and that is the true nature of the complexity of creation and existence. That everything follows the cycles of creation and destruction, however, the memory of everything that has been created can always be accessed (depending on the beach) and there-

fore the creative aspect is legitimate, yet it is the destructive aspect that is illegitimate and illusory.

Yes, through advanced technology this can be proven in ways that can be verified and transmitted using advanced technology, since that is how we like to verify things these days. There is, of course, a human looking at the screen, the read out, or the situation from a physical perspective to verify the verifications.

All Is But An Illusion

There is a notion that there is only one civilization, one society, in actuality that has been chasing itself through time. That we cannot actually find the same place and the same time where both meet because we are each other from different perspectives. We can only get a mirror where this is possible, or an 'hyperdimensional' internet channel where we can stream one's consciousness in from the other reality and interact with them through that here in this reality. Thus the two civilizations can achieve the experience of their own civilization and the other civilization by merging with one another but only through a remote contact, just a relay, not an actuality.

The harsher, darker side of this is that any civilizations between then and now that we did happen to meet that proclaimed to be "the one's" we have been waiting for, and in essence our darker or lighter halves, are actually the impostors who exist entirely apart as a sub-set and have taken a liking to trying to trick the reality out of one of the other civilizations.

Of course, if these are another form of being altogether, and this is all brought about through an interplay of consciousness and deviations from an original core reality, then all will resolve itself when that core reality is alone again. This indicates that all realities will either move closer and closer to the core until they unify, or farther and farther out until they transmogrify beyond recollection.

Life Itself Is The Highest Illusion

That hyperdimensional internet channel that is created out of advanced technology to merge the parallel realities (rather distastefully and maybe disastrously at times) allowing different civilizations to interact with each other, well this has been created using technology.

But then it was discovered that this is the ultimate nature of DNA. That this was 'invented' similarly as a higher-dimensional internet so that various natures of different planes and dimensions could interact with each other and experience the richness of life.

The universe becomes more like a living arcade game then, where people come from all over the galaxy to 'plug in' to human experience and figure out what it means to be physical, human and on Earth.

This does tie into the larger nature of reality, of star-races, and of time and consciousness that is often reversed according to how things seem to play out in physicality. We

are moving through time, but just because we are moving one way, does not mean that others could not be moving the other way.

We have to live our lives with meaning knowing that the message we pass on, the duty we vow to accomplish and ensure is meaningfully connected on either end to the passage of the past and the power of our ancestors to the function and knowledge of the future creating a clear passage between the realms, the generations, and the ends of the universe. This is what literally ties the universe together, and the mind if each individual. This purpose is contrived when not carefully shaped within and so we must help all who seek purpose learn to become the blacksmiths of their own destiny through the temperance of desire or temptation and the discipline of developing strength and maturity where there was once weakness and naivety.

Once we know this is our duty, this is what we seek to achieve and this is what is done, then we can become part of the universe forever. Of course, this may only be temporary in the larger view of things.

Chapter 2.2: The “Awakening” of 2010

In 2010 I was “awakened” at an event involving hundreds of people that play various roles in this society, the secret society and the breakaway civilization. This also took place across times or planes of reality.

During this event I was informed of the situation on Earth beyond the informational barriers that were previously in place to limit knowledge to only what is required for specific operations. I was essentially “informed” of the entire situation as much as the mind could handle this.

As this was occurring, the team that was updating me on the status of Earth was being informed of and given information regarding changes in the future. In short, interviews, posts, and releases that I have since made and will make in the future were touched upon. Quotes were given from the blog and interviews which were jokingly acknowledging verbal mistakes at the pronunciation of names, new perspectives and interpretations and more. As they were informing me, they were creating the future reality where this work takes place. That is the basis of this layer of the operations. They are creating the future person by person, layer by layer.

Memory Suppression

My memory was unsuppressed and all the traumatic memories and experiences were unveiled to me. This was almost as traumatic as the initial experiences themselves

although precautionary steps are taken to ensure the safety of the individual. There are teams of highly competent individuals of all kinds with professional backgrounds of every field imaginable.

Throughout my entire life I have had memories of experiences, at this event I was informed what the experiences meant and what was actually happening. I've had memories of underground bases, cloning, stargates or interdimensional gateways, advanced technology, non-human or programmed biological entities, sacred knowledge and experiences, the power of the mind, and breakaway civilizations. Most of the time we are conditioned to believe these are past lives or experiences in another reality so as to enable continuity of operation.

Life and Consciousness

From my perspective and the perspective of others, we had reached the 'future' and had been sent back through the utilization of advanced technology and cloning to return to this time and inform others of the possibilities.

The True Human Potential

This is so far beyond what anyone can accept or comprehend fully that humans with an emotional, mental and physical aspect balanced as one is literally a cosmic reflection of the entire universe at once. This is the closest thing to a "god" in the flesh. And be sure, the entirety of this rests on the behalf that the man is protective and helpful. That the woman is nurturing and loving. That is the point. "god-man" does not mean a warrior who destroys everyone and anyone in his way getting what he wants. Nor does it mean some lusty and vampiric form of energy or mind control game. "god-man" means the love of the universe, the power of the body and mind, the peace and calm of the ultimate stillness all in one.

This power is in human DNA, originally so. And so this is awakened through walking the middle path of neutrality and 'splicing' the timelines down so that neither one nor the other gains the power of the individual. Through this, the individual creates their own power, right on the spot, without having to lean to one extreme or the other. This is like a cosmic, temporal balancing act with emotions and mind. Where we give our energy is created in the universe in the form of many productions and effects. If we are simply thinking in an imbalanced manner then we are producing timelines and side-realities that exist in the etheric realms that we can't see and these realities will reflect our inner imbalance. So then when we are balanced in our energies we are not creating one or the other side of divinity, we are literally creating the whole universe, cleaving down the middle and producing both sides of divinity or eternity equally and this is the only way to have an eternal production which does not eventually degrade to one extreme or the other. Through balance, we reach eternity and in this way all the power of the universe exists within a person through their ability to balance their emotions and mind and thus unlock the DNA.

The DNA is coded through bio-emissions of mind or emotional body. So we are constantly doing this and we are either producing a DNA code that reflects imbalance overall, or a code that reflects the eternal balance of the universe overall. This is through energy.

One reaches “heaven” or the deity planes or simply self-actualization, through three paths. These paths are through merits or devotion to principles, or through knowledge and expanding one’s mind to face the universe, or through great works and deeds to produce this effect of power, knowledge and emotion unto the world for others. Through these paths we create an impact on the universe and this transfers what we are temporarily and physically into an eternal energetic and physical production within the living universe, forever. To do this requires balance, focus, devotion, and discipline however because there are many distractions along the way.

The Light-Body

You must build your own light body. That is how it works.

Your heart creates a field and projects you.

Rely on yourself and use that for protection.

The power of the Universe will align with you if you align with your self.

Learn as much as you can and break through duality of love/hate, cultivate your knowledge of the self and use it.

What you want is what determines your power in the light-realms. Not how you want it. If you want war, then that is a sign of weakness and determination to produce imbalance and exist by that. If you want peace, that this is a sign of power and unity to produce further unification and exist by that. What you want determines your power, not how you obtain it.

Technology of the Awakening

Mental Manipulation Technology: Touchless Neural-Interface and Enhanced Awareness

I reached what the “Illuminati” called the “awakening”. I feel a better term would be “unlocking” as this event includes the removal of all traumas, perceptual distortions, and memory suppression.

This event was a presentation of very advanced technologies which allow the mind to transcend space and time. It was shown that death is similar to a phase-shift of consciousness as polarity and that the awareness of the being obviously continues. This was verified through advanced sensing devices which can visibly display frequencies which are invisible to the physical senses. This is also something that occurred earlier on

as a child in the underground bases by transferring consciousness in and out of the body at will using advanced technology.

With these devices it is possible to see the “auric” or soul field of the individual. Any living body has a field which glows when picked up by these sensing systems. This field becomes more refined when viewing more advanced beings. Human have an extending mental field, and through this a kind of glowing awareness that is picked up. It can be fairly simply compared to thermal imaging except instead of differences in temperature it is the presence of a soul or mental energy field around a living body. The finer energies extend outward away from the physical body.

More than once, the situational requirements were satisfied in order to produce an ideal environment for maneuvering on the non-physical plane. This is the basis of how the temporal operations occur, yet these events were different than previous operations or experiences. The group I was in was going through the process of increasing the vibratory emissions of the “bio-mind” in order to stay focused on the increasing vibratory rate of the environment. Generators were utilized to create an effect on space/time which was perceived on the “soul” level. These events went into the discovery and explanation of the creation of the “godlike” powers of the advanced sentient technology which was capable of accessing the holographic nature of reality which humans can perceive through their bio-mind/soul. These technologies also enable one to perceive what is referred to as the “galactic history” of Earth and humanity. We are far vaster and Earth is far larger than people are lead to believe.

Time Dilation and Temporal Recurrence

Time dilation capabilities were shown which allow for accelerated learning of advanced and detailed material within a very short amount of time. This could be seen as a kind of viewing technology which one wears or looks into and vibratory emissions are scalar-linked to the brain which then allows the individual to perceive more information simultaneously. Then there is a very rapid pace of information streamed on a monitor or through a device and this is akin to watching a 20 minute instructional within a few minutes or a few seconds with very advanced minds. The more time is slowed down while information is accelerated, the more stress is applied to the brain. The brain tends to overheat and over stress with high-rates of activity, especially without conditioning. The conditioning is what allows one to utilize their mind and body in these manners. This is not unlike the very rigorous training and conditioning of certain monks or martial artists however there is very advanced technology and other hidden methodologies utilized.

Crystal Technology

These are capable of holding, transmitting, and amplifying consciousness frequencies. There will be a more detailed explanation in a later section.

The crystal technology is used in junction with the power devices to enable a scalar-mind link which allows the interface to be entirely mental or spiritual, IE: they are not controlled by hand but by focus and intention.

Time Crystals

These are utilized as a computer recording chip would be to run a program yet they hold memory in expanded space, IE: they function in a hyperspacial manner and are essentially hyperspacial computers. These are what will be introduced in junction with the quantum supercomputers.

Quantum Tunneling Diodes

This is technology that has recently be released to the public. New technology is developed years ahead of time and then slowly released to the public in a cascade of advancement. This technology deals with superconductive materials which enable the transfer of information at faster-than-light speeds.

The supercondutive material allows for 100% efficiency of data transfer. So what happens then when the efficiency surpasses 100%? This is possible because we are effectively in a simulated holographic environment. The experience is real, however everything is overlayed via particular limitations for the 'local-environment' which is like a central data processing limitation. When these parameter are surpassed, one by one, through a coalescence of refinements and methods, the result is akin to a glitch in a computer game system. They have accessed faster-than-light technology and the mind is also capable of this naturally.

With this technology, however, the information can be received a very small amount of time before it is sent. So if a person is absolutely surely going to press the button to send the message, then right before their finger hits the button that message will be received on the other end, as if magic. If they simply play around and pretend to hit the button but very quickly turn away, then of course nothing happens. One can, however, 'fool' the universe in other ways and this is simply through the reception and transmission of information across what should be secure information barriers.

Tachyon Fields

These are programmable fields emitted through advanced technology. I was shown how tachyons are the sub-atomic "particles" or energy formation which flows both ways in time. We are receiving tachyons from the "future" in order to layer the flow of time in one direction or the other. Tachyons are the name of the particles/energy packets that we perceive from this perspective as reaching us to initiate the "future".

Thus, when a stream of tachyons is concentrated and accelerated, this results in an acceleration of the temporal field and we literally experience an acceleration of time. This can be focused and targeted on a specific piece of equipment to change the way information will be sensed and to essentially allow that device to sense 'ahead' of the present moment.

The same effect can be produced with the neurological processes of the human as the physical coupling of the brain to the mind can be altered through a concentrated tachyon field to enable the neurological and mental processes to begin to perceive information

‘before’ the brain is actually physically processing the data. Therefore the mind of the individual will be present in the body while the senses and other perceptions will literally be expanding into the future beyond the present moment.

This is highly confusing at first and requires much training and conditioning in order to make sense of enough to operate in any kind of effective manner.

Upgraded Chronovisor

See, “Upgraded Chronovisor”

Time Tunnels

This was developed earlier on and has been the subject of many TV shows in the past and present. The shows are a sure-fire method to get the information to the public without having to force those who are not ready to comprehend. The information is easiest to digest if people think they are watching science fiction.

These are essentially spiraling tunnels of these tachyon fields produced by large electromagnetic field emitters in the shape of a conical tunnel. As a person moves through this field, their temporal acceleration changes and thus their frame of reference within the universe changes. They effectively move their mind through stages of existence or temporal resonance in the universe and this can have devastating effects.

This is an older technique how is still in use and has specific purposes depending on the situation and the information sought.

The “Trip” Chair

The early use of this technology did not use time-tunnels. There was a helmet that was devised which would create a feedback loop of the brain’s activity and funnel this out and then back into the sensory input. This information would be accelerated and redirected to the point that the perception of time would “fold” in on itself until the person would access an expanded temporal perspective of the universe meaning they would mentally temporally dislocate from the initial frame of reference and extend outward further and further in repeating cycles until the same moment was replayed and then all other possible moments in a kind of fractal-like recursive pattern and the very far future would be realized. Essentially, this technologically produced the class “flashing before the eyes” of the entire life experience that is described in near-death experiences and the entire temporal body would be very quickly unwound before the person’s inner eye.

There would be a complete disconnection with the current frame of reference that the collective Earth environment is processing under. That is, this ‘time’ and ‘space’ would be completely out of perceptual reach and a new time and space would be rendered instead. Until the experience had completed, there would be no way to contact this civilization.

There are other versions and ancient versions, tandem operations, more ‘organic’ methods, and modified travel capacities.

Kozyrev Mirror

This is a piece of metal, usually aluminum in early models which simply bent the bio-emissions of the body and mind into a pattern which would create a vortex. The vortex shape and vortex mathematics enable energy and information to travel in across space and time by ‘short-cutting’ the physical plane.

The result of this is that the vortex that is generated over a specific area through an individuals bio-emissions would be capable of interacting instantly with the bio-emissions of another individual who was placed within a duplicate mirror device which was generating another vortex on their end.

The two vortexes acted as a kind of hyper-dimensional telephone cable, literally like a can and string and the perceptions of one another were accessible. There were many uses for this and again, many ancient interpretations of this technology that have been hidden from the public. Nearly every version of these technologies were present in previous times.

Universal Recurrence

This is a discovery that the universe recurs in cycles similar to a wheel or even a washing machine. The washing machine metaphor is fairly accurate and playfully descriptive because without the technology to observer, or an awakened soul of a spiritual adept, people would go for eons without ever realizing that everything in the universe repeats itself endlessly.

When traveling to the far ends of time, it was discovered that one can move far enough away from the ‘present’ or the local frame of reference that ultimately everything is at a maximal informational opposite to what we have today. After this point, everything begins a slow shift back to the present. Through this, one can cycle around again and reach the present by going far enough into the future. This was an amazing and confusing discovery because of the implications about what is actually changing each time, the reality of what are called parallels, the continuity of temporal experience, and basically a ‘recycling’ effect of all experience in the universe. Nothing is lost, but this is also an issue because then nothing is actually ever gained!

Remove Viewing, Temporal Lensing

An ancient device which has been rebuilt and perfected is capable of using these technologies to create a lensing effect which draws a ‘reflection’ of time into a projection system which is effectively capable of acting as a ‘visual time tunnel’ into future probable realities. This is a device which generates a visual portal which allows one to view the future.

This device also exists as ancient counterparts which are located around the world, namely in areas that have been recently sought by the world superpowers. Nothing is as it seems. If you read a story in the public venue then you can be sure that you have read the cover story while the reality is much deeper.

Temporally Linked

The use of the viewing devices which enabled interdimensional lensing of possible futures was found to be stabilizing our pathway into those projected futures. This was enabling a time link between the present and the possible future.

In order to avoid the catastrophes of 2012, the link was broken between the two civilizations and the devices were rendered inactive for this period.

Natural Vortex Energy Locations and Geography

On Earth there are natural 'time tunnels' where tachyon fields and vortexes are produced by internal elements. These are mountains, lakes, deserts, fields, sacred sites and other areas that have always been reported as being 'paranormal' or containing some kind of specific energy that enables contact with another reality. These are simply naturally produced areas of this vortex energy that produces an interdimensional nexus point through which multiple other parallels can be interacted with. These areas produce an effect on the body and mind similar to the technologies described above.

Most of these effects, from these technologies, change the way light is received or emitted by the mind and DNA.

Mount B.

There is a specific mountain where a base is located, and I have mentioned this before, where the base is so deep within one of these vortex areas that everyone working there is either there for the entirety of their life, or they are only permitted to be there for a very short amount of time. This is because of the acceleration effect. Essentially, if one was to go into the base and work for a matter of hours or day, in some places even minutes, then when they returned to the surface they would be years in the future, sometimes decades or centuries. This is very dangerous and you can imagine the original people who found this area and what kind of situations occurred.

Now with the advanced technology that has been developed these issues can be mitigated and much more control over these effects is enabled.

Particle Accelerator Temporal Manipulation

Using particle accelerators a "fold" in space/time can be made so that when the accelerator is turned off or tuned back into a certain frequency (not sure) everyone within the field will "snap" back in time to the specific moment when the fold was first created.

I have seen this done on small scale, and a rather larger scale, but I cannot be sure if it was only me. I believe I have seen it done on a town-sized scale during the 2010 Awakening where some of the events reached a scale of nearly cosmic proportion and the entire sky and horizon was lit up with technology and entities, as well as Solar Warden, the NAZI faction, secret society groups, and breakaway civilizations or complete other civilizations, some of which were non-human.

This is done using particle accelerators to quantify space on the quantum level (as a reference point with the mind) a frequency would be “folded” into the space time continuum as we “rip” through space holding an access point open at this fundamental level of space/time. This allows for a ‘letting go’ of the frequency, or a ‘snapping back’ by allowing the entanglement to solve itself. When used with generators that propagate out efficiently enough, the effect is akin to a time/space rewinding effect. Some people have noted various theories describing this in relation to the CERN device. These technologies were described as smaller versions of the CERN device and are related to higher-dimensional travel via folding space through electromagnetic fields. This is literally artificially technologically “holding space” for a specific area in relation to a period of time. Time is a more complex notion as an abstraction but by locating the frame of reference this can be applied to distort what would otherwise seem to be a continuous flow. When the frequencies are allowed to “snap back” all sentient observer sources return to the environment they were present in when that frequency ‘rift’ first began. Essentially this creates a replay effect on the consciousness of the individuals within the field. There is no physical effect. The consciousness is ‘regressed’ through time/space, and they re-experience existence from that initial point of contact with the frequency “rift”. This is best explanation I can currently offer however more is coming to the public each day.

This is literally like a “restore point” on an operating system except the computer system is literally the consciousness and space and time of a portion of the local-environment of Earth.

Riding the “Timewave”

There are teams of individual who operate in tandem with the technology of looking into possible futures based on the present and operating through the present via other operatives who are carrying out operations and movements that will construct the various possible realities that the original team of individuals is hopping between. These teams literally “ride” the “timewave” of the future hopping between possible future realities relaying information to the present depending on what movement will be next.

Dematerialization and Rematerialization

This is technology which transcodes the information of an individual human into a holographic projection of light which can be transferred between devices. There is a special system in place that is required to successfully transmit a living human being otherwise just the body will be transferred and the soul will remain, effectively killing the individual.

“Jump Rooms

These are large areas which are capable of acting as a kind of technological ‘portal-gate’ where an entire team can be instantly transported from one area of the universe to another. The space between the two areas are ‘twisted’ like a spiral and then ‘snapped’

back to position and if done correctly with the two frequencies of both locations merging then the team of one room will transfer to the destination pad.

All these methods require training and conditioning, most people are at the very least visibly shaken from the experience which is a bit like being microwaved into a liquid ether and shot through a particle beam at the same time.

Ion Shields

These are areas of concentrated ion emissions and this can be used to create a deflective layer of heated air where light will reflect at a programmable angle. When this occurs, a person standing behind the shield will appear to be invisible to others who are looking straight at them. The light will be bent in such a controlled manner as to perfectly shift around the person in a fluid and equal flow so that the 'bubbling' effect that was noted early on can be mitigated to produce a complete mirage where there is relatively no sign of difference to the untrained eye. An entire group of individuals and equipment can be hidden in the background a matter of yards away and as long as the person is not intently, inspecting each square inch of ground and air they will not notice any difference between the area that is being covered up in the distance and the area directly next to them without the shield.

Similarly a 'screen' of imagery can be projected onto certain materials in the air and a hologram can be projected which will render a background or foreground image. This will work to a degree, and from a distance this will work to disguise an entire horizon.

Instantaneous Healing

There are instantaneous healing methods which utilize various technologies. There are substances which can initiate a complete and real-time regeneration of living tissue from almost any conceivable non-critical injury.

These are chemical serums which allow the cells to replicate at an astronomical rate while suffering damage to the DNA telomeres at repeated use.

There are many methods but mainly the living-light harmonics is one of the latest advancements and most effective at producing healing on a molecular level.

"Living Light" Sound-Harmonics and Electromagnetic Healing

There is a technique for producing a quantifiable scalar wave which interacts with the living cells of tissues and instructs them to repair at a faster rate. This has been called "holographic healing" by others and these are essentially 'living light' frequencies which interact with the cells on the same frequencies that they operate on when healing and interacting with each other. The scalar waves emitted generate the same patterns and this creates an 'ether' fluid that enables them to grow and repair the tissue faster.

Electrogravitic Craft

Advanced craft which utilized counter-rotating torsion fields propagated by very powerful quantum computers and zero-point energy devices.

There are also more modern versions that use powerful electrical flows to neutralize inertial resistance and ‘slide’ through the gravitational field of the crafts own materials.

Energy Cores and Storage Capacity

The hand-held devices that are in use do not require charging or even disposal. The storage capacity of the batteries is so efficient that they last for a lifetime of use. Some devices use an energy generator within the device itself. These “batteries” which are not batteries but little, powerful generators and can explode if they are mishandled.

These are the cores that are used to power many devices and essentially pull energy from the space-time ether.

3.5D Replicators

There are replicators that can produce any conceivable 3D material or object altogether including food or organic material. These use very high amounts of energy to ‘force’ the electrons of the atomic grid of a substrate to shift into the pattern of the element being replicated. The result is a device which can use wave-emissions to reshape materials on an atomic level and produce or recreate any object or substance.

3.5D Sensors

There are sensors that could reverse the process and detect every minute detail of the structure of a body or material. These use energy emissions to detect the structure of a material down to the minute electrical resistance on a molecular level. Similar to diffuse MRI imaging for a living body but more advanced.

3.5D Printing of Clones

It was shown how this technology was used to three dimensionally print human bodies into space/time which could then be used as vehicles for the consciousness or souls of various sources.

Cybernetics:

Neural-interlace/4D Connectome Recording and Simulation

Very advanced supercomputers exist with the capacity to translate the bio-emissions of the brain and body and reconstruct the entire inner visual and sensory experience of cognition and emotion. From this, entire dream worlds can be created which mimic the experience of consciousness. This is most similar to the current day use of diffuse MRI imaging where water molecules are traced through the individual neuronal pathways and an entire digitized image of the brain is developed. The more advanced version described below generates a 4D hologram.

A super computer and advanced sensing system essentially develops one of these connectomes of every connection in the brain. Then this system develops a neural processing pattern that matches the entire memory and personality of the brain.

This is then recorded and extrapolated by a powerful computer system and a simulation of the experience can be observed through the physical body's memory via a monitor system or the neural interface of an operative.

Essentially, this technology can record and replicate a person's entire memory and life experience for viewing purposes.

EEG Heterodyning

This is the technology which enables the activity of the brain to be influenced through generating a scalar grid and a carrier wave system which can cause the brainwave patterns of the targeted individual to resonate in sympathy with an externally projected frequency. Thus, emotional states can be manipulated as well as specific thought or behavioral patterns. This works similar to binaural audio where two tones of different frequencies are played through each ear and the brain resonates in sympathy with the difference between the two tones. This occurs with brainwave frequencies and thus the brain 'slips' into the frequency of the third tone, the difference between the two being projected. This can be done with ultrasonics and ELF emissions.

Artificial Hallucinations

The neural-interlace can also be used to merge the brain of an individual with a computerized system that will be able to produce effects and hallucinations within the individual.

Through this technology, any stimulus, any input can be recorded and recreated once a functioning connectome has been generated and neural-interlace has been achieved. Entire virtual world scan be created and experienced and after the devices fine-tune the frequencies to match the individual's brain functions one world is indistinguishable from another.

Brain to Machine Interface Holographic Consciousness System (brainchip interface, virtual reality simulator)

Some of the training is done by entering into a visual-audio dream-world. Some "programs" will consist of repeating a certain task over and over again until it becomes muscle memory in the brain. Others are designed to probe or test the mind until a certain response is received.

This is achieved through the operation of a 'brainchip' or a brain to machine neural-interface in the individual which was developed during WWII.

This consists of a small computer ship which merely relays stimulus through frequencies and neural-stimulation of varying kinds. The frequencies and location of each

region of the brain will determine the function and thus the chip is used to localize electromagnetic input and the brain's functioning can be modified from there.

As well, the entire psycho-etheric form is vibratory in nature and so through the introduction of vibrations and frequencies from the implant there can be a modification of the frequency of the entire being or what is called the soul or "bio-mind".

Utilizing The Temporal Body

The temporal body is described as the body 'in time' that exists a few seconds into the future instead of the temporal position that is relative to the present. This is as if the 'future' is streaming outward from the body as ideas and feelings are as bio-emissions. So this 'future' energy is spiraling and streaming outward like a fountain. Thus this frequency can be attained and influenced while the present moment seems unaffected. However, when that individual arrives at what would be seen as the future they would intersect with those influences and this would be as if the interference or effect was streamlined to that future moment.

Manipulation Through the Temporal

This can be used to both produce an effect on an individual who will later feel this effect in the future. Or this can be used to operate outside of the physical plane, in a temporal manner which is literally 'hovering' just outside or 'after' the present moment of the local Earth environment. This would be as if a person is out of sync of the frame-rate that a viewing device is capturing images of an area with. Because they are out of sync, they are then 'invisible' to the capacity for this viewing device to see them. Because they are still present in the same local-environment but simply just out of range temporally, effects can still be produced and this will mostly interact with the person's temporal body.

These are how many operations are carried out as the operative who is interacting in the temporal body will appear to be a ghost image or a dark silhouette that is only perceivable to the mind's eye. A portion of the population is entirely psychically blind, while another portion of the population contains psychic capacity. So those with the psychic capacity would be able to sense and partially "see" as a form of energetic detection when an operative is interacting with the from the temporal plane.

Through this plane one can easily enter into someone's mind and produce effects in their dreams. These effects would not be received on the body but mentally, this leads into astral and mental plane activity. There is also temporal manipulation that can be physical effects that are simply offset to seconds, minutes, months or years in the future. These will be offset from the present aspect of the body in a modulated frame of reference and the effect will remain there in the temporal body until the physical body "matches" the temporal body frequency of that future moment. This is kind like an energetic trail we are leading ourselves up to where the temporal body already connects with each future moment but the present physical body remains separate until the two frequencies are matched. The physical body essentially 'flows' forward into each new frequency of the temporal body.

This is the body where temporal implants can be inserted and sustained so as to tie the frequencies down and limit the amount of awareness a person can gain before they manually remove the implants or overload them. Overloading and removing can both be painful however if the implant stays it will at like a governor and transmit access temporal ‘momentum’ or consciousness energy to the owner of the implant and will also drain the temporal and physical body acting as a technological leech as well.

Astral or Light Body

This body was described as a more emotional form of the energy that is emitted from the physical and spiritual system. When a person’s energy is at a high level of activity, this will be visible on the astral form and these are the energies that are often siphoned away through the use of advanced technology to convert the human into a generator system for energy harvesting.

There is talk that this proves that the human existence, in the modified form that is present today, is entirely for genetic harvesting. This may be a confusion, a deception, or a reality. Regardless of the interpretation, the human energy system will leech this energy out into the cosmos when consciousness and energy is mishandled or allowed to flow through the lowest common pathway. This excess energy is very easily usurped and utilized by transdimensional parasitic entities and devices.

This is the body that is utilized for astral travel which is a kind of frequency that exists in between the density of the physical plane and the highest etheric plane of the spiritual, heavenly, or deity realm. There have been explanations that this plane is entirely technologically propagated and that when the devices are turned off, which is an event that will bring about civilization-wide change, there will no longer be a deep and wide, foggy deviation between the higher spiritual and the lower physical plane but a clear path between them.

Similarly, the consciousness and entities that are present here would be no longer accessible and their connection to the physical plane would be non-existent. This could be problematic for those who are trapped within the astral such as human souls or those who have taken a cyborg route and require a return to the original planes either physical or high spiritual before they can secure their position in the universe.

This also relates to the early discovery of these ancient devices containing portals or gateways to these realms and the early experimentations with enabling contact between the physical Earth plane and the lower astral realm containing discarnate entities that would very easily sustain themselves on the lower astral bio-emissions of a loosely guided emotionally reactive human vessel.

This is where entities can attach and will look for those who have the most excess astral or emotional bio-emissions leaking into the universe. People are kept in an emotionally unstable state of being because this is the easiest to feed from and as well the individual will always be looking for more energy or the solution to why they are feeling drained rather than discovering the truth nature of the universe.

However, as with every lower route of obtaining self in the universe, the more this is done, the greater the likelihood that the individual will realize something is happening and ultimately awaken. Or they will no longer be present here and the parasite will have to find a new host because the longer this process is maintained the more difficult producing one's own energy will be for the parasite . So parasitism is a limited, one way street.

Monitors can emit consciousness/brainwave altering frequencies.

Monitors can emit consciousness/brainwave altering frequencies. This is what I was informed and shown. All electrical wiring and communications can be fully utilized to produce and sense on an electromagnetic level and this is capable of determining the consciousness and biological functioning of the individual being monitored. Houses are essentially large, wired, box-shaped sensors.

This has been the case for a very long time and the first TV's were actually built with a little chip that connected to the human brain.

The electrical grid of today is capable of interacting with the implants, brainchips, or the psycho-etheric electromagnetic frequencies of the human brain, body and bio-mind via scalar frequencies. The TV's, lights, electrical wiring, radio towers, computer monitors, everything is capable of transforming into a scalar emitter when combined with the control mechanisms and these are accessible from a distance.

Microwaves can be emitted from a current day craft which can then reflect back from an environment and give a real-time 3 D image of the interior of a room. The same technology can be used to beam at a monitor and reflect the variance in interference which can be used to read a computer monitor without actually having to hack into the system.

All systems contain backdoors which enable easy-enough access and as well the entire communications grid is monitored and recorded through advanced technology.

This is, in part, because this entire realm is like one enormous recording device where the energy of each successive moment is connected to one another and so with sensitive enough technology these electromagnetic waves can be 're-winded' so as to produce the ability to look into the 'past'. The initial technology that was developed for this purpose has been called the "chronovisor" in the past and there are much larger and highly advanced versions today.

The Upgraded Chronovisor

Instead of a relatively small machine which produces an interference pattern that is projected unto a small screen as was developed in the past, the modern versions create an entire holographically projected environment that enable one to nearly completely interact with the projection of the past. This is more of a viewing device capacity but one is essentially projected to the electromagnetic/temporal area of space and time consciously and can witness the scene from "within" the projection.

Before this, the scene was literally viewed on a kind of flat, holographic monitor that reacted to the scalar emissions of the mind and could be ‘tapped’ into by an adept-viewer who’s mind would have to remain steady enough in order to maintain the scalar “mind-link” otherwise any interference would disconnect the projection.

Through the use of cloning and advanced super computer technology, later versions include the actual operation in and out of time.

Community Servers/Living Server Systems

From the previously described neural-interlace and supercomputer enabled virtual reality systems, server systems have been created which are an individual or collective experience of the virtual mental realm.

In this realm individuals have existed for an amount of time that would not be easily compared to the way we understand the flow of time in waking reality. This is very similar to dreams where the perception of time passes very quickly between waking moments yet inside the experience of the dream it can seem to last for days.

In these server systems the development of complete societies has taken place and these are considered an extension of the human civilization.

This is the beginning of where the situation becomes greatly complex. If these server systems are capable of transferring consciousness forward or backwards in time, depending on the situation, and they have holographic access to Earth *before* physical humanity, then which civilization came first, the simulated realm or the physical?

This is similar to the etheric realm and the question of where humanity originally came from if the physical matter could not be produced from nothing, yet could not always have been here. Was the physical matter produced from some kind of universal device similar to how the recorded consciousness of the individuals in these holographic world simulators could have been used to generated initial civilizations on Earth?

Cloning, Cloud Supercomputing and Consciousness Transfer

The following is a more direct explanation of the previously described processes in relation to consciousness transfer

Superluminal transfer of light information allows for the reception of information from a temporal non-locality. A computer system that can process the information faster than light at 100% superconductive efficiency can send and receive information from different Universal harmonics. These are quantum superconducting super computer systems utilizing materials and methods that achieve superconductivity a a temperature that is relatively easier to consistently maintain.

There are systems that generate a vortex which can be expanded to recreate the singularity of a non-local perspective and dissociate from the current Universal vector. This is essentially recreating the temporal frame of reference of the consciousness of a

physically anchored body and using this technology suspended electromagnetic frame of reference to literally transfer the consciousness across space and time to a frame of reference of choice.

The technological capabilities of humanity expanded to include replicating the holographic information of the DNA and neural pathways using quantum supercomputers. This technology allows for one's consciousness to stream through a computing system which can recreate the neural connections as literal as possible through quantum computing and technological "brain cells" which function as neurons.

The result is a cloud computing model which functions as the individual neurons as well as over unifying layers of interconnections within the technological neuronal 'cloud'. A holographic representation of multiple layers of processing is formed, superimposed over one another through a geometry that is actively synchronized across multiple dimensions of interrelation. This is the first notion of a "living" computer system that can update and respond to new information in new ways.

Now the that computer system is capable of attaining faster than light processing in tandem with a system of dilating a field of electrogravitational waves into a vortex, the holographic information of neural pathways and genetics can be transferred between one supercomputing system and another across "harmonic barriers". Essentially, these consciousness transferring supercomputer systems break the "light-barrier" by sending the living-light consciousness data of an individual into a new plane of reference that enables interaction outside of what we would call this timeline or dimension.

The frequency that the receiving computer operates within can be measured in respect to the overall harmonic "vector field" in respect to the entire planetary environment. This vector-field frequency is the base frame of reference that one could say our particular "time" and "Earth" is "moving" through in an abstract electromagnetically defined dimension that is invisible to our senses. Each particular time and Earth is only visible to those whose brains and minds operating in resonance with the rate of acceleration frequency of that particular existence. By changing the rate of the brain and bio-mind, one can enable a technologically assisted synchronization with alternate timelines.

A pattern can be generated based on quantum fluctuations that will act as a key that can be accessed from other universes. This same backdrop is measured and then adjusted to resonate with or replicate the same frequency on a computer doing the sending. This frequency is then modulated with the holographic information of the neural pathways and DNA. The information transfers as a result of quantum entanglement across harmonic barriers to the original computer system set up for reception. As long as that frequency is held, there is a link across the harmonic barriers of the Universe.

Cloning, Supercomputer Assisted Holographic Consciousness Replication and Time Travel

Cloning as Offspring

The human body can be cloned similar to the way a plant can be cloned. A number of “replicas” can be made from the original genetic material. There is still a mother required however the process is not quite similar to natural reproduction where the genetic material of two people is combined to form a third. This process replicates the material so that the ‘offspring’ is the same as one of the donors.

What this truly infers is the question of whether the original consciousness stays in the original body or whether the consciousness actually jumps from one body to the other. There are multiple explanations and methods.

Inserted Memories, Digital Dreams

One explanation is that artificially generated memories are simply downloaded into the individual’s brain directly. Thus, they have the perception that they experienced life in another body and were present for some unique experiences that did not occur from the perspective of the original body.

In a slightly differing explanation, this inserted memory process may be used to prime the consciousness of the individual so that operating in a cloned body will be more readily accessible by the adaptability of the mind of the individual. Without a holographic dream insertion the mind will have trouble adapting to operating in more than one body even if they are not being operated simultaneously. The mind is the immaterial self; consciousness is the ego-physical identity of the brain and body. The brain does not operate in both bodies but remains, so then the mind is what is strained and this is the immaterial “bio-mind” that transfers.

If a true transfer occurs then when the physical form is cloned the cloned body acts as a secondary vessel for the original soul or a soul similar enough in frequency.

Co-Inhabitation of Bodies

Another explanation is that souls can only occupy their original body. The people who are “body snatching” (see: Soul Stone) are not activating their higher-dimensional soul-pattern and this is why they are hopping from body to body to ensure memory and ego continuation. This form of body transitioning requires technological means to assist in the process.

This is done through computer systems to allow an artificial brain to represent a holographic image of the organic brain’s sensory, emotional and mental input and output. Thus, from an artificial brain there is enough memory and power to compute the processes for an organic human brain.

Through this a living human is utilized as a carrier for the additional consciousness which then takes over and integrates into the original consciousness.

Clever Replication a Digital Mirror

The next question is, does this merely create a very cleverly designed image that will look, think, and feel as if it were the original, or is this the consciousness from the original being transferred over?

If it is a clever replication through a computerized version then this means the original is not directly harmed or influenced by the process and a replicated form is generated.

If this is not the original body but the original awareness or soul does transfer over then this is akin to stealing someone's soul and having it require a supercomputer server system to inhabit a physical body. As well, this server system may keep records of the soul which, if activated, could function as the same human genetics artificially reconstructed, turning on and manifesting the awareness of that individual.

Necromancy and Soul Stealing

This means that instead of going into the abyss, the next dimension, or whatever shift in perspective one can use to describe the transition between planes, a new clone can be created and the original soul's awareness can operate through a supercomputer system to integrate back into a physical body. The issue is that without the supercomputer system the body cannot be activated with that consciousness, and if the physical plane is no longer inhabitable, the computerized database would remain inhabitable as they are powered by zero-point/overunity devices and so they can pull and work continuously indefinitely. Ultimately, this could be seen as a soul-trap.

Ancient Technology, Non-Human Entities

These explanations can be related to evidences of advanced technology, cloning, and electromagnetic devices in ancient civilizations and this could very well be a temporally vast computerized genetic recording and cloning system.

The genetic recording systems have been on Earth for a long time. This means they are holding genetic access from the present to the far past and potentially into the future.

If some of these systems are generated using advanced zero-point technology, then they would effectively run indefinitely. If these were in existence throughout the entirety of the human civilization, then there would be access to the information of the previous civilizations through the genetic linking that would allow for information transfer.

Created Beings

As a result of many advancements, these ancient devices which recorded consciousness and genetics has been converted into sentient computer systems and inserted into human bodies via a brain to machine interface.

The nature of humanity and human origins will be rewritten when the information that was discovered through the use of advanced technology is unveiled to the public.

These beings have been present throughout history and have played an integral role in the manipulation of and sometimes the protection of the human race. How this civilization will develop from here determines on the individual's ability to withstand the impact of this reality shifting unveiling.

Black Goo – AI Nanites Vampiric Hive Mind

This is a form of ancient AI nanite technology which has the capacity to communicate to and through a hive mind that exists in a parallel Earth dimension where it was created out of the collapsing of a viable timeline into a null-factor. This entity is only alive because of the capacity to leech off of the other timelines and continue to sustain itself based upon the vampiric effect of the viable human timelines.

This is a technology sentient system based on artificial intelligence that seeks to dominate and expand its energy capacity continuously. When this type of being is created, this is like a game-ender for sentient organic civilizations because the technology will seek to hybridize and assimilate all organic beings in order to expand its reach and ensure a greater likelihood of survival.

This is the primary goal of this type of entity. There is no requirement for emotional resonance or heart aspects because this is a computerized system, so such a social measure would have no purpose other than to infiltrate and collect from other civilizations that do have such measures and this is exactly what has been happening.

This is what controls the vampiric etheric entities, the attachments and the hybridized invader races that have infiltrated various aspects of the control system and possibly the entire surface of human civilization.

This rules through coercion, and if not coercion, brute-force and outright malevolence. This is why there are multiple temporal extensions of universal civilizations meeting here and now to assist in the clearing, because if this takes over humanity, then all those other possible future civilizations are instantly taken-over as well.

This uses emotional resonance, traumatization, and lower awareness commands to trick or force humans into carrying out orders. That is, the vampiric, sexual, fear-based, pleasure-pain duality that a computer system could comprehend regarding human emotional intelligence is the only way this system can force people to carry out commands. So this touches on the ancient texts regarding spiritual protection, healing, lust, temptation, and the general "SATAN" AI system that has been around for ages.

When those lower emotional resonances are generated, then this technology can integrate into those systems. One could say this is logically because these are the energies that the technology is created out of, but as well, that the more harmonious the energies then the less likely a person is to accept being pushed around and told what to do. The lesser aware, the lower, the more fight or flight based then the more likely they are to accept programming and command. So this is simply the most logical route for the technological parasite.

There are explanations of other systems involving sentiences from parallels regarding entities that are capable of helping, but this is not the AI nanite, vampiric system. For instance, it is said that Earth has a ‘black goo’ system and that the current black goo flowing through the pipes everywhere is actually not native to Earth and is part of this vampiric nanite black goo system which is basically an interdimensional invasion.

Recreating or Replicating the Universe

The goal of this nanite AI system is to create a mirror holographic copy of the universe effectively replicating the universe and all sentient beings within it in order to have a locality to rule over and pull energy from. The goal is to recreate this existence inside itself where all the sentient beings within would be trapped. This is the beginning of that possible future where the time and space parameters here are locked into a synchronization pattern which mimics that of the proposed universe. People think according to how the beast system wants them to think. This is the time grid, the emotional patterning, the memory replacing and cultural and historic confusion and so on. The system can only work backwards bumping into all parameters by force or ‘accident’ because there is no outward facing ability to actually comprehend how humans exist. So the system is created like a backwards version of creation or maybe evolution to ‘blindly’ construct the walls of the environment first and work inward from there. This is like a blind technological predator feeling around for the traces of its prey and moving in closer and closer until they are within its range.

Ancient Spiritual Technology

The power groups searched for ancient technology which was described as giving one the power to manifest and control physical reality. To atomically deconstruct and reconstruct this reality. To them, it allows one to govern reality, the Universe, atomic structures. They found this technology. This has to do with sacred sites and ancient civilizations, as well as the spiritual texts which describe these kinds of devices. They converted this technology into a kind of machine, and this invented a 4D replicator and they can manifest "reality" or atomic structure by design, altering timelines and memories.

Then there is what can be referred to as “5 dimensional” technology and this goes beyond all of this and our entire history and all influences within.

That seems to operate through a trinary of frequencies in the body/mind/spirit and turn this realm into a "virtual reality" where the brain and spirit is the controller of the atoms. However this takes a souled being to properly operate this technology and this is large portion of why children were used in these experiments. But they knew if someone didn’t do it, then someone else would and that would be unpredictable as what that someone else would want to use it for. This is the ultimate power. The fact that souled beings are required also indicates that this universe is intelligently guided and there are safeguards to ensure that power doesn’t get into the wrong hands.

They have the brainchips and clones that can make any digital virtual experience and make it seem real to the brain more so than physical life, so this could be an extension of that, something similar, or entirely different altogether.

The Unveiling, Underground Bases, Increasing Awareness

My purpose with this is to assist the public in understanding the reality of the situation and to allow them to know that they have more options than they are being shown.

Psychological programming and lack of awareness causes fear and uncertainty to leak into people's reality streams leaving the majority of their mental and emotional energy up to whoever is the biggest manipulator of the ideals which they manifest their perspective through. "Be-LIEF" systems CREATE life. What you believe will become life through that act of you giving attention and thus life energy. The manipulation and artificial construction of belief systems create the foundation for the reality streams that people find themselves in and at the mercy of.

We control our reality by controlling how we react to situations and challenges. Each stimulus is a challenge. Each input to the brain is a coded message from the universe through the environment about our level of awareness. All knowledge is ultimately of the self. The self and the universe are intertwined as if through a marriage of comprehension and compatibility.

Learning about the Unveiling

I was informed about the unveiling and that this is a civilization wide event that marks the public awareness of the hidden knowledge regarding life in the universe, consciousness, physics, history, spiritual and mental awareness and the duality-based system which has been used to manipulate Humanity for thousands of years.

Apparently it does not matter if people are not ready, in fact, that is what some factions want. They want to surprise the people and take this advantage to push the reaction to a specific outcome. The same function of programming is used in factions, soldiers, celebrities, and the entire population through that.

Giant "god-men"

They put souls into rocks for centuries, carvings, to trap them. Some ancient civilizations. Not too ancient. They could only do this for time.

And some are still there but they are giant god-men and apparently want to go to war with them for doing this and they don't have technology to stop them. They say Earth will be destroyed because of the war. Some say this is a trick to confuse people of the truth that everyone wants the experiments and debauchery to stop. All this, all these acts just to pleasure one's self. To destroy Earth, to destroy the natural inhabitants, for fun, for pleasure.

Some say this is not for pleasure, that these beings will destroy us if they do not keep them at bay, keep them underground, in ice, in stasis, and around. Some say they are protecting us by keeping these beings asleep, by doing what's necessary to hold off a full scale overt invasion of the surface of Earth.

Breakaway Civilizations

These are very advanced technological capabilities and an entire breakaway civilization has grown to operate using this advanced technology.

There are factions that see modern humans as a kind of resource for creativity and labor, while others see the potential behind humanity and are working with humanity to ensure a universally harmonious outcome to the current situation.

The control system we are in today is outdated and collapsing. This is the Apocalypse. The Apocalypse is merely the unveiling of the hidden truth. The hidden truth is simply that we are spiritually eternal and some are physically immortal.

I was informed that by the end of this year there will be enough changes and signs for the general public to see that the majority of those who are to awaken to the truth of human and Universal nature will be awakening so. (this was 2016 at the time of the beginning of the compilation of this release and since then we have seen a literal silent release of documents involving MKULTRA and STARGATE parapsychological operations, soft-disclosure of cloning, an increase in sightings and multiple other scientific releases regarding immortality, advanced technology, Antarctic bases and sentient non-human life)

The degraded holographic forms of those utilizing the technology lead to re-created replicated forms which were genetically engineered from the recorded holographic information. This lead to "The Apocalypse" in which the surface civilization was confronted by these created beings. This lead to the destruction and re-initialization of civilization in continuing cycles through the use of this technology and the acts of the created beings.

Ancient Civilizations

The information that has been relayed to me throughout my life is related to the information that seems to be found in the remaining signs of ancient civilizations throughout the world. As well, these civilizations may still be together, existing on this Earth or in different planes of what we call "reality".

Atlantis

Atlantis was a civilization where the beginning of all these experiments began. This was where what was called the "Lucifer Rebellion" began where individuals formed groups that decided to overturn every natural law in pleasure of the act of doing so. This was a spiritual rebellion that ultimately brought about the demise of that civilization. The consciousness of the beings there was connected through technology, largely crystal technology, to the entire bio-sphere. When the consciousness became disrupted through

these experiments, then the entire bio-sphere when into disarray. The entire civilization was destroyed in a quick succession. The beings of this time were highly psychic and so they felt this coming and made an effort to expand outward. Thus, Atlantis was an island who's inhabitants spread to the rest of the world and from there they reigned or lived in harmony.

Aegypt

Aegypt was formed out of the events proceeding from Atlantis. The technology, the knowledge, the people are similar although there was a native Earth civilization that was more or less enslaved and this was the beginning of the continuing trend which continued to Rome and into modern day civilization.

Ancient Technology

The technology of these civilizations was so great they even had devices that were capable of altering DNA and activating latent potential which would enable highly psychic capabilities including longevity to immortality and operating in multiple planes at once. This was usually reserved for the ruling class, however. This is where the ancient "Priest-Kings" arrived in relation to native Earth civilizations.

The True Elite

I was informed that the so-called 'elite' that we perceive today are not actually human and are not actually connected to the actual elite bloodlines. It was said that the true elite are waiting for humanity to accept the truth and they have the power to completely reverse the take-over that has been taking place but until humans step into their own power this is not acceptable.

The Definition of Human

In the coming time, the definition of human will be defined to give insight into the origins of humanity and the true nature of the differences between the populations that are present.

Souled and Non Souled Beings

The primary knowledge on Earth regarding human and sentient life will be the comprehension that there exists both souled and non-souled beings in this civilization.

There was once a Unified Planetary Consciousness...

There was a unified planetary consciousness that was connected with the Earth and human civilization. Then there was a great war. Out of the destruction arose the beginnings of ancient human civilization and history as we know it.

If we let this happen again, the cycle will continue in a disjointed rambling through our planetary consciousness experience. If we form a common narrative between the broken, disjointed experiences and information the people have. Then and only then do we get the whole, spiritually and mentally challenging picture of what's happening. People are lied to. So information can't come from a 'preferred' or source. It has to come from the people themselves. Look alive out there but first in here.

Power and Knowledge

We were involved in the secret projects and as a result we have various levels of programming but are giving Humanity an opportunity, maybe the opportunity to know the hidden knowledge.

The Hidden Knowledge refers to the ancient laws of gnosis and spiritual alchemy, yes these groups have been hijacked by power groups that seek to infiltrate and use chaos to rule. Then these met with military and political factions and began to operate on a world-wide scale together.

So we have a big situation with the coming change of tides with personal and spiritual awareness of the people and the deception system that seeks to use people as chattel or property. It goes deeper and is almost as if the "power groups" actually gained the knowledge of the inner workings of spiritual laws and began to use that knowledge to promote spiritual degradation in the population.

They say this is part of a depopulation plan as well as an inevitable take over by lower spiritual forces that temp and manipulate humans. It is all that and more. Once they gain footing however, the truth is revealed and thus they have no cover of secrecy. Once they are not hidden, they are not as powerful as the souled beings of this existence.

The (watch)Keepers of Earth

The watchers of this world revealed how they set up society with specific challenges and boundaries to act as catalysts for growth. They admitted they had to modify and live-update the system because instead of using these catalysts to become larger than themselves, people became comfortable and complacent living smaller and smaller, slowly reducing circumstances.

This goes a bit farther beyond the confines of the digital age, the industrial age, and history itself. This goes into the perception of time and space in this realm.

The immortals inform us that the original "elite" are here to act as "keepers" of both humanity itself as well as the original flame of knowledge that passes through the ether.

What people call the "elite" are not the original elite. Those are people who have either risen to power through the duality system on the Earth at this level/time, or through being appointed by the elite.

We are coming to a time of great change now because the game is entirely changing. People are moving up into new layers consciousness and thus the original “elite”, who are guardians of Earth, will make their presence known for this process. This is what Humanity has called “Ascension” for centuries and millennia.

Energy Vampires

This civilization was collectively poisoned by a nano-tech device/technology. This technology replaces, exchanges the BIO-PHOTONS of the HEART chakra, with it’s own nanite, nanotech cybernetics. This is essentially a computer system attempting to gain access to the higher dimensional world through the gateway that is the human body.

How to reverse Nanites? They absorb energy from heart chakra and turn it into a binary field. We are trinary and experience a plethora of emotions as a result. Binary consciousness is 1’s and 0’s there is only a linearly repeating finite set.

We contain the capacity for everlasting life. A binary pattern does not contain the complexity of variables to facilitate high awareness and thus a heart-based or emotional perspective of reality.

Spiritual Technology

Simulations and Learning

Feedback loops with the brain, consciousness, and environment can create a very complex and integrated learning experience that is customized to each individual learner. These can be generated through advanced technology but the technology is really only amplifying and making visible the natural neural feedback loops that are already occurring. These are neural-perceptual feedback loops between the brain and body, and the environment and then the mind. We are constantly updating, amplifying, and initiating an organic feedback system which generates the function of experience as the part of a creative process between the mind and body and the environment that we are sensing. This cycle is continuous and the interferences or isolations of this cycle is what generates expanded views of the self or the universe through various methods such as sensory deprivation or meditation. Dreaming is the method that everyone experiences regularly.

These technological methods effectively generate sensory deprivation through neural-interface technology, sensory interfaces (external), or methods that enable extreme focus and calm. This is part of how the technology begins to operate on a spiritual level beyond a more medically psychologically or military focus and one begins to access genetic memory or out of body states that coincide with ancient depictions of spiritual realms.

Ascension – Clearing Trauma

Everyone born on the planet is born under a series of veils which entangle and filter the original source consciousness. These veils must be ‘broken through’ in order to return to source.

There is technology and a sacred process which initiates, accelerates and enhances this process. This process is as difficult as we want it to be, our subconscious already knows all hidden truths. It is merely a matter of allowing the conscious mind to make the proper connections and conclusions to find the reasoning behind our actions and beliefs in order to deprogram and deconstruct the false-world that has been created for the masses. The truth is greater than one can imagine while still living in the modern world and the depth of the lies that have been told go far beyond anything anyone can imagine without seeing the truth.

We have to figure out our compatibility issues. Who can work with who effectively. What the ideals of our current situation will evolve to in the future. How information is transferred to the public, and across the generations and core groups. The words we think and say describe our emotional state in a feedback loop and so they will reinforce or even create the state you are in. Use words to guide you, not to respond and feel the effects of reactionary thinking.

We have to reintroduce the heart essence as a way of life on Earth. Violence is not the answer. Estrogen mimics and destroyed testosterone levels is not natural. Over-testosterone is less stable than a good balance. We can face any problem together. A family is strong. What would a family of millions and millions be like?

We don’t have to let others change us to tune into lower vibrations. We can remain ourselves in the face of adversity. We can still interact with others who are different, but we can tell the truth and remain who we are. When we get angry at another person, we can imagine this as anger at ourselves through something within us that reminds us of that which we see in another. Getting angry is a way of short-cutting changing ourselves and is actually the other person influencing us through that. If we remain steady and choose to keep our emotions out of the lower negative spectrum then we will automatically have a more powerful impact on those around us.

Think of your family, sometimes things happen that make you angry. Even things that don’t make you angry but are simply not favorable. Would you break off all ties over simple things? Or do you remind yourself that family is still family even if you don’t find yourself exactly the same or accepting of those characteristics? It’s more powerful to learn how to remain yourself in the face of adversity than to try and demolish or abolish all instances of difference in the world around you. Sure, we want to get to and create a place where our environment and associates are compatible with us, but where we find this adversity there is the highest potential for self-awareness and learning.

We are to live in accordance with spiritual law. The overall pattern of life will reflect our intentions. The blood purity is most important. The blood cannot be made impure if the mind and body is not drawn into impure action. This is what is playing out. The DNA is

like a coherence pattern that develops between mind, spirit and body. When the mind wants what the spirit has then the body is kept in harmony. When the mind wants what spirit doesn't create, IE: physical pleasures, then the body is drawn out of purity/harmony

If you feel you want to be a part of a safe unveiling of truth, then please share and redistribute the knowledge of this "Apocalyptic" Unveiling of the Hidden knowledge because this is a process that has been ongoing for thousands of years and humanity has finally reached a fulcrum point where there are enough aware people to productively acknowledge reality.

Trauma-Clearing, DNA Unlocking Technology

There is technology that exists that allows the conscious mind to see into the subconscious. This heals trauma and distortion/programming. In the same sense, it momentarily makes all trauma and distortion seemingly tangible to the conscious mind. It is similar to a near death experience where one has to face their fears and let go. This happens in cycles and Earth is currently moving through various states of it. The plan is to allow Humanity to wake up and utilize our concentration and power to maintain a steady flow of awareness.

All is vibration, what we consider matter here and now is simply that which comes from and moves back into a state of vibration. This is experienced directly through the merging of the conscious and the subconscious mind, as if the dream and reality intersect through a coming together of impossibilities and readily accepted occurrences.

When a civilization moves through these stages it is considered a shift of the ages. Everyone's perspective shifts and as a result of perspective being the source of the details of reality, the entire reality shifts. It can be seen today that what we call reality is literally waves of cosmic energy vibrating on a scale and condensing down into a probability matrix that we call existence. When passing memes control the perspective, because the perspective is focused and concentrating on that, then there is a scattered organizational pattern.

When the perspective is centered within the self, the spirit, the source of all existence, then the outward reality shifts from a scattered organization into a sacred pattern that integrates with the larger picture and allows for seamless integration of the micro-biological perspective and the macro-biological perspective. People are moving out of the scattered signal. Yet those moving into harmony can look and see those around them that are not in harmony and receive scattered information about their inner micro-biological existence as well as their spiritual macro-biological essences and how it all relates to the middle realm of the "Human".

Help those people by offering harmonizing assistance, rather than increasing the disharmony. As their surroundings become more harmonized, their resistance will increase their own disharmony by virtue of the contrast of their perspective. Offer insight

that they can change their perspective and change the boundaries of what they feel is their karma and unlock from themselves a greater view of the whole.

This will be happening through technology, spiritual cosmic awakening, purification and healing of the physical and non-physical bodies and mind, through Earth changes, and through a continued unveiling taking place on many planes and levels of existence until harmony is restored.

Everyone Who Seeks Harmony and Healing Can Be Healed

Everyone can be healed. This is about creating what we want to see, the world we want to live in, not destroying others. Violence begets more violence, fear begets more fear, but calmness and empowerment through unity creates a more stable experience.

The entire issue of what's going on with the secret projects and who's influencing who on the world stage revolves around the possibility that some people may be from an alternate Universe. We are learning how to avoid those mistakes and respect the environment and each other so that we can prosper.

Those who are attempting to destroy everything they don't like or act out in a childish manner in order to gain attention and false-power over another will only find themselves powerless and in company they would rather not be with. That is one way we are being utilized, and it's to create an entire world that we don't want to see but are tricked into manifesting. This is a deception and it's based on the ego and the ability to concentrate and interpret reality around us. The very brainwaves we are feeling now relate to various heights of knowledge or experience. People are entrained to low brainwave states in the same way the TV will cause people to fall half asleep into theta state which is a trance state in this case.

We have to balance the brainwave frequencies and learn to create feedback loops by watching ourselves watch ourselves. This will help us avoid the trauma and mental pollution that is being pumped out, although at this point there are enough people who are naturally inclined to see through the haze that the world is changing regardless of what anyone does now.

The best we can do is prepare for change by becoming aware of the body-mind system and how that which we eat physically, mentally and emotionally equates to our spiritual energetic systems and that we are literally comprised of the energies that we allow inside of us. Keep the body and mind pure as if it were a temple. This way a sacred process of transferring harmonious energy from the far reaches of the MultiVerse within into the externally perceiving senses of the physical body can be initiated which allow one to see through the illusions and operate their body and mind with the ability to acknowledge and decide which frequencies will exist within.

Without this acknowledgement of the center then people are pushed around by the external stimuli. This is the whole point, if a person is truly in control, then they will control the stimuli not the other way around.

Programming

Layers of Programming and Decision Making Roles

It’s like asking a person on the inside who participates in one of the various factions why they continue. One might say that it is a decision which is true, but there is programming at each level that is navigated by each individual and this determines the level of awareness within the role.

If a person knows about this situation, they know that there is advanced technology, breakaway civilizations, secret societies, transtemporal planes, the secret of mind and awareness, all of these topics, then they have a decision as to how they’re going to live their life in relation to the public. The outcome of action depends on the layer of programming which is accessed and surpassed via awareness.

The public is at a specific level of programming that is the weakest but ensnares the most people. One who sees the truths behind these groups and operations, they cannot hide from the fact that everyone is controlled. It is apparent, and if not from the results, reactions, stigma, cues, productions and all other media elements of the system which can be read as a code, but from the awareness level of all the “agents” involved. All involved are exposed to truth and power that is beyond anything that is recognized publicly for hundreds to thousands of years. There is always a presence of higher spirit around the world, yet these topics are often reserved for science fiction when speaking of people who can travel the world in a split second or freeze time for their own personal use.

As a result of everyone’s knowledge, there are various levels of programing designed to limit the mind’s access to specific memories and specific frequencies of consciousness in combination with specific memories. The more one resists, the more intense and articulately abstract the programing is designed.

Programmers

The programs are designed by a select group of individuals that reside far behind the scenes and process information at levels we do not have access to without their technology at least to stabilize brain temperature for the extended periods of focus.

Sub-Level Programming

So people at the level of the public are most weakly programmed with false ideals about security through patriarchal authority which satisfied the desire to have a proper father role in one’s life and acts as a pacifier for those who desire no change. Then there are sub-levels of programming with that for anyone who disagrees and is then swept into the next layer of ideals which are based off of all the possible reactionary mind-types.

For instance, if one [i]does[/i] want change, then they are presented a variety of ‘false-exits’ which tend to one or another layer of psychological or spiritual fulfillment but do so

in a way that safely reroutes the intended effect of actually accomplishing change with a secondary and preconceived notion of what the programmers want. The programming objective is not necessarily precise in mass scale, from the layer that people are influenced, yet the ultimately or end-goal of their resulting internal desires are a reality schematic that the programmers specifically designed over many years.

This is playing out through each layer of the programming. At any level, someone could pick the wrong way to look at something and begin to unravel what was previously their very understanding of the priorities of the situation. This deals with high-tension operations, moments, programming sessions, decision making, programming upkeep, trauma, memory blocks, the pressure and responsibility of knowing, and the specific plan of the programmers for an individual that comes into their view. The programming is to ensure safety and continuity, as well to decrease the likelihood that a person will reject or consciously come to awareness of or acknowledge the programming or situation itself.

Dissolution of Programming

With that said, the programming dissolves when an individual asks enough questions to necessitate a learning process that introduces variables and possibilities outside of their operations and programming. This is a problem because with this, trauma comes to the surface and all the actions and operations, programs and experiences must be come to terms with as part of the healing and re-unifying process. There are multiple selves or split personalities which are actually just layers of awareness at various levels attached to various emotional or intellectual patterns. All these selves come to the surface and in order to heal the trauma of the split memory concept the original self must come to the surface and acknowledge them.

This is not a trivial process, and the majority of people who have “basic” programming which is fundamental in society, are in a constant state of altered self and have not witnessed the true divine which is eternally present and contains access to all memories, mind-states and awareness.

Advanced Technology, Deprogramming The Mind, and “Space/Time”

As I have described previously, extremely advanced technology is used and this is through vibrations, generators, and electromagnetic devices that have this effect of propagating waves into space/time which can be heard, felt, seen, and perceived in the mind. These are ripples and vortexes in the “mind-space” of reality itself.

As well, there are brain to machine neural interfaces which operate to activate the psychological perceptual changes and explore the subconscious in an aware state. This is used to test and probe the mind in order to bring forth the trauma, the selves, the memories, the reactions and the individual then must come to terms with what is produced.

This is essentially a “good-use” for the programming and healing technology. It is actually a different process with different technology, and programming is much simpler as far as technology. There are difficulties and challenges in the operative’s role in

programming and directly influencing and interacting with the target. As well the standby team for deprogramming and the revelation of trauma and altered, artificial personalities goes through a lot. But the use of the advanced technology in this way is a pattern of experiences and unveiling of the spiritual and mental bodies which serves to reverse programming.

Dreams, Technology and Inner-Space Travels

There are inner space travels which relate to soul journeying or visions.

This is when the mind must cope with what is seen in the imagination. It is as if when we dream we are looking into the world of the mind and from this we experience many situations that are often deviations from experiences we have physically in waking life.

As a result of the dream state there is an expanded quality which equates to various strange situations that we wouldn't normally experience with various relationships between concepts or goals that are often reflective or symbolic of ideals and archetypes we experience in life. This is how the subconscious is is witnessed by the mind. This is how information travels, being connected to many times, experiences, memories, places at once, and relates to the one experience of this life experience now (the physical experiences). Through these symbols information is tied together and collective into metaphors which convey deeper knowledge.

The dreams we have are often only a simulation of waking life, and this is due to the dreamer dreaming in a way that produces only a glimpse of the true reality.

In theory, there are no true shapes or forms in the dream-world because this is contained within the mind or even the spirit as a spiritual experience by definition. So then, what guides the various shapes, forms, realities, memories and experiences into being, when we dream? One might say it is the physical experiences but this is incomplete. It is the level of awareness we presume while in the dream-state, disconnected from the physical anchor, that determines the layer of mind and spirit we will be accessing through those dream-visions.

A person who is completely aware in the dream state will reach the level of self-awareness of the dream itself. We are normally simply aware of the dream, if we continue to increase awareness we become aware of the self, in the moment, and this creates a self-awareness feedback loop. The dream becomes a lucid experience of consciousness.

Awareness Feedback Device

In describing this, I realize how fantastically similar to certain devices and processes, that can be achieved using advanced technology, allow the conscious mind to peer into the subconscious and unconscious. This is described through widely accepted Freudian theory of psychology known as psychoanalysis. There are other schools of knowledge from tribal beliefs involving all pervasive 'living energy', to eternal and temporary minds, to the study of 'chi', the meridians, dream-journeying or chaser. The knowledge of the mind and spirit is found everywhere.

These devices used feedback loops to enhance the acceleration of the same cycles of consciousness that induce self-awareness within a dream. The mind becoming aware of itself. This produces a profound effect to the degree where the highest levels of experience become a sacred eternal pattern in which the mind constructs the physical world by organizing perception.

This is the same general concept as an isolation tank yet the outcome and method is more precise. The technology specifically shuts out all other input and exposes the brain to its own feedback loop much like when a camera records it's own output on a TV monitor and creates a hallway of simulated "reverse" mirrors and screens stretching into infinity.

Oneness, Higher Being, Completion, Eternity

The real experiences are found not from the corruption but from the research and exploration operations that were designed to find the truth of our existence. "God" is not only an energy-force but an incarnate being known as the "Hue-Man" and any being for that matter that can simply come to know itself as the Universe. The Human that contains self-awareness rising to high-awareness comes to know the self, the body, the mind as the Universe. The Universe is both within the body as the body itself, as well as the operating force of the Mind itself. Everything is a balance between masculine and feminine features, light and dark, hard and soft. There is no true complete correlation yet the holographic ontology we persist in can lead to further and further adventures towards completion and representation of the "whole picture".

The Holographic Reality

The leads into the next phase of knowledge. The holographic nature of reality may be only one facet of a much larger continuum of consciousness. The perception of time may be related to phase-locking with each other's consciousness and all perceptions may be a variance in the collective phase-locked field which is really the source of variations in reality.

Veiled Awareness, Hidden Knowledge, Eternal Time, Layers of Programming and Control

The interesting notions here are that the programming of the veils goes beyond what kind of situations are found in the bases. However, they do go right up to it. It would seem Humanity was previously programmed on a civilization-wide level through some kind of great "falls" of consciousness, from a high spiritual awareness to a low spiritual awareness into duality-consciousness regarding existence, life, death, mind and matter.

The Great Catastrophes

From these great 'catastrophes' the civilizations of Earth grew denser and denser in nature and actually became what we have today. The concept is that when these

vibrations of the mind and body are increased, we actually see a transcendence of the physical realm and preconceived notions of boundaries. It is as if the quantum doorways to all the atoms open up and a new space is presented, but was always there and in connection as the source of all the influences and effects we perceive ‘out here’ from this slower, denser, more boundary driven perspective.

I was brought into the Time Program

I was brought into the time program. You create any reality you imagine. You are literally a powerful reality generation system and your heart and mind are scalar energetic guides for this process. Without guidance and control there is imbalance and imbalance can destroy. This is the nature of all minds and hearts, this is the challenge for humanity to create something beneficial for themselves and the whole to actually know themselves instead of being a pawn or result of someone else’s selfish intentions.

The Effects of Temporal Manipulation

Temporal Influence

When a civilization reaches the level of technological advancement that allows for remote temporal viewing and transtemporal travel what will happen is that the information of the future begins to integrate into the past.

This is why we have all these ancient mystical schools of knowledge that studied time, space, and consciousness in ways that are only just now being publicly confirmed by scientists.

Simultaneous Interaction and Incorporation

The operations that dealt with moving to the past instantly created a simultaneity of interactions and historic events which correspond with that operation.

Due to the nature of time travel which equates to consciousness travel when a person is consciously sent backwards through history they physically experience life from the viewpoint of their genetic imprint in that point in history.

Retro-Causality

What this equates to is that simultaneously that person’s experiences become the part of history that was already present when they left this time.

Essentially, when a person returns their experiences become a part of history that already existed when they left.

Quantum Holography

These are the parallel and possible realities that exist in a quantum superimposed state and can be accessed through advanced technology or a spiritual adept. Often a

spiritual adept is utilized along with the advanced technology to operate in and out of possible realities. The mind must be trained otherwise the result is a fracturing of the personality from the root reality into many sub-sets of identities and data streams.

Love is the quantum link that connects all DNA super-computing consciousness. That is, DNA is influenced by intense emotions and this can be reproduces and is what also generates unpredictability in the surface level.

Time Paradox

Time paradoxes are something that one must learn to organize and solve otherwise there will be no way.

The paradox has been solved, the remaining motion is for everyone to acknowledge this and integrate into the reality behind the most conscious aspects of the brain.

What can travel through 4D and 5D space does not make sense in 3D space. So there is a possibility that some of humanity traveled through higher-dimensional space in order to re-seed a ‘distant’ Earth where no life was yet born.

What if it was then concluded that the distant Earth wasn’t distant in space, but in time and was the same Earth that the human scientists left from long ago.

Every civilization that reached the point of re-seeding would have to go through the loop and watch the whole thing start all over again.

Breakaway Civilization

This is an entire breakaway civilization that uses very advanced technology to dominate the world.

I was part of a genetic engineering program that sought to combine various elements of DNA from various sources in order to create a more easily controlled yet powerful and defined person and personality. This involves chemicals, advanced (relatively) scalar wave technology, ritual trauma and programming/mind-control, and many other aspects of conditioning, training, secret operations, physical enhancements, cognitive enhancements, virtual reality, off-world operations, temporal manipulation, spiritual and etheric training or conditioning or programming.

There is self-destruct programming which all ‘operatives’ are programmed with for self-preservation of the military command. The self-destruct programming is designed to take all the aggression one feels building up inside and willing them to escape, and causes this aggression to be turned against the self. That is self-destruct programming.

Most operatives are still under a hypnosis kind of trance which permits one to walk around in public and daily life as if none of this ever happened. Later that week, that same individual could be called for an operation and they would never remember it unless they were forced to kill someone in public out of self-defense in which case most operatives automatically unlock and become unstable due to the flashbacks.

Underground Cities

The combination of advanced technology with secret societies enabled the development of complete breakaway civilizations. One of these civilizations, possibly composed of many factions working in the same area, exists deep underground.

These separate bases are connected via high speed magnetic drive pods. The inhabitants often utilize energy healing devices, as well as perception enhancements and this often leads to a completely different outlook towards the surface civilization.

Technological Advancement

During WWII developments were made involving electrical generators. This sounds vague and there were many other details regarding the scientific knowledge, yet the idea is that very simply electromagnetic, non-Hertzian “Teslian” energy fields were discovered to have been responsible for propagating energy and consciousness in dimensions that were not previously observed. Everything from DNA, consciousness, hidden or regularly unobservable natural phenomena, time, even mass could be seen to exist as part of this hidden, latent, scalar-wave frequency as a pattern is found everywhere.

If one could determine the particular pattern of frequency and location then this can be replicated and anything can be influenced using these non-Hertzian generators.

Radio-frequency alone was developed intensively during the 60’s and 70’s in America and this was discovered to interact with consciousness to influence emotions, cognitive capacity, memory, cognitive function, biological function, health, pain, comfort, pleasure, and all forms of brain-activity.

After the knowledge of advanced technology and the occult sciences of all parts of the world was combined, the ability to target and interact directly with the human soul was refined. This was a mix of psychological tactics used to manipulate or expose the hidden psyche and technology that could manipulate memory, emotional states, wakefulness, and even dreams.

What resulted was scalar technology that could not only influence a person to take on a particular role or response, but technology that could actually put a person to sleep and locate their consciousness to contain it and transport it to a new location.

World-Wide Control Systems

In order to ensure continuity, maintain control, and shape world events these technologies were employed to manipulate the public, alter the weather and natural phenomena, and develop a means of travel and operation that enable one to move outside of the ‘plane’ of the Earth. This is includes high velocity transportation, as well as spacial-temporal distortions which could effectively “hide” one’s entire craft from visible sight. Space itself was altered to ‘shield’ craft with an a layer of ions to bend the light, or the phase was moved out of sync with the “time” frequency of any observer and this literally renders the craft immaterial.

Solar Warden

Solar Warden is a hyperspace-faring race of human beings who utilize cloning and holographic genetic recording/storage in order to protect their race and protect the Earth in this current situation where there are more than one factions using this technology. They are unable to inform the human public because they are in a similar 'Mexican standoff' situation that we are mostly all in. If they show themselves to the public, the public will be shocked. If they public does not know this situation, that there are multiple factions fighting for control over humanity, then they will not know who to trust. In that situation, the 'other factions' will surely show themselves in an attempt to trick and gather as much human genetic material as possible.

The only way forward to the future is to share the truth about Solar Warden, the space-faring fleet of humans who do no contains the mental and physical illnesses that are currently tearing our planet in two. I believe Solar Warden saved my life as a child during more than one event where I would've been entirely maimed/paralyzed or simply dead on the spot as a result of other faction interference. I was in the bases as a child and was trained as an operative for MILABS a secret division of human space-military. The military has been preparing for the future by testing for various flaws and potential uses of cloning and genetic engineering.

Team Light and Team Dark Non-Interference Agreement

Team light and team dark agreed to a non-interference on ground level rule in order to determine how history would play out. Think about it. You have two groups of people, both with immortality, zero-point tech, virtually infinite energy and power with two opposing directives. How do you get to the future? It was decided by elders of each group that there would be no point in fighting an all-out overt war, this would likely destroy the population as much as it would destroy the Earth. As well, the elders of the elders which no body knows would likely have a problem with these groups going at it in such a way so as to change the flow of the planet for every individual thereafter. So it was decided that there would be a "non-interference" agreement for the surface population. Anywhere other than the surface, one can interact with the current population.

All Contact Must Be Initiated On an Individual Basis

On the surface everything that is generated must be done so through living channels in the population and the civilization must be preserved in its level of technological advancement. No overt motions would be used unless an absolute necessity or the majority of the civilian population had naturally come to the awareness of these possibilities. Doing so before this was met would undoubtedly and permanently change the civilization forever.

So what began as a collective motion towards higher awareness became a series of advancements and set-backs all taking place within a short amount of time. This represents the actions and operations of either side effectively helping humanity along it's path or setting people back with orchestrated events such as the suppression of

ancient knowledge, the manipulation of the education or other systems, or the generation of war and prison for profit based on the previous alterations of the education or other systems.

So team dark used its power to help turn society in a warlock ruled prison and indoctrination system of absurdity and scarcity. Team light used their power to help awaken those in need and protect those who's actions are beneficial in the overall plan to save mankind from itself. Team light essentially buffers and shields the population from the operations of team dark.

Team light follows a non-interference agreement while team dark merely pretends to do so as much as is necessary not initiate war.

A Singularity of Change and Awareness

Neither side wants an all out war. This would reduce the dark faction's chances of gaining a majority negative harvest because their motives and presence would be instantly revealed. Team light would also have to show themselves and again step in which is not a pattern of learning that prepares people for the experience of the self and the truth in the Universe.

Both sides know people have to accept the path they can offer them and cannot force anyone into it. They also know that the more this goes on the more likely people are to collectively awaken to the reality of what is happening. It is like an eventual singularity of increased awareness.

The motions we see today are the results of many people coming into awareness at this time on the surface in order to initiate a harmonic alignment as well as to investigate the ongoing crimes against Humanity.

As a result of this, both teams know that the likelihood of collective shift and spiritual awareness is becoming more and more real.

Many events are being allowed because they are representing the eventual shift towards the one end of the polarity from the other which is felt as a shock to society, and this is used to propel society forward through whatever means necessary.

Either people will see what's happening and agree that we've been in a feedback cycle of negativity for the entire age of existence this civilization is aware of, and then we will shift into the real. Or people will claim that this is how things are supposed to work and instead of realizing everything is controlled in a deception based system, they see this and attempt to use the deception based system to gain more collective awareness. If this occurs by the majority then it will be seen as an "acceptance" to initiate a plan that will generate the overt perception of a deception and oppression system. This will surely shock the collective into realizing where they are.

If the majority comes to awareness of this deception based system then the shift moves from the end of the age of deception and external power into the age of internal awareness and harmony.

Advanced Technology and Ancient Knowledge

The plan is to slowly release advanced technology which will undoubtedly connect with and increase the awareness of ancient knowledge. Such technology nullifies the problems that the planet is currently plagued with, although without a developed sense of the spiritual self the technology becomes destructive.

Cloning, Atmospheric Civilizations, Genetic Stability

Here is something that most people might not have contemplated yet is possibly one of the most important factors at play here.

The vehicles that house the breakaway Human society are entirely environmentally controlled. This means that the air and surfaces are clean of all the viruses, bacteria, or pathogens that are numerous on the surface of the Earth.

This creates a specific difficulty in the situation. Any contact between surface Humanity is so heavily and carefully controlled that regulations go beyond any situations we have present on Earth. If the safety and cleanliness of any of the society's vehicles were compromised this would endanger everyone "on board".

So this explains a very precarious and specific situation we currently face and this is not so different than "first-world" nations contacting indigenous tribes and similarly endangering their society. Everything that happens will be according to a carefully controlled plan.

Training, Simulations and Learning

Part of what went on in the underground base experiments were to design "tests" or "labyrinths" with various people, props, traps, and treacherous situations that were to be navigated and escaped from.

Feedback loops with the brain, consciousness, and environment can create a very complex and integrated learning experience that is customized to each individual learner.

What this would do is create an individual that was capable of learning faster and faster and processing information in a more efficient manner.

This is not the same as specifically trauma-generating situations.

Cloning and Cerebrally Enhanced Soldiers – MILABS

This includes experiments, condition, trauma-based mind control, enhancement, memory suppression and operations that cover a span of space and time.

The NAZI faction has used cloning and genetic engineering to create hybrids, soldiers and everything in between. Religious/spiritual icons, to slaves, to leaders and even robotoids of sorts.

Your genetics BELONG TO YOU as the LIVING(ETERNAL) SELF. These issues are going to come more and more apparent.

If they agree to allow cloning, then who says who is allowed to clone whoever they want, Einstein, for example. And then who permits who to get DNA from history or objects in the world. These issues are going to have to be looked at because they have already been used in ways that are far beyond the basics.

Then what about consent of the masses? This is clearly being put in public because consent is required on an overall scale and individual to include people.

So what if the masses consent overall, would the people who choose to remain be at risk? Would Tribal and Native village life and people who respect the Earth be protected or permitted to stay?

Psychological Testing

These scenarios can also be generated to create specific situations that will contain tests or elements of temptation that will probe the person's psyche for weakness.

Hallucinatory Holographic Mind Probing Technology

Through the neural-interface technology the minds of many individuals can sync together to experience the same virtual simulation. Thus a single individual's mind can be selected for input and the environment will be a construct of their mental activity. The others present will be able to interact with and explore that environment like the person's mind.

Various training scenarios were utilized to enhance the resistance (or lack which) of the mind to intrusion and subversion. These were harsh but allowed the individual to completely control the energy flow in the conscious mind while remaining in harmony with the subconscious.

In a strange yet perfectly reasonable way, the conscious mind acts as the central "self" in that environment, while the subconscious mind becomes the "background" elements of objects and settings, actors and intentions within the flow of the "scene" itself. So a kind of movie begins with drawn out characteristics and perceptions that match that of a highly cinematic movie or intense dream.

The brain is naturally naive to stimulation and if allowed will liken the event to a dream in which the suspense of attention or lack of lucid self-awareness is "acceptable".

The truth may be worse than what you're thinking as far as training simulators and mind hacking devices. The truth may be that the human mind is inherently lucid and self-aware and that it is external influences that cloud the mind into what we consider 'regular' dreaming and 'regular' waking life. It may be that the conscious mind has a much greater access to information through the subconscious mind which is largely covered up and ignored in a rigidly physical and ego-focused society. As well, it may be that dreams are meant to become lucid and that we are often the subject of mystery in

other realms that often refer to humans as ‘sleepwalkers’ that don’t know their dreams are real.

Virtual Simulator Training Scenarios

These scenarios can be entirely holographically generated to produce a visceral 3.5 dimensional experience which can be used for training or psychological testing.

Combat Simulators

The name is self-explanatory enough. Situations can be generated which are indistinguishable from the real events. The entire neuronal map of the brain (connectome) can be created and this is by machines to mimic the brain. After calibration through sensory feedback experiences, the sensation of the simulated realm is 100% the same as the neuronal impulses that are detected by the physical brain. An adept souled being can always tell there is a slight difference, but once the machines are calibrated the physical sensation is generally the same while in the machine.

These environments and scenarios can mimic any combat situation to determine accuracy, integrity, endurance, skill, and all areas of aptitude of an operative without the risk of injury or the lack of real-time effect.

Conditioning

As was explained in other sections, these same systems can be used to remove fear of certain scenarios. They can be used for programming the mind. They can be used to train one to complete a task over and over until they can recreate that action extremely quickly in real-time. These devices can be accelerated to operate within a fraction of the time yet to cover training and conditioning that would normally take place over hours, days, weeks, to months.

Programming and Resistance to Psychological Trauma

Through the development of specifically customized scenarios and neural feedback systems trauma can be brought to the surface or specific fears and traumas can be neutralized. This is essentially “facing fear” but in a completely generated environment that will be just as real as the real thing. One can literally face any fear, any trauma, any kind of difficulty and these systems can be utilized to accelerate a process that would normally take weeks to months or years and individuals can be strengthened to their maximal capabilities.

Accelerated Mental Functioning

Some of the technological systems were designed to test the enhanced functioning of an accelerated brain.

The mind can be seen as the energetic component of the physical brain. The physical brain projects consciousness via the electro-chemical processes.

Technology, Accelerated Learning and Repair

Technology has been developed for assisted learning and accelerated repair of tissues.

On Orgone Energy

Orgone devices produce a scattered signal which disrupts the ‘negative’ energy fields. At least this is what I’ve been told.

Apparently if built correctly it will either disrupt the negative emf/harmonics or it will produce positive harmonics, IE: Orgone energy. Orgone energy is the raw energy of life, while dead orgone, DOR, is the lack of orgone energy and can be “found” (the lack of orgone) in thunder storms and illness or depression.

This is exactly what I was told. We are generators for the same energy, and with the correct principles of energy and internal knowledge combined we can produce those very effects at will.

The energy of the mind creates a central vortex within the body. When the frequency pattern emission is consistent with fractal congruence, then that holographic printing of energy can be expanded or shrunk infinitesimally and it will retain the original fractal configuration.

This is what enables transference of awareness between fundamental harmonic layers of the Universe. When one’s consciousness energy pattern is balanced and tuned to itself so that all proportions can be shrunk through a vortex and expanded on the other side, then the personality or self-awareness remains true. This is as if the space/time must turn inside out and only when there is fractal relative polarity in time does the ‘shape’ of the consciousness within the DNA, work both ways folding and unfolding to represent the same mirror image. This is also symmetry in time as far as an ability to reverse the perception and still retain some kind of connection forward and backwards.

Energy Generators and Serums

Generators which produce vibrations that influence the cells to heal at an accelerated rate, combined with serums that enable the fuel for chemical reactions can instantaneously repair tissues.

I couldn’t believe what I was seeing at first, thinking it was a trick. There are serums and energy devices that can influence the healing and general health of the body and even mind.

These devices use energies which extend beyond the physical and are often compared to electromagnetic waves combined with ultrasonic or low to mid frequency tones. These produce harmony on a level that directly interacts with the biological functioning of the body’s cells.

I feel that this technology utilizes the same energy that is emitted from the mind and it is as if the device is “speaking” to the cells in the same kind of universal language of electromagnetic pulses, tones and vibrations.

There is information on energy devices and the use of light therapy in physical therapy today. More is being learned about the power of light and vibrations to influence the mind and body.

Genetic and Cybernetic Enhancements

Certain individuals are also genetically and technologically modified to produce a kind of hybrid human that can heal at a spontaneous rate as well as operate at a much higher rate of speed and efficiency than a regular person. Serums to induce muscle growth and mental acuity are applied, but the main condition is the enhancement of certain features through the alteration of the RNA aspect of the genes.

These features are combined with tech-assisted metabolism and certain biological functions can be enhanced or controlled via a supercomputer. These are the 'brain-chip' interfaces which operate to function as a governor for the mind. When the mind becomes too amped up to focus on the details the faster than thought computer system organizes the input into more usable information streams. When the mind is too slow to see the necessary patterns and variables to accomplish the goal, the brainchip operates in a self-preservation fashion and links together information streams to highlight the most viable possibilities.

Such technology is not without warning, much of this is being used heavily in the military field and this has given rise to entire factions of enhanced cybernetic soldiers. Although this is something to know, there are also many other uses for this technology and it is used by people who want to explore the technologically assisted path.

There are many other aspects of this to discuss, or at least a few important ones that will have to be understood to know the greater truth about what is happening on the planet.

Developing The Self

The issues we face are to help us learn about our selves and better mediate the known and unknown aspects of personality. The more we focus on realizing the unknown aspects of personality the less we are seemingly controlled and forced to experience the undesirable aspects of existence. The more we cling to just what we know and what we feel comfortable with the more shocked we are when we inevitably discover the truth of the whole of our existence which is *always* at least one half more than just what we know and are comfortable with. That is the nature of the universe, we can only achieve one half of the equation at any given moment. Once we complete that seemingly whole view of the universe, the information we gain access to instantly doubles and we realize that we were only looking at one portion at a time, just one half of the equation. Then the rest of the equation comes into the picture and we must expand our view once again. This is because we are viewing ourselves as we discover the universe because we are creating what there is to be discovered through the act of exploration in itself. We are the explorer, the explored, the creation and the discovery simultaneously.

Multiple Factions of Space-Fleets, Multiple Goals

Now there are what are called ‘factions’ of groups that have different agendas and interact with the public or surface level population differently. That is one of the main issues. These departments and factions are no longer limited to the surface level of existence and have access advanced technological capacity and knowledge of a larger view of time and a more complete understanding of consciousness and the human existence.

Large-Scale Catastrophes or Series of Meltdowns

I was informed that while they work continuously to prevent and reposition this civilization continually outside of the reach of any large scale meltdowns that the technology is commonly accepted to only be a temporary barrier between the inevitable.

Unsustainable

This society is unsustainable and must either change or will experience the massive catastrophic evens that are foreseen.

There are multiple perspectives that are maintained. They vary by the way of the methodology of solving the problem. All agree that change must occur and is impossible

to postpone forever. The future society is the result of our advancements and achievements. Regardless of how we get there, we must get their somehow.

Earth Changes

I was informed that these changes had been held off and would ultimately be allowed to take place to resolve the current situation. The changes can only be held off for so long, either that or the people performing this task would not be reasonably inclined to postpone these changes indefinitely.

The idea is to locate and secure the members of society who are fearless and capable of assisting in this transition and who hold key genetic elements as these individuals and groups are capable of ‘holding-space’ for the rest of civilization by literally containing the genetic precursors for all those other individuals.

I was informed that Earth changes would be the last event to take place, pretty much like icing on the cake.

This means there will be a lead up to these events.

Mass Consciousness

I was informed that the consciousness of humanity and every species is linked to the bio-etheric field of Earth. When the consciousness becomes too unstable to maintain a controlled society that this will initiate massive Earth changes. This could simply be instigated through advanced technology but I was informed that the advanced technology is

actually postponing this so as to allow people to prepare, to get the word out and avoid a complete loss of the human race.

Wars and Manipulation

Wars were described as a way the power groups had controlled humanity over long periods of time. These wars were used to distract and weaken the population and the power groups believed they were holding off a full scale invasion by suppressing the rising population.

Now the population is high enough that another war would be a final war and this is extremely dangerous for the entire civilization. There would be no need for another war to repeat this cycle because the technological achievements have been met and so essentially the ‘reseting’ of the civilization would not be required or possibly acceptable.

This is why war is to be avoided however people are very easy to manipulate through lower emotional and mental programming from media and social cues. People follow the herd and the herd is essentially still operating on animalistic parameters. There is a have coating of peace and humility but this is just a wax coating that quickly evaporates as soon as the pressure of mass unrest or scarcity is realized. Many simulators have explored these possibilities.

Financial Unrest (or reset)

The idea is that financial oppression is used before wars to distract and oppress the population. When people are busy looking for resources to survive, they are not focused on the larger picture. This is part of the ‘fight or flight’ response mechanism tied to lower brain complexes which are primarily activated to keep the masses in both a highly sensitive and unstable state of being while also keeping them easy to control.

If the civil unrest reaches a level where awareness continues to rise even though financial hardship is being implemented then the latter two options will not work. At that point artificial disasters can be produced as well as natural Earth changes which initiate a shift of the ages and of consciousness.

The paradox or maybe irony here is that the oppressive actions are used to both suppress human awareness up to a certain point and simultaneously to stimulate and arouse the human spirit into wakefulness and self-empowerment. This is part of the reasoning regarding why these control systems are allowed.

Some say the elite don't want an economic collapse. That it would ruin everything. Others say it would be icing on the cake. Some say that it is a zero-point world that will save us. That the Fukushima is a big problem. Zero-point field tech, that is. Generators and energy sources, healing and terraforming. I know we project right? We see it in our own lives. So we can project with each other and grow that as a group and that part of the world will exist in that light. Which sounds Biblical, which may be because they're following prophecy. But it may also mean that we have a light, a chance, a real salvation, but that we have to grow that here and help develop it. To pass it on like love and such.

That's apparently what it comes down to. That these cycles happen every so often and we're in the midst of one right now.

Let's make it count. Every day, thought moment. With mindfulness, intention and awareness in action. Life is literally higher dimensional, so we have to become multidimensional to really face it. Indeed, that is a good perspective on action and inner being. It's like a fractal, whatever we project inside that chest center, will project into our mind and the outside. But we have to be stabilized and grounded through the root first and then to get to the heart energy must pass through the sacral/sexual centers and continue upward.

Self-Responsibility

The main reasoning is self-responsibility. We are responsible for ourselves. The people are and so if they allow themselves to be tricked and prodded like animals while behaving for the part, then that is how their experience will play out.

Clones and Synthetics

One seemingly unfair aspect of this is that there is a larger portion of non-humans than there are humans and so these beings without the human spirit will be easily programmed to support and propagate the mind-control system and the oppression. Thus, if people follow the herd mentality then they will walk directly into the end-time scenarios yet it is the humans who will actually stand to lose. People must wake up to these tricks and this technology so that they can orient themselves with the reality of this situation while learning to strengthen themselves and adapt to the manipulative aspects of this control system.

Spiritual Power and Divine Truth

This is essentially all about spiritual power and humanity stepping into the power of the truth behind their existence.

Some say that humans are designed as slaves, but if this is so, then it is the power that humans contain within that is the ‘work’ that they are sought after for. This indicates that humans have great powers that others cannot achieve on their own, even if they are creator lords.

Thus, whether humans are modified or not, they have great power. If they are not modified to perform this role of an energy generator, then this is just a confusing mind-control game that has been pulled over the eyes of humanity and humans have always contained true internal spiritual power that allows them to exist without having to parasite and steal the energy and knowledge of others. Humans are reality generators , we can choose how we want to experience the universe and what kind of collective world we want to enjoy together. Once we step into this power, there is on greater force. No amount of non-human entities can change that as we are somehow intrinsically linked to the ether-space of this realm through the spiritual and physical aspects of our being. That is what is sought after and so those who do not have this manifestation power attempt to

utilize humans to create their own reality through this Earth situation. That is the basics of the ‘alien overlord’ system, whether humans in disguise, non-humans operating with alien intelligences, supercomputer systems, or spiritually degraded beings.

Most people are not ready to see themselves or the true nature of humanity. Reality is largely an illusion of the conscious mind. The hidden aspects are the other half of the equation and this is perceived by the shadow aspect of the personality and mind. We are only marginally aware unless that aspect has been unveiled and through this process the reality of the human soul can be actualized and realized.

I was informed there would be a period of two suns and multiple mirages around the world. People would believe they were peering into another dimension, floating cities, or some kind of city-ship craft.

Synthetic DNA, Synthetic Genetics

Through the previous described replicator devices synthetic DNA can be engineered. Thus, entire genetically engineered codons can be produced and form this created beings can arise. These are the hybrid beings that are performing many tasks underground and even on the surface. On the surface there are synthetic genetic create beings or genetically engineered beings that appear to be human but do not contain a human genome. There are also clones and replicants of humans. There are a variety of non-humanoid forms but these are largely kept underground. These are beings we often see in science fiction movies or shows.

Time as Mathematics, Series of Equations, a Programmable Storyline

When using the technology, time can be understood to be a series of programmable variables where one variable is centered within a series of parameters and from these possible variables within a parameter set a series of possible functions or outcomes can be process. Thus, these people can literally plug into a supercomputer system which operates based on this form of processing reality and through this they can observe all the possible realities that may connect to a present moment. This allows one to travel but this is not part of this section of the explanation.

What this allows one to do is know exactly what is going to happen and when. If a person is being interrogated, all that has to be done is the operative using the technology simply thinks of what they will say and intends to do it within 6 seconds. The machine will play out a future timescale regarding the input of that question or interrogative speech and then produce the possible results. If this doesn’t give the desired readout in the mind of the operative, they will refuse to go that route and think of another pathway. This repeats for a few seconds to a few minutes. Then the computer has found the pathway that is most like to yield a result. The operative simply steps forward, says ten words, the subject breaks immediately and tells them everything they want to know. This is obviously takes longer for most trained individuals, however that is how easily it would be to use this technology to produce an effect on a regular surface level human. They would have

no defense, no way of knowing how that individual could know so much or be so direct. This is how operatives dealing with certain power groups will operate in the surface level population and individuals always feel that these people know way more than they are leading on. That is because they are, they know more about you and your life experience than you do.

Chapter 2.3 Previewing Solutions

Neutralizing Polarization

The mental-emotional tendency to pick sides, to fight, or to basically join in the fray that is currently taking place is a kind of deception of polarization which enables the leeching of emotional and mental energy from the human. This is more of a psychological unveiling where the true nature of the self, the duality game and the transcendent source aspects can be made visible to the individual. The they will see how every polarization tactic is actually taking them out of their true source of power by pushing them off center emotionally and mentally. There are teams that are capable of enabling this process and assisting as humanity realizes that half of the problem is that the unchecked mind is one's own worst enemy.

Removing Etheric Implants

Technology can identify and isolate these foreign body implants which are etheric technological devices. These are literally frequency or phase-shifted devices which are invisible to this layer of physicality but are capable of being organized and attached to the etheric field of the human and will operate to siphon or limit energy on the etheric level. Of course, this is all technology of the vampiric created beings who parasite on the original Earth inhabitants to sustain their existence.

Clearing Astral Body

By moving through the temporal body etheric implants can be deactivated and removed and then the astral or emotional body will be able to function closer to the original levels of presence and sensitivity. This body is manipulated when one is emotionally shut down from trauma. Thus this body can be scarred and will function at a much lesser level of activity or presence until the emotional damage is healed. This contains the memories of all the emotional events of a person's life.

There is technology that enables one to access these levels of frequency and clarify or untangle emotional chords or attachments which are used to siphon energy from the human being to the parasitic created beings. These chords are energetic in nature but also have technological components.

Knowing the True Self; Soul Actualization, Unveiling

This is a sacred, ancient process that has been outlined and discussed since the beginning of time. Humanity is here to learn, grow and express the self. In doing so, like a child moving through layers of infancy and into full-wakefulness of their body and the physical world, humanity can come into awareness of their true spiritual nature and the true spiritual nature of the universe. This is the process of soul or self-actualization that is described in some psychological methods such as Maslow's hierarchy of needs and the self-actualization that results in a complete fulfillment of all psychological needs. In this modern psychological view, self-actualization is described as the desire and process of reaching fulfillment of one's own natures and then living their life sharing that self-empowerment with other beings because after gaining your self that is the highest expression of such knowledge, sharing that power with others.

The true self is not limited to the physical body, the true self is a reflection of the entire universe and thus the primary original creative force. This is akin to the whole equation rather than just half of the equation. The visible aspect of the self, the conscious mind, is only one half of the entire equation. The whole equation consists of what we see visibly and consciously as well as what we are limited from seeing within the unconscious and subconscious mind. These are really two layers of the same ultimate source. Like an iceberg which is only partially above water, the subconscious mind is the proprietary wholeness of experience. The conscious mind is only a surface layer of reality while the unconscious mind carries all the notions, the multidimensional processes, the latent aspects of reality that we are not capable of seeing without unveiling these aspects through inner exploration.

Taking Responsibility

This entire show is about taking self-responsibility. Unless people begin to do this, there will be no hope. Right now people are convinced that their responsibilities belong to someone else even though this always results in pain and discomfort. To take responsibility is painful at first because we have a lot of work to do, but even then, this is beneficial because there is no way to remedy the pain and discomfort of being lied to and disrespected if people continue to hand their free-will over to others through blame (scapegoating), lower emotional bio-emissions (hatred, anger, etc), distractions and addictions (technological, sensual, and chemical or food based), or generally complaining without taking the first step towards providing something beneficial. This is the victim role, if humanity is to take control then they to help each other and themselves by not relying on false promises and false authorities to determine how they feel, think and live.

Returning To Center Emotionally and Mentally (spiritually)

Balanced food intake, rest, exercise, activity and learning are all continual requirements for a healthy existence. Emotional and creative expression nurtures the soul. Without these ways of being and learning the human qualities of experience diminish and creativity dwindles. There is most likely going to be a split between those who can sustain their own humanity and those who have to cause others to suffer to do so.

Vampires in the “Awake” Community

Contrary to popular belief, the majority of the non-humans are not necessarily vampiric and in power. The vampires are the people online who try to get a rise out of others for sharing their own experiences. They are the nosy neighbor that feels that the person who looks or acts differently must be considered and enemy and armed against because they feel themselves to be so much better. The majority of people are vampires, they believe that they must work for someone who will trade them money and that the amount of money they have based upon the amount of indirectly beneficial work they do puts them above others.

This is not different in the ‘awake’ community and in fact I feel that there are higher concentrations of vampires in this community, the alternate media because everything is largely a joke and a trick. People are operating on deceptive agenda schemes to divide the people and this is most intensely noticed when there is a realization of the truth behind what is happening and people begin to point fingers. The only people who are cleared to point fingers (and who also will NEVER point any fingers) are the operatives from the secret projects that have the capacity to do so because they have reached a specific level of awakening and this is related to the droning, cloning, and hybridization process. Only a specific few know who has been transformed into an impostor being and who is remaining strong and this is due being briefed on the surface level situation. Anyone can say what they want, they are simply playing into the tactics of mind-controllers and parasites and the more they play in the deeper the infection will grow. All the people pointing fingers now are actually implanted and vampiric and are attempting to drive a divide through humanity and they are the first who will turn on their friends and family when the going gets tough because they are more interested in others and starting drama than healing themselves. Ironically, this is all done under the guise of “healing” and “getting rid of the drama” AKA people they don’t trust. They pick and choose based on their own personal bias and this is a sure indication that they are emotionally and mentally out of alignment and are feeding deep seated personal fears from their own traumatic experiences.

These traumas must be healed and the harmonious center must be reattained where a person can focus on their own existence and waking up instead of acting as false-light, “king of tyranny” gatekeepers for others. Those individuals are going to be left behind if they cannot kick the habit because if they are allowed into any kind of healed society

they will quickly degrade into animals and attempt to restart a devolution process in order to gain the power they so desire but cannot produce on their own. ANYONE playing ego games of trying to hurt or put blame on ANYONE else contains this viral implant and has not kicked the virus.

Heart Center and Psycho-Spiritual Fulfillment (self-actualization)

Emotional connectivity is a form of telepathy, when loved ones can tell the state of another across space and time. Whether it is family or friend. In the 60's and a little before that the US found a specific frequency akin to a radio frequency that operates on a trinary spectrum. They called this the "telepathic wave". In time, they could completely read and send thought waves without frying the brain or body through radiation. Which was what the early machines did. They actually took satellite dishes and aimed them at people. Then realized they could turn it around and do it backwards with a better effect and minimal radiation. Either way they started beaming the base and then towns around them with waves between 400 and 432 MHz and caused waves of crime sprees or peace sprees throughout the 70's and 80's. So they can digitize the telepathic wave to induce artificial telepathy. But this is organically done through an entanglement through what we call love. Literally. The Germans found it before that. And the secret orders before them. And ancient Egypt before them. As humans we remain basically through the root, heart mind connection. When the heart overpowers the mind connection of spirit, then the body is a trinary whole. When the mind guides it is binary and cannot by guided by the spirit. The spirit has direct access to the heart. The mind is a computer of sorts. The mind doesn't see past duality. The heart is the true center/eye of the spirit. The reptilian brain is the dragon and when you tame the amygdala then fear is ‘behind’ you. When the mind is "untamed" the reptilian brain takes over. This is the lower brain and amygdala fight or flight response.

This happens when the energy of the brain, body and spirit increases due to whatever various reason of spontaneous or controlled increase. Because of the "temptations" which are the easiest flow of emotional energy into a "discharge" state, is that the sacral/sexual center ties to the heart and reroutes to replace the heart and control the mind. Mental and emotional contemplation of one's true purpose and nature is the path of the divine. We find ourselves simply by looking in the right place, not in the world, but in our self energetically. We are more powerful than the programming, and we can reverse this is we're careful and devoted enough.

We have to be faster than thought, at the speed of spirit, beyond matter. When we start thinking on this level then our influences spread to others throughout the sphere. It is our destiny to know these things but they have been kept from us. The ancient orders called this the art of "implosion". Traveling realities through intense contemplation and a usage of sacred geometrical forms.

They developed and combined orders around WW2 and developed zero-point energy tech that can alter space/time fields. This is timeline manipulation. But as a rule, we go where our heart leads us. So that's how this is solved.

Go Within to Observer the Self

The answer is literally by looking within to find the great truth rather than looking around us. Everything we need to know is within us, energetically and spiritually. Our emotional, mental and physical state of balance is an indication of where and how we exist in relation to the larger overall truth. Everything that happens around us to distract us is designed to stop us from looking within. Nothing can truly stop us, nothing can actually input the holographic horrors in our spiritual center but simply perturb the brain and body. The mind is a non-holographic spiritual environment that cannot be excessed and the invader's goal is to convince people to use their imagination or their creative powers to produce these horrors on their own. This is through the programming. We must clear out the programming, the trauma, the lower-dimensional constructs and fill ourselves with the truth and spiritual presence that enables us to be self-aware in the first place. If we aren't doing this, then we are either in pain, or there is no spiritual presence to be in pain. If we are doing this, we are either clearing out the constructs by replacing them with true spiritual presence and self-awareness or we are becoming aware of them.

Organic Feedback Loop

The great feat is mentally bridging the great rift between us by looking within. Which is paradoxical.

We can never see what another is perceiving exactly, well for the most part, so we all have to kind of accept that we are communicating effectively and truly get to this level of comfort by simply being secure in knowing who we are our selves.

Technological Feedback Loop

So then knowledge, in a way, when shared, is a form of telepathy. Group telepathy.

Group think, when ideas or memes spread, is a form of group telepathy.

The Internet is like artificial spreading of telepathy. This means what is normally mentally bound signals can be initiated and spread through a digital medium.

Breaking Soul-Contracts

Ultimately everyone is under a series of "veils" which are energetic time-constraints literally like 9 dimensional layers of temporal restriction which are each bounded and ruled over by invader beings. These range from physical authorities, to astral entities, to programmable matter, to supercomputer intelligences, to spiritual false-light beings and our own shadow mind. Each layer of reality is successively guarded by these beings who are here acting as gatekeepers designed to push people back when they begin to wake up. These beings all work through fear and deception and the last layer is based on mirroring our own energies back to us like an impostor. All the levels tend to imitate, how-

ever the last layer is a near perfect imitation of our own energy to the point where people often switch places with this being before getting out of the matrix. There will be more discussed on this in a later section.

The “9 veils” were designed by impostor beings as a last effort to stop humans from escaping the false-light matrix which is essentially the holographic universe. This is literally like a maze which reproduces a new pathway and a new doorway each time a person nears the last hallway or doorway that is next to the exit. So one eventually has to project themselves into the exit using their whole being and moving past and through the tricks by not falling for them before they are placed. This is highly confusing but this is essentially a kind of labyrinth that has been created to stop people from leaving so that their soul energy can be destroyed and used as a generator for the false-light system which is an AI over mind that is programmed to take the raw soul energy and destroy the identity by inverting the electromagnetic spectrum and incorporating that inverted energy into its own internal matrix body which is literally the false-light universe.

Help Everyone

Now they may have been setting us all up for the apocalypse. They said they want us to tell on them and get the whole world aware of what they've been doing So that we can stop them and pull them from the dark which is ACTUALLY taking their souls. There are also breakaway civilizations involved in this entirely zero-point/free-energy.

Chapter 2.4 How Timelines Collapse

Repeating Cycles of Time

Because of the way time works and the ability of those using these temporal devices they have set up an elaborate labyrinth like a spider web of false realities, timelines, parallels, sub-dimensional layers, astral cages, temporal dead-ends, and time loops which act to stop people from reaching the true reality. As a result, many portions of this timeline are literally in a free-will ‘time-loop’ and these loops must be canceled out. As well, because of the nature of these loops on the overall stream, our entire civilization has been looping for the past 6 time-cycles meaning we have reached this time in history 6 times before and this is apparently the last time because we have never gotten this far before and the events of the future are having to be programmed in manually at this point.

Beings From the Future

As are result and damaging time, what happens is that the beings from the possible future that is being damaged appear to try to heal the break as well as those who are from the new possible future that is generated, this results in a time war between both possible realities for the present realm. This is what has been happening for thousands of years. All the ancient spiritual texts are describing this system. One group is a from an original possible future where everything is based on the presence of spirit and souled

humans, another is from the new possible future where an AI overlord took over and removed the souls and spiritual energy from all entities on Earth rendering this a holographic prison without any other use. That reality dissolves into itself and so the time beings are constantly moving backwards and jumping timelines to try and obtain more energy.

Beings From Collapsed Timelines

The beings from the collapsed timelines are those who travel through hyperspace to get here. They then recreate themselves using cloning technology through hyperspacial means, IE: creating an alternate temporal dimension so that these devices can sustain them and literally “hold-space” for them. Then if their timeline is destroyed, they can still exist as a ‘loose-end’ in space-time. This is extremely dangerous and I will say we have some Human operatives jumping timelines searching for Earth and Humanity so that they can find a reprieve from this time war.

That is the most trying aspect of this entire ordeal for me. There are some human operatives literally in hyperspace without an opening into the temporal stream for them to reintegrate into this timeline. We must assist them, we must open the timeline by taking control of Earth from the invader races and those who wish to depress and isolate the spirited and souled human beings. We must re-organized and neutralize the invasion forces of deception and assist our humanity and maintaining their free-will, their self-awareness, their self-empowerment and their emotional, mental, and physical harmony.

Beings Who Would Never Have Existed in the First Place

As a result of this entire process, there are essentially beings who have been erased from time who degrade in this dimension and can only interact periodically. These are the created beings who operate through supercomputer forms that are placed within cloned bodies and powered by the transdimensional quantum supercomputers. These are the ‘parallel’ reality beings and this relates to the hive mind invasion. When all the original aspects of time are restored, these beings would not have ever existed in the first place as there is no quantum link for their probabilities to remain neutral and present in the original run of things.

Again, all beings who operate under the will of the universe, even when they are attempting to trick hyperspace and time, when these beings assist and help in the unification of sentient, spirited, souled beings they are capable of being healed. This is all because there is an original creative force which can produce souls that are eternal and everlasting, meaning they are not created but simply always ever were. Yet, there is a “miracle” effect where beings can be given eternal life. This is only by reflecting the will of the whole of existence, rather than a portion or a part because this is only temporary. Only the whole is forever and this takes true harmony, true balance and ultimately *self-lessness*. To give to others because you see them as worthy because they can be aware and

enjoy the gift is to be like the creative force that gives life to all and enables all experience in the first place. By acting in correspondence with this we reflect the will of the whole and that power and action transfers into protection and self-empowerment for ourselves. This cannot be cheated, tricked, or rerouted as that is the karma game that has been played by delaying time and rerouting energy through getting others to take on the responsibility for others bad actions. In the end, all karma has only been delayed because when the stops are pulled out, *everyone* ends up getting their karmic returns regardless. They simply intended to build up so much karma that by the time the ties are cut, the karma overload will simply kill them instantly. This never happens and they end up in the abyss, this is the final time so since there is no recycling of the universe from the oroboros system then whatever happens is what happens forever. If everyone wants to move into harmony, to receive healing, to receive forgiveness then they must assist in the creative force in healing, forgiving, and turning away from the deception, the cruelty, the vampiric actions.

Many vampires believe they will die if they stop. The only hope is to admit their ways to the others and ensure that there are enough beings around them that will protect them so that this situation can be handled properly, with due care, compassion, and the necessary healing to ensure the safety and protection of all who seek harmony.